IN THE DISTRICT COURT OF THE FOURTH JUDICIAL DISTRICT OF

THE STATE OF IDAHO, IN AND FOR THE COUNTY OF ADA

IDAHO CONSERVATION LEAGUE, a non-profit corporation, and SAVE THE SOUTH FORK SALMON, a non-profit corporation, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, and IDAHO BOARD OF ENVIRONMENTAL QUALITY, Respondents.	Case No. CV01-25-13306 Agency Case No. 0101-22-01 OAH Case No. 23-245-01

SETTLED AGENCY RECORD

Judicial Review from the Idaho Department of Environmental Quality
Idaho Board of Environmental Quality Presiding

RAÚL R. LABRADOR
Attorney General

SCOTT L. CAMPBELL
Deputy Attorney General
Chief, Energy and Natural Resources Division

Michael A. Short
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: (208)373-0494
michael.short@deq.idaho.gov

Attorneys for Department of Environmental Quality

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
Telephone: (208)334-4141
ann.yribar@ag.idaho.gov

Attorneys for Idaho Board of Environmental Quality

Bryan Hurlbutt
Andrew Hursh
ADVOCATES FOR THE WEST
P.O. Box 1612
Boise, Idaho 83701
Telephone: (208)342-7024
bhurlbutt@advocateswest.org
ahursh@advocateswest.org

Julia Thrower
MOUNTAIN TOP LAW PLLC
614 Thompson Ave.
McCall, Idaho 83638
Telephone: (208)271-6503
jthrower@mtntoplaw.com

Attorneys for Idaho Conservation League and Save the South Fork Salmon

CORRECTION TO AGENCY RECORD
SUMMARY | MAY 15, 2024

Agency record documents are stamped with sequential REC page numbers. Documents 095 through 105 were stamped with out-of-sequence page numbers resulting in duplicative REC numbers.

The agency record and Table of Contents have been corrected by adding the correct page numbers for documents 095 through 105 and identifying them as C-REC on the documents and in the Table of Contents. The out-of-sequence/duplicative numbers have also been retained on the documents and in the Table of Contents for future reference as the incorrect REC numbers may have been referred to and cited in documents filed between January 30, 2024, and May 9, 2024.

When referring to the corrected agency record documents for future filings, cite to C-REC page numbers.

TABLE OF CONTENTS

AGENCY RECORD
Prepared by the Department of Environmental Quality

In the Matter of Permit to Construct Issued to Perpetua Resources Idaho, Inc.
Agency Case No. 0101-22-01
OAH Case No. 23-245-01

Table of Contents		i - x
Index		x - xx
AGENCY RECORD		
001	Petition to Initiate Contested Case: Air Quality Permit to Construct P-2019.0047 (Jun. 17, 2022), July 22, 2022	REC 0001 - 0028
002	Notice of Filing and Service of Petition, July 22, 2022	REC 0029 - 0030
003	Notice of Appointment of Hearing Officer, July 28, 2022	REC 0031- 0032
004	Response to Petition to Initiate Contested Case: Air Permit to Construct P-2019.0047 (Jun. 17, 2022), August 12, 2022	REC 0033 - 0039
005	Petition to Intervene, August 12, 2022	REC 0040 - 0043
006	Order Approving Petition to Intervene, August 22, 2022	REC 0044 - 0045
007	Notice of Prehearing Conference, August 23, 2022	REC 0046 - 0048
008	Notice of Appearance, September 6, 2022	REC 0049 - 0051
009	Perpetua's Motion to Dismiss and Supporting Brief, September 6, 2022	REC 0052 - 0121
010	Notice of Joinder, September 12, 2022	REC 0122 - 0124
011	Petitioners' Opposition to Perpetua's Motion to Dismiss, September 20, 2022	REC 0125 - 0142
012	Prehearing Order, September 23, 2022	REC 0143 - 0146
013	Notice of Virtual Status Conference, September 27, 2022	REC 0147 - 0148
014	Order on Status Conference; Notice of Status Conference, October 14, 2022	REC 0149 - 0154
015	Order on Status Conference; Notice of Status Conference, October 28, 2022	REC 0155 - 1059

016	Order on Motion to Dismiss, November 15, 2022	REC 0160 - 0186
017	Order on Status Conference, November 30, 2022	REC 0187 - 0189
018	Motion to File First Amended Petition to Initiate Contested Case, December 6, 2022	REC 0190 - 0193
019	First Amended Petition to Initiate Contested Case, December 6, 2022	REC 0194 - 0223
020	Perpetua's Notice of Non-Opposition to Motion to File First Amended Petition to Initiate Contested Case, December 13, 2022	REC 0224 - 0226
021	Perpetua's Response to First Amended Petition to Initiate Contested Case, December 13, 2022	REC 0227 - 0243
022	Notice of Reassignment of Pending Matters, December 19, 2022	REC 0244 - 0248
023	Notice of Appointment of Hearing Officer, January 3, 2023	REC 0249 - 0254
024	Order Granting Motion to File First Amended Petition, January 6, 2023	REC 0255 - 0257
025	Notice of Status Conference, January 10, 2023	REC 0258 - 0262
026	First Amended Petition to Initiate Contested Case, January 11, 2023	REC 0263 - 0292
027	Joint Motion to Enter Stipulated Scheduling Order, January 13, 2023	REC 0293 - 0295
028	Response to First Amended Petition to Initiate Contested Case, January 17, 2023	REC 0296 - 0302
029	Scheduling Order, January 19, 2023	REC 0303 - 0306
030	Respondent's Motion to Extend Deadline for Discovery and Modify the Scheduling Order Dated January 19, 2023, February 9, 2023	REC 0307 - 0309
031	Order Granting Motion to Extend Deadline, February 13, 2023	REC 0310 - 0312
032	Respondent's Notice of Discovery Service, February 14, 2023	REC 0313 - 0315
033	Respondent's Notice of Discovery Service, February 21, 2023	REC 0316 - 0318
034	Petitioners' Motion for Summary Judgment, April 14, 2023	REC 0319 - 0322
035	Petitioners' Opening Brief in Support of Motion for Summary Judgment, April 14, 2023	REC 0323 - 0363

036	Declaration of Bryan Hurlbutt, April 14, 2023	REC 0364 - 1203
037	DEQ's Cross Motion for Summary Judgment, May 12, 2023	REC 1204 - 1206
038	DEQ's Response to Petitioners' Motion for Summary Judgment and Brief in Support of Cross Motion for Summary Judgment, May 12, 2023	REC 1207 - 1232
039	Declaration of Kevin Schilling, May 12, 2023	REC 1233 - 1255
040	Declaration of Mike Simon, May 12, 2023	REC 1256 - 1270
041	Declaration of Tiffany Floyd, May 12, 2023	REC 1271 - 1275
042	Intervenor-Respondent's Motion for Summary Judgment, May 12, 2023	REC 1276 - 1278
043	Memorandum in Support of Intervenor-Respondent's Motion for Summary Judgment and in Opposition to Petitioners' Motion for Summary Judgment, May 12, 2023	REC 1279 - 1336
044	Declaration of W. Christopher Pooser in Support of Intervenor-Respondent's Motion for Summary Judgment, May 12, 2023	REC 1337 - 2316
045	Petitioners' Response to DEQ's Cross-Motion for Summary Judgement and Intervenor Perpetua's Motion for Summary Judgment and Petitioner's Reply in Support of Petitioners' Motion for Summary Judgment, June 9, 2023	REC 2317 - 2371
046	Declaration of Allison Fowle, June 9, 2023	REC 2372 - 2377
047	Declaration of Drew Hollenback, June 9, 2023	REC 2378 - 2384
048	Declaration of Asa Menlove, June 9, 2023	REC 2385 - 2389
049	Declaration of Joseph Oatman, June 9, 2023	REC 2390 - 2394
050	Declaration of Jonathan Oppenheimer, June 9, 2023	REC 2395 - 2538
051	Declaration of Zak Sears, June 9, 2023	REC 2539 - 2547
052	Declaration of Emmit Taylor Jr., June 9, 2023	REC 2548 - 2554
053	Declaration of Julia Thrower, June 9, 2023	REC 2555 - 2985
054	Respondent's Non-Reply to Petitioners' Response, June 23, 2023	REC 2986 - 2988
055	Reply Memorandum in Support of Intervenor-Respondent Perpetua's Motion for Summary Judgment, June 23, 2023	REC 2989 - 3023

056	Declaration of Kevin Lewis in Support of Intervenor-Respondent Perpetua's Reply in Support of Motion for Summary Judgment, June 23, 2023	REC 3024 - 3028
057	Intervenor-Respondent Perpetua's Motion to Strike, June 23, 2023	REC 3029 - 3034
058	Notice of Status and Scheduling Conference, July 7, 2023	REC 3035 - 3039
059	Opposition to Perpetua's Motion to Strike Oppenheimer Declaration, July 7, 2023	REC 3040 - 3049
060	Petitioners' Motion to Strike Declaration of Kevin Lewis and Brief in Support, July 7, 2023	REC 3050 - 3055
061	Order and Notice from Status and Scheduling Conference, July 12, 2023	REC 3056 - 3058
062	Intervenor-Respondent's Reply in Support of Motion to Strike Oppenheimer Declaration, July 14, 2023	REC 3059 - 3064
063	Intervenor-Respondent's Opposition to Petitioners' Motion to Strike Declaration of Kevin Lewis, July 14, 2023	REC 3065 - 3072
064	Petitioners' Reply in Support of Motion to Strike Declaration of Kevin Lewis, July 20, 2023	REC 3073 - 3078
065	Order on Perpetua's Motion to Strike, July 31, 2023	REC 3079 - 3085
066	Order on Petitioners' Motion to Strike, July 31, 2023	REC 3086 - 3091
067	Notice Pursuant to IRAP 412, August 8, 2023	REC 3092 - 3096
068	Joint Motion in Limine to Exclude Communications from U.S. EPA Sent After Permit was Issued, August 28, 2023	REC 3097 - 3103
069	Joint Motion to Shorten Time and for Expedited Consideration, August 31, 2023	REC 3104 - 3107
070	Petitioners' Motion to Stay the Case and Brief in Support, September 1, 2023	REC 3108 - 3136
071	Petitioners' Motion to Supplement with August 10, 2023 EPA Letter and Brief in Support, September 1, 2023	REC 3137 - 3166
072	Scheduling Order on Motions Related to Recent EPA Letter, September 6, 2023	REC 3167 - 3171
073	Petitioners' Response in Opposition to Motion in Limine, September 8, 2023	REC 3172 - 3189

074	Petitioners' Motion to Amend Contested Case Petition, September 8, 2023	REC 3190 - 3235
075	Joint Opposition to Petitioners' Motion to Amend Contested Case Petition, September 11, 2023	REC 3236 - 3242
076	Joint Response in Opposition to Petitioners' Motion to Supplement with August 10, 2023 EPA Letter, September 11, 2023	REC 3243 - 3250
077	Joint Response in Opposition to Petitioners' Motion to Stay the Case, September 11, 2023	REC 3251 - 3258
078	Declaration of Tiffany Floyd Opposing the Motion to Stay, September 11, 2023	REC 3259 - 3264
079	Order on Motions Related to Recent EPA Letter, September 15, 2023	REC 3265 - 3274
080	Notice Regarding Summary Judgment Hearing, September 15, 2023	REC 3275 - 3279
081	Memorandum Decision on Motions for Summary Judgment and Preliminary Order, October 31, 2023	REC 3280 - 3328
082	Notice of Substitution of Counsel, November 2, 2023	REC 3329 - 3331
083	Joint Motion for Reconsideration and/or Clarification, November 10, 2023	REC 3332 - 3334
084	Memorandum in Support of Joint Motion for Reconsideration and/or Clarification, November 10, 2023	REC 3335 - 3341
085	Petition for Review of Preliminary Order, November 14, 2023	REC 3342 - 3356
086	Order on Post Preliminary Order Procedures, November 17, 2023	REC 3357 - 3360
087	Petitioners' Response to Joint Motion for Reconsideration and/or Clarification, November 20, 2023	REC 3361 - 3366
088	Order on Joint Motion for Reconsideration and/or Clarification, December 5, 2023	REC 3367 - 3371
089	Amended Memorandum Decision on Motions for Summary Judgment and Preliminary Order, December 5, 2023	REC 3372 - 3425
090	Amended Petition for Review of Preliminary Orders, December 15, 2023	REC 3426 - 3441

091	Certification and Transmittal of Agency Record and Transcript, December 15, 2023	REC 3442 - 3444
092	Notice of Briefing Schedule, December 27, 2023	REC 3445 - 3447
093	Notice of Oral Argument, January 9, 2024	REC 3448 - 3450
094	Petitioners' Opening Brief in Support of Amended Petition for Review of Preliminary Orders, January 17, 2024	REC 3451 - 3508
095	Amended Notice of Oral Argument, January 30, 2024	REC 3059 – 3061 C-REC 3509 - 3511
096	Respondent Idaho Department of Environmental Quality's Brief and Response to Petitioners' Opening Brief, February 7, 2024	REC 3062 – 3095 C-REC 3512 - 3545
097	Intervenor-Respondent's Brief in Opposition to Petitioners' Amended Petition for Review of Preliminary Orders, February 7, 2024	REC 3096 – 3152 C-REC 3546 - 3602
098	Joint Motion to Supplement Record with DEQ Response to EPA Letter, February 7, 2024	REC 3153 – 3159 C-REC 3603 - 3609
099	Declaration of Tiffany Floyd in Support of Joint Motion to Supplement Record with DEQ Response to EPA Letter, February 7, 2024	REC 3160 – 3196 C-REC 3610 - 3646
100	Petitioners' Reply Brief in Support of Amended Petition for Review of Preliminary Orders, February 14, 2024	REC 3197 – 3222 C-REC 3647 - 3672
101	Petitioners' Opposition to DEQ and Perpetua's Joint Motion to Supplement Record with DEQ Response to EPA Letter, February 21, 2024	REC 3223 – 3227 C-REC 3673 - 3677
102	Joint Motion to Supplement Record with March 12, 2024 EPA Letter, March 13, 2024	REC 3228 – 3232 C-REC 3678 - 3682
103	Declaration of Tiffany Floyd in Support of Joint Motion to Supplement Record with March 12, 2024 EPA Letter, March 13, 2024	REC 3233 – 3238 C-REC 3683 - 3688
104	Notice of Special Meeting of the Board of Environmental Quality | April 8, 2024, March 22, 2024	REC 3239 – 3241 C-REC 3689 - 3691
105	Notice of Special Meeting of the Board of Environmental Quality | May 1, 2024, March 22, 2024	REC 3242 – 3244 C-REC 3692 - 3694
106	Final Order, May 9, 2024	REC 3695 – 3720

107	Petitioners' Motion for Clarification and/or Reconsideration, May 23, 2024	REC 3721 - 3727
108	Joint Motion for Reconsideration and/or Clarification of Final Order, May 23, 2024	REC 3728 - 3730
109	Memorandum in Support of Joint Motion for Reconsideration and/or Clarification of Final Order, May 23, 2024	REC 3731 - 3751
110	Notice of Special Meeting of the Board of Environmental Quality | May 29, 2024, May 24, 2024	REC 3752 - 3753
111	Notice of Special Meeting of the Board of Environmental Quality | June 12, 2024, June 3, 2024	REC 3754 - 3756
112	Petitioners' Response Opposing DEQ/Perpetua's Motion for Reconsideration, June 3, 2024	REC 3757 - 3761
113	Declaration of William Tiedemann, June 3, 2024	REC 3762 - 3822
114	Joint Motion to Strike Petitioners' Response, June 4, 2024	REC 3823 - 3827
115	Notice of Appearance, June 5, 2024	REC 3828 - 3830
116	Petitioners' Response Opposing DEQ/Perpetua's Motion to Strike, June 7, 2024	REC 3831 - 3834
117	Order on Petitions for Reconsideration and/or Clarification of Final Order, June 12, 2024	REC 3835 – 3843
118	Notice of Status and Scheduling Conference; Updated Disclosure, June 24, 2024	REC 3844 - 3848
119	Idaho Department of Environmental Quality's Initial Status Report, July 1, 2024	REC 3849 - 3854
120	Intervenor-Respondent's Status Report, July 1, 2024	REC 3855 - 3860
121	Petitioners' Status Report, July 1, 2024	REC 3861 - 3866
122	Scheduling Order, July 8, 2024	REC 3867 - 3872

123	Expert Declaration of Norka E. Paden, Ph.D., August 13, 2024	REC 3873 - 3916
124	Expert Declaration of Kevin Schilling, August 13, 2024	REC 3917 - 4122
125	Notice of Appearance, August 29, 2024	REC 4123 - 4125
126	Notice of Expert Declarations, August 30, 2024	REC 4126 - 4128
127	Expert Declaration of Kevin Lewis, August 30, 2024	REC 4129 - 4276
128	Expert Declaration of Theresa Lopez, August 30, 2024	REC 4277 - 4318
129	Documents identified in Expert Declaration of Theresa Lopez, Attachment A of Memorandum in Support of Declaration, August 30, 2024	REC 4319 - 6009
130	Notice Re: Declaration of Norka E. Paden, Ph.D., September 10, 2024	REC 6010 - 6039
131	Letter to Hearing Officer Lawrence Re Perpetua Resources Idaho, Inc. Expert Declarations, September 11, 2024	REC 6040
132	Amended Scheduling Order, September 17, 2024	REC 6041 - 6043
133	Letter to Hearing Officer Lawrence Re Department of Environmental Quality's Expert Declarations, September 24, 2024	REC 6044
134	Second Amended Scheduling Order and Notice of Hearing, September 25, 2024	REC 6045 - 6047
135	Expert Declaration of William Tiedemann, October 4, 2024	REC 6048 - 6099
136	Expert Declaration of Ian H. von Lindern, P.E., Ph.D., October 4, 2024	REC 6100 - 6891
137	Department of Environmental Quality's Prehearing Statement, October 11, 2024	REC 6892 - 6901
138	Perpetua's Prehearing Statement, October 11, 2024	REC 6902 - 6916
139	Petitioners' Pre-Hearing Statement, October 11, 2024	REC 6917 - 6928

140	Motion to Strike Expert Declarations of William Tiedemann and Ian H. von Lindern, October 14, 2024	REC 6929 - 6959
141	Amended Motion to Strike Declarations of William Tiedemann and Ian H. von Lindern, October 15, 2024	REC 6960 - 6990
142	Third Amended Scheduling Order, Notice of Hearing, and Prehearing Order, October 16, 2024	REC 6991 - 6994
143	Notice of Replacement of DEQ Hearing Coordinator, November 4, 2024	REC 6995 - 6996
144	Department of Environmental Quality's Post-Hearing Brief, November 8, 2024	REC 6997 - 7019
145	Perpetua's Posthearing Statement, November 8, 2024	REC 7020 - 7048
146	Petitioners' Post-Hearing Statement, November 8, 2024	REC 7049 - 7075
147	Petitioners' Response to Opposing Perpetua's Motion to Strike Expert Declarations, November 8, 2024	REC 7076 - 7082
148	Reply in Support of Motion to Strike Expert Declarations of William Tiedemann and Ian H. von Lindern, November 13, 2024	REC 7083 - 7090
149	Findings of Fact, Conclusions of Law, and Preliminary Order, January 7, 2025	REC 7091 - 7118
150	Petitioners' Petition for Review of January 7, 2025 Preliminary Order, Memorandum in Support, and Request for Hearing, January 21, 2025	REC 7119 - 7145
151	Petitioner Save the South Fork Salmon's Motion for Reconsideration Based on New Evidence, January 24, 2025	REC 7146 - 7185
152	Certification and Transmittal of Agency Record and Transcripts, January 27, 2025	REC 7186 - 7188
153	Notice of Special Meeting of the Board of Environmental Quality | February 13, 2025, February 4, 2025	REC 7189 - 7191
154	Respondent Idaho Department of Environmental Quality's Response to Petitioners' Petition for Review of January 7, 2025 Preliminary Order, February 4, 2025	REC 7192 - 7222
155	Perpetua's Opposition to Petition for Review of January 7, 2025 Preliminary Order, February 4, 2025	REC 7223 - 7252

156	Respondent Idaho Department of Environmental Quality's Response to Petitioner Save the South Fork Salmon's Motion for Reconsideration Based on New Evidence, February 7, 2025	REC 7253 - 7263
157	Perpetua's Brief in Opposition to Petitioner's Motion for Reconsideration Based on New Evidence, February 7, 2025	REC 7264 - 7276
158	Declaration of W. Christopher Pooser in Support of Perpetua's Opposition to Reconsideration, February 7, 2025	REC 7277 - 7342
159	Order on Save the South Fork Salmon's Motion for Reconsideration Based on New Evidence, February 24, 2025	REC 7343 - 7348
160	Notice of Oral Argument, February 26, 2025	REC 7349 - 7351
161	Notice of Special Meeting of the Board of Environmental Quality | April 28, 2025, April 11, 2025	REC 7352 - 7354
162	Notice of Special Meeting of the Board of Environmental Quality | May 15, 2025, May 1, 2025	REC 7355 - 7357
163	Final Order, May 27, 2025	REC 7358 - 7373
164	Petitioner Save the South Fork Salmon's Motion for Reconsideration Based on New Evidence and Memorandum in Support, June 6, 2025	REC 7374 - 7391
165	Declaration of Julia Thrower, June 6, 2025	REC 7392 - 7455
166	Notice of Special Meeting of the Board of Environmental Quality | June 24, 2025, June 13, 2025	REC 7456 - 7458
167	Respondent Idaho Department of Environmental Quality's Response to Petitioner Save the South Fork Salmon's Motion for Reconsideration Based on New Evidence, June 18, 2025	REC 7459 - 7469
168	Perpetua's Brief in Opposition to Petitioner's Motion for Reconsideration Based on New Evidence, June 18, 2025	REC 7470 - 7486
169	Declaration of W. Christopher Pooser in Support of Perpetua's Opposition to Reconsideration, June 18, 2025	REC 7487 - 7567
170	Order on Save the South Fork Salmon's Motion for Reconsideration Based on New Evidence Dated June 6, 2025, June 27, 2025	REC 7568 - 7574
INDEX		
089	Amended Memorandum Decision on Motions for Summary Judgment and Preliminary Order, December 5, 2023	REC 3372 - 3425

141	Amended Motion to Strike Declarations of William Tiedemann and Ian H. von Lindern, October 15, 2024	REC 6960 - 6990
095	Amended Notice of Oral Argument, January 30, 2024	REC 3059 – 3061 C-REC 3509 - 3511
090	Amended Petition for Review of Preliminary Orders, December 15, 2023	REC 3426 - 3441
132	Amended Scheduling Order, September 17, 2024	REC 6041 - 6043
091	Certification and Transmittal of Agency Record and Transcript, December 15, 2023	REC 3442 - 3444
152	Certification and Transmittal of Agency Record and Transcripts, January 27, 2025	REC 7186 - 7188
046	Declaration of Allison Fowle, June 9, 2023	REC 2372 - 2377
048	Declaration of Asa Menlove, June 9, 2023	REC 2385 - 2389
036	Declaration of Bryan Hurlbutt, April 14, 2023	REC 0364 - 1203
047	Declaration of Drew Hollenback, June 9, 2023	REC 2378 - 2384
052	Declaration of Emmit Taylor Jr., June 9, 2023	REC 2548 - 2554
050	Declaration of Jonathan Oppenheimer, June 9, 2023	REC 2395 - 2538
049	Declaration of Joseph Oatman, June 9, 2023	REC 2390 - 2394
165	Declaration of Julia Thrower, June 6, 2025	REC 7392 - 7455
053	Declaration of Julia Thrower, June 9, 2023	REC 2555 - 2985
056	Declaration of Kevin Lewis in Support of Intervenor-Respondent Perpetua's Reply in Support of Motion for Summary Judgment, June 23, 2023	REC 3024 - 3028
039	Declaration of Kevin Schilling, May 12, 2023	REC 1233 - 1255
040	Declaration of Mike Simon, May 12, 2023	REC 1256 - 1270
099	Declaration of Tiffany Floyd in Support of Joint Motion to Supplement Record with DEQ Response to EPA Letter, February 7, 2024	REC 3160 – 3196 C-REC 3610 - 3646
103	Declaration of Tiffany Floyd in Support of Joint Motion to Supplement Record with March 12, 2024 EPA Letter, March 13, 2024	REC 3233 – 3238 C-REC 3683 - 3688

078	Declaration of Tiffany Floyd Opposing the Motion to Stay, September 11, 2023	REC 3259 - 3264
041	Declaration of Tiffany Floyd, May 12, 2023	REC 1271 - 1275
044	Declaration of W. Christopher Pooser in Support of Intervenor-Respondent's Motion for Summary Judgment, May 12, 2023	REC 1337 - 2316
158	Declaration of W. Christopher Pooser in Support of Perpetua's Opposition to Reconsideration, February 7, 2025	REC 7277 - 7342
169	Declaration of W. Christopher Pooser in Support of Perpetua's Opposition to Reconsideration, June 18, 2025	REC 7487 - 7567
113	Declaration of William Tiedemann, June 3, 2024	REC 3762 - 3822
051	Declaration of Zak Sears, June 9, 2023	REC 2539 - 2547
144	Department of Environmental Quality's Post-Hearing Brief, November 8, 2024	REC 6997 - 7019
137	Department of Environmental Quality's Prehearing Statement, October 11, 2024	REC 6892 - 6901
037	DEQ's Cross Motion for Summary Judgment, May 12, 2023	REC 1204 - 1206
038	DEQ's Response to Petitioners' Motion for Summary Judgment and Brief in Support of Cross Motion for Summary Judgment, May 12, 2023	REC 1207 - 1232
129	Documents identified in Expert Declaration of Theresa Lopez, Attachment A of Memorandum in Support of Declaration, August 30, 2024	REC 4319 - 6009
136	Expert Declaration of Ian H. von Lindern, P.E., Ph.D., October 4, 2024	REC 6100 - 6891
127	Expert Declaration of Kevin Lewis, August 30, 2024	REC 4129 - 4276
124	Expert Declaration of Kevin Schilling, August 13, 2024	REC 3917 - 4122
123	Expert Declaration of Norka E. Paden, Ph.D., August 13, 2024	REC 3873 - 3916
128	Expert Declaration of Theresa Lopez, August 30, 2024	REC 4277 - 4318
135	Expert Declaration of William Tiedemann, October 4, 2024	REC 6048 - 6099

163	Final Order, May 27, 2025	REC 7358 - 7373
106	Final Order, May 9, 2024	REC 3695 – 3720
149	Findings of Fact, Conclusions of Law, and Preliminary Order, January 7, 2025	REC 7091 - 7118
019	First Amended Petition to Initiate Contested Case, December 6, 2022	REC 0194 - 0223
026	First Amended Petition to Initiate Contested Case, January 11, 2023	REC 0263 - 0292
119	Idaho Department of Environmental Quality's Initial Status Report, July 1, 2024	REC 3849 - 3854
057	Intervenor-Respondent Perpetua's Motion to Strike, June 23, 2023	REC 3029 - 3034
097	Intervenor-Respondent's Brief in Opposition to Petitioners' Amended Petition for Review of Preliminary Orders, February 7, 2024	REC 3096 – 3152 C-REC 3546 - 3602
042	Intervenor-Respondent's Motion for Summary Judgment, May 12, 2023	REC 1276 - 1278
063	Intervenor-Respondent's Opposition to Petitioners' Motion to Strike Declaration of Kevin Lewis, July 14, 2023	REC 3065 - 3072
062	Intervenor-Respondent's Reply in Support of Motion to Strike Oppenheimer Declaration, July 14, 2023	REC 3059 - 3064
120	Intervenor-Respondent's Status Report, July 1, 2024	REC 3855 - 3860
108	Joint Motion for Reconsideration and/or Clarification of Final Order, May 23, 2024	REC 3728 - 3730
083	Joint Motion for Reconsideration and/or Clarification, November 10, 2023	REC 3332 - 3334
068	Joint Motion in Limine to Exclude Communications from U.S. EPA Sent After Permit was Issued, August 28, 2023	REC 3097 - 3103
027	Joint Motion to Enter Stipulated Scheduling Order, January 13, 2023	REC 0293 - 0295
069	Joint Motion to Shorten Time and for Expedited Consideration, August 31, 2023	REC 3104 - 3107
114	Joint Motion to Strike Petitioners' Response, June 4, 2024	REC 3823 - 3827

098	Joint Motion to Supplement Record with DEQ Response to EPA Letter, February 7, 2024	REC 3153 – 3159 C-REC 3603 - 3609
102	Joint Motion to Supplement Record with March 12, 2024 EPA Letter, March 13, 2024	REC 3228 – 3232 C-REC 3678 - 3682
075	Joint Opposition to Petitioners' Motion to Amend Contested Case Petition, September 11, 2023	REC 3236 - 3242
077	Joint Response in Opposition to Petitioners' Motion to Stay the Case, September 11, 2023	REC 3251 - 3258
076	Joint Response in Opposition to Petitioners' Motion to Supplement with August 10, 2023 EPA Letter, September 11, 2023	REC 3243 - 3250
133	Letter to Hearing Officer Lawrence Re Department of Environmental Quality's Expert Declarations, September 24, 2024	REC 6044
131	Letter to Hearing Officer Lawrence Re Perpetua Resources Idaho, Inc. Expert Declarations, September 11, 2024	REC 6040
081	Memorandum Decision on Motions for Summary Judgment and Preliminary Order, October 31, 2023	REC 3280 - 3328
043	Memorandum in Support of Intervenor-Respondent's Motion for Summary Judgment and in Opposition to Petitioners' Motion for Summary Judgment, May 12, 2023	REC 1279 - 1336
084	Memorandum in Support of Joint Motion for Reconsideration and/or Clarification, November 10, 2023	REC 3335 - 3341
109	Memorandum in Support of Joint Motion for Reconsideration and/or Clarification of Final Order, May 23, 2024	REC 3731 - 3751
018	Motion to File First Amended Petition to Initiate Contested Case, December 6, 2022	REC 0190 - 0193
140	Motion to Strike Expert Declarations of William Tiedemann and Ian H. von Lindern, October 14, 2024	REC 6929 - 6959
125	Notice of Appearance, August 29, 2024	REC 4123 - 4125
115	Notice of Appearance, June 5, 2024	REC 3828 - 3830
008	Notice of Appearance, September 6, 2022	REC 0049 - 0051

023	Notice of Appointment of Hearing Officer, January 3, 2023	REC 0249 - 0254
003	Notice of Appointment of Hearing Officer, July 28, 2022	REC 0031- 0032
092	Notice of Briefing Schedule, December 27, 2023	REC 3445 - 3447
126	Notice of Expert Declarations, August 30, 2024	REC 4126 - 4128
002	Notice of Filing and Service of Petition, July 22, 2022	REC 0029 - 0030
010	Notice of Joinder, September 12, 2022	REC 0122 - 0124
160	Notice of Oral Argument, February 26, 2025	REC 7349 - 7351
093	Notice of Oral Argument, January 9, 2024	REC 3448 - 3450
007	Notice of Prehearing Conference, August 23, 2022	REC 0046 - 0048
022	Notice of Reassignment of Pending Matters, December 19, 2022	REC 0244 - 0248
143	Notice of Replacement of DEQ Hearing Coordinator, November 4, 2024	REC 6995 - 6996
104	Notice of Special Meeting of the Board of Environmental Quality | April 8, 2024, March 22, 2024	REC 3239 – 3241 C-REC 3689 - 3691
105	Notice of Special Meeting of the Board of Environmental Quality | May 1, 2024, March 22, 2024	REC 3242 – 3244 C-REC 3692 - 3694
110	Notice of Special Meeting of the Board of Environmental Quality | May 29, 2024, May 24, 2024	REC 3752 - 3753
111	Notice of Special Meeting of the Board of Environmental Quality | June 12, 2024, June 3, 2024	REC 3754 - 3756
153	Notice of Special Meeting of the Board of Environmental Quality | February 13, 2025, February 4, 2025	REC 7189 - 7191
161	Notice of Special Meeting of the Board of Environmental Quality | April 28, 2025, April 11, 2025	REC 7352 - 7354
162	Notice of Special Meeting of the Board of Environmental Quality | May 15, 2025, May 1, 2025	REC 7355 - 7357
166	Notice of Special Meeting of the Board of Environmental Quality | June 24, 2025, June 13, 2025	REC 7456 - 7458
058	Notice of Status and Scheduling Conference, July 7, 2023	REC 3035 - 3039

118	Notice of Status and Scheduling Conference; Updated Disclosure, June 24, 2024	REC 3844 - 3848
025	Notice of Status Conference, January 10, 2023	REC 0258 - 0262
082	Notice of Substitution of Counsel, November 2, 2023	REC 3329 - 3331
013	Notice of Virtual Status Conference, September 27, 2022	REC 0147 - 0148
067	Notice Pursuant to IRAP 412, August 8, 2023	REC 3092 - 3096
130	Notice Re: Declaration of Norka E. Paden, Ph.D., September 10, 2024	REC 6010 - 6039
080	Notice Regarding Summary Judgment Hearing, September 15, 2023	REC 3275 - 3279
059	Opposition to Perpetua's Motion to Strike Oppenheimer Declaration, July 7, 2023	REC 3040 - 3049
061	Order and Notice from Status and Scheduling Conference, July 12, 2023	REC 3056 - 3058
006	Order Approving Petition to Intervene, August 22, 2022	REC 0044 - 0045
031	Order Granting Motion to Extend Deadline, February 13, 2023	REC 0310 - 0312
024	Order Granting Motion to File First Amended Petition, January 6, 2023	REC 0255 - 0257
088	Order on Joint Motion for Reconsideration and/or Clarification, December 5, 2023	REC 3367 - 3371
016	Order on Motion to Dismiss, November 15, 2022	REC 0160 - 0186
079	Order on Motions Related to Recent EPA Letter, September 15, 2023	REC 3265 - 3274
065	Order on Perpetua’s Motion to Strike, July 31, 2023	REC 3079 - 3085
066	Order on Petitioners’ Motion to Strike, July 31, 2023	REC 3086 - 3091
117	Order on Petitions for Reconsideration and/or Clarification of Final Order, June 12, 2024	REC 3835 – 3843
086	Order on Post Preliminary Order Procedures, November 17, 2023	REC 3357 - 3360
159	Order on Save the South Fork Salmon’s Motion for Reconsideration Based on New Evidence, February 24, 2025	REC 7343 - 7348

170	Order on Save the South Fork Salmon's Motion for Reconsideration Based on New Evidence Dated June 6, 2025, June 27, 2025	REC 7568 - 7574
017	Order on Status Conference, November 30, 2022	REC 0187 - 0189
014	Order on Status Conference; Notice of Status Conference, October 14, 2022	REC 0149 - 0154
015	Order on Status Conference; Notice of Status Conference, October 28, 2022	REC 0155 - 1059
157	Perpetua's Brief in Opposition to Petitioner's Motion for Reconsideration Based on New Evidence, February 7, 2025	REC 7264 - 7276
168	Perpetua's Brief in Opposition to Petitioner's Motion for Reconsideration Based on New Evidence, June 18, 2025	REC 7470 - 7486
155	Perpetua's Opposition to Petition for Review of January 7, 2025 Preliminary Order, February 4, 2025	REC 7223 - 7252
145	Perpetua's Posthearing Statement, November 8, 2024	REC 7020 - 7048
138	Perpetua's Prehearing Statement, October 11, 2024	REC 6902 - 6916
021	Perpetua's Response to First Amended Petition to Initiate Contested Case, December 13, 2022	REC 0227 - 0243
009	Perpetua's Motion to Dismiss and Supporting Brief, September 6, 2022	REC 0052 - 0121
020	Perpetua's Notice of Non-Opposition to Motion to File First Amended Petition to Initiate Contested Case, December 13, 2022	REC 0224 - 0226
085	Petition for Review of Preliminary Order, November 14, 2023	REC 3342 - 3356
001	Petition to Initiate Contested Case: Air Quality Permit to Construct P-2019.0047 (Jun. 17, 2022), July 22, 2022	REC 0001 - 0028
005	Petition to Intervene, August 12, 2022	REC 0040 - 0043
151	Petitioner Save the South Fork Salmon's Motion for Reconsideration Based on New Evidence, January 24, 2025	REC 7146 - 7185
164	Petitioner Save the South Fork Salmon's Motion for Reconsideration Based on New Evidence and Memorandum in Support, June 6, 2025	REC 7374 - 7391
060	Petitioners' Motion to Strike Declaration of Kevin Lewis and Brief in Support, July 7, 2023	REC 3050 - 3055

064	Petitioners' Reply in Support of Motion to Strike Declaration of Kevin Lewis, July 20, 2023	REC 3073 - 3078
107	Petitioners' Motion for Clarification and/or Reconsideration, May 23, 2024	REC 3721 - 3727
034	Petitioners' Motion for Summary Judgment, April 14, 2023	REC 0319 - 0322
074	Petitioners' Motion to Amend Contested Case Petition, September 8, 2023	REC 3190 - 3235
070	Petitioners' Motion to Stay the Case and Brief in Support, September 1, 2023	REC 3108 - 3136
071	Petitioners' Motion to Supplement with August 10, 2023 EPA Letter and Brief in Support, September 1, 2023	REC 3137 - 3166
094	Petitioners' Opening Brief in Support of Amended Petition for Review of Preliminary Orders, January 17, 2024	REC 3451 - 3508
035	Petitioners' Opening Brief in Support of Motion for Summary Judgment, April 14, 2023	REC 0323 - 0363
101	Petitioners' Opposition to DEQ and Perpetua's Joint Motion to Supplement Record with DEQ Response to EPA Letter, February 21, 2024	REC 3223 – 3227 C-REC 3673 - 3677
011	Petitioners' Opposition to Perpetua's Motion to Dismiss, September 20, 2022	REC 0125 - 0142
150	Petitioners' Petition for Review of January 7, 2025 Preliminary Order, Memorandum in Support, and Request for Hearing, January 21, 2025	REC 7119 - 7145
146	Petitioners' Post-Hearing Statement, November 8, 2024	REC 7049 - 7075
139	Petitioners' Pre-Hearing Statement, October 11, 2024	REC 6917 - 6928
100	Petitioners' Reply Brief in Support of Amended Petition for Review of Preliminary Orders, February 14, 2024	REC 3197 – 3222 C-REC 3647 - 3672
073	Petitioners' Response in Opposition to Motion in Limine, September 8, 2023	REC 3172 - 3189
112	Petitioners' Response Opposing DEQ/Perpetua's Motion for Reconsideration, June 3, 2024	REC 3757 - 3761
116	Petitioners' Response Opposing DEQ/Perpetua's Motion to Strike, June 7, 2024	REC 3831 - 3834

045	Petitioners' Response to DEQ's Cross-Motion for Summary Judgement and Intervenor Perpetua's Motion for Summary Judgment and Petitioner's Reply in Support of Petitioners' Motion for Summary Judgment, June 9, 2023	REC 2317 - 2371
087	Petitioners' Response to Joint Motion for Reconsideration and/or Clarification, November 20, 2023	REC 3361 - 3366
147	Petitioners' Response to Opposing Perpetua's Motion to Strike Expert Declarations, November 8, 2024	REC 7076 - 7082
121	Petitioners' Status Report, July 1, 2024	REC 3861 - 3866
012	Prehearing Order, September 23, 2022	REC 0143 - 0146
148	Reply in Support of Motion to Strike Expert Declarations of William Tiedemann and Ian H. von Lindern, November 13, 2024	REC 7083 - 7090
055	Reply Memorandum in Support of Intervenor-Respondent Perpetua's Motion for Summary Judgment, June 23, 2023	REC 2989 - 3023
096	Respondent Idaho Department of Environmental Quality's Brief and Response to Petitioners' Opening Brief, February 7, 2024	REC 3062 – 3095 C-REC 3512 - 3545
154	Respondent Idaho Department of Environmental Quality's Response to Petitioners' Petition for Review of January 7, 2025 Preliminary Order, February 4, 2025	REC 7192 - 7222
156	Respondent Idaho Department of Environmental Quality's Response to Petitioner Save the South Fork Salmon's Motion for Reconsideration Based on New Evidence, February 7, 2025	REC 7253 - 7263
167	Respondent Idaho Department of Environmental Quality's Response to Petitioner Save the South Fork Salmon's Motion for Reconsideration Based on New Evidence, June 18, 2025	REC 7459 - 7469
030	Respondent's Motion to Extend Deadline for Discovery and Modify the Scheduling Order Dated January 19, 2023, February 9, 2023	REC 0307 - 0309
054	Respondent's Non-Reply to Petitioners' Response, June 23, 2023	REC 2986 - 2988
032	Respondent's Notice of Discovery Service, February 14, 2023	REC 0313 - 0315
033	Respondent's Notice of Discovery Service, February 21, 2023	REC 0316 - 0318
028	Response to First Amended Petition to Initiate Contested Case, January 17, 2023	REC 0296 - 0302

004	Response to Petition to Initiate Contested Case: Air Permit to Construct P-2019.0047 (Jun. 17, 2022), August 12, 2022	REC 0033 - 0039
072	Scheduling Order on Motions Related to Recent EPA Letter, September 6, 2023	REC 3167 - 3171
029	Scheduling Order, January 19, 2023	REC 0303 - 0306
122	Scheduling Order, July 8, 2024	REC 3867 - 3872
134	Second Amended Scheduling Order and Notice of Hearing, September 25, 2024	REC 6045 - 6047
142	Third Amended Scheduling Order, Notice of Hearing, and Prehearing Order, October 16, 2024	REC 6991 - 6994

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON	)	**CASE DOCKET NO. _____**
Petitioners,	)	**PETITION TO INITIATE CONTESTED CASE: AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 (JUN. 17, 2022)**
v.	)	
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent.	)	

ATTENTION: Hearing Coordinator

INTRODUCTION

1. Petitioners Nez Perce Tribe, Idaho Conservation League ("ICL"), and Save the South Fork Salmon ("SSFS"), by and through their attorneys of record, file this Petition to Initiate Contested Case ("Petition") before the Idaho Board of Environmental Quality ("Board") pursuant to Idaho Code § 39-107(5) and IDAPA 58.01.23. This Petition challenges the Air Quality Permit to Construct P-2019.0047 ("PTC") issued by the Idaho Department of Environmental Quality ("DEQ") on June 17, 2022, to mining company Perpetua Resources Idaho, Inc. ("Perpetua") for its proposed Stibnite Gold Project ("SGP").

2. The SGP is in the headwaters of the East Fork of the South Fork of the Salmon River approximately ten miles east of the town of Yellow Pine, Idaho. The SGP is geographically located within the Nez Perce Tribe's aboriginal homeland and within the area over which the Nez Perce Tribe has Treaty-reserved rights and resources. As proposed, Perpetua would use conventional mining techniques to extract ore from three open pits, process gold, and dispose of mine waste at the SGP site.

3. The PTC being challenged here authorizes emissions of air pollutants from the SGP that will occur over the mine's anticipated 16-year life span. These emissions include massive quantities of dust generated by mining, hauling, and processing. The dust includes particulate matter and arsenic—pollutants which can cause serious harm to human health and the environment.

4. When it issued the PTC, DEQ failed to comply with the federal Clean Air Act and with Idaho rules, regulations, and guidance for Clean Air Act permitting in multiple ways set forth below. Petitioners respectfully request that the Board reverse and set aside the PTC and remand to DEQ to correct these errors.

LISTING OF REPRESENTATIVES

5. Copies of all pleadings, correspondence, and official documents shall be served on the Petitioners' counsel listed below:

For the Nez Perce Tribe and the Idaho Conservation League:

Bryan Hurlbutt
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org

For Save the South Fork Salmon:

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com

JURISDICTION, STANDARD OF REVIEW, PARTIES, AND STANDING

6. Pursuant to Idaho Code § 39-107(5), IDAPA 58.01.23, and IDAPA 58.01.01 (the "Idaho Air Rules"), the Board has jurisdiction over this contested case challenging DEQ's action issuing PTC P-2019.0047 for the SGP on June 17, 2022. This Petition is timely filed on July 22, 2022, within thirty-five (35) days of the date of DEQ's June 17, 2022 decision. *See* IDAPA 58.01.23.060.

7. An agency action, such as DEQ's issuance of the PTC being challenged here, may be reversed if it is in violation of constitutional or statutory provisions, is in excess of statutory authority, is made on unlawful procedure, or is arbitrary, capricious, or an abuse of discretion. Idaho Code ("I.C.") § 67-5279. When an agency action is not affirmed, it shall be set aside, in whole or in part, and remanded for further proceedings as necessary. *Id.*

8. Pursuant to IDAPA 58.01.23.002.02: "Any person aggrieved by an action or inaction of the Department may file a petition to initiate a contested case pursuant to Chapter 52, Title 67, Idaho Code." An aggrieved person is defined as "any person or entity with legal standing to challenge an action or inaction of the Department, including but not limited to permit holders and applicants for permits challenging Department permitting actions." IDAPA 58.01.23.005.01.

9. PETITIONER NEZ PERCE TRIBE is a federally-recognized Indian tribe with headquarters on the Nez Perce Reservation in Lapwai, Idaho; and with offices in Orofino, McCall, and Powell, Idaho, and Joseph, Oregon.

10. The Nez Perce Tribe has standing to bring this contested case. The Nez Perce people, the *Nimiipuu*, exclusively occupied, since time immemorial, over thirteen million acres encompassing a large part of what is today Idaho, Oregon, and Washington—stretching from the Bitterroot Mountains to the Blue Mountains. Nez Perce also traveled far beyond this homeland to fish, hunt, gather, and pasture—frequently going east to buffalo country, in what is today the state of Montana, and west along the Snake and Columbia rivers to the Pacific Ocean. The Nez Perce actively maintain their connection to the land, water, and resources of their vast homeland. The Nez Perce's intimate knowledge and continuous use of their homeland over millennia have created a unique and reverential bond between people and place that defines Nez Perce culture and identity.

11. When the Nez Perce Tribe entered into a treaty with the United States in 1855, it sought to reserve the rights central to maintaining its culture and way of life. The 1855 Treaty reserved to the Tribe, for its "exclusive use and benefit," 7.5 million acres of its more than

thirteen-million- acre homeland, including an area spanning present-day north-central Idaho, southeast Washington, and northeast Oregon as well as:

> [T]he right of taking fish at all usual and accustomed places in common with citizens of the Territory; and of erecting temporary buildings for curing, together with the privilege of hunting, gathering roots and berries, and pasturing their horses and cattle upon open and unclaimed land.

Treaty with the Nez Perces, art. 3, June 11, 1855, 12 Stat. 957. Nez Perce Tribal members, pursuant to the Nez Perce Tribe's Treaty-reserved rights, continue to fish, hunt, gather, and pasture across the Nez Perce Tribe's vast aboriginal homeland and at traditional places, including areas within and surrounding the SGP. The Nez Perce Tribe, as a co-manager of its treaty-reserved resources, also plays a leading role in the restoration of the East Fork South Fork Salmon River and South Fork Salmon River fisheries, expending approximately $2.5 million annually to restore Chinook salmon runs in both rivers through hatchery supplementation, fishery research, and watershed restoration.

12. The Nez Perce Tribe will suffer physical, cultural, spiritual, and economic injury caused by excessive air pollutants resulting from DEQ's issuance of the PTC. Clean, clear air is a critical component to ensuring the health and resiliency of the Nez Perce Tribe's Treaty-reserved rights and resources. Air pollution reduces visibility, which impairs cultural and ceremonial practices for Tribal members and reduces enjoyment of these special places. Air pollution causes a host of environmental and human health problems, including damage to culturally important plants, sensitive forests, and fish habitat, acidification of lakes and streams, depletion of soil nutrients, aggravated asthma, heart attacks, and premature death. Impacts can be especially harmful to at-risk ecosystems and especially harmful for sensitive human populations such as asthmatics, children, the elderly, people with diabetes, and people with heart or lung disease.

13. To safeguard its rights and interests, the Nez Perce Tribe has participated extensively in DEQ's review process, including submitting comments on October 12 and November 10, 2020, March 8, 2021, and March 14, 2022. A favorable decision in the Contested Case will redress these injuries suffered by the Tribe.

14. PETITIONER IDAHO CONSERVATION LEAGUE is an Idaho non-profit conservation organization. Its main office is located in Boise, Idaho, and it has three field offices in Sandpoint, Ketchum, and McCall. ICL represents approximately 50,000 supporters dedicated to protecting and conserving Idaho's clean water, air, public lands, and wildlife.

15. ICL has standing to bring this contested case. ICL supporters, staff, and board members ("ICL members") regularly visit the SGP and/or nearby areas where air quality would be affected by the SGP for professional, recreational, aesthetic, and other purposes. ICL members will suffer health, environmental, and aesthetic injuries from the particulate matter and arsenic air pollution emitted by the SGP and authorized by DEQ's issuance of the PTC. A favorable decision in the Contested Case will redress ICL's injuries. Neither the claim asserted, nor the relief requested, requires participation of these individual ICL members in the lawsuit. The interests ICL seeks to protect are germane to the organization's purpose in protecting Idaho's clean water, clean air, wildlife, and public lands.

16. In furtherance of its mission, ICL participated extensively in the public processes for the PTC, including by submitting formal public comments to DEQ on October 12 and November 11, 2020, March 19, 2021, and March 16, 2022.

17. PETITIONER SAVE THE SOUTH FORK SALMON is a community-based, non-profit conservation organization headquartered in McCall, Idaho. SSFS represents members and supporters dedicated to preserving the South Fork Salmon River watershed and ecosystem.

18. SSFS has standing to bring this contested case. SSFS members, supporters, and members of the Board of Directors ("SSFS members") regularly visit the South Fork Salmon River watershed and the SGP site, where the emission of excessive air pollutants due to DEQ's issuance of the PTC would impact professional, economic, recreational, aesthetic, environmental, and human health interests. SSFS members would suffer injury from DEQ's issuance of the PTC from environmental, health, and aesthetic harms caused by the emission of harmful air pollutants, including particulate matter and arsenic. A favorable decision in the Contested Case will redress these injuries suffered by SSFS members. Neither the claims asserted, nor the relief requested, requires participation of these individual supporters in the lawsuit. The interests SSFS seeks to protect are germane to the organization's mission of protecting and preserving the South Fork Salmon River watershed and ecosystem, and protecting public health, the river, the fish, and recreational opportunities in the area.

19. In furtherance of this mission, SSFS participated extensively in the public process for the PTC, including submitting formal public comments to DEQ on October 12 and November 11, 2020, March 19, 2021, and March 16, 2022.

20. RESPONDENT IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY is an executive department and administrative agency organized under the laws of the State of Idaho, pursuant to the Idaho Constitution (Article IV, Section 20) and Idaho Code section 39-104(1). Its principal offices are located at 1410 N. Hilton, Boise, Idaho 83706. DEQ, through its Director, and subject to Board oversight, is responsible for issuing air quality PTCs under the Idaho Air Rules, IDAPA 58.01.01.

21. On June 17, 2022, DEQ issued PTC P-2019.0047, which is the subject of this contested case.

FACTUAL SUPPORT FOR PETITION

I. OVERVIEW OF SGP & CHRONOLOGY OF DEQ'S ISSUING THE PTC

22. Perpetua is currently in the process of seeking multiple permits and other approvals from multiple agencies and other authorities for the proposed SGP. As described by DEQ in the Statement of Basis ("SOB") document prepared with the PTC:

> Perpetua proposes to construct and operate the SGP, consisting of conventional open-pit mining, ore preparation, and gold extraction operations. The SGP is to be located in Valley County at the intersection Forest Service roads NF-374 and NF-412 (Stibnite Road), approximately 10 miles east of Yellow Pine. The project will be located on a combination of public national forest and private lands. The mining operations boundary within which public access will be excluded is defined in Figure 1. This operations boundary also defines the ambient air boundary that was used in all ambient air quality impact analyses as part of the development process of the PTC.
>
> The SGP will require the construction of significant infrastructure, including a power transmission line, a primary mine site access road, onsite haul roads, an ore processing facility, onsite workspaces, employee housing and recreation, water storage and distribution facilities, and sewage disposal facilities.
>
> Conventional open-pit mining methods including drilling, blasting, excavating, and hauling will be used to extract ore and waste rock, termed development rock (DR). Hydraulic shovels and front-end loaders will be used to load ore and DR into haul trucks. DR will be used for construction, restoration, and backfilling, or hauled to the dedicated development rock storage facilities (DRSF). Approximately 340 million tons of DR will be handled over the life of the mine.
>
> The SGP will include three years of pre-mining development and construction activities, followed by an operating mine life of approximately 12 years. Mining will occur in three open pits: Yellow Pine Pit (YPP), Hangar Flats pit (HFP), and West End pit (WEP). Although there will be overlap in mine development, construction and operations, the general sequence of mining will be the YPP deposit, followed by the HFP and WEP deposits. Legacy tailings from the Meadow Creek valley (Bradley Tailings [BT]) will also be reclaimed and reprocessed during the initial project schedule. Surface exploration drilling will occur within the pits and within the Scout Prospect decline (underground exploration) throughout the mine operation period. Restoration and reclamation of other legacy mining features will occur prior to mining, throughout the life of the mine, and as part of the mine closure.
>
> Ore will be hauled to the primary crusher area, where it will be fed directly into the crusher dump pocket or stockpiled. The ore crushing plant will be designed

> to operate at a maximum rate of 25,000 tons per calendar day (T/day). Approximately 100 million tons of ore will be mined from the three pits over the life of the project. The metal-recovery process from ore will include conventional crushing and grinding, followed by froth-flotation circuits that will generate separate gold-silver and antimony-silver concentrates. The antimony-silver concentrate will be shipped offsite for refining, whereas additional onsite processing of the gold-silver concentrate will include pressure oxidation, carbon-in-leach circuits, and refining processes to recover gold and minor amounts of silver. The finely ground leftover ore material from the mineral recovery process, termed tailings, will be neutralized, thickened, and transported via a pipeline to the tailings storage facility. A diagram of ore processing and ore concentration and refining process flows is provided in Figure 2.

23. Perpetua (previously Midas Gold) submitted a PTC application for the SGP to DEQ on August 20, 2019. As shown in the "Application Chronology" section of the SOB, between that date and March 6, 2020, DEQ determined that the application was incomplete, requested additional information, and received supplementary materials from Perpetua no fewer than four times. On May 15, 2020, DEQ deemed Perpetua's application complete.

24. Between May 15, 2020, and March 16, 2022, DEQ developed three versions of the draft PTC and released them for public comment. As noted in comments submitted by the Nez Perce Tribe, ICL, and SSFS, the first two draft versions of the PTC (herein referred to the September 2020 and February 2021 draft PTCs) contained significant shortcomings. As a result, the September 2020 draft PTC was considered deficient and required updated information from Perpetua, including updated hazardous air pollutants ("HAP") and toxic air pollutants ("TAP") emissions estimates, a HAP/TAP addendum to the application, updated TAP modeling analyses, supporting references, and updated modeling files with corrections for formaldehyde and sulfuric acid.

25. DEQ subsequently updated the draft PTC and in February 2021, provided a revised draft PTC for public comment. Following additional comments, DEQ again determined that the February 2021 draft PTC was deficient and required additional information from

Perpetua, including Prevention of Significant Deterioration emissions estimates and regulatory applicability for the lime manufacturing plant, as well as an updated TAP/HAP addendum including an updated emission inventory and modeling files.

26. DEQ revised theFebruary 2021 draft PTC and released it for public comment on January 13, 2022. Comments were submitted by the Nez Perce Tribe, ICL, SSFS, the U.S. Environmental Protection Agency ("EPA") Region 10, and Ian von Lindern of Terragraphics International Foundation. Commenters raised numerous concerns with the draft PTC and urged DEQ to gather additional information, to perform additional modeling and analysis, and to develop additional enforceable permit conditions and limits prior to issuing a final PTC. On June 17, 2022, DEQ issued the final PTC, along with responses to comments and the SOB. While DEQ made limited updates to the PTC, it rejected most of the issues raised by the commenters.

II. PM_{10} & ARSENIC EMISSIONS FROM THE SGP

27. While the SGP will emit numerous air pollutants, PM_{10} and arsenic are the air pollutants of greatest concern and are the pollutants at issue in this contested case.

A. PM_{10} Pollution and Regulation

28. Particulate matter ("PM") contains microscopic solids or liquid droplets that are so small that they can be inhaled and cause serious health problems. Some particles less than 10 micrometers in diameter can get deep into a person's lungs, and some may even get into the person's bloodstream. Numerous scientific studies have linked particle pollution exposure to a variety of problems, including premature death in people with heart or lung disease; nonfatal heart attacks; irregular heartbeat; aggravated asthma; decreased lung function; and increased respiratory symptoms, such as irritation of the airways, coughing or difficulty breathing. People

with heart or lung diseases, children, and older adults are the most likely to be affected by particle pollution exposure.

29. In addition to causing human health problems, PM causes environmental damage. Particles can be carried over long distances by wind and then settle on ground or water. Depending on their chemical composition, the effects of settling may include making lakes and streams acidic; changing the nutrient balance in river basins; depleting nutrients in soil; damaging sensitive forests and crops; affecting diversity of ecosystems; and contributing to acid rain.

30. Under Sections 108 and 109 of the federal Clean Air Act, EPA is required to establish National Ambient Air Quality Standards ("NAAQS") for each "criteria air pollutant" to protect the nation's public health and welfare. "[E]ffects on welfare include[ ], but [are] not limited to, effects on soils, water, crops, vegetation, manmade materials, animals, wildlife, weather, visibility, and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being, whether caused by transformation, conversion, or combination with other air pollutants." 42 U.S.C. § 7602(h).

31. PM is a criteria air pollutant. EPA has established primary and secondary NAAQS for coarse particulate matter, or "PM_{10}," 40 C.F.R. § 50.6, and for fine particulate matter, or "$PM_{2.5}$," *id.* at § 50.7. PM_{10} consists of inhalable particles with diameters that are generally ten micrometers and smaller. 42. U.S.C. § 7602(t). $PM_{2.5}$ consists of inhalable particles that are 2.5 micrometers and smaller. The NAAQS specify a maximum amount of PM to be present in the outdoor air. *See* 40 C.F.R. §§ 50.6, 50.7.

32. EPA has delegated to DEQ authority to issue air quality permits in Idaho. Under the Rules for the Control of Air Pollution in Idaho, DEQ is required to ensure that no PTC shall be granted for a new or modified stationary source unless the applicant shows to the satisfaction of DEQ that the source would not cause or significantly contribute to a violation of any NAAQS. IDAPA 58.01.01.203.02. To satisfy these requirements, DEQ must assess air impacts using maximum potential emissions as limited by either the capacity of the unit/operation or as limited by enforceable permit provisions. *See* IDAPA 58.01.01.006.88.

B. PM_{10} Pollution from the SGP & Flaws in the PTC

33. According to DEQ's Statement of Basis for the SGP, the SGP has the potential to emit 55.7 tons per year of PM_{10} from a variety of sources. The generation of dust from ore haul trucks traveling along haul roads is the most significant source, estimated to be approximately 55% of all modeled PM_{10} emissions. The next most significant source is open pit drilling fugitive emissions, estimated by DEQ to account for approximately 24% of all modeled emissions.

34. DEQ modeled receptors at various locations along the SGP's ambient air boundary and determined that the maximum potential emissions will be below (and thus comply with) the 24-hour PM_{10} NAAQS. DEQ found the maximum 24-hour PM_{10} pollution from the SGP would be 123.5 ug/m^3, which is 82.3% of the NAAQS.

35. DEQ's determination that the SGP will not cause or contribute to a violation of the PM_{10} NAAQS is flawed.

36. First, important variables affecting the quantity of PM_{10} generated by the ore haul trucks are not directly limited and enforceable as PTC permit conditions. Perpetua estimated the quantity of PM_{10} that would be emitted by the ore haul trucks based on EPAs compilation of air emissions factors (AP-42 Chapter 13.2.2) and their subsequent analysis of sources used by the

EPA to develop Chapter 13.2.2. Critical variables that Perpetua used as inputs to PM emission calculations include: the average empty weight of ore haul trucks; the average loaded weight of ore haul trucks; the silt content of the haul road being traveled; and the total number vehicle miles traveled by ore haul trucks. However, only one of these critical variables is directly limited and enforceable as a condition in the PTC: the silt content of the haul roads. *See* PTC condition 3.13.

37. Instead of developing PTC conditions for these other critical variables, DEQ relied on a surrogate limit in the PTC (total ore haulage per day, *see* PTC conditions 3.5) and on plans that have not yet been developed—a Fugitive Dust Control Plan ("FDCP") and a Haul Road Capping Plan ("HRCP")—to claim the PTC ensures enforceable compliance with 24-hour PM_{10} NAAQS. Without developing the FDCP and HRCP first, and without including important variables as enforceable permit conditions, there is no assurance the SGP will comply with the 24-hour PM_{10} NAAQS, even with the total ore haulage per day limit. Perpetua used a very specific combination of these variables to arrive at a quantity of ore haul truck generated PM_{10} that they contend ensures compliance with the NAAQS. Changing these variables in any number of ways (ways which are not precluded by any conditions in the PTC) can result in higher PM_{10} levels—levels so high that they exceed the NAAQS. As just one example, merely changing the ratio of large to small trucks used by Perpetua (to include more large trucks) could cause a violation of the NAAQS.

38. Second, DEQ assumed 93.3% of all haul road PM_{10} emissions from the SGP can be controlled by using an unspecified combination, volume, and frequency of water sprays and chemical dust suppressants. This extremely high level of control which DEQ assumed Perpetua can achieve is based on Perpetua's interpretation of AP-42 Chapter 13.2.2. AP-42 Chapter 13.2.2

discusses the critically important variables surrounding control efficiencies (in particular to chemical suppressants, some of which can reasonably be assumed to apply to water too):

> The control effectiveness of chemical dust suppressants appears to depend on (a) the dilution rate used in the mixture; (b) the application rate (volume of solution per unit road surface area); (c) the time between applications; (d) the size, speed and amount of traffic during the period between applications; and (e) meteorological conditions (rainfall, freeze/thaw cycles, etc.) during the period. Other factors that affect the performance of dust suppressants include other traffic characteristics (e. g., cornering, track-on from unpaved areas) and road characteristics (e. g., bearing strength, grade). The variabilities in the above factors and differences between individual dust control products make the control efficiencies of chemical dust suppressants difficult to estimate. Past field testing of emissions from controlled unpaved roads has shown that chemical dust suppressants provide a PM-10 control efficiency of **about 80 percent when applied at regular intervals of 2 weeks to 1 month (**emphasis added)**.**

39. None of the above variables, however, have any specific and enforceable permit conditions within the PTC to ensure a 93.3% control efficiency. Instead, the PTC has a permit condition (permit condition 2.6) only requiring the permittee to develop and submit the FCDP and HRCP, which merely describe how these variables will be addressed 30 days before start-up of the SGP. Permit condition 2.6 details what variables contributing to PM_{10} control effectiveness must be detailed in the FCDP, but the specific details that are so important to control efficiency (e.g., the amount of water or chemical suppressants applied and the frequency of application) are undetermined at present and are left to Perpetua to decide at a later date. A lesser control efficiency, even just slightly lesser, could result in large enough PM_{10} emissions to violate the NAAQS. In fact, if the SGP were to instead achieve 80% control (as EPA found through past field testing of chemical dust suppressants), then the SGP's PM_{10} emissions could exceed the NAAQS.

40. Third, DEQ relied on monitoring and record keeping (permit condition 3.16) using devices and methodologies in the Operation and Maintenance ("O&M") Manual for the

potential to emit limit associated with the 180,000 tons per day hauling in permit condition 3.5. However, the O&M Manual has not yet been developed, submitted to the public for comment, or reviewed and revised by DEQ. Further, the PTC itself does not include all monitoring, recordkeeping, and reporting necessary to assure compliance with the permit emission limitations and applicable requirements.

41. Fourth, DEQ assumed there would be 120 days of recordable precipitation at the SGP (defined as recording precipitation of 0.01 inch or greater) as a variable in its ore haul road fugitive PM emission calculations. This 120 days comes from general geographic guidance from AP-42 Chapter 13.2.2-1. DEQ, however, should have used local meteorological data. Section 6.8 (Meteorological Data) of DEQ's *Guideline for Performing Air Quality Impact Analyses* states: "The meteorological data used in the modeling analysis should be representative of the meteorological conditions at the particular site of the proposed construction or modification." Days of recordable precipitation is an important variable affecting the SGP's emissions of PM_{10} from ore haul roads. DEQ's failure to use the most representative site data is counter to this guidance and increases the risk of miscalculation of ore haul road emissions. As a result, DEQ failed to ensure PM_{10} emissions from the SGP will comply with the NAAQS.

C. Arsenic Pollution & Regulation

42. Arsenic is a naturally occurring element in soils and minerals. When soil or rock containing arsenic is disturbed, arsenic may enter the air, water, and land from wind-blown dust and from run-off and leaching. The EPA classifies inorganic arsenic as a "human carcinogen," based on evidence in human studies of links to lung, bladder, kidney, skin, and liver cancers.

43. Arsenic released from the soil and rock as airborne dust causes environmental damage. Airborne arsenic pollutes soil, plants, and water resources when it is removed from the

air by rain, snow, or gradually settling. Studies have shown that there is a strong correlation between arsenic concentrations in water and in the tissues of fish collected from arsenic-polluted waters. Plants may also absorb arsenic in their leaves and root system from arsenic-polluted soil. The health effects of long-term ingestion of arsenic include developmental effects, diabetes, pulmonary disease, cardiovascular disease, and skin, bladder, or lung cancer.

44. Arsenic is a Toxic Air Pollutant regulated by DEQ. DEQ is required to ensure that no permit to construct shall be granted for a new or modified stationary source unless emissions of TAPs from the constructed source would not injure or unreasonably affect human or animal life or vegetation as required by Section 161. IDAPA 58.01.01.203.03. Section 161 states, "any contaminant which is by its nature toxic to human or animal life or vegetation shall not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation." IDAPA 58.01.01.161.

45. To comply with these TAPs regulations, emissions from a facility must not exceed the Acceptable Ambient Concentrations of Carcinogens ("AACC") at the ambient air boundary. For each carcinogenic TAP, IDAPA 58.01.01.586 lists the applicable TAP and its AACC in ug/m^3 as an annual average. The AACC can practically be defined as the concentration of a TAP that, if an individual was exposed to yearly over a 70-year lifetime, would equate to a cancer development probability risk of 1 in 1,000,000. *See* IDAPA 58.01.01.006.125 & 58.01.01.210.12.

46. In order to determine a facility's TAP concentration at their ambient air boundary, and as noted similarly for PM_{10} emissions, DEQ must assess air impacts using maximum

potential emissions as limited by either the capacity of the unit/operation or as limited by enforceable permit provisions. *See* IDAPA 58.01.01.006.88.

D. Arsenic Pollution from the SGP & Flaws in the PTC

47. There are numerous arsenic sources at the SGP, including drilling, blasting, excavating, hauling, silos, rock dumps, and storage and tailing piles. Table 3 in the SGP TAPs Addendum indicates that the maximum arsenic Potential Total Emissions ("PTE") is 0.544 lbs/hr at the maximum mine production rate of 180,000 tons/day. The largest source of arsenic emissions are haul roads estimated at 0.464 lbs/yr (Table B1-W3 in SOB). PTE estimates for arsenic are calculated using the same formulas and Emission Factors as total particulate and PM_{10} emission rates. As such, like the PM and PM_{10} emission estimates discussed already, the arsenic emission estimates are similarly underestimated and equally unreliable.

48. During the permitting process, DEQ determined that the SGP's estimated arsenic emissions and concentrations at the ambient air boundary were excessive and would not meet the AACC for arsenic. To get around this problem, Perpetua chose to employ a process known as T-RACT. T-RACT is a demonstration that allows a permittee to analyze and employ reasonably available control technologies ("RACT") that could be applied to a source of TAPs. If RACT does not sufficiently reduce toxic emissions to below the AACC, then the permittee is allowed a 10-fold increase in the AACC and can employ production limitations to ensure compliance with the now 10-times-bigger AACC. These production limitations should then be incorporated as enforceable permit conditions. *See* IDAPA 58.01.01.210.13–14.

49. As part of the T-RACT determination process, the applicant must supply, and DEQ must consider, information on a variety of factors relevant to determining a "reasonable"

control technology including, but not limited to, control effectiveness, economic costs, operational feasibility, and associated environmental impact. IDAPA 58.01.01.210.14a–d.

50. Perpetua submitted to DEQ a T-RACT demonstration for arsenic emissions from open-pit drilling and ore haul roads. Perpetua determined that the most effective RACT for open-pit drilling was dry drilling with dust collectors and that the most effective RACT for ore haul roads was water sprays and chemical suppressants. In its T-RACT demonstration, Perpetua included limited qualitative discussion, and no quantitative support, regarding economic considerations. Perpetua failed to provide any discussion of environmental impacts.

51. DEQ approved Perpetua's T-RACT demonstration and granted Perpetua a 10-fold increase in allowable arsenic pollution, subject to operational limitations to reduce PTE. And as modeled by DEQ, arsenic pollution from the SGP would comply with this larger AACC.

52. DEQ's approval of Perpetua's T-RACT demonstration for arsenic, and its analysis determining the SGP will not exceed the AACC and thus will not injure or unreasonably affect human or animal life or vegetation, is flawed.

53. First, the T-RACT demonstration contained no persuasive economic information and no discussion at all regarding associated environmental impacts, despite the requirements to do so in IDAPA 58.01.01.210.14. There will be water quality and biological impacts associated with Perpetua's use of substantial amounts of chemical dust suppressants and water that have not been considered in the PTC. For example, the use of chemical dust suppressants like magnesium chloride can cause toxicity in trees and can lead to tree death. Magnesium chloride is also known to adversely affect aquatic ecosystems. Moreover, the proposed water source for dust control is primarily water collected in runoff ponds (captured rain or snowfall that has become contaminated through the contact of mine facilities), groundwater, and surface water from the

East Fork of the South Fork of the Salmon River. USGS sampling indicates elevated arsenic in these waters. The environmental impact of using magnesium chloride or arsenic-polluted water as dust suppression methods was never considered as part of the T-RACT demonstration. Likewise, the T-RACT demonstration did not provide sufficient economic support for Perpetua's decision to use water and chemical dust suppressants as compared to paving the haul roads, even though paving was shown to achieve the highest reasonable dust control efficiency.

54. Second, because the underlying particulate and PM_{10} emissions estimates and particulate control assumptions are unreliable in numerous respects, as already discussed above, so too are the estimated arsenic emissions. The SGP's estimated arsenic emissions were based on its PM_{10} emissions. PM_{10} emissions from the SGP may be higher, and their control effectiveness may be lower, than DEQ assumed, in which case arsenic emissions would also be higher and might exceed the AACC.

55. Third, Perpetua's and DEQ's TAPs analyses substantially reduce the SGP's purported arsenic emissions using three improper averaging tactics: (1) averaging emissions over a 5-year period for the T-RACT input to ambient toxics modeling; (2) averaging the estimated annual ambient modeling impacts across two multi-year scenarios; and (3) averaging the resultant 16-year total emissions over the 70-year human lifetime to assert compliance. Nothing in the Idaho Air Rules allows for multi-year emissions averaging and ambient air concentration adjustments. Rather, the arsenic AACC is an annual average. *See* IDAPA 58.01.01.586). DEQ's T-RACT regulations require comparing the estimated maximum annual ambient air arsenic concentration to 10 times the listed annual AACC. IDAPA 58.01.01.12.b. Therefore, to determine compliance with the AACC requires that DEQ estimate the SGP's maximum 1-year annual arsenic emissions and compare it to the annual arsenic AACC.

56. By relying on these improper averaging tactics, DEQ fails to show the SGP will satisfy the arsenic AACC and the resulting analysis masks potentially severe human health and environmental impacts of SGP's potential arsenic emissions. The underlying analyses supporting the TAPs requirements allows for a 1-in-1,000,000 excess cancer risk factor. The T-RACT approval increases that risk 10-fold to a 1-in-100,000 excess cancer risk factor. IDAPA 58.01.01.12.b. Perpetua's multi-year averaging of emission rates combined with DEQ's decision to allow the full lifetime exposure (70 years) to be imposed on receptors during the 16-year estimated life of mine increases the cancer risk by another order of magnitude to the 1-in-10,000 range or higher. Combined with uncertainties associated with the underlying particulate emissions calculations noted above, the SGP may result in extremely dangerous arsenic exposures.

57. Excacerbating this cancer risk is the fact that under DEQ's incremental TAPs regulations (*see* IDAPA 58.01.01.585), when DEQ considers permitting any additional sources of arsenic in the area over the next 70 years (such as an extension of the life of the SGP, expansion of the facility itself, and/or any adjacent facilities seeking a similar permit, like the potential Horse Heaven project), DEQ will not have to consider the arsenic emissions authorized by this PTC.

E. DEQ's Ambient Air Boundary for the SGP

58. The Clean Air Act and Idaho Air Rules require meeting various air standards, including the NAAQS and TAPs, in ambient air. *See*, *e.g.*, IDAPA 58.01.01.006.11 (NAAQS), 58.01.01.006.125 (TAPs). EPA defines "ambient air" as "that portion of the atmosphere, external to buildings, to which the general public has access." 40 C.F.R. § 50.1(e). In defining an ambient air boundary, the EPA has long followed a policy that exempts "the atmosphere over land owned

or controlled by the source and to which public access is precluded . . .” from ambient air. EPA’s Revised Policy on Exclusions from “Ambient Air” (Nov. 2018) states that “it is appropriate to exclude the atmosphere over land owned or controlled by the stationary source, where the owner or operator of the source employs measures, which may include physical barriers, that are effective in deterring or precluding access to the land by the general public.”

59. The Idaho Air Rules define “ambient air” as “[t]hat portion of the atmosphere, external to building, to which the general public has access.” IDAPA 58.01.01.005.09. To exclude areas from consideration as ambient air, the following conditions must be met: (1) the permittee must have the legal authority to exclude the general public from the area; (2) the boundary to ambient air must be clearly discernible to the general public; (3) the general public must be effectively precluded from assessing the facility; and (4) the general public is not considered employees of the facility; those having official business with the facility; guests of the facility, including participants in facility routes and those seeking access for a specific purpose.

60. Perpetua established an operations boundary (the active industrial site where mining activities and heavy equipment operation will occur) for the purposes of excluding this area from ambient air analysis, and for excluding public access. The area includes the current Stibnite Road point of entry and proposed site access via the Burntlog Route. According to Perpetua, access inside the operations boundary will be restricted for the life of the mine by physical barriers at points of potential access, as well as natural features of the landscape that prevent public access.

61. DEQ’s determination to exclude the access route from ambient air protections is flawed.

62. Perpetua has indicated that it intends to allow access to the general public through the mine site between Stibnite Road at Sugar Creek and Thunder Mountain Road at Meadow Creek. Furthermore, this roadway is currently accessible to and has been regularly used by the general public. And while Perpetua claims that it has "legal and practical ability to enforce its control over roadway access," the Forest Service has not yet completed its NEPA analysis and approval of the SGP, which would include a decision on whether it will require or will not permit general public access through the mine site.

63. DEQ states that the route would be managed in accordance with the Stibnite Road Access Management Plan ("AMP"). DEQ, however, relied on an ambiguous description of measures and requirements to preclude public access and ensure that those traveling over the road can be classified as "guests" of the mine.

64. PTC condition 2.7 requires the development of an AMP to address whether the NAAQS apply to the mine's access road through the Perpetua site given the extent of public access allowed. PTC condition 2.8 allows the AMP to be developed later, after the PTC was issued and without public comment, and it does not require the AMP to be enforceable. For the AMP to preclude the applicability of the NAAQS along the access road, the AMP must be reviewed and approved by DEQ, it must be reviewed through public comment, and it must be enforceable under the PTC.

65. Without full disclosure and knowledge of the exact measures and requirements in the AMP and enforceable permit limits, DEQ cannot make a determination of whether exclusion of the access road from ambient air protections complies with EPA's ambient air policy and the Idaho Air Rules, nor can DEQ determine whether the SGP will comply with the NAAQS and TAPs.

F. DEQ's Failure to Require Ambient Air Monitoring for the SGP

66. DEQ has the authority to require ambient air monitoring to determine the effect emissions from the stationary source or facility may have on the air quality of the area potentially impacted by the source. IDAPA 58.01.01.211.01(d).

67. DEQ received comments from the Nez Perce Tribe, EPA Region 10, ICL, and SSFS urging the PTC to require ambient air monitoring to verify the SGP's compliance with the NAAQS and TAPs increments. But DEQ declined, stating in the Response to Comments (pg. 16): "DEQ disagrees that a PM/PM_{10} ambient monitoring network is necessary to make the PTC practically enforceable." DEQ states in the Response to Comments that any violation of the permit would be processed in accordance with DEQ's enforcement procedures manual.

68. However, without ambient air monitoring, it will be impossible for DEQ to assess whether the SGP's operation is in compliance with NAAQS and TAPs increments at any given time. Ambient air monitoring is necessary because of the large uncertainty surrounding dust control efficiency and emissions factors associated with the SGP for PM_{10} and arsenic, as well as the lack of enforceable permit conditions for many important variables, as already described in this Petition.

RELIEF REQUESTED

69. An agency action, like DEQ's issuance of the PTC, may be reversed if it is in violation of constitutional or statutory provisions, is in excess of statutory authority, is made on unlawful procedure, or is arbitrary, capricious or an abuse of discretion. I.C. § 67-5279. When an agency action is not affirmed, it shall be set aside, in whole or in part, and remanded for further proceedings as necessary. *Id.*

70. As stated above, under the Idaho Air Rules, DEQ must not issue a PTC unless it determines: (1) "the stationary source or modification would comply with all applicable local, state or federal emission standards"; (2) "the stationary source would not cause or significantly contribute to a violation of any ambient air quality standard"; and (3) "the emissions of toxic air pollutants from the stationary source or modification would not injure or unreasonably affect human or animal life or vegetation as required by Section 161." IDAPA 58.01.01.203. Based on the flaws in DEQ's issuance of the PTC described above, DEQ's action is in violation of these provisions of the Idaho Air Rules and is otherwise arbitrary, capricious, and an abuse of discretion and must be reversed.

71. By issuing the PTC in its current form, DEQ failed to adequately protect the public and environment from harmful air pollution causing injury to the Nez Perce Tribe, ICL, SSFS, and their members and supporters. To redress these injuries, Petitioners respectfully request the Board set aside and remand the PTC and direct DEQ to correct the following errors prior to issuing any new or revised PTC:

Ore Haul Road PM_{10} & Arsenic Emissions

A. DEQ must develop and include in the PTC enforceable permit conditions for the maximum average empty weight of ore haul trucks, the maximum average loaded weight of ore haul trucks, the maximum total number vehicle miles traveled annually by ore haul trucks, the silt content of the roadbed, the arsenic content of the silt in the roadbed, and any other important variables affecting the SGP's fugitive emissions of PM_{10} and arsenic from vehicle traffic on mine haul roads. To develop such permit conditions and ensure compliance with the NAAQS and TAP limits, DEQ must reevaluate and recalculate fugitive emissions of PM_{10} and arsenic.

B. Silt and arsenic levels should be included as permit conditions and monitored regularly *in situ,* rather than from stockpiles as applied to the roadbed.

C. Instead of assuming 120 days of recordable precipitation at the SGP as a variable within ore haul road fugitive PM emission calculations, as done by the applicant based off general geographic guidance from AP-42 chapter 13.2.2-1, DEQ must recalculate all fugitive emissions after analyzing local meteorological data sources to determine a more accurate and representative number of days with recordable precipitation.

FDCP, AMP, O&M Manual, & HRCP

D. DEQ must require Perpetua to submit the FDCP, AMP, O&M Manual, and HRCP (collectively, "Plans"), must provide for public comment on the Plans, must review and revise Plans to ensure the SGP's emissions comply with IDAPA 58.01.01.203, and must incorporate the Plans as enforceable PTC conditions.

Arsenic Averaging

E. DEQ must remove the 5-year averaging for arsenic emissions, the averaging of estimated annual ambient modeling impacts across two multi-year scenarios, and the 16/70 life of mine versus lifetime exposure adjustment for the SGP's maximum arsenic ambient concentration it used to assess arsenic TAPs compliance. DEQ must use the SGP's highest 1-year arsenic emission rates for each scenario evaluated and repeat the modeling analyses using these rates. DEQ must use the maximum annual ambient arsenic concentration from the single emission scenario producing the highest annual concentration for any 1-year as the point of compliance. *See* IDAPA 58.01.01.210.03b ("The point of compliance is the receptor site that is estimated to have the highest ambient concentration of the toxic air pollutant of all the receptor sites that are located either at or beyond the facility property boundary or at a point of public

access . . . ."). DEQ must assess the impact of the SGP's maximum 1-year annual emissions from the single emission configuration by comparing to the T-RACT AACC for arsenic (10 times the AACC value published in IDAPA 58.01.01.586), without averaging over multiple years, and without adjusting for the alleged 16-year life of the mine or the 70-year lifetime exposure.

Ambient Air Boundary Monitoring

F. As part of any PTC for the SGP, DEQ must require ambient air boundary monitoring, as provided for by IDAPA 58.01.01.211.01(d), to ensure compliance with the NAAQS and the TAPs increments. DEQ must require Perpetua to submit an ambient air boundary monitoring plan ("AABMP"), must take public comment on the AABMP, must review and revise the AABMP, and must incorporate the AABMP as enforceable PTC conditions. At a minimum, the AABMP must provide a strategy for monitoring the ambient air concentrations of PM_{total}, PM_{10}, $PM_{2.5}$ and arsenic at the SGP's ambient air boundary. The AABMP must be developed according to best industry and regulatory practices, consulting contemporary sources (e.g., DEQ or EPA guidance, similarly established plans for other state permits, etc.). At a minimum, monitoring stations must be required for areas of the ambient air boundary in which DEQ ambient air modeling results (specifically results using operating scenario W3 and BULKRN meteorological data) show receptors with 24-hour PM_{10} or arsenic concentrations within 70% of the applicable NAAQS or AACC (without consideration to multi-year emissions averaging and 16/70 adjustment).

Environmental & Economic Impacts of Arsenic Control Technology

G. DEQ must require Perpetua to update their T-RACT analysis to include analysis of "environmental impacts caused by the control technology that cannot be mitigated, including, but not limited to, water pollution and the production of solid wastes," including the use of

magnesium chloride and its aquatic life and tree toxicity effects, as well as using arsenic-contaminated water sources for dust suppression. IDAPA 58.01.01.210.14.c.ii. DEQ must also require the updated T-RACT to adequately address the "economic feasibility of a control technology or other requirement, including the costs of necessary mitigation measures, for a particular source," including detailed consideration of the economic feasibility of paving haul roads to better control fugitive dust emissions. IDAPA 58.01.01.210.14.d. DEQ must provide the updated T-RACT demonstration for public comment, must review and revise the T-RACT demonstration, and must incorporate enforceable PTC conditions from the T-RACT demonstration in the PTC.

CONCLUSION

72. When it issued the PTC for the SGP, DEQ failed to comply with critical requirements of the federal Clean Air Act, the Idaho Air Rules, and related regulations and guidance. Accordingly, the Board should vacate and withdraw the PTC and remanded to DEQ to correct all errors.

Dated: July 22, 2022

Respectfully submitted,

/s/ Bryan Hurlbutt
Bryan Hurlbutt
Attorney for the Nez Perce Tribe and the Idaho Conservation League

/s/ Julia Thrower
Julia S. Thrower
Attorney for Save the South Fork Salmon

CERTIFICATION OF SERVICE

I hereby certify that on this July 22, 2022, I caused a true and correct copy of the foregoing PETITION TO INITIATE CONTESTED CASE to be served upon the following persons:

Via Email:

Paula Wilson, Hearing Coordinator
Idaho Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706-1255
paula.wilson@deq.idaho.gov

Hannah Young
Deputy Attorney General
Idaho Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
hannah.young@deq.idaho.gov

/s/ Bryan Hurlbutt
Bryan Hurlbutt

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioner, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent.	Case Docket No. 0101-22-01 NOTICE OF FILING AND SERVICE OF PETITION

NOTICE IS HEREBY GIVEN that:

1. A Petition to Initiate Contested Case was filed with the Idaho Board of Environmental Quality on July 22, 2022.

2. In accordance with IDAPA 58.01.23.800.01.b, a true and correct copy of the Petition is hereby served on the Department of Environmental Quality and on the permit holder/permit applicant as provided below.

On Behalf of the Department of Environmental Quality:

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

On Behalf of Permit Holder/Permit Applicant:

Alan Haslam, Vice President – Permitting
405 South 8th Street, Suite 201
Boise, ID 83702
Alan.Haslam@Perpetua.us
via electronic service

3. Pursuant to IDAPA 58.01.23.008.01.b and 352.02, in any proceeding involving a

permit, a petition to intervene by the permit applicant or permit holder must be filed within twenty-one (21) days after the date of service of this petition. Permit applicants or permit holders may be bound by any decision rendered in this proceeding.

Dated this 22nd day of July 22, 2022

Paula J. Wilson
Hearing Coordinator
Department of Environmental Quality
1410 N Hilton, Boise ID 83706
(208)373-0418
paula.wilson@deq.idaho.gov

CERTIFICATE OF SERVICE

I hereby certify that on this 22nd day of July 2022, a true and correct copy of the **Notice of Filing and Service of Petition** was served on the following:

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Alan Haslam, Vice President – Permitting
405 South 8th Street, Suite 201
Boise, ID 83702
Alan.Haslam@Perpetua.us
via electronic service

Paula J. Wilson

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent.	Case Docket No. 0101-22-01 NOTICE OF APPOINTMENT OF HEARING OFFICER

NOTICE IS HEREBY GIVEN that, in accordance with IDAPA 58.01.23.003; IDAPA 04.11.01.410, Dylan B. Lawrence has been appointed as hearing officer by the Idaho Board of Environmental Quality.

Dated this 28th day of July, 2022.

Paula J. Wilson, Hearing Coordinator
Department of Environmental Quality
1410 N Hilton, Boise ID 83706
(208)373-0418/Fax No. (208)373-0481
Paula.wilson@deq.idaho.gov

CERTIFICATE OF SERVICE

I hereby certify that on this 28th day of July, 2022, a true and correct copy of the **Notice of Appointment of Hearing Officer** was served on the following:

Dylan B. Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylanlawrence@varinwardwell.com
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Alan Haslam, Vice President – Permitting
405 South 8th Street, Suite 201
Boise, ID 83702
Alan.Haslam@Perpetua.us
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service



Paula J. Wilson

LAWRENCE G. WASDEN
Attorney General

DARRELL G. EARLY
Deputy Attorney General
Chief, Natural Resources Division

JOHN R. SHACKELFORD (ISB# 8647)
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: (208) 373-0453
Facsimile: (208) 373-0481
john.shackelford@deq.idaho.gov

Attorneys for Respondent

BEFORE THE DEPARTMENT OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent.	Case Docket No. 0101-22-01 RESPONSE TO PETITION TO INITIATE CONTESTED CASE: AIR PERMIT TO CONSTRUCT P-2019.0047 (JUN. 17, 2022)

COMES NOW, Respondent, the Idaho Department of Environmental Quality (Department), by and through the Office of the Attorney General, and hereby submits this Response to Petition to Initiate Contested Case in accordance with the Contested Case Rules & Rules for Protection & Disclosure of Records, IDAPA 58.01.23.161, in response

to the Petition to Initiate Contested Case filed by Petitioners Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon on July 22, 2022 ("Petition").

FACTUAL AVERMENTS

The Department cannot separately admit or deny each fact alleged in the Petition because the factual averments were not made separately. Moreover, the Petition is written in the style of a legal brief, which intermingles the Petitioners' alleged facts with their arguments. Therefore, it difficult to discern whether a statement is a factual averment, argument, a conclusion of law or a combination of any of these. For this reason, any statements of fact set forth in the Petition that are not explicitly admitted or agreed upon, are hereby denied. Without waiving this objection, the Department responds as follows:

A. "INTRODUCTION" Section

The Department agrees with the facts alleged in Paragraph One. The Department admits that the Stibnite Gold Project ("SGP") is located approximately ten miles east of the town of Yellow Pine, Idaho, but has insufficient information to admit or deny the claim that the SGP is located with the Nez Perce Tribe's aboriginal homeland, as stated in Paragraph Two. The Department generally agrees with the statements in Paragraph Three but does not agree with the characterization of dust emissions, which are described as "massive." The Department denies the statements in Paragraph Four.

The Department will abide by the request for service in Paragraph Five and admits the statement of jurisdiction in Paragraph Six. Paragraphs Seven and Eight contain no facts which can be admitted or denied. The Department has insufficient information regarding the Nez Perce Tribe to admit or deny the factual averments in Paragraphs Nine through Thirteen. However, whether the Nez Perce Tribe has standing, a conclusion of

law asserted within Paragraph Ten, is disputed, and therefore denied. The Department denies the claim in Paragraph Twelve that the Nez Perce Tribe will suffer injuries from permitted dust emissions at the SGP.

Similarly, the Department can neither admit nor deny the assortment of factual averments scattered throughout Paragraphs Fourteen through Nineteen, which generally describe the constituencies, goals, and activities of the Petitioners, Idaho Conservation League and Save the South Fork Salmon. Again, whether Idaho Conservation League and Save the South Fork Salmon have standing, a conclusion of law asserted within Paragraphs Fifteen and Eighteen, is disputed, and therefore denied. The Department admits that all the Petitioners submitted multiple comments to the Department regarding the Department's Permit to Construct ("PTC"). However, the Department denies the statements claiming that these entities will suffer injuries from permitted dust emissions. The Department admits the statements in Paragraphs Twenty and Twenty-One.

B. **Section I "Overview of SGP & Chronology of DEQ's Issuing the PTC"**

The Department agrees with the course of events as set forth in Paragraphs Twenty-Two through Twenty-Six. However, the Department avers that the permittee, Perpetua Resources Idaho, Inc. ("Perpetua"), followed the Department's process of submitting a draft permit and then responding to requests for further information from the Department.

C. **Section II A, "PM_{10} Pollution and Regulation"**

The Department generally agrees with the statements of fact and the directly cited materials provided in Paragraphs Twenty-Eight through Thirty-Two.

D. **Section II B, "PM_{10} Pollution from the SGP & Flaws in the PTC"**

The Department largely agrees with the statements in Paragraph Thirty-Three, except that the generation of dust from trucks traveling along haul roads is estimated to be approximately 55% of all *fugitive mining* emissions, or 53% of all modeled PM_{10} emissions. The statements in Paragraph Thirty-Four appear to be correct.

Paragraphs Thirty-Five through Forty-One contain mixed statements of fact and argument, which must be denied. Generally, the Department agrees that the Fugitive Dust Control Plan and Haul Road Capping Plan will be important for ensuring compliance with air quality standards. Those plans are subject to the Department's approval, and individual provisions within each plan will be enforceable through the PTC. Thus, the Department denies the assertions that those plans are not directly enforceable.

E. **Section II C, "Arsenic Pollution & Regulation"**

The Department agrees with the Petitioners' description of arsenic as a toxic air pollutant in Paragraphs Forty-Two through Forty-Five. The Department neither admits nor denies the statement in Paragraph Forty-Six, which references the definition of "Potential to Emit/Potential Emissions" at IDAPA 58.01.01.006.88.

F. **Section II D, "Arsenic Pollution from the SGP & Flaws in the PTC**"

The Department largely agrees with the substance of Paragraphs Forty-Seven through Forty-Nine. Regarding Paragraph Fifty, the Department agrees that Perpetua submitted to the Department a T-RACT demonstration. The Department agrees with the statements in Paragraph Fifty-One but denies the allegations in Fifty-Two through Fifty-Seven.

G. **Section II E, "DEQ's Ambient Air Boundary for the SGP"**

The Department agrees with the averments in Paragraphs Fifty-Eight, Fifty-Nine, and Sixty; however, the definition of "ambient air" is found at IDAPA 58.01.01.006.10. The Department disagrees with the arguments contained in Sixty-One through Sixty-Five.

H. **Section II F, "DEQ's Failure to Require Ambient Air Monitoring for the SGP"**

The Department agrees with the statements in Paragraphs Sixty-Six and Sixty-Seven but disagrees with the arguments in Paragraph Sixty-Eight.

LEGAL AUTHORITY

As indicated in the Petition, the permit at issue in this contested case was issued pursuant to Title 39 Idaho Code and the Rules for the Control of Air Pollution in Idaho, IDAPA 58.01.01 *et. seq*.

ADDITIONAL FACTS

The Department's Air Quality Permitting Response to Public Comments (June 17, 2022) contains the factual underpinnings supporting the issuance of the PTC as well as the Department's positions on fugitive dust control efficiency (Third Response to Comments 1-4), monitoring, recordkeeping, and reporting (Third Response to Comments 5-9), operational plans (Third Response to Comments 10-18), estimation of potential emissions (Third Response to Comments 19-30), the applicability of "ambient air" standards (Comments 35-36), and the T-RACT process (Comment 39-41). The Response to Public Comments is located on the Department's website at https://www2.deq.idaho.gov/admin/LEIA/api/document/download/16969.

The Department's PTC issued to Perpetua is located on the Department's website at https://www2.deq.idaho.gov/admin/LEIA/api/document/download/16954.

The Statement of Basis is located on the Department's website at https://www2.deq.idaho.gov/admin/LEIA/api/document/download/16956.

These documents contain the additional facts relied upon by the Department.

RELIEF SOUGHT

The Department requests the Board issue an order affirming the Department's action in issuing the PTC.

DATED: August 12, 2022, FOR RESPONDENT:

STATE OF IDAHO, DEPARTMENT OF ENVIRONMENTAL QUALITY

By: /s/ *John R. Shackelford*
John R. Shackelford
Attorney for Respondent

CERTIFICATE OF SERVICE

I HEREBY CERTIFY that on this 12th day of August, 2022, a true and correct copy of the foregoing RESPONSE TO PETITION TO INITIATE CONTESTED CASE was served on the following via electronic mail to the indicated address:

Hearing Coordinator
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706-1255
paula.wilson@deq.idaho.gov
via electronic service

Dylan B. Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylanlawrence@varinwardwell.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Alan Haslam, Vice President – Permitting
405 South 8th Street, Suite 201
Boise, ID 83702
Alan.Haslam@Perpetua.us
via electronic service

Patricia Jordan
Patricia Jordan, Legal Assistant

Krista K. McIntyre, ISB No. 4675
Wade C. Foster, ISB No. 11105
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000
krista.mcintyre@stoel.com
wade.foster@stoel.com

Attorneys for Perpetua Resources, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent.	Case Docket No. 0101-22-01 **PETITION TO INTERVENE**

I. INTRODUCTION

Perpetua Resources Idaho, Inc. ("Perpetua"), hereby petitions to intervene as a party in the above-entitled matter pursuant to IDAPA 58.01.23.352 and .353. A Petition to Initiate Contested Case ("Petition"), filed by the Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon (collectively "Protestants"), challenges the Permit to Construct, Permit No. P-2019.0047 ("Permit") issued to Perpetua on June 17, 2022 by the Idaho Department of Environmental Quality ("IDEQ"). The Permit authorizes Perpetua to begin development of the

Stibnite Gold Project ("SGP"), consisting of conventional open-pit mining, ore preparation, and gold extraction operations. Protestants challenge of the Permit is legally and factually unsupported. Perpetua seeks to intervene in this proceeding to fully respond to Protestants' allegations and defend the Permit.

II. LISTING OF REPRESENTATIVES

Pursuant to IDAPA 58.01.23.040, copies of all pleadings, correspondence, and official documents shall be served on Perpetua's counsel listed below:

Krista K. McIntyre
Stoel Rives LLP
101 S. Capitol Boulevard
Suite 1900
Boise, ID 83702
Email: krista.mcintyre@stoel.com

Wade C. Foster
Stoel Rives LLP
101 S. Capitol Boulevard
Suite 1900
Boise, ID 83702
Email: wade.foster@stoel.com

III. BACKGROUND

Perpetua is an Idaho corporation authorized to conduct business in the State of Idaho. Perpetua's corporate office is located at 405 South 8th Street, Suite 201, Boise Idaho 83702.

In August 2019, Perpetua applied to IDEQ for a permit to construct the SGP pursuant to the *Rules for the Control of Air Pollution in Idaho*, IDAPA 58.01.01. IDEQ thoroughly reviewed Perpetua's application for nearly three years. During that time, and as part of IDEQ's review, Perpetua submitted additional information as requested by IDEQ in support of its application. IDEQ provided three public comment periods on drafts of the permit, including an extended sixty-day public comment period for interested parties that began on December 9, 2021. When IDEQ issued the final Permit on June 17, 2022, IDEQ prepared a detailed Statement of Basis supporting the Permit, and a thorough and complete Response to Comments. The Permit was issued in compliance with the *Rules for the Control of Air Pollution in Idaho*. IDAPA 58.01.01.

On July 22, 2022, IDEQ served Perpetua with the Notice of Filing and Service of Petition and a copy of the Petition.

IV. ARGUMENT

Petitions to intervene filed by the permit applicant or permit holder must be filed within twenty-one (21) days after service of the initiating petition. IDAPA 58.01.23.352.02. A permit applicant or permit holder may intervene as a matter of right in any contested case in which the permit is contested. IDAPA 58.01.23.353.01.

The Notice of Filing and Service of Petition was served on Perpetua on July 22, 2022. Perpetua files this petition to intervene on August 12, 2022. Therefore, this petition to intervene is timely as it is filed within twenty-one days of service of the Petition. Further, Perpetua, as the holder of the Permit contested in this proceeding, is entitled to intervene as a matter of right. Finally, Perpetua has a direct and substantial interest in this proceeding as Protestants challenge the Permit authorizing Perpetua to begin development of the SGP.

V. CONCLUSION

Perpetua as the holder of the Permit contested in this proceeding is entitled to intervene as a matter of right, to participate in these proceedings fully, respond to the allegations in Protestants' Petition and, if a contested case hearing is held, to provide any relevant evidence concerning the Permit and the legality of the Permit.

DATED: August 12, 2022.

STOEL RIVES LLP

Krista K. McIntyre
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

CERTIFICATE OF SERVICE

I hereby certify that on this 12th day of August 2022, a true and correct copy of the **PETITION TO INTERVENE** was served on the following:

Dylan B. Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylanlawrence@varinwardell.com
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Alan Haslam, Vice President – Permitting
Perpetua Resources, Inc.
405 South 8th Street, Suite 201
Boise, ID 83702
Alan.haslam@perpetua.us
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Krista K. McIntyre
Wade C. Foster

Attorneys for Perpetua Resources, Inc.

DYLAN LAWRENCE
VARIN THOMAS LLC
P.O. Box 1676
Boise, ID 83701
(208)345-6021
dylan@varinthomas.com

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v.	Case Docket No. 0101-22-01 ORDER APPROVING PETITION TO INTERVENE
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	

PERPETUA RESOURCES IDAHO, INC. filed a Petition to Intervene on August 12, 2022, and good cause appearing therefore,

IT IS HEREBY ORDERED that said Petition to Intervene is hereby GRANTED.

FURTHER, all documents served in this matter shall also be served on the Intervenor as listed in its Petition to Intervene.

Dated this 22nd day of August, 2022.

Dylan Lawrence
Hearing Officer

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v.	)	Case Docket No. 0101-22-01
	)	CERTIFICATE OF SERVICE
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC., Intervenor.	)	

I hereby certify that on this 22nd day of August, 2022, a true and correct copy of the **Order Approving Petition to Intervene** was served on the following:

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Dylan Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Krista McIntyre
Wade Foster
Stoel Rives LLP
101 S Capitol Blvd., Ste. 1900
Boise, ID 83701
krista.mcintyre@stoel.com
wade.foster@stoel.com
via electronic service

Paula J. Wilson
Hearing Coordinator

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,	)	Case Docket No. 0101-22-01
Petitioners,	)	NOTICE OF PREHEARING CONFERENCE
v.	)	
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC., Intervenor.	)	

Pursuant to IDAPA 58.01.23.300; IDAPA 04.11.01.510 - 514, NOTICE IS HEREBY GIVEN that Dylan Lawrence, the designated presiding officer, will convene a prehearing conference on September 21, 2022, beginning at 10 a.m. MDT in Conference Rooms A and B of the Department of Environmental Quality state office building,1410 N. Hilton, Boise, Idaho. Those who are unable to attend in person may join via Microsoft Teams. The Teams link is in the attached email.

The conference facility meets the accessibility requirements of the Americans with Disabilities Act. To request assistance with accommodations, contact the undersigned by September 12, 2022.

As listed in IDAPA 04.11.01.510, a prehearing conference is held for the following purposes:

1. Formulating or simplifying the issues;
2. Obtaining concessions of fact or identification of documents to avoid unnecessary proof;
3. Scheduling discovery when discovery is authorized before the agency;
4. Arranging for the exchange of proposed exhibits or prepared testimony;
5. Limiting witnesses;
6. Discussing settlement offers or making settlement offers;
7. Scheduling hearings;
8. Establishing procedure at hearings; and
9. Addressing other matters that may expedite orderly conduct and disposition of the proceeding or its settlement.

The prehearing conference will not be recorded.

Dated this 23rd day of August, 2022.

Paula J. Wilson
Hearing Coordinator
Department of Environmental Quality
1410 N Hilton, Boise ID 83706
(208)373-0418/Fax No. (208)373-0481
Paula.wilson@deq.idaho.gov

CERTIFICATE OF SERVICE

I hereby certify that on this 23rd day of August, 2022, a true and correct copy of the **Notice of Prehearing Conference** was served on the following:

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Krista McIntyre
Wade Foster
Stoel Rives LLP
101 S Capitol Blvd., Ste. 1900
Boise, ID 83701
krista.mcintyre@stoel.com
wade.foster@stoel.com
via electronic service

Dylan Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Paula J. Wilson
Hearing Coordinator

From: Paula Wilson
To: Paula Wilson
Subject: FW: In the Matter of Perpetua Air Quality PTC, Case Docket no. 0101-22-01 - NOTICE OF PREHEARING CONFERENCE
Date: Tuesday, August 23, 2022 4:21:09 PM

A prehearing conference has been scheduled for September 21, 2022, at 10am MDT in the DEQ state office conference center. The conference is expected to last 60 to 90 minutes.
Those who are unable to attend in person may join via Microsoft Teams. Details are in the attached Notice of Prehearing Conference; the Teams link is provided below.

Microsoft Teams meeting

Join on your computer or mobile app
Click here to join the meeting
Meeting ID: 258 562 328 077
Passcode: Wuqmez
Download Teams | Join on the web

Or call in (audio only)
+1 208-985-2810,,448066007# United States, Boise
Phone Conference ID: 448 066 007#

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	Case Docket No. 0101-22-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGE, and SAVE THE SOUTH FORK SALMON, Petitioner, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	NOTICE OF APPEARANCE

PLEASE TAKE NOTICE that the undersigned attorney, W. Christopher Pooser of Stoel Rives LLP, hereby appears as counsel of record for Perpetua Resources, Inc. Please send all future notices, pleadings, orders or other communications in this matter on the undersigned counsel at the above listed address.

DATED: September 6, 2022.

STOEL RIVES LLP

/s/ W. Christopher Pooser
W. Christopher Pooser

Attorney for Perpetua Resources, Inc.

CERTIFICATE OF SERVICE

I hereby certify that on this 6th day of September 2022, a true and correct copy of the **NOTICE OF APPEARANCE** was served on the following:

Dylan B. Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Paula J. Wilson
Hearing Coordinator
Idaho Department of Environmental Quality
1410 N Hilton St
Boise, ID 83706
Paula.Wilson@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

/s/ Wade. C. Foster
Wade C. Foster

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 _____ NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGE, and SAVE THE SOUTH FORK SALMON, Petitioner, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	Case Docket No. 0101-22-01 **PERPETUA RESOURCES IDAHO'S MOTION TO DISMISS AND SUPPORTING BRIEF**

Pursuant to IDAPA 58.01.23.161.02 and .162, Perpetua Resources Idaho, Inc. ("Perpetua") respectfully moves to dismiss the Petition to Initiate Contested Case (the "Petition") filed by the Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon ("Petitioners"). Perpetua moves to dismiss the Petition because Petitioners have failed to comply

with the pleading standards of IDAPA 58.01.23.160.01 and otherwise failed to state a claim upon which relief can be granted.

I. INTRODUCTION

In August 2019, Perpetua applied to the Idaho Department of Environmental Quality (the "Department") for a permit to construct for the Stibnite Gold Project (the "SGP"). Nearly three years later, and after numerous Department requests for supplemental information and multiple opportunities for public input and engagement, the Department issued Perpetua a preconstruction permit, Permit to Construct No. 2019.0047 (the "Final Permit"). Petitioners ask the Board of Environmental Quality to set aside and remand the Final Permit on the grounds that the Department's issuance of the permit "failed to comply with" and "is in violation of" the federal Clean Air Act ("CAA"), 42 U.S.C. § 7401, *et seq.*, and "Idaho rules regulations, and guidance for [CAA] permitting." Petition ¶¶ 4, 70, 72.

But nowhere does the Petition cite the governing regulations that the Department allegedly violated. Nowhere does the Petition set forth any claim that would entitle Petitioners to relief. Instead, the Petition is filled with conditions that Petitioners wish the Department would have included in the Final Permit. The Petition is deficient in that it fails to connect Petitioners' wishes to binding regulatory provisions, fails to state facts or identify legal grounds supporting the requested relief, and fails to satisfy the heightened pleading standard of IDAPA 58.01.23.160.01. Accordingly, the Petition must be dismissed.

II. BACKGROUND

The SGP is designed to develop gold and antimony in Valley County, Idaho approximately 10 miles east of Yellow Pine. *See* Petition ¶ 22 (quoting Statement of Basis

("SOB")).[1] Perpetua has three distinct purposes for the SGP: (1) to responsibly produce precious metals as well as critical minerals necessary for the country's energy transformation; (2) to remediate and restore the legacy Stibnite mine site that was abandoned in 2012 by the federal government after decades of mining; and (3) to maintain a strong partnership with the local community.

On August 20, 2019, Perpetua applied to the Department for a Permit to Construct. Petition ¶ 23. The Department's review of Perpetua's application was thorough and comprehensive. It included four requests for additional information to supplement the application, three extended public comment opportunities to solicit feedback from the public and other stakeholders, two informational meetings requested by the public, and three iterations of draft permits. SOB at 9-11. This multi-year, comprehensive process culminated in the issuance of the Final Permit on June 17, 2022. *See* Petition ¶¶ 23-26; SOB at 9-11.

Petitioners fully participated in every public comment opportunity and informational meeting hosted by the Department, repeating critiques of the Department's evaluations and proposed controls of particulate matter ("PM") and toxic air pollutant ("TAP") emissions. *See* Petition ¶¶ 24-26. In response to those critiques, the Department requested, and Perpetua provided, additional information such as hazardous air pollutant ("HAP") and TAP emission inventories and modeling files. *See* SOB at 9-11. The Department also conducted additional modeling evaluations of PM emissions, additional analyses of TAP emissions, and enhanced enforceable permit requirements. *See id*. at 10-11.

[1] The Petition repeatedly references and incorporates information from the Permit and SOB. The Final Permit is attached as Exhibit A. The SOB is available on the Department's website at https://www2.deq.idaho.gov/admin/LEIA/api/document/download/16956.

The Petition repeats the same critiques and comments pressed during the public review periods, seeks more review and work by the Department, and alleges that the Department's actions and the Final Permit are "flawed." *See* Petition ¶¶ 35, 52, 61; *see also id*. ¶ 70. Notwithstanding their active participation in its development, Petitioners are dissatisfied with the Final Permit issued by the Department, but the Petition fails to state facts or identify law sufficient to support allegations that the Department "failed to comply with" or "is in violation of" an applicable law.

III. STANDARD OF REVIEW

A. An agency action may only be reversed if it is contrary to law, arbitrary, capricious, or an abuse of discretion.

An agency action may only be reversed if it is in violation of constitutional or statutory provisions, is in excess of statutory authority, is made on unlawful procedure, or is arbitrary, capricious, or an abuse of discretion. I.C. § 67-5279. The party challenging the agency decision must demonstrate that the agency erred in a manner specified in Idaho Code § 67-5279. *Wheeler v. Idaho Dep't of Health & Welfare*, 147 Idaho 257, 260, 207 P.3d 988, 991 (2009). As shown below, the Petition fails to present the requisite arbitrary and capricious action, an abuse of discretion, or a violation of law to reverse the Final Permit issued by the Department.

B. A petition for a contested case may be dismissed if defective or if it fails to allege facts that, if true, entitle petitioners to the relief requested.

The Board of Environmental Quality's Contested Case Rules, IDAPA 58.01.23, expressly permit a case to be disposed of through a motion to dismiss. IDAPA 58.01.23.162.01; IDAPA 58.01.23.161.02; IDAPA 04.11.01.304 (incorporated by IDAPA 58.01.23.003.04). The

Contested Case Rules also allow all motions recognized under the Idaho Rules of Civil Procedure ("I.R.C.P").[2] IDAPA 58.01.23.162.01.

Unlike I.R.C.P 8(a)(2), which requires "a short and plain statement of the claim showing that the pleader is entitled to relief," the Board's rules require a heightened pleading standard. The Contested Case Rules require a petition for a contested case to: (a) "[f]ully state the facts upon which it is based" and (b) "[r]efer to the particular provisions of statute, rule, order or other controlling law upon which it is based. Legal assertions will be accompanied by citations of cases and statutory provisions[.]" IDAPA 58.01.23.160.01. Thus, the pleading standard under IDAPA 58.01.23.160.01 is akin to the heightened pleading standards of I.R.C.P 9.

I.R.C.P. 12(b)(6) permits the dismissal of a claim if the plaintiffs, or here the petitioners, "fail[] to state a claim upon which relief can be granted." A motion to dismiss under Rule 12(b)(6) tests the legal sufficiency of a complaint. *See Hoffer v. City of Boise*, 151 Idaho 400, 402, 257 P.3d 1226, 1228 (2011). Where a petition fails to meet the heightened pleading standard set forth in the Contested Case Rules, dismissal is appropriate. IDAPA 04.011.01.304 (incorporated by IDAPA 58.01.23.003.04); *see also Jenkins v. Boise Cascade Corp.*, 141 Idaho 233, 239, 108 P.3d 380, 386 (2005) (upholding dismissal of fraud claim because plaintiff failed to plead claim with specificity as required by I.R.C.P. 9); *Fields v. State*, 155 Idaho 532, 534, 314 P.3d 587, 589 (2013) (dismissal appropriate where petition for post-conviction relief failed to meet heightened pleading standards required by statute).

Under I.R.C.P. 12(b)(6), the Board must also determine if the facts alleged in the complaint, if true, are sufficient to entitle the petitioners to the relief requested. *See Hoffer*, 151

[2] This includes motions to dismiss under I.R.C.P. 12(b)(6). *In the Matter of Petition for Review of HWMA/RCRA Hazardous Waste Treatment and Storage Permit Renewal for the AMWTP*, Docket No. 0105-19-01, Amended Order at 3-4 (Sept. 24, 2019).

Idaho at 402, 257 P.3d at 1228. In doing so, the Board must view all the facts and inferences in favor of the petitioners and ask if a claim for relief has been stated. *See id*. "The issue is not whether the plaintiff will ultimately prevail, but whether the party is entitled to offer evidence to support the claims." *Orthman v. Idaho Power Co.*, 126 Idaho 960, 962, 895 P.2d 561, 563 (1995) (internal quotation marks and citation omitted).

To survive an I.R.C.P. 12(b)(6) motion to dismiss, it is not enough for the complaint to make conclusory allegations. *See Owsley v. Idaho Indus. Comm'n*, 141 Idaho 129, 136, 106 P.3d 455, 462 (2005). "Although the non-movant is entitled to have his factual assertions treated as true, this privilege does not extend to the conclusions of law the non-movant hopes the court to draw from those facts." *Id*. (citation omitted). Where all factual allegations in the pleadings, if true, still fail to meet the elements of a claim showing a plaintiff is entitled to relief, dismissal is appropriate. *Orrock v. Appleton*, 147 Idaho 613, 618, 213 P.3d 398, 403 (2009).

When deciding a motion to dismiss under I.R.C.P. 12(b)(6), a court, or the Board, may consider documents incorporated by reference in a pleading without converting the motion to a motion for summary judgment. *Taylor v. McNichols*, 149 Idaho 826, 833, 243 P.3d 642, 649 (2010) (distinguishing between documents referenced in complaint and documents entirely outside the complaint); *Paslay v. A&B Irrigation Dist.*, 162 Idaho 866, 873, 406 P.3d 878, 885 (2017) (Burdick, C.J., concurring in part and dissenting in part) (explaining the Idaho Supreme Court's standard for considering documents referenced in the pleadings on a motion to dismiss).

IV. ANALYSIS

A. The Petition fails to plead a legal basis for remand of the Final Permit.

Perpetua was required to obtain a permit to construct for the SGP by the CAA and Idaho's State Implementation Plan ("SIP"), which is codified at IDAPA 58.01.01 ("Idaho Air

Rules").[3] Petitioners acknowledge that "EPA has delegated to [the Department] authority to issue air quality permits in Idaho." Petition ¶ 32. Although the Petition generally alleges that the Department failed to comply with the CAA, *id.* ¶¶ 4, 72, the Petition does not identify or allege any provision of the CAA that was violated; therefore, Perpetua focuses on the alleged violations of the Idaho Air Rules.

The Petition generally alleges that the Department's action violated statutory and regulatory provisions. *Id.* ¶¶ 4, 72. Petitioners also suggest that the Department's action was otherwise arbitrary, capricious, and an abuse of discretion.[4] *Id.* ¶ 70. While Petitioners generally cite Idaho Code § 67-5279 and suggest that some action of the Department was contrary to law, the Petition never specifically identifies which provisions of the Final Permit are contrary to law. Instead, Petitioners repeatedly allege that the Department's issuance of the Final Permit was "flawed" or "deficient" or contained "shortcomings." Petition ¶¶ 24, 25, 35, 52, 61, 70. But "flawed," "deficient," or containing "shortcomings" are not grounds for relief. *See* I.C. § 67-5279.

As observed by the Department's Response to the Petition (filed Aug. 12, 2022), the Petition is informally presented in the style of a legal brief, intermingling alleged facts, arguments, opinions, suggestions for permit content, and conclusory statements. Consequently, identifying any specifically pled basis for remand in the Petition is very difficult. The Petition contains no "short and plain statement of the claim showing that the pleader is entitled to relief."

---

[3] Idaho's SIP was adopted pursuant to Section 110 of the CAA, 40 U.S.C. § 7410, and approved by the U.S. Environmental Protection Agency. 40 C.F.R. § 52.670. Idaho's SIP has been amended multiple times to remain consistent with federal regulations. *See* 68 Fed. Reg. 2217 (Jan. 16, 2003); 87 Fed. Reg. 31,429 (May 24, 2022).

[4] Petitioners do not allege that the Department acted in excess of its statutory authority. *See* Petition ¶¶ 4, 70, 72.

I.R.C.P. 8(a)(2). And although styled as a legal brief, the Petition fails to plead with any specificity the particular legal bases that would entitle Petitioners to relief and therefore fails to meet the heightened pleading standard of IDAPA 58.01.23.160.01.

Petitioners do not like the Final Permit, and Petitioners oppose the SGP. But dislike of a project or permit is an insufficient basis to remand the Final Permit. Petitioners prefer a different permit, or no permit authorizing the SGP. The Petition is filled with Petitioner's wish list of conditions and speculation about the possible harm from the construction and operation of the SGP. But differences of opinion and speculation of hypothetical harm are insufficient bases to remand the Final Permit. *See Friends of the Columbia Gorge, Inc. v. Schafer*, 624 F. Supp. 2d 1253, 1271 (D. Or. 2008) (a difference of opinion between petitioners and the agency does not provide grounds to remand the agency action).

B. The Petition does not allege any violations of IDAPA 58.01.01.203.

The Petition does not allege that Perpetua failed to demonstrate each of the elements of IDAPA 58.01.01.203 to the satisfaction of the Department. The Petition does not allege that the SGP will violate any of the provisions of IDAPA 58.01.01.203. To be sure, Petitioners acknowledge that Perpetua demonstrated compliance with the elements of IDAPA 58.01.01.203 to the Department's satisfaction. Petition ¶¶ 34, 51. Instead, the Petition generally hypothesizes that Perpetua "could" exceed ambient air quality standards or TAP increments based on speculation and what-if scenarios. Even when liberally construed in favor of Petitioners, the Petition fails to state a claim, or sufficient facts supporting a claim, that the Final Permit is contrary to law.

Under IDAPA 58.01.01.203, to obtain a preconstruction permit for a new stationary source, the applicant must show "to the satisfaction of the Department all of the following:"

01. Emission Standards. The stationary source or modification would comply with all applicable local, state or federal emission standards.

02. NAAQS. The stationary source or modification would not cause or significantly contribute to a violation of any ambient air quality standard.

03. Toxic Air Pollutants. Using the methods provided in Section 210, the emissions of toxic air pollutants from the stationary source or modification would not injure or unreasonably affect human or animal life or vegetation as required by Section 161. Compliance with all applicable toxic air pollutant carcinogenic increments and toxic air pollutant non-carcinogenic increments will also demonstrate preconstruction compliance with Section 161 with regards to the pollutants listed in Sections 585 and 586.

In issuing the Final Permit, the Department found

> [t]he applicant has *demonstrated preconstruction compliance to DEQ's satisfaction* that emissions from this facility will not cause nor significantly contribute to a violation of any ambient air quality standard. The applicant has also *demonstrated preconstruction compliance to DEQ's satisfaction* that the emissions increase due to this permitting action will not exceed any acceptable ambient concentration (AAC) or acceptable ambient concentration for carcinogens (AACC) for toxic air pollutants (TAP).

SOB at 26 (emphasis added). Specific elements of IDAPA 58.01.01.203 are discussed below.

1. In accordance with IDAPA 58.01.01.203.02, Perpetua demonstrated to the satisfaction of the Department that the SGP would not cause or contribute to a violation of the NAAQS, and the Petition fails to state a factual or legal basis for remand of the Final Permit.

In Section II.B of the Petition ("PM_{10} Pollution from the SGP & Flaws in the PTC"), Petitioners critique the Department's determination under IDAPA 58.01.01.203.02 that the SGP will not cause or contribute to a violation of the PM_{10} NAAQS. Petitioners claim that the Department's determination is "flawed," Petition ¶ 35, and then suggest various enforceable requirements that they prefer to those imposed by the Department in the Final Permit, *id.* ¶¶ 36-41. Ultimately Petitioners speculate that under the Department's approach emissions "could" exceed the NAAQS. *Id.* ¶¶ 37, 39, 41.

Petitioners' opinions regarding the Department's work and their preferences for permit content – after three public comment periods and the development of a robust administrative record – do not support a claim that the Department's action and issuance of the Final Permit were unlawful. Under the governing regulations the applicant must show "*to the satisfaction of the Department*" that "[t]he stationary source or modification would not cause or significantly contribute to a violation of any ambient air quality standard." IDAPA 58.01.01.203.02 (emphasis added). Petitioners admit that

> DEQ modeled receptors at various locations along the SGP's ambient air boundary and *determined that the maximum potential emissions will be below (and thus comply with) the 24-hour PM10 NAAQS. DEQ found the maximum 24-hour PM_{10} pollution from the SGP would be 123.5 ug/m3, which is 82.3% of the NAAQS.*

Petition ¶ 34 (emphasis added). The Petition provides a commentary on the Final Permit, but there is no requisite factual or legal allegation in the Petition that the Department's work violated the applicable law.

Next, Petitioners second guess the Department's choices for enforceable requirements to ensure NAAQS compliance, alleging that the Department: (1) failed to establish enforceable permit conditions on ore haul trucks (*id.* ¶¶ 36, 39); (2) failed to require that the Fugitive Dust Control Plan ("FDCP"), Haul Road Capping Plan ("HRCP"), and Operations and Maintenance Manual ("O&M Manual") be developed prior to issuance of the permit and submitted to public comment (*id.* ¶¶ 37, 39, 40); (3) failed to require sufficient monitoring and recordkeeping (*id.* ¶ 40); and (4) allowed Perpetua to use precipitation data that was not the most representative data (*id.* ¶ 41). Critically, however, the Petition fails to identify any violations of the Idaho Air Rules.

Enforceable permit conditions on ore haul trucks. Petitioners admit that the Department required enforceable permit conditions for control of PM_{10} emissions in the Final Permit: silt

content of the haul roads (Petition ¶ 36 and Condition 3.13), total ore haulage per day (Petition ¶ 37 and Condition 3.5), enforceable work practice plans (Petition ¶¶ 37, 39, 40 and Conditions 2.4, 2.5, 2.6, 2.7, 2.8, 2.20, 3.10, 3.13), and application of water spray and chemical dust suppressants (Petition ¶ 38 and Condition 2.6). Petitioners entirely ignore Condition 2.5, which requires fugitive dust control measures on haul roads sufficient to ensure that visible emissions do not exceed 10% opacity. Instead, they suggest the Department should have included alternative or additional conditions. Still, the Petition fails to point to any regulations requiring such alternatives – because there are no such requirements.

Instead, the Idaho Air Rules provide the Department with discretion to impose "any reasonable conditions upon an approval [a permit to construct]." IDAPA 58.01.01.211.01. As the Department explained in the SOB, "Permit Conditions 2.1-2.8 incorporate fugitive dust emission limits and control requirements as required by IDAPA 58.01.01.650-51." SOB at 47. IDAPA 58.01.01.651 states:

> All reasonable precautions shall be taken to prevent particulate matter from becoming airborne. In determining what is reasonable, consideration will be given to factors such as the proximity of dust emitting operations to human habitations and/or activities, the proximity to mandatory Class I Federal Areas and atmospheric conditions which might affect the movement of particulate matter. Some of the reasonable precautions may include, but are not limited to….
>
> ... [u]se, where practical, of water or chemicals for control of dust ….
>
> ... [a]pplication, where practical, of asphalt, oil, water or suitable chemicals to, or covering of dirt roads…."

These are exactly the conditions that Petitioners admit the Department included in the Final Permit. Petition ¶ 38.

The submission of work practice plans for public comment. Petitioners acknowledge that the Department required work practice plans for control of PM_{10} emissions in the Final Permit.

Petitioners repeatedly allege, however, that the work practice plans – the FDCP, HRCP, and O&M Manual – should have been developed prior to issuance of the Final Permit and submitted for public comment. *Id.* ¶¶ 37, 39, 40. The regulations do not require that these work practice plans be developed, much less that they be prepared before construction of the SGP commences or be available for public comment. *See* IDAPA 58.01.01.211.01 (Department may impose reasonable conditions). Consistent with the Idaho Air Rules, the Department required that Perpetua develop these work practice plans, include specific provisions in the plans, and submit them to the Department *for approval* at least 30 days prior to startup. Condition 2.8 (FDCP), 2.21 (O&M Manual), 3.13 (HRCP). Once approved the requirements specified in these work practice plans become enforceable conditions of the PTC. Condition 2.6 (FDCP), 2.20 (O&M Manual), 3.13 (HRCP).

Sufficient monitoring and recordkeeping. Petitioners next object that the Final Permit "itself does not include all monitoring, recordkeeping, and reporting necessary to assure compliance with the permit emission limitations and applicable requirements." Petition ¶ 40. First, this is a conclusory statement without any associated factual support and should be dismissed on that basis. Second, Petitioners ignore the recordkeeping requirements included as conditions throughout the Final Permit. *See, e.g.,* Condition 2.2 (records of fugitive dust control required to be updated once every 12 hours), 2.3 (records of fugitive dust complaints), 2.4 (records of daily inspections), 2.11 (visible emission inspections).

Also, Condition 7.10 requires Perpetua to maintain "sufficient records to ensure compliance with all of the terms and conditions of this permit," including monitoring records and supporting information, such as calibration and maintenance records. These conditions were included in the Final Permit to comply with IDAPA 58.01.01.211. SOB at 50. IDAPA

58.01.01.211 does not contain specific recordkeeping requirements; instead, it gives the Department discretion to impose "reasonable conditions" necessary to ensure compliance with the Final Permit. Petitioners have identified no legal obligations for the Department to require additional recordkeeping, reporting, or monitoring requirements.

The use of representative precipitation data. Finally, Petitioners speculate that the precipitation data used to model fugitive PM emissions from the ore haul roads is not representative of actual precipitation at the SGP. Petition ¶ 41. Failing to meet their burden, Petitioners offer no facts alleging that the precipitation data used was not representative, nor do they identify any data that should have been used instead. *See id.* Rather, they make a conclusory allegation that the data was not representative without any supporting facts. This conclusory allegation is insufficient. *Orrock*, 147 Idaho at 618, 213 P.3d at 403 ("[F]actual allegations will be accepted as true, unless they are purely conclusory.").

Further, Petitioners' only support for their assertion that the Department erred by using unrepresentative precipitation data is the Department's *Guideline for Performing Air Quality Impact Analysis* ("Modeling Guideline"). The Modeling Guideline is "provided as general guidance" for permit applicants and "does not alter the discretionary authority of DEQ to protect public health." Modeling Guideline at 1. Nothing in the Idaho Air Rules or the Modeling Guideline requires Perpetua to provide, or the Department to require, "local meteorological data." Petition ¶ 41.

Section II.B of the Petition should be dismissed. In Section II.B of the Petition, Petitioners reaffirm that the Department complied with the Idaho Air Rules, IDAPA 58.01.01.203.02. While Petitioners dislike the Final Permit and question the Department's analyses of NAAQS compliance, none of the opinions presented in the Petition state a claim that

the Department *violated* the Idaho Air Rules or the CAA in issuing the Final Permit. Petitioners also do not satisfy their burden to allege any omission from the Final Permit that is required by law. Petitioners fail to comply with IDAPA 58.01.23.160.01 and fail to state a claim that the Department's issuance of the Final Permit is contrary to law. Accordingly, Perpetua requests that the allegations in Section II.B of the Petition be dismissed.

2. In accordance with IDAPA 58.01.01.203.03, Perpetua demonstrated to the satisfaction of the Department that TAP emissions would not injure or unreasonably affect human or animal life or vegetation, and the Petition fails to state a factual or legal basis for remand of the Final Permit.

In Section II.D of the Petition ("Arsenic Pollution from the SGP & Flaws in the PTC"), Petitioners attempt to pick apart the Department's work to select reasonably available control technology for TAPs ("T-RACT"), the Department's determination of compliance with the Acceptable Ambient Concentrations of Carcinogens ("AACC"), and the Department's conclusion that emissions of arsenic will not injure or unreasonably affect human or animal life or vegetation.

As before, Petitioners assert the Department's approval and analysis are "flawed." Petition ¶ 52. Then, Petitioners attack the Department's interpretation and application of the Idaho Air Rules that govern TAP emissions analyses (IDAPA 58.01.01.210). Petition ¶¶ 53-57. Ultimately Petitioners hypothesize that under the Department's approach emissions "could" exceed the AACC without supporting factual statements. *Id.* ¶¶ 54, 56. Petitioners' conjecture regarding the Department's work and Petitioners' preferences for different analytical approaches fail to support a claim that the Department's issuance of the Final Permit was unlawful. *See id.* ¶¶ 52-57.

Under IDAPA 58.01.01.203.03, the applicant must show "*to the satisfaction of the Department*" that

> [u]sing the methods provided in Section 210, the emissions of toxic air pollutants from the stationary source or modification would not injure or unreasonably affect human or animal life or vegetation as required by Section 161. Compliance with all applicable toxic air pollutant carcinogenic increments and toxic air pollutant non-carcinogenic increments will also demonstrate preconstruction compliance with Section 161 with regards to the pollutants listed in Sections 585 and 586.

(Emphasis added.) Although in the opinion of Petitioners the Department's work was flawed, Petitioners concede throughout Section II.D that the Department used the methods provided in Section 210 to evaluate T-RACT and AACC compliance. *See* Petition ¶¶ 47-51. Petitioners fail to allege and support with facts an allegation that the Department's work violated the requirements of the Idaho Air Rules, IDAPA 58.01.01.203.03 and 210.

T-RACT review complied with applicable analyses. Petitioners misconstrue IDAPA 58.01.01.210.14 and then attempt to argue that the Department was required to discuss environmental and economic impacts for the T-RACT Perpetua proposed and the Department selected, specifically, chemical dust suppressants. Petition ¶ 53. To understand why Petitioners fail to state a claim, it is helpful to begin with the regulatory definition of T-RACT:

> An emission standard based on the lowest emission of toxic air pollutants that a particular source is capable of meeting by the application of control technology that is reasonably available, as determined by the Department, considering technological and economic feasibility. If control technology is not feasible, the emission standard may be based on the application of a design, equipment, work practice or operational requirement, or combination thereof.

IDAPA 58.01.01.007.12. Petitioners wrongfully allege that the T-RACT demonstration failed to provide sufficient environmental and economic information. Petition ¶ 53.

The Idaho Air Rules only require the applicant to submit environmental and economic information to assist the Department in determining if the proposed control technology is reasonably available. *See* IDAPA 58.01.01.007.12; *id.* 210.14.a. ("The applicant shall submit information to the Department identifying and documenting which control technologies or other

requirements the applicant *believes to be* T-RACT." (emphasis added)); *id.* 210.14.b ("The Department shall review the information submitted by the applicant and determine whether the applicant has proposed T-RACT."); *id.* 210.14.e ("If the Department determines the applicant has proposed T-RACT, the Department shall determine which of the options, or combination of options, will result in the lowest emission of toxic air pollutants….").

The Department, applying its agency expertise, considered three dust control technologies for controlling fugitive dust from haul roads: paving, application of chemical dust suppressants, and watering. SOB, Appendix G, T-RACT Analysis, at 30. The Department then determined that paving was technologically infeasible because the weight of the haul trucks would significantly exceed the weight limits of paved roads. *Id.* at 32. The remaining control technologies were then ranked by control effectiveness and the most efficient control technology – chemical dust suppressants – was selected, along with supplemental frequent watering. *Id.* at 33.

As written into IDAPA 58.01.01.210.14, consideration of environmental and economic impacts is only necessary if the Department is required to evaluate whether a control technology is reasonably available. Use of chemical dust suppressants and watering are well recognized both in practice, and by the Idaho Air Rules, as reasonably available control technologies for fugitive dust.[5] *See, e.g.,* IDAPA 58.01.01.651 (prescribing use of water or suitable chemical suppressants to control fugitive dust from dirt roads). Therefore, no additional evaluation of the economic or environmental impacts of the chosen control technologies was required.

[5] The Department relied on well-recognized control technologies in the EPA RACT/BACT/LAER Clearinghouse database, to assist in its determination that (1) Perpetua had proposed T-RACT and (2) the level of control effectiveness of each of the alternatives. SOB, Appendix G, T-RACT Analysis, at 31.

The Petition also alleges that Perpetua submitted insufficient economic information for Perpetua's decision to use water and chemical dust suppressants instead of paving haul roads. Petition ¶ 53. The Department, applying agency expertise, determined that paving was technologically infeasible due to the weight of the haul trucks traveling on the roads. SOB, Appendix G, T-RACT Analysis, at 32. Therefore, no economic analysis of paving was required. IDAPA 58.01.01.210.14. Because chemical dust suppressant was selected as T-RACT and is well recognized as "reasonably available" no additional consideration of economic information was triggered. Again, the Petition fails to identify any violation of the Idaho Air Rules.

Emissions estimations did not violate the Idaho Air Rules. Petitioners allege that, because the Department's work on PM_{10} emissions estimates and controls was "flawed," so too was its estimates of arsenic emissions. Petition ¶ 54. For the same reasons described in Section IV.B.1, *supra*, the Petition fails to allege a claim that the Department violated any specific provision of the Idaho Air Rules.

Arsenic analysis complied with the Idaho Air Rules. Petitioners critique the Department's work on implementing T-RACT and using averages to establish a representative AACC, Petition ¶¶ 55-56, and assert that "[n]othing in the Idaho Air Rules allows for multi-year emissions averaging and ambient air concentration adjustments," *id.* ¶ 55. Critically, the Petition fails to identify any provision of the Idaho Air Rules that prohibits the approach taken by Perpetua in quantifying arsenic emissions or that invalidates the Department's approval of such approach. Instead, the applicant must show to the "satisfaction of the Department" that

> [u]sing the methods provided in Section 210, the emissions of toxic air pollutants from the stationary source or modification would not injure or unreasonably affect human or animal lie or vegetation as required by Section 161. Compliance with all applicable toxic air pollutant carcinogenic increments and toxic air pollutant non-carcinogenic increments *will also* demonstrate preconstruction compliance with Section 161 with regards to the pollutants listed in Sections 585 and 586.

IDAPA 58.01.01.203.03 (emphasis added). Section 161 provides: "Any contaminant which is by its nature is toxic … shall not be emitted in such quantities or concentrations as to … injure or unreasonably affect human or animal life or vegetation." IDAPA 58.01.01.161. Section 210 requires "the applicant … demonstrate preconstruction compliance with Section 161 *to the satisfaction of the Department*. The accuracy, completeness, execution and results of the demonstration *are all subject to review and approval by the Department*." IDAPA 58.01.01.210 (emphasis added).

As relevant here, Section 210.12 sets out the methods for calculating compliance with Section 161.

> Compare the source's or modification's approved T-RACT ambient concentration at the point of compliance for the toxic air pollutant to the amount of the toxic air pollutant that would contribute an ambient air cancer risk probability of less than one to one hundred thousand (1:100,000) (which amount is equivalent to ten (10) times the applicable acceptable ambient concentration listed in Section 586).

IDAPA 58.01.01.210.12.b.

> If the source's or modifications approved T-RACT ambient concentration at the point of compliance is less than or equal to the amount of the toxic air pollutant that would contribute to an ambient air cancer risk probability of less than one to one hundred thousand (1:100,000), no further procedures for demonstrating preconstruction compliance will be required for that toxic air pollutant as part of the application process.

IDAPA 58.01.01.210.12.c. As described by the regulations, and contrary to Petitioners' assertions, the applicant is required to demonstrate to the Department's satisfaction that the ambient concentration of the TAP at the point of compliance is equal to or less than the amount of TAP that would contribute to a cancer risk of one to 100,000. The Idaho Air Rules do not require annual averaging as Petitioners suggest.

As described fully in the SOB, the Department complied with the Idaho Air Rules in determining that the permitted arsenic emissions would not injure or unreasonably affect human or animal life or vegetation. SOB at 26 ("The applicant has … demonstrated preconstruction compliance to DEQ's satisfaction that the emissions increase due to this permitting action will not exceed any … acceptable ambient concentration for carcinogens (AACC) for toxic air pollutants (TAP)"); *id.* ("adjusted arsenic HAP TAP emissions at 0.544 pounds per hour (lb/hr) did not exceed 42% of the applicable AACC"); TAPS Addendum Modeling Review Attachment, SOB. While the AACCs in Section 586 are stated in annual averages, nothing in the Idaho Air Rules require the applicant to utilize annual averages in demonstrating compliance with Section 161. Instead, the regulations require that the applicant demonstrate the ambient air concentration of TAPs creates a cancer risk probability of less than one to 100,000. IDAPA 58.01.01.210.12.b.

Petitioners' critiques and opinions of the interpretation, application, and determination made by the Department in support of the requirement at IDAPA 58.01.01.203.03 do not support a claim that the Department's action and issuance of the Final Permit were unlawful.

Paragraph 57 of the Petition is irrelevant. The allegations in Paragraph 57 of the Petition, regarding the incremental nature of the Department's TAPs regulations, is irrelevant to whether the Final Permit is lawful and must be dismissed. *See In Re: Permit Applicant Garnet Energy LLC (Permit No. 0027-00081)*, No. 0101-01-10, Order Granting Motion for Summary Judgement at 11 (Feb. 22, 2002) (dismissing claim premised on irrelevant regulatory requirements).

Section II.D of the Petition should be dismissed. In Section II.D of the Petition, Petitioners reaffirm that the Department complied with the Idaho Air Rules, IDAPA 58.01.01.203.03 and 210. While Petitioners dislike the Final Permit and question the

Department's analyses of T-RACT and AACC for the SGP, none of the opinions presented in the Petition state facts supporting a claim that the Department violated the Idaho Air Rules in issuing the Final Permit. Section II.D does not identify a violation of applicable law for air quality permit issuance nor identify an action by the Department contrary to applicable law for air quality permit issuance. Accordingly, Perpetua requests that the allegations contained in Section II.D of the Petition be dismissed.

C. The Petition does not allege a violation of any law governing the ambient air boundary.

In Section II.E of the Petition ("DEQ's Ambient Air Boundary for the SGP"), Petitioners critique the Department's decision to exclude from ambient air the access route between Stibnite Road at Sugar Creek and Thunder Mountain Road at Meadow Creek (the "North Access Route"), claiming that the Department's determination is "flawed." Petition ¶ 61.

Petitioners attack the Department's interpretation and application of the Idaho Air Rules and policy that govern ambient air boundary assessments, demanding that the access management plan ("AMP") required by the Final Permit be reviewed by the public and enforceable. *Id.* ¶¶ 62-65. Petitioners' opinions and suggestions regarding the Department's work and Petitioners' preference for public review of the AMP do not support a claim that the Department's action and issuance of the Final Permit were unlawful. *Id.* ¶¶ 61-65. The Petition does not identify a violation of law for air quality permit issuance nor identify an action by the Department contrary to law for air quality permit issuance.

Under IDAPA 58.01.01.203.02, the applicant must show "*to the satisfaction of the Department*" that "[t]he stationary source or modification would not cause or significantly contribute to a violation of any ambient air quality standard." (Emphasis added.) "Ambient air" is defined at IDAPA 58.01.01.006.10 as "[t]hat portion of the atmosphere, external to buildings,

to which the general public has access." Although in the opinions of Petitioners the Department's exclusion of the North Access Route is flawed, Petitioners fail to allege a violation of the Idaho Air Rules.

Contrary to Petitioners' critique of the Department's AMP requirements in the Final Permit, the measures required for the AMP are not "ambiguous." Petition ¶¶ 63-65. Condition 2.7 of the Final Permit requires the AMP to include concrete and unambiguous measures to exclude the general public from the SGP, like locked gates and barriers for the two primary access points, plus posted warning signs, plus registration by users seeking access, and more. Contrary to the assertions in the Petition, "[t]he measures specified in the AMP shall be incorporated by reference to this permit and *shall be enforceable permit conditions*." Condition 2.7 (emphasis added). The AMP must be submitted to the Department for review and approval prior to startup. Condition 2.8. There is no legal requirement in the Idaho Air Rule for the AMP to be reviewed by the public.

Petitioners also allege that without "disclosure and knowledge" of the AMP contents, the Department cannot comply with policy, the Idaho Air Rules, the NAAQS, or TAPs. Petition ¶ 65. But Petitioners do not identify any specific violation of law. Petitioners' opinion overlooks the details of substance and process imposed by the Department for the AMP in Conditions 2.7 and 2.8 of the Final Permit. Petitioners are dissatisfied with the AMP requirements as imposed by the Department, but the Petition fails to allege any violation of law with respect to the ambient air boundary. Perpetua requests that the allegations contained in Section II.E of the Petition be dismissed.

D. The Petition does not allege a violation of any law governing ambient air monitoring.

In Section II.F of the Petition ("DEQ's Failure to Require Ambient Air Monitoring for the SGP"), Petitioners demand ambient air monitoring to verify compliance with NAAQS and TAPs. Petition ¶¶ 66-68. Although the Department has authority to require monitoring under IDAPA 58.01.01.211.01(d), ambient air monitoring is not a legal requirement for lawful issuance of an air quality permit. Petitioners are dissatisfied with the Department's decision not to require ambient air monitoring for the SGP, but do not identify any regulatory provision compelling the Department to require such monitoring because there is none. The Petition fails to state a claim in Section II.F that the Department acted contrary to law in issuing the Final Permit. Perpetua requests that the allegations contained in Section II.F of the Petition be dismissed.

E. Petitioners requested relief is not required by law.

Petitioners include a laundry list of requested relief, including:

(1) additional permit conditions to limit PM_{10} and arsenic emissions;

(2) analysis of local meteorological data to calculate fugitive emissions;

(3) submission of the FDCP, HRCP, O&M Manual, and AMP for public comment;

(4) analysis of an annual average concentration of arsenic emissions;

(5) required ambient air boundary monitoring; and

(6) additional environmental and economic analyses of T-RACT.

Petitioners have entirely failed to state any facts or identify any provision of the Idaho Air Rules that would legally entitle them to the relief they request. To the contrary, and as explained at length above, the Idaho Air Rules do not provide any legal requirement that a permit to construct contain any of the conditions Petitioners request; nor do the Idaho Air Rules compel the Department to require the applicant to model emissions in the way Petitioners suggest. The Idaho

Air Rules require the applicant to show "to the satisfaction of the Department" that the permitted project will not cause a violation of an ambient air quality standard, and that TAP emissions will not injure or unreasonably affect human or animal life or vegetation. IDAPA 58.01.01.203.

The Idaho Air Rules then vest the Department with discretion to "impose any reasonable conditions" in granting the final permit. IDAPA 58.01.01.211.01. The Idaho Air Rules simply contain no provision entitling Petitioners to the relief they request. Therefore, Petitioners have failed to allege that they are entitled to any of the relief they seek in the Petition.

F. The Petition fails to comply with IDAPA 58.01.23.160.01, is defective, and should be dismissed because it fails to allege a legally sufficient claim that the Department's action was arbitrary, capricious, or an abuse of discretion.

Petitioners dislike the Final Permit and oppose the SGP and wish it were permitted differently or not at all. But dislike of a project or a permit does not provide a legal basis to remand the agency action and reverse the issuance of the Final Permit. The Petition is rich with Petitioner's wish list of conditions for the Final Permit and speculation about the possible harm from the construction and operation of the SGP. But the Petition fails to satisfy the basic requirements of IDAPA 58.01.23.160.01, and as such it is defective and must be returned or dismissed. *See* IDAPA 04.11.01.304.

Specifically, the Petition fails to fully state facts and identify the particular statute or rule under which the Department allegedly erred. Further, to the extent Petitioners believe that the Department's action was arbitrary and capricious and an abuse of discretion they have failed to sufficiently allege facts or law supporting such a claim. An arbitrary and capricious decision occurs where the decision was reached in an unreasonable manner or based on clearly erroneous findings. *Floyd v. Bd. of Ada Cnty. Comm'rs*, 164 Idaho 659, 668, 434 P.3d 1265, 1274 (2019). An abuse of discretion standard examines whether the agency acted within the boundaries of its

discretionary decision and applicable legal standards and reached a decision by exercising reason. *Id.*

Nowhere in the Petition do Petitioners identify with specificity how the Department's issuance of the Final Permit was arbitrary, capricious, or an abuse of discretion. Nor does the Petition use words such as "unreasonable" or "clearly erroneous," which would at least alert the reader that Petitioners were attempting to raise a claim that the action was arbitrary or capricious. In fact, the Petition uses the terms "arbitrary," "capricious," and "abuse of discretion" only three times, none of which are in reference to a specific allegation, and two of which simply restate Idaho Code § 67-5279. Petition ¶¶ 7, 69, 70. The Petition fails to provide factual allegations or citations to legal authority to allude to, let alone support, claims of any arbitrary and capricious decision or any abuse of discretion.

Rather, Petitioners allege that the Department's determination was "flawed" or "deficient" or contained "shortcomings." *Id.* ¶¶ 24, 25, 35, 52, 61, 70. However, "flawed," "deficient," and containing "shortcomings" are not the grounds identified in Idaho Code § 67-5279, on which the permit may be remanded. The Petition is insufficient to apprise the Department and Perpetua of Petitioners' claims of violations of law, arbitrary and capricious decision making, or any abuse of discretion. *Vendelin v. Costco Wholesale Corp.*, 140 Idaho 416, 427, 95 P.3d 34, 45 (2004) ("The key issue in determining the validity of a complaint is whether the adverse party is put on notice of the claims brought against it."). Judged under the standard of I.R.C.P 12(b)(6) and the heightened pleading standard of IDAPA 58.01.23.160.01, the Petition is wholly deficient and must be dismissed. IDAPA 04.11.01.304.

V. CONCLUSION

The Petition challenging the Final Permit is abundant on speculation and hypotheticals but devoid of factual or legal foundation. Petitioners completely fail to allege and to support

factually any claim that the Final Permit is contrary to law. Indeed, each of the regulatory provisions that Petitioners contend were violated afford the Department ample discretion to rely on the information submitted by Perpetua and to assemble the Final Permit as issued. Ultimately, Petitioners' so-called "flaws" are differences of opinion between themselves and the permitting authority.

Further, the Petition fails to meet the heightened pleading standard set out in IDAPA 58.01.23.160.01 that requires Petitioners to apprise the Department or Perpetua of both the facts and the law underlying the specific claims allegedly entitling them to relief. The Petition fails to put Perpetua and the Department on notice of Petitioners' theory of their claims. Instead, they offer a smorgasbord of legally ungrounded "flaws." Absent facts alleging that the Final Permit is contrary to the Idaho Air Rules, or that the Department's issuance of the Final Permit was arbitrary, capricious, or an abuse of discretion, Petitioners fail to state a claim upon relief can be granted. Accordingly, Perpetua respectfully requests that the Petition be dismissed.

DATED: September 6, 2022.

STOEL RIVES LLP

/s/ W. Christopher Pooser
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

CERTIFICATE OF SERVICE

I hereby certify that on this 6th day of September 2022, a true and correct copy of the **PERPETUA RESOURCES IDAHO'S MOTION TO DISMISS AND SUPPORTING BRIEF** was served on the following:

Dylan B. Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Paula J. Wilson
Hearing Coordinator
Idaho Department of Environmental Quality
1410 N Hilton St
Boise, ID 83706
Paula.Wilson@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

/s/ Wade C. Foster
Wade C. Foster

EXHIBIT A

Air Quality

PERMIT TO CONSTRUCT

Permittee	Perpetua Resources Idaho, Inc.
Permit Number	P-2019.0047
Project ID	62288
Facility ID	085-00011
Facility Location	Forest Service Roads NF-374 and NF-412 Stibnite, Idaho 83611

Permit Authority

This permit (a) is issued according to the "Rules for the Control of Air Pollution in Idaho" (Rules), IDAPA 58.01.01.200–228; (b) pertains only to emissions of air contaminants regulated by the State of Idaho and to the sources specifically allowed to be constructed or modified by this permit; (c) has been granted on the basis of design information presented with the application; (d) does not affect the title of the premises upon which the equipment is to be located; (e) does not release the permittee from any liability for any loss due to damage to person or property caused by, resulting from, or arising out of the design, installation, maintenance, or operation of the proposed equipment; (f) does not release the permittee from compliance with other applicable federal, state, tribal, or local laws, regulations, or ordinances; and (g) in no manner implies or suggests that the Idaho Department of Environmental Quality (DEQ) or its officers, agents, or employees assume any liability, directly or indirectly, for any loss due to damage to person or property caused by, resulting from, or arising out of design, installation, maintenance, or operation of the proposed equipment. Changes in design, equipment, or operations may be considered a modification subject to DEQ review in accordance with IDAPA 58.01.01.200–228.

Date Issued June 17, 2022

Kelli Wetzel

Kelli Wetzel, Permit Writer

Mike Simon

Mike Simon, Stationary Source Bureau Chief

Contents

1 Permit Scope 3
2 Facility-Wide 8
3 Mining and Ore Processing 17
4 Ore Concentration and Refining 22
5 Lime, Aggregate, and Concrete Production 30
6 Engines 36
7 General Provisions 39

1 Permit Scope

Purpose

1.1 This is an initial permit to construct (PTC) for ore processing, ore concentration and refining, and ancillary equipment at the Stibnite Gold Project (SGP).

Regulated Sources

1.2 Table 1.1 lists all sources of regulated emissions in this permit.

Source ID No.	Source	Control Equipment
Mining		
	Drilling activities	Reasonable control and Fugitive Dust Control Plan (FDCP) Dust collection systems on drilling rigs Control efficiency: 90%
	Blasting activities	Reasonable control & FDCP
	Excavating and hauling activities	Reasonable control & FDCP – Chemical suppression and water sprays Control efficiency: 93.3% for PM/PM_{10} (haul roads) Haul road capping with low-arsenic (90 ppm or less) quartzite
	Rock dumps and storage piles	Reasonable control & FDCP
PS1–2-L/U	(2) Prill Silos #1-2 Maximum capacity: 100 T (each)	Loading – None Unloading – None
Ore Processing		
OC1	Loader Transfer of Ore to Grizzly	Reasonable control & FDCP – Water sprays and moisture carryover
OC2	Grizzly to Apron Feeder	
OC3	Conveyor – Apron Feeder to Dribble	
OC4	Conveyor – Apron Feeder to Grizzly	
OC5	Conveyor – Dribble to Grizzly	
OC6	Grizzly to Primary Crusher or Coarse Ore Stockpile Feed	
OC7	Primary Crusher	Reasonable control & FDCP – Water sprays and moisture carryover
OC8	Conveyor – Coarse Ore Stockpile Feed Transfer to Stockpile	
OC9	Stockpile Transfer to Reclaim Conveyors	Reasonable control & FDCP – Below-grade of storage piles Control efficiency: 80% for PM/PM_{10}
OC10	Conveyor – Reclaim Conveyors to SAG Mill Feed Conveyor	
OC11	Conveyor – SAG Mill Feed Transfer to SAG Mill	Reasonable control & FDCP – Enclosure Control efficiency: 80% for PM/PM_{10}
OC12	Pebble Crusher	Reasonable control & FDCP – Water sprays and moisture carryover
OC13	Pebble Discharge to SAG Mill Feed	
Ore Concentration and Refining		
CN Tanks	Cyanide Leach Tanks and Cyanide Detox Tanks	Chemical treatment (lime, caustic soda, hydrogen peroxide, copper sulfate, etc.)
Float Tanks	Floatation Tanks	None

Source ID No.	Source	Control Equipment
AC	Autoclave (AC)	Venturi Scrubber (VS1) Vent Gas Cleaning Tower (ST1) Vent Gas Steam Condensation Tower (CT1) Carbon Filter (CA5) Type: sulfur-impregnated activated carbon Form: granulated
EW	Electrowinning Cells and Pregnant Solution Tank	Shared Carbon Filter (CA2) Type: sulfur-impregnated activated carbon Form: granulated
MR	Mercury Retort	Condenser Carbon Filter (CA3) Type: sulfur-impregnated activated carbon Form: granulated
MF	Induction Melting Furnace	Baghouse (BH2) Carbon Filter (CA4) Type: sulfur-impregnated activated carbon Form: granulated
CKD	Carbon Regeneration Kiln (Drum)	Wet Scrubber (WS2) Carbon Filter (CA1) Type: sulfur-impregnated activated carbon Form: granulated
Tailings and Maintenance Pond activities		Chemical treatment, reasonable control & FDCP
Process Heating		
ACB	POX Boiler (for AC) Maximum capacity: 17 MMBtu/hr Fuel: propane	None
HS	Strip Circuit Solution Heater Maximum capacity: 5 MMBtu/hr Fuel: propane	None
CKB	Carbon Regeneration Kiln Burners Maximum capacity: 2.255 MMBtu/hr Fuel: propane	None
PV	Propane Vaporizer Maximum capacity: 0.1 MMBtu/hr Fuel: propane	None
LKC	PFR Shaft Lime Kiln Combustion Maximum capacity: 22.0 MMBtu/hr Fuel: propane	None

Source ID No.	Source	Control Equipment
Lime Production		
LS1	Limestone transfer to Primary Crusher Hopper	Reasonable control & FDCP
LS2	Primary Crusher Maximum capacity: 1,130 T/day	
LS3	Primary Screen	
LS4	Secondary Crusher	
LS5	Secondary Screen	
LS6	Conveyor – Limestone to Ball Mill Feed Bin	
LS7	Conveyor – Limestone to Ball Mill Feed	
LS8	Conveyor – Ball Mill Feed to Ball Mill	
LSBM	Limestone Ball Mill	Reasonable control & FDCP Baghouse (BH3)
LS9	Conveyor – Limestone to Kiln Feed Bin	Reasonable control & FDCP
LS10	Conveyor – Limestone to Lime Kiln Feed	
LS11	Fines Screen	
LS12	Conveyor – Kiln Feed to PFR Shaft Lime Kiln	
LK	Parallel Flow Regenerative (PFR) Shaft Kiln	Reasonable control & FDCP Baghouse (BH4)
LCR	Lime Mill Crusher	Reasonable control & FDCP Baghouse (BH5)
LS-L/U	Bucket Elevator – Pebble Lime Silo Loading	Loading – Bin Vent Filter
	Pebble Lime Silo discharge to Lime Slaker	Unloading – Wet Scrubber (WS3)
LS1-L/U	SAG Mill Lime Silo #1 Maximum capacity: 250 T/day	Loading – Bin Vent Filter Unloading – None
MillS2-L/U	SAG Mill Lime Silo #2 Maximum capacity: 250 T/day	Loading – Bin Vent Filter Unloading – None
ACS1	AC Lime Silo #1 Maximum capacity: 1,000 T/day	Loading – Bin Vent Filter Unloading – None
ACS2	AC Lime Silo #2 Maximum capacity: 1,000 T/day	Loading – Bin Vent Filter Unloading – None
ACS3	AC Lime Silo #3 Maximum capacity: 1,000 T/day	Loading – Bin Vent Filter Unloading – None
ACS4	AC Lime Silo #4 Maximum capacity: 500 T/day	Loading – Bin Vent Filter Unloading – None
Aggregate Production		
PCSP1	Portable Crushing and Screening Plant 1 Crushers, screens, and conveyors	Reasonable control & FDCP – water sprays and moisture carryover
PCSP2	Portable Crushing and Screening Plant 2 Crushers, screens, and conveyors	Reasonable control & FDCP – water sprays and moisture carryover
Concrete Production		
CM	Central Mixer Loading Maximum capacity: 120 T/hr	Reasonable control & FDCP – Controls may include water sprays, enclosures, hoods, curtains, shrouds, movable and telescoping chutes, and central duct collection systems.
CS1-L/U	Cement/Shotcrete Silo #1 Maximum capacity: 80 T	Loading – Bin Vent Filter Unloading – None
CS2-L/U	Cement/Shotcrete Silo #2 Maximum capacity: 80 T	Loading – Bin Vent Filter Unloading – None
CA-L/U	Aggregate Bin Maximum capacity: 2,400 T	Loading – None Unloading – None

Source ID No.	Source	Control Equipment
Heating, Ventilation, and Air Conditioning (HVAC)		
H1M	Mine Air Heater #1 Maximum capacity: 4 MMBtu/hr Fuel: propane	None
H2M	Mine Air Heater #2 Maximum capacity: 4 MMBtu/hr Fuel: propane	None
HM	(4) Mill HVAC Heaters #1-4 Maximum capacity: 1.0 MMBtu/hr (each) Fuel: propane	None
HAC	Autoclave HVAC Heater Maximum capacity: 0.25 MMBtu/hr Fuel: propane	None
HR	Refinery HVAC Heater Maximum capacity: 0.25 MMBtu/hr Fuel: propane	None
HA	Admin HVAC Heater Maximum capacity: 0.25 MMBtu/hr Fuel: propane	None
HMO	(2) Mine Ops. HVAC Heaters Maximum capacity: 0.25 MMBtu/hr (each) Fuel: propane	None
HTS	(2) Truck Shop HVAC Heaters Maximum capacity: 1.0 MMBtu/hr (each) Fuel: propane	None
HW	(3) Warehouse HVAC Heaters Maximum capacity: 1.0 MMBtu/hr (each) Fuel: propane	None

Source ID No.	Source	Control Equipment
Emergency Power Generation and Fire Suppression		
EDG1	Camp Emergency Generator Date of construction: 2007 or later Maximum capacity: 1,000 bkW Maximum operation: 100 hr/yr (non-emergency) Fuel: ultra-low sulfur diesel (ULSD) Displacement: <10 L/cyl	EPA Tier 2 certified or better
EDG2	Plant Emergency Generator #1 Date of construction: 2007 or later Maximum capacity: 1,000 bkW Maximum operation: 100 hr/yr (non-emergency) Fuel: ULSD Displacement: <10 L/cyl	EPA Tier 2 certified or better
EDG3	Plant Emergency Generator #2 Date of construction: 2007 or later Maximum capacity: 1,000 bkW Maximum operation: 100 hr/yr (non-emergency) Fuel: ULSD Displacement: <10 L/cyl	EPA Tier 2 certified or better
EDFP	Mill Fire Pump Date of construction: 2009 or later Maximum capacity: 200 bkW Maximum operation: 100 hr/yr (non-emergency) Fuel: ULSD Displacement: <10 L/cyl	None
Fuel Storage		
TG1–TG2	Mine Site Gasoline Tanks (#1 through #2) Maximum capacity: 5,000 gal each	Lids or other appropriate closure with gasketed seal and submerged filling
TD3–TD10	Mine Site Diesel Tanks (#3 through #10)	Lids or other appropriate closure

2 Facility-Wide

Fugitive Dust

2.1 All reasonable precautions shall be taken to prevent particulate matter from becoming airborne in accordance with IDAPA 58.01.01.650-651. In determining what is reasonable, consideration will be given to factors such as the proximity of dust-emitting operations to human habitations and/or activities and atmospheric conditions which might affect the movement of PM. Some of the reasonable precautions include, but are not limited to, the following:

- Use, where practical, of water or chemicals for control of dust in the demolition of existing buildings or structures, construction operations, the grading of roads, or the clearing of land.
- Application, where practical, of asphalt, oil, water, or suitable chemicals to, or covering of dirt roads, material stockpiles, and other surfaces which can create dust.
- Installation and use, where practical, of hoods, fans, and fabric filters or equivalent systems to enclose and vent the handling of dusty materials. Adequate containment methods should be employed during sandblasting or other operations.
- Covering, when practical, open-bodied trucks transporting materials likely to give rise to airborne dusts.
- Paving of roadways and their maintenance in a clean condition, where practical.
- Prompt removal of earth or other stored material from streets, where practical.

2.2 At least once every 12 hours, the permittee shall monitor and maintain records of the frequency and the methods used (e.g., water, chemical dust suppressants) to reasonably control fugitive dust emissions.

2.3 The permittee shall maintain records of all fugitive dust complaints received. The permittee shall take appropriate corrective action as expeditiously as practicable after receipt of a valid complaint. The records shall include, at a minimum, the date that each complaint was received and a description of the following: the complaint, the permittee's assessment of the validity of the complaint, any corrective action taken, and the date the corrective action was taken.

2.4 Each day during daylight hours and under normal operating conditions, the permittee shall conduct a facility-wide inspection of potential sources of fugitive emissions from the following equipment: drilling activities, blasting activities, excavating and hauling activities, rock dumps and storage piles, ore processing, aggregate production, and central mixer loading. These sources are identified in the Fugitive Dust Control Plan to ensure that the methods used to reasonably control fugitive dust emissions are effective. If emissions are not being reasonably controlled the permittee shall take corrective action as expeditiously as practicable. The permittee shall maintain records of the results of each fugitive dust emissions inspection. The records shall include, at a minimum, the date of each inspection and a description of the following: the permittee's assessment of the conditions existing at the time fugitive emissions were present (if observed), any corrective action taken in response to the fugitive dust emissions, and the date the corrective action was taken.

2.5 Fugitive dust control measures shall be applied to haul roads on a frequency such that visible emissions from vehicle traffic on a haul road do not exceed 10% opacity. When emissions are observed at any time to exceed this control trigger level, an appropriate control measure such as those defined in the Fugitive Dust Control Plan (FDCP) shall be used to reasonably control the emissions of fugitive dust. If the control measure chosen does not adequately control fugitive dust emissions, the permittee shall employ additional control measures until fugitive dust control is achieved.

2.6 The permittee shall develop and maintain a FDCP to ensure compliance with fugitive dust requirements (Permit Conditions 2.1–2.5) and also fugitive dust best management practices at the lime production, aggregate production, and concrete plants in accordance with IDAPA 58.01.01.799. The permittee shall comply with the FDCP at all times. The requirements specified in the FDCP shall be incorporated by reference to this permit and shall be enforceable permit conditions. At a minimum, the FDCP shall contain a list of all potential sources of fugitive dust emissions and the following reasonable precautions to minimize fugitive dust emissions (Permit Condition 2.1):

- Post and limit the maximum speed of haul trucks in accordance with the FDCP. Signs shall be posted along the haul route and placed so they are visible to vehicles entering and leaving the site of operations.
- Apply water or suitable dust suppressant chemicals (e.g., magnesium chloride, calcium chloride) to disturbed areas, haul roads, equipment staging areas, parking areas, and storage piles during the dry season and at other times as necessary to control fugitive dust.
- Prior to onset of winter conditions each year, the condition of haul and access roads should be assessed before freeze-up and required maintenance needed to maintain the roads through the winter months should be performed, and any preventative dust suppression activities should be completed before the roads are frozen and liquid application of suppressants or water are unrealistic.
- Apply water or suitable dust suppressant chemicals to transfer points, screening operations, and crushing operations identified in the FDCP as necessary to control fugitive dust. Transfer points include points where material (e.g., ore and development rock (DR), lime, aggregate, cement, etc.) is transferred to or from a belt conveyor, conveying system, bucket elevator, screening operation, or stockpile. Controls shall include manual water spray capability or installing, operating, and maintaining water spray bars at transfer points to wet the material and to provide moisture carryover for downstream control. Controls shall also include limiting drop heights in truck loading, front-end loader dumping, and conveying operations to ensure a homogeneous flow of material.
- Apply water or suitable dust suppressant chemicals to storage piles as necessary to control fugitive dust. Water may need to be applied to storage piles before and during truck loading, and when stockpiled ore and waste rock is not processed promptly in order to avoid drying and becoming airborne. Stockpile height should be limited to limit disturbance.
- Apply appropriate dust control at the initial point of material handling to suppress dust throughout the material handling process.
- Apply crushed gravel to haul roads, equipment staging areas, and other areas as necessary to limit migration of fine sediment.
- Install wind fences or barriers around, place below grade, or enclose all storage piles, parking areas, and equipment staging areas as necessary to control fugitive dust. This is required for

the Stockpile Transfer to Reclaim Conveyors (OC9), Reclaim Conveyors to SAG Mill Feed Conveyor (OC10), and SAG Mill Feed Transfer to SAG Mill conveyor (OC11).

- Develop specific criteria to determine what frequency and type (water and/or chemical) of dust suppressant must be applied, and appropriate suppressant application rates. Chemical dust suppressants shall be applied consistent with manufacturer's instructions and recommendations.
- Develop and implement precautionary measures to address high-wind events, such as when average (sustained) wind speed is forecast to exceed 25 miles per hour.
- Provide training/orientation to all relevant employees regarding FDCP requirements, including the necessity of restricting public access as specified in the Access Management Plan (AMP). Visible emissions evaluations shall be conducted by the permittee's employees who are certified visible emission observers.
- At least once each year, evaluate FDCP requirements to identify additional requirements and evaluate effectiveness of practices, including dust suppressant application rates, as appropriate.

2.7 The permittee shall develop and maintain an AMP that identifies the facility boundary and all primary and secondary access points, and clearly specifies measures used to discourage public access to the facility. The permittee shall comply with the measures identified in the AMP at all times. The measures specified in the AMP shall be incorporated by reference to this permit and shall be enforceable permit conditions. At a minimum, the AMP shall include requirements to:

- Observe all primary access points to preclude unauthorized public access. Onsite personnel shall be available for this purpose during active mining and mineral processing operations. Public access to the facility may be monitored by the use of security escort vehicles or manned guardhouses, or sufficiently precluded by the use of locked gates, barriers, or equivalent measures. Primary access points include the North and South Security Gates.
- Post warning signs and periodically patrol secondary access points to the facility to preclude public access. Onsite personnel shall be available for this purpose. Plans shall be described in the AMP, including identifying the access points monitored, the frequency of patrol, and measures employed to discourage access (e.g., locked gates, barriers, natural features, etc.). Secondary access points include secondary roadways and trails traversing the facility.
- Only registered guests of the facility will be allowed access to or through the facility. Those seeking to be a guest for the sole purpose of passing through the facility to another destination shall be provided a registration sheet that explains Perpetua's requirements for accessing the site and identifies potential hazards of the site.

2.8 Copies of the FDCP and AMP shall be submitted to DEQ for approval 30 days prior to startup at the address provided (Permit Condition 2.26), and shall remain onsite at all times. Any changes to the FDCP or the AMP shall be submitted to DEQ for review, comment, and approval 30 days prior to the change.

Visible Emissions

2.9 The permittee shall not discharge any air pollutant to the atmosphere from any point of emission for a period or periods aggregating more than three minutes in any 60-minute period which is greater than 20% opacity as determined by the test methods and procedures contained in IDAPA 58.01.01.625. These provisions shall not apply when the presence of uncombined water, nitrogen oxides, and/or chlorine gas is the only reason for the failure of the emission to comply with this permit condition.

2.10 Each day during daylight hours and under normal operating conditions, the permittee shall conduct a facility-wide inspection of potential point sources of visible emissions including stacks, vents, and functionally equivalent openings. Sources that are monitored using a continuous opacity monitoring system (COMS) are not required to comply with this permit condition. The inspection shall consist of a see/no see evaluation for each potential source of visible emissions. If any visible emissions are present from any point of emission, the permittee shall either:

- Take appropriate corrective action as expeditiously as practicable to eliminate the visible emissions. Within 24 hours of the initial see/no see evaluation and after the corrective action, the permittee shall conduct a see/no see evaluation of the emissions point in question. If the visible emissions are not eliminated, the permittee shall comply with the following; or
- Perform a Method 9 opacity test in accordance with the procedures outlined in IDAPA 58.01.01.625. A minimum of 30 observations shall be recorded when conducting the opacity test. If opacity is greater than 20% for a period or periods aggregating more than three minutes in any 60-minute period, the permittee shall take all necessary corrective action and report the exceedance in the annual compliance certification and in accordance with IDAPA 58.01.01.130-136.

2.11 The permittee shall maintain records of the results of each visible emission inspection and each opacity test when conducted. The records shall include, at a minimum, the date and results of each inspection and test and a description of the following: the permittee's assessment of the conditions existing at the time visible emissions are present (if observed), any corrective action taken in response to the visible emissions, and the date corrective action was taken.

2.12 The permittee shall have a certified opacity reader onsite at all times during operation of any regulated sources (in Table 1.1). The reader shall be certified in using the test methods and procedures of EPA Reference Methods 9 and knowledgeable of Method 22 procedures.

2.13 Reserved.

Odor

2.14 The permittee shall not allow, suffer, cause, or permit the emission of odorous gases, liquids, or solids into the atmosphere in such quantities as to cause air pollution in accordance with IDAPA 58.01.01.776.01.

2.15 The permittee shall maintain records of all odor complaints received. If the complaint has merit, the permittee shall take appropriate corrective action as expeditiously as practicable. The records shall include, at a minimum, the date that each complaint was received and a description of the following: the complaint, the permittee's assessment of the validity of the complaint, any corrective action taken, and the date the corrective action was taken.

Fuels

2.16 The permittee shall not sell, distribute, use, or make available for use any distillate fuel oil containing more than the following percentages of sulfur, in accordance with IDAPA 58.01.01.725:

- ASTM Grade 1 fuel oil - 0.3% by weight.
- ASTM Grade 2 fuel oil - 0.5% by weight.

2.17 The permittee shall maintain documentation of supplier verification of fuel oil sulfur content on an as-received basis to ensure compliance with fuel specifications (Permit Condition 2.16).

2.18 The maximum throughput of gasoline to the Gasoline Tanks (TG1, TG2) shall not exceed 100,000 gallons per month (gal/mo).

2.19 After startup, each month the permittee shall maintain records demonstrating compliance with gasoline throughput limits, by tracking either amounts loaded or amounts dispensed from each Gasoline Tank.

O&M Manual

2.20 Thirty days prior to startup of any process equipment (Permit Condition 2.13), the permittee shall develop and maintain an Operation and Maintenance (O&M) manual to ensure compliance with emission limits (Permit Conditions 2.9, 2.13, 4.3, and 5.3) and the control equipment maintenance and operation general provision (Permit Condition 7.2). The O&M manual shall be a permittee-developed document based upon, but independent from, manufacturer-supplied operating manuals. The permittee shall operate control equipment in accordance with the O&M manual at all times. The requirements in the O&M manual shall be incorporated by reference to this permit and shall be enforceable permit conditions. At a minimum, the O&M manual shall include the following for all (Table 1.1):

- Identify the manufacturer, model, date of manufacture, and maximum capacity (as-built) for each regulated emission source assigned a source ID, and for each control device in the service of ore concentration and refining, lime production, and concrete production (in Table 1.1). For each wet scrubber, vent gas cleaning tower, venturi scrubber, carbon filter, baghouse and bin vent filter cartridge control device, a copy of the vendor-supplied performance guarantee shall be included. For each engine, a copy of the EPA tier certification shall be included. For each cyanide leach tank and for each cyanide detox tank, the tank dimensions (e.g., diameter) shall be included.
- Establish operating ranges for control equipment, based on manufacturer specifications and conditions measured during performance testing.
    - Minimum pressure drop across each wet scrubber, vent gas cleaning tower, and venturi scrubber;
    - Minimum circulation flow rate for each wet scrubber, vent gas cleaning tower, venturi scrubber;
    - Maximum inlet gas stream temperature to each carbon filter;
    - Maximum pressure drop across each carbon filter;
    - Minimum pressure drop across each baghouse; and
    - Minimum coolant flow rate in the mercury retort (MR) condenser and vent gas steam condensation tower;

- Describe the procedures for proper operation, startup, and shutdown of control equipment, based on manufacturer specifications.
- Describe the schedule and procedures for routine inspection (Permit Condition 2.10), maintenance, repair, and replacement of control equipment.
    - See-no-see visible emissions inspection of each wet scrubber, carbon filter, baghouse, and bin vent shall be conducted at least once per day.
    - At least once every six months, the drum lining of the carbon regeneration kiln shall be visually inspected for structural damage and cracks.
    - The dates, times, and results from each inspection (as required by Permit Condition 2.11), corrective action, maintenance, repair, and replacement of control equipment shall be recorded at least once per month.
    - The replacement dates for each baghouse and bin vent filter cartridge and for each activated carbon filter medium shall be recorded at the time of each replacement. For cartridges, records shall include the manufacturer and model. For carbon filters, records shall include the manufacturer, type, and form of medium added. Records shall also include any changes in supplier and other relevant information.
    - All carbon filter beds shall be disposed of in an acceptable manner in compliance with all applicable state rules and federal regulations.
- Describe the schedule and procedures for corrective action that will be taken if visible emissions are present from wet scrubber (WS2, WS3), carbon filter (CA1, CA2, CA3, CA4, CA5), baghouse (BH2, BH3, BH4, BH5), or bin vent filter (LS, LS1, MillS2, ACS1, ACS2, ACS3, ACS4, CS1, CS2) control equipment at any time. Procedures should include how to determine whether filter cartridges are ruptured or are not appropriately secured in place, and how to determine whether the wet scrubber, condenser, and carbon filters are operating properly.
- Describe each monitoring device and methodology used to measure weight rates of materials to demonstrate compliance with each material throughput limit (Permit Conditions 3.5–3.9, 4.8–4.11, and 5.4–5.8). Procedures for proper installation, calibration, and maintenance shall be included.
- Describe each monitoring device and methodology used to measure the volumetric rates of materials to demonstrate compliance with the electrowinning cells and pregnant solution tank throughput limit (Permit Condition 4.12). Procedures for proper installation, calibration, and maintenance shall be included.
- Describe each monitoring device and methodology used to monitor pH, temperature, and free cyanide in each cyanide leach tank, each cyanide detox tank, and each tailings reclaim stream to comply with Cyanide Emissions Limit Compliance Monitoring (Permit Condition 4.18). Procedures for proper installation, calibration, and maintenance shall be included.
- Describe the methodology and sample calculations used to estimate monthly and rolling 12-month facility-wide cyanide emissions to assess compliance with the Cyanide Emissions Limit (Permit Condition 4.4). Calculations shall be based on the pH, temperature, and free cyanide concentrations that are measured each day, and the methodology used shall be consistent with the permittee's application as addended December 18, 2020 and shall be based on the following equation:

    $$r_v = k_g \alpha_0 C_l H A F_a F_w$$

where,

r_v = hydrogen cyanide emissions from surface (g/s)

k_g = gas phase mass transfer coefficient (m/s)

α_0 = non-ionized cyanide fraction determined from pH and pK_a (ionization coefficient)

C_l = total liquid phase free cyanide concentration (g/m^3)

H = Henrys Law Coefficient (g/m^3 per g/m^3)

A = process surface area (m^2)

F_a = area factor

F_w = wind factor

- Describe the monitoring methodology used to monitor xanthates usage (Permit Condition 4.19).

2.21 The O&M manual shall be submitted for approval to DEQ 30 days prior to startup of any ore processing, ore concentration and refining, lime production, or aggregate production emission source regulated by this permit (as identified in Table 1.1) at the address provided (Permit Condition 2.26), and shall remain onsite at all times. Any changes to the O&M manual shall be submitted to DEQ for review, comment, and approval 30 days prior to the change.

Incorporation of Federal Requirements

2.22 Unless expressly provided otherwise, any reference in this permit to any document identified in IDAPA 58.01.01.107.03 shall constitute the full incorporation into this permit of that document for the purposes of the reference, including any notes and appendices therein. Documents include, but are not limited to:

- Standards of Performance for New Stationary Sources (NSPS) 40 CFR 60, Subpart A – General Provisions.
- NSPS 40 CFR 60, Subpart LL – Standards of Performance for Metallic Mineral Processing Plants. Each crusher (OC7, OC12), conveyor belt transfer point (OC2–OC6, OC9–OC11, OC13), and truck unloading station (OC1) is an affected facility.
- NSPS 40 CFR 60, Subpart OOO – Standards of Performance for Nonmetallic Mineral Processing Plants. Each crusher (LS2, LS4), grinding mill (LSBM), screening operation (LS3, LS5, LS11), belt conveyor (LS6–LS10, LS12), and storage bin (LS1) is an affected facility.
- NSPS 40 CFR 60, Subpart IIII – Standards of Performance for Stationary Compression Ignition Internal Combustion Engines. Each emergency generator engine and fire pump (EDG1, EDG2, EDG3, and EDFP) is an affected facility.
- National Emission Standards for Hazardous Air Pollutants for Source Categories (NESHAP) 40 CFR 63, Subpart A – General Provisions.
- NESHAP 40 CFR 63, Subpart EEEEEEE – National Emission Standards for Hazardous Air Pollutants: Gold Mine Ore Processing and Production Area Source Category. The collection of ore pretreatment processes including the autoclave (AC) and the carbon process including the carbon regeneration kiln (CKD), the electrowinning cells and pregnant solution tank (EW), the mercury retort (MR), and the induction melting furnace (MF) are affected facilities.

- NESHAP 40 CFR 63, Subpart ZZZZ – National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines (RICE). Each emergency generator engine and fire pump (EDG1, EDG2, EDG3, and EDFP) is an affected facility.
- NESHAP 40 CFR 63, Subpart CCCCCC – National Emission Standards for Hazardous Air Pollutants for Source Category: Gasoline Dispensing Facilities. Each gasoline fuel storage tank (TG1, TG2) is an affected facility.

The permittee shall comply with all applicable NSPS and NESHAP requirements. For permit conditions referencing or cited in accordance with any document incorporated by reference (including permit conditions identified as NSPS or NESHAP), should there be any conflict between the requirements of the permit condition and the requirements of the document, the requirements of the document shall govern, including any amendments to that regulation.

2.23 In accordance with IDAPA 58.01.01.314.06, the permittee shall notify DEQ in writing the date upon which the Tier I source (e.g., gold ore concentration and refining process equipment) commences operation. The notification shall be titled, "TIER I SOURCE NOTIFICATION OF COMMENCING OPERATION," and shall include the name of the permittee, the permit and project numbers, the date the permit was issued, and the date the Tier I source commences operation. The notification shall be submitted to DEQ within five (5) days of commencing operation and shall be sent to:

Air Quality Permitting
Idaho Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706-1255

2.24 In accordance with IDAPA 58.01.01.313.01.b., the permittee shall submit a complete application to DEQ at the address provided (Permit Condition 2.26) for an initial Tier I operating permit within 12 months of becoming a Tier I source or commencing operation.

REC 0093

Test Methods

2.25 Except as otherwise specified in this permit and in IDAPA 58.01.01.157.02, when testing is required the following test methods shall be used to measure pollutant emissions.

Table 2.1 Test Methods

Pollutant		Test Method	Additional Requirements
H_2SO_4		EPA Method 8	
$PM_{2.5}$ or PM_{10}		EPA Methods 5 and 202, or 201A and 202	Particulate matter (PM), including condensable PM as defined in IDAPA 58.01.01.006 with an aerodynamic diameter less than or equal to a nominal 10 micrometers for PM_{10}, and less than or equal to a nominal 2.5 micrometers for $PM_{2.5}$.
Opacity	point	EPA Method 9	For NSPS and NESHAP sources, use IDAPA 58.01.01.625 and Method 9. For other sources, use IDAPA 58.01.01.625 only.
	fugitive	EPA Method 22	Visible fugitive PM.

Notifications

2.26 All requests, reports, applications, submittals, certifications, and other communications required by this permit shall be submitted to:

Air Quality Permit Compliance
Department of Environmental Quality
Boise Regional Office
1445 N. Orchard St.
Boise, Idaho 83706

phone: (208) 373-0550
fax: (208) 373-0287

3 Mining and Ore Processing

3.1 Process Description

Conventional open-pit mining methods including drilling, blasting, excavating, and hauling will be used to extract ore and waste rock, termed development rock (DR). Hydraulic shovels and front-end loaders will be used to load ore and DR into haul trucks. DR will be used for construction, restoration, and backfilling, or hauled to dedicated development rock storage facilities (DRSF). Approximately 340 million tons of DR will be handled over the life of the mine.

The SGP will include three years of pre-mining development and construction activities, followed by an operating mine life of approximately 12 years. Mining will occur in three open pits: Yellow Pine Pit (YPP), Hangar Flats pit (HFP), and West End pit (WEP). Legacy tailings from the Meadow Creek valley (Bradley Tailings [BT]) will also be reclaimed and reprocessed. Surface exploration drilling will occur within the pits and underground within the Scout Prospect decline.

Ore will be hauled to the primary crusher area, where it will be fed directly into the crusher dump pocket or stockpiled. The ore crushing plant will be designed to operate at a maximum rate of 25,000 tons per calendar day (T/day). Approximately 100 million tons of ore will be mined from the three pits over the life of the project.

The metal-recovery process from ore will include conventional crushing and grinding, followed by froth-flotation circuits that will generate separate gold-silver and antimony-silver concentrates. The antimony-silver concentrate will be shipped offsite for refining, whereas additional onsite processing of the gold-silver concentrate will include pressure oxidation, carbon-in-leach circuits, and refining processes to recover gold and minor amounts of silver. The finely ground leftover ore material from the mineral-recovery process, termed tailings, will be neutralized, thickened, and transported via a pipeline to the tailings storage facility.

3.2 Control Device Descriptions

Table 3.1 contains a description of control equipment used to control emissions from mining and ore processing activities.

Table 3.1 Mining and Ore Processing Control Device Descriptions

Emission Sources	Control Devices
Mining	
Drilling activities	Reasonable control and Fugitive Dust Control Plan (FDCP) Dust collection systems on drilling rigs Control efficiency: 90%
Blasting activities	Reasonable control & FDCP
Excavating and hauling activities	Reasonable control & FDCP Chemical suppression and water sprays Control efficiency: 93.3% for PM/PM_{10} (haul roads) Haul road capping with low-arsenic quartzite
Rock dumps and storage piles	Reasonable control & FDCP
(2) Prill Silos #1-2 Maximum capacity: 100 T (each)	None
Ore Processing	
Loader Transfer of Ore to Grizzly	Reasonable control & FDCP Water sprays and moisture carryover
Grizzly to Apron Feeder	
Apron Feeder to Dribble	
Apron Feeder to Grizzly	
Dribble to Grizzly	
Grizzly to Primary Crusher or Coarse Ore Stockpile Feed	
Primary Crusher	Reasonable control & FDCP Water sprays and moisture carryover
Coarse Ore Stockpile Feed Transfer to Stockpile	
Stockpile Transfer to Reclaim Conveyors	Reasonable control & FDCP Below-grade of storage piles Control efficiency: 80% for PM/PM_{10}
Reclaim Conveyors to SAG Mill Feed Conveyor	
SAG Mill Feed Transfer to SAG Mill	Reasonable control & FDCP Enclosure Control efficiency: 80% for PM/PM_{10}
Pebble Crusher	Reasonable control & FDCP Water sprays and moisture carryover
Pebble Discharge to SAG Mill Feed	

Operating Limits

3.3 Drilling Limits

The permittee shall drill no more than 1,200 blast holes per day.

3.4 Blasting Limits

The permittee shall complete no more than two blasting operations per day.

3.5 Daily Hauling and Excavating Limits

The permittee shall haul no more than 180,000 tons per day (T/day) of ore and DR.

The permittee shall haul no more than 135,000 T/day of ore and DR, based on a 5-year rolling average.

3.6 Life of Mine Hauling and Excavating Limits

The permittee shall haul no more than 788.4 million tons (MT) of ore and DR from all deposits over the life of the mine and no more than 394.2 MT of ore and DR from the West End deposit over the life of the mine.

3.7 Primary Crusher Limit

The permittee shall process ore as the raw material in the primary crusher, and the maximum input to the primary crusher shall not exceed 25,000 T/day.

3.8 Pebble Crusher Limit

The permittee shall process ore as the raw material, and the maximum input to the pebble crusher shall not exceed 27,600 T/day.

3.9 Prill Loading Limit

The permittee shall not load in excess of 200 T/day and 9,000 tons per any consecutive 12-month period of prill (ammonium nitrate) to the prill silos.

3.10 Mining and Ore Processing Dust Control

The permittee shall control emissions from mining and ore processing emission sources (Table 3.1) in accordance with the Fugitive Dust Control Plan.

3.11 Drilling Rigs Dust Control System

The permittee shall install and operate dust collection systems with a minimum control efficiency of 90% on all drilling rigs in accordance with the O&M manual (Permit Condition 2.20). The dust collection systems shall be in operation at all times when the drilling rigs are operated.

3.12 Ore Processing Equipment Water Sprays

The permittee shall install, operate, and maintain water sprays in accordance with the O&M manual (Permit Condition 2.20) to control PM emissions from each ore processing crusher and conveyor. Water sprays shall operate according to the FDCP when this equipment is operated to ensure compliance with Fugitive Dust requirements (Permit Conditions 2.1–2.6).

3.13 Haul Road Capping

The permittee shall cap haul roads that are outside of the Yellow Pine Pit (YPP), Hangar Flats Pit (HFP), and West End Pit (WEP) and development rock storage facilities (DRSF) including the Yellow Pine DRSF, Fiddle DRSF, and Hangar Flats DRSF with low-arsenic material.

The permittee shall use low-arsenic quartzite rock deposits from the WEP, or other material with equal or lower arsenic concentration, as capping material. Low-arsenic quartzite rock is defined as material with a median arsenic concentration of 90 parts per million (ppm) or less.

The permittee shall use capping material with a maximum of 4.0% silt content.

The permittee shall develop and maintain a Haul Road Capping Plan (HRCP) that identifies the low-arsenic quartzite rock deposits in the West End pit based on core sample analyses. The permittee shall comply with the measures identified in the HRCP at all times. The measures specified in the HRCP shall be incorporated by reference to this permit and shall be enforceable permit conditions. At a minimum, the HRCP shall include:

- The low-arsenic quartzite rock sampling plan including standard operational procedure for sampling, frequency of sampling, and ASTM (or equivalent) method of analysis for arsenic concentration.
- The frequency of inspection of the haul roads and maintenance procedures.
- The silt content sampling plan including standard operational procedure for sampling, frequency of sampling, and ASTM (or equivalent) method of analysis for silt content.

A copy of the HRCP shall be submitted to DEQ for approval 30 days prior to startup at the address provided (Permit Condition 2.26), and shall remain onsite at all times. Any changes to the HRCP shall be submitted to DEQ for review, comment, and approval 30 days prior to the change.

Monitoring and Recordkeeping Requirements

3.14 Drilling Limits Monitoring

Each day, the permittee shall monitor and record the number of blast holes drilled.

3.15 Blasting Limits Monitoring

Each day, the permittee shall monitor and record the number of blasting operations completed.

3.16 Daily Hauling and Excavating Monitoring

Each day, the permittee shall monitor and record the amount of ore and DR transported on haul trucks (T/day). The devices and methodologies used to measure weights shall be identified in the O&M Manual.

Each calendar month, the permittee shall monitor and record the amount of ore and DR transported on haul trucks in tons per month (T/mo) and in tons per year (T/yr). Annual amounts of ore and DR transported shall be determined by summing the monthly amount over the previous consecutive 12-month period. The annual amounts of ore and DR transported shall be used to calculate the 5-year rolling average in T/day.

3.17 Life of Mine Hauling and Excavating Limit Monitoring

Each day, the permittee shall monitor and record the amount of ore and DR transported on haul trucks from all deposits (T/day) and the amount of ore and DR transported on haul trucks (T/day) from the West End deposit. The devices and methodologies used to measure weights shall be identified in the O&M Manual.

Each calendar month, the permittee shall monitor and record the amount of ore and DR transported on haul trucks in tons per month (T/mo) and in tons per year (T/yr) from all deposits and the West End deposit. Annual amounts of ore and DR transported shall be determined by summing the monthly amount over the previous consecutive 12-month period. The annual amounts of ore and DR transported shall be used to calculate the life of mine total (MT) for all deposits and the West End deposit.

3.18 Primary Crusher Limit Monitoring

Each day, the permittee shall monitor and record the tons of ore input to the crusher (T/day). The devices and methodologies used to measure weights shall be identified in the O&M Manual.

3.19 Pebble Crusher Limit Monitoring

Each day, the permittee shall monitor and record the tons of ore input to the pebble crusher (T/day). The devices and methodologies used to measure weights shall be identified in the O&M Manual.

3.20 Prill Loading Limit Monitoring

Each day, the permittee shall monitor and record the amount of prill loaded to all of the prill silos combined in tons (T/day). The devices and methodologies used to measure weights shall be identified in the O&M Manual.

Each month, the permittee shall monitor and record the amount of prill loaded to all of the prill silos combined in tons per month (T/mo) and in tons per year (T/yr) to demonstrate compliance with the annual prill silos limit. Annual prill loaded shall be determined by summing the monthly input over the previous consecutive 12-month period.

4 Ore Concentration and Refining

4.1 Process Description

The autoclave is a pressure oxidation (POX) vessel used to oxidize gold gold-silver concentrate at elevated temperature and pressure in the presence of oxygen. Upon exiting the autoclave, the slurry is cooled in flash vessels and neutralized using lime and caustic soda prior to being sent to the vat leaching circuit for gold and silver recovery. A dilute sodium cyanide solution is added to the leach tanks to dissolve the gold and silver from the ore. Leached "pulp" is sent to multistage carbon-in-pulp (CIP) and/or carbon-in-leach (CIL) tanks, where gold is recovered onto activated carbon. The autoclave is located in the POX Building and the exhaust from the autoclave passes through a venturi scrubber, vent gas cleaning tower, vent gas steam condensation tower, and carbon filter.

Carbon loaded with gold is removed and washed with acid, then stripped with a caustic solution. This mineral-bearing solution is sent to the electrowinning cells and pregnant solution tank (EW). The EW cells remove the gold from the solution by plating it onto cathodes consisting of stainless-steel plates with steel wool. The EW cell exhaust passes through a carbon adsorption column (CA2), where remaining mercury vapor is adsorbed onto sulfur-impregnated activated carbon (SIAC). The stripped carbon must be periodically regenerated in the carbon regeneration kiln. Exhaust from the carbon regeneration kiln passes through a carbon adsorption bed (CA1), where mercury is adsorbed onto SIAC.

Gold concentrate is loaded into the mercury retort (MR), where it is heated under vacuum to drive off mercury. The MR exhaust passes through a shell-and-tube condenser to cool the exhaust and condense the mercury vapor into a liquid, which is collected by the mercury trap. The exhaust passes through a carbon adsorption column (CA3), where remaining vapor mercury is adsorbed onto SIAC.

After retorting, the gold concentrate is transferred to the electric induction melting furnace. Only retorted concentrate is melted in the furnace. The exhaust passes through a carbon adsorption column (CA4), where remaining mercury vapor is adsorbed onto SIAC. The electrowinning cells and pregnant solution tank, carbon regeneration kiln, MR, and induction melting furnace are located in the Refinery Building.

4.2 Control Device Descriptions

Table 4.1 Ore Concentration and Refining Control Device Descriptions

Emissions Unit / Processes	Control Devices	Emission Points
Cyanide Leach Tanks and Cyanide Detox Tanks	Chemical treatment (lime, caustic soda, hydrogen peroxide, copper sulfate, etc.)	Various
Flotation Tanks	None	
Autoclave	Venturi Scrubber (VS1) Minimum pressure drop and Minimum circulation flow rate in O&M	Autoclave Carbon Filter Stack
	Vent Gas Cleaning Tower (ST1) Minimum pressure drop and Minimum circulation flow rate in O&M	
	Vent Gas Steam Condensation Tower (CT1) Minimum coolant flow rate in O&M	
	Carbon Filter (CA5) Maximum pressure drop established in O&M Maximum inlet gas stream temperature established in O&M and by Subpart EEEEEEE	
POX Boiler	None	POX Boiler Stack
Electrowinning Cells and Pregnant Solution Tank	Shared Carbon Filter (CA2) Maximum pressure drop established in O&M Maximum inlet gas stream temperature established in O&M and by Subpart EEEEEEE in O&M	Electrowinning Cells and Pregnant Solution Tank Shared Carbon Filter Stack
Strip Circuit Solution Heater	None	Strip Circuit Solution Heater Stack
Mercury Retort	Condenser Minimum coolant flow rate established in O&M	Mercury Retort Carbon Filter Stack
	Carbon Filter (CA3) Maximum pressure drop established in O&M Maximum inlet gas stream temperature established in O&M and by Subpart EEEEEEE	
Induction Melting Furnace	Baghouse (BH2) Minimum pressure drop established in O&M	Induction Melting Furnace Carbon Filter Stack
	Carbon Filter (CA4) Maximum pressure drop established in O&M Maximum inlet gas stream temperature established in O&M and by Subpart EEEEEEE	
Carbon Regeneration Kiln	Wet Scrubber (WS2) Minimum pressure drop and Minimum circulation flow rate established in O&M	Carbon Regeneration Kiln Carbon Filter Stack
	Carbon Filter (CA1) Maximum pressure drop established in O&M Maximum inlet gas stream temperature established in O&M and by Subpart EEEEEEE	
Carbon Regeneration Kiln Burners	None	Carbon Regeneration Kiln Burners Stack
Propane Vaporizer	None	Propane Vaporizer Stack
Tailings and Maintenance Pond	None	Various

Emission Limits

4.3 Ore Concentration and Refining Equipment Emissions Limits

Emissions from ore concentration and refining equipment stacks shall not exceed any corresponding emission rate limits (Table 4.2).

Table 4.2 Ore Concentration and Refining Emissions Limits [a]

Source Description	PM / PM_{10} / $PM_{2.5}$ [b]	NO_x	CO	VOC	SO_2	H_2SO_4
	lb/hr [c]	lb/hr [c]	lb/hr [c]	lb/hr [c]	lb/hr [c]	lb/hr [c]
Autoclave (AC)	5.08				0.65	2.03
Carbon regeneration kiln (CKD)	0.42	0.01	0.12	0.11		
Electrowinning cells and pregnant solution tank (EW)	0.07					
Mercury retort (MR)	0.01 [d]					
Induction melting furnace (MF)	2.84					

a) In absence of any other credible evidence, compliance is ensured by complying with permit operating, monitoring, and recordkeeping requirements.
b) Particulate matter (PM) including condensable PM as defined in IDAPA 58.01.01.006, with an aerodynamic diameter less than or equal to a nominal 10 micrometers for PM_{10}, and less than or equal to a nominal 2.5 micrometers for $PM_{2.5}$.
c) Pounds per hour, as determined by a test method prescribed by IDAPA 58.01.01.157, EPA reference test method, continuous emission monitoring system (CEMS) data, or DEQ-approved alternative.
d) For this emission limit, compliance may be demonstrated as measurement below detection limits, when addressed as part of a performance test protocol that is approved by DEQ.

4.4 Cyanide Emissions Limit

Facility-wide emissions shall not exceed 1.99 tons per any consecutive 12-month period of cyanide compounds.

4.5 Carbon Disulfide Emissions Limit

Facility-wide emissions shall not exceed 0.063 tons per any consecutive 12-month period of carbon disulfide.

Operating Limits

4.6 Xanthates Usage

The permittee shall use potassium amyl xanthate (PAX) for flotation treatment. Total xanthate usage shall not exceed 1,700 tons per any consecutive 12-month period.

4.7 POX Boiler Operation

Operation of the POX Boiler shall be limited to the autoclave start-up operation only.

4.8 Autoclave Input

The permittee shall process ore concentrate as the raw material in the autoclave, and the maximum input to the autoclave shall not exceed 6,960 T/day.

4.9 Mercury Retort Input

The permittee shall process precious metal concentrate as the raw material in the mercury retort, and the maximum input to the mercury retort shall not exceed 1,000 pounds per batch (lb/batch) and 21 tons per any consecutive 12-month period.

Precious metal concentrate includes material loaded with precious metals produced by electrowinning, flotation and gravity separation, and other gold concentration or precipitation processes; and material collected from the wash-down of equipment and surfaces contacted with precious metals that have been concentrated through these concentration methods.

4.10 Induction Melting Furnace Input

The permittee shall process retorted concentrate as the raw material in the induction melting furnace, and the input to the induction melting furnace shall not exceed 1,000 lb/batch, and 21 tons per any consecutive 12-month period. Retorted concentrate includes precious metal

concentrate that has been retorted and dust collected from the baghouse and fume hood of the induction melting furnace.

4.11 Carbon Regeneration Kiln Input

The permittee shall process carbon filters as the raw material in the carbon regeneration kiln, and the maximum input to the carbon regeneration kiln shall not exceed 7.2 T/day.

4.12 Electrowinning Cells and Pregnant Solution Tank Throughput

The permittee shall process mineral-bearing solution as the raw materials in the electrowinning cells and pregnant solution tank, and the maximum throughput for the electrowinning cells and pregnant solution tank shall not exceed 100 gallons per minute (gpm).

4.13 Autoclave Venturi Scrubber, Vent Gas Cleaning Tower, Vent Gas Steam Condensation Tower, and Carbon Filter

The permittee shall install, operate, and maintain venturi scrubber (VS1), vent gas cleaning tower (ST1), vent gas steam condensation tower (CT1), and carbon filter (CA5) systems in accordance with the O&M manual (Permit Condition 2.20) and consistent with manufacturer's recommendations. All emissions from the autoclave shall be ducted to these control devices at all times to ensure compliance with autoclave emission limits (Table 4.2).

4.14 Electrowinning Cells and Pregnant Solution Tank Shared Carbon Filter

The permittee shall install, operate, and maintain a carbon filter (CA2) in accordance with the O&M manual (Permit Condition 2.20) and consistent with manufacturer's recommendations. All emissions from the electrowinning cells and pregnant solution tank shall be ducted to a carbon filter at all times to ensure compliance with electrowinning cells and pregnant solution tank emission limits (Table 4.2).

4.15 Mercury Retort Condenser and Carbon Filter

The permittee shall install, operate, and maintain a condenser and carbon filter (CA3) in series in accordance with the O&M manual (Permit Condition 2.20) and manufacturer's recommendations. All emissions from the mercury retort (MR) shall be ducted to the condenser and activated carbon filter at all times to ensure compliance with mercury retort emission limits (Table 4.2).

- The MR shall be fully enclosed in the refinery building.
- The air pressure within the MR shall be maintained lower than the room air pressure such that air flows into the MR at all times when the MR is operating. The MR door shall be kept closed at all times during operation.
- The permittee shall not operate the MR unless the chilled water condenser is operating, carbon filter in place, and the condenser coolant flow rate is maintained within the range specified in the O&M manual.
- The condenser and carbon filter shall be maintained and operated in accordance with the O&M manual.
- All liquid mercury captured from the MR shall be stored in closed containers.

4.16 Induction Melting Furnace Baghouse and Carbon Filter

The permittee shall install, operate, and maintain a baghouse (BH2) and carbon filter (CA4) in series in accordance with the O&M manual (Permit Condition 2.20) and manufacturer's recommendations. All emissions from the induction melting furnace shall be ducted to the

baghouse and carbon filter at all times during operation to ensure compliance with induction melting furnace emission limits (Table 4.2).

4.17 Carbon Regeneration Kiln Wet Scrubber and Carbon Filter

The permittee shall install, operate, and maintain a wet scrubber (WS2) and carbon filter (CA1) in series in accordance with the O&M manual (Permit Condition 2.20) and consistent with manufacturer's recommendations. All emissions from the carbon regeneration kiln shall be ducted to the wet scrubber and a carbon filter at all times to ensure compliance with carbon regeneration kiln drum emission limits (Table 4.2).

Monitoring and Recordkeeping

4.18 Cyanide Emissions Limit Compliance Monitoring

On at least a daily basis, the permittee shall monitor and record the pH, temperature, and free cyanide concentration levels in grams per cubic meter (g/m^3) of each cyanide leach tank, detox tank, and tailings reclaim stream, and use this information to estimate monthly facility-wide cyanide emissions using the equation and calculation methodology in the O&M Manual (Permit Condition 2.20).

Each month, the permittee shall estimate the monthly and rolling 12-month facility-wide cyanide emissions. Monthly facility-wide cyanide emissions shall be estimated from all emission sources including cyanide leach tanks, detox tanks, electrowinning cells and pregnant solution tank, and barren tanks. Rolling 12-month facility-wide cyanide emissions shall be estimated by summing the monthly emissions from all sources over the previous consecutive 12-month period. The rolling 12-month facility-wide cyanide emissions shall be used to assess compliance with the Cyanide Emissions Limit (Permit Condition 4.4).

4.19 Xanthates Usage Monitoring

Each month, the permittee shall monitor and record the xanthates delivered to the facility and the xanthates used by the facility in tons per month (T/mo) and in tons per 12-month period to demonstrate compliance with the xanthates usage limit. Annual delivery and usage shall be determined by summing the respective monthly amounts over the previous consecutive 12-month period. The methodologies used to measure xanthates usage shall be identified in the O&M Manual.

4.20 POX Boiler Operation Monitoring

Each month, the permittee shall monitor and record the operating hours of the POX Boiler, in hours (hr/mo) and in hours per 12-month period (hr/yr). Annual hours shall be determined by summing the monthly hours over the previous consecutive 12-month period.

4.21 Autoclave Input Monitoring

Each day, the permittee shall monitor and record the material input to the autoclave in tons (T/day) to demonstrate compliance with the autoclave input limit. The devices and methodologies used to measure weights shall be identified in the O&M Manual, and the devices shall be installed in accordance with the requirements of NESHAP Subpart EEEEEEE.

4.22 Mercury Retort Input Monitoring

Each day, the permittee shall monitor and record the material input to the mercury retort in pounds (lb/day) to demonstrate compliance with the daily mercury retort input limit. The devices and methodologies used to measure weights shall be in accordance with the requirements of NESHAP Subpart EEEEEEE.

Each month, the permittee shall monitor and record the material input to the mercury retort in T/mo and T/yr to demonstrate compliance with the annual mercury retort input limit. Annual material input shall be determined by summing the monthly input over the previous consecutive 12-month period.

4.23 Induction Melting Furnace Input Monitoring

Each day, the permittee shall monitor and record the material input to the induction melting furnace in pounds (lb/day) to demonstrate compliance with the daily induction melting furnace input limit. The devices and methodologies used to measure weights shall be identified in the O&M Manual.

Each month, the permittee shall monitor and record the material input to the induction melting furnace in T/mo and in T/yr to demonstrate compliance with the annual induction melting furnace input limit. Annual material input shall be determined by summing the monthly input over the previous consecutive 12-month period.

4.24 Carbon Regeneration Kiln Input Monitoring

Each day, the permittee shall monitor and record the material input to the carbon regeneration kiln in tons (T/day) to demonstrate compliance with the carbon regeneration kiln input limit. The devices and methodologies used to measure weights shall be identified in the O&M Manual.

4.25 Electrowinning Cells and Pregnant Solution Tank Throughput Monitoring

Each day, the permittee shall monitor and record the material throughput in the electrowinning cells and pregnant solution tank in gallons per minute (gpm) to demonstrate compliance with the Electrowinning Cells and Pregnant Solution Tank Throughput limit. The devices and methodologies used to measure weights shall be identified in the O&M Manual.

4.26 Autoclave Venturi Scrubber and Vent Gas Cleaning Tower Monitoring

The permittee shall install, calibrate, operate, and maintain devices for monitoring the circulation flow rate in the venturi scrubber, the circulation flow rate in the vent gas cleaning tower, the pressure drop across the venturi scrubber, and the pressure drop across the vent gas cleaning tower for the autoclave.

At least once per shift, the permittee shall monitor and record the circulation flow rate in the venturi scrubber, the circulation flow rate in the vent gas cleaning tower, the pressure drop across the venturi scrubber, and the pressure drop across the vent gas cleaning tower to ensure compliance with O&M specifications.

4.27 Autoclave Vent Gas Steam Condensation Tower Monitoring

The permittee shall install, calibrate, operate, and maintain devices for monitoring the coolant flow rate to the vent gas steam condensation tower for the autoclave.

At least once per shift, the permittee shall monitor and record the coolant flow rate to the vent gas steam condensation tower to ensure compliance with O&M specifications.

4.28 Autoclave Carbon Filter Monitoring

The permittee shall install, calibrate, operate, and maintain devices for monitoring the inlet gas stream temperature to the carbon filter, and the pressure drop across the carbon filter for the autoclave.

At least once per shift, the permittee shall monitor and record the inlet gas stream temperature and pressure drop across the carbon filter to ensure compliance with O&M specifications.

4.29 Electrowinning Cells and Pregnant Solution Tank Shared Carbon Filter Monitoring

The permittee install, calibrate, operate, and maintain devices for monitoring the inlet gas stream temperature to the carbon filter, and the pressure drop across the carbon filter for the electrowinning cells and pregnant solution tank.

At least once per shift, the permittee shall monitor and record the inlet gas stream temperature and pressure drop across the carbon filter to ensure compliance with O&M specifications.

4.30 Mercury Retort Condenser and Carbon Filter Monitoring

The permittee shall install, calibrate, operate, and maintain devices for monitoring the coolant flow rate in the condenser, the inlet gas temperature to the carbon filter, the pressure drop across the carbon filter, and the difference between the pressure inside the MR and the air pressure in the room.

At least once per shift, the permittee shall monitor and record the coolant flow rate to the condenser, the inlet gas stream temperature, the pressure drop across the carbon filter, and the difference between the pressure inside the MR and the air pressure in the room to ensure compliance with O&M specifications.

4.31 Induction Melting Furnace Baghouse and Carbon Filter Monitoring

The permittee shall install, calibrate, operate, and maintain devices for monitoring the pressure drop across the baghouse, the inlet gas stream temperature to the carbon filter, and the pressure drop across the carbon filter for the induction melting furnace.

At least once per shift, the permittee shall monitor and record the pressure drop across the induction melting furnace baghouse, the inlet gas stream temperature to the carbon filter, and pressure drop across the carbon filter to ensure compliance with O&M specifications.

4.32 Carbon Regeneration Kiln Wet Scrubber and Carbon Filter Monitoring

The permittee shall install, calibrate, operate, and maintain a device for monitoring the circulation flow rate in the wet scrubber, the pressure drop across the wet scrubber, the inlet gas stream temperature to the carbon filter, and the pressure drop across the carbon filter for the carbon regeneration kiln.

At least once per shift, the permittee shall monitor and record the circulation flow rate, the pressure drop across the carbon regeneration kiln wet scrubber, the inlet gas stream temperature to the carbon filter, and the pressure drop across the carbon filter to ensure compliance with O&M specifications.

Testing

4.33 Ore Concentration and Refining Equipment Performance Tests

Within 180 days after initial startup, performance testing shall be conducted to demonstrate compliance with the following Ore Concentration and Refining Equipment Emissions Limits. The permittee shall conduct three separate test runs for each performance test using the appropriate test method (Permit Condition 2.25). The source test shall be conducted under "worst-case normal" conditions as required by IDAPA 58.01.01.157 and the General Provisions of this permit, and the source test report shall contain documentation that the test was conducted under these conditions.

- $PM_{10}/PM_{2.5}$ and H_2SO_4 in lb/hr from the Autoclave Wet Scrubber Stack
- $PM_{10}/PM_{2.5}$ in lb/hr from the Carbon Regeneration Kiln Carbon Filter Stack

- $PM_{10}/PM_{2.5}$ in lb/hr from the Electrowinning Cells and Pregnant Solution Tank Shared Carbon Filter Stack
- $PM_{10}/PM_{2.5}$ in lb/hr from the Mercury Retort Carbon Filter Stack
- $PM_{10}/PM_{2.5}$ in lb/hr from the Induction Melting Furnace Carbon Filter Stack

4.34 Ore Concentration and Refining Equipment Performance Tests Monitoring

The permittee shall monitor and record the following during each performance test:

- Material input rates for all ore concentration and refining process equipment (Permit Conditions 4.21 through 4.25) during each test run.
- Control equipment monitoring relevant to the stack tested (Permit Condition 4.26 through 4.32), measured at least once during each test run.
- The visible emissions observed for the stack tested during each test, using the methods specified in IDAPA 58.01.01.625 (Permit Condition 2.9).

5 Lime, Aggregate, and Concrete Production

5.1 Process Description

The lime, aggregate, and cement batch plants produce raw materials necessary for mining and ore concentration and refining operations. Lime is used in ore processing for pH control. Aggregate and cement are used in concrete production, with aggregate also used in road construction.

Lime production consists of a limestone crushing, screening, and grinding plant and lime storage silos. The limestone grinding process utilizes a baghouse to reduce emissions during processing. Each storage silo has a bin vent filter used to reduce PM emissions during silo loading.

Aggregate production consists of two portable crushing and screening plants and aggregate and cement storage silos. Each portable crushing and screening plant utilizes water sprays and moisture carryover to reduce emissions during processing. Each storage silo has a bin vent filter used to reduce PM emissions during silo loading.

Concrete production consists of a central mix batch plant and cement storage silos. The central mix batch plant utilizes controls that may include water sprays, enclosures, hoods, curtains, shrouds, movable and telescoping chutes, and central duct collection systems to reduce PM emissions during processing. Each storage silo has a bin vent filter used to reduce PM emissions during silo loading.

5.2 Control Device Descriptions

Table 5.1 Lime, Aggregate, and Concrete Production Control Device Descriptions

Lime Production Plant Emissions Unit / Processes	Control Devices	Emission Points
Limestone transfer to Primary Crusher Hopper	Reasonable control & FDCP	Various
Primary Crusher		
Primary Screen		
Secondary Crusher		
Secondary Screen		
Limestone to Ball Mill Feed Bin		
Limestone to Ball Mill Feed		
Ball Mill Feed to Ball Mill		
Limestone to Kiln Feed Bin		
Limestone to Lime Kiln Feed		
Fines Screen		
Kiln Feed to PFR Shaft Lime Kiln		
Limestone Ball Mill	Reasonable control & FDCP Baghouse (BH3) Minimum pressure drop established in O&M	Limestone Ball Mill Baghouse Stack
Pebble Lime Silo loading	Bin vent filter	Pebble Lime Silo Stack
unloading	Wet Scrubber (WS3) Minimum pressure drop established in O&M	Pebble Lime Silo Wet Scrubber Stack
Parallel Flow Regenerative Shaft Kiln	Baghouse (BH4) Minimum pressure drop established in O&M	PFR Shaft Kiln Carbon Filter Stack
Lime Mill Crusher	Baghouse (BH5) Minimum pressure drop established in O&M	Lime Mill Crusher Baghouse Stack
SAG Mill Lime Silo #1, and SAG Mill Lime Silo #2 loading	Bin vent filters	SAG Mill Lime Silo #1 Stack and SAG Mill Lime Silo #2 Stack
unloading	None	Fugitive
AC Lime Silo #1, AC Lime Silo #2, AC Lime Silo #3, and AC Lime Silo #4 loading	Bin vent filters	AC Lime Silo #1 Stack, AC Lime Silo #2 Stack, AC Lime Silo #3 Stack, and AC Lime Silo #4 Stack
unloading	None	Fugitive
Aggregate Production Plant Emissions Unit / Processes	**Control Devices**	**Emission Points**
Portable Crushing and Screening Plant 1 Crushers, screens, and conveyors	Reasonable control & FDCP Water sprays and moisture carryover	Various
Portable Crushing and Screening Plant 2 Crushers, screens, and conveyors	Reasonable control & FDCP Water sprays and moisture carryover	Various
Concrete Production Plant Emissions Unit / Processes	**Control Devices**	
Central Mix Plant	Reasonable control & FDCP Controls may include water sprays, enclosures, hoods, curtains, shrouds, movable and telescoping chutes, and central duct collection systems.	Various
Aggregate bin loading/unloading	None	Fugitive
Cement/Shotcrete Silo #1 and Cement/Shotcrete Silo #2 loading	Bin vent filters	Cement/Shotcrete Silo #1 Stack and Cement/Shotcrete Silo #2 Stack
unloading	None	Fugitive

Emission Limits

5.3 Lime, Aggregate, and Concrete Production Emission Limits

Emissions from the lime production plant stacks shall not exceed any emission rate limit in the following table.

Table 5.2 Lime, Aggregate, and Concrete Production Plant Emission Limits [a]

Source Description	PM [b]	PM_{10} [b]	$PM_{2.5}$ [b]	NO_x	CO	VOC	SO_2
	lb/hr [c]	lb/hr [c]	lb/hr [c]	lb/hr [c]	lb/hr [c]	lb/hr [c]	lb/hr [c]
Lime Production							
Parallel Flow Regenerative Shaft Kiln (LK, LKC)	1.08	1.08	1.08	4.82	4.98	0.19	0.39
Limestone Ball Mill (LSBM)	1.90	1.60	0.57				
Lime Mill Crusher (LCR)	0.28	0.24	0.09				
Lime Mill screens and conveyors (LS2, LS4, LS3, LS5, LS11, LS1, LS6–LS10, LS12)	3.66	1.34	0.20				
Mill Lime Silo loading (each) (LS1L, MillS2L)	0.06	0.02	0.01				
Mill Lime Silo unloading (each) (LS1U, MillS2U)	0.10	0.06	0.01				
AC Lime Silo loading (each) (ACS1L, ACS2L, ACS3L, ACS4L)	0.12	0.04	0.01				
AC Lime Silo loading (each) (ACS1U, ACS2U, ACS3U, ACS4U)	0.10	0.06	0.01				
Pebble Lime Silo loading (LS-L)	0.01	0.01	0.01				
Pebble Lime Silo unloading (LS-U)	0.001	0.001	0.001				
Crushers, screens, conveyors, silo unloading (LSBM, LCR, LS1– LS12)	6.00	3.22	0.87				
Aggregate Production							
Portable Crushing and Screening Plant 1	0.63	0.23	0.03				
Portable Crushing and Screening Plant 2	0.63	0.23	0.03				
Concrete Production							
Central Mix Plant (CM, CS1, CS2, CA)	2.10	0.94	0.14				

a) In absence of any other credible evidence, compliance is ensured by complying with permit operating, monitoring, and recordkeeping requirements.

b) Particulate matter (PM) including condensable PM as defined in IDAPA 58.01.01.006, with an aerodynamic diameter less than or equal to a nominal 10 micrometers for PM_{10}, and less than or equal to a nominal 2.5 micrometers for $PM_{2.5}$.

c) Pounds per hour, as determined by a test method prescribed by IDAPA 58.01.01.157, EPA reference test method, continuous emission monitoring system (CEMS) data, or DEQ-approved alternative.

Operating Requirements

5.4 Primary Crusher Limit

The permittee shall process limestone as the raw material, and the maximum input to the primary crusher shall not exceed 1,130 T/day.

5.5 Parallel Flow Regenerative Kiln Limit

The permittee shall process lime as the raw material in the Parallel Flow Regenerative Kiln. The maximum output from the kiln shall not exceed 169 T/day and 52,377 tons per any consecutive 12-month period.

5.6 Portable Crushing and Screening Plant 1 Input Limit

The permittee shall process aggregate as the raw material, and the maximum input to the Portable Crushing and Screening Plant 1 shall not exceed 2,000 T/day.

5.7 Portable Crushing and Screening Plant 2 Input Limit

The permittee shall process aggregate as the raw material, and the maximum input to the Portable Crushing and Screening Plant 2 shall not exceed 2,000 T/day.

5.8 Central Mix Input Limit

The permittee shall process cement and aggregate as the raw materials, and the maximum input to the central mix plant shall not exceed 2,480 T/day and 560,000 tons per any consecutive 12-month period.

5.9 Lime Silos Input Limit

The permittee shall load lime as the raw material, and the maximum input to the Mill Lime Silos and the AC Lime Silos shall not exceed 4,000 T/day and 70,000 tons per any consecutive 12-month period combined.

5.10 Lime, Aggregate, and Concrete Production Dust Control

The permittee shall control emissions from lime production, aggregate production, and concrete production emission sources (Table 5.1) in accordance with the Fugitive Dust Control Plan.

5.11 Portable Crushing and Screening Plant Water Sprays

The permittee shall install, operate, and maintain water sprays in accordance with the O&M manual (Permit Condition 2.20) to control PM emissions from each portable crushing and screening plant. Water sprays shall operate at all times, except as specified in the O&M manual during winter conditions, when this equipment is operated to ensure compliance with Fugitive Dust requirements (Permit Conditions 2.1–2.6).

5.12 Parallel Flow Regenerative Kiln Baghouse

The permittee shall install, operate, and maintain a baghouse system (BH4) in accordance with the O&M manual (Permit Condition 2.20) and consistent with manufacturer's recommendations. All emissions from the parallel flow regenerative kiln shall be ducted to the baghouse at all times to ensure compliance with parallel flow regenerative emission limits.

5.13 Limestone Ball Mill Baghouse

The permittee shall install, operate, and maintain a baghouse system (BH3) in accordance with the O&M manual (Permit Condition 2.20) and consistent with manufacturer's recommendations. All emissions from the limestone ball mill shall be ducted to the baghouse at all times to ensure compliance with limestone ball mill emission limits.

5.14 Lime Mill Crusher Baghouse

The permittee shall install, operate, and maintain a baghouse (BH5) in accordance with the O&M manual (Permit Condition 2.20) and consistent with manufacturer's recommendations.
All emissions from the lime mill crusher shall be ducted to the baghouse at all times to ensure compliance with limestone ball mill emission limits.

5.15 Pebble Lime Silo Wet Scrubber

The permittee shall install, operate, and maintain a wet scrubber on the Pebble Lime Silo discharge (LS) in accordance with the O&M manual (Permit Condition 2.20) and consistent with manufacturer's recommendations. All emissions during discharge from the Pebble Lime Silo shall be ducted to the wet scrubber to ensure compliance with pebble lime silo emission limits (Table 5.2).

5.16 Silo Bin Vent Filters

The permittee shall install, operate, and maintain a bin vent filter on each silo (LS1, MillS2, ACS1, ACS2, ACS3, ACS4, LS, CS1, CS2) in accordance with the O&M manual (Permit Condition 2.20) and consistent with manufacturer's recommendations. All emissions during loading of each silo shall be ducted to the corresponding bin vent filter to ensure compliance with corresponding silo emission limits (Table 5.2).

Monitoring and Recordkeeping Requirements

5.17 Primary Crusher Monitoring

Each day, the permittee shall monitor and record the material input to the Primary Crusher in tons (T/day) to demonstrate compliance with the daily Primary Crusher Limit. The devices and methodologies used to measure weights shall be identified in the O&M Manual.

5.18 Parallel Flow Regenerative Kiln Limit Monitoring

Each day, the permittee shall monitor and record the material output from the Parallel Flow Regenerative Kiln in tons (T/day) to demonstrate compliance with the daily Parallel Flow Regenerative Kiln Limits. The devices and methodologies used to measure weights shall be identified in the O&M Manual.

Each month, the permittee shall calculate and record the material output from the Parallel Flow Regenerative Kiln in T/mo and in T/yr to demonstrate compliance with the annual Parallel Flow Regenerative Kiln Limit. Annual material output shall be determined by summing the monthly output over the previous consecutive 12-month period.

5.19 Portable Crushing and Screening Plant 1 Input Limit Monitoring

Each day, the permittee shall monitor and record the material input to the Portable Crushing and Screening Plant 1 plant in tons (T/day) to demonstrate compliance with the daily Portable Crushing and Screening Plant 1 Input Limit. The devices and methodologies used to measure weights shall be identified in the O&M Manual.

5.20 Portable Crushing and Screening Plant 2 Input Limit Monitoring

Each day, the permittee shall monitor and record the material input to the Portable Crushing and Screening Plant 2 plant in tons (T/day) to demonstrate compliance with the daily Portable Crushing and Screening Plant 2 Input Limit. The devices and methodologies used to measure weights shall be identified in the O&M Manual.

5.21 Central Mix Input Limit Monitoring

Each day, the permittee shall monitor and record the material input to the Central Mix Plant in tons (T/day) to demonstrate compliance with the daily Central Mix Input Limit. The devices and methodologies used to measure weights shall be identified in the O&M Manual.

Each month, the permittee shall calculate and record the material input to the central mix plant in T/mo and in T/yr to demonstrate compliance with the annual Central Mix Input Limit. Annual

material input shall be determined by summing the monthly input over the previous consecutive 12-month period.

5.22 Lime Silos Input Limit Monitoring

Each day, the permittee shall monitor and record the material input to the Mill Lime Silos and the AC Lime Silos in tons (T/day) to demonstrate compliance with the daily Lime Silos Input Limit. The devices and methodologies used to measure weights shall be identified in the O&M Manual.

Each month, the permittee shall calculate and record the material input to the Mill Lime Silos and the AC Lime Silos in T/mo and in T/yr to demonstrate compliance with the annual Lime Silos Input Limit. Annual material input shall be determined by summing the monthly input over the previous consecutive 12-month period.

5.23 Parallel Flow Regenerative Kiln Baghouse Monitoring

The permittee shall install, calibrate, operate, and maintain a device for monitoring the pressure drop across the parallel flow regenerative kiln baghouse. At least once per shift, the permittee shall monitor and record the pressure drop across the parallel flow regenerative kiln baghouse to demonstrate compliance with O&M specifications.

5.24 Limestone Ball Mill Baghouse Monitoring

The permittee shall install, calibrate, operate, and maintain a device for monitoring the pressure drop across the limestone ball mill baghouse. At least once per shift, the permittee shall monitor and record the pressure drop across the limestone ball mill kiln baghouse to demonstrate compliance with O&M specifications.

5.25 Lime Mill Crusher Baghouse Monitoring

The permittee shall install, calibrate, operate, and maintain a device for monitoring the pressure drop across the lime mill crusher baghouse. At least once per shift, the permittee shall monitor and record the pressure drop across the lime mill crusher kiln baghouse to demonstrate compliance with O&M specifications.

5.26 Pebble Lime Silo Wet Scrubber Monitoring

The permittee shall install, calibrate, operate, and maintain a device for monitoring the circulation flow rate in the pebble lime silo wet scrubber, and the pressure drop across the pebble lime silo wet scrubber. At least once per shift, the permittee shall monitor and record the circulation flow rate and the pressure drop across the pebble lime silo wet scrubber to demonstrate compliance with O&M specifications.

6 Engines

6.1 Process Description

Stationary internal combustion engines (ICE) for emergency power generation and fire suppression are essential to ensure safety and uninterrupted essential operations in case of unforeseen power failures or emergency situations. Portable diesel-fired light plant engines provide supplemental lighting as needed; these are not regulated by this permit and will be operated as nonroad engines defined in 40 CFR 1068.30.

6.2 Emission Standards for Emergency Generators and Fire Pump Engines

In accordance with 40 CFR 60.4205(b) and 40 CFR 60.4206, EDG1, EDG2, and EDG3 shall be EPA Tier II Certified engines and must comply with the emission standards for new nonroad CI engines in § 60.4202, for all pollutants, for the same model year and maximum engine power and must be operated and maintained so that they achieve the emission standards as required in §§60.4204 and 60.4205 over the entire life of the engine.

In accordance with 40 CFR 60.4205(c), EDFP must comply with the emission standards in Table 4 to the Subpart for all pollutants.

6.3 Emergency Generator and Fire Pump Engine Operation

Operation of each emergency generator engine (EDG1, EDG2, EDG3) and each fire pump engine (EDFP) shall not exceed 1 hour per day (hr/day) and 100 hr/yr for non-emergency purposes.

6.4 Emergency Generator Monitoring Requirements

In accordance with 40 CFR 60.4209(a), EDG1, EDG2, and EDG3 shall have non-resettable hour meters installed prior to startup.

6.5 Emergency Generator Compliance Requirements

In accordance with 40 CFR 60.4211(f), EDG1, EDG2, and EDG3 must be operated according to the requirements in paragraphs (f)(1) through (3) of this section of the Subpart. In order for the engines to be considered emergency stationary ICE under this subpart, any operation other than emergency operation, maintenance and testing, emergency demand response, and operation in non-emergency situations for 50 hours per year, as described in paragraphs (f)(1) through (3) of this section, is prohibited. If you do not operate the engine according to the requirements in paragraphs (f)(1) through (3) of this section, the engine will not be considered an emergency engine under this subpart and must meet all requirements for non-emergency engines.

(1) There is no time limit on the use of emergency stationary ICE in emergency situations.

(2) You may operate your emergency stationary ICE for any combination of the purposes specified in paragraphs (f)(2)(i) through (iii) of this section for a maximum of 100 hours per calendar year. Any operation for non-emergency situations as allowed by paragraph (f)(3) of this section counts as part of the 100 hours per calendar year allowed by this paragraph (f)(2).

(i) Emergency stationary ICE may be operated for maintenance checks and readiness testing, provided that the tests are recommended by federal, state or local government, the manufacturer, the vendor, the regional transmission

organization or equivalent balancing authority and transmission operator, or the insurance company associated with the engine. The owner or operator may petition the Administrator for approval of additional hours to be used for maintenance checks and readiness testing, but a petition is not required if the owner or operator maintains records indicating that federal, state, or local standards require maintenance and testing of emergency ICE beyond 100 hours per calendar year.

(ii) Emergency stationary ICE may be operated for emergency demand response for periods in which the Reliability Coordinator under the North American Electric Reliability Corporation (NERC) Reliability Standard EOP-002-3, Capacity and Energy Emergencies (incorporated by reference, see § 60.17), or other authorized entity as determined by the Reliability Coordinator, has declared an Energy Emergency Alert Level 2 as defined in the NERC Reliability Standard EOP-002-3.

(iii) Emergency stationary ICE may be operated for periods where there is a deviation of voltage or frequency of 5 percent or greater below standard voltage or frequency.

(3) Emergency stationary ICE may be operated for up to 50 hours per calendar year in non-emergency situations. The 50 hours of operation in non-emergency situations are counted as part of the 100 hours per calendar year for maintenance and testing and emergency demand response provided in paragraph (f)(2) of this section. Except as provided in paragraph (f)(3)(i) of this section, the 50 hours per calendar year for non-emergency situations cannot be used for peak shaving or non-emergency demand response, or to generate income for a facility to an electric grid or otherwise supply power as part of a financial arrangement with another entity.

(i) The 50 hours per year for non-emergency situations can be used to supply power as part of a financial arrangement with another entity if all of the following conditions are met:

(A) The engine is dispatched by the local balancing authority or local transmission and distribution system operator.

(B) The dispatch is intended to mitigate local transmission and/or distribution limitations so as to avert potential voltage collapse or line overloads that could lead to the interruption of power supply in a local area or region.

(C) The dispatch follows reliability, emergency operation or similar protocols that follow specific NERC, regional, state, public utility commission or local standards or guidelines.

(D) The power is provided only to the facility itself or to support the local transmission and distribution system.

(E) The owner or operator identifies and records the entity that dispatches the engine and the specific NERC, regional, state, public utility commission or local standards or guidelines that are being followed for dispatching the engine. The local balancing authority or local transmission and distribution system operator may keep these records on behalf of the engine owner or operator.

6.6 Emergency Generator and Fire Pump Engine Operation Monitoring

Each month, the permittee shall monitor and record the emergency and non-emergency operating hours of each emergency generator and fire pump engine, in hr/mo and in hr/yr to demonstrate compliance with the emergency generator and fire pump engine operation limit. Annual operation shall be determined by summing the monthly hours over the previous consecutive 12-month period.

6.7 Engines Subject to Regulation Notification

With the exception of the emergency generator and fire pump engines (identified in Table 1.1) and engines used to propel vehicles, notification shall be provided to DEQ if an engine (including any previously operated as a nonroad engine) will be operated onsite at a specific location beyond 12 months, and no longer meets criteria for regulation as a nonroad engine. Notification shall be provided as soon as practicable in advance of exceeding 12 months of operation at a single location and within 30 days after the engine ceases to meet the definition of nonroad engine in 40 CFR 1068.30.

- A nonroad engine may include engines that are portable or transportable, meaning designed to be and capable of being carried or moved from one location to another (e.g., portable light plant engines). Indicia of transportability include, but are not limited to, wheels, skids, carrying handles, dolly, trailer, or platform.
- A portable or transportable internal combustion engine is not a nonroad engine if it remains or will remain at a location for more than 12 consecutive months, or a shorter period of time for an engine located at a seasonal source. A location is any single site at a building, structure, facility, or installation. Any engines (or engine) that replace(s) an engine at a location and is intended to perform the same or similar function as the engine(s) replaced are included in calculating the consecutive time period. Permitting requirements and emission standards may become applicable when an engine becomes a stationary source.

7 General Provisions

General Compliance

7.1 The permittee has a continuing duty to comply with all terms and conditions of this permit. All emissions authorized herein shall be consistent with the terms and conditions of this permit and the "Rules for the Control of Air Pollution in Idaho." The emissions of any pollutant in excess of the limitations specified herein, or noncompliance with any other condition or limitation contained in this permit, shall constitute a violation of this permit, the "Rules for the Control of Air Pollution in Idaho," and the Environmental Protection and Health Act (Idaho Code §39-101, et seq).

[Idaho Code §39-101, et seq.]

7.2 The permittee shall at all times (except as provided in the "Rules for the Control of Air Pollution in Idaho") maintain in good working order and operate as efficiently as practicable all treatment or control facilities or systems installed or used to achieve compliance with the terms and conditions of this permit and other applicable Idaho laws for the control of air pollution.

[IDAPA 58.01.01.211]

7.3 Nothing in this permit is intended to relieve or exempt the permittee from the responsibility to comply with all applicable local, state, or federal statutes, rules, and regulations.

[IDAPA 58.01.01.212.01]

Inspection and Entry

7.4 Upon presentation of credentials, the permittee shall allow DEQ or an authorized representative of DEQ to do the following:

- Enter upon the permittee's premises where an emissions source is located, emissions-related activity is conducted, or where records are kept under conditions of this permit;
- Have access to and copy, at reasonable times, any records that are kept under the conditions of this permit;
- Inspect at reasonable times any facilities, equipment (including monitoring and air pollution control equipment), practices, or operations regulated or required under this permit; and
- As authorized by the Idaho Environmental Protection and Health Act, sample or monitor, at reasonable times, substances or parameters for the purpose of determining or ensuring compliance with this permit or applicable requirements.

[Idaho Code §39-108]

Construction and Operation Notification

7.5 This permit shall expire if construction has not begun within two years of its issue date, or if construction is suspended for one year.

[IDAPA 58.01.01.211.02]

7.6 The permittee shall furnish DEQ written notifications as follows:

- A notification of the date of initiation of construction, within five working days after occurrence; except in the case where pre-permit construction approval has been granted then notification shall be made within five working days after occurrence or within five working days after permit issuance whichever is later;
- A notification of the date of any suspension of construction, if such suspension lasts for one year or more; and

- A notification of the initial date of achieving the maximum production rate, within five working days after occurrence - production rate and date.

[IDAPA 58.01.01.211.01]

- A notification of the anticipated date of initial start-up of the stationary source or facility not more than sixty days or less than thirty days prior to such date; and
- A notification of the actual date of initial start-up of the stationary source or facility within fifteen days after such date.

[IDAPA 58.01.01.211.03]

Performance Testing

7.7 If performance testing (air emissions source test) is required by this permit, the permittee shall provide notice of intent to test to DEQ at least 15 days prior to the scheduled test date or shorter time period as approved by DEQ. DEQ may, at its option, have an observer present at any emissions tests conducted on a source. DEQ requests that such testing not be performed on weekends or state holidays.

7.8 All performance testing shall be conducted in accordance with the procedures in IDAPA 58.01.01.157. Without prior DEQ approval, any alternative testing is conducted solely at the permittee's risk. If the permittee fails to obtain prior written approval by DEQ for any testing deviations, DEQ may determine that the testing does not satisfy the testing requirements. Therefore, at least 30 days prior to conducting any performance test, the permittee is encouraged to submit a performance test protocol to DEQ for approval. The written protocol shall include a description of the test method(s) to be used, an explanation of any or unusual circumstances regarding the proposed test, and the proposed test schedule for conducting and reporting the test.

7.9 Within 60 days following the date in which a performance test required by this permit is concluded, the permittee shall submit to DEQ a performance test report. The report shall include a description of the process, identification of the test method(s) used, equipment used, all process operating data collected during the test period, and test results, as well as raw test data and associated documentation, including any approved test protocol.

[IDAPA 58.01.01.157]

Monitoring and Recordkeeping

7.10 The permittee shall maintain sufficient records to ensure compliance with all of the terms and conditions of this permit. Monitoring records shall include, but not be limited to, the following: (a) the date, place, and times of sampling or measurements; (b) the date analyses were performed; (c) the company or entity that performed the analyses; (d) the analytical techniques or methods used; (e) the results of such analyses; and (f) the operating conditions existing at the time of sampling or measurement. All monitoring records and support information shall be retained for a period of at least five years from the date of the monitoring sample, measurement, report, or application. Supporting information includes, but is not limited to, all calibration and maintenance records, all original strip-chart recordings for continuous monitoring instrumentation, and copies of all reports required by this permit. All records required to be maintained by this permit shall be made available in either hard copy or electronic format to DEQ representatives upon request.

[IDAPA 58.01.01.211]

Excess Emissions

7.11 The permittee shall comply with the procedures and requirements of IDAPA 58.01.01.130-136 for excess emissions. The provisions of IDAPA 58.01.01.130-136 shall govern in the event of conflicts between the excess emissions general provisions and the regulations of IDAPA 58.01.01.130-136.

During an excess emissions event, the permittee shall, with all practicable speed, initiate and complete appropriate and reasonable action to correct the conditions causing the excess emissions event; to reduce the frequency of occurrence of such events; to minimize the amount by which the emission standard is exceeded; and shall, as provided below or upon request of DEQ, submit a full report of such occurrence, including a statement of all known causes, and of the scheduling and nature of the actions to be taken.

[IDAPA 58.01.01.132]

7.12 In all cases where startup, shutdown, or scheduled maintenance of any equipment or emission unit is expected to result or results in an excess emissions event, the permittee shall demonstrate compliance with IDAPA 58.01.01.133.01(a) through (d), including, but not limited to, the following:

- Prohibiting any scheduled startup, shutdown, or maintenance resulting in excess emissions shall occur during any period in which an Atmospheric Stagnation Advisory or a Wood Stove Curtailment Advisory has been declared by DEQ.
- Notifying DEQ of the excess emissions event as soon as reasonably possible, but no later than two hours prior to, the start of the event, unless the permittee demonstrates to DEQ's satisfaction that a shorter advance notice was necessary.
- Reporting and recording the information required pursuant to the excess emissions reporting and recordkeeping requirements and IDAPA 58.01.01.135 and 136 for each excess emissions event due to startup, shutdown, or scheduled maintenance.

[IDAPA 58.01.01.133]

7.13 In all cases where upset or breakdown of equipment or an emissions unit, or the initiation of safety measures, results or may result in an excess emissions event, the permittee shall demonstrate compliance with IDAPA 58.01.01.134.01(a) and (b) and the following:

- Immediately undertake all appropriate measures to reduce and, to the extent possible, eliminate excess emissions resulting from the event and to minimize the impact of such excess emissions on the ambient air quality and public health.
- Notify DEQ of any upset, breakdown, or safety event that results in excess emissions. Such notification shall identify the time, specific location, equipment or emissions unit involved, and (to the extent known) the cause(s) of the occurrence. The notification shall be given as soon as reasonably possible, but no later than 24 hours after the event, unless the permittee demonstrates to DEQ's satisfaction that the longer reporting period was necessary.
- Report and record the information required pursuant to the excess emissions reporting and recordkeeping facility wide conditions and IDAPA 58.01.01.135 and 136 for each excess emissions event caused by an upset, breakdown, or safety measure.

- During any period of excess emissions caused by upset, breakdown, or operation under facility safety measures, DEQ may require the permittee to immediately reduce or cease operation of the equipment or emissions unit causing the period until such time as the condition causing the excess has been corrected or brought under control. Such action by DEQ shall be taken upon consideration of the factors listed in IDAPA 58.01.01.134.03 and after consultation with the permittee.

[IDAPA 58.01.01.134]

7.14 The permittee shall submit a written report to DEQ for each excess emissions event, no later than 15 days after the beginning of such an event. Each report shall contain the information specified in IDAPA 58.01.01.135.02.

[IDAPA 58.01.01.135]

7.15 The permittee shall maintain excess emissions records at the facility for the most recent five calendar-year period. The excess emissions records shall be made available to DEQ upon request and shall include the information requested by IDAPA 58.01.01.136.03(a) and (b) as summarized in the following:

- An excess emissions log book for each emissions unit or piece of equipment containing copies of all reports that have been submitted to DEQ pursuant to IDAPA 58.01.01.135 for the particular emissions unit or equipment; and
- Copies of all startup, shutdown, and scheduled maintenance procedures and upset, breakdown, or safety preventative maintenance plans that have been developed by the permittee in accordance with IDAPA 58.01.01.133 and 134, and facility records as necessary to demonstrate compliance with such procedures and plans.

[IDAPA 58.01.01.136]

Certification

7.16 All documents submitted to DEQ—including, but not limited to, records, monitoring data, supporting information, requests for confidential treatment, testing reports, or compliance certification—shall contain a certification by a responsible official. The certification shall state that, based on information and belief formed after reasonable inquiry, the statements and information in the document(s) are true, accurate, and complete.

[IDAPA 58.01.01.123]

False Statements

7.17 No person shall knowingly make any false statement, representation, or certification in any form, notice, or report required under this permit or any applicable rule or order in force pursuant thereto.

[IDAPA 58.01.01.125]

Tampering

7.18 No person shall knowingly render inaccurate any monitoring device or method required under this permit or any applicable rule or order in force pursuant thereto.

[IDAPA 58.01.01.126]

Transferability

7.19 This permit is transferable in accordance with procedures listed in IDAPA 58.01.01.209.06.

[IDAPA 58.01.01.209.06]

Severability

7.20 The provisions of this permit are severable, and if any provision of this permit to any circumstance is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

[IDAPA 58.01.01.211]

LAWRENCE G. WASDEN
Attorney General

DARRELL G. EARLY
Deputy Attorney General
Chief, Natural Resources Division

JOHN R. SHACKELFORD (ISB# 8647)
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: (208) 373-0453
Facsimile: (208) 373-0481
john.shackelford@deq.idaho.gov

Attorneys for Respondent

BEFORE THE DEPARTMENT OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	Case Docket No. 0101-22-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	NOTICE OF JOINDER

COMES NOW, Respondent, the Idaho Department of Environmental Quality (Department), by and through its attorney of record, the Office of the Attorney General,

and pursuant to IDAPA 58.01.03.162.02, to join the Motion to Dismiss filed by Intervenor, Perpetua Resources. The Department does not intend to file a supplementary memorandum in support of the Motion to Dismiss and does not request a hearing on the motion.

DATED: September 12, 2022, FOR RESPONDENT:

STATE OF IDAHO, DEPARTMENT OF ENVIRONMENTAL QUALITY

By: /s/ *John R. Shackelford*
John R. Shackelford
Attorney for Respondent

CERTIFICATE OF SERVICE

I HEREBY CERTIFY that on this 12th day of September, 2022, a true and correct copy of the foregoing NOTICE OF JOINDER was served on the following via electronic mail to the indicated address:

Hearing Coordinator
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706-1255
paula.wilson@deq.idaho.gov
via electronic service

Dylan B. Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Patricia Jordan

Patricia Jordan, Legal Assistant

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	CASE DOCKET NO. 0101-22-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON *Petitioners*,	)	**PETITIONERS' OPPOSITION TO PERPETUA'S MOTION TO DISMISS**
v.	)	
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, *Respondent*,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC., *Intervenor.*	)	

INTRODUCTION

The Motion to Dismiss ("MTD") filed by Perpetua Resources Idaho ("Perpetua") applies the wrong legal standards, while disregarding the detailed facts and law recited in the Petition to Initiate Contested Case Hearing challenging the Idaho Department of Environmental Quality's ("DEQ") Air Quality Permit to Construct ("Final Permit") for the Stibnite Gold Project ("SGP"). Perpetua's attempt to deprive Petitioners Nez Perce Tribe *et al.* of their right to challenge the Final Permit through contested case procedures must be rejected.

As explained below, Perpetua wrongly invokes standards for pleading fraud or similar claims with particularity under the Idaho Rules of Civil Procedure—which are inapplicable here—while disregarding Petitioners' detailed allegations of how the Final Permit violates specific requirements and/or was arbitrary, capricious, or an abuse of discretion under the Idaho Administrative Procedure Act (APA) and DEQ regulations. Petitioners did not merely allege the Final Permit was "flawed," "deficient," or "contained shortcomings," as Perpetua claims—their Petition documented those flaws, deficiencies, and shortcomings in detailed allegations, which the Hearing Officer must accept as true in considering the motion to dismiss.

Moreover, rather than accept as true all facts alleged in the Petition, Perpetua repeatedly cites to the Final Permit and its supporting Statement of Basis ("SOB") to argue the merits of its position that DEQ acted correctly. But that is a determination that can only be made by the Hearing Officer through the contested case hearing procedures, not through the kind of summary judgment determination that Perpetua is seeking under the guise of its motion to dismiss.

Neither is Perpetua right as a matter of law in invoking the "to the satisfaction of the Department" language from the Idaho Air Rules, to argue that Petitioners have no right to challenge those determinations. *See* Perpetua MTD at 10, 14, 17. Contrary to Perpetua's reading,

this language provides no "free pass" that insulates DEQ's determinations from challenges under the Idaho APA and Idaho Air Rules. The whole point of contested proceedings is to allow interested parties to establish facts and legal principles that DEQ may have misconstrued, ignored, or misapplied in making the Final Permit decision—including whether adequate basis exists to support determinations that air quality requirements would be met under the permit.

As detailed below, the Petition clearly states the factual and legal grounds supporting Petitioners' arguments that DEQ violated the Air Rules and the APA by issuing the Final Permit without complying with all applicable rules, by acting arbitrarily or capriciously, and by abusing its discretion. The Hearing Officer should, therefore, deny Perpetua's Motion to Dismiss.

STANDARD OF REVIEW

On a motion to dismiss for failure to state a claim, the Hearing Officer can look "only at the pleadings, and all inferences are viewed in favor of the non-moving party." *Burghart v. Carlin*, 151 Idaho 730, 731, 264 P.3d 71, 72 (Idaho App. 2011) (citation omitted). "[T]he non-moving party is entitled to have all inferences from the record viewed in his favor and only then may the question be asked whether a claim for relief has been stated". *Miles v. Idaho Power Co.*, 116 Idaho 635, 637, 778 P.2d 757, 759 (1989). "[T]he question is whether the non-movant has alleged sufficient facts in support of his claim which, if true, would entitle him to relief." *Rincover v. State, Dep't of Finance, Securities Bureau*, 128 Idaho 653, 656, 917 P.2d 1293, 1296 (1996). A motion to dismiss for failure to state a claim "will not be granted unless it appears beyond doubt that the [plaintiff] could prove no set of facts in support of his claim which would entitle him to relief." *Orthman v. Idaho Power Co.*, 126 Idaho 960, 962, 895 P.2d 561, 563 (1995)). "The issue is not whether the plaintiff will ultimately prevail, but whether the party is entitled to offer evidence to support the claims." *Young*, 137 Idaho at 104, 44 P.3d at 1159.

ARGUMENT

I. CONTESTED CASE PLEADING RULES REQUIRE LIBERAL CONSTRUCTION, ALLOW AMENDMENT, AND DISFAVOR DISMISSAL.

Perpetua points to "heightened" pleading standards under the Idaho Rules of Civil Procedure (IRCP) for "special matters," including fraud, to contend that such heightened pleading standards apply here. MTD at 5. But the IRCP do not apply to this contested case, and the rules that do apply require liberal construction of pleadings and frown against dismissal.

DEQ's Contested Case Rules and Rules for the Protection and Disclosure of Records ("Contested Case Rules"), IDAPA 58.01.23, govern contested cases, such as this one. The Contested Case Rules incorporate Rules 52 and 305 (among others) of the Idaho Rules of Administrative Procedure of the Attorney General ("Idaho Rules of Administrative Procedure"). IDAPA 58.01.23.003.01, .05. Rule 52 states:

> The rules in this chapter will be liberally construed to secure just, speedy and economical determination of all issues presented to the agency. Unless prohibited by statute, the agency may permit deviation from these rules when it finds that compliance with them is impracticable, unnecessary or not in the public interest.

IDAPA 04.11.01.052. Similarly, Rule 305 favors liberal construction of the pleadings and amendment if necessary:

> The presiding officer may allow any pleading to be amended or corrected or any omission to be supplied. Pleadings will be liberally construed, and defects that do not affect substantial rights of the parties will be disregarded. . . .

IDAPA 04.11.01.305

Notably, Rule 52 further provides: "Unless required by statute, the Idaho Rules of Civil Procedure and the Idaho Rules of Evidence do not apply to contested case proceedings." *Id.* (emphasis added). Perpetua's Motion to Dismiss ignores Rule 52 and fails to point to any statute requiring the IRCP to apply to contested cases like this one before the Board. The IRCP do not

apply here;[1] and the rules that do apply—DEQ's Contested Case Rules and the Idaho Rules of Administrative Procedure—are to be liberally construed, defects in pleadings can be disregarded, and amendments are to be liberally granted.[2]

As set forth below, the Petition complies with all pleading requirements, and Perpetua's Motion to Dismiss must be denied. However, even if the Hearing Officer finds any defects in the Petition, Rules 52 and 305 do not support dismissal. Perpetua has not even argued, let alone demonstrated, that any of the supposed defects in the Petition affect Perpetua's substantial rights, as required under Rule 305. *See* IDAPA 04.11.01.305. Nor could Perpetua show any substantial rights are affected. Perpetua's own Motion to Dismiss shows it clearly has been put on notice of the challenged decision and of the alleged errors DEQ made in making that decision, and shows that Perpetua is prepared to defend against them.

Thus, even if there are any defects in the Petition—which there are not, as explained further below—the Hearing Officer should, consistent with Rule 305, disregard them and deny Perpetua's Motion to Dismiss, or alternatively direct Petitioners to file an amended petition. *See* IDAPA 04.11.01.305. Dismissing the Petition, as Perpetua seeks, runs counter to the applicable rules, would be extreme, would impose overly-burdensome and unforgiving requirements on anyone seeking to challenge an agency's decision through contested case proceedings before the Board, and would thus be in contravention of the public interest.

---

[1]Nothing in the Idaho APA requires application of the IRCP to contested cases either. *See* Idaho Code § 67-5206(2) (directing attorney general to create Idaho Rules of Administrative Procedure); I.C. §§ 67-5240–5253 (provisions on contested cases).

[2] In freely allowing amended pleadings, Rule 305 is consistent with IRCP 15(a)(2), which likewise allows liberal amendments to ensure claims are "determined on the merits rather than on technicalities, and to make pleadings serve the limited role of providing notice of the nature of the claim and the facts at issue." *Hayward v. Valley Vista Care Corp.*, 136 Idaho 342, 33 P.3d 816, 819 (2001) (quotation omitted).

II. THE PETITION COMPLIES WITH ALL PLEADING REQUIREMENTS IN DEQ'S CONTESTED CASE RULES.

Perpetua contends that the Petition does not comply with the pleading requirements in Rule 160.01 of DEQ's Contested Case Rules. *See* MTD at 4–5, 7–8. Rule 160.01 provides that a contested case petition must include the following contents:

> a. Fully state the facts upon which it is based, including the specific alleged action or inaction of the Department;
> b. Refer to the particular provisions of statute, rule, order or other controlling law upon which it is based. Legal assertions will be accompanied by citations of cases and statutory provisions;
> c. State the relief sought; and
> d. State the basis for the petitioner's legal standing to initiate the contested case.

IDAPA 58.01.23.160.01. As discussed below, the Petition complies with all these pleading requirements, and Perpetua's Motion to Dismiss should be denied.

First, the Petition fully states the facts upon which it is based, satisfying Rule 160.01.a. The section of the Petition titled "FACTUAL SUPPORT FOR PETITION" includes seventeen pages of detailed factual allegations about DEQ's challenged action in issuing the Final Permit. *See* Petition ¶¶ 22–68. This section of the Petition states facts describing the Stibnite Gold Project and the action being challenged in this contested case, *i.e.*, DEQ's issuance of the Final Permit. *Id.* ¶¶ 22–26. Next, after stating background facts on PM_{10} pollution and regulation, *id.* ¶¶ 27–32, the Petition states detailed facts surrounding the alleged flaws in the way DEQ addressed PM_{10} permitting requirements when it issued the Final Permit. *Id.* ¶¶ 33–41. Third, after stating background facts on arsenic pollution and regulation, *id.* ¶¶ 42–46, the Petition states detailed facts surrounding the alleged flaws in the way DEQ addressed arsenic permitting requirements when it issued the Final Permit. *Id.* ¶¶ 47–57. Then, the Petition states detailed facts about DEQ's establishment of the ambient air boundary for the Stibnite Gold Project and the alleged flaws in the way DEQ did this. *Id.* ¶¶ 58–65. Finally, the Petition states detailed facts

about DEQ's failure to require ambient air monitoring in the Final Permit. *Id.* ¶¶ 66–68. The Petition thus amply meets the requirements of Rule 160.01.a to "[f]ully state the facts upon which it is based . . ." IDAPA 58.01.23.160.01.a.

Second, the Petition satisfies the requirement under Rule 160.01.b to "refer" to the controlling law. The Petition has a section entitled "JURISDICTION, STANDARD OF REVIEW, PARTIES and STANDING," plus a "RELIEF REQUESTED" section, which both refer to provisions of controlling law upon which the Petition is based, including I.C. § 67-5279 and Rule 203 of the Idaho Air Rules. *See* Petition ¶¶ 6–8, 69–70. Additionally, throughout the sections on "FACTUAL SUPPORT FOR THE PETITION," the Petition refers to Rule 203 of the Idaho Air Rules, other provisions of the Idaho Air Rules, and to the federal Clean Air Act and Clean Air Act Regulations when applicable for every set of issues raised in the Petition. *Id.* ¶¶ 30–32 (PM_{10} issues); 44–46, 48–49, 55–57 (arsenic issues); 58–59 (ambient air boundary issues); 66 (ambient monitoring issues). Furthermore, the "RELIEF REQUESTED" section of the Petition restates many of the controlling provisions of the Idaho Air Rules. *Id.* ¶¶ D–G. The Petition thus complies with the requirements of Rule 160.01.b to "[r]efer to the particular provisions of statute, rule, order or other controlling law upon which it is based." IDAPA 58.01.23.160.01.b.

Third, the Petition satisfies the requirement under Rule 160.01.c to "state the relief sought." The section of the Petition titled "RELIEF REQUESTED" does exactly that. *See* Petition ¶¶ 69–71, A–G. There, the Petition requests that the "Board set aside and remand the [Final Permit] and direct DEQ to correct the following errors prior to issuing any new or revised [Final Permit]." Petition ¶ 71. The Petition then states specifically what DEQ should be directed to do on remand to correct each alleged error. Petition ¶¶ A–C (stating relief to correct errors on

remand regarding PM_{10} and arsenic emissions from ore haul), D (stating relief to correct errors on remand regarding various plans and manuals), E (stating relief to correct errors on remand regarding arsenic averaging), F (stating relief to correct errors on remand regarding ambient air boundary monitoring), G (stating relief on remand to correct errors regarding environmental and economic impacts of arsenic control technology). The Petition is thus consistent with the requirement to "state the relief sought." IDAPA 58.01.23.160.01.d.

Finally, the Petition "states the basis" for each Petitioner's standing, satisfying Rule 160.01.d. *See* Petition ¶¶ 9–13 (Nez Perce Tribe), 14–16 (Idaho Conservation League), 17–19 (Save the South Fork Salmon).

In short, the Petition fully meets the pleading requirements of Rule 160 of DEQ's Contested Case Rules. Perpetua's Motion to Dismiss should therefore be denied.

III. THE PETITION SUFFICIENTLY PLEADS NUMEROUS BASES FOR REVIEWING DEQ'S ACTION IN ISSUING THE FINAL PERMIT.

Perpetua argues that the "Petition fails to plead a legal basis for remand of the Final Permit" and that it "never specifically identifies which provisions of the Final Permit are contrary to law." MTD at 6, 7. Perpetua similarly contends the Petition fails to fully state facts and identify statutes or rules under which DEQ erred, and it fails to sufficiently allege facts or law supporting a claim that DEQ's action was arbitrary, capricious, or an abuse of discretion. MTD at 23–24. Perpetua specifically criticizes the Petition for stating DEQ's action in issuing the permit contained various "flaws," "deficiencies," and "shortcomings," arguing that the Petition failed to use the words "unreasonable" or "clearly erroneous" instead and that this provides grounds for dismissal. *Id.*

Perpetua's contentions are patently wrong. As discussed further below, the Petition clearly identifies numerous errors DEQ made and connects those errors to specific provisions in

the Idaho Air Rules that, based on the facts alleged, were violated by DEQ's issuance of the Final Permit, or otherwise asserts that those errors were arbitrary, capricious, and an abuse of discretion in violation of the Idaho APA. Perpetua's Motion should therefore be denied.

A. DEQ Rules and the Idaho APA Provide for Review of Agency Actions Like This One.

Pursuant to I.C. § 39-107(5), IDAPA 58.01.23 (Contested Case Rules), and IDAPA 58.01.01 (Idaho Air Rules), the Board has jurisdiction over this contested case challenging DEQ's action issuing the Final Permit. IDAPA 58.01.23.002.02 provides that "[a]ny person aggrieved by an action or inaction of the Department may file a petition to initiate a contested case pursuant to Chapter 52, Title 67, Idaho Code." *See also* I.C. § 39-107(5). Under the Idaho APA, an agency action—such as DEQ's issuance of the Final Permit being challenged here—must be reversed if it is in violation of constitutional or statutory provisions, is in excess of statutory authority, is made on unlawful procedure, is not supported by substantial evidence on the record as a whole, or is arbitrary, capricious, or an abuse of discretion. I.C. § 67-5279(3). "If the agency action is not affirmed, it shall be set aside, in whole or in part, and remanded for further proceedings as necessary." *Id.*

The Petition clearly states that it is being brought pursuant to the above-referenced codes, and that Petitioners seek review of DEQ's issuance of the Final Permit under the Idaho APA, which provides for the relief Petitioners requested. Petition ¶¶ 6–8, 72.

The Board has considered similar challenges to this one and reached decisions on the merits in its precedential orders. *See*, *e.g.*, *In re: Permit Applicant Garnet Energy LLC*, Docket No. 0101-01-10 (challenged to air quality permit to construct); *Rickards v. Idaho Dep't of Health & Welfare*, Docket No. 0101-92-12 (same). *See also In re Section 401 Water Quality Certification for Relicensing of the C.J. Strike Hydroelectric Facility*, Docket No. 0102-01-06; *In*

re IDEQ Report - The Upper Snake Rock TMDL Modification, Docket No. 0102-05-02; *In re Section 401 Water Quality Certification, Wetland Fill and Boat Dock Along Lake Cascade*, Docket No. 0102-07-04. For example, in the precedential order from *In re Sunnyside Park Utilities*, Docket No. 0103-07-02, the Board explained:

> Under [IDAPA], the Board must determine whether DEQ has acted reasonably and in accordance with law. *See* I.C. §§ 67-5248(a) and 67-5279. These requirements provide parties subject to regulation with a reasoned explanation for agency action and furnish a basis for effective administrative and judicial review. For the reasons set forth below, the Board concludes that the record before us is inadequate to determine whether DEQ acted reasonably and in accordance with law in denying Sunnyside's permit application.

Id., Final Order at 10.

The Board has thus considered challenges to DEQ's decisions to issue permits to construct, such as is at issue in this case, and on the same or similar grounds as alleged here. Perpetua's argument that the Petition fails to articulate any legal basis for challenging the Final Permit is flatly wrong, and its Motion to Dismiss again must be denied.

B. The Petition Sufficiently Alleges Flaws, Deficiencies, and Shortcomings in DEQ's Action Entitling Petitioners to Relief.

Perpetua argues that the "flaws," "deficiencies," and "shortcomings" identified in the Petition are not grounds for relief, because Petitioners supposedly did not connect the dots clearly enough or use the right magic words to convey the precise legal violations associated with each flaw, deficiency, or shortcoming. *See* MTD at 23–24. To the contrary, the Petition sufficiently sets forth the alleged flaws, deficiencies, and shortcomings DEQ committed[3] and the alleged legal violations associated with each, and thus Perpetua's Motion should be denied.

[3] Perpetua also contends that the Petition "does not allege that Perpetua failed to demonstrate each of the elements of IDAPA 58.01.01.203," or "that the [Stibnite Gold Project] will violate any of the provisions" of the Idaho Air Rules. MTD at 8. The Petition does not challenge actions taken by Perpetua; it challenges DEQ's actions approving the Final Permit, and DEQ's actions must comply with applicable provisions of the Idaho Air Rules and the Idaho APA.

1. PM_{10}

At the outset, the Petition states: "An agency action, such as DEQ's issuance of the PTC being challenged here, may be reversed if it is in violation of constitutional or statutory provisions, is in excess of statutory authority, is made on unlawful procedure, or is arbitrary, capricious, or an abuse of discretion." Petition ¶ 7 (citing I.C. § 67-5279). In sections on PM_{10}, the Petition states that PM_{10} is a criteria pollutant for which National Ambient Air Quality Standards ("NAAQS") have been established. *Id.* ¶ 31. It then states in the PM_{10} section:

> DEQ is required to ensure that no [Final Permit] shall be granted for a new or modified stationary source unless the applicant shows to the satisfaction of DEQ that the source would not cause or significantly contribute to a violation of any NAAQS. IDAPA 58.01.01.203.02. To satisfy these requirements, DEQ must assess air impacts using maximum potential emissions as limited by either the capacity of the unit/operation or as limited by enforceable permit provisions. *See* IDAPA 58.01.01.006.88.

Id. ¶ 32. The Petition then states a couple paragraphs later: "DEQ's determination that the SGP will not cause or contribute to a violation of the PM_{10} NAAQS is flawed." *Id.* ¶ 35. Immediately after, the Petition alleges, flaw by flaw and in detail, four ways DEQ failed to include enforceable permit limitations and other ways the agency acted unreasonably or improperly in making its determination that the Stibnite Gold Project will not cause or contribute to an exceedance of the NAAQS. *See id.* ¶¶ 36-42.

These allegations are more than adequate to establish Petitioners' challenges relating to PM_{10} emissions—as Perpetua recognizes, since its MTD argues at length that DEQ's issuance of the Final Permit complied with all of the PM_{10} requirements discussed in the Petition. *See* MTD at 9–14. In truth, Perpetua's substantive arguments go to the merits of Petitioners' contested case and are not properly decided at the outset in a motion to dismiss. Perpetua's arguments can be properly decided by the Hearing Officer only by denying the Motion to Dismiss and by continuing with this contested case.

2. Arsenic

In its sections on arsenic, the Petition identifies arsenic as a Toxic Air Pollutant (TAP) regulated by DEQ, and properly alleges that DEQ is required to ensure that no permit to construct shall be granted for a new or modified stationary source unless DEQ determines emissions of TAPS from the constructed source would not injure or unreasonably affect human or animal life or vegetation as required by Section 161 of the Air Quality Rules. *See* Petition ¶¶ 42–57. The Petition states that Section 161 requires that "any contaminant which is by its nature toxic to human or animal life or vegetation shall not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation." *Id.* ¶ 44, citing IDAPA 58.01.01.161.

The next two paragraphs in the Petition cite other requirements of the Idaho Air Rules relevant to complying with TAPs regulations. *See* Petition ¶¶ 45–46 (describing and citing IDAPA 58.01.01.586, 006.125, 210.12, 006.88). Additional paragraphs then explain the related T-RACT process and its relevant requirements, again describing and citing the specific Idaho Air Rules at issue. *Id.* ¶¶ 48–49 (citing IDAPA 58.01.01.210.13–14). A couple paragraphs later, the Petition states: "DEQ's approval of Perpetua's T-RACT demonstration for arsenic, and its analysis determining the SGP will not exceed the AACC and thus will not injure or unreasonably affect human or animal life or vegetation, is flawed." *Id.* ¶ 52. The Petition then alleges, flaw by flaw and in detail, the ways DEQ failed to comply with the cited provisions of the Idaho Air Rules and otherwise acted arbitrarily and capriciously. *Id.* ¶¶ 53–57.

These allegations are more than sufficient to identify Petitioners' challenges regarding arsenic. Again, Perpetua might dispute on the merits whether these flaws occurred in the arsenic TAPs analysis and T-RACT approval, or whether they rise to the level of arbitrary and

capricious decision-making. In fact, much of Perpetua's brief is devoted to such arguments. *See* MTD at 14–20. But such disputes go to the merits of Petitioner's contested case and are not properly decided at the outset in a motion to dismiss.

3. Ambient Air Boundary

In the section on the ambient air boundary, the Petition cites to the provision of the Air Rules and EPA regulations explaining what counts as "ambient air", and to EPA policy on determining ambient air boundaries. Petition, ¶¶ 58–59. Then, after a paragraph describing the air boundary DEQ approved for the SGP, the Petition states: "DEQ's determination to exclude the access route from ambient air protections is flawed." *Id.*, ¶ 61. The Petition then explains, including by alleging in factual detail, the bases for why this determination was flawed under the previously cited rules, regulations, and policies. *Id.* ¶¶ 62–65.

These allegations are more than sufficient to put DEQ and Perpetua on notice of Petitioners' challenges related to the air boundary, and these challenges should not be dismissed.

4. Ambient Air Monitoring

In the section on ambient air monitoring, the Petition cites to the provision of the Air Rules granting DEQ authority to require ambient air monitoring. Petition, ¶ 66 (citing IDAPA 58.01.01.211.01(d). Then, identifying comments submitted to DEQ urging the agency to require ambient air monitoring, the Petition states that DEQ responded by saying monitoring was not necessary. *Id.* ¶ 67. The Petition then alleges, and explains how, DEQ was incorrect and why monitoring is necessary. *Id.* ¶ 68. These allegations—which must be accepted as true at this stage—are more than adequate to lay out Petitioners' challenges, and Perpetua's defense of the Final Permit regarding ambient air monitoring must be addressed on the merits, not through a motion to dismiss.

D. Perpetua's Reliance on the "To the Satisfaction of" DEQ Language of Section 203 of the Air Rules Is Misplaced.

Throughout its Motion, Perpetua wrongly implies that the "to the satisfaction of the Department" language in Section 203 of the Idaho Air Rules provides DEQ with unlimited discretion in applying the rules and approving permits, thus requiring dismissal of the Petition. *See*, *e.g.*, MTD at 10, 14, 17. Under Section 203, DEQ cannot issue a permit to construct unless it determines that the applicant has shown "to the satisfaction of the Department" that three conditions are satisfied: (1) the facility will comply with applicable emissions standards; (2) the facility not cause or contribute to an exceedance of the NAAQS; and (3) the emissions of toxic air pollutants from the stationary source or modification would not injure or unreasonably affect human or animal life or vegetation. IDAPA 58.01.01.203.

Contrary to Perpetua's incorrect reading, this "satisfaction" language does not render DEQ's determinations that these three conditions were met when it approved the Final Permit immune from challenge and review. DEQ's actions issuing the Final Permit are subject to review and shall be "set aside, in whole or in part, and remanded for further proceedings" if DEQ's decision to issue the Final Permit violated constitutional or statutory provisions, is in excess of statutory authority, was made on unlawful procedure, is not supported by substantial evidence on the record as a whole, or was arbitrary, capricious, or an abuse of discretion. I.C. § 67-5279(3).

As a matter of law, the Air Quality Rules cannot somehow limit or immunize a DEQ decision from challenge under the Idaho APA and the DEQ contested case regulations, as Perpetua seems to believe. Rather, the Idaho APA broadly provides that "[a] proceeding by an agency . . . which may result in the issuance of an order[ ] is a contested case and is governed by the provisions of" Title 67, Chapter 52 (Idaho Administrative Procedure Act) of the Idaho Code. *See* I.C. § 67-5240.

Review of agency action under the Idaho APA is limited or prohibited only if "provided by other provisions of law." I.C. § 67-5240. Perpetua has not cited any law that prohibits the review of DEQ's decision to approve a permit to construct under the Idaho Air Quality Rules under the provisions of the Idaho APA, and no such law exists to Petitioners knowledge. Proceedings in front of DEQ, such as contesting the approval of the Final Permit in this case, therefore are unequivocally subject to the Idaho APA.

DEQ's determination that it is "satisfied" the requirements would be met can obviously be arbitrary, capricious, an abuse of discretion, or contrary to law, just as any other agency determination or decision can be. For example, in determining whether a facility "would not cause or significantly contribute to a violation of any ambient air quality standard," as required by Idaho Air Rule 58.01.01.203.02, the fact that DEQ was "satisfied" there would be no such violation does not somehow exempt that aspect of the Final Permit immune from challenge and review to show that DEQ erred, either factually or legally.

Thus, whether DEQ acted in an arbitrary and capricious manner, abused its discretion, or violated legal requirements of Section 203 of the Air Rules when it issued the Final Permit is properly challenged by Petitioners, regardless of whether DEQ found "to its satisfaction" that the Section 203 requirements would be met. Petitioners are entitled to develop and present the full record, through contested case proceedings, for the Hearing Officer to fully evaluate their challenges, including whether DEQ was arbitrary and capricious in concluding it was "satisfied" all requirements in Section 203 were met.

IV. PETITIONERS' REQUESTED RELIEF IS PROPER.

Finally, Perpetua argues that Petitioners are not entitled to any of the relief requested in the Petition. *See* MTD at 22–23. This argument is wrong, and must be rejected.

Petitioners requested that the Final Permit be set aside and remanded for any of the flaws, deficiencies, or shortcomings identified in the Petition. *See* Petition ¶ 71 ("Petitioners respectfully request that the Board set aside and remand the PTC and direct DEQ to correct the following errors prior to issuing any new or revised PTC"). This is not only appropriate, but it is the very relief the Idaho APA requires for a successful challenge to an agency decision: "If the agency action is not affirmed, it shall be set aside, in whole or in part, and remanded for further proceedings as necessary." I.C. § 67-5279(3) (emphasis added). *See, e.g., In re Variance ZV2011-2*, 156 Idaho 491, 496 (Idaho 2014) (vacating and remanding arbitrary approval of subdivision); *In re Sunnyside Park Utilities*, Docket No. 0103-07-0, p. 11 (Apr. 7, 2009) (Final Order, stating: "Since we cannot determine that DEQ's reasoning and conclusion were rational, the permit denial must be set aside."). Upon prevailing on the merits of any of their claims, Petitioners will thus be entitled to have the Final Permit set aside and remanded.

Petitioners also request that DEQ be directed to take specific steps to rectify the various deficiencies in the Final Permit during remand. Again, I.C. § 67-5279(2) provides for remand "for further proceedings as necessary." *See, e.g., In re Variance ZV2011-2*, 156 Idaho at 496–97 (providing guidance to agency on remand); *In re Sunnyside Park Utilities*, Docket No. 0103-07-0, p. 12 (providing direction to DEQ for reviewing permit application on remand). DEQ has the duty or authority to take each action Petitioners have requested in order to issue a lawful permit. *See* IDAPA 58.01.01.202.03 (authorizing DEQ to obtain from permit applicant "[a]ny additional information, plans, specifications, evidence or documents the Department may require to make the determinations required under [the PTC sections of the Air Rules]"); IDAPA 58.01.01.211 (authorizing DEQ to "impose any reasonable conditions upon an approval" of a PTC); IDAPA 58.01.01.121 (authorizing DEQ to require schedules, reports, records, monitoring, and plans to

ensure compliance with Air Rules); IDAPA 58.01.01.122.03.g (authorizing DEQ to issue an information order to provide any "information the Department may require").

Perpetua might argue that such relief is not warranted under the specific circumstances of this case, but that is not a proper basis for dismissing the Petition at outset. After discovery, briefing, and hearing, the Hearing Office can decide these issues.

CONCLUSION

For the foregoing reasons, Petitioners respectfully request that Perpetua's Motion to Dismiss be denied. Alternatively, if the Hearing Officer finds any defects in the Petition that cannot be disregarded under Idaho Rule of Administrative Procedure 305, he should grant Petitioners leave to amend the Petition to correct such defects.

Dated: September 20, 2022

Respectfully submitted,

/s/ Bryan Hurlbutt
Bryan Hurlbutt
Laurence ("Laird") J. Lucas
Attorneys for the Nez Perce Tribe and the Idaho Conservation League

/s/ Julia S. Thrower
Julia S. Thrower
Attorney for Save the South Fork Salmon

CERTIFICATION OF SERVICE

I hereby certify that on this September 20, 2022, I caused a true and correct copy of the foregoing **PETITIONERS' OPPOSITION TO PERPETUA'S MOTION TO DISMISS** to be served upon the following persons via the means indicated:

Via Email:

Dylan B. Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com

Paula Wilson, Hearing Coordinator
Idaho Department of Environmental Quality
1410 N. Hilton St.
Boise, ID 83706-1255
paula.wilson@deq.idaho.gov

John Shackelford
Deputy Attorney General
Idaho Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
john.shackelford@deq.idaho.gov

Julia Thrower
Mountain Top Law PLLC
614 Thompson Avenue
McCall, ID 8638
jthrower@mtntoplaw.com

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org

/s/ Bryan Hurlbutt
Bryan Hurlbutt

DYLAN LAWRENCE
VARIN THOMAS LLC
P.O. Box 1676
Boise, ID 83701
(208)345-6021
dylan@varinthomas.com

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v.	)	Case Docket No. 0101-22-01
	)	PREHEARING ORDER
DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC., Intervenor.	)	

On September 21, 2022, a prehearing conference was held at the Department of Environmental Quality state office in Boise, Idaho, with the option of joining via Microsoft Teams. Bryan Hurlbutt and Laird Lucas appeared for Petitioners Nez Perce Tribe and Idaho Conservation League, and Julia Thrower appeared for Petitioner Save the South Fork Salmon. John Shackelford, Deputy Attorney General, appeared for Respondent. W. Christopher Pooser and Wade Foster appeared for Intervenor.

Pending before the hearing officer was Intervenor's Motion to Dismiss and Supporting Brief and the scheduling of proceedings related thereto. As discussed, the hearing officer previously participated in a contested case before the Board of Environmental Quality in which the standards

governing dispositive motions in contested air permit matters were at issue. That matter ultimately settled and did not result in the issuance of a precedential order. However, it is possible that the transcribed deliberations of Board members could have some relevance to this matter. Given the passage of time and out of an abundance of caution, prior to hearing and ruling on the Intervenor's Motion to Dismiss, the hearing officer would like to give the parties an opportunity to review those materials and express their opinions as to how those deliberations affect this matter, if at all.

Rule 003 of the Board's Contested Case Rules, IDAPA 58.01.23, adopt the Idaho Rules of Administrative Procedure of the Attorney General, IDAPA 04.11.01, to the extent they are not inconsistent with the Board's Rules. Rule 602 of the AG's rules provides in pertinent part that, "official notice may be taken of any facts that could be judicially noticed in the courts of Idaho…." If one were to substitute "agency" for "court" and "administrative" for "judicial," Idaho Rule of Evidence 201 would read in pertinent part:

> The [agency] may [administratively] notice a fact that is not subject to reasonable dispute because it: (1) is generally known within the [agency's] territorial jurisdiction; or (2) can be accurately and readily determined from sources whose accuracy cannot reasonably be questioned.
>
> ***
>
> The [agency]: (1) may take [administrative] notice on its own….
>
> ***
>
> When a[n] [agency] takes [administrative] notice of records, exhibits, or transcripts from the [agency] file in the same or a separate case, the [agency] must identify the specific documents or items so noticed.

Upon discussion with the parties, and based upon the foregoing, IT IS HEREBY ORDERED that administrative notice is taken of the following documents, all of which are from the Board's Docket No. 0101-14-01, which the parties may access at https://cloud.deq.idaho.gov/s/c5f5SZLBR87nxJE :

1. Motion to Dismiss or in the Alternative Motion for Summary Judgment, Idaho Dept. of Environmental Quality, June 18, 2014;

2. Memorandum in Support of Motion to Dismiss or in the Alternative Motion for Summary Judgment, Idaho Dept. of Environmental Quality, June 18, 2014;

3. Magnida's Motion to Dismiss, Magnolia Nitrogen Idaho LLC, June 25, 2014;

4. Interlocutory Order Denying Intervenor's Motion to Dismiss, Presiding Officer Michael J. Kane, August 8, 2014;

5. Recommended Order Granting Motion for Summary Judgment, Presiding Officer Michael J. Kane, September 15, 2014;

6. Reporter's Transcript of Proceedings before the Board of November 20, 2014; and

7. Reporter's Transcript of Proceedings before the Board of December 4, 2014.

Further, upon service of this Order, Hearing Coordinator Paula Wilson will coordinate with the parties to schedule a virtual status conference to discuss whether any further briefing on the Motion to Dismiss is warranted, the scheduling of a hearing on the Motion to Dismiss, and any other procedural issues the parties would like to discuss.

Dated this 23rd day of September, 2022.



Dylan Lawrence
Hearing Officer

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v.	)	Case Docket No. 0101-22-01
	)	CERTIFICATE OF SERVICE
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC., Intervenor.	)	

I hereby certify that on this 23rd day of September, 2022, a true and correct copy of the **Prehearing Order** was served on the following:

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Dylan Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Krista McIntyre
W. Christopher Pooser
Wade Foster
Stoel Rives LLP
101 S Capitol Blvd., Ste. 1900
Boise, ID 83701
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Paula J. Wilson
Hearing Coordinator

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,	)	Case Docket No. 0101-22-01
Petitioners,	)	NOTICE OF VIRTUAL STATUS CONFERENCE
v.	)	
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC., Intervenor.	)	

NOTICE IS HEREBY GIVEN that Hearing Officer Dylan Lawrence will hold a status conference on October 11, 2022, beginning at 2 p.m. MDT via Microsoft Teams.

Join Microsoft Teams Meeting

https://teams.microsoft.com/l/meetup-join/19%3ameeting_Mjk5OWI3OGEtOTkzNi00ZGY5LWIwNmQtZWNiODBmYWY5Mjdm%40thread.v2/0?context=%7b%22Tid%22%3a%22c53b7a63-2d6e-4d96-87c9-9f583f6d1c81%22%2c%22Oid%22%3a%22585df9bf-7e62-4188-a6bf-d94826517522%22%7d

Meeting ID: 242 264 116 978
Passcode: shUWky

Or call in (audio only)
+1 208-985-2810,,927231418# United States, Boise
Phone Conference ID: 927 231 418#

The purpose of the status conference is to discuss whether any further briefing on Intervenor's Motion to Dismiss is warranted, the scheduling of a hearing on the Motion to Dismiss, and any other procedural issues the parties would like to discuss.

The status conference will not be recorded and transcribed for the record. However, the hearing officer may request that the hearing coordinator make a Microsoft Teams recording of the status conference to supplement his notes.

Dated this 27th day of September, 2022.

Paula J. Wilson
Hearing Coordinator
Department of Environmental Quality
1410 N Hilton, Boise ID 83706
(208)373-0418/Fax No. (208)373-0481
Paula.wilson@deq.idaho.gov

CERTIFICATE OF SERVICE

I hereby certify that on this 27th day of September, 2022, a true and correct copy of the **Notice of Virtual Status Conference** was served on the following:

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Dylan Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Krista McIntyre
W. Christopher Pooser
Wade Foster
Stoel Rives LLP
101 S Capitol Blvd., Ste. 1900
Boise, ID 83701
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Paula J. Wilson
Hearing Coordinator

DYLAN LAWRENCE
VARIN THOMAS LLC
P.O. Box 1676
Boise, ID 83701
(208)345-6021
dylan@varinthomas.com

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,	)	Case Docket No. 0101-22-01
Petitioners,	)	ORDER ON STATUS CONFERENCE; NOTICE OF STATUS CONFERENCE
v.	)	
DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC.,	)	
Intervenor.	)	

On October 11, 2022, a status conference was held virtually via Microsoft Teams. Bryan Hurlbutt and Laird Lucas appeared for Petitioners Nez Perce Tribe and Idaho Conservation League, and Julia Thrower appeared for Petitioner Save the South Fork Salmon. John Shackelford, Deputy Attorney General, appeared for Respondent. W. Christopher Pooser and Wade Foster appeared for Intervenor. The parties and hearing officer discussed the following matters:

Motion to Dismiss: Perpetua Resources filed a combined motion to dismiss the petition in this matter and supporting legal brief on September 6, 2022. The Petitioners filed a brief in opposition to that motion on September 20, 2022. The hearing officer issued an order taking official

notice of filings and hearing transcripts from a prior Board of Environmental Quality (BEQ) matter on September 23, 2022. At the status conference, the parties and hearing officer agreed that as long as the hearing officer accepts the Petition's factual allegations as true and confines his consideration of factual issues to the "four corners" of the pleadings, those officially noticed documents are of limited relevance to the pending motion to dismiss. Therefore, additional briefing referencing the noticed documents is not necessary.

In addition, Perpetua Resources stated it does not request to file a reply brief or hold oral argument on its motion pursuant to BEQ Rule of Procedure 162.02. Therefore, Perpetua's motion to dismiss has been fully submitted for decision by the hearing officer.

Scheduling Order: The parties agreed to coordinate among themselves regarding a potential stipulated scheduling order to present to the hearing officer. The parties may wish to consider the following items in connection with this effort:

The number of days needed for a hearing on the merits. Ideally, the parties would also present at least three sets of dates that are mutually agreeable to the parties for the hearing officer's consideration and to confirm facility availability at DEQ's offices.

Whether the hearing on the merits will include direct testimony or, alternatively, whether written direct testimony will be provided in advance of the hearing on the merits, in which case deadlines for the filing of written direct testimony and objections thereto should also be considered.

Potential dates for a final pre-hearing conference to discuss procedural issues related to the hearing on the merits and the resolution of any remaining pre-trial motions, objections, or other filings.

Deadlines for final witness and exhibit lists and the filing of any pre-hearing briefs.

Deadlines for the filing of additional dispositive motions, motions in limine, and other pre-

hearing motions.

Deadlines for the filing of expert reports.

Dates for the opening and completion of written discovery and depositions.

Office of Administrative Hearings: During the initial September 21 prehearing conference, the parties and hearing officer acknowledged the possibility that the newly-formed Office of Administrative Hearings (OAH) could impact this proceeding. At the time, the parties and hearing officer generally agreed to continue with this proceeding under existing, applicable procedural rules until they receive formal notice from the BEQ of any changes to the proceeding. However, at the October 11 status conference, counsel for DEQ brought to the attention of the parties and hearing officer the specific language of newly enacted Idaho Code Section 67-5286.

In particular, subsection (1) of that statute suggests that if a hearing on the merits is not scheduled to be completed before January 1, 2023, the hearing is to be conducted by OAH. The parties and hearing officer agreed that it is infeasible to complete a hearing on the merits in this matter by that time, and also that the transition of this matter to OAH could result in substantial delay directly impacting any scheduling order. Based on that, the hearing officer committed to coordinate with BEQ staff to find out any additional information regarding this issue.

Establishing Administrative Record for Hearing: The parties and hearing officer also discussed in general terms potential approaches to establishing a written record of documents for the parties, hearing officer, and BEQ to refer to during the course of these proceedings. The BEQ Rules of Procedure do not contain a specific rule regarding the compilation of an agency record. Historically, such records were created through the discovery process, though that does not appear to be the parties' first choice here.

While not specifically discussed during the status conference, the hearing officer notes that

BEQ has recently amended its Rules of Procedure to incorporate some of the AG's Rule of Procedure, specifically including Rule 650, which enumerates items that "shall" be included in the agency record. *See* BEQ RULE OF PROCEDURE 003.15; AG RULE OF PROCEDURE 650.02. While Rule 650.02 may be somewhat helpful, it does not appear to specifically resolve the issue of how to select specific documents out of a voluminous DEQ permitting record that likely contains several hundreds of pages of documents not relevant to the Petition in this matter. AG Rule of Procedure 650.02(h) mandates that the record for a contested case include "[a]ll staff memoranda or data submitted in connection with the consideration of the proceeding." Perhaps one approach would be for DEQ to issue a staff memorandum with the documents it believes are relevant, and then the other parties could use discovery and motion practice to supplement the record as necessary. This seems consistent with the discussions at the October 11 status conference. In any event, the parties agreed to further evaluate this issue for discussion at the next status conference.

Based on the foregoing, NOTICE IS HEREBY GIVEN that the hearing officer will hold a follow-up status conference on Thursday, October 27, 2022, at 9:30 a.m. MDT via Microsoft Teams. Due to difficulties accessing the Microsoft Teams link for the October 11 status conference, the hearing coordinator is sending an electronic calendar appointment to the participants, a hard copy of which is attached hereto. During the status conference, the hearing officer intends to 1) update the parties regarding issues related to the OAH; 2) inquire with the parties regarding efforts to coordinate regarding a stipulated scheduling order and/or administrative record; and 3) discuss any additional issues the parties wish to discuss.

Dated this 14th day of October, 2022.

Dylan Lawrence
Hearing Officer

From: Paula Wilson
To: Paula Wilson
Subject: Status Conference - Perpetua AQ PTC - October 27, 2022
Date: Thursday, October 13, 2022 11:14:44 AM

October 27, 2022 – 9:30am
Status Conference – Perpetua AQ PTC

Microsoft Teams meeting

Join on your computer, mobile app or room device
Click here to join the meeting

Meeting ID: 263 838 813 502
Passcode: haKcj6
Download Teams | Join on the web

Join with a video conferencing device
idahogov@m.webex.com
Video Conference ID: 112 587 225 2
Alternate VTC instructions

Or call in (audio only)
+1 208-985-2810,,335283620# United States, Boise
Phone Conference ID: 335 283 620#
Find a local number | Reset PIN
Learn More | Meeting options

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v.	)	Case Docket No. 0101-22-01
	)	CERTIFICATE OF SERVICE
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC., Intervenor.	)	

I hereby certify that on this 14th day of October, 2022, a true and correct copy of the **Order on Status Conference; Notice of Status Conference** was served on the following:

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Dylan Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Krista McIntyre
W. Christopher Pooser
Wade Foster
Stoel Rives LLP
101 S Capitol Blvd., Ste. 1900
Boise, ID 83701
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Paula J. Wilson
Hearing Coordinator

DYLAN LAWRENCE
VARIN THOMAS LLC
P.O. Box 1676
Boise, ID 83701
(208)345-6021
dylan@varinthomas.com

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v.	)	Case Docket No. 0101-22-01
	)	ORDER ON STATUS CONFERENCE; NOTICE OF STATUS CONFERENCE
DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	)	

On October 27, 2022, a status conference was held virtually via Microsoft Teams. Bryan Hurlbutt and Laird Lucas appeared for Petitioners Nez Perce Tribe and Idaho Conservation League, and Julia Thrower appeared for Petitioner Save the South Fork Salmon. John Shackelford, Deputy Attorney General, appeared for Respondent. Krista McIntyre, W. Christopher Pooser, and Wade Foster appeared for Intervenor. The parties and hearing officer discussed the following matters:

Office of Administrative Hearings (OAH): Based upon recently adopted Idaho Code Section 67-5286 and recent discussions with Board representatives, the hearing officer reported his understandings to the parties as follows:

1) If the hearing-on-the-merits in this proceeding has not been scheduled to commence prior to January 1, 2023, OAH intends to assume responsibility for this proceeding from the Board and hearing officer.

2) OAH plans to contact Board representatives on or about December 1, 2022, to inquire regarding the status of the proceeding and a potential transition plan.

3) The hearing officer may apply to OAH by December 15, 2022, to be re-appointed as the hearing officer in this matter.

Motion to dismiss: The hearing officer reported that he still intends to issue a decision on Perpetua's motion to dismiss in mid-November.

Scheduling order: Perpetua reported that it has developed a proposed framework for a scheduling order in this matter, which can be completed and circulated for consideration once a decision is issued on the motion to dismiss.

Administrative record: The parties reported that DEQ has made its project file available to the other parties, which will be helpful in finalizing an administrative record once a decision on the motion to dismiss has been issued.

Status conference: Based on the above, the parties and hearing officer agreed to schedule the next status conference in this proceeding for mid- to late-November.

Therefore, based on the foregoing, NOTICE IS HEREBY GIVEN that the hearing officer and parties will hold a follow-up status conference on Monday, November 28, 2022, at 2:00 p.m. mountain time, via Microsoft Teams. At the status conference, the participants will discuss the status of, and any updates to, the above matters. The hearing coordinator has sent an electronic calendar appointment to the participants, a hard copy of which is attached hereto.

Dated this 28th day of October, 2022.



Dylan Lawrence
Hearing Officer

From: Paula Wilson
To: Paula Wilson
Subject: Status Conference - Perpetua AQ PTC - November 28, 2022
Date: Friday, October 28, 2022 9:28:57 AM

November 28, 2022 – 2pm
Status Conference – Perpetua AQ PTC

Microsoft Teams meeting

Join on your computer, mobile app or room device
Click here to join the meeting

Meeting ID: 262 758 243 95
Passcode: CA3Cj4
Download Teams | Join on the web

Join with a video conferencing device
idahogov@m.webex.com
Video Conference ID: 111 489 986 4
Alternate VTC instructions

Or call in (audio only)
+1 208-985-2810,,993332060# United States, Boise
Phone Conference ID: 993 332 060#
Find a local number | Reset PIN

Learn More | Meeting options

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,	)	Case Docket No. 0101-22-01
Petitioners,	)	CERTIFICATE OF SERVICE
v.	)	
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC., Intervenor.	)	

I hereby certify that on this 28th day of October, 2022, a true and correct copy of the **Order on Status Conference; Notice of Status Conference** was served on the following:

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Dylan Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Krista McIntyre
W. Christopher Pooser
Wade Foster
Stoel Rives LLP
101 S Capitol Blvd., Ste. 1900
Boise, ID 83701
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Paula J. Wilson
Hearing Coordinator

DYLAN LAWRENCE
VARIN THOMAS LLC
P.O. Box 1676
Boise, ID 83701
(208) 345-6021
dylan@varinthomas.com

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v.	)	Case Docket No. 0101-22-01
	)	ORDER ON MOTION TO DISMISS
DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC., Intervenor.	)	

I. FACTUAL AND PROCEDURAL HISTORY

Perpetua Resources Idaho, Inc. is in the process of applying for a variety of permits for its proposed Stibnite Gold Project ("SGP") in Valley County, Idaho. The SGP would consist of conventional open-pit mining, ore preparation, and gold extraction operations. In August 2019, Perpetua applied to the Idaho Department of Environmental Quality ("DEQ") for an air quality permit for the construction and operation of the SGP, pursuant to the Rules for the Control of Air Pollution in Idaho in IDAPA 58.01.01 (the "Air Rules"). DEQ issued the final version of air quality permit-to-construct P-2019.0047 (the "Permit") on June 17, 2022.

On July 22, 2022, the Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon ("Petitioners") filed a joint petition to initiate a contested case (the "Petition") regarding the Permit. The Petition alleges that DEQ committed several errors in its development of the Permit and requests that the Board of Environmental Quality ("Board" or "BEQ") vacate and withdraw the Permit and remand it to DEQ to correct such errors.

DEQ filed its response to the Petition on August 12, 2022, denying that its development of the Permit was in error and requesting that the Board affirm the Permit. DEQ's response consists primarily of general admissions or denials. For denied allegations, the DEQ response contains virtually no explanation or elaboration. That same day, Perpetua filed a petition to intervene in the contested case proceeding pursuant to Rule 353.01 of the Board's Contested Case Rules in IDAPA 58.01.23 (the "BEQ Procedural Rules"), which the hearing officer granted on August 22, 2022.

On September 6, 2022, Perpetua filed a motion to dismiss the Petition in its entirety and a supporting legal brief (collectively, the "Motion"). DEQ filed a notice of joinder in the Motion on September 12, 2022, without further explanation. At a status conference held October 11, 2022, Perpetua waived filing a reply brief and holding oral argument on its Motion pursuant to BEQ Procedure Rule 162.02. Therefore, the Motion has been fully submitted for decision.

II. RELEVANT LEGAL STANDARDS

A. Standards on Motion to Dismiss

The BEQ Procedural Rules specifically contemplate motions to dismiss but do not articulate applicable standards. *See* BEQ PROCEDURAL RULE 161.02. The Board has typically applied the standards for such motions in judicial proceedings under Idaho Rule of Civil Procedure 12(b)(6).

"In reviewing an I.R.C.P. 12(b)(6) motion to dismiss for failure to state a claim upon which relief must be granted, the question is whether the non-movant has alleged sufficient facts in support

of his claim, which if true, would entitle him to relief." *Canyon County v. Idaho Dept. of Envr. Quality*, FINAL ORDER ON REVIEW OF RECOMMENDED ORDER, at p. 14 (BEQ Dkt. No. 0101-11-02, Dec. 28, 2011) (*citing Orrock v. Appleton*, 147 Idaho 613, 618, 213 P.3d 398, 403 (2009)). As Perpetua acknowledges, "[t]he issue [on a motion to dismiss] is not whether the plaintiff will ultimately prevail, but whether the party is entitled to offer evidence to support the claims." (Mot., p. 6 (*quoting Orthman v. Idaho Power Co*., 126 Idaho 960, 962, 895 P.2d 561, 563 (1995)).

In *Freeman v. Idaho Dept. of Envr. Quality*, the petitioner argued his vehicle was exempt from DEQ's emissions testing program. FINAL ORDER ON REVIEW OF AMENDED ORDER, at pp. 9-10 (BEQ Dkt. No. 0101-11-04, Apr. 11, 2012). However, the relevant statute and rule did not provide DEQ with authority to exempt his vehicle. *Id*. In essence, he was asking DEQ to do something it was not authorized to do. Even assuming all factual allegations to be true, there was no legal avenue available to obtain the requested relief. Therefore, granting a motion to dismiss was appropriate. *Id*.

While it may be necessary to consult applicable law to determine if a valid claim exists, when evaluating the sufficiency of the factual allegations, "[a] 12(b)(6) motion looks only at the pleadings to determine whether a claim for relief has been stated." *Thatcher v. Idaho Dept. of Envr. Quality*, AMENDED ORDER ON IDAHO DEPT. OF ENVR. QUALITY'S MOT. TO DISMISS at pp. 3-4 (BEQ Dkt. No. 0105-19-01; Sept. 24, 2019) (*citing Young v. City of Ketchum*, 137 Idaho 102, 104, 44 P.3d 1157, 1159 (2002)). And, when reviewing the pleadings, one must "draw[] all inferences in the non-moving party's favor" and grant the motion to dismiss only if "it appears beyond doubt that the [plaintiff] could prove no set of facts in support of his claim which would entitle him to relief." *Orthman*, 126 Idaho at 962, 895 P.2d at 562 (citations omitted).

Perpetua asserts that, "[w]hen deciding a motion to dismiss under I.R.C.P. 12(b)(6), a court, or the Board, may consider documents incorporated by reference in a pleading without converting

the motion to a motion for summary judgment. (Mot., p. 6 (citations omitted)). However, in both of the cited cases, the Idaho Supreme Court held the district court erred by considering matters outside the pleadings. Also, at the October 11 status conference, the parties and hearing officer agreed he would confine his consideration of factual matters to the "four corners" of the pleadings. (*See generally* Order of 10/14/22, p. 2).

Clearly, reference to the Permit itself is necessary to resolve the Motion; to not consider the relevant provisions in the Permit would be akin to ignoring the relevant agreement in a breach of contract case. However, on several occasions, Perpetua argues for dismissal of claims based upon DEQ's Statement of Basis ("SOB"). The hearing officer finds justifications documented in the SOB to be outside the scope of the pleadings. Consideration of the SOB may be appropriate on a motion for summary judgment, but not on a motion to dismiss.

B. Standards Applicable to Pleadings

Perpetua argues the BEQ Rules of Procedure contain "heightened" pleading standards. (Mot., pp. 5, 8, 24-25). Perpetua further argues Petitioners' use of terms such as "flawed," "deficient," and "shortcomings," instead of the specific language of Idaho Code Section 67-5279, fails to meet these "heightened" pleading standards, and that "the Petition is wholly efficient and must be dismissed." (Mot., pp. 23-24). Therefore, a brief discussion of the standards appliable to pleadings in BEQ proceedings is warranted.

For civil judicial actions, the Idaho Rules of Civil Procedure contain a "relaxed notice pleading standard" that simply requires that the "adverse party is put on notice of the claims brought against it." *Raymond v. Idaho State Police*, 165 Idaho 682, 689, 451 P.3d 17, 24 (Idaho 2019). By contrast, BEQ Procedural Rule 160.01 requires the Petition to "[f]ully state the facts upon which it is based, including the specific alleged action or inaction of the Department," and to "[r]efer to the

particular provisions of statute, rule, order or other controlling law upon which it is based," including "citations of cases and statutory provisions." Therefore, as a general matter, the hearing officer agrees with Perpetua that, when compared to the Idaho Rules of Civil Procedure, the BEQ Procedural Rules contain a "heightened" pleading standard.

However, satisfying the pleading standards in a judicial action is a low threshold to meet. Also, BEQ Procedural Rule 003.01 adopts AG Procedural Rule 052, which states that the procedural rules "will be ***liberally construed*** to secure just, speedy and economical determination of ***all issues presented to the agency***." Similarly, BEQ Procedural Rule 003.05 adopts AG Procedural Rule 305, which states that "[p]leadings will be liberally construed…." Focusing only on the pleading standard in BEQ Procedural Rule 160.01 to the exclusion of AG Procedural Rules 052 and 350 would render BEQ Procedural Rule 003 a nullity—a result to be avoided. *See generally Hillside Landscape Constr., Inc. v. City of Lewiston*, 151 Idaho 749, 753, 264 P.3d 388, 392 (Idaho 2011) ("[i]n determining the ordinary meaning of a statute 'effect must be given to all the words of the statute if possible, so that none will be void, superfluous, or redundant'").

C. Idaho APA Judicial Standards of Review

Perpetua's Motion invokes Idaho Code Section 67-5279 multiple times. (*See* Mot., pp. 4, 7, 24). That statute contains the standards of review that apply when a petition for judicial review of an agency decision has been filed pursuant to the Idaho Administrative Procedure Act, Idaho Code Sections 67-5201 – 67-5292 (the "APA"). After the Board has rendered a final decision in this matter, if one or more of the parties appeals to the judicial system, Section 67-5279 contains the standards that govern the court's evaluation of the Board's decision.

Even though those standards are not directly applicable to the Motion, it is still important to understand the standards that will ultimately govern judicial review of the Board's decision. As the

Board itself has recognized, in a contested case proceeding, "the Board must determine whether DEQ has acted reasonably and in accordance with law." *In the Matter of Sunnyside Park Utilities' Application for Sewage Disposal Permit*, Final Order on Petition for Review of Preliminary Order, at p. 10 (BEQ Dkt. 0103-07-02, Apr. 7, 2009).[1]

Pursuant to DEQ Procedural Rule 003.18 and AG Procedural Rule 740, the Board will render a decision in this matter by issuing a final order. Therefore, subsection (3) of Section 67-5279 would apply to judicial review, and the court would affirm the Board's decision unless it finds:

- DEQ or the Board acted in violation of constitutional or statutory provisions;
- DEQ or the Board acted in excess of their statutory authority;
- DEQ's approval of the Permit or the Board's decision were made upon unlawful procedure;
- The Board's decision was not supported by substantial evidence on the record as a whole; or
- DEQ or the Board otherwise acted in a manner that qualifies as arbitrary, capricious, or an abuse of discretion.

IDAHO CODE § 67-5279(3)

The Petition does not raise constitutional questions or assert DEQ followed an unlawful procedure in issuing the Permit. In addition, the record for judicial appeal has not yet been created; that is the purpose of the contested case hearing process. Taking into consideration the standards governing pleadings, the standards governing motions to dismiss, and the standards that will govern

[1] The hearing officer is aware that Board members have previously expressed concern regarding application of Section 67-5279 standards too early in an administrative hearing process. (*See generally* Order of 9/23/22, *taking administrative notice of* Tr. of 12/4/14, 47:5-9 (BEQ Dkt. No. 0101-14-01)). To be clear, the hearing officer is not applying those standards directly here in ruling on Perpetua's Motion. The phrase "motion to dismiss" is shorthand for a "motion to dismiss [a petition] for failure to state a claim upon which relief must [or could] be granted." It is practically impossible to apply this standard without an understanding of the "relief" that is possible and how it could be obtained. Section 67-5279 is the ultimate basis for any such "relief." That is why its standards are relevant generally, even though they are not being applied

judicial review, the following questions govern review of the Petition and the pending Motion:

- Taking all of the factual allegations in the Petition as true, could the Petitioners demonstrate that DEQ violated a statute when it issued the Permit?
- Taking all of the factual allegations in the Petition as true, even if DEQ did not overtly violate a statute, could the Petitioners demonstrate that DEQ exceeded the scope of its statutory authority when it issued the permit?
- Taking all of the factual allegations in the Petition as true, even if DEQ did not overtly violate a statute or exceed its statutory authority, could the Petitioners demonstrate that DEQ took some action that could be described as "arbitrary" or "capricious" when it issued the Permit?
- Taking all of the factual allegations in the Petition as true, if DEQ has been provided with discretion regarding the development of a particular Permit provision, could the Petitioners demonstrate that DEQ abused that discretion?

III. ANALYSIS

A. The Petition Overall

As previously referenced, Perpetua's Motion asserts the entire Petition should be dismissed for failure to satisfy the "heightened" pleading standard of BEQ Procedural Rule 160.01. (*See* Mot., pp. 2, 23-24). The Motion further asserts "the Petition is informally presented in the style of a legal brief, intermingling alleged facts, arguments, opinions, suggestions for permit content, and conclusory statements," and that it "contains no 'short and plain statement of the claim showing that the pleader is entitled to relief.'" (Mot., p. 7; *see also* DEQ Resp. of 8/12/22, p. 2).

Again, the "heightened" pleading standard of Rule 160.01 requires the Petition to "[f]ully state the facts" and to "[r]efer to the particular provisions of….controlling law." The Petition contains detailed factual allegations and several references to Idaho Code, IDAPA provisions, and the Code of Federal Regulations. Also relevant is the relatively short 35-day deadline to file the Petition, *see* BEQ PROCEDURAL RULE 060, a document to be "liberally construed."

Under these circumstances, dismissing the Petition outright would impose a pleading

---

specifically to the Motion.

standard nearly impossible to satisfy. Despite Perpetua's criticism of the format of the Petition, in a typical civil judicial action, a plaintiff asserts discrete, well-known causes of action, such as "breach of contract," "trespass," and "negligence." An administrative proceeding challenging an air quality permit does not necessarily lend itself to this pleading style. Taken as a whole, the Petition is adequately pled, and the hearing officer declines to dismiss the Petition in its entirety. Instead, given the pleading requirements of BEQ Procedural Rule 160.01, the hearing officer believes it is appropriate to evaluate the Petition and the Motion on a claim-by-claim basis.

B. Summary of Claims Asserted in Petition

As previously discussed, an administrative proceeding involving air quality permitting does not involve discrete, recognized causes of action. Before discussing whether particular claims should be dismissed, it is necessary to identify the individual alleged errors. The Petition is 26 pages long, with more than 70 separately numbered allegations, many of which are long and detailed. The sooner the Petition is reduced to discrete, identifiable claims, the better.

The hearing officer believes the following table fairly summarizes the individual errors alleged in the Petition:

Claim No.	Petition ¶ No.	Pollutant/Source/Issue	Summary of Alleged Error
1	36-37	PM_{10} from haul trucks/road	Variables relied upon not adopted as enforceable limitations; instead, relied on plans that have not yet been developed
2	38	PM_{10} from haul trucks/road	Assumed control of 93.3% of emissions without related enforceable limitations
3	40	PM_{10} from haul trucks/road	Based monitoring and recordkeeping requirements on O&M Plan not yet developed
4	40	PM_{10} from haul trucks/road	Permit does not include adequate monitoring, recordkeeping, and reporting requirements
5	41	PM_{10} from haul trucks/road	Assumed 120 days of recordable precipitation rather than using local weather data
6	53	Arsenic from various sources	T-RACT demonstration did not contain persuasive economic information re suppressants vs. paving

Claim No.	Petition ¶ No.	Pollutant/Source/Issue	Summary of Alleged Error
7	53	Arsenic from various sources	T-RACT demonstration did not evaluate environmental impacts
8	54	Arsenic from various sources	Estimated As emissions based on PM_{10} emissions, so same flawed assumptions above apply
9	55-56	Arsenic from various sources	Multi-year averaging of arsenic emissions not authorized by Air Rules
10	57	Arsenic from various sources	Impacts on future permitting actions
11	62	Ambient air boundary	Insufficient legal authority to exclude general public
12	65	Ambient air boundary	Whether Permit effectively precludes access by general public
13	68	Ambient air monitoring	Lack of ambient air monitoring makes it impossible to assess compliance

C. Alleged Errors Related to PM_{10} Emissions From Haul Trucks and Roads

For all of the allegations in the Petition related to PM_{10} emissions from haul trucks and roads, Perpetua's Motion argues:

> While Petitioners dislike the Final Permit and question the Department's analyses of NAAQS compliance, none of the opinions presented in the Petition state a claim that the Department ***violated the Idaho Air Rules or the CAA*** in issuing the Final Permit. Petitioners also do not satisfy their burden to allege any omission from the Final Permit ***that is required by law***.

(Mot., pp. 13-14 (emphasis added)).

As previously discussed, the Petitioners could ultimately obtain relief by demonstrating that DEQ (1) violated a statute, (2) exceeded its statutory authority, (3) took action that could be characterized as "arbitrary" or "capricious," or (4) abused its discretion.

1. Claim No. 1: Reliance on Variables Not Adopted as Enforceable Conditions

The Petition asserts error occurred because "important variables affecting the quantity of PM_{10} generated by the ore haul trucks are not directly limited and enforceable as PTC permit conditions." (Pet., ¶ 36). More specifically, even though Perpetua used multiple "[c]ritical

variables…as inputs to PM emission calculations," the Petition argues DEQ erred by "rel[ying] on a surrogate limit in the PTC," "[i]nstead of developing PTC conditions for these other critical variables." (Pet., ¶¶ 36-37). According to the Petition, the three "critical variables" lacking relevant Permit conditions are the average empty weight of ore haul trucks, the average loaded weight of ore haul trucks, and the total number of vehicle miles traveled by ore haul trucks.[2] (*See* Pet., ¶ 36).

As Perpetua's Motion notes, it does not appear the Petition asserts DEQ's decision not to adopt certain variables as enforceable permit conditions constitutes a statutory violation or an exceedance of statutory authority. However, Perpetua has not cited to legal authority precluding DEQ from adopting such enforceable conditions, either. To the contrary, Perpetua acknowledges "the Idaho Air Rules provide [DEQ] with discretion to impose 'any reasonable conditions upon an approval [of a permit to construct].'" (Mot., p. 11 (*citing* AIR RULE 211.01)).

If DEQ had discretion to adopt certain variables as enforceable permit conditions and declined to do so, it is possible for Petitioners to demonstrate DEQ abused that discretion. Therefore, Perpetua's Motion as to Claim No. 1 is hereby denied. However, due to the heightened pleading requirements of Procedural Rule 160.01, the Petitioners will be limited to the three variables specifically raised in the Petition: the average empty weight of ore haul trucks, the average loaded weight of ore haul trucks, and the total number of vehicle miles traveled by ore haul trucks.

2. Claim No. 2: Assumption of 93.3% Emissions Control

The Petition asserts error occurred because "DEQ assumed 93.3% of all haul road PM_{10} emissions from the SGP can be controlled by using an unspecified combination, volume, and frequency of water sprays and chemical dust suppressants" without also including "specific and enforceable permit conditions within the PT to ensure a 93.3% control efficiency." (Pet., ¶¶ 38-39).

[2] The Petition acknowledges that an enforceable Permit condition was included for silt content of

According to the Petition, "[a] lesser control efficiency, even just slightly lesser, could result in large enough PM_{10} emissions to violate the NAAQS." (Pet., ¶ 39).

Perpetua's arguments as to this claim are essentially identical as they are for Claim No. 1. (*See* Mot., pp. 10-11). If DEQ had discretion to include permit conditions that would help ensure a 93.3% control efficiency, it is possible for Petitioners to demonstrate DEQ abused that discretion by declining to do so. Therefore, Perpetua's Motion as to Claim No. 2 is denied.

3. Claim No. 3: Basing Monitoring and Recordkeeping Requirements on Undeveloped O&M Plan

Section 3.5 of the Permit contains daily limits on the amount of ore and development rock Perpetua may haul, expressed in tons per day. In order to help ensure compliance with these daily weight limits, Section 3.16 of the Permit provides:

> Each day, the permittee shall monitor and record the amount of ore and DR [development rock] transported on haul trucks (T/day). ***The devices and methodologies used to measure weights shall be identified in the O&M [Operation and Maintenance] Manual***.

(Mot., Ex. A, p. 20 (emphasis added)).

Section 2.20 of the Permit governs development of the O&M Manual. It states:

> Thirty days prior to startup of any process equipment (Permit Condition 2.13), the permittee shall develop and maintain an Operation and Maintenance (O&M) manual to ensure compliance with emission limits (Permit Conditions 2.9, 2.13, 4.3, and 5.3) and the control equipment maintenance and operation general provisions (Permit Condition 7.2). The O&M manual shall be a permittee-developed document based upon, but independent from, manufacturer-supplied operating manuals. The permittee shall operate control equipment in accordance with the O&M manual at all times. The requirements in the O&M manual shall be incorporated by reference to this permit and shall be enforceable permit conditions.

(Mot., Ex. A, p. 12).

---

haul roads.

Section 2.20 then proceeds to enumerate a full page-and-a-half of very detailed requirements that the O&M Manual must satisfy, followed by requirements in Section 2.21 for the O&M Manual to be submitted to DEQ at least 30 days prior to startup and to obtain DEQ approval prior to changing the Manual. (Mot., Ex. A, pp. 12-14).

The Petition alleges error occurred because "DEQ relied on monitoring and record keeping (permit condition 3.16) using ***devices and methodologies*** in the [O&M Manual]" even though "the O&M Manual has not yet been developed." (Pet., ¶ 40 (emphasis added)). The Petition is ***not*** challenging the numeric daily hauling limitations adopted in Section 3.5 of the Permit. Instead, it alleges DEQ erred by allowing Perpetua to identify the "devices and methodologies" for weighing haulage in a plan that has not yet been developed.

The Petition does not cite any specific legal provision that has arguably been violated, and it does otherwise articulate how identification of the "devices and methodologies" for weighing haulage later might qualify as arbitrary, capricious, or an abuse of discretion. The closest the Petitioners get to addressing this allegation in their response brief is to cite authorities in the Air Rules authorizing DEQ to require "plans" as a general matter. (*See* Resp. Br. of 9/20/22, pp. 15-16 (citing Air Rules 121, 122.03(g), 202.03, 211)).

Even though AG Procedural Rule 052 requires the rules of procedure to be "liberally construed," DEQ Procedural Rule 160.01 must be given ***some*** effect. The hearing officer finds this allegation of error does not satisfy the requirements in Rule 160.01 to "[f]ully state the facts" and to "[r]efer to the particular provisions of statute, rule, order or other controlling law…." Therefore, as to Claim No. 3, Perpetua's Motion is granted, and Claim No. 3 is dismissed.

4. Claim No. 4: The Permit Does Not Contain Monitoring, Recordkeeping, and Reporting Requirements Necessary to Assure Compliance

The Permit contains several monitoring and recordkeeping requirements. Generally applicable requirements to the SGP appear in Section 7.10, which states:

> The permittee shall maintain sufficient records to ensure compliance with all of the terms and conditions of this permit. Monitoring records shall include, but not be limited to, the following: (a) the date, place, and times of sampling or measurements; (b) the date analyses were performed; (c) the company or entity that performed the analyses; (d) the analytical techniques or methods used; (e) the results of such analyses; and (f) the operating conditions existing at the time of sampling or measurement. All monitoring records and support information shall be retained for a period of at least five years from the date of the monitoring sample, measurement, report, or application. Supporting information includes, but is not limited to, all calibration and maintenance records, all original strip-chart recordings for continuous monitoring instrumentation, and copies of all reports required by this permit. All records required to be maintained by this permit shall be made available in either hard copy or electronic format to DEQ representatives upon request.

(Mot., Ex. A, p. 40).

The same "General Provisions" portion of the Permit contains multiple reporting requirements. (*See* Mot., Ex. A, pp. 41-42 (§§ 7.11, 7.12, 7.13, 7.14)). In addition, the portion of the Permit applicable to fugitive dust contains several monitoring and recordkeeping requirements. (*See* Mot., Ex. A, pp. 8 (§ 2.2), 11 (§ 2.10), 12-14 (§ 2.20)). Moreover, the Permit incorporates several portions of the Code of Federal Regulations, including 40 C.F.R. Part 60, Subpart A (General Provisions), which includes requirements related to recordkeeping (40 C.F.R. § 60.7), monitoring (40 C.F.R. § 60.13), and reporting (40 C.F.R. § 60.19). (*See* Mot., Ex. A, p. 14, § 2.22)).

The Petition alleges "the PTC itself does not include all monitoring, recordkeeping, and reporting necessary to assure compliance…." (Pet., ¶ 40). Neither the Petition nor the Petitioners' response brief further elaborate on this allegation.

Because the Permit contains detailed monitoring, recordkeeping, and reporting requirements, the Petition should have explained how those requirements could be inadequate. The hearing officer finds this alleged error does not satisfy the pleading standards in BEQ Procedural Rule 160.01. Stated in terms of the standards governing a motion to dismiss, even assuming these factual allegations to be true, they are too conclusory to benefit from that standard. Without more than a bald allegation of inadequacy, the Petitioners could not obtain relief on this issue. Therefore, as to Claim No. 4, Perpetua's Motion is granted, and Claim No. 4 is dismissed.

5. Claim No. 5: Assumption of 120 Days of Recordable Precipitation Without Using Local Weather Data

The Petition alleges that (1) "[d]ays of recordable precipitation is an important variable affecting the SGP's emissions of PM_{10} from ore haul roads;" (2) "DEQ assumed there would be 120 days of recordable precipitation at the SGP" based on "general geographic guidance" instead of "local meteorological data;" and (3) "DEQ's failure to use the most representative site data…increases the risk of miscalculation of ore haul road emissions." (Pet., ¶ 41). On a motion to dismiss, these allegations are taken as true.

DEQ's responsive pleading states generally that Paragraph 41 of the Petition "contain[s] mixed statements of fact and argument, which must be denied," then proceeds to discuss the various work plans. (Resp. of 8/12/22, p. 4). Perpetua's Motion argues the Petition's factual allegations on this issue are conclusory and that neither the Air Rules nor the referenced DEQ "Modeling Guideline" require DEQ to utilize "local meteorological data." (Mot, p. 13).

While the Petition does not allege an outright statutory violation, its allegations can fairly be read to allege DEQ's action was arbitrary, capricious, or an abuse of discretion. It is conceivable that if local precipitation data was available but not utilized, resulting in an underestimation of

emissions, disregarding such data could be arbitrary, capricious, or an abuse of discretion.[3] While Petitioners would have the burden to demonstrate error at hearing, the hearing officer finds the factual allegations in the Petition to be adequately pled for the purposes of Rule 160.01 and withstanding a motion to dismiss. Therefore, as to Claim No. 5, Perpetua's Motion is denied.

D. Alleged Errors Related to Arsenic Emissions

Section 2 of the Permit contains several requirements related to control of fugitive dust. These include: (1) "[u]se, where practical, of water or chemicals for control of dust" in a variety of activities (Mot., Ex. A, p. 8, § 2.1); (2) "[a]pplication, where practical, of asphalt, oil, water, or suitable chemicals to…surfaces which can create dust" (*id.*); and (3) application of "water or suitable dust suppressant chemicals (*e.g.*, magnesium chloride, calcium chloride)" to a variety of facilities "as necessary to control fugitive dust." (*Id*. at p. 9, § 2.6).

1. Claim No. 6: T-RACT Determination Lacked Persuasive Economic Information Regarding Suppressants vs. Paving

The Petition alleges DEQ's evaluation of "reasonably available control technologies" ("RACT") for the toxic air pollutant arsenic ("T-RACT") "contained no persuasive economic information" regarding "Perpetua's decision to use water and chemical dust suppressants as compared to paving the haul roads, even though paving was shown to achieve the highest reasonable dust control efficiency." (Pet., ¶¶ 48, 53). According to the Petition, this violated Air Rule 210.14.

T-RACT is defined in the Air Rules as:

> An emission standard based on the lowest emission of toxic air pollutants that a particular source is capable of meeting by the application of control technology that is reasonably available, as determined by the Department, considering technological and ***economic feasibility***. If control technology is not feasible, the

[3] While there are references in the SOB suggesting some use of local precipitation data, that is a factual issue not relevant on a motion to dismiss. (*See generally* SOB of 6/17/22, pp. 9, 44, 46-47, 64).

> emission standard may be based on the application of a design, equipment, work practice or operational requirement, or combination thereof.

AIR RULE 007.12 (emphasis added).

The first step in the T-RACT process established by the Air Rules is for the applicant to "submit information to [DEQ] identifying and documenting which control technologies or other requirements the applicant believes to be T-RACT." AIR RULE 210.14(a). DEQ must determine T-RACT "on a case-by-case basis" considering separate factors for technological feasibility and economic feasibility. AIR RULE 210.14. For economic feasibility, DEQ must consider a non-exclusive list of factors, including costs of necessary mitigation measures, capital costs, cost effectiveness, and the difference in costs between the particular source and other sources, if any, that have implemented emissions reductions. AIR RULE 210.14(d).

The Motion responds to these allegations in two ways. First, it argues DEQ complied with the Air Rules. More specifically, the Motion argues that pursuant to Air Rules 007.12 and 210.14(a), Perpetua was only required "to submit environmental and economic information to assist [DEQ] in determining if the proposed technology is reasonably available." (Mot., p. 15).

The hearing officer does not read these rules so narrowly. Both rules require DEQ to consider economic feasibility when evaluating T-RACT. Perpetua's argument appears to be that there can be no error because "[u]se of chemical and dust suppressants and watering are well recognized…as reasonably available control technologies for fugitive dust." (Mot, p. 16). However, the hearing officer does not read the Petition to allege the T-RACT adopted by DEQ is infeasible. Instead, the hearing officer reads the Petition to allege DEQ erred in its evaluation of whether another technology that would have achieved a higher level of control was economically feasible.

These arguments are highly technical, and it is possible the hearing officer is missing some nuance. However, without oral argument, there was no ability to discuss nuance. Taking the

Petition's factual allegations as true, it is conceivable the Petitioners could demonstrate DEQ's evaluation of economic feasibility qualified as arbitrary, capricious, or an abuse of discretion.

Second, Perpetua also references the SOB to support DEQ's action. (*See* Mot., p. 16). While reference to the SOB may be appropriate on a motion for summary judgment or at hearing, it exceeds the inquiry on a motion to dismiss. As to Claim No. 6, Perpetua's Motion is denied.

2. Claim No. 7: T-RACT Determination Did Not Evaluate Other Environmental Impacts

The Petition alleges DEQ's T-RACT determination failed to evaluate impacts to water quality potentially caused by chemical dust suppressants. (Pet., ¶ 53). The Petition further alleges use of chemical dust suppressants can cause toxicity to trees and impact water quality and aquatic ecosystems, and that "[t]he environmental impact of using magnesium chloride or arsenic-polluted water as dust suppression methods was never considered as part of the T-RACT demonstration." In its Motion, Perpetua relies upon references within the SOB to argue that DEQ did, in fact, appropriately evaluate T-RACT. (Mot., pp. 15-17).

As previously referenced, DEQ's T-RACT determination involves analysis of both economic feasibility and technological feasibility. *See* AIR RULE 210.14(c), (d). The Air Rules specifically require DEQ's evaluation of technological feasibility to include consideration of "[t]he environmental impacts caused by the control technology that cannot be mitigated, including, but not limited to, water pollution and the production of solid wastes." AIR RULE 210.14(c)(ii).

In short, DEQ is required by the Air Rules to consider "environmental impacts" in its T-RACT determination, and the Petition alleges DEQ did not consider certain environmental impacts. Taking all of the factual allegations in Paragraph 53 as true, it would be inappropriate to dismiss Claim No. 7. To evaluate this claim by reference to deliberations by DEQ described in the SOB is resolution of a factual issue outside the pleadings, which is not appropriate on a motion to

dismiss. Therefore, as to Claim No. 7, Perpetua's Motion is denied.

3. Claim No. 8: Arsenic Emissions Estimates Are Based on PM_{10} Emissions Estimates, So Are Subject to Same Flawed Assumptions

Paragraph 54 of the Petition alleges:

> Second, because the underlying particulate and PM_{10} emissions estimates and particulate control assumptions are unreliable in numerous respects, as already discussed above, so too are the estimated arsenic emissions. The SGP's estimated arsenic emissions were based on its PM_{10} emissions. PM_{10} emissions from the SGP may be higher, and their control effectiveness may be lower, than DEQ assumed, in which case arsenic emissions would also be higher and might exceed the AACC [Acceptable Concentrations of Carcinogens].

(Pet., ¶ 54).

Similar to the Petition's approach to this allegation, Perpetua's Motion refers back to counter-arguments lodged earlier in the Motion. (*See* Motion, p. 17). DEQ's response generally denies these allegations. (See Resp., p. 4).

The hearing officer finds Paragraph 54 to flirt with non-compliance with Rule 160.01's requirements to "[f]ully state the facts" and to "[r]efer to the particular provisions" of law upon which it is based. However, given AG Procedural Rule's directive to "liberally construe[]" the procedural rules, and because Claim Nos. 1, 2, and 5 have been adequately pled, outright dismissal of Paragraph 54 in its entirety does not seem appropriate.

Therefore, to the extent Claim No. 8 incorporates by reference the allegations comprising Claim Nos. 1, 2, and 5 (which survive the Motion), Perpetua's Motion is denied. To the extent Claim No. 8 incorporates by reference the allegations comprising Claim Nos. 3 and 4 (which are dismissed), Perpetua's Motion is granted, and that portion of Claim No. 8 is dismissed.

4. Claim No. 9: DEQ Improperly Averaged Arsenic Emissions

The Petition alleges DEQ improperly averaged arsenic emissions over multi-year periods.

(Pet., ¶ 55). According to the Petition, this resulted in "substantially reduc[ing] the SGP's purported arsenic emissions…." (*Id*.) The Petition also alleges it is inappropriate to compare the AAC for arsenic, which is an annual standard, to multi-year averages. (*Id*.)

It is worth noting the Petition identifies three multi-year averaging "tactics" as inappropriate. (*See* Pet., ¶ 55). At some point, it may be appropriate to treat them as separate claims. For the purposes of the Motion, all three "tactics" are within the umbrella of "multi-year averaging."

DEQ denies the allegations in Paragraph 55 without explanation. (Resp., p. 4). The Motion addresses Paragraph 55 in three ways. First, it argues "the Petition fails to identify any provision of the Idaho Air Rules that prohibits the approach taken by Perpetua in quantifying arsenic emissions or that invalidates the Department's approval of such approach." (Mot., p. 17). Second, the Motion engages in detailed analysis of the language of the Air Rules to argue that "[t]he Idaho Air Rules do not require annual averaging as Petitioners suggest." (Mot., p. 18). Third, the Motion references DEQ's SOB to argue DEQ complied with the Air Rules. (Mot., p 19).

Even if the Air Rules do not prohibit multi-year averaging, it is still theoretically possible for the Petitioners to demonstrate DEQ's approval of multi-year averaging was arbitrary, capricious, or an abuse of discretion. At this stage of the proceedings, it would be appropriate to dismiss this claim only if the averaging techniques employed by Perpetua and approved by DEQ were mandatory, in which case it would be arbitrary, capricious, or an abuse of discretion ***not*** to use them. However, this is not the Motion's argument. Therefore, as to Claim No. 9, the Motion is denied.

5. Claim No. 10: Consideration of Arsenic Emissions in Future Permitting Decisions

Paragraph 57 of the Petition alleges:

> Excacerbating [*sic*] this cancer risk [from arsenic emissions] is the fact that under DEQ's incremental TAPs regulations (*see* IDAPA 58.01.01.585), when DEQ considers permitting any additional

> sources of arsenic in the area over the next 70 years (such as an extension of the life of the SGP, expansion of the facility itself, and/or any adjacent facilities seeking a similar permit, like the potential Horse Heaven project), DEQ will not have to consider the arsenic emissions authorized by this PTC.

(Pet., ¶ 57).

DEQ generally denies this allegation without explanation. (DEQ Resp. of 8/12/22, p. 4). Perpetua argues Paragraph 57 "is irrelevant to whether the Final Permit is lawful and must be dismissed." (Mot., p. 19). It is unclear to the hearing officer if the Petitioners intend Paragraph 57 to allege a reversible error. However, Perpetua reads it as a claim and has requested its dismissal.

After having read Paragraph 57 and Air Rule 585, the hearing officer does not find any discernable basis for reversible error based upon implications for future permitting decisions. As to Claim No. 10, the Motion is granted, and the claim is dismissed.

E. Alleged Errors Related to Ambient Air Boundary and Monitoring

The Petition alleges multiple errors regarding ambient air boundaries and monitoring. Even though the phrase "ambient air" appears in the Permit one time, (*see* Permit, p. 41, § 7.13), it is an important concept behind many Permit conditions. Therefore, before addressing each individual error alleged regarding ambient air, it will be helpful to briefly discuss the concept of ambient air within the context of air quality regulation.

Under the federal Clean Air Act, EPA is required to establish national ambient air quality standards for a handful of "criteria" air pollutants, including PM_{10}. *See generally* 42 U.S.C. § 7602(t); 40 C.F.R. § 50.6. When DEQ evaluates an application for a permit to construct for a new or modified source of air pollutants, it must determine that "[t]he stationary source or modification would not cause or significantly contribute to a violation of any ambient air quality standard." AIR RULE § 203.02. Ambient air can also be relevant to DEQ's determination of T-RACT for toxic air

pollutants such as arsenic. *See* AIR RULE §§ 006.125, 210.12(b), (c).

Based on the federal definition, the Air Rules define "ambient air" as "[t]hat portion of the atmosphere, external to buildings, to which the general public has access." AIR RULES § 006.10. The Petition alleges—and DEQ agrees—that to exclude areas from ambient air, the following must be true: (1) the permittee must have the ***legal authority to exclude the general public*** from the area; (2) the boundary to ambient air must be clearly discernable to the general public; (3) the general public must be ***effectively precluded*** from assessing the facility; and (4) the general public is not considered (a) employees of the facility; (b) those having official business with the facility; or (c) guests of the facility, including participants in facility routes and those seeking access for a specific purpose. (Pet., ¶ 59; DEQ Resp., p. 5 (emphasis added)).

As the hearing officer understands, the Petition alleges the ambient air boundary was established by Perpetua and DEQ to coincide with the boundaries of the SGP. However, there is an existing road bisecting the SGP through which members of the public will have some level of access. Therefore, according to the Petition, that access road should have been treated as ambient air, not excluded from it. (*See generally* Petition, ¶¶ 60, 62).

Section 2.7 of the Permit contains the following minimum requirements for access management at the SGP:

- Perpetua must "observe" all primary access points to preclude unauthorized public access. The Permit does not specifically define the phrase "primary access point," but states that it includes the North and South Security Gates.

- Perpetua must post warning signs and periodically patrol secondary access points to the facility to preclude public access. Secondary access points include secondary roadways and trails traversing the SGP.

- Only registered guests will be allowed access to or through the SGP. For those seeking to pass through the SGP to another destination, Perpetua will provide them with a "registration sheet" explaining Perpetua's requirements for accessing the SGP and identifying potential hazards.

(*See generally* Permit, p. 10, § 2.7).

1. Claim No. 11: Whether Perpetua Has Sufficient Legal Authority to Exclude the General Public From the Access Route

As previously discussed, one of the requirements to exclude an area from ambient air is that the permittee must have "the legal authority to exclude the general public from the area." The Petition alleges the access road "is currently accessible to and has been regularly used by the general public" and that the Forest Service has not yet decided "whether it will require or will not permit general public access through the mine site." (Pet., ¶ 62).

These allegations must be taken as true on a motion to dismiss, and they are directly relevant to the "legal authority" requirement for exclusion from ambient air. If the Petitioners demonstrate Perpetua does not have legal authority to exclude the general public from the access road, it is possible they could demonstrate it was error to exclude the access road from ambient air. As to Claim No. 10, the Motion is denied.

2. Claim No. 12: Whether the Existing Permit Conditions "Effectively Preclude" Access by the General Public

Sections 2.6 and 2.7 of the Permit require Perpetua to develop and implement an "Access Management Plan" ("AMP"). Some requirements related to the AMP include:

- Identifying the SGP facility boundary and all primary and secondary access points;
- Specifying measures used to discourage public access to the facility;
- "Observ[ing]" all primary access points to preclude unauthorized public access;
- Posting warning signs;
- Requiring onsite personnel to be available to preclude unauthorized public access;
- Periodically patrolling secondary access points to preclude public access;
- Identifying the access points monitored, the frequency of patrol, and measures employed to discourage access;

- Limiting access to the SGP to "registered guests of the facility;"
- Providing guests whose sole purpose is to pass through the SGP with a "registration sheet that explains Perpetua's requirements for accessing the site and identifies potential hazards of the site;" and
- Providing training to employees regarding the need to restrict public access.

(Permit, pp. 9-10, §§ 2.6-2.7).

Also, "[t]he measures specified in the AMP shall be incorporated by reference to [the Permit] and shall be enforceable [P]ermit conditions." (*Id*., p. 10, § 2.7).

The Petition alleges that, "[w]ithout full disclosure and knowledge of the exact measures and requirements in the AMP and enforceable permit limits, DEQ cannot make a determination of whether exclusion of the access road from ambient air protections complies with EPA's ambient air policy and the Idaho Air Rules, nor can DEQ determine whether the SGP will comply with the NAAQS and TAPs." (Pet., ¶¶ 58, 59, 62, 65).

In response, DEQ agrees with some of these allegations and disagrees with others. (Resp., p. 5). Paraphrasing, Perpetua responds that (1) the Petition does not identify any violations of law or the Air Rules, and (2) even though the AMP has not been fully developed, the provisions in the Permit are sufficiently concrete and enforceable to preclude public access to the road excluded from ambient air. (*See* Mot., pp. 20-21).

As to the first argument, even if DEQ has not overtly violated the law or exceeded the scope of its authority, it is theoretically possible its actions were arbitrary, capricious, or an abuse of discretion. Therefore, dismissal of the claim on this basis is not appropriate.

As to the second argument, it is unclear how this claim could be dismissed without exceeding the scope of a motion to dismiss. While the Permit contains minimum requirements the AMP must satisfy, the hearing officer is not equipped at this stage to evaluate the adequacy of those requirements. Therefore, as to Claim No. 11, Perpetua's Motion is denied.

3. Claim No. 13: Lack of Ambient Air Monitoring

The Permit contains several "monitoring" requirements, but it does not require monitoring of the quality of the ambient air. The Petition alleges that "without ambient air monitoring, it will be impossible for DEQ to assess whether the SGP's operation is in compliance with NAAQS and TAPs increments at any given time." (Pet., ¶ 68). Air Rule 211.01(d) expressly authorizes DEQ to include reasonable ambient air monitoring requirements in a permit-to-construct, and neither DEQ nor Perpetua dispute this. (*See* Resp. of 8/12/22, p. 5; Mot., p. 22). Instead, Perpetua argues this claim should be dismissed because "ambient air monitoring is not a legal requirement for lawful issuance of an air quality permit." (Mot., p. 22).

If DEQ had discretion to require ambient air monitoring, it is possible there are circumstances under which not including such requirements is an abuse of discretion. Because demonstrating abuse of discretion is one of the ways Petitioners could obtain relief, the Petition states a claim on which relief could be granted. Therefore, as to Claim No. 12, the Motion is denied.

IV. SUMMARY, CONCLUSION, AND ORDER

Based on the foregoing, it is hereby ordered that:

- As to Claim Nos. 3 and 4, the Motion is granted, and those claims are dismissed;
- As to Claim Nos. 1, 2, 5, 6, 7, 9, 10, 11, 12, and 13,the Motion is denied, and those claims survive the Motion, though Claim No. 1 is limited to the three variables specifically referenced in the Petition; and
- As to Claim No. 8, the Motion is granted in part and denied in part. To the extent Claim No. 8 incorporates by reference the allegations comprising Claim Nos. 1, 2, and 5, Perpetua's Motion is denied, and that portion of Claim 8 survives the Motion. To the extent Claim No. 8 incorporates by reference the allegations comprising Claim Nos. 3 and 4, Perpetua's Motion is granted, and that portion of Claim No. 8 is dismissed.

The following table summarizes the results of this Order:

Claim No.	Pollutant/Source/Issue	Summary of Alleged Error	Motion	Claim
1	PM_{10} from haul trucks/road	Variables relied upon not adopted as enforceable limitations; instead, relied on plans that have not yet been developed	Denied	Survives, but limited to 3 variables described in Petition
2	PM_{10} from haul trucks/road	Assumed control of 93.3% of emissions without related enforceable limitations	Denied	Survives
3	PM_{10} from haul trucks/road	Based monitoring and recordkeeping requirements on O&M Plan not yet developed	Granted	Dismissed
4	PM_{10} from haul trucks/road	Permit does not include adequate monitoring, recordkeeping, and reporting requirements	Granted	Dismissed
5	PM_{10} from haul trucks/road	Assumed 120 days of recordable precipitation rather than using local weather data	Denied	Survives
6	Arsenic from various sources	T-RACT demonstration did not contain persuasive economic information re suppressants vs. paving	Denied	Survives
7	Arsenic from various sources	T-RACT demonstration did not evaluate environmental impacts	Denied	Survives
8	Arsenic from various sources	Estimated As emissions based on PM10 emissions, so same flawed assumptions above apply	Denied (1,2,5); granted (3,4)	Survives (1,2,5); dismissed (3,4)
9	Arsenic from various sources	Multi-year averaging of arsenic emissions not authorized by Air Rules	Denied	Survives
10	Arsenic from various sources	Impacts on future permitting actions	Granted	Dismissed
11	Ambient air boundary	Insufficient legal authority to exclude general public	Denied	Survives
12	Ambient air boundary	Whether Permit effectively precludes access by general public	Denied	Survives

Claim No.	Pollutant/Source/Issue	Summary of Alleged Error	Motion	Claim
13	Ambient air monitoring	Lack of ambient air monitoring makes it impossible to assess compliance	Denied	Survives

Finally, while most of Petitioners' claims survive Perpetua's Motion, four have been fully or partially dismissed. In their response to the Motion, the Petitioners suggest that instead of dismissing claims, they should be allowed to file an amended petition pursuant to the language in AG Procedural Rule 305 stating that "[t]he presiding officer ***may*** allow any pleading to be amended or corrected or any omission to be supplied." (Opp. Br. of 9/20/22, p. 4, n. 2 (emphasis added)). The hearing officer declines to exercise that discretion unless and until Petitioners file a formal motion to amend their Petition.

Pursuant to DEQ Procedural Rule 003.17 and AG Procedural Rule 710, this order is an interlocutory order because it does not decide all previously undecided issues in this matter.

Dated this 15th day of November 2022.

Dylan Lawrence
Hearing Officer

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,	)	Case Docket No. 0101-22-01
Petitioners,	)	CERTIFICATE OF SERVICE
v.	)	
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC., Intervenor.	)	

I hereby certify that on this 15th day of November, 2022, a true and correct copy of the **Order on Motion to Dismiss** was served on the following:

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Dylan Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Krista McIntyre
W. Christopher Pooser
Wade Foster
Stoel Rives LLP
101 S Capitol Blvd., Ste. 1900
Boise, ID 83701
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Paula J. Wilson
Hearing Coordinator

CERTIFICATE OF SERVICE

DYLAN LAWRENCE
VARIN THOMAS LLC
P.O. Box 1676
Boise, ID 83701
(208)345-6021
dylan@varinthomas.com

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,	)	Case Docket No. 0101-22-01
Petitioners,	)	ORDER ON STATUS CONFERENCE
v.	)	
DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC.,	)	
Intervenor.	)	

On November 28, 2022, a status conference was held virtually via Microsoft Teams. Bryan Hurlbutt and Laird Lucas appeared for Petitioners Nez Perce Tribe and Idaho Conservation League, and Julia Thrower appeared for Petitioner Save the South Fork Salmon. John Shackelford, Deputy Attorney General, appeared for Respondent. W. Christopher Pooser, and Wade Foster appeared for Intervenor.

At the status conference, the Petitioners expressed an intent to file a motion to amend their Petition pursuant to Board of Environmental Quality (BEQ) Procedural Rules 003.05 and 162.01 and AG Procedural Rule 305, based upon the November 15 Order on Motion to Dismiss. The parties

and hearing officer agreed that 21 days after the Order, *i.e.*, December 6, is a reasonable deadline for motions to amend pleadings.

The parties also reported progress on a stipulated scheduling order. However, the scheduling order cannot be finalized until there is more clarity regarding the impacts of the motion to amend on the proceedings. Therefore, the parties agreed to schedule a call shortly after the December 6 deadline to attempt to finalize the scheduling order at that time.

Finally, the parties and hearing officer discussed the status of establishing an administrative record. Intervenor suggested it is appropriate to open discovery at this time to allow for supplementation of the DEQ project file, while Petitioners expressed concern that doing so before resolution of their motion to amend would be premature. As a result, the hearing officer has not yet formally authorized discovery pursuant to BEQ Procedural Rule 003.11 and AG Procedural Rules 413.01(b) and 521, though any party desiring discovery at this time is free to file a motion to that effect.

Based on the foregoing, it is hereby ordered that any motions to amend pleadings in this matter shall be filed no later than Tuesday, December 6, 2022.

Dated this 30th day of November, 2022.



Dylan Lawrence
Hearing Officer

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,	)	Case Docket No. 0101-22-01
Petitioners,	)	CERTIFICATE OF SERVICE
v.	)	
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC., Intervenor.	)	

I hereby certify that on this 30th day of November, 2022, a true and correct copy of the **Order on Status Conference** was served on the following:

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Dylan Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Krista McIntyre
W. Christopher Pooser
Wade Foster
Stoel Rives LLP
101 S Capitol Blvd., Ste. 1900
Boise, ID 83701
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Paula J. Wilson
Hearing Coordinator

CERTIFICATE OF SERVICE

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	
	)	CASE DOCKET NO. 0101-22-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON	)	**MOTION TO FILE FIRST AMENDED PETITION**
Petitioners,	)	
v.	)	
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC.	)	
Intervenor.	)	

Petitioners Nez Perce Tribe, Idaho Conservation League ("ICL"), and Save the South Fork Salmon ("SSFS") hereby move to file the First Amended Petition to Initiate Contested Case (attached), as invited by the Hearing Officer in his November 15, 2022, Order on Motion to Dismiss, and under AG Procedural Rule 305 and Idaho Rule of Civil Procedure 15(a)(2).

BEQ Procedural Rule 003.01 adopts AG Procedural Rule 305, which states: "The presiding officer may allow any pleading to be amended or corrected or any omission to be supplied." IDAPA 04.11.01.350.

Similarly, after a responsive pleading has been filed, the Idaho Rules of Civil Procedure allow the pre-trial amendment of a pleading either with the opposing party's written consent or with the court's leave, and states that "[t]he court should freely give leave when justice so requires." IRCP 15(a)(2). "The twin purposes behind the rule are to allow claims to be determined on the merits rather than on technicalities, and to make pleadings serve the limited role of providing notice of the nature of the claim and the facts at issue." *Carl H. Christensen Family Trust v. Christensen*, 133 Idaho 866, 871 (Idaho 1999) (citation omitted). Thus, "motions for leave to amend pleadings are to be liberally granted." *Taylor v. McNichols*, 149 Idaho 826, 847 (Idaho 2010).

"In considering whether to grant a motion for leave to amend, a trial court may consider whether the amended pleading sets out a valid claim, whether the opposing party would be prejudiced by any undue delay, or whether the opposing party has an avialable defense to the newly added claim." *Spur Products Corp v. Stoel Rives LLP*, 142 Idaho 41, 44 (Idaho 2005) (citation omitted). "Timeliness of a motion for leave to amend is not decisive, but it is important in view of factors such as undue delay, bad faith, and prejudice to the opponent." *Id.* (quotation and citation omitted).

Petitioners Motion to Amend should be granted. Granting the Motion furthers the two purposes behind the rule that leave to amend should be freely given: (1) it will allow Petitioners' claims to be determined on the merits rather than on technicalities; and (2) it will ensure the pleadings serve the limited role of providing notice of the nature of the claims and the facts at issue.

Neither DEQ nor Perpetua faces any undue delay or prejudice. Petitioners merely seek to correct deficiencies the Hearing Officer found with respect to some claims and to provide additional detail and clarity regarding each claim being pursued in this contested case, each of which was already raised in the original Petition. The First Amended Petition does not add new claims or otherwise expand the scope of the contested case. This Motion is promptly filed within 21 days of the Order on Motion to Dismiss. No hearing date or contested case schedule has been set yet, and granting this motion will not result in any delay.

Dated: December 6, 2022

Respectfully submitted,

/s/ Bryan Hurlbutt
Bryan Hurlbutt
Attorney for the Nez Perce Tribe and the Idaho Conservation League

/s/ Julia S. Thrower
Julia S. Thrower
Attorney for Save the South Fork Salmon

CERTIFICATION OF SERVICE

I hereby certify that on this December 6, 2022, I caused a true and correct copy of the foregoing MOTION TO FILE FIRST AMENDED PETITION TO INITIATE CONTESTED CASE and the accompanying FIRST AMENDED PETITION to be served upon the following persons:

Via Email:

Paula Wilson, Hearing Coordinator
Idaho Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706-1255
paula.wilson@deq.idaho.gov

Dylan Lawrence
Varin Thomas LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com

John Shackelford, Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov

Krista McIntyre
W. Christopher Poower
Wade Foster
Stoel Rives LLP
101 S. Capitol Blvd., Ste. 1900
Boise, ID 83701
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com

/s/ Bryan Hurlbutt
Bryan Hurlbutt

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	CASE DOCKET NO. 0101-22-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC. Intervenor.	**<u>FIRST AMENDED</u> PETITION TO INITIATE CONTESTED CASE: AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 (JUN. 17, 2022)***

** This First Amended Petition uses <u>underscoring to highlight the additions made to the original Petition,</u> ~~and strikeouts to show redactions from the original Petition~~, <u>as illustrated here</u>. Where text underscoring was used in the original Petition, *it has been replaced with italics as illustrated here.*

INTRODUCTION

1. Petitioners Nez Perce Tribe, Idaho Conservation League ("ICL"), and Save the South Fork Salmon ("SSFS"), by and through their attorneys of record, file this Petition to Initiate Contested Case ("Petition") before the Idaho Board of Environmental Quality ("Board") pursuant to Idaho Code § 39-107(5) and IDAPA 58.01.23. This Petition challenges the Air Quality Permit to Construct P-2019.0047 ("PTC") issued by the Idaho Department of Environmental Quality ("DEQ") on June 17, 2022, to mining company Perpetua Resources Idaho, Inc. ("Perpetua") for its proposed Stibnite Gold Project ("SGP").

2. The SGP is in the headwaters of the East Fork of the South Fork of the Salmon River approximately ten miles east of the town of Yellow Pine, Idaho. The SGP is geographically located within the Nez Perce Tribe's aboriginal homeland and within the area over which the Nez Perce Tribe has Treaty-reserved rights and resources. As proposed, Perpetua would use conventional mining techniques to extract ore from three open pits, process gold, and dispose of mine waste at the SGP site.

3. The PTC being challenged here authorizes emissions of air pollutants from the SGP that will occur over the mine's anticipated 16-year life span. These emissions include massive quantities of dust generated by mining, hauling, and processing. The dust includes particulate matter and arsenic—pollutants which can cause serious harm to human health and the environment.

4. When it issued the PTC, DEQ failed to comply with the federal Clean Air Act and with Idaho rules, regulations, and guidance for Clean Air Act permitting, and DEQ acted arbitrarily and capriciously, acted on unlawful procedure, and abused its discretion, under the Idaho Administrative Procedure Act, Idaho Code § 67-5279, in multiple ways set forth below.

Petitioners respectfully request that the Board reverse and set aside the PTC and remand to DEQ to correct these errors.

LISTING OF REPRESENTATIVES

5. Copies of all pleadings, correspondence, and official documents shall be served on the Petitioners' counsel listed below:

For the Nez Perce Tribe and the Idaho Conservation League:

Bryan Hurlbutt
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org

For Save the South Fork Salmon:

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com

JURISDICTION, STANDARD OF REVIEW, PARTIES, AND STANDING

6. Pursuant to Idaho Code § 39-107(5), IDAPA 58.01.23, and IDAPA 58.01.01 (the "Idaho Air Rules"), the Board has jurisdiction over this contested case challenging DEQ's action issuing PTC P-2019.0047 for the SGP on June 17, 2022. Th~~is~~e original Petition ~~is~~was timely filed on July 22, 2022, within thirty-five (35) days of the date of DEQ's June 17, 2022 decision. *See* IDAPA 58.01.23.060. This Amended Petition is proper under IDAPA 58.01.23.003.01, IDAPA 04.11.01.305, and Idaho Rule of Civil Procedure 15(a)(2).

7. An agency action, such as DEQ's issuance of the PTC being challenged here, may be reversed if it is in violation of constitutional or statutory provisions, is in excess of statutory authority, is made on unlawful procedure, or is arbitrary, capricious, or an abuse of discretion.

Idaho Code ("I.C.") § 67-5279. When an agency action is not affirmed, it shall be set aside, in whole or in part, and remanded for further proceedings as necessary. *Id.*

8. Pursuant to IDAPA 58.01.23.002.02: "Any person aggrieved by an action or inaction of the Department may file a petition to initiate a contested case pursuant to Chapter 52, Title 67, Idaho Code." An aggrieved person is defined as "any person or entity with legal standing to challenge an action or inaction of the Department, including but not limited to permit holders and applicants for permits challenging Department permitting actions." IDAPA 58.01.23.005.01.

9. PETITIONER NEZ PERCE TRIBE is a federally-recognized Indian tribe with headquarters on the Nez Perce Reservation in Lapwai, Idaho; and with offices in Orofino, McCall, and Powell, Idaho, and Joseph, Oregon.

10. The Nez Perce Tribe has standing to bring this contested case. The Nez Perce people, the *Nimiipuu*, exclusively occupied, since time immemorial, over thirteen million acres encompassing a large part of what is today Idaho, Oregon, and Washington—stretching from the Bitterroot Mountains to the Blue Mountains. Nez Perce also traveled far beyond this homeland to fish, hunt, gather, and pasture—frequently going east to buffalo country, in what is today the state of Montana, and west along the Snake and Columbia rivers to the Pacific Ocean. The Nez Perce actively maintain their connection to the land, water, and resources of their vast homeland. The Nez Perce's intimate knowledge and continuous use of their homeland over millennia have created a unique and reverential bond between people and place that defines Nez Perce culture and identity.

11. When the Nez Perce Tribe entered into a treaty with the United States in 1855, it sought to reserve the rights central to maintaining its culture and way of life. The 1855 Treaty

reserved to the Tribe, for its "exclusive use and benefit," 7.5 million acres of its more than thirteen-million- acre homeland, including an area spanning present-day north-central Idaho, southeast Washington, and northeast Oregon as well as:

> [T]he right of taking fish at all usual and accustomed places in common with citizens of the Territory; and of erecting temporary buildings for curing, together with the privilege of hunting, gathering roots and berries, and pasturing their horses and cattle upon open and unclaimed land.

Treaty with the Nez Perces, art. 3, June 11, 1855, 12 Stat. 957. Nez Perce Tribal members, pursuant to the Nez Perce Tribe's Treaty-reserved rights, continue to fish, hunt, gather, and pasture across the Nez Perce Tribe's vast aboriginal homeland and at traditional places, including areas within and surrounding the SGP. The Nez Perce Tribe, as a co-manager of its treaty-reserved resources, also plays a leading role in the restoration of the East Fork South Fork Salmon River and South Fork Salmon River fisheries, expending approximately $2.5 million annually to restore Chinook salmon runs in both rivers through hatchery supplementation, fishery research, and watershed restoration.

12. The Nez Perce Tribe will suffer physical, cultural, spiritual, and economic injury caused by excessive air pollutants resulting from DEQ's issuance of the PTC. Clean, clear air is a critical component to ensuring the health and resiliency of the Nez Perce Tribe's Treaty-reserved rights and resources. Air pollution reduces visibility, which impairs cultural and ceremonial practices for Tribal members and reduces enjoyment of these special places. Air pollution causes a host of environmental and human health problems, including damage to culturally important plants, sensitive forests, and fish habitat, acidification of lakes and streams, depletion of soil nutrients, aggravated asthma, heart attacks, and premature death. Impacts can be especially harmful to at-risk ecosystems and especially harmful for sensitive human populations such as asthmatics, children, the elderly, people with diabetes, and people with heart or lung disease.

13. To safeguard its rights and interests, the Nez Perce Tribe has participated extensively in DEQ's review process, including submitting comments on October 12 and November 10, 2020, March 8, 2021, and March 14, 2022. A favorable decision in the Contested Case will redress these injuries suffered by the Tribe.

14. PETITIONER IDAHO CONSERVATION LEAGUE is an Idaho non-profit conservation organization. Its main office is located in Boise, Idaho, and it has three field offices in Sandpoint, Ketchum, and McCall. ICL represents approximately 50,000 supporters dedicated to protecting and conserving Idaho's clean water, air, public lands, and wildlife.

15. ICL has standing to bring this contested case. ICL supporters, staff, and board members ("ICL members") regularly visit the SGP and/or nearby areas where air quality would be affected by the SGP for professional, recreational, aesthetic, and other purposes. ICL members will suffer health, environmental, and aesthetic injuries from the particulate matter and arsenic air pollution emitted by the SGP and authorized by DEQ's issuance of the PTC. A favorable decision in the Contested Case will redress ICL's injuries. Neither the claim asserted, nor the relief requested, requires participation of these individual ICL members in the lawsuit. The interests ICL seeks to protect are germane to the organization's purpose in protecting Idaho's clean water, clean air, wildlife, and public lands.

16. In furtherance of its mission, ICL participated extensively in the public processes for the PTC, including by submitting formal public comments to DEQ on October 12 and November 11, 2020, March 19, 2021, and March 16, 2022.

17. PETITIONER SAVE THE SOUTH FORK SALMON is a community-based, non-profit conservation organization headquartered in McCall, Idaho. SSFS represents members and supporters dedicated to preserving the South Fork Salmon River watershed and ecosystem.

18. SSFS has standing to bring this contested case. SSFS members, supporters, and members of the Board of Directors ("SSFS members") regularly visit the South Fork Salmon River watershed and the SGP site, where the emission of excessive air pollutants due to DEQ's issuance of the PTC would impact professional, economic, recreational, aesthetic, environmental, and human health interests. SSFS members would suffer injury from DEQ's issuance of the PTC from environmental, health, and aesthetic harms caused by the emission of harmful air pollutants, including particulate matter and arsenic. A favorable decision in the Contested Case will redress these injuries suffered by SSFS members. Neither the claims asserted, nor the relief requested, requires participation of these individual supporters in the lawsuit. The interests SSFS seeks to protect are germane to the organization's mission of protecting and preserving the South Fork Salmon River watershed and ecosystem, and protecting public health, the river, the fish, and recreational opportunities in the area.

19. In furtherance of this mission, SSFS participated extensively in the public process for the PTC, including submitting formal public comments to DEQ on October 12 and November 11, 2020, March 19, 2021, and March 16, 2022.

20. RESPONDENT IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY is an executive department and administrative agency organized under the laws of the State of Idaho, pursuant to the Idaho Constitution (Article IV, Section 20) and Idaho Code section 39-104(1). Its principal offices are located at 1410 N. Hilton, Boise, Idaho 83706. DEQ, through its Director, and subject to Board oversight, is responsible for issuing air quality PTCs under the Idaho Air Rules, IDAPA 58.01.01.

21. On June 17, 2022, DEQ issued PTC P-2019.0047, which is the subject of this contested case. On July 22, 2022, Petitioners timely filed the original Petition to Initiate

Contested Case. On July 28, 2022, the Hearing Officer Dylan Lawrence was assigned to preside over this matter. On August 12, 2022, Perpetua filed a Petition to Intervene. On August 22, 2022, Perpetua's Petition to Intervene was granted. On September 6, 2022, Perpetua filed a Motion to Dismiss. On November 15, 2022, the Hearing Officer issued the Order on Motion to Dismiss, denying the motion with respect to the majority of Petitioners' claims, dismissing or partially dismissing four claims, and declining to allow the pleadings to be amended unless Petitioners file for consideration a formal motion to amend the Petition.

FACTUAL SUPPORT FOR PETITION

I. OVERVIEW OF SGP & CHRONOLOGY OF DEQ'S ISSUING THE PTC

22. Perpetua is currently in the process of seeking multiple permits and other approvals from multiple agencies and other authorities for the proposed SGP. As described by DEQ in the Statement of Basis ("SOB") document prepared with the PTC:

> Perpetua proposes to construct and operate the SGP, consisting of conventional open-pit mining, ore preparation, and gold extraction operations. The SGP is to be located in Valley County at the intersection Forest Service roads NF-374 and NF-412 (Stibnite Road), approximately 10 miles east of Yellow Pine. The project will be located on a combination of public national forest and private lands. The mining operations boundary within which public access will be excluded is defined in Figure 1. This operations boundary also defines the ambient air boundary that was used in all ambient air quality impact analyses as part of the development process of the PTC.
>
> The SGP will require the construction of significant infrastructure, including a power transmission line, a primary mine site access road, onsite haul roads, an ore processing facility, onsite workspaces, employee housing and recreation, water storage and distribution facilities, and sewage disposal facilities.
>
> Conventional open-pit mining methods including drilling, blasting, excavating, and hauling will be used to extract ore and waste rock, termed development rock (DR). Hydraulic shovels and front-end loaders will be used to load ore and DR into haul trucks. DR will be used for construction, restoration, and backfilling, or hauled to the dedicated development rock storage facilities (DRSF). Approximately 340 million tons of DR will be handled over the life of the mine.

> The SGP will include three years of pre-mining development and construction activities, followed by an operating mine life of approximately 12 years. Mining will occur in three open pits: Yellow Pine Pit (YPP), Hangar Flats pit (HFP), and West End pit (WEP). Although there will be overlap in mine development, construction and operations, the general sequence of mining will be the YPP deposit, followed by the HFP and WEP deposits. Legacy tailings from the Meadow Creek valley (Bradley Tailings [BT]) will also be reclaimed and reprocessed during the initial project schedule. Surface exploration drilling will occur within the pits and within the Scout Prospect decline (underground exploration) throughout the mine operation period. Restoration and reclamation of other legacy mining features will occur prior to mining, throughout the life of the mine, and as part of the mine closure.
>
> Ore will be hauled to the primary crusher area, where it will be fed directly into the crusher dump pocket or stockpiled. The ore crushing plant will be designed to operate at a maximum rate of 25,000 tons per calendar day (T/day). Approximately 100 million tons of ore will be mined from the three pits over the life of the project. The metal-recovery process from ore will include conventional crushing and grinding, followed by froth-flotation circuits that will generate separate gold-silver and antimony-silver concentrates. The antimony-silver concentrate will be shipped offsite for refining, whereas additional onsite processing of the gold-silver concentrate will include pressure oxidation, carbon-in-leach circuits, and refining processes to recover gold and minor amounts of silver. The finely ground leftover ore material from the mineral recovery process, termed tailings, will be neutralized, thickened, and transported via a pipeline to the tailings storage facility. A diagram of ore processing and ore concentration and refining process flows is provided in Figure 2.

23. Perpetua (previously Midas Gold) submitted a PTC application for the SGP to DEQ on August 20, 2019. As shown in the "Application Chronology" section of the SOB, between that date and March 6, 2020, DEQ determined that the application was incomplete, requested additional information, and received supplementary materials from Perpetua no fewer than four times. On May 15, 2020, DEQ deemed Perpetua's application complete.

24. Between May 15, 2020, and March 16, 2022, DEQ developed three versions of the draft PTC and released them for public comment. As noted in comments submitted by the Nez Perce Tribe, ICL, and SSFS, the first two draft versions of the PTC (herein referred to the September 2020 and February 2021 draft PTCs) contained significant shortcomings. As a result, the September 2020 draft PTC was considered deficient and required updated information from

Perpetua, including updated hazardous air pollutants ("HAP") and toxic air pollutants ("TAP") emissions estimates, a HAP/TAP addendum to the application, updated TAP modeling analyses, supporting references, and updated modeling files with corrections for formaldehyde and sulfuric acid.

25. DEQ subsequently updated the draft PTC and in February 2021, provided a revised draft PTC for public comment. Following additional comments, DEQ again determined that the February 2021 draft PTC was deficient and required additional information from Perpetua, including Prevention of Significant Deterioration emissions estimates and regulatory applicability for the lime manufacturing plant, as well as an updated TAP/HAP addendum including an updated emission inventory and modeling files.

26. DEQ revised theFebruary 2021 draft PTC and released it for public comment on January 13, 2022. Comments were submitted by the Nez Perce Tribe, ICL, SSFS, the U.S. Environmental Protection Agency ("EPA") Region 10, and Ian von Lindern of Terragraphics International Foundation. Commenters raised numerous concerns with the draft PTC and urged DEQ to gather additional information, to perform additional modeling and analysis, and to develop additional enforceable permit conditions and limits prior to issuing a final PTC. On June 17, 2022, DEQ issued the final PTC, along with responses to comments and the SOB. While DEQ made limited updates to the PTC, it rejected most of the issues raised by the commenters.

II. PM_{10} & ARSENIC EMISSIONS FROM THE SGP

27. While the SGP will emit numerous air pollutants, PM_{10} and arsenic are the air pollutants of greatest concern and are the pollutants at issue in this contested case.

A. PM_{10} Pollution and Regulation

28. Particulate matter ("PM") contains microscopic solids or liquid droplets that are so small that they can be inhaled and cause serious health problems. Some particles less than 10 micrometers in diameter can get deep into a person's lungs, and some may even get into the person's bloodstream. Numerous scientific studies have linked particle pollution exposure to a variety of problems, including premature death in people with heart or lung disease; nonfatal heart attacks; irregular heartbeat; aggravated asthma; decreased lung function; and increased respiratory symptoms, such as irritation of the airways, coughing or difficulty breathing. People with heart or lung diseases, children, and older adults are the most likely to be affected by particle pollution exposure.

29. In addition to causing human health problems, PM causes environmental damage. Particles can be carried over long distances by wind and then settle on ground or water. Depending on their chemical composition, the effects of settling may include making lakes and streams acidic; changing the nutrient balance in river basins; depleting nutrients in soil; damaging sensitive forests and crops; affecting diversity of ecosystems; and contributing to acid rain.

30. Under Sections 108 and 109 of the federal Clean Air Act, EPA is required to establish National Ambient Air Quality Standards ("NAAQS") for each "criteria air pollutant" to protect the nation's public health and welfare. "[E]ffects on welfare include[ ], but [are] not limited to, effects on soils, water, crops, vegetation, manmade materials, animals, wildlife, weather, visibility, and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being, whether caused by transformation, conversion, or combination with other air pollutants." 42 U.S.C. § 7602(h).

31. PM is a criteria air pollutant. EPA has established primary and secondary NAAQS for coarse particulate matter, or "PM_{10}," 40 C.F.R. § 50.6, and for fine particulate matter, or "$PM_{2.5}$," *id.* at § 50.7. PM_{10} consists of inhalable particles with diameters that are generally ten micrometers and smaller. 42. U.S.C. § 7602(t). $PM_{2.5}$ consists of inhalable particles that are 2.5 micrometers and smaller. The NAAQS specify a maximum amount of PM to be present in the outdoor air. *See* 40 C.F.R. §§ 50.6, 50.7.

32. EPA has delegated to DEQ authority to issue air quality permits in Idaho. Under the Clean Air Act, State air rules like DEQ's "shall" include "enforceable emission limitations" and other control measures, means, or techniques as necessary or appropriate to meet Clean Air Act requirements. 42 U.S.C. § 7410(a)(2)(A). State plans "shall" include a "program to provide for the enforcement" of the limitations and measures described in subparagraph (A), and for the "regulation of the modification and construction of any stationary source . . . to assure that [NAAQS] are achieved." *Id.* § 7410(a)(2)(C). EPA's Clean Air Act regulations require each State plan to "set forth legally enforceable procedures" that enable the State to determine whether the construction of a facility will result in a violation of its air pollution control strategies or interfere with attaining or maintaining the NAAQS. 40 C.F.R. § 51.160(a). These legally enforceable procedures: must icnlude means by which the State will prevent construction if the facility will violate air pollution control strategies or will interfere with attaining or maintaining the NAAQS; and must provide for the applicant to submit information on the "location, design, construction, and operation of such facility . . . as may be necessary" to permit the state to "to make the determination" that the facility will comply with its air pollution control strategies and the NAAQS. *Id.* § 51.160(b)–(c). "The legally enforceable procedures in § 51.160(b) must also require" the State to provide opportunity for public comment on information

submitted by the applicant and on the State's analysis of the effects on ambient air quality. *Id.* § 51.161(a). Under the Rules for the Control of Air Pollution in Idaho, DEQ is required to ensure that no PTC shall be granted for a new or modified stationary source unless the applicant shows to the satisfaction of DEQ that the source would not cause or significantly contribute to a violation of any NAAQS. IDAPA 58.01.01.203.02. To satisfy these requirements, DEQ must assess air impacts using maximum potential emissions as limited by either the capacity of the unit/operation or as limited by enforceable permit provisions. *See* IDAPA 58.01.01.006.88. Prior to issuing a permit to contruct, DEQ must provide an opportunity for public comment by making available DEQ's proposed action together with information provided by the applicant and with DEQ's analysis of air quality impacts. IDAPA 58.01.01.209.c.

B. PM_{10} Pollution from the SGP & Flaws in the PTC

33. According to DEQ's Statement of Basis for the SGP, the SGP has the potential to emit 55.7 tons per year of PM_{10} from a variety of sources. The generation of dust from ore haul trucks traveling along haul roads is the most significant source, estimated to be approximately 55% of all modeled PM_{10} emissions. The next most significant source is open pit drilling fugitive emissions, estimated by DEQ to account for approximately 24% of all modeled emissions.

34. DEQ modeled receptors at various locations along the SGP's ambient air boundary and determined that the maximum potential emissions will be below (and thus comply with) the 24-hour PM_{10} NAAQS. DEQ found the maximum 24-hour PM_{10} pollution from the SGP would be 123.5 ug/m^3, which is 82.3% of the NAAQS.

35. For each of the reasons below, DEQ's determination that the SGP will not cause or contribute to a violation of the PM_{10} NAAQS and its action approving the PTC ~~is flawed~~violates the Clean Air Act, violates EPA's Clean Air Act regulations, violates the Idaho

Air Rules, and is otherwise arbitrary, capricious, made on unlawful procedure, and an abuse of discretion and must be set aside under I.C. § 67-5279.

36. First, important variables affecting the quantity of PM_{10} generated by the ore haul trucks are not directly limited and enforceable as PTC permit conditions. Perpetua estimated the quantity of PM_{10} that would be emitted by the ore haul trucks based on EPAs compilation of air emissions factors (AP-42 Chapter 13.2.2) and their subsequent analysis of sources used by the EPA to develop Chapter 13.2.2. Critical variables that Perpetua used as inputs to PM emission calculations include: the average empty weight of ore haul trucks; the average loaded weight of ore haul trucks; the total number of larger versus smaller ore haul trucks (CAT 789D versus CAT 740B); the silt content of the haul road being traveled; the number of days per year with precipitation greater than or equal to 0.01 inches per day; and the total number vehicle miles traveled by ore haul trucks. However, only one of these critical variables is directly limited and enforceable as a condition in the PTC: the silt content of the haul roads. *See* PTC condition 3.13.

37. Instead of developing PTC conditions for these other critical variables, DEQ relied on a surrogate limit in the PTC (total ore haulage per day, *see* PTC conditions 3.5) and on plans that have not yet been developed and have not been subject to public comment,—a Fugitive Dust Control Plan ("FDCP") and a Haul Road Capping Plan ("HRCP")—to claim the PTC ensures enforceable compliance with 24-hour PM_{10} NAAQS. Without developing the FDCP and HRCP first, without taking public comment on them, and without including important variables as enforceable permit conditions, there is no assurance the SGP will comply with the 24-hour PM_{10} NAAQS, even with the total ore haulage per day limit. Perpetua used a very specific combination of these variables to arrive at a quantity of ore haul truck generated PM_{10} that they contend ensures compliance with the NAAQS. Changing these variables in any number

of ways (ways which are not precluded by any conditions in the PTC) can result in higher PM_{10} levels—levels so high that they exceed the NAAQS. As just one example, merely changing the ratio of large to small ore haul trucks used by Perpetua (to include more ~~large~~ small trucks) could cause a violation of the NAAQS.

38. Second, DEQ assumed 93.3% of all haul road PM_{10} emissions from the SGP can be controlled by using an unspecified combination, volume, and frequency of water sprays and chemical dust suppressants. This extremely high level of control which DEQ assumed Perpetua can achieve is based on Perpetua's interpretation of AP-42 Chapter 13.2.2. AP-42 Chapter 13.2.2 discusses the critically important variables surrounding control efficiencies (in particular to chemical suppressants, some of which can reasonably be assumed to apply to water too):

> The control effectiveness of chemical dust suppressants appears to depend on (a) the dilution rate used in the mixture; (b) the application rate (volume of solution per unit road surface area); (c) the time between applications; (d) the size, speed and amount of traffic during the period between applications; and (e) meteorological conditions (rainfall, freeze/thaw cycles, etc.) during the period. Other factors that affect the performance of dust suppressants include other traffic characteristics (e. g., cornering, track-on from unpaved areas) and road characteristics (e. g., bearing strength, grade). The variabilities in the above factors and differences between individual dust control products make the control efficiencies of chemical dust suppressants difficult to estimate. Past field testing of emissions from controlled unpaved roads has shown that chemical dust suppressants provide a PM-10 control efficiency of **about 80 percent when applied at regular intervals of 2 weeks to 1 month (**emphasis added**).**

39. None of the above variables, however, have any specific and enforceable permit conditions within the PTC to ensure a 93.3% control efficiency. Instead, the PTC has a permit condition (permit condition 2.6) only requiring the permittee to develop and submit the FCDP and HRCP, which merely describe how these variables will be addressed 30 days before start-up of the SGP. Permit condition 2.6 details what variables contributing to PM_{10} control effectiveness must be detailed in the FCDP, but the specific details that are so important to

control efficiency (e.g., the amount of water or chemical suppressants applied and the frequency of application) are undetermined at present, have not been subject to public comment, and are left to Perpetua to decide at a later date. A lesser control efficiency, even just slightly lesser, could result in large enough PM_{10} emissions to violate the NAAQS. In fact, if the SGP were to instead achieve 80% control (as EPA found through past field testing of chemical dust suppressants), then the SGP's PM_{10} emissions could exceed the NAAQS.

40. Third, DEQ relied on monitoring and record keeping (permit condition 3.16) using devices and methodologies in the Operation and Maintenance ("O&M") Manual for the potential to emit limit associated with the 180,000 tons per day hauling in permit condition 3.5. However, the O&M Manual has not yet been developed, submitted to the public for comment, ~~or~~ reviewed and revised by DEQ, or incorporated into and made enforceable under the Permit. The O&M Manual is critical to ensuring the 180,000 tons per day hauling condition is satisfied, and the 180,000 tons per day is critical to DEQ's determination under IDAPA 58.01.01.203.02 that the SGP will not exceed the NAAQS. Additionally, DEQ is authorized to require plans and to impose any reasonable conditions on permits, but instead of doing so here, it is letting Perpetua do this later, outside of the permit process. *See* IDAPA 58.01.01.202.03 (authorizing DEQ to obtain from permit applicant "[a]ny additional information, plans, specifications, evidence or documents the Department may require to make the determinations required under [the PTC sections of the Air Rules]"); IDAPA 58.01.01.211 (authorizing DEQ to "impose any reasonable conditions upon an approval" of a PTC); IDAPA 58.01.01.121 (authorizing DEQ to require schedules, reports, records, monitoring, and plans to ensure compliance with Air Rules); IDAPA 58.01.01.122.03.g (authorizing DEQ to issue an information order to provide any "information the Department may require"). ~~Further, the PTC itself does not include all monitoring,~~

~~recordkeeping, and reporting necessary to assure compliance with the permit emission limitations and applicable requirements.~~

41. Fourth, DEQ assumed there would be 120 days of recordable precipitation at the SGP (defined as recording precipitation of 0.01 inch or greater) as a variable in its ore haul road fugitive PM emission calculations. This 120 days comes from general geographic guidance from AP-42 Chapter 13.2.2-1. DEQ, however, should have used local meteorological data. Section 6.8 (Meteorological Data) of DEQ's *Guideline for Performing Air Quality Impact Analyses* states: "The meteorological data used in the modeling analysis should be representative of the meteorological conditions at the particular site of the proposed construction or modification." Days of recordable precipitation is an important variable affecting the SGP's emissions of PM_{10} from ore haul roads. DEQ's failure to use the most representative site data is counter to this guidance and increases the risk of miscalculation of ore haul road emissions. As a result, DEQ failed to ensure PM_{10} emissions from the SGP will comply with the NAAQS.

C. Arsenic Pollution & Regulation

42. Arsenic is a naturally occurring element in soils and minerals. When soil or rock containing arsenic is disturbed, arsenic may enter the air, water, and land from wind-blown dust and from run-off and leaching. The EPA classifies inorganic arsenic as a "human carcinogen," based on evidence in human studies of links to lung, bladder, kidney, skin, and liver cancers.

43. Arsenic released from the soil and rock as airborne dust causes environmental damage. Airborne arsenic pollutes soil, plants, and water resources when it is removed from the air by rain, snow, or gradually settling. Studies have shown that there is a strong correlation between arsenic concentrations in water and in the tissues of fish collected from arsenic-polluted waters. Plants may also absorb arsenic in their leaves and root system from arsenic-polluted soil.

The health effects of long-term ingestion of arsenic include developmental effects, diabetes, pulmonary disease, cardiovascular disease, and skin, bladder, or lung cancer.

44. Arsenic is a Toxic Air Pollutant regulated by DEQ. DEQ is required to ensure that no permit to construct shall be granted for a new or modified stationary source unless emissions of TAPs from the constructed source would not injure or unreasonably affect human or animal life or vegetation as required by Section 161. IDAPA 58.01.01.203.03. Section 161 states, "any contaminant which is by its nature toxic to human or animal life or vegetation shall not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation." IDAPA 58.01.01.161.

45. To comply with these TAPs regulations, emissions from a facility must not exceed the Acceptable Ambient Concentrations of Carcinogens ("AACC") at the ambient air boundary. For each carcinogenic TAP, IDAPA 58.01.01.586 lists the applicable TAP and its AACC in ug/m^3 as an annual average. The AACC can practically be defined as the concentration of a TAP that, if an individual was exposed to yearly over a 70-year lifetime, would equate to a cancer development probability risk of 1 in 1,000,000. *See* IDAPA 58.01.01.006.125 & 58.01.01.210.12.

46. In order to determine a facility's TAP concentration at their ambient air boundary, and as noted similarly for PM_{10} emissions, DEQ must assess air impacts using maximum potential emissions as limited by either the capacity of the unit/operation or as limited by enforceable permit provisions. *See* IDAPA 58.01.01.006.88.

D. Arsenic Pollution from the SGP & Flaws in the PTC

47. There are numerous arsenic sources at the SGP, including drilling, blasting, excavating, hauling, silos, rock dumps, and storage and tailing piles. Table 3 in the SGP TAPs Addendum indicates that the maximum arsenic Potential Total Emissions ("PTE") is 0.544 lbs/hr at the maximum mine production rate of 180,000 tons/day. The largest source of arsenic emissions are haul roads estimated at 0.464 lbs/yr (Table B1-W3 in SOB). PTE estimates for arsenic are calculated using the same formulas and Emission Factors as total particulate and PM_{10} emission rates. As such, like the PM and PM_{10} emission estimates discussed already, the arsenic emission estimates are similarly underestimated and equally unreliable.

48. During the permitting process, DEQ determined that the SGP's estimated arsenic emissions and concentrations at the ambient air boundary were excessive and would not meet the AACC for arsenic. To get around this problem, Perpetua chose to employ a process known as T-RACT. T-RACT is a demonstration that allows a permittee to analyze and employ reasonably available control technologies ("RACT") that could be applied to a source of TAPs. If RACT does not sufficiently reduce toxic emissions to below the AACC, then the permittee is allowed a 10-fold increase in the AACC and can employ production limitations to ensure compliance with the now 10-times-bigger AACC. These production limitations should then be incorporated as enforceable permit conditions. *See* IDAPA 58.01.01.210.13–14.

49. As part of the T-RACT determination process, the applicant must supply, and DEQ must consider, information on a variety of factors relevant to determining a "reasonable" control technology including, but not limited to, control effectiveness, economic costs, operational feasibility, and associated environmental impact. IDAPA 58.01.01.210.14a–d.

50. Perpetua submitted to DEQ a T-RACT demonstration for arsenic emissions from open-pit drilling and ore haul roads. Perpetua determined that the most effective RACT for open-

pit drilling was dry drilling with dust collectors and that the most effective RACT for ore haul roads was water sprays and chemical suppressants. In its T-RACT demonstration, Perpetua included limited qualitative discussion, and no quantitative support, regarding economic considerations. Perpetua failed to provide any discussion of environmental impacts.

51. DEQ approved Perpetua's T-RACT demonstration and granted Perpetua a 10-fold increase in allowable arsenic pollution, subject to operational limitations to reduce PTE. And as modeled by DEQ, arsenic pollution from the SGP would comply with this larger AACC.

52. For each of the reasons below, DEQ's approval of Perpetua's T-RACT demonstration for arsenic, ~~and~~ its analysis determining the SGP will not exceed the AACC and thus will not injure or unreasonably affect human or animal life or vegetation, and its action approving the PTC ~~is flawed~~violates the Clean Air Act, violates EPA's Clean Air Act regulations, violates the Idaho Air Rules, and is otherwise arbitrary, capricious, made on unlawful procedure, and an abuse of discretion and must be set aside under I.C. § 67-5279.

53. First, the T-RACT demonstration contained no persuasive economic information and no discussion at all regarding associated environmental impacts, despite the requirements to do so in IDAPA 58.01.01.210.14. There will be water quality and biological impacts associated with Perpetua's use of substantial amounts of chemical dust suppressants and water that have not been considered in the PTC. For example, the use of chemical dust suppressants like magnesium chloride can cause toxicity in trees and can lead to tree death. Magnesium chloride is also known to adversely affect aquatic ecosystems. Moreover, the proposed water source for dust control is primarily water collected in runoff ponds (captured rain or snowfall that has become contaminated through the contact of mine facilities), groundwater, and surface water from the East Fork of the South Fork of the Salmon River. USGS sampling indicates elevated arsenic in

these waters. The environmental impact of using magnesium chloride or arsenic-polluted water as dust suppression methods was never considered as part of the T-RACT demonstration. Likewise, the T-RACT demonstration did not provide sufficient economic support for Perpetua's decision to use water and chemical dust suppressants as compared to paving the haul roads, even though paving was shown to achieve the highest reasonable dust control efficiency.

54. Second, because the underlying particulate and PM_{10} emissions estimates and particulate control assumptions are unreliable in numerous respects, as already discussed above, so too are the estimated arsenic emissions. The SGP's estimated arsenic emissions were based on its PM_{10} emissions. PM_{10} emissions from the SGP may be higher, and their control effectiveness may be lower, than DEQ assumed, in which case arsenic emissions would also be higher and might exceed the AACC.

55. Third, Perpetua's and DEQ's TAPs analyses substantially reduce the SGP's purported arsenic emissions using three improper averaging tactics: (1) averaging emissions over a 5-year period for the T-RACT input to ambient toxics modeling; (2) averaging the estimated annual ambient modeling impacts across two multi-year scenarios; and (3) averaging the resultant 16-year total emissions over the 70-year human lifetime to assert compliance. Nothing in the Idaho Air Rules allows for multi-year emissions averaging and ambient air concentration adjustments. Rather, the arsenic AACC is an annual average. *See* IDAPA 58.01.01.586). DEQ's T-RACT regulations require comparing the estimated maximum annual ambient air arsenic concentration to 10 times the listed annual AACC. IDAPA 58.01.01.12.b. Therefore, to determine compliance with the AACC requires that DEQ estimate the SGP's maximum 1-year annual arsenic emissions and compare it to the annual arsenic AACC.

56. By relying on these improper averaging tactics, DEQ fails to show the SGP will satisfy the arsenic AACC and the resulting analysis masks potentially severe human health and environmental impacts of SGP's potential arsenic emissions. The underlying analyses supporting the TAPs requirements allows for a 1-in-1,000,000 excess cancer risk factor. The T-RACT approval increases that risk 10-fold to a 1-in-100,000 excess cancer risk factor. IDAPA 58.01.01.12.b. Perpetua's multi-year averaging of emission rates combined with DEQ's decision to allow the full lifetime exposure (70 years) to be imposed on receptors during the 16-year estimated life of mine increases the cancer risk by another order of magnitude to the 1-in-10,000 range or higher. Combined with uncertainties associated with the underlying particulate emissions calculations noted above, the SGP may result in extremely dangerous arsenic exposures.

57. While not the basis for a separate claim for relief, Petitioners note that excacerbating this cancer risk is the fact that under DEQ's incremental TAPs regulations (*see* IDAPA 58.01.01.585), when DEQ considers permitting any additional sources of arsenic in the area over the next 70 years (such as an extension of the life of the SGP, expansion of the facility itself, and/or any adjacent facilities seeking a similar permit, like the potential Horse Heaven project), DEQ will not have to consider the arsenic emissions authorized by this PTC.

E. DEQ's Ambient Air Boundary for the SGP

58. The Clean Air Act and Idaho Air Rules require meeting various air standards, including the NAAQS and TAPs, in ambient air. *See*, *e.g.*, IDAPA 58.01.01.006.11 (NAAQS), 58.01.01.006.125 (TAPs). EPA defines "ambient air" as "that portion of the atmosphere, external to buildings, to which the general public has access." 40 C.F.R. § 50.1(e). In defining an ambient air boundary, the EPA has long followed a policy that exempts "the atmosphere over land owned

or controlled by the source and to which public access is precluded . . .” from ambient air. EPA’s Revised Policy on Exclusions from “Ambient Air” (Nov. 2018) states that “it is appropriate to exclude the atmosphere over land owned or controlled by the stationary source, where the owner or operator of the source employs measures, which may include physical barriers, that are effective in deterring or precluding access to the land by the general public.”

59. The Idaho Air Rules define “ambient air” as “[t]hat portion of the atmosphere, external to building, to which the general public has access.” IDAPA 58.01.01.005.09. To exclude areas from consideration as ambient air, the following conditions must be met: (1) the permittee must have the legal authority to exclude the general public from the area; (2) the boundary to ambient air must be clearly discernible to the general public; (3) the general public must be effectively precluded from assessing the facility; and (4) the general public is not considered employees of the facility; those having official business with the facility; guests of the facility, including participants in facility routes and those seeking access for a specific purpose.

60. Perpetua established an operations boundary (the active industrial site where mining activities and heavy equipment operation will occur) for the purposes of excluding this area from ambient air analysis, and for excluding public access. The area includes the current Stibnite Road point of entry and proposed site access via the Burntlog Route. According to Perpetua, access inside the operations boundary will be restricted for the life of the mine by physical barriers at points of potential access, as well as natural features of the landscape that prevent public access.

61. DEQ’s determination to exclude the access route from ambient air protections, and its action approving the PTC ~~is flawed~~violates the Clean Air Act, violates EPA’s Clean Air

Act regulations, violates the Idaho Air Rules, and is otherwise arbitrary, capricious, made on unlawful procedure, and an abuse of discretion and must be set aside under I.C. § 67-5279.

62. Perpetua has indicated that it intends to allow access to the general public through the mine site between Stibnite Road at Sugar Creek and Thunder Mountain Road at Meadow Creek. Furthermore, this roadway is currently accessible to and has been regularly used by the general public. And while Perpetua claims that it has "legal and practical ability to enforce its control over roadway access," the Forest Service has not yet completed its NEPA analysis and approval of the SGP, which would include a decision on whether it will require or will not permit general public access through the mine site.

63. DEQ states that the route would be managed in accordance with the Stibnite Road Access Management Plan ("AMP"). DEQ, however, relied on an ambiguous description of measures and requirements to preclude public access and ensure that those traveling over the road can be classified as "guests" of the mine.

64. PTC condition 2.7 requires the development of an AMP to address whether the NAAQS apply to the mine's access road through the Perpetua site given the extent of public access allowed. PTC condition 2.8 allows the AMP to be developed later, after the PTC was issued and without public comment, and it does not require the AMP to be enforceable. For the AMP to preclude the applicability of the NAAQS along the access road, the AMP must be reviewed and approved by DEQ, it must be reviewed through public comment, and it must be enforceable under the PTC.

65. Without full disclosure and knowledge of the exact measures and requirements in the AMP and enforceable permit limits, DEQ cannot make a determination of whether exclusion of the access road from ambient air protections complies with EPA's ambient air policy and the

Idaho Air Rules, nor can DEQ determine whether the SGP will comply with the NAAQS and TAPs.

F. DEQ's Failure to Require Ambient Air Monitoring for the SGP

66. DEQ has the authority to require ambient air monitoring to determine the effect emissions from the stationary source or facility may have on the air quality of the area potentially impacted by the source. IDAPA 58.01.01.211.01(d).

67. DEQ received comments from the Nez Perce Tribe, EPA Region 10, ICL, and SSFS urging the PTC to require ambient air monitoring to verify the SGP's compliance with the NAAQS and TAPs increments. But DEQ declined, stating in the Response to Comments (pg. 16): "DEQ disagrees that a PM/PM_{10} ambient monitoring network is necessary to make the PTC practically enforceable." DEQ states in the Response to Comments that any violation of the permit would be processed in accordance with DEQ's enforcement procedures manual.

68. However, without ambient air monitoring, it will be impossible for DEQ to assess whether the SGP's operation is in compliance with NAAQS and TAPs increments at any given time. Ambient air monitoring is necessary because of the large uncertainty surrounding dust control efficiency and emissions factors associated with the SGP for PM_{10} and arsenic, as well as the lack of enforceable permit conditions for many important variables, as already described in this Petition.

RELIEF REQUESTED

69. An agency action, like DEQ's issuance of the PTC, may be reversed if it is in violation of constitutional or statutory provisions, is in excess of statutory authority, is made on unlawful procedure, or is arbitrary, capricious or an abuse of discretion. I.C. § 67-5279. When an

agency action is not affirmed, it shall be set aside, in whole or in part, and remanded for further proceedings as necessary. *Id.*

70. As stated above, under the Idaho Air Rules, DEQ must not issue a PTC unless it determines: (1) "the stationary source or modification would comply with all applicable local, state or federal emission standards"; (2) "the stationary source would not cause or significantly contribute to a violation of any ambient air quality standard"; and (3) "the emissions of toxic air pollutants from the stationary source or modification would not injure or unreasonably affect human or animal life or vegetation as required by Section 161." IDAPA 58.01.01.203. Prior to issuing a permit to contruct, DEQ must provide an opportunity for public comment by making available DEQ's proposed action together with the information provided by the applicant and with DEQ's analysis. IDAPA 58.01.01.209.c. To ensure compliance with the NAAQS and other air pollution control strategies, the Clean Air Act and EPA's Clean Air Act regulations require state air rules like DEQ's: to include "enforceable emission limitations" and other measures, 42 U.S.C. § 7410(a)(2)(A); to include a "program to provide for the enforcement" of such measures, and to regulate the construction of any stationary source, *id.* § 7410(a)(2)(C); to "set forth legally enforceable procedures" for determining whether the construction of a facility will comply with control strategies and NAAQS, 40 C.F.R. § 51.160(a); to require sufficient information needed "to make the determination" whether the facility will comply with air pollution control strategies and the NAAQS, i*d.* § 51.160(c); and to provide opportunity for public comment on information submitted by the applicant and on the agency's analysis of the effects to air quality. *Id.* § 51.161(a). Based on the flaws in DEQ's issuance of the PTC described above, DEQ's action is in violation of these provisions of the Idaho Air Rules, the Clean Air Act, and EPA's Clean Air Act

regulations, and is otherwise arbitrary, capricious, made on unlawful procedure, and an abuse of discretion and must be reversed.

71. By issuing the PTC in its current form, DEQ failed to adequately protect the public and environment from harmful air pollution causing injury to the Nez Perce Tribe, ICL, SSFS, and their members and supporters. To redress these injuries, Petitioners respectfully request the Board set aside and remand the PTC and direct DEQ to correct the following errors prior to issuing any new or revised PTC:

Ore Haul Road PM_{10} & Arsenic Emissions

A. DEQ must develop and include in the PTC enforceable permit conditions for the maximum average empty weight of ore haul trucks, the maximum average loaded weight of ore haul trucks, the maximum total number vehicle miles traveled annually by ore haul trucks, the silt content of the roadbed, the arsenic content of the silt in the roadbed, and any other important variables affecting the SGP's fugitive emissions of PM_{10} and arsenic from vehicle traffic on mine haul roads. To develop such permit conditions and ensure compliance with the NAAQS and TAP limits, DEQ must reevaluate and recalculate fugitive emissions of PM_{10} and arsenic.

B. Silt and arsenic levels should be included as permit conditions and monitored regularly *in situ,* rather than from stockpiles as applied to the roadbed.

C. Instead of assuming 120 days of recordable precipitation at the SGP as a variable within ore haul road fugitive PM emission calculations, as done by the applicant based off general geographic guidance from AP-42 chapter 13.2.2-1, DEQ must recalculate all fugitive emissions after analyzing local meteorological data sources to determine a more accurate and representative number of days with recordable precipitation.

FDCP, AMP, O&M Manual, & HRCP

D. DEQ must require Perpetua to submit the FDCP, AMP, O&M Manual, and HRCP (collectively, "Plans"), must provide for public comment on the Plans, must review and revise Plans to ensure the SGP's emissions comply with IDAPA 58.01.01.203, and must incorporate the Plans as enforceable PTC conditions.

Arsenic Averaging

E. DEQ must remove the 5-year averaging for arsenic emissions, the averaging of estimated annual ambient modeling impacts across two multi-year scenarios, and the 16/70 life of mine versus lifetime exposure adjustment for the SGP's maximum arsenic ambient concentration it used to assess arsenic TAPs compliance. DEQ must use the SGP's highest 1-year arsenic emission rates for each scenario evaluated and repeat the modeling analyses using these rates. DEQ must use the maximum annual ambient arsenic concentration from the single emission scenario producing the highest annual concentration for any 1-year as the point of compliance. *See* IDAPA 58.01.01.210.03b ("The point of compliance is the receptor site that is estimated to have the highest ambient concentration of the toxic air pollutant of all the receptor sites that are located either at or beyond the facility property boundary or at a point of public access . . . ."). DEQ must assess the impact of the SGP's maximum 1-year annual emissions from the single emission configuration by comparing to the T-RACT AACC for arsenic (10 times the AACC value published in IDAPA 58.01.01.586), without averaging over multiple years, and without adjusting for the alleged 16-year life of the mine or the 70-year lifetime exposure.

Ambient Air Boundary Monitoring

F. As part of any PTC for the SGP, DEQ must require ambient air boundary monitoring, as provided for by IDAPA 58.01.01.211.01(d), to ensure compliance with the NAAQS and the TAPs increments. DEQ must require Perpetua to submit an ambient air

boundary monitoring plan ("AABMP"), must take public comment on the AABMP, must review and revise the AABMP, and must incorporate the AABMP as enforceable PTC conditions. At a minimum, the AABMP must provide a strategy for monitoring the ambient air concentrations of PM_{total}, PM_{10}, $PM_{2.5}$ and arsenic at the SGP's ambient air boundary. The AABMP must be developed according to best industry and regulatory practices, consulting contemporary sources (e.g., DEQ or EPA guidance, similarly established plans for other state permits, etc.). At a minimum, monitoring stations must be required for areas of the ambient air boundary in which DEQ ambient air modeling results (specifically results using operating scenario W3 and BULKRN meteorological data) show receptors with 24-hour PM_{10} or arsenic concentrations within 70% of the applicable NAAQS or AACC (without consideration to multi-year emissions averaging and 16/70 adjustment).

Environmental & Economic Impacts of Arsenic Control Technology

G. DEQ must require Perpetua to update their T-RACT analysis to include analysis of "environmental impacts caused by the control technology that cannot be mitigated, including, but not limited to, water pollution and the production of solid wastes," including the use of magnesium chloride and its aquatic life and tree toxicity effects, as well as using arsenic-contaminated water sources for dust suppression. IDAPA 58.01.01.210.14.c.ii. DEQ must also require the updated T-RACT to adequately address the "economic feasibility of a control technology or other requirement, including the costs of necessary mitigation measures, for a particular source," including detailed consideration of the economic feasibility of paving haul roads to better control fugitive dust emissions. IDAPA 58.01.01.210.14.d. DEQ must provide the updated T-RACT demonstration for public comment, must review and revise the T-RACT

demonstration, and must incorporate enforceable PTC conditions from the T-RACT demonstration in the PTC.

CONCLUSION

72. When it issued the PTC for the SGP, DEQ ~~failed to comply with critical requirements of~~violated the federal Clean Air Act, EPA's Clean Air Act regulations, and the Idaho Air Rules; and it acted arbitrarily, capriciously, and on unlawful procedure and abused its discretion under I.C. § 67-5279. Accordingly, the Board should vacate and withdraw the PTC and remanded to DEQ to correct all errors.

Dated: December 6, 2022

Respectfully submitted,

/s/ Bryan Hurlbutt
Bryan Hurlbutt
Attorney for the Nez Perce Tribe and the Idaho Conservation League

/s/ Julia S. Thrower
Julia S. Thrower
Attorney for Save the South Fork Salmon

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC. Intervenor-Respondent.	Case Docket No. 0101-22-01 **PERPETUA RESOURCES IDAHO, INC.'S NOTICE OF NON-OPPOSITION TO MOTION TO FILE FIRST AMENDED PETITION**

Perpetua Resources Idaho, Inc. ("Perpetua"), through its undersigned counsel, hereby provides notice that it does not oppose the Motion to File First Amended Petition filed by Petitioners on December 6, 2022. To expedite proceedings in this matter, Perpetua is filing its Response to the First Amended Petition concurrently with the filing of this Notice.

DATED: December 13, 2022.

STOEL RIVES LLP

/s/ W. Christopher Pooser
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

CERTIFICATE OF SERVICE

I hereby certify that on this December 13, 2022, a true and correct copy of **PERPETUA RESOURCES IDAHO, INC.'S NOTICE OF NON-OPPOSITION TO MOTION TO FILE FIRST AMENDED PETITION** was served on the following:

Dylan B. Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Paula J. Wilson
Hearing Coordinator
Idaho Department of Environmental Quality
1410 N Hilton St
Boise, ID 83706
Paula.Wilson@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

/s/ Wade C. Foster
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC. Intervenor-Respondent.	Case Docket No. 0101-22-01 **PERPETUA RESOURCES IDAHO, INC.'S RESPONSE TO FIRST AMENDED PETITION TO INITIATE CONTESTED CASE: AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 (JUN. 17, 2022)**

Pursuant to IDAPA 58.01.23.161, Perpetua Resources Idaho, Inc. ("Perpetua"), through its undersigned counsel, hereby submits its response to Petitioners' First Amended Petition to Initiate Contested Case: Air Quality Permit to Construct P-2019.0047 (Jun. 17, 2022) ("FAP").

I. GENERAL RESPONSES

The FAP is informally presented in the style of a legal brief, intermingling alleged facts, arguments, opinions, suggestions for permit content, and conclusory statements. Almost every paragraph of the FAP contains multiple assertions of fact, law, and suggestions for how the Department of Environmental Quality ("Department") could have done better. These mixed pleadings make it difficult to separate factual allegations, to which a response is required, from legal assertions, to which no response is required. Therefore, Perpetua denies all allegations contained in the FAP that are not explicitly admitted below.

Petitioners repeatedly reference those portions of the Clean Air Act ("CAA") and 40 C.F.R. Part 51 ("Part 51 Regulations") setting forth the requirements for development and approval of a State Implementation Plan ("SIP"). *See* FAP ¶¶ 32, 70. Idaho's SIP was originally approved in 1972, and amendments thereto have been approved multiple times over the years. *See Safe Air for Everyone v. United States EPA*, 488 F.3d 1088, 1093 (9th Cir. 2007) (describing history of Idaho's SIP).[1] Idaho's SIP is codified in the Department's Rules for the Control of Air Pollution in Idaho, IDAPA 58.01.01 ("Air Rules"). It is unclear whether Petitioners seek to collaterally attack the Air Rules through this proceeding, or if they are attempting to import the requirements of the CAA provisions relating to SIP approval and the Part 51 Regulations as a governing legal standard for review of the Permit to Construct.

Under either scenario, Petitioners reliance on the CAA provisions relating to SIP approval and the Part 51 Regulations is improper. As explained by *NRDC v. S. Coast Air Quality Mgmt. Dist.*, a plaintiff cannot challenge a state agency action, such as issuance of a permit, for

[1] *See also* U.S. EPA, *EPA Approved Regulations in the Idaho SIP* (updated May 31, 2022), https://www.epa.gov/sips-id/epa-approved-regulations-idaho-sip.

failure to comply with the CAA provisions relating to SIP approval or the Part 51 Regulations because those provisions and regulations do not "establish enforceable emissions standards or limitations, but rather identify the types of emissions standards and limitations that must be set forth in a SIP." 694 F. Supp. 2d 1092, 1111 (C.D. Cal. 2010). And to the extent Petitioners seek to collaterally attack the Air Rules for failure to comply with the CAA or the Part 51 Regulations, the Board lacks jurisdiction over their claim. *See Cal. Dump Truck Owners Ass'n v. Nichols*, 784 F.3d 500, 502 (9th Cir. 2015) (the CAA vests federal circuit courts of appeals with exclusive jurisdiction over challenges to a SIP).

II. SPECIFIC RESPONSES

1. Perpetua admits that Petitioners filed a Petition to Initiate Contested Case on July 22, 2022, challenging the Permit to Construct P-2019.0047 ("PTC") issued by the Department on June 17, 2022 to Perpetua for the Stibnite Gold Project ("SGP").

2. Perpetua admits the allegations contained in the first and third sentence of Paragraph 2 of the FAP. Perpetua lacks knowledge or information sufficient to form a belief as to the truth of the allegations contained in the second sentence of Paragraph 2 of the FAP, and therefore denies those allegations.

3. In Paragraph 3 of the FAP, Perpetua admits that the PTC authorizes Perpetua to construct and begin operating the SGP. Perpetua admits that dust will be generated by normal mining activities, which were fully analyzed by the Department in reaching its decision to issue the PTC. Perpetua denies that the amount of dust emitted from operation of the SGP will be a "massive quantity," which is an entirely subjective term and has no legal relevance or meaning. Perpetua admits that the dust generated by operation of the SGP will contain particulate matter and may contain arsenic, both of which are recognized and regulated as air pollutants by the Department.

4. Perpetua denies the allegations contained in Paragraph 4 of the FAP. Perpetua affirmatively states that there are no grounds for the Board of Environmental Quality (the "Board") to reverse or set aside the PTC, nor to remand the PTC to the Department. Perpetua further states that Petitioners are entitled to no relief and respectfully requests that this case be dismissed.

5. Perpetua admits that the individuals listed in Paragraph 5 of the FAP have entered appearances as counsel for Petitioners.

6. Perpetua admits the allegations of Paragraph 6 of the FAP to the extent Petitioners seek to challenge the Department's action under the Air Rules of issuing the PTC. Perpetua denies that the Board has jurisdiction to the extent Petitioners raise claims that the Air Rules are deficient under the CAA or the Part 51 Regulations.

7. Perpetua admits that Idaho Code ("I.C.") § 67-5279 provides the applicable standard of review of this matter. Perpetua affirmatively states that I.C. § 67-5279 speaks for itself. Perpetua denies all allegations contained in Paragraph 7 of the FAP to the extent they are inconsistent with I.C. § 67-5279.

8. Perpetua admits that IDAPA 58.01.23 authorizes Petitioners to initiate a contested case and defines "aggrieved person." Perpetua affirmatively states that IDAPA 58.01.23 speaks for itself. Perpetua denies all allegations contained in Paragraph 8 of the FAP to the extent they are inconsistent with IDAPA 58.01.23.

9. Perpetua admits that the Nez Perce Tribe is a federally recognized Indian tribe. Perpetua lacks knowledge or information sufficient to form a belief as to the truth of the remaining allegations contained in Paragraph 9 of the FAP and, therefore, denies those allegations.

10. Perpetua denies that the Nez Perce Tribe has standing to bring this contested case. Perpetua lacks knowledge or information sufficient to form a belief as to the truth of the remaining allegations contained in Paragraph 10 of the FAP and, therefore, denies those allegations.

11. Perpetua admits that the Nez Perce Tribe entered into a treaty with the United States, which speaks for itself. To the extent the allegations contained in Paragraph 11 of the FAP are inconsistent with the treaty, Perpetua denies those allegations. Perpetua lacks knowledge or information sufficient to form a belief as to the truth of the remaining allegations contained in Paragraph 11 of the FAP and, therefore, denies those allegations.

12. Perpetua denies that issuance of the PTC will result in the emission of "excessive air pollutants," which is an entirely subjective term and has no legal relevance or meaning. Perpetua denies that the Nez Perce Tribe has suffered, or will suffer, a legally cognizable injury caused by the Department's issuance of the PTC. Perpetua admits that air pollution may cause environmental and human health impacts, but denies that the ecosystem surrounding the SGP or members of the Nez Perce Tribe will suffer any of the harms alleged in Paragraph 12 of the FAP.

13. Perpetua admits that the Nez Perce Tribe submitted comments on the draft versions of the PTC. Perpetua denies that the Nez Perce Tribe is entitled to any relief because neither the Nez Perce Tribe nor its members have suffered, or will suffer, a legally cognizable injury due to the Department's issuance of the PTC.

14. Perpetua lacks knowledge or information sufficient to form a belief as to the truth of the allegations contained in Paragraph 14 of the FAP and, therefore, denies those allegations.

15. Perpetua denies the allegations contained in Paragraph 15 of the FAP. Perpetua affirmatively states that neither Idaho Conservation League ("ICL") nor its members have

suffered, or will suffer, a legally cognizable injury caused by the Department's issuance of the PTC and ICL is therefore entitled to no relief.

16. Perpetua admits that ICL submitted comments on the various drafts of the PTC.

17. Perpetua lacks knowledge or information sufficient to form a belief as to the truth of the allegations contained in Paragraph 17 of the FAP, and therefore denies those allegations.

18. Perpetua denies the allegations contained in Paragraph 18 of the FAP. Perpetua affirmatively states that neither Save the South Fork Salmon ("SSFS") nor its members have suffered, or will suffer, a legally cognizable injury caused by the Department's issuance of the PTC and SSFS is, therefore, entitled to no relief.

19. Perpetua admits that SSFS submitted comments on the various drafts of the PTC.

20. Perpetua admits the allegations contained in Paragraph 20 of the FAP.

21. Perpetua admits the allegations contained in Paragraph 21 of the FAP.

22. Perpetua admits the allegations contained in Paragraph 22 of the FAP.

23. Perpetua admits the allegations contained in Paragraph 23 of the FAP.

24. In Paragraph 24, Perpetua admits that the Department developed, and issued for comment, three draft versions of the PTC. Perpetua admits that Petitioners commented on the draft versions of the PTC. Perpetua denies that any draft "contained significant shortcomings," which is a subjective term that has no legal meaning or relevance. Perpetua denies that the "draft PTC was considered deficient."

25. Perpetua admits that the Department issued a revised draft of the PTC for public comment in February 2021. Perpetua denies that the "February 2021 draft was deficient."

26. Perpetua admits that the Department issued a revised draft PTC on January 13, 2021, for which the Petitioners, the U.S. Environmental Protection Agency ("EPA"), and Mr. von

Lindern submitted comments. Perpetua admits that the Department appropriately rejected many of the issues raised by Petitioners' comments because they were either baseless or would not meaningfully improve compliance with the Air Rules.

27. Perpetua admits that construction and operation of the SGP has the potential to cause emissions of arsenic and particular matter ("PM") with diameters less than 10 micrometers ("PM_{10}"). Perpetua admits that the FAP only makes allegations relating to arsenic and PM_{10} and no other air pollutant.

28. Perpetua admits that certain types of PM may cause negative impacts to human health. Perpetua denies that PM emissions from the SGP will cause any of the health effects alleged in Paragraph 28 of the FAP.

29. Perpetua admits that certain types of PM may cause negative environmental impacts. Perpetua denies that PM emissions from the SGP will cause any of the environmental harms alleged in Paragraph 29 of the Petition. Perpetua further states that Petitioners have not alleged that the PM emissions potentially generated from the SGP are of the nature that would cause the environmental impacts alleged in Paragraph 29 of the FAP.

30. Perpetua admits that Sections 108 and 109 of the CAA govern the establishment of National Ambient Air Quality Standards ("NAAQS"). Perpetua affirmatively states that the statute speaks for itself, and denies all allegation contained in Paragraph 30 of the FAP to the extent they are inconsistent with the language of the CAA.

31. Perpetua admits that, consistent with the CAA, EPA has established NAAQS for PM_{10} and $PM_{2.5}$. Perpetua affirmatively states that 40 C.F.R. §§ 50.6 and 50.7 speak for themselves, and denies all allegations contained in Paragraph 31 of the FAP that are inconsistent with those regulations.

32. Perpetua admits that EPA has approved Idaho's SIP, which is codified in the Air Rules. *See Safe Air for Everyone v. United States EPA*, 488 F.3d 1088, 1093 (9th Cir. 2007). Perpetua admits that the Department has authority to issue air quality permits in Idaho. Perpetua denies that those sections of the CAA or the Part 51 Regulations cited in Paragraph 32 of the FAP have any relevance to this proceeding because they govern the creation and approval of SIPs, but do not govern the issuance of permits under an approved SIP. Perpetua affirmatively states that, to the extent Petitioners seek to challenge the Air Rules as failing to comply with the CAA or Part 51 Regulations, the Board lacks jurisdiction. Perpetua admits that IDAPA 58.01.01.203.02 sets forth permit requirements for new and modified stationary sources related to NAAQS. Perpetua admits that IDAPA 58.01.01.006.88 sets forth the definition of "Potential to Emit/Potential Emissions." Perpetua admits that IDAPA 58.01.01.209 sets forth procedures for issuing permits. Perpetua affirmatively states that the cited provisions of IDAPA 58.01.01 speak for themselves, and Perpetua denies all allegations contained in Paragraph 32 of the FAP to the extent they are inconsistent with IDAPA 58.01.01.

33. Perpetua admits the allegations contained in Paragraph 33 of the FAP.

34. Perpetua admits the allegations contained in Paragraph 34 of the FAP.

35. Perpetua denies the allegations contained in Paragraph 35 of the FAP.

36. Perpetua admits that it relied, in-part, on AP-42 Chapter 13.2.2 to model particulate matter emissions from ore hauling operations. Perpetua admits that the Department established an enforceable condition in the PTC for the silt content of the haul roads. Perpetua admits that the average loaded weight of ore haul trucks, the size of trucks used, the number of days of precipitation, and the total number of vehicle miles traveled by ore haul trucks, were not included as specific conditions in the PTC. Perpetua denies that it is necessary for these

additional variables to be limited by permit conditions to ensure compliance with the NAAQS. Perpetua affirmatively states that the variables used to model emissions were the most representative of proposed operations and most realistic for the proposed mining activities. Perpetua denies that it would be possible to set a permit condition limiting the number of days per year with precipitation greater than or equal to 0.01 inches per day. Perpetua affirmatively states that, in addition to the silt content of the haul roads, the Department established permit conditions that establish enforceable limits on multiple operating parameters of the SGP, including daily ore hauling limits, which will ensure compliance with the NAAQS. PTC Conditions 3.3 – 3.13.

37. Perpetua admits that PTC Condition 3.5 establishes enforceable maximum daily hauling limits of 180,000 tons per day, and 135,000 tons per day based on a 5-year rolling average, of ore and development rock. Perpetua admits that the PTC requires Perpetua to develop a Fugitive Dust Control Plan ("FDCP"), which must ensure compliance with the fugitive dust requirements of the PTC (Conditions 2.1 – 2.5). PTC Condition 2.6. Perpetua admits that the PTC requires Perpetua to develop a Haul Road Capping Plan ("HRCP"), consistent with the requirements of Condition 3.13. PTC Condition 3.13. Perpetua admits that it must submit the FDCP and HRCP to the Department for approval at least 30-days prior to startup, and once approved the provisions of those plans will become enforceable permit conditions. PTC Conditions 2.6, 3.13. Perpetua denies that the Department erred by requiring the FDCP and HRCP to be submitted for approval after issuance of the PTC. Perpetua denies that the PTC lacks enforceable permit conditions or lacks assurance that the SGP will comply with the NAAQS.

38. Perpetua admits that the Department analyzed emissions from the SGP using a 93.3% control factor from water sprays and chemical dust suppressants applied to haul roads. Perpetua admits that AP-42 is a reference source for control effectiveness.

39. Perpetua denies that the PTC omits specific and enforceable conditions to ensure a 93.3% control efficiency. Perpetua affirmatively states that the PTC contains multiple conditions for the control of fugitive dust. PTC Conditions 2.1 – 2.6, 2.8. Perpetua denies that the Department erred by not including the variables identified by Petitioners as conditions of the PTC. Perpetua admits that it will develop a FDCP and HRCP and submit those plans to the Department 30 days prior startup for approval. Perpetua affirmatively states that there is no requirement in the Air Rules that the Department provide these Plans for public comment.

40. Perpetua admits that the Air Rules, which speak for themselves, give the Department authority to require Perpetua to submit an Operations and Maintenance Manual ("O&M Manual"). Perpetua further admits that the PTC requires Perpetua to develop and submit an O&M Manual to the Department for approval. Perpetua denies that the Air Rules require the O&M Manual to be submitted for public comment.

41. Perpetua admits that the Department relied on emissions modeling, which assumed 120 days of recordable precipitation at the SGP. Perpetua denies that the *Guidelines for Performing Air Quality Impact Analyses* are binding on the Department. Perpetua denies that the Department erred by using 120 days of recordable precipitation at the SGP for purposes of modeling fugitive PM emissions.

42. Perpetua admits the allegations in Paragraph 42.

43. Perpetua admits the allegations of environmental transport and human health effects of arsenic contained in Paragraph 43 of the FAP.

44. Perpetua admits that the Air Rules, which speak for themselves, give the Department authority to regulate the emission of toxic air pollutants ("TAPs"), including arsenic. To the extent any allegations contained in Paragraph 44 of the FAP are inconsistent with the Air Rules, Perpetua denies those allegations.

45. Perpetua admits that the Air Rules give the Department authority to regulate emissions of TAPs and establish acceptable risk levels of TAPs. Perpetua affirmatively states that the Air Rules speak for themselves. Perpetua denies all allegations contained in Paragraph 45 to the extent they are inconsistent with the Air Rules.

46. Perpetua admits that the Air Rules require the Department to assess impacts of TAPs based on a facility's potential to emit. Perpetua affirmatively states that the Air Rules speak for themselves. Perpetua denies all allegations contained in Paragraph 46 of the FAP to the extent they are inconsistent with the Air Rules.

47. Perpetua admits that construction and operation of the SGP has the potential to cause arsenic emissions. Perpetua admits that the TAPS Addendum estimates arsenic emissions from the various potential sources at the SGP. Perpetua affirmatively states that the TAPS Addendum speaks for itself, and denies all allegations contained in Paragraph 47 of the FAP to the extent they are inconsistent with the TAPS Addendum. Perpetua denies that any portion of arsenic emission estimates relied on by the Department in granting the PTC are "underestimated" or "unreliable."

48. Perpetua admits that it selected T-RACT to control arsenic emissions from the SGP. Perpetua further admits that the Air Rules establish the requirements for T-RACT and give the Department authority to allow a permittee to utilize T-RACT to control emissions of TAPs, like arsenic. Perpetua affirmatively states that the Air Rules speak for themselves and denies all

allegations contained in Paragraph 48 of the FAP to the extent they are inconsistent with the Air Rules. Perpetua denies that the arsenic emissions from the SGP will be "excessive," which is an entirely subjective term and has no legal relevance or meaning.

49. Perpetua admits that the Air Rules set forth various factors for the Department to consider when determining whether a control technology is "reasonably available." Perpetua affirmatively states that the Air Rules speak for themselves and denies all allegations contained in Paragraph 49 of the FAP to the extent they are inconsistent with the Air Rules.

50. Perpetua admits that it submitted a T-RACT demonstration for arsenic to the Department, which included "reasonably available" control technologies, including using dry drilling with dust collectors for open pit drilling and the use of dust suppressant (water and chemical) for ore haul roads. Perpetua denies that its T-RACT analysis was deficient or that Perpetua was required to submit additional information.

51. Perpetua admits that the Department approved Perpetua's T-RACT demonstration and issued the PTC consistent with the Air Rules, which speak for themselves.

52. Perpetua denies the allegations contained in Paragraph 52 of the FAP.

53. Perpetua denies that its T-RACT demonstration submitted to the Department was deficient or that use of the selected reasonably available control technologies would result in adverse environmental impacts. Perpetua denies that additional economic analysis was required to justify its determination that paving was not "reasonably available."

54. Perpetua admits that the analysis of potential arsenic emissions from the SGP are based on the same underlying analysis as potential PM emissions. Perpetua denies that the analysis of potential arsenic emissions, or PM emissions, are "unreliable" or that arsenic emissions could exceed the limits established by the Air Rules.

55. Perpetua admits that it utilized source-specific TAPs emission rates that are representative of a 5-year averaging period in dispersion modeling for the T-RACT Analysis. Statement of Basis, TAPS Addendum Modeling Review Attachment at 2. Perpetua admits that it averaged estimated annual modeling impacts across two multi-year scenarios. Perpetua admits that it refined the life-time exposures to carcinogenic TAPs by multiplying the maximum modeled annual impact by a ratio of 16/70 to account for the life-of-mine emissions. *Id.* Perpetua denies that these were "improper averaging tactics," or contrary to the Air Rules. Perpetua affirmatively states that the Air Rules speak for themselves and denies all allegations contained in Paragraph 55 to the extent they are inconsistent with the Air Rules.

56. Perpetua admits that the Air Rules allow an increase in the cancer risk factor when T-RACT is utilized to control TAPs emissions. Perpetua affirmatively states that the Air Rules speak for themselves and denies all allegations contained in Paragraph 56 of the FAP to the extent they are inconsistent with the Air Rules. Perpetua denies that its TAPs analysis will result in cancer risk levels above those authorized by the Air Rules. Perpetua denies that construction or operation of the SGP will result in "extremely dangerous arsenic exposures," which is a subjective term and has no legal relevance or meaning. Perpetua denies that these were "improper averaging tactics," or are contrary to the Air Rules.

57. Perpetua admits that the Air Rules, which speak for themselves, do not require the Department to consider the emissions from the SGP when making permitting decisions on permit applications for new facilities. Perpetua affirmatively states that this paragraph is legally irrelevant as to whether the Department erred in issuing the PTC.

58. Perpetua admits that the Air Rules, which speak for themselves, require facilities operating under a PTC to meet various air standards. Perpetua admits that the Air Rules,

consistent with 40 C.F.R. § 50.1(e), define "ambient air." Perpetua admits that EPA has issued guidance to assist in determining what portions of a facility should be excluded from "ambient air." Perpetua affirmatively states that EPA's guidance speaks for itself and denies all allegations contained in Paragraph 58 of the FAP to the extent they are inconsistent with the guidance.

59. Perpetua admits that the Air Rules establish the definition of "ambient air" and set forth the factors that must be considered in determining whether an area can be excluded from "ambient air." Perpetua affirmatively states that the Air Rules speak for themselves and denies all allegations contained in Paragraph 59 of the FAP to the extent they are inconsistent with the Air Rules.

60. Perpetua admits that it established an operations boundary, the interior of which is excluded from "ambient air" as described in Perpetua's application and supplemental materials submitted to the Department. To the extent any allegations contained in Paragraph 60 are inconsistent with the application and supplemental materials, Perpetua denies those allegations.

61. Perpetua denies the allegations contained in Paragraph 61 of the FAP.

62. Perpetua denies that it will allow the "general public," as that term is used by the Air Rules, access within the operations boundary. Perpetua denies that it will lack effective legal authority to control access to areas within the operations boundary following the U.S. Forest Service's approval of Perpetua's operations plan.

63. Perpetua admits that the PTC requires it to prepare and submit an Access Management Plan ("AMP") to the Department at least 30 days prior to startup, which must be approved by the Department. Perpetua denies that the application or supplemental materials submitted to the Department contained "an ambiguous description" of the control measures used to preclude the "general public" from accessing the area within the operations boundary.

64. Perpetua admits that PTC Conditions 2.7 and 2.8 require preparation and submission of an AMP to the Department. Perpetua denies that for the AMP to be legally sufficient or ensure that the entire operations boundary be excluded from "ambient air" it must be submitted for public comment.

65. Perpetua denies the allegations contained in Paragraph 65 of the Petition.

66. Perpetua admits that the Air Rules, which speak for themselves, give the Department authority to require ambient air monitoring when issuing a PTC.

67. Perpetua admits that the various entities identified in Paragraph 67 commented on the various draft permits, and that the Department declined to require ambient air monitoring.

68. Perpetua denies the allegations contained in Paragraph 68 of the FAP.

69. Perpetua admits that I.C. § 67-5279 sets forth the applicable standard of review of an agency action and remedies if an agency action is not affirmed. Perpetua affirmatively states that I.C. § 67-5279 speaks for itself, and to the extent any allegations contained in Paragraph 69 of the FAP are inconsistent with I.C. § 67-5279, Perpetua denies those allegations.

70. Perpetua admits that the Air Rules set forth the applicable standard for the Department to consider in issuing a PTC. Perpetua affirmatively states that the Air Rules speak for themselves, and to the extent any allegations contained in Paragraph 70 are inconsistent with the Air Rules, Perpetua denies those allegations. Perpetua denies that the provisions of the CAA relating to SIP approval, or the Part 51 Regulations, provide a governing legal standard for review of the Department's action in issuing the PTC. Perpetua affirmatively states that to the extent the Petitioners seek to collaterally attack the Air Rules in this proceeding, the Board lacks jurisdiction to consider their claims. Perpetua denies that the Department's issuance of the PTC was in violation of the Air Rules, the CAA, EPA's CAA regulations, or is otherwise arbitrary,

capricious, made on unlawful procedure, or an abuse of discretion. Perpetua affirmatively states that there are no grounds for reversal of the Department's issuance of the PTC.

71. Perpetua denies the allegations contained in Paragraph 71, including subsections A through G, of the FAP. Perpetua affirmatively states that Petitioners are entitled to no relief.

72. Perpetua denies the allegations contained in Paragraph 72 of the FAP.

III. RELIEF REQUESTED

Perpetua respectfully requests that the Board affirm the Department's issuance of the PTC and dismiss the FAP with prejudice.

DATED: December 13, 2022.

STOEL RIVES LLP

/s/ W. Christopher Pooser
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

CERTIFICATE OF SERVICE

I hereby certify that on December 13, 2022, a true and correct copy of the **PERPETUA RESOURCES IDAHO, INC.'S RESPONSE TO FIRST AMENDED PETITION TO INITIATE CONTESTED CASE: AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 (JUN. 17, 2022)** was served on the following:

Dylan B. Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Paula J. Wilson
Hearing Coordinator
Idaho Department of Environmental Quality
1410 N Hilton St
Boise, ID 83706
Paula.Wilson@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

/s/ Wade C. Foster
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,	)	Agency Case No. 0101-22-01
Petitioners,	)	NOTICE OF REASSIGNMENT OF PENDING MATTERS
v.	)	
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC., Intervenor.	)	

TO ALL PARTIES AND COUNSEL OF RECORD

Pursuant to Idaho Code §§ 67-5280(2)(a) and 67- 5286(1), this matter is hereby reassigned to the Office of Administrative Hearings (OAH), effective January 1, 2023. The Contested Case Transmittal Sheet is attached.

OAH will assign a hearing officer to handle this matter.

DATED December 19, 2022

By _____
Jess Byrne, Director
Department of Environmental Quality

CERTIFICATE OF SERVICE

I hereby certify that on December 19, 2022, a true and correct copy of the **Notice of Reassignment of Pending Matters** was served on the following:

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Dylan Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Krista McIntyre
W. Christopher Pooser
Wade Foster
Stoel Rives LLP
101 S. Capitol Blvd., Ste. 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Bryan Nickels
Chief Administrative Hearing Officer
Office of Administrative Hearings
816 W. Bannock St., Ste 203
bryan.nickels@oah.idaho.gov
via electronic service

Paula J. Wilson, Hearing Coordinator
Department of Environmental Quality
1410 N. Hilton, Boise, ID 83709
paula.wilson@deq.idaho.gov
(208)373-0418

CONTESTED CASE TRANSMITTAL SHEET
State of Idaho – Office of Administrative Hearings

TO: OFFICE OF ADMINISTRATIVE HEARINGS (email: bryan.nickels@oah.idaho.gov)

DATE	December 13, 2022
FROM (Referring Agency/Board)	Board of Environmental Quality
AGENCY CASE/ PROCEEDING NO.	0101-22-01

PARTY/LICENSEE

NAME	Petitioners Nez Perce Tribe, Idaho Conservation League (ICL), Save the South Fork Salmon
ADDRESS	N/A Petitioners' addresses, emails, and phone numbers were not included in petition
EMAIL	N/A
PHONE	N/A

PARTY/LICENSEE ATTORNEY (if any)

NAME	Attorneys for Petitioners Nez Perce Tribe and ICL Bryan Hurlbutt Laird Lucas	Attorney for Petitioner Save the South Fork Salmon Julia Thrower
ADDRESS	Advocates for the West P.O. Box 1612 Boise, ID 83701	Mountain Top Law PLLC 614 Thompson Ave. McCall, ID 83638
EMAIL	bhurlbutt@advocateswest.org llucas@advocateswest.org	jthrower@mtntoplaw.com
PHONE	(208)342-7024	(208)271-6503

NON-PETITIONER LICENSEE/PERMITTEE (potential intervenor)

NAME	Intervenor Perpetua Resources Idaho, Inc. (Order Approving Petition to Intervene issued 8/22/22)
ADDRESS	N/A Intervenor's address, email, and phone number was not included in petition
EMAIL	N/A
PHONE	N/A

NON-PETITIONER LICENSEE/PERMITTEE ATTORNEY (potential intervenor)

NAME	Attorneys for Intervenor Perpetua Resources Idaho, Inc. Krista McIntyre W. Christopher Pooser Wade Foster	
ADDRESS	Stoel Rives LLP 101 S. Capitol Blvd., Ste. 1900 Boise, ID 83702	
EMAIL	krista.mcintyre@stoel.com christopher.pooser@stoel.com wade.foster@stoel.com	
PHONE	(208)389-9000	

AGENCY/BOARD ATTORNEY

NAME	John Shackelford
ADDRESS	Idaho Attorney General's Office 1410 N. Hilton Boise, ID 83706
EMAIL	john.shackelford@deq.idaho.gov
PHONE	(208)373-0494

SHORT STATEMENT OF THE NATURE OF THE CASE (e.g., "Suspension of license based on following grounds . . .") AND GOVERNING STATUTES

Short statement of the nature of the case
Petitioners are seeking Board review of Air Quality Permit to Construct P-2019.0047 issued by the Department of Environmental Quality on June 17, 2022, to Perpetua Resources Idaho, Inc. for its proposed Stibnite Gold Project.
Governing statutes and administrative rules
The Board of Environmental Quality has legal authority to hear this matter pursuant to the Environmental Protection and Health Act, Chapter 1, Title 39, Idaho Code. This proceeding is governed by the Administrative Procedure Act, Chapter 52, Title 67, Idaho Code; IDAPA 04.11.01, Idaho Rules of Administrative Procedure of the Attorney General; IDAPA 58.01.23, Contested Case Rules and Rules for Protection and Disclosure of Records; and IDAPA 58.01.01, Rules for the Control of Air Pollution in Idaho.

ARE THERE SPECIFIC STATUTORY/REGULATORY RULES ON THE TIME FOR HEARING OR DECISION?
YES: **NO:** X
[OAH typically sets hearings based on parties' availability and agreement with written decision no later than the end of the month following the month the hearing was held]
If yes:

Deadline for hearing		
Deadline for decision		
Statute(s)/Rule(s) citation		

HAS ANY PARTY TO THE CONTESTED CASE PROCEEDING REQUESTED INTERIM, EXPEDITED, OR EMERGENCY RELIEF?
YES: **NO: X**

If yes, briefly explain	

DO ANY HEARING PROCEDURAL RULES, OTHER THAN THE IDAHO RULES OF ADMINISTRATIVE PROCEDURE OF THE ATTORNEY GENERAL, APPLY TO THIS PROCEEDING?
YES: X **NO:**

If yes, statute(s)/rule(s) citation	IDAPA 58.01.23, Contested Case Rules and Rules for Protection and Disclosure of Records IDAPA 58.01.01, Rules for the Control of Air Pollution in Idaho

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS

STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047,	)	Agency Case No. 010-22-01
	)	OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE and SAVE THE SOUTH FORK SALMON,	)	**NOTICE OF APPOINTMENT OF HEARING OFFICER**
Petitioners,	)	
v.	)	
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC.,	)	
Intervenor.	)	

TO ALL PARTIES AND COUNSEL OF RECORD:

The Chief Administrative Hearing Officer of the Office of Administrative Hearings, pursuant to his authority under Idaho Code § 67-5282(1)(d), hereby appoints as the duly authorized Hearing Officer in this matter the following individual:

Dylan B. Lawrence
Varin Thomas, LLC
242 N. 8th St., Suite 220
Boise, ID 83702
(208) 345-6021
DYLAN@VARINTHOMAS.COM

The Hearing Officer is appointed to conduct a hearing in this matter in accord with all governing statutes and rules, and make appropriate findings of fact, conclusions of law, and

recommended orders to the Director of Idaho Department of Environmental Quality. The Hearing Officer is required to comply with the Office of Administrative Hearing's Code of Conduct.

AUTHORITY OF HEARING OFFICER

The Hearing Officer has the authority to:

1. Schedule and conduct motion hearings and enter the appropriate orders disposing of all pre-hearing motions, such as motions for notices of proposed default orders, motions on the admissibility of evidence, and motions for continuances.

2. Schedule and conduct any pre-hearing conference and enter the appropriate orders for any purpose recognized by IDAPA 04.11.01.510.

3. Perform other duties assigned by the Board and as authorized by the Idaho Administrative Procedure Act, promulgated at Idaho Code §§ 67-5201 *et seq.*, and the Idaho Rules of Administrative Procedure of the Attorney General, promulgated at IDAPA 04.11.01 *et seq*. The hearing officer may not engage in *ex parte* communications concerning the substance of this matter, except as provided in Idaho Code § 67-5253 and IDAPA 04.11.01.424.

FILING OF DOCUMENTS

All **original** documents must be filed directly with the Office of Administrative Hearings at the following address:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104

Additionally, all documents filed in this matter must also be served upon or mailed to the Hearing Officer at the address listed above, **as well as** OAH at the following email:

filings@oah.idaho.gov

REQUIRED SERVICE OF DOCUMENTS ON OTHER PARTIES

Any document filed by either party in this matter must be served on the other party (or the other party's attorney, if represented). The contact information for each party is as follows:

Petitioners

Nez Perce Tribe, Idaho Conservation League (ICL), Save the South Fork Salmon

Bryan Hurlbutt
Laird Lucas
Advocates for the West, Inc.
P.O. Box 1612
Boise, ID 83701
(208) 342-7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Petitioners Nez Perce Tribe and ICL

Save the South Fork Salmon

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
(208) 271-6503
jthrower@mtntoplaw.com

Attorney for Petitioner Save the South Fork Salmon

Intervenor

Perpetua Resources Idaho, Inc.

Krista McIntyre
W. Christopher Pooser
Wade Foster
Stoel Rives, LLP
101 S. Capital Blvd., Suite 1900
Boise, ID 83702
(208) 389-9000
krista.mcintyre@stoel.com

Respondent

Idaho Department of Environmental Quality

John Shackelford
Office of the Attorney General
1410 N. Hilton, 2nd Floor
Boise, ID 83706
(208) 373-0453
john.shackelford@deq.idaho.gov

Attorney for the Idaho Department of Environmental Quality

christopher.pooser@stoel.com
wade.foster@stoel.com

Attorneys for Intervenor Perpetua Resources Idaho Inc.

DATED this 3rd day of January, 2023.

OFFICE OF ADMINISTRATIVE HEARINGS

/s/ Bryan A. Nickels
Bryan A. Nickels
Chief Administrative Hearing Officer

CERTIFICATE OF SERVICE

I hereby certify that on this 3rd day of January, 2023, I caused to be served a true and correct copy of the foregoing by the following method to:

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
(208) 342-7024
Attorneys for Petitioners Nez Perce Tribe and ICL

☐ U.S. Mail
☒ Email: bhurlbutt@advocateswest.org
llucas@advocateswest.org

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
(208) 271-6503
Attorney for Petitioner Save the South Fork Salmon

☐ U.S. Mail
☒ Email: jthrower@mtntoplaw.com

John Shackelford
Idaho Attorney General's Office
1410 N. Hilton
Boise, ID 83706
(208) 373-0494
Attorney for Respondent Idaho Department of Environmental Quality

☐ U.S. Mail
☒ Email: john.shackelford@deq.idaho.gov

Krista McIntyre
W. Christopher Pooser
Wade Foster
Stoel Rives, LLP
101 S. Capital Blvd., Suite 1099
Boise, ID 83702
(208) 389-9000
Attorneys for Intervenor Perpetua Resources Idaho Inc.

☐ U.S. Mail
☒ Email: krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com

Dylan B. Lawrence
Varin Thomas
242 N. 8th St., Suite 220
Boise, ID 83701
Hearing Officer

☐ U.S. Mail
☒ Email: Dylan@VarinThomas.com

OAH
P.O. Box 83720
Boise, ID 83720-0104
Located at: 816 W. Bannock St., Suite 203
Boise, ID 83702
(208) 605-4300

☒ Email: filings@oah.idaho.gov

/s/ *Bryan A. Nickels*
Bryan A. Nickels
Office of Administrative Hearings

DYLAN LAWRENCE
VARIN THOMAS LLC
P.O. Box 1676
Boise, ID 83701
(208)345-6021
dylan@varinthomas.com

BEFORE THE BOARD OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	Agency Case No. 0101-22-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	OAH Case No. 23-245-01 ORDER GRANTING MOTION TO FILE FIRST AMENDED PETITION

On December 6, 2022, the Petitioners in this matter filed a Motion to File First Amended Petition, along with a proposed amended petition identifying proposed changes to their original petition filed July 22, 2022. On December 13, 2022, Intervenor Perpetua Resources Idaho, Inc. (Perpetua) filed its Notice of Non-Opposition to the Motion, along with its responsive pleading. Respondent Idaho Department of Environmental Quality (DEQ) has not formally responded to the Motion.

BEQ Procedural Rule 003.05 and AG Procedural Rule 305 provide that, "[t]he presiding officer may allow any pleading to be amended or corrected or any omission to be supplied." They also state that, "[p]leadings will be liberally construed, and defects that do not affect substantial

rights of the parties will be disregarded."

Neither DEQ nor Perpetua opposes the Motion. The hearing officer has reviewed the proposed amended petition and sees no reason it should not be granted. Therefore:

The Petitioners' Motion to File First Amended Petition is hereby granted;

The Petitioners shall file a formal version of the amended petition accompanying their Motion with changes accepted within seven days of service of this order; and

Respondent DEQ shall file a formal responsive pleading to the First Amended Petition within seven days of service of Petitioners' First Amended Petition.

Dated this 6th day of January, 2023.

Dylan Lawrence
Hearing Officer

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	Agency Case No. 0101-22-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	)	OAH Case No. 23-245-01 CERTIFICATE OF SERVICE

I hereby certify that on January 6, 2023, a true and correct copy of the **Order Granting Motion to File First Amended Petition** was served on the following:

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Dylan Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Krista McIntyre
W. Christopher Pooser
Wade Foster
Stoel Rives LLP
101 S. Capitol Blvd., Ste. 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

Paula J. Wilson
DEQ Hearing Coordinator

CERTIFICATE OF SERVICE

DYLAN LAWRENCE
VARIN THOMAS LLC
P.O. Box 1676
Boise, ID 83701
(208)345-6021
dylan@varinthomas.com

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	BEQ Case No. 0101-22-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v.	)	OAH Case No. 23-245-01 NOTICE OF STATUS CONFERENCE
DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC., Intervenor.	)	

On December 19, 2022, the Director of the Environmental Quality, on behalf of BEQ, issued a notice reassigning this matter to OAH. At the time of that notice, the following were recently completed or currently pending items:

1. On November 15, 2022, the hearing officer issued a decision on the motion to dismiss filed by Perpetua Resources;
2. At the November 28, 2022 status conference, Petitioners expressed an intent to file a motion to amend its petition;
3. At the same status conference, Perpetua Resources reported substantial progress on a

stipulated scheduling order that could potentially be finalized after the disposition of any motions to amend pleadings;

4. At the same status conference, the parties and hearing officer discussed a potential approach to establishing an administrative record for this matter; and
5. On December 6, 2022, the Petitioners filed a motion to amend their petition in this matter.

On January 3, 2023, OAH issued a notice re-appointing the hearing officer in this matter. On January 6, 2023, the hearing officer issued an order granting the Petitioners' motion to amend their petition in this matter. Now that the transition of this matter from BEQ to OAH is complete and the scope of the claims in the Petition have been finalized, it is appropriate for the parties and hearing officer to hold a status conference to discuss the items enumerated above that are still pending or undecided.

Therefore, based on the foregoing, NOTICE IS HEREBY GIVEN that the hearing officer and parties will hold a follow-up status conference on Thursday, January 12, 2023, at 10:00 a.m. mountain time, via Zoom. The hearing officer has sent an electronic calendar appointment to the participants, a hard copy of which is attached hereto.

Dated this 10th day of January, 2023.

Dylan Lawrence
Hearing Officer



Perpetua air permit status conference

Created by: Dylan Lawrence · Your response: ✔Yes, I'm going

Time
10am - 11am (Mountain Time - Boise)

Date
Thu Jan 12, 2023

Where
https://us04web.zoom.us/j/77501224946?pwd=6NS4XO8ilyw0yuOdzfHxiZ2K9DDpib.1

Description

Dylan Lawrence is inviting you to a scheduled Zoom meeting.

Join Zoom Meeting
https://us04web.zoom.us/j/77501224946?pwd=6NS4XO8ilyw0yuOdzfHxiZ2K9DDpib.1

Meeting ID: 775 0122 4946
Passcode: 9E77TJ

Guests

- ✔ Dylan Lawrence
- ⊘ llucas@advocateswest.org
  Automatically declined due to event conflict.
- bhurlbutt@advocateswest.org
- christopher.pooser@stoel.com
- john.shackelford@deq.idaho.gov
- jthrower@mtntoplaw.com
- krista.mcintyre@stoel.com
- leslie.hayes@oah.idaho.gov
- wade.foster@stoel.com

My Notes

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	BEQ Case No. 0101-22-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	)	OAH Case No. 23-245-01
	)	CERTIFICATE OF SERVICE

I hereby certify that on January 10, 2023, a true and correct copy of the **Notice of Status Conference** was served on the following:

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Dylan Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Krista McIntyre
W. Christopher Pooser
Wade Foster
Stoel Rives LLP
101 S. Capitol Blvd., Ste. 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

Paula J. Wilson
DEQ Hearing Coordinator

CERTIFICATE OF SERVICE

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	
	Agency Case No. 0101-22-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC. Intervenor.	OAH Case No. 23-245-01 **FIRST AMENDED PETITION TO INITIATE CONTESTED CASE: AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 (JUN. 17, 2022)***

* As directed in the Order Granting Motion to File First Amended Petition First Amended Petition (Jan. 6, 2023), Petitioners file this formal version of the First Amended Petition.

INTRODUCTION

1. Petitioners Nez Perce Tribe, Idaho Conservation League ("ICL"), and Save the South Fork Salmon ("SSFS"), by and through their attorneys of record, file this Petition to Initiate Contested Case ("Petition") before the Idaho Board of Environmental Quality ("Board") pursuant to Idaho Code § 39-107(5) and IDAPA 58.01.23. This Petition challenges the Air Quality Permit to Construct P-2019.0047 ("PTC") issued by the Idaho Department of Environmental Quality ("DEQ") on June 17, 2022, to mining company Perpetua Resources Idaho, Inc. ("Perpetua") for its proposed Stibnite Gold Project ("SGP").

2. The SGP is in the headwaters of the East Fork of the South Fork of the Salmon River approximately ten miles east of the town of Yellow Pine, Idaho. The SGP is geographically located within the Nez Perce Tribe's aboriginal homeland and within the area over which the Nez Perce Tribe has Treaty-reserved rights and resources. As proposed, Perpetua would use conventional mining techniques to extract ore from three open pits, process gold, and dispose of mine waste at the SGP site.

3. The PTC being challenged here authorizes emissions of air pollutants from the SGP that will occur over the mine's anticipated 16-year life span. These emissions include massive quantities of dust generated by mining, hauling, and processing. The dust includes particulate matter and arsenic—pollutants which can cause serious harm to human health and the environment.

4. When it issued the PTC, DEQ failed to comply with the federal Clean Air Act and with Idaho rules, regulations, and guidance for Clean Air Act permitting, and DEQ acted arbitrarily and capriciously, acted on unlawful procedure, and abused its discretion, under the Idaho Administrative Procedure Act, Idaho Code § 67-5279, in multiple ways set forth below.

Petitioners respectfully request that the Board reverse and set aside the PTC and remand to DEQ to correct these errors.

LISTING OF REPRESENTATIVES

5. Copies of all pleadings, correspondence, and official documents shall be served on the Petitioners' counsel listed below:

For the Nez Perce Tribe and the Idaho Conservation League:

Bryan Hurlbutt
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org

For Save the South Fork Salmon:

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com

JURISDICTION, STANDARD OF REVIEW, PARTIES, AND STANDING

6. Pursuant to Idaho Code § 39-107(5), IDAPA 58.01.23, and IDAPA 58.01.01 (the "Idaho Air Rules"), the Board has jurisdiction over this contested case challenging DEQ's action issuing PTC P-2019.0047 for the SGP on June 17, 2022. The original Petition was timely filed on July 22, 2022, within thirty-five (35) days of the date of DEQ's June 17, 2022 decision. *See* IDAPA 58.01.23.060. This Amended Petition is proper under IDAPA 58.01.23.003.01, IDAPA 04.11.01.305, and Idaho Rule of Civil Procedure 15(a)(2).

7. An agency action, such as DEQ's issuance of the PTC being challenged here, may be reversed if it is in violation of constitutional or statutory provisions, is in excess of statutory authority, is made on unlawful procedure, or is arbitrary, capricious, or an abuse of discretion.

Idaho Code ("I.C.") § 67-5279. When an agency action is not affirmed, it shall be set aside, in whole or in part, and remanded for further proceedings as necessary. *Id.*

8. Pursuant to IDAPA 58.01.23.002.02: "Any person aggrieved by an action or inaction of the Department may file a petition to initiate a contested case pursuant to Chapter 52, Title 67, Idaho Code." An aggrieved person is defined as "any person or entity with legal standing to challenge an action or inaction of the Department, including but not limited to permit holders and applicants for permits challenging Department permitting actions." IDAPA 58.01.23.005.01.

9. PETITIONER NEZ PERCE TRIBE is a federally-recognized Indian tribe with headquarters on the Nez Perce Reservation in Lapwai, Idaho; and with offices in Orofino, McCall, and Powell, Idaho, and Joseph, Oregon.

10. The Nez Perce Tribe has standing to bring this contested case. The Nez Perce people, the *Nimiipuu*, exclusively occupied, since time immemorial, over thirteen million acres encompassing a large part of what is today Idaho, Oregon, and Washington—stretching from the Bitterroot Mountains to the Blue Mountains. Nez Perce also traveled far beyond this homeland to fish, hunt, gather, and pasture—frequently going east to buffalo country, in what is today the state of Montana, and west along the Snake and Columbia rivers to the Pacific Ocean. The Nez Perce actively maintain their connection to the land, water, and resources of their vast homeland. The Nez Perce's intimate knowledge and continuous use of their homeland over millennia have created a unique and reverential bond between people and place that defines Nez Perce culture and identity.

11. When the Nez Perce Tribe entered into a treaty with the United States in 1855, it sought to reserve the rights central to maintaining its culture and way of life. The 1855 Treaty

reserved to the Tribe, for its "exclusive use and benefit," 7.5 million acres of its more than thirteen-million- acre homeland, including an area spanning present-day north-central Idaho, southeast Washington, and northeast Oregon as well as:

> [T]he right of taking fish at all usual and accustomed places in common with citizens of the Territory; and of erecting temporary buildings for curing, together with the privilege of hunting, gathering roots and berries, and pasturing their horses and cattle upon open and unclaimed land.

Treaty with the Nez Perces, art. 3, June 11, 1855, 12 Stat. 957. Nez Perce Tribal members, pursuant to the Nez Perce Tribe's Treaty-reserved rights, continue to fish, hunt, gather, and pasture across the Nez Perce Tribe's vast aboriginal homeland and at traditional places, including areas within and surrounding the SGP. The Nez Perce Tribe, as a co-manager of its treaty-reserved resources, also plays a leading role in the restoration of the East Fork South Fork Salmon River and South Fork Salmon River fisheries, expending approximately $2.5 million annually to restore Chinook salmon runs in both rivers through hatchery supplementation, fishery research, and watershed restoration.

12. The Nez Perce Tribe will suffer physical, cultural, spiritual, and economic injury caused by excessive air pollutants resulting from DEQ's issuance of the PTC. Clean, clear air is a critical component to ensuring the health and resiliency of the Nez Perce Tribe's Treaty-reserved rights and resources. Air pollution reduces visibility, which impairs cultural and ceremonial practices for Tribal members and reduces enjoyment of these special places. Air pollution causes a host of environmental and human health problems, including damage to culturally important plants, sensitive forests, and fish habitat, acidification of lakes and streams, depletion of soil nutrients, aggravated asthma, heart attacks, and premature death. Impacts can be especially harmful to at-risk ecosystems and especially harmful for sensitive human populations such as asthmatics, children, the elderly, people with diabetes, and people with heart or lung disease.

13. To safeguard its rights and interests, the Nez Perce Tribe has participated extensively in DEQ's review process, including submitting comments on October 12 and November 10, 2020, March 8, 2021, and March 14, 2022. A favorable decision in the Contested Case will redress these injuries suffered by the Tribe.

14. PETITIONER IDAHO CONSERVATION LEAGUE is an Idaho non-profit conservation organization. Its main office is located in Boise, Idaho, and it has three field offices in Sandpoint, Ketchum, and McCall. ICL represents approximately 50,000 supporters dedicated to protecting and conserving Idaho's clean water, air, public lands, and wildlife.

15. ICL has standing to bring this contested case. ICL supporters, staff, and board members ("ICL members") regularly visit the SGP and/or nearby areas where air quality would be affected by the SGP for professional, recreational, aesthetic, and other purposes. ICL members will suffer health, environmental, and aesthetic injuries from the particulate matter and arsenic air pollution emitted by the SGP and authorized by DEQ's issuance of the PTC. A favorable decision in the Contested Case will redress ICL's injuries. Neither the claim asserted, nor the relief requested, requires participation of these individual ICL members in the lawsuit. The interests ICL seeks to protect are germane to the organization's purpose in protecting Idaho's clean water, clean air, wildlife, and public lands.

16. In furtherance of its mission, ICL participated extensively in the public processes for the PTC, including by submitting formal public comments to DEQ on October 12 and November 11, 2020, March 19, 2021, and March 16, 2022.

17. PETITIONER SAVE THE SOUTH FORK SALMON is a community-based, non-profit conservation organization headquartered in McCall, Idaho. SSFS represents members and supporters dedicated to preserving the South Fork Salmon River watershed and ecosystem.

18. SSFS has standing to bring this contested case. SSFS members, supporters, and members of the Board of Directors ("SSFS members") regularly visit the South Fork Salmon River watershed and the SGP site, where the emission of excessive air pollutants due to DEQ's issuance of the PTC would impact professional, economic, recreational, aesthetic, environmental, and human health interests. SSFS members would suffer injury from DEQ's issuance of the PTC from environmental, health, and aesthetic harms caused by the emission of harmful air pollutants, including particulate matter and arsenic. A favorable decision in the Contested Case will redress these injuries suffered by SSFS members. Neither the claims asserted, nor the relief requested, requires participation of these individual supporters in the lawsuit. The interests SSFS seeks to protect are germane to the organization's mission of protecting and preserving the South Fork Salmon River watershed and ecosystem, and protecting public health, the river, the fish, and recreational opportunities in the area.

19. In furtherance of this mission, SSFS participated extensively in the public process for the PTC, including submitting formal public comments to DEQ on October 12 and November 11, 2020, March 19, 2021, and March 16, 2022.

20. RESPONDENT IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY is an executive department and administrative agency organized under the laws of the State of Idaho, pursuant to the Idaho Constitution (Article IV, Section 20) and Idaho Code section 39-104(1). Its principal offices are located at 1410 N. Hilton, Boise, Idaho 83706. DEQ, through its Director, and subject to Board oversight, is responsible for issuing air quality PTCs under the Idaho Air Rules, IDAPA 58.01.01.

21. On June 17, 2022, DEQ issued PTC P-2019.0047, which is the subject of this contested case. On July 22, 2022, Petitioners timely filed the original Petition to Initiate

Contested Case. On July 28, 2022, the Hearing Officer Dylan Lawrence was assigned to preside over this matter. On August 12, 2022, Perpetua filed a Petition to Intervene. On August 22, 2022, Perpetua's Petition to Intervene was granted. On September 6, 2022, Perpetua filed a Motion to Dismiss. On November 15, 2022, the Hearing Officer issued the Order on Motion to Dismiss, denying the motion with respect to the majority of Petitioners' claims, dismissing or partially dismissing four claims, and declining to allow the pleadings to be amended unless Petitioners file for consideration a formal motion to amend the Petition.

FACTUAL SUPPORT FOR PETITION

I. OVERVIEW OF SGP & CHRONOLOGY OF DEQ'S ISSUING THE PTC

22. Perpetua is currently in the process of seeking multiple permits and other approvals from multiple agencies and other authorities for the proposed SGP. As described by DEQ in the Statement of Basis ("SOB") document prepared with the PTC:

> Perpetua proposes to construct and operate the SGP, consisting of conventional open-pit mining, ore preparation, and gold extraction operations. The SGP is to be located in Valley County at the intersection Forest Service roads NF-374 and NF-412 (Stibnite Road), approximately 10 miles east of Yellow Pine. The project will be located on a combination of public national forest and private lands. The mining operations boundary within which public access will be excluded is defined in Figure 1. This operations boundary also defines the ambient air boundary that was used in all ambient air quality impact analyses as part of the development process of the PTC.
>
> The SGP will require the construction of significant infrastructure, including a power transmission line, a primary mine site access road, onsite haul roads, an ore processing facility, onsite workspaces, employee housing and recreation, water storage and distribution facilities, and sewage disposal facilities.
>
> Conventional open-pit mining methods including drilling, blasting, excavating, and hauling will be used to extract ore and waste rock, termed development rock (DR). Hydraulic shovels and front-end loaders will be used to load ore and DR into haul trucks. DR will be used for construction, restoration, and backfilling, or hauled to the dedicated development rock storage facilities (DRSF). Approximately 340 million tons of DR will be handled over the life of the mine.

> The SGP will include three years of pre-mining development and construction activities, followed by an operating mine life of approximately 12 years. Mining will occur in three open pits: Yellow Pine Pit (YPP), Hangar Flats pit (HFP), and West End pit (WEP). Although there will be overlap in mine development, construction and operations, the general sequence of mining will be the YPP deposit, followed by the HFP and WEP deposits. Legacy tailings from the Meadow Creek valley (Bradley Tailings [BT]) will also be reclaimed and reprocessed during the initial project schedule. Surface exploration drilling will occur within the pits and within the Scout Prospect decline (underground exploration) throughout the mine operation period. Restoration and reclamation of other legacy mining features will occur prior to mining, throughout the life of the mine, and as part of the mine closure.
>
> Ore will be hauled to the primary crusher area, where it will be fed directly into the crusher dump pocket or stockpiled. The ore crushing plant will be designed to operate at a maximum rate of 25,000 tons per calendar day (T/day). Approximately 100 million tons of ore will be mined from the three pits over the life of the project. The metal-recovery process from ore will include conventional crushing and grinding, followed by froth-flotation circuits that will generate separate gold-silver and antimony-silver concentrates. The antimony-silver concentrate will be shipped offsite for refining, whereas additional onsite processing of the gold-silver concentrate will include pressure oxidation, carbon-in-leach circuits, and refining processes to recover gold and minor amounts of silver. The finely ground leftover ore material from the mineral recovery process, termed tailings, will be neutralized, thickened, and transported via a pipeline to the tailings storage facility. A diagram of ore processing and ore concentration and refining process flows is provided in Figure 2.

23. Perpetua (previously Midas Gold) submitted a PTC application for the SGP to DEQ on August 20, 2019. As shown in the "Application Chronology" section of the SOB, between that date and March 6, 2020, DEQ determined that the application was incomplete, requested additional information, and received supplementary materials from Perpetua no fewer than four times. On May 15, 2020, DEQ deemed Perpetua's application complete.

24. Between May 15, 2020, and March 16, 2022, DEQ developed three versions of the draft PTC and released them for public comment. As noted in comments submitted by the Nez Perce Tribe, ICL, and SSFS, the first two draft versions of the PTC (herein referred to the September 2020 and February 2021 draft PTCs) contained significant shortcomings. As a result, the September 2020 draft PTC was considered deficient and required updated information from

Perpetua, including updated hazardous air pollutants ("HAP") and toxic air pollutants ("TAP") emissions estimates, a HAP/TAP addendum to the application, updated TAP modeling analyses, supporting references, and updated modeling files with corrections for formaldehyde and sulfuric acid.

25. DEQ subsequently updated the draft PTC and in February 2021, provided a revised draft PTC for public comment. Following additional comments, DEQ again determined that the February 2021 draft PTC was deficient and required additional information from Perpetua, including Prevention of Significant Deterioration emissions estimates and regulatory applicability for the lime manufacturing plant, as well as an updated TAP/HAP addendum including an updated emission inventory and modeling files.

26. DEQ revised theFebruary 2021 draft PTC and released it for public comment on January 13, 2022. Comments were submitted by the Nez Perce Tribe, ICL, SSFS, the U.S. Environmental Protection Agency ("EPA") Region 10, and Ian von Lindern of Terragraphics International Foundation. Commenters raised numerous concerns with the draft PTC and urged DEQ to gather additional information, to perform additional modeling and analysis, and to develop additional enforceable permit conditions and limits prior to issuing a final PTC. On June 17, 2022, DEQ issued the final PTC, along with responses to comments and the SOB. While DEQ made limited updates to the PTC, it rejected most of the issues raised by the commenters.

II. PM_{10} & ARSENIC EMISSIONS FROM THE SGP

27. While the SGP will emit numerous air pollutants, PM_{10} and arsenic are the air pollutants of greatest concern and are the pollutants at issue in this contested case.

A. PM_{10} Pollution and Regulation

28. Particulate matter ("PM") contains microscopic solids or liquid droplets that are so small that they can be inhaled and cause serious health problems. Some particles less than 10 micrometers in diameter can get deep into a person's lungs, and some may even get into the person's bloodstream. Numerous scientific studies have linked particle pollution exposure to a variety of problems, including premature death in people with heart or lung disease; nonfatal heart attacks; irregular heartbeat; aggravated asthma; decreased lung function; and increased respiratory symptoms, such as irritation of the airways, coughing or difficulty breathing. People with heart or lung diseases, children, and older adults are the most likely to be affected by particle pollution exposure.

29. In addition to causing human health problems, PM causes environmental damage. Particles can be carried over long distances by wind and then settle on ground or water. Depending on their chemical composition, the effects of settling may include making lakes and streams acidic; changing the nutrient balance in river basins; depleting nutrients in soil; damaging sensitive forests and crops; affecting diversity of ecosystems; and contributing to acid rain.

30. Under Sections 108 and 109 of the federal Clean Air Act, EPA is required to establish National Ambient Air Quality Standards ("NAAQS") for each "criteria air pollutant" to protect the nation's public health and welfare. "[E]ffects on welfare include[ ], but [are] not limited to, effects on soils, water, crops, vegetation, manmade materials, animals, wildlife, weather, visibility, and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being, whether caused by transformation, conversion, or combination with other air pollutants." 42 U.S.C. § 7602(h).

31. PM is a criteria air pollutant. EPA has established primary and secondary NAAQS for coarse particulate matter, or "PM_{10}," 40 C.F.R. § 50.6, and for fine particulate matter, or "$PM_{2.5}$," *id.* at § 50.7. PM_{10} consists of inhalable particles with diameters that are generally ten micrometers and smaller. 42. U.S.C. § 7602(t). $PM_{2.5}$ consists of inhalable particles that are 2.5 micrometers and smaller. The NAAQS specify a maximum amount of PM to be present in the outdoor air. *See* 40 C.F.R. §§ 50.6, 50.7.

32. EPA has delegated to DEQ authority to issue air quality permits in Idaho. Under the Clean Air Act, State air rules like DEQ's "shall" include "enforceable emission limitations" and other control measures, means, or techniques as necessary or appropriate to meet Clean Air Act requirements. 42 U.S.C. § 7410(a)(2)(A). State plans "shall" include a "program to provide for the enforcement" of the limitations and measures described in subparagraph (A), and for the "regulation of the modification and construction of any stationary source . . . to assure that [NAAQS] are achieved." *Id.* § 7410(a)(2)(C). EPA's Clean Air Act regulations require each State plan to "set forth legally enforceable procedures" that enable the State to determine whether the construction of a facility will result in a violation of its air pollution control strategies or interfere with attaining or maintaining the NAAQS. 40 C.F.R. § 51.160(a). These legally enforceable procedures: must include means by which the State will prevent construction if the facility will violate air pollution control strategies or will interfere with attaining or maintaining the NAAQS; and must provide for the applicant to submit information on the "location, design, construction, and operation of such facility . . . as may be necessary" to permit the state to "to make the determination" that the facility will comply with its air pollution control strategies and the NAAQS. *Id.* § 51.160(b)–(c). "The legally enforceable procedures in § 51.160(b) must also require" the State to provide opportunity for public comment on information

submitted by the applicant and on the State's analysis of the effects on ambient air quality. *Id.* § 51.161(a). Under the Rules for the Control of Air Pollution in Idaho, DEQ is required to ensure that no PTC shall be granted for a new or modified stationary source unless the applicant shows to the satisfaction of DEQ that the source would not cause or significantly contribute to a violation of any NAAQS. IDAPA 58.01.01.203.02. To satisfy these requirements, DEQ must assess air impacts using maximum potential emissions as limited by either the capacity of the unit/operation or as limited by enforceable permit provisions. *See* IDAPA 58.01.01.006.88. Prior to issuing a permit to contruct, DEQ must provide an opportunity for public comment by making available DEQ's proposed action together with information provided by the applicant and with DEQ's analysis of air quality impacts. IDAPA 58.01.01.209.c.

B. PM_{10} Pollution from the SGP & Flaws in the PTC

33. According to DEQ's Statement of Basis for the SGP, the SGP has the potential to emit 55.7 tons per year of PM_{10} from a variety of sources. The generation of dust from ore haul trucks traveling along haul roads is the most significant source, estimated to be approximately 55% of all modeled PM_{10} emissions. The next most significant source is open pit drilling fugitive emissions, estimated by DEQ to account for approximately 24% of all modeled emissions.

34. DEQ modeled receptors at various locations along the SGP's ambient air boundary and determined that the maximum potential emissions will be below (and thus comply with) the 24-hour PM_{10} NAAQS. DEQ found the maximum 24-hour PM_{10} pollution from the SGP would be 123.5 ug/m^3, which is 82.3% of the NAAQS.

35. For each of the reasons below, DEQ's determination that the SGP will not cause or contribute to a violation of the PM_{10} NAAQS and its action approving the PTC violates the Clean Air Act, violates EPA's Clean Air Act regulations, violates the Idaho Air Rules, and is

otherwise arbitrary, capricious, made on unlawful procedure, and an abuse of discretion and must be set aside under I.C. § 67-5279.

36. First, important variables affecting the quantity of PM_{10} generated by the ore haul trucks are not directly limited and enforceable as PTC permit conditions. Perpetua estimated the quantity of PM_{10} that would be emitted by the ore haul trucks based on EPAs compilation of air emissions factors (AP-42 Chapter 13.2.2) and their subsequent analysis of sources used by the EPA to develop Chapter 13.2.2. Critical variables that Perpetua used as inputs to PM emission calculations include: the average empty weight of ore haul trucks; the average loaded weight of ore haul trucks; the total number of larger versus smaller ore haul trucks (CAT 789D versus CAT 740B); the silt content of the haul road being traveled; the number of days per year with precipitation greater than or equal to 0.01 inches per day; and the total number vehicle miles traveled by ore haul trucks. However, only one of these critical variables is directly limited and enforceable as a condition in the PTC: the silt content of the haul roads. *See* PTC condition 3.13.

37. Instead of developing PTC conditions for these other critical variables, DEQ relied on a surrogate limit in the PTC (total ore haulage per day, *see* PTC conditions 3.5) and on plans that have not yet been developed and have not been subject to public comment,—a Fugitive Dust Control Plan ("FDCP") and a Haul Road Capping Plan ("HRCP")—to claim the PTC ensures enforceable compliance with 24-hour PM_{10} NAAQS. Without developing the FDCP and HRCP first, without taking public comment on them, and without including important variables as enforceable permit conditions, there is no assurance the SGP will comply with the 24-hour PM_{10} NAAQS, even with the total ore haulage per day limit. Perpetua used a very specific combination of these variables to arrive at a quantity of ore haul truck generated PM_{10} that they contend ensures compliance with the NAAQS. Changing these variables in any number

of ways (ways which are not precluded by any conditions in the PTC) can result in higher PM_{10} levels—levels so high that they exceed the NAAQS. As just one example, merely changing the ratio of large to small ore haul trucks used by Perpetua (to include more small trucks) could cause a violation of the NAAQS.

38. Second, DEQ assumed 93.3% of all haul road PM_{10} emissions from the SGP can be controlled by using an unspecified combination, volume, and frequency of water sprays and chemical dust suppressants. This extremely high level of control which DEQ assumed Perpetua can achieve is based on Perpetua's interpretation of AP-42 Chapter 13.2.2. AP-42 Chapter 13.2.2 discusses the critically important variables surrounding control efficiencies (in particular to chemical suppressants, some of which can reasonably be assumed to apply to water too):

> The control effectiveness of chemical dust suppressants appears to depend on (a) the dilution rate used in the mixture; (b) the application rate (volume of solution per unit road surface area); (c) the time between applications; (d) the size, speed and amount of traffic during the period between applications; and (e) meteorological conditions (rainfall, freeze/thaw cycles, etc.) during the period. Other factors that affect the performance of dust suppressants include other traffic characteristics (e. g., cornering, track-on from unpaved areas) and road characteristics (e. g., bearing strength, grade). The variabilities in the above factors and differences between individual dust control products make the control efficiencies of chemical dust suppressants difficult to estimate. Past field testing of emissions from controlled unpaved roads has shown that chemical dust suppressants provide a PM-10 control efficiency of **about 80 percent when applied at regular intervals of 2 weeks to 1 month (**emphasis added**).**

39. None of the above variables, however, have any specific and enforceable permit conditions within the PTC to ensure a 93.3% control efficiency. Instead, the PTC has a permit condition (permit condition 2.6) only requiring the permittee to develop and submit the FCDP and HRCP, which merely describe how these variables will be addressed 30 days before start-up of the SGP. Permit condition 2.6 details what variables contributing to PM_{10} control effectiveness must be detailed in the FCDP, but the specific details that are so important to

control efficiency (e.g., the amount of water or chemical suppressants applied and the frequency of application) are undetermined at present, have not been subject to public comment, and are left to Perpetua to decide at a later date. A lesser control efficiency, even just slightly lesser, could result in large enough PM_{10} emissions to violate the NAAQS. In fact, if the SGP were to instead achieve 80% control (as EPA found through past field testing of chemical dust suppressants), then the SGP's PM_{10} emissions could exceed the NAAQS.

40. Third, DEQ relied on monitoring and record keeping (permit condition 3.16) using devices and methodologies in the Operation and Maintenance ("O&M") Manual for the potential to emit limit associated with the 180,000 tons per day hauling in permit condition 3.5. However, the O&M Manual has not yet been developed, submitted to the public for comment, ~~or~~ reviewed and revised by DEQ, or incorporated into and made enforceable under the Permit. The O&M Manual is critical to ensuring the 180,000 tons per day hauling condition is satisfied, and the 180,000 tons per day is critical to DEQ's determination under IDAPA 58.01.01.203.02 that the SGP will not exceed the NAAQS. Additionally, DEQ is authorized to require plans and to impose any reasonable conditions on permits, but instead of doing so here, it is letting Perpetua do this later, outside of the permit process. *See* IDAPA 58.01.01.202.03 (authorizing DEQ to obtain from permit applicant "[a]ny additional information, plans, specifications, evidence or documents the Department may require to make the determinations required under [the PTC sections of the Air Rules]"); IDAPA 58.01.01.211 (authorizing DEQ to "impose any reasonable conditions upon an approval" of a PTC); IDAPA 58.01.01.121 (authorizing DEQ to require schedules, reports, records, monitoring, and plans to ensure compliance with Air Rules); IDAPA 58.01.01.122.03.g (authorizing DEQ to issue an information order to provide any "information the Department may require").

41. Fourth, DEQ assumed there would be 120 days of recordable precipitation at the SGP (defined as recording precipitation of 0.01 inch or greater) as a variable in its ore haul road fugitive PM emission calculations. This 120 days comes from general geographic guidance from AP-42 Chapter 13.2.2-1. DEQ, however, should have used local meteorological data. Section 6.8 (Meteorological Data) of DEQ's *Guideline for Performing Air Quality Impact Analyses* states: "The meteorological data used in the modeling analysis should be representative of the meteorological conditions at the particular site of the proposed construction or modification." Days of recordable precipitation is an important variable affecting the SGP's emissions of PM_{10} from ore haul roads. DEQ's failure to use the most representative site data is counter to this guidance and increases the risk of miscalculation of ore haul road emissions. As a result, DEQ failed to ensure PM_{10} emissions from the SGP will comply with the NAAQS.

C. Arsenic Pollution & Regulation

42. Arsenic is a naturally occurring element in soils and minerals. When soil or rock containing arsenic is disturbed, arsenic may enter the air, water, and land from wind-blown dust and from run-off and leaching. The EPA classifies inorganic arsenic as a "human carcinogen," based on evidence in human studies of links to lung, bladder, kidney, skin, and liver cancers.

43. Arsenic released from the soil and rock as airborne dust causes environmental damage. Airborne arsenic pollutes soil, plants, and water resources when it is removed from the air by rain, snow, or gradually settling. Studies have shown that there is a strong correlation between arsenic concentrations in water and in the tissues of fish collected from arsenic-polluted waters. Plants may also absorb arsenic in their leaves and root system from arsenic-polluted soil. The health effects of long-term ingestion of arsenic include developmental effects, diabetes, pulmonary disease, cardiovascular disease, and skin, bladder, or lung cancer.

44. Arsenic is a Toxic Air Pollutant regulated by DEQ. DEQ is required to ensure that no permit to construct shall be granted for a new or modified stationary source unless emissions of TAPs from the constructed source would not injure or unreasonably affect human or animal life or vegetation as required by Section 161. IDAPA 58.01.01.203.03. Section 161 states, "any contaminant which is by its nature toxic to human or animal life or vegetation shall not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation." IDAPA 58.01.01.161.

45. To comply with these TAPs regulations, emissions from a facility must not exceed the Acceptable Ambient Concentrations of Carcinogens ("AACC") at the ambient air boundary. For each carcinogenic TAP, IDAPA 58.01.01.586 lists the applicable TAP and its AACC in ug/m^3 as an annual average. The AACC can practically be defined as the concentration of a TAP that, if an individual was exposed to yearly over a 70-year lifetime, would equate to a cancer development probability risk of 1 in 1,000,000. *See* IDAPA 58.01.01.006.125 & 58.01.01.210.12.

46. In order to determine a facility's TAP concentration at their ambient air boundary, and as noted similarly for PM_{10} emissions, DEQ must assess air impacts using maximum potential emissions as limited by either the capacity of the unit/operation or as limited by enforceable permit provisions. *See* IDAPA 58.01.01.006.88.

D. Arsenic Pollution from the SGP & Flaws in the PTC

47. There are numerous arsenic sources at the SGP, including drilling, blasting, excavating, hauling, silos, rock dumps, and storage and tailing piles. Table 3 in the SGP TAPs Addendum indicates that the maximum arsenic Potential Total Emissions ("PTE") is 0.544 lbs/hr

at the maximum mine production rate of 180,000 tons/day. The largest source of arsenic emissions are haul roads estimated at 0.464 lbs/yr (Table B1-W3 in SOB). PTE estimates for arsenic are calculated using the same formulas and Emission Factors as total particulate and PM_{10} emission rates. As such, like the PM and PM_{10} emission estimates discussed already, the arsenic emission estimates are similarly underestimated and equally unreliable.

48. During the permitting process, DEQ determined that the SGP's estimated arsenic emissions and concentrations at the ambient air boundary were excessive and would not meet the AACC for arsenic. To get around this problem, Perpetua chose to employ a process known as T-RACT. T-RACT is a demonstration that allows a permittee to analyze and employ reasonably available control technologies ("RACT") that could be applied to a source of TAPs. If RACT does not sufficiently reduce toxic emissions to below the AACC, then the permittee is allowed a 10-fold increase in the AACC and can employ production limitations to ensure compliance with the now 10-times-bigger AACC. These production limitations should then be incorporated as enforceable permit conditions. *See* IDAPA 58.01.01.210.13–14.

49. As part of the T-RACT determination process, the applicant must supply, and DEQ must consider, information on a variety of factors relevant to determining a "reasonable" control technology including, but not limited to, control effectiveness, economic costs, operational feasibility, and associated environmental impact. IDAPA 58.01.01.210.14a–d.

50. Perpetua submitted to DEQ a T-RACT demonstration for arsenic emissions from open-pit drilling and ore haul roads. Perpetua determined that the most effective RACT for open-pit drilling was dry drilling with dust collectors and that the most effective RACT for ore haul roads was water sprays and chemical suppressants. In its T-RACT demonstration, Perpetua

included limited qualitative discussion, and no quantitative support, regarding economic considerations. Perpetua failed to provide any discussion of environmental impacts.

51. DEQ approved Perpetua's T-RACT demonstration and granted Perpetua a 10-fold increase in allowable arsenic pollution, subject to operational limitations to reduce PTE. And as modeled by DEQ, arsenic pollution from the SGP would comply with this larger AACC.

52. For each of the reasons below, DEQ's approval of Perpetua's T-RACT demonstration for arsenic, its analysis determining the SGP will not exceed the AACC and thus will not injure or unreasonably affect human or animal life or vegetation, and its action approving the PTC violates the Clean Air Act, violates EPA's Clean Air Act regulations, violates the Idaho Air Rules, and is otherwise arbitrary, capricious, made on unlawful procedure, and an abuse of discretion and must be set aside under I.C. § 67-5279.

53. First, the T-RACT demonstration contained no persuasive economic information and no discussion at all regarding associated environmental impacts, despite the requirements to do so in IDAPA 58.01.01.210.14. There will be water quality and biological impacts associated with Perpetua's use of substantial amounts of chemical dust suppressants and water that have not been considered in the PTC. For example, the use of chemical dust suppressants like magnesium chloride can cause toxicity in trees and can lead to tree death. Magnesium chloride is also known to adversely affect aquatic ecosystems. Moreover, the proposed water source for dust control is primarily water collected in runoff ponds (captured rain or snowfall that has become contaminated through the contact of mine facilities), groundwater, and surface water from the East Fork of the South Fork of the Salmon River. USGS sampling indicates elevated arsenic in these waters. The environmental impact of using magnesium chloride or arsenic-polluted water as dust suppression methods was never considered as part of the T-RACT demonstration.

Likewise, the T-RACT demonstration did not provide sufficient economic support for Perpetua's decision to use water and chemical dust suppressants as compared to paving the haul roads, even though paving was shown to achieve the highest reasonable dust control efficiency.

54. Second, because the underlying particulate and PM_{10} emissions estimates and particulate control assumptions are unreliable in numerous respects, as already discussed above, so too are the estimated arsenic emissions. The SGP's estimated arsenic emissions were based on its PM_{10} emissions. PM_{10} emissions from the SGP may be higher, and their control effectiveness may be lower, than DEQ assumed, in which case arsenic emissions would also be higher and might exceed the AACC.

55. Third, Perpetua's and DEQ's TAPs analyses substantially reduce the SGP's purported arsenic emissions using three improper averaging tactics: (1) averaging emissions over a 5-year period for the T-RACT input to ambient toxics modeling; (2) averaging the estimated annual ambient modeling impacts across two multi-year scenarios; and (3) averaging the resultant 16-year total emissions over the 70-year human lifetime to assert compliance. Nothing in the Idaho Air Rules allows for multi-year emissions averaging and ambient air concentration adjustments. Rather, the arsenic AACC is an annual average. *See* IDAPA 58.01.01.586). DEQ's T-RACT regulations require comparing the estimated maximum annual ambient air arsenic concentration to 10 times the listed annual AACC. IDAPA 58.01.01.12.b. Therefore, to determine compliance with the AACC requires that DEQ estimate the SGP's maximum 1-year annual arsenic emissions and compare it to the annual arsenic AACC.

56. By relying on these improper averaging tactics, DEQ fails to show the SGP will satisfy the arsenic AACC and the resulting analysis masks potentially severe human health and environmental impacts of SGP's potential arsenic emissions. The underlying analyses supporting

the TAPs requirements allows for a 1-in-1,000,000 excess cancer risk factor. The T-RACT approval increases that risk 10-fold to a 1-in-100,000 excess cancer risk factor. IDAPA 58.01.01.12.b. Perpetua's multi-year averaging of emission rates combined with DEQ's decision to allow the full lifetime exposure (70 years) to be imposed on receptors during the 16-year estimated life of mine increases the cancer risk by another order of magnitude to the 1-in-10,000 range or higher. Combined with uncertainties associated with the underlying particulate emissions calculations noted above, the SGP may result in extremely dangerous arsenic exposures.

57. While not the basis for a separate claim for relief, Petitioners note that excacerbating this cancer risk is the fact that under DEQ's incremental TAPs regulations (*see* IDAPA 58.01.01.585), when DEQ considers permitting any additional sources of arsenic in the area over the next 70 years (such as an extension of the life of the SGP, expansion of the facility itself, and/or any adjacent facilities seeking a similar permit, like the potential Horse Heaven project), DEQ will not have to consider the arsenic emissions authorized by this PTC.

E. DEQ's Ambient Air Boundary for the SGP

58. The Clean Air Act and Idaho Air Rules require meeting various air standards, including the NAAQS and TAPs, in ambient air. *See*, *e.g.*, IDAPA 58.01.01.006.11 (NAAQS), 58.01.01.006.125 (TAPs). EPA defines "ambient air" as "that portion of the atmosphere, external to buildings, to which the general public has access." 40 C.F.R. § 50.1(e). In defining an ambient air boundary, the EPA has long followed a policy that exempts "the atmosphere over land owned or controlled by the source and to which public access is precluded . . ." from ambient air. EPA's Revised Policy on Exclusions from "Ambient Air" (Nov. 2018) states that "it is appropriate to exclude the atmosphere over land owned or controlled by the stationary source, where the owner

or operator of the source employs measures, which may include physical barriers, that are effective in deterring or precluding access to the land by the general public."

59. The Idaho Air Rules define "ambient air" as "[t]hat portion of the atmosphere, external to building, to which the general public has access." IDAPA 58.01.01.005.09. To exclude areas from consideration as ambient air, the following conditions must be met: (1) the permittee must have the legal authority to exclude the general public from the area; (2) the boundary to ambient air must be clearly discernible to the general public; (3) the general public must be effectively precluded from assessing the facility; and (4) the general public is not considered employees of the facility; those having official business with the facility; guests of the facility, including participants in facility routes and those seeking access for a specific purpose.

60. Perpetua established an operations boundary (the active industrial site where mining activities and heavy equipment operation will occur) for the purposes of excluding this area from ambient air analysis, and for excluding public access. The area includes the current Stibnite Road point of entry and proposed site access via the Burntlog Route. According to Perpetua, access inside the operations boundary will be restricted for the life of the mine by physical barriers at points of potential access, as well as natural features of the landscape that prevent public access.

61. DEQ's determination to exclude the access route from ambient air protections, and its action approving the PTC violates the Clean Air Act, violates EPA's Clean Air Act regulations, violates the Idaho Air Rules, and is otherwise arbitrary, capricious, made on unlawful procedure, and an abuse of discretion and must be set aside under I.C. § 67-5279.

62. Perpetua has indicated that it intends to allow access to the general public through the mine site between Stibnite Road at Sugar Creek and Thunder Mountain Road at Meadow Creek. Furthermore, this roadway is currently accessible to and has been regularly used by the general public. And while Perpetua claims that it has "legal and practical ability to enforce its control over roadway access," the Forest Service has not yet completed its NEPA analysis and approval of the SGP, which would include a decision on whether it will require or will not permit general public access through the mine site.

63. DEQ states that the route would be managed in accordance with the Stibnite Road Access Management Plan ("AMP"). DEQ, however, relied on an ambiguous description of measures and requirements to preclude public access and ensure that those traveling over the road can be classified as "guests" of the mine.

64. PTC condition 2.7 requires the development of an AMP to address whether the NAAQS apply to the mine's access road through the Perpetua site given the extent of public access allowed. PTC condition 2.8 allows the AMP to be developed later, after the PTC was issued and without public comment, and it does not require the AMP to be enforceable. For the AMP to preclude the applicability of the NAAQS along the access road, the AMP must be reviewed and approved by DEQ, it must be reviewed through public comment, and it must be enforceable under the PTC.

65. Without full disclosure and knowledge of the exact measures and requirements in the AMP and enforceable permit limits, DEQ cannot make a determination of whether exclusion of the access road from ambient air protections complies with EPA's ambient air policy and the Idaho Air Rules, nor can DEQ determine whether the SGP will comply with the NAAQS and TAPs.

F. DEQ's Failure to Require Ambient Air Monitoring for the SGP

66. DEQ has the authority to require ambient air monitoring to determine the effect emissions from the stationary source or facility may have on the air quality of the area potentially impacted by the source. IDAPA 58.01.01.211.01(d).

67. DEQ received comments from the Nez Perce Tribe, EPA Region 10, ICL, and SSFS urging the PTC to require ambient air monitoring to verify the SGP's compliance with the NAAQS and TAPs increments. But DEQ declined, stating in the Response to Comments (pg. 16): "DEQ disagrees that a PM/PM_{10} ambient monitoring network is necessary to make the PTC practically enforceable." DEQ states in the Response to Comments that any violation of the permit would be processed in accordance with DEQ's enforcement procedures manual.

68. However, without ambient air monitoring, it will be impossible for DEQ to assess whether the SGP's operation is in compliance with NAAQS and TAPs increments at any given time. Ambient air monitoring is necessary because of the large uncertainty surrounding dust control efficiency and emissions factors associated with the SGP for PM_{10} and arsenic, as well as the lack of enforceable permit conditions for many important variables, as already described in this Petition.

RELIEF REQUESTED

69. An agency action, like DEQ's issuance of the PTC, may be reversed if it is in violation of constitutional or statutory provisions, is in excess of statutory authority, is made on unlawful procedure, or is arbitrary, capricious or an abuse of discretion. I.C. § 67-5279. When an agency action is not affirmed, it shall be set aside, in whole or in part, and remanded for further proceedings as necessary. *Id.*

70. As stated above, under the Idaho Air Rules, DEQ must not issue a PTC unless it determines: (1) "the stationary source or modification would comply with all applicable local, state or federal emission standards"; (2) "the stationary source would not cause or significantly contribute to a violation of any ambient air quality standard"; and (3) "the emissions of toxic air pollutants from the stationary source or modification would not injure or unreasonably affect human or animal life or vegetation as required by Section 161." IDAPA 58.01.01.203. Prior to issuing a permit to contruct, DEQ must provide an opportunity for public comment by making available DEQ's proposed action together with the information provided by the applicant and with DEQ's analysis. IDAPA 58.01.01.209.c. To ensure compliance with the NAAQS and other air pollution control strategies, the Clean Air Act and EPA's Clean Air Act regulations require state air rules like DEQ's: to include "enforceable emission limitations" and other measures, 42 U.S.C. § 7410(a)(2)(A); to include a "program to provide for the enforcement" of such measures, and to regulate the construction of any stationary source, *id.* § 7410(a)(2)(C); to "set forth legally enforceable procedures" for determining whether the construction of a facility will comply with control strategies and NAAQS, 40 C.F.R. § 51.160(a); to require sufficient information needed "to make the determination" whether the facility will comply with air pollution control strategies and the NAAQS, i*d.* § 51.160(c); and to provide opportunity for public comment on information submitted by the applicant and on the agency's analysis of the effects to air quality. *Id.* § 51.161(a). Based on the flaws in DEQ's issuance of the PTC described above, DEQ's action is in violation of these provisions of the Idaho Air Rules, the Clean Air Act, and EPA's Clean Air Act regulations, and is otherwise arbitrary, capricious, made on unlawful procedure, and an abuse of discretion and must be reversed.

71. By issuing the PTC in its current form, DEQ failed to adequately protect the public and environment from harmful air pollution causing injury to the Nez Perce Tribe, ICL, SSFS, and their members and supporters. To redress these injuries, Petitioners respectfully request the Board set aside and remand the PTC and direct DEQ to correct the following errors prior to issuing any new or revised PTC:

Ore Haul Road PM_{10} & Arsenic Emissions

A. DEQ must develop and include in the PTC enforceable permit conditions for the maximum average empty weight of ore haul trucks, the maximum average loaded weight of ore haul trucks, the maximum total number vehicle miles traveled annually by ore haul trucks, the silt content of the roadbed, the arsenic content of the silt in the roadbed, and any other important variables affecting the SGP's fugitive emissions of PM_{10} and arsenic from vehicle traffic on mine haul roads. To develop such permit conditions and ensure compliance with the NAAQS and TAP limits, DEQ must reevaluate and recalculate fugitive emissions of PM_{10} and arsenic.

B. Silt and arsenic levels should be included as permit conditions and monitored regularly *in situ,* rather than from stockpiles as applied to the roadbed.

C. Instead of assuming 120 days of recordable precipitation at the SGP as a variable within ore haul road fugitive PM emission calculations, as done by the applicant based off general geographic guidance from AP-42 chapter 13.2.2-1, DEQ must recalculate all fugitive emissions after analyzing local meteorological data sources to determine a more accurate and representative number of days with recordable precipitation.

FDCP, AMP, O&M Manual, & HRCP

D. DEQ must require Perpetua to submit the FDCP, AMP, O&M Manual, and HRCP (collectively, "Plans"), must provide for public comment on the Plans, must review and revise

Plans to ensure the SGP's emissions comply with IDAPA 58.01.01.203, and must incorporate the Plans as enforceable PTC conditions.

Arsenic Averaging

E. DEQ must remove the 5-year averaging for arsenic emissions, the averaging of estimated annual ambient modeling impacts across two multi-year scenarios, and the 16/70 life of mine versus lifetime exposure adjustment for the SGP's maximum arsenic ambient concentration it used to assess arsenic TAPs compliance. DEQ must use the SGP's highest 1-year arsenic emission rates for each scenario evaluated and repeat the modeling analyses using these rates. DEQ must use the maximum annual ambient arsenic concentration from the single emission scenario producing the highest annual concentration for any 1-year as the point of compliance. *See* IDAPA 58.01.01.210.03b ("The point of compliance is the receptor site that is estimated to have the highest ambient concentration of the toxic air pollutant of all the receptor sites that are located either at or beyond the facility property boundary or at a point of public access . . . ."). DEQ must assess the impact of the SGP's maximum 1-year annual emissions from the single emission configuration by comparing to the T-RACT AACC for arsenic (10 times the AACC value published in IDAPA 58.01.01.586), without averaging over multiple years, and without adjusting for the alleged 16-year life of the mine or the 70-year lifetime exposure.

Ambient Air Boundary Monitoring

F. As part of any PTC for the SGP, DEQ must require ambient air boundary monitoring, as provided for by IDAPA 58.01.01.211.01(d), to ensure compliance with the NAAQS and the TAPs increments. DEQ must require Perpetua to submit an ambient air boundary monitoring plan ("AABMP"), must take public comment on the AABMP, must review and revise the AABMP, and must incorporate the AABMP as enforceable PTC conditions. At a

minimum, the AABMP must provide a strategy for monitoring the ambient air concentrations of PM_{total}, PM_{10}, $PM_{2.5}$ and arsenic at the SGP's ambient air boundary. The AABMP must be developed according to best industry and regulatory practices, consulting contemporary sources (e.g., DEQ or EPA guidance, similarly established plans for other state permits, etc.). At a minimum, monitoring stations must be required for areas of the ambient air boundary in which DEQ ambient air modeling results (specifically results using operating scenario W3 and BULKRN meteorological data) show receptors with 24-hour PM_{10} or arsenic concentrations within 70% of the applicable NAAQS or AACC (without consideration to multi-year emissions averaging and 16/70 adjustment).

Environmental & Economic Impacts of Arsenic Control Technology

G. DEQ must require Perpetua to update their T-RACT analysis to include analysis of "environmental impacts caused by the control technology that cannot be mitigated, including, but not limited to, water pollution and the production of solid wastes," including the use of magnesium chloride and its aquatic life and tree toxicity effects, as well as using arsenic-contaminated water sources for dust suppression. IDAPA 58.01.01.210.14.c.ii. DEQ must also require the updated T-RACT to adequately address the "economic feasibility of a control technology or other requirement, including the costs of necessary mitigation measures, for a particular source," including detailed consideration of the economic feasibility of paving haul roads to better control fugitive dust emissions. IDAPA 58.01.01.210.14.d. DEQ must provide the updated T-RACT demonstration for public comment, must review and revise the T-RACT demonstration, and must incorporate enforceable PTC conditions from the T-RACT demonstration in the PTC.

CONCLUSION

72. When it issued the PTC for the SGP, DEQ violated the federal Clean Air Act, EPA's Clean Air Act regulations, and the Idaho Air Rules; and it acted arbitrarily, capriciously, and on unlawful procedure and abused its discretion under I.C. § 67-5279. Accordingly, the Board should vacate and withdraw the PTC and remanded to DEQ to correct all errors.

Dated: December 6, 2022

Respectfully submitted,

/s/ Bryan Hurlbutt
Bryan Hurlbutt
Attorney for the Nez Perce Tribe and the Idaho Conservation League

/s/ Julia S. Thrower
Julia S. Thrower
Attorney for Save the South Fork Salmon

Krista K. McIntyre, ISB No. 4675
W. Christopher Pooser, ISB No. 5525
Wade C. Foster, ISB No. 11105
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 _____ NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC. Intervenor-Respondent.	Agency Case No. 0101-22-01 OAH Case No. 23-245-01 **JOINT MOTION TO ENTER STIPULATED SCHEDULING ORDER**

The Parties, through their undersigned counsel, jointly move for entry of the Stipulated Scheduling Order, which is filed concurrently with this Joint Motion.

Respectfully submitted on January 13, 2023, by:

STOEL RIVES LLP

/s/ Wade C. Foster
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

STIPULATED AND AGREED TO BY:

ADVOCATES FOR THE WEST

/s/ Bryan Hurlbutt
Bryan Hurlbutt
Laurence J. Lucas

Attorneys for Nez Perce Tribe and Idaho Conservation League

MOUNTAIN TOP LAW

/s/ Julia Thrower
Julia Thrower

Attorney for Save the South Fork Salmon

DEPARTMENT OF ENVIRONMENTAL QUALITY

/s/ John Shackleford
John Shackleford
Deputy Attorney General

Attorneys for Respondent

CERTIFICATE OF SERVICE

I hereby certify that on this 13th day of January 2023, a true and correct copy of the **JOINT MOTION TO ENTER STIPULATED SCHEDULING ORDER** was served on the following:

Dylan B. Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

/s/ Wade C. Foster
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Perpetua Resources, Inc.

RAÚL R. LABRADOR
Attorney General

SCOTT L. CAMPBELL
Deputy Attorney General
Chief, Energy and Natural Resources Division

JOHN R. SHACKELFORD, ISB# 8647
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: (208) 373-0453
Facsimile: (208) 373-0481
john.shackelford@deq.idaho.gov

Attorneys for Respondent

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 _____ NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	Agency Case No. 0101-22-01 OAH Case No. 23-245-01 RESPONSE TO FIRST AMENDED PETITION TO INITIATE CONTESTED CASE: AIR PERMIT TO CONSTRUCT P-2019.0047 (JUN. 17, 2022)

RESPONSE TO FIRST AMENDED PETITION TO INITIATE CONTESTED CASE- 1

COMES NOW, Respondent, the Idaho Department of Environmental Quality (Department), by and through the Office of the Attorney General, and hereby submits this Response to First Amended Petition to Initiate Contested Case in accordance with the Rules of Administrative Procedure before the Board of Environmental Quality, IDAPA 58.01.23.161.

FACTUAL AVERMENTS

The Department cannot separately admit or deny each fact alleged in the Petition because the factual averments were not made separately. Moreover, the Petition is written in the style of a legal brief, which intermingles the Petitioners' alleged facts with their arguments. Therefore, it difficult to discern whether a statement is a factual averment, argument, a conclusion of law or a combination of any of these. For this reason, any statements of fact set forth in the Petition that are not explicitly admitted or agreed upon, are hereby denied. Without waiving this objection, the Department responds as follows:

A. "INTRODUCTION" Section

The Department does not disagree with the facts alleged in Paragraph One. The Department admits that the Stibnite Gold Project ("SGP") is located approximately ten miles east of the town of Yellow Pine, Idaho, but has insufficient information to admit or deny the claim that the SGP is located with the Nez Perce Tribe's aboriginal homeland, as stated in Paragraph Two. The Department generally agrees with the statements in Paragraph Three but does not agree with the characterization of dust emissions, which are described as "massive." The Department denies the statements in Paragraph Four.

The Department will abide by the request for service in Paragraph Five and admits the statement of jurisdiction in Paragraph Six. Paragraphs Seven and Eight contain no

facts which can be admitted or denied. The Department has insufficient information regarding the Nez Perce Tribe to admit or deny the factual averments in Paragraphs Nine through Thirteen. However, whether the Nez Perce Tribe has standing, a conclusion of law asserted within Paragraph Ten, is disputed, and therefore denied. The Department denies the claim in Paragraph Twelve that the Nez Perce Tribe will suffer injuries from permitted dust emissions at the SGP.

Similarly, the Department can neither admit nor deny the assortment of factual averments scattered throughout paragraphs Fourteen through Nineteen, which generally describe the constituencies, goals, and activities of the Petitioners, Idaho Conservation League and Save the South Fork Salmon. The Department admits that all the Petitioners submitted multiple comments to the Department regarding the Department's Permit to Construct ("PTC"). However, the Department denies the statements claiming that these entities will suffer injuries from permitted dust emissions. The Department admits the statements in Paragraphs Twenty and Twenty-One.

B. **Section I "Overview of SGP & Chronology of DEQ's Issuing the PTC"**

The Department agrees with the course of events as set forth in Paragraphs Twenty-Two through Twenty-Six. However, the Department avers that the permittee, Perpetua Resources Idaho, Inc. ("Perpetua"), followed the Department's process of submitting a draft permit and then responding to requests for further information from the Department.

C. **Section II A, "PM_{10} Pollution and Regulation"**

The Department generally agrees with the statements of fact and the directly cited materials provided in Paragraphs Twenty-Eight through Thirty-Two.

D. **Section II B, "PM_{10} Pollution from the SGP & Flaws in the PTC"**

The Department largely agrees with the statements in Paragraph Thirty-Three, except that the generation of dust from trucks traveling along haul roads is estimated to be approximately 55% of all *fugitive mining* emissions, or 53% of all modeled PM_{10} emissions. The statements in Paragraph Thirty-Four appear to be correct.

Paragraphs Thirty-Five through Forty-One contain mixed statements of fact and argument, which must be denied. Generally, the Department agrees that the Fugitive Dust Control Plan and Haul Road Capping Plan will be important for ensuring compliance with air quality standards. Those plans do not currently exist but will be subject to the Department's approval, and individual provisions within each plan will be enforceable through the PTC. Thus, the Department denies the allegations that those plans are not directly enforceable.

E. **Section II C, "Arsenic Pollution & Regulation"**

The Department agrees with the Petitioners' description of arsenic as a toxic air pollutant in Paragraphs Forty-Two through Forty-Five. The Department neither admits nor denies the statement in Paragraph Forty-Six, which references the definition of "Potential to Emit/Potential Emissions" at IDAPA 58.01.01.006.88.

F. **Section II D, "Arsenic Pollution from the SGP & Flaws in the PTC"**

The Department largely agrees with the substance of Paragraphs Forty-Seven through Forty-Nine. Regarding Paragraph Fifty, the Department agrees that Perpetua submitted to the Department a T-RACT demonstration. The Department agrees with the statements in Paragraph Fifty-One but denies the allegations in Fifty-Two through Fifty-Seven.

G. **Section II E, "DEQ's Ambient Air Boundary for the SGP"**

The Department agrees with the averments in Paragraphs Fifty-Eight, Fifty-Nine, and Sixty; however, the definition of "ambient air" is found at IDAPA 58.01.01.006.10. The Department disagrees with the arguments contained in Sixty-One through Sixty-Five.

H. **Section II F, "DEQ's Failure to Require Ambient Air Monitoring for the SGP"**

The Department agrees with the statements in Paragraphs Sixty-Six and Sixty-Seven but disagrees with the arguments in Paragraph Sixty-Eight.

LEGAL AUTHORITY

The contested permit was issued pursuant to Title 39 Idaho Code and the Rules for the Control of Air Pollution in Idaho, IDAPA 58.01.01 *et. seq*.

ADDITIONAL FACTS

The Department's Air Quality Permitting Response to Public Comments (June 17, 2022), Exhibit A, which can be found at:

https://www2.deq.idaho.gov/admin/LEIA/api/document/download/16969

contains the factual underpinnings supporting the issuance of the PTC as well as the Department's positions on fugitive dust control efficiency (Third Response to Comments 1-4), monitoring, recordkeeping, and reporting (Third Response to Comments 5-9), operational plans (Third Response to Comments 10-18), estimation of potential emissions (Third Response to Comments 19-30), the applicability of "ambient air" standards (Comments 35-36), and the T-RACT process (Comment 39-41). The Department's PTC and associated Statement of Basis, Exhibit B, can be found at:

https://www2.deq.idaho.gov/admin/LEIA/index.html?view=folder&id=3144

RELIEF SOUGHT

The Department requests the Board issue an order affirming the Department's action.

DATED: January 17, 2023, FOR RESPONDENT:

STATE OF IDAHO, DEPARTMENT OF ENVIRONMENTAL QUALITY

By: /s/ *John R. Shackelford*
John R. Shackelford
Attorney for Respondent

CERTIFICATE OF SERVICE

I HEREBY CERTIFY that on this 17th day of January, 2023, a true and correct copy of the foregoing RESPONSE TO FIRST AMENDED PETITION TO INITIATE CONTESTED CASE was served on the following via electronic mail to the indicated address:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Dylan Lawrence
Hearing Officer
Varin Thomas, LLC
242 N. 8th St., Suite 220
Boise, ID 83702
dylan@varinthomas.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Patricia Jordan

Patricia Jordan, Legal Assistant

DYLAN LAWRENCE
VARIN THOMAS LLC
P.O. Box 1676
Boise, ID 83701
(208) 345-6021
dylan@varinthomas.com

BEFORE THE BOARD OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 _____ NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC. Intervenor-Respondent.	Agency Case No. 0101-22-01 OAH Case No. 23-245-01 **SCHEDULING ORDER**

On January 13, 2023, the parties filed a Joint Motion to Enter Stipulated Scheduling Order and a proposed Stipulated Scheduling Order. Good cause appearing therefor, the hearing officer hereby orders that the following deadlines and discovery parameters shall govern this matter, unless amended jointly by the parties and approved by the hearing officer, pursuant to BEQ Procedural Rules 003.010 and 162.02 and AG Procedural Rules 513, 520, 521, and 710:

Fact Discovery:

Discovery shall open on **upon entry of this order.**

The Parties shall limit discovery to documents or information in the possession of the Department. The Parties shall issue all requests for production, interrogatories, or otherwise request documents by **January 31, 2023.**

The Department shall respond to all discovery requests by **February 14, 2023.** Each Party shall serve upon the other Parties any additional documentary evidence they deem relevant to these proceedings by **February 14, 2023.**

If any Party believes that discovery is required from any other party, besides the Department, they shall meet and confer to determine an appropriate scope of discovery and response deadline.

Dispositive Motions:

Petitioners shall file a joint motion for summary judgment by **April 14, 2023.**

The Department and Perpetua Resources Idaho, Inc. ("Perpetua") shall file their respective responses by **May 12, 2023.** To the extent the Department or Perpetua believe it is necessary to file a motion for summary judgment, such motions shall be filed by **May 12, 2023**, and all briefing on such motions shall be combined with the briefing on the respective responses.

Petitioners shall file a joint reply by **June 9, 2023.** If the Department or Perpetua file a motion for summary judgment, the Petitioners' response shall be combined with their joint reply and filed on **June 9, 2023**.

If the Department and Perpetua file motion(s) for summary judgment, they shall file their respective reply briefs by **June 23, 2023**

The Parties will coordinate with the hearing officer a date for the hearing on the motion(s) for summary judgment on the next status conference held in this matter.

If all issues are not resolved on the order on the motion(s) for summary judgment, the Parties shall meet and confer to develop a proposed schedule to govern prehearing matters and a hearing. The proposed schedule developed by the Parties, if any, shall be filed as a proposed scheduling order within 14 days of the order on the motion(s) for summary judgment.

Finally, it is hereby ordered that all future filings shall be served on Paula Wilson as the Hearing Coordinator via email at Paula.Wilson@deq.idaho.gov, in addition to the service parties identified in the January 3, 2023 Notice of Appointment of Hearing Officer.

Date this 19th day of January, 2023.

Dylan B. Lawrence
Hearing Officer

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	BEQ Case No. 0101-22-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	)	OAH Case No. 23-245-01
	)	CERTIFICATE OF SERVICE

I hereby certify that on January 19, 2023, a true and correct copy of the **Scheduling Order** was served on the following:

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Dylan Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Krista McIntyre
W. Christopher Pooser
Wade Foster
Stoel Rives LLP
101 S. Capitol Blvd., Ste. 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

Paula J. Wilson
DEQ Hearing Coordinator

CERTIFICATE OF SERVICE

RAÚL R. LABRADOR
Attorney General

SCOTT L. CAMPBELL
Deputy Attorney General
Chief, Energy and Natural Resources Division

JOHN R. SHACKELFORD, ISB# 8647
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: (208) 373-0453
Facsimile: (208) 373-0481
john.shackelford@deq.idaho.gov

Attorneys for Respondent

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 _____ NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	Agency Case No. 0101-22-01 OAH Case No. 23-245-01 RESPONDENT'S MOTION TO EXTEND DEADLINE FOR DISCOVERY AND MODIFY THE SCHEDULING ORDER DATED JANUARY 19, 2023

RESPONDENT'S MOTION TO EXTEND DEADLINE FOR DISCOVERY AND MODIFY THE SCHEDULING ORDER DATED JANUARY 19, 2023 - 1

Pursuant to the Scheduling Order entered on January 19, 2023 ("Scheduling Order"), discovery responses from the Idaho Department of Environmental Quality ("Department") are due February 14, 2023. However, the Department has determined that the more time will be necessary to fully respond to the Petitioners' discovery requests. Therefore, the Department respectfully moves the Office of Administrative Hearings to extend the time permitted for a response to the Petitioners' request to February 21, 2023.

The Department has consulted with Petitioners' counsel who do not oppose the extension sought in this motion.

CONCLUSION

For the reasons stated above, the Department respectfully requests the Hearing Officer to extend the time permitted for discovery under the Scheduling Order and to modify the dates set forth in the Scheduling Order accordingly.

DATED: February 9, 2023, FOR RESPONDENT:

STATE OF IDAHO, DEPARTMENT OF ENVIRONMENTAL QUALITY

By: /s/ *John R. Shackelford*
John R. Shackelford
Attorney for Respondent

CERTIFICATE OF SERVICE

I HEREBY CERTIFY that on this 9th day of February, 2023, a true and correct copy of the foregoing RESPONDENT'S MOTION TO EXTEND DEADLINE FOR DISCOVERY AND MODIFY THE SCHEDULING ORDER DATED JANUARY 19, 2023 was served on the following via electronic mail to the indicated address:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Dylan Lawrence
Hearing Officer
Varin Thomas, LLC
242 N. 8th St., Suite 220
Boise, ID 83702
dylan@varinthomas.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Resources Division
Office of the Attorney General
1410 N. Hilton St.
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

Patricia Jordan

Patricia Jordan, Legal Assistant

DYLAN LAWRENCE
VARIN THOMAS LLC
P.O. Box 1676
Boise, ID 83701
(208)345-6021
dylan@varinthomas.com

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	Agency Case No. 0101-22-01
	OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	ORDER GRANTING MOTION TO EXTEND DEADLINE

Respondent, the Idaho Department of Environmental Quality ("Department") filed its Motion to Extend Discovery and Modify the Scheduling Order Dated January 19, 2023, brought before the Office of Administrative Hearings, State of Idaho.

Good cause appearing therefor, IT IS HEREBY ORDERED THAT the deadline for the Department to respond to Petitioners' discovery requests is extended by one week, from February 14, 2023 to February 21, 2023.

ORDERED:

Dylan B. Lawrence
Hearing Officer

CERTIFICATE OF SERVICE

I hereby certify that on this 13th day of February, 2023, I caused to be served a true and correct copy of the foregoing by the following method to:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Dylan Lawrence
Hearing Officer
Varin Thomas, LLC
242 N. 8th St., Suite 220
Boise, ID 83702
dylan@varinthomas.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Resources Division
Office of the Attorney General
1410 N. Hilton St.
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

Dylan B. Lawrence
Hearing Officer

RAÚL R. LABRADOR
Attorney General

RAÚL R. LABRADOR
Attorney General

SCOTT L. CAMPBELL
Deputy Attorney General
Chief, Energy and Natural Resources Division

JOHN R. SHACKELFORD, ISB# 8647
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: (208) 373-0453
Facsimile: (208) 373-0481
john.shackelford@deq.idaho.gov

Attorneys for Respondent

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	Agency Case No. 0101-22-01 OAH Case No. 23-245-01 RESPONSENT'S NOTICE OF DISCOVERY SERVICE

COMES NOW, Respondent, the Idaho Department of Environmental Quality, by and through the Office of the Attorney General, and hereby submits this Notice of Discovery Service in response to Intervenor's First Discovery Requests for Production of Documents, dated January 31, 2023.

This is to notify the Office of Administrative Hearings that Respondent's Response to Intervenor's First Set of Requests for Production of Documents was served on parties via electronic mail as indicated below:

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Dated: February 14, 2023, FOR RESPONDENT:

STATE OF IDAHO, DEPARTMENT OF ENVIRONMENTAL QUALITY

By: /s/ *John R. Shackelford*
John R. Shackelford
Attorney for Respondent

CERTIFICATION OF SERVICE

I HEREBY CERTIFY that on this 14th day of February, 2023, a true and correct copy of the foregoing RESPONDENT'S NOTICE OF DISCOVERY SERVICE was served on the following via electronic mail to the indicated address:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Dylan Lawrence
Hearing Officer
Varin Thomas, LLC
242 N. 8th St., Suite 220
Boise, ID 83702
dylan@varinthomas.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Resources Division
Office of the Attorney General
1410 N. Hilton St.
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

Patricia Jordan

Patricia Jordan, Legal Assistant

RAÚL R. LABRADOR
Attorney General

RAÚL R. LABRADOR
Attorney General

SCOTT L. CAMPBELL
Deputy Attorney General
Chief, Energy and Natural Resources Division

JOHN R. SHACKELFORD, ISB# 8647
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: (208) 373-0453
Facsimile: (208) 373-0481
john.shackelford@deq.idaho.gov

Attorneys for Respondent

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	Agency Case No. 0101-22-01 OAH Case No. 23-245-01 RESPONSENT'S NOTICE OF DISCOVERY SERVICE

COMES NOW, Respondent, the Idaho Department of Environmental Quality, by and through the Office of the Attorney General, and hereby submits this Notice of Discovery Service in response to Petitioners' First Discovery Requests for Production of Documents, dated January 31, 2023.

This is to notify the Office of Administrative Hearings that Respondent's *Response to Petitioners' First Discovery Requests and Requests for Production of Documents* was served on parties via electronic mail as indicated below:

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Dated: February 21, 2023, FOR RESPONDENT:

STATE OF IDAHO, DEPARTMENT OF ENVIRONMENTAL QUALITY

By: /s/ *John R. Shackelford*
John R. Shackelford
Attorney for Respondent

CERTIFICATION OF SERVICE

I HEREBY CERTIFY that on this 21st day of February, 2023, a true and correct copy of the foregoing RESPONDENT'S NOTICE OF DISCOVERY SERVICE was served on the following via electronic mail to the indicated address:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Dylan Lawrence
Hearing Officer
Varin Thomas, LLC
242 N. 8th St., Suite 220
Boise, ID 83702
dylan@varinthomas.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Resources Division
Office of the Attorney General
1410 N. Hilton St.
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

Patricia Jordan, Legal Assistant

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	
	Agency Case No. 0101-22-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON	OAH Case No. 23-245-01
	PETITIONERS' MOTION FOR SUMMARY JUDGMENT
Petitioners,	
v.	
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,	
Respondent,	
and	
PERPETUA RESOURCES IDAHO, INC.	
Intervenor.	

Pursuant to IDAPA 58.01.23, Idaho Rule of Civil Procedure 56, and the January 19, 2023 Scheduling Order in this matter, Petitioners Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon move for the Hearing Officer to enter summary judgment in Petitioners' favor on the claims in First Amended Petition to Initiate Contested Case: Air Quality Permit to Construct P-2019.0047 (Jun. 17, 2022), challenging the Idaho Department of Environmental Quality's issuance of a permit to construct (the "Permit") to Perpetua Resources Idaho, Inc. for the Stibnite Gold Project.

Summary judgment is appropriate, as the claims involve no genuine dispute of material fact, and Petitioners are entitled to judgment as a matter of law.

This Motion is supported by the accompanying: Petitioners' Opening Brief in Support of Motion for Summary Judgment; the Declaration of Bryan Hurlbutt; and Exhibits 1-14 to the Hurlbutt Declaration. This Motion is also supported by the pleadings and files before the Hearing Officer.

WHEREFORE, Petitioners respectfully request the Hearing Officer grant this Motion for Summary Judgment, enter judgment in Petitioners' favor, and set aside and remand the Permit to DEQ.

//

//

//

//

Dated this 14th day of April, 2023.

Respectfully submitted,

/s/ Bryan Hurlbutt
Bryan Hurlbutt (ISB #8501)
P.O. Box 1612
Boise, ID 83701
(208) 342-7024
bhurlbutt@advocateswest.org
filings@advocateswest.org
Attorney for the Nez Perce Tribe and the Idaho Conservation League

/s/ Julia S. Thrower
Julia S. Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
Attorney for Save the South Fork Salmon

CERTIFICATE OF SERVICE

I hereby certify that on April 14, 2023, a true and correct copy of the **Petitioners' Motion for Summary Judgment, Petitioners' Opening Brief in Support of Motion for Summary, and Declaration of Bryan Hurblutt** was served on the following:

Dylan B. Lawrence Varin Thomas, LLC 242 N. 8th St., Suite 220 Boise, ID 83702 (208) 345-6021 dylan@varinthomas.com *Hearing Officer*	Via:	Email: Fax: CM/ECF: Hand Delivery: U.S. Mail:	[x] [ ] [ ] [ ] [ ]
Paula Wilson paula.wilson@deq.idaho.gov *Hearing Coordinator*	Via:	Email:	[x]
Office of Administrative Hearings P.O. Box 83720 Boise, ID 83720-0104 filings@oah.idaho.gov	Via:	Email: U.S. Mail:	[x] [x]
John Shackelford Office of the Attorney General 1410 N. Hilton, 2nd Floor Boise, ID 83706 (208) 373-0453 john.shackelford@deq.idaho.gov *Attorney for Respondent*	Via:	Email: Fax: CM/ECF: Hand Delivery: U.S. Mail:	[x] [ ] [ ] [ ] [ ]
Krista McIntyre W. Christopher Pooser Wade Foster Stoel Rives, LLP 101 S. Capital Blvd., Suite 1900 Boise, ID 83702 (208) 389-9000 krista.mcintyre@stoel.com christopher.pooser@stoel.com wade.foster@stoel.com *Attorneys for Intervenor*	Via:	Email: Fax: CM/ECF: Hand Delivery: U.S. Mail:	[x] [ ] [ ] [ ] [ ]

/s/ Bryan Hurlbutt
Bryan Hurlbutt

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org
Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com
Attorney for Save the South Fork Salmon

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	Agency Case No. 0101-2201
	)	OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, *Petitioners*, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, *Respondent,* and PERPETUA RESOURCES IDAHO, INC., *Intervenor.*	)	**PETITIONERS' OPENING BRIEF IN SUPPORT OF MOTION FOR SUMMARY JUDGMENT**

Table of Contents

INTRODUCTION 1

THE CLEAN AIR ACT AND IDAHO RULES 2

STATEMENT OF FACTS 5

I. THE STIBNITE GOLD PROJECT 5

II. OVERVIEW OF PERPETUA'S APPLICATION AND DEQ'S APPROVAL 6

III. PM_{10} EMISSIONS FROM THE PROJECT 7

IV. ARSENIC EMISSIONS FROM THE PROJECT 9

V. AMBIENT AIR BOUNDARY AND THE STIBNITE ROAD ACCESS ROUTE 11

VI. LACK OF AMBIENT AIR MONITORING AT THE PROJECT SITE 12

APPLICABLE LEGAL STANDARD 13

ARGUMENT 14

I. DEQ'S DECISION TO EXCLUDE THE STIBNITE ACCESS ROUTE FROM AMBIENT AIR PROTECTIONS IS UNALWFUL 14

II. DEQ'S DETERMINATIONS THAT PROJECT WILL COMPLY WITH PM_{10} AND ARSENIC LIMITS ARE ARBITRARY AND VIOLATE THE RULES 19

A. DEQ's Assumption that Perpetua Will Prevent 93.3% of Fugitive Dust Emissions Is Unreasonable and Violates the Air Rules. 19

B. DEQ Failed to Include Conditions Restricting Ore Haul Truck Weights, Sizes, and Miles Traveled in the Permit. 23

C. DEQ Failed to Use Representative Precipitation Data. 25

D. DEQ Failed to Include in the Permit Monitoring and Recordkeeping Requirements Critical to Ensuring Haul Limits are Met. 26

III. DEQ'S RELIANCE ON FUTURE PLANS TO BE PREPARED BY PERPETUA OUTSIDE OF THE PTC PROCESS VIOLATES THE AIR RULES AND CAA 28

IV. DEQ MUST REQUIRE AMBIENT AIR MONITORING 31

V. DEQ FAILED TO ANALYZE ECONOMIC INFORMATION AND ENVIRONMENTAL IMPACTS IN THE ARSENIC T-TRACT 32

VI. DEQ IMPROPERLY DILUTED PROJECT ARSENIC EXPOSURE, MASKING THE TRUE HEALTH RISKS IN VIOLATION OF THE AIR RULES.....34

VII. THE PERMIT MUST BE SET ASIDE AND REMANDED TO DEQ TO CORRECT ALL ERRORS 37

CONCLUSION.....38

Petitioners Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon challenge the Idaho Department of Environmental Quality's ("DEQ" or "Department") approval of a permit to construct (the "Permit") issued to Perpetua Resources Idaho, Inc. ("Perpetua") for the proposed Stibnite Gold Project ("SPG" or "Project"): a massive open-pit mine in Valley County, Idaho. As proposed, Perpetua would excavate 340 million tons of waste rock to mine and process approximately 100 million tons of ore, using 55 miles of haul truck routes over 16 years. Blasting, excavating, ore hauling, and other Project activities will emit air pollutants, including coarse particulate matter ("PM_{10}") and arsenic. PM_{10} and arsenic are regulated under the federal Clean Air Act and Idaho's air pollution regulations, because they can cause significant and severe health and environmental hazards.

When it issued the Permit, DEQ concluded that the Project would comply with applicable limits on PM_{10} and arsenic. But in reaching these conclusions, DEQ made many unreasonable assumptions, deviated from established permitting practices, and failed to follow governing laws, regulations, and guidance. For example, DEQ repeatedly deferred developing and imposing important conditions in the Permit, leaving these to be developed by Perpetua later–if at all–and shielded from public scrutiny. DEQ also employed a new tactic to dilute the arsenic exposures associated with the Project so that they appear to be a mere 23% of what they will be in actuality.

As a result of these and other errors, DEQ failed to account for a large portion of the Project's PM_{10} and arsenic emissions, and underestimated the degree to which they will degrade ambient air quality and threaten public health and the environment. The Permit is thus arbitrary, capricious, an abuse of discretion, and/or contrary to law under relevant legal standards and the Idaho Administrative Procedure Act ("APA"). The Hearing Officer should grant summary judgment for Petitioners, set aside the Permit, and remand for DEQ to correct these errors.

THE CLEAN AIR ACT AND IDAHO AIR RULES

The federal Clean Air Act ("CAA"), 42 U.S.C. § 7401 *et seq.*, was passed to "protect and enhance the quality of the Nation's air resources" by prescribing national ambient air quality standards ("NAAQS") which state and regional authorities are required to either maintain or make progress toward. To achieve the CAA's goals, Congress directed the Environmental Protection Agency ("EPA") to establish primary and secondary NAAQS for any pollutant "reasonably . . . anticipated to endanger public health or welfare" and to periodically review and revise those standards. *Id.* §§ 7408(a)(1)(A), 7409(a)(1), (d). The CAA also requires the EPA to divide up the country into areas designated as "nonattainment," "attainment," or "unclassified" based on whether these areas meet the NAAQS. *Id.* § 7407(d).

States have the primary responsibility for assuring that air quality within their borders meets the NAAQS. Each state must establish a state implementation plan (SIP), which is submitted to EPA for review. *Id.* § 7410. To be approved by EPA, each SIP must "include enforceable emission limitations and other control measures, means, or techniques . . . as may be necessary or appropriate to meet the applicable requirements of [the CAA]." *Id.* § 7410(a)(2)(A); 40 C.F.R. § 52.02(a). States can adopt and enforce their own standards regarding emissions "provided such state standard is no less stringent than any applicable federally mandated SIP provision." *Nat. Res. Def. Council v. Thomas*, 845 F.2d 1088, 1090 (D.C. Cir. 1988).

The CAA requires that State air rules "shall" include "enforceable emission limitations" and other control measures, means, or techniques as necessary or appropriate to meet CAA requirements. 42 U.S.C. § 7410(a)(2)(A). SIPs "shall" also include a "program to provide for the enforcement" of the limitations and measures described in subparagraph (A), and for the

"regulation of the modification and construction of any stationary source . . . to assure that [NAAQS] are achieved." *Id.* § 7410(a)(2)(C).

EPA's CAA regulations require each SIP to "set forth legally enforceable procedures" that enable the State to determine whether the construction of a facility will result in a violation of its air pollution control strategies or interfere with attaining or maintaining the NAAQS. 40 C.F.R. § 51.160(a). These legally enforceable procedures must include means by which the State will prevent construction if the facility will violate air pollution control strategies or interfere with attaining or maintaining the NAAQS, and they must provide for the applicant to submit information on the "location, design, construction, and operation of such facility . . . as may be necessary" to permit the State to "to make the determination" that the facility will comply with its air pollution control strategies and the NAAQS. *Id.* § 51.160(b)–(c). "The legally enforceable procedures in § 51.160(b) must also require" the State to provide opportunity for public comment on information submitted by the applicant and on the State's analysis of the effects on ambient air quality. *Id.* § 51.161(a).

EPA has delegated to DEQ authority to issue air quality permits in Idaho pursuant to the Rules for the Control of Air Pollution in Idaho ("Air Rules"), IDAPA 58.01.01. Prior to construction of a facility, the owner or operator must first obtain a permit to construct ("PTC") from DEQ which satisfies the applicable requirements of the Air Rules. Air Rules Section 201.

A PTC application "shall be accompanied by all information necessary to perform any analysis or make any determination required under Sections 200 through 228." Air Rules Section 202. The applicant must provide the following required information: "Site information, plans, descriptions, specifications, and drawings showing the design of the stationary source, facility, or modification, the nature and amount of emissions (including secondary emissions),

and the manner in which it will be operated and controlled." Air Rules Section 202.01.a.i. The applicant must also provide: "Any additional information, plans, specifications, evidence or documents that the Department may require to make the determinations required under Sections 200 through 225 shall be furnished upon request." Air Rules Section 202.03.

Among other determinations, DEQ cannot issue a PTC unless it determines that the facility: (1) "would comply with all applicable federal emissions standards;" (2) "would not cause or significantly contribute to a violation of any ambient air quality standards" (i.e., the NAAQS); and (3) "emissions of toxic air pollutants . . . would not injure or unreasonably affect human or animal life or vegetation as required by Section 161." Air Rules Section 203.

When making these determinations, DEQ must consider the source's "potential to emit" ("PTE"), which is defined as:

> The maximum capacity of a facility or stationary source to emit an air pollutant under its physical and operational design. Any physical or operational limitation on the capacity of the facility or source to emit an air pollutant, including air pollution control equipment and restrictions on hours of operation or on the type or amount of material combusted, stored or processed, shall be treated as part of its design if the limitation or the effect it would have on emissions is state or federally enforceable. Secondary emissions do not count in determining the potential to emit of a facility or stationary source.

Air Rules Section 006.88.

For all PTC applications, DEQ must provide an opportunity for public comment. Air Rules Section 209.01.c. The Air Rules also require DEQ to issue either an "approval," a "conditional approval," or a "denial." Air Rules Sections 209.01.b.i & ii, c.iv. DEQ "may impose any reasonable conditions" upon the facility in the PTC. Air Rules Section 211. DEQ can also authorize revisions to permits, but such revisions must go through the Air Rule Section 209 public comment process if the revision results in an increase in emissions or if deemed appropriate by the DEQ director. Air Rules Section 209.04.b.iii.

STATEMENT OF FACTS

I. THE STIBNITE GOLD PROJECT.

Perpetua proposes to construct and operate a conventional open-pit mine with ore preparation and gold extraction facilities approximately 10 miles east of the town of Yellow Pine, in Valley County, Idaho. *See* PET 049-51.[1] The Project is located on a combination of public National Forest and private lands. *Id.* The Project is also geographically located within the Nez Perce Tribe's aboriginal homeland and within the area over which the Nez Perce Tribe has Treaty-reserved rights and resources.

The Project includes 3 years of development and construction activities, followed by approximately 12 years of mining. *Id.* The Project would require "construction of significant infrastructure," including a power transmission line, a primary mine site access road, onsite haul roads, an ore processing facility, onsite workspaces, employee housing and recreation, water storage and distribution facilities, and sewage disposal facilities. *Id.* Conventional open-pit mining methods including drilling, blasting, excavating, and hauling will be used to extract ore and waste rock (termed development rock) from three open pits. *Id*. Over the life of the mine, approximately 340 million tons of waste rock would be handled and 100 million tons of ore will be mined from the three pits. *Id.* A fleet of large trucks will haul ore and waste rock using a network of over 55 miles of unpaved haul roads at the mine site. PET 065.

The Permit issued by DEQ is the first of over 50 permits required from various local, state, and federal agencies for the proposed mine. Perpetua is currently in the process of seeking

[1] Petitioners' Exhibits, which include documents from DEQ's project record and documents exchanged during discovery, were Bates numbered and are filed with the accompanying Hurlbutt Declaration. Citations to Petitioners' Exhibits are cited here as "PET [Bates #]."

these other permits for the proposed Project, including from the U.S. Forest Service, U.S. Army Corps of Engineers, and U.S. Fish and Wildlife Service.

II. OVERVIEW OF PERPETUA'S APPLICATION AND DEQ'S APPROVAL.

Perpetua (previously Midas Gold) submitted a PTC application to DEQ on August 20, 2019. *See* PET 052-54 (SOB Application Chronology). Between that date and March 6, 2020, DEQ determined that the application was incomplete, requested additional information, and received supplementary materials from Perpetua no fewer than four times. *Id.* On May 15, 2020, DEQ deemed Perpetua's application complete. *Id.*

Between May 15, 2020, and March 16, 2022, DEQ developed three versions of the draft Permit and released them for public comment. *Id.* As noted in comments submitted by the Nez Perce Tribe, ICL, SSFS, and other members of the public and agencies, the first two draft versions of the Permit (the "September 2020" and "February 2021" Draft Permits) contained significant shortcomings. *See* PET 617-34 (DEQ Response to Comments ("RTC")). After taking public comment, DEQ deemed the September 2020 draft Permit deficient and required updated information from Perpetua, including updated hazardous air pollutants ("HAP") and toxic air pollutants ("TAP") emissions estimates. *See* PET 052-54..

DEQ subsequently updated the draft Permit in February 2021, and took public comment. *Id.* Following additional comments, DEQ determined that the February 2021 draft Permit was deficient and required additional information from Perpetua, including Prevention of Significant Deterioration ("PSD") emissions estimates and regulatory applicability for the lime manufacturing plant. *Id.*

DEQ revised the February 2021 draft PTC and released it for public comment on January 13, 2022. *Id.* Comments were submitted by the Nez Perce Tribe, ICL, SSFS, EPA, and

Ian von Lindern of Terragraphics International Foundation. *See* PET 550-616. Commenters raised numerous concerns and urged DEQ to gather additional information, to perform additional modeling and analysis, and to develop additional enforceable permit conditions and limits prior to issuing a final Permit. *See id.*

DEQ rejected most of the issues raised by the commenters. *See id.* And on June 17, 2022, DEQ issued the final Permit (PET 001) along with the Statement of Basis ("SOB") (PET 044) and Response to Comments ("RTC") (PET 549).

III. PM_{10} EMISSIONS FROM THE PROJECT.

Particulate matter ("PM") is a "criteria air pollutant." Under CAA Sections 108 and 109, EPA is required to establish NAAQS for each criteria pollutant to protect the nation's public health and welfare. The NAAQS specify a maximum amount of PM to be present in the outdoor air. *See* 40 C.F.R. §§ 50.6, 50.7. EPA established primary and secondary NAAQS for coarse particulate matter, or "PM_{10}," and for fine particulate matter, or "$PM_{2.5}$". 40 C.F.R. § 50.6-50.7. PM_{10} consists of inhalable particles with diameters that are generally ten micrometers and smaller; whereas, $PM_{2.5}$ consists of inhalable particles that are 2.5 micrometers and smaller. *Id.*

DEQ found that the Project has the potential to emit 986 tons per year of PM_{10} from a variety of controlled fugitive sources, plus 55.7 additional tons per year of PM_{10} from a variety of controlled point sources. PET 064 (Table 3). The generation of dust from ore haul trucks traveling along haul roads is the most significant source, representing approximately 72% of all fugitive PM_{10} emissions, and 68% of all modeled PM_{10} emissions. *See id.* The next most significant sources of PM_{10} are from drilling and blasting activities, which together account for an estimated 21% of all fugitive PM_{10} emissions (20% of all emissions). *See id.*

To evaluate whether the Project would comply with the PM_{10} NAAQS, DEQ modeled receptors at various locations along the Project's ambient air boundary and found the Project would exceed the 24-hour PM_{10} NAAQS at one receptor, when using a single-value for PM_{10} background at the site. PET 351-53 (SOB, App'x B at "TAPs Addendum Modeling Review"). DEQ then used seasonal and monthly background PM_{10} values to find that the maximum 24-hour PM_{10} pollution from the Project would be 123.5 micrograms per meter cubed ("ug/m^3), which is 82.3% of the NAAQS. PET 351 (Table 7).

Among other factors, these modeled PM_{10} emissions are based on Permit Condition 3.5 limiting Perpetua's production to no more than 180,000 tons per day, and no more than an average of 135,000 tons per day on a rolling five-year basis. *See* PET 055 (Table 1). They also depend on Perpetua achieving a 93.3% rate of control of fugitive dust. *Id.* Achieving these and other Permit conditions, and assumptions used in the modeling, also depend on future plans called for in the Permit, including a Fugitive Dust Control Plan ("FDCP"), Operations and Maintenance Plan ("O&M Plan"), and Haul Road Capping Plan ("HRCP"). *See* PET 009, 012, 020 (Permit Conditions 2.6, 2.20, 3.13); PET 090-91.

During public comment, Petitioners, EPA, and other commenters warned that DEQ unreasonably assumed PM_{10} emissions would be this low. PET 555-59. Specifically, Petitioners and EPA commented that DEQ unreasonably assumed Perpetua would be able to control 93.3% of dust it would otherwise emit on haul roads, and pointed out that DEQ's assumptions relied on the yet-to-be determined details of numerous future plans that have not yet been developed by Perpetua, submitted to DEQ, or included as conditions of the Permit. *Id.*

In its comments, EPA underscored that achieving 93.3% control for excavation and haul roads, and 90% control for drilling, "are critical to ensuring no violation of the NAAQS and

Title V HAP limits." PET 555. EPA warned that the Permit lacks conditions necessary to assure Perpetua achieves these efficiencies and that record fails to show those efficiencies are achievable based on site-specific conditions. PET 555-56. EPA also noted that DEQ failed to provide evidence to support its claim that a 90% control using magnesium chloride could be improved by also using water sprays to achieve a 93.3% control. PET 557.

Similarly, the NPT commented that DEQ had not demonstrated that 93.3% control was attainable or enforceable under the Permit. PET 555. And as ICL and SSFS pointed out in their comments, of the facilities Perpetua and DEQ pointed to as demonstrating compliance with high control rates, only one of these facilities was actually verified to have achieved that rate. PET 557-58. Furthermore, only one of these facilities was a gold mining operation. *Id.*

IV. ARSENIC EMISSIONS FROM THE PROJECT.

Arsenic is a Toxic Air Pollutant ("TAP") regulated by DEQ. Air Rules Section 586. DEQ determined arsenic is the largest projected TAP emission from the Project. PET 069. DEQ found that the Project could emit 0.544 lbs/hr at the maximum mine production rate of 180,000 tons per day. PET 067. Arsenic is a component of rocks, soils, and dust at the Project site, so arsenic emissions are essentially a percentage of the Project's PM_{10} emissions, and like with PM_{10}, the largest source of Project arsenic emissions are haul roads, estimated at 0.464 lbs/hr. PET 062.

No PTC can be granted unless DEQ determines the applicant showed "the emissions of toxic air pollutants from the . . . source . . . would not injure or unreasonably affect human health or animal life or vegetation as required by Section 161." Air Rules Section 203.03. Section 161 states, "[a]ny contaminant which is by its nature toxic to human or animal life or vegetation shall not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation." Air Rules

Section 161. For each carcinogenic TAP, including arsenic, the Air Rules set Acceptable Ambient Concentrations of Carcinogens ("AACC"), where each AACC is an annual average in ug/m^3. Air Rules Section 586. To demonstrate compliance with these TAPs requirements, ambient impacts must be less than the AACC. Air Rule Section 203; *see also* PET 470.

Because of the Project's high arsenic emissions, Perpetua used what DEQ described in the SOB as "a highly refined TAPs analysis approach to demonstrate compliance with applicable TAP increments." PET 332.

As one part of this approach, DEQ approved Perpetua's "T-RACT demonstration" to allow a 10-times increase in the arsenic AACC. *Id.* As the Air Rules provide, a permittee can analyze reasonable available control technologies ("RACT") that could be applied to a source of TAPs. *See* Air Rules Section 210.14. If using RACT does not sufficiently reduce toxic emissions to below the AACC, then the permittee is allowed a 10-fold increase in the AACC and can employ production limitations to ensure compliance with the now increased AACC. *See* Air Rules Section 210.12.b. Perpetua submitted to DEQ a T-RACT demonstration for arsenic emissions from open-pit drilling and ore haul roads. *See* PET 543-548 (SOB, App'x G, "T-RACT Analysis"). For open-pit drilling, Perpetua determined dry drilling with dust collectors was the most effective RACT. PET 545. For ore haul roads, Perpetua determined that the application of chemical dust suppressant, supplemented with frequent watering, as the RACT. PET 548.

As another part of this approach, DEQ allowed what it called an "AACC adjustment for the Operational Life of the Mine." PET 332. Under this approach, instead of comparing the highest annual average ambient arsenic concentration during the Project lifetimes to the T-RACT adjusted AACC (which is also an annual average), DEQ stretched out and diluted the arsenic

concentrations from the 16-year Project lifetime over a longer 70-year human life. *See* PET 344. During permitting, DEQ staff noted that this approach had not been used before, and raised concerns about whether it was permissible under the Air Rule. *See* PET 817-24; PET 825-30.

During public comment, Petitioners questioned DEQ's novel tactic for diluting the apparent arsenic exposure by spreading it over 70 years, and warned that without this the Project would exceed the arsenic AACC, even with the T-RACT adjustment. PET 596, 605, 609. Petitioners also warned that DEQ failed to assess the environmental impacts caused by the control technology, including by applying large amounts of magnesium chloride to roads to control dust, which can accumulate over time to toxic concentrations in trees and soils and can impact water. PET 596, 612.

In the end, DEQ approved Perpetua's T-RACT demonstration and, thus, granted a 10-fold increase in allowable arsenic pollution combined with using the creative new "adjustment" to dilute the apparent arsenic exposure by spreading it over 70 years so that DEQ could determined the Project would comply with this larger AACC. *See* PET 332.

V. AMBIENT AIR BOUNDARY AND THE STIBITE ROAD ACCESS ROUTE.

The CAA and Idaho Air Rules require Perpetua to meet various air standards, including the NAAQS and TAPs AACCs, in ambient air. *See*, *e.g.*, Air Rules Sections 006.11 (NAAQS), 006.125 (TAPs). EPA's CAA regulations define "ambient air" as "that portion of the atmosphere, external to buildings, to which the general public has access." 40 C.F.R. § 50.1(e).

The Stibnite Road Access Route ("Route") is a road that passes through what Perpetua and DEQ have defined as the mine's operations boundary and the ambient air boundary, and the inside of that boundary is the active industrial site where Project mining activities and heavy equipment operation will occur. PET 049 (map). Perpetua has indicated that it will not cut off

public access along the Stibnite Road Access Route during mine operations, and as explained by DEQ, Perpetua "will manage an access route to provide the general public with limited access through the [Project] site between Stibnite Road at Sugar Creek and Thunder Mountain Road at Meadow Creek." PET 310.

In public comments, Petitioners urged DEQ to count the Stibnite Road Access Route as ambient air where air quality standards would have to be met, since Perpetua plans to allow public access on the Route. PET 590-92. But DEQ excluded everything within the mine operations boundary from ambient air—including the Stibnite Road Access Route. *See id.*; *see also* PET 049 (map).

In its comments, EPA urged: "Given the unique situation with a public access road traversing the mine site, the key assumptions, parameters, and methodologies used to preclude public access from the mine site must be fully disclosed in the permit record and the necessary requirements be included in the permit and available for public review and comment." PET 569. But instead of following EPA's advice, DEQ is instead allowing Perpetua to develop an Access Management Plan ("AMP") to address these issues later without public review. PET 010, 070.

VI. LACK OF AMBIENT AIR MONITORING AT THE PROJECT SITE.

DEQ has the authority to require ambient air monitoring to determine the effect emissions from the stationary source or facility may have on the air quality of the area potentially impacted by the source. Air Rules Section 211.01(d). Petitioners and EPA urged DEQ to require ambient air monitoring to verify Project compliance with the NAAQS and AACCs. PET 560-64. DEQ responded that it "recognizes the uncertainty of predicted impacts (from the use of dispersion models) in complex terrain, the uncertainty in predicted impacts when using modeling techniques for fugitive emission sources, the uncertainty in emission factors and equations, the

uncertainty and variability in input parameters to emission equations, and the variability in background pollutant concentrations." PET 561. Despite all of this uncertainty, DEQ refused to require Perpetua to perform any ambient air monitoring. PET 561-62.

APPLICABLE LEGAL STANDARDS

Petitioners bring this contested case to challenge DEQ's action in issuing the Permit. Under the Idaho APA, an agency action like issuing the Permit will be overturned where its findings, inferences, conclusions, or decisions are: "(a) in violation of constitutional or statutory provisions; (b) in excess of the statutory authority of the agency; (c) made upon unlawful procedure; (d) not supported by substantial evidence on the record as a whole; or (e) arbitrary, capricious, or an abuse of discretion." Idaho Code ("I.C."). § 67-5279(3). *See 917 Lusk v. City of Boise*, 158 Idaho 12, 14 (2015).

"An action is capricious if it was done without a rational basis. It is arbitrary if it was done in disregard to the facts and circumstances presented or without adequate determining principles." *Am. Lung Ass'n of Idaho/Nev. v. Idaho State Dep't of Agric.*, 142 Idaho 544, 547 (2006) (citations omitted). Under the "well-established standard of review to evaluate whether there has been an abuse of discretion" the "decision-maker must have perceived the issue in question as discretionary, acted within the outer limits of its discretion and consistently with the legal standards applicable to the available choices, and reached its own decision through an exercise of reasons." *917 Lusk*, 158 Idaho at 14 (quotations omitted).

Motions for summary judgment before the Board are allowed by IDAPA 58.01.23.162.02 and are governed by the Idaho Rules of Civil Procedure ("I.R.C.P."). Summary judgment is proper here under I.R.C.P. 56(c), because there is no genuine issue as to any material fact and Petitioners are entitled to judgment as a matter of law. I.R.C.P. 56(c).

ARGUMENT

I. DEQ'S DECISION TO EXCLUDE THE STIBNITE ACCESS ROUTE FROM AMBIENT AIR PROTECTIONS IS UNLAWFUL.

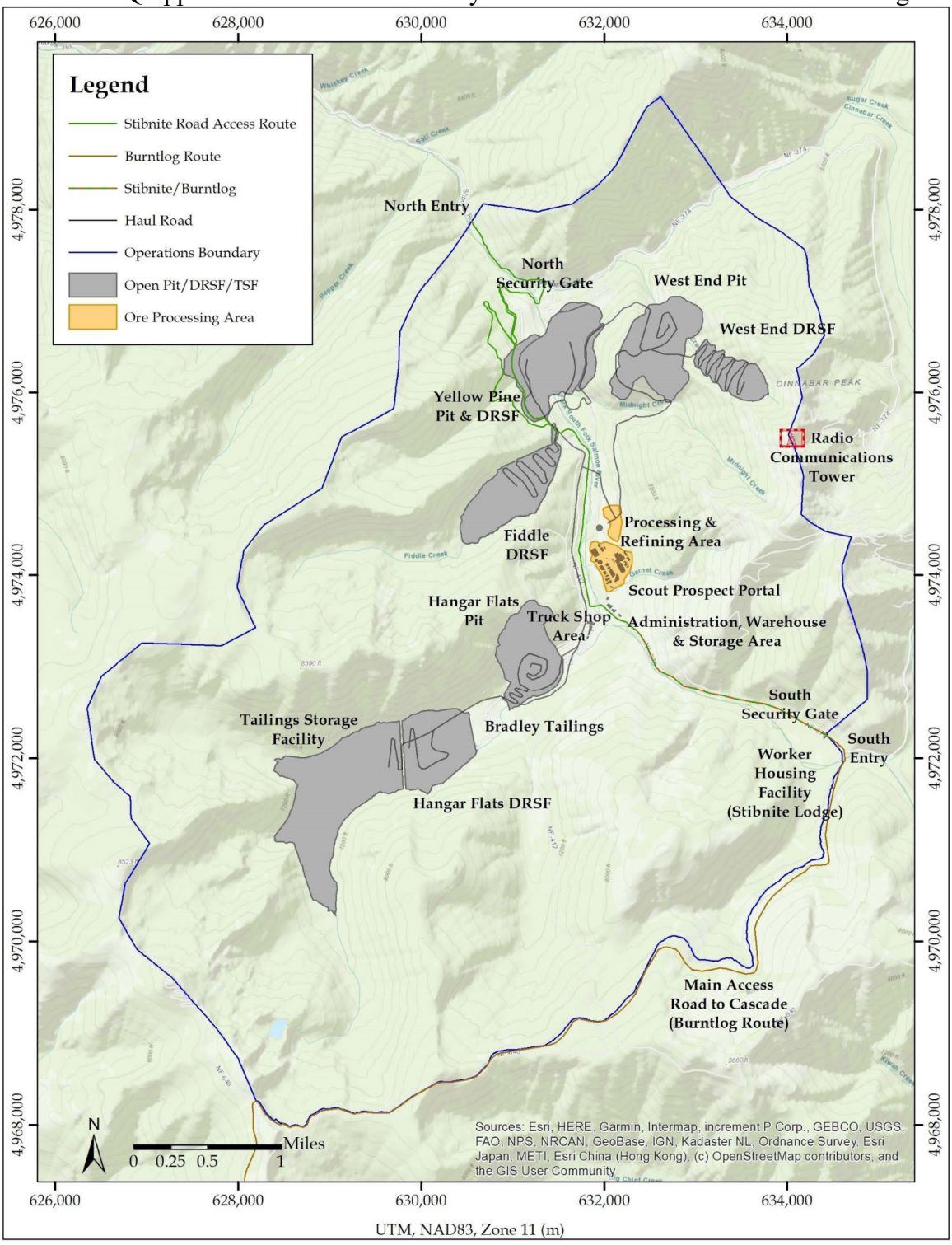
Health-based limits on pollution, such as the NAAQS and TAPs, form the foundation of the CAA and the Air Rules, and these limits must be met in "ambient air." By contrast, in areas excluded from ambient air, a facility does not have to demonstrate compliance with the NAAQS or TAPs. Both EPA and DEQ define "ambient air" as "that portion of the atmosphere . . . to which the general public has access." 40 C.F.R. § 50.19(c); Air Rules Section 006.10. "The essence of EPA's regulatory definition of ambient air links ambient air to public access." *Resisting Envtl. Destruction on Indigenous Lands (REDOIL) v. U.S. EPA*, 716 F.3d 1155, 1164 (9th Cir. 2013). EPA's long-standing policy, accordingly, has been to exempt from ambient air only "the atmosphere over land owned or controlled by the source and to which public access is precluded." PET 772.

The Stibnite Road Access Route is a public access road traversing the Project site. S*ee* Fig. 1 below. Perpetua has committed to allowing public access on this Route during operations. PET 310 (SOB). The importance of maintaining public access was highlighted in public comments submitted to the Forest Service through the National Environmental Policy Act ("NEPA") process for the Project, "particularly for those in the Johnson Creek and Yellow Pine area who use Stibnite Road to access Thunder Mountain Road and points beyond." PET 529. Maintaining access to these important recreational areas "is consistent with the [Forest Service] travel management plan." PET 530.

Because the public will be able to use the Route, it qualifies as ambient air where health-based air quality standards must be met. DEQ, however, excluded Perpetua's entire operations boundary (shown in Fig. 1 below) from ambient air–including the Route. DEQ's decision to

exclude the Route from ambient air cannot be squared with the CAA, the Air Rules, and EPA's national ambient air policy.

Fig. 1. Map reproduced from SOB (PET 049) showing Project operations boundary, which is also the DEQ-approved ambient air boundary. The Stibnite Road Access Route is in green.



As the Supreme Court stated in *Train v. Natural Resources Defense Council, Inc.*, 421 U.S. 60, 65 (1975), ambient air "is the statute's term for outdoor air used by the general public." EPA's policy for excluding certain portions from ambient air explains:

> [T]he EPA's policy allowing exclusion of some areas external to buildings is not based on language in the regulatory definition mandating exclusion or providing particular criteria for such an exclusion, but rather, is inferred as the inverse of what is affirmatively covered by that definition (*i.e.*, if "ambient air" is defined as that to which the general public has access, then that to which the general public does not have access is not ambient air. . . . The EPA continues to view the "general public" to include any person(s) other than those who are permitted access to the property as employees or business invitees of a specific stationary source (including trespassers).

PET 779. It is clear from EPA's policy that the exemption from ambient air is available only for areas where the general public *will be precluded from entering*–both because there is no legal right to access, as well as no "physical or practical access." *Id.* The Permit, however, does not preclude access by the general public. Rather, it permits Perpetua to allow public access and, therefore, inappropriately exempts the Route from ambient air.

To circumvent this problem, DEQ maintains that the "roadway is not public" because Perpetua "has sole control of access through the site" and "is not obligated to allow access." PET 590, 592. Furthermore, DEQ erroneously rationalized because Perpetua will have the ability to "state the conditions of allowed access," the general public passing through the mine site to access public land are now "guests of [Perpetua] in the same manner as those touring the facility as part of a classroom fieldtrip [sic]." PET 590. Disavowing itself of any responsibility for mine "guests," including schoolchildren, DEQ explained: "Since those requesting access to the site are guests of [Perpetua] and no longer members of the public, health and safety of such guests . . . is the responsibility of [Perpetua] and outside of the scope of the PTC." PET 570. DEQ's

rationalization is disingenuous, and as EPA warns in its policy "would expand the exclusion beyond reason and deny the protection of the NAAQS to large numbers of people." PET 779.

This interpretation of EPA's ambient air policy requires the anomalous conclusion that the mere *ability* to preclude the general public is the same as *actually* precluding the general public. EPA's policy for excluding a facility from ambient air is based on "that to which the general public does not have access." PET 772. Physical access "addresses whether the general public is able to, *under actual circumstances*, enter a particular parcel of land." PET 779 (emphasis added). The actual circumstances here are that Perpetua plans, with limited exceptions (like during blasting), to continue to allow public access on the Route during the life of the Project. PET 310. Because the general public will actually have access—as Perpetua has consistently committed—the Route is ambient air.

DEQ guidelines further support this point. Those guidelines state that an applicant's proposal to exclude an area from ambient air "must include justification that demonstrates the facility has reasonable control of the area and *effectively precludes public access on a routine basis*." PET 743 (emphasis added). Notably, DEQ guidelines identify the precise situation here—when "general public [is] allowed on site as a part of a right-of-way easement or common service road"—as being ambient air. PET 744. Again, while Perpetua would "state the conditions of allowed access" on the Route, Perpetua is not precluding public access. PET 087.

DEQ guidelines also provide that the "'general public' is considered anyone not directly associated with the facility." PET 743. This contradicts DEQ's assertion that people traveling the Route to access public lands are not the general public but are rather "guests" of the mine. *See* PET 529. DEQ's contorted definition of the general public as "guests" of the mine has no rational basis and does not make them "directly associated with the facility."

The Permit requirement for Perpetua to develop and follow an Access Management Plan does not change this. Under Permit Condition 2.7, the AMP is supposed to specify the "measures to be used to discourage public access to the facility." PET 010. It also provides that: "Only registered guests of the facility will be allowed access to or through the facility." *Id.* Again, simply classifying general members of the public seeking to pass through the facility as "registered guests" does not convert them to people who are directly associated with the facility.

Furthermore, as EPA warned in its comments: "Given the unique situation with a public access road traversing the mine site, the key assumptions, parameters, and methodologies used to preclude public access from the mine site must be fully disclosed in the permit record and the necessary requirements be included in the permit and available for public review and comment." PET 569. But instead of fully disclosing these key assumptions, parameters, and methodologies in the Permit, DEQ is letting Perpetua develop these later, without public comment or full DEQ review. Under Permit Condition 2.8, Perpetua need not submit the AMP to DEQ until 30 days prior to startup. PET 010.

DEQ cannot issue a Permit first and leave important issues to be addressed in the AMP outside the required permit process, behind closed doors, and without full DEQ review. Without full disclosure and review of the specific measures and requirements in the AMP, DEQ had no rational basis for concluding that the Route can be properly excluded from ambient air, rendering that decision arbitrary and capricious. DEQ's decision to exclude the access road from ambient air protections is thus arbitrary and capricious and fails to comply with the CAA, the Air Rules, and EPA and DEQ policies, and places the public at risk. The Hearing Officer should grant summary judgment for Petitioners, set aside the Permit, and order DEQ on remand to include the Route as ambient air.

II. DEQ'S DETERMINATION THAT THE PROJECT WILL COMPLY WITH PM_{10} AND ARSENIC LIMITS IS ARBITRARY AND VIOLATES THE AIR RULES.

Even using DEQ's ambient air boundary, DEQ's determinations that the Project's potential to emit will not cause or contribute to an exceedance of the PM_{10} NAAQS and the arsenic AACC—as required under Air Rules Section 203 prior to issuing a PTC—are arbitrary and capricious and violate the Air Rules, must be set aside and remanded.

When it made these determinations, DEQ relied on modeling that included a number of important inputs, including: the percentage of fugitive dust emissions that Perpetua will effectively control; the sizes and weights of, and miles traveled by, Perpetua's ore haul trucks; the number of days of recordable precipitation; and others. However, the values DEQ used for each of these inputs were unreasonable and/or not included as enforceable Permit conditions, as set forth in the sections below. Thus, Perpetua's actual operations, and the site conditions, might differ from what was assumed in the modeling, and PM_{10} and arsenic concentrations could violate applicable standards even if Perpetua fully complies with the terms of the Permit.

A. DEQ's Assumption that Perpetua Will Prevent 93.3% of Fugitive Dust Emissions Is Unreasonable and Violates the Air Rules.

A critical factor affecting fugitive dust emissions, and therefore whether the Project will comply with the PM_{10} NAAQS and arsenic AACC limits, is the degree to which Perpetua will effectively control dust from haul roads.[2] When it approved the Permit, DEQ assumed that Perpetua will achieve a 93.3% control efficiency of all haul road dust by using a combination of water sprays and chemical dust suppressants. *See* PET 065. However, as EPA and other commenters pointed out, it is highly questionable whether 93.3% fugitive dust control is

[2] There are other sources of fugitive dust emissions at the facility, including "drilling and blasting activities, crushing and ore handling equipment, ore and rock storage piles, and unpaved roadways." PET 064. However, fugitive dust emissions from unpaved roadways represents a majority of the estimated PM_{10} and arsenic emissions from the facility. PET 061, 063 (Table 3).

realistically attainable for this Project, and the Permit lacks conditions necessary to ensure that Perpetua will achieve such a high level of control. *See* PET 554-559.

EPA has found, for example, that chemical dust suppressants achieved only 80% control efficiency, far less than the 93.3% DEQ relied on. Specifically, "past field testing of emissions from controlled unpaved roads has shown that chemical dust suppressants provide a PM_{10} control efficiency of about 80 percent when applied at regular intervals of 2 weeks to 1 month." PET 809. If Perpetua achieved only 80% control of dust emissions, then 20% of dust will be emitted (2,218 tons per year), compared to emitting only 6.7% of dust as assumed in the modeling (713 tons per year). This means, at a realistic 80% control level, Perpetua would generate *3 times* the amount of dust than what was assumed in the modeling DEQ relied on when it determined the Project would not exceed the PM_{10} NAAQS and the arsenic AACC.

Additionally, DEQ asserted that chemical suppressants could achieve 90% dust control on their own, asserted that water could 33.3% alone, and then assumed that combined these two practices could achieve 93.3%. PET 143. But as EPA and other commenters stated in their comments, DEQ failed to provide any support for its assumption that the *combination* of magnesium chloride sprays and water sprays would improve the control efficiency at all, let alone to 93.3%. *See* PET 555, 557. For example, the application of water may dissolve the bond between the chemical suppressant and road particles, thus decreasing the control efficiency—not increasing it.

Furthermore, even if one assumes that the high 93.3 % dust control efficiency could technically be achieved, the Permit fails to include enforceable limits on the spray frequency and rates, and other important factors, affecting whether Perpetua will in fact achieve anywhere near 93.3% dust control. EPA guidance identifies the following factors bearing on the effectiveness of

chemical dust suppressants: (a) the dilution rate used in the mixture; (b) the application rate (volume of solution per unit road surface area); (c) the time between applications; (d) the size, speed, and amount of traffic during the period between applications; and (e) meteorological conditions (rainfall, freeze/thaw cycles, etc.) during the period. PET 797-816.

To be sure, the Permit includes conditions related to dust control. Permit Conditions 2.1 through 2.5 require Perpetua to take "reasonable precautions" to monitor and maintain records related to dust emissions; but they do not specify the quantity or frequency of spray or other important variables. *See* PET 008-09. Permit Condition 2.6 requires Perpetua to develop the Fugitive Dust Control Plan ("FDCP"), which will become an enforceable part of the Permit, with a "list of all potential sources of fugitive dust emissions and the following reasonable precautions to minimize fugitive dust emissions." PET 009. But Permit Condition 2.6 does not set out those "reasonable precautions" such as requirements for the frequency or quantity of sprays and other important variables. Instead, Condition 2.6 directs Perpetua to "[d]evelop specific criteria to determine what frequency and type (water and/or chemical) of dust suppressant must be applied, and appropriate suppressant application rates." PET 010.

This vague direction for Perpetua to develop "criteria to determine" spray frequency, rates, and types in no way assures that Perpetua will both develop and follow criteria to actually achieve its ambitious 93.3% control efficiency—or anywhere close to it. This is especially so since the FDCP will be developed by Perpetua and submitted to DEQ for approval 30 days prior to startup, without public comment. *Id.*

Notably, DEQ itself recognized that it will be "challenging to consistently and continuously achieve the targeted level of fugitive dust control for emissions from traffic on unpaved roadways, with over 55 miles of haul truck routes within the operations boundary a fleet

of 32 haul trucks weighting between 37 and 357 tons, and a targeted dust control efficiency of 93.3% accomplished by application of both dust suppressant and water controls." PET 064. Later in the SOB, DEQ admitted that meeting 93.3% was based on an "assumption" that Perpetua would appropriately apply water and magnesium chloride, that "vigilant inspection and monitoring" would be required, and that additional measures beyond those actually required by the Permit would be necessary in the FDCP:

> Reduction of PM emissions from haul roads by a combined 93.3% was supported by assuming appropriate application of water and magnesium chloride dust suppression; DEQ is cognizant that to consistently achieve this level of control requires conscientious efforts, vigilant inspection and monitoring, and a comprehensive FDCP. Because continuous operation was proposed, suppression measures will need to account for and accommodate all weather conditions including diurnal and seasonal variability, and all traffic loads including mining and public traffic along publicly accessible roads. Conditions outside of what may normally be anticipated may require additional measures such as a reduction in vehicle speeds or selection of a more effective chemical dust suppressant. Although the FDCP specifies a minimum of efforts required, additional operational limits and monitoring are to be considered moving forward and evaluated for incorporation into the FDCP.

PET 090.

DEQ's modeling staff similarly recognized that "it is critical for NAAQS compliance that this high level of control [(93.3%)] be achieved." PET 275. The modeling staff called this "an aggressive level of control," adding that this "high level of emission control was needed to demonstrate compliance with NAAQS." PET 325. In fact, DEQ modeled what would happen if Perpetua cut its operations by a third (hauling 120,000 tons per day instead of the authorized 180,000 tons per day) and achieved only 90% dust control; DEQ found that this slightly lower dust control, even when combined with a major cut in mining activity, would cause exceedances of the PM_{10} 24-hour NAAQS. PET 325-26. Ultimately, DEQ's modeling team "recommend[ed]

that *the permit require an aggressive implementation of measures to achieve above 93% control* efficiency for fugitive particulate emissions from roadways." PET 328 (emphasis added).

But DEQ failed to require such "aggressive implementation" and "vigilant inspection and monitoring" in the Permit, instead relying on the vague direction for Perpetua to consider some of these issues later in its FDCP. Like with the AMP, DEQ once again failed to develop important conditions as part of the Permit and is instead leaving important issues to be addressed by Perpetua later in the FDCP, outside the required permit process, behind closed doors, and without full review by the public. Without determining first what dust suppressant types, frequencies, and rates can actually achieve such a high 93.3% control level, and without including those types, frequencies, and rates as enforceable Permit requirements, the Project's potential to emit fugitive dust is higher than what DEQ assumed. Contrary to DEQ's determinations, Perpetua's operations would cause a violation of the PM_{10} NAAQS and arsenic AACC, even while fully complying with the Permit.

B. DEQ Failed to Include Conditions Restricting Ore Haul Truck Weights, Sizes, and Miles Traveled in the Permit.

The amount of fugitive dust Perpetua will emit is also dependent on the weights and sizes of the ore haul trucks it uses, and on the miles those trucks travel. As DEQ admitted in the SOB, "accurate determination of site-specific parameters characterizing road conditions and vehicle traffic was *critical* to estimating particulate matter emissions and ambient air impacts." PET 062 (emphasis added). Important traffic-related modeling parameters for the Project include: the average empty weight of ore haul trucks; the average loaded weight of ore haul trucks; the number of larger versus smaller ore haul trucks (CAT 789D versus CAT 740B); and the total miles traveled by ore haul trucks. PET 798. *See also* PET 061.

Despite recognizing they were "critical" to PM emissions and air impacts, the Permit failed to include any enforceable Permit conditions for these parameters. As Perpetua admits: "the average loaded weight of ore haul trucks, the size of trucks used, . . . and the total number of vehicle miles traveled by ore haul trucks were not included as specific conditions in the PTC." *Perpetua's Resp. to First Amended Petition*, ¶ 36. Because these are not specified Permit requirements, Perpetua could use different sizes and weights of trucks, and drive them a different number of miles, than what was used in the modeling for the Permit, reviewed by the public, and reviewed and approved by DEQ—all without violating any enforceable condition of the Permit.

Without enforceable conditions for these important vehicle parameters, DEQ could not reasonably claim when it issued the Permit that the facility will not cause or significantly contribute to a violation of the PM_{10} NAAQS and that it will comply with the arsenic AACC under Air Rules Section 203.

In its comments, EPA urged DEQ to include as enforceable permit conditions those "parameters and assumptions used to develop the fugitive dust emission factors estimates for the haul roads and access roads" including "mean vehicle weight (tons), speed limit (mph), and daily vehicle miles traveled." PET 556. Once again, DEQ relied on the yet-to-be developed FDCP. *See* PET 061. However, while Permit Condition 2.6 states that measures specified in the FDCP will be incorporated by reference and will be enforceable, PET 009, there is no requirement that the FDCP actually address these and other important traffic-related parameters.

While Permit Condition 2.6 identifies minimum items the FDCP should include, *see* PET 009-10, nowhere does it require Perpetua to specify the average empty weight of ore haul trucks, the average loaded weight of ore haul trucks, the total number of larger versus smaller ore haul trucks (CAT 789D versus CAT 740B), or the total number vehicle miles traveled by ore

haul trucks. There is simply no requirement for Perpetua to include these variables in its future plan. Thus, there is no assurance that any, let alone all, of these important variables will be addressed in the FDCP and will become enforceable permit conditions. And even if Perpetua voluntarily chooses to address these variables in those future plans, there is no requirement that Perpetua will set these variables at levels that cause the same (or less) dust emissions than was assumed in the modeling.

As a result, Perpetua's operations could cause a violation of the PM_{10} NAAQS and could exceed acceptable arsenic levels even while complying with the Permit and with future plans adopted under it. DEQ, thus, lacked any reasonable basis for concluding the Project will comply with PM_{10} NAAQS and arsenic AACC Air Rules Section 203.

C. DEQ Failed to Use Representative Precipitation Data.

Another important input to the model estimating the Project's fugitive dust emissions is the number of days per year of recordable precipitation, defined as recording precipitation of 0.01 inch or greater, as precipitation can reduce fugitive dust emissions. *See* PET 061, 062; PET 809. Rather than use available site-specific meteorological data to calculate fugitive dust emissions from haul roads, DEQ used a generic value in EPA guidance to assume that there are 120 days of recordable precipitation at the Project site. *See* PET 146; *see also* PET 805 (map). This was arbitrary and counter to DEQ guidance.

For modeling ambient air impacts, Section 6.8 of DEQ's Guideline for Performing Air Quality Impact Analyses states: "The meteorological data used in the modeling analysis should be representative of the meteorological conditions at the particular site of the proposed construction or modification." PET 745. DEQ had and used local data for its ambient air impacts

modeling. PET 301 (discussing use of "historic 30-year (1985-2014) precipitation data from the Taylor Ranch station in Idaho (closest station from which this type of data is available)").

But when it came to calculating fugitive dust emissions from Project haul roads, DEQ failed to use this same local data and instead relied on the more generic 120 days per year number. The failure to use the local, representative data undermines DEQ's estimates of Project road emissions, and DEQ's determinations that the project will not cause or contribute to a violation of the PM_{10} NAAQS and arsenic AACC.

D. DEQ Failed to Include in the Permit Monitoring and Recordkeeping Requirements Critical to Ensuring Haul Limits Are Met.

Perhaps the most critical factor affecting the Project's dust emissions is the amount of ore and waste rock (development rock) hauled during operations. The more ore and waste rock hauled, the more fugitive dust emissions. DEQ did include Permit limits on ore haul. Permit Condition 3.5 limits Perpetua to haul no more than 180,000 tons per day, and no more than an average of 135,000 tons per day on a rolling five-year basis. PET 019. But the Permit lacks any developed and enforceable monitoring requirements to ensure these critical haul limits are met.

As EPA warned in its comments, the "monitoring methods associated with the haul roads appear to be unenforceable as they do not specify how the monitoring and recordkeeping demonstrating compliance with the applicable . . . limitations will be achieved." PET 561. EPA added that the "permit must include all monitoring, recordkeeping and reporting necessary to assure compliance with the permit emission limitations and applicable requirements." *Id.*

But instead of including all such monitoring, recordkeeping, and reporting as specific Permit conditions, DEQ again relied on a future plan to be prepared by Perpetua outside the normal PTC permitting process, like it did with the AMP and the FDCP. Permit Condition 3.16 requires: "Each day, the permit shall monitor and record the amount of ore and DR transported

on haul trucks (T/day)." PET 020. However, the Permit fails to establish how such monitoring will be accomplished. Instead, the Permit directs: "The devices and methodologies used to measure weights shall be identified in the O&M Manual." *Id.* The O&M (operation and maintenance) Manual is required to: "Describe each monitoring device and methodology used to measure weight rates of materials to demonstrate compliance with each material throughput limit," including 180,000 T/day haul limit. PET 013. But the O&M Manual (like the AMP and FDCP) is a "permittee-developed document" which Perpetua need not submit to DEQ until 30 days prior to startup. PET 013-14.

As DEQ admitted in the SOB, "[c]ompliance is assured by complying with the [O&M Manual] monitoring and recordkeeping requirements." PET 563. But because the O&M Manual was not developed, released to the public for comment, or reviewed and revised by DEQ when it issued the Permit, DEQ had no reasonable basis for assuming O&M Manual will be adequate to ensure sufficient monitoring and recordkeeping requirements will be developed and, therefore, that compliance will be met. And because actually complying with the haul limits is critical to limiting fugitive dust emissions, DEQ's determinations under Air Rules Section 203 that the Project will not cause or contribute to any NAAQS violations and will meet the TAPs AACCs were unreasonable.

In summary, without developing and including important variables and factors as enforceable conditions before issuing the Permit, and without using representative precipitation data, as set forth in the sections above, there was no reasonable basis for DEQ to assume the Project will comply with the 24-hour PM_{10} NAAQS and arsenic AACC. For these reasons, the Hearing Officer should set aside and remand the Permit and order that these conditions be developed as part of the normal PTC process, and not through an after-the-fact, secret process, to

ensure the Project will comply with the PM_{10} NAAQS and arsenic AACC. Without doing so, DEQ has no reasonable basis for concluding the Project will not cause or contribute to violation of these air standards.

III. DEQ'S RELIANCE ON FUTURE PLANS TO BE PREPARED BY PERPETUA OUTSIDE OF THE PTC PROCESS VIOLATES THE AIR RULES AND CAA.

As discussed in sections above, DEQ deferred addressing many issues during the PTC permitting process and will let Perpetua address those issues in the future through various plans. These "Plans" include the AMP (Supra I), FDCP (Supra II.A & B), and O&M Manual (Supra II.D). *See also* PET 565-70. The Plans also include the Haul Road and Capping Plan ("HRCP"). *Id.* Under Permit Condition 3.13, the HRCP is to include a sampling plan for analyzing the arsenic concentration of materials Perpetua uses, a silt content sampling plan, and details about maintenance procedures and the frequency Perpetua will inspect haul roads. PET 019-20. Like the AMP, FDCP, and O&M Manual, the HRCP was not developed as part of the PTC permitting process. *See id.* All of the Plans are to be developed by Perpetua later and submitted to DEQ for 30 days prior to starting operations, without public comment. PET 010, 014, 020 (Permit Conditions 2.8, 2.21, 3.13).

DEQ's reliance on these future Plans violates the CAA and the Air Rules, and is otherwise arbitrary and capricious. No provisions in the Air Rules authorize DEQ to save portions of a PTC to be developed later, outside the normal PTC permitting process. Rather, the Air Rules require DEQ to process PTC applications only when they are complete, require DEQ to ensure the applicant has submitted sufficient information so DEQ can make all required determinations for PTCs, and requires DEQ to take public comment. *See* Air Rules Section 209.

During permitting, but not after, the applicant must provide: "Site information, plans, descriptions, specifications, and drawings showing the design of the stationary source, facility, or

modification, the nature and amount of emissions (including secondary emissions), and the manner in which it will be operated and controlled." Air Rules Section 202.01.a.i. Additionally, DEQ is authorized to obtain from the applicant during the permitting process "[a]ny additional information, plans, specifications, evidence or documents the Department may require to make the determinations required [to issue a PTC]." Air Rules Section 202.03. And in response to a PTC application, the Air Rules require DEQ ultimately to issue either an "approval," a "conditional approval," or a "denial." Air Rules Sections 209.01.b.i & ii, c.iv.

Similarly, to ensure compliance with the NAAQS and other air pollution control strategies, the CAA and EPA's CAA regulations require State air rules like DEQ's to include: "enforceable emission limitations" and other measures, 42 U.S.C. § 7410(a)(2)(A); a "program to provide for the enforcement" of such measures, and to regulate the construction of any stationary source, *id.* § 7410(a)(2)(C); "legally enforceable procedures" for determining whether the construction of a facility will comply with control strategies and NAAQS, 40 C.F.R. § 51.160(a); sufficient information needed "to make the determination" whether the facility will comply with air pollution control strategies and the NAAQS, i*d.* § 51.160(c); and an opportunity for public comment on information submitted by the applicant and on the agency's analysis of the effects to air quality. *Id.* § 51.161(a).

Here, instead of following these requirements, DEQ rushed forward and issued Perpetua what is essentially a *partial, incomplete PTC*, based on incomplete information and analysis, and lacking numerous permit conditions. DEQ will effectively issue a complete PTC later, after Perpetua develops and submits to DEQ additional plans, information, and conditions through the AMP, HRCP, FDCP, and O&M Manual, shielded from public review and outside the normal PTC process required by the Air Rules and the CAA.

Not only does DEQ's reliance on these Plans fail to comport with the Air Rules and the CAA provisions discussed above, but it also undermines DEQ's determinations that the Project will comply with air quality standards. Because DEQ has deprived the public of meaningful involvement, and has failed to conduct a full and adequate review of the application before it issued the Permit, DEQ cannot reasonably claim that the Project will comply with the PM_{10} NAAQS and arsenic AACC.

Federal courts have rejected similar tactics when it comes to Clean Water Act ("CWA") permitting. In one case, the Second Circuit recognized that CWA permitting schemes that do not allow for public review of best management practices incorporated into permits violate the CWA. *Waterkeeper Alliance v. U.S. EPA*, 399 F.3d 486, 503-504 (2d Cir. 2005). The Second Circuit held that a permit that relies on best management practices but does not specifically list those best management practies in the permit itself "deprives the public of the opportunity for the sort of regulatory participation that the Act guarantees because [such a permit] effectively shields the . . . management plans from public scrutiny and comment." *Id*. at 503. The Ninth Circuit has similarly held that "programs that are designed by regulated parties must, in every instance, be subject to meaningful review by an appropriate regulating entity to ensure that each such program reduces the discharge of pollutants to the maximum extent practicable [i.e., the relevant statutory standard]." *Envtl Def. Ctr. v. U.S. EPA*, 344 F.3d 832, 856 (9th Cir. 2003).

By allowing Perpetua to provide plans, descriptions, specifications, and information about the manner in which the facility will be operated and controlled at a later date after the Permit has already been approved, DEQ has similarly circumvented the Air Rules and CAA permitting requirements, deprived the public of meaningful comment, and undermined DEQ's determinations that the Project will comply with applicable standards. The Hearing Officer

should grant summary judgment to Petitioners, set aside the Permit and order DEQ to: require Perpetua to submit the AMP, FDCP, O&M Manual, and HRCP; to provide for public comment on the Plans; to review and revise Plans to ensure the Project's emissions, as limited by enforceable conditions, comply with Air Rules Section 203; and to complete these steps before issuing a new Permit—not after.

IV. DEQ MUST REQUIRE AMBIENT AIR MONITORING.

DEQ has the authority to require ambient air monitoring to determine the effect emissions from the stationary source or facility may have on the air quality of the area potentially impacted by the source. Air Rules Section 211.01(d). During public comment, EPA and Petitioners urged DEQ to require ambient air monitoring to verify the Project's compliance with the NAAQS and TAP AACCs. PET 560-64.

As EPA commented: "Given the high level of uncertainty in the assumptions and requirements to ensure compliance with the PM_{10} 24-hr NAAQS, the addition of post-construction ambient monitoring requirements is highly prudent." PET 561. EPA recommended that DEQ "add a permit requirement for the source to deploy a fenceline PM10 monitoring network . . . to demonstrate 24-hour and annual PM10 NAAQS compliance." *Id*. Similarly, ICL and SSFS urged ambient air boundary monitoring because of the "uncertainty surrounding dust control efficiency and emissions factors." PET 565. But DEQ declined.

Without ambient air monitoring, it will be impossible for DEQ to assess whether Perpetua is indeed complying with the NAAQS and TAPs AACCs. For example, DEQ admitted that Perpetua aims to achieve a "high" and "aggressive" level of dust control, which DEQ modelers recommended requires aggressive implementation in the Permit. PET 275, 325, 328. Furthermore, as already discussed, DEQ failed to establish numerous Permit conditions related to

potential emissions and related to monitoring and reporting, instead relying on future Perpetua Plans (the FDCP, O&M Manual, and HRCP). This approach leaves it highly uncertain how the Project will operate and what the emissions will in fact be. If DEQ is going to employ these approaches, then it is imperative to require Perpetua to conduct ambient air monitoring.

The Hearing Officer should grant Petitioners summary judgment, set aside the Permit, and order DEQ to require on remand that the Permit include ambient air boundary monitoring, as provided for by Air Rules Section 211.01(d), to ensure compliance with the NAAQS and AACCs. Prior to issuing any Permit, DEQ must require Perpetua to submit an ambient air boundary monitoring plan ("AABMP"), must take public comment on the AABMP and then review and revise the AABMP, and must incorporate the terms of the AABMP as enforceable Permit conditions.

V. DEQ FAILED TO ANALYZE ECONOMIC INFORMATION AND ENVIRONMENTAL IMPACTS IN THE ARSENIC T-RACT.

As described in the background, Perpetua submitted a T-RACT demonstration, which DEQ granted, thereby endorsing Perpetua's plan to use chemical dust suppressants combined with frequent watering to reduce dust emissions from Project roads, and allowing a 10-fold increase in the AACCs—acceptable concentrations of arsenic and other TAPs in the ambient air during operations. *See* PET 544-548 ("T-RACT Analysis"). DEQ's approval of Perpetua's T-RACT is arbitrary and capricious and violates the Air Rules because DEQ failed to consider the economic costs, operational feasibility, and environmental impacts of Perpetua's plan.

The Air Rules dictate that, as part of the T-RACT determination process, an applicant must supply, and DEQ must consider, information relevant to the "control technologies or other requirements the applicant believes to be T-RACT." Air Rules Sections 210.14.a-b. Factors that DEQ must consider include, but are not limited to: control effectiveness, economic costs,

operational feasibility, and associated environmental impacts. Air Rules Sections 210.14.a–d. As the Third Circuit has explained, "RACT is not designed to rubber-stamp existing control methods" and the controlling agency's review "must satisfy both technological and economic feasibility." *Sierra Club v. U.S. EPA*, 972 F.3d 290, 295 (3d Cir. 2020). As the court explained in *Sierra Club*:

> The EPA explains, "[t]he technological feasibility of applying an emission reduction method to a particular source should consider the source's process and operating procedures, raw materials, physical plant layout, and any other environmental impacts such as water pollution, waste disposal, and energy requirements." Whereas the economic feasibility "considers the cost of reducing emissions and the difference in costs between the particular source and other similar sources that have implemented emission reduction."

Id. Despite these requirements, DEQ approved Perpetua's T-RACT demonstration even though it failed to include any information at all about the environmental impacts of the control technologies, and failed to include information about the economic costs and operational feasibility of employing them.

As for environmental impacts, Petitioners warned that applying large amounts of magnesium chloride to roads to control dust can accumulate over time to toxic concentrations in trees and soils, impact water, and compromise aquatic environments. PET 596, 612. Additionally, the water that will be used to supplement dust control measures will be from sources that already have elevated arsenic levels, so "frequent watering" may cause additional environmental harm. PET 612. But the T-RACT Analysis failed to include any information about these or any other environmental impacts of Perpetua's proposed dust control technologies. *See* PET 543-548. By wholly failing to address this, it is unknown whether to what degree Perpetua's aggressive magnesium chloride application will harm the environment. DEQ,

thus, failed to comply with the requirement to consider this information under Air Rules Sections 210.14.c.ii.

The economic and operational feasibility analysis fairs no better. The T-RACT Analysis states that paving roads would achieve better dust control but is "costly" and will not be used for the Project. PET 545-47. This is the *only* economic information—if that even counts as such—in the T-RACT analysis. *See* PET 544-548. Again, DEQ must address the "economic feasibility of a control technology or other requirement, including the costs of necessary mitigation measures, for a particular source." Air Rules Section 210.14.d. But the T-RACT Analysis includes no information about the economic feasibility of Perpetua's proposed control technology. *See* PET 544-48. It is thus unknown how much it will cost Perpetua to employ the type of "aggressive" magnesium chloride application and the "vigilant" practices and monitoring necessary, whether sufficient supplies are even available, and if this plan is otherwise feasible.

The Hearing Officer should grant Petitioners summary judgment, set aside the Permit, and remand for a complete T-RACT analysis under the Air Rules.

VI. DEQ IMPROPERLY DILUTED PROJECT ARSENIC EXPOSURE, MASKING THE TRUE HEALTH RISKS IN VIOLATION OF THE AIR RULES.

Even with the T-RACT adjusted arsenic AACC—which allows Perpetua 10 times the normal limit—DEQ recognized that the Project would still exceed the arsenic AACC. To avoid this problem, DEQ contrived a new tactic to artificially reduce the apparent arsenic exposure by spreading out the actual arsenic exposure resulting from the 16-year Project over a longer 70-year human lifetime. *See* PET 332, 344 (SOB, App'x B). This new trick artificially reduces the apparent concentration of arsenic to a mere 23% (16/70 x 100) of what the arsenic concentration will actually be each year during the Project.

Nothing in the Air Rules allows for diluting arsenic (or any TAPs) concentrations like this. Under Air Rule Section 203:

> No permit to construct shall be granted for a new or modified stationary source unless the applicant shows to the satisfaction of the Department all of the following:
>
> . . .
>
> 03. Toxic Air Pollutants. *Using the methods provided in Section 210*, the emissions of toxic air pollutants from the stationary source or modification would not injure or unreasonably affect human or animal life or vegetation as required by Section 161. *Compliance with all applicable toxic air pollutant carcinogenic increments* and toxic air pollutant non-carcinogenic increments will also demonstrate preconstruction compliance with Section 161 with regards to the pollutants listed in Sections 585 and 586.

(emphases added).

The applicable TAPs "carcinogenic increments" that must be met to satisfy Section 203.03 are the AACCs, which are *annual average* ambient concentrations. *See* Air Rules Section 586. The "methods provided in Section 210" that must be followed to satisfy Section 203.03 spell out in detail how to estimate TAPs emissions and ambient concentrations. *See* Air Rules Section 210. Section 210 even allows applicants to seek a 10 times larger AACC through T-RACT—a huge leniency, which DEQ allowed Perpetua. *Id.* But nothing in Section 210 allows DEQ to grant *even greater leniency* when it comes to meetings the AACCs, such as by diluting a project's 16-year TAPs concentrations over 70 years. *See* Air Rules Section 210.[3]

DEQ permitting staff recognized this problem, and documented their concerns in two memos. *See* PET 817-24; PET 825-30. DEQ staff acknowledged that this approach had not been used before, stating that requiring the methods in Section 210 is "certainly how DEQ has used

[3] This point is reinforced by the fact that the Air Rules explicitly grant leniency for short-term sources operating for five years or less, but not for other temporary facilities. *See* Air Rules, 210.15

this in the past." PET 819.[4] DEQ staff questioned whether this novel approach was allowed under the Air Rules. *See*, *e.g.*, PET 822 ("Can a 70 year average concentration be used for comparison to AACCs rather than a single year average for Section 210 analyses?"). DEQ staff also cautioned that "DEQ would need legal opinion as to whether this meets requirements of Section 210." PET 817.

The record does not reveal whether DEQ ever sought or obtained a legal opinion on this issue. But in the end, DEQ broke from its established practice of comparing annual average arsenic exposures from a facility to the annual average AACC. Instead, DEQ spread the arsenic exposures from the 16-year Project over 70 years, reducing the supposed arsenic exposure to a mere 23% of what it will really be during Perpetua's operations.

Had DEQ compared the annual arsenic concentration during the Project to the annual T-RACT adjusted AACC (as required by the Air Rules and as DEQ has done in the past), then the arsenic emissions would vastly *exceed* the T-RACT adjusted AACC. Applying the novel "lifetime exposure adjustment" to dilute the Project's annual arsenic concentration by 16/70, DEQ calculated a Maximum Modeled Lifetime Exposure Concentration of 0.00095 ug/m^3 of arsenic. PET 348 (Table 6). *See also* PET 344. This value is less than (about 41% of) the T-RACT adjusted arsenic AACC of 0.0023 ug/m^3 (*see* Air Rules Section 586). DEQ's dilution can be removed by multiplying 0.00095 ug/m^3 by 70 and then dividing by 16, which results in an *annual* arsenic exposure during the Project of 0.0042 ug/m^3. This value, which represents the arsenic exposure that will actually occur during the 16 years of the Project, is 181% of the T-RACT adjusted arsenic AACC.

[4] Further confirming that this is a novel approach, DEQ found no responsive documents to Petitioners' RFP No. 8, which requested: "Provide all air permits issued by IDEQ, other than the PTC, that applied a 70-year 'lifetime' average for any carcinogenic TAP in comparison to the associated AACC, including statements of basis." PET 835.

DEQ's creative paper exercise thus not only violates the Air Rules, but it creates a real risk to public health, allowing arsenic exposures of 181% of T-RACT adjusted AACC. EPA explained this well in comments submitted in January 2023 to the Forest Service for its ongoing review of the Project:

> [T]his screening threshold is not necessarily intended to be compared against a 70-year lifetime scenario where 57 years of the period assumes zero exposure. . . . Under IDEQ's hazardous air pollutant program, in practice, project impacts from the maximum year of emissions would typically be compared to the annual average AACC for arsenic.
>
> If the impacts were determined using annual average emissions during the period of the project only, the resulting arsenic concentrations would exceed the AACC.

PET 677. And EPA added: "There is significant uncertainty in the emission rates of fugitive dust associated with the project such that arsenic emissions could be underpredicted." PET 677-78.

DEQ's disregard of the Air Rules and break from past practice to mask the true arsenic exposure risks from the Project cannot be condoned. The Hearing Officer should grant summary judgment for Petitioners, set aside the Permit, and order DEQ to evaluate TAPs without spreading exposures during the 16-year Project over any longer time frame.

VII. THE PERMIT MUST BE SET ASIDE AND REMANDED TO DEQ TO CORRECT ALL ERRORS.

Under the Idaho APA, when an agency action is not affirmed, it "shall" be set aside, in whole or in part, and remanded for further proceedings as necessary. I.C. § 67-5279. *See also In re Variance ZV2011-2*, 156 Idaho 491, 496 (Idaho 2014) (vacating and remanding arbitrary agency action for further proceedings consistent with the Court's opinion). Upon granting summary judgment for Petitioners on any of their claims above, the Hearing Officer must set aside the Permit and remand to DEQ for further proceedings to correct the errors DEQ made when it issued the Permit.

CONCLUSION

For the foregoing reasons, Petitioners respectfully request that the Hearing Officer grant Petitioners' Motion for Summary Judgment and set aside and remand the Permit.

Dated: April 14, 2023

Respectfully submitted,

/s/ Bryan Hurlbutt
Bryan Hurlbutt
Attorney for Petitioners Nez Perce Tribe and Idaho Conservation League

/s/ Julia S. Thrower
Julia S. Thrower
Attorney for Petitioner Save the South Fork Salmon

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	
	Agency Case No. 0101-22-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON	OAH Case No. 23-245-01
	DECLARATION OF BRYAN HURLBUTT
Petitioners,	
v.	
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,	
Respondent,	
and	
PERPETUA RESOURCES IDAHO, INC.	
Intervenor.	

I, BRYAN HURLBUTT, hereby declare as follows:

1. The following facts are personally known to me, and if called as a witness, I could and would competently testify thereto. I am over eighteen years of age.

2. I am counsel of record representing Petitioners Nez Perce Tribe and Idaho Conservation League in this matter.

3. The attached Exhibits 1 – 14 are true and correct copies of the following documents, which were produced during discovery in this matter:

Doc. No.	Bates No.	Document Description
1	PET 001–043	Final Permit to Construct (June 17, 2022)
2	PET 044–548	DEQ Statement of Basis (June 17, 2022)
3	PET 549–634	DEQ Response to Comment (June 17, 2022)
4	PET 635–652	Petitioners ICL/SSFS Comment Letter (Mar. 16, 2022)
5	PET 653–662	Petitioners Nez Perce Comment Letter (Mar. 14, 2022)
6	PET 663–672	EPA Comment Letter on PTC (Mar. 16, 2022)
7	PET 673–700	EPA Comment Letter on SDEIS (Jan. 10, 2023)
8	PET 701–771	DEQ Guideline for Performing Air Quality Impact Analysis (July 2021)
9	PET 772–785	EPA Revised Policy on Ambient Air (2019)
10	PET 786–796	EPA Guidance on Enforceability Requirements (1995)
11	PET 797–816	EPA Guidance on Unpaved Roads and Particulate Matter (2006)
12	PET 817–824	Arsenic Modeling Addendum Review
13	PET 825–830	Schilling, DEQ Position on the Arsenic Modeling Addendum
14	PET 831–837	DEQ Response to Petitioners' First Discovery Requests and Requests for Production of Documents

I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge, information, and belief, and based on my personal experiences.

Signed this 14th day of April, 2023 in Boise, Idaho.

/s/ Bryan Hurlbutt
Bryan Hurlbutt

Air Quality

PERMIT TO CONSTRUCT

Permittee	Perpetua Resources Idaho, Inc.
Permit Number	P-2019.0047
Project ID	62288
Facility ID	085-00011
Facility Location	Forest Service Roads NF-374 and NF-412 Stibnite, Idaho 83611

Permit Authority

This permit (a) is issued according to the "Rules for the Control of Air Pollution in Idaho" (Rules), IDAPA 58.01.01.200–228; (b) pertains only to emissions of air contaminants regulated by the State of Idaho and to the sources specifically allowed to be constructed or modified by this permit; (c) has been granted on the basis of design information presented with the application; (d) does not affect the title of the premises upon which the equipment is to be located; (e) does not release the permittee from any liability for any loss due to damage to person or property caused by, resulting from, or arising out of the design, installation, maintenance, or operation of the proposed equipment; (f) does not release the permittee from compliance with other applicable federal, state, tribal, or local laws, regulations, or ordinances; and (g) in no manner implies or suggests that the Idaho Department of Environmental Quality (DEQ) or its officers, agents, or employees assume any liability, directly or indirectly, for any loss due to damage to person or property caused by, resulting from, or arising out of design, installation, maintenance, or operation of the proposed equipment. Changes in design, equipment, or operations may be considered a modification subject to DEQ review in accordance with IDAPA 58.01.01.200–228.

Date Issued June 17, 2022

Kelli Wetzel

Kelli Wetzel, Permit Writer

Mike Simon

Mike Simon, Stationary Source Bureau Chief

Contents

1 Permit Scope 3
2 Facility-Wide 8
3 Mining and Ore Processing 17
4 Ore Concentration and Refining 22
5 Lime, Aggregate, and Concrete Production 30
6 Engines 36
7 General Provisions 39

1 Permit Scope

Purpose

1.1 This is an initial permit to construct (PTC) for ore processing, ore concentration and refining, and ancillary equipment at the Stibnite Gold Project (SGP).

Regulated Sources

1.2 Table 1.1 lists all sources of regulated emissions in this permit.

Source ID No.	Source	Control Equipment
Mining		
	Drilling activities	Reasonable control and Fugitive Dust Control Plan (FDCP) Dust collection systems on drilling rigs Control efficiency: 90%
	Blasting activities	Reasonable control & FDCP
	Excavating and hauling activities	Reasonable control & FDCP – Chemical suppression and water sprays Control efficiency: 93.3% for PM/PM_{10} (haul roads) Haul road capping with low-arsenic (90 ppm or less) quartzite
	Rock dumps and storage piles	Reasonable control & FDCP
PS1–2-L/U	(2) Prill Silos #1-2 Maximum capacity: 100 T (each)	Loading – None Unloading – None
Ore Processing		
OC1	Loader Transfer of Ore to Grizzly	Reasonable control & FDCP – Water sprays and moisture carryover
OC2	Grizzly to Apron Feeder	
OC3	Conveyor – Apron Feeder to Dribble	
OC4	Conveyor – Apron Feeder to Grizzly	
OC5	Conveyor – Dribble to Grizzly	
OC6	Grizzly to Primary Crusher or Coarse Ore Stockpile Feed	
OC7	Primary Crusher	Reasonable control & FDCP – Water sprays and moisture carryover
OC8	Conveyor – Coarse Ore Stockpile Feed Transfer to Stockpile	
OC9	Stockpile Transfer to Reclaim Conveyors	Reasonable control & FDCP – Below-grade of storage piles Control efficiency: 80% for PM/PM_{10}
OC10	Conveyor – Reclaim Conveyors to SAG Mill Feed Conveyor	
OC11	Conveyor – SAG Mill Feed Transfer to SAG Mill	Reasonable control & FDCP – Enclosure Control efficiency: 80% for PM/PM_{10}
OC12	Pebble Crusher	Reasonable control & FDCP – Water sprays and moisture carryover
OC13	Pebble Discharge to SAG Mill Feed	
Ore Concentration and Refining		
CN Tanks	Cyanide Leach Tanks and Cyanide Detox Tanks	Chemical treatment (lime, caustic soda, hydrogen peroxide, copper sulfate, etc.)
Float Tanks	Floatation Tanks	None

Source ID No.	Source	Control Equipment
AC	Autoclave (AC)	Venturi Scrubber (VS1) Vent Gas Cleaning Tower (ST1) Vent Gas Steam Condensation Tower (CT1) Carbon Filter (CA5) Type: sulfur-impregnated activated carbon Form: granulated
EW	Electrowinning Cells and Pregnant Solution Tank	Shared Carbon Filter (CA2) Type: sulfur-impregnated activated carbon Form: granulated
MR	Mercury Retort	Condenser Carbon Filter (CA3) Type: sulfur-impregnated activated carbon Form: granulated
MF	Induction Melting Furnace	Baghouse (BH2) Carbon Filter (CA4) Type: sulfur-impregnated activated carbon Form: granulated
CKD	Carbon Regeneration Kiln (Drum)	Wet Scrubber (WS2) Carbon Filter (CA1) Type: sulfur-impregnated activated carbon Form: granulated
Tailings and Maintenance Pond activities		Chemical treatment, reasonable control & FDCP
Process Heating		
ACB	POX Boiler (for AC) Maximum capacity: 17 MMBtu/hr Fuel: propane	None
HS	Strip Circuit Solution Heater Maximum capacity: 5 MMBtu/hr Fuel: propane	None
CKB	Carbon Regeneration Kiln Burners Maximum capacity: 2.255 MMBtu/hr Fuel: propane	None
PV	Propane Vaporizer Maximum capacity: 0.1 MMBtu/hr Fuel: propane	None
LKC	PFR Shaft Lime Kiln Combustion Maximum capacity: 22.0 MMBtu/hr Fuel: propane	None

Source ID No.	Source	Control Equipment
Lime Production		
LS1	Limestone transfer to Primary Crusher Hopper	Reasonable control & FDCP
LS2	Primary Crusher Maximum capacity: 1,130 T/day	
LS3	Primary Screen	
LS4	Secondary Crusher	
LS5	Secondary Screen	
LS6	Conveyor – Limestone to Ball Mill Feed Bin	
LS7	Conveyor – Limestone to Ball Mill Feed	
LS8	Conveyor – Ball Mill Feed to Ball Mill	
LSBM	Limestone Ball Mill	Reasonable control & FDCP Baghouse (BH3)
LS9	Conveyor – Limestone to Kiln Feed Bin	Reasonable control & FDCP
LS10	Conveyor – Limestone to Lime Kiln Feed	
LS11	Fines Screen	
LS12	Conveyor – Kiln Feed to PFR Shaft Lime Kiln	
LK	Parallel Flow Regenerative (PFR) Shaft Kiln	Reasonable control & FDCP Baghouse (BH4)
LCR	Lime Mill Crusher	Reasonable control & FDCP Baghouse (BH5)
LS-L/U	Bucket Elevator – Pebble Lime Silo Loading	Loading – Bin Vent Filter
	Pebble Lime Silo discharge to Lime Slaker	Unloading – Wet Scrubber (WS3)
LS1-L/U	SAG Mill Lime Silo #1 Maximum capacity: 250 T/day	Loading – Bin Vent Filter Unloading – None
MillS2-L/U	SAG Mill Lime Silo #2 Maximum capacity: 250 T/day	Loading – Bin Vent Filter Unloading – None
ACS1	AC Lime Silo #1 Maximum capacity: 1,000 T/day	Loading – Bin Vent Filter Unloading – None
ACS2	AC Lime Silo #2 Maximum capacity: 1,000 T/day	Loading – Bin Vent Filter Unloading – None
ACS3	AC Lime Silo #3 Maximum capacity: 1,000 T/day	Loading – Bin Vent Filter Unloading – None
ACS4	AC Lime Silo #4 Maximum capacity: 500 T/day	Loading – Bin Vent Filter Unloading – None
Aggregate Production		
PCSP1	Portable Crushing and Screening Plant 1 Crushers, screens, and conveyors	Reasonable control & FDCP – water sprays and moisture carryover
PCSP2	Portable Crushing and Screening Plant 2 Crushers, screens, and conveyors	Reasonable control & FDCP – water sprays and moisture carryover
Concrete Production		
CM	Central Mixer Loading Maximum capacity: 120 T/hr	Reasonable control & FDCP – Controls may include water sprays, enclosures, hoods, curtains, shrouds, movable and telescoping chutes, and central duct collection systems.
CS1-L/U	Cement/Shotcrete Silo #1 Maximum capacity: 80 T	Loading – Bin Vent Filter Unloading – None
CS2-L/U	Cement/Shotcrete Silo #2 Maximum capacity: 80 T	Loading – Bin Vent Filter Unloading – None
CA-L/U	Aggregate Bin Maximum capacity: 2,400 T	Loading – None Unloading – None

Source ID No.	Source	Control Equipment
Heating, Ventilation, and Air Conditioning (HVAC)		
H1M	Mine Air Heater #1 Maximum capacity: 4 MMBtu/hr Fuel: propane	None
H2M	Mine Air Heater #2 Maximum capacity: 4 MMBtu/hr Fuel: propane	None
HM	(4) Mill HVAC Heaters #1-4 Maximum capacity: 1.0 MMBtu/hr (each) Fuel: propane	None
HAC	Autoclave HVAC Heater Maximum capacity: 0.25 MMBtu/hr Fuel: propane	None
HR	Refinery HVAC Heater Maximum capacity: 0.25 MMBtu/hr Fuel: propane	None
HA	Admin HVAC Heater Maximum capacity: 0.25 MMBtu/hr Fuel: propane	None
HMO	(2) Mine Ops. HVAC Heaters Maximum capacity: 0.25 MMBtu/hr (each) Fuel: propane	None
HTS	(2) Truck Shop HVAC Heaters Maximum capacity: 1.0 MMBtu/hr (each) Fuel: propane	None
HW	(3) Warehouse HVAC Heaters Maximum capacity: 1.0 MMBtu/hr (each) Fuel: propane	None

Source ID No.	Source	Control Equipment
Emergency Power Generation and Fire Suppression		
EDG1	Camp Emergency Generator Date of construction: 2007 or later Maximum capacity: 1,000 bkW Maximum operation: 100 hr/yr (non-emergency) Fuel: ultra-low sulfur diesel (ULSD) Displacement: <10 L/cyl	EPA Tier 2 certified or better
EDG2	Plant Emergency Generator #1 Date of construction: 2007 or later Maximum capacity: 1,000 bkW Maximum operation: 100 hr/yr (non-emergency) Fuel: ULSD Displacement: <10 L/cyl	EPA Tier 2 certified or better
EDG3	Plant Emergency Generator #2 Date of construction: 2007 or later Maximum capacity: 1,000 bkW Maximum operation: 100 hr/yr (non-emergency) Fuel: ULSD Displacement: <10 L/cyl	EPA Tier 2 certified or better
EDFP	Mill Fire Pump Date of construction: 2009 or later Maximum capacity: 200 bkW Maximum operation: 100 hr/yr (non-emergency) Fuel: ULSD Displacement: <10 L/cyl	None
Fuel Storage		
TG1–TG2	Mine Site Gasoline Tanks (#1 through #2) Maximum capacity: 5,000 gal each	Lids or other appropriate closure with gasketed seal and submerged filling
TD3–TD10	Mine Site Diesel Tanks (#3 through #10)	Lids or other appropriate closure

2 Facility-Wide

Fugitive Dust

2.1 All reasonable precautions shall be taken to prevent particulate matter from becoming airborne in accordance with IDAPA 58.01.01.650-651. In determining what is reasonable, consideration will be given to factors such as the proximity of dust-emitting operations to human habitations and/or activities and atmospheric conditions which might affect the movement of PM. Some of the reasonable precautions include, but are not limited to, the following:

- Use, where practical, of water or chemicals for control of dust in the demolition of existing buildings or structures, construction operations, the grading of roads, or the clearing of land.
- Application, where practical, of asphalt, oil, water, or suitable chemicals to, or covering of dirt roads, material stockpiles, and other surfaces which can create dust.
- Installation and use, where practical, of hoods, fans, and fabric filters or equivalent systems to enclose and vent the handling of dusty materials. Adequate containment methods should be employed during sandblasting or other operations.
- Covering, when practical, open-bodied trucks transporting materials likely to give rise to airborne dusts.
- Paving of roadways and their maintenance in a clean condition, where practical.
- Prompt removal of earth or other stored material from streets, where practical.

2.2 At least once every 12 hours, the permittee shall monitor and maintain records of the frequency and the methods used (e.g., water, chemical dust suppressants) to reasonably control fugitive dust emissions.

2.3 The permittee shall maintain records of all fugitive dust complaints received. The permittee shall take appropriate corrective action as expeditiously as practicable after receipt of a valid complaint. The records shall include, at a minimum, the date that each complaint was received and a description of the following: the complaint, the permittee's assessment of the validity of the complaint, any corrective action taken, and the date the corrective action was taken.

2.4 Each day during daylight hours and under normal operating conditions, the permittee shall conduct a facility-wide inspection of potential sources of fugitive emissions from the following equipment: drilling activities, blasting activities, excavating and hauling activities, rock dumps and storage piles, ore processing, aggregate production, and central mixer loading. These sources are identified in the Fugitive Dust Control Plan to ensure that the methods used to reasonably control fugitive dust emissions are effective. If emissions are not being reasonably controlled the permittee shall take corrective action as expeditiously as practicable. The permittee shall maintain records of the results of each fugitive dust emissions inspection. The records shall include, at a minimum, the date of each inspection and a description of the following: the permittee's assessment of the conditions existing at the time fugitive emissions were present (if observed), any corrective action taken in response to the fugitive dust emissions, and the date the corrective action was taken.

2.5 Fugitive dust control measures shall be applied to haul roads on a frequency such that visible emissions from vehicle traffic on a haul road do not exceed 10% opacity. When emissions are observed at any time to exceed this control trigger level, an appropriate control measure such as those defined in the Fugitive Dust Control Plan (FDCP) shall be used to reasonably control the emissions of fugitive dust. If the control measure chosen does not adequately control fugitive dust emissions, the permittee shall employ additional control measures until fugitive dust control is achieved.

2.6 The permittee shall develop and maintain a FDCP to ensure compliance with fugitive dust requirements (Permit Conditions 2.1–2.5) and also fugitive dust best management practices at the lime production, aggregate production, and concrete plants in accordance with IDAPA 58.01.01.799. The permittee shall comply with the FDCP at all times. The requirements specified in the FDCP shall be incorporated by reference to this permit and shall be enforceable permit conditions. At a minimum, the FDCP shall contain a list of all potential sources of fugitive dust emissions and the following reasonable precautions to minimize fugitive dust emissions (Permit Condition 2.1):

- Post and limit the maximum speed of haul trucks in accordance with the FDCP. Signs shall be posted along the haul route and placed so they are visible to vehicles entering and leaving the site of operations.
- Apply water or suitable dust suppressant chemicals (e.g., magnesium chloride, calcium chloride) to disturbed areas, haul roads, equipment staging areas, parking areas, and storage piles during the dry season and at other times as necessary to control fugitive dust.
- Prior to onset of winter conditions each year, the condition of haul and access roads should be assessed before freeze-up and required maintenance needed to maintain the roads through the winter months should be performed, and any preventative dust suppression activities should be completed before the roads are frozen and liquid application of suppressants or water are unrealistic.
- Apply water or suitable dust suppressant chemicals to transfer points, screening operations, and crushing operations identified in the FDCP as necessary to control fugitive dust. Transfer points include points where material (e.g., ore and development rock (DR), lime, aggregate, cement, etc.) is transferred to or from a belt conveyor, conveying system, bucket elevator, screening operation, or stockpile. Controls shall include manual water spray capability or installing, operating, and maintaining water spray bars at transfer points to wet the material and to provide moisture carryover for downstream control. Controls shall also include limiting drop heights in truck loading, front-end loader dumping, and conveying operations to ensure a homogeneous flow of material.
- Apply water or suitable dust suppressant chemicals to storage piles as necessary to control fugitive dust. Water may need to be applied to storage piles before and during truck loading, and when stockpiled ore and waste rock is not processed promptly in order to avoid drying and becoming airborne. Stockpile height should be limited to limit disturbance.
- Apply appropriate dust control at the initial point of material handling to suppress dust throughout the material handling process.
- Apply crushed gravel to haul roads, equipment staging areas, and other areas as necessary to limit migration of fine sediment.
- Install wind fences or barriers around, place below grade, or enclose all storage piles, parking areas, and equipment staging areas as necessary to control fugitive dust. This is required for

the Stockpile Transfer to Reclaim Conveyors (OC9), Reclaim Conveyors to SAG Mill Feed Conveyor (OC10), and SAG Mill Feed Transfer to SAG Mill conveyor (OC11).

- Develop specific criteria to determine what frequency and type (water and/or chemical) of dust suppressant must be applied, and appropriate suppressant application rates. Chemical dust suppressants shall be applied consistent with manufacturer's instructions and recommendations.
- Develop and implement precautionary measures to address high-wind events, such as when average (sustained) wind speed is forecast to exceed 25 miles per hour.
- Provide training/orientation to all relevant employees regarding FDCP requirements, including the necessity of restricting public access as specified in the Access Management Plan (AMP). Visible emissions evaluations shall be conducted by the permittee's employees who are certified visible emission observers.
- At least once each year, evaluate FDCP requirements to identify additional requirements and evaluate effectiveness of practices, including dust suppressant application rates, as appropriate.

2.7 The permittee shall develop and maintain an AMP that identifies the facility boundary and all primary and secondary access points, and clearly specifies measures used to discourage public access to the facility. The permittee shall comply with the measures identified in the AMP at all times. The measures specified in the AMP shall be incorporated by reference to this permit and shall be enforceable permit conditions. At a minimum, the AMP shall include requirements to:

- Observe all primary access points to preclude unauthorized public access. Onsite personnel shall be available for this purpose during active mining and mineral processing operations. Public access to the facility may be monitored by the use of security escort vehicles or manned guardhouses, or sufficiently precluded by the use of locked gates, barriers, or equivalent measures. Primary access points include the North and South Security Gates.
- Post warning signs and periodically patrol secondary access points to the facility to preclude public access. Onsite personnel shall be available for this purpose. Plans shall be described in the AMP, including identifying the access points monitored, the frequency of patrol, and measures employed to discourage access (e.g., locked gates, barriers, natural features, etc.). Secondary access points include secondary roadways and trails traversing the facility.
- Only registered guests of the facility will be allowed access to or through the facility. Those seeking to be a guest for the sole purpose of passing through the facility to another destination shall be provided a registration sheet that explains Perpetua's requirements for accessing the site and identifies potential hazards of the site.

2.8 Copies of the FDCP and AMP shall be submitted to DEQ for approval 30 days prior to startup at the address provided (Permit Condition 2.26), and shall remain onsite at all times. Any changes to the FDCP or the AMP shall be submitted to DEQ for review, comment, and approval 30 days prior to the change.

Visible Emissions

2.9 The permittee shall not discharge any air pollutant to the atmosphere from any point of emission for a period or periods aggregating more than three minutes in any 60-minute period which is greater than 20% opacity as determined by the test methods and procedures contained in IDAPA 58.01.01.625. These provisions shall not apply when the presence of uncombined water, nitrogen oxides, and/or chlorine gas is the only reason for the failure of the emission to comply with this permit condition.

2.10 Each day during daylight hours and under normal operating conditions, the permittee shall conduct a facility-wide inspection of potential point sources of visible emissions including stacks, vents, and functionally equivalent openings. Sources that are monitored using a continuous opacity monitoring system (COMS) are not required to comply with this permit condition. The inspection shall consist of a see/no see evaluation for each potential source of visible emissions. If any visible emissions are present from any point of emission, the permittee shall either:

- Take appropriate corrective action as expeditiously as practicable to eliminate the visible emissions. Within 24 hours of the initial see/no see evaluation and after the corrective action, the permittee shall conduct a see/no see evaluation of the emissions point in question. If the visible emissions are not eliminated, the permittee shall comply with the following; or
- Perform a Method 9 opacity test in accordance with the procedures outlined in IDAPA 58.01.01.625. A minimum of 30 observations shall be recorded when conducting the opacity test. If opacity is greater than 20% for a period or periods aggregating more than three minutes in any 60-minute period, the permittee shall take all necessary corrective action and report the exceedance in the annual compliance certification and in accordance with IDAPA 58.01.01.130-136.

2.11 The permittee shall maintain records of the results of each visible emission inspection and each opacity test when conducted. The records shall include, at a minimum, the date and results of each inspection and test and a description of the following: the permittee's assessment of the conditions existing at the time visible emissions are present (if observed), any corrective action taken in response to the visible emissions, and the date corrective action was taken.

2.12 The permittee shall have a certified opacity reader onsite at all times during operation of any regulated sources (in Table 1.1). The reader shall be certified in using the test methods and procedures of EPA Reference Methods 9 and knowledgeable of Method 22 procedures.

2.13 Reserved.

Odor

2.14 The permittee shall not allow, suffer, cause, or permit the emission of odorous gases, liquids, or solids into the atmosphere in such quantities as to cause air pollution in accordance with IDAPA 58.01.01.776.01.

2.15 The permittee shall maintain records of all odor complaints received. If the complaint has merit, the permittee shall take appropriate corrective action as expeditiously as practicable. The records shall include, at a minimum, the date that each complaint was received and a description of the following: the complaint, the permittee's assessment of the validity of the complaint, any corrective action taken, and the date the corrective action was taken.

Fuels

2.16 The permittee shall not sell, distribute, use, or make available for use any distillate fuel oil containing more than the following percentages of sulfur, in accordance with IDAPA 58.01.01.725:

- ASTM Grade 1 fuel oil - 0.3% by weight.
- ASTM Grade 2 fuel oil - 0.5% by weight.

2.17 The permittee shall maintain documentation of supplier verification of fuel oil sulfur content on an as-received basis to ensure compliance with fuel specifications (Permit Condition 2.16).

2.18 The maximum throughput of gasoline to the Gasoline Tanks (TG1, TG2) shall not exceed 100,000 gallons per month (gal/mo).

2.19 After startup, each month the permittee shall maintain records demonstrating compliance with gasoline throughput limits, by tracking either amounts loaded or amounts dispensed from each Gasoline Tank.

O&M Manual

2.20 Thirty days prior to startup of any process equipment (Permit Condition 2.13), the permittee shall develop and maintain an Operation and Maintenance (O&M) manual to ensure compliance with emission limits (Permit Conditions 2.9, 2.13, 4.3, and 5.3) and the control equipment maintenance and operation general provision (Permit Condition 7.2). The O&M manual shall be a permittee-developed document based upon, but independent from, manufacturer-supplied operating manuals. The permittee shall operate control equipment in accordance with the O&M manual at all times. The requirements in the O&M manual shall be incorporated by reference to this permit and shall be enforceable permit conditions. At a minimum, the O&M manual shall include the following for all (Table 1.1):

- Identify the manufacturer, model, date of manufacture, and maximum capacity (as-built) for each regulated emission source assigned a source ID, and for each control device in the service of ore concentration and refining, lime production, and concrete production (in Table 1.1). For each wet scrubber, vent gas cleaning tower, venturi scrubber, carbon filter, baghouse and bin vent filter cartridge control device, a copy of the vendor-supplied performance guarantee shall be included. For each engine, a copy of the EPA tier certification shall be included. For each cyanide leach tank and for each cyanide detox tank, the tank dimensions (e.g., diameter) shall be included.
- Establish operating ranges for control equipment, based on manufacturer specifications and conditions measured during performance testing.
    - Minimum pressure drop across each wet scrubber, vent gas cleaning tower, and venturi scrubber;
    - Minimum circulation flow rate for each wet scrubber, vent gas cleaning tower, venturi scrubber;
    - Maximum inlet gas stream temperature to each carbon filter;
    - Maximum pressure drop across each carbon filter;
    - Minimum pressure drop across each baghouse; and
    - Minimum coolant flow rate in the mercury retort (MR) condenser and vent gas steam condensation tower;

- Describe the procedures for proper operation, startup, and shutdown of control equipment, based on manufacturer specifications.
- Describe the schedule and procedures for routine inspection (Permit Condition 2.10), maintenance, repair, and replacement of control equipment.
    - See-no-see visible emissions inspection of each wet scrubber, carbon filter, baghouse, and bin vent shall be conducted at least once per day.
    - At least once every six months, the drum lining of the carbon regeneration kiln shall be visually inspected for structural damage and cracks.
    - The dates, times, and results from each inspection (as required by Permit Condition 2.11), corrective action, maintenance, repair, and replacement of control equipment shall be recorded at least once per month.
    - The replacement dates for each baghouse and bin vent filter cartridge and for each activated carbon filter medium shall be recorded at the time of each replacement. For cartridges, records shall include the manufacturer and model. For carbon filters, records shall include the manufacturer, type, and form of medium added. Records shall also include any changes in supplier and other relevant information.
    - All carbon filter beds shall be disposed of in an acceptable manner in compliance with all applicable state rules and federal regulations.
- Describe the schedule and procedures for corrective action that will be taken if visible emissions are present from wet scrubber (WS2, WS3), carbon filter (CA1, CA2, CA3, CA4, CA5), baghouse (BH2, BH3, BH4, BH5), or bin vent filter (LS, LS1, MillS2, ACS1, ACS2, ACS3, ACS4, CS1, CS2) control equipment at any time. Procedures should include how to determine whether filter cartridges are ruptured or are not appropriately secured in place, and how to determine whether the wet scrubber, condenser, and carbon filters are operating properly.
- Describe each monitoring device and methodology used to measure weight rates of materials to demonstrate compliance with each material throughput limit (Permit Conditions 3.5–3.9, 4.8–4.11, and 5.4–5.8). Procedures for proper installation, calibration, and maintenance shall be included.
- Describe each monitoring device and methodology used to measure the volumetric rates of materials to demonstrate compliance with the electrowinning cells and pregnant solution tank throughput limit (Permit Condition 4.12). Procedures for proper installation, calibration, and maintenance shall be included.
- Describe each monitoring device and methodology used to monitor pH, temperature, and free cyanide in each cyanide leach tank, each cyanide detox tank, and each tailings reclaim stream to comply with Cyanide Emissions Limit Compliance Monitoring (Permit Condition 4.18). Procedures for proper installation, calibration, and maintenance shall be included.
- Describe the methodology and sample calculations used to estimate monthly and rolling 12-month facility-wide cyanide emissions to assess compliance with the Cyanide Emissions Limit (Permit Condition 4.4). Calculations shall be based on the pH, temperature, and free cyanide concentrations that are measured each day, and the methodology used shall be consistent with the permittee's application as addended December 18, 2020 and shall be based on the following equation:

    $r_v = k_g \alpha_0 C_l H A F_a F_w$

where,

r_v = hydrogen cyanide emissions from surface (g/s)

k_g = gas phase mass transfer coefficient (m/s)

α_0 = non-ionized cyanide fraction determined from pH and pK_a (ionization coefficient)

C_l = total liquid phase free cyanide concentration (g/m^3)

H = Henrys Law Coefficient (g/m^3 per g/m^3)

A = process surface area (m^2)

F_a = area factor

F_w = wind factor

- Describe the monitoring methodology used to monitor xanthates usage (Permit Condition 4.19).

2.21 The O&M manual shall be submitted for approval to DEQ 30 days prior to startup of any ore processing, ore concentration and refining, lime production, or aggregate production emission source regulated by this permit (as identified in Table 1.1) at the address provided (Permit Condition 2.26), and shall remain onsite at all times. Any changes to the O&M manual shall be submitted to DEQ for review, comment, and approval 30 days prior to the change.

Incorporation of Federal Requirements

2.22 Unless expressly provided otherwise, any reference in this permit to any document identified in IDAPA 58.01.01.107.03 shall constitute the full incorporation into this permit of that document for the purposes of the reference, including any notes and appendices therein. Documents include, but are not limited to:

- Standards of Performance for New Stationary Sources (NSPS) 40 CFR 60, Subpart A – General Provisions.
- NSPS 40 CFR 60, Subpart LL – Standards of Performance for Metallic Mineral Processing Plants. Each crusher (OC7, OC12), conveyor belt transfer point (OC2–OC6, OC9–OC11, OC13), and truck unloading station (OC1) is an affected facility.
- NSPS 40 CFR 60, Subpart OOO – Standards of Performance for Nonmetallic Mineral Processing Plants. Each crusher (LS2, LS4), grinding mill (LSBM), screening operation (LS3, LS5, LS11), belt conveyor (LS6–LS10, LS12), and storage bin (LS1) is an affected facility.
- NSPS 40 CFR 60, Subpart IIII – Standards of Performance for Stationary Compression Ignition Internal Combustion Engines. Each emergency generator engine and fire pump (EDG1, EDG2, EDG3, and EDFP) is an affected facility.
- National Emission Standards for Hazardous Air Pollutants for Source Categories (NESHAP) 40 CFR 63, Subpart A – General Provisions.
- NESHAP 40 CFR 63, Subpart EEEEEEE – National Emission Standards for Hazardous Air Pollutants: Gold Mine Ore Processing and Production Area Source Category. The collection of ore pretreatment processes including the autoclave (AC) and the carbon process including the carbon regeneration kiln (CKD), the electrowinning cells and pregnant solution tank (EW), the mercury retort (MR), and the induction melting furnace (MF) are affected facilities.

- NESHAP 40 CFR 63, Subpart ZZZZ – National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines (RICE). Each emergency generator engine and fire pump (EDG1, EDG2, EDG3, and EDFP) is an affected facility.
- NESHAP 40 CFR 63, Subpart CCCCCC – National Emission Standards for Hazardous Air Pollutants for Source Category: Gasoline Dispensing Facilities. Each gasoline fuel storage tank (TG1, TG2) is an affected facility.

The permittee shall comply with all applicable NSPS and NESHAP requirements. For permit conditions referencing or cited in accordance with any document incorporated by reference (including permit conditions identified as NSPS or NESHAP), should there be any conflict between the requirements of the permit condition and the requirements of the document, the requirements of the document shall govern, including any amendments to that regulation.

2.23 In accordance with IDAPA 58.01.01.314.06, the permittee shall notify DEQ in writing the date upon which the Tier I source (e.g., gold ore concentration and refining process equipment) commences operation. The notification shall be titled, "TIER I SOURCE NOTIFICATION OF COMMENCING OPERATION," and shall include the name of the permittee, the permit and project numbers, the date the permit was issued, and the date the Tier I source commences operation. The notification shall be submitted to DEQ within five (5) days of commencing operation and shall be sent to:

Air Quality Permitting
Idaho Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706-1255

2.24 In accordance with IDAPA 58.01.01.313.01.b., the permittee shall submit a complete application to DEQ at the address provided (Permit Condition 2.26) for an initial Tier I operating permit within 12 months of becoming a Tier I source or commencing operation.

Test Methods

2.25 Except as otherwise specified in this permit and in IDAPA 58.01.01.157.02, when testing is required the following test methods shall be used to measure pollutant emissions.

Table 2.1 Test Methods

Pollutant		Test Method	Additional Requirements
H_2SO_4		EPA Method 8	
$PM_{2.5}$ or PM_{10}		EPA Methods 5 and 202, or 201A and 202	Particulate matter (PM), including condensable PM as defined in IDAPA 58.01.01.006 with an aerodynamic diameter less than or equal to a nominal 10 micrometers for PM_{10}, and less than or equal to a nominal 2.5 micrometers for $PM_{2.5}$.
Opacity	point	EPA Method 9	For NSPS and NESHAP sources, use IDAPA 58.01.01.625 and Method 9. For other sources, use IDAPA 58.01.01.625 only.
	fugitive	EPA Method 22	Visible fugitive PM.

Notifications

2.26 All requests, reports, applications, submittals, certifications, and other communications required by this permit shall be submitted to:

Air Quality Permit Compliance
Department of Environmental Quality
Boise Regional Office
1445 N. Orchard St.
Boise, Idaho 83706

phone: (208) 373-0550
fax: (208) 373-0287

3 Mining and Ore Processing

3.1 Process Description

Conventional open-pit mining methods including drilling, blasting, excavating, and hauling will be used to extract ore and waste rock, termed development rock (DR). Hydraulic shovels and front-end loaders will be used to load ore and DR into haul trucks. DR will be used for construction, restoration, and backfilling, or hauled to dedicated development rock storage facilities (DRSF). Approximately 340 million tons of DR will be handled over the life of the mine.

The SGP will include three years of pre-mining development and construction activities, followed by an operating mine life of approximately 12 years. Mining will occur in three open pits: Yellow Pine Pit (YPP), Hangar Flats pit (HFP), and West End pit (WEP). Legacy tailings from the Meadow Creek valley (Bradley Tailings [BT]) will also be reclaimed and reprocessed. Surface exploration drilling will occur within the pits and underground within the Scout Prospect decline.

Ore will be hauled to the primary crusher area, where it will be fed directly into the crusher dump pocket or stockpiled. The ore crushing plant will be designed to operate at a maximum rate of 25,000 tons per calendar day (T/day). Approximately 100 million tons of ore will be mined from the three pits over the life of the project.

The metal-recovery process from ore will include conventional crushing and grinding, followed by froth-flotation circuits that will generate separate gold-silver and antimony-silver concentrates. The antimony-silver concentrate will be shipped offsite for refining, whereas additional onsite processing of the gold-silver concentrate will include pressure oxidation, carbon-in-leach circuits, and refining processes to recover gold and minor amounts of silver. The finely ground leftover ore material from the mineral-recovery process, termed tailings, will be neutralized, thickened, and transported via a pipeline to the tailings storage facility.

3.2 Control Device Descriptions

Table 3.1 contains a description of control equipment used to control emissions from mining and ore processing activities.

Table 3.1 Mining and Ore Processing Control Device Descriptions

Emission Sources	Control Devices
Mining	
Drilling activities	Reasonable control and Fugitive Dust Control Plan (FDCP) Dust collection systems on drilling rigs Control efficiency: 90%
Blasting activities	Reasonable control & FDCP
Excavating and hauling activities	Reasonable control & FDCP Chemical suppression and water sprays Control efficiency: 93.3% for PM/PM_{10} (haul roads) Haul road capping with low-arsenic quartzite
Rock dumps and storage piles	Reasonable control & FDCP
(2) Prill Silos #1-2 Maximum capacity: 100 T (each)	None
Ore Processing	
Loader Transfer of Ore to Grizzly	Reasonable control & FDCP Water sprays and moisture carryover
Grizzly to Apron Feeder	
Apron Feeder to Dribble	
Apron Feeder to Grizzly	
Dribble to Grizzly	
Grizzly to Primary Crusher or Coarse Ore Stockpile Feed	
Primary Crusher	Reasonable control & FDCP Water sprays and moisture carryover
Coarse Ore Stockpile Feed Transfer to Stockpile	
Stockpile Transfer to Reclaim Conveyors	Reasonable control & FDCP Below-grade of storage piles Control efficiency: 80% for PM/PM_{10}
Reclaim Conveyors to SAG Mill Feed Conveyor	
SAG Mill Feed Transfer to SAG Mill	Reasonable control & FDCP Enclosure Control efficiency: 80% for PM/PM_{10}
Pebble Crusher	Reasonable control & FDCP Water sprays and moisture carryover
Pebble Discharge to SAG Mill Feed	

Operating Limits

3.3 Drilling Limits

The permittee shall drill no more than 1,200 blast holes per day.

3.4 Blasting Limits

The permittee shall complete no more than two blasting operations per day.

3.5 Daily Hauling and Excavating Limits

The permittee shall haul no more than 180,000 tons per day (T/day) of ore and DR.

The permittee shall haul no more than 135,000 T/day of ore and DR, based on a 5-year rolling average.

3.6 Life of Mine Hauling and Excavating Limits

The permittee shall haul no more than 788.4 million tons (MT) of ore and DR from all deposits over the life of the mine and no more than 394.2 MT of ore and DR from the West End deposit over the life of the mine.

3.7 Primary Crusher Limit

The permittee shall process ore as the raw material in the primary crusher, and the maximum input to the primary crusher shall not exceed 25,000 T/day.

3.8 Pebble Crusher Limit

The permittee shall process ore as the raw material, and the maximum input to the pebble crusher shall not exceed 27,600 T/day.

3.9 Prill Loading Limit

The permittee shall not load in excess of 200 T/day and 9,000 tons per any consecutive 12-month period of prill (ammonium nitrate) to the prill silos.

3.10 Mining and Ore Processing Dust Control

The permittee shall control emissions from mining and ore processing emission sources (Table 3.1) in accordance with the Fugitive Dust Control Plan.

3.11 Drilling Rigs Dust Control System

The permittee shall install and operate dust collection systems with a minimum control efficiency of 90% on all drilling rigs in accordance with the O&M manual (Permit Condition 2.20). The dust collection systems shall be in operation at all times when the drilling rigs are operated.

3.12 Ore Processing Equipment Water Sprays

The permittee shall install, operate, and maintain water sprays in accordance with the O&M manual (Permit Condition 2.20) to control PM emissions from each ore processing crusher and conveyor. Water sprays shall operate according to the FDCP when this equipment is operated to ensure compliance with Fugitive Dust requirements (Permit Conditions 2.1–2.6).

3.13 Haul Road Capping

The permittee shall cap haul roads that are outside of the Yellow Pine Pit (YPP), Hangar Flats Pit (HFP), and West End Pit (WEP) and development rock storage facilities (DRSF) including the Yellow Pine DRSF, Fiddle DRSF, and Hangar Flats DRSF with low-arsenic material.

The permittee shall use low-arsenic quartzite rock deposits from the WEP, or other material with equal or lower arsenic concentration, as capping material. Low-arsenic quartzite rock is defined as material with a median arsenic concentration of 90 parts per million (ppm) or less.

The permittee shall use capping material with a maximum of 4.0% silt content.

The permittee shall develop and maintain a Haul Road Capping Plan (HRCP) that identifies the low-arsenic quartzite rock deposits in the West End pit based on core sample analyses. The permittee shall comply with the measures identified in the HRCP at all times. The measures specified in the HRCP shall be incorporated by reference to this permit and shall be enforceable permit conditions. At a minimum, the HRCP shall include:

- The low-arsenic quartzite rock sampling plan including standard operational procedure for sampling, frequency of sampling, and ASTM (or equivalent) method of analysis for arsenic concentration.
- The frequency of inspection of the haul roads and maintenance procedures.
- The silt content sampling plan including standard operational procedure for sampling, frequency of sampling, and ASTM (or equivalent) method of analysis for silt content.

A copy of the HRCP shall be submitted to DEQ for approval 30 days prior to startup at the address provided (Permit Condition 2.26), and shall remain onsite at all times. Any changes to the HRCP shall be submitted to DEQ for review, comment, and approval 30 days prior to the change.

Monitoring and Recordkeeping Requirements

3.14 Drilling Limits Monitoring

Each day, the permittee shall monitor and record the number of blast holes drilled.

3.15 Blasting Limits Monitoring

Each day, the permittee shall monitor and record the number of blasting operations completed.

3.16 Daily Hauling and Excavating Monitoring

Each day, the permittee shall monitor and record the amount of ore and DR transported on haul trucks (T/day). The devices and methodologies used to measure weights shall be identified in the O&M Manual.

Each calendar month, the permittee shall monitor and record the amount of ore and DR transported on haul trucks in tons per month (T/mo) and in tons per year (T/yr). Annual amounts of ore and DR transported shall be determined by summing the monthly amount over the previous consecutive 12-month period. The annual amounts of ore and DR transported shall be used to calculate the 5-year rolling average in T/day.

3.17 Life of Mine Hauling and Excavating Limit Monitoring

Each day, the permittee shall monitor and record the amount of ore and DR transported on haul trucks from all deposits (T/day) and the amount of ore and DR transported on haul trucks (T/day) from the West End deposit. The devices and methodologies used to measure weights shall be identified in the O&M Manual.

Each calendar month, the permittee shall monitor and record the amount of ore and DR transported on haul trucks in tons per month (T/mo) and in tons per year (T/yr) from all deposits and the West End deposit. Annual amounts of ore and DR transported shall be determined by summing the monthly amount over the previous consecutive 12-month period. The annual amounts of ore and DR transported shall be used to calculate the life of mine total (MT) for all deposits and the West End deposit.

3.18 Primary Crusher Limit Monitoring

Each day, the permittee shall monitor and record the tons of ore input to the crusher (T/day). The devices and methodologies used to measure weights shall be identified in the O&M Manual.

3.19 Pebble Crusher Limit Monitoring

Each day, the permittee shall monitor and record the tons of ore input to the pebble crusher (T/day). The devices and methodologies used to measure weights shall be identified in the O&M Manual.

3.20 Prill Loading Limit Monitoring

Each day, the permittee shall monitor and record the amount of prill loaded to all of the prill silos combined in tons (T/day). The devices and methodologies used to measure weights shall be identified in the O&M Manual.

Each month, the permittee shall monitor and record the amount of prill loaded to all of the prill silos combined in tons per month (T/mo) and in tons per year (T/yr) to demonstrate compliance with the annual prill silos limit. Annual prill loaded shall be determined by summing the monthly input over the previous consecutive 12-month period.

4 Ore Concentration and Refining

4.1 Process Description

The autoclave is a pressure oxidation (POX) vessel used to oxidize gold gold-silver concentrate at elevated temperature and pressure in the presence of oxygen. Upon exiting the autoclave, the slurry is cooled in flash vessels and neutralized using lime and caustic soda prior to being sent to the vat leaching circuit for gold and silver recovery. A dilute sodium cyanide solution is added to the leach tanks to dissolve the gold and silver from the ore. Leached "pulp" is sent to multistage carbon-in-pulp (CIP) and/or carbon-in-leach (CIL) tanks, where gold is recovered onto activated carbon. The autoclave is located in the POX Building and the exhaust from the autoclave passes through a venturi scrubber, vent gas cleaning tower, vent gas steam condensation tower, and carbon filter.

Carbon loaded with gold is removed and washed with acid, then stripped with a caustic solution. This mineral-bearing solution is sent to the electrowinning cells and pregnant solution tank (EW). The EW cells remove the gold from the solution by plating it onto cathodes consisting of stainless-steel plates with steel wool. The EW cell exhaust passes through a carbon adsorption column (CA2), where remaining mercury vapor is adsorbed onto sulfur-impregnated activated carbon (SIAC). The stripped carbon must be periodically regenerated in the carbon regeneration kiln. Exhaust from the carbon regeneration kiln passes through a carbon adsorption bed (CA1), where mercury is adsorbed onto SIAC.

Gold concentrate is loaded into the mercury retort (MR), where it is heated under vacuum to drive off mercury. The MR exhaust passes through a shell-and-tube condenser to cool the exhaust and condense the mercury vapor into a liquid, which is collected by the mercury trap. The exhaust passes through a carbon adsorption column (CA3), where remaining vapor mercury is adsorbed onto SIAC.

After retorting, the gold concentrate is transferred to the electric induction melting furnace. Only retorted concentrate is melted in the furnace. The exhaust passes through a carbon adsorption column (CA4), where remaining mercury vapor is adsorbed onto SIAC. The electrowinning cells and pregnant solution tank, carbon regeneration kiln, MR, and induction melting furnace are located in the Refinery Building.

4.2 Control Device Descriptions

Table 4.1 Ore Concentration and Refining Control Device Descriptions

Emissions Unit / Processes	Control Devices	Emission Points
Cyanide Leach Tanks and Cyanide Detox Tanks	Chemical treatment (lime, caustic soda, hydrogen peroxide, copper sulfate, etc.)	Various
Flotation Tanks	None	
Autoclave	Venturi Scrubber (VS1) Minimum pressure drop and Minimum circulation flow rate in O&M	Autoclave Carbon Filter Stack
	Vent Gas Cleaning Tower (ST1) Minimum pressure drop and Minimum circulation flow rate in O&M	
	Vent Gas Steam Condensation Tower (CT1) Minimum coolant flow rate in O&M	
	Carbon Filter (CA5) Maximum pressure drop established in O&M Maximum inlet gas stream temperature established in O&M and by Subpart EEEEEEE	
POX Boiler	None	POX Boiler Stack
Electrowinning Cells and Pregnant Solution Tank	Shared Carbon Filter (CA2) Maximum pressure drop established in O&M Maximum inlet gas stream temperature established in O&M and by Subpart EEEEEEE in O&M	Electrowinning Cells and Pregnant Solution Tank Shared Carbon Filter Stack
Strip Circuit Solution Heater	None	Strip Circuit Solution Heater Stack
Mercury Retort	Condenser Minimum coolant flow rate established in O&M	Mercury Retort Carbon Filter Stack
	Carbon Filter (CA3) Maximum pressure drop established in O&M Maximum inlet gas stream temperature established in O&M and by Subpart EEEEEEE	
Induction Melting Furnace	Baghouse (BH2) Minimum pressure drop established in O&M	Induction Melting Furnace Carbon Filter Stack
	Carbon Filter (CA4) Maximum pressure drop established in O&M Maximum inlet gas stream temperature established in O&M and by Subpart EEEEEEE	
Carbon Regeneration Kiln	Wet Scrubber (WS2) Minimum pressure drop and Minimum circulation flow rate established in O&M	Carbon Regeneration Kiln Carbon Filter Stack
	Carbon Filter (CA1) Maximum pressure drop established in O&M Maximum inlet gas stream temperature established in O&M and by Subpart EEEEEEE	
Carbon Regeneration Kiln Burners	None	Carbon Regeneration Kiln Burners Stack
Propane Vaporizer	None	Propane Vaporizer Stack
Tailings and Maintenance Pond	None	Various

Emission Limits

4.3 Ore Concentration and Refining Equipment Emissions Limits

Emissions from ore concentration and refining equipment stacks shall not exceed any corresponding emission rate limits (Table 4.2).

Table 4.2 Ore Concentration and Refining Emissions Limits [a]

Source Description	PM / PM_{10} / $PM_{2.5}$ [b]	NO_x	CO	VOC	SO_2	H_2SO_4
	lb/hr [c]	lb/hr [c]	lb/hr [c]	lb/hr [c]	lb/hr [c]	lb/hr [c]
Autoclave (AC)	5.08				0.65	2.03
Carbon regeneration kiln (CKD)	0.42	0.01	0.12	0.11		
Electrowinning cells and pregnant solution tank (EW)	0.07					
Mercury retort (MR)	0.01 [d]					
Induction melting furnace (MF)	2.84					

a) In absence of any other credible evidence, compliance is ensured by complying with permit operating, monitoring, and recordkeeping requirements.
b) Particulate matter (PM) including condensable PM as defined in IDAPA 58.01.01.006, with an aerodynamic diameter less than or equal to a nominal 10 micrometers for PM_{10}, and less than or equal to a nominal 2.5 micrometers for $PM_{2.5}$.
c) Pounds per hour, as determined by a test method prescribed by IDAPA 58.01.01.157, EPA reference test method, continuous emission monitoring system (CEMS) data, or DEQ-approved alternative.
d) For this emission limit, compliance may be demonstrated as measurement below detection limits, when addressed as part of a performance test protocol that is approved by DEQ.

4.4 Cyanide Emissions Limit

Facility-wide emissions shall not exceed 1.99 tons per any consecutive 12-month period of cyanide compounds.

4.5 Carbon Disulfide Emissions Limit

Facility-wide emissions shall not exceed 0.063 tons per any consecutive 12-month period of carbon disulfide.

Operating Limits

4.6 Xanthates Usage

The permittee shall use potassium amyl xanthate (PAX) for flotation treatment. Total xanthate usage shall not exceed 1,700 tons per any consecutive 12-month period.

4.7 POX Boiler Operation

Operation of the POX Boiler shall be limited to the autoclave start-up operation only.

4.8 Autoclave Input

The permittee shall process ore concentrate as the raw material in the autoclave, and the maximum input to the autoclave shall not exceed 6,960 T/day.

4.9 Mercury Retort Input

The permittee shall process precious metal concentrate as the raw material in the mercury retort, and the maximum input to the mercury retort shall not exceed 1,000 pounds per batch (lb/batch) and 21 tons per any consecutive 12-month period.

Precious metal concentrate includes material loaded with precious metals produced by electrowinning, flotation and gravity separation, and other gold concentration or precipitation processes; and material collected from the wash-down of equipment and surfaces contacted with precious metals that have been concentrated through these concentration methods.

4.10 Induction Melting Furnace Input

The permittee shall process retorted concentrate as the raw material in the induction melting furnace, and the input to the induction melting furnace shall not exceed 1,000 lb/batch, and 21 tons per any consecutive 12-month period. Retorted concentrate includes precious metal

concentrate that has been retorted and dust collected from the baghouse and fume hood of the induction melting furnace.

4.11 Carbon Regeneration Kiln Input

The permittee shall process carbon filters as the raw material in the carbon regeneration kiln, and the maximum input to the carbon regeneration kiln shall not exceed 7.2 T/day.

4.12 Electrowinning Cells and Pregnant Solution Tank Throughput

The permittee shall process mineral-bearing solution as the raw materials in the electrowinning cells and pregnant solution tank, and the maximum throughput for the electrowinning cells and pregnant solution tank shall not exceed 100 gallons per minute (gpm).

4.13 Autoclave Venturi Scrubber, Vent Gas Cleaning Tower, Vent Gas Steam Condensation Tower, and Carbon Filter

The permittee shall install, operate, and maintain venturi scrubber (VS1), vent gas cleaning tower (ST1), vent gas steam condensation tower (CT1), and carbon filter (CA5) systems in accordance with the O&M manual (Permit Condition 2.20) and consistent with manufacturer's recommendations. All emissions from the autoclave shall be ducted to these control devices at all times to ensure compliance with autoclave emission limits (Table 4.2).

4.14 Electrowinning Cells and Pregnant Solution Tank Shared Carbon Filter

The permittee shall install, operate, and maintain a carbon filter (CA2) in accordance with the O&M manual (Permit Condition 2.20) and consistent with manufacturer's recommendations. All emissions from the electrowinning cells and pregnant solution tank shall be ducted to a carbon filter at all times to ensure compliance with electrowinning cells and pregnant solution tank emission limits (Table 4.2).

4.15 Mercury Retort Condenser and Carbon Filter

The permittee shall install, operate, and maintain a condenser and carbon filter (CA3) in series in accordance with the O&M manual (Permit Condition 2.20) and manufacturer's recommendations. All emissions from the mercury retort (MR) shall be ducted to the condenser and activated carbon filter at all times to ensure compliance with mercury retort emission limits (Table 4.2).

- The MR shall be fully enclosed in the refinery building.
- The air pressure within the MR shall be maintained lower than the room air pressure such that air flows into the MR at all times when the MR is operating. The MR door shall be kept closed at all times during operation.
- The permittee shall not operate the MR unless the chilled water condenser is operating, carbon filter in place, and the condenser coolant flow rate is maintained within the range specified in the O&M manual.
- The condenser and carbon filter shall be maintained and operated in accordance with the O&M manual.
- All liquid mercury captured from the MR shall be stored in closed containers.

4.16 Induction Melting Furnace Baghouse and Carbon Filter

The permittee shall install, operate, and maintain a baghouse (BH2) and carbon filter (CA4) in series in accordance with the O&M manual (Permit Condition 2.20) and manufacturer's recommendations. All emissions from the induction melting furnace shall be ducted to the

baghouse and carbon filter at all times during operation to ensure compliance with induction melting furnace emission limits (Table 4.2).

4.17 Carbon Regeneration Kiln Wet Scrubber and Carbon Filter

The permittee shall install, operate, and maintain a wet scrubber (WS2) and carbon filter (CA1) in series in accordance with the O&M manual (Permit Condition 2.20) and consistent with manufacturer's recommendations. All emissions from the carbon regeneration kiln shall be ducted to the wet scrubber and a carbon filter at all times to ensure compliance with carbon regeneration kiln drum emission limits (Table 4.2).

Monitoring and Recordkeeping

4.18 Cyanide Emissions Limit Compliance Monitoring

On at least a daily basis, the permittee shall monitor and record the pH, temperature, and free cyanide concentration levels in grams per cubic meter (g/m^3) of each cyanide leach tank, detox tank, and tailings reclaim stream, and use this information to estimate monthly facility-wide cyanide emissions using the equation and calculation methodology in the O&M Manual (Permit Condition 2.20).

Each month, the permittee shall estimate the monthly and rolling 12-month facility-wide cyanide emissions. Monthly facility-wide cyanide emissions shall be estimated from all emission sources including cyanide leach tanks, detox tanks, electrowinning cells and pregnant solution tank, and barren tanks. Rolling 12-month facility-wide cyanide emissions shall be estimated by summing the monthly emissions from all sources over the previous consecutive 12-month period. The rolling 12-month facility-wide cyanide emissions shall be used to assess compliance with the Cyanide Emissions Limit (Permit Condition 4.4).

4.19 Xanthates Usage Monitoring

Each month, the permittee shall monitor and record the xanthates delivered to the facility and the xanthates used by the facility in tons per month (T/mo) and in tons per 12-month period to demonstrate compliance with the xanthates usage limit. Annual delivery and usage shall be determined by summing the respective monthly amounts over the previous consecutive 12-month period. The methodologies used to measure xanthates usage shall be identified in the O&M Manual.

4.20 POX Boiler Operation Monitoring

Each month, the permittee shall monitor and record the operating hours of the POX Boiler, in hours (hr/mo) and in hours per 12-month period (hr/yr). Annual hours shall be determined by summing the monthly hours over the previous consecutive 12-month period.

4.21 Autoclave Input Monitoring

Each day, the permittee shall monitor and record the material input to the autoclave in tons (T/day) to demonstrate compliance with the autoclave input limit. The devices and methodologies used to measure weights shall be identified in the O&M Manual, and the devices shall be installed in accordance with the requirements of NESHAP Subpart EEEEEEE.

4.22 Mercury Retort Input Monitoring

Each day, the permittee shall monitor and record the material input to the mercury retort in pounds (lb/day) to demonstrate compliance with the daily mercury retort input limit. The devices and methodologies used to measure weights shall be in accordance with the requirements of NESHAP Subpart EEEEEEE.

Each month, the permittee shall monitor and record the material input to the mercury retort in T/mo and T/yr to demonstrate compliance with the annual mercury retort input limit. Annual material input shall be determined by summing the monthly input over the previous consecutive 12-month period.

4.23 Induction Melting Furnace Input Monitoring

Each day, the permittee shall monitor and record the material input to the induction melting furnace in pounds (lb/day) to demonstrate compliance with the daily induction melting furnace input limit. The devices and methodologies used to measure weights shall be identified in the O&M Manual.

Each month, the permittee shall monitor and record the material input to the induction melting furnace in T/mo and in T/yr to demonstrate compliance with the annual induction melting furnace input limit. Annual material input shall be determined by summing the monthly input over the previous consecutive 12-month period.

4.24 Carbon Regeneration Kiln Input Monitoring

Each day, the permittee shall monitor and record the material input to the carbon regeneration kiln in tons (T/day) to demonstrate compliance with the carbon regeneration kiln input limit. The devices and methodologies used to measure weights shall be identified in the O&M Manual.

4.25 Electrowinning Cells and Pregnant Solution Tank Throughput Monitoring

Each day, the permittee shall monitor and record the material throughput in the electrowinning cells and pregnant solution tank in gallons per minute (gpm) to demonstrate compliance with the Electrowinning Cells and Pregnant Solution Tank Throughput limit. The devices and methodologies used to measure weights shall be identified in the O&M Manual.

4.26 Autoclave Venturi Scrubber and Vent Gas Cleaning Tower Monitoring

The permittee shall install, calibrate, operate, and maintain devices for monitoring the circulation flow rate in the venturi scrubber, the circulation flow rate in the vent gas cleaning tower, the pressure drop across the venturi scrubber, and the pressure drop across the vent gas cleaning tower for the autoclave.

At least once per shift, the permittee shall monitor and record the circulation flow rate in the venturi scrubber, the circulation flow rate in the vent gas cleaning tower, the pressure drop across the venturi scrubber, and the pressure drop across the vent gas cleaning tower to ensure compliance with O&M specifications.

4.27 Autoclave Vent Gas Steam Condensation Tower Monitoring

The permittee shall install, calibrate, operate, and maintain devices for monitoring the coolant flow rate to the vent gas steam condensation tower for the autoclave.

At least once per shift, the permittee shall monitor and record the coolant flow rate to the vent gas steam condensation tower to ensure compliance with O&M specifications.

4.28 Autoclave Carbon Filter Monitoring

The permittee shall install, calibrate, operate, and maintain devices for monitoring the inlet gas stream temperature to the carbon filter, and the pressure drop across the carbon filter for the autoclave.

At least once per shift, the permittee shall monitor and record the inlet gas stream temperature and pressure drop across the carbon filter to ensure compliance with O&M specifications.

4.29 Electrowinning Cells and Pregnant Solution Tank Shared Carbon Filter Monitoring

The permittee install, calibrate, operate, and maintain devices for monitoring the inlet gas stream temperature to the carbon filter, and the pressure drop across the carbon filter for the electrowinning cells and pregnant solution tank.

At least once per shift, the permittee shall monitor and record the inlet gas stream temperature and pressure drop across the carbon filter to ensure compliance with O&M specifications.

4.30 Mercury Retort Condenser and Carbon Filter Monitoring

The permittee shall install, calibrate, operate, and maintain devices for monitoring the coolant flow rate in the condenser, the inlet gas temperature to the carbon filter, the pressure drop across the carbon filter, and the difference between the pressure inside the MR and the air pressure in the room.

At least once per shift, the permittee shall monitor and record the coolant flow rate to the condenser, the inlet gas stream temperature, the pressure drop across the carbon filter, and the difference between the pressure inside the MR and the air pressure in the room to ensure compliance with O&M specifications.

4.31 Induction Melting Furnace Baghouse and Carbon Filter Monitoring

The permittee shall install, calibrate, operate, and maintain devices for monitoring the pressure drop across the baghouse, the inlet gas stream temperature to the carbon filter, and the pressure drop across the carbon filter for the induction melting furnace.

At least once per shift, the permittee shall monitor and record the pressure drop across the induction melting furnace baghouse, the inlet gas stream temperature to the carbon filter, and pressure drop across the carbon filter to ensure compliance with O&M specifications.

4.32 Carbon Regeneration Kiln Wet Scrubber and Carbon Filter Monitoring

The permittee shall install, calibrate, operate, and maintain a device for monitoring the circulation flow rate in the wet scrubber, the pressure drop across the wet scrubber, the inlet gas stream temperature to the carbon filter, and the pressure drop across the carbon filter for the carbon regeneration kiln.

At least once per shift, the permittee shall monitor and record the circulation flow rate, the pressure drop across the carbon regeneration kiln wet scrubber, the inlet gas stream temperature to the carbon filter, and the pressure drop across the carbon filter to ensure compliance with O&M specifications.

Testing

4.33 Ore Concentration and Refining Equipment Performance Tests

Within 180 days after initial startup, performance testing shall be conducted to demonstrate compliance with the following Ore Concentration and Refining Equipment Emissions Limits. The permittee shall conduct three separate test runs for each performance test using the appropriate test method (Permit Condition 2.25). The source test shall be conducted under "worst-case normal" conditions as required by IDAPA 58.01.01.157 and the General Provisions of this permit, and the source test report shall contain documentation that the test was conducted under these conditions.

- $PM_{10}/PM_{2.5}$ and H_2SO_4 in lb/hr from the Autoclave Wet Scrubber Stack
- $PM_{10}/PM_{2.5}$ in lb/hr from the Carbon Regeneration Kiln Carbon Filter Stack

- $PM_{10}/PM_{2.5}$ in lb/hr from the Electrowinning Cells and Pregnant Solution Tank Shared Carbon Filter Stack
- $PM_{10}/PM_{2.5}$ in lb/hr from the Mercury Retort Carbon Filter Stack
- $PM_{10}/PM_{2.5}$ in lb/hr from the Induction Melting Furnace Carbon Filter Stack

4.34 Ore Concentration and Refining Equipment Performance Tests Monitoring

The permittee shall monitor and record the following during each performance test:

- Material input rates for all ore concentration and refining process equipment (Permit Conditions 4.21 through 4.25) during each test run.
- Control equipment monitoring relevant to the stack tested (Permit Condition 4.26 through 4.32), measured at least once during each test run.
- The visible emissions observed for the stack tested during each test, using the methods specified in IDAPA 58.01.01.625 (Permit Condition 2.9).

5 Lime, Aggregate, and Concrete Production

5.1 Process Description

The lime, aggregate, and cement batch plants produce raw materials necessary for mining and ore concentration and refining operations. Lime is used in ore processing for pH control. Aggregate and cement are used in concrete production, with aggregate also used in road construction.

Lime production consists of a limestone crushing, screening, and grinding plant and lime storage silos. The limestone grinding process utilizes a baghouse to reduce emissions during processing. Each storage silo has a bin vent filter used to reduce PM emissions during silo loading.

Aggregate production consists of two portable crushing and screening plants and aggregate and cement storage silos. Each portable crushing and screening plant utilizes water sprays and moisture carryover to reduce emissions during processing. Each storage silo has a bin vent filter used to reduce PM emissions during silo loading.

Concrete production consists of a central mix batch plant and cement storage silos. The central mix batch plant utilizes controls that may include water sprays, enclosures, hoods, curtains, shrouds, movable and telescoping chutes, and central duct collection systems to reduce PM emissions during processing. Each storage silo has a bin vent filter used to reduce PM emissions during silo loading.

5.2 Control Device Descriptions

Table 5.1 Lime, Aggregate, and Concrete Production Control Device Descriptions

Lime Production Plant Emissions Unit / Processes	Control Devices	Emission Points
Limestone transfer to Primary Crusher Hopper	Reasonable control & FDCP	Various
Primary Crusher		
Primary Screen		
Secondary Crusher		
Secondary Screen		
Limestone to Ball Mill Feed Bin		
Limestone to Ball Mill Feed		
Ball Mill Feed to Ball Mill		
Limestone to Kiln Feed Bin		
Limestone to Lime Kiln Feed		
Fines Screen		
Kiln Feed to PFR Shaft Lime Kiln		
Limestone Ball Mill	Reasonable control & FDCP Baghouse (BH3) Minimum pressure drop established in O&M	Limestone Ball Mill Baghouse Stack
Pebble Lime Silo loading	Bin vent filter	Pebble Lime Silo Stack
unloading	Wet Scrubber (WS3) Minimum pressure drop established in O&M	Pebble Lime Silo Wet Scrubber Stack
Parallel Flow Regenerative Shaft Kiln	Baghouse (BH4) Minimum pressure drop established in O&M	PFR Shaft Kiln Carbon Filter Stack
Lime Mill Crusher	Baghouse (BH5) Minimum pressure drop established in O&M	Lime Mill Crusher Baghouse Stack
SAG Mill Lime Silo #1, and SAG Mill Lime Silo #2 loading	Bin vent filters	SAG Mill Lime Silo #1 Stack and SAG Mill Lime Silo #2 Stack
unloading	None	Fugitive
AC Lime Silo #1, AC Lime Silo #2, AC Lime Silo #3, and AC Lime Silo #4 loading	Bin vent filters	AC Lime Silo #1 Stack, AC Lime Silo #2 Stack, AC Lime Silo #3 Stack, and AC Lime Silo #4 Stack
unloading	None	Fugitive
Aggregate Production Plant Emissions Unit / Processes	**Control Devices**	**Emission Points**
Portable Crushing and Screening Plant 1 Crushers, screens, and conveyors	Reasonable control & FDCP Water sprays and moisture carryover	Various
Portable Crushing and Screening Plant 2 Crushers, screens, and conveyors	Reasonable control & FDCP Water sprays and moisture carryover	Various
Concrete Production Plant Emissions Unit / Processes	**Control Devices**	
Central Mix Plant	Reasonable control & FDCP Controls may include water sprays, enclosures, hoods, curtains, shrouds, movable and telescoping chutes, and central duct collection systems.	Various
Aggregate bin loading/unloading	None	Fugitive
Cement/Shotcrete Silo #1 and Cement/Shotcrete Silo #2 loading	Bin vent filters	Cement/Shotcrete Silo #1 Stack and Cement/Shotcrete Silo #2 Stack
unloading	None	Fugitive

Emission Limits

5.3 Lime, Aggregate, and Concrete Production Emission Limits

Emissions from the lime production plant stacks shall not exceed any emission rate limit in the following table.

Table 5.2 Lime, Aggregate, and Concrete Production Plant Emission Limits [a]

Source Description	PM [b]	PM_{10} [b]	$PM_{2.5}$ [b]	NO_x	CO	VOC	SO_2
	lb/hr [c]	lb/hr [c]	lb/hr [c]	lb/hr [c]	lb/hr [c]	lb/hr [c]	lb/hr [c]
Lime Production							
Parallel Flow Regenerative Shaft Kiln (LK, LKC)	1.08	1.08	1.08	4.82	4.98	0.19	0.39
Limestone Ball Mill (LSBM)	1.90	1.60	0.57				
Lime Mill Crusher (LCR)	0.28	0.24	0.09				
Lime Mill screens and conveyors (LS2, LS4, LS3, LS5, LS11, LS1, LS6–LS10, LS12)	3.66	1.34	0.20				
Mill Lime Silo loading (each) (LS1L, MillS2L)	0.06	0.02	0.01				
Mill Lime Silo unloading (each) (LS1U, MillS2U)	0.10	0.06	0.01				
AC Lime Silo loading (each) (ACS1L, ACS2L, ACS3L, ACS4L)	0.12	0.04	0.01				
AC Lime Silo loading (each) (ACS1U, ACS2U, ACS3U, ACS4U)	0.10	0.06	0.01				
Pebble Lime Silo loading (LS-L)	0.01	0.01	0.01				
Pebble Lime Silo unloading (LS-U)	0.001	0.001	0.001				
Crushers, screens, conveyors, silo unloading (LSBM, LCR, LS1– LS12)	6.00	3.22	0.87				
Aggregate Production							
Portable Crushing and Screening Plant 1	0.63	0.23	0.03				
Portable Crushing and Screening Plant 2	0.63	0.23	0.03				
Concrete Production							
Central Mix Plant (CM, CS1, CS2, CA)	2.10	0.94	0.14				

a) In absence of any other credible evidence, compliance is ensured by complying with permit operating, monitoring, and recordkeeping requirements.

b) Particulate matter (PM) including condensable PM as defined in IDAPA 58.01.01.006, with an aerodynamic diameter less than or equal to a nominal 10 micrometers for PM_{10}, and less than or equal to a nominal 2.5 micrometers for $PM_{2.5}$.

c) Pounds per hour, as determined by a test method prescribed by IDAPA 58.01.01.157, EPA reference test method, continuous emission monitoring system (CEMS) data, or DEQ-approved alternative.

Operating Requirements

5.4 Primary Crusher Limit

The permittee shall process limestone as the raw material, and the maximum input to the primary crusher shall not exceed 1,130 T/day.

5.5 Parallel Flow Regenerative Kiln Limit

The permittee shall process lime as the raw material in the Parallel Flow Regenerative Kiln. The maximum output from the kiln shall not exceed 169 T/day and 52,377 tons per any consecutive 12-month period.

5.6 Portable Crushing and Screening Plant 1 Input Limit

The permittee shall process aggregate as the raw material, and the maximum input to the Portable Crushing and Screening Plant 1 shall not exceed 2,000 T/day.

5.7 Portable Crushing and Screening Plant 2 Input Limit

The permittee shall process aggregate as the raw material, and the maximum input to the Portable Crushing and Screening Plant 2 shall not exceed 2,000 T/day.

5.8 Central Mix Input Limit

The permittee shall process cement and aggregate as the raw materials, and the maximum input to the central mix plant shall not exceed 2,480 T/day and 560,000 tons per any consecutive 12-month period.

5.9 Lime Silos Input Limit

The permittee shall load lime as the raw material, and the maximum input to the Mill Lime Silos and the AC Lime Silos shall not exceed 4,000 T/day and 70,000 tons per any consecutive 12-month period combined.

5.10 Lime, Aggregate, and Concrete Production Dust Control

The permittee shall control emissions from lime production, aggregate production, and concrete production emission sources (Table 5.1) in accordance with the Fugitive Dust Control Plan.

5.11 Portable Crushing and Screening Plant Water Sprays

The permittee shall install, operate, and maintain water sprays in accordance with the O&M manual (Permit Condition 2.20) to control PM emissions from each portable crushing and screening plant. Water sprays shall operate at all times, except as specified in the O&M manual during winter conditions, when this equipment is operated to ensure compliance with Fugitive Dust requirements (Permit Conditions 2.1–2.6).

5.12 Parallel Flow Regenerative Kiln Baghouse

The permittee shall install, operate, and maintain a baghouse system (BH4) in accordance with the O&M manual (Permit Condition 2.20) and consistent with manufacturer's recommendations. All emissions from the parallel flow regenerative kiln shall be ducted to the baghouse at all times to ensure compliance with parallel flow regenerative emission limits.

5.13 Limestone Ball Mill Baghouse

The permittee shall install, operate, and maintain a baghouse system (BH3) in accordance with the O&M manual (Permit Condition 2.20) and consistent with manufacturer's recommendations. All emissions from the limestone ball mill shall be ducted to the baghouse at all times to ensure compliance with limestone ball mill emission limits.

5.14 Lime Mill Crusher Baghouse

The permittee shall install, operate, and maintain a baghouse (BH5) in accordance with the O&M manual (Permit Condition 2.20) and consistent with manufacturer's recommendations.
All emissions from the lime mill crusher shall be ducted to the baghouse at all times to ensure compliance with limestone ball mill emission limits.

5.15 Pebble Lime Silo Wet Scrubber

The permittee shall install, operate, and maintain a wet scrubber on the Pebble Lime Silo discharge (LS) in accordance with the O&M manual (Permit Condition 2.20) and consistent with manufacturer's recommendations. All emissions during discharge from the Pebble Lime Silo shall be ducted to the wet scrubber to ensure compliance with pebble lime silo emission limits (Table 5.2).

5.16 Silo Bin Vent Filters

The permittee shall install, operate, and maintain a bin vent filter on each silo (LS1, MillS2, ACS1, ACS2, ACS3, ACS4, LS, CS1, CS2) in accordance with the O&M manual (Permit Condition 2.20) and consistent with manufacturer's recommendations. All emissions during loading of each silo shall be ducted to the corresponding bin vent filter to ensure compliance with corresponding silo emission limits (Table 5.2).

Monitoring and Recordkeeping Requirements

5.17 Primary Crusher Monitoring

Each day, the permittee shall monitor and record the material input to the Primary Crusher in tons (T/day) to demonstrate compliance with the daily Primary Crusher Limit. The devices and methodologies used to measure weights shall be identified in the O&M Manual.

5.18 Parallel Flow Regenerative Kiln Limit Monitoring

Each day, the permittee shall monitor and record the material output from the Parallel Flow Regenerative Kiln in tons (T/day) to demonstrate compliance with the daily Parallel Flow Regenerative Kiln Limits. The devices and methodologies used to measure weights shall be identified in the O&M Manual.

Each month, the permittee shall calculate and record the material output from the Parallel Flow Regenerative Kiln in T/mo and in T/yr to demonstrate compliance with the annual Parallel Flow Regenerative Kiln Limit. Annual material output shall be determined by summing the monthly output over the previous consecutive 12-month period.

5.19 Portable Crushing and Screening Plant 1 Input Limit Monitoring

Each day, the permittee shall monitor and record the material input to the Portable Crushing and Screening Plant 1 plant in tons (T/day) to demonstrate compliance with the daily Portable Crushing and Screening Plant 1 Input Limit. The devices and methodologies used to measure weights shall be identified in the O&M Manual.

5.20 Portable Crushing and Screening Plant 2 Input Limit Monitoring

Each day, the permittee shall monitor and record the material input to the Portable Crushing and Screening Plant 2 plant in tons (T/day) to demonstrate compliance with the daily Portable Crushing and Screening Plant 2 Input Limit. The devices and methodologies used to measure weights shall be identified in the O&M Manual.

5.21 Central Mix Input Limit Monitoring

Each day, the permittee shall monitor and record the material input to the Central Mix Plant in tons (T/day) to demonstrate compliance with the daily Central Mix Input Limit. The devices and methodologies used to measure weights shall be identified in the O&M Manual.

Each month, the permittee shall calculate and record the material input to the central mix plant in T/mo and in T/yr to demonstrate compliance with the annual Central Mix Input Limit. Annual

material input shall be determined by summing the monthly input over the previous consecutive 12-month period.

5.22 Lime Silos Input Limit Monitoring

Each day, the permittee shall monitor and record the material input to the Mill Lime Silos and the AC Lime Silos in tons (T/day) to demonstrate compliance with the daily Lime Silos Input Limit. The devices and methodologies used to measure weights shall be identified in the O&M Manual.

Each month, the permittee shall calculate and record the material input to the Mill Lime Silos and the AC Lime Silos in T/mo and in T/yr to demonstrate compliance with the annual Lime Silos Input Limit. Annual material input shall be determined by summing the monthly input over the previous consecutive 12-month period.

5.23 Parallel Flow Regenerative Kiln Baghouse Monitoring

The permittee shall install, calibrate, operate, and maintain a device for monitoring the pressure drop across the parallel flow regenerative kiln baghouse. At least once per shift, the permittee shall monitor and record the pressure drop across the parallel flow regenerative kiln baghouse to demonstrate compliance with O&M specifications.

5.24 Limestone Ball Mill Baghouse Monitoring

The permittee shall install, calibrate, operate, and maintain a device for monitoring the pressure drop across the limestone ball mill baghouse. At least once per shift, the permittee shall monitor and record the pressure drop across the limestone ball mill kiln baghouse to demonstrate compliance with O&M specifications.

5.25 Lime Mill Crusher Baghouse Monitoring

The permittee shall install, calibrate, operate, and maintain a device for monitoring the pressure drop across the lime mill crusher baghouse. At least once per shift, the permittee shall monitor and record the pressure drop across the lime mill crusher kiln baghouse to demonstrate compliance with O&M specifications.

5.26 Pebble Lime Silo Wet Scrubber Monitoring

The permittee shall install, calibrate, operate, and maintain a device for monitoring the circulation flow rate in the pebble lime silo wet scrubber, and the pressure drop across the pebble lime silo wet scrubber. At least once per shift, the permittee shall monitor and record the circulation flow rate and the pressure drop across the pebble lime silo wet scrubber to demonstrate compliance with O&M specifications.

6 Engines

6.1 Process Description

Stationary internal combustion engines (ICE) for emergency power generation and fire suppression are essential to ensure safety and uninterrupted essential operations in case of unforeseen power failures or emergency situations. Portable diesel-fired light plant engines provide supplemental lighting as needed; these are not regulated by this permit and will be operated as nonroad engines defined in 40 CFR 1068.30.

6.2 Emission Standards for Emergency Generators and Fire Pump Engines

In accordance with 40 CFR 60.4205(b) and 40 CFR 60.4206, EDG1, EDG2, and EDG3 shall be EPA Tier II Certified engines and must comply with the emission standards for new nonroad CI engines in § 60.4202, for all pollutants, for the same model year and maximum engine power and must be operated and maintained so that they achieve the emission standards as required in §§60.4204 and 60.4205 over the entire life of the engine.

In accordance with 40 CFR 60.4205(c), EDFP must comply with the emission standards in Table 4 to the Subpart for all pollutants.

6.3 Emergency Generator and Fire Pump Engine Operation

Operation of each emergency generator engine (EDG1, EDG2, EDG3) and each fire pump engine (EDFP) shall not exceed 1 hour per day (hr/day) and 100 hr/yr for non-emergency purposes.

6.4 Emergency Generator Monitoring Requirements

In accordance with 40 CFR 60.4209(a), EDG1, EDG2, and EDG3 shall have non-resettable hour meters installed prior to startup.

6.5 Emergency Generator Compliance Requirements

In accordance with 40 CFR 60.4211(f), EDG1, EDG2, and EDG3 must be operated according to the requirements in paragraphs (f)(1) through (3) of this section of the Subpart. In order for the engines to be considered emergency stationary ICE under this subpart, any operation other than emergency operation, maintenance and testing, emergency demand response, and operation in non-emergency situations for 50 hours per year, as described in paragraphs (f)(1) through (3) of this section, is prohibited. If you do not operate the engine according to the requirements in paragraphs (f)(1) through (3) of this section, the engine will not be considered an emergency engine under this subpart and must meet all requirements for non-emergency engines.

(1) There is no time limit on the use of emergency stationary ICE in emergency situations.

(2) You may operate your emergency stationary ICE for any combination of the purposes specified in paragraphs (f)(2)(i) through (iii) of this section for a maximum of 100 hours per calendar year. Any operation for non-emergency situations as allowed by paragraph (f)(3) of this section counts as part of the 100 hours per calendar year allowed by this paragraph (f)(2).

(i) Emergency stationary ICE may be operated for maintenance checks and readiness testing, provided that the tests are recommended by federal, state or local government, the manufacturer, the vendor, the regional transmission

organization or equivalent balancing authority and transmission operator, or the insurance company associated with the engine. The owner or operator may petition the Administrator for approval of additional hours to be used for maintenance checks and readiness testing, but a petition is not required if the owner or operator maintains records indicating that federal, state, or local standards require maintenance and testing of emergency ICE beyond 100 hours per calendar year.

(ii) Emergency stationary ICE may be operated for emergency demand response for periods in which the Reliability Coordinator under the North American Electric Reliability Corporation (NERC) Reliability Standard EOP-002-3, Capacity and Energy Emergencies (incorporated by reference, see § 60.17), or other authorized entity as determined by the Reliability Coordinator, has declared an Energy Emergency Alert Level 2 as defined in the NERC Reliability Standard EOP-002-3.

(iii) Emergency stationary ICE may be operated for periods where there is a deviation of voltage or frequency of 5 percent or greater below standard voltage or frequency.

(3) Emergency stationary ICE may be operated for up to 50 hours per calendar year in non-emergency situations. The 50 hours of operation in non-emergency situations are counted as part of the 100 hours per calendar year for maintenance and testing and emergency demand response provided in paragraph (f)(2) of this section. Except as provided in paragraph (f)(3)(i) of this section, the 50 hours per calendar year for non-emergency situations cannot be used for peak shaving or non-emergency demand response, or to generate income for a facility to an electric grid or otherwise supply power as part of a financial arrangement with another entity.

(i) The 50 hours per year for non-emergency situations can be used to supply power as part of a financial arrangement with another entity if all of the following conditions are met:

(A) The engine is dispatched by the local balancing authority or local transmission and distribution system operator.

(B) The dispatch is intended to mitigate local transmission and/or distribution limitations so as to avert potential voltage collapse or line overloads that could lead to the interruption of power supply in a local area or region.

(C) The dispatch follows reliability, emergency operation or similar protocols that follow specific NERC, regional, state, public utility commission or local standards or guidelines.

(D) The power is provided only to the facility itself or to support the local transmission and distribution system.

(E) The owner or operator identifies and records the entity that dispatches the engine and the specific NERC, regional, state, public utility commission or local standards or guidelines that are being followed for dispatching the engine. The local balancing authority or local transmission and distribution system operator may keep these records on behalf of the engine owner or operator.

6.6 Emergency Generator and Fire Pump Engine Operation Monitoring

Each month, the permittee shall monitor and record the emergency and non-emergency operating hours of each emergency generator and fire pump engine, in hr/mo and in hr/yr to demonstrate compliance with the emergency generator and fire pump engine operation limit. Annual operation shall be determined by summing the monthly hours over the previous consecutive 12-month period.

6.7 Engines Subject to Regulation Notification

With the exception of the emergency generator and fire pump engines (identified in Table 1.1) and engines used to propel vehicles, notification shall be provided to DEQ if an engine (including any previously operated as a nonroad engine) will be operated onsite at a specific location beyond 12 months, and no longer meets criteria for regulation as a nonroad engine. Notification shall be provided as soon as practicable in advance of exceeding 12 months of operation at a single location and within 30 days after the engine ceases to meet the definition of nonroad engine in 40 CFR 1068.30.

- A nonroad engine may include engines that are portable or transportable, meaning designed to be and capable of being carried or moved from one location to another (e.g., portable light plant engines). Indicia of transportability include, but are not limited to, wheels, skids, carrying handles, dolly, trailer, or platform.
- A portable or transportable internal combustion engine is not a nonroad engine if it remains or will remain at a location for more than 12 consecutive months, or a shorter period of time for an engine located at a seasonal source. A location is any single site at a building, structure, facility, or installation. Any engines (or engine) that replace(s) an engine at a location and is intended to perform the same or similar function as the engine(s) replaced are included in calculating the consecutive time period. Permitting requirements and emission standards may become applicable when an engine becomes a stationary source.

7 General Provisions

General Compliance

7.1 The permittee has a continuing duty to comply with all terms and conditions of this permit. All emissions authorized herein shall be consistent with the terms and conditions of this permit and the "Rules for the Control of Air Pollution in Idaho." The emissions of any pollutant in excess of the limitations specified herein, or noncompliance with any other condition or limitation contained in this permit, shall constitute a violation of this permit, the "Rules for the Control of Air Pollution in Idaho," and the Environmental Protection and Health Act (Idaho Code §39-101, et seq).

[Idaho Code §39-101, et seq.]

7.2 The permittee shall at all times (except as provided in the "Rules for the Control of Air Pollution in Idaho") maintain in good working order and operate as efficiently as practicable all treatment or control facilities or systems installed or used to achieve compliance with the terms and conditions of this permit and other applicable Idaho laws for the control of air pollution.

[IDAPA 58.01.01.211]

7.3 Nothing in this permit is intended to relieve or exempt the permittee from the responsibility to comply with all applicable local, state, or federal statutes, rules, and regulations.

[IDAPA 58.01.01.212.01]

Inspection and Entry

7.4 Upon presentation of credentials, the permittee shall allow DEQ or an authorized representative of DEQ to do the following:

- Enter upon the permittee's premises where an emissions source is located, emissions-related activity is conducted, or where records are kept under conditions of this permit;
- Have access to and copy, at reasonable times, any records that are kept under the conditions of this permit;
- Inspect at reasonable times any facilities, equipment (including monitoring and air pollution control equipment), practices, or operations regulated or required under this permit; and
- As authorized by the Idaho Environmental Protection and Health Act, sample or monitor, at reasonable times, substances or parameters for the purpose of determining or ensuring compliance with this permit or applicable requirements.

[Idaho Code §39-108]

Construction and Operation Notification

7.5 This permit shall expire if construction has not begun within two years of its issue date, or if construction is suspended for one year.

[IDAPA 58.01.01.211.02]

7.6 The permittee shall furnish DEQ written notifications as follows:

- A notification of the date of initiation of construction, within five working days after occurrence; except in the case where pre-permit construction approval has been granted then notification shall be made within five working days after occurrence or within five working days after permit issuance whichever is later;
- A notification of the date of any suspension of construction, if such suspension lasts for one year or more; and

- A notification of the initial date of achieving the maximum production rate, within five working days after occurrence - production rate and date.

[IDAPA 58.01.01.211.01]

- A notification of the anticipated date of initial start-up of the stationary source or facility not more than sixty days or less than thirty days prior to such date; and
- A notification of the actual date of initial start-up of the stationary source or facility within fifteen days after such date.

[IDAPA 58.01.01.211.03]

Performance Testing

7.7 If performance testing (air emissions source test) is required by this permit, the permittee shall provide notice of intent to test to DEQ at least 15 days prior to the scheduled test date or shorter time period as approved by DEQ. DEQ may, at its option, have an observer present at any emissions tests conducted on a source. DEQ requests that such testing not be performed on weekends or state holidays.

7.8 All performance testing shall be conducted in accordance with the procedures in IDAPA 58.01.01.157. Without prior DEQ approval, any alternative testing is conducted solely at the permittee's risk. If the permittee fails to obtain prior written approval by DEQ for any testing deviations, DEQ may determine that the testing does not satisfy the testing requirements. Therefore, at least 30 days prior to conducting any performance test, the permittee is encouraged to submit a performance test protocol to DEQ for approval. The written protocol shall include a description of the test method(s) to be used, an explanation of any or unusual circumstances regarding the proposed test, and the proposed test schedule for conducting and reporting the test.

7.9 Within 60 days following the date in which a performance test required by this permit is concluded, the permittee shall submit to DEQ a performance test report. The report shall include a description of the process, identification of the test method(s) used, equipment used, all process operating data collected during the test period, and test results, as well as raw test data and associated documentation, including any approved test protocol.

[IDAPA 58.01.01.157]

Monitoring and Recordkeeping

7.10 The permittee shall maintain sufficient records to ensure compliance with all of the terms and conditions of this permit. Monitoring records shall include, but not be limited to, the following: (a) the date, place, and times of sampling or measurements; (b) the date analyses were performed; (c) the company or entity that performed the analyses; (d) the analytical techniques or methods used; (e) the results of such analyses; and (f) the operating conditions existing at the time of sampling or measurement. All monitoring records and support information shall be retained for a period of at least five years from the date of the monitoring sample, measurement, report, or application. Supporting information includes, but is not limited to, all calibration and maintenance records, all original strip-chart recordings for continuous monitoring instrumentation, and copies of all reports required by this permit. All records required to be maintained by this permit shall be made available in either hard copy or electronic format to DEQ representatives upon request.

[IDAPA 58.01.01.211]

Excess Emissions

7.11 The permittee shall comply with the procedures and requirements of IDAPA 58.01.01.130-136 for excess emissions. The provisions of IDAPA 58.01.01.130-136 shall govern in the event of conflicts between the excess emissions general provisions and the regulations of IDAPA 58.01.01.130-136.

During an excess emissions event, the permittee shall, with all practicable speed, initiate and complete appropriate and reasonable action to correct the conditions causing the excess emissions event; to reduce the frequency of occurrence of such events; to minimize the amount by which the emission standard is exceeded; and shall, as provided below or upon request of DEQ, submit a full report of such occurrence, including a statement of all known causes, and of the scheduling and nature of the actions to be taken.

[IDAPA 58.01.01.132]

7.12 In all cases where startup, shutdown, or scheduled maintenance of any equipment or emission unit is expected to result or results in an excess emissions event, the permittee shall demonstrate compliance with IDAPA 58.01.01.133.01(a) through (d), including, but not limited to, the following:

- Prohibiting any scheduled startup, shutdown, or maintenance resulting in excess emissions shall occur during any period in which an Atmospheric Stagnation Advisory or a Wood Stove Curtailment Advisory has been declared by DEQ.
- Notifying DEQ of the excess emissions event as soon as reasonably possible, but no later than two hours prior to, the start of the event, unless the permittee demonstrates to DEQ's satisfaction that a shorter advance notice was necessary.
- Reporting and recording the information required pursuant to the excess emissions reporting and recordkeeping requirements and IDAPA 58.01.01.135 and 136 for each excess emissions event due to startup, shutdown, or scheduled maintenance.

[IDAPA 58.01.01.133]

7.13 In all cases where upset or breakdown of equipment or an emissions unit, or the initiation of safety measures, results or may result in an excess emissions event, the permittee shall demonstrate compliance with IDAPA 58.01.01.134.01(a) and (b) and the following:

- Immediately undertake all appropriate measures to reduce and, to the extent possible, eliminate excess emissions resulting from the event and to minimize the impact of such excess emissions on the ambient air quality and public health.
- Notify DEQ of any upset, breakdown, or safety event that results in excess emissions. Such notification shall identify the time, specific location, equipment or emissions unit involved, and (to the extent known) the cause(s) of the occurrence. The notification shall be given as soon as reasonably possible, but no later than 24 hours after the event, unless the permittee demonstrates to DEQ's satisfaction that the longer reporting period was necessary.
- Report and record the information required pursuant to the excess emissions reporting and recordkeeping facility wide conditions and IDAPA 58.01.01.135 and 136 for each excess emissions event caused by an upset, breakdown, or safety measure.

- During any period of excess emissions caused by upset, breakdown, or operation under facility safety measures, DEQ may require the permittee to immediately reduce or cease operation of the equipment or emissions unit causing the period until such time as the condition causing the excess has been corrected or brought under control. Such action by DEQ shall be taken upon consideration of the factors listed in IDAPA 58.01.01.134.03 and after consultation with the permittee.

[IDAPA 58.01.01.134]

7.14 The permittee shall submit a written report to DEQ for each excess emissions event, no later than 15 days after the beginning of such an event. Each report shall contain the information specified in IDAPA 58.01.01.135.02.

[IDAPA 58.01.01.135]

7.15 The permittee shall maintain excess emissions records at the facility for the most recent five calendar-year period. The excess emissions records shall be made available to DEQ upon request and shall include the information requested by IDAPA 58.01.01.136.03(a) and (b) as summarized in the following:

- An excess emissions log book for each emissions unit or piece of equipment containing copies of all reports that have been submitted to DEQ pursuant to IDAPA 58.01.01.135 for the particular emissions unit or equipment; and
- Copies of all startup, shutdown, and scheduled maintenance procedures and upset, breakdown, or safety preventative maintenance plans that have been developed by the permittee in accordance with IDAPA 58.01.01.133 and 134, and facility records as necessary to demonstrate compliance with such procedures and plans.

[IDAPA 58.01.01.136]

Certification

7.16 All documents submitted to DEQ—including, but not limited to, records, monitoring data, supporting information, requests for confidential treatment, testing reports, or compliance certification—shall contain a certification by a responsible official. The certification shall state that, based on information and belief formed after reasonable inquiry, the statements and information in the document(s) are true, accurate, and complete.

[IDAPA 58.01.01.123]

False Statements

7.17 No person shall knowingly make any false statement, representation, or certification in any form, notice, or report required under this permit or any applicable rule or order in force pursuant thereto.

[IDAPA 58.01.01.125]

Tampering

7.18 No person shall knowingly render inaccurate any monitoring device or method required under this permit or any applicable rule or order in force pursuant thereto.

[IDAPA 58.01.01.126]

Transferability

7.19 This permit is transferable in accordance with procedures listed in IDAPA 58.01.01.209.06.

[IDAPA 58.01.01.209.06]

Severability

7.20 The provisions of this permit are severable, and if any provision of this permit to any circumstance is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

[IDAPA 58.01.01.211]

Statement of Basis

Permit to Construct No. P-2019.0047
Project ID 62288

Perpetua Resources Idaho, Inc.
Stibnite, Idaho

Facility ID 085-00011

Final

June 17, 2022

Kelli Wetzel KW
Permit Writer

The purpose of this Statement of Basis is to satisfy the requirements of IDAPA 58.01.01.et seq, Rules for the Control of Air Pollution in Idaho, for issuing air permits.

ACRONYMS, UNITS, AND CHEMICAL NOMENCLATURE **3**
FACILITY INFORMATION **6**
Description 6
Permitting History 8
Application Scope 8
Application Chronology 9
TECHNICAL ANALYSIS **12**
Emissions Units and Control Equipment 12
Emissions Inventories 17
Ambient Air Quality Impact Analyses 26
T-RACT Analysis 27
REGULATORY ANALYSIS **28**
Attainment Designation (40 CFR 81.313) 28
Facility Classification 28
Permit to Construct (IDAPA 58.01.01.201) 29
Tier II Operating Permit (IDAPA 58.01.01.401) 29
Subsection 210.20 (IDAPA 58.01.01.210.20) 29
Mercury Emission Standard (IDAPA 58.01.01.215) 31
Particulate Matter – New Equipment Process Weight Limitations (IDAPA 58.01.01.701) 31
Title V Classification (IDAPA 58.01.01.300, 40 CFR Part 70) 32
PSD Classification (40 CFR 52.21) 32
NSPS Applicability (40 CFR 60) 34
NESHAP Applicability (40 CFR 61) 38
MACT/GACT Applicability (40 CFR 63) 39
Permit Conditions Review 46
PUBLIC REVIEW **50**
Public Comment Opportunity 50
Public Comment Period 50
APPENDIX A – EMISSIONS INVENTORIES
APPENDIX B – AMBIENT AIR QUALITY IMPACT ANALYSES REVIEW MEMORANDUM
APPENDIX C – FACILITY DRAFT COMMENTS
APPENDIX D – PROCESSING FEE
APPENDIX E – ACCESS MANAGEMENT
APPENDIX F – SUBSECTION 210.20 INTERPRETATION OF ADDRESSED
APPENDIX G – T-RACT ANALYSIS

ACRONYMS, UNITS, AND CHEMICAL NOMENCLATURE

AAC	acceptable ambient concentrations
AACC	acceptable ambient concentrations for carcinogens
acfm	actual cubic feet per minute
ANFO	ammonium nitrate/fuel oil
As	arsenic
ASTM	American Society for Testing and Materials
bkW	brake kilowatt
BT	Bradley Tailings
Btu	British thermal units
CAA	Clean Air Act
CAM	Compliance Assurance Monitoring
CAS No.	Chemical Abstracts Service registry number
Cd	cadmium
CEMS	continuous emission monitoring systems
cfm	cubic feet per minute
CFR	Code of Federal Regulations
CI	compression ignition
CMS	continuous monitoring systems
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	CO_2 equivalent emissions
COC	contaminants of concern
COMS	continuous opacity monitoring systems
DEQ	Department of Environmental Quality
DR	development rock
DRSF	development rock storage facilities
dscf	dry standard cubic feet
EF	emission factors
EIS	Environmental Impact Statement required by the National Environmental Policy Act
EL	screening emission levels
EPA	United States Environmental Protection Agency
FDCP	Fugitive Dust Control Plan
FDRSF	Fiddle Development Rock Storage Facility
Forest Service	United States Forest Service
GACT	Generally Available Control Technology
gpm	gallons per minute
gr	grains (1 lb = 7,000 grains)
H_2SO_4	Sulfuric Acid
HAP	hazardous air pollutants
HFDRSF	Hangar Flats Development Rock Storage Facility
HFP	Hangar Flats Pit
Hg	mercury
hp	horsepower
hr/yr	hours per consecutive 12-calendar-month period
HVAC	heating, ventilation, and air conditioning
ICE	internal combustion engines
IDAPA	a numbering designation for all administrative rules in Idaho promulgated in accordance with the Idaho Administrative Procedures Act
km	kilometers
lb/hr	pounds per hour
lb/qtr	pound per quarter

LMP	lime manufacturing plant
MACT	Maximum Achievable Control Technology
MMGU	Middle Marble Geologic Unit
PRI	Perpetua Resources Idaho, Inc.
MMBtu	million British thermal units
MMscf	million standard cubic feet
NAAQS	National Ambient Air Quality Standard
NESHAP	National Emission Standards for Hazardous Air Pollutants
Ni	nickel
NF	National Forest System road
NMMP	nonmetallic mineral processing
NO_2	nitrogen dioxide
NO_x	oxides of nitrogen
NSPS	New Source Performance Standards
NSR	New Source Review
O&M	operation and maintenance
O_2	oxygen
PAH	polycyclic aromatic hydrocarbons
Pb	lead
PM	particulate matter
$PM_{2.5}$	particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers
PM_{10}	particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers
POM	polycyclic organic matter
POX	pressure oxidation
ppm	parts per million
PSD	Prevention of Significant Deterioration
PTC	permit to construct
PTE	potential to emit
PW	process weight rate
RICE	reciprocating internal combustion engines
Rules	*Rules for the Control of Air Pollution in Idaho*
SAG	semi-autogenous grinding
Sb	antimony
scf	standard cubic feet
SCL	significant contribution limits
Se	selenium
SGP	Stibnite Gold Project
SIP	State Implementation Plan
SM	synthetic minor
SM80	synthetic minor facility with emissions greater than or equal to 80% of a major source threshold
SO_2	sulfur dioxide
STKP	crusher stockpile
Subsection 210.20	HAP TAP exemption for NSPS and NESHAP sources in IDAPA 58.01.01.210.20
T/day	tons per calendar day
T/hr	tons per hour
T/yr	tons per consecutive 12-calendar-month period
TAP	toxic air pollutants
ULSD	ultra-low sulfur diesel
U.S.C.	United States Code
VOC	volatile organic compounds
WEDRSF	West End Development Rock Storage Facility

WEP	West End pit
YPDRSF	Yellow Pine Development Rock Storage Facility
YPP	Yellow Pine Pit
$\mu g/m^3$	micrograms per cubic meter

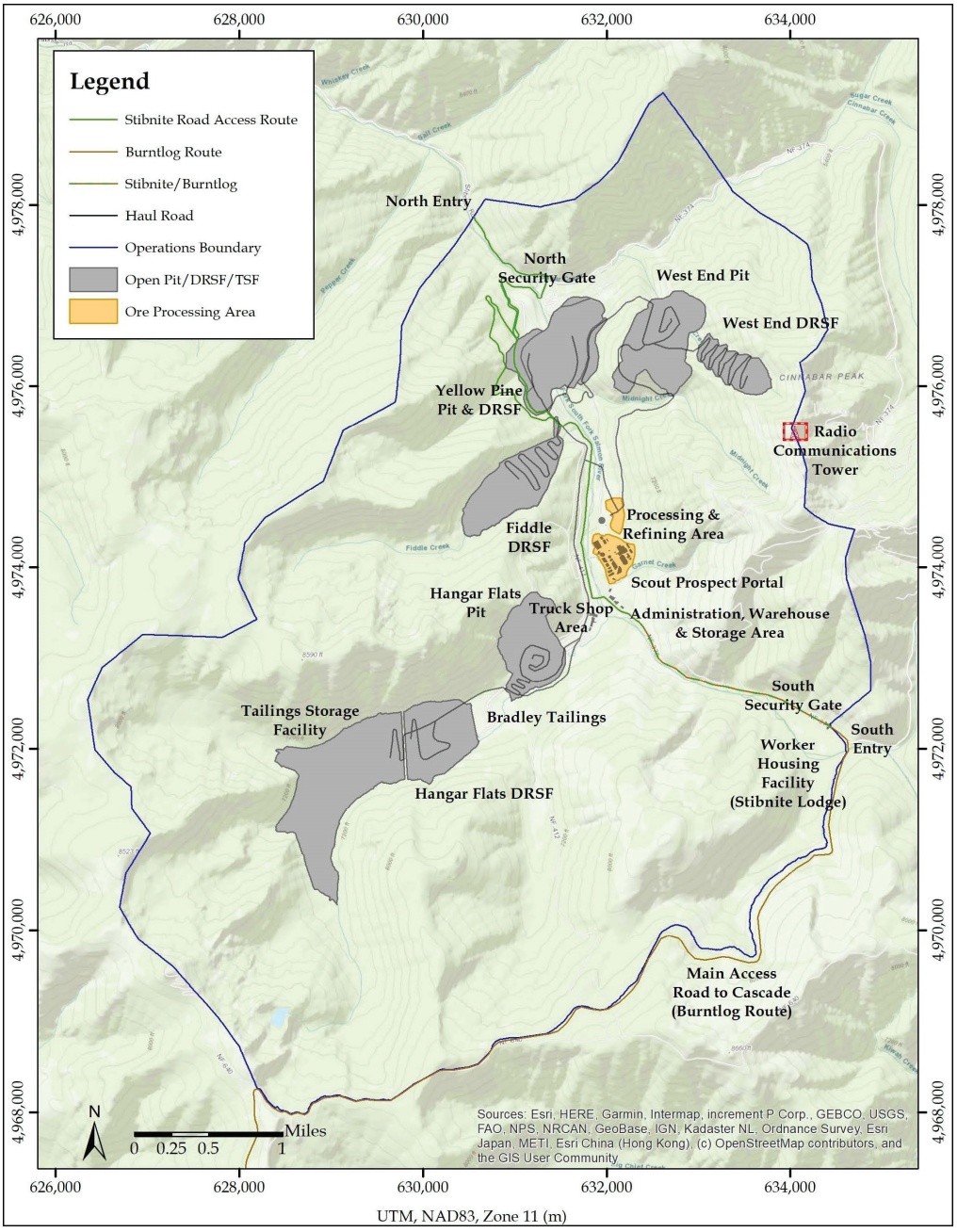
FACILITY INFORMATION

Description

Perpetua Resources Idaho, Inc. (PRI) proposes to construct and operate the Stibnite Gold Project (SGP), consisting of conventional open-pit mining, ore preparation, and gold extraction operations.

SGP is to be located in Valley County at the intersection Forest Service roads NF-374 and NF-412 (Stibnite Road), approximately 10 miles east of Yellow Pine. The proposed Burntlog Route access road will provide year-round access to the site. The project comprises a combination of public national forest and private lands. The mining operations boundary within which public access will be excluded is defined in Figure 1. This operations boundary also defines the ambient air boundary used in all ambient air quality impact analyses.

Figure 1 PROJECT AREA OF OPERATIONS

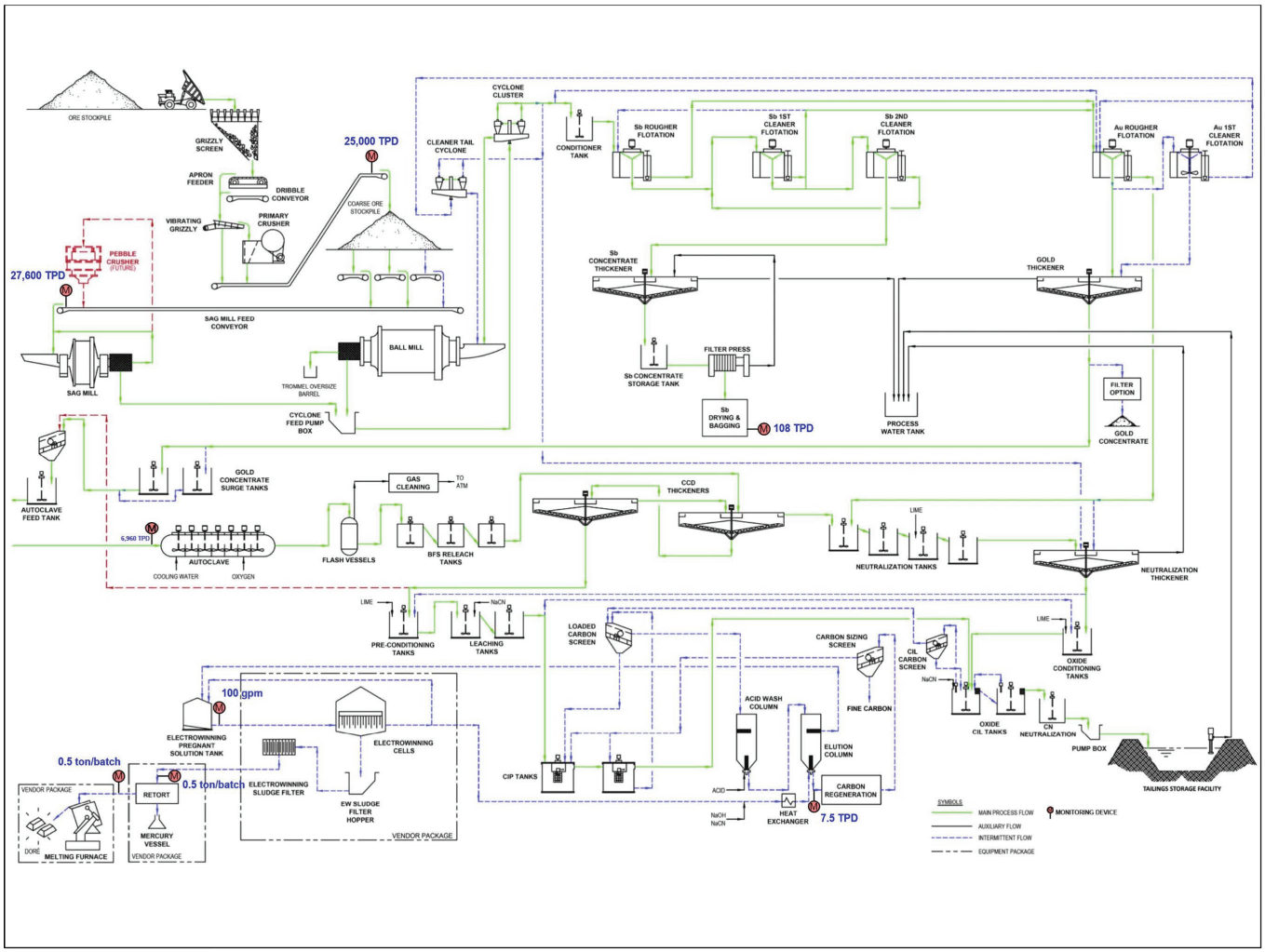


SGP will require the construction of significant infrastructure, including a power transmission line, a primary mine site access road, onsite haul roads, an ore processing facility, onsite workspaces, employee housing and recreation, water storage and distribution facilities, and sewage disposal facilities.

Conventional open-pit mining methods including drilling, blasting, excavating, and hauling will be used to extract ore and waste rock, termed development rock (DR). Hydraulic shovels and front-end loaders will be used to load ore and DR into haul trucks. DR will be used for construction, restoration, and backfilling, or hauled to the dedicated development rock storage facilities (DRSF). Approximately 340 million tons of DR will be handled over the life of the mine.

The SGP will include three years of pre-mining development and construction activities, followed by an operating mine life of approximately 12 years. Mining will occur in three open pits: Yellow Pine Pit (YPP), Hangar Flats pit (HFP), and West End pit (WEP). Although there will be overlap in mine development construction and operations, the general sequence of mining will be the YPP deposit, followed by the HFP and WEP deposits. Legacy tailings from the Meadow Creek valley (Bradley Tailings [BT]) will also be reclaimed and reprocessed during the initial project schedule. Surface exploration drilling will occur within the pits and within the Scout Prospect decline (underground exploration) throughout the mine operation period. Restoration and reclamation of other legacy mining features will occur prior to mining, throughout the life of the mine, and as part of the mine closure.

Figure 2 DIAGRAM OF PROCESS FLOWS



Ore will be hauled to the primary crusher area, where it will be fed directly into the crusher dump pocket or stockpiled. The ore crushing plant will be designed to operate at a maximum rate of 25,000 tons per calendar day (T/day). Approximately 100 million tons of ore will be mined from the three pits over the life of the project. The metal-recovery process from ore will include conventional crushing and grinding, followed by froth-flotation circuits that will generate separate gold-silver and antimony-silver concentrates. The antimony-silver concentrate will be shipped offsite for refining, whereas additional onsite processing of the gold-silver concentrate will include pressure oxidation, carbon-in-leach circuits, and refining processes to recover gold and minor amounts of silver. The finely ground leftover ore material from the mineral-recovery process, termed tailings, will be neutralized, thickened, and transported via a pipeline to the tailings storage facility. A diagram of ore processing and ore concentration and refining process flows is provided in Figure 2.

Permitting History

This is the initial PTC for a new facility, thus there is no permitting history.

Application Scope

This permit is the initial PTC for this facility.

The applicant has proposed to conduct mining operations and to install and operate ore processing, ore concentration and refining, and ancillary equipment:

- Drilling, blasting, excavating, hauling operations, rock dumps and storage piles, and prill silos;
- Ore processing operations (OC1–OC13);
- Ore concentration and refining operations (AC, EW, MR, MF, CKD);
- Process heating (ACB, CKB, PV, HS, LKC);
- Lime production operations (LS1–LS12, LSBM, LS-L/U, LK, LCR, LS1-L/U, MillS2-L/U, ACS1–ACS4);
- Aggregate production operations (PCSP1, PCSP2);
- Concrete production operations (CM; CS1–CS2-L/U, CA-L/U);
- Heating, Ventilation, and Air Conditioning heaters (H1M–H2M, HM, HAC, HR, HA, HMO, HTS, HW);
- Emergency generator engines (EDG1–EDG3, EDFP); and
- Fuel storage (TG1–TG2, TD3—TD10).

Application Chronology

August 20, 2019	DEQ received an application and an application fee.
August 29 – September 13, 2019	DEQ provided an opportunity to request a public comment period on the application and proposed permitting action.
September 19, 2019	DEQ determined that the application was incomplete.
October 4, 2019	DEQ received a preliminary response and supplemental information from the applicant, including a request to delegate authority of responsible official.
October 9, 2019	DEQ approved the request to delegate authority of responsible official.
October 15, 2019	DEQ met with the applicant to review and discuss the preliminary response.
October 22, 2019	DEQ determined that the application remained incomplete while the applicant prepared a response to the remaining items previously identified (9/19/19), and included a summary of recommendations provided at the meeting (10/15/19).
November 8, 2019	DEQ requested additional information from the applicant via email, relating to items previously identified (9/19/19).
November 21, 2019	DEQ received a request from the applicant for extension until November 27, 2019 to respond.
November 27, 2019	DEQ received supplemental information from the applicant, including a revised application with updated emissions inventories and modeling analyses.
December 24, 2019	DEQ determined that the application was incomplete.
January 8, 2020	DEQ received a request from the applicant for extension until February 7, 2020 to respond.
January 31, 2020	DEQ requested additional information from the applicant via email, relating to items previously identified (12/24/19).
February 5, 2020	DEQ received supplemental information from the applicant, including a revised application with updated emissions inventories and modeling analyses.
March 6, 2020	DEQ determined that the application was incomplete.
April 2, 2020	DEQ received a request from the applicant for extension until April 15, 2020 to respond.
April 15, 2020	DEQ received supplemental information from the applicant, including updated modeling analyses.
May 15, 2020	DEQ determined that the application was complete.
June 24, 2020	DEQ received the final application including all updates.
July 6, 2020	DEQ made available the draft permit and statement of basis for peer and regional office review.
July 14, 2020	DEQ made available the draft permit and statement of basis for applicant review.
July 31, 2020	DEQ made available an updated draft statement of basis Appendix B for applicant review.

August 3 and 13, 2020	DEQ received comments from the applicant on the draft permit and statement of basis.
August 20, 2020	DEQ received the permit processing fee.
September 10 – October 12, 2020	DEQ provided a public comment period on the proposed action.
October 12, 2020	DEQ received substantive comments and a request to extend the public comment period.
October 13 – November 11, 2020	DEQ extended the public comment period on the proposed action.
October 27, 2020	DEQ provided an information meeting during the extended public comment period.
November 11, 2020	DEQ received substantive comments during the extended comment period.
November 20, 2020	DEQ requested additional information from the applicant to address substantive public comments received, including missing TAP and HAP emission estimates.
November 25 and December 11, 2020	DEQ extended the time required to respond to public comments received until February 22, 2021 to allow additional time for the applicant and DEQ to respond to substantive public comments.
December 17, 2020	DEQ received a response to the request for additional information from the applicant.[1]
December 18 and 21, 2020	DEQ received supplemental information from the applicant, including a response and HAP/TAP addendum to the application,[2] updated HAP and TAP emissions estimates,[3] updated TAP modeling analyses,[4] and supporting references.[5]
January 28, 2021	DEQ received updated modeling files with corrections for formaldehyde and sulfuric acid, and an updated figure showing TAP modeled impacts.
February 8, 2021	DEQ made available the draft permit, statement of basis, and response to comments for peer and regional office review.
February 18 – March 19, 2021	DEQ provided a public comment period on the proposed action as updated to address the HAP and TAP addendum and updates.
February 23, 2021	DEQ received notification from the applicant of a facility name change from Midas Gold Idaho, Inc. to Perpetua Resources Idaho, Inc.
March 3, 2021	DEQ provided an information meeting during the public comment period.
March 4, 18, and 19, 2021	DEQ received comments during the extended comment period.
April 5, 2021	DEQ received substantive comments during the extended comment period.

[1] "Response to DEQ's Request for Information," PRI, December 17, 2020 (2020AAG2130).

[2] "HAP/TAP Addendum," PRI, December 18, 2020. (2020AAG2150)

[3] "20200623-Midas Gold SGP PTC EI - Final-TAPr2.2.xls," PRI, December 21, 2020. (2020AAG2152)

[4] "Modeling Files 2020-12.zip," PRI, December 21, 2020. (2020AAG2154)

[5] "References-20201222T020853Z-001.zip," PRI, December 21, 2020. (2020AAG2153)

April 6, 2021	DEQ extended the time required to respond to public comments received until June 4, 2021 to allow additional time for the applicant and DEQ to respond to substantive public comments.
April 6, 2021	DEQ requested additional information from the applicant to address Prevention of Significant Deterioration (PSD) emissions estimates and regulatory applicability for the lime manufacturing plant.
April 16, 2021	DEQ received a response to the request for additional information from the applicant, including identification of emission sources comprising the lime manufacturing plant.[6]
September 14, 2021	DEQ received an updated TAP modeling protocol addendum from the applicant.[7]
September 23, 2021	DEQ received supplemental information from the applicant regarding the lime plant source status determination.[8]
October 6, 2021	DEQ received an updated TAP/HAP addendum including an updated emission inventory and modeling files.[9]
December 9, 2021	DEQ made available the draft permit and statement of basis for applicant review.
January 13, 2022 – March 16, 2022	DEQ provided a public comment period with a 30 day extension on the proposed permit to address the TAP/HAP addendum and updates.
June 17, 2022	DEQ issued the final permit, first, second, and third responses to comments, and statement of basis.

[6] "Permit to Construct Request for Additional Information" PRI, April 16, 2021 (2021AAG646).

[7] "TAP Addendum Modeling Protocol" PRI, September 14, 2021 (2021AAG1757).

[8] "Limeplant PSD Source Discussion" PRI, September 23, 2021 (2021AAG1687).

[9] "Updated TAP/HAP Addendum" PRI, October 6, 2021 (2021AAG1766).

TECHNICAL ANALYSIS

Emissions Units and Control Equipment

Table 1 lists all sources of regulated emissions.

Table 1 EMISSIONS UNIT AND CONTROL EQUIPMENT INFORMATION

Source ID No.	Source	Control Equipment	Maximum Process Rate
Mining			
	Drilling activities	Reasonable control and Fugitive Dust Control Plan (FDCP) Dust collection systems on drilling rigs Control efficiency: 90%	1,200 holes/day
	Blasting activities	Reasonable control & FDCP	2 blasts/day
	Excavating and hauling activities	Reasonable control & FDCP – Chemical suppression and water sprays Control efficiency: 93.3% for PM/PM_{10} (haul roads) Haul road capping with low-arsenic quartzite	180,000 T/day 135,000 T/day 5-year rolling average 788.4 MT of ore and rock from all deposits 394.2MT of ore and rock from the West End deposit
	Rock dumps and storage piles	Reasonable control & FDCP	n/a
PS1–2-L/U	(2) Prill Silos #1-2 Maximum capacity: 100 T (each)	Loading – None Unloading – None	200 T/day and 9,000 T/yr (combined)
Ore Processing			
OC1	Loader Transfer of Ore to Grizzly	Reasonable control & FDCP – Water sprays and moisture carryover	25,000 T/day
OC2	Grizzly to Apron Feeder		
OC3	Conveyor – Apron Feeder to Dribble		
OC4	Conveyor – Apron Feeder to Grizzly		
OC5	Conveyor – Dribble to Grizzly		
OC6	Grizzly to Primary Crusher or Coarse Ore Stockpile Feed		
OC7	Primary Crusher	Reasonable control & FDCP – Water sprays and moisture carryover	
OC8	Conveyor – Coarse Ore Stockpile Feed Transfer to Stockpile		
OC9	Stockpile Transfer to Reclaim Conveyors	Reasonable control & FDCP – Below-grade of storage piles Control efficiency: 80% for PM/PM_{10}	27,600 T/day
OC10	Conveyor – Reclaim Conveyors to SAG Mill Feed Conveyor		
OC11	Conveyor – SAG Mill Feed Transfer to SAG Mill	Reasonable control & FDCP – Enclosure Control efficiency: 80% for PM/PM_{10}	
OC12	Pebble Crusher	Reasonable control & FDCP – Water sprays and moisture carryover	
OC13	Pebble Discharge to SAG Mill Feed		
Ore Concentration and Refining			
CN Tanks	Cyanide Leach Tanks and Cyanide Detox Tanks	Chemical treatment (lime, caustic soda, hydrogen peroxide, copper sulfate, etc.)	1.99 T/yr of CN (facility-wide)
Float Tanks	Floatation Tanks	None	1,700 T/yr PAX

Table 1 EMISSIONS UNIT AND CONTROL EQUIPMENT INFORMATION

Source ID No.	Source	Control Equipment	Maximum Process Rate
AC	Autoclave (AC)	Venturi Scrubber (VS1) Vent Gas Cleaning Tower (ST1) Vent Gas Steam Condensation Tower (CT1) Carbon Filter (CA5) Type: sulfur-impregnated activated carbon Form: granulated	6,960 T/day
EW	Electrowinning Cells and Pregnant Solution Tank	Shared Carbon Filter (CA2) Type: sulfur-impregnated activated carbon Form: granulated	100 gpm
MR	Mercury Retort	Condenser Carbon Filter (CA3) Type: sulfur-impregnated activated carbon Form: granulated	1,000 lb/batch and 21 T/yr
MF	Induction Melting Furnace	Baghouse (BH2) Carbon Filter (CA4) Type: sulfur-impregnated activated carbon Form: granulated	
CKD	Carbon Regeneration Kiln (Drum)	Wet Scrubber (WS2) Carbon Filter (CA1) Type: sulfur-impregnated activated carbon Form: granulated	7.2 T/day
Tailings and Maintenance Pond activities		Chemical treatment, reasonable control & FDCP	1.99 T/yr of CN (facility-wide)
Process Heating			
ACB	POX Boiler (for AC) Maximum capacity: 17 MMBtu/hr Fuel: propane	None	operation is limited to AC startup only
HS	Strip Circuit Solution Heater Maximum capacity: 5 MMBtu/hr Fuel: propane	None	n/a
CKB	Carbon Regeneration Kiln Burners Maximum capacity: 2.255 MMBtu/hr Fuel: propane	None	n/a
PV	Propane Vaporizer Maximum capacity: 0.1 MMBtu/hr Fuel: propane	None	n/a
LKC	PFR Shaft Lime Kiln Combustion Maximum capacity: 22.0 MMBtu/hr Fuel: propane	None	n/a

Table 1 EMISSIONS UNIT AND CONTROL EQUIPMENT INFORMATION

Source ID No.	Source	Control Equipment	Maximum Process Rate
Lime Production			
LS1	Limestone transfer to Primary Crusher Hopper	Reasonable control & FDCP	1,130 T/day
LS2	Primary Crusher Maximum capacity: 1,130 T/day		
LS3	Primary Screen		
LS4	Secondary Crusher		
LS5	Secondary Screen		
LS6	Conveyor – Limestone to Ball Mill Feed Bin		
LS7	Conveyor – Limestone to Ball Mill Feed		
LS8	Conveyor – Ball Mill Feed to Ball Mill		
LSBM	Limestone Ball Mill	Reasonable control & FDCP Baghouse (BH3)	
LS9	Conveyor – Limestone to Kiln Feed Bin	Reasonable control & FDCP	267 T/day
LS10	Conveyor – Limestone to Lime Kiln Feed		
LS11	Fines Screen		
LS12	Conveyor – Kiln Feed to PFR Shaft Lime Kiln		
LK	Parallel Flow Regenerative (PFR) Shaft Kiln	Baghouse (BH4)	169 T/day and 52,377 T/yr
LCR	Lime Mill Crusher	Reasonable control & FDCP Baghouse (BH5)	
LS-L/U	Bucket Elevator – Pebble Lime Silo Loading	Loading – Bin Vent Filter	
	Pebble Lime Silo discharge to Lime Slaker	Unloading – Wet Scrubber (WS3)	
LS1-L/U	SAG Mill Lime Silo #1 Maximum capacity: 250 T/day	Loading – Bin Vent Filter Unloading – None	4,000 T/day and 70,000 T/yr (combined)
MillS2-L/U	SAG Mill Lime Silo #2 Maximum capacity: 250 T/day	Loading – Bin Vent Filter Unloading – None	
ACS1	AC Lime Silo #1 Maximum capacity: 1,000 T/day	Loading – Bin Vent Filter Unloading – None	
ACS2	AC Lime Silo #2 Maximum capacity: 1,000 T/day	Loading – Bin Vent Filter Unloading – None	
ACS3	AC Lime Silo #3 Maximum capacity: 1,000 T/day	Loading – Bin Vent Filter Unloading – None	
ACS4	AC Lime Silo #4 Maximum capacity: 500 T/day	Loading – Bin Vent Filter Unloading – None	
Aggregate Production			
PCSP1	Portable Crushing and Screening Plant 1 Crushers, screens, and conveyors	Reasonable control & FDCP – water sprays and moisture carryover	2,000 T/day (aggregate)
PCSP2	Portable Crushing and Screening Plant 2 Crushers, screens, and conveyors	Reasonable control & FDCP – water sprays and moisture carryover	2,000 T/day (aggregate)
Concrete Production			
CM	Central Mixer Loading Maximum capacity: 120 T/hr	Reasonable control & FDCP – Controls may include water sprays, enclosures, hoods, curtains, shrouds, movable and telescoping chutes, and central duct collection systems.	2,480 T/day and 560,000 T/yr (cement + aggregate)
CS1-L/U	Cement/Shotcrete Silo #1 Maximum capacity: 80 T	Loading – Bin Vent Filter Unloading – None	
CS2-L/U	Cement/Shotcrete Silo #2 Maximum capacity: 80 T	Loading – Bin Vent Filter Unloading – None	
CA-L/U	Aggregate Bin Maximum capacity: 2,400 T	Loading – None Unloading – None	

Table 1 EMISSIONS UNIT AND CONTROL EQUIPMENT INFORMATION

Source ID No.	Source	Control Equipment	Maximum Process Rate
Heating, Ventilation, and Air Conditioning (HVAC)			
H1M	Mine Air Heater #1 Maximum capacity: 4 MMBtu/hr Fuel: propane	None	n/a
H2M	Mine Air Heater #2 Maximum capacity: 4 MMBtu/hr Fuel: propane	None	n/a
HM	(4) Mill HVAC Heaters #1-4 Maximum capacity: 1.0 MMBtu/hr (each) Fuel: propane	None	n/a
HAC	Autoclave HVAC Heater Maximum capacity: 0.25 MMBtu/hr Fuel: propane	None	n/a
HR	Refinery HVAC Heater Maximum capacity: 0.25 MMBtu/hr Fuel: propane	None	n/a
HA	Admin HVAC Heater Maximum capacity: 0.25 MMBtu/hr Fuel: propane	None	n/a
HMO	(2) Mine Ops. HVAC Heaters Maximum capacity: 0.25 MMBtu/hr (each) Fuel: propane	None	n/a
HTS	(2) Truck Shop HVAC Heaters Maximum capacity: 1.0 MMBtu/hr (each) Fuel: propane	None	n/a
HW	(3) Warehouse HVAC Heaters Maximum capacity: 1.0 MMBtu/hr (each) Fuel: propane	None	n/a

Table 1 EMISSIONS UNIT AND CONTROL EQUIPMENT INFORMATION

Source ID No.	Source	Control Equipment	Maximum Process Rate
Emergency Power Generation and Fire Suppression			
EDG1	Camp Emergency Generator Date of construction: 2007 or later Maximum capacity: 1,000 bkW Maximum operation: 100 hr/yr (non-emergency) Fuel: ultra-low sulfur diesel (ULSD) Displacement: <10 L/cyl	EPA Tier 2 certified	1 hr/day and 100 hr/yr
EDG2	Plant Emergency Generator #1 Date of construction: 2007 or later Maximum capacity: 1,000 bkW Maximum operation: 100 hr/yr (non-emergency) Fuel: ULSD Displacement: <10 L/cyl	EPA Tier 2 certified	1 hr/day and 100 hr/yr
EDG3	Plant Emergency Generator #2 Date of construction: 2007 or later Maximum capacity: 1,000 bkW Maximum operation: 100 hr/yr (non-emergency) Fuel: ULSD Displacement: <10 L/cyl	EPA Tier 2 certified	1 hr/day and 100 hr/yr
EDFP	Mill Fire Pump Date of construction: 2009 or later Maximum capacity: 200 bkW Maximum operation: 100 hr/yr (non-emergency) Fuel: ULSD Displacement: <10 L/cyl	None	1 hr/day and 100 hr/yr
Fuel Storage			
TG1–TG2	Mine Site Gasoline Tanks (#1 through #2) Maximum capacity: 5,000 gal each	Lids or other appropriate closure with gasketed seal and submerged filling	<100,000 gal/mo
TD3–TD10	Mine Site Diesel Tanks (#3 through #10)	Lids or other appropriate closure	n/a

Emissions Inventories

Potential to Emit

IDAPA 58.01.01 defines Potential to Emit (PTE) as the maximum capacity of a facility or stationary source to emit an air pollutant under its physical and operational design. Any physical or operational limitation on the capacity of the facility or source to emit an air pollutant, including air pollution control equipment and restrictions on hours of operation or on the type or amount of material combusted, stored or processed, shall be treated as part of its design if the limitation or the effect it would have on emissions is state or federally enforceable. Secondary emissions did not count in determining the PTE of a facility or stationary source.

Using this definition of PTE, an emissions inventory was developed for the SGP (see Appendix A). Emissions estimates of criteria pollutant and hazardous air pollutant (HAP) PTE were based on project-specific activity rates (e.g., continuous operation with the exception of the POX Boiler and emergency generator engines, design production rates, material haul rates, blasting agent usage rates, reagent usage rates, etc.), process design (e.g., open-pit mining, process concentration and pH, parallel flow regenerative lime production, central mix concrete production, haul fleet, etc.), emission abatement techniques (e.g., dust suppressant, chemical treatment, carbon filter, baghouse, bin vent filtration, wet scrubber, venturi scrubber, vent gas cleaning tower, and vent gas steam condensation tower control equipment), material characteristics (e.g., moisture content, road silt content, haul route distances, etc.), site conditions (onsite meteorological data, precipitation, etc.), and emission factors based on AP-42,[10] representative source test emissions data, and representative emission limits. Estimated emissions from the autoclave and the carbon regeneration kiln relied on emissions data from representative source test emissions data, scaled to the proposed equipment capacity. Estimated emissions from fuel storage tanks relied on TANKS[11] emission estimation software and projected annual gasoline and ULSD usage rates. Estimated emissions from the emergency generator engines relied on the use of certified engine emission factors.

Uncontrolled PTE

Using the definition of PTE, uncontrolled PTE is then defined as the maximum capacity of a facility or stationary source to emit an air pollutant under its physical and operational design. Any physical or operational limitation on the capacity of the facility or source to emit an air pollutant, including air pollution control equipment and restrictions on hours of operation or on the type or amount of material combusted, stored or processed, shall **not** be treated as part of its design **since** the limitation or the effect it would have on emissions **is not** state or federally enforceable.

The uncontrolled PTE is used to determine if a facility is a "synthetic minor" source of emissions. Synthetic minor sources are facilities that have an uncontrolled PTE for regulated air pollutants or HAP above an applicable major source threshold without permit limits.

For PRI, uncontrolled PTE was based upon a worst-case for operation of the facility of continuous operation at proposed maximum material throughput and fuel input rates (Table 1), without consideration of control equipment. For batch operations, the number of operations necessary to achieve the proposed daily throughput rates was assumed in estimating emissions (MR, MF). Silo loading and unloading operations were assumed to occur at most once per day (LS1-L/U, MillS2-L/U, LS-L/U, PS-L/U, ACS1–ACS4-L/U, CS1–CS2-L/U, CA-L/U). Fuel storage was based on estimated facility-wide fuel usage rates (TG1, TG2 and TD3—TD10). For the purposes of maintenance and testing, emergency power generation operations were assumed to occur 1 hour per day and 100 hours per year (EDG1–EDG3, EDFP). With the exception of the POX Boiler in which operation is limited to AC startup only, continuous operation at maximum fuel input rates was assumed for all process heating and HVAC equipment.

---

[10] Compilation of Air Pollutant Emission Factors, AP-42, Volume I, Fifth Edition (AP-42), Section 1.3 –Fuel Oil Combustion, 1.4 – Natural Gas Combustion, 1.5 – LPG Combustion, 3.2 – Natural Gas-Fired Reciprocating Engines, 3.3 – Gasoline and Diesel Industrial Engines, 3.4 – Large Stationary Diesel and All Stationary Dual-Fuel Engines, 8.3 – Ammonium Nitrate, 11.9 – Western Surface Coal Mining, 11.12 – Concrete Batching, 11.17 – Lime Manufacturing, 11.19 – Construction and Aggregate Processing, 13.2 – Fugitive Dust Sources, and 13.3 – Explosives Detonation, Office of Air Quality Planning and Standards Office of Air and Radiation (OAQPS), EPA, updated as of August 2011.

[11] TANKS Storage Tank Emissions Calculation Software Version 4.09D, OAQPS, EPA, released October 5, 2006.

The following table presents the uncontrolled PTE for regulated air pollutants as submitted by the applicant and verified by DEQ staff. Refer to Appendix A for a summary of the calculations and the assumptions used to determine emissions for each source, and the Facility Classification section for a review of facility classification based on uncontrolled and controlled PTE.

Table 2 UNCONTROLLED POTENTIAL TO EMIT FOR CRITERIA AIR POLLUTANTS

Source	PM	PM_{10}	$PM_{2.5}$	CO	NO_x	VOC	SO_2
	T/yr	T/yr	T/yr	T/yr	T/yr	T/yr	T/yr
OC1	13.69	5.02	0.78				
OC2	13.69	5.02	0.78				
OC3	13.69	5.02	0.78				
OC4	13.69	5.02	0.78				
OC5	13.69	5.02	0.78				
OC6	13.69	5.02	0.78				
OC7	24.64	10.95	1.64				
OC8	13.69	5.02	0.78				
OC9	15.11	5.54	0.86				
OC10	15.11	5.54	0.86				
OC11	15.11	5.54	0.86				
OC12	27.20	12.09	1.81				
OC13	15.11	5.54	0.86				
PS-L	0.07	0.03	0.004				
PS-U	0.07	0.03	0.004				
AC	74.10	74.10	74.10				2.86
MF	1.77	1.77	1.77				
CKD (EW, MR)	6.13	6.13	6.13	0.53	0.05	0.48	
LS1	0.48	0.17	0.03				
LS2	0.86	0.38	0.06				
LS3	3.97	1.38	0.21				
LS4	0.86	0.38	0.06				
LS5	3.97	1.38	0.21				
LS6	0.48	0.17	0.03				
LSBM	64.22	53.89	19.23				
LS7	0.48	0.17	0.03				
LS8	0.48	0.17	0.03				
LS9	0.12	0.05	0.007				
LS10	0.12	0.05	0.007				
LS11	1.03	0.36	0.05				
LS12	0.12	0.05	0.007				
LS-L	0.23	0.23	0.23				
LS-U	0.02	0.02	0.02				
LK	34.05	34.05	34.05	11.78	6.29		0.03
LCR	10.58	8.88	3.17				
LS1-L	1.60	1.03	0.16				
LS1-U	0.01	0.006	0.001				
MillS2-L	1.60	1.03	0.16				
MillS2-U	0.01	0.006	0.001				
ACS1-L	6.39	4.11	0.62				
ACS1-U	0.04	0.02	0.004				
ACS2-L	6.39	4.11	0.62				
ACS2-U	0.04	0.02	0.004				
ACS3-L	6.39	4.11	0.62				
ACS3-U	0.04	0.02	0.004				
ACS4-L	3.19	2.06	0.31				
ACS4-U	0.02	0.01	0.002				
PCSP1	27.67	10.11	1.54				
PCSP2	27.67	10.11	1.54				
CM	17.16	4.68	0.71				
CS1-L	21.90	14.10	2.14				
CS1-U	0.14	0.08	0.01				
CS2-L	21.90	14.10	2.14				

Table 2 UNCONTROLLED POTENTIAL TO EMIT FOR CRITERIA AIR POLLUTANTS

Source	PM	PM_{10}	$PM_{2.5}$	CO	NO_x	VOC	SO_2
	T/yr	T/yr	T/yr	T/yr	T/yr	T/yr	T/yr
CS2-U	0.14	0.08	0.01				
CA-L	1.73	0.83	0.13				
CA-U	1.73	0.83	0.13				
ACB	0.002	0.002	0.002	0.02	0.04	0.002	0.004
CKB	0.08	0.08	0.08	0.81	1.40	0.09	0.17
PV	0.003	0.003	0.003	0.04	0.06	0.004	0.008
HS	0.17	0.17	0.17	1.80	3.11	0.19	0.38
LKC	0.63	0.63	0.63	6.72	11.65	0.72	1.42
H1M	0.13	0.13	0.13	1.44	2.49	0.15	0.30
H2M	0.13	0.13	0.13	1.44	2.49	0.15	0.30
HM	0.13	0.13	0.13	1.44	2.49	0.15	0.30
HAC	0.008	0.008	0.008	0.09	0.16	0.01	0.02
HR	0.008	0.008	0.008	0.09	0.16	0.01	0.02
HA	0.008	0.008	0.008	0.09	0.16	0.01	0.02
HMO	0.02	0.02	0.02	0.18	0.31	0.02	0.04
HTS	0.07	0.07	0.07	0.72	1.24	0.08	0.15
HW	0.10	0.10	0.10	1.08	1.87	0.11	0.23
EDG1	0.02	0.02	0.02	0.39	0.71	0.14	0.001
EDG2	0.02	0.02	0.02	0.39	0.71	0.14	0.001
EDG3	0.02	0.02	0.02	0.39	0.71	0.14	0.001
EDFP	0.004	0.004	0.004	0.08	0.09	0.09	0.0001
TG1–TG2						1.91	
TD3—TD10						0.06	
Total	**560**	**337**	**164**	**29.47**	**36.16**	**4.68**	**6.27**

Although not explicitly calculated, it was confirmed by PRI in the response to a request for additional information[1] that the uncontrolled HAP PTE for SGP is estimated to exceed 25 tons per year (T/yr) without application of the specified control equipment (Table 1). Arsenic HAP PTE from haul roads at a controlled emission rate of 0.464 pounds per hour (lb/hr) and accounting for 93.3% control efficiency exceeds 20 T/yr, supporting that uncontrolled HAP PTE exceeds 10 T/yr of single HAP and 25 T/yr of total HAP.

Pre-Project PTE

Pre-project PTE is used to establish the change in emissions at a facility as a result of this project. Because this is a new facility, pre-project emissions are set to zero for all criteria pollutants.

Post-Project PTE

Post-project PTE is used in determining the change in emissions at a facility and in determining the facility's classification as a result of this project. Post-project PTE includes all permit limits resulting from this project.

In addition to assuming continuous operation of the facility at the proposed material throughput and fuel input rates, post-project emissions estimates account for the use of dust suppressant, chemical treatment, carbon filter, baghouse, bin vent filtration, wet scrubber, venturi scrubber, vent gas cleaning tower, and vent gas steam condensation tower control equipment.

A variety of factors impact emissions from unpaved roadways, and it was recognized that accurate determination of site-specific parameters characterizing road conditions and vehicle traffic was critical to estimating particulate matter emissions and ambient air impacts. PRI provided site-specific information to support parameters such as silt content, mean vehicle weight, and dust suppressant control efficiencies, and provided an analysis evaluating the conservatism of the resulting emission factor (AP-42).[12] To ensure operation consistent with these parameters and to reasonably control fugitive emissions, compliance with requirements identified in the FDCP is required by

[12] Appendix A – Model Parameter / Assumption / Data Level of Conservatism IDEQ Forms to the Stibnite Gold Project Permit to Construct Application, PRI, revised June 23, 2020 (2020AAG1078).

the permit. Further discussion of the sensitivity of predicted air quality impacts is provided in the Ambient Air Quality Impact Analyses section.

The following table presents the post-project PTE for criteria pollutants from all emissions units at the facility as determined by DEQ staff. Because this is a new facility, the post-project PTE is equivalent to the facility-wide PTE. Refer to Appendix A for a summary of the calculations and the assumptions used to determine emissions from each source, and the Facility Classification section for a review of facility classifications based on uncontrolled and controlled PTE.

Table 3 POST-PROJECT POTENTIAL TO EMIT FOR CRITERIA AIR POLLUTANTS

Source	PM	PM_{10}	$PM_{2.5}$	CO	NO_x	VOC	SO_2
	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]
POINT SOURCE EMISSIONS							
OC1	0.64	0.21	0.06				
OC2	0.64	0.21	0.06				
OC3	0.64	0.21	0.06				
OC4	0.64	0.21	0.06				
OC5	0.64	0.21	0.06				
OC6	0.64	0.21	0.06				
OC7	5.48	2.46	0.46				
OC8	0.64	0.21	0.06				
OC9	3.02	1.11	0.17				
OC10	3.02	1.11	0.17				
OC11	3.02	1.11	0.17				
OC12	6.04	2.72	0.50				
OC13	0.71	0.23	0.07				
PS-L	0.07	0.03	0.004				
PS-U	0.07	0.03	0.004				
AC	22.23	22.23	22.23				2.86
EW	0.31	0.31	0.31				
MR	0.006	0.006	0.006				
MF	0.89	0.89	0.89				
CKD	1.84	1.84	1.84	0.53	0.05	0.48	
LS1	0.48	0.18	0.03				
LS2	0.86	0.38	0.06				
LS3	3.97	1.38	0.21				
LS4	0.86	0.38	0.06				
LS5	3.97	1.38	0.21				
LS6	0.48	0.18	0.03				
LSBM	6.42	5.39	1.92				
LS7	0.48	0.18	0.03				
LS8	0.48	0.18	0.03				
LS9	0.12	0.05	0.01				
LS10	0.12	0.05	0.01				
LS11	1.03	0.36	0.06				
LS12	0.12	0.05	0.01				
LS-L	0.02	0.02	0.02				
LS-U	0.002	0.002	0.002				
LK	3.40	3.40	3.40	11.79	6.29		0.03
LCR	1.06	0.89	0.32				
LS1-L	0.002	0.001	0.0001				
LS1-U	0.01	0.006	0.001				
MillS2-L	0.002	0.001	0.0001				
MillS2-U	0.01	0.006	0.001				
ACS1-L	0.009	0.003	0.0004				
ACS1-U	0.04	0.02	0.004				
ACS2-L	0.009	0.003	0.0004				
ACS2-U	0.04	0.02	0.004				
ACS3-L	0.009	0.003	0.0004				
ACS3-U	0.04	0.02	0.004				
ACS4-L	0.004	0.001	0.0002				

Table 3 POST-PROJECT POTENTIAL TO EMIT FOR CRITERIA AIR POLLUTANTS

Source	PM	PM_{10}	$PM_{2.5}$	CO	NO_x	VOC	SO_2
	T/yr [a]	T/yr [a]	T/yr [a]	T/yr [a]	T/yr [a]	T/yr [a]	T/yr [a]
ACS4-U	0.02	0.01	0.002				
PCSP1	2.74	1.02	0.13				
PCSP2	2.74	1.02	0.13				
CM	0.55	0.17	0.02				
CS1-L	0.03	0.01	0.002				
CS1-U	0.14	0.08	0.01				
CS2-L	0.03	0.01	0.002				
CS2-U	0.14	0.08	0.01				
CA-L	1.73	0.83	0.13				
CA-U	1.73	0.83	0.13				
ACB	0.002	0.002	0.002	0.02	0.04	0.002	0.004
CKB	0.08	0.08	0.08	0.81	1.40	0.09	0.17
PV	0.003	0.003	0.003	0.04	0.06	0.004	0.008
HS	0.17	0.17	0.17	1.80	3.11	0.19	0.38
LKC	0.63	0.63	0.63	6.72	11.65	0.72	1.42
H1M	0.13	0.13	0.13	1.44	2.49	0.15	0.30
H2M	0.13	0.13	0.13	1.44	2.49	0.15	0.30
HM	0.13	0.13	0.13	1.44	2.49	0.15	0.30
HAC	0.008	0.008	0.008	0.09	0.16	0.01	0.02
HR	0.008	0.008	0.008	0.09	0.16	0.01	0.02
HA	0.008	0.008	0.008	0.09	0.16	0.01	0.02
HMO	0.02	0.02	0.02	0.18	0.31	0.02	0.04
HTS	0.07	0.07	0.07	0.72	1.24	0.08	0.15
HW	0.10	0.10	0.10	1.08	1.87	0.12	0.23
EDG1	0.02	0.02	0.02	0.39	0.71	0.14	0.001
EDG2	0.02	0.02	0.02	0.39	0.71	0.14	0.001
EDG3	0.02	0.02	0.02	0.39	0.71	0.14	0.001
EDFP	0.004	0.004	0.004	0.08	0.09	0.09	0.0001
TG1–TG2						1.91	
TD3—TD10						0.06	
Post-Project PTE [c]	**86.6**	**55.7**	**35.8**	**29.5**	**36.2**	**4.7**	**6.3**
MINING FUGITIVE EMISSIONS							
Blasting activities	117.35	61.02	3.52	635.83	17.08		0.03
Drilling activities	284.70	148.04	8.54				
Hauling	2901.27	712.95	71.29				
Material load / unload (L/UL) [b]	15.00	7.10	1.07				
Dozing	103.56	19.78	10.87				
Grading	36.80	11.04	1.14				
Water Truck Travel	109.27	26.85	2.69				
Access Roads	6.95	1.72	0.17				
Wind Erosion [b]	5.72	2.86	0.43				
Surface Exploration	1.12	0.39	0.06				
Underground Exploration	0.002	0.001	0.0001				
Fugitive Total [b]	**3,569**	**986**	**100**	**636**	**17.1**		**0.03**

a) Controlled average emission rate in tons per year is an annual average, based on the proposed annual operating scenarios and annual limits.

b) Estimated emissions from the "W3" scenario resulted in the most emissions across most activities, with the exception of material load/unload and wind erosion activities, which occurred in the Y1, H1, W1, and B1 scenarios. Totals reported are for the "W3" scenario.

c) In the response to a request for additional information, PRI confirmed that antimony process dryer and bagging operation emission sources (Sb1 and Sb2) initially proposed would be replaced by a dewatering/packaging circuit. As a result, these emission sources have been removed from the permit and post-project PTE.

Fourteen operational scenarios were evaluated by the applicant and verified by DEQ in order to estimate maximum hourly, daily, and annual potential emissions from sources. These scenarios encompassed all feasible origin and destination location combinations for locating ore and development rock. A summary of these scenarios is provided in Table 4. Although drilling, blasting, excavating, and hauling activities are not expected to be confined to a single scenario in practice, emissions in each scenario were conservatively estimated at the maximum daily proposed processing rate (180,000 of ore and rock) to allow for maximum operational flexibility, and to evaluate potential air quality impacts. Scenarios having the greatest potential emissions (i.e., the top seven) were those with the longest origin-to-destination distances, which resulted in increased emissions evident in onsite hauling and material loading and unloading activities. Consequently, the W3 scenario having the maximum origin-to-destination distance (16,415 daily vehicle miles traveled) is representative of maximum potential emissions.

Table 4 OPERATING SCENARIOS

Scenario	Origin [a]	Destination [a]
Y1	YPP	STKP
Y2	YPP	FDRSF
Y3	YPP	HFDRSF
H1	HFP	STKP
H2	HFP	FDRSF
H3	HFP	HFDRSF
H4	HFP	YPDRSF
W1	WEP	STKP
W2	WEP	FDRSF
W3	WEP	HFDRSF
W4	WEP	YPDRSF
W5	WEP	WEDRSF
B1	BT	STKP
B2	BT	HFDRSF

a) Where ore and rock origin and destination locations as depicted in Figure 1 are abbreviated as follows:
YPP = Yellow Pine Pit, HFP = Hangar Flats pit, WEP = West End pit, BT = Bradley Tailings, STKP = Primary Crusher Stockpile, FDRSF = Fiddle DRSF, HFDRSF = Hangar Flats DRSF, YPDRSF = Yellow Pine DRSF, WEDRSF = West End DRSF, and DRSF = development rock storage facilities.

There are numerous sources of fugitive dust emissions at the facility, including drilling and blasting activities, crushing and ore handling equipment, ore and rock storage piles, and unpaved roadways. Calculated at maximum daily processing rates, emissions from these sources would tend to be conservatively estimated. But it is also recognized that uncertainties exist in some of the emission factors used, and that predicted modeled impacts may be sensitive to emissions from such sources. In particular, it may prove challenging to consistently and continuously achieve the targeted level of fugitive dust control for emissions from traffic on unpaved roadways, with over 55 miles of haul truck routes within the mining operations boundary, a fleet of 32 haul trucks weighing between 37 and 357 tons, and a targeted dust control efficiency of 93.3% accomplished by application of both dust suppressant and water controls. Based on this, and the scale of operations, a detailed Fugitive Dust Control Plan (FDCP) was required (Permit Conditions 2.6). It is noted that PRI projected actual annual production at approximately 42.7 million T/yr, or 65% of the permitted annual production limit of 65.7 million T/yr (Permit Condition 3.5), and that as a result actual emissions are expected to be lower than presented.

Change in PTE

The change in facility-wide PTE is used to determine if a public comment period may be required and to determine the processing fee per IDAPA 58.01.01.225. The following table presents the facility-wide change in the potential to emit for criteria pollutants, which for a new source is equivalent to the facility-wide and post-project PTE.

Table 5 CHANGES IN PTE FOR REGULATED AIR POLLUTANTS

Source	PM	PM_{10}	$PM_{2.5}$	CO	NO_x	VOC	SO_2
	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]
Pre-Project PTE	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Post-Project PTE	86.6	55.7	35.8	29.5	36.2	4.7	6.3
Changes in Potential to Emit	**86.6**	**55.7**	**35.8**	**29.5**	**36.2**	**4.70**	**6.30**

a) Controlled average emission rate in tons per year is an annual average, based on the proposed annual operating scenarios and annual limits.

Controlled Hazardous and Toxic Air Pollutant Emissions

A summary of the estimated PTE for hazardous air pollutants (HAP) and emissions increases (PTE) for non-carcinogenic and carcinogenic toxic air pollutants (TAP) and for potential is provided in the following table (Table 6). This table and the Ambient Air Quality Impact Analyses were updated to include new and updated TAP emission estimates from additional emission sources identified in public comments and in a response and HAP/TAP addendum to the application provided by PRI.[2,3]

All permitted fugitive and point emission sources were evaluated in the new HAP and TAP emission estimates. In Table 6 below, HAP and TAP PTE emissions estimates are for the highest emissions year Scenario "W3" referenced from Table B1-W3 of Appendix B to the HAP/TAP addendum and 'TblB1' worksheet in the supporting spreadsheet. Process and production activities include ore processing; ore concentration and refining; process heating; aggregate production; concrete production; heating, ventilation, and air conditioning (HVAC); emergency power generation and fire suppression; and fuel storage. Mining and leaching activities include drilling, blasting, excavating, hauling, prill silos, rock dumps and storage piles, and tailings. Metal HAP and TAP emissions from process materials were based on metal concentration profiles from onsite core samples of ore and limestone materials, including 98 samples of SGP limestone[13] and over 55,000 samples of SGP ore.[14,15] As a conservative assumption, the limestone profile was also used for emissions from aggregate materials. Mercury emissions from the LK were estimated by assuming all mercury in the limestone feed is volatilized and emitted. For each non-mercury metal HAP and TAP, emissions from the LK were calculated as PM emissions multiplied by the median metal concentration measured. Elemental analysis of core samples was complemented with an evaluation of whether each result represented a regulated HAP and/or TAP substance (element or compound) in Table 2 of the HAP/TAP addendum.[2]

TAP also classified as HAP emitted from sources addressed by New Source Performance Standards (NSPS) or National Emission Standards for Hazardous Air Pollutants (NESHAP) were not required to be evaluated for compliance with TAP increments in accordance with IDAPA 58.01.01.210.20 (Subsection 210.20). Guidance and clarification of Subsection 210.20 source exemptions were included in the Subsection 210.20 (IDAPA 58.01.01.210.20) section and in the response to public comments document that is part of the final permit package for this permitting action. Some of the screening levels for non-carcinogenic and carcinogenic TAP were exceeded as a result of this project and required modeling. Modeling was required for aluminum, barium, calcium carbonate, calcium oxide, cyanide, iron, manganese, phosphorus, sulfuric acid, thallium, and vanadium because the 24-hour average non-carcinogenic screening emission levels (EL) in IDAPA 58.01.01.585 were exceeded. Modeling was required for arsenic, beryllium, cadmium, formaldehyde, and nickel because the annual average carcinogenic EL in IDAPA 58.01.01.586 were exceeded. Refer to the Ambient Air Quality Impact Analyses section and Appendix B for additional discussion.

---

[13] "M3-PN170045 Stibnite Gold Feasibility Study RE: M3-MGI-029E Lime Kiln Analysis Memo" and MGI-17-431-FullGeochem - MB.xlsx, M3 Engineering & Technology, June 14, 2018. (ref. M3 2018; 2020AAG2153)

[14] "Geochemistry Statistics" email R. McCluskey to E. Memon, Stibnite Gold Project, Air Sciences, September 26, 2017. (ref. PRI 2017c; 2020AAG205)

[15] "Re: Te-2" and 2020-12-09_Fe and Se data.xlsx, Stibnite Gold Project, December 9, 2020. 1,500 of these samples were tested for selenium. (ref. PRI 2020; 2020AAG2153)

Table 6 POTENTIAL TO EMIT FOR HAZARDOUS & TOXIC AIR POLLUTANTS (HAP/TAP) [a]

HAP/TAP	Mining and Leaching Emissions		Processing and Production Emissions		Facility-Wide Total Emissions		Adjusted TAP Emissions	Screening Emission Level
	lb/hr [b]	T/yr [c]	lb/hr [b]	T/yr [c]	lb/hr [b]	T/yr [c]	lb/hr [b,d]	lb/hr [d]
1,3-Butadiene [e]	0	0	8.4E-07	3.7E-06	8.4E-07	3.7E-06	0	2.4E-05
2-Methylnaphthalene [e,f]	0	0	1.1E-06	4.6E-06	1.1E-06	4.6E-06	0	9.1E-05
3-Methylcholanthrene [e]	0	0	7.8E-08	3.4E-07	7.8E-08	3.4E-07	4.5E-08	2.5E-06
7,12-Dimethylbenz(a)anthracene [e,f]	0	0	7.6E-07	3.0E-06	7.6E-07	3.0E-06	0	9.1E-05
Acenaphthene [e,f]	0	0	5.7E-06	7.1E-06	5.7E-06	7.1E-06	0	9.1E-05
Acenaphthylene [e,f]	0	0	1.1E-05	1.4E-05	1.1E-05	1.4E-05	0	9.1E-05
Acetaldehyde [e]	0	0	2.5E-05	1.1E-04	2.5E-05	1.1E-04	0	3.0E-03
Acrolein	0	0	1.6E-05	2.0E-05	1.6E-05	2.0E-05	0	0.017
Anthracene [e,f]	0	0	1.7E-06	2.4E-06	1.7E-06	2.4E-06	0	9.1E-05
Antimony	0.019	0.082	5.7E-04	2.5E-03	0.019	0.085	0.019	0.033
Arsenic [e]	0.544	2.381	4.5E-03	0.020	0.548	2.400	**0.544**	1.5E-06
Benzene [e]	0	0	7.4E-03	0.032	7.4E-03	0.032	5.3E-05	8.0E-04
Benzo(a)pyrene [e,f]	0	0	1.4E-07	6.1E-07	2.0E-06	8.8E-06	2.9E-07	2.0E-06
Benz(a)anthracene [e,f]	0	0	3.1E-07	1.4E-06				
Benzo(b)fluoranthene [e,f]	0	0	4.4E-07	1.9E-06				
Benzo(k)fluoranthene [e,f]	0	0	1.5E-07	6.6E-07				
Chrysene [e,f]	0	0	5.8E-07	2.5E-06				
Dibenz(a,h)anthracene [e,f]	0	0	1.8E-07	7.7E-07				
Indeno(1,2,3-cd)pyrene [e,f]	0	0	2.2E-07	9.6E-07				
Benzo(g,h,i)perylene [e,f]	0	0	7.5E-07	1.1E-06	7.5E-07	1.1E-06	0	9.1E-05
Beryllium [e]	2.6E-03	0.011	4.3E-04	1.9E-03	3.0E-03	0.013	**2.6E-03**	2.8E-05
Biphenyl	0	0	4.4E-05	1.9E-04	4.4E-05	1.9E-04	0	0.1
Cadmium [e]	4.1E-04	1.8E-03	4.6E-04	2.0E-03	8.7E-04	3.8E-03	**4.4E-04**	3.7E-06
Carbon disulfide	0.014	0.063	0	0	0.014	0.063	0.014	2
Chromium	7.3E-03	0.032	6.8E-04	2.8E-03	8.0E-03	0.035	7.4E-03	0.033
Chromium (VI) [e]	0	0	3.4E-07	1.5E-06	3.4E-07	1.5E-06	3.4E-07	5.6E-07
Cobalt	3.3E-03	0.014	4.7E-04	2.0E-03	3.7E-03	0.016	3.26E-03	3.3E-03
Cyanide	0.453	1.983	1.2E-03	5.3E-03	0.454	1.988	**0.454**	0.333
Dichlorobenzene	0	0	5.7E-05	2.3E-04	5.7E-05	2.3E-04	3.1E-05	20 [j]
Fluoranthene [e,f]	0	0	5.5E-06	7.0E-06	5.5E-06	7.0E-06	0	9.1E-05
Fluorene [e,f]	0	0	1.7E-05	2.1E-05	1.7E-05	2.1E-05	0	9.1E-05
Formaldehyde [e]	0	0	3.3E-03	0.015	3.3E-03	0.015	**1.9E-03**	5.1E-04
Hexane	0	0	0.117	0.480	0.117	0.48	0.046	12
Hydrogen Chloride	0	0	0.986	3.666	0.986	**3.666**	0	0.05
Lead	6.5E-03	0.029	4.8E-04	2.1E-03	7.0E-03	0.031	0	
Manganese	0.244	1.067	4.6E-03	0.017	0.248	1.085	**0.244**	0.067
Mercury [g]	1.3E-03	5.7E-03	7.1E-04	2.9E-03	*< 0.028*	*< 0.122*	*0.108 lb/yr*	*25 lb/yr*
Naphthalene	0	0	2.1E-03	8.8E-03	2.1E-03	8.8E-03	1.6E-05	3.33
Nickel [e]	1.6E-03	7.1E-03	5.5E-04	2.4E-03	2.2E-03	9.5E-03	**1.7E-03**	2.7E-05
Phenanthrene [e,f]	0	0	5.1E-05	6.3E-05	5.1E-05	6.3E-05	0	9.1E-05
Phenol	0	0	2.4E-04	1.1E-03	2.4E-04	1.1E-03	0	1.27
Phosphorus	0.53	2.32	5.6E-03	0.023	0.535	2.343	**0.053**	7.0E-03
Pyrene [e,f]	0	0	5.0E-06	6.6E-06	5.0E-06	6.6E-06	0	9.1E-05
Selenium	3.3E-04	1.4E-03	4.1E-04	1.8E-03	7.4E-04	3.2E-03	3.3E-04	0.013
Toluene	0	0	0.032	0.139	0.032	0.139	8.8E-05	25
Xylene	0	0	0.032	0.138	0.032	0.138	0	29
Total HAP [h]	1.83	8.00	1.20	4.57	3.05	12.68	1.39	

Table 6 POTENTIAL TO EMIT FOR HAZARDOUS & TOXIC AIR POLLUTANTS (HAP/TAP) [a]

HAP/TAP	Mining and Leaching Emissions		Processing and Production Emissions		Facility-Wide Total Emissions		Adjusted TAP Emissions	Screening Emission Level
	lb/hr [b]	T/yr [c]	lb/hr [b]	T/yr [c]	lb/hr [b]	T/yr [c]	lb/hr [b,d]	lb/hr [d]
Aluminum [i]	57.855	253	0.648	2.577	58.504	256	**58.504**	0.667
Barium [i]	0.652	2.855	6.8E-03	0.028	0.659	2.883	**0.659**	0.033
Calcium Carbonate [i]	11.408	49.967	2.244	8.125	13.652	58.092	**13.652**	0.667
Calcium Oxide [i]	0	0	0.696	0.952	0.696	0.952	**0.696**	0.133
Copper [i]	4.1E-03	0.018	5.3E-04	2.2E-03	4.6E-03	0.020	0.0046	0.067
Cyclohexane [i]	0	0	1.0E-03	4.6E-03	1.0E-03	4.6E-03	0.0010	70
Hydrogen Sulfide [i]	0	0	0.900	3.942	0.900	3.942	0.900	0.933
Iron [i]	14.831	64.958	0.213	0.812	15.043	65.770	**15.043**	0.067
Molybdenum [i]	8.1E-04	3.6E-03	4.7E-04	2.0E-03	1.3E-03	5.6E-03	0.0013	0.333
Pentane [i]	0	0	0.123	0.495	0.123	0.495	0.123	118
Silver [i]	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.2E-4	3.6E-03	0.00082	7.0E-03
Sulfuric Acid [i]	0	0	2.030	8.891	2.030	8.891	**2.030**	0.067
Thallium [i]	8.1E-03	0.036	5.2E-04	2.2E-03	8.7E-03	0.038	**0.0087**	0.007
Uranium [i]	8.1E-03	0.036	5.2E-04	2.2E-03	8.7E-03	0.038	0.0087	0.013
Vanadium [i]	0.023	0.100	8.4E-04	3.5E-03	0.024	0.103	**0.024**	0.003
Trimethyl Benzene [i]	0	0	0.011	0.048	0.011	0.048	0.011	8.2
Tungsten [i]	8.1E-03	0.036	5.2E-04	2.2E-03	8.7E-03	0.038	0.0087	0.333
Zinc [i]	0.029	0.125	2.2E-03	8.8E-03	0.031	0.134	0.031	0.667

a) HAP and TAP PTE emissions estimates are for the highest emissions year Scenario W3, referenced from Table B1-W3 of Appendix B to the HAP/TAP addendum and 'TblB1' worksheet in the supporting spreadsheet. Process and production activities include ore processing; ore concentration and refining; process heating; aggregate production; concrete production; heating, ventilation, and air conditioning (HVAC); emergency power generation and fire suppression; and fuel storage. Mining and leaching activities include drilling, blasting, excavating, hauling, prill silos, rock dumps and storage piles, and tailings.

b) Controlled average emissions rates in pounds per hour (lb/hr). Emissions rates for non-carcinogens are daily averages, based on the proposed daily operating scenarios and limits. Emissions rates for carcinogens are annual averages, based on the proposed annual operating scenarios and limits.

c) Controlled average emissions rates in tons per year (T/yr) are annual averages, based on the proposed annual operating scenarios and annual limits.

d) Adjusted TAP emissions and screening emission levels (EL) as specified in IDAPA 58.01.01.585-586 for purposes of TAP preconstruction compliance demonstrations. For TAP, adjusted emissions do not include sources addressed by NSPS and NESHAP in accordance with IDAPA 58.01.01.210.20 Table 9.

e) Carcinogenic TAP as identified in IDAPA 58.01.01.586.

f) Polycyclic aromatic hydrocarbon (PAH). The group of seven PAH with a single EL are regulated as polycyclic organic matter (POM) equivalent in potency to benzo(a)pyrene as specified in IDAPA 58.01.01.586.

g) Adjusted mercury emissions (which are not TAP) are reported in pounds per year (lb/yr) and do not include fugitive sources and sources addressed by NESHAP 40 CFR 63 for comparison to the Mercury Emission Standard threshold of 25 lb/yr. Facility-wide mercury PTE emission rates were calculated as annual average based on federally-enforceable NESHAP Subpart EEEEEEE limits, and exceed values referenced from Table B1-W3 of Appendix B to the HAP/TAP addendum and 'TblB1' worksheet in the supporting spreadsheet (which account for the proposed mercury control devices for refinery process sources AC, EW, MR, MF, CKD).

h) Total hazardous air pollutant (HAP) emissions from all permitted sources and activities (combined). The maximum potential emissions of any single HAP is hydrogen chloride.

i) Toxic air pollutant that is not also a hazardous air pollutant (i.e., non-HAP TAP) and is not included in HAP totals.

j) Dichlorobenzene is regulated as both the ortho- and para- isomers (o-dichlorobenzene and 1,4-dichlorobenzene). For the purposes of TAP compliance, the lowest EL (and therefore most conservative) is listed.

HAP and TAP particulate metals are indirectly regulated via facility-wide fugitive dust requirements for particulate matter (PM) (Permit Conditions 2.1–2.8, 3.10, 5.10), material throughput and operational limits (Permit Conditions 3.3–3.9, 4.6–4.12, 5.4–5.9, 6.2-6.3, 6.5), PM emission limits (Permit Conditions 4.3, 5.3), control device requirements (Permit Conditions 3.11–3.13, 4.13–4.17, 5.12–5.16), and associated testing, monitoring, recordkeeping, and reporting requirements. Because usage of process reagents were not correlated to material throughput rates and not otherwise inherently limited, HAP emissions limits and usage limits were established for potassium amyl xanthate (PAX) and sodium cyanide (Permit Conditions 4.4–4.6). Cyanide emissions were sensitive to leachant concentration and basicity, and monitoring of these parameters was established (Permit Condition 4.5) to ensure compliance with the emission limit. Monitoring of these limits and process parameters also ensure compliance with the major threshold for each individual HAP of 10 tons per year (T/yr).

Ambient Air Quality Impact Analyses

The applicant has demonstrated preconstruction compliance to DEQ's satisfaction that emissions from this facility will not cause nor significantly contribute to a violation of any ambient air quality standard. The applicant has also demonstrated preconstruction compliance to DEQ's satisfaction that the emissions increase due to this permitting action will not exceed any acceptable ambient concentration (AAC) or acceptable ambient concentration for carcinogens (AACC) for toxic air pollutants (TAP). A summary of the Ambient Air Impact Analysis for TAP is provided in Appendix B.

As presented in the modeling memorandum in Appendix B, the estimated emission rates of PM_{10}, $PM_{2.5}$, SO_2, CO, NO_x, and certain TAP from this project exceeded applicable screening emission levels (EL) and published DEQ modeling thresholds established in IDAPA 58.01.01.585-586 and in the State of Idaho Air Quality Modeling Guideline.[16] The facility-wide emission rate of lead (Pb) was determined to be below the "below regulatory concern" (BRC) threshold level of less than 10% of the "significant" emission rate defined in IDAPA 58.01.01.006 (i.e., less than 0.06 T/yr) and therefore modeling was not required.[16] Refer to the Emissions Inventories section for additional information concerning the emissions inventories.

New and updated TAP increment compliance demonstrations[4] were provided after evaluation of fugitive particulate TAP emissions from emission sources (Table 6) as identified in public comments and in a response and HAP/TAP addendum to the application provided by PRI.[2] For non-HAP TAP, all sources were evaluated for TAP compliance by comparison of facility-wide emissions to applicable screening emission levels (EL). After exclusion of sources addressed by NSPS and NESHAP (Table 9), applicable concrete production, HVAC emission sources, and gold mining operations were evaluated for HAP TAP compliance by comparison of adjusted emissions to applicable EL. Refer to the Emissions Inventories section for estimates of HAP and TAP emissions (as summarized in Table 6) and to the Subsection 210.20 (IDAPA 58.01.01.210.20) section for relevant guidance and discussion of sources addressed by NSPS and NESHAP. With the exception of 16 TAP, estimated emission increases of non-carcinogenic and carcinogenic TAP demonstrated preconstruction compliance with TAP standards in accordance with IDAPA 58.01.01.210.07 using controlled average emission rates. Modeling analyses conducted in the development of TAP rules supports that if controlled average emission rates do not exceed applicable screening emission levels (EL) in IDAPA 58.01.01.585–586, controlled ambient concentrations are expected to be below the applicable acceptable ambient concentration (AAC/AACC).

Estimated emission increases of aluminum, arsenic, barium, beryllium, cadmium, calcium carbonate, calcium oxide, cyanide, formaldehyde, iron, manganese, nickel, phosphorus, sulfuric acid, thallium, and vanadium (16 TAP) demonstrated preconstruction compliance with TAP standards in accordance with IDAPA 58.01.01.210.08 for controlled ambient concentrations. Modeling analyses demonstrated preconstruction compliance with the acceptable ambient concentrations for the eleven non-carcinogenic TAP (AAC) in IDAPA 58.01.01.585. Emission limits (Permit Condition 4.3), operational and material throughput limits (Permit Conditions 3.3–3.9, 4.6–4.12, 5.4–5.9), fugitive dust control requirements (Permit Conditions 2.1–2.8), and control equipment requirements (Permit Conditions 2.6, 3.11–3.13, 4.13–4.17, and 5.12–5.16) limit these TAP emissions in accordance with IDAPA 58.01.01.210.08.c, limit Pb to BRC, and limit PM, PM_{10} ,and $PM_{2.5}$ to below the emission rates relied upon in the NAAQS evaluation of ambient air impacts in the modeling analyses. The remaining five carcinogenic TAP were modeled using an emission inventory that includes T-RACT controls and other emission inventory refinements (see the T-RACT Analysis section).

Arsenic represented the single greatest HAP TAP emission; adjusted arsenic HAP TAP emissions at 0.544 pounds per hour (lb/hr) did not exceed 42% of the applicable AACC. Iron (Fe) represented the greatest single non-HAP TAP emission at over 15 lb/hr, which did not exceed 4% of the applicable AAC. Any uncertainties in metal TAP emission estimates are not expected to affect compliance with TAP provisions.

---

[16] Criteria pollutant thresholds in Table 2, State of Idaho Guideline for Performing Air Quality Impact Analyses, Doc ID AQ-011, September 2013, criteria pollutant BRC thresholds as provided in IDAPA 58.01.01.221.01, and DEQ guidance pertaining to BRC (2014ACF3).

It was recognized that accurately defining the mining operations boundary and controlling public access within that boundary was critical to estimating ambient air impacts. To ensure operation consistent with the defined mining operations boundary, site-specific access control measures will be employed. PRI has committed to identifying and complying with these site-specific access control measures in an Access Management Plan (AMP, as required by Permit Condition 2.7).[17] Refer to Appendix E for a description and discussion of the mining operations boundary and control measures that may be included in this plan.

An ambient air quality impact analyses document has been crafted by DEQ based on a review of the modeling analysis submitted in the application. That document is part of the final permit package for this permitting action (refer to Appendix B). Refer to the Emissions Inventories section and Appendix A for additional information concerning development of the emissions inventories.

T-RACT Analysis

Further evaluation of the sources of HAP emissions that were previously considered addressed by the NESHAP Subpart EEEEEEE per IDAPA 58.01.01.210.20(b), specifically the mining emissions, was conducted by SGP. Estimated emission increases of aluminum, arsenic, barium, beryllium, cadmium, calcium carbonate, calcium oxide, cyanide, formaldehyde, iron, manganese, nickel, phosphorus, sulfuric acid, thallium, and vanadium (16 TAP) exceeded the screening emission levels. Modeling analyses demonstrated preconstruction compliance with the acceptable ambient concentrations for the eleven non-carcinogenic TAP (AAC) in IDAPA 58.01.01.585. The remaining five carcinogenic TAP were modeled using an emission inventory that includes T-RACT controls, long-term mining production limits (Permit Conditions 3.5 and 3.6), constructing the Burntlog access road with offsite material containing minimal level arsenic concentrations, updating the bulldozing emission factor using the SGP site-specific silt content of 4 percent, and the elimination of modeling scenario W5 as a potential operating scenario as the West End DRSF will not be constructed.

In accordance with IDAPA 58.01.01.210.12, the proposed T-RACT ambient concentrations at the point of compliance for each applicable TAP are less than, or equal to, the T-RACT ambient concentration (i.e., less than 10 times the applicable AACC listed in IDAPA 58.01.01.586).

In accordance with IDAPA 58.01.01.210.14, this T-RACT analysis included consideration of available control technologies and/or "The application of a design, equipment, work practice or operational requirement, or combination thereof", for compliance with the T-RACT requirements. This included a search of EPA's RACT, BACT, LAER Clearinghouse to identify available control technologies. To meet the T-RACT requirements, the permit requires the control measures determined to meet T-RACT as summarized in the following table. These control measures were selected based upon consideration of the technological feasibility for this process/operation, the economic feasibility, energy requirements, and environmental impacts.

Table 7 T-RACT CONTROL MEASURES

TAP	Proposed T-RACT Control Measures	Permit Conditions
Arsenic, Beryllium, Cadmium, Formaldehyde, Nickel	Drilling rigs dust control system	3.11
Arsenic	Chemical dust suppressant with frequent watering on roads	2.1 – 2.6
	Haul road capping	3.13

In accordance with IDAPA 58.01.01.210.12.d and 58.01.01.210.14.e, emission limits and other permit conditions for each T-RACT pollutant have been incorporated into the permit as summarized in the table above to assure that the facility will be operated in the manner described in the preconstruction compliance demonstration. A detailed T-RACT analysis is provided in the updated HAP/TAP addendum[9] and is included in Appendix G.

[17] Attachment 2 – Stibnite Road Access Management Plan to the Stibnite Gold Project Permit to Construct Application, PRI, revised June 23, 2020 (2020AAG1078).

REGULATORY ANALYSIS

Attainment Designation (40 CFR 81.313)

The facility is located in Valley County, which is designated as attainment or unclassifiable for $PM_{2.5}$, PM_{10}, SO_2, NO_2, CO, and Ozone. Refer to 40 CFR 81.313 for additional information.

Facility Classification

The AIRS/AFS facility classification codes are as follows:

For HAP (hazardous air pollutants) only:

A = Use when any one HAP has permitted emissions > 10 T/yr or if the aggregate of all HAP (Total HAP) has permitted emissions > 25 T/yr.

SM80 = Use if a synthetic minor (uncontrolled HAP emissions are > 10 T/yr or if the aggregate of all uncontrolled HAP (Total HAP) emissions are > 25 T/yr and permitted emissions fall below applicable major source thresholds) and the permit sets limits > 8 T/yr of a single HAP or ≥ 20 T/yr of Total HAP.

SM = Use if a synthetic minor (uncontrolled HAP emissions are > 10 T/yr or if the aggregate of all uncontrolled HAP (Total HAP) emissions are > 25 T/yr and permitted emissions fall below applicable major source thresholds) and the permit sets limits < 8 T/yr of a single HAP and/or < 20 T/yr of Total HAP.

B = Use when the potential to emit (i.e. uncontrolled emissions and permitted emissions) are below the 10 and 25 T/yr HAP major source thresholds.

UNK = Class is unknown.

For All Other Pollutants:

A = Use when permitted emissions of a pollutant are > 100 T/yr.

SM80 = Use if a synthetic minor for the applicable pollutant (uncontrolled emissions are > 100 T/yr and permitted emissions fall below 100 T/yr) and permitted emissions of the pollutant are ≥ 80 T/yr.

SM = Use if a synthetic minor for the applicable pollutant (uncontrolled emissions are > 100 T/yr and permitted emissions fall below 100 T/yr) and permitted emissions of the pollutant are < 80 T/yr.

B = Use when the potential to emit (i.e. uncontrolled emissions and permitted emissions) are below the 100 T/yr major source threshold.

UNK = Class is unknown.

Table 8 REGULATED AIR POLLUTANT FACILITY CLASSIFICATION

Pollutant	Uncontrolled PTE (T/yr)	Permitted PTE (T/yr)	Major Source Thresholds (T/yr)	AIRS/AFS Classification
PM	560	86.6	**100**	SM80
PM_{10}	337	55.7	**100**	SM
$PM_{2.5}$	164	35.8	**100**	SM
SO_2	6.27	6.3	**100**	B
NO_x	36.16	36.2	**100**	B
CO	29.47	29.5	**100**	B
VOC	4.68	4.7	**100**	B
HAP (single)	>20	3.666	**10**	SM
Total HAP	>25	12.68	**25**	SM

Based on the uncontrolled PTE summarized in Table 2 and controlled PTE summarized above and in Table 3, Table 6, and Appendix A, the permittee will be a "synthetic minor" source of PM, PM_{10}, $PM_{2.5}$, and HAP emissions for new source review and Title V (Tier I) permitting purposes. The uncontrolled PTE for the remaining criteria pollutants (SO_2, NO_x, CO, VOC) confirm PRI will be a natural minor source for these emissions.

Permit to Construct (IDAPA 58.01.01.201)

The permittee has requested that a PTC be issued to the facility for the proposed new emission sources. Therefore, a permit to construct is required in accordance with IDAPA 58.01.01.201. This permitting action was processed in accordance with the procedures of IDAPA 58.01.01.200-228.

Tier II Operating Permit (IDAPA 58.01.01.401)

IDAPA 58.01.01.401 ..... Tier II Operating Permit

The application was submitted for a permit to construct (refer to the Permit to Construct (IDAPA 58.01.01.201) section), and an optional Tier II operating permit has not been requested. Therefore, the procedures of IDAPA 58.01.01.400–410 were not applicable to this permitting action.

Subsection 210.20 (IDAPA 58.01.01.210.20)

IDAPA 58.01.01.210.20..... NSPS and NESHAP Sources

No demonstration of compliance with the TAP provisions is required to obtain a PTC or to demonstrate PTC exemption criteria for a new source or for modification of an existing source if the TAP is also a listed HAP from:

The equipment or activity covered by a NSPS or NESHAP; or

The source category of equipment or activity addressed by a NSPS or NESHAP even if the equipment or activity is not subject to compliance requirements under the federal rule.

Emission sources covered or addressed by NSPS or NESHAP are identified in the following table, and guidance on interpretation of "addressed" is provided in Appendix F. For the sources identified, emissions of TAP that are also HAP (HAP TAP) were excluded from TAP compliance demonstrations (i.e., excluded from comparison to TAP EL and from modeling to demonstrate compliance with TAP AAC/AACC, as discussed in the Ambient Air Quality Impact Analyses).

Table 9 NSPS and NESHAP Sources

NESHAP / NSPS	Source Category Covered & Addressed	Sources
NESHAP Subpart ZZZZ [a] NSPS Subpart IIII	Any industry using a stationary internal combustion engine	*Emergency Power Generation* EDG1, EDG2, EDG3, EDFP
NESHAP Subpart AAAAA [a] NSPS Subpart HH	Any lime manufacturing plant	*Lime Production* LK, LKC, LS12, LS-L/U, LCR
NESHAP Subpart CCCCCC [a]	Any gasoline dispensing facility Includes any operation that transfers and stores gasoline	*Gasoline Fuel Storage and Dispensing* TG1–TG2
NESHAP Subpart EEEEEEE [a]	Gold ore mining Includes an establishment engaged in developing the mine site, mining, and/or beneficiating ores valued chiefly for their gold content, or in transformation of gold into bullion or doré bar in combination with mining activities	*Ore Concentration and Refining* AC, EW, MR, MF, CKD
NSPS Subpart LL	Any metallic mineral plant Includes any combination of equipment that extracts aluminum, copper, gold, iron, lead, molybdenum, silver, titanium, tungsten, uranium, zinc, and zirconium	*Ore Processing* OC1–OC13
NSPS Subpart OOO	Any nonmetallic mineral plant Includes plants processing crushed and broken stone, crushed and broken limestone, lime plants, sand and gravel, clay, etc.	*Aggregate Production* PCSP1, PCSP2 *Concrete Production* CA-L/U *Lime Production* LS1–LS11, LSBM
Source category that may not be subject to or may not be addressed by NSPS or NESHAP		*Concrete Production* CM, CS1-L/U, CS2-L/U *Heating, Ventilation, and Air Conditioning* H1M–H2M, HM, HAC, HR, HA, HMO, HTS, HW *Process Heating* ACB, CKB, PV, HS *Mining* drilling, blasting, excavating, hauling, prill silos, rock dumps and storage piles, tailings *Lime Storage and Crushing* LS1-LU, Mills2-L/U, ACS1-ASC4

a) NESHAP in 40 CFR 63.

NESHAP 40 CFR 63, Subpart EEEEEEE applies only to the following affected sources: each collection of "ore pretreatment processes" at a gold mine ore processing and production facility, each collection of "carbon processes with mercury retorts" at a gold mine ore processing and production facility, each collection of "carbon processes without mercury retorts" at a gold mine ore processing and production facility, and each collection of "non-carbon concentrate processes" at a gold mine ore processing and production facility. Ore pretreatment processes include the autoclave (AC). Carbon processes with mercury retort include the electrowinning cells and pregnant solution tank (EW), the mercury retort (MR), induction melting furnace (MF), and the carbon regeneration kiln (CKD). These sources are covered by NESHAP, as referenced in IDAPA 58.01.01.210.20.

Emissions of TAP from the gold mining operations such as drilling, blasting, excavating, hauling, prill silos, rock dumps and storage piles, and tailings are not covered by NESHAP Subpart EEEEEEE, as referenced in IDAPA 58.01.01.210.20. Further evaluation was conducted by SGP for these sources of HAP TAP emissions.

After exclusion of sources addressed by NSPS and/or NESHAP, the remaining sources were evaluated for compliance with TAP provisions. Emissions of each TAP from these sources (non-NESHAP-covered-or-addressed) were estimated and compared to the applicable screening emission level (as summarized in Table 6).

Mercury Emission Standard (IDAPA 58.01.01.215)

IDAPA 58.01.01.215..... Mercury Emission Standard for New or Modified Sources

No owner or operator may commence construction or modification of a stationary source or facility that results in an increase in annual potential emissions of mercury of 25 pounds or more unless the owner or operator has obtained a PTC under Sections 200–228 of the Rules. The PTC application shall include an MBACT analysis for the new or modified source or sources for review and approval by DEQ. A determination of applicability under Section 215 shall be based upon the best available information.

Fugitive emissions shall not be included in a determination of applicability under Section 215.

New or modified stationary sources within a source category subject to 40 CFR 63 are exempt from the requirements of Section 215.

IDAPA 58.01.01.215 sets requirements for mercury emissions. For this standard, fugitive emissions and sources in a source category subject to 40 CFR 63 are exempt. As identified in Table 9, emission sources within a source category subject to NESHAP 40 CFR 63, including Subpart ZZZZ, Subpart AAAAA, Subpart CCCCCC, and Subpart EEEEEEE were therefore exempt from this standard. Although non-applicable to area sources of HAP such as PRI, as a source category lime manufacturing plants are subject to NESHAP 40 CFR 63, Subpart AAAAA and associated sources (identified in Table 9) therefore exempt from this standard. Fugitive emissions from drilling, blasting, excavating, roadways (hauling), dozing, grading, storage piles, tailings and other fugitive and mobile emission sources were also exempt from this standard. Refer to the MACT/GACT Applicability (40 CFR 63) section for regulatory applicability analysis. No mercury emissions are expected from fuel storage, emergency power generation, and fire suppression sources.

After exclusion of sources within a source category subject to an area source NESHAP (40 CFR 63), aggregate production (crushers, screens, and conveyors), concrete production (aggregate bin), and heating, ventilation, and air conditioning (HVAC) units comprise the remaining sources that are applicable to the Mercury Emission Standard. Mercury emissions from these sources (non-fugitive and non-NESHAP-addressed) were estimated at less than 0.041 pounds per year (lb/yr), below the level at which MBACT review is required. Mercury emissions from propane combustion in HVAC sources are uncontrolled. Mercury emissions from materials processed in aggregate production and concrete production are controlled via water sprays and moisture carryover. As such controls are required for the portable crushing and screening plant, central mixer, and cement/shotcrete silos (Permit Conditions 2.1–2.8, 5.11, 5.12, and 5.16).

For the autoclave, electrowinning cells and pregnant solution tank, mercury retort, and induction melting furnace refinery sources (AC, EW, MR, MF) with enforceable NESHAP Subpart EEEEEEE mercury emission limits, potential emissions estimates (PTE) calculated consistent with these limits were included in the facility-wide mercury emission totals in Table 6. These values were substituted in lieu of the controlled emission estimates referenced from Table B1-W3 of Appendix B to the HAP/TAP addendum and ‘TblB1’ worksheet in the supporting spreadsheet. Although the mercury emissions from these sources are ultimately not included in the adjusted mercury emission totals for the purposes of the Mercury Emission Standard, these were used for the purposes of estimating HAP PTE consistent with enforceable limits.

Particulate Matter – New Equipment Process Weight Limitations (IDAPA 58.01.01.701)

IDAPA 58.01.01.701 ..... Particulate Matter – New Equipment Process Weight Limitations

IDAPA 58.01.01.700 through 703 set PM emission limits for process equipment based on when the piece of equipment commenced operation and the piece of equipment’s process weight (PW) in pounds per hour (lb/hr). IDAPA 58.01.01.701 establishes PM emission limits for equipment that commenced operation on or after October 1, 1979.

For equipment commencing operation on or after October 1, 1979, the PM allowable emission rate (E) is based on one of the following equations:

IDAPA 58.01.01.701.01.a: If PW is < 9,250 lb/hr; $E = 0.045 (PW)^{0.60}$

IDAPA 58.01.01.701.01.b: If PW is ≥ 9,250 lb/hr; $E = 1.10 (PW)^{0.25}$

For the new ore processing, ore concentration and refining, lime production, aggregate production, and concrete production equipment sources (Table 1) emissions (E) were calculated at the proposed maximum throughput rates (Table 1), and estimated emissions from all sources demonstrated compliance with this requirement. Compliance with operational and material throughput limits (Permit Conditions 3.3–3.9, 4.6–4.12, 5.4–5.9) and control equipment requirements (Permit Conditions 2.6, 3.11–3.13, 4.13–4.17, and 5.12–5.16) assure compliance with this standard, resulting in much lower emission rates.

Title V Classification (IDAPA 58.01.01.300, 40 CFR Part 70)

IDAPA 58.01.01.301 ..... Requirement to Obtain Tier I Operating Permit

Any source subject to 40 CFR 63, Subpart EEEEEEE is a Tier I source as defined in IDAPA 58.01.01.006.122.c. In accordance with IDAPA 58.01.01.313.01.b., the permittee must submit a complete application to DEQ for an initial Tier I operating permit within 12 months of becoming a Tier I source.

PRI has committed to applying for a Tier I permit. Detailed federal regulatory applicability were provided in the PTC application, and specific federally-applicable requirements will be incorporated into the Tier I. Refer to the NSPS Applicability (40 CFR 60), NESHAP Applicability (40 CFR 61), and MACT/GACT Applicability (40 CFR 63) sections below for additional information regarding applicable requirements.

Post-project facility-wide emissions from this facility do not have a PTE greater than 100 tons per year for criteria pollutants or 10 tons per year for any one HAP or 25 tons per year for all HAP combined as demonstrated previously in the Emissions Inventories section of this analysis. Although not a major facility as defined in IDAPA 58.01.01.008.10, any source subject to 40 CFR 63, Subpart EEEEEEE is a Tier I source as defined in IDAPA 58.01.01.006.122.c. In accordance with IDAPA 58.01.01.313.01.b., the permittee must submit a complete application to DEQ for an initial Tier I operating permit within 12 months of becoming a Tier I source. Refer to the NESHAP Applicability (40 CFR 61) section for additional discussion of Subpart EEEEEEE applicability.

Permit Condition 2.24 incorporates the requirement to obtain a Tier I permit in accordance with IDAPA 58.01.01.313.01.b.

PSD Classification (40 CFR 52.21)

40 CFR 52.21 ..... Prevention of Significant Deterioration of Air Quality

The project includes a lime manufacturing plant (LMP) that uses a Parallel Flow Regenerative Shaft Kiln (LK, LKC) to produce lime product from limestone by calcination, which is a designated facility as defined in 40 CFR 52.21(b)(1)(i)(a). As a designated facility, both fugitive and non-fugitive emissions from the lime plant must be counted toward a determination of a major stationary source with a threshold of 100 T/yr. SGP is a gold mine with a nested lime plant operating within the stationary source. The primary activity of the stationary source is the mining and processing of gold ore. As explained in the United States Environmental Protection Agency's (EPA) March 6, 2003, guidance,[18] an example is "A coal mine with an onsite coal cleaning plant with a thermal dryer. The primary activity of the source, in this example, is the mining of coal, and coal mines are not a listed source category. The coal cleaning plant, however, does fall within a listed source category. You include fugitive emissions only from the coal cleaning plant to determine if the source is a major stationary source." Gold mines are not a designated facility as defined in 40 CFR 52.21(b)(1)(i)(a). Therefore, emissions from the primary activity, the gold mining operation, are not included in the LMP major source determination as summarized in Table 10 below (values referenced are from 'PROC' tab in the emissions inventory spreadsheet, see Appendix A).

[18] "Clarification on fugitive emissions policy" letter to Janet McCabe, Assistant Commissioner, Office of Air Quality, Indiana Department of Environmental Management, March 6, 2003.

Using the definition of a LMP in the federal regulation Subpart AAAAA - National Emission Standards for Hazardous Air Pollutants for Lime Manufacturing Plants, the Subpart applies to each existing or new lime kiln(s) and their associated cooler(s), and processed stone handling (PSH) operations system(s). PSH operations systems includes all equipment associated with PSH operations beginning at the processed stone storage bin(s) or open storage pile(s) and ending where the processed stone is fed into the kiln. It includes man-made processed stone storage bins (but not open processed stone storage piles), conveying system transfer points, bulk loading or unloading systems, screening operations, surge bins, bucket elevators, and belt conveyors. These sources are included in the table below under the designated facility section. In addition, supporting equipment to the LMP has been included under the fugitive sources.

Table 10 LIME PLANT POTENTIAL TO EMIT

Source	PM	PM_{10}	$PM_{2.5}$	CO	NO_x	VOC	SO_2
	T/yr [a]	T/yr [a]	T/yr [a]	T/yr [a]	T/yr [a]	T/yr [a]	T/yr [a]
LMP (Designated Facility)							
LS12	0.12	0.05	0.01				
LS-L	0.02	0.02	0.02				
LS-U	0.002	0.002	0.002				
LK	3.40	3.40	3.40	11.79	6.29		0.03
LKC	0.63	0.63	0.63	6.72	11.6	0.72	1.42
LCR	1.06	0.89	0.32				
LMP / Fugitive Sources							
LS1	0.48	0.17	0.03				
LS2	0.86	0.38	0.06				
LS3	3.97	1.38	0.21				
LS4	0.86	0.38	0.06				
LS5	3.97	1.38	0.21				
LS6	0.48	0.17	0.03				
LSBM	6.42	5.39	1.92				
LS7	0.48	0.17	0.03				
LS8	0.48	0.17	0.03				
LS9	0.12	0.05	0.007				
LS10	0.12	0.05	0.007				
LS11	1.03	0.36	0.05				
Post-Project PTE	**24.5**	**15.0**	**7.0**	**18.5**	**17.9**	**0.7**	**1.5**

a) Controlled average emission rate in tons per year is an annual average, based on the proposed annual operating scenarios and annual limits.

To be conservative, if the primary activity of the stationary source was not considered and the LMP was treated as the primary activity of the mine with a threshold of 100 T/yr including both fugitive and non-fugitive emissions, the LMP affected sources are summarized in Table 11 below (values referenced from 'PROC' tab in the emissions inventory spreadsheet, see Appendix A).

The source of marble, the Middle Marble Geologic Unit (MMGU), for the LMP is overburden excavated from the West End pit. Because of its location, the overburden must be removed even if it were not used for onsite lime production. A percentage of the West End pit overburden, 0.63%, will provide the lime plant feed over the life of the mine. The potential throughput rate of limestone (marble) feed to the SGP LMP primary crusher is 1,130 tons/day (limited by Permit Condition 5.4) and the potential overburden mining rate is 180,000 tons/day (limited by Permit Condition 3.5).

LMP throughput percentage calculation: 1,130 tons/day / 180,000 tons/day = 0.0063 or 0.63%

This percentage was used to conservatively calculate the potential annual emissions from the marble overburden mining associated with the LMP operation.

Table 11 LIME PLANT POTENTIAL TO EMIT INCLUDING FUGITIVES FROM MARBLE OVERBURDEN MINING

Source	PM	PM_{10}	$PM_{2.5}$	CO	NO_x	VOC	SO_2
	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]
LMP (Designated Facility)							
LS12	0.12	0.05	0.01				
LS-L	0.02	0.02	0.02				
LS-U	0.002	0.002	0.002				
LK	3.40	3.40	3.40	11.79	6.29		0.03
LKC	0.63	0.63	0.63	6.72	11.6	0.72	1.42
LCR	1.06	0.89	0.32				
LMP / Fugitive Sources							
LS1	0.48	0.17	0.03				
LS2	0.86	0.38	0.06				
LS3	3.97	1.38	0.21				
LS4	0.86	0.38	0.06				
LS5	3.97	1.38	0.21				
LS6	0.48	0.17	0.03				
LSBM	6.42	5.39	1.92				
LS7	0.48	0.17	0.03				
LS8	0.48	0.17	0.03				
LS9	0.12	0.05	0.007				
LS10	0.12	0.05	0.007				
LS11	1.03	0.36	0.05				
LMP Marble Overburden Mining / Fugitive Sources [(b)]							
Blasting activities	0.739	0.384	0.022	4.006	0.108		0.0002
Drilling activities	1.794	0.933	0.054				
Hauling	18.28	4.49	0.449				
Material load / unload (L/UL)	0.095	0.045	0.007				
Dozing	0.652	0.125	0.068				
Grading	0.232	0.070	0.007				
Water Truck Travel	0.688	0.169	0.017				
Access Roads	0.044	0.011	0.001				
Wind Erosion	0.036	0.018	0.003				
Surface Exploration	0.007	0.002	0.0004				
Underground Exploration	0.00001	0.000006	0.0000006				
Post-Project PTE	**47.07**	**21.29**	**7.65**	**22.52**	**18.00**	**0.72**	**1.45**

a) Controlled average emission rate in tons per year is an annual average, based on the proposed annual operating scenarios and annual limits.

b) Emissions are from Table 3 and multiplied by the percentage of overburden used as marble feed (<0.63%) to the SGP lime plant.

NSPS Applicability (40 CFR 60)

The permittee has affected facilities subject to New Source Performance Standards (NSPS). The POX Boiler (ACB) meets the definition of process heater rather than steam generating unit, and the use of a rotary lime kiln has not been proposed in the production of lime; therefore Subpart Dc and Subpart HH are not applicable. Initial regulatory applicability analyses and determinations are provided below; detailed analyses and explicit incorporation of applicable requirements is left to the required Tier I permit action as discussed in the Title V Classification (IDAPA 58.01.01.300, 40 CFR Part 70) section.

- Standards of Performance for New Stationary Sources (NSPS) 40 CFR 60, Subpart A – General Provisions. DEQ is delegated this Subpart.
- NSPS 40 CFR 60, Subpart LL – Standards of Performance for Metallic Mineral Processing Plants. DEQ is delegated this Subpart. Each crusher, conveyor belt transfer point, and truck unloading station is an affected facility.

- NSPS 40 CFR 60, Subpart OOO – Standards of Performance for Nonmetallic Mineral Processing Plants. DEQ is delegated this Subpart. Each crusher, grinding mill, screening operation, belt conveyor, and storage bin is an affected facility.
- NSPS 40 CFR 60, Subpart IIII – Standards of Performance for Stationary Compression Ignition Internal Combustion Engines. DEQ is delegated this Subpart. Each emergency generator engine and fire pump is an affected facility.

Emission sources regulated by Subpart LL, Subpart OOO, and Subpart IIII are identified in the incorporation of federal requirements condition (Permit Condition 2.22)

40 CFR 60, Subpart A ..... General Provisions

§60.1 ..... Applicability

(a) Except as provided in subparts B and C, the provisions of this part apply to the owner or operator of any stationary source which contains an affected facility, the construction or modification of which is commenced after the date of publication in this part of any standard (or, if earlier, the date of publication of any proposed standard) applicable to that facility.

(b) Any new or revised standard of performance promulgated pursuant to section 111(b) of the Act shall apply to the owner or operator of any stationary source which contains an affected facility, the construction or modification of which is commenced after the date of publication in this part of such new or revised standard (or, if earlier, the date of publication of any proposed standard) applicable to that facility.

Because the permittee will own or operate NSPS affected facilities, which have been proposed to commence construction after the date of publication of the relevant applicable NSPS standards (as listed above), general provisions in Subpart A are applicable.

40 CFR 60, Subpart A is incorporated by reference into Permit Condition 2.22, and specific applicable requirements will be incorporated into the Tier I operating permit.

40 CFR 60, Subpart Dc ..... Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units

§60.40c ..... Applicability and delegation of authority.

(a) Except as provided in paragraphs (d), (e), (f), and (g) of this section, the affected facility to which this subpart applies is each steam generating unit for which construction, modification, or reconstruction is commenced after June 9, 1989 and that has a maximum design heat input capacity of 29 megawatts (MW) (100 million British thermal units per hour (MMBtu/h)) or less, but greater than or equal to 2.9 MW (10 MMBtu/h).

§60.41c ..... Definitions.

As used in this subpart, all terms not defined herein shall have the meaning given them in the Clean Air Act and in subpart A of this part.

...

Heat input *means heat derived from combustion of fuel in a steam generating unit and does not include the heat derived from preheated combustion air, recirculated flue gases, or exhaust gases from other sources (such as stationary gas turbines, internal combustion engines, and kilns).*

Heat transfer medium *means any material that is used to transfer heat from one point to another point.*

...

Process heater *means a device that is primarily used to heat a material to initiate or promote a chemical reaction in which the material participates as a reactant or catalyst.*

...

Steam generating unit *means a device that combusts any fuel and produces steam or heats water or heats any heat transfer medium. This term includes any duct burner that combusts fuel and is part of a combined cycle system. This term does not include process heaters as defined in this subpart.*

Although the Pressure Oxidation Boiler (POX Boiler) is between 10 and 100 MMBtu/hr in design heat input capacity (17 MMBtu/hr) and is proposed for construction after June 9, 1989, it meets the definition of process heater rather than steam generating unit, and therefore is not applicable to this subpart. The POX Boiler (ACB) is a device used to directly heat ore material via steam injection into the autoclave, to promote chemical oxidation reactions in which the heated ore participates as a reactant. DEQ is delegated this Subpart.

40 CFR 60, Subpart HH ..... Standards of Performance for Lime Manufacturing Plants

§60.340 ..... Applicability and designation of affected facility.

(a) The provisions of this subpart are applicable to each rotary lime kiln used in the manufacture of lime.

(b) The provisions of this subpart are not applicable to facilities used in the manufacture of lime at kraft pulp mills.

(c) Any facility under paragraph (a) of this section that commences construction or modification after May 3, 1977, is subject to the requirements of this subpart.

§60.341 ..... Definitions.

As used in this subpart, all terms not defined herein shall have the same meaning given them in the Act and in the General Provisions.

(a) Lime manufacturing plant *means any plant which uses a rotary lime kiln to produce lime product from limestone by calcination.*

(b) Lime product *means the product of the calcination process including, but not limited to, calcitic lime, dolomitic lime, and dead-burned dolomite.*

(c) Positive-pressure fabric filter *means a fabric filter with the fans on the upstream side of the filter bags.*

(d) Rotary lime kiln *means a unit with an inclined rotating drum that is used to produce a lime product from limestone by calcination.*

(e) Stone feed *means limestone feedstock and mill scale or other iron oxide additives that become part of the product.*

The use of a rotary lime kiln has not been proposed in the production of lime, and therefore the requirements of Subpart HH are not applicable. DEQ is delegated this Subpart.

40 CFR 60, Subpart LL ..... Standards of Performance for Metallic Mineral Processing Plants

§60.380 ..... Applicability and designation of affected facility.

(a) The provisions of this subpart are applicable to the following affected facilities in metallic mineral processing plants: Each crusher and screen in open-pit mines; each crusher, screen, bucket elevator, conveyor belt transfer point, thermal dryer, product packaging station, storage bin, enclosed storage area, truck loading station, truck unloading station, railcar loading station, and railcar unloading station at the mill or concentrator with the following exceptions. All facilities located in underground mines are exempted from the provisions of this subpart. At uranium ore processing plants, all facilities subsequent to and including the beneficiation of uranium ore are exempted from the provisions of this subpart.

(b) An affected facility under paragraph (a) of this section that commences construction or modification after August 24, 1982, is subject to the requirements of this part.

Because the permittee will own or operate a metallic mineral processing plant with a crusher at an open-pit mine; with crushers, conveyor belt transfer points, and truck unloading stations at the mill or concentrator; and because these are proposed to commence construction after August 24, 1982, requirements in Subpart LL are applicable.

40 CFR 60, Subpart LL is incorporated by reference into Permit Condition 2.22, and specific applicable requirements will be incorporated into the Tier I operating permit.

40 CFR 60, Subpart OOO ..... Standards of Performance for Nonmetallic Mineral Processing Plants

§60.670 ..... Applicability and designation of affected facility.

(a)(1) Except as provided in paragraphs (a)(2), (b), (c), and (d) of this section, the provisions of this subpart are applicable to the following affected facilities in fixed or portable nonmetallic mineral processing plants: each crusher, grinding mill, screening operation, bucket elevator, belt conveyor, bagging operation, storage bin, enclosed truck or railcar loading station. Also, crushers and grinding mills at hot mix asphalt facilities that reduce the size of nonmetallic minerals embedded in recycled asphalt pavement and subsequent affected facilities up to, but not including, the first storage silo or bin are subject to the provisions of this subpart.

(2) The provisions of this subpart do not apply to the following operations: All facilities located in underground mines; plants without crushers or grinding mills above ground; and wet material processing operations (as defined in §60.671).

(b) An affected facility that is subject to the provisions of subparts F or I of this part or that follows in the plant process any facility subject to the provisions of subparts F or I of this part is not subject to the provisions of this subpart.

(c) Facilities at the following plants are not subject to the provisions of this subpart:

(1) Fixed sand and gravel plants and crushed stone plants with capacities, as defined in §60.671, of 23 megagrams per hour (25 tons per hour) or less;

(2) Portable sand and gravel plants and crushed stone plants with capacities, as defined in §60.671, of 136 megagrams per hour (150 tons per hour) or less; and

(3) Common clay plants and pumice plants with capacities, as defined in §60.671, of 9 megagrams per hour (10 tons per hour) or less.

(d)(1) When an existing facility is replaced by a piece of equipment of equal or smaller size, as defined in §60.671, having the same function as the existing facility, and there is no increase in the amount of emissions, the new facility is exempt from the provisions of §§60.672, 60.674, and 60.675 except as provided for in paragraph (d)(3) of this section.

(2) An owner or operator complying with paragraph (d)(1) of this section shall submit the information required in §60.676(a).

(3) An owner or operator replacing all existing facilities in a production line with new facilities does not qualify for the exemption described in paragraph (d)(1) of this section and must comply with the provisions of §§60.672, 60.674 and 60.675.

(e) An affected facility under paragraph (a) of this section that commences construction, modification, or reconstruction after August 31, 1983, is subject to the requirements of this part.

(f) Table 1 of this subpart specifies the provisions of subpart A of this part 60 that do not apply to owners and operators of affected facilities subject to this subpart or that apply with certain exceptions.

Because the project contains crushers, grinding mills, screening operations, belt conveyors, and storage bins in a fixed or portable nonmetallic mineral processing plant, which are proposed to commence construction after August 31, 1983, requirements in Subpart OOO are applicable. The portable crushing and screening plants (PCSP1, PCSP2) will be rated at below 150 tons per hour (T/hr), and are therefore not subject to the provisions of Subpart OOO.

40 CFR 60, Subpart OOO is incorporated by reference into Permit Condition 2.22, and specific applicable requirements will be incorporated into the Tier I operating permit.

40 CFR 60, Subpart IIII..... Standards of Performance for Stationary Compression Ignition Internal Combustion Engines

§60.4200..... Am I subject to this subpart?

(a) The provisions of this subpart are applicable to manufacturers, owners, and operators of stationary compression ignition (CI) internal combustion engines (ICE) and other persons as specified in paragraphs (a)(1) through (4) of this section. For the purposes of this subpart, the date that construction commences is the date the engine is ordered by the owner or operator.

(1) Manufacturers of stationary CI ICE with a displacement of less than 30 liters per cylinder where the model year is:

(i) 2007 or later, for engines that are not fire pump engines;

(ii) The model year listed in Table 3 to this subpart or later model year, for fire pump engines.

(2) Owners and operators of stationary CI ICE that commence construction after July 11, 2005, where the stationary CI ICE are:

(i) Manufactured after April 1, 2006, and are not fire pump engines, or

(ii) Manufactured as a certified National Fire Protection Association (NFPA) fire pump engine after July 1, 2006.

(3) Owners and operators of any stationary CI ICE that are modified or reconstructed after July 11, 2005 and any person that modifies or reconstructs any stationary CI ICE after July 11, 2005.

(4) The provisions of §60.4208 of this subpart are applicable to all owners and operators of stationary CI ICE that commence construction after July 11, 2005.

(b) The provisions of this subpart are not applicable to stationary CI ICE being tested at a stationary CI ICE test cell/stand.

(c) If you are an owner or operator of an area source subject to this subpart, you are exempt from the obligation to obtain a permit under 40 CFR part 70 or 40 CFR part 71, provided you are not required to obtain a permit under 40 CFR 70.3(a) or 40 CFR 71.3(a) for a reason other than your status as an area source under this subpart. Notwithstanding the previous sentence, you must continue to comply with the provisions of this subpart applicable to area sources.

(d) Stationary CI ICE may be eligible for exemption from the requirements of this subpart as described in 40 CFR part 1068, subpart C (or the exemptions described in 40 CFR part 89, subpart J and 40 CFR part 94, subpart J, for engines that would need to be certified to standards in those parts), except that owners and operators, as well as manufacturers, may be eligible to request an exemption for national security.

(e) Owners and operators of facilities with CI ICE that are acting as temporary replacement units and that are located at a stationary source for less than 1 year and that have been properly certified as meeting the standards that would be applicable to such engine under the appropriate nonroad engine provisions, are not required to meet any other provisions under this subpart with regard to such engines.

Because the permittee will own or operate compression ignition (CI) internal combustion engines (ICE) which are proposed to commence construction after July 11, 2005 and which will be ordered after April 1, 2006 for the emergency generator engines, and which will be ordered after July 1, 2006 for the fire pump engine, requirements in Subpart IIII are applicable. The permittee has not requested or qualified for exemption pursuant to §60.4200(b), (d), or (e).

40 CFR 60, Subpart IIII is incorporated by reference into Permit Condition 2.22, and specific applicable requirements will be incorporated into the Tier I operating permit.

NESHAP Applicability (40 CFR 61)

The facility is not subject to any NESHAP requirements in 40 CFR 61.

MACT/GACT Applicability (40 CFR 63)

The permittee has proposed to operate as a minor source of hazardous air pollutant (HAP) emissions, and has affected facilities subject to the following National Emission Standards for Hazardous Air Pollutants (NESHAP). The lime manufacturing plant is proposed at an area source of HAP, and therefore is not applicable to Subpart AAAAA. The process boiler is at an area source of Applicability determinations and regulatory analyses are provided below.

- National Emission Standards for Hazardous Air Pollutants for Source Categories (NESHAP) 40 CFR 63, Subpart A – General Provisions. DEQ is delegated this Subpart for Tier I sources.
- NESHAP 40 CFR 63, Subpart ZZZZ – National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines (RICE). DEQ is delegated this Subpart. The emergency generator and fire pump engines (EDG1, EDG2, EDG3, and EDFP) are affected sources.
- NESHAP 40 CFR 63, Subpart CCCCCC – National Emission Standards for Hazardous Air Pollutants for Source Category: Gasoline Dispensing Facilities. DEQ is delegated this Subpart for Tier I sources. The gasoline fuel storage tanks (TG1, TG2) are affected sources.
- NESHAP 40 CFR 63, Subpart EEEEEEE – National Emission Standards for Hazardous Air Pollutants: Gold Mine Ore Processing and Production Area Source Category. DEQ is delegated this Subpart for Tier I sources. The collection of ore pretreatment processes and the carbon process with mercury retort are affected sources. Ore pretreatment processes include the autoclave (AC). Carbon processes with mercury retort include the electrowinning cells and pregnant solution tank (EW), the mercury retort (MR), induction melting furnace (MF), and the carbon regeneration kiln (CKD).

Emission sources regulated by Subpart EEEEEEE, Subpart CCCCCC, and Subpart ZZZZ are identified in the incorporation of federal requirements condition (Permit Condition 2.22)

40 CFR 63, Subpart A ..... General Provisions

§63.1..... Applicability.

(a) General. *(1) Terms used throughout this part are defined in §63.2 or in the Clean Air Act (Act) as amended in 1990, except that individual subparts of this part may include specific definitions in addition to or that supersede definitions in §63.2.*

(2) This part contains national emission standards for hazardous air pollutants (NESHAP) established pursuant to section 112 of the Act as amended November 15, 1990. These standards regulate specific categories of stationary sources that emit (or have the potential to emit) one or more hazardous air pollutants listed in this part pursuant to section 112(b) of the Act. This section explains the applicability of such standards to sources affected by them. The standards in this part are independent of NESHAP contained in 40 CFR part 61. The NESHAP in part 61 promulgated by signature of the Administrator before November 15, 1990 (i.e., the date of enactment of the Clean Air Act Amendments of 1990) remain in effect until they are amended, if appropriate, and added to this part.

(3) No emission standard or other requirement established under this part shall be interpreted, construed, or applied to diminish or replace the requirements of a more stringent emission limitation or other applicable requirement established by the Administrator pursuant to other authority of the Act (section 111, part C or D or any other authority of this Act), or a standard issued under State authority. The Administrator may specify in a specific standard under this part that facilities subject to other provisions under the Act need only comply with the provisions of that standard.

(4)(i) Each relevant standard in this part 63 must identify explicitly whether each provision in this subpart A is or is not included in such relevant standard.

(ii) If a relevant part 63 standard incorporates the requirements of 40 CFR part 60, part 61 or other part 63 standards, the relevant part 63 standard must identify explicitly the applicability of each corresponding part 60, part 61, or other part 63 subpart A (General) provision.

(iii) The General Provisions in this subpart A do not apply to regulations developed pursuant to section 112(r) of the amended Act, unless otherwise specified in those regulations.

…

(b) Initial applicability determination for this part. *(1) The provisions of this part apply to the owner or operator of any stationary source that—*

(i) Emits or has the potential to emit any hazardous air pollutant listed in or pursuant to section 112(b) of the Act; and

(ii) Is subject to any standard, limitation, prohibition, or other federally enforceable requirement established pursuant to this part.

(2) [Reserved]

(3) An owner or operator of a stationary source who is in the relevant source category and who determines that the source is not subject to a relevant standard or other requirement established under this part must keep a record as specified in §63.10(b)(3).

Because the permittee will own or operate stationary sources that emit HAP which are subject to standards, limitations, prohibitions, or other federally-enforceable requirements established pursuant to NESHAP, provisions in Subpart A are applicable.

40 CFR 63, Subpart A is incorporated by reference into Permit Condition 2.22, and specific applicable requirements will be incorporated into the Tier I operating permit.

40 CFR 63, Subpart ZZZZ..... National Emissions Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines

§63.6580..... What is the purpose of subpart ZZZZ?

Subpart ZZZZ establishes national emission limitations and operating limitations for hazardous air pollutants (HAP) emitted from stationary reciprocating internal combustion engines (RICE) located at major and area sources of HAP emissions. This subpart also establishes requirements to demonstrate initial and continuous compliance with the emission limitations and operating limitations.

§63.6585..... Am I subject to this subpart?

You are subject to this subpart if you own or operate a stationary RICE at a major or area source of HAP emissions, except if the stationary RICE is being tested at a stationary RICE test cell/stand.

(a) A stationary RICE is any internal combustion engine which uses reciprocating motion to convert heat energy into mechanical work and which is not mobile. Stationary RICE differ from mobile RICE in that a stationary RICE is not a non-road engine as defined at 40 CFR 1068.30, and is not used to propel a motor vehicle or a vehicle used solely for competition.

(b) A major source of HAP emissions is a plant site that emits or has the potential to emit any single HAP at a rate of 10 tons (9.07 megagrams) or more per year or any combination of HAP at a rate of 25 tons (22.68 megagrams) or more per year, except that for oil and gas production facilities, a major source of HAP emissions is determined for each surface site.

(c) An area source of HAP emissions is a source that is not a major source.

(d) If you are an owner or operator of an area source subject to this subpart, your status as an entity subject to a standard or other requirements under this subpart does not subject you to the obligation to obtain a permit under 40 CFR part 70 or 71, provided you are not required to obtain a permit under 40 CFR 70.3(a) or 40 CFR 71.3(a) for a reason other than your status as an area source under this subpart. Notwithstanding the previous sentence, you must continue to comply with the provisions of this subpart as applicable.

(e) If you are an owner or operator of a stationary RICE used for national security purposes, you may be eligible to request an exemption from the requirements of this subpart as described in 40 CFR part 1068, subpart C.

(f) The emergency stationary RICE listed in paragraphs (f)(1) through (3) of this section are not subject to this subpart. The stationary RICE must meet the definition of an emergency stationary RICE in §63.6675, which includes operating according to the provisions specified in §63.6640(f).

(1) Existing residential emergency stationary RICE located at an area source of HAP emissions that do not operate or are not contractually obligated to be available for more than 15 hours per calendar year for the purposes specified in §63.6640(f)(2)(ii) and (iii) and that do not operate for the purpose specified in §63.6640(f)(4)(ii).

(2) Existing commercial emergency stationary RICE located at an area source of HAP emissions that do not operate or are not contractually obligated to be available for more than 15 hours per calendar year for the purposes specified in §63.6640(f)(2)(ii) and (iii) and that do not operate for the purpose specified in §63.6640(f)(4)(ii).

(3) Existing institutional emergency stationary RICE located at an area source of HAP emissions that do not operate or are not contractually obligated to be available for more than 15 hours per calendar year for the purposes specified in §63.6640(f)(2)(ii) and (iii) and that do not operate for the purpose specified in §63.6640(f)(4)(ii).

Because the permittee will own or operate stationary RICE at an area source of HAP which are subject to standards, limitations, prohibitions, or other federally-enforceable requirements established pursuant to NESHAP, requirements in Subpart ZZZZ are applicable.

40 CFR 63, Subpart ZZZZ is incorporated by reference into Permit Condition 2.22, and specific applicable requirements will be incorporated into the Tier I operating permit.

40 CFR 63, Subpart AAAAA..... National Emission Standards for Hazardous Air Pollutants for Lime Manufacturing Plants

§63.7080..... What is the purpose of this subpart?

This subpart establishes national emission standards for hazardous air pollutants (NESHAP) for lime manufacturing plants. This subpart also establishes requirements to demonstrate initial and continuous compliance with the emission limitations.

§63.7081..... Am I subject to this subpart?

(a) You are subject to this subpart if you own or operate a lime manufacturing plant (LMP) that is a major source, or that is located at, or is part of, a major source of hazardous air pollutant (HAP) emissions, unless the LMP is located at a kraft pulp mill, soda pulp mill, sulfite pulp mill, beet sugar manufacturing plant, or only processes sludge containing calcium carbonate from water softening processes.

(1) An LMP is an establishment engaged in the manufacture of lime product (calcium oxide, calcium oxide with magnesium oxide, or dead burned dolomite) by calcination of limestone, dolomite, shells or other calcareous substances.

(2) A major source of HAP is a plant site that emits or has the potential to emit any single HAP at a rate of 9.07 megagrams (10 tons) or more per year or any combination of HAP at a rate of 22.68 megagrams (25 tons) or more per year from all emission sources at the plant site.

(b) [Reserved]

§63.7143..... What definitions apply to this subpart?

Terms used in this subpart are defined in the Clean Air Act, in §63.2, and in this section as follows:

...

Lime manufacturing plant (LMP) *means any plant which uses a lime kiln to produce lime product from limestone or other calcareous material by calcination.*

Lime product *means the product of the lime kiln calcination process including, calcitic lime, dolomitic lime, and dead-burned dolomite.*

Limestone *means the material comprised primarily of calcium carbonate (referred to sometimes as calcitic or high calcium limestone), magnesium carbonate, and/or the double carbonate of both calcium and magnesium (referred to sometimes as dolomitic limestone or dolomite).*

...

The lime manufacturing plant is proposed at an area source of HAP, and therefore is not subject to this Subpart.

40 CFR 60, Subpart CCCCCC..... National Emission Standards for Hazardous Air Pollutants for Source Category: Gasoline Dispensing Facilities

§63.11110..... What is the purpose of this subpart?

This subpart establishes national emission limitations and management practices for hazardous air pollutants (HAP) emitted from the loading of gasoline storage tanks at gasoline dispensing facilities (GDF). This subpart also establishes requirements to demonstrate compliance with the emission limitations and management practices.

§63.11111..... Am I subject to the requirements in this subpart?

(a) The affected source to which this subpart applies is each GDF that is located at an area source. The affected source includes each gasoline cargo tank during the delivery of product to a GDF and also includes each storage tank.

(b) If your GDF has a monthly throughput of less than 10,000 gallons of gasoline, you must comply with the requirements in §63.11116.

(c) If your GDF has a monthly throughput of 10,000 gallons of gasoline or more, you must comply with the requirements in §63.11117.

(d) If your GDF has a monthly throughput of 100,000 gallons of gasoline or more, you must comply with the requirements in §63.11118.

(e) An affected source shall, upon request by the Administrator, demonstrate that their monthly throughput is less than the 10,000-gallon or the 100,000-gallon threshold level, as applicable. For new or reconstructed affected sources, as specified in §63.11112(b) and (c), recordkeeping to document monthly throughput must begin upon startup of the affected source. For existing sources, as specified in §63.11112(d), recordkeeping to document monthly throughput must begin on January 10, 2008. For existing sources that are subject to this subpart only because they load gasoline into fuel tanks other than those in motor vehicles, as defined in §63.11132, recordkeeping to document monthly throughput must begin on January 24, 2011. Records required under this paragraph shall be kept for a period of 5 years.

(f) If you are an owner or operator of affected sources, as defined in paragraph (a) of this section, you are not required to obtain a permit under 40 CFR part 70 or 40 CFR part 71 as a result of being subject to this subpart. However, you must still apply for and obtain a permit under 40 CFR part 70 or 40 CFR part 71 if you meet one or more of the applicability criteria found in 40 CFR 70.3(a) and (b) or 40 CFR 71.3(a) and (b).

(g) The loading of aviation gasoline into storage tanks at airports, and the subsequent transfer of aviation gasoline within the airport, is not subject to this subpart.

(h) Monthly throughput is the total volume of gasoline loaded into, or dispensed from, all the gasoline storage tanks located at a single affected GDF. If an area source has two or more GDF at separate locations within the area source, each GDF is treated as a separate affected source.

(i) If your affected source's throughput ever exceeds an applicable throughput threshold, the affected source will remain subject to the requirements for sources above the threshold, even if the affected source throughput later falls below the applicable throughput threshold.

(j) The dispensing of gasoline from a fixed gasoline storage tank at a GDF into a portable gasoline tank for the on-site delivery and subsequent dispensing of the gasoline into the fuel tank of a motor vehicle or other gasoline-fueled engine or equipment used within the area source is only subject to §63.11116 of this subpart.

(k) For any affected source subject to the provisions of this subpart and another Federal rule, you may elect to comply only with the more stringent provisions of the applicable subparts. You must consider all provisions of the rules, including monitoring, recordkeeping, and reporting. You must identify the affected source and provisions with which you will comply in your Notification of Compliance Status required under §63.11124. You also must demonstrate in your Notification of Compliance Status that each provision with which you will comply is at least as stringent as the otherwise applicable requirements in this subpart. You are responsible for making accurate determinations concerning the more stringent provisions, and noncompliance with this rule is not excused if it is later determined that your determination was in error, and, as a result, you are violating this subpart. Compliance with this rule is your responsibility and the Notification of Compliance Status does not alter or affect that responsibility.

§63.11132..... What definitions apply to this subpart?

As used in this subpart, all terms not defined herein shall have the meaning given them in the Clean Air Act (CAA), or in subparts A and BBBBBB of this part. For purposes of this subpart, definitions in this section supersede definitions in other parts or subparts.

Dual-point vapor balance system *means a type of vapor balance system in which the storage tank is equipped with an entry port for a gasoline fill pipe and a separate exit port for a vapor connection.*

Gasoline *means any petroleum distillate or petroleum distillate/alcohol blend having a Reid vapor pressure of 27.6 kilopascals or greater, which is used as a fuel for internal combustion engines.*

Gasoline cargo tank *means a delivery tank truck or railcar which is loading or unloading gasoline, or which has loaded or unloaded gasoline on the immediately previous load.*

Gasoline dispensing facility (GDF) *means any stationary facility which dispenses gasoline into the fuel tank of a motor vehicle, motor vehicle engine, nonroad vehicle, or nonroad engine, including a nonroad vehicle or nonroad engine used solely for competition. These facilities include, but are not limited to, facilities that dispense gasoline into on- and off-road, street, or highway motor vehicles, lawn equipment, boats, test engines, landscaping equipment, generators, pumps, and other gasoline-fueled engines and equipment.*

Monthly throughput *means the total volume of gasoline that is loaded into, or dispensed from, all gasoline storage tanks at each GDF during a month. Monthly throughput is calculated by summing the volume of gasoline loaded into, or dispensed from, all gasoline storage tanks at each GDF during the current day, plus the total volume of gasoline loaded into, or dispensed from, all gasoline storage tanks at each GDF during the previous 364 days, and then dividing that sum by 12.*

Motor vehicle *means any self-propelled vehicle designed for transporting persons or property on a street or highway.*

Nonroad engine *means an internal combustion engine (including the fuel system) that is not used in a motor vehicle or a vehicle used solely for competition, or that is not subject to standards promulgated under section 7411 of this title or section 7521 of this title.*

Nonroad vehicle *means a vehicle that is powered by a nonroad engine, and that is not a motor vehicle or a vehicle used solely for competition.*

Submerged filling *means, for the purposes of this subpart, the filling of a gasoline storage tank through a submerged fill pipe whose discharge is no more than the applicable distance specified in §63.11117(b) from the bottom of the tank. Bottom filling of gasoline storage tanks is included in this definition.*

Vapor balance system *means a combination of pipes and hoses that create a closed system between the vapor spaces of an unloading gasoline cargo tank and a receiving storage tank such that vapors displaced from the storage tank are transferred to the gasoline cargo tank being unloaded.*

Vapor-tight *means equipment that allows no loss of vapors. Compliance with vapor-tight requirements can be determined by checking to ensure that the concentration at a potential leak source is not equal to or greater than 100 percent of the Lower Explosive Limit when measured with a combustible gas detector, calibrated with propane, at a distance of 1 inch from the source.*

Vapor-tight gasoline cargo tank *means a gasoline cargo tank which has demonstrated within the 12 preceding months that it meets the annual certification test requirements in §63.11092(f) of this part.*

Because the permittee will own or operate a gasoline dispensing facility (GDF) at an area source of HAP, requirements in Subpart CCCCCC are applicable. Because the permittee has committed to loading and dispensing of less than 100,000 gallons of gasoline per month (gal/mo), the requirements of 40 CFR 63.11117 will become applicable in accordance with 40 CFR 63.11111(b) and (c). Gasoline loading and dispensing is limited by Permit Condition 2.18 to avoid requirements applicable to GDF exceeding 100,000 gal/mo, and requires recordkeeping in accordance with 40 CFR 63.11111(e).

40 CFR 63, Subpart CCCCCC is incorporated by reference into Permit Condition 2.22, and specific applicable requirements will be incorporated into the Tier I operating permit.

40 CFR 63, Subpart EEEEEEE..... National Emission Standards for Hazardous Air Pollutants: Gold Mine Ore Processing and Production Area Source Category

§40 CFR 63.11640..... Am I subject to this subpart?

(a) You are subject to this subpart if you own or operate a gold mine ore processing and production facility as defined in §63.11651, that is an area source.

(b) This subpart applies to each new or existing affected source. The affected sources are each collection of "ore pretreatment processes" at a gold mine ore processing and production facility, each collection of "carbon processes with mercury retorts" at a gold mine ore processing and production facility, each collection of "carbon processes without mercury retorts" at a gold mine ore processing and production facility, and each collection of "non-carbon concentrate processes" at a gold mine ore processing and production facility, as defined in §63.11651.

(1) An affected source is existing if you commenced construction or reconstruction of the affected source on or before April 28, 2010.

(2) An affected source is new if you commenced construction or reconstruction of the affected source after April 28, 2010.

(c) This subpart does not apply to research and development facilities, as defined in section 112(c)(7) of the Clean Air Act (CAA).

(d) If you own or operate a source subject to this subpart, you must have or you must obtain a permit under 40 CFR part 70 or 40 CFR part 71.

§40 CFR 63.11651..... What definitions apply to this subpart?

Terms used in this subpart are defined in the Clean Air Act, in §63.2, and in this section as follows:

Autoclave *means a pressure oxidation vessel that is used to treat gold ores (primarily sulfide refractory ore) and involves pumping a slurry of milled ore into the vessel which is highly pressurized with oxygen and heated to temperatures of approximately 350° to 430 °F.*

Calomel-based mercury control system *means a mercury emissions control system that uses scrubbers to remove mercury from the gas stream of a roaster or combination of roasters by complexing the mercury from the gas stream with mercuric chloride to form mercurous chloride (calomel). These scrubbers are also referred to as "mercury scrubbers."*

Carbon adsorber *means a control device consisting of a single fixed carbon bed, multiple carbon beds or columns, carbon filter packs or modules, and other variations that uses activated carbon to remove pollutants from a gas stream.*

Carbon kiln *means a kiln or furnace where carbon is regenerated by heating, usually in the presence of steam, after the gold has been stripped from the carbon.*

Carbon processes with mercury retorts *means the affected source that includes carbon kilns, preg tanks, electrowinning cells, mercury retorts, and melt furnaces at gold mine ore processing and production facilities that use activated carbon, or resins that can be used as a substitute for activated carbon, to recover (adsorb) gold from the pregnant cyanide solution.*

Carbon processes without mercury retorts *means the affected source that includes carbon kilns, preg tanks, electrowinning cells, and melt furnaces, but has no retorts, at gold mine ore processing and production facilities that use activated carbon, or resins that can be used as a substitute for activated carbon, to recover (adsorb) gold from the pregnant cyanide solution.*

Concentrate *means the sludge-like material that is loaded with gold along with various other metals (such as silver, copper, and mercury) and various other substances, that is produced by electrowinning, the Merrill-Crowe process, flotation and gravity separation processes. Concentrate is measured as the input to mercury retorts, or for facilities without mercury retorts, as the input to melt furnaces before any drying takes place. For facilities without mercury retorts or melt furnaces, concentrate is measured as the quantity shipped.*

Deviation *means any instance where an affected source subject to this subpart, or an owner or operator of such a source:*

(1) Fails to meet any requirement or obligation established by this subpart, including but not limited to any emissions limitation or work practice standard;

(2) Fails to meet any term or condition that is adopted to implement an applicable requirement in this subpart and that is included in the operating permit for any affected source required to obtain such a permit; or

(3) Exceeds any operating limit established under this subpart.

Electrowinning *means a process that uses induced voltage on anode and cathode plates to remove metals from the continuous flow of solution, where the gold in solution is plated onto the cathode. Steel wool is typically used as the plating surface.*

Electrowinning Cells *means a tank in which the electrowinning takes place.*

Gold mine ore processing and production facility *means any industrial facility engaged in the processing of gold mine ore that uses any of the following processes: Roasting operations, autoclaves, carbon kilns, preg tanks, electrowinning, mercury retorts, or melt furnaces. Laboratories (see CAA section 112(c)(7)), individual prospectors, and very small pilot scale mining operations that processes or produces less than 100 pounds of concentrate per year are not a gold mine ore processing and production facility. A facility that produces primarily metals other than gold, such as copper, lead, zinc, or nickel (where these metals other than gold comprise 95 percent or more of the total metal production) that may also recover some gold as a byproduct is not a gold mine ore processing and production facility. Those facilities whereby 95 percent or more of total mass of metals produced are metals other than gold, whether final metal production is onsite or offsite, are not part of the gold mine ore processing and production source category.*

Melt furnace *means a furnace (typically a crucible furnace) that is used for smelting the gold-bearing material recovered from mercury retorting, or the gold-bearing material from electrowinning, the Merrill-Crowe process, or other processes for facilities without mercury retorts.*

Mercury retort *means a vessel that is operated under a partial vacuum at approximately 1,100° to 1,300 °F to remove mercury and moisture from the gold bearing sludge material that is recovered from electrowinning, the Merrill-Crowe process, or other processes. Mercury retorts are usually equipped with condensers that recover liquid mercury during the processing.*

Merrill-Crowe process *means a precipitation technique using zinc oxide for removing gold from a cyanide solution. Zinc dust is added to the solution, and gold is precipitated to produce a concentrate.*

Non-carbon concentrate processes *means the affected source that includes mercury retorts and melt furnaces at gold mine ore processing and production facilities that use the Merrill-Crowe process or other processes and do not use carbon (or resins that substitute for carbon) to recover (adsorb) gold from the pregnant cyanide solution.*

Ore dry grinding *means a process in which the gold ore is ground and heated (dried) prior to additional preheating or prior to entering the roaster.*

Ore preheating *means a process in which ground gold ore is preheated prior to entering the roaster.*

Ore pretreatment processes *means the affected source that includes roasting operations and autoclaves that are used to pre-treat gold mine ore at gold mine ore processing and production facilities prior to the cyanide leaching process.*

Pregnant solution tank (or preg tank) *means a storage tank for pregnant solution, which is the cyanide solution that contains gold-cyanide complexes that is generated from leaching gold ore with cyanide solution.*

Pregnant cyanide solution *means the cyanide solution that contains gold-cyanide complexes that are generated from leaching gold ore with a dilute cyanide solution.*

Quenching *means a process in which the hot calcined ore is cooled and quenched with water after it leaves the roaster.*

Roasting operation *means a process that uses an industrial furnace in which milled ore is combusted across a fluidized bed to oxidize and remove organic carbon and sulfide mineral grains in refractory gold ore. The emissions points of the roasting operation subject to this subpart include ore dry grinding, ore preheating, the roaster stack, and quenching.*

Because the permittee will own or operate a gold mine ore processing and production facility at an area source of HAP, requirements in Subpart EEEEEEE are applicable. The collection of ore pretreatment processes and the carbon process with mercury retort are affected sources. Ore pretreatment processes include the autoclave (AC). Carbon processes with mercury retort include the electrowinning cells and pregnant solution tank (EW), the mercury retort (MR), induction melting furnace (MF), and the carbon regeneration kiln (CKD).

Any source subject to 40 CFR 63, Subpart EEEEEEE is a Tier I source as defined in IDAPA 58.01.01.006.122.c. In accordance with IDAPA 58.01.01.313.01.b., the permittee must submit a complete application to DEQ for an initial Tier I operating permit within 12 months of becoming a Tier I source.

This subpart includes mercury emissions limits for the collection of new ore pretreatment processes and for the new carbon processes with mercury retort. This subpart also requires weight measurement devices for measuring ore throughput for the autoclave (AC) and mineral-bearing solution throughput for the electrowinning cells and pregnant solution tank (EW). Requires monitoring of mercury emissions, and monitoring of either inlet gas temperature for each process unit with a carbon filter (EW, MR, MF, CKD) or both water flow and pressure drop for each process unit with a wet scrubber not followed by a carbon filter (AC).

40 CFR 63, Subpart EEEEEEE is incorporated by reference into Permit Condition 2.22, and specific applicable requirements will be incorporated into the Tier I operating permit.

Permit Conditions Review

This section describes the permit conditions for this initial permit.

Permit Conditions 1.1–1.2 describe the purpose of this permitting action and the emission sources and the control equipment regulated by this permit. This reflects information presented in the application and relied upon in the development of emissions inventories, and in the evaluation of ambient air impacts in the modeling analyses. Refer to the Emissions Inventories and the Ambient Air Quality Impact Analyses sections for additional information concerning these analyses.

Because specific vendor and manufacturer information was unavailable at the time of permitting, documentation and testing requirements were included (Permit Condition 2.20) to verify consistency with the information specified in the application. Production values and limits were based on process flow diagrams and engineering design information provided.

Permit Conditions 2.1–2.8 incorporate fugitive dust emission limits and control requirements as required by IDAPA 58.01.01.650-651. Compliance is ensured by implementing reasonable control precautions and corrective actions when appropriate, excluding public access to operations, and complying with inspection, monitoring, recordkeeping, and notification requirements. Specific precautions are identified and required in the fugitive dust control plan (FDCP), and specific measures to control public access within the operations boundary are identified in and required by the Access Management Plan (AMP; Permit Conditions 2.6 and 2.7, respectively). A trigger level for haul roads was also established requiring employment of control measures (Permit Condition 2.5).

Reduction of PM emissions from each of the identified conveyors by 80% was supported by assuming location of these material transfers at below grade (OC9, OC10) or enclosure on all sides (OC11). Reduction of PM emissions from haul roads by a combined 93.3% was supported by assuming appropriate application of water and magnesium chloride dust suppression; DEQ is cognizant that to consistently achieve this level of control requires conscientious efforts, vigilant inspection and monitoring, and a comprehensive FDCP. Because continuous operation was proposed, suppression measures will need to account for and accommodate all weather conditions including diurnal and seasonal variability, and all traffic loads including mining and public traffic along publicly accessible roads. Conditions outside of what may normally be anticipated may require additional measures such as a reduction in vehicle speeds or selection of a more effective chemical dust suppressant. Although the FDCP specifies a minimum of efforts required, additional operational limits and monitoring are to be considered moving forward and evaluated for incorporation into the FDCP. Certification of employees for visible emissions inspection, training and orientation of relevant employees, and periodic evaluation of FDCP requirements are also required.

Access control measures are described in the Ambient Air Boundary section of the application (Section 5.6), and address primary access points, secondary access points, and surveillance.

Permit Conditions 2.9–2.12 incorporate visible emission limits and control requirements (Permit Condition 2.9) in accordance with IDAPA 58.01.01.625. Compliance is ensured by implementing corrective actions when appropriate and complying with inspection, monitoring, and recordkeeping requirements. Certification of employees for visible emissions inspection is also required.

Permit Condition 2.13 is listed as reserved to ensure the integrity of the permit numbering. The process weight rate permit condition has been removed because as discussed previously in the Process Weight section, compliance has been demonstrated with the process weight rule.

Permit Conditions 2.14–2.15 incorporate odorous emission limits in accordance with IDAPA 58.01.01.776.01. Compliance is ensured by complying with monitoring and recordkeeping requirements, including corrective action when appropriate.

Permit Conditions 2.16–2.17 incorporate sulfur content limits for distillate fuel oil, in accordance with IDAPA 58.01.01.725. Compliance is ensured by complying with monitoring and recordkeeping requirements.

Permit Conditions 2.18–2.19 limit facility-wide gasoline fuel throughput. Limiting gasoline throughput limits PTE, ensures avoidance of Subpart CCCCCC requirements applicable to GDF exceeding 100,000 gal/mo, and requires recordkeeping in accordance with 40 CFR 63.11111(e). Compliance is ensured by complying with monitoring and recordkeeping requirements.

Permit Conditions 2.20–2.21 require developing and complying with the requirements of an O&M manual to ensure compliance with control equipment maintenance and operation general provisions (Permit Condition 7.2). Documentation of as-built process equipment specifications and control equipment performance guarantees and establishing control equipment operating parameters and procedures were required, since these were relied upon in the development of emissions inventories, and in the evaluation of ambient air impacts in the modeling analyses. Compliance is ensured by complying with monitoring and recordkeeping requirements.

Permit Condition 2.22 incorporates applicable general compliance, notification, recordkeeping, reporting, general provisions, and other federal requirements by reference in accordance with IDAPA 58.01.01.107.03 and 590-591. Compliance is ensured by complying with applicable federal testing, monitoring, recordkeeping, and reporting requirements. In the event there is a conflict between the subparts and/or emission sources listed (Permit Condition 2.22), the federal requirements shall apply.

With regard to permit conditions referenced in accordance with federal requirements (i.e., NSPS and NESHAP requirements), should there be a conflict between the language of the permit condition and the language of the requirement, the language of the requirement shall govern. Refer to NSPS Applicability (40 CFR 60) and MACT/GACT Applicability (40 CFR 63) sections for additional information concerning applicable requirements.

Permit Conditions 2.23–2.24 require notification upon becoming a Tier I source and require the permittee to obtain a Tier I operation permit within 12 months of commencement of operation of any ore concentration and refining equipment (i.e., NESHAP Subpart EEEEEEE-affected sources) in accordance with IDAPA 58.01.01.313.01.b.

Permit Condition 2.25 specifies recommended test methods to be used when performance testing is required, unless otherwise specified in the permit, in accordance with IDAPA 58.01.01.157. The permittee is required to comply with notification and reporting requirements and is encouraged to submit performance test protocol to DEQ for approval prior to any performance testing in accordance with the performance testing general provisions (Permit Condition 7.7–7.9).

Permit Condition 2.26 provides DEQ agency contact information.

Permit Conditions 3.1–3.2 describe mining and ore processing equipment and controls. This reflects information presented in the application and relied upon in the development of emissions inventories, and in the evaluation of ambient air impacts in the modeling analyses.

Permit Conditions 3.3–3.9 establish limits on material throughput and production. These limits were relied upon in the development of emissions inventories and in the evaluation of ambient air impacts in the modeling analyses. Overall mine throughput is limited by hauling and excavating limits including T-RACT control measures (Permit Conditions 3.5 and 3.6). Compliance is ensured by complying with monitoring and recordkeeping requirements (Permit Conditions 3.14–3.20).

Permit Conditions 3.10 and 3.12 require measures to include in the FDCP to control fugitive emissions. Use of reasonable controls were relied upon in the development of emissions inventories and in the evaluation of ambient air impacts in the modeling analyses. Compliance is ensured by complying with fugitive dust monitoring and recordkeeping requirements (Permit Conditions 2.1–2.8).

Permit Conditions 3.11 and 3.13 establish a drilling rigs dust control system and a haul road capping plan. Use of these controls in the T-RACT analysis were relied upon in the evaluation of ambient air impacting in the modeling analyses. Compliance is ensured by complying with monitoring and recordkeeping requirements (Permit Conditions 3.11 and 3.13).

Permit Conditions 4.1–4.2 describe ore concentration and refining equipment and controls. This reflects information presented in the application and relied upon in the development of emissions inventories, and in the evaluation of ambient air impacts in the modeling analyses.

Permit Condition 4.3, and 4.33–4.34 establish emissions limits for ore concentration and refining equipment, consistent with estimates relied upon in the development of emissions inventories and in the evaluation of ambient air impacts in the modeling analyses for these sources. A sulfuric acid emission limit consistent with the modeled TAP emission rate from the autoclave was established in accordance with IDAPA 58.01.01.210.08. Compliance is ensured by complying with equipment operating and testing requirements (Permit Conditions 4.5–4.17, and 4.33–4.34).

Permit Conditions 4.4, 4.5–4.6, 4.7–4.12 and 4.18–4.25 limit operations of ore concentration and refining process equipment, consistent with the hours of operation, reagent usage, and material throughput assumptions relied upon in the development of emissions inventories and in the evaluation of ambient air impacts in the modeling analyses for these sources. Compliance is ensured by complying with monitoring and recordkeeping requirements (Permit Conditions 4.18–4.25). Cyanide is consumed, recycled, and destroyed in the process, and cyanide HAP emissions (and emission factors) dependent upon leachant concentration and basicity. Monitoring of these parameters was established to ensure that emissions do not exceed 10 T/yr of cyanide HAP to avoid classification as a HAP major source. Re-classification as a major source would affect NSPS and NESHAP applicability determinations, such as Subpart AAAAA as discussed in the NESHAP Applicability (40 CFR 61) section.

Permit Conditions 4.13–4.17 and 4.26–4.32 require control equipment for ore concentration and refining processes, consistent with controls relied upon in the development of emissions inventories and in the evaluation of ambient air impacts in the modeling analyses. Compliance is ensured by complying with monitoring and recordkeeping requirements (Permit Conditions 4.26–4.32).

Permit Condition 4.33 and 4.34 require testing of ore concentration and refining emission sources to demonstrate compliance with emissions limits (Permit Condition 4.3).

Permit Conditions 5.1–5.2 describe lime, aggregate, and concrete production equipment and controls. This reflects information presented in the application and relied upon in the development of emissions inventories, and in the evaluation of ambient air impacts in the modeling analyses.

Permit Condition 5.3 establishes emissions limits for lime, aggregate, and concrete production equipment, consistent with estimates relied upon in the development of emissions inventories and in the evaluation of ambient air impacts in the modeling analyses for these sources. Compliance is ensured by complying with equipment operating requirements (Permit Conditions 5.4–5.15).

Permit Conditions 5.4–5.9 and 5.17–5.22 limit operations of each lime, aggregate, and concrete production process equipment, consistent with material throughput assumptions relied upon in the development of emissions inventories and in the evaluation of ambient air impacts in the modeling analyses for these sources. Compliance is ensured by complying with monitoring and recordkeeping requirements (Permit Conditions 5.15–5.20).

Permit Conditions 5.10–5.11 require measures to include in the FDCP to control fugitive emissions. Use of water sprays, building enclosures, and reasonable controls were relied upon in the development of emissions inventories and in the evaluation of ambient air impacts in the modeling analyses. Compliance is ensured by complying with fugitive dust monitoring and recordkeeping requirements (Permit Conditions 2.1–2.8).

Permit Conditions 5.12–5.16 and 5.23–5.26 require control equipment for lime, aggregate, and concrete production processes, consistent with controls relied upon in the development of emissions inventories and in the evaluation of ambient air impacts in the modeling analyses. Compliance is ensured by complying with monitoring and recordkeeping requirements (Permit Conditions 5.23–5.26).

Permit Condition 6.1 describes the emergency power generation equipment. This reflects information presented in the application and relied upon in the development of emissions inventories, and in the evaluation of ambient air impacts in the modeling analyses.

Permit Conditions 6.2, 6.3, and 6.5 limit operations of each emergency power generation engine, consistent with the purpose and hours of operation assumptions relied upon in the development of emissions inventories, in the determination of federal regulatory applicability, and in the evaluation of ambient air impacts in the modeling analyses for these sources. Compliance is ensured by complying with monitoring, recordkeeping, and notification requirements (Permit Conditions 6.4, 6.6–6.7).

Permit Condition 7.1, the duty to comply general compliance provision, requires that the permittee comply with all of the permit terms and conditions pursuant to Idaho Code §39-101.

Permit Condition 7.2, the maintenance and operation general compliance provision, requires that the permittee maintain and operate all treatment and control facilities at the facility in accordance with IDAPA 58.01.01.211.

Permit Condition 7.3, the obligation to comply general compliance provision, specifies that no permit condition is intended to relieve or exempt the permittee from compliance with applicable state and federal requirements, in accordance with IDAPA 58.01.01.212.01.

Permit Condition 7.4, the inspection and entry provision, requires that the permittee allow DEQ inspection and entry pursuant to Idaho Code §39-108.

Permit Condition 7.5, the permit expiration construction and operation provision, specifies that the permit expires if construction has not begun within two years of permit issuance or if construction has been suspended for a year in accordance with IDAPA 58.01.01.211.02.

Permit Condition 7.6, the notification of construction and operation provision, requires that the permittee notify DEQ of the dates of construction and operation, in accordance with IDAPA 58.01.01.211.01 and 211.03.

Permit Condition 7.7, the performance testing notification of intent provision, requires that the permittee notify DEQ at least 15 days prior to any performance test to provide DEQ the option to have an observer present, in accordance with IDAPA 58.01.01.157.03.

Permit Condition 7.8, the performance test protocol provision, requires that any performance testing be conducted in accordance with the procedures of IDAPA 58.01.01.157 and encourages the permittee to submit a protocol to DEQ for approval prior to testing.

Permit Condition 7.9, the performance test report provision, requires that the permittee report any performance test results to DEQ within 60 days of completion, in accordance with IDAPA 58.01.01.157.04-05.

Permit Condition 7.10, the monitoring and recordkeeping provision, requires that the permittee maintain sufficient records to ensure compliance with permit conditions, in accordance with IDAPA 58.01.01.211.

Permit Condition 7.11, the excess emissions provision, requires that the permittee follow the procedures required for excess emissions events, in accordance with IDAPA 58.01.01.130-136.

Permit Condition 7.12, the certification provision, requires that a responsible official certify all documents submitted to DEQ, in accordance with IDAPA 58.01.01.123.

Permit Condition 7.13, the false statement provision, requires that no person make false statements, representations, or certifications, in accordance with IDAPA 58.01.01.125.

Permit Condition 7.14, the tampering provision, requires that no person render inaccurate any required monitoring device or method, in accordance with IDAPA 58.01.01.126.

Permit Condition 7.15, the transferability provision, specifies that this permit to construct is transferable, in accordance with the procedures of IDAPA 58.01.01.209.06.

Permit Condition 7.16, the severability provision, specifies that permit conditions are severable, in accordance with IDAPA 58.01.01.211.

PUBLIC REVIEW

Public Comment Opportunity

An opportunity for public comment period on the application was provided in accordance with IDAPA 58.01.01.209.01.c. During this time, there was a request for a public comment period on DEQ's proposed action. Refer to the Application Chronology for public comment opportunity dates.

Public Comment Period

Comment periods were made available to the public in accordance with IDAPA 58.01.01.209.01.c. An initial comment period and extension were provided to address the initial application and proposed action (i.e., permit and technical statement of basis), and a second comment period was provided to address updates to the proposed action resulting from a HAP/TAP application addendum[2] submitted by PRI that included new HAP and TAP emission estimates, additional information and discussion supporting HAP and TAP emission estimates, new and updated TAP increment compliance demonstrations which included particulate TAP emissions from fugitive sources, and a source-by-source inventory of HAP and TAP emissions. A third comment period was provided to address updates to the proposed action resulting from a lime plant source status determination[8] and a HAP/TAP application addendum[9] submitted by PRI that includes a T-RACT analysis and proposed control measures. During this time, comments were submitted in response to DEQ's proposed action. Refer to the Application Chronology for the dates of each public comment period.

A response to public comments document has been crafted by DEQ based on comments submitted during each public comment period. That document is part of the final permit package for this permitting action.

APPENDIX A – EMISSIONS INVENTORIES

Facility Wide Potential to Emit Emission Inventory

Table 8. POTENTIAL TO EMIT FOR NSR REGULATED POLLUTANTS

Emissions	PM	PM10	PM2.5	CO	Pb	NO2	VOC	SO2	CO2e
Unit	T/yr	T/yr	T/yr	T/yr	T/yr	T/yr	T/yr	T/yr	T/yr
Process & Ancillary Point Sources									
LS1L	2.2E-3	7.4E-4	1.1E-4		--				--
MillS2L	2.2E-3	7.4E-4	1.1E-4		--				--
Sb1	0.09	0.09	0.09	0.98	--	1.69	0.10	0.21	1,658
Sb2	0.52	0.52	0.52		--				--
AC	22.23	22.23	22.23		--			2.86	47,316
ACB	2.0E-3	2.0E-3	2.0E-3	0.02	--	0.04	2.2E-3	4.4E-3	35.49
ACS1L	8.7E-3	3.0E-3	4.4E-4		--				--
ACS2L	8.7E-3	3.0E-3	4.4E-4		--				--
ACS3L	8.7E-3	3.0E-3	4.4E-4		--				--
ACS4L	4.3E-3	1.5E-3	2.2E-4		--				--
CKD	1.84	1.84	1.84	0.53	--	0.05	0.48		--
CKB	0.08	0.08	0.08	0.81	--	1.40	0.09	0.17	1,375
EW	0.31	0.31	0.31		--				--
MR	6.2E-3	6.2E-3	6.2E-3		--				--
MF	0.89	0.89	0.89		--				--
EDG1	0.02	0.02	0.02	0.39	--	0.71	0.14	7.2E-4	76.79
EDG2	0.02	0.02	0.02	0.39	--	0.71	0.14	7.2E-4	76.79
EDG3	0.02	0.02	0.02	0.39	--	0.71	0.14	7.2E-4	76.79
EDFP	4.4E-3	4.4E-3	4.4E-3	0.08	--	0.09	0.09	1.4E-4	15.36
PV	3.4E-3	3.4E-3	3.4E-3	0.04	--	0.06	3.8E-3	7.6E-3	60.95
HS	0.17	0.17	0.17	1.80	--	3.11	0.19	0.38	3,048
H1M	0.13	0.13	0.13	1.44	--	2.49	0.15	0.30	2,438
H2M	0.13	0.13	0.13	1.44	--	2.49	0.15	0.30	2,438
HM	0.13	0.13	0.13	1.44	--	2.49	0.15	0.30	2,438
HAC	8.4E-3	8.4E-3	8.4E-3	0.09	--	0.16	9.6E-3	0.02	152
HR	8.4E-3	8.4E-3	8.4E-3	0.09	--	0.16	9.6E-3	0.02	152
HA	8.4E-3	8.4E-3	8.4E-3	0.09	--	0.16	9.6E-3	0.02	152
HMO	0.02	0.02	0.02	0.18	--	0.31	0.02	0.04	305
HTS	0.07	0.07	0.07	0.72	--	1.24	0.08	0.15	1,219
HW	0.10	0.10	0.10	1.08	--	1.87	0.11	0.23	1,829
PSL	0.07	0.03	3.9E-3		--				--
CS1L	0.03	0.01	1.5E-3		2.2E-5				--
CS2L	0.03	0.01	1.5E-3		2.2E-5				--
TG1					--		0.96		--
TG2					--		0.96		--
TD3					--		7.3E-3		--
TD4					--		7.3E-3		--
TD5					--		7.3E-3		--
TD6					--		7.3E-3		--
TD7					--		7.3E-3		--
TD8					--		7.3E-3		--
TD9					--		7.3E-3		--
TD10					--		7.3E-3		--
LS6	0.48	0.17	0.03		--				--
LSBM	6.42	5.39	1.92		--				--
LS9	0.12	0.05	7.0E-3		--				--
LK	3.40	3.40	3.40	11.78	--	6.29		0.03	30,311
LKC	0.63	0.63	0.63	6.72	--	11.65	0.72	1.42	11,407
LCR	1.06	0.89	0.32		--				--
LSL	0.02	0.02	0.02		--				--

Midas Gold - Stibnite Gold Project
IDEQ - Emission Inventory

Facility Wide Potential to Emit Emission Inventory

Table 8. POTENTIAL TO EMIT FOR NSR REGULATED POLLUTANTS

Emissions	PM	PM10	PM2.5	CO	Pb	NO2	VOC	SO2	CO2e
Unit	T/yr	T/yr	T/yr	T/yr	T/yr	T/yr	T/yr	T/yr	T/yr
Process & Ancillary Fugitive Sources									
OC1	0.64	0.21	0.06		5.1E-6				--
OC2	0.64	0.21	0.06		5.1E-6				--
OC3	0.64	0.21	0.06		5.1E-6				--
OC4	0.64	0.21	0.06		5.1E-6				--
OC5	0.64	0.21	0.06		5.1E-6				--
OC6	0.64	0.21	0.06		5.1E-6				--
OC7	5.48	2.46	0.46		4.4E-5				--
OC8	0.64	0.21	0.06		5.1E-6				--
OC9	3.02	1.11	0.17		2.4E-5				--
OC10	3.02	1.11	0.17		2.4E-5				--
OC11	3.02	1.11	0.17		2.4E-5				--
OC12	6.04	2.72	0.50		4.8E-5				--
OC13	0.71	0.23	0.07		5.6E-6				--
LS1U	0.01	6.1E-3	9.2E-4		--				--
MillS2U	0.01	6.1E-3	9.2E-4		--				--
ACS1U	0.04	0.02	3.5E-3		--				--
ACS2U	0.04	0.02	3.5E-3		--				--
ACS3U	0.04	0.02	3.5E-3		--				--
ACS42U	0.02	0.01	1.8E-3		--				--
PSU	0.07	0.03	3.9E-3		--				--
CS1U	0.14	0.08	0.01		--				--
CS2U	0.14	0.08	0.01		--				--
CAL	1.73	0.83	0.13		--				--
CAU	1.73	0.83	0.13		--				--
CM	0.55	0.17	0.02		1.1E-5				--
PCSP1	2.74	1.02	0.13		--				--
PCSP2	2.74	1.02	0.13		--				--
LS1	0.48	0.17	0.03		--				--
LS2	0.86	0.38	0.06		--				--
LS3	3.97	1.38	0.21		--				--
LS4	0.86	0.38	0.06		--				--
LS5	3.97	1.38	0.21		--				--
LS7	0.48	0.17	0.03		--				--
LS8	0.48	0.17	0.03		--				--
LS10	0.12	0.05	7.0E-3		--				--
LS11	1.03	0.36	0.05		--				--
LS12	0.12	0.05	7.0E-3		--				--
LSU	2.3E-3	2.3E-3	2.3E-3		--				--
Mining Fugitive Sources Model Scenario: W3									
YPP	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
HFP	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
WEP	345	162	14.53	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
BT	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
TSF	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
UGEXP	1.5E-3	7.3E-4	1.1E-4	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
YPPBL	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
HFPBL	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
WEPBL	117	61.02	3.52	636		17.08	0.0E+0	0.03	
BTBL	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
STKP	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
FDRSF	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
HFDRSF	52.91	10.42	5.52	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
YPDRSF	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
WEDRSF	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
HR	3,047	751	75.12	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
ACCRD	6.95	1.72	0.17	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
Totals	**3,656**	**1,042**	**135**	**666**	**2.6E-4**	**54.93**	**4.78**	**6.51**	**106,580**

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 1 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emissions	DATE: December 18, 2020

Model Scenario W3

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	HAP/TAP	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
106-99-0	1,3-Butadiene	8.4E-07	3.7E-06	0	0	0	0	8.4E-07	3.7E-06	Y	Y
91-57-6	2-Methylnaphthalene	1.1E-06	4.6E-06	0	0	0	0	1.1E-06	4.6E-06	Y	N
56-49-5	3-Methylchloranthrene	7.8E-08	3.4E-07	0	0	0	0	7.8E-08	3.4E-07	Y	Y
57-97-6	7,12-Dimethylbenz(a)anthracene	7.6E-07	3.0E-06	0	0	0	0	7.6E-07	3.0E-06	Y	N
83-32-9	Acenaphthene	5.7E-06	7.1E-06	0	0	0	0	5.7E-06	7.1E-06	Y	N
208-96-8	Acenaphthylene	1.1E-05	1.4E-05	0	0	0	0	1.1E-05	1.4E-05	Y	N
75-07-0	Acetaldehyde	2.5E-05	1.1E-04	0	0	0	0	2.5E-05	1.1E-04	Y	Y
107-02-8	Acrolein	1.6E-05	2.0E-05	0	0	0	0	1.6E-05	2.0E-05	Y	Y
120-12-7	Anthracene	1.7E-06	2.4E-06	0	0	0	0	1.7E-06	2.4E-06	Y	N
7440-36-0	Antimony	0	0	5.7E-04	2.5E-03	1.9E-02	8.2E-02	1.9E-02	8.5E-02	Y	Y
7440-38-2	Arsenic	8.7E-06	3.8E-05	4.5E-03	2.0E-02	0.54	2.38	0.55	2.40	Y	Y
56-55-3	Benz(a)anthracene	3.1E-07	1.4E-06	0	0	0	0	3.1E-07	1.4E-06	Y	Y
71-43-2	Benzene	3.6E-04	1.6E-03	7.0E-03	3.1E-02	0	0	7.4E-03	3.2E-02	Y	Y
50-32-8	Benzo(a)pyrene	1.4E-07	6.1E-07	0	0	0	0	1.4E-07	6.1E-07	Y	Y
205-99-2	Benzo(b)fluoranthene	4.4E-07	1.9E-06	0	0	0	0	4.4E-07	1.9E-06	Y	Y
191-24-2	Benzo(g,h,i)perylene	7.5E-07	1.1E-06	0	0	0	0	7.5E-07	1.1E-06	Y	N
207-08-9	Benzo(k)fluoranthene	1.5E-07	6.6E-07	0	0	0	0	1.5E-07	6.6E-07	Y	Y
7440-41-7	Beryllium	5.2E-07	2.3E-06	4.3E-04	1.9E-03	2.6E-03	1.1E-02	3.0E-03	1.3E-02	Y	Y
92-52-4	Biphenyl	0	0	4.4E-05	1.9E-04	0	0	4.4E-05	1.9E-04	Y	Y
7440-43-9	Cadmium	4.8E-05	2.1E-04	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.7E-04	3.8E-03	Y	Y
75-15-0	Carbon Disulfide	0	0	1.4E-02	6.3E-02	0	0	1.4E-02	6.3E-02	Y	Y
7440-47-3	Chromium	6.6E-05	2.7E-04	6.1E-04	2.5E-03	7.3E-03	3.2E-02	8.0E-03	3.5E-02	Y	Y
18540-29-9	Cr (VI)	0	0	3.4E-07	1.5E-06	0	0	3.4E-07	1.5E-06	Y	Y
218-01-9	Chrysene	5.8E-07	2.5E-06	0	0	0	0	5.8E-07	2.5E-06	Y	Y
7440-48-4	Cobalt	4.0E-06	1.6E-05	4.7E-04	2.0E-03	3.3E-03	1.4E-02	3.7E-03	1.6E-02	Y	Y
592-01-8	Cyanide	0	0	0.45	1.99	0	0	0.45	1.99	Y	Y
53-70-3	Dibenzo(a,h)anthracene	1.8E-07	7.7E-07	0	0	0	0	1.8E-07	7.7E-07	Y	Y
106-46-7	Dichlorobenzene	5.7E-05	2.3E-04	0	0	0	0	5.7E-05	2.3E-04	Y	Y
206-44-0	Fluoranthene	5.5E-06	7.0E-06	0	0	0	0	5.5E-06	7.0E-06	Y	N
86-73-7	Fluorene	1.7E-05	2.1E-05	0	0	0	0	1.7E-05	2.1E-05	Y	N
50-00-0	Formaldehyde	3.3E-03	1.5E-02	0	0	0	0	3.3E-03	1.5E-02	Y	Y
110-54-3	Hexane	8.5E-02	0.34	3.1E-02	0.14	0	0	0.12	0.48	Y	Y
7647-01-0	Hydrogen Chloride	0	0	0.99	3.67	0	0	0.99	**3.67**	Y	Y
193-39-5	Indeno(1,2,3-cd)pyrene	2.2E-07	9.6E-07	0	0	0	0	2.2E-07	9.6E-07	Y	Y
7439-92-1	Lead	0	0	4.8E-04	2.1E-03	6.5E-03	2.9E-02	7.0E-03	3.1E-02	Y	N
7439-96-5	Manganese	1.8E-05	7.2E-05	4.6E-03	1.7E-02	0.24	1.07	0.25	1.08	Y	Y
7439-97-6	Mercury	1.2E-05	5.0E-05	6.9E-04	2.9E-03	1.3E-03	5.7E-03	2.0E-03	8.6E-03	Y	N
91-20-3	Naphthalene	1.9E-04	3.1E-04	1.9E-03	8.5E-03	0	0	2.1E-03	8.8E-03	Y	Y
7440-02-0	Nickel	9.1E-05	4.0E-04	4.6E-04	2.0E-03	1.6E-03	7.1E-03	2.2E-03	9.5E-03	Y	Y
85-01-8	Phenanthrene	5.1E-05	6.3E-05	0	0	0	0	5.1E-05	6.3E-05	Y	N
108-95-2	Phenol	0	0	2.4E-04	1.1E-03	0	0	2.4E-04	1.1E-03	Y	Y
7723-14-0	Phosphorus	0	0	5.6E-03	2.3E-02	0.53	2.32	0.54	2.34	Y	Y
129-00-0	Pyrene	5.0E-06	6.6E-06	0	0	0	0	5.0E-06	6.6E-06	Y	N
7782-49-2	Selenium	1.1E-06	4.6E-06	4.1E-04	1.8E-03	3.3E-04	1.4E-03	7.4E-04	3.2E-03	Y	Y
108-88-3	Toluene	5.2E-04	1.1E-03	3.2E-02	0.14	0	0	3.2E-02	0.14	Y	Y
1330-20-7	Xylene	2.5E-04	3.0E-04	3.1E-02	0.14	0	0	3.2E-02	0.14	Y	Y
Total HAP		9.0E-02	0.36	1.58	6.25	1.36	5.95	3.03	12.56		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
TRUE	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
	chk	chk	chk	chk	chk	chk	chk	chk

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary - continued

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	Non-HAP TAP	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
7429-90-5	Aluminum	0	0	0.65	2.58	57.86	253.41	58.50	255.98	N	Y
7440-39-3	Barium	2.1E-04	8.4E-04	6.6E-03	2.7E-02	0.65	2.86	0.66	2.88	N	Y
1317-65-3	Calcium Carbonate	0	0	2.24	8.12	11.41	49.97	13.65	58.09	N	Y
1305-78-8	Calcium Oxide	0	0	0.70	0.95	0	0	0.70	0.95	N	Y
7440-50-8	Copper	4.0E-05	1.6E-04	4.9E-04	2.1E-03	4.1E-03	1.8E-02	4.6E-03	2.0E-02	N	Y
110-82-7	Cyclohexane	0	0	1.0E-03	4.6E-03	0	0	1.0E-03	4.6E-03	N	Y
7783-06-4	Hydrogen Sulfide	0	0	0.90	3.94	0	0	0.90	3.94	N	Y
7439-89-6	Iron	0	0	0.21	0.81	14.83	64.96	15.04	65.77	N	Y
7439-98-7	Molybdenum	5.2E-05	2.1E-04	4.2E-04	1.8E-03	8.1E-04	3.6E-03	1.3E-03	5.6E-03	N	Y
109-66-0	Pentane	0.12	0.50	0	0	0	0	0.12	0.50	N	Y
7440-22-4	Silver	0	0	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.2E-04	3.6E-03	N	Y
7664-93-9	Sulfuric Acid	0	0	2.03	8.89	0	0	2.03	8.89	N	Y
7440-28-0	Thallium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-61-1	Uranium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-62-2	Vanadium	1.1E-04	4.4E-04	7.3E-04	3.0E-03	2.3E-02	1.0E-01	2.4E-02	0.10	N	Y
25551-13-7	Trimethyl benzene	0	0	1.1E-02	4.8E-02	0	0	1.1E-02	4.8E-02	N	Y
7440-33-7	Tungsten	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-66-6	Zinc	1.4E-03	5.5E-03	8.0E-04	3.3E-03	2.9E-02	0.12	3.1E-02	0.13	N	Y
Total Non-HAP TAP		0.13	0.50	6.75	25.40	84.83	371.54	91.71	397.44		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

Conversions
- 2,000 lb/ton
- 8,760 hr/yr
- 24 hr/day

TABLE B1-W3. HAP/TAP Emissions and Exemptions

						MINING										LEACHING	
						Mining Model Scenario W3										*CN Leach/PAX*	
						YPP,HFP,WEP,BT		YPPBL,HFPBL,WEP BL,BTBL		HR000		STKP, FDRSF, HFDRSF, YPDRSF, WEDRSF		TSF,ACCRD,UGEXP			
CAS	HAP/TAP	HAP	TAP			Pits		Blasting		Haul Roads		Stockpiles and DRFS		Tails, Access Road, Exploration		CN Leach and PAX	
	NSPS or NESHAP HAP/TAP -->			*Y*		*7E*	*7E*	*7E*	*7E*	*7E*	*7E*	*7E*	*7E*	*7E*	*7E*	*7E*	*7E*
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				*A/C*	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
106-99-0	1,3-Butadiene	Y	Y	Y	C	0	0	0	0	0	0	0	0	0	0		
91-57-6	2-Methylnaphthalene	Y	N	n/a		0	0	0	0	0	0	0	0	0	0		
56-49-5	3-Methylchloranthrene	Y	Y	Y	C	0	0	0	0	0	0	0	0	0	0		
57-97-6	7,12-Dimethylbenz(a)anthracene	Y	N	n/a		0	0	0	0	0	0	0	0	0	0		
83-32-9	Acenaphthene	Y	N	n/a		0	0	0	0	0	0	0	0	0	0		
208-96-8	Acenaphthylene	Y	N	n/a		0	0	0	0	0	0	0	0	0	0		
75-07-0	Acetaldehyde	Y	Y	Y	C	0	0	0	0	0	0	0	0	0	0		
107-02-8	Acrolein	Y	Y	Y	A	0	0	0	0	0	0	0	0	0	0		
120-12-7	Anthracene	Y	N	n/a		0	0	0	0	0	0	0	0	0	0		
7440-36-0	Antimony	Y	Y	Y	A	1.8E-3	7.9E-3	6.2E-4	2.7E-3	0.016	0.070	2.8E-4	1.2E-3	3.7E-5	1.6E-4		
7440-38-2	Arsenic	Y	Y	Y	C	0.052	0.230	0.018	0.078	0.464	2.033	8.1E-3	0.035	1.1E-3	4.6E-3		
71-43-2	Benzene	Y	Y	Y	C	0	0	0	0	0	0	0	0	0	0		
50-32-8	**Benzo(a)pyrene**	Y	Y	Y	C	0	0	0	0	0	0	0	0	0	0		
56-55-3	**Benz(a)anthracene**	Y	Y	Y	C	0	0	0	0	0	0	0	0	0	0		
205-99-2	**Benzo(b)fluoranthene**	Y	Y	Y	C	0	0	0	0	0	0	0	0	0	0		
207-08-9	**Benzo(k)fluoranthene**	Y	Y	Y	C	0	0	0	0	0	0	0	0	0	0		
218-01-9	**Chrysene**	Y	Y	Y	C	0	0	0	0	0	0	0	0	0	0		
53-70-3	**Dibenzo(a,h)anthracene**	Y	Y	Y	C	0	0	0	0	0	0	0	0	0	0		
193-39-5	**Indeno(1,2,3-cd)pyrene**	Y	Y	Y	C	0	0	0	0	0	0	0	0	0	0		
191-24-2	Benzo(g,h,i)perylene	Y	N	n/a		0	0	0	0	0	0	0	0	0	0		
7440-41-7	Beryllium	Y	Y	Y	C	2.5E-4	1.1E-3	8.6E-5	3.8E-4	2.2E-3	9.8E-3	3.9E-5	1.7E-4	5.1E-6	2.2E-5		
92-52-4	Biphenyl	Y	Y	Y	A	0	0	0	0	0	0	0	0	0	0		
7440-43-9	Cadmium	Y	Y	Y	C	3.9E-5	1.7E-4	1.3E-5	5.9E-5	3.5E-4	1.5E-3	6.0E-6	2.6E-5	7.9E-7	3.5E-6		
75-15-0	Carbon Disulfide	Y	Y	Y	A	0	0	0	0	0	0	0	0	0	0	0.014	0.063
7440-47-3	Chromium	Y	Y	Y	A	7.1E-4	3.1E-3	2.4E-4	1.1E-3	6.3E-3	0.027	1.1E-4	4.8E-4	1.4E-5	6.3E-5		
18540-29-9	Cr (VI)	Y	Y	Y	C	0	0	0	0	0	0	0	0	0	0		
7440-48-4	Cobalt	Y	Y	Y	A	3.1E-4	1.4E-3	1.1E-4	4.7E-4	2.8E-3	0.012	4.8E-5	2.1E-4	6.4E-6	2.8E-5		
592-01-8	Cyanide	Y	Y	Y	A	0	0	0	0	0	0	0	0	0	0	0.453	1.983
106-46-7	Dichlorobenzene	Y	Y	Y	A	0	0	0	0	0	0	0	0	0	0		
206-44-0	Fluoranthene	Y	N	n/a		0	0	0	0	0	0	0	0	0	0		
86-73-7	Fluorene	Y	N	n/a		0	0	0	0	0	0	0	0	0	0		
50-00-0	Formaldehyde	Y	Y	Y	C	0	0	0	0	0	0	0	0	0	0		
110-54-3	Hexane	Y	Y	Y	A	0	0	0	0	0	0	0	0	0	0		
7647-01-0	Hydrogen Chloride	Y	Y	Y	A	0	0	0	0	0	0	0	0	0	0		
7439-92-1	Lead	Y	N	n/a		6.3E-4	2.8E-3	2.1E-4	9.4E-4	5.6E-3	0.024	9.7E-5	4.2E-4	1.3E-5	5.6E-5		
7439-96-5	Manganese	Y	Y	Y	A	0.024	0.103	8.0E-3	0.035	0.208	0.911	3.6E-3	0.016	4.7E-4	2.1E-3		
7439-97-6	Mercury	Y	N	n/a		9.7E-5	4.3E-4	1.6E-5	7.0E-5	4.2E-4	1.8E-3	5.4E-5	2.4E-4	7.2E-4	3.2E-3		
91-20-3	Naphthalene	Y	Y	Y	A	0	0	0	0	0	0	0	0	0	0		
7440-02-0	Nickel	Y	Y	Y	C	1.6E-4	6.9E-4	5.4E-5	2.3E-4	1.4E-3	6.1E-3	2.4E-5	1.1E-4	3.2E-6	1.4E-5		
85-01-8	Phenanthrene	Y	N	n/a		0	0	0	0	0	0	0	0	0	0		
108-95-2	Phenol	Y	Y	Y	A	0	0	0	0	0	0	0	0	0	0		
7723-14-0	Phosphorus	Y	Y	Y	A	0.051	0.224	0.017	0.076	0.452	1.981	7.9E-3	0.034	1.0E-3	4.5E-3		
129-00-0	Pyrene	Y	N	n/a		0	0	0	0	0	0	0	0	0	0		
7782-49-2	Selenium	Y	Y	Y	A	3.1E-5	1.4E-4	1.1E-5	4.7E-5	2.8E-4	1.2E-3	4.8E-6	2.1E-5	6.4E-7	2.8E-6		
108-88-3	Toluene	Y	Y	Y	A	0	0	0	0	0	0	0	0	0	0		
1330-20-7	Xylene	Y	Y	Y	A	0	0	0	0	0	0	0	0	0	0		
7429-90-5	Aluminum	N	Y	N	A	5.585	24.463	1.902	8.332	49.397	216	0.858	3.756	0.113	0.494		
7440-39-3	Barium	N	Y	N	A	0.063	0.276	0.021	0.094	0.557	2.438	9.7E-3	0.042	1.3E-3	5.6E-3		
1317-65-3	Calcium Carbonate	N	Y	N	A	1.101	4.824	0.375	1.643	9.740	42.663	0.169	0.741	0.022	0.097		
1305-78-8	Calcium Oxide	N	Y	N	A	0	0	0	0	0	0	0	0	0	0		
7440-50-8	Copper	N	Y	N	A	3.9E-4	1.7E-3	1.3E-4	5.9E-4	3.5E-3	0.015	6.0E-5	2.6E-4	7.9E-6	3.5E-5		
110-82-7	Cyclohexane	N	Y	N	A	0	0	0	0	0	0	0	0	0	0		
7783-06-4	Hydrogen Sulfide	N	Y	N	A	0	0	0	0	0	0	0	0	0	0		
7439-89-6	Iron	N	Y	N	A	1.432	6.271	0.488	2.136	12.662	55.462	0.220	0.963	0.029	0.127		
7439-98-7	Molybdenum	N	Y	N	A	7.9E-5	3.4E-4	2.7E-5	1.2E-4	7.0E-4	3.0E-3	1.2E-5	5.3E-5	1.6E-6	7.0E-6		
109-66-0	Pentane	N	Y	N	A	0	0	0	0	0	0	0	0	0	0		
7440-22-4	Silver	N	Y	N	A	3.9E-5	1.7E-4	1.3E-5	5.9E-5	3.5E-4	1.5E-3	6.0E-6	2.6E-5	7.9E-7	3.5E-6		
7664-93-9	Sulfuric Acid	N	Y	N	A	0	0	0	0	0	0	0	0	0	0		
7440-28-0	Thallium	N	Y	N	A	7.9E-4	3.4E-3	2.7E-4	1.2E-3	7.0E-3	0.030	1.2E-4	5.3E-4	1.6E-5	7.0E-5		
7440-61-1	Uranium	N	Y	N	A	7.9E-4	3.4E-3	2.7E-4	1.2E-3	7.0E-3	0.030	1.2E-4	5.3E-4	1.6E-5	7.0E-5		
7440-62-2	Vanadium	N	Y	N	A	2.2E-3	9.6E-3	7.5E-4	3.3E-3	0.019	0.085	3.4E-4	1.5E-3	4.4E-5	1.9E-4		
25551-13-7	Trimethyl benzene	N	Y	N	A	0	0	0	0	0	0	0	0	0	0		
7440-33-7	Tungsten	N	Y	N	A	7.9E-4	3.4E-3	2.7E-4	1.2E-3	7.0E-3	0.030	1.2E-4	5.3E-4	1.6E-5	7.0E-5		
7440-66-6	Zinc	N	Y	N	A	2.8E-3	0.012	9.4E-4	4.1E-3	0.024	0.107	4.2E-4	1.9E-3	5.6E-5	2.4E-4		
HAP TOTAL						***0.131***	***0.574***	***0.045***	***0.196***	***1.160***	***5.079***	***0.020***	***0.088***	***3.4E-3***	***0.015***	***0.467***	***2.046***
MERCURY TOTAL (exempt)						***9.7E-5***	***4.3E-4***	***1.6E-5***	***7.0E-5***	***4.2E-4***	***1.8E-3***	***5.4E-5***	***2.4E-4***	***7.2E-4***	***3.2E-3***		
MERCURY TOTAL (non-exempt)						***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***
TAP TOTAL (HAP-TAP addressed by NSPS/NESHAP)						***0.130***	***0.571***	***0.044***	***0.195***	***1.154***	***5.053***	***0.020***	***0.088***	***2.6E-3***	***0.012***	***0.467***	***2.046***
TAP TOTAL (For EL Evaluation)						***8.189***	***35.867***	***2.789***	***12.216***	***72.426***	***317***	***1.257***	***5.508***	***0.165***	***0.724***	***0***	***0***

TABLE B1-W3. HAP/TAP Emissions and Exemptions

CAS	HAP/TAP	HAP	TAP		A/C	PROCESSING AND PRODUCTION											
						Ore Processing				*Ore Concentration and Refining*				*Process Heating*			
						OC1-13		PS		AC		EW,MR,MF,CKD		ACB, CKB, PV, HS		LKC	
						Crushers & Xfers		Prill Silos		Autoclave		EW, Preg Tank, Retort, Furnace, Carbon Kiln		POX Boiler, C. Kiln Comb., Prop. Vap., Sol'n Heater		Lime Kiln Combustion	
	NSPS or NESHAP HAP/TAP -->			*Y*		*7E/LL*	*7E/LL*	*7E*	*7E*	*7E*	*7E*	*7E*	*7E*	*7E*	*7E*	*5A*	*5A*
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->					lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
106-99-0	1,3-Butadiene	Y	Y	Y	C												
91-57-6	2-Methylnaphthalene	Y	N	n/a										1.9E-7	7.6E-7	5.2E-7	1.9E-6
56-49-5	3-Methylchloranthrene	Y	Y	Y	C									1.3E-8	5.7E-8	3.3E-8	1.4E-7
57-97-6	7,12-Dimethylbenz(a)anthracene	Y	N	n/a										1.3E-7	5.1E-7	3.5E-7	1.3E-6
83-32-9	Acenaphthene	Y	N	n/a										1.4E-8	5.7E-8	3.9E-8	1.4E-7
208-96-8	Acenaphthylene	Y	N	n/a										1.4E-8	5.7E-8	3.9E-8	1.4E-7
75-07-0	Acetaldehyde	Y	Y	Y	C												
107-02-8	Acrolein	Y	Y	Y	A												
120-12-7	Anthracene	Y	N	n/a										1.9E-8	7.6E-8	5.2E-8	1.9E-7
7440-36-0	Antimony	Y	Y	Y	A	1.4E-4	5.9E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7440-38-2	Arsenic	Y	Y	Y	C	3.9E-3	0.017			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.5E-6	6.4E-6	3.7E-6	1.6E-5
71-43-2	Benzene	Y	Y	Y	C									1.5E-5	6.7E-5	3.9E-5	1.7E-4
50-32-8	**Benzo(a)pyrene**	Y	Y	Y	C									8.7E-9	3.8E-8	2.2E-8	9.6E-8
56-55-3	**Benz(a)anthracene**	Y	Y	Y	C									1.3E-8	5.7E-8	3.3E-8	1.4E-7
205-99-2	**Benzo(b)fluoranthene**	Y	Y	Y	C									1.3E-8	5.7E-8	3.3E-8	1.4E-7
207-08-9	**Benzo(k)fluoranthene**	Y	Y	Y	C									1.3E-8	5.7E-8	3.3E-8	1.4E-7
218-01-9	**Chrysene**	Y	Y	Y	C									1.3E-8	5.7E-8	3.3E-8	1.4E-7
53-70-3	**Dibenzo(a,h)anthracene**	Y	Y	Y	C									8.7E-9	3.8E-8	2.2E-8	9.6E-8
193-39-5	**Indeno(1,2,3-cd)pyrene**	Y	Y	Y	C									1.3E-8	5.7E-8	3.3E-8	1.4E-7
191-24-2	Benzo(g,h,i)perylene	Y	N	n/a										9.5E-9	3.8E-8	2.6E-8	9.6E-8
7440-41-7	Beryllium	Y	Y	Y	C	1.9E-5	8.2E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	8.7E-8	3.8E-7	2.2E-7	9.6E-7
92-52-4	Biphenyl	Y	Y	Y	A												
7440-43-9	Cadmium	Y	Y	Y	C	2.9E-6	1.3E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	8.0E-6	3.5E-5	2.0E-5	8.8E-5
75-15-0	Carbon Disulfide	Y	Y	Y	A												
7440-47-3	Chromium	Y	Y	Y	A	5.3E-5	2.3E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.1E-5	4.5E-5	3.0E-5	1.1E-4
18540-29-9	Cr (VI)	Y	Y	Y	C												
7440-48-4	Cobalt	Y	Y	Y	A	2.4E-5	1.0E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3	6.6E-7	2.7E-6	1.8E-6	6.8E-6
592-01-8	Cyanide	Y	Y	Y	A					0	0	1.2E-3	5.3E-3				
106-46-7	Dichlorobenzene	Y	Y	Y	A									9.5E-6	3.8E-5	2.6E-5	9.6E-5
206-44-0	Fluoranthene	Y	N	n/a										2.4E-8	9.5E-8	6.5E-8	2.4E-7
86-73-7	Fluorene	Y	N	n/a										2.2E-8	8.9E-8	6.1E-8	2.3E-7
50-00-0	Formaldehyde	Y	Y	Y	C									5.5E-4	2.4E-3	1.4E-3	6.0E-3
110-54-3	Hexane	Y	Y	Y	A									0.014	0.057	0.039	0.145
7647-01-0	Hydrogen Chloride	Y	Y	Y	A												
7439-92-1	Lead	Y	N	n/a		4.7E-5	2.1E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7439-96-5	Manganese	Y	Y	Y	A	1.8E-3	7.7E-3			2.3E-5	1.0E-4	3.8E-4	1.7E-3	3.0E-6	1.2E-5	8.2E-6	3.1E-5
7439-97-6	Mercury	Y	N	n/a		5.6E-6	2.5E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	2.1E-6	8.3E-6	5.6E-6	2.1E-5
91-20-3	Naphthalene	Y	Y	Y	A									4.8E-6	1.9E-5	1.3E-5	4.9E-5
7440-02-0	Nickel	Y	Y	Y	C	1.2E-5	5.2E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.5E-5	6.7E-5	3.9E-5	1.7E-4
85-01-8	Phenanthrene	Y	N	n/a										1.3E-7	5.4E-7	3.7E-7	1.4E-6
108-95-2	Phenol	Y	Y	Y	A												
7723-14-0	Phosphorus	Y	Y	Y	A	3.8E-3	0.017			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
129-00-0	Pyrene	Y	N	n/a										4.0E-8	1.6E-7	1.1E-7	4.0E-7
7782-49-2	Selenium	Y	Y	Y	A	2.4E-6	1.0E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.9E-7	7.6E-7	5.2E-7	1.9E-6
108-88-3	Toluene	Y	Y	Y	A									2.7E-5	1.1E-4	7.3E-5	2.7E-4
1330-20-7	Xylene	Y	Y	Y	A												
7429-90-5	Aluminum	N	Y	N	A	0.418	1.829			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7440-39-3	Barium	N	Y	N	A	4.7E-3	0.021			2.3E-5	1.0E-4	3.8E-4	1.7E-3	3.5E-5	1.4E-4	9.5E-5	3.5E-4
1317-65-3	Calcium Carbonate	N	Y	N	A	0.082	0.361			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
1305-78-8	Calcium Oxide	N	Y	N	A												
7440-50-8	Copper	N	Y	N	A	2.9E-5	1.3E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3	6.7E-6	2.7E-5	1.8E-5	6.8E-5
110-82-7	Cyclohexane	N	Y	N	A												
7783-06-4	Hydrogen Sulfide	N	Y	N	A					0.900	3.942	0	0				
7439-89-6	Iron	N	Y	N	A	0.107	0.469			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7439-98-7	Molybdenum	N	Y	N	A	5.9E-6	2.6E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	8.7E-6	3.5E-5	2.4E-5	8.8E-5
109-66-0	Pentane	N	Y	N	A									0.021	0.083	0.056	0.209
7440-22-4	Silver	N	Y	N	A	2.9E-6	1.3E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7664-93-9	Sulfuric Acid	N	Y	N	A					2.030	8.891	0	0				
7440-28-0	Thallium	N	Y	N	A	5.9E-5	2.6E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7440-61-1	Uranium	N	Y	N	A	5.9E-5	2.6E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7440-62-2	Vanadium	N	Y	N	A	1.6E-4	7.2E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.8E-5	7.3E-5	5.0E-5	1.8E-4
25551-13-7	Trimethyl benzene	N	Y	N	A												
7440-33-7	Tungsten	N	Y	N	A	5.9E-5	2.6E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7440-66-6	Zinc	N	Y	N	A	2.1E-4	9.0E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3	2.3E-4	9.2E-4	6.3E-4	2.3E-3
HAP TOTAL						***9.8E-3***	***0.043***	***0***	***0***	***2.8E-4***	***1.2E-3***	***5.8E-3***	***0.025***	***0.015***	***0.060***	***0.041***	***0.152***
MERCURY TOTAL (exempt)						***5.6E-6***	***2.5E-5***	***0***	***0***	***2.3E-5***	***1.0E-4***	***3.8E-4***	***1.7E-3***	***2.1E-6***	***8.3E-6***	***5.6E-6***	***2.1E-5***
MERCURY TOTAL (non-exempt)						***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***
TAP TOTAL (HAP-TAP addressed by NSPS/NESHAP)						***9.8E-3***	***0.043***	***0***	***0***	***2.3E-4***	***1.0E-3***	***5.0E-3***	***0.022***	***0.015***	***0.060***	***0.041***	***0.152***
TAP TOTAL (For EL Evaluation)						***0.612***	***2.682***	***0***	***0***	***2.930***	***12.835***	***4.6E-3***	***0.020***	***0.021***	***0.084***	***0.057***	***0.212***

TABLE B1-W3. HAP/TAP Emissions and Exemptions

						1	1	1	1	1	1	0	0	0	0	0	0	0	0
						PROCESSING AND PRODUCTION - Continued													
						Lime Production						*Aggregate Prod.*		*Concrete Production*					
						LS1-12,LSBM		LK		LS-L/U,LCR,LS1-L/U,MillS2-L/U,ACS1-4		PCSP1,PCSP2		CM		CS1L,CS1U,CS2L, CS2U		CA-L/U	
CAS	HAP/TAP	HAP	TAP			Limestone Crushers, Screens, Mill, Xfers		Lime Kiln		Lime Silos and Lime Mill Crushing		Portable Crushers, Screens, Xfers		Central Mixer		Cement Silo #1 and #2 L/U		Aggregate Bin	
	NSPS or NESHAP HAP/TAP -->			*Y*		*5A*	*5A*	*5A*	*5A*	*5A*	*5A*	*OOO*	*OOO*					*OOO*	*OOO*
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				**A/C**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
106-99-0	1,3-Butadiene	Y	Y	Y	C														
91-57-6	2-Methylnaphthalene	Y	N	n/a															
56-49-5	3-Methylchloranthrene	Y	Y	Y	C														
57-97-6	7,12-Dimethylbenz(a)anthracene	Y	N	n/a															
83-32-9	Acenaphthene	Y	N	n/a															
208-96-8	Acenaphthylene	Y	N	n/a															
75-07-0	Acetaldehyde	Y	Y	Y	C														
107-02-8	Acrolein	Y	Y	Y	A														
120-12-7	Anthracene	Y	N	n/a															
7440-36-0	Antimony	Y	Y	Y	A	1.4E-5	4.8E-5	2.3E-6	8.5E-6	2.4E-6	3.2E-6	3.1E-6	1.4E-5					3.5E-6	8.6E-6
7440-38-2	Arsenic	Y	Y	Y	C	1.0E-4	4.5E-4	1.8E-5	7.8E-5	6.8E-6	3.0E-5	2.9E-5	1.3E-4	2.0E-6	8.9E-6	1.2E-7	5.1E-7	1.8E-5	7.9E-5
71-43-2	Benzene	Y	Y	Y	C														
50-32-8	**Benzo(a)pyrene**	Y	Y	Y	C														
56-55-3	**Benz(a)anthracene**	Y	Y	Y	C														
205-99-2	**Benzo(b)fluoranthene**	Y	Y	Y	C														
207-08-9	**Benzo(k)fluoranthene**	Y	Y	Y	C														
218-01-9	**Chrysene**	Y	Y	Y	C														
53-70-3	**Dibenzo(a,h)anthracene**	Y	Y	Y	C														
193-39-5	**Indeno(1,2,3-cd)pyrene**	Y	Y	Y	C														
191-24-2	Benzo(g,h,i)perylene	Y	N	n/a															
7440-41-7	Beryllium	Y	Y	Y	C	3.5E-6	1.6E-5	6.2E-7	2.7E-6	2.3E-7	1.0E-6	1.0E-6	4.4E-6	0	0	1.3E-8	5.8E-8	6.3E-7	2.8E-6
92-52-4	Biphenyl	Y	Y	Y	A														
7440-43-9	Cadmium	Y	Y	Y	C	1.1E-6	4.8E-6	1.9E-7	8.5E-7	7.3E-8	3.2E-7	3.1E-7	1.4E-6	4.9E-9	2.1E-8	0	0	2.0E-7	8.6E-7
75-15-0	Carbon Disulfide	Y	Y	Y	A														
7440-47-3	Chromium	Y	Y	Y	A	8.6E-5	2.9E-4	1.4E-5	5.1E-5	1.4E-5	1.9E-5	1.9E-5	8.2E-5	8.7E-7	3.8E-6	7.9E-7	3.5E-6	2.1E-5	5.2E-5
18540-29-9	Cr (VI)	Y	Y	Y	C									1.9E-7	8.1E-7	1.6E-7	7.0E-7		
7440-48-4	Cobalt	Y	Y	Y	A	2.3E-5	7.8E-5	3.7E-6	1.4E-5	3.8E-6	5.1E-6	5.0E-6	2.2E-5					5.5E-6	1.4E-5
592-01-8	Cyanide	Y	Y	Y	A														
106-46-7	Dichlorobenzene	Y	Y	Y	A														
206-44-0	Fluoranthene	Y	N	n/a															
86-73-7	Fluorene	Y	N	n/a															
50-00-0	Formaldehyde	Y	Y	Y	C														
110-54-3	Hexane	Y	Y	Y	A														
7647-01-0	Hydrogen Chloride	Y	Y	Y	A	0	0	0.986	3.666										
7439-92-1	Lead	Y	N	n/a		1.7E-5	5.8E-5	2.7E-6	1.0E-5	2.8E-6	3.9E-6	3.8E-6	1.6E-5	2.5E-7	1.1E-6	3.0E-7	1.3E-6	4.1E-6	1.0E-5
7439-96-5	Manganese	Y	Y	Y	A	1.3E-3	4.6E-3	2.2E-4	8.1E-4	2.2E-4	3.0E-4	3.0E-4	1.3E-3	2.6E-5	1.1E-4	3.2E-6	1.4E-5	3.3E-4	8.2E-4
7439-97-6	Mercury	Y	N	n/a		1.1E-7	3.9E-7	2.8E-4	1.0E-3	1.9E-8	2.6E-8	2.5E-8	1.1E-7					2.8E-8	6.9E-8
91-20-3	Naphthalene	Y	Y	Y	A														
7440-02-0	Nickel	Y	Y	Y	C	2.2E-5	9.7E-5	3.9E-6	1.7E-5	1.5E-6	6.4E-6	6.3E-6	2.7E-5	1.7E-6	7.4E-6	1.1E-6	5.0E-6	3.9E-6	1.7E-5
85-01-8	Phenanthrene	Y	N	n/a															
108-95-2	Phenol	Y	Y	Y	A														
7723-14-0	Phosphorus	Y	Y	Y	A	7.4E-4	2.5E-3	1.2E-4	4.4E-4	1.2E-4	1.7E-4	1.6E-4	7.1E-4	8.2E-6	3.6E-5	0	0	1.8E-4	4.5E-4
129-00-0	Pyrene	Y	N	n/a															
7782-49-2	Selenium	Y	Y	Y	A														
108-88-3	Toluene	Y	Y	Y	A														
1330-20-7	Xylene	Y	Y	Y	A														
7429-90-5	Aluminum	N	Y	N	A	0.129	0.438	0.021	0.077	0.021	0.029	0.028	0.124					0.031	0.078
7440-39-3	Barium	N	Y	N	A	8.3E-4	2.8E-3	1.3E-4	4.9E-4	1.4E-4	1.9E-4	1.8E-4	7.9E-4					2.0E-4	5.0E-4
1317-65-3	Calcium Carbonate	N	Y	N	A	1.567	5.325	0.251	0.935			0.343	1.503						
1305-78-8	Calcium Oxide	N	Y	N	A					0.696	0.952								
7440-50-8	Copper	N	Y	N	A	2.9E-5	9.7E-5	4.6E-6	1.7E-5	4.7E-6	6.4E-6	6.3E-6	2.7E-5					6.9E-6	1.7E-5
110-82-7	Cyclohexane	N	Y	N	A														
7783-06-4	Hydrogen Sulfide	N	Y	N	A														
7439-89-6	Iron	N	Y	N	A	0.059	0.201	9.5E-3	0.035	9.7E-3	0.013	0.013	0.057					0.014	0.036
7439-98-7	Molybdenum	N	Y	N	A	2.9E-6	9.7E-6	4.6E-7	1.7E-6	4.7E-7	6.4E-7	6.3E-7	2.7E-6					6.9E-7	1.7E-6
109-66-0	Pentane	N	Y	N	A														
7440-22-4	Silver	N	Y	N	A	0	0	0	0	0	0	0	0					0	0
7664-93-9	Sulfuric Acid	N	Y	N	A														
7440-28-0	Thallium	N	Y	N	A	2.9E-5	9.7E-5	4.6E-6	1.7E-5	4.7E-6	6.4E-6	6.3E-6	2.7E-5					6.9E-6	1.7E-5
7440-61-1	Uranium	N	Y	N	A	2.9E-5	9.7E-5	4.6E-6	1.7E-5	4.7E-6	6.4E-6	6.3E-6	2.7E-5					6.9E-6	1.7E-5
7440-62-2	Vanadium	N	Y	N	A	8.8E-5	3.0E-4	1.4E-5	5.3E-5	1.5E-5	2.0E-5	1.9E-5	8.5E-5					2.1E-5	5.3E-5
25551-13-7	Trimethyl benzene	N	Y	N	A														
7440-33-7	Tungsten	N	Y	N	A	2.9E-5	9.7E-5	4.6E-6	1.7E-5	4.7E-6	6.4E-6	6.3E-6	2.7E-5					6.9E-6	1.7E-5
7440-66-6	Zinc	N	Y	N	A	1.0E-4	3.5E-4	1.6E-5	6.1E-5	1.7E-5	2.3E-5	2.3E-5	9.9E-5					2.5E-5	6.2E-5
HAP TOTAL						***2.4E-3***	***8.1E-3***	***0.986***	***3.669***	***3.8E-4***	***5.4E-4***	***5.3E-4***	***2.3E-3***	***3.9E-5***	***1.7E-4***	***5.7E-6***	***2.5E-5***	***5.6E-4***	***1.4E-3***
MERCURY TOTAL (exempt)						***1.1E-7***	***3.9E-7***	***2.8E-4***	***1.0E-3***	***1.9E-8***	***2.6E-8***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***
MERCURY TOTAL (non-exempt)						***0***	***0***	***0***	***0***	***0***	***0***	***2.5E-8***	***1.1E-7***					***2.8E-8***	***6.9E-8***
TAP TOTAL (HAP-TAP addressed by NSPS/NESHAP)						***2.3E-3***	***8.1E-3***	***0.986***	***3.668***	***3.7E-4***	***5.4E-4***	***5.2E-4***	***2.3E-3***	***0***	***0***	***0***	***0***	***5.6E-4***	***1.4E-3***
TAP TOTAL (For EL Evaluation)						***1.756***	***5.968***	***0.282***	***1.047***	***0.727***	***0.994***	***0.385***	***1.684***	***3.9E-5***	***1.7E-4***	***5.4E-6***	***2.4E-5***	***0.046***	***0.114***

TABLE B1-W3. HAP/TAP Emissions and Exemptions

						0	0	1	1	1	1			1	1	0	0				
						PROCESSING AND PRODUCTION - Continued						MINING and LEACHING - Totals									
						HVAC		*Emer. Power/Fire*		*Fuel Storage*		*HAP Total*		*Mercury Total*		*Mercury Total*		*TAP Total*		*TAP Total*	
						H1M,H2M,HM, HAC,HR,HA,H MO,HTS,HW		EDG1,EDG2,ED G3,EDFP		TG1,TG2				*Exempt*		*Non-Exempt*		*HAP-TAP addressed by NSPS/NESHAP*		*For EL Evaluation*	
CAS	HAP/TAP	HAP	TAP			Heaters		Emergency Generators and Fire Pump		Gasoline Fuel Tanks											
	NSPS or NESHAP HAP/TAP -->		*Y*					*4Z*	*4Z*	*6C*	*6C*										
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				*A/C*	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
106-99-0	1,3-Butadiene	Y	Y	Y	C			8.4E-7	3.7E-6			0	0					0	0	0	0
91-57-6	2-Methylnaphthalene	Y	N	n/a		4.3E-7	1.9E-6					0	0					0	0	0	0
56-49-5	3-Methylchloranthrene	Y	Y	Y	C	3.2E-8	1.4E-7					0	0					0	0	0	0
57-97-6	7,12-Dimethylbenz(a)anthracene	Y	N	n/a		2.9E-7	1.3E-6					0	0					0	0	0	0
83-32-9	Acenaphthene	Y	N	n/a		3.2E-8	1.4E-7	5.6E-6	6.7E-6			0	0					0	0	0	0
208-96-8	Acenaphthylene	Y	N	n/a		3.2E-8	1.4E-7	1.1E-5	1.3E-5			0	0					0	0	0	0
75-07-0	Acetaldehyde	Y	Y	Y	C			2.5E-5	1.1E-4			0	0					0	0	0	0
107-02-8	Acrolein	Y	Y	Y	A			1.6E-5	2.0E-5			0	0					0	0	0	0
120-12-7	Anthracene	Y	N	n/a		4.3E-8	1.9E-7	1.6E-6	1.9E-6			0	0					0	0	0	0
7440-36-0	Antimony	Y	Y	Y	A							0.019	0.082					0.019	0.082	0	0
7440-38-2	Arsenic	Y	Y	Y	C	3.6E-6	1.6E-5					0.544	2.381					0.544	2.381	0	0
71-43-2	Benzene	Y	Y	Y	C	3.8E-5	1.6E-4	2.7E-4	1.2E-3	7.0E-3	0.031	0	0					0	0	0	0
50-32-8	**Benzo(a)pyrene**	Y	Y	Y	C	2.1E-8	9.4E-8	8.7E-8	3.8E-7			0	0					0	0	0	0
56-55-3	**Benz(a)anthracene**	Y	Y	Y	C	3.2E-8	1.4E-7	2.4E-7	1.0E-6			0	0					0	0	0	0
205-99-2	**Benzo(b)fluoranthene**	Y	Y	Y	C	3.2E-8	1.4E-7	3.6E-7	1.6E-6			0	0					0	0	0	0
207-08-9	**Benzo(k)fluoranthene**	Y	Y	Y	C	3.2E-8	1.4E-7	7.3E-8	3.2E-7			0	0					0	0	0	0
218-01-9	**Chrysene**	Y	Y	Y	C	3.2E-8	1.4E-7	5.0E-7	2.2E-6			0	0					0	0	0	0
53-70-3	**Dibenzo(a,h)anthracene**	Y	Y	Y	C	2.1E-8	9.4E-8	1.2E-7	5.4E-7			0	0					0	0	0	0
193-39-5	**Indeno(1,2,3-cd)pyrene**	Y	Y	Y	C	3.2E-8	1.4E-7	1.4E-7	6.2E-7			0	0					0	0	0	0
191-24-2	Benzo(g,h,i)perylene	Y	N	n/a		2.1E-8	9.4E-8	6.9E-7	8.3E-7			0	0					0	0	0	0
7440-41-7	Beryllium	Y	Y	Y	C	2.1E-7	9.4E-7					2.6E-3	0.011					2.6E-3	0.011	0	0
92-52-4	Biphenyl	Y	Y	Y	A					4.4E-5	1.9E-4	0	0					0	0	0	0
7440-43-9	Cadmium	Y	Y	Y	C	2.0E-5	8.6E-5					4.1E-4	1.8E-3					4.1E-4	1.8E-3	0	0
75-15-0	Carbon Disulfide	Y	Y	Y	A							0.014	0.063					0.014	0.063	0	0
7440-47-3	Chromium	Y	Y	Y	A	2.5E-5	1.1E-4					7.3E-3	0.032					7.3E-3	0.032	0	0
18540-29-9	Cr (VI)	Y	Y	Y	C							0	0					0	0	0	0
7440-48-4	Cobalt	Y	Y	Y	A	1.5E-6	6.6E-6					3.3E-3	0.014					3.3E-3	0.014	0	0
592-01-8	Cyanide	Y	Y	Y	A							0.453	1.983					0.453	1.983	0	0
106-46-7	Dichlorobenzene	Y	Y	Y	A	2.1E-5	9.4E-5					0	0					0	0	0	0
206-44-0	Fluoranthene	Y	N	n/a		5.4E-8	2.4E-7	5.3E-6	6.4E-6			0	0					0	0	0	0
86-73-7	Fluorene	Y	N	n/a		5.0E-8	2.2E-7	1.7E-5	2.1E-5			0	0					0	0	0	0
50-00-0	Formaldehyde	Y	Y	Y	C	1.3E-3	5.9E-3	5.1E-5	2.2E-4			0	0					0	0	0	0
110-54-3	Hexane	Y	Y	Y	A	0.032	0.141			0.031	0.137	0	0					0	0	0	0
7647-01-0	Hydrogen Chloride	Y	Y	Y	A							0	0					0	0	0	0
7439-92-1	Lead	Y	N	n/a								6.5E-3	0.029					0	0	0	0
7439-96-5	Manganese	Y	Y	Y	A	6.8E-6	3.0E-5					0.244	1.067					0.244	1.067	0	0
7439-97-6	Mercury	Y	N	n/a		4.7E-6	2.0E-5					1.3E-3	5.7E-3	1.3E-3	5.7E-3	0	0	0	0	0	0
91-20-3	Naphthalene	Y	Y	Y	A	1.1E-5	4.8E-5	1.6E-4	1.9E-4	1.9E-3	8.5E-3	0	0					0	0	0	0
7440-02-0	Nickel	Y	Y	Y	C	3.8E-5	1.6E-4					1.6E-3	7.1E-3					1.6E-3	7.1E-3	0	0
85-01-8	Phenanthrene	Y	N	n/a		3.0E-7	1.3E-6	5.0E-5	6.0E-5			0	0					0	0	0	0
108-95-2	Phenol	Y	Y	Y	A					2.4E-4	1.1E-3	0	0					0	0	0	0
7723-14-0	Phosphorus	Y	Y	Y	A							0.530	2.320					0.530	2.320	0	0
129-00-0	Pyrene	Y	N	n/a		8.9E-8	3.9E-7	4.7E-6	5.7E-6			0	0					0	0	0	0
7782-49-2	Selenium	Y	Y	Y	A	4.3E-7	1.9E-6					3.3E-4	1.4E-3					3.3E-4	1.4E-3	0	0
108-88-3	Toluene	Y	Y	Y	A	6.1E-5	2.7E-4	3.6E-4	4.3E-4	0.032	0.138	0	0					0	0	0	0
1330-20-7	Xylene	Y	Y	Y	A			2.5E-4	3.0E-4	0.031	0.137	0	0					0	0	0	0
7429-90-5	Aluminum	N	Y	N	A							0	0					0	0	57.855	253
7440-39-3	Barium	N	Y	N	A	7.9E-5	3.4E-4					0	0					0	0	0.652	2.855
1317-65-3	Calcium Carbonate	N	Y	N	A							0	0					0	0	11.408	49.967
1305-78-8	Calcium Oxide	N	Y	N	A							0	0					0	0	0	0
7440-50-8	Copper	N	Y	N	A	1.5E-5	6.7E-5					0	0					0	0	4.1E-3	0.018
110-82-7	Cyclohexane	N	Y	N	A					1.0E-3	4.6E-3	0	0					0	0	0	0
7783-06-4	Hydrogen Sulfide	N	Y	N	A							0	0					0	0	0	0
7439-89-6	Iron	N	Y	N	A							0	0					0	0	14.831	64.958
7439-98-7	Molybdenum	N	Y	N	A	2.0E-5	8.6E-5					0	0					0	0	8.1E-4	3.6E-3
109-66-0	Pentane	N	Y	N	A	0.047	0.204					0	0					0	0	0	0
7440-22-4	Silver	N	Y	N	A							0	0					0	0	4.1E-4	1.8E-3
7664-93-9	Sulfuric Acid	N	Y	N	A							0	0					0	0	0	0
7440-28-0	Thallium	N	Y	N	A							0	0					0	0	8.1E-3	0.036
7440-61-1	Uranium	N	Y	N	A							0	0					0	0	8.1E-3	0.036
7440-62-2	Vanadium	N	Y	N	A	4.1E-5	1.8E-4					0	0					0	0	0.023	0.100
25551-13-7	Trimethyl benzene	N	Y	N	A					0.011	0.048	0	0					0	0	0	0
7440-33-7	Tungsten	N	Y	N	A							0	0					0	0	8.1E-3	0.036
7440-66-6	Zinc	N	Y	N	A	5.2E-4	2.3E-3					0	0					0	0	0.029	0.125
HAP TOTAL						***0.034***	***0.148***	***1.2E-3***	***2.6E-3***	***0.103***	***0.453***	***1.826***	***7.998***								
MERCURY TOTAL (exempt)						***0***	***0***							***1.3E-3***	***5.7E-3***						
MERCURY TOTAL (non-exempt)						***4.7E-6***	***2.0E-5***	***0***	***0***	***0***	***0***					***0***	***0***				
TAP TOTAL (HAP-TAP addressed by NSPS/NESHAP)						***0***	***0***	***1.1E-3***	***2.5E-3***	***0.103***	***0.453***							***1.818***	***7.964***		
TAP TOTAL (For EL Evaluation)						***0.081***	***0.355***	***0***	***0***	***0.012***	***0.052***									***84.827***	***372***

TABLE B1-W3. HAP/TAP Emissions and Exemptions

						PROCESSING AND PRODUCTION - Totals										ALL	ALL	ALL	TAP EL	
						HAP Total		Mercury Total Exempt		Mercury Total Non-Exempt		TAP Total HAP-TAP addressed by NSPS/NESHAP		TAP Total For EL Evaluation		HAP	Hg Non-Exempt	TAP For EL Evaluation	TAP Emission Screening Level (EL)	
CAS	HAP/TAP	HAP	TAP																	
	NSPS or NESHAP HAP/TAP -->			*Y*															Non-car	Carcin
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				A/C	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr	ton/yr	lb/hr	lb/hr	lb/hr
106-99-0	1,3-Butadiene	Y	Y	Y	C	8.4E-7	3.7E-6					8.4E-7	3.7E-6	0	0	3.7E-6		0	--	2.4E-5
91-57-6	2-Methylnaphthalene	Y	N	n/a		1.1E-6	4.6E-6					0	0	0	0	4.6E-6		0	--	--
56-49-5	3-Methylchloranthrene	Y	Y	Y	C	7.8E-8	3.4E-7					4.6E-8	2.0E-7	3.2E-8	1.4E-7	3.4E-7		3.2E-8	--	2.5E-6
57-97-6	7,12-Dimethylbenz(a)anthracene	Y	N	n/a		7.6E-7	3.0E-6					0	0	0	0	3.0E-6		0	--	--
83-32-9	Acenaphthene	Y	N	n/a		5.7E-6	7.1E-6					0	0	0	0	7.1E-6		0	--	--
208-96-8	Acenaphthylene	Y	N	n/a		1.1E-5	1.4E-5					0	0	0	0	1.4E-5		0	--	--
75-07-0	Acetaldehyde	Y	Y	Y	C	2.5E-5	1.1E-4					2.5E-5	1.1E-4	0	0	1.1E-4		0	--	3.0E-3
107-02-8	Acrolein	Y	Y	Y	A	1.6E-5	2.0E-5					1.6E-5	2.0E-5	0	0	2.0E-5		0	0.017	--
120-12-7	Anthracene	Y	N	n/a		1.7E-6	2.4E-6					0	0	0	0	2.4E-6		0	--	--
7440-36-0	Antimony	Y	Y	Y	A	5.7E-4	2.5E-3					5.7E-4	2.5E-3	0	0	0.085		0	0.033	--
7440-38-2	Arsenic	Y	Y	Y	C	4.5E-3	0.020					4.5E-3	0.020	5.7E-6	2.5E-5	2.400		5.7E-6	--	1.5E-6
71-43-2	Benzene	Y	Y	Y	C	7.4E-3	0.032					7.4E-3	0.032	3.8E-5	1.6E-4	0.032		3.8E-5	--	8.0E-4
50-32-8	**Benzo(a)pyrene**	Y	Y	Y	C	1.4E-7	6.1E-7					1.2E-7	5.1E-7	2.1E-8	9.4E-8	6.1E-7				
56-55-3	**Benz(a)anthracene**	Y	Y	Y	C	3.1E-7	1.4E-6					2.8E-7	1.2E-6	3.2E-8	1.4E-7	1.4E-6				
205-99-2	**Benzo(b)fluoranthene**	Y	Y	Y	C	4.4E-7	1.9E-6					4.1E-7	1.8E-6	3.2E-8	1.4E-7	1.9E-6				
207-08-9	**Benzo(k)fluoranthene**	Y	Y	Y	C	1.5E-7	6.6E-7					1.2E-7	5.2E-7	3.2E-8	1.4E-7	6.6E-7		2.0E-7	--	2.0E-6
218-01-9	**Chrysene**	Y	Y	Y	C	5.8E-7	2.5E-6					5.5E-7	2.4E-6	3.2E-8	1.4E-7	2.5E-6				
53-70-3	**Dibenzo(a,h)anthracene**	Y	Y	Y	C	1.8E-7	7.7E-7					1.5E-7	6.8E-7	2.1E-8	9.4E-8	7.7E-7				
193-39-5	**Indeno(1,2,3-cd)pyrene**	Y	Y	Y	C	2.2E-7	9.6E-7					1.9E-7	8.2E-7	3.2E-8	1.4E-7	9.6E-7				
191-24-2	Benzo(g,h,i)perylene	Y	N	n/a		7.5E-7	1.1E-6					0	0	0	0	1.1E-6		0	--	--
7440-41-7	Beryllium	Y	Y	Y	C	4.3E-4	1.9E-3					4.3E-4	1.9E-3	2.3E-7	1.0E-6	0.013		2.3E-7	--	2.8E-5
92-52-4	Biphenyl	Y	Y	Y	A	4.4E-5	1.9E-4					4.4E-5	1.9E-4	0	0	1.9E-4		0	0.100	--
7440-43-9	Cadmium	Y	Y	Y	C	4.6E-4	2.0E-3					4.4E-4	1.9E-3	2.0E-5	8.6E-5	3.8E-3		2.0E-5	--	3.7E-6
75-15-0	Carbon Disulfide	Y	Y	Y	A	0	0					0	0	0	0	0.063		0	2.000	--
7440-47-3	Chromium	Y	Y	Y	A	6.8E-4	2.8E-3					6.5E-4	2.7E-3	2.7E-5	1.2E-4	0.035		2.7E-5	0.033	--
18540-29-9	Cr (VI)	Y	Y	Y	C	3.4E-7	1.5E-6					0	0	3.4E-7	1.5E-6	1.5E-6		3.4E-7	--	5.6E-7
7440-48-4	Cobalt	Y	Y	Y	A	4.7E-4	2.0E-3					4.7E-4	2.0E-3	1.5E-6	6.6E-6	0.016		1.5E-6	3.3E-3	--
592-01-8	Cyanide	Y	Y	Y	A	1.2E-3	5.3E-3					1.2E-3	5.3E-3	0	0	1.988		0	0.333	--
106-46-7	Dichlorobenzene	Y	Y	Y	A	5.7E-5	2.3E-4					3.5E-5	1.3E-4	2.1E-5	9.4E-5	2.3E-4		2.1E-5	30.000	--
206-44-0	Fluoranthene	Y	N	n/a		5.5E-6	7.0E-6					0	0	0	0	7.0E-6		0	--	--
86-73-7	Fluorene	Y	N	n/a		1.7E-5	2.1E-5					0	0	0	0	2.1E-5		0	--	--
50-00-0	Formaldehyde	Y	Y	Y	C	3.3E-3	0.015					2.0E-3	8.6E-3	1.3E-3	5.9E-3	0.015		1.3E-3	--	5.1E-4
110-54-3	Hexane	Y	Y	Y	A	0.117	0.480					0.084	0.339	0.032	0.141	0.480		0.032	12.000	--
7647-01-0	Hydrogen Chloride	Y	Y	Y	A	0.986	3.666					0.986	3.666	0	0	3.666		0	0.050	--
7439-92-1	Lead	Y	N	n/a		4.8E-4	2.1E-3					0	0	0	0	0.031		0	--	--
7439-96-5	Manganese	Y	Y	Y	A	4.6E-3	0.017					4.6E-3	0.017	3.6E-5	1.6E-4	1.085		3.6E-5	0.067	--
7439-97-6	Mercury	Y	N	n/a		7.1E-4	2.9E-3	7.0E-4	2.9E-3	4.7E-6	2.1E-5	0	0	0	0	8.6E-3	2.1E-5	0	--	--
91-20-3	Naphthalene	Y	Y	Y	A	2.1E-3	8.8E-3					2.1E-3	8.8E-3	1.1E-5	4.8E-5	8.8E-3		1.1E-5	3.330	--
7440-02-0	Nickel	Y	Y	Y	C	5.5E-4	2.4E-3					5.1E-4	2.2E-3	4.0E-5	1.8E-4	9.5E-3		4.0E-5	--	2.7E-5
85-01-8	Phenanthrene	Y	N	n/a		5.1E-5	6.3E-5					0	0	0	0	6.3E-5		0	--	--
108-95-2	Phenol	Y	Y	Y	A	2.4E-4	1.1E-3					2.4E-4	1.1E-3	0	0	1.1E-3		0	1.270	--
7723-14-0	Phosphorus	Y	Y	Y	A	5.6E-3	0.023					5.6E-3	0.023	8.2E-6	3.6E-5	2.343		8.2E-6	7.0E-3	--
129-00-0	Pyrene	Y	N	n/a		5.0E-6	6.6E-6					0	0	0	0	6.6E-6		0	--	--
7782-49-2	Selenium	Y	Y	Y	A	4.1E-4	1.8E-3					4.1E-4	1.8E-3	4.3E-7	1.9E-6	3.2E-3		4.3E-7	0.013	--
108-88-3	Toluene	Y	Y	Y	A	0.032	0.139					0.032	0.139	6.1E-5	2.7E-4	0.139		6.1E-5	25.000	--
1330-20-7	Xylene	Y	Y	Y	A	0.032	0.138					0.032	0.138	0	0	0.138		0	29.000	--
7429-90-5	Aluminum	N	Y	N	A	0	0					0	0	0.648	2.577	0		58.504	0.667	--
7440-39-3	Barium	N	Y	N	A	0	0					0	0	6.8E-3	0.028	0		0.659	0.033	--
1317-65-3	Calcium Carbonate	N	Y	N	A	0	0					0	0	2.244	8.125	0		13.652	0.667	--
1305-78-8	Calcium Oxide	N	Y	N	A	0	0					0	0	0.696	0.952	0		0.696	0.133	--
7440-50-8	Copper	N	Y	N	A	0	0					0	0	5.3E-4	2.2E-3	0		4.6E-3	0.067	--
110-82-7	Cyclohexane	N	Y	N	A	0	0					0	0	1.0E-3	4.6E-3	0		1.0E-3	70.000	--
7783-06-4	Hydrogen Sulfide	N	Y	N	A	0	0					0	0	0.900	3.942	0		0.900	0.933	--
7439-89-6	Iron	N	Y	N	A	0	0					0	0	0.213	0.812	0		15.043	0.067	--
7439-98-7	Molybdenum	N	Y	N	A	0	0					0	0	4.7E-4	2.0E-3	0		1.3E-3	0.333	--
109-66-0	Pentane	N	Y	N	A	0	0					0	0	0.123	0.495	0		0.123	118	--
7440-22-4	Silver	N	Y	N	A	0	0					0	0	4.1E-4	1.8E-3	0		8.2E-4	7.0E-3	--
7664-93-9	Sulfuric Acid	N	Y	N	A	0	0					0	0	2.030	8.891	0		2.030	0.067	--
7440-28-0	Thallium	N	Y	N	A	0	0					0	0	5.2E-4	2.2E-3	0		8.7E-3	7.0E-3	--
7440-61-1	Uranium	N	Y	N	A	0	0					0	0	5.2E-4	2.2E-3	0		8.7E-3	0.013	--
7440-62-2	Vanadium	N	Y	N	A	0	0					0	0	8.4E-4	3.5E-3	0		0.024	3.0E-3	--
25551-13-7	Trimethyl benzene	N	Y	N	A	0	0					0	0	0.011	0.048	0		0.011	8.200	--
7440-33-7	Tungsten	N	Y	N	A	0	0					0	0	5.2E-4	2.2E-3	0		8.7E-3	0.333	--
7440-66-6	Zinc	N	Y	N	A	0	0					0	0	2.2E-3	8.8E-3	0		0.031	0.667	--
HAP TOTAL						***1.200***	***4.566***									***12.564***				
MERCURY TOTAL (exempt)								***7.0E-4***	***2.9E-3***											
MERCURY TOTAL (non-exempt)										***4.7E-6***	***2.1E-5***						***2.1E-5***			
TAP TOTAL (HAP-TAP addressed by NSPS/NESHAP)												***1.165***	***4.413***							
TAP TOTAL (For EL Evaluation)														***6.913***	***26.048***			***91.740***		

TABLE B2-Y1. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.089	1.0E-3	0.018	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	7E/LL	7E/LL	7E/LL	7E/LL	0.098	1.1E-3	0.019	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.011	1.3E-4	2.3E-3	0	2.9E-3	0	1.6E-6	4.5E-6
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	2.3E-5	2.3E-5	2.3E-5	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	3.1E-6	0	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	7E	7E	7E	7E	0	9.7E-6	0	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	4.3E-7	0	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	7E	7E	7E	7E	0	2.2E-5	0	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	0	9.5E-5	0	0	0	0	0	5.0E-5
Lime Production	LS1	Limestone transfer to Primary Crusher Hopper	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS6	Limestone transfer to Ball Mill Feed Bin	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	5A	5A	5A	5A	0.043	2.8E-4	0.522	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	5A	5A	5A	5A	6.3E-3	4.0E-5	0.076	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	0.021	1.3E-4	0.251	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	6.4E-3	4.1E-5	0	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	1.4E-4	9.0E-7	0	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	1.4E-5	9.0E-8	0	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7

TABLE B2-Y1. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	5A	5A	5A	5A	4.7E-4	3.0E-6	0	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	2.0E-6	4.9E-9	0	1.7E-6	0	0	0	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.4E-7	3.7E-5	1.0E-6	0	2.2E-6	0	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.2E-6	1.5E-4	4.1E-6	0	8.6E-6	0	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.2E-6	2.2E-4	6.2E-6	0	1.3E-5	0	0	0	0	0	6.8E-6
Mining - Modeling Scenario: Y1	YPP	Yellow Pine Pit	7E	7E	7E	7E	5.585	0.063	1.101	0	1.432	0	7.9E-4	2.2E-3
	YPPBL	Yellow Pine Pit Blasting	7E	7E	7E	7E	1.902	0.021	0.375	0	0.488	0	2.7E-4	7.5E-4
	STKP	PC Stockpile	7E	7E	7E	7E	1.063	0.012	0.210	0	0.272	0	1.5E-4	4.2E-4
	HR000	Haul Roads	7E	7E	7E	7E	15.394	0.173	3.035	0	3.946	0	2.2E-3	6.1E-3
	ACCRD	Access Roads	7E	7E	7E	7E	0.113	1.3E-3	0.022	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	7E	7E	7E	7E	2.5E-5	2.8E-7	4.9E-6	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**5.7E-6**	**2.0E-5**	**1.3E-3**	**4.0E-5**	**24.705**	**0.278**	**6.987**	**0.696**	**6.380**	**2.030**	**3.9E-3**	**0.010**

TABLE B2-Y2. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.089	1.0E-3	0.018	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	7E/LL	7E/LL	7E/LL	7E/LL	0.098	1.1E-3	0.019	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.011	1.3E-4	2.3E-3	0	2.9E-3	0	1.6E-6	4.5E-6
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	2.3E-5	2.3E-5	2.3E-5	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	3.1E-6	0	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	7E	7E	7E	7E	0	9.7E-6	0	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	4.3E-7	0	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	7E	7E	7E	7E	0	2.2E-5	0	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	0	9.5E-5	0	0	0	0	0	5.0E-5
Lime Production	LS1	Limestone transfer to Primary Crusher Hopper	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS6	Limestone transfer to Ball Mill Feed Bin	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	5A	5A	5A	5A	0.043	2.8E-4	0.522	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	5A	5A	5A	5A	6.3E-3	4.0E-5	0.076	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	0.021	1.3E-4	0.251	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	6.4E-3	4.1E-5	0	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	1.4E-4	9.0E-7	0	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	1.4E-5	9.0E-8	0	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7

TABLE B2-Y2. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	5A	5A	5A	5A	4.7E-4	3.0E-6	0	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	2.0E-6	4.9E-9	0	1.7E-6	0	0	0	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.4E-7	3.7E-5	1.0E-6	0	2.2E-6	0	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.2E-6	1.5E-4	4.1E-6	0	8.6E-6	0	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.2E-6	2.2E-4	6.2E-6	0	1.3E-5	0	0	0	0	0	6.8E-6
Mining - Modeling Scenario: Y2	YPP	Yellow Pine Pit	7E	7E	7E	7E	5.585	0.063	1.101	0	1.432	0	7.9E-4	2.2E-3
	YPPBL	Yellow Pine Pit Blasting	7E	7E	7E	7E	1.902	0.021	0.375	0	0.488	0	2.7E-4	7.5E-4
	FDRSF	Fiddle DRSF	7E	7E	7E	7E	0.858	9.7E-3	0.169	0	0.220	0	1.2E-4	3.4E-4
	HR000	Haul Roads	7E	7E	7E	7E	22.711	0.256	4.478	0	5.822	0	3.2E-3	9.0E-3
	ACCRD	Access Roads	7E	7E	7E	7E	0.113	1.3E-3	0.022	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	7E	7E	7E	7E	2.5E-5	2.8E-7	4.9E-6	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**5.7E-6**	**2.0E-5**	**1.3E-3**	**4.0E-5**	**31.817**	**0.358**	**8.390**	**0.696**	**8.203**	**2.030**	**4.9E-3**	**0.013**

TABLE B2-Y3. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.089	1.0E-3	0.018	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	7E/LL	7E/LL	7E/LL	7E/LL	0.098	1.1E-3	0.019	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.011	1.3E-4	2.3E-3	0	2.9E-3	0	1.6E-6	4.5E-6
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	2.3E-5	2.3E-5	2.3E-5	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	3.1E-6	0	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	7E	7E	7E	7E	0	9.7E-6	0	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	4.3E-7	0	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	7E	7E	7E	7E	0	2.2E-5	0	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	0	9.5E-5	0	0	0	0	0	5.0E-5
Lime Production	LS1	Limestone transfer to Primary Crusher Hopper	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS6	Limestone transfer to Ball Mill Feed Bin	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	5A	5A	5A	5A	0.043	2.8E-4	0.522	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	5A	5A	5A	5A	6.3E-3	4.0E-5	0.076	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	0.021	1.3E-4	0.251	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	6.4E-3	4.1E-5	0	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	1.4E-4	9.0E-7	0	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	1.4E-5	9.0E-8	0	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7

TABLE B2-Y3. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	5A	5A	5A	5A	4.7E-4	3.0E-6	0	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	2.0E-6	4.9E-9	0	1.7E-6	0	0	0	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.4E-7	3.7E-5	1.0E-6	0	2.2E-6	0	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.2E-6	1.5E-4	4.1E-6	0	8.6E-6	0	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.2E-6	2.2E-4	6.2E-6	0	1.3E-5	0	0	0	0	0	6.8E-6
Mining - Modeling Scenario: Y3	YPP	Yellow Pine Pit	7E	7E	7E	7E	5.585	0.063	1.101	0	1.432	0	7.9E-4	2.2E-3
	YPPBL	Yellow Pine Pit Blasting	7E	7E	7E	7E	1.902	0.021	0.375	0	0.488	0	2.7E-4	7.5E-4
	HFDRSF	Hangar Flats DRSF	7E	7E	7E	7E	0.858	9.7E-3	0.169	0	0.220	0	1.2E-4	3.4E-4
	HR000	Haul Roads	7E	7E	7E	7E	36.835	0.415	7.263	0	9.442	0	5.2E-3	0.015
	ACCRD	Access Roads	7E	7E	7E	7E	0.113	1.3E-3	0.022	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	7E	7E	7E	7E	2.5E-5	2.8E-7	4.9E-6	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**5.7E-6**	**2.0E-5**	**1.3E-3**	**4.0E-5**	**45.941**	**0.517**	**11.175**	**0.696**	**11.823**	**2.030**	**6.9E-3**	**0.019**

TABLE B2-H1. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.089	1.0E-3	0.018	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	7E/LL	7E/LL	7E/LL	7E/LL	0.098	1.1E-3	0.019	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.011	1.3E-4	2.3E-3	0	2.9E-3	0	1.6E-6	4.5E-6
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	2.3E-5	2.3E-5	2.3E-5	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	3.1E-6	0	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	7E	7E	7E	7E	0	9.7E-6	0	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	4.3E-7	0	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	7E	7E	7E	7E	0	2.2E-5	0	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	0	9.5E-5	0	0	0	0	0	5.0E-5
Lime Production	LS1	Limestone transfer to Primary Crusher Hopper	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS6	Limestone transfer to Ball Mill Feed Bin	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	5A	5A	5A	5A	0.043	2.8E-4	0.522	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	5A	5A	5A	5A	6.3E-3	4.0E-5	0.076	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	0.021	1.3E-4	0.251	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	6.4E-3	4.1E-5	0	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	1.4E-4	9.0E-7	0	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	1.4E-5	9.0E-8	0	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7

TABLE B2-H1. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	5A	5A	5A	5A	4.7E-4	3.0E-6	0	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	2.0E-6	4.9E-9	0	1.7E-6	0	0	0	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.4E-7	3.7E-5	1.0E-6	0	2.2E-6	0	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.2E-6	1.5E-4	4.1E-6	0	8.6E-6	0	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.2E-6	2.2E-4	6.2E-6	0	1.3E-5	0	0	0	0	0	6.8E-6
Mining - Modeling Scenario: H1	HFP	Hangar Flats Pit	7E	7E	7E	7E	5.585	0.063	1.101	0	1.432	0	7.9E-4	2.2E-3
	HFPBL	Hangar Flats Pit Blasting	7E	7E	7E	7E	1.902	0.021	0.375	0	0.488	0	2.7E-4	7.5E-4
	STKP	PC Stockpile	7E	7E	7E	7E	1.063	0.012	0.210	0	0.272	0	1.5E-4	4.2E-4
	HR000	Haul Roads	7E	7E	7E	7E	24.940	0.281	4.918	0	6.393	0	3.5E-3	9.8E-3
	ACCRD	Access Roads	7E	7E	7E	7E	0.113	1.3E-3	0.022	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	7E	7E	7E	7E	2.5E-5	2.8E-7	4.9E-6	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**5.7E-6**	**2.0E-5**	**1.3E-3**	**4.0E-5**	**34.252**	**0.385**	**8.870**	**0.696**	**8.827**	**2.030**	**5.2E-3**	**0.014**

TABLE B2-H2. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.089	1.0E-3	0.018	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	7E/LL	7E/LL	7E/LL	7E/LL	0.098	1.1E-3	0.019	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.011	1.3E-4	2.3E-3	0	2.9E-3	0	1.6E-6	4.5E-6
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	2.3E-5	2.3E-5	2.3E-5	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	3.1E-6	0	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	7E	7E	7E	7E	0	9.7E-6	0	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	4.3E-7	0	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	7E	7E	7E	7E	0	2.2E-5	0	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	0	9.5E-5	0	0	0	0	0	5.0E-5
Lime Production	LS1	Limestone transfer to Primary Crusher Hopper	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS6	Limestone transfer to Ball Mill Feed Bin	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	5A	5A	5A	5A	0.043	2.8E-4	0.522	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	5A	5A	5A	5A	6.3E-3	4.0E-5	0.076	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	0.021	1.3E-4	0.251	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	6.4E-3	4.1E-5	0	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	1.4E-4	9.0E-7	0	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	1.4E-5	9.0E-8	0	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7

TABLE B2-H2. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	5A	5A	5A	5A	4.7E-4	3.0E-6	0	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	2.0E-6	4.9E-9	0	1.7E-6	0	0	0	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.4E-7	3.7E-5	1.0E-6	0	2.2E-6	0	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.2E-6	1.5E-4	4.1E-6	0	8.6E-6	0	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.2E-6	2.2E-4	6.2E-6	0	1.3E-5	0	0	0	0	0	6.8E-6
Mining - Modeling Scenario: H2	HFP	Hangar Flats Pit	7E	7E	7E	7E	5.585	0.063	1.101	0	1.432	0	7.9E-4	2.2E-3
	HFPBL	Hangar Flats Pit Blasting	7E	7E	7E	7E	1.902	0.021	0.375	0	0.488	0	2.7E-4	7.5E-4
	FDRSF	Fiddle DRSF	7E	7E	7E	7E	0.858	9.7E-3	0.169	0	0.220	0	1.2E-4	3.4E-4
	HR000	Haul Roads	7E	7E	7E	7E	37.334	0.421	7.362	0	9.570	0	5.3E-3	0.015
	ACCRD	Access Roads	7E	7E	7E	7E	0.113	1.3E-3	0.022	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	7E	7E	7E	7E	2.5E-5	2.8E-7	4.9E-6	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**5.7E-6**	**2.0E-5**	**1.3E-3**	**4.0E-5**	**46.440**	**0.523**	**11.273**	**0.696**	**11.951**	**2.030**	**7.0E-3**	**0.019**

TABLE B2-H3. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.089	1.0E-3	0.018	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	7E/LL	7E/LL	7E/LL	7E/LL	0.098	1.1E-3	0.019	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.011	1.3E-4	2.3E-3	0	2.9E-3	0	1.6E-6	4.5E-6
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	2.3E-5	2.3E-5	2.3E-5	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	3.1E-6	0	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	7E	7E	7E	7E	0	9.7E-6	0	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	4.3E-7	0	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	7E	7E	7E	7E	0	2.2E-5	0	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	0	9.5E-5	0	0	0	0	0	5.0E-5
Lime Production	LS1	Limestone transfer to Primary Crusher Hopper	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS6	Limestone transfer to Ball Mill Feed Bin	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	5A	5A	5A	5A	0.043	2.8E-4	0.522	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	5A	5A	5A	5A	6.3E-3	4.0E-5	0.076	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	0.021	1.3E-4	0.251	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	6.4E-3	4.1E-5	0	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	1.4E-4	9.0E-7	0	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	1.4E-5	9.0E-8	0	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7

TABLE B2-H3. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	5A	5A	5A	5A	4.7E-4	3.0E-6	0	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	2.0E-6	4.9E-9	0	1.7E-6	0	0	0	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.4E-7	3.7E-5	1.0E-6	0	2.2E-6	0	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.2E-6	1.5E-4	4.1E-6	0	8.6E-6	0	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.2E-6	2.2E-4	6.2E-6	0	1.3E-5	0	0	0	0	0	6.8E-6
Mining - Modeling Scenario: H3	HFP	Hangar Flats Pit	7E	7E	7E	7E	5.585	0.063	1.101	0	1.432	0	7.9E-4	2.2E-3
	HFPBL	Hangar Flats Pit Blasting	7E	7E	7E	7E	1.902	0.021	0.375	0	0.488	0	2.7E-4	7.5E-4
	HFDRSF	Hangar Flats DRSF	7E	7E	7E	7E	0.858	9.7E-3	0.169	0	0.220	0	1.2E-4	3.4E-4
	HR000	Haul Roads	7E	7E	7E	7E	22.854	0.258	4.506	0	5.858	0	3.2E-3	9.0E-3
	ACCRD	Access Roads	7E	7E	7E	7E	0.113	1.3E-3	0.022	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	7E	7E	7E	7E	2.5E-5	2.8E-7	4.9E-6	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**5.7E-6**	**2.0E-5**	**1.3E-3**	**4.0E-5**	**31.960**	**0.360**	**8.418**	**0.696**	**8.239**	**2.030**	**4.9E-3**	**0.013**

TABLE B2-H4. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.089	1.0E-3	0.018	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	7E/LL	7E/LL	7E/LL	7E/LL	0.098	1.1E-3	0.019	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.011	1.3E-4	2.3E-3	0	2.9E-3	0	1.6E-6	4.5E-6
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	2.3E-5	2.3E-5	2.3E-5	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	3.1E-6	0	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	7E	7E	7E	7E	0	9.7E-6	0	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	4.3E-7	0	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	7E	7E	7E	7E	0	2.2E-5	0	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	0	9.5E-5	0	0	0	0	0	5.0E-5
Lime Production	LS1	Limestone transfer to Primary Crusher Hopper	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS6	Limestone transfer to Ball Mill Feed Bin	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	5A	5A	5A	5A	0.043	2.8E-4	0.522	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	5A	5A	5A	5A	6.3E-3	4.0E-5	0.076	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	0.021	1.3E-4	0.251	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	6.4E-3	4.1E-5	0	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	1.4E-4	9.0E-7	0	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	1.4E-5	9.0E-8	0	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7

TABLE B2-H4. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	5A	5A	5A	5A	4.7E-4	3.0E-6	0	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	2.0E-6	4.9E-9	0	1.7E-6	0	0	0	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.4E-7	3.7E-5	1.0E-6	0	2.2E-6	0	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.2E-6	1.5E-4	4.1E-6	0	8.6E-6	0	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.2E-6	2.2E-4	6.2E-6	0	1.3E-5	0	0	0	0	0	6.8E-6
Mining - Modeling Scenario: H4	HFP	Hangar Flats Pit	7E	7E	7E	7E	5.585	0.063	1.101	0	1.432	0	7.9E-4	2.2E-3
	HFPBL	Hangar Flats Pit Blasting	7E	7E	7E	7E	1.902	0.021	0.375	0	0.488	0	2.7E-4	7.5E-4
	YPDRSF	Yellow Pine DRSF	7E	7E	7E	7E	0.858	9.7E-3	0.169	0	0.220	0	1.2E-4	3.4E-4
	HR000	Haul Roads	7E	7E	7E	7E	29.277	0.330	5.773	0	7.505	0	4.1E-3	0.012
	ACCRD	Access Roads	7E	7E	7E	7E	0.113	1.3E-3	0.022	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	7E	7E	7E	7E	2.5E-5	2.8E-7	4.9E-6	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**5.7E-6**	**2.0E-5**	**1.3E-3**	**4.0E-5**	**38.383**	**0.432**	**9.685**	**0.696**	**9.886**	**2.030**	**5.8E-3**	**0.016**

TABLE B2-W1. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.089	1.0E-3	0.018	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	7E/LL	7E/LL	7E/LL	7E/LL	0.098	1.1E-3	0.019	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.011	1.3E-4	2.3E-3	0	2.9E-3	0	1.6E-6	4.5E-6
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	2.3E-5	2.3E-5	2.3E-5	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	3.1E-6	0	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	7E	7E	7E	7E	0	9.7E-6	0	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	4.3E-7	0	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	7E	7E	7E	7E	0	2.2E-5	0	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	0	9.5E-5	0	0	0	0	0	5.0E-5
Lime Production	LS1	Limestone transfer to Primary Crusher Hopper	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS6	Limestone transfer to Ball Mill Feed Bin	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	5A	5A	5A	5A	0.043	2.8E-4	0.522	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	5A	5A	5A	5A	6.3E-3	4.0E-5	0.076	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	0.021	1.3E-4	0.251	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	6.4E-3	4.1E-5	0	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	1.4E-4	9.0E-7	0	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	1.4E-5	9.0E-8	0	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7

TABLE B2-W1. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	5A	5A	5A	5A	4.7E-4	3.0E-6	0	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	2.0E-6	4.9E-9	0	1.7E-6	0	0	0	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.4E-7	3.7E-5	1.0E-6	0	2.2E-6	0	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.2E-6	1.5E-4	4.1E-6	0	8.6E-6	0	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.2E-6	2.2E-4	6.2E-6	0	1.3E-5	0	0	0	0	0	6.8E-6
Mining - Modeling Scenario: W1	WEP	West End Pit	7E	7E	7E	7E	5.585	0.063	1.101	0	1.432	0	7.9E-4	2.2E-3
	WEPBL	West End Pit Blasting	7E	7E	7E	7E	1.902	0.021	0.375	0	0.488	0	2.7E-4	7.5E-4
	STKP	PC Stockpile	7E	7E	7E	7E	1.063	0.012	0.210	0	0.272	0	1.5E-4	4.2E-4
	HR000	Haul Roads	7E	7E	7E	7E	21.435	0.242	4.227	0	5.495	0	3.0E-3	8.5E-3
	ACCRD	Access Roads	7E	7E	7E	7E	0.113	1.3E-3	0.022	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	7E	7E	7E	7E	2.5E-5	2.8E-7	4.9E-6	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**5.7E-6**	**2.0E-5**	**1.3E-3**	**4.0E-5**	**30.746**	**0.346**	**8.179**	**0.696**	**7.928**	**2.030**	**4.8E-3**	**0.013**

TABLE B2-W2. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.089	1.0E-3	0.018	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	7E/LL	7E/LL	7E/LL	7E/LL	0.098	1.1E-3	0.019	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.011	1.3E-4	2.3E-3	0	2.9E-3	0	1.6E-6	4.5E-6
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	2.3E-5	2.3E-5	2.3E-5	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	3.1E-6	0	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	7E	7E	7E	7E	0	9.7E-6	0	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	4.3E-7	0	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	7E	7E	7E	7E	0	2.2E-5	0	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	0	9.5E-5	0	0	0	0	0	5.0E-5
Lime Production	LS1	Limestone transfer to Primary Crusher Hopper	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS6	Limestone transfer to Ball Mill Feed Bin	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	5A	5A	5A	5A	0.043	2.8E-4	0.522	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	5A	5A	5A	5A	6.3E-3	4.0E-5	0.076	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	0.021	1.3E-4	0.251	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	6.4E-3	4.1E-5	0	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	1.4E-4	9.0E-7	0	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	1.4E-5	9.0E-8	0	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7

TABLE B2-W2. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	5A	5A	5A	5A	4.7E-4	3.0E-6	0	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	2.0E-6	4.9E-9	0	1.7E-6	0	0	0	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.4E-7	3.7E-5	1.0E-6	0	2.2E-6	0	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.2E-6	1.5E-4	4.1E-6	0	8.6E-6	0	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.2E-6	2.2E-4	6.2E-6	0	1.3E-5	0	0	0	0	0	6.8E-6
Mining - Modeling Scenario: W2	WEP	West End Pit	7E	7E	7E	7E	5.585	0.063	1.101	0	1.432	0	7.9E-4	2.2E-3
	WEPBL	West End Pit Blasting	7E	7E	7E	7E	1.902	0.021	0.375	0	0.488	0	2.7E-4	7.5E-4
	FDRSF	Fiddle DRSF	7E	7E	7E	7E	0.858	9.7E-3	0.169	0	0.220	0	1.2E-4	3.4E-4
	HR000	Haul Roads	7E	7E	7E	7E	34.484	0.389	6.800	0	8.840	0	4.9E-3	0.014
	ACCRD	Access Roads	7E	7E	7E	7E	0.113	1.3E-3	0.022	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	7E	7E	7E	7E	2.5E-5	2.8E-7	4.9E-6	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**5.7E-6**	**2.0E-5**	**1.3E-3**	**4.0E-5**	**43.590**	**0.491**	**10.711**	**0.696**	**11.221**	**2.030**	**6.6E-3**	**0.018**

TABLE B2-W3. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.089	1.0E-3	0.018	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	7E/LL	7E/LL	7E/LL	7E/LL	0.098	1.1E-3	0.019	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.011	1.3E-4	2.3E-3	0	2.9E-3	0	1.6E-6	4.5E-6
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	2.3E-5	2.3E-5	2.3E-5	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	3.1E-6	0	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	7E	7E	7E	7E	0	9.7E-6	0	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	4.3E-7	0	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	7E	7E	7E	7E	0	2.2E-5	0	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	0	9.5E-5	0	0	0	0	0	5.0E-5
Lime Production	LS1	Limestone transfer to Primary Crusher Hopper	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS6	Limestone transfer to Ball Mill Feed Bin	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	5A	5A	5A	5A	0.043	2.8E-4	0.522	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	5A	5A	5A	5A	6.3E-3	4.0E-5	0.076	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	0.021	1.3E-4	0.251	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	6.4E-3	4.1E-5	0	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	1.4E-4	9.0E-7	0	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	1.4E-5	9.0E-8	0	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7

TABLE B2-W3. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	5A	5A	5A	5A	4.7E-4	3.0E-6	0	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	2.0E-6	4.9E-9	0	1.7E-6	0	0	0	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.4E-7	3.7E-5	1.0E-6	0	2.2E-6	0	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.2E-6	1.5E-4	4.1E-6	0	8.6E-6	0	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.2E-6	2.2E-4	6.2E-6	0	1.3E-5	0	0	0	0	0	6.8E-6
Mining - Modeling Scenario: W3	WEP	West End Pit	7E	7E	7E	7E	5.585	0.063	1.101	0	1.432	0	7.9E-4	2.2E-3
	WEPBL	West End Pit Blasting	7E	7E	7E	7E	1.902	0.021	0.375	0	0.488	0	2.7E-4	7.5E-4
	HFDRSF	Hangar Flats DRSF	7E	7E	7E	7E	0.858	9.7E-3	0.169	0	0.220	0	1.2E-4	3.4E-4
	HR000	Haul Roads	7E	7E	7E	7E	49.397	0.557	9.740	0	12.662	0	7.0E-3	0.019
	ACCRD	Access Roads	7E	7E	7E	7E	0.113	1.3E-3	0.022	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	7E	7E	7E	7E	2.5E-5	2.8E-7	4.9E-6	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**5.7E-6**	**2.0E-5**	**1.3E-3**	**4.0E-5**	**58.504**	**0.659**	**13.652**	**0.696**	**15.043**	**2.030**	**8.7E-3**	**0.024**

TABLE B2-W4. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.089	1.0E-3	0.018	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	7E/LL	7E/LL	7E/LL	7E/LL	0.098	1.1E-3	0.019	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.011	1.3E-4	2.3E-3	0	2.9E-3	0	1.6E-6	4.5E-6
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	2.3E-5	2.3E-5	2.3E-5	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	3.1E-6	0	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	7E	7E	7E	7E	0	9.7E-6	0	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	4.3E-7	0	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	7E	7E	7E	7E	0	2.2E-5	0	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	0	9.5E-5	0	0	0	0	0	5.0E-5
Lime Production	LS1	Limestone transfer to Primary Crusher Hopper	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS6	Limestone transfer to Ball Mill Feed Bin	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	5A	5A	5A	5A	0.043	2.8E-4	0.522	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	5A	5A	5A	5A	6.3E-3	4.0E-5	0.076	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	0.021	1.3E-4	0.251	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	6.4E-3	4.1E-5	0	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	1.4E-4	9.0E-7	0	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	1.4E-5	9.0E-8	0	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7

TABLE B2-W4. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	5A	5A	5A	5A	4.7E-4	3.0E-6	0	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	2.0E-6	4.9E-9	0	1.7E-6	0	0	0	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.4E-7	3.7E-5	1.0E-6	0	2.2E-6	0	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.2E-6	1.5E-4	4.1E-6	0	8.6E-6	0	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.2E-6	2.2E-4	6.2E-6	0	1.3E-5	0	0	0	0	0	6.8E-6
Mining - Modeling Scenario: W4	WEP	West End Pit	7E	7E	7E	7E	5.585	0.063	1.101	0	1.432	0	7.9E-4	2.2E-3
	WEPBL	West End Pit Blasting	7E	7E	7E	7E	1.902	0.021	0.375	0	0.488	0	2.7E-4	7.5E-4
	YPDRSF	Yellow Pine DRSF	7E	7E	7E	7E	0.858	9.7E-3	0.169	0	0.220	0	1.2E-4	3.4E-4
	HR000	Haul Roads	7E	7E	7E	7E	22.281	0.251	4.393	0	5.711	0	3.1E-3	8.8E-3
	ACCRD	Access Roads	7E	7E	7E	7E	0.113	1.3E-3	0.022	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	7E	7E	7E	7E	2.5E-5	2.8E-7	4.9E-6	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**5.7E-6**	**2.0E-5**	**1.3E-3**	**4.0E-5**	**31.387**	**0.353**	**8.305**	**0.696**	**8.092**	**2.030**	**4.8E-3**	**0.013**

TABLE B2-W5. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.089	1.0E-3	0.018	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	7E/LL	7E/LL	7E/LL	7E/LL	0.098	1.1E-3	0.019	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.011	1.3E-4	2.3E-3	0	2.9E-3	0	1.6E-6	4.5E-6
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	2.3E-5	2.3E-5	2.3E-5	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	3.1E-6	0	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	7E	7E	7E	7E	0	9.7E-6	0	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	4.3E-7	0	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	7E	7E	7E	7E	0	2.2E-5	0	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	0	9.5E-5	0	0	0	0	0	5.0E-5
Lime Production	LS1	Limestone transfer to Primary Crusher Hopper	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS6	Limestone transfer to Ball Mill Feed Bin	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	5A	5A	5A	5A	0.043	2.8E-4	0.522	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	5A	5A	5A	5A	6.3E-3	4.0E-5	0.076	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	0.021	1.3E-4	0.251	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	6.4E-3	4.1E-5	0	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	1.4E-4	9.0E-7	0	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	1.4E-5	9.0E-8	0	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7

TABLE B2-W5. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	5A	5A	5A	5A	4.7E-4	3.0E-6	0	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	2.0E-6	4.9E-9	0	1.7E-6	0	0	0	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.4E-7	3.7E-5	1.0E-6	0	2.2E-6	0	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.2E-6	1.5E-4	4.1E-6	0	8.6E-6	0	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.2E-6	2.2E-4	6.2E-6	0	1.3E-5	0	0	0	0	0	6.8E-6
Mining - Modeling Scenario: W5	WEP	West End Pit	7E	7E	7E	7E	5.585	0.063	1.101	0	1.432	0	7.9E-4	2.2E-3
	WEPBL	West End Pit Blasting	7E	7E	7E	7E	1.902	0.021	0.375	0	0.488	0	2.7E-4	7.5E-4
	WEDRSF	West End DRSF	7E	7E	7E	7E	0.858	9.7E-3	0.169	0	0.220	0	1.2E-4	3.4E-4
	HR000	Haul Roads	7E	7E	7E	7E	24.595	0.277	4.850	0	6.305	0	3.5E-3	9.7E-3
	ACCRD	Access Roads	7E	7E	7E	7E	0.113	1.3E-3	0.022	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	7E	7E	7E	7E	2.5E-5	2.8E-7	4.9E-6	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**5.7E-6**	**2.0E-5**	**1.3E-3**	**4.0E-5**	**33.702**	**0.379**	**8.761**	**0.696**	**8.686**	**2.030**	**5.2E-3**	**0.014**

TABLE B2-B1. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.089	1.0E-3	0.018	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	7E/LL	7E/LL	7E/LL	7E/LL	0.098	1.1E-3	0.019	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.011	1.3E-4	2.3E-3	0	2.9E-3	0	1.6E-6	4.5E-6
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	2.3E-5	2.3E-5	2.3E-5	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	3.1E-6	0	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	7E	7E	7E	7E	0	9.7E-6	0	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	4.3E-7	0	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	7E	7E	7E	7E	0	2.2E-5	0	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	0	9.5E-5	0	0	0	0	0	5.0E-5
Lime Production	LS1	Limestone transfer to Primary Crusher Hopper	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS6	Limestone transfer to Ball Mill Feed Bin	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	5A	5A	5A	5A	0.043	2.8E-4	0.522	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	5A	5A	5A	5A	6.3E-3	4.0E-5	0.076	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	0.021	1.3E-4	0.251	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	6.4E-3	4.1E-5	0	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	1.4E-4	9.0E-7	0	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	1.4E-5	9.0E-8	0	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7

TABLE B2-B1. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	5A	5A	5A	5A	4.7E-4	3.0E-6	0	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	2.0E-6	4.9E-9	0	1.7E-6	0	0	0	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.4E-7	3.7E-5	1.0E-6	0	2.2E-6	0	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.2E-6	1.5E-4	4.1E-6	0	8.6E-6	0	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.2E-6	2.2E-4	6.2E-6	0	1.3E-5	0	0	0	0	0	6.8E-6
Mining - Modeling Scenario: B1	BT	Bradley Tailings	7E	7E	7E	7E	5.567	0.063	1.098	0	1.427	0	7.8E-4	2.2E-3
	BTBL	Bradley Tailings Blasting	7E	7E	7E	7E	1.902	0.021	0.375	0	0.488	0	2.7E-4	7.5E-4
	STKP	PC Stockpile	7E	7E	7E	7E	1.063	0.012	0.210	0	0.272	0	1.5E-4	4.2E-4
	HR000	Haul Roads	7E	7E	7E	7E	28.394	0.320	5.599	0	7.278	0	4.0E-3	0.011
	ACCRD	Access Roads	7E	7E	7E	7E	0.113	1.3E-3	0.022	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	7E	7E	7E	7E	2.5E-5	2.8E-7	4.9E-6	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**5.7E-6**	**2.0E-5**	**1.3E-3**	**4.0E-5**	**37.687**	**0.424**	**9.547**	**0.696**	**9.707**	**2.030**	**5.7E-3**	**0.015**

TABLE B2-B2. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.089	1.0E-3	0.018	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	7E/LL	7E/LL	7E/LL	7E/LL	0.098	1.1E-3	0.019	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.011	1.3E-4	2.3E-3	0	2.9E-3	0	1.6E-6	4.5E-6
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	2.3E-5	2.3E-5	2.3E-5	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	3.1E-6	0	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	7E	7E	7E	7E	0	9.7E-6	0	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	4.3E-7	0	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	7E	7E	7E	7E	0	2.2E-5	0	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	0	9.5E-5	0	0	0	0	0	5.0E-5
Lime Production	LS1	Limestone transfer to Primary Crusher Hopper	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS6	Limestone transfer to Ball Mill Feed Bin	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	5A	5A	5A	5A	0.043	2.8E-4	0.522	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	5A	5A	5A	5A	6.3E-3	4.0E-5	0.076	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	0.021	1.3E-4	0.251	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	6.4E-3	4.1E-5	0	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	1.4E-4	9.0E-7	0	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	1.4E-5	9.0E-8	0	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7

TABLE B2-B2. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	5A	5A	5A	5A	4.7E-4	3.0E-6	0	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	2.0E-6	4.9E-9	0	1.7E-6	0	0	0	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.4E-7	3.7E-5	1.0E-6	0	2.2E-6	0	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.2E-6	1.5E-4	4.1E-6	0	8.6E-6	0	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.2E-6	2.2E-4	6.2E-6	0	1.3E-5	0	0	0	0	0	6.8E-6
Mining - Modeling Scenario: B2	BT	Bradley Tailings	7E	7E	7E	7E	5.567	0.063	1.098	0	1.427	0	7.8E-4	2.2E-3
	BTBL	Bradley Tailings Blasting	7E	7E	7E	7E	1.902	0.021	0.375	0	0.488	0	2.7E-4	7.5E-4
	HFDRSF	Hangar Flats DRSF	7E	7E	7E	7E	0.858	9.7E-3	0.169	0	0.220	0	1.2E-4	3.4E-4
	HR000	Haul Roads	7E	7E	7E	7E	6.713	0.076	1.324	0	1.721	0	9.5E-4	2.6E-3
	ACCRD	Access Roads	7E	7E	7E	7E	0.113	1.3E-3	0.022	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	7E	7E	7E	7E	2.5E-5	2.8E-7	4.9E-6	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**5.7E-6**	**2.0E-5**	**1.3E-3**	**4.0E-5**	**15.801**	**0.178**	**5.232**	**0.696**	**4.097**	**2.030**	**2.7E-3**	**6.8E-3**

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis/E. Memon
	PROJECT NO: 335-1-4	PAGE: 1 OF: 4 SHEET: Summary
AIR EMISSION CALCULATIONS	SUBJECT: Emissions Summary	DATE: June 22, 2020

Facility-Wide Criteria Pollutant PTE

Activity	PM ton/yr	PM10 lb/hr	PM10 ton/yr	PM2.5 lb/hr	PM2.5 ton/yr	CO lb/hr	CO ton/yr	NOX lb/hr	NOX ton/yr	SO2 lb/hr	SO2 ton/yr	VOC ton/yr
Process & Ancillary	87.3	21.7	56.3	13.4	36.4	33.5	30.5	55.4	37.9	1.9	6.5	4.8
Mining Fugitive	3,569	225	986	22.5	98.9	1,742	636	46.8	17.1	9.4E-02	3.4E-02	0.0E+00
Total	3,656	246	1,042	35.9	135	1,776	666	102	54.9	2.0	6.5	4.8

Mining fugitive emissions are for model scenario: W3

Permitting Applicability

	PM ton/yr	PM10 ton/yr	PM2.5 ton/yr	CO ton/yr	NOX ton/yr	SO2 ton/yr
Total Process & Ancillary	87.3	56.3	36.4	30.5	37.9	6.5
Significant Threshold [1]	25	15	10	100	40	40
	Above	Above	Above	Minor	Minor	Minor
Regulatory Concern Threshold (10% of Significant) [2]						
	2.5	1.5	1	10	4	4
	Permit	Permit	Permit	Permit	Permit	Permit
Major Source Determination		100	100	100	100	100
		Minor	Minor	Minor	Minor	Minor

[1] *IDAPA 58.01.01.006.108.a.*

[2] *IDAPA 58.01.01.221.01*

Modeling Applicability

	PM10 lb/hr	PM2.5 lb/hr	PM2.5 ton/yr	CO lb/hr	NOX lb/hr	NOX ton/yr	SO2 lb/hr	SO2 ton/yr	Pb lb/month
Process & Ancillary	21.7	13.4	36.4	33.5	55.4	37.9	1.9	6.5	4.4E-02
Mining Fugitive	225	22.5	98.9	1,742	46.8	17.1	9.4E-02	3.4E-02	0.0E+00
Total	246	35.9	135	1,776	102	54.9	2.0	6.5	4.4E-02
Level I Thresholds [1]	0.22	0.054	0.35	15	0.20	1.20	0.21	1.2	14
Modeling Triggered?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

[1] *IDEQ, Guideline for Performing Air Quality Impact Analyses Table 2, September-2013*

Permit to Construct Processing Fee Determination [1]

Regulated Pollutant	ton/yr
PM10	56.3
CO	30.5
NOX	37.9
SO2	6.5
VOC	4.8
Total [2]	136

[1] *Process & Ancillary Sources Only*

[2] *In accordance with 58.01.01.225, the Permit to Construct Processing Fee will be $7,500. This is for a non major new source with an increase of emissions of 100 tpy or more.*

Conversions

2,000 lb/ton

8,760 hr/yr

Autoclave Non-HAP TAP Emissions

		Throughpu	Operation			Emissions	
CAS No.	Pollutant	ton/hr	hr/yr	Emission Factor		lb/hr	ton/yr
7664-93-9	Sulfuric Acid	290	8,760	0.007	lb/ton[1]	2.03	8.9
7783-06-4	Hydrogen Sulfide		8,760	0.9	lb/hr[2]	0.9	3.9

[1] *H2SO4 is based on Acidic Autoclave test data (APT 2010)*

[2] *H2S is based on Acidic Autoclave test data (APT 2013)*

MATERIAL PROCESSING HAP/TAP EMISSIONS

Ore Processing PM Emissions 5.9 lb/hr
25.8 ton/yr

Ore Dust HAP Concentrations[1] and Emissions

		Concentration	Emissions	
CAS No.	Pollutant	ppm	lb/hr	ton/yr
7440-38-2	Arsenic	667	0.003923	0.0172
7440-41-7	Beryllium	3.2	0.000019	0.0001
7440-43-9	Cadmium	0.5	0.000003	0.00001
7440-48-4	Cobalt	4	0.000024	0.0001
7440-47-3	Chromium	9	0.000053	0.0002
7439-97-6	Mercury	0.96	0.000006	0.00002
7439-96-5	Manganese	299	0.001759	0.0077
7440-02-0	Nickel	2	0.000012	0.0001
7439-92-1	Lead	8	0.000047	0.0002
7440-36-0	Antimony	23	0.000135	0.0006
7723-14-0	Phosphorus	650	0.003823	0.0167
Dust HAP Total			0.009803	0.0429

[1] *(Midas Gold 2017c)*

Ore Dust Non-HAP TAP Concentrations[1] and Emissions

		Concentration	Emissions	
CAS No.	Pollutant	ppm	lb/hr	ton/yr
7440-22-4	Silver	0.5	0.000003	0.00001
7440-39-3	Barium	800	0.004705	0.0206
7440-50-8	Copper	5	0.000029	0.0001
7439-98-7	Molybdenum	1	0.000006	0.00003
7440-28-0	Thallium	10	0.000059	0.00026
7440-61-1	Uranium	10	0.000059	0.0003
Dust HAP Total			0.004861	0.0213

[1] *(Midas Gold 2017c)*

Sb Concentrate Processing PM Emissions 0.12 lb/hr
0.52 ton/yr

Stib. Conc.

Sb Concentrate Dust Non-HAP TAP Concentrations[1] and Emissions

		Concentration	Emissions	
CAS No.	Pollutant	ppm	lb/hr	ton/yr
7440-36-0	Antimony	580,000	0.0684	0.2998

[1] *(Midas Gold 2019d)*

Carbon Disulfide Emissions from Xanthate Decomposition

		Xanthate[1]	Molar	CS_2 MW	Temperature	Emissions	
CAS No.	Pollutant	ton/yr	Decomp.[2]	Ratio	Adj. Factor[3]	lb/hr	ton/yr
75-15-0	Carbon Disulfide	1,700	0.99%	0.376	0.01	0.0145	0.063

[1] *(Midas Gold 2016) p. 12-11*

[2] *(Air Sciences 2020) molar decomposition of of xanthate in solution to CS2 gas*

[3] *(Air Sciences 2020) based on the comparison of CS2 generation at 50C and 70C*

Conversions			MW	
2,000	lb/ton	Xanthate (PAX)	202.37	$C_6H_{11}KOS_2$
8,760	hr/yr	Carbon difulfide	76.139	CS_2

MATERIAL PROCESSING HAP/TAP EMISSIONS

Lead Emission by Source

	Source ID	Description	TRUE Pb_tpy Pb ton/yr
	CS1L	Cement/Shotcrete Silo #1 Loading	2.21E-5
	CS2L	Cement/Shotcrete Silo #2 Loading	2.21E-5
	CM	Central Mixer Loading	1.15E-5
1	OC1	Loader Transfer of Ore to Grizzly	5.11E-6
1	OC2	Grizzly to Apron Feeder	5.11E-6
1	OC3	Apron Feeder to Dribble Conveyor	5.11E-6
1	OC4	Apron Feeder to Vibrating Grizzly	5.11E-6
1	OC5	Dribble Conveyor to Vibrating Grizzly	5.11E-6
1	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	5.11E-6
5	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	4.38E-5
1	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	5.11E-6
3	OC9	Stockpile Transfers to Reclaim Conveyors	2.42E-5
3	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	2.42E-5
3	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	2.42E-5
6	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	4.84E-5
1	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	5.64E-6
	Total		2.62E-4

40 CFR 63 Subpart 7E MERCURY SOURCES

Mercury Emissions

Description	Subpart 7E Hg Emissions ton/yr	Oper. hr/yr	% of Subpart 7E for Controlled Systems* %	Controlled Hg Emissions* lb/hr	lb/yr	ton/yr
Autoclave **	0.107	8,760	10.0%	0.002	21.34	0.011
Refinery Sources (Kiln, EW, Retort, Furnace)	0.008	1,248	20.0%	0.003	3.36	0.002
Total 7439-97-6	0.115			0.005	24.70	0.012

**Based on Similar Source Hg Reporting Levels provided below*

***Expected actual emissions from Autoclave:* 0.0105 g/hr 2.3E-05 lb/hr 0.20 lb/yr *(M3 2019)*

Subpart 7E Limit - Ore Pretreatment Processes *(CFR 2018b)*

$$\frac{84\ \text{lb}}{\cancel{\text{MMton}}} \times \frac{2{,}540{,}400\ \cancel{\text{ton}}}{\text{yr}} \times \frac{\cancel{\text{MMton}}}{1.0\text{E+6}\ \cancel{\text{ton}}} = \frac{213.39\ \text{lb}}{\text{yr}}$$

Subpart 7E Limit - Carbon Processes with Mercury Retorts

$$\frac{0.8\ \text{lb}}{\cancel{\text{ton}}} \times \frac{21\ \cancel{\text{ton}}}{\text{yr}} = \frac{16.8\ \text{lb}}{\text{yr}}$$

Similar Source Hg Reporting Levels

Goldstrike Autoclaves 2 & 3 (2015 & 2016 Hg Reports) *(NDEP 2015a) (NDEP 2016)*

$$\frac{28.79\ \text{lb}}{\text{yr}} \times \frac{\text{yr}}{3.13\ \text{MMton}} = \frac{9.18\ \text{lb}}{\text{MMton}} \times \frac{\text{MMton}}{84\ \text{lb}} = 10.9\%$$

Twin Creeks Autoclaves 1 & 2 (2015 & 2016 Hg Reports) *(NDEP 2015a) (NDEP 2016)*

$$\frac{1.01\ \text{lb}}{\text{yr}} \times \frac{\text{yr}}{7.63\ \text{MMton}} = \frac{0.13\ \text{lb}}{\text{MMton}} \times \frac{\text{MMton}}{84\ \text{lb}} = 0.2\%$$

Goldstrike Refinery (2015 & 2016 Hg Reports) *(NDEP 2015a) (NDEP 2016)*

$$\frac{28.79\ \text{lb}}{\text{yr}} \times \frac{\text{yr}}{251.00\ \text{ton}} = \frac{0.11\ \text{lb}}{\text{MMton}} \times \frac{\text{MMton}}{0.8\ \text{lb}} = 14.3\%$$

Twin Creeks Refinery (2015 & 2016 Hg Reports) *(NDEP 2015a) (NDEP 2016)*

$$\frac{31.27\ \text{lb}}{\text{yr}} \times \frac{\text{yr}}{142.77\ \text{ton}} = \frac{0.22\ \text{lb}}{\text{MMton}} \times \frac{\text{MMton}}{0.8\ \text{lb}} = 27.4\%$$

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: E. Huelson/E. Memon
	PROJECT NO: 335-1-4	PAGE: 1 OF: 5 SHEET: Tanks
AIR EMISSION CALCULATIONS	SUBJECT: Fuel Storage Tanks	DATE: June 22, 2020

Fuel Storage Tanks

	Dimensions				VOC Emissions[1]		
	Capacity	Diameter	Length	Throughput			Reference
Storage Tank	gal	ft	ft	gal/yr	lb/yr	ton/yr	
Mine Site Gasoline Tank #1	5,000	8.5	14.33	250,000	1,914.73	0.96	*(Midas Gold 2016), Table 12-4, annual use*
Mine Site Gasoline Tank #2	5,000	8.5	14.33	250,000	1,914.73	0.96	*(Midas Gold 2016), Table 12-4, annual use*
Mine Site Diesel Tank #3	25,000	12	29.70	725,000	14.60	0.007	*(Midas Gold 2016), (Midas Gold 2018c)*
Mine Site Diesel Tank #4	25,000	12	29.70	725,000	14.60	0.007	*(Midas Gold 2016), (Midas Gold 2018c)*
Mine Site Diesel Tank #5	25,000	12	29.70	725,000	14.60	0.007	*(Midas Gold 2016), (Midas Gold 2018c)*
Mine Site Diesel Tank #6	25,000	12	29.70	725,000	14.60	0.007	*(Midas Gold 2016), (Midas Gold 2018c)*
Mine Site Diesel Tank #7	25,000	12	29.70	725,000	14.60	0.007	*(Midas Gold 2016), (Midas Gold 2018c)*
Mine Site Diesel Tank #8	25,000	12	29.70	725,000	14.60	0.007	*(Midas Gold 2016), (Midas Gold 2018c)*
Mine Site Diesel Tank #9	25,000	12	29.70	725,000	14.60	0.007	*(Midas Gold 2016), (Midas Gold 2018c)*
Mine Site Diesel Tank #10	25,000	12	29.70	725,000	14.60	0.007	*(Midas Gold 2016), (Midas Gold 2018c)*

[1] *Emissions calculated using EPA Tanks 4.0.9d (EPA 1999)*

AIR EMISSION CALCULATIONS	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-1-4	PAGE: 1 OF: 2 SHEET: MineLimits
	SUBJECT: Max Case Operation	DATE: June 22, 2020

Maximum Mining Activity Rate

Maximum Operating Schedule

24 hr/day
365 day/yr

Maximum Production

180,000 ton/day, ore and rock *(Midas Gold 2019b)*
180,000 ton/day, ore *(Midas Gold 2019b)*
180,000 ton/day, rock *(Midas Gold 2019b)*

2 blasts per day *(Midas Gold 2019b)*
600 holes per blast *(Midas Gold 2019a)*

Modeling Scenarios

	Model Scenario	Pit YPP ton/day	Pit HFP ton/day	Pit WEP ton/day	Pit BT ton/day	Ore Destination PC ton/day	Ore Destination STKP ton/day	Development Rock Destination FDRSF ton/day	Development Rock Destination HFDRSF ton/day	Development Rock Destination YPDRSF ton/day	Development Rock Destination WEDRSF ton/day
YP	Y1	180,000	--	--	--	--	180,000	--	--	--	--
YP	Y2	180,000	--	--	--	--	--	180,000	--	--	--
YP	Y3	180,000	--	--	--	--	--	--	180,000	--	--
HF	H1	--	180,000	--	--	--	180,000	--	--	--	--
HF	H2	--	180,000	--	--	--	--	180,000	--	--	--
HF	H3	--	180,000	--	--	--	--	--	180,000	--	--
HF	H4	--	180,000	--	--	--	--	--	--	180,000	--
WI	W1	--	--	180,000	--	--	180,000	--	--	--	--
WI	W2	--	--	180,000	--	--	--	180,000	--	--	--
WI	W3	--	--	180,000	--	--	--	--	180,000	--	--
WI	W4	--	--	180,000	--	--	--	--	--	180,000	--
WI	W5	--	--	180,000	--	--	--	--	--	--	180,000
BT	B1	--	--	--	180,000	--	180,000	--	--	--	--
BT	B2	--	--	--	180,000	--	--	--	180,000	--	--

Daily maximum mining equipment

Equipment		Units	
Truck Fleet	Cat 789D	20	*(Midas Gold 2017b)*
Truck Fleet	Cat 740B	12	*(Midas Gold 2019b)*
Water truck	Cat 777D	2	*(Midas Gold 2017b)*
Dozer		6	*(Midas Gold 2017b)*
Grader		3	*(Midas Gold 2017b)*

Daily maximum access road traffic

	One-Way Trips per Day	
Road maintenance equipment	4	*(Midas Gold 2016); Table 12-2*
Light vehicles	19	*(Midas Gold 2016); Table 12-2*
Heavy vehicles	45	*(Midas Gold 2016); Table 12-2*
Total	68	

Acronyms

YPP	Yellow Pine Pit
HFP	Hangar Flats Pit
WEP	West End Pit
BT	Bradley Tailings
FDRSF	Fiddle DRSF
HFDRSF	Hangar Flats DRSF
YPDRSF	Yellow Pine DRSF
WEDRSF	West End DRSF
PC	Primary Crusher
STKP	Primary Crusher Stockpile

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis/E. Memon
	PROJECT NO: 335-1-4	PAGE: 1 OF: 20 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 22, 2020

Model Scenario W3

Mining Activity and Emissions Emissions Summary

By Area/Model ID

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	CO_PPH	CO_TPY	NOX_PPH	NOX_TPY	SO2_PPH	SO2_TPY	VOC_TPY
Area/	Location of	PM	PM10		PM2.5		CO		NOX		SO2		VOC
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr
YPP	Yellow Pine Pit	--	--	--	--	--	--	--	--	--	--	--	--
HFP	Hangar Flats Pit	--	--	--	--	--	--	--	--	--	--	--	--
WEP	West End Pit	344.54	885.54	161.61	79.64	14.53	--	--	--	--	--	--	--
BT	Bradley Tailings	--	--	--	--	--	--	--	--	--	--	--	--
YPPBL	Yellow Pine Pit Blasting	--	--	--	--	--	--	--	--	--	--	--	--
HFPBL	Hangar Flats Pit Blasting	--	--	--	--	--	--	--	--	--	--	--	--
WEPBL	West End Pit Blasting	117.35	334.38	61.02	19.29	3.52	1,742.00	635.83	46.80	17.08	0.09	0.03	--
BTBL	Bradley Tailings Blasting	--	--	--	--	--	--	--	--	--	--	--	--
STKP	PC Stockpile	--	--	--	--	--	--	--	--	--	--	--	--
FDRSF	Fiddle DRSF	--	--	--	--	--	--	--	--	--	--	--	--
HFDRSF	Hangar Flats DRSF	52.91	57.12	10.42	30.23	5.52	--	--	--	--	--	--	--
YPDRSF	Yellow Pine DRSF	--	--	--	--	--	--	--	--	--	--	--	--
WEDRSF	West End DRSF	--	--	--	--	--	--	--	--	--	--	--	--
TSF	Tailing Storage Facility	--	--	--	--	--	--	--	--	--	--	--	--
HR	Haul Roads	3,047.34	4,106.76	750.84	410.88	75.12	--	--	--	--	--	--	--
ACCRD	Access Roads	6.95	9.38	1.72	0.94	0.17	--	--	--	--	--	--	--
UGEXP	Scout Portal	0.002	0.004	0.001	0.001	0.0001	--	--	--	--	--	--	--
Total		3,569.10	5,393.19	985.62	540.98	98.87	1,742.00	635.83	46.80	17.08	0.09	0.03	--

See worksheet ROADS for haul road (HR) emissions by Model ID.

By Activity

	chk	chk-12	chk	chk	chk	chk	chk	chk	chk	chk	chk	chk
	PM	PM10		PM2.5		CO		NOX		SO2		VOC
Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr
Open Pit Drilling	284.70	811.20	148.04	46.80	8.54							
Open Pit Blasting	117.35	334.38	61.02	19.29	3.52	1,742.00	635.83	46.80	17.08	0.09	0.03	
Onsite Hauling	2,901.27	3,899.39	712.95	389.94	71.29							
Material Load / Unload	8.06	20.88	3.81	3.16	0.58							
Dozing	103.56	108.40	19.78	59.58	10.87							
Grading	36.80	60.51	11.04	6.25	1.14							
Water Truck Travel	109.27	146.86	26.85	14.69	2.69							
Access Road	6.95	9.38	1.72	0.94	0.17							
Wind Erosion	0.02	0.04	0.01	0.01	0.00							
Surface Exploration	1.12	2.14	0.39	0.32	0.06							
Underground Exploration	0.002	0.004	0.0007	0.0006	0.0001							
Total	3,569.10	5,393.19	985.62	540.98	98.87	1,742.00	635.83	46.80	17.08	0.09	0.03	--

W3 Model Input Emission Rates (g/s)

By Area/Model ID

		CO_PPH	NOX_TPY	NOX_PPH	PM2.5_TPY	PM2.5_PPD	PM10_PPD	SO2_PPH
Area/	Location of	CO	NO_X		$PM_{2.5}$		PM_{10}	SO_2
Model ID	Activity	8, 1-hr	Annual	1-hr	Annual	24-hr	24-hr	3, 1-hr
YPP	Yellow Pine Pit	--	--	--	--	--	--	--
HFP	Hangar Flats Pit	--	--	--	--	--	--	--
WEP	West End Pit	--	--	--	0.42	0.42	4.65	--
BT	Bradley Tailings	--	--	--	--	--	--	--
YPPBL	Yellow Pine Pit Blasting	--	--	--	--	--	--	--
HFPBL	Hangar Flats Pit Blasting	--	--	--	--	--	--	--
WEPBL	West End Pit Blasting	219.49	0.49	5.90	0.10	0.10	1.76	0.01
BTBL	Bradley Tailings Blasting	--	--	--	--	--	--	--
STKP	PC Stockpile	--	--	--	--	--	--	--
FDRSF	Fiddle DRSF	--	--	--	--	--	--	--
HFDRSF	Hangar Flats DRSF	--	--	--	0.16	0.16	0.30	--
YPDRSF	Yellow Pine DRSF	--	--	--	--	--	--	--
WEDRSF	West End DRSF	--	--	--	--	--	--	--
TSF	Tailing Storage Facility	--	--	--	--	--	--	--
HR	Haul Roads	--	--	--	2.16	2.16	21.56	--
ACCRD	Access Roads	--	--	--	0.00	0.00	0.05	--
UGEXP	Scout Portal	--	--	--	0.000003	0.000003	0.000021	--
Total		219.49	0.49	5.90	2.844043237	2.84	28.31	0.01
		TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE

Model Scenario W3

Open Pit Drilling

Activity Information

Operating schedule 365 day/yr

Total drill holes per year 1,200 hole/day 2 blast/day 600 hole/blast

Annual LOM-W3 rates		Material blasted	Drilling
YPP	Yellow Pine Pit	0 ton/day	0 hole/day
HFP	Hangar Flats Pit	0 ton/day	0 hole/day
WEP	West End Pit	180,000 ton/day	1,200 hole/day
BT	Bradley Tailings	0 ton/day	0 hole/day
	Total	180,000 ton/day	1,200 hole/day

Emission Factors

TSP (PM) 1.3 lb/hole *AP-42, Tab. 11.9-4, 7/98 (overburden)*

PM Scaling Factors

PM 1

PM10 0.52 *AP-42, Tab. 11.9-1, 7/98 (blasting, overburden)*

PM2.5 0.03 *AP-42, Tab. 11.9-1, 7/98 (blasting, overburden)*

Emissions by Model ID

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY
	Location of	PM	PM10		PM2.5	
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr
YPP	Yellow Pine Pit	--	--	--	--	--
HFP	Hangar Flats Pit	--	--	--	--	--
WEP	West End Pit	284.70	811.20	148.04	46.80	8.54
BT	Bradley Tailings	--	--	--	--	--
Total	Open Pit Drilling	284.70	811.20	148.04	46.80	8.54

Source Parameters [1]

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	PITVOL_M3	SXINIT_M	SYINIT_M	SIG_Z_M	ANGL_DEG	Area
		Source	UTM NAD 83		Elev.	Rel. Ht.	Pit Vol.	Len X	Len Y	S-z	Angle	
Model ID	Activity	Type	E m	N m	m	m	m^3	m	m	m	deg	m2
YPP	Yellow Pine Pit	AREA	631,160	4,975,865	1,832	4.75		882.0	882.0	4.42	-8.0	777906
HFP	Hangar Flats Pit	AREA	630,925	4,972,884	1,993	4.75		491.0	491.0	4.42	0.0	241069
WEP	West End Pit	AREA	632,398	4,976,290	2,192	4.75		376.2	376.2	4.42	0.0	141544

[1] *UTM - (Midas Gold 2017d); Rel. Ht. - (EPA 2012); Len X, Len Y, Angle - best-fit equal area rectangle; Elev. - (Midas Gold 2018g)*

Source Parameters [1]

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M		SXINIT_M	SYINIT_M	SIG_Z_M	ANGL_DEG	
		Source	UTM NAD 83		Elev.	Rel. Ht.	Pit Vol.	Len X	Len Y	S-z	Angle	
Model ID	Activity	Type	E m	N m	m	m	m^3	m	m	m	deg	
BT	Bradley Tailings	AREA	630,110	4,972,105	2,012	4.75		820	420	4.42	0.0	344400

[1] *UTM, Elev. - (Midas Gold 2017d); Rel. Ht. - (EPA 2012); Len X, Len Y - best-fit equal area rectangle*

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis/E. Memon
	PROJECT NO: 335-1-4	PAGE: 4 OF: 20 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 22, 2020

Model Scenario W3

Open Pit Blasting

Activity Information

Operating schedule	365	day/yr	24	hr/day	
Blast area	80,795	ft^2/blast	*(Midas Gold 2017b)*		
Blast frequency	1	blast/hr	2	blast/day	730 blast/yr
ANFO use	26	ton/blast	*(Midas Gold 2017b)*		18,980 ton/yr

Annual LOM-W3 rates	Material blasted		Blasting		ANFO use		
Yellow Pine Pit	0	ton/day	0	blast/day	0	ton ANFO/hr	*(Midas Gold 2017b)*
Hangar Flats Pit	0	ton/day	0	blast/day	0	ton ANFO/hr	*(Midas Gold 2017b)*
West End Pit	180,000	ton/day	2	blast/day	26	ton ANFO/hr	*(Midas Gold 2017b)*
Bradley Tailings	0	ton/day	0	blast/day	0	ton ANFO/hr	
Total	180,000	ton/day	2	blast/day	26	ton ANFO/hr	

Emission Factors

Emission factor equation	TSP (lb/blast) = 0.000014 x $A^{1.5}$	*AP-42, Tab. 11.9-1, 7/98 (blasting, overburden)*	
A = Area per blast	80,795 ft^2		
TSP (PM)	321.52 lb/blast		
CO	67 lb/ton-ANFO	*AP-42, Tab. 13.3-1, 2/80 (ANFO)*	
NOX	0.9 kg/t-ANFO	*(CSIRO 2008)*	
	1.8 lb/ton-ANFO		
SO2	3.6E-03 lb/ton-ANFO	*Based on:* 6% *diesel content in ANFO*	*(Midas Gold 2017e)*

$$\frac{1.5E\text{-}05\ \text{lb S}}{\text{lb FO}} \times \frac{2\ \text{lb SO2}}{\text{lb S}} \times \frac{6\%\ \text{lb FO}}{\text{lb ANFO}} \times \frac{2{,}000\ \text{lb ANFO}}{\text{ton ANFO}} = \frac{3.6E\text{-}03\ \text{lb SO2}}{\text{ton ANFO}}$$

PM Scaling Factors

PM10	0.52	*AP-42, Tab. 11.9-1, 7/98 (blasting, overburden)*
PM2.5	0.03	*AP-42, Tab. 11.9-1, 7/98 (blasting, overburden)*

Emissions by Model ID

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	CO_PPH	CO_TPY	NOX_PPH	NOX_TPY	SO2_PPH	SO2_TPY
		PM	PM10		PM2.5		CO		NOX[1]		SO2	
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
YPPBL	Yellow Pine Pit Blasting	--	--	--	--	--	--	--	--	--	--	--
HFPBL	Hangar Flats Pit Blasting	--	--	--	--	--	--	--	--	--	--	--
WEPBL	West End Pit Blasting	117.35	334.38	61.02	19.29	3.52	1,742.00	635.83	46.80	17.08	0.0936	0.0342
BTBL	Bradley Tailings Blasting	--	--	--	--	--	--	--	--	--	--	--
Total	Open Pit Blasting	117.35	334.38	61.02	19.29	3.52	1,742	635.83	46.80	17.08	0.0936	0.0342

(1) *NO2 / NOX:* 0.0357 *(CSIRO 2008)*

Source Parameters (1)

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	SIG_Y_M	SIG_Z_M
		Source	UTM NAD 83		Elev.	Rel. Ht.	S-y	S-z
Model ID	Activity	Type	E m	N m	m	m	m	m
YPPBL	Yellow Pine Pit Blasting	VOLUME	631,471	4,976,374	1,717	15	20.23	6.98
HFPBL	Hangar Flats Pit Blasting	VOLUME	631,171	4,973,129	1,891	15	20.23	6.98
WEPBL	West End Pit Blasting	VOLUME	632,586	4,976,478	1,994	15	20.23	6.98
BTBL	Bradley Tailings Blasting	VOLUME	630,520	4,972,315	2,012	15	20.23	6.98

(1) *UTM, Elev. - (Midas Gold 2017d); Rel. Ht. - (CSIRO 2008); S-y, S-z factors - (EPA 2016)*

Blast height (BH)	30	m	*(CSIRO 2008)/5 for conservatism*	Sigma divider			
Blast width	87	m	*sqrt(blast area)*	Rel. Ht.	2	of BH	*(EPA 2016)*
Blast depth	87	m	*sqrt(blast area)*	S-y	4.3	of SL	*(EPA 2016)*
Equal area side length (SL)	87	m		S-z	4.3	of BH	*(EPA 2016)*

Conversions

2,000	lb/ton
2.205	lb/kg
1.102	ton/t
3.281	ft/m

Model Scenario W3
Onsite Hauling

Activity Information
Operating schedule 365 day/yr 24 hr/day

Hauling Routes, Production Rates and Distances

	Route Origin		Destination		Material Hauled [1] Material Type	Rate ton/day	One-Way Hauling [2] mi	Truck Loads [3] load/day	Total Travel [4] VMT/day
Unpaved Roads									
YPP-I	Yellow Pine Pit	YPP	Process PC	PC	Ore	--	1.84	--	--
YPP-S	Yellow Pine Pit	YPP	PC Stockpile	STKP	Ore	--	1.80	--	--
YPP-F	Yellow Pine Pit	YPP	Fiddle DRSF	FDRSF	Rock	--	2.81	--	--
YPP-H	Yellow Pine Pit	YPP	Hangar Flats DRSF	HFDRSF	Rock	--	4.76	--	--
YPP-Y	Yellow Pine Pit	YPP	Yellow Pine DRSF	YPDRSF	Rock	--		--	--
YPP-W	Yellow Pine Pit	YPP	West End DRSF	WEDRSF	Rock	--		--	--
HFP-I	Hangar Flats Pit	HFP	Process PC	PC	Ore	--	3.16	--	--
HFP-S	Hangar Flats Pit	HFP	PC Stockpile	STKP	Ore	--	3.12	--	--
HFP-F	Hangar Flats Pit	HFP	Fiddle DRSF	FDRSF	Rock	--	4.83	--	--
HFP-H	Hangar Flats Pit	HFP	Hangar Flats DRSF	HFDRSF	Rock	--	2.83	--	--
HFP-Y	Hangar Flats Pit	HFP	Yellow Pine DRSF	YPDRSF	Rock	--	3.72	--	--
HFP-W	Hangar Flats Pit	HFP	West End DRSF	WEDRSF	Rock	--		--	--
WEP-I	West End Pit	WEP	Process PC	PC	Ore	--	2.68	--	--
WEP-S	West End Pit	WEP	PC Stockpile	STKP	Ore	--	2.63	--	--
WEP-F	West End Pit	WEP	Fiddle DRSF	FDRSF	Rock	--	4.43	--	--
WEP-H	West End Pit	WEP	Hangar Flats DRSF	HFDRSF	Rock	180,000	6.49	1,264	16,415
WEP-Y	West End Pit	WEP	Yellow Pine DRSF	YPDRSF	Rock	--	2.75	--	--
WEP-W	West End Pit	WEP	West End DRSF	WEDRSF	Rock	--	3.07	--	--
BT-PC	Bradley Tailings	BT	Process PC	PC	Ore	--		--	--
BT-STK	Bradley Tailings	BT	PC Stockpile	STKP	Ore	--	3.59	--	--
BT-FDR	Bradley Tailings	BT	Fiddle DRSF	FDRSF	Rock	--		--	--
BT-HFD	Bradley Tailings	BT	Hangar Flats DRSF	HFDRSF	Rock	--	0.60	--	--
BT-YPD	Bradley Tailings	BT	Yellow Pine DRSF	YPDRSF	Rock	--		--	--
BT-WED	Bradley Tailings	BT	West End DRSF	WEDRSF	Rock	--		--	--
	Total					180,000			16,415

(1) *(Midas Gold 2019b)*
(2) *(Midas Gold 2017d)*
(3) *See truck fleet information below.*
(4) *Truck loads × One-way hauling ×* 2 *(round-trip)*

Truck Fleet

Truck	Payload Capacity [1] ton	Empty Weight [1] ton	Units [2]	Average Weight ton
Cat 789D	201.8	155.7	20	256.6
Cat 740B	43.5	37.6	12	59.4
Weighted Average	142.4		32	182.6

(1) *789D: (Caterpillar 2016), page 10-14*
740B: (Caterpillar 2011), page 13
(2) *(Midas Gold 2017b)* *(Midas Gold 2019b)*

Model Scenario W3
Onsite Hauling - continued

Hauling Emissions by Route

Route Origin		Destination		Material Hauled Material Type	PM_TPY PM ton/yr	PM10_PPD PM10 lb/day	PM10_TPY PM10 ton/yr	PM2.5_PPD PM2.5 lb/day	PM2.5_TPY PM2.5 ton/yr
Unpaved Roads									
YPP- Yellow Pine Pit	YPP	Process PC	PC	Ore	--	--	--	--	--
YPP- Yellow Pine Pit	YPP	PC Stockpile	STKP	Ore	--	--	--	--	--
YPP- Yellow Pine Pit	YPP	Fiddle DRSF	FDRSF	Rock	--	--	--	--	--
YPP- Yellow Pine Pit	YPP	Hangar Flats DRSF	HFDRSF	Rock	--	--	--	--	--
YPP- Yellow Pine Pit	YPP	Yellow Pine DRSF	YPDRSF	Rock	--	--	--	--	--
YPP- Yellow Pine Pit	YPP	West End DRSF	WEDRSF	Rock	--	--	--	--	--
HFP- Hangar Flats Pit	HFP	Process PC	PC	Ore	--	--	--	--	--
HFP- Hangar Flats Pit	HFP	PC Stockpile	STKP	Ore	--	--	--	--	--
HFP- Hangar Flats Pit	HFP	Fiddle DRSF	FDRSF	Rock	--	--	--	--	--
HFP- Hangar Flats Pit	HFP	Hangar Flats DRSF	HFDRSF	Rock	--	--	--	--	--
HFP- Hangar Flats Pit	HFP	Yellow Pine DRSF	YPDRSF	Rock	--	--	--	--	--
HFP- Hangar Flats Pit	HFP	West End DRSF	WEDRSF	Rock	--	--	--	--	--
WEP West End Pit	WEP	Process PC	PC	Ore	--	--	--	--	--
WEP West End Pit	WEP	PC Stockpile	STKP	Ore	--	--	--	--	--
WEP West End Pit	WEP	Fiddle DRSF	FDRSF	Rock	--	--	--	--	--
WEP West End Pit	WEP	Hangar Flats DRSF	HFDRSF	Rock	2,901.27	3,906.57	712.95	390.66	71.29
WEP West End Pit	WEP	Yellow Pine DRSF	YPDRSF	Rock	--	--	--	--	--
WEP West End Pit	WEP	West End DRSF	WEDRSF	Rock	--	--	--	--	--
BT-P Bradley Tailings	BT	Process PC	PC	Ore	--	--	--	--	--
BT-S Bradley Tailings	BT	PC Stockpile	STKP	Ore	--	--	--	--	--
BT-F Bradley Tailings	BT	Fiddle DRSF	FDRSF	Rock	--	--	--	--	--
BT-H Bradley Tailings	BT	Hangar Flats DRSF	HFDRSF	Rock	--	--	--	--	--
BT-Y Bradley Tailings	BT	Yellow Pine DRSF	YPDRSF	Rock	--	--	--	--	--
BT-W Bradley Tailings	BT	West End DRSF	WEDRSF	Rock	--	--	--	--	--
Pit Subtotal					2,901.27	3,906.57	712.95	390.66	71.29

Emission Factors

Unpaved roads

Annual emission factor equation	$E = k(s/12)^a (W/3)^b [(365-P)/365]$		*AP-42, Sec. 13.2.2, Eq. 1a, 11/06*
Daily emission factor equation	$E = k(s/12)^a (W/3)^b$		*AP-42, Sec. 13.2.2, Eq. 1a, 11/06*
s = Surface material silt content	4	%	*(Midas Gold 2015)*
W = Mean vehicle weight	182.6	ton	
P = Days/year with ≥0.01 in precip	120	day/yr	*AP-42 Fig. 13.2.2-1, 11/06*

	PM	PM10	PM2.5		
k = Size-specific empirical constant	4.9	1.5	0.15		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
a = Size-specific empirical constant	0.7	0.9	0.9		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
b = Size-specific empirical constant	0.45	0.45	0.45		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
E = Size-specific emission factor					
Annual	9.68	2.38	0.24	lb/VMT	
Daily	14.43	3.55	0.35	lb/VMT	

Emission Controls

Unpaved roads - periodic application of water and chemical dust suppressant

Control efficiency: 90% *(Air Sciences 2018)* for chemical suppressant; annual and daily
33% *Conservative estimate* for watering; daily only

Model Scenario W3
Onsite Hauling - continued

Emissions by Area

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY
		PM	PM10		PM2.5	
Area ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr
HR	Onsite Hauling	2,901.27	3,899.39	712.95	389.94	71.29

See worksheet ROADS for haul road (HR) emissions by Model ID.

Source Parameters [1]

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	SIG_Y_M	SIG_Z_M
		Source	UTM NAD 83		Elev.	Rel. Ht.	S-y	S-z
Model ID	Activity	Type	E m	N m	m	m	m	m
HR	Onsite Hauling	VOLUME	*See worksheet: ROADS*			4.75	15.14	4.42

[1] *UTM, Elev. - (Midas Gold 2017d); Rel. Ht., Sy, Sz - (EPA 2012)*

Truck	Height		Reference
Cat 789D	6.5	m	*(Caterpillar 2016), page 10-14*
Cat 740B	4.1	m	*(Caterpillar 2011), page 14*
Weighted	5.58	m	
Road width (RW)	26.5	m	*(Midas Gold 2016), Fig. 9-1*

Plume Parameter	Calculation	Value (m)	Const.
Plume top (PT) - unpaved	1.7 x VH	9.49	1.7
Release height - unpaved	0.5 x PT	4.75	0.5
Plume width (PW)	RW + 6 m	32.55	6
Sigma-z - unpaved	PT / 2.15	4.42	2.15
Sigma-y	PW / 2.15	15.14	2.15

(EPA 2012)

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis/E. Memon
	PROJECT NO: 335-1-4	PAGE: 8 OF: 20 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 22, 2020

Model Scenario W3

Material Load / Unload

Activity Information

Operating schedule 365 day/yr

Throughput Rates

Model ID	Location of Activity	No. of Xfers	Rate ton/day	Total Rate ton/day	Xfer Description
YPP	Yellow Pine Pit	1	0	0	Load
HFP	Hangar Flats Pit	1	0	0	Load
WEP	West End Pit	1	180,000	180,000	Load
BT	Bradley Tailings	1	0	0	Load
PC	Process PC (1)	0	0	0	Unload
STKP	PC Stockpile	2	0	0	Unload & Reload
FDRSF	Fiddle DRSF	1	0	0	Unload
HFDRSF	Hangar Flats DRSF	1	180,000	180,000	Unload
YPDRSF	Yellow Pine DRSF	1	0	0	Unload
WEDRSF	West End DRSF	1	0	0	Unload

(1) *Ore unloading at primary crusher is accounted for in process sources*

Emission Factors

		PM	PM10	PM2.5		
k = Particle size multiplier		0.74	0.35	0.053		*AP-42, Sec. 13.2.4, Pg. 4, 11/06*
E = Emission factor	Load	0.00021	0.0001	0.000015	lb/ton	*AP-42, Tab. 11.19.2-2, 8/04 (truck loading - crushed stone)*
	Unload	0.00003	0.000016	0.0000024	lb/ton	*AP-42, Tab. 11.19.2-2, 8/04 (truck unloading - fragmented stone)*
	Unload &	0.00012	0.00006	0.00001	lb/ton	*Average of loading and unloading EF*

Emissions by Model ID

Model ID	Location of Activity	Total Rate ton/day	PM ton/yr	PM10 lb/day	PM10 ton/yr	PM2.5 lb/day	PM2.5 ton/yr
YPP	Yellow Pine Pit	--	--	--	--	--	--
HFP	Hangar Flats Pit	--	--	--	--	--	--
WEP	West End Pit	180,000	6.95	18.00	3.29	2.73	0.50
BT	Bradley Tailings	--	--	--	--	--	--
PC	Process PC	--	--	--	--	--	--
STKP	PC Stockpile	--	--	--	--	--	--
FDRSF	Fiddle DRSF	--	--	--	--	--	--
HFDRSF	Hangar Flats DRSF	180,000	1.11	2.88	0.53	0.44	0.08
YPDRSF	Yellow Pine DRSF	--	--	--	--	--	--
WEDRSF	West End DRSF	--	--	--	--	--	--
Total	Material Load / Unload	360,000	8.06	20.88	3.81	3.16	0.58

Model Scenario W3

Access Road

Activity Information

Operating schedule 365 day/yr 24 hr/day

Maintenance Equipment, Light and Heavy Truck Specifications and Traffic

Equipment	Equipment Model[1]	Notes	AADT[2]	Annual Traffic	Travel[3] VMT/yr	Vehicle Weight[4] Empty ton	Gross ton	Average Weight ton
Maintenance Equipment	Caterpillar 725C		3	1,095	1,772	25.6	51.6	38.6
Light Vehicles	Ford F-350	5	19	6,935	11,223	4.0	7.9	6.0
Heavy Trucks	Caterpillar CT660 (8X6)	6	45	16,425	26,581	10.1	34.5	22.3
Weighted Average Vehicle Weight								18.4

[1] *Appropriate equipment model from (Midas Gold 2017b)*

[2] *AADT = annual average daily traffic (Midas Gold 2016) Tab. 12-2;*
75% of total maintanance AADT (4) assigned to non-grader maintenance equipment and 25% assigned to grader

[3] *Based on access road length of:* 1.6 *mi (within project boundary)* *(Midas Gold 2017d)*

[4] *(Caterpillar 2016)/manufacturer specifications*

[5] *Light vehicles include visitor and employee vehicles.*

[6] *Heavy trucks include buses, supply, product shipment and trash trucks . 2917 lime delivery trips ((Midas Gold 2017a) Tab. 12-4) are excluded.*

Emission Factors

Annual emission factor equation	$E = k(s/12)^a (W/3)^b [(365-P)/365]$	*AP-42, Sec. 13.2.2, Eq. 1a, 11/06*
Daily emission factor equation	$E = k(s/12)^a (W/3)^b$	*AP-42, Sec. 13.2.2, Eq. 1a, 11/06*
s = Surface material silt content	4 %	*(Midas Gold 2015)*
W = Mean vehicle weight	18.42 ton	
P = Days/year with ≥0.01 in precip.	120 day/yr	*AP-42 Fig. 13.2.2-1, 11/06*

	PM	PM10	PM2.5		
k = Size-specific empirical constant	4.9	1.5	0.15		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
a = Size-specific empirical constant	0.7	0.9	0.9		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
b = Size-specific empirical constant	0.45	0.45	0.45		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
E = Size-specific emission factor					
Annual	3.45	0.85	0.08	lb/VMT	
Daily	5.14	1.26	0.13	lb/VMT	

Emission Controls

Periodic application of water and chemical dust suppressant

Control efficiency: 90% *for chemical suppressant; annual and daily* *See Onsite Hauling*
33% *for watering; daily only*

Emissions by Area

				PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY
				PM	PM10		PM2.5	
Area ID	Activity	VMT/day	VMT/yr	ton/yr	lb/day	ton/yr	lb/day	ton/yr
ACCRD	Vehicle Travel	108.4	39,576	6.83	9.17	1.68	0.92	0.17

Model Scenario W3

Access Road

Grading Traffic

Equipment	AADT	Annual Traffic	VMT/day	VMT/yr
Grader	1	365	1.6	591

Emission Factors *Detailed emission factor calculations are provided on page 10*

PM	4.3	lb/VMT
PM10	1.3	lb/VMT
PM2.5	0.1	lb/VMT

Emission Controls

Periodic application of water and chemical dust suppressant

Control efficiency: 90% *See Onsite Hauling*

Emissions by Area

				PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY
				PM	PM10		PM2.5	
Area ID	Activity	VMT/day	VMT/yr	ton/yr	lb/day	ton/yr	lb/day	ton/yr
ACCRD	Grading	1.6	591	0.13	0.21	0.04	0.02	0.004

Source Parameters [1]

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	SIG_Y_M	SIG_Z_M
		Source	UTM NAD 83		Elev.	Rel. Ht.	Width	S-z
Model ID	Activity	Type	E m	N m	m	m	m	m
ACCRD	*Access Roads*	LINE		*Variable*		2.98	6.10	2.77

[1] *UTM, Elev. - (Midas Gold 2017d); Rel. Ht., Sz - (EPA 2012)*

Vehicle	Height		
Average	3.5	m	
Grader	3.7	m	
HD Truck	3.6	m	
LD Truck	3.2	m	
Road width (RW)	6.1	m	*(Midas Gold 2016), Fig. 7-2*
Road length	2,590	m	

Plume Parameter	Calculation	Value (m)	Const.
Plume top (PT) - unpaved	1.7 x VH	5.95	1.7
Release height - unpaved	0.5 x PT	2.98	0.5
Plume width (PW)	RW + 6 m	12.096	6
Sigma-z - unpaved	PT / 2.15	2.77	2.15

(EPA 2012)

Source Parameters

See Onsite Hauling for source parameters.

Model Scenario W3

Wind Erosion

Activity Information

Operating schedule 365 day/yr

Erodible Area

Model ID	Location of Activity	Surface Type	Total Rate ton/yr	Erodible Area [3] Flat acre/yr	Erodible Area [3] Pile acre/yr	Surface Footprint
STKP	PC Stockpile	Pile	--		--	13
FDRSF	Fiddle DRSF	Pile	--		--	148
HFDRSF	Hangar Flats DRSF	Pile	180,000		20	140
YPDRSF	Yellow Pine DRSF	Pile	--		--	152
WEDRSF	West End DRSF	Pile	--		--	70
BT	Bradley Tailings	Flat		85		85
TSF	Tailing Storage Facility	Flat		331		331
HR	Haul Roads [1]	Flat		582		582
ACCRD	Access Roads [2]	Flat		4		4

[1] *Based on scenario haul road length of* 55 *mi* *and width of* 26.5 *m* *(Midas Gold 2016), Fig. 9-1*

[2] *Based on access road (within boundary) length of* 1.6 *mi* *and width of* 6.1 *m* *(Midas Gold 2016), Fig. 7-2*

[3] *Pile surface area calculations:*

Truck dump (TD) size 142.4 ton

Material density 150.2 lb/ft^3 *(Midas Gold 2017b), Average Ore & Waste (YP, HF, WE, BT)*

0.075 ton/ft^3

Material specific volume 13.3 ft^3/ton

TD volume (V) 1,896 ft^3

Conical surface calculations

Side slope 38 deg *Typical*

0.7 rad

Conical surface area (SA) Π × r × (h^2 + r^2)^0.5

Conical volume (V) (Π × h × r^2) ÷ 3

Conical base radius r = s × cos(slope)

Conical height h = s × sin(slope)

Sloped side length s = (h^2 + r^2)^0.5

Solution of conical volume equation

Replacing h and r with s × sin(slope) and s × cos(slope), respectively:

s = [3 × V/(pi × sin(slope) × cos^2(slope)]^(1/3) 16.8 ft

r 13.2 ft

h 10.3 ft

SA 698 ft^2

0.016 acre

1.1E-4 acre/ton-TD

Scaling Factors

PM10 0.5 *AP-42, Pg. 13.2.5-3, 11/06*

PM2.5 0.075 *AP-42, Pg. 13.2.5-3, 11/06*

Model Scenario W3

Surface Exploration

Activity Information

Operating schedule	365 day/yr	24 hr/day		
Duration	14 yr	168 mo		*(Midas Gold 2018a)*
Construction disturbance	13 acres	0.08 acre/mo		*(Midas Gold 2016), p. 13-1*
Total wet drilling (maximum)	700 holes	50 holes/yr		*(Midas Gold 2016), p. 13-1*
Material blasted	724.9 ton/hole			

Construction Emission Calculations

Emission Factors

PM	1.2 ton/acre	per month of activity	*AP-42, Page 13.2.3-1, 1/95*

PM Scaling Factors

PM10	0.35	*AP-42, Sec. 13.2.4, Pg. 4, 11/06*
PM2.5	0.053	*AP-42, Sec. 13.2.4, Pg. 4, 11/06*

Construction Emissions

Activity	PM	PM10		PM2.5	
	ton/yr	lb/day	ton/yr	lb/day	ton/yr
Drill Pad and Temporary Road Construction	1.1	2.1	0.4	0.3	0.1

Wet Drilling Emission Calculations

Emission Factors

PM10	8.0E-5	lb/ton (material blasted)	*AP-42, Table 11.19.2-2 (wet drilling), Rev. 8/04*
	0.058	lb/hole	

PM Scaling Factors

PM	0.74	*AP-42, Sec. 13.2.4-4, 11/06*
PM10	0.35	*AP-42, Sec. 13.2.4-4, 11/06*
PM2.5	0.053	*AP-42, Sec. 13.2.4-4, 11/06*

Wet Drilling Emissions

Activity	PM	PM10		PM2.5	
	ton/yr	lb/day	ton/yr	lb/day	ton/yr
Wet Drilling	0.0031	0.0079	0.0015	0.0012	0.00022

Surface Exploration Total Emissions

PM	PM10		PM2.5	
ton/yr	lb/day	ton/yr	lb/day	ton/yr
1.12	2.14	0.39	0.32	0.06

Emissions by Model ID [1]

		chk PM_TPY	chk PM10_PPD	chk PM10_TPY	chk PM2.5_PPD	chk PM2.5_TPY
		PM	PM10		PM2.5	
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr
WEP	Surface Exploration	1.12	2.14	0.39	0.32	0.06

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis/E. Memon
	PROJECT NO: 335-1-4	PAGE: 20 OF: 20 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 22, 2020

Model Scenario W3

Underground Exploration

Activity Information

Operating schedule	365	day/yr	
Wet drilling	25	holes/yr	*(Midas Gold 2020)*

Wet Drilling Emission Calculations

Emission Factors

PM10	8.0E-5	lb/ton (material blasted)	*AP-42, Table 11.19.2-2 (wet drilling), Rev. 8/04*
	0.058	lb/hole	

PM Scaling Factors

PM	0.74	*AP-42, Sec. 13.2.4-4, 11/06*
PM10	0.35	*AP-42, Sec. 13.2.4-4, 11/06*
PM2.5	0.053	*AP-42, Sec. 13.2.4-4, 11/06*

Wet Drilling Emissions

Activity	PM	PM10		PM2.5	
	ton/yr	lb/day	ton/yr	lb/day	ton/yr
Wet Drilling	0.0015	0.0040	0.0007	0.0006	0.00011

Source Parameters [1]

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	SIG_Y_M	SIG_Z_M	SXINIT_M	SYINIT_M
		Source	UTM NAD 83		Elev.	Rel. Ht.	S-y	S-z	Length	Width
Model ID	Activity	Type	E m	N m	m	m	m	m	m	m
UGEXP	*Scout Portal*	AREA	632,362	4,973,690	2018	0	0	0	4.88	4.88

UTM, Elev. - (Midas Gold 2017d)

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis/E. Memon		
	PROJECT NO: 335-1-4	PAGE: 4	OF: 4	SHEET: Conv
AIR EMISSION CALCULATIONS	SUBJECT: Conversions and Constants	DATE: June 22, 2020		

Fuel Burning Equipment Emissions

	Source	MMBtu/hr	Flow Rate dscfm (dscfm)	PM lb/hr (PM_pph)	PM gr/dscf	PM Limit [1] gr/dscf	
Sb1	Sb Dryer (2.72 MMBtu/hr Propane-Fired)	2.72	461	0.021	0.005	0.015	In Compliance
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	17	2,881	0.130	0.005	0.015	In Compliance
CKB	Carbon Regeneration Kiln (Burners)	2.255	382	0.017	0.005	0.015	In Compliance
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0.1	17	0.001	0.005	0.015	In Compliance
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	5	847	0.038	0.005	0.015	In Compliance
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	4	678	0.031	0.005	0.015	In Compliance
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	4	678	0.031	0.005	0.015	In Compliance
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	4	678	0.031	0.005	0.015	In Compliance
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0.25	42	0.002	0.005	0.015	In Compliance
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0.25	42	0.002	0.005	0.015	In Compliance
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0.25	42	0.002	0.005	0.015	In Compliance
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0.5	85	0.004	0.005	0.015	In Compliance
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	2	339	0.015	0.005	0.015	In Compliance
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	3	508	0.023	0.005	0.015	In Compliance
LKC	PFR Shaft Lime Kiln Combustion	22.0	8,000	0.169	0.002	0.015	In Compliance
EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	9.39	1,259	0.441	0.041	0.05	In Compliance
EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	9.39	1,259	0.441	0.041	0.05	In Compliance
EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	9.39	1,259	0.441	0.041	0.05	In Compliance
EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	1.88	252	0.088	0.041	0.05	In Compliance

[1] *58.01.01.676, Fuel Type: Gas, Emission Oxygen 3%*

Baghouse/Bin Vent Filter PM Emission Concentration

	Source	Control (control)	Flow Rate dscfm (dscfm)	PM lb/hr (PM_pph)	PM gr/dscf	PM10 lb/hr (PM10_pph)	PM10 gr/dscf
Sb2	Sb Bagging	Baghouse (BH1)	800	0.118	0.017	0.118	0.017
MF	Induction Melting Furnace	Baghouse (BH2)	3,500	2.839	0.095	2.839	0.095
LSBM	Limestone Ball Mill	Baghouse (BH3)	13,000	1.902	0.017	1.596	0.014
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	Baghouse (BH4)	8,000	0.915	0.013	0.915	0.013
LCR	Lime Mill Crushing and associated transfers In and Out	Baghouse (BH5)	2,000	0.284	0.017	0.239	0.014
LS1L	Mill Lime Silo #1 Loading	Bin Vent Filter	700	0.059	0.010	0.020	0.003
MillS2L	Mill Lime Silo #2 Loading	Bin Vent Filter	700	0.059	0.010	0.020	0.003
ACS1L	AC Lime Silo #1 Loading	Bin Vent Filter	1,400	0.119	0.010	0.041	0.003
ACS2L	AC Lime Silo #2 Loading	Bin Vent Filter	1,400	0.119	0.010	0.041	0.003
ACS3L	AC Lime Silo #3 Loading	Bin Vent Filter	1,400	0.119	0.010	0.041	0.003
ACS4L	AC Lime Silo #4 Loading	Bin Vent Filter	1,400	0.119	0.010	0.041	0.003
CS1L	Cement/Shotcrete Silo #1 Loading	Bin Vent Filter	930	0.079	0.010	0.027	0.003
CS2L	Cement/Shotcrete Silo #2 Loading	Bin Vent Filter	930	0.079	0.010	0.027	0.003
LSL	Pebble Lime Silo Loading via Bucket Elevator	Bin Vent Filter	70	0.006	0.010	0.006	0.010

PROJECT TITLE: Stibnite Gold Project
PROJECT NO.: 335-1-4
SUBJECT: **Process Activity Uncontrolled Emissions**

SOURCE DESCRIPTION		HOURLY EMISSIONS							DAILY EMISSIONS							ANNUAL EMISSIONS						
Model	Source Description	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC
ID		lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr
OC1	Loader Transfer of Ore to Grizzly	3.13	1.15	0.18					75.00	27.50	4.25					13.69	5.02	0.78				
OC2	Grizzly to Apron Feeder	3.13	1.15	0.18					75.00	27.50	4.25					13.69	5.02	0.78				
OC3	Apron Feeder to Dribble Conveyor	3.13	1.15	0.18					75.00	27.50	4.25					13.69	5.02	0.78				
OC4	Apron Feeder to Vibrating Grizzly	3.13	1.15	0.18					75.00	27.50	4.25					13.69	5.02	0.78				
OC5	Dribble Conveyor to Vibrating Grizzly	3.13	1.15	0.18					75.00	27.50	4.25					13.69	5.02	0.78				
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	3.13	1.15	0.18					75.00	27.50	4.25					13.69	5.02	0.78				
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	5.63	2.50	0.38					135	60.00	9.00					24.64	10.95	1.64				
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	3.13	1.15	0.18					75.00	27.50	4.25					13.69	5.02	0.78				
OC9	Stockpile Transfers to Reclaim Conveyors	3.45	1.27	0.20					82.80	30.36	4.69					15.11	5.54	0.86				
OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	3.45	1.27	0.20					82.80	30.36	4.69					15.11	5.54	0.86				
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	3.45	1.27	0.20					82.80	30.36	4.69					15.11	5.54	0.86				
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	6.21	2.76	0.41					149	66.24	9.94					27.20	12.09	1.81				
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	3.45	1.27	0.20					82.80	30.36	4.69					15.11	5.54	0.86				
LS1L	Mill Lime Silo #1 Loading	43.80	28.20	4.27					183	118	17.79					1.60	1.03	0.16				
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	9.60E-2	5.60E-2	8.40E-3					1.20	0.70	0.11					1.05E-2	6.13E-3	9.19E-4				
MillS2L	Mill Lime Silo #2 Loading	43.80	28.20	4.27					183	118	17.79					1.60	1.03	0.16				
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	9.60E-2	5.60E-2	8.40E-3					1.20	0.70	0.11					1.05E-2	6.13E-3	9.19E-4				
Sb1	Sb Dryer (2.72 MMBtu/hr Propane-Fired)	2.08E-2	2.08E-2	2.08E-2	0.22	0.39	4.73E-2	2.38E-2	0.50	0.50	0.50	5.35	9.27	1.13	0.57	9.11E-2	9.11E-2	9.11E-2	0.98	1.69	0.21	0.10
Sb2	Sb Bagging	1.18	1.18	1.18					28.27	28.27	28.27					5.16	5.16	5.16				
AC	Autoclave	16.92	16.92	16.92			0.65		406	406	406			15.66		74.10	74.10	74.10			2.86	
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0.13	0.13	0.13	1.39	2.42	0.30	0.15	0.13	0.13	0.13	1.39	2.42	0.30	0.15	1.95E-3	1.95E-3	1.95E-3	2.09E-2	3.62E-2	4.43E-3	2.23E-3
ACS1L	AC Lime Silo #1 Loading	87.60	56.40	8.54					730	470	71.17					6.39	4.11	0.62				
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	9.60E-2	5.60E-2	8.00E-3					2.30	1.34	0.19					4.20E-2	2.45E-2	3.50E-3				
ACS2L	AC Lime Silo #2 Loading	87.60	56.40	8.54					730	470	71.17					6.39	4.11	0.62				
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	9.60E-2	5.60E-2	8.00E-3					2.30	1.34	0.19					4.20E-2	2.45E-2	3.50E-3				
ACS3L	AC Lime Silo #3 Loading	87.60	56.40	8.54					730	470	71.17					6.39	4.11	0.62				

PROJECT TITLE: Stibnite Gold Project
PROJECT NO.: 335-1-4
SUBJECT: **Process Activity Uncontrolled Emissions**

SOURCE DESCRIPTION		HOURLY EMISSIONS							DAILY EMISSIONS							ANNUAL EMISSIONS						
Model ID	Source Description	PM lb/hr	PM_{10} lb/hr	$PM_{2.5}$ lb/hr	CO lb/hr	NOx lb/hr	SO_2 lb/hr	VOC lb/hr	PM lb/day	PM_{10} lb/day	$PM_{2.5}$ lb/day	CO lb/day	NOx lb/day	SO_2 lb/day	VOC lb/day	PM ton/yr	PM_{10} ton/yr	$PM_{2.5}$ ton/yr	CO ton/yr	NOx ton/yr	SO_2 ton/yr	VOC ton/yr
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	9.60E-2	5.60E-2	8.00E-3					2.30	1.34	0.19					4.20E-2	2.45E-2	3.50E-3				
ACS4L	AC Lime Silo #4 Loading	87.60	56.40	8.54					365	235	35.59					3.19	2.06	0.31				
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	9.60E-2	5.60E-2	8.00E-3					2.30	1.34	0.19					2.10E-2	1.23E-2	1.75E-3				
CKD	Carbon Regeneration Kiln (Drum)	1.40	1.40	1.40	0.12	1.20E-2		0.11	33.60	33.60	33.60	2.88	0.29	0.00E+0	2.64	6.13	6.13	6.13	0.53	5.26E-2		0.48
CKB	Carbon Regeneration Kiln (Burners)	1.73E-2	1.73E-2	1.73E-2	0.18	0.32	3.92E-2	1.97E-2	0.41	0.41	0.41	4.44	7.69	0.94	0.47	7.56E-2	7.56E-2	7.56E-2	0.81	1.40	0.17	8.64E-2
EW	Electrowinning Cells and Pregnant Solution Tank																					
MR	Mercury Retort																					
MF	Induction Melting Furnace	5.68	5.68	5.68					68.14	68.14	68.14					1.77	1.77	1.77				
EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0.44	0.44	0.44	7.72	14.11	1.45E-2	2.87	0.44	0.44	0.44	7.72	14.11	1.45E-2	2.87	2.20E-2	2.20E-2	2.20E-2	0.39	0.71	7.24E-4	0.14
EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0.44	0.44	0.44	7.72	14.11	1.45E-2	2.87	0.44	0.44	0.44	7.72	14.11	1.45E-2	2.87	2.20E-2	2.20E-2	2.20E-2	0.39	0.71	7.24E-4	0.14
EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0.44	0.44	0.44	7.72	14.11	1.45E-2	2.87	0.44	0.44	0.44	7.72	14.11	1.45E-2	2.87	2.20E-2	2.20E-2	2.20E-2	0.39	0.71	7.24E-4	0.14
EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	8.82E-2	8.82E-2	8.82E-2	1.54	1.76	2.90E-3	1.76	8.82E-2	8.82E-2	8.82E-2	1.54	1.76	2.90E-3	1.76	4.41E-3	4.41E-3	4.41E-3	7.72E-2	8.82E-2	1.45E-4	8.82E-2
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7.65E-4	7.65E-4	7.65E-4	8.20E-3	1.42E-2	1.74E-3	8.74E-4	1.84E-2	1.84E-2	1.84E-2	0.20	0.34	4.17E-2	2.10E-2	3.35E-3	3.35E-3	3.35E-3	3.59E-2	6.22E-2	7.61E-3	3.83E-3
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	3.83E-2	3.83E-2	3.83E-2	0.41	0.71	8.69E-2	4.37E-2	0.92	0.92	0.92	9.84	17.05	2.09	1.05	0.17	0.17	0.17	1.80	3.11	0.38	0.19
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	3.06E-2	3.06E-2	3.06E-2	0.33	0.57	6.95E-2	3.50E-2	0.73	0.73	0.73	7.87	13.64	1.67	0.84	0.13	0.13	0.13	1.44	2.49	0.30	0.15
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	3.06E-2	3.06E-2	3.06E-2	0.33	0.57	6.95E-2	3.50E-2	0.73	0.73	0.73	7.87	13.64	1.67	0.84	0.13	0.13	0.13	1.44	2.49	0.30	0.15
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	3.06E-2	3.06E-2	3.06E-2	0.33	0.57	6.95E-2	3.50E-2	0.73	0.73	0.73	7.87	13.64	1.67	0.84	0.13	0.13	0.13	1.44	2.49	0.30	0.15
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	1.91E-3	1.91E-3	1.91E-3	2.05E-2	3.55E-2	4.34E-3	2.19E-3	4.59E-2	4.59E-2	4.59E-2	0.49	0.85	0.10	5.25E-2	8.38E-3	8.38E-3	8.38E-3	8.98E-2	0.16	1.90E-2	9.57E-3
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	1.91E-3	1.91E-3	1.91E-3	2.05E-2	3.55E-2	4.34E-3	2.19E-3	4.59E-2	4.59E-2	4.59E-2	0.49	0.85	0.10	5.25E-2	8.38E-3	8.38E-3	8.38E-3	8.98E-2	0.16	1.90E-2	9.57E-3
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	1.91E-3	1.91E-3	1.91E-3	2.05E-2	3.55E-2	4.34E-3	2.19E-3	4.59E-2	4.59E-2	4.59E-2	0.49	0.85	0.10	5.25E-2	8.38E-3	8.38E-3	8.38E-3	8.98E-2	0.16	1.90E-2	9.57E-3
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	3.83E-3	3.83E-3	3.83E-3	4.10E-2	7.10E-2	8.69E-3	4.37E-3	9.18E-2	9.18E-2	9.18E-2	0.98	1.70	0.21	0.10	1.68E-2	1.68E-2	1.68E-2	0.18	0.31	3.81E-2	1.91E-2
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	1.53E-2	1.53E-2	1.53E-2	0.16	0.28	3.48E-2	1.75E-2	0.37	0.37	0.37	3.93	6.82	0.83	0.42	6.70E-2	6.70E-2	6.70E-2	0.72	1.24	0.15	7.66E-2
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	2.30E-2	2.30E-2	2.30E-2	0.25	0.43	5.21E-2	2.62E-2	0.55	0.55	0.55	5.90	10.23	1.25	0.63	0.10	0.10	0.10	1.08	1.87	0.23	0.11
PSL	Prill Silos Loading (2 x 100 ton)	4.00	1.40	0.21					4.00	1.40	0.21					7.30E-2	2.56E-2	3.87E-3				
PSU	Prill Silos Unloading (2 x 100 ton)	4.00	1.40	0.21					4.00	1.40	0.21					7.30E-2	2.56E-2	3.87E-3				
CS1L	Cement/Shotcrete Silo #1 Loading	58.40	37.60	5.69					58.40	37.60	5.69					21.90	14.10	2.14				
CS1U	Cement/Shotcrete Silo #1 Unloading	9.60E-2	5.60E-2	8.00E-3					0.38	0.22	3.20E-2					0.14	8.40E-2	1.20E-2				
CS2L	Cement/Shotcrete Silo #2 Loading	58.40	37.60	5.69					58.40	37.60	5.69					21.90	14.10	2.14				
CS2U	Cement/Shotcrete Silo #2 Unloading	9.60E-2	5.60E-2	8.00E-3					0.38	0.22	3.20E-2					0.14	8.40E-2	1.20E-2				
CAL	Aggregate Bin Loading	0.69	0.33	5.00E-2					16.56	7.92	1.20					1.73	0.83	0.13				
CAU	Aggregate Bin Unloading	0.69	0.33	5.00E-2					16.56	7.92	1.20					1.73	0.83	0.13				
CM	Central Mixer Loading	11.44	3.12	0.47					45.76	12.48	1.89					17.16	4.68	0.71				

PROJECT TITLE: Stibnite Gold Project
PROJECT NO.: 335-1-4
SUBJECT: **Process Activity Uncontrolled Emissions**

SOURCE DESCRIPTION		HOURLY EMISSIONS							DAILY EMISSIONS							ANNUAL EMISSIONS						
Model ID	Source Description	PM lb/hr	PM_{10} lb/hr	$PM_{2.5}$ lb/hr	CO lb/hr	NOx lb/hr	SO_2 lb/hr	VOC lb/hr	PM lb/day	PM_{10} lb/day	$PM_{2.5}$ lb/day	CO lb/day	NOx lb/day	SO_2 lb/day	VOC lb/day	PM ton/yr	PM_{10} ton/yr	$PM_{2.5}$ ton/yr	CO ton/yr	NOx ton/yr	SO_2 ton/yr	VOC ton/yr
TG1	Mine Site Gasoline Tank #1							0.22							5.25							0.96
TG2	Mine Site Gasoline Tank #2							0.22							5.25							0.96
TD3	Mine Site Diesel Tank #3							1.67E-3							4.00E-2							7.30E-3
TD4	Mine Site Diesel Tank #4							1.67E-3							4.00E-2							7.30E-3
TD5	Mine Site Diesel Tank #5							1.67E-3							4.00E-2							7.30E-3
TD6	Mine Site Diesel Tank #6							1.67E-3							4.00E-2							7.30E-3
TD7	Mine Site Diesel Tank #7							1.67E-3							4.00E-2							7.30E-3
TD8	Mine Site Diesel Tank #8							1.67E-3							4.00E-2							7.30E-3
TD9	Mine Site Diesel Tank #9							1.67E-3							4.00E-2							7.30E-3
TD10	Mine Site Diesel Tank #10							1.67E-3							4.00E-2							7.30E-3
PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	6.32	2.31	0.35					152	55.40	8.42					27.67	10.11	1.54				
PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	6.32	2.31	0.35					152	55.40	8.42					27.67	10.11	1.54				
TRUE	LIME PRODUCTION																					
LS1	Limestone transfer to Primary Crusher Hopper	0.14	5.18E-2	8.00E-3					3.39	1.24	0.19					0.48	0.17	2.70E-2				
LS2	Primary Crushing and Associated Transfers In and Out	0.25	0.11	1.69E-2					6.10	2.71	0.41					0.86	0.38	5.72E-2				
LS3	Primary Screening and Associated Transfers In and Out	1.18	0.41	6.21E-2					28.25	9.83	1.49					3.97	1.38	0.21				
LS4	Secondary Crushing and Associated Transfers In and Out	0.25	0.11	1.69E-2					6.10	2.71	0.41					0.86	0.38	5.72E-2				
LS5	Secondary Screening and Associated Transfers In and Out	1.18	0.41	6.21E-2					28.25	9.83	1.49					3.97	1.38	0.21				
LS6	Limestone transfer to Ball Mill Feed Bin	0.14	5.18E-2	8.00E-3					3.39	1.24	0.19					0.48	0.17	2.70E-2				
LS7	Limestone transfer to Ball Mill Feed Conveyor	0.14	5.18E-2	8.00E-3					3.39	1.24	0.19					0.48	0.17	2.70E-2				
LS8	Ball Mill Feed transfer to Ball Mill	0.14	5.18E-2	8.00E-3					3.39	1.24	0.19					0.48	0.17	2.70E-2				
LSBM	Limestone Ball Mill	19.02	15.96	5.70					456	383	137					64.22	53.89	19.23				
LS9	Limestone transfer to Kiln Feed Bin	3.34E-2	1.22E-2	1.89E-3					0.80	0.29	4.54E-2					0.12	4.55E-2	7.03E-3				
LS10	Limestone transfer to Lime Kiln Feed Conveyor	3.34E-2	1.22E-2	1.89E-3					0.80	0.29	4.54E-2					0.12	4.55E-2	7.03E-3				
LS11	Fines Screening and Associated Transfers In and Out	0.28	9.68E-2	1.47E-2					6.68	2.32	0.35					1.03	0.36	5.46E-2				
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	3.34E-2	1.22E-2	1.89E-3					0.80	0.29	4.54E-2					0.12	4.55E-2	7.03E-3				
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	9.15	9.15	9.15	3.17	1.69	8.45E-3		220	220	220	76.05	40.56	0.20		34.05	34.05	34.05	11.78	6.29	3.14E-2	
LKC	PFR Shaft Lime Kiln Combustion	0.17	0.17	0.17	1.81	3.13	0.38	0.19	4.05	4.05	4.05	43.36	75.15	9.19	4.62	0.63	0.63	0.63	6.72	11.65	1.42	0.72
LCR	Lime Mill Crushing and associated transfers In and Out	2.84	2.39	0.85					68.28	57.29	20.45					10.58	8.88	3.17				
LSL	Pebble Lime Silo Loading via Bucket Elevator	6.20E-2	6.20E-2	6.20E-2					1.49	1.49	1.49					0.23	0.23	0.23				
LSU	Pebble Lime Silo discharge to Lime Slaker	6.20E-3	6.20E-3	6.20E-3					0.15	0.15	0.15					2.30E-2	2.30E-2	2.30E-2				
Total		**699**	**443**	**102**	**33.50**	**55.37**	**1.88**	**11.51**	**5,964**	**3,786**	**1,316**	**204**	**259**	**37.21**	**34.53**	**565**	**342**	**169**	**30.45**	**37.85**	**6.48**	**4.78**

SOURCE DESCRIPTION		OPERATING LIMITS							EMISSION FACTORS									EMISSION CON	
Model	Source Description	Design Throughput						Throughput reference	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	unit	reference	control	efficiency
ID		unit/hr	unit/day	unit/yr	units	Material	hr/yr											system	
OC1	Loader Transfer of Ore to Grizzly	1,042	25,000	9,125,000	ton	Ore	8,760	(Midas Gold 2016), Sec. 10.1	0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.	Water Sprays	
OC2	Grizzly to Apron Feeder	1,042	25,000	9,125,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.	Moisture Carry-Over	
OC3	Apron Feeder to Dribble Conveyor	1,042	25,000	9,125,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.	Moisture Carry-Over	
OC4	Apron Feeder to Vibrating Grizzly	1,042	25,000	9,125,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.	Moisture Carry-Over	
OC5	Dribble Conveyor to Vibrating Grizzly	1,042	25,000	9,125,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.	Moisture Carry-Over	
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	1,042	25,000	9,125,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.	Moisture Carry-Over	
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	1,042	25,000	9,125,000	ton	Ore	8,760		0.0012	0.00054	0.0001					lb/ton	AP-42, Table 11.19.2-2 (08/04) Tert. Crushing - ctrl.	Water Sprays	
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	1,042	25,000	9,125,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.	Moisture Carry-Over	
OC9	Stockpile Transfers to Reclaim Conveyors	1,150	27,600	10,074,000	ton	Ore	8,760	(M3 2017b)	0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - unctrl.; PM2.5 Ch. 13.2.4	Undergrnd	80%
OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	1,150	27,600	10,074,000	ton	Ore	8,760		0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - unctrl.; PM2.5 Ch. 13.2.4	Undergrnd	80%
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	1,150	27,600	10,074,000	ton	Ore	8,760		0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - unctrl.; PM2.5 Ch. 13.2.4	Enclosure	80%
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	1,150	27,600	10,074,000	ton	Ore	8,760		0.0012	0.00054	0.0001					lb/ton	AP-42, Table 11.19.2-2 (08/04) Tert. Crushing - ctrl.	Water Sprays	
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	1,150	27,600	10,074,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.	Moisture Carry-Over	
LS1L	Mill Lime Silo #1 Loading	60	250	4,375	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.00099	0.00034	0.00005					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4	Bin Vent Filter	
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	20	250	4,375	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.00042					lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4	None	0%
MillS2L	Mill Lime Silo #2 Loading	60	250	4,375	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.00099	0.00034	0.00005					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4	Bin Vent Filter	
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	20	250	4,375	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.00042					lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4	None	0%
Sb1	Sb Dryer (2.72 MMBtu/hr Propane-Fired)	2.72	65.28	23,827	MMBtu	Propane	8,760	(M3 2017d)	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal	None	NA
Sb2	Sb Bagging	4.5	108	39,420	ton	Stib. Conc.	8,760	(M3 2017d)	0.118	0.118	0.118					lb/hr	Based on NDEP-BAPC Permit for Clay Bagging Operation (Hectatone) (NDEP 2015b)	Baghouse (BH1)	NA
AC	Autoclave	290	6,960	2,540,400	ton	Float Conc.	8,760	(M3 2017b)	5.075	5.075	5.075			0.6525		lb/hr	Based on NDEP-BAPC Permits/test data for Autoclaves: PM & SO2 - [Goldstrike (NDEP 2012)]. Negligible CO due to no organic carbon in the feed (M3 2017a)	Wet Scrubber (WS1)	NA
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	17	17	510	MMBtu	Propane	30	(M3 2017b)	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Ind. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal	None	NA
ACS1L	AC Lime Silo #1 Loading	120	1,000	17,500	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.00099	0.00034	0.00005					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4	Bin Vent Filter	
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	20	480	17,500	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.0004					lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4	None	0%
ACS2L	AC Lime Silo #2 Loading	120	1,000	17,500	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.00099	0.00034	0.00005					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4	Bin Vent Filter	
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	20	480	17,500	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.0004					lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4	None	0%
ACS3L	AC Lime Silo #3 Loading	120	1,000	17,500	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.00099	0.00034	0.00005					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4	Bin Vent Filter	
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	20	480	17,500	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.0004					lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4	None	0%
ACS4L	AC Lime Silo #4 Loading	120	500	8,750	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.00099	0.00034	0.00005					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4	Bin Vent Filter	
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	20	480	8,750	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.0004					lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4	None	0%
CKD	Carbon Regeneration Kiln (Drum)	0.3	7.2	2,628	ton	Carbon	8,760	(M3 2017b)	0.42	0.42	0.42	0.12	0.012		0.11	lb/hr	Based on NDEP-BAPC Permit for Carbon Regeneration Kiln [Goldstrike (NDEP 2012)]	Wet Scrubber (WS2) / Carbon Filter (CA1)	NA
CKB	Carbon Regeneration Kiln (Burners)	2.255	54.12	19,754	MMBtu	Propane	8,760	(M3 2017b)	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal	None	NA
EW	Electrowinning Cells and Pregnant Solution Tank	100	24 hr		gpm	Au Sol.	8,760	Typical Ind. Oper.	0.07	0.07	0.07					lb/hr	Based on similar source stack test data and 5× safety factor (APT 2016)	Shared Carbon Filter (CA2)	
MR	Mercury Retort	0.5/batch	24 hr	21	ton	Au Conc.	1,248	(M3 2017b) & (M3 2017a)	0.01	0.01	0.01					lb/hr	Based on similar source stack test data and 5× safety factor (APT 2017)	Condenser / Carbon Filter (CA3)	
MF	Induction Melting Furnace	0.5/batch	12 hr	21	ton	Au Conc.	624	(M3 2017b) & (M3 2017a)	2.84	2.84	2.84					lb/hr	Based on IDAPA 58.01.01.701 PM Weight Limit	Baghouse (BH2) / Carbon Filter (CA4)	NA

SOURCE DESCRIPTION		TROLS	HOURLY EMISSIONS							DAILY EMISSIONS							ANNUAL EMISSIONS								
Model	Source Description	reference	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	UTM E	UTM N
ID			lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	m	m
OC1	Loader Transfer of Ore to Grizzly	Control efficiency included in emission factor	0.146	0.0479	0.0135					3.50	1.15	0.325					0.639	0.210	0.0593					632,045	4,974,583
OC2	Grizzly to Apron Feeder	Control efficiency included in emission factor	0.146	0.0479	0.0135					3.50	1.15	0.325					0.639	0.210	0.0593					632,045	4,974,583
OC3	Apron Feeder to Dribble Conveyor	Control efficiency included in emission factor	0.146	0.0479	0.0135					3.50	1.15	0.325					0.639	0.210	0.0593					632,045	4,974,583
OC4	Apron Feeder to Vibrating Grizzly	Control efficiency included in emission factor	0.146	0.0479	0.0135					3.50	1.15	0.325					0.639	0.210	0.0593					632,045	4,974,583
OC5	Dribble Conveyor to Vibrating Grizzly	Control efficiency included in emission factor	0.146	0.0479	0.0135					3.50	1.15	0.325					0.639	0.210	0.0593					632,045	4,974,583
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	Control efficiency included in emission factor	0.146	0.0479	0.0135					3.50	1.15	0.325					0.639	0.210	0.0593					632,045	4,974,583
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	Control efficiency included in emission factor	1.25	0.563	0.104					30.0	13.5	2.50					5.48	2.46	0.456					632,045	4,974,583
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	Control efficiency included in emission factor	0.146	0.0479	0.0135					3.50	1.15	0.325					0.639	0.210	0.0593					631,947	4,974,520
OC9	Stockpile Transfers to Reclaim Conveyors	Based on AP-42, Chapter 13.2.4, reduction in EF due to wind speed reduction	0.690	0.253	0.0391					16.6	6.07	0.938					3.02	1.11	0.171					631,947	4,974,520
OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	Based on AP-42, Chapter 13.2.4, reduction in EF due to wind speed reduction	0.690	0.253	0.0391					16.6	6.07	0.938					3.02	1.11	0.171					631,947	4,974,520
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	Based on AP-42, Chapter 13.2.4, reduction in EF due to wind speed reduction	0.690	0.253	0.0391					16.6	6.07	0.94					3.02	1.11	0.171					632,113	4,974,243
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	Control efficiency included in emission factor	1.380	0.621	0.1150					33.12	14.90	2.760					6.04	2.720	0.504					632,028	4,974,187
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	Control efficiency included in emission factor	0.1610	0.0529	0.01495					3.864	1.270	0.3588					0.705	0.2317	0.0655					632,028	4,974,187
LS1L	Mill Lime Silo #1 Loading	Control efficiency included in emission factor	0.0594	0.0204	0.00300					0.248	0.0850	0.0125					0.00217	7.44E-4	1.09E-4					632,095	4,974,272
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor		0.0960	0.0560	0.00840					1.20	0.700	0.105					0.0105	0.00613	9.19E-4					632,095	4,974,272
MillS2L	Mill Lime Silo #2 Loading	Control efficiency included in emission factor	0.0594	0.0204	0.00300					0.248	0.0850	0.0125					0.00217	7.44E-4	1.09E-4					632,090	4,974,282
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor		0.0960	0.0560	0.00840					1.20	0.700	0.105					0.0105	0.00613	9.19E-4					632,090	4,974,282
Sb1	Sb Dryer (2.72 MMBtu/hr Propane-Fired)		0.0208	0.0208	0.0208	0.223	0.386	0.0473	0.0238	0.499	0.499	0.499	5.35	9.27	1.13	0.571	0.0911	0.0911	0.0911	0.977	1.69	0.207	0.104	632,231	4,974,183
Sb2	Sb Bagging	Control efficiency included in emission factor	0.118	0.118	0.118					2.83	2.83	2.83					0.517	0.517	0.517					632,208	4,974,221
AC	Autoclave	PM control efficiency included in emission factor	5.08	5.08	5.08			0.653		122	122	122			15.7		22.2	22.2	22.2			2.86		632,229	4,974,096
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)		0.130	0.130	0.130	1.39	2.42	0.295	0.149	0.130	0.130	0.130	1.39	2.42	0.295	0.149	0.00195	0.00195	0.00195	0.0209	0.0362	0.00443	0.00223	632,261	4,974,116
ACS1L	AC Lime Silo #1 Loading	Control efficiency included in emission factor	0.119	0.0408	0.00600					0.990	0.340	0.0500					0.00866	0.00298	4.38E-4					632,267	4,974,124
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker		0.0960	0.0560	0.00800					2.30	1.34	0.192					0.0420	0.0245	0.00350					632,267	4,974,124
ACS2L	AC Lime Silo #2 Loading	Control efficiency included in emission factor	0.119	0.0408	0.00600					0.990	0.340	0.0500					0.00866	0.00298	4.38E-4					632,257	4,974,140
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker		0.0960	0.0560	0.00800					2.30	1.34	0.192					0.0420	0.0245	0.00350					632,257	4,974,140
ACS3L	AC Lime Silo #3 Loading	Control efficiency included in emission factor	0.119	0.0408	0.00600					0.990	0.340	0.0500					0.00866	0.00298	4.38E-4					632,248	4,974,156
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker		0.0960	0.0560	0.00800					2.30	1.34	0.192					0.0420	0.0245	0.00350					632,248	4,974,156
ACS4L	AC Lime Silo #4 Loading	Control efficiency included in emission factor	0.119	0.0408	0.00600					0.495	0.170	0.0250					0.00433	0.00149	2.19E-4					632,238	4,974,171
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker		0.0960	0.0560	0.00800					2.30	1.34	0.192					0.0210	0.0123	0.00175					632,238	4,974,171
CKD	Carbon Regeneration Kiln (Drum)	PM control efficiency included in emission factor	0.420	0.420	0.420	0.120	0.0120		0.110	10.1	10.1	10.1	2.88	0.288	0	2.64	1.84	1.84	1.84	0.526	0.0526		0.482	632,013	4,974,051
CKB	Carbon Regeneration Kiln (Burners)		0.0173	0.0173	0.0173	0.185	0.320	0.0392	0.0197	0.414	0.414	0.414	4.44	7.69	0.940	0.473	0.0756	0.0756	0.0756	0.810	1.40	0.172	0.0864	631,998	4,974,042
EW	Electrowinning Cells and Pregnant Solution Tank		0.07	0.07	0.07					1.68	1.68	1.68					0.31	0.31	0.31					631,983	4,974,033
MR	Mercury Retort		0.01	0.01	0.01					0.24	0.24	0.24					0.006	0.006	0.006					632,003	4,974,001
MF	Induction Melting Furnace	Control efficiency included in emission factor	2.84	2.84	2.84					34.1	34.1	34.1					0.89	0.89	0.89					632,032	4,974,019

SOURCE DESCRIPTION		TROLS	HOURLY EMISSIONS							DAILY EMISSIONS							ANNUAL EMISSIONS								
Model	Source Description	reference	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	UTM E	UTM N
ID			lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	m	m
EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)		0.441	0.441	0.441	7.72	14.1	0.0145	2.87	0.441	0.441	0.441	7.72	14.11	0.01448	2.866	0.0220	0.0220	0.0220	0.386	0.705	7.24E-4	0.143	634,274	4,972,050
EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)		0.441	0.441	0.441	7.72	14.1	0.0145	2.87	0.441	0.441	0.441	7.72	14.11	0.01448	2.866	0.0220	0.0220	0.0220	0.386	0.705	7.24E-4	0.143	632,105	4,974,154
EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)		0.441	0.441	0.441	7.72	14.1	0.0145	2.87	0.441	0.441	0.441	7.72	14.11	0.01448	2.866	0.0220	0.0220	0.0220	0.386	0.705	7.24E-4	0.143	632,109	4,974,148
EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)		0.0882	0.0882	0.0882	1.54	1.76	0.00290	1.76	0.0882	0.0882	0.0882	1.543	1.764	2.90E-3	1.764	0.00441	0.00441	0.00441	0.0772	0.0882	1.45E-4	0.0882	632,113	4,974,141
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)		7.65E-4	7.65E-4	7.65E-4	0.00820	0.0142	0.00174	8.74E-4	0.0184	0.0184	0.0184	0.197	0.341	0.0417	0.0210	0.00335	0.00335	0.00335	0.0359	0.0622	0.00761	0.00383	632,216	4,974,118
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)		0.0383	0.0383	0.0383	0.410	0.710	0.0869	0.0437	0.918	0.918	0.918	9.84	17.0	2.09	1.05	0.168	0.168	0.168	1.80	3.11	0.381	0.191	632,017	4,974,010
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)		0.0306	0.0306	0.0306	0.328	0.568	0.0695	0.0350	0.734	0.734	0.734	7.87	13.6	1.67	0.839	0.134	0.134	0.134	1.44	2.49	0.304	0.153	632,287	4,974,227
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)		0.0306	0.0306	0.0306	0.328	0.568	0.0695	0.0350	0.734	0.734	0.734	7.87	13.6	1.67	0.839	0.134	0.134	0.134	1.44	2.49	0.304	0.153	632,288	4,974,228
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)		0.0306	0.0306	0.0306	0.328	0.568	0.0695	0.0350	0.734	0.734	0.734	7.87	13.6	1.67	0.839	0.134	0.134	0.134	1.44	2.49	0.304	0.153	632,168	4,974,191
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)		0.00191	0.00191	0.00191	0.0205	0.0355	0.00434	0.00219	0.0459	0.0459	0.0459	0.492	0.852	0.104	0.0525	0.00838	0.00838	0.00838	0.0898	0.156	0.0190	0.00957	632,238	4,974,130
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)		0.00191	0.00191	0.00191	0.0205	0.0355	0.00434	0.00219	0.0459	0.0459	0.0459	0.492	0.852	0.104	0.0525	0.00838	0.00838	0.00838	0.0898	0.156	0.0190	0.00957	632,008	4,974,026
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)		0.00191	0.00191	0.00191	0.0205	0.0355	0.00434	0.00219	0.0459	0.0459	0.0459	0.492	0.852	0.104	0.0525	0.00838	0.00838	0.00838	0.0898	0.156	0.0190	0.00957	632,038	4,973,751
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)		0.00383	0.00383	0.00383	0.0410	0.0710	0.00869	0.00437	0.0918	0.0918	0.0918	0.984	1.70	0.209	0.105	0.0168	0.0168	0.0168	0.180	0.311	0.0381	0.0191	631,889	4,973,472
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)		0.0153	0.0153	0.0153	0.164	0.284	0.0348	0.0175	0.367	0.367	0.367	3.93	6.82	0.834	0.420	0.0670	0.0670	0.0670	0.718	1.24	0.152	0.0766	631,848	4,973,398
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)		0.0230	0.0230	0.0230	0.246	0.426	0.0521	0.0262	0.551	0.551	0.551	5.90	10.2	1.25	0.630	0.101	0.101	0.101	1.08	1.87	0.228	0.115	632,060	4,973,664
PSL	Prill Silos Loading (2 x 100 ton)		4.00	1.40	0.212					4.00	1.40	0.212					0.0730	0.0256	0.00387					632,346	4,973,500
PSU	Prill Silos Unloading (2 x 100 ton)		4.00	1.40	0.212					4.00	1.40	0.212					0.0730	0.0256	0.00387					632,346	4,973,500
CS1L	Cement/Shotcrete Silo #1 Loading	Control efficiency included in emission factor	0.0792	0.0272	0.00400					0.0792	0.0272	0.00400					0.0297	0.0102	0.00150					632,095	4,974,272
CS1U	Cement/Shotcrete Silo #1 Unloading		0.0960	0.0560	0.00800					0.384	0.224	0.0320					0.144	0.0840	0.0120					632,095	4,974,272
CS2L	Cement/Shotcrete Silo #2 Loading	Control efficiency included in emission factor	0.0792	0.0272	0.00400					0.0792	0.0272	0.00400					0.0297	0.0102	0.00150					632,095	4,974,272
CS2U	Cement/Shotcrete Silo #2 Unloading		0.0960	0.0560	0.00800					0.384	0.224	0.0320					0.144	0.0840	0.0120					632,095	4,974,272
CAL	Aggregate Bin Loading		0.690	0.330	0.0500					16.6	7.92	1.20					1.73	0.825	0.125					632,095	4,974,272
CAU	Aggregate Bin Unloading		0.690	0.330	0.0500					16.6	7.92	1.20					1.73	0.825	0.125					632,095	4,974,272
CM	Central Mixer Loading	Control efficiency included in emission factor	0.368	0.110	0.0160					1.47	0.440	0.0640					0.552	0.165	0.0240					632,095	4,974,272
TG1	Mine Site Gasoline Tank #1								0.219							5.25							0.957		
TG2	Mine Site Gasoline Tank #2								0.219							5.25							0.957		
TD3	Mine Site Diesel Tank #3								0.00167							0.0400							0.00730		
TD4	Mine Site Diesel Tank #4								0.00167							0.0400							0.00730		
TD5	Mine Site Diesel Tank #5								0.00167							0.0400							0.00730		
TD6	Mine Site Diesel Tank #6								0.00167							0.0400							0.00730		
TD7	Mine Site Diesel Tank #7								0.00167							0.0400							0.00730		
TD8	Mine Site Diesel Tank #8								0.00167							0.0400							0.00730		

SOURCE DESCRIPTION		TROLS	HOURLY EMISSIONS							DAILY EMISSIONS							ANNUAL EMISSIONS								
Model	Source Description	reference	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	UTM E	UTM N
ID			lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	m	m
TD9	Mine Site Diesel Tank #9								0.00167							0.0400							0.00730		
TD10	Mine Site Diesel Tank #10								0.00167							0.0400							0.00730		
PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	Control efficiency included in emission factor	0.63	0.233	0.030					15.0	5.6	0.73					2.74	1.02	0.133					632,348	4,973,429
PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	Control efficiency included in emission factor	0.625	0.2325	0.0304					15.00	5.58	0.730					2.738	1.018	0.1332					632,348	4,973,369
TRUE	LIME PRODUCTION																								
LS1	Limestone transfer to Primary Crusher Hopper		0.141	0.0518	0.0080					3.39	1.24	0.192	0	0	0	0	0.477	0.175	0.0270					632,239	4,974,256
LS2	Primary Crushing and Associated Transfers In and Out		0.254	0.113	0.0169					6.10	2.71	0.407	0	0	0	0	0.86	0.381	0.057					632,239	4,974,256
LS3	Primary Screening and Associated Transfers In and Out		1.18	0.410	0.0621					28.2	9.8	1.49	0	0	0	0	3.97	1.38	0.210					632,239	4,974,256
LS4	Secondary Crushing and Associated Transfers In and Out		0.254	0.113	0.0169					6.10	2.71	0.407	0	0	0	0	0.86	0.381	0.057					632,227	4,974,268
LS5	Secondary Screening and Associated Transfers In and Out		1.18	0.410	0.0621					28.2	9.8	1.49	0	0	0	0	3.97	1.38	0.210					632,227	4,974,268
LS6	Limestone transfer to Ball Mill Feed Bin		0.141	0.0518	0.0080					3.39	1.24	0.192	0	0	0	0	0.477	0.175	0.0270					632,181	4,974,307
LS7	Limestone transfer to Ball Mill Feed Conveyor		0.141	0.0518	0.00800					3.39	1.243	0.192	0	0	0	0	0.477	0.175	0.0270					632,181	4,974,307
LS8	Ball Mill Feed transfer to Ball Mill		0.141	0.0518	0.00800					3.39	1.243	0.192	0	0	0	0	0.477	0.175	0.0270					632,200	4,974,273
LSBM	Limestone Ball Mill	Control efficiency included in emission factor	1.902	1.5959	0.56964					45.65	38.303	13.671	0	0	0	0	6.422	5.389	1.9233					632,215	4,974,248
LS9	Limestone transfer to Kiln Feed Bin		0.033	0.0122	0.0019					0.80	0.29	0.045	0	0	0	0	0.124	0.045	0.0070					632,169	4,974,325
LS10	Limestone transfer to Lime Kiln Feed Conveyor		0.033	0.0122	0.00189					0.80	0.294	0.045	0	0	0	0	0.124	0.045	0.0070					632,169	4,974,325
LS11	Fines Screening and Associated Transfers In and Out		0.28	0.097	0.0147					6.7	2.3	0.35	0	0	0	0	1.03	0.36	0.055					632,151	4,974,314
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln		0.033	0.0122	0.00189					0.80	0.294	0.045	0	0	0	0	0.124	0.045	0.0070					632,056	4,974,285
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	Control efficiency included in emission factor	0.915	0.915	0.915	3.17	1.69	0.0085		21.97	21.97	21.97	76.05	40.6	0.203	0.00	3.40	3.40	3.40	11.8	6.29	0.0314		632,057	4,974,265
LKC	PFR Shaft Lime Kiln Combustion		0.169	0.169	0.169	1.81	3.13	0.383	0.193	4.05	4.05	4.05	43.4	75.2	9.2	4.62	0.627	0.627	0.627	6.72	11.6	1.42	0.72	632,057	4,974,265
LCR	Lime Mill Crushing and associated transfers In and Out	Control efficiency included in emission factor	0.28448	0.23871	0.08520					6.828	5.729	2.045	0	0	0	0	1.0580	0.8878	0.3169					632,073	4,974,233
LSL	Pebble Lime Silo Loading via Bucket Elevator	Control efficiency included in emission factor	6.20E-3	6.20E-3	6.20E-3					0.1487	0.1487	0.1487	0	0	0	0	0.02305	0.02305	0.02305					632,069	4,974,206
LSU	Pebble Lime Silo discharge to Lime Slaker	Control efficiency included in emission factor	6.20E-4	6.20E-4	6.20E-4					0.0149	0.0149	0.0149	0	0	0	0	0.00230	0.00230	0.00230					632,069	4,974,206
Total			**35.8**	**21.7**	**13.4**	**33.5**	**55.4**	**1.88**	**11.5**	**578**	**376**	**241**	**204**	**259**	**37.2**	**34.5**	**87.3**	**56.3**	**36.4**	**30.5**	**37.9**	**6.48**	**4.78**		

UPDATED EMISSIONS INVENTORIES AS SUBMITTED ON 10/8/2021

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 1 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021

Model Scenario W3 180,000 T/day Emissions

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**HAP/TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
106-99-0	1,3-Butadiene	8.4E-07	3.7E-06	0	0	0	0	8.4E-07	3.7E-06	Y	Y
91-57-6	2-Methylnaphthalene	1.1E-06	4.6E-06	0	0	0	0	1.1E-06	4.6E-06	Y	N
56-49-5	3-Methylchloranthrene	7.8E-08	3.4E-07	0	0	0	0	7.8E-08	3.4E-07	Y	Y
57-97-6	7,12-Dimethylbenz(a)anthracene	7.6E-07	3.0E-06	0	0	0	0	7.6E-07	3.0E-06	Y	N
83-32-9	Acenaphthene	5.7E-06	7.1E-06	0	0	0	0	5.7E-06	7.1E-06	Y	N
208-96-8	Acenaphthylene	1.1E-05	1.4E-05	0	0	0	0	1.1E-05	1.4E-05	Y	N
75-07-0	Acetaldehyde	2.5E-05	1.1E-04	0	0	0	0	2.5E-05	1.1E-04	Y	Y
107-02-8	Acrolein	1.6E-05	2.0E-05	0	0	0	0	1.6E-05	2.0E-05	Y	Y
120-12-7	Anthracene	1.7E-06	2.4E-06	0	0	0	0	1.7E-06	2.4E-06	Y	N
7440-36-0	Antimony	0	0	5.7E-04	2.5E-03	1.9E-02	8.2E-02	1.9E-02	8.5E-02	Y	Y
7440-38-2	Arsenic	8.7E-06	3.8E-05	4.5E-03	2.0E-02	0.54	2.38	0.55	2.40	Y	Y
56-55-3	Benz(a)anthracene	3.1E-07	1.4E-06	0	0	0	0	3.1E-07	1.4E-06	Y	Y
71-43-2	Benzene	3.6E-04	1.6E-03	7.0E-03	3.1E-02	0	0	7.4E-03	3.2E-02	Y	Y
50-32-8	Benzo(a)pyrene	1.4E-07	6.1E-07	0	0	0	0	1.4E-07	6.1E-07	Y	Y
205-99-2	Benzo(b)fluoranthene	4.4E-07	1.9E-06	0	0	0	0	4.4E-07	1.9E-06	Y	Y
191-24-2	Benzo(g,h,i)perylene	7.5E-07	1.1E-06	0	0	0	0	7.5E-07	1.1E-06	Y	N
207-08-9	Benzo(k)fluoranthene	1.5E-07	6.6E-07	0	0	0	0	1.5E-07	6.6E-07	Y	Y
7440-41-7	Beryllium	5.2E-07	2.3E-06	4.3E-04	1.9E-03	2.6E-03	1.1E-02	3.0E-03	1.3E-02	Y	Y
92-52-4	Biphenyl	0	0	4.4E-05	1.9E-04	0	0	4.4E-05	1.9E-04	Y	Y
7440-43-9	Cadmium	4.8E-05	2.1E-04	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.7E-04	3.8E-03	Y	Y
75-15-0	Carbon Disulfide	0	0	1.4E-02	6.3E-02	0	0	1.4E-02	6.3E-02	Y	Y
7440-47-3	Chromium	6.6E-05	2.7E-04	6.1E-04	2.5E-03	7.3E-03	3.2E-02	8.0E-03	3.5E-02	Y	Y
18540-29-9	Cr (VI)	0	0	3.4E-07	1.5E-06	0	0	3.4E-07	1.5E-06	Y	Y
218-01-9	Chrysene	5.8E-07	2.5E-06	0	0	0	0	5.8E-07	2.5E-06	Y	Y
7440-48-4	Cobalt	4.0E-06	1.6E-05	4.7E-04	2.0E-03	3.3E-03	1.4E-02	3.7E-03	1.6E-02	Y	Y
592-01-8	Cyanide	0	0	0.45	1.99	0	0	0.45	1.99	Y	Y
53-70-3	Dibenzo(a,h)anthracene	1.8E-07	7.7E-07	0	0	0	0	1.8E-07	7.7E-07	Y	Y
106-46-7	Dichlorobenzene	5.7E-05	2.3E-04	0	0	0	0	5.7E-05	2.3E-04	Y	Y
206-44-0	Fluoranthene	5.5E-06	7.0E-06	0	0	0	0	5.5E-06	7.0E-06	Y	N
86-73-7	Fluorene	1.7E-05	2.1E-05	0	0	0	0	1.7E-05	2.1E-05	Y	N
50-00-0	Formaldehyde	3.3E-03	1.5E-02	0	0	0	0	3.3E-03	1.5E-02	Y	Y
110-54-3	Hexane	8.5E-02	0.34	3.1E-02	0.14	0	0	0.12	0.48	Y	Y
7647-01-0	Hydrogen Chloride	0	0	0.99	3.67	0	0	0.99	**3.67**	Y	Y
193-39-5	Indeno(1,2,3-cd)pyrene	2.2E-07	9.6E-07	0	0	0	0	2.2E-07	9.6E-07	Y	Y
7439-92-1	Lead	0	0	4.8E-04	2.1E-03	6.5E-03	2.9E-02	7.0E-03	3.1E-02	Y	N
7439-96-5	Manganese	1.8E-05	7.2E-05	4.6E-03	1.7E-02	0.24	1.07	0.25	1.08	Y	Y
7439-97-6	Mercury	1.2E-05	5.0E-05	6.9E-04	2.9E-03	1.3E-03	5.7E-03	2.0E-03	8.6E-03	Y	N
91-20-3	Naphthalene	1.9E-04	3.1E-04	1.9E-03	8.5E-03	0	0	2.1E-03	8.8E-03	Y	Y
7440-02-0	Nickel	9.1E-05	4.0E-04	4.6E-04	2.0E-03	1.6E-03	7.1E-03	2.2E-03	9.5E-03	Y	Y
85-01-8	Phenanthrene	5.1E-05	6.3E-05	0	0	0	0	5.1E-05	6.3E-05	Y	N
108-95-2	Phenol	0	0	2.4E-04	1.1E-03	0	0	2.4E-04	1.1E-03	Y	Y
7723-14-0	Phosphorus	0	0	5.6E-03	2.3E-02	0.53	2.32	0.54	2.34	Y	Y
129-00-0	Pyrene	5.0E-06	6.6E-06	0	0	0	0	5.0E-06	6.6E-06	Y	N
7782-49-2	Selenium	1.1E-06	4.6E-06	4.1E-04	1.8E-03	3.3E-04	1.4E-03	7.4E-04	3.2E-03	Y	Y
108-88-3	Toluene	5.2E-04	1.1E-03	3.2E-02	0.14	0	0	3.2E-02	0.14	Y	Y
1330-20-7	Xylene	2.5E-04	3.0E-04	3.1E-02	0.14	0	0	3.2E-02	0.14	Y	Y
Total HAP		9.0E-02	0.36	1.58	6.25	1.36	5.95	3.03	12.56		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
TRUE	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
	chk	chk	chk-15	chk	chk	chk	chk	chk

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 1 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021

Model Scenario W3 180,000 T/day Emissions

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**HAP/TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
106-99-0	1,3-Butadiene	8.4E-07	3.7E-06	0	0	0	0	8.4E-07	3.7E-06	Y	Y
91-57-6	2-Methylnaphthalene	1.1E-06	4.6E-06	0	0	0	0	1.1E-06	4.6E-06	Y	N
56-49-5	3-Methylchloranthrene	7.8E-08	3.4E-07	0	0	0	0	7.8E-08	3.4E-07	Y	Y
57-97-6	7,12-Dimethylbenz(a)anthracene	7.6E-07	3.0E-06	0	0	0	0	7.6E-07	3.0E-06	Y	N
83-32-9	Acenaphthene	5.7E-06	7.1E-06	0	0	0	0	5.7E-06	7.1E-06	Y	N
208-96-8	Acenaphthylene	1.1E-05	1.4E-05	0	0	0	0	1.1E-05	1.4E-05	Y	N
75-07-0	Acetaldehyde	2.5E-05	1.1E-04	0	0	0	0	2.5E-05	1.1E-04	Y	Y
107-02-8	Acrolein	1.6E-05	2.0E-05	0	0	0	0	1.6E-05	2.0E-05	Y	Y
120-12-7	Anthracene	1.7E-06	2.4E-06	0	0	0	0	1.7E-06	2.4E-06	Y	N
7440-36-0	Antimony	0	0	5.7E-04	2.5E-03	1.9E-02	8.2E-02	1.9E-02	8.5E-02	Y	Y
7440-38-2	Arsenic	8.7E-06	3.8E-05	4.5E-03	2.0E-02	0.54	2.38	0.55	2.40	Y	Y
56-55-3	Benz(a)anthracene	3.1E-07	1.4E-06	0	0	0	0	3.1E-07	1.4E-06	Y	Y
71-43-2	Benzene	3.6E-04	1.6E-03	7.0E-03	3.1E-02	0	0	7.4E-03	3.2E-02	Y	Y
50-32-8	Benzo(a)pyrene	1.4E-07	6.1E-07	0	0	0	0	1.4E-07	6.1E-07	Y	Y
205-99-2	Benzo(b)fluoranthene	4.4E-07	1.9E-06	0	0	0	0	4.4E-07	1.9E-06	Y	Y
191-24-2	Benzo(g,h,i)perylene	7.5E-07	1.1E-06	0	0	0	0	7.5E-07	1.1E-06	Y	N
207-08-9	Benzo(k)fluoranthene	1.5E-07	6.6E-07	0	0	0	0	1.5E-07	6.6E-07	Y	Y
7440-41-7	Beryllium	5.2E-07	2.3E-06	4.3E-04	1.9E-03	2.6E-03	1.1E-02	3.0E-03	1.3E-02	Y	Y
92-52-4	Biphenyl	0	0	4.4E-05	1.9E-04	0	0	4.4E-05	1.9E-04	Y	Y
7440-43-9	Cadmium	4.8E-05	2.1E-04	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.7E-04	3.8E-03	Y	Y
75-15-0	Carbon Disulfide	0	0	1.4E-02	6.3E-02	0	0	1.4E-02	6.3E-02	Y	Y
7440-47-3	Chromium	6.6E-05	2.7E-04	6.1E-04	2.5E-03	7.3E-03	3.2E-02	8.0E-03	3.5E-02	Y	Y
18540-29-9	Cr (VI)	0	0	3.4E-07	1.5E-06	0	0	3.4E-07	1.5E-06	Y	Y
218-01-9	Chrysene	5.8E-07	2.5E-06	0	0	0	0	5.8E-07	2.5E-06	Y	Y
7440-48-4	Cobalt	4.0E-06	1.6E-05	4.7E-04	2.0E-03	3.3E-03	1.4E-02	3.7E-03	1.6E-02	Y	Y
592-01-8	Cyanide	0	0	0.45	1.99	0	0	0.45	1.99	Y	Y
53-70-3	Dibenzo(a,h)anthracene	1.8E-07	7.7E-07	0	0	0	0	1.8E-07	7.7E-07	Y	Y
106-46-7	Dichlorobenzene	5.7E-05	2.3E-04	0	0	0	0	5.7E-05	2.3E-04	Y	Y
206-44-0	Fluoranthene	5.5E-06	7.0E-06	0	0	0	0	5.5E-06	7.0E-06	Y	N
86-73-7	Fluorene	1.7E-05	2.1E-05	0	0	0	0	1.7E-05	2.1E-05	Y	N
50-00-0	Formaldehyde	3.3E-03	1.5E-02	0	0	0	0	3.3E-03	1.5E-02	Y	Y
110-54-3	Hexane	8.5E-02	0.34	3.1E-02	0.14	0	0	0.12	0.48	Y	Y
7647-01-0	Hydrogen Chloride	0	0	0.99	3.67	0	0	0.99	**3.67**	Y	Y
193-39-5	Indeno(1,2,3-cd)pyrene	2.2E-07	9.6E-07	0	0	0	0	2.2E-07	9.6E-07	Y	Y
7439-92-1	Lead	0	0	4.8E-04	2.1E-03	6.5E-03	2.9E-02	7.0E-03	3.1E-02	Y	N
7439-96-5	Manganese	1.8E-05	7.2E-05	4.6E-03	1.7E-02	0.24	1.07	0.25	1.08	Y	Y
7439-97-6	Mercury	1.2E-05	5.0E-05	6.9E-04	2.9E-03	1.3E-03	5.7E-03	2.0E-03	8.6E-03	Y	N
91-20-3	Naphthalene	1.9E-04	3.1E-04	1.9E-03	8.5E-03	0	0	2.1E-03	8.8E-03	Y	Y
7440-02-0	Nickel	9.1E-05	4.0E-04	4.6E-04	2.0E-03	1.6E-03	7.1E-03	2.2E-03	9.5E-03	Y	Y
85-01-8	Phenanthrene	5.1E-05	6.3E-05	0	0	0	0	5.1E-05	6.3E-05	Y	N
108-95-2	Phenol	0	0	2.4E-04	1.1E-03	0	0	2.4E-04	1.1E-03	Y	Y
7723-14-0	Phosphorus	0	0	5.6E-03	2.3E-02	0.53	2.32	0.54	2.34	Y	Y
129-00-0	Pyrene	5.0E-06	6.6E-06	0	0	0	0	5.0E-06	6.6E-06	Y	N
7782-49-2	Selenium	1.1E-06	4.6E-06	4.1E-04	1.8E-03	3.3E-04	1.4E-03	7.4E-04	3.2E-03	Y	Y
108-88-3	Toluene	5.2E-04	1.1E-03	3.2E-02	0.14	0	0	3.2E-02	0.14	Y	Y
1330-20-7	Xylene	2.5E-04	3.0E-04	3.1E-02	0.14	0	0	3.2E-02	0.14	Y	Y
Total HAP		9.0E-02	0.36	1.58	6.25	1.36	5.95	3.03	12.56		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
TRUE	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
	chk	chk	chk-15	chk	chk	chk	chk	chk

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary - continued

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**Non-HAP TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
7429-90-5	Aluminum	0	0	0.65	2.58	57.86	253.41	58.50	255.98	N	Y
7440-39-3	Barium	2.1E-04	8.4E-04	6.6E-03	2.7E-02	0.65	2.86	0.66	2.88	N	Y
1317-65-3	Calcium Carbonate	0	0	2.24	8.12	11.41	49.97	13.65	58.09	N	Y
1305-78-8	Calcium Oxide	0	0	0.70	0.95	0	0	0.70	0.95	N	Y
7440-50-8	Copper	4.0E-05	1.6E-04	4.9E-04	2.1E-03	4.1E-03	1.8E-02	4.6E-03	2.0E-02	N	Y
110-82-7	Cyclohexane	0	0	1.0E-03	4.6E-03	0	0	1.0E-03	4.6E-03	N	Y
7783-06-4	Hydrogen Sulfide	0	0	0.90	3.94	0	0	0.90	3.94	N	Y
7439-89-6	Iron	0	0	0.21	0.81	14.83	64.96	15.04	65.77	N	Y
7439-98-7	Molybdenum	5.2E-05	2.1E-04	4.2E-04	1.8E-03	8.1E-04	3.6E-03	1.3E-03	5.6E-03	N	Y
109-66-0	Pentane	0.12	0.50	0	0	0	0	0.12	0.50	N	Y
7440-22-4	Silver	0	0	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.2E-04	3.6E-03	N	Y
7664-93-9	Sulfuric Acid	0	0	2.03	8.89	0	0	2.03	8.89	N	Y
7440-28-0	Thallium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-61-1	Uranium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-62-2	Vanadium	1.1E-04	4.4E-04	7.3E-04	3.0E-03	2.3E-02	1.0E-01	2.4E-02	0.10	N	Y
25551-13-7	Trimethyl benzene	0	0	1.1E-02	4.8E-02	0	0	1.1E-02	4.8E-02	N	Y
7440-33-7	Tungsten	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-66-6	Zinc	1.4E-03	5.5E-03	8.0E-04	3.3E-03	2.9E-02	0.12	3.1E-02	0.13	N	Y
Total Non-HAP TAP		0.13	0.50	6.75	25.40	84.83	371.54	91.71	397.44		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

Conversions

2,000 lb/ton
8,760 hr/yr
24 hr/day

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary - continued

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**Non-HAP TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
7429-90-5	Aluminum	0	0	0.65	2.58	57.86	253.41	58.50	255.98	N	Y
7440-39-3	Barium	2.1E-04	8.4E-04	6.6E-03	2.7E-02	0.65	2.86	0.66	2.88	N	Y
1317-65-3	Calcium Carbonate	0	0	2.24	8.12	11.41	49.97	13.65	58.09	N	Y
1305-78-8	Calcium Oxide	0	0	0.70	0.95	0	0	0.70	0.95	N	Y
7440-50-8	Copper	4.0E-05	1.6E-04	4.9E-04	2.1E-03	4.1E-03	1.8E-02	4.6E-03	2.0E-02	N	Y
110-82-7	Cyclohexane	0	0	1.0E-03	4.6E-03	0	0	1.0E-03	4.6E-03	N	Y
7783-06-4	Hydrogen Sulfide	0	0	0.90	3.94	0	0	0.90	3.94	N	Y
7439-89-6	Iron	0	0	0.21	0.81	14.83	64.96	15.04	65.77	N	Y
7439-98-7	Molybdenum	5.2E-05	2.1E-04	4.2E-04	1.8E-03	8.1E-04	3.6E-03	1.3E-03	5.6E-03	N	Y
109-66-0	Pentane	0.12	0.50	0	0	0	0	0.12	0.50	N	Y
7440-22-4	Silver	0	0	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.2E-04	3.6E-03	N	Y
7664-93-9	Sulfuric Acid	0	0	2.03	8.89	0	0	2.03	8.89	N	Y
7440-28-0	Thallium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-61-1	Uranium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-62-2	Vanadium	1.1E-04	4.4E-04	7.3E-04	3.0E-03	2.3E-02	1.0E-01	2.4E-02	0.10	N	Y
25551-13-7	Trimethyl benzene	0	0	1.1E-02	4.8E-02	0	0	1.1E-02	4.8E-02	N	Y
7440-33-7	Tungsten	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-66-6	Zinc	1.4E-03	5.5E-03	8.0E-04	3.3E-03	2.9E-02	0.12	3.1E-02	0.13	N	Y
Total Non-HAP TAP		0.13	0.50	6.75	25.40	84.83	371.54	91.71	397.44		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

Conversions

2,000 lb/ton
8,760 hr/yr
24 hr/day

PROPANE COMBUSTION

Source Data

Source ID	Description	MMBtu/day	MMBtu/yr
Lime Process Heating			
LKC	PFR Shaft Lime Kiln Combustion	529.0	163,935
Ore Process Heating			
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	17.0	510
CKB	Carbon Regeneration Kiln (Burners)	54.1	19,754
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	2.4	876
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	120.0	43,800
Subtotal		193.5	64,940
HVAC			
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	96.0	35,040
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	96.0	35,040
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	96.0	35,040
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	12.0	4,380
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	48.0	17,520
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	72.0	26,280
Subtotal		438.0	159,870

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 1 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021

Model Scenario W3 180,000 T/day Emissions

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**HAP/TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
106-99-0	1,3-Butadiene	8.4E-07	3.7E-06	0	0	0	0	8.4E-07	3.7E-06	Y	Y
91-57-6	2-Methylnaphthalene	1.1E-06	4.6E-06	0	0	0	0	1.1E-06	4.6E-06	Y	N
56-49-5	3-Methylchloranthrene	7.8E-08	3.4E-07	0	0	0	0	7.8E-08	3.4E-07	Y	Y
57-97-6	7,12-Dimethylbenz(a)anthracene	7.6E-07	3.0E-06	0	0	0	0	7.6E-07	3.0E-06	Y	N
83-32-9	Acenaphthene	5.7E-06	7.1E-06	0	0	0	0	5.7E-06	7.1E-06	Y	N
208-96-8	Acenaphthylene	1.1E-05	1.4E-05	0	0	0	0	1.1E-05	1.4E-05	Y	N
75-07-0	Acetaldehyde	2.5E-05	1.1E-04	0	0	0	0	2.5E-05	1.1E-04	Y	Y
107-02-8	Acrolein	1.6E-05	2.0E-05	0	0	0	0	1.6E-05	2.0E-05	Y	Y
120-12-7	Anthracene	1.7E-06	2.4E-06	0	0	0	0	1.7E-06	2.4E-06	Y	N
7440-36-0	Antimony	0	0	5.7E-04	2.5E-03	1.9E-02	8.2E-02	1.9E-02	8.5E-02	Y	Y
7440-38-2	Arsenic	8.7E-06	3.8E-05	4.5E-03	2.0E-02	0.54	2.38	0.55	2.40	Y	Y
56-55-3	Benz(a)anthracene	3.1E-07	1.4E-06	0	0	0	0	3.1E-07	1.4E-06	Y	Y
71-43-2	Benzene	3.6E-04	1.6E-03	7.0E-03	3.1E-02	0	0	7.4E-03	3.2E-02	Y	Y
50-32-8	Benzo(a)pyrene	1.4E-07	6.1E-07	0	0	0	0	1.4E-07	6.1E-07	Y	Y
205-99-2	Benzo(b)fluoranthene	4.4E-07	1.9E-06	0	0	0	0	4.4E-07	1.9E-06	Y	Y
191-24-2	Benzo(g,h,i)perylene	7.5E-07	1.1E-06	0	0	0	0	7.5E-07	1.1E-06	Y	N
207-08-9	Benzo(k)fluoranthene	1.5E-07	6.6E-07	0	0	0	0	1.5E-07	6.6E-07	Y	Y
7440-41-7	Beryllium	5.2E-07	2.3E-06	4.3E-04	1.9E-03	2.6E-03	1.1E-02	3.0E-03	1.3E-02	Y	Y
92-52-4	Biphenyl	0	0	4.4E-05	1.9E-04	0	0	4.4E-05	1.9E-04	Y	Y
7440-43-9	Cadmium	4.8E-05	2.1E-04	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.7E-04	3.8E-03	Y	Y
75-15-0	Carbon Disulfide	0	0	1.4E-02	6.3E-02	0	0	1.4E-02	6.3E-02	Y	Y
7440-47-3	Chromium	6.6E-05	2.7E-04	6.1E-04	2.5E-03	7.3E-03	3.2E-02	8.0E-03	3.5E-02	Y	Y
18540-29-9	Cr (VI)	0	0	3.4E-07	1.5E-06	0	0	3.4E-07	1.5E-06	Y	Y
218-01-9	Chrysene	5.8E-07	2.5E-06	0	0	0	0	5.8E-07	2.5E-06	Y	Y
7440-48-4	Cobalt	4.0E-06	1.6E-05	4.7E-04	2.0E-03	3.3E-03	1.4E-02	3.7E-03	1.6E-02	Y	Y
592-01-8	Cyanide	0	0	0.45	1.99	0	0	0.45	1.99	Y	Y
53-70-3	Dibenzo(a,h)anthracene	1.8E-07	7.7E-07	0	0	0	0	1.8E-07	7.7E-07	Y	Y
106-46-7	Dichlorobenzene	5.7E-05	2.3E-04	0	0	0	0	5.7E-05	2.3E-04	Y	Y
206-44-0	Fluoranthene	5.5E-06	7.0E-06	0	0	0	0	5.5E-06	7.0E-06	Y	N
86-73-7	Fluorene	1.7E-05	2.1E-05	0	0	0	0	1.7E-05	2.1E-05	Y	N
50-00-0	Formaldehyde	3.3E-03	1.5E-02	0	0	0	0	3.3E-03	1.5E-02	Y	Y
110-54-3	Hexane	8.5E-02	0.34	3.1E-02	0.14	0	0	0.12	0.48	Y	Y
7647-01-0	Hydrogen Chloride	0	0	0.99	3.67	0	0	0.99	**3.67**	Y	Y
193-39-5	Indeno(1,2,3-cd)pyrene	2.2E-07	9.6E-07	0	0	0	0	2.2E-07	9.6E-07	Y	Y
7439-92-1	Lead	0	0	4.8E-04	2.1E-03	6.5E-03	2.9E-02	7.0E-03	3.1E-02	Y	N
7439-96-5	Manganese	1.8E-05	7.2E-05	4.6E-03	1.7E-02	0.24	1.07	0.25	1.08	Y	Y
7439-97-6	Mercury	1.2E-05	5.0E-05	6.9E-04	2.9E-03	1.3E-03	5.7E-03	2.0E-03	8.6E-03	Y	N
91-20-3	Naphthalene	1.9E-04	3.1E-04	1.9E-03	8.5E-03	0	0	2.1E-03	8.8E-03	Y	Y
7440-02-0	Nickel	9.1E-05	4.0E-04	4.6E-04	2.0E-03	1.6E-03	7.1E-03	2.2E-03	9.5E-03	Y	Y
85-01-8	Phenanthrene	5.1E-05	6.3E-05	0	0	0	0	5.1E-05	6.3E-05	Y	N
108-95-2	Phenol	0	0	2.4E-04	1.1E-03	0	0	2.4E-04	1.1E-03	Y	Y
7723-14-0	Phosphorus	0	0	5.6E-03	2.3E-02	0.53	2.32	0.54	2.34	Y	Y
129-00-0	Pyrene	5.0E-06	6.6E-06	0	0	0	0	5.0E-06	6.6E-06	Y	N
7782-49-2	Selenium	1.1E-06	4.6E-06	4.1E-04	1.8E-03	3.3E-04	1.4E-03	7.4E-04	3.2E-03	Y	Y
108-88-3	Toluene	5.2E-04	1.1E-03	3.2E-02	0.14	0	0	3.2E-02	0.14	Y	Y
1330-20-7	Xylene	2.5E-04	3.0E-04	3.1E-02	0.14	0	0	3.2E-02	0.14	Y	Y
Total HAP		9.0E-02	0.36	1.58	6.25	1.36	5.95	3.03	12.56		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
TRUE	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
	chk	chk	chk-15	chk	chk	chk	chk	chk

REC 0531

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 1 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021

Model Scenario W3 180,000 T/day Emissions

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**HAP/TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
106-99-0	1,3-Butadiene	8.4E-07	3.7E-06	0	0	0	0	8.4E-07	3.7E-06	Y	Y
91-57-6	2-Methylnaphthalene	1.1E-06	4.6E-06	0	0	0	0	1.1E-06	4.6E-06	Y	N
56-49-5	3-Methylchloranthrene	7.8E-08	3.4E-07	0	0	0	0	7.8E-08	3.4E-07	Y	Y
57-97-6	7,12-Dimethylbenz(a)anthracene	7.6E-07	3.0E-06	0	0	0	0	7.6E-07	3.0E-06	Y	N
83-32-9	Acenaphthene	5.7E-06	7.1E-06	0	0	0	0	5.7E-06	7.1E-06	Y	N
208-96-8	Acenaphthylene	1.1E-05	1.4E-05	0	0	0	0	1.1E-05	1.4E-05	Y	N
75-07-0	Acetaldehyde	2.5E-05	1.1E-04	0	0	0	0	2.5E-05	1.1E-04	Y	Y
107-02-8	Acrolein	1.6E-05	2.0E-05	0	0	0	0	1.6E-05	2.0E-05	Y	Y
120-12-7	Anthracene	1.7E-06	2.4E-06	0	0	0	0	1.7E-06	2.4E-06	Y	N
7440-36-0	Antimony	0	0	5.7E-04	2.5E-03	1.9E-02	8.2E-02	1.9E-02	8.5E-02	Y	Y
7440-38-2	Arsenic	8.7E-06	3.8E-05	4.5E-03	2.0E-02	0.54	2.38	0.55	2.40	Y	Y
56-55-3	Benz(a)anthracene	3.1E-07	1.4E-06	0	0	0	0	3.1E-07	1.4E-06	Y	Y
71-43-2	Benzene	3.6E-04	1.6E-03	7.0E-03	3.1E-02	0	0	7.4E-03	3.2E-02	Y	Y
50-32-8	Benzo(a)pyrene	1.4E-07	6.1E-07	0	0	0	0	1.4E-07	6.1E-07	Y	Y
205-99-2	Benzo(b)fluoranthene	4.4E-07	1.9E-06	0	0	0	0	4.4E-07	1.9E-06	Y	Y
191-24-2	Benzo(g,h,i)perylene	7.5E-07	1.1E-06	0	0	0	0	7.5E-07	1.1E-06	Y	N
207-08-9	Benzo(k)fluoranthene	1.5E-07	6.6E-07	0	0	0	0	1.5E-07	6.6E-07	Y	Y
7440-41-7	Beryllium	5.2E-07	2.3E-06	4.3E-04	1.9E-03	2.6E-03	1.1E-02	3.0E-03	1.3E-02	Y	Y
92-52-4	Biphenyl	0	0	4.4E-05	1.9E-04	0	0	4.4E-05	1.9E-04	Y	Y
7440-43-9	Cadmium	4.8E-05	2.1E-04	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.7E-04	3.8E-03	Y	Y
75-15-0	Carbon Disulfide	0	0	1.4E-02	6.3E-02	0	0	1.4E-02	6.3E-02	Y	Y
7440-47-3	Chromium	6.6E-05	2.7E-04	6.1E-04	2.5E-03	7.3E-03	3.2E-02	8.0E-03	3.5E-02	Y	Y
18540-29-9	Cr (VI)	0	0	3.4E-07	1.5E-06	0	0	3.4E-07	1.5E-06	Y	Y
218-01-9	Chrysene	5.8E-07	2.5E-06	0	0	0	0	5.8E-07	2.5E-06	Y	Y
7440-48-4	Cobalt	4.0E-06	1.6E-05	4.7E-04	2.0E-03	3.3E-03	1.4E-02	3.7E-03	1.6E-02	Y	Y
592-01-8	Cyanide	0	0	0.45	1.99	0	0	0.45	1.99	Y	Y
53-70-3	Dibenzo(a,h)anthracene	1.8E-07	7.7E-07	0	0	0	0	1.8E-07	7.7E-07	Y	Y
106-46-7	Dichlorobenzene	5.7E-05	2.3E-04	0	0	0	0	5.7E-05	2.3E-04	Y	Y
206-44-0	Fluoranthene	5.5E-06	7.0E-06	0	0	0	0	5.5E-06	7.0E-06	Y	N
86-73-7	Fluorene	1.7E-05	2.1E-05	0	0	0	0	1.7E-05	2.1E-05	Y	N
50-00-0	Formaldehyde	3.3E-03	1.5E-02	0	0	0	0	3.3E-03	1.5E-02	Y	Y
110-54-3	Hexane	8.5E-02	0.34	3.1E-02	0.14	0	0	0.12	0.48	Y	Y
7647-01-0	Hydrogen Chloride	0	0	0.99	3.67	0	0	0.99	**3.67**	Y	Y
193-39-5	Indeno(1,2,3-cd)pyrene	2.2E-07	9.6E-07	0	0	0	0	2.2E-07	9.6E-07	Y	Y
7439-92-1	Lead	0	0	4.8E-04	2.1E-03	6.5E-03	2.9E-02	7.0E-03	3.1E-02	Y	N
7439-96-5	Manganese	1.8E-05	7.2E-05	4.6E-03	1.7E-02	0.24	1.07	0.25	1.08	Y	Y
7439-97-6	Mercury	1.2E-05	5.0E-05	6.9E-04	2.9E-03	1.3E-03	5.7E-03	2.0E-03	8.6E-03	Y	N
91-20-3	Naphthalene	1.9E-04	3.1E-04	1.9E-03	8.5E-03	0	0	2.1E-03	8.8E-03	Y	Y
7440-02-0	Nickel	9.1E-05	4.0E-04	4.6E-04	2.0E-03	1.6E-03	7.1E-03	2.2E-03	9.5E-03	Y	Y
85-01-8	Phenanthrene	5.1E-05	6.3E-05	0	0	0	0	5.1E-05	6.3E-05	Y	N
108-95-2	Phenol	0	0	2.4E-04	1.1E-03	0	0	2.4E-04	1.1E-03	Y	Y
7723-14-0	Phosphorus	0	0	5.6E-03	2.3E-02	0.53	2.32	0.54	2.34	Y	Y
129-00-0	Pyrene	5.0E-06	6.6E-06	0	0	0	0	5.0E-06	6.6E-06	Y	N
7782-49-2	Selenium	1.1E-06	4.6E-06	4.1E-04	1.8E-03	3.3E-04	1.4E-03	7.4E-04	3.2E-03	Y	Y
108-88-3	Toluene	5.2E-04	1.1E-03	3.2E-02	0.14	0	0	3.2E-02	0.14	Y	Y
1330-20-7	Xylene	2.5E-04	3.0E-04	3.1E-02	0.14	0	0	3.2E-02	0.14	Y	Y
Total HAP		9.0E-02	0.36	1.58	6.25	1.36	5.95	3.03	12.56		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
TRUE	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
	chk	chk	chk-15	chk	chk	chk	chk	chk

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary - continued

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**Non-HAP TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
7429-90-5	Aluminum	0	0	0.65	2.58	57.86	253.41	58.50	255.98	N	Y
7440-39-3	Barium	2.1E-04	8.4E-04	6.6E-03	2.7E-02	0.65	2.86	0.66	2.88	N	Y
1317-65-3	Calcium Carbonate	0	0	2.24	8.12	11.41	49.97	13.65	58.09	N	Y
1305-78-8	Calcium Oxide	0	0	0.70	0.95	0	0	0.70	0.95	N	Y
7440-50-8	Copper	4.0E-05	1.6E-04	4.9E-04	2.1E-03	4.1E-03	1.8E-02	4.6E-03	2.0E-02	N	Y
110-82-7	Cyclohexane	0	0	1.0E-03	4.6E-03	0	0	1.0E-03	4.6E-03	N	Y
7783-06-4	Hydrogen Sulfide	0	0	0.90	3.94	0	0	0.90	3.94	N	Y
7439-89-6	Iron	0	0	0.21	0.81	14.83	64.96	15.04	65.77	N	Y
7439-98-7	Molybdenum	5.2E-05	2.1E-04	4.2E-04	1.8E-03	8.1E-04	3.6E-03	1.3E-03	5.6E-03	N	Y
109-66-0	Pentane	0.12	0.50	0	0	0	0	0.12	0.50	N	Y
7440-22-4	Silver	0	0	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.2E-04	3.6E-03	N	Y
7664-93-9	Sulfuric Acid	0	0	2.03	8.89	0	0	2.03	8.89	N	Y
7440-28-0	Thallium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-61-1	Uranium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-62-2	Vanadium	1.1E-04	4.4E-04	7.3E-04	3.0E-03	2.3E-02	1.0E-01	2.4E-02	0.10	N	Y
25551-13-7	Trimethyl benzene	0	0	1.1E-02	4.8E-02	0	0	1.1E-02	4.8E-02	N	Y
7440-33-7	Tungsten	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-66-6	Zinc	1.4E-03	5.5E-03	8.0E-04	3.3E-03	2.9E-02	0.12	3.1E-02	0.13	N	Y
Total Non-HAP TAP		0.13	0.50	6.75	25.40	84.83	371.54	91.71	397.44		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

Conversions

2,000 lb/ton
8,760 hr/yr
24 hr/day

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary - continued

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**Non-HAP TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
7429-90-5	Aluminum	0	0	0.65	2.58	57.86	253.41	58.50	255.98	N	Y
7440-39-3	Barium	2.1E-04	8.4E-04	6.6E-03	2.7E-02	0.65	2.86	0.66	2.88	N	Y
1317-65-3	Calcium Carbonate	0	0	2.24	8.12	11.41	49.97	13.65	58.09	N	Y
1305-78-8	Calcium Oxide	0	0	0.70	0.95	0	0	0.70	0.95	N	Y
7440-50-8	Copper	4.0E-05	1.6E-04	4.9E-04	2.1E-03	4.1E-03	1.8E-02	4.6E-03	2.0E-02	N	Y
110-82-7	Cyclohexane	0	0	1.0E-03	4.6E-03	0	0	1.0E-03	4.6E-03	N	Y
7783-06-4	Hydrogen Sulfide	0	0	0.90	3.94	0	0	0.90	3.94	N	Y
7439-89-6	Iron	0	0	0.21	0.81	14.83	64.96	15.04	65.77	N	Y
7439-98-7	Molybdenum	5.2E-05	2.1E-04	4.2E-04	1.8E-03	8.1E-04	3.6E-03	1.3E-03	5.6E-03	N	Y
109-66-0	Pentane	0.12	0.50	0	0	0	0	0.12	0.50	N	Y
7440-22-4	Silver	0	0	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.2E-04	3.6E-03	N	Y
7664-93-9	Sulfuric Acid	0	0	2.03	8.89	0	0	2.03	8.89	N	Y
7440-28-0	Thallium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-61-1	Uranium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-62-2	Vanadium	1.1E-04	4.4E-04	7.3E-04	3.0E-03	2.3E-02	1.0E-01	2.4E-02	0.10	N	Y
25551-13-7	Trimethyl benzene	0	0	1.1E-02	4.8E-02	0	0	1.1E-02	4.8E-02	N	Y
7440-33-7	Tungsten	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-66-6	Zinc	1.4E-03	5.5E-03	8.0E-04	3.3E-03	2.9E-02	0.12	3.1E-02	0.13	N	Y
Total Non-HAP TAP		0.13	0.50	6.75	25.40	84.83	371.54	91.71	397.44		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

Conversions

2,000 lb/ton
8,760 hr/yr
24 hr/day

PROPANE COMBUSTION

Source Data

Source ID	Description	MMBtu/day	MMBtu/yr
Lime Process Heating			
LKC	PFR Shaft Lime Kiln Combustion	529.0	163,935
Ore Process Heating			
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	17.0	510
CKB	Carbon Regeneration Kiln (Burners)	54.1	19,754
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	2.4	876
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	120.0	43,800
Subtotal		193.5	64,940
HVAC			
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	96.0	35,040
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	96.0	35,040
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	96.0	35,040
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	12.0	4,380
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	48.0	17,520
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	72.0	26,280
Subtotal		438.0	159,870

PROPANE COMBUSTION

Source Data

Source ID	Description	MMBtu/day	MMBtu/yr
Lime Process Heating			
LKC	PFR Shaft Lime Kiln Combustion	529.0	163,935
Ore Process Heating			
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	17.0	510
CKB	Carbon Regeneration Kiln (Burners)	54.1	19,754
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	2.4	876
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	120.0	43,800
Subtotal		193.5	64,940
HVAC			
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	96.0	35,040
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	96.0	35,040
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	96.0	35,040
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	12.0	4,380
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	48.0	17,520
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	72.0	26,280
Subtotal		438.0	159,870

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 1 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021

Model Scenario W3 180,000 T/day Emissions

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	HAP/TAP	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
106-99-0	1,3-Butadiene	8.4E-07	3.7E-06	0	0	0	0	8.4E-07	3.7E-06	Y	Y
91-57-6	2-Methylnaphthalene	1.1E-06	4.6E-06	0	0	0	0	1.1E-06	4.6E-06	Y	N
56-49-5	3-Methylchloranthrene	7.8E-08	3.4E-07	0	0	0	0	7.8E-08	3.4E-07	Y	Y
57-97-6	7,12-Dimethylbenz(a)anthracene	7.6E-07	3.0E-06	0	0	0	0	7.6E-07	3.0E-06	Y	N
83-32-9	Acenaphthene	5.7E-06	7.1E-06	0	0	0	0	5.7E-06	7.1E-06	Y	N
208-96-8	Acenaphthylene	1.1E-05	1.4E-05	0	0	0	0	1.1E-05	1.4E-05	Y	N
75-07-0	Acetaldehyde	2.5E-05	1.1E-04	0	0	0	0	2.5E-05	1.1E-04	Y	Y
107-02-8	Acrolein	1.6E-05	2.0E-05	0	0	0	0	1.6E-05	2.0E-05	Y	Y
120-12-7	Anthracene	1.7E-06	2.4E-06	0	0	0	0	1.7E-06	2.4E-06	Y	N
7440-36-0	Antimony	0	0	5.7E-04	2.5E-03	1.9E-02	8.2E-02	1.9E-02	8.5E-02	Y	Y
7440-38-2	Arsenic	8.7E-06	3.8E-05	4.5E-03	2.0E-02	0.54	2.38	0.55	2.40	Y	Y
56-55-3	Benz(a)anthracene	3.1E-07	1.4E-06	0	0	0	0	3.1E-07	1.4E-06	Y	Y
71-43-2	Benzene	3.6E-04	1.6E-03	7.0E-03	3.1E-02	0	0	7.4E-03	3.2E-02	Y	Y
50-32-8	Benzo(a)pyrene	1.4E-07	6.1E-07	0	0	0	0	1.4E-07	6.1E-07	Y	Y
205-99-2	Benzo(b)fluoranthene	4.4E-07	1.9E-06	0	0	0	0	4.4E-07	1.9E-06	Y	Y
191-24-2	Benzo(g,h,i)perylene	7.5E-07	1.1E-06	0	0	0	0	7.5E-07	1.1E-06	Y	N
207-08-9	Benzo(k)fluoranthene	1.5E-07	6.6E-07	0	0	0	0	1.5E-07	6.6E-07	Y	Y
7440-41-7	Beryllium	5.2E-07	2.3E-06	4.3E-04	1.9E-03	2.6E-03	1.1E-02	3.0E-03	1.3E-02	Y	Y
92-52-4	Biphenyl	0	0	4.4E-05	1.9E-04	0	0	4.4E-05	1.9E-04	Y	Y
7440-43-9	Cadmium	4.8E-05	2.1E-04	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.7E-04	3.8E-03	Y	Y
75-15-0	Carbon Disulfide	0	0	1.4E-02	6.3E-02	0	0	1.4E-02	6.3E-02	Y	Y
7440-47-3	Chromium	6.6E-05	2.7E-04	6.1E-04	2.5E-03	7.3E-03	3.2E-02	8.0E-03	3.5E-02	Y	Y
18540-29-9	Cr (VI)	0	0	3.4E-07	1.5E-06	0	0	3.4E-07	1.5E-06	Y	Y
218-01-9	Chrysene	5.8E-07	2.5E-06	0	0	0	0	5.8E-07	2.5E-06	Y	Y
7440-48-4	Cobalt	4.0E-06	1.6E-05	4.7E-04	2.0E-03	3.3E-03	1.4E-02	3.7E-03	1.6E-02	Y	Y
592-01-8	Cyanide	0	0	0.45	1.99	0	0	0.45	1.99	Y	Y
53-70-3	Dibenzo(a,h)anthracene	1.8E-07	7.7E-07	0	0	0	0	1.8E-07	7.7E-07	Y	Y
106-46-7	Dichlorobenzene	5.7E-05	2.3E-04	0	0	0	0	5.7E-05	2.3E-04	Y	Y
206-44-0	Fluoranthene	5.5E-06	7.0E-06	0	0	0	0	5.5E-06	7.0E-06	Y	N
86-73-7	Fluorene	1.7E-05	2.1E-05	0	0	0	0	1.7E-05	2.1E-05	Y	N
50-00-0	Formaldehyde	3.3E-03	1.5E-02	0	0	0	0	3.3E-03	1.5E-02	Y	Y
110-54-3	Hexane	8.5E-02	0.34	3.1E-02	0.14	0	0	0.12	0.48	Y	Y
7647-01-0	Hydrogen Chloride	0	0	0.99	3.67	0	0	0.99	**3.67**	Y	Y
193-39-5	Indeno(1,2,3-cd)pyrene	2.2E-07	9.6E-07	0	0	0	0	2.2E-07	9.6E-07	Y	Y
7439-92-1	Lead	0	0	4.8E-04	2.1E-03	6.5E-03	2.9E-02	7.0E-03	3.1E-02	Y	N
7439-96-5	Manganese	1.8E-05	7.2E-05	4.6E-03	1.7E-02	0.24	1.07	0.25	1.08	Y	Y
7439-97-6	Mercury	1.2E-05	5.0E-05	6.9E-04	2.9E-03	1.3E-03	5.7E-03	2.0E-03	8.6E-03	Y	N
91-20-3	Naphthalene	1.9E-04	3.1E-04	1.9E-03	8.5E-03	0	0	2.1E-03	8.8E-03	Y	Y
7440-02-0	Nickel	9.1E-05	4.0E-04	4.6E-04	2.0E-03	1.6E-03	7.1E-03	2.2E-03	9.5E-03	Y	Y
85-01-8	Phenanthrene	5.1E-05	6.3E-05	0	0	0	0	5.1E-05	6.3E-05	Y	N
108-95-2	Phenol	0	0	2.4E-04	1.1E-03	0	0	2.4E-04	1.1E-03	Y	Y
7723-14-0	Phosphorus	0	0	5.6E-03	2.3E-02	0.53	2.32	0.54	2.34	Y	Y
129-00-0	Pyrene	5.0E-06	6.6E-06	0	0	0	0	5.0E-06	6.6E-06	Y	N
7782-49-2	Selenium	1.1E-06	4.6E-06	4.1E-04	1.8E-03	3.3E-04	1.4E-03	7.4E-04	3.2E-03	Y	Y
108-88-3	Toluene	5.2E-04	1.1E-03	3.2E-02	0.14	0	0	3.2E-02	0.14	Y	Y
1330-20-7	Xylene	2.5E-04	3.0E-04	3.1E-02	0.14	0	0	3.2E-02	0.14	Y	Y
Total HAP		9.0E-02	0.36	1.58	6.25	1.36	5.95	3.03	12.56		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
TRUE	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
	chk	chk	chk-15	chk	chk	chk	chk	chk

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary - continued

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**Non-HAP TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
7429-90-5	Aluminum	0	0	0.65	2.58	57.86	253.41	58.50	255.98	N	Y
7440-39-3	Barium	2.1E-04	8.4E-04	6.6E-03	2.7E-02	0.65	2.86	0.66	2.88	N	Y
1317-65-3	Calcium Carbonate	0	0	2.24	8.12	11.41	49.97	13.65	58.09	N	Y
1305-78-8	Calcium Oxide	0	0	0.70	0.95	0	0	0.70	0.95	N	Y
7440-50-8	Copper	4.0E-05	1.6E-04	4.9E-04	2.1E-03	4.1E-03	1.8E-02	4.6E-03	2.0E-02	N	Y
110-82-7	Cyclohexane	0	0	1.0E-03	4.6E-03	0	0	1.0E-03	4.6E-03	N	Y
7783-06-4	Hydrogen Sulfide	0	0	0.90	3.94	0	0	0.90	3.94	N	Y
7439-89-6	Iron	0	0	0.21	0.81	14.83	64.96	15.04	65.77	N	Y
7439-98-7	Molybdenum	5.2E-05	2.1E-04	4.2E-04	1.8E-03	8.1E-04	3.6E-03	1.3E-03	5.6E-03	N	Y
109-66-0	Pentane	0.12	0.50	0	0	0	0	0.12	0.50	N	Y
7440-22-4	Silver	0	0	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.2E-04	3.6E-03	N	Y
7664-93-9	Sulfuric Acid	0	0	2.03	8.89	0	0	2.03	8.89	N	Y
7440-28-0	Thallium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-61-1	Uranium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-62-2	Vanadium	1.1E-04	4.4E-04	7.3E-04	3.0E-03	2.3E-02	1.0E-01	2.4E-02	0.10	N	Y
25551-13-7	Trimethyl benzene	0	0	1.1E-02	4.8E-02	0	0	1.1E-02	4.8E-02	N	Y
7440-33-7	Tungsten	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-66-6	Zinc	1.4E-03	5.5E-03	8.0E-04	3.3E-03	2.9E-02	0.12	3.1E-02	0.13	N	Y
Total Non-HAP TAP		0.13	0.50	6.75	25.40	84.83	371.54	91.71	397.44		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

Conversions

2,000 lb/ton
8,760 hr/yr
24 hr/day

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 1 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021

Model Scenario W3 180,000 T/day Emissions

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**HAP/TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
106-99-0	1,3-Butadiene	8.4E-07	3.7E-06	0	0	0	0	8.4E-07	3.7E-06	Y	Y
91-57-6	2-Methylnaphthalene	1.1E-06	4.6E-06	0	0	0	0	1.1E-06	4.6E-06	Y	N
56-49-5	3-Methylchloranthrene	7.8E-08	3.4E-07	0	0	0	0	7.8E-08	3.4E-07	Y	Y
57-97-6	7,12-Dimethylbenz(a)anthracene	7.6E-07	3.0E-06	0	0	0	0	7.6E-07	3.0E-06	Y	N
83-32-9	Acenaphthene	5.7E-06	7.1E-06	0	0	0	0	5.7E-06	7.1E-06	Y	N
208-96-8	Acenaphthylene	1.1E-05	1.4E-05	0	0	0	0	1.1E-05	1.4E-05	Y	N
75-07-0	Acetaldehyde	2.5E-05	1.1E-04	0	0	0	0	2.5E-05	1.1E-04	Y	Y
107-02-8	Acrolein	1.6E-05	2.0E-05	0	0	0	0	1.6E-05	2.0E-05	Y	Y
120-12-7	Anthracene	1.7E-06	2.4E-06	0	0	0	0	1.7E-06	2.4E-06	Y	N
7440-36-0	Antimony	0	0	5.7E-04	2.5E-03	1.9E-02	8.2E-02	1.9E-02	8.5E-02	Y	Y
7440-38-2	Arsenic	8.7E-06	3.8E-05	4.5E-03	2.0E-02	0.54	2.38	0.55	2.40	Y	Y
56-55-3	Benz(a)anthracene	3.1E-07	1.4E-06	0	0	0	0	3.1E-07	1.4E-06	Y	Y
71-43-2	Benzene	3.6E-04	1.6E-03	7.0E-03	3.1E-02	0	0	7.4E-03	3.2E-02	Y	Y
50-32-8	Benzo(a)pyrene	1.4E-07	6.1E-07	0	0	0	0	1.4E-07	6.1E-07	Y	Y
205-99-2	Benzo(b)fluoranthene	4.4E-07	1.9E-06	0	0	0	0	4.4E-07	1.9E-06	Y	Y
191-24-2	Benzo(g,h,i)perylene	7.5E-07	1.1E-06	0	0	0	0	7.5E-07	1.1E-06	Y	N
207-08-9	Benzo(k)fluoranthene	1.5E-07	6.6E-07	0	0	0	0	1.5E-07	6.6E-07	Y	Y
7440-41-7	Beryllium	5.2E-07	2.3E-06	4.3E-04	1.9E-03	2.6E-03	1.1E-02	3.0E-03	1.3E-02	Y	Y
92-52-4	Biphenyl	0	0	4.4E-05	1.9E-04	0	0	4.4E-05	1.9E-04	Y	Y
7440-43-9	Cadmium	4.8E-05	2.1E-04	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.7E-04	3.8E-03	Y	Y
75-15-0	Carbon Disulfide	0	0	1.4E-02	6.3E-02	0	0	1.4E-02	6.3E-02	Y	Y
7440-47-3	Chromium	6.6E-05	2.7E-04	6.1E-04	2.5E-03	7.3E-03	3.2E-02	8.0E-03	3.5E-02	Y	Y
18540-29-9	Cr (VI)	0	0	3.4E-07	1.5E-06	0	0	3.4E-07	1.5E-06	Y	Y
218-01-9	Chrysene	5.8E-07	2.5E-06	0	0	0	0	5.8E-07	2.5E-06	Y	Y
7440-48-4	Cobalt	4.0E-06	1.6E-05	4.7E-04	2.0E-03	3.3E-03	1.4E-02	3.7E-03	1.6E-02	Y	Y
592-01-8	Cyanide	0	0	0.45	1.99	0	0	0.45	1.99	Y	Y
53-70-3	Dibenzo(a,h)anthracene	1.8E-07	7.7E-07	0	0	0	0	1.8E-07	7.7E-07	Y	Y
106-46-7	Dichlorobenzene	5.7E-05	2.3E-04	0	0	0	0	5.7E-05	2.3E-04	Y	Y
206-44-0	Fluoranthene	5.5E-06	7.0E-06	0	0	0	0	5.5E-06	7.0E-06	Y	N
86-73-7	Fluorene	1.7E-05	2.1E-05	0	0	0	0	1.7E-05	2.1E-05	Y	N
50-00-0	Formaldehyde	3.3E-03	1.5E-02	0	0	0	0	3.3E-03	1.5E-02	Y	Y
110-54-3	Hexane	8.5E-02	0.34	3.1E-02	0.14	0	0	0.12	0.48	Y	Y
7647-01-0	Hydrogen Chloride	0	0	0.99	3.67	0	0	0.99	**3.67**	Y	Y
193-39-5	Indeno(1,2,3-cd)pyrene	2.2E-07	9.6E-07	0	0	0	0	2.2E-07	9.6E-07	Y	Y
7439-92-1	Lead	0	0	4.8E-04	2.1E-03	6.5E-03	2.9E-02	7.0E-03	3.1E-02	Y	N
7439-96-5	Manganese	1.8E-05	7.2E-05	4.6E-03	1.7E-02	0.24	1.07	0.25	1.08	Y	Y
7439-97-6	Mercury	1.2E-05	5.0E-05	6.9E-04	2.9E-03	1.3E-03	5.7E-03	2.0E-03	8.6E-03	Y	N
91-20-3	Naphthalene	1.9E-04	3.1E-04	1.9E-03	8.5E-03	0	0	2.1E-03	8.8E-03	Y	Y
7440-02-0	Nickel	9.1E-05	4.0E-04	4.6E-04	2.0E-03	1.6E-03	7.1E-03	2.2E-03	9.5E-03	Y	Y
85-01-8	Phenanthrene	5.1E-05	6.3E-05	0	0	0	0	5.1E-05	6.3E-05	Y	N
108-95-2	Phenol	0	0	2.4E-04	1.1E-03	0	0	2.4E-04	1.1E-03	Y	Y
7723-14-0	Phosphorus	0	0	5.6E-03	2.3E-02	0.53	2.32	0.54	2.34	Y	Y
129-00-0	Pyrene	5.0E-06	6.6E-06	0	0	0	0	5.0E-06	6.6E-06	Y	N
7782-49-2	Selenium	1.1E-06	4.6E-06	4.1E-04	1.8E-03	3.3E-04	1.4E-03	7.4E-04	3.2E-03	Y	Y
108-88-3	Toluene	5.2E-04	1.1E-03	3.2E-02	0.14	0	0	3.2E-02	0.14	Y	Y
1330-20-7	Xylene	2.5E-04	3.0E-04	3.1E-02	0.14	0	0	3.2E-02	0.14	Y	Y
Total HAP		9.0E-02	0.36	1.58	6.25	1.36	5.95	3.03	12.56		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
TRUE	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
	chk	chk	chk-15	chk	chk	chk	chk	chk

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 1 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021

Model Scenario W3 180,000 T/day Emissions

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**HAP/TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
106-99-0	1,3-Butadiene	8.4E-07	3.7E-06	0	0	0	0	8.4E-07	3.7E-06	Y	Y
91-57-6	2-Methylnaphthalene	1.1E-06	4.6E-06	0	0	0	0	1.1E-06	4.6E-06	Y	N
56-49-5	3-Methylchloranthrene	7.8E-08	3.4E-07	0	0	0	0	7.8E-08	3.4E-07	Y	Y
57-97-6	7,12-Dimethylbenz(a)anthracene	7.6E-07	3.0E-06	0	0	0	0	7.6E-07	3.0E-06	Y	N
83-32-9	Acenaphthene	5.7E-06	7.1E-06	0	0	0	0	5.7E-06	7.1E-06	Y	N
208-96-8	Acenaphthylene	1.1E-05	1.4E-05	0	0	0	0	1.1E-05	1.4E-05	Y	N
75-07-0	Acetaldehyde	2.5E-05	1.1E-04	0	0	0	0	2.5E-05	1.1E-04	Y	Y
107-02-8	Acrolein	1.6E-05	2.0E-05	0	0	0	0	1.6E-05	2.0E-05	Y	Y
120-12-7	Anthracene	1.7E-06	2.4E-06	0	0	0	0	1.7E-06	2.4E-06	Y	N
7440-36-0	Antimony	0	0	5.7E-04	2.5E-03	1.9E-02	8.2E-02	1.9E-02	8.5E-02	Y	Y
7440-38-2	Arsenic	8.7E-06	3.8E-05	4.5E-03	2.0E-02	0.54	2.38	0.55	2.40	Y	Y
56-55-3	Benz(a)anthracene	3.1E-07	1.4E-06	0	0	0	0	3.1E-07	1.4E-06	Y	Y
71-43-2	Benzene	3.6E-04	1.6E-03	7.0E-03	3.1E-02	0	0	7.4E-03	3.2E-02	Y	Y
50-32-8	Benzo(a)pyrene	1.4E-07	6.1E-07	0	0	0	0	1.4E-07	6.1E-07	Y	Y
205-99-2	Benzo(b)fluoranthene	4.4E-07	1.9E-06	0	0	0	0	4.4E-07	1.9E-06	Y	Y
191-24-2	Benzo(g,h,i)perylene	7.5E-07	1.1E-06	0	0	0	0	7.5E-07	1.1E-06	Y	N
207-08-9	Benzo(k)fluoranthene	1.5E-07	6.6E-07	0	0	0	0	1.5E-07	6.6E-07	Y	Y
7440-41-7	Beryllium	5.2E-07	2.3E-06	4.3E-04	1.9E-03	2.6E-03	1.1E-02	3.0E-03	1.3E-02	Y	Y
92-52-4	Biphenyl	0	0	4.4E-05	1.9E-04	0	0	4.4E-05	1.9E-04	Y	Y
7440-43-9	Cadmium	4.8E-05	2.1E-04	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.7E-04	3.8E-03	Y	Y
75-15-0	Carbon Disulfide	0	0	1.4E-02	6.3E-02	0	0	1.4E-02	6.3E-02	Y	Y
7440-47-3	Chromium	6.6E-05	2.7E-04	6.1E-04	2.5E-03	7.3E-03	3.2E-02	8.0E-03	3.5E-02	Y	Y
18540-29-9	Cr (VI)	0	0	3.4E-07	1.5E-06	0	0	3.4E-07	1.5E-06	Y	Y
218-01-9	Chrysene	5.8E-07	2.5E-06	0	0	0	0	5.8E-07	2.5E-06	Y	Y
7440-48-4	Cobalt	4.0E-06	1.6E-05	4.7E-04	2.0E-03	3.3E-03	1.4E-02	3.7E-03	1.6E-02	Y	Y
592-01-8	Cyanide	0	0	0.45	1.99	0	0	0.45	1.99	Y	Y
53-70-3	Dibenzo(a,h)anthracene	1.8E-07	7.7E-07	0	0	0	0	1.8E-07	7.7E-07	Y	Y
106-46-7	Dichlorobenzene	5.7E-05	2.3E-04	0	0	0	0	5.7E-05	2.3E-04	Y	Y
206-44-0	Fluoranthene	5.5E-06	7.0E-06	0	0	0	0	5.5E-06	7.0E-06	Y	N
86-73-7	Fluorene	1.7E-05	2.1E-05	0	0	0	0	1.7E-05	2.1E-05	Y	N
50-00-0	Formaldehyde	3.3E-03	1.5E-02	0	0	0	0	3.3E-03	1.5E-02	Y	Y
110-54-3	Hexane	8.5E-02	0.34	3.1E-02	0.14	0	0	0.12	0.48	Y	Y
7647-01-0	Hydrogen Chloride	0	0	0.99	3.67	0	0	0.99	**3.67**	Y	Y
193-39-5	Indeno(1,2,3-cd)pyrene	2.2E-07	9.6E-07	0	0	0	0	2.2E-07	9.6E-07	Y	Y
7439-92-1	Lead	0	0	4.8E-04	2.1E-03	6.5E-03	2.9E-02	7.0E-03	3.1E-02	Y	N
7439-96-5	Manganese	1.8E-05	7.2E-05	4.6E-03	1.7E-02	0.24	1.07	0.25	1.08	Y	Y
7439-97-6	Mercury	1.2E-05	5.0E-05	6.9E-04	2.9E-03	1.3E-03	5.7E-03	2.0E-03	8.6E-03	Y	N
91-20-3	Naphthalene	1.9E-04	3.1E-04	1.9E-03	8.5E-03	0	0	2.1E-03	8.8E-03	Y	Y
7440-02-0	Nickel	9.1E-05	4.0E-04	4.6E-04	2.0E-03	1.6E-03	7.1E-03	2.2E-03	9.5E-03	Y	Y
85-01-8	Phenanthrene	5.1E-05	6.3E-05	0	0	0	0	5.1E-05	6.3E-05	Y	N
108-95-2	Phenol	0	0	2.4E-04	1.1E-03	0	0	2.4E-04	1.1E-03	Y	Y
7723-14-0	Phosphorus	0	0	5.6E-03	2.3E-02	0.53	2.32	0.54	2.34	Y	Y
129-00-0	Pyrene	5.0E-06	6.6E-06	0	0	0	0	5.0E-06	6.6E-06	Y	N
7782-49-2	Selenium	1.1E-06	4.6E-06	4.1E-04	1.8E-03	3.3E-04	1.4E-03	7.4E-04	3.2E-03	Y	Y
108-88-3	Toluene	5.2E-04	1.1E-03	3.2E-02	0.14	0	0	3.2E-02	0.14	Y	Y
1330-20-7	Xylene	2.5E-04	3.0E-04	3.1E-02	0.14	0	0	3.2E-02	0.14	Y	Y
Total HAP		9.0E-02	0.36	1.58	6.25	1.36	5.95	3.03	12.56		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
TRUE	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
	chk	chk	chk-15	chk	chk	chk	chk	chk

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary - continued

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**Non-HAP TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
7429-90-5	Aluminum	0	0	0.65	2.58	57.86	253.41	58.50	255.98	N	Y
7440-39-3	Barium	2.1E-04	8.4E-04	6.6E-03	2.7E-02	0.65	2.86	0.66	2.88	N	Y
1317-65-3	Calcium Carbonate	0	0	2.24	8.12	11.41	49.97	13.65	58.09	N	Y
1305-78-8	Calcium Oxide	0	0	0.70	0.95	0	0	0.70	0.95	N	Y
7440-50-8	Copper	4.0E-05	1.6E-04	4.9E-04	2.1E-03	4.1E-03	1.8E-02	4.6E-03	2.0E-02	N	Y
110-82-7	Cyclohexane	0	0	1.0E-03	4.6E-03	0	0	1.0E-03	4.6E-03	N	Y
7783-06-4	Hydrogen Sulfide	0	0	0.90	3.94	0	0	0.90	3.94	N	Y
7439-89-6	Iron	0	0	0.21	0.81	14.83	64.96	15.04	65.77	N	Y
7439-98-7	Molybdenum	5.2E-05	2.1E-04	4.2E-04	1.8E-03	8.1E-04	3.6E-03	1.3E-03	5.6E-03	N	Y
109-66-0	Pentane	0.12	0.50	0	0	0	0	0.12	0.50	N	Y
7440-22-4	Silver	0	0	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.2E-04	3.6E-03	N	Y
7664-93-9	Sulfuric Acid	0	0	2.03	8.89	0	0	2.03	8.89	N	Y
7440-28-0	Thallium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-61-1	Uranium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-62-2	Vanadium	1.1E-04	4.4E-04	7.3E-04	3.0E-03	2.3E-02	1.0E-01	2.4E-02	0.10	N	Y
25551-13-7	Trimethyl benzene	0	0	1.1E-02	4.8E-02	0	0	1.1E-02	4.8E-02	N	Y
7440-33-7	Tungsten	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-66-6	Zinc	1.4E-03	5.5E-03	8.0E-04	3.3E-03	2.9E-02	0.12	3.1E-02	0.13	N	Y
Total Non-HAP TAP		0.13	0.50	6.75	25.40	84.83	371.54	91.71	397.44		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

Conversions

2,000 lb/ton
8,760 hr/yr
24 hr/day

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary - continued

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**Non-HAP TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
7429-90-5	Aluminum	0	0	0.65	2.58	57.86	253.41	58.50	255.98	N	Y
7440-39-3	Barium	2.1E-04	8.4E-04	6.6E-03	2.7E-02	0.65	2.86	0.66	2.88	N	Y
1317-65-3	Calcium Carbonate	0	0	2.24	8.12	11.41	49.97	13.65	58.09	N	Y
1305-78-8	Calcium Oxide	0	0	0.70	0.95	0	0	0.70	0.95	N	Y
7440-50-8	Copper	4.0E-05	1.6E-04	4.9E-04	2.1E-03	4.1E-03	1.8E-02	4.6E-03	2.0E-02	N	Y
110-82-7	Cyclohexane	0	0	1.0E-03	4.6E-03	0	0	1.0E-03	4.6E-03	N	Y
7783-06-4	Hydrogen Sulfide	0	0	0.90	3.94	0	0	0.90	3.94	N	Y
7439-89-6	Iron	0	0	0.21	0.81	14.83	64.96	15.04	65.77	N	Y
7439-98-7	Molybdenum	5.2E-05	2.1E-04	4.2E-04	1.8E-03	8.1E-04	3.6E-03	1.3E-03	5.6E-03	N	Y
109-66-0	Pentane	0.12	0.50	0	0	0	0	0.12	0.50	N	Y
7440-22-4	Silver	0	0	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.2E-04	3.6E-03	N	Y
7664-93-9	Sulfuric Acid	0	0	2.03	8.89	0	0	2.03	8.89	N	Y
7440-28-0	Thallium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-61-1	Uranium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-62-2	Vanadium	1.1E-04	4.4E-04	7.3E-04	3.0E-03	2.3E-02	1.0E-01	2.4E-02	0.10	N	Y
25551-13-7	Trimethyl benzene	0	0	1.1E-02	4.8E-02	0	0	1.1E-02	4.8E-02	N	Y
7440-33-7	Tungsten	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-66-6	Zinc	1.4E-03	5.5E-03	8.0E-04	3.3E-03	2.9E-02	0.12	3.1E-02	0.13	N	Y
Total Non-HAP TAP		0.13	0.50	6.75	25.40	84.83	371.54	91.71	397.44		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

Conversions

2,000 lb/ton
8,760 hr/yr
24 hr/day

PROPANE COMBUSTION

Source Data

Source ID	Description	MMBtu/day	MMBtu/yr
Lime Process Heating			
LKC	PFR Shaft Lime Kiln Combustion	529.0	163,935
Ore Process Heating			
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	17.0	510
CKB	Carbon Regeneration Kiln (Burners)	54.1	19,754
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	2.4	876
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	120.0	43,800
Subtotal		193.5	64,940
HVAC			
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	96.0	35,040
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	96.0	35,040
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	96.0	35,040
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	12.0	4,380
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	48.0	17,520
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	72.0	26,280
Subtotal		438.0	159,870

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 1 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021

Model Scenario W3 180,000 T/day Emissions

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**HAP/TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
106-99-0	1,3-Butadiene	8.4E-07	3.7E-06	0	0	0	0	8.4E-07	3.7E-06	Y	Y
91-57-6	2-Methylnaphthalene	1.1E-06	4.6E-06	0	0	0	0	1.1E-06	4.6E-06	Y	N
56-49-5	3-Methylchloranthrene	7.8E-08	3.4E-07	0	0	0	0	7.8E-08	3.4E-07	Y	Y
57-97-6	7,12-Dimethylbenz(a)anthracene	7.6E-07	3.0E-06	0	0	0	0	7.6E-07	3.0E-06	Y	N
83-32-9	Acenaphthene	5.7E-06	7.1E-06	0	0	0	0	5.7E-06	7.1E-06	Y	N
208-96-8	Acenaphthylene	1.1E-05	1.4E-05	0	0	0	0	1.1E-05	1.4E-05	Y	N
75-07-0	Acetaldehyde	2.5E-05	1.1E-04	0	0	0	0	2.5E-05	1.1E-04	Y	Y
107-02-8	Acrolein	1.6E-05	2.0E-05	0	0	0	0	1.6E-05	2.0E-05	Y	Y
120-12-7	Anthracene	1.7E-06	2.4E-06	0	0	0	0	1.7E-06	2.4E-06	Y	N
7440-36-0	Antimony	0	0	5.7E-04	2.5E-03	1.9E-02	8.2E-02	1.9E-02	8.5E-02	Y	Y
7440-38-2	Arsenic	8.7E-06	3.8E-05	4.5E-03	2.0E-02	0.54	2.38	0.55	2.40	Y	Y
56-55-3	Benz(a)anthracene	3.1E-07	1.4E-06	0	0	0	0	3.1E-07	1.4E-06	Y	Y
71-43-2	Benzene	3.6E-04	1.6E-03	7.0E-03	3.1E-02	0	0	7.4E-03	3.2E-02	Y	Y
50-32-8	Benzo(a)pyrene	1.4E-07	6.1E-07	0	0	0	0	1.4E-07	6.1E-07	Y	Y
205-99-2	Benzo(b)fluoranthene	4.4E-07	1.9E-06	0	0	0	0	4.4E-07	1.9E-06	Y	Y
191-24-2	Benzo(g,h,i)perylene	7.5E-07	1.1E-06	0	0	0	0	7.5E-07	1.1E-06	Y	N
207-08-9	Benzo(k)fluoranthene	1.5E-07	6.6E-07	0	0	0	0	1.5E-07	6.6E-07	Y	Y
7440-41-7	Beryllium	5.2E-07	2.3E-06	4.3E-04	1.9E-03	2.6E-03	1.1E-02	3.0E-03	1.3E-02	Y	Y
92-52-4	Biphenyl	0	0	4.4E-05	1.9E-04	0	0	4.4E-05	1.9E-04	Y	Y
7440-43-9	Cadmium	4.8E-05	2.1E-04	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.7E-04	3.8E-03	Y	Y
75-15-0	Carbon Disulfide	0	0	1.4E-02	6.3E-02	0	0	1.4E-02	6.3E-02	Y	Y
7440-47-3	Chromium	6.6E-05	2.7E-04	6.1E-04	2.5E-03	7.3E-03	3.2E-02	8.0E-03	3.5E-02	Y	Y
18540-29-9	Cr (VI)	0	0	3.4E-07	1.5E-06	0	0	3.4E-07	1.5E-06	Y	Y
218-01-9	Chrysene	5.8E-07	2.5E-06	0	0	0	0	5.8E-07	2.5E-06	Y	Y
7440-48-4	Cobalt	4.0E-06	1.6E-05	4.7E-04	2.0E-03	3.3E-03	1.4E-02	3.7E-03	1.6E-02	Y	Y
592-01-8	Cyanide	0	0	0.45	1.99	0	0	0.45	1.99	Y	Y
53-70-3	Dibenzo(a,h)anthracene	1.8E-07	7.7E-07	0	0	0	0	1.8E-07	7.7E-07	Y	Y
106-46-7	Dichlorobenzene	5.7E-05	2.3E-04	0	0	0	0	5.7E-05	2.3E-04	Y	Y
206-44-0	Fluoranthene	5.5E-06	7.0E-06	0	0	0	0	5.5E-06	7.0E-06	Y	N
86-73-7	Fluorene	1.7E-05	2.1E-05	0	0	0	0	1.7E-05	2.1E-05	Y	N
50-00-0	Formaldehyde	3.3E-03	1.5E-02	0	0	0	0	3.3E-03	1.5E-02	Y	Y
110-54-3	Hexane	8.5E-02	0.34	3.1E-02	0.14	0	0	0.12	0.48	Y	Y
7647-01-0	Hydrogen Chloride	0	0	0.99	3.67	0	0	0.99	**3.67**	Y	Y
193-39-5	Indeno(1,2,3-cd)pyrene	2.2E-07	9.6E-07	0	0	0	0	2.2E-07	9.6E-07	Y	Y
7439-92-1	Lead	0	0	4.8E-04	2.1E-03	6.5E-03	2.9E-02	7.0E-03	3.1E-02	Y	N
7439-96-5	Manganese	1.8E-05	7.2E-05	4.6E-03	1.7E-02	0.24	1.07	0.25	1.08	Y	Y
7439-97-6	Mercury	1.2E-05	5.0E-05	6.9E-04	2.9E-03	1.3E-03	5.7E-03	2.0E-03	8.6E-03	Y	N
91-20-3	Naphthalene	1.9E-04	3.1E-04	1.9E-03	8.5E-03	0	0	2.1E-03	8.8E-03	Y	Y
7440-02-0	Nickel	9.1E-05	4.0E-04	4.6E-04	2.0E-03	1.6E-03	7.1E-03	2.2E-03	9.5E-03	Y	Y
85-01-8	Phenanthrene	5.1E-05	6.3E-05	0	0	0	0	5.1E-05	6.3E-05	Y	N
108-95-2	Phenol	0	0	2.4E-04	1.1E-03	0	0	2.4E-04	1.1E-03	Y	Y
7723-14-0	Phosphorus	0	0	5.6E-03	2.3E-02	0.53	2.32	0.54	2.34	Y	Y
129-00-0	Pyrene	5.0E-06	6.6E-06	0	0	0	0	5.0E-06	6.6E-06	Y	N
7782-49-2	Selenium	1.1E-06	4.6E-06	4.1E-04	1.8E-03	3.3E-04	1.4E-03	7.4E-04	3.2E-03	Y	Y
108-88-3	Toluene	5.2E-04	1.1E-03	3.2E-02	0.14	0	0	3.2E-02	0.14	Y	Y
1330-20-7	Xylene	2.5E-04	3.0E-04	3.1E-02	0.14	0	0	3.2E-02	0.14	Y	Y
Total HAP		9.0E-02	0.36	1.58	6.25	1.36	5.95	3.03	12.56		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
TRUE	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
	chk	chk	chk-15	chk	chk	chk	chk	chk

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 1 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021

Model Scenario W3 180,000 T/day Emissions

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	HAP/TAP	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
106-99-0	1,3-Butadiene	8.4E-07	3.7E-06	0	0	0	0	8.4E-07	3.7E-06	Y	Y
91-57-6	2-Methylnaphthalene	1.1E-06	4.6E-06	0	0	0	0	1.1E-06	4.6E-06	Y	N
56-49-5	3-Methylchloranthrene	7.8E-08	3.4E-07	0	0	0	0	7.8E-08	3.4E-07	Y	Y
57-97-6	7,12-Dimethylbenz(a)anthracene	7.6E-07	3.0E-06	0	0	0	0	7.6E-07	3.0E-06	Y	N
83-32-9	Acenaphthene	5.7E-06	7.1E-06	0	0	0	0	5.7E-06	7.1E-06	Y	N
208-96-8	Acenaphthylene	1.1E-05	1.4E-05	0	0	0	0	1.1E-05	1.4E-05	Y	N
75-07-0	Acetaldehyde	2.5E-05	1.1E-04	0	0	0	0	2.5E-05	1.1E-04	Y	Y
107-02-8	Acrolein	1.6E-05	2.0E-05	0	0	0	0	1.6E-05	2.0E-05	Y	Y
120-12-7	Anthracene	1.7E-06	2.4E-06	0	0	0	0	1.7E-06	2.4E-06	Y	N
7440-36-0	Antimony	0	0	5.7E-04	2.5E-03	1.9E-02	8.2E-02	1.9E-02	8.5E-02	Y	Y
7440-38-2	Arsenic	8.7E-06	3.8E-05	4.5E-03	2.0E-02	0.54	2.38	0.55	2.40	Y	Y
56-55-3	Benz(a)anthracene	3.1E-07	1.4E-06	0	0	0	0	3.1E-07	1.4E-06	Y	Y
71-43-2	Benzene	3.6E-04	1.6E-03	7.0E-03	3.1E-02	0	0	7.4E-03	3.2E-02	Y	Y
50-32-8	Benzo(a)pyrene	1.4E-07	6.1E-07	0	0	0	0	1.4E-07	6.1E-07	Y	Y
205-99-2	Benzo(b)fluoranthene	4.4E-07	1.9E-06	0	0	0	0	4.4E-07	1.9E-06	Y	Y
191-24-2	Benzo(g,h,i)perylene	7.5E-07	1.1E-06	0	0	0	0	7.5E-07	1.1E-06	Y	N
207-08-9	Benzo(k)fluoranthene	1.5E-07	6.6E-07	0	0	0	0	1.5E-07	6.6E-07	Y	Y
7440-41-7	Beryllium	5.2E-07	2.3E-06	4.3E-04	1.9E-03	2.6E-03	1.1E-02	3.0E-03	1.3E-02	Y	Y
92-52-4	Biphenyl	0	0	4.4E-05	1.9E-04	0	0	4.4E-05	1.9E-04	Y	Y
7440-43-9	Cadmium	4.8E-05	2.1E-04	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.7E-04	3.8E-03	Y	Y
75-15-0	Carbon Disulfide	0	0	1.4E-02	6.3E-02	0	0	1.4E-02	6.3E-02	Y	Y
7440-47-3	Chromium	6.6E-05	2.7E-04	6.1E-04	2.5E-03	7.3E-03	3.2E-02	8.0E-03	3.5E-02	Y	Y
18540-29-9	Cr (VI)	0	0	3.4E-07	1.5E-06	0	0	3.4E-07	1.5E-06	Y	Y
218-01-9	Chrysene	5.8E-07	2.5E-06	0	0	0	0	5.8E-07	2.5E-06	Y	Y
7440-48-4	Cobalt	4.0E-06	1.6E-05	4.7E-04	2.0E-03	3.3E-03	1.4E-02	3.7E-03	1.6E-02	Y	Y
592-01-8	Cyanide	0	0	0.45	1.99	0	0	0.45	1.99	Y	Y
53-70-3	Dibenzo(a,h)anthracene	1.8E-07	7.7E-07	0	0	0	0	1.8E-07	7.7E-07	Y	Y
106-46-7	Dichlorobenzene	5.7E-05	2.3E-04	0	0	0	0	5.7E-05	2.3E-04	Y	Y
206-44-0	Fluoranthene	5.5E-06	7.0E-06	0	0	0	0	5.5E-06	7.0E-06	Y	N
86-73-7	Fluorene	1.7E-05	2.1E-05	0	0	0	0	1.7E-05	2.1E-05	Y	N
50-00-0	Formaldehyde	3.3E-03	1.5E-02	0	0	0	0	3.3E-03	1.5E-02	Y	Y
110-54-3	Hexane	8.5E-02	0.34	3.1E-02	0.14	0	0	0.12	0.48	Y	Y
7647-01-0	Hydrogen Chloride	0	0	0.99	3.67	0	0	0.99	**3.67**	Y	Y
193-39-5	Indeno(1,2,3-cd)pyrene	2.2E-07	9.6E-07	0	0	0	0	2.2E-07	9.6E-07	Y	Y
7439-92-1	Lead	0	0	4.8E-04	2.1E-03	6.5E-03	2.9E-02	7.0E-03	3.1E-02	Y	N
7439-96-5	Manganese	1.8E-05	7.2E-05	4.6E-03	1.7E-02	0.24	1.07	0.25	1.08	Y	Y
7439-97-6	Mercury	1.2E-05	5.0E-05	6.9E-04	2.9E-03	1.3E-03	5.7E-03	2.0E-03	8.6E-03	Y	N
91-20-3	Naphthalene	1.9E-04	3.1E-04	1.9E-03	8.5E-03	0	0	2.1E-03	8.8E-03	Y	Y
7440-02-0	Nickel	9.1E-05	4.0E-04	4.6E-04	2.0E-03	1.6E-03	7.1E-03	2.2E-03	9.5E-03	Y	Y
85-01-8	Phenanthrene	5.1E-05	6.3E-05	0	0	0	0	5.1E-05	6.3E-05	Y	N
108-95-2	Phenol	0	0	2.4E-04	1.1E-03	0	0	2.4E-04	1.1E-03	Y	Y
7723-14-0	Phosphorus	0	0	5.6E-03	2.3E-02	0.53	2.32	0.54	2.34	Y	Y
129-00-0	Pyrene	5.0E-06	6.6E-06	0	0	0	0	5.0E-06	6.6E-06	Y	N
7782-49-2	Selenium	1.1E-06	4.6E-06	4.1E-04	1.8E-03	3.3E-04	1.4E-03	7.4E-04	3.2E-03	Y	Y
108-88-3	Toluene	5.2E-04	1.1E-03	3.2E-02	0.14	0	0	3.2E-02	0.14	Y	Y
1330-20-7	Xylene	2.5E-04	3.0E-04	3.1E-02	0.14	0	0	3.2E-02	0.14	Y	Y
Total HAP		9.0E-02	0.36	1.58	6.25	1.36	5.95	3.03	12.56		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
TRUE	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
	chk	chk	chk-15	chk	chk	chk	chk	chk

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary - continued

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**Non-HAP TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
7429-90-5	Aluminum	0	0	0.65	2.58	57.86	253.41	58.50	255.98	N	Y
7440-39-3	Barium	2.1E-04	8.4E-04	6.6E-03	2.7E-02	0.65	2.86	0.66	2.88	N	Y
1317-65-3	Calcium Carbonate	0	0	2.24	8.12	11.41	49.97	13.65	58.09	N	Y
1305-78-8	Calcium Oxide	0	0	0.70	0.95	0	0	0.70	0.95	N	Y
7440-50-8	Copper	4.0E-05	1.6E-04	4.9E-04	2.1E-03	4.1E-03	1.8E-02	4.6E-03	2.0E-02	N	Y
110-82-7	Cyclohexane	0	0	1.0E-03	4.6E-03	0	0	1.0E-03	4.6E-03	N	Y
7783-06-4	Hydrogen Sulfide	0	0	0.90	3.94	0	0	0.90	3.94	N	Y
7439-89-6	Iron	0	0	0.21	0.81	14.83	64.96	15.04	65.77	N	Y
7439-98-7	Molybdenum	5.2E-05	2.1E-04	4.2E-04	1.8E-03	8.1E-04	3.6E-03	1.3E-03	5.6E-03	N	Y
109-66-0	Pentane	0.12	0.50	0	0	0	0	0.12	0.50	N	Y
7440-22-4	Silver	0	0	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.2E-04	3.6E-03	N	Y
7664-93-9	Sulfuric Acid	0	0	2.03	8.89	0	0	2.03	8.89	N	Y
7440-28-0	Thallium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-61-1	Uranium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-62-2	Vanadium	1.1E-04	4.4E-04	7.3E-04	3.0E-03	2.3E-02	1.0E-01	2.4E-02	0.10	N	Y
25551-13-7	Trimethyl benzene	0	0	1.1E-02	4.8E-02	0	0	1.1E-02	4.8E-02	N	Y
7440-33-7	Tungsten	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-66-6	Zinc	1.4E-03	5.5E-03	8.0E-04	3.3E-03	2.9E-02	0.12	3.1E-02	0.13	N	Y
Total Non-HAP TAP		0.13	0.50	6.75	25.40	84.83	371.54	91.71	397.44		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

Conversions

2,000 lb/ton
8,760 hr/yr
24 hr/day

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary - continued

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**Non-HAP TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
7429-90-5	Aluminum	0	0	0.65	2.58	57.86	253.41	58.50	255.98	N	Y
7440-39-3	Barium	2.1E-04	8.4E-04	6.6E-03	2.7E-02	0.65	2.86	0.66	2.88	N	Y
1317-65-3	Calcium Carbonate	0	0	2.24	8.12	11.41	49.97	13.65	58.09	N	Y
1305-78-8	Calcium Oxide	0	0	0.70	0.95	0	0	0.70	0.95	N	Y
7440-50-8	Copper	4.0E-05	1.6E-04	4.9E-04	2.1E-03	4.1E-03	1.8E-02	4.6E-03	2.0E-02	N	Y
110-82-7	Cyclohexane	0	0	1.0E-03	4.6E-03	0	0	1.0E-03	4.6E-03	N	Y
7783-06-4	Hydrogen Sulfide	0	0	0.90	3.94	0	0	0.90	3.94	N	Y
7439-89-6	Iron	0	0	0.21	0.81	14.83	64.96	15.04	65.77	N	Y
7439-98-7	Molybdenum	5.2E-05	2.1E-04	4.2E-04	1.8E-03	8.1E-04	3.6E-03	1.3E-03	5.6E-03	N	Y
109-66-0	Pentane	0.12	0.50	0	0	0	0	0.12	0.50	N	Y
7440-22-4	Silver	0	0	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.2E-04	3.6E-03	N	Y
7664-93-9	Sulfuric Acid	0	0	2.03	8.89	0	0	2.03	8.89	N	Y
7440-28-0	Thallium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-61-1	Uranium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-62-2	Vanadium	1.1E-04	4.4E-04	7.3E-04	3.0E-03	2.3E-02	1.0E-01	2.4E-02	0.10	N	Y
25551-13-7	Trimethyl benzene	0	0	1.1E-02	4.8E-02	0	0	1.1E-02	4.8E-02	N	Y
7440-33-7	Tungsten	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-66-6	Zinc	1.4E-03	5.5E-03	8.0E-04	3.3E-03	2.9E-02	0.12	3.1E-02	0.13	N	Y
Total Non-HAP TAP		0.13	0.50	6.75	25.40	84.83	371.54	91.71	397.44		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

Conversions

2,000 lb/ton
8,760 hr/yr
24 hr/day

PROPANE COMBUSTION

Source Data

Source ID	Description	MMBtu/day	MMBtu/yr
Lime Process Heating			
LKC	PFR Shaft Lime Kiln Combustion	529.0	163,935
Ore Process Heating			
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	17.0	510
CKB	Carbon Regeneration Kiln (Burners)	54.1	19,754
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	2.4	876
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	120.0	43,800
Subtotal		193.5	64,940
HVAC			
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	96.0	35,040
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	96.0	35,040
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	96.0	35,040
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	12.0	4,380
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	48.0	17,520
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	72.0	26,280
Subtotal		438.0	159,870

PROPANE COMBUSTION

Source Data

Source ID	Description	MMBtu/day	MMBtu/yr
Lime Process Heating			
LKC	PFR Shaft Lime Kiln Combustion	529.0	163,935
Ore Process Heating			
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	17.0	510
CKB	Carbon Regeneration Kiln (Burners)	54.1	19,754
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	2.4	876
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	120.0	43,800
Subtotal		193.5	64,940
HVAC			
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	96.0	35,040
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	96.0	35,040
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	96.0	35,040
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	12.0	4,380
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	48.0	17,520
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	72.0	26,280
Subtotal		438.0	159,870

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 1 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021

Model Scenario W3 180,000 T/day Emissions

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	HAP/TAP	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
106-99-0	1,3-Butadiene	8.4E-07	3.7E-06	0	0	0	0	8.4E-07	3.7E-06	Y	Y
91-57-6	2-Methylnaphthalene	1.1E-06	4.6E-06	0	0	0	0	1.1E-06	4.6E-06	Y	N
56-49-5	3-Methylchloranthrene	7.8E-08	3.4E-07	0	0	0	0	7.8E-08	3.4E-07	Y	Y
57-97-6	7,12-Dimethylbenz(a)anthracene	7.6E-07	3.0E-06	0	0	0	0	7.6E-07	3.0E-06	Y	N
83-32-9	Acenaphthene	5.7E-06	7.1E-06	0	0	0	0	5.7E-06	7.1E-06	Y	N
208-96-8	Acenaphthylene	1.1E-05	1.4E-05	0	0	0	0	1.1E-05	1.4E-05	Y	N
75-07-0	Acetaldehyde	2.5E-05	1.1E-04	0	0	0	0	2.5E-05	1.1E-04	Y	Y
107-02-8	Acrolein	1.6E-05	2.0E-05	0	0	0	0	1.6E-05	2.0E-05	Y	Y
120-12-7	Anthracene	1.7E-06	2.4E-06	0	0	0	0	1.7E-06	2.4E-06	Y	N
7440-36-0	Antimony	0	0	5.7E-04	2.5E-03	1.9E-02	8.2E-02	1.9E-02	8.5E-02	Y	Y
7440-38-2	Arsenic	8.7E-06	3.8E-05	4.5E-03	2.0E-02	0.54	2.38	0.55	2.40	Y	Y
56-55-3	Benz(a)anthracene	3.1E-07	1.4E-06	0	0	0	0	3.1E-07	1.4E-06	Y	Y
71-43-2	Benzene	3.6E-04	1.6E-03	7.0E-03	3.1E-02	0	0	7.4E-03	3.2E-02	Y	Y
50-32-8	Benzo(a)pyrene	1.4E-07	6.1E-07	0	0	0	0	1.4E-07	6.1E-07	Y	Y
205-99-2	Benzo(b)fluoranthene	4.4E-07	1.9E-06	0	0	0	0	4.4E-07	1.9E-06	Y	Y
191-24-2	Benzo(g,h,i)perylene	7.5E-07	1.1E-06	0	0	0	0	7.5E-07	1.1E-06	Y	N
207-08-9	Benzo(k)fluoranthene	1.5E-07	6.6E-07	0	0	0	0	1.5E-07	6.6E-07	Y	Y
7440-41-7	Beryllium	5.2E-07	2.3E-06	4.3E-04	1.9E-03	2.6E-03	1.1E-02	3.0E-03	1.3E-02	Y	Y
92-52-4	Biphenyl	0	0	4.4E-05	1.9E-04	0	0	4.4E-05	1.9E-04	Y	Y
7440-43-9	Cadmium	4.8E-05	2.1E-04	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.7E-04	3.8E-03	Y	Y
75-15-0	Carbon Disulfide	0	0	1.4E-02	6.3E-02	0	0	1.4E-02	6.3E-02	Y	Y
7440-47-3	Chromium	6.6E-05	2.7E-04	6.1E-04	2.5E-03	7.3E-03	3.2E-02	8.0E-03	3.5E-02	Y	Y
18540-29-9	Cr (VI)	0	0	3.4E-07	1.5E-06	0	0	3.4E-07	1.5E-06	Y	Y
218-01-9	Chrysene	5.8E-07	2.5E-06	0	0	0	0	5.8E-07	2.5E-06	Y	Y
7440-48-4	Cobalt	4.0E-06	1.6E-05	4.7E-04	2.0E-03	3.3E-03	1.4E-02	3.7E-03	1.6E-02	Y	Y
592-01-8	Cyanide	0	0	0.45	1.99	0	0	0.45	1.99	Y	Y
53-70-3	Dibenzo(a,h)anthracene	1.8E-07	7.7E-07	0	0	0	0	1.8E-07	7.7E-07	Y	Y
106-46-7	Dichlorobenzene	5.7E-05	2.3E-04	0	0	0	0	5.7E-05	2.3E-04	Y	Y
206-44-0	Fluoranthene	5.5E-06	7.0E-06	0	0	0	0	5.5E-06	7.0E-06	Y	N
86-73-7	Fluorene	1.7E-05	2.1E-05	0	0	0	0	1.7E-05	2.1E-05	Y	N
50-00-0	Formaldehyde	3.3E-03	1.5E-02	0	0	0	0	3.3E-03	1.5E-02	Y	Y
110-54-3	Hexane	8.5E-02	0.34	3.1E-02	0.14	0	0	0.12	0.48	Y	Y
7647-01-0	Hydrogen Chloride	0	0	0.99	3.67	0	0	0.99	**3.67**	Y	Y
193-39-5	Indeno(1,2,3-cd)pyrene	2.2E-07	9.6E-07	0	0	0	0	2.2E-07	9.6E-07	Y	Y
7439-92-1	Lead	0	0	4.8E-04	2.1E-03	6.5E-03	2.9E-02	7.0E-03	3.1E-02	Y	N
7439-96-5	Manganese	1.8E-05	7.2E-05	4.6E-03	1.7E-02	0.24	1.07	0.25	1.08	Y	Y
7439-97-6	Mercury	1.2E-05	5.0E-05	6.9E-04	2.9E-03	1.3E-03	5.7E-03	2.0E-03	8.6E-03	Y	N
91-20-3	Naphthalene	1.9E-04	3.1E-04	1.9E-03	8.5E-03	0	0	2.1E-03	8.8E-03	Y	Y
7440-02-0	Nickel	9.1E-05	4.0E-04	4.6E-04	2.0E-03	1.6E-03	7.1E-03	2.2E-03	9.5E-03	Y	Y
85-01-8	Phenanthrene	5.1E-05	6.3E-05	0	0	0	0	5.1E-05	6.3E-05	Y	N
108-95-2	Phenol	0	0	2.4E-04	1.1E-03	0	0	2.4E-04	1.1E-03	Y	Y
7723-14-0	Phosphorus	0	0	5.6E-03	2.3E-02	0.53	2.32	0.54	2.34	Y	Y
129-00-0	Pyrene	5.0E-06	6.6E-06	0	0	0	0	5.0E-06	6.6E-06	Y	N
7782-49-2	Selenium	1.1E-06	4.6E-06	4.1E-04	1.8E-03	3.3E-04	1.4E-03	7.4E-04	3.2E-03	Y	Y
108-88-3	Toluene	5.2E-04	1.1E-03	3.2E-02	0.14	0	0	3.2E-02	0.14	Y	Y
1330-20-7	Xylene	2.5E-04	3.0E-04	3.1E-02	0.14	0	0	3.2E-02	0.14	Y	Y
Total HAP		9.0E-02	0.36	1.58	6.25	1.36	5.95	3.03	12.56		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
TRUE	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
	chk	chk	chk-15	chk	chk	chk	chk	chk

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary - continued

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**Non-HAP TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
7429-90-5	Aluminum	0	0	0.65	2.58	57.86	253.41	58.50	255.98	N	Y
7440-39-3	Barium	2.1E-04	8.4E-04	6.6E-03	2.7E-02	0.65	2.86	0.66	2.88	N	Y
1317-65-3	Calcium Carbonate	0	0	2.24	8.12	11.41	49.97	13.65	58.09	N	Y
1305-78-8	Calcium Oxide	0	0	0.70	0.95	0	0	0.70	0.95	N	Y
7440-50-8	Copper	4.0E-05	1.6E-04	4.9E-04	2.1E-03	4.1E-03	1.8E-02	4.6E-03	2.0E-02	N	Y
110-82-7	Cyclohexane	0	0	1.0E-03	4.6E-03	0	0	1.0E-03	4.6E-03	N	Y
7783-06-4	Hydrogen Sulfide	0	0	0.90	3.94	0	0	0.90	3.94	N	Y
7439-89-6	Iron	0	0	0.21	0.81	14.83	64.96	15.04	65.77	N	Y
7439-98-7	Molybdenum	5.2E-05	2.1E-04	4.2E-04	1.8E-03	8.1E-04	3.6E-03	1.3E-03	5.6E-03	N	Y
109-66-0	Pentane	0.12	0.50	0	0	0	0	0.12	0.50	N	Y
7440-22-4	Silver	0	0	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.2E-04	3.6E-03	N	Y
7664-93-9	Sulfuric Acid	0	0	2.03	8.89	0	0	2.03	8.89	N	Y
7440-28-0	Thallium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-61-1	Uranium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-62-2	Vanadium	1.1E-04	4.4E-04	7.3E-04	3.0E-03	2.3E-02	1.0E-01	2.4E-02	0.10	N	Y
25551-13-7	Trimethyl benzene	0	0	1.1E-02	4.8E-02	0	0	1.1E-02	4.8E-02	N	Y
7440-33-7	Tungsten	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-66-6	Zinc	1.4E-03	5.5E-03	8.0E-04	3.3E-03	2.9E-02	0.12	3.1E-02	0.13	N	Y
Total Non-HAP TAP		0.13	0.50	6.75	25.40	84.83	371.54	91.71	397.44		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

Conversions

2,000 lb/ton
8,760 hr/yr
24 hr/day

PROPANE COMBUSTION

Source Data

Source ID	Description	MMBtu/day	MMBtu/yr
Lime Process Heating			
LKC	PFR Shaft Lime Kiln Combustion	529.0	163,935
Ore Process Heating			
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	17.0	510
CKB	Carbon Regeneration Kiln (Burners)	54.1	19,754
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	2.4	876
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	120.0	43,800
Subtotal		193.5	64,940
HVAC			
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	96.0	35,040
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	96.0	35,040
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	96.0	35,040
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	12.0	4,380
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	48.0	17,520
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	72.0	26,280
Subtotal		438.0	159,870

PROPANE COMBUSTION

Source Data

Source ID	Description	MMBtu/day	MMBtu/yr
Lime Process Heating			
LKC	PFR Shaft Lime Kiln Combustion	529.0	163,935
Ore Process Heating			
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	17.0	510
CKB	Carbon Regeneration Kiln (Burners)	54.1	19,754
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	2.4	876
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	120.0	43,800
Subtotal		193.5	64,940
HVAC			
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	96.0	35,040
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	96.0	35,040
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	96.0	35,040
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	12.0	4,380
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	48.0	17,520
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	72.0	26,280
Subtotal		438.0	159,870

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 1 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021

Model Scenario W3 180,000 T/day Emissions

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	HAP/TAP	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
106-99-0	1,3-Butadiene	8.4E-07	3.7E-06	0	0	0	0	8.4E-07	3.7E-06	Y	Y
91-57-6	2-Methylnaphthalene	1.1E-06	4.6E-06	0	0	0	0	1.1E-06	4.6E-06	Y	N
56-49-5	3-Methylchloranthrene	7.8E-08	3.4E-07	0	0	0	0	7.8E-08	3.4E-07	Y	Y
57-97-6	7,12-Dimethylbenz(a)anthracene	7.6E-07	3.0E-06	0	0	0	0	7.6E-07	3.0E-06	Y	N
83-32-9	Acenaphthene	5.7E-06	7.1E-06	0	0	0	0	5.7E-06	7.1E-06	Y	N
208-96-8	Acenaphthylene	1.1E-05	1.4E-05	0	0	0	0	1.1E-05	1.4E-05	Y	N
75-07-0	Acetaldehyde	2.5E-05	1.1E-04	0	0	0	0	2.5E-05	1.1E-04	Y	Y
107-02-8	Acrolein	1.6E-05	2.0E-05	0	0	0	0	1.6E-05	2.0E-05	Y	Y
120-12-7	Anthracene	1.7E-06	2.4E-06	0	0	0	0	1.7E-06	2.4E-06	Y	N
7440-36-0	Antimony	0	0	5.7E-04	2.5E-03	1.9E-02	8.2E-02	1.9E-02	8.5E-02	Y	Y
7440-38-2	Arsenic	8.7E-06	3.8E-05	4.5E-03	2.0E-02	0.54	2.38	0.55	2.40	Y	Y
56-55-3	Benz(a)anthracene	3.1E-07	1.4E-06	0	0	0	0	3.1E-07	1.4E-06	Y	Y
71-43-2	Benzene	3.6E-04	1.6E-03	7.0E-03	3.1E-02	0	0	7.4E-03	3.2E-02	Y	Y
50-32-8	Benzo(a)pyrene	1.4E-07	6.1E-07	0	0	0	0	1.4E-07	6.1E-07	Y	Y
205-99-2	Benzo(b)fluoranthene	4.4E-07	1.9E-06	0	0	0	0	4.4E-07	1.9E-06	Y	Y
191-24-2	Benzo(g,h,i)perylene	7.5E-07	1.1E-06	0	0	0	0	7.5E-07	1.1E-06	Y	N
207-08-9	Benzo(k)fluoranthene	1.5E-07	6.6E-07	0	0	0	0	1.5E-07	6.6E-07	Y	Y
7440-41-7	Beryllium	5.2E-07	2.3E-06	4.3E-04	1.9E-03	2.6E-03	1.1E-02	3.0E-03	1.3E-02	Y	Y
92-52-4	Biphenyl	0	0	4.4E-05	1.9E-04	0	0	4.4E-05	1.9E-04	Y	Y
7440-43-9	Cadmium	4.8E-05	2.1E-04	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.7E-04	3.8E-03	Y	Y
75-15-0	Carbon Disulfide	0	0	1.4E-02	6.3E-02	0	0	1.4E-02	6.3E-02	Y	Y
7440-47-3	Chromium	6.6E-05	2.7E-04	6.1E-04	2.5E-03	7.3E-03	3.2E-02	8.0E-03	3.5E-02	Y	Y
18540-29-9	Cr (VI)	0	0	3.4E-07	1.5E-06	0	0	3.4E-07	1.5E-06	Y	Y
218-01-9	Chrysene	5.8E-07	2.5E-06	0	0	0	0	5.8E-07	2.5E-06	Y	Y
7440-48-4	Cobalt	4.0E-06	1.6E-05	4.7E-04	2.0E-03	3.3E-03	1.4E-02	3.7E-03	1.6E-02	Y	Y
592-01-8	Cyanide	0	0	0.45	1.99	0	0	0.45	1.99	Y	Y
53-70-3	Dibenzo(a,h)anthracene	1.8E-07	7.7E-07	0	0	0	0	1.8E-07	7.7E-07	Y	Y
106-46-7	Dichlorobenzene	5.7E-05	2.3E-04	0	0	0	0	5.7E-05	2.3E-04	Y	Y
206-44-0	Fluoranthene	5.5E-06	7.0E-06	0	0	0	0	5.5E-06	7.0E-06	Y	N
86-73-7	Fluorene	1.7E-05	2.1E-05	0	0	0	0	1.7E-05	2.1E-05	Y	N
50-00-0	Formaldehyde	3.3E-03	1.5E-02	0	0	0	0	3.3E-03	1.5E-02	Y	Y
110-54-3	Hexane	8.5E-02	0.34	3.1E-02	0.14	0	0	0.12	0.48	Y	Y
7647-01-0	Hydrogen Chloride	0	0	0.99	3.67	0	0	0.99	**3.67**	Y	Y
193-39-5	Indeno(1,2,3-cd)pyrene	2.2E-07	9.6E-07	0	0	0	0	2.2E-07	9.6E-07	Y	Y
7439-92-1	Lead	0	0	4.8E-04	2.1E-03	6.5E-03	2.9E-02	7.0E-03	3.1E-02	Y	N
7439-96-5	Manganese	1.8E-05	7.2E-05	4.6E-03	1.7E-02	0.24	1.07	0.25	1.08	Y	Y
7439-97-6	Mercury	1.2E-05	5.0E-05	6.9E-04	2.9E-03	1.3E-03	5.7E-03	2.0E-03	8.6E-03	Y	N
91-20-3	Naphthalene	1.9E-04	3.1E-04	1.9E-03	8.5E-03	0	0	2.1E-03	8.8E-03	Y	Y
7440-02-0	Nickel	9.1E-05	4.0E-04	4.6E-04	2.0E-03	1.6E-03	7.1E-03	2.2E-03	9.5E-03	Y	Y
85-01-8	Phenanthrene	5.1E-05	6.3E-05	0	0	0	0	5.1E-05	6.3E-05	Y	N
108-95-2	Phenol	0	0	2.4E-04	1.1E-03	0	0	2.4E-04	1.1E-03	Y	Y
7723-14-0	Phosphorus	0	0	5.6E-03	2.3E-02	0.53	2.32	0.54	2.34	Y	Y
129-00-0	Pyrene	5.0E-06	6.6E-06	0	0	0	0	5.0E-06	6.6E-06	Y	N
7782-49-2	Selenium	1.1E-06	4.6E-06	4.1E-04	1.8E-03	3.3E-04	1.4E-03	7.4E-04	3.2E-03	Y	Y
108-88-3	Toluene	5.2E-04	1.1E-03	3.2E-02	0.14	0	0	3.2E-02	0.14	Y	Y
1330-20-7	Xylene	2.5E-04	3.0E-04	3.1E-02	0.14	0	0	3.2E-02	0.14	Y	Y
Total HAP		9.0E-02	0.36	1.58	6.25	1.36	5.95	3.03	12.56		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
TRUE	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
	chk	chk	chk-15	chk	chk	chk	chk	chk

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary - continued

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**Non-HAP TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
7429-90-5	Aluminum	0	0	0.65	2.58	57.86	253.41	58.50	255.98	N	Y
7440-39-3	Barium	2.1E-04	8.4E-04	6.6E-03	2.7E-02	0.65	2.86	0.66	2.88	N	Y
1317-65-3	Calcium Carbonate	0	0	2.24	8.12	11.41	49.97	13.65	58.09	N	Y
1305-78-8	Calcium Oxide	0	0	0.70	0.95	0	0	0.70	0.95	N	Y
7440-50-8	Copper	4.0E-05	1.6E-04	4.9E-04	2.1E-03	4.1E-03	1.8E-02	4.6E-03	2.0E-02	N	Y
110-82-7	Cyclohexane	0	0	1.0E-03	4.6E-03	0	0	1.0E-03	4.6E-03	N	Y
7783-06-4	Hydrogen Sulfide	0	0	0.90	3.94	0	0	0.90	3.94	N	Y
7439-89-6	Iron	0	0	0.21	0.81	14.83	64.96	15.04	65.77	N	Y
7439-98-7	Molybdenum	5.2E-05	2.1E-04	4.2E-04	1.8E-03	8.1E-04	3.6E-03	1.3E-03	5.6E-03	N	Y
109-66-0	Pentane	0.12	0.50	0	0	0	0	0.12	0.50	N	Y
7440-22-4	Silver	0	0	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.2E-04	3.6E-03	N	Y
7664-93-9	Sulfuric Acid	0	0	2.03	8.89	0	0	2.03	8.89	N	Y
7440-28-0	Thallium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-61-1	Uranium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-62-2	Vanadium	1.1E-04	4.4E-04	7.3E-04	3.0E-03	2.3E-02	1.0E-01	2.4E-02	0.10	N	Y
25551-13-7	Trimethyl benzene	0	0	1.1E-02	4.8E-02	0	0	1.1E-02	4.8E-02	N	Y
7440-33-7	Tungsten	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-66-6	Zinc	1.4E-03	5.5E-03	8.0E-04	3.3E-03	2.9E-02	0.12	3.1E-02	0.13	N	Y
Total Non-HAP TAP		0.13	0.50	6.75	25.40	84.83	371.54	91.71	397.44		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

Conversions

2,000 lb/ton
8,760 hr/yr
24 hr/day

PROPANE COMBUSTION

Source Data

Source ID	Description	MMBtu/day	MMBtu/yr
Lime Process Heating			
LKC	PFR Shaft Lime Kiln Combustion	529.0	163,935
Ore Process Heating			
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	17.0	510
CKB	Carbon Regeneration Kiln (Burners)	54.1	19,754
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	2.4	876
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	120.0	43,800
Subtotal		193.5	64,940
HVAC			
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	96.0	35,040
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	96.0	35,040
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	96.0	35,040
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	12.0	4,380
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	48.0	17,520
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	72.0	26,280
Subtotal		438.0	159,870

PROPANE COMBUSTION - CONTINUED

HAP/TAP Emission Factors and Emissions

O.Heat_pph O.Heat_tpy L.Heat_pph L.Heat_tpy HVAC_pph HVAC_tpy lb/hr ton/yr

		Emission Factor[2]		Emissions[1] Ore Proc Heat		Lime Proc Heat		HVAC		Total			
CAS	Pollutant	lb/MMscf	lb/MMBtu[3]	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	TAP	A/C
91-57-6	2-Methylnaphthalene	2.4E-05	2.35E-8	1.9E-07	7.6E-07	5.2E-07	1.9E-06	4.3E-07	1.9E-06	1.1E-06	4.6E-06	N	
56-49-5	3-Methylchloranthrene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
57-97-6	7,12-Dimethylbenz(a)ant	< 1.6E-05	1.57E-8	1.3E-07	5.1E-07	3.5E-07	1.3E-06	2.9E-07	1.3E-06	7.6E-07	3.0E-06	N	
83-32-9	Acenaphthene	< 1.8E-06	1.76E-9	1.4E-08	5.7E-08	3.9E-08	1.4E-07	3.2E-08	1.4E-07	8.5E-08	3.4E-07	N	
208-96-8	Acenaphthylene	< 1.8E-06	1.76E-9	1.4E-08	5.7E-08	3.9E-08	1.4E-07	3.2E-08	1.4E-07	8.5E-08	3.4E-07	N	
120-12-7	Anthracene	< 2.4E-06	2.35E-9	1.9E-08	7.6E-08	5.2E-08	1.9E-07	4.3E-08	1.9E-07	1.1E-07	4.6E-07	N	
7440-38-2	Arsenic	2.0E-04	1.96E-7	1.5E-06	6.4E-06	3.7E-06	1.6E-05	3.6E-06	1.6E-05	8.7E-06	3.8E-05	Y	C
56-55-3	Benz(a)anthracene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
71-43-2	Benzene	2.1E-03	2.06E-6	1.5E-05	6.7E-05	3.9E-05	1.7E-04	3.8E-05	1.6E-04	9.1E-05	4.0E-04	Y	C
50-32-8	Benzo(a)pyrene	< 1.2E-06	1.18E-9	8.7E-09	3.8E-08	2.2E-08	9.6E-08	2.1E-08	9.4E-08	5.2E-08	2.3E-07	Y	C
205-99-2	Benzo(b)fluoranthene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
191-24-2	Benzo(g,h,i)perylene	< 1.2E-06	1.18E-9	9.5E-09	3.8E-08	2.6E-08	9.6E-08	2.1E-08	9.4E-08	5.7E-08	2.3E-07	N	
207-08-9	Benzo(k)fluoranthene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
7440-41-7	Beryllium	< 1.2E-05	1.18E-8	8.7E-08	3.8E-07	2.2E-07	9.6E-07	2.1E-07	9.4E-07	5.2E-07	2.3E-06	Y	C
7440-43-9	Cadmium	1.1E-03	1.08E-6	8.0E-06	3.5E-05	2.0E-05	8.8E-05	2.0E-05	8.6E-05	4.8E-05	2.1E-04	Y	C
7440-47-3	Chromium	1.4E-03	1.37E-6	1.1E-05	4.5E-05	3.0E-05	1.1E-04	2.5E-05	1.1E-04	6.6E-05	2.7E-04	Y	A
218-01-9	Chrysene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
7440-48-4	Cobalt	8.4E-05	8.24E-8	6.6E-07	2.7E-06	1.8E-06	6.8E-06	1.5E-06	6.6E-06	4.0E-06	1.6E-05	Y	A
53-70-3	Dibenzo(a,h)anthracene	< 1.2E-06	1.18E-9	8.7E-09	3.8E-08	2.2E-08	9.6E-08	2.1E-08	9.4E-08	5.2E-08	2.3E-07	Y	C
106-46-7	Dichlorobenzene	1.2E-03	1.18E-6	9.5E-06	3.8E-05	2.6E-05	9.6E-05	2.1E-05	9.4E-05	5.7E-05	2.3E-04	Y	A
206-44-0	Fluoranthene	3.0E-06	2.94E-9	2.4E-08	9.5E-08	6.5E-08	2.4E-07	5.4E-08	2.4E-07	1.4E-07	5.7E-07	N	
86-73-7	Fluorene	2.8E-06	2.75E-9	2.2E-08	8.9E-08	6.1E-08	2.3E-07	5.0E-08	2.2E-07	1.3E-07	5.3E-07	N	
50-00-0	Formaldehyde	7.5E-02	7.35E-5	5.5E-04	2.4E-03	1.4E-03	6.0E-03	1.3E-03	5.9E-03	3.3E-03	1.4E-02	Y	C
110-54-3	Hexane	1.8E+00	1.76E-3	1.4E-02	5.7E-02	3.9E-02	1.4E-01	3.2E-02	1.4E-01	8.5E-02	3.4E-01	Y	A
193-39-5	Indeno(1,2,3-cd)pyrene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
7439-96-5	Manganese	3.8E-04	3.73E-7	3.0E-06	1.2E-05	8.2E-06	3.1E-05	6.8E-06	3.0E-05	1.8E-05	7.2E-05	Y	A
7439-97-6	Mercury	2.6E-04	2.55E-7	2.1E-06	8.3E-06	5.6E-06	2.1E-05	4.7E-06	2.0E-05	1.2E-05	5.0E-05	N	
91-20-3	Naphthalene	6.1E-04	5.98E-7	4.8E-06	1.9E-05	1.3E-05	4.9E-05	1.1E-05	4.8E-05	2.9E-05	1.2E-04	Y	A
7440-02-0	Nickel	2.1E-03	2.06E-6	1.5E-05	6.7E-05	3.9E-05	1.7E-04	3.8E-05	1.6E-04	9.1E-05	4.0E-04	Y	C
85-01-8	Phenanthrene	1.7E-05	1.67E-8	1.3E-07	5.4E-07	3.7E-07	1.4E-06	3.0E-07	1.3E-06	8.1E-07	3.2E-06	N	
129-00-0	Pyrene	5.0E-06	4.90E-9	4.0E-08	1.6E-07	1.1E-07	4.0E-07	8.9E-08	3.9E-07	2.4E-07	9.5E-07	N	
7782-49-2	Selenium	< 2.4E-05	2.35E-8	1.9E-07	7.6E-07	5.2E-07	1.9E-06	4.3E-07	1.9E-06	1.1E-06	4.6E-06	Y	A
108-88-3	Toluene	3.4E-03	3.33E-6	2.7E-05	1.1E-04	7.3E-05	2.7E-04	6.1E-05	2.7E-04	1.6E-04	6.5E-04	Y	A
109-66-0	Pentane	2.6E+00	2.55E-3	2.1E-02	8.3E-02	5.6E-02	2.1E-01	4.7E-02	2.0E-01	1.2E-01	5.0E-01	Y	A
7440-39-3	Barium	4.4E-03	4.31E-6	3.5E-05	1.4E-04	9.5E-05	3.5E-04	7.9E-05	3.4E-04	2.1E-04	8.4E-04	Y	A
7440-50-8	Copper	8.5E-04	8.33E-7	6.7E-06	2.7E-05	1.8E-05	6.8E-05	1.5E-05	6.7E-05	4.0E-05	1.6E-04	Y	A
7439-98-7	Molybdenum	1.1E-03	1.08E-6	8.7E-06	3.5E-05	2.4E-05	8.8E-05	2.0E-05	8.6E-05	5.2E-05	2.1E-04	Y	A
7440-62-2	Vanadium	2.3E-03	2.25E-6	1.8E-05	7.3E-05	5.0E-05	1.8E-04	4.1E-05	1.8E-04	1.1E-04	4.4E-04	Y	A
7440-66-6	Zinc	2.9E-02	2.84E-5	2.3E-04	9.2E-04	6.3E-04	2.3E-03	5.2E-04	2.3E-03	1.4E-03	5.5E-03	Y	A
Total				3.6E-02	1.4E-01	9.8E-02	3.6E-01	8.1E-02	3.5E-01	2.1E-01	8.6E-01		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *AP-42, Table 1.4-3 & 1.4-4 (7/98) Natural Gas Combustion* 1.0766 1.0766

(3) *Natural Gas Higher Heating Value* 1,020 *MMBtu/MMscf* chk

DIESEL COMBUSTION

Source Data

Source ID	Description	Power Rating kW	Power Rating hp	Operation hr/day	Operation hr/yr	Fuel Consumption[1] & [2] MMBtu/day	Fuel Consumption[1] & [2] MMBtu/yr
EDG1	Camp Emergency Generator	1,000	1,341	1	100	9.39	938.70
EDG2	Plant Emergency Generator #1	1,000	1,341	1	100	9.39	938.7
EDG3	Plant Emergency Generator #2	1,000	1,341	1	100	9.39	938.7
EDFP	Mill Fire Pump	200	268	1	100	1.88	187.7
Total						30.0	3,003.8

(1) *Based on brake specific fuel consumption for diesel generators* 7,000 *Btu/hp-hr* *AP-42 Tbl 3.3-1*

(2) *Heat Content of* 0.137 *MMBtu/gal* 1E+6 *Btu/MMBtu* 1.341 *hp/kW*

HAP/TAP Emission Factors and Emissions

lb/hr ton/yr

	Pollutant	Factor (lb/MMBtu) ≤600 hp[2]	Factor (lb/MMBtu) >600hp[3]	Emissions (≤600 hp) lb/hr	Emissions (≤600 hp) ton/yr	Emissions (>600 hp) lb/hr	Emissions (>600 hp) ton/yr	Total Emissions[1] lb/hr	Total Emissions[1] ton/yr	TAP	A/C
106-99-0	1,3-Butadiene	< 3.9E-05		8.4E-07	3.7E-06	0.0E+00	0.0E+00	8.4E-07	3.7E-06	Y	C
83-32-9	Acenaphthene	< 1.4E-06	4.7E-06	1.1E-07	1.3E-07	5.5E-06	6.6E-06	5.6E-06	6.7E-06	N	
208-96-8	Acenaphthylene	< 5.1E-06	9.2E-06	4.0E-07	4.7E-07	1.1E-05	1.3E-05	1.1E-05	1.3E-05	N	
75-07-0	Acetaldehyde	7.7E-04	2.5E-05	1.6E-05	7.2E-05	8.1E-06	3.5E-05	2.5E-05	1.1E-04	Y	C
107-02-8	Acrolein	< 9.3E-05	7.9E-06	7.2E-06	8.7E-06	9.2E-06	1.1E-05	1.6E-05	2.0E-05	Y	A
120-12-7	Anthracene	1.9E-06	1.2E-06	1.5E-07	1.8E-07	1.4E-06	1.7E-06	1.6E-06	1.9E-06	N	
56-55-3	Benz(a)anthracene	1.7E-06	6.2E-07	3.6E-08	1.6E-07	2.0E-07	8.8E-07	2.4E-07	1.0E-06	Y	C
71-43-2	Benzene	9.3E-04	7.8E-04	2.0E-05	8.8E-05	2.5E-04	1.1E-03	2.7E-04	1.2E-03	Y	C
50-32-8	Benzo(a)pyrene	< 1.9E-07	< 2.6E-07	4.0E-09	1.8E-08	8.3E-08	3.6E-07	8.7E-08	3.8E-07	Y	C
205-99-2	Benzo(b)fluoranthene	< 9.9E-08	< 1.1E-06	2.1E-09	9.3E-09	3.6E-07	1.6E-06	3.6E-07	1.6E-06	Y	C
191-24-2	Benzo(g,h,i)perylene	< 4.9E-07	< 5.6E-07	3.8E-08	4.6E-08	6.5E-07	7.8E-07	6.9E-07	8.3E-07	N	
207-08-9	Benzo(k)fluoranthene	< 1.6E-07	< 2.2E-07	3.3E-09	1.5E-08	7.0E-08	3.1E-07	7.3E-08	3.2E-07	Y	C
218-01-9	Chrysene	3.5E-07	1.5E-06	7.6E-09	3.3E-08	4.9E-07	2.2E-06	5.0E-07	2.2E-06	Y	C
53-70-3	Dibenzo(a,h)anthracene	< 5.8E-07	< 3.5E-07	1.2E-08	5.5E-08	1.1E-07	4.9E-07	1.2E-07	5.4E-07	Y	C
206-44-0	Fluoranthene	7.6E-06	4.0E-06	6.0E-07	7.1E-07	4.7E-06	5.7E-06	5.3E-06	6.4E-06	N	
86-73-7	Fluorene	2.9E-05	1.3E-05	2.3E-06	2.7E-06	1.5E-05	1.8E-05	1.7E-05	2.1E-05	N	
50-00-0	Formaldehyde	1.2E-03	7.9E-05	2.5E-05	1.1E-04	2.5E-05	1.1E-04	5.1E-05	2.2E-04	Y	C
193-39-5	Indeno(1,2,3-cd)pyrene	< 3.8E-07	< 4.1E-07	8.0E-09	3.5E-08	1.3E-07	5.8E-07	1.4E-07	6.2E-07	Y	C
91-20-3	Naphthalene	8.5E-05	1.3E-04	6.6E-06	8.0E-06	1.5E-04	1.8E-04	1.6E-04	1.9E-04	Y	A
85-01-8	Phenanthrene	2.9E-05	4.1E-05	2.3E-06	2.8E-06	4.8E-05	5.7E-05	5.0E-05	6.0E-05	N	
129-00-0	Pyrene	4.8E-06	3.7E-06	3.7E-07	4.5E-07	4.4E-06	5.2E-06	4.7E-06	5.7E-06	N	
108-88-3	Toluene	4.1E-04	2.8E-04	3.2E-05	3.8E-05	3.3E-04	4.0E-04	3.6E-04	4.3E-04	Y	A
1330-20-7	Xylene	2.9E-04	1.9E-04	2.2E-05	2.7E-05	2.3E-04	2.7E-04	2.5E-04	3.0E-04	Y	A
Total				1.4E-04	3.6E-04	1.1E-03	2.2E-03	1.2E-03	2.6E-03		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *AP-42, Tab. 3.3-2, 10/96, diesel engines (≤ 600 hp)* chk chk

(3) *AP-42, Tabs. 3.4-3 & 3.4-4, 10/96, large diesel engines (> 600 hp)*

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 1 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021

Model Scenario W3 180,000 T/day Emissions

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**HAP/TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
106-99-0	1,3-Butadiene	8.4E-07	3.7E-06	0	0	0	0	8.4E-07	3.7E-06	Y	Y
91-57-6	2-Methylnaphthalene	1.1E-06	4.6E-06	0	0	0	0	1.1E-06	4.6E-06	Y	N
56-49-5	3-Methylchloranthrene	7.8E-08	3.4E-07	0	0	0	0	7.8E-08	3.4E-07	Y	Y
57-97-6	7,12-Dimethylbenz(a)anthracene	7.6E-07	3.0E-06	0	0	0	0	7.6E-07	3.0E-06	Y	N
83-32-9	Acenaphthene	5.7E-06	7.1E-06	0	0	0	0	5.7E-06	7.1E-06	Y	N
208-96-8	Acenaphthylene	1.1E-05	1.4E-05	0	0	0	0	1.1E-05	1.4E-05	Y	N
75-07-0	Acetaldehyde	2.5E-05	1.1E-04	0	0	0	0	2.5E-05	1.1E-04	Y	Y
107-02-8	Acrolein	1.6E-05	2.0E-05	0	0	0	0	1.6E-05	2.0E-05	Y	Y
120-12-7	Anthracene	1.7E-06	2.4E-06	0	0	0	0	1.7E-06	2.4E-06	Y	N
7440-36-0	Antimony	0	0	5.7E-04	2.5E-03	1.9E-02	8.2E-02	1.9E-02	8.5E-02	Y	Y
7440-38-2	Arsenic	8.7E-06	3.8E-05	4.5E-03	2.0E-02	0.54	2.38	0.55	2.40	Y	Y
56-55-3	Benz(a)anthracene	3.1E-07	1.4E-06	0	0	0	0	3.1E-07	1.4E-06	Y	Y
71-43-2	Benzene	3.6E-04	1.6E-03	7.0E-03	3.1E-02	0	0	7.4E-03	3.2E-02	Y	Y
50-32-8	Benzo(a)pyrene	1.4E-07	6.1E-07	0	0	0	0	1.4E-07	6.1E-07	Y	Y
205-99-2	Benzo(b)fluoranthene	4.4E-07	1.9E-06	0	0	0	0	4.4E-07	1.9E-06	Y	Y
191-24-2	Benzo(g,h,i)perylene	7.5E-07	1.1E-06	0	0	0	0	7.5E-07	1.1E-06	Y	N
207-08-9	Benzo(k)fluoranthene	1.5E-07	6.6E-07	0	0	0	0	1.5E-07	6.6E-07	Y	Y
7440-41-7	Beryllium	5.2E-07	2.3E-06	4.3E-04	1.9E-03	2.6E-03	1.1E-02	3.0E-03	1.3E-02	Y	Y
92-52-4	Biphenyl	0	0	4.4E-05	1.9E-04	0	0	4.4E-05	1.9E-04	Y	Y
7440-43-9	Cadmium	4.8E-05	2.1E-04	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.7E-04	3.8E-03	Y	Y
75-15-0	Carbon Disulfide	0	0	1.4E-02	6.3E-02	0	0	1.4E-02	6.3E-02	Y	Y
7440-47-3	Chromium	6.6E-05	2.7E-04	6.1E-04	2.5E-03	7.3E-03	3.2E-02	8.0E-03	3.5E-02	Y	Y
18540-29-9	Cr (VI)	0	0	3.4E-07	1.5E-06	0	0	3.4E-07	1.5E-06	Y	Y
218-01-9	Chrysene	5.8E-07	2.5E-06	0	0	0	0	5.8E-07	2.5E-06	Y	Y
7440-48-4	Cobalt	4.0E-06	1.6E-05	4.7E-04	2.0E-03	3.3E-03	1.4E-02	3.7E-03	1.6E-02	Y	Y
592-01-8	Cyanide	0	0	0.45	1.99	0	0	0.45	1.99	Y	Y
53-70-3	Dibenzo(a,h)anthracene	1.8E-07	7.7E-07	0	0	0	0	1.8E-07	7.7E-07	Y	Y
106-46-7	Dichlorobenzene	5.7E-05	2.3E-04	0	0	0	0	5.7E-05	2.3E-04	Y	Y
206-44-0	Fluoranthene	5.5E-06	7.0E-06	0	0	0	0	5.5E-06	7.0E-06	Y	N
86-73-7	Fluorene	1.7E-05	2.1E-05	0	0	0	0	1.7E-05	2.1E-05	Y	N
50-00-0	Formaldehyde	3.3E-03	1.5E-02	0	0	0	0	3.3E-03	1.5E-02	Y	Y
110-54-3	Hexane	8.5E-02	0.34	3.1E-02	0.14	0	0	0.12	0.48	Y	Y
7647-01-0	Hydrogen Chloride	0	0	0.99	3.67	0	0	0.99	**3.67**	Y	Y
193-39-5	Indeno(1,2,3-cd)pyrene	2.2E-07	9.6E-07	0	0	0	0	2.2E-07	9.6E-07	Y	Y
7439-92-1	Lead	0	0	4.8E-04	2.1E-03	6.5E-03	2.9E-02	7.0E-03	3.1E-02	Y	N
7439-96-5	Manganese	1.8E-05	7.2E-05	4.6E-03	1.7E-02	0.24	1.07	0.25	1.08	Y	Y
7439-97-6	Mercury	1.2E-05	5.0E-05	6.9E-04	2.9E-03	1.3E-03	5.7E-03	2.0E-03	8.6E-03	Y	N
91-20-3	Naphthalene	1.9E-04	3.1E-04	1.9E-03	8.5E-03	0	0	2.1E-03	8.8E-03	Y	Y
7440-02-0	Nickel	9.1E-05	4.0E-04	4.6E-04	2.0E-03	1.6E-03	7.1E-03	2.2E-03	9.5E-03	Y	Y
85-01-8	Phenanthrene	5.1E-05	6.3E-05	0	0	0	0	5.1E-05	6.3E-05	Y	N
108-95-2	Phenol	0	0	2.4E-04	1.1E-03	0	0	2.4E-04	1.1E-03	Y	Y
7723-14-0	Phosphorus	0	0	5.6E-03	2.3E-02	0.53	2.32	0.54	2.34	Y	Y
129-00-0	Pyrene	5.0E-06	6.6E-06	0	0	0	0	5.0E-06	6.6E-06	Y	N
7782-49-2	Selenium	1.1E-06	4.6E-06	4.1E-04	1.8E-03	3.3E-04	1.4E-03	7.4E-04	3.2E-03	Y	Y
108-88-3	Toluene	5.2E-04	1.1E-03	3.2E-02	0.14	0	0	3.2E-02	0.14	Y	Y
1330-20-7	Xylene	2.5E-04	3.0E-04	3.1E-02	0.14	0	0	3.2E-02	0.14	Y	Y
Total HAP		9.0E-02	0.36	1.58	6.25	1.36	5.95	3.03	12.56		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
TRUE	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
	chk	chk	chk-15	chk	chk	chk	chk	chk

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 1 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021

Model Scenario W3 180,000 T/day Emissions

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	HAP/TAP	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
106-99-0	1,3-Butadiene	8.4E-07	3.7E-06	0	0	0	0	8.4E-07	3.7E-06	Y	Y
91-57-6	2-Methylnaphthalene	1.1E-06	4.6E-06	0	0	0	0	1.1E-06	4.6E-06	Y	N
56-49-5	3-Methylchloranthrene	7.8E-08	3.4E-07	0	0	0	0	7.8E-08	3.4E-07	Y	Y
57-97-6	7,12-Dimethylbenz(a)anthracene	7.6E-07	3.0E-06	0	0	0	0	7.6E-07	3.0E-06	Y	N
83-32-9	Acenaphthene	5.7E-06	7.1E-06	0	0	0	0	5.7E-06	7.1E-06	Y	N
208-96-8	Acenaphthylene	1.1E-05	1.4E-05	0	0	0	0	1.1E-05	1.4E-05	Y	N
75-07-0	Acetaldehyde	2.5E-05	1.1E-04	0	0	0	0	2.5E-05	1.1E-04	Y	Y
107-02-8	Acrolein	1.6E-05	2.0E-05	0	0	0	0	1.6E-05	2.0E-05	Y	Y
120-12-7	Anthracene	1.7E-06	2.4E-06	0	0	0	0	1.7E-06	2.4E-06	Y	N
7440-36-0	Antimony	0	0	5.7E-04	2.5E-03	1.9E-02	8.2E-02	1.9E-02	8.5E-02	Y	Y
7440-38-2	Arsenic	8.7E-06	3.8E-05	4.5E-03	2.0E-02	0.54	2.38	0.55	2.40	Y	Y
56-55-3	Benz(a)anthracene	3.1E-07	1.4E-06	0	0	0	0	3.1E-07	1.4E-06	Y	Y
71-43-2	Benzene	3.6E-04	1.6E-03	7.0E-03	3.1E-02	0	0	7.4E-03	3.2E-02	Y	Y
50-32-8	Benzo(a)pyrene	1.4E-07	6.1E-07	0	0	0	0	1.4E-07	6.1E-07	Y	Y
205-99-2	Benzo(b)fluoranthene	4.4E-07	1.9E-06	0	0	0	0	4.4E-07	1.9E-06	Y	Y
191-24-2	Benzo(g,h,i)perylene	7.5E-07	1.1E-06	0	0	0	0	7.5E-07	1.1E-06	Y	N
207-08-9	Benzo(k)fluoranthene	1.5E-07	6.6E-07	0	0	0	0	1.5E-07	6.6E-07	Y	Y
7440-41-7	Beryllium	5.2E-07	2.3E-06	4.3E-04	1.9E-03	2.6E-03	1.1E-02	3.0E-03	1.3E-02	Y	Y
92-52-4	Biphenyl	0	0	4.4E-05	1.9E-04	0	0	4.4E-05	1.9E-04	Y	Y
7440-43-9	Cadmium	4.8E-05	2.1E-04	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.7E-04	3.8E-03	Y	Y
75-15-0	Carbon Disulfide	0	0	1.4E-02	6.3E-02	0	0	1.4E-02	6.3E-02	Y	Y
7440-47-3	Chromium	6.6E-05	2.7E-04	6.1E-04	2.5E-03	7.3E-03	3.2E-02	8.0E-03	3.5E-02	Y	Y
18540-29-9	Cr (VI)	0	0	3.4E-07	1.5E-06	0	0	3.4E-07	1.5E-06	Y	Y
218-01-9	Chrysene	5.8E-07	2.5E-06	0	0	0	0	5.8E-07	2.5E-06	Y	Y
7440-48-4	Cobalt	4.0E-06	1.6E-05	4.7E-04	2.0E-03	3.3E-03	1.4E-02	3.7E-03	1.6E-02	Y	Y
592-01-8	Cyanide	0	0	0.45	1.99	0	0	0.45	1.99	Y	Y
53-70-3	Dibenzo(a,h)anthracene	1.8E-07	7.7E-07	0	0	0	0	1.8E-07	7.7E-07	Y	Y
106-46-7	Dichlorobenzene	5.7E-05	2.3E-04	0	0	0	0	5.7E-05	2.3E-04	Y	Y
206-44-0	Fluoranthene	5.5E-06	7.0E-06	0	0	0	0	5.5E-06	7.0E-06	Y	N
86-73-7	Fluorene	1.7E-05	2.1E-05	0	0	0	0	1.7E-05	2.1E-05	Y	N
50-00-0	Formaldehyde	3.3E-03	1.5E-02	0	0	0	0	3.3E-03	1.5E-02	Y	Y
110-54-3	Hexane	8.5E-02	0.34	3.1E-02	0.14	0	0	0.12	0.48	Y	Y
7647-01-0	Hydrogen Chloride	0	0	0.99	3.67	0	0	0.99	**3.67**	Y	Y
193-39-5	Indeno(1,2,3-cd)pyrene	2.2E-07	9.6E-07	0	0	0	0	2.2E-07	9.6E-07	Y	Y
7439-92-1	Lead	0	0	4.8E-04	2.1E-03	6.5E-03	2.9E-02	7.0E-03	3.1E-02	Y	N
7439-96-5	Manganese	1.8E-05	7.2E-05	4.6E-03	1.7E-02	0.24	1.07	0.25	1.08	Y	Y
7439-97-6	Mercury	1.2E-05	5.0E-05	6.9E-04	2.9E-03	1.3E-03	5.7E-03	2.0E-03	8.6E-03	Y	N
91-20-3	Naphthalene	1.9E-04	3.1E-04	1.9E-03	8.5E-03	0	0	2.1E-03	8.8E-03	Y	Y
7440-02-0	Nickel	9.1E-05	4.0E-04	4.6E-04	2.0E-03	1.6E-03	7.1E-03	2.2E-03	9.5E-03	Y	Y
85-01-8	Phenanthrene	5.1E-05	6.3E-05	0	0	0	0	5.1E-05	6.3E-05	Y	N
108-95-2	Phenol	0	0	2.4E-04	1.1E-03	0	0	2.4E-04	1.1E-03	Y	Y
7723-14-0	Phosphorus	0	0	5.6E-03	2.3E-02	0.53	2.32	0.54	2.34	Y	Y
129-00-0	Pyrene	5.0E-06	6.6E-06	0	0	0	0	5.0E-06	6.6E-06	Y	N
7782-49-2	Selenium	1.1E-06	4.6E-06	4.1E-04	1.8E-03	3.3E-04	1.4E-03	7.4E-04	3.2E-03	Y	Y
108-88-3	Toluene	5.2E-04	1.1E-03	3.2E-02	0.14	0	0	3.2E-02	0.14	Y	Y
1330-20-7	Xylene	2.5E-04	3.0E-04	3.1E-02	0.14	0	0	3.2E-02	0.14	Y	Y
Total HAP		9.0E-02	0.36	1.58	6.25	1.36	5.95	3.03	12.56		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
TRUE	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
	chk	chk	chk-15	chk	chk	chk	chk	chk

REC 0560

PET 194

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary - continued

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**Non-HAP TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
7429-90-5	Aluminum	0	0	0.65	2.58	57.86	253.41	58.50	255.98	N	Y
7440-39-3	Barium	2.1E-04	8.4E-04	6.6E-03	2.7E-02	0.65	2.86	0.66	2.88	N	Y
1317-65-3	Calcium Carbonate	0	0	2.24	8.12	11.41	49.97	13.65	58.09	N	Y
1305-78-8	Calcium Oxide	0	0	0.70	0.95	0	0	0.70	0.95	N	Y
7440-50-8	Copper	4.0E-05	1.6E-04	4.9E-04	2.1E-03	4.1E-03	1.8E-02	4.6E-03	2.0E-02	N	Y
110-82-7	Cyclohexane	0	0	1.0E-03	4.6E-03	0	0	1.0E-03	4.6E-03	N	Y
7783-06-4	Hydrogen Sulfide	0	0	0.90	3.94	0	0	0.90	3.94	N	Y
7439-89-6	Iron	0	0	0.21	0.81	14.83	64.96	15.04	65.77	N	Y
7439-98-7	Molybdenum	5.2E-05	2.1E-04	4.2E-04	1.8E-03	8.1E-04	3.6E-03	1.3E-03	5.6E-03	N	Y
109-66-0	Pentane	0.12	0.50	0	0	0	0	0.12	0.50	N	Y
7440-22-4	Silver	0	0	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.2E-04	3.6E-03	N	Y
7664-93-9	Sulfuric Acid	0	0	2.03	8.89	0	0	2.03	8.89	N	Y
7440-28-0	Thallium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-61-1	Uranium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-62-2	Vanadium	1.1E-04	4.4E-04	7.3E-04	3.0E-03	2.3E-02	1.0E-01	2.4E-02	0.10	N	Y
25551-13-7	Trimethyl benzene	0	0	1.1E-02	4.8E-02	0	0	1.1E-02	4.8E-02	N	Y
7440-33-7	Tungsten	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-66-6	Zinc	1.4E-03	5.5E-03	8.0E-04	3.3E-03	2.9E-02	0.12	3.1E-02	0.13	N	Y
Total Non-HAP TAP		0.13	0.50	6.75	25.40	84.83	371.54	91.71	397.44		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

Conversions

2,000 lb/ton
8,760 hr/yr
24 hr/day

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary - continued

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**Non-HAP TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
7429-90-5	Aluminum	0	0	0.65	2.58	57.86	253.41	58.50	255.98	N	Y
7440-39-3	Barium	2.1E-04	8.4E-04	6.6E-03	2.7E-02	0.65	2.86	0.66	2.88	N	Y
1317-65-3	Calcium Carbonate	0	0	2.24	8.12	11.41	49.97	13.65	58.09	N	Y
1305-78-8	Calcium Oxide	0	0	0.70	0.95	0	0	0.70	0.95	N	Y
7440-50-8	Copper	4.0E-05	1.6E-04	4.9E-04	2.1E-03	4.1E-03	1.8E-02	4.6E-03	2.0E-02	N	Y
110-82-7	Cyclohexane	0	0	1.0E-03	4.6E-03	0	0	1.0E-03	4.6E-03	N	Y
7783-06-4	Hydrogen Sulfide	0	0	0.90	3.94	0	0	0.90	3.94	N	Y
7439-89-6	Iron	0	0	0.21	0.81	14.83	64.96	15.04	65.77	N	Y
7439-98-7	Molybdenum	5.2E-05	2.1E-04	4.2E-04	1.8E-03	8.1E-04	3.6E-03	1.3E-03	5.6E-03	N	Y
109-66-0	Pentane	0.12	0.50	0	0	0	0	0.12	0.50	N	Y
7440-22-4	Silver	0	0	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.2E-04	3.6E-03	N	Y
7664-93-9	Sulfuric Acid	0	0	2.03	8.89	0	0	2.03	8.89	N	Y
7440-28-0	Thallium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-61-1	Uranium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-62-2	Vanadium	1.1E-04	4.4E-04	7.3E-04	3.0E-03	2.3E-02	1.0E-01	2.4E-02	0.10	N	Y
25551-13-7	Trimethyl benzene	0	0	1.1E-02	4.8E-02	0	0	1.1E-02	4.8E-02	N	Y
7440-33-7	Tungsten	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-66-6	Zinc	1.4E-03	5.5E-03	8.0E-04	3.3E-03	2.9E-02	0.12	3.1E-02	0.13	N	Y
Total Non-HAP TAP		0.13	0.50	6.75	25.40	84.83	371.54	91.71	397.44		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

Conversions

2,000 lb/ton
8,760 hr/yr
24 hr/day

PROPANE COMBUSTION

Source Data

Source ID	Description	MMBtu/day	MMBtu/yr
Lime Process Heating			
LKC	PFR Shaft Lime Kiln Combustion	529.0	163,935
Ore Process Heating			
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	17.0	510
CKB	Carbon Regeneration Kiln (Burners)	54.1	19,754
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	2.4	876
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	120.0	43,800
Subtotal		193.5	64,940
HVAC			
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	96.0	35,040
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	96.0	35,040
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	96.0	35,040
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	12.0	4,380
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	48.0	17,520
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	72.0	26,280
Subtotal		438.0	159,870

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 1 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021

Model Scenario W3 180,000 T/day Emissions

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**HAP/TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
106-99-0	1,3-Butadiene	8.4E-07	3.7E-06	0	0	0	0	8.4E-07	3.7E-06	Y	Y
91-57-6	2-Methylnaphthalene	1.1E-06	4.6E-06	0	0	0	0	1.1E-06	4.6E-06	Y	N
56-49-5	3-Methylchloranthrene	7.8E-08	3.4E-07	0	0	0	0	7.8E-08	3.4E-07	Y	Y
57-97-6	7,12-Dimethylbenz(a)anthracene	7.6E-07	3.0E-06	0	0	0	0	7.6E-07	3.0E-06	Y	N
83-32-9	Acenaphthene	5.7E-06	7.1E-06	0	0	0	0	5.7E-06	7.1E-06	Y	N
208-96-8	Acenaphthylene	1.1E-05	1.4E-05	0	0	0	0	1.1E-05	1.4E-05	Y	N
75-07-0	Acetaldehyde	2.5E-05	1.1E-04	0	0	0	0	2.5E-05	1.1E-04	Y	Y
107-02-8	Acrolein	1.6E-05	2.0E-05	0	0	0	0	1.6E-05	2.0E-05	Y	Y
120-12-7	Anthracene	1.7E-06	2.4E-06	0	0	0	0	1.7E-06	2.4E-06	Y	N
7440-36-0	Antimony	0	0	5.7E-04	2.5E-03	1.9E-02	8.2E-02	1.9E-02	8.5E-02	Y	Y
7440-38-2	Arsenic	8.7E-06	3.8E-05	4.5E-03	2.0E-02	0.54	2.38	0.55	2.40	Y	Y
56-55-3	Benz(a)anthracene	3.1E-07	1.4E-06	0	0	0	0	3.1E-07	1.4E-06	Y	Y
71-43-2	Benzene	3.6E-04	1.6E-03	7.0E-03	3.1E-02	0	0	7.4E-03	3.2E-02	Y	Y
50-32-8	Benzo(a)pyrene	1.4E-07	6.1E-07	0	0	0	0	1.4E-07	6.1E-07	Y	Y
205-99-2	Benzo(b)fluoranthene	4.4E-07	1.9E-06	0	0	0	0	4.4E-07	1.9E-06	Y	Y
191-24-2	Benzo(g,h,i)perylene	7.5E-07	1.1E-06	0	0	0	0	7.5E-07	1.1E-06	Y	N
207-08-9	Benzo(k)fluoranthene	1.5E-07	6.6E-07	0	0	0	0	1.5E-07	6.6E-07	Y	Y
7440-41-7	Beryllium	5.2E-07	2.3E-06	4.3E-04	1.9E-03	2.6E-03	1.1E-02	3.0E-03	1.3E-02	Y	Y
92-52-4	Biphenyl	0	0	4.4E-05	1.9E-04	0	0	4.4E-05	1.9E-04	Y	Y
7440-43-9	Cadmium	4.8E-05	2.1E-04	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.7E-04	3.8E-03	Y	Y
75-15-0	Carbon Disulfide	0	0	1.4E-02	6.3E-02	0	0	1.4E-02	6.3E-02	Y	Y
7440-47-3	Chromium	6.6E-05	2.7E-04	6.1E-04	2.5E-03	7.3E-03	3.2E-02	8.0E-03	3.5E-02	Y	Y
18540-29-9	Cr (VI)	0	0	3.4E-07	1.5E-06	0	0	3.4E-07	1.5E-06	Y	Y
218-01-9	Chrysene	5.8E-07	2.5E-06	0	0	0	0	5.8E-07	2.5E-06	Y	Y
7440-48-4	Cobalt	4.0E-06	1.6E-05	4.7E-04	2.0E-03	3.3E-03	1.4E-02	3.7E-03	1.6E-02	Y	Y
592-01-8	Cyanide	0	0	0.45	1.99	0	0	0.45	1.99	Y	Y
53-70-3	Dibenzo(a,h)anthracene	1.8E-07	7.7E-07	0	0	0	0	1.8E-07	7.7E-07	Y	Y
106-46-7	Dichlorobenzene	5.7E-05	2.3E-04	0	0	0	0	5.7E-05	2.3E-04	Y	Y
206-44-0	Fluoranthene	5.5E-06	7.0E-06	0	0	0	0	5.5E-06	7.0E-06	Y	N
86-73-7	Fluorene	1.7E-05	2.1E-05	0	0	0	0	1.7E-05	2.1E-05	Y	N
50-00-0	Formaldehyde	3.3E-03	1.5E-02	0	0	0	0	3.3E-03	1.5E-02	Y	Y
110-54-3	Hexane	8.5E-02	0.34	3.1E-02	0.14	0	0	0.12	0.48	Y	Y
7647-01-0	Hydrogen Chloride	0	0	0.99	3.67	0	0	0.99	**3.67**	Y	Y
193-39-5	Indeno(1,2,3-cd)pyrene	2.2E-07	9.6E-07	0	0	0	0	2.2E-07	9.6E-07	Y	Y
7439-92-1	Lead	0	0	4.8E-04	2.1E-03	6.5E-03	2.9E-02	7.0E-03	3.1E-02	Y	N
7439-96-5	Manganese	1.8E-05	7.2E-05	4.6E-03	1.7E-02	0.24	1.07	0.25	1.08	Y	Y
7439-97-6	Mercury	1.2E-05	5.0E-05	6.9E-04	2.9E-03	1.3E-03	5.7E-03	2.0E-03	8.6E-03	Y	N
91-20-3	Naphthalene	1.9E-04	3.1E-04	1.9E-03	8.5E-03	0	0	2.1E-03	8.8E-03	Y	Y
7440-02-0	Nickel	9.1E-05	4.0E-04	4.6E-04	2.0E-03	1.6E-03	7.1E-03	2.2E-03	9.5E-03	Y	Y
85-01-8	Phenanthrene	5.1E-05	6.3E-05	0	0	0	0	5.1E-05	6.3E-05	Y	N
108-95-2	Phenol	0	0	2.4E-04	1.1E-03	0	0	2.4E-04	1.1E-03	Y	Y
7723-14-0	Phosphorus	0	0	5.6E-03	2.3E-02	0.53	2.32	0.54	2.34	Y	Y
129-00-0	Pyrene	5.0E-06	6.6E-06	0	0	0	0	5.0E-06	6.6E-06	Y	N
7782-49-2	Selenium	1.1E-06	4.6E-06	4.1E-04	1.8E-03	3.3E-04	1.4E-03	7.4E-04	3.2E-03	Y	Y
108-88-3	Toluene	5.2E-04	1.1E-03	3.2E-02	0.14	0	0	3.2E-02	0.14	Y	Y
1330-20-7	Xylene	2.5E-04	3.0E-04	3.1E-02	0.14	0	0	3.2E-02	0.14	Y	Y
Total HAP		9.0E-02	0.36	1.58	6.25	1.36	5.95	3.03	12.56		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
TRUE	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
	chk	chk	chk-15	chk	chk	chk	chk	chk

REC 0564

PET 198

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 1 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021

Model Scenario W3 180,000 T/day Emissions

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	HAP/TAP	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
106-99-0	1,3-Butadiene	8.4E-07	3.7E-06	0	0	0	0	8.4E-07	3.7E-06	Y	Y
91-57-6	2-Methylnaphthalene	1.1E-06	4.6E-06	0	0	0	0	1.1E-06	4.6E-06	Y	N
56-49-5	3-Methylchloranthrene	7.8E-08	3.4E-07	0	0	0	0	7.8E-08	3.4E-07	Y	Y
57-97-6	7,12-Dimethylbenz(a)anthracene	7.6E-07	3.0E-06	0	0	0	0	7.6E-07	3.0E-06	Y	N
83-32-9	Acenaphthene	5.7E-06	7.1E-06	0	0	0	0	5.7E-06	7.1E-06	Y	N
208-96-8	Acenaphthylene	1.1E-05	1.4E-05	0	0	0	0	1.1E-05	1.4E-05	Y	N
75-07-0	Acetaldehyde	2.5E-05	1.1E-04	0	0	0	0	2.5E-05	1.1E-04	Y	Y
107-02-8	Acrolein	1.6E-05	2.0E-05	0	0	0	0	1.6E-05	2.0E-05	Y	Y
120-12-7	Anthracene	1.7E-06	2.4E-06	0	0	0	0	1.7E-06	2.4E-06	Y	N
7440-36-0	Antimony	0	0	5.7E-04	2.5E-03	1.9E-02	8.2E-02	1.9E-02	8.5E-02	Y	Y
7440-38-2	Arsenic	8.7E-06	3.8E-05	4.5E-03	2.0E-02	0.54	2.38	0.55	2.40	Y	Y
56-55-3	Benz(a)anthracene	3.1E-07	1.4E-06	0	0	0	0	3.1E-07	1.4E-06	Y	Y
71-43-2	Benzene	3.6E-04	1.6E-03	7.0E-03	3.1E-02	0	0	7.4E-03	3.2E-02	Y	Y
50-32-8	Benzo(a)pyrene	1.4E-07	6.1E-07	0	0	0	0	1.4E-07	6.1E-07	Y	Y
205-99-2	Benzo(b)fluoranthene	4.4E-07	1.9E-06	0	0	0	0	4.4E-07	1.9E-06	Y	Y
191-24-2	Benzo(g,h,i)perylene	7.5E-07	1.1E-06	0	0	0	0	7.5E-07	1.1E-06	Y	N
207-08-9	Benzo(k)fluoranthene	1.5E-07	6.6E-07	0	0	0	0	1.5E-07	6.6E-07	Y	Y
7440-41-7	Beryllium	5.2E-07	2.3E-06	4.3E-04	1.9E-03	2.6E-03	1.1E-02	3.0E-03	1.3E-02	Y	Y
92-52-4	Biphenyl	0	0	4.4E-05	1.9E-04	0	0	4.4E-05	1.9E-04	Y	Y
7440-43-9	Cadmium	4.8E-05	2.1E-04	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.7E-04	3.8E-03	Y	Y
75-15-0	Carbon Disulfide	0	0	1.4E-02	6.3E-02	0	0	1.4E-02	6.3E-02	Y	Y
7440-47-3	Chromium	6.6E-05	2.7E-04	6.1E-04	2.5E-03	7.3E-03	3.2E-02	8.0E-03	3.5E-02	Y	Y
18540-29-9	Cr (VI)	0	0	3.4E-07	1.5E-06	0	0	3.4E-07	1.5E-06	Y	Y
218-01-9	Chrysene	5.8E-07	2.5E-06	0	0	0	0	5.8E-07	2.5E-06	Y	Y
7440-48-4	Cobalt	4.0E-06	1.6E-05	4.7E-04	2.0E-03	3.3E-03	1.4E-02	3.7E-03	1.6E-02	Y	Y
592-01-8	Cyanide	0	0	0.45	1.99	0	0	0.45	1.99	Y	Y
53-70-3	Dibenzo(a,h)anthracene	1.8E-07	7.7E-07	0	0	0	0	1.8E-07	7.7E-07	Y	Y
106-46-7	Dichlorobenzene	5.7E-05	2.3E-04	0	0	0	0	5.7E-05	2.3E-04	Y	Y
206-44-0	Fluoranthene	5.5E-06	7.0E-06	0	0	0	0	5.5E-06	7.0E-06	Y	N
86-73-7	Fluorene	1.7E-05	2.1E-05	0	0	0	0	1.7E-05	2.1E-05	Y	N
50-00-0	Formaldehyde	3.3E-03	1.5E-02	0	0	0	0	3.3E-03	1.5E-02	Y	Y
110-54-3	Hexane	8.5E-02	0.34	3.1E-02	0.14	0	0	0.12	0.48	Y	Y
7647-01-0	Hydrogen Chloride	0	0	0.99	3.67	0	0	0.99	**3.67**	Y	Y
193-39-5	Indeno(1,2,3-cd)pyrene	2.2E-07	9.6E-07	0	0	0	0	2.2E-07	9.6E-07	Y	Y
7439-92-1	Lead	0	0	4.8E-04	2.1E-03	6.5E-03	2.9E-02	7.0E-03	3.1E-02	Y	N
7439-96-5	Manganese	1.8E-05	7.2E-05	4.6E-03	1.7E-02	0.24	1.07	0.25	1.08	Y	Y
7439-97-6	Mercury	1.2E-05	5.0E-05	6.9E-04	2.9E-03	1.3E-03	5.7E-03	2.0E-03	8.6E-03	Y	N
91-20-3	Naphthalene	1.9E-04	3.1E-04	1.9E-03	8.5E-03	0	0	2.1E-03	8.8E-03	Y	Y
7440-02-0	Nickel	9.1E-05	4.0E-04	4.6E-04	2.0E-03	1.6E-03	7.1E-03	2.2E-03	9.5E-03	Y	Y
85-01-8	Phenanthrene	5.1E-05	6.3E-05	0	0	0	0	5.1E-05	6.3E-05	Y	N
108-95-2	Phenol	0	0	2.4E-04	1.1E-03	0	0	2.4E-04	1.1E-03	Y	Y
7723-14-0	Phosphorus	0	0	5.6E-03	2.3E-02	0.53	2.32	0.54	2.34	Y	Y
129-00-0	Pyrene	5.0E-06	6.6E-06	0	0	0	0	5.0E-06	6.6E-06	Y	N
7782-49-2	Selenium	1.1E-06	4.6E-06	4.1E-04	1.8E-03	3.3E-04	1.4E-03	7.4E-04	3.2E-03	Y	Y
108-88-3	Toluene	5.2E-04	1.1E-03	3.2E-02	0.14	0	0	3.2E-02	0.14	Y	Y
1330-20-7	Xylene	2.5E-04	3.0E-04	3.1E-02	0.14	0	0	3.2E-02	0.14	Y	Y
Total HAP		9.0E-02	0.36	1.58	6.25	1.36	5.95	3.03	12.56		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
TRUE	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
	chk	chk	chk-15	chk	chk	chk	chk	chk

REC 0565

PET 199

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary - continued

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**Non-HAP TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
7429-90-5	Aluminum	0	0	0.65	2.58	57.86	253.41	58.50	255.98	N	Y
7440-39-3	Barium	2.1E-04	8.4E-04	6.6E-03	2.7E-02	0.65	2.86	0.66	2.88	N	Y
1317-65-3	Calcium Carbonate	0	0	2.24	8.12	11.41	49.97	13.65	58.09	N	Y
1305-78-8	Calcium Oxide	0	0	0.70	0.95	0	0	0.70	0.95	N	Y
7440-50-8	Copper	4.0E-05	1.6E-04	4.9E-04	2.1E-03	4.1E-03	1.8E-02	4.6E-03	2.0E-02	N	Y
110-82-7	Cyclohexane	0	0	1.0E-03	4.6E-03	0	0	1.0E-03	4.6E-03	N	Y
7783-06-4	Hydrogen Sulfide	0	0	0.90	3.94	0	0	0.90	3.94	N	Y
7439-89-6	Iron	0	0	0.21	0.81	14.83	64.96	15.04	65.77	N	Y
7439-98-7	Molybdenum	5.2E-05	2.1E-04	4.2E-04	1.8E-03	8.1E-04	3.6E-03	1.3E-03	5.6E-03	N	Y
109-66-0	Pentane	0.12	0.50	0	0	0	0	0.12	0.50	N	Y
7440-22-4	Silver	0	0	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.2E-04	3.6E-03	N	Y
7664-93-9	Sulfuric Acid	0	0	2.03	8.89	0	0	2.03	8.89	N	Y
7440-28-0	Thallium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-61-1	Uranium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-62-2	Vanadium	1.1E-04	4.4E-04	7.3E-04	3.0E-03	2.3E-02	1.0E-01	2.4E-02	0.10	N	Y
25551-13-7	Trimethyl benzene	0	0	1.1E-02	4.8E-02	0	0	1.1E-02	4.8E-02	N	Y
7440-33-7	Tungsten	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-66-6	Zinc	1.4E-03	5.5E-03	8.0E-04	3.3E-03	2.9E-02	0.12	3.1E-02	0.13	N	Y
Total Non-HAP TAP		0.13	0.50	6.75	25.40	84.83	371.54	91.71	397.44		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

Conversions

2,000 lb/ton
8,760 hr/yr
24 hr/day

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary - continued

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**Non-HAP TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
7429-90-5	Aluminum	0	0	0.65	2.58	57.86	253.41	58.50	255.98	N	Y
7440-39-3	Barium	2.1E-04	8.4E-04	6.6E-03	2.7E-02	0.65	2.86	0.66	2.88	N	Y
1317-65-3	Calcium Carbonate	0	0	2.24	8.12	11.41	49.97	13.65	58.09	N	Y
1305-78-8	Calcium Oxide	0	0	0.70	0.95	0	0	0.70	0.95	N	Y
7440-50-8	Copper	4.0E-05	1.6E-04	4.9E-04	2.1E-03	4.1E-03	1.8E-02	4.6E-03	2.0E-02	N	Y
110-82-7	Cyclohexane	0	0	1.0E-03	4.6E-03	0	0	1.0E-03	4.6E-03	N	Y
7783-06-4	Hydrogen Sulfide	0	0	0.90	3.94	0	0	0.90	3.94	N	Y
7439-89-6	Iron	0	0	0.21	0.81	14.83	64.96	15.04	65.77	N	Y
7439-98-7	Molybdenum	5.2E-05	2.1E-04	4.2E-04	1.8E-03	8.1E-04	3.6E-03	1.3E-03	5.6E-03	N	Y
109-66-0	Pentane	0.12	0.50	0	0	0	0	0.12	0.50	N	Y
7440-22-4	Silver	0	0	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.2E-04	3.6E-03	N	Y
7664-93-9	Sulfuric Acid	0	0	2.03	8.89	0	0	2.03	8.89	N	Y
7440-28-0	Thallium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-61-1	Uranium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-62-2	Vanadium	1.1E-04	4.4E-04	7.3E-04	3.0E-03	2.3E-02	1.0E-01	2.4E-02	0.10	N	Y
25551-13-7	Trimethyl benzene	0	0	1.1E-02	4.8E-02	0	0	1.1E-02	4.8E-02	N	Y
7440-33-7	Tungsten	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-66-6	Zinc	1.4E-03	5.5E-03	8.0E-04	3.3E-03	2.9E-02	0.12	3.1E-02	0.13	N	Y
Total Non-HAP TAP		0.13	0.50	6.75	25.40	84.83	371.54	91.71	397.44		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

Conversions

2,000 lb/ton
8,760 hr/yr
24 hr/day

PROPANE COMBUSTION

Source Data

Source ID	Description	MMBtu/day	MMBtu/yr
Lime Process Heating			
LKC	PFR Shaft Lime Kiln Combustion	529.0	163,935
Ore Process Heating			
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	17.0	510
CKB	Carbon Regeneration Kiln (Burners)	54.1	19,754
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	2.4	876
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	120.0	43,800
Subtotal		193.5	64,940
HVAC			
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	96.0	35,040
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	96.0	35,040
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	96.0	35,040
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	12.0	4,380
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	48.0	17,520
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	72.0	26,280
Subtotal		438.0	159,870

PROPANE COMBUSTION

Source Data

Source ID	Description	MMBtu/day	MMBtu/yr
Lime Process Heating			
LKC	PFR Shaft Lime Kiln Combustion	529.0	163,935
Ore Process Heating			
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	17.0	510
CKB	Carbon Regeneration Kiln (Burners)	54.1	19,754
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	2.4	876
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	120.0	43,800
Subtotal		193.5	64,940
HVAC			
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	96.0	35,040
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	96.0	35,040
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	96.0	35,040
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	12.0	4,380
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	48.0	17,520
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	72.0	26,280
Subtotal		438.0	159,870

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 1 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021

Model Scenario W3 180,000 T/day Emissions

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	HAP/TAP	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
106-99-0	1,3-Butadiene	8.4E-07	3.7E-06	0	0	0	0	8.4E-07	3.7E-06	Y	Y
91-57-6	2-Methylnaphthalene	1.1E-06	4.6E-06	0	0	0	0	1.1E-06	4.6E-06	Y	N
56-49-5	3-Methylchloranthrene	7.8E-08	3.4E-07	0	0	0	0	7.8E-08	3.4E-07	Y	Y
57-97-6	7,12-Dimethylbenz(a)anthracene	7.6E-07	3.0E-06	0	0	0	0	7.6E-07	3.0E-06	Y	N
83-32-9	Acenaphthene	5.7E-06	7.1E-06	0	0	0	0	5.7E-06	7.1E-06	Y	N
208-96-8	Acenaphthylene	1.1E-05	1.4E-05	0	0	0	0	1.1E-05	1.4E-05	Y	N
75-07-0	Acetaldehyde	2.5E-05	1.1E-04	0	0	0	0	2.5E-05	1.1E-04	Y	Y
107-02-8	Acrolein	1.6E-05	2.0E-05	0	0	0	0	1.6E-05	2.0E-05	Y	Y
120-12-7	Anthracene	1.7E-06	2.4E-06	0	0	0	0	1.7E-06	2.4E-06	Y	N
7440-36-0	Antimony	0	0	5.7E-04	2.5E-03	1.9E-02	8.2E-02	1.9E-02	8.5E-02	Y	Y
7440-38-2	Arsenic	8.7E-06	3.8E-05	4.5E-03	2.0E-02	0.54	2.38	0.55	2.40	Y	Y
56-55-3	Benz(a)anthracene	3.1E-07	1.4E-06	0	0	0	0	3.1E-07	1.4E-06	Y	Y
71-43-2	Benzene	3.6E-04	1.6E-03	7.0E-03	3.1E-02	0	0	7.4E-03	3.2E-02	Y	Y
50-32-8	Benzo(a)pyrene	1.4E-07	6.1E-07	0	0	0	0	1.4E-07	6.1E-07	Y	Y
205-99-2	Benzo(b)fluoranthene	4.4E-07	1.9E-06	0	0	0	0	4.4E-07	1.9E-06	Y	Y
191-24-2	Benzo(g,h,i)perylene	7.5E-07	1.1E-06	0	0	0	0	7.5E-07	1.1E-06	Y	N
207-08-9	Benzo(k)fluoranthene	1.5E-07	6.6E-07	0	0	0	0	1.5E-07	6.6E-07	Y	Y
7440-41-7	Beryllium	5.2E-07	2.3E-06	4.3E-04	1.9E-03	2.6E-03	1.1E-02	3.0E-03	1.3E-02	Y	Y
92-52-4	Biphenyl	0	0	4.4E-05	1.9E-04	0	0	4.4E-05	1.9E-04	Y	Y
7440-43-9	Cadmium	4.8E-05	2.1E-04	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.7E-04	3.8E-03	Y	Y
75-15-0	Carbon Disulfide	0	0	1.4E-02	6.3E-02	0	0	1.4E-02	6.3E-02	Y	Y
7440-47-3	Chromium	6.6E-05	2.7E-04	6.1E-04	2.5E-03	7.3E-03	3.2E-02	8.0E-03	3.5E-02	Y	Y
18540-29-9	Cr (VI)	0	0	3.4E-07	1.5E-06	0	0	3.4E-07	1.5E-06	Y	Y
218-01-9	Chrysene	5.8E-07	2.5E-06	0	0	0	0	5.8E-07	2.5E-06	Y	Y
7440-48-4	Cobalt	4.0E-06	1.6E-05	4.7E-04	2.0E-03	3.3E-03	1.4E-02	3.7E-03	1.6E-02	Y	Y
592-01-8	Cyanide	0	0	0.45	1.99	0	0	0.45	1.99	Y	Y
53-70-3	Dibenzo(a,h)anthracene	1.8E-07	7.7E-07	0	0	0	0	1.8E-07	7.7E-07	Y	Y
106-46-7	Dichlorobenzene	5.7E-05	2.3E-04	0	0	0	0	5.7E-05	2.3E-04	Y	Y
206-44-0	Fluoranthene	5.5E-06	7.0E-06	0	0	0	0	5.5E-06	7.0E-06	Y	N
86-73-7	Fluorene	1.7E-05	2.1E-05	0	0	0	0	1.7E-05	2.1E-05	Y	N
50-00-0	Formaldehyde	3.3E-03	1.5E-02	0	0	0	0	3.3E-03	1.5E-02	Y	Y
110-54-3	Hexane	8.5E-02	0.34	3.1E-02	0.14	0	0	0.12	0.48	Y	Y
7647-01-0	Hydrogen Chloride	0	0	0.99	3.67	0	0	0.99	**3.67**	Y	Y
193-39-5	Indeno(1,2,3-cd)pyrene	2.2E-07	9.6E-07	0	0	0	0	2.2E-07	9.6E-07	Y	Y
7439-92-1	Lead	0	0	4.8E-04	2.1E-03	6.5E-03	2.9E-02	7.0E-03	3.1E-02	Y	N
7439-96-5	Manganese	1.8E-05	7.2E-05	4.6E-03	1.7E-02	0.24	1.07	0.25	1.08	Y	Y
7439-97-6	Mercury	1.2E-05	5.0E-05	6.9E-04	2.9E-03	1.3E-03	5.7E-03	2.0E-03	8.6E-03	Y	N
91-20-3	Naphthalene	1.9E-04	3.1E-04	1.9E-03	8.5E-03	0	0	2.1E-03	8.8E-03	Y	Y
7440-02-0	Nickel	9.1E-05	4.0E-04	4.6E-04	2.0E-03	1.6E-03	7.1E-03	2.2E-03	9.5E-03	Y	Y
85-01-8	Phenanthrene	5.1E-05	6.3E-05	0	0	0	0	5.1E-05	6.3E-05	Y	N
108-95-2	Phenol	0	0	2.4E-04	1.1E-03	0	0	2.4E-04	1.1E-03	Y	Y
7723-14-0	Phosphorus	0	0	5.6E-03	2.3E-02	0.53	2.32	0.54	2.34	Y	Y
129-00-0	Pyrene	5.0E-06	6.6E-06	0	0	0	0	5.0E-06	6.6E-06	Y	N
7782-49-2	Selenium	1.1E-06	4.6E-06	4.1E-04	1.8E-03	3.3E-04	1.4E-03	7.4E-04	3.2E-03	Y	Y
108-88-3	Toluene	5.2E-04	1.1E-03	3.2E-02	0.14	0	0	3.2E-02	0.14	Y	Y
1330-20-7	Xylene	2.5E-04	3.0E-04	3.1E-02	0.14	0	0	3.2E-02	0.14	Y	Y
Total HAP		9.0E-02	0.36	1.58	6.25	1.36	5.95	3.03	12.56		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
TRUE	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
	chk	chk	chk-15	chk	chk	chk	chk	chk

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary - continued

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**Non-HAP TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
7429-90-5	Aluminum	0	0	0.65	2.58	57.86	253.41	58.50	255.98	N	Y
7440-39-3	Barium	2.1E-04	8.4E-04	6.6E-03	2.7E-02	0.65	2.86	0.66	2.88	N	Y
1317-65-3	Calcium Carbonate	0	0	2.24	8.12	11.41	49.97	13.65	58.09	N	Y
1305-78-8	Calcium Oxide	0	0	0.70	0.95	0	0	0.70	0.95	N	Y
7440-50-8	Copper	4.0E-05	1.6E-04	4.9E-04	2.1E-03	4.1E-03	1.8E-02	4.6E-03	2.0E-02	N	Y
110-82-7	Cyclohexane	0	0	1.0E-03	4.6E-03	0	0	1.0E-03	4.6E-03	N	Y
7783-06-4	Hydrogen Sulfide	0	0	0.90	3.94	0	0	0.90	3.94	N	Y
7439-89-6	Iron	0	0	0.21	0.81	14.83	64.96	15.04	65.77	N	Y
7439-98-7	Molybdenum	5.2E-05	2.1E-04	4.2E-04	1.8E-03	8.1E-04	3.6E-03	1.3E-03	5.6E-03	N	Y
109-66-0	Pentane	0.12	0.50	0	0	0	0	0.12	0.50	N	Y
7440-22-4	Silver	0	0	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.2E-04	3.6E-03	N	Y
7664-93-9	Sulfuric Acid	0	0	2.03	8.89	0	0	2.03	8.89	N	Y
7440-28-0	Thallium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-61-1	Uranium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-62-2	Vanadium	1.1E-04	4.4E-04	7.3E-04	3.0E-03	2.3E-02	1.0E-01	2.4E-02	0.10	N	Y
25551-13-7	Trimethyl benzene	0	0	1.1E-02	4.8E-02	0	0	1.1E-02	4.8E-02	N	Y
7440-33-7	Tungsten	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-66-6	Zinc	1.4E-03	5.5E-03	8.0E-04	3.3E-03	2.9E-02	0.12	3.1E-02	0.13	N	Y
Total Non-HAP TAP		0.13	0.50	6.75	25.40	84.83	371.54	91.71	397.44		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

Conversions

2,000 lb/ton
8,760 hr/yr
24 hr/day

PROPANE COMBUSTION

Source Data

Source ID	Description	MMBtu/day	MMBtu/yr
Lime Process Heating			
LKC	PFR Shaft Lime Kiln Combustion	529.0	163,935
Ore Process Heating			
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	17.0	510
CKB	Carbon Regeneration Kiln (Burners)	54.1	19,754
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	2.4	876
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	120.0	43,800
Subtotal		193.5	64,940
HVAC			
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	96.0	35,040
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	96.0	35,040
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	96.0	35,040
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	12.0	4,380
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	48.0	17,520
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	72.0	26,280
Subtotal		438.0	159,870

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 1 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021

Model Scenario W3 180,000 T/day Emissions

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**HAP/TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
106-99-0	1,3-Butadiene	8.4E-07	3.7E-06	0	0	0	0	8.4E-07	3.7E-06	Y	Y
91-57-6	2-Methylnaphthalene	1.1E-06	4.6E-06	0	0	0	0	1.1E-06	4.6E-06	Y	N
56-49-5	3-Methylchloranthrene	7.8E-08	3.4E-07	0	0	0	0	7.8E-08	3.4E-07	Y	Y
57-97-6	7,12-Dimethylbenz(a)anthracene	7.6E-07	3.0E-06	0	0	0	0	7.6E-07	3.0E-06	Y	N
83-32-9	Acenaphthene	5.7E-06	7.1E-06	0	0	0	0	5.7E-06	7.1E-06	Y	N
208-96-8	Acenaphthylene	1.1E-05	1.4E-05	0	0	0	0	1.1E-05	1.4E-05	Y	N
75-07-0	Acetaldehyde	2.5E-05	1.1E-04	0	0	0	0	2.5E-05	1.1E-04	Y	Y
107-02-8	Acrolein	1.6E-05	2.0E-05	0	0	0	0	1.6E-05	2.0E-05	Y	Y
120-12-7	Anthracene	1.7E-06	2.4E-06	0	0	0	0	1.7E-06	2.4E-06	Y	N
7440-36-0	Antimony	0	0	5.7E-04	2.5E-03	1.9E-02	8.2E-02	1.9E-02	8.5E-02	Y	Y
7440-38-2	Arsenic	8.7E-06	3.8E-05	4.5E-03	2.0E-02	0.54	2.38	0.55	2.40	Y	Y
56-55-3	Benz(a)anthracene	3.1E-07	1.4E-06	0	0	0	0	3.1E-07	1.4E-06	Y	Y
71-43-2	Benzene	3.6E-04	1.6E-03	7.0E-03	3.1E-02	0	0	7.4E-03	3.2E-02	Y	Y
50-32-8	Benzo(a)pyrene	1.4E-07	6.1E-07	0	0	0	0	1.4E-07	6.1E-07	Y	Y
205-99-2	Benzo(b)fluoranthene	4.4E-07	1.9E-06	0	0	0	0	4.4E-07	1.9E-06	Y	Y
191-24-2	Benzo(g,h,i)perylene	7.5E-07	1.1E-06	0	0	0	0	7.5E-07	1.1E-06	Y	N
207-08-9	Benzo(k)fluoranthene	1.5E-07	6.6E-07	0	0	0	0	1.5E-07	6.6E-07	Y	Y
7440-41-7	Beryllium	5.2E-07	2.3E-06	4.3E-04	1.9E-03	2.6E-03	1.1E-02	3.0E-03	1.3E-02	Y	Y
92-52-4	Biphenyl	0	0	4.4E-05	1.9E-04	0	0	4.4E-05	1.9E-04	Y	Y
7440-43-9	Cadmium	4.8E-05	2.1E-04	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.7E-04	3.8E-03	Y	Y
75-15-0	Carbon Disulfide	0	0	1.4E-02	6.3E-02	0	0	1.4E-02	6.3E-02	Y	Y
7440-47-3	Chromium	6.6E-05	2.7E-04	6.1E-04	2.5E-03	7.3E-03	3.2E-02	8.0E-03	3.5E-02	Y	Y
18540-29-9	Cr (VI)	0	0	3.4E-07	1.5E-06	0	0	3.4E-07	1.5E-06	Y	Y
218-01-9	Chrysene	5.8E-07	2.5E-06	0	0	0	0	5.8E-07	2.5E-06	Y	Y
7440-48-4	Cobalt	4.0E-06	1.6E-05	4.7E-04	2.0E-03	3.3E-03	1.4E-02	3.7E-03	1.6E-02	Y	Y
592-01-8	Cyanide	0	0	0.45	1.99	0	0	0.45	1.99	Y	Y
53-70-3	Dibenzo(a,h)anthracene	1.8E-07	7.7E-07	0	0	0	0	1.8E-07	7.7E-07	Y	Y
106-46-7	Dichlorobenzene	5.7E-05	2.3E-04	0	0	0	0	5.7E-05	2.3E-04	Y	Y
206-44-0	Fluoranthene	5.5E-06	7.0E-06	0	0	0	0	5.5E-06	7.0E-06	Y	N
86-73-7	Fluorene	1.7E-05	2.1E-05	0	0	0	0	1.7E-05	2.1E-05	Y	N
50-00-0	Formaldehyde	3.3E-03	1.5E-02	0	0	0	0	3.3E-03	1.5E-02	Y	Y
110-54-3	Hexane	8.5E-02	0.34	3.1E-02	0.14	0	0	0.12	0.48	Y	Y
7647-01-0	Hydrogen Chloride	0	0	0.99	3.67	0	0	0.99	**3.67**	Y	Y
193-39-5	Indeno(1,2,3-cd)pyrene	2.2E-07	9.6E-07	0	0	0	0	2.2E-07	9.6E-07	Y	Y
7439-92-1	Lead	0	0	4.8E-04	2.1E-03	6.5E-03	2.9E-02	7.0E-03	3.1E-02	Y	N
7439-96-5	Manganese	1.8E-05	7.2E-05	4.6E-03	1.7E-02	0.24	1.07	0.25	1.08	Y	Y
7439-97-6	Mercury	1.2E-05	5.0E-05	6.9E-04	2.9E-03	1.3E-03	5.7E-03	2.0E-03	8.6E-03	Y	N
91-20-3	Naphthalene	1.9E-04	3.1E-04	1.9E-03	8.5E-03	0	0	2.1E-03	8.8E-03	Y	Y
7440-02-0	Nickel	9.1E-05	4.0E-04	4.6E-04	2.0E-03	1.6E-03	7.1E-03	2.2E-03	9.5E-03	Y	Y
85-01-8	Phenanthrene	5.1E-05	6.3E-05	0	0	0	0	5.1E-05	6.3E-05	Y	N
108-95-2	Phenol	0	0	2.4E-04	1.1E-03	0	0	2.4E-04	1.1E-03	Y	Y
7723-14-0	Phosphorus	0	0	5.6E-03	2.3E-02	0.53	2.32	0.54	2.34	Y	Y
129-00-0	Pyrene	5.0E-06	6.6E-06	0	0	0	0	5.0E-06	6.6E-06	Y	N
7782-49-2	Selenium	1.1E-06	4.6E-06	4.1E-04	1.8E-03	3.3E-04	1.4E-03	7.4E-04	3.2E-03	Y	Y
108-88-3	Toluene	5.2E-04	1.1E-03	3.2E-02	0.14	0	0	3.2E-02	0.14	Y	Y
1330-20-7	Xylene	2.5E-04	3.0E-04	3.1E-02	0.14	0	0	3.2E-02	0.14	Y	Y
Total HAP		9.0E-02	0.36	1.58	6.25	1.36	5.95	3.03	12.56		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
TRUE	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
	chk	chk	chk-15	chk	chk	chk	chk	chk

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary - continued

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**Non-HAP TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
7429-90-5	Aluminum	0	0	0.65	2.58	57.86	253.41	58.50	255.98	N	Y
7440-39-3	Barium	2.1E-04	8.4E-04	6.6E-03	2.7E-02	0.65	2.86	0.66	2.88	N	Y
1317-65-3	Calcium Carbonate	0	0	2.24	8.12	11.41	49.97	13.65	58.09	N	Y
1305-78-8	Calcium Oxide	0	0	0.70	0.95	0	0	0.70	0.95	N	Y
7440-50-8	Copper	4.0E-05	1.6E-04	4.9E-04	2.1E-03	4.1E-03	1.8E-02	4.6E-03	2.0E-02	N	Y
110-82-7	Cyclohexane	0	0	1.0E-03	4.6E-03	0	0	1.0E-03	4.6E-03	N	Y
7783-06-4	Hydrogen Sulfide	0	0	0.90	3.94	0	0	0.90	3.94	N	Y
7439-89-6	Iron	0	0	0.21	0.81	14.83	64.96	15.04	65.77	N	Y
7439-98-7	Molybdenum	5.2E-05	2.1E-04	4.2E-04	1.8E-03	8.1E-04	3.6E-03	1.3E-03	5.6E-03	N	Y
109-66-0	Pentane	0.12	0.50	0	0	0	0	0.12	0.50	N	Y
7440-22-4	Silver	0	0	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.2E-04	3.6E-03	N	Y
7664-93-9	Sulfuric Acid	0	0	2.03	8.89	0	0	2.03	8.89	N	Y
7440-28-0	Thallium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-61-1	Uranium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-62-2	Vanadium	1.1E-04	4.4E-04	7.3E-04	3.0E-03	2.3E-02	1.0E-01	2.4E-02	0.10	N	Y
25551-13-7	Trimethyl benzene	0	0	1.1E-02	4.8E-02	0	0	1.1E-02	4.8E-02	N	Y
7440-33-7	Tungsten	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-66-6	Zinc	1.4E-03	5.5E-03	8.0E-04	3.3E-03	2.9E-02	0.12	3.1E-02	0.13	N	Y
Total Non-HAP TAP		0.13	0.50	6.75	25.40	84.83	371.54	91.71	397.44		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

Conversions

2,000 lb/ton
8,760 hr/yr
24 hr/day

PROPANE COMBUSTION

Source Data

Source ID	Description	MMBtu/day	MMBtu/yr
Lime Process Heating			
LKC	PFR Shaft Lime Kiln Combustion	529.0	163,935
Ore Process Heating			
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	17.0	510
CKB	Carbon Regeneration Kiln (Burners)	54.1	19,754
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	2.4	876
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	120.0	43,800
Subtotal		193.5	64,940
HVAC			
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	96.0	35,040
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	96.0	35,040
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	96.0	35,040
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	12.0	4,380
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	48.0	17,520
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	72.0	26,280
Subtotal		438.0	159,870

PROPANE COMBUSTION - CONTINUED

HAP/TAP Emission Factors and Emissions

O.Heat_pph O.Heat_tpy L.Heat_pph L.Heat_tpy HVAC_pph HVAC_tpy lb/hr ton/yr

		Emission Factor[2]		Emissions[1] Ore Proc Heat		Lime Proc Heat		HVAC		Total			
CAS	Pollutant	lb/MMscf	lb/MMBtu[3]	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	TAP	A/C
91-57-6	2-Methylnaphthalene	2.4E-05	2.35E-8	1.9E-07	7.6E-07	5.2E-07	1.9E-06	4.3E-07	1.9E-06	1.1E-06	4.6E-06	N	
56-49-5	3-Methylchloranthrene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
57-97-6	7,12-Dimethylbenz(a)ant	< 1.6E-05	1.57E-8	1.3E-07	5.1E-07	3.5E-07	1.3E-06	2.9E-07	1.3E-06	7.6E-07	3.0E-06	N	
83-32-9	Acenaphthene	< 1.8E-06	1.76E-9	1.4E-08	5.7E-08	3.9E-08	1.4E-07	3.2E-08	1.4E-07	8.5E-08	3.4E-07	N	
208-96-8	Acenaphthylene	< 1.8E-06	1.76E-9	1.4E-08	5.7E-08	3.9E-08	1.4E-07	3.2E-08	1.4E-07	8.5E-08	3.4E-07	N	
120-12-7	Anthracene	< 2.4E-06	2.35E-9	1.9E-08	7.6E-08	5.2E-08	1.9E-07	4.3E-08	1.9E-07	1.1E-07	4.6E-07	N	
7440-38-2	Arsenic	2.0E-04	1.96E-7	1.5E-06	6.4E-06	3.7E-06	1.6E-05	3.6E-06	1.6E-05	8.7E-06	3.8E-05	Y	C
56-55-3	Benz(a)anthracene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
71-43-2	Benzene	2.1E-03	2.06E-6	1.5E-05	6.7E-05	3.9E-05	1.7E-04	3.8E-05	1.6E-04	9.1E-05	4.0E-04	Y	C
50-32-8	Benzo(a)pyrene	< 1.2E-06	1.18E-9	8.7E-09	3.8E-08	2.2E-08	9.6E-08	2.1E-08	9.4E-08	5.2E-08	2.3E-07	Y	C
205-99-2	Benzo(b)fluoranthene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
191-24-2	Benzo(g,h,i)perylene	< 1.2E-06	1.18E-9	9.5E-09	3.8E-08	2.6E-08	9.6E-08	2.1E-08	9.4E-08	5.7E-08	2.3E-07	N	
207-08-9	Benzo(k)fluoranthene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
7440-41-7	Beryllium	< 1.2E-05	1.18E-8	8.7E-08	3.8E-07	2.2E-07	9.6E-07	2.1E-07	9.4E-07	5.2E-07	2.3E-06	Y	C
7440-43-9	Cadmium	1.1E-03	1.08E-6	8.0E-06	3.5E-05	2.0E-05	8.8E-05	2.0E-05	8.6E-05	4.8E-05	2.1E-04	Y	C
7440-47-3	Chromium	1.4E-03	1.37E-6	1.1E-05	4.5E-05	3.0E-05	1.1E-04	2.5E-05	1.1E-04	6.6E-05	2.7E-04	Y	A
218-01-9	Chrysene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
7440-48-4	Cobalt	8.4E-05	8.24E-8	6.6E-07	2.7E-06	1.8E-06	6.8E-06	1.5E-06	6.6E-06	4.0E-06	1.6E-05	Y	A
53-70-3	Dibenzo(a,h)anthracene	< 1.2E-06	1.18E-9	8.7E-09	3.8E-08	2.2E-08	9.6E-08	2.1E-08	9.4E-08	5.2E-08	2.3E-07	Y	C
106-46-7	Dichlorobenzene	1.2E-03	1.18E-6	9.5E-06	3.8E-05	2.6E-05	9.6E-05	2.1E-05	9.4E-05	5.7E-05	2.3E-04	Y	A
206-44-0	Fluoranthene	3.0E-06	2.94E-9	2.4E-08	9.5E-08	6.5E-08	2.4E-07	5.4E-08	2.4E-07	1.4E-07	5.7E-07	N	
86-73-7	Fluorene	2.8E-06	2.75E-9	2.2E-08	8.9E-08	6.1E-08	2.3E-07	5.0E-08	2.2E-07	1.3E-07	5.3E-07	N	
50-00-0	Formaldehyde	7.5E-02	7.35E-5	5.5E-04	2.4E-03	1.4E-03	6.0E-03	1.3E-03	5.9E-03	3.3E-03	1.4E-02	Y	C
110-54-3	Hexane	1.8E+00	1.76E-3	1.4E-02	5.7E-02	3.9E-02	1.4E-01	3.2E-02	1.4E-01	8.5E-02	3.4E-01	Y	A
193-39-5	Indeno(1,2,3-cd)pyrene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
7439-96-5	Manganese	3.8E-04	3.73E-7	3.0E-06	1.2E-05	8.2E-06	3.1E-05	6.8E-06	3.0E-05	1.8E-05	7.2E-05	Y	A
7439-97-6	Mercury	2.6E-04	2.55E-7	2.1E-06	8.3E-06	5.6E-06	2.1E-05	4.7E-06	2.0E-05	1.2E-05	5.0E-05	N	
91-20-3	Naphthalene	6.1E-04	5.98E-7	4.8E-06	1.9E-05	1.3E-05	4.9E-05	1.1E-05	4.8E-05	2.9E-05	1.2E-04	Y	A
7440-02-0	Nickel	2.1E-03	2.06E-6	1.5E-05	6.7E-05	3.9E-05	1.7E-04	3.8E-05	1.6E-04	9.1E-05	4.0E-04	Y	C
85-01-8	Phenanthrene	1.7E-05	1.67E-8	1.3E-07	5.4E-07	3.7E-07	1.4E-06	3.0E-07	1.3E-06	8.1E-07	3.2E-06	N	
129-00-0	Pyrene	5.0E-06	4.90E-9	4.0E-08	1.6E-07	1.1E-07	4.0E-07	8.9E-08	3.9E-07	2.4E-07	9.5E-07	N	
7782-49-2	Selenium	< 2.4E-05	2.35E-8	1.9E-07	7.6E-07	5.2E-07	1.9E-06	4.3E-07	1.9E-06	1.1E-06	4.6E-06	Y	A
108-88-3	Toluene	3.4E-03	3.33E-6	2.7E-05	1.1E-04	7.3E-05	2.7E-04	6.1E-05	2.7E-04	1.6E-04	6.5E-04	Y	A
109-66-0	Pentane	2.6E+00	2.55E-3	2.1E-02	8.3E-02	5.6E-02	2.1E-01	4.7E-02	2.0E-01	1.2E-01	5.0E-01	Y	A
7440-39-3	Barium	4.4E-03	4.31E-6	3.5E-05	1.4E-04	9.5E-05	3.5E-04	7.9E-05	3.4E-04	2.1E-04	8.4E-04	Y	A
7440-50-8	Copper	8.5E-04	8.33E-7	6.7E-06	2.7E-05	1.8E-05	6.8E-05	1.5E-05	6.7E-05	4.0E-05	1.6E-04	Y	A
7439-98-7	Molybdenum	1.1E-03	1.08E-6	8.7E-06	3.5E-05	2.4E-05	8.8E-05	2.0E-05	8.6E-05	5.2E-05	2.1E-04	Y	A
7440-62-2	Vanadium	2.3E-03	2.25E-6	1.8E-05	7.3E-05	5.0E-05	1.8E-04	4.1E-05	1.8E-04	1.1E-04	4.4E-04	Y	A
7440-66-6	Zinc	2.9E-02	2.84E-5	2.3E-04	9.2E-04	6.3E-04	2.3E-03	5.2E-04	2.3E-03	1.4E-03	5.5E-03	Y	A
Total				3.6E-02	1.4E-01	9.8E-02	3.6E-01	8.1E-02	3.5E-01	2.1E-01	8.6E-01		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *AP-42, Table 1.4-3 & 1.4-4 (7/98) Natural Gas Combustion* 1.0766 1.0766

(3) *Natural Gas Higher Heating Value* 1,020 *MMBtu/MMscf* chk

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 5 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021

DIESEL COMBUSTION

Source Data

		Power Rating		Operation	Operation	Fuel Consumption[1] & [2]	
Source ID	Description	kW	hp	hr/day	hr/yr	MMBtu/day	MMBtu/yr
EDG1	Camp Emergency Generator	1,000	1,341	1	100	9.39	938.70
EDG2	Plant Emergency Generator #1	1,000	1,341	1	100	9.39	938.7
EDG3	Plant Emergency Generator #2	1,000	1,341	1	100	9.39	938.7
EDFP	Mill Fire Pump	200	268	1	100	1.88	187.7
Total						30.0	3,003.8

(1) *Based on brake specific fuel consumption for diesel generators* 7,000 *Btu/hp-hr* *AP-42 Tbl 3.3-1*

(2) *Heat Content of* 0.137 *MMBtu/gal* 1E+6 *Btu/MMBtu* 1.341 *hp/kW*

HAP/TAP Emission Factors and Emissions

lb/hr ton/yr

		Factor (lb/MMBtu)		Emissions (≤600 hp)		Emissions (>600 hp)		Total Emissions[1]			
	Pollutant	≤600 hp[2]	>600hp[3]	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	TAP	A/C
106-99-0	1,3-Butadiene	< 3.9E-05		8.4E-07	3.7E-06	0.0E+00	0.0E+00	8.4E-07	3.7E-06	Y	C
83-32-9	Acenaphthene	< 1.4E-06	4.7E-06	1.1E-07	1.3E-07	5.5E-06	6.6E-06	5.6E-06	6.7E-06	N	
208-96-8	Acenaphthylene	< 5.1E-06	9.2E-06	4.0E-07	4.7E-07	1.1E-05	1.3E-05	1.1E-05	1.3E-05	N	
75-07-0	Acetaldehyde	7.7E-04	2.5E-05	1.6E-05	7.2E-05	8.1E-06	3.5E-05	2.5E-05	1.1E-04	Y	C
107-02-8	Acrolein	< 9.3E-05	7.9E-06	7.2E-06	8.7E-06	9.2E-06	1.1E-05	1.6E-05	2.0E-05	Y	A
120-12-7	Anthracene	1.9E-06	1.2E-06	1.5E-07	1.8E-07	1.4E-06	1.7E-06	1.6E-06	1.9E-06	N	
56-55-3	Benz(a)anthracene	1.7E-06	6.2E-07	3.6E-08	1.6E-07	2.0E-07	8.8E-07	2.4E-07	1.0E-06	Y	C
71-43-2	Benzene	9.3E-04	7.8E-04	2.0E-05	8.8E-05	2.5E-04	1.1E-03	2.7E-04	1.2E-03	Y	C
50-32-8	Benzo(a)pyrene	< 1.9E-07	< 2.6E-07	4.0E-09	1.8E-08	8.3E-08	3.6E-07	8.7E-08	3.8E-07	Y	C
205-99-2	Benzo(b)fluoranthene	< 9.9E-08	< 1.1E-06	2.1E-09	9.3E-09	3.6E-07	1.6E-06	3.6E-07	1.6E-06	Y	C
191-24-2	Benzo(g,h,i)perylene	< 4.9E-07	< 5.6E-07	3.8E-08	4.6E-08	6.5E-07	7.8E-07	6.9E-07	8.3E-07	N	
207-08-9	Benzo(k)fluoranthene	< 1.6E-07	< 2.2E-07	3.3E-09	1.5E-08	7.0E-08	3.1E-07	7.3E-08	3.2E-07	Y	C
218-01-9	Chrysene	3.5E-07	1.5E-06	7.6E-09	3.3E-08	4.9E-07	2.2E-06	5.0E-07	2.2E-06	Y	C
53-70-3	Dibenzo(a,h)anthracene	< 5.8E-07	< 3.5E-07	1.2E-08	5.5E-08	1.1E-07	4.9E-07	1.2E-07	5.4E-07	Y	C
206-44-0	Fluoranthene	7.6E-06	4.0E-06	6.0E-07	7.1E-07	4.7E-06	5.7E-06	5.3E-06	6.4E-06	N	
86-73-7	Fluorene	2.9E-05	1.3E-05	2.3E-06	2.7E-06	1.5E-05	1.8E-05	1.7E-05	2.1E-05	N	
50-00-0	Formaldehyde	1.2E-03	7.9E-05	2.5E-05	1.1E-04	2.5E-05	1.1E-04	5.1E-05	2.2E-04	Y	C
193-39-5	Indeno(1,2,3-cd)pyrene	< 3.8E-07	< 4.1E-07	8.0E-09	3.5E-08	1.3E-07	5.8E-07	1.4E-07	6.2E-07	Y	C
91-20-3	Naphthalene	8.5E-05	1.3E-04	6.6E-06	8.0E-06	1.5E-04	1.8E-04	1.6E-04	1.9E-04	Y	A
85-01-8	Phenanthrene	2.9E-05	4.1E-05	2.3E-06	2.8E-06	4.8E-05	5.7E-05	5.0E-05	6.0E-05	N	
129-00-0	Pyrene	4.8E-06	3.7E-06	3.7E-07	4.5E-07	4.4E-06	5.2E-06	4.7E-06	5.7E-06	N	
108-88-3	Toluene	4.1E-04	2.8E-04	3.2E-05	3.8E-05	3.3E-04	4.0E-04	3.6E-04	4.3E-04	Y	A
1330-20-7	Xylene	2.9E-04	1.9E-04	2.2E-05	2.7E-05	2.3E-04	2.7E-04	2.5E-04	3.0E-04	Y	A
Total				1.4E-04	3.6E-04	1.1E-03	2.2E-03	1.2E-03	2.6E-03		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *AP-42, Tab. 3.3-2, 10/96, diesel engines (≤ 600 hp)* chk chk

(3) *AP-42, Tabs. 3.4-3 & 3.4-4, 10/96, large diesel engines (> 600 hp)*

ORE PROCESSING

Source Data

Source ID	Description	PM Emissions lb/day	PM Emissions ton/yr
OC1	Loader Transfer of Ore to Grizzly	3.500	0.639
OC2	Grizzly to Apron Feeder	3.500	0.639
OC3	Apron Feeder to Dribble Conveyor	3.500	0.639
OC4	Apron Feeder to Vibrating Grizzly	3.500	0.639
OC5	Dribble Conveyor to Vibrating Grizzly	3.500	0.639
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	3.500	0.639
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	30.000	5.475
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	3.500	0.639
OC9	Stockpile Transfers to Reclaim Conveyors	16.560	3.022
OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	16.560	3.022
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	16.560	3.022
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge C	33.120	6.044
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	3.864	0.705
Total		141.164	25.762

HAP/TAP Emission Factors and Emissions

CAS No.	Pollutant	Concentration ppm[2]	Emissions[1] lb/hr	Emissions[1] ton/yr	TAP	A/C
7440-38-2	Arsenic	667	3.9E-03	1.7E-02	Y	C
7440-41-7	Beryllium	3.2	1.9E-05	8.2E-05	Y	C
7440-43-9	Cadmium	0.50	2.9E-06	1.3E-05	Y	C
7440-48-4	Cobalt	4	2.4E-05	1.0E-04	Y	A
7440-47-3	Chromium	9	5.3E-05	2.3E-04	Y	A
7439-97-6	Mercury [3]	0.96	5.6E-06	2.5E-05	N	
7439-96-5	Manganese	299	1.8E-03	7.7E-03	Y	A
7440-02-0	Nickel	2	1.2E-05	5.2E-05	Y	C
7439-92-1	Lead	8	4.7E-05	2.1E-04	N	
7440-36-0	Antimony	23	1.4E-04	5.9E-04	Y	A
7723-14-0	Phosphorus	650	3.8E-03	1.7E-02	Y	A
7782-49-2	Selenium [4]	0.40	2.4E-06	1.0E-05	Y	A
7440-22-4	Silver	0.50	2.9E-06	1.3E-05	Y	A
7429-90-5	Aluminum	71,000	4.2E-01	1.8E+00	Y	A
7440-39-3	Barium	800	4.7E-03	2.1E-02	Y	A
1317-65-3	Calcium Carbonate	14,000	8.2E-02	3.6E-01	Y	A
7440-50-8	Copper	5	2.9E-05	1.3E-04	Y	A
7439-89-6	Iron [4]	18,200	1.1E-01	4.7E-01	Y	A
7439-98-7	Molybdenum	1	5.9E-06	2.6E-05	Y	A
7440-28-0	Thallium	10	5.9E-05	2.6E-04	Y	A
7440-61-1	Uranium	10	5.9E-05	2.6E-04	Y	A
7440-62-2	Vanadium	28	1.6E-04	7.2E-04	Y	A
7440-33-7	Tungsten	10	5.9E-05	2.6E-04	Y	A
7440-66-6	Zinc	35	2.1E-04	9.0E-04	Y	A
Total			6.2E-01	2.7E+00		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *(Midas Gold 2017c) Median concentration of 55,000 SGP samples.*

[3] *(Midas Gold 2018e) Median ore concentration of 151,000 SGP samples; resource block model.*

[4] *(Midas Gold 2020) Median concentration of 56,000 SGP samples for Fe and 1,500 SGP samples for Se.*

1E+6 parts/ppm

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 7 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021

ORE CONCETRATION AND REFINING

Source Data

Source ID	Description	Subpart 7E Allowable Limit lb/yr[1]	Oper. hr/yr	% of Subpart 7E for Controlled Systems %		Controlled Hg Emissions lb/hr	ton/yr	lb/yr
AC	Autoclave	213.4	8,760	[2]		0.000023	0.00010	0.20
EW,MR,MF,CKD	Refinery Sources (C. Kiln, EW, Retort, Furn	16.8		20%	[3]	0.000384	0.00168	3.36
7439-97-6 Mercury	Total	230.2				0.000407	0.00178	3.56

[1] *Subpart 7E Limit - Ore Pretreatment Processes (CFR 2018b)*

84 lb / MMton × 2,540,400 ton / yr × MMton / 1.0E+6 ton = 213.4 lb / yr

[1] *Subpart 7E Limit - Carbon Processes with Mercury Retorts*

0.8 lb / ton × 21 ton / yr = 16.8 lb / yr

[2] *Controlled SysCAD modeled emissions from Autoclave:* 0.0105 g/hr 2.3E-05 lb/hr 0.20 lb/yr (M3 2019)

[3] *Based on similar source (but with much higher ore Hg content) Hg reporting levels provided below:*

Goldstrike Refinery (2015 & 2016 Hg Reports) (NDEP 2015a) (NDEP 2016)

28.79 lb / yr × 251.00 ton / yr = 0.11 lb / MMton × ton / 0.8 lb = 14.3%

Twin Creeks Refinery (2015 & 2016 Hg Reports) (NDEP 2015a) (NDEP 2016)

31.27 lb / yr × 142.77 ton / yr = 0.22 lb / MMton × ton / 0.8 lb = 27.4%

HAP/TAP Emission Factors and Emission

AC_pph AC_tpy Refin_pph Refin_tpy lb/hr ton/yr

CAS No.	Pollutant	Emission Factor[1]	Autoclave lb/hr	Autoclave ton/yr	Refinery lb/hr	Refinery ton/yr	Total Emissions lb/hr	Total Emissions ton/yr	TAP	A/C
7440-38-2	Arsenic	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	C
7440-41-7	Beryllium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	C
7440-43-9	Cadmium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	C
7440-48-4	Cobalt	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-47-3	Chromium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7439-97-6	Mercury	see above	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	N	
7439-96-5	Manganese	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-02-0	Nickel	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	C
7439-92-1	Lead	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	N	
7440-36-0	Antimony	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7723-14-0	Phosphorus	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7782-49-2	Selenium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-22-4	Silver	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7429-90-5	Aluminum	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-39-3	Barium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
1317-65-3	Calcium Carbonate	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-50-8	Copper	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7439-89-6	Iron	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7439-98-7	Molybdenum	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-28-0	Thallium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-61-1	Uranium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-62-2	Vanadium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-33-7	Tungsten	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-66-6	Zinc	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
Total			5.5E-04	2.4E-03	9.2E-03	4.0E-02	9.8E-03	4.3E-02		

[1] *Hg is the most difficult metal to control due to it existing in both particulate and gaseous form. Therefore, all other metals are conservatively estimated to be equal to or less than the Hg emissions.*

0.0525 0.0525 chk

7664-93-9	Sulfuric Acid	Autoclave	2.03	8.89			2.03	8.89
7783-06-4	Hydrogen Sulfid	Autoclave	0.90	3.94			0.90	3.94
592-01-8	Cyanide	Point Sources - 5 EW Cells			0.0012	0.0053	0.00	0.01
Total			2.93	12.84	0.01	0.05	2.94	12.88

ORE CONCETRATION AND REFINING - CONTINUED

Source Data

Source ID	Description	Throughput ton/day	Throughput ton/yr	Operation hr/day	Operation hr/yr
AC	Autoclave	6,960	2,540,400	24	8,760

Autoclave HAP/TAP Emission Factors and Emission lb/hr ton/yr

CAS No.	Pollutant	Emission Factor		Emissions[1] lb/hr	Emissions[1] ton/yr
7664-93-9	Sulfuric Acid	0.007	lb/ton[2]	2.03	8.89
7783-06-4	Hydrogen Sulfide	0.9	lb/hr[3]	0.90	3.94

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *H2SO4 is based on Acidic Autoclave test data (APT 2010)*

[3] *H2S is based on Acidic Autoclave test data (APT 2013)*

LEACHING OPERATION

Cyanide (HCN) Source Data, Emission Factors, and Emissions

Source ID	Description	Dia. ft[1]	pH[1]	Free CN- g/m3[1]	T C[1]	pKa	a0	H	kG[2] m/s	Fa*Fw	g/s	lb/hr	ton/yr
												lb/hr	ton/yr
TSF	***Fugitive Sources***												
TSF	Tailings Maint. Pond	76	7.75	1	3.74	9.803	0.9912	0.0025	1.89E-05	0.641	1.27E-05	0.0001	0.0004
MILLTA	CN Detox Tank 1	40	8.5	25	25	9.250	0.8490	0.0055	0.000311	0.688	0.002891	0.0229	0.101
MILLTA	CN Detox Tank 2	40	8.5	25	25	9.250	0.8490	0.0055	0.000311	0.688	0.002891	0.0229	0.101
MILLTA	CIP Leach Tank 1	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	0.0114	0.050
MILLTA	CIP Leach Tank 2	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	0.0114	0.050
MILLTA	CIP Leach Tank 3	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	0.0114	0.050
MILLTA	CIP Leach Tank 4	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	0.0114	0.050
MILLTA	CIL Tank 1	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIL Tank 2	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIL Tank 3	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIL Tank 4	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIL Tank 5	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIL Tank 6	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIP Tank 1	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA	CIP Tank 2	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA	CIP Tank 3	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA	CIP Tank 4	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA	CIP Tank 5	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA	CIP Tank 6	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
		Acres[1]											
TSF	Tails, Aqueous Surface	110.222	7.75	1	3.74	9.803	0.9912	0.0025	1.89E-05	0.421	0.008845	0.0702	0.307
TSF	Tails, Wet Sediment	110.222							5.31E-08	0.421	0.009961	0.0791	0.346
TSF	Tails, Dry Sediment	110.222							2.33E-08	1	0.010375	0.0823	0.361
		330.666											
592-01-8	Cyanide Fugitive Sources - Subtotal											0.4527	1.983
75-15-0	Carbon Disulfide											0.01446	0.06332
	Point Sources												
EW	EW Cells	[3]										0.0006	0.003
EW	Preg/Barren Tanks	[3]										0.0006	0.003
592-01-8	Cyanide Point Sources - Subtotal											0.0012	0.0053
	Total											0.454	1.988

[1] *(Midas Gold 2016)(M3 2017c)(M3 2017d)*

[2] *The emission factors and caculation methodology are from the EPA directed HCN study: (Card, T. 2009)(EPA 2009)(Schmidt 2010)*

[3] *(APT 2009)*

Carbon Disulfide Emissions from Xanthate Decomposition

CAS No.	Pollutant	Xanthate[1] ton/yr	Molar Decomp.[2]	CS_2 MW Ratio	Temperature Adj. Factor[3]	Emissions lb/hr	Emissions ton/yr
						lb/hr	ton/yr
75-15-0	Carbon Disulfide	1,700	0.99%	0.376	1%	0.0145	0.063

	MW	
Xanthate (PAX)	202.37	$C6H11KOS_2$
Carbon disulfide	76.139	CS_2

[1] *(Midas Gold 2016) p. 12-11*

[2] *(Air Sciences 2020) molar decomposition of xanthate in solution to CS2 gas*

[3] *(Air Sciences 2020) based on the comparison of CS2 generation at 25C and 70C*

Conversions

8,760	hr/yr	453.5929	g/lb
2,000	lb/ton	3.28084	ft/m
4,046.86	m2/acre	3,600	s/hr

Wind adjustment factor Fw 1

LIME PRODUCTION

Source Data

Source ID	Description	Throughput ton/day	Throughput ton/yr	PM Emissions lb/day	PM Emissions ton/yr
LS1	Limestone transfer to Primary Crusher Hopper			3.39	0.48
LS2	Primary Crushing and Associated Transfers In and Out			6.10	0.86
LS3	Primary Screening and Associated Transfers In and Out			28.25	3.97
LS4	Secondary Crushing and Associated Transfers In and Out			6.10	0.86
LS5	Secondary Screening and Associated Transfers In and Out			28.25	3.97
LS6	Limestone transfer to Ball Mill Feed Bin			3.39	0.48
LS7	Limestone transfer to Ball Mill Feed Conveyor			3.39	0.48
LS8	Ball Mill Feed transfer to Ball Mill			3.39	0.48
LSBM	Limestone Ball Mill			45.65	6.42
LS9	Limestone transfer to Kiln Feed Bin			0.80	0.12
LS10	Limestone transfer to Lime Kiln Feed Conveyor			0.80	0.12
LS11	Fines Screening and Associated Transfers In and Out			6.68	1.03
Subtotal LS1-11				136.18	19.28
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln			0.80	0.12
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	169	52,377	21.97	3.40
Subtotal LS12,LK				22.77	3.53
Total				158.95	22.80

HAP/TAP Emission Factors and Emissions

			LS_pph	LS_tpy	LS12_pph	LS12_tpy	LK_pph	LK_tpy	lb/hr	ton/yr		
		Concentration	LS1-11,LSBM		LS12		Lime Kiln		Emissions[1]			
CAS No.	Pollutant	ppm[2]	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	TAP	A/C
7440-38-2	Arsenic	23	1.01E-04	4.43E-04	6.51E-07	2.85E-06	1.79E-05	7.83E-05	1.20E-04	5.24E-04	Y	C
7440-41-7	Beryllium	0.8	3.52E-06	1.54E-05	2.27E-08	9.92E-08	6.22E-07	2.72E-06	4.17E-06	1.82E-05	Y	C
7440-43-9	Cadmium	0.25	1.10E-06	4.82E-06	7.08E-09	3.10E-08	1.94E-07	8.51E-07	1.30E-06	5.70E-06	Y	C
7440-48-4	Cobalt	4	2.27E-05	7.71E-05	1.34E-07	4.96E-07	3.66E-06	1.36E-05	2.65E-05	9.12E-05	Y	A
7440-47-3	Chromium	15	8.51E-05	2.89E-04	5.01E-07	1.86E-06	1.37E-05	5.11E-05	9.93E-05	3.42E-04	Y	A
7439-97-6	Mercury [3]	0.02	1.13E-07	3.86E-07	6.68E-10	2.48E-09	2.82E-04	1.05E-03	2.82E-04	1.05E-03	N	
7439-96-5	Manganese	236.5	1.34E-03	4.56E-03	7.89E-06	2.93E-05	2.16E-04	8.05E-04	1.57E-03	5.39E-03	Y	A
7440-02-0	Nickel	5	2.20E-05	9.64E-05	1.42E-07	6.20E-07	3.89E-06	1.70E-05	2.60E-05	1.14E-04	Y	C
7439-92-1	Lead	3	1.70E-05	5.78E-05	1.00E-07	3.72E-07	2.75E-06	1.02E-05	1.99E-05	6.84E-05	N	
7440-36-0	Antimony	2.5	1.42E-05	4.82E-05	8.34E-08	3.10E-07	2.29E-06	8.51E-06	1.66E-05	5.70E-05	Y	A
7723-14-0	Phosphorus	130	7.38E-04	2.51E-03	4.34E-06	1.61E-05	1.19E-04	4.43E-04	8.61E-04	2.96E-03	Y	A
7440-22-4	Silver	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	Y	A
7429-90-5	Aluminum	22600	1.28E-01	4.36E-01	7.54E-04	2.80E-03	2.07E-02	7.69E-02	1.50E-01	5.15E-01	Y	A
7440-39-3	Barium	145	8.23E-04	2.79E-03	4.84E-06	1.80E-05	1.33E-04	4.94E-04	9.60E-04	3.31E-03	Y	A
1317-65-3	Calcium Carbonate	274500	1.56E+00	5.29E+00	9.16E-03	3.40E-02	2.51E-01	9.35E-01	1.82E+00	6.26E+00	Y	A
7440-50-8	Copper	5	2.84E-05	9.64E-05	1.67E-07	6.20E-07	4.58E-06	1.70E-05	3.31E-05	1.14E-04	Y	A
7439-89-6	Iron	10350	5.87E-02	1.99E-01	3.45E-04	1.28E-03	9.47E-03	3.52E-02	6.85E-02	2.36E-01	Y	A
7439-98-7	Molybdenum	0.5	2.84E-06	9.64E-06	1.67E-08	6.20E-08	4.58E-07	1.70E-06	3.31E-06	1.14E-05	Y	A
7440-28-0	Thallium	5	2.84E-05	9.64E-05	1.67E-07	6.20E-07	4.58E-06	1.70E-05	3.31E-05	1.14E-04	Y	A
7440-61-1	Uranium	5	2.84E-05	9.64E-05	1.67E-07	6.20E-07	4.58E-06	1.70E-05	3.31E-05	1.14E-04	Y	A
7440-62-2	Vanadium	15.5	8.79E-05	2.99E-04	5.17E-07	1.92E-06	1.42E-05	5.28E-05	1.03E-04	3.53E-04	Y	A
7440-33-7	Tungsten	5	2.84E-05	9.64E-05	1.67E-07	6.20E-07	4.58E-06	1.70E-05	3.31E-05	1.14E-04	Y	A
7440-66-6	Zinc	18	1.02E-04	3.47E-04	6.01E-07	2.23E-06	1.65E-05	6.13E-05	1.19E-04	4.10E-04	Y	A
Subtotal			1.75E+00	5.94E+00	1.03E-02	3.82E-02	2.82E-01	1.05E+00	2.04E+00	7.03E+00	9.0667	9.0667
7647-01-0	Hydrogen Chloride	0.14 lb/ton product[4]					0.99	3.67	0.99	3.67		chk

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *(M3 2018) Median concentrations of SGP limestone material. Metals with medians below the detection limit (DL) are set to 1/2DL.*

[3] *Hg emissions from the Lime Kiln are conservatively estimated assuming 100% volatilization of all Hg in the limestone*

[4] *(EPA 1999b)*

1E+6 parts/ppm

LIME PRODUCTION - CONTINUED

Source Data

PM_ppd PM_tpy

Source ID	description Description	PM Emissions lb/day	ton/yr
LS1L	Mill Lime Silo #1 Loading	0.248	0.002
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	1.200	0.011
MillS2L	Mill Lime Silo #2 Loading	0.248	0.002
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	1.200	0.011
ACS1L	AC Lime Silo #1 Loading	0.990	0.009
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.304	0.042
ACS2L	AC Lime Silo #2 Loading	0.990	0.009
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.304	0.042
ACS3L	AC Lime Silo #3 Loading	0.990	0.009
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.304	0.042
ACS4L	AC Lime Silo #4 Loading	0.495	0.004
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	2.304	0.021
Subtotal - Mill & AC Lime Silos		15.576	0.203
LCR	Lime Mill Crushing and associated transfers In and Out	6.828	1.058
LSL	Pebble Lime Silo Loading via Bucket Elevator	0.149	0.023
LSU	Pebble Lime Silo discharge to Lime Slaker	0.015	0.002
Subtotal - Lime Mfg		6.991	1.083
Total		22.567	1.286

HAP/TAP Emission Factors and Emissions

MillAC_pph MillAC_tpy LimeM_pph LimeM_tpy lb/hr ton/yr

CAS No.	Pollutant	Concentration ppm[2]	Mill and AC lb/hr	Mill and AC ton/yr	Lime Mfg lb/hr	Lime Mfg ton/yr	Emissions[1] lb/hr	Emissions[1] ton/yr	TAP	A/C
7440-38-2	Arsenic	23	1.06E-06	4.66E-06	5.69E-06	2.49E-05	6.75E-06	2.96E-05	Y	C
7440-41-7	Beryllium	0.8	3.70E-08	1.62E-07	1.98E-07	8.67E-07	2.35E-07	1.03E-06	Y	C
7440-43-9	Cadmium	0.25	1.16E-08	5.07E-08	6.18E-08	2.71E-07	7.34E-08	3.22E-07	Y	C
7440-48-4	Cobalt	4	2.60E-06	8.11E-07	1.17E-06	4.33E-06	3.76E-06	5.14E-06	Y	A
7440-47-3	Chromium	15	9.74E-06	3.04E-06	4.37E-06	1.63E-05	1.41E-05	1.93E-05	Y	A
7439-97-6	Mercury	0.02	1.30E-08	4.05E-09	5.83E-09	2.17E-08	1.88E-08	2.57E-08	N	
7439-96-5	Manganese	236.5	1.53E-04	4.79E-05	6.89E-05	2.56E-04	2.22E-04	3.04E-04	Y	A
7440-02-0	Nickel	5	2.31E-07	1.01E-06	1.24E-06	5.42E-06	1.47E-06	6.43E-06	Y	C
7439-92-1	Lead	3	1.95E-06	6.08E-07	8.74E-07	3.25E-06	2.82E-06	3.86E-06	N	
7440-36-0	Antimony	2.5	1.62E-06	5.07E-07	7.28E-07	2.71E-06	2.35E-06	3.22E-06	Y	A
7723-14-0	Phosphorus	130	8.44E-05	2.63E-05	3.79E-05	1.41E-04	1.22E-04	1.67E-04	Y	A
7440-22-4	Silver	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	Y	A
7429-90-5	Aluminum	22,600	1.47E-02	4.58E-03	6.58E-03	2.45E-02	2.13E-02	2.91E-02	Y	A
7440-39-3	Barium	145	9.41E-05	2.94E-05	4.22E-05	1.57E-04	1.36E-04	1.86E-04	Y	A
1305-78-8	Calcium Oxide	740,000 [3]	4.80E-01	1.50E-01	2.16E-01	8.02E-01	6.96E-01	9.52E-01	Y	A
7440-50-8	Copper	5	3.25E-06	1.01E-06	1.46E-06	5.42E-06	4.70E-06	6.43E-06	Y	A
7439-89-6	Iron	10350	6.72E-03	2.10E-03	3.01E-03	1.12E-02	9.73E-03	1.33E-02	Y	A
7439-98-7	Molybdenum	0.5	3.25E-07	1.01E-07	1.46E-07	5.42E-07	4.70E-07	6.43E-07	Y	A
7440-28-0	Thallium	5	3.25E-06	1.01E-06	1.46E-06	5.42E-06	4.70E-06	6.43E-06	Y	A
7440-61-1	Uranium	5	3.25E-06	1.01E-06	1.46E-06	5.42E-06	4.70E-06	6.43E-06	Y	A
7440-62-2	Vanadium	15.5	1.01E-05	3.14E-06	4.52E-06	1.68E-05	1.46E-05	1.99E-05	Y	A
7440-33-7	Tungsten	5	3.25E-06	1.01E-06	1.46E-06	5.42E-06	4.70E-06	6.43E-06	Y	A
7440-66-6	Zinc	18	1.17E-05	3.65E-06	5.24E-06	1.95E-05	1.69E-05	2.31E-05	Y	A
Total			5.02E-01	1.57E-01	2.25E-01	8.38E-01	7.27E-01	9.95E-01		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *See LIME PRODUCTION, page 10*

[3] *(NLA 2007) 40% to 74% CaO in lime*

1E+6 parts/ppm

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis		
	PROJECT NO: 335-20-3	PAGE: 12	OF: 19	SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021		

AGGREGATE PRODUCTION

Source Data

Source ID	Description	PM Emissions lb/day	PM Emissions ton/yr
PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conve	15.00	2.74
PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conve	15.00	2.74
Total		30.00	5.48

HAP/TAP Emission Factors and Emissions

CAS No.	Pollutant	Concentration ppm[2]	Emissions[1] lb/hr	Emissions[1] ton/yr	TAP	A/C
7440-38-2	Arsenic	23	2.88E-05	1.26E-04	Y	C
7440-41-7	Beryllium	0.8	1.00E-06	4.38E-06	Y	C
7440-43-9	Cadmium	0.25	3.13E-07	1.37E-06	Y	C
7440-48-4	Cobalt	4	5.00E-06	2.19E-05	Y	A
7440-47-3	Chromium	15	1.88E-05	8.21E-05	Y	A
7439-97-6	Mercury	0.02	2.50E-08	1.10E-07	N	
7439-96-5	Manganese	236.5	2.96E-04	1.29E-03	Y	A
7440-02-0	Nickel	5	6.25E-06	2.74E-05	Y	C
7439-92-1	Lead	3	3.75E-06	1.64E-05	N	
7440-36-0	Antimony	2.5	3.13E-06	1.37E-05	Y	A
7723-14-0	Phosphorus	130	1.63E-04	7.12E-04	Y	A
7440-22-4	Silver	0	0.00E+00	0.00E+00	Y	A
7429-90-5	Aluminum	22600	2.83E-02	1.24E-01	Y	A
7440-39-3	Barium	145	1.81E-04	7.94E-04	Y	A
1317-65-3	Calcium Carbonate	274500	3.43E-01	1.50E+00	Y	A
7440-50-8	Copper	5	6.25E-06	2.74E-05	Y	A
7439-89-6	Iron	10350	1.29E-02	5.67E-02	Y	A
7439-98-7	Molybdenum	0.5	6.25E-07	2.74E-06	Y	A
7440-28-0	Thallium	5	6.25E-06	2.74E-05	Y	A
7440-61-1	Uranium	5	6.25E-06	2.74E-05	Y	A
7440-62-2	Vanadium	15.5	1.94E-05	8.49E-05	Y	A
7440-33-7	Tungsten	5	6.25E-06	2.74E-05	Y	A
7440-66-6	Zinc	18	2.25E-05	9.86E-05	Y	A
Total			3.85E-01	1.69E+00		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *See LIME PRODUCTION, page 10*

1E+6 parts/ppm

REC 0584

CONCRETE PRODUCTION

Source Data

TP_unit/day TP_unit/yr

Source ID	description Description	Throughput ton/day	ton/yr
CS1L	Cement/Shotcrete Silo #1 Loading	164	60,000
CS1U	Cement/Shotcrete Silo #1 Unloading	164	60,000
CS2L	Cement/Shotcrete Silo #2 Loading	164	60,000
CS2U	Cement/Shotcrete Silo #2 Unloading	164	60,000
CM	Central Mixer Loading	164	60,000
	Subtotal Cement Silo Filling	658	240,000
	Subtotal Central Mix Batching	164	60,000

HAP/TAP Emission Factors and Emissions

CF_pph CF_tpy CM_pph CM_tpy lb/hr ton/yr

CAS No.	HAP/TAP	Silo Fill lb/ton[2]	Central Mixer lb/ton[3]	Cement Silo L/U lb/hr	Cement Silo L/U ton/yr	Central Mix Batching lb/hr	Central Mix Batching ton/yr	Total Emissions[3] lb/hr	Total Emissions[3] ton/yr	TAP	A/C
7440-38-2	Arsenic	4.24E-09	2.96E-07	1.16E-7	5.09E-7	2.03E-6	8.88E-6	2.14E-6	9.39E-6	Y	C
7440-41-7	Beryllium	4.86E-10		1.33E-8	5.83E-8	--	--	1.33E-8	5.83E-8	Y	C
7440-43-9	Cadmium		7.10E-10	--	--	4.86E-9	2.13E-8	4.86E-9	2.13E-8	Y	C
7440-47-3	Chromium	2.90E-08	1.27E-07	7.95E-7	3.48E-6	8.70E-7	3.81E-6	1.66E-6	7.29E-6	Y	A
18540-29-9	Cr (VI)	5.80E-09	2.70E-08	1.59E-7	6.96E-7	1.85E-7	8.11E-7	3.44E-7	1.51E-6	Y	C
7439-92-1	Lead	1.09E-08	3.66E-08	2.99E-7	1.31E-6	2.51E-7	1.10E-6	5.49E-7	2.41E-6	N	
7439-96-5	Manganese	1.17E-07	3.78E-06	3.21E-6	1.40E-5	2.59E-5	1.13E-4	2.91E-5	1.27E-4	Y	A
7440-02-0	Nickel	4.18E-08	2.48E-07	1.15E-6	5.02E-6	1.70E-6	7.44E-6	2.84E-6	1.25E-5	Y	C
7723-14-0	Phosphorus		1.20E-06	--	--	8.22E-6	3.60E-5	8.22E-6	3.60E-5	Y	A
Total				5.73E-6	2.51E-5	3.91E-5	1.71E-4	4.49E-5	1.97E-4		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *AP-42, Table 11.12-8, (06/06) Cement Silo Filing, Controlled.* 20% *Cr (VI), IDEQ email on 11/23/2020* 0.0002 0.0002

(3) *AP-42, Table 11.12-8, (06/06) Central Mix Batching, Controlled.* 21.29% *Cr (VI), IDEQ email on 11/23/2020* chk

Conversions

24 hr/day

CONCRETE PRODUCTION - CONTINUED

Source Data

PM_ppd PM_tpy

Source ID	description Description	PM Emissions lb/day	ton/yr
CAL	Aggregate Bin Loading	16.56	1.73
CAU	Aggregate Bin Unloading	16.56	1.73
Total		33.12	3.45

HAP/TAP Emission Factors and Emissions

lb/hr ton/yr

CAS No.	Pollutant	Concentration ppm[2]	Emissions[1] lb/hr	ton/yr	TAP	A/C
7440-38-2	Arsenic	23	1.81E-05	7.94E-05	Y	C
7440-41-7	Beryllium	0.8	6.30E-07	2.76E-06	Y	C
7440-43-9	Cadmium	0.25	1.97E-07	8.63E-07	Y	C
7440-48-4	Cobalt	4	5.52E-06	1.38E-05	Y	A
7440-47-3	Chromium	15	2.07E-05	5.18E-05	Y	A
7439-97-6	Mercury	0.02	2.76E-08	6.90E-08	N	
7439-96-5	Manganese	236.5	3.26E-04	8.16E-04	Y	A
7440-02-0	Nickel	5	3.94E-06	1.73E-05	Y	C
7439-92-1	Lead	3	4.14E-06	1.04E-05	N	
7440-36-0	Antimony	2.5	3.45E-06	8.63E-06	Y	A
7723-14-0	Phosphorus	130	1.79E-04	4.49E-04	Y	A
7440-22-4	Silver	0	0.00E+00	0.00E+00	Y	A
7429-90-5	Aluminum	22600	3.12E-02	7.80E-02	Y	A
7440-39-3	Barium	145	2.00E-04	5.00E-04	Y	A
7440-50-8	Copper	5	6.90E-06	1.73E-05	Y	A
7439-89-6	Iron	10350	1.43E-02	3.57E-02	Y	A
7439-98-7	Molybdenum	0.5	6.90E-07	1.73E-06	Y	A
7440-28-0	Thallium	5	6.90E-06	1.73E-05	Y	A
7440-61-1	Uranium	5	6.90E-06	1.73E-05	Y	A
7440-62-2	Vanadium	15.5	2.14E-05	5.35E-05	Y	A
7440-33-7	Tungsten	5	6.90E-06	1.73E-05	Y	A
7440-66-6	Zinc	18	2.48E-05	6.21E-05	Y	A
Total			4.63E-02	1.16E-01		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *See LIME PRODUCTION, page 10*

1E+6 parts/ppm

FUEL STORAGE - GASOLINE

Source Data

Source ID	Description	VOC Emissions lb/day	VOC Emissions ton/yr
	description	VOC_ppd	VOC_tpy
TG1	Mine Site Gasoline Tank #1	5.25	0.96
TG2	Mine Site Gasoline Tank #2	5.25	0.96
Total		10.49	1.91

HAP/TAP Emission Factors and Emissions

CAS No.	Pollutant	Concentration wt. %[2]	Emissions[1] lb/hr	Emissions[1] ton/yr	TAP	A/C
			lb/hr	ton/yr		
71-43-2	Benzene	1.608%	7.03E-03	3.08E-02	Y	C
92-52-4	Biphenyl	0.010%	4.37E-05	1.91E-04	Y	A
110-82-7	Cyclohexane	0.240%	1.05E-03	4.60E-03	Y	A
110-54-3	Hexane	7.138%	3.12E-02	1.37E-01	Y	A
91-20-3	Naphthalene	0.444%	1.94E-03	8.50E-03	Y	A
108-95-2	Phenol	0.055%	2.40E-04	1.05E-03	Y	A
108-88-3	Toluene	7.212%	3.15E-02	1.38E-01	Y	A
25551-13-7	Trimethyl benzene	2.500%	1.09E-02	4.79E-02	Y	A
1330-20-7	Xylene	7.170%	3.13E-02	1.37E-01	Y	A
Total			1.15E-01	5.05E-01		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *(EPA 1999a)*

MINING FUGITIVE EMISSIONS

Dust Emissions

Source Data **Model Scenario** **W3** **180,000 T/day Emissions**

Operating schedule 365 day/yr

Clean rock cap (CR >0% [1]

[1] *(Perpetua 2021h) Percent of VMTs on haul roads capped with CR*
Roads outside of the pits and DRSFs are capped with CR

Source ID	Description	PM Emissions lb/day	PM Emissions ton/yr
YPP	Yellow Pine Pit	--	--
HFP	Hangar Flats Pit	--	--
WEP	West End Pit	1,887.91	344.54
BT	Bradley Tailings	--	--
YPPBL	Yellow Pine Pit Blasting	--	--
HFPBL	Hangar Flats Pit Blasting	--	--
WEPBL	West End Pit Blasting	643.03	117.35
BTBL	Bradley Tailings Blasting	--	--
STKP	PC Stockpile	--	--
FDRSF	Fiddle DRSF	--	--
HFDRSF	Hangar Flats DRSF	289.91	52.91
YPDRSF	Yellow Pine DRSF	--	--
WEDRSF	West End DRSF	--	--
HR000	Haul Roads	16,697.74	3,047.34
TSF	Tailing Storage Facility	--	--
ACCRD	Access Roads	38.10	6.95
UGEXP	Scout Portal	0.008	0.002
Total		19,556.71	3,569.10

TSF, ACCRD, UGEXP 38.11 6.95 chk 3569.10

HAP/TAP Emission Factors		ORE	DR	CR	HRD	Borrow	AR
		Concentration					
CAS No.	Pollutant	ppm[1]	ppm[1]	ppm[3]	ppm[4]	ppm[5]	ppm
7440-38-2	Arsenic	667	667	90	667	2.5	667
7440-41-7	Beryllium	3.2	3.2		3.2		3.2
7440-43-9	Cadmium	0.5	0.5		0.5		0.5
7440-48-4	Cobalt	4	4		4		4
7440-47-3	Chromium	9	9		9		9
7439-97-6	Mercury [2]	0.96	0.6		0.6		0.6
7439-96-5	Manganese	299	299		299		299
7440-02-0	Nickel	2	2		2		2
7439-92-1	Lead	8	8		8		8
7440-36-0	Antimony	23	23		23		23
7723-14-0	Phosphorus	650	650		650		650
7782-49-2	Selenium	0.4	0.4		0.4		0.4
7440-22-4	Silver	0.5	0.5		0.5		0.5
7429-90-5	Aluminum	71000	71000		71000		71000
7440-39-3	Barium	800	800		800		800
1317-65-3	Calcium Carbonate	14000	14000		14000		14000
7440-50-8	Copper	5	5		5		5
7439-89-6	Iron	18200	18200		18200		18200
7439-98-7	Molybdenum	1	1		1		1
7440-28-0	Thallium	10	10		10		10
7440-61-1	Uranium	10	10		10		10
7440-62-2	Vanadium	28	28		28		28
7440-33-7	Tungsten	10	10		10		10
7440-66-6	Zinc	35	35		35		35

[1] *(Midas Gold 2017c)* *Median concentration of 55,000 SGP samples.* *1E+6 parts/ppm*

[2] *(Midas Gold 2018e)* *Median ore and development rock (DR) concentrations of 151,000 samples; resource block model.*

[3] *(Perpetua 2021g)* *Median concentration of 265 SGP samples.*

[4] *HRD: haul road - emissions calculated based on 0% of the total VMT occuring on CR*

[5] *(ALS 2018)* *Median concentration of 8 SGP samples.*

DR DR DR DR DR DR DR DR ORE DR DR DR DR HRD DR/AR

MINING FUGITIVE EMISSIONS - CONTINUED **Model Scenario W3** DR **180,000 T/day Emissions**

HAP/TAP Emissions

Hourly [1] YPP_pph HFP_pph WEP_pph BT_pph YPPBL_pph HFPBL_pph WEPBL_pph BTBL_pph STKP_pph FDRSF_pph HFDRSF_pph YPDRSF_pph WEDRSF_pph HR000_pph CCRD, UGE lb/hr

CAS No.	Pollutant	YPP lb/hr	HFP lb/hr	WEP lb/hr	BT lb/hr	YPPBL lb/hr	HFPBL lb/hr	WEPBL lb/hr	BTBL lb/hr	STKP lb/hr	FDRSF lb/hr	HFDRSF lb/hr	YPDRSF lb/hr	WEDRSF lb/hr	HR000 lb/hr	TSF, ACCRD, UGEXP lb/hr	Total lb/hr
7440-38-2	Arsenic	0	0	0.052	0	0	0	0.018	0	0	0	8.1E-3	0	0	0.464	1.1E-3	0.544
7440-41-7	Beryllium	0	0	2.5E-4	0	0	0	8.6E-5	0	0	0	3.9E-5	0	0	2.2E-3	5.1E-6	2.6E-3
7440-43-9	Cadmium	0	0	3.9E-5	0	0	0	1.3E-5	0	0	0	6.0E-6	0	0	3.5E-4	7.9E-7	4.1E-4
7440-48-4	Cobalt	0	0	3.1E-4	0	0	0	1.1E-4	0	0	0	4.8E-5	0	0	2.8E-3	6.4E-6	3.3E-3
7440-47-3	Chromium	0	0	7.1E-4	0	0	0	2.4E-4	0	0	0	1.1E-4	0	0	6.3E-3	1.4E-5	7.3E-3
7439-97-6	Mercury	0	0	4.7E-5	0	0	0	1.6E-5	0	0	0	7.2E-6	0	0	4.2E-4	9.5E-7	4.9E-4
7439-96-5	Manganese	0	0	0.024	0	0	0	8.0E-3	0	0	0	3.6E-3	0	0	0.208	4.7E-4	0.244
7440-02-0	Nickel	0	0	1.6E-4	0	0	0	5.4E-5	0	0	0	2.4E-5	0	0	1.4E-3	3.2E-6	1.6E-3
7439-92-1	Lead	0	0	6.3E-4	0	0	0	2.1E-4	0	0	0	9.7E-5	0	0	5.6E-3	1.3E-5	6.5E-3
7440-36-0	Antimony	0	0	1.8E-3	0	0	0	6.2E-4	0	0	0	2.8E-4	0	0	0.016	3.7E-5	0.019
7723-14-0	Phosphorus	0	0	0.051	0	0	0	0.017	0	0	0	7.9E-3	0	0	0.452	1.0E-3	0.530
7782-49-2	Selenium	0	0	3.1E-5	0	0	0	1.1E-5	0	0	0	4.8E-6	0	0	2.8E-4	6.4E-7	3.3E-4
7440-22-4	Silver	0	0	3.9E-5	0	0	0	1.3E-5	0	0	0	6.0E-6	0	0	3.5E-4	7.9E-7	4.1E-4
7429-90-5	Aluminum	0	0	5.585	0	0	0	1.902	0	0	0	0.858	0	0	49.397	0.113	57.855
7440-39-3	Barium	0	0	0.063	0	0	0	0.021	0	0	0	9.7E-3	0	0	0.557	1.3E-3	0.652
1317-65-3	Calcium Ca	0	0	1.101	0	0	0	0.375	0	0	0	0.169	0	0	9.740	0.022	11.408
7440-50-8	Copper	0	0	3.9E-4	0	0	0	1.3E-4	0	0	0	6.0E-5	0	0	3.5E-3	7.9E-6	4.1E-3
7439-89-6	Iron	0	0	1.432	0	0	0	0.488	0	0	0	0.220	0	0	12.662	0.029	14.831
7439-98-7	Molybdenu	0	0	7.9E-5	0	0	0	2.7E-5	0	0	0	1.2E-5	0	0	7.0E-4	1.6E-6	8.1E-4
7440-28-0	Thallium	0	0	7.9E-4	0	0	0	2.7E-4	0	0	0	1.2E-4	0	0	7.0E-3	1.6E-5	8.1E-3
7440-61-1	Uranium	0	0	7.9E-4	0	0	0	2.7E-4	0	0	0	1.2E-4	0	0	7.0E-3	1.6E-5	8.1E-3
7440-62-2	Vanadium	0	0	2.2E-3	0	0	0	7.5E-4	0	0	0	3.4E-4	0	0	0.019	4.4E-5	0.023
7440-33-7	Tungsten	0	0	7.9E-4	0	0	0	2.7E-4	0	0	0	1.2E-4	0	0	7.0E-3	1.6E-5	8.1E-3
7440-66-6	Zinc	0	0	2.8E-3	0	0	0	9.4E-4	0	0	0	4.2E-4	0	0	0.024	5.6E-5	0.029
Total		0	0	8.320	0	0	0	2.834	0	0	0	1.278	0	0	73.586	0.168	86.185

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.* chk 86.1849 86.1849

DR DR DR DR DR DR DR DR ORE DR DR DR DR HRD DR/AR

MINING FUGITIVE EMISSIONS - CONTINUED **Model Scenario W3** DR **180,000 T/day Emissions**

HAP/TAP Emissions

Annual

		YPP_tpy	HFP_tpy	WEP_tpy	BT_tpy	YPPBL_tpy	HFPBL_tpy	WEPBL_tpy	BTBL_tpy	STKP_tpy	FDRSF_tpy	HFDRSF_tpy	YPDRSF_tpy	WEDRSF_tpy	HR000_tpy	CCRD, UGE	ton/yr
		YPP	HFP	WEP	BT	YPPBL	HFPBL	WEPBL	BTBL	STKP	FDRSF	HFDRSF	YPDRSF	WEDRSF	HR000	TSF, ACCRD, UGEXP	Total
CAS No.	Pollutant	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr
7440-38-2	Arsenic	0	0	0.230	0	0	0	0.078	0	0	0	0.035	0	0	2.033	4.6E-3	2.381
7440-41-7	Beryllium	0	0	1.1E-3	0	0	0	3.8E-4	0	0	0	1.7E-4	0	0	9.8E-3	2.2E-5	0.011
7440-43-9	Cadmium	0	0	1.7E-4	0	0	0	5.9E-5	0	0	0	2.6E-5	0	0	1.5E-3	3.5E-6	1.8E-3
7440-48-4	Cobalt	0	0	1.4E-3	0	0	0	4.7E-4	0	0	0	2.1E-4	0	0	0.012	2.8E-5	0.014
7440-47-3	Chromium	0	0	3.1E-3	0	0	0	1.1E-3	0	0	0	4.8E-4	0	0	0.027	6.3E-5	0.032
7439-97-6	Mercury	0	0	2.1E-4	0	0	0	7.0E-5	0	0	0	3.2E-5	0	0	1.8E-3	4.2E-6	2.1E-3
7439-96-5	Manganese	0	0	0.103	0	0	0	0.035	0	0	0	0.016	0	0	0.911	2.1E-3	1.067
7440-02-0	Nickel	0	0	6.9E-4	0	0	0	2.3E-4	0	0	0	1.1E-4	0	0	6.1E-3	1.4E-5	7.1E-3
7439-92-1	Lead	0	0	2.8E-3	0	0	0	9.4E-4	0	0	0	4.2E-4	0	0	0.024	5.6E-5	0.029
7440-36-0	Antimony	0	0	7.9E-3	0	0	0	2.7E-3	0	0	0	1.2E-3	0	0	0.070	1.6E-4	0.082
7723-14-0	Phosphorus	0	0	0.224	0	0	0	0.076	0	0	0	0.034	0	0	1.981	4.5E-3	2.320
7782-49-2	Selenium	0	0	1.4E-4	0	0	0	4.7E-5	0	0	0	2.1E-5	0	0	1.2E-3	2.8E-6	1.4E-3
7440-22-4	Silver	0	0	1.7E-4	0	0	0	5.9E-5	0	0	0	2.6E-5	0	0	1.5E-3	3.5E-6	1.8E-3
7429-90-5	Aluminum	0	0	24.463	0	0	0	8.332	0	0	0	3.756	0	0	216	0.494	253
7440-39-3	Barium	0	0	0.276	0	0	0	0.094	0	0	0	0.042	0	0	2.438	5.6E-3	2.855
1317-65-3	Calcium Ca	0	0	4.824	0	0	0	1.643	0	0	0	0.741	0	0	42.663	0.097	49.967
7440-50-8	Copper	0	0	1.7E-3	0	0	0	5.9E-4	0	0	0	2.6E-4	0	0	0.015	3.5E-5	0.018
7439-89-6	Iron	0	0	6.271	0	0	0	2.136	0	0	0	0.963	0	0	55.462	0.127	64.958
7439-98-7	Molybdenu	0	0	3.4E-4	0	0	0	1.2E-4	0	0	0	5.3E-5	0	0	3.0E-3	7.0E-6	3.6E-3
7440-28-0	Thallium	0	0	3.4E-3	0	0	0	1.2E-3	0	0	0	5.3E-4	0	0	0.030	7.0E-5	0.036
7440-61-1	Uranium	0	0	3.4E-3	0	0	0	1.2E-3	0	0	0	5.3E-4	0	0	0.030	7.0E-5	0.036
7440-62-2	Vanadium	0	0	9.6E-3	0	0	0	3.3E-3	0	0	0	1.5E-3	0	0	0.085	1.9E-4	0.100
7440-33-7	Tungsten	0	0	3.4E-3	0	0	0	1.2E-3	0	0	0	5.3E-4	0	0	0.030	7.0E-5	0.036
7440-66-6	Zinc	0	0	0.012	0	0	0	4.1E-3	0	0	0	1.9E-3	0	0	0.107	2.4E-4	0.125
Total		0	0	36.441	0	0	0	12.412	0	0	0	5.596	0	0	322	0.736	377
															chk	377.4900	377.4900

MINING FUGITIVE EMISSIONS - CONTINUED

Mercury Evaporative Flux Emissions

Fugitive Mercury Flux and Emissions

			Area		Hg Flux	Emissions[1] lb/hr	ton/yr	lb/yr
CAS No.	Pollutant	Source	m^2	ha	µg/m^2-yr			
		Stockpiles	52,623	5.3	556	7.37E-6	3.2E-5	6.5E-2
		Rock Dumps	2,063,990	206.4	76.2	3.96E-5	1.7E-4	0.35
		Tailings	1,338,158	133.8	2,144	7.22E-4	3.2E-3	6.32
		Pits	1,504,919	150.5	132.3	5.01E-5	2.2E-4	0.44
7439-97-6	Mercury					8.2E-4	3.6E-3	7.17

[1] *Hourly emissions based on:* 8,760 *hours per year of operation*

Fugitive Mercury Emission Factors

	Twin Creeks (TC)		Ore Hg Adjusted	Stibnite	
	Hg Flux [1]	Hg [2]	µg/m^2/yr	Hg Flux [3]	Hg [4]
Source	µg/m^2-yr	µg/g	TC	µg/m^2-yr	µg/g
Stockpiles	5,609	33	556	556	0.96
Rock Dumps	768	3.5	76.2	76.2	0.60
Tailings	21,621	33	2,144	2,144	0.96
Pits	1,334	9.5	132	132.3	0.60

[1] *(Eckley 2010)* *Table 1: Hg flux µg/m^2-yr*

[2] *(Eckley 2010)* *Table 1: Average Hg flux mg/g: " Stockpiles - high-grade stockpiles, Rock Dumps - waste rock dumps, Tailings - high-grade stockpiles as a surrogate; Pits - pit"*

[3] *(Eckley 2010)* *Figure 2: log(y) = m*log(x) + b*

y = Hg Flux (ng/m^2-d)
x = material Hg concentration (µg/g)]

Slope =	*Solar*	*TC*
	Low	*0.59*
	Medium	*0.6*
	High	*0.77*
	Average	*0.65*

[4] *(Midas Gold 2018e)*

Sample Calculation: m = log (y1/y2) / log(x1/x2)

m=	0.65	unitless
y1=	5,609	µg/m^2-yr
x1=	33	µg/m^2-yr
x2=	0.96	µg/m^2-yr
log(x1/x2)=	1.536243	unitless
log(y1/y2)=	1.003679	unitless
y1/y2=	10.08506	unitless
y2=	556.2	µg/m^2-yr

Conversions

2,000	lb/ton
10,000	m2/ha
453.593	g/lb

TABLE A-W3. HAP/TAP Emissions and Exemptions

180,000 T/day Emissions					MINING										LEACHING	
chk					*Mining*	*Model Scenario W3*									*CN Leach/PAX*	
					YPP,HFP,WEP,BT	YPPBL,HFPBL,WEPBL,BTBL		HR000		STKP, FDRSF, HFDRSF, YPDRSF, WEDRSF		TSF,ACCRD,UGEXP				
CAS	HAP/TAP	HAP	TAP		Pits		Blasting		Haul Roads		Stockpiles and DRFS		Tails, Access Road, Exploration		CN Leach and PAX	
	NSPS or NESHAP HAP/TAP -->	*Y*														
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->			A/C	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
106-99-0	1,3-Butadiene	Y	Y	Y C				0	0	0		0				
91-57-6	2-Methylnaphthalene	Y	N	n/a							0					
56-49-5	3-Methylchloranthrene	Y	Y	Y C												
57-97-6	7,12-Dimethylbenz(a)anthracene	Y	N	n/a												
83-32-9	Acenaphthene	Y	N	n/a												
208-96-8	Acenaphthylene	Y	N	n/a												
75-07-0	Acetaldehyde	Y	Y	Y C												
107-02-8	Acrolein	Y	Y	Y A												
120-12-7	Anthracene	Y	N	n/a												
7440-36-0	Antimony	Y	Y	Y A	1.8E-3	7.9E-3	6.2E-4	2.7E-3	0.016	0.070	2.8E-4	1.2E-3	3.7E-5	1.6E-4		
7440-38-2	Arsenic	Y	Y	Y C	0.052	0.230	0.018	0.078	0.464	2.033	8.1E-3	0.035	1.1E-3	4.6E-3		
71-43-2	Benzene	Y	Y	Y C												
50-32-8	Benzo(a)pyrene	Y	Y	Y C												
56-55-3	Benz(a)anthracene	Y	Y	Y C												
205-99-2	Benzo(b)fluoranthene	Y	Y	Y C												
207-08-9	Benzo(k)fluoranthene	Y	Y	Y C												
218-01-9	Chrysene	Y	Y	Y C												
53-70-3	Dibenzo(a,h)anthracene	Y	Y	Y C												
193-39-5	Indeno(1,2,3-cd)pyrene	Y	Y	Y C												
191-24-2	Benzo(g,h,i)perylene	Y	N	n/a												
7440-41-7	Beryllium	Y	Y	Y C	2.5E-4	1.1E-3	8.6E-5	3.8E-4	2.2E-3	9.8E-3	3.9E-5	1.7E-4	5.1E-6	2.2E-5		
92-52-4	Biphenyl	Y	Y	Y A												
7440-43-9	Cadmium	Y	Y	Y C	3.9E-5	1.7E-4	1.3E-5	5.9E-5	3.5E-4	1.5E-3	6.0E-6	2.6E-5	7.9E-7	3.5E-6		
75-15-0	Carbon Disulfide	Y	Y	Y A											0.014	0.063
7440-47-3	Chromium	Y	Y	Y A	7.1E-4	3.1E-3	2.4E-4	1.1E-3	6.3E-3	0.027	1.1E-4	4.8E-4	1.4E-5	6.3E-5		
18540-29-9	Cr (VI)	Y	Y	Y C												
7440-48-4	Cobalt	Y	Y	Y A	3.1E-4	1.4E-3	1.1E-4	4.7E-4	2.8E-3	0.012	4.8E-5	2.1E-4	6.4E-6	2.8E-5		
592-01-8	Cyanide	Y	Y	Y A											0.453	1.983
106-46-7	Dichlorobenzene	Y	Y	Y A												
206-44-0	Fluoranthene	Y	N	n/a												
86-73-7	Fluorene	Y	N	n/a												
50-00-0	Formaldehyde	Y	Y	Y C												
110-54-3	Hexane	Y	Y	Y A												
7647-01-0	Hydrogen Chloride	Y	Y	Y A												
7439-92-1	Lead	Y	N	n/a	6.3E-4	2.8E-3	2.1E-4	9.4E-4	5.6E-3	0.024	9.7E-5	4.2E-4	1.3E-5	5.6E-5		
7439-96-5	Manganese	Y	Y	Y A	0.024	0.103	8.0E-3	0.035	0.208	0.911	3.6E-3	0.016	4.7E-4	2.1E-3		
7439-97-6	Mercury	Y	N	n/a	9.7E-5	4.3E-4	1.6E-5	7.0E-5	4.2E-4	1.8E-3	5.4E-5	2.4E-4	7.2E-4	3.2E-3		
91-20-3	Naphthalene	Y	Y	Y A												
7440-02-0	Nickel	Y	Y	Y C	1.6E-4	6.9E-4	5.4E-5	2.3E-4	1.4E-3	6.1E-3	2.4E-5	1.1E-4	3.2E-6	1.4E-5		
85-01-8	Phenanthrene	Y	N	n/a												
108-95-2	Phenol	Y	Y	Y A												
7723-14-0	Phosphorus	Y	Y	Y A	0.051	0.224	0.017	0.076	0.452	1.981	7.9E-3	0.034	1.0E-3	4.5E-3		
129-00-0	Pyrene	Y	N	n/a												
7782-49-2	Selenium	Y	Y	Y A	3.1E-5	1.4E-4	1.1E-5	4.7E-5	2.8E-4	1.2E-3	4.8E-6	2.1E-5	6.4E-7	2.8E-6		
108-88-3	Toluene	Y	Y	Y A												
1330-20-7	Xylene	Y	Y	Y A												
7429-90-5	Aluminum	N	Y	N A	5.585	24.463	1.902	8.332	49.397	216	0.858	3.756	0.113	0.494		
7440-39-3	Barium	N	Y	N A	0.063	0.276	0.021	0.094	0.557	2.438	9.7E-3	0.042	1.3E-3	5.6E-3		
1317-65-3	Calcium Carbonate	N	Y	N A	1.101	4.824	0.375	1.643	9.740	42.663	0.169	0.741	0.022	0.097		
1305-78-8	Calcium Oxide	N	Y	N A												
7440-50-8	Copper	N	Y	N A	3.9E-4	1.7E-3	1.3E-4	5.9E-4	3.5E-3	0.015	6.0E-5	2.6E-4	7.9E-6	3.5E-5		
110-82-7	Cyclohexane	N	Y	N A												
7783-06-4	Hydrogen Sulfide	N	Y	N A												
7439-89-6	Iron	N	Y	N A	1.432	6.271	0.488	2.136	12.662	55.462	0.220	0.963	0.029	0.127		
7439-98-7	Molybdenum	N	Y	N A	7.9E-5	3.4E-4	2.7E-5	1.2E-4	7.0E-4	3.0E-3	1.2E-5	5.3E-5	1.6E-6	7.0E-6		
109-66-0	Pentane	N	Y	N A												
7440-22-4	Silver	N	Y	N A	3.9E-5	1.7E-4	1.3E-5	5.9E-5	3.5E-4	1.5E-3	6.0E-6	2.6E-5	7.9E-7	3.5E-6		
7664-93-9	Sulfuric Acid	N	Y	N A												
7440-28-0	Thallium	N	Y	N A	7.9E-4	3.4E-3	2.7E-4	1.2E-3	7.0E-3	0.030	1.2E-4	5.3E-4	1.6E-5	7.0E-5		
7440-61-1	Uranium	N	Y	N A	7.9E-4	3.4E-3	2.7E-4	1.2E-3	7.0E-3	0.030	1.2E-4	5.3E-4	1.6E-5	7.0E-5		
7440-62-2	Vanadium	N	Y	N A	2.2E-3	9.6E-3	7.5E-4	3.3E-3	0.019	0.085	3.4E-4	1.5E-3	4.4E-5	1.9E-4		
25551-13-7	Trimethyl benzene	N	Y	N A												
7440-33-7	Tungsten	N	Y	N A	7.9E-4	3.4E-3	2.7E-4	1.2E-3	7.0E-3	0.030	1.2E-4	5.3E-4	1.6E-5	7.0E-5		
7440-66-6	Zinc	N	Y	N A	2.8E-3	0.012	9.4E-4	4.1E-3	0.024	0.107	4.2E-4	1.9E-3	5.6E-5	2.4E-4		
HAP TOTAL					***0.131***	***0.574***	***0.045***	***0.196***	***1.160***	***5.079***	***0.020***	***0.088***	***3.4E-3***	***0.015***	***0.467***	***2.046***
MERCURY TOTAL (exempt)					***9.7E-5***	***4.3E-4***	***1.6E-5***	***7.0E-5***	***4.2E-4***	***1.8E-3***	***5.4E-5***	***2.4E-4***	***7.2E-4***	***3.2E-3***		
MERCURY TOTAL (non-exempt)																
TAP TOTAL (HAP-TAP addressed by NSPS/NESHAP)																
TAP TOTAL (For EL Evaluation)					***8.319***	***36.438***	***2.834***	***12.411***	***73.580***	***322***	***1.278***	***5.595***	***0.168***	***0.735***	***0.467***	***2.046***

TABLE A-W3. HAP/TAP Emissions and Exemptions

180,000 T/day Emissions						PROCESSING AND PRODUCTION											
chk						*Ore Processing*				*Ore Concentration and Refining*				*Process Heating*			
						OC1-13		PS		AC		EW,MR,MF,CKD		ACB, CKB, PV, HS		LKC	
CAS	HAP/TAP	HAP	TAP			Crushers & Xfers		Prill Silos		Autoclave		EW, Preg Tank, Retort, Furnace, Carbon Kiln		POX Boiler, C. Kiln Comb., Prop. Vap., Sol'n Heater		Lime Kiln Combustion	
	NSPS or NESHAP HAP/TAP -->			*Y*		*LL*	*LL*			*7E*	*7E*	*7E*	*7E*			*5A*	*5A*
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				*A/C*	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
106-99-0	1,3-Butadiene	Y	Y	Y	C												
91-57-6	2-Methylnaphthalene	Y	N	n/a										1.9E-7	7.6E-7	5.2E-7	1.9E-6
56-49-5	3-Methylchloranthrene	Y	Y	Y	C									1.3E-8	5.7E-8	3.3E-8	1.4E-7
57-97-6	7,12-Dimethylbenz(a)anthracene	Y	N	n/a										1.3E-7	5.1E-7	3.5E-7	1.3E-6
83-32-9	Acenaphthene	Y	N	n/a										1.4E-8	5.7E-8	3.9E-8	1.4E-7
208-96-8	Acenaphthylene	Y	N	n/a										1.4E-8	5.7E-8	3.9E-8	1.4E-7
75-07-0	Acetaldehyde	Y	Y	Y	C												
107-02-8	Acrolein	Y	Y	Y	A												
120-12-7	Anthracene	Y	N	n/a										1.9E-8	7.6E-8	5.2E-8	1.9E-7
7440-36-0	Antimony	Y	Y	Y	A	1.4E-4	5.9E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7440-38-2	Arsenic	Y	Y	Y	C	3.9E-3	0.017			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.5E-6	6.4E-6	3.7E-6	1.6E-5
71-43-2	Benzene	Y	Y	Y	C									1.5E-5	6.7E-5	3.9E-5	1.7E-4
50-32-8	Benzo(a)pyrene	Y	Y	Y	C									8.7E-9	3.8E-8	2.2E-8	9.6E-8
56-55-3	Benz(a)anthracene	Y	Y	Y	C									1.3E-8	5.7E-8	3.3E-8	1.4E-7
205-99-2	Benzo(b)fluoranthene	Y	Y	Y	C									1.3E-8	5.7E-8	3.3E-8	1.4E-7
207-08-9	Benzo(k)fluoranthene	Y	Y	Y	C									1.3E-8	5.7E-8	3.3E-8	1.4E-7
218-01-9	Chrysene	Y	Y	Y	C									1.3E-8	5.7E-8	3.3E-8	1.4E-7
53-70-3	Dibenzo(a,h)anthracene	Y	Y	Y	C									8.7E-9	3.8E-8	2.2E-8	9.6E-8
193-39-5	Indeno(1,2,3-cd)pyrene	Y	Y	Y	C									1.3E-8	5.7E-8	3.3E-8	1.4E-7
191-24-2	Benzo(g,h,i)perylene	Y	N	n/a										9.5E-9	3.8E-8	2.6E-8	9.6E-8
7440-41-7	Beryllium	Y	Y	Y	C	1.9E-5	8.2E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	8.7E-8	3.8E-7	2.2E-7	9.6E-7
92-52-4	Biphenyl	Y	Y	Y	A												
7440-43-9	Cadmium	Y	Y	Y	C	2.9E-6	1.3E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	8.0E-6	3.5E-5	2.0E-5	8.8E-5
75-15-0	Carbon Disulfide	Y	Y	Y	A												
7440-47-3	Chromium	Y	Y	Y	A	5.3E-5	2.3E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.1E-5	4.5E-5	3.0E-5	1.1E-4
18540-29-9	Cr (VI)	Y	Y	Y	C												
7440-48-4	Cobalt	Y	Y	Y	A	2.4E-5	1.0E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3	6.6E-7	2.7E-6	1.8E-6	6.8E-6
592-01-8	Cyanide	Y	Y	Y	A							1.2E-3	5.3E-3				
106-46-7	Dichlorobenzene	Y	Y	Y	A									9.5E-6	3.8E-5	2.6E-5	9.6E-5
206-44-0	Fluoranthene	Y	N	n/a										2.4E-8	9.5E-8	6.5E-8	2.4E-7
86-73-7	Fluorene	Y	N	n/a										2.2E-8	8.9E-8	6.1E-8	2.3E-7
50-00-0	Formaldehyde	Y	Y	Y	C									5.5E-4	2.4E-3	1.4E-3	6.0E-3
110-54-3	Hexane	Y	Y	Y	A									0.014	0.057	0.039	0.145
7647-01-0	Hydrogen Chloride	Y	Y	Y	A												
7439-92-1	Lead	Y	N	n/a		4.7E-5	2.1E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7439-96-5	Manganese	Y	Y	Y	A	1.8E-3	7.7E-3			2.3E-5	1.0E-4	3.8E-4	1.7E-3	3.0E-6	1.2E-5	8.2E-6	3.1E-5
7439-97-6	Mercury	Y	N	n/a		5.6E-6	2.5E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	2.1E-6	8.3E-6	5.6E-6	2.1E-5
91-20-3	Naphthalene	Y	Y	Y	A									4.8E-6	1.9E-5	1.3E-5	4.9E-5
7440-02-0	Nickel	Y	Y	Y	C	1.2E-5	5.2E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.5E-5	6.7E-5	3.9E-5	1.7E-4
85-01-8	Phenanthrene	Y	N	n/a										1.3E-7	5.4E-7	3.7E-7	1.4E-6
108-95-2	Phenol	Y	Y	Y	A												
7723-14-0	Phosphorus	Y	Y	Y	A	3.8E-3	0.017			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
129-00-0	Pyrene	Y	N	n/a										4.0E-8	1.6E-7	1.1E-7	4.0E-7
7782-49-2	Selenium	Y	Y	Y	A	2.4E-6	1.0E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.9E-7	7.6E-7	5.2E-7	1.9E-6
108-88-3	Toluene	Y	Y	Y	A									2.7E-5	1.1E-4	7.3E-5	2.7E-4
1330-20-7	Xylene	Y	Y	Y	A												
7429-90-5	Aluminum	N	Y	N	A	0.418	1.829			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7440-39-3	Barium	N	Y	N	A	4.7E-3	0.021			2.3E-5	1.0E-4	3.8E-4	1.7E-3	3.5E-5	1.4E-4	9.5E-5	3.5E-4
1317-65-3	Calcium Carbonate	N	Y	N	A	0.082	0.361			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
1305-78-8	Calcium Oxide	N	Y	N	A												
7440-50-8	Copper	N	Y	N	A	2.9E-5	1.3E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3	6.7E-6	2.7E-5	1.8E-5	6.8E-5
110-82-7	Cyclohexane	N	Y	N	A												
7783-06-4	Hydrogen Sulfide	N	Y	N	A					0.900	3.942						
7439-89-6	Iron	N	Y	N	A	0.107	0.469			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7439-98-7	Molybdenum	N	Y	N	A	5.9E-6	2.6E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	8.7E-6	3.5E-5	2.4E-5	8.8E-5
109-66-0	Pentane	N	Y	N	A									0.021	0.083	0.056	0.209
7440-22-4	Silver	N	Y	N	A	2.9E-6	1.3E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7664-93-9	Sulfuric Acid	N	Y	N	A					2.030	8.891						
7440-28-0	Thallium	N	Y	N	A	5.9E-5	2.6E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7440-61-1	Uranium	N	Y	N	A	5.9E-5	2.6E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7440-62-2	Vanadium	N	Y	N	A	1.6E-4	7.2E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.8E-5	7.3E-5	5.0E-5	1.8E-4
25551-13-7	Trimethyl benzene	N	Y	N	A												
7440-33-7	Tungsten	N	Y	N	A	5.9E-5	2.6E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7440-66-6	Zinc	N	Y	N	A	2.1E-4	9.0E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3	2.3E-4	9.2E-4	6.3E-4	2.3E-3
HAP TOTAL						***9.8E-3***	***0.043***			***2.8E-4***	***1.2E-3***	***5.8E-3***	***0.025***	***0.015***	***0.060***	***0.041***	***0.152***
MERCURY TOTAL (exempt)										***2.3E-5***	***1.0E-4***	***3.8E-4***	***1.7E-3***			***5.6E-6***	***2.1E-5***
MERCURY TOTAL (non-exempt)						***5.6E-6***	***2.5E-5***							***2.1E-6***	***8.3E-6***		
TAP TOTAL (HAP-TAP addressed by NSPS/NESHAP)						***9.8E-3***	***0.043***			***2.3E-4***	***1.0E-3***	***5.0E-3***	***0.022***			***0.041***	***0.152***
TAP TOTAL (For EL Evaluation)						***0.612***	***2.682***			***2.930***	***12.835***	***4.6E-3***	***0.020***	***0.036***	***0.144***	***0.057***	***0.212***

TABLE A-W3. HAP/TAP Emissions and Exemptions

180,000 T/day Emissions

chk

CAS	HAP/TAP	HAP	TAP		
	NSPS or NESHAP HAP/TAP -->			*Y*	
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				*A/C*
106-99-0	1,3-Butadiene	Y	Y	Y	C
91-57-6	2-Methylnaphthalene	Y	N	n/a	
56-49-5	3-Methylchloranthrene	Y	Y	Y	C
57-97-6	7,12-Dimethylbenz(a)anthracene	Y	N	n/a	
83-32-9	Acenaphthene	Y	N	n/a	
208-96-8	Acenaphthylene	Y	N	n/a	
75-07-0	Acetaldehyde	Y	Y	Y	C
107-02-8	Acrolein	Y	Y	Y	A
120-12-7	Anthracene	Y	N	n/a	
7440-36-0	Antimony	Y	Y	Y	A
7440-38-2	Arsenic	Y	Y	Y	C
71-43-2	Benzene	Y	Y	Y	C
50-32-8	Benzo(a)pyrene	Y	Y	Y	C
56-55-3	Benz(a)anthracene	Y	Y	Y	C
205-99-2	Benzo(b)fluoranthene	Y	Y	Y	C
207-08-9	Benzo(k)fluoranthene	Y	Y	Y	C
218-01-9	Chrysene	Y	Y	Y	C
53-70-3	Dibenzo(a,h)anthracene	Y	Y	Y	C
193-39-5	Indeno(1,2,3-cd)pyrene	Y	Y	Y	C
191-24-2	Benzo(g,h,i)perylene	Y	N	n/a	
7440-41-7	Beryllium	Y	Y	Y	C
92-52-4	Biphenyl	Y	Y	Y	A
7440-43-9	Cadmium	Y	Y	Y	C
75-15-0	Carbon Disulfide	Y	Y	Y	A
7440-47-3	Chromium	Y	Y	Y	A
18540-29-9	Cr (VI)	Y	Y	Y	C
7440-48-4	Cobalt	Y	Y	Y	A
592-01-8	Cyanide	Y	Y	Y	A
106-46-7	Dichlorobenzene	Y	Y	Y	A
206-44-0	Fluoranthene	Y	N	n/a	
86-73-7	Fluorene	Y	N	n/a	
50-00-0	Formaldehyde	Y	Y	Y	C
110-54-3	Hexane	Y	Y	Y	A
7647-01-0	Hydrogen Chloride	Y	Y	Y	A
7439-92-1	Lead	Y	N	n/a	
7439-96-5	Manganese	Y	Y	Y	A
7439-97-6	Mercury	Y	N	n/a	
91-20-3	Naphthalene	Y	Y	Y	A
7440-02-0	Nickel	Y	Y	Y	C
85-01-8	Phenanthrene	Y	N	n/a	
108-95-2	Phenol	Y	Y	Y	A
7723-14-0	Phosphorus	Y	Y	Y	A
129-00-0	Pyrene	Y	N	n/a	
7782-49-2	Selenium	Y	Y	Y	A
108-88-3	Toluene	Y	Y	Y	A
1330-20-7	Xylene	Y	Y	Y	A
7429-90-5	Aluminum	N	Y	N	A
7440-39-3	Barium	N	Y	N	A
1317-65-3	Calcium Carbonate	N	Y	N	A
1305-78-8	Calcium Oxide	N	Y	N	A
7440-50-8	Copper	N	Y	N	A
110-82-7	Cyclohexane	N	Y	N	A
7783-06-4	Hydrogen Sulfide	N	Y	N	A
7439-89-6	Iron	N	Y	N	A
7439-98-7	Molybdenum	N	Y	N	A
109-66-0	Pentane	N	Y	N	A
7440-22-4	Silver	N	Y	N	A
7664-93-9	Sulfuric Acid	N	Y	N	A
7440-28-0	Thallium	N	Y	N	A
7440-61-1	Uranium	N	Y	N	A
7440-62-2	Vanadium	N	Y	N	A
25551-13-7	Trimethyl benzene	N	Y	N	A
7440-33-7	Tungsten	N	Y	N	A
7440-66-6	Zinc	N	Y	N	A

PROCESSING AND PRODUCTION - Continued

Lime Production						*Aggregate Prod.*		*Concrete Production*					
LS1-11,LSBM		LK,LS12,LCR,LS-L/U		LS1-L/U,MillS2-L/U,ACS1-4		PCSP1,PCSP2		CM		CS1L,CS1U,CS2L, CS2U		CA-L/U	
Limestone Crushers, Screens, Mill, Xfers		Lime Kiln, Kiln Feed, Lime Mill, Pebble Lime Silo		Lime Silos and Lime Mill Crushing		Portable Crushers, Screens, Xfers		Central Mixer		Cement Silo #1 and #2 L/U		Aggregate Bin	
OOO	*OOO*	*5A*	*5A*			*OOO*	*OOO*					*OOO*	*OOO*
lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
1.4E-5	4.8E-5	3.1E-6	1.2E-5	1.6E-6	5.1E-7	3.1E-6	1.4E-5					3.5E-6	8.6E-6
1.0E-4	4.4E-4	2.4E-5	1.1E-4	1.1E-6	4.7E-6	2.9E-5	1.3E-4	2.0E-6	8.9E-6	1.2E-7	5.1E-7	1.8E-5	7.9E-5
3.5E-6	1.5E-5	8.4E-7	3.7E-6	3.7E-8	1.6E-7	1.0E-6	4.4E-6			1.3E-8	5.8E-8	6.3E-7	2.8E-6
1.1E-6	4.8E-6	2.6E-7	1.2E-6	1.2E-8	5.1E-8	3.1E-7	1.4E-6	4.9E-9	2.1E-8			2.0E-7	8.6E-7
8.5E-5	2.9E-4	1.9E-5	6.9E-5	9.7E-6	3.0E-6	1.9E-5	8.2E-5	8.7E-7	3.8E-6	7.9E-7	3.5E-6	2.1E-5	5.2E-5
								1.9E-7	8.1E-7	1.6E-7	7.0E-7		
2.3E-5	7.7E-5	5.0E-6	1.8E-5	2.6E-6	8.1E-7	5.0E-6	2.2E-5					5.5E-6	1.4E-5
0	0	0.986	3.666										
1.7E-5	5.8E-5	3.7E-6	1.4E-5	1.9E-6	6.1E-7	3.8E-6	1.6E-5	2.5E-7	1.1E-6	3.0E-7	1.3E-6	4.1E-6	1.0E-5
1.3E-3	4.6E-3	2.9E-4	1.1E-3	1.5E-4	4.8E-5	3.0E-4	1.3E-3	2.6E-5	1.1E-4	3.2E-6	1.4E-5	3.3E-4	8.2E-4
1.1E-7	3.9E-7	2.8E-4	1.0E-3	1.3E-8	4.1E-9	2.5E-8	1.1E-7					2.8E-8	6.9E-8
2.2E-5	9.6E-5	5.3E-6	2.3E-5	2.3E-7	1.0E-6	6.3E-6	2.7E-5	1.7E-6	7.4E-6	1.1E-6	5.0E-6	3.9E-6	1.7E-5
7.4E-4	2.5E-3	1.6E-4	6.0E-4	8.4E-5	2.6E-5	1.6E-4	7.1E-4	8.2E-6	3.6E-5			1.8E-4	4.5E-4
0.128	0.436	0.028	0.104	0.015	4.6E-3	0.028	0.124					0.031	0.078
8.2E-4	2.8E-3	1.8E-4	6.7E-4	9.4E-5	2.9E-5	1.8E-4	7.9E-4					2.0E-4	5.0E-4
1.558	5.291	0.260	0.969			0.343	1.503						
		0.216	0.802	0.480	0.150								
2.8E-5	9.6E-5	6.2E-6	2.3E-5	3.2E-6	1.0E-6	6.3E-6	2.7E-5					6.9E-6	1.7E-5
0.059	0.199	0.013	0.048	6.7E-3	2.1E-3	0.013	0.057					0.014	0.036
2.8E-6	9.6E-6	6.2E-7	2.3E-6	3.2E-7	1.0E-7	6.3E-7	2.7E-6					6.9E-7	1.7E-6
0	0												
2.8E-5	9.6E-5	6.2E-6	2.3E-5	3.2E-6	1.0E-6	6.3E-6	2.7E-5					6.9E-6	1.7E-5
2.8E-5	9.6E-5	6.2E-6	2.3E-5	3.2E-6	1.0E-6	6.3E-6	2.7E-5					6.9E-6	1.7E-5
8.8E-5	3.0E-4	1.9E-5	7.1E-5	1.0E-5	3.1E-6	1.9E-5	8.5E-5					2.1E-5	5.3E-5
2.8E-5	9.6E-5	6.2E-6	2.3E-5	3.2E-6	1.0E-6	6.3E-6	2.7E-5					6.9E-6	1.7E-5
1.0E-4	3.5E-4	2.2E-5	8.3E-5	1.2E-5	3.6E-6	2.3E-5	9.9E-5					2.5E-5	6.2E-5
2.3E-3	***8.1E-3***	***0.987***	***3.669***	***2.6E-4***	***8.5E-5***	***5.3E-4***	***2.3E-3***	***3.9E-5***	***1.7E-4***	***5.7E-6***	***2.5E-5***	***5.6E-4***	***1.4E-3***
0	***0***	***2.8E-4***	***1.0E-3***										
1.1E-7	***3.9E-7***			***1.3E-8***	***4.1E-9***	***2.5E-8***	***1.1E-7***					***2.8E-8***	***6.9E-8***
2.3E-3	***8.0E-3***	***0.986***	***3.668***			***5.2E-4***	***2.3E-3***					***5.6E-4***	***1.4E-3***
1.746	***5.930***	***0.517***	***1.923***	***0.502***	***0.157***	***0.385***	***1.684***	***3.9E-5***	***1.7E-4***	***5.4E-6***	***2.4E-5***	***0.046***	***0.114***

TABLE A-W3. HAP/TAP Emissions and Exemptions

180,000 T/day Emissions						PROCESSING AND PRODUCTION - Continued						MINING and LEACHING - Totals									
chk						*HVAC*		*Emer. Power/Fire*		*Fuel Storage*		*HAP Total*		*Mercury Total*		*Mercury Total*		*TAP Total*		*TAP Total*	
CAS	HAP/TAP	HAP	TAP			H1M,H2M,HM,HAC,HR,HA,HMO,HTS,HW		EDG1,EDG2,EDG3,EDFP		TG1,TG2				*Exempt*		*Non-Exempt*		*HAP-TAP addressed by NSPS/NESHAP*		*For EL Evaluation*	
						Heaters		Emergency Generators and Fire Pump		Gasoline Fuel Tanks											
	NSPS or NESHAP HAP/TAP -->			*Y*		*4Z*	*4Z*	*6C*	*6C*												
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				*A/C*	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
106-99-0	1,3-Butadiene	Y	Y	Y	C			8.4E-7	3.7E-6			0	0					0	0	0	0
91-57-6	2-Methylnaphthalene	Y	N	n/a		4.3E-7	1.9E-6														
56-49-5	3-Methylchloranthrene	Y	Y	Y	C	3.2E-8	1.4E-7														
57-97-6	7,12-Dimethylbenz(a)anthracene	Y	N	n/a		2.9E-7	1.3E-6														
83-32-9	Acenaphthene	Y	N	n/a		3.2E-8	1.4E-7	5.6E-6	6.7E-6												
208-96-8	Acenaphthylene	Y	N	n/a		3.2E-8	1.4E-7	1.1E-5	1.3E-5												
75-07-0	Acetaldehyde	Y	Y	Y	C			2.5E-5	1.1E-4												
107-02-8	Acrolein	Y	Y	Y	A			1.6E-5	2.0E-5												
120-12-7	Anthracene	Y	N	n/a		4.3E-8	1.9E-7	1.6E-6	1.9E-6												
7440-36-0	Antimony	Y	Y	Y	A							0.019	0.082							0.019	0.082
7440-38-2	Arsenic	Y	Y	Y	C	3.6E-6	1.6E-5					0.544	2.381							0.544	2.381
71-43-2	Benzene	Y	Y	Y	C	3.8E-5	1.6E-4	2.7E-4	1.2E-3	7.0E-3	0.031										
50-32-8	Benzo(a)pyrene	Y	Y	Y	C	2.1E-8	9.4E-8	8.7E-8	3.8E-7												
56-55-3	Benz(a)anthracene	Y	Y	Y	C	3.2E-8	1.4E-7	2.4E-7	1.0E-6												
205-99-2	Benzo(b)fluoranthene	Y	Y	Y	C	3.2E-8	1.4E-7	3.6E-7	1.6E-6												
207-08-9	Benzo(k)fluoranthene	Y	Y	Y	C	3.2E-8	1.4E-7	7.3E-8	3.2E-7												
218-01-9	Chrysene	Y	Y	Y	C	3.2E-8	1.4E-7	5.0E-7	2.2E-6												
53-70-3	Dibenzo(a,h)anthracene	Y	Y	Y	C	2.1E-8	9.4E-8	1.2E-7	5.4E-7												
193-39-5	Indeno(1,2,3-cd)pyrene	Y	Y	Y	C	3.2E-8	1.4E-7	1.4E-7	6.2E-7												
191-24-2	Benzo(g,h,i)perylene	Y	N	n/a		2.1E-8	9.4E-8	6.9E-7	8.3E-7												
7440-41-7	Beryllium	Y	Y	Y	C	2.1E-7	9.4E-7					2.6E-3	0.011							2.6E-3	0.011
92-52-4	Biphenyl	Y	Y	Y	A					4.4E-5	1.9E-4										
7440-43-9	Cadmium	Y	Y	Y	C	2.0E-5	8.6E-5					4.1E-4	1.8E-3							4.1E-4	1.8E-3
75-15-0	Carbon Disulfide	Y	Y	Y	A							0.014	0.063							0.014	0.063
7440-47-3	Chromium	Y	Y	Y	A	2.5E-5	1.1E-4					7.3E-3	0.032							7.3E-3	0.032
18540-29-9	Cr (VI)	Y	Y	Y	C																
7440-48-4	Cobalt	Y	Y	Y	A	1.5E-6	6.6E-6					3.3E-3	0.014							3.3E-3	0.014
592-01-8	Cyanide	Y	Y	Y	A							0.453	1.983							0.453	1.983
106-46-7	Dichlorobenzene	Y	Y	Y	A	2.1E-5	9.4E-5														
206-44-0	Fluoranthene	Y	N	n/a		5.4E-8	2.4E-7	5.3E-6	6.4E-6												
86-73-7	Fluorene	Y	N	n/a		5.0E-8	2.2E-7	1.7E-5	2.1E-5												
50-00-0	Formaldehyde	Y	Y	Y	C	1.3E-3	5.9E-3	5.1E-5	2.2E-4												
110-54-3	Hexane	Y	Y	Y	A	0.032	0.141			0.031	0.137										
7647-01-0	Hydrogen Chloride	Y	Y	Y	A																
7439-92-1	Lead	Y	N	n/a								6.5E-3	0.029								
7439-96-5	Manganese	Y	Y	Y	A	6.8E-6	3.0E-5					0.244	1.067							0.244	1.067
7439-97-6	Mercury	Y	N	n/a		4.7E-6	2.0E-5					1.3E-3	5.7E-3	1.3E-3	5.7E-3	0	0	0	0	0	0
91-20-3	Naphthalene	Y	Y	Y	A	1.1E-5	4.8E-5	1.6E-4	1.9E-4	1.9E-3	8.5E-3	0	0					0	0	0	0
7440-02-0	Nickel	Y	Y	Y	C	3.8E-5	1.6E-4					1.6E-3	7.1E-3					0	0	1.6E-3	7.1E-3
85-01-8	Phenanthrene	Y	N	n/a		3.0E-7	1.3E-6	5.0E-5	6.0E-5			0	0					0	0	0	0
108-95-2	Phenol	Y	Y	Y	A					2.4E-4	1.1E-3	0	0					0	0	0	0
7723-14-0	Phosphorus	Y	Y	Y	A							0.530	2.320					0	0	0.530	2.320
129-00-0	Pyrene	Y	N	n/a		8.9E-8	3.9E-7	4.7E-6	5.7E-6			0	0					0	0	0	0
7782-49-2	Selenium	Y	Y	Y	A	4.3E-7	1.9E-6					3.3E-4	1.4E-3					0	0	3.3E-4	1.4E-3
108-88-3	Toluene	Y	Y	Y	A	6.1E-5	2.7E-4	3.6E-4	4.3E-4	0.032	0.138	0	0					0	0	0	0
1330-20-7	Xylene	Y	Y	Y	A			2.5E-4	3.0E-4	0.031	0.137	0	0					0	0	0	0
7429-90-5	Aluminum	N	Y	N	A							0	0					0	0	57.855	253
7440-39-3	Barium	N	Y	N	A	7.9E-5	3.4E-4					0	0					0	0	0.652	2.855
1317-65-3	Calcium Carbonate	N	Y	N	A							0	0					0	0	11.408	49.967
1305-78-8	Calcium Oxide	N	Y	N	A							0	0					0	0	0	0
7440-50-8	Copper	N	Y	N	A	1.5E-5	6.7E-5					0	0					0	0	4.1E-3	0.018
110-82-7	Cyclohexane	N	Y	N	A					1.0E-3	4.6E-3	0	0					0	0	0	0
7783-06-4	Hydrogen Sulfide	N	Y	N	A							0	0					0	0	0	0
7439-89-6	Iron	N	Y	N	A							0	0					0	0	14.831	64.958
7439-98-7	Molybdenum	N	Y	N	A	2.0E-5	8.6E-5					0	0					0	0	8.1E-4	3.6E-3
109-66-0	Pentane	N	Y	N	A	0.047	0.204					0	0					0	0	0	0
7440-22-4	Silver	N	Y	N	A							0	0					0	0	4.1E-4	1.8E-3
7664-93-9	Sulfuric Acid	N	Y	N	A							0	0					0	0	0	0
7440-28-0	Thallium	N	Y	N	A							0	0					0	0	8.1E-3	0.036
7440-61-1	Uranium	N	Y	N	A							0	0					0	0	8.1E-3	0.036
7440-62-2	Vanadium	N	Y	N	A	4.1E-5	1.8E-4					0	0					0	0	0.023	0.100
25551-13-7	Trimethyl benzene	N	Y	N	A					0.011	0.048	0	0					0	0	0	0
7440-33-7	Tungsten	N	Y	N	A							0	0					0	0	8.1E-3	0.036
7440-66-6	Zinc	N	Y	N	A	5.2E-4	2.3E-3					0	0					0	0	0.029	0.125
HAP TOTAL						*0.034*	*0.148*	*1.2E-3*	*2.6E-3*	*0.103*	*0.453*	*1.826*	*7.998*								
MERCURY TOTAL (exempt)														*1.3E-3*	*5.7E-3*						
MERCURY TOTAL (non-exempt)						*4.7E-6*	*2.0E-5*									*0*	*0*				
TAP TOTAL (HAP-TAP addressed by NSPS/NESHAP)								*1.1E-3*	*2.5E-3*	*0.103*	*0.453*							*0*	*0*		
TAP TOTAL (For EL Evaluation)						*0.081*	*0.355*			*0.012*	*0.052*									*86.645*	*380*

TABLE A-W3. HAP/TAP Emissions and Exemptions

180,000 T/day Emissions					PROCESSING AND PRODUCTION - Totals										ALL	ALL	ALL	TAP EL	
chk					*HAP Total*		*Mercury Total Exempt*		*Mercury Total Non-Exempt*		*TAP Total HAP-TAP addressed by NSPS/NESHAP*		*TAP Total For EL Evaluation*		*HAP*	*Hg Non-Exempt*	*TAP For EL Evaluation*	*TAP Emission Screening Level (EL)*	
CAS	HAP/TAP	HAP	TAP																
	NSPS or NESHAP HAP/TAP -->			*Y*														Non-car	Carcin
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->			*A/C*	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr	ton/yr	lb/hr	lb/hr	lb/hr
106-99-0	1,3-Butadiene	Y	Y	Y C	8.4E-7	3.7E-6					8.4E-7	3.7E-6			3.7E-6		0	--	2.4E-5
91-57-6	2-Methylnaphthalene	Y	N	n/a	1.1E-6	4.6E-6									4.6E-6			--	--
56-49-5	3-Methylchloranthrene	Y	Y	Y C	7.8E-8	3.4E-7					3.3E-8	1.4E-7	4.5E-8	2.0E-7	3.4E-7		4.5E-8	--	2.5E-6
57-97-6	7,12-Dimethylbenz(a)anthracene	Y	N	n/a	7.6E-7	3.0E-6									3.0E-6			--	--
83-32-9	Acenaphthene	Y	N	n/a	5.7E-6	7.1E-6									7.1E-6			--	--
208-96-8	Acenaphthylene	Y	N	n/a	1.1E-5	1.4E-5									1.4E-5			--	--
75-07-0	Acetaldehyde	Y	Y	Y C	2.5E-5	1.1E-4					2.5E-5	1.1E-4			1.1E-4			--	3.0E-3
107-02-8	Acrolein	Y	Y	Y A	1.6E-5	2.0E-5					1.6E-5	2.0E-5			2.0E-5			0.017	--
120-12-7	Anthracene	Y	N	n/a	1.7E-6	2.4E-6									2.4E-6			--	--
7440-36-0	Antimony	Y	Y	Y A	5.7E-4	2.5E-3					5.7E-4	2.5E-3	1.6E-6	5.1E-7	0.085		0.019	0.033	--
7440-38-2	Arsenic	Y	Y	Y C	4.5E-3	0.020					4.5E-3	0.020	8.2E-6	3.6E-5	2.400		0.544	--	1.5E-6
71-43-2	Benzene	Y	Y	Y C	7.4E-3	0.032					7.3E-3	0.032	5.3E-5	2.3E-4	0.032		5.3E-5	--	8.0E-4
50-32-8	Benzo(a)pyrene	Y	Y	Y C	1.4E-7	6.1E-7					1.1E-7	4.8E-7	3.0E-8	1.3E-7	6.1E-7				
56-55-3	Benz(a)anthracene	Y	Y	Y C	3.1E-7	1.4E-6					2.7E-7	1.2E-6	4.5E-8	2.0E-7	1.4E-6				
205-99-2	Benzo(b)fluoranthene	Y	Y	Y C	4.4E-7	1.9E-6					3.9E-7	1.7E-6	4.5E-8	2.0E-7	1.9E-6				
207-08-9	Benzo(k)fluoranthene	Y	Y	Y C	1.5E-7	6.6E-7					1.1E-7	4.7E-7	4.5E-8	2.0E-7	6.6E-7		2.9E-7	--	2.0E-6
218-01-9	Chrysene	Y	Y	Y C	5.8E-7	2.5E-6					5.3E-7	2.3E-6	4.5E-8	2.0E-7	2.5E-6				
53-70-3	Dibenzo(a,h)anthracene	Y	Y	Y C	1.8E-7	7.7E-7					1.5E-7	6.4E-7	3.0E-8	1.3E-7	7.7E-7				
193-39-5	Indeno(1,2,3-cd)pyrene	Y	Y	Y C	2.2E-7	9.6E-7					1.7E-7	7.6E-7	4.5E-8	2.0E-7	9.6E-7				
191-24-2	Benzo(g,h,i)perylene	Y	N	n/a	7.5E-7	1.1E-6									1.1E-6			--	--
7440-41-7	Beryllium	Y	Y	Y C	4.3E-4	1.9E-3					4.3E-4	1.9E-3	3.5E-7	1.5E-6	0.013		2.6E-3	--	2.8E-5
92-52-4	Biphenyl	Y	Y	Y A	4.4E-5	1.9E-4					4.4E-5	1.9E-4			1.9E-4			0.100	--
7440-43-9	Cadmium	Y	Y	Y C	4.6E-4	2.0E-3					4.3E-4	1.9E-3	2.8E-5	1.2E-4	3.8E-3		4.4E-4	--	3.7E-6
75-15-0	Carbon Disulfide	Y	Y	Y A											0.063		0.014	2.000	--
7440-47-3	Chromium	Y	Y	Y A	6.8E-4	2.8E-3					6.3E-4	2.6E-3	4.8E-5	1.6E-4	0.035		7.4E-3	0.033	--
18540-29-9	Cr (VI)	Y	Y	Y C	3.4E-7	1.5E-6							3.4E-7	1.5E-6	1.5E-6		3.4E-7	--	5.6E-7
7440-48-4	Cobalt	Y	Y	Y A	4.7E-4	2.0E-3					4.7E-4	2.0E-3	4.8E-6	1.0E-5	0.016		3.3E-3	3.3E-3	--
592-01-8	Cyanide	Y	Y	Y A	1.2E-3	5.3E-3					1.2E-3	5.3E-3			1.988		0.453	0.333	--
106-46-7	Dichlorobenzene	Y	Y	Y A	5.7E-5	2.3E-4					2.6E-5	9.6E-5	3.1E-5	1.3E-4	2.3E-4		3.1E-5	30.000	--
206-44-0	Fluoranthene	Y	N	n/a	5.5E-6	7.0E-6									7.0E-6			--	--
86-73-7	Fluorene	Y	N	n/a	1.7E-5	2.1E-5									2.1E-5			--	--
50-00-0	Formaldehyde	Y	Y	Y C	3.3E-3	0.015					1.4E-3	6.2E-3	1.9E-3	8.3E-3	0.015		1.9E-3	--	5.1E-4
110-54-3	Hexane	Y	Y	Y A	0.117	0.480					0.070	0.281	0.046	0.198	0.480		0.046	12.000	--
7647-01-0	Hydrogen Chloride	Y	Y	Y A	0.986	3.666					0.986	3.666			3.666			0.050	--
7439-92-1	Lead	Y	N	n/a	4.8E-4	2.1E-3									0.031			--	--
7439-96-5	Manganese	Y	Y	Y A	4.6E-3	0.017					4.4E-3	0.017	1.9E-4	2.2E-4	1.085		0.244	0.067	--
7439-97-6	Mercury	Y	N	n/a	7.1E-4	2.9E-3	6.9E-4	2.8E-3	1.3E-5	5.4E-5					8.6E-3	5.4E-5		--	--
91-20-3	Naphthalene	Y	Y	Y A	2.1E-3	8.8E-3					2.1E-3	8.7E-3	1.6E-5	6.7E-5	8.8E-3		1.6E-5	3.330	--
7440-02-0	Nickel	Y	Y	Y C	5.5E-4	2.4E-3					4.9E-4	2.2E-3	5.6E-5	2.4E-4	9.5E-3		1.7E-3	--	2.7E-5
85-01-8	Phenanthrene	Y	N	n/a	5.1E-5	6.3E-5									6.3E-5			--	--
108-95-2	Phenol	Y	Y	Y A	2.4E-4	1.1E-3					2.4E-4	1.1E-3			1.1E-3			1.270	--
7723-14-0	Phosphorus	Y	Y	Y A	5.6E-3	0.023					5.5E-3	0.023	9.3E-5	6.2E-5	2.343		0.530	7.0E-3	--
129-00-0	Pyrene	Y	N	n/a	5.0E-6	6.6E-6									6.6E-6			--	--
7782-49-2	Selenium	Y	Y	Y A	4.1E-4	1.8E-3					4.1E-4	1.8E-3	6.2E-7	2.6E-6	3.2E-3		3.3E-4	0.013	--
108-88-3	Toluene	Y	Y	Y A	0.032	0.139					0.032	0.139	8.8E-5	3.7E-4	0.139		8.8E-5	25.000	--
1330-20-7	Xylene	Y	Y	Y A	0.032	0.138					0.032	0.138			0.138			29.000	--
7429-90-5	Aluminum	N	Y	N A									0.648	2.577			58.504	0.667	--
7440-39-3	Barium	N	Y	N A									6.8E-3	0.028			0.659	0.033	--
1317-65-3	Calcium Carbonate	N	Y	N A									2.244	8.125			13.652	0.667	--
1305-78-8	Calcium Oxide	N	Y	N A									0.696	0.952			0.696	0.133	--
7440-50-8	Copper	N	Y	N A									5.3E-4	2.2E-3			4.6E-3	0.067	--
110-82-7	Cyclohexane	N	Y	N A									1.0E-3	4.6E-3			1.0E-3	70.000	--
7783-06-4	Hydrogen Sulfide	N	Y	N A									0.900	3.942			0.900	0.933	--
7439-89-6	Iron	N	Y	N A									0.213	0.812			15.043	0.067	--
7439-98-7	Molybdenum	N	Y	N A									4.7E-4	2.0E-3			1.3E-3	0.333	--
109-66-0	Pentane	N	Y	N A									0.123	0.495			0.123	118	--
7440-22-4	Silver	N	Y	N A									4.1E-4	1.8E-3			8.2E-4	7.0E-3	--
7664-93-9	Sulfuric Acid	N	Y	N A									2.030	8.891			2.030	0.067	--
7440-28-0	Thallium	N	Y	N A									5.2E-4	2.2E-3			8.7E-3	7.0E-3	--
7440-61-1	Uranium	N	Y	N A									5.2E-4	2.2E-3			8.7E-3	0.013	--
7440-62-2	Vanadium	N	Y	N A									8.4E-4	3.5E-3			0.024	3.0E-3	--
25551-13-7	Trimethyl benzene	N	Y	N A									0.011	0.048			0.011	8.200	--
7440-33-7	Tungsten	N	Y	N A									5.2E-4	2.2E-3	0		8.7E-3	0.333	--
7440-66-6	Zinc	N	Y	N A									2.2E-3	8.8E-3	0		0.031	0.667	--
HAP TOTAL					*1.200*	*4.566*									*12.564*				
MERCURY TOTAL (exempt)							*6.9E-4*	*2.8E-3*											
MERCURY TOTAL (non-exempt)									*1.3E-5*	*5.4E-5*						*5.4E-5*			
TAP TOTAL (HAP-TAP addressed by NSPS/NESHAP)											*1.150*	*4.353*							
TAP TOTAL (For EL Evaluation)													*6.928*	*26.109*			*93.573*		

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 1 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021

Model Scenario W3 T-RACT Emissions

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	HAP/TAP	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
106-99-0	1,3-Butadiene	8.4E-07	3.7E-06	0	0	0	0	8.4E-07	3.7E-06	Y	Y
91-57-6	2-Methylnaphthalene	1.1E-06	4.6E-06	0	0	0	0	1.1E-06	4.6E-06	Y	N
56-49-5	3-Methylchloranthrene	7.8E-08	3.4E-07	0	0	0	0	7.8E-08	3.4E-07	Y	Y
57-97-6	7,12-Dimethylbenz(a)anthracene	7.6E-07	3.0E-06	0	0	0	0	7.6E-07	3.0E-06	Y	N
83-32-9	Acenaphthene	5.7E-06	7.1E-06	0	0	0	0	5.7E-06	7.1E-06	Y	N
208-96-8	Acenaphthylene	1.1E-05	1.4E-05	0	0	0	0	1.1E-05	1.4E-05	Y	N
75-07-0	Acetaldehyde	2.5E-05	1.1E-04	0	0	0	0	2.5E-05	1.1E-04	Y	Y
107-02-8	Acrolein	1.6E-05	2.0E-05	0	0	0	0	1.6E-05	2.0E-05	Y	Y
120-12-7	Anthracene	1.7E-06	2.4E-06	0	0	0	0	1.7E-06	2.4E-06	Y	N
7440-36-0	Antimony	0	0	5.7E-04	2.5E-03	1.3E-02	5.8E-02	1.4E-02	6.1E-02	Y	Y
7440-38-2	Arsenic	8.7E-06	3.8E-05	4.5E-03	2.0E-02	0.23	1.02	0.24	1.04	Y	Y
56-55-3	Benz(a)anthracene	3.1E-07	1.4E-06	0	0	0	0	3.1E-07	1.4E-06	Y	Y
71-43-2	Benzene	3.6E-04	1.6E-03	7.0E-03	3.1E-02	0	0	7.4E-03	3.2E-02	Y	Y
50-32-8	Benzo(a)pyrene	1.4E-07	6.1E-07	0	0	0	0	1.4E-07	6.1E-07	Y	Y
205-99-2	Benzo(b)fluoranthene	4.4E-07	1.9E-06	0	0	0	0	4.4E-07	1.9E-06	Y	Y
191-24-2	Benzo(g,h,i)perylene	7.5E-07	1.1E-06	0	0	0	0	7.5E-07	1.1E-06	Y	N
207-08-9	Benzo(k)fluoranthene	1.5E-07	6.6E-07	0	0	0	0	1.5E-07	6.6E-07	Y	Y
7440-41-7	Beryllium	5.2E-07	2.3E-06	4.3E-04	1.9E-03	1.9E-03	8.1E-03	2.3E-03	1.0E-02	Y	Y
92-52-4	Biphenyl	0	0	4.4E-05	1.9E-04	0	0	4.4E-05	1.9E-04	Y	Y
7440-43-9	Cadmium	4.8E-05	2.1E-04	4.1E-04	1.8E-03	2.9E-04	1.3E-03	7.5E-04	3.3E-03	Y	Y
75-15-0	Carbon Disulfide	0	0	1.4E-02	6.3E-02	0	0	1.4E-02	6.3E-02	Y	Y
7440-47-3	Chromium	6.6E-05	2.7E-04	6.1E-04	2.5E-03	5.2E-03	2.3E-02	5.9E-03	2.6E-02	Y	Y
18540-29-9	Cr (VI)	0	0	3.4E-07	1.5E-06	0	0	3.4E-07	1.5E-06	Y	Y
218-01-9	Chrysene	5.8E-07	2.5E-06	0	0	0	0	5.8E-07	2.5E-06	Y	Y
7440-48-4	Cobalt	4.0E-06	1.6E-05	4.7E-04	2.0E-03	2.3E-03	1.0E-02	2.8E-03	1.2E-02	Y	Y
592-01-8	Cyanide	0	0	0.45	1.99	0	0	0.45	1.99	Y	Y
53-70-3	Dibenzo(a,h)anthracene	1.8E-07	7.7E-07	0	0	0	0	1.8E-07	7.7E-07	Y	Y
106-46-7	Dichlorobenzene	5.7E-05	2.3E-04	0	0	0	0	5.7E-05	2.3E-04	Y	Y
206-44-0	Fluoranthene	5.5E-06	7.0E-06	0	0	0	0	5.5E-06	7.0E-06	Y	N
86-73-7	Fluorene	1.7E-05	2.1E-05	0	0	0	0	1.7E-05	2.1E-05	Y	N
50-00-0	Formaldehyde	3.3E-03	1.5E-02	0	0	0	0	3.3E-03	1.5E-02	Y	Y
110-54-3	Hexane	8.5E-02	0.34	3.1E-02	0.14	0	0	0.12	0.48	Y	Y
7647-01-0	Hydrogen Chloride	0	0	0.99	3.67	0	0	0.99	**3.67**	Y	Y
193-39-5	Indeno(1,2,3-cd)pyrene	2.2E-07	9.6E-07	0	0	0	0	2.2E-07	9.6E-07	Y	Y
7439-92-1	Lead	0	0	4.8E-04	2.1E-03	4.6E-03	2.0E-02	5.1E-03	2.2E-02	Y	N
7439-96-5	Manganese	1.8E-05	7.2E-05	4.6E-03	1.7E-02	0.17	0.76	0.18	0.78	Y	Y
7439-97-6	Mercury	1.2E-05	5.0E-05	6.9E-04	2.9E-03	1.2E-03	5.1E-03	1.9E-03	8.0E-03	Y	N
91-20-3	Naphthalene	1.9E-04	3.1E-04	1.9E-03	8.5E-03	0	0	2.1E-03	8.8E-03	Y	Y
7440-02-0	Nickel	9.1E-05	4.0E-04	4.6E-04	2.0E-03	1.2E-03	5.1E-03	1.7E-03	7.5E-03	Y	Y
85-01-8	Phenanthrene	5.1E-05	6.3E-05	0	0	0	0	5.1E-05	6.3E-05	Y	N
108-95-2	Phenol	0	0	2.4E-04	1.1E-03	0	0	2.4E-04	1.1E-03	Y	Y
7723-14-0	Phosphorus	0	0	5.6E-03	2.3E-02	0.38	1.65	0.38	1.67	Y	Y
129-00-0	Pyrene	5.0E-06	6.6E-06	0	0	0	0	5.0E-06	6.6E-06	Y	N
7782-49-2	Selenium	1.1E-06	4.6E-06	4.1E-04	1.8E-03	2.3E-04	1.0E-03	6.4E-04	2.8E-03	Y	Y
108-88-3	Toluene	5.2E-04	1.1E-03	3.2E-02	0.14	0	0	3.2E-02	0.14	Y	Y
1330-20-7	Xylene	2.5E-04	3.0E-04	3.1E-02	0.14	0	0	3.2E-02	0.14	Y	Y
Total HAP		9.0E-02	0.36	1.58	6.25	0.81	3.56	2.48	10.17		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

	0.2155	0.8650	8.3307	31.6474	61.0803	267.5316	69.6264	300.0439
TRUE	0.2155	0.8650	8.3307	31.6474	61.0803	267.5316	69.6264	300.0439
	chk	chk	chk-15	chk	chk	chk	chk-14	chk

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary - continued

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**Non-HAP TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
7429-90-5	Aluminum	0	0	0.65	2.58	41.11	180.04	41.75	182.62	N	Y
7440-39-3	Barium	2.1E-04	8.4E-04	6.6E-03	2.7E-02	0.46	2.03	0.47	2.06	N	Y
1317-65-3	Calcium Carbonate	0	0	2.24	8.12	8.11	35.50	10.35	43.63	N	Y
1305-78-8	Calcium Oxide	0	0	0.70	0.95	0	0	0.70	0.95	N	Y
7440-50-8	Copper	4.0E-05	1.6E-04	4.9E-04	2.1E-03	2.9E-03	1.3E-02	3.4E-03	1.5E-02	N	Y
110-82-7	Cyclohexane	0	0	1.0E-03	4.6E-03	0	0	1.0E-03	4.6E-03	N	Y
7783-06-4	Hydrogen Sulfide	0	0	0.90	3.94	0	0	0.90	3.94	N	Y
7439-89-6	Iron	0	0	0.21	0.81	10.54	46.15	10.75	46.96	N	Y
7439-98-7	Molybdenum	5.2E-05	2.1E-04	4.2E-04	1.8E-03	5.8E-04	2.5E-03	1.0E-03	4.6E-03	N	Y
109-66-0	Pentane	0.12	0.50	0	0	0	0	0.12	0.50	N	Y
7440-22-4	Silver	0	0	4.1E-04	1.8E-03	2.9E-04	1.3E-03	7.0E-04	3.1E-03	N	Y
7664-93-9	Sulfuric Acid	0	0	2.03	8.89	0	0	2.03	8.89	N	Y
7440-28-0	Thallium	0	0	5.2E-04	2.2E-03	5.8E-03	2.5E-02	6.3E-03	2.8E-02	N	Y
7440-61-1	Uranium	0	0	5.2E-04	2.2E-03	5.8E-03	2.5E-02	6.3E-03	2.8E-02	N	Y
7440-62-2	Vanadium	1.1E-04	4.4E-04	7.3E-04	3.0E-03	1.6E-02	7.1E-02	1.7E-02	7.4E-02	N	Y
25551-13-7	Trimethyl benzene	0	0	1.1E-02	4.8E-02	0	0	1.1E-02	4.8E-02	N	Y
7440-33-7	Tungsten	0	0	5.2E-04	2.2E-03	5.8E-03	2.5E-02	6.3E-03	2.8E-02	N	Y
7440-66-6	Zinc	1.4E-03	5.5E-03	8.0E-04	3.3E-03	2.0E-02	8.9E-02	2.2E-02	9.8E-02	N	Y
Total Non-HAP TAP		0.13	0.50	6.75	25.40	60.27	263.98	67.15	289.88		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

Conversions
2,000 lb/ton
8,760 hr/yr
24 hr/day

PROPANE COMBUSTION

Source Data

Source ID	Description	MMBtu/day	MMBtu/yr
Lime Process Heating			
LKC	PFR Shaft Lime Kiln Combustion	529.0	163,935
Ore Process Heating			
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	17.0	510
CKB	Carbon Regeneration Kiln (Burners)	54.1	19,754
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	2.4	876
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	120.0	43,800
Subtotal		193.5	64,940
HVAC			
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	96.0	35,040
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	96.0	35,040
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	96.0	35,040
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	12.0	4,380
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	48.0	17,520
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	72.0	26,280
Subtotal		438.0	159,870

PROPANE COMBUSTION - CONTINUED

HAP/TAP Emission Factors and Emissions

O.Heat_pph O.Heat_tpy L.Heat_pph L.Heat_tpy HVAC_pph HVAC_tpy lb/hr ton/yr

		Emission Factor[2]		Emissions[1] Ore Proc Heat		Lime Proc Heat		HVAC		Total			
CAS	Pollutant	lb/MMscf	lb/MMBtu[3]	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	TAP	A/C
91-57-6	2-Methylnaphthalene	2.4E-05	2.35E-8	1.9E-07	7.6E-07	5.2E-07	1.9E-06	4.3E-07	1.9E-06	1.1E-06	4.6E-06	N	
56-49-5	3-Methylchloranthrene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
57-97-6	7,12-Dimethylbenz(a)ant	< 1.6E-05	1.57E-8	1.3E-07	5.1E-07	3.5E-07	1.3E-06	2.9E-07	1.3E-06	7.6E-07	3.0E-06	N	
83-32-9	Acenaphthene	< 1.8E-06	1.76E-9	1.4E-08	5.7E-08	3.9E-08	1.4E-07	3.2E-08	1.4E-07	8.5E-08	3.4E-07	N	
208-96-8	Acenaphthylene	< 1.8E-06	1.76E-9	1.4E-08	5.7E-08	3.9E-08	1.4E-07	3.2E-08	1.4E-07	8.5E-08	3.4E-07	N	
120-12-7	Anthracene	< 2.4E-06	2.35E-9	1.9E-08	7.6E-08	5.2E-08	1.9E-07	4.3E-08	1.9E-07	1.1E-07	4.6E-07	N	
7440-38-2	Arsenic	2.0E-04	1.96E-7	1.5E-06	6.4E-06	3.7E-06	1.6E-05	3.6E-06	1.6E-05	8.7E-06	3.8E-05	Y	C
56-55-3	Benz(a)anthracene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
71-43-2	Benzene	2.1E-03	2.06E-6	1.5E-05	6.7E-05	3.9E-05	1.7E-04	3.8E-05	1.6E-04	9.1E-05	4.0E-04	Y	C
50-32-8	Benzo(a)pyrene	< 1.2E-06	1.18E-9	8.7E-09	3.8E-08	2.2E-08	9.6E-08	2.1E-08	9.4E-08	5.2E-08	2.3E-07	Y	C
205-99-2	Benzo(b)fluoranthene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
191-24-2	Benzo(g,h,i)perylene	< 1.2E-06	1.18E-9	9.5E-09	3.8E-08	2.6E-08	9.6E-08	2.1E-08	9.4E-08	5.7E-08	2.3E-07	N	
207-08-9	Benzo(k)fluoranthene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
7440-41-7	Beryllium	< 1.2E-05	1.18E-8	8.7E-08	3.8E-07	2.2E-07	9.6E-07	2.1E-07	9.4E-07	5.2E-07	2.3E-06	Y	C
7440-43-9	Cadmium	1.1E-03	1.08E-6	8.0E-06	3.5E-05	2.0E-05	8.8E-05	2.0E-05	8.6E-05	4.8E-05	2.1E-04	Y	C
7440-47-3	Chromium	1.4E-03	1.37E-6	1.1E-05	4.5E-05	3.0E-05	1.1E-04	2.5E-05	1.1E-04	6.6E-05	2.7E-04	Y	A
218-01-9	Chrysene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
7440-48-4	Cobalt	8.4E-05	8.24E-8	6.6E-07	2.7E-06	1.8E-06	6.8E-06	1.5E-06	6.6E-06	4.0E-06	1.6E-05	Y	A
53-70-3	Dibenzo(a,h)anthracene	< 1.2E-06	1.18E-9	8.7E-09	3.8E-08	2.2E-08	9.6E-08	2.1E-08	9.4E-08	5.2E-08	2.3E-07	Y	C
106-46-7	Dichlorobenzene	1.2E-03	1.18E-6	9.5E-06	3.8E-05	2.6E-05	9.6E-05	2.1E-05	9.4E-05	5.7E-05	2.3E-04	Y	A
206-44-0	Fluoranthene	3.0E-06	2.94E-9	2.4E-08	9.5E-08	6.5E-08	2.4E-07	5.4E-08	2.4E-07	1.4E-07	5.7E-07	N	
86-73-7	Fluorene	2.8E-06	2.75E-9	2.2E-08	8.9E-08	6.1E-08	2.3E-07	5.0E-08	2.2E-07	1.3E-07	5.3E-07	N	
50-00-0	Formaldehyde	7.5E-02	7.35E-5	5.5E-04	2.4E-03	1.4E-03	6.0E-03	1.3E-03	5.9E-03	3.3E-03	1.4E-02	Y	C
110-54-3	Hexane	1.8E+00	1.76E-3	1.4E-02	5.7E-02	3.9E-02	1.4E-01	3.2E-02	1.4E-01	8.5E-02	3.4E-01	Y	A
193-39-5	Indeno(1,2,3-cd)pyrene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
7439-96-5	Manganese	3.8E-04	3.73E-7	3.0E-06	1.2E-05	8.2E-06	3.1E-05	6.8E-06	3.0E-05	1.8E-05	7.2E-05	Y	A
7439-97-6	Mercury	2.6E-04	2.55E-7	2.1E-06	8.3E-06	5.6E-06	2.1E-05	4.7E-06	2.0E-05	1.2E-05	5.0E-05	N	
91-20-3	Naphthalene	6.1E-04	5.98E-7	4.8E-06	1.9E-05	1.3E-05	4.9E-05	1.1E-05	4.8E-05	2.9E-05	1.2E-04	Y	A
7440-02-0	Nickel	2.1E-03	2.06E-6	1.5E-05	6.7E-05	3.9E-05	1.7E-04	3.8E-05	1.6E-04	9.1E-05	4.0E-04	Y	C
85-01-8	Phenanthrene	1.7E-05	1.67E-8	1.3E-07	5.4E-07	3.7E-07	1.4E-06	3.0E-07	1.3E-06	8.1E-07	3.2E-06	N	
129-00-0	Pyrene	5.0E-06	4.90E-9	4.0E-08	1.6E-07	1.1E-07	4.0E-07	8.9E-08	3.9E-07	2.4E-07	9.5E-07	N	
7782-49-2	Selenium	< 2.4E-05	2.35E-8	1.9E-07	7.6E-07	5.2E-07	1.9E-06	4.3E-07	1.9E-06	1.1E-06	4.6E-06	Y	A
108-88-3	Toluene	3.4E-03	3.33E-6	2.7E-05	1.1E-04	7.3E-05	2.7E-04	6.1E-05	2.7E-04	1.6E-04	6.5E-04	Y	A
109-66-0	Pentane	2.6E+00	2.55E-3	2.1E-02	8.3E-02	5.6E-02	2.1E-01	4.7E-02	2.0E-01	1.2E-01	5.0E-01	Y	A
7440-39-3	Barium	4.4E-03	4.31E-6	3.5E-05	1.4E-04	9.5E-05	3.5E-04	7.9E-05	3.4E-04	2.1E-04	8.4E-04	Y	A
7440-50-8	Copper	8.5E-04	8.33E-7	6.7E-06	2.7E-05	1.8E-05	6.8E-05	1.5E-05	6.7E-05	4.0E-05	1.6E-04	Y	A
7439-98-7	Molybdenum	1.1E-03	1.08E-6	8.7E-06	3.5E-05	2.4E-05	8.8E-05	2.0E-05	8.6E-05	5.2E-05	2.1E-04	Y	A
7440-62-2	Vanadium	2.3E-03	2.25E-6	1.8E-05	7.3E-05	5.0E-05	1.8E-04	4.1E-05	1.8E-04	1.1E-04	4.4E-04	Y	A
7440-66-6	Zinc	2.9E-02	2.84E-5	2.3E-04	9.2E-04	6.3E-04	2.3E-03	5.2E-04	2.3E-03	1.4E-03	5.5E-03	Y	A
Total				3.6E-02	1.4E-01	9.8E-02	3.6E-01	8.1E-02	3.5E-01	2.1E-01	8.6E-01		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *AP-42, Table 1.4-3 & 1.4-4 (7/98) Natural Gas Combustion* 1.0766 1.0766

(3) *Natural Gas Higher Heating Value* 1,020 *MMBtu/MMscf* chk

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis	
	PROJECT NO: 335-20-3	PAGE: 5	OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021	

DIESEL COMBUSTION

Source Data

Source ID	Description	Power Rating kW	Power Rating hp	Operation hr/day	Operation hr/yr	Fuel Consumption[1] & [2] MMBtu/day	Fuel Consumption[1] & [2] MMBtu/yr
EDG1	Camp Emergency Generator	1,000	1,341	1	100	9.39	938.70
EDG2	Plant Emergency Generator #1	1,000	1,341	1	100	9.39	938.7
EDG3	Plant Emergency Generator #2	1,000	1,341	1	100	9.39	938.7
EDFP	Mill Fire Pump	200	268	1	100	1.88	187.7
Total						30.0	3,003.8

[1] *Based on brake specific fuel consumption for diesel generators* 7,000 *Btu/hp-hr* *AP-42 Tbl 3.3-1*

[2] *Heat Content of* 0.137 *MMBtu/gal* 1E+6 *Btu/MMBtu* 1.341 *hp/kW*

HAP/TAP Emission Factors and Emissions

	Pollutant	Factor (lb/MMBtu) ≤600 hp[2]	Factor (lb/MMBtu) >600hp[3]	Emissions (≤600 hp) lb/hr	Emissions (≤600 hp) ton/yr	Emissions (>600 hp) lb/hr	Emissions (>600 hp) ton/yr	Total Emissions[1] lb/hr	Total Emissions[1] ton/yr	TAP	A/C
106-99-0	1,3-Butadiene	< 3.9E-05		8.4E-07	3.7E-06	0.0E+00	0.0E+00	8.4E-07	3.7E-06	Y	C
83-32-9	Acenaphthene	< 1.4E-06	4.7E-06	1.1E-07	1.3E-07	5.5E-06	6.6E-06	5.6E-06	6.7E-06	N	
208-96-8	Acenaphthylene	< 5.1E-06	9.2E-06	4.0E-07	4.7E-07	1.1E-05	1.3E-05	1.1E-05	1.3E-05	N	
75-07-0	Acetaldehyde	7.7E-04	2.5E-05	1.6E-05	7.2E-05	8.1E-06	3.5E-05	2.5E-05	1.1E-04	Y	C
107-02-8	Acrolein	< 9.3E-05	7.9E-06	7.2E-06	8.7E-06	9.2E-06	1.1E-05	1.6E-05	2.0E-05	Y	A
120-12-7	Anthracene	1.9E-06	1.2E-06	1.5E-07	1.8E-07	1.4E-06	1.7E-06	1.6E-06	1.9E-06	N	
56-55-3	Benz(a)anthracene	1.7E-06	6.2E-07	3.6E-08	1.6E-07	2.0E-07	8.8E-07	2.4E-07	1.0E-06	Y	C
71-43-2	Benzene	9.3E-04	7.8E-04	2.0E-05	8.8E-05	2.5E-04	1.1E-03	2.7E-04	1.2E-03	Y	C
50-32-8	Benzo(a)pyrene	< 1.9E-07	< 2.6E-07	4.0E-09	1.8E-08	8.3E-08	3.6E-07	8.7E-08	3.8E-07	Y	C
205-99-2	Benzo(b)fluoranthene	< 9.9E-08	< 1.1E-06	2.1E-09	9.3E-09	3.6E-07	1.6E-06	3.6E-07	1.6E-06	Y	C
191-24-2	Benzo(g,h,i)perylene	< 4.9E-07	< 5.6E-07	3.8E-08	4.6E-08	6.5E-07	7.8E-07	6.9E-07	8.3E-07	N	
207-08-9	Benzo(k)fluoranthene	< 1.6E-07	< 2.2E-07	3.3E-09	1.5E-08	7.0E-08	3.1E-07	7.3E-08	3.2E-07	Y	C
218-01-9	Chrysene	3.5E-07	1.5E-06	7.6E-09	3.3E-08	4.9E-07	2.2E-06	5.0E-07	2.2E-06	Y	C
53-70-3	Dibenzo(a,h)anthracene	< 5.8E-07	< 3.5E-07	1.2E-08	5.5E-08	1.1E-07	4.9E-07	1.2E-07	5.4E-07	Y	C
206-44-0	Fluoranthene	7.6E-06	4.0E-06	6.0E-07	7.1E-07	4.7E-06	5.7E-06	5.3E-06	6.4E-06	N	
86-73-7	Fluorene	2.9E-05	1.3E-05	2.3E-06	2.7E-06	1.5E-05	1.8E-05	1.7E-05	2.1E-05	N	
50-00-0	Formaldehyde	1.2E-03	7.9E-05	2.5E-05	1.1E-04	2.5E-05	1.1E-04	5.1E-05	2.2E-04	Y	C
193-39-5	Indeno(1,2,3-cd)pyrene	< 3.8E-07	< 4.1E-07	8.0E-09	3.5E-08	1.3E-07	5.8E-07	1.4E-07	6.2E-07	Y	C
91-20-3	Naphthalene	8.5E-05	1.3E-04	6.6E-06	8.0E-06	1.5E-04	1.8E-04	1.6E-04	1.9E-04	Y	A
85-01-8	Phenanthrene	2.9E-05	4.1E-05	2.3E-06	2.8E-06	4.8E-05	5.7E-05	5.0E-05	6.0E-05	N	
129-00-0	Pyrene	4.8E-06	3.7E-06	3.7E-07	4.5E-07	4.4E-06	5.2E-06	4.7E-06	5.7E-06	N	
108-88-3	Toluene	4.1E-04	2.8E-04	3.2E-05	3.8E-05	3.3E-04	4.0E-04	3.6E-04	4.3E-04	Y	A
1330-20-7	Xylene	2.9E-04	1.9E-04	2.2E-05	2.7E-05	2.3E-04	2.7E-04	2.5E-04	3.0E-04	Y	A
Total				1.4E-04	3.6E-04	1.1E-03	2.2E-03	1.2E-03	2.6E-03		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *AP-42, Tab. 3.3-2, 10/96, diesel engines (≤ 600 hp)*

[3] *AP-42, Tabs. 3.4-3 & 3.4-4, 10/96, large diesel engines (> 600 hp)*

ORE PROCESSING

Source Data

Source ID	Description	PM Emissions lb/day	PM Emissions ton/yr
OC1	Loader Transfer of Ore to Grizzly	3.500	0.639
OC2	Grizzly to Apron Feeder	3.500	0.639
OC3	Apron Feeder to Dribble Conveyor	3.500	0.639
OC4	Apron Feeder to Vibrating Grizzly	3.500	0.639
OC5	Dribble Conveyor to Vibrating Grizzly	3.500	0.639
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	3.500	0.639
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	30.000	5.475
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	3.500	0.639
OC9	Stockpile Transfers to Reclaim Conveyors	16.560	3.022
OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	16.560	3.022
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	16.560	3.022
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge C	33.120	6.044
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	3.864	0.705
Total		141.164	25.762

HAP/TAP Emission Factors and Emissions

CAS No.	Pollutant	Concentration ppm[2]	Emissions[1] lb/hr	Emissions[1] ton/yr	TAP	A/C
7440-38-2	Arsenic	667	3.9E-03	1.7E-02	Y	C
7440-41-7	Beryllium	3.2	1.9E-05	8.2E-05	Y	C
7440-43-9	Cadmium	0.50	2.9E-06	1.3E-05	Y	C
7440-48-4	Cobalt	4	2.4E-05	1.0E-04	Y	A
7440-47-3	Chromium	9	5.3E-05	2.3E-04	Y	A
7439-97-6	Mercury [3]	0.96	5.6E-06	2.5E-05	N	
7439-96-5	Manganese	299	1.8E-03	7.7E-03	Y	A
7440-02-0	Nickel	2	1.2E-05	5.2E-05	Y	C
7439-92-1	Lead	8	4.7E-05	2.1E-04	N	
7440-36-0	Antimony	23	1.4E-04	5.9E-04	Y	A
7723-14-0	Phosphorus	650	3.8E-03	1.7E-02	Y	A
7782-49-2	Selenium [4]	0.40	2.4E-06	1.0E-05	Y	A
7440-22-4	Silver	0.50	2.9E-06	1.3E-05	Y	A
7429-90-5	Aluminum	71,000	4.2E-01	1.8E+00	Y	A
7440-39-3	Barium	800	4.7E-03	2.1E-02	Y	A
1317-65-3	Calcium Carbonate	14,000	8.2E-02	3.6E-01	Y	A
7440-50-8	Copper	5	2.9E-05	1.3E-04	Y	A
7439-89-6	Iron [4]	18,200	1.1E-01	4.7E-01	Y	A
7439-98-7	Molybdenum	1	5.9E-06	2.6E-05	Y	A
7440-28-0	Thallium	10	5.9E-05	2.6E-04	Y	A
7440-61-1	Uranium	10	5.9E-05	2.6E-04	Y	A
7440-62-2	Vanadium	28	1.6E-04	7.2E-04	Y	A
7440-33-7	Tungsten	10	5.9E-05	2.6E-04	Y	A
7440-66-6	Zinc	35	2.1E-04	9.0E-04	Y	A
Total			6.2E-01	2.7E+00		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *(Midas Gold 2017c)* *Median concentration of 55,000 SGP samples.*

[3] *(Midas Gold 2018e)* *Median ore concentration of 151,000 SGP samples; resource block model.*

[4] *(Midas Gold 2020)* *Median concentration of 56,000 SGP samples for Fe and 1,500 SGP samples for Se.*

1E+6 parts/ppm

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 7 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021

ORE CONCETRATION AND REFINING

Source Data

Source ID	Description	Subpart 7E Allowable Limit lb/yr[1]	Oper. hr/yr	% of Subpart 7E for Controlled Systems %		Controlled Hg Emissions lb/hr	ton/yr	lb/yr
AC	Autoclave	213.4	8,760	[2]		0.000023	0.00010	0.20
EW,MR,MF,CKD	Refinery Sources (C. Kiln, EW, Retort, Furn	16.8		20%	[3]	0.000384	0.00168	3.36
7439-97-6 Mercury	Total	230.2				0.000407	0.00178	3.56

[1] *Subpart 7E Limit - Ore Pretreatment Processes (CFR 2018b)*

$$\frac{84\ lb}{MMton} \times \frac{2{,}540{,}400\ ton}{yr} \times \frac{MMton}{1.0E{+}6\ ton} = \frac{213.4\ lb}{yr}$$

[1] *Subpart 7E Limit - Carbon Processes with Mercury Retorts*

$$\frac{0.8\ lb}{ton} \times \frac{21\ ton}{yr} = \frac{16.8\ lb}{yr}$$

[2] *Controlled SysCAD modeled emissions from Autoclave:* 0.0105 g/hr 2.3E-05 lb/hr 0.20 lb/yr (M3 2019)

[3] *Based on similar source (but with much higher ore Hg content) Hg reporting levels provided below:*

Goldstrike Refinery (2015 & 2016 Hg Reports) (NDEP 2015a) (NDEP 2016)

$$\frac{28.79\ lb}{yr} \times \frac{yr}{251.00\ ton} = \frac{0.11\ lb}{MMton} \times \frac{ton}{0.8\ lb} = 14.3\%$$

Twin Creeks Refinery (2015 & 2016 Hg Reports) (NDEP 2015a) (NDEP 2016)

$$\frac{31.27\ lb}{yr} \times \frac{yr}{142.77\ ton} = \frac{0.22\ lb}{MMton} \times \frac{ton}{0.8\ lb} = 27.4\%$$

HAP/TAP Emission Factors and Emission

AC_pph AC_tpy Refin_pph Refin_tpy lb/hr ton/yr

CAS No.	Pollutant	Emission Factor[1]	Autoclave lb/hr	Autoclave ton/yr	Refinery lb/hr	Refinery ton/yr	Total Emissions lb/hr	Total Emissions ton/yr	TAP	A/C
7440-38-2	Arsenic	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	C
7440-41-7	Beryllium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	C
7440-43-9	Cadmium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	C
7440-48-4	Cobalt	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-47-3	Chromium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7439-97-6	Mercury	see above	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	N	
7439-96-5	Manganese	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-02-0	Nickel	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	C
7439-92-1	Lead	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	N	
7440-36-0	Antimony	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7723-14-0	Phosphorus	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7782-49-2	Selenium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-22-4	Silver	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7429-90-5	Aluminum	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-39-3	Barium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
1317-65-3	Calcium Carbonate	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-50-8	Copper	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7439-89-6	Iron	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7439-98-7	Molybdenum	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-28-0	Thallium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-61-1	Uranium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-62-2	Vanadium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-33-7	Tungsten	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-66-6	Zinc	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
Total			5.5E-04	2.4E-03	9.2E-03	4.0E-02	9.8E-03	4.3E-02		

[1] *Hg is the most difficult metal to control due to it existing in both particulate and gaseous form. Therefore, all other metals are conservatively estimated to be equal to or less than the Hg emissions.*

0.0525 0.0525 chk

7664-93-9	Sulfuric Acid	Autoclave	2.03	8.89			2.03	8.89
7783-06-4	Hydrogen Sulfid	Autoclave	0.90	3.94			0.90	3.94
592-01-8	Cyanide	Point Sources - 5 EW Cells			0.0012	0.0053	0.00	0.01
Total			2.93	12.84	0.01	0.05	2.94	12.88

ORE CONCETRATION AND REFINING - CONTINUED

Source Data

Source ID	Description	Throughput ton/day	Throughput ton/yr	Operation hr/day	Operation hr/yr
AC	Autoclave	6,960	2,540,400	24	8,760

Autoclave HAP/TAP Emission Factors and Emission lb/hr ton/yr

CAS No.	Pollutant	Emission Factor		Emissions[1] lb/hr	Emissions[1] ton/yr
7664-93-9	Sulfuric Acid	0.007	lb/ton[2]	2.03	8.89
7783-06-4	Hydrogen Sulfide	0.9	lb/hr[3]	0.90	3.94

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *H2SO4 is based on Acidic Autoclave test data (APT 2010)*

[3] *H2S is based on Acidic Autoclave test data (APT 2013)*

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 9 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021

LEACHING OPERATION

Cyanide (HCN) Source Data, Emission Factors, and Emissions

Source ID	Description	Dia. ft[1]	pH[1]	Free CN- g/m3[1]	T C[1]	pKa	a0	H	kG[2] m/s	Fa*Fw	g/s	lb/hr	ton/yr
												lb/hr	ton/yr
TSF	***Fugitive Sources***												
TSF	Tailings Maint. Pond	76	7.75	1	3.74	9.803	0.9912	0.0025	1.89E-05	0.641	1.27E-05	0.0001	0.0004
MILLTA	CN Detox Tank 1	40	8.5	25	25	9.250	0.8490	0.0055	0.000311	0.688	0.002891	0.0229	0.101
MILLTA	CN Detox Tank 2	40	8.5	25	25	9.250	0.8490	0.0055	0.000311	0.688	0.002891	0.0229	0.101
MILLTA	CIP Leach Tank 1	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	0.0114	0.050
MILLTA	CIP Leach Tank 2	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	0.0114	0.050
MILLTA	CIP Leach Tank 3	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	0.0114	0.050
MILLTA	CIP Leach Tank 4	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	0.0114	0.050
MILLTA	CIL Tank 1	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIL Tank 2	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIL Tank 3	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIL Tank 4	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIL Tank 5	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIL Tank 6	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIP Tank 1	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA	CIP Tank 2	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA	CIP Tank 3	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA	CIP Tank 4	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA	CIP Tank 5	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA	CIP Tank 6	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
		Acres[1]											
TSF	Tails, Aqueous Surface	110.222	7.75	1	3.74	9.803	0.9912	0.0025	1.89E-05	0.421	0.008845	0.0702	0.307
TSF	Tails, Wet Sediment	110.222							5.31E-08	0.421	0.009961	0.0791	0.346
TSF	Tails, Dry Sediment	110.222							2.33E-08	1	0.010375	0.0823	0.361
		330.666											
592-01-8	Cyanide Fugitive Sources - Subtotal											0.4527	1.983
75-15-0	Carbon Disulfide											0.01446	0.06332
	Point Sources												
EW	EW Cells	[3]										0.0006	0.003
EW	Preg/Barren Tanks	[3]										0.0006	0.003
592-01-8	Cyanide Point Sources - Subtotal											0.0012	0.0053
	Total											0.454	1.988

[1] *(Midas Gold 2016)(M3 2017c)(M3 2017d)*

[2] *The emission factors and caculation methodology are from the EPA directed HCN study: (Card, T. 2009)(EPA 2009)(Schmidt 2010)*

[3] *(APT 2009)*

Carbon Disulfide Emissions from Xanthate Decomposition

CAS No.	Pollutant	Xanthate[1] ton/yr	Molar Decomp.[2]	CS_2 MW Ratio	Temperature Adj. Factor[3]	Emissions lb/hr	Emissions ton/yr
						lb/hr	ton/yr
75-15-0	Carbon Disulfide	1,700	0.99%	0.376	1%	0.0145	0.063

	MW	
Xanthate (PAX)	202.37	$C6H11KOS_2$
Carbon disulfide	76.139	CS_2

[1] *(Midas Gold 2016) p. 12-11*

[2] *(Air Sciences 2020) molar decomposition of xanthate in solution to CS2 gas*

[3] *(Air Sciences 2020) based on the comparison of CS2 generation at 25C and 70C*

Conversions

8,760	hr/yr	453.5929	g/lb
2,000	lb/ton	3.28084	ft/m
4,046.86	m2/acre	3,600	s/hr

Wind adjustment factor Fw 1

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis		
	PROJECT NO: 335-20-3	PAGE: 10	OF: 19	SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021		

LIME PRODUCTION

Source Data

Source ID	Description	Throughput ton/day	Throughput ton/yr	PM Emissions lb/day	PM Emissions ton/yr
LS1	Limestone transfer to Primary Crusher Hopper			3.39	0.48
LS2	Primary Crushing and Associated Transfers In and Out			6.10	0.86
LS3	Primary Screening and Associated Transfers In and Out			28.25	3.97
LS4	Secondary Crushing and Associated Transfers In and Out			6.10	0.86
LS5	Secondary Screening and Associated Transfers In and Out			28.25	3.97
LS6	Limestone transfer to Ball Mill Feed Bin			3.39	0.48
LS7	Limestone transfer to Ball Mill Feed Conveyor			3.39	0.48
LS8	Ball Mill Feed transfer to Ball Mill			3.39	0.48
LSBM	Limestone Ball Mill			45.65	6.42
LS9	Limestone transfer to Kiln Feed Bin			0.80	0.12
LS10	Limestone transfer to Lime Kiln Feed Conveyor			0.80	0.12
LS11	Fines Screening and Associated Transfers In and Out			6.68	1.03
Subtotal LS1-11				136.18	19.28
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln			0.80	0.12
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	169	52,377	21.97	3.40
Subtotal LS12,LK				22.77	3.53
Total				158.95	22.80

HAP/TAP Emission Factors and Emissions

			LS_pph	LS_tpy	LS12_pph	LS12_tpy	LK_pph	LK_tpy	lb/hr	ton/yr		
		Concentration	LS1-11,LSBM		LS12		Lime Kiln		Emissions[1]			
CAS No.	Pollutant	ppm[2]	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	TAP	A/C
7440-38-2	Arsenic	23	1.01E-04	4.43E-04	6.51E-07	2.85E-06	1.79E-05	7.83E-05	1.20E-04	5.24E-04	Y	C
7440-41-7	Beryllium	0.8	3.52E-06	1.54E-05	2.27E-08	9.92E-08	6.22E-07	2.72E-06	4.17E-06	1.82E-05	Y	C
7440-43-9	Cadmium	0.25	1.10E-06	4.82E-06	7.08E-09	3.10E-08	1.94E-07	8.51E-07	1.30E-06	5.70E-06	Y	C
7440-48-4	Cobalt	4	2.27E-05	7.71E-05	1.34E-07	4.96E-07	3.66E-06	1.36E-05	2.65E-05	9.12E-05	Y	A
7440-47-3	Chromium	15	8.51E-05	2.89E-04	5.01E-07	1.86E-06	1.37E-05	5.11E-05	9.93E-05	3.42E-04	Y	A
7439-97-6	Mercury [3]	0.02	1.13E-07	3.86E-07	6.68E-10	2.48E-09	2.82E-04	1.05E-03	2.82E-04	1.05E-03	N	
7439-96-5	Manganese	236.5	1.34E-03	4.56E-03	7.89E-06	2.93E-05	2.16E-04	8.05E-04	1.57E-03	5.39E-03	Y	A
7440-02-0	Nickel	5	2.20E-05	9.64E-05	1.42E-07	6.20E-07	3.89E-06	1.70E-05	2.60E-05	1.14E-04	Y	C
7439-92-1	Lead	3	1.70E-05	5.78E-05	1.00E-07	3.72E-07	2.75E-06	1.02E-05	1.99E-05	6.84E-05	N	
7440-36-0	Antimony	2.5	1.42E-05	4.82E-05	8.34E-08	3.10E-07	2.29E-06	8.51E-06	1.66E-05	5.70E-05	Y	A
7723-14-0	Phosphorus	130	7.38E-04	2.51E-03	4.34E-06	1.61E-05	1.19E-04	4.43E-04	8.61E-04	2.96E-03	Y	A
7440-22-4	Silver	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	Y	A
7429-90-5	Aluminum	22600	1.28E-01	4.36E-01	7.54E-04	2.80E-03	2.07E-02	7.69E-02	1.50E-01	5.15E-01	Y	A
7440-39-3	Barium	145	8.23E-04	2.79E-03	4.84E-06	1.80E-05	1.33E-04	4.94E-04	9.60E-04	3.31E-03	Y	A
1317-65-3	Calcium Carbonate	274500	1.56E+00	5.29E+00	9.16E-03	3.40E-02	2.51E-01	9.35E-01	1.82E+00	6.26E+00	Y	A
7440-50-8	Copper	5	2.84E-05	9.64E-05	1.67E-07	6.20E-07	4.58E-06	1.70E-05	3.31E-05	1.14E-04	Y	A
7439-89-6	Iron	10350	5.87E-02	1.99E-01	3.45E-04	1.28E-03	9.47E-03	3.52E-02	6.85E-02	2.36E-01	Y	A
7439-98-7	Molybdenum	0.5	2.84E-06	9.64E-06	1.67E-08	6.20E-08	4.58E-07	1.70E-06	3.31E-06	1.14E-05	Y	A
7440-28-0	Thallium	5	2.84E-05	9.64E-05	1.67E-07	6.20E-07	4.58E-06	1.70E-05	3.31E-05	1.14E-04	Y	A
7440-61-1	Uranium	5	2.84E-05	9.64E-05	1.67E-07	6.20E-07	4.58E-06	1.70E-05	3.31E-05	1.14E-04	Y	A
7440-62-2	Vanadium	15.5	8.79E-05	2.99E-04	5.17E-07	1.92E-06	1.42E-05	5.28E-05	1.03E-04	3.53E-04	Y	A
7440-33-7	Tungsten	5	2.84E-05	9.64E-05	1.67E-07	6.20E-07	4.58E-06	1.70E-05	3.31E-05	1.14E-04	Y	A
7440-66-6	Zinc	18	1.02E-04	3.47E-04	6.01E-07	2.23E-06	1.65E-05	6.13E-05	1.19E-04	4.10E-04	Y	A
Subtotal			1.75E+00	5.94E+00	1.03E-02	3.82E-02	2.82E-01	1.05E+00	2.04E+00	7.03E+00	9.0667	9.0667
7647-01-0	Hydrogen Chloride	0.14 lb/ton product[4]					0.99	3.67	0.99	3.67		chk

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *(M3 2018) Median concentrations of SGP limestone material. Metals with medians below the detection limit (DL) are set to 1/2DL.*

[3] *Hg emissions from the Lime Kiln are conservatively estimated assuming 100% volatilization of all Hg in the limestone*

[4] *(EPA 1999b)*

1E+6 parts/ppm

LIME PRODUCTION - CONTINUED

Source Data

PM_ppd PM_tpy

Source ID	description Description	PM Emissions lb/day	ton/yr
LS1L	Mill Lime Silo #1 Loading	0.248	0.002
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	1.200	0.011
MillS2L	Mill Lime Silo #2 Loading	0.248	0.002
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	1.200	0.011
ACS1L	AC Lime Silo #1 Loading	0.990	0.009
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.304	0.042
ACS2L	AC Lime Silo #2 Loading	0.990	0.009
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.304	0.042
ACS3L	AC Lime Silo #3 Loading	0.990	0.009
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.304	0.042
ACS4L	AC Lime Silo #4 Loading	0.495	0.004
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	2.304	0.021
Subtotal - Mill & AC Lime Silos		15.576	0.203
LCR	Lime Mill Crushing and associated transfers In and Out	6.828	1.058
LSL	Pebble Lime Silo Loading via Bucket Elevator	0.149	0.023
LSU	Pebble Lime Silo discharge to Lime Slaker	0.015	0.002
Subtotal - Lime Mfg		6.991	1.083
Total		22.567	1.286

HAP/TAP Emission Factors and Emissions

MillAC_pph MillAC_tpy LimeM_pph LimeM_tpy lb/hr ton/yr

CAS No.	Pollutant	Concentration ppm[2]	Mill and AC lb/hr	Mill and AC ton/yr	Lime Mfg lb/hr	Lime Mfg ton/yr	Emissions[1] lb/hr	Emissions[1] ton/yr	TAP	A/C
7440-38-2	Arsenic	23	1.06E-06	4.66E-06	5.69E-06	2.49E-05	6.75E-06	2.96E-05	Y	C
7440-41-7	Beryllium	0.8	3.70E-08	1.62E-07	1.98E-07	8.67E-07	2.35E-07	1.03E-06	Y	C
7440-43-9	Cadmium	0.25	1.16E-08	5.07E-08	6.18E-08	2.71E-07	7.34E-08	3.22E-07	Y	C
7440-48-4	Cobalt	4	2.60E-06	8.11E-07	1.17E-06	4.33E-06	3.76E-06	5.14E-06	Y	A
7440-47-3	Chromium	15	9.74E-06	3.04E-06	4.37E-06	1.63E-05	1.41E-05	1.93E-05	Y	A
7439-97-6	Mercury	0.02	1.30E-08	4.05E-09	5.83E-09	2.17E-08	1.88E-08	2.57E-08	N	
7439-96-5	Manganese	236.5	1.53E-04	4.79E-05	6.89E-05	2.56E-04	2.22E-04	3.04E-04	Y	A
7440-02-0	Nickel	5	2.31E-07	1.01E-06	1.24E-06	5.42E-06	1.47E-06	6.43E-06	Y	C
7439-92-1	Lead	3	1.95E-06	6.08E-07	8.74E-07	3.25E-06	2.82E-06	3.86E-06	N	
7440-36-0	Antimony	2.5	1.62E-06	5.07E-07	7.28E-07	2.71E-06	2.35E-06	3.22E-06	Y	A
7723-14-0	Phosphorus	130	8.44E-05	2.63E-05	3.79E-05	1.41E-04	1.22E-04	1.67E-04	Y	A
7440-22-4	Silver	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	Y	A
7429-90-5	Aluminum	22,600	1.47E-02	4.58E-03	6.58E-03	2.45E-02	2.13E-02	2.91E-02	Y	A
7440-39-3	Barium	145	9.41E-05	2.94E-05	4.22E-05	1.57E-04	1.36E-04	1.86E-04	Y	A
1305-78-8	Calcium Oxide	740,000 [3]	4.80E-01	1.50E-01	2.16E-01	8.02E-01	6.96E-01	9.52E-01	Y	A
7440-50-8	Copper	5	3.25E-06	1.01E-06	1.46E-06	5.42E-06	4.70E-06	6.43E-06	Y	A
7439-89-6	Iron	10350	6.72E-03	2.10E-03	3.01E-03	1.12E-02	9.73E-03	1.33E-02	Y	A
7439-98-7	Molybdenum	0.5	3.25E-07	1.01E-07	1.46E-07	5.42E-07	4.70E-07	6.43E-07	Y	A
7440-28-0	Thallium	5	3.25E-06	1.01E-06	1.46E-06	5.42E-06	4.70E-06	6.43E-06	Y	A
7440-61-1	Uranium	5	3.25E-06	1.01E-06	1.46E-06	5.42E-06	4.70E-06	6.43E-06	Y	A
7440-62-2	Vanadium	15.5	1.01E-05	3.14E-06	4.52E-06	1.68E-05	1.46E-05	1.99E-05	Y	A
7440-33-7	Tungsten	5	3.25E-06	1.01E-06	1.46E-06	5.42E-06	4.70E-06	6.43E-06	Y	A
7440-66-6	Zinc	18	1.17E-05	3.65E-06	5.24E-06	1.95E-05	1.69E-05	2.31E-05	Y	A
Total			5.02E-01	1.57E-01	2.25E-01	8.38E-01	7.27E-01	9.95E-01		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *See LIME PRODUCTION, page 10*

[3] *(NLA 2007) 40% to 74% CaO in lime*

1E+6 parts/ppm

AGGREGATE PRODUCTION

Source Data

Source ID	Description	PM Emissions lb/day	PM Emissions ton/yr
PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conve	15.00	2.74
PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conve	15.00	2.74
Total		30.00	5.48

HAP/TAP Emission Factors and Emissions

CAS No.	Pollutant	Concentration ppm[2]	Emissions[1] lb/hr	Emissions[1] ton/yr	TAP	A/C
7440-38-2	Arsenic	23	2.88E-05	1.26E-04	Y	C
7440-41-7	Beryllium	0.8	1.00E-06	4.38E-06	Y	C
7440-43-9	Cadmium	0.25	3.13E-07	1.37E-06	Y	C
7440-48-4	Cobalt	4	5.00E-06	2.19E-05	Y	A
7440-47-3	Chromium	15	1.88E-05	8.21E-05	Y	A
7439-97-6	Mercury	0.02	2.50E-08	1.10E-07	N	
7439-96-5	Manganese	236.5	2.96E-04	1.29E-03	Y	A
7440-02-0	Nickel	5	6.25E-06	2.74E-05	Y	C
7439-92-1	Lead	3	3.75E-06	1.64E-05	N	
7440-36-0	Antimony	2.5	3.13E-06	1.37E-05	Y	A
7723-14-0	Phosphorus	130	1.63E-04	7.12E-04	Y	A
7440-22-4	Silver	0	0.00E+00	0.00E+00	Y	A
7429-90-5	Aluminum	22600	2.83E-02	1.24E-01	Y	A
7440-39-3	Barium	145	1.81E-04	7.94E-04	Y	A
1317-65-3	Calcium Carbonate	274500	3.43E-01	1.50E+00	Y	A
7440-50-8	Copper	5	6.25E-06	2.74E-05	Y	A
7439-89-6	Iron	10350	1.29E-02	5.67E-02	Y	A
7439-98-7	Molybdenum	0.5	6.25E-07	2.74E-06	Y	A
7440-28-0	Thallium	5	6.25E-06	2.74E-05	Y	A
7440-61-1	Uranium	5	6.25E-06	2.74E-05	Y	A
7440-62-2	Vanadium	15.5	1.94E-05	8.49E-05	Y	A
7440-33-7	Tungsten	5	6.25E-06	2.74E-05	Y	A
7440-66-6	Zinc	18	2.25E-05	9.86E-05	Y	A
Total			3.85E-01	1.69E+00		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *See LIME PRODUCTION, page 10*

1E+6 parts/ppm

CONCRETE PRODUCTION

Source Data

Source ID	description: Description	TP_unit/day: Throughput ton/day	TP_unit/yr: Throughput ton/yr
CS1L	Cement/Shotcrete Silo #1 Loading	164	60,000
CS1U	Cement/Shotcrete Silo #1 Unloading	164	60,000
CS2L	Cement/Shotcrete Silo #2 Loading	164	60,000
CS2U	Cement/Shotcrete Silo #2 Unloading	164	60,000
CM	Central Mixer Loading	164	60,000
	Subtotal Cement Silo Filling	658	240,000
	Subtotal Central Mix Batching	164	60,000

HAP/TAP Emission Factors and Emissions

CAS No.	HAP/TAP	Silo Fill lb/ton[2] (CF_pph)	Central Mixer lb/ton[3] (CM_pph)	Cement Silo L/U lb/hr (CF_tpy)	Cement Silo L/U ton/yr (CF_tpy)	Central Mix Batching lb/hr (CM_tpy)	Central Mix Batching ton/yr (CM_tpy)	Total Emissions[3] lb/hr (lb/hr)	Total Emissions[3] ton/yr (ton/yr)	TAP	A/C
7440-38-2	Arsenic	4.24E-09	2.96E-07	1.16E-7	5.09E-7	2.03E-6	8.88E-6	2.14E-6	9.39E-6	Y	C
7440-41-7	Beryllium	4.86E-10		1.33E-8	5.83E-8	--	--	1.33E-8	5.83E-8	Y	C
7440-43-9	Cadmium		7.10E-10	--	--	4.86E-9	2.13E-8	4.86E-9	2.13E-8	Y	C
7440-47-3	Chromium	2.90E-08	1.27E-07	7.95E-7	3.48E-6	8.70E-7	3.81E-6	1.66E-6	7.29E-6	Y	A
18540-29-9	Cr (VI)	5.80E-09	2.70E-08	1.59E-7	6.96E-7	1.85E-7	8.11E-7	3.44E-7	1.51E-6	Y	C
7439-92-1	Lead	1.09E-08	3.66E-08	2.99E-7	1.31E-6	2.51E-7	1.10E-6	5.49E-7	2.41E-6	N	
7439-96-5	Manganese	1.17E-07	3.78E-06	3.21E-6	1.40E-5	2.59E-5	1.13E-4	2.91E-5	1.27E-4	Y	A
7440-02-0	Nickel	4.18E-08	2.48E-07	1.15E-6	5.02E-6	1.70E-6	7.44E-6	2.84E-6	1.25E-5	Y	C
7723-14-0	Phosphorus		1.20E-06	--	--	8.22E-6	3.60E-5	8.22E-6	3.60E-5	Y	A
Total				5.73E-6	2.51E-5	3.91E-5	1.71E-4	4.49E-5	1.97E-4		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *AP-42, Table 11.12-8, (06/06) Cement Silo Filing, Controlled.* 20% *Cr (VI), IDEQ email on 11/23/2020* 0.0002 0.0002

(3) *AP-42, Table 11.12-8, (06/06) Central Mix Batching, Controlled.* 21.29% *Cr (VI), IDEQ email on 11/23/2020* chk

Conversions

24 hr/day

CONCRETE PRODUCTION - CONTINUED

Source Data

PM_ppd PM_tpy

Source ID	description Description	PM Emissions lb/day	ton/yr
CAL	Aggregate Bin Loading	16.56	1.73
CAU	Aggregate Bin Unloading	16.56	1.73
Total		33.12	3.45

HAP/TAP Emission Factors and Emissions

lb/hr ton/yr

CAS No.	Pollutant	Concentration ppm[2]	Emissions[1] lb/hr	ton/yr	TAP	A/C
7440-38-2	Arsenic	23	1.81E-05	7.94E-05	Y	C
7440-41-7	Beryllium	0.8	6.30E-07	2.76E-06	Y	C
7440-43-9	Cadmium	0.25	1.97E-07	8.63E-07	Y	C
7440-48-4	Cobalt	4	5.52E-06	1.38E-05	Y	A
7440-47-3	Chromium	15	2.07E-05	5.18E-05	Y	A
7439-97-6	Mercury	0.02	2.76E-08	6.90E-08	N	
7439-96-5	Manganese	236.5	3.26E-04	8.16E-04	Y	A
7440-02-0	Nickel	5	3.94E-06	1.73E-05	Y	C
7439-92-1	Lead	3	4.14E-06	1.04E-05	N	
7440-36-0	Antimony	2.5	3.45E-06	8.63E-06	Y	A
7723-14-0	Phosphorus	130	1.79E-04	4.49E-04	Y	A
7440-22-4	Silver	0	0.00E+00	0.00E+00	Y	A
7429-90-5	Aluminum	22600	3.12E-02	7.80E-02	Y	A
7440-39-3	Barium	145	2.00E-04	5.00E-04	Y	A
7440-50-8	Copper	5	6.90E-06	1.73E-05	Y	A
7439-89-6	Iron	10350	1.43E-02	3.57E-02	Y	A
7439-98-7	Molybdenum	0.5	6.90E-07	1.73E-06	Y	A
7440-28-0	Thallium	5	6.90E-06	1.73E-05	Y	A
7440-61-1	Uranium	5	6.90E-06	1.73E-05	Y	A
7440-62-2	Vanadium	15.5	2.14E-05	5.35E-05	Y	A
7440-33-7	Tungsten	5	6.90E-06	1.73E-05	Y	A
7440-66-6	Zinc	18	2.48E-05	6.21E-05	Y	A
Total			4.63E-02	1.16E-01		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *See LIME PRODUCTION, page 10*

1E+6 parts/ppm

FUEL STORAGE - GASOLINE

Source Data

Source ID	description Description	VOC_ppd VOC Emissions lb/day	VOC_tpy VOC Emissions ton/yr
TG1	Mine Site Gasoline Tank #1	5.25	0.96
TG2	Mine Site Gasoline Tank #2	5.25	0.96
Total		10.49	1.91

HAP/TAP Emission Factors and Emissions

CAS No.	Pollutant	Concentration wt. %[2]	lb/hr Emissions[1] lb/hr	ton/yr Emissions[1] ton/yr	TAP	A/C
71-43-2	Benzene	1.608%	7.03E-03	3.08E-02	Y	C
92-52-4	Biphenyl	0.010%	4.37E-05	1.91E-04	Y	A
110-82-7	Cyclohexane	0.240%	1.05E-03	4.60E-03	Y	A
110-54-3	Hexane	7.138%	3.12E-02	1.37E-01	Y	A
91-20-3	Naphthalene	0.444%	1.94E-03	8.50E-03	Y	A
108-95-2	Phenol	0.055%	2.40E-04	1.05E-03	Y	A
108-88-3	Toluene	7.212%	3.15E-02	1.38E-01	Y	A
25551-13-7	Trimethyl benzene	2.500%	1.09E-02	4.79E-02	Y	A
1330-20-7	Xylene	7.170%	3.13E-02	1.37E-01	Y	A
Total			1.15E-01	5.05E-01		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *(EPA 1999a)*

MINING FUGITIVE EMISSIONS

Dust Emissions

Source Data **Model Scenario** **W3** **T-RACT Emissions**

Operating schedule 365 day/yr

Clean rock cap (CR) >50% [1]

[1] *(Perpetua 2021h) Percent of VMTs on haul roads capped with CR*

Roads outside of the pits and DRSFs are capped with CR

Source ID	Description	PM Emissions lb/day	PM Emissions ton/yr
YPP	Yellow Pine Pit	--	--
HFP	Hangar Flats Pit	--	--
WEP	West End Pit	338.16	61.71
BT	Bradley Tailings	--	--
YPPBL	Yellow Pine Pit Blasting	--	--
HFPBL	Hangar Flats Pit Blasting	--	--
WEPBL	West End Pit Blasting	643.03	117.35
BTBL	Bradley Tailings Blasting	--	--
STKP	PC Stockpile	--	--
FDRSF	Fiddle DRSF	--	--
HFDRSF	Hangar Flats DRSF	152.12	27.76
YPDRSF	Yellow Pine DRSF	--	--
WEDRSF	West End DRSF	--	--
HR000	Haul Roads	12,723.41	2,322.02
TSF	Tailing Storage Facility	--	--
ACCRD	Access Roads	38.10	6.95
UGEXP	Scout Portal	0.008	0.002
Total		13,894.82	2,535.81

TSF, ACCRD, UGEXP 38.11 6.95 chk 2535.81

HAP/TAP Emission Factors

CAS No.	Pollutant	ORE Concentration ppm[1]	DR Concentration ppm[1]	CR Concentration ppm[3]	HRD Concentration ppm[4]	Borrow Concentration ppm[5]	AR Concentration ppm
7440-38-2	Arsenic	667	667	90	378.5	2.5	2.5
7440-41-7	Beryllium	3.2	3.2		3.2		3.2
7440-43-9	Cadmium	0.5	0.5		0.5		0.5
7440-48-4	Cobalt	4	4		4		4
7440-47-3	Chromium	9	9		9		9
7439-97-6	Mercury [2]	0.96	0.6		0.6		0.6
7439-96-5	Manganese	299	299		299		299
7440-02-0	Nickel	2	2		2		2
7439-92-1	Lead	8	8		8		8
7440-36-0	Antimony	23	23		23		23
7723-14-0	Phosphorus	650	650		650		650
7782-49-2	Selenium	0.4	0.4		0.4		0.4
7440-22-4	Silver	0.5	0.5		0.5		0.5
7429-90-5	Aluminum	71000	71000		71000		71000
7440-39-3	Barium	800	800		800		800
1317-65-3	Calcium Carbonate	14000	14000		14000		14000
7440-50-8	Copper	5	5		5		5
7439-89-6	Iron	18200	18200		18200		18200
7439-98-7	Molybdenum	1	1		1		1
7440-28-0	Thallium	10	10		10		10
7440-61-1	Uranium	10	10		10		10
7440-62-2	Vanadium	28	28		28		28
7440-33-7	Tungsten	10	10		10		10
7440-66-6	Zinc	35	35		35		35

[1] *(Midas Gold 2017c)* *Median concentration of 55,000 SGP samples.* *1E+6 parts/ppm*

[2] *(Midas Gold 2018e)* *Median ore and development rock (DR) concentrations of 151,000 samples; resource block model.*

[3] *(Perpetua 2021g)* *Median concentration of 265 SGP samples.*

[4] *HRD: haul road - emissions calculated based on 50% of the total VMT occuring on CR*

[5] *(ALS 2018)* *Median concentration of 8 SGP samples.*

DR DR DR DR DR DR DR DR ORE DR DR DR DR HRD DR/AR

MINING FUGITIVE EMISSIONS - CONTINUED **Model Scenario W3** DR **T-RACT Emissions**

HAP/TAP Emissions

Hourly [1] YPP_pph HFP_pph WEP_pph BT_pph YPPBL_pph HFPBL_pph WEPBL_pph BTBL_pph STKP_pph FDRSF_pph HFDRSF_pph YPDRSF_pph WEDRSF_pph HR000_pph CCRD, UGE lb/hr

CAS No.	Pollutant	YPP lb/hr	HFP lb/hr	WEP lb/hr	BT lb/hr	YPPBL lb/hr	HFPBL lb/hr	WEPBL lb/hr	BTBL lb/hr	STKP lb/hr	FDRSF lb/hr	HFDRSF lb/hr	YPDRSF lb/hr	WEDRSF lb/hr	HR000 lb/hr	TSF, ACCRD, UGEXP lb/hr	Total lb/hr
7440-38-2	Arsenic	0	0	9.4E-3	0	0	0	0.018	0	0	0	4.2E-3	0	0	0.201	4.2E-6	0.232
7440-41-7	Beryllium	0	0	4.5E-5	0	0	0	8.6E-5	0	0	0	2.0E-5	0	0	1.7E-3	5.1E-6	1.9E-3
7440-43-9	Cadmium	0	0	7.0E-6	0	0	0	1.3E-5	0	0	0	3.2E-6	0	0	2.7E-4	7.9E-7	2.9E-4
7440-48-4	Cobalt	0	0	5.6E-5	0	0	0	1.1E-4	0	0	0	2.5E-5	0	0	2.1E-3	6.4E-6	2.3E-3
7440-47-3	Chromium	0	0	1.3E-4	0	0	0	2.4E-4	0	0	0	5.7E-5	0	0	4.8E-3	1.4E-5	5.2E-3
7439-97-6	Mercury	0	0	8.5E-6	0	0	0	1.6E-5	0	0	0	3.8E-6	0	0	3.2E-4	9.5E-7	3.5E-4
7439-96-5	Manganese	0	0	4.2E-3	0	0	0	8.0E-3	0	0	0	1.9E-3	0	0	0.159	4.7E-4	0.173
7440-02-0	Nickel	0	0	2.8E-5	0	0	0	5.4E-5	0	0	0	1.3E-5	0	0	1.1E-3	3.2E-6	1.2E-3
7439-92-1	Lead	0	0	1.1E-4	0	0	0	2.1E-4	0	0	0	5.1E-5	0	0	4.2E-3	1.3E-5	4.6E-3
7440-36-0	Antimony	0	0	3.2E-4	0	0	0	6.2E-4	0	0	0	1.5E-4	0	0	0.012	3.7E-5	0.013
7723-14-0	Phosphorus	0	0	9.2E-3	0	0	0	0.017	0	0	0	4.1E-3	0	0	0.345	1.0E-3	0.376
7782-49-2	Selenium	0	0	5.6E-6	0	0	0	1.1E-5	0	0	0	2.5E-6	0	0	2.1E-4	6.4E-7	2.3E-4
7440-22-4	Silver	0	0	7.0E-6	0	0	0	1.3E-5	0	0	0	3.2E-6	0	0	2.7E-4	7.9E-7	2.9E-4
7429-90-5	Aluminum	0	0	1.000	0	0	0	1.902	0	0	0	0.450	0	0	37.640	0.113	41.106
7440-39-3	Barium	0	0	0.011	0	0	0	0.021	0	0	0	5.1E-3	0	0	0.424	1.3E-3	0.463
1317-65-3	Calcium Ca	0	0	0.197	0	0	0	0.375	0	0	0	0.089	0	0	7.422	0.022	8.105
7440-50-8	Copper	0	0	7.0E-5	0	0	0	1.3E-4	0	0	0	3.2E-5	0	0	2.7E-3	7.9E-6	2.9E-3
7439-89-6	Iron	0	0	0.256	0	0	0	0.488	0	0	0	0.115	0	0	9.649	0.029	10.537
7439-98-7	Molybdenu	0	0	1.4E-5	0	0	0	2.7E-5	0	0	0	6.3E-6	0	0	5.3E-4	1.6E-6	5.8E-4
7440-28-0	Thallium	0	0	1.4E-4	0	0	0	2.7E-4	0	0	0	6.3E-5	0	0	5.3E-3	1.6E-5	5.8E-3
7440-61-1	Uranium	0	0	1.4E-4	0	0	0	2.7E-4	0	0	0	6.3E-5	0	0	5.3E-3	1.6E-5	5.8E-3
7440-62-2	Vanadium	0	0	3.9E-4	0	0	0	7.5E-4	0	0	0	1.8E-4	0	0	0.015	4.4E-5	0.016
7440-33-7	Tungsten	0	0	1.4E-4	0	0	0	2.7E-4	0	0	0	6.3E-5	0	0	5.3E-3	1.6E-5	5.8E-3
7440-66-6	Zinc	0	0	4.9E-4	0	0	0	9.4E-4	0	0	0	2.2E-4	0	0	0.019	5.6E-5	0.020
Total		0	0	1.490	0	0	0	2.834	0	0	0	0.670	0	0	55.918	0.167	61.079

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.* chk 61.0794 61.0794

DR DR DR DR DR DR DR DR ORE DR DR DR DR HRD DR/AR

MINING FUGITIVE EMISSIONS - CONTINUED **Model Scenario W3** DR **T-RACT Emissions**

HAP/TAP Emissions

Annual

		YPP_tpy	HFP_tpy	WEP_tpy	BT_tpy	YPPBL_tpy	HFPBL_tpy	WEPBL_tpy	BTBL_tpy	STKP_tpy	FDRSF_tpy	HFDRSF_tpy	YPDRSF_tpy	WEDRSF_tpy	HR000_tpy	CCRD, UGE	ton/yr
		YPP	HFP	WEP	BT	YPPBL	HFPBL	WEPBL	BTBL	STKP	FDRSF	HFDRSF	YPDRSF	WEDRSF	HR000	TSF, ACCRD, UGEXP	Total
CAS No.	Pollutant	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr
7440-38-2	Arsenic	0	0	0.041	0	0	0	0.078	0	0	0	0.019	0	0	0.879	1.8E-5	1.017
7440-41-7	Beryllium	0	0	2.0E-4	0	0	0	3.8E-4	0	0	0	8.9E-5	0	0	7.4E-3	2.2E-5	8.1E-3
7440-43-9	Cadmium	0	0	3.1E-5	0	0	0	5.9E-5	0	0	0	1.4E-5	0	0	1.2E-3	3.5E-6	1.3E-3
7440-48-4	Cobalt	0	0	2.5E-4	0	0	0	4.7E-4	0	0	0	1.1E-4	0	0	9.3E-3	2.8E-5	0.010
7440-47-3	Chromium	0	0	5.6E-4	0	0	0	1.1E-3	0	0	0	2.5E-4	0	0	0.021	6.3E-5	0.023
7439-97-6	Mercury	0	0	3.7E-5	0	0	0	7.0E-5	0	0	0	1.7E-5	0	0	1.4E-3	4.2E-6	1.5E-3
7439-96-5	Manganese	0	0	0.018	0	0	0	0.035	0	0	0	8.3E-3	0	0	0.694	2.1E-3	0.758
7440-02-0	Nickel	0	0	1.2E-4	0	0	0	2.3E-4	0	0	0	5.6E-5	0	0	4.6E-3	1.4E-5	5.1E-3
7439-92-1	Lead	0	0	4.9E-4	0	0	0	9.4E-4	0	0	0	2.2E-4	0	0	0.019	5.6E-5	0.020
7440-36-0	Antimony	0	0	1.4E-3	0	0	0	2.7E-3	0	0	0	6.4E-4	0	0	0.053	1.6E-4	0.058
7723-14-0	Phosphorus	0	0	0.040	0	0	0	0.076	0	0	0	0.018	0	0	1.509	4.5E-3	1.648
7782-49-2	Selenium	0	0	2.5E-5	0	0	0	4.7E-5	0	0	0	1.1E-5	0	0	9.3E-4	2.8E-6	1.0E-3
7440-22-4	Silver	0	0	3.1E-5	0	0	0	5.9E-5	0	0	0	1.4E-5	0	0	1.2E-3	3.5E-6	1.3E-3
7429-90-5	Aluminum	0	0	4.382	0	0	0	8.332	0	0	0	1.971	0	0	165	0.494	180
7440-39-3	Barium	0	0	0.049	0	0	0	0.094	0	0	0	0.022	0	0	1.858	5.6E-3	2.029
1317-65-3	Calcium Ca	0	0	0.864	0	0	0	1.643	0	0	0	0.389	0	0	32.508	0.097	35.501
7440-50-8	Copper	0	0	3.1E-4	0	0	0	5.9E-4	0	0	0	1.4E-4	0	0	0.012	3.5E-5	0.013
7439-89-6	Iron	0	0	1.123	0	0	0	2.136	0	0	0	0.505	0	0	42.261	0.127	46.152
7439-98-7	Molybdenu	0	0	6.2E-5	0	0	0	1.2E-4	0	0	0	2.8E-5	0	0	2.3E-3	7.0E-6	2.5E-3
7440-28-0	Thallium	0	0	6.2E-4	0	0	0	1.2E-3	0	0	0	2.8E-4	0	0	0.023	7.0E-5	0.025
7440-61-1	Uranium	0	0	6.2E-4	0	0	0	1.2E-3	0	0	0	2.8E-4	0	0	0.023	7.0E-5	0.025
7440-62-2	Vanadium	0	0	1.7E-3	0	0	0	3.3E-3	0	0	0	7.8E-4	0	0	0.065	1.9E-4	0.071
7440-33-7	Tungsten	0	0	6.2E-4	0	0	0	1.2E-3	0	0	0	2.8E-4	0	0	0.023	7.0E-5	0.025
7440-66-6	Zinc	0	0	2.2E-3	0	0	0	4.1E-3	0	0	0	9.7E-4	0	0	0.081	2.4E-4	0.089
Total		0	0	6.527	0	0	0	12.412	0	0	0	2.936	0	0	245	0.731	268
															chk	267.5280	267.5280

MINING FUGITIVE EMISSIONS - CONTINUED

Mercury Evaporative Flux Emissions

Fugitive Mercury Flux and Emissions

			Area		Hg Flux	Emissions[1] lb/hr	ton/yr	lb/yr
CAS No.	Pollutant	Source	m^2	ha	µg/m^2-yr			
		Stockpiles	52,623	5.3	556	7.37E-6	3.2E-5	6.5E-2
		Rock Dumps	2,063,990	206.4	76.2	3.96E-5	1.7E-4	0.35
		Tailings	1,338,158	133.8	2,144	7.22E-4	3.2E-3	6.32
		Pits	1,504,919	150.5	132.3	5.01E-5	2.2E-4	0.44
7439-97-6	Mercury					8.2E-4	3.6E-3	7.17

(1) *Hourly emissions based on:* 8,760 *hours per year of operation*

Fugitive Mercury Emission Factors

	Twin Creeks (TC)		Ore Hg Adjusted	Stibnite	
	Hg Flux (1)	Hg (2)	µg/m^2/yr	Hg Flux (3)	Hg (4)
Source	µg/m^2-yr	µg/g	TC	µg/m^2-yr	µg/g
Stockpiles	5,609	33	556	556	0.96
Rock Dumps	768	3.5	76.2	76.2	0.60
Tailings	21,621	33	2,144	2,144	0.96
Pits	1,334	9.5	132	132.3	0.60

(1) *(Eckley 2010)* *Table 1: Hg flux µg/m^2-yr*

(2) *(Eckley 2010)* *Table 1: Average Hg flux mg/g: " Stockpiles - high-grade stockpiles, Rock Dumps - waste rock dumps, Tailings - high-grade stockpiles as a surrogate; Pits - pit"*

(3) *(Eckley 2010)* *Figure 2: log(y) = m*log(x) + b*

y = Hg Flux (ng/m^2-d)
x = material Hg concentration (µg/g)]

Slope =	*Solar*	*TC*
	Low	*0.59*
	Medium	*0.6*
	High	*0.77*
	Average	*0.65*

(4) *(Midas Gold 2018e)*

Sample Calculation: m = log (y1/y2) / log(x1/x2)

m=	0.65	unitless
y1=	5,609	µg/m^2-yr
x1=	33	µg/m^2-yr
x2=	0.96	µg/m^2-yr
log(x1/x2)=	1.536243	unitless
log(y1/y2)=	1.003679	unitless
y1/y2=	10.08506	unitless
y2=	556.2	µg/m^2-yr

Conversions

2,000	lb/ton
10,000	m2/ha
453.593	g/lb

TABLE A-W3. HAP/TAP Emissions and Exemptions

T-RACT Emissions						MINING										LEACHING	
chk						*Mining Model Scenario W3*										*CN Leach/PAX*	
						YPP,HFP,WEP,BT		YPPBL,HFPBL,WEPBL,BTBL		HR000		STKP, FDRSF, HFDRSF, YPDRSF, WEDRSF		TSF,ACCRD,UGEXP			
CAS	HAP/TAP	HAP	TAP			Pits		Blasting		Haul Roads		Stockpiles and DRFS		Tails, Access Road, Exploration		CN Leach and PAX	
	NSPS or NESHAP HAP/TAP -->			*Y*													
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				A/C	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
7440-38-2	Arsenic	Y	Y	Y	C	9.4E-3	0.041	0.018	0.078	0.201	0.879	4.2E-3	0.019	4.2E-6	1.8E-5		
7440-41-7	Beryllium	Y	Y	Y	C	4.5E-5	2.0E-4	8.6E-5	3.8E-4	1.7E-3	7.4E-3	2.0E-5	8.9E-5	5.1E-6	2.2E-5		
7440-43-9	Cadmium	Y	Y	Y	C	7.0E-6	3.1E-5	1.3E-5	5.9E-5	2.7E-4	1.2E-3	3.2E-6	1.4E-5	7.9E-7	3.5E-6		
50-00-0	Formaldehyde	Y	Y	Y	C												
7440-02-0	Nickel	Y	Y	Y	C	2.8E-5	1.2E-4	5.4E-5	2.3E-4	1.1E-3	4.6E-3	1.3E-5	5.6E-5	3.2E-6	1.4E-5		

TABLE A-W3. HAP/TAP Emissions and Exemptions

T-RACT Emissions						PROCESSING AND PRODUCTION											
chk						*Ore Processing*				*Ore Concentration and Refining*				*Process Heating*			
						OC1-13		PS		AC		EW,MR,MF,CKD		ACB, CKB, PV, HS		LKC	
CAS	HAP/TAP	HAP	TAP			Crushers & Xfers		Prill Silos		Autoclave		EW, Preg Tank, Retort, Furnace, Carbon Kiln		POX Boiler, C. Kiln Comb., Prop. Vap., Sol'n Heater		Lime Kiln Combustion	
	NSPS or NESHAP HAP/TAP -->			*Y*		*LL*	*LL*			*7E*	*7E*	*7E*	*7E*			*5A*	*5A*
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				*A/C*	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
7440-38-2	Arsenic	Y	Y	Y	C	3.9E-3	0.017			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.5E-6	6.4E-6	3.7E-6	1.6E-5
7440-41-7	Beryllium	Y	Y	Y	C	1.9E-5	8.2E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	8.7E-8	3.8E-7	2.2E-7	9.6E-7
7440-43-9	Cadmium	Y	Y	Y	C	2.9E-6	1.3E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	8.0E-6	3.5E-5	2.0E-5	8.8E-5
50-00-0	Formaldehyde	Y	Y	Y	C									5.5E-4	2.4E-3	1.4E-3	6.0E-3
7440-02-0	Nickel	Y	Y	Y	C	1.2E-5	5.2E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.5E-5	6.7E-5	3.9E-5	1.7E-4

TABLE A-W3. HAP/TAP Emissions and Exemptions

T-RACT Emissions						PROCESSING AND PRODUCTION - Continued													
chk						*Lime Production*						*Aggregate Prod.*		*Concrete Production*					
						LS1-11,LSBM		LK,LS12,LCR,LS-L/U		LS1-L/U,MillS2-L/U,ACS1-4		PCSP1,PCSP2		CM		CS1L,CS1U,CS2L, CS2U		CA-L/U	
CAS	HAP/TAP	HAP	TAP			Limestone Crushers, Screens, Mill, Xfers		Lime Kiln, Kiln Feed, Lime Mill, Pebble Lime Silo		Lime Silos and Lime Mill Crushing		Portable Crushers, Screens, Xfers		Central Mixer		Cement Silo #1 and #2 L/U		Aggregate Bin	
	NSPS or NESHAP HAP/TAP -->			*Y*		*OOO*	*OOO*	*5A*	*5A*			*OOO*	*OOO*					*OOO*	*OOO*
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				A/C	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
7440-38-2	Arsenic	Y	Y	Y	C	1.0E-4	4.4E-4	2.4E-5	1.1E-4	1.1E-6	4.7E-6	2.9E-5	1.3E-4	2.0E-6	8.9E-6	1.2E-7	5.1E-7	1.8E-5	7.9E-5
7440-41-7	Beryllium	Y	Y	Y	C	3.5E-6	1.5E-5	8.4E-7	3.7E-6	3.7E-8	1.6E-7	1.0E-6	4.4E-6			1.3E-8	5.8E-8	6.3E-7	2.8E-6
7440-43-9	Cadmium	Y	Y	Y	C	1.1E-6	4.8E-6	2.6E-7	1.2E-6	1.2E-8	5.1E-8	3.1E-7	1.4E-6	4.9E-9	2.1E-8			2.0E-7	8.6E-7
50-00-0	Formaldehyde	Y	Y	Y	C														
7440-02-0	Nickel	Y	Y	Y	C	2.2E-5	9.6E-5	5.3E-6	2.3E-5	2.3E-7	1.0E-6	6.3E-6	2.7E-5	1.7E-6	7.4E-6	1.1E-6	5.0E-6	3.9E-6	1.7E-5

TABLE A-W3. HAP/TAP Emissions and Exemptions

T-RACT Emissions						PROCESSING AND PRODUCTION - Continued						MINING and LEACHING - Totals									
chk						*HVAC*		*Emer. Power/Fire*		*Fuel Storage*		*HAP Total*		*Mercury Total*		*Mercury Total*		*TAP Total*		*TAP Total*	
						H1M,H2M,HM,HAC,HR,HA,HMO,HTS,HW		EDG1,EDG2,EDG3,EDFP		TG1,TG2				*Exempt*		*Non-Exempt*		*HAP-TAP addressed by NSPS/NESHAP*		*For EL Evaluation*	
CAS	HAP/TAP	HAP	TAP			Heaters		Emergency Generators and Fire Pump		Gasoline Fuel Tanks											
	NSPS or NESHAP HAP/TAP -->			*Y*				*4Z*	*4Z*	*6C*	*6C*										
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				*A/C*	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
7440-38-2	Arsenic	Y	Y	Y	C	3.6E-6	1.6E-5					0.232	1.017							0.232	1.017
7440-41-7	Beryllium	Y	Y	Y	C	2.1E-7	9.4E-7					1.9E-3	8.1E-3							1.9E-3	8.1E-3
7440-43-9	Cadmium	Y	Y	Y	C	2.0E-5	8.6E-5					2.9E-4	1.3E-3							2.9E-4	1.3E-3
50-00-0	Formaldehyde	Y	Y	Y	C	1.3E-3	5.9E-3	5.1E-5	2.2E-4												
7440-02-0	Nickel	Y	Y	Y	C	3.8E-5	1.6E-4					1.2E-3	5.1E-3					0	0	1.2E-3	5.1E-3

REC 0619

PET 253

TABLE A-W3. HAP/TAP Emissions and Exemptions

T-RACT Emissions						PROCESSING AND PRODUCTION - Totals										ALL	ALL	ALL	TAP EL	
chk						*HAP Total*		*Mercury Total Exempt*		*Mercury Total Non-Exempt*		*TAP Total HAP-TAP addressed by NSPS/NESHAP*		*TAP Total For EL Evaluation*		*HAP*	*Hg Non-Exempt*	*TAP For EL Evaluation*	*TAP Emission Screening Level (EL)*	
CAS	HAP/TAP	HAP	TAP																	
	NSPS or NESHAP HAP/TAP -->	*Y*																	Non-car	Carcin
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				*A/C*	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr	ton/yr	lb/hr	lb/hr	lb/hr
7440-38-2	Arsenic	Y	Y	Y	C	4.5E-3	0.020					4.5E-3	0.020	8.2E-6	3.6E-5	1.037		0.232	--	1.5E-6
7440-41-7	Beryllium	Y	Y	Y	C	4.3E-4	1.9E-3					4.3E-4	1.9E-3	3.5E-7	1.5E-6	0.010		1.9E-3	--	2.8E-5
7440-43-9	Cadmium	Y	Y	Y	C	4.6E-4	2.0E-3					4.3E-4	1.9E-3	2.8E-5	1.2E-4	3.3E-3		3.2E-4	--	3.7E-6
50-00-0	Formaldehyde	Y	Y	Y	C	3.3E-3	0.015					1.4E-3	6.2E-3	1.9E-3	8.3E-3	0.015		1.9E-3	--	5.1E-4
7440-02-0	Nickel	Y	Y	Y	C	5.5E-4	2.4E-3					4.9E-4	2.2E-3	5.6E-5	2.4E-4	7.5E-3		1.2E-3	--	2.7E-5

APPENDIX B – AMBIENT AIR QUALITY IMPACT ANALYSES REVIEW MEMORANDUM

M E M O R A N D U M

DATE: January 6, 2022

TO: Kelli Wetzel, Permit Writer, Air Program

FROM: Pao Baylon, Modeling Review Analyst, Air Program
Through Kevin Schilling, Modeling Supervisor, Air Program

PROJECT: P-2019.0047 PROJ 62288, Permit for an Open-pit Gold Mine and On-site Ore Preparation and Gold Extraction Operation located in Valley County, Idaho.

SUBJECT: Demonstration of Compliance with IDAPA 58.01.01.203.02 (NAAQS) and 203.03 (TAPs) as it relates to air quality impact analyses.

Contents

Acronyms, Units, and Chemical Nomenclature 3

1.0 Summary 6

2.0 Background Information 12

2.1 Project Description 12

2.2 Facility Location and Area Classification 13

2.3 Air Impact Analyses Required for All Permits to Construct 16

2.4 Significant Impact Level and Cumulative NAAQS Impact Analyses 17

2.5 Toxic Air Pollutant Analyses 19

3.0 Analytical Methods and Data 20

3.1 Emission Source Data 20

3.1.1 Criteria Pollutant Modeling Applicability and Modeled Emission Rates 21

3.1.2 TAPs Modeling Applicability and Modeled Emission Rates 28

3.1.3 Modeling Scenarios 29

3.1.4 Processing, Refining, and Ancillary Sources 30

3.1.5 Fugitive Sources: Blasting, Material Origin and Destination, and Underground Exploration Emissions 31

3.1.6 Fugitive Sources: Haul Roads 33

3.1.7 Fugitive Sources: Burntlog Route Access Road 36

3.1.8 Emission Release Parameters 36

3.1.9 Emission Release Parameter Justification 40

3.2 Background Concentrations 42
3.2.1 Onsite Particulate Monitoring 42
3.2.2 Gaseous Pollutant Background Concentrations 43
3.2.3 Medium-Traffic Pollutant Background Concentrations 44
3.3 Impact Modeling Methodology 44
3.3.1 General Overview of Impact Analyses 44
3.3.2 Modeling Protocol 45
3.3.3 Modeling Methodology 45
3.3.4 Model Selection 45
3.3.5 Meteorological Data 45
3.3.6 Effects of Terrain on Modeled Impacts 49
3.3.7 Facility Layout and Downwash 51
3.3.8 NOx Chemistry 51
3.3.9 Particulate Deposition 52
3.3.10 Ambient Air Boundary 55
3.3.11 Nearby Co-Contributing Sources 56
3.3.12 Receptor Network 56
3.3.13 Good Engineering Practice Stack Height 58
4.0 NAAQS and TAPs Impact Modeling Results 58
4.1 Results for NAAQS Analyses 58
4.1.1 Significant Impact Level Analyses 58
4.1.2 Cumulative NAAQS Impact Analyses 58
4.1.3 DEQ's Sensitivity Analyses for 1-hour and Annual NO_2 61
4.1.4 DEQ's Weight-of-Evidence Analyses for 24-hour PM_{10} 61
4.1.5 DEQ's Sensitivity Analyses for a Lower Fugitive Road Dust Control Efficiency 70
4.2 Results for TAPs Impact Analyses 73
5.0 Conclusions 73
References 74

REC 0623

PET 257

Acronyms, Units, and Chemical Nomenclature

AAC	Acceptable Ambient Concentration of a non-carcinogenic TAP
AACC	Acceptable Ambient Concentration of a Carcinogenic TAP
acfm	Actual cubic feet per minute
ADJ_U*	AERMOD Adjusted Friction Velocity Model Option
AERMAP	The terrain data preprocessor for AERMOD
AERMET	The meteorological data preprocessor for AERMOD
AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
Air Sciences	Air Sciences, Inc. (permittee's permitting and modeling consultant)
amsl	Above mean sea level
ANFO	Ammonium Nitrate Fuel Oil
Appendix W	40 CFR 51, Appendix W – Guideline on Air Quality Models
ASOS	Automated Surface Observing System
B_o	Bowen Ratio
BNF	Boise National Forest
BPIP	Building Profile Input Program
BRC	Below Regulatory Concern
BT	Bradley Tailings
BULKRN	Meteorological data processed using Bulk Richardson Method
CAPCOA	California Air Pollution Control Officers Association
CFR	Code of Federal Regulations
CMAQ	Community Multi-Scale Air Quality Modeling System
CO	Carbon Monoxide
CSIRO	Commonwealth Scientific and Industrial Research Organization
DEQ	Idaho Department of Environmental Quality
DR	Development Rock
DRSF	Development Rock Storage Facility
DV	Design Values
EF	Emission Factors
EFSFSR	East Fork of the South Fork of the Salmon River
EIS	Environmental Impact Statement
EL	Emissions Screening Level of a TAP
EPA	United States Environmental Protection Agency
FDRSF	Fiddle Development Rock Storage Facility
g/cm^3	Grams per Cubic Centimeter
GEP	Good Engineering Practice
H_2SO_4	Sulfuric Acid Gas
HAP	Hazardous Air Pollutant
HFDRSF	Hangar Flats Development Rock Storage Facility
HFP	Hangar Flats Pit
Hg	Mercury
hr	Hours
Idaho Air Rules	Rules for the Control of Air Pollution in Idaho, located in the Idaho Administrative Procedures Act 58.01.01

REC 0624

PET 258

in	Inches
ISCST3	Industrial Source Complex Short Term 3 dispersion model
K	Kelvin
km	Kilometers
lb/hr	Pounds per hour
lb/yr	Pounds per year
LOM	Life of Mine
m	Meters
m/sec	Meters per second
MBACT	Mercury Best Available Control Technology
MERPs	Modeled Emission Rates for Precursors
mg/m^3	Milligrams per Cubic Meter
MM	Million
MMBtu	Million British Thermal Units
mph	Miles per hour
NAAQS	National Ambient Air Quality Standards
NAD83	North American Datum of 1983
NED	National Elevation Dataset
NESHAP	National Emission Standards for Hazardous Air Pollutants
NO	Nitrogen Oxide
NO_2	Nitrogen Dioxide
NON-BULKRN	Meteorological data processed without Bulk Richardson Method
NOx	Oxides of Nitrogen
NSPS	New Source Performance Standards
NSR	New Source Review
NW AIRQUEST	Northwest International Air Quality Environmental Science and Technology Consortium
NWS	National Weather Service
O_3	Ozone
OLM	Ozone Limiting Method
Pb	Lead
PM_{10}	Particulate matter with an aerodynamic particle diameter less than or equal to a nominal 10 micrometers
$PM_{2.5}$	Particulate matter with an aerodynamic particle diameter less than or equal to a nominal 2.5 micrometers
PNF	Payette National Forest
ppb	parts per billion
ppm	parts per million
PRI	Perpetua Resources Idaho, Inc. (permittee)
PRIME	Plume Rise Model Enhancement
PRO	Perpetua Resources Idaho, Inc. Plan of Restoration and Operations
PSD	Prevention of Significant Deterioration
PTC	Permit to Construct
PTE	Potential to Emit
PVMRM	Plume Volume Molar Ratio Method
r	Albedo

REC 0625

PET 259

scfm	Standard cubic feet per minute
SED	Segment Emission Denominator
SGP	Stibnite Gold Project
SIL	Significant Impact Level
SO_2	Sulfur Dioxide
STKP	Crusher Stockpile
TAP	Toxic Air Pollutant
ton/day	Tons per Day
ton/year	Tons per Year
TSF	Tailings Storage Facility
TSP	Total Suspended Particulate
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
VOC	Volatile Organic Compounds
WBAN	Weather-Bureau-Army-Navy
WEDRSF	West End Development Rock Storage Facility
WEP	West End Pit
YPDRSF	Yellow Pine Development Rock Storage Facility
YPP	Yellow Pine Pit
z_o	Surface Roughness Length
ºF	Degrees Fahrenheit
µg/m^3	Micrograms per cubic meter of air
µm	Microns

1.0 Summary

Perpetua Resources Idaho, Inc. (PRI) submitted a Permit to Construct (PTC) application to construct and operate the Stibnite Gold Project (SGP) in Valley County, Idaho. The SGP will consist of conventional open-pit mining operations and onsite ore preparation and gold extraction processes. The potential air emissions from the SGP are less than the applicable major source thresholds for both criteria and hazardous air pollutants (HAP), and therefore, the facility is designated as a minor source for Title V and New Source Review (NSR) requirements, and an area source for National Emission Standards for Hazardous Air Pollutants (NESHAP) applicability. Project-specific air quality analyses involving atmospheric dispersion modeling of estimated emissions associated with the facility were submitted to DEQ to demonstrate that applicable emissions do not result in violation of a National Ambient Air Quality Standard (NAAQS) or Toxic Air Pollutant (TAP) increment as required by the Idaho Administrative Procedures Act 58.01.01.203.02 and 203.03 (Idaho Air Rules Section 203.02 and 203.03). This memorandum provides a summary of the applicability assessment for analyses and air impact analyses used to demonstrate compliance with applicable NAAQS and TAP increments, as required by Idaho Air Rules Section 203.02 and 203.03.

Air Sciences, Inc. (Air Sciences), on behalf of PRI, prepared the PTC application and performed ambient air impact analyses for this project. DEQ review of submitted data and DEQ analyses summarized by this memorandum addressed only the rules, policies, methods, and data pertaining to the air impact analyses used to demonstrate that estimated emissions associated with operation of the facility will not cause or significantly contribute to a violation of any applicable air quality standard. This review did not address/evaluate compliance with other rules or analyses not pertaining to the air impact analyses. Evaluation of emission estimates was the responsibility of the DEQ permit writer and is addressed in the main body of the DEQ Statement of Basis, and emission calculation methods were not evaluated in this modeling review memorandum.

DEQ reevaluated source-specific TAP regulatory applicability for the project after the February/March 2021 public comment period in response to expressed concerns regarding sources excluded as per *Idaho Air Rules* Section 210.20 (excluding sources that are "covered" or "addressed" by a federal rule). Air Sciences made substantial refinements in assessed operational scenarios and emission calculations, and they also worked with DEQ on a refined TAPs regulatory approach. Air Sciences addressed this issue separately from the NAAQS compliance demonstration presented in the main body of the PTC application and submitted the *Stibnite Gold Project Permit to Construct Application TAP Addendum* (*TAP Addendum*). Since all the refinements reduced calculated allowable particulate emissions from sources, the NAAQS compliance demonstration did not require revision for permit issuance. Impacts from revised sources would obviously be lower and still demonstrate compliance with NAAQS. DEQ's review of the *TAP Addendum* is discussed in the *TAPs Addendum Modeling Review Attachment* (*Modeling Review Attachment*) to this memorandum.

Table 1 presents key assumptions and results to be considered in the development of the permit. Idaho Air Rules require air impact analyses be conducted in accordance with methods outlined in 40 Code of Federal Regulations (CFR) 51, Appendix W *Guideline on Air Quality Models* (*Appendix W*). *Appendix W* requires that air quality impacts be assessed using atmospheric dispersion models with emissions and operations representative of design capacity or as limited by a federally enforceable permit condition.

The submitted information and analyses: 1) utilized appropriate methods and models; 2) was conducted using reasonably accurate or conservative model parameters and input data (review of emission estimates was addressed by the DEQ permit writer); 3) adhered to established DEQ guidelines for new source review dispersion modeling; 4) showed either a) that estimated potential/allowable emissions are at a

REC 0627

PET 261

level defined as below regulatory concern (BRC) and do not require a NAAQS compliance demonstration; b) that predicted pollutant concentrations from emissions associated with the project as modeled were below Significant Impact Levels (SILs) or other applicable regulatory thresholds; or c) that predicted pollutant concentrations from emissions associated with the project, when appropriately combined with co-contributing sources and background concentrations, were below applicable NAAQS at ambient air locations where and when the project has a significant impact; 5) showed that TAP emission increases associated with the project will not result in increased ambient air impacts exceeding allowable TAP increments. This conclusion assumes that conditions in Table 1 are representative of facility design capacity or operations as limited by a federally enforceable permit condition. The DEQ permit writer should use Table 1 and other information presented in this memorandum to generate appropriate permit provisions/restrictions to assure emissions do not exceed applicable regulatory thresholds requiring further analyses and to assure the requirements of *Appendix W* are met regarding emissions representative of design capacity or permit allowable rates.

Table 1. KEY ASSUMPTIONS USED IN MODELING ANALYSES.

Criteria/Assumption/Result	Explanation/Consideration
General Emission Rates. Emission rates used in the air impact analyses must represent maximum potential emissions as given by design capacity, inherently limited by the nature of the process or configuration of the facility, or as limited by the issued permit for the specific pollutant and averaging period.	Compliance has not been demonstrated for emission rates greater than those used in the air impact analyses.
Air Impact Analyses for Criteria Pollutant Emissions. Stibnite Gold Project (SGP) facility-wide maximum potential to emit are greater than the respective Level I thresholds for all criteria pollutants and averaging periods except for Lead. Therefore, modeling is triggered for applicable averaging periods for $PM_{2.5}$[a], PM_{10}[b], CO[c], NOx[d], and SO_2[e]. Modeling was not required for Lead.	Project-specific air impact analyses demonstrating compliance with NAAQS, as required by Idaho Air Rules Section 203.02, are required for pollutant increases above Below Regulatory Concern (BRC) thresholds, or for pollutants having an emissions increase that is greater than Level I modeling applicability thresholds (where the BRC exclusion cannot be used). DEQ modeling applicability thresholds were revised in July 2021. Revised thresholds were not used because the permit application was submitted prior to the revision.
Air Impact Analyses for TAP Emissions. TAP analyses were reworked after the February/March 2021 public comment period and submitted to DEQ in the *TAP Addendum*. DEQ's review of the *TAP Addendum* is discussed in the *Modeling Review Attachment* to this memorandum. SGP final facility-wide potential Toxic Air Pollutant (TAP) emissions exceed the respective screening emission levels (ELs) for aluminum, arsenic, barium, beryllium, cadmium, calcium carbonate, calcium oxide, cyanide, formaldehyde, iron, manganese, nickel, phosphorus, sulfuric acid, thallium, and vanadium. Therefore, air dispersion modeling was required for these 16 TAPs. TAPs also classified as Hazardous Air Pollutants (HAPs) emitted from sources addressed by New Source Performance Standards (NSPS) or National Emission Standards for Hazardous Air Pollutants (NESHAP) were not required to be evaluated for compliance with TAP increments in accordance with IDAPA 58.01.01.210.20.	A TAP increment compliance demonstration would be required for any TAPs with emissions above ELs. IDAPA 58.01.01.210.20 states that if TAP emissions from a specific source are addressed by NSPS or NESHAP, then a TAP impact analysis is not required for that TAP from that specific source.
Significant Impact Level Analysis Not Conducted. A Significant Impact Level (SIL) analysis was not conducted for the SGP facility.	Based on the magnitude of the facility-wide emissions and preliminary modeling analyses, it was determined that the impacts from the SGP emissions exceeded the SIL for most criteria pollutants. Therefore, SIL analyses were considered redundant and not performed for the project.
Multiple Modeling Scenarios. To evaluate the worst-case air impacts from the SGP facility, a total of 14 scenarios were modeled. These scenarios represent the hauling of material, which can be either ore or development rock (DR), from four	Conventional open-pit methods will be used to extract ore and DR from four possible origins (Yellow Pine Pit [YPP], Hangar Flats Pit [HFP], West End Pit [WEP], and Bradley Tailings [BT]). Ore and DR will be hauled to five possible

REC 0628

PET 262

Table 1. KEY ASSUMPTIONS USED IN MODELING ANALYSES.	
Criteria/Assumption/Result	**Explanation/Consideration**
possible origins (three pits and a tailings facility) to five possible destinations (ore will be hauled to the crushing area while DR will be hauled to one of four development rock storage facilities [DRSF]). Modeled design values listed in this modeling memo represent the worst-case modeling scenario for every modeled pollutant and averaging period.	destinations (Stockpile [STKP], Yellow Pine DRSF [YPDRSF], Hangar Flats DRSF [HFDRSF], West End DRSF [WEDRSF], and Fiddle DRSF [FDRSF]). Only 14 of the 20 possible scenarios were modeled. Six scenarios were not feasible because the timing of the activity within the sequence of mine operations makes the scenarios logistically impossible. Modeled results listed in this memo represent worst-case modeling scenarios.
Modeling of Material Origin and Destination. Each material origin location (YPP, HFP, WEP, and BT) was modeled as an AREA source. Ore destination (STKP) was modeled as a VOLUME source. Each DR destination (YPDRSF, HFDRSF, WEDRSF, and FDRSF) was modeled as a VOLUME source.	Each material origin location comprised appropriate emissions from drilling, material loading, dozing, and surface exploration. Ore destination comprised ore unloading emissions. Each DR destination comprised appropriate emissions from DR unloading, dozing, and wind erosion. For the four AREA and five VOLUME sources, the dimensions were developed by reasonably fitting an equal-area rectangle within the actual footprint of each fugitive source. For the pit and DRSF fugitive activity locations, the release height was based on the haul truck height. The applicable initial lateral dispersion for each VOLUME source was calculated from the respective shorter dimension and EPA-specified methods. The applicable initial vertical dispersion for each AREA and VOLUME source was calculated from the respective vertical dimension and EPA-specified methods.
Modeling of Haul Roads. A representative haul road network for hauling material from inside the pit to various destinations was developed for each of the 14 modeling scenarios.	The haul road network was divided into 22 sections. Each section was further divided into multiple segments with a length equal to twice the adjusted haul road width. Each of the segments was characterized as an individual VOLUME source in the model. Material hauling emissions associated with each origin-destination route were assigned to each segment along the route based on estimated total emissions along the route and traffic distribution along each section.
Modeling of Blasting Emissions. Blasting emissions were represented by a VOLUME source inside a pit (YPPBL, HFPBL, and WEPBL). Blasting is not expected to occur in BT but was modeled (BTBL) in order to streamline the permitting process.	The blasting physical parameters were developed from dimensions based on blast area used in the emission calculation. The blasting release height was the midpoint of the blasting height. The initial lateral and vertical dispersion dimensions for blasting were calculated per methods specified in the AERMOD User's Guide.
Modeling of Burntlog Route Access Road. The access road portion within the operations boundary was characterized by a series of LINE sources laid along the actual route.	Emissions associated with the portion of the Burntlog Route mine access road that is within project boundary (from the south gate to the process area) are included in the SGP analyses. These include dust emissions generated from travel of maintenance equipment, light-duty pickup trucks and buses used for employee, visitor, and contractor transportation, and heavy-duty trucks used for cargo (including fuel, consumables, machine parts, ore processing supplies, ore concentrate, etc.) and services (including food supplies, trash, recyclables, etc.) transportation. Release parameters for the LINE sources were based on an estimated average vehicle height. The access road emissions were evenly distributed along the road by dividing the total access road emissions by its total area.
Control of Fugitive Dust from Roadways. Fugitive particulate emissions from roadways were assumed to be controlled above 93%, which is an aggressive level of control.	The high level of emission control was needed to demonstrate compliance with NAAQS. Compliance is not demonstrated for emissions greater than those associated with above 93% control.

REC 0629

PET 263

Table 1. KEY ASSUMPTIONS USED IN MODELING ANALYSES.	
Criteria/Assumption/Result	**Explanation/Consideration**
NOx Chemistry and NO_2/NOx In-Stack Ratios. Ozone Limiting Method (OLM), a Tier 3 NO_2 screening method, was used to estimate the 1-hour and annual NO_2 impacts. The following NO_2/NOx In-Stack Ratios (ISR) were used in the modeling analyses: Blasting: 0.036 Diesel engines: 0.11 Propane heaters: 0.10	The OLM method requires an input of NO_2/NOx ISRs for each modeled source. The NO_2/NOx ratio for blasting was based on blasting plume measurements provided in published literature. The NO_2/NOx ratio for stationary diesel combustion sources was based on heavy-duty diesel trucks in the California Air Pollution Control Officers Association (CAPCOA) Guidance Document. This NO_2/NOx ratio (11 percent) is conservatively higher than the diesel combustion NO_2/NOx ratio provided in the EPA ISR database: 6 percent average, 9.8 percent maximum. The CAPCOA document and the EPA ISR database do not provide an NO_2/NOx ratio for propane boilers. The CAPCOA-recommended NO_2/NOx ratio for natural gas boilers was selected for the propane boilers. The natural gas boilers NO_2/NOx ratio is considered appropriate for the propane boilers because both are gaseous fuels with relatively similar combustion characteristics and are expected to have similar NO_2/NOx ratios. DEQ performed a sensitivity analysis using Tier 2 (Ambient Ratio Method 2), a more conservative NO_2 screening method, and found that the facility is safely below the 1-hour and annual NO_2 NAAQS.
Alternate Meteorological Data Processed Using Cloud Cover. An alternative meteorological dataset was processed without using the Bulk Richardson (BULKRN) method. This alternate processing (NON-BULKRN) used upper air data from Boise airport, supplemented with the cloud-cover data collected at the National Weather Service station in McCall, Idaho.	Meteorological data processing with and without BULKRN are considered acceptable regulatory options by EPA. The NON-BULKRN meteorological data yielded lower modeled design values than the meteorological data processed using the BULKRN method.
Ambient Air Boundary. PRI will legally control the SGP, an active industrial site where mining activities will occur, such as heavy equipment operation. Most areas of the mine will require strict safety protocols and controlled access. PRI has established an operations boundary to identify the area where public access will be excluded. Public access inside the operations boundary will be restricted for the life of the mine by physical barriers at points of potential access, including the current Stibnite Road point of entry and proposed site access via the Burntlog Route, as well as natural features of the landscape that prevent access.	Ambient air is defined in Section 006 of the Idaho Air Rules as "that portion of the atmosphere, external to buildings, to which the general public has access." Receptors must be placed at any portion of the atmosphere that is considered ambient air.
Onsite Background $PM_{2.5}$ and PM_{10} Concentrations. The following background $PM_{2.5}$ and PM_{10} concentrations were measured at SGP in 2014 and used in the cumulative NAAQS impact analysis: Annual $PM_{2.5}$: 3.5 µg/m^3 (weighted average of quarterly means) 24-hour $PM_{2.5}$: 15.0 µg/m^3 (98th percentile/8th high) 24-hour PM_{10}: 37.0 µg/m^3 (highest 1st high)	PRI developed an onsite monitoring program to collect site-specific meteorological parameters and determine ambient particulate matter ($PM_{2.5}$ and PM_{10}) concentrations at its Stibnite monitoring station. $PM_{2.5}$ and PM_{10} background concentrations were based on calendar year 2014 instead of the complete dataset (November 2013 through June 2015). For 24-hour PM_{10}, the design value is the *second-highest* 24-hour average concentration in a given year. However, the background value that was used in the modeling analyses represents the *first-highest* 24-hour average concentration measured in 2014. Therefore, using a larger background concentration adds a layer of conservatism to the calculated total impact for 24-hour PM_{10}.
NW AIRQUEST Background CO, NO_2, and SO_2 Concentrations. The following background concentrations for CO, NO_2, and SO_2 were used in the cumulative NAAQS impact analysis: 1-hour CO: 1,740 µg/m^3 8-hour CO: 1,110 µg/m^3	Gaseous pollutant background concentrations were determined using the Northwest International Air Quality Environmental Science and Technology Consortium (NW AIRQUEST) online tool. The NW AIRQUEST tool uses regional scale modeling of pollutants in Washington, Oregon, and Idaho, with model results adjusted according to

REC 0630

PET 264

Table 1. KEY ASSUMPTIONS USED IN MODELING ANALYSES.	
Criteria/Assumption/Result	**Explanation/Consideration**
1-hour NO_2: 4.3 µg/m^3 Annual NO_2: 0.9 µg/m^3 1-hour SO_2: 12.3 µg/m^3 3-hour SO_2: 16.8 µg/m^3	available monitoring data.
Medium-Traffic Background Concentrations. To provide additional information regarding the relative contribution of traffic emissions, background concentrations were obtained from NW AIRQUEST for the road section between mile markers 143 and 144 on Highway 55 passing through the town of McCall.	The McCall location is approximately 38 miles west of the SGP. The annual average daily traffic count for this road section is over 10,000 vehicles per day. Although the background concentrations at McCall are not representative of the rural SGP area, they provide additional information regarding the relative contribution of traffic emissions.
Weight-of-Evidence Analyses for 24-hour PM_{10}. PM_{10} modeling with meteorological dataset processed using the site-specific BULKRN method shows up to five hotspot receptors for Scenario W5 (the highest PM_{10} modeling scenario) that exceed NAAQS. All modeled violations occur during winter when the average snow depth and average precipitation at the project site are 21-68 inches and 6.0 inches, respectively. Therefore, fugitive road dust emissions during high-modeled impact hours could be overestimated. PM_{10} modeling simulation was based on a mining production rate of 180,000 ton/day of development rock (65,700,000 ton/year, which is more conservative than the expected peak production rate of 42,692,000 ton/year). To investigate the effect of a lower modeled mining production rate on design value concentrations, DEQ performed a modeling simulation where mining production rate was assumed to be 120,000 ton/day instead of 180,000 ton/day, but everything else was held constant. Maximum modeled concentration, when summed with the background concentration, is lower than the 24-hour PM_{10} NAAQS thereby demonstrating NAAQS compliance. DEQ's weight-of-evidence analyses conclude that, considering all the collective conservative layers of the modeling analyses, including the use of meteorological data processed by two different methods, there is a satisfactory level of confidence that operation of the project as described in the application will not cause or contribute to a violation of NAAQS.	Meteorological data processing with and without BULKRN are considered acceptable by EPA, with the BULKRN method utilizing more of the onsite collected meteorological parameters. However, the BULKRN-processed meteorological data yielded higher modeled design value impacts for the SGP facility than the meteorological data processed without the BULKRN method. DEQ's supplemental analyses suggest that when emissions are more-closely representative of typical daily mining production rates for a high-production period (everything else held constant), the SGP facility is able to demonstrate compliance with 24-hour PM_{10} NAAQS at those few receptors showing a potential violation when using meteorological data processed with the BULKRN method. PRI later determined that the WEDRSF will not be constructed. This change eliminated Scenario W5 as a potential operating scenario. DEQ reanalyzed PM_{10} impacts to account for the refinements, and results are presented in the *Modeling Review Attachment* to this memorandum.

[a.] Particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers.
[b.] Particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers.
[c.] Carbon monoxide.
[d.] Nitrogen oxides.
[e.] Sulfur dioxide.

Summary of Submittals and Actions

May 30, 2019 Modeling protocol was submitted to DEQ by Brown and Caldwell on behalf of the applicant.

June 27, 2019 Conditional modeling protocol approval was provided to Brown and Caldwell by DEQ.

August 21, 2019 Regulatory start date. PTC application and modeling report were prepared by Air Sciences on behalf of the applicant.

September 19, 2019 Application deemed incomplete by DEQ.

October 4, 2019 DEQ received a preliminary response and supplemental information from the

REC 0631

PET 265

	applicant.
October 15, 2019	DEQ met with the applicant to review and discuss the preliminary response.
October 22, 2019	DEQ determined that the application remained incomplete while the applicant prepared a response to remaining items previously identified, and included a summary of recommendations provided at the meeting.
November 8, 2019	DEQ requested additional information from the applicant via e-mail, relating to items previously identified.
November 21, 2019	Applicant requested extension until November 27, 2019 to respond to incompleteness.
November 27, 2019	DEQ received supplemental information from the applicant, including a revised application with updated emission inventories and modeling analyses.
December 24, 2019	DEQ determined that the application was incomplete.
January 8, 2020	Applicant requested extension until February 7, 2020 to respond to incompleteness.
February 5, 2020	DEQ received supplemental information from the applicant, including a revised application with updated emission inventories and modeling analyses.
March 6, 2020	DEQ determined that the application was incomplete.
April 2, 2020	Applicant requested extension until April 15, 2020 to respond to incompleteness.
April 15, 2020	DEQ received supplemental information from the applicant, including updated modeling analyses.
May 15, 2020	DEQ determined that the application was complete.
June 24, 2020	DEQ received the final updated application.
July 14, 2020	DEQ made available the draft permit and statement of basis for applicant review.
July 31, 2020	DEQ made available an updated draft statement of basis for applicant review.
August 3 and 13, 2020	DEQ received comments from the applicant on the draft permit and statement of basis.
September 10 – October 12, 2020	DEQ provided a public comment period on the proposed action.
October 12, 2020	DEQ received a request to extend the public comment period.
October 13 – November 11, 2020	DEQ extended the public comment period.

November 20, 2020	DEQ requested additional information from the applicant to address substantive public comments received, including missing HAP and TAP emission estimates.
December 18, 2020	DEQ received supplemental information from the applicant, including a HAP/TAP addendum, updated HAP and TAP emission estimates, and updated TAP modeling analyses.
January 28, 2021	DEQ received updated modeling files with corrections for formaldehyde and sulfuric acid, and an updated figure showing TAP modeled impacts.
February 18, 2021-March 19, 2021	DEQ provided a public comment period on the proposed action as updated to address the HAP and TAP addendum and updates.
February 23, 2021	DEQ received notification from the applicant of a facility name change from Midas Gold Idaho, Inc. to Perpetua Resources Idaho, Inc.
March 3, 2021	DEQ provided an information meeting during the public comment period.
September 14, 2021	DEQ received a TAP modeling protocol for revisions to the TAP analyses.
October 6, 2021	DEQ received the *TAP Addendum*, revising TAP analyses for the project.

2.0 Background Information

This section provides background information applicable to the project and the site proposed for the facility. It also provides a brief description of the applicable air impact analyses requirements for the project.

2.1 Project Description

The SGP will require the construction of significant infrastructure, including a power transmission line, a primary mine site access road, onsite haul roads, an ore processing facility, onsite workspaces, employee housing and recreation, water storage and distribution facilities, and sewage disposal facilities.

The SGP will include three years of pre-mining development and construction activities, followed by an operating mine life of approximately 12 years. Mining will occur in three open pits: Yellow Pine Pit (YPP), Hangar Flats Pit (HFP), and West End Pit (WEP). The general sequence of mining will be the YPP deposit, followed by the HFP and WEP deposits. Legacy tailings from the Meadow Creek valley (Bradley Tailings [BT]) also will be reclaimed and reprocessed during the initial project schedule. Surface exploration drilling will continue within the pits and the Scout Prospect decline (underground exploration) throughout the mine operation period. Restoration and reclamation of other legacy mining features will occur prior to mining, throughout the life of the mine, and as part of the mine closure.

Conventional open-pit methods including drilling, blasting, excavating, and hauling will be used to extract ore and waste rock, termed development rock (DR). Hydraulic shovels and front-end loaders will be used to load ore and DR into haul trucks. DR will be used for construction, restoration, and backfilling, or hauled to the dedicated development rock storage facilities (DRSF). Approximately 340 million tons of DR will be handled over the life of the mine. Ore will be hauled to the primary crusher area, where it will

REC 0633

PET 267

be fed directly into the crusher dump pocket or stockpiled. The ore crushing plant will be designed to operate at a maximum rate of 25,000 tons per day (ton/day). Approximately 100 million tons of ore will be mined from the three pits over the life of the project.

The metal-recovery process from ore will include conventional crushing and grinding, followed by froth-flotation circuits that will generate separate gold-silver and antimony-silver concentrates. The antimony-silver concentrate will be shipped offsite for refining, whereas additional onsite processing of the gold-silver concentrate will include pressure oxidation, carbon-in-leach circuits, and refining processes to recover gold and minor amounts of silver. The finely ground leftover ore material from the mineral-recovery process, termed tailings, will be neutralized, thickened, and transported via a pipeline to the tailings storage facility (TSF).

Lime used in the ore processing will either be purchased or manufactured onsite from limestone available at the site. In addition, certain construction and maintenance activities during operations may require sized aggregate. To allow for the operational flexibility to produce construction aggregate onsite, the application included two portable crushing and screening plants.

The following air pollutants are expected from operations at the SGP facility:

- Criteria air pollutants: carbon monoxide (CO), oxides of nitrogen (NOx), particulate matter less than 2.5 microns (μm) and 10 μm ($PM_{2.5}$ and PM_{10}), sulfur dioxide (SO_2), lead (Pb), and ozone (O_3) precursor volatile organic compounds (VOC)
- Hazardous air pollutants (HAP), including mercury (Hg)
- Other non-HAP toxic air pollutants (TAP)
- Greenhouse gases

Based on the uncontrolled potential to emit (PTE) and controlled PTE, the SGP facility will be a "synthetic minor" source of PM, PM_{10}, $PM_{2.5}$, and HAP emissions for new source review (NSR) and Title V (Tier I) permitting purposes. The uncontrolled PTE for the remaining criteria pollutants (SO_2, NOx, CO, VOC) confirm that the SGP facility will be a natural minor source for these emissions. Facility classification is reviewed by the permit writer. Detailed calculations and explanations are provided in the DEQ Statement of Basis.

The PTC addresses all air pollutant-emitting activities associated with the facility.

2.2 Facility Location and Area Classification

The SGP is located in the Stibnite-Yellow Pine Mining District in Valley County, central Idaho (Northing: 4,973,751 meters [m]; Easting: 632,038 m; UTM Zone 11), approximately 100 miles northeast of Boise, 38 miles east of McCall, and approximately 10 miles east of Yellow Pine. A facility location map for the SGP is presented in Figure 1. This figure also shows the proposed Burntlog Route (access road) that will provide a year-round safe access to the site. The SGP site layout is presented in Figure 2.

The Stibnite-Yellow Pine Mining District is characterized by historic mining activities and unpatented (federal land) and patented (private land) mining claims that include deposits of gold, silver, tungsten, and antimony. The district lies in both Boise National Forest (BNF) and Payette National Forest (PNF), but is administered by the PNF's Krassel Ranger District (Perpetua Resources Idaho 2017a). The project area terrain is characterized by narrow valleys 6,000 to 6,600 feet above mean sea level (amsl), surrounded by steep mountains ranging over 8,500 feet amsl. The main drainage basin in the project area is the East Fork of the South Fork of the Salmon River (EFSFSR).

REC 0634

PET 268

The EFSFSR joins Johnson Creek 16 miles downstream, near the village of Yellow Pine. The project area is encompassed by the watersheds of EFSFSR tributaries, including Sugar Creek, Meadow Creek, Johnson Creek, Riordan Creek, Burntlog Creek, Midnight Creek, and Trout Creek. Primary commercial activity in the area comprises mineral exploration, mining, logging, and dispersed recreation.

This area is designated as an attainment or unclassifiable area for SO_2, NO_2, CO, Lead, O_3, PM_{10}, and $PM_{2.5}$. The area is not classified as non-attainment for any criteria pollutants.

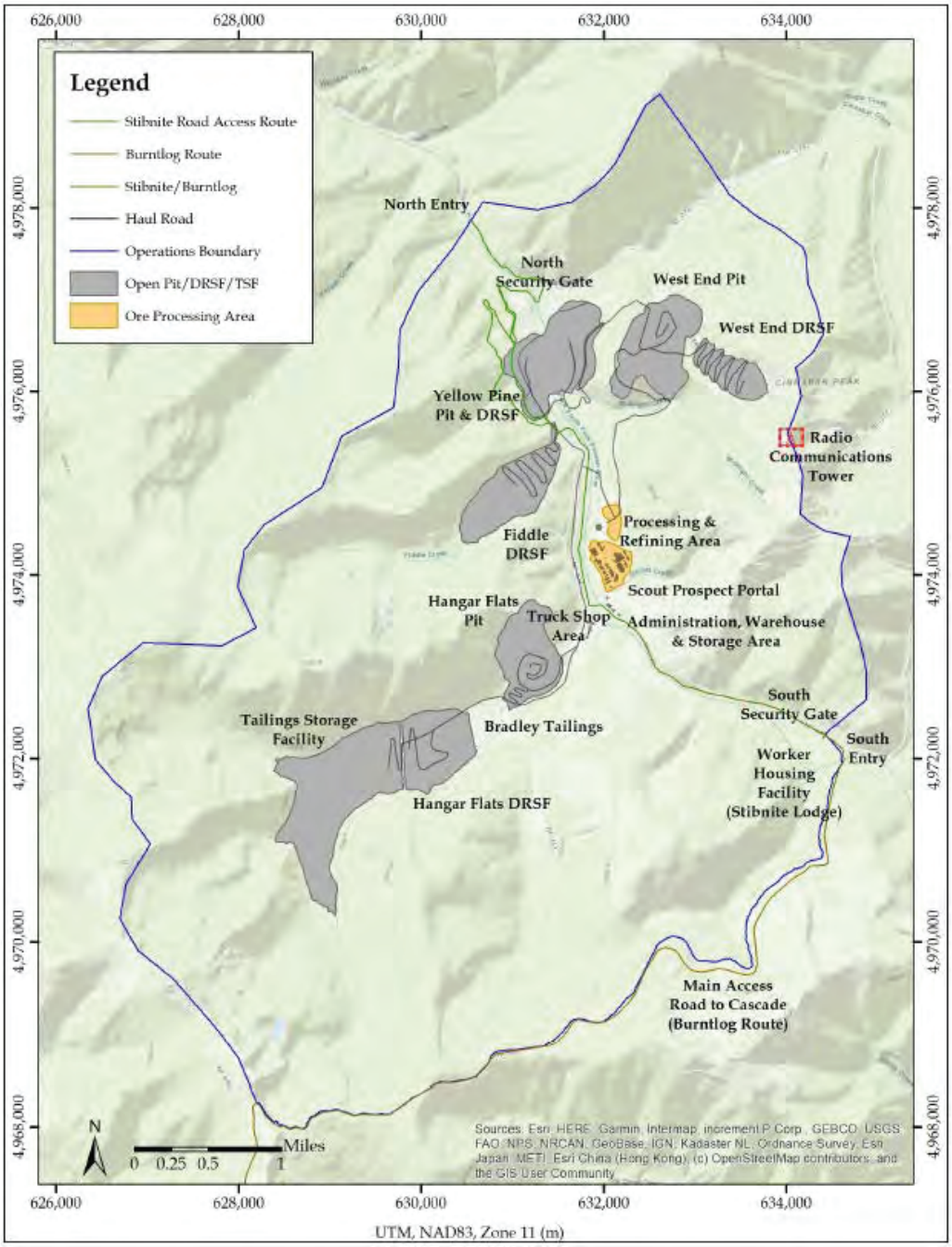
REC 0635

PET 269

Figure 1. SGP FACILITY LOCATION MAP.



Figure 2. SGP SITE LAYOUT AND STIBNITE ROAD ACCESS ROUTE.



2.3 Air Impact Analyses Required for All Permits to Construct

Idaho Air Rules Sections 203.02 and 203.03:

> *No permit to construct shall be granted for a new or modified stationary source unless the applicant shows to the satisfaction of the Department all of the following:*

***02. NAAQS**. The stationary source or modification would not cause or significantly contribute to a violation of any ambient air quality standard.*

***03. Toxic Air Pollutants.** Using the methods provided in Section 210, the emissions of toxic air pollutants from the stationary source or modification would not injure or unreasonably affect human or animal life or vegetation as required by Section 161. Compliance with all applicable toxic air pollutant carcinogenic increments and toxic air pollutant non-carcinogenic increments will also demonstrate preconstruction compliance with Section 161 with regards to the pollutants listed in Sections 585 and 586.*

Atmospheric dispersion modeling, using computerized simulations, is used to demonstrate compliance with both NAAQS and TAPs. Idaho Air Rules Section 202.02 states:

***02. Estimates of Ambient Concentrations**. All estimates of ambient concentrations shall be based on the applicable air quality models, data bases, and other requirements specified in 40 CFR 51 Appendix W (Guideline on Air Quality Models).*

2.4 Significant Impact Level and Cumulative NAAQS Impact Analyses

If specific criteria pollutant emission increases associated with the proposed permitting project cannot qualify for a BRC exemption as per Idaho Air Rules Section 221, then the permit cannot be issued unless the application demonstrates that applicable emission increases will not cause or significantly contribute to a violation of NAAQS, as required by Idaho Air Rules Section 203.02.

The first phase of a NAAQS compliance demonstration is to evaluate whether the proposed facility/project could have a significant impact to ambient air. Section 3.1.1 of this memorandum describes the applicability evaluation of Idaho Air Rules Section 203.02. The Significant Impact Level (SIL) analysis for a new facility or proposed modification to a facility involves modeling estimated criteria air pollutant emissions from the facility or modification to determine the potential impacts to ambient air. Air impact analyses are required by Idaho Air Rules to be conducted in accordance with methods outlined in *Appendix W*. *Appendix W* requires that facilities be modeled using emissions and operations representative of design capacity or as limited by a federally enforceable permit condition.

A facility or modification is considered to have a significant impact on air quality if maximum modeled impacts to ambient air exceed the established SIL listed in Idaho Air Rules Section 006 (referred to as a "significant contribution" in Idaho Air Rules) or as incorporated by reference as per Idaho Air Rules Section 107.03.b. Table 2 lists the applicable SILs.

Table 2. APPLICABLE REGULATORY LIMITS.

Pollutant	Averaging Period	Significant Impact Levels[a] (µg/m^3)[b]	Regulatory Limit[c] (µg/m^3)	Modeled Design Value Used[d]
PM_{10}[e]	24-hour	5.0	150[f]	Maximum 6th highest[g]
$PM_{2.5}$[h]	24-hour	1.2	35[i]	Mean of maximum 8th highest[j]
	Annual	0.2	12[k]	Mean of maximum 1st highest[l]
Carbon monoxide (CO)	1-hour	2,000	40,000[m]	Maximum 2nd highest[n]
	8-hour	500	10,000[m]	Maximum 2nd highest[n]
Sulfur Dioxide (SO_2)	1-hour	3 ppb[o] (7.8 µg/m^3)	75 ppb[p] (196 µg/m^3)	Mean of maximum 4th highest[q]
	3-hour	25	1,300[m]	Maximum 2nd highest[n]
Nitrogen Dioxide (NO_2)	1-hour	4 ppb (7.5 µg/m^3)	100 ppb[s] (188 µg/m^3)	Mean of maximum 8th highest[t]
	Annual	1.0	100[r]	Maximum 1st highest[n]
Lead (Pb)	3-month[u]	NA	0.15[r]	Maximum 1st highest[n]

REC 0638

PET 272

	Quarterly	NA	1.5[r]	Maximum 1st highest[n]
Ozone (O_3)	8-hour	40 TPY VOC[v]	70 ppb[w]	Not typically modeled

a. Idaho Air Rules Section 006 (definition for significant contribution) or as incorporated by reference as per Idaho Air Rules Section 107.03.b.
b. Micrograms per cubic meter.
c. Incorporated into Idaho Air Rules by reference, as per Idaho Air Rules Section 107.
d. The maximum 1st highest modeled value is always used for the significant impact analysis unless indicated otherwise. Modeled design values are calculated for each ambient air receptor.
e. Particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers.
f. Not to be exceeded more than once per year on average over 3 years.
g. Concentration at any modeled receptor when using five years of meteorological data.
h. Particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers.
i. 3-year mean of the upper 98th percentile of the annual distribution of 24-hour concentrations.
j. 5-year mean of the 8th highest modeled 24-hour concentrations at the modeled receptor for each year of meteorological data modeled. For the SIL analysis, the 5-year mean of the 1st highest modeled 24-hour impacts at the modeled receptor for each year.
k. 3-year mean of annual concentration.
l. 5-year mean of annual averages at the modeled receptor.
m. Not to be exceeded more than once per year.
n. Concentration at any modeled receptor.
o. Interim SIL established by EPA policy memorandum.
p. 3-year mean of the upper 99th percentile of the annual distribution of maximum daily 1-hour concentrations.
q. 5-year mean of the 4th highest daily 1-hour maximum modeled concentrations for each year of meteorological data modeled. For the significant impact analysis, the 5-year mean of 1st highest modeled 1-hour impacts for each year is used.
r. Not to be exceeded in any calendar year.
s. 3-year mean of the upper 98th percentile of the annual distribution of maximum daily 1-hour concentrations.
t. 5-year mean of the 8th highest daily 1-hour maximum modeled concentrations for each year of meteorological data modeled. For the significant impact analysis, the 5-year mean of maximum modeled 1-hour impacts for each year is used.
u. 3-month rolling average.
v. An annual emissions rate of 40 ton/year of VOCs is considered significant for O_3.
w. Annual 4th highest daily maximum 8-hour concentration averaged over three years.

If modeled maximum pollutant impacts to ambient air from the emission sources associated with a new facility or modification exceed the SILs, then a cumulative NAAQS impact analysis is necessary to demonstrate compliance with NAAQS and Idaho Air Rules Section 203.02.

A cumulative NAAQS impact analysis for attainment area pollutants involves assessing ambient impacts (typically the design values consistent with the form of the standard) from potential/allowable emissions resulting from the project and emissions from any nearby co-contributing sources (including existing emissions from the facility that are unrelated to the project), and then adding a DEQ-approved background concentration value to the modeled result that is appropriate for the criteria pollutant/averaging-period at the facility location and the area of significant impact. The resulting pollutant concentrations in ambient air are then compared to the NAAQS listed in Table 2. Table 2 also specifies the modeled design value that must be used for comparison to the NAAQS. NAAQS compliance is evaluated on a receptor-by-receptor basis for the modeling domain.

If the cumulative NAAQS impact analysis indicates an exceedance of NAAQS, a culpability analysis can determine if this exceedance is due to emissions from the proposed project. The permit may not be issued if the proposed project has a significant contribution (exceeding the SIL) to the modeled violation. If project-specific impacts are below the SIL, then the project does not have a significant contribution to the specific violations.

Compliance with Idaho Air Rules Section 203.02 is generally demonstrated if: a) applicable specific criteria pollutant emission increases are at a level defined as BRC, using the criteria established by DEQ regulatory interpretation (DEQ 2014); or b) all modeled impacts of the SIL analysis are below the

REC 0639

PET 273

applicable SIL or other level determined to be inconsequential to NAAQS compliance; or c) modeled design values of the cumulative NAAQS impact analysis (modeling all emissions from the facility and co-contributing sources, and adding a background concentration) are less than applicable NAAQS at receptors where impacts from the proposed facility/modification exceeded the SIL or other identified level of consequence; or d) if the cumulative NAAQS analysis showed NAAQS violations, the impact of proposed facility/modification to any modeled violation was inconsequential (typically assumed to be less than the established SIL) for that specific receptor and for the specific modeled time when the violation occurred.

2.5 Toxic Air Pollutant Analyses

Emissions of toxic substances are generally addressed by Idaho Air Rules Section 161:

> *Any contaminant which is by its nature toxic to human or animal life or vegetation shall not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation.*

Permitting requirements for toxic air pollutants (TAPs) from new or modified sources are specifically addressed by Idaho Air Rules Section 203.03 and require the applicant to demonstrate to the satisfaction of DEQ the following:

> *Using the methods provided in Section 210, the emissions of toxic air pollutants from the stationary source or modification would not injure or unreasonably affect human or animal life or vegetation as required by Section 161. Compliance with all applicable toxic air pollutant carcinogenic increments and toxic air pollutant non-carcinogenic increments will also demonstrate preconstruction compliance with Section 161 with regards to the pollutants listed in Sections 585 and 586.*

Per Section 210, if the total project-wide emission increase of any TAP associated with a new source or modification exceeds screening emission levels (ELs) of Idaho Air Rules Section 585 or 586, then the ambient impact of the emission increase must be estimated. If ambient impacts are less than applicable Acceptable Ambient Concentrations (AACs) for non-carcinogens of Idaho Air Rules Section 585 and Acceptable Ambient Concentrations for Carcinogens (AACCs) of Idaho Air Rules Section 586, then compliance with TAP requirements has been demonstrated.

TAPs also classified as HAPs emitted from sources addressed by New Source Performance Standards (NSPS) or National Emission Standards for Hazardous Air Pollutants (NESHAP) were not required to be evaluated for compliance with TAP increments in accordance with IDAPA 58.01.01.210.20 (Subsection 210.20). The DEQ permit writer evaluates the applicability of specific TAPs to the Subsection 210.20 exclusion. Guidance and clarification of Subsection 210.20 source exemptions are included in the DEQ Statement of Basis.

IDAPA 58.01.01.215 sets requirements for mercury emissions. For this standard, fugitive emissions and sources in a source category subject to 40 CFR 63 are exempt. The DEQ permit writer evaluates the applicability of mercury emissions to the exemption criteria. Details are provided in the DEQ Statement of Basis. Adjusted mercury emissions from non-fugitive and non-NESHAP-addressed sources were below the level (25 pounds per year) at which Mercury Best Available Control Technology (MBACT) review is required.

REC 0640

PET 274

3.0 Analytical Methods and Data

This section describes the methods and data used in the analyses to demonstrate compliance with applicable air quality impact requirements. The DEQ Statement of Basis provides a discussion of the methods and data used to estimate criteria and TAP emission rates.

Air Sciences made substantial refinements in assessed operational scenarios, TAP emission calculations, and modeled TAP impacts in response to issues identified after the February/March 2021 public comment period. Air Sciences addressed these issues separately from the NAAQS compliance demonstration presented in the main body of the PTC application and submitted the revised analyses in the *TAP Addendum*. DEQ's review of the *TAP Addendum* is described in the *Modeling Review Attachment* to this memorandum. Since all the refinements resulted in reduced calculated allowable particulate emissions from sources, the previous NAAQS compliance demonstration (described in the main body of this *Modeling Review Memorandum*) did not require revision for permit issuance and remains unaltered. However, DEQ reanalyzed PM_{10} impacts to account for the largest refinements, and results are presented in the *Modeling Review Attachment*.

3.1 Emission Source Data

Emissions of criteria pollutants and TAPs resulting from operation of the SGP facility were estimated by Air Sciences for various applicable averaging periods. The calculation of potential emissions is the responsibility of the DEQ permit writer, and the representativeness and accuracy of emission estimates is not addressed in this modeling memorandum. DEQ air impact analysts are responsible for assuring that potential emission rates provided in the emission inventory are properly used in the model. The rates listed must represent the maximum allowable rate as averaged over the specified period.

Emission rates used in the impact modeling applicability analyses and any modeling analyses, as listed in this memorandum, should be reviewed by the DEQ permit writer and compared with those in the final emission inventory. All modeled criteria air pollutant and TAP emission rates must be equal to or greater than the facility's potential emissions calculated in the PTC emission inventory or proposed permit allowable emission rates.

Emissions from unpaved roads were calculated based on a control efficiency of 90% from chemical application and 33% from watering (combined control efficiency above 93%). Emission controls and emission calculations are not reviewed in this modeling memorandum. However, it is critical for NAAQS compliance that this high level of control be achieved.

Activity-specific (e.g., drilling, blasting, material crushing and conveying, refining, and other ancillary sources) emissions were estimated based on maximum activity rates, coupled with applicable emission estimation techniques. Maximum emissions were calculated on a short-term (hourly and daily) and long-term (annual) basis for ore processing and mining operations, as discussed below.

The ore-processing rate will range from 20,000 ton/day to 25,000 ton/day at full production. Therefore, maximum potential daily ore processing emissions were based on the maximum design rate of 25,000 ton/day. Maximum potential annual emissions were based on potential daily emissions multiplied by 365 days per year.

Emissions from mining operations (drilling, blasting, material extraction and movement, mobile mine machinery use, and other ancillary sources) vary for each year of the life of the mine (LOM). However,

REC 0641

PET 275

for the modeling analyses, the mining operation potential emissions were estimated using conservatively high maximum activity rates provided in Table 3.

Table 3. MINING ACTIVITY RATES FOR POTENTIAL EMISSION CALCULATIONS.

Activity	Maximum Rate		Comments
Drilling	600	holes per blast	--
Blasting	2	blasts per day	--
	1	blast per hour	--
Material extraction and hauling	180,000	tons per day	Ore or DR
Onsite dozing	144	hours per day	6 dozers operating continuously
Onsite grading	72	hours per day	3 graders operating continuously
Onsite water trucking	48	hours per day	2 trucks operating continuously

The potential hourly emission rates for ore processing and mining operation activities were calculated by dividing the daily rate by the 24 hour-per-day operation schedule, and annual rates were calculated by multiplying maximum daily emissions with 365 days per year. This is conservative because the mine is expected to operate for only 355 days per year.

The maximum mine production rate is approximately 42.7 million (MM) tons per year (ton/yr); however, a maximum daily production rate of 180,000 ton/day used for potential emission calculations results in a conservatively higher production rate of approximately 65.7 MMton/yr, approximately 50 percent higher than the projected production rate.

PRI will employ newer model year mining and maintenance machines (excavators, shovels, haul trucks, dozers, graders, portable light plants, etc.) that are expected to meet or exceed applicable regulatory emission standards. Non-road mobile equipment engines are exempt from permitting requirements; therefore, the tailpipe emissions resulting from fuel combustion in the non-road mobile equipment are not quantified for the SGP facility. Background concentrations from McCall, 38 miles west of the SGP, were used in the cumulative NAAQS impact analyses (Section 4.1.2) to conservatively account for the impact contribution of traffic emissions.

The approximately 38-mile long Burntlog Route mine access road will be outside the project ambient air boundary and open to the public. Traffic emissions on public roads generally are considered to be part of background concentrations. Therefore, emissions on the Burntlog Route mine access road that are outside of the project boundary are not included in the SGP analyses. However, the emissions associated with the portion of the Burntlog Route mine access road that is within project boundary (from the south gate to the process area) are included in the SGP analyses. These include dust emissions generated from travel of maintenance equipment, light-duty pickup trucks and buses used for employee, visitor, and contractor transportation, and heavy-duty trucks used for cargo (including fuel, consumables, machine parts, ore processing supplies, ore concentrate, etc.) and services (including food supplies, trash, recyclables, etc.) transportation.

3.1.1 Criteria Pollutant Modeling Applicability and Modeled Emission Rates

If project-specific emission increases for criteria pollutants would qualify for a BRC permit exemption as per Idaho Air Rules Section 221 if it were not for potential emissions of one or more pollutants exceeding the BRC threshold of 10 percent of emissions defined by Idaho Air Rules as significant, then a NAAQS compliance demonstration may not be required for those pollutants with emissions below BRC levels. DEQ's regulatory interpretation policy of exemption provisions of Idaho Air Rules is that: "*A DEQ NAAQS compliance assertion will not be made by the DEQ modeling group for specific criteria*

REC 0642

PET 276

pollutants having a project emissions increase below BRC levels, provided the proposed project would have qualified for a Category I Exemption for BRC emissions quantities except for the emissions of another criteria pollutant" (DEQ 2014). The interpretation policy also states that the exemption criteria of uncontrolled potential to emit (PTE) not to exceed 100 ton/year (Idaho Air Rules Section 220.01.a.i) is not applicable when evaluating whether a NAAQS impact analysis is required. A permit will be issued limiting PTE below 100 ton/year, thereby negating the need to maintain calculated uncontrolled PTE under 100 ton/year. The BRC exemption cannot be used to exempt a project from a pollutant-specific NAAQS compliance demonstration in most cases where a PTC is required for the action regardless of emission quantities, such as the modification of an existing emission or throughput limit.

A NAAQS compliance demonstration must be performed for pollutant increases that would not qualify for the BRC exemption from the requirement to demonstrate compliance with NAAQS.

Site-specific air impact modeling analyses may not be necessary for some pollutants, even where such emissions do not qualify for the BRC exemption. DEQ has developed modeling applicability thresholds, below which a site-specific modeling analysis is not required. DEQ generic air impact modeling analyses that were used to develop the modeling thresholds provide a conservative SIL analysis for projects with emissions below identified threshold levels. Project-specific modeling applicability thresholds are provided in the *Idaho Air Modeling Guideline* (DEQ 2013). These thresholds were based on assuring an ambient impact of less than the established SIL for specific pollutants and averaging periods. DEQ revised modeling applicability thresholds in 2021 as described in the revised DEQ *Air Modeling Guideline* (DEQ 2021). Modeling applicability for the SGP facility was not revised because the application was submitted prior to revision of the thresholds.

If total project-specific emission rate increases of a pollutant are below Level I Modeling Applicability Thresholds, then project-specific air impact analyses are not necessary for permitting. Use of Level II Modeling Applicability Thresholds is conditional, requiring DEQ approval. DEQ approval is based on dispersion-affecting characteristics of the emission sources such as stack height, stack gas exit velocity, stack gas temperature, distance from sources to ambient air, presence of elevated terrain, and potential exposure to sensitive public receptors.

For the SGP analyses, several modeling scenarios were considered to evaluate the worst-case air impacts from the SGP facility. The different modeling scenarios are discussed in Section 3.1.3. Table 4 provides a comparison between facility-wide maximum PTE for the highest-emitting scenario (W3) and modeling applicability thresholds. The short-term and long-term PTE emissions are equal to the sum of process and ancillary emissions and mining fugitive emissions. It is important to note that the process and ancillary source emissions remain the same for each modeling scenario discussed in Section 3.1.3.

Table 4. SITE-SPECIFIC CRITERIA POLLUTANT MODELING APPLICABILITY.

Source Category	Carbon Monoxide (CO)	Nitrogen Oxides (NOx)		$PM_{2.5}$[a]		PM_{10}[b]	Sulfur Dioxide (SO_2)		Lead (Pb)
	lb/hr[c]	ton/yr[d]	lb/hr	ton/yr	lb/hr	lb/hr	ton/yr	lb/hr	lb/month[e]
Process and ancillary	33.5	37.9	55.4	36.4	13.4	21.7	6.5	1.88	0.0437
Mining fugitive	1,742.0	17.1	46.8	98.9	22.5	224.7	0.03	0.09	--
Total	1,775.5	55.0	102.2	135.3	35.9	246.4	6.5	1.97	0.0437
Level I threshold	15.0	1.2	0.2	0.35	0.054	0.22	1.2	0.21	14.0
Modeling	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

REC 0643

PET 277

required									

a. Particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers.
b. Particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometer.
c. Pounds per hour.
d. Tons per year.
e. Pounds per month.

As indicated in Table 4, the SGP facility-wide maximum PTE are greater than the respective Level I thresholds for all criteria pollutants and averaging periods except for Pb. Therefore, modeling is triggered for applicable averaging periods for CO, NOx, $PM_{2.5}$, PM_{10}, and SO_2. Modeling is not required for Pb. The use of Level II modeling thresholds was not approved by DEQ for this project.

Tables 5-7 list criteria pollutant emission rates used in the cumulative NAAQS impact analyses for the worst-case modeling scenarios. Significant Impact Level (SIL) analyses were not performed. Based on the magnitude of the facility-wide emissions and preliminary modeling analyses, it was determined that the impacts from the SGP emissions exceeded the SIL for most criteria pollutants. Therefore, SIL analyses were considered redundant and not performed for this report. Table 5 lists the source-specific modeled emission rates for 24-hour and annual $PM_{2.5}$ and 24-hour PM_{10} (worst-case modeling scenario: W5). Modeling scenario W5 was later removed as an allowable operational scenario as described in the submitted *TAP Addendum* and the *Modeling Review Attachment* to this memorandum. Air Sciences did not adjust the existing PM_{10} and $PM_{2.5}$ analyses for the removal of scenario W5 because NAAQS compliance was already confidently demonstrated with W5 included. Table 6 lists the source-specific modeled emission rates for 1-hour and 8-hour CO and annual NO_2 (worst-case modeling scenario: W1). Table 7 lists the source-specific modeled emission rates for 1-hour NO_2 and 1-hour and 3-hour SO_2 (worst-case modeling scenario: B1). Modeling scenarios are discussed in Section 3.1.3. For 1-, 3-, and 8-hour averaging times, hourly emission rates provided in pounds per hour were used. For 24-hour averaging time, daily emission rates provided in pounds per day were used. For the annual averaging time, annual emission rates provided in tons per year were used. All modeled emission rates in Tables 5-7 are listed in units of pounds per hour (lb/hr). The total modeled input emission rates (highest emission scenario) are listed in Table 8.

Table 5. MODELED 24-HOUR PM_{10}, 24-HOUR $PM_{2.5}$, AND ANNUAL $PM_{2.5}$ EMISSION RATES FOR CUMULATIVE NAAQS IMPACT ANALYSES (WORST-CASE MODELING SCENARIO, W5).

Type of Source	Source ID	Description	24-hour PM_{10} (lb/hr)[a]	24-hour $PM_{2.5}$ (lb/hr)	Annual $PM_{2.5}$ (lb/hr)
Point Sources	LS1L	Mill Lime Silo #1 Loading	3.54E-03	5.21E-04	2.50E-05
	MILLS2L	Mill Lime Silo #2 Loading	3.54E-03	5.21E-04	2.50E-05
	SB1	Sb Dryer (2.72 MMBtu/hr Propane-Fired)	2.08E-02	2.08E-02	2.08E-02
	SB2	Sb Bagging	1.18E-01	1.18E-01	1.18E-01
	AC	Autoclave	5.08E+00	5.08E+00	5.08E+00
	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	5.42E-03	5.42E-03	4.45E-04
	ACS1L	AC Lime Silo #1 Loading	1.42E-02	2.08E-03	9.99E-05
	ACS2L	AC Lime Silo #2 Loading	1.42E-02	2.08E-03	9.99E-05
	ACS3L	AC Lime Silo #3 Loading	1.42E-02	2.08E-03	9.99E-05
	ACS4L	AC Lime Silo #4 Loading	7.08E-03	1.04E-03	4.99E-05
	CKD	Carbon Regeneration (Drum)	4.20E-01	4.20E-01	4.20E-01
	CKB	Carbon Regeneration (Kiln)	1.73E-02	1.73E-02	1.73E-02
	EW	Electrowinning Cells and Pregnant Solution Tank	7.00E-02	7.00E-02	7.00E-02
	MR	Mercury Retort	1.00E-02	1.00E-02	1.42E-03
	MF	Induction Melting Furnace	1.42E+00	1.42E+00	2.02E-01
	EDG1	Camp Emergency Generator (Mfr. Yr.	1.84E-02	1.84E-02	5.03E-03

REC 0644

PET 278

Table 5. MODELED 24-HOUR PM_{10}, 24-HOUR $PM_{2.5}$, AND ANNUAL $PM_{2.5}$ EMISSION RATES FOR CUMULATIVE NAAQS IMPACT ANALYSES (WORST-CASE MODELING SCENARIO, W5).					
Type of Source	**Source ID**	**Description**	**24-hour PM_{10} (lb/hr)[a]**	**24-hour $PM_{2.5}$ (lb/hr)**	**Annual $PM_{2.5}$ (lb/hr)**
		>2007; diesel)			
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	1.84E-02	1.84E-02	5.03E-03
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	1.84E-02	1.84E-02	5.03E-03
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	3.67E-03	3.67E-03	1.01E-03
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7.65E-04	7.65E-04	7.65E-04
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	3.83E-02	3.83E-02	3.83E-02
	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	3.06E-02	3.06E-02	3.06E-02
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	3.06E-02	3.06E-02	3.06E-02
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	3.06E-02	3.06E-02	3.06E-02
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	1.91E-03	1.91E-03	1.91E-03
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	1.91E-03	1.91E-03	1.91E-03
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	1.91E-03	1.91E-03	1.91E-03
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	3.83E-03	3.83E-03	3.83E-03
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	1.53E-02	1.53E-02	1.53E-02
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	2.30E-02	2.30E-02	2.30E-02
	PSL	Prill Silos Loading (2 x 100 ton)	5.83E-02	8.83E-03	8.83E-04
	CS1L	Cement/Shotcrete Silo #1 Loading	1.13E-03	1.67E-04	3.42E-04
	CS2L	Cement/Shotcrete Silo #2 Loading	1.13E-03	1.67E-04	3.42E-04
	LS6	Limestone transfer to Ball Mill Feed Bin	5.18E-02	8.00E-03	6.17E-03
	LSBM	Limestone Ball Mill	1.60E+00	5.70E-01	4.39E-01
	LS9	Limestone transfer to Kiln Feed Bin	1.22E-02	1.89E-03	1.60E-03
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	9.15E-01	9.15E-01	7.77E-01
	LKC	PFR Shaft Lime Kiln Combustion	1.69E-01	1.69E-01	1.43E-01
	LCR	Lime Mill Crushing and associated transfers In and Out	2.39E-01	8.52E-02	7.23E-02
	LSL	Pebble Lime Silo Loading via Bucket Elevator	6.20E-03	6.20E-03	5.26E-03
Area Sources	WEP	West End Pit	3.69E+01	3.32E+00	3.32E+00
	UGEXP	Underground Exploration	1.66E-04	2.51E-05	2.51E-05
Line Sources	AR01	Access Road within Operations Boundary	7.02E-02	7.02E-03	7.03E-03
	AR02	Access Road within Operations Boundary	5.39E-02	5.40E-03	5.41E-03
	AR03	Access Road within Operations Boundary	1.36E-01	1.36E-02	1.37E-02
	AR04	Access Road within Operations Boundary	1.31E-01	1.31E-02	1.31E-02
Volume Sources	WEPBL	West End Pit Blasting	1.39E+01	8.04E-01	8.04E-01
	WEDRSF	West End Pit Development Rock Storage Facility	2.38E+00	1.26E+00	1.26E+00
	OC1	Loader Transfer of Ore to Grizzly	4.79E-02	1.35E-02	1.35E-02
	OC2	Grizzly to Apron Feeder	4.79E-02	1.35E-02	1.35E-02

REC 0645

PET 279

Table 5. MODELED 24-HOUR PM_{10}, 24-HOUR $PM_{2.5}$, AND ANNUAL $PM_{2.5}$ EMISSION RATES FOR CUMULATIVE NAAQS IMPACT ANALYSES (WORST-CASE MODELING SCENARIO, W5).					
Type of Source	**Source ID**	**Description**	**24-hour PM_{10} (lb/hr)[a]**	**24-hour $PM_{2.5}$ (lb/hr)**	**Annual $PM_{2.5}$ (lb/hr)**
	OC3	Apron Feeder to Dribble Conveyor	4.79E-02	1.35E-02	1.35E-02
	OC4	Apron Feeder to Vibrating Grizzly	4.79E-02	1.35E-02	1.35E-02
	OC5	Dribble Conveyor to Vibrating Grizzly	4.79E-02	1.35E-02	1.35E-02
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	4.79E-02	1.35E-02	1.35E-02
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	5.63E-01	1.04E-01	1.04E-01
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	4.79E-02	1.35E-02	1.35E-02
	OC9	Stockpile Transfers to Reclaim Conveyors	2.53E-01	3.91E-02	3.91E-02
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	2.53E-01	3.91E-02	3.91E-02
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	2.53E-01	3.91E-02	3.91E-02
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	6.21E-01	1.15E-01	1.15E-01
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	5.29E-02	1.50E-02	1.50E-02
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	2.92E-02	4.37E-03	2.10E-04
	MILLS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	2.92E-02	4.37E-03	2.10E-04
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	5.60E-02	8.00E-03	7.99E-04
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	5.60E-02	8.00E-03	7.99E-04
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	5.60E-02	8.00E-03	7.99E-04
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	5.60E-02	8.00E-03	4.00E-04
	PSU	Prill Silos Unloading (2 x 100 ton)	5.83E-02	8.83E-03	8.83E-04
	CS1U	Cement/Shotcrete Silo #1 Unloading	9.33E-03	1.33E-03	2.74E-03
	CS2U	Cement/Shotcrete Silo #2 Unloading	9.33E-03	1.33E-03	2.74E-03
	CAL	Aggregate Bin Loading	3.30E-01	5.00E-02	2.85E-02
	CAU	Aggregate Bin Unloading	3.30E-01	5.00E-02	2.85E-02
	CM	Central Mixer Loading	1.83E-02	2.67E-03	5.48E-03
	PCSP1	Portable Crushing and Screening Plant 1	2.33E-01	3.04E-02	3.04E-02
	PCSP2	Portable Crushing and Screening Plant 2	2.33E-01	3.04E-02	3.04E-02
	LS1	Limestone transfer to Primary Crusher Hopper	5.18E-02	8.00E-03	6.17E-03
	LS2	Primary Crushing and Associated Transfers In and Out	1.13E-01	1.69E-02	1.31E-02
	LS3	Primary Screening and Associated Transfers In and Out	4.10E-01	6.21E-02	4.79E-02
	LS4	Secondary Crushing and Associated Transfers In and Out	1.13E-01	1.69E-02	1.31E-02
	LS5	Secondary Screening and Associated Transfers In and Out	4.10E-01	6.21E-02	4.79E-02
	LS7	Limestone transfer to Ball Mill Feed Conveyor	5.18E-02	8.00E-03	6.17E-03
	LS8	Ball Mill Feed transfer to Ball Mill	5.18E-02	8.00E-03	6.17E-03
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	1.22E-02	1.89E-03	1.60E-03
	LS11	Fines Screening and Associated Transfers In and Out	9.68E-02	1.47E-02	1.25E-02

Table 5. MODELED 24-HOUR PM_{10}, 24-HOUR $PM_{2.5}$, AND ANNUAL $PM_{2.5}$ EMISSION RATES FOR CUMULATIVE NAAQS IMPACT ANALYSES (WORST-CASE MODELING SCENARIO, W5).					
Type of Source	**Source ID**	**Description**	**24-hour PM_{10} (lb/hr)[a]**	**24-hour $PM_{2.5}$ (lb/hr)**	**Annual $PM_{2.5}$ (lb/hr)**
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	1.22E-02	1.89E-03	1.60E-03
	LSU	Pebble Lime Silo discharge to Lime Slaker	6.20E-04	6.20E-04	5.26E-04
	HRT001-HRT072	Haul Road[b]	9.09E-01	9.10E-02	9.11E-02
	HRN001-HRN022	Haul Road[b]	9.09E-01	9.10E-02	9.11E-02

a. Pounds per hour.

b. The Haul Road was represented in the model as a series of volume sources. The emission rates listed in this table represent each individual volume source.

Table 6. MODELED 1-HOUR CO, 8-HOUR CO, and ANNUAL NO_2 EMISSION RATES FOR CUMULATIVE NAAQS IMPACT ANALYSES (WORST-CASE MODELING SCENARIO, W1).				
Type of Source	**Source ID**	**Description**	**1-hour, 8-hour CO (lb/hr)[a]**	**Annual NO_2 (lb/hr)**
Point Sources	SB1	Sb Dryer (2.72 MMBtu/hr Propane-Fired)	2.23E-01	3.86E-01
	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	1.39E+00	8.27E-03
	CKD	Carbon Regeneration (Drum)	1.20E-01	1.20E-02
	CKB	Carbon Regeneration (Kiln)	1.85E-01	3.20E-01
	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	7.72E+00	1.61E-01
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	7.72E+00	1.61E-01
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	7.72E+00	1.61E-01
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	1.54E+00	2.01E-02
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	8.20E-03	1.42E-02
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	4.10E-01	7.10E-01
	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	3.28E-01	5.68E-01
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	3.28E-01	5.68E-01
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	3.28E-01	5.68E-01
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	2.05E-02	3.55E-02
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	2.05E-02	3.55E-02
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	2.05E-02	3.55E-02
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	4.10E-02	7.10E-02
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	1.64E-01	2.84E-01
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	2.46E-01	4.26E-01
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	3.17E+00	1.44E+00

REC 0647

PET 281

	LKC	PFR Shaft Lime Kiln Combustion	1.81E+00	2.66E+00
Volume Source	WEPBL	West End Pit Blasting	1.74E+03	3.90E+00

a. Pounds per hour.

Table 7. MODELED 1-HOUR NO_2, 1-HOUR SO_2, AND 3-HOUR SO_2 EMISSION RATES FOR CUMULATIVE NAAQS IMPACT ANALYSES (WORST-CASE MODELING SCENARIO, B1).

Type of Source	Source ID	Description	1-hour NO_2 (lb/hr)[a]	1-hour, 3-hour SO_2 (lb/hr)
Point Sources	SB1	Sb Dryer (2.72 MMBtu/hr Propane-Fired)	3.86E-01	4.73E-02
	AC	Autoclave	0.00E+00	6.53E-01
	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	2.42E+00	2.95E-01
	CKD	Carbon Regeneration (Drum)	1.20E-02	0.00E+00
	CKB	Carbon Regeneration (Kiln)	3.20E-01	3.92E-02
	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0.00E+00	1.45E-02
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0.00E+00	1.45E-02
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0.00E+00	1.45E-02
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0.00E+00	2.90E-03
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	1.42E-02	1.74E-03
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	7.10E-01	8.69E-02
	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	5.68E-01	6.95E-02
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	5.68E-01	6.95E-02
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	5.68E-01	6.95E-02
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	3.55E-02	4.34E-03
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	3.55E-02	4.34E-03
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	3.55E-02	4.34E-03
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	7.10E-02	8.69E-03
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	2.84E-01	3.48E-02
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	4.26E-01	5.21E-02
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	1.69E+00	8.45E-03
	LKC	PFR Shaft Lime Kiln Combustion	3.13E+00	3.83E-01
Volume Source	BTBL	Bradley Tailings Blasting	4.68E+01	9.36E-02

a. Pounds per hour.

Table 8. CRITERIA POLLUTANT TOTAL MODELED EMISSION RATES (WORST-CASE MODELING SCENARIOS).

Pollutant	Averaging Time	Emissions[a]

REC 0648

PET 282

CO	8 hours	1,775.50	lb/hr
	1 hour	1,775.50	lb/hr
NO_2	1 year	54.93	ton/yr
	1 hour	58.07	lb/hr
$PM_{2.5}$	1 year	135.23	ton/yr
	24 hours	781.69	lb/day
PM_{10}	24 hours	5,768.93	lb/day
SO_2	3 hours	1.97	lb/hr
	1 hour	1.97	lb/hr

[a.] Combined process, ancillary, and fugitive emissions modeled. Fugitive emissions vary by pit scenario. Maximum pit scenario emissions are shown.

Ozone (O_3) differs from other criteria pollutants in that it is not typically emitted directly into the atmosphere. O_3 is formed in the atmosphere through reactions of VOCs, NOx, and sunlight. Atmospheric dispersion models used in stationary source air permitting analyses cannot be used to estimate O_3 impacts resulting from VOC and NOx emissions from an industrial facility. O_3 concentrations resulting from area-wide emissions are predicted by using more complex airshed models such as the Community Multi-Scale Air Quality (CMAQ) modeling system. Use of the CMAQ model is very resource-intensive and DEQ asserts that performing a CMAQ analysis for a particular permit application is not typically a reasonable or necessary requirement for air quality permitting.

Addressing secondary formation of O_3 within the context of permitting a new stationary source has been somewhat addressed in EPA regulation and policy. As stated in a letter from Gina McCarthy of EPA to Robert Ukeiley, acting on behalf of the Sierra Club (letter from Gina McCarthy, Assistant Administrator, United States Environmental Protection Agency, to Robert Ukeiley, January 4, 2012):

> *. . . footnote 1 to sections 51.166(I)(5)(I) of the EPA's regulations says the following: "No de minimis air quality level is provided for ozone. However, any net emission increase of 100 tons per year or more of volatile organic compounds or nitrogen oxides subject to PSD would be required to perform an ambient impact analysis, including the gathering of air quality data."*
>
> *"The EPA believes it unlikely a source emitting below these levels would contribute to such a violation of the 8-hour ozone NAAQS, but consultation with an EPA Regional Office should still be conducted in accordance with section 5.2.1.c. of Appendix W when reviewing an application for sources with emissions of these ozone precursors below 100 TPY."*

DEQ determined it was not appropriate or necessary to require a quantitative source-specific O_3 impact analysis because allowable emission estimates of VOCs and NOx are below the 100 tons/year threshold.

3.1.2 TAPs Modeling Applicability and Modeled Emission Rates

Source-specific applicability for TAP analyses and calculated TAP emission rates were reworked by Air Sciences and presented in the *TAP Addendum*, submitted in October 2021. DEQ's review of the *TAP Addendum* is presented in the *Modeling Review Attachment* of this memorandum.

REC 0649

PET 283

3.1.3 Modeling Scenarios

As discussed in Section 2.1, conventional open-pit methods will be used to extract ore and DR from three pits: YPP, HFP, and WEP, and legacy tailings from BT. Ore will be hauled to the crushing area, and the DR will be moved to four DRSF: Yellow Pine (YPDRSF), Hangar Flats (HFDRSF), West End (WEDRSF), and Fiddle (FDRSF). The SGP site layout provided later in Figure 4 shows these locations.

PRI plans for an up to three-year construction schedule to build mine site facilities and infrastructure, as well as the power transmission line, followed by 12 years of mining operations (i.e., LOM Years 1 through 12). Depending on the mine design and operating schedule, mining activity rates will vary temporally and spatially during the 12 years of mine production and operation. For example, ore production varies from approximately 6.8 MMton in LOM Year 1 (67% in YPP, 26% in WEP, and 7% in BT) to 9 MMton in LOM 3 (78% in YPP, 10% in BT, 7% in WEP, and 5% in HFP). Similarly, DR production varies from approximately 4.8 MMton in LOM Year 12 (100% in WEP) to 34 MMton in each of LOM Years 4 through 9, with varying distribution among the four DRSF for each LOM Year. The total material (ore and DR) production varies from approximately 12.5 MMton in LOM Year 12 to 42.7 MMton in LOM Year 4.

Similar to the material production, the distribution and hauling of DR to the four destinations (YPDRSF, HFDRSF, WEDRSF, FDRSF) also will vary for each LOM year. Depending on the material origin (pits and BT) and destination (crushing area and DRSF), material hauling distances also will vary for each LOM year.

Therefore, depending on material production rates and origin, DR destination, and hauling distances, mining emissions will vary spatially and temporally throughout the mine life. For permitting purposes, PRI used a maximum production rate of 180,000 tons of material (ore and/or DR) per day, for an annual production rate of 65.7 MMton/yr. This annual production rate is more than 50% higher than the estimated maximum total material production rate of 42.7 MMton/yr.

In order to allow PRI with operation flexibility and to capture variability in material origin and destination in the air quality analyses, several pit scenarios were developed for the SGP air quality analyses. Each pit scenario uses the maximum production rate of 180,000 ton/day in a single pit and uses a single material destination. Each pit has a dedicated ore scenario that assumes all material produced is ore and is hauled to the crusher area; and depending on mine design multiple DR destination scenarios each assuming all material produced is DR and is transported to a single DRSF. For example, most of the DR from HFP will be moved to HFDRSF and during LOM Years 2 through 10, but a fraction of this rock will be moved to FDRSF during LOM Years 3 and 8, and a fraction to YPDRSF during LOM Year 9. Therefore, in order to evaluate all hauling scenarios originating from HFP, the following four (one for ore hauling, three for DR hauling) HFP scenarios were modeled:

1. HFP Scenario 1 – 180,000 ton/day of ore produced and hauled to the crusher area
2. HFP Scenario 2 – 180,000 ton/day of DR produced and hauled to the FDRSF
3. HFP Scenario 3 – 180,000 ton/day of DR produced and hauled to the HFDRSF
4. HFP Scenario 4 – 180,000 ton/day of DR produced and hauled to the YPDRSF

Overall, 14 scenarios were modeled for $PM_{2.5}$ and PM_{10} analyses to cover all possible origin and destination combinations. Each modeling scenario included processing and ancillary source potential emissions. The multiple scenarios modeled for $PM_{2.5}$ and PM_{10} analyses are presented in Table 9. This table also shows the six origin/destination options that are not applicable to the SGP Project as denoted by "0 ton/day." These six scenarios are not feasible because the timing of the activity within the sequence of

REC 0650

PET 284

mine operations makes the scenarios logistically impossible. Also, Scenario W5 was eliminated after the February/March 2021 public comment period, as presented in the *TAP Addendum*.

Table 9. MODELING SCENARIOS FOR $PM_{2.5}$ AND PM_{10} ANALYSES.

Pit Scenario	Pit/Origin (ton/day)				Ore Destination (ton/day)	DR Destination (ton/day)			
	YPP	HFP	WEP	BT	STKP	FDRSF	HFDRSF	YPDRSF	WEDRSF
Y1	180,000	--	--	--	180,000	--	--	--	--
Y2	180,000	--	--	--	--	180,000	--	--	--
Y3	180,000	--	--	--	--	--	180,000	--	--
Y4	0	--	--	--	--	--	--	0	--
Y5	0	--	--	--	--	--	--	--	0
H1	--	180,000	--	--	180,000	--	--	--	--
H2	--	180,000	--	--	--	180,000	--	--	--
H3	--	180,000	--	--	--	--	180,000	--	--
H4	--	180,000	--	--	--	--	--	180,000	--
H5	--	0	--	--	--	--	--	--	0
W1	--	--	180,000	--	180,000	--	--	--	--
W2	--	--	180,000	--	--	180,000	--	--	--
W3	--	--	180,000	--	--	--	180,000	--	--
W4	--	--	180,000	--	--	--	--	180,000	--
W5	--	--	180,000	--	--	--	--	--	180,000
B1	--	--	--	180,000	180,000	--	--	--	--
B2	--	--	--	180,000	--	--	180,000	--	--
B3	--	--	--	0	--	0	--	--	--
B4	--	--	--	0	--	--	--	0	--
B5	--	--	--	0	--	--	--	--	0

Scenario Y4 is not applicable because the YPDRSF and the YPP are in the same area; therefore, the pit cannot be backfilled with development rock until after mining of the pit is completed. Scenarios Y5 and H5 are not applicable because the WEDRSF will only be utilized by the WEP because of its proximity; it is only accessible from the WEP. Scenarios B3, B4 and B5 are not applicable because the development rock from the BT will only be hauled to the HFDRSF because of its proximity. All other development rock storage facilities are significantly farther away from BT.

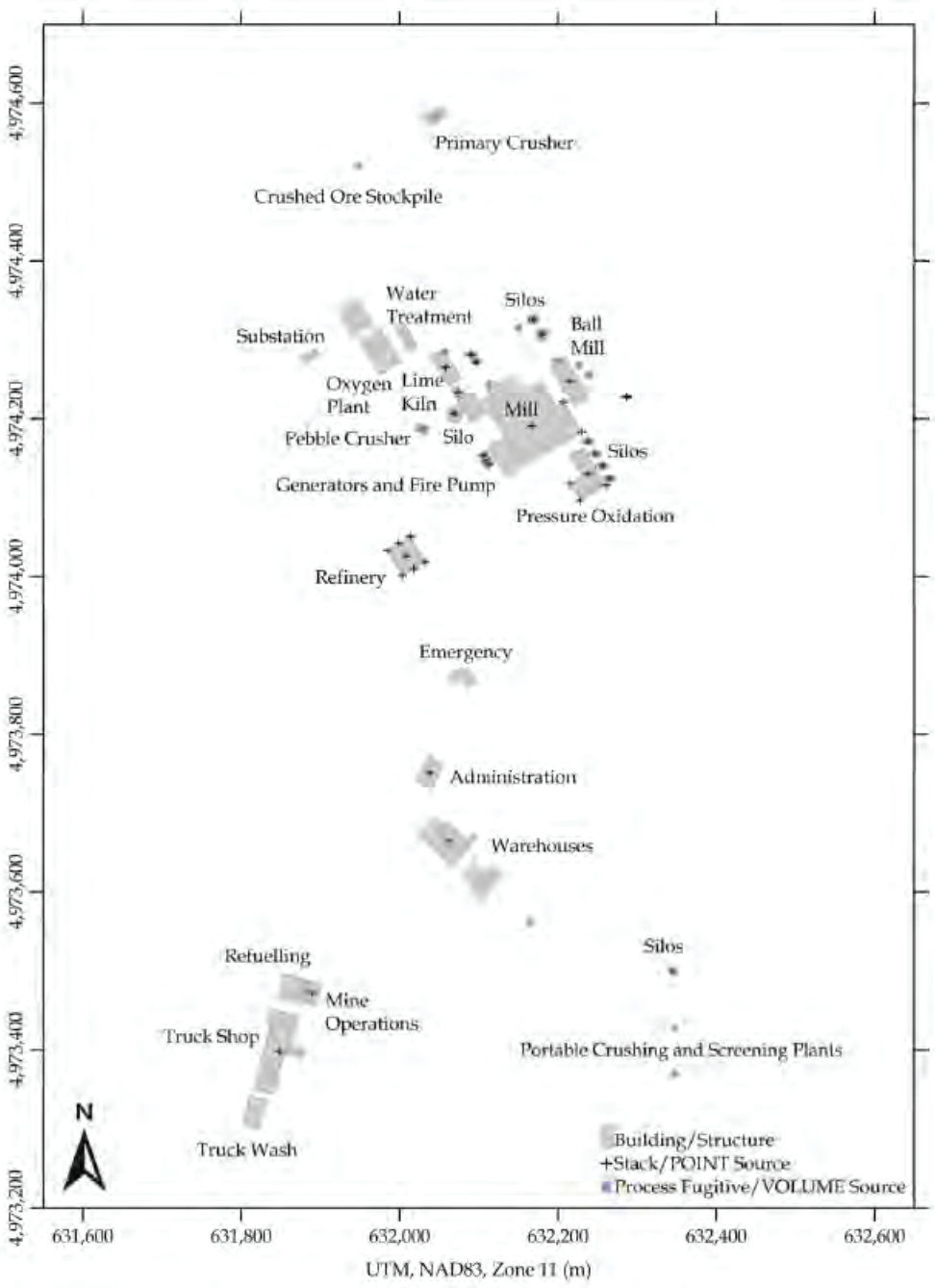
The fugitive CO, NO_2, and SO_2 emissions are limited to pits only, and they do not vary by ore and/or DR hauling and destinations. Therefore, for these pollutants, one scenario for each pit, including processing and ancillary source potential emissions, was modeled, i.e., scenarios Y1, H1, W1, and B1.

The TAP emissions are limited to processing and ancillary sources, so a single scenario was modeled for each applicable TAP analysis.

3.1.4 Processing, Refining, and Ancillary Sources

The processing, refining, and ancillary sources with exhaust stacks, such as baghouse-equipped sources, generators, process and building heaters, autoclave, retort, smelting furnace, carbon kiln, lime kiln, etc., were modeled as POINT sources. The process sources without exhaust stacks, such as material transfers, ore screening and crushing, etc., were modeled as VOLUME sources. A plot plan showing the processing and refining area buildings and sources is provided in Figure 3. Process and ancillary source model input parameters are provided later in Tables 13 and 14.

Figure 3. PROCESSING AND REFINING AREA BUILDING AND SOURCE LAYOUT.



3.1.5 Fugitive Sources: Blasting, Material Origin and Destination, and Underground Exploration Emissions

Blasting emissions were represented by a VOLUME source located inside a pit. Each material origin location (YPP, HFP, WEP, BT) was modeled as an AREA source and comprised appropriate emissions from drilling, material loading, dozing, and surface exploration. Ore destination (crusher area) was modeled as a VOLUME source and comprised ore unloading emissions. Each DR destination (FDRSF,

HFDRSF, YPDRSF, WEDRSF) was modeled as a VOLUME source comprising appropriate emissions from DR unloading, dozing, and wind erosion. Emissions from underground core sampling drilling (UGEXP) in the Scout prospect decline were represented by an AREA source characterized by the portal opening dimensions.

Model input physical characteristics for blasting and possible material origin and destination locations, and Scout portal are presented in Table 10. This table also shows the source type and associated dimensions for each of the modeled fugitive source/location. The VOLUME source dimensions for blasting provided in Table 10 were based on an estimated blast area. For the remaining AREA and VOLUME sources listed in Table 10, the dimensions were developed by reasonably fitting an equal-area rectangle within the actual footprint of each fugitive source. Blasting is not expected to occur in BT. However, blasting emissions were modeled in BT (BTBL) in order to streamline the permitting process.

Table 10. MODELED FUGITIVE ACTIVITY LOCATIONS.

Model ID	Activity Location	Type	Lateral Dimensions (m)	Emission Sources
YPP	Yellow Pine Pit	AREA	882 × 882	Drilling, loading, dozing, surface exploration
HFP	Hangar Flats Pit	AREA	491 × 491	Drilling, loading, dozing, surface exploration
WEP	West End Pit	AREA	376 × 376	Drilling, loading, dozing, surface exploration
BT	Bradley Tailings	AREA	820 × 420	Loading, dozing, wind erosion
YPPBL	Yellow Pine Pit (Blasting)	VOLUME	87 × 87	Blasting
HFPBL	Hangar Flats Pit (Blasting)	VOLUME	87 × 87	Blasting
WEPBL	West End Pit (Blasting)	VOLUME	87 × 87	Blasting
BTBL	Bradley Tailings (Blasting)	VOLUME	87 × 87	Blasting
STKP	PC Stockpile	VOLUME	229 × 229	Unloading, dozing, wind erosion
FDRSF	Fiddle DRSF	VOLUME	775 × 775	Unloading, dozing, wind erosion
HFDRSF	Hangar Flats DRSF	VOLUME	752 × 752	Unloading, dozing, wind erosion
YPDRSF	Yellow Pine DRSF	VOLUME	784 × 784	Unloading, dozing, wind erosion
WEDRSF	West End DRSF	VOLUME	533 × 533	Unloading, dozing, wind erosion
UGEXP	Scout Portal	AREA	4.9 × 4.9	Sample core drilling

The model input physical parameters for blasting, material origin and destination locations, and Scout portal are provided in Table 11.

Table 11. MODEL INPUT PARAMETERS FOR FUGITIVE ACTIVITY LOCATIONS.

Model ID	Base Elevation (m)	Release Height (m)	Initial Lateral Dispersion (m)	Initial Vertical Dispersion (m)
YPP	1,832.4	4.7	N/A	4.4
HFP	1,993.3	4.7	N/A	4.4
WEP	2,191.8	4.7	N/A	4.4
BT	2,011.7	4.7	N/A	4.4
YPPBL	1,717.2	15.0	20.2	7.0
HFPBL	1,890.6	15.0	20.2	7.0
WEPBL	1,994.0	15.0	20.2	7.0

BTBL	2,011.7	15.0	20.2	7.0
STKP	1,979.8	4.7	53.3	4.4
FDRSF	2,115.2	4.7	180.2	4.4
HFDRSF	2,079.8	4.7	174.8	4.4
YPDRSF	1,904.1	4.7	182.2	4.4
WEDRSF	2,376.5	4.7	124.1	4.4
UGEXP	2,018.0	0	N/A	0

The blasting physical parameters were developed from dimensions (provided in Table 10) based on blast area used in the emission calculation. The blasting release height is the midpoint of the blasting height (30 m).

The initial lateral and vertical dispersion dimensions for blasting were calculated per methods specified in (EPA 2018c) for a volume source not on or adjacent to a building, as:

$$Initial\ Lateral\ Dispesion = \frac{Width\ (87\ m)}{4.3}$$

$$Initial\ Vertical\ Dispesion = \frac{Height\ (30\ m)}{4.3}$$

For the pit and DRSF fugitive activity locations listed in Table 10, i.e., YPP, HFP, WEP, BT, FDRSF, HFDRSF, and WEDRSF, the release height was based on the haul truck height (weighted based on model-specific usage) and calculated using the recommendations provided in the Haul Road Workgroup Report (EPA 2012), as:

$$Release\ Height = \frac{Plume\ Top\ (Weighted\ Truck\ Height \times 1.7)}{2}$$

The applicable initial lateral dispersion for each VOLUME source was calculated from the respective shorter dimension and EPA-specified methods (EPA 2018c) (EPA 2016) as follows:

$$Initial\ Lateral\ Dispesion = \frac{Short\ Lateral\ Dimension}{2.15}$$

The applicable initial vertical dispersion for each AREA and VOLUME source was calculated from the respective vertical dimension and EPA-specified methods (EPA 2018c) (EPA 2016) as follows:

$$Initial\ Vertical\ Dispersion = \frac{Plume\ Top\ (Weighted\ Truck\ Height \times 1.7)}{2.15}$$

Scout portal was modeled as a surface-based AREA source with zero release height.

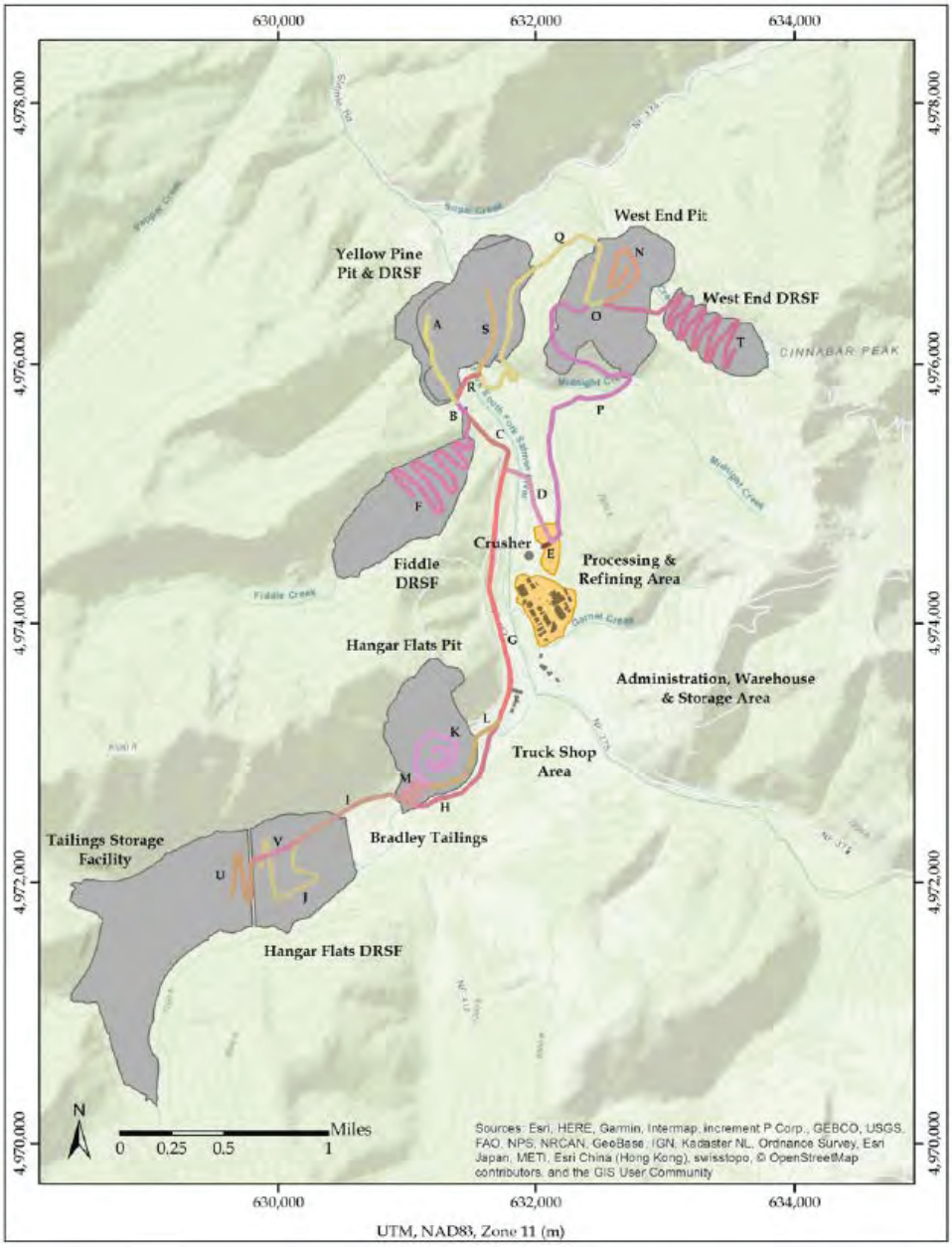
3.1.6 Fugitive Sources: Haul Roads

A representative haul road network for hauling material from inside the pit (or origin) to various destinations was developed for each pit scenario provided in Table 9. The haul road network is presented in Figure 4.

REC 0654

PET 288

Figure 4. HAUL ROAD NETWORK AND SECTIONS.



As shown in Figure 4, the haul road network was divided into 22 sections, A through V. Each section was further divided into multiple segments with a length equal to twice the adjusted haul road width of 32.5 m (26 m road width plus 6 m (EPA 2012)). Each of the segments was characterized as an individual VOLUME source in the model, with a release height of 4.75 m (weighted-average truck height times 1.7, divided by 2 (EPA 2012)), an initial lateral dispersion of 15.1 m (adjusted road width divided by 2.15 (EPA 2012)), and an initial vertical dispersion of 4.42 m (weighted-average top-of-plume height divided by 2.15 (EPA 2012)). Material hauling emissions associated with each origin-destination route were assigned to each segment along the route based on estimated total emissions along the route and traffic distribution along each section, as provided in Table 12 for the four HFP scenarios.

REC 0655

PET 289

Table 12. HAUL ROAD EMISSION DISTRIBUTION GRID FOR HFP SCENARIOS.					
Pit Scenario		**H1**	**H2**	**H3**	**H4**
Route: Origin-Destination		**HFP-STKP**	**HFP-FDRSF**	**HFP-HFDRSF**	**HFP-YPDRSF**
Segment Emission Denominator		96	148	87	115
Section	**No. of Segments**	**Traffic Distribution per Route**			
A	37	--	--	--	--
B	3	--	--	--	1
C	11	--	1	--	1
D	14	1	--	--	--
E	2	--	--	--	--
F	55	--	1	--	--
G	38	1	1	--	1
H	20	--	--	--	--
I	20	--	--	1	--
J	27	--	--	1	--
K	28	1	1	1	1
L	16	1	1	--	1
M	12	--	--	1	--
N	22	--	--	--	--
O	2	--	--	--	--
P	57	--	--	--	--
Q	49	--	--	--	--
R	6	--	--	--	1
S	13	--	--	--	1
T	72	--	--	--	--
U	19	--	--	--	--
V	7	--	--	--	--

The top row in Table 12 shows the pit scenarios, and the next two rows show hauling route and the associated segment emission denominator (SED) used to distribute segment emissions along each route. The remainder of Table 12 presents the number of segments for each road section (shown in Figure 4) and the associated traffic distribution factor for each route. The emission distribution for each applicable segment is illustrated in the following example.

For route: HFP–STKP (Hangar Flats pit to crusher stockpile), Figure 4 shows that material from HFP will be hauled to the crusher area following the route along Sections K, L, G, and D. All (100%) of the ore from HFP will travel on each of these sections; therefore, each of these sections has a traffic distribution factor of 1.0 for this route.

The SED for each route is the sum-product of the number of segments and traffic distribution for the applicable sections. The SED for the HFP–STKP route is calculated as:

$$SED_{(HFP-STKP)} = (28 \times 1) + (16 \times 1) + (38 \times 1) + (14 \times 1) = 96$$

Emissions for each section-segment were estimated by dividing the total emissions along the route by its SED and multiplying by the section distribution factor. For example, the emission rate for each of the 28 segments along Section K was calculated as:

$$Emission\ Rate - Section\ K_{(Segments\ 1-28)} = \frac{Total\ Emissions_{(HFP-STKP)}}{96} \times 1$$

3.1.7 Fugitive Sources: Burntlog Route Access Road

The access road portion within the operations boundary was characterized by a series of LINE sources laid along the actual route. Emissions associated along this access road include dust emissions generated from travel of maintenance equipment, light-duty pickup trucks and buses used for employee, visitor, and contractor transportation, and heavy-duty trucks used for cargo and services transportation. These sources were assigned a release height of 3 m and an initial vertical dispersion of 2.8 m. These release parameters were based on an estimated average vehicle height of 3.5 m, which is representative of an overall approximation of anticipated vehicle heights (grader – 3.7 m, heavy-duty truck – 3.6 m, and pickup truck – 3.2 m) and the AREA source parameterization recommendations provided in the Haul Road Workgroup Report (EPA 2012). The AERMOD emission input units for AREA source are grams per meter square. The access road emissions were evenly distributed along the road by dividing the total access road emissions by its total area, i.e., the Burntlog Route section within the operations boundary (2,950 m) multiplied by the road width (6.1 m).

3.1.8 Emission Release Parameters

Table 13 lists the emission release parameters, including stack height, exhaust temperature, exhaust velocity, and stack diameter for SGP's process and ancillary point sources in metric units (English units are in parentheses). Table 14 lists the emission release parameters for SGP's process and ancillary volume sources in metric units (English units are in parentheses). Emission release parameters were based on information provided in the application. Justification for emission release parameters is summarized in the next section.

Table 13. PROCESS AND ANCILLARY POINT SOURCE EMISSION RELEASE PARAMETERS IN METRIC UNITS (ENGLISH UNITS IN PARENTHESES).

Release Point	Description	UTM[a] Coordinates		Stack Height in m (ft)[c]	Stack Exhaust Temp. in K (°F)[d]	Stack Exhaust Velocity in m/sec (fps)[e]	Stack Diameter in m (ft)	Orient. Of Release[f]
		Easting-X in m[b]	Northing-Y in m					
LS1L	Mill Lime Silo #1 Loading	632,095	4,974,272	13.3 (43.7)	0.0 (-459.7)	18.1 (59.4)	0.15 (0.49)	D
MillS2L	Mill Lime Silo #2 Loading	632,090	4,974,282	13.3 (43.7)	0.0 (-459.7)	18.1 (59.4)	0.15 (0.49)	D
SB1	Sb Dryer (2.72 MMBtu/hr Propane-Fired)	632,231	4,974,183	45.7 (150.0)	455.4 (360.0)	6.9 (22.8)	0.30 (0.98)	D
SB2	Sb Bagging	632,208	4,974,221	45.7 (150.0)	0.0 (-459.7)	6.5 (21.2)	0.30 (0.98)	D
AC	Autoclave	632,229	4,974,096	23.5 (77.0)	364.3 (196.1)	7.4 (24.3)	1.52 (4.99)	D
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	632,261	4,974,116	23.5 (77.0)	455.4 (360.0)	10.8 (35.6)	0.61 (2.00)	D
ACS1L	AC Lime Silo #1 Loading	632,267	4,974,124	17.4 (57.2)	0.0 (-459.7)	16.1 (52.8)	0.23 (0.75)	D
ACS2L	AC Lime Silo #2 Loading	632,257	4,974,140	17.4 (57.2)	0.0 (-459.7)	16.1 (52.8)	0.23 (0.75)	D
ACS3L	AC Lime Silo #3 Loading	632,248	4,974,156	17.4 (57.2)	0.0 (-459.7)	16.1 (52.8)	0.23 (0.75)	D
ACS4L	AC Lime Silo #4 Loading	632,238	4,974,171	14.5 (47.5)	0.0 (-459.7)	16.1 (52.8)	0.23 (0.75)	D
CKD	Carbon	632,013	4,974,051	16.8	338.7	5.1	0.15	D

REC 0657

PET 291

Table 13. PROCESS AND ANCILLARY POINT SOURCE EMISSION RELEASE PARAMETERS IN METRIC UNITS (ENGLISH UNITS IN PARENTHESES).								
Release Point	**Description**	**UTM[a] Coordinates**		**Stack Height in m (ft)[c]**	**Stack Exhaust Temp. in K (°F)[d]**	**Stack Exhaust Velocity in m/sec (fps)[e]**	**Stack Diameter in m (ft)**	**Orient. Of Release[f]**
		Easting-X in m[b]	**Northing-Y in m**					
	Regeneration Kiln (Drum)			(55.0)	(150.0)	(16.6)	(0.49)	
CKB	Carbon Regeneration Kiln (Burners)	631,998	4,974,042	14.0 (46.0)	455.4 (360.0)	5.8 (18.9)	0.30 (0.98)	D
EW	Electrowinning Cells and Pregnant Solution Tank	631,983	4,974,033	16.8 (55.0)	310.9 (100.0)	24.2 (79.4)	0.30 (0.98)	D
MR	Mercury Retort	632,003	4,974,001	16.8 (55.0)	338.7 (150.0)	1.5 (5.1)	0.09 (0.30)	D
MF	Induction Melting Furnace	632,032	4,974,019	16.8 (55.0)	338.7 (150.0)	21.5 (70.6)	0.38 (1.25)	D
EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	634,274	4,972,050	2.1 (7.0)	866.5 (1,100.0)	29.7 (97.4)	0.46 (1.51)	D
EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	632,105	4,974,154	2.1 (7.0)	866.5 (1,100.0)	29.7 (97.4)	0.46 (1.51)	D
EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	632,109	4,974,148	2.1 (7.0)	866.5 (1,100.0)	29.7 (97.4)	0.46 (1.51)	D
EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	632,113	4,974,141	2.1 (7.0)	866.5 (1,100.0)	23.8 (78.0)	0.23 (0.75)	D
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	632,216	4,974,118	20.7 (68.0)	455.4 (360.0)	1.6 (5.2)	0.12 (0.39)	D
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	632,017	4,974,010	14.0 (46.0)	455.4 (360.0)	7.5 (24.8)	0.40 (1.31)	D
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	632,287	4,974,227	2.1 (7.0)	455.4 (360.0)	6.0 (19.8)	0.40 (1.31)	D
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	632,288	4,974,228	2.1 (7.0)	455.4 (360.0)	20.8 (68.3)	0.21 (0.69)	D
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	632,168	4,974,191	43.0 (141.0)	455.4 (360.0)	28.3 (92.9)	0.09 (0.30)	D
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	632,238	4,974,130	20.7 (68.0)	455.4 (360.0)	7.1 (23.3)	0.09 (0.30)	D
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	632,008	4,974,026	14.0 (46.0)	455.4 (360.0)	7.1 (23.3)	0.09 (0.30)	D
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	632,038	4,973,751	6.4 (21.0)	455.4 (360.0)	7.1 (23.3)	0.09 (0.30)	D

Table 13. PROCESS AND ANCILLARY POINT SOURCE EMISSION RELEASE PARAMETERS IN METRIC UNITS (ENGLISH UNITS IN PARENTHESES).								
Release Point	**Description**	**UTM[a] Coordinates**		**Stack Height in m (ft)[c]**	**Stack Exhaust Temp. in K (°F)[d]**	**Stack Exhaust Velocity in m/sec (fps)[e]**	**Stack Diameter in m (ft)**	**Orient. Of Release[f]**
		Easting-X in m[b]	**Northing-Y in m**					
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	631,889	4,973,472	12.5 (41.0)	455.4 (360.0)	1.3 (4.3)	0.21 (0.69)	D
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	631,848	4,973,398	12.5 (41.0)	455.4 (360.0)	5.2 (17.1)	0.21 (0.69)	D
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	632,060	4,973,664	12.5 (41.0)	455.4 (360.0)	5.2 (17.1)	0.21 (0.69)	D
PSL	Prill Silos Loading (2 x 100 ton)	632,346	4,973,500	7.8 (25.5)	0.0 (-459.7)	18.1 (59.4)	0.15 (0.49)	D
CS1L	Cement/Shotcrete Silo #1 Loading	632,095	4,974,272	13.3 (43.7)	0.0 (-459.7)	24.1 (78.9)	0.15 (0.49)	D
CS2L	Cement/Shotcrete Silo #2 Loading	632,095	4,974,272	13.3 (43.7)	0.0 (-459.7)	24.1 (78.9)	0.15 (0.49)	D
LS6	Limestone transfer to Ball Mill Feed Bin	632,181	4,974,307	8.8 (29.0)	0.0 (-459.7)	0.001 (0.003)	0.30 (0.98)	D
LSBM	Limestone Ball Mill	632,215	4,974,248	21.3 (70.0)	0.0 (-459.7)	26.7 (87.5)	0.61 (2.00)	D
LS9	Limestone transfer to Kiln Feed Bin	632,169	4,974,325	8.8 (29.0)	0.0 (-459.7)	0.001 (0.003)	0.30 (0.98)	D
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	632,057	4,974,265	45.7 (150.0)	449.8 (350.0)	26.4 (86.5)	0.61 (2.00)	D
LKC	PFR Shaft Lime Kiln Combustion	632,057	4,974,265	45.7 (150.0)	449.8 (350.0)	26.4 (86.5)	0.61 (2.00)	D
LCR	Lime Mill Crushing and associated transfers In and Out	632,073	4,974,233	15.2 (50.0)	0.0 (-459.7)	28.7 (94.3)	0.23 (0.75)	D
LSL	Pebble Lime Silo Loading via Bucket Elevator	632,069	4,974,206	8.8 (29.0)	0.0 (-459.7)	4.1 (13.4)	0.10 (0.33)	D

a. Universal Transverse Mercator.
b. m: meters.
c. ft: feet.
d. K: Kelvin; °F: degrees Fahrenheit.
e. m/sec: meters per second; fps: feet per second.
f. D: default (vertical, uninterrupted release); R: raincap; H: horizontal.
g. The exhaust temperature for the new silo was set to 0 K. This triggers AERMOD to use the actual temperatures from the meteorological data input files.

Table 14. PROCESS AND ANCILLARY VOLUME SOURCE EMISSION RELEASE PARAMETERS IN METRIC UNITS (ENGLISH UNITS IN PARENTHESES).						
Release Point	**Description**	**UTM[a] Coordinates**		**Release Height in m (ft)[c]**	**Init. Horiz. Dim. in m (ft)**	**Init. Vert. Dim. in m (ft)**
		Easting-X in m[b]	**Northing-Y in m**			
OC1	Loader Transfer of Ore to Grizzly	632,045	4,974,583	19.5 (64.0)	3.8 (12.3)	18.1 (59.5)
OC2	Grizzly to Apron Feeder	632,045	4,974,583	19.5 (64.0)	3.8 (12.3)	18.1 (59.5)
OC3	Apron Feeder to Dribble Conveyor	632,045	4,974,583	19.5 (64.0)	3.8 (12.3)	18.1 (59.5)
OC4	Apron Feeder to Vibrating Grizzly	632,045	4,974,583	19.5 (64.0)	3.8 (12.3)	18.1 (59.5)
OC5	Dribble Conveyor to Vibrating Grizzly	632,045	4,974,583	19.5 (64.0)	3.8 (12.3)	18.1 (59.5)
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	632,045	4,974,583	19.5 (64.0)	3.8 (12.3)	18.1 (59.5)
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	632,045	4,974,583	19.5 (64.0)	3.8 (12.3)	18.1 (59.5)
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	631,947	4,974,520	10.9 (35.8)	0.2 (0.7)	10.2 (33.3)
OC9	Stockpile Transfers to Reclaim Conveyors	631,947	4,974,520	1.2 (4.0)	0.6 (1.9)	1.1 (3.7)
OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	631,947	4,974,520	1.2 (4.0)	0.6 (1.9)	1.1 (3.7)
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	632,113	4,974,243	20.7 (69.0)	0.3 (0.9)	0.6 (1.9)
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	632,028	4,974,187	3.0 (10.0)	2.3 (7.6)	2.8 (9.3)
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	632,028	4,974,187	3.0 (10.0)	2.3 (7.6)	2.8 (9.3)
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	632,095	4,974,272	1.4 (4.5)	0.1 (0.2)	0.1 (0.5)
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	632,090	4,974,282	1.4 (4.5)	0.1 (0.2)	0.1 (0.5)
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	632,267	4,974,124	1.4 (4.5)	0.1 (0.2)	0.1 (0.5)
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	632,257	4,974,140	1.4 (4.5)	0.1 (0.2)	0.1 (0.5)
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	632,248	4,974,156	1.4 (4.5)	0.1 (0.2)	0.1 (0.5)
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	632,238	4,974,171	1.4 (4.5)	0.1 (0.2)	0.1 (0.5)
PSU	Prill Silos Unloading (2 x 100 ton)	632,346	4,973,500	1.4 (4.5)	0.1 (0.2)	0.1 (0.5)
CS1U	Cement/Shotcrete Silo #1 Unloading	632,095	4,974,272	1.5 (5.0)	5.1 (16.8)	1.4 (4.7)
CS2U	Cement/Shotcrete Silo #2 Unloading	632,095	4,974,272	1.5 (5.0)	5.1 (16.8)	1.4 (4.7)
CAL	Aggregate Bin Loading	632,095	4,974,272	1.5 (5.0)	5.1 (16.8)	1.4 (4.7)
CAU	Aggregate Bin Unloading	632,095	4,974,272	1.5 (5.0)	5.1 (16.8)	1.4 (4.7)
CM	Central Mixer Loading	632,095	4,974,272	1.5	5.1	1.4

Table 14. PROCESS AND ANCILLARY VOLUME SOURCE EMISSION RELEASE PARAMETERS IN METRIC UNITS (ENGLISH UNITS IN PARENTHESES).						
Release Point	Description	UTM[a] Coordinates		Release Height in m (ft)[c]	Init. Horiz. Dim. in m (ft)	Init. Vert. Dim. in m (ft)
		Easting-X in m[b]	Northing-Y in m			
				(5.0)	(16.8)	(4.7)
PCSP1	Portable Crushing and Screening Plant 1	632,348	4,973,429	2.1 (7.0)	13.1 (43.1)	2.0 (6.5)
PCSP2	Portable Crushing and Screening Plant 2	632,348	4,973,369	2.1 (7.0)	13.1 (43.1)	2.0 (6.5)
LS1	Limestone transfer to Primary Crusher Hopper	632,239	4,974,256	3.4 (11.3)	1.6 (5.2)	3.2 (10.5)
LS2	Primary Crushing and Associated Transfers In and Out	632,239	4,974,256	3.4 (11.3)	1.6 (5.2)	3.2 (10.5)
LS3	Primary Screening and Associated Transfers In and Out	632,239	4,974,256	3.4 (11.3)	1.6 (5.2)	3.2 (10.5)
LS4	Secondary Crushing and Associated Transfers In and Out	632,227	4,974,268	3.4 (11.3)	1.6 (5.2)	3.2 (10.5)
LS5	Secondary Screening and Associated Transfers In and Out	632,227	4,974,268	3.4 (11.3)	1.6 (5.2)	3.2 (10.5)
LS7	Limestone transfer to Ball Mill Feed Conveyor	632,181	4,974,307	1.1 (3.5)	0.1 (0.2)	0.4 (1.4)
LS8	Ball Mill Feed transfer to Ball Mill	632,200	4,974,273	8.5 (28.0)	0.3 (0.9)	0.6 (1.9)
LS10	Limestone transfer to Lime Kiln Feed Conveyor	632,169	4,974,325	1.1 (3.5)	0.1 (0.2)	0.4 (1.4)
LS11	Fines Screening and Associated Transfers In and Out	632,151	4,974,314	0.8 (2.5)	0.6 (1.9)	0.7 (2.3)
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	632,056	4,974,285	20.7 (68.0)	0.3 (0.9)	0.6 (1.9)
LSU	Pebble Lime Silo discharge to Lime Slaker	632,069	4,974,206	1.1 (3.5)	0.1 (0.2)	0.4 (1.4)

a. Universal Transverse Mercator.
b. m: meters.
c. ft: feet.

3.1.9 Emission Release Parameter Justification

Modeled Process and Ancillary Point Sources

The pneumatic transfer silo loadings and bin transfers (LS1L, MillS2L, ACS1L, ACS2L, ACS3L, ACS4L, PSL, CS1L, CS2L, LS6, LSBM, LS9, LSL) were modeled as POINT sources with a 3-foot bin vent above standard silo height as release height. Exit velocity was estimated using the standard stack diameter and flow rates for similar sources (NDEP 2019) or 0.001 meter per second for horizontal exhaust. These sources were modeled with ambient exhaust temperature.

For propane-fired process (Sb1, ACB, CKB, PV, HS) and building heaters (H1M, H2M, HM, HAC, HR, HA, HMO, HTS, HW), exhaust flow rates were calculated using EPA Method 9 with 3% oxygen content and 15% moisture content. Standard stack diameters were selected based on the heater rating. The process heaters were modeled with a 10-foot stack above the building, whereas the building heaters were modeled with a release height of 1 foot above the respective buildings.

Similar source exhaust temperature, flow, and diameter from (NDEP 2017) were used for refinery sources, including the carbon regeneration kiln (CKD), electrowinning cells (EW), mercury retort (MR),

REC 0661

PET 295

and induction furnace (MF). Each of these sources was modeled with a 10- foot stack above the refinery building.

For emergency generators (EDG1, EDG2, EDG3) and the fire pump (EDFP), the exhaust flow rates were calculated using EPA Method 9 with 9% oxygen content and 8% moisture content. Standard stack diameters were selected based on engine rating. Each engine was modeled with a 7-foot-high stack.

Antimony bagging (Sb2), autoclave (AC), lime kiln (LK) (common stack with kiln burner (LKC)), and lime crushing (LCR) were characterized with similar source parameters from (NDEP 2015b), (APT 2013), and (NDEP 2010). Each of these sources was modeled with a 10-foot stack above its respective building.

Release parameters for the process and ancillary point sources were appropriately documented and justified. DEQ's source-group analysis (Table 27 in Section 4.1.4) suggests that the process and ancillary point sources contribute a small amount to the modeled design concentrations.

Modeled Process and Ancillary Volume Sources

For the following VOLUME source characterization discussion, release height was estimated as half of the vertical length (for example, building height), initial vertical dispersion was calculated by dividing the vertical length by the applicable EPA-recommended constant (EPA 2018c) for a single VOLUME source (4.3), and initial lateral dispersion was determined using the lesser lateral dimension (for example, building width) divided by the applicable EPA-recommended constant (EPA 2018c) for the surface source or elevated source with a building (2.15).

The sources associated with the primary crusher building, including loader transfer (OC1), grizzly feeder (OC2), apron feeders (OC3, OC4), ore transfers (OC5, OC6), and primary crusher (OC7), were characterized by the primary crusher building dimensions: 128' high and 52.9' wide.

The stockpile height (71.6') and the conveyor width (3') were used to determine the VOLUME source parameters for the stockpile feed conveyor (OC8).

Tunnel exit dimensions (8' high and 8' wide) were used to estimate the VOLUME release parameters for the stockpile transfer points (OC9, OC10). The SAG mill feed conveyor transfer (OC11) was characterized by a building opening (4' high and 4' wide) at the mid-height (70') of the mill building.

Pebble crusher building dimensions (20' high and 32.7' wide) were used to characterize the pebble crusher-associated sources (OC12, OC13).

Silo/bin unloading sources (LS1U, Mill2SU, ACS1U, ACS2U, ACS3U, ACS42U, PSU) were characterized by a typical screw discharge feeder characteristic, i.e., 5' above the ground with a 1' diameter.

Aggregate transfer and handling sources (CS1U, CS2U, CAL, CAU, CM) were characterized by the aggregate stockpile dimensions: 20' high and 72.2' wide.

Each portable crushing and screening plant was characterized by typical portable crushing and screening plant dimensions: 14' high and 185' wide.

REC 0662

PET 296

Sources associated with limestone crushing (LS1, LS2, LS3, LS4, LS5) were characterized by the associated crusher building dimensions: 22.6’ high and 22.6’ wide.

The crushed limestone/pebble lime transfers (LS7, LS10, LSU) were characterized by a typical screw discharge to a conveyor characteristic, i.e., 5’ above the ground, 3’ drop, and a 1’ diameter.

The limestone ball mill feed discharge (LS8) was characterized by a building opening (4’ high and 4’ wide) at the mid-height (30’) of the ball mill building.
The limestone fines screening (LS11) was characterized by screen dimensions: 5’ drop and 8’ wide.

The limestone kiln feed (LS12) was characterized by a building opening (4’ high and 4’ wide) at the mid-height (70’) of the kiln building.

Model input source characterization for fugitive emissions is described in Sections 3.1.5 and 3.1.6. Fugitive activity locations and their respective dimensions are provided in Table 10 and associated release parameters are listed in Table 11.

Release parameters for the process and ancillary volume sources were appropriately documented and justified. DEQ’s source-group analysis (Table 27 in Section 4.1.4) suggests that the process and ancillary volume sources contribute a small amount to the modeled design concentrations.

3.2 Background Concentrations

Background concentrations are used if a cumulative NAAQS impact analysis is needed to demonstrate compliance with applicable NAAQS.

3.2.1 Onsite Particulate Monitoring

To establish background ambient air conditions for the SGP area, PRI developed an onsite monitoring program to collect site-specific meteorological parameters and determine ambient particulate matter ($PM_{2.5}$ and PM_{10}) concentrations at its Stibnite monitoring station.

In September 2015, PRI submitted the data collected at the Stibnite monitoring station for the period of November 2013 through June 2015 to DEQ. After reviewing the data and associated quality control procedures, DEQ concluded that the $PM_{2.5}$ and PM_{10} data collected at the Stibnite monitoring station satisfied the applicable regulatory requirements and approved the data to be used for background concentrations in the SGP air quality analyses (DEQ 2015). In its conclusions, DEQ recommended that the $PM_{2.5}$ and PM_{10} background concentrations should be based on calendar year 2014 instead of the complete dataset (November 2013 through June 2015).

DEQ-approved $PM_{2.5}$ and PM_{10} background concentrations, in units of micrograms per cubic meter ($\mu g/m^3$), are provided in Table 15. For 24-hour PM_{10}, the design value is the *second-highest* 24-hour average concentration in a given year. However, review of the Meteorological and Air Quality Data Summary for the SGP Monitoring Network (Perpetua Resources Idaho 2015) indicates that the DEQ-approved background for 24-hour PM_{10} (37.0 $\mu g/m^3$) is the *first-highest* 24-hour average concentration measured in 2014 (DEQ 2015). Therefore, using the first-high instead of the second-high as background adds a layer of conservatism to the cumulative NAAQS impact analyses for 24-hour PM_{10}.

REC 0663

PET 297

Table 15. DEQ-APPROVED $PM_{2.5}$ AND PM_{10} BACKGROUND CONCENTRATIONS FOR SGP.			
Pollutant	**Averaging Time**	**Background Concentration ($\mu g/m^3$)**	**Design Value Rank**
$PM_{2.5}$	1 year	3.5	Weighted average of quarterly means
	24 hours	15.0	98th percentile/8th high
PM_{10}	24 hours	37.0	Highest 1st high

3.2.2 Gaseous Pollutant Background Concentrations

With a few exceptions of very large facilities or facilities located in nonattainment areas, regulatory agencies do not require the collection of gaseous criteria pollutants, including CO, NOx (and/or nitrogen dioxide [NO_2]), O_3, and SO_2. For these gaseous pollutants, data collected at government-regulated monitoring stations located in settings similar to the project area in terms of terrain, land use, and proximity of emission sources are typically used to establish background concentrations.

To determine representative background concentrations of CO, NOx, O_3, and SO_2 for the SGP site, which is located in a remote rural area, the DEQ-maintained ambient monitoring network was reviewed by Air Sciences. This review revealed that DEQ only conducts limited trace monitoring for CO, NOx, O_3, and SO_2 in the Boise metropolitan area along the Interstate 84 corridor. Thus, the data collected at these monitors are exposed to high emissions from industrial, urban, and transportation sources (DEQ 2015a) (DEQ 2018). For this reason, the gaseous pollutant concentrations recorded at these urban monitoring locations were not considered to be representative of a rural area, like the SGP site.

The EPA-maintained monitoring stations (EPA 2018a) in Idaho and surrounding states also were reviewed by Air Sciences to determine representative gaseous pollutant background concentrations for the SGP site. This review also did not identify any representative monitoring station to establish background gaseous pollutant concentrations for the SGP site.

The DEQ-recommended (DEQ 2019) CO, NOx, O_3, and SO_2 background concentrations for the SGP air quality analyses in units of parts per billion (ppb) and $\mu g/m^3$, are provided in Table 16. These background concentrations were obtained from the Northwest International Air Quality Environmental Science and Technology Consortium (NW AIRQUEST; https://arcg.is/1jXmHH) online tool using the project site coordinates. These background air pollutant levels are based on regional-scale air pollution modeling of pollutants in Washington, Oregon, and Idaho, with modeling results adjusted according to available monitoring data.

Table 16. DEQ-RECOMMENDED GASEOUS POLLUTANT BACKGROUND CONCENTRATIONS FOR SGP.				
Pollutant	**Averaging Time**	**Background Concentration**		**Reference**
		(ppb)	**($\mu g/m^3$)**	
CO	8 hours	970	1,110	NW AIRQUEST, 2014-2017 design value
	1 hour	1,520	1,740	
NO_2	1 year	0.5	0.9	
	1 hour	2.3	4.3	
O_3 (for NO_2 modeling)	8 hours	55	107.9	
SO_2	3 hours	6.4	16.8	
	1 hour	4.7	12.3	

REC 0664

PET 298

3.2.3 Medium-Traffic Pollutant Background Concentrations

For additional information, background concentrations were obtained from NW AIRQUEST for the road section between mile markers 143 and 144 on Highway 55 passing through the town of McCall. This site (latitude 44.906° N, longitude 116.098° W) is approximately 38 miles west of the SGP. The annual average daily traffic count for this road section is over 10,000 vehicles per day. Table 17 provides the background concentrations for this medium-traffic site. Although these concentrations are not representative of the rural SGP area, they do provide additional information regarding the relative contribution of traffic emissions.

Table 17. MEDIUM-TRAFFIC BACKGROUND CONCENTRATIONS.

Pollutant	Averaging Time	Background Concentration		Reference
		(ppb)	($\mu g/m^3$)	
CO	8 hours	1,000	1,145	NW AIRQUEST, 2014-2017 design value, near McCall, ID (44.91°N, 116.10°W)
	1 hour	1,570	1,797	
NO_2	1 year	1.4	2.6	
	1 hour	7.6	14.3	
$PM_{2.5}$	1 year	--	5.1	
	24 hours	--	17.5	
PM_{10}	24 hours	--	60.1	
SO_2	3 hours	6.4	16.8	
	1 hour	4.7	12.3	

3.3 Impact Modeling Methodology

This section describes the modeling methods used by the applicant/consultant to demonstrate preconstruction compliance with applicable air quality standards.

3.3.1 General Overview of Impact Analyses

Air Sciences performed the project-specific air pollutant emission inventory and air impact analyses that were submitted with the application. The submitted information/analyses, in combination with results from DEQ's air impact analyses, demonstrate compliance with applicable air quality standards to DEQ's satisfaction, provided the facility is operated as described in the submitted application and in this memorandum.

Table 18 provides a brief description of parameters used in the modeling analyses.

Table 18. MODELING PARAMETERS.

Parameter	Description/Values	Documentation/Addition Description
General Facility Location	Stibnite, Idaho	The area is an attainment or unclassified area for all criteria pollutants.
Model	AERMOD	AERMOD with the PRIME downwash algorithm, version 19191.
Meteorological Data	Onsite and McCall, Idaho surface data; Boise, Idaho upper air data	See Section 3.3.5 of this memorandum for additional details of the meteorological data.
Terrain	Considered	1/3 arc second National Elevation Dataset (NED) was acquired from the USGS for the surrounding area. AERMAP version 18081 was used to process terrain elevation data for all buildings and receptors. See Section 3.3.6 for more details.
Building Downwash	Considered	Plume downwash was considered for the structures associated with the

		facility. BPIP-PRIME was used to evaluate building dimensions for consideration of downwash effects in AERMOD. See Section 3.3.7.
NOx Chemistry	Ozone Limiting Method	See Section 3.3.8.
Receptor Grid	**SIL Analysis** A SIL analysis was not performed.	
	Cumulative NAAQS Impact Analysis The selection of receptors for use in the cumulative NAAQS impact analysis is as follows (see Section 3.3.12):	
	Boundary	25-meter (m) spacing
	Grid 1	50-m spacing, 0.25 kilometers (km) out
	Grid 2	100-m spacing, 0.25 km to 1.25 km out
	Grid 3	500-m spacing, 1.25 km to 5 km out
	Grid 4	1,000-m spacing, 5 km to 10 km out
	Hotspot	25-m spacing, 200-m × 200-m around highest model impacts
	TAPs Analysis The receptor network used in the cumulative NAAQS impact analysis was also used in the TAPs analysis.	

3.3.2 Modeling Protocol

A modeling protocol for the SGP analyses was submitted to DEQ prior to the application, on May 30, 2019. The protocol was submitted by Brown and Caldwell on behalf of PRI. Conditional DEQ protocol approval was provided to Brown and Caldwell on June 27, 2019.

3.3.3 Modeling Methodology

Project-specific modeling and other required impact analyses were generally conducted using data and methods described in the *Idaho Air Quality Modeling Guideline* (DEQ 2013).

3.3.4 Model Selection

Idaho Air Rules Section 202.02 requires that estimates of ambient concentrations be based on air quality models specified in *Appendix W*. The refined, steady-state, multiple-source, Gaussian dispersion model AERMOD was promulgated as the replacement model for ISCST3 in December 2005. AERMOD retains the single straight-line trajectory of ISCST3, but it includes more advanced algorithms to assess turbulent mixing processes in the planetary boundary layer for both convective and stable stratified layers.

AERMOD version 19191 was used by Air Sciences for the modeling analyses to evaluate impacts of the facility. This version was the current version at the time the application was received by DEQ.

3.3.5 Meteorological Data

AERMOD requires an input of hourly meteorological data to estimate pollutant concentrations in ambient air resulting from modeled source emissions. These data are commonly obtained from National Weather Service (NWS) stations at airports throughout the state. Applicants select data from an airport site that is determined to be reasonably representative of the permitted site location. Collection of meteorological data from the permitted site is not typically required by DEQ for minor source permit applications. The collection of one year of onsite data is required for permitting projects subject to the Prevention of Significant Deterioration (PSD) program, which is triggered by larger non-fugitive emission quantities.

Site-specific hourly surface meteorological data were collected and used in air impact analyses for this project, as described in the submitted modeling report. These data were collected from January 1, 2014

REC 0666

PET 300

through December 31, 2014 at the Stibnite monitoring station. They were collected for analyses supporting an Environmental Impact Statement (EIS) and the Idaho DEQ minor source permit.

The site-specific surface data were supplemented with the twice-daily upper-air data (all levels) collected at the National Weather Service (NWS) station in Boise, Idaho (WBAN 24131).

These meteorological datasets were processed with the most recent version (19191) of the AERMOD meteorological pre-processor, AERMET, to produce AERMOD-input-ready hourly surface and profile meteorological files. The default option of adjusted surface friction velocity (ADJ_U*) and the Bulk Richardson (BULKRN) method for boundary layer parameter calculations was used for this meteorological data processing.

Additionally, an alternative meteorological dataset was processed without using the BULKRN method (NON-BULKRN). This alternate processing used the onsite and upper air datasets discussed above, supplemented with the cloud-cover data collected at the NWS station in McCall, Idaho (WBAN 94182).

Both processing methods (BULKRN and NON-BULKRN) are considered default for regulatory modeling analyses. EPA Region X Regional Modeling Contact, Jay McAlpine, PhD, was consulted for guidance on which data processing procedure to require for the analyses supporting the Idaho PTC. The BULKRN method was used for air impact analyses supporting the EIS after consultation with EPA, DEQ, and the US Forest Service. EPA recommended (June 18, 2019, email from Jay McAlpine, EPA, to Kevin Schilling, DEQ) using the BULKRN method since "use of the onsite data best fulfills the Guidance, and ensures consistency with the EIS, but this should be looked upon as technical advice only and not a requirement of the EPA."

Compliance with all NAAQS was easily demonstrated using meteorological data processed by the NON-BULKRN method; however, a small number of receptors showed 24-hour PM_{10} violations when the meteorological data processed with BULKRN method was used. DEQ performed a weight of evidence analyses (see Section 4.1.4 of this memorandum) to further evaluate the confidence of NAAQS compliance, using sensitivity analyses of various model input variables and the meteorological data processed using the BULKRN method.

AERMET requires the input of three surface boundary layer parameters: midday Bowen ratio (B_o), midday albedo (r), and surface roughness length (z_o). These parameters are dependent on the land use and vegetative cover of the area being evaluated. The EPA-recommended model, AERSURFACE, was used to estimate these surface parameters for the Stibnite meteorological data processing. AERSURFACE uses 1992 National Land Cover Data to determine these surface characteristics.

The determination of B_o is dependent on ambient moisture conditions (i.e., wet, average, or dry). For this purpose, historic 30-year (1985–2014) precipitation data from the Taylor Ranch station in Idaho (the closest station from which this type of data is available) were used.

The 70th and 30th percentile values estimated from the 30-year precipitation data were used to assign a moisture class to each calendar month per the following scheme: monthly precipitation greater than the 70th percentile was considered "wet"; between the 70th and 30th percentiles was considered "average"; and less than the 30th percentile was considered "dry." The monthly season and moisture classifications and estimated r and B_o for 2014 Stibnite meteorological data processing are presented in Table 19.

REC 0667

PET 301

Table 19. 2014 MONTHLY SEASON AND MOISTURE CLASSIFICATION, AND CALCULATED *r* AND B_o.							
Month	**Season**	***r***	**30-Year Precipitation Percentile (in)**		**2014 Precipitation (in)**	**Moisture Classification**	***Bo***
			30th	**70th**			
January	Winter	0.38	0.64	1.29	0.74	Average	0.50
February	Winter	0.38	0.40	0.81	0.99	Wet	0.50
March	Spring	0.13	0.83	1.23	2.33	Wet	0.34
April	Spring	0.13	1.11	1.57	0.99	Dry	1.57
May	Spring	0.13	1.43	2.23	0.74	Dry	1.57
June	Summer	0.13	1.17	1.80	1.32	Average	0.37
July	Summer	0.13	0.46	1.45	0.40	Dry	0.76
August	Summer	0.13	0.42	1.11	2.03	Wet	0.25
September	Fall	0.13	0.27	1.23	0.43	Average	0.87
October	Fall	0.13	0.59	1.69	1.75	Wet	0.35
November	Fall	0.13	0.72	1.44	3.73	Wet	0.35
December	Winter	0.38	0.64	1.16	0.83	Average	0.50

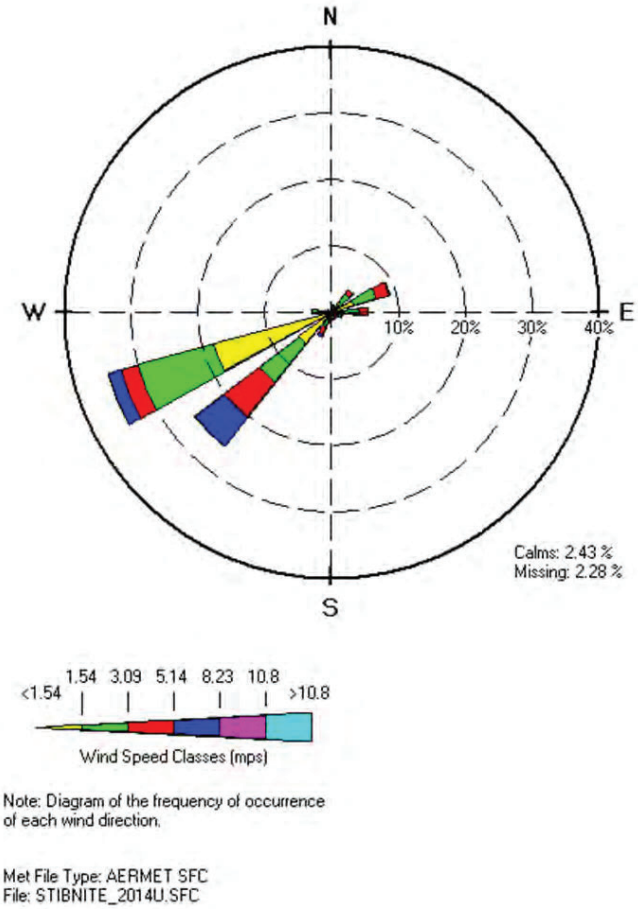
The seasonal z_o values in m for each 30-degree sector of the 1-km radius for the Stibnite monitoring station are provided in Table 20 (i.e., Sector 1 is 0° to 30° clockwise from the north, Sector 2 is 30° to 60° clockwise from the north, etc.).

Table 20. CALCULATED SEASONAL z_o VALUES (m).				
Sector	**Winter**	**Spring**	**Summer**	**Fall**
1	0.410	0.564	0.610	0.607
2	0.212	0.347	0.392	0.387
3	0.517	0.640	0.671	0.669
4	0.769	0.865	0.894	0.894
5	0.989	1.044	1.055	1.055
6	0.741	0.874	0.918	0.915
7	0.400	0.563	0.617	0.614
8	0.414	0.522	0.552	0.550
9	0.049	0.171	0.244	0.243
10	0.060	0.197	0.274	0.274
11	0.183	0.372	0.449	0.449
12	0.576	0.710	0.743	0.742

Winter = December, January, February
Spring = March, April, May
Summer = June, July, August
Fall = September, October, November

Wind frequency distribution for the 2014 Stibnite meteorological dataset is presented in Figure 5, and a map showing the location of the meteorological monitoring stations used for this meteorological data processing is presented in Figure 6.

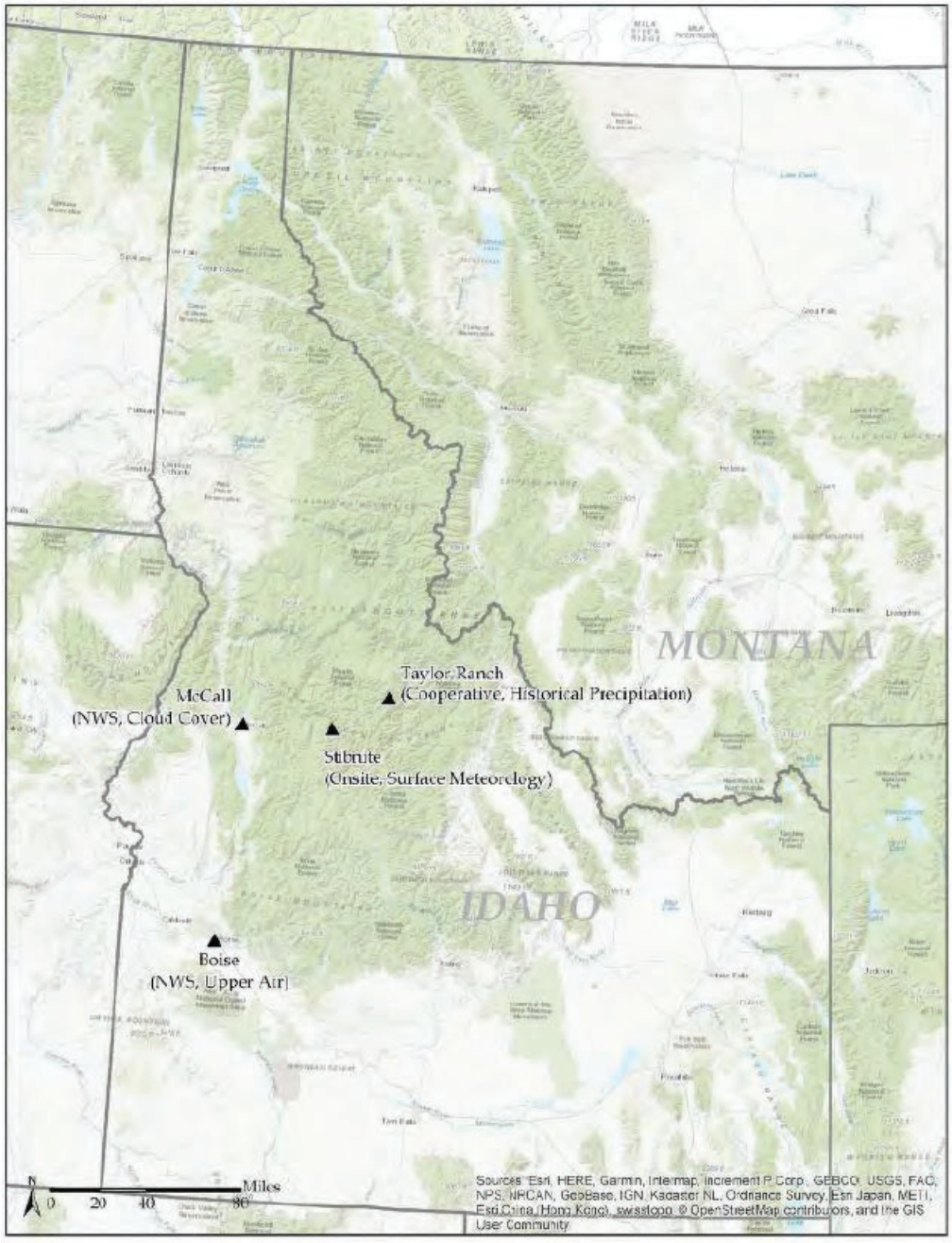
Figure 5. WIND FREQUENCY DISTRIBUTION FOR 2014 SGP METEOROLOGICAL DATA (NON-BULKRN).



Note: Diagram of the frequency of occurrence of each wind direction.

Met File Type: AERMET SFC
File: STIBNITE_2014U.SFC

Figure 6. METEOROLOGICAL STATION LOCATIONS FOR SGP MODELING.



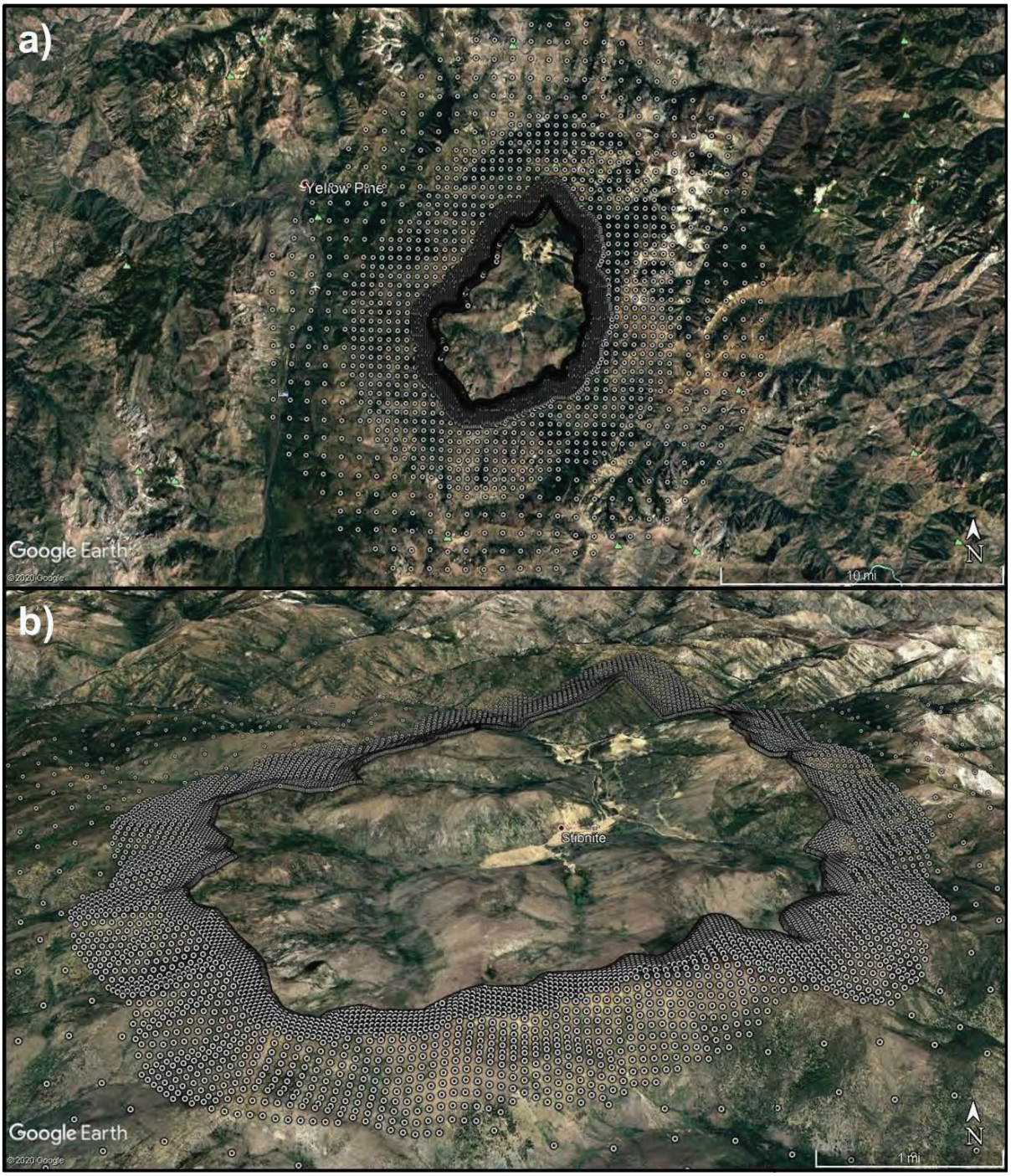
3.3.6 Effects of Terrain on Modeled Impacts

Submitted ambient air impact analyses used terrain data extracted from United States Geological Survey (USGS) National Elevation Dataset (NED) files.

The terrain preprocessor AERMAP version 18081 was used by Air Sciences to extract the elevations from the NED files and assign them to receptors in the modeling domain in a format usable by AERMOD. AERMAP also determined the hill-height scale for each receptor. The hill-height scale is an

elevation value based on the surrounding terrain which has the greatest effect on that individual receptor. AERMOD uses those heights to evaluate whether the emission plume has sufficient energy to travel up and over the terrain or if the plume will travel around the terrain. Figure 7a depicts the full receptor grid used in the modeling analyses and Figure 7b illustrates a close-up of Figure 7a, overlaid on a terrain image from Google Earth.

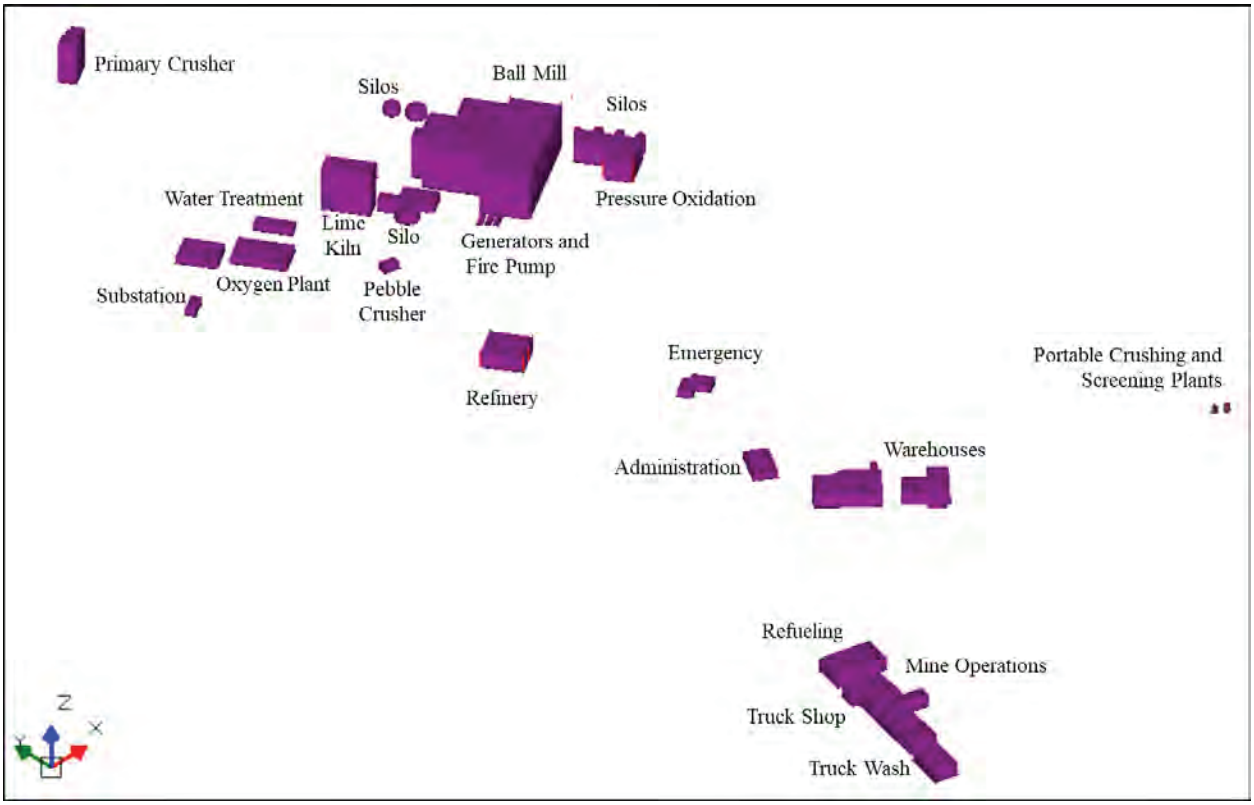
Figure 7. RECEPTOR GRID CENTERED AT THE SGP FACILITY.



3.3.7 Facility Layout and Downwash

Figure 3 shows the processing and refining area buildings and sources at the SGP facility. Figure 8 below depicts a three-dimensional view of Figure 3, as viewed from the southwest.

Figure 8. THREE-DIMENSIONAL VIEW OF PROCESSING AND REFINING AREA BUILDINGS AND SOURCES AT THE SGP FACILITY AS VIEWED FROM THE SOUTHWEST.



DEQ verified proper identification of the site location and the ambient air boundary by comparing a graphical representation of the modeling input file to aerial photographs on Google Earth (available at https://www.google.com/earth).

Potential downwash effects on emission plumes were accounted for in the model by using building dimensions and locations (locations of building corners, base elevation, and building heights). Dimensions and orientation of proposed buildings were used as input to the Building Profile Input Program for the Plume Rise Model Enhancements downwash algorithm (BPIP-PRIME version 04274) to calculate direction-specific dimensions and Good Engineering Practice (GEP) stack height information for input to AERMOD.

3.3.8 NOx Chemistry

The atmospheric chemistry of NO, NO_2, and O_3 complicates accurate prediction of NO_2 impacts resulting from NOx emissions. The conversion of NO to NO_2 can be conservatively addressed through the use of

several methods as outlined in a *2014 EPA NO_2 Modeling Clarification Memorandum* (EPA 2014). The guidance outlines a three-tiered approach:

- Tier 1 – assume full conversion of NO to NO_2 where total NOx emissions are modeled and modeled impacts are assumed to be 100 percent NO_2.
- Tier 2 – use an ambient ratio to adjust impacts from the Tier 1 analysis.
- Tier 3 – use a detailed screening method to account for $NO/NO_2/O_3$ chemistry such as the Ozone Limiting Method (OLM) or the Plume Volume Molar Ratio Method (PVMRM).

The default option of the Ozone Limiting Method (OLM), a third-tier method from 40 CFR 51, *Appendix W*, was used by Air Sciences to estimate the NO_2 1-hour and annual impacts for these analyses. The OLM method requires an input of in-stack NO_2/NOx ratio for each modeled source.

An in-depth literature review was conducted by Air Sciences to identify reasonable NO_2/NOx ratios for different combustion source categories. Based on this research, the NO_2/NOx ratio recommended for the heavy-duty diesel trucks in the California Air Pollution Control Officers Association (CAPCOA) Guidance Document (CAPCOA 2011) was selected for stationary diesel combustion sources. This NO_2/NOx ratio (11 percent) is conservatively higher than the diesel combustion NO_2/NOx ratio provided in the EPA ISR (In-Stack Ratio) database: 6 percent average, 9.8 percent maximum. The CAPCOA document and the EPA ISR database do not provide an NO_2/NOx ratio for propane boilers. The CAPCOA-recommended NO_2/NOx ratio for natural gas boilers was selected for the propane boilers. The natural gas boilers NO_2/NOx ratio is considered appropriate for the propane boilers because both are gaseous fuels with relatively similar combustion characteristics and are expected to have similar NO_2/NOx ratios. The NO_2/NOx ratio for blasting is based on blasting plume measurements provided in an Australian study (CSIRO 2008). The NO_2/NOx ratios used for the SGP NO_2 analyses are presented in Table 21.

Table 21. NO_2/NOx RATIOS.

Source Type	NO_2/NO_X Ratio	Reference
Blasting	0.036	Commonwealth Scientific and Industrial Research Organization (CSIRO 2008)
Diesel Engines	0.11	CAPCOA Guidance Document, heavy-duty diesel trucks (CAPCOA 2011)
Propane Heaters	0.10	CAPCOA Guidance Document, natural gas boilers (CAPCOA 2011)

DEQ performed a sensitivity analysis using a Tier 2 screening method (ARM2), which is more conservative than OLM, and found that the SGP facility is safely below the 1-hour and annual NO_2 NAAQS. Results are summarized in Section 4.1.3.

3.3.9 Particulate Deposition

For $PM_{2.5}$ and PM_{10} analyses, default particulate modeling methods, including deposition (Method 1, to account for depletion due to particulate settling), were used. To account for particulate settling, AERMOD requires the following source-specific variables:

1. Mass-mean aerodynamic particle diameter (PARTDIAM) for each particle size bin
2. Mass fraction (MASSFRAX) for each particle size bin
3. Particle density (PARTDENS) for each particle size bin

REC 0673

PET 307

A list of references that were used to develop the broad source category particle size bins and associated mass fractions was provided in the application. PRI (Perpetua Resources Idaho 2017b) provided the ore and DR material densities. The diesel and propane combustion particulate densities were adopted from technical literature (UMN 2002) and (Khalizov et al. 2012), respectively. Densities for the remaining materials were obtained from the Engineering Toolbox (https://www.engineeringtoolbox.com/density-materials-d_1652.html). An average density was used when a material-specific density range was available.

For sources that were aggregated and modeled as activity locations, deposition parameters were selected for the dominant source within the activity location. For open-pits (YPP, HFP, WEP), approximately 90% of emissions were associated with drilling; therefore, drilling deposition parameters were assigned to these sources. Similarly, emissions from dozing accounted for over 70% of emissions in the DRSF (FDRSF, HFDRSF, WEDRSF) and BT; therefore, these sources were assigned deposition parameters based on a dozing particulate profile.

The deposition parameters including mass fractions, mass mean diameters, and densities for the different source categories/groups are provided in Table 22.

Table 22. DEPOSITION PARAMETERS BY SOURCE CATEGORY.

Source Category	Parameter	PM_{10}				$PM_{2.5}$	
		Bin 1	Bin 2	Bin 3	Bin 4	Bin 1	Bin 2
Haul Roads	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction	0.10	0.90	--	--	1.00	--
	Mass Mean Diameter (µm)	2.50	10.00	--	--	2.50	--
	Density (g/cm^3) (YPP, HFP, WEP DR average)	2.46	2.46	--	--	2.46	--
Material Handling (Ore, DR, Limestone)	Bin Upper Diameter (µm)	2.50	5.00	10.00	--	2.50	--
	Mass Fraction	0.15	0.42	0.43	--	1.00	--
	Mass Mean Diameter (µm)	2.50	5.00	10.00	--	2.50	--
	Density (g/cm^3) (Ore)	Pit-specific, see Table 23.					
	Density (g/cm^3) (Ore and Waste)	Pit-specific, see Table 23.					
	Density (g/cm^3) (Limestone)	1.09	1.09	1.09	--	1.09	--
Baghouses	Bin Upper Diameter (µm)	2.50	6.00	10.00	--	2.50	--
	Mass Fraction	0.28	0.50	0.22	--	1.00	--
	Mass Mean Diameter (µm)	2.50	6.00	10.00	--	2.50	--
	Density (g/cm^3) (Ore)	Pit-specific, see Table 23.					
Diesel Engines	Bin Upper Diameter (µm)	1.00	2.50	6.00	10.00	1.00	2.50
	Mass Fraction	0.85	0.08	0.03	0.03	0.91	0.09
	Mass Mean Diameter (µm)	1.00	2.50	6.00	10.00	1.00	2.50
	Density (g/cm^3) (Diesel Combustion)	1.00	1.00	1.00	1.00	1.00	1.00
Heaters and Boilers	Bin Upper Diameter (µm)	1.00	2.50	6.00	10.00	1.00	2.50
	Mass Fraction	0.29	0.28	0.32	0.11	0.51	0.49
	Mass Mean Diameter (µm)	1.00	2.50	6.00	10.00	1.00	2.50
	Density (g/cm^3) (Propane Combustion)	1.24	1.24	1.24	1.24	1.24	1.24
Lime Loading and Unloading (Quick, Pebble)	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction	0.15	0.85	--	--	1.00	--
	Mass Mean Diameter	2.50	10.00	--	--	2.50	--
	Density (g/cm^3) (Quick)	0.44	0.44	--	--	0.44	--
	Density (g/cm^3) (Pebble)	0.96	0.96	--	--	0.96	--
Lime Unloading (Quick, Pebble)	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction	0.15	0.85	--	--	1.00	--
	Mass Mean Diameter (µm)	2.50	10.00	--	--	2.50	--
	Density (g/cm^3) (Quick)	0.44	0.44	--	--	0.44	--
	Density (g/cm^3) (Pebble)	0.96	0.96	--	--	0.96	--
Cement and	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--

Table 22. DEPOSITION PARAMETERS BY SOURCE CATEGORY.							
Source Category	**Parameter**	**PM_{10}**				**$PM_{2.5}$**	
		Bin 1	**Bin 2**	**Bin 3**	**Bin 4**	**Bin 1**	**Bin 2**
Aggregate Loading and Unloading	Mass Fraction	0.15	0.85	--	--	1.00	--
	Mass Mean Diameter (µm)	2.50	10.00	--	--	2.50	--
	Density (g/cm^3) (Cement)	1.44	1.44	--	--	1.44	--
	Density (g/cm^3) (Aggregate)	1.28	1.28	--	--	1.28	--
Prill Loading and Unloading	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction	0.15	0.85	--	--	1.00	--
	Mass Mean Diameter (µm)	2.50	10.00	--	--	2.50	--
	Density (g/cm^3) (Prill)	0.84	0.84	--	--	0.84	--
Refining Processes	Bin Upper Diameter (µm)	1.00	2.50	6.00	10.00	1.00	2.50
	Mass Fraction	0.78	0.11	0.08	0.03	0.88	0.12
	Mass Mean Diameter (µm)	1.00	2.50	6.00	10.00	1.00	2.50
	Density (g/cm^3) (Diesel Combustion)	1.00	1.00	1.00	1.00	1.00	1.00
Portable Crushing and Screening Plant	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction	0.13	0.87	--	--	1.00	--
	Mass Mean Diameter (µm)	2.50	10.00	--	--	2.50	--
	Density (g/cm^3) (YPP, HFP, WEP DR average)	2.46	2.46	--	--	2.46	--
Lime Kiln and Ball Mill	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction (Kiln)	0.49	0.51	--	--	1.00	--
	Mass Fraction (Ball Mill)	0.36	0.64	--	--	1.00	--
	Mass Mean Diameter (µm)	2.50	10.00	--	--	2.50	--
	Density (g/cm^3)	1.09	1.09	--	--	1.09	--
Blasting and Drilling	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction	0.06	0.94	--	--	1.00	--
	Mass Mean Diameter (µm)	2.50	10.00	--	--	2.50	--
	Density (g/cm^3) (Ore or DR)	Pit-specific, see Table 23.					
Dozing	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction	0.55	0.45	--	--	1.00	--
	Mass Mean Diameter (µm)	2.50	10.00	--	--	2.50	--
	Density (g/cm^3) (DR)	Pit-specific, see Table 23.					

In order to account for variability in ore and DR densities for different pits, pit-specific densities were used for the ore and DR for each modeling scenario, with the following exception – for haul roads, access roads, and portable crushers, the average DR density from YPP, HFP, and WEP was used. Note that the BT density was excluded from those sources because the BT material will not be used for roads or construction. The pit-specific ore and DR densities are provided in Table 23.

Table 23. PIT-SPECIFIC ORE AND DEVELOPMENT ROCK DENSITIES FOR DEPOSITION.		
Pit	**Material**	**Density (g/cm^3)**
YPP	Ore	2.59
BT	Ore	2.00
HFP	Ore	2.59
WEP	Ore	2.68
YPP	DR	2.48
BT	DR	2.00
HFP	DR	2.34
WEP	DR	2.57
Average (YPP,HFP, WEP)	DR	2.46

3.3.10 Ambient Air Boundary

Ambient air is defined in Section 006 of the Idaho Air Rules as "that portion of the atmosphere, external to buildings, to which the general public has access."

PRI will legally control the SGP, an active industrial site where mining activities will occur, such as heavy equipment operation. Most areas of the mine will require strict safety protocols and controlled access. PRI has established an operations boundary to identify the area where public access will be excluded. Public access inside the operations boundary will be restricted for the life of the mine by physical barriers at points of potential access, including the current Stibnite Road point of entry and proposed site access via the Burntlog Route, as well as natural features of the landscape that prevent access. Consistent with the guidance provided in the EPA's draft revised policy on ambient air (EPA 2018b), public access control will include the following measures:

- Primary Access Points: The Stibnite Road (north) and Burntlog Route (south) access points will include locked gates. Guard shacks will be located at each gate to monitor all vehicle ingress/egress. Each gate also will include appropriate adjacent barriers (i.e., fencing, bollards, boulders, or other barriers) to prevent any vehicle from circumventing the gate and gaining site access. These primary access points are also controlled by adjacent natural features, such as streams and creeks, steep topography, and areas of thick vegetation and undergrowth that serve as natural barriers or impediments to access.

- Secondary Access Points: Other potential access points, such as secondary roadways and trails, will include posted signs warning the public against entry into the site. At these locations, boulders will be placed across the trail and at an appropriate width adjacent to the trail to prevent any vehicle from circumventing the barrier. These secondary access points also incorporate adjacent natural features, such as streams and creeks, steep topography, and areas of thick vegetation and undergrowth that serve as natural barriers or impediments to access. Some mine features, such as the TSF and process plant areas, will include perimeter fencing.

- Surveillance: PRI security personnel will routinely patrol mine facilities and roadways for unauthorized individuals. In addition, all onsite personnel will be trained on the necessity of restricting public access to areas within the operations boundary. Any suspected trespassing by unauthorized individuals will be reported immediately to security, and trespassers will be escorted off the site.

In response to comments from local community citizens, PRI will manage an access route to provide the general public with limited access through the SGP site between Stibnite Road at Sugar Creek and Thunder Mountain Road at Meadow Creek (shown in Figure 2). This route will be managed in accordance with the Stibnite Road Access Management Plan which is summarized as follows:

The proposed Stibnite Road access route through the SGP site is meant to provide controlled through-site access that is safe, provides travel-time comparable to current conditions and is consistent with the United States Forest Service travel management plan. The Stibnite Road access route extends from the north entry point southward to the Administration, Warehouse and Storage Area. Continuing southward, the Stibnite Road access route incorporates the Burntlog access road segment that occurs within the operations area and extends to the south entry point as shown on Figure 2. PRI has the legal authority to control access to the Stibnite Road access route and would provide seasonal (non-winter conditions) access only. At the discretion of PRI, additional access controls may occur during various phases of construction, during mine operations that present potential safely hazards such as blasting, due to

REC 0676

PET 310

inclement weather, or under any other circumstances that may present a threat to the protection of public or employee health and safety. PRI has the legal and practical ability to enforce its control over roadway access and to monitor traffic passing through the SGP site. Signage will be placed at the North Security Gate (near the bridge over Sugar Creek) and the South Security Gate (near the Stibnite Lodge) to provide information to travelers, and guard shacks will be located at each gate to monitor all vehicle ingress/egress. Persons wishing to traverse the SGP site on the Stibnite Road access route will be required to check in at the security gate to receive a safety briefing and to alert mine staff of their presence. Travelers will be required to check out upon exiting the site to ensure passage through the site in a safe and timely manner. Travelers will not be allowed to stop or loiter while traveling though the operations area. Along its full length, the Stibnite Road access route would have appropriate signage to direct travelers and would be separated from mine haul roads and areas of mine operations by fencing, berms, or gates to prevent travelers from straying from the route. When possible and to the degree practicable, anticipated public access restrictions will be communicated to the public in a timely manner so that they may plan appropriately. Receptors on the Stibnite Road access route were not included in the SGP air quality analyses as this road is not considered ambient air.

The worker housing facility will be located within the project operations boundary, near the south access security gate. This housing facility will be used strictly for accommodating employees, contractors, and official visitors, and it will not be accessible to the general public. Therefore, the atmosphere over the land occupied by the worker housing facility is not considered ambient air, and receptors were not placed at this location for the air quality analyses.

The operations boundary, shown in Figure 2 above and Figure 9 below, was used to define the ambient air boundary for air dispersion modeling purposes.

3.3.11 Nearby Co-Contributing Sources

If impacts of neighboring emission sources on receptors showing a significant impact from the sources subject to the permitting action are not adequately accounted for by the background concentration used, then emissions from those sources must be modeled. The nearest significant permitted facility to SGP is Tamarack Mill, located more than 75 kilometers (km) west. This facility is located too far away to cause a significant concentration gradient along the periphery of the SGP and was therefore not included in the cumulative impact analyses for SGP.

3.3.12 Receptor Network

DEQ determined that the receptor grid used in the submitted modeling analyses was adequate to resolve maximum modeled impacts.

The SGP air quality analyses were performed using the following receptor spacing and extents (Table 18):

- 25-m-spaced receptors placed along the ambient air boundary;
- 50-m-spaced receptors extending 250 m beyond the ambient air boundary;
- 100-m-spaced receptors extending 1 km beyond the 50-m-spaced receptors;
- 500-m-spaced receptors extending 5 km beyond the ambient air boundary; and
- 1-km-spaced receptors extending 10 km beyond the ambient air boundary.

In addition, each highest modeled impact was evaluated further by performing a hot-spot analysis using a finer 25-m-spacing receptor grid. The modeling receptor grid is shown below in Figure 9. The full grid,

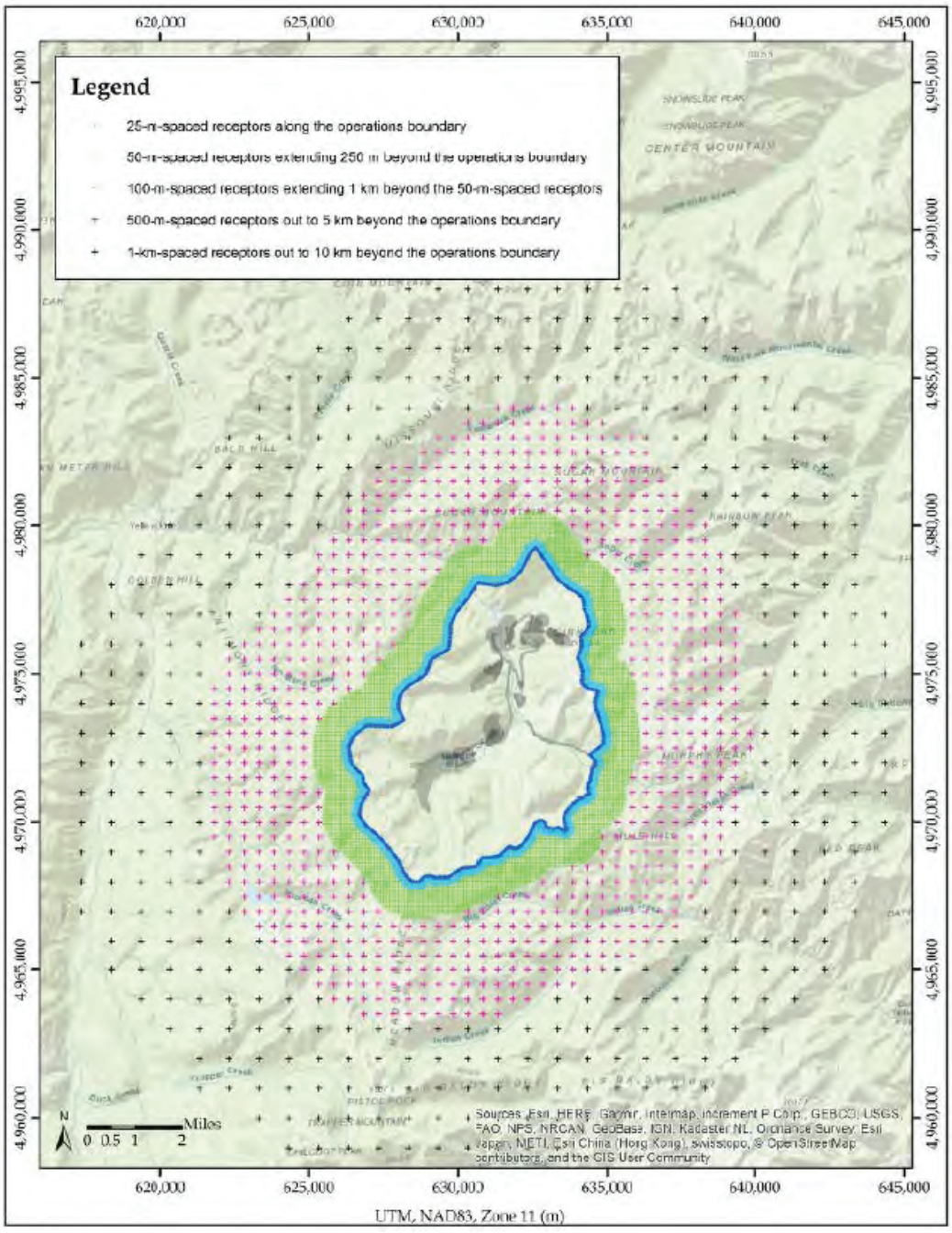
REC 0677

PET 311

along with the fenceline receptors, includes a total of 9,631 receptors. A SIL analysis was not conducted. The full receptor grid was used in the cumulative NAAQS impact and TAPs impact analyses.

The receptor grid used in the submitted modeling analyses met the minimum recommendations specified in the *Idaho Air Quality Modeling Guideline* (DEQ 2013), and DEQ determined that the receptor network was effective in reasonably assuring compliance with applicable air quality standards at all ambient air locations.

Figure 9. SGP AMBIENT AIR BOUNDARY AND MODELING RECEPTOR GRID.



REC 0678

PET 312

3.3.13 Good Engineering Practice Stack Height

An allowable good engineering practice (GEP) stack height may be established using the following equation in accordance with Idaho Air Rules Section 512.03.b:

H = S + 1.5L, where:

H = good engineering practice stack height measured from the ground-level elevation at the base of the stack.

S = height of the nearby structure(s) measured from the ground-level elevation at the base of the stack.

L = lesser dimension, height or projected width, of the nearby structure.

Sources from the SGP facility are below GEP stack height. Therefore, consideration of downwash caused by nearby buildings was required.

4.0 NAAQS and TAPs Impact Modeling Results

4.1 Results for NAAQS Analyses

4.1.1 Significant Impact Level Analyses

A SIL analysis was not performed for the SGP project.

4.1.2 Cumulative NAAQS Impact Analyses

Table 24 provides results (highest of 14 scenarios) for the cumulative NAAQS impact analysis. It provides the model-predicted maximum design concentration (including the hot-spot analyses) and the associated modeling scenario, the background concentration, and the estimated total concentration (SGP impact plus background) for each pollutant-averaging time combination. A comparison of the estimated total concentrations with the applicable NAAQS is also provided in this table. For each pollutant and averaging period, two modeled design concentrations are listed, each corresponding to the meteorological data processed with (BULKRN) and without (NON-BULKRN, grey shading) the Bulk Richardson method.

Table 24. RESULTS FOR CUMULATIVE NAAQS IMPACT ANALYSES.

Pollutant	Averaging Time	Max. Conc.[a] (µg/m^3)[b]	Model Scenario	Back. Conc.[c] (µg/m^3)	Total Conc.[d] (µg/m^3)	NAAQS (µg/m^3)	Percent of NAAQS
Carbon monoxide	8 hours	6,218[e]	W1	1,110	7,328	10,000	73.3%
		3,516[f]	W1		4,626		46.3%
	1 hour	17,054	W1	1,740	18,794	40,000	47.0%
		9,467	W1		11,207		28.0%
Nitrogen dioxide	1 year	2.3	W1	0.9	3.2	100	3.2%
		1.4	W1		2.3		2.3%
	1 hour	116.7	B1	4.3	121.0	188	64.4%
		111.0	W1		115.3		61.3%

$PM_{2.5}$[g]	1 year	7.7	W5	3.5	11.2	12	93.3%
		4.2	W5		7.7		64.2%
	24 hours	18.6	W5	15.0	33.6	35	96.0%
		11.0	W5		26.0		74.3%
PM_{10}[h]	24 hours	121.5	W5	37.0[i]	158.5	150	105.7%[j]
		75.7	W5		112.7		75.1%
Sulfur dioxide	3 hours	1.8	B1	16.8	18.6	1,300	1.4%
		1.2	B1		18.0		1.4%
	1 hour	3.2	B1	12.3	15.5	196	7.9%
		2.7	B1		15.0		7.7%

a. Max. Conc. = maximum modeled design concentration.
b. Micrograms per cubic meter.
c. Back. Conc. = background concentration.
d. Total Conc. = total (modeled + background) concentration.
e. The first Max. Conc. value for each pollutant and averaging time represents results using the BULKRN meteorological data.
f. The second (grey-shaded) Max. Conc. value for each pollutant and averaging time represents results using the NON-BULKRN meteorological data.
g. Particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers.
h. Particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers.
i. For 24-hour PM_{10}, the design value is the *second-highest* 24-hour average concentration in a given year. However, the background value that was used in the modeling analyses represents the *first-highest* 24-hour average concentration measured in 2014. Therefore, using a larger background concentration adds a layer of conservatism to the calculated total impact for 24-hour PM_{10}.
j. Results for 24-hour PM_{10} with meteorological data processed using BULKRN show up to five hotspot receptors that exceed NAAQS. Refer to Section 4.1.4 of this modeling memo for a weight-of-evidence analysis demonstrating NAAQS compliance.

Table 24 shows that modeled concentrations derived using the BULKRN meteorological data are higher than the NON-BULKRN dataset. It also shows that the total (modeled + background) concentrations from the SGP cumulative impact analyses do not exceed the applicable NAAQS, except for when the BULKRN meteorological data are used in modeling 24-hour PM_{10} (total concentration is 105.7% of the 24-hour PM_{10} NAAQS).

PM_{10} modeling with the meteorological dataset processed with the BULKRN method shows up to five hotspot receptors for three modeling scenarios (W1, W3, and W5) with slight exceedance of NAAQS. Scenario W5 is the worst-case scenario, with a maximum total concentration of 158.5 $\mu g/m^3$ which exceeds the NAAQS of 150 $\mu g/m^3$. A weight-of-evidence analysis demonstrating PM_{10} NAAQS compliance is presented in Section 4.1.4 of this modeling memo.

The locations of the maximum impacts for each pollutant and averaging time are illustrated in Figure 10. The results presented in this figure include the hot-spot analyses conducted for each applicable pollutant-averaging time combination. For $PM_{2.5}$ and PM_{10}, the alternate meteorological data (NON-BULKRN) were used.

Modeling for ozone and secondary $PM_{2.5}$ were not performed for this minor stationary source. These analyses are typically associated with applications for major stationary sources. Nonetheless, taking the ratio of the VOC, NOx, and SO_2 emissions from the SGP facility by the emissions and resulting concentrations of O_3 and secondary $PM_{2.5}$ from EPA's modeled emission rates for precursors (MERPs) guidance yields estimated O_3 and secondary $PM_{2.5}$ concentrations of less than 1 ppb of O_3 and less than 0.1 $\mu g/m^3$ of $PM_{2.5}$ (24-hour and annual) for the SGP. These estimated concentrations have a negligible effect on compliance demonstration with the NAAQS.

REC 0680

PET 314

Figure 10. SGP CUMULATIVE IMPACTS (µg/m^3) AND LOCATIONS.



Higher background concentrations from McCall that include medium-traffic emissions provided in Section 3.2.3 were then combined with the SGP model-predicted maximum design concentrations to provide an additional level of conservatism in demonstrating compliance. These results are shown in Table 25. For $PM_{2.5}$ and PM_{10}, the alternate meteorological data (NON-BULKRN) were used. For the rest of the criteria pollutants, the BULKRN meteorological data were used.

Table 25. RESULTS FOR CUMULATIVE NAAQS IMPACT ANALYSES WITH MEDIUM-TRAFFIC BACKGROUND.							
Pollutant	**Averaging Time**	**Max. Conc.[a] (µg/m³)[b]**	**Model Scenario**	**Back. Conc.[c] (µg/m³)**	**Total Conc.[d] (µg/m³)**	**NAAQS (µg/m³)**	**Percent of NAAQS**
Carbon monoxide	8 hours	6,218	W1	1,145	7,363	10,000	73.6%
	1 hour	17,054	W1	1,797	18,851	40,000	47.1%
Nitrogen dioxide	1 year	2.3	W1	2.6	4.9	100	4.9%
	1 hour	116.7	B1	14.3	131.0	188	69.7%
$PM_{2.5}$[e]	1 year	4.2	W5	5.1	9.3	12	77.5%
	24 hours	11.0	W5	17.5	28.5	35	81.4%
PM_{10}[f]	24 hours	75.7	W5	60.1	135.8	150	90.5%
Sulfur dioxide	3 hours	1.8	B1	16.8	18.6	1,300	1.4%
	1 hour	3.2	B1	12.3	15.5	196	7.9%

a. Max. Conc. = maximum modeled design concentration.
b. Micrograms per cubic meter.
c. Back. Conc. = background concentration.
d. Total Conc. = total (modeled + background) concentration.
e. Particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers.
f. Particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers.

4.1.3 DEQ's Sensitivity Analyses for 1-hour and Annual NO_2

DEQ performed a sensitivity analysis for 1-hour and annual NO_2 using a Tier 2 (ARM2) screening method. Minimum and maximum NO_2/NOx ratios of 0.5 and 0.9, respectively, were used. Results from DEQ's cumulative NAAQS impact analyses, summarized below in Table 26, indicate that the SGP facility is safely below the 1-hour and annual NO_2 NAAQS even when using a more conservative NO_2 screening method.

Table 26. RESULTS FOR DEQ'S NO_2 SENSITIVITY ANALYSES USING TIER 2 (AMBIENT RATIO METHOD 2) SCREENING METHOD.							
Pollutant	**Averaging Time**	**Max. Conc.[a] (µg/m³)[b]**	**Model Scenario**	**Back. Conc.[c] (µg/m³)**	**Total Conc.[d] (µg/m³)**	**NAAQS (µg/m³)**	**Percent of NAAQS**
Nitrogen dioxide	1 year	1.8	B1	0.9	2.7	100	2.7%
		1.8	H1		2.7		2.7%
		2.3	W1		3.2		3.2%
		1.8	Y1		2.7		2.7%
	1 hour	110.9	B1	4.3	115.2	188	61.3%
		73.0	H1		77.3		41.1%
		162.6	W1		166.9		88.8%
		59.8	Y1		64.1		34.1%

a. Max. Conc. = maximum modeled design concentration.
b. Micrograms per cubic meter.
c. Back. Conc. = background concentration.
d. Total Conc. = total (modeled + background) concentration.

4.1.4 DEQ's Weight-of-Evidence Analyses for 24-hour PM_{10}

This section describes a weight-of-evidence analysis that provides additional analytical information to evaluate the degree of NAAQS compliance confidence for 24-hour PM_{10}. NAAQS compliance was demonstrated in the submitted application using meteorological data processed with an EPA-approved method using regional cloud cover to calculate stability parameters rather than site-specific monitored solar radiation and measured temperature differences with height. Both methods are considered default for regulatory purposes, and modeling using this dataset shows that the facility is well below NAAQS.

REC 0682

PET 316

As described in Section 4.1.2, PM_{10} modeling with meteorological dataset processed using the site-specific BULKRN method shows up to five hotspot receptors for Scenario W5 (the highest PM_{10} modeling scenario) that exceed NAAQS (150 µg/m^3). The hotspot receptors have a 25-meter grid spacing. Hotspot receptors that exceed 24-hour PM_{10} NAAQS have total (modeled + background) concentrations of 152.7, 154.3, 155.0, 155.7, and 158.5 µg/m^3. Locations of these receptors are illustrated in Figure 11. Figure 12 shows these receptors overlaid on Google Earth. As noted in Section 3.2.1 of this modeling memorandum, the design value for 24-hour PM_{10} is the *second-highest* 24-hour average concentration in a given year. However, the background value that was used in the modeling analyses (37.0 µg/m^3) represents the *first-highest* 24-hour average concentration measured in 2014. Therefore, using a larger background concentration adds another layer of conservatism to the calculated total impact for 24-hour PM_{10}. If the *second-highest* 24-hour average concentration (34.0 µg/m^3) were used in the modeling analyses, the number of receptors that exceed the 24-hour PM_{10} NAAQS is reduced from five to four.

REC 0683

PET 317

Figure 11. HOTSPOT RECEPTORS THAT EXCEED 24-HOUR PM_{10} NAAQS (SCENARIO W5, BULKRN METEOROLOGICAL DATA).

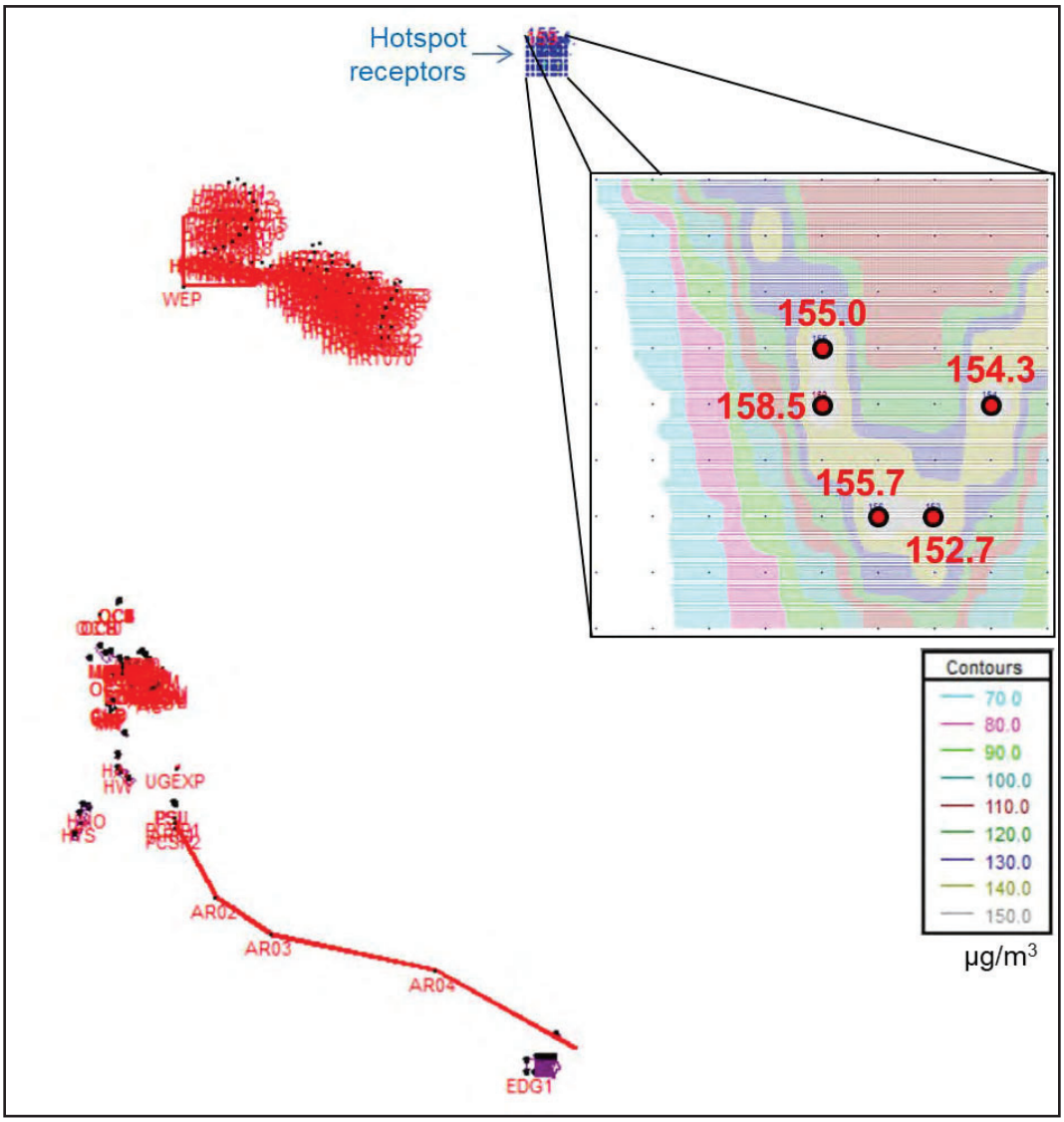
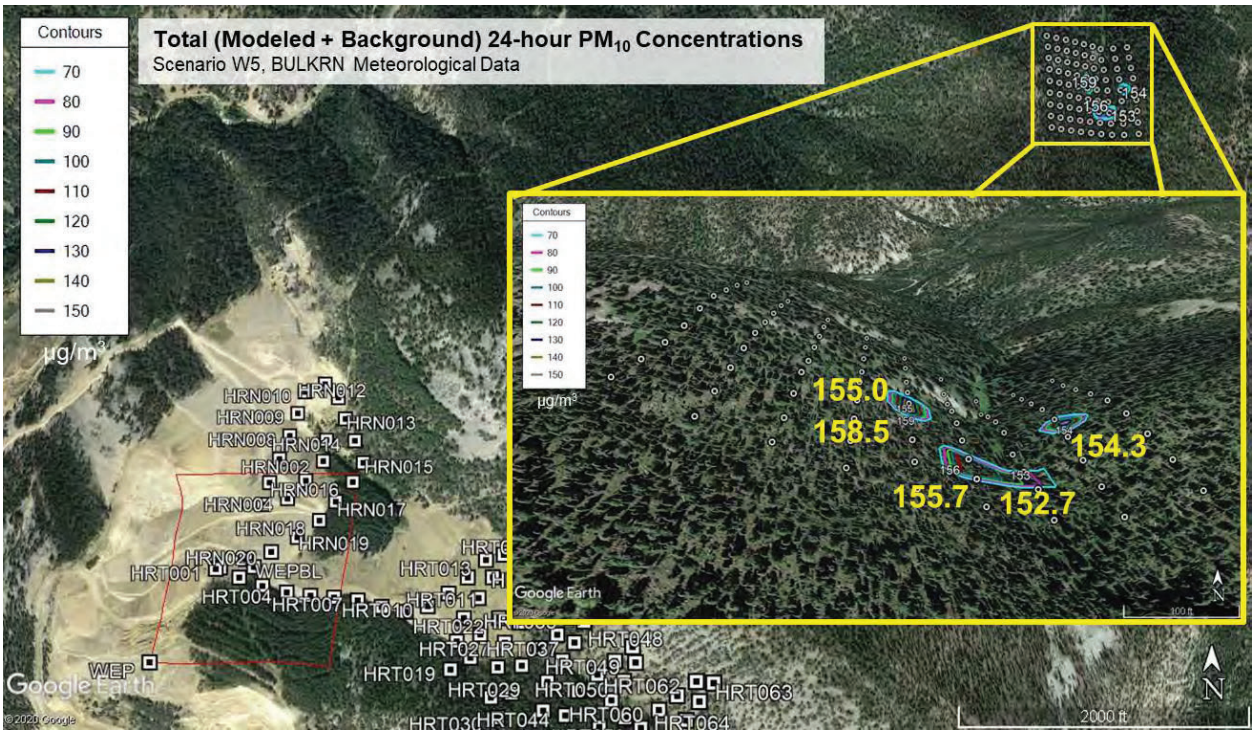


Figure 12. HOTSPOT RECEPTORS THAT EXCEED 24-HOUR PM_{10} NAAQS, OVERLAID ON GOOGLE EARTH IMAGE (SCENARIO W5, BULKRN METEOROLOGICAL DATA).



Figures 11 and 12 show that the modeled PM_{10} NAAQS exceedances are located northeast of the SGP facility. These receptors are located 2 km away from the center of the West End Pit (WEP). The AERMOD output files indicate that all modeled violations occur during winter (all modeled violations occur on December 23, 2014). Data provided in the SGP baseline study (Perpetua Resources Idaho 2017a) specify an average snow depth of 21-68 inches and an average precipitation of 6.0 inches at the project site during this period. Therefore, fugitive road dust emissions during high-modeled impact hours could be overestimated.

DEQ performed a source-group analysis (Table 27) which indicates that emissions from the WEP and the Haul Road (HR) are the largest contributors to the maximum modeled PM_{10} design concentrations. For comparison, source-group analyses using the NON-BULKRN meteorological data are also listed in Table 27.

Table 27. SOURCE-GROUP ANALYSES FOR 24-HOUR PM_{10} (SCENARIO W5).

Emission Source Group	Modeled Design Concentration (µg/m³)[a]	
	BULKRN	NON-BULKRN
ALL	121.5	75.7
West End Pit (WEP)	89.3	24.5
West End Pit Blasting (WEPBL)	1.94	1.81
West End Pit Development Rock Storage Facility (WEDRSF)	0.98	3.47
Haul Road (HR)	51.0	52.5
Access Road (ACCRD)	0.0064	0.0074
Underground Exploration (UGEXP)	0.00001	0.00001

Process & Ancillary Point Sources	0.23	0.76
Process & Ancillary Volume Sources	0.20	0.29

[a] Micrograms per cubic meter.

The six source groups listed in Table 27 that are related to mining activity and emissions (WEP, WEPBL, WEDRSF, HR, ACCRD, UGEXP) were examined further. Table 28 lists the daily modeled PM_{10} emissions (in pounds per day [lb/day]), grouped according to mining activity. Key assumptions for calculating the daily emissions are also listed in this table. Total modeled PM_{10} emission from mining activity for Scenario W5 is 3,336.76 lb/day. The contribution from each source group is listed in the second column of Table 28, and a pie chart is illustrated in Figure 13.

Table 28. KEY ASSUMPTIONS FOR CALCULATING DAILY MINING ACTIVITY EMISSIONS FOR 24-HOUR PM_{10} (SCENARIO W5).

Mining Activity	Emissions (lb/day)[a]
WEP (West End Pit)	**885.54**
Open Pit Drilling	
• Blasting 180,000 tons of material (DR) per day • Drilling 1,200 holes per day	811.20
Material Loading	
• Blasting 180,000 tons of material (DR) per day	18.00
Dozing	
• Dozers operating 144 hours per day • Surface material silt content of 6.9% • Material moisture content of 7.9%	54.20
Surface Exploration	
• Total wet drilling holes of 700 divided by 14 years • 50 holes per year	2.15
WEPBL (West End Pit Blasting)	**334.38**
Open Pit Blasting	
• Blasting 180,000 tons of material (DR) per day • Two blasts per day	334.38
WEDRSF (West End Pit Development Rock Storage Facility)	**57.12**
Material Unloading	
• Blasting 180,000 tons of material (DR) per day	2.88
Dozing	
• Six dozers operating 144 hours per day • Surface material silt content of 6.9% • Material moisture content of 7.9%	54.20
Wind Erosion	0.04
HR (Haul Road)	**2,050.34**
Onsite Hauling	
• Blasting 180,000 tons of material (DR) per day • One-way hauling distance of 3.07 miles • Total travel of 7,758 vehicle miles traveled (VMT) per day • Surface material silt content of 4% • Daily PM_{10} emission factor of 3.55 pounds per VMT • Control efficiency of 90% for chemical suppressant • Control efficiency of 33% for watering	1,842.97
Grading	
• Grader average speed of 6.5 mph • Three graders operating 72 hours per day • Control efficiency of 90% for chemical suppressant	60.51
Water Truck Travel	
• Two water trucks operating 48 hours per day	146.86

REC 0686

PET 320

• Average truck speed of 15 mph • Surface material silt content of 4% • Daily PM_{10} emission factor of 3.04 pounds per VMT • Control efficiency of 90% for chemical suppressant • Control efficiency of 33% for watering	
ACCRD (Access Road) *Vehicle Travel* • Access road length of 1.6 miles (within project boundary) • Surface material silt content of 4% • Daily PM_{10} emission factor of 1.26 pounds per VMT • Control efficiency of 90% for chemical suppressant • Control efficiency of 33% for watering *Grading* • PM_{10} emission factor of 1.3 pounds per VMT • Control efficiency of 90% for chemical suppressant	**9.38** 9.17 0.21
UGEXP (Underground Exploration) *Underground Exploration* • Wet drilling 25 holes per year	**0.004** 0.004

[a.] Pounds per day.

Figure 13. PIE CHART FOR DAILY MODELED PM_{10} EMISSIONS FROM MINING ACTIVITY (SCENARIO W5).

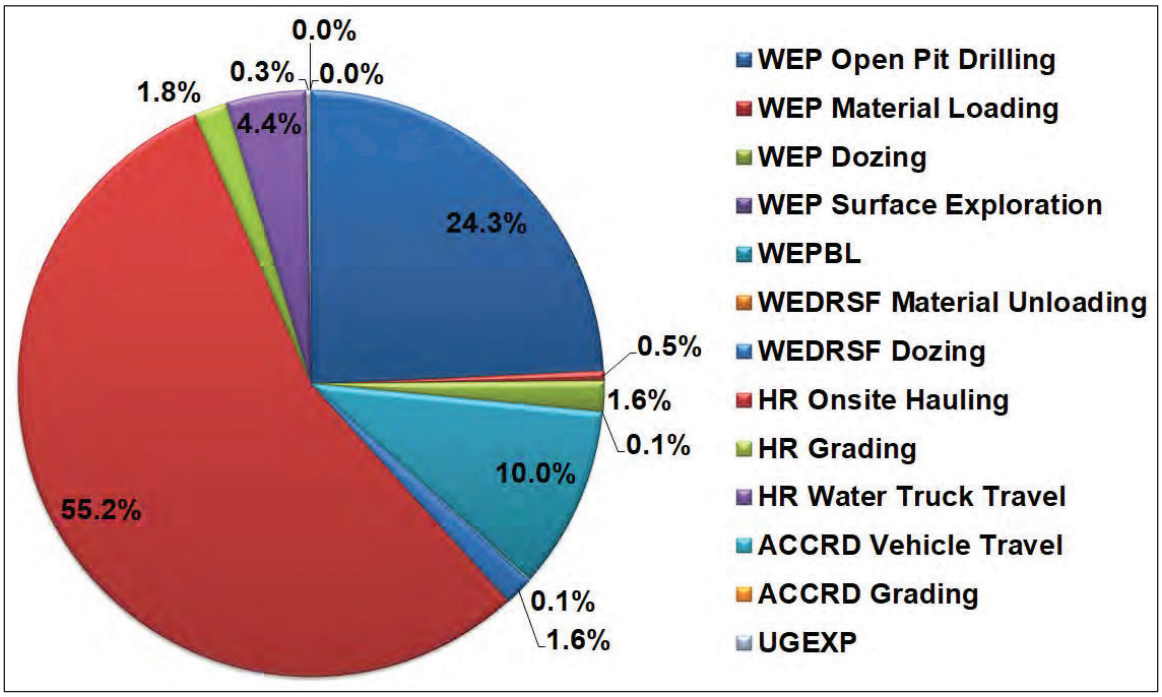


Figure 13 shows that onsite hauling on haul roads ("HR Onsite Hauling") accounts for 55.2% of the total daily PM_{10} emissions. Open pit drilling at the WEP ("WEP Open Pit Drilling") and blasting ("WEPBL") account for 24.3% and 10.0% of the daily PM_{10} emissions, respectively. Therefore, it is not surprising that HR, WEP, and WEPBL are associated with the highest modeled design concentrations in Table 27.

Table 29 shows the ten highest-ranked modeled 24-hour PM_{10} impacts from each emission source group. Note that for 24-hour PM_{10}, the design value is the *second-highest* 24-hour average concentration in a given year. Therefore, the second-high modeled value for source group ALL (121.5 $\mu g/m^3$) was summed

with the background concentration for comparison to NAAQS. The calculated total impact (modeled design value + background concentration) is conservative because the background value that was used in the cumulative NAAQS impact analyses (37.0 µg/m^3) represents the *first-highest* 24-hour average concentration measured in 2014.

Table 29. TEN HIGHEST-RANKED MODELED 24-HOUR PM_{10} IMPACTS IN µg/m^3 FROM DIFFERENT SOURCE GROUPS (SCENARIO W5, BULKRN METEOROLOGICAL DATA).

Rank	ALL[a]	WEP[b]	WEPBL[c]	WEDRSF[d]	HR[e]	ACCRD[f]	UGEXP[g]	PRCSPT[h]	PRCSVOL[i]
1ST	142.2	102.5	2.27	1.02	52.1	7.26E-03	1.00E-05	0.24	0.23
2ND	121.5	89.3	1.94	0.98	51.0	6.41E-03	1.00E-05	0.23	0.20
3RD	113.4	78.1	1.83	0.96	49.6	5.31E-03	1.00E-05	0.22	0.13
4TH	110.1	77.0	1.73	0.93	49.4	3.39E-03	1.00E-05	0.20	0.10
5TH	108.5	76.9	1.62	0.90	46.1	3.39E-03	1.00E-05	0.18	0.09
6TH	107.7	75.7	1.57	0.85	45.5	3.22E-03	1.00E-05	0.17	0.08
7TH	105.7	73.3	1.49	0.84	43.4	3.21E-03	0	0.16	0.08
8TH	105.6	72.3	1.30	0.77	42.9	2.91E-03	0	0.15	0.08
9TH	101.5	71.4	1.28	0.77	41.8	2.87E-03	0	0.15	0.08
10TH	99.8	71.2	1.23	0.76	41.8	2.56E-03	0	0.15	0.08

a. ALL = all emission sources.
b. WEP = West End Pit.
c. WEPBL = West End Pit Blasting.
d. WEDRSF = West End Pit Development Rock Storage Facility.
e. HR = Haul Road.
f. ACCRD = Access Road.
g. UGEXP = Underground Exploration.
h. PRCSPT = Process & Ancillary Point Sources.
i. PRCSVOL = Process & Ancillary Volume Sources.

Given a background of 37.0 µg/m^3 and a NAAQS of 150 µg/m^3, the critical modeled concentration threshold for any 24-hour PM_{10} NAAQS violation is therefore 113.0 µg/m^3. Table 29 shows that the third-high modeled value for source group ALL (113.4 µg/m^3) barely exceeds NAAQS. Fourth-high (and lower-ranked) modeled impacts, when added to the background concentration, are below NAAQS.

As discussed earlier in this section, HR Onsite Hauling, WEP Open Pit Drilling, and WEP Blasting are the three largest components of the total daily PM_{10} emissions. Therefore, it is not surprising that HR, WEP, and WEPBL are associated with the highest modeled concentrations among all source groups.

To investigate the potential culpability of each source group to the modeled 24-hour PM_{10} NAAQS violation, DEQ performed a culpability analysis using the MAXIFILE output option in AERMOD. The MAXIFILE option provides the receptor location and date of an impact. DEQ performed two MAXIFILE runs. In the first MAXIFILE simulation, the model was run using source group ALL. A threshold value (113.0 µg/m^3) equal to the NAAQS minus background was set. The output file provided a list of the receptors where the NAAQS is exceeded. In the second MAXIFILE simulation, the model was run using only the receptors identified by the first MAXIFILE run. Source groups were included in the second modeling simulation. A threshold value equal to the 24-hour PM_{10} SIL (5.0 µg/m^3) was set. The output file provided a date stamp for any day when a source group exceeds the SIL and potentially contributes to a violation of the NAAQS. A significant contribution to a NAAQS violation would be predicted to occur if the date stamps for source group ALL (from the first MAXIFILE run) and for a specific source group (from the second MAXIFILE run) matched.

DEQ's culpability analyses confirm that emission source groups HR and WEP are culpable for the 24-hour PM_{10} NAAQS exceedances. The date stamps indicate NAAQS violations during the winter season (January 6, January 15, and December 23). We show next that when modeled emissions are more-closely

REC 0688

PET 322

representative of typical daily mining production rates for a high-production period (everything else held constant), the SGP facility is able to demonstrate compliance with 24-hour PM_{10} NAAQS at those few receptors showing a potential violation when using meteorological data processed with the BULKRN method. We also discuss next the implication of NAAQS violations occurring during the winter season.

As listed in Table 28, PM_{10} modeling simulation for Scenario W5 was based on a mining production rate of 180,000 ton/day of development rock. This corresponds to 65,700,000 ton/year, which is more conservative than the expected peak production rate of 42,692,000 ton/year (116,964 ton/day). To investigate the effect of a lower modeled mining production rate on design value concentrations, DEQ performed a modeling simulation ("DEQ Run 1") where mining production rate was assumed to be 120,000 ton/day instead of 180,000 ton/day, but all other model variables were held constant. This adjustment lowered the modeled daily emission rates for WEP, WEDRSF, and HR, which are summarized in Table 30. Because the modeled emission rates were lower, the modeled design concentrations were also lower. Results for DEQ's sensitivity analyses are summarized in Table 31.

Table 30. DAILY MINING ACTIVITY EMISSIONS USED IN DEQ'S SENSITIVITY ANALYSES FOR 24-HOUR PM_{10} (SCENARIO W5).

Mining Activity	Emissions (lb/day)[a]	
	Applicant's Submittal	DEQ Run 1
WEP (West End Pit)	**885.54**	**879.54**
Open Pit Drilling	811.20	811.20
Material Loading	18.00	12.00
Dozing	54.20	54.20
Surface Exploration	2.15	2.14
WEPBL (West End Pit Blasting)	**334.38**	**334.38**
Open Pit Blasting	334.38	334.38
WEDRSF (West End Pit Development Rock Storage Facility)	**57.12**	**56.15**
Material Unloading	2.88	1.92
Dozing	54.20	54.20
Wind Erosion	0.04	0.03
HR (Haul Road)	**2,050.34**	**1,436.50**
Onsite Hauling	1,842.97	1,229.13
Grading	60.51	60.51
Water Truck Travel	146.86	146.86
ACCRD (Access Road)	**9.38**	**9.38**
Vehicle Travel	9.17	9.17
Grading	0.21	0.21
UGEXP (Underground Exploration)	**0.004**	**0.004**
Underground Exploration	0.004	0.004
Total	**3,336.76**	**2,715.95**

a. Pounds per day.

Table 31. RESULTS FOR DEQ'S SENSITIVITY ANALYSES FOR 24-HOUR PM_{10} (SCENARIO W5, BULKRN METEOROLOGICAL DATA).

Pollutant	Averaging Time	Max. Conc.[a] (µg/m³)[b]	Model Scenario	Back. Conc.[c] (µg/m³)	Total Conc.[d] (µg/m³)	NAAQS (µg/m³)	Percent of NAAQS
PM_{10}[e]	24 hours	111.5[f]	W5	37.0[g]	148.5	150	99.0%

a. Max. Conc. = maximum modeled design concentration.
b. Micrograms per cubic meter.

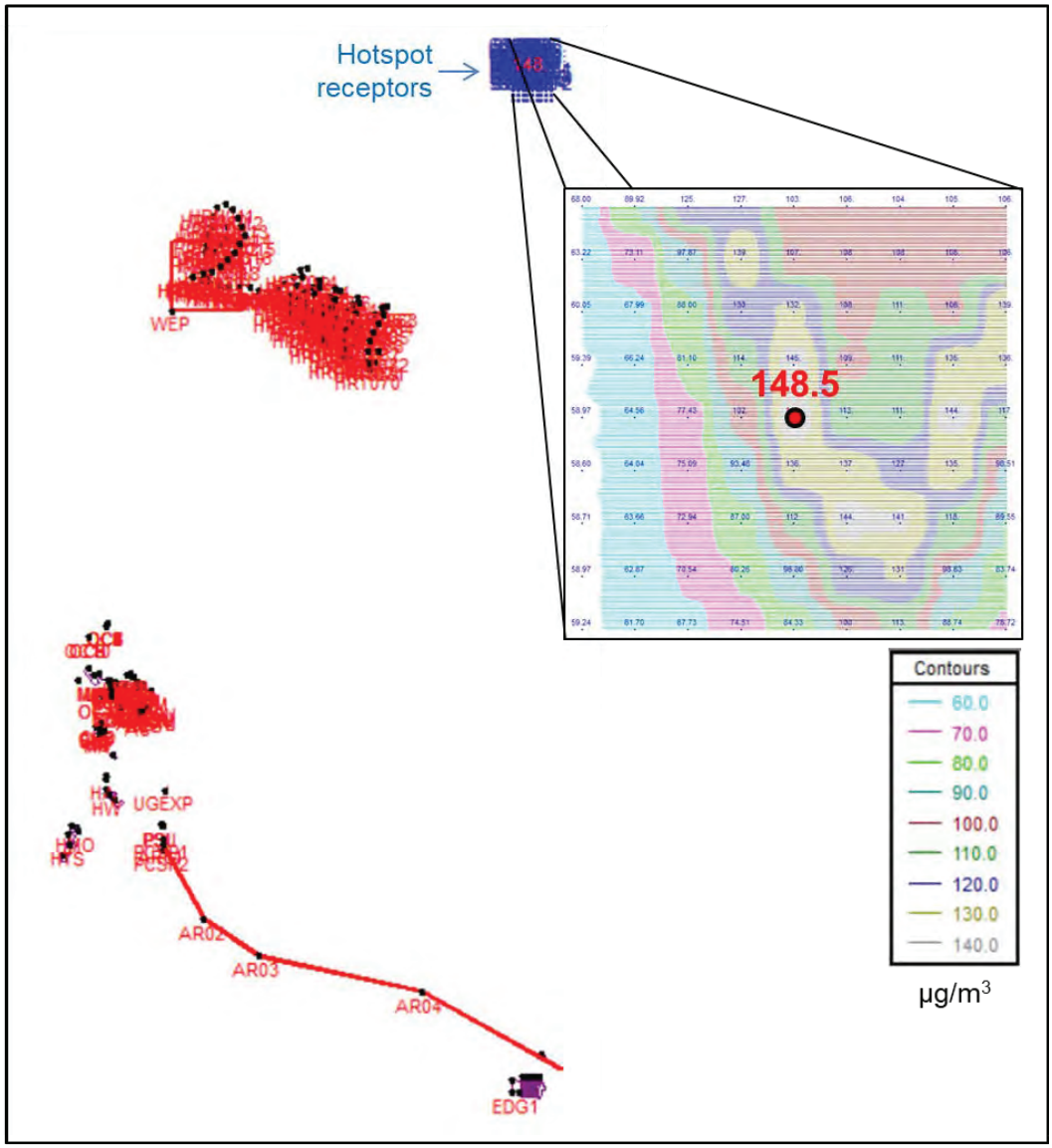
REC 0689

PET 323

c. Back. Conc. = background concentration.
d. Total Conc. = total (modeled + background) concentration.
e. Particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers.
f. DEQ Run 1: mining production rate was modeled at 120,000 ton/day instead of 180,000 ton/day. Everything else was held constant.
g. For 24-hour PM_{10}, the design value is the *second-highest* 24-hour average concentration in a given year. However, the background value that was used in the modeling analyses represents the *first-highest* 24-hour average concentration measured in 2014. Therefore, using a larger background concentration adds a layer of conservatism to the calculated total impact for 24-hour PM_{10}.

Maximum modeled concentration for "DEQ Run 1", when summed with the background concentration, is lower than NAAQS thereby demonstrating NAAQS compliance. Total (modeled + background) concentrations for all hotspot receptors are depicted in Figure 14; maximum total impact is depicted by the red circle. The SGP facility complies with the 24-hour PM_{10} NAAQS when daily mining production rates closer to a more typical daily rate for a high-production period are used in the model, instead of a very conservative mining production rate, even when using site-specific BULKRN meteorological data.

Figure 14. RESULTS FOR DEQ'S SENSITIVITY ANALYSES SHOWING TOTAL (MODELED + BACKGROUND) 24-HOUR PM_{10} CONCENTRATIONS AT HOTSPOT RECEPTORS (SCENARIO W5, BULKRN METEOROLOGICAL DATA).



Meteorological data processing with and without BULKRN are considered acceptable by EPA. However, the BULKRN meteorological data yielded higher modeled design values for the SGP facility than the meteorological data processed without the BULKRN method. DEQ's analyses suggest that when daily mining production rates closer to a more typical daily rate for a high-production period are used (everything else held constant), the SGP facility is able to demonstrate compliance with 24-hour PM_{10} NAAQS at those few receptors showing a potential violation when using meteorological data processed with the BULKRN method.

Maximum modeled design value 24-hour PM_{10} impacts, even with the use of more reasonably expected daily production rates, are still just under the 150 $\mu g/m^3$ NAAQS. As noted earlier in this section, these high values were observed during the winter season. During this period, not only are fugitive emissions minimized because of the higher moisture content of material handled or driven over, but background concentrations in such remote areas are generally much lower because of the absence of wildfires and dust-generating sources.

To summarize, DEQ considered the following assumptions and results in its weight-of-evidence analyses:

a. All modeled impacts are below NAAQS for meteorological data with stability parameters calculated by regional cloud cover data.
b. Modeled impacts over the 24-hour PM_{10} NAAQS using BULKRN meteorological data are limited to a small area and limited period of time.
c. Modeled 24-hour PM_{10} NAAQS exceedances are limited to the winter season, where emissions and background levels are likely overestimated.
d. The model assumes maximum allowable operations/emissions.
e. The model assumes minimum allowable controls on emissions. The permit would require at least 93% control of maximum potential fugitive emissions, but the fugitive emissions may in fact be controlled by more than that, especially during winter and periods of precipitation.
f. Finally, 24-hour PM_{10} background concentrations represent the maximum 1st high (instead of the maximum 2nd high) which is on the higher end of the distribution.

DEQ's weight-of-evidence analyses show that, considering all the collective conservative layers of the modeling analyses, modeling efforts using both site-specific and alternative meteorological datasets show acceptable impacts. DEQ is highly confident that operation of the SGP will not cause or contribute to a violation of NAAQS. This is based on: (1) the submitted application materials and analyses; (2) DEQ's supplemental analyses; and (3) the assumption that the facility is constructed and operated as described in the application and limited by the PTC.

PRI later determined that the West End Development Rock Storage Facility will not be constructed. This change eliminated Scenario W5 as a potential operating scenario. Scenario W3 is now the scenario producing the highest modeled impacts, and NAAQS compliance is easily demonstrated when using temporally varying background PM_{10} values, which were obtained from onsite monitoring data. Results are presented in the *Modeling Review Attachment* to this memorandum.

4.1.5 DEQ's Sensitivity Analyses for a Lower Fugitive Road Dust Control Efficiency

Fugitive particulate emissions from roadways were estimated by the applicant to be controlled above 93%, which is an aggressive level of control. The high level of emission control was needed to demonstrate compliance with NAAQS. To investigate the effect of lower unpaved road emission control efficiency, DEQ performed a modeling simulation ("DEQ Run 2") where the control efficiency was set to

REC 0691

PET 325

90%. The daily mining production rate was assumed to be 120,000 ton/day instead of 180,000 ton/day, but everything else was held constant. These adjustments lowered the daily modeled emission rates for WEP and WEDRSF, but increased the daily modeled emission rate for HR and the Access Road (ACCRD) (Table 32). Five receptors exceed the 24-hour PM_{10} NAAQS. Figure 15 shows the locations of these receptors.

Table 32. DAILY MINING ACTIVITY EMISSIONS USED IN DEQ'S SENSITIVITY ANALYSES FOR 24-HOUR PM_{10} (SCENARIO W5).

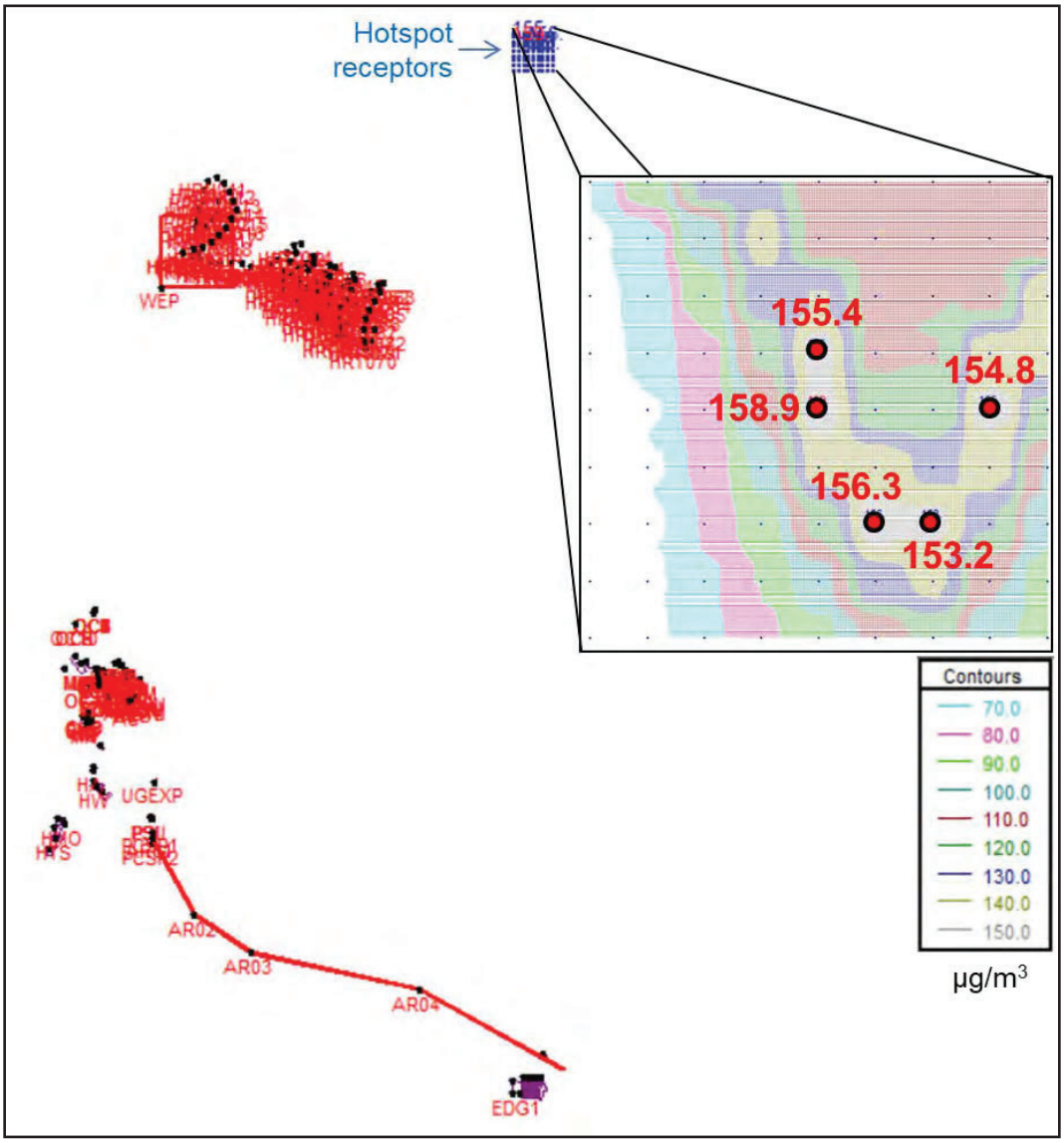
Mining Activity	Emissions (lb/day)[a]	
	Applicant's Submittal	DEQ Run 2
WEP (West End Pit)	**885.54**	**879.54**
Open Pit Drilling	811.20	811.20
Material Loading	18.00	12.00
Dozing	54.20	54.20
Surface Exploration	2.15	2.14
WEPBL (West End Pit Blasting)	**334.38**	**334.38**
Open Pit Blasting	334.38	334.38
WEDRSF (West End Pit Development Rock Storage Facility)	**57.12**	**56.15**
Material Unloading	2.88	1.92
Dozing	54.20	54.20
Wind Erosion	0.04	0.03
HR (Haul Road)	**2,050.34**	**2,114.24**
Onsite Hauling	1,842.97	1,834.53
Grading	60.51	60.51
Water Truck Travel	146.86	219.20
ACCRD (Access Road)	**9.38**	**13.90**
Vehicle Travel	9.17	13.69
Grading	0.21	0.21
UGEXP (Underground Exploration)	**0.004**	**0.004**
Underground Exploration	0.004	0.004
Total	**3,336.76**	**3,398.21**

a. Pounds per day.

REC 0692

PET 326

Figure 15. RESULTS FOR DEQ'S SENSITIVITY ANALYSES SHOWING HOTSPOT RECEPTORS THAT EXCEED 24-HOUR PM_{10} NAAQS, ASSUMING MINING PRODUCTION RATE OF 120,000 TONS PER DAY AND FUGITIVE ROAD DUST CONTROL EFFICIENCY OF 90% (SCENARIO W5, BULKRN METEOROLOGICAL DATA).



DEQ's sensitivity analyses suggest that a few hotspot receptors exceed the 24-hour PM_{10} NAAQS when the unpaved road control efficiency falls below 93% and the meteorological data processed with the BULKRN method is used. When the meteorological data processed without the BULKRN method is used, all the hotspot receptors demonstrate compliance with NAAQS at a 90% control efficiency and at both examined production levels:

- maximum impact at 120,000 ton per day: 73.9 $\mu g/m^3$ + 37.0 $\mu g/m^3$ = 110.9 $\mu g/m^3$.
- maximum impact at 180,000 ton per day: 84.6 $\mu g/m^3$ + 37.0 $\mu g/m^3$ = 121.6 $\mu g/m^3$.

While using alternative meteorological data processed without the BULKRN method safely demonstrates

compliance with NAAQS, using site-specific BULKRN meteorological data does not. Therefore, DEQ's modeling team recommends that the permit require an aggressive implementation of measures to achieve above 93% control efficiency for fugitive particulate emissions from roadways.

4.2 Results for TAPs Impact Analyses

TAP analyses were extensively refined after the February/March public comment period, as described in the *TAP Addendum* submitted by Perpetua. DEQ's review of the *TAP Addendum* is provided in the DEQ *Modeling Review Attachment* to this memorandum.

5.0 Conclusions

The information submitted with the PTC application (including the *TAP Addendum*), combined with DEQ's air impact analyses and the assumption that the facility is constructed and operated as described in the application and limited by the PTC, demonstrated to DEQ's satisfaction that emissions from the Stibnite Gold Project in Valley County, Idaho will not cause or significantly contribute to a violation of any applicable ambient air quality standard or TAP increment.

REC 0694

PET 328

References

APT. 2009. "Source Emissions Testing Report, Barrick Cortez, Inc." *Hydrogen Cyanide Emissions, Electrowinning Cells #1 & #2.* November 11.

APT. 2013. "Source Emissions Test Report for Barrick Goldstrike Mines, Inc.: Carlin, Nevada Facility Title V Compliance Testing Operating Permit No. AP1041-0739.02." Report prepared for: Barrick Goldstrike Mines, Inc., August 28.

CAPCOA. 2011. "Modeling Compliance of The Federal 1-Hour NO_2 NAAQS." California Air Pollution Control Officers Association, October 27.

CSIRO. 2008. "NOx Emissions from Blasting Operations in Open-Cut Coal Mining." *Atmospheric Environment.* November.

DEQ. 2013. "State of Idaho Guideline for Performing Air Quality Impact Analyses." Idaho Department of Environmental Quality. September. State of Idaho DEQ Air Doc. ID AQ-011. http://www.deq.idaho.gov/media/1029/modeling-guideline.pdf.

DEQ. 2014. "Policy on NAAQS Compliance Demonstration Requirements." Idaho Department of Environmental Quality Policy Memorandum. July 11.

DEQ. 2015. "Approval Re: Meteorological and Air Quality Data Summary - Stibnite Gold Project Monitoring Network." October 8.

DEQ. 2021. "Guideline for Performing Air Quality Impact Analyses." Stationary Source Program. AQ Division. Idaho Department of Environmental Quality. July 2021. https://www.deq.idaho.gov/permits/air-quality-permitting. July.

EPA. 2012. "Haul Road Workgroup Final Report Submission to EPA-OAQPS." Memorandum from Tyler Fox (EPA Air Quality Modeling Group Leader) to Regional Office Modeling Contacts, March 2. Accessed July 2, 2015. http://www.epa.gov/scram001/reports/Haul_Road_Workgroup-Final_Report_Package-20120302.pdf.

EPA. 2014. "Clarification on the Use of AERMOD Dispersion Modeling for Demonstrating Compliance with the NO_2 National Ambient Air Quality Standard." Guidance memorandum from R. Chris Owen and Roger Brode to Regional Dispersion Modeling Contacts. Office of Air Quality Planning and Standards. Air Quality Modeling Group. Research Triangle Park, NC. September 30.

EPA. 2016. "AERMOD Implementation Guide." EPA-454/B-16-013. Office of Air Quality Planning and Standards Air Quality Assessment Division AERMOD Implementation Workgroup. Research Triangle Park, North Carolina, December.

EPA. 2018a. "Air Data: Air Quality Data Collected at Outdoor Monitors Across the US." Accessed March 17, 2018. https://www.epa.gov/outdoor-air-quality-data.

EPA. 2018b. "Draft. Revised Policy on Exclusions from Ambient Air." United States Environmental Protection Agency, November.

EPA. 2018c. "User's Guide for the AMS/EPA Regulatory Model (AERMOD)." EPA-454/B-18-001.

Office of Air Quality Planning and Standards Air Quality Assessment Division Air Quality Modeling Group. Research Triangle Park, North Carolina, April.

Khalizov et al. 2012. "Characterization of Soot Aerosol Produced from Combustion of Propane in a Shock Tube." Alexei F. Khalizov, Brian Hogan, Chong Qiu, Eric L. Petersen, and Renyi Zhang. *Aerosol Science and Technology*, 46:925–936, 2012. https://doi.org/10.1080/02786826.2012.683839.

Perpetua Resources Idaho. 2015. "Meteorological and Air Quality Data Summary: Stibnite Gold Project Monitoring Network (Project Data Summary)." Stantec Consulting Services, Inc. September 23.

Perpetua Resources Idaho. 2017a. "Air Quality Baseline Study. Stibnite Gold Project." Stantec Consulting Services, Inc. And Trinity Consultants, Inc. December 2015 - Revised April 2017, April.

Perpetua Resources Idaho. 2017b. "Equipment Fuel Burn." *Attachment: Midas Stibnite Mine Plan and Equipment Schedule (13Sep17).xlsx.* Email from R. McCluskey, Midas Gold Idaho, to E. Memon, Air Sciences, September 12.

NDEP. 2010. "Class I Air Quality Operating Permit No. AP3274-1329.01. Issued to Graymont Western US Inc." Nevada Department of Conservation and Natural Resources. Division of Environmental Protection. Bureau of Air Pollution Control, May 7.

NDEP. 2015b. "Class II Air Quality Operating Permit No. AP3295-3398. Issued to Hectatone, Inc." Nevada Department of Conservation and Natural Resources. Division of Environmental Protection. Bureau of Air Pollution Control, April 6.

NDEP. 2017. "Mercury Operating Permit to Construct: Phase 2. Issued to: Smokey Valley Common Operation - Round Mountain Gold Corporation." Nevada Division of Environmental Protection (NDEP) Bureau of Air Pollution Control, July 5.

NDEP. 2019. "Class II Air Quality Operating Permit AP1041-3955." Issued to: Round Mountain Gold Corporation." Nevada Department of Conservation and Natural Resources. Division of Environmental Protection (NDEP). Bureau of Air Pollution Control, June 17. Accessed June 28, 2019. , June 17.

UMN. 2002. "Diesel Aerosol Sampling Methodology - CRC E-43." University of Minnesota Department of Mechanical Engineering, August 19.

TAPs Addendum Modeling Review Attachment

1.0 Introduction and Summary

Perpetua Resources Idaho, Inc. (PRI) submitted the *Stibnite Gold Project (SGP) Permit to Construct Application TAP Addendum* (*TAP Addendum*), prepared by Air Sciences Inc. (Air Sciences) and submitted to DEQ on October 5, 2021. The TAP Addendum reassessed source applicability to Toxic Air Pollutant (TAP) permitting requirements, refined TAPs regulatory methods to demonstrate compliance with applicable TAP increments, revised and/or refined operations and operational parameters affecting TAP emissions, and refined TAP air impact analyses. The revisions and refinements made for the TAP Addendum also reduced PM_{10} and $PM_{2.5}$ emissions, and this effect is presented in this *TAPs Addendum Modeling Review Attachment* (*Modeling Review Attachment*).

2.0 Scope of TAPs Addendum

DEQ reevaluated TAPs compliance regulatory interpretations and impact assessment methods following the second public comment period of February 18, 2021, through March 19, 2021. Areas of revision in response to issues identified after the public comment period included:

- Revising source-specific TAP impact assessment applicability, primarily identifying what sources can be excluded because they are "covered" or "addressed" by a National Emissions Standard for Hazardous Air Pollutants (NESHAP) or New Source Performance Standard (NSPS).
- Refining regulatory methods used to demonstrate compliance with TAP increments.
- Refining TAP emission calculation methods and dispersion-affecting parameters.
- Reassessing TAP impacts resulting from revised and/or refined methods and data.
- Providing a best-estimate of actual TAP emissions that will occur from operation of the mine, and then comparing this to maximum permit-allowable emissions.

PRI and Air Sciences, PRI's permitting consultant, submitted the *TAP Addendum* on October 5, 2021.

3.0 Revised NESHAP/NSPS TAP Exclusion

DEQ and PRI reevaluated TAP source applicability after the second public comment period in response to expressed concerns regarding sources excluded as per *Idaho Air Rules* Section 210.20 (excluding sources that are "covered" or "addressed" by a NESHAP). TAP applicability is explained in greater detail in the main body of the DEQ Statement of Basis. As a result of the reevaluation, some additional sources were included in the TAP impact modeling analyses that were not previously. TAP sources from gold mining that were modeled in the final TAP analyses included: drilling, blasting, excavating, hauling, prill silos, rock dumps and storage piles, and tailings.

Air Sciences consulted with DEQ to refine TAP compliance demonstration methods from what was originally submitted in the application. The refinement was primarily needed to show compliance with the

arsenic Acceptable Ambient Concentration of a Carcinogen (AACC). The revised methods are described in the submitted *TAP Addendum* and this DEQ *Modeling Review Attachment*.

4.0 TAPs Refined Compliance Demonstration Approach

PRI, in consultation with DEQ, used a highly refined TAPs analysis approach to demonstrate compliance with applicable TAP increments. This approach involved the following:

- AACC Adjustment for Toxic Air Pollutant Reasonably Available Control Technology (T-RACT) Utilization.
- TAP Emission Averaging Period.
- AACC Adjustment for the Operational Life of the Mine.

4.1 AACC Adjustment for T-RACT Utilization

Idaho Air Rules Section 210.12 allows TAP impacts of 10 times the AACC if the application demonstrates that T-RACT is used for the TAP emission sources. This represents a life-time cancer risk of 1-in-100,000. An adjustment cannot be made for non-carcinogenic TAPs listed in *Idaho Air Rules* Section 585.

Review of the T-RACT demonstration is performed by the DEQ permit writer and is described in the main body of the DEQ Statement of Basis.

4.2 TAP Emission Averaging Period

Annual average emissions of carcinogenic TAPs are typically used in the dispersion model to estimate maximum annual impacts. PRI refined the analyses by using source-specific emission rates that are representative of a 5-year averaging period. This approach is appropriate because carcinogenic impacts are of concern from a long-term exposure basis.

4.3 AACC Adjustment for the Operational Life of the Mine

AACCs were established based on a 1-in-1,000,000 cancer risk over a 70-year lifetime, as stated in *Idaho Air Rules* Section 006.125:

> ***Toxic Air Pollutant Carcinogenic Increments****. Those ambient air quality increments based on the probability of developing excess cancers over a seventy (70) year lifetime exposure to one (1) microgram per cubic meter (1 ug/m3) of a given carcinogen and expressed in terms of a screening emission level or an acceptable ambient concentration for a carcinogenic toxic air pollutant. They are listed in Section 586.*

PRI indicated the maximum life-of-mine will be 16 years. Life-time exposures to carcinogenic TAPs were refined by multiplying the maximum modeled annual impact by a ratio of 16/70. Section 5.7 of this *Modeling Review Attachment* provides more details on this adjustment for the project.

5.0 Refined TAP Emission Estimates and Modeling Methods/Parameters

This section describes changes made to TAP emission estimates and to methods/parameters used in the impact modeling analyses.

5.1 Operational Adjustments

PRI and Air Sciences proposed and committed to several operational adjustments to reduce actual and estimated TAP emissions:

- Installing and operating dust collection systems on drilling rigs (determined to be T-RACT).
- Capping the haul roads that are outside of the pits and development rock storage facilities (DRSFs) with clean (lower levels of arsenic) development rock (determined to be T-RACT).
- Eliminating the West End Development Rock Storage Facility, which eliminated the highest-emitting operational scenario W5.
- Limiting long-term mining production to an average of 135,000 tons/day for a 5-year rolling average.
- Constructing the Burntlog access road with offsite materials containing "background" levels of arsenic.
- Updating the bulldozing emission factor using the SGP site-specific silt content.

5.2 General Modeling Methods and Parameters

Modeling methods and parameters used in TAP impact analyses presented in the *TAP Addendum* are largely identical to those used in the previously submitted application. These include the air dispersion model used, meteorological data, terrain, building downwash, ambient air boundary, and receptors. TAP modeling was conducted for the 14 operational modeling scenarios, consistent with the NAAQS analyses. Modeling Scenario W5 was eliminated from the arsenic modeling, as discussed in Section 5.8 of this *Modeling Review Attachment*.

The meteorological dataset processed using McCall, Idaho, cloud cover data was used for analyses in the *TAP Addendum*. Impacts were not assessed using the dataset processed using the Bulk Richardson (BULKRN) method for boundary layer parameter calculations. EPA considers both methods to be acceptable. Although modeled impacts tend to be somewhat larger when using meteorological data processed by the BULKRN method, DEQ contends that the impact analyses are still largely conservative compared to actual impacts anticipated. Conservative aspects include: continual operation of the worst-case operational scenario; operation at maximum allowable rates for the averaging period; no reduction in winter-time emissions from fugitive sources, accounting for emission suppression effects of increased moisture.

5.3 TAP Modeling Applicability

Table 1 provides a comparison between applicable facility-wide maximum potential TAP emissions for the highest-emitting scenario (W3) and TAP screening emission levels (ELs) from *Idaho Air Rules* Sections 585 (for non-carcinogens) and 586 (for carcinogens). Note that TAPs also classified as HAPs

emitted from sources "addressed" or "covered" by NSPS or NESHAP were not required to be evaluated for compliance with TAP increments in accordance with *Idaho Air Rules* Section 210.20. Furthermore, PRI has determined that the West End Development Rock Storage Facility will not be constructed. This change eliminated Modeling Scenario W5 (the highest-emitting scenario described in the main body of the DEQ *Modeling Review Memorandum*) as a potential operating scenario. After eliminating Modeling Scenario W5, it was determined that Modeling Scenario W3 is the highest-emitting scenario for all TAPs.

Table 1. TAP MODELING APPLICABILITY DETERMINATION (HIGHEST-EMITTING MODELING SCENARIO: W3).

HAP/TAP	Emissions (lb/hr)			EL (lb/hr)		Determination
	(a)	(b)	Total	(c)	(d)	
1,3-Butadiene	--	--	--	--	2.4E-5	EL not exceeded
3-Methylchloranthrene	--	4.5E-8	4.5E-8	--	2.5E-6	EL not exceeded
Acetaldehyde	--	--	--	--	3.0E-3	EL not exceeded
Acrolein	--	--	--	1.7E-2	--	EL not exceeded
Antimony	1.9E-2	1.6E-6	1.9E-2	3.3E-2	--	EL not exceeded
Arsenic	5.4E-1	8.2E-6	5.4E-1	--	1.5E-6	Carcinogenic EL exceeded
Benzene	--	5.3E-5	5.3E-5	--	8.0E-4	EL not exceeded
Benzo(a)pyrene[e]	--	3.0E-8				
Benz(a)anthracene[e]	--	4.5E-8				
Benzo(b)fluoranthene[e]	--	4.5E-8				
Benzo(k)fluoranthene[e]	--	4.5E-8	2.9E-7	--	2.0E-6	EL not exceeded
Chrysene[e]	--	4.5E-8				
Dibenzo(a,h)anthracene[e]	--	3.0E-8				
Indenol(1,2,3-cd)pyrene[e]	--	4.5E-8				
Beryllium	2.6E-3	3.5E-7	2.6E-3	--	2.8E-5	Carcinogenic EL exceeded
Biphenyl	--	--	--	1.0E-1	--	EL not exceeded
Cadmium	4.1E-4	2.8E-5	4.4E-4	--	3.7E-6	Carcinogenic EL exceeded
Carbon disulfide	1.4E-2	--	1.4E-2	2.0E+0	--	EL not exceeded
Chromium	7.3E-3	4.8E-5	7.4E-3	3.3E-2	--	EL not exceeded
Chromium (VI)	--	3.4E-7	3.4E-7	--	5.6E-7	EL not exceeded
Cobalt	3.3E-3	4.8E-6	3.26E-3	3.3E-3	--	EL not exceeded
Cyanide	4.5E-1	--	4.5E-1	3.3E-1	--	Non-carcinogenic EL exceeded
Dichlorobenzene	--	3.1E-5	3.1E-5	3.0E+1	--	EL not exceeded
Formaldehyde	--	1.9E-3	1.9E-3	--	5.1E-4	Carcinogenic EL exceeded
Hexane	--	4.6E-2	4.6E-2	1.2E+1	--	EL not exceeded
Hydrogen Chloride	--	--	--	5.0E-2	--	EL not exceeded
Manganese	2.4E-1	1.9E-4	2.4E-1	6.7E-2	--	Non-carcinogenic EL exceeded
Naphthalene	--	1.6E-5	1.6E-5	3.3E+0	--	EL not exceeded
Nickel	1.6E-3	5.6E-5	1.7E-3	--	2.7E-5	Carcinogenic EL exceeded
Phenol	--	--	--	1.3E+0	--	EL not exceeded
Phosphorus	5.3E-1	9.3E-5	5.3E-1	7.0E-3	--	Non-carcinogenic EL exceeded
Selenium	3.3E-4	6.2E-7	3.3E-4	1.3E-2	--	EL not exceeded
Toluene	--	8.8E-5	8.8E-5	2.5E+1	--	EL not exceeded
Xylene	--	--	--	2.9E+1	--	EL not exceeded
Aluminum	5.8E+1	6.5E-1	5.9E+1	6.7E-1	--	Non-carcinogenic EL exceeded
Barium	6.5E-1	6.8E-3	6.6E-1	3.3E-2	--	Non-carcinogenic EL exceeded
Calcium Carbonate	1.1E+1	2.2E+0	1.4E+1	6.7E-1	--	Non-carcinogenic EL exceeded
Calcium Oxide	--	7.0E-1	7.0E-1	1.3E-1	--	Non-carcinogenic EL exceeded
Copper	4.1E-3	5.3E-4	4.6E-3	6.7E-2	--	EL not exceeded
Cyclohexane	--	1.0E-3	1.0E-3	7.0E+1	--	EL not exceeded
Hydrogen Sulfide	--	9.0E-1	9.0E-1	9.3E-1	--	EL not exceeded
Iron	1.5E+1	2.1E-1	1.5E+1	6.7E-2	--	Non-carcinogenic EL exceeded
Molybdenum	8.1E-4	4.7E-4	1.3E-3	3.3E-1	--	EL not exceeded
Pentane	--	1.2E-1	1.2E-1	1.2E+2	--	EL not exceeded
Silver	4.1E-4	4.1E-4	8.2E-4	7.0E-3	--	EL not exceeded
Sulfuric Acid	--	2.0E+0	2.0E+0	6.7E-2	--	Non-carcinogenic EL exceeded

REC 0700

PET 334

Table 1. TAP MODELING APPLICABILITY DETERMINATION (HIGHEST-EMITTING MODELING SCENARIO: W3).						
HAP/TAP	Emissions (lb/hr)			EL (lb/hr)		Determination
	(a)	(b)	Total	(c)	(d)	
Thallium	8.1E-3	5.2E-4	8.7E-3	7.0E-3	--	Non-carcinogenic EL exceeded
Uranium	8.1E-3	5.2E-4	8.7E-3	1.3E-2	--	EL not exceeded
Vanadium	2.3E-2	8.4E-4	2.4E-2	3.0E-3	--	Non-carcinogenic EL exceeded
Trimethyl Benzene	--	1.1E-2	1.1E-2	8.2E+0	--	EL not exceeded
Tungsten	8.1E-3	5.2E-4	8.7E-3	3.3E-1	--	EL not exceeded
Zinc	2.9E-2	2.2E-3	3.1E-2	6.7E-1	--	EL not exceeded

a. Total HAP/TAP emissions for EL evaluation from mining (i.e., pits, blasting, haul roads, stockpiles and DRSF, tailings storage facility, access road, and underground exploration) and leaching. Emissions from sources covered/addressed by NSPS/NESHAP are not included in the evaluation for modeling applicability.

b. Total HAP/TAP emissions for EL evaluation from processing and production (i.e., ore processing [crushers and transfer, prill silos], ore concentration and refining [autoclave, electrowinning cells and pregnant solution tank, retort, furnace, carbon kiln], process heating [POX boiler, carbon regeneration kiln, propane vaporizer, solution heater], lime production [limestone crushers, screens, mill, transfers, lime kiln, kiln feed, lime mill, pebble lime silo, lime silos, lime mill crushing], aggregate production [portable crushers, screens, transfers], concrete production [central mixer, cement silos, aggregate bin], HVAC [heaters], emergency power [emergency generators, fire pump], fuel storage [gasoline fuel and tanks]). Emissions from sources covered/addressed by NSPS/NESHAP are not included in the evaluation for modeling applicability.

c. Non-carcinogenic EL from *Idaho Air Rules* Section 585.

d. Carcinogenic EL from *Idaho Air Rules* Section 586.

Table 1 shows that the SGP facility-wide potential TAP emissions exceed the respective EL for arsenic, beryllium, cadmium, cyanide, formaldehyde, manganese, nickel, phosphorus, aluminum, barium, calcium carbonate, calcium oxide, iron, sulfuric acid, thallium, and vanadium. Therefore, modeling was required for these 16 TAPs (11 non-carcinogenic and five carcinogenic TAPs) to demonstrate compliance with Acceptable Ambient Concentrations of Non-Carcinogens (AACs) and AACCs.

5.4 TAP Modeled Emission Rates

Table 2 lists the source-specific modeled emission rates for all 11 non-carcinogenic TAPs that required modeling (worst-case modeling scenario for all non-carcinogenic TAPs: W5). Table 3 lists the source-specific modeled emission rates for all five carcinogenic TAPs that required modeling (worst-case impacts for arsenic are associated with modeling scenario W2; worst-case impacts for all other carcinogenic TAPs are associated with modeling scenario W1). Note that all source-specific emission rates listed in Tables 2 and 3 were extracted by DEQ's modeling staff from the submitted modeling input files.

The total modeled emission rates for all non-carcinogenic TAPs are equal to the total facility-wide HAP/TAP emissions as stated in the permitting emissions inventory (excluding sources addressed by NSPS/NESHAP), evaluated at 180,000 T/day (see last two rows of Table 2). However, for carcinogenic TAPs, modeling was performed using an emission inventory that included T-RACT controls, long-term mining production limits, and other emission inventory refinements, as described in Section 4.0 of this *Modeling Review Attachment* (see last three rows of Table 3).

Table 2. MODELED EMISSION RATES FOR NON-CARCINOGENIC TAPS (WORST-CASE MODELING SCENARIOS).												
Type of Source	**Source ID**	**ALUM[a] (lb/hr)[b]**	**BARI[c] (lb/hr)**	**CACA[d] (lb/hr)**	**CAOX[e] (lb/hr)**	**CYAN[f] (lb/hr)**	**IRON[g] (lb/hr)**	**MANG[h] (lb/hr)**	**PHOS[i] (lb/hr)**	**SULF[j] (lb/hr)**	**THAL[k] (lb/hr)**	**VANA[l] (lb/hr)**
Point Sources	LS1L	2.33E-04	1.50E-06	0	7.63E-03	0	1.07E-04	2.44E-06	1.34E-06	0	5.16E-08	1.60E-07
	MILLS2L	2.33E-04	1.50E-06	0	7.63E-03	0	1.07E-04	2.44E-06	1.34E-06	0	5.16E-08	1.60E-07
	AC	2.31E-05	2.31E-05	2.31E-05	0	0	2.31E-05	0	0	2.03E+00	2.31E-05	2.31E-05
	ACB	0	3.06E-06	0	0	0	0	2.64E-07	0	0	0	1.60E-06
	ACS1L	9.32E-04	5.98E-06	0	3.05E-02	0	4.27E-04	9.76E-06	5.36E-06	0	2.06E-07	6.39E-07
	ACS2L	9.32E-04	5.98E-06	0	3.05E-02	0	4.27E-04	9.76E-06	5.36E-06	0	2.06E-07	6.39E-07
	ACS3L	9.32E-04	5.98E-06	0	3.05E-02	0	4.27E-04	9.76E-06	5.36E-06	0	2.06E-07	6.39E-07
	ACS4L	4.66E-04	2.99E-06	0	1.53E-02	0	2.13E-04	4.88E-06	2.68E-06	0	1.03E-07	3.20E-07
	CKD	9.59E-05	9.59E-05	9.59E-05	0	0	9.59E-05	0	0	0	9.59E-05	9.59E-05
	CKB	0	9.73E-06	0	0	0	0	8.40E-07	0	0	0	5.08E-06
	EW	9.59E-05	9.59E-05	9.59E-05	0	0	9.59E-05	0	0	0	9.59E-05	9.59E-05
	MR	9.59E-05	9.59E-05	9.59E-05	0	0	9.59E-05	0	0	0	9.59E-05	9.59E-05
	MF	9.59E-05	9.59E-05	9.59E-05	0	0	9.59E-05	0	0	0	9.59E-05	9.59E-05
	EDG1	0	0	0	0	0	0	0	0	0	0	0
	EDG2	0	0	0	0	0	0	0	0	0	0	0
	EDG3	0	0	0	0	0	0	0	0	0	0	0
	EDFP	0	0	0	0	0	0	0	0	0	0	0
	PV	0	4.31E-07	0	0	0	0	3.73E-08	0	0	0	2.25E-07
	HS	0	2.16E-05	0	0	0	0	1.86E-06	0	0	0	1.13E-05
	H1M	0	1.73E-05	0	0	0	0	1.49E-06	0	0	0	9.02E-06
	H2M	0	1.73E-05	0	0	0	0	1.49E-06	0	0	0	9.02E-06
	HM	0	1.73E-05	0	0	0	0	1.49E-06	0	0	0	9.02E-06
	HAC	0	1.08E-06	0	0	0	0	9.31E-08	0	0	0	5.64E-07
	HR	0	1.08E-06	0	0	0	0	9.31E-08	0	0	0	5.64E-07
	HA	0	1.08E-06	0	0	0	0	9.31E-08	0	0	0	5.64E-07
	HMO	0	2.16E-06	0	0	0	0	1.86E-07	0	0	0	1.13E-06
	HTS	0	8.63E-06	0	0	0	0	7.45E-07	0	0	0	4.51E-06
	HW	0	1.29E-05	0	0	0	0	1.12E-06	0	0	0	6.76E-06
	PSL	0	0	0	0	0	0	0	0	0	0	0
	CS1L	0	0	0	0	0	0	8.01E-07	0	0	0	0
	CS2L	0	0	0	0	0	0	8.01E-07	0	0	0	0
	LS6	3.19E-03	2.05E-05	3.88E-02	0	0	1.46E-03	0	0	0	7.06E-07	2.19E-06
	LSBM	4.30E-02	2.76E-04	5.22E-01	0	0	1.97E-02	0	0	0	9.51E-06	2.95E-05
	LS9	7.54E-04	4.84E-06	9.16E-03	0	0	3.45E-04	0	0	0	1.67E-07	5.17E-07
	LK	2.07E-02	1.33E-04	2.51E-01	0	0	9.47E-03	0	0	0	4.58E-06	1.42E-05
	LKC	0	9.51E-05	0	0	0	0	0	0	0	0	4.97E-05
	LCR	6.43E-03	4.12E-05	0	2.11E-01	0	2.94E-03	0	0	0	1.42E-06	4.41E-06
	LSL	1.40E-04	8.99E-07	0	4.59E-03	0	6.41E-05	0	0	0	3.10E-08	9.60E-08

Table 2. MODELED EMISSION RATES FOR NON-CARCINOGENIC TAPS (WORST-CASE MODELING SCENARIOS).												
Type of Source	**Source ID**	**ALUM[a] (lb/hr)[b]**	**BARI[c] (lb/hr)**	**CACA[d] (lb/hr)**	**CAOX[e] (lb/hr)**	**CYAN[f] (lb/hr)**	**IRON[g] (lb/hr)**	**MANG[h] (lb/hr)**	**PHOS[i] (lb/hr)**	**SULF[j] (lb/hr)**	**THAL[k] (lb/hr)**	**VANA[l] (lb/hr)**
Area Sources	WEP	5.59E+00	6.29E-02	1.10E+00	0	0	1.43E+00	2.35E-02	5.11E-02	0	7.87E-04	2.20E-03
	UGEXP	2.49E-05	2.80E-07	4.91E-06	0	0	6.38E-06	1.05E-07	2.28E-07	0	3.50E-09	9.81E-09
	TSF	0	0	0	0	2.32E-01	0	0	0	0	0	0
Line Sources	AR01	2.02E-02	2.28E-04	3.99E-03	0	0	5.18E-03	8.52E-05	1.85E-04	0	2.85E-06	7.98E-06
	AR02	1.56E-02	1.75E-04	3.07E-03	0	0	3.99E-03	6.55E-05	1.42E-04	0	2.19E-06	6.13E-06
	AR03	3.93E-02	4.43E-04	7.75E-03	0	0	1.01E-02	1.66E-04	3.60E-04	0	5.54E-06	1.55E-05
	AR04	3.77E-02	4.25E-04	7.43E-03	0	0	9.66E-03	1.59E-04	3.45E-04	0	5.31E-06	1.49E-05
Volume Sources	WEPBL	1.90E+00	2.14E-02	3.75E-01	0	0	4.88E-01	8.01E-03	1.74E-02	0	2.68E-04	7.50E-04
	WEDRSF	8.58E-01	9.66E-03	1.69E-01	0	0	2.20E-01	3.61E-03	7.85E-03	0	1.21E-04	3.38E-04
	OC1	1.04E-02	1.17E-04	2.04E-03	0	0	2.65E-03	0	0	0	1.46E-06	4.08E-06
	OC2	1.04E-02	1.17E-04	2.04E-03	0	0	2.65E-03	0	0	0	1.46E-06	4.08E-06
	OC3	1.04E-02	1.17E-04	2.04E-03	0	0	2.65E-03	0	0	0	1.46E-06	4.08E-06
	OC4	1.04E-02	1.17E-04	2.04E-03	0	0	2.65E-03	0	0	0	1.46E-06	4.08E-06
	OC5	1.04E-02	1.17E-04	2.04E-03	0	0	2.65E-03	0	0	0	1.46E-06	4.08E-06
	OC6	1.04E-02	1.17E-04	2.04E-03	0	0	2.65E-03	0	0	0	1.46E-06	4.08E-06
	OC7	8.87E-02	1.00E-03	1.75E-02	0	0	2.28E-02	0	0	0	1.25E-05	3.50E-05
	OC8	1.04E-02	1.17E-04	2.04E-03	0	0	2.65E-03	0	0	0	1.46E-06	4.08E-06
	OC9	4.90E-02	5.52E-04	9.66E-03	0	0	1.26E-02	0	0	0	6.90E-06	1.93E-05
	OC10	4.90E-02	5.52E-04	9.66E-03	0	0	1.26E-02	0	0	0	6.90E-06	1.93E-05
	OC11	4.90E-02	5.52E-04	9.66E-03	0	0	1.26E-02	0	0	0	6.90E-06	1.93E-05
	OC12	9.80E-02	1.10E-03	1.93E-02	0	0	2.51E-02	0	0	0	1.38E-05	3.86E-05
	OC13	1.14E-02	1.29E-04	2.25E-03	0	0	2.93E-03	0	0	0	1.61E-06	4.51E-06
	LS1U	1.13E-03	7.25E-06	0	3.70E-02	0	5.18E-04	1.18E-05	6.50E-06	0	2.50E-07	7.75E-07
	MILLS2U	1.13E-03	7.25E-06	0	3.70E-02	0	5.18E-04	1.18E-05	6.50E-06	0	2.50E-07	7.75E-07
	ACS1U	2.17E-03	1.39E-05	0	7.10E-02	0	9.94E-04	2.27E-05	1.25E-05	0	4.80E-07	1.49E-06
	ACS2U	2.17E-03	1.39E-05	0	7.10E-02	0	9.94E-04	2.27E-05	1.25E-05	0	4.80E-07	1.49E-06
	ACS3U	2.17E-03	1.39E-05	0	7.10E-02	0	9.94E-04	2.27E-05	1.25E-05	0	4.80E-07	1.49E-06
	ACS42U	2.17E-03	1.39E-05	0	7.10E-02	0	9.94E-04	2.27E-05	1.25E-05	0	4.80E-07	1.49E-06
	PSU	0	0	0	0	0	0	0	0	0	0	0
	CS1U	0	0	0	0	0	0	8.01E-07	0	0	0	0
	CS2U	0	0	0	0	0	0	8.01E-07	0	0	0	0
	CAL	1.56E-02	1.00E-04	0	0	0	7.14E-03	0	0	0	3.45E-06	1.07E-05
	CAU	1.56E-02	1.00E-04	0	0	0	7.14E-03	0	0	0	3.45E-06	1.07E-05
	CM	0	0	0	0	0	0	2.59E-05	8.22E-06	0	0	0
	PCSP1	1.41E-02	9.06E-05	1.72E-01	0	0	6.47E-03	0	0	0	3.12E-06	9.69E-06
	PCSP2	1.41E-02	9.06E-05	1.72E-01	0	0	6.47E-03	0	0	0	3.12E-06	9.69E-06
	LS1	3.19E-03	2.05E-05	3.88E-02	0	0	1.46E-03	0	0	0	7.06E-07	2.19E-06
	LS2	5.75E-03	3.69E-05	6.98E-02	0	0	2.63E-03	0	0	0	1.27E-06	3.94E-06
	LS3	2.66E-02	1.71E-04	3.23E-01	0	0	1.22E-02	0	0	0	5.88E-06	1.82E-05

Table 2. MODELED EMISSION RATES FOR NON-CARCINOGENIC TAPS (WORST-CASE MODELING SCENARIOS).												
Type of Source	**Source ID**	**ALUM[a] (lb/hr)[b]**	**BARI[c] (lb/hr)**	**CACA[d] (lb/hr)**	**CAOX[e] (lb/hr)**	**CYAN[f] (lb/hr)**	**IRON[g] (lb/hr)**	**MANG[h] (lb/hr)**	**PHOS[i] (lb/hr)**	**SULF[j] (lb/hr)**	**THAL[k] (lb/hr)**	**VANA[l] (lb/hr)**
	LS4	5.75E-03	3.69E-05	6.98E-02	0	0	2.63E-03	0	0	0	1.27E-06	3.94E-06
	LS5	2.66E-02	1.71E-04	3.23E-01	0	0	1.22E-02	0	0	0	5.88E-06	1.82E-05
	LS7	3.19E-03	2.05E-05	3.88E-02	0	0	1.46E-03	0	0	0	7.06E-07	2.19E-06
	LS8	3.19E-03	2.05E-05	3.88E-02	0	0	1.46E-03	0	0	0	7.06E-07	2.19E-06
	LS10	7.54E-04	4.84E-06	9.16E-03	0	0	3.45E-04	0	0	0	1.67E-07	5.17E-07
	LS11	6.29E-03	4.03E-05	7.63E-02	0	0	2.88E-03	0	0	0	1.39E-06	4.31E-06
	LS12	7.54E-04	4.84E-06	9.16E-03	0	0	3.45E-04	0	0	0	1.67E-07	5.17E-07
	LSU	1.40E-05	8.99E-08	0	4.59E-04	0	6.41E-06	0	0	0	3.10E-09	9.60E-09
	MILLTANKS	0	0	0	0	2.21E-01	0	0	0	0	0	0
	HRT001-HRT072[m]	2.62E-01	2.95E-03	5.16E-02	0	0	6.71E-02	1.10E-03	2.40E-03	0	3.69E-05	1.03E-04
	HRN001-HRN022[m]	2.62E-01	2.95E-03	5.16E-02	0	0	6.71E-02	1.10E-03	2.40E-03	0	3.69E-05	1.03E-04
Total Modeled Rates		***3.37E+01***	***3.79E-01***	***8.76E+00***	***6.96E-01***	***4.53E-01***	***8.69E+00***	***1.39E-01***	***3.03E-01***	***2.03E+00***	***5.17E-03***	***1.39E-02***
Total Emission Rates at 180,000 T/day[n]		***3.37E+01***	***3.79E-01***	***8.76E+00***	***6.96E-01***	***4.53E-01***	***8.69E+00***	***1.39E-01***	***3.03E-01***	***2.03E+00***	***5.17E-03***	***1.39E-02***

a. Aluminum (worst-case modeling scenario: W5).
b. Pounds per hour.
c. Barium (worst-case modeling scenario: W5).
d. Calcium carbonate (worst-case modeling scenario: W5).
e. Calcium oxide (worst-case modeling scenario: W5).
f. Cyanide (worst-case modeling scenario: W5).
g. Iron (worst-case modeling scenario: W5).
h. Manganese (worst-case modeling scenario: W5).
i. Phosphorus (worst-case modeling scenario: W5).
j. Sulfuric acid (worst-case modeling scenario: W5).
k. Thallium (worst-case modeling scenario: W5).
l. Vanadium (worst-case modeling scenario: W5).
m. The Haul Road was represented in the model as a series of volume sources. The emission rates listed in this table represent each individual volume source.
n. Total emission rates at 180,000 tons per day were derived from Worksheet "TblA" in the emission inventory dated October 5, 2021. The total emission rates in this row represent all facility-wide HAP/TAP emission sources from mining, leaching, and processing and production (excluding emissions from sources "addressed" or "covered" by NSPS/NESHAP).

Table 3. MODELED EMISSION RATES FOR CARCINOGENIC TAPS (WORST-CASE MODELING SCENARIOS).						
Type of Source	**Source ID**	**ARSE[a] (lb/hr)[b]**	**BERY[c] (lb/hr)**	**CADM[d] (lb/hr)**	**FORM[e] (lb/hr)**	**NICK[f] (lb/hr)**
Point Sources	LS1L	1.14E-08	3.96E-10	1.24E-10	0	2.47E-09
	MILLS2L	1.14E-08	3.96E-10	1.24E-10	0	2.47E-09
	AC	0	0	0	0	0
	ACB	1.28E-07	7.66E-09	7.02E-07	4.79E-05	1.34E-06
	ACS1L	4.55E-08	1.58E-09	4.94E-10	0	9.89E-09
	ACS2L	4.55E-08	1.58E-09	4.94E-10	0	9.89E-09
	ACS3L	4.55E-08	1.58E-09	4.94E-10	0	9.89E-09
	ACS4L	2.27E-08	7.91E-10	2.47E-10	0	4.94E-09
	CKD	0	0	0	0	0
	CKB	4.07E-07	2.44E-08	2.24E-06	1.52E-04	4.27E-06
	EW	0	0	0	0	0
	MR	0	0	0	0	0
	MF	0	0	0	0	0
	EDG1	0	0	0	0	0
	EDG2	0	0	0	0	0
	EDG3	0	0	0	0	0
	EDFP	0	0	0	0	0
	PV	1.80E-08	1.08E-09	9.91E-08	6.76E-06	1.89E-07
	HS	9.01E-07	5.41E-08	4.96E-06	3.38E-04	9.46E-06
	H1M	7.84E-07	4.71E-08	4.31E-06	2.94E-04	8.24E-06
	H2M	7.84E-07	4.71E-08	4.31E-06	2.94E-04	8.24E-06
	HM	7.84E-07	4.71E-08	4.31E-06	2.94E-04	8.24E-06
	HAC	4.90E-08	2.94E-09	2.70E-07	1.84E-05	5.15E-07
	HR	4.90E-08	2.94E-09	2.70E-07	1.84E-05	5.15E-07
	HA	4.90E-08	2.94E-09	2.70E-07	1.84E-05	5.15E-07
	HMO	9.80E-08	5.88E-09	5.39E-07	3.68E-05	1.03E-06
	HTS	3.92E-07	2.35E-08	2.16E-06	1.47E-04	4.12E-06
	HW	5.88E-07	3.53E-08	3.24E-06	2.21E-04	6.18E-06
	PSL	0	0	0	0	0
	CS1L	2.90E-08	3.33E-09	0	0	2.86E-07
	CS2L	2.90E-08	3.33E-09	0	0	2.86E-07
	LS6	0	0	0	0	0
	LSBM	0	0	0	0	0
	LS9	0	0	0	0	0
	LK	0	0	0	0	0
	LKC	0	0	0	0	0
	LCR	0	0	0	0	0
	LSL	0	0	0	0	0
Area Sources	WEP	9.40E-03	4.51E-05	7.04E-06	0	2.82E-05
	UGEXP	2.34E-07	1.12E-09	1.75E-10	0	7.01E-10
	TSF	0	0	0	0	0
Line Sources	AR01	7.12E-07	9.12E-07	1.42E-07	0	5.70E-07
	AR02	5.48E-07	7.01E-07	1.10E-07	0	4.38E-07
	AR03	1.38E-06	1.77E-06	2.77E-07	0	1.11E-06
	AR04	1.33E-06	1.70E-06	2.65E-07	0	1.06E-06

REC 0705

PET 339

Table 3. MODELED EMISSION RATES FOR CARCINOGENIC TAPS (WORST-CASE MODELING SCENARIOS).						
Type of Source	**Source ID**	**ARSE[a] (lb/hr)[b]**	**BERY[c] (lb/hr)**	**CADM[d] (lb/hr)**	**FORM[e] (lb/hr)**	**NICK[f] (lb/hr)**
Volume Sources	WEPBL	1.79E-02	8.57E-05	1.34E-05	0	5.36E-05
	FDRSF	4.23E-03				
	STKP		2.72E-05	4.25E-06	0	1.70E-05
	OC1	0	0	0	0	0
	OC2	0	0	0	0	0
	OC3	0	0	0	0	0
	OC4	0	0	0	0	0
	OC5	0	0	0	0	0
	OC6	0	0	0	0	0
	OC7	0	0	0	0	0
	OC8	0	0	0	0	0
	OC9	0	0	0	0	0
	OC10	0	0	0	0	0
	OC11	0	0	0	0	0
	OC12	0	0	0	0	0
	OC13	0	0	0	0	0
	LS1U	5.51E-08	1.92E-09	5.99E-10	0	1.20E-08
	MILLS2U	5.51E-08	1.92E-09	5.99E-10	0	1.20E-08
	ACS1U	2.21E-07	7.67E-09	2.40E-09	0	4.79E-08
	ACS2U	2.21E-07	7.67E-09	2.40E-09	0	4.79E-08
	ACS3U	2.21E-07	7.67E-09	2.40E-09	0	4.79E-08
	ACS42U	1.10E-07	3.84E-09	1.20E-09	0	2.40E-08
	PSU	0	0	0	0	0
	CS1U	2.90E-08	3.33E-09	0	0	2.86E-07
	CS2U	2.90E-08	3.33E-09	0	0	2.86E-07
	CAL	0	0	0	0	0
	CAU	0	0	0	0	0
	CM	2.03E-06	0	4.86E-09	0	1.70E-06
	PCSP1	0	0	0	0	0
	PCSP2	0	0	0	0	0
	LS1	0	0	0	0	0
	LS2	0	0	0	0	0
	LS3	0	0	0	0	0
	LS4	0	0	0	0	0
	LS5	0	0	0	0	0
	LS7	0	0	0	0	0
	LS8	0	0	0	0	0
	LS10	0	0	0	0	0
	LS11	0	0	0	0	0
	LS12	0	0	0	0	0
	LSU	0	0	0	0	0
	MILLTANKS	0	0	0	0	0

REC 0706

PET 340

Table 3. MODELED EMISSION RATES FOR CARCINOGENIC TAPS (WORST-CASE MODELING SCENARIOS).						
Type of Source	**Source ID**	**ARSE[a] (lb/hr)[b]**	**BERY[c] (lb/hr)**	**CADM[d] (lb/hr)**	**FORM[e] (lb/hr)**	**NICK[f] (lb/hr)**
Volume Sources	HRF001-HRF055[g]	1.03E-03				
	HRQ001-HRQ049[g]	1.03E-03				
	HRR001-HRR006[g]	1.03E-03				
	HRN001-HRN022[g]	1.03E-03	9.27E-06	1.45E-06	0	5.80E-06
	HRB001-HRB003[g]	1.03E-03				
	HRP001-HRP057[g]		9.27E-06	1.45E-06	0	5.80E-06
	HRO001-HRO002[g]	1.03E-03	9.27E-06	1.45E-06	0	5.80E-06
Total Modeled Rates		***1.73E-01***	***9.15E-04***	***1.71E-04***	***1.89E-03***	***6.27E-04***
Total T-RACT Emission Rates[h]		***1.73E-01***	***9.1E-04***	***1.7E-04***	***1.9E-03***	***6.3E-04***
Total Emission Rates at 180,000 T/day[i]		***4.03E-01***	***1.36E-03***	***2.40E-04***	***1.89E-03***	***9.04E-04***

a. Arsenic (worst-case modeling scenario: W2).
b. Pounds per hour.
c. Beryllium (worst-case modeling scenario: W1).
d. Cadmium (worst-case modeling scenario: W1).
e. Formaldehyde (worst-case modeling scenario: W1).
f. Nickel (worst-case modeling scenario: W1).
g. The Haul Road was represented in the model as a series of volume sources. The emission rates listed in this table represent each individual volume source.
h. Total T-RACT emission rates – calculated based on T-RACT controls, long-term mining production limits, and other emission inventory refinements, as described in Section 4.0 of this *Modeling Review Attachment* – are derived from Tables B-W2 (for Arsenic) and B-W1 (for Beryllium, Cadmium, Formaldehyde, and Nickel) in Appendix B of the *TAP Addendum*.
i. Total emission rates at 180,000 tons per day were derived from Worksheet "TblA" in the emission inventory dated October 5, 2021. The total emission rates in this row represent all facility-wide HAP/TAP emission sources from mining, leaching, and processing and production (excluding emissions from sources "addressed" or "covered" by NSPS/NESHAP).

5.5 Cyanide Modeling Emission Source Parameters

Modeling analyses for cyanide introduced two new emission sources that were not previously evaluated by DEQ: tailings storage facility (model ID: TSF) and mill tanks (model ID: MILLTANKS).

1. The tailings storage facility was modeled by Air Sciences as a surface-based (zero release height above ground-level and zero initial vertical dimension) AREA source. The easterly and northerly lengths were calculated as square-root of the TSF area (easterly length = northerly length = $\sqrt{1{,}338{,}158\ square\ meters}$ = 1,157 meters).

2. The mill tanks were grouped and modeled by Air Sciences as a single VOLUME source. The tanks sit on the ground, so the release height was set to the average tank height of 12.2 meters (40 feet). The initial lateral dispersion (σ_y) was calculated as the equivalent diameter of the combined (18) tank area divided by the single VOLUME source coefficient of 4.3:

REC 0707

$$\sigma_{y(MILLTANKS)} = \frac{Equivalent\ diameter}{4.3} = \frac{\sqrt{\Sigma(d)^2}}{4.3} = 42.8\ feet$$

The individual tank diameters (d) are: two tanks at 40 feet, four tanks at 52 feet, six tanks at 54 feet, and six tanks at 20 feet.

DEQ typically requires that tailings storage facilities be modeled as an AREAPOLY source with an outline that follows the contour of the emission source, and that mill tanks be represented in the model as individual volume sources; but, given that the maximum modeled concentration for cyanide is safely below the AAC (0.08%), DEQ's modeling team accepted the modeling analysis submitted by Air Sciences and concluded that it confidently demonstrates that the cyanide AAC will not be exceeded.

5.6 Deposition Modeling

Air Sciences applied particle deposition algorithms in the impact modeling for particulate TAPs. The particulate deposition parameters used in the NAAQS compliance analysis were derived for PM_{10} and $PM_{2.5}$ (see Tables 22 and 23 in the main body of the DEQ *Modeling Review Memorandum*). Dust-related metal TAP emissions include total particulates (all size fractions of particulate matter [PM] up to PM_{30}). Therefore, the deposition parameters for PM were calculated using the same methodology and EPA references used for PM_{10} and $PM_{2.5}$ in the NAAQS compliance demonstration analyses. The PM deposition parameters are provided below in Table 4. The same density values were used as in the previous TAPs modeling analysis. However, an additional deposition characterization bin was added to better handle deposition of 10 µm to 30 µm particulates; mass fractions were adjusted accordingly.

Table 4. PARTICULATE MATTER DEPOSITION PARAMETERS BY SOURCE CATEGORY.

Source Category	Parameter	PM				
		Bin 1	**Bin 2**	**Bin 3**	**Bin 4**	**Bin 5**
Haul Roads	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.02	0.23	0.75	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3) (YPP, HFP, WEP DR average)	2.46	2.46	2.46	--	--
Material Handling (Ore, DR, Limestone)	Bin Upper Diameter (µm)	2.50	5.00	10.00	30.00	--
	Mass Fraction	0.07	0.20	0.20	0.53	--
	Mass Mean Diameter (µm)	2.50	5.00	10.00	30.00	--
	Density (g/cm^3) (Ore)	Pit-specific, see Table 23[a].				
	Density (g/cm^3) (Ore and Waste)	Pit-specific, see Table 23.				
	Density (g/cm^3) (Limestone)	1.09	1.09	1.09	1.09	--
Baghouses	Bin Upper Diameter (µm)	2.50	6.00	10.00	30.00	--
	Mass Fraction	0.25	0.45	0.20	0.10	--
	Mass Mean Diameter (µm)	2.50	6.00	10.00	30.00	--
	Density (g/cm^3) (Ore)	Pit-specific, see Table 23.				
Diesel Engines	Bin Upper Diameter (µm)	1.00	2.50	6.00	10.00	30.00
	Mass Fraction	0.82	0.08	0.03	0.03	0.04
	Mass Mean Diameter (µm)	1.00	2.50	6.00	10.00	30.00
	Density (g/cm^3) (Diesel Combustion)	1.00	1.00	1.00	1.00	1.00
Heaters and Boilers	Bin Upper Diameter (µm)	1.00	2.50	6.00	10.00	30.00
	Mass Fraction	0.23	0.22	0.25	0.09	0.21
	Mass Mean Diameter (µm)	1.00	2.50	6.00	10.00	30.00
	Density (g/cm^3) (Propane Combustion)	1.24	1.24	1.24	1.24	1.24

REC 0708

PET 342

Table 4. PARTICULATE MATTER DEPOSITION PARAMETERS BY SOURCE CATEGORY.						
Source Category	**Parameter**	**PM**				
		Bin 1	**Bin 2**	**Bin 3**	**Bin 4**	**Bin 5**
Lime Loading and Unloading (Quick, Pebble)	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.05	0.29	0.66	--	--
	Mass Mean Diameter	2.50	10.00	30.00	--	--
	Density (g/cm^3) (Quick)	0.44	0.44	0.44	--	--
	Density (g/cm^3) (Pebble)	0.96	0.96	0.96	--	--
Lime Unloading (Quick, Pebble)	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.09	0.49	0.42	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3) (Quick)	0.44	0.44	0.44	--	--
	Density (g/cm^3) (Pebble)	0.96	0.96	0.96	--	--
Cement and Aggregate Loading and Unloading	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.05	0.29	0.66	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3) (Cement)	1.44	1.44	1.44	--	--
	Density (g/cm^3) (Aggregate)	1.28	1.28	1.28	--	--
Prill Loading and Unloading	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.05	0.30	0.65	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3) (Prill)	0.84	0.84	0.84	--	--
Refining Processes	Bin Upper Diameter (µm)	1.00	2.50	6.00	10.00	30.00
	Mass Fraction	0.72	0.10	0.07	0.03	0.08
	Mass Mean Diameter (µm)	1.00	2.50	6.00	10.00	30.00
	Density (g/cm^3) (Diesel Combustion)	1.00	1.00	1.00	1.00	1.00
Portable Crushing and Screening Plant	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.05	0.32	0.63	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3) (YPP, HFP, WEP DR average)	2.46	2.46	2.46	--	--
Lime Kiln and Ball Mill	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction (Kiln)	0.27	0.28	0.45	--	--
	Mass Fraction (Ball Mill)	0.30	0.54	0.16	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3)	1.09	1.09	1.09	--	--
Blasting and Drilling	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.03	0.49	0.48	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3) (Ore or DR)	Pit-specific, see Table 23.				
Dozing	Bin Upper Diameter (µm)	2.50	10.00	15.00	30.00	--
	Mass Fraction	0.11	0.08	0.06	0.75	--
	Mass Mean Diameter (µm)	2.50	10.00	15.00	30.00	--
	Density (g/cm^3) (DR)	Pit-specific, see Table 23.				

[a.] See Table 23 in the main body of the DEQ *Modeling Review Memorandum*.

5.7 Carcinogenic TAP Modeling Lifetime Exposure Adjustment

Maximum modeled concentrations for carcinogenic TAPs were adjusted to account for the life-of-mine production limits, which affects the lifetime exposure.

PRI evaluated the highest modeled annual carcinogenic TAP concentration from each of the 14 modeling scenarios for lifetime exposure as follows:

$$Lifetime\ exposure\ \left(\frac{\mu g}{m^3}\right) = \frac{Highest\ annual\ concentration\ \left(\frac{\mu g}{m^3}\right) \times 16\ (mine\ operation\ years)}{70\ (years, lifetime\ exposure)}$$

This equation assumes that the highest annual concentration from the 14 modeling scenarios is repeated for 16 years of mining operation. This was then averaged over 70 years to calculate the 70-year lifetime exposure.

PRI and Air Sciences contend that calculating lifetime exposure based on 16 years of mining operation is conservative. The annual emissions for carcinogenic TAP modeling are based on 135,000 tons/day (see Section 5.1 of this *Modeling Review Attachment*) and 365 days per year. Over 16 years, this equates to a potential mining production of 788.4 million tons:

$$\frac{135{,}000\ \left(\frac{tons}{day}\right) \times 365\ \left(\frac{days}{year}\right) \times 16\ years}{1{,}000{,}000\ \left(\frac{tons}{million\ ton}\right)} = 788.4\ million\ tons$$

The actual life-of-mine total production as described in the SGP *Refined Proposed Action* (*ModPRO2*) mine plan is only 402.86 million tons (Perpetua 2021), which is 51.1% of the potential life-of-mine production represented in the above equation and related emission evaluations.

5.8 Arsenic Compliance Demonstration for Modeling Scenarios W1-W4

To demonstrate compliance with the AACC for arsenic, PRI applied two additional operating limitations:

- The removal of Modeling Scenario W5 as a potential operating scenario
- Limiting the West End Pit's life-of-mine potential mining production to 50% of the total life-of-mine potential mining production of 788.4 million tons: 50% * 788.4 million tons = 394.2 million tons

PRI has determined that the West End Development Rock Storage Facility (DRSF) will not be constructed. This change eliminated Modeling Scenario W5 from the arsenic modeling evaluation. The remaining four West End Pit modeling scenarios (W1–W4) are evaluated using the 70-year lifetime exposure equation from Section 5.7 and adjusting for the proposed West End Pit life-of-mine production limit of 50% of the total production as follows:

$$LifeExpose_{Wi,j,n} = \left[\left(WEPExpose_{Wi,n}\right)(50\%) + \left(nonWEPExpose_{Sj,n}\right)(50\%)\right]\left[\frac{16\ year\ LOM}{70\ year\ exposure}\right]$$

where:

W*i*	=	West End Pit scenario, where *i* = 1 to 4.
S*j*	=	non West End Pit scenario, where *j* = B1, B2, H1, H2, H3, H4, Y1, Y2, and Y3.
n	=	specific receptor.
$LifeExpose_{Wi,j,n}$	=	lifetime exposure in µg/m^3 for West End Pit scenario *i*, non West End Pit scenario *j*, at receptor *n*.
$WEPExpose_{Wi,n}$	=	annual maximum impact in µg/m^3 for West End Pit scenario *i* at receptor *n*.
$nonWEPExpose_{Sj,n}$	=	annual maximum impact in µg/m^3 for non West End Pit scenario *j* at receptor *n*.
16 year LOM	=	maximum life-of-mine.
70 year exposure	=	Lifetime exposure used for development of AACCs in *Idaho Air Rules*.

The above equation was used to calculate the lifetime arsenic exposure from the West End Pit scenarios (W1–W4) on a receptor-by-receptor basis. Combining the concentrations from Modeling Scenarios W1–W4 with the highest concentration from the remaining non-West End Pit scenarios (B1, B2, H1, H2, H3, H4, Y1, Y2, or Y3) conservatively ensures that the maximum potential impacts from applicable sources are evaluated and remain below AACCs.

PRI contends that calculating lifetime arsenic exposure based on the proposed West End Pit life-of-mine production limit of 50% of the total production is conservative. The actual life-of-mine total production from the West End Pit as described in the ModPRO2 mine plan is only 198.26 million tons (Perpetua 2021), which is 50.3% of the proposed West End Pit life-of-mine production limit of 394.2 million tons.

6.0 Impact Results

TAP impact analysis results, as submitted in the *TAP Addendum* and as further assessed by DEQ, are discussed in this section. The effect of various operational refinements also reduced PM_{10} and $PM_{2.5}$ impacts, and this is discussed in Section 6.2.

6.1 TAP Impact Analyses Results

This section describes the revised TAP impact analyses and demonstrates that applicable TAP emissions resulting from operation of the SGP will not result in increased impacts that exceed AACs or AACCs.

6.1.1 Modeling Non-Carcinogenic TAPs

The non-carcinogenic TAPs subject to impact modeling requirements to demonstrate compliance with AACs of *Idaho Air Rules* Section 585 were modeled at the emission levels shown in Table 1 above. The maximum 24-hour modeled concentration for each of the 14 modeling scenarios demonstrates compliance with the applicable AAC, as summarized below in Table 5. PRI elected to include Scenario W5 in the modeling analysis for non-carcinogenic TAPs. Figure 1 illustrates the locations of the maximum impacts for each non-carcinogenic TAP.

REC 0711

PET 345

Table 5. RESULTS FOR TAPS IMPACT ANALYSES FOR NON-CARCINOGENIC TAPS.					
Toxic Air Pollutant	**Averaging Time**	**Maximum Modeled Concentration ($\mu g/m^3$)[a]**	**Model Scenario**	**AAC[b] ($\mu g/m^3$)**	**Percent of AAC**
Aluminum	24-hour	6.17	W5	500	1.23%
Barium	24-hour	0.07	W5	25	0.28%
Calcium carbonate	24-hour	1.22	W5	500	0.24%
Calcium oxide	24-hour	0.15	All	100	0.15%
Cyanide	24-hour	0.20	All	250	0.08%
Iron	24-hour	1.58	W5	50	3.16%
Manganese	24-hour	0.03	W5	250	0.01%
Phosphorus	24-hour	0.06	W5	5	1.20%
Sulfuric acid	24-hour	0.41	All	50	0.82%
Thallium	24-hour	0.001	W5	5	0.02%
Vanadium	24-hour	0.002	W5	2.5	0.08%

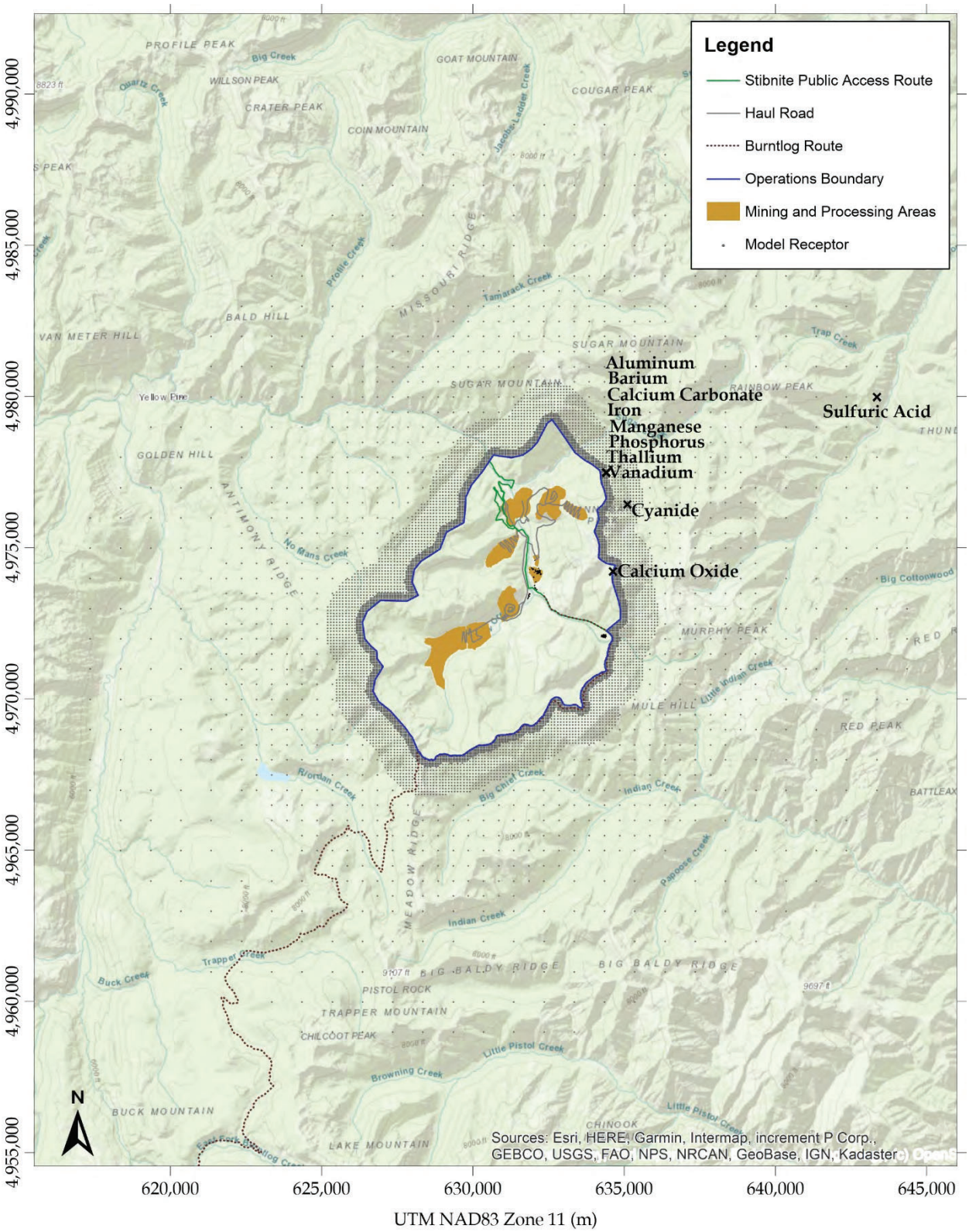
a. Micrograms per cubic meter.

b. Acceptable Ambient Concentration of a Non-carcinogenic TAP.

REC 0712

PET 346

Figure 1. SGP NON-CARCINOGENIC MAXIMUM TAP IMPACT LOCATIONS.



6.1.2 Modeling Carcinogenic TAPs

The carcinogenic TAPs subject to impact modeling requirements to demonstrate compliance with AACCs of *Idaho Air Rules* Section 586 were modeled using an emission inventory that includes the T-RACT controls, long-term mining production limits, and other emission inventory refinements, as described in Section 4.0 and 5.0 of this *Modeling Review Attachment*.

The maximum modeled impact for each of the 14 modeling scenarios demonstrated compliance with the T-RACT AACC, as summarized below in Table 6. The SGP maximum concentrations were adjusted to account for the life-of-mine production limits, which affect the lifetime exposure, and to account for the elimination of Modeling Scenario W5. See Sections 5.7 and 5.8 of this *Modeling Review Attachment* for more detail. The locations of the maximum impacts for each carcinogenic TAP are presented in Figure 2. Arsenic concentrations are considerably lower in areas away from the location of maximum impact as shown in Figure 3.

Table 6. RESULTS FOR TAPS IMPACT ANALYSES FOR CARCINOGENIC TAPS.

Toxic Air Pollutant	Averaging Time	Maximum Modeled Lifetime Exposure Concentration ($\mu g/m^3$)[a,b]	Model Scenario	AACC[c] ($\mu g/m^3$)	T-RACT[d] AACC	Percent of T-RACT AACC
Arsenic	Annual	0.00095	W2	0.00023	0.0023	41.30%
Beryllium	Annual	0.00001	W1	0.0042	0.042	0.02%
Cadmium	Annual	0.000002	W1	0.00056	0.0056	0.04%
Formaldehyde	Annual	0.00007	W1	0.077	0.77	0.01%
Nickel	Annual	0.00001	W1	0.042	0.42	<0.01%

a. Micrograms per cubic meter.
b. The lifetime exposure concentrations are based on the proposed restrictions discussed in Sections 5.7 and 5.8 of this *Modeling Review Attachment*.
c. Acceptable Ambient Concentration of a Carcinogenic TAP.
d. Toxic Air Pollutant Reasonably Available Control Technology allows the AACCs to be increased by a factor of ten per *Idaho Air Rules* Section 210.12(b).

Figure 2. SGP CARCINOGENIC MAXIMUM TAP IMPACT LOCATIONS.

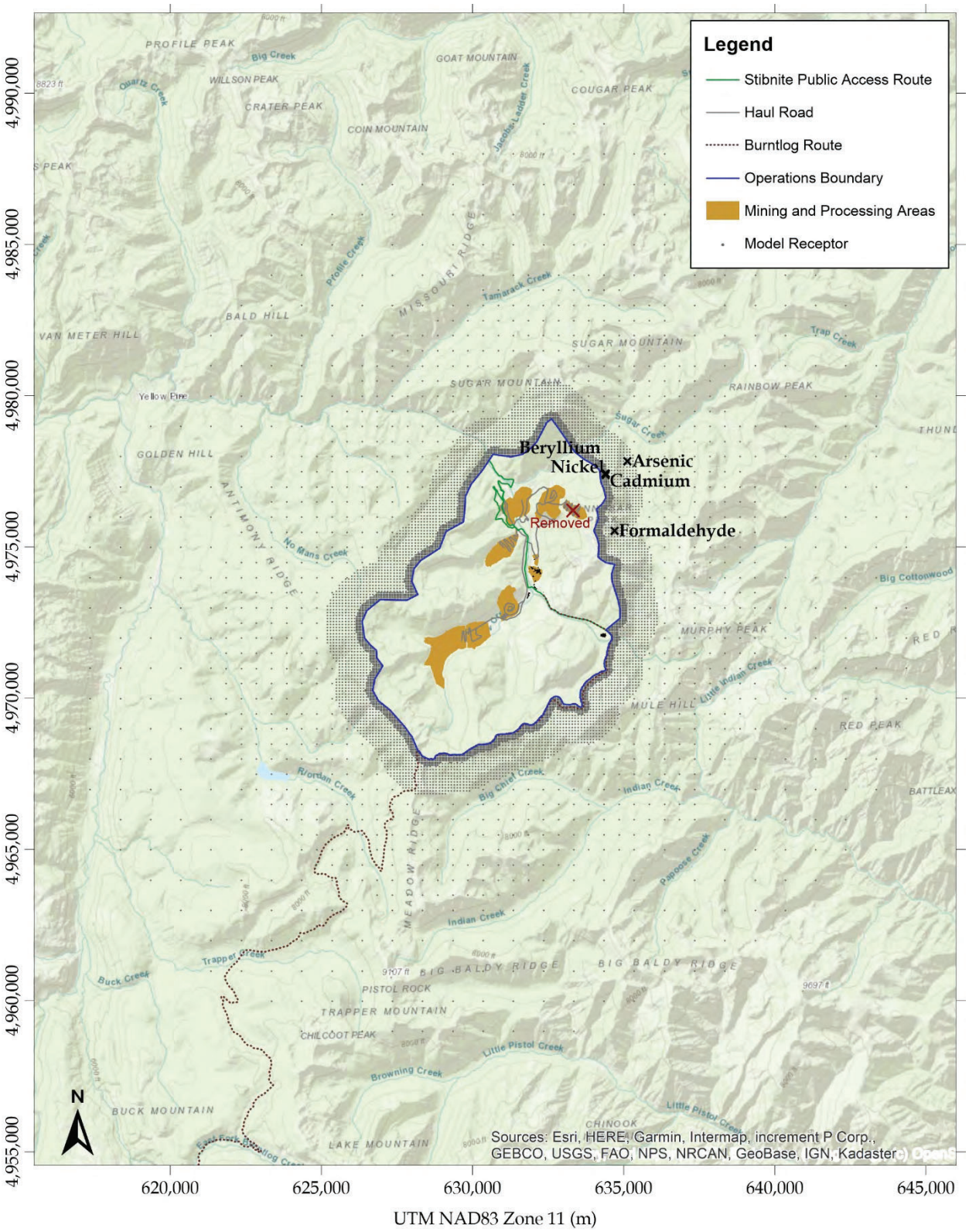
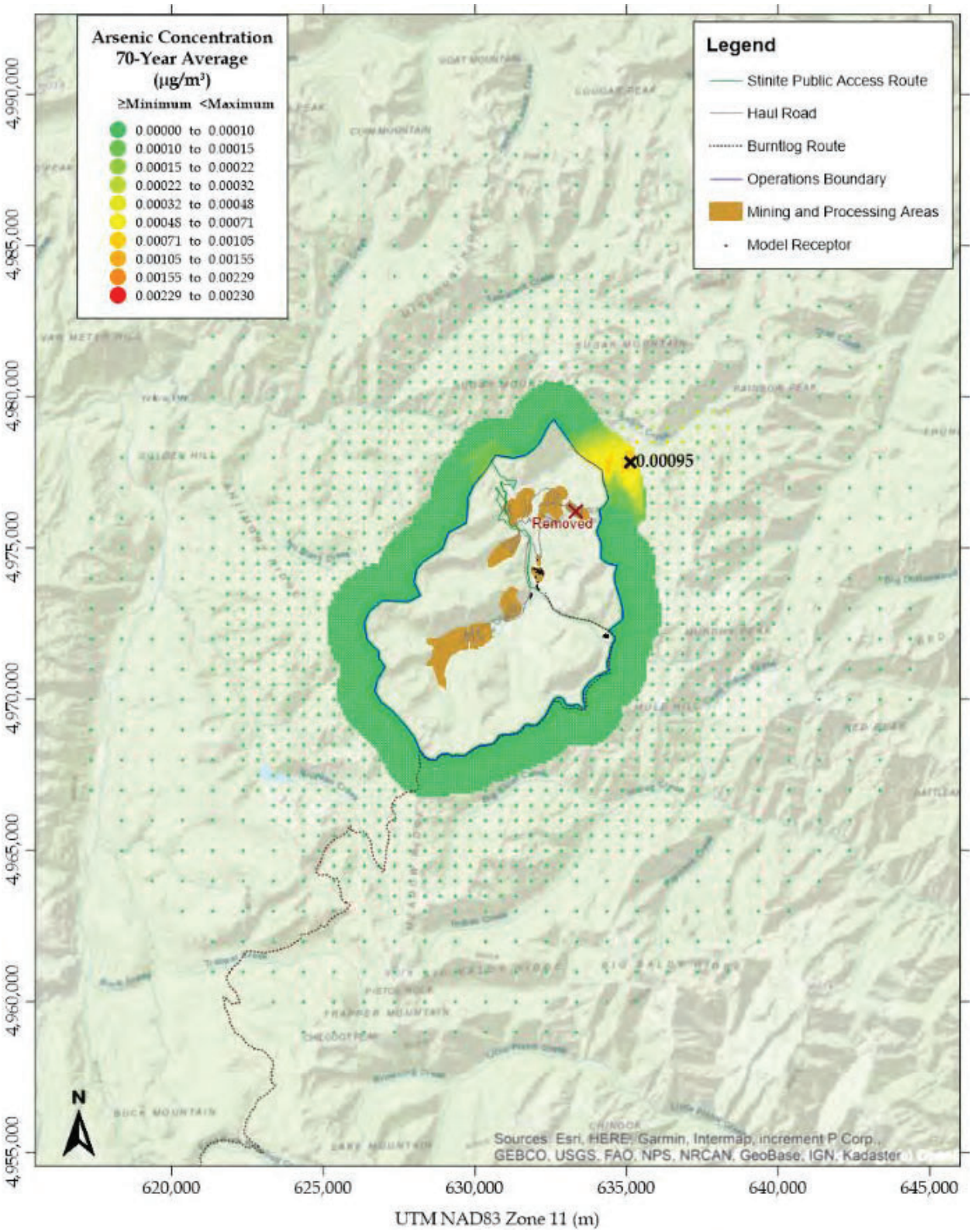


Figure 3. SGP CONTOURS OF LIFETIME ARSENIC IMPACTS.



6.2 Effect of Changes to Modeled PM_{10} Results

PRI has determined that the West End Development Rock Storage Facility will not be constructed. This change eliminated Modeling Scenario W5 as a potential operating scenario. In Section 4.1.4 in the main body of the DEQ *Modeling Review Memorandum*, DEQ identified PM_{10} NAAQS exceedances at four hotspot receptors when using the BULKRN meteorological dataset for Modeling Scenario W5 (the highest PM_{10} impact modeling scenario). When Modeling Scenario W5 is removed, the highest modeled impacts are predicted to occur for Modeling Scenario W3, which represents the transport of development rock from the West End Pit to the Hangar Flats Development Rock Storage Facility.

Table 7 presents results for the cumulative NAAQS impact analyses for Scenario W3. Results still exceed the 24-hour PM_{10} NAAQS even when Modeling Scenario W5 is eliminated. However, there is only one hotspot receptor exceeding NAAQS. The modeled violation is also predicted to occur during winter. This is a critical consideration because during winter, not only are fugitive emissions minimized because of the higher moisture content of material handled or driven over, but background concentrations in such remote areas are also generally much lower because of the absence of wildfires and dust-generating sources.

Table 7 also lists the results when using temporally varying backgrounds, instead of a single-value background, in the cumulative NAAQS impact analysis (using the "SEASON" and "MONTH" options in AERMOD). The highest daily average PM_{10} concentrations measured at Stibnite for every season and month in 2014 were used as inputs in the model. Table 7 shows that the SGP facility ***safely*** demonstrates compliance with the 24-hour PM_{10} NAAQS when temporally varying backgrounds (both seasonal and monthly) are used instead of the single-value background. Summing modeled design values with a single-value background that is on the upper end of the distribution results in a very conservative estimate of total impacts. DEQ strongly believes that using temporally varying backgrounds that respect seasonality is appropriate for the SGP facility, and that using the highest value in the period interval is very conservative.

TABLE 7. RESULTS FOR 24-HOUR PM_{10} CUMULATIVE NAAQS IMPACT ANALYSES FOR MODELING SCENARIO W3.

Backgrounds Scenario	Max. Conc.[a] (µg/m³)[b]	Model Scenario	Back. Conc.[c] (µg/m³)	Total Conc.[d] (µg/m³)	NAAQS (µg/m³)	Percent of NAAQS
Single-Value Background	116.9	W3	34.0	150.9[e]	150	100.6%
Seasonally Varying Backgrounds	123.5[f]	W3	*Seasonal*	123.5[f]		82.3%
Monthly Varying Backgrounds	123.5[f]	W3	*Monthly*	123.5[f]		82.3%

a. Max. Conc. = maximum modeled design concentration.
b. Micrograms per cubic meter.
c. Back. Conc. = background concentration.
d. Total Conc. = total (modeled + background) concentration.
e. One hotspot receptor exceeds NAAQS.
f. The maximum modeled design concentration already incorporates the seasonal and monthly background values.

The time series plot in Figure 4 and the box-and-whiskers plot in Figure 5 illustrate the variability in daily average PM_{10} concentrations collected at the Stibnite Site in 2014. Figures 4 and 5 confirm that the highest concentrations from the modeled and monitored datasets do ***not*** occur simultaneously. Highest modeled impacts are predicted to occur during winter while the highest background concentrations were measured at Stibnite during summer. Therefore, the summation method, where total impacts are

REC 0717

PET 351

calculated by summing modeled design values with a background concentration that is also consistent in form with the regulatory design value, results in a very conservative estimate of the total impact for comparison to NAAQS. DEQ concludes that use of temporally varying (i.e., seasonal and monthly) backgrounds for SGP is justified. DEQ is highly confident that operation of the SGP will not cause or contribute to a violation of NAAQS.

PM_{10} and $PM_{2.5}$ NAAQS compliance was previously demonstrated prior to refinements and adjustments proposed in the submitted *TAP Addendum*. The main body of the DEQ *Modeling Review Memorandum* discussed and considered results from both modeling with meteorological data processed using the BULKRN method and modeling with data processed using cloud cover data, and DEQ concluded that NAAQS compliance was demonstrated with a high degree of confidence. The adjustments and refinements described in the *TAP Addendum* further increase DEQ's confidence in NAAQS compliance.

Figure 4. TIME SERIES OF DAILY AVERAGE PM_{10} CONCENTRATIONS MEASURED AT STIBNITE IN 2014.

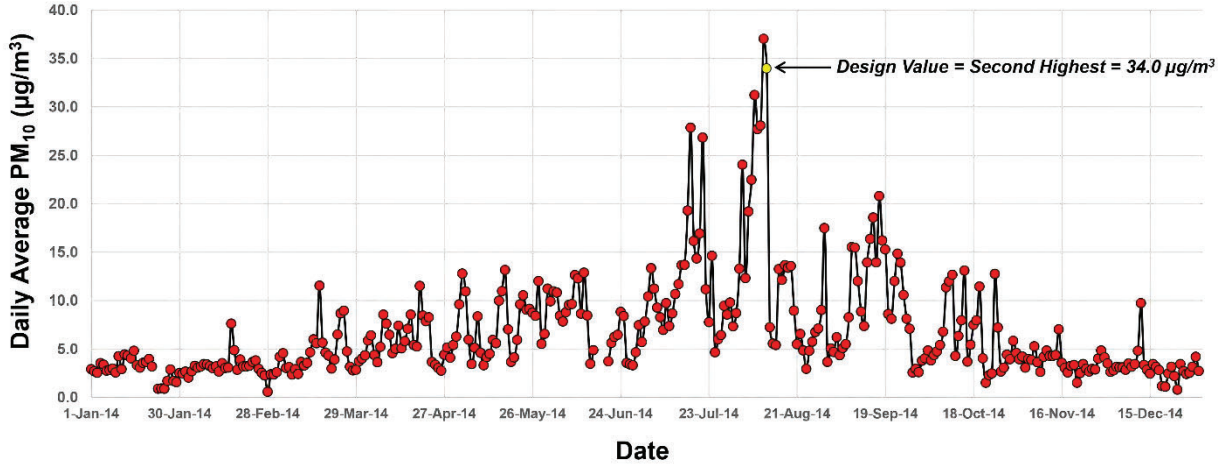
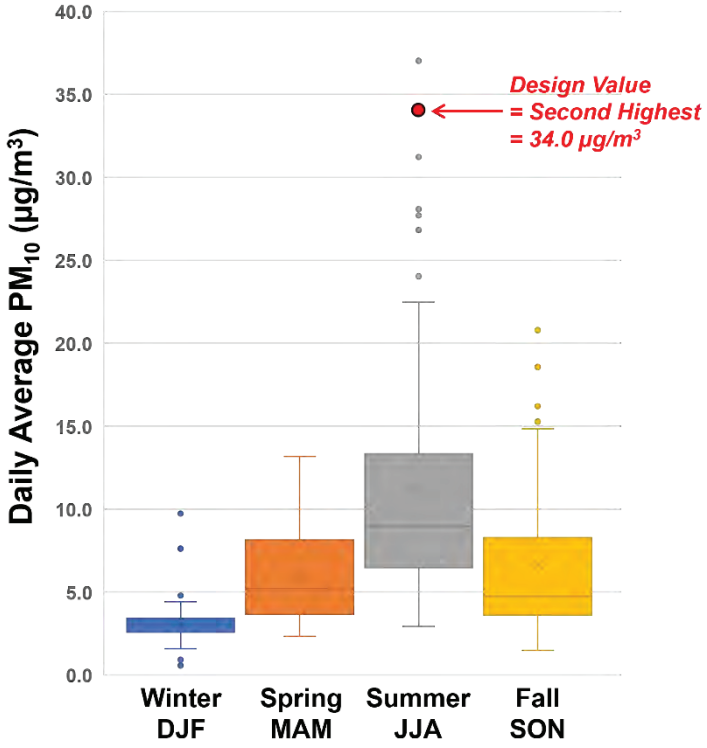


Figure 5. BOX-AND-WHISKERS PLOT FOR SEASONAL PM_{10} BACKGROUND CONCENTRATIONS MEASURED AT STIBNITE IN 2014.



In Figure 5 the middle line of each box represents the median. The "x" in the box represents the mean. The bottom and the top lines of the box represent the 1st quartile (25th percentile) and the 3rd quartile (75th percentile), respectively. The whiskers extend to the minimum and maximum values not considered outliers. Outliers are plotted individually.

7.0 Conclusions

This section provides conclusions of the *TAP Addendum* and DEQ's review of the *TAP Addendum*.

7.1 Conclusions of Revised TAP Analyses

The revised and refined TAP analyses:

- Revised TAP-applicable sources at the SGP facility.
- Proposed additional emission control measure and adjusted operations to reduce TAP emissions.
- Refined the approach used to demonstrate compliance with TAP regulations.

The submitted application, with the adjustments and refinements to analyses as described in the *TAP Addendum*, demonstrated to DEQ's satisfaction that the emissions of applicable TAPs will not result in impacts to ambient air that exceed TAP increments of *Idaho Air Rules* Section 585 and 586.

7.2 Effects of Adjustments/Revisions on NAAQS Compliance Demonstrations

The submitted application, prior to the *TAP Addendum*, demonstrated compliance with NAAQS to DEQ's satisfaction; and the operational measures proposed in the *TAP Addendum* will only further reduce estimated emissions. Eliminating Modeling Scenario W5 impacts, with the elimination of the West End Development Rock Storage Facility, affects the 24-hour PM_{10} impact modeling analysis for SGP. Modeling Scenario W3 is now the scenario producing the highest modeled impacts, and NAAQS compliance is easily demonstrated when using temporally varying background PM_{10} values, which were obtained from onsite monitoring data.

7.3 Conservatism of Permitting Analyses

Emissions and locations from which emissions occur are highly dynamic at mining facilities. This presents unique challenges for permit development because permits must include limits and operational requirements that ensure air quality standards are not violated. Permitting rules require that air impacts be assessed using maximum potential emissions as limited by either the capacity of the unit/operation or as limited by enforceable permit provisions. A permit where actual emissions are nearly representative of maximum allowable emissions, through imposing permit limits, would be exceedingly complex and require overly burdensome monitoring and record-keeping requirements. To avoid this, applicants typically calculate allowable emissions and perform impact analyses based on simplistic operational scenarios that largely overstate emissions estimated to occur from the facility.

PRI and Air Sciences have asserted that the submitted emission estimates, operational scenarios, and air impact analyses associated with the permit application greatly overstate best-estimated values. This point is evident when comparing the permit application materials and analyses with those presented in ModPRO2, PRI's revised mine plan and associated impacts. ModPRO2 is used in support of the Environmental Impact Statement (EIS).

Reference

Perpetua. 2021. "ModPRO2 Mine Plan." *File: Midas Stibnite Mine Plan and Equipment Schedule (10Feb21).xlsx.* Email from R. McCluskey, Perpetua Resources Inc., to E. Memon, Air Sciences Inc., February 11.

APPENDIX C – FACILITY DRAFT COMMENTS

The following comments were received from the facility on August 3 and 13, 2020:

Editorial proposed changes were provided in a redlined version of the draft permit. Each non-editorial proposed change was addressed in the following comments. DEQ agreed with and incorporated the redlined editorial corrections that were not individually addressed in the following (non-editorial) comments below.

Facility Comment #1: Condition 1.2, Table 1.1, and Condition 3.2, Table 3.1: Please remove the control efficiency values listed for haul roads (93.3%) and enclosures (80%). It appears that these percentages are provided for descriptive purposes only. As such, this information would more appropriately be provided in the Statement of Basis only. In addition, it does not appear that Idaho mining PTCs typically contain control efficiency values for fugitive sources. Alternatively, the following language may be added to Condition 1.2, "Control equipment information and maximum process rate information is provided for information only unless also included in specific enforceable permit conditions."

DEQ Response:

Permit Conditions 1.2 and 3.2 were revised for clarification to include a statement that the information in the tables is provided for informational purposes.

Proposed control efficiencies were left unchanged. Although control efficiencies are included for informational purposes, this information serves as an important reference when observing and characterizing emissions as required by the permit. The specified control efficiencies were relied upon in estimating and modeling emissions and are one of many important parameters which form the basis of this permit.

Facility Comment #2: Condition 1.2, Table 1.1, Hauling, and Condition 2.5, 2nd and 17th Bullets: Please remove the Maximum Process Rate of "490,000 mi/mo" and related monitoring obligation. The mining excavation rate is already limited to 180,000 T/day, which directly impacts vehicle miles traveled. At this limit, all hauling scenarios were modeled to capture the maximum-case hauling distances, which included a hauling mileage of 16,415 mi/day (492,465 mi/30 days or 508,880 mi/31 days). The maximum-case mileage far exceeds the peak production total actual annual hauling mileage of 1.4 million mi/yr (116,700 mi/mo). Therefore, a mileage limit is not necessary to limit emissions, and recording miles daily adds unnecessary and burdensome monitoring.

DEQ Response:

Permit Conditions 1.2 and 2.6 (renumbered) were revised to remove the explicit mileage limit. As supported by the emission estimates, hauling operations and associated emissions are constrained by the daily production limit and the proposed vehicle fleet characteristics.

Although all conditions that affect roadway conditions should be considered when determining water and suppressant application rates and frequency, it is left to the permittee to determine and define within the FDCP the site-specific parameters most critical to ensuring successful control of fugitive emissions. An effective FDCP will require active monitoring on the part of the permittee to determine the appropriate frequencies and amounts of water and dust suppressant applications sufficient to achieve the target 93.3% reduction in haul road emissions. Monitoring of vehicle mileage is one option that may need to be considered.

Facility Comment #3:

Condition 1.2, Table 1.1, Prill Silos, and Conditions 3.8 and 3.17: Please revise the Maximum Process Rate of "608/month" to "200 T/day." The daily rate was used for the 24- hour PM_{10} and 24-hour $PM_{2.5}$ modeling. See Appendix B, pages 11, 12, and 15 of the June 23, 2020, PTC Application (Application). No other criteria pollutants or toxic air pollutants (TAP) are emitted by these insignificant sources. The Application also requested a 7,300 T/yr limit. However, it has come to our attention that an annual limit of 9,000 T/yr is needed. This change has essentially no effect on the annual emission inventory for annual $PM_{2.5}$ modeling. The $PM_{2.5}$ emission change from increasing the annual throughput from 7,300 T/yr to 9,000 T/yr (an increase of 0.00005 g/s) is less than five-thousandth of a percent of the total $PM_{2.5}$ emissions.

DEQ Response:

Permit Condition 1.2 was revised to reflect the requested daily and annual rates.

Annual emission estimates were updated in the statement of basis to reflect the increase in annual silo material loading and unloading rates from 7,300 to 9,000 T/yr. Based on a supplemental modeling analysis performed by DEQ, in which the Prill Silos Loading (PSL) and Prill Silos Unloading (PSU) were each modeled with adjusted annual $PM_{2.5}$ emission rates, the model impacts reported did not change.

Facility Comment #4:

Condition 1.2, Table 1.1, Autoclave (AC) and Electrowinning Cells: Please remove "and as limited by Subpart EEEEEEE" from the Maximum Process Rate. Subpart EEEEEEE does not contain any process rate limits. This subpart only provides emission limits, and control and monitoring requirements as noted in Condition 4.2, Table 4.1, and Conditions 4.18 and 4.19.

DEQ Response:

Permit Condition 1.2 was updated as requested to remove references to Subpart EEEEEEE. As indicated, process emissions rather than process maximum rates are limited by this subpart.

Because federally-applicable requirements will be explicitly incorporated into the required Tier I permit, high-level references and incorporation by reference were considered sufficient within the PTC.

Facility Comment #5:

Condition 1.2, Table 1.1, POX Boiler, and Condition 4.4: Please replace the Maximum Process Rate of "1 hr/day and 30 hr/yr" with "operation is limited to AC start-up only." The boiler is used only for starting up the AC. Once the AC is running, the boiler is turned off; however, a start-up will be longer than 1 hour. AC start-ups are expected to require up to 10 hours of POX Boiler firing, and there may be as many as three start-ups per year. Limiting operation only to start-up provides flexibility and reflects the proposed operating scenario. Midas will continue to monitor boiler operating hours during AC start-up, per Condition 4.17.

DEQ Response:
Permit Condition 1.2 was updated as requested to reflect operation during autoclave startup only. Based on a supplemental modeling analysis performed by DEQ, operation as described does not change reported model impacts.

Facility Comment #6:

Condition 1.2, Table 1.1, PFR Shaft Lime Kiln Combustion: Please replace "20.5" with "22.0 MMBtu/hr." See page 93 of the Application.

DEQ Response:

Permit Condition 1.2 was updated to reflect the correct heat input capacity for the Parallel Flow Regenerative Shaft Kiln.

Facility Comment #7:

Condition 1.2, Table 1.1, SAG Mill and AC Lime Silos: The Maximum Process Rate of "169 T/day and 52,337 T/yr" only applies to LS-L/U, LK, and LCR. The SAG Mill and AC Lime Silos (6 storage silos) have a combined Maximum Process Rate of 70,000 T/yr of lime.

DEQ Response:

Permit Condition 1.2 was revised to reflect the correct maximum process rates, including the combined daily and annual loading and unloading rates from all six silos.

Facility Comment #8:

Condition 1.2, Table 1.1, Concrete Production, and Condition 5.8: Please replace the Maximum Process Rate of "80 T/day and 60,000 T/yr (cement + aggregate)" with "2,480 T/day and 560,000 T/yr of (cement + aggregate)." See page 47 of the Application. Also, the Central Mixer capacity is 120 T/hr (20 T/hr of cement plus 100 T/hr of aggregate).

DEQ Response:

Permit Condition 1.2 was revised to reflect the correct maximum daily and annual process rates, when considering both cement and aggregate inputs.

Facility Comment #9:

Condition 1.2, Table 1.1, Concrete Production, Central Mixer Loading, and Conditions 5.1 and 5.2: Please revise the control description to match the control options listed in AP-42 and the Application (page 7 and Appendix B page 11).

DEQ Response:

Permit Condition 1.2 was revised to reflect the variety of control equipment options described in AP-42 that were considered in the development of emission factors for central mix plants.

Facility Comment #10:

Condition 2.4: Please replace the facility-wide inspection frequency with "monthly." A monthly inspection rate is typical for large mining operations and consistent with other Idaho mining PTCs.

DEQ Response:

For clarification, this frequency was revised from once each shift to once every 12 hours. Daily inspection was considered reasonable and adequate based on the size and scale of proposed ore processing, ore concentration and refining operations. A frequency of once every 12 hours ensures that both daytime and nighttime operations will be observed, to confirm that sufficient fugitive dust control measures are applied as assumed in demonstrations of compliance with NAAQS on a 24-hour basis. Frequent inspection of fugitive sources, in particular haul roads from which the contribution to $PM_{10}/PM_{2.5}$ modeled impacts was greatest, is necessary to ensure that the target 93.3% reduction in haul road emissions is consistently achieved.

Facility Comment #11:

Condition 2.5, 1st Paragraph: IDAPA 58.01.01.799 applies to nonmetallic mineral processing plants. Thus, clarifying language should be added: "IDAPA 58.01.01.799 applies to fugitive dust sources at the limestone crushing plant and aggregate production plant."

DEQ Response:

Permit Condition 2.6 (renumbered) was updated to clarify that IDAPA 58.01.01.799 specifies best management practices specifically applicable to emission sources at the lime production and aggregate production plants.

Although the requirements in this rule are specific to these sources, the FDCP is to address the control of fugitive emissions from all fugitive sources (facility-wide). Additional discussion is also provided below (response to Comment #14).

Facility Comment #12:

Condition 2.5, 1st Bullet: Please replace "to 20 miles per hour or lower if appropriate" with "in accordance with the FDCP." The Application did not propose a 20 miles per hour speed limit, and certain haul road sections may be driven at higher speeds while emissions are minimized.

DEQ Response:

Permit Condition 2.6 was revised to remove the explicit vehicle speed limit. As supported by the emission estimates, hauling operations and associated emissions are constrained by the daily production limit and the proposed vehicle fleet characteristics.

Although all conditions that affect roadway conditions should be considered in controlling emissions, it is left to the permittee to determine safe and appropriate vehicle speeds onsite, and to define these site-specific parameters within the FDCP to ensure successful control of fugitive emissions. An effective FDCP will require active monitoring on the part of the permittee to ensure that the target 93.3% reduction in haul road emissions is achieved. Monitoring to ensure that appropriate vehicle speeds are observed is one option that may need to be considered.

Facility Comment #13:

Condition 2.5, 2nd Bullet: Please remove this bullet as discussed in Condition 1.2, Table 1.1, Hauling, above.

DEQ Response:

Permit Condition 2.6 was revised to remove the explicit mileage limit as discussed above (response to Comment #2).

Facility Comment #14:

Condition 2.5; 3rd, 4th, 5th, 7th, 13th, 15th Bullets: Each of these bullets require some action if fugitive PM emissions are observed to exceed 20% or leaving a roadway in the case of haul roads. However, the periods that trigger corrective action in these bullets are inconsistent with each other. IDAPA 58.01.01.650 does not impose a trigger for action, other than the requirement to take reasonable precautions. While the visible emissions rule IDAPA 58.01.01.625 does not suit fugitive emission observations, for comparison, that rule states, "for a period or periods aggregating more than ***three*** minutes in any 60-minute period." The Draft Permit states, "for a period or periods aggregating more than ***one*** minute in any 60- minute period." If IDEQ prefers to establish a threshold for dust mitigation action, then the following period would be acceptable to Midas Gold:

- Whenever visible fugitive PM emissions exceed 20% for more than two consecutive minutes (4th, 5th, 7th bullets)
- Whenever visible fugitive PM emissions are observed leaving a roadway for more than two consecutive minutes (3rd bullet). Note that this would also apply to the 13th and 15th bullets, but Midas Gold is proposing to remove these conditions.

DEQ Response:

Permit Condition 2.6 was revised and Permit Condition 2.5 added to clarify the intended requirements. The FDCP applies facility-wide to all fugitive emission sources, and while IDAPA 58.01.01.799 includes requirements specific to the lime production and aggregate production plants, it was considered reasonable to apply best management practices for haul roads on a facility-wide basis.

Control strategy triggers specific to unpaved haul roads, transfer points, screening operations, crushers, grinding mills, and building vents are specified in IDAPA 58.01.01.799 – Nonmetallic Mineral Processing Plant Fugitive Dust Best Management Practice. A progressive control strategy is outlined wherein when defined triggers are exceeded, successive control strategies are employed until fugitive dust control is achieved.

Although these requirements are specifically applicable to the lime production and aggregate production plants as noted, in the case of haul roads, it was considered that the emission sources dedicated to nonmetallic and metallic mineral processing and to mining operations are similar enough in practice to justify applying the haul road control strategy trigger to all such hauling operations (facility-wide). Similar to the responses above, compliance with such reasonable precautions helps to ensure conservatism in estimates of emissions from unpaved roadways and to justify the aggressive dust control efficiencies applied to these estimates.

To distinguish it as a requirement separate from recommended control strategies, the control trigger level was separated into a new permit condition (Permit Condition 2.5), and Permit Conditions 2.4 and 2.6 were updated as appropriate to reference the new permit condition.

Facility Comment #15:

Condition 2.5, 4th Bullet: Please add language to address upstream water sprays that provide downstream control via moisture carryover.

DEQ Response:

Permit Condition 2.6 (renumbered) was revised to clarify that water sprays provide moisture carryover for downstream control.

Facility Comment #16:

Condition 2.5, 6th Bullet: There are no plans to apply water or chemical to the "mine working face." Please revise to, "Apply appropriate dust control at the initial point of material handling to suppress dust throughout the material handling process, as necessary."

DEQ Response:

Permit Condition 2.6 (renumbered) was revised as requested to remove the example control measure. Although this specific example of a reasonable control measure was removed and use of this measure may not be planned, it remains the responsibility of the permittee to implement reasonable precautions as necessary to prevent fugitive emissions (Permit Condition 2.1).

Facility Comment #17:

Condition 2.5, 13th Bullet: Please remove "Whenever visible fugitive PM emissions are observed leaving a roadway during inspection or valid complaint (Permit Condition 2.3), the adequacy of water and dust suppressant application rates should be evaluated." These requirements are already addressed elsewhere:

- The Condition 2.5, 3rd bullet addresses the dust mitigation action whenever visible PM emissions are observed leaving a roadway.
- The Condition 2.5, 20th bullet addresses the periodic evaluation of the FDCP, including dust suppressant application rates.
- The Condition 2.3 addresses valid complaints.

DEQ Response:

Permit Condition 2.6 (renumbered) was revised and Permit Condition 2.5 added. Trigger levels for dust mitigation were revised as discussed above (response to Comment #14). Annual evaluation was considered adequate as minimum frequency for formal evaluation of the FDCP to ensure timely incorporation of updates, and requirements to respond to citizen complaints were adequately addressed in Permit Condition 2.3, and these permit conditions were revised accordingly. Control measures utilized in response to any fugitive dust complaints received (e.g., any change to dust suppressant application rates) over the annual period should be taken into consideration during each such evaluation.

Facility Comment #18:

Condition 2.5, 14th Bullet: Please remove this bullet. Chemical suppressant application will be based on the manufacturer's recommendations and periodic inspections of fugitive dust, not atmospheric conditions.

DEQ Response:

Permit Condition 2.6 (renumbered) was revised as requested to remove the specific requirement to evaluate ambient temperature, humidity and wind speed conditions onsite.

Although all conditions that affect roadway conditions should be considered when determining water and suppressant application rates and frequency, it is left to the permittee to determine and define within the FDCP the site-specific parameters most critical to ensuring successful control of fugitive emissions. An effective FDCP will require active monitoring on the part of the permittee to determine the appropriate frequencies and amounts of water and dust suppressant applications sufficient to achieve the target 93.3% reduction in haul road emissions. Monitoring of ambient conditions may need to be considered.

Facility Comment #19:

Condition 2.5, 15th Bullet: Please remove this bullet, as it is a repeat of the 2nd sentence of the 13th bullet.

DEQ Response:

Permit Condition 2.6 (renumbered) was revised as requested to remove this bullet. Trigger levels were separated into a new permit condition and annual evaluation of the FDCP required as discussed above (responses to Comments #14 and #17).

Facility Comment #20:

Condition 2.5, 17th Bullet: Please remove this bullet as discussed in Condition 1.2, Table 1.1, Hauling, above.

DEQ Response:

Permit Condition 2.6 (renumbered) was revised as requested to remove the explicit mileage limit and associated monitoring as discussed above (response to Comment #2). Although monitoring of mileage is no longer required by the permit, active monitoring of conditions affecting haul roads should be considered when determining appropriate water and suppressant application rates.

Facility Comment #21:

Condition 2.5, 18th Bullet: Please remove this bullet as the 10th bullet already requires that "Chemical dust suppressants shall be applied consistent with manufacturer's instructions and recommendations" and the 16th bullet already requires that "At least once per day during operation, monitor and record the frequency of application and application rates for water and suppressant controls."

DEQ Response:

Permit Condition 2.6 (renumbered) was revised as requested to remove requirements for water spray calibration inspection beyond compliance with manufacturer's specifications. Adequacy of fugitive dust controls and associated equipment calibrations shall be determined by inspection at least once per day.

In addition, due to the similarity of the 16th bullet referenced above and Permit Condition 2.2, these were both combined by moving the daily frequency requirement into Permit Condition 2.2 and removal of this bullet.

Facility Comment #22:

Condition 2.5, 20th Bullet: Please add "and evaluate effectiveness of practices including dust suppressant application rates."

DEQ Response:

Permit Condition 2.6 (renumbered) was revised as requested to add the language referencing evaluation of the effectiveness of practices.

Facility Comment #23:

Condition 2.5, 20th Bullet: Please replace "every six-months" with "every year." Annual review is more typical for the mining industry. Also, it does not appear that Idaho mining PTCs typically require a six-month review of FDCPs.

DEQ Response:

Permit Condition 2.6 (renumbered) was revised as requested to require annual evaluation of the FDCP as discussed above (response to Comment #17)

Facility Comment #24:

Condition 2.9: Please replace "each shift" with "each month" and add "including any stack, vent, or functionally equivalent opening" after "potential sources of visible emissions" to clarify which sources are subject to this condition. It does not appear that Idaho mining PTCs typically contain a visible emission inspection frequency for each shift.

DEQ Response:

Permit Condition 2.10 (renumbered) was reduced to a frequency of once per day from once per shift to facilitate inspection of point sources during daylight hours. As discussed above (response to Comment #10), monthly inspection was considered insufficient due to the continuous nature of operations (24 hours per day, 7 days per week).

Facility Comment #25:

Condition 2.11: Please revise "and 22" to "and knowledgeable of procedures of Method 22" language to reflect that there is no certification for Method 22.

DEQ Response:

Permit Condition 2.12 (renumbered) was revised as requested to clarify that the certification requirement applies only to Method 9.

Facility Comment #26:

Condition 2.21, NSPS 40 CFR 60, Subpart LL: Please remove "OC8." Conveyor drops to stockpiles are not subject to Subpart LL.

DEQ Response:

Permit Condition 2.22 (renumbered) was revised as requested to remove reference to the coarse ore stockpile feed transfer to stockpile (OC8).

Conveyor belt transfer points subject to Subpart LL as defined in 40 CFR 60.381 do not include where the metallic mineral is transferred to a stockpile.

Facility Comment #27:

Condition 2.23: Please add the citation "40 CFR 70.3(c)(2)" to specify that the Tier I operating permit is required only for the emission units that cause the source to be subject to the part 70 program.

DEQ Response:

The citation in Permit Condition 2.24 (renumbered) was abbreviated to reflect only IDAPA 58.01.01.313.01.b. Procedures and requirements for Tier I Operating Permits are established in IDAPA 58.01.01.300–399, and the appropriate reference was cited in incorporating the deadline to apply for a Tier I operating permit. All underlying PTC conditions in this permit, for all emission sources comprising the facility, will be incorporated into the Tier I operating permit.

Facility Comment #28:

Condition 2.24, Table 2.1, Pollutant: Please replace "PM" with "PM_{10}" as this is the pollutant that is required to be tested in the Draft Permit (Condition 4.3).

DEQ Response:

Permit Condition 2.25 (renumbered) was revised to reflect the correct pollutant (PM_{10}) as limited by the permit.

Facility Comment #29:

Condition 2.24, Table 2.1, Test Method: Please add Method 201A for PM_{10}.

DEQ Response:

Permit Condition 2.25 (renumbered) was revised as requested to include reference to approved EPA Reference Method 201A for measurement of PM_{10} emissions.

Facility Comment #30:

Condition 2.24, Table 2.1, Additional Requirements: Please revise the PM Additional Requirements to: "Particulate matter (PM) including condensable PM as defined in IDAPA 58.01.01.006, with an aerodynamic diameter less than or equal to a nominal 10 micrometers for PM_{10}, and less than or equal to a nominal 2.5 micrometers for $PM_{2.5}$" to make it consistent with the rest of the Draft Permit.

DEQ Response:

Permit Condition 2.25 (renumbered) was revised as requested to include the complete descriptions for $PM_{2.5}$ and PM_{10}.

Facility Comment #31:

Condition 3.2, Table 3.1: Please revise as discussed in Condition 1.2, Table 1.1, above.

DEQ Response:

Permit Conditions 1.2 and 3.2 were revised for clarification to include a statement that the information in the tables is provided for informational purposes, as discussed above (response to Comment #1).

Facility Comment #32:

Condition 3.8 and 3.17: Please revise as discussed in Condition 1.2, Table 1.1, Prill Silos, above.

DEQ Response:

Permit Condition 3.8 and 3.16 (renumbered) were revised as requested to reflect the proposed daily and annual rates, as discussed above (response to Comment #3).

Facility Comment #33:

Condition 3.11: Please remove this condition. The crushers will be controlled by water sprays. No emission control credit was taken for the buildings, which will likely have door and vent openings.

DEQ Response:

Permit Conditions 3.10 (renumbered) and 5.11 were revised to remove the requirement to enclose these processes within a building. Consistent with the controls identified in Table 3.1 and Table 5.1, only credit for the use of water spray and moisture carryover controls were relied upon for reductions within emission estimates for these processes.

Facility Comment #34:

Condition 4.2, Table 4.1: Please revise as follows:

- Carbon bed pressure drop is a maximum limit (O&M)
- Carbon bed inlet gas temperature is a maximum limit (Subpart EEEEEEE)
- Baghouse pressure is a maximum limit (O&M)

DEQ Response:

Permit Condition 4.2 was revised to reflect the corrections noted for these monitoring parameters.

Facility Comment #35:

Condition 4.3, Table 4.2: Please remove footnote (c) from NO_x, CO, VOC, and SO_2 as there is no testing required for these pollutants.

DEQ Response:

No change was made to the permit. This standard footnote is applied generally to all pound-per-hour emission limits. Although source testing was not required in the permit for NO_x, CO, VOC, and SO_2 emissions from ore concentration and refining process equipment, it remains that credible evidence can be used to show compliance or noncompliance with these established emission limits, and alteration or removal is not supported.

Facility Comment #36:

Condition 4.4: Please revise as discussed in Condition 1.2, Table 1.1, POX Boiler, above.

DEQ Response:

Permit Condition 4.4 was revised as requested to limit operation of the POX Boiler to autoclave start-up operation only.

Facility Comment #37:

Condition 4.11 through 4.16: Please remove "and in accordance with IDAPA 58.01.01.210.21." The rule states, "Additional procedures and requirements to demonstrate and ensure actual and continuing compliance may be required by the Department in the permit to construct." Conditions 4.11 through 4.16 establish procedures or requirements regarding compliance, and therefore it is not necessary to cite this rule. Including the citation suggests that there are more requirements than stated in the PTC, but any additional requirements are to be in the PTC according to the rule text.

DEQ Response:

Permit Conditions 4.11 through 4.16 were revised as requested to remove reference to Section 210.21. These citations were replaced with the correct citation of Section 210.08.c, consistent with establishing TAP emission limits.

Permit Condition 4.11 through 4.16 were revised, with Section 210.21 citations replaced with the correct citation of Section 210.08.c, consistent with establishing emission limits when controlled ambient concentrations is used to demonstrate preconstruction compliance with TAP AAC or AACC.

Facility Comment #38:

Condition 4.28: Please add carbon filter monitoring requirements.

DEQ Response:

Permit Condition 4.28 was revised as requested to add monitoring of inlet gas stream temperature and pressure drop across the carbon filter to ensure compliance with O&M specifications.

Facility Comment #39:

Conditions 5.1 and 5.2: Please revise as discussed in Condition 1.2, Table 1.1, Concrete Production, Central Mixer Loading, above.

DEQ Response:

Permit Conditions 5.1 and 5.2 were revised to reflect the variety of control equipment options described in AP-42 that were considered in the development of emission factors for central mix plants, as discussed above (response to Comment #9).

Facility Comment #40:

Condition 5.3: Please remove footnote (c) as there are no testing requirements for these pollutants.

DEQ Response:

No change was made to the permit. This standard footnote is applied generally to all pound-per-hour emission limits even if testing is not required, as discussed above (response to Comment #35).

Facility Comment #41:

Condition 5.8: Please revise as discussed in Condition 1.2, Table 1.1, Concrete Production, above.

DEQ Response:

Permit Condition 5.8 was revised to reflect the correct maximum daily and annual process rates, as discussed above (response to Comment #8).

Facility Comment #42:

Condition 5.11: Please remove this condition. The crushers will be controlled by water sprays. No emission control credit was taken for the building, which will likely have openings.

DEQ Response:

Permit Condition 5.11 was revised as requested to remove the requirement to enclose these processes within a building, as discussed above (response to Comment #33).

Facility Comments in Redlined Permit and DEQ Response:

In addition to the comments specifically addressed above, many of the remaining recommended corrections identified and descriptive language suggested in the redlined permit were incorporated (except as noted in the comments above), with minor editorial changes made for clarification. One noted exception concerns the lime, aggregate, and concrete production plant emission limits in Table 5.2. An effort was made to separately identify each activity and to establish the limits consistent with the emission estimates provided in the emissions inventory for each.

Facility Comments in Redlined Statement of Basis and DEQ Response:

In addition to the comments specifically addressed above, many of the remaining recommended corrections identified and descriptive language suggested in the redlined statement of basis were also incorporated (except as noted in the comments above), with minor editorial changes made for clarification. There were a few exceptions noted:

- Discussion of facility classification (comments relating to "synthetic minor" and "natural minor") was left to the appropriate "Facility Classification" section. Where concerns were noted, a reference to this section was included.
- Language addressing any conflict with federal NSPS/NESHAP requirements was not included in the "Toxic Air Pollutant Emissions" section, as it was addressed elsewhere in the appropriate "Permit Conditions Review" section.
- Although an updated Access Management Plan is required by the permit, the initial and relevant Stibnite Road Access Management Plan was retained for reference and appended to this statement of basis.
- The source ID corrections were removed from the "NSPS Applicability" section and were left for explicit identification in the permit (Permit Condition 2.22).
- As discussed above, although applicable requirements are cited, the scope and intent of the FDCP is to address the control of emissions from all fugitive emission sources facility-wide. And although the permit does not include requirements to enclose processes within buildings as requested, this is still recommended where prudent to do so.

Facility Comments in Redlined Modeling Review Memorandum:

The recommended corrections identified and descriptive language suggested in the redlined modeling review memorandum were also incorporated, with minor editorial changes made for clarification. Results from a culpability analysis were also added. There were a few exceptions noted pertaining to the following suggested verbiage for Section 4.1.5:

"DEQ's sensitivity analyses suggest that a few hotspot receptors exceed the 24-hour PM_{10} NAAQS when the unpaved road control efficiency falls below 93% and the meteorological data processed with the BULKRN method is used. However, all the hotspot receptors demonstrate compliance with NAAQS at a 90% control efficiency when using the meteorological data processed without the BULKRN method, and at both examined production levels:

- *maximum impact at 120,000 ton per day – 73.9 $\mu g/m^3$ + 37.0 $\mu g/m^3$ = 110.9 $\mu g/m^3$.*
- *maximum impact 180,000 ton per day – 84.6 $\mu g/m^3$ + 37.0 $\mu g/m^3$ = 121.6 $\mu g/m^3$.*

As previously stated, meteorological data processing with and without BULKRN are both considered acceptable regulatory options by EPA. Therefore, this demonstrates that emissions resulting from a lower unpaved road control efficiency (even potentially less than 90%) do not cause or contribute to a NAAQS violation. Nonetheless, the permit requires an aggressive implementation of measures to control fugitive particulate emissions from roadways."

DEQ Response:

DEQ disagrees with the suggested modification. Because meteorological data processing with and without BULKRN are both considered acceptable regulatory options by EPA, an argument can be made that modeling

simulations using both meteorological datasets (especially for site-specific BULKRN meteorological data) must demonstrate compliance with NAAQS. Furthermore, EPA recommended using data processed with the BULKRN method since it utilizes more of the site-specific data collected. DEQ's sensitivity analyses suggest that 93.3% control efficiency is a very critical assumption for demonstrating 24-hour PM_{10} NAAQS compliance when using the BULKRN meteorological data and when modeled emissions are more-closely representative of typical daily mining production rates for a high-production period. Therefore, DEQ's modeling team maintains that this critical assumption (above 93.3% control efficiency for unpaved road dust) needs to be highlighted in Section 4.1.5 of the modeling memo. DEQ ***strongly disagrees*** with the facility's comment that "emissions resulting from a lower unpaved road control efficiency (even potentially less than 90%) do not cause or contribute to a NAAQS violation."

The highlighted discussion in Section 4.1.5 now reads:

"DEQ's sensitivity analyses suggest that a few hotspot receptors exceed the 24-hour PM_{10} NAAQS when the unpaved road control efficiency falls below 93% and the meteorological data processed with the BULKRN method is used. When the meteorological data processed without the BULKRN method is used, all the hotspot receptors demonstrate compliance with NAAQS at a 90% control efficiency and at both examined production levels:

- *maximum impact at 120,000 ton per day: 73.9 $\mu g/m^3$ + 37.0 $\mu g/m^3$ = 110.9 $\mu g/m^3$.*
- *maximum impact at 180,000 ton per day: 84.6 $\mu g/m^3$ + 37.0 $\mu g/m^3$ = 121.6 $\mu g/m^3$.*

While using alternative meteorological data processed without the BULKRN method safely demonstrates compliance with NAAQS, using site-specific BULKRN meteorological data does not. Therefore, DEQ's modeling team recommends that the permit require an aggressive implementation of measures to achieve above 93% control efficiency for fugitive particulate emissions from roadways."

In addition to the changes enumerated above, DEQ performed a culpability analysis for 24-hour PM_{10}. Results for the culpability analyses are added in Section 4.1.4 of the modeling memo (all succeeding table numbers have been updated):

"Table 30 shows the ten highest-ranked modeled 24-hour PM_{10} impacts from each emission source group. Note that for 24-hour PM_{10}, the design value is the second-highest 24-hour average concentration in a given year. Therefore, the second-high modeled value for source group ALL (121.5 $\mu g/m^3$) was summed with the background concentration for comparison to NAAQS.

Table 30. TEN HIGHEST-RANKED MODELED 24-HOUR PM_{10} IMPACTS IN $\mu g/m^3$ FROM DIFFERENT SOURCE GROUPS (SCENARIO W5, BULKRN METEOROLOGICAL DATA).

Rank	ALL[a]	WEP[b]	WEPBL[c]	WEDRSF[d]	HR[e]	ACCRD[f]	UGEXP[g]	PRCSPT[h]	PRCSVOL[i]
1ST	142.2	102.5	2.27	1.02	52.1	7.26E-03	1.00E-05	0.24	0.23
2ND	121.5	89.3	1.94	0.98	51.0	6.41E-03	1.00E-05	0.23	0.20
3RD	113.4	78.1	1.83	0.96	49.6	5.31E-03	1.00E-05	0.22	0.13
4TH	110.1	77.0	1.73	0.93	49.4	3.39E-03	1.00E-05	0.20	0.10
5TH	108.5	76.9	1.62	0.90	46.1	3.39E-03	1.00E-05	0.18	0.09
6TH	107.7	75.7	1.57	0.85	45.5	3.22E-03	1.00E-05	0.17	0.08
7TH	105.7	73.3	1.49	0.84	43.4	3.21E-03	0	0.16	0.08
8TH	105.6	72.3	1.30	0.77	42.9	2.91E-03	0	0.15	0.08
9TH	101.5	71.4	1.28	0.77	41.8	2.87E-03	0	0.15	0.08
10TH	99.8	71.2	1.23	0.76	41.8	2.56E-03	0	0.15	0.08

a. ALL = all emission sources
b. WEP = West End Pit
c. WEPBL = West End Pit Blasting
d. WEDRSF = West End Pit Development Rock Storage Facility
e. HR = Haul Road
f. ACCRD = Access Road
g. UGEXP = Underground Exploration
h. PRCSPT = Process & Ancillary Point Sources
i. PRCSVOL = Process & Ancillary Volume Sources

Given a background of 37.0 µg/m^3 and a NAAQS of 150 µg/m^3, the critical modeled concentration threshold for any 24-hour PM_{10} NAAQS violation is therefore 113.0 µg/m^3. Table 30 shows that the third-high modeled value for source group ALL (113.4 µg/m^3) barely exceeds NAAQS. Fourth-high (and lower-ranked) modeled impacts, when added to the background concentration, are below NAAQS.

As discussed earlier in this section, HR Onsite Hauling, WEP Open Pit Drilling, and WEP Blasting are the three largest components of the total daily PM_{10} emissions. Therefore, it is not surprising that HR, WEP, and WEPBL are associated with the highest modeled concentrations among all source groups.

To investigate the potential culpability of each source group to the modeled 24-hour PM_{10} NAAQS violation, DEQ performed a culpability analysis using the MAXIFILE output option in AERMOD. The MAXIFILE option provides the receptor location and date of an impact. DEQ performed two MAXIFILE runs. In the first MAXIFILE simulation, the model was run using source group ALL. A threshold value (113.0 µg/m^3) equal to the NAAQS minus background was set. The output file provided a list of the receptors where the NAAQS is exceeded. In the second MAXIFILE simulation, the model was run using only the receptors identified by the first MAXIFILE run. Source groups were included in the second modeling simulation. A threshold value equal to the 24-hour PM_{10} SIL (5.0 µg/m^3) was set. The output file provided a date stamp for any day when a source group exceeds the SIL and potentially contributes to a violation of the NAAQS. A significant contribution to a NAAQS violation would be predicted to occur if the date stamps for source group ALL (from the first MAXIFILE run) and for a specific source group (from the second MAXIFILE run) matched.

DEQ's culpability analyses confirm that emission source groups HR and WEP are culpable for the 24-hour PM_{10} NAAQS exceedances. The date stamps indicate NAAQS violations during the winter season (January 6, January 15, and December 23). We show next that when modeled emissions are more-closely representative of typical daily mining production rates for a high-production period (everything else held constant), the SGP facility is able to demonstrate compliance with 24-hour PM_{10} NAAQS at those few receptors showing a potential violation when using meteorological data processed with the BULKRN method. We also discuss next the implication of NAAQS violations occurring during the winter season."

Air Quality

PERMIT TO CONSTRUCT

Permittee	Midas Gold Idaho, Inc.
Permit Number	P-2019.0047
Project ID	62288
Facility ID	085-00011
Facility Location	Forest Service Roads NF-374 and NF-412 Stibnite, Idaho 83611

Permit Authority

This permit (a) is issued according to the "Rules for the Control of Air Pollution in Idaho" (Rules), IDAPA 58.01.01.200–228; (b) pertains only to emissions of air contaminants regulated by the State of Idaho and to the sources specifically allowed to be constructed or modified by this permit; (c) has been granted on the basis of design information presented with the application; (d) does not affect the title of the premises upon which the equipment is to be located; (e) does not release the permittee from any liability for any loss due to damage to person or property caused by, resulting from, or arising out of the design, installation, maintenance, or operation of the proposed equipment; (f) does not release the permittee from compliance with other applicable federal, state, tribal, or local laws, regulations, or ordinances; and (g) in no manner implies or suggests that the Idaho Department of Environmental Quality (DEQ) or its officers, agents, or employees assume any liability, directly or indirectly, for any loss due to damage to person or property caused by, resulting from, or arising out of design, installation, maintenance, or operation of the proposed equipment. Changes in design, equipment, or operations may be considered a modification subject to DEQ review in accordance with IDAPA 58.01.01.200–228.

Date Issued DRAFT July 14, 2020

Morrie Lewis, Permit Writer

Mike Simon, Stationary Source Manager

Contents

1 Permit Scope 3
2 Facility-Wide 8
3 Mining and Ore Processing 16
4 Ore Concentration and Refining 19
5 Lime, Aggregate, and Concrete Production 27
6 Engines 33
7 General Provisions 34

1 Permit Scope

Purpose

1.1 This is an initial permit to construct (PTC) for ore processing, ore concentration and refining, and ancillary equipment at the Stibnite Gold Project (SGP).

Regulated Sources

1.2 Table 1.1 lists all sources of regulated emissions in this permit.

Table 1.1 Regulated Sources

Source ID No.	Source	Control Equipment	Maximum Process Rate
Mining			
	Drilling activities	Reasonable control and Fugitive Dust Control Plan (FDCP)	1,200 holes/day
	Blasting activities	Reasonable control & FDCP	2 blasts/day
	Excavating and hauling activities	Reasonable control & FDCP – Chemical suppression and water sprays ~~Control efficiency: 93.3% for PM/PM_{10}~~ (haul roads)	180,000 T/day and ~~490,000 mi/mo (combined mileage of all haul trucks)~~
Ore Processing			
OC1	~~Conveyor~~ Loader Transfer of Ore to Grizzly	Reasonable control & FDCP – Water sprays and moisture carryover	25,000 T/day
OC2	~~Conveyor~~ Grizzly to Apron Feeder		
OC3	Conveyor – Apron Feeder to Dribble		
OC4	Conveyor – Apron Feeder to Grizzly		
OC5	Conveyor – Dribble to Grizzly		
OC6	~~Conveyor~~ Grizzly to Primary Crusher or Coarse Ore Stockpile Feed		
OC7	Primary Crusher	Reasonable control & FDCP – Water sprays and moisture carryover	
OC8	Conveyor – Coarse Ore Stockpile Feed Transfer to Stockpile		
OC9	~~Conveyor~~ Stockpile Transfer to Reclaim Conveyors	Reasonable control & FDCP – Below-grade of storage piles ~~Control efficiency: 80% for PM/PM_{10}~~	27,600 T/day
OC10	Conveyor – Reclaim Conveyors to Feed Conveyor		
OC11	Conveyor – Feed Transfer to	Reasonable control & FDCP – Enclosure ~~Control efficiency: 80% for PM/PM_{10}~~	
OC12	Pebble Crusher	Reasonable control & FDCP – Water sprays and moisture carryover	
OC13	~~Conveyor~~ Pebble Discharge to Feed		
PS	(2) Prill Silos #1-2 Maximum capacity: 100 T (each)	Loading – None Unloading – None	~~608 T/month~~200 T/day; 9,000 T/yr (combined)

Source ID No.	Source	Control Equipment	Maximum Process Rate
Ore Concentration and Refining			
AC	Autoclave (AC)	Wet Scrubber (WS1)	6,960 T/day ~~, and as limited by Subpart EEEEEEE~~
EW	Electrowinning Cells and Pregnant Solution Tank	Shared Carbon Filter (CA2) Type: sulfur-impregnated activated carbon Form: granulated	100 gpm ~~, and as limited by Subpart EEEEEEE~~
MR	Mercury Retort	Condenser Carbon Filter (CA3) Type: sulfur-impregnated activated carbon Form: granulated	1,000 lb/batch and 21 T/yr
MF	Induction Melting Furnace	Baghouse (BH2) Carbon Filter (CA4) Type: sulfur-impregnated activated carbon Form: granulated	
CKD	Carbon Regeneration Kiln (Drum)	Wet Scrubber (WS2) Carbon Filter (CA1) Type: sulfur-impregnated activated carbon Form: granulated	7.2 T/day
Sb2	Antimony Bagging	Baghouse (BH1)	108 T/day, or as limited by source testing
Process Heating			
Sb1	Sb Dryer Maximum capacity: 2.72 MMBtu/hr Fuel: propane	None	not applicable (n/a)
ACB	POX Boiler Maximum capacity: 17 MMBtu/hr Fuel: propane	None	~~1 hr/day and 30 hr/yr~~ operation is limited to AC startup only
CKB	Carbon Regeneration Kiln (Burners) Maximum capacity: 2.255 MMBtu/hr Fuel: propane	None	n/a
PV	Propane Vaporizer Maximum capacity: 0.1 MMBtu/hr Fuel: propane	None	n/a
HS	Strip Circuit Solution Heater Maximum capacity: 5 MMBtu/hr Fuel: propane	None	n/a
LKC	PFR Shaft Lime Kiln Combustion Maximum capacity: ~~20.5~~22.0 MMBtu/hr (each) Fuel: propane	None	n/a

Source ID No.	Source	Control Equipment	Maximum Process Rate
Lime Production			
LS1	~~Conveyor~~ Limestone transfer to Primary Crusher Hopper	None	1,130 T/day
LS2	~~SAG Mill~~ Primary Crusher Maximum capacity: 1,130 T/day	None	
LS3	Primary Screen	None	
LS4	~~SAG Mill~~ Secondary Crusher	None	
LS5	Secondary Screen	None	
LS6	Conveyor – Limestone to Ball Mill Feed Bin	None	
LSBM	Limestone Ball Mill	Baghouse (BH3)	
LS7	Conveyor – Limestone to Ball Mill Feed	None	
LS8	Conveyor – Ball Mill Feed to Ball Mill	None	
LS9	Conveyor – Limestone to Kiln Feed Bin	None	267 T/day
LS10	Conveyor – Limestone to Lime Kiln Feed	None	
LS11	Fines Screen	None	
LS12	Conveyor – Kiln Feed to PFR Shaft Lime Kiln	None	
LS-L/U	Bucket Elevator – Pebble Lime Silo Loading	Loading – Bin Vent Filter	169 T/day and 52,377 T/yr
	Pebble Lime Silo discharge to Lime Slaker	Unloading – Wet Scrubber (WS3)	
LK	Parallel Flow Regenerative Shaft Kiln	Baghouse (BH4)	
LCR	Lime Mill Crusher	Baghouse (BH5)	
LS1-L/U	Lime Silo #1 Maximum capacity: 250 T/day	Loading – Bin Vent Filter Unloading – None	70,000 T/yr (combined)
MillS2-L/U	Lime Silo #2 Maximum capacity: 250 T/day	Loading – Bin Vent Filter Unloading – None	
ACS1	AC Lime Silo #1 Maximum capacity: 1,000 T/day	Loading – Bin Vent Filter Unloading – None	
ACS2	AC Lime Silo #2 Maximum capacity: 1,000 T/day	Loading – Bin Vent Filter Unloading – None	
ACS3	AC Lime Silo #3 Maximum capacity: 1,000 T/day	Loading – Bin Vent Filter Unloading – None	
ACS4	AC Lime Silo #4 Maximum capacity: 500 T/day	Loading – Bin Vent Filter Unloading – None	

Source ID No.	Source	Control Equipment	Maximum Process Rate
Aggregate Production			
PCSP1	Portable Crushing and Screening Plant 1 Crushers, screens, and conveyors	Reasonable control & FDCP – water sprays and moisture carryover	2,000 T/day (aggregate)
PCSP2	Portable Crushing and Screening Plant 2 Crushers, screens, and conveyors	Reasonable control & FDCP – water sprays and moisture carryover	2,000 T/day (aggregate)
Concrete Production			
CM	Central Mixer Loading Maximum capacity: 120 T/hr	Reasonable control & FDCP – ~~Water sprays and moisture carryover, and~~ Controls may ~~also~~ include water sprays, enclosures, hoods, curtains, shrouds, movable and telescoping chutes, central duct collection systems, etc.	~~80~~ 2,480 T/day and 560,000 T/yr (cement + aggregate)
CS1-L/U	Cement/Shotcrete Silo #1 Maximum capacity: 80 T	Loading – Bin Vent Filter Unloading – None	
CS2-L/U	Cement/Shotcrete Silo #2 Maximum capacity: 80 T	Loading – Bin Vent Filter Unloading – None	
CA-L/U	Aggregate Bin Maximum capacity: 2,400 T	Loading – None Unloading – None	
Heating, Ventilation, and Air Conditioning (HVAC)			
H1M	Mine Air Heater #1 Maximum capacity: 4 MMBtu/hr Fuel: propane	None	n/a
H2M	Mine Air Heater #2 Maximum capacity: 4 MMBtu/hr Fuel: propane	None	n/a
HM	(4) Mill HVAC Heaters #1-4 Maximum capacity: 1.0 MMBtu/hr (each) Fuel: propane	None	n/a
HAC	Autoclave HVAC Heater Maximum capacity: 0.25 MMBtu/hr Fuel: propane	None	n/a
HR	Refinery HVAC Heater Maximum capacity: 0.25 MMBtu/hr Fuel: propane	None	n/a
HA	Admin HVAC Heater Maximum capacity: 0.25 MMBtu/hr Fuel: propane	None	n/a
HMO	(2) Mine Ops. HVAC Heaters Maximum capacity: 0.25 MMBtu/hr (each) Fuel: propane	None	n/a
HTS	(2) Truck Shop HVAC Heaters Maximum capacity: 1.0 MMBtu/hr (each) Fuel: propane	None	n/a
HW	(3) Warehouse HVAC Heaters Maximum capacity: 1.0 MMBtu/hr (each) Fuel: propane	None	n/a

Source ID No.	Source	Control Equipment	Maximum Process Rate
Emergency Power Generation and Fire Suppression			
EDG1	Camp Emergency Generator Date of construction: 2007 or later Maximum capacity: 1,000 bkW Maximum operation: 100 hr/yr (non-emergency) Fuel: ultra-low sulfur diesel (ULSD) Displacement: <10 L/cyl	EPA Tier 2 technologies	1 hr/day and 100 hr/yr
EDG2	Plant Emergency Generator #1 Date of construction: 2007 or later Maximum capacity: 1,000 bkW Maximum operation: 100 hr/yr (non-emergency) Fuel: ULSD Displacement: <10 L/cyl	EPA Tier 2 technologies	1 hr/day and 100 hr/yr
EDG3	Plant Emergency Generator #2 Date of construction: 2007 or later Maximum capacity: 1,000 bkW Maximum operation: 100 hr/yr (non-emergency) Fuel: ULSD Displacement: <10 L/cyl	EPA Tier 2 technologies	1 hr/day and 100 hr/yr
EDFP	Mill Fire Pump Date of construction: 2009 or later Maximum capacity: 200 bkW Maximum operation: 100 hr/yr (non-emergency) Fuel: ULSD Displacement: <10 L/cyl	None	1 hr/day and 100 hr/yr
Fuel Storage			
TG1–TG2	Mine Site Gasoline Tanks (#1 through #2) Maximum capacity: 5,000 gal each	Lids or other appropriate closure with gasketed seal and submerged filling	<100,000 gal/mo
TD3–TD10	Mine Site Diesel Tanks (#3 through #10)	Lids or other appropriate closure	n/a

REC 0740

PET 374

2 Facility-Wide

Fugitive Dust

2.1 All reasonable precautions shall be taken to prevent particulate matter from becoming airborne in accordance with IDAPA 58.01.01.650-651. In determining what is reasonable, consideration will be given to factors such as the proximity of dust-emitting operations to human habitations and/or activities and atmospheric conditions which might affect the movement of PM. Some of the reasonable precautions include, but are not limited to, the following:

- Use, where practical, of water or chemicals for control of dust in the demolition of existing buildings or structures, construction operations, the grading of roads, or the clearing of land.
- Application, where practical, of asphalt, oil, water, or suitable chemicals to, or covering of dirt roads, material stockpiles, and other surfaces which can create dust.
- Installation and use, where practical, of hoods, fans, and fabric filters or equivalent systems to enclose and vent the handling of dusty materials. Adequate containment methods should be employed during sandblasting or other operations.
- Covering, when practical, open-bodied trucks transporting materials likely to give rise to airborne dusts.
- Paving of roadways and their maintenance in a clean condition, where practical.
- Prompt removal of earth or other stored material from streets, where practical.

2.2 The permittee shall monitor and maintain records of the frequency and the methods used (e.g., water, chemical dust suppressants) to reasonably control fugitive dust emissions.

2.3 The permittee shall maintain records of all fugitive dust complaints received. The permittee shall take appropriate corrective action as expeditiously as practicable after receipt of a valid complaint. The records shall include, at a minimum, the date that each complaint was received and a description of the following: the complaint, the permittee's assessment of the validity of the complaint, any corrective action taken, and the date the corrective action was taken.

2.4 The permittee shall conduct a facility-wide inspection of potential sources of fugitive emissions (e.g., stockpiles, transfer points, etc.) identified in the Fugitive Dust Control Plan (FDCP) at least once per ~~shift~~ month during daylight hours and under normal operating conditions to ensure that the methods used to reasonably control fugitive dust emissions are effective. If emissions are not being reasonably controlled, the permittee shall take corrective action as expeditiously as practicable. The permittee shall maintain records of the results of each fugitive dust emissions inspection. The records shall include, at a minimum, the date of each inspection and a description of the following: the permittee's assessment of the conditions existing at the time fugitive emissions were present (if observed), any corrective action taken in response to the fugitive dust emissions, and the date the corrective action was taken.

2.5 The permittee shall develop and maintain a Fugitive Dust Control Plan (FDCP) to ensure compliance with fugitive dust requirements (Permit Conditions 2.1–2.4) and fugitive dust best management practices in accordance with IDAPA 58.01.01.799. IDAPA 58.01.01.799 applies to fugitive dust sources at the limestone crushing plant and aggregate production plant. The permittee shall comply with the FDCP at all times. The requirements specified in the FDCP shall be incorporated by reference to this permit and shall be enforceable permit conditions. At a minimum, the FDCP shall contain a list of all potential sources of fugitive dust emissions, and a list of reasonable precautions to minimize fugitive dust emissions (Permit Condition 2.1), ~~and requirements to~~such as:

- Post and limit the maximum speed of haul trucks ~~to 20 miles per hour or lower if appropriate~~in accordance with the FDCP. Signs shall be posted along the haul route and placed so they are visible to vehicles entering and leaving the site of operations.
- ~~Limit vehicle miles traveled from all haul trucks (combined) to less than 490,000 miles per month.~~
- Apply water or suitable dust suppressant chemicals (e.g., magnesium chloride, calcium chloride) to disturbed areas, haul roads, equipment staging areas, parking areas, and storage piles during the dry season and at other times as necessary to control fugitive dust. Water ~~and~~ or dust suppressant should be applied to a haul road consistent with industry standards and whenever visible fugitive PM emissions are observed leaving a roadway for more than two consecutive minutes.~~a period or periods aggregating more than one minute in any 60-minute period.~~
- Apply water or suitable dust suppressant whenever visible fugitive PM emissions exceed 20% for more than two consecutive minutes from any transfer point, screening operation, or crushing operation identified in the FDCP and at other times as necessary to control fugitive dust. Transfer points include points where material (e.g., ore and rock, lime, aggregate, cement, etc.) is transferred to or from a belt conveyor, conveying system, bucket elevator, screening operation, or stockpile. Controls shall include manual water spray capability or installing, operating, and maintaining water spray bars at transfer points to wet the material for downstream control; moisture carryover. Controls shall also include limiting drop heights in truck loading, front-end loader dumping, and conveying operations to ensure a homogeneous flow of material.
- Apply water or suitable dust suppressant whenever visible fugitive PM emissions from wind erosion of any stockpile exceeds 20% opacity for more than two consecutive minutes~~a period or periods aggregating more than one minute in any 60-minute period~~, and at other times as necessary to control fugitive dust. Water may need to be applied to storage piles before and during truck loading, and when stockpiled ore and waste rock is not processed promptly in order to avoid drying and becoming airborne. Stockpile height should be limited to limit disturbance.
- Apply appropriate dust control at the initial point of material handling~~, such as the mine working face,~~ to suppress dust throughout the material handling process as necessary.
- Apply appropriate dust control whenever visible fugitive PM emissions exceed 20% for more than two consecutive minutes from any grinding mill building vent~~ or capture system stack~~.
- Apply crushed gravel to haul roads, equipment staging areas, and other areas as necessary to limit migration of fine sediment.
- Install wind fences or barriers around, place below grade, or enclose all storage piles, parking areas, and equipment staging areas as necessary to control fugitive dust. This is required for

the Stockpile Transfer to Reclaim Conveyors (OC9), Reclaim Conveyors to Feed Conveyor (OC10), and Feed Transfer to conveyor (OC11).

- Develop specific criteria to determine when and what type of dust suppressant must be applied, and appropriate suppressant application rates. Chemical dust suppressants shall be applied consistent with manufacturer's instructions and recommendations.
- Develop specific criteria to determine when water must be applied, and appropriate water application rates.
- Develop and implement precautionary measures to address high-wind events, such as when average (sustained) wind speed is forecast to exceed 25 miles per hour.
- At least ~~twice~~ once per ~~day~~ month while haul trucks are transporting ore and/or rock, inspect active haul routes for visible fugitive PM emissions using the specified method and procedures (Permit Condition 2.4). ~~Whenever visible fugitive PM emissions are observed leaving a roadway during inspection or valid complaint (Permit Condition 2.3), the adequacy of water and dust suppressant application rates should be evaluated.~~
- ~~At least once per day during operation, monitor and record criteria relied upon to determine water and suppressant application rates and frequency, such as temperature, humidity, and wind speed.~~
-
- , monitor and record the frequency of application and application rates for water and suppressant controls.
- ~~Each month, monitor and record haul truck vehicle miles traveled.~~
- ~~At least once every six months, inspect each water and suppressant spray calibration to ensure adequate coverage and delivery rate and to ensure operation in accordance with manufacturer's recommendations.~~
- Provide training/orientation to all relevant employees regarding FDCP requirements, including the necessity of restricting public access. Visible emissions evaluations shall be conducted by the permittee's ~~own~~ employees who~~m~~ are certified visible emission observers.
- , evaluate FDCP requirements to identify additional requirements and evaluate effectiveness of practices, including dust suppressant application rates, as appropriate.

2.6 The permittee shall develop and maintain an Access Management Plan (AMP) that identifies the facility boundary and all primary and secondary access points, and clearly specifies measures used to discourage public access to the facility. The permittee shall comply with the measures identified in the AMP at all times. The measures specified in the AMP shall be incorporated by reference to this permit and shall be enforceable permit conditions. At a minimum, the AMP shall include requirements to:

- Observe all primary access points to the facility in an effort to discourage public access. Onsite personnel shall be available for this purpose during active mining and mineral processing operations. Public access to the facility may be monitored by the use of security escort vehicles or manned guardhouses, or sufficiently precluded by the use of locked gates, barriers, or equivalent measures. Primary access points include the North and South Security Gates.
- Post warning signs and periodically patrol secondary access points to the facility in an effort to discourage public access. Onsite personnel shall be available for this purpose. Plans shall

be described in the AMP, including identifying the access points monitored, the frequency of patrol, and measures employed to discourage access (e.g., locked gates, barriers, natural features, etc.). Secondary access points include secondary roadways and trails traversing the facility.

2.7 Copies of the FDCP and AMP shall be submitted to DEQ within 60 days of permit issuance at the address provided (Permit Condition 2.25), and shall remain onsite at all times. Any changes to the FDCP or the AMP shall be submitted to DEQ for review and comment within 15 days of the change.

Visible Emission

2.8 The permittee shall not discharge any air pollutant to the atmosphere from any point of emission for a period or periods aggregating more than three minutes in any 60-minute period which is greater than 20% opacity as determined by the test methods and procedures contained in IDAPA 58.01.01.625. These provisions shall not apply when the presence of uncombined water, nitrogen oxides, and/or chlorine gas is the only reason for the failure of the emission to comply with this permit condition.

2.9 The permittee shall conduct a facility-wide inspection of potential point sources of visible emissions; including any stack, vent, or functionally equivalent opening; each ~~shift~~month, during daylight hours and under normal operating conditions. Sources that are monitored using a continuous opacity monitoring system (COMS) are not required to comply with this permit condition. The inspection shall consist of a see/no see evaluation for each potential source of visible emissions. If any visible emissions are present from any point of emission, the permittee shall either:

- Take appropriate corrective action as expeditiously as practicable to eliminate the visible emissions. Within 24 hours of the initial see/no see evaluation and after the corrective action, the permittee shall conduct a see/no see evaluation of the emissions point in question. If the visible emissions are not eliminated, the permittee shall comply with the following; or
- Perform a Method 9 opacity test in accordance with the procedures outlined in IDAPA 58.01.01.625. A minimum of 30 observations shall be recorded when conducting the opacity test. If opacity is greater than 20% for a period or periods aggregating more than three minutes in any 60-minute period, the permittee shall take all necessary corrective action and report the exceedance in the annual compliance certification and in accordance with IDAPA 58.01.01.130-136.

2.10 The permittee shall maintain records of the results of each visible emission inspection and each opacity test when conducted. The records shall include, at a minimum, the date and results of each inspection and test and a description of the following: the permittee's assessment of the conditions existing at the time visible emissions are present (if observed), any corrective action taken in response to the visible emissions, and the date corrective action was taken.

2.11 The permittee shall have a certified opacity reader onsite at all times during operation of any regulated sources (in Table 1.1). The reader shall be certified in using the test methods and procedures of EPA Reference Methods 9 and ~~22~~knowledgeable of Method 22 procedures.

Process Weight

2.12 The permittee shall not emit PM to the atmosphere from any process or process equipment in excess of the amount shown by the equations in IDAPA 58.01.01.700-703.

- The ore processing; ore concentration and refining; lime production; aggregate production; concrete production; and process heating equipment (identified in Table 1.1) are process equipment as defined in IDAPA 58.01.01.006.

Odor

2.13 The permittee shall not allow, suffer, cause, or permit the emission of odorous gases, liquids, or solids into the atmosphere in such quantities as to cause air pollution in accordance with IDAPA 58.01.01.776.01.

2.14 The permittee shall maintain records of all odor complaints received. If the complaint has merit, the permittee shall take appropriate corrective action as expeditiously as practicable. The records shall include, at a minimum, the date that each complaint was received and a description of the following: the complaint, the permittee's assessment of the validity of the complaint, any corrective action taken, and the date the corrective action was taken.

Fuels

2.15 The permittee shall not sell, distribute, use, or make available for use any distillate fuel oil containing more than the following percentages of sulfur, in accordance with IDAPA 58.01.01.725:

- ASTM Grade 1 fuel oil - 0.3% by weight.
- ASTM Grade 2 fuel oil - 0.5% by weight.

2.16 The permittee shall maintain documentation of supplier verification of fuel oil sulfur content on an as-received basis to ensure compliance with fuel specifications (Permit Condition 2.15).

2.17 The maximum ~~combined~~ throughput of gasoline to the Gasoline Tanks (TG1, TG2) shall not exceed 100,000 gallons per month (gal/mo).

2.18 After startup, each month the permittee shall maintain records demonstrating compliance with gasoline throughput limits, by tracking either amounts loaded or amounts dispensed from each Gasoline Tank.

O&M Manual

2.19 Within 60 days after startup of any process equipment (Permit Condition 2.12), the permittee shall develop and maintain an Operation and Maintenance (O&M) manual to ensure compliance with emission limits (Permit Conditions 2.8, 2.12, 4.3, and 0) and the control equipment maintenance and operation general provision (Permit Condition 7.2). The O&M manual shall be a permittee-developed document based upon, but independent from, manufacturer-supplied operating manuals. The permittee shall operate control equipment in accordance with the O&M manual at all times. The requirements in the O&M manual shall be incorporated by reference to this permit and shall be enforceable permit conditions. At a minimum, the O&M manual shall include the following for all (Table 1.1):

- Identify the manufacturer, model, date of manufacture, and maximum capacity (as-built) for each regulated emission source assigned a source ID, and for each control device in the service of ore concentration and refining, lime production, and concrete production (in Table 1.1). For each wet scrubber, carbon filter, baghouse and bin vent filter cartridge control device, a copy of the vendor-supplied performance guarantee shall be included. For each engine, a copy of the EPA tier certification shall be included.
- Establish operating ranges for control equipment, based on manufacturer specifications and conditions measured during performance testing;

- Minimum pressure drop across each wet scrubber
- Minimum recirculation flow rate for each wet scrubber
- Maximum inlet gas stream temperature to each carbon filter
- ~~Minimum~~ Maximum pressure drop across each carbon filter
- Maximum pressure drop across each baghouse
- Minimum coolant flow rate in the mercury retort condenser

- Describe the procedures for proper operation, startup, and shutdown of control equipment, based on manufacturer specifications.
- Describe the schedule and procedures for routine inspection (Permit Condition 2.9), maintenance, repair, and replacement of control equipment.
  - See-no-see visible emissions inspection of each wet scrubber, carbon filter, baghouse, and bin vent shall be conducted at least once per month.
  - , the drum lining of the carbon regeneration kiln shall be visually inspected for structural damage and cracks.
  - The dates, times, and results from each inspection (as required by Permit Condition 2.10), corrective action, maintenance, repair, and replacement of control equipment shall be recorded at least once per month.
  - The replacement dates for each baghouse and bin vent filter cartridge and for each activated carbon filter medium shall be recorded ~~at least once per month~~for each replacement. For cartridges, records shall include the manufacturer and model. For carbon filters, records shall include the manufacturer, type, and form of medium added. Records shall also include any changes in supplier and other relevant information.
  - All carbon filter beds ~~from the mercury retort~~ shall be disposed of in an acceptable manner in compliance with all applicable state rules and federal regulations.
- Describe the schedule and procedures for corrective action that will be taken if visible emissions are present from wet scrubber (WS1, WS2, WS3), carbon filter (CA1, CA2, CA3, CA4), baghouse (BH1, BH2, BH3, BH4, BH5), or bin vent filter (LS, LS1, MillS2, ACS1, ACS2, ACS3, ACS4, CS1, CS2) control equipment at any time. Procedures should include how to determine whether filter cartridges are ruptured or are not appropriately secured in place, and how to determine whether the wet scrubber, condenser, and carbon filters are operating properly.
- Describe each monitoring device and methodology used to measure weights of materials to demonstrate compliance with each material throughput limit (Permit Conditions 3.5–3.8, 4.5–4.10, and 5.4–5.8). Procedures for proper installation, calibration, and maintenance shall be included.

2.20 ~~Copies of the~~ The O&M manual shall be submitted to DEQ within 60 days after initial startup of any ore processing, ore concentration and refining, lime production, or aggregate production emission source regulated by this permit (as identified in Table 1.1) at the address provided (Permit Condition 2.25), and shall remain onsite at all times. Any changes to the O&M manual shall be submitted to DEQ for review and comment within 15 days of the change.

Incorporation of Federal Requirements

2.21 Unless expressly provided otherwise, any reference in this permit to any document identified in IDAPA 58.01.01.107.03 shall constitute the full incorporation into this permit of that document for the purposes of the reference, including any notes and appendices therein. Documents include, but are not limited to:

- Standards of Performance for New Stationary Sources (NSPS) 40 CFR 60, Subpart A – General Provisions.
- NSPS 40 CFR 60, Subpart LL – Standards of Performance for Metallic Mineral Processing Plants. Each crusher (OC7, OC12), conveyor belt transfer point (~~OC1~~OC1–OC6, ~~OC8~~OC8–OC11, OC13), and truck unloading station (OC1) is an affected facility.
- NSPS 40 CFR 60, Subpart OOO – Standards of Performance for Nonmetallic Mineral Processing Plants. Each crusher (LS2, LS4), grinding mill (LSBM~~, OC12~~), screening operation (LS3, LS5, LS11), belt conveyor (LS6–LS10, LS12), and storage bin (LS1) is an affected facility.
- NSPS 40 CFR 60, Subpart IIII – Standards of Performance for Stationary Compression Ignition Internal Combustion Engines. Each emergency generator engine and fire pump (EDG1, EDG2, EDG3, and EDFP) is an affected facility.
- National Emission Standards for Hazardous Air Pollutants for Source Categories (NESHAP) 40 CFR 63, Subpart A – General Provisions.
- NESHAP 40 CFR 63, Subpart EEEEEEE – National Emission Standards for Hazardous Air Pollutants: Gold Mine Ore Processing and Production Area Source Category. The collection of ore pretreatment processes including the autoclave (AC) and the carbon process including the carbon regeneration kiln (CKD), the electrowinning cells and pregnant solution tank (EW), the mercury retort (MR), and the induction melting furnace (MF) are affected facilities.
- NESHAP 40 CFR 63, Subpart ZZZZ – National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines (RICE). Each emergency generator engine and fire pump (EDG1, EDG2, EDG3, and EDFP) is an affected facility.
- NESHAP 40 CFR 63, Subpart CCCCCC – National Emission Standards for Hazardous Air Pollutants for Source Category: Gasoline Dispensing Facilities. Each gasoline fuel storage tank (TG1, TG2) is an affected facility.

2.22 For permit conditions referencing or cited in accordance with any document incorporated by reference (including permit conditions identified as NSPS or NESHAP), should there be any conflict between the requirements of the permit condition and the requirements of the document, the requirements of the document shall govern, including any amendments to that regulation.

2.23 In accordance with IDAPA 58.01.01.313.01.b., 40 CFR 70.3(c)(2), and 40 CFR 63.11640(d), the permittee shall submit a complete application to DEQ at the address provided (Permit Condition 2.25) for an initial Tier I operating permit within 12 months of becoming a Tier I source.

Test Methods

2.24 Except as otherwise specified in this permit and in IDAPA 58.01.01.157.02, when testing is required the following test methods shall be used to measure pollutant emissions.

Table 2.1 Test Methods

Pollutant		Test Method	Additional Requirements
H_2SO_4		EPA Method 8	
PM_{10}		EPA Method 5 and 201A, and 202	PM, including condensable particulate as defined in IDAPA 58.01.01.006~~.~~, with an aerodynamic diameter less than or equal to a nominal 10 micrometers for PM_{10}, and less than or equal to a nominal 2.5 micrometers for $PM_{2.5}$.
Opacity	point	EPA Method 9	For NSPS and NESHAP sources, use IDAPA 58.01.01.625 and Method 9. For other sources, use IDAPA 58.01.01.625 only.
	fugitive	EPA Method 22	Visible fugitive PM.

Notifications

2.25 All requests, reports, applications, submittals, certifications, and other communications required by this permit shall be submitted to:

Air Quality Permit Compliance
Department of Environmental Quality
Boise Regional Office
1445 N. Orchard St.
Boise, Idaho 83706

phone: (208) 373-0550
fax: (208) 373-0287

3 Mining and Ore Processing

3.1 Process Description

Conventional open-pit mining methods including drilling, blasting, excavating, and hauling will be used to extract ore and waste rock, termed development rock (DR). Hydraulic shovels and front-end loaders will be used to load ore and DR into haul trucks. DR will be used for construction, restoration, and backfilling, or hauled to dedicated development rock storage facilities (DRSF). Approximately 340 million tons of DR will be handled over the life of the mine.

The SGP will include three years of pre-mining development and construction activities, followed by an operating mine life of approximately 12 years. Mining will occur in three open pits: Yellow Pine Pit (YPP), Hangar Flats pit (HFP), and West End pit (WEP). Legacy tailings from the Meadow Creek valley (Bradley Tailings [BT]) will also be reclaimed and reprocessed. Surface exploration drilling will occur within the pits and underground within the Scout Prospect decline.

Ore will be hauled to the primary crusher area, where it will be fed directly into the crusher dump pocket or stockpiled. The ore crushing plant will be designed to operate at a maximum rate of 25,000 tons per calendar day (T/day). Approximately 100 million tons of ore will be mined from the three pits over the life of the project.

The metal-recovery process from ore will include conventional crushing and grinding, followed by froth-flotation circuits that will generate separate gold-silver and antimony-silver concentrates. The antimony-silver concentrate will be shipped offsite for refining, whereas additional onsite processing of the gold-silver concentrate will include pressure oxidation, carbon-in-leach circuits, and refining processes to recover gold and minor amounts of silver. The finely ground leftover ore material from the mineral-recovery process, termed tailings, will be neutralized, thickened, and transported via a pipeline to the tailings storage facility (TSF).

3.2 Control Device Descriptions

Table 3.1 Mining and Ore Processing Control Equipment

Emission Sources	Control Devices
Excavating and hauling activities	Chemical suppression and water sprays ~~Control efficiency: 93.3% for PM/PM_{10}~~ (haul roads)
Loader Transfer of Ore to Grizzly	Water sprays and moisture carryover
Grizzly to Apron Feeder	
Apron Feeder to Dribble	
Apron Feeder to Grizzly	
Dribble to Grizzly	
Grizzly to Primary Crusher or Coarse Ore Stockpile Feed	
Primary Crusher	Water sprays and moisture carryover
Coarse Ore Stockpile Feed Transfer to Stockpile	
Stockpile Transfer to Reclaim Conveyors	Below-grade of storage piles ~~Control efficiency: 80% for PM/PM_{10}~~
Reclaim Conveyors to Feed Conveyor	
Feed Transfer to	Enclosure ~~Control efficiency: 80% for PM/PM_{10}~~
Pebble Crusher	Water sprays and moisture carryover
Pebble Discharge to Feed	
(2) Prill Silos #1-2 Maximum capacity: 100 T (each)	None

Operating Limits

3.3 Drilling Limits

The permittee shall drill no more than 1,200 blast holes per day.

3.4 Blasting Limits

The permittee shall complete no more than 2 blasting operations per day.

3.5 Hauling and Excavating Limits

The permittee shall haul no more than 180,000 tons of ore and rock per day.

3.6 Primary Crusher Limit

The permittee shall process ore as the raw material in the primary crusher, and the maximum input to the primary crusher shall not exceed 25,000 T/day.

3.7 Pebble Crusher Limit

The permittee shall process ore as the raw material, and the maximum input to the pebble crusher shall not exceed 27,600 T/day.

3.8 Prill Loading Limit

The permittee shall not load in excess of ~~608 tons per month (T/mo)~~200 T/day nor 9,000 T/yr of prill (ammonium nitrate) to the prill silos.

3.9 Mining and Ore Processing Dust Control

The permittee shall control emissions from mining and ore processing emission sources (Table 3.1) in accordance with the Fugitive Dust Control Plan.

3.10 Ore Processing Equipment Water Sprays

The permittee shall install, maintain, and operate water sprays in accordance with the O&M manual (Permit Condition 2.19) to control PM emissions from each ore processing crusher and conveyor. Water sprays shall operate at all times when this equipment is operated to ensure compliance with Fugitive Dust requirements (Permit Conditions 2.1–2.5).

3.11 ~~Building Enclosures~~

~~The Primary Crusher (OC7) shall be fully enclosed within a building (Primary Crusher Building).~~

~~The Pebble Crusher (OC12) shall be fully enclosed within a building (Pebble Crusher Building).~~

Monitoring and Recordkeeping Requirements

3.12 Drilling Limits Monitoring

The permittee shall monitor and record the number of blast holes drilled per calendar day.

3.13 Blasting Limits Monitoring

The permittee shall monitor and record the number of blasting operations completed each calendar day.

3.14 Hauling and Excavating Limit Monitoring

The permittee shall monitor and record the amount of ore and rock transported on haul trucks each calendar day. The devices and methodologies used to measure weights shall be identified in O&M Manual.

3.15 Primary Crusher Limit Monitoring

The permittee shall monitor and record the tons of ore input to the crusher each calendar day (T/day). The devices and methodologies used to measure weights shall be identified in O&M Manual.

3.16 Pebble Crusher Limit Monitoring

The permittee shall monitor and record the tons of ore input to the pebble crusher each calendar day (T/day). The devices and methodologies used to measure weights shall be identified in O&M Manual.

3.17 Prill Loading Limit Monitoring

The permittee shall monitor and record the amount of prill loaded to the prill silos each calendar day (T/day). Annual material loading shall be determined by summing the monthly loading over the previous consecutive 12-month period. The devices and methodologies used to measure weights shall be identified in O&M Manual.

4 Ore Concentration and Refining

4.1 Process Description

The autoclave is a pressure oxidation (POX) vessel used to ~~extract gold from~~oxidize gold-silver concentrate at elevated temperature and pressure, in the presence of oxygen. Upon exiting the autoclave, the slurry is cooled in flash vessels, neutralized using lime and caustic soda prior to being sent to the vat leaching circuit for gold and silver recovery. ~~The autoclave discharges to flash vessels and a wet scrubber (WS1).~~ A dilute sodium cyanide solution is added to the leach tanks to dissolve the gold and silver from the ore.~~Slurry discharge from the flash vessels processes through basic ferric sulfate (BFS) re-leach tanks to stabilize the solids. The concentrate is then conditioned with lime before cyanide leaching.~~ Leached "pulp" is sent to multistage carbon-in-pulp (CIP) and/or carbon-in-leach (CIL) tanks, where gold is recovered via adsorption onto activated carbon~~carbon filters~~. The autoclave is located in the POX Building and the exhaust from autoclave passes through a wet scrubber (WS1).

~~Carbon filters~~Carbon loaded with gold ~~are~~ is removed and washed with acid, then stripped with a caustic solution. This mineral-bearing solution is sent to the electrowinning cells and pregnant solution tank (EW). The EW cells remove the gold from the solution by plating it onto cathodes consisting of stainless-steel plates with steel wool. The EW cell exhaust passes through a carbon adsorption column (CA2), where ~~any~~ remaining mercury vapor is adsorbed onto sulfur-impregnated activated carbon (SIAC) ~~before being emitted to the atmosphere~~. The stripped ~~carbon filters~~carbon must be periodically regenerated in the carbon regeneration kiln. Exhaust from the carbon regeneration kiln passes through a carbon adsorption bed (CA1), where ~~any~~ mercury is adsorbed onto SIAC ~~before being emitted to the atmosphere~~.

Gold concentrate is loaded into the mercury retort, where it is heated under vacuum to drive off mercury. The mercury retort exhaust passes through a shell-and-tube condenser to cool the exhaust and condense the mercury vapor into a liquid, which is collected by the mercury trap. The exhaust passes through a carbon adsorption column (CA3), where ~~any~~ remaining vapor mercury is adsorbed onto ~~sulfur-impregnated activated carbon (~~SIAC~~) before being emitted to the atmosphere~~.

After retorting, the gold concentrate is transferred to the electric induction melting furnace. Only retorted concentrate is melted in the furnace. The exhaust passes through a carbon adsorption column (CA4), where ~~any~~ remaining mercury vapor is adsorbed onto SIAC ~~before being emitted to the atmosphere~~. The electrowinning cells and pregnant solution tank, carbon regeneration kiln, mercury retort, and induction melting furnace are located in the Refinery Building.

4.2 Control Device Descriptions

Table 4.1 Ore Concentration and Refining Equipment Descriptions

Lime Production Plant Emissions Unit / Processes	Control Devices	Emission Points
Autoclave	Wet Scrubber (WS1) Minimum pressure drop and minimum recirculation flow rate monitoring established in accordance with Subpart EEEEEEE	Autoclave Wet Scrubber Stack
Electrowinning Cells and Pregnant Solution Tank	Shared Carbon Filter (CA2) ~~Minimum~~ Maximum Maximum pressure drop monitoring~~and~~ established in accordance with O&M ~~minimum~~ Maximum inlet gas stream temperature monitoring established in accordance with Subpart EEEEEEE	Electrowinning Cells and Pregnant Solution Tank Shared Carbon Filter Stack
Mercury Retort	Condenser Minimum coolant flow rate monitoring established in accordance with O&M Carbon Filter (CA3) Maximum Maximum pressure drop monitoring established in accordance with O&M Maximum inlet gas stream temperature monitoring established in accordance with Subpart EEEEEEE	Mercury Retort Carbon Filter Stack
Induction Melting Furnace	Baghouse (BH2) Maximum~~Minimum~~ pressure drop monitoring established in accordance with O&M Carbon Filter (CA4) Maximum Maximum pressure drop monitoring established in accordance with O&M Maximum inlet gas stream temperature monitoring established in accordance with Subpart EEEEEEE	Induction Melting Furnace Carbon Filter Stack
Carbon Regeneration Kiln	Wet Scrubber (WS2) Minimum pressure drop and minimum recirculation flow rate monitoring established in accordance with O&M Carbon Filter (CA1) Maximum Maximum pressure drop monitoring established in accordance with O&M Maximum inlet gas stream temperature monitoring established in accordance with Subpart EEEEEEE	Carbon Regeneration Kiln Carbon Filter Stack
Antimony Bagging	Baghouse (BH1) Maximum ~~Minimum~~ pressure drop monitoring established in accordance with O&M	Antimony Bagging Baghouse Stack

Emission Limits

4.3 Ore Concentration and Refining Equipment Emission Limits

Emissions from ore concentration and refining equipment stacks shall not exceed any corresponding emission rate limits (Table 4.2~~Table 4.1~~).

Table 4.2 Ore Concentration and Refining Emissions Limits [a]

Source Description	PM / PM_{10} / $PM_{2.5}$ [b]	NO_x	CO	VOC	SO_2	H_2SO_4
	lb/hr [c]	lb/hr ~~(c)~~	lb/hr ~~(c)~~	lb/hr ~~(c)~~	lb/hr ~~(c)~~	lb/hr [c]
Autoclave (AC)	5.08				0.65	2.03
Carbon regeneration kiln (CKD~~, CKB~~)	~~0.44~~0.42	0.01	0.12	0.11		
Antimony Bagging (Sb2)	0.12					
Electrowinning cells and pregnant solution tank (EW)	0.07					
Mercury retort (MR)	0.01 [d]					
Induction melting furnace (MF)	2.84					

a) In absence of any other credible evidence, compliance is ensured by complying with permit operating, monitoring, and recordkeeping requirements.
b) Particulate matter (PM) including condensable PM as defined in IDAPA 58.01.01.006, with an aerodynamic diameter less than or equal to a nominal 10 micrometers for PM_{10}, and less than or equal to a nominal 2.5 micrometers for $PM_{2.5}$.
c) Pounds per hour, as determined by a test method prescribed by IDAPA 58.01.01.157, EPA reference test method, continuous emission monitoring system (CEMS) data, or DEQ-approved alternative.
d) For this emission limit, compliance may be demonstrated as measurement below detection limits, when addressed as part of a performance test protocol that is approved by DEQ.

Operating Limits

4.4 POX Boiler Operation

Operation of the POX Boiler shall be limited to the autoclave strat-up operation only~~not exceed 1 hour per calendar day and 30 hours per consecutive 12-month period~~.

4.5 Autoclave Input

The permittee shall process ore concentrate as the raw material in the autoclave, and the maximum input to the autoclave shall not exceed 6,960 T/day.

4.6 Mercury Retort Input

The permittee shall process precious metal concentrate as the raw material in the mercury retort, and the maximum input to the mercury retort shall not exceed 1,000 pounds per batch (lb/batch) and 21 T/yr.

Precious metal concentrate includes material loaded with precious metals produced by electrowinning, flotation and gravity separation, and other gold concentration or precipitation processes; and material collected from the wash-down of equipment and surfaces contacted with precious metals that have been concentrated through these concentration methods.

4.7 Induction Melting Furnace Input

The permittee shall process retorted concentrate as the raw material in the induction melting furnace, and the input to the induction melting furnace shall not exceed 1,000 lb/batch, and 21 T/yr. Retorted concentrate includes precious metal concentrate that has been retorted and dust collected from the baghouse and fume hood of the induction melting furnace.

4.8 Carbon Regeneration Kiln Input

The permittee shall process carbon filters as the raw material in the carbon regeneration kiln, and the maximum input to the carbon regeneration kiln shall not exceed 7.2 T/day.

4.9 Electrowinning Cells and Pregnant Solution Tank Throughput

The permittee shall process ~~ore and ore concentrate~~mineral-bearing solution as the raw materials in the electrowinning cells and pregnant solution tank, and the maximum throughput for the electrowinning cells and pregnant solution tank shall not exceed 100 gallons per minute (gpm).

4.10 Antimony Bagging Input

The maximum throughput through the antimony bagging process shall not exceed 108 T/day, or the maximum throughput established during performance testing when addressed as part of a performance test protocol that is approved by DEQ (Permit Condition 4.30).

4.11 Autoclave Wet Scrubber

The permittee shall install, maintain, and operate a wet scrubber (WS1) in accordance with the O&M manual (Permit Condition 2.19) and manufacturer's specifications. All emissions from the autoclave shall be ducted to the wet scrubber at all times to ensure compliance with autoclave emission limits (Table 4.2)~~ and in accordance with IDAPA 58.01.01.210.21~~.

4.12 Electrowinning Cells and Pregnant Solution Tank Shared Carbon Filter

The permittee shall install, maintain, and operate a carbon filter (CA2) in accordance with the O&M manual (Permit Condition 2.19) and consistent with manufacturer's recommendations. All emissions from the electrowinning cells and pregnant solution tank shall be ducted to a carbon filter at all times to ensure compliance with electrowinning cells and pregnant solution tank emission limits (Table 4.2)~~ and in accordance with IDAPA 58.01.01.210.21~~.

4.13 Mercury Retort Condenser and Carbon Filter

The permittee shall install, maintain, and operate a condenser and carbon filter (CA3) in series in accordance with the O&M manual (Permit Condition 2.19) and manufacturer's recommendations. All emissions from the mercury retort (MR) shall be ducted to the condenser and activated carbon filter at all times to ensure compliance with mercury retort emission limits (Table 4.2~~Table 4.1~~) ~~and in accordance with IDAPA 58.01.01.210.21~~.

- The MR shall be fully enclosed in the refinery building.
- The air pressure within the MR shall be maintained lower than the room air pressure such that air flows into the MR at all times when the MR is operating. The MR door shall be kept closed at all times during operation.
- The permittee shall not operate the MR unless the chilled water condenser is operating, carbon filter in place, and the condenser coolant flow rate~~exhaust gas temperature~~ is maintained within the range specified in the O&M manual.
- The condenser and carbon filter shall be maintained and operated in accordance with the O&M manual.
- All liquid mercury captured from the MR shall be stored in closed containers

4.14 Induction Melting Furnace Baghouse and Carbon Filter

The permittee shall install, maintain, and operate a baghouse (BH2) and carbon filter (CA4) in series in accordance with the O&M manual (Permit Condition 2.19) and manufacturer's recommendations. All emissions from the induction melting furnace shall be ducted to the baghouse and carbon filter at all times during operation to ensure compliance with induction melting furnace emission limits (Table 4.2)~~ and in accordance with IDAPA 58.01.01.210.21~~.

4.15 Carbon Regeneration Kiln Wet Scrubber and Carbon Filter

The permittee shall install, maintain, and operate a wet scrubber (WS2) and carbon filter (CA1) in series in accordance with the O&M manual (Permit Condition 2.19) and consistent with manufacturer's recommendations. All emissions from the carbon regeneration kiln shall be ducted to the wet scrubber and a carbon filter at all times to ensure compliance with carbon regeneration kiln drum emission limits (Table 4.2~~Table 4.1~~) ~~and in accordance with IDAPA 58.01.01.210.21~~.

4.16 Antimony Bagging Baghouse

The permittee shall install, maintain, and operate a baghouse (BH1) in accordance with the O&M manual (Permit Condition 2.19) and consistent with manufacturer's recommendations. All emissions from antimony bagging shall be ducted to the baghouse at all times to ensure compliance with antimony bagging emission limits (Table 4.2~~Table 4.1~~) ~~and in accordance with IDAPA 58.01.01.210.21~~.

Monitoring and Recordkeeping

4.17 POX Boiler Operation Monitoring

Each calendar month, the permittee shall monitor and record the operating hours of the POX Boiler, in hours per calendar month and in hours per consecutive 12-month period ~~to demonstrate with the POX Boiler Operation limits~~.

4.18 Autoclave Input Monitoring

Each day, the permittee shall monitor and record the material input to the autoclave in tons per day (T/day) to demonstrate compliance with the autoclave input limit. The devices and methodologies used to measure weights shall be identified in O&M Manual, and the device shall be installed in accordance with the requirements of NESHAP Subpart EEEEEEE.

4.19 Mercury Retort Input Monitoring

Each day, the permittee shall monitor and record the material input to the mercury retort in pounds per day (lb/day) to demonstrate compliance with the daily mercury retort input limit. ~~The devices and methodologies used to measure weights shall be identified in O&M Manual.~~The device and methodologies used to measure weights shall be in accordance with the requirements of NESHAP Subpart EEEEEEE.

Each month, the permittee shall monitor and record the material input to the mercury retort in tons per month (T/mo) and in tons per year (T/yr) to demonstrate compliance with the annual mercury retort input limit. Annual material input shall be determined by summing the monthly input over the previous consecutive 12-month period.

4.20 Induction Melting Furnace Input Monitoring

Each day, the permittee shall monitor and record the material input to the induction melting furnace in lb/day to demonstrate compliance with the daily induction melting furnace input limit. The devices and methodologies used to measure weights shall be identified in O&M Manual.

Each month, the permittee shall monitor and record the material input to the induction melting furnace in T/mo and in T/yr to demonstrate compliance with the annual induction melting furnace input limit. Annual material input shall be determined by summing the monthly input over the previous consecutive 12-month period.

4.21 Carbon Regeneration Kiln Input Monitoring

Each day, the permittee shall monitor and record the material input to the carbon regeneration kiln in tons per day (T/day) to demonstrate compliance with the carbon regeneration kiln input limit. The devices and methodologies used to measure weights shall be identified in O&M Manual.

4.22 Electrowinning Cells and Pregnant Solution Tank Throughput Monitoring

Each day, the permittee shall monitor and record the material throughput in the electrowinning cells and pregnant solution tank in gallons per minute (gpm) to demonstrate compliance with the Electrowinning Cells and Pregnant Solution Tank Throughput limit. The devices and methodologies used to measure weights shall be identified in O&M Manual. ~~The device shall be installed in accordance with the requirements of NESHAP Subpart EEEEEEE.~~

4.23 Antimony Bagging Input Monitoring

Each day, the permittee shall monitor and record the material input to antimony bagging operations in tons per day (T/day) to demonstrate compliance with the antimony bagging input limit. The devices and methodologies used to measure weights shall be identified in O&M Manual.

4.24 Autoclave Wet Scrubber Monitoring

The permittee shall install, calibrate, maintain, and operate a device for monitoring the recirculation flow rate in the autoclave wet scrubber, and the pressure drop across the autoclave wet scrubber.

At least once per shift, the permittee shall monitor and record the recirculation flow rate and the pressure drop across the autoclave wet scrubber to ensure compliance with O&M specifications.

4.25 Electrowinning Cells and Pregnant Solution Tank Shared Carbon Filter Monitoring

The permittee shall install, calibrate, maintain, and operate a device for monitoring the inlet gas stream temperature to the carbon filter, and the maximum pressure drop across the carbon filter.

At least once per shift, the permittee shall monitor and record the inlet gas stream temperature and maximum pressure drop across the carbon filter for the electrowinning cells and pregnant solution tank to ensure compliance with O&M specifications.

4.26 Mercury Retort Condenser and Carbon Filter Monitoring

The permittee shall install, calibrate, maintain, and operate a device for monitoring the coolant flow rate in the condenser, a device for monitoring the inlet gas temperature to the carbon filter, maximum pressure drop across the carbon filter, and a device for monitoring the difference between the pressure inside the MR and the air pressure in the room.

At least once per shift, the permittee shall monitor and record the coolant flow rate to the condenser, and the inlet gas stream temperature and maximum pressure drop across the carbon filter for the mercury retort to ensure compliance with O&M specifications.

4.27 Induction Melting Furnace Baghouse and Carbon Filter Monitoring

The permittee shall install, calibrate, maintain, and operate a device for monitoring the pressure drop across the induction melting furnace baghouse, the inlet gas stream temperature to the carbon filter, and the maximum pressure drop across the carbon filter.

At least once per shift, the permittee shall monitor and record the pressure drop across the induction melting furnace baghouse, and the inlet gas stream temperature and maximum pressure drop across the carbon filter for the induction melting furnace to ensure compliance with O&M specifications.

4.28 Carbon Regeneration Kiln Wet Scrubber and Carbon Filter Monitoring

The permittee shall install, calibrate, maintain, and operate a device for monitoring the recirculation flow rate in the carbon regeneration kiln wet scrubber, ~~and~~ the pressure drop across the carbon regeneration kiln wet scrubber, the inlet gas stream temperature to the carbon filter, and the maximum pressure drop across the carbon filter.

At least once per shift, the permittee shall monitor and record the recirculation flow rate and the pressure drop across the carbon regeneration kiln wet scrubber, and the inlet gas stream temperature and maximum pressure drop across the carbon filter to ensure compliance with O&M specifications.

4.29 Antimony Bagging Baghouse Monitoring

The permittee shall install, calibrate, maintain, and operate a device for monitoring the pressure drop across the antimony bagging baghouse. At least once per shift, the permittee shall monitor and record the pressure drop across the antimony bagging baghouse to ensure compliance with O&M specifications.

Testing

4.30 Ore Concentration and Refining Equipment Performance Tests

Within 180 days after initial startup, performance testing shall be conducted to demonstrate compliance with the following Ore Concentration and Refining Equipment Emission Limits. The permittee shall conduct three separate test runs for each performance test using the appropriate test method (Permit Condition 2.24). The source test shall be conducted under "worst-case normal" conditions as required by IDAPA 58.01.01.157 and the General Provisions of this permit, and the source test report shall contain documentation that the test was conducted under these conditions.

- PM_{10} and H_2SO_4 in lb/hr from the Autoclave Wet Scrubber Stack
- PM_{10} in lb/hr from the Carbon Regeneration Kiln Carbon Filter Stack
- PM_{10} in lb/hr from the Antimony Bagging Baghouse Stack
- PM_{10} in lb/hr from the Electrowinning Cells and Pregnant Solution Tank Shared Carbon Filter Stack
- PM_{10} in lb/hr from the Mercury Retort Carbon Filter Stack

- PM_{10} in lb/hr from the Induction Melting Furnace Carbon Filter Stack

4.31 Ore Concentration and Refining Equipment Performance Tests Monitoring

The permittee shall monitor and record the following during each performance test:

- Material input rates for all ore concentration and refining process equipment (Permit Conditions 4.18, 4.19, 4.20, ~~and~~ 4.21, 4.22, and 4.23) during each test run, in tons.
- Control equipment monitoring relevant to the stack tested (Permit Condition 4.24, 4.25, 4.26, 4.27, 4.28, or 4.29), measured at least once ~~every 15 minutes~~ during each test run.
- The visible emissions observed for the stack tested during each test run, using the methods specified in IDAPA 58.01.01.625 (Permit Condition 2.8).

5 Lime, Aggregate, and Concrete Production

5.1 Process Description

The lime, aggregate, and cement batch plants produce raw materials necessary for mining and ore concentration and refining operations. Lime is used in ~~the lime slaking mill~~ore processing for pH control. Aggregate and cement are used in concrete production, with aggregate also used in road construction.

Lime production consists of a ~~central mix batch~~limestone crushing, screening, and grinding plant and lime storage silos. The ~~central mix batch plant~~limestone grinding process utilizes ~~water sprays and moisture carryover~~a baghouse to reduce emissions during processing. Each storage silo has a bin vent filter used to reduce PM emissions during silo loading.

Aggregate production consists of two portable crushing and screening plants ~~batch plant~~ and aggregate and cement storage silos. Each portable crushing and screening plant utilizes water sprays and moisture carryover to reduce emissions during processing. Each storage silo has a bin vent filter used to reduce PM emissions during silo loading.

Concrete production consists of a central mix batch plant and ~~lime~~ cement storage silos. The central mix batch plant utilizes controls that controls may include water sprays, enclosures, hoods, curtains, shrouds, movable and telescoping chutes, central duct collection systems, etc. to reduce PM emissions during processing. Each storage silo has a bin vent filter used to reduce PM emissions during silo loading.

5.2 Control Device Descriptions

Table 5.1 Lime, Aggregate, and Concrete Production Equipment Descriptions

Lime Production Plant Emissions Unit / Processes	Control Devices	Emission Points
~~Central Mix Loading~~	~~Water sprays and moisture carryover, and may also include enclosures, hoods, curtains, shrouds, movable and telescoping chutes, central duct collection systems, etc.~~	~~Fugitive~~
AC Lime Silo #1, AC Lime Silo #2, AC Lime Silo #3, and AC Lime Silo #4 loading	Bin vent filters	AC Lime Silo #1 Stack, AC Lime Silo #2 Stack, AC Lime Silo #3 Stack, and AC Lime Silo #4 Stack
unloading	None	Fugitive

Aggregate Production Plant Emissions Unit / Processes	Control Devices	
Portable Crushing and Screening Plant 1 Crushers, screens, and conveyors	Water sprays and moisture carryover	Fugitive
Portable Crushing and Screening Plant 2 Crushers, screens, and conveyors	Water sprays and moisture carryover	Fugitive
Concrete Production Plant Emissions Unit / Processes	**Control Devices**	
Central Mix	Controls Controls may include water sprays, enclosures, hoods, curtains, shrouds, movable and telescoping chutes, central duct collection systems, etc.	Fugitive
Aggregate bin loading/unloading	None	~~Aggregate Bin Stack~~Fugitive
Cement/Shotcrete Silo #1 and Silo #2 loading	Bin vent filters	Cement/Shotcrete Silo #1 Stack, and Cement/Shotcrete Silo #2 Stack
unloading	None	Fugitive

Emission Limits

5.3 Lime, Aggregate, and Concrete Production Emission Limits

Emissions from the lime production plant stacks shall not exceed any emission rate limit in the following table.

Table 5.2 Lime, Aggregate, and Concrete Production Plant Emission Limits [a]

Source Description	PM [b] lb/hr [c]	PM_{10} [b] lb/hr [c]	$PM_{2.5}$ [b] lb/hr [c]	NO_x lb/hr [c]	CO lb/hr [c]	VOC lb/hr [c]	SO_2 lb/hr [c]
Lime Production							
Parallel Flow Regenerative Shaft Kiln (LK, LKC)	1.07	1.07	1.07	~~4.61~~4.82	~~4.85~~4.98	~~0.18~~0.19	~~0.37~~0.39
Limestone Ball Mill (LSBM)	1.90	1.60	0.57				
Lime Mill Crusher (LCR)	0.28	0.24	0.09				
~~Lime Mill screens and conveyors (LS2, LS4, LS3, LS5, LS11, LS1, LS6–LS10, LS12)~~	~~3.66~~	~~1.34~~	~~0.20~~				
Mill Lime Silo loading and unloading (LS1, MillS2)	~~0.06~~0.31	~~0.02~~0.15	~~0.01~~0.02				
AC Lime Silo loading and unloading (ACS1, ACS2, ACS3, ACS4)	~~0.12~~0.86	~~0.04~~0.39	~~0.01~~0.06				
Pebble Lime Silo loading (LS-L)	0.01	0.01	0.01				
Pebble Lime Silo unloading (LS-U)	0.001	0.001	0.001				
Crushers, screens, conveyors ~~, silo unloading (LSBM, LCR,~~ LS1– LS12)	~~6.00~~3.81	~~3.22~~1.39	~~0.87~~0.21				
Aggregate Production							
Portable Crushing and Screening Plant 1	0.63	0.23	0.03				
Portable Crushing and Screening Plant 2	0.63	0.23	0.03				
Concrete Production							
Central Mix Plant (CM, CS1, CS2, CA)	2.10	0.94	0.14				

a) In absence of any other credible evidence, compliance is ensured by complying with permit operating, monitoring, and recordkeeping requirements.

b) Particulate matter (PM) including condensable PM as defined in IDAPA 58.01.01.006 , with an aerodynamic diameter less than or equal to a nominal 10 micrometers for PM_{10}, and less than or equal to a nominal 2.5 micrometers for $PM_{2.5}$.

c) ~~Pounds per hour, as determined by a test method prescribed by IDAPA 58.01.01.157, EPA reference test method, continuous emission monitoring system (CEMS) data, or DEQ approved alternative.~~

Operating Requirements

5.4 Primary Crusher Limit

The permittee shall process limestone as the raw material, and the maximum input to the ~~Semi-Autogenous Grinding (SAG) Mill~~ Primary Crusher shall not exceed 1,130 T/day.

5.5 Parallel Flow Regenerative Kiln Limit

The permittee shall process lime~~stone~~ as the raw material in the Parallel Flow Regenerative Kiln. The maximum output from the kiln shall not exceed 169 T/day and 52,377 T/yr.

5.6 Portable Crushing and Screening Plant 1 Input Limit

The permittee shall process aggregate as the raw material, and the maximum input to the Portable Crushing and Screening Plant 1 shall not exceed 2,000 tons per calendar day.

5.7 Portable Crushing and Screening Plant 2 Input Limit

The permittee shall process aggregate as the raw material, and the maximum input to the Portable Crushing and Screening Plant 2 shall not exceed 2,000 tons per calendar day.

5.8 Central Mix Input Limit

The permittee shall process cement and aggregate as the raw materials, and the maximum input to the central mix plant shall not exceed ~~80~~ 2,480 tons per calendar day and 5560,000 tons per 12-month period.

5.9 Lime, Aggregate, and Concrete Production Dust Control

The permittee shall control emissions from lime production, aggregate production, and concrete production emission sources (Table 5.1) in accordance with the Fugitive Dust Control Plan.

5.10 Portable Crushing and Screening Plant Water Sprays

The permittee shall install, maintain, and operate water sprays in accordance with the O&M manual (Permit Condition 2.19) to control PM emissions from each portable crushing and screening plant ~~and from Central Mix loading~~. Water sprays shall operate at all times when this equipment is operated to ensure compliance with Fugitive Dust requirements (Permit Conditions 2.1–2.5)

5.11 ~~Building Enclosures~~

~~The Limestone Ball Mill (LSBM) shall be fully enclosed within a building (Ball Mill Building) and all emissions from the limestone ball mill shall be ducted to the baghouse at all times to ensure compliance with limestone ball mill emission limits (Table 5.2).~~

~~The Lime Mill Crusher (LCR) shall be fully enclosed within a building (Lime Kiln Discharge Crusher Building) and all emissions from the lime mill crusher shall be ducted to the baghouse at all times to ensure compliance with lime mill crusher emission limits (Table 5.2).~~

5.12 Parallel Flow Regenerative Kiln Baghouse

The permittee shall install, operate, and maintain a baghouse system (BH4) in accordance with the O&M manual (Permit Condition 2.19) and consistent with manufacturer's recommendations. All emissions from the parallel flow regenerative kiln shall be ducted to the baghouse at all times to ensure compliance with parallel flow regenerative emission limits.

5.13 Limestone Ball Mill Baghouse

The permittee shall install, operate, and maintain a baghouse system (BH3) in accordance with the O&M manual (Permit Condition 2.19) and consistent with manufacturer's recommendations. All emissions from the limestone ball mill kiln shall be ducted to the baghouse at all times to ensure compliance with parallel flow regenerative emission limits (Table 5.2).

5.14 Lime Mill Crusher Baghouse

The permittee shall install, operate, and maintain a baghouse (BH5) in accordance with the O&M manual (Permit Condition 2.19) and consistent with manufacturer's recommendations.

5.15 Pebble Lime Silo Wet Scrubber

The permittee shall install, operate, and maintain a wet scrubber on the Pebble Lime Silo discharge (LS) in accordance with the O&M manual (Permit Condition 2.19) and consistent with manufacturer's recommendations. All emissions during discharge from the Pebble Lime Silo shall be ducted to the wet scrubber to ensure compliance with pebble lime silo emission limits (Table 5.2).

5.16 Silo Bin Vent Filters

The permittee shall install, operate, and maintain a bin vent filter on each silo (LS1, MillS2, ACS1, ACS2, ACS3, ACS4, LS, CS1, CS2) in accordance with the O&M manual (Permit Condition 2.19) and consistent with manufacturer's recommendations. All emissions during loading of each silo shall be ducted to the corresponding bin vent filter to ensure compliance with corresponding silo emission limits (Table 5.2).

Monitoring and Recordkeeping Requirements

5.17 Primary Crusher Monitoring

Each day, the permittee shall monitor and record the material input to the Primary Crusher in tons per calendar (T/day) to demonstrate compliance with the daily Primary Crusher Limit. The devices and methodologies used to measure weights shall be identified in O&M Manual.

5.18 Parallel Flow Regenerative Kiln Limit Monitoring

Each day, the permittee shall monitor and record the material output from the Parallel Flow Regenerative Kiln in tons per calendar day (T/day) to demonstrate compliance with the daily Parallel Flow Regenerative Kiln Limits. The devices and methodologies used to measure weights shall be identified in O&M Manual.

Each month, the permittee shall calculate and record the material output from the Parallel Flow Regenerative Kiln in tons per calendar month (T/mo) and in tons per consecutive 12-month period (T/yr) to demonstrate compliance with the annual Parallel Flow Regenerative Kiln Limit. Annual material output shall be determined by summing the monthly output over the previous consecutive 12-month period.

5.19 Portable Crushing and Screening Plant 1 Input Limit Monitoring

Each day, the permittee shall monitor and record the material input to the Portable Crushing and Screening Plant 1 plant in tons per calendar day (T/day) to demonstrate compliance with the daily Portable Crushing and Screening Plant 1 Input Limit. The devices and methodologies used to measure weights shall be identified in O&M Manual.

5.20 Portable Crushing and Screening Plant 2 Input Limit Monitoring

Each day, the permittee shall monitor and record the material input to the Portable Crushing and Screening Plant 2 plant in tons per calendar day (T/day) to demonstrate compliance with the daily Portable Crushing and Screening Plant 2 Input Limit. The devices and methodologies used to measure weights shall be identified in O&M Manual.

5.21 Central Mix Input Limit Monitoring

Each day, the permittee shall monitor and record the material input to the Central Mix Plant in tons per calendar day (T/day) to demonstrate compliance with the daily Central Mix Input Limit. The devices and methodologies used to measure weights shall be identified in O&M Manual.

Each month, the permittee shall calculate and record the material input to the central mix plant in tons per calendar month (T/mo) and in tons per consecutive 12-month period (T/yr) to demonstrate compliance with the annual Central Mix Input Limit. Annual material input shall be determined by summing the monthly input over the previous consecutive 12-month period.

5.22 Parallel Flow Regenerative Kiln Baghouse Monitoring

The permittee shall install, calibrate, maintain, and operate a device for monitoring the pressure drop across the parallel flow regenerative kiln baghouse. At least once per shift, the permittee shall monitor and record the pressure drop across the parallel flow regenerative kiln baghouse to demonstrate compliance with O&M specifications.

5.23 Limestone Ball Mill Baghouse Monitoring

The permittee shall install, calibrate, maintain, and operate a device for monitoring the pressure drop across the limestone ball mill baghouse. At least once per shift, the permittee shall monitor and record the pressure drop across the limestone ball mill kiln baghouse to demonstrate compliance with O&M specifications.

5.24 Lime Mill Crusher Baghouse Monitoring

The permittee shall install, calibrate, maintain, and operate a device for monitoring the pressure drop across the lime mill crusher baghouse. At least once per shift, the permittee shall monitor and record the pressure drop across the lime mill crusher kiln baghouse to demonstrate compliance with O&M specifications.

5.25 Pebble Lime Silo Wet Scrubber Monitoring

The permittee shall install, calibrate, maintain, and operate a device for monitoring the recirculation flow rate in the pebble lime silo wet scrubber, and the pressure drop across the pebble lime silo wet scrubber. At least once per shift, the permittee shall monitor and record the recirculation flow rate and the pressure drop across the pebble lime silo wet scrubber to demonstrate compliance with O&M specifications.

6 Engines

6.1 Process Description

Stationary internal combustion engines (ICE) for emergency power generation and fire suppression are essential to ensure safety and uninterrupted essential operations in case of unforeseen power failures or emergency situations. Portable diesel-fired light plant engines provide supplemental lighting as needed; these are not regulated by this permit and will be operated as nonroad engines defined in 40 CFR 1068.30.

6.2 Emergency Generator and Fire Pump Engine Operation

Operation of each emergency generator engine (EDG1, EDG2, EDG3) and each fire pump engine (EDFP) shall not exceed 1 hour per calendar day and 100 hours per consecutive 12-month period for non-emergency purposes.

6.3 Emergency Generator and Fire Pump Engine Operation Monitoring

Each calendar month, the permittee shall monitor and record the non-emergency operating hours of each emergency generator and fire pump engine, in hours per calendar month and in hours per consecutive 12-month period to demonstrate compliance with the emergency generator and fire pump engine operation limit.

6.4 Engines Subject to Regulation Notification

With the exception of the emergency generator and fire pump engines (identified in Table 1.1) and engines used to propel vehicles, notification shall be provided to DEQ if an engine (including any previously operated as a nonroad engine) will be operated onsite at a specific location beyond 12 months, and no longer meets criteria for regulation as a nonroad engine. Notification shall be provided as soon as practicable in advance of exceeding 12 months of operation at a single location and within 30 days after the engine ceases to meet the definition of nonroad engine in 40 CFR 1068.30.

- A nonroad engine may include engines that are portable or transportable, meaning designed to be and capable of being carried or moved from one location to another (e.g., portable light plant engines). Indicia of transportability include, but are not limited to, wheels, skids, carrying handles, dolly, trailer, or platform.
- A portable or transportable internal combustion engine is not a nonroad engine if it remains or will remain at a location for more than 12 consecutive months, or a shorter period of time for an engine located at a seasonal source. A location is any single site at a building, structure, facility, or installation. Any engines (or engine) that replace(s) an engine at a location and is intended to perform the same or similar function as the engine(s) replaced are included in calculating the consecutive time period. Permitting requirements and emission standards may become applicable when an engine becomes a stationary source.

7 General Provisions

General Compliance

7.1 The permittee has a continuing duty to comply with all terms and conditions of this permit. All emissions authorized herein shall be consistent with the terms and conditions of this permit and the "Rules for the Control of Air Pollution in Idaho." The emissions of any pollutant in excess of the limitations specified herein, or noncompliance with any other condition or limitation contained in this permit, shall constitute a violation of this permit, the "Rules for the Control of Air Pollution in Idaho," and the Environmental Protection and Health Act (Idaho Code §39-101, et seq).

[Idaho Code §39-101, et seq.]

7.2 The permittee shall at all times (except as provided in the "Rules for the Control of Air Pollution in Idaho") maintain in good working order and operate as efficiently as practicable all treatment or control facilities or systems installed or used to achieve compliance with the terms and conditions of this permit and other applicable Idaho laws for the control of air pollution.

[IDAPA 58.01.01.211, 5/1/94]

7.3 Nothing in this permit is intended to relieve or exempt the permittee from the responsibility to comply with all applicable local, state, or federal statutes, rules, and regulations.

[IDAPA 58.01.01.212.01, 5/1/94]

Inspection and Entry

7.4 Upon presentation of credentials, the permittee shall allow DEQ or an authorized representative of DEQ to do the following:

- Enter upon the permittee's premises where an emissions source is located, emissions-related activity is conducted, or where records are kept under conditions of this permit;
- Have access to and copy, at reasonable times, any records that are kept under the conditions of this permit;
- Inspect at reasonable times any facilities, equipment (including monitoring and air pollution control equipment), practices, or operations regulated or required under this permit; and
- As authorized by the Idaho Environmental Protection and Health Act, sample or monitor, at reasonable times, substances or parameters for the purpose of determining or ensuring compliance with this permit or applicable requirements.

[Idaho Code §39-108]

Construction and Operation Notification

7.5 This permit shall expire if construction has not begun within two years of its issue date, or if construction is suspended for one year.

[IDAPA 58.01.01.211.02, 5/1/94]

7.6 The permittee shall furnish DEQ written notifications as follows:

- A notification of the date of initiation of construction, within five working days after occurrence; except in the case where pre-permit construction approval has been granted then notification shall be made within five working days after occurrence or within five working days after permit issuance whichever is later;
- A notification of the date of any suspension of construction, if such suspension lasts for one year or more; and

- A notification of the initial date of achieving the maximum production rate, within five working days after occurrence - production rate and date.

[IDAPA 58.01.01.211.01, 5/1/94]

- A notification of the anticipated date of initial start-up of the stationary source or facility not more than sixty days or less than thirty days prior to such date; and
- A notification of the actual date of initial start-up of the stationary source or facility within fifteen days after such date.

[IDAPA 58.01.01.211.03, 5/1/94]

Performance Testing

7.7 If performance testing (air emissions source test) is required by this permit, the permittee shall provide notice of intent to test to DEQ at least 15 days prior to the scheduled test date or shorter time period as approved by DEQ. DEQ may, at its option, have an observer present at any emissions tests conducted on a source. DEQ requests that such testing not be performed on weekends or state holidays.

7.8 All performance testing shall be conducted in accordance with the procedures in IDAPA 58.01.01.157. Without prior DEQ approval, any alternative testing is conducted solely at the permittee's risk. If the permittee fails to obtain prior written approval by DEQ for any testing deviations, DEQ may determine that the testing does not satisfy the testing requirements. Therefore, at least 30 days prior to conducting any performance test, the permittee is encouraged to submit a performance test protocol to DEQ for approval. The written protocol shall include a description of the test method(s) to be used, an explanation of any or unusual circumstances regarding the proposed test, and the proposed test schedule for conducting and reporting the test.

7.9 Within 60 days following the date in which a performance test required by this permit is concluded, the permittee shall submit to DEQ a performance test report. The report shall include a description of the process, identification of the test method(s) used, equipment used, all process operating data collected during the test period, and test results, as well as raw test data and associated documentation, including any approved test protocol.

[IDAPA 58.01.01.157, 4/5/00 and 4/11/15]

Monitoring and Recordkeeping

7.10 The permittee shall maintain sufficient records to ensure compliance with all of the terms and conditions of this permit. Monitoring records shall include, but not be limited to, the following: (a) the date, place, and times of sampling or measurements; (b) the date analyses were performed; (c) the company or entity that performed the analyses; (d) the analytical techniques or methods used; (e) the results of such analyses; and (f) the operating conditions existing at the time of sampling or measurement. All monitoring records and support information shall be retained for a period of at least five years from the date of the monitoring sample, measurement, report, or application. Supporting information includes, but is not limited to, all calibration and maintenance records, all original strip-chart recordings for continuous monitoring instrumentation, and copies of all reports required by this permit. All records required to be maintained by this permit shall be made available in either hard copy or electronic format to DEQ representatives upon request.

[IDAPA 58.01.01.211, 5/1/94]

Excess Emissions

7.11 The permittee shall comply with the procedures and requirements of IDAPA 58.01.01.130–136 for excess emissions due to start-up, shut-down, scheduled maintenance, safety measures, upsets, and breakdowns.

[IDAPA 58.01.01.130–136, 4/5/00]

Certification

7.12 All documents submitted to DEQ—including, but not limited to, records, monitoring data, supporting information, requests for confidential treatment, testing reports, or compliance certification—shall contain a certification by a responsible official. The certification shall state that, based on information and belief formed after reasonable inquiry, the statements and information in the document(s) are true, accurate, and complete.

[IDAPA 58.01.01.123, 5/1/94]

False Statements

7.13 No person shall knowingly make any false statement, representation, or certification in any form, notice, or report required under this permit or any applicable rule or order in force pursuant thereto.

[IDAPA 58.01.01.125, 3/23/98]

Tampering

7.14 No person shall knowingly render inaccurate any monitoring device or method required under this permit or any applicable rule or order in force pursuant thereto.

[IDAPA 58.01.01.126, 3/23/98]

Transferability

7.15 This permit is transferable in accordance with procedures listed in IDAPA 58.01.01.209.06.

[IDAPA 58.01.01.209.06, 4/11/06]

Severability

7.16 The provisions of this permit are severable, and if any provision of this permit to any circumstance is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

[IDAPA 58.01.01.211, 5/1/94]

Statement of Basis

Permit to Construct No. P-2019.0047
Project ID 62288

Midas Gold Idaho, Inc.
Stibnite, Idaho

Facility ID 085-00011

Draft for Facility Review

July 14, 2020
Morrie Lewis
Permit Writer

The purpose of this Statement of Basis is to satisfy the requirements of IDAPA 58.01.01.et seq, Rules for the Control of Air Pollution in Idaho, for issuing air permits.

ACRONYMS, UNITS, AND CHEMICAL NOMENCLATURE....3
FACILITY INFORMATION....5
Description....5
Permitting History....7
Application Scope....7
Application Chronology....7
TECHNICAL ANALYSIS....8
Emissions Units and Control Equipment....8
Emissions Inventories....14
Ambient Air Quality Impact Analyses....23
REGULATORY ANALYSIS....25
Attainment Designation (40 CFR 81.313)....25
Facility Classification....25
Permit to Construct (IDAPA 58.01.01.201)....26
Tier II Operating Permit (IDAPA 58.01.01.401)....26
Particulate Matter – New Equipment Process Weight Limitations (IDAPA 58.01.01.701)....26
Mercury Emission Standard for New or Modified Sources....27
Title V Classification (IDAPA 58.01.01.300, 40 CFR Part 70)....27
PSD Classification (40 CFR 52.21)....27
NSPS Applicability (40 CFR 60)....28
NESHAP Applicability (40 CFR 61)....32
MACT/GACT Applicability (40 CFR 63)....32
Permit Conditions Review....41
PUBLIC REVIEW....45
Public Comment....45
APPENDIX A – EMISSIONS INVENTORIES....46
APPENDIX B – AMBIENT AIR QUALITY IMPACT ANALYSES....47
APPENDIX C – FACILITY DRAFT COMMENTS....48
APPENDIX D – PROCESSING FEE....50
APPENDIX E – ACCESS MANAGEMENT PLAN....51

REC 0771

PET 405

ACRONYMS, UNITS, AND CHEMICAL NOMENCLATURE

AAC	acceptable ambient concentrations
AACC	acceptable ambient concentrations for carcinogens
acfm	actual cubic feet per minute
ANFO	ammonium nitrate/fuel oil
ASTM	American Society for Testing and Materials
bkW	brake kilowatt
BT	Bradley Tailings
Btu	British thermal units
CAA	Clean Air Act
CAM	Compliance Assurance Monitoring
CAS No.	Chemical Abstracts Service registry number
CEMS	continuous emission monitoring systems
cfm	cubic feet per minute
CFR	Code of Federal Regulations
CI	compression ignition
CMS	continuous monitoring systems
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	CO_2 equivalent emissions
COMS	continuous opacity monitoring systems
DEQ	Department of Environmental Quality
DR	development rock
DRSF	development rock storage facilities
dscf	dry standard cubic feet
EF	emission factors
EL	screening emission levels
EPA	U.S. Environmental Protection Agency
FDCP	Fugitive Dust Control Plan
FDRSF	Fiddle Development Rock Storage Facility
GACT	Generally Available Control Technology
gpm	gallons per minute
gr	grains (1 lb = 7,000 grains)
H_2SO_4	Sulfuric Acid gas
HAP	hazardous air pollutants
HFDRSF	Hangar Flats Development Rock Storage Facility
HFP	Hangar Flats Pit
Hg	mercury
hp	horsepower
hr/yr	hours per consecutive 12-calendar-month period
HVAC	heating, ventilation, and air conditioning
ICE	internal combustion engines
IDAPA	a numbering designation for all administrative rules in Idaho promulgated in accordance with the Idaho Administrative Procedures Act
km	kilometers
lb/hr	pounds per hour
lb/qtr	pound per quarter
LMP	lime manufacturing plant
Midas Gold	Midas Gold Idaho, Inc.
MACT	Maximum Achievable Control Technology
MMBtu	million British thermal units
MMscf	million standard cubic feet

NAAQS	National Ambient Air Quality Standard
NESHAP	National Emission Standards for Hazardous Air Pollutants
NF	National Forest System road
NO_2	nitrogen dioxide
NO_x	oxides of nitrogen
NSPS	New Source Performance Standards
NSR	New Source Review
O&M	operation and maintenance
O_2	oxygen
PAH	polycyclic aromatic hydrocarbons
Pb	lead
PM	particulate matter
$PM_{2.5}$	particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers
PM_{10}	particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers
POM	polycyclic organic matter
POX	pressure oxidation
ppm	parts per million
PSD	Prevention of Significant Deterioration
PTC	permit to construct
PTE	potential to emit
PW	process weight rate
RICE	reciprocating internal combustion engines
Rules	*Rules for the Control of Air Pollution in Idaho*
SAG	semi-autogenous grinding
scf	standard cubic feet
SCL	significant contribution limits
SGP	Stibnite Gold Project
SIP	State Implementation Plan
SM	synthetic minor
SM80	synthetic minor facility with emissions greater than or equal to 80% of a major source threshold
SO_2	sulfur dioxide
STKP	crusher stockpile
T/day	tons per calendar day
T/hr	tons per hour
T/yr	tons per consecutive 12-calendar-month period
TAP	toxic air pollutants
TSF	tailings storage facility
ULSD	ultra-low sulfur diesel
U.S.C.	United States Code
VOC	volatile organic compounds
WEDRSF	West End Development Rock Storage Facility
WEP	West End pit
YPDRSF	Yellow Pine Development Rock Storage Facility
YPP	Yellow Pine Pit
$\mu g/m^3$	micrograms per cubic meter

REC 0773

PET 407

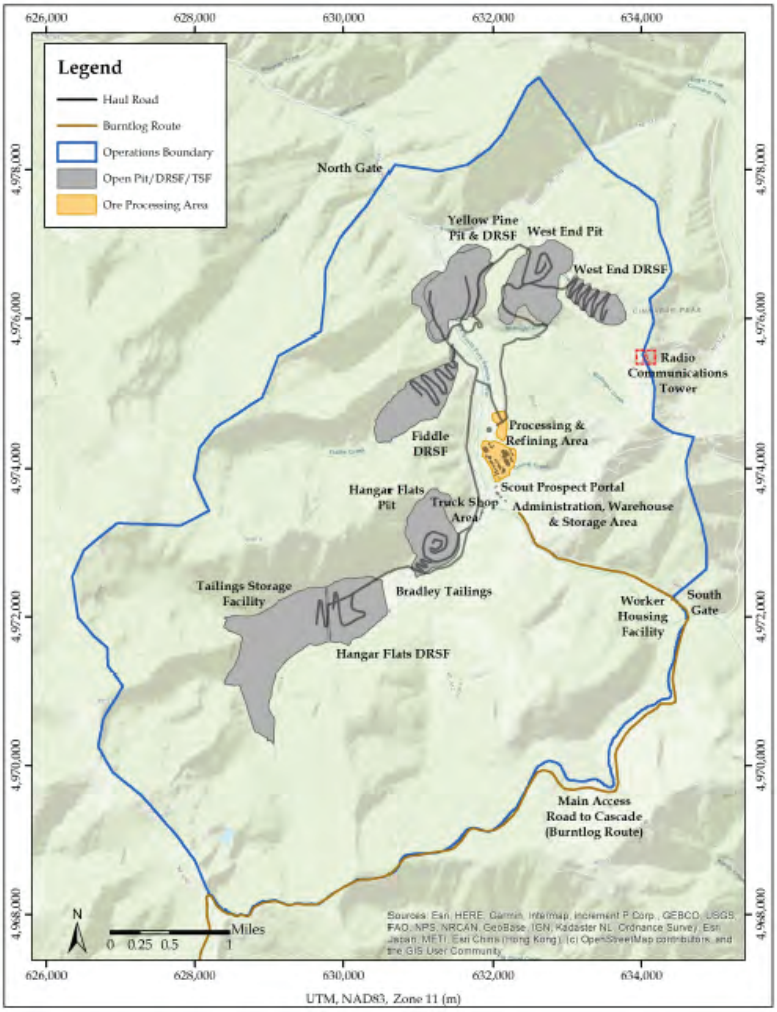
FACILITY INFORMATION

Description

Midas Gold Idaho, Inc. (Midas Gold) proposes to construct and operate the Stibnite Gold Project (SGP), consisting of conventional open-pit mining, ore preparation, and gold extraction operations.

SGP is to be located in Valley County at the intersection Forest Service roads NF-374 and NF-412 (Stibnite Road), approximately 10 miles east of Yellow Pine. The proposed Burntlog Route access road will provide year-round access to the site. The project comprises a combination of public national forest and private lands. The mining operations boundary within which public access will be excluded is defined in Figure 1. This operations boundary also defines the ambient air boundary used in all ambient air quality impact analyses.

Figure 1 PROJECT AREA OF OPERATIONS

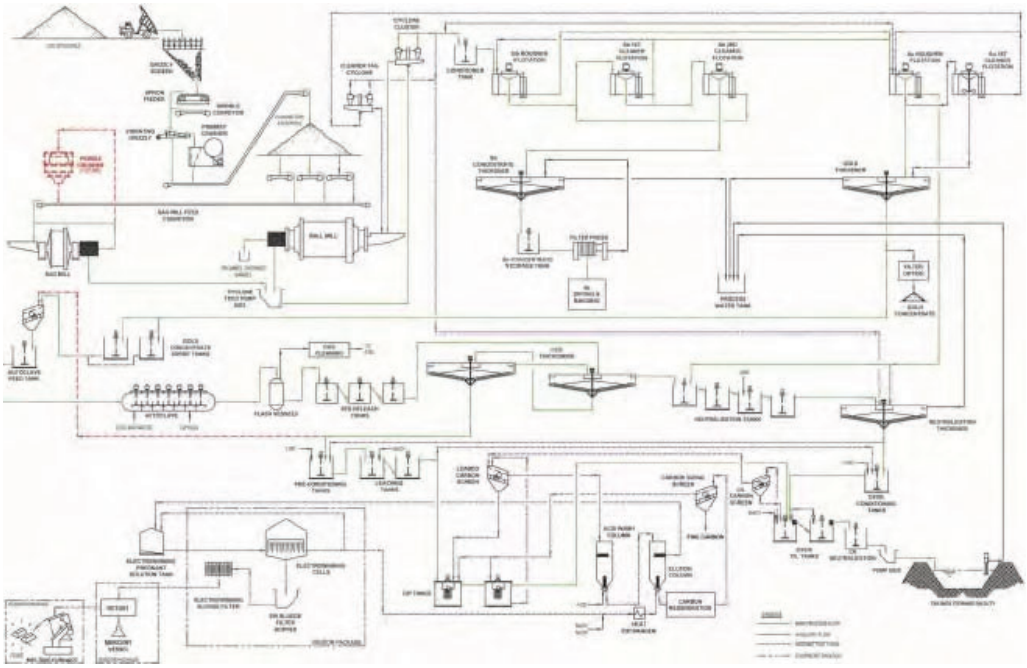


SGP will require the construction of significant infrastructure, including a power transmission line, a primary mine site access road, onsite haul roads, an ore processing facility, onsite workspaces, employee housing and recreation, water storage and distribution facilities, and sewage disposal facilities.

Conventional open-pit mining methods including drilling, blasting, excavating, and hauling will be used to extract ore and waste rock, termed development rock (DR). Hydraulic shovels and front-end loaders will be used to load ore and DR into haul trucks. DR will be used for construction, restoration, and backfilling, or hauled to the dedicated development rock storage facilities (DRSF). Approximately 340 million tons of DR will be handled over the life of the mine.

The SGP will include three years of pre-mining development and construction activities, followed by an operating mine life of approximately 12 years. Mining will occur in three open pits: Yellow Pine Pit (YPP), Hangar Flats pit (HFP), and West End pit (WEP). Although there will be overlap in mine development construction and operations, the general sequence of mining will be the YPP deposit, followed by the HFP and WEP deposits. Legacy tailings from the Meadow Creek valley (Bradley Tailings [BT]) will also be reclaimed and reprocessed during the initial project schedule. Surface exploration drilling will occur within the pits and within the Scout Prospect decline (underground exploration) throughout the mine operation period. Restoration and reclamation of other legacy mining features will occur prior to mining, throughout the life of the mine, and as part of the mine closure.

Figure 2 DIAGRAM OF PROCESS FLOWS



Ore will be hauled to the primary crusher area, where it will be fed directly into the crusher dump pocket or stockpiled. The ore crushing plant will be designed to operate at a maximum rate of 25,000 tons per calendar day (T/day). Approximately 100 million tons of ore will be mined from the three pits over the life of the project. The metal-recovery process from ore will include conventional crushing and grinding, followed by froth-flotation circuits that will generate separate gold-silver and antimony-silver concentrates. The antimony-silver concentrate will be shipped offsite for refining, whereas additional onsite processing of the gold-silver concentrate will include pressure oxidation, carbon-in-leach circuits, and refining processes to recover gold and minor amounts of silver. The finely ground leftover ore material from the mineral-recovery process, termed tailings, will be neutralized, thickened, and transported via a pipeline to the tailings storage facility (TSF). A diagram of ore processing and ore concentration and refining process flows is provided in Figure 2.

Permitting History

This is the initial PTC for a new facility, thus there is no permitting history.

Application Scope

This permit is the initial PTC for this facility.

The applicant has proposed to conduct mining operations and to install and operate ore processing, ore concentration and refining, and ancillary equipment:

- Drilling, blasting, excavating, and hauling operations;
- Ore processing operations (OC1–OC13, PS);
- Ore concentration and refining operations (AC, EW, MR, MF, CKD, Sb2);
- Process heating (Sb1, ACB, CKB, PV, HS, LKC);
- Lime production operations (LS1–LS12, LSBM, LS-L/U, LK, LCR, LS1-L/U, MillS2-L/U, ACS1–ACS4);
- Aggregate production operations (PCSP1, PCSP2);
- Concrete production operations (CM; CS1–CS2-L/U, CA-L/U);
- Heating, Ventilation, and Air Conditioning heaters (H1M–H2M, HM, HAC, HR, HA, HMO, HTS, HW);
- Emergency generator engines (EDG1–EDG3, EDFP); and
- Fuel storage (TG1–TG2, TD3—TD10).

Application Chronology

August 20, 2019	DEQ received an application and an application fee.
August 29 – September 13, 2019	DEQ provided an opportunity to request a public comment period on the application and proposed permitting action.
September 19, 2019	DEQ determined that the application was incomplete.
October 4, 2019	DEQ received a preliminary response and supplemental information from the applicant, including a request to delegate authority of responsible official.
October 9, 2019	DEQ approved the request to delegate authority of responsible official.
October 15, 2019	DEQ met with the applicant to review and discuss the preliminary response.
October 22, 2019	DEQ determined that the application remained incomplete while the applicant prepared a response to remaining items previously identified

	(9/19/19), and included a summary of recommendations provided at the meeting (10/15/19).
November 8, 2019	DEQ requested additional information from the applicant via email, relating to items previously identified (9/19/19).
November 27, 2019	DEQ received supplemental information from the applicant, including a revised application with updated emission inventories and modeling analyses.
December 24, 2019	DEQ determined that the application was incomplete.
February 5, 2020	DEQ received supplemental information from the applicant, including a revised application with updated emission inventories and modeling analyses.
March 6, 2019	DEQ determined that the application was incomplete.
April 15, 2020	DEQ received supplemental information from the applicant, including updated modeling analyses.
May 15, 2020	DEQ determined that the application was complete.
July 6, 2020	DEQ made available the draft permit and statement of basis for peer and regional office review.
July 14, 2020	DEQ made available the draft permit and statement of basis for applicant review.
Month XX – Month XX, 2020	DEQ provided a public comment period on the proposed action.
Month XX, 2020	DEQ received the permit processing fee.
DRAFT	DEQ issued the final permit and statement of basis.

TECHNICAL ANALYSIS

Emissions Units and Control Equipment

Table 1 EMISSIONS UNIT AND CONTROL EQUIPMENT INFORMATION

Information presented in Table 1 is for information purposes only and is unenforceable unless included in another permit condition.

Comment [A1]: Please update as per comments provided on the draft PTC.

Source ID No.	Source	Control Equipment	Maximum Process Rate
Mining			
	Drilling activities	Reasonable control and Fugitive Dust Control Plan (FDCP)	1,200 holes/day
	Blasting activities	Reasonable control & FDCP	2 blasts/day
	Excavating and hauling activities	Reasonable control & FDCP – Chemical suppression and water sprays Control efficiency: 93.3% for PM/PM_{10} (haul roads)	180,000 T/day and 490,000 mi/mo (combined mileage of all haul trucks)
Ore Processing			
OC1	Conveyor – Loader Transfer of Ore to Grizzly	Reasonable control & FDCP – Water sprays and moisture carryover	25,000 T/day
OC2	Conveyor – Grizzly to Apron Feeder		
OC3	Conveyor – Apron Feeder to Dribble		
OC4	Conveyor – Apron Feeder to Grizzly		
OC5	Conveyor – Dribble to Grizzly		
OC6	Conveyor – Grizzly to Primary Crusher or Coarse Ore Stockpile Feed		
OC7	Primary Crusher	Reasonable control & FDCP – Water sprays and moisture carryover	
OC8	Conveyor – Coarse Ore Stockpile Feed Transfer to Stockpile		
OC9	Conveyor – Stockpile Transfer to Reclaim Conveyors	Reasonable control & FDCP – Below-grade storage piles Control efficiency: 80% for PM/PM_{10}	27,600 T/day
OC10	Conveyor – Reclaim Conveyors to SAG Mill Feed Conveyor		
OC11	Conveyor – SAG Mill Feed Transfer to SAG Mill	Reasonable control & FDCP – Enclosure Control efficiency: 80% for PM/PM_{10}	
OC12	Pebble Crusher	Reasonable control & FDCP – Water sprays and moisture carryover	
OC13	Conveyor – Pebble Discharge to SAG Mill Feed		
PS	(2) Prill Silos #1-2 Maximum capacity: 100 T (each)	Loading – None Unloading – None	608 T/month (combined)
Ore Concentration and Refining			
AC	Autoclave (AC)	Wet Scrubber (WS1)	6,960 T/day, and as limited by Subpart EEEEEEE
EW	Electrowinning Cells and Pregnant Solution Tank	Shared Carbon Filter (CA2) Type: sulfur-impregnated activated carbon Form: granulated	100 gpm, and as limited by Subpart EEEEEEE
MR	Mercury Retort	Condenser Carbon Filter (CA3) Type: sulfur-impregnated activated carbon Form: granulated	1,000 lb/batch and 21 T/yr
MF	Induction Melting Furnace	Baghouse (BH2) Carbon Filter (CA4) Type: sulfur-impregnated activated carbon Form: granulated	
CKD	Carbon Regeneration Kiln (Drum)	Wet Scrubber (WS2) Carbon Filter (CA1) Type: sulfur-impregnated activated carbon Form: granulated	7.2 T/day
Sb2	Antimony Bagging	Baghouse (BH1)	108 T/day, or as limited by source testing

Source ID No.	Source	Control Equipment	Maximum Process Rate
Lime Production			
LS1	Conveyor – Limestone to Primary Crusher Hopper	None	1,130 T/day
LS2	SAG Mill Primary Crusher Maximum capacity: 1,130 T/day	None	
LS3	Primary Screen	None	
LS4	SAG Mill Secondary Crusher	None	
LS5	Secondary Screen	None	
LS6	Conveyor – Limestone to Ball Mill Feed Bin	None	
LSBM	Limestone Ball Mill	Baghouse (BH3)	
LS7	Conveyor – Limestone to Ball Mill Feed	None	
LS8	Conveyor – Ball Mill Feed to Ball Mill	None	
LS9	Conveyor – Limestone to Kiln Feed Bin	None	267 T/day
LS10	Conveyor – Limestone to Lime Kiln Feed	None	
LS11	Fines Screen	None	
LS12	Conveyor – Kiln Feed to PFR Shaft Lime Kiln	None	
LS-L/U	Bucket Elevator – Pebble Lime Silo Loading	Loading – Bin Vent Filter	169 T/day and 52,377 T/yr
	Pebble Lime Silo discharge to Lime Slaker	Unloading – Wet Scrubber (WS3)	
LK	Parallel Flow Regenerative Shaft Kiln	Baghouse (BH4)	
LCR	Lime Mill Crusher	Baghouse (BH5)	
LS1-L/U	SAG Mill Lime Silo #1 Maximum capacity: 250 T	Loading – Bin Vent Filter Unloading – None	
MillS2-L/U	SAG Mill Lime Silo #2 Maximum capacity: 250 T	Loading – Bin Vent Filter Unloading – None	
ACS1	AC Lime Silo #1 Maximum capacity: 1,000 T	Loading – Bin Vent Filter Unloading – None	
ACS2	AC Lime Silo #2 Maximum capacity: 1,000 T	Loading – Bin Vent Filter Unloading – None	
ACS3	AC Lime Silo #3 Maximum capacity: 1,000 T	Loading – Bin Vent Filter Unloading – None	
ACS4	AC Lime Silo #4 Maximum capacity: 500 T	Loading – Bin Vent Filter Unloading – None	

Source ID No.	Source	Control Equipment	Maximum Process Rate
Aggregate Production			
PCSP1	Portable Crushing and Screening Plant 1 Crushers, screens, and conveyors	Reasonable control & FDCP – water sprays and moisture carryover	2,000 T/day (aggregate)
PCSP2	Portable Crushing and Screening Plant 2 Crushers, screens, and conveyors	Reasonable control & FDCP – water sprays and moisture carryover	2,000 T/day (aggregate)
Concrete Production			
CM	Central Mixer Loading Maximum capacity: 20 T/hr	Reasonable control & FDCP – Water sprays and moisture carryover, and may also include enclosures, hoods, curtains, shrouds, movable and telescoping chutes, central duct collection systems, etc.	80 T/day and 60,000 T/yr (cement + aggregate)
CS1-L/U	Cement/Shotcrete Silo #1 Maximum capacity: 80 T	Loading – Bin Vent Filter Unloading – None	
CS2-L/U	Cement/Shotcrete Silo #2 Maximum capacity: 80 T	Loading – Bin Vent Filter Unloading – None	
CA-L/U	Aggregate Bin Maximum capacity: 2,400 T	Loading – None Unloading – None	
Process Heating			
Sb1	Sb Dryer Maximum capacity: 2.72 MMBtu/hr Fuel: propane	None	not applicable (n/a)
ACB	POX Boiler Maximum capacity: 17 MMBtu/hr Fuel: propane	None	1 hr/day and 30 hr/yr
CKB	Carbon Regeneration Kiln (Burners) Maximum capacity: 2.255 MMBtu/hr Fuel: propane	None	n/a
PV	Propane Vaporizer Maximum capacity: 0.1 MMBtu/hr Fuel: propane	None	n/a
HS	Strip Circuit Solution Heater Maximum capacity: 5 MMBtu/hr Fuel: propane	None	n/a
LKC	PFR Shaft Lime Kiln Combustion Maximum capacity: 20.5 MMBtu/hr (each) Fuel: propane	None	n/a

Source ID No.	Source	Control Equipment	Maximum Process Rate
Heating, Ventilation, and Air Conditioning (HVAC)			
H1M	Mine Air Heater #1 Maximum capacity: 4 MMBtu/hr Fuel: propane	None	n/a
H2M	Mine Air Heater #2 Maximum capacity: 4 MMBtu/hr Fuel: propane	None	n/a
HM	(4) Mill HVAC Heaters #1-4 Maximum capacity: 1.0 MMBtu/hr (each) Fuel: propane	None	n/a
HAC	Autoclave HVAC Heater Maximum capacity: 0.25 MMBtu/hr Fuel: propane	None	n/a
HR	Refinery HVAC Heater Maximum capacity: 0.25 MMBtu/hr Fuel: propane	None	n/a
HA	Admin HVAC Heater Maximum capacity: 0.25 MMBtu/hr Fuel: propane	None	n/a
HMO	(2) Mine Ops. HVAC Heaters Maximum capacity: 0.25 MMBtu/hr (each) Fuel: propane	None	n/a
HTS	(2) Truck Shop HVAC Heaters Maximum capacity: 1.0 MMBtu/hr (each) Fuel: propane	None	n/a
HW	(3) Warehouse HVAC Heaters Maximum capacity: 1.0 MMBtu/hr (each) Fuel: propane	None	n/a

Source ID No.	Source	Control Equipment	Maximum Process Rate
Emergency Power Generation and Fire Suppression			
EDG1	Camp Emergency Generator Date of construction: 2007 or later Maximum capacity: 1,000 bkW Maximum operation: 100 hr/yr (non-emergency) Fuel: ultra-low sulfur diesel (ULSD) Displacement: <10 L/cyl	EPA Tier 2 technologies	1 hr/day and 100 hr/yr
EDG2	Plant Emergency Generator #1 Date of construction: 2007 or later Maximum capacity: 1,000 bkW Maximum operation: 100 hr/yr (non-emergency) Fuel: ULSD Displacement: <10 L/cyl	EPA Tier 2 technologies	1 hr/day and 100 hr/yr
EDG3	Plant Emergency Generator #2 Date of construction: 2007 or later Maximum capacity: 1,000 bkW Maximum operation: 100 hr/yr (non-emergency) Fuel: ULSD Displacement: <10 L/cyl	EPA Tier 2 technologies	1 hr/day and 100 hr/yr
EDFP	Mill Fire Pump Date of construction: 2009 or later Maximum capacity: 200 bkW Maximum operation: 100 hr/yr Fuel: ULSD Displacement: <10 L/cyl	None	1 hr/day and 100 hr/yr
Fuel Storage			
TG1–TG2	Mine Site Gasoline Tanks (#1 through #2) Maximum capacity: 5,000 gal each	Lids or other appropriate closure with gasketed seal and submerged filling	<100,000 gal/mo
TD3–TD10	Mine Site Diesel Tanks (#3 through #10)	Lids or other appropriate closure	n/a

REC 0782

PET 416

Emissions Inventories

Potential to Emit

IDAPA 58.01.01 defines Potential to Emit (PTE) as the maximum capacity of a facility or stationary source to emit an air pollutant under its physical and operational design. Any physical or operational limitation on the capacity of the facility or source to emit an air pollutant, including air pollution control equipment and restrictions on hours of operation or on the type or amount of material combusted, stored or processed, shall be treated as part of its design if the limitation or the effect it would have on emissions is state or federally enforceable. Secondary emissions did not count in determining the PTE of a facility or stationary source.

Using this definition of PTE, an emissions inventory was developed for the SGP (see Appendix A). Emissions estimates of criteria pollutant and hazardous air pollutant (HAP) PTE were based on project-specific activity rates (e.g., continuous operation with the exception of the POX Boiler and emergency generator engines, design production rates, material haul rates, blasting agent usage rates, etc.), process design (e.g., open-pit mining, electrowinning cells and pregnant solution tank plating, parallel flow regenerative lime production, central mix concrete production, haul fleet, etc.), emission abatement techniques (e.g., dust suppressant, carbon filter, wet scrubber, baghouse, and bin vent filtration control equipment), material characteristics (e.g., moisture content, road silt content, haul route distances, etc.), site conditions (onsite meteorological data, precipitation, etc.), and emission factors based on AP-42,[1] representative source test emissions data, and representative emission limits. Estimated emissions from the autoclave and the carbon regeneration kiln relied on emissions data from representative source test emissions data, scaled to the proposed equipment capacity. Estimated emissions from fuel storage tanks relied on TANKS[2] emission estimation software and projected annual gasoline and ULSD usage rates. Estimated emissions from the emergency generator engines relied on the use of certified engine emission factors.

Uncontrolled PTE

Using the definition of PTE, uncontrolled PTE is then defined as the maximum capacity of a facility or stationary source to emit an air pollutant under its physical and operational design. Any physical or operational limitation on the capacity of the facility or source to emit an air pollutant, including air pollution control equipment and restrictions on hours of operation or on the type or amount of material combusted, stored or processed, shall **not** be treated as part of its design **since** the limitation or the effect it would have on emissions **is not** state or federally enforceable.

The uncontrolled PTE is used to determine if a facility is a "synthetic minor" source of emissions. Synthetic minor sources are facilities that have an uncontrolled PTE for regulated air pollutants or HAP above an applicable major source threshold without permit limits. Based on the uncontrolled PTE shown in Table 2 below and the emissions inventory in Appendix A, Midas Gold will be a "synthetic minor" source of PM, PM_{10}, and $PM_{2.5}$ emissions for new source review and Title V permitting purposes. The uncontrolled PTE for other criteria pollutants and for HAP emissions confirm Midas Gold will be a natural minor source of these emissions.

[1] Compilation of Air Pollutant Emission Factors, AP-42, Volume I, Fifth Edition (AP-42), Section 1.3 –Fuel Oil Combustion, 1.4 –Natural Gas Combustion, 1.5 – LPG Combustion, 3.2 – Natural Gas-Fired Reciprocating Engines, 3.3 – Gasoline and Diesel Industrial Engines, 3.4 – Large Stationary Diesel and All Stationary Dual-Fuel Engines, 8.3 – Ammonium Nitrate, 11.9 – Western Surface Coal Mining, 11.12 – Concrete Batching, 11.17 – Lime Manufacturing, 11.19 – Construction and Aggregate Processing, 13.2 – Fugitive Dust Sources, and 13.3 – Explosives Detonation, Office of Air Quality Planning and Standards Office of Air and Radiation (OAQPS), EPA, updated as of August 2011.

[2] TANKS Storage Tank Emissions Calculation Software Version 4.09D, OAQPS, EPA, released October 5, 2006.

For Midas Gold, uncontrolled PTE was based upon a worst-case for operation of the facility of continuous operation at proposed maximum material throughput and fuel input rates (Table 1), without consideration of control equipment. For batch operations, the number of operations necessary to achieve the proposed daily throughput rates was assumed in estimating emissions (~~LS-L/U, EW,~~ MR, MF~~, CKD, MF, Sb2, ACB, CM~~). Silo loading and unloading operations were assumed to occur at most once per day (LS1-L/U, MillS2-L/U, LS1-L/U, Mill2S-L/U, LS-L/U, PS-L/U, ACS1–ACS4-L/U, PS-L/U, CS1–CS2-L/U, CA-L/U). Fuel storage was based on estimated facility-wide fuel usage rates (TG1, TG2 and TD3-TD10). For the purposes of maintenance and testing, emergency power generation operations were assumed to occur 1 hour per day and 100 hours per year (EDG1–EDG3, EDFP). With the exception of the POX Boiler operated at 1 hour per day of simultaneous operation with the autoclave ~~(at full boiler and autoclave capacity) and 30 hours per year, continuous operation at~~ maximum fuel input rates was assumed for all process heating and HVAC equipment.

Comment [A2]: Please see related comments provided on the draft PTC.

The following table presents the uncontrolled PTE for regulated air pollutants as submitted by the applicant and verified by DEQ staff. See Appendix A for a detailed presentation of the calculations and the assumptions used to determine emissions for each source.

Table 2 UNCONTROLLED POTENTIAL TO EMIT FOR REGULATED AIR POLLUTANTS

Source	PM	PM_{10}	$PM_{2.5}$	CO	NO_x	VOC	SO_2
	T/yr[(a)]	T/yr[(a)]	T/yr[(a)]	T/yr[(a)]	T/yr[(a)]	T/yr[(a)]	T/yr[(a)]
OC1	13.69	5.02	0.78				
OC2	13.69	5.02	0.78				
OC3	13.69	5.02	0.78				
OC4	13.69	5.02	0.78				
OC5	13.69	5.02	0.78				
OC6	13.69	5.02	0.78				
OC7	24.64	10.95	1.64				
OC8	13.69	5.02	0.78				
OC9	15.11	5.54	0.86				
OC10	15.11	5.54	0.86				
OC11	15.11	5.54	0.86				
OC12	27.20	12.09	1.81				
OC13	15.11	5.54	0.86				
PS-L~~/U~~	0.07	0.03	0.004				
PS-U	0.07	0.03	0.004				
AC	74.10	74.10	74.10				2.86
MF	1.77	1.77	1.77				
CKD (EW, MR)	6.13	6.13	6.13	0.53	0.05	0.48	
Sb2	5.16	5.16	5.16				
LS1	0.48	0.17	0.03				
LS2	0.86	0.38	0.06				
LS3	3.97	1.38	0.21				
LS4	0.86	0.38	0.06				
LS5	3.97	1.38	0.21				
LS6	0.48	0.17	0.03				
LSBM	64.22	53.89	19.23				
LS7	0.48	0.17	0.03				
LS8	0.48	0.17	0.03				
LS9	0.12	0.05	0.007				
LS10	0.12	0.05	0.007				
LS11	1.03	0.36	0.05				
LS12	0.12	0.05	0.007				
LS-L	0.23	0.23	0.23				
LS-U	0.02	0.02	0.02				
LK	34.05	34.05	34.05	11.78	6.29		0.03
LCR	10.58	8.88	3.17				
LS1-L	1.60	1.03	0.16				
LS1-U	0.01	0.006	0.001				
MillS2-L	1.60	1.03	0.16				
MillS2-U	0.01	0.006	0.001				
ACS1-L	6.39	4.11	0.62				

Source	PM	PM_{10}	$PM_{2.5}$	CO	NO_x	VOC	SO_2
	T/yr[(a)]	T/yr[(a)]	T/yr[(a)]	T/yr[(a)]	T/yr[(a)]	T/yr[(a)]	T/yr[(a)]
ACS1-U	0.04	0.02	0.004				
ACS2-L	6.39	4.11	0.62				
ACS2-U	0.04	0.02	0.004				
ACS3-L	6.39	4.11	0.62				
ACS3-U	0.04	0.02	0.004				
ACS4-L	3.19	2.06	0.31				
ACS4-U	0.02	0.01	0.002				
PCSP1	27.67	10.11	1.54				
PCSP2	27.67	10.11	1.54				
CM	17.16	4.68	0.71				
CS1-L	21.90	14.10	2.14				
CS1-U	0.14	0.08	0.01				
CS2-L	21.90	14.10	2.14				
CS2-U	0.14	0.08	0.01				
CA-L	1.73	0.83	0.13				
CA-U	1.73	0.83	0.13				
Sb1	0.09	0.09	0.09	0.98	1.69	0.10	0.21
ACB	0.002	0.002	0.002	0.02	0.04	0.002	0.004
CKB	0.08	0.08	0.08	0.81	1.40	0.09	0.17
PV	0.003	0.003	0.003	0.04	0.06	0.004	0.008
HS	0.17	0.17	0.17	1.80	3.11	0.19	0.38
LKC	0.63	0.63	0.63	6.72	11.65	0.72	1.42
H1M	0.13	0.13	0.13	1.44	2.49	0.15	0.30
H2M	0.13	0.13	0.13	1.44	2.49	0.15	0.30
HM	0.13	0.13	0.13	1.44	2.49	0.15	0.30
HAC	0.008	0.008	0.008	0.09	0.16	0.01	0.02
HR	0.008	0.008	0.008	0.09	0.16	0.01	0.02
HA	0.008	0.008	0.008	0.09	0.16	0.01	0.02
HMO	0.02	0.02	0.02	0.18	0.31	0.02	0.04
HTS	0.07	0.07	0.07	0.72	1.24	0.08	0.15
HW	0.10	0.10	0.10	1.08	1.87	0.11	0.23
EDG1	0.02	0.02	0.02	0.39	0.71	0.14	0.001
EDG2	0.02	0.02	0.02	0.39	0.71	0.14	0.001
EDG3	0.02	0.02	0.02	0.39	0.71	0.14	0.001
EDFP	0.004	0.004	0.004	0.08	0.09	0.09	0.0001
TG1–TG2						1.91	
TD3—TD10						0.06	
Total	**565**	**342**	**169**	**30.45**	**37.85**	**4.78**	**6.48**

The following table presents the uncontrolled PTE for HAP pollutants as submitted by the applicant and verified by DEQ staff. See Appendix A for a detailed presentation of the calculations and the assumptions used to determine emissions for each source.

Table 3 UNCONTROLLED POTENTIAL TO EMIT FOR HAZARDOUS AIR POLLUTANTS

Hazardous Air Pollutants	PTE (T/yr)
1,3-Butadiene	3.67E-6
2-Methylnaphthalene	4.85E-6
3-Methylchloranthrene	3.64E-7
7,12-Dimethylbenz(a)anthracene	3.24E-6
Acenaphthene	7.09E-6
Acenaphthylene	1.38E-5
Acetaldehyde	1.07E-4
Acrolein	1.98E-5
Anthracene	2.39E-6
Antimony	3.00E-1
Arsenic	1.76E-2
Benz(a)anthracene	1.40E-6
Benzene	1.60E-3
Benzo(a)pyrene	6.22E-7
Benzo(b)fluoranthene	1.94E-6
Benzo(g,h,i)perylene	1.07E-6
Benzo(k)fluoranthene	6.86E-7
Beryllium	8.59E-5
Cadmium	2.50E-4
Carbon disulfide	6.33E-2
Chromium	5.73E-4
Chrysene	2.55E-6
Cobalt	1.20E-4
Cyanide	9.73E-1
Dibenz(a,h)anthracene	7.85E-7
Dichlorobenzene	2.43E-4
Fluoranthene	7.00E-6
Fluorene	2.13E-5
Formaldehyde	1.54E-2
Hexane	3.64E-1
Indeno(1,2,3-cd)pyrene	9.82E-7
Lead	2.62E-4
Manganese	2.17E-2
Mercury	1.60E-2
Naphthalene	3.14E-4
Nickel	1.63E-3
Phenanthrene	6.36E-5
Phosphorus	1.81E-2
Pyrene	6.68E-6
Selenium	4.85E-6
Toluene	1.12E-3
Xylene	2.99E-4
Total	**1.80**
Maximum Single HAP	**0.97**

Pre-Project PTE

Pre-project PTE is used to establish the change in emissions at a facility as a result of this project. Because this is a new facility, pre-project emissions are set to zero for all criteria pollutants.

Post-Project PTE

For existing sources, the Post-project PTE is used to establish the change in emissions at a facility and to determine the facility's classification as a result of this project. Post-project PTE includes all permit limits resulting from this project. Midas Gold is a new source, so the post-project PTE is equivalent to the PTE presented in the emissions inventory at Appendix A.

In addition to assuming continuous operation of the facility at the proposed material throughput and fuel input rates, post-project emissions estimates account for the use of baghouse and bin vent filtration, wet scrubber systems, carbon filter systems, water sprays and moisture carryover, and any other control equipment or methods as defined in the Fugitive Dust Control Plan (FDCP).

A variety of factors impact emissions from unpaved roadways, and it was recognized that accurate determination of site-specific parameters characterizing road conditions and vehicle traffic was critical to estimating particulate matter emissions and ambient air impacts. Midas Gold provided site-specific information to support parameters such as silt content, mean vehicle weight, and dust suppressant control efficiencies, and provided an analysis evaluating the conservatism of the resulting emission factor (AP-42).[3] To ensure operation consistent with these parameters and to reasonably control fugitive emissions, compliance with requirements identified in the FDCP is required by the permit. Further discussion of the sensitivity of predicted air quality impacts is provided in the Ambient Air Quality Impact Analyses section.

The following table presents the post-project PTE for criteria pollutants from all emissions units at the facility as determined by DEQ staff, confirming source status as a "synthetic minor" source.. See Appendix A for a detailed presentation of the calculations of these emissions for each emissions unit.

Table 4 POST-PROJECT PTE FOR REGULATED AIR POLLUTANTS

Source	PM	PM_{10}	$PM_{2.5}$	CO	NO_x	VOC	SO_2
	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]
POINT SOURCE EMISSIONS							
OC1	0.64	0.21	0.06				
OC2	0.64	0.21	0.06				
OC3	0.64	0.21	0.06				
OC4	0.64	0.21	0.06				
OC5	0.64	0.21	0.06				
OC6	0.64	0.21	0.06				
OC7	5.48	2.46	0.46				
OC8	0.64	0.21	0.06				
OC9	3.02	1.11	0.17				
OC10	3.02	1.11	0.17				
OC11	3.02	1.11	0.17				
OC12	6.04	2.72	0.50				
OC13	0.71	0.23	0.07				
PS-L	0.07	0.03	0.004				
PS-U	0.07	0.03	0.004				
AC	22.23	22.23	22.23				2.86
EW	0.31	0.31	0.31				
MR	0.006	0.006	0.006				
MF	0.89	0.89	0.89				
CKD	1.84	1.84	1.84	0.53	0.05	0.48	
Sb2	0.52	0.52	0.52				
LS1	0.48	0.18	0.03				
LS2	0.86	0.38	0.06				
LS3	3.97	1.38	0.21				
LS4	0.86	0.38	0.06				
LS5	3.97	1.38	0.21				

[3] Appendix A – Model Parameter / Assumption / Data Level of Conservatism IDEQ Forms, Stibnite Gold Project Permit to Construct Application, Midas Gold, revised February 5, 2020 (2020AAG1078).

Source	PM	PM_{10}	$PM_{2.5}$	CO	NO_x	VOC	SO_2
	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]
LS6	0.48	0.18	0.03				
LSBM	6.42	5.39	1.92				
LS7	0.48	0.18	0.03				
LS8	0.48	0.18	0.03				
LS9	0.12	0.05	0.01				
LS10	0.12	0.05	0.01				
LS11	1.03	0.36	0.06				
LS12	0.12	0.05	0.01				
LS-L	0.02	0.02	0.02				
LS-U	0.002	0.002	0.002				
LK	3.40	3.40	3.40	11.79	6.29		0.03
LCR	1.06	0.89	0.32				
LS1-L	0.002	0.001	0.0001				
LS1-U	0.01	0.006	0.001				
MillS2-L	0.002	0.001	0.0001				
MillS2-U	0.01	0.006	0.001				
ACS1-L	0.009	0.003	0.0004				
ACS1-U	0.04	0.02	0.004				
ACS2-L	0.009	0.003	0.0004				
ACS2-U	0.04	0.02	0.004				
ACS3-L	0.009	0.003	0.0004				
ACS3-U	0.04	0.02	0.004				
ACS4-L	0.004	0.001	0.0002				
ACS4-U	0.02	0.01	0.002				
PCSP1	2.74	1.02	0.13				
PCSP2	2.74	1.02	0.13				
CM	0.55	0.17	0.02				
CS1-L	0.03	0.01	0.002				
CS1-U	0.14	0.08	0.01				
CS2-L	0.03	0.01	0.002				
CS2-U	0.14	0.08	0.01				
CA-L	1.73	0.83	0.13				
CA-U	1.73	0.83	0.13				
Sb1	0.09	0.09	0.09	0.98	1.69	0.10	0.21
ACB	0.002	0.002	0.002	0.02	0.04	0.002	0.004
CKB	0.08	0.08	0.08	0.81	1.40	0.09	0.17
PV	0.003	0.003	0.003	0.04	0.06	0.004	0.008
HS	0.17	0.17	0.17	1.80	3.11	0.19	0.38
LKC	0.63	0.63	0.63	6.72	11.65	0.72	1.42
H1M	0.13	0.13	0.13	1.44	2.49	0.15	0.30
H2M	0.13	0.13	0.13	1.44	2.49	0.15	0.30
HM	0.13	0.13	0.13	1.44	2.49	0.15	0.30
HAC	0.008	0.008	0.008	0.09	0.16	0.01	0.02
HR	0.008	0.008	0.008	0.09	0.16	0.01	0.02
HA	0.008	0.008	0.008	0.09	0.16	0.01	0.02
HMO	0.02	0.02	0.02	0.18	0.31	0.02	0.04
HTS	0.07	0.07	0.07	0.72	1.24	0.08	0.15
HW	0.10	0.10	0.10	1.08	1.87	0.12	0.23
EDG1	0.02	0.02	0.02	0.39	0.71	0.14	0.001
EDG2	0.02	0.02	0.02	0.39	0.71	0.14	0.001
EDG3	0.02	0.02	0.02	0.39	0.71	0.14	0.001
EDFP	0.004	0.004	0.004	0.08	0.09	0.09	0.0001
TG1–TG2						1.91	
TD3—TD10						0.06	
Post-Project PTE	**87.3**	**56.3**	**36.4**	**30.5**	**37.9**	**4.8**	**6.5**

Source	PM	PM_{10}	$PM_{2.5}$	CO	NO_x	VOC	SO_2
	T/yr [a]	T/yr [a]	T/yr [a]	T/yr [a]	T/yr [a]	T/yr [a]	T/yr [a]
FUGITIVE EMISSIONS							
Blasting activities	117.35	61.02	3.52	635.83	17.08		0.03
Drilling activities	284.70	148.04	8.54				
Hauling	2901.27	712.95	71.29				
Material load / unload (L/UL) [b]	15.00	7.10	1.07				
Dozing	103.56	19.78	10.87				
Grading	36.80	11.04	1.14				
Water Truck Travel	109.27	26.85	2.69				
Access Roads	6.95	1.72	0.17				
Wind Erosion [b]	5.72	2.86	0.43				
Surface Exploration	1.12	0.39	0.06				
Underground Exploration	0.002	0.001	0.0001				
Fugitive Total [b]	**3,569**	**986**	**100**	**636**	**17.1**		**0.03**

a) Controlled average emission rate in tons per year is an annual average, based on the proposed annual operating scenarios and annual limits.

b) Estimated emissions from the "W3" scenario resulted in the most emissions across most activities, with the exception of material load/unload and wind erosion activities, which occurred in the Y1, H1, W1, and B1 scenarios. Totals reported are for the "W3" scenario.

Fourteen operational scenarios were evaluated by the applicant and verified by DEQ in order to estimate maximum hourly, daily, and annual potential emissions from sources. These scenarios encompassed all feasible origin and destination location combinations for locating ore and development rock. A summary of these scenarios is provided in Table 5. Although drilling, blasting, excavating, and hauling activities are not expected to be confined to a single scenario in practice, emissions in each scenario were conservatively estimated at the maximum daily proposed processing rate (180,000 of ore and rock) to allow for maximum operational flexibility, and to evaluate potential air quality impacts. Scenarios having the greatest potential emissions (i.e., the top seven) were those with the longest origin-to-destination distances, which resulted in increased emissions evident in onsite hauling and material loading and unloading activities. Consequently, the W3 scenario having the maximum origin-to-destination distance (16,415 daily vehicle miles traveled) is representative of maximum potential emissions.

There are numerous sources of fugitive dust emissions at the facility, including drilling and blasting activities, crushing and ore handling equipment, ore and rock storage piles, and unpaved roadways. Calculated at maximum daily processing rates, emissions from these sources would tend to be conservatively estimated. But it is also recognized that uncertainties exist in some of the emission factors used, and that predicted modeled impacts may be sensitive to emissions from such sources. In particular, it may prove challenging to consistently and continuously achieve the targeted level of fugitive dust control for emissions from traffic on unpaved roadways, with over 55 miles of haul truck routes within the mining operations boundary, a fleet of 32 haul trucks weighing between 37 and 357 tons, and a targeted dust control efficiency of 93.3% accomplished by application of both dust suppressant and water controls. Based on this, and the scale of operations, a detailed Fugitive Dust Control Plan (FDCP) was required (Permit Conditions 2.5). It is noted that Midas Gold projected actual annual production at approximately 42.7 million T/yr, or 65% of the permitted annual production limit of 65.7 million T/yr (Permit Condition 3.5), and that as a result actual emissions are expected to be lower than presented.

REC 0789

PET 423

Table 5 OPERATING SCENARIOS

Scenario	Origin [a]	Destination [a]
Y1	YPP	STKP
Y2	YPP	FDRSF
Y3	YPP	HFDRSF
H1	HFP	STKP
H2	HFP	FDRSF
H3	HFP	HFDRSF
H4	HFP	YPDRSF
W1	WEP	STKP
W2	WEP	FDRSF
W3	WEP	HFDRSF
W4	WEP	YPDRSF
W5	WEP	WEDRSF
B1	BT	STKP
B2	BT	HFDRSF

a) Where ore and rock origin and destination locations as depicted in Figure 1 are abbreviated as follows:
YPP = Yellow Pine Pit, HFP = Hangar Flats pit, WEP = West End pit, BT = Bradley Tailings, STKP = Primary Crusher Stockpile, FDRSF = Fiddle DRSF, HFDRSF = Hangar Flats DRSF, YPDRSF = Yellow Pine DRSF, WEDRSF = West End DRSF, and DRSF = development rock storage facilities.

Change in PTE

For existing source, t~~T~~he change in facility-wide PTE is used to determine if a public comment period may be required and to determine the processing fee per IDAPA 58.01.01.225. The following table presents the facility-wide change in the potential to emit for criteria pollutants which for a new source equals the post project PTE.

Table 6 CHANGES IN PTE FOR REGULATED AIR POLLUTANTS

Source	PM	PM_{10}	$PM_{2.5}$	CO	NO_x	VOC	SO_2
	T/yr[a]	T/yr[a]	T/yr[a]	T/yr[a]	T/yr[a]	T/yr[a]	T/yr[a]
Pre-Project PTE	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Post-Project PTE	87.3	56.3	36.4	30.5	37.9	4.8	6.5
Changes in Potential to Emit	**87.3**	**56.3**	**36.4**	**30.5**	**37.9**	**4.80**	**6.50**

Comment [A3]: Footnote (a) is missing.

Toxic Air Pollutant Emissions

A summary of the estimated PTE for emissions increase of non-carcinogenic and carcinogenic toxic air pollutants (TAP) is provided in the following table. Toxic air pollutants (TAP) also classified as hazardous air pollutants (HAP) emitted from sources regulated by National Emission Standards for Hazardous Air Pollutants (NESHAP) were estimated by the applicant. These regulated HAP emissions ~~, but~~ were not required to be evaluated~~included in the evaluation~~ for compliance with TAP increments, in accordance with IDAPA 58.01.01.210.20. Affected sources subject to ~~applicable to~~ Subpart EEEEEEE, Subpart CCCCCC, and Subpart ZZZZ are identified in the incorporation of federal requirements condition (Permit Condition 2.21) and in the MACT/GACT Applicability (40 CFR 63) section. In the event there is a conflict between Permit Condition 2.21 and the listed Subparts in determining applicability, the federal applicability requirements shall apply.

Table 7 POST- PROJECT PTE FOR TOXIC AIR POLLUTANTS

Toxic Air Pollutants	Emissions (lb/hr)				Screening Emission Level [e]		Exceeds Screening Level? (Y/N)
	Propane Combustion (a)	Material Handling (b)	Fugitive Mining (c)	Total TAP (d)	Non-Carcinogenic (lb/hr)	Carcinogenic (lb/hr)	
1,3-Butadiene						2.40E-5	No
2-Methylnaphthalene [f]	1.59E-6			1.59E-6		9.10E-5	No
3-Methylchloranthrene	1.19E-7			1.19E-7		2.50E-6	No
7,12-Dimethylbenz(a)anthracene [f]	1.06E-6			1.06E-6		9.10E-5	No
Acenaphthene [f]	1.19E-7			1.19E-7		9.10E-5	No
Acenaphthylene [f]	1.19E-7			1.19E-7		9.10E-5	No
Acetaldehyde						3.00E-3	No
Acrolein					1.70E-2		No
Anthracene [f]	1.59E-7			1.59E-7		9.10E-5	No
Antimony		6.86E-2		6.86E-2	3.30E-2		**Yes**
Arsenic	1.32E-5	4.36E-3		4.37E-3		1.50E-6	**Yes**
Benzene	1.39E-4			1.39E-4		8.00E-4	No
Benzo(a)pyrene [g]	7.93E-8			7.54E-7		2.00E-6	No
Benz(a)anthracene [g]	1.19E-7						
Benzo(b)fluoranthene [g]	1.19E-7						
Benzo(k)fluoranthene [g]	1.19E-7						
Dibenz(a,h)anthracene [g]	7.93E-8						
Chrysene	1.19E-7						
Indeno(1,2,3-cd)pyrene	1.19E-7						
Benzo(g,h,i)perylene	7.93E-8			7.93E-8		9.10E-5	No
Beryllium	7.93E-7	2.17E-5		2.25E-5		2.80E-5	No
Cadmium	7.26E-5	4.06E-5		1.13E-4		3.70E-6	**Yes**
Carbon disulfide		1.45E-2		1.45E-2	2.00E+0		No
Chromium	9.25E-5	1.22E-4		2.14E-4	3.30E-2		No
Cobalt	5.55E-6	2.35E-5		2.91E-5	3.30E-3		No
Cyanide		2.22E-1		2.22E-1	3.33E-1		No
Dichlorobenzene	7.93E-5			7.93E-5	3.00E+1		No
Fluoranthene	1.98E-7			1.98E-7		9.10E-5	No
Fluorene	1.85E-7			1.85E-7		9.10E-5	No
Formaldehyde	4.95E-3			4.95E-3		5.10E-4	**Yes**
Hexane	1.19E-1			1.19E-1	1.20E+1		No
Manganese	2.51E-5	3.53E-2		3.53E-2	6.70E-2		No
Naphthalene	4.03E-5			4.03E-5	3.33E+0		No
Nickel	1.39E-4	2.89E-3		3.03E-3		2.70E-5	**Yes**
Phenanthrene	1.12E-6			1.12E-6		9.10E-5	No
Phosphorus		6.12E-3		6.12E-3	7.00E-3		No
Pyrene	3.30E-7			3.30E-7		9.10E-5	No
Selenium	1.59E-6			1.59E-6	1.30E-2		No
Toluene	2.25E-4			2.25E-4	2.50E+1		No
Xylene					2.90E+1		No
Barium	2.91E-4	4.71E-3		5.00E-3	3.30E-2		No
Copper	5.61E-5	2.94E-5		8.55E-5	6.70E-2		No
Hydrogen Sulfide		9.00E-1		9.00E-1	9.33E-1		No
Molybdenum	7.26E-5	5.88E-6		7.85E-5	3.33E-1		No
Pentane	1.72E-1			1.72E-1	1.18E+2		No
Silver		2.94E-6		2.94E-6	7.00E-3		No

Toxic Air Pollutants	Emissions (lb/hr)				Screening Emission Level [e]		Exceeds Screening Level? (Y/N)
	Propane Combustion (a)	Material Handling (b)	Fugitive Mining (c)	Total TAP (d)	Non-Carcinogenic (lb/hr)	Carcinogenic (lb/hr)	
Sulfuric Acid		2.03E+0		2.03E+0	6.70E-2		**Yes**
Thallium		5.88E-5		5.88E-5	7.00E-3		No
Uranium		5.88E-5		5.88E-5	1.30E-2		No
Vanadium	1.52E-4			1.52E-4	3.00E-3		No
Zinc	1.92E-3			1.92E-3	6.67E-1		No

a) TAP from propane combustion.
b) TAP from material processing.
c) Fugitive TAP from mining activities.
d) Total TAP from all regulated sources and activities. Does not include TAP addressed by NESHAP in accordance with IDAPA 58.01.01.210.20.
e) Non-carcinogenic and carcinogenic screening emission levels (EL) from IDAPA 58.01.01.585-586.
f) Polycyclic aromatic hydrocarbons (PAH) as defined in IDAPA 58.01.01.586.
g) Polycyclic organic matter (POM) as defined in IDAPA 58.01.01.586.

Some of the screening levels ~~changes in emissions rates~~ for non-carcinogenic and carcinogenic TAP were exceeded as a result of this project, triggering modeling. Modeling was required for antimony and sulfuric acid (H_2SO_4) because the 24-hour average non-carcinogenic screening emission levels (EL) in IDAPA 58.01.01.585 were exceeded. Modeling was required for arsenic, cadmium, formaldehyde, and nickel because the annual average carcinogenic EL in IDAPA 58.01.01.586 were exceeded.

Ambient Air Quality Impact Analyses

The applicant has demonstrated preconstruction compliance to DEQ's satisfaction that emissions from this facility will not cause nor significantly contribute to a violation of any ambient air quality standard. The applicant has also demonstrated preconstruction compliance to DEQ's satisfaction that the emissions increase due to this permitting action will not exceed any acceptable ambient concentration (AAC) or acceptable ambient concentration for carcinogens (AACC) for toxic air pollutants (TAP). A summary of the Ambient Air Impact Analysis for TAP is provided in Appendix A.

As presented in the modeling memorandum in Appendix B, the estimated emission rates of PM_{10}, $PM_{2.5}$, SO_2, CO, NO_x, and certain TAP from this project exceeded applicable screening emission levels (EL) and published DEQ modeling thresholds established in IDAPA 58.01.01.585-586 and in the State of Idaho Air Quality Modeling Guideline.[4] Refer to the Emissions Inventories section for additional information concerning the emissions inventories.

Facility-wide emission rate~~s~~ of lead (Pb) ~~and SO_2 were~~was determined to be below the "below regulatory concern" (BRC) threshold level of less than 10% of the "significant" emission rate defined in IDAPA 58.01.01.006 (i.e., less than 0.06 ~~and 4.0 T/yr, respectively~~), and therefore modeling was not required. ~~CO facility-wide emission rates were below published DEQ modeling thresholds, and therefore modeling was not required.~~[5]

[4] Criteria pollutant thresholds in Table 2, State of Idaho Guideline for Performing Air Quality Impact Analyses, Doc ID AQ-011 (September 2013), September 2013, criteria pollutant BRC thresholds as provided in IDAPA 58.01.01.221.01, and DEQ guidance pertaining to BRC (2009ACF12).

[5] Criteria pollutant thresholds in Table 2, State of Idaho Guideline for Performing Air Quality Impact Analyses, Doc ID AQ-011 (September 2013), September 2013, criteria pollutant BRC thresholds as provided in IDAPA 58.01.01.221.01, and DEQ guidance pertaining to BRC (2009ACF12).

With the exception of antimony, arsenic, cadmium, formaldehyde, nickel, and sulfuric acid, estimated emission increases of non-carcinogenic and carcinogenic TAP demonstrated preconstruction compliance with TAP standards, in accordance with IDAPA 58.01.01.210.07 using controlled average emission rates. Modeling analyses conducted in the development of TAP rules supports that if controlled average emission rates do not exceed applicable screening emission levels (EL) in IDAPA 58.01.01.585–586, controlled ambient concentrations are expected to be below the applicable acceptable ambient concentration (AAC/AACC).

Estimated emission increases of antimony, arsenic, cadmium, formaldehyde, nickel, and sulfuric acid demonstrated preconstruction compliance with TAP standards in accordance with IDAPA 58.01.01.210.08 for controlled ambient concentrations. Modeling analyses demonstrated preconstruction compliance with the acceptable ambient concentrations for these non-carcinogens (AAC) and carcinogens (AACC) in IDAPA 58.01.01.585–586. Emission limits consistent with modeled TAP emission rates were established in accordance with IDAPA 58.01.01.210.08. Emission limits (Permit Condition 4.3), operational and material throughput limits (Permit Conditions 3.3–3.8, 4.4–4.10, and 5.4–5.8), fugitive dust control requirements (Permit Conditions 2.1–2.7), and control equipment requirements (Permit Conditions 2.5, 3.9–3.11, 4.11–4.16, and 5.9–5.16) were established to limit nickel, antimony, arsenic, cadmium, formaldehyde, nickel, and sulfuric acid TAP emissions in accordance with IDAPA 58.01.01.210.08.c, to limit Pb to BRC, and to limit PM, PM_{10} ,and $PM_{2.5}$ below the emission rates relied upon in the NAAQS evaluation of ambient air impacts in the modeling analyses.

The applicant has demonstrated preconstruction compliance to DEQ's satisfaction that emissions from this facility will not cause nor significantly contribute to a violation of any ambient air quality standard. The applicant has also demonstrated preconstruction compliance to DEQ's satisfaction that the emissions increase due to this permitting action will not exceed any acceptable ambient concentration (AAC) or acceptable ambient concentration for carcinogens (AACC) for toxic air pollutants (TAP). A summary of the Ambient Air Impact Analysis for TAP is provided in Appendix A.

It was recognized that accurately defining the mining operations boundary and controlling public access within that boundary was critical to estimating ambient air impacts. Midas Gold identified site-specific access control measures used to define the mining operations boundary.[6] To ensure operation consistent with these measures, compliance with requirements identified in an Access Management Plan (AMP) is required (Permit Condition 2.6)~~; the proposed plan is include in Appendix E~~.

An ambient air quality impact analyses document has been crafted by DEQ based on a review of the modeling analysis submitted in the application. That document is part of the final permit package for this permitting action (refer to Appendix B). Refer to the Emissions Inventories section and Appendix A for additional information concerning development of the emissions inventories.

Comment [A4]: GLOBAL: Please update the permit condition references as per comments provided on the draft PTC.

Comment [A5]: Please verify this reference. Appendix A to this report is Emission Inventories.

Comment [A6]: A new AMP will be developed per the requirements of Condition 2.6.

[6] Appendix A – Model Parameter / Assumption / Data Level of Conservatism IDEQ Forms, Stibnite Gold Project Permit to Construct Application, Midas Gold, revised February 5, 2020 (2020AAG1078).

REGULATORY ANALYSIS

Attainment Designation (40 CFR 81.313)

The facility is located in Valley County, which is designated as attainment or unclassifiable for $PM_{2.5}$, PM_{10}, SO_2, NO_2, CO, and Ozone. Refer to 40 CFR 81.313 for additional information.

Facility Classification

The AIRS/AFS facility classification codes are as follows:

For HAP (hazardous air pollutants) only:

A = Use when any one HAP has permitted emissions > 10 T/yr or if the aggregate of all HAP (Total HAP) has permitted emissions > 25 T/yr.

SM80 = Use if a synthetic minor (uncontrolled HAP emissions are > 10 T/yr or if the aggregate of all uncontrolled HAP (Total HAP) emissions are > 25 T/yr and permitted emissions fall below applicable major source thresholds) and the permit sets limits > 8 T/yr of a single HAP or ≥ 20 T/yr of Total HAP.

SM = Use if a synthetic minor (uncontrolled HAP emissions are > 10 T/yr or if the aggregate of all uncontrolled HAP (Total HAP) emissions are > 25 T/yr and permitted emissions fall below applicable major source thresholds) and the permit sets limits < 8 T/yr of a single HAP and/or < 20 T/yr of Total HAP.

B = Use when the potential to emit (i.e. uncontrolled emissions and permitted emissions) are below the 10 and 25 T/yr HAP major source thresholds.

UNK = Class is unknown.

For All Other Pollutants:

A = Use when permitted emissions of a pollutant are > 100 T/yr.

SM80 = Use if a synthetic minor for the applicable pollutant (uncontrolled emissions are > 100 T/yr and permitted emissions fall below 100 T/yr) and permitted emissions of the pollutant are ≥ 80 T/yr.

SM = Use if a synthetic minor for the applicable pollutant (uncontrolled emissions are > 100 T/yr and permitted emissions fall below 100 T/yr) and permitted emissions of the pollutant are < 80 T/yr.

B = Use when the potential to emit (i.e. uncontrolled emissions and permitted emissions) are below the 100 T/yr major source threshold.

UNK = Class is unknown.

Table 8 REGULATED AIR POLLUTANT FACILITY CLASSIFICATION

Pollutant	Uncontrolled PTE (T/yr)	Permitted PTE (T/yr)	Relevant ~~Major Source~~ Thresholds (T/yr)	AIRS/AFS Classification
PM	565	87.3	**100**	SM80
PM_{10}	342	56.3	**100**	SM
$PM_{2.5}$	169	36.4	**100**	SM
SO_2	6.48	6.5	**100**	B
NO_x	37.85	37.9	**100**	B
CO	30.45	30.5	**100**	B
VOC	4.78	4.8	**100**	B
HAP (single)	0.97	0.97	**10**	B
Total HAP	1.80	1.80	**25**	B

Comment [A7]: Major source is not a defined term in IDAPA. Could confuse reader since for PSD major source threshold is 250 TPY

Permit to Construct (IDAPA 58.01.01.201)

The permittee has requested that a PTC be issued to the facility for the proposed new emission sources. Therefore, a permit to construct is required in accordance with IDAPA 58.01.01.220~~0~~1. This permitting action was processed in accordance with the procedures of IDAPA 58.01.01.200-228.

Comment [A8]: 220 is for PTC exemptions.

Tier II Operating Permit (IDAPA 58.01.01.401)

IDAPA 58.01.01.401 ..... Tier II Operating Permit

The application was submitted for a permit to construct (refer to the Permit to Construct (IDAPA 58.01.01.201) section), and an optional Tier II operating permit has not been requested. Therefore, the procedures of IDAPA 58.01.01.400–410 were not applicable to this permitting action.

Particulate Matter – New Equipment Process Weight Limitations (IDAPA 58.01.01.701)

IDAPA 58.01.01.701 ..... Particulate Matter – New Equipment Process Weight Limitations

IDAPA 58.01.01.700 through 703 set PM emission limits for process equipment based on when the piece of equipment commenced operation and the piece of equipment's process weight (PW) in pounds per hour (lb/hr). IDAPA 58.01.01.701 establishes PM emission limits for equipment that commenced operation on or after October 1, 1979.

For equipment commencing operation on or after October 1, 1979, the PM allowable emission rate (E) is based on one of the following equations:

IDAPA 58.01.01.701.01.a: If PW is < 9,250 lb/hr; $E = 0.045\ (PW)^{0.60}$

IDAPA 58.01.01.701.01.b: If PW is ≥ 9,250 lb/hr; $E = 1.10\ (PW)^{0.25}$

For the new ore processing, ore concentration and refining, lime production, aggregate production, and concrete production equipment sources (Table 1) emissions (E) were calculated at the proposed maximum throughput rates (Table 1), and estimated emissions from all sources demonstrated compliance with this requirement. Compliance with operational and material throughput limits (Permit Conditions 3.3–3.8, 4.4–4.10, and 5.4–5.8) and control equipment requirements (Permit Conditions 2.5, 3.9–3.11, 4.11–4.16, and 5.9–5.16) assure compliance with this standard, resulting in much lower emission rates.

Mercury Emission Standard for New or Modified Sources

IDAPA 58.01.01.215..... Mercury Emission Standard for New or Modified Sources

IDAPA 58.01.01.215 sets requirements for mercury emissions. No owner or operator may commence construction or modification of a stationary source or facility that results in an increase in annual potential emissions of mercury of 25 pounds or more unless a PTC is obtained and Mercury Best Available Control Technology (MBACT) determined. For this standard, fugitive emissions shall not be included in a determination of applicability, and new or modified stationary sources within a source category subject to NESHAP 40 CFR 63 are exempt. As identified in the MACT/GACT Applicability (40 CFR 63) section, sources addressed by NESHAP 40 CFR 63, Subpart EEEEEEE (AC, EW, MR, MF, CKD), Subpart ZZZZ (EDG1, EDG2, EDG3, and EDFP), and Subpart CCCCCC (TG1, TG2) were exempt from this standard. Emissions from drilling, blasting, material handling (excavating), roadways (hauling), dozing, grading, storage piles, and other fugitive and mobile emission sources were also exempt from this standard.

Mercury emissions from the applicable process sources (non-fugitive and non-NESHAP) were estimated to be less than 0.2 pounds per year (lb/yr), below the level at which MBACT review is required.

Title V Classification (IDAPA 58.01.01.300, 40 CFR Part 70)

IDAPA 58.01.01.301..... Requirement to Obtain Tier I Operating Permit

Any source subject to 40 CFR 63, Subpart EEEEEEE is a Tier I source as defined in IDAPA 58.01.01.006.122.c. In accordance with IDAPA 58.01.01.313.01.b., 40 CFR 70.3(c)(2), and 40 CFR 63.11640(d), the permittee must submit a complete application to DEQ for an initial Tier I operating permit within 12 months of becoming a Tier I source.

Midas Gold has committed to applying for a Tier I permit. Detailed federal regulatory applicability were provided in the PTC application, and specific federally-applicable requirements will be incorporated into the Tier I. Refer to the NSPS Applicability (40 CFR 60), NESHAP Applicability (40 CFR 61), and MACT/GACT Applicability (40 CFR 63) sections below for additional information regarding applicable requirements.

Post-project facility-wide emissions from this facility do not have a PTE greater than 100 tons per year for criteria pollutants or 10 tons per year for any one HAP or 25 tons per year for all HAP combined as demonstrated previously in the Emissions Inventories section of this analysis. Although not a major facility as defined in IDAPA 58.01.01.008.10, any source subject to 40 CFR 63, Subpart EEEEEEE is a Tier I source as defined in IDAPA 58.01.01.006.122.c. In accordance with IDAPA 58.01.01.313.01.b., 40 CFR 70.3(c)(2), and 40 CFR 63.11640(d), the permittee must submit a complete application to DEQ for an initial Tier I operating permit within 12 months of becoming a Tier I source. Refer to the NESHAP Applicability (40 CFR 61) section for additional discussion of Subpart EEEEEEE applicability.

Permit Condition 2.23 incorporates the requirement to obtain a Tier I permit in accordance with IDAPA 58.01.01.313.01.b., 40 CFR 70.3(c)(2), and 40 CFR 63.11640(d).

Comment [A9]: Added to specify that the Tier I operating permit is required only for the emission units that cause the source to be subject to the part 70 program.

PSD Classification (40 CFR 52.21)

40 CFR 52.21 ..... Prevention of Significant Deterioration of Air Quality

The facility is not a major stationary source as defined in 40 CFR 52.21(b)(1), nor is it undergoing any physical change at a stationary source not otherwise qualifying under paragraph 40 CFR 52.21(b)(1) as a major stationary source which would constitute a major stationary source by itself as defined in 40 CFR 52. PSD requirements were therefore not applicable to this permitting action in accordance with 40 CFR 52.21(a)(2).

The facility includes a lime manufacturing plant (LMP) that uses a Parallel Flow Regenerative Shaft Kiln (LK, LKC) to produce lime product from limestone by calcination, which is a designated facility as defined in 40 CFR 52.21(b)(1)(i)(a). For each criteria pollutant, LMP emissions do not exceed 100 T/yr and facility-wide emissions do not exceed 250 T/yr.

NSPS Applicability (40 CFR 60)

The project emissions units were reviewed for NSPS applicability. ~~The permittee has affected facilities subject to the following New Source Performance Standards (NSPS).~~ The POX Boiler (ACB) meets the definition of process heater rather than steam generating unit, and the use of a rotary lime kiln has not been proposed in the production of lime; therefore Subpart Dc and Subpart HH are not applicable. Applicability determinations and regulatory analyses are provided below.

- Standards of Performance for New Stationary Sources (NSPS) 40 CFR 60, Subpart A – General Provisions. DEQ is delegated this Subpart.
- NSPS 40 CFR 60, Subpart LL – Standards of Performance for Metallic Mineral Processing Plants. DEQ is delegated this Subpart. Each crusher (OC7, OC12), conveyor belt transfer point (OC1–OC6, OC8–OC11, OC13), and truck unloading station is an affected facility.
- NSPS 40 CFR 60, Subpart OOO – Standards of Performance for Nonmetallic Mineral Processing Plants. DEQ is delegated this Subpart. Each crusher (LS2, LS4), grinding mill (LSBM, OC12), screening operation (LS3, LS5, LS11), belt conveyor (LS6–LS10, LS12), and storage bin is an affected facility.
- NSPS 40 CFR 60, Subpart IIII – Standards of Performance for Stationary Compression Ignition Internal Combustion Engines. DEQ is delegated this Subpart. Each emergency generator engine and fire pump (EDG1, EDG2, EDG3, and EDFP) is an affected facility.

Comment [A10]: Please update the source IDs as per comments provided on the draft PTC.

40 CFR 60, Subpart A ..... General Provisions

§60.1 ..... Applicability

(a) Except as provided in subparts B and C, the provisions of this part apply to the owner or operator of any stationary source which contains an affected facility, the construction or modification of which is commenced after the date of publication in this part of any standard (or, if earlier, the date of publication of any proposed standard) applicable to that facility.

(b) Any new or revised standard of performance promulgated pursuant to section 111(b) of the Act shall apply to the owner or operator of any stationary source which contains an affected facility, the construction or modification of which is commenced after the date of publication in this part of such new or revised standard (or, if earlier, the date of publication of any proposed standard) applicable to that facility.

Because the permittee will own or operate NSPS affected facilities, which have been proposed to commence construction after the date of publication of the relevant applicable NSPS standards (as listed above), general provisions in Subpart A are applicable.

40 CFR 60, Subpart A is incorporated by reference into Permit Condition 2.23, and specific applicable requirements will be incorporated into the Tier I operating permit.

40 CFR 60, Subpart Dc ..... Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units

§60.40c ..... Applicability and delegation of authority.

(a) Except as provided in paragraphs (d), (e), (f), and (g) of this section, the affected facility to which this subpart applies is each steam generating unit for which construction, modification, or reconstruction is commenced after June 9, 1989 and that has a maximum design heat input capacity of 29 megawatts (MW) (100 million British thermal units per hour (MMBtu/h)) or less, but greater than or equal to 2.9 MW (10 MMBtu/h).

§60.41c ..... Definitions.

As used in this subpart, all terms not defined herein shall have the meaning given them in the Clean Air Act and in subpart A of this part.

...

Heat input *means heat derived from combustion of fuel in a steam generating unit and does not include the heat derived from preheated combustion air, recirculated flue gases, or exhaust gases from other sources (such as stationary gas turbines, internal combustion engines, and kilns).*

Heat transfer medium *means any material that is used to transfer heat from one point to another point.*

...

Process heater *means a device that is primarily used to heat a material to initiate or promote a chemical reaction in which the material participates as a reactant or catalyst.*

...

Steam generating unit *means a device that combusts any fuel and produces steam or heats water or heats any heat transfer medium. This term includes any duct burner that combusts fuel and is part of a combined cycle system. This term does not include process heaters as defined in this subpart.*

Although the Pressure Oxidation Boiler (POX Boiler) is between 10 and 100 MMBtu/hr in design heat input capacity (17 MMBtu/hr) and is proposed for construction after June 9, 1989, it meets the definition of process heater rather than steam generating unit, and therefore is not applicable to this subpart. The POX Boiler (ACB) is a device used to directly heat ore material via steam injection into the autoclave, to promote chemical oxidation reactions in which the heated ore participates as a reactant. DEQ is delegated this Subpart.

40 CFR 60, Subpart HH..... Standards of Performance for Lime Manufacturing Plants

§60.340..... Applicability and designation of affected facility.

(a) The provisions of this subpart are applicable to each rotary lime kiln used in the manufacture of lime.

(b) The provisions of this subpart are not applicable to facilities used in the manufacture of lime at kraft pulp mills.

(c) Any facility under paragraph (a) of this section that commences construction or modification after May 3, 1977, is subject to the requirements of this subpart.

§60.341..... Definitions.

As used in this subpart, all terms not defined herein shall have the same meaning given them in the Act and in the General Provisions.

(a) Lime manufacturing plant *means any plant which uses a rotary lime kiln to produce lime product from limestone by calcination.*

(b) Lime product *means the product of the calcination process including, but not limited to, calcitic lime, dolomitic lime, and dead-burned dolomite.*

(c) Positive-pressure fabric filter *means a fabric filter with the fans on the upstream side of the filter bags.*

(d) Rotary lime kiln *means a unit with an inclined rotating drum that is used to produce a lime product from limestone by calcination.*

(e) Stone feed *means limestone feedstock and mill scale or other iron oxide additives that become part of the product.*

The use of a rotary lime kiln has not been proposed in the production of lime, and therefore the requirements of Subpart HH are not applicable. DEQ is delegated this Subpart.

40 CFR 60, Subpart LL ..... Standards of Performance for Metallic Mineral Processing Plants

§60.380 ..... Applicability and designation of affected facility.

(a) The provisions of this subpart are applicable to the following affected facilities in metallic mineral processing plants: Each crusher and screen in open-pit mines; each crusher, screen, bucket elevator, conveyor belt transfer point, thermal dryer, product packaging station, storage bin, enclosed storage area, truck loading station, truck unloading station, railcar loading station, and railcar unloading station at the mill or concentrator with the following exceptions. All facilities located in underground mines are exempted from the provisions of this subpart. At uranium ore processing plants, all facilities subsequent to and including the beneficiation of uranium ore are exempted from the provisions of this subpart.

(b) An affected facility under paragraph (a) of this section that commences construction or modification after August 24, 1982, is subject to the requirements of this part.

Because the permittee will own or operate a metallic mineral processing plant with a crusher at an open-pit mine; with crushers, conveyor belt transfer points, and truck unloading stations at the mill or concentrator; and because these are proposed to commence construction after August 24, 1982, requirements in Subpart LL are applicable.

40 CFR 60, Subpart LL is incorporated by reference into Permit Condition 2.23, and specific applicable requirements will be incorporated into the Tier I operating permit.

40 CFR 60, Subpart OOO ..... Standards of Performance for Nonmetallic Mineral Processing Plants

§60.670 ..... Applicability and designation of affected facility.

(a)(1) Except as provided in paragraphs (a)(2), (b), (c), and (d) of this section, the provisions of this subpart are applicable to the following affected facilities in fixed or portable nonmetallic mineral processing plants: each crusher, grinding mill, screening operation, bucket elevator, belt conveyor, bagging operation, storage bin, enclosed truck or railcar loading station. Also, crushers and grinding mills at hot mix asphalt facilities that reduce the size of nonmetallic minerals embedded in recycled asphalt pavement and subsequent affected facilities up to, but not including, the first storage silo or bin are subject to the provisions of this subpart.

(2) The provisions of this subpart do not apply to the following operations: All facilities located in underground mines; plants without crushers or grinding mills above ground; and wet material processing operations (as defined in §60.671).

(b) An affected facility that is subject to the provisions of subparts F or I of this part or that follows in the plant process any facility subject to the provisions of subparts F or I of this part is not subject to the provisions of this subpart.

(c) Facilities at the following plants are not subject to the provisions of this subpart:

(1) Fixed sand and gravel plants and crushed stone plants with capacities, as defined in §60.671, of 23 megagrams per hour (25 tons per hour) or less;

(2) Portable sand and gravel plants and crushed stone plants with capacities, as defined in §60.671, of 136 megagrams per hour (150 tons per hour) or less; and

(3) Common clay plants and pumice plants with capacities, as defined in §60.671, of 9 megagrams per hour (10 tons per hour) or less.

(d)(1) When an existing facility is replaced by a piece of equipment of equal or smaller size, as defined in §60.671, having the same function as the existing facility, and there is no increase in the amount of emissions, the new facility is exempt from the provisions of §§60.672, 60.674, and 60.675 except as provided for in paragraph (d)(3) of this section.

(2) An owner or operator complying with paragraph (d)(1) of this section shall submit the information required in §60.676(a).

(3) An owner or operator replacing all existing facilities in a production line with new facilities does not qualify for the exemption described in paragraph (d)(1) of this section and must comply with the provisions of §§60.672, 60.674 and 60.675.

(e) An affected facility under paragraph (a) of this section that commences construction, modification, or reconstruction after August 31, 1983, is subject to the requirements of this part.

(f) Table 1 of this subpart specifies the provisions of subpart A of this part 60 that do not apply to owners and operators of affected facilities subject to this subpart or that apply with certain exceptions.

Because the project contains crushers, grinding mills, screening operations, belt conveyors, and storage bins in a fixed or portable nonmetallic mineral processing plant, which are proposed to commence construction after August 31, 1983, requirements in Subpart OOO are applicable. The portable crushing and screening plants (PCSP1, PCSP2) will be rated at below 150 tons per hour (T/hr), and are therefore not subject to the provisions of Subpart OOO.

40 CFR 60, Subpart OOO is incorporated by reference into Permit Condition 2.212~~.23~~, and specific applicable requirements will be incorporated into the Tier I operating permit.

40 CFR 60, Subpart IIII..... Standards of Performance for ~~Nonmetallic Mineral Processing Plants~~Stationary Compression Ignition Internal Combustion Engines

§60.4200..... Am I subject to this subpart?

(a) The provisions of this subpart are applicable to manufacturers, owners, and operators of stationary compression ignition (CI) internal combustion engines (ICE) and other persons as specified in paragraphs (a)(1) through (4) of this section. For the purposes of this subpart, the date that construction commences is the date the engine is ordered by the owner or operator.

(1) Manufacturers of stationary CI ICE with a displacement of less than 30 liters per cylinder where the model year is:

(i) 2007 or later, for engines that are not fire pump engines;

(ii) The model year listed in Table 3 to this subpart or later model year, for fire pump engines.

(2) Owners and operators of stationary CI ICE that commence construction after July 11, 2005, where the stationary CI ICE are:

(i) Manufactured after April 1, 2006, and are not fire pump engines, or

(ii) Manufactured as a certified National Fire Protection Association (NFPA) fire pump engine after July 1, 2006.

(3) Owners and operators of any stationary CI ICE that are modified or reconstructed after July 11, 2005 and any person that modifies or reconstructs any stationary CI ICE after July 11, 2005.

(4) The provisions of §60.4208 of this subpart are applicable to all owners and operators of stationary CI ICE that commence construction after July 11, 2005.

(b) The provisions of this subpart are not applicable to stationary CI ICE being tested at a stationary CI ICE test cell/stand.

(c) If you are an owner or operator of an area source subject to this subpart, you are exempt from the obligation to obtain a permit under 40 CFR part 70 or 40 CFR part 71, provided you are not required to obtain a permit under 40 CFR 70.3(a) or 40 CFR 71.3(a) for a reason other than your status as an area source under this subpart. Notwithstanding the previous sentence, you must continue to comply with the provisions of this subpart applicable to area sources.

(d) Stationary CI ICE may be eligible for exemption from the requirements of this subpart as described in 40 CFR part 1068, subpart C (or the exemptions described in 40 CFR part 89, subpart J and 40 CFR part 94, subpart J, for engines that would need to be certified to standards in those parts), except that owners and operators, as well as manufacturers, may be eligible to request an exemption for national security.

(e) Owners and operators of facilities with CI ICE that are acting as temporary replacement units and that are located at a stationary source for less than 1 year and that have been properly certified as meeting the standards that would be applicable to such engine under the appropriate nonroad engine provisions, are not required to meet any other provisions under this subpart with regard to such engines.

Because the permittee will own or operate compression ignition (CI) internal combustion engines (ICE) which are proposed to commence construction after July 11, 2005 and which will be ordered after April 1, 2006 for the emergency generator engines, and which will be ordered after July 1, 2006 for the fire pump engine, requirements in Subpart IIII are applicable. The permittee has not requested or qualified for exemption pursuant to §60.4200(b), (d), or (e).

40 CFR 60, Subpart IIII is incorporated by reference into Permit Condition 2.23, and specific applicable requirements will be incorporated into the Tier I operating permit.

NESHAP Applicability (40 CFR 61)

The facility is not subject to any NESHAP requirements in 40 CFR 61.

MACT/GACT Applicability (40 CFR 63)

The permittee has proposed to operate as a minor source of hazardous air pollutant (HAP) emissions, and has affected facilities subject to the following National Emission Standards for Hazardous Air Pollutants (NESHAP). The lime manufacturing plant is proposed at an area source of HAP, and therefore is not applicable to Subpart AAAAA. Applicability determinations and regulatory analyses are provided below.

- National Emission Standards for Hazardous Air Pollutants for Source Categories (NESHAP) 40 CFR 63, Subpart A – General Provisions. DEQ is delegated this Subpart for Tier I sources.
- NESHAP 40 CFR 63, Subpart ZZZZ – National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines (RICE). DEQ is delegated this Subpart. The emergency generator and fire pump engines (EDG1, EDG2, EDG3, and EDFP) are affected sources.
- NESHAP 40 CFR 63, Subpart CCCCCC – National Emission Standards for Hazardous Air Pollutants for Source Category: Gasoline Dispensing Facilities. DEQ is delegated this Subpart for Tier I sources. The gasoline fuel storage tanks (TG1, TG2) are affected sources.
- NESHAP 40 CFR 63, Subpart EEEEEEE – National Emission Standards for Hazardous Air Pollutants: Gold Mine Ore Processing and Production Area Source Category. DEQ is delegated this Subpart for Tier I sources. The collection of ore pretreatment processes and the carbon process with mercury retort are affected sources. Ore pretreatment processes include the autoclave (AC). Carbon processes with mercury retort include the electrowinning cells and pregnant solution tank (EW), the mercury retort (MR), induction melting furnace (MF), and the carbon regeneration kiln (CKD).

40 CFR 63, Subpart A ..... General Provisions

§63.1 ..... Applicability.

(a) General. *(1) Terms used throughout this part are defined in §63.2 or in the Clean Air Act (Act) as amended in 1990, except that individual subparts of this part may include specific definitions in addition to or that supersede definitions in §63.2.*

(2) This part contains national emission standards for hazardous air pollutants (NESHAP) established pursuant to section 112 of the Act as amended November 15, 1990. These standards regulate specific categories of stationary sources that emit (or have the potential to emit) one or more hazardous air pollutants listed in this part pursuant to section 112(b) of the Act. This section explains the applicability of such standards to sources affected by them. The standards in this part are independent of NESHAP contained in 40 CFR part 61. The NESHAP in part 61 promulgated by signature of the Administrator before November 15, 1990 (i.e., the date of enactment of the Clean Air Act Amendments of 1990) remain in effect until they are amended, if appropriate, and added to this part.

(3) No emission standard or other requirement established under this part shall be interpreted, construed, or applied to diminish or replace the requirements of a more stringent emission limitation or other applicable requirement established by the Administrator pursuant to other authority of the Act (section 111, part C or D or any other authority of this Act), or a standard issued under State authority. The Administrator may specify in a specific standard under this part that facilities subject to other provisions under the Act need only comply with the provisions of that standard.

(4)(i) Each relevant standard in this part 63 must identify explicitly whether each provision in this subpart A is or is not included in such relevant standard.

(ii) If a relevant part 63 standard incorporates the requirements of 40 CFR part 60, part 61 or other part 63 standards, the relevant part 63 standard must identify explicitly the applicability of each corresponding part 60, part 61, or other part 63 subpart A (General) provision.

(iii) The General Provisions in this subpart A do not apply to regulations developed pursuant to section 112(r) of the amended Act, unless otherwise specified in those regulations.

…

(b) Initial applicability determination for this part*. (1) The provisions of this part apply to the owner or operator of any stationary source that—*

(i) Emits or has the potential to emit any hazardous air pollutant listed in or pursuant to section 112(b) of the Act; and

(ii) Is subject to any standard, limitation, prohibition, or other federally enforceable requirement established pursuant to this part.

(2) [Reserved]

(3) An owner or operator of a stationary source who is in the relevant source category and who determines that the source is not subject to a relevant standard or other requirement established under this part must keep a record as specified in §63.10(b)(3).

Because the permittee will own or operate stationary sources that emit HAP which are subject to standards, limitations, prohibitions, or other federally-enforceable requirements established pursuant to NESHAP, provisions in Subpart A are applicable.

40 CFR 63, Subpart A is incorporated by reference into Permit Condition 2.23, and specific applicable requirements will be incorporated into the Tier I operating permit.

40 CFR 63, Subpart ZZZZ..... ~~*General Provisions*~~*National Emissions Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines*

§63.6580..... *What is the purpose of subpart ZZZZ?*

Subpart ZZZZ establishes national emission limitations and operating limitations for hazardous air pollutants (HAP) emitted from stationary reciprocating internal combustion engines (RICE) located at major and area sources of HAP emissions. This subpart also establishes requirements to demonstrate initial and continuous compliance with the emission limitations and operating limitations.

§63.6585..... *Am I subject to this subpart?*

You are subject to this subpart if you own or operate a stationary RICE at a major or area source of HAP emissions, except if the stationary RICE is being tested at a stationary RICE test cell/stand.

(a) A stationary RICE is any internal combustion engine which uses reciprocating motion to convert heat energy into mechanical work and which is not mobile. Stationary RICE differ from mobile RICE in that a stationary RICE is not a non-road engine as defined at 40 CFR 1068.30, and is not used to propel a motor vehicle or a vehicle used solely for competition.

(b) A major source of HAP emissions is a plant site that emits or has the potential to emit any single HAP at a rate of 10 tons (9.07 megagrams) or more per year or any combination of HAP at a rate of 25 tons (22.68 megagrams) or more per year, except that for oil and gas production facilities, a major source of HAP emissions is determined for each surface site.

(c) An area source of HAP emissions is a source that is not a major source.

(d) If you are an owner or operator of an area source subject to this subpart, your status as an entity subject to a standard or other requirements under this subpart does not subject you to the obligation to obtain a permit under 40 CFR part 70 or 71, provided you are not required to obtain a permit under 40 CFR 70.3(a) or 40 CFR 71.3(a) for a reason other than your status as an area source under this subpart. Notwithstanding the previous sentence, you must continue to comply with the provisions of this subpart as applicable.

(e) If you are an owner or operator of a stationary RICE used for national security purposes, you may be eligible to request an exemption from the requirements of this subpart as described in 40 CFR part 1068, subpart C.

(f) The emergency stationary RICE listed in paragraphs (f)(1) through (3) of this section are not subject to this subpart. The stationary RICE must meet the definition of an emergency stationary RICE in §63.6675, which includes operating according to the provisions specified in §63.6640(f).

(1) Existing residential emergency stationary RICE located at an area source of HAP emissions that do not operate or are not contractually obligated to be available for more than 15 hours per calendar year for the purposes specified in §63.6640(f)(2)(ii) and (iii) and that do not operate for the purpose specified in §63.6640(f)(4)(ii).

(2) Existing commercial emergency stationary RICE located at an area source of HAP emissions that do not operate or are not contractually obligated to be available for more than 15 hours per calendar year for the purposes specified in §63.6640(f)(2)(ii) and (iii) and that do not operate for the purpose specified in §63.6640(f)(4)(ii).

(3) Existing institutional emergency stationary RICE located at an area source of HAP emissions that do not operate or are not contractually obligated to be available for more than 15 hours per calendar year for the purposes specified in §63.6640(f)(2)(ii) and (iii) and that do not operate for the purpose specified in §63.6640(f)(4)(ii).

Because the permittee will own or operate stationary RICE at an area source of HAP which are subject to standards, limitations, prohibitions, or other federally-enforceable requirements established pursuant to NESHAP, requirements in Subpart ZZZZ are applicable.

40 CFR 63, Subpart ZZZZ is incorporated by reference into Permit Condition 2.23, and specific applicable requirements will be incorporated into the Tier I operating permit.

40 CFR 63, Subpart AAAAA..... ~~General Provisions~~National Emission Standards for Hazardous Air Pollutants for Lime Manufacturing Plants

§63.7080..... What is the purpose of this subpart?

This subpart establishes national emission standards for hazardous air pollutants (NESHAP) for lime manufacturing plants. This subpart also establishes requirements to demonstrate initial and continuous compliance with the emission limitations.

§63.7081..... Am I subject to this subpart?

(a) You are subject to this subpart if you own or operate a lime manufacturing plant (LMP) that is a major source, or that is located at, or is part of, a major source of hazardous air pollutant (HAP) emissions, unless the LMP is located at a kraft pulp mill, soda pulp mill, sulfite pulp mill, beet sugar manufacturing plant, or only processes sludge containing calcium carbonate from water softening processes.

(1) An LMP is an establishment engaged in the manufacture of lime product (calcium oxide, calcium oxide with magnesium oxide, or dead burned dolomite) by calcination of limestone, dolomite, shells or other calcareous substances.

(2) A major source of HAP is a plant site that emits or has the potential to emit any single HAP at a rate of 9.07 megagrams (10 tons) or more per year or any combination of HAP at a rate of 22.68 megagrams (25 tons) or more per year from all emission sources at the plant site.

(b) [Reserved]

§63.7143..... What definitions apply to this subpart?

Terms used in this subpart are defined in the Clean Air Act, in §63.2, and in this section as follows:

...

Lime manufacturing plant (LMP) *means any plant which uses a lime kiln to produce lime product from limestone or other calcareous material by calcination.*

Lime product *means the product of the lime kiln calcination process including, calcitic lime, dolomitic lime, and dead-burned dolomite.*

Limestone *means the material comprised primarily of calcium carbonate (referred to sometimes as calcitic or high calcium limestone), magnesium carbonate, and/or the double carbonate of both calcium and magnesium (referred to sometimes as dolomitic limestone or dolomite).*

...

The lime manufacturing plant is proposed at an area source of HAP, and therefore is not subject to this Subpart.

40 CFR 60, Subpart CCCCCC..... ~~General Provisions~~National Emission Standards for Hazardous Air Pollutants for Source Category: Gasoline Dispensing Facilities

§63.11110..... What is the purpose of this subpart?

This subpart establishes national emission limitations and management practices for hazardous air pollutants (HAP) emitted from the loading of gasoline storage tanks at gasoline dispensing facilities (GDF). This subpart also establishes requirements to demonstrate compliance with the emission limitations and management practices.

§63.11111..... Am I subject to the requirements in this subpart?

(a) The affected source to which this subpart applies is each GDF that is located at an area source. The affected source includes each gasoline cargo tank during the delivery of product to a GDF and also includes each storage tank.

(b) If your GDF has a monthly throughput of less than 10,000 gallons of gasoline, you must comply with the requirements in §63.11116.

(c) If your GDF has a monthly throughput of 10,000 gallons of gasoline or more, you must comply with the requirements in §63.11117.

(d) If your GDF has a monthly throughput of 100,000 gallons of gasoline or more, you must comply with the requirements in §63.11118.

(e) An affected source shall, upon request by the Administrator, demonstrate that their monthly throughput is less than the 10,000-gallon or the 100,000-gallon threshold level, as applicable. For new or reconstructed affected sources, as specified in §63.11112(b) and (c), recordkeeping to document monthly throughput must begin upon startup of the affected source. For existing sources, as specified in §63.11112(d), recordkeeping to document monthly throughput must begin on January 10, 2008. For existing sources that are subject to this subpart only because they load gasoline into fuel tanks other than those in motor vehicles, as defined in §63.11132, recordkeeping to document monthly throughput must begin on January 24, 2011. Records required under this paragraph shall be kept for a period of 5 years.

(f) If you are an owner or operator of affected sources, as defined in paragraph (a) of this section, you are not required to obtain a permit under 40 CFR part 70 or 40 CFR part 71 as a result of being subject to this subpart. However, you must still apply for and obtain a permit under 40 CFR part 70 or 40 CFR part 71 if you meet one or more of the applicability criteria found in 40 CFR 70.3(a) and (b) or 40 CFR 71.3(a) and (b).

(g) The loading of aviation gasoline into storage tanks at airports, and the subsequent transfer of aviation gasoline within the airport, is not subject to this subpart.

(h) Monthly throughput is the total volume of gasoline loaded into, or dispensed from, all the gasoline storage tanks located at a single affected GDF. If an area source has two or more GDF at separate locations within the area source, each GDF is treated as a separate affected source.

(i) If your affected source's throughput ever exceeds an applicable throughput threshold, the affected source will remain subject to the requirements for sources above the threshold, even if the affected source throughput later falls below the applicable throughput threshold.

(j) The dispensing of gasoline from a fixed gasoline storage tank at a GDF into a portable gasoline tank for the on-site delivery and subsequent dispensing of the gasoline into the fuel tank of a motor vehicle or other gasoline-fueled engine or equipment used within the area source is only subject to §63.11116 of this subpart.

(k) For any affected source subject to the provisions of this subpart and another Federal rule, you may elect to comply only with the more stringent provisions of the applicable subparts. You must consider all provisions of the rules, including monitoring, recordkeeping, and reporting. You must identify the affected source and provisions with which you will comply in your Notification of Compliance Status required under §63.11124. You also must demonstrate in your Notification of Compliance Status that each provision with which you will comply is at least as stringent as the otherwise applicable requirements in this subpart. You are responsible for making accurate determinations concerning the more stringent provisions, and noncompliance with this rule is not excused if it is later determined that your determination was in error, and, as a result, you are violating this subpart. Compliance with this rule is your responsibility and the Notification of Compliance Status does not alter or affect that responsibility.

§63.11132 ..... What definitions apply to this subpart?

As used in this subpart, all terms not defined herein shall have the meaning given them in the Clean Air Act (CAA), or in subparts A and BBBBBB of this part. For purposes of this subpart, definitions in this section supersede definitions in other parts or subparts.

Dual-point vapor balance system *means a type of vapor balance system in which the storage tank is equipped with an entry port for a gasoline fill pipe and a separate exit port for a vapor connection.*

Gasoline *means any petroleum distillate or petroleum distillate/alcohol blend having a Reid vapor pressure of 27.6 kilopascals or greater, which is used as a fuel for internal combustion engines.*

Gasoline cargo tank *means a delivery tank truck or railcar which is loading or unloading gasoline, or which has loaded or unloaded gasoline on the immediately previous load.*

Gasoline dispensing facility (GDF) *means any stationary facility which dispenses gasoline into the fuel tank of a motor vehicle, motor vehicle engine, nonroad vehicle, or nonroad engine, including a nonroad vehicle or nonroad engine used solely for competition. These facilities include, but are not limited to, facilities that dispense gasoline into on- and off-road, street, or highway motor vehicles, lawn equipment, boats, test engines, landscaping equipment, generators, pumps, and other gasoline-fueled engines and equipment.*

Monthly throughput *means the total volume of gasoline that is loaded into, or dispensed from, all gasoline storage tanks at each GDF during a month. Monthly throughput is calculated by summing the volume of gasoline loaded into, or dispensed from, all gasoline storage tanks at each GDF during the current day, plus the total volume of gasoline loaded into, or dispensed from, all gasoline storage tanks at each GDF during the previous 364 days, and then dividing that sum by 12.*

Motor vehicle *means any self-propelled vehicle designed for transporting persons or property on a street or highway.*

Nonroad engine *means an internal combustion engine (including the fuel system) that is not used in a motor vehicle or a vehicle used solely for competition, or that is not subject to standards promulgated under section 7411 of this title or section 7521 of this title.*

Nonroad vehicle *means a vehicle that is powered by a nonroad engine, and that is not a motor vehicle or a vehicle used solely for competition.*

Submerged filling *means, for the purposes of this subpart, the filling of a gasoline storage tank through a submerged fill pipe whose discharge is no more than the applicable distance specified in §63.11117(b) from the bottom of the tank. Bottom filling of gasoline storage tanks is included in this definition.*

Vapor balance system *means a combination of pipes and hoses that create a closed system between the vapor spaces of an unloading gasoline cargo tank and a receiving storage tank such that vapors displaced from the storage tank are transferred to the gasoline cargo tank being unloaded.*

Vapor-tight *means equipment that allows no loss of vapors. Compliance with vapor-tight requirements can be determined by checking to ensure that the concentration at a potential leak source is not equal to or greater than 100 percent of the Lower Explosive Limit when measured with a combustible gas detector, calibrated with propane, at a distance of 1 inch from the source.*

Vapor-tight gasoline cargo tank *means a gasoline cargo tank which has demonstrated within the 12 preceding months that it meets the annual certification test requirements in §63.11092(f) of this part.*

Because the permittee will own or operate a gasoline dispensing facility (GDF) at an area source of HAP, requirements in Subpart CCCCCC are applicable. Because the permittee has committed to loading and dispensing of less than 100,000 gallons of gasoline per month (gal/mo), the requirements of 40 CFR 63.11117 will become applicable in accordance with 40 CFR 63.11111(b) and (c). Gasoline loading and dispensing is limited by Permit Condition 2.17 to avoid requirements applicable to GDF exceeding 100,000 gal/mo, and requires recordkeeping in accordance with 40 CFR 63.11111(e).

40 CFR 63, Subpart CCCCCC is incorporated by reference into Permit Condition 2.23, and specific applicable requirements will be incorporated into the Tier I operating permit.

40 CFR 63, Subpart EEEEEEE..... National Emission Standards for Hazardous Air Pollutants: Gold Mine Ore Processing and Production Area Source Category

§40 CFR 63.11640..... Am I subject to this subpart?

(a) You are subject to this subpart if you own or operate a gold mine ore processing and production facility as defined in §63.11651, that is an area source.

(b) This subpart applies to each new or existing affected source. The affected sources are each collection of "ore pretreatment processes" at a gold mine ore processing and production facility, each collection of "carbon processes with mercury retorts" at a gold mine ore processing and production facility, each collection of "carbon processes without mercury retorts" at a gold mine ore processing and production facility, and each collection of "non-carbon concentrate processes" at a gold mine ore processing and production facility, as defined in §63.11651.

(1) An affected source is existing if you commenced construction or reconstruction of the affected source on or before April 28, 2010.

(2) An affected source is new if you commenced construction or reconstruction of the affected source after April 28, 2010.

(c) This subpart does not apply to research and development facilities, as defined in section 112(c)(7) of the Clean Air Act (CAA).

(d) If you own or operate a source subject to this subpart, you must have or you must obtain a permit under 40 CFR part 70 or 40 CFR part 71.

§40 CFR 63.11651..... What definitions apply to this subpart?

Terms used in this subpart are defined in the Clean Air Act, in §63.2, and in this section as follows:

Autoclave *means a pressure oxidation vessel that is used to treat gold ores (primarily sulfide refractory ore) and involves pumping a slurry of milled ore into the vessel which is highly pressurized with oxygen and heated to temperatures of approximately 350° to 430 °F.*

Calomel-based mercury control system *means a mercury emissions control system that uses scrubbers to remove mercury from the gas stream of a roaster or combination of roasters by complexing the mercury from the gas stream with mercuric chloride to form mercurous chloride (calomel). These scrubbers are also referred to as "mercury scrubbers."*

Carbon adsorber *means a control device consisting of a single fixed carbon bed, multiple carbon beds or columns, carbon filter packs or modules, and other variations that uses activated carbon to remove pollutants from a gas stream.*

Carbon kiln *means a kiln or furnace where carbon is regenerated by heating, usually in the presence of steam, after the gold has been stripped from the carbon.*

Carbon processes with mercury retorts *means the affected source that includes carbon kilns, preg tanks, electrowinning cells, mercury retorts, and melt furnaces at gold mine ore processing and production facilities that use activated carbon, or resins that can be used as a substitute for activated carbon, to recover (adsorb) gold from the pregnant cyanide solution.*

Carbon processes without mercury retorts *means the affected source that includes carbon kilns, preg tanks, electrowinning cells, and melt furnaces, but has no retorts, at gold mine ore processing and production facilities that use activated carbon, or resins that can be used as a substitute for activated carbon, to recover (adsorb) gold from the pregnant cyanide solution.*

Concentrate *means the sludge-like material that is loaded with gold along with various other metals (such as silver, copper, and mercury) and various other substances, that is produced by electrowinning, the Merrill-Crowe process, flotation and gravity separation processes. Concentrate is measured as the input to mercury retorts, or for facilities without mercury retorts, as the input to melt furnaces before any drying takes place. For facilities without mercury retorts or melt furnaces, concentrate is measured as the quantity shipped.*

Deviation *means any instance where an affected source subject to this subpart, or an owner or operator of such a source:*

(1) Fails to meet any requirement or obligation established by this subpart, including but not limited to any emissions limitation or work practice standard;

(2) Fails to meet any term or condition that is adopted to implement an applicable requirement in this subpart and that is included in the operating permit for any affected source required to obtain such a permit; or

(3) Exceeds any operating limit established under this subpart.

Electrowinning *means a process that uses induced voltage on anode and cathode plates to remove metals from the continuous flow of solution, where the gold in solution is plated onto the cathode. Steel wool is typically used as the plating surface.*

Electrowinning Cells *means a tank in which the electrowinning takes place.*

Gold mine ore processing and production facility *means any industrial facility engaged in the processing of gold mine ore that uses any of the following processes: Roasting operations, autoclaves, carbon kilns, preg tanks, electrowinning, mercury retorts, or melt furnaces. Laboratories (see CAA section 112(c)(7)), individual prospectors, and very small pilot scale mining operations that processes or produces less than 100 pounds of concentrate per year are not a gold mine ore processing and production facility. A facility that produces primarily metals other than gold, such as copper, lead, zinc, or nickel (where these metals other than gold comprise 95 percent or more of the total metal production) that may also recover some gold as a byproduct is not a gold mine ore processing and production facility. Those facilities whereby 95 percent or more of total mass of metals produced are metals other than gold, whether final metal production is onsite or offsite, are not part of the gold mine ore processing and production source category.*

Melt furnace *means a furnace (typically a crucible furnace) that is used for smelting the gold-bearing material recovered from mercury retorting, or the gold-bearing material from electrowinning, the Merrill-Crowe process, or other processes for facilities without mercury retorts.*

Mercury retort *means a vessel that is operated under a partial vacuum at approximately 1,100° to 1,300 °F to remove mercury and moisture from the gold bearing sludge material that is recovered from electrowinning, the Merrill-Crowe process, or other processes. Mercury retorts are usually equipped with condensers that recover liquid mercury during the processing.*

Merrill-Crowe process *means a precipitation technique using zinc oxide for removing gold from a cyanide solution. Zinc dust is added to the solution, and gold is precipitated to produce a concentrate.*

Non-carbon concentrate processes *means the affected source that includes mercury retorts and melt furnaces at gold mine ore processing and production facilities that use the Merrill-Crowe process or other processes and do not use carbon (or resins that substitute for carbon) to recover (adsorb) gold from the pregnant cyanide solution.*

Ore dry grinding *means a process in which the gold ore is ground and heated (dried) prior to additional preheating or prior to entering the roaster.*

Ore preheating *means a process in which ground gold ore is preheated prior to entering the roaster.*

Ore pretreatment processes *means the affected source that includes roasting operations and autoclaves that are used to pre-treat gold mine ore at gold mine ore processing and production facilities prior to the cyanide leaching process.*

Pregnant solution tank (or preg tank) *means a storage tank for pregnant solution, which is the cyanide solution that contains gold-cyanide complexes that is generated from leaching gold ore with cyanide solution.*

Pregnant cyanide solution *means the cyanide solution that contains gold-cyanide complexes that are generated from leaching gold ore with a dilute cyanide solution.*

Quenching *means a process in which the hot calcined ore is cooled and quenched with water after it leaves the roaster.*

Roasting operation *means a process that uses an industrial furnace in which milled ore is combusted across a fluidized bed to oxidize and remove organic carbon and sulfide mineral grains in refractory gold ore. The emissions points of the roasting operation subject to this subpart include ore dry grinding, ore preheating, the roaster stack, and quenching.*

Because the permittee will own or operate a gold mine ore processing and production facility at an area source of HAP, requirements in Subpart EEEEEEE are applicable. The collection of ore pretreatment processes and the carbon process with mercury retort are affected sources. Ore pretreatment processes include the autoclave (AC). Carbon processes with mercury retort include the electrowinning cells and pregnant solution tank (EW), the mercury retort (MR), induction melting furnace (MF), and the carbon regeneration kiln (CKD).

Any source subject to 40 CFR 63, Subpart EEEEEEE is a Tier I source as defined in IDAPA 58.01.01.006.122.c. In accordance with IDAPA 58.01.01.313.01.b., 40 CFR 70.3(c)(2), and 40 CFR 63.11640(d), the permittee must submit a complete application to DEQ for an initial Tier I operating permit within 12 months of becoming a Tier I source.

This subpart includes mercury emissions limits for the collection of new ore pretreatment processes and for the new carbon processes with mercury retort. This subpart also requires weight measurement devices for measuring ore throughput for the autoclave (AC) and ~~ore concentrate~~mineral-bearing solution throughput for the electrowinning cells and pregnant solution tank (EW). Requires monitoring of mercury emissions, and monitoring of either inlet gas temperature for each process unit with a carbon filter (EW, MR, MF, CKD) or both water flow and pressure drop for each process unit with a wet scrubber not followed by a carbon filter (AC).

40 CFR 63, Subpart EEEEEEE is incorporated by reference into Permit Condition 2.23, and specific applicable requirements will be incorporated into the Tier I operating permit.

Permit Conditions Review

This section describes the permit conditions for this initial permit.

Permit Conditions 1.1–1.2

These permit conditions describe the purpose of this permitting action and the emission sources and the control equipment regulated by this permit. This reflects information presented in the application and relied upon in the development of emissions inventories, and in the evaluation of ambient air impacts in the modeling analyses. Refer to the Emissions Inventories and the Ambient Air Quality Impact Analyses sections for additional information concerning these analyses.

Because specific vendor and manufacturer information was unavailable at the time of permitting, documentation and testing requirements were included (Permit Condition 2.19) to verify consistency with the information specified in the application. Production values ~~limits~~ were based on process flow diagrams and engineering design information provided.

Permit Conditions 2.1–2.7

These permit conditions incorporate fugitive dust emission control requirements ~~limits~~ (Permit Condition 2.1) in accordance with IDAPA 58.01.01.650-651. Compliance is ensured by implementing reasonable control precautions and corrective actions when appropriate, excluding public access to operations, and complying with inspection, monitoring, recordkeeping, and notification requirements. Specific precautions are identified and required in the fugitive dust control plan (FDCP), and specific measures to control public access within the operations boundary are identified in and required by the Access Control Plan (ACP) (Permit Conditions 2.5 and 2.6, respectively).

Reduction of PM emissions from each of the identified conveyors by 80% was supported by assuming location of these material transfers at below grade (OC9, OC10) or enclosure on all sides (OC11), as specified. Reduction of PM emissions from haul roads by a combined 93.3% was supported by assuming appropriate application ~~liberal use~~ of water and magnesium chloride dust suppression; DEQ is cognizant that to consistently achieve this level of control requires conscientious efforts, vigilant inspection and monitoring, and a comprehensive FDCP. Maximum monthly haul mileage was based on the maximum operating scenario mileage (W3 = 16,415 mi/day ≈ 490,000 mi/mo). Because continuous operation was proposed, suppression measures will need to account for and accommodate all weather conditions including diurnal and seasonal variability, and all traffic loads including mining and public traffic along publicly accessible roads. Conditions outside of what may normally be anticipated may require additional measures such as a reduction in vehicle speeds or selection of a more effective chemical dust suppressant. Although the FDCP specifies a minimum of efforts required, additional operational limits and monitoring are to be considered moving forward and evaluated for incorporation into the FDCP comply with IDAPA 50.01.01.650-651 ~~to achieve this level of control~~ under all conditions and all operating scenarios. Certification of employees for visible emission inspections, training and orientation of relevant employees, and evaluation of FDCP requirements on at least a semi-annual basis are also required.

Comment [A11]: Please update this frequency per comments provided on the draft PTC.

Access control measures are described in the Ambient Air Boundary section of the application (Section 5.6), and address primary access points, secondary access points, and surveillance.

Permit Conditions 2.8–2.11

These permit conditions incorporate visible emission control requirements ~~limits~~ (Permit Condition 2.8) in accordance with IDAPA 58.01.01.625. Compliance is ensured by implementing corrective actions when appropriate and complying with inspection, monitoring, and recordkeeping requirements. Certification of employees for visible emission inspections, is also required.

Permit Condition 2.12

This permit condition incorporates PM emission limits for process equipment as defined in IDAPA 58.01.01.006, in accordance with IDAPA 58.01.01.700-703, which includes ~~all mining,~~ ore processing, ore concentration and refining, lime production, aggregate production, and concrete production equipment (Table 1). Compliance with operational and material throughput limits (Permit Conditions 3.3–3.8, 4.4–4.10, and 5.4–5.8) and control equipment requirements (Permit Conditions 2.5, 3.9–3.11, 4.11–4.16, and 5.9–5.16) and associated monitoring were considered adequate to ensure compliance with process weight-based PM emission limitations.

Comment [A12]: "all mining" is not mentioned in the draft PTC

Permit Conditions 2.13–2.14 incorporate odorous emission limits in accordance with IDAPA 58.01.01.776.01. Compliance is ensured by complying with monitoring and recordkeeping requirements, including corrective action when appropriate.

Permit Conditions 2.15–2.16 incorporate sulfur content limits for distillate fuel oil, in accordance with IDAPA 58.01.01.725. Compliance is ensured by complying with monitoring and recordkeeping requirements.

Permit Conditions 2.17–2.18 limit facility-wide gasoline fuel throughput. Limiting gasoline throughput limits PTE, ensures avoidance of Subpart CCCCCC requirements applicable to GDF exceeding 100,000 gal/mo, and requires recordkeeping in accordance with 40 CFR 63.11111(e). Compliance is ensured by complying with monitoring and recordkeeping requirements.

Permit Conditions 2.19–2.20 require developing and complying with the requirements of an O&M manual to ensure compliance with control equipment maintenance and operation general provisions (Permit Condition 7.2). Documentation of as-built process equipment specifications and control equipment performance guarantees and establishing control equipment operating parameters and procedures were required, since these were relied upon in the development of emissions inventories, and in the evaluation of ambient air impacts in the modeling analyses. Compliance is ensured by complying with monitoring and recordkeeping requirements.

Permit Conditions 2.21–2.23 incorporate applicable general compliance, notification, recordkeeping, reporting, applicable general provisions, and other federal requirements by reference in accordance with IDAPA 58.01.01.107.03 and 590-591. Compliance is ensured by complying with applicable federal testing, monitoring, recordkeeping, and reporting requirements.

These permit conditions specify that with regard to permit conditions referenced in accordance with federal requirements (i.e., NSPS and NESHAP requirements), should there be a conflict between the language of the permit condition and the language of the requirement, the language of the requirement shall govern. The permittee is also required to obtain a Tier I operation permit within 12 months of commencement of operation of any ore concentration and refining equipment (i.e., NESHAP 7E affected sources). Refer to NSPS Applicability (40 CFR 60) and MACT/GACT Applicability (40 CFR 63) sections for additional information concerning applicable requirements.

Permit Condition 2.24 specifies recommended test methods to be used when performance testing is required, unless otherwise specified in the permit, in accordance with IDAPA 58.01.01.157. The permittee is required to comply with notification and reporting requirements and is encouraged to submit performance test protocol to DEQ for approval prior to any performance testing in accordance with the performance testing general provisions (Permit Condition 7.7–7.9).

Permit Condition 2.25 provides DEQ agency contact information.

Permit Conditions 3.1–3.2

These permit conditions describe mining and ore processing equipment and controls. This reflects information presented in the application and relied upon in the development of emissions inventories, and in the evaluation of ambient air impacts in the modeling analyses.

Permit Conditions 3.3–3.8 and 3.12–3.17 establish limits on material throughput and production. These limits were relied upon in the development of emissions inventories and in the evaluation of ambient air impacts in the modeling analyses. Overall mine throughput is limited by hauling and excavating limits (Permit Condition 3.5). Compliance is ensured by complying with monitoring and recordkeeping requirements (Permit Conditions 3.12–3.17).

Permit Conditions 3.9–3.11 require measures to include in the facility's FDCP~~control fugitive emissions~~. Use of ~~building enclosures and~~ reasonable controls were relied upon in the development of emissions inventories and in the evaluation of ambient air impacts in the modeling analyses. Compliance is ensured by complying with fugitive dust monitoring and recordkeeping requirements (Permit Conditions 2.1–2.7).

Comment [A13]: Building enclosures were not relied upon in the emissions inventories for the crushers.

Permit Conditions 4.1–4.2

These permit conditions describe ore concentration and refining equipment and controls. This reflects information presented in the application and relied upon in the development of emissions inventories, and in the evaluation of ambient air impacts in the modeling analyses.

Permit Condition 4.3 and 4.30–4.31 establish emissions limits for ore concentration and refining equipment, consistent with estimates relied upon in the development of emissions inventories and in the evaluation of ambient air impacts in the modeling analyses for these sources. A sulfuric acid emission limit consistent with the modeled TAP emission rate from the autoclave was established in accordance with IDAPA 58.01.01.210.08. Compliance is ensured by complying with equipment operating and testing requirements (Permit Conditions 4.4–4.16, and 4.30–4.31).

Permit Conditions 4.4–4.10 and 4.17–4.23 limit operations of ore concentration and refining process equipment, consistent with the hours of operation and material throughput assumptions relied upon in the development of emissions inventories and in the evaluation of ambient air impacts in the modeling analyses for these sources. Compliance is ensured by complying with monitoring and recordkeeping requirements (Permit Conditions 4.16–4.23).

Permit Conditions 4.11–4.16 and 4.24–4.29 require control equipment for ore concentration and refining processes, consistent with controls relied upon in the development of emissions inventories and in the evaluation of ambient air impacts in the modeling analyses. Compliance is ensured by complying with monitoring and recordkeeping requirements (Permit Conditions 4.24–4.29).

Permit Condition requires testing of ore concentration and refining emission sources to demonstrate compliance with emissions limits (Permit Condition 4.3).

Permit Conditions 5.1–5.2

These permit conditions describe lime, aggregate, and concrete production equipment and controls. This reflects information presented in the application and relied upon in the development of emissions inventories, and in the evaluation of ambient air impacts in the modeling analyses.

Permit Condition 5.3 establishes emissions limits for lime, aggregate, and concrete production equipment, consistent with estimates relied upon in the development of emissions inventories and in the evaluation of ambient air impacts in the modeling analyses for these sources. Compliance is ensured by complying with equipment operating requirements (Permit Conditions 5.4–5.16).

Permit Conditions 5.4–5.8 and 5.17–5.21 limit operations of each lime, aggregate, and concrete production process equipment, consistent with material throughput assumptions relied upon in the development of emissions inventories and in the evaluation of ambient air impacts in the modeling analyses for these sources. Compliance is ensured by complying with monitoring and recordkeeping requirements (Permit Conditions 5.16–5.21).

Permit Conditions 5.9–5.11 require measures to ~~control fugitive emissions~~include in the facility's FDCP. Use of water sprays, building enclosures, and reasonable controls were relied upon in the development of emissions inventories and in the evaluation of ambient air impacts in the modeling analyses. Compliance is ensured by complying with fugitive dust monitoring and recordkeeping requirements (Permit Conditions 2.1–2.7).

Permit Conditions 5.12–5.16 and 5.22–5.25 require control equipment for lime, aggregate, and concrete production processes, consistent with controls relied upon in the development of emissions inventories and in the evaluation of ambient air impacts in the modeling analyses. Compliance is ensured by complying with monitoring and recordkeeping requirements (Permit Conditions 5.22–5.25).

Permit Condition 6.1

This permit condition describes the emergency power generation equipment. This reflects information presented in the application and relied upon in the development of emissions inventories, and in the evaluation of ambient air impacts in the modeling analyses.

Permit Conditions 6.2 and 6.3–6.4 limit operations of each emergency power generation engine, consistent with the purpose and hours of operation assumptions relied upon in the development of emissions inventories, in the determination of federal regulatory applicability, and in the evaluation of ambient air impacts in the modeling analyses for these sources. Compliance is ensured by complying with monitoring, recordkeeping, and notification requirements (Permit Conditions 6.3–6.4).

Permit Condition 7.1

The duty to comply general compliance provision requires that the permittee comply with all of the permit terms and conditions pursuant to Idaho Code §39-101.

Permit Condition 7.2

The maintenance and operation general compliance provision requires that the permittee maintain and operate all treatment and control facilities at the facility in accordance with IDAPA 58.01.01.211.

Permit Condition 7.3

The obligation to comply general compliance provision specifies that no permit condition is intended to relieve or exempt the permittee from compliance with applicable state and federal requirements, in accordance with IDAPA 58.01.01.212.01.

Permit Condition 7.4

The inspection and entry provision requires that the permittee allow DEQ inspection and entry pursuant to Idaho Code §39-108.

Permit Condition 7.5

The permit expiration construction and operation provision specifies that the permit expires if construction has not begun within two years of permit issuance or if construction has been suspended for a year in accordance with IDAPA 58.01.01.211.02.

Permit Condition 7.6

The notification of construction and operation provision requires that the permittee notify DEQ of the dates of construction and operation, in accordance with IDAPA 58.01.01.211.01 and 211.03.

Permit Condition 7.7

The performance testing notification of intent provision requires that the permittee notify DEQ at least 15 days prior to any performance test to provide DEQ the option to have an observer present, in accordance with IDAPA 58.01.01.157.03.

Permit Condition 7.8

The performance test protocol provision requires that any performance testing be conducted in accordance with the procedures of IDAPA 58.01.01.157 and encourages the permittee to submit a protocol to DEQ for approval prior to testing.

Permit Condition 7.9

The performance test report provision requires that the permittee report any performance test results to DEQ within 60 days of completion, in accordance with IDAPA 58.01.01.157.04-05.

Permit Condition 7.10

The monitoring and recordkeeping provision requires that the permittee maintain sufficient records to ensure compliance with permit conditions, in accordance with IDAPA 58.01.01.211.

Permit Condition 7.11

The excess emissions provision requires that the permittee follow the procedures required for excess emissions events, in accordance with IDAPA 58.01.01.130-136.

Permit Condition 7.12

The certification provision requires that a responsible official certify all documents submitted to DEQ, in accordance with IDAPA 58.01.01.123.

Permit Condition 7.13

The false statement provision requires that no person make false statements, representations, or certifications, in accordance with IDAPA 58.01.01.125.

Permit Condition 7.14

The tampering provision requires that no person render inaccurate any required monitoring device or method, in accordance with IDAPA 58.01.01.126.

Permit Condition 7.15

The transferability provision specifies that this permit to construct is transferable, in accordance with the procedures of IDAPA 58.01.01.209.06.

Permit Condition 7.16

The severability provision specifies that permit conditions are severable, in accordance with IDAPA 58.01.01.211.

PUBLIC REVIEW

Public Comment

An opportunity for public comment period on the application was provided in accordance with IDAPA 58.01.01.209.01.c. During this time, there was a request for a public comment period on DEQ's proposed action.

A public comment period was made available to the public in accordance with IDAPA 58.01.01.209.01.c.

Refer to the Application Chronology section for public comment opportunity and public comment period dates.

APPENDIX A – EMISSIONS INVENTORIES

APPENDIX B – AMBIENT AIR QUALITY IMPACT ANALYSES

APPENDIX C – FACILITY DRAFT COMMENTS

APPENDIX D – PROCESSING FEE

~~APPENDIX E – ACCESS MANAGEMENT PLAN~~

M E M O R A N D U M_DRAFT

DATE: July 31, 2020

TO: Morrie Lewis, Permit Writer, Air Program

FROM: Pao Baylon, Modeling Review Analyst, Air Program
Through Kevin Schilling, Modeling Supervisor, Air Program

PROJECT: P-2019.0047 PROJ 62288, Permit for an Open-pit Gold Mine and On-site Ore Preparation and Gold Extraction Operation located in Valley County, Idaho.

SUBJECT: Demonstration of Compliance with IDAPA 58.01.01.203.02 (NAAQS) and 203.03 (TAPs) as it relates to air quality impact analyses.

Contents

Acronyms, Units, and Chemical Nomenclature 3

1.0 Summary 6

2.0 Background Information 11

2.1 Project Description 11

2.2 Facility Location and Area Classification 12

2.3 Air Impact Analyses Required for All Permits to Construct 14

2.4 Significant Impact Level and Cumulative NAAQS Impact Analyses 15

2.5 Toxic Air Pollutant Analyses 17

3.0 Analytical Methods and Data 17

3.1 Emission Source Data 17

3.1.1 Criteria Pollutant Modeling Applicability and Modeled Emission Rates 19

3.1.2 TAPs Modeling Applicability and Modeled Emission Rates 25

3.1.3 Modeling Scenarios 26

3.1.4 Processing, Refining, and Ancillary Sources 28

3.1.5 Fugitive Sources: Blasting, Material Origin and Destination, and Underground Exploration Emissions 29

3.1.6 Fugitive Sources: Haul Roads 31

3.1.7 Fugitive Sources: Burntlog Route Access Road 34

3.1.8 Emission Release Parameters 34

3.1.9 Emission Release Parameter Justification 38

DRAFT

3.2 Background Concentrations 39
3.2.1 Onsite Particulate Monitoring 40
3.2.2 Gaseous Pollutant Background Concentrations 40
3.2.3 Medium-Traffic Pollutant Background Concentrations 41
3.3 Impact Modeling Methodology 41
3.3.1 General Overview of Impact Analyses 41
3.3.2 Modeling Protocol 42
3.3.3 Modeling Methodology 42
3.3.4 Model Selection 42
3.3.5 Meteorological Data 43
3.3.6 Effects of Terrain on Modeled Impacts 46
3.3.7 Facility Layout and Downwash 48
3.3.8 NOx Chemistry 48
3.3.9 Particulate Deposition 49
3.3.10 Ambient Air Boundary 51
3.3.11 Nearby Co-Contributing Sources 53
3.3.12 Receptor Network 53
3.3.13 Good Engineering Practice Stack Height 54
4.0 NAAQS and TAPs Impact Modeling Results 55
4.1 Results for NAAQS Analyses 55
4.1.1 Significant Impact Level Analyses 55
4.1.2 Cumulative NAAQS Impact Analyses 55
4.1.3 DEQ's Sensitivity Analyses for 1-hour and annual NO_2 58
4.1.4 DEQ's Weight-of-Evidence Analyses for 24-hour PM_{10} 58
4.1.5 DEQ's Sensitivity Analyses for a Lower Fugitive Road Dust Control Efficiency 65
4.2 Results for TAPs Impact Analyses 67
5.0 Conclusions 68
References 69

DRAFT

Acronyms, Units, and Chemical Nomenclature

AAC	Acceptable Ambient Concentration of a non-carcinogenic TAP
AACC	Acceptable Ambient Concentration of a Carcinogenic TAP
acfm	Actual cubic feet per minute
ADJ_U*	AERMOD Adjusted Friction Velocity Model Option
AERMAP	The terrain data preprocessor for AERMOD
AERMET	The meteorological data preprocessor for AERMOD
AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
Air Sciences	Air Sciences, Inc. (permittee's permitting and modeling consultant)
amsl	Above mean sea level
ANFO	Ammonium Nitrate Fuel Oil
Appendix W	40 CFR 51, Appendix W – Guideline on Air Quality Models
ASOS	Automated Surface Observing System
B_o	Bowen Ratio
BNF	Boise National Forest
BPIP	Building Profile Input Program
BRC	Below Regulatory Concern
BT	Bradley Tailings
BULKRN	Meteorological data processed using Bulk Richardson Method
CAPCOA	California Air Pollution Control Officers Association
CFR	Code of Federal Regulations
CMAQ	Community Multi-Scale Air Quality Modeling System
CO	Carbon Monoxide
CSIRO	Commonwealth Scientific and Industrial Research Organization
DEQ	Idaho Department of Environmental Quality
DR	Development Rock
DRSF	Development Rock Storage Facility
DV	Design Values
EF	Emission Factors
EFSFSR	East Fork of the South Fork of the Salmon River
EIS	Environmental Impact Statement
EL	Emissions Screening Level of a TAP
EPA	United States Environmental Protection Agency
FDRSF	Fiddle Development Rock Storage Facility
g/cm^3	Grams per Cubic Centimeter
GEP	Good Engineering Practice
H_2SO_4	Sulfuric Acid Gas
HAP	Hazardous Air Pollutant
HFDRSF	Hangar Flats Development Rock Storage Facility
HFP	Hangar Flats Pit
Hg	Mercury
hr	Hours
Idaho Air Rules	Rules for the Control of Air Pollution in Idaho, located in the Idaho Administrative Procedures Act 58.01.01

DRAFT

in	Inches
ISCST3	Industrial Source Complex Short Term 3 dispersion model
K	Kelvin
km	Kilometers
lb/hr	Pounds per hour
lb/yr	Pounds per year
LOM	Life of Mine
m	Meters
m/sec	Meters per second
MERPs	Modeled Emission Rates for Precursors
mg/m^3	Milligrams per Cubic Meter
Midas Gold	Midas Gold Idaho, Inc. (permittee)
MM	Million
MMBtu	Million British Thermal Units
mph	Miles per hour
NAAQS	National Ambient Air Quality Standards
NAD83	North American Datum of 1983
NED	National Elevation Dataset
NESHAP	National Emission Standards for Hazardous Air Pollutants
NO	Nitrogen Oxide
NO_2	Nitrogen Dioxide
NON-BULKRN	Meteorological data processed without Bulk Richardson Method
NOx	Oxides of Nitrogen
NSR	New Source Review
NW AIRQUEST	Northwest International Air Quality Environmental Science and Technology Consortium
NWS	National Weather Service
O_3	Ozone
OLM	Ozone Limiting Method
Pb	Lead
PM_{10}	Particulate matter with an aerodynamic particle diameter less than or equal to a nominal 10 micrometers
$PM_{2.5}$	Particulate matter with an aerodynamic particle diameter less than or equal to a nominal 2.5 micrometers
PNF	Payette National Forest
ppb	parts per billion
ppm	parts per million
PRIME	Plume Rise Model Enhancement
PRO	Midas Gold Plan of Restoration and Operations
PSD	Prevention of Significant Deterioration
PTC	Permit to Construct
PTE	Potential to Emit
PVMRM	Plume Volume Molar Ratio Method
r	Albedo
scfm	Standard cubic feet per minute
SED	Segment Emission Denominator

DRAFT

SGP	Stibnite Gold Project
SIL	Significant Impact Level
SO_2	Sulfur Dioxide
STKP	Crusher Stockpile
TAP	Toxic Air Pollutant
ton/day	Tons per Day
ton/year	Tons per Year
TSF	Tailings Storage Facility
TSP	Total Suspended Particulate
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
VOC	Volatile Organic Compounds
WBAN	Weather-Bureau-Army-Navy
WEDRSF	West End Development Rock Storage Facility
WEP	West End Pit
YPDRSF	Yellow Pine Development Rock Storage Facility
YPP	Yellow Pine Pit
z_o	Surface Roughness Length
ºF	Degrees Fahrenheit
µg/m^3	Micrograms per cubic meter of air
µm	Microns

DRAFT

REC 0824

PET 458

1.0 Summary

Midas Gold Idaho, Inc. (Midas Gold) submitted a Permit to Construct (PTC) application to construct and operate the Stibnite Gold Project (SGP) in Valley County, Idaho. The SGP will consist of conventional open-pit mining operations and onsite ore preparation and gold extraction processes. The potential air emissions from the SGP are less than the applicable major source thresholds for both criteria and hazardous air pollutants (HAP), and therefore, the facility is designated as a minor source for Title V and New Source Review (NSR) requirements, and an area source for National Emission Standards for Hazardous Air Pollutants (NESHAP) applicability. Project-specific air quality analyses involving atmospheric dispersion modeling of estimated emissions associated with the facility were submitted to DEQ to demonstrate that applicable emissions do not result in violation of a National Ambient Air Quality Standard (NAAQS) or Toxic Air Pollutant (TAP) increment as required by the Idaho Administrative Procedures Act 58.01.01.203.02 and 203.03 (Idaho Air Rules Section 203.02 and 203.03). This memorandum provides a summary of the applicability assessment for analyses and air impact analyses used to demonstrate compliance with applicable NAAQS and TAP increments, as required by Idaho Air Rules Section 203.02 and 203.03.

Air Sciences, Inc. (Air Sciences), on behalf of Midas Gold, prepared the PTC application and performed ambient air impact analyses for this project. DEQ review of submitted data and DEQ analyses summarized by this memorandum addressed only the rules, policies, methods, and data pertaining to the air impact analyses used to demonstrate that estimated emissions associated with operation of the facility will not cause or significantly contribute to a violation of any applicable air quality standard. This review did not address/evaluate compliance with other rules or analyses not pertaining to the air impact analyses. Evaluation of emission estimates was the responsibility of the DEQ permit writer and is addressed in the main body of the DEQ Statement of Basis, and emission calculation methods were not evaluated in this modeling review memorandum.

Table 1 presents key assumptions and results to be considered in the development of the permit. Idaho Air Rules require air impact analyses be conducted in accordance with methods outlined in 40 CFR 51, Appendix W *Guideline on Air Quality Models* (Appendix W). Appendix W requires that air quality impacts be assessed using atmospheric dispersion models with emissions and operations representative of design capacity or as limited by a federally enforceable permit condition.

The submitted information and analyses: 1) utilized appropriate methods and models; 2) was conducted using reasonably accurate or conservative model parameters and input data (review of emission estimates was addressed by the DEQ permit writer); 3) adhered to established DEQ guidelines for new source review dispersion modeling; 4) showed either a) that estimated potential/allowable emissions are at a level defined as below regulatory concern (BRC) and do not require a NAAQS compliance demonstration; b) that predicted pollutant concentrations from emissions associated with the project as modeled were below Significant Impact Levels (SILs) or other applicable regulatory thresholds; or c) that predicted pollutant concentrations from emissions associated with the project, when appropriately combined with co-contributing sources and background concentrations, were below applicable NAAQS at ambient air locations where and when the project has a significant impact; 5) showed that TAP emission increases associated with the project will not result in increased ambient air impacts exceeding allowable TAP increments. This conclusion assumes that conditions in Table 1 are representative of facility design capacity or operations as limited by a federally enforceable permit condition. The DEQ permit writer should use Table 1 and other information presented in this memorandum to generate appropriate permit provisions/restrictions to assure emissions do not exceed applicable regulatory thresholds requiring further analyses and to assure the requirements of Appendix W are met regarding emissions representative of design capacity or permit allowable rates.

DRAFT

Table 1. KEY ASSUMPTIONS USED IN MODELING ANALYSES.	
Criteria/Assumption/Result	**Explanation/Consideration**
General Emission Rates. Emission rates used in the air impact analyses must represent maximum potential emissions as given by design capacity, inherently limited by the nature of the process or configuration of the facility, or as limited by the issued permit for the specific pollutant and averaging period.	Compliance has not been demonstrated for emission rates greater than those used in the air impact analyses.
Air Impact Analyses for Criteria Pollutant Emissions. SGP facility-wide maximum potential to emit are greater than the respective Level I thresholds for all criteria pollutants and averaging periods except for Lead. Therefore, modeling is triggered for applicable averaging periods for $PM_{2.5}$[a], PM_{10}[b], CO[c], NOx[d], and SO_2[e]. Modeling was not required for Lead.	Project-specific air impact analyses demonstrating compliance with NAAQS, as required by Idaho Air Rules Section 203.02, are required for pollutant increases above BRC thresholds, or for pollutants having an emissions increase that is greater than Level I modeling applicability thresholds (where the BRC exclusion cannot be used).
Air Impact Analyses for TAP Emissions. SGP facility-wide potential TAP emissions exceed the respective screening emission levels (ELs) for antimony, arsenic, cadmium, formaldehyde, nickel, and sulfuric acid. Therefore, air dispersion modeling was required for these six TAPs.	A TAP increment compliance demonstration would be required for any TAPs with emissions above ELs.
Significant Impact Level Analysis Not Conducted. A Significant Impact Level (SIL) analysis was not conducted for the SGP facility.	Based on the magnitude of the facility-wide emissions and preliminary modeling analyses, it was determined that the impacts from the SGP emissions exceeded the SIL for most criteria pollutants. Therefore, SIL analyses were considered redundant and not performed for the project.
Multiple Modeling Scenarios. To evaluate the worst-case air impacts from the SGP facility, a total of 14 scenarios were modeled. These scenarios represent the hauling of material, which can be either ore or development rock (DR), from four possible origins (three pits and a tailings facility) to five possible destinations (ore will be hauled to the crushing area while DR will be hauled to one of four development rock storage facilities [DRSF]). Modeled design values listed in this modeling memo represent the worst-case modeling scenario for every modeled pollutant and averaging period.	Conventional open-pit methods will be used to extract ore and DR from four possible origins (Yellow Pine Pit [YPP], Hangar Flats Pit [HFP], West End Pit [WEP], and Bradley Tailings [BT]). Ore and DR will be hauled to five possible destinations (Stockpile [STKP], Yellow Pine DRSF [YPDRSF], Hangar Flats DRSF [HFDRSF], West End DRSF [WEDRSF], and Fiddle DRSF [FDRSF]). Only 14 of the 20 possible scenarios were modeled. Six scenarios were not feasible because the timing of the activity within the sequence of mine operations makes the scenarios logistically impossible. Modeled results listed in this memo represent worst-case modeling scenarios.
Modeling of Material Origin and Destination. Each material origin location (YPP, HFP, WEP, and BT) was modeled as an AREA source. Ore destination (STKP) was modeled as a VOLUME source. Each DR destination (YPDRSF, HFDRSF, WEDRSF, and FDRSF) was modeled as a VOLUME source.	Each material origin location comprised appropriate emissions from drilling, material loading, dozing, and surface exploration. Ore destination comprised ore unloading emissions. Each DR destination comprised appropriate emissions from DR unloading, dozing, and wind erosion. For the four AREA and five VOLUME sources, the dimensions were developed by reasonably fitting an equal-area rectangle within the actual footprint of each fugitive source. For the pit and DRSF fugitive activity locations, the release height was based on the haul truck height. The applicable initial lateral dispersion for each VOLUME source was calculated from the respective shorter dimension and EPA-specified methods. The applicable initial vertical dispersion for each AREA and VOLUME source was calculated from the respective vertical dimension and EPA-specified methods.
Modeling of Haul Roads. A representative haul road network for hauling material from inside the pit to various destinations was developed for each of the 14 modeling scenarios.	The haul road network was divided into 22 sections. Each section was further divided into multiple segments with a length equal to twice the adjusted haul road width. Each of the segments was characterized as an individual VOLUME source in the model. Material hauling emissions associated with each origin-destination route were assigned to each

REC 0826

PET 460

Table 1. KEY ASSUMPTIONS USED IN MODELING ANALYSES.	
Criteria/Assumption/Result	**Explanation/Consideration**
	segment along the route based on estimated total emissions along the route and traffic distribution along each section.
Modeling of Blasting Emissions. Blasting emissions were represented by a VOLUME source inside a pit (YPPBL, HFPBL, and WEPBL). Blasting is not expected to occur in BT but was modeled (BTBL) in order to streamline the permitting process.	The blasting physical parameters were developed from dimensions based on blast area used in the emission calculation. The blasting release height was the midpoint of the blasting height. The initial lateral and vertical dispersion dimensions for blasting were calculated per methods specified in the AERMOD User's Guide.
Modeling of Burntlog Route Access Road. The access road portion within the operations boundary was characterized by a series of LINE sources laid along the actual route.	Emissions associated with the portion of the Burntlog Route mine access road that is within project boundary (from the south gate to the process area) are included in the SGP analyses. These include dust emissions generated from travel of maintenance equipment, light-duty pickup trucks and buses used for employee, visitor, and contractor transportation, and heavy-duty trucks used for cargo (including fuel, consumables, machine parts, ore processing supplies, ore concentrate, etc.) and services (including food supplies, trash, recyclables, etc.) transportation. Release parameters for the LINE sources were based on an estimated average vehicle height. The access road emissions were evenly distributed along the road by dividing the total access road emissions by its total area.
Control of Fugitive Dust from Roadways. Fugitive particulate emissions from roadways were assumed to be controlled above 93%, which is an aggressive level of control.	The high level of emission control was needed to demonstrate compliance with NAAQS. Compliance is not demonstrated for emissions greater than those associated with above 93% control.
NOx Chemistry and NO_2/NOx In-Stack Ratios. Ozone Limiting Method (OLM), a Tier 3 NO_2 screening method, was used to estimate the 1-hour and annual NO_2 impacts. The following NO_2/NOx In-Stack Ratios (ISR) were used in the modeling analyses: Blasting: 0.036 Diesel engines: 0.11 Propane heaters: 0.10	The OLM method requires an input of NO_2/NOx ISRs for each modeled source. The NO_2/NOx ratio for blasting was based on blasting plume measurements provided in published literature. The NO_2/NOx ratio for stationary diesel combustion sources was based on heavy-duty diesel trucks in the California Air Pollution Control Officers Association (CAPCOA) Guidance Document. This NO_2/NOx ratio (11 percent) is conservatively higher than the diesel combustion NO_2/NOx ratio provided in the EPA ISR database: 6 percent average, 9.8 percent maximum. The CAPCOA document and the EPA ISR database do not provide an NO_2/NOx ratio for propane boilers. The CAPCOA-recommended NO_2/NOx ratio for natural gas boilers was selected for the propane boilers. The natural gas boilers NO_2/NOx ratio is considered appropriate for the propane boilers because both are gaseous fuels with relatively similar combustion characteristics and are expected to have similar NO_2/NOx ratios. DEQ performed a sensitivity analysis using Tier 2 (Ambient Ratio Method 2), a more conservative NO_2 screening method, and found that the facility is safely below the 1-hour and annual NO_2 NAAQS.
Alternate Meteorological Data Processed Using Cloud Cover. An alternative meteorological dataset was processed without using the Bulk Richardson (BULKRN) method. This alternate processing (NON-BULKRN) used upper air data from Boise airport, supplemented with the cloud-cover data collected at the National Weather Service station in McCall, Idaho.	Meteorological data processing with and without BULKRN are considered acceptable regulatory options by EPA. The NON-BULKRN meteorological data yielded lower modeled design values than the meteorological data processed using the BULKRN method.
Ambient Air Boundary. Midas Gold will legally control the SGP, an active industrial site where mining activities will occur,	Ambient air is defined in Section 006 of the Idaho Air Rules as "that portion of the atmosphere, external to buildings, to

DRAFT

Table 1. KEY ASSUMPTIONS USED IN MODELING ANALYSES.	
Criteria/Assumption/Result	**Explanation/Consideration**
such as heavy equipment operation. Most areas of the mine will require strict safety protocols and controlled access. Midas Gold has established an operations boundary to identify the area where public access will be excluded. Public access inside the operations boundary will be restricted for the life of the mine by physical barriers at points of potential access, including the current Stibnite Road point of entry and proposed site access via the Burntlog Route, as well as natural features of the landscape that prevent access.	which the general public has access." Receptors must be placed at any portion of the atmosphere that is considered ambient air.
Onsite Background $PM_{2.5}$ and PM_{10} Concentrations. The following background $PM_{2.5}$ and PM_{10} concentrations were measured at SGP in 2014 and used in the cumulative NAAQS impact analysis: Annual $PM_{2.5}$: 3.5 µg/m^3 (weighted average of quarterly means) 24-hour $PM_{2.5}$: 15 µg/m^3 (98th percentile/8th high) 24-hour PM_{10}: 37 µg/m^3 (highest 2nd high)	Midas Gold developed an onsite monitoring program to collect site-specific meteorological parameters and determine ambient particulate matter ($PM_{2.5}$ and PM_{10}) concentrations at its Stibnite monitoring station. $PM_{2.5}$ and PM_{10} background concentrations were based on calendar year 2014 instead of the complete dataset (November 2013 through June 2015).
NW AIRQUEST Background CO, NO_2, and SO_2 Concentrations. The following background concentrations for CO, NO_2, and SO_2 were used in the cumulative NAAQS impact analysis: 1-hour CO: 1,740 µg/m^3 8-hour CO: 1,110 µg/m^3 1-hour NO_2: 4.3 µg/m^3 Annual NO_2: 0.9 µg/m^3 1-hour SO_2: 12.3 µg/m^3 3-hour SO_2: 16.8 µg/m^3	Gaseous pollutant background concentrations were determined using the Northwest International Air Quality Environmental Science and Technology Consortium (NW AIRQUEST) online tool. The NW AIRQUEST tool uses regional scale modeling of pollutants in Washington, Oregon, and Idaho, with model results adjusted according to available monitoring data.
Medium-Traffic Background Concentrations. To provide additional information regarding the relative contribution of traffic emissions, background concentrations were obtained from NW AIRQUEST for the road section between mile markers 143 and 144 on Highway 55 passing through the town of McCall.	The McCall location is approximately 38 miles west of the SGP. The annual average daily traffic count for this road section is over 10,000 vehicles per day. Although the background concentrations at McCall are not representative of the rural SGP area, they provide additional information regarding the relative contribution of traffic emissions.
Weight-of-Evidence Analyses for 24-hour PM_{10}. PM_{10} modeling with meteorological dataset processed using the site-specific BULKRN method shows up to five hotspot receptors for Scenario W5 (the highest PM_{10} modeling scenario) that exceed NAAQS. All modeled violations occur during winter when the average snow depth and average precipitation at the project site are 21-68 inches and 6.0 inches, respectively. Therefore, fugitive road dust emissions during high-modeled impact hours could be overestimated. PM_{10} modeling simulation was based on a mining production rate of 180,000 ton/day of development rock (6~~2~~5,700,000 ton/year, which is more conservative than the expected peak production rate of 42,692,000 ton/year). To investigate the effect of a lower modeled mining production rate on design value concentrations, DEQ performed a modeling simulation where mining production rate was assumed to be 120,000 ton/day instead of 180,000 ton/day, but everything else was held constant. Maximum modeled concentration, when summed with the background concentration, is lower than the 24-hour PM_{10} NAAQS thereby demonstrating NAAQS compliance. DEQ's weight-of-evidence analyses conclude that, considering all the collective conservative layers of the modeling analyses, including the use of meteorological data processed by two different methods, there is a satisfactory level of confidence that operation of the project as described in the application will not cause or contribute to a violation of NAAQS.	Meteorological data processing with and without BULKRN are considered acceptable by EPA, with the BULKRN method utilizing more of the onsite collected meteorological parameters. However, the BULKRN-processed meteorological data yielded higher modeled design value impacts for the SGP facility than the meteorological data processed without the BULKRN method. DEQ's supplemental analyses suggest that when emissions are more-closely representative of typical daily mining production rates for a high-production period (everything else held constant), the SGP facility is able to demonstrate compliance with 24-hour PM_{10} NAAQS at those few receptors showing a potential violation when using meteorological data processed with the BULKRN method.

DRAFT

Table 1. KEY ASSUMPTIONS USED IN MODELING ANALYSES.	
Criteria/Assumption/Result	**Explanation/Consideration**

[a.] Particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers.
[b.] Particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers.
[c.] Carbon monoxide.
[d.] Nitrogen oxides.
[e.] Sulfur dioxide.

Summary of Submittals and Actions

May 30, 2019	Modeling protocol was submitted to DEQ by Brown and Caldwell on behalf of the applicant.
June 27, 2019	Conditional modeling protocol approval was provided to Brown and Caldwell by DEQ.
August 21, 2019	Regulatory start date. PTC application and modeling report were prepared by Air Sciences on behalf of the applicant.
September 19, 2019	Application deemed incomplete by DEQ.
October 4, 2019	DEQ received a preliminary response and supplemental information from the applicant.
October 15, 2019	DEQ met with the applicant to review and discuss the preliminary response.
October 22, 2019	DEQ determined that the application remained incomplete while the applicant prepared a response to remaining items previously identified, and included a summary of recommendations provided at the meeting.
November 8, 2019	DEQ requested additional information from the applicant via e-mail, relating to items previously identified.
November 21, 2019	Applicant requested extension until November 27, 2019 to respond to incompleteness.
November 27, 2019	DEQ received supplemental information from the applicant, including a revised application with updated emission inventories and modeling analyses.
December 24, 2019	DEQ determined that the application was incomplete.
January 8, 2020	Applicant requested extension until February 7, 2020 to respond to incompleteness.
February 5, 2020	DEQ received supplemental information from the applicant, including a revised application with updated emission inventories and modeling analyses.
March 6, 2020	DEQ determined that the application was incomplete.
April 2, 2020	Applicant requested extension until April 15, 2020 to respond to incompleteness.

DRAFT

April 15, 2020	DEQ received supplemental information from the applicant, including updated modeling analyses.
May 15, 2020	DEQ determined that the application was complete.
June 24, 2020	DEQ received the final updated application.

2.0 Background Information

This section provides background information applicable to the project and the site proposed for the facility. It also provides a brief description of the applicable air impact analyses requirements for the project.

2.1 Project Description

The SGP will require the construction of significant infrastructure, including a power transmission line, a primary mine site access road, onsite haul roads, an ore processing facility, onsite workspaces, employee housing and recreation, water storage and distribution facilities, and sewage disposal facilities.

The SGP will include three years of pre-mining development and construction activities, followed by an operating mine life of approximately 12 years. Mining will occur in three open pits: Yellow Pine Pit (YPP), Hangar Flats Pit (HFP), and West End Pit (WEP). The general sequence of mining will be the YPP deposit, followed by the HFP and WEP deposits. Legacy tailings from the Meadow Creek valley (Bradley Tailings [BT]) also will be reclaimed and reprocessed during the initial project schedule. Surface exploration drilling will continue within the pits and the Scout Prospect decline (underground exploration) throughout the mine operation period. Restoration and reclamation of other legacy mining features will occur prior to mining, throughout the life of the mine, and as part of the mine closure.

Conventional open-pit methods including drilling, blasting, excavating, and hauling will be used to extract ore and waste rock, termed development rock (DR). Hydraulic shovels and front-end loaders will be used to load ore and DR into haul trucks. DR will be used for construction, restoration, and backfilling, or hauled to the dedicated development rock storage facilities (DRSF). Approximately 340 million tons of DR will be handled over the life of the mine. Ore will be hauled to the primary crusher area, where it will be fed directly into the crusher dump pocket or stockpiled. The ore crushing plant will be designed to operate at a maximum rate of 25,000 tons per day (ton/day). Approximately 100 million tons of ore will be mined from the three pits over the life of the project.

The metal-recovery process from ore will include conventional crushing and grinding, followed by froth-flotation circuits that will generate separate gold-silver and antimony-silver concentrates. The antimony-silver concentrate will be shipped offsite for refining, whereas additional onsite processing of the gold-silver concentrate will include pressure oxidation, carbon-in-leach circuits, and refining processes to recover gold and minor amounts of silver. The finely ground leftover ore material from the mineral-recovery process, termed tailings, will be neutralized, thickened, and transported via a pipeline to the tailings storage facility (TSF).

Lime used in the ore processing will either be purchased or manufactured onsite from limestone available at the site. In addition, certain construction and maintenance activities during operations may require sized aggregate. To allow for the operational flexibility to produce construction aggregate onsite, the application included two portable crushing and screening plants.

DRAFT

The following air pollutants are expected from operations at the SGP facility:

- Criteria air pollutants: carbon monoxide (CO), oxides of nitrogen (NOx), particulate matter less than 2.5 microns (µm) and 10 µm ($PM_{2.5}$ and PM_{10}), sulfur dioxide (SO_2), lead (Pb), and ozone (O_3) precursor volatile organic compounds (VOC)
- Hazardous air pollutants (HAP), including mercury (Hg)
- Other non-HAP toxic air pollutants (TAP)
- Greenhouse gases

The potential emissions from the SGP are less than the applicable major source thresholds for both criteria (100 ton/yr per pollutant) and hazardous air pollutants (HAP) (25 ton/yr aggregate and 10 ton/yr per single HAP); therefore, it is expected to be designated a minor source for Title V and New Source Review (NSR) (applicable threshold is 250 ton/yr per criteria pollutant) requirements and an area source for National Emission Standards for Hazardous Air Pollutants (NESHAP) applicability.

The PTC addresses all air pollutant-emitting activities associated with the facility.

2.2 Facility Location and Area Classification

The SGP is located in the Stibnite-Yellow Pine Mining District in Valley County, central Idaho (Northing: 4,973,751 meters [m]; Easting: 632,038 m; UTM Zone 11), approximately 100 miles northeast of Boise, 38 miles east of McCall, and approximately 10 miles east of Yellow Pine. A facility location map for the SGP is presented in Figure 1. This figure also shows the proposed Burntlog Route (access road) that will provide a year-round safe access to the site. The SGP site layout is presented in Figure 2.

The Stibnite-Yellow Pine Mining District is characterized by historic mining activities and unpatented (federal land) and patented (private land) mining claims that include deposits of gold, silver, tungsten, and antimony. The district lies in both Boise National Forest (BNF) and Payette National Forest (PNF), but is administered by the PNF's Krassel Ranger District (Midas Gold 2017a). The project area terrain is characterized by narrow valleys 6,000 to 6,600 feet above mean sea level (amsl), surrounded by steep mountains ranging over 8,500 feet amsl. The main drainage basin in the project area is the East Fork of the South Fork of the Salmon River (EFSFSR).

The EFSFSR joins Johnson Creek 16 miles downstream, near the village of Yellow Pine. The project area is encompassed by the watersheds of EFSFSR tributaries, including Sugar Creek, Meadow Creek, Johnson Creek, Riordan Creek, Burntlog Creek, Midnight Creek, and Trout Creek. Primary commercial activity in the area comprises mineral exploration, mining, logging, and dispersed recreation.

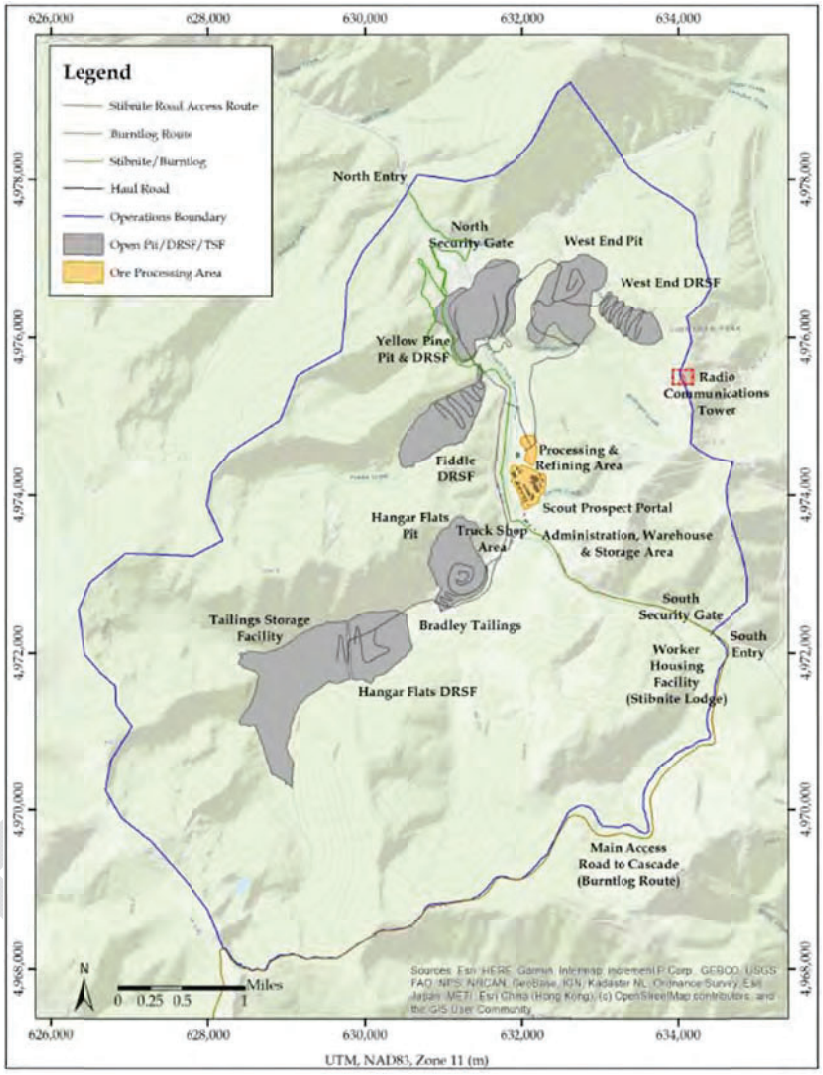
This area is designated as an attainment or unclassifiable area for SO_2, NO_2, CO, Lead, O_3, PM_{10}, and $PM_{2.5}$. The area is not classified as non-attainment for any criteria pollutants.

DRAFT

Figure 1. SGP FACILITY LOCATION MAP.



Figure 2. SGP SITE LAYOUT AND STIBNITE ROAD ACCESS ROUTE.



2.3 Air Impact Analyses Required for All Permits to Construct

Idaho Air Rules Sections 203.02 and 203.03:

> *No permit to construct shall be granted for a new or modified stationary source unless the applicant shows to the satisfaction of the Department all of the following:*

***02. NAAQS**. The stationary source or modification would not cause or significantly contribute to a violation of any ambient air quality standard.*

***03. Toxic Air Pollutants.** Using the methods provided in Section 210, the emissions of toxic air pollutants from the stationary source or modification would not injure or unreasonably affect human or animal life or vegetation as required by Section 161. Compliance with all applicable toxic air pollutant carcinogenic increments and toxic air pollutant non-carcinogenic increments will also demonstrate preconstruction compliance with Section 161 with regards to the pollutants listed in Sections 585 and 586.*

Atmospheric dispersion modeling, using computerized simulations, is used to demonstrate compliance with both NAAQS and TAPs. Idaho Air Rules Section 202.02 states:

***02. Estimates of Ambient Concentrations**. All estimates of ambient concentrations shall be based on the applicable air quality models, data bases, and other requirements specified in 40 CFR 51 Appendix W (Guideline on Air Quality Models).*

2.4 Significant Impact Level and Cumulative NAAQS Impact Analyses

If specific criteria pollutant emission increases associated with the proposed permitting project cannot qualify for a BRC exemption as per Idaho Air Rules Section 221, then the permit cannot be issued unless the application demonstrates that applicable emission increases will not cause or significantly contribute to a violation of NAAQS, as required by Idaho Air Rules Section 203.02.

The first phase of a NAAQS compliance demonstration is to evaluate whether the proposed facility/project could have a significant impact to ambient air. Section 3.1.1 of this memorandum describes the applicability evaluation of Idaho Air Rules Section 203.02. The Significant Impact Level (SIL) analysis for a new facility or proposed modification to a facility involves modeling estimated criteria air pollutant emissions from the facility or modification to determine the potential impacts to ambient air. Air impact analyses are required by Idaho Air Rules to be conducted in accordance with methods outlined in Appendix W. Appendix W requires that facilities be modeled using emissions and operations representative of design capacity or as limited by a federally enforceable permit condition.

A facility or modification is considered to have a significant impact on air quality if maximum modeled impacts to ambient air exceed the established SIL listed in Idaho Air Rules Section 006 (referred to as a "significant contribution" in Idaho Air Rules) or as incorporated by reference as per Idaho Air Rules Section 107.03.b. Table 2 lists the applicable SILs.

Table 2. APPLICABLE REGULATORY LIMITS.

Pollutant	Averaging Period	Significant Impact Levels[a] ($\mu g/m^3$)[b]	Regulatory Limit[c] ($\mu g/m^3$)	Modeled Design Value Used[d]
PM_{10}[e]	24-hour	5.0	150[f]	Maximum 6th highest[g]
$PM_{2.5}$[h]	24-hour	1.2	35[i]	Mean of maximum 8th highest[j]
	Annual	0.2	12[k]	Mean of maximum 1st highest[l]
Carbon monoxide (CO)	1-hour	2,000	40,000[m]	Maximum 2nd highest[n]
	8-hour	500	10,000[m]	Maximum 2nd highest[n]
Sulfur Dioxide (SO_2)	1-hour	3 ppb[o] (7.8 $\mu g/m^3$)	75 ppb[p] (196 $\mu g/m^3$)	Mean of maximum 4th highest[q]
	3-hour	25	1,300[m]	Maximum 2nd highest[n]
Nitrogen Dioxide (NO_2)	1-hour	4 ppb (7.5 $\mu g/m^3$)	100 ppb[s] (188 $\mu g/m^3$)	Mean of maximum 8th highest[t]
	Annual	1.0	100[r]	Maximum 1st highest[n]
Lead (Pb)	3-month[u]	NA	0.15[r]	Maximum 1st highest[n]

DRAFT

	Quarterly	NA	1.5[r]	Maximum 1st highest[n]
Ozone (O_3)	8-hour	40 TPY VOC[v]	70 ppb[w]	Not typically modeled

a. Idaho Air Rules Section 006 (definition for significant contribution) or as incorporated by reference as per Idaho Air Rules Section 107.03.b.
b. Micrograms per cubic meter.
c. Incorporated into Idaho Air Rules by reference, as per Idaho Air Rules Section 107.
d. The maximum 1st highest modeled value is always used for the significant impact analysis unless indicated otherwise. Modeled design values are calculated for each ambient air receptor.
e. Particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers.
f. Not to be exceeded more than once per year on average over 3 years.
g. Concentration at any modeled receptor when using five years of meteorological data.
h. Particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers.
i. 3-year mean of the upper 98th percentile of the annual distribution of 24-hour concentrations.
j. 5-year mean of the 8th highest modeled 24-hour concentrations at the modeled receptor for each year of meteorological data modeled. For the SIL analysis, the 5-year mean of the 1st highest modeled 24-hour impacts at the modeled receptor for each year.
k. 3-year mean of annual concentration.
l. 5-year mean of annual averages at the modeled receptor.
m. Not to be exceeded more than once per year.
n. Concentration at any modeled receptor.
o. Interim SIL established by EPA policy memorandum.
p. 3-year mean of the upper 99th percentile of the annual distribution of maximum daily 1-hour concentrations.
q. 5-year mean of the 4th highest daily 1-hour maximum modeled concentrations for each year of meteorological data modeled. For the significant impact analysis, the 5-year mean of 1st highest modeled 1-hour impacts for each year is used.
r. Not to be exceeded in any calendar year.
s. 3-year mean of the upper 98th percentile of the annual distribution of maximum daily 1-hour concentrations.
t. 5-year mean of the 8th highest daily 1-hour maximum modeled concentrations for each year of meteorological data modeled. For the significant impact analysis, the 5-year mean of maximum modeled 1-hour impacts for each year is used.
u. 3-month rolling average.
v. An annual emissions rate of 40 ton/year of VOCs is considered significant for O_3.
w. Annual 4th highest daily maximum 8-hour concentration averaged over three years.

If modeled maximum pollutant impacts to ambient air from the emission sources associated with a new facility or modification exceed the SILs, then a cumulative NAAQS impact analysis is necessary to demonstrate compliance with NAAQS and Idaho Air Rules Section 203.02.

A cumulative NAAQS impact analysis for attainment area pollutants involves assessing ambient impacts (typically the design values consistent with the form of the standard) from potential/allowable emissions resulting from the project and emissions from any nearby co-contributing sources (including existing emissions from the facility that are unrelated to the project), and then adding a DEQ-approved background concentration value to the modeled result that is appropriate for the criteria pollutant/averaging-period at the facility location and the area of significant impact. The resulting pollutant concentrations in ambient air are then compared to the NAAQS listed in Table 2. Table 2 also specifies the modeled design value that must be used for comparison to the NAAQS. NAAQS compliance is evaluated on a receptor-by-receptor basis for the modeling domain.

If the cumulative NAAQS impact analysis indicates an exceedance of NAAQS, a culpability analysis can determine if this exceedance is due to emissions from the proposed project. The permit may not be issued if the proposed project has a significant contribution (exceeding the SIL) to the modeled violation. If project-specific impacts are below the SIL, then the project does not have a significant contribution to the specific violations.

Compliance with Idaho Air Rules Section 203.02 is generally demonstrated if: a) applicable specific criteria pollutant emission increases are at a level defined as BRC, using the criteria established by DEQ regulatory interpretation (DEQ 2014); or b) all modeled impacts of the SIL analysis are below the

DRAFT

applicable SIL or other level determined to be inconsequential to NAAQS compliance; or c) modeled design values of the cumulative NAAQS impact analysis (modeling all emissions from the facility and co-contributing sources, and adding a background concentration) are less than applicable NAAQS at receptors where impacts from the proposed facility/modification exceeded the SIL or other identified level of consequence; or d) if the cumulative NAAQS analysis showed NAAQS violations, the impact of proposed facility/modification to any modeled violation was inconsequential (typically assumed to be less than the established SIL) for that specific receptor and for the specific modeled time when the violation occurred.

2.5 Toxic Air Pollutant Analyses

Emissions of toxic substances are generally addressed by Idaho Air Rules Section 161:

> *Any contaminant which is by its nature toxic to human or animal life or vegetation shall not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation.*

Permitting requirements for toxic air pollutants (TAPs) from new or modified sources are specifically addressed by Idaho Air Rules Section 203.03 and require the applicant to demonstrate to the satisfaction of DEQ the following:

> *Using the methods provided in Section 210, the emissions of toxic air pollutants from the stationary source or modification would not injure or unreasonably affect human or animal life or vegetation as required by Section 161. Compliance with all applicable toxic air pollutant carcinogenic increments and toxic air pollutant non-carcinogenic increments will also demonstrate preconstruction compliance with Section 161 with regards to the pollutants listed in Sections 585 and 586.*

Per Section 210, if the total project-wide emission increase of any TAP associated with a new source or modification exceeds screening emission levels (ELs) of Idaho Air Rules Section 585 or 586, then the ambient impact of the emission increase must be estimated. If ambient impacts are less than applicable Acceptable Ambient Concentrations (AACs) for non-carcinogens of Idaho Air Rules Section 585 and Acceptable Ambient Concentrations for Carcinogens (AACCs) of Idaho Air Rules Section 586, then compliance with TAP requirements has been demonstrated.

Idaho Air Rules Section 210.20 states that if TAP emissions from a specific source are regulated by the Department or EPA under 40 CFR 60, 61, or 63, then a TAP impact analysis under Section 210 is not required for that TAP. The DEQ permit writer evaluates the applicability of specific TAPs to the Section 210.20 exclusion.

3.0 Analytical Methods and Data

This section describes the methods and data used in the analyses to demonstrate compliance with applicable air quality impact requirements. The DEQ Statement of Basis provides a discussion of the methods and data used to estimate criteria and TAP emission rates.

3.1 Emission Source Data

Emissions of criteria pollutants and TAPs resulting from operation of the SGP facility were estimated by

DRAFT

Air Sciences for various applicable averaging periods. The calculation of potential emissions is the responsibility of the DEQ permit writer, and the representativeness and accuracy of emission estimates is not addressed in this modeling memorandum. DEQ air impact analysts are responsible for assuring that potential emission rates provided in the emission inventory are properly used in the model. The rates listed must represent the maximum allowable rate as averaged over the specified period.

Emission rates used in the impact modeling applicability analyses and any modeling analyses, as listed in this memorandum, should be reviewed by the DEQ permit writer and compared with those in the final emission inventory. All modeled criteria air pollutant and TAP emission rates must be equal to or greater than the facility's potential emissions calculated in the PTC emission inventory or proposed permit allowable emission rates.

Emissions from unpaved roads were calculated based on a control efficiency of 90% from chemical application and 33% from watering (combined control efficiency above 93%). Emission controls and emission calculations are not reviewed in this modeling memorandum. However, it is critical for NAAQS compliance that this high level of control be achieved.

Activity-specific (e.g., drilling, blasting, material crushing and conveying, refining, and other ancillary sources) emissions were estimated based on maximum activity rates, coupled with applicable emission estimation techniques. Maximum emissions were calculated on a short-term (hourly and daily) and long-term (annual) basis for ore processing and mining operations, as discussed below.

The ore-processing rate will range from 20,000 ton/day to 25,000 ton/day at full production. Therefore, maximum potential daily ore processing emissions were based on the maximum design rate of 25,000 ton/day. Maximum potential annual emissions were based on potential daily emissions multiplied by 365 days per year.

Emissions from mining operations (drilling, blasting, material extraction and movement, mobile mine machinery use, and other ancillary sources) vary for each year of the life of the mine (LOM). However, for the modeling analyses, the mining operation potential emissions were estimated using conservatively high maximum activity rates provided in Table 3.

Table 3. MINING ACTIVITY RATES FOR POTENTIAL EMISSION CALCULATIONS.

Activity	Maximum Rate		Comments
Drilling	600	holes per blast	--
Blasting	2	blasts per day	--
	1	blast per hour	--
Material extraction and hauling	180,000	tons per day	Ore or DR
Onsite dozing	144	hours per day	6 dozers operating continuously
Onsite grading	72	hours per day	3 graders operating continuously
Onsite water trucking	48	hours per day	2 trucks operating continuously

The potential hourly emission rates for ore processing and mining operation activities were calculated by dividing the daily rate by the 24 hour-per-day operation schedule, and annual rates were calculated by multiplying maximum daily emissions with 365 days per year. This is conservative because the mine is expected to operate for only 355 days per year.

The maximum mine production rate is approximately 42.7 million (MM) tons per year (ton/yr); however, a maximum daily production rate of 180,000 ton/day used for potential emission calculations results in a

DRAFT

conservatively higher production rate of approximately 65.7 MMton/yr, approximately 50 percent higher than the projected production rate.

Midas Gold will employ newer model year mining and maintenance machines (excavators, shovels, haul trucks, dozers, graders, portable light plants, etc.) that are expected to meet or exceed applicable regulatory emission standards. Non-road mobile equipment engines are exempt from permitting requirements; therefore, the tailpipe emissions resulting from fuel combustion in the non-road mobile equipment are not quantified for the SGP facility. Background concentrations from McCall, 38 miles west of the SGP, were used in the cumulative NAAQS impact analyses (Section 4.1.2) to conservatively account for the impact contribution of traffic emissions.

The approximately 38-mile long Burntlog Route mine access road will be outside the project ambient air boundary and open to the public. Traffic emissions on public roads generally are considered to be part of background concentrations. Therefore, emissions on the Burntlog Route mine access road that are outside of the project boundary are not included in the SGP analyses. However, the emissions associated with the portion of the Burntlog Route mine access road that is within project boundary (from the south gate to the process area) are included in the SGP analyses. These include dust emissions generated from travel of maintenance equipment, light-duty pickup trucks and buses used for employee, visitor, and contractor transportation, and heavy-duty trucks used for cargo (including fuel, consumables, machine parts, ore processing supplies, ore concentrate, etc.) and services (including food supplies, trash, recyclables, etc.) transportation.

3.1.1 Criteria Pollutant Modeling Applicability and Modeled Emission Rates

If project-specific emission increases for criteria pollutants would qualify for a BRC permit exemption as per Idaho Air Rules Section 221 if it were not for potential emissions of one or more pollutants exceeding the BRC threshold of 10 percent of emissions defined by Idaho Air Rules as significant, then a NAAQS compliance demonstration may not be required for those pollutants with emissions below BRC levels. DEQ's regulatory interpretation policy of exemption provisions of Idaho Air Rules is that: "*A DEQ NAAQS compliance assertion will not be made by the DEQ modeling group for specific criteria pollutants having a project emissions increase below BRC levels, provided the proposed project would have qualified for a Category I Exemption for BRC emissions quantities except for the emissions of another criteria pollutant*" (DEQ 2014). The interpretation policy also states that the exemption criteria of uncontrolled potential to emit (PTE) not to exceed 100 ton/year (Idaho Air Rules Section 220.01.a.i) is not applicable when evaluating whether a NAAQS impact analyses is required. A permit will be issued limiting PTE below 100 ton/year, thereby negating the need to maintain calculated uncontrolled PTE under 100 ton/year. The BRC exemption cannot be used to exempt a project from a pollutant-specific NAAQS compliance demonstration in most cases where a PTC is required for the action regardless of emission quantities, such as the modification of an existing emission or throughput limit.

A NAAQS compliance demonstration must be performed for pollutant increases that would not qualify for the BRC exemption from the requirement to demonstrate compliance with NAAQS.

Site-specific air impact modeling analyses may not be necessary for some pollutants, even where such emissions do not qualify for the BRC exemption. DEQ has developed modeling applicability thresholds, below which a site-specific modeling analysis is not required. DEQ generic air impact modeling analyses that were used to develop the modeling thresholds provide a conservative SIL analysis for projects with emissions below identified threshold levels. Project-specific modeling applicability thresholds are provided in the *Idaho Air Modeling Guideline* (DEQ 2013). These thresholds were based on assuring an ambient impact of less than the established SIL for specific pollutants and averaging periods.

DRAFT

If total project-specific emission rate increases of a pollutant are below Level I Modeling Applicability Thresholds, then project-specific air impact analyses are not necessary for permitting. Use of Level II Modeling Applicability Thresholds is conditional, requiring DEQ approval. DEQ approval is based on dispersion-affecting characteristics of the emission sources such as stack height, stack gas exit velocity, stack gas temperature, distance from sources to ambient air, presence of elevated terrain, and potential exposure to sensitive public receptors.

For the SGP analyses, several modeling scenarios were considered to evaluate the worst-case air impacts from the SGP facility. The different modeling scenarios are discussed in Section 3.1.3. Table 4 provides a comparison between facility-wide maximum PTE and modeling applicability thresholds. The short-term and long-term PTE emissions are equal to the sum of process and ancillary emissions and mining fugitive emissions. It is important to note that the process and ancillary source emissions remain the same for each modeling scenario discussed in Section 3.1.3.

Table 4. SITE-SPECIFIC CRITERIA POLLUTANT MODELING APPLICABILITY.

Source Category	Carbon Monoxide (CO)	Nitrogen Oxides (NOx)		$PM_{2.5}$[a]		PM_{10}[b]	Sulfur Dioxide (SO_2)		Lead (Pb)
	lb/hr[c]	ton/yr[d]	lb/hr	ton/yr	lb/hr	lb/hr	ton/yr	lb/hr	lb/month[e]
Process and ancillary	33.5	37.9	55.4	36.4	13.4	21.7	6.5	1.88	0.0437
Mining fugitive	1,742.0	17.1	46.8	98.9	22.5	224.7	0.03	0.09	--
Total	1,775.5	55.0	102.2	135.3	35.9	246.4	6.5	1.97	0.0437
Level I threshold	15.0	1.2	0.2	0.35	0.054	0.22	1.2	0.21	14.0
Modeling required	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

a. Particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers.
b. Particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometer.
c. Pounds per hour.
d. Tons per year.
e. Pounds per month.

As indicated in Table 4, the SGP facility-wide maximum PTE are greater than the respective Level I thresholds for all criteria pollutants and averaging periods except for Pb. Therefore, modeling is triggered for applicable averaging periods for CO, NOx, $PM_{2.5}$, PM_{10}, and SO_2. Modeling is not required for Pb. The use of Level II modeling thresholds was not approved by DEQ for this project.

Tables 5-7 list criteria pollutant emission rates used in the cumulative NAAQS impact analyses for the worst-case modeling scenarios. Significant Impact Level (SIL) analyses were not performed. Based on the magnitude of the facility-wide emissions and preliminary modeling analyses, it was determined that the impacts from the SGP emissions exceeded the SIL for most criteria pollutants. Therefore, SIL analyses were considered redundant and not performed for this report. Table 5 lists the source-specific modeled emission rates for 24-hour and annual $PM_{2.5}$ and 24-hour PM_{10} (worst-case modeling scenario: W5). Table 6 lists the source-specific modeled emission rates for 1-hour and 8-hour CO and annual NO_2 (worst-case modeling scenario: W1). Table 7 lists the source-specific modeled emission rates for 1-hour NO_2 and 1-hour and 3-hour SO_2 (worst-case modeling scenario: B1). Modeling scenarios are discussed in Section 3.1.3. For 1-, 3-, and 8-hour averaging times, hourly emission rates provided in pounds per hour were used. For 24-hour averaging time, daily emission rates provided in pounds per day were used. For the annual averaging time, annual emission rates provided in tons per year were used. All modeled

DRAFT

emission rates in Tables 5-7 are listed in units of pounds per hour (lb/hr). The total modeled input emission rates (highest emission scenario) are listed in Table 8.

Table 5. MODELED 24-HR PM_{10}, 24-HR $PM_{2.5}$, AND ANNUAL $PM_{2.5}$ EMISSION RATES FOR CUMULATIVE NAAQS IMPACT ANALYSIS (WORST-CASE SCENARIO, W5).

Type of Source	Source ID	Description	24-hr PM_{10} (lb/hr)[a]	24-hr $PM_{2.5}$ (lb/hr)	Annual $PM_{2.5}$ (lb/hr)
Point Sources	LS1L	Mill Lime Silo #1 Loading	3.54E-03	5.21E-04	2.50E-05
	MILLS2L	Mill Lime Silo #2 Loading	3.54E-03	5.21E-04	2.50E-05
	SB1	Sb Dryer (2.72 MMBtu/hr Propane-Fired)	2.08E-02	2.08E-02	2.08E-02
	SB2	Sb Bagging	1.18E-01	1.18E-01	1.18E-01
	AC	Autoclave	5.08E+00	5.08E+00	5.08E+00
	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	5.42E-03	5.42E-03	4.45E-04
	ACS1L	AC Lime Silo #1 Loading	1.42E-02	2.08E-03	9.99E-05
	ACS2L	AC Lime Silo #2 Loading	1.42E-02	2.08E-03	9.99E-05
	ACS3L	AC Lime Silo #3 Loading	1.42E-02	2.08E-03	9.99E-05
	ACS4L	AC Lime Silo #4 Loading	7.08E-03	1.04E-03	4.99E-05
	CKD	Carbon Regeneration (Drum)	4.20E-01	4.20E-01	4.20E-01
	CKB	Carbon Regeneration (Kiln)	1.73E-02	1.73E-02	1.73E-02
	EW	Electrowinning Cells and Pregnant Solution Tank	7.00E-02	7.00E-02	7.00E-02
	MR	Mercury Retort	1.00E-02	1.00E-02	1.42E-03
	MF	Induction Melting Furnace	1.42E+00	1.42E+00	2.02E-01
	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	1.84E-02	1.84E-02	5.03E-03
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	1.84E-02	1.84E-02	5.03E-03
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	1.84E-02	1.84E-02	5.03E-03
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	3.67E-03	3.67E-03	1.01E-03
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7.65E-04	7.65E-04	7.65E-04
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	3.83E-02	3.83E-02	3.83E-02
	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	3.06E-02	3.06E-02	3.06E-02
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	3.06E-02	3.06E-02	3.06E-02
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	3.06E-02	3.06E-02	3.06E-02
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	1.91E-03	1.91E-03	1.91E-03
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	1.91E-03	1.91E-03	1.91E-03
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	1.91E-03	1.91E-03	1.91E-03
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	3.83E-03	3.83E-03	3.83E-03
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	1.53E-02	1.53E-02	1.53E-02
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	2.30E-02	2.30E-02	2.30E-02
	PSL	Prill Silos Loading (2 x 100 ton)	5.83E-02	8.83E-03	8.83E-04
	CS1L	Cement/Shotcrete Silo #1 Loading	1.13E-03	1.67E-04	3.42E-04
	CS2L	Cement/Shotcrete Silo #2 Loading	1.13E-03	1.67E-04	3.42E-04
	LS6	Limestone transfer to Ball Mill Feed Bin	5.18E-02	8.00E-03	6.17E-03
	LSBM	Limestone Ball Mill	1.60E+00	5.70E-01	4.39E-01

DRAFT

REC 0840

PET 474

	LS9	Limestone transfer to Kiln Feed Bin	1.22E-02	1.89E-03	1.60E-03
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	9.15E-01	9.15E-01	7.77E-01
	LKC	PFR Shaft Lime Kiln Combustion	1.69E-01	1.69E-01	1.43E-01
	LCR	Lime Mill Crushing and associated transfers In and Out	2.39E-01	8.52E-02	7.23E-02
	LSL	Pebble Lime Silo Loading via Bucket Elevator	6.20E-03	6.20E-03	5.26E-03
Area Sources	WEP	West End Pit	3.69E+01	3.32E+00	3.32E+00
	UGEXP	Underground Exploration	1.66E-04	2.51E-05	2.51E-05
Line Sources	AR01	Access Road within Operations Boundary	7.02E-02	7.02E-03	7.03E-03
	AR02	Access Road within Operations Boundary	5.39E-02	5.40E-03	5.41E-03
	AR03	Access Road within Operations Boundary	1.36E-01	1.36E-02	1.37E-02
	AR04	Access Road within Operations Boundary	1.31E-01	1.31E-02	1.31E-02
Volume Sources	WEPBL	West End Pit Blasting	1.39E+01	8.04E-01	8.04E-01
	WEDRSF	West End Pit Development Rock Storage Facility	2.38E+00	1.26E+00	1.26E+00
	OC1	Loader Transfer of Ore to Grizzly	4.79E-02	1.35E-02	1.35E-02
	OC2	Grizzly to Apron Feeder	4.79E-02	1.35E-02	1.35E-02
	OC3	Apron Feeder to Dribble Conveyor	4.79E-02	1.35E-02	1.35E-02
	OC4	Apron Feeder to Vibrating Grizzly	4.79E-02	1.35E-02	1.35E-02
	OC5	Dribble Conveyor to Vibrating Grizzly	4.79E-02	1.35E-02	1.35E-02
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	4.79E-02	1.35E-02	1.35E-02
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	5.63E-01	1.04E-01	1.04E-01
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	4.79E-02	1.35E-02	1.35E-02
	OC9	Stockpile Transfers to Reclaim Conveyors	2.53E-01	3.91E-02	3.91E-02
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	2.53E-01	3.91E-02	3.91E-02
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	2.53E-01	3.91E-02	3.91E-02
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	6.21E-01	1.15E-01	1.15E-01
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	5.29E-02	1.50E-02	1.50E-02
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	2.92E-02	4.37E-03	2.10E-04
	MILLS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	2.92E-02	4.37E-03	2.10E-04
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	5.60E-02	8.00E-03	7.99E-04
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	5.60E-02	8.00E-03	7.99E-04
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	5.60E-02	8.00E-03	7.99E-04
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	5.60E-02	8.00E-03	4.00E-04
	PSU	Prill Silos Unloading (2 x 100 ton)	5.83E-02	8.83E-03	8.83E-04
	CS1U	Cement/Shotcrete Silo #1 Unloading	9.33E-03	1.33E-03	2.74E-03
	CS2U	Cement/Shotcrete Silo #2 Unloading	9.33E-03	1.33E-03	2.74E-03
	CAL	Aggregate Bin Loading	3.30E-01	5.00E-02	2.85E-02
	CAU	Aggregate Bin Unloading	3.30E-01	5.00E-02	2.85E-02
	CM	Central Mixer Loading	1.83E-02	2.67E-03	5.48E-03
	PCSP1	Portable Crushing and Screening Plant 1	2.33E-01	3.04E-02	3.04E-02
	PCSP2	Portable Crushing and Screening Plant 2	2.33E-01	3.04E-02	3.04E-02
	LS1	Limestone transfer to Primary Crusher Hopper	5.18E-02	8.00E-03	6.17E-03
	LS2	Primary Crushing and Associated Transfers In and Out	1.13E-01	1.69E-02	1.31E-02
	LS3	Primary Screening and Associated	4.10E-01	6.21E-02	4.79E-02

DRAFT

		Transfers In and Out			
	LS4	Secondary Crushing and Associated Transfers In and Out	1.13E-01	1.69E-02	1.31E-02
	LS5	Secondary Screening and Associated Transfers In and Out	4.10E-01	6.21E-02	4.79E-02
	LS7	Limestone transfer to Ball Mill Feed Conveyor	5.18E-02	8.00E-03	6.17E-03
	LS8	Ball Mill Feed transfer to Ball Mill	5.18E-02	8.00E-03	6.17E-03
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	1.22E-02	1.89E-03	1.60E-03
	LS11	Fines Screening and Associated Transfers In and Out	9.68E-02	1.47E-02	1.25E-02
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	1.22E-02	1.89E-03	1.60E-03
	LSU	Pebble Lime Silo discharge to Lime Slaker	6.20E-04	6.20E-04	5.26E-04
	HRT001-HRT072	Haul Road	9.09E-01	9.10E-02	9.11E-02
	HRN001-HRN022	Haul Road	9.09E-01	9.10E-02	9.11E-02

a. Pounds per hour.

Table 6. MODELED 1-HR and 8-HR CO and ANNUAL NO_2 EMISSION RATES FOR CUMULATIVE NAAQS IMPACT ANALYSIS (WORST-CASE SCENARIO, W1).

Type of Source	Source ID	Description	1-hr, 8-hr CO (lb/hr)[a]	Annual NO_2 (lb/hr)
Point Sources	SB1	Sb Dryer (2.72 MMBtu/hr Propane-Fired)	2.23E-01	3.86E-01
	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	1.39E+00	8.27E-03
	CKD	Carbon Regeneration (Drum)	1.20E-01	1.20E-02
	CKB	Carbon Regeneration (Kiln)	1.85E-01	3.20E-01
	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	7.72E+00	1.61E-01
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	7.72E+00	1.61E-01
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	7.72E+00	1.61E-01
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	1.54E+00	2.01E-02
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	8.20E-03	1.42E-02
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	4.10E-01	7.10E-01
	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	3.28E-01	5.68E-01
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	3.28E-01	5.68E-01
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	3.28E-01	5.68E-01
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	2.05E-02	3.55E-02
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	2.05E-02	3.55E-02
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	2.05E-02	3.55E-02
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	4.10E-02	7.10E-02
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	1.64E-01	2.84E-01
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	2.46E-01	4.26E-01

DRAFT

	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	3.17E+00	1.44E+00
	LKC	PFR Shaft Lime Kiln Combustion	1.81E+00	2.66E+00
Volume Source	WEPBL	West End Pit Blasting	1.74E+03	3.90E+00

[a] Pounds per hour.

Table 7. MODELED 1-HR NO_2 AND 1-HR AND 3-HR SO_2 EMISSION RATES FOR CUMULATIVE NAAQS IMPACT ANALYSIS (WORST-CASE SCENARIO, B1).

Type of Source	Source ID	Description	1-hr NO_2 (lb/hr)[a]	1-hr, 3-hr SO_2 (lb/hr)
Point Sources	SB1	Sb Dryer (2.72 MMBtu/hr Propane-Fired)	3.86E-01	4.73E-02
	AC	Autoclave	0.00E+00	6.53E-01
	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	2.42E+00	2.95E-01
	CKD	Carbon Regeneration (Drum)	1.20E-02	0.00E+00
	CKB	Carbon Regeneration (Kiln)	3.20E-01	3.92E-02
	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0.00E+00	1.45E-02
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0.00E+00	1.45E-02
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0.00E+00	1.45E-02
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0.00E+00	2.90E-03
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	1.42E-02	1.74E-03
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	7.10E-01	8.69E-02
	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	5.68E-01	6.95E-02
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	5.68E-01	6.95E-02
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	5.68E-01	6.95E-02
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	3.55E-02	4.34E-03
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	3.55E-02	4.34E-03
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	3.55E-02	4.34E-03
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	7.10E-02	8.69E-03
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	2.84E-01	3.48E-02
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	4.26E-01	5.21E-02
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	1.69E+00	8.45E-03
	LKC	PFR Shaft Lime Kiln Combustion	3.13E+00	3.83E-01
Volume Source	BTBL	Bradley Tailings Blasting	4.68E+01	9.36E-02

[a] Pounds per hour.

Table 8. CRITERIA POLLUTANT TOTAL MODELED EMISSION RATES.

Pollutant	Averaging Time	Emissions[a]

DRAFT

CO	8 hours	1,775.50	lb/hr
	1 hour	1,775.50	lb/hr
NO_2	1 year	54.93	ton/yr
	1 hour	58.07	lb/hr
$PM_{2.5}$	1 year	135.23	ton/yr
	24 hours	781.69	lb/day
PM_{10}	24 hours	5,768.93	lb/day
SO_2	3 hours	1.97	lb/hr
	1 hour	1.97	lb/hr

[a.] Combined process, ancillary, and fugitive emissions modeled. Fugitive emissions vary by pit scenario. Maximum pit scenario emissions are shown.

Ozone (O_3) differs from other criteria pollutants in that it is not typically emitted directly into the atmosphere. O_3 is formed in the atmosphere through reactions of VOCs, NOx, and sunlight. Atmospheric dispersion models used in stationary source air permitting analyses cannot be used to estimate O_3 impacts resulting from VOC and NOx emissions from an industrial facility. O_3 concentrations resulting from area-wide emissions are predicted by using more complex airshed models such as the Community Multi-Scale Air Quality (CMAQ) modeling system. Use of the CMAQ model is very resource-intensive and DEQ asserts that performing a CMAQ analysis for a particular permit application is not typically a reasonable or necessary requirement for air quality permitting.

Addressing secondary formation of O_3 within the context of permitting a new stationary source has been somewhat addressed in EPA regulation and policy. As stated in a letter from Gina McCarthy of EPA to Robert Ukeiley, acting on behalf of the Sierra Club (letter from Gina McCarthy, Assistant Administrator, United States Environmental Protection Agency, to Robert Ukeiley, January 4, 2012):

> *. . . footnote 1 to sections 51.166(I)(5)(I) of the EPA's regulations says the following: "No de minimis air quality level is provided for ozone. However, any net emission increase of 100 tons per year or more of volatile organic compounds or nitrogen oxides subject to PSD would be required to perform an ambient impact analysis, including the gathering of air quality data."*
>
> *"The EPA believes it unlikely a source emitting below these levels would contribute to such a violation of the 8-hour ozone NAAQS, but consultation with an EPA Regional Office should still be conducted in accordance with section 5.2.1.c. of Appendix W when reviewing an application for sources with emissions of these ozone precursors below 100 TPY."*

DEQ determined it was not appropriate or necessary to require a quantitative source-specific O_3 impact analysis because allowable emission estimates of VOCs and NOx are below the 100 tons/year threshold.

3.1.2 TAPs Modeling Applicability and Modeled Emission Rates

A comparison of the applicable non-carcinogenic and carcinogenic screening emission levels (EL) for the TAP from Idaho Administrative Procedures Act (IDAPA) 58.01.01, Sections 585 and 586, respectively, with applicable facility-wide maximum potential TAP emissions is provided in Table 9.

Table 9. TAP MODELING APPLICABILITY DETERMINATION.

HAP/TAP	Emissions (lb/hr)				EL (lb/hr)		Determination
	(a)	(b)	(c)	Total	(d)	(e)	
1,3-Butadiene	--	--	--	--	--	2.4E-5	EL not exceeded
3-Methylchloranthrene	1.2E-7	--	--	1.2E-7	--	2.5E-6	EL not exceeded
Acetaldehyde	--	--	--	--	--	3.0E-3	EL not exceeded

DRAFT

Acrolein	--	--	--	--	1.7E-2	--	EL not exceeded
Antimony	--	--	6.9E-2	6.9E-2	3.3E-2	--	Non-carcinogenic EL exceeded
Arsenic	1.3E-5	--	4.4E-3	4.4E-3	--	1.5E-6	Carcinogenic EL exceeded
Benzene	1.4E-4	--	--	1.4E-4	--	8.0E-4	EL not exceeded
Benzo(a)pyrene	7.9E-8	--	--	7.9E-8	--	2.0E-6	EL not exceeded
Beryllium	7.9E-7	--	2.2E-5	2.2E-5	--	2.8E-5	EL not exceeded
Cadmium	7.3E-5	--	4.1E-5	1.1E-4	--	3.7E-6	Carcinogenic EL exceeded
Carbon disulfide	--	--	1.4E-2	1.4E-2	2.0E+0	--	EL not exceeded
Chromium	9.2E-5	--	1.2E-4	2.1E-4	3.3E-2	--	EL not exceeded
Cobalt	5.5E-6	--	2.4E-5	2.9E-5	3.3E-3	--	EL not exceeded
Cyanide	--	--	2.2E-1	2.2E-1	3.3E-1	--	EL not exceeded
Dichlorobenzene	7.9E-5	--	--	7.9E-5	3.0E+1	--	EL not exceeded
Formaldehyde	5.0E-3	--	--	5.0E-3	--	5.1E-4	Carcinogenic EL exceeded
Hexane	1.2E-1	--	--	1.2E-1	1.2E+1	--	EL not exceeded
Manganese	2.5E-5	--	3.5E-2	3.5E-2	6.7E-2	--	EL not exceeded
Naphthalene	4.0E-5	--	--	4.0E-5	3.3E+0	--	EL not exceeded
Nickel	1.4E-4	--	2.9E-3	3.0E-3	--	2.7E-5	Carcinogenic EL exceeded
Phosphorus	--	--	6.1E-3	6.1E-3	7.0E-3	--	EL not exceeded
Selenium	1.6E-6	--	--	1.6E-6	1.3E-2	--	EL not exceeded
Toluene	2.2E-4	--	--	2.2E-4	2.5E+1	--	EL not exceeded
Xylene	--	--	--	--	2.9E+1	--	EL not exceeded
Barium	2.9E-4	--	4.7E-3	5.0E-3	3.3E-2	--	EL not exceeded
Copper	5.6E-5	--	2.9E-5	8.6E-5	6.7E-2	--	EL not exceeded
Hydrogen Sulfide	--	--	9.0E-1	9.0E-1	9.3E-1	--	EL not exceeded
Molybdenum	7.3E-5	--	5.9E-6	7.9E-5	3.3E-1	--	EL not exceeded
Pentane	1.7E-1	--	--	1.7E-1	1.2E+2	--	EL not exceeded
Silver	--	--	2.9E-6	2.9E-6	7.0E-3	--	EL not exceeded
Sulfuric Acid	--	--	2.0E+0	2.0E+0	6.7E-2	--	Non-carcinogenic EL exceeded
Thallium	--	--	5.9E-5	5.9E-5	7.0E-3	--	EL not exceeded
Uranium	--	--	5.9E-5	5.9E-5	1.3E-2	--	EL not exceeded
Vanadium	1.5E-4	--	--	1.5E-4	3.0E-3	--	EL not exceeded
Zinc	1.9E-3	--	--	1.9E-3	6.7E-1	--	EL not exceeded

[a] HAP/TAP emissions from propane combustion.
[b] HAP/TAP emissions from diesel combustion. Diesel engine HAP emissions are regulated by Code of Federal Regulations, Title 40, Part 63 (40 CFR 63), Subpart ZZZZ and therefore exempt from TAP analysis per IDAPA 58.01.01 Section 210.20.
[c] HAP/TAP emissions from material processing.
[d] Non-carcinogenic EL from IDAPA 58.01.01 Section 585.
[e] Carcinogenic EL from IDAPA 58.01.01 Section 586.

Table 9 shows that the SGP facility-wide potential TAP emissions exceed the respective EL for antimony, arsenic, cadmium, formaldehyde, nickel, and sulfuric acid. Therefore, modeling was required for these six TAPs.

3.1.3 Modeling Scenarios

As discussed in Section 2.1, conventional open-pit methods will be used to extract ore and DR from three pits: YPP, HFP, and WEP, and legacy tailings from BT. Ore will be hauled to the crushing area, and the DR will be moved to four DRSF: Yellow Pine (YPDRSF), Hangar Flats (HFDRSF), West End (WEDRSF), and Fiddle (FDRSF). The SGP site layout provided later in Figure 4 shows these locations.

Midas Gold plans for an up to three-year construction schedule to build mine site facilities and infrastructure, as well as the power transmission line, followed by 12 years of mining operations (i.e., LOM Years 1 through 12). Depending on the mine design and operating schedule, mining activity rates will vary temporally and spatially during the 12 years of mine production and operation. For example, ore production varies from approximately 6.8 MMton in LOM Year 1 (67% in YPP, 26% in WEP, and 7% in

DRAFT

BT) to 9 MMton in LOM 3 (78% in YPP, 10% in BT, 7% in WEP, and 5% in HFP). Similarly, DR production varies from approximately 4.8 MMton in LOM Year 12 (100% in WEP) to 34 MMton in each of LOM Years 4 through 9, with varying distribution among the four DRSF for each LOM Year. The total material (ore and DR) production varies from approximately 12.5 MMton in LOM Year 12 to 42.7 MMton in LOM Year 4.

Similar to the material production, the distribution and hauling of DR to the four destinations (YPDRSF, HFDRSF, WEDRSF, FDRSF) also will vary for each LOM year. Depending on the material origin (pits and BT) and destination (crushing area and DRSF), material hauling distances also will vary for each LOM year.

Therefore, depending on material production rates and origin, DR destination, and hauling distances, mining emissions will vary spatially and temporally throughout the mine life. For permitting purposes, Midas Gold used a maximum production rate of 180,000 tons of material (ore and/or DR) per day, for an annual production rate of 65.7 MMton/yr. This annual production rate is more than 50% higher than the estimated maximum total material production rate of 42.7 MMton/yr.

In order to allow Midas Gold with operation flexibility and to capture variability in material origin and destination in the air quality analyses, several pit scenarios were developed for the SGP air quality analyses. Each pit scenario uses the maximum production rate of 180,000 ton/day in a single pit and uses a single material destination. Each pit has a dedicated ore scenario that assumes all material produced is ore and is hauled to the crusher area; and depending on mine design multiple DR destination scenarios each assuming all material produced is DR and is transported to a single DRSF. For example, most of the DR from HFP will be moved to HFDRSF and during LOM Years 2 through 10, but a fraction of this rock will be moved to FDRSF during LOM Years 3 and 8, and a fraction to YPDRSF during LOM Year 9. Therefore, in order to evaluate all hauling scenarios originating from HFP, the following four (one for ore hauling, three for DR hauling) HFP scenarios were modeled:

1. HFP Scenario 1 – 180,000 ton/day of ore produced and hauled to the crusher area
2. HFP Scenario 2 – 180,000 ton/day of DR produced and hauled to the FDRSF
3. HFP Scenario 3 – 180,000 ton/day of DR produced and hauled to the HFDRSF
4. HFP Scenario 4 – 180,000 ton/day of DR produced and hauled to the YPDRSF

Overall, 14 scenarios were modeled for $PM_{2.5}$ and PM_{10} analyses to cover all possible origin and destination combinations. Each modeling scenario included processing and ancillary source potential emissions. The multiple scenarios modeled for $PM_{2.5}$ and PM_{10} analyses are presented in Table 10. This table also shows the six origin/destination options that are not applicable to the SGP Project as denoted by "0 ton/day." These six scenarios are not feasible because the timing of the activity within the sequence of mine operations makes the scenarios logistically impossible.

Table 10. MODELING SCENARIOS FOR $PM_{2.5}$ AND PM_{10} ANALYSES.

Pit Scenario	Pit/Origin (ton/day)				Ore Destination (ton/day)	DR Destination (ton/day)			
	YPP	HFP	WEP	BT	STKP	FDRSF	HFDRSF	YPDRSF	WEDRSF
Y1	180,000	--	--	--	180,000	--	--	--	--
Y2	180,000	--	--	--	--	180,000	--	--	--
Y3	180,000	--	--	--	--	--	180,000	--	--
Y4	0	--	--	--	--	--	--	0	--
Y5	0	--	--	--	--	--	--	--	0
H1	--	180,000	--	--	180,000	--	--	--	--

REC 0846

PET 480

H2	--	180,000	--	--	--	180,000	--	--	--
H3	--	180,000	--	--	--	--	180,000	--	--
H4	--	180,000	--	--	--	--	--	180,000	--
H5	--	0	--	--	--	--	--	--	0
W1	--	--	180,000	--	180,000	--	--	--	--
W2	--	--	180,000	--	--	180,000	--	--	--
W3	--	--	180,000	--	--	--	180,000	--	--
W4	--	--	180,000	--	--	--	--	180,000	--
W5	--	--	180,000	--	--	--	--	--	180,000
B1	--	--	--	180,000	180,000	--	--	--	--
B2	--	--	--	180,000	--	--	180,000	--	--
B3	--	--	--	0	--	0	--	--	--
B4	--	--	--	0	--	--	--	0	--
B5	--	--	--	0	--	--	--	--	0

Scenario Y4 is not applicable because the YPDRSF and the YPP are in the same area; therefore, the pit cannot be backfilled with development rock until after mining of the pit is completed. Scenarios Y5 and H5 are not applicable because the WEDRSF will only be utilized by the WEP because of its proximity; it is only accessible from the WEP. Scenarios B3, B4 and B5 are not applicable because the development rock from the BT will only be hauled to the HFDRSF because of its proximity. All other development rock storage facilities are significantly farther away from BT.

The fugitive CO, NO_2, and SO_2 emissions are limited to pits only, and they do not vary by ore and/or DR hauling and destinations. Therefore, for these pollutants, one scenario for each pit, including processing and ancillary source potential emissions, was modeled, i.e., scenarios Y1, H1, W1, and B1.

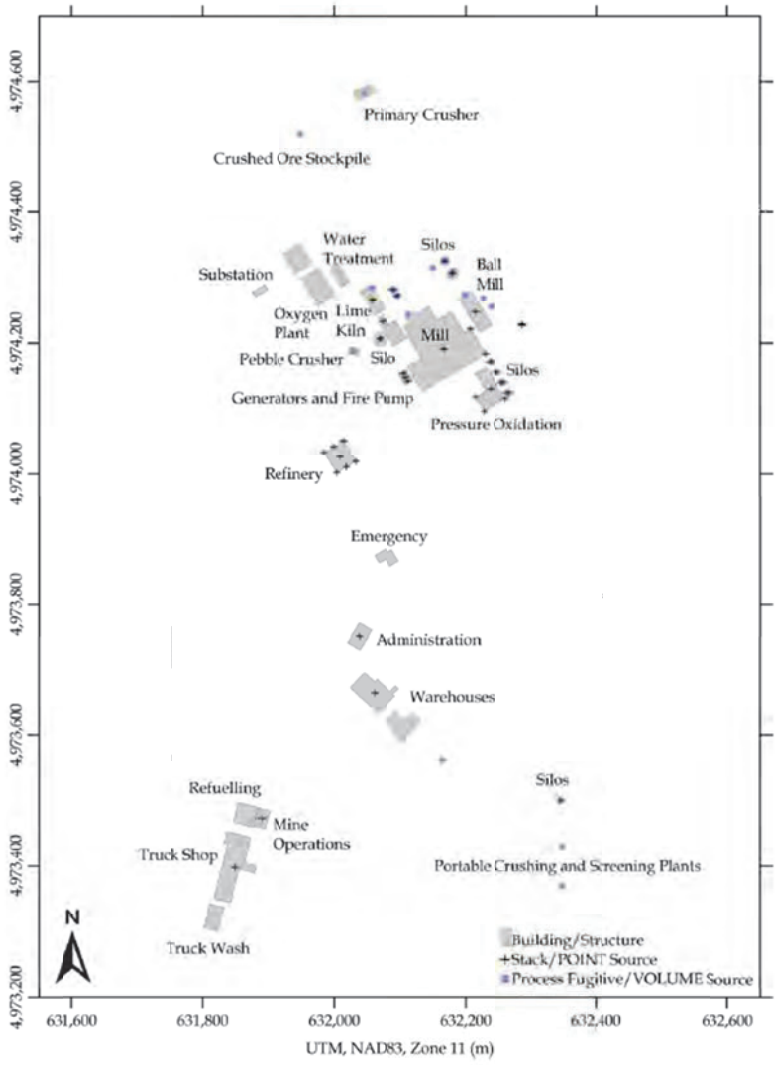
The TAP emissions are limited to processing and ancillary sources, so a single scenario was modeled for each applicable TAP analysis.

3.1.4 Processing, Refining, and Ancillary Sources

The processing, refining, and ancillary sources with exhaust stacks, such as baghouse-equipped sources, generators, process and building heaters, autoclave, retort, smelting furnace, carbon kiln, lime kiln, etc., were modeled as POINT sources. The process sources without exhaust stacks, such as material transfers, ore screening and crushing, etc., were modeled as VOLUME sources. A plot plan showing the processing and refining area buildings and sources is provided in Figure 3. Process and ancillary source model input parameters are provided later in Tables 14 and 15.

DRAFT

Figure 3. PROCESSING AND REFINING AREA BUILDING AND SOURCE LAYOUT.



3.1.5 Fugitive Sources: Blasting, Material Origin and Destination, and Underground Exploration Emissions

Blasting emissions were represented by a VOLUME source located inside a pit. Each material origin location (YPP, HFP, WEP, BT) was modeled as an AREA source and comprised appropriate emissions from drilling, material loading, dozing, and surface exploration. Ore destination (crusher area) was modeled as a VOLUME source and comprised ore unloading emissions. Each DR destination (FDRSF,

HFDRSF, YPDRSF, WEDRSF) was modeled as a VOLUME source comprising appropriate emissions from DR unloading, dozing, and wind erosion. Emissions from underground core sampling drilling (UGEXP) in the Scout prospect decline were represented by an AREA source characterized by the portal opening dimensions.

Model input physical characteristics for blasting and possible material origin and destination locations, and Scout portal are presented in Table 11. This table also shows the source type and associated dimensions for each of the modeled fugitive source/location. The VOLUME source dimensions for blasting provided in Table 11 were based on an estimated blast area. For the remaining AREA and VOLUME sources listed in Table 11, the dimensions were developed by reasonably fitting an equal-area rectangle within the actual footprint of each fugitive source. Blasting is not expected to occur in BT. However, blasting emissions were modeled in BT (BTBL) in order to streamline the permitting process.

Table 11. MODELED FUGITIVE ACTIVITY LOCATIONS.

Model ID	Activity Location	Type	Lateral Dimensions (m)	Emission Sources
YPP	Yellow Pine Pit	AREA	882 × 882	Drilling, loading, dozing, surface exploration
HFP	Hangar Flats Pit	AREA	491 × 491	Drilling, loading, dozing, surface exploration
WEP	West End Pit	AREA	376 × 376	Drilling, loading, dozing, surface exploration
BT	Bradley Tailings	AREA	820 × 420	Loading, dozing, wind erosion
YPPBL	Yellow Pine Pit (Blasting)	VOLUME	87 × 87	Blasting
HFPBL	Hangar Flats Pit (Blasting)	VOLUME	87 × 87	Blasting
WEPBL	West End Pit (Blasting)	VOLUME	87 × 87	Blasting
BTBL	Bradley Tailings (Blasting)	VOLUME	87 × 87	Blasting
STKP	PC Stockpile	VOLUME	229 × 229	Unloading, dozing, wind erosion
FDRSF	Fiddle DRSF	VOLUME	775 × 775	Unloading, dozing, wind erosion
HFDRSF	Hangar Flats DRSF	VOLUME	752 × 752	Unloading, dozing, wind erosion
YPDRSF	Yellow Pine DRSF	VOLUME	784 × 784	Unloading, dozing, wind erosion
WEDRSF	West End DRSF	VOLUME	533 × 533	Unloading, dozing, wind erosion
UGEXP	Scout Portal	AREA	4.9 × 4.9	Sample core drilling

The model input physical parameters for blasting, material origin and destination locations, and Scout portal are provided in Table 12.

Table 12. MODEL INPUT PARAMETERS FOR FUGITIVE ACTIVITY LOCATIONS.

Model ID	Base Elevation (m)	Release Height (m)	Initial Lateral Dispersion (m)	Initial Vertical Dispersion (m)
YPP	1,832.4	4.7	N/A	4.4
HFP	1,993.3	4.7	N/A	4.4
WEP	2,191.8	4.7	N/A	4.4
BT	2,011.7	4.7	N/A	4.4
YPPBL	1,717.2	15.0	20.2	7.0
HFPBL	1,890.6	15.0	20.2	7.0
WEPBL	1,994.0	15.0	20.2	7.0

DRAFT

BTBL	2,011.7	15.0	20.2	7.0
STKP	1,979.8	4.7	53.3	4.4
FDRSF	2,115.2	4.7	180.2	4.4
HFDRSF	2,079.8	4.7	174.8	4.4
YPDRSF	1,904.1	4.7	182.2	4.4
WEDRSF	2,376.5	4.7	124.1	4.4
UGEXP	2,018.0	0	N/A	0

The blasting physical parameters were developed from dimensions (provided in Table 11) based on blast area used in the emission calculation. The blasting release height is the midpoint of the blasting height (30 m).

The initial lateral and vertical dispersion dimensions for blasting were calculated per methods specified in (EPA 2018c) for a volume source not on or adjacent to a building, as:

$$Initial\ Lateral\ Dispesion = \frac{Width\ (87\ m)}{4.3}$$

$$Initial\ Vertical\ Dispesion = \frac{Height\ (30\ m)}{4.3}$$

For the pit and DRSF fugitive activity locations listed in Table 11, i.e., YPP, HFP, WEP, BT, FDRSF, HFDRSF, and WEDRSF, the release height was based on the haul truck height (weighted based on model-specific usage) and calculated using the recommendations provided in the Haul Road Workgroup Report (EPA 2012), as:

$$Release\ Height = \frac{Plume\ Top\ (Weighted\ Truck\ Height \times 1.7)}{2}$$

The applicable initial lateral dispersion for each VOLUME source was calculated from the respective shorter dimension and EPA-specified methods (EPA 2018c) (EPA 2016) as follows:

$$Initial\ Lateral\ Dispesion = \frac{Short\ Lateral\ Dimension}{2.15}$$

The applicable initial vertical dispersion for each AREA and VOLUME source was calculated from the respective vertical dimension and EPA-specified methods (EPA 2018c) (EPA 2016) as follows:

$$Initial\ Vertical\ Dispersion = \frac{Plume\ Top\ (Weighted\ Truck\ Height \times 1.7)}{2.15}$$

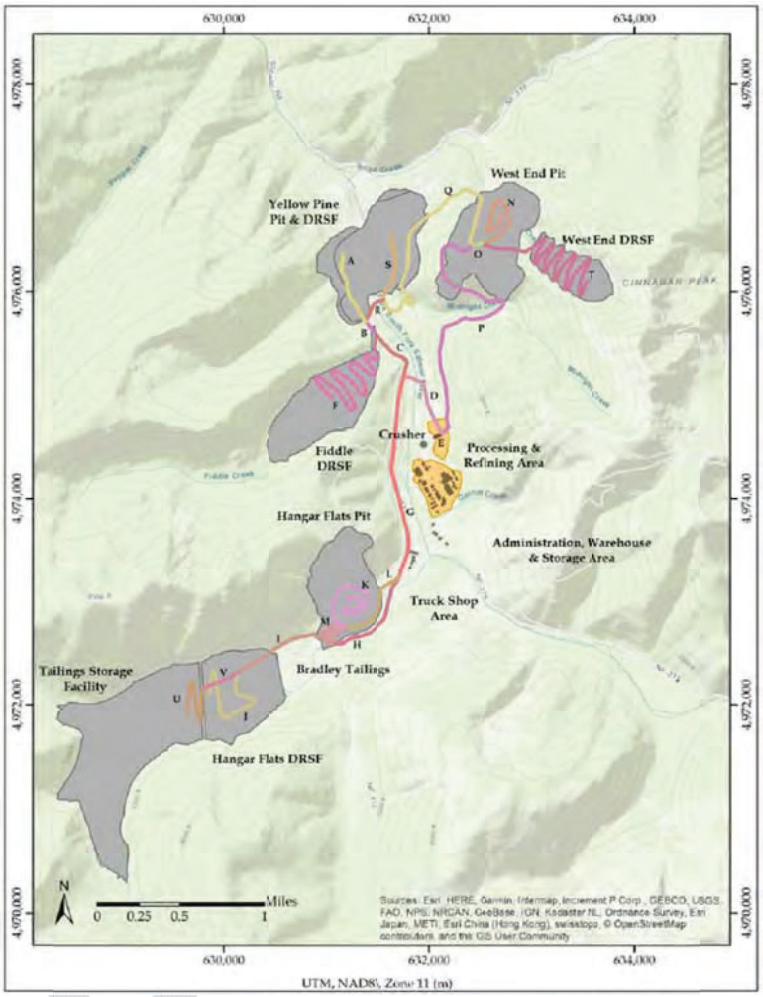
Scout portal was modeled as a surface-based AREA source with zero release height.

3.1.6 Fugitive Sources: Haul Roads

A representative haul road network for hauling material from inside the pit (or origin) to various destinations was developed for each pit scenario provided in Table 10. The haul road network is presented in Figure 4.

DRAFT

Figure 4. HAUL ROAD NETWORK AND SECTIONS.



As shown in Figure 4, the haul road network was divided into 22 sections, A through V. Each section was further divided into multiple segments with a length equal to twice the adjusted haul road width of 32.5 m (26 m road width plus 6 m (EPA 2012)). Each of the segments was characterized as an individual VOLUME source in the model, with a release height of 4.75 m (weighted-average truck height times 1.7, divided by 2 (EPA 2012)), an initial lateral dispersion of 15.1 m (adjusted road width divided by 2.15 (EPA 2012)), and an initial vertical dispersion of 4.42 m (weighted-average top-of-plume height divided by 2.15 (EPA 2012)). Material hauling emissions associated with each origin-destination route were assigned to each segment along the route based on estimated total emissions along the route and traffic distribution along each section, as provided in Table 13 for the four HFP scenarios.

Table 13. HAUL ROAD EMISSION DISTRIBUTION GRID FOR HFP SCENARIOS.					
Pit Scenario		**H1**	**H2**	**H3**	**H4**
Route: Origin-Destination		**HFP-STKP**	**HFP-FDRSF**	**HFP-HFDRSF**	**HFP-YPDRSF**
Segment Emission Denominator		96	148	87	115
Section	**No. of Segments**	**Traffic Distribution per Route**			
A	37	--	--	--	--
B	3	--	--	--	1
C	11	--	1	--	1
D	14	1	--	--	--
E	2	--	--	--	--
F	55	--	1	--	--
G	38	1	1	--	1
H	20	--	--	--	--
I	20	--	--	1	--
J	27	--	--	1	--
K	28	1	1	1	1
L	16	1	1	--	1
M	12	--	--	1	--
N	22	--	--	--	--
O	2	--	--	--	--
P	57	--	--	--	--
Q	49	--	--	--	--
R	6	--	--	--	1
S	13	--	--	--	1
T	72	--	--	--	--
U	19	--	--	--	--
V	7	--	--	--	--

The top row in Table 13 shows the pit scenarios, and the next two rows show hauling route and the associated segment emission denominator (SED) used to distribute segment emissions along each route. The remainder of Table 13 presents the number of segments for each road section (shown in Figure 4) and the associated traffic distribution factor for each route. The emission distribution for each applicable segment is illustrated in the following example.

For route: HFP–STKP (Hangar Flats pit to crusher stockpile), Figure 4 shows that material from HFP will be hauled to the crusher area following the route along Sections K, L, G, and D. All (100%) of the ore from HFP will travel on each of these sections; therefore, each of these sections has a traffic distribution factor of 1.0 for this route.

The SED for each route is the sum-product of the number of segments and traffic distribution for the applicable sections. The SED for the HFP–STKP route is calculated as:

$$SED_{(HFP-STKP)} = (28 \times 1) + (16 \times 1) + (38 \times 1) + (14 \times 1) = 96$$

Emissions for each section-segment were estimated by dividing the total emissions along the route by its SED and multiplying by the section distribution factor. For example, the emission rate for each of the 28 segments along Section K was calculated as:

$$Emission\ Rate - Section\ K_{(Segments\ 1-28)} = \frac{Total\ Emissions_{(HFP-STKP)}}{96} \times 1$$

DRAFT

3.1.7 Fugitive Sources: Burntlog Route Access Road

The access road portion within the operations boundary was characterized by a series of LINE sources laid along the actual route. Emissions associated along this access road include dust emissions generated from travel of maintenance equipment, light-duty pickup trucks and buses used for employee, visitor, and contractor transportation, and heavy-duty trucks used for cargo and services transportation. These sources were assigned a release height of 3 m and an initial vertical dispersion of 2.8 m. These release parameters were based on an estimated average vehicle height of 3.5 m, which is representative of an overall approximation of anticipated vehicle heights (grader – 3.7 m, heavy-duty truck – 3.6 m, and pickup truck – 3.2 m) and the AREA source parameterization recommendations provided in the Haul Road Workgroup Report (EPA 2012). The AERMOD emission input units for AREA source are grams per meter square. The access road emissions were evenly distributed along the road by dividing the total access road emissions by its total area, i.e., the Burntlog Route section within the operations boundary (2,950 m) multiplied by the road width (6.1 m).

3.1.8 Emission Release Parameters

Table 14 lists the emission release parameters, including stack height, exhaust temperature, exhaust velocity, and stack diameter for SGP's process and ancillary point sources in metric units (English units are in parentheses). Table 15 lists the emission release parameters for SGP's process and ancillary volume sources in metric units (English units are in parentheses). Emission release parameters were based on information provided in the application. Justification for emission release parameters is summarized in the next section.

Table 14. PROCESS AND ANCILLARY POINT SOURCE EMISSION RELEASE PARAMETERS IN METRIC UNITS (ENGLISH UNITS IN PARENTHESES).

Release Point	Description	UTM[a] Coordinates		Stack Height in m (ft)[c]	Stack Exhaust Temp. in K (°F)[d]	Stack Exhaust Velocity in m/sec (fps)[e]	Stack Diameter in m (ft)	Orient. Of Release[f]
		Easting-X in m[b]	Northing-Y in m					
LS1L	Mill Lime Silo #1 Loading	632,095	4,974,272	13.3 (43.7)	0.0 (-459.7)	18.1 (59.4)	0.15 (0.49)	D
MillS2L	Mill Lime Silo #2 Loading	632,090	4,974,282	13.3 (43.7)	0.0 (-459.7)	18.1 (59.4)	0.15 (0.49)	D
SB1	Sb Dryer (2.72 MMBtu/hr Propane-Fired)	632,231	4,974,183	45.7 (150.0)	455.4 (360.0)	6.9 (22.8)	0.30 (0.98)	D
SB2	Sb Bagging	632,208	4,974,221	45.7 (150.0)	0.0 (-459.7)	6.5 (21.2)	0.30 (0.98)	D
AC	Autoclave	632,229	4,974,096	23.5 (77.0)	364.3 (196.1)	7.4 (24.3)	1.52 (4.99)	D
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	632,261	4,974,116	23.5 (77.0)	455.4 (360.0)	10.8 (35.6)	0.61 (2.00)	D
ACS1L	AC Lime Silo #1 Loading	632,267	4,974,124	17.4 (57.2)	0.0 (-459.7)	16.1 (52.8)	0.23 (0.75)	D
ACS2L	AC Lime Silo #2 Loading	632,257	4,974,140	17.4 (57.2)	0.0 (-459.7)	16.1 (52.8)	0.23 (0.75)	D
ACS3L	AC Lime Silo #3 Loading	632,248	4,974,156	17.4 (57.2)	0.0 (-459.7)	16.1 (52.8)	0.23 (0.75)	D
ACS4L	AC Lime Silo #4 Loading	632,238	4,974,171	14.5 (47.5)	0.0 (-459.7)	16.1 (52.8)	0.23 (0.75)	D
CKD	Carbon	632,013	4,974,051	16.8	338.7	5.1	0.15	D

REC 0853

PET 487

	Regeneration Kiln (Drum)			(55.0)	(150.0)	(16.6)	(0.49)	
CKB	Carbon Regeneration Kiln (Burners)	631,998	4,974,042	14.0 (46.0)	455.4 (360.0)	5.8 (18.9)	0.30 (0.98)	D
EW	Electrowinning Cells and Pregnant Solution Tank	631,983	4,974,033	16.8 (55.0)	310.9 (100.0)	24.2 (79.4)	0.30 (0.98)	D
MR	Mercury Retort	632,003	4,974,001	16.8 (55.0)	338.7 (150.0)	1.5 (5.1)	0.09 (0.30)	D
MF	Induction Melting Furnace	632,032	4,974,019	16.8 (55.0)	338.7 (150.0)	21.5 (70.6)	0.38 (1.25)	D
EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	634,274	4,972,050	2.1 (7.0)	866.5 (1,100.0)	29.7 (97.4)	0.46 (1.51)	D
EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	632,105	4,974,154	2.1 (7.0)	866.5 (1,100.0)	29.7 (97.4)	0.46 (1.51)	D
EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	632,109	4,974,148	2.1 (7.0)	866.5 (1,100.0)	29.7 (97.4)	0.46 (1.51)	D
EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	632,113	4,974,141	2.1 (7.0)	866.5 (1,100.0)	23.8 (78.0)	0.23 (0.75)	D
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	632,216	4,974,118	20.7 (68.0)	455.4 (360.0)	1.6 (5.2)	0.12 (0.39)	D
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	632,017	4,974,010	14.0 (46.0)	455.4 (360.0)	7.5 (24.8)	0.40 (1.31)	D
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	632,287	4,974,227	2.1 (7.0)	455.4 (360.0)	6.0 (19.8)	0.40 (1.31)	D
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	632,288	4,974,228	2.1 (7.0)	455.4 (360.0)	20.8 (68.3)	0.21 (0.69)	D
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	632,168	4,974,191	43.0 (141.0)	455.4 (360.0)	28.3 (92.9)	0.09 (0.30)	D
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	632,238	4,974,130	20.7 (68.0)	455.4 (360.0)	7.1 (23.3)	0.09 (0.30)	D
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	632,008	4,974,026	14.0 (46.0)	455.4 (360.0)	7.1 (23.3)	0.09 (0.30)	D
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	632,038	4,973,751	6.4 (21.0)	455.4 (360.0)	7.1 (23.3)	0.09 (0.30)	D
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	631,889	4,973,472	12.5 (41.0)	455.4 (360.0)	1.3 (4.3)	0.21 (0.69)	D
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	631,848	4,973,398	12.5 (41.0)	455.4 (360.0)	5.2 (17.1)	0.21 (0.69)	D

DRAFT

HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	632,060	4,973,664	12.5 (41.0)	455.4 (360.0)	5.2 (17.1)	0.21 (0.69)	D
PSL	Prill Silos Loading (2 x 100 ton)	632,346	4,973,500	7.8 (25.5)	0.0 (-459.7)	18.1 (59.4)	0.15 (0.49)	D
CS1L	Cement/Shotcrete Silo #1 Loading	632,095	4,974,272	13.3 (43.7)	0.0 (-459.7)	24.1 (78.9)	0.15 (0.49)	D
CS2L	Cement/Shotcrete Silo #2 Loading	632,095	4,974,272	13.3 (43.7)	0.0 (-459.7)	24.1 (78.9)	0.15 (0.49)	D
LS6	Limestone transfer to Ball Mill Feed Bin	632,181	4,974,307	8.8 (209.0)	0.0 (-459.7)	0.001 (0.003)	0.30 (0.98)	D
LSBM	Limestone Ball Mill	632,215	4,974,248	21.3 (70.0)	0.0 (-459.7)	26.7 (87.5)	0.61 (2.00)	D
LS9	Limestone transfer to Kiln Feed Bin	632,169	4,974,325	8.8 (209.0)	0.0 (-459.7)	0.001 (0.003)	0.30 (0.98)	D
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	632,057	4,974,265	45.7 (150.0)	449.8 (350.0)	26.4 (86.5)	0.61 (2.00)	D
LKC	PFR Shaft Lime Kiln Combustion	632,057	4,974,265	45.7 (150.0)	449.8 (350.0)	26.4 (86.5)	0.61 (2.00)	D
LCR	Lime Mill Crushing and associated transfers In and Out	632,073	4,974,233	15.2 (50.0)	0.0 (-459.7)	28.7 (94.3)	0.23 (0.75)	D
LSL	Pebble Lime Silo Loading via Bucket Elevator	632,069	4,974,206	8.8 (29.0)	0.0 (-459.7)	4.1 (13.4)	0.10 (0.33)	D

a. Universal Transverse Mercator.
b. m: meters.
c. ft: feet.
d. K: Kelvin; ºF: degrees Fahrenheit.
e. m/sec: meters per second; fps: feet per second.
f. D: default (vertical, uninterrupted release); R: raincap; H: horizontal.
g. The exhaust temperature for the new silo was set to 0 K. This triggers AERMOD to use the actual temperatures from the meteorological data input files.

Table 15. PROCESS AND ANCILLARY VOLUME SOURCE EMISSION RELEASE PARAMETERS IN METRIC UNITS (ENGLISH UNITS IN PARENTHESES).

Release Point	Description	UTM[a] Coordinates		Release Height in m (ft)[c]	Init. Horiz. Dim. in m (ft)	Init. Vert. Dim. in m (ft)
		Easting-X in m[b]	Northing-Y in m			
OC1	Loader Transfer of Ore to Grizzly	632,045	4,974,583	19.5 (64.0)	3.8 (12.3)	18.1 (59.5)
OC2	Grizzly to Apron Feeder	632,045	4,974,583	19.5 (64.0)	3.8 (12.3)	18.1 (59.5)
OC3	Apron Feeder to Dribble Conveyor	632,045	4,974,583	19.5 (64.0)	3.8 (12.3)	18.1 (59.5)
OC4	Apron Feeder to Vibrating Grizzly	632,045	4,974,583	19.5 (64.0)	3.8 (12.3)	18.1 (59.5)
OC5	Dribble Conveyor to Vibrating Grizzly	632,045	4,974,583	19.5 (64.0)	3.8 (12.3)	18.1 (59.5)
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	632,045	4,974,583	19.5 (64.0)	3.8 (12.3)	18.1 (59.5)
OC7	Primary Crusher and Associated Transfers out to Coarse Ore	632,045	4,974,583	19.5 (64.0)	3.8 (12.3)	18.1 (59.5)

DRAFT

	Stockpile Feed Conveyor					
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	631,947	4,974,520	10.9 (35.8)	0.2 (0.7)	10.2 (33.3)
OC9	Stockpile Transfers to Reclaim Conveyors	631,947	4,974,520	1.2 (4.0)	0.6 (1.9)	1.1 (3.7)
OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	631,947	4,974,520	1.2 (4.0)	0.6 (1.9)	1.1 (3.7)
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	632,113	4,974,243	20.7 (69.0)	0.3 (0.9)	0.6 (1.9)
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	632,028	4,974,187	3.0 (10.0)	2.3 (7.6)	2.8 (9.3)
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	632,028	4,974,187	3.0 (10.0)	2.3 (7.6)	2.8 (9.3)
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	632,095	4,974,272	1.4 (4.5)	0.1 (0.2)	0.1 (0.5)
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	632,090	4,974,282	1.4 (4.5)	0.1 (0.2)	0.1 (0.5)
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	632,267	4,974,124	1.4 (4.5)	0.1 (0.2)	0.1 (0.5)
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	632,257	4,974,140	1.4 (4.5)	0.1 (0.2)	0.1 (0.5)
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	632,248	4,974,156	1.4 (4.5)	0.1 (0.2)	0.1 (0.5)
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	632,238	4,974,171	1.4 (4.5)	0.1 (0.2)	0.1 (0.5)
PSU	Prill Silos Unloading (2 x 100 ton)	632,346	4,973,500	1.4 (4.5)	0.1 (0.2)	0.1 (0.5)
CS1U	Cement/Shotcrete Silo #1 Unloading	632,095	4,974,272	1.5 (5.0)	5.1 (16.8)	1.4 (4.7)
CS2U	Cement/Shotcrete Silo #2 Unloading	632,095	4,974,272	1.5 (5.0)	5.1 (16.8)	1.4 (4.7)
CAL	Aggregate Bin Loading	632,095	4,974,272	1.5 (5.0)	5.1 (16.8)	1.4 (4.7)
CAU	Aggregate Bin Unloading	632,095	4,974,272	1.5 (5.0)	5.1 (16.8)	1.4 (4.7)
CM	Central Mixer Loading	632,095	4,974,272	1.5 (5.0)	5.1 (16.8)	1.4 (4.7)
PCSP1	Portable Crushing and Screening Plant 1	632,348	4,973,429	2.1 (7.0)	13.1 (43.1)	2.0 (6.5)
PCSP2	Portable Crushing and Screening Plant 2	632,348	4,973,369	2.1 (7.0)	13.1 (43.1)	2.0 (6.5)
LS1	Limestone transfer to Primary Crusher Hopper	632,239	4,974,256	3.4 (11.3)	1.6 (5.2)	3.2 (10.5)
LS2	Primary Crushing and Associated Transfers In and Out	632,239	4,974,256	3.4 (11.3)	1.6 (5.2)	3.2 (10.5)
LS3	Primary Screening and Associated Transfers In and Out	632,239	4,974,256	3.4 (11.3)	1.6 (5.2)	3.2 (10.5)
LS4	Secondary Crushing and Associated Transfers In and Out	632,227	4,974,268	3.4 (11.3)	1.6 (5.2)	3.2 (10.5)
LS5	Secondary Screening and Associated Transfers In and Out	632,227	4,974,268	3.4 (11.3)	1.6 (5.2)	3.2 (10.5)
LS7	Limestone transfer to Ball Mill Feed Conveyor	632,181	4,974,307	1.1 (3.5)	0.1 (0.2)	0.4 (1.4)
LS8	Ball Mill Feed transfer to Ball Mill	632,200	4,974,273	8.5 (28.0)	0.3 (0.9)	0.6 (1.9)
LS10	Limestone transfer to Lime Kiln Feed Conveyor	632,169	4,974,325	1.1 (3.5)	0.1 (0.2)	0.4 (1.4)
LS11	Fines Screening and Associated	632,151	4,974,314	0.8	0.6	0.7

DRAFT

	Transfers In and Out			(2.5)	(1.9)	(2.3)
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	632,056	4,974,285	20.7 (68.0)	0.3 (0.9)	0.6 (1.9)
LSU	Pebble Lime Silo discharge to Lime Slaker	632,069	4,974,206	1.1 (3.5)	0.1 (0.2)	0.4 (1.4)

a. Universal Transverse Mercator.
b. m: meters.
c. ft: feet.

3.1.9 Emission Release Parameter Justification

Modeled Process and Ancillary Point Sources

The pneumatic transfer silo loadings and bin transfers (LS1L, MillS2L, ACS1L, ACS2L, ACS3L, ACS4L, PSL, CS1L, CS2L, LS6, LSBM, LS9, LSL) were modeled as POINT sources with a 3-foot bin vent above standard silo height as release height. Exit velocity was estimated using the standard stack diameter and flow rates for similar sources (NDEP 2019) or 0.001 meter per second for horizontal exhaust. These sources were modeled with ambient exhaust temperature.

For propane-fired process (Sb1, ACB, CKB, PV, HS) and building heaters (H1M, H2M, HM, HAC, HR, HA, HMO, HTS, HW), exhaust flow rates were calculated using EPA Method 9 with 3% oxygen content and 15% moisture content. Standard stack diameters were selected based on the heater rating. The process heaters were modeled with a 10-foot stack above the building, whereas the building heaters were modeled with a release height of 1 foot above the respective buildings.

Similar source exhaust temperature, flow, and diameter from (NDEP 2017) were used for refinery sources, including the carbon regeneration kiln (CKD), electrowinning cells (EW), mercury retort (MR), and induction furnace (MF). Each of these sources was modeled with a 10- foot stack above the refinery building.

For emergency generators (EDG1, EDG2, EDG3) and the fire pump (EDFP), the exhaust flow rates were calculated using EPA Method 9 with 9% oxygen content and 8% moisture content. Standard stack diameters were selected based on engine rating. Each engine was modeled with a 7-foot-high stack.

Antimony bagging (Sb2), autoclave (AC), lime kiln (LK) (common stack with kiln burner (LKC)), and lime crushing (LCR) were characterized with similar source parameters from (NDEP 2015b), (APT 2013), and (NDEP 2010). Each of these sources was modeled with a 10-foot stack above its respective building.

Release parameters for the process and ancillary point sources were appropriately documented and justified. DEQ's source-group analysis (Table 28 in Section 4.1.4) suggests that the process and ancillary point sources contribute a small amount to the modeled design concentrations.

Modeled Process and Ancillary Volume Sources

For the following VOLUME source characterization discussion, release height was estimated as half of the vertical length (for example, building height), initial vertical dispersion was calculated by dividing the vertical length by the applicable EPA-recommended constant (EPA 2018c) for a single VOLUME source (4.3), and initial lateral dispersion was determined using the lesser lateral dimension (for example, building width) divided by the applicable EPA-recommended constant (EPA 2018c) for the surface source or elevated source with a building (2.15).

DRAFT

The sources associated with the primary crusher building, including loader transfer (OC1), grizzly feeder (OC2), apron feeders (OC3, OC4), ore transfers (OC5, OC6), and primary crusher (OC7), were characterized by the primary crusher building dimensions: 128’ high and 52.9’ wide.

The stockpile height (71.6’) and the conveyor width (3’) were used to determine the VOLUME source parameters for the stockpile feed conveyor (OC8).

Tunnel exit dimensions (8’ high and 8’ wide) were used to estimate the VOLUME release parameters for the stockpile transfer points (OC9, OC10). The SAG mill feed conveyor transfer (OC11) was characterized by a building opening (4’ high and 4’ wide) at the mid-height (70’) of the mill building.

Pebble crusher building dimensions (20’ high and 32.7’ wide) were used to characterize the pebble crusher-associated sources (OC12, OC13).

Silo/bin unloading sources (LS1U, Mill2SU, ACS1U, ACS2U, ACS3U, ACS42U, PSU) were characterized by a typical screw discharge feeder characteristic, i.e., 5’ above the ground with a 1’ diameter.

Aggregate transfer and handling sources (CS1U, CS2U, CAL, CAU, CM) were characterized by the aggregate stockpile dimensions: 20’ high and 72.2’ wide.

Each portable crushing and screening plant was characterized by typical portable crushing and screening plant dimensions: 14’ high and 185’ wide.

Sources associated with limestone crushing (LS1, LS2, LS3, LS4, LS5) were characterized by the associated crusher building dimensions: 22.6’ high and 22.6’ wide.

The crushed limestone/pebble lime transfers (LS7, LS10, LSU) were characterized by a typical screw discharge to a conveyor characteristic, i.e., 5’ above the ground, 3’ drop, and a 1’ diameter.

The limestone ball mill feed discharge (LS8) was characterized by a building opening (4’ high and 4’ wide) at the mid-height (30’) of the ball mill building.
The limestone fines screening (LS11) was characterized by screen dimensions: 5’ drop and 8’ wide.

The limestone kiln feed (LS12) was characterized by a building opening (4’ high and 4’ wide) at the mid-height (70’) of the kiln building.

Model input source characterization for fugitive emissions is described in Sections 3.1.5 and 3.1.6. Fugitive activity locations and their respective dimensions are provided in Table 11 and associated release parameters are listed in Table 12.

Release parameters for the process and ancillary volume sources were appropriately documented and justified. DEQ’s source-group analysis (Table 28 in Section 4.1.4) suggests that the process and ancillary volume sources contribute a small amount to the modeled design concentrations.

3.2 Background Concentrations

Background concentrations are used if a cumulative NAAQS impact analysis is needed to demonstrate compliance with applicable NAAQS.

DRAFT

3.2.1 *Onsite Particulate Monitoring*

To establish background ambient air conditions for the SGP area, Midas Gold developed an onsite monitoring program to collect site-specific meteorological parameters and determine ambient particulate matter ($PM_{2.5}$ and PM_{10}) concentrations at its Stibnite monitoring station.

In September 2015, Midas Gold submitted the data collected at the Stibnite monitoring station for the period of November 2013 through June 2015 to DEQ. After reviewing the data and associated quality control procedures, DEQ concluded that the $PM_{2.5}$ and PM_{10} data collected at the Stibnite monitoring station satisfied the applicable regulatory requirements and approved the data to be used for background concentrations in the SGP air quality analyses. In its conclusions, DEQ recommended that the $PM_{2.5}$ and PM_{10} background concentrations should be based on calendar year 2014 instead of the complete dataset (November 2013 through June 2015).

DEQ-approved $PM_{2.5}$ and PM_{10} background concentrations, in units of micrograms per cubic meter ($\mu g/m^3$), are provided in Table 16.

Table 16. DEQ-APPROVED $PM_{2.5}$ AND PM_{10} BACKGROUND CONCENTRATIONS FOR SGP.

Pollutant	Averaging Time	Background Concentration ($\mu g/m^3$)	Design Value Rank
$PM_{2.5}$	1 year	3.5	Weighted average of quarterly means
	24 hours	15	98th percentile/8th high
PM_{10}	24 hours	37	Highest 2nd high

3.2.2 *Gaseous Pollutant Background Concentrations*

With a few exceptions of very large facilities or facilities located in nonattainment areas, regulatory agencies do not require the collection of gaseous criteria pollutants, including CO, NOx (and/or nitrogen dioxide [NO_2]), O_3, and SO_2. For these gaseous pollutants, data collected at government-regulated monitoring stations located in settings similar to the project area in terms of terrain, land use, and proximity of emission sources are typically used to establish background concentrations.

To determine representative background concentrations of CO, NOx, O_3, and SO_2 for the SGP site, which is located in a remote rural area, the DEQ-maintained ambient monitoring network was reviewed by Air Sciences. This review revealed that DEQ only conducts limited trace monitoring for CO, NOx, O_3, and SO_2 in the Boise metropolitan area along the Interstate 84 corridor. Thus, the data collected at these monitors are exposed to high emissions from industrial, urban, and transportation sources (DEQ 2015a) (DEQ 2018). For this reason, the gaseous pollutant concentrations recorded at these urban monitoring locations were not considered to be representative of a rural area, like the SGP site.

The EPA-maintained monitoring stations (EPA 2018a) in Idaho and surrounding states also were reviewed by Air Sciences to determine representative gaseous pollutant background concentrations for the SGP site. This review also did not identify any representative monitoring station to establish background gaseous pollutant concentrations for the SGP site.

The DEQ-recommended (DEQ 2019) CO, NOx, O_3, and SO_2 background concentrations for the SGP air quality analyses in units of parts per billion (ppb) and $\mu g/m^3$, are provided in Table 17. These background concentrations were obtained from the Northwest International Air Quality Environmental Science and

DRAFT

Technology Consortium (NW AIRQUEST; https://arcg.is/1jXmHH) online tool using the project site coordinates. These background air pollutant levels are based on regional-scale air pollution modeling of pollutants in Washington, Oregon, and Idaho, with modeling results adjusted according to available monitoring data.

Table 17. DEQ-RECOMMENDED GASEOUS POLLUTANT BACKGROUND CONCENTRATIONS FOR SGP.

Pollutant	Averaging Time	Background Concentration		Reference
		(ppb)	($\mu g/m^3$)	
CO	8 hours	970	1,110	NW AIRQUEST, 2014-2017 design value
	1 hour	1,520	1,740	
NO_2	1 year	0.5	0.9	
	1 hour	2.3	4.3	
O_3 (for NO_2 modeling)	8 hours	55	107.9	
SO_2	3 hours	6.4	16.8	
	1 hour	4.7	12.3	

3.2.3 Medium-Traffic Pollutant Background Concentrations

For additional information, background concentrations were obtained from NW AIRQUEST for the road section between mile markers 143 and 144 on Highway 55 passing through the town of McCall. This site (latitude 44.906° N, longitude 116.098° W) is approximately 38 miles west of the SGP. The annual average daily traffic count for this road section is over 10,000 vehicles per day. Table 18 provides the background concentrations for this medium traffic site. Although these concentrations are not representative of the rural SGP area, they do provide additional information regarding the relative contribution of traffic emissions.

Table 18. MEDIUM-TRAFFIC BACKGROUND CONCENTRATIONS.

Pollutant	Averaging Time	Background Concentration		Reference
		(ppb)	($\mu g/m^3$)	
CO	8 hours	1,000	1,145	NW AIRQUEST, 2014-2017 design value, near McCall, ID (44.91°N, 116.10°W)
	1 hour	1,570	1,797	
NO_2	1 year	1.4	2.6	
	1 hour	7.6	14.3	
$PM_{2.5}$	1 year	--	5.1	
	24 hours	--	17.5	
PM_{10}	24 hours	--	60.1	
SO_2	3 hours	6.4	16.8	
	1 hour	4.7	12.3	

3.3 Impact Modeling Methodology

This section describes the modeling methods used by the applicant/consultant to demonstrate preconstruction compliance with applicable air quality standards.

3.3.1 General Overview of Impact Analyses

Air Sciences performed the project-specific air pollutant emission inventory and air impact analyses that were submitted with the application. The submitted information/analyses, in combination with results from DEQ's air impact analyses, demonstrate compliance with applicable air quality standards to DEQ's

DRAFT

satisfaction, provided the facility is operated as described in the submitted application and in this memorandum.

Table 19 provides a brief description of parameters used in the modeling analyses.

Table 19. MODELING PARAMETERS.

Parameter	Description/Values	Documentation/Addition Description
General Facility Location	Stibnite, Idaho	The area is an attainment or unclassified area for all criteria pollutants.
Model	AERMOD	AERMOD with the PRIME downwash algorithm, version 19191.
Meteorological Data	Onsite and McCall, Idaho surface data; Boise upper air data	See Section 3.3.5 of this memorandum for additional details of the meteorological data.
Terrain	Considered	1/3 arc second National Elevation Dataset (NED) was acquired from the USGS for the surrounding area. AERMAP version 18081 was used to process terrain elevation data for all buildings and receptors. See Section 3.3.6 for more details.
Building Downwash	Considered	Plume downwash was considered for the structures associated with the facility. BPIP-PRIME was used to evaluate building dimensions for consideration of downwash effects in AERMOD. See Section 3.3.7.
NOx Chemistry	Ozone Limiting Method	See Section 3.3.8.
Receptor Grid	**SIL Analysis** A SIL analysis was not performed.	
	Cumulative NAAQS Impact Analysis The selection of receptors for use in the cumulative NAAQS impact analysis is as follows (see Section 3.3.1~~1~~2):	
	Boundary	25-meter (m) spacing
	Grid 1	50-m spacing, 0.25 kilometers (km) out
	Grid 2	100-m spacing, 0.25 km to 1.25 km out
	Grid 3	500-m spacing, 1.25 km to 5 km out
	Grid 4	1,000-m spacing, 5 km to 10 km out
	Hotspot	25-m spacing, 200-m × 200-m around highest model impacts
	TAPs Analysis The receptor network used in the cumulative NAAQS impact analysis was also used in the TAPs analysis.	

3.3.2 Modeling Protocol

A modeling protocol for the SGP analyses was submitted to DEQ prior to the application, on May 30, 2019. The protocol was submitted by Brown and Caldwell on behalf of Midas Gold. Conditional DEQ protocol approval was provided to Brown and Caldwell on June 27, 2019.

3.3.3 Modeling Methodology

Project-specific modeling and other required impact analyses were generally conducted using data and methods described in the *Idaho Air Quality Modeling Guideline* (DEQ 2013).

3.3.4 Model Selection

Idaho Air Rules Section 202.02 requires that estimates of ambient concentrations be based on air quality models specified in Appendix W. The refined, steady-state, multiple-source, Gaussian dispersion model AERMOD was promulgated as the replacement model for ISCST3 in December 2005. AERMOD retains the single straight-line trajectory of ISCST3, but it includes more advanced algorithms to assess turbulent mixing processes in the planetary boundary layer for both convective and stable stratified layers.

DRAFT

AERMOD version 19191 was used by Air Sciences for the modeling analyses to evaluate impacts of the facility. This version was the current version at the time the application was received by DEQ.

3.3.5 Meteorological Data

AERMOD requires an input of hourly meteorological data to estimate pollutant concentrations in ambient air resulting from modeled source emissions. These data are commonly obtained from National Weather Service (NWS) stations at airports throughout the state. Applicants select data from an airport site that is determined to be reasonably representative of the permitted site location. Collection of meteorological data from the permitted site is not typically required by DEQ for minor source permit applications. The collection of one year of onsite data is required for permitting projects subject to the Prevention of Significant Deterioration (PSD) program, which is triggered by larger non-fugitive emission quantities.

Site-specific hourly surface meteorological data were collected and used in air impact analyses for this project, as described in the submitted modeling report. These data were collected from January 1, 2014 through December 31, 2014 at the Stibnite monitoring station. They were collected for analyses supporting an Environmental Impact Statement (EIS) and the Idaho DEQ minor source permit.

The site-specific surface data were supplemented with the twice-daily upper-air data (all levels) collected at the National Weather Service (NWS) station in Boise, Idaho (WBAN 24131).

These meteorological datasets were processed with the most recent version (19191) of the AERMOD meteorological pre-processor, AERMET, to produce AERMOD-input-ready hourly surface and profile meteorological files. The default option of adjusted surface friction velocity (ADJ_U*) and the Bulk Richardson (BULKRN) method for boundary layer parameter calculations was used for this meteorological data processing.

Additionally, an alternative meteorological dataset was processed without using the BULKRN method (NON-BULKRN). This alternate processing used the onsite and upper air datasets discussed above, supplemented with the cloud-cover data collected at the NWS station in McCall, Idaho (WBAN 94182).

Both processing methods (BULKRN and NON-BULKRN) are considered default for regulatory modeling analyses. EPA Region X Regional Modeling Contact, Jay McAlpine, PhD, was consulted for guidance on which data processing procedure to require for the analyses supporting the Idaho PTC. The BULKRN method was used for air impact analyses supporting the EIS after consultation with EPA, DEQ, and the US Forest Service. EPA recommended (June 18, 2019, email from Jay McAlpine, EPA, to Kevin Schilling, DEQ) using the BULKRN method since "use of the onsite data best fulfills the Guidance, and ensures consistency with the EIS, but this should be looked upon as technical advice only and not a requirement of the EPA."

Compliance with all NAAQS was easily demonstrated using meteorological data processed by the NON-BULKRN method; however, a small number of receptors showed 24-hour PM_{10} violations when the meteorological data processed with BULKRN method was used. DEQ performed a weight of evidence analyses (see Section 4.1.4 of this memorandum) to further evaluate the confidence of NAAQS compliance, using sensitivity analyses of various model input variables and the meteorological data processed using the BULKRN method.

AERMET requires the input of three surface boundary layer parameters: midday Bowen ratio (B_o), midday albedo (r), and surface roughness length (z_o). These parameters are dependent on the land use and

DRAFT

vegetative cover of the area being evaluated. The EPA-recommended model, AERSURFACE, was used to estimate these surface parameters for the Stibnite meteorological data processing. AERSURFACE uses 1992 National Land Cover Data to determine these surface characteristics.

The determination of B_o is dependent on ambient moisture conditions (i.e., wet, average, or dry). For this purpose, historic 30-year (1985–2014) precipitation data from the Taylor Ranch station in Idaho (the closest station from which this type of data is available) were used.

The 70th and 30th percentile values estimated from the 30-year precipitation data were used to assign a moisture class to each calendar month per the following scheme: monthly precipitation greater than the 70th percentile was considered "wet"; between the 70th and 30th percentiles was considered "average"; and less than the 30th percentile was considered "dry." The monthly season and moisture classifications and estimated r and B_o for 2014 Stibnite meteorological data processing are presented in Table 20.

Table 20. 2014 MONTHLY SEASON AND MOISTURE CLASSIFICATION, AND CALCULATED r AND B_O.

Month	Season	r	30-Year Precipitation Percentile (in)		2014 Precipitation (in)	Moisture Classification	*Bo*
			30th	70th			
January	Winter	0.38	0.64	1.29	0.74	Average	0.50
February	Winter	0.38	0.40	0.81	0.99	Wet	0.50
March	Spring	0.13	0.83	1.23	2.33	Wet	0.34
April	Spring	0.13	1.11	1.57	0.99	Dry	1.57
May	Spring	0.13	1.43	2.23	0.74	Dry	1.57
June	Summer	0.13	1.17	1.80	1.32	Average	0.37
July	Summer	0.13	0.46	1.45	0.40	Dry	0.76
August	Summer	0.13	0.42	1.11	2.03	Wet	0.25
September	Fall	0.13	0.27	1.23	0.43	Average	0.87
October	Fall	0.13	0.59	1.69	1.75	Wet	0.35
November	Fall	0.13	0.72	1.44	3.73	Wet	0.35
December	Winter	0.38	0.64	1.16	0.83	Average	0.50

The seasonal z_o values in m for each 30-degree sector of the 1-km radius for the Stibnite monitoring station are provided in Table 21 (i.e., Sector 1 is 0° to 30° clockwise from the north, Sector 2 is 30° to 60° clockwise from the north, etc.).

Table 21. CALCULATED SEASONAL z_O VALUES (m).

Sector	Winter	Spring	Summer	Fall
1	0.410	0.564	0.610	0.607
2	0.212	0.347	0.392	0.387
3	0.517	0.640	0.671	0.669
4	0.769	0.865	0.894	0.894
5	0.989	1.044	1.055	1.055
6	0.741	0.874	0.918	0.915
7	0.400	0.563	0.617	0.614
8	0.414	0.522	0.552	0.550
9	0.049	0.171	0.244	0.243
10	0.060	0.197	0.274	0.274
11	0.183	0.372	0.449	0.449
12	0.576	0.710	0.743	0.742

Winter = December, January, February
Spring = March, April, May
Summer = June, July, August

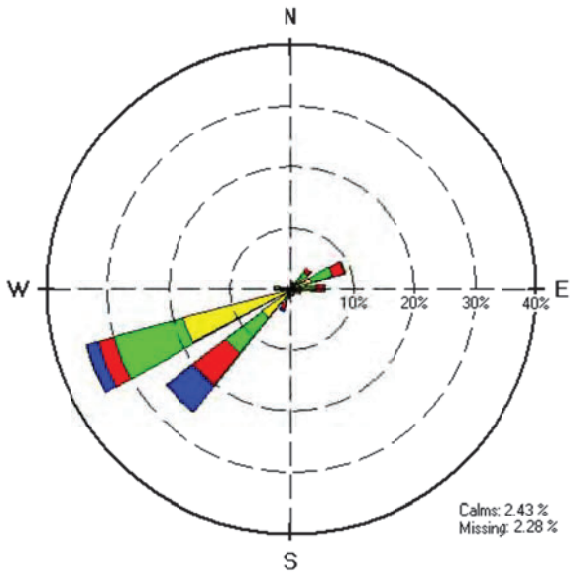
DRAFT

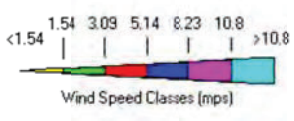
Fall = September, October, November

Wind frequency distribution for the 2014 Stibnite meteorological dataset is presented in Figure 5, and a map showing the location of the meteorological monitoring stations used for this meteorological data processing is presented in Figure 6.

Figure 5. WIND FREQUENCY DISTRIBUTION FOR 2014 SGP METEOROLOGICAL DATA (NON-BULKRN).

Comment [E1]: Station No. and ID in the figure are for the McCall NWS station.





Note: Diagram of the frequency of occurrence of each wind direction.

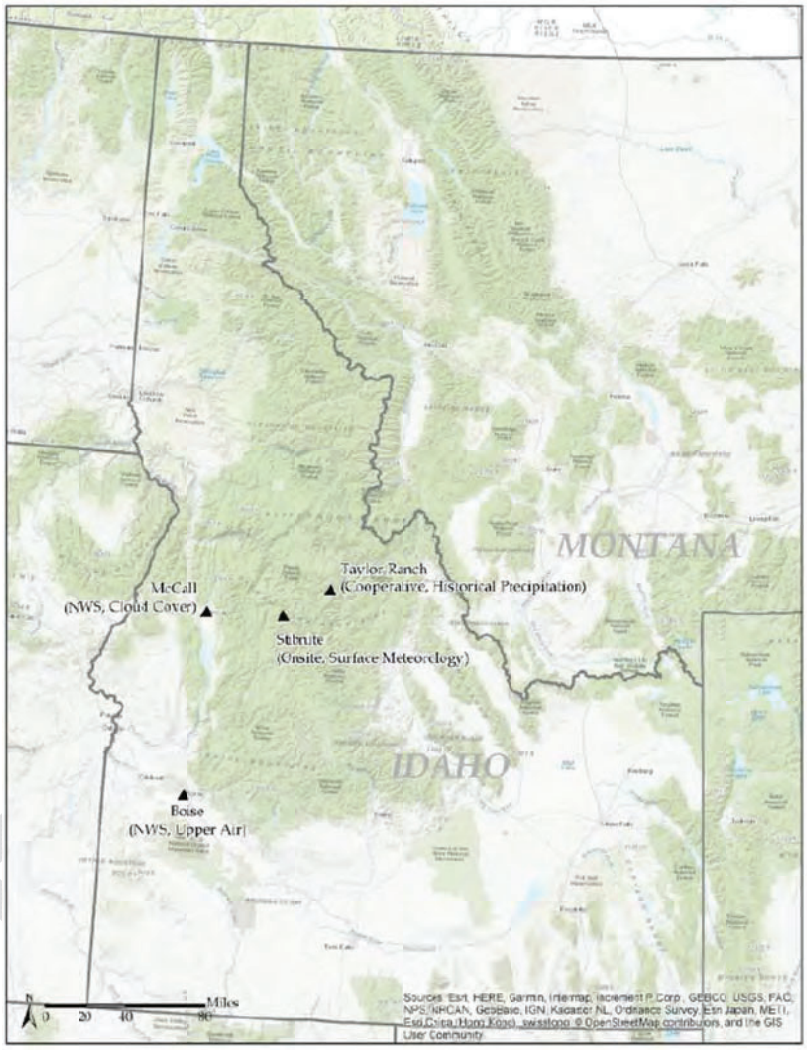
Met File Type: AERMET SFC
File: STIBNITE_2014U.SFC

Figure 1
WINDROSE

Station No. 94182
MC CALL, ID
Year: 2014

Some Text Here

Figure 6. METEOROLOGICAL STATION LOCATIONS FOR SGP MODELING.



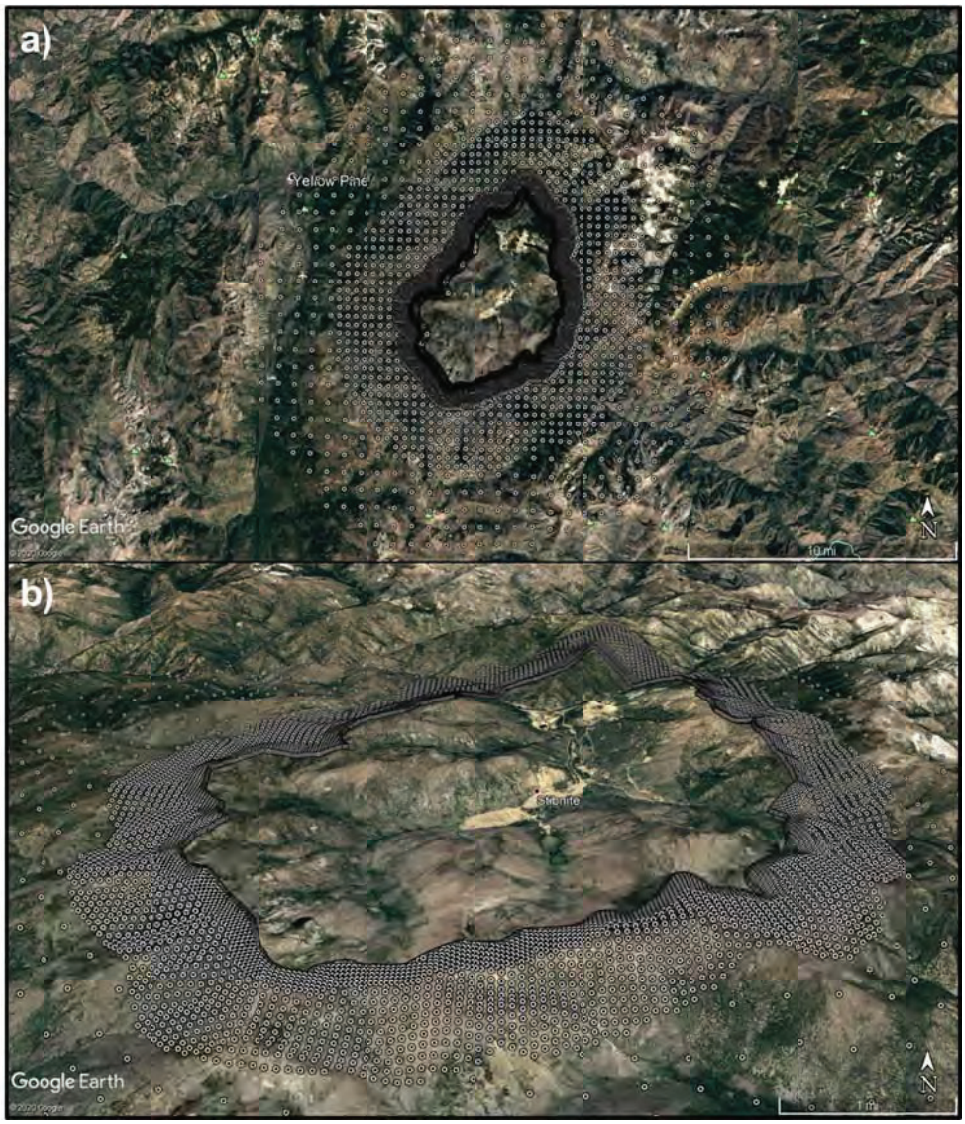
3.3.6 Effects of Terrain on Modeled Impacts

Submitted ambient air impact analyses used terrain data extracted from United States Geological Survey (USGS) National Elevation Dataset (NED) files.

The terrain preprocessor AERMAP version 18081 was used by Air Sciences to extract the elevations from the NED files and assign them to receptors in the modeling domain in a format usable by AERMOD. AERMAP also determined the hill-height scale for each receptor. The hill-height scale is an

elevation value based on the surrounding terrain which has the greatest effect on that individual receptor. AERMOD uses those heights to evaluate whether the emission plume has sufficient energy to travel up and over the terrain or if the plume will travel around the terrain. Figure 7a depicts the full receptor grid used in the modeling analyses and Figure 7b illustrates a close-up of Figure 7a, overlaid on a terrain image from Google Earth.

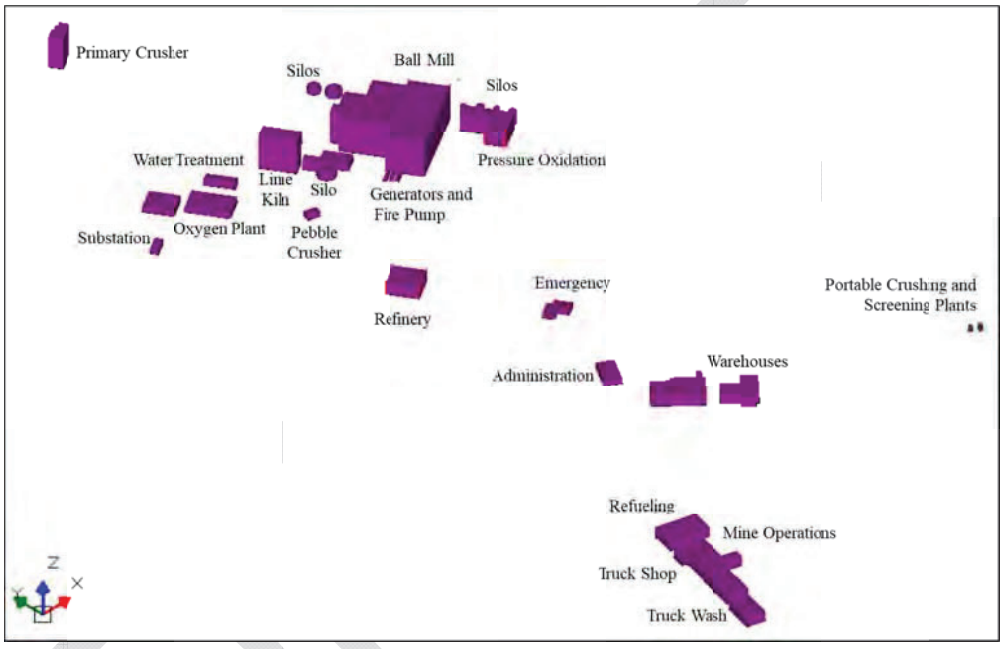
Figure 7. RECEPTOR GRID CENTERED AT THE SGP FACILITY.



3.3.7 Facility Layout and Downwash

Figure 3 shows the processing and refining area buildings and sources at the SGP facility. Figure 8 below depicts a three-dimensional view of Figure 3, as viewed from the southwest.

Figure 8. THREE-DIMENSIONAL VIEW OF PROCESSING AND REFINING AREA BUILDINGS AND SOURCES AT THE SGP FACILITY AS VIEWED FROM THE SOUTHWEST.



DEQ verified proper identification of the site location and the ambient air boundary by comparing a graphical representation of the modeling input file to aerial photographs on Google Earth (available at https://www.google.com/earth).

Potential downwash effects on emission plumes were accounted for in the model by using building dimensions and locations (locations of building corners, base elevation, and building heights). Dimensions and orientation of proposed buildings were used as input to the Building Profile Input Program for the Plume Rise Model Enhancements downwash algorithm (BPIP-PRIME version 04274) to calculate direction-specific dimensions and Good Engineering Practice (GEP) stack height information for input to AERMOD.

3.3.8 NOx Chemistry

The atmospheric chemistry of NO, NO_2, and O_3 complicates accurate prediction of NO_2 impacts resulting from NOx emissions. The conversion of NO to NO_2 can be conservatively addressed through the use of

REC 0867

PET 501

several methods as outlined in a *2014 EPA NO_2 Modeling Clarification Memorandum* (EPA 2014). The guidance outlines a three-tiered approach:

- Tier 1 – assume full conversion of NO to NO_2 where total NOx emissions are modeled and modeled impacts are assumed to be 100 percent NO_2.
- Tier 2 – use an ambient ratio to adjust impacts from the Tier 1 analysis.
- Tier 3 – use a detailed screening method to account for $NO/NO_2/O_3$ chemistry such as the Ozone Limiting Method (OLM) or the Plume Volume Molar Ratio Method (PVMRM).

The default option of the Ozone Limiting Method (OLM), a third-tier method from 40 CFR 51, Appendix W, was used by Air Sciences to estimate the NO_2 1-hour and annual impacts for these analyses. The OLM method requires an input of in-stack NO_2/NOx ratio for each modeled source.

An in-depth literature review was conducted by Air Sciences to identify reasonable NO_2/NOx ratios for different combustion source categories. Based on this research, the NO_2/NOx ratio recommended for the heavy-duty diesel trucks in the California Air Pollution Control Officers Association (CAPCOA) Guidance Document (CAPCOA 2011) was selected for stationary diesel combustion sources. This NO_2/NOx ratio (11 percent) is conservatively higher than the diesel combustion NO_2/NOx ratio provided in the EPA ISR (In-Stack Ratio) database: 6 percent average, 9.8 percent maximum. The CAPCOA document and the EPA ISR database do not provide an NO_2/NOx ratio for propane boilers. The CAPCOA-recommended NO_2/NOx ratio for natural gas boilers was selected for the propane boilers. The natural gas boilers NO_2/NOx ratio is considered appropriate for the propane boilers because both are gaseous fuels with relatively similar combustion characteristics and are expected to have similar NO_2/NOx ratios. The NO_2/NOx ratio for blasting is based on blasting plume measurements provided in an Australian study (CSIRO 2008). The NO_2/NOx ratios used for the SGP NO_2 analyses are presented in Table 22.

Table 22. NO_2/NOx RATIOS.

Source Type	NO_2/NO_X Ratio	Reference
Blasting	0.036	Commonwealth Scientific and Industrial Research Organisation (CSIRO 2008)
Diesel Engines	0.11	CAPCOA Guidance Document, heavy-duty diesel trucks (CAPCOA 2011)
Propane Heaters	0.10	CAPCOA Guidance Document, natural gas boilers (CAPCOA 2011)

DEQ performed a sensitivity analysis using a Tier 2 screening method (ARM2), which is more conservative than OLM, and found that the SGP facility is safely below the 1-hour and annual NO_2 NAAQS. Results are summarized in Section 4.1.3.

3.3.9 Particulate Deposition

For $PM_{2.5}$ and PM_{10} analyses, default particulate modeling methods, including deposition (Method 1, to account for depletion due to particulate settling), were used. To account for particulate settling, AERMOD requires the following source-specific variables:

1. Mass-mean aerodynamic particle diameter (PARTDIAM) for each particle size bin
2. Mass fraction (MASSFRAX) for each particle size bin
3. Particle density (PARTDENS) for each particle size bin

DRAFT

A list of references that were used to develop the broad source category particle size bins and associated mass fractions was provided in the application. Midas Gold (Midas Gold 2017b) provided the ore and DR material densities. The diesel and propane combustion particulate densities were adopted from technical literature (UMN 2002) and (Khalizov et al. 2012), respectively. Densities for the remaining materials were obtained from the Engineering Toolbox (https://www.engineeringtoolbox.com/density-materials-d_1652.html). An average density was used when a material-specific density range was available.

For sources that were aggregated and modeled as activity locations, deposition parameters were selected for the dominant source within the activity location. For open-pits (YPP, HFP, WEP), approximately 90% of emissions were associated with drilling; therefore, drilling deposition parameters were assigned to these sources. Similarly, emissions from dozing accounted for over 70% of emissions in the DRSF (FDRSF, HFDRSF, WEDRSF) and BT; therefore, these sources were assigned deposition parameters based on a dozing particulate profile.

The deposition parameters including mass fractions, mass mean diameters, and densities for the different source categories/groups are provided in Table 23.

Table 23. DEPOSITION PARAMETERS BY SOURCE CATEGORY.

Source Category	Parameter	PM_{10}				$PM_{2.5}$	
		Bin 1	Bin 2	Bin 3	Bin 4	Bin 1	Bin 2
Haul Roads	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction	0.10	0.90	--	--	1.00	--
	Mass Mean Diameter (µm)	2.50	10.00	--	--	2.50	--
	Density (g/cm^3) (YPP, HFP, WEP DR average)	2.46	2.46	--	--	2.46	--
Material Handling (Ore, DR, Limestone)	Bin Upper Diameter (µm)	2.50	5.00	10.00	--	2.50	--
	Mass Fraction	0.15	0.42	0.43	--	1.00	--
	Mass Mean Diameter (µm)	2.50	5.00	10.00	--	2.50	--
	Density (g/cm^3) (Ore)	Pit-specific, see Table 24.					
	Density (g/cm^3) (Ore and Waste)	Pit-specific, see Table 24.					
	Density (g/cm^3) (Limestone)	1.09	1.09	1.09	--	1.09	--
Baghouses	Bin Upper Diameter (µm)	2.50	6.00	10.00	--	2.50	--
	Mass Fraction	0.28	0.50	0.22	--	1.00	--
	Mass Mean Diameter (µm)	2.50	6.00	10.00	--	2.50	--
	Density (g/cm^3) (Ore)	Pit-specific, see Table 24.					
Diesel Engines	Bin Upper Diameter (µm)	1.00	2.50	6.00	10.00	1.00	2.50
	Mass Fraction	0.85	0.08	0.03	0.03	0.91	0.09
	Mass Mean Diameter (µm)	1.00	2.50	6.00	10.00	1.00	2.50
	Density (g/cm^3) (Diesel Combustion)	1.00	1.00	1.00	1.00	1.00	1.00
Heaters and Boilers	Bin Upper Diameter (µm)	1.00	2.50	6.00	10.00	1.00	2.50
	Mass Fraction	0.29	0.28	0.32	0.11	0.51	0.49
	Mass Mean Diameter (µm)	1.00	2.50	6.00	10.00	1.00	2.50
	Density (g/cm^3) (Propane Combustion)	1.24	1.24	1.24	1.24	1.24	1.24
Lime Loading and Unloading (Quick, Pebble)	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction	0.15	0.85	--	--	1.00	--
	Mass Mean Diameter	2.50	10.00	--	--	2.50	--
	Density (g/cm^3) (Quick)	0.44	0.44	--	--	0.44	--
	Density (g/cm^3) (Pebble)	0.96	0.96	--	--	0.96	--
Lime Unloading (Quick, Pebble)	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction	0.15	0.85	--	--	1.00	--
	Mass Mean Diameter (µm)	2.50	10.00	--	--	2.50	--
	Density (g/cm^3) (Quick)	0.44	0.44	--	--	0.44	--
	Density (g/cm^3) (Pebble)	0.96	0.96	--	--	0.96	--
Cement and Aggregate	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction	0.15	0.85	--	--	1.00	--

DRAFT

Loading and Unloading	Mass Mean Diameter (µm)	2.50	10.00	--	--	2.50	--
	Density (g/cm^3) (Cement)	1.44	1.44	--	--	1.44	--
	Density (g/cm^3) (Aggregate)	1.28	1.28	--	--	1.28	--
Prill Loading and Unloading	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction	0.15	0.85	--	--	1.00	--
	Mass Mean Diameter (µm)	2.50	10.00	--	--	2.50	--
	Density (g/cm^3) (Prill)	0.84	0.84	--	--	0.84	--
Refining Processes	Bin Upper Diameter (µm)	1.00	2.50	6.00	10.00	1.00	2.50
	Mass Fraction	0.78	0.11	0.08	0.03	0.88	0.12
	Mass Mean Diameter (µm)	1.00	2.50	6.00	10.00	1.00	2.50
	Density (g/cm^3) (Diesel Combustion)	1.00	1.00	1.00	1.00	1.00	1.00
Portable Crushing and Screening Plant	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction	0.13	0.87	--	--	1.00	--
	Mass Mean Diameter (µm)	2.50	10.00	--	--	2.50	--
	Density (g/cm^3) (YPP, HFP, WEP DR average)	2.46	2.46	--	--	2.46	--
Lime Kiln and Ball Mill	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction (Kiln)	0.49	0.51	--	--	1.00	--
	Mass Fraction (Ball Mill)	0.36	0.64	--	--	1.00	--
	Mass Mean Diameter (µm)	2.50	10.00	--	--	2.50	--
	Density (g/cm^3)	1.09	1.09	--	--	1.09	--
Blasting and Drilling	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction	0.06	0.94	--	--	1.00	--
	Mass Mean Diameter (µm)	2.50	10.00	--	--	2.50	--
	Density (g/cm^3) (Ore or DR)	Pit-specific, see Table 24.					
Dozing	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction	0.55	0.45	--	--	1.00	--
	Mass Mean Diameter (µm)	2.50	10.00	--	--	2.50	--
	Density (g/cm^3) (DR)	Pit-specific, see Table 24.					

In order to account for variability in ore and DR densities for different pits, pit-specific densities were used for the ore and DR for each modeling scenario, with the following exception – for haul roads, access roads, and portable crushers, the average DR density from YPP, HFP, and WEP was used. Note that the BT density was excluded from those sources because the BT material will not be used for roads or construction. The pit-specific ore and DR densities are provided in Table 24.

Table 24. PIT-SPECIFIC ORE AND DEVELOPMENT ROCK (DR) DENSITIES FOR DEPOSITION.

Pit	Material	Density (g/cm^3)
YPP	Ore	2.59
BT	Ore	2.00
HFP	Ore	2.59
WEP	Ore	2.68
YPP	DR	2.48
BT	DR	2.00
HFP	DR	2.34
WEP	DR	2.57
Average (YPP,HFP, WEP)	DR	2.46

3.3.10 Ambient Air Boundary

Ambient air is defined in Section 006 of the Idaho Air Rules as "that portion of the atmosphere, external to buildings, to which the general public has access."

DRAFT

Midas Gold will legally control the SGP, an active industrial site where mining activities will occur, such as heavy equipment operation. Most areas of the mine will require strict safety protocols and controlled access. Midas Gold has established an operations boundary to identify the area where public access will be excluded. Public access inside the operations boundary will be restricted for the life of the mine by physical barriers at points of potential access, including the current Stibnite Road point of entry and proposed site access via the Burntlog Route, as well as natural features of the landscape that prevent access. Consistent with the guidance provided in the EPA's draft revised policy on ambient air (EPA 2018b), public access control will include the following measures:

- Primary Access Points: The Stibnite Road (north) and Burntlog Route (south) access points will include locked gates. Guard shacks will be located at each gate to monitor all vehicle ingress/egress. Each gate also will include appropriate adjacent barriers (i.e., fencing, bollards, boulders, or other barriers) to prevent any vehicle from circumventing the gate and gaining site access. These primary access points are also controlled by adjacent natural features, such as streams and creeks, steep topography, and areas of thick vegetation and undergrowth that serve as natural barriers or impediments to access.

- Secondary Access Points: Other potential access points, such as secondary roadways and trails, will include posted signs warning the public against entry into the site. At these locations, boulders will be placed across the trail and at an appropriate width adjacent to the trail to prevent any vehicle from circumventing the barrier. These secondary access points also incorporate adjacent natural features, such as streams and creeks, steep topography, and areas of thick vegetation and undergrowth that serve as natural barriers or impediments to access. Some mine features, such as the TSF and process plant areas, will include perimeter fencing.

- Surveillance: Midas Gold security personnel will routinely patrol mine facilities and roadways for unauthorized individuals. In addition, all onsite personnel will be trained on the necessity of restricting public access to areas within the operations boundary. Any suspected trespassing by unauthorized individuals will be reported immediately to security, and trespassers will be escorted off the site.

In response to comments from local community citizens, Midas Gold will manage an access route to provide the general public with limited access through the SGP site between Stibnite Road at Sugar Creek and Thunder Mountain Road at Meadow Creek (shown in Figure 2). This route will be managed in accordance with the Stibnite Road Access Management Plan which is summarized as follows:

The proposed Stibnite Road access route through the SGP site is meant to provide controlled through-site access that is safe, provides travel-time comparable to current conditions and is consistent with the United States Forest Service travel management plan. The Stibnite Road access route extends from the north entry point southward to the Administration, Warehouse and Storage Area. Continuing southward, the Stibnite Road access route incorporates the Burntlog access road segment that occurs within the operations area and extends to the south entry point as shown on Figure 2. Midas Gold has the legal authority to control access to the Stibnite Road access route and would provide seasonal (non-winter conditions) access only. At the discretion of Midas Gold, additional access controls may occur during various phases of construction, during mine operations that present potential safely hazards such as blasting, due to inclement weather, or under any other circumstances that may present a threat to the protection of public or employee health and safety. Midas Gold has the legal and practical ability to enforce its control over roadway access and to monitor traffic passing through the SGP site. Signage will be placed at the North Security Gate (near the bridge over Sugar Creek) and the South Security Gate (near the Stibnite Lodge) to provide information to travelers, and guard shacks will be located at each gate to

DRAFT

monitor all vehicle ingress/egress. Persons wishing to traverse the SGP site on the Stibnite Road access route will be required to check in at the security gate to receive a safety briefing and to alert mine staff of their presence. Travelers will be required to check out upon exiting the site to ensure passage through the site in a safe and timely manner. Travelers will not be allowed to stop or loiter while traveling though the operations area. Along its full length, the Stibnite Road access route would have appropriate signage to direct travelers and would be separated from mine haul roads and areas of mine operations by fencing, berms, or gates to prevent travelers from straying from the route. When possible and to the degree practicable, anticipated public access restrictions will be communicated to the public in a timely manner so that they may plan appropriately. Receptors on the Stibnite Road access route were not included in the SGP air quality analyses as this road is not considered ambient air.

The worker housing facility will be located within the project operations boundary, near the south access security gate. This housing facility will be used strictly for accommodating employees, contractors, and official visitors, and it will not be accessible to the general public. Therefore, the atmosphere over the land occupied by the worker housing facility is not considered ambient air, and receptors were not placed at this location for the air quality analyses.

The operations boundary, shown in Figure 2 above and Figure 9 below, was used to define the ambient air boundary for air dispersion modeling purposes.

3.3.11 Nearby Co-Contributing Sources

If impacts of neighboring emission sources on receptors showing a significant impact from the sources subject to the permitting action are not adequately accounted for by the background concentration used, then emissions from those sources must be modeled. The nearest significant permitted facility to SGP is Tamarack Mill, located more than 75 kilometers (km) west. This facility is located too far away to cause a significant concentration gradient along the periphery of the SGP and was therefore not included in the cumulative impact analyses for SGP.

3.3.12 Receptor Network

DEQ determined that the receptor grid used in the submitted modeling analyses was adequate to resolve maximum modeled impacts.

The SGP air quality analyses were performed using the following receptor spacing and extents (Table 19):

- 25-m-spaced receptors placed along the ambient air boundary;
- 50-m-spaced receptors extending 250 m beyond the ambient air boundary;
- 100-m-spaced receptors extending 1 km beyond the 50-m-spaced receptors;
- 500-m-spaced receptors extending 5 km beyond the ambient air boundary; and
- 1-km-spaced receptors extending 10 km beyond the ambient air boundary.

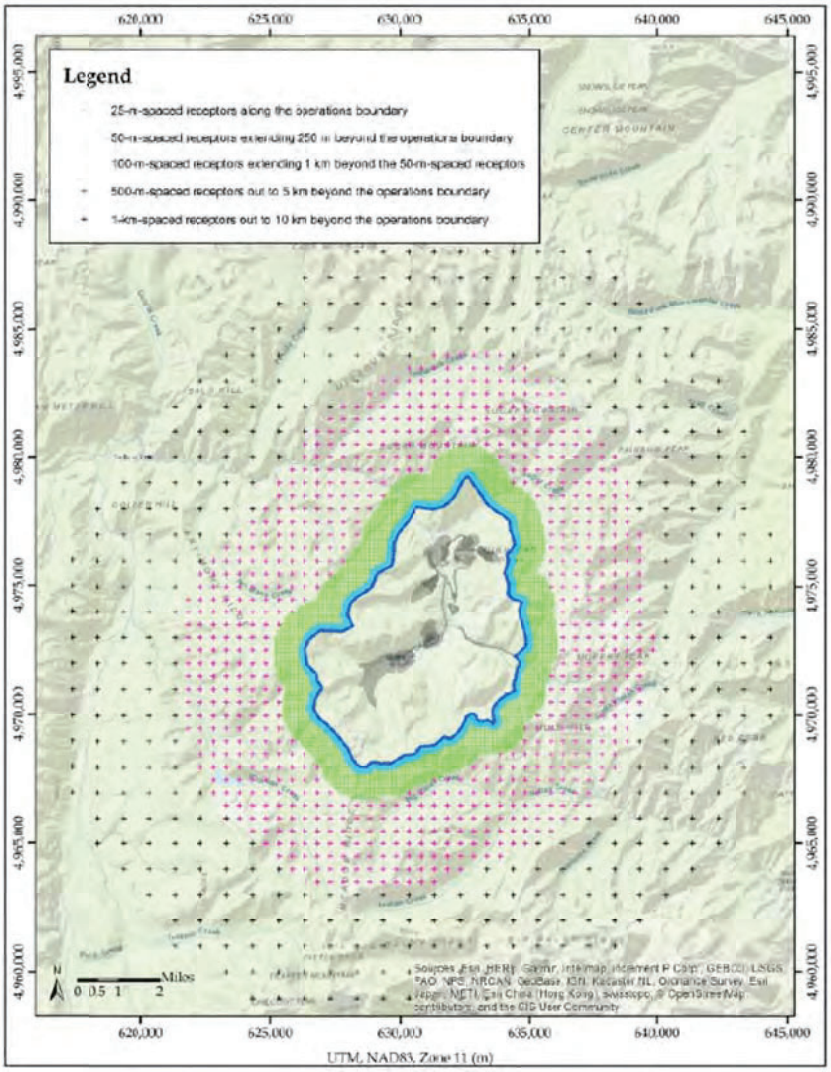
In addition, each highest modeled impact was evaluated further by performing a hot-spot analysis using a finer 25-m-spacing receptor grid. The modeling receptor grid is shown below in Figure 9. The full grid, along with the fenceline receptors, includes a total of 9,631 receptors. A SIL analysis was not conducted. The full receptor grid was used in the cumulative NAAQS impact and TAPs impact analyses.

The receptor grid used in the submitted modeling analyses met the minimum recommendations specified in the *Idaho Air Quality Modeling Guideline* (DEQ 2013), and DEQ determined that the receptor network

DRAFT

was effective in reasonably assuring compliance with applicable air quality standards at all ambient air locations.

Figure 9. SGP AMBIENT AIR BOUNDARY AND MODELING RECEPTOR GRID.



3.3.13 Good Engineering Practice Stack Height

An allowable good engineering practice (GEP) stack height may be established using the following equation in accordance with Idaho Air Rules Section 512.03.b:

H = S + 1.5L, where:

H = good engineering practice stack height measured from the ground-level elevation at the base of the stack.

S = height of the nearby structure(s) measured from the ground-level elevation at the base of the stack.

L = lesser dimension, height or projected width, of the nearby structure.

Sources from the SGP facility are below GEP stack height. Therefore, consideration of downwash caused by nearby buildings was required.

4.0 NAAQS and TAPs Impact Modeling Results

4.1 Results for NAAQS Analyses

4.1.1 Significant Impact Level Analyses

A SIL analysis was not performed for the SGP project.

4.1.2 Cumulative NAAQS Impact Analyses

Table 25 provides results (highest of 14 scenarios) for the cumulative NAAQS impact analysis. It provides the model-predicted maximum design concentration (including the hot-spot analyses) and the associated modeling scenario, the background concentration, and the estimated total concentration (SGP impact plus background) for each pollutant-averaging time combination. A comparison of the estimated total concentrations with the applicable NAAQS is also provided in this table. For each pollutant and averaging period, two modeled design concentrations are listed, each corresponding to the meteorological data processed with (BULKRN) and without (NON-BULKRN, grey shading) the Bulk Richardson method.

Table 25. RESULTS FOR CUMULATIVE NAAQS IMPACT ANALYSIS.

Pollutant	Averaging Time	Max. Conc.[a] (µg/m^3)[b]	Model Scenario	Back. Conc.[c] (µg/m^3)	Total Conc.[d] (µg/m^3)	NAAQS (µg/m^3)	Percent of NAAQS
Carbon monoxide	8 hours	6,218[e]	W1	1,110	7,328	10,000	73.3%
		3,516[f]	W1		4,626		46.3%
	1 hour	17,054	W1	1,740	18,794	40,000	47.0%
		9,467	W1		11,207		28.0%
Nitrogen dioxide	1 year	2.3	W1	0.9	3.2	100	3.2%
		1.4	W1		2.3		2.3%
	1 hour	116.7	B1	4.3	121.0	188	64.4%
		111.0	W1		115.3		61.3%
$PM_{2.5}$[g]	1 year	7.7	W5	3.5	11.2	12	93.3%
		4.2	W5		7.7		64.2%
	24 hours	18.6	W5	15.0	33.6	35	96.0%
		11.0	W5		26.0		74.3%
PM_{10}[h]	24 hours	121.5	W5	37.0	158.5	150	105.7%[i]
		75.7	W5		112.7		75.1%

DRAFT

Sulfur dioxide	3 hours	1.8	B1	16.8	18.6	1,300	1.4%
		1.2	B1		18.0		1.4%
	1 hour	3.2	B1	12.3	15.5	196	7.9%
		2.7	B1		15.0		7.7%

a. Max. Conc. = maximum modeled design concentration.
b. Micrograms per cubic meter.
c. Back. Conc. = background concentration.
d. Total Conc. = total (modeled + background) concentration.
e. The first Max. Conc. value for each pollutant and averaging time represents results using the BULKRN meteorological data.
f. The second (grey-shaded) Max. Conc. value for each pollutant and averaging time represents results using the NON-BULKRN meteorological data.
g. Particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers.
h. Particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers.
i. Results for 24-hour PM_{10} with meteorological data processed using BULKRN show up to five hotspot receptors that exceed NAAQS. Refer to Section 4.1.4 of this modeling memo for a weight-of-evidence analysis demonstrating NAAQS compliance.

Table 25 shows that modeled concentrations derived using the BULKRN meteorological data are higher than the NON-BULKRN dataset. It also shows that the total (modeled + background) concentrations from the SGP cumulative impact analyses do not exceed the applicable NAAQS, except for when the BULKRN meteorological data are used in modeling 24-hour PM_{10} (total concentration is 105.7% of the 24-hour PM_{10} NAAQS).

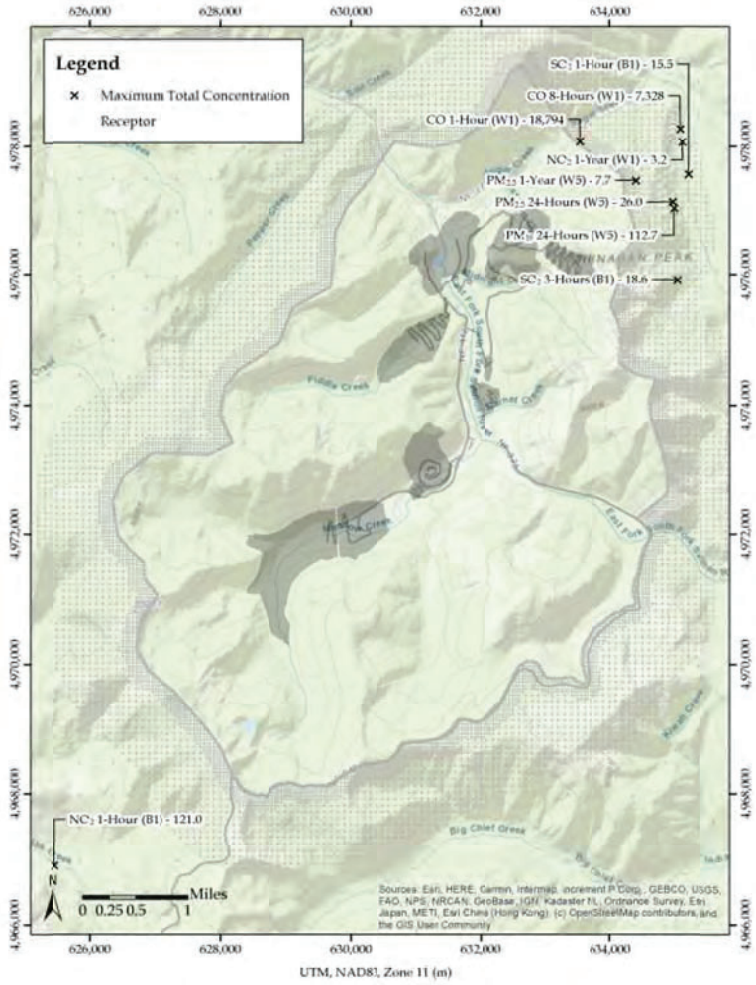
PM_{10} modeling with the meteorological dataset processed with the BULKRN method shows up to five hotspot receptors for three modeling scenarios (W1, W3, and W5) with slight exceedance of NAAQS. Scenario W5 is the worst-case scenario, with a maximum total concentration of 158.5 µg/m^3 which exceeds the NAAQS of 150 µg/m^3. A weight-of-evidence analysis demonstrating PM_{10} NAAQS compliance is presented in Section 4.1.4 of this modeling memo.

The locations of the maximum impacts for each pollutant and averaging time are illustrated in Figure 10. The results presented in this figure include the hot-spot analyses conducted for each applicable pollutant-averaging time combination. For $PM_{2.5}$ and PM_{10}, the alternate meteorological data (NON-BULKRN) were used.

Modeling for ozone and secondary $PM_{2.5}$ were not performed for this minor stationary source. These analyses are typically associated with applications for major stationary sources. Nonetheless, taking the ratio of the VOC, NOx, and SO_2 emissions from the SGP facility by the emissions and resulting concentrations of O_3 and secondary $PM_{2.5}$ from EPA's modeled emission rates for precursors (MERPs) guidance yields estimated O_3 and secondary $PM_{2.5}$ concentrations of less than 1 ppb of O_3 and less than 0.1 µg/m^3 of $PM_{2.5}$ (24-hour and annual) for the SGP. These estimated concentrations have a negligible effect on compliance demonstration with the NAAQS.

DRAFT

Figure 10. SGP CUMULATIVE IMPACTS (µg/m^3) AND LOCATIONS.



Higher background concentrations from McCall that include medium-traffic emissions provided in Section 3.2.3 were then combined with the SGP model-predicted maximum design concentrations to provide an additional level of conservatism in demonstrating compliance. These results are shown in Table 26. For $PM_{2.5}$ and PM_{10}, the alternate meteorological data (NON-BULKRN) were used. For the rest of the criteria pollutants, the BULKRN meteorological data were used.

Table 26. RESULTS FOR CUMULATIVE NAAQS IMPACT ANALYSIS WITH MEDIUM-TRAFFIC BACKGROUND.

Pollutant	Averaging Time	Max. Conc.[a] (µg/m^3)[b]	Model Scenario	Back. Conc.[c]	Total Conc.[d]	NAAQS (µg/m^3)	Percent of NAAQS

				(µg/m^3)	(µg/m^3)		
Carbon monoxide	8 hours	6,218	W1	1,145	7,363	10,000	73.6%
	1 hour	17,054	W1	1,797	18,851	40,000	47.1%
Nitrogen dioxide	1 year	2.3	W1	2.6	4.9	100	4.9%
	1 hour	116.7	B1	14.3	131.0	188	69.7%
$PM_{2.5}$[e]	1 year	4.2	W5	5.1	9.3	12	77.5%
	24 hours	11.0	W5	17.5	28.5	35	81.4%
PM_{10}[f]	24 hours	75.7	W5	60.1	135.8	150	90.5%
Sulfur dioxide	3 hours	1.8	B1	16.8	18.6	1,300	1.4%
	1 hour	3.2	B1	12.3	15.5	196	7.9%

a. Max. Conc. = maximum modeled design concentration.
b. Micrograms per cubic meter.
c. Back. Conc. = background concentration.
d. Total Conc. = total (modeled + background) concentration.
e. Particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers.
f. Particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers.

4.1.3 DEQ's Sensitivity Analyses for 1-hour and annual NO_2

DEQ performed a sensitivity analysis for 1-hour and annual NO_2 using a Tier 2 (ARM2) screening method. Minimum and maximum NO_2/NOx ratios of 0.5 and 0.9, respectively, were used. Results from DEQ's cumulative NAAQS impact analyses, summarized below in Table 27, indicate that the SGP facility is safely below the 1-hour and annual NO_2 NAAQS even when using a more conservative NO_2 screening method.

Table 27. RESULTS FOR DEQ'S NO_2 SENSITIVITY ANALYSES USING TIER 2 (AMBIENT RATIO METHOD 2) SCREENING METHOD.

Pollutant	Averaging Time	Max. Conc.[a] (µg/m^3)[b]	Model Scenario	Back. Conc.[c] (µg/m^3)	Total Conc.[d] (µg/m^3)	NAAQS (µg/m^3)	Percent of NAAQS
Nitrogen dioxide	1 year	1.8	B1	0.9	2.7	100	2.7%
		1.8	H1		2.7		2.7%
		2.3	W1		3.2		3.2%
		1.8	Y1		2.7		2.7%
	1 hour	110.9	B1	4.3	115.2	188	61.3%
		73.0	H1		77.3		41.1%
		162.6	W1		166.9		88.8%
		59.8	Y1		64.1		34.1%

a. Max. Conc. = maximum modeled design concentration.
b. Micrograms per cubic meter.
c. Back. Conc. = background concentration.
d. Total Conc. = total (modeled + background) concentration.

4.1.4 DEQ's Weight-of-Evidence Analyses for 24-hour PM_{10}

This section describes a weight-of-evidence analysis that provides additional analytical information to evaluate the degree of NAAQS compliance confidence for 24-hour PM_{10}. NAAQS compliance was demonstrated in the submitted application using meteorological data processed with an EPA-approved method using regional cloud cover to calculate stability parameters rather than site-specific monitored solar radiation and measured temperature differences with height.

As described in Section 4.1.2, PM_{10} modeling with meteorological dataset processed using the site-specific BULKRN method shows up to five hotspot receptors for Scenario W5 (the highest PM_{10} modeling scenario) that exceed NAAQS (150 µg/m^3). The hotspot receptors have a 25-meter grid

DRAFT

spacing. Hotspot receptors that exceed 24-hour PM_{10} NAAQS have total (modeled + background) concentrations of 152.7, 154.3, 155.0, 155.7, and 158.5 µg/m^3. Locations of these receptors are illustrated in Figure 11. Figure 12 shows these receptors overlaid on Google Earth.

Figure 11. HOTSPOT RECEPTORS THAT EXCEED 24-HOUR PM_{10} NAAQS (SCENARIO W5, BULKRN METEOROLOGICAL DATA).

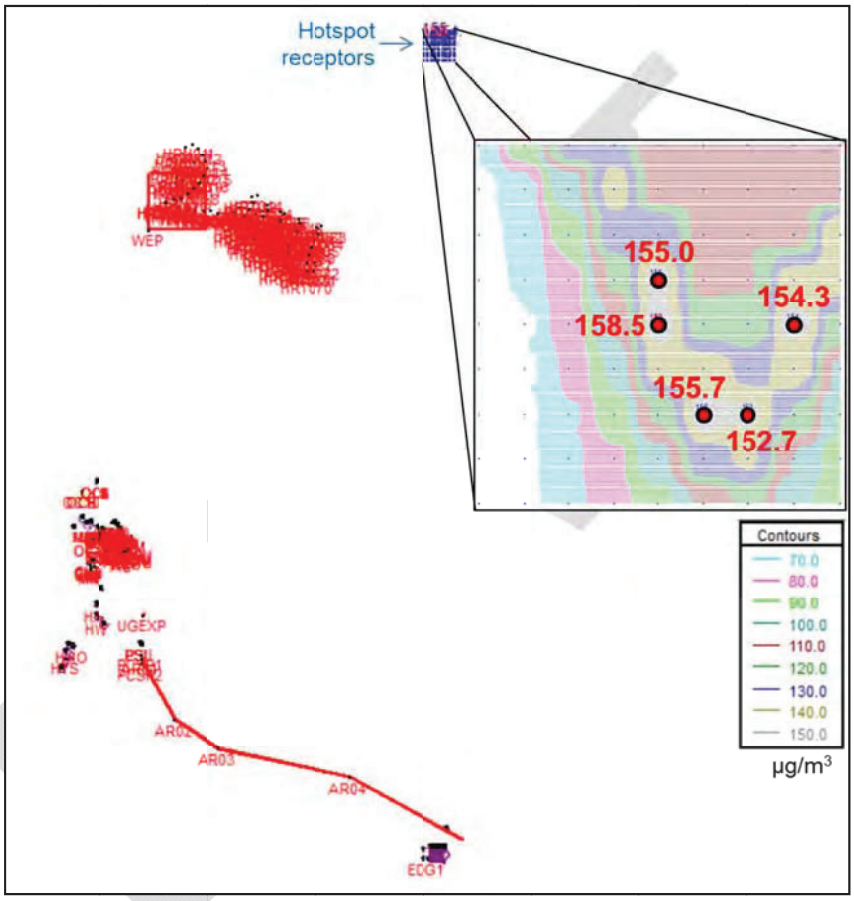
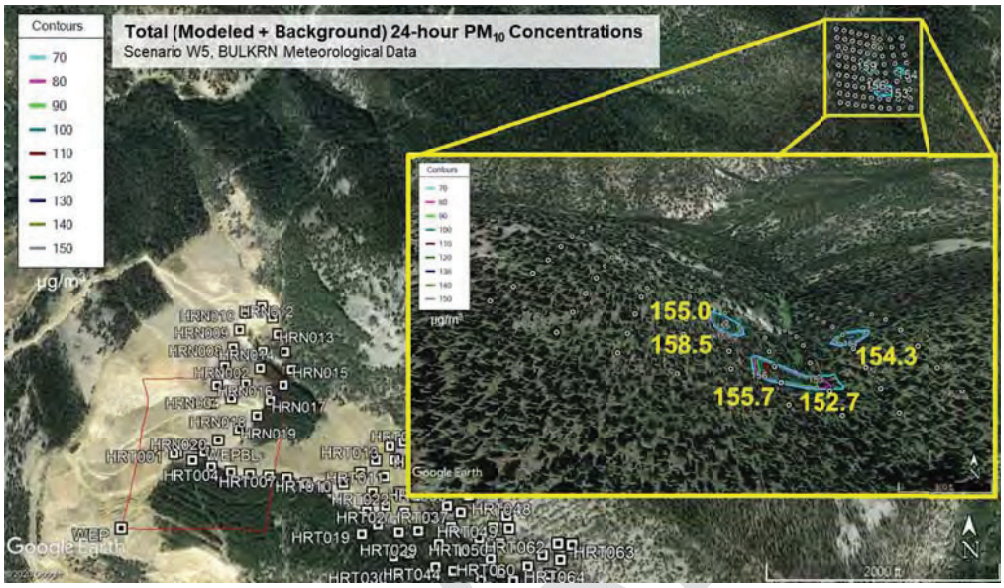


Figure 12. HOTSPOT RECEPTORS THAT EXCEED 24-HOUR PM_{10} NAAQS, OVERLAID ON GOOGLE EARTH IMAGE (SCENARIO W5, BULKRN METEOROLOGICAL DATA).



Figures 11 and 12 show that the modeled PM_{10} NAAQS exceedances are located northeast of the SGP facility. These receptors are located 2 km away from the center of the West End Pit (WEP). The AERMOD output files indicate that all modeled violations occur during winter (all modeled violations occur on December 23, 2014). Data provided in the SGP baseline study (Midas Gold 2017a) specify an average snow depth of 21-68 inches and an average precipitation of 6.0 inches at the project site during this period. Therefore, fugitive road dust emissions during high-modeled impact hours could be overestimated.

DEQ performed a source-group analysis (Table 28) which indicates that emissions from the WEP and the Haul Road (HR) are the largest contributors to the maximum modeled PM_{10} design concentrations. For comparison, source-group analyses using the NON-BULKRN meteorological data are also listed in Table 28.

Table 28. SOURCE-GROUP ANALYSIS FOR 24-HOUR PM_{10} (SCENARIO W5).

Emission Source Group	Modeled Design Concentration ($\mu g/m^3$)[a]	
	BULKRN	NON-BULKRN
ALL	121.5	75.7
West End Pit (WEP)	89.3	24.5
West End Pit Blasting (WEPBL)	1.94	1.81
West End Pit Development Rock Storage Facility (WEDRSF)	0.98	3.47
Haul Road (HR)	51.0	52.5
Access Road (ACCRD)	0.0064	0.0074
Underground Exploration (UGEXP)	0.00001	0.00001

REC 0879

PET 513

Process & Ancillary Point Sources	0.23	0.76
Process & Ancillary Volume Sources	0.20	0.29

[a.] Micrograms per cubic meter.

The six source groups listed in Table 28 that are related to mining activity and emissions (WEP, WEPBL, WEDRSF, HR, ACCRD, UGEXP) were examined further. Table 29 lists the daily modeled PM_{10} emissions (in pounds per day [lb/day]), grouped according to mining activity. Key assumptions for calculating the daily emissions are also listed in this table. Total modeled PM_{10} emission from mining activity for Scenario W5 is 3,336.76 lb/day. The contribution from each source group is listed in the second column of Table 29, and a pie chart is illustrated in Figure 13.

Table 29. KEY ASSUMPTIONS FOR CALCULATING DAILY MINING ACTIVITY EMISSIONS FOR 24-HOUR PM_{10} (SCENARIO W5).

Mining Activity	Emissions (lb/day)[a]
WEP (West End Pit)	**885.54**
Open Pit Drilling	
• Blasting 180,000 tons of material (DR) per day • Drilling 1,200 holes per day	811.20
Material Loading	
• Blasting 180,000 tons of material (DR) per day	18.00
Dozing	
• Dozers operating 144 hours per day • Surface material silt content of 6.9% • Material moisture content of 7.9%	54.20
Surface Exploration	
• Total wet drilling holes of 700 divided by 14 years • 50 holes per year	2.15
WEPBL (West End Pit Blasting)	**334.38**
Open Pit Blasting	
• Blasting 180,000 tons of material (DR) per day • Two blasts per day	334.38
WEDRSF (West End Pit Development Rock Storage Facility)	**57.12**
Material Unloading	
• Blasting 180,000 tons of material (DR) per day	2.88
Dozing	
• Six dozers operating 144 hours per day • Surface material silt content of 6.9% • Material moisture content of 7.9%	54.20
Wind Erosion	0.04
HR (Haul Road)	**2,050.34**
Onsite Hauling	
• Blasting 180,000 tons of material (DR) per day • One-way hauling distance of 3.07 miles • Total travel of 7,758 vehicle miles traveled (VMT) per day • Surface material silt content of 4% • Daily PM_{10} emission factor of 3.55 pounds per VMT • Control efficiency of 90% for chemical suppressant • Control efficiency of 33% for watering	1,842.97
Grading	
• Grader average speed of 6.5 mph • Three graders operating 72 hours per day • Control efficiency of 90% for chemical suppressant	60.51
Water Truck Travel	
• Two water trucks operating 48 hours per day	146.86

DRAFT

• Average truck speed of 15 mph • Surface material silt content of 4% • Daily PM_{10} emission factor of 3.04 pounds per VMT • Control efficiency of 90% for chemical suppressant • Control efficiency of 33% for watering	
ACCRD (Access Road) *Vehicle Travel* • Access road length of 1.6 miles (within project boundary) • Surface material silt content of 4% • Daily PM_{10} emission factor of 1.26 pounds per VMT • Control efficiency of 90% for chemical suppressant • Control efficiency of 33% for watering *Grading* • PM_{10} emission factor of 1.3 pounds per VMT • Control efficiency of 90% for chemical suppressant	**9.38** 9.17 0.21
UGEXP (Underground Exploration) *Underground Exploration* • Wet drilling 25 holes per year	**0.004** 0.004

[a] Pounds per day.

Figure 13. PIE CHART FOR DAILY MODELED PM_{10} EMISSIONS FROM MINING ACTIVITY (SCENARIO W5).

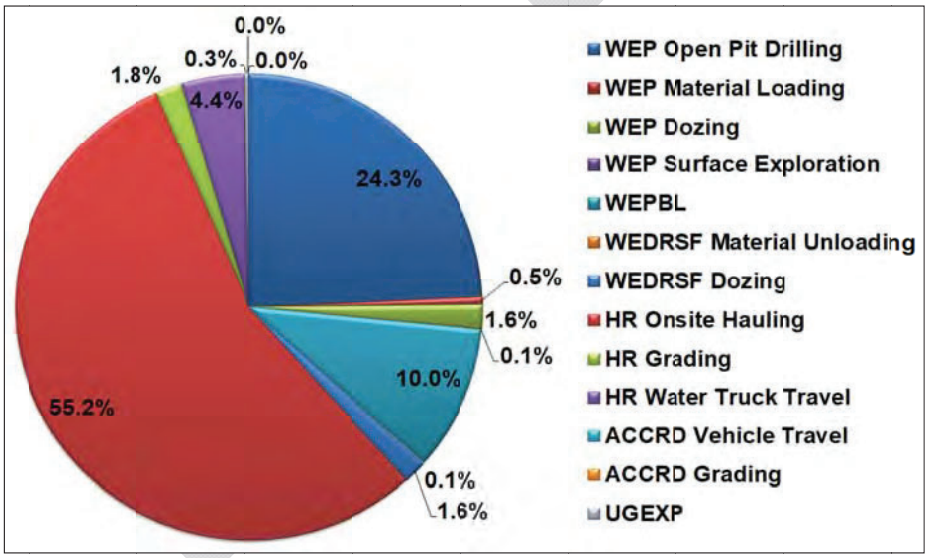


Figure 13 shows that onsite hauling on haul roads ("HR Onsite Hauling") accounts for 55.2% of the total daily PM_{10} emissions. Open pit drilling at the WEP ("WEP Open Pit Drilling") and blasting ("WEPBL") account for 24.3% and 10.0% of the daily PM_{10} emissions, respectively. Therefore, it is not surprising that HR, WEP, and WEPBL are the largest contributors to the modeled design concentrations in Table 28.

As listed in Table 29, PM_{10} modeling simulation for Scenario W5 was based on a mining production rate of 180,000 ton/day of development rock. This corresponds to 6~~2~~5,700,000 ton/year, which is more conservative than the expected peak production rate of 42,692,000 ton/year (116,964 ton/day). To

REC 0881

PET 515

investigate the effect of a lower modeled mining production rate on design value concentrations, DEQ performed a modeling simulation ("DEQ Run 1") where mining production rate was assumed to be 120,000 ton/day instead of 180,000 ton/day, but all other model variables were held constant. This adjustment lowered the modeled daily emission rates for WEP, WEDRSF, and HR, which are summarized in Table 30. Because the modeled emission rates were lower, the modeled design concentrations were also lower. Results for DEQ's sensitivity analyses are summarized in Table 31.

Table 30. DAILY MINING ACTIVITY EMISSIONS USED IN DEQ'S SENSITIVITY ANALYSES FOR 24-HOUR PM_{10} (SCENARIO W5).

Mining Activity	Emissions (lb/day)[a]	
	Applicant's Submittal	DEQ Run 1
WEP (West End Pit)	**885.54**	**879.54**
Open Pit Drilling	811.20	811.20
Material Loading	18.00	12.00
Dozing	54.20	54.20
Surface Exploration	2.15	2.14
WEPBL (West End Pit Blasting)	**334.38**	**334.38**
Open Pit Blasting	334.38	334.38
WEDRSF (West End Pit Development Rock Storage Facility)	**57.12**	**56.15**
Material Unloading	2.88	1.92
Dozing	54.20	54.20
Wind Erosion	0.04	0.03
HR (Haul Road)	**2,050.34**	**1,436.50**
Onsite Hauling	1,842.97	1,229.13
Grading	60.51	60.51
Water Truck Travel	146.86	146.86
ACCRD (Access Road)	**9.38**	**9.38**
Vehicle Travel	9.17	9.17
Grading	0.21	0.21
UGEXP (Underground Exploration)	**0.004**	**0.004**
Underground Exploration	0.004	0.004
Total	**3,336.76**	**2,715.95**

a. Pounds per day.

Table 31. RESULTS FOR DEQ'S SENSITIVITY ANALYSES FOR 24-HOUR PM_{10} (SCENARIO W5, BULKRN METEOROLOGICAL DATA).

Pollutant	Averaging Time	Max. Conc.[a] ($\mu g/m^3$)[b]	Model Scenario	Back. Conc.[c] ($\mu g/m^3$)	Total Conc.[d] ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	Percent of NAAQS
PM_{10}[e]	24 hours	111.5[f]	W5	37.0	148.5	150	99.0%

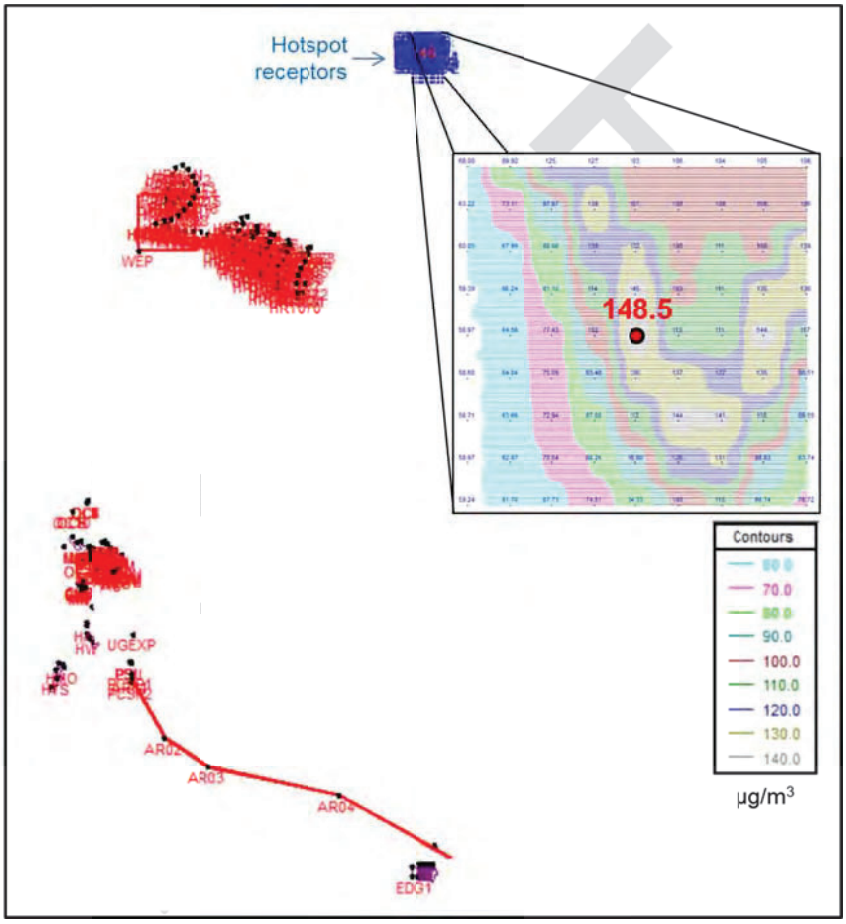
a. Max. Conc. = maximum modeled design concentration.
b. Micrograms per cubic meter.
c. Back. Conc. = background concentration.
d. Total Conc. = total (modeled + background) concentration.
e. Particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers.
f. DEQ Run 1: mining production rate was modeled at 120,000 ton/day instead of 180,000 ton/day. Everything else was held constant.

Maximum modeled concentration for "DEQ Run 1", when summed with the background concentration, is lower than NAAQS thereby demonstrating NAAQS compliance. Total (modeled + background) concentrations for all hotspot receptors are depicted in Figure 14; maximum total impact is depicted by

DRAFT

the red circle. The SGP facility complies with the 24-hour PM_{10} NAAQS when daily mining production rates closer to a more typical daily rate for a high-production period are used in the model, instead of a very conservative mining production rate, even when using site-specific BULKRN meteorological data.

Figure 14. RESULTS FOR DEQ'S SENSITIVITY ANALYSES SHOWING TOTAL (MODELED + BACKGROUND) 24-HOUR PM_{10} CONCENTRATIONS AT HOTSPOT RECEPTORS (SCENARIO W5, BULKRN METEOROLOGICAL DATA).



Meteorological data processing with and without BULKRN are considered acceptable by EPA. However, the BULKRN meteorological data yielded higher modeled design values for the SGP facility than the meteorological data processed without the BULKRN method. DEQ's analyses suggest that when daily mining production rates closer to a more typical daily rate for a high-production period are used (everything else held constant), the SGP facility is able to demonstrate compliance with 24-hour PM_{10} NAAQS at those few receptors showing a potential violation when using meteorological data processed with the BULKRN method.

Maximum modeled design value 24-hour PM_{10} impacts, even with the use of more reasonably expected daily production rates, are still just under the 150 $\mu g/m^3$ NAAQS. As noted earlier in this section, these high values were observed during the winter season. During this period, not only are fugitive emissions minimized because of the higher moisture content of material handled or driven over, but background concentrations in such remote areas are generally much lower because of the absence of wildfires and dust-generating sources.

DEQ's weight-of-evidence analyses show that, considering all the collective conservative layers of the modeling analyses, modeling efforts using both site-specific and alternative meteorological datasets show acceptable impacts.

4.1.5 DEQ's Sensitivity Analyses for a Lower Fugitive Road Dust Control Efficiency

Fugitive particulate emissions from roadways were estimated by the applicant to be controlled above 93%, which is an aggressive level of control. The high level of emission control was needed to demonstrate compliance with NAAQS. To investigate the effect of lower unpaved road emission control efficiency, DEQ performed a modeling simulation ("DEQ Run 2") where the control efficiency was set to 90%. The daily mining production rate was assumed to be 120,000 ton/day instead of 180,000 ton/day, but everything else was held constant. These adjustments lowered the daily modeled emission rates for WEP and WEDRSF, but increased the daily modeled emission rate for HR and the Access Road (ACCRD) (Table 32). Five receptors exceed the 24-hour PM_{10} NAAQS. Figure 15 shows the locations of these receptors.

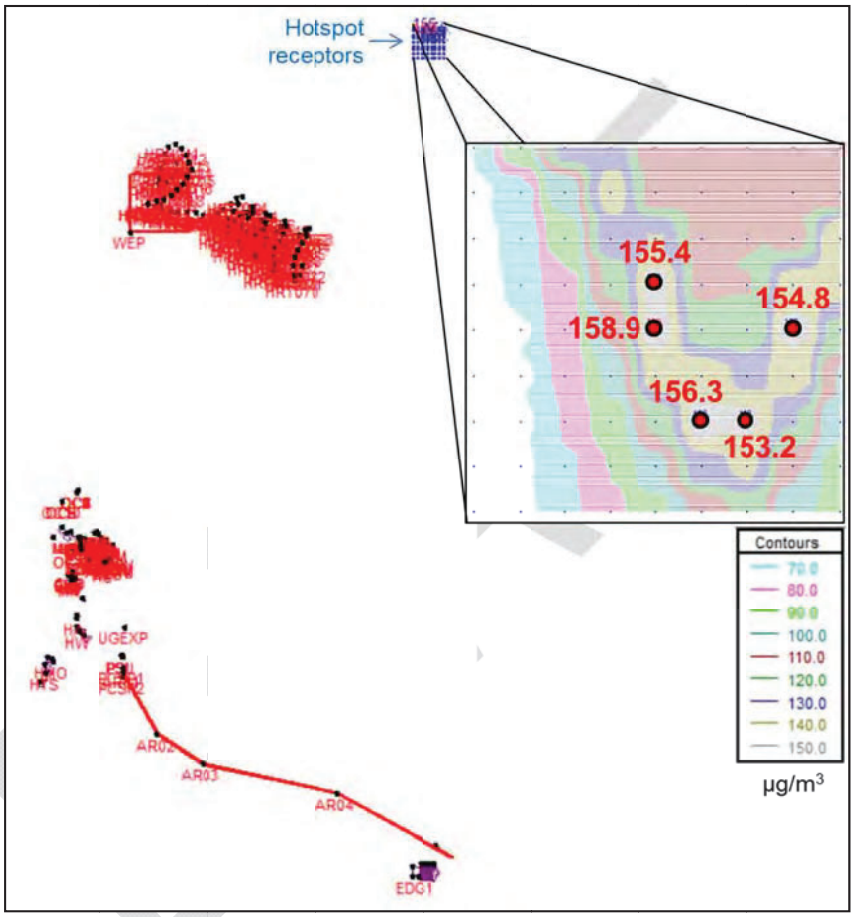
Table 32. DAILY MINING ACTIVITY EMISSIONS USED IN DEQ'S SENSITIVITY ANALYSES FOR 24-HOUR PM_{10} (SCENARIO W5).

Mining Activity	Emissions (lb/day)[a]	
	Applicant's Submittal	DEQ Run 2
WEP (West End Pit)	**885.54**	**879.54**
Open Pit Drilling	811.20	811.20
Material Loading	18.00	12.00
Dozing	54.20	54.20
Surface Exploration	2.15	2.14
WEPBL (West End Pit Blasting)	**334.38**	**334.38**
Open Pit Blasting	334.38	334.38
WEDRSF (West End Pit Development Rock Storage Facility)	**57.12**	**56.15**
Material Unloading	2.88	1.92
Dozing	54.20	54.20
Wind Erosion	0.04	0.03
HR (Haul Road)	**2,050.34**	**2,114.24**
Onsite Hauling	1,842.97	1,834.53
Grading	60.51	60.51
Water Truck Travel	146.86	219.20
ACCRD (Access Road)	**9.38**	**13.90**
Vehicle Travel	9.17	13.69
Grading	0.21	0.21
UGEXP (Underground Exploration)	**0.004**	**0.004**
Underground Exploration	0.004	0.004
Total	**3,336.76**	**3,398.21**

[a] Pounds per day.

DRAFT

Figure 15. RESULTS FOR DEQ'S SENSITIVITY ANALYSES SHOWING HOTSPOT RECEPTORS THAT EXCEED 24-HOUR PM_{10} NAAQS, ASSUMING MINING PRODUCTION RATE OF 120,000 TONS PER DAY AND FUGITIVE ROAD DUST CONTROL EFFICIENCY OF 90% (SCENARIO W5, BULKRN METEOROLOGICAL DATA).



DEQ's sensitivity analyses suggest that a few hotspot receptors exceed the 24-hour PM_{10} NAAQS when the unpaved road control efficiency falls below 93% and the meteorological data processed with the BULKRN method is used. However, all the hotspot receptors demonstrate compliance with NAAQS at a 90% control efficiency when using the meteorological data processed without the BULKRN method, and at both examined production levels:

- maximum impact at 120,000 ton per day – 73.9 µg/m^3 + 37.0 µg/m^3 = 110.9 µg/m^3.
- maximum impact 180,000 ton per day – 84.6 µg/m^3 + 37.0 µg/m^3 = 121.6 µg/m^3.

As previously stated, meteorological data processing with and without BULKRN are both considered

acceptable regulatory options by EPA. Therefore, this demonstrates that emissions resulting from a lower unpaved road control efficiency (even potentially less than 90%) do not cause or contribute to a NAAQS violation. Nonetheless, the permit requires ~~This highlights the need for~~ an aggressive implementation of measures to ~~achieve above 93%~~ control ~~efficiency for~~ fugitive particulate emissions from roadways.

4.2 Results for TAPs Impact Analyses

The SGP TAP modeling results and their comparison with the applicable AACs/AACCs are provided in Table 33.

Table 33. RESULTS FOR TAPS IMPACT ANALYSIS.

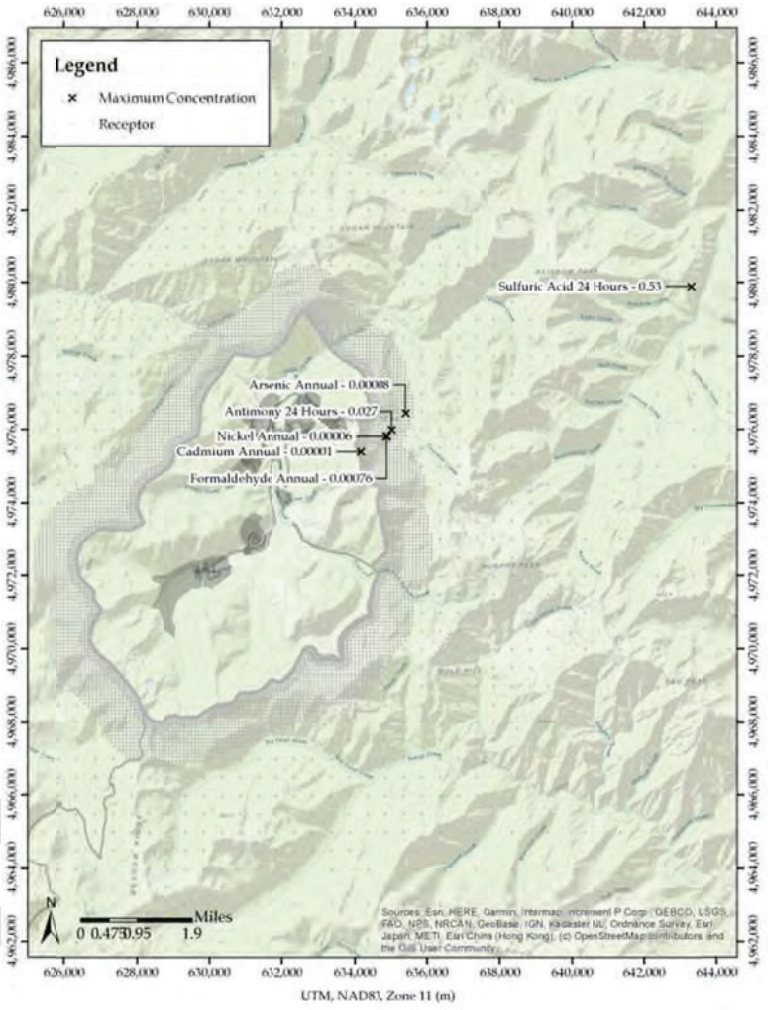
Pollutant	Averaging Time	Maximum Modeled Concentration ($\mu g/m^3$)[a]	Model Scenario	AAC[b] ($\mu g/m^3$)	AACC[c] ($\mu g/m^3$)	Percent of AAC/AACC
Antimony	24 hours	2.7E-02	B1	25	--	0.1%
Arsenic	Annual	8.0E-05	All	--	0.00023	34.8%
Cadmium	Annual	1.0E-05	All	--	0.00056	1.8%
Formaldehyde	Annual	7.6E-04	All	--	0.077	1.0%
Nickel	Annual	6.0E-05	All	--	0.0042	1.4%
Sulfuric Acid	24 hours	5.3E-01	All	50	--	1.1%

a. Micrograms per cubic meter.
b. Acceptable Ambient Concentration of a non-carcinogenic TAP.
c. Acceptable Ambient Concentration of a Carcinogenic TAP.

Table 33 shows that the modeled TAP impacts from the SGP sources do not exceed the applicable AACs/AACCs. The locations of the maximum impacts for each TAP are presented in Figure 16.

DRAFT

Figure 16. SGP TAP IMPACTS (µg/m^3) AND LOCATIONS.



5.0 Conclusions

The information submitted with the PTC application, combined with DEQ's air impact analyses, demonstrated to DEQ's satisfaction that emissions from the Stibnite Gold Project in Valley County, Idaho will not cause or significantly contribute to a violation of any applicable ambient air quality standard or TAP increment.

References

APT. 2009. "Source Emissions Testing Report, Barrick Cortez, Inc." *Hydrogen Cyanide Emissions, Electrowinning Cells #1 & #2.* November 11.

APT. 2013. "Source Emissions Test Report for Barrick Goldstrike Mines, Inc.: Carlin, Nevada Facility Title V Compliance Testing Operating Permit No. AP1041-0739.02." Report prepared for: Barrick Goldstrike Mines, Inc., August 28.

CAPCOA. 2011. "Modeling Compliance of The Federal 1-Hour NO_2 NAAQS." California Air Pollution Control Officers Association, October 27.

CSIRO. 2008. "NOx Emissions from Blasting Operations in Open-Cut Coal Mining." *Atmospheric Environment.* November.

DEQ. 2013. "State of Idaho Guideline for Performing Air Quality Impact Analyses." Idaho Department of Environmental Quality. September. State of Idaho DEQ Air Doc. ID AQ-011. http://www.deq.idaho.gov/media/1029/modeling-guideline.pdf.

DEQ. 2014. "Policy on NAAQS Compliance Demonstration Requirements." Idaho Department of Environmental Quality Policy Memorandum. July 11.

EPA. 2012. "Haul Road Workgroup Final Report Submission to EPA-OAQPS." Memorandum from Tyler Fox (EPA Air Quality Modeling Group Leader) to Regional Office Modeling Contacts, March 2. Accessed July 2, 2015. http://www.epa.gov/scram001/reports/Haul_Road_Workgroup-Final_Report_Package-20120302.pdf.

EPA. 2014. "Clarification on the Use of AERMOD Dispersion Modeling for Demonstrating Compliance with the NO_2 National Ambient Air Quality Standard." Guidance memorandum from R. Chris Owen and Roger Brode to Regional Dispersion Modeling Contacts. Office of Air Quality Planning and Standards. Air Quality Modeling Group. Research Triangle Park, NC. September 30.

EPA. 2016. "AERMOD Implementation Guide." EPA-454/B-16-013. Office of Air Quality Planning and Standards Air Quality Assessment Division AERMOD Implementation Workgroup. Research Triangle Park, North Carolina, December.

EPA. 2018a. "Air Data: Air Quality Data Collected at Outdoor Monitors Across the US." Accessed March 17, 2018. https://www.epa.gov/outdoor-air-quality-data.

EPA. 2018b. "Draft. Revised Policy on Exclusions from Ambient Air." United States Environmental Protection Agency, November.

EPA. 2018c. "User's Guide for the AMS/EPA Regulatory Model (AERMOD)." EPA-454/B-18-001. Office of Air Quality Planning and Standards Air Quality Assessment Division Air Quality Modeling Group. Research Triangle Park, North Carolina, April.

Khalizov et al. 2012. "Characterization of Soot Aerosol Produced from Combustion of Propane in a Shock Tube." Alexei F. Khalizov, Brian Hogan, Chong Qiu, Eric L. Petersen, and Renyi Zhang. *Aerosol Science and Technology*, 46:925–936, 2012. https://doi.org/10.1080/02786826.2012.683839.

DRAFT

Midas Gold. 2017a. "Air Quality Baseline Study. Stibnite Gold Project." Stantec Consulting Services, Inc. And Trinity Consultants, Inc. December 2015 - Revised April 2017, April.

Midas Gold. 2017b. "Equipment Fuel Burn." *Attachment: Midas Stibnite Mine Plan and Equipment Schedule (13Sep17).xlsx.* Email from R. McCluskey, Midas Gold Idaho, to E. Memon, Air Sciences., September 12.

NDEP. 2010. "Class I Air Quality Operating Permit No. AP3274-1329.01. Issued to Graymont Western US Inc." Nevada Department of Conservation and Natural Resources. Division of Environmental Protection. Bureau of Air Pollution Control, May 7.

NDEP. 2015b. "Class II Air Quality Operating Permit No. AP3295-3398. Issued to Hectatone, Inc." Nevada Department of Conservation and Natural Resources. Division of Environmental Protection. Bureau of Air Pollution Control, April 6.

NDEP. 2017. "Mercury Operating Permit to Construct: Phase 2." Issued to: Smokey Valley Common Operation - Round Mountain Gold Corporation." Nevada Division of Environmental Protection (NDEP) Bureau of Air Pollution Control, July 5.

NDEP. 2019. "Class II Air Quality Operating Permit AP1041-3955." Issued to: Round Mountain Gold Corporation." Nevada Department of Conservation and Natural Resources. Division of Environmental Protection (NDEP). Bureau of Air Pollution Control, June 17. Accessed June 28, 2019. , June 17.

UMN. 2002. "Diesel Aerosol Sampling Methodology - CRC E-43." University of Minnesota Department of Mechanical Engineering, August 19.

DRAFT

APPENDIX D – PROCESSING FEE

PTC Processing Fee Calculation Worksheet

Instructions:
Fill in the following information and answer the following questions with a Y or N. Enter the emissions increases and decreases for each pollutant in the table.

Company:	**Midas Gold Idaho, Inc.**
Address:	**Forest Service Roads NF-374 &**
City:	**Stibnite**
State:	**ID**
Zip Code:	**83611**
Facility Contact:	**Alan Haslam**
Title:	**Vice President - Permitting**
AIRS No.:	**085-00011**

N	Does this facility qualify for a general permit (i.e. concrete batch plant, hot-mix asphalt plant)? Y/N
Y	Did this permit require engineering analysis? Y/N
N	Is this a PSD permit Y/N (IDAPA 58.01.01.205.04)

Emissions Inventory			
Pollutant	Annual Emissions Increase (T/yr)	Annual Emissions Reduction (T/yr)	Annual Emissions Change (T/yr)
NO_X	37.9	0	37.9
SO_2	6.5	0	6.5
CO	30.5	0	30.5
PM10	56.3	0	56.3
VOC	4.8	0	4.8
Total:	**135.8**	0.0	**135.8**
Fee Due	**$ 7,500.00**		

Comments: Non-major facility required to obtain T1 permit in accordance with IDAPA 58.01.01.313.01.b and 40 CFR 63.11640(d).

APPENDIX E – ACCESS MANAGEMENT

405 S. 8th Street #201
Boise, ID USA 83702
info@midasgoldidaho.com

MAX.TSX
MDRPF.OTCQX

www.midasgoldidaho.com

Midas Gold Idaho, Inc. - Stibnite Gold Project
Stibnite Road Access Management Plan – Version 1

April 15, 2020

1 Purpose and Objectives

This Stibnite Road Access Management Plan (Plan) describes the methods whereby Midas Gold Idaho, Inc. (Midas Gold), an Idaho corporation, would manage access on designated roads that traverse the proposed Stibnite Gold Project (SGP) mine site. The SGP is described in Midas Gold's Plan of Restoration and Operations (PRO).

The SGP is a proposed open pit mine that will be located at Stibnite, in central Idaho (see inset, Figure 1). The United States Forest Service (USFS) Forest System Road (FR) that passes through Stibnite (Stibnite Road; FR 50412) extends from the village of Yellow Pine eastward along the East Fork of the South Fork of the Salmon River for approximately 14 miles. Stibnite Road then continues south through the historic Stibnite mine site and connects with Thunder Mountain Road (FR 50375) on the southeastern portion of the proposed SGP. This route also allows for access to Meadow Creek Lookout Road (FR 51290; see Figure 1). As initially proposed, construction and operations at the SGP would prohibit access through the mine site for the life of the mine (approximately 20 to 25 years). During this period, alternative access to Thunder Mountain Road and Meadow Creek Lookout Road would be provided via the newly constructed Burntlog Route; a proposed mine access route that would connect the existing Burnt Log Road to Thunder Mountain Road with a new section of roadway and an upgraded section of Meadow Creek Lookout Road. Additionally, as proposed in the PRO, an off-highway vehicle (OHV) Trail would be upgraded to connect Horse Heaven/Powerline Road to Meadow Creek Lookout Road. Public access routes proposed in the PRO are illustrated in Figure 1. As part of reclamation of the SGP and closure of the mine site, Stibnite Road would be re-established in an alignment similar to its current location and would become the primary access route to Thunder Mountain Road. The Burntlog Route would be reclaimed to its previous condition and would no longer be connected to Thunder Mountain Road.

Following the presentation of the proposed public access routes described above in Midas Gold's PRO, an alternative public access route has been proposed by Midas Gold and would pass through the SGP mine site (Stibnite Road access route). This alternative route is under evaluation as part of the USFS's obligation to review the SGP in accordance with the National Environmental Policy Act (NEPA). One of the alternatives currently being evaluated in the Draft environmental impact statement (EIS), Alternative 2, would provide continued access through the SGP site on a realigned Stibnite Road during mine operations. The implementation of this Plan is contingent upon the selection of the applicable alternative by the USFS as the preferred alternative for the SGP and inclusion of the proposed Stibnite Road access route as a component of the approved SGP.

The health and safety of the public and the employees of the SGP is Midas Gold's priority. The procedures included in this Plan would be implemented by Midas Gold over the course of the life of the mine to ensure that the use of the Stibnite Road access route is conducted safely and responsibly.

2 Project Information

2.1 Introduction

Midas Gold has proposed to redevelop portions of the Stibnite Mining District (District) as described in the SGP PRO, submitted to the United States Forest Service (USFS) in September 2016. The SGP will be located at Stibnite in Valley County, approximately 92 miles by air and 144 miles by road northeast of Boise, Idaho; 44 air miles northeast of Cascade, Idaho; and 10 air miles east of Yellow Pine, Idaho. Current access to the site is from State Highway 55 to the SGP area via Warm Lake, Johnson Creek, and Stibnite Roads as shown in Figure 1. The proposed layout of the SGP mine features is illustrated in Figure 2.

Mining operations in the District first began in the 1920s and continued episodically through 1996. Proposed SGP mine operations described in Section 9 of the PRO would include open-pit mining in the three previously mined areas:

- The Yellow Pine open pit will encompass the area of the former Yellow Pine pit, Homestake pit, and portions of the Bradley Mining Company rock dumps.
- The West End open pit will encompass the former Stibnite Mines, Inc., open pits.
- The Hangar Flats open pit will encompass the former underground Meadow Creek Mine area, Hecla heap, and adjacent former mill and smelter area.

Other features and facilities that would be part of SGP mine operations include development rock storage facilities (DRSF), a tailings storage facility (TSF) and tailings pipeline, surface water management features (diversions, collection ditches, stormwater collection ponds), an ore processing facility, a water treatment facility, equipment maintenance and storage buildings, a worker housing facility, and all associated haul roads and access roads. The north and south points of entry to the SGP would have security gates and guard shacks that would be occupied on a continual basis. Features related to SGP mine but located off-site are illustrated in Figure 1 and include the Landmark Road Maintenance Facility, Stibnite Gold Logistics Facility, and features associated with powerline upgrades and extension.

The general timeline for constructing, operating, restoring, and mitigating the SGP is approximately 20 to 25 years, including 3 years of site preparation, construction, and early restoration activities; 12 to 15 years of operations; and 5 to 7 years of final closure and reclamation work. The SGP will produce gold, silver, and antimony over the 12- to 15-year mining period.

2.2 The SGP and NEPA

The proposed SGP occurs on patented mining claims (private land) and land administered by the United States Forest Service (USFS) within both the Boise National Forest (BNF) and Payette National Forest (PNF). The Big Creek/Stibnite Management Area 13, which includes the District, is administered by the Krassel Ranger District of the PNF. Proposed actions that occur on Federally managed lands require environmental review and analysis in compliance with NEPA. The NEPA analysis for the SGP was initiated

in mid-2017 with the USFS as the lead agency. The USFS is preparing an EIS to evaluate the environmental effects of the proposed SGP as well as a range of alternatives to the proposed action.

Public comments received for the SGP indicated that the change in access through the SGP for 20 to 25 years was of significant concern, particularly for those in the Johnson Creek and Yellow Pine area who use Stibnite Road to access Thunder Mountain Road and points beyond. At the direction of the USFS, Midas Gold evaluated numerous additional access options for the SGP that provided access similar to existing conditions and travel times. Midas Gold identified a suitable access route through the SGP site that would provide through-site access during operations. The road was designed to be separated from mine operations and to provide access similar to that provided by the existing Stibnite Road. The alternative access route through the SGP was included for consideration in the Draft EIS document as a component of Alternative 2.

2.3 Proposed Stibnite Road Access Route Through the SGP

The proposed SGP Stibnite Road access route that is currently under evaluation in the SGP Draft EIS is illustrated in Figure 2 and would include one of the two optional routes described below. During mine site construction, a new 12-foot-wide gravel road would be constructed to provide public access from Stibnite Road on the northern end of the SGP to Thunder Mountain Road on the southeastern end of the site. Along its full length, the Stibnite Road access route would have appropriate signage to direct travelers and would be separated from mine haul roads and areas of mine operations by fencing, berms, or gates to prevent travelers from straying from the route.

Two optional routes were identified and include variations in alignment in the vicinity of the Yellow Pine pit:

- **Stibnite Road Access Route: Option 1** – The access road would begin at the North Security Gate and would be constructed along a widened bench of the western portion of Yellow Pine pit during an early operational phase of the mine. South of the Yellow Pine pit this road would pass beneath the mine haul leading to the Fiddle Creek DRSF and would then parallel a mine haul road along a partially revegetated portion of the former Bradley mine haul road. In the central portion of the SGP site near the Mine Administration Building, the road would connect with the Burntlog Route and continue southeast toward the Worker Housing Facility and the South (Main) Security Gate. From the north end (North Security Gate) of the SGP to the south end (South Security Gate), this road would be approximately 3 miles in length.

- **Stibnite Road Access Route: Option 2** – The access road would begin at the North Security Gate and would be constructed west of the Yellow Pine pit. South of the Yellow Pine pit this road would pass beneath the mine haul leading to the Fiddle Creek DRSF and would then parallel a mine haul road along a partially revegetated portion of the former Bradley mine haul road. In the central portion of the SGP site near the Mine Administration Building, the road would connect with the Burntlog Route and continue southeast toward the Worker Housing Facility and the South (Main) Security Gate. From the north end (North Security Gate) of the SGP to the south end (South Security Gate), this road would be approximately 4 miles in length.

Based on assessment of impacts and public and agency feedback, one of these two options would be selected if Alternative 2 is identified as the Preferred Alternative for the Midas Gold SGP.

2.4 Access Controls

The proposed Stibnite Road access route through the SGP site is meant to provide controlled, through-site access that is safe, and provides travel-time comparable to current conditions. Additionally, the Stibnite Road access route would provide access that is consistent with the USFS travel management plan. Whereas Stibnite Road between Yellow Pine and Stibnite is not plowed in winter, Midas Gold would operate the Stibnite Road access route on a seasonal basis, i.e. access would not be provided in winter. Public access to the road would begin when Stibnite Road becomes passable in the Spring.

For either of the two route options described above, the northern extent of the Stibnite Road access route would begin at the North Security Gate, would continue southward traversing the SGP mine site, would connect with the Burntlog Route and would continue southeastward out of the mine operations area. The access route would exit South Security Gate near the employee housing facility.

Midas Gold has the legal authority to control access to the Stibnite Road access route and would provide seasonal (non-winter conditions) access only. At the discretion of Midas Gold, additional access controls may occur during various phases of construction, during mine operations that present potential safety hazards such as blasting or pit expansion, due to inclement weather, or under any other circumstances that may present a threat to the protection of public health and safety. Midas Gold has the legal and practical ability to enforce its control over roadway access and to monitor traffic passing through the SGP site. Signage would be placed at the North Security Gate (near the bridge over Sugar Creek) and the Main (South) Security Gate (near the Stibnite Lodge) entry points to provide information to travelers, and guard shacks would be located at each SGP Site entry gate to monitor all vehicle ingress/egress. To ensure passage through the site in a safe and timely manner, persons wishing to traverse the SGP site on the Stibnite Road access route would be required to check in at the security gate upon entry to receive a safety briefing and to alert mine staff as to their presence. After passing through the SGP site, travelers would also be required to stop at the guard shack upon exiting to check out. Travelers would not be allowed to stop or loiter while traveling though the operations area. Along its full length, the Stibnite Road access route would have appropriate signage to direct travelers and would be separated from mine haul roads and areas of mine operations by fencing, berms, or gates to prevent travelers from straying from the route.

Midas Gold would have the ability to temporarily restrict travel along the Stibnite Road access route for the protection of public health and safety. When possible and to the degree practicable, anticipated public access restrictions would be communicated to the public in a timely manner so that they may plan appropriately.

3 Conclusion

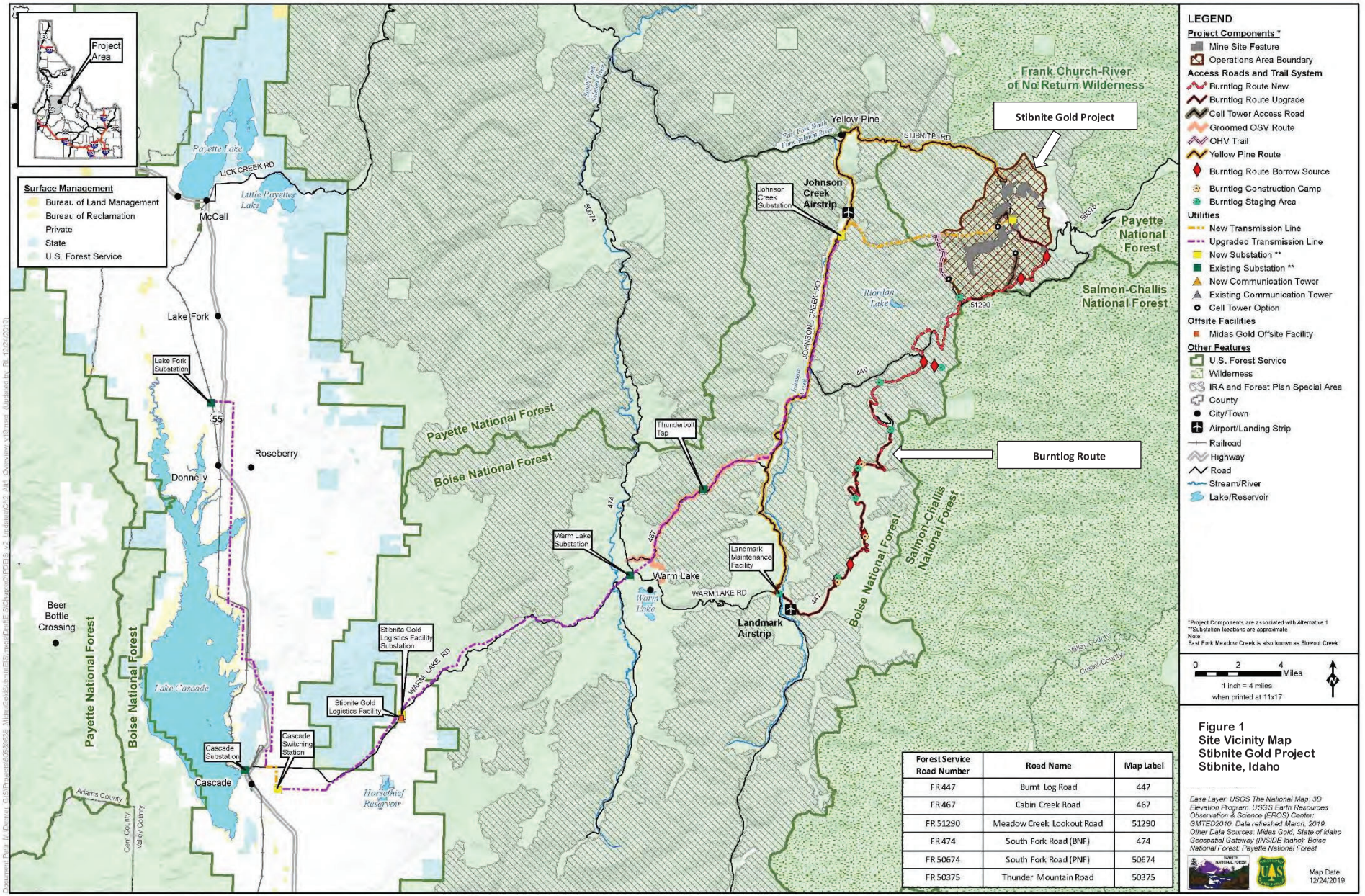
Midas Gold's SGP is under evaluation by the USFS and is proceeding through environmental analysis under NEPA. Midas Gold's proposed action and several alternatives to the proposed action will be included in the forthcoming Draft EIS. Alternative 2 in the Draft EIS includes an access alternative that would route a roadway, the Stibnite Road access route, through the mine site.

Maintaining and protecting SGP mine employee and public health and safety is Midas Gold's priority. This Stibnite Road Access Management Plan has been prepared to demonstrate that appropriate best practices, roadway construction features, and Midas Gold SGP site security measures would be in place over the life of the SGP mine and would effectively control access to the Stibnite Road access route.

This Plan will be updated and revised as appropriate.

List of Figures

Figure 1 – Site Vicinity Map
Figure 2 – Mine Site Layout



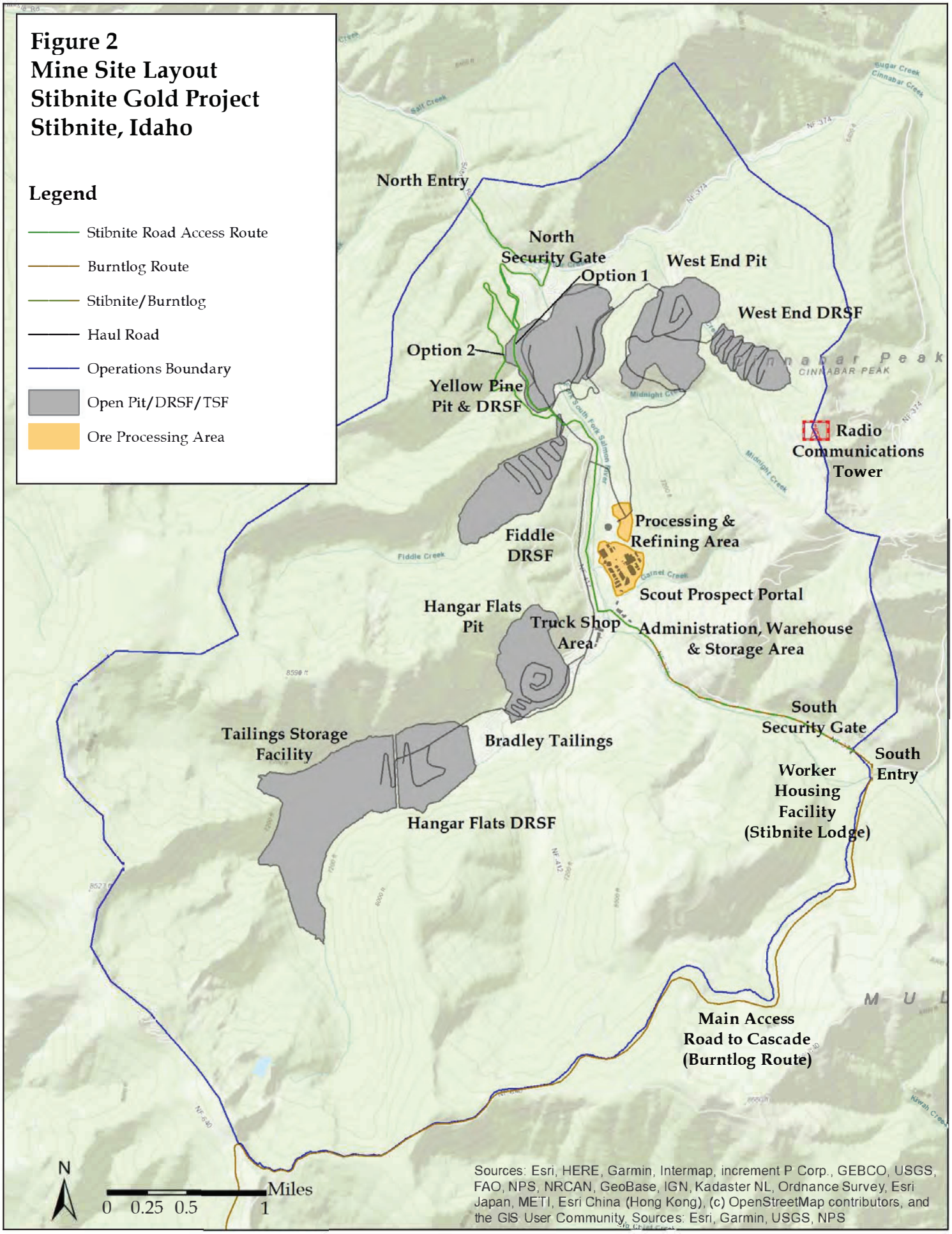
Forest Service Road Number	Road Name	Map Label
FR 447	Burnt Log Road	447
FR 467	Cabin Creek Road	467
FR 51290	Meadow Creek Lookout Road	51290
FR 474	South Fork Road (BNF)	474
FR 50674	South Fork Road (PNF)	50674
FR 50375	Thunder Mountain Road	50375

Figure 1
Site Vicinity Map
Stibnite Gold Project
Stibnite, Idaho

Base Layer: USGS The National Map: 3D Elevation Program. USGS Earth Resources Observation & Science (EROS) Center. GMTED2010. Data refreshed March, 2019. Other Data Sources: Midas Gold; State of Idaho Geospatial Gateway (INSIDE Idaho); Boise National Forest; Payette National Forest

Map Date: 12/24/2019

Figure 2
Mine Site Layout
Stibnite Gold Project
Stibnite, Idaho



405 S. 8th Street #201
Boise, ID USA 83702
info@midasgoldidaho.com

MAX.TSX
MDRPF.OTCQX

www.midasgoldidaho.com

August 03, 2020

Michael Simon
Air Quality Stationary Source Bureau Chief
Morrie Lewis
Permit Writer, Air Quality Division
Idaho Department of Environmental Quality
1410 North Hilton Street
Boise, Idaho 83706

Via: Email Michael.Simon@deq.idaho.gov and Morrie.Lewis@deq.idaho.gov

Re: Facility ID No. 085-00011, Midas Gold Idaho, Inc., Stibnite Gold Project, Draft Permit to Construct No. P-2019.0047, Project 62288, Issued for Applicant Review

Dear Mr. Simon and Mr. Lewis:

Midas Gold Idaho, Inc. (Midas Gold) greatly appreciates the opportunity to provide these comments on the Idaho Department of Environmental Quality's (IDEQ) Stibnite Gold Project (SGP) Draft Permit to Construct (PTC) No. P-2019.0047, Project 62288 (Draft Permit), dated July 14, 2020. Midas Gold has also received the updated Appendix B to the Statement of Basis from IDEQ on July 31, 2020, starting the 10-day review. Additional comments on the Statement of Basis, if any, will be presented to IDEQ before the close of the 10-day review period. During our review, Midas Gold examined examples of PTCs for similar surface mining operations authorized by IDEQ to evaluate consistency within this industry. Our proposed changes and edits are shown in a redlined version of the Draft Permit enclosed with this letter.

A short description of each of the noneditorial proposed change is provided below:

1. Condition 1.2, Table 1.1, and Condition 3.2, Table 3.1 (Item 31): Please remove the control efficiency values listed for haul roads (93.3%) and enclosures (80%). It appears that these percentages are provided for descriptive purposes only. As such, this information would more appropriately be provided in the Statement of Basis only. In addition, it does not appear that Idaho mining PTCs typically contain control efficiency values for fugitive sources. Alternatively, the following language may be added to Condition 1.2, "Control equipment information and maximum process rate information is provided for information only unless also included in specific enforceable permit conditions."

2. Condition 1.2, Table 1.1, Hauling, and Condition 2.5, 2nd (Item 13) and 17th (Item 20) Bullets: Please remove the Maximum Process Rate of "490,000 mi/mo" and related monitoring obligation. The

   mining excavation rate is already limited to 180,000 T/day, which directly impacts vehicle miles traveled. At this limit, all hauling scenarios were modeled to capture the maximum-case hauling distances, which included a hauling mileage of 16,415 mi/day (492,465 mi/30 days or 508,880 mi/31 days). The maximum-case mileage far exceeds the peak production total actual annual hauling mileage of 1.4 million mi/yr (116,700 mi/mo). Therefore, a mileage limit is not necessary to limit emissions, and recording miles daily adds unnecessary and burdensome monitoring.

3. Condition 1.2, Table 1.1, Prill Silos, and Conditions 3.8 and 3.17 (Item 32): Please revise the Maximum Process Rate of "608/month" to "200 T/day." The daily rate was used for the 24-hour PM_{10} and 24-hour $PM_{2.5}$ modeling. See Appendix B, pages 11, 12, and 15 of the June 23, 2020, PTC Application (Application). No other criteria pollutants or toxic air pollutants (TAP) are emitted by these insignificant sources. The Application also requested a 7,300 T/yr limit. However, it has come to our attention that an annual limit of 9,000 T/yr is needed. This change has essentially no effect on the annual emission inventory for annual $PM_{2.5}$ modeling. The $PM_{2.5}$ emission change from increasing the annual throughput from 7,300 T/yr to 9,000 T/yr (an increase of 0.00005 g/s) is less than five-thousandth of a percent of the total $PM_{2.5}$ emissions.

4. Condition 1.2, Table 1.1, Autoclave (AC) and Electrowinning Cells: Please remove "and as limited by Subpart EEEEEEE" from the Maximum Process Rate. Subpart EEEEEEE does not contain any process rate limits. This subpart only provides emission limits, and control and monitoring requirements as noted in Condition 4.2, Table 4.1, and Conditions 4.18 and 4.19.

5. Condition 1.2, Table 1.1, POX Boiler, and Condition 4.4 (Item 36): Please replace the Maximum Process Rate of "1 hr/day and 30 hr/yr" with "operation is limited to AC start-up only." The boiler is used only for starting up the AC. Once the AC is running, the boiler is turned off; however, a start-up will be longer than 1 hour. AC start-ups are expected to require up to 10 hours of POX Boiler firing, and there may be as many as three start-ups per year. Limiting operation only to start-up provides flexibility and reflects the proposed operating scenario. Midas will continue to monitor boiler operating hours during AC start-up, per Condition 4.17.

6. Condition 1.2, Table 1.1, PFR Shaft Lime Kiln Combustion: Please replace "20.5" with "22.0 MMBtu/hr." See page 93 of the Application.

7. Condition 1.2, Table 1.1, SAG Mill and AC Lime Silos: The Maximum Process Rate of "169 T/day and 52,337 T/yr" only applies to LS-L/U, LK, and LCR. The SAG Mill and AC Lime Silos (6 storage silos) have a combined Maximum Process Rate of 70,000 T/yr of lime.

8. Condition 1.2, Table 1.1, Concrete Production, and Condition 5.8 (Item 41): Please replace the Maximum Process Rate of "80 T/day and 60,000 T/yr (cement + aggregate)" with "2,480 T/day and 560,000 T/yr of (cement + aggregate)." See page 47 of the Application. Also, the Central Mixer capacity is 120 T/hr (20 T/hr of cement plus 100 T/hr of aggregate).

9. Condition 1.2, Table 1.1, Concrete Production, Central Mixer Loading, and Conditions 5.1 and 5.2 (Item 39): Please revise the control description to match the control options listed in AP-42 and the Application (page 7 and Appendix B page 11).

10. Condition 2.4: Please replace the facility-wide inspection frequency with "monthly." A monthly inspection rate is typical for large mining operations and consistent with other Idaho mining PTCs.

11. Condition 2.5, 1st Paragraph: IDAPA 58.01.01.799 applies to nonmetallic mineral processing plants. Thus, clarifying language should be added: "IDAPA 58.01.01.799 applies to fugitive dust sources at the limestone crushing plant and aggregate production plant."

12. Condition 2.5, 1st Bullet: Please replace "to 20 miles per hour or lower if appropriate" with "in accordance with the FDCP." The Application did not propose a 20 miles per hour speed limit, and certain haul road sections may be driven at higher speeds while emissions are minimized.

13. Condition 2.5, 2nd Bullet: Please remove this bullet as discussed in Condition 1.2, Table 1.1, Hauling, above (Item 2).

14. Condition 2.5; 3rd, 4th, 5th, 7th, 13th, 15th Bullets: Each of these bullets require some action if fugitive PM emissions are observed to exceed 20% or leaving a roadway in the case of haul roads. However, the periods that trigger corrective action in these bullets are inconsistent with each other. IDAPA 58.01.01.650 does not impose a trigger for action, other than the requirement to take reasonable precautions. While the visible emissions rule IDAPA 58.01.01.625 does not suit fugitive emission observations, for comparison, that rule states, "for a period or periods aggregating more than ***three*** minutes in any 60-minute period." The Draft Permit states, "for a period or periods aggregating more than ***one*** minute in any 60-minute period." If IDEQ prefers to establish a threshold for dust mitigation action, then the following period would be acceptable to Midas Gold:

    - Whenever visible fugitive PM emissions exceed 20% for more than two consecutive minutes (4th, 5th, 7th bullets)

    - Whenever visible fugitive PM emissions are observed leaving a roadway for more than two consecutive minutes (3rd bullet). Note that this would also apply to the 13th and 15th bullets, but Midas Gold is proposing to remove these conditions.

15. Condition 2.5, 4th Bullet: Please add language to address upstream water sprays to provides downstream control via moisture carryover.



16. Condition 2.5, 6th Bullet: There are no plans to apply water or chemical to the "mine working face." Please revise to, "Apply appropriate dust control at the initial point of material handling to suppress dust throughout the material handling process, as necessary."

17. Condition 2.5, 13th Bullet: Please remove "Whenever visible fugitive PM emissions are observed leaving a roadway during inspection or valid complaint (Permit Condition 2.3), the adequacy of water and dust suppressant application rates should be evaluated." These requirements are already addressed elsewhere:

    - The Condition 2.5, 3rd bullet addresses the dust mitigation action whenever visible PM emissions are observed leaving a roadway.

    - The Condition 2.5, 20th bullet addresses the periodic evaluation of the FDCP, including dust suppressant application rates.

    - The Condition 2.3 addresses valid complaints.

18. Condition 2.5, 14th Bullet: Please remove this bullet. Chemical suppressant application will be based on the manufacturer's recommendations and periodic inspections of fugitive dust, not atmospheric conditions.

19. Condition 2.5, 15th Bullet: Please remove this bullet, as it is a repeat of the 2nd sentence of the 13th bullet.

20. Condition 2.5, 17th Bullet: Please remove this bullet as discussed in Condition 1.2, Table 1.1, Hauling, above (Item 2).

21. Condition 2.5, 18th Bullet: Please remove this bullet as the 10th bullet already requires that "Chemical dust suppressants shall be applied consistent with manufacturer's instructions and recommendations" and the 16th bullet already requires that "At least once per day during operation, monitor and record the frequency of application and application rates for water and suppressant controls."

22. Condition 2.5, 20th Bullet: Please add "and evaluate effectiveness of practices including dust suppressant application rates."

23. Condition 2.5, 20th Bullet: Please replace "every six-months" with "every year." Annual review is more typical for the mining industry. Also, it does not appear that Idaho mining PTCs typically require a six-month review of FDCPs.

24. Condition 2.9: Please replace "each shift" with "each month" and add "including any stack, vent, or functionally equivalent opening" after "potential sources of visible emissions" to clarify which sources are subject to this condition. It does not appear that Idaho mining PTCs typically contain a visible emission inspection frequency for each shift.

25. Condition 2.11: Please revise "and 22" to "and knowledgeable of procedures of Method 22" language to reflect that there is no certification for Method 22.

26. Condition 2.21, NSPS 40 CFR 60, Subpart LL: Please remove "OC8." Conveyor drops to stockpiles are not subject to Subpart LL.

27. Condition 2.23: Please add the citation "40 CFR 70.3(c)(2)" to specify that the Tier I operating permit is required only for the emission units that cause the source to be subject to the part 70 program.

28. Condition 2.24, Table 2.1, Pollutant: Please replace "PM" with "PM_{10}" as this is the pollutant that is required to be tested in the Draft Permit (Condition 4.3).

29. Condition 2.24, Table 2.1, Test Method: Please add Method 201A for PM_{10}.

30. Condition 2.24, Table 2.1, Additional Requirements: Please revise the PM Additional Requirements to: "Particulate matter (PM) including condensable PM as defined in IDAPA 58.01.01.006, with an aerodynamic diameter less than or equal to a nominal 10 micrometers for PM_{10}, and less than or equal to a nominal 2.5 micrometers for $PM_{2.5}$" to make it consistent with the rest of the Draft Permit.

31. Condition 3.2, Table 3.1: Please revise as discussed in Condition 1.2, Table 1.1, above (Item 1).

32. Condition 3.8 and 3.17: Please revise as discussed in Condition 1.2, Table 1.1, Prill Silos, above (Item 3).

33. Condition 3.11: Please remove this condition. The crushers will be controlled by water sprays. No emission control credit was taken for the buildings, which will likely have door and vent openings.

34. Condition 4.2, Table 4.1: Please revise as follows:

    - Carbon bed pressure drop is a <u>maximum</u> limit (O&M)
    - Carbon bed inlet gas temperature is a <u>maximum</u> limit (Subpart EEEEEEE)
    - Baghouse pressure is a <u>maximum</u> limit (O&M)

35. Condition 4.3, Table 4.2: Please remove footnote (c) from NO_X, CO, VOC, and SO_2 as there is no testing required for these pollutants.

36. Condition 4.4: Please revise as discussed in Condition 1.2, Table 1.1, POX Boiler, above (Item 5).

37. Condition 4.11 through 4.16: Please remove "and in accordance with IDAPA 58.01.01.210.21." The rule states, "Additional procedures and requirements to demonstrate and ensure actual and continuing compliance may be required by the Department in the permit to construct." Conditions 4.11 through 4.16 establish procedures or requirements regarding compliance, and therefore it is not necessary to cite this rule. Including the citation suggests that there are more requirements than stated in the PTC, but any additional requirements are to be in the PTC according to the rule text.

38. Condition 4.28: Please add carbon filter monitoring requirements.

39. Conditions 5.1 and 5.2: Please revise as discussed in Condition 1.2, Table 1.1, Concrete Production, Central Mixer Loading, above (Item 9):

40. Condition 5.3: Please remove footnote (c) as there are no testing requirements for these pollutants.

41. Condition 5.8: Please revise as discussed in Condition 1.2, Table 1.1, Concrete Production, above (Item 8).

42. Condition 5.11: Please remove this condition. The crushers will be controlled by water sprays. No emission control credit was taken for the building, which will likely have openings.

Thank you for your consideration of these comments. We note that the updated Appendix B to the Statement of Basis was received via email from Morrie Lewis on July 31, 2020. Any additional comments that we have to the Statement of Basis will be submitted to IDEQ within the 10-day review period. We will notify you via email prior to that date if we have no additional comments.

If you have any questions regarding this submittal, please contact me at 208-901-3053 or ahaslam@midasgoldinc.com.

Sincerely,
MIDAS GOLD IDAHO, INC.

Alan Haslam
VP Permitting

Enclosure: Redlined Draft Permit

APPENDIX F – SUBSECTION 210.20 INTERPRETATION OF ADDRESSED

STATE OF IDAHO
DEPARTMENT OF
ENVIRONMENTAL QUALITY

1410 N Hilton Street, Boise, ID 83706
(208) 373-0502

Brad Little, Governor
Jess Byrne, Director

Examples of How DEQ Interprets the Word "Addressed" in Subsection 210.20

For example, 40 CFR 63 Subpart 6J - National Emission Standards for Hazardous Air Pollutants for Industrial, Commercial, and Institutional Boilers Area Sources regulates HAP emissions from coal, biomass, and oil-fired boilers. However, the subpart specifically exempts gas-fired (i.e. natural gas-fired) boilers because EPA determined that HAP emissions from these sources were too inconsequential to be regulated by the Subpart. DEQ interprets this to mean EPA did "address" natural gas boiler HAP emissions by choosing to exempt them. Thus, HAP emissions that are also TAP emissions from coal, biomass, oil-fired boilers, and natural gas-fired boilers are not required to demonstrate compliance with IDAPA 58.01.01.210 per section 210.20.

For example, 40 CFR 63 Subpart ZZZZ - National Emissions Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines regulates HAP emissions from IC engines by regulating CO emissions as a surrogate for HAP emissions. Therefore, HAP emissions from IC engines are not directly regulated by the Subpart. DEQ interprets this to mean EPA "addressed" HAP emissions by regulating CO emissions as a surrogate. Therefore HAP emissions that are also TAP emissions from IC engines are not required to demonstrate compliance with IDAPA 58.01.01.210 per section 210.20.

For example, HAP/TAP emissions from lumber drying kilns were evaluated in promulgating 40 CFR 63 Subpart DDDD - National Emission Standard for Hazardous Air Pollutants: Plywood and Composite Wood Products (PCWP). This Subpart regulates major sources of HAP emissions and includes lumber drying kilns at PCWP manufacturing facilities and "at any other kind of facility" as affected sources, even though this subpart does not include any substantive requirements to control or limit emissions from the kilns. In developing Subpart DDDD EPA stated "…we know of no other lumber kilns that are controlled for HAP, and we know of no cost effective HAP controls for lumber kilns…" (see Fed. Reg. /Vol 68, No. 6/Thursday, Jan 9, 2003/Proposed Rules page 1285). DEQ interprets this to mean EPA "addressed" HAPS that are also TAPS for both major and minor sources of HAP emissions; and therefore, lumber kilns are not required to demonstrate compliance with IDAPA 58.01.01.210, per section 210.20.

For example, when EPA regulated Phosphoric Acid Manufacturing for new sources, only the wet-process phosphoric acid line, superphosphoric acid process line, phosphate rock dryer, and the phosphate rock calciner have specific emissions limits in the rule. However, other emissions sources at facility were also looked at but they were determined by EPA to be insignificant and were not regulated in the rule. Therefore, when EPA looks at a source category to regulate, all emissions sources associated with the source category are "addressed" whether EPA establishes specific emissions limits for the emissions sources or not.
In sum, the term "addressed" is interpreted to mean EPA (1) specifically regulated, (2) specifically regulated by a surrogate, (3) reviewed, or (4) evaluated, the HAP emissions that are also TAPs.

Please note that in all cases it is presumed that EPA evaluated the 187 HAPs when developing the emission standards for new, modified or existing stationary sources regulated by 40 CFR Part 63 Subparts. Therefore, in all cases IDAPA Toxic Air Pollutants that are not one of the 187 Hazardous Air Pollutants will still need to be evaluated for compliance with IDAPA 58.01.01 Section 210.

APPENDIX G – T-RACT ANALYSIS

6.0 T-RACT ANALYSIS

Per IDAPA 58.01.01.210.14(a), this section documents the T-RACT control technologies.

6.1 Drilling Dust Control System

As discussed in Section 5.1, Perpetua Resources will install and operate drilling rigs mounted with dust collection systems. The following paragraphs evaluate this control as T-RACT:

Identification of all possible control technologies

Drilling operations create dust-related metal TAP emissions. The possible control technologies for these emissions are as follows:

- Applying best management practices
- Wet drilling with water injection
- Dry drilling with dust collectors

Best management practices include: (1) avoiding drilling operations during high dust conditions, and (2) shrouding drill areas to limit dust emissions.

Wet drilling includes injected water flows through the center of the drill and out though the drill bit to reduce dust emissions by 96% to 98%.[10]

Dry drilling includes rigs equipped with dust collection systems that shroud dust generated from the drilling area, capture, and remove dust through a dust collection system composed of an exhaust fan and filters that can achieve up to 99% control efficiency (CDC 2012).

Elimination of technologically infeasible or unreasonable technologies

Wet drilling at the SGP has the following disadvantages:

- It is subject to freezing at the low temperatures expected for the SGP location.
- It can result in drill bit plugging, drill rotation binding, and drill bit degradation.
- A wet drill hole can interfere with the blasting agent.

Based on the above disadvantages of wet drilling, it is considered an infeasible or unreasonable technology for the SGP.

[10] *Testing has demonstrated that dust control efficiencies of up to 98 percent can be obtained using the water separator sub while dust control efficiencies of wet drilling without the water separator sub were 96 percent* (CDC 2012).

Ranking the remaining technologies by control effectiveness

The ranking of the possible control technologies for drilling by control effectiveness is as follows (highest to lowest):

1. Dry drilling with dust collectors – up to 99% control efficiency
2. Best management practices

Evaluation of the most effective control technology and selection of T-RACT

Perpetua Resources selects the top (most effective) control technology of dry drilling with dust collectors as T-RACT. Selecting the top control negates the need for considering economic, energy, and environmental impacts regarding the other control technologies.

6.2 Haul Road Dust and Arsenic Control

Dust emissions from unpaved roads are caused by vehicle traffic on these roads. Particles are lifted and dropped from the rolling wheels, and the turbulent wake behind the vehicles causes these particulates to become air borne. Dust control options include surface improvement (paving) or surface treatment (chemical suppressant application or watering).

As discussed in the SOB from February 18, 2021, Perpetua Resources will control dust emissions from haul roads by treating the surface with frequent watering and the periodic application of a chemical suppressant. Reducing dust emissions reduces dust-related metal TAP emissions. In addition, Perpetua Resources will reduce arsenic emissions by capping the haul roads outside of the pits and DRSFs with clean (low arsenic) development rock, as discussed in Section 5.2. The following sections evaluate these control measures as T-RACT.

6.2.1 Dust Control Technologies

Identification of all possible control technologies

Vehicle traffic on unpaved haul roads creates dust-related metal TAP emissions. The possible control technologies for these emissions are as follows:

- Paving
- Application of a chemical dust suppressant
- Watering

Paving: *The control efficiencies achievable by paving can be estimated by comparing emission factors for unpaved and paved road conditions* (EPA 2006). The particulate emission factor for a paved road with a silt loading of 0.2 g/m^2 (based on the EPA default value for the SGP average daily traffic of 500–5,000 trips per day) (EPA 2011a) and the SGP average vehicle weight of 182.6 tons is

0.515 lb/VMT. The SGP unpaved road particulate emission factor is 14.43 lb/VMT (uncontrolled). Based on these emission factors, the estimated control efficiency of paving the haul roads is 96%.

Dust suppressant and watering: The SGP dust emissions from unpaved haul roads are calculated based on a surface treatment control efficiency of 90% (annual basis) for the application of a chemical dust suppressant supplemented with frequent watering. As discussed in the SGP Application, this control efficiency is supported by EPA's AP-42 13.2.2 referenced test reports, which show that a chemical dust suppressant alone can achieve 90% to 99% control efficiency and 98% for magnesium chloride in particular (Air Sciences 2020, Appendix A to Attachment A). A control efficiency of 90% is also supported by the control efficiency limits established under Reasonable Achievable Control Technology (RACT), Best Available Control Technology (BACT), and Lowest Achievable Emission Rate (LAER) determinations under EPA's New Source Review permitting program.

The EPA RACT/BACT/LAER Clearinghouse (RBLC) database contains case-specific information on the air pollution technologies required by major stationary sources seeking a permit under EPA's New Source Review (NSR) program. This database was queried for all listings of air pollution technologies for unpaved roads using chemical dust suppressants or a combination of chemical dust suppressants and watering. The results of the query identified 10 projects containing a control efficiency of 90% or greater for unpaved roads. These determinations are listed in Table 10.

Table 10. EPA RBLC Determinations for 90% or Greater Control Efficiency of Unpaved Roads

State	Facility Name	RBLC-ID	Dust Control	Dust Control Efficiency
AK	Donlin Gold Project	AK-0084	water/chem	90%
AR	Turk Power Plant	AR-0094	water/chem	90%
CO	Rio Grande Portland Cement Corp.	CO-0043	water/chem	90%
IN	Nucor Steel	IN-0034	chem	90%
LA	Nucor Steel Louisiana	LA-0239	water/chem	90%
MO	Lafarge Corp.	MO-0048	chem	90%
NV	Sloan Quarry	NV-0045	chem	98%
NV	Nellis Air Force Base	NV-0047	water/chem	90%
OH	Unlimited Concrete	OH-0126	water/chem	90%
OH	Unlimited Concrete	OH-0131	water/chem	90%

(EPA 2021)

Elimination of technologically infeasible or unreasonable technologies

Paving haul roads at the SGP has the following disadvantages:

- The paving of haul roads is not conventional practice at mining operations.
- Paved highway weight limits are only approximately 20,000 pounds (10 tons).
- Paving is costly.

The conventional practice for mining operations is to utilize unpaved haul roads with treated surfaces to control fugitive dust. Haul trucks are single axle vehicles with a gross loaded weight of 60 tons to 685 tons. The loaded weight range for the SGP haul trucks is 60 to 260 tons. These weights significantly exceed regulatory weight limits for paved highways of 10 tons. Furthermore, the SGP mining activity locations move as mining progresses. This requires haul roads to be rerouted as necessary. Due to the temporary nature of hauling routes and the heavy weight of haul trucks, paving is considered an infeasible or unreasonable technology for the SGP.

Ranking the remaining technologies by control effectiveness

The ranking of the possible control technologies for drilling by control effectiveness is as follows (highest to lowest):

1. Application of a chemical dust suppressant – 90% to 99% control efficiency

REC 0913

PET 547

2. Watering – 75% to 95% control efficiency (EPA 2006, Figure 13.2.2-2)

Evaluation of the most effective control technology and selection of T-RACT

After eliminating paving as a viable control option, Perpetua Resources selects the next most effective control technologies of the application of a chemical dust suppressant supplemented with frequent watering as T-RACT.

6.2.2 Arsenic Control Technologies

After applying T-RACT for dust control, as discussed in Section 6.2.1, dust-related arsenic emissions can only be further reduced by capping the haul roads with clean (low-arsenic) development rock. The median arsenic concentration of the SPG onsite material is 667 ppm (Midas Gold 2017c). However, there are quartzite rock deposits at the West End pit that have significantly lower mineralization and, thus, lower arsenic levels. The median arsenic concentration of this quartzite rock is 90 ppm (Perpetua 2021g), and there is approximately 3 million tons of this material available. Figure 6 shows the locations of the quartzite rock deposits.

Figure 6. Quartzite Rock Areas



Perpetua Resources proposes capping the haul roads that are outside of the pits and DRSFs with clean (low-arsenic) development rock as a T-RACT work practice, in addition to the T-RACT dust control measures discussed in Section 6.2.1. Haul roads within the pits and DRSFs cannot be capped with this material because of steep grades and periodic road rerouting as mining areas develop.

Air Quality Permitting
Response to Public Comments

June 17, 2022

Permit to Construct No. P-2019.0047

Project No. 62288

Perpetua Resources Idaho, Inc.
Stibnite, Idaho

Facility ID No. 085-00011

Prepared by:
Kelli Wetzel, Permit Writer
AIR QUALITY DIVISION

FINAL

Table of Contents

BACKGROUND 2

PUBLIC COMMENTS AND RESPONSES 2

BACKGROUND

1 The Idaho Department of Environmental Quality (DEQ) provided a third public comment period on the proposed permit to construct (PTC) for Perpetua Resources Idaho, Inc. (PRI) from January 13 – March 16, 2022, in accordance with IDAPA 58.01.01.209.01.c. During this period, comments were submitted in response to DEQ's proposed action.

2 DEQ appreciates all of the comments received concerning this project during the third comment period. Substantive comments were provided, particularly concerning the representativeness and uncertainty of emissions, the preconstruction demonstrations of compliance with toxic and mercury standards, and the PSD classification for the lime plant. These topics and DEQ's responses to each comment pertaining to air quality are provided in the sections that follow, and updates to the proposed permit and technical review have been made. As described in the responses that follow, the following conditions have been updated in Permit to Construct No. P-2019.0047 Project 62288:

- Permit Conditions 1.2 (Table 1.1), 2.4, 2.6, 2.7, 2.8, 2.13, 2.20, 2.21, 3.2 (Table 3.1), 3.9, 3.13, 4.4 – 4.6, 4.9, 4.10, 5.2 (Table 5.1), 5.5, 5.8, 5.9, 5.22, 6.2, 6.4, 6.5, and 6.6

The following sections of technical and regulatory analyses have been updated in the Statement of Basis:

- Application Scope, permit condition numbering in the Controlled Hazardous and Toxic Air Pollutant Emissions, Ambient Air Quality Impact Analyses, Mercury Emission Standard, and Particulate Matter – New Equipment Process Weight Limitations, and Permit Conditions Review sections

PUBLIC COMMENTS AND RESPONSES

Additional public comments regarding the technical and regulatory analyses and the air quality aspects of the proposed permit are summarized below. Questions, comments, and suggestions received during the comment period that did not relate to the air quality aspects of the permit application, the Department's technical analysis, or the proposed permit were not addressed. It is also noted that while a response to each comment is provided herein, many of the topics discussed were also previously addressed in the first and second Response to Public Comments, in the Statement of Basis, and/or in PRI's application materials. All original public comments submitted for this project can be requested via the public records request process as DEQ has included public comments that may not include in-text citations.

PET 550

REC 0916

REPRESENTATIVENESS AND UNCERTAINTY OF EMISSIONS

3 Several comments were received relating to the representativeness and uncertainty of parameters used in developing the emission factors used to estimate emissions. Although some degree of uncertainty is present in all emission factors used in estimating emissions, all emission factors were adequately supported and the approach of estimating potential to emit (PTE) at design capacity and maximum activity rates was considered a sufficiently conservative approach. Maximum hourly and daily activity rates were used to estimate the maximum 24hour and annual emission rates, and emissions were modeled based on these maximum shortterm activity rates occurring continuously every day.

It was recognized by DEQ and by commenters that emissions estimates and modeling of $PM/PM_{10}/PM_{2.5}$, HAP, and TAP are all sensitive to each of the specified controls and sitespecific parameters identified in the following paragraphs. Representativeness of these parameters was discussed with and reconfirmed by PRI at various points during review,[1,2,3,4,5,6] and the estimates of emissions and underlying assumptions were supported to the satisfaction of DEQ. Sufficient information was provided to demonstrate preconstruction compliance with applicable TAP and mercury standards and to support facility classifications.

4 Relevant DEQ guidance concerning the acceptability of emissions data can be found in DEQ's Guidance on Emissions Data Hierarchy:
https://www2.deq.idaho.gov/admin/LEIA/api/document/download/5521

Water and chemical dust suppressant control efficiencies

5 A combined control efficiency of 93.3% was included in the permit for haul roads because this was recognized as an aggressive level of control and because haul roads were identified as a key contributing source to ambient air quality impacts. PRI has committed to undertaking all measures necessary to achieve this level of control and has confirmed based on a review of test studies that this can be achieved using water and magnesium chloride dust suppressants (Appendix A to the application – Model Parameter/Assumption/Data Level of Conservatism).

6 DEQ recognizes that in practice chemical and water dust suppressants are used in combination for the control of dust from haul roads, and that achieving the target combined control efficiency of 93.3% is ultimately important to ensure compliance with applicable standards. It is for this reason that the combined control efficiency was listed in the permit in lieu of separate chemical (90% control) and water (33.3%) dust suppressant control efficiencies. DEQ agrees with commenters that compliance with fugitive dust requirements is also necessary to ensure compliance with applicable standards, including application of both water and chemical dust suppressant in proper amounts and at proper frequencies as local conditions dictate.

---

[1] "PTC Application Incompleteness," DEQ, September 19, 2019 and "Preliminary Response to Application Information Request", PRI, October 4, 2019. (2019AAG1508, 2019AAG1747)

[2] Additional questions relating to the second incompleteness letter, DEQ, November 8, 2019. (2019AAG1903)

[3] "PTC Request for Additional Information, Stibnite mine," DEQ, November 20, 2020 and response, PRI, December 17, 2020. (2020AAG1992, 2020AAG2130)

[4] Revised "SGP PTC HAP/TAP Addendum," PRI, January 28, 2021. (2021AAG125)

[5] "PTC Request for Additional Information, Stibnite mine," PRI, April 16, 2021. (2021AAG646)

[6] "Updated TAP/HAP Addendum," PRI, October 6, 2021. (2021AAG1766)

7 *Silt content*

8 The use of site-specific median values for silt content is commonly accepted by DEQ, and the values used in calculations were supported by PRI. Metal hazardous air pollutant (HAP) and toxic air pollutant (TAP) emissions from process materials were based on median measured metal concentration profiles from onsite core samples of ore and limestone materials, including 98 samples of PRI limestone and over 55,000 samples of PRI ore. PRI has confirmed that ore samples were taken primarily from the mineralized zones of the PRI pits and were representative for the purposes of estimating emissions. Although a median value of sampled silt percentages of roadway material was used in emission estimates presented in the application, DEQ recognizes the importance of the silt content parameter in the estimation of emissions. Since compliance with the 24-hour PM_{10} National Ambient Air Quality Standards (NAAQS) is the primary driver of NAAQS compliance, minimizing variability of the parameter is very important to ensure NAAQS compliance. To achieve this, the permit will limit *maximum silt content* to 4.0 %, as specified in Section 3.13 Haul Road Capping of the PTC as well as associated monitoring and recordkeeping.

Metal concentrations

9 The use of site-specific median values for metal concentrations is commonly accepted by DEQ, and the values used were supported by PRI. Metal hazardous air pollutant (HAP) and toxic air pollutant (TAP) emissions from process materials were based on median measured metal concentration profiles from onsite core samples of ore and limestone materials, including 98 samples of PRI limestone and over 55,000 samples of PRI ore. PRI has confirmed that ore samples were taken primarily from the mineralized zones of the PRI pits and were representative for the purposes of estimating emissions. While the use of an average or 90^{th} percentile value is a more conservative approach, the use of sitespecific median values combined with estimating and modeling PTE at design capacity and maximum activity rates was considered a sufficiently conservative approach and is commonly accepted by DEQ. Furthermore, use of a median value is appropriate for long-term standards (annual and above), since short-term spikes in emissions do not heavily influence a long-term average concentration. PRI has confirmed that use of a concentration average would be unduly influenced by a high values in a skewed distribution. PRI has confirmed that the use of mineralized metal profiles is conservative when compared to low-mineralization materials such as development rock (DR) and clean gravel. DEQ does not typically require applicants to include an analysis of potential HAP and TAP emissions from materials used in capping of unpaved roads.

Material balance

While a material balance is a useful approach to developing emission estimates, it is not a requirement, and the use of maximum activity rates and representative performance test data to estimate and model emissions is commonly accepted by DEQ. While the use of an average or maximum value is a more conservative approach, the use of sitespecific median values combined with estimating and modeling PTE at design capacity and maximum activity rates was considered a sufficiently conservative approach.

COMPLIANCE WITH TOXIC AND MERCURY STANDARDS

10 Several comments were received relating to the methods used to demonstrate compliance with toxic and mercury standards. As discussed in the Emissions Inventories section and reported in Table 6 of the Statement of Basis as "Adjusted TAP Emissions", HAP TAP and mercury emissions from *addressed* sources were excluded from emission totals used to demonstrate preconstruction compliance with toxic standards (TAP) and the mercury emission standard in accordance with the Rules and DEQ guidance. Detailed discussion is provided in the "Subsection 210.20", Table 9, and "Mercury Emission Standard" sections of the Statement of Basis, and DEQ guidance on the interpretation of "addressed" is included in Appendix F to the Statement of Basis.

11 Specifically in regard to the applicability to National Emission Standard for Hazardous Air Pollutants: Gold Mine Ore Processing and Production Area Source Category Subpart EEEEEEE (NESHAP Subpart 7E), PRI has proposed construction and operation of an affected source meeting the definition of "gold mine ore processing and production facility" as defined in 40 CFR 63.11651 and will construct autoclave, carbon kiln, preg tank, electrowinning, mercury retort, and melt furnace processes. The permit is issued on this basis, and applicable NESHAP Subpart 7E requirements are incorporated by reference (Permit Condition 2.22).

12 *Source categories* are classified using the North American Industry Classification System (NAICS), and the primary classification code for PRI is 212221 for "Gold Ore Mining," as identified in Table 9 of the Statement of Basis. The description for this code is "this U.S. industry comprises establishments primarily engaged in developing the mine site, mining, and/or beneficiating (i.e., preparing) ores valued chiefly for their gold content. Establishments primarily engaged in transformation of the gold into bullion or doré bar in combination with mining activities are included in this industry." Beyond identifying the *source category*, a variation of this descriptive language was similarly included in Table 9.

13 The methods for demonstrating preconstruction compliance with TAP and mercury emission standards and by extension compliance with Section 161 are defined in Section 210 of the Rules and DEQ guidance. As detailed in DEQ guidance regarding the interpretation of "addressed" in Appendix F to the Statement of Basis, when EPA looks at a source category to regulate, it is presumed that all emissions sources associated with a *source category* are "addressed" whether EPA establishes specific emissions limits for the emissions sources or not in the NESHAP. For carcinogens including arsenic and antimony, the TAP screening emission levels (EL) and the acceptable ambient concentrations for carcinogens (AACC) were established in Section 586 of the Rules based on the probability of developing excess cancers over a 70-year lifetime exposure. Beyond these considerations, a risk analysis is not required to obtain a PTC.

PSD CLASSIFICATION FOR THE LIME PLANT

A response to a request for additional information was submitted by PRI[3] in which the emissions units comprising the lime plant were identified. The project includes a lime manufacturing plant (LMP) that uses a Parallel Flow Regenerative Shaft Kiln to produce lime product from limestone by calcination, which is a designated facility as defined in 40 CFR 52.21(b)(1)(i)(*a*). As described in the "Facility Classification" and "PSD Classification" section of the Statement of Basis, the LMP is a designated facility "nested" inside a non-designated facility. As explained in the United States Environmental Protection Agency's (EPA) March 6, 2003, guidance,[67] an example is "A coal mine with an onsite coal cleaning plant with a thermal dryer. The primary activity of the source, in this example, is the mining of coal, and coal mines are not a listed source category. The coal cleaning plant, however, does fall within a listed source category. Fugitive emissions are only included from the coal cleaning plant to determine if the source is a major stationary source." Applying this guidance, these emissions are included in Table 10 of the Statement of Basis. For each regulated pollutant, LMP emissions did not exceed 100 T/yr, and facility-wide emissions did not exceed 250 T/yr applicability thresholds. To be conservative, DEQ has demonstrated that if the LMP was considered as the primary activity of the mine and the marble overburden mining associated with the LMP is included in the list of LMP sources, LMP emissions did not exceed 100 T/yr (see Table 11 of the Statement of Basis).

[67] "Clarification on fugitive emissions policy" letter to Janet McCabe, Assistant Commissioner, Office of Air Quality, Indiana Department of Environmental Management, March 6, 2003.

FUGITIVE DUST CONTROL EFFICIENCY

Comment 1 - Nez Perce Tribe (NPT): DEQ's reliance on a 93.3% fugitive dust control efficiency to ensure compliance with permit requirements and for the Project to be classified as a synthetic minor source is unsupported

Permit conditions must ensure compliance and enforceability, and DEQ has not demonstrated evidence that a 93.3% fugitive dust control efficiency is attainable or practically enforceable. DEQ has not provided any case studies that a 93.3% fugitive dust control efficiency can be met through a combination of chemical suppressant and added water. Not only is the 93.3% control efficiency requirement not backed up by supporting technically accurate documentation to be possible in the real world, permit conditions are not written so that it is possible to verify compliance and document violations when enforcement would be necessary. DEQ is, therefore, unable to ensure that permit conditions can be met.

DEQ also relies on the unproved 93.3% fugitive dust control efficiency for the Project to be considered a synthetic minor for facility-wide emissions of PM/PM10/PM2.5 to be below 250 tons/yr PSD applicability thresholds, Title V 100 tons/yr applicability thresholds, and to limit facility-wide emissions of single and total HAP to below HAP major source applicability thresholds of 10/25 tons/yr. As described above, because the 93.3% fugitive dust control efficiency is not practically achievable or enforceable, the Project does not meet the standard to avoid classification as a major source for PSD, Title V, and HAP**.**

DEQ Response:

14 For the Fugitive Dust Control Plan (FDCP), the minimum and substantive requirements were specified in the permit (Permit Conditions 2.1-2.6, 2.7-2.8, 2.20-2.21). DEQ contends that these and other relevant conditions are sufficient, reasonable, and appropriate to ensure compliance with applicable requirements including National Ambient Air Quality Standards (NAAQS). Relevant conditions include visible emissions limits (Permit Conditions 2.9-2.12), material throughput and operational limits (Permit Conditions 3.3-3.9, 4.5-4.12, 5.4-5.9, 6.3), emissions limits (Permit Conditions 4.3-4.4, 5.3), control device requirements (Permit Conditions 3.10-3.12, 4.13-4.17, 5.10-5.16), and testing (Permit Condition 4.33) requirements. To ensure enforceability of each of these requirements, supporting testing and monitoring, recordkeeping, and reporting (MRR) requirements were also included. In addition, DEQ will review and approve the FDCP which is incorporated by reference in the permit and is enforceable as part of the permit.

As described previously in the Representativeness and Uncertainty of Emissions section, although some degree of uncertainty is present in all emission factors used in estimating emissions, all emission factors were adequately supported and the approach of estimating potential to emit (PTE) at design capacity was considered a conservative approach. DEQ contends that the material throughput, operational limits, emissions limits, control device requirements, testing, and supporting MRR requirements in combination with reagent usage limits for cyanide and xanthate (Permit Conditions 4.4-4.6) are sufficient, reasonable, and appropriate to ensure HAP minor source classification and to verify that dust controls are being achieved.

Comment 2 – Environmental Protection Agency (EPA): Limiting PTE of the Mining Fugitive Dust Emissions for NAAQS and Title V HAP Purposes

The permit does not ensure that the fugitive dust emissions related to the mining of ore and limestone will not cause or significantly contribute to a violation of the NAAQS or exceedance of the Title V HAP major source permitting thresholds. The emission limits necessary to ensure compliance with the NAAQS and Title V HAP applicability limits do not appear to be enforceable as a practical matter. In particular (I) achieving 93.3% control efficiency for fugitive dust resulting from mining activities (excavation and haul roads) and 90% control efficiency for drilling activities are critical to ensuring no violation of the NAAQS and Title V HAP limits, (2) the permit does not contain the conditions necessary to ensure the permittee achieves those efficiencies at all times and (3) the permit record does not demonstrate that those efficiencies are achievable based on the

site-specific conditions at the Perpetua mine. EPA made similar comments in its March 19, 2021, comment letter to IDEQ regarding the previous Perpetua draft.

Examples of these specific issues include, but may not be limited to, the following:

Mining Fugitive Dust PTE Permit Limitations:

16. PTE limitations consistent with the 93.3% control efficiency applicable to haul road and access road do not appear to be specified in the permit conditions. These PTE limitations may include permit conditions requiring control measures such as how frequently chemical suppressant supplemented with watering must be applied, the atmospheric and operational conditions under which magnesium chloride supplemented with watering should be applied, the time of day that magnesium chloride supplemented with watering should be applied, and/or the amount that should be applied. [13] The permit requires that fugitive road dust PTE limitations such as those indicated above are to be developed by the permittee after the permit is issued. The permit also allows these types of PTE limitations to be changed without IDEQ review and approval. PTE limitations addressing the 93.3% control efficiency must be reviewed and approved by IDEQ, subject to review by the public during the public comment period and must be enforceable at all times upon the issuance of the initial permit. Also, any changes to the approved PTE limitations after the permit is issued that are less stringent must go through IDEQ public review and approval and must be enforceable at all times upon the issuance of the revised permit.

17. PTE limitations to achieve a 93.3% control efficiency for fugitive dust emissions associated with the mining excavation activities as specified in Table 1.1 and Table 3.1 do not appear to be specified in the permit conditions. Although permit condition 3.10 requires the "permittee shall control emissions from mining... emission sources (Table 3.1) in accordance with the Fugitive Dust Control Plan." it does not specify what those controls are and as such are unenforceable. These control measures must be specified as part of the permit consistent with the permitting record and subject to review during the public comment period. In addition, these control measures must be enforceable at all times upon issuance of the permit. Any changes that are less stringent than the approved control measures made after the initial permit is issued must be proposed for review using public notice procedures and must be enforceable at all times upon issuance of the revised permit.

18. To make the PTE limitations enforceable as a practical matter, the permit should include the parameters and assumptions used to develop the fugitive dust emission factors estimates for the haul roads and access roads (see AP-42 Section 13.2.2, Equation la).[14] Per AP-42 and the application, these parameters and assumptions include surface material silt content (%), mean vehicle weight (tons), speed limit (mph), and daily vehicle miles travelled.

Mining PTE Fugitive Dust Control Efficiencies and Emissions Factors:

19. IDEQ's permitting record does not appear to provide support for a 93.3% control efficiency applicable to fugitive dust emissions resulting from mining excavation operations and haul roads. IDEQ's permitting record cites three studies that address the control efficiencies associated with fugitive dust emissions associated with haul roads but not mining excavation activities. Based on these studies, IDEQ concludes that applying magnesium chloride will achieve a control efficiency of 90%. However, IDEQ's permitting record does not provide a reasoned analysis consistent with AP-42's control effectiveness factors (or equivalent) that this control efficiency and associated control measures identified by these studies would be representative of Perpetua's mining operation. In addition, IDEQ's permitting record does not identify the specific study details that support their conclusion and does not include copies of these studies for review during public comment period. (see Appendix A, Air Sciences 2020 application, page 339 of 421). IDEQ's permitting record indicates that a control efficiency of 90% is also supported by control efficiency limits established for 10 projects in the EPA RACT/BACT/LAER Clearinghouse (RBLC) database. However, IDEQ's permitting record does not provide a reasoned analysis consistent with AP-42's control effectiveness factors (or equivalent) that the control efficiencies and associated control measures identified by these permitting projects would be representative of Perpetua's mining operation. In addition, IDEQ's permitting record does not identify the specific details from the permitting projects and associated documentation that support their conclusions (IDEQ's 2021 TAP Addendum,

page 37 of226). Moreover, IDEQ's permitting record does not provide any technical studies showing that the supplementing magnesium chloride with watering will improve the control efficiency of magnesium chloride. Lastly, IDEQ's permitting record does not appear to provide support for a 10% opacity associated with a 93.3% control efficiency for haul roads as established in Permit Condition 2.5. To support the 93.3% claim of road dust control efficiency, a see-no see approach to opacity monitoring may be more appropriate.

DEQ Response:

Enforceable monitoring, recordkeeping, and reporting requirements were established in the permit. PM/PM_{10}/$PM_{2.5}$ emissions limits for point sources were established with supporting activity rate limits and MRR requirements. While emissions limits and emission factors are not commonly included in the permit for fugitive sources, activity rate limits and MRR requirements were established for those sources that were identified as process rate-limiting (as summarized in Table 1.1 of the permit). These activity rate limits serve as surrogate emissions limits for PM, PM_{10}, $PM_{2.5}$, HAP and TAP from fugitive sources. And while documented in the Statement of Basis and application materials, underlying parameters associated with calculating emissions such as vehicle speed limit, type, and miles traveled are not typically included in the permit but can be found in the application materials (Appendix A).

15 Based on public comment, Permit Condition 2.8 has been updated to include DEQ approval both initially (before startup) and after any subsequent changes and that the Fugitive Dust Control Plan (FDCP) shall be approved 30 days prior to startup. The approved FDCP is incorporated by reference in the permit and is enforceable as part of the permit. For the FDCP, the minimum and substantive requirements are specified in the permit and available for public review (Permit Conditions 2.1-2.6). DEQ contends that these and other relevant conditions are sufficient, reasonable, and appropriate to ensure compliance with applicable requirements including National Ambient Air Quality Standards (NAAQS).

DEQ recognizes that in practice chemical and water dust suppressants are used in combination for the control of dust from haul roads, and that achieving the target combined control efficiency of 93.3% is ultimately important to ensure compliance with applicable standards. It is for this reason that the combined control efficiency was listed in the permit in lieu of separate chemical (90% control) and water (33.3%) dust suppressant control efficiencies. An instantaneous 10% opacity limit for vehicle traffic on haul roads is considered a very conservative control trigger level to ensure that an appropriate control measure is taken to reasonably control emissions of fugitive dust (Permit condition 2.5). DEQ agrees with commenters that compliance with fugitive dust requirements is also necessary to ensure compliance with applicable standards, including application of both water and chemical dust suppressant in proper amounts and at proper frequencies as local conditions dictate.

Comment 3 – Idaho Conservation League (ICL)/ Save the South Fork Salmon (SSFS): Dust Control Efficiency

IDEQ states in this permit that the Applicant will have to achieve a dust control efficiency of at least 93.3% on the haul roads in order to achieve air quality compliance, yet the agency has not provided sufficient evidence that such a high target is attainable or practically enforceable. In Appendix G of the Statement of Basis, IDEQ discusses the T-RACT Analysis, including dust control efficiency. We have reviewed the references listed in Appendix G, Table 10 of other facilities with determinations of 90% or greater control efficiency for unpaved roads. Upon investigation of these references through the EPA's Clean Air Technology Center database,[2] we found that only 1 of the 10 facilities referenced actually has *verified* compliance of achieving at least 90% control efficiency. The other nine facilities listed in Table 10 had either unverified or unknown compliance with that permit condition. In addition, only one of these facilities is actually a gold mining operation and therefore most of these references should not be used as a point of comparison to the Stibnite project.

Listed Facilities in Appendix G, Table 10
AK Donlin Gold Project AK-0084 water/chem 90% (unverified/unknown compliance)
AR Turk Power Plant AR-0094 water/chem 90% (unverified/unknown compliance)

CO Rio Grande Portland Cement Corp. CO-0043 water/chem 90% (unverified/unknown compliance)
IN Nucor Steel IN-0034 chem 90% (unverified/unknown compliance)
LA Nucor Steel Louisiana LA-0239 water/chem 90% (unverified/unknown compliance)
MO Lafarge Corp. MO-0048 chem 90% (unverified/unknown compliance)
NV Sloan Quarry NV-0045 chem 98% (compliance verified)
NV Nellis Air Force Base NV-0047 water/chem 90% (unverified/unknown compliance)
OH Unlimited Concrete OH-0126 water/chem 90% (unverified/unknown compliance)
OH Unlimited Concrete OH-0131 water/chem 90% (unverified/unknown compliance)

According to the T-RACT analysis, the Applicant has eliminated paving as a control mechanism due to it being deemed too costly, instead selecting the application of a chemical dust suppressant supplemented by frequent watering. However, there is no assurance that other facilities of this size and nature have been able to achieve this high bar for dust control efficiency. IDEQ itself states on page 22 of the Statement of Basis that "it may prove challenging to consistently and continuously achieve the targeted level of fugitive dust control for emissions from traffic on unpaved roadways, with over 55 miles of haul truck routes within the mining operations boundary, a fleet of 32 haul trucks weighing between 37 and 357 tons, and a targeted dust control efficiency of 93.3% accomplished by application of both dust suppressant and water controls." Because the fugitive dust control efficiency is not practically attainable or enforceable, this facility should not be classified as a non-major source.

IDEQ should:

- Rigorously evaluate if the 93.3% dust control efficiency target is realistically attainable by the Applicant. If not, reclassify the facility as a major source.
- Include enforceable provisions in the permit to hold the Applicant to continuous achievement of that dust control efficiency level.
- Adjust emission calculations for ore handling and processing activities when temperatures are below freezing and proposed water controls would not be practical.

DEQ Response:

The Fugitive Dust Control Plan (FDCP) contains the minimum and substantive requirements and were specified in the permit and available for public review (Permit Conditions 2.1-2.6). DEQ contends that these and other relevant conditions are sufficient, reasonable, and appropriate to ensure compliance with applicable requirements including National Ambient Air Quality Standards (NAAQS). In addition, DEQ will review and approve the FDCP which is incorporated by reference in the permit and is enforceable as part of the permit. DEQ recognizes that in practice chemical and water dust suppressants are used in combination for the control of dust from haul roads, and that achieving the target combined control efficiency of 93.3% is ultimately important to ensure compliance with applicable standards. It is for this reason that the combined control efficiency was listed in the permit in lieu of separate chemical (90% control) and water (33.3%) dust suppressant control efficiencies. DEQ agrees with commenters that compliance with fugitive dust requirements is also necessary to ensure compliance with applicable standards, including application of both water and chemical dust suppressant in proper amounts and at proper frequencies as local conditions dictate. The references listed in Appendix G, Table 10 from the EPA RBLC database were provided as additional supporting information. The references illustrate that a control efficiency of 90% is achievable by treating unpaved roads with chemical suppressant in various states with similar operations.

Air impact sensitivity modeling analyses for the project, prior to refined adjustments for background pollutant levels, shows all modeled PM_{10} violations occur during the winter (Statement of Basis, Appendix B) where emissions and background levels are likely overestimated. Data provided in the SGP baseline study specify an average snow depth of 21-68 inches and an average precipitation of 6.0 inches at the project site during this period. Therefore, fugitive dust emissions during high-modeled impact hours could be overestimated and may be controlled by more than 93%. An impact modeling sensitivity analysis, using meteorological data processed with the Bulk Richardson (BULKRN) method, with exclusion of the high impacting operating scenario W5, and

with background concentrations adjusted for seasonality, showed compliance with the 24-hour PM_{10} NAAQS at all receptor locations.

Comment 4 – Ian von Lindern, TerraGraphics International Foundation (TIFO): Estimated Unpaved Roads Emissions

As pointed out by numerous public comments and critiques, calculations of unpaved roads are not based on conservative data as required by State regulations and USEPA guidance. This remains a major concern as use of conservative values could show that this facility would not comply with particulate and toxic air pollutant health standards. The Applicant has now admitted that these same particulate emissions, as calculated, cannot comply with carcinogenic risk ambient air standards; has requested a ten-fold relaxation in health-risk protectiveness; and alleges a 57% reduction in PTE is required reach compliance. The consequences of IDEQ's reliance on these uncertain Applicant assertions are immense, as it could determine whether the facility can be permitted under the current configuration, and whether public health and the environment can be protected. IDEQ continues to resist requiring meaningful and effective monitoring that could detect these exceedances should the Applicant's assertions prove untrue. Nor are there any provision for corrective actions should the health criteria be exceeded.

These potential dangers are exacerbated by the T-RACT proposal and additional critique is offered for the Agency's consideration in the following Section 8.0 T-RACT REVIEW.

DEQ Response:

The Fugitive Dust Control Plan (FDCP) contains the minimum and substantive requirements and were specified in the permit and available for public review (Permit Conditions 2.1-2.6). DEQ contends that these and other relevant conditions are sufficient, reasonable, and appropriate to ensure compliance with applicable requirements at a reasonable level of confidence, including National Ambient Air Quality Standards (NAAQS). In addition, DEQ will review and approve the FDCP which is incorporated by reference in the permit and is enforceable as part of the permit.

T-RACT is an emission standard based on the lowest emission of toxic air pollutants that a particular source is capable of meeting by the application of control technology that is **reasonably available**, as determined by DEQ, considering technological and economic feasibility. T-RACT is an allowable analysis to demonstrate preconstruction compliance for toxic air pollutants (IDAPA 58.01.01.210.12) that PRI has used to demonstrate compliance for arsenic.

DEQ asserts that ambient air monitoring is not warranted for the SGP. Although there are identified uncertainties in the analyses predicting air pollutant emissions and atmospheric dispersion of such emissions, DEQ is reasonably confident that impacts to ambient air will be below applicable standards. Furthermore, ambient monitoring would only be required where such monitoring would serve to protect a potentially exposed public residing in the area of impact. The areas where maximum potential impacts from the SGP are highest are remote, located far from areas where the general public live and reside. There are no public residences, public businesses, schools, hospitals, or other areas where members of the general public would be expected on a continual basis.

INSUFFICIENT MONITORING AND RECORDKEEPING

Comment 5 - NPT: The state of Idaho's internal controls and program resources are inadequate to guarantee permit conditions will be met

The PTC lacks sufficient monitoring for enforcement and compliance to ensure that permit conditions are met. In the Tribe's March 18, 2021 comment letter, the Tribe states that a once every two years inspection schedule and response by phone was woefully insufficient to ensure the Project is meeting the 93.3 percent fugitive dust control permit requirements that guarantee human life, animal life, and vegetation, and the Tribe's Treaty-reserved resources are not injured or unreasonably affected. DEQ now states that the inspection schedule will be even more insufficient – at a rate of once every five years.

Meteorological data used in the modeling came from on-site monitoring at one location. With the complex terrain of the site, the inputs to the modelling will not be representative of the actual weather throughout the entire mining site over the life of the mine. With that in mind, fenceline monitoring should be a requirement to ensure compliance with the PM10 NAAQS, if the permit is issued.

As described in our November 10, 2020 comments, additional monitoring (real-time continuous, federal reference PM2.5 and PM10 monitoring, web cameras, aerial drones, and collocation of meteorological monitoring) and weekly on-site inspections are necessary for DEQ to accomplish its responsibilities under the Clean Air Act to implement and enforce permit conditions and ensure the NAAQS are not violated.

DEQ Response:

The Fugitive Dust Control Plan (FDCP) contains the minimum and substantive requirements that were specified in the permit and available for public review (Permit Conditions 2.1-2.6). DEQ contends that these and other relevant conditions are sufficient, reasonable, and appropriate to ensure compliance with applicable requirements at a reasonable level of confidence, including National Ambient Air Quality Standards (NAAQS). In addition, DEQ will review and approve the FDCP which is incorporated by reference in the permit and is enforceable as part of the permit.

DEQ is requiring extensive fugitive dust control measures in the permit and has reviewed or conducted modeling analyses that demonstrates compliance with NAAQS at a satisfactory level of confidence for permit issuance. Therefore, DEQ is not requiring any ambient air monitoring in the permit.

DEQ disagrees that a PM/PM_{10} ambient air PM_{10} monitoring is necessary to ensure NAAQS compliance. The issued permit includes limits on operational levels and key parameters such as (but not limited to) ore excavation and hauling rates, silt content of roadway material, application of dust suppressant measures, etc. These limits represent values associated with maximum or upper-level emissions for the time interval consistent with the averaging period of the standard. The permit also includes monitoring and recordkeeping requirements to ensure compliance with permit limits and ultimately ensure compliance with NAAQS and TAP increments at a satisfactory level of confidence to support permit issuance.

The comment is correct in that use of one meteorological monitoring site for such a large area with complex terrain is not representative of conditions throughout the area. However, considering other conservative assumptions used in analyses and the permitting process, combined with DEQ's extensive fugitive dust control measures, DEQ has determined that operation of the SGP as described in the application will not likely cause a violation of a NAAQS or TAP increment. This constitutes a *satisfactory* demonstration, thereby justifying permit issuance as required by *Idaho Air Rules* Section 203.

Comment 6 - EPA: Mining Fugitive Dust Monitoring, Recordkeeping, and Reporting Requirements

22. No monitoring, recordkeeping and reporting (MRR) requirements appear to be specified for the excavation mining controls required by permit conditions 3.10 to ensure their enforceability.

23. No monitoring, recordkeeping, and reporting requirements appear to be specified for the 90% control efficiency applicable to the drilling activities required in permit condition 3.11.

24. The monitoring methods associated with the haul roads appear to be unenforceable as they do not specify how the monitoring and recordkeeping demonstrating compliance with the applicable PTE limitations will be achieved. For example, Permit Condition 3.16 specifies "the permittee shall monitor and record" using the "devices and methodologies ... identified in the O&M Manual" for the PTE limitation associated with the 180,000 tpd hauling PTE limitation in permit condition 3.5. The permit must include all monitoring, recordkeeping and reporting necessary to assure compliance with the permit emission limitations and applicable requirements.

25. Given the high level of uncertainty in the assumptions and requirements to ensure compliance with the PM10 24-hr NAAQS, the addition of post-construction ambient monitoring requirements is highly prudent. IDEQ may be able to require post-construction monitoring when determined to be necessary to determine the effect a stationary source may have on air quality in the vicinity of the source, especially when there is high uncertainty in project air quality impacts determined from modeling. The EPA recommends IDEQ add a permit requirement for the source to deploy a fenceline PM10 monitoring network, in a manner determined to be adequate by IDEQ, to demonstrate 24-hour and annual PM10 NAAQS compliance.

DEQ Response:

The emissions from mining and ore processing sources shall be controlled in accordance with the FDCP in Permit condition 2.6. The minimum and substantive requirements were specified in the permit under the FDCP. DEQ contends that these and other relevant conditions are sufficient, reasonable, and appropriate to ensure compliance with applicable requirements including National Ambient Air Quality Standards (NAAQS) at a reasonable level of confidence.

DEQ contends that, like other control equipment in the permit, the drilling rigs dust control system will be operated in accordance with the O&M manual which specifies a copy of the vendor-supplied performance guarantee shall be included along with minimum pressure drop, procedures for proper operation, and routine inspection and maintenance. The minimum requirements for the O&M manual are specified in the permit to demonstrate that the drilling rigs dust control system operates as designed. Likewise, the O&M manual (Permit Condition 2.20) specifies that each monitoring device and methodology used to measure weight rates of materials, installation, calibration, and maintenance shall be described to demonstrate compliance with each material throughput limit.

DEQ disagrees that ambient air PM_{10} monitoring is necessary to ensure NAAQS compliance. The issued permit includes limits on operational levels and key parameters such as (but not limited to) ore excavation and hauling rates, silt content of roadway material, application of dust suppressant measures, etc. These limits represent values associated with maximum or upper-level emissions for the time interval consistent with the averaging period of the standard. The permit also includes monitoring and recordkeeping requirements to ensure compliance with permit limits and ultimately ensure compliance with NAAQS and TAP increments at a satisfactory level of confidence to support permit issuance.

DEQ recognizes the uncertainty of predicted impacts (from the use of dispersion models) in complex terrain, the uncertainty in predicted impacts when using modeling techniques for fugitive emission sources, the uncertainty in emission factors and equations, the uncertainty and variability in input parameters to emission equations, and the variability in background pollutant concentrations. However, these uncertainties and variabilities are offset by other approaches in the permitting process and modeling methods that are

conservative (overstating impacts). Some of these include (for 24-hour PM_{10}, which is the driver in analyses): 1) not accounting for times when fugitive emissions will be greatly reduced because of precipitation or lingering periods of high moisture content of material handled or roadways driven over; 2) assuming emissions from short-term maximum allowable operational rates, and from the worst-case operational scenario for the receptor location in question, occur during each day of operation; 3) DEQ's high level of confidence that required emission control efficiencies will be the minimum level attained during operations, verified through the use of emission-affecting parameter monitoring and record-keeping; 4) ensuring that fugitive emissions are less than estimated values provided in the application through required frequent inspection of emission sources that drive highest modeled impacts; 5) assuming that maximum modeled design value impacts occur simultaneously with design value background concentrations.

Idaho Air Rules Section 203 requires that a permit may not be issued unless it is demonstrated to DEQ's satisfaction that the proposed project will not cause or contribute to a violation of a NAAQS or TAP increment. In conclusion, through DEQ's review of the application and DEQ's additional analyses, DEQ has determined that operation of the SGP as described in the permit application is unlikely to cause a violation of an applicable NAAQS or TAP increment. This represents a satisfactory demonstration to support permit issuance.

DEQ does not typically require ambient air pollutant monitoring for permit issuance, especially at facilities with emissions below major source thresholds. Ambient monitoring is not considered unless DEQ lacks a satisfactory confidence of NAAQS or TAP increment compliance (as specified by *Idaho Air Rules* Section 203.02 and 203.03) without such monitoring. All of the following conditions would normally be required to justify post-construction ambient air monitoring:

1. The application used questionable, non-conservative data or assumptions in the calculation of emissions or dispersion-affecting parameters.
2. There is an inability to verify emissions or dispersion-affecting parameters during operation of the facility. This would include monitoring parameters of emission equations or monitoring indicators of a condition of unacceptable control of emissions.
3. There are sensitive receptors (private residence, school, public business, hospital, or other area where members of the general public would be expected to be present) in areas where elevated ambient air impacts could occur.

The SGP does not meet the above criteria to justify the requirement of ambient air monitoring. It has been indicated that PRI did not use convincingly conservative data and assumptions for some emission calculations. Where the conservatism of such data was in question, DEQ required enhanced monitoring and record-keeping of such parameters. Such monitoring includes the monitoring of maximum road silt content, monitoring of production levels to verify estimated vehicle miles traveled (VMT) used in fugitive road dust emission calculations, and monitoring of the median arsenic content of road base material to help justify fugitive road dust arsenic emissions used in TAP analyses. Finally, there are no sensitive receptors identified near the ambient boundary of the facility, where elevated impacts of pollutants would be expected.

Comment 7 - EPA: Ore Processing Monitoring, Recordkeeping and Reporting Requirements/

6. The monitoring method does not appear to specify how and where the PTE limitations will be measured consistent with the application's emissions calculations. For example, Permit Condition 3.18 specifies "The devices and methodologies used to measure weights shall be identified in the O&M Manual" for determining compliance with the input to the primary crusher. Per the application, this monitoring should apply at OCI (Loader Transfer of ORE to Grizzly) and not OC7 (Primary Crusher) as specified in the permit condition. The permit also does not specify generally how the weight is measured such as by a truck scale or some other method but is to be developed in an O&M Manual after the permit is issued and is not enforceable to this permit condition (see permit conditions 2.20 and 2.21). The permit must include all monitoring, recordkeeping and reporting necessary to assure compliance with the permit emission

limitations and applicable requirements. This comment is also applicable to permit conditions 3.16 through 3.20, 4.18 through 4.32, 4.34, and 5.16 through 5.24.

7. IDEQ required monitoring of baghouse pressure drop to assure compliance in permit condition 4.31. Though pressure drop monitoring can be an indicator of the source's maintenance program, monitoring experts within EPA have concluded that pressure drop is not a reliable approach for monitoring baghouse compliance. Alternatives to pressure drop include opacity monitoring/readings and bag leak detectors. Bag leak detectors are a good alternative for baghouses that require a more rigorous level of scrutiny than periodic observations provide. These monitoring techniques can be combined with a good operation and maintenance program to assure compliance. This comment is also applicable to permit conditions 5.21, 5.22, and 5.23.

DEQ Response:

Permit condition 3.7 establishes a primary crusher limit. Compliance is ensured by complying with the monitoring and recordkeeping requirements specified in Permit Condition 3.18. The monitoring on the primary crushing circuit, per the application (see the process flow diagram), is via a weighometer on the Coarse Ore Stockpile Feed conveyor downstream of the primary crusher. This is standard practice for the mining industry. The O&M manual (Permit Condition 2.20) specifies that each monitoring device and methodology used to measure weight rates of materials, installation, calibration, and maintenance shall be described to demonstrate compliance with each material throughput limit. DEQ contends that the O&M manual specifies that each monitoring device and methodology used to measure weight rates of materials, installation, calibration, and maintenance shall be described to demonstrate compliance with each material throughput limit and is an enforceable permit condition.

Based on public comment, Permit Condition 2.20 has been updated to state that the O&M manual shall be developed 30 days prior to startup of any process equipment. In the case of the O&M Manual, certain operating parameters will not be determined or available until after control equipment has been installed. Permit Condition 2.21 was updated to include DEQ approval 30 days prior to startup and 30 days before any subsequent changes are made to the O&M Manual.

Although bag leak detectors are a reliable approach to ensure baghouse monitoring compliance, measuring pressure drop across the baghouse is commonly accepted by DEQ as an effective way of determining proper baghouse operation.

Comment 8 - EPA: Lime Plant Monitoring, Recordkeeping and Reporting Requirements

12. Consistent with comment #6 for ore processing, the lime plant MRR requirements appear to be unenforceable as Permit Condition 5.16 specifies "the permittee shall monitor and record" using the "devices and methodologies ... identified in the O&M Manual" for the PTE limitation associated with the limestone primary crusher. The permit must include all monitoring, recordkeeping and reporting necessary to assure compliance with the permit emission limitations and applicable requirements.

13. If the O&M Manual is used to provide the monitoring, recordkeeping, and reporting (MRR) requirements for the applicable PTE limitations then the O&M Manual would need to be reviewed and approved by IDEQ, available for review during the public comment period and must be enforceable at all times upon issuance of the permit. Also, any changes to the O&M Manual that that would make the approved MRR requirements less stringent would be subject to the same IDEQ and public review approval process and need to be enforceable at all times upon issuance of the revised permit.

DEQ Response:

The O&M manual (Permit Condition 2.20) specifies that each monitoring device and methodology used to measure weight rates of materials, installation, calibration, and maintenance shall be described to demonstrate compliance with each material throughput limit. DEQ contends that the O&M manual specifies

that each monitoring device and methodology used to measure weight rates of materials, installation, calibration, and maintenance shall be described to demonstrate compliance with each material throughput limit and is an enforceable permit condition.

Based on public comment, permit condition 2.20 has been updated so that the O&M manual shall be developed 30 days prior to startup of any process equipment. Enforceable testing and monitoring, recordkeeping, and reporting (MRR) requirements that were determined reasonable and appropriate were established and incorporated in the permit. The O&M manual establishes a regular schedule for operation, inspection, maintenance, and repair of the control equipment to ensure compliance.

Comment 9 - ICL/SSFS: PM/PM10 Monitoring

In order to make this air permit practically enforceable, IDEQ must require that the Applicant install a PM/PM10 monitoring system on site at the ambient air boundary to ensure that PM/PM10 NAAQS are not violated. This step is warranted because of the uncertainty surrounding dust control efficiency and emissions factors associated with this project. To our knowledge, it is neither technologically or financially infeasible for the Applicant to install this monitoring. Additionally, IDEQ should include penalties and corrective actions in the permit that would be triggered if this monitoring system shows NAAQS violations occurring at the ambient air boundary. These penalties should entail a mandatory reduction in mining and processing throughput.

IDEQ should:

- Add a permit condition that requires the Applicant to install a comprehensive continuous PM/PM10 monitoring system on site.
- Add enforceable penalties and corrective actions to the permit that are triggered if this monitoring system ever indicates that NAAQS are being exceeded.

DEQ Response:

DEQ disagrees that a PM/PM_{10} ambient monitoring network is necessary to make the PTC practically enforceable. As discussed previously in DEQ's response to Comment 6, the issued permit includes limits on operational levels and key parameters such as (but not limited to) ore excavation and hauling rates, silt content of roadway material, application of dust suppressant measures, etc. These limits represent values associated with maximum or upper-level emissions for the time interval consistent with the averaging period of the standard. The permit also includes monitoring and recordkeeping requirements to assure compliance with permit limits and ultimately assure compliance with NAAQS and TAP increments at a satisfactory level of confidence to support permit issuance.

Even though DEQ is not proposing a monitoring network, it should be noted that any violation of the permit would be processed in accordance with DEQ's enforcement procedures manual.

CONCERNS WITH THE FCDP, O&M MANUAL, AMP, AND HRCP

Comment 10 - NPT: Concerns with Fugitive Dust Control Plan (FDCP), Operations and Maintenance Manual (O&M), Access Management Plan (AMP), and Haul Road Cap Plan (HRCP) submission and review process

These plans are key to holding Project emissions at or below assumed emissions in the emissions inventory and modeling used to determine the source applicability of the Project. Any assumptions, including emission controls, need a practically enforceable permit requirement to keep the Project a synthetic minor for PSD, Title V, and HAP. As these plans are not yet written, and their associated permit conditions not included in the PTC, the PTC is not practically enforceable.

Our understanding is that the first opportunity for meaningful comment on the FDCP, O&M, AMP, and HRCP will be when a Tier I air operating permit is drafted. Strict adherence to these plans is critical to ensuring compliance, and only giving the public the opportunity to review and comment on these plans when the Tier I air operating permit is drafted, and every five years thereafter, is inadequate.

DEQ Response:

16 For the Fugitive Dust Control Plan (FDCP), Operations and Maintenance (O&M) Manual, AMP, and HRCP the minimum and substantive requirements were specified in the permit (Permit Conditions 2.1-2.6, 2.7-2.8, 2.20-2.21, 3.13). DEQ has added additional minimum requirements for the AMP and HRCP (Permit Conditions 2.7 and 3.13). DEQ contends that these and other relevant conditions are sufficient, reasonable, and appropriate to ensure compliance with applicable requirements including National Ambient Air Quality Standards (NAAQS). Relevant conditions include visible emissions limits (Permit Conditions 2.9-2.12), material throughput and operational limits (Permit Conditions 3.3-3.9, 4.5-4.12, 5.4-5.9, 6.2), emissions limits (Permit Conditions 4.3-4.4, 5.3), control device requirements (Permit Conditions 3.10-3.12, 4.13-4.17, 5.10-5.16), and testing (Permit Condition 4.33) requirements. To ensure enforceability of each of these requirements, supporting testing and monitoring, recordkeeping, and reporting (MRR) requirements were also included. In addition, DEQ will review and approve the FDCP, O&M's, AMP and HRCP. These approved plans and manuals are incorporated by reference in the permit and are enforceable as part of the permit.

All state and federally applicable requirements are incorporated into the Tier I permit as required by 40 CFR 63 Subpart EEEEEEE, including all applicable PTC, NESHAP and NSPS requirements. Copies of all permit-required compliance documents, including but not limited to the FDCP, O&M, AMP, and HRCP are required to be included in the permit application and thus included in the docket for review during each Tier I public comment period (Tier I Application Completeness Checklist). As such, any plan updates will be subject to public review during each Tier I permit renewal comment period once every five years. Additionally, DEQ plans to post the FDCP, O&M, AMP, and HRCP on DEQ's website with the final permit and statement of basis when completed. Once DEQ approves these plans they will also be available for public records request.

Comment 11 - NPT: Concerns with Permit Condition 2.20 O&M Manual

Permit condition 2.20 requires the permittee to develop and maintain an Operation and Maintenance (O&M) manual to ensure compliance with emission limits and the control equipment maintenance and operation general provision. The Tribe has the following concerns about section 2.20:

- Please explain why the O&M manual is termed a "manual" and not a "plan", and please justify why the O&M manual does not require approval by DEQ when DEQ approval is required for the FDCP, AMP and HRCP plans.
- Please explain the rationale for the O&M manual being due 60 days after startup of any process equipment, unlike the 60 days after permit issuance required for the FDCP, AMP, and HRCP plans.
- The O&M permit condition, 2.20, states a once per month visible emission (VE) inspection requirement for wet scrubber, carbon filter, baghouse, and bin vents, but permit condition 2.10 requires the following VE

inspection: "Each day during daylight hours and under normal operating conditions, the permittee shall conduct a facility-wide inspection of potential point sources of visible emissions including stacks, vents, and functionally equivalent openings." Since wet scrubber, carbon filter, baghouse, and bin vents have openings, the VE inspection requirement for this control equipment should be the same as permit condition 2.10.

DEQ Response:

Based on public comment, Permit Condition 2.20 has been updated to be consistent with the FDCP, AMP, and HRCP to state that the O&M manual shall be developed 30 days before startup of any process equipment. In the case of the O&M Manual, certain operating parameters will not be determined or available until after control equipment has been installed. Permit Condition 2.20 was also updated to describe the schedule and procedures for routine inspection as a see-no-see visible emissions inspection conducted at least once per day to eliminate the discrepancy with Permit Condition 2.10. Permit Condition 2.21 was updated to include DEQ approval 30 days prior to startup and 30 days before any subsequent changes are made to the O&M Manual.

Comment 12 - NPT: Concerns with Permit Condition 3.11 Drilling Rigs Dust Control System

We appreciate that DEQ has added controls for the drilling activities. However, the details in actually achieving the 90% control are to be included in an O&M manual which will be developed after the PTC permit is issued. If DEQ relied on vendor-stated control efficiencies, there should be testing requirements included in the PTC to validate the emissions controls.

DEQ Response:

DEQ contends that, like other control equipment in the permit, the drilling rigs dust control system will be operated in accordance with the O&M manual which specifies a copy of the vendor-supplied performance guarantee shall be included along with minimum pressure drop, procedures for proper operation, and routine inspection and maintenance. These minimum requirements for the O&M manual were specified in the permit.

Comment 13 - NPT: Concerns with Permit Condition 3.13 Haul Road Capping

The addition of permit condition 3.13 Haul Road Capping is appreciated. However, haul road surfaces will degrade over time. Because the arsenic concentration in the roadbed will come from both the road material itself and spilled ore, DEQ should require periodic testing of both silt and arsenic content of the road bed to validate assumptions underlying the estimated emissions and assure the representativeness of the emission factors used. Periodic measurement would increase confidence that the NAAQS are being protected (PM10 from haul road fugitives) and fugitive arsenic is being controlled. We suggest use of most conservative average arsenic concentration in the quartzite used. In the 55,000 ore samples presented, that would be the mean, not the median as proposed in 3.13. Please explain in better detail how DEQ justified the assumption that 50% of the vehicle miles traveled (VMT) will occur on low-arsenic capped haul roads and what level of detail will be required in the HRCP such that the emission limits are enforceable.

DEQ Response:

DEQ concurs that silt content is an important component in the HRCP. Permit condition 3.13 has been updated to include a silt content maximum percentage of 4.0% and a corresponding sampling plan including frequency and method of analysis for verification. As discussed previously in the Representativeness and Uncertainty of Emissions section, the use of site-specific median values for silt content is commonly accepted by DEQ, and the values used in calculations were supported by PRI. Although a median value of sampled silt percentages of roadway material was used in emission estimates presented in the application, DEQ recognizes the importance of the silt content parameter in the estimation of fugitive emissions. Since compliance with the 24-hour PM_{10} NAAQS is the primary driver of NAAQS compliance, minimizing variability of this parameter is very important to ensure NAAQS compliance.

The HRCP contains the minimum and substantive requirements in the permit to ensure compliance with the NAAQS. The assumption that 50% of the vehicle miles traveled (VMT) will occur on low-arsenic capped haul roads has been substantiated in a reference email from PRI on June 16, 2021 where the annual average percentage of haul road travel on capped roads is over 60%. A lower value of 50% was used in the analysis as a conservative assumption.

Comment 14 - NPT: Concerns about fugitive dust controls

The FDCP plan is key for the facility to reach the 93.3% fugitive dust control that allows DEQ to demonstrate the facility is a synthetic minor. We are concerned that the use of such non-specific permit requirement terms of "as necessary" and "periodic" is not practical enforceability.

We are very concerned about PRI's commitment to 93.3% control for fugitives on haul roads. In Facility Comment #10, PRI asked for a change from a twice daily to a monthly frequency for permit condition 2.4 fugitive emission inspection. A monthly inspection frequency is woefully inadequate. We appreciate that DEQ has retained the twice daily inspection frequency.

Retention of records should exceed five years. The records of FDCP are key to compliance checking and it is plausible that inspection frequency will exceed 5 years. The description of the facility information in the Statement of Basis states "the SGP will include three years of premining development and construction activities, followed by an operating mine life of approximately 12 years." And permit condition 2.24 states "In accordance with IDAPA 58.01.01.313.01.b., the permittee shall submit a complete application to DEQ at the address provided (Permit Condition 2.26) for an initial Tier I operating permit within 12 months of becoming a Tier I source or commencing operation." Therefore, it is very plausible the facility will operate for 4 years or more before an operating permit is issued. If compliance inspection is every 5 years, earthmoving activities at the mine may go for 9 years before any compliance check is made by DEQ.

Permit condition 2.5 includes a 10% opacity trigger: "Fugitive dust control measures shall be applied to haul roads on a frequency such that visible emissions from vehicle traffic on a haul road do not exceed 10% opacity". We are unaware of any study showing that a 10% opacity limit ensures a 93.3% fugitive dust control efficiency. A more protective trigger would be an instantaneous see/no-see. Any trigger, to be sufficiently evaluated, should specify a timeframe for measurement (example: instantaneous or 15 second), a location, and when to take the opacity reading (example: immediately after a loaded ore truck passes near surface of the road bed). Additionally, with over 55 miles of haul roads, there should be multiple locations being monitored during each inspection.

DEQ Response:

Enforceable testing and monitoring, recordkeeping, and reporting (MRR) requirements that were determined reasonable and appropriate were established and incorporated in the permit. DEQ contends that program resources are adequate for the purposes of monitoring compliance with permit conditions, for inspection, and for complaint response and that the inspection schedule is sufficient for a minor source of emissions.

DEQ recognizes that in practice chemical and water dust suppressants are used in combination for the control of dust from haul roads, and that achieving the target combined control efficiency of 93.3% is ultimately important to ensure compliance with applicable standards. It is for this reason that the combined control efficiency was listed in the permit in lieu of separate chemical (90% control) and water (33.3%) dust suppressant control efficiencies. A 10% opacity is considered a very conservative control trigger level to ensure that an appropriate control measure is taken to reasonably control emissions of fugitive dust (Permit condition 2.5). DEQ agrees with commenters that compliance with fugitive dust requirements is also necessary to ensure compliance with applicable standards, including application of both water and chemical dust suppressant in proper amounts and at proper frequencies as local conditions dictate.

Comment 15 - NPT: Regular testing requirements needed for process and control equipment

Permit Conditions 2.20-2.21 require developing and complying with the requirements of an O&M manual to ensure compliance with control equipment maintenance and operation general provisions (Permit Condition 7.2). Documentation of as-built Process equipment specifications and control equipment performance guarantees and establishing control equipment operating parameters and procedures were required, since these were relied upon in the development of emissions inventories, and in the evaluation of ambient air impacts in the modeling analyses. Compliance is ensured by complying with monitoring and recordkeeping requirements. There should be regular testing required to confirm process and control equipment are operating/performing to the specifications, guarantees, and parameters identified in the PTC application.

DEQ Response:

Based on public comment, Permit Condition 2.20 has been updated so that the O&M manual shall be developed 30 days prior to startup of any process equipment. Enforceable testing and monitoring, recordkeeping, and reporting (MRR) requirements that were determined reasonable and appropriate were established and incorporated in the permit. The O&M manual establishes a regular schedule for operation, inspection, maintenance, and repair of the control equipment to ensure compliance.

Comment 16 - EPA: Mining Access Management Plan (AMP) for NAAQS Purposes

26. Permit Condition 2.7 requires the development of an Access Management Plan (AMP) to address whether the NAAQS apply to the mine's access road through the Perpetua Mining site given the extent of public access allowed. Permit Condition 2.8 allows the AMP to be developed after the permit is issued and does not require the AMP to be enforceable. For the AMP to preclude the applicability of the NAAQS along the access road, the AMP must be reviewed and approved by IDEQ, subject to review by the public during the public comment period and must be enforceable at all times upon issuance of the initial permit. Any changes to the AMP that are less stringent than the approved AMP must be reviewed and approved by IDEQ, subject to review by the public, and enforceable at all times upon issuance of the revised permit.

27. Given the unique situation with a public access road traversing the mine site, the key assumptions, parameters, and methodologies used to preclude public access from the mine site must be fully disclosed in the permit record and the necessary requirements be included in the permit and available for public review and comment. The State assumes measures taken to preclude public access will be appropriate and adequately comply with EPA's Revised Policy on Exclusions from Ambient Air (as specified in the December 2, 2019, memo from Andrew Wheeler to the EPA Regional Administrators). Section 2.7 of the permit provides requirements for the source to develop a plan to preclude public access, but these requirements offer a range of measures the source may choose to implement and are therefore ambiguous. Without full disclosure in the record of the exact measures and permit requirements to ensure compliance with national ambient air policy, it is not clear if the public access road can be excluded from ambient air protections. The state needs to provide sufficient justification to demonstrate the measures and requirements to preclude public access and ensure members of the public traversing the road can be classified as "guests of the mine" sufficiently complies with national ambient air policy. Given the uniqueness and ambiguity of the situation, a petition to the EPA national ambient air policy team for review and concurrence with the State's findings could be warranted.

DEQ Response:

Ambient air is defined in *Idaho Air Rules* Section 005.09 as, “That portion of the atmosphere, external to buildings, to which the general public has access.” To exclude areas from consideration as ambient air in air pollutant impact analyses, the following must be met:

1. The permittee must have the legal authority to exclude the *general public* from the area.
2. The boundary to ambient air must be clearly discernable to the *general public*.
3. The *general public* must be effectively precluded from accessing the facility.

4. The *general public* is not considered: employees of the facility; those having official business with the facility; guests of facility, including participants in facility tours and those seeking access for a specific purpose.

PRI has asserted they have complete and sole authority to control access to or through the facility, granting or excluding access at their discretion to anyone wishing to visit the site or pass through the site. Section 2.7 of the PTC establishes requirements to effectively preclude public access to the facility by: 1) adequately informing anyone approaching an access point that travel beyond the established gate involves entering an active mine site as a guest of PRI; 2) providing verbal or written requirements that must be followed while on the SGP site to all wishing to access the site. Since those requesting access to the site are guest of PRI and no longer members of the public, health and safety of such guests and managing how guests are monitored or escorted while on the site is the responsibility of PRI and outside of the scope of the PTC. It is not DEQ's responsibility or concern as to the reasons PRI may invite people to access the facility as a guest; it is primarily DEQ's concern that those accessing the facility understand the are no longer on public property and are entering an active mine site and agree to accept all such risks associated with the site and requirements imposed by the facility.

PRI may allow controlled use of a facility roadway to access offsite areas that would otherwise require a longer travel time around the mine. This roadway was excluded from consideration as ambient air and those using the road are considered guests of PRI rather than members of the general public. Since PRI has legal authority control all access through the facility, this meets the first criteria for exclusion from ambient air. To achieve the second and third criterion, PRI will post signs indicating the entry to the mine site and will establish manned access gates at points prior to the ambient air boundary. All persons seeking access will be required to register at the access gate and will be instructed on procedures and any potential hazards of areas they may encounter while on the SGP mine site (see Permit Condition 2.7).

Based on public comment, Permit Condition 2.7 has been updated with the following: "Only registered guests of the facility will be allowed access to or through the facility. Those seeking to be a guest for the sole purpose of passing through the facility to another destination shall be provided a registration sheet that explains PRI's requirements for accessing the site and identifies potential hazards of the site."

DEQ is confident in its interpretation of ambient air for the PRI minor source PTC, and DEQ asserts the methods used to excluded areas from ambient air is solid and unambiguous. Therefore, consultation with EPA's ambient air policy team is not warranted.

Comment 17 - EPA: Mining Dust Haul Road Capping Plan (HRCP) for NAAQS and Title V HAP Purposes

28. Permit Condition 3.13 requires the development of a Haul Road Capping Plan (HRCP) to address fugitive dust emissions from the haul roads and development rock storage facilities after the permit is issued.

29. To the extent that this plan is being relied upon to limit fugitive dust emissions for Title V HAP applicability and NAAQS compliance purposes, the HRCP would need to be reviewed and approved by IDEQ prior to the public comment period, subject to review during the public comment period, and enforceable upon the issuance of the initial permit. Also, any changes to the HRCP after the permit is issued and that are less stringent than the approved HRCP would need IDEQ approval and public review and be enforceable at all times after the revised permit is issued. There does not appear to be a reason that the HRCP can't be developed and incorporated into the permit now.

DEQ Response:

The HRCP is a T-RACT control for arsenic. DEQ has added additional minimum requirements for the HRCP (Permit Condition 3.13) and has updated Permit Condition 2.21 to include DEQ approval both initially (before startup) and after any subsequent changes.

17 All state- and federally- applicable requirements are incorporated into the Tier I permit as required by 40 CFR 63 Subpart EEEEEEE, including all PTC requirements and all NESHAP and NSPS requirements. Copies of all permit-required compliance documents, including but not limited to the FDCP, O&M, AMP, and HRCP are required to be included in the permit application and thus included in the docket for review during each Tier I public comment period (Tier I Application Completeness Checklist). As such, any plan updates will be subject to public review during each Tier I permit renewal comment period once every five years. Additionally, DEQ plans to post the FDCP, O&M, AMP, and HRCP on DEQ's website with the final permit and statement of basis when completed. Once DEQ approves these plans they will also be available for public records request. In addition, all approved plans and manuals are incorporated by reference in the permit and are enforceable as part of the permit.

Comment 18 - ICL/SSFS: Fugitive Dust Control Plan

The Fugitive Dust Control Plan (FDCP) continues to be an area of significant concern for us. IDEQ has required the applicant to complete this plan as a condition of this permit. However, despite the FDCP clearly being a crux of the applicant's air quality compliance, the public will not have the opportunity to review and comment on this plan. We once again formally request the opportunity to do so. Furthermore, the permit specifies that the FDCP shall be submitted within 60 days of permit issuance. In this case, the permit would be approved without IDEQ or the public knowing specifically how the applicant will attain this aggressive standard of dust control. For instance, we have no indication of how the applicant will suppress fugitive emissions sources other than roads.

Given that the specifics of the FDCP are crucial to ascertaining exactly how the applicant will achieve the lofty 93.3% dust control efficiency required to achieve compliance, and how enforceable the limits are, this permit should not be approved until a FDCP is submitted to IDEQ, reviewed by both IDEQ, EPA, and the public, and approved or denied pending modifications. A review of the FDCP prior to permit issuance is necessary to ensure compliance with air quality standards. If approved, the salient points of FDCP should be incorporated in the permit as clearly enforceable limits. This permit cannot be issued without enforceable provisions and limits to ensure that the high bar of fugitive dust control will actually be attained at the Stibnite Gold Project.

IDEQ should:

- Allow for public review and comment on the Fugitive Dust Control Plan *before* it is finalized.
- Incorporate clear, enforceable limits for fugitive dust control into this permit *before* any potential approval.

DEQ Response:

18 Based on public comment, Permit Condition 2.8 has been updated to include DEQ approval both initially (before startup) and after any subsequent changes and that the plan shall be submitted 30 days prior to startup. For the Fugitive Dust Control Plan (FDCP), the minimum and substantive requirements were specified in the permit and available for public review (Permit Conditions 2.1-2.6). DEQ contends that these and other relevant conditions are sufficient, reasonable, and appropriate to ensure compliance with applicable requirements including National Ambient Air Quality Standards (NAAQS).

All state- and federally- applicable requirements are incorporated into the Tier I permit as required by 40 CFR 63 Subpart EEEEEEE, including all PTC requirements and all NESHAP and NSPS requirements. Copies of all permit-required compliance documents, including but not limited to the FDCP, O&M, AMP, and HRCP are required to be included in the permit application and thus included in the docket for review during each Tier I public comment period (Tier I Application Completeness Checklist). As such, any plan updates will be subject to public review during each Tier I permit renewal comment period once every five years. Additionally, DEQ plans to post the FDCP, O&M, AMP, and HRCP on DEQ's website with the final permit and statement of basis when completed. Once DEQ approves these plans they will also be available for public records request.

POTENTIAL TO EMIT AND EMISSION FACTORS

Comment 19 - NPT: Representativeness of the emission factors

The applicability determination depends on the emissions inventory (EI). The EI depends on the proposed processes and the EFs used to characterized these activities. There are instances where we are concerned that inappropriate EFs have been used. The EFs for the ore processing come from AP 42 chapter 11.19 Crushed Stone Processing and Pulverized Mineral Processing. The AP-42 chapter 11.24 Metallic Minerals Processing might be a better representation for the OC1- OC13. In all cases, the most conservative EFs should be used.

When an EF has a control efficiency built into it, the permit should specify conditions to assure equipment will employ the same controls to assure the representativeness of the EF. Permit conditions do not clearly specify this.

DEQ Response:

As discussed previously in the Representativeness and Uncertainty of Emissions section, although some degree of uncertainty is present in all emission factors used in estimating emissions, all emission factors were adequately supported and the approach of estimating potential to emit (PTE) at design capacity was considered a conservative approach. Emission factors with control efficiencies built into them were adequately supported by that corresponding control device listed in the permit. The facility's emission inventory includes crushers, screens, and conveyors controlled by water sprays. EPA's AP-42 11.19.2 (08/2004) provides representative emission factors for these specific processes and controls.

Comment 20 - NPT: Emissions estimate values are not sufficiently conservative

DEQ should use conservative values for all emission estimates. For any emission factor (EF) requiring an average value, the most conservative average value should be used to protect human health. Examples include the silt content for used in EF for Haul Road fugitives and the metal concentrations in the ore for HAP/TAP. The median is only a statistical number. The arithmetic mean is most commonly considered the average.

In the Statement of Basis it states, "It is noted that PRI projected actual annual production at approximately 42.7 million T/yr, or 65% of the permitted annual production limit of 65.7 million T/yr (Permit Condition 3.5), and that as a result actual emissions are expected to be lower than presented." The 65.7 MT/y value comes from 180,000 T/day for 365 days, however, permit condition 3.5 also has a 135,000 T/day limit based on a 5-year rolling average. Thus the actual permit limit is 49.3 MT/y (135,000 T/day x 365 day/y). Therefore, the projected actual annual production is closer to 87% (42.7/49.3) of the permitted annual production limit. The permit is less protective than DEQ has presented.

DEQ Response:

As described previously in the Representativeness and Uncertainty of Emissions section, the use of site-specific median values for silt content is commonly accepted by DEQ, and the values used in calculations were supported by PRI. Although a median value of sampled silt percentages of roadway material was used in emission estimates presented in the application, DEQ recognizes the importance of the silt content parameter in the estimation of emissions. Since compliance with the 24-hour PM_{10} NAAQS is the primary driver of NAAQS compliance, minimizing variability of the parameter is very important to ensure NAAQS compliance. To achieve this, the permit will limit *maximum silt content* to 4.0 %, as specified in Permit Condition 3.13 Haul Road Capping of the PTC as well as associated monitoring and recordkeeping.

The hauling and excavating limit of 135,000 T/day of ore and DR (Permit Condition 3.5) on a 5-year rolling average was added as a T-RACT level of control. This is not a daily limit but a 5-year limit expressed as a daily average rate. This limit actually lowers the production limit of the facility on a 5 year rolling basis and is potentially a more restrictive limit than 180,000 T/day for long-term impacts.

Comment 21 - EPA: Limiting PTE for PSD, Title V (including HAP) and NAAQS Purposes

Many of the emission limits in the permit are derived from emissions factors. Similarly, the permit assumes control efficiencies for certain emission sources. However, the permit lacks conditions incorporating the numerous assumptions and parameters associated with the emissions factors and control efficiencies. Emission factors include numerous operating assumptions and variables regarding the source. Accordingly, the permit should contain conditions to ensure the operating assumptions and variables underlying the emission factor accurately reflect site-specific conditions and are enforceable.[4] Similarly, when permits require add-on controls operated at a specified efficiency level, permit writers should include, so that the operating efficiency condition is enforceable as a practical matter, those operating parameters and assumptions which the permitting agency depended upon to determine that the control equipment would have a given efficiency.[5]

The permit record does not demonstrate that the emission factors used to estimate the source's PTE and derive the emission limits are technically accurate. Emission factors used to derive a PTE limitation must be technically accurate.[6] In general, AP-42 emissions factors are based on averages and are not intended for establishing source-specific limits.[7] When using AP-42 emissions factors to establish limits on PTE, EPA recommends using these emissions factors only when source specific emissions factors are not available and selecting conservatively higher emissions factors.[8]

EPA states in AP-42, "Before simply applying AP-42 emission factors to predict emissions from new or proposed sources, or to make other source-specific emission assessments, the user should review the latest literature and technology to be aware of circumstances that might cause such sources to exhibit emission characteristics different from those of other, typical existing sources. Care should be taken to assure that the subject source type and design, controls, and raw material input are those of the source(s) analyzed to produce the emission factor. This fact should be considered, as well as the age of the information and the user's knowledge of technology advances."[9]

When permits contain emissions, production or operational PTE limitations, they should also have monitoring, recordkeeping, and reporting requirements that allow a permitting agency to verify a source's compliance with its limits.[10] The permit should provide for the collecting, maintaining, and reporting of information necessary to determine emissions of each pollutant as well as compliance with operating parameters. [11] The permit must include conditions that clearly specify the monitoring requirements and how the permittee must demonstrate compliance via the monitoring requirements. [12]

DEQ Response:

19 As discussed previously in the Representativeness and Uncertainty of Emissions section, maximum hourly and daily activity rates were used to estimate the maximum 24hour and annual emission rates, and fugitive dust control requirements, emission rate limits, material activity rate limits, and supporting testing and monitoring, recordkeeping, and reporting (MRR) requirements were established as synthetic minor limits for the purposes of limiting facility-wide emissions of $PM/PM_{10}/PM_{2.5}$ to below 250 T/yr PSD applicability thresholds and Title V 100 T/yr applicability thresholds. These limits were also established for the purposes of limiting facility-wide emissions of single and total HAP to below HAP major source applicability thresholds (10/25 T/yr), and to ensure compliance with all NAAQS. Limits were established consistent with current DEQ guidance and the estimates of emissions and underlying assumptions were supported to the satisfaction of DEQ.
20

Enforceable monitoring, recordkeeping, and reporting requirements were established in the permit. $PM/PM_{10}/PM_{2.5}$ emissions limits for point sources were established with supporting activity rate limits and MRR requirements. While emissions limits and emission factors are not commonly included in the permit for fugitive sources, activity rate limits and MRR requirements were established for those sources that were identified as process rate-limiting (as summarized in Table 1.1 of the permit). These activity rate limits serve as surrogate emissions limits for PM, PM_{10}, $PM_{2.5}$, HAP and TAP from fugitive sources. And while documented in the Statement of Basis and application materials, underlying parameters associated with calculating emissions such as vehicle speed limit, type, and miles traveled are not typically included in the permit.

Comment 22 - EPA: Limiting PTE of the Mining Fugitive Dust Emissions for NAAQS and Title V HAP Purposes

21. As noted in Comment #15 and #16, the mining excavation PTE limitation of 180,000 tpd may not be technically accurate because it is not based on emission factors that are representative of mining emission sources. For example, AP-42 Section 11.9 Western Surface Coal Mining Section includes emission factors applicable to mining excavation operations. However, the application appears to use AP-42 emissions factors from Section 11.19.2 Crushed Stone Processing for truck loading and unloading of crushed stone.

DEQ Response:

As described previously in the Representativeness and Uncertainty of Emissions section, although some degree of uncertainty is present in all emission factors used in estimating emissions, all emission factors were adequately supported and the approach of estimating potential to emit (PTE) at design capacity was considered a conservative approach. Emission factors with control efficiencies built into them were adequately supported by that corresponding control device listed in the permit. The facility's emission inventory includes crushers, screens, and conveyors controlled by water sprays. EPA's AP-42 11.19.2 (08/2004) provides representative emission factors for these specific processes and controls.

Comment 23 - EPA: Limiting PTE for the Ore Processing and Lime Plant Operations for PSD, Title V (including HAP), and NAAQS Purposes

The Permit does not appear to specify technically accurate emission limitations and the portions of the source subject to the limitation because: (i) the permit may not adequately require compliance with all PTE emission limits for each emission source or include PTE emissions limits representing all emissions sources, (ii) the permit record may not adequately demonstrate that the emission limits are based on accurate emissions factors, and (iii) the permit may not contain monitoring, recordkeeping, and reporting conditions sufficient to ensure compliance with all emission limits and associated controls.

Examples of these specific issues with respect to the Ore Processing and Lime Plant Operations include, but may not be limited to, the following:

Ore Processing PTE Limitations:

1. A PTE limitation appears to be needed to restrict the amount of ore material storage piles consistent with the emission estimates in the permit application.

2. Per Table 1.1, the 80% control efficiency applicable to the associated ore storage piles, and source ID. No. OC9, OC10 and OC11 is not included.

3. Per the application Ore Processing Diagram (Figure 1), the 108 ton per day (tpd) process rate associated with the Sb Drying and Bagging, the 7.5 tpd process rate associated with the Carbon Regeneration, and the 6,980 tpd rate associated with the Autoclave are not included.

PET 574

REC 0940

4. Per the application Ore Processing Diagram (Figure 1), emission sources Sb1 and Sb2 are not included in Table 1.1 or specified in the permit conditions.

Ore Processing PTE Emission Factors:

5. Some of the PTE limitations may not be technically accurate because they are not based on emission factors that are representative of the emission sources. For example, AP-42 Section 11.24 Metallic Minerals Processing emission factors applies to the processing of hard ores including gold. However, the application uses AP-42 emissions factors from Section 11.19.2 Crushed Stone Processing that is applicable to non-metallic mineral processing. The permitting record does not provide a reasoned explanation as to why emission factors from Section 11.24 were selected over those from Section 11.19.2.

DEQ Response:

The ore materials are limited by the primary crusher limit and pebble crusher limit (Permit Conditions 3.7 and 3.8) for storage pile feed.

Source ID. Nos. OC9, OC10, and OC11 list control equipment in Table 1.1 as reasonable control and FDCP. An 80% control efficiency is achieved through implementation of the FDCP (Permit Condition 2.6), below-grade of storage piles, and enclosure of the conveyor (Permit Condition 3.2).

Tables 1.1 and 4.1 were updated in the permit to remove the antimony process dryer and bagging operation (sources Sb1 and Sb2) as requested by PRI, and consistent with proposed mercury control devices for the autoclave.

21 As discussed previously in the Representativeness and Uncertainty of Emissions section above, the estimates of emissions and underlying assumptions were supported to the satisfaction of DEQ, and sufficient information was provided to demonstrate preconstruction compliance with applicable TAP and mercury standards and to support facility classifications. The facility's emission inventory includes crushers, screens, and conveyors controlled by water sprays. EPA's AP-42 11.19.2 (08/2004) provides representative emission factors for these specific processes and controls.

22

Comment 24 - EPA: Lime Plant PTE Limitations

8. The following PTE limitations specified in Table 1.1 and the application do not appear to be included in the permit including: 267 tpd applicable to LK, LCR, and LS-L/U; 250 tpd applicable to LS1-L/U and MillS2-L/U; 1,000 tpd applicable to ACS1, ACS2, and ACS3; 500 tpd applicable to ACS4; and 70,000 tons per year applicable to LSI-L/U, MillS2-L/U, ACS1-L/U, ACS2-L/U, AC3-L/U and ACS4-L/U.

9. The PTE limitation of 1,130 tpd of limestone in permit condition 5.4 may not be technically accurate as it does not appear to account for all of the emissions sources comprising the lime plant subject to PSD and Title V permitting limits of a 100 tons per year. For example, the limestone mining activities (e.g., drilling, blasting, excavating, hauling, and storage piles) and all of the lime plant processing emission units and activities shown in the application's Figure 2 do not appear to be included in the emissions estimates. These emission units presented in Figure 2 include the dump truck unloading, stationary grizzly, rock breaker, primary crusher feed hopper, vibrating grizzly feeder, and the emission units and activities following the limestone ball mill and lime slaker (e.g., Milk of Lime Distribution Tank). Emissions from those aspects of the limestone handling and processing that would not happen if the lime plant did not exist must be accounted for as support activities to the lime plant. Furthermore, if the mining of limestone (including overburden removal) would not be done if the lime plant did not exist, emissions from those activities must also be included with the lime plant emission inventory. For example, IDEQ's SOB and Perpetua's letter dated September 23, 2021, indicates that the limestone is overburden excavated from the Middle Marble Geologic Unit (MMGU) located in the northwest portion of the West End Pit and that the overburden must be removed to access the gold ore. However, Midas Gold documents from 2016 and 2020 indicate, contrary to this information, that the MMGU is located in the northeast portion of the West End Pit, is located

beneath a 30 ft- to 250 ft-thick quartzite unit and requires the addition of a haul road to transport limestone to the lime plant processing facility. Because the limestone deposits are buried 30 to 250 feet below the surface, as noted above, it appears more than 1,130 tpd of material would need to be excavated to access the limestone deposit.

10. IDEQ's PSD applicability analysis in the Statement of Basis (SOB) does not appear to include all of these emission sources or provide the necessary information to support their Lime Plant PSD emission estimates.

DEQ Response:

Lime production limits for LK, LCR, and LS-L/U are limited by the Parallel Flow Regenerative Kiln output limit in Permit Condition 5.5. As can been seen in the Lime Production Flow Diagram in the application, 267 tpd is the maximum capacity and input to the Kiln. DEQ chose to limit the output of the Kiln as seen in Permit Condition 5.5 (169 T/day). The mill and autoclave lime silos (LS1, MillS2, and ACS1-4) are limited by the control requirements in Permit Condition 5.16 and the lime usage, which is inherently limited by the gold ore processing limits in Permit Conditions 3.7 and 3.8 for the mill and Permit Condition 4.8 for the autoclave. All above equipment has emission limits specified in Permit Condition 5.3 (Table 5.2). As a result of the comments received, although the lime silos (LS1-L/U, MillS2-L/U, ACS1 – ACS4) are permitted at maximum capacity, DEQ has added a permit condition to limit the lime silos to 4,000 T/day and 70,000 T/yr combined (new Permit Condition 5.9) with corresponding monitoring and recordkeeping (new Permit Condition 5.22).

23 A response to a request for additional information was submitted by PRI[3] in which the emissions units comprising the lime plant were identified. The project includes a lime manufacturing plant (LMP) that uses a Parallel Flow Regenerative Shaft Kiln to produce lime product from limestone by calcination, which is a designated facility as defined in 40 CFR 52.21(b)(1)(i)(*a*). As described in the "Facility Classification" and "PSD Classification" section of the Statement of Basis, permitted facilitywide emissions (PTE) were less than 100 tons per year (T/yr) for regulated pollutants. For each regulated pollutant, LMP emissions did not exceed 100 T/yr, and facility-wide emissions did not exceed 250 T/yr applicability thresholds. For the purposes of classification, the LMP was true minor for all NSR pollutants. Per EPA's March 6, 2003, guidance, both fugitive and non-fugitive emissions from the LMP must be counted toward a determination of a major stationary source. Total emissions are below 100 tons per year for each pollutant (Table 10 in the Statement of Basis). However, even if fugitive emissions from the upstream stone crushing and milling equipment and marble overburden mining were included, emissions would still not exceed 100 tons per year (Table 11 in the Statement of Basis).
24
Restrictions on PTE from fugitive and non-fugitive sources and supporting monitoring, recordkeeping, and reporting were established in the permit, including control of fugitive dust (Permit Conditions 2.1–2.6), emissions limits (Permit Condition 5.3), a PFR Kiln output limit (Permit Conditions 5.5 and 5.17), and control device requirements (Permit Conditions 5.11-5.12, 5.14-5.15, and 5.21-5.22). Emissions are not permitted to exceed these limits during startup, shutdown, and malfunction. Any emissions that exceed emissions limits are required to be reported in accordance with excess emissions requirements (Permit Condition 7.11). While emissions limits and emission factors are not commonly included in the permit for fugitive sources, activity rate limits and MRR requirements were established for those sources that were identified as process rate-limiting (as summarized in Table 1.1 of the permit). These activity rate limits serve as surrogate emissions limits for PM, PM_{10}, $PM_{2.5}$, HAP and TAP from LMP fugitive sources.

Comment 25 - EPA: Lime Plant PTE Emission Factors

11. IDEQ's SOB Table 10 PSD emission estimates may not be technically accurate because they do not appear to be based on emission factors that are representative of the emission sources. For example, AP-42 Section 11.17 Lime Manufacturing emission factors applies to the processing of lime derived from marble. However, the application uses AP-42 emissions factors from Section 11.19.2 Crushed Stone Processing. In addition, the limestone excavating emission estimates (Material Load & Unload) appear to use emission factors from Section

11.19.2 Crushed Stone Processing instead of Section 11.9 Western Surface Coal Mining emission factors that are representative and specific to mining excavation activities. The permitting record does not explain why emission factors from 11.19.2 were selected over those from 11.17 and 11.9. If IDEQ does not have a good technical reason for their selection of emission factors, consistent with comment #5, the most conservative emission factor should be used for emission units that make verification difficult. Comment 19 would also apply to fugitive dust emissions resulting from limestone mining sources including limestone drilling, blasting, excavating, and haul road activities.

DEQ Response:

As described previously in the Representativeness and Uncertainty of Emissions section, although some degree of uncertainty is present in all emission factors used in estimating emissions, all emission factors were adequately supported and the approach of estimating potential to emit (PTE) at design capacity was considered a conservative approach. Emission factors with control efficiencies built into them were adequately supported by that corresponding control device listed in the permit. Representative emission factors from EPA's AP-42 Section 11.17, 11.19.2 and 11.9 were used to estimate emissions from the lime plant, lime plant support equipment, and marble overburden mining, respectively. The facility's emission inventory includes crushers, screens, and conveyors controlled by water sprays. EPA's AP-42 11.19.2 (08/2004) provides representative emission factors for these specific processes and controls.

Comment 26 - EPA: Other PTE Limitations

14. Central Mixer Loading (Source ID No. CM) controls are unspecified in Table 1.1 and the permit consistent with the emission estimates in the permitting record.

15. Engine PTE limitations specifying the capacity of 1,000 bkW for the three emergency generators (EDG1, EDG2, and EDG3) should be specified in the permit. Also, the monitoring and recordkeeping requirement specified in permit condition 6.3 should include all hours of operation, not just non-emergency operating hours, and specify the devices and methodologies by which the monitoring and recordkeeping will be achieved.

DEQ Response:

Central Mixer Loading (CM) controls are specified in Tables 1.1 and 5.1 as reasonable control and the FDCP. Controls can include water sprays, enclosures, hoods, curtains, shrouds, movable and telescoping chutes, and central dust collection systems. Permit Condition 5.3 lists the emission limits for CM and Permit Condition 5.10 states that emissions must be controlled in accordance with the FDCP.

The capacity of the three emergency generators (EDG1, EDG2, and EDG3) are specified in Table 1.1. The emergency generators are subject to NSPS 40 CFR 60, Subpart IIII and those requirements are incorporated by reference (Permit Condition 2.22) and specific applicable requirements have been added to the permit including monitoring and recordkeeping to include all hours of operation (Permit Conditions 6.2, 6.4, and 6.5).

Comment 27 - ICL/SSFS: Conservatism

We have continued concern with IDEQ's position on conservative analyses and uncertainty in emissions calculations. IDEQ's response to previous critiques of emission calculations states:

> "… (the) approach of estimating potential emissions (PTE) at design capacity and maximum activity rates was considered a sufficiently conservative approach. Maximum hourly and daily activity rates were used to estimate the maximum 24-hour and annual emission rates, and emissions were modeled based on these maximum short-term activity rates occurring continuously every day."

IDEQ is conflating the "conservative" strategy long inherent in the PTC process with the conservative analyses required in estimating the potential to emit (PTE). Even if IDEQ uses a "conservative" strategy, the agency is still using non-conservative model input parameters for the emissions calculations. PTCs have been based on design PTE calculated using "maximum 24-hour and annual emission rates, and emissions modeled based on these maximum short-term activity rates occurring continuously every day" since the inception of the Clean Air Act (CAA). Comparing these required conservative rates to the Applicant's "good intentions" to operate below design capacity is not a conservative approach. The CAA has long recognized that any facility may change management, exploit additional resources, accept feedstock from adjacent properties, or numerous other production scenarios that could utilize design capacity.

IDEQ's *Guidelines for Performing Ambient Impact Analyses* states:

> "To demonstrate compliance, potential emissions must be used in the modeling analyses rather than future projected actual emissions. The maximum emission rate for each averaging period must be identified. For example, PM2.5 has both a 24 hour and annual standard. If a source will only operate 7000 hours per year, but can operate for 24 hours in a single 24 hour period, then different emission rates would be modeled for the 24 hour and annual standard" (Section 6.4.1).

The analyses for impacts for pollutants with averaging periods less than annual are not using maximum potential emissions over those short-term averaging periods. Annual emission impact analyses were also based upon an estimate of the five-year average of projected actual emissions. In assuring the appropriate level of health protectiveness, the permit process is, and has always been, designed to assure compliance at design capacity.

With respect to the use of AP-42 Emission Factors in calculating the PTE, IDEQ regulations require that "screening engineering analyses use unrefined conservative data." (6-30-95). Moreover, IDEQ guidance ranks the use of AP-42 as a last choice, with the least reliable data, and the greatest potential to underestimate emissions.[1] Accordingly, it is incumbent on IDEQ to require use of conservative emission factors. Accepting promises that intended operations will not exploit the full design capacity of the facility is not a substitute for utilizing conservative emissions factors in calculating PTE emissions.

DEQ Response:

25 As discussed previously in the Representativeness and Uncertainty of Emissions section, maximum hourly and daily activity rates were used to estimate the maximum 24hour and annual emission rates, and fugitive dust control requirements, emission rate limits, material activity rate limits, and supporting testing and monitoring, recordkeeping, and reporting (MRR) requirements were established as synthetic minor limits for the purposes of limiting facility-wide emissions of PM/PM_{10}/$PM_{2.5}$ to below 250 T/yr PSD applicability thresholds and Title V 100 T/yr applicability thresholds. These limits were also established for the purposes of limiting facility-wide emissions of single and total HAP to below HAP major source applicability thresholds (10/25 T/yr), and to ensure compliance with all NAAQS. Limits were established consistent with current DEQ guidance and the estimates of emissions and underlying assumptions were supported to the satisfaction of DEQ.

26 Enforceable monitoring, recordkeeping, and reporting requirements were established in the permit. PM/PM_{10}/$PM_{2.5}$ emissions limits for point sources were established with supporting activity rate limits and MRR requirements. While emissions limits and emission factors are not commonly included in the permit for fugitive sources, activity rate limits and MRR requirements were established for those sources that were identified as process rate-limiting (as summarized in Table 1.1 of the permit). These activity rate limits serve as surrogate emissions limits for PM, PM_{10}, $PM_{2.5}$, HAP and TAP from fugitive sources. And while documented in the Statement of Basis and application materials, underlying parameters associated with calculating emissions such as vehicle speed limit, type, and miles traveled are not typically included in the permit.

The regulatory bar for permit issuance is that the applicant, through analyses submitted in the application, demonstrate to the satisfaction of the Department that the proposed facility or modification not cause or

significantly contribute to a violation of a NAAQS or TAP increment (as per *Idaho Air Rules* Section 203). Air pollutant impact analyses performed for mining operations typically involve considerable uncertainty and variability in emission-affecting parameters and in dispersion-affecting parameters to estimate potential impacts to ambient air for specific averaging periods.

Uncertainty can be reduced by obtaining more application-specific information on the operation or parameter in question. Use of site-specific or project-specific information/data to better estimate emissions and dispersion-affecting parameters represents refining the analyses rather than use of non-conservative methods. A non-conservative approach would involve using the lower-emitting value of a listed range without justification. Variability cannot be reduced by more refined approaches. Variability can be accounted for by either: 1) using a worst-case approach of assuming the upper values (resulting in highest emissions) of the parameter persist at all times; 2) use of a more probabilistic approach to consider the variability either in a quantitative statistical approach or in a more qualitative "weight of evidence" approach. A weight of evidence approach is implemented where the use of clearly conservative values for all methods and data would result in an unrealistically high impact, thereby misrepresenting potential impacts and potentially triggering inappropriate monitoring and record-keeping requirements.

The comment also states that a 5-year average allowable emission rate was used for demonstrating compliance with the arsenic carcinogenic AACC, which is expressed as an annual average value. However, the definition of *Toxic Air Pollutant Carcinogenic Increments* in *Idaho Air Rules* Section 005.125, states, "Those ambient air quality increments based on the probability of developing excess cancers over a seventy (70) year lifetime exposure to one (1) microgram per cubic meter (1 $\mu g/m^3$) of a given carcinogen and expressed in terms of a screening emission level or an acceptable ambient concentration for a carcinogenic toxic air pollutant." Since the AACCs are based on a 70-year exposure, use of a 5-year averaging period is appropriate.

Comment 28 - ICL/SSFS: Facility Classification

In the Statement of Basis (SOB), IDEQ classified this facility as a synthetic minor source (SM) for PM, PM10, and PM2.5 and Class B for Hazardous Air Pollutants (HAPs). A number of comments by ICL, SSFS, and other reviewers address instances where we believe that HAP emissions continue to be underestimated. Once IDEQ completes the appropriate analyses and calculations to verify the PM and HAP emissions, the agency should assess whether the source still meets the requirements of a synthetic minor.

The Applicant and IDEQ calculations show that this facility will also emit >30,000 tons per year (TPY) of uncontrolled PM (removing the 90% control on hauling fugitive emissions + the emissions total for uncontrolled point sources) and 3,655 TPY of permitted PM point source + fugitive emissions (Table 3, SOB). However, IDEQ contends the Major Source classification of 100 TPY is not met despite the apparent 36-fold exceedance. IDEQ continues to ignore 3,569 TPY of permitted PTE PM fugitive emissions from mining operations (97.6% of total controlled PM by the Applicant's calculation) and 986 TPY of associated PM10 fugitive emissions. This clear exclusion of significant emissions from regulatory constraints is a major concern for us. Furthermore, this determination avoids the federal oversight that this permit would be afforded if classified properly as a Major Source.

To avoid including the fugitive emissions sources, IDEQ apparently relies on IDAPA 58.01.01.220.01:

> *For purposes of Sections 220 through 223, fugitive emissions shall not be considered in determining whether a source meets the applicable exemption criteria unless required by federal law.*

Accepting the Applicant's and IDEQ assertions, the current classification determination for this facility as a synthetic minor source is based on merely 2.4% of the total PM emissions. If only 13.6 TPY (0.4%) of the excluded PM fugitive emissions were included in the source classification determination, the facility would be a Class A Major Source, subject to federal review.

In the interest of health and environmental responsibility, it is imperative that the IDEQ consider all emissions including mining fugitive impacts and classify this a Major Category A Source. The only comparable facilities operating in the U.S. at this time, in Nevada, are Class 1 Major Sources according to the same criteria as Idaho's designation, even though most of the Nevada facilities do not include onsite gold ore processing. Idahoans should be afforded the same level of air quality protection as Nevadans.

Even by IDEQ exclusion criteria, some of the ignored sources asserted to be "mining fugitives" should be considered as mineral processing activity emissions controlled with and attendant to specific point sources included in the source classification determination. Significant percentages of mine ores are trucked to stockpiles and placed in storage to be processed months or years later. Alleged mine fugitive emissions also include significant on-site hauling associated with the Portable Crusher and Screening Plant. Some of this hauling is related to the lime plant and gold ore refinery operations, which are specifically listed by federal rules as requiring inclusion of fugitive emission in determining source classification.

Subchapter C Part 70.3(d). Fugitive emissions from a part 70 source shall be included in the permit application and the part 70 permit in the same manner as stack emissions, regardless of whether the source category in question is included in the list of sources contained in the definition of major source.

This rule should be interpreted that if any portion of the emissions is due to a listed source, then all emissions from that source should be included in the source classification determination.

These alleged "excluded mine fugitive" sources alone (not including On-site Hauling) exceed 270 TPY PM. If only 5% of these activities were considered attendant to listed sources or mineral processing and stockpile point source operations (as opposed to mining) then the Major A Source Category threshold would be met. Unfortunately, it is not possible for us or other reviewers to quantify these sources from the available emission inventories. Fugitive emissions were reportedly estimated for a dozen different operational scenarios. However, Table 7 of the SOB and the example calculations provided use scenario W-3, because it is the maximum total PM emissions. This scenario is heavily weighted toward exploitation of the West End Pits, and provides little information to assess the potential emissions associated with those sources that might not be exempt on closer examination.

Examination of the W3 scenario also shows that the 2,901 TPY of PM estimated for On-Site Hauling is 100% attributed to hauling emissions from the West End Pit to the Hangar Flat DRSF. This is the main process stream for limestone feeding the lime plant, gold oxidation circuit, neutralization of waste streams, etc. This scenario also attributes zero hauling emissions from stockpiles to crushers. It is not possible to ascertain from these data how much of the fugitive emissions are attendant to these listed sources or are attendant to mineral processing point sources. However, the W3 scenario does not encompass other haul routes that will be used as part of the mining operation; therefore, the total PM emissions attributed to hauling would be expected to be greater than 2,901 TPY.

These observations suggest that IDEQ's reliance on operational scenarios designed to support modeling analyses to assess fugitive exclusion from Source Classification has allowed listed and point source attendant emissions to be misclassified as excluded mining fugitives. Misclassification of only a tiny percentage of the massive excluded emissions prevents Major Source determination and federal review of key portions of this PTC. The ambient impact analysis must consider the potential impacts of any operational scenario allowable under the federal approval process and the IDEQ permit.

Lastly, the classification of the facility as a synthetic minor source for criteria pollutants and HAPs is hugely dependent upon the facility consistently attaining the target 93.3% fugitive dust control effectiveness. A facility that does not have legally enforceable conditions to ensure those fugitive dust controls, which IDEQ states will be challenging to show continual compliance with, should be considered a major source. Enforceability is extremely important because without enforceable limits, the source otherwise has the potential to emit criteria pollutants in amounts that are at or above the threshold for a major source.

IDEQ should:

- Carefully review these fugitive emission claims with regard to the exclusion criteria, and publicly disclose the review.
- Update the source classification determination for this facility based on these comments.
- Ensure total consistency between project processes and activities approved in the air permit with those that would be approved in the federal approval process.

DEQ Response:

In accordance with IDAPA 58.01.01.006. a stationary source is defined as any building, structure, facility, emissions unit, or installation which emits or may emit any air pollutant. The fugitive emissions shall not be considered in determining whether a permit is required unless required by federal law. For New Sources Review permitting purposes, the fugitive emissions shall not be considered in determining whether the facility is major unless the facility is a designated facility per IDAPA 58.01.01.008.10.c.i. A gold mine is not a listed designated facility under IDAPA 58.01.01.006.30 and therefore fugitive emissions are not considered. Fugitive emissions of criteria pollutants are counted toward PSD classification from designated facilities such as the lime plant. Lime plant fugitive emissions are quantified under the PSD Classification section of the Statement of Basis.

For Title V permitting purposes arsenic is a HAP and arsenic fugitive emissions from haul roads do count towards the major source determination of 10 tons per year of any HAP and 25 tons per year for any combination of HAP. Accounting for water and chemical dust suppressant control efficiencies and use of the equations cited from AP-42 Section 13.2.2 (11/2006) for unpaved roads and site-specific silt values supports an arsenic HAP PTE from the haul roads of 30.3 tons per year (T/yr) for uncontrolled emissions (above 20 T/yr as described in the Statement of Basis) and 2.03 T/yr for controlled emissions. Despite the noted limitations of using AP-42, these equations remain commonly used and accepted by DEQ.

As discussed previously in the Representativeness and Uncertainty of Emissions section above, the estimates of emissions and underlying assumptions were supported to the satisfaction of DEQ, and sufficient information was provided to demonstrate preconstruction compliance with applicable TAP and mercury standards and to support facility classifications. Key assumptions identified in this section and by the commenter (including 93.3% control efficiency for haul roads) were confirmed by PRI and accepted by DEQ and were the basis of the facility classifications.

Comment 29 - ICL/SSFS: TAPs Mass Balance

We recommend that IDEQ develop a material balance for TAPs to inform and assist the agency in assessing the quality and uncertainty inherent in the data underlying the Applicant's assertions. Many other states specifically require a material balance for criteria pollutants, HAPs, and TAPs. IDEQ's response reiterates the same "conservative" claim:

"While a material balance is a useful approach to developing emission estimates, it is not a requirement, and the use of maximum activity rates and representative performance test data to estimate and model emissions is commonly accepted by DEQ. While the use of an average or maximum value is a more conservative approach, the use of site-specific median values combined with estimating and modeling PTE at design capacity and maximum activity rates was considered a sufficiently conservative approach."

IDEQ's own TAPs guidance, however, specifies the use of AP-42 and mass balance techniques:

"Determine if a new (constructed after June 30, 1995) emission unit has the potential to emit a TAP listed in IDAPA 58.01.01.585 (Rules Section 585) or IDAPA 58.0101.586 (Rules Section 586). Potential toxic air pollutants can be determined by reviewing commonly available emission factors, such as EPA's AP-42, or calculating emissions using a mass balance."

Mass balance analyses would be invaluable in enhancing regulators' and the public's ability to follow and review emission calculations, and designing appropriate operational limitations and controls for this PTC.

IDEQ should:

- Require a facility-wide mass balance for TAPs in subsequent submittals for this PTC.

DEQ Response:

As described previously in the Representativeness and Uncertainty of Emissions section, while a material balance is a useful approach to developing emission estimates, it is not a requirement, and the use of maximum activity rates and representative performance test data to estimate and model emissions is commonly accepted by DEQ. While the use of an average or maximum value is a more conservative approach, the use of sitespecific median values combined with estimating and modeling PTE at design capacity and maximum activity rates was considered a sufficiently conservative approach.

Comment 30 - ICL/SSFS: Arsenic Emissions

The proposed Stibnite Gold Project clearly presents hazardous concerns associated with toxic metal releases. Arsenic and mercury are of particular concern due to their high toxicity and importance in the metallurgical processes. This facility will potentially emit 170 to 360 TPY of arsenic. About 85-90% of the uncontrolled arsenic emissions are proposed to be contained or captured by proposed controls and approximately 13 to 38 TPY will be released to the atmosphere as fine particulate (controlled PTE). The PTC Application underestimates these emissions by a factor of 5.6 to 12 times by our calculations (see previous public comments on version 2 of this PTC), and asserts arsenic emissions of about 30 TPY PTE uncontrolled and 2.4 TPY controlled PTE. Most of this mischaracterization is associated with road dust suspended from the massive volume of heavy trucks moving thousands of loads of arsenical contaminated materials across the site. The Applicant apparently achieves this low estimate by using minimal emission factors and particulate arsenic content, and claiming an unprecedented capability to control 93.3% of the road dust through chemical suppressants and watering.

An in-depth review of the Emissions Inventory reveals there are several factors that have not been given appropriate treatment in developing the arsenic emissions totals. We incorporate our detailed prior comments on this matter by reference into this latest round of comments and continue to have significant concerns that the arsenic emissions from this facility are being grossly underestimated.

The underestimation of fugitive dust emissions from haul roads resulting from the use of non-conservative modeling parameters is exacerbated when one considers that there appear to be three largely unaccounted for processes that will increase the arsenic content of haul road related fugitive dust emissions over time: 1) haul truck spillage of ore or waste rock containing higher arsenic content than the surface aggregate, 2) an increase in silt-sized particles in the haul road surface layer due to traffic wear, and 3) the application of dust abatement water sourced from the East Fork South Fork of the Salmon River containing elevated levels of arsenic.

DEQ Response:

As discussed previously in the Representativeness and Uncertainty of Emissions section above, the estimates of emissions and underlying assumptions were supported to the satisfaction of DEQ, and sufficient information was provided to demonstrate preconstruction compliance with applicable TAP and mercury standards and to support facility classifications. Key assumptions identified in this section and by the commenter (including 93.3% control efficiency for haul roads) were confirmed by PRI and accepted by DEQ, and were the basis of the facility classifications. As discussed previously, enforceable testing and monitoring, recordkeeping, and reporting (MRR) requirements were also established and incorporated in the permit.

Comment 31 - NPT: Antimony hauling not sufficiently characterized

The mineral products from the proposed Stibnite Gold Project are gold and antimony, accounting for 1 and 99% by mass, respectively. In earlier versions of the PTC, the antimony concentrated was going to be dried and bagged, and then was proposed to be dewatered and packaged wet.

Page six of the Statement of Basis states, "The metal-recovery process from ore will include conventional crushing and grinding, followed by froth-flotation circuits that will generate separate gold-silver and antimony-silver concentrates. The antimony-silver concentrate will be shipped offsite for refining... ". In Footnote c) of Table 3 in the Statement of Basis; it states that "In the response to a request for additional information, PRI confirmed that antimony process dryer and bagging operation emission sources (Sbl and Sb2) initially proposed would be replaced by a dewatering/packaging circuit. As a result, these emission sources have been removed from the permit and post-project PTE." Please include documentation confirming there are no air emissions associated with removing the antimony-silver concentrate from the site and how hauling the antimony concentrate from the processing area to the property boundary is accurately accounted for in the emissions inventory for the permit. If no market for the antimony is found and the concentrate is either stockpiled, stored on-site, or hauled to the tailings storage facility, emissions from this concentrate should be reevaluated.

DEQ Response:

PRI has confirmed and as stated in the Statement of Basis, the antimony process dryer and bagging operation emission sources (Sb1 and Sb2) has been removed from the permit and project potential to emit. The hauling of antimony is accounted for in the emission inventory in ore concentrate haulage under the mining tab of the emission inventory spreadsheet (Appendix A in the Statement of Basis).

Comment 32 - TIFO: IDEQ response to previous comments

TIFO has reviewed all three revisions of the Draft Permit to Construct and associated documents and submitted comments on three previous occasions. The current version of IDEQs draft Response to Comments indicates that several of alternative data and calculations provided in earlier reviews were not demonstrated to be more accurate or appropriate than data provided by the Applicant, and accepted by IDEQ.

TIFO requests that the past comments be incorporated as supporting the additional critiques offered in this review, and be reconsidered by IDEQ with supplemental data and analyses presented below. Specifically, there is continued concern with IDEQs position on conservative analyses and uncertainty in emissions calculations.

IDEQ response to previous critiques of emission calculations states:

> … (the) approach of estimating potential emissions (PTE) at design capacity and maximum activity rates was considered a sufficiently conservative approach. Maximum hourly and daily activity rates were used to estimate the maximum 24-hour and annual emission rates, and emissions were modeled based on these maximum short-term activity rates occurring continuously every day.

IDEQ is conflating the “conservative” strategy long inherent in the PTC and Operating Permit process, with the conservative analyses required in the estimating PTE. Since the inception of the Clean Air Act (CAA), PTCs and Operational Permits have been based on design PTE calculated using “maximum 24-hour and annual emission rates, and emissions modeled based on these maximum short-term activity rates occurring continuously every day”.,. Comparing these required conservative rates to *good intentions to operate below design capacity alleged by the Applicant* is not a conservative approach. The CAA has long recognized that any facility may change management, exploit additional resources, accept feedstock from adjacent properties, or create numerous other production scenarios that could subsequently utilize design capacity. In assuring the appropriate level of health protectiveness, the Permit process is, and has always been, designed to assure compliance at design capacity.

With respect, specifically, to the use of AP-42 Emission Factors in calculating the PTE, IDEQ regulations, <u>specifically</u>, requires:

> “Screening engineering analyses use <u>unrefined conservative data</u>. (6-30-95).

With respect to uncertainty and reliability, IDEQ guidance ranks the use of AP-42 as a last choice, with the least reliable data, and the greatest potential to underestimate emissions. (https://www2.deq.idaho.gov/admin/LEIA/api/document/download/5521

As a result, it is incumbent on IDEQ to require use of conservative Emission Factors. Accepting promises that intended operations will not exploit the full design capacity of the facility is not a substitute for utilizing conservative EFs in calculating PTE emissions.

On a similar note, TIFO has advised IDEQ that development of a material balance for toxic air pollutants is good engineering practice and could inform and assist the Agency in assessing the quality and uncertainty inherent in the data underlying the Applicant's assertions; and that many State's specifically require a material balance for criteria pollutants, HAPs, and TAPs. IDEQ's response reiterates the same "conservative" claim:

> While a material balance is a useful approach to developing emission estimates, it is not a requirement, and the use of maximum activity rates and representative performance test data to estimate and model emissions is commonly accepted by DEQ. While the use of an average or maximum value is a more conservative approach, the use of site-specific median values combined with estimating and modeling PTE at design capacity and maximum activity rates was considered a sufficiently conservative approach.

IDEQs own TAPS guidance, however, specifies the use of AP-42 and mass balance techniques:

> Determine if a new (constructed after June 30, 1995) emission unit has the potential to emit a TAP listed in IDAPA 58.01.01.585 (Rules Section 585) or IDAPA 58.0101.586 (Rules Section 586). Potential toxic air pollutants can be determined by reviewing commonly available emission factors, such as EPA's AP-42, or calculating emissions using a mass balance.

Mass balance analyses would be invaluable in designing appropriate operational limitations and controls in a T-RACT application. IDEQ should require a facility-wide mass balance for TAPs in revised or new submittals for this PTC.

DEQ Response:

As described previously in the Representativeness and Uncertainty of Emissions section, while a material balance is a useful approach to developing emission estimates, it is not a requirement, and the use of maximum activity rates and representative performance test data to estimate and model emissions is commonly accepted by DEQ. Use of a mass balance is one method that can be used to assess emissions. Perpetua elected to use other methods based on emission factors. DEQ has reviewed those methods and has found them to be reasonably accurate or conservative. A potential problem with some mass balance approaches can be observed in the accuracy of calculating a very small value by examining the difference between two large values. Because the uncertainty in the beginning inputs is greater than the final value, confidence in the final value is very low.

Similarly, use of maximum values of emission-affecting parameters is recommended for permitting analyses, especially when considering compliance with short-term standards (24-hour PM_{10} and 24-hour $PM_{2.5}$). Where compliance cannot be demonstrated when using upper limit values of parameters, DEQ may allow values representative of an average or median value. This is contingent on other aspects of the air impact analyses (emission-affecting parameters and pollutant dispersion-affecting parameters) providing an overall weight of evidence that NAAQS compliance confidence is high enough to support permit issuance, as required by *Idaho Air Rules* section 203. Although a median value of sampled silt percentages of roadway material was used in emission estimates presented in the application, DEQ recognizes the importance of the silt content parameter in the estimation of emissions. Since compliance with the 24-hour PM_{10} NAAQS is the primary driver of NAAQS compliance, minimizing variability of the parameter is very important to

ensure NAAQS compliance. To achieve this, the permit will limit *maximum silt content* to 4.0 %, as specified in Section 3.13 Haul Road Capping of the PTC.

Also, despite the noted limitations of AP-42, these emission factors remain commonly used and accepted by DEQ in the absence of site-specific data, manufacturer emissions guarantee, or continuous emissions monitoring data.

Comment 33 - TIFO: General comments and discussion

The following analyses are the fourth round of public comments offered on three revisions of the proposed PTC and Draft Permit for the SGP. Some progress has been achieved in securing health and environmental protectiveness through this repetitive review process. However, despite the Agency's persistent attempts to obtain objective and transparent submittals from the Applicant, this patchwork approach to upgrade an inherently deficient application is eroding public trust in the process to provide for health and environmental protectiveness.

The proposed Midas Gold / Perpetua Resources Idaho (PRI) mining operations clearly offer hazardous concerns associated with toxic metal releases. Arsenic and mercury are of particular concern due to the high toxicity and importance in the metallurgical processes. The principal refractory gold ores proposed for exploitation are auro-arsenical deposits yielding an estimated 230 to >1000 pounds of waste arsenic for each ounce of gold captured. Approximately 493,000 (mean) to 2,190,000 tons (95^{th} %-tile) of arsenic will be excavated according to prospective mining reports issued by the Applicant. Nearly all of the arsenic will be disposed of on-site, or released by air and water to adjacent public lands and water. Much of this arsenic is handled repeatedly during operations and is present as, converted to, and released to the environment as, the more toxic chemical species.

With regard to arsenic air pollution, this facility will potentially emit 170 to 360 tons per year (TPY) (or about 1%) of the total arsenic waste. About 85-90% of the uncontrolled emission will be contained or captured by proposed controls and approximately 13 to 38 TPY will be released to the atmosphere as fine particulate (controlled Potential Total Emissions PTE). The PTC Application underestimates these emissions by a factor of 5.6 to 12 times, (See previous public comments – Draft 2 PTC), and asserts about 30 TPY PTE uncontrolled and 2.4 TPY controlled PTE. Most of this mischaracterization is associated with road dust suspended from the massive volume of heavy trucks moving thousands of loads of arsenical contaminated materials across the site. The Applicant achieves this low estimate by using minimal emission factors (EFs) and particulate arsenic content, and claiming an unprecedented capability to control 93.3% of the road dust through chemical suppressants and watering. A detailed critique of these emissions was provided in the comments to Draft 2 PTC, and are amplified below in these comments.

The public should be aware that IDEQ is extending unusual latitude to the Applicant in reviewing the PTC, accepting minimal technical parameters, and accepting unrealistic control assumptions. These overly optimistic particulate and arsenic emission claims are necessary to obtain the PTC. The proposed facility would not be able to comply with health standards if conservative EFs, arsenic content and more realistic control levels were used in the calculations, as required by the regulations.

The public should also be aware that (3569/(3569+86,6)) 97.6 % of controlled particulate emissions admitted to in the PTC are classified as "mining fugitive" emissions. Mining fugitive emissions are exempt from consideration in Major Source Classification in Idaho. As a result, this source, which will be one of the largest in the State, is classified as Synthetic Minor and is precluded from federal review. Many of these alleged mining fugitive sources are arguably not exempt and could be classified as attendant to listed or point sources. If only 0.4 % of these "mining fugitive" emissions (13.4 TPY) were reclassified, the facility would be a Major A Source and the Idaho public could apply to the federal government for relief.

The public should also be aware that application for a PTC, prior to receiving approval from the federal government on a project requiring an Environmental Impact Statement EIS), is also unusual. The Applicant is attempting to secure both State and federal Agencies approvals simultaneously. Generally, the federal

approval dictates the type of facility that is acceptable, followed by State implementation of the required controls. The Applicant is submitting confusing, and apparently inconsistent, air pollution emission estimates to the different regulators, hampering the transparency required for the public to understand and comment in both forums. Both the proposed PTC and Draft EIS largely ignored potential airborne toxic arsenic impacts in the initial submittals. These comments are being forwarded to the US Forest Service and Environmental Protection Agency for their consideration.

DEQ Response:

In accordance with IDAPA 58.01.01.006. a stationary source is defined as any building, structure, facility, emissions unit, or installation which emits or may emit any air pollutant. The fugitive emissions shall not be considered in determining whether a permit is required unless required by federal law. For New Sources Review permitting purposes, the fugitive emissions shall not be considered in determining whether the facility is major unless the facility is a designated facility per IDAPA 58.01.01.008.10.c.i. A gold mine is not a listed designated facility under IDAPA 58.01.01.006.30 and therefore fugitive emissions are not considered. Fugitive emissions of criteria pollutants are counted toward PSD classification from designated facilities such as the lime plant. Lime plant fugitive emissions are quantified under the PSD Classification section of the Statement of Basis.

For Title V permitting purposes arsenic is a HAP and arsenic fugitive emissions from haul roads do count towards the major source determination of 10 tons per year of any HAP and 25 tons per year for any combination of HAP. Accounting for water and chemical dust suppressant control efficiencies and use of the equations cited from AP-42 Section 13.2.2 (11/2006) for unpaved roads and site-specific silt values supports an arsenic HAP PTE from the haul roads of 30.3 tons per year (T/yr) for uncontrolled emissions (above 20 T/yr as described in the Statement of Basis) and 2.03 T/yr for controlled emissions. Despite the noted limitations of using AP-42, these equations remain commonly used and accepted by DEQ.

As discussed previously in the Representativeness and Uncertainty of Emissions section above, the estimates of emissions and underlying assumptions were supported to the satisfaction of DEQ, and sufficient information was provided to demonstrate preconstruction compliance with applicable TAP and mercury standards and to support facility classifications. Key assumptions identified in this section were confirmed by PRI and accepted by DEQ and were the basis of the facility classifications.

Comment 34 - TIFO: Facility Source Classification

IDEQ's initially classified this facility as a synthetic minor source (SM) for PM, PM10 and PM25 and Class B for HAP. The initial PTC application erroneously characterized this facility as a minor source with negligible environmental, and no health, significance. Unraveling the complex and confusing calculations that supported these conclusions required public information hearings, access to IDEQ Staff, weeks of reverse engineering, and in-depth review by public commenters.

The PM classification determination is apparently based on "mineral processing" point source PM emissions totaling 560 TPY uncontrolled and 86.6 TPY permitted controlled PTE emissions, indicating an overall 85% control of these sources. In Table 2 of the current Statement of Basis (SOB), IDEQ compares the 86.6 TPY PTE to the 100 TPY threshold for major source classification, indicating SM80 classification (>80 but <100 TPY). It is unclear why IDEQ classifies the source as SM despite this finding. The HAP classification has been modified from B to SM based on the IDEQ inclusion of previously excluded arsenic emissions.

The Applicant and IDEQ calculations show that this facility will also emit >30,000 TPY of uncontrolled PM and 3655 TPY of permitted PM emissions (Table 3, SOB). However, the Agency contends the Major Source classification of 100 TPY is not met (despite the 36-fold exceedance). This illogical conclusion is a continuing example of IDEQs exclusions of massive emissions from regulatory constraints, and a major source of concern for the Public. More disconcerting, this determination avoids federal oversight and severely impedes the Public's ability to secure protection from federal authorities.

IDEQ continues to ignore 3569 TPY of permitted PTE PM fugitive emissions from mining operations (97.8% and of total controlled PM by the Applicant's calculation) and 986 TPY of associated PM10 emissions (all of which are likely underestimated by 1.6 to 3.5 times).

In avoiding consideration of these thousands of tons of annual particulate emissions, IDEQ apparently relies on:

> **220.GENERAL EXEMPTION CRITERIA FOR PERMIT TO CONSTRUCT EXEMPTIONS.**
> 01. **General Exemption Criteria**.
> … For purposes of Sections 220 through 223, fugitive emissions shall not be considered in determining whether a source meets the applicable exemption criteria unless required by federal law.

Accepting the Applicant's and IDEQ assertions, this classification determination is based on 2.4% of the total PM emissions. If only 13.6 TPY (0.4%) of the massive excluded PM emissions were included in the Source Classification determination, the facility would be a Major A Source, subject to federal review.

In the interest of health and environmental responsibility, it seems logical, if not imperative, that the Agency consider all emissions including mining fugitive impacts and classify this a Major Category A Source. Comparable facilities operating in the US at this time, in the State of Nevada, are Class 1 Major sources according to the same 100 TPY criteria as Idaho's A designation. Idahoans should be accorded the same level of protection as Nevadans. In addition, these facilities are not co-located mining, mineral processing, waste disposal, reclamation, and remediation activities; ongoing simultaneously in mountainous complex terrain, on the headwaters of a wild-scenic river, as is proposed at Stibnite.

The proposed facility is a sophisticated combined integrated mining and mineral processing and refining operation, located in a challenging environmental setting. The current PTC classifies practically all fugitive emissions as "mining fugitives". Even by IDEQ exclusion criteria, some of the ignored sources asserted to be "mining fugitives" should be considered as mineral processing activity emissions controlled with, and attendant to, specific point sources included in the Classification determination. These "fugitive emissions" should be included in the Source Classification totals. Significant percentages of mine ores are trucked to stockpiles and placed in storage to be processed months or years later. Alleged mine fugitive emissions also include significant on-site hauling associated with Portable Crusher and Screening Plants. Some of this hauling is related to the lime plant and gold ore refinery operations, that are specifically listed by federal rules as requiring inclusion of fugitive emission in determining source classification. For example,

> Subchapter C Part 70.3d) Fugitive emissions from a part 70 source shall be included in the permit application and the part 70 permit in the same manner as stack emissions, regardless of whether the source category in question is included in the list of sources contained in the definition of major source.

This rule should be interpreted that if the any portion of the emissions is due to a listed source, then all emissions from that source should be included in the Source Classification determination. A portion of the maintenance grading, dozing and load/unload activities and all watering truck, placement of "clean gravel" and dust suppressant emissions are applied continually, independent of the mine production rate, specifically for PM control. These sources should also be assessed as attendant to T-RACT "*environmental impacts caused by the control technology that cannot be mitigated"*, in part, for listed sources and considered for inclusion in Source Categorization.

These alleged "excluded mine fugitive" sources alone (not including On-site Hauling) exceed 270 TPY. If only 5% of these activities were considered attendant to listed sources or mineral processing and stockpile point source operations (as opposed to mining) then the Major A Source Category threshold would be met. Unfortunately, it is not possible for public reviewers to assess the magnitude of or quantify these sources from the available emission inventories. Fugitive emissions were reportedly estimated for a dozen different operational scenarios. However, Table 7 of the SOB and the example calculations provided use scenario W-3, because it is the maximum total PM emissions. This scenario is heavily weighted toward exploitation

of the West End Pits, and provides little information to assess the potential emissions associated with those sources that might not be exempt on closer examination.

Examination of the W3 scenario also shows that the 2901 TPY of PM estimated for On-site Hauling is 100% attributed to hauling from the West End Pit to the Hangar Flat DRSF. This is the main process stream for limestone feeding the lime plant, gold oxidation circuit, neutralization of waste streams, etc. This scenario also attributes zero hauling from stockpiles to crushers. It is not possible to ascertain from these data how much of the fugitive emissions are attendant to these listed sources or to mineral processing point sources.

These observations suggest that IDEQ's reliance on operational scenarios, designed to support modeling analyses to assess fugitive exclusion from Source Classification, has allowed listed and point source attendant emissions to be misclassified as excluded mining fugitives. Misclassification of only a tiny percentage of the massive excluded emissions prevents Major source determination and federal review of key portions of this defective PTC.

IDEQ should carefully review these fugitive emission claims with regard to the exclusion criteria and publicly disclose the review.

DEQ Response:

As noted in the previous response, in accordance with IDAPA 58.01.01.006. a stationary source is defined as any building, structure, facility, emissions unit, or installation which emits or may emit any air pollutant. The fugitive emissions shall not be considered in determining whether a permit is required unless required by federal law. For New Sources Review permitting purposes, the fugitive emissions shall not be considered in determining whether the facility is major unless the facility is a designated facility per IDAPA 58.01.01.008.10.c.i. A gold mine is not a listed designated facility under IDAPA 58.01.01.006.30 and therefore fugitive emissions are not considered. Fugitive emissions of criteria pollutants are counted toward PSD classification from designated facilities such as the lime plant. Lime plant fugitive emissions are quantified under the PSD Classification section of the Statement of Basis.

For Title V permitting purposes arsenic is a HAP and arsenic fugitive emissions from haul roads do count towards the major source determination of 10 tons per year of any HAP and 25 tons per year for any combination of HAP. Accounting for water and chemical dust suppressant control efficiencies and use of the equations cited from AP-42 Section 13.2.2 (11/2006) for unpaved roads and site-specific silt values supports an arsenic HAP PTE from the haul roads of 30.3 tons per year (T/yr) for uncontrolled emissions (above 20 T/yr as described in the Statement of Basis) and 2.03 T/yr for controlled emissions. Despite the noted limitations of using AP-42, these equations remain commonly used and accepted by DEQ.

As discussed previously in the Representativeness and Uncertainty of Emissions section above, the estimates of emissions and underlying assumptions were supported to the satisfaction of DEQ, and sufficient information was provided to demonstrate preconstruction compliance with applicable TAP and mercury standards and to support facility classifications. Key assumptions identified in this section were confirmed by PRI and accepted by DEQ, and were the basis of the facility classifications.

AMBIENT AIR – PUBLIC ACCESS ROAD

Comment 35 - NPT: DEQ has erred in its interpretation of EPA's Revised Policy on Exclusions from "Ambient Air"[4] for the public access road through the mine site

The public access road between Stibnite Road at Sugar Creek and Thunder Mountain Road at Meadow Creek should not be excluded from the regulatory definition of ambient air. This road is intended to allow public access, not preclude it. EPA's revised Ambient Air Policy describes conditions by which the public is to be excluded from an area controlled by a source and which would then justify excluding an area for purposes of analyzing the source's impact on ambient air. Controlling public access on the public access road between Stibnite Road at Sugar Creek and Thunder Mountain Road at Meadow Creek, as is described Section 3.3.10 of the Statement of Basis, Appendix B Ambient Air Quality Impact Analyses Review Memorandum, consists of providing "controlled through-site access that is safe, provides travel-time comparable to current conditions and is consistent with the United States Forest Service travel management plan."[5] Controlling public access through a site is not excluding public access to a site, thus the EPA revised Ambient Air Policy does not apply, and, therefore, the public access road should be considered ambient air.

As the public access road is ambient air, all emissions, modeling, and controls must be characterized and considered, and subject to the NAAQS.

DEQ Response:

DEQ does not agree with the comment that the access road between Stibnite Road at Sugar Creek and Thunder Mountain Road at Meadow Creek was inappropriately excluded from consideration as ambient air. The roadway is not public, as PRI has sole control of access through the site. As explained in DEQ's response to Comment 16, those seeking to use the roadway will be guests of PRI, subject to those conditions specified by PRI. The issued permit requires PRI to clearly identify the roadway as "not public" and managed by PRI.

Comment 36 - ICL/SSFS: Ambient Air Boundary Determination

We are concerned that the exclusion of the public access road between Stibnite Road at Sugar Creek and Thunder Mountain Road at Meadow Creek from the regulatory definition of ambient air is inconsistent with Clean Air Act's definition of ambient air,[3] EPA's long-standing policy that allows excluding certain areas of a source's property from ambient air,[4] and EPA's most recent revised policy for ambient air.[5] Allowing the public to access this road, even under the conditions of the Stibnite Road Access Management Plan, may result in acute exposure of the public to hazardous air conditions.

EPA's long-standing policy has been to exempt "the atmosphere over land owned or controlled by the source and to which public access is precluded by a fence or other physical barriers" from ambient air requirements.[6] In 2019, recognizing advances in surveillance and monitoring capabilities, EPA revised the "fence or other physical barriers element of this ambient air policy while maintaining public health protection" to allow stationary sources to use "other types of measures "to support exclusion of an area from ambient air."[7] Key to this policy revision was the fact that "legal" access – whether the public has the right or permission to enter a specific property – did not change the definition of ambient air. In other words, "if 'ambient air' is defined as that to which the general public has access, then that to which the general public does not have access is not ambient air."[8]

Under this permit, the general public would have access to the road through the project area and not be entirely precluded from using it throughout the life of the mine. Based on EPA's policy, since the general public would have access, albeit restricted, the road is ambient air. The Response to Comments justifies this exclusion because "[t]he roadway is completely within the boundary of the mine," "[u]se of the roadway by [the public] is completely at the discretion of PRI and will be tightly controlled," and the public "will be considered [business invitees] of PRI."[9] This rationale cannot be reconciled with EPA's policy.

The EPA Revised Policy explains:

> "The EPA's view is that the general public has legal access to areas that are owned and controlled by parties other than the owner or operator of a stationary source. The EPA continues to view the "general public" to include any person(s) other than those who are permitted access to the property as employees or business invitees of a specific stationary source (including trespassers)."[10]

In other words, people that are traveling on the road through the mine site to access public (Forest Service) property are members of the general public. The Applicant's attempt to label the public as "guests of PRI"[11] is disingenuous and "would expand the exclusion beyond reason and deny the protection of the NAAQS to large numbers of people."[12] The fact that these "guests" would "abide by access and safety procedures established by PRI" is meaningless in terms of protecting the public from exposure to hazardous air conditions. There are no air quality monitors on the road because it has been excluded from ambient air.[13] Thus, it will not be known to those traveling on the road what type of acute exposure to air pollutants will result.

Moreover, IDEQ's own definition of "ambient air" is "[t]hat portion of the atmosphere, external to buildings, to which the general public has access."[14] The public access road through the project area fits that definition exactly. In addition, IDEQ's Modeling Guidelines[15] for determining the ambient air boundary demonstrate that this public road should <u>not</u> be excluded from the ambient air boundary:

- "It shall be assumed that the air within the facility boundaries is ambient air unless the facility can demonstrate that public access is precluded." Here, although public access might be controlled, it will not be precluded. Filing for required federal permits acknowledges that the Applicant does not have the right to preclude public access across the project site. Thus the road should not be excluded from an ambient air analysis.
- "For the purpose of defining ambient air, the 'general public' is considered anyone not directly associated with the facility. In general, if someone present at the site would not be subject to OSHA or other worker exposure regulations, then they are considered as the general public." People passing through the facility to access public land on the other side of the project area are not "directly associated with the facility" and would not be "subject to OSHA or other worker exposure regulations" and therefore are the general public
- "If the facility is not controlled by a physical barrier AND/OR general public access is not discouraged by the type of area, size of the facility, or the remoteness of the facility location, then the ambient air boundary is determined to be inside the property boundary." The Applicant does not propose a physical barrier. General public access is not discouraged by the items listed above. Access to these public lands is long-standing, an important part of Valley County's recreational experience, and acknowledged in fillings for federal permits.
- "Is the general public allowed on site as a part of a right-of-way easement or a common service road? If "yes," then the right-of-way is determined to be ambient air." The public is allowed access through the site because it is a public road. The Applicant cannot completely preclude public access.

IDEQ precedent, reaffirmed as recently as 2021, makes it clear that a public right-of-way access through a project area is considered – not excluded from – ambient air, and regulatory analyses of the potential impacts along that road must show compliance with all ambient impact limits for averaging periods under one year. This determination has been applied by IDEQ for public roads, non-navigable rivers, and railroad tracks. Here, the general public would be allowed access through the mine site on a public road that the Applicant does not have the right to completely deny access. There is no indication that this public road should be treated any differently from past projects. Nothing in the ambient air impact assessments supporting this permit includes any analysis of the impacts on the road through the project area.

IDEQ should:

- Reassess the ambient air boundary determination and model ambient air concentrations along public access routes.

DEQ Response:

DEQ does not agree with the comment that the road between Stibnite Road at Sugar Creek and Thunder Mountain Road at Meadow Creek should be considered as ambient, as previously explained in DEQ's response to Comment 16. PRI is not obligated to allow access to those seeking passage through the site, and PRI is able to state the conditions of allowed access. In this regard, those passing are guests of PRI in the same manner as those touring the facility as part of a classroom fieldtrip as the road is not a "right-of-way easement."

SILT CONTENT

Comment 37 - EPA: Limiting PTE of the Mining Fugitive Dust Emissions for NAAQS and Title V HAP Purposes

20. IDEQ estimated fugitive dust emissions from haul roads based on a 4.0% surface material silt content.[15] However, the arithmetic average silt content for haul roads based on Perpetua's site-specific data is 4.3%. The silt content value can have a significant impact on the representativeness and conservativeness of the emissions factor and, thus, emissions estimate.[16] Use of the 4.3% average value results in about 7% more fugitive dust emissions from the haul roads than estimated using the median value. IDEQ's modeling sensitivity study showed values just below the NAAQS, such that an 7% increase in fugitive dust from haul roads would have resulted in 24-hour PMl0 NAAQS violations. AP-42 values for similar operations show a wide range of silt fractions, with average values around 8% silt fraction for mine haul roads. The permit record does not include an adequate justification for using the 4.0% silt content figure to derive the fugitive dust haul roads emissions factor and whether a 4.3% is representative for the haul roads including inside the open pits.

DEQ Response:

The use of site-specific median values for silt content is commonly accepted by DEQ, and the values used in calculations were supported by PRI. Metal hazardous air pollutant (HAP) and toxic air pollutant (TAP) emissions from process materials were based on median measured metal concentration profiles from onsite core samples of ore and limestone materials, including 98 samples of PRI limestone and over 55,000 samples of PRI ore. PRI has confirmed that ore samples were taken primarily from the mineralized zones of the PRI pits and were representative for the purposes of estimating emissions. Although a median value of sampled silt percentages of roadway material was used in emission estimates presented in the application, DEQ recognizes the importance of the silt content parameter in the estimation of emissions. Since compliance with the 24-hour PM_{10} NAAQS is the primary driver of NAAQS compliance, minimizing variability of the parameter is very important to ensure NAAQS compliance. To achieve this, the permit will limit *maximum silt content* to 4.0 %, as specified in Section 3.13 Haul Road Capping of the PTC as well as associated monitoring and recordkeeping.

Comment 38 - ICL/SSFS: Silt Content

As IDEQ has acknowledged in their response to comments, there are three key data-based variables used in estimating controlled, unpaved road arsenic emissions: silt content, arsenic content of the silt, and control efficiency. We remain concerned that using a 4% silt content for surface aggregate material for haul roads is too low according to scientific literature. Using a lower than reasonable silt content results in an underestimation of fugitive dust emissions. In its response to comments, IDEQ failed to provide a rationale for why the Applicant’s assumption that a 4% silt content was appropriate in this case when EPA’s publication AP-42 (that IDEQ relies on for other purposes) provides a mean silt content range for industrial unpaved haul roads of 5.8 to 24%.

Table 13.2.2-1. TYPICAL SILT CONTENT VALUES OF SURFACE MATERIAL ON INDUSTRIAL UNPAVED ROADS			
AP-42		All Gravel Road	Haul Roads
	Industry Types	18	4
	No. Sites	53	10
	No. Samples	272	58
	Minimum	4.3%	5.8%
	Maximum	24.0%	24.0%
	Average	10.1%	11.6%
	Median	8.4%	8.4%
	Geomean	8.8%	9.9%

The mean silt content range reported in AP-42 is consistent with other scientific literature. Tannant and Regensberg's *Guidelines for Haul Road Design* (2001), for example, provides guidelines for haul road surface material properties (Section 5.1.1, pg. 58) and recommend a range of 5-10% fines (material passing a #200 sieve). They cite two separate studies stating 5-15% and 5-10% respectively to support this guideline. We have not been able to find any evidence for *functional* haul road surface material having less than 5% silt content. The following table summarizes plausible values for three variables at this site. These values are rated as minimal, typical, and conservative emissions factors.

Comparison of Characteristic Values for Key Variables Used in Calculating Particulate and Arsenic Emissions from Gravel Haul Roads				
Characteristic Values	Silt Content All Gravel Roads	Silt Content Haul Roads	As Content ppm	Control Efficiency % Emitted
AP-42 Minimal	4.3%	5.8%	909	10%
AP-42 Typical	8.8%	9.9%	1231	15%
AP-42 Conservative	10.1%	11.6%	1812	20%
Midas PRI	4%	4%	667	6.7%

In each case, the Applicant has used less than minimal values. Our concern is that reliance on an unrealistically low silt characteristic value combined with the need for extremely aggressive fugitive dust control efficiencies raises the significant likelihood that this permit may exceed National Ambient Air Quality Standards for particulate matter. IDEQ's response to comments simply states that the assumption for a 4% silt content was "confirmed by

no stated rationale
is particular haul

IDEQ should:

- Reassess emissions calculations and fugitive dust control efficiencies using a more realistic silt content for haul roads.

DEQ Response:

The use of site-specific median values for silt content is commonly accepted by DEQ, and the values used in calculations were supported by PRI. Metal hazardous air pollutant (HAP) and toxic air pollutant (TAP) emissions from process materials were based on median measured metal concentration profiles from onsite core samples of ore and limestone materials, including 98 samples of PRI limestone and over 55,000 samples of PRI ore. PRI has confirmed that ore samples were taken primarily from the mineralized zones of the PRI pits and were representative for the purposes of estimating emissions. Although a median value of sampled silt percentages of roadway material was used in emission estimates presented in the application, DEQ recognizes the importance of the silt content parameter in the estimation of emissions. Since compliance with the 24-hour

PM_{10} NAAQS is the primary driver of NAAQS compliance, minimizing variability of the parameter is very important to ensure NAAQS compliance. To achieve this, the permit will limit *maximum silt content* to 4.0 %, as specified in Section 3.13 Haul Road Capping of the PTC as well as associated monitoring and recordkeeping.

PET 595

REC 0961

T-RACT

Comment 39 - ICL/SSFS: T-RACT

In this latest iteration of the permit, the T-RACT control measures were applied to meet human health criteria for airborne toxics. A T-RACT application is an admission that compliance with environmental health criteria is not feasible with reasonably available control technology (RACT). This is in contrast to prior IDEQ assertions that all standards would be met with available technology. The previous submittals also assured the public there were no environmental or health concerns associated with Toxic Air Pollutants (TAPs) compliance. This proposal requests exemptions from those standards. It is both confusing and concerning that IDEQ has modified its position from no significant impact to requiring T-RACT without disclosing the analyses that support these conclusions.

Before granting T-RACT, IDEQ should require the Applicant to address the feasibility of achieving compliance through more aggressive application of the current RACT proposed for particulate control, and require the necessary supporting calculations regarding environmental, cost, and energy impacts. These analyses should be based on appropriate RACT emissions and should identify the levels of control necessary for compliance with the AACC.

For detailed technical comments on T-RACT, we refer IDEQ to Section 8.0 of the comments submitted by Ian von Lindern, P.E. PhD, from the TerraGraphics International Foundation. To summarize his technical comments, IDEQ should disapprove this T-RACT submittal in accordance with IDAPA 58.01.01.14 based on the following considerations:

- The emissions used to support modeling are based on inappropriate multi-year averages and do not reflect the PTE or T-RACT.
- The proposed operational limits on mine production will have no practical constraint on facility operations, emissions, or ambient impacts.
- The lifetime averaging of exposure is inappropriate. Just because this facility proposes to have “only” a 16-year life of mine, the Applicant is not therefore entitled to expend a receptor’s equivalent 70 years of allowable exposure with regards to cancer risk.
- If the direct comparison of predicted maximum annual average ambient arsenic concentrations to the AACC is correctly applied, it shows a 30-factor exceedance, or 3 times the T-RACT AACC.
- Considerably higher levels of operational constraints will be required to support T-RACT. These limits are likely to require reductions in the proposed MODPRO2 levels of operations.
- The T-RACT controls are largely unenforceable, do not require any effective monitoring, or provisions for corrective actions, should the Applicant’s assurances prove unachievable.
- The T-RACT analysis does not address the requirements in IDAPA 58.01.01.210.14.c.ii to access “the environmental impacts caused by the control technology that can not be mitigated, including, but not limited to, water pollution” despite the massive amounts of magnesium chloride and associated products that would be required to achieve the unprecedented dust control effectiveness proposed.

This relaxation of health protections deserves intensive review, public involvement, and consideration by other regulators. We are concerned that the repetitive nature of this PTC review undermines public awareness regarding the significance of this major change in strategy regarding emissions control from this facility as well as the health implications of relaxing health standards.

DEQ Response:

DEQ does not agree with the comment that, “A T-RACT application is an admission that compliance with environmental health criteria is not feasible with reasonably available control technology (RACT).” The established criteria for carcinogenic TAPs is 10 times the listed AACC, and emission controls that are deemed

T-RACT must be used when impacts are greater than the AACC. This is provided by *Idaho Air Rules* Section 210.12.

Initial technical analyses for the SGP attempted to demonstrate compliance with carcinogenic TAP increments without justification that T-RACT will be used for emissions. When it was determined that additional sources had to be included in the arsenic TAP impact modeling analyses, a more refined approach was needed to demonstrate compliance, including demonstrating T-RACT is used to allow the criteria of 10 times the AACC to be used.

DEQ has no regulatory authority to require facilities to utilize other measures before using the T-RACT adjustment. The T-RACT adjustment is provided by *Idaho Air Rules* and can be used at the discretion of permit applicants.

Regarding the bullet list of comments, DEQ has the following responses (in the same order as the comments):

- Carcinogenic AACCs are expressed as annual averages, but as stated in DEQ's response to Comment 27, the definition of *Toxic Air Pollutant Carcinogenic Increments* in *Idaho Air Rules* Section 005.125, states, "Those ambient air quality increments based on the probability of developing excess cancers over a seventy (70) year lifetime exposure to one (1) microgram per cubic meter (1 $\mu g/m^3$) of a given carcinogen and expressed in terms of a screening emission level or an acceptable ambient concentration for a carcinogenic toxic air pollutant." Since the AACCs are based on a 70-year exposure, use of a 5-year averaging period is appropriate.
- DEQ has incorporated requirements to monitor and record operational parameters that are limited by the permit, thereby making them practically enforceable.
- DEQ disagrees with the comment that allowing a lifetime allowable risk to occur over a 16-year mine life is inappropriate. The acceptability criteria is that a facility not pose a cancer risk greater than 1-in-1,000,000 or 1-in-100,000 if T-RACT is used. The annual value of the AACC is provided under the assumption that a facility will emit at such a level on a permanent basis. Since the criteria of Idaho's TAP rules is the risk associated with the project, the time over which that risk is spread is immaterial. If an individual's lifetime total cancer risk were the focus of Idaho's TAP rules, then the rules would have required a cumulative risk assessment, accounting for existing risks at the location of actual receptors.
- The comparison offered, comparing maximum annual impacts to the T-RACT adjusted AACC, is irrelevant. Compliance with TAPs rules was demonstrated through a refined analysis, so there is no utility in focusing on results from a more conservative, less refined analysis.
- How meeting the requirements of the DEQ issued PTC affects proposed MODPRO2 levels of operation is outside the scope of DEQ's permitting process.
- T-RACT controls are included in the PTC as a daily hauling limit based on a 5-year rolling average (Permit Condition 3.5), a life of mine hauling and excavating limit (Permit Condition 3.6), a drilling rigs dust control system (Permit Condition 3.11), and a Haul Road Capping Plan (Permit Condition 3.13). All listed permit conditions have enforceable monitoring and recordkeeping associated with them.
- T-RACT did not address magnesium chloride application on the roads because it was not a proposed control. Magnesium chloride application is addressed in the Fugitive Dust Control Plan in Permit Condition 2.6.

Comment 40 - TIFO: PTC Public review

The initial PTC submittal and IDEQ's position were particularly disappointing. The draft PTC excluded 99.3% of carcinogenic arsenic from regulation and 97.6% of PM emissions from Source Classification. Aside from the disregard for public health and the environment, issuing the initial proposed permit would have had the likely effect of:

-exceedance of criteria pollutant standards,
-arsenic concentrations in the 10^{-3} cancer risk range,
-providing for no monitoring or measurement of critical emissions or ambient impact,
-requiring no corrective actions during operations, and
-precluding federal oversight.

Questioning of IDEQ Staff during public information meetings revealed that these mining friendly determinations depended on:

-unreasonable interpretations of 7E NESHAPS definitions,
-non-conservative estimates of PM emissions and potential control efficiencies,
-minimal estimates of toxic concentrations in PM, and
-exclusions of major sources from permit classification determinations.

The original PTC was an irresponsible proposal and a cause for concern that the Applicant and the environmental/ health agency put it forward. It should not be the responsibility of public reviewers to identify these threats and suggest remedies for these situations. Public entities do not have the resources to repeatedly rebut insufficient industry submittals. The Public depends on IDEQ to ensure health and environmental protection.

Review of the T-RACT (Toxic - Reasonable Available Control Technology) analysis in this third submittal continues the same uncomfortable pattern of minimal, insufficient, and vague calculations; ineffective monitoring; and lack of provisions for enforcement and corrective actions. In the broadest overview, the refined air quality modeling underlying the T-RACT analysis suggests that massive disturbance of toxic arsenic contemplated in the proposed multiple open-pit operation cannot meet air quality criteria in the complex terrain and environmental setting of Stibnite.

The T-RACT Review below also reveals enhanced concerns with respect to insufficiencies pointed out in the previous drafts of the PTC Application. Considerable concern remains with respect to IDEQ's acceptance of the Applicant's assertion regarding three areas of the PTC:

-Estimated Unpaved Road Emissions.
-Facility Source Classification
-T-RACT Review

As a result, these specific concerns are re-iterated and additional comments are found in the following Sections.

DEQ Response:

In accordance with IDAPA 58.01.01.006. a stationary source is defined as any building, structure, facility, emissions unit, or installation which emits or may emit any air pollutant. The fugitive emissions shall not be considered in determining whether a permit is required unless required by federal law. For New Sources Review permitting purposes, the fugitive emissions shall not be considered in determining whether the facility is major unless the facility is a designated facility per IDAPA 58.01.01.008.10.c.i. A gold mine is not a listed designated facility under IDAPA 58.01.01.006.30 and therefore fugitive emissions are not considered. Fugitive emissions of criteria pollutants are counted toward PSD classification from designated

facilities such as the lime plant. Lime plant fugitive emissions are quantified under the PSD Classification section of the Statement of Basis.

For Title V permitting purposes arsenic is a HAP and arsenic fugitive emissions from haul roads do count towards the major source determination of 10 tons per year of any HAP and 25 tons per year for any combination of HAP. Accounting for water and chemical dust suppressant control efficiencies and use of the equations cited from AP-42 Section 13.2.2 (11/2006) for unpaved roads and site-specific silt values supports an arsenic HAP PTE from the haul roads of 30.3 tons per year (T/yr) for uncontrolled emissions (above 20 T/yr as described in the Statement of Basis) and 2.03 T/yr for controlled emissions. Despite the noted limitations of using AP-42, these equations remain commonly used and accepted by DEQ.

As discussed in the Representativeness and Uncertainty of Emissions section above, the estimates of emissions and underlying assumptions were supported to the satisfaction of DEQ, and sufficient information was provided to demonstrate preconstruction compliance with applicable TAP and mercury standards and to support facility classifications. Key assumptions identified in this section and by the commenter (including 93.3% control efficiency for haul roads) were confirmed by PRI and accepted by DEQ and were the basis of the facility classifications.

T-RACT is an emission standard based on the lowest emission of toxic air pollutants that a particular source is capable of meeting by the application of control technology that is reasonably available, as determined by DEQ, considering technological and economic feasibility. T-RACT is an allowable analysis to demonstrate preconstruction compliance for toxic air pollutants (IDAPA 58.01.01.210.12) that PRI has used to demonstrate compliance for arsenic.

How DEQ reviews impacts associated with the proposed SGP is governed by *Idaho Air Rules* pertaining to permit applicability and permit issuance. While commenters may not agree with approaches directed by *Idaho Air Rules*, DEQ does not have latitude to deviate from what is established by rule. Comments suggesting the inappropriateness of approaches mandated by rules are outside the scope of this project and responses will not be provided.

Comment 41 - TIFO: T-RACT Review

T-RACT is an unusual exemption to meeting health criteria undertaken because the facility is unable to comply with health criteria using reasonably available control technology, and the Applicant requests a permit that allows a ten-fold increase in cancer risk. This relaxation of health protections deserves intensive review, public involvement, and consideration by other regulators. There is concern that the repetitive nature of this PTC review undermines public awareness regarding the significance of this major change in strategy regarding emissions control from this facility, and the health implications of relaxing health standards. In that regard, the public should be informed if IDEQ has considered the following questions:

> Is there precedent in Idaho for this relaxation of health standards for a facility of this size?
>
> Have any similar facilities received comparable relief in other jurisdictions?
>
> Has there been any public notice specifically referencing this unusual request and relaxation of health standards?
>
> Have the cancer risk calculations been reviewed by qualified risk assessment personnel?
>
> Has the Agency requested advice or guidance from other environmental or health agencies in the application of the T-RACT?

With regard to the T-RACT analysis and the request for relief, IDEQ regulations define T-RACT as:

> 12. Toxic Air Pollutant Reasonably Available Control Technology (T-RACT). An emission standard based on the lowest emission of toxic air pollutants that a particular source is capable of meeting by the application of control technology that is reasonably available, as determined by the Department, considering technological and economic feasibility. If control technology is not feasible, the emission standard may be based on the application of a design, equipment, work practice or operational requirement, or combination thereof. (5-1-94)

Compliance Feasibility: A T-RACT application is an admission that compliance with environmental health criteria is not feasible with reasonably available control technology (RACT). This is in contrast to earlier Agency assertions that all standards would be met with available technology. The previous submittals also assured the public there were no environmental or health concerns associated with (Toxic Air Pollutant) TAPs compliance. This proposal requests exemptions from those standards. It is confusing that IDEQ has modified its position from no significant impact to T-RACT without disclosing the analyses that support these conclusions.

With regard to *"...if control technology is not feasible ..."*, IDEQ has not demonstrated that it is infeasible to comply with the required ambient air quality standard with the application of RACT. Despite numerous public requests, the Agency has not publicly disclosed the estimated ambient arsenic concentrations associated and with this facility's design capacity PTE arsenic emissions using RACT, nor has IDEQ compared this ambient concentration to AACC carcinogenic risk criteria. This comparison should be presented to document the lack of feasibility, the magnitude of the exceedance at maximum design operations, and to demonstrate the methodology. In this way the public can understand and meaningfully assess the degree of relief the IDEQ is proposing to yield to the Applicant. The correct comparison is the maximum 1-year average ambient concentration calculated through refined modelling, using the maximum 1-year annual RACT PTE, compared to the Section 586 AACC annual standard.

The Statement of Basis should be amended to present the derivation of the RACT facility design PTE, model inputs, and the appropriate ambient concentrations comparison to the AACC.

Determining RACT: The first requirement of a T-RACT analysis is calculation of "… *the lowest emission of toxic air pollutants that a particular source is capable of meeting by the application of control technology that is*

reasonably available…". With regard to determining the *control technology that is reasonably available* for the largest arsenic source, IDEQ accepts the Applicant's contention that RACT is 90% control of road dust through application of chemical suppressants and water; and now contends this level of control is insufficient to meet the TAPs criteria (with no supporting calculation, as noted above). It is curious that the Applicant asserts 90% control for RACT; while simultaneously claiming that 93.3% control is readily achievable, and has committed to that level as reasonable and available to meet PM10 standards without a RACT determination. The Applicant is simultaneously claiming one level of control is readily achievable for compliance with the PM-10 standard, but that same level is not achievable for the arsenic in the same particulate matter.

In justifying the 93.3% control assumption, the Applicant provides support information that this technology can allegedly achieve higher control levels up to 98%. Review of the pertinent research regarding these controls, indicates achieving these levels requires extensive maintenance and massive continuous application of suppressants. If these levels of control are, indeed, achievable, then IDEQ should deny the T-RACT exemption relaxing the cancer risk criteria.

The T-RACT analyses should explore the efficacy, environmental, energy and cost feasibility of more aggressive application of the current technology. The analyses also indicate higher levels of control could be achieved with paved or hard surfaced roads. The Applicant maintains that paving is cost prohibitive and a typical highway design would not support the heavy traffic. The application provides no supporting information for these claims. Neither the RACT nor TRACT feasibility analyses discuss or present the supporting material required by State regulations regarding "*environmental impacts caused by the control technology that cannot be mitigated, energy requirements of the control technology"; or "costs of necessary mitigation measures, capital costs, cost effectiveness, annualized cost of the control technology divided by the amount of emission reduction, difference in costs between the particular source and other similar sources".* All of these supporting analyses are specifically cited in:

> Department of Environmental Quality - Air Quality Division, Toxic Air Pollutant (TAP) Preconstruction Compliance Application Completeness Checklist

IDEQ has noted that this an aggressive control level not previously demonstrated in Idaho. Several commenters have expressed concerns both that this level of control cannot be maintained, and that even higher levels of control will be required if PM emissions are under- estimated. The Section below summarizes concerns related to the insufficiencies in calculating emissions.

There seem to be contradictory IDEQ positions regarding the effectiveness of controls for particulates and arsenic from the same source. Values ranging from 85% to 98% are cited throughout the PTC and support material. The analyses seem to select the most convenient control level depending on the need to demonstrate compliance for the contaminant under review, even for the same physical particle. Does IDEQ have an explicit opinion of the levels of control that are achievable, feasible, and reasonably available for these dust sources? If so, IDEQ should publicly disclose the conservative, average, RACT, minimal, and maximal level of control for these particulate and arsenic sources.

Before granting T-RACT, IDEQ should require the Applicant to address the feasibility of achieving compliance through more aggressive application the current RACT proposed for particulate control, and require the necessary support calculations regarding environmental, cost and energy impacts of these and hard surfaced road options. These analyses should be based on appropriate RACT emissions and should identify the levels of control necessary for compliance with the AACC, as noted above.

Determining RACT Emissions: T-RACT requires calculation of "… *the lowest emission of toxic air pollutants that a particular source is capable of meeting by the application of control technology that is reasonably available…".* Assuming the Applicant's current submittal represents RACT, IDEQ identifies this baseline RACT PTE arsenic emission rate as 0.544 lbs/hr in Table 7 of the TAPS Addendum. Review of the calculations reveals that 0.464 lbs/hr is attributable to Haul Roads. As another example of the confusion regarding control levels, IDEQ states in the SOB that this rate is calculated at 93.3% control, while the supporting spreadsheets

seems to indicate 90% control. As noted in previous comments, this emission rate is not based on conservative data, and has yet to be appropriately estimated. This failure to appropriately calculate RACT emissions exacerbates the insufficiencies of calculating T-RACT limit.

For this reason, additional critiques of this determination are important to highlight. State regulations require PTE to be calculated as follows:

> **02. Quantification of Emission Rates**.
>
> **a.** The applicant may use standard scientific and engineering principles and practices to estimate the emission rate of any toxic air pollutant at the point(s) of emission. (6-30-95)
>
> i. Screening engineering analyses use unrefined conservative data. (6-30-95)
>
> ii. Refined engineering analyses utilize refined and less conservative data including, but not limited to, emission factors requiring detailed input and actual emissions testing at a comparable emissions unit using EPA or Department approved methods. (6-30-95)

For estimating unpaved road fugitive emissions, no option ii) (refined engineering analyses) techniques exist. Emissions are calculated using option i) Screening analyses and unrefined conservative data. In this case, procedures outlined in Section 13.2 of EPA AP-42 unpaved road techniques were applied. IDEQ has acknowledged that the Agency routinely accepts these AP- 42 techniques.

IDEQ's Guidance on Emissions Data Hierarchy: correctly notes that AP-42 calculations are the last choice and "worst data" acceptable for emissions calculations and offer the following warning:

> *AP-42 emissions factors represent the average emissions for a given group of stationary sources or activities. Being averages, AP-42 emission factors must be used with caution because emissions from half of the group of stationary sources or activities may be higher than the emission factor while emissions from the other half of the group may be lower.AP-42 emissions factors are rated A through E; A is considered the most reliable and E the least reliable. The rating of the AP-42 factor must be considered in determining how accurately the AP-42 emissions factor represents actual emissions from the subject source. If industry derived emissions factors are used, they must be accompanied with documentation describing how the emission factor was derived.*
> https://www2.deq.idaho.gov/admin/LEIA/api/document/download/5521

IDEQ acknowledges that AP-42 parameters are averages and 50% of emissions calculated using this technique likely have higher values than those calculated using average EFs. This PTC application uses minimal EFs, indicating >>50% likelihood that emissions are under- estimated. This amplifies the requirement to use conservative data in the interest of health protectiveness, and particularly with respect to carcinogenic air pollutants.

As IDEQ has acknowledged in previous response to comments, there are three key (data- based) variables used in estimating controlled, unpaved road arsenic emissions: silt content, arsenic content of the silt, and control efficiency. The silt content values recommended from AP- 42 are summarized in the following Table:

Table 13.2.2-1. TYPICAL SILT CONTENT VALUES OF SURFACE MATERIAL ON INDUSTRIAL UNPAVED ROADS		
AP-42	All Gravel Road	Haul Roads
Industry Types	18	4
No. Sites	53	10
No. Samples	272	58
Minimum	4.3%	5.8%
Maximum	24.0%	24.0%
Average	10.1%	11.6%
Median	8.4%	8.4%
Geomean	8.8%	9.9%

The silt content observations represent 272 gravel road samples from 53 sites at 18 different industries. Ten (10) sites and 58 samples were obtained specifically from Haul Roads. The minimal mean silt content from any one site was 4.3% and for all gravel roads and 5.8% from Haul Roads. Midas – PRI uses 4.0%. The following Table summarizes plausible values for the three key variables at this site as noted in previous comments. These values are rated as minimal, typical, and conservative EFs.

Comparison of Characteristic Values for Key Variables Used in Calculating Particulate and Arsenic Emissions from Gravel Haul Roads				
Characteristic	Silt Content	Silt Content	As Content	Control
Values	All Gravel Roads	Haul Roads	ppm	%- Emitted
AP-42 Minimal	4.3%	5.8%	909	10%
AP-42 Typical	8.8%	9.9%	1231	15%
AP-42 Conservative	10.1%	11.6%	1812	20%
Midas PRI	4%	4%	667	6.7%

In each case, the Applicant has used less than minimal values. Moreover, these equations are non-linear and variables are multiplicative, exacerbating the degree of under-estimation. IDEQ has in each case accepted the minimal plausible value, despite the requirement that conservative values be used, and IDEQs own guidance includes warnings regarding the uncertainties. The result is that it is likely that emissions are underestimated by several times. It is important to note that, if even a modest increase in PTE for haul roads is acknowledged, this facility will not be able to meet particulate and carcinogenic arsenic standards. Use of any combination of typical or conservative values would likely result in exceedance of particulate and arsenic health criteria.

The potential health related consequences associated with under-estimation of haul road related emissions continues to haunt the PTC and is amplified in the T-RACT analysis.

Calculating the T-RACT Emission Limit: State regulations require that:

> **d.** The T-RACT emissions rate of a toxic air pollutant from a source or modification is calculated using the maximum capacity of the source or modification under its physical and operational design with the effect of: (6-30-95)
>
> i. Any physical or operational limitation other than control equipment that has been specifically described in a written and certified submission to the Department; and (6-30-95)

The T-RACT emission rate should be calculated in the same manner as the original PTE estimates, but allowing for enforceable operational limitations noted in i) above. These operational limitations have the practical effect of reducing the design capacity, and enforcing an artificial ceiling on the facility's ability to pollute. The

T-RACT calculation should then parallel the original PTE analyses, substituting this artificial design capacity. Subsequent Operating Permit conditions should then reflect rigid controls to that ensure the facility will not operate beyond the T-RACT PTE ceiling.

With regard to Haul Road emissions the Applicant offers two operational limitations:

- Limiting long-term mining production to 135,000 T/day (5-year rolling total)
- Capping the haul roads that are outside of the pits and development rock storage facilities (DRSFs) with clean development rock (T-RACT)

The proposed T-RACT emission used by IDEQ is not an operationally constrained equivalent of the PTE determined for the 180,000 TPD design limit used in the original PTC. The current PTC T-RACT analysis uses an inappropriate levels of averaging to modify the calculation. Emissions are calculated based on an apparently arbitrary rolling five-year average mine production rate limit of 135,000 TPD. Although IDEQ accepts this artificial manipulation to support a 25% reduction in modeled emissions and estimated ambient impacts; this limitation has no practical constraint on facility operations, emissions or ambient impacts; and does not reflect PTE under T-RACT. This alleged T-RACT emission limit is not based on a maximum annual rate, or a maximum hourly rate scaled to a maximum annual rate, as required to subsequently compare to an AACC. It is an apparent arbitrary average of 1825 consecutive days of alleged intended operations.

The correct T-RACT emission limit should be the maximum single-year annual PTE rate consistent with enforceable design-equivalent operational constraints, not a rolling average based on good intentions. Because the AACC for carcinogens is an annual incremental standard, there is no specific provision for averaging emissions or ambient concentrations for carcinogenic toxic air pollutants over periods greater than one year. There are provisions for adjusting the AACC for short-term exposures less than the standard basis (<5 year exposures).

> **15. Short Term Source Factor**. For short term sources, the applicant may utilize a short term adjustment factor of ten (10). For a carcinogen, multiply either the applicable acceptable ambient concentration (AACC) or the screening emission rate, but not both, by ten (10), to demonstrate preconstruction compliance. This method may be used for TAPs listed in Section 586 only and may be utilized in conjunction with standard methods for quantification of emission rates (Subsections 210.05 through 210.08).

It should be noted that this calculation specifically excludes simultaneous adjustments to both the emission rates and ambient criteria, as undertaken in the current T-RACT analyses.

Table 7 TAPS Addendum shows the overall decrease in the T-RACT emission limit used by IDEQ in modelling (0.544 vs. 0.232 lbs/hr) reflects a 57% (not a 25%) reduction from the original alleged controlled emission rate. Presumably this reduction reflects both the 25% reduction due to the alleged production limitation, with the remainder due to the low arsenic gravel cover.

These calculations are referenced to an Appendix in the TAPS Addendum, but are not possible to reproduce from the information provided. As such, the efficacy of the additional operational constraints associated with gravel cover is difficult to evaluate. However, it also appears to be based on minimal, rather than conservative, emission factors (i.e., median concentration of contaminants, optimistic control levels, minimal silt content, and no enrichment factor accounting for spillage of high arsenic content ores and development rock fines spilled on the roads).

With respect to the alleged production curtailment, the 135,000TPY mining capacity is not an appropriate operational control for haul road source limits for T-RACT. The MODPRO2 operational scheme uses extensive stockpiling of ores and development rock to effect a near- constant rate of mineral processing activities as shown in Figures 1.2, 1.3 and 1.4 in the STIBNITE GOLD PROJECT, FEASIBILITY STUDY TECHNICAL REPORT, M3-PN170045, Effective Date 12/22/2020 and Figures 3-9 and 3-10 of the STIBNITE GOLD PROJECT: REFINED PROPOSED ACTION – MODPRO2, Perpetua Resources Idaho Inc. October 15, 2021. In contrast, the proposed mine plan initiates and concludes with low rates of ore production and varying rates of

material mined production over the 16 years of alleged life of mine, making a five-year rolling average meaningless in terms of limiting production throughout the complex.

Alleged mine fugitive emissions also include significant on-site hauling associated with Portable Crusher and Screening Plant, lime plant and limestone amendment activities that are months or years removed from mine production; and maintenance, load/unload, watering truck, lime plant, limestone amendments to the gold-refinery, etc. emissions that are applied continually, independent of mine production. These Haul Road and other fugitive emissions are dependent on mineral processing schedules, not mine production. As a result, these should be separately addressed in T-RACT as enforceable operational process rate limitations imposed on milling, refining, and disposal operations, as well as mine production. These sources should also be considered in Source Categorization determinations, as noted above.

Calculating T-RACT Ambient Concentrations: State regulations specify that TAPs increments be calculated as follows:

> **03. Quantification of Ambient Concentrations**. (6-30-95)
>
> **a.** The applicant may use the modeling methods provided in Subsection 202.02 to estimate the ambient concentrations at specified receptor sites for any toxic air pollutant emitted from the point(s) of emission. (6-30-95)
>
> i. For screening modeling, the models use arbitrary meteorological data and predict maximum one (1) hour concentrations for all specified receptor sites. For toxic air pollutants listed in Section 586, multiply the maximum hourly concentration output from the model by a persistence factor of one hundred twenty five one-thousandths (0.125) to convert the hourly average to an annual average. For toxic air pollutants listed in Section 585, multiply the maximum hourly concentration output from the model by a persistence factor of four tenths (0.4) to convert the hourly concentration to a twenty-four (24) hour average. (6-30- 95)
>
> ii. For refined modeling, the models use site specific information. If actual meteorological data is used and the model predicts annual averages for toxic air pollutants listed in Section 586 and twenty-four (24) hour averages for toxic air pollutants listed in Section 585, persistence factors need not be used. (6-30-95)

In order to secure a permit under T-RACT, the Applicant needs to identify enforceable operational limitations that reduce PTE to levels that, when applied through refined modelling, comply with the appropriate AACC. The appropriate comparison under T-RACT is the maximum one-year annual average concentration compared to 10 times the listed AACC. This process is equivalent to PTE modeling of PM pollutants compared to ambient air quality standards. There is no provision for altering or averaging emissions or ambient concentration for intended operations schemes. Similarly, there should be no provision to modify either emissions or the AACC for alleged long-term cancer exposure considerations. The cancer risk calculation is an incremental screening method that looks at the immediate potential impact of the source in the absence of background, past, or future exposures from other sources. As such, both procedures have inherent large margins of safety (i.e., emissions calculated at maximum rates and compared to stringent standards annual maximum concentrations. The 78% life-of-mine (LOM) to receptor lifetime reduction (16 yr LOM/70 yr lifetime) is inappropriate, as this facility is not entitled to consume the remaining 54 years of the receptor's lifetime acceptable exposure during the Applicant's alleged 16 years of operation.

> b. The point of compliance is the receptor site that is estimated to have the highest ambient concentration of the toxic air pollutant of all the receptor sites that are located either at or beyond the facility property boundary or at a point of public access; provided that, if the toxic air pollutant is listed in Section 586, the receptor site is not considered to be at a point of public access if the receptor site is located on or within a road, highway or other transportation corridor transecting the facility.

The ambient concentrations used for the point of compliance are incorrect. Three levels of inappropriate dilution of ambient values are accomplished by IDEQ in alleging compliance with T-RACT. In addition to the inappropriate dilution of emissions noted above, IDEQ inappropriately dilutes ambient concentrations by averaging the results of two scenarios, decreasing the maximum annual average by 41%. This technique is justified on the basis that no one scenario will apply during the life of the mine. A third averaging technique further dilutes the ambient calculation by adjusting the by the ratio of the life of the mine to the assumed lifetime of the receptor. All three manipulations are incorrect.

Once again, IDEQ conflates conservativeness built into the evaluation criteria, with claims of conservatism associated with alleged intended operations. Additionally, the analysis then confuses screening level concentrations with exposure. The correct compliance comparison is the maximum annual ambient concentration to the annual AACC, or T_RACT AACC. There are no provisions for adjusting this concentration to alleged exposures average over multiple years. Any relaxation of health standards on the basis of exposure requires comprehensive risk assessment analyses considering external factors not addressed in the derivation of incremental standards.

The T-RACT analysis accepted by IDEQ seems to be a one-step hybrid of the traditional three step process of risk-adjusted compliance with carcinogenic exposures. The State of Washington, for example, requires a three-tiered analysis formalizing this procedure (Guidance Document First, Second, and Third Tier Review of Toxic Air Pollution Sources (Chapter 173-460 WAC.)

Generally, the first Step requires a relatively simple incremental calculation of ambient concentrations, compared to a conservative risk-based standard or acceptable concentration. These calculations are reviewed and compliance is confirmed if these conservative criteria are met. In this step, the calculation/comparison is the maximum annual concentration compared to the annual AACC and the averaging period is one year. IDEQ never performed, or disclosed, this comparison, which should be accomplished with RACT PTE. As frequently practiced throughout this PTC Application, the required conservative values were modified to reflect lower emission and the AACC was modified to reflect lower concentrations.

These analyses used a non-conservative emission rate, averaged over five years (not one year). It is not possible from the available data to determine how this five-year average compared to the maximum one-year emission rate that should have been used. The overall, reduction appears to be 43% of RACT PTE. The ambient concentration predicted is then additionally reduced by 41% by averaging two different five-year scenarios. Finally, the AACC is reduced by adjusting the result downward by 78% to account for the life of the mine (LOM). This inappropriate triple dilution comparison then alleges compliance.

Direct comparison of the once-diluted emissions predicted annual concentration to the one-year incremental AACC fails by 30-fold (or is 3-fold times the T-RACT AACC). These exceedances are dependent on the once-diluted five-year, non-conservative emission calculations discussed extensively in these comments. Use of required one-year maximum conservative emission calculations, would likely result in orders of magnitude exceedances of the associated one-year maximum concentration T-RACT AACC.

IDEQ should present this calculation.

In a typical carcinogenic risk analyses, the second Step in evaluating the TAPs exemption would apply risk assessment techniques, requiring consideration of receptor and environmental setting characteristics; site history; other sources, including background and potential future increments; susceptible populations, and alternate exposure frequencies and duration, data quality, and uncertainties. This step would transparently address many of the factors allegedly considered in the dilution of the AACC in this PTC analysis.

Revision of the incremental AACC through post-modeling to collectively reflect select factors inherent in the risk assessment/management is neither correct nor transparent, and neglects numerous factors that should be considered in the public interest.

The third Step introduces risk management considerations that would limit emissions sufficiently to effect ambient concentrations consistent with allowable exposures determined in the risk assessment phase (i.e. the T-RACT emission level). This step would consider effective operational limits and controls, establish a *de facto* design capacity, and establish rigid permit limits that would guarantee compliance with the T-RACT AACC.

Even considering these diluted non-conservative emissions used in these analyses, the prospect for complying with carcinogenic risk criteria is doubtful. The modeled results, based on the .232 lbs/hr alleged T-RACT emission rate, indicate that the maximum one-year average ambient air arsenic concentration at the point of compliance is .00698 ug/m^3 under the W-3 scenario. This value exceeds the 10^{-6} AACC for Arsenic of 0.00023 ug/m^3 by 30 times. Applying the allowable T-RACT relief factor of 10 increase in cancer risk indicates a 3-fold exceedance of the appropriate .0023 ug/m^3 maximum annual increment limit. This translates to a required T-RACT emission limit of .232 / (.00698/.0023) = .076 lbs/hr to achieve compliance.

This is an (1-(076/.544)) = 86% required reduction in the under-estimated PTE. In reality, the currently accepted PTE for this facility must be reduced by 86% to achieve compliance through enforceable operational constraints to comply with T-RACT. Even accepting the underestimated PTE as accurate, and assuming that (43-24%) = 19% can be obtained through application of low arsenic road gravel, a 67% reduction is required to be achieved through enforceable production limitations to comply under T-RACT.

This calculation uses the five-year rolling average mining production limitation, offered as an operational control. This proposed operational control both dilutes the emission calculation, and is practically meaningless in limiting emissions and largely unenforceable. The most effective and enforceable limitations would likely be restrictions on annual site-wide VMT limits, rigorously applied to both mineral process-related and mine hauling activities. A 67% annual VMT reduction will require substantial decreases in both mine and process related milling, refining, and disposal operations hauling.

Additionally, IDEQ has argued that the T-RACT controls proposed in the current PTC are conservative citing various levels of mine operation schemes offered by the Applicant. (i.e., 180,000 TPD design rate, alleged135,000 TPD T-RACT rate, 402,859,000 ton LOM alleged MODPRO2 rate), However, the required >67% reduction required to meet T-RACT likely requires limits well below MODPRO2 mine production rates. Developing such a plan would likely require substantial re-evaluation of MODPRP2 strategy.

9.0 ENFORCEABILITY

With regard to air pollution impacts, there are major concerns associated with potential mining and mineral processing fugitive emissions of particulates and arsenic. Unprecedented fugitive emissions control levels will be required to meet NAAQS criteria especially with regard to PM10 compliance. The Applicant is also requesting T-RACT relief from TAPs carcinogenic risk health standards. T-RACT, by definition, asserts that the required PM10 control levels are insufficient to meet carcinogenic risk levels in the ambient air.

There is considerable, if not unprecedented, levels of uncertainty in the magnitude and toxicity of the PTE and T-RACT emission estimates. Should the optimistic emission rates and control levels proposed by the Applicant prove untrue, the facility emissions and subsequent ambient air concentrations will exceed health standards at the facility boundary and result in hazardous exposures to workers, resident worker families, and on-site visitors within the facility.

The proposed Permit Conditions are ineffective in exercising requisite control over these emissions and rely largely on a Fugitive Dust Control Plan, to be developed and implemented later, after issuance of the Permit.

Because this is a proposed T-RACT Site, the Fugitive Dust Control Plan is the primary enforcement mechanism for both NAAQS and TAPs. The control and enforcement strategies for the sources are inextricably linked, as these are the same physical particles. Curiously, NAAQS compliance is achieved by Applicant asserted extra-ordinary (93.3%) controls levels, which is 33% less emissions than the alleged RACT (90.0%), TAPs compliance requires (RACT) and adds operational controls limiting production capacity to achieve emissions

well below design PTE. Whether this is supposedly accomplished at 93.3% or at 90% is unclear, and not trivial as it represents a 33% increase in emissions.

The T-RACT operational controls must be effective in reducing T-RACT emissions to levels that result in meeting the AACC. To effectively reduce these emissions, the operational controls should be aimed at reducing traffic-related fugitive releases. This should be accomplished by the Operator demonstrating the capacity to maintain required Emission Factors (EF)s that will result in NAAQS and T-RACT AACC compliance; and monitoring the ambient environment to assure the necessary control level has been achieved.

As a result, to provide health and environmental protectiveness and ensure enforceability and the effectiveness of the Fugitive Dust Control Plan:

- The facility should be Classified as Major A to ensure federal oversight of the simultaneous NAAQS and TAPs controls, and associated federal review and approval of the Fugitive Dust Control Plan should be required.

- The specific technical specifications, monitoring plan, and corrective action requirements of the Fugitive Dust Control Plan should be explicitly stated as Permit Conditions prior to issuance of the PTC, included in the Operating Permit, and be a condition for State and federal approval.

- The Permit Conditions should include explicit monitoring requirements for ambient air and the key emission factors (EF)s used in estimating PTE and T-RACT emissions. These are roadbed silt content, silt arsenic content, ambient air total PM and PM arsenic content at select property line locations and roadside locations within the facility, ambient PM10 at select property line locations, and VMT for all on-site traffic.

- The operational controls should be daily (PM10 related) and annual (PM and arsenic related) site-wide VMT limits. The operational VMT limits should be tiered, with tier levels related to the monitored EF and ambient concentrations. For example, the initial VMT limits would correspond to maintaining 4% silt content and 90 mg/kg arsenic in the silt. Should these silt and arsenic levels not be maintained, VMT operational limits shall be decreased, proportionately, to a lower VMT limited operational tier. Simultaneously, should PM, PM-arsenic or PM10 monitoring exceed ambient criteria, VMT limits should be lowered accordingly. There should be provisions to refine the tier levels at two year intervals, as site-specific data are obtained.

10.0 **RECOMMENDATION**

With respect to reviewing this T-RACT application, IDEQ is obligated to:

> **e.** If the Department determines that the applicant has proposed T-RACT, the Department shall determine which of the options, or combination of options, will result in the lowest emission of toxic air pollutants, develop the emission standards constituting T-RACT and incorporate the emission standards into the permit to construct. (5-1-94)
>
> **f.** If the Department determines that the applicant has not proposed T-RACT, the Department shall disapprove the submittal. If the submittal is disapproved, the applicant may supplement its submittal or demonstrate preconstruction compliance through a different method provided in Section 210. If the applicant does not supplement its submittal or demonstrate preconstruction compliance through a different method provided in Section 210, the Department shall deny the permit. (6-30-95)

This application is clearly deficient with respect to T-RACT and IDEQ should disapprove the Application for, at least, the following considerations:

- It based on PTE emissions that have not been calculated using conservative emission factors.

- The emissions used to support modeling are based on inappropriate multi-year averages and do not reflect PTE or T-RACT.

- The proposed operational limits on mine production will have no practical constraint on facility operations, emissions or ambient impacts.

- The post-model multi-year and lifetime averaging of exposures are inappropriate, as this facility's 16-year life of mine is not entitled to expend a receptor's equivalent 70- year of allowable exposure.

- Correctly applied, direct comparison of predicted maximum annual average ambient arsenic concentrations to the AACC shows a 30 factor exceedance, or 3 times the T- RACT AACC.

- Considerably higher levels of operational constraints will be required to support T- RACT. These limits are likely to require reductions in the proposed MODPRO2 levels of operations.

- The Permit Conditions are largely unenforceable, do not require any effective monitoring, or provisions for corrective actions, should the Applicant's assurances prove unachievable.

DEQ Response:

How DEQ reviews impacts associated with the proposed SGP is governed by *Idaho Air Rules* pertaining to permit applicability and permit issuance. While commenters may not agree with approaches directed by *Idaho Air Rules*, DEQ does not have latitude to deviate from what is established by rule. Comments suggesting the inappropriateness of approaches mandated by rules are outside the scope of this project and responses will not be provided.

As discussed previously, although some degree of uncertainty is present in all emission factors used in estimation emissions, all emission factors were adequately supported and the approach of estimating PTE at design capacity for combustion sources and at maximum throughputs for process sources was considered a conservative approach. The use of representative performance test data was determined to be valid and accepted by DEQ.

T-RACT is an emission standard based on the lowest emission of toxic air pollutants that a particular source is capable of meeting by the application of control technology that is reasonably available, as determined by DEQ, considering technological and economic feasibility. T-RACT is an allowable analysis to demonstrate preconstruction compliance for toxic air pollutants (IDAPA 58.01.01.210.12) that PRI has used to demonstrate compliance for arsenic.

Carcinogenic AACCs are expressed as annual averages, but as stated in DEQ's response to Comment 27, the definition of *Toxic Air Pollutant Carcinogenic Increments* in *Idaho Air Rules* Section 005.125, states, "Those ambient air quality increments based on the probability of developing excess cancers over a seventy (70) year lifetime exposure to one (1) microgram per cubic meter (1 $\mu g/m^3$) of a given carcinogen and expressed in terms of a screening emission level or an acceptable ambient concentration for a carcinogenic toxic air pollutant." Since the AACCs are based on a 70-year exposure, use of a 5-year averaging period is appropriate.

DEQ has incorporated requirements to monitor and record operational parameters that are limited in the permit, thereby making them practically enforceable.

OTHER COMMENTS

Comment 42 - ICL/SSFS: Mining/Processing Throughput Limits

The draft permit contains several throughput limits as defined in Permit Conditions 3.5 and 3.6. These conditions are artificial production limits on the facility, and will not have a bearing on the actual emissions being produced once the mine is simultaneously mining and also processing from stockpiled material. We have concerns that these artificial production limits are not actually enforceable in any way by IDEQ. Furthermore, we do not have any assurances that these artificial production limits will remain the same throughout the entire life of mine. For example, Figure 3.9 of the proposed mine plan[17] initiates and concludes with low rates over the 16 years of the mine with higher rates in the middle, making a five-year rolling average (like what is proposed in Permit Condition 3.5) meaningless in terms of limiting production.

Permit conditions should also be developed that establish throughput limits on the refining facilities and haul roads themselves, not just hauling and excavation tonnages. This is because the design capacity of the refining facilities exceeds the mine production capacity, and new ore could theoretically come in from other sources and be refined/processed at Stibnite. Without specific throughput limits on the refining process, those added emissions would not be considered.

Lastly, because IDEQ treats TAPs emissions on an incremental rather than cumulative basis, we can envision problems arising in a scenario where this facility gets permitted at the current throughput limits but then asks for an expansion five years down the road. If they are then permitted for an expansion, any increases in TAPs emissions will be permitted on a standalone basis rather than cumulatively on top of what was initially permitted. Ultimately, we are concerned that this is an approach the Applicant could use to circumvent being permitted as a TAPs Major Source in this initial PTC.

IDEQ should:

- Indicate how they plan to enforce these throughput limits and include additional measures in the permit to this effect.
- Add throughput limits for the refining and processing facilities.

DEQ Response:

27 As discussed previously in the Representativeness and Uncertainty of Emissions section, maximum hourly and daily activity rates were used to estimate the maximum 24hour and annual emission rates, and fugitive dust control requirements, emission rate limits, material activity rate limits, and supporting testing and monitoring, recordkeeping, and reporting (MRR) requirements were established as synthetic minor limits for the purposes of limiting facility-wide emissions of $PM/PM_{10}/PM_{2.5}$ to below 250 T/yr PSD applicability thresholds and Title V 100 T/yr applicability thresholds. These limits were also established for the purposes of limiting facility-wide emissions of single and total HAP to below HAP major source applicability thresholds (10/25 T/yr), and to ensure compliance with all NAAQS. Limits were established consistent with current DEQ guidance and the estimates of emissions and underlying assumptions were supported to the satisfaction of DEQ.

28 Enforceable monitoring, recordkeeping, and reporting requirements were established in the permit. $PM/PM_{10}/PM_{2.5}$ emissions limits for point sources were established with supporting activity rate limits and MRR requirements. While emissions limits and emission factors are not commonly included in the permit for fugitive sources, activity rate limits and MRR requirements were established for those sources that were identified as process rate-limiting (as summarized in Table 1.1 of the permit). These activity rate limits serve as surrogate emissions limits for PM, PM_{10}, $PM_{2.5}$, HAP and TAP from fugitive sources. Any emission increases or changes proposed after permit issuance will need to be evaluated as to whether they may require modification or revision of the PTC.

Comment 43 - NPT: Adverse impacts of dust control abatement on other resources

The Tribe is concerned about the impacts of dust abatement chemicals on soils, vegetation, and wildlife. As it is DEQ's mission to protect human health and the quality of Idaho's air, land, and water, the Tribe is including this concern with these comments on the PTC.

Magnesium chloride (MgCb) and MgCh-lignin sulfonate products used to suppress dust on roadsides can damage vegetation foliage, alter soil quality, move in roadside drainages of up to 98 m from roads, and accumulate over time, often to toxic concentrations, in trees and soils.[1] High MgCh soil concentrations from application caused mortality of Douglas-fir, lodgepole, ponderosa, and limber pines, and aspen in just two to four years.[2] Considering the life of the Project, the Tribe is concerned about long-term consequences to soils and vegetation from dust abatement chemicals.

Water is a scarce commodity in the project area. We are concerned that the limited quantity of water available is insufficient to meet permit conditions for use of water in fugitive dust control and water spraying for ore processing, and aggregate and concrete production. The quality of water is also a concern. The water source for dust control is proposed to be surface water diversion from the East Fork of the South Fork of the Salmon River, groundwater, and runoff ponds. USGS sampling indicates elevated arsenic in these waters.[3] Water quality should not create additional environmental burden if contaminated waters are used to water roads. This should have been considered in the T-RACT determination as described in IDAPA 58.01.01.210.14.

DEQ Response:

As described in the Technical Analysis section of the Statement of Basis and supporting documents, the proposed emissions and impacts of criteria, hazardous, and toxic air pollutants from various sources at the facility were evaluated by DEQ and determined to comply with applicable preconstruction requirements required for issuance of a permit to construct (PTC).

Comment 44 - NPT: Process flow description does not reflect applicant operations

Statement of Basis Facility Information Description and Figure 2 DIAGRAM OF PROCESS FLOWS are not updated to reflect Project operations.

DEQ Response:

Figure 2 in the Statement of Basis is representative of the processes modeled for compliance with the NAAQS which includes processes Sb1 and Sb2. The processes were removed from the permit, and no HAP or TAP emissions will be generated in the new Sb circuit.

Comment 45 - NPT: Limestone values are misleading

The limestone mineralogy is expressed as median concentration values from 98 samples, yet it appears that all 98 samples came from one single core MGI-17-431. This is misleading, and we question if the metal concentrations used in the emissions inventory coming from the 55,000 ore samples are also incorrectly characterized.

DEQ Response:

As described previously in the Representativeness and Uncertainty of Emissions section, metal hazardous air pollutant (HAP) and toxic air pollutant (TAP) emissions from process materials were based on median measured metal concentration profiles from onsite core samples of ore and limestone materials, including 98 samples of PRI limestone and over 55,000 samples of PRI ore. PRI has confirmed that ore samples were taken primarily from the mineralized zones of the PRI pits and were representative for the purposes of estimating emissions. PRI

has confirmed that the use of mineralized metal profiles is conservative when compared to low-mineralization materials such as development rock and clean gravel and it is pretty typical that approximately 100 samples come from each core.

Comment 46 - NPT: No accounting for winter impacts on water controls

Permit condition 3.12 requires water control for ore processing crusher and conveyer at all times. Permit condition 5.10 also requires water control for portable crushing and screening at all times. When water freezes during low temperatures, water control will not be feasible. Therefore, each ore processing crusher and conveyor (3.12) and each portable crushing and screening plant (5.10) should not operate at temperatures below freezing or there will be no control of fugitives from these emission units (EUs). If any chemical(s) is added to the water to lower freezing and thus extend ability to use water control, they and their effects should be disclosed. Please address these concerns about freezing-weather operations for these permit conditions.

DEQ Response:

As discussed previously in the response to comment 3, modeling analyses for the project, prior to refined adjustments, shows all modeled PM_{10} violations occur during the winter (Statement of Basis, Appendix B) where emissions and background levels are likely overestimated. Data provided in the SGP baseline study specify an average snow depth of 21-68 inches and an average precipitation of 6.0 inches at the project site during this period. Therefore, fugitive dust emissions from emission units and roads during high-modeled impact hours could be overestimated. Permit condition 3.12 references Permit conditions 2.1 through 2.6. Permit condition 2.6 requires a FDCP which at a minimum contains requirements to apply water or suitable dust suppressant chemicals to transfer points, screening operations, and crushing operations as necessary to control fugitive dust.

Comment 47 - NPT: Clarification needed on 3.9 Prill Loading Limit

Permit condition 3.9 Prill Loading Limit is unclear: "The permittee shall not load in excess of 200 T/day nor and 9,000 T/yr of prill (ammonium nitrate) to the prill silos." The use of"nor and" is confusing. Please clarify the intent of this section.

DEQ Response:

As a result of the public comment, Permit Condition 3.9 has been revised to remove “nor”. The permit condition is intended to limit the prill loading to 200 T/day and 9,000 T/yr.

Comment 48 - NPT: Comments on Table 1.1 Regulated Sources

Table 1.1 in the permit lists all sources of regulated emission in the permit. For clarity it would be easier to follow the permit and check limits for all the EUs if their Source ID No. were carried over from Table 1.1 to the remaining tables throughout the permit. Additionally, it is unclear if the control efficiency and maximum process rates listed in Table 1.1 are enforceable. The comments that follow are from checking the source ID listed in Table 1.1 for consistency in the permit and Statement of Basis.

- For the Mercury Retort and Induction Melting Furnace, Table 1.1 has a maximum process rate of 1,000 lb/batch and 21 T/yr. Monitoring in permit conditions 4.22 and 4.23 does not include monitoring of batch rather only weight is monitored. If only weight is recorded there is no criteria to measure compliance with the batch limitation.
- The emission units LS9-LS12 are missing a permit operating limit to ensure maximum process rate of 267 T/day.
- Statement of Basis application scope lists PS in ore processing. Assuming PS is PS1-2- L/U, in Table 1.1 of the permit, they (PS1-2-L/U) are listed under mining.
- Rock dumps and storage piles are missing from the Statement of Basis application scope.

- In Table 1.1 of the permit all mining sources except Prill Silos (PS1-2-L/U) have FCDP listed as Control Equipment. In Table 3.1 Mining and Ore Processing Control Device Descriptions some sources retain the FDCP as a listed Control Equipment (Drilling and Blasting) while others do not (Excavating and hauling activities) and some sources do not appear at all in Table 3.1 (rock dumps and storage piles).
- Although there is a facility-wide fugitive dust control and permit conditions 3.10 and 5.9 direct permittee to control fugitive dust, Reasonable Control and FDCP are listed in Table 1.1, but are missing from corresponding Tables for Control Description Descriptions for the following EUs: OC1-OC13, PCSP1, PCSP2, CM.
- For EUs EDG1-3 in Table 1.1, please allow for better performance control equipment, we suggest modifying EPA Tier 2 technologies to "EPA Tier 2 technologies or better".

DEQ Response:

The Mercury Retort and Induction Melting Furnace have a design limit of 1000 lb/batch as seen in the application. The monitoring requirements in Permit Conditions 4.22 and 4.23 require monitoring in lb/day. The mercury retort runs for 24 hours so therefore lb/batch and lb/day are the same measurement.

Lime production limits for LK, LCR, and LS-L/U are limited by the Parallel Flow Regenerative Kiln output limit in Permit Condition 5.5. As can been seen in the Lime Production Flow Diagram in the application, 267 tpd in the maximum capacity and input to the Kiln (LS9-LS12). DEQ chose to limit the output of the Kiln as seen in Permit Condition 5.5 (169 T/day).

As a result of the public comment, rock dumps and storage piles have been added under the Statement of Basis' application scope section to ensure all activities are included. Prill silos have been moved from ore processing operations to the mining activities under the Statement of Basis' application scope section to ensure consistency with Table 1.1 of the PTC.

As a result of the public comment, Table 3.1 of the PTC has been revised to include reasonable control and FDCP as control devices for the excavating and hauling activities as well as all other emission sources in the Table (OC1 – OC13). Rock dumps and storage piles have been added to Table 3.1 with the corresponding control devices of reasonable control and FDCP. Table 5.2 has been revised to include reasonable control and FDCP as control devices for the Aggregate Production Plant Emissions Units/Processes (PCSP1 and PCSP2) as well as the Central Mix Plant (CM). The Prill Silos (PS1-2-L/U) are not controlled under the FDCP as the material can be explosive and are treated differently.

Emission units EDG1-3 in Table 1.1 are specified to be EPA Tier 2 certified engines but there is no prohibition on the units meeting emissions limits more stringent than those required of EPA Tier 2 certified engines.

Comment 49 - TIFO: Conclusions of fourth comment submittal

- Each of the Permit to Construct (PTC) applications and Operating Permits proposed to date have lacked an objective treatment of potential emissions and ambient impacts.
- The initial proposals largely ignored massive emissions of toxic and hazardous air pollutants.
- Revisions of the PTC analyses have shown that approval of the previously proposed permits would have allowed significant exceedances of health standards; with no provision for monitoring, measurement, corrective action, or opportunity to seek federal relief.
- Significant emission sources excluded from Source Classification calculations as mining fugitive emissions could be mis-classified and considered as attendant to included mineral processing point or federally listed sources. IDEQ should carefully review these sources for inclusion in total emissions compared to Major Source thresholds.
- Significant under-estimation of haul road fugitive PTE emissions continues in this PTC. The estimates are not conservative as required by Idaho Code. IDEQs claim the Applicant's intentions to operate below design capacity is not a conservative emission estimate. Calculating PTE at design capacity has been

standard practice since the inception of the Clean Air Act. IDEQ conflates this long-held principle with the requirement to use conservative data in estimating AP-42 unpaved road emission estimates.

- The current proposed PTC continues to underestimate potential emissions, but acknowledges when using these minimal estimates, that compliance with health standards is not achievable with reasonably available control technologies (RACT).
- This application requests T-RACT relief from compliance with the cancer-related health standards, in contrast to the previous PTC version assertions of meeting all standards and being protective of public health, using the same controls.
- The additional operational controls (T-RACT) offered to guarantee meeting the relaxed standard require reducing the facility's allowable emission by 57%. Both the calculations supporting the required emission reduction and efficacy of the underlying operational controls are insufficient, rely on inappropriate averaging and dilution techniques, and impose no enforceable reduction in emissions or ambient air quality improvements. Greater reductions in emissions and substantial production curtailments will be required to achieve compliance.
- Alleging compliance with carcinogenic health risk standard in this PTC required multiple dilution techniques including i) using non-conservative emission factors, ii) requesting T-RACT relief from the health standard, iii) inappropriate averaging of T- RACT arsenic emissions, and iv) two levels of inappropriate post-modeling averaging of ambient air concentrations; resulting in order-of-magnitude under-predictions of arsenic exposures.
- The refined air quality modeling underlying the T-RACT analysis suggests that the massive disturbance of toxic arsenic contemplated, in this proposed multiple open-pit mining and co-located mineral processing operation, cannot meet air quality criteria in the complex terrain and challenging environmental setting of Stibnite.
- This is the third draft attempt to bring this insufficient PTC application into compliance. In the public interest IDEQ should dis-approve the PTC and require a new Application that objectively presents the emissions and controls required to comply with State and federal requirements.

DEQ Response:

29 As discussed in previous responses, maximum hourly and daily activity rates were used to estimate the maximum 24hour and annual emission rates, and Fugitive Dust, Emissions Limits, material activity rate limits, and supporting testing and monitoring, recordkeeping, and reporting (MRR) requirements were established as synthetic minor limits for the purposes of limiting facility-wide emissions of $PM/PM_{10}/PM_{2.5}$ to below 250 T/yr PSD applicability thresholds and Title V 100 T/yr applicability thresholds. These limits were also established for the purposes of limiting facility-wide emissions of single and total HAP to below HAP major source applicability thresholds (10/25 T/yr), and to ensure compliance with all NAAQS. Limits were established consistent with current DEQ guidance and the estimates of emissions and underlying assumptions were supported to the satisfaction of DEQ.

30

DEQ contends that the operational limits on mine production are sufficient, reasonable, and appropriate to ensure compliance with applicable requirements including National Ambient Air Quality Standards (NAAQS) at a sufficient level of confidence to support permit issuance. Relevant conditions include material throughput and operational limits (Permit Conditions 3.3-3.9, 4.5-4.12, 5.4-5.9, 6.3), emissions limits (Permit Conditions 4.3-4.4, 5.3), control device requirements (Permit Conditions 3.10-3.12, 4.13-4.17, 5.10-5.16), and testing (Permit Condition 4.33) requirements. To ensure enforceability of each of these requirements, supporting testing and monitoring, recordkeeping, and reporting (MRR) requirements were also included.

In accordance with IDAPA 58.01.01.006. a stationary source is defined as any building, structure, facility, emissions unit, or installation which emits or may emit any air pollutant. The fugitive emissions shall not be considered in determining whether a permit is required unless required by federal law. For New Sources Review permitting purposes, the fugitive emissions shall not be considered in determining whether the facility is major unless the facility is a designated facility per IDAPA 58.01.01.008.10.c.i. A gold mine is not a listed designated facility under IDAPA 58.01.01.006.30 and therefore fugitive emissions are not considered. Fugitive emissions of criteria pollutants are counted toward PSD classification from designated

facilities such as the lime plant. Lime plant fugitive emissions are quantified under the PSD Classification section of the Statement of Basis.

For Title V permitting purposes arsenic is a HAP and arsenic fugitive emissions from haul roads do count towards the major source determination of 10 tons per year of any HAP and 25 tons per year for any combination of HAP. Accounting for water and chemical dust suppressant control efficiencies and use of the equations cited from AP-42 Section 13.2.2 (11/2006) for unpaved roads and site-specific silt values supports an arsenic HAP PTE from the haul roads of 30.3 tons per year (T/yr) for uncontrolled emissions (above 20 T/yr as described in the Statement of Basis) and 2.03 T/yr for controlled emissions. Despite the noted limitations of using AP-42, these equations remain commonly used and accepted by DEQ.

As discussed previously in the Representativeness and Uncertainty of Emissions section above, the estimates of emissions and underlying assumptions were supported to the satisfaction of DEQ, and sufficient information was provided to demonstrate preconstruction compliance with applicable TAP and mercury standards and to support facility classifications. Key assumptions identified in this section and by the commenter (including 93.3% control efficiency for haul roads) were confirmed by PRI and accepted by DEQ, and were the basis of the facility classifications.

T-RACT is an emission standard based on the lowest emission of toxic air pollutants that a particular source is capable of meeting by the application of control technology that is reasonably available, as determined by DEQ, considering technological and economic feasibility. T-RACT is an allowable analysis to demonstrate preconstruction compliance for toxic air pollutants (IDAPA 58.01.01.210.12) that PRI has used to demonstrate compliance for arsenic.

SECOND PUBLIC COMMENT PERIOD

DEQ provided a second public comment period on the proposed PTC for PRI from February 18 – March 19, 2021, in accordance with IDAPA 58.01.01.209.01.c. During this period, comments were submitted in response to DEQ's proposed action. Public comments regarding the technical and regulatory analyses and the air quality aspects of the proposed permit are summarized below. Questions, comments, and suggestions received during the comment period that did not relate to the air quality aspects of the permit application, the Department's technical analysis, or the proposed permit were not addressed. It is also noted that many of the topics discussed during the second public comment period were addressed in the third public comment period and therefore have not been included below.

Comment 1 – A. Michaels: Environmental impacts

DEQ seeks comment on draft permit to construct for Midas Gold Idaho Inc.'s Stibnite Mine. I am reading through the Statement of Basis and seeing things like chemical treatment (lime, caustic soda, hydrogen peroxide, copper sulfate, etc.), lime production, concrete manufacturing, diesel, gas, and more. Seriously? Do we want to introduce these things into this area - again and in excess of what was likely used in the mining process in the past? Have you seen the other mine sites around the area (Cinnabar) and how horrible they look? The environmental toll is devastating. Please don't allow more mining in this area. Let this area heal from the wounds already inflicted rather than add more.

And Meadow Creek runs right through the site which flows to a high mountain like, Meadow Creek Lake. Please consider the aquatic species, birds, and other animals that drink and or live in the water that will be impacted by the mine operation.

DEQ Response:

As described in the Technical Analysis section of the Statement of Basis and supporting documents, the proposed emissions and impacts of criteria, hazardous, and toxic air pollutants from chemical treatment, lime production, concrete manufacturing, and diesel and gas storage and combustion were evaluated by DEQ and determined to comply with applicable preconstruction requirements required for issuance of a permit to construct (PTC).

Comment 2 – PRI: Cyanide emissions and monitoring

General Comment: Conditions in the draft permit to construct for cyanide emissions were first reviewed by Perpetua during this public comment period. The Department proposed an annual emissions limit for cyanide of 1.99 tons per year (Proposed Condition 4.4) and proposed operating constraints atypical of other mining projects (Proposed Condition 4.5). The proposed emission limit reflects Perpetua's estimate of actual emissions during normal operations, as presented in the application. Perpetua requests an emissions limit that ensures compliance with the minor source threshold for hazardous air pollutants (<10 tons per year) and affords operational flexibility. In addition, Perpetua requests a monitoring approach to collect data (pH and free cyanide concentrations) to use in calculations that confirm compliance with the emission limit. Specific language is suggested below to revise Proposed Conditions 4.4 and 4.18. Consistent with this approach Perpetua requests deletion of Proposed Condition 4.5 and Table 4.3 that impose process limits on pH and free cyanide because these values may vary during normal operations (making compliance with operating limits challenging); however, Perpetua can control operations to ensure compliance with the annual HAP emissions limit.

Specific Comments: To ensure compliance with the HAP minor source emissions limit, Perpetua proposes the revisions to proposed sections noted below, plus deletion of the operational constraints.

Emission Limits

4.4 Cyanide and Carbon Disulfide Emissions Limits

Facility-wide emissions shall not exceed 0.063 tons per year of carbon disulfide and 2.4 tons per year of cyanide

compounds. Compliance with the annual 2.4 ton per year limit shall be demonstrated on a rolling twelve-month basis as prescribed in Condition 4.18.

[Justification for revised emission limit: the revised emission limit establishes a compliance margin consistent with DEQ practice of approximately 20% over the actual emission during normal operations presented in the Application.]

Operating Limits [Perpetua proposes deletion of Proposed Condition 4.5 and Table 4.3]

[Justification for deleted operating limits: mines are not typically required to adhere to pH and free CN enforceable limits because the process conditions and material characteristics are variable; demonstrating compliance with the new emission limit in Proposed Condition 4.4 (2.4 tons per year) is now reflected in Proposed Condition 4.18 (Monitoring and Recordkeeping).]

Monitoring and Recordkeeping

4.18 Cyanide Specifications Monitoring

Each day, the permittee shall monitor and record the pH and free cyanide concentration level(s) in grams per cubic meter (g/m^3) from each cyanide leach and detox tank and use this information to determine compliance with the 2.4 tons per year emissions limit in Condition 4.4.

Each month, the permittee shall monitor and record the pH and free cyanide concentration level(s) in grams per cubic meter (g/m^3) from each tailings reclaim stream and use this information to determine compliance with the 2.4 tons per year emissions limit in Condition 4.4.

The recorded daily and monthly information shall be used to determine compliance with the 2.4 tons per year emissions limit in Condition 4.4 on a rolling twelve-month basis using Equation 1:

Equation 1

$$r_v = k_g \alpha_0 C_l H A F_a F_w$$

Where,

r_v = hydrogen cyanide emissions from surface (g/s)

k_g = gas phase mass transfer coefficient (m/s)

α_0 = non-ionized cyanide fraction determined from pH and pK_a (ionization coefficient)

C_l = total liquid phase free cyanide concentration (g/m^3)

H = Henry's Law Coefficient (g/m^3 per g/m^3)

A = process surface area (m^2)

F_a = area factor

F_w = wind factor

The devices and methodologies used to measure and free cyanide concentration, pH, and other variables of Equation 1 shall be identified in the O&M Manual.

[Justification for revised monitoring and recordkeeping: recording operating parameters and calculating emissions on a rolling 12-month basis will confirm continuous compliance with the new (2.4 tons per year) cyanide emission limit in Proposed Condition 4.4.]

DEQ Response:

Permit Condition 4.18 (cyanide emissions limit compliance monitoring) and Permit Condition 2.20 (O&M manual requirements) were updated consistent with the request for emissions tracking for operational flexibility. For clarification purposes, Permit Condition 4.5 (facilitywide carbon disulfide emissions limit) was separated

from Permit Condition 4.4 (facility-wide cyanide emissions limit); both limits remain unchanged and were established consistent with emissions estimates included in the application.

All emissions limits, reagent usage, and process limits in the permit were established based on the emissions estimates presented in the application as potential emissions (PTE). It was considered reasonable and appropriate to allow for monitoring of actual process parameters and monthly estimation of emissions to comply with the facility-wide cyanide emissions limit. With emissions tracking, although pH and concentration process limits were removed, monitoring of these and temperature were included on a daily basis to ensure that all inputs necessary for calculating emissions are monitored. The equation for estimating cyanide emissions was included and variables cited in the O&M manual requirements.

Comment 3 – PRI: Editorial corrections

*General Comment***:** Perpetua requests several editorial corrections for proposed permit terms.

Specific Comments: The Source ID No. and Source description lists "CIP Leach 1-4 Carbon-in-Pulp Leach Tanks," "CIL 1-6 Carbon-in-Leach Tanks," "CIP 1-6 Carbon-in-Pulp Tanks," and "CN Detox 1-2 Cyanide Detox Tanks" (Proposed Condition 1.2). To provide configuration and operational flexibility, Perpetua requests that this equipment be grouped under a single Source ID No. labeled "CN Tanks" with a single Source description of "Cyanide Leach and Detox Tanks" as shown below.

Source ID No.	Source	Control Equipment	Maximum Process Rate
CN Tanks	Cyanide Leach and Detox Tanks	Chemical Treatment for maintaining pH	n/a

A maximum process rate is listed with the CIL and CIP tanks of "1,700 T/yr PAX" (Proposed Condition 1.2). This information more appropriately fits with the floatation circuit. Please revise as shown below.

Source ID No.	Source	Control Equipment	Maximum Process Rate
Float Tanks	Floatation tanks	None	1,700 T/yr PAX

Please revise Proposed Condition 2.20, Bullet 6 of 7 to read: "Permit Conditions 3.53.8, 4.8, 4.12, and 5.45.8." Please revise Proposed Condition 2.20, Bullet 7 of 7 from "each tailings stream" to "each tailings reclaim stream." The reclaim streams are used to measure the bulk solution of the tailings facility.

DEQ Response:

Permit Conditions 1.2 (Table 1.1) and 2.20 were updated. Updates were consistent with potassium amyl xanthate (PAX) being used and carbon disulfide emitted in the floatation circuit, and cyanide being used and emitted in the cyanide leach tanks, detox tanks, electrowinning cells and pregnant solution tank, and barren tanks. The referenced permit numbers and description of the tailings reclaim streams were also updated as requested, and correction made that the rate monitored for the electrowinning cells and pregnant solution tank is a volumetric flow rate. The emissions calculations associated with reagent usage were presented as potential emissions (PTE) in the application, and as such increasing the facilitywide emissions limit for cyanide and compounds to accommodate a surplus compliance margin was not supported.

In implementing emissions tracking as described in the response to the previous comment, monitoring and recording of parameters necessary for estimating emissions from the Cyanide Leach Tanks and Cyanide Detox tanks was also required (e.g., quantity of tanks, tank dimensions, pH, temperature, and cyanide concentration).

Comment 4 – SSFS: Non-carcinogenic TAP analyses underestimated the emissions rates of acute exposure to iron and aluminum from fugitive dust.

The basic underpredictions of fugitive emissions due to the use of unreasonably low silt content value, as

discussed above, indicate that the true potential to emit other IDAPA § 585 TAPs, such as iron oxides and aluminum, could also be significantly underpredicted. Calculations of IDAPA § 585 TAP increments also suffer from cherry-picking of data so as to make it appear that emissions will comply with the stated increments in IDAPA §58.01.01.585.

According to IDEQ guidance, IDAPA § 585 TAPs exposure limits should be calculated from the maximum potential impacts over 24 hours for comparison against the acute impact limits. Modeling pollutants with short-term ambient air standards requires the use of a potential emissions rate that occurs over the duration of that averaging period, which for IDAPA § 585 TAPs is a maximum daily emissions. This would require conservative estimates that are well above the median rate of emissions; in other words, emission rates should be based on a concentration much higher than the median, and closer to the 90th percentile of the concentration of the pollutant in the source material.

The analyses of the short-term effects of iron and aluminum emissions here, however, were based on the median concentrations of those metals in the development rock samples in the assays, thus potentially significantly underestimating the predicted emission rates. Additionally, compounding factors, such as an underestimation of silt content value, enrichment from physical effects of heavy road traffic, and deposition (which increases TAP concentrations in surface materials over time), and basing emissions on PM rather than PM10, have all contributed to an underestimation of emission rates.

Moreover, it is unclear - because there is no development rock management plan and no specified preferred alternative by the Forest Service - exactly what material will be used for haul roads. As discussed above, one alternative in the DEIS proposes using development rock as well as spent ore disposal area material, while the MODPRO2 - which is yet to be evaluated by the Forest Service - only mentions the use of development rock. This uncertainty and lack of planning calls into question the data presented in the permit to construct and Statement of Basis.

The data presented in the application for the permit to construct already indicate that ambient air concentrations of iron will increase by 14.1%, and 5.5% for aluminum. IDEQ's review of these analyses in the Statement of Basis indicates impacts as high as 27% for iron and 10% for aluminum. It is likely, based on the discussion above, that a new analysis of the impacts of iron and aluminum would show that emissions would cause exceedances of the ACC ambient impact limits that go beyond the emission limits established in IDAPA 58.01.01.585 for non carcinogenic TAPs, creating a noncompliant ambient impact and unacceptable public health inhalation risk.

Conclusion

Based on the comments above, SSFS asks that IDEQ deny this draft permit to construct.

DEQ Response:

As discussed previously in the Representativeness and Uncertainty of Emissions section, the estimates of emissions and underlying assumptions were supported to the satisfaction of DEQ, and sufficient information was provided to demonstrate preconstruction compliance with non-carcinogenic TAP requirements. Key assumptions identified in this section and by the commenter (including 93.3% control efficiency for haul roads, 4% silt content, and use of median concentrations including for iron and aluminum) were confirmed by PRI and accepted by DEQ, and it was not demonstrated that the alternative underlying assumptions presented were more accurate or appropriate than data provided by PRI and accepted by DEQ. Although a median value of sampled silt percentages of roadway material was used in emission estimates presented in the application, DEQ recognizes the importance of the silt content parameter in the estimation of emissions. Since compliance with the 24-hour PM_{10} National Ambient Air Quality Standards (NAAQS) is the primary driver of NAAQS compliance, minimizing variability of the parameter is very important to ensure NAAQS compliance. To achieve this, the permit will limit *maximum silt content* to 4.0 %, as specified in Section 3.13 Haul Road

Capping of the PTC as well as associated monitoring and recordkeeping. PRI has confirmed that the use of mineralized metal profiles is conservative when compared to low-mineralization materials such as development rock and clean gravel.

Despite the noted limitations of using AP-42, these equations remain commonly used and accepted by DEQ. And while the use of an average or 90th percentile value is a more conservative approach (for silt content and/or metal concentrations), the use of site-specific median values combined with estimating and modeling PTE at design capacity and maximum activity rates was considered a sufficiently conservative approach and is commonly accepted by DEQ. Maximum hourly and daily activity rates were used to estimate the maximum 24 hour and annual emission rates. The use of enrichment factors has not been required, and DEQ is unaware of any prior instances in which such factors were applied.

FIRST PUBLIC COMMENT PERIOD

DEQ provided a first public comment period on the proposed PTC for PRI from September 10 – October 12, 2020, in accordance with IDAPA 58.01.01.209.01.c. During this period, comments were submitted in response to DEQ's proposed action. **P**ublic comments regarding the technical and regulatory analyses and the air quality aspects of the proposed permit are summarized below. Questions, comments, and suggestions received during the comment period that did not relate to the air quality aspects of the permit application, the Department's technical analysis, or the proposed permit were not addressed. It is also noted that many of the topics discussed during the first public comment period were addressed in the second and third public comment periods and therefore have not been included below.

Comment 1 – PRI: Editorial corrections

Condition 2.6: The condition currently references "(Permit Conditions 2.1–2.4)." With the addition of Condition 2.5, the reference may need to be updated to "(Permit Conditions 2.1–2.5)."

DEQ Response:

Permit Condition 2.6 was revised to correct the condition referenced to Permit Condition 2.5.

Comment 2 – PRI: Editorial corrections

Condition 2.20: Please correct the condition cross-reference from "0" to "5.3."

DEQ Response:

Permit Condition 2.20 was revised to correct the condition referenced to Permit Condition 5.3.

Comment 3 – PRI: Editorial corrections

Condition 3.2: Please correct the table cross-reference from "1.1" to "3.1."

DEQ Response:

Permit Condition 3.2 was revised to correct the table referenced to Table 3.1.

Comment 4 – PRI: Visible emission monitoring frequency

Condition 4.34: Please change the visible emission monitoring frequency from "each test run" to "each test." This request is made based on industry-standard practices and review of similar requirements in other permits. Monitoring frequency of once per each test run seems excessive and unnecessary as these source types typically do not generate visible emissions.

DEQ Response:

Permit Condition 4.34 was revised to reduce the frequency of visible emissions monitoring to once per test. The proposed frequency was considered reasonable and appropriate for capturing representative emissions during each performance test. This is also consistent with DEQ source testing guidance.

Comment 5 – TIFO and ICL: Toxic metals

With regard to toxic metals, the screening analysis indicates potential exceedance of carcinogenic and non-carcinogenic toxicity criteria for arsenic (As), antimony (Sb), cadmium (Cd), nickel (Ni), and mercury (Hg). Despite considerable uncharacterized uncertainties in the source terms and emissions estimates that cannot

be appropriately evaluated without a representative material balance for toxic metals, DEQ has dismissed any concern relative to these toxins based on modeling results.

This facility anticipates mining and processing an estimated 200 to 600 tons of Hg, 200K to 1M tons of Sb, 400K to 1M tons of As. Approximately 85% of the Sb and some undetermined fraction of the Hg will exit the site as product. The remaining toxic metals will be discharged to various environmental media, sinks, and repositories on-site or shipped to hazardous waste facilities. The applicant projects that the most significant thermal source on the site will exhaust 0.2 pounds per year (lb/yr) of Hg over 20 years to the atmosphere. This extraordinary level of control must be verified by material balance calculations to be relied upon. The applicant has not produced a material balance for toxics, and DEQ has not assessed the overall coherence of toxic metal pathways necessary to verify the applicant's assertions.

It seems that the draft permit does not require measurement, monitoring, reporting, or testing of toxic metals either in the process streams, emissions, or releases from the operations during the entire 20-year life of mining, milling, and refining. With respect to toxic metals, the permit only requires the applicant to operate the equipment in conformance with manufacturer's recommendations with the implicit assumption that this will result in health-protective Hg, Sb, As, Cd, and Ni ambient concentrations. If this interpretation is correct, then neither the emission estimates nor ambient metals concentrations will be verified by DEQ. This conclusion should be reconsidered after thorough review of a material balance.

DEQ Response:

A response and HAP/TAP application addendum were submitted by PRI that included new HAP and TAP emission estimates, new and revised TAP increment compliance demonstrations, and a sourceby-source inventory of HAP and TAP emissions. After exclusion of sources addressed by NSPS and/or NESHAP, applicable emission sources from concrete production and HVAC were evaluated for compliance with TAP increments, and compliance with TAP provisions was demonstrated. After exclusion of sources within a source category subject to an area source NESHAP (40 CFR 63), emissions from the remaining applicable nonfugitive sources in aggregate production, concrete production, and HVAC were evaluated for compliance with the Mercury Emission Standard (Table 6).

Any uncertainties in metal HAP and TAP emission estimates are not expected to affect classification as a HAP minor source or to affect compliance with TAP provisions. Although some degree of uncertainty is present in all emission factors used in estimating emissions, all emission factors were adequately supported and the approach of estimating PTE at design capacity for combustion sources and at maximum throughputs for process sources was considered a conservative approach. The use of representative performance test data (i.e., autoclave emissions data from Nevada operations) was determined to be valid and accepted by DEQ.

Comment 6 – TIFO: NDEP

The application makes several references to similar operations in Nevada regulated by the Nevada Division of Environmental Protection (NDEP). However, there are significant differences between the DEQ and NDEP regulatory approaches that could question DEQ's reliance on data from the Nevada operations cited. NDEP guidance cites AP-42 and material balances as the two main sources for developing emission factors for the mining industry.

According to NDEP website information sources, NDEP requirements are significantly more stringent than DEQ's. NDEP has implemented the Nevada Mercury Control Program (NMCP) that applies Hg emissions controls on thermal units located at precious metal mines that include both the EPA promulgated NESHAP Subpart 7E and additional NMCP permitting conditions. NMCP requires that all precious metal processing facilities that operate, construct, or modify a thermal unit that emits Hg must apply for, and obtain, a Mercury Operating Permit to Construct. DEQ is requiring only the minimal federal requirements and a generic PTC. NESHAP Subpart 7E sets Hg emission limits for three source categories that are groups of units promulgated in 2013; two of which apply to this application. NMCP requires unitlevel emission limits that are periodically re-evaluated for applicable sources. DEQ relies on alleged similar NDEP emission reports to assess NESHAP

Subpart 7E compliance, with Hg emission data presented from two Nevada operations (Goldstrike and Twin Creeks) to show that these facilities are in compliance with allowable limits.

This somewhat convoluted analysis portends that 2 autoclave examples from Nevada operations show that these facilities are, respectively, utilizing 0.2% to 10.9% of the 84 lb/ton allowable Hg emission; and 14.2% to 27.4% of the allowable 0.8 lb/ton concentrate carbon-based mercury retort emission limit. It is then assumed a nominal 10.0% and 20.0%, respectively, will be utilized at Stibnite. This results in an estimated 21.34 lb/yr emissions from the autoclave and 3.36 lb/yr retort emissions. The ** footnote suggests the actual autoclave emissions will be an extremely low 0.2 lb/yr.

The assertion that these two facilities operate in compliance with the federal portion of the Nevada permit is not conclusive evidence that the Stibnite facility will meet the standard without showing that the ore composition, process parameters and operational factors are comparable.

NESHAP Subpart 7E Mercury Sources

Subpart 7E Description	**Oper. ton/yr**	**% of Subpart 7E hr/yr**	**for Controlled Systems**	**Hg Emissions* lb/hr**	**Controlled Hg Emissions* lb/yr**	**ton/yr**
Autoclave	** 0.107	8,760	10.0%	0.002	21.34	0.011
Refinery Sources (Kiln, EW, Retort, Furnace)	0.008	1,248	20.0%	0.003	3.36	0.002
Total 7439-97-6	0.115			0.005	24.70	0.012

*Based on Similar Source Hg Reporting Levels provided below

**Expected actual emissions from Autoclave: 0.0105 g/hr, 2.3E-05 lb/hr, 0.20 lb/yr (M3 2019)

Similar Source Hg Reporting Levels
Goldstrike Autoclaves 2 & 3 (2015 & 2016 Hg Reports) = 10.9%
Twin Creeks Autoclaves 1 & 2 (2015 & 2016 Hg Reports) = 0.2%
Goldstrike Refinery (2015 & 2016 Hg Reports) = 14.3%
Twin Creeks Refinery (2015 & 2016 Hg Reports) = 27.4%

Review of the cited sources is confusing. There is an obvious and considerable difference in the two example reported values with no explanation for the difference or why the nominal values for the analysis were selected. The State of Nevada regulates more than 35 mines with applicable thermal process units, and has accumulated hundreds of emission test results. There is no indication in the DEQ application as to why these two particular test results were offered to demonstrate compliance with the applicable NESHAP requirements. The Goldstrike autoclaves report 32 lb/yr in 2016 and a facility-wide release of 271 lb/yr and has ranged from 166 to 709 lb/yr over the previous decade. The unusually low 0.2 lb/yr attributed to (M3 2019) is an undated and unlabeled excel sheet attachment to an email requesting various process information with the single cited value in a column title “Final Cleaned Autoclave Vent Offgas to Atmosphere.” It is not discernable from the referenced material what facility or process stream this test result applies to and any indication is appropriate for consideration in relation to the Stibnite proposal.

The application also references pages from the Nevada Operating permit. The NDEP Barrick Goldstrike Mine Class 1 Permit is 148 pages and does not include an antimony facility. The Draft DEQ Permit, in contrast, is 34 pages and requires almost no toxic metal monitoring, testing, reporting or assessment during the life of the mining operation.

Additional comments were provided discussing the relative jurisdictional risk of other states to that of Idaho.

DEQ Response:

PRI confirmed in the response to a request for additional information that the emissions data from Barrick Goldstrike Mines relied upon to estimate emissions is representative of the proposed autoclave and process, and that the remaining thermal source will not be constructed and will be replaced instead by a dewatering/packaging circuit. As a result, the antimony process dryer and bagging operation emission sources Sb1 and Sb2 were removed from the permit.

While it is acknowledged that there are differences between Idaho and Nevada regulatory programs and requirements, compliance with applicable federal regulations and state Rules for the Control of Air Pollution in Idaho (Rules) are required to obtain a PTC. Beyond the explicit Hg emission limits for sources in NESHAP Subpart 7E, HAP and TAP particulate metals are regulated indirectly (i.e., surrogate limits) via facility wide fugitive dust requirements, material throughput and operational limits, PM emission limits, and control device requirements. DEQ views these limits as sufficient to ensure compliance with applicable HAP and TAP requirements based on estimates of potential emissions and predicted modeled TAP concentrations, and the accuracy of autoclave and refinery emission sources estimates will ultimately be determined via testing as required by NESHAP Subpart 7E.

Comment 7 – NPT: Fugitive emissions from the tailings storage facility

The permit does not, but must, include the potential for fugitive emissions from the tailings storage facility. There are no fugitive emissions from the tailings storage facility in the emissions inventory or appended to the Statement of Basis. Significant fugitive emissions were seen from the tailings storage facility of the Thompson Creek Mine based on an aerial tour of the Thompson Creek Mine, and similar emissions are expected from the project. In addition to PM10 emissions, fugitive tailings would have higher metals and cyanide concentrations than other fugitive emissions at the mine and would thus be more injurious to the environment. The potential to emit concentrations of PM10, metals, and cyanide from the tailings storage facility should be included in the emissions inventory and modeled emissions scenarios and appropriate emissions controls should be identified in the permit.

DEQ Response:

A response and HAP/TAP application addendum were submitted by PRI that included new HAP and TAP emission estimates, including cyanide and carbon disulfide from the TSF (tailings storage facility). In the response to a request for additional information, PRI confirmed it will have one TSF as identified in Figure 1 of the PTC application, in the Meadow Creek drainage upstream of the Hangar Flats pit and adjacent to (west of) the Hanger Flats Development Rock Storage Facility (DRSF). The TSF has the potential to emit mercury and hydrogen cyanide (HCN) due to evaporative flux. Spent ore from the mill will be pumped (not hauled) to the TSF as thickened tailings slurry. This process will not create criteria pollutant nor HAP/TAP emissions. The majority of the TSF surface will be either wet beach or a supernatant liquid, with some dry areas. PM from dry beach areas was estimated using EPA's wind erosion equations in AP-42 Section 13.2.5, Industrial Wind Erosion. These equations predicted that a fastest-mile wind speed of over 19 meters per second (m/s) is required to cause windblown dust from a flat, dry tailings surface. Based on SGP onsite meteorological data, the highest fastest-mile wind speed recorded was only 12.5 m/s, resulting in no estimated emissions of windblown dust and dust metal emissions from the TSF. While these emission estimates were supported, reasonable precautions to minimize dust from any high-wind events forecast to exceed 25 mph (11.2 m/s) is required in the permit (Permit Condition 2.5).

Comment 8 – NPT: Mercury emissions from the lime kiln

Mercury emissions from the lime kiln are not quantified. Although there are no Hg limits or controls proposed for emission units associated with the lime production in the permit, there is Hg in the carbonate rock at Stibnite and Hg in the limestone will be released from the lime kiln. Mercury emissions should be accurately characterized, and there should be controls for Hg on the lime kiln regardless of the legal loopholes in the Idaho Administrative Procedures Act rules.

DEQ Response:

A response and HAP/TAP application addendum were submitted by PRI that included new HAP and TAP emission estimates, including emissions from the lime kiln based on a metals concentration profile of the source limestone.

Mercury emissions from the lime kiln were estimated by assuming all mercury in the limestone feed is volatilized and emitted. For each non mercury metal HAP and TAP, emissions from the lime kiln were calculated as PM emissions multiplied by the median metal concentration measured.

As detailed in the Mercury Emission Standard section of the Statement of Basis, as a source category lime manufacturing plants are subject to NESHAP 40 CFR 63, Subpart AAAAA (5A) and as such HAP emissions from the lime kiln (including mercury) are therefore exempt from this standard. Although there are no NSPS and NESHAP standards applicable to the SGP lime kiln, a baghouse control device was proposed and is required for the lime kiln (Permit Condition 5.11).

Comment 9 – NPT: Fugitive dust and VOC emissions from the on-site landfarm

The potential for fugitive dust and volatile organic compound ("VOC") emissions from the on-site landfarm has not been included in the emissions inventory. The Project will be operating a landfarm onsite, as identified in the Forest Service Stibnite Gold Project Draft Environmental Impact Statement (EIS). As identified by the Federal Remediation Technologies Roundtable, "landfarming sites must be managed properly to prevent both on-site and off-site issues with contamination. Leachate collection, fugitive dust emission control, adequate monitoring, and environmental safeguards are required." Landfarm emissions should be characterized and subject to facility-wide fugitive dust and VOC control requirements.

DEQ Response:

Although identified as a possible onsite activity in the Plan of Restoration and Operations (PRO), PRI did not propose landfarming activities at the SGP within the PTC application. In the response to a request for additional information, PRI confirmed that landfarming activities are not currently planned. As a result, these activities are not authorized by the PTC. Any activities or operating scenarios not regulated by the permit or otherwise addressed in the application are not expressly permitted, and any changes proposed after permit issuance will need to be evaluated as to whether they may require modification or revision of the PTC.

Comment 10 – NPT: Modeling assumptions

The modeling assumptions used for the access road are incorrect. The modeling assumptions in Table 29 of the Statement of Basis state the access road length is 1.6 miles within the Project boundary, however, the access road proposed by Midas Gold is longer, either three or four miles in length depending on the option.

DEQ Response:

The source ACCRD (Access Road) listed in Table 28 of the Ambient Air Quality Impact Analyses Review Memorandum (Appendix B to the Statement of Basis), refers to the access road portion within the SGP operations boundary that runs from the south gate to the process area. ACCRD is characterized by dust emissions generated from travel of maintenance equipment, light-duty pickup trucks and buses used for employee, visitor, and contractor transportation, and heavy-duty trucks used for cargo (including fuel, consumables, machine parts, ore processing supplies, ore concentrate, etc.) and services (including food supplies, trash, recyclables, etc.) transportation. ACCRD was represented in the model as a series of LINE sources laid along the actual route. The length of ACCRD is 1.6 miles (verified by DEQ by comparing a graphical representation of the modeling input file to aerial photographs on Google Earth) and does not change with modeling scenarios.

Comment 11 – NPT: Density of limestone

The density of limestone in the modeling is unrealistically low at 1.09 g/cm3. A more universally accepted range for limestone density should be used in the modeling.

DEQ Response:

There were 15 emission sources that were modeled using a limestone density of 1.09 g/cm3 ("limestone, dust" in The Engineering Toolbox): LS1-LS12, LSBM, LK, and LCR. The Engineering Toolbox lists a higher density of 1.36 g/cm3 for "limestone, crushed." An argument could be made that this higher density value is more appropriate for some of those 15 emission sources. However, a lower density is the more conservative assumption because it allows material to remain airborne for a longer period of time. Hence, theoretically a lower limestone density suggests higher modeled concentrations. To satisfy the commenter's concern, DEQ performed a sensitivity analysis using a density of 2.74 g/cm3 for those 15 emission sources (while keeping everything else in the model constant). This density value is on the higher end for solid limestone. Results from DEQ's sensitivity analyses show that the modeled particulate concentrations remain unchanged. This is consistent with DEQ's source group analyses in Table 27 of the Ambient Air Quality Impact Analyses Review Memorandum (Appendix B to the Statement of Basis), which show that process/ancillary sources (such as those 15 emission sources) contribute an inconsequential amount to the modeled design concentrations.

Comment 12 – NPT: Commence construction

If Midas Gold does not commence construction of an emissions unit within two years, and an extension to the PTC permit is needed, DEQ should re-open the tribal and public comment period. Midas Gold is sure to be revising its proposed construction and operations scenarios during that time, which will lead to revisions in emissions scenarios and updated PTC permit application submissions. DEQ should provide the public with the opportunity to comment on a PTC permit renewal and any updated application materials submitted by Midas Gold since its original application.

DEQ Response:

General Provision 7.5 states that the permit will expire if construction has not commenced within two years of permit issuance. If construction has not commenced, any request would be evaluated by DEQ for any additional applicable requirements prior to granting an extension.

Comment 13 – ICL: Publicly available report and records

Inspection reports and permit compliance records need to be publicly available on the DEQ website. We will also be asking the Forest Service to provide a link to the DEQ website as part of the Forest Service's implementation and monitoring website. Posting this already-existing information on the agency webpages will eliminate the need for Public Records Requests and increase both project transparency and applicant accountability.

DEQ Response:

At this time, only issued permitting documents relating to air quality are posted online on DEQ's "Issued Permits and Water Quality Certifications" webpage.

Application materials (and Tier I permit-required plans) are posted during the public comment period for each respective permitting action on DEQ's "Public Comment Opportunities" webpage, and inspection reports and compliance documents are not currently posted online.

As public records, DEQ encourages interested parties to request copies of such documents. Public record requests can be made online at DEQ's "Public Records Request" webpage.

Comment 14 – SSFS: Impact analysis

The impact analysis underestimates potential emissions by assuming the emissions scenario will be the same throughout the entire life of mining.

Emissions from blasting, mining, and materials management were modeled as a volume source inside a pit at year seven, after several years of mining will have deepened the pits. Emissions escaping from the pits from blasting and associated ore transport and handling would be greater and have more impact per volume of ore processed in the earlier years when pits are less deep. Emissions may also vary due to spatial distribution over the different years the mine is in operation. Thus, the predicted ambient air quality impacts may be underestimated by not analyzing the maximum potential daily emissions during earlier years when the pits are less deep or not analyzing the different spatial distribution or potentially different concentrations from one pit and disposal area to the next.

DEQ Response:

Emissions from mining operations (drilling, blasting, material extraction and movement, mobile mine machinery use, and other ancillary sources) vary for each year of the life of the mine (LOM). However, for the modeling analyses, the mining operation potential emissions were estimated using conservatively high maximum activity rates as limited in the permit and summarized in Table 3 of the Ambient Air Quality Impact Analyses Review Memorandum (Appendix B to the Statement of Basis), (i.e., extracting and hauling 180,000 tons per day (T/day) of ore or development rock). The maximum mine production rate is approximately 42.7 MMT/yr; however, a maximum daily production rate of 180,000 T/day used for potential emission calculations results in a conservatively higher production rate of approximately 65.7 MMT/yr, approximately 50 percent higher than the projected production rate. Also, the modeled emissions were based on maximum short-term activity rates occurring continuously, including blasting emissions based on one blast occurring every hour for the applicable 1-hour standards, and two blasts occurring every day for the applicable 24-hour standards. Actual blasting is not expected to exceed one blast per day.

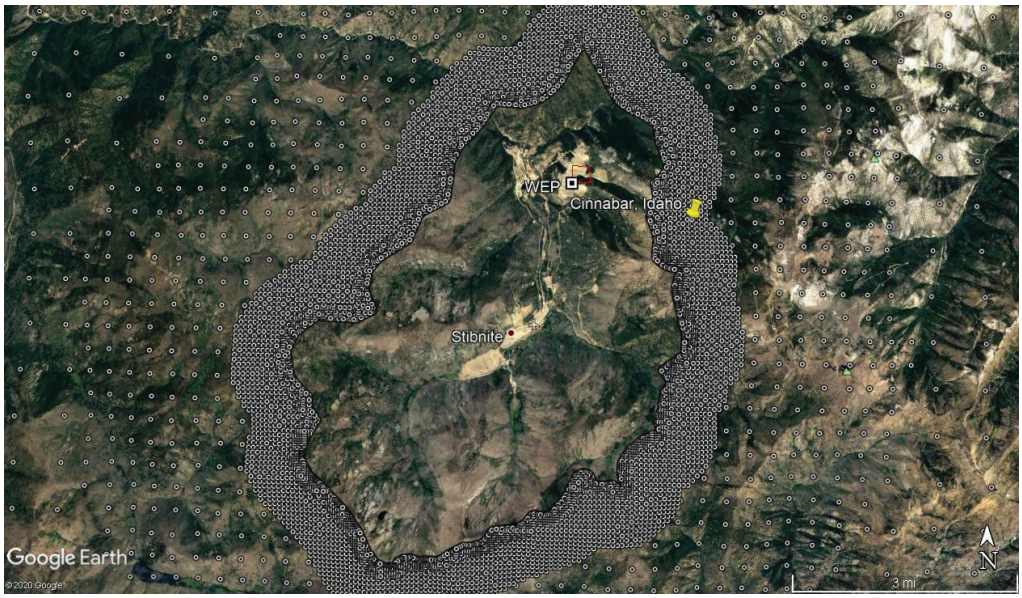
Accurately accounting for all potential configurations is effectively impossible. DEQ contends that other conservative assumptions in analyses (such as assuming that design value modeled values occur simultaneously with design value background concentration values) will offset any unintended underestimation of emissions that occur because of uncertainties and variabilities.

Comment 15 – SSFS: Cinnabar site

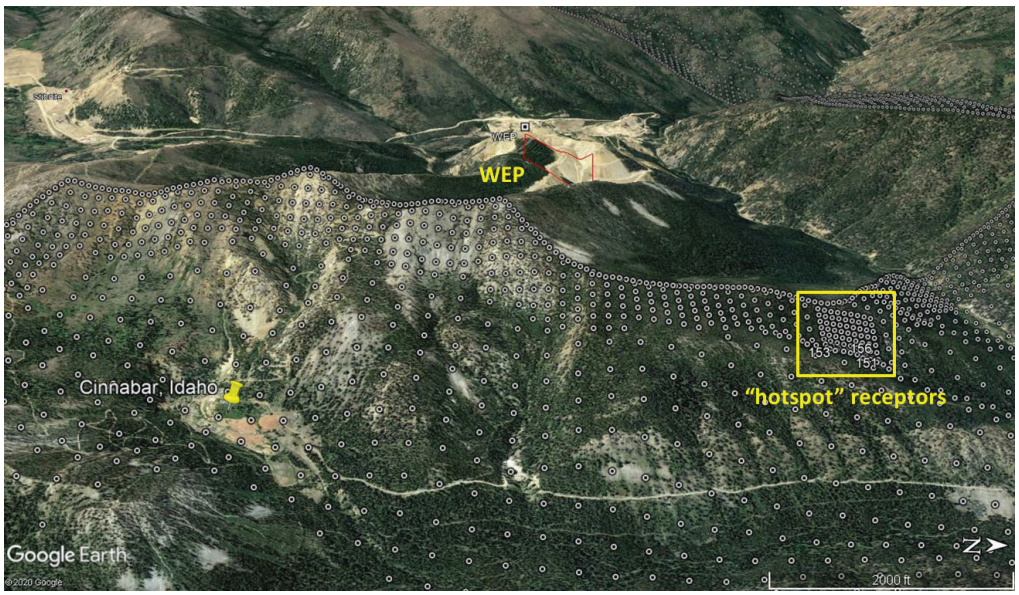
The impacts analysis failed to consider particulate ambient air concentrations at the Cinnabar site. The permit application proposes mining rates of 180,000 tons material per day from the West End pit. The West End pit is located in the Sugar Creek drainage about two kilometers northeast of Cinnabar Peak. Modeling shows that particulate ambient air concentrations at Cinnabar Peak would exceed NAAQS limits and qualitatively show that lower mining rates at the West End pit of about 120,000 tons per day would be required in winter to barely comply with ambient air quality standards. There is no demonstration of NAAQS compliance for winter conditions. Therefore, a permit that allows operations during winter conditions cannot be issued. (If the permit applicant argues that the scenario modeled isn't representative, the burden is on the applicant to provide a representative modeling analysis. If there is less activity in the winter, then there would be more activity in the warmer seasons where there would be a serious potential for dust to reach the annual levels throughout. The draft permit's dust control efforts would be challenged to meet the levels modeled and needed to show compliance assuming 93% control efficiency.)

DEQ Response:

The figure below shows the location of West End Pit (WEP) with respect to Cinnabar. It shows that WEP is located to the west, not northeast, of Cinnabar.



The figure below (note that north is facing to the right) shows the locations of WEP, Cinnabar, and the hotspot receptors that show modeled violations of 24-hour PM10 NAAQS when using the BULKRN met dataset.



To evaluate the degree of NAAQS compliance confidence for 24-hour PM_{10}, DEQ performed a weight-of-evidence analysis as described in Section 4.1.4 of the Ambient Air Quality Impact Analyses Review Memorandum (Appendix B to the Statement of Basis). NAAQS compliance was demonstrated in the application using meteorological data processed with an EPA-approved method using regional cloud cover to calculate stability parameters rather than site-specific monitored solar radiation and measured temperature differences with height.

All modeled violations for 24-hour PM_{10} shown by sensitivity analyses, using BULKRN met data at a proposed mining rate of 180,000 tons material per day (T/day), occur during winter. During winter, fugitive road dust emissions are likely overestimated because of the higher moisture content of material handled or driven over. The permit requires at least 93.3% control of maximum potential fugitive emissions, but the fugitive emissions may in fact be controlled by more than that, especially during winter and periods of precipitation. Also, background concentrations in such remote areas during winter are generally much lower because of the absence

of wildfires and dust-generating sources. Background PM_{10} concentrations represent the higher end of the distribution. Accounting for reduced fugitive emissions during wintertime conditions and accounting for lower background concentrations will easily demonstrate compliance with the 24-hour PM_{10} NAAQS without the need to rerun the model for wintertime conditions. The 180,000 T/yr mining rate was established as a permit limit (Permit Condition 3.5) and is reflected in the modeling for all months of operation.

DEQ is confident that operation of the SGP will not cause or contribute to a violation of NAAQS. This is based on: (1) the submitted application materials and analyses, (2) DEQ's supplemental analyses, and (3) the assumption that the facility is constructed and operated as described in the application and limited by the PTC.

Comment 16 – SSFS: Modeling topography

Modeling using straight-line dispersion of emissions fails to account for the topography of the area, and results in an underestimation of the impacts. The near-field analyses of impacts within 10 kilometers of the project site all assume straight-line dispersion based upon onsite surface winds measured in a central location within the project area, and are only representative of a small area near the monitoring station. Actual dispersion in this area is terrain driven, flowing up, down, and around valleys, and over ridges to the next valley. Assessing impacts using straight-line dispersion therefore may not reflect impacts at all locations and actually underestimate impacts of emissions.

DEQ Response:

DEQ concurs with the commenter that dispersion in complex mountainous terrain is not well characterized by straight-lined Gaussian dispersion models utilizing a single wind direction and speed. DEQ also concurs that a potentially more accurate way to assess impacts of a source in complex terrain would be to use a more refined model with terrain-influenced meteorology and pollutant concentration "memory" from one time-step to the next, such as CALPUFF or other puff models. The objective of the air impact analysis is to satisfactorily evaluate whether the proposed project will not cause a violation of an applicable air quality standard or increment.

The Gaussian, straight-line model AERMOD has been identified by EPA as the "regulatory guideline model" for stationary source permitting, as established in 40 CFR 51, Appendix W (Guideline on Air Quality Models). AERMOD was used by PRI to evaluate NAAQS and TAP increment compliance, and DEQ contends that it is appropriate for this purpose. DEQ also contends that results obtained, using the input parameters described in the application, assure compliance with a high degree of confidence, thereby justifying permit issuance. Also, the PRI PTC is a minor source permit, and use of resource-intensive models such as CALPUFF would be overly burdensome for such projects.

Straight-line Gaussian dispersion models tend to over-predict impacts in complex terrain, especially with increasing distance from the source. However, improved algorithms in the AERMOD model do address terrain effects at a reasonably conservative (over prediction of concentrations) level. Also, studies have generally demonstrated that Gaussian models perform reasonably well at estimating the magnitude of maximum impacts, especially at longer averaging periods; however, they perform poorly at predicting the location and time of maximum impacts. The EPA approved AERMOD Gaussian model has been established as acceptably accurate for assessing air quality impacts from stationary sources, even in rather complex terrain.

Comment 17 – SSFS: Hg from terrestrial sources

The impact analysis fails to account for release of Hg from terrestrial sources. The impacts analysis does not account for Hg respiration from vegetation after uptake. Uptake of Hg by vegetation is the largest point of entry for atmospheric Hg into terrestrial environments. Due to the long history of mining in the area, the predicted impact from respiration is 19% above background levels. The impact analysis did not account for this potential release of Hg.

DEQ Response:

Mercury modeling was not performed by the applicant for the PTC application because it was not required by regulation.

Comment 18 – SSFS: Post-mining conditions

There are no air impact analyses regarding post-mining conditions. The entire air quality analysis says nothing about post-mining conditions, other than the applicant will attempt to revegetate. Because of the climate, metals, and chemicals in the area, there will be limits to the effectiveness of revegetation. The area will remain a source of dust and erosion contaminated with heavy metals. The permit should account for this source of emissions.

DEQ Response:

DEQ's requirement for permit issuance is to assure that all operations performed will not cause a violation of NAAQS or a TAP increment. DEQ is confident that emissions and impacts to ambient air resulting from post-mining conditions will be less than those associated with activities during active mining or ore processing.

In the response to a request for additional information, PRI confirmed that post-mining activities at the SGP will not commence until mining is completed in approximately 12 years or more. Post-mining activities will remain subject to permit conditions, including pertinent facility-wide conditions such as fugitive dust, visible emissions, and odor requirements (Permit Conditions 2.1–2.15) and operating limits such as the hauling limit (Permit Condition 3.5). Any activities or operating scenarios not regulated by the permit or otherwise addressed in the application are not expressly permitted, and any changes proposed after permit issuance will need to be evaluated as to whether they may require modification or revision of the PTC.

Comment 19 – NPT: Post-mining conditions

Permit Condition 2.1 should include secondary NAAQS factors when considering what are reasonable precautions. In addition to "...proximity of dust-emitting operations to human habitations and/or activities and atmospheric conditions which might affect the movement of PM...," DEQ should include public welfare protection, proximity to critical habitats, and potential for damage to the environment.

DEQ Response:

PTC permit issuance requires demonstration of compliance with NAAQS and TAP increments. As stated in Section 4.1.2 of the Ambient Air Quality Impact Analyses Review Memorandum (Appendix B to the Statement of Basis), "Modeling for ozone and secondary $PM_{2.5}$ were not performed for this minor stationary source. These analyses are typically associated with applications for major stationary sources. Nonetheless, taking the ratio of the VOC, NO_x, and SO_2 emissions from the SGP facility by the emissions and resulting concentrations of O_3 and secondary $PM_{2.5}$ from EPA's modeled emission rates for precursors (MERPs) guidance yields estimated O_3 and secondary $PM_{2.5}$ concentrations of less than 1 ppb of O_3 and less than 0.1 $\mu g/m^3$ of $PM_{2.5}$ (24-hour and annual) for the SGP facility. These estimated concentrations have a negligible effect on compliance demonstration with the NAAQS."

Comment 20 – NPT: Recordkeeping

There is discrepancy in frequency of the recordkeeping Permit Condition 2.2 ("each day") and inspection Permit Condition 2.4 ("every 12 hours"). Recordkeeping frequency should be adjusted to match the inspection frequency.

DEQ Response:

Permit Condition 2.4 was updated for consistency with the inspection frequency as requested and to ensure that

fugitive emissions are reasonably controlled.

Comment 21 – NPT: Winter conditions

Prior to onset of winter conditions each year, the condition of the haul and access roads should be assessed before freeze-up and required maintenance needed to maintain the roads through the winter months should be performed, and any preventative dust suppression activities should be completed before the roads are frozen and liquid application of suppressants or water are unrealistic.

DEQ Response:

Permit Condition 2.6 was updated as requested to include this requirement to help ensure that fugitive emissions are reasonably controlled.

As discussed previously, DEQ believes as suggested that frequent monitoring (at least once every 12 hours) will be required to ensure sufficient application of chemical and water dust suppression and that this is a reasonable precaution in advance of the winter season to minimize fugitive dust from roadways.

Comment 22 – NPT: Designate employees

DEQ should require the permittee to designate specific employees to be the on-site visible and fugitive emissions observers solely responsible for fulfilling the ongoing PTC permit requirements of conducting the required test methods and procedures of EPA Reference Method 9 and Method 22, initiating any appropriate corrective actions, and completing and maintaining recordkeeping.

DEQ Response:

Although designation of specific employees is not required by the permit or by regulation, training on the specified methods is required for observers. Because certification is required for Method 9, only trained employees will be able to perform once-per-day observations of point sources as required by Permit Condition 2.10. Similarly, only employees with an understanding of the procedures of Method 22 will be able to perform the 12-hourly observations of fugitive sources as required by Permit Condition 2.4.

Comment 23 – NPT: Completeness requirement

DEQ should have a 95% completeness requirement for recordkeeping of fugitive and visible emissions inspection records.

DEQ Response:

The permit requires that records be maintained at all times to ensure compliance (General Provision 7.10) and that records be retained for a period of five years.

Comment 24 – NPT: AMP

The Statement of Basis refers to an Access Control Plan (ACP) on page 39 and an Access Management Plan (AMP) on page 24, while the PTC permit refers to an Access Management Plan (AMP) on pages 9 and 10. If these are the same plans, we suggest DEQ be consistent in the naming of this plan.

DEQ Response:

The Statement of Basis was updated for consistency with the permit, with all instances now referencing the Access Management Plan as intended.

Comment 25 – TIFO: COC impacts

Both the NAAQS and COC-related analyses provided are largely performed for “average” conditions.

Numerous EPA guidance and sound scientific practice indicate that analyses of potential COC impacts should be conducted at expected typical (central tendency) and reasonable maximum concentrations, with appropriate discussion of the uncertainty and likelihood of worst-case conditions. Even if the input values were shown to be coherent, the modeling presented in the PTC fails with regard to worst case analyses. Even qualitative evaluation for COCs falls short, as there is no discussion of the uncertainty associated with the assertions and conclusions.

DEQ Response:

Permit issuance requires the application demonstrate to DEQ's satisfaction that impacts of applicable pollutants from applicable sources not exceed established standards, as stated in IDAPA 58.01.01.203.02 and 203.03. Agency "satisfaction" represents high confidence of compliance with standards, but it does not require certainty. Also, IDAPA 58.01.01.202.02 (Application Procedures, Estimates of Ambient Concentrations) requires that "All estimates of ambient concentrations shall be based on the applicable air quality models, data bases, and other requirements specified in 40 CFR 51, Appendix W (Guideline on Air Quality Models)." Appendix W dictates the models to be used for air permitting, including those programs that process hourly meteorological data and terrain data used in the models. DEQ-specific guidance and procedures are also provided in the *Idaho Air Modeling Guideline* (*State of Idaho Guideline for Performing Air Quality Impact Analyses*, Idaho Department of Environmental Quality, September 2013, State of Idaho DEQ Air Doc. ID AQ-011. Available at http://www.deq.idaho.gov/media/1029/modeling-guideline.pdf).

The analyses to evaluate compliance must be performed using established methods and data to the extent such methods/data are reasonably representative and available. The following are considered in evaluating whether the compliance demonstration is to DEQ "satisfaction":

- Consistency of methods/data used with requirements of Appendix W and the *Idaho Air Modeling Guideline*.
- Accuracy or conservatism of emission estimates, considering potential uncertainty in estimates and variability in parameters affecting emissions. Permit-required control measures, and associated verification of such measures, affect DEQ confidence of emission estimates.
- Modeled impact levels, the extent of elevated impacts, and the frequency of elevated impacts.
- Potential for exposure. Although the ambient air standards and TAP increments must be met at all ambient air locations, DEQ reviewers exercise a higher degree of scrutiny when modeled levels approach standards and have the potential to impact areas where people are likely to be present, including homes, schools, businesses, and hospitals.

The analyses performed for permit issuance differ from those performed for risk assessments and similar analyses. DEQ does not attempt to characterize the uncertainty and variability in results and analytical input variables beyond that needed to attain agency satisfaction of compliance. Furthermore, the application and the Ambient Air Quality Impact Analyses Review Memorandum (Appendix B to the Statement of Basis), discuss the uncertainty and variability in key variables at an appropriate level considering the magnitude and extent of impacts.

Comment 26 – ICL: Reports and records

Inspection reports, air quality monitoring data, and permit compliance records need to be publicly available on the DEQ website. We will also be asking the Forest Service to provide a link to the DEQ website as part of the Forest Service's implementation and monitoring website. Posting this already-existing information on the agency webpages will eliminate the need for superfluous Public Records Requests and increase both project transparency and applicant accountability.

Based on the information provided in our comments, we request that DEQ return the application to Midas Gold as incomplete. Once Midas Gold has resubmitted a complete application and DEQ has made the appropriate modifications to the permit, the permit should be re-noticed for public comment.

DEQ Response:

As discussed previously, issued permitting documents relating to air quality are posted online on DEQ's "Issued Permits and Water Quality Certifications" webpage.

Application materials (and Tier I permit-required plans) are posted during the public comment period for each respective permitting action on DEQ's "Public Comment Opportunities" webpage.

Because updates to the application, the proposed permit, and technical review were made, an additional 30-day public comment period will also be provided to allow for review and comment on these updates.

IDAHO CONSERVATION LEAGUE
208.345.6933 • PO Box 844, Boise, ID 83702 • www.idahoconservation.org

Save the South Fork Salmon
P.O. Box 1808, McCall, ID 83638
www.savethesouthforksalmon.com

Kelli Wetzel
Idaho Department of Environmental Quality
1410 N. Hilton St.
Boise, ID 83706

March 16, 2022

Submitted via email to: Kelli.Wetzel@deq.idaho.gov

RE: Proposed permit to construct for Perpetua Resources (PTC No. P-2019.0047)

Dear Ms. Wetzel:

Thank you for considering our latest comments regarding the proposed permit to construct for the Perpetua Resources ("the Applicant") Stibnite Gold Project (PTC No. P-2019.0047). We also thank IDEQ for extending the public comment period by an additional 30 days upon request. The Idaho Conservation League and Save the South Fork Salmon have previously (individually) submitted three rounds of comments on this proposed permit that we incorporate by reference in these comments. For this round of comments, our organizations have decided to submit joint comments to IDEQ. Representatives from both groups also attended IDEQ's informational meeting on March 2, 2022, and had subsequent conversations with IDEQ staff regarding this permit. These comments also incorporate points from technical comments submitted separately by Ian von Lindern, P.E. PhD, from the TerraGraphics International Foundation.

Since 1973, the Idaho Conservation League ("ICL") has been Idaho's leading voice for clean water, clean air, and wilderness – values that are the foundation for Idaho's extraordinary quality of life. As a 501(c)(3) nonprofit organization, ICL works to protect these values through public education, outreach, advocacy, and policy development. ICL is Idaho's largest state-based conservation organization and represents over 35,000 supporters, many of whom have a deep personal interest in protecting Idaho's human health and environment. The Stibnite Gold Project is of significant concern to our members and supporters, leading ICL to be engaged on nearly every aspect of this project's regulatory permitting.

Save the South Salmon ("SSFS") is a community-based citizens' organization, headquartered in Valley County, Idaho, dedicated to protecting the South Fork of the Salmon River watershed, its outstanding and remarkable natural values, and the economies that depend on those values. SSFS's members and supporters have a strong interest in protecting natural resources, maintaining recreational opportunities and access, and ensuring future generations can enjoy and benefit from these resources and opportunities in the South Fork of the Salmon River watershed. SSFS's members and supporters have participated in the Stibnite Gold Project environmental review process under the National Environmental Policy Act since the Payette National Forest opened the scoping comment period in 2017, and have made significant investments in time and resources to better understand the Stibnite Gold Project and the impacts it might have on the quality of the air, water, and land of the South Fork of the Salmon River watershed.

We continue to have significant concerns about whether this permit would be protective of human health and if the permit is in accordance with state and federal regulations given the significant uncertainty in the emissions inventory and calculations. Accordingly, we once again urge IDEQ to deny Perpetua's current application for a permit to construct and require a new application that objectively presents the emissions and controls required to comply with State and Federal requirements. We are forwarding these comments to the U.S. Forest Service and Environmental Protection Agency as well. We appreciate your consideration of our comments and look forward to continued dialogue with IDEQ on this matter.

Sincerely,





Josh Johnson
Central Idaho Conservation Associate
Idaho Conservation League
jjohnson@idahoconservation.org
(208) 345-6933 x 301

Fred Coriell
Board of Directors
Save the South Fork Salmon
savethesouthforksalmon@gmail.com

ICL/SSFS Comments on the Permit to Construct for Perpetua Resources

General Comments

ICL and SSFS appreciate the significant amount of work that IDEQ staff have put into this permit thus far. We recognize that this is an exceedingly complex and difficult application to review from both a technical and regulatory perspective. Nevertheless, there remain a number of substantial deficiencies in this application that require critical review. Despite the substantial modifications that have been made to the draft permit thus far, we remain very concerned that this permit will not adequately protect air quality and public health.

The following analyses are the fourth round of public comments offered on three revisions of the proposed Permit to Construct (PTC) and Draft Operating Permit for the Stibnite Gold Project. Some progress has been achieved in securing health and environmental protectiveness through this lengthy review process. However, despite IDEQ's persistent attempts to obtain objective and transparent submittals from the Applicant, this patchwork approach to upgrade an inherently deficient application is eroding public trust in the process to provide for health and environmental safeguards. This third and latest PTC submittal continues the same unsettling pattern of minimal, insufficient, and vague calculations; ineffective monitoring; and lack of provisions for enforcement and corrective actions.

It is also worth noting that it is unusual for a PTC application for this type of project on federal lands to be considered and potentially approved prior to receiving approval from the Forest Service through the National Environmental Policy Act (NEPA) process. The Applicant is attempting to secure both State and Federal approvals simultaneously. Generally, the Federal approval dictates the type of facility that is acceptable, followed by state implementation of the required controls. The Applicant is submitting confusing and inconsistent air pollution emission claims to the different regulators, hampering the transparency required for the public to understand and comment in both forums. Additionally, the project has already, and will likely continue to, change substantially through the NEPA process - necessarily forcing changes to any prior PTC approval as well.

Conservatism

We have continued concern with IDEQ's position on conservative analyses and uncertainty in emissions calculations. IDEQ's response to previous critiques of emission calculations states:

> "… (the) approach of estimating potential emissions (PTE) at design capacity and maximum activity rates was considered a sufficiently conservative approach. Maximum hourly and daily activity rates were used to estimate the maximum 24-hour and annual

> emission rates, and emissions were modeled based on these maximum short-term activity rates occurring continuously every day."

IDEQ is conflating the "conservative" strategy long inherent in the PTC process with the conservative analyses required in estimating the potential to emit (PTE). Even if IDEQ uses a "conservative" strategy, the agency is still using non-conservative model input parameters for the emissions calculations. PTCs have been based on design PTE calculated using "maximum 24-hour and annual emission rates, and emissions modeled based on these maximum short-term activity rates occurring continuously every day" since the inception of the Clean Air Act (CAA). Comparing these required conservative rates to the Applicant's "good intentions" to operate below design capacity is not a conservative approach. The CAA has long recognized that any facility may change management, exploit additional resources, accept feedstock from adjacent properties, or numerous other production scenarios that could utilize design capacity.

IDEQ's *Guidelines for Performing Ambient Impact Analyses* states:

> "To demonstrate compliance, potential emissions must be used in the modeling analyses rather than future projected actual emissions. The maximum emission rate for each averaging period must be identified. For example, PM2.5 has both a 24 hour and annual standard. If a source will only operate 7000 hours per year, but can operate for 24 hours in a single 24 hour period, then different emission rates would be modeled for the 24 hour and annual standard" (Section 6.4.1).

The analyses for impacts for pollutants with averaging periods less than annual are not using maximum potential emissions over those short-term averaging periods. Annual emission impact analyses were also based upon an estimate of the five-year average of projected actual emissions. In assuring the appropriate level of health protectiveness, the permit process is, and has always been, designed to assure compliance at design capacity.

With respect to the use of AP-42 Emission Factors in calculating the PTE, IDEQ regulations require that "screening engineering analyses use unrefined conservative data." (6-30-95). Moreover, IDEQ guidance ranks the use of AP-42 as a last choice, with the least reliable data, and the greatest potential to underestimate emissions.[1] Accordingly, it is incumbent on IDEQ to require use of conservative emission factors. Accepting promises that intended operations will not exploit the full design capacity of the facility is not a substitute for utilizing conservative emissions factors in calculating PTE emissions.

[1] "Emissions Data Hierarchy." https://www2.deq.idaho.gov/admin/LEIA/api/document/download/5521

Facility Classification

In the Statement of Basis (SOB), IDEQ classified this facility as a synthetic minor source (SM) for PM, PM10, and PM2.5 and Class B for Hazardous Air Pollutants (HAPs). A number of comments by ICL, SSFS, and other reviewers address instances where we believe that HAP emissions continue to be underestimated. Once IDEQ completes the appropriate analyses and calculations to verify the PM and HAP emissions, the agency should assess whether the source still meets the requirements of a synthetic minor.

The Applicant and IDEQ calculations show that this facility will also emit >30,000 tons per year (TPY) of uncontrolled PM (removing the 90% control on hauling fugitive emissions + the emissions total for uncontrolled point sources) and 3,655 TPY of permitted PM point source + fugitive emissions (Table 3, SOB). However, IDEQ contends the Major Source classification of 100 TPY is not met despite the apparent 36-fold exceedance. IDEQ continues to ignore 3,569 TPY of permitted PTE PM fugitive emissions from mining operations (97.6% of total controlled PM by the Applicant's calculation) and 986 TPY of associated PM10 fugitive emissions. This clear exclusion of significant emissions from regulatory constraints is a major concern for us. Furthermore, this determination avoids the federal oversight that this permit would be afforded if classified properly as a Major Source.

To avoid including the fugitive emissions sources, IDEQ apparently relies on IDAPA 58.01.01.220.01:

> *For purposes of Sections 220 through 223, fugitive emissions shall not be considered in determining whether a source meets the applicable exemption criteria unless required by federal law.*

Accepting the Applicant's and IDEQ assertions, the current classification determination for this facility as a synthetic minor source is based on merely 2.4% of the total PM emissions. If only 13.6 TPY (0.4%) of the excluded PM fugitive emissions were included in the source classification determination, the facility would be a Class A Major Source, subject to federal review.

In the interest of health and environmental responsibility, it is imperative that the IDEQ consider all emissions including mining fugitive impacts and classify this a Major Category A Source. The only comparable facilities operating in the U.S. at this time, in Nevada, are Class 1 Major Sources according to the same criteria as Idaho's designation, even though most of the Nevada facilities do not include onsite gold ore processing. Idahoans should be afforded the same level of air quality protection as Nevadans.

Even by IDEQ exclusion criteria, some of the ignored sources asserted to be "mining fugitives" should be considered as mineral processing activity emissions controlled with and attendant to specific point sources included in the source classification determination. Significant percentages of mine ores are trucked to stockpiles and placed in storage to be processed months or years later. Alleged mine fugitive emissions also include significant on-site hauling associated with the Portable Crusher and Screening Plant. Some of this hauling is related to the lime plant and gold ore refinery operations, which are specifically listed by federal rules as requiring inclusion of fugitive emission in determining source classification.

> *Subchapter C Part 70.3(d). Fugitive emissions from a part 70 source shall be included in the permit application and the part 70 permit in the same manner as stack emissions, regardless of whether the source category in question is included in the list of sources contained in the definition of major source.*

This rule should be interpreted that if any portion of the emissions is due to a listed source, then all emissions from that source should be included in the source classification determination.

These alleged "excluded mine fugitive" sources alone (not including On-site Hauling) exceed 270 TPY PM. If only 5% of these activities were considered attendant to listed sources or mineral processing and stockpile point source operations (as opposed to mining) then the Major A Source Category threshold would be met. Unfortunately, it is not possible for us or other reviewers to quantify these sources from the available emission inventories. Fugitive emissions were reportedly estimated for a dozen different operational scenarios. However, Table 7 of the SOB and the example calculations provided use scenario W-3, because it is the maximum total PM emissions. This scenario is heavily weighted toward exploitation of the West End Pits, and provides little information to assess the potential emissions associated with those sources that might not be exempt on closer examination.

Examination of the W3 scenario also shows that the 2,901 TPY of PM estimated for On-Site Hauling is 100% attributed to hauling emissions from the West End Pit to the Hangar Flat DRSF. This is the main process stream for limestone feeding the lime plant, gold oxidation circuit, neutralization of waste streams, etc. This scenario also attributes zero hauling emissions from stockpiles to crushers. It is not possible to ascertain from these data how much of the fugitive emissions are attendant to these listed sources or are attendant to mineral processing point sources. However, the W3 scenario does not encompass other haul routes that will be used as part of the mining operation; therefore, the total PM emissions attributed to hauling would be expected to be greater than 2,901 TPY.

These observations suggest that IDEQ's reliance on operational scenarios designed to support modeling analyses to assess fugitive exclusion from Source Classification has allowed listed and point source attendant emissions to be misclassified as excluded mining fugitives. Misclassification of only a tiny percentage of the massive excluded emissions prevents Major Source determination and federal review of key portions of this PTC. The ambient impact analysis must consider the potential impacts of any operational scenario allowable under the federal approval process and the IDEQ permit.

Lastly, the classification of the facility as a synthetic minor source for criteria pollutants and HAPs is hugely dependent upon the facility consistently attaining the target 93.3% fugitive dust control effectiveness. A facility that does not have legally enforceable conditions to ensure those fugitive dust controls, which IDEQ states will be challenging to show continual compliance with, should be considered a major source. Enforceability is extremely important because without enforceable limits, the source otherwise has the potential to emit criteria pollutants in amounts that are at or above the threshold for a major source.

IDEQ should:

- Carefully review these fugitive emission claims with regard to the exclusion criteria, and publicly disclose the review.
- Update the source classification determination for this facility based on these comments.
- Ensure total consistency between project processes and activities approved in the air permit with those that would be approved in the federal approval process.

Dust Control Efficiency

IDEQ states in this permit that the Applicant will have to achieve a dust control efficiency of at least 93.3% on the haul roads in order to achieve air quality compliance, yet the agency has not provided sufficient evidence that such a high target is attainable or practically enforceable. In Appendix G of the Statement of Basis, IDEQ discusses the T-RACT Analysis, including dust control efficiency. We have reviewed the references listed in Appendix G, Table 10 of other facilities with determinations of 90% or greater control efficiency for unpaved roads. Upon investigation of these references through the EPA's Clean Air Technology Center database,[2] we found that only 1 of the 10 facilities referenced actually has *verified* compliance of achieving at least 90% control efficiency. The other nine facilities listed in Table 10 had either unverified or unknown compliance with that permit condition. In addition, only one of these facilities is actually a gold mining operation and therefore most of these references should not be used as a point of comparison to the Stibnite project.

[2] https://cfpub.epa.gov/rblc/index.cfm?action=Search.BasicSearch&lang=en

Listed Facilities in Appendix G, Table 10
AK Donlin Gold Project AK-0084 water/chem 90% (unverified/unknown compliance)
AR Turk Power Plant AR-0094 water/chem 90% (unverified/unknown compliance)
CO Rio Grande Portland Cement Corp. CO-0043 water/chem 90% (unverified/unknown compliance)
IN Nucor Steel IN-0034 chem 90% (unverified/unknown compliance)
LA Nucor Steel Louisiana LA-0239 water/chem 90% (unverified/unknown compliance)
MO Lafarge Corp. MO-0048 chem 90% (unverified/unknown compliance)
NV Sloan Quarry NV-0045 chem 98% (compliance verified)
NV Nellis Air Force Base NV-0047 water/chem 90% (unverified/unknown compliance)
OH Unlimited Concrete OH-0126 water/chem 90% (unverified/unknown compliance)
OH Unlimited Concrete OH-0131 water/chem 90% (unverified/unknown compliance)

According to the T-RACT analysis, the Applicant has eliminated paving as a control mechanism due to it being deemed too costly, instead selecting the application of a chemical dust suppressant supplemented by frequent watering. However, there is no assurance that other facilities of this size and nature have been able to achieve this high bar for dust control efficiency. IDEQ itself states on page 22 of the Statement of Basis that "it may prove challenging to consistently and continuously achieve the targeted level of fugitive dust control for emissions from traffic on unpaved roadways, with over 55 miles of haul truck routes within the mining operations boundary, a fleet of 32 haul trucks weighing between 37 and 357 tons, and a targeted dust control efficiency of 93.3% accomplished by application of both dust suppressant and water controls." Because the fugitive dust control efficiency is not practically attainable or enforceable, this facility should not be classified as a non-major source.

IDEQ should:

- Rigorously evaluate if the 93.3% dust control efficiency target is realistically attainable by the Applicant. If not, reclassify the facility as a major source.
- Include enforceable provisions in the permit to hold the Applicant to continuous achievement of that dust control efficiency level.
- Adjust emission calculations for ore handling and processing activities when temperatures are below freezing and proposed water controls would not be practical.

Fugitive Dust Control Plan

The Fugitive Dust Control Plan (FDCP) continues to be an area of significant concern for us. IDEQ has required the applicant to complete this plan as a condition of this permit. However, despite the FDCP clearly being a crux of the applicant's air quality compliance, the public will not have the opportunity to review and comment on this plan. We once again formally request the opportunity to do so. Furthermore, the permit specifies that the FDCP shall be submitted within 60 days of permit issuance. In this case, the permit would be approved without IDEQ or the public knowing specifically how the applicant will attain this aggressive standard of dust

control. For instance, we have no indication of how the applicant will suppress fugitive emissions sources other than roads.

Given that the specifics of the FDCP are crucial to ascertaining exactly how the applicant will achieve the lofty 93.3% dust control efficiency required to achieve compliance, and how enforceable the limits are, this permit should not be approved until a FDCP is submitted to IDEQ, reviewed by both IDEQ, EPA, and the public, and approved or denied pending modifications. A review of the FDCP prior to permit issuance is necessary to ensure compliance with air quality standards. If approved, the salient points of FDCP should be incorporated in the permit as clearly enforceable limits. This permit cannot be issued without enforceable provisions and limits to ensure that the high bar of fugitive dust control will actually be attained at the Stibnite Gold Project.

IDEQ should:

- Allow for public review and comment on the Fugitive Dust Control Plan *before* it is finalized.
- Incorporate clear, enforceable limits for fugitive dust control into this permit *before* any potential approval.

T-RACT

In this latest iteration of the permit, the T-RACT control measures were applied to meet human health criteria for airborne toxics. A T-RACT application is an admission that compliance with environmental health criteria is not feasible with reasonably available control technology (RACT). This is in contrast to prior IDEQ assertions that all standards would be met with available technology. The previous submittals also assured the public there were no environmental or health concerns associated with Toxic Air Pollutants (TAPs) compliance. This proposal requests exemptions from those standards. It is both confusing and concerning that IDEQ has modified its position from no significant impact to requiring T-RACT without disclosing the analyses that support these conclusions.

Before granting T-RACT, IDEQ should require the Applicant to address the feasibility of achieving compliance through more aggressive application of the current RACT proposed for particulate control, and require the necessary supporting calculations regarding environmental, cost, and energy impacts. These analyses should be based on appropriate RACT emissions and should identify the levels of control necessary for compliance with the AACC.

For detailed technical comments on T-RACT, we refer IDEQ to Section 8.0 of the comments submitted by Ian von Lindern, P.E. PhD, from the TerraGraphics International Foundation. To

summarize his technical comments, IDEQ should disapprove this T-RACT submittal in accordance with IDAPA 58.01.01.14 based on the following considerations:

- The emissions used to support modeling are based on inappropriate multi-year averages and do not reflect the PTE or T-RACT.
- The proposed operational limits on mine production will have no practical constraint on facility operations, emissions, or ambient impacts.
- The lifetime averaging of exposure is inappropriate. Just because this facility proposes to have "only" a 16-year life of mine, the Applicant is not therefore entitled to expend a receptor's equivalent 70 years of allowable exposure with regards to cancer risk.
- If the direct comparison of predicted maximum annual average ambient arsenic concentrations to the AACC is correctly applied, it shows a 30-factor exceedance, or 3 times the T-RACT AACC.
- Considerably higher levels of operational constraints will be required to support T-RACT. These limits are likely to require reductions in the proposed MODPRO2 levels of operations.
- The T-RACT controls are largely unenforceable, do not require any effective monitoring, or provisions for corrective actions, should the Applicant's assurances prove unachievable.
- The T-RACT analysis does not address the requirements in IDAPA 58.01.01.210.14.c.ii to access "the environmental impacts caused by the control technology that can not be mitigated, including, but not limited to, water pollution" despite the massive amounts of magnesium chloride and associated products that would be required to achieve the unprecedented dust control effectiveness proposed.

This relaxation of health protections deserves intensive review, public involvement, and consideration by other regulators. We are concerned that the repetitive nature of this PTC review undermines public awareness regarding the significance of this major change in strategy regarding emissions control from this facility as well as the health implications of relaxing health standards.

PM/PM10 Monitoring

In order to make this air permit practically enforceable, IDEQ must require that the Applicant install a PM/PM10 monitoring system on site at the ambient air boundary to ensure that PM/PM10 NAAQS are not violated. This step is warranted because of the uncertainty surrounding dust control efficiency and emissions factors associated with this project. To our knowledge, it is neither technologically or financially infeasible for the Applicant to install this monitoring. Additionally, IDEQ should include penalties and corrective actions in the permit that would be triggered if this monitoring system shows NAAQS violations occurring at the ambient

air boundary. These penalties should entail a mandatory reduction in mining and processing throughput.

IDEQ should:

- Add a permit condition that requires the Applicant to install a comprehensive continuous PM/PM10 monitoring system on site.
- Add enforceably penalties and corrective actions to the permit that are triggered if this monitoring system ever indicates that NAAQS are being exceeded.

Ambient Air Boundary Determination

We are concerned that the exclusion of the public access road between Stibnite Road at Sugar Creek and Thunder Mountain Road at Meadow Creek from the regulatory definition of ambient air is inconsistent with Clean Air Act's definition of ambient air,[3] EPA's long-standing policy that allows excluding certain areas of a source's property from ambient air,[4] and EPA's most recent revised policy for ambient air.[5] Allowing the public to access this road, even under the conditions of the Stibnite Road Access Management Plan, may result in acute exposure of the public to hazardous air conditions.

EPA's long-standing policy has been to exempt "the atmosphere over land owned or controlled by the source and to which public access is precluded by a fence or other physical barriers" from ambient air requirements.[6] In 2019, recognizing advances in surveillance and monitoring capabilities, EPA revised the "fence or other physical barriers element of this ambient air policy while maintaining public health protection" to allow stationary sources to use "other types of measures "to support exclusion of an area from ambient air."[7] Key to this policy revision was the fact that "legal" access – whether the public has the right or permission to enter a specific property – did not change the definition of ambient air. In other words, "if 'ambient air' is defined as that to which the general public has access, then that to which the general public does not have access is not ambient air."[8]

---

[3] 40 C.F.R. 50.1(e).

[4] Letter from EPA Administrator Douglas Costle to Hon. Jennings Randolph (Dec. 19, 2980), available at: https://19january2021snapshot.epa.gov/sites/static/files/2019-11/documents/1980_costle_letter_ambient_air.pdf.

[5] EPA, *Revised Policy on Exclusions from "Ambient Air"* (Dec. 2, 2019) ("Revised Policy"), available at: http://www.epa.gov/sites/default/files/2019-12/documents/revised_policy_on_exclusions_from_ambient_air.pdf.

[6] Memorandum to Revised Policy.

[7] Memorandum to Revised Policy; Revised Policy at 2.

[8] Revised Policy at 6.

Under this permit, the general public would have access to the road through the project area and not be entirely precluded from using it throughout the life of the mine. Based on EPA's policy, since the general public would have access, albeit restricted, the road is ambient air. The Response to Comments justifies this exclusion because "[t]he roadway is completely within the boundary of the mine," "[u]se of the roadway by [the public] is completely at the discretion of PRI and will be tightly controlled," and the public "will be considered [business invitees] of PRI."[9] This rationale cannot be reconciled with EPA's policy.

The EPA Revised Policy explains:

> "The EPA's view is that the general public has legal access to areas that are owned and controlled by parties other than the owner or operator of a stationary source. The EPA continues to view the "general public" to include any person(s) other than those who are permitted access to the property as employees or business invitees of a specific stationary source (including trespassers)."[10]

In other words, people that are traveling on the road through the mine site to access public (Forest Service) property are members of the general public. The Applicant's attempt to label the public as "guests of PRI"[11] is disingenuous and "would expand the exclusion beyond reason and deny the protection of the NAAQS to large numbers of people."[12] The fact that these "guests" would "abide by access and safety procedures established by PRI" is meaningless in terms of protecting the public from exposure to hazardous air conditions. There are no air quality monitors on the road because it has been excluded from ambient air.[13] Thus, it will not be known to those traveling on the road what type of acute exposure to air pollutants will result.

Moreover, IDEQ's own definition of "ambient air" is "[t]hat portion of the atmosphere, external to buildings, to which the general public has access."[14] The public access road through the project area fits that definition exactly. In addition, IDEQ's Modeling Guidelines[15] for determining the ambient air boundary demonstrate that this public road should <u>not</u> be excluded from the ambient air boundary:

- "It shall be assumed that the air within the facility boundaries is ambient air unless the facility can demonstrate that public access is precluded." Here, although public access

[9] IDEQ, *Air Quality Permitting 2nd Response to Public Comments* (June 4, 2021) at 7 ("Response to Comments").
[10] Revised Policy at 6.
[11] Response to Comments at 7.
[12] Revised Policy at 6.
[13] Statement of Basis, pg. 269
[14] IDAPA 58.01.01.006.10.
[15] IDEQ, *Guideline for Performing Air Quality Impact Analyses* (July 2021) at 37-38.

might be controlled, it will not be precluded. Filing for required federal permits acknowledges that the Applicant does not have the right to preclude public access across the project site. Thus the road should not be excluded from an ambient air analysis.

- "For the purpose of defining ambient air, the 'general public' is considered anyone not directly associated with the facility. In general, if someone present at the site would not be subject to OSHA or other worker exposure regulations, then they are considered as the general public." People passing through the facility to access public land on the other side of the project area are not "directly associated with the facility" and would not be "subject to OSHA or other worker exposure regulations" and therefore are the general public

- "If the facility is not controlled by a physical barrier AND/OR general public access is not discouraged by the type of area, size of the facility, or the remoteness of the facility location, then the ambient air boundary is determined to be inside the property boundary." The Applicant does not propose a physical barrier. General public access is not discouraged by the items listed above. Access to these public lands is long-standing, an important part of Valley County's recreational experience, and acknowledged in fillings for federal permits.

- "Is the general public allowed on site as a part of a right-of-way easement or a common service road? If "yes," then the right-of-way is determined to be ambient air." The public is allowed access through the site because it is a public road. The Applicant cannot completely preclude public access.

IDEQ precedent, reaffirmed as recently as 2021, makes it clear that a public right-of-way access through a project area is considered – not excluded from – ambient air, and regulatory analyses of the potential impacts along that road must show compliance with all ambient impact limits for averaging periods under one year. This determination has been applied by IDEQ for public roads, non-navigable rivers, and railroad tracks. Here, the general public would be allowed access through the mine site on a public road that the Applicant does not have the right to completely deny access. There is no indication that this public road should be treated any differently from past projects. Nothing in the ambient air impact assessments supporting this permit includes any analysis of the impacts on the road through the project area.

IDEQ should:

- Reassess the ambient air boundary determination and model ambient air concentrations along public access routes.

TAPs Mass Balance

We recommend that IDEQ develop a material balance for TAPs to inform and assist the agency in assessing the quality and uncertainty inherent in the data underlying the Applicant's assertions. Many other states specifically require a material balance for criteria pollutants, HAPs, and TAPs. IDEQ's response reiterates the same "conservative" claim:

> "While a material balance is a useful approach to developing emission estimates, it is not a requirement, and the use of maximum activity rates and representative performance test data to estimate and model emissions is commonly accepted by DEQ. While the use of an average or maximum value is a more conservative approach, the use of site-specific median values combined with estimating and modeling PTE at design capacity and maximum activity rates was considered a sufficiently conservative approach."

IDEQ's own TAPs guidance, however, specifies the use of AP-42 and mass balance techniques:

> "Determine if a new (constructed after June 30, 1995) emission unit has the potential to emit a TAP listed in IDAPA 58.01.01.585 (Rules Section 585) or IDAPA 58.0101.586 (Rules Section 586). Potential toxic air pollutants can be determined by reviewing commonly available emission factors, such as EPA's AP-42, or calculating emissions using a mass balance."

Mass balance analyses would be invaluable in enhancing regulators' and the public's ability to follow and review emission calculations, and designing appropriate operational limitations and controls for this PTC.

IDEQ should:

- Require a facility-wide mass balance for TAPs in subsequent submittals for this PTC.

Arsenic Emissions

The proposed Stibnite Gold Project clearly presents hazardous concerns associated with toxic metal releases. Arsenic and mercury are of particular concern due to their high toxicity and importance in the metallurgical processes. This facility will potentially emit 170 to 360 TPY of arsenic. About 85-90% of the uncontrolled arsenic emissions are proposed to be contained or captured by proposed controls and approximately 13 to 38 TPY will be released to the atmosphere as fine particulate (controlled PTE). The PTC Application underestimates these emissions by a factor of 5.6 to 12 times by our calculations (see previous public comments on version 2 of this PTC), and asserts arsenic emissions of about 30 TPY PTE uncontrolled and 2.4 TPY controlled PTE. Most of this mischaracterization is associated with road dust suspended from the massive volume of heavy trucks moving thousands of loads of arsenical contaminated materials across the site. The Applicant apparently achieves this low estimate by using minimal

emission factors and particulate arsenic content, and claiming an unprecedented capability to control 93.3% of the road dust through chemical suppressants and watering.

An in-depth review of the Emissions Inventory reveals there are several factors that have not been given appropriate treatment in developing the arsenic emissions totals. We incorporate our detailed prior comments on this matter by reference into this latest round of comments and continue to have significant concerns that the arsenic emissions from this facility are being grossly underestimated.

The underestimation of fugitive dust emissions from haul roads resulting from the use of non-conservative modeling parameters is exacerbated when one considers that there appear to be three largely unaccounted for processes that will increase the arsenic content of haul road related fugitive dust emissions over time: 1) haul truck spillage of ore or waste rock containing higher arsenic content than the surface aggregate, 2) an increase in silt-sized particles in the haul road surface layer due to traffic wear, and 3) the application of dust abatement water sourced from the East Fork South Fork of the Salmon River containing elevated levels of arsenic.

Silt Content

As IDEQ has acknowledged in their response to comments, there are three key data-based variables used in estimating controlled, unpaved road arsenic emissions: silt content, arsenic content of the silt, and control efficiency. We remain concerned that using a 4% silt content for surface aggregate material for haul roads is too low according to scientific literature. Using a lower than reasonable silt content results in an underestimation of fugitive dust emissions. In its response to comments, IDEQ failed to provide a rationale for why the Applicant's assumption that a 4% silt content was appropriate in this case when EPA's publication AP-42 (that IDEQ relies on for other purposes) provides a mean silt content range for industrial unpaved haul roads of 5.8 to 24%.

Table 13.2.2-1. TYPICAL SILT CONTENT VALUES OF SURFACE			
AP-42	MATERIAL ON INDUSTRIAL UNPAVED ROADS		
		All Gravel Road	Haul Roads
	Industry Types	18	4
	No. Sites	53	10
	No. Samples	272	58
	Minimum	4.3%	5.8%
	Maximum	24.0%	24.0%
	Average	10.1%	11.6%
	Median	8.4%	8.4%
	Geomean	8.8%	9.9%

The mean silt content range reported in AP-42 is consistent with other scientific literature. Tannant and Regensberg's *Guidelines for Haul Road Design* (2001), for example, provides guidelines for haul road surface material properties (Section 5.1.1, pg. 58) and recommend a range of 5-10% fines (material passing a #200 sieve). They cite two separate studies stating 5-15% and 5-10% respectively to support this guideline. We have not been able to find any evidence for *functional* haul road surface material having less than 5% silt content. The following table summarizes plausible values for three variables at this site. These values are rated as minimal, typical, and conservative emissions factors.

Comparison of Characteristic Values for Key Variables Used in Calculating Particulate and Arsenic Emissions from Gravel Haul Roads				
Characteristic	Silt Content	Silt Content	As Content	Control
Values	All Gravel Roads	Haul Roads	ppm	%- Emitted
AP-42 Minimal	4.3%	5.8%	909	10%
AP-42 Typical	8.8%	9.9%	1231	15%
AP-42 Conservative	10.1%	11.6%	1812	20%
Midas PRI	4%	4%	667	6.7%

In each case, the Applicant has used less than minimal values. Our concern is that reliance on an unrealistically low silt content value combined with the need for extremely aggressive fugitive dust control efficiencies raises the significant likelihood that this permit may exceed National Ambient Air Quality Standards for particulate matter. IDEQ's response to comments simply states that the assumption for a 4% silt content was "confirmed by PRI and accepted by DEQ."[16]

[16] Response to Comments at 62.

But there is no discussion on what basis DEQ accepted this value for silt content and there is no stated rationale for why a higher silt content that is recommended in scientific literature does not apply to this particular haul road.

IDEQ should:

- Reassess emissions calculations and fugitive dust control efficiencies using a more realistic silt content for haul roads.

Mining/Processing Throughput Limits

The draft permit contains several throughput limits as defined in Permit Conditions 3.5 and 3.6. These conditions are artificial production limits on the facility, and will not have a bearing on the actual emissions being produced once the mine is simultaneously mining and also processing from stockpiled material. We have concerns that these artificial production limits are not actually enforceable in any way by IDEQ. Furthermore, we do not have any assurances that these artificial production limits will remain the same throughout the entire life of mine. For example, Figure 3.9 of the proposed mine plan[17] initiates and concludes with low rates over the 16 years of the mine with higher rates in the middle, making a five-year rolling average (like what is proposed in Permit Condition 3.5) meaningless in terms of limiting production.

Permit conditions should also be developed that establish throughput limits on the refining facilities and haul roads themselves, not just hauling and excavation tonnages. This is because the design capacity of the refining facilities exceeds the mine production capacity, and new ore could theoretically come in from other sources and be refined/processed at Stibnite. Without specific throughput limits on the refining process, those added emissions would not be considered.

Lastly, because IDEQ treats TAPs emissions on an incremental rather than cumulative basis, we can envision problems arising in a scenario where this facility gets permitted at the current throughput limits but then asks for an expansion five years down the road. If they are then permitted for an expansion, any increases in TAPs emissions will be permitted on a standalone basis rather than cumulatively on top of what was initially permitted. Ultimately, we are concerned that this is an approach the Applicant could use to circumvent being permitted as a TAPs Major Source in this initial PTC.

[17] STIBNITE GOLD PROJECT: REFINED PROPOSED ACTION – MODPRO2, Perpetua Resources Idaho Inc. October 15, 2021.

IDEQ should:

- Indicate how they plan to enforce these throughput limits and include additional measures in the permit to this effect.
- Add throughput limits for the refining and processing facilities.

In summary, we once again urge IDEQ to deny Perpetua's current application for a permit to construct and require a new application that objectively presents the emissions and controls required to comply with State and Federal requirements.

Nez Perce

TRIBAL EXECUTIVE COMMITTEE
P.O. BOX 305 • LAPWAI, IDAHO 83540 • (208) 843-2253

March 14, 2022

Submitted via email to: kelli.wetzel@deq.idaho.gov

Ms. Kelli Wetzel
Air Quality Division
Idaho Department of Environmental Quality
1410 North Hilton
Boise, ID 83706-1255

Re: ***Nez Perce Tribe's Comments on Perpetua Resources Idaho, Inc., Stibnite Gold Project, Updated Proposed Permit to Construct and Operate an Air Pollution-Emitting Source (Docket No. AQ-1700)***

Dear Ms. Wetzel:

On behalf of the Nez Perce Tribe ("Tribe"), I submit this letter and accompanying technical comments on the updated proposed permit to construct and operate an air pollution-emitting source ("updated PTC") for Perpetua Resources Idaho, Inc., ("PRI") proposed Stibnite Gold Project ("Project") located at the intersection of Forest Service Roads NF-374 and NF-412, Docket No. AQ-1700. The Tribe's comments supplement the comments it previously submitted on October 12 and November 10, 2020 and on March 18, 2021.

The Tribe would like to acknowledge the additional effort undertaken by the Idaho Department of Environmental Quality ("DEQ") to address substantive comments received during previous public comment periods concerning the emissions of hazardous air pollutants ("HAP") and toxic air pollutants ("TAP") and the lime plant status determination. The Tribe would also like to thank DEQ for extending the public comment period by an additional 30 days. The original 30-day comment period was inadequate to provide the Tribe and the public sufficient time to review PRI's new reports and the revisions to the draft PTC and Statement of Basis.

The Tribe has reviewed the DEQ response to comments, updated proposed permit and technical review for the Project. For the reasons outlined in the attached technical comments, the Tribe disagrees with DEQ's determination to issue the proposed permit. DEQ has not adequately resolved the questions and concerns submitted by the Tribe, and, therefore, has not demonstrated that constructing and operating an open-pit gold mine, on-site ore processing, ore concentration and refining, and ancillary equipment would be achievable without causing or contributing to a violation of the National Ambient Air Quality Standards ("NAAQS") for PM10. Project activities

will therefore injure or unreasonably affect human or animal life or vegetation and the Tribe's Treaty-reserved resources, and DEQ must accordingly not issue the proposed permit to PRI.

The Nez Perce Tribe appreciates this opportunity to provide these comments on the updated PTC. If you have any questions or require clarification from the Tribe, please do not hesitate to contact Julie Simpson, Air Quality Program Coordinator, Environmental Restoration & Waste Management Division, Nez Perce Tribe, at (208) 621-3818 or Mike Lopez, Senior Staff Attorney, Nez Perce Tribe Office of Legal Counsel, at 208-843-7355.

Sincerely,

Samuel N. Penney

Samuel N. Penney
Chairman

cc: Michelle Prizadeh, Acting Administrator, U.S. Environmental Protection Agency (EPA) Region 10
Krishna Viswanathan, Air and Radiation Division Director, EPA Region 10
Linda Jackson, Forest Supervisor, U.S. Forest Service Payette National Forest
Tim Allen, Meteorologist, U.S. Fish and Wildlife Service

NEZ PERCE TRIBE'S COMMENTS ON AQ-1700
PERPETUA RESOURCES IDAHO, INC., STIBNITE GOLD PROJECT,
UPDATED PROPOSED PERMIT TO CONSTRUCT AND OPERATE
AN AIR POLLUTION-EMITTING SOURCE

The Nez Perce Tribe ("Tribe") submits the following comments on Perpetua Resources Idaho, Inc.'s updated proposed permit to construct and operation an air pollution-emitting source for the Stibnite Gold Project. The Tribe's comments supplement the comments it previously submitted on October 12 and November 10, 2020 and on March 18, 2021.

DEQ's reliance on a 93.3% fugitive dust control efficiency to ensure compliance with permit requirements and for the Project to be classified as a synthetic minor source is unsupported

Permit conditions must ensure compliance and enforceability, and DEQ has not demonstrated evidence that a 93.3% fugitive dust control efficiency is attainable or practically enforceable. DEQ has not provided any case studies that a 93.3% fugitive dust control efficiency can be met through a combination of chemical suppressant and added water. Not only is the 93.3% control efficiency requirement not backed up by supporting technically accurate documentation to be possible in the real world, permit conditions are not written so that it is possible to verify compliance and document violations when enforcement would be necessary. DEQ is, therefore, unable to ensure that permit conditions can be met.

DEQ also relies on the unproved 93.3% fugitive dust control efficiency for the Project to be considered a synthetic minor for facility-wide emissions of PM/PM_{10}/PM2.5 to be below 250 tons/yr PSD applicability thresholds, Title V 100 tons/yr applicability thresholds, and to limit facility-wide emissions of single and total HAP to below HAP major source applicability thresholds of 10/25 tons/yr. As described above, because the 93.3% fugitive dust control efficiency is not practically achievable or enforceable, the Project does not meet the standard to avoid classification as a major source for PSD, Title V, and HAP.

The state of Idaho's internal controls and program resources are inadequate to guarantee permit conditions will be met

The PTC lacks sufficient monitoring for enforcement and compliance to ensure that permit conditions are met. In the Tribe's March 18, 2021 comment letter, the Tribe states that a once every two years inspection schedule and response by phone was woefully insufficient to ensure the Project is meeting the 93.3 percent fugitive dust control permit requirements that guarantee human life, animal life, and vegetation, and the Tribe's Treaty-reserved resources are not injured or unreasonably affected. DEQ now states that the inspection schedule will be even more insufficient – at a rate of once every five years.

Meteorological data used in the modeling came from on-site monitoring at one location. With the complex terrain of the site, the inputs to the modelling will not be representative of the actual weather throughout the entire mining site over the life of the mine. With that in mind, fenceline monitoring should be a requirement to ensure compliance with the PM10 NAAQS, if the permit is issued.

As described in our November 10, 2020 comments, additional monitoring (real-time continuous, federal reference PM2.5 and PM10 monitoring, web cameras, aerial drones, and collocation of meteorological monitoring) and weekly on-site inspections are necessary for DEQ to accomplish its responsibilities under the Clean Air Act to implement and enforce permit conditions and ensure the NAAQS are not violated.

Concerns with Fugitive Dust Control Plan (FDCP), Operations and Maintenance Manual (O&M), Access Management Plan (AMP), and Haul Road Cap Plan (HRCP) submission and review process

These plans are key to holding Project emissions at or below assumed emissions in the emissions inventory and modeling used to determine the source applicability of the Project. Any assumptions, including emission controls, need a practically enforceable permit requirement to keep the Project a synthetic minor for PSD, Title V, and HAP. As these plans are not yet written, and their associated permit conditions not included in the PTC, the PTC is not practically enforceable.

Our understanding is that the first opportunity for meaningful comment on the FDCP, O&M, AMP, and HRCP will be when a Tier I air operating permit is drafted. Strict adherence to these plans is critical to ensuring compliance, and only giving the public the opportunity to review and comment on these plans when the Tier I air operating permit is drafted, and every five years thereafter, is inadequate.

Adverse impacts of dust control abatement on other resources

The Tribe is concerned about the impacts of dust abatement chemicals on soils, vegetation, and wildlife. As it is DEQ's mission to protect human health and the quality of Idaho's air, land, and water, the Tribe is including this concern with these comments on the PTC.

Magnesium chloride ($MgCl_2$) and $MgCl_2$-lignin sulfonate products used to suppress dust on roadsides can damage vegetation foliage, alter soil quality, move in roadside drainages of up to 98 m from roads, and accumulate over time, often to toxic concentrations, in trees and soils.[1] High $MgCl_2$ soil concentrations from application caused mortality of Douglas-fir, lodgepole, ponderosa, and limber pines, and aspen in just two to four years.[2] Considering the life of the Project, the Tribe is concerned about long-term consequences to soils and vegetation from dust abatement chemicals.

Water is a scarce commodity in the project area. We are concerned that the limited quantity of water available is insufficient to meet permit conditions for use of water in fugitive dust control and water spraying for ore processing, and aggregate and concrete production. The quality of water is also a concern. The water source for dust control is proposed to be surface water

[1] Goodrich, B. A., et al., Condition of Soils and Vegetation along Roads Treated with Magnesium Chloride for Dust Suppression (Water, Air, and Soil Pollution 198, 165-188) (2009).
[2] Goodrich, B. A. and Jacobi. W. R. 2012. Foliar damage, ion content, and mortality rate of five common roadside tree species heated with soil applications of Magnesium Chloride. Water, Air, and Soil Pollution 223:847-862.

diversion from the East Fork of the South Fork of the Salmon River, groundwater, and runoff ponds. USGS sampling indicates elevated arsenic in these waters.[3] Water quality should not create additional environmental burden if contaminated waters are used to water roads. This should have been considered in the T-RACT determination as described in IDAPA 58.01.01.210.14.

Concerns with Permit Condition 2.20 O&M Manual

Permit condition 2.20 requires the permittee to develop and maintain an Operation and Maintenance (O&M) manual to ensure compliance with emission limits and the control equipment maintenance and operation general provision. The Tribe has the following concerns about section 2.20:

- Please explain why the O&M manual is termed a "manual" and not a "plan", and please justify why the O&M manual does not require approval by DEQ when DEQ approval is required for the FDCP, AMP and HRCP plans.

- Please explain the rationale for the O&M manual being due 60 days after startup of any process equipment, unlike the 60 days after permit issuance required for the FDCP, AMP, and HRCP plans.

- The O&M permit condition, 2.20, states a once per month visible emission (VE) inspection requirement for wet scrubber, carbon filter, baghouse, and bin vents, but permit condition 2.10 requires the following VE inspection: "Each day during daylight hours and under normal operating conditions, the permittee shall conduct a facility-wide inspection of potential point sources of visible emissions including stacks, vents, and functionally equivalent openings." Since wet scrubber, carbon filter, baghouse, and bin vents have openings, the VE inspection requirement for this control equipment should be the same as permit condition 2.10.

Concerns with Permit Condition 3.11 Drilling Rigs Dust Control System

We appreciate that DEQ has added controls for the drilling activities. However, the details in actually achieving the 90% control are to be included in an O&M manual which will be developed after the PTC permit is issued. If DEQ relied on vendor-stated control efficiencies, there should be testing requirements included in the PTC to validate the emissions controls.

Concerns with Permit Condition 3.13 Haul Road Capping

The addition of permit condition 3.13 Haul Road Capping is appreciated. However, haul road surfaces will degrade over time. Because the arsenic concentration in the roadbed will come from both the road material itself and spilled ore, DEQ should require periodic testing of both silt and arsenic content of the road bed to validate assumptions underlying the estimated emissions and assure the representativeness of the emission factors used. Periodic measurement would

[3] Baldwin, A.K., and Etheridge, A.B., 2019, Arsenic, antimony, mercury, and water temperature in streams near Stibnite mining area, central Idaho, 2011–17: U.S. Geological Survey Scientific Investigations Report 2019-5072, 20 p., plus appendix, https://doi.org/10.3133/sir20195072.

increase confidence that the NAAQS are being protected (PM_{10} from haul road fugitives) and fugitive arsenic is being controlled. We suggest use of most conservative average arsenic concentration in the quartzite used. In the 55,000 ore samples presented, that would be the mean, not the median as proposed in 3.13. Please explain in better detail how DEQ justified the assumption that 50% of the vehicle miles traveled (VMT) will occur on low-arsenic capped haul roads and what level of detail will be required in the HRCP such that the emission limits are enforceable.

Process flow description does not reflect applicant operations

Statement of Basis Facility Information Description and Figure 2 DIAGRAM OF PROCESS FLOWS are not updated to reflect Project operations.

Limestone values are misleading

The limestone mineralogy is expressed as median concentration values from 98 samples, yet it appears that all 98 samples came from one single core MGI-17-431. This is misleading, and we question if the metal concentrations used in the emissions inventory coming from the 55,000 ore samples are also incorrectly characterized.

Emissions estimate values are not sufficiently conservative

DEQ should use conservative values for all emission estimates. For any emission factor (EF) requiring an average value, the most conservative average value should be used to protect human health. Examples include the silt content for used in EF for Haul Road fugitives and the metal concentrations in the ore for HAP/TAP. The median is only a statistical number. The arithmetic mean is most commonly considered the average.

In the Statement of Basis it states, "It is noted that PRI projected actual annual production at approximately 42.7 million T/yr, or 65% of the permitted annual production limit of 65.7 million T/yr (Permit Condition 3.5), and that as a result actual emissions are expected to be lower than presented." The 65.7 MT/y value comes from 180,000 T/day for 365 days, however, permit condition 3.5 also has a 135,000 T/day limit based on a 5-year rolling average. Thus the actual permit limit is 49.3 MT/y (135,000 T/day x 365 day/y). Therefore, the projected actual annual production is closer to 87% (42.7/49.3) of the permitted annual production limit. The permit is less protective than DEQ has presented.

Concerns about fugitive dust controls

The FDCP plan is key for the facility to reach the 93.3% fugitive dust control that allows DEQ to demonstrate the facility is a synthetic minor. We are concerned that the use of such non-specific permit requirement terms of "as necessary" and "periodic" is not practical enforceability.

We are very concerned about PRI's commitment to 93.3% control for fugitives on haul roads. In Facility Comment #10, PRI asked for a change from a twice daily to a monthly frequency for permit condition 2.4 fugitive emission inspection. A monthly inspection frequency is woefully inadequate. We appreciate that DEQ has retained the twice daily inspection frequency.

PET 658

REC 1024

Retention of records should exceed five years. The records of FDCP are key to compliance checking and it is plausible that inspection frequency will exceed 5 years. The description of the facility information in the Statement of Basis states "the SGP will include three years of pre-mining development and construction activities, followed by an operating mine life of approximately 12 years." And permit condition 2.24 states "In accordance with IDAPA 58.01.01.313.01.b., the permittee shall submit a complete application to DEQ at the address provided (Permit Condition 2.26) for an initial Tier I operating permit within 12 months of becoming a Tier I source or commencing operation." Therefore, it is very plausible the facility will operate for 4 years or more before an operating permit is issued. If compliance inspection is every 5 years, earthmoving activities at the mine may go for 9 years before any compliance check is made by DEQ.

Permit condition 2.5 includes a 10% opacity trigger: "Fugitive dust control measures shall be applied to haul roads on a frequency such that visible emissions from vehicle traffic on a haul road do not exceed 10% opacity". We are unaware of any study showing that a 10% opacity limit ensures a 93.3% fugitive dust control efficiency. A more protective trigger would be an instantaneous see/no-see. Any trigger, to be sufficiently evaluated, should specify a timeframe for measurement (example: instantaneous or 15 second), a location, and when to take the opacity reading (example: immediately after a loaded ore truck passes near surface of the road bed). Additionally, with over 55 miles of haul roads, there should be multiple locations being monitored during each inspection.

Regular testing requirements needed for process and control equipment

Permit Conditions 2.20–2.21 require developing and complying with the requirements of an O&M manual to ensure compliance with control equipment maintenance and operation general provisions (Permit Condition 7.2). Documentation of as-built process equipment specifications and control equipment performance guarantees and establishing control equipment operating parameters and procedures were required, since these were relied upon in the development of emissions inventories, and in the evaluation of ambient air impacts in the modeling analyses. Compliance is ensured by complying with monitoring and recordkeeping requirements. There should be regular testing required to confirm process and control equipment are operating/performing to the specifications, guarantees, and parameters identified in the PTC application.

Antimony hauling not sufficiently characterized

The mineral products from the proposed Stibnite Gold Project are gold and antimony, accounting for 1 and 99% by mass, respectively. In earlier versions of the PTC, the antimony concentrated was going to be dried and bagged, and then was proposed to be dewatered and packaged wet. Page six of the Statement of Basis states, "The metal-recovery process from ore will include conventional crushing and grinding, followed by froth-flotation circuits that will generate separate gold-silver and antimony-silver concentrates. The antimony-silver concentrate will be shipped offsite for refining…". In Footnote c) of Table 3 in the Statement of Basis, it states that "In the response to a request for additional information, PRI confirmed that antimony process dryer and bagging operation emission sources (Sb1 and Sb2) initially proposed would be

replaced by a dewatering/packaging circuit. As a result, these emission sources have been removed from the permit and post-project PTE." Please include documentation confirming there are no air emissions associated with removing the antimony-silver concentrate from the site and how hauling the antimony concentrate from the processing area to the property boundary is accurately accounted for in the emissions inventory for the permit. If no market for the antimony is found and the concentrate is either stockpiled, stored on-site, or hauled to the tailings storage facility, emissions from this concentrate should be reevaluated.

No accounting for winter impacts on water controls

Permit condition 3.12 requires water control for ore processing crusher and conveyer at all times. Permit condition 5.10 also requires water control for portable crushing and screening at all times. When water freezes during low temperatures, water control will not be feasible. Therefore, each ore processing crusher and conveyor (3.12) and each portable crushing and screening plant (5.10) should not operate at temperatures below freezing or there will be no control of fugitives from these emission units (EUs). If any chemical(s) is added to the water to lower freezing and thus extend ability to use water control, they and their effects should be disclosed. Please address these concerns about freezing-weather operations for these permit conditions.

Clarification needed on 3.9 Prill Loading Limit

Permit condition 3.9 Prill Loading Limit is unclear: "The permittee shall not load in excess of 200 T/day nor and 9,000 T/yr of prill (ammonium nitrate) to the prill silos." The use of "nor and" is confusing. Please clarify the intent of this section.

Comments on Table 1.1 Regulated Sources

Table 1.1 in the permit lists all source of regulated emission in the permit. For clarity it would be easier to follow the permit and check limits for all the EUs if their Source ID No. were carried over from Table 1.1 to the remaining tables throughout the permit. Additionally, it is unclear if the control efficiency and maximum process rates listed in Table 1.1 are enforceable. The comments that follow are from checking the source ID listed in Table 1.1 for consistency in the permit and Statement of Basis.

- For the Mercury Retort and Induction Melting Furnace, Table 1.1 has a maximum process rate of 1,000 lb/batch and 21 T/yr. Monitoring in permit conditions 4.22 and 4.23 does not include monitoring of batch rather only weight is monitored. If only weight is recorded there is no criteria to measure compliance with the batch limitation.

- The emission units LS9-LS12 are missing a permit operating limit to ensure maximum process rate of 267 T/day.

- Statement of Basis application scope lists PS in ore processing. Assuming PS is PS1-2-L/U, in Table 1.1 of the permit, they (PS1-2-L/U) are listed under mining.

- Rock dumps and storage piles are missing from the Statement of Basis application scope.

- In Table 1.1 of the permit all mining sources except Prill Silos (PS1-2-L/U) have FCDP listed as Control Equipment. In Table 3.1 Mining and Ore Processing Control Device Descriptions some sources retain the FDCP as a listed Control Equipment (Drilling and Blasting) while others do not (Excavating and hauling activities) and some sources do not appear at all in Table 3.1 (rock dumps and storage piles).

- Although there is a facility-wide fugitive dust control and permit conditions 3.10 and 5.9 direct permittee to control fugitive dust, Reasonable Control and FDCP are listed in Table 1.1, but are missing from corresponding Tables for Control Description Descriptions for the following EUs: OC1-OC13, PCSP1, PCSP2, CM.

- For EUs EDG1-3 in Table 1.1, please allow for better performance control equipment, we suggest modifying EPA Tier 2 technologies to "EPA Tier 2 technologies or better".

Representativeness of the emission factors

The applicability determination depends on the emissions inventory (EI). The EI depends on the proposed processes and the EFs used to characterized these activities. There are instances where we are concerned that inappropriate EFs have been used. The EFs for the ore processing come from AP 42 chapter 11.19 Crushed Stone Processing and Pulverized Mineral Processing. The AP-42 chapter 11.24 Metallic Minerals Processing might be a better representation for the OC1-OC13. In all cases, the most conservative EFs should be used.

When an EF has a control efficiency built into it, the permit should specify conditions to assure equipment will employ the same controls to assure the representativeness of the EF. Permit conditions do not clearly specify this.

DEQ has erred in its interpretation of EPA's Revised Policy on Exclusions from "Ambient Air"[4] for the public access road through the mine site

The public access road between Stibnite Road at Sugar Creek and Thunder Mountain Road at Meadow Creek should not be excluded from the regulatory definition of ambient air. This road is intended to allow public access, not preclude it. EPA's revised Ambient Air Policy describes conditions by which the public is to be excluded from an area controlled by a source and which would then justify excluding an area for purposes of analyzing the source's impact on ambient air. Controlling public access on the public access road between Stibnite Road at Sugar Creek and Thunder Mountain Road at Meadow Creek, as is described Section 3.3.10 of the Statement of Basis, Appendix B Ambient Air Quality Impact Analyses Review Memorandum, consists of providing "controlled through-site access that is safe, provides travel-time comparable to current conditions and is consistent with the United States Forest Service travel management plan."[5] Controlling public access through a site is not excluding public access to a site, thus the EPA

[4] Memorandum from U.S. Environmental Protection Agency Administrator Andrew R. Wheeler to Regional Administrators (Dec. 2, 2019), https://www.epa.gov/nsr/ambient-air-guidance.

[5] Morrie Lewis and Kelli Wetzel, *Statement of Basis: Permit to Construct No. P-2019.0047, Project ID 62288, Appendix B: Ambient Air Quality Impact Analysis Review Memorandum*, pp. 55-56, (Jan. 6, 2022), https://www2.deq.idaho.gov/admin/LEIA/api/document/download/16522.

revised Ambient Air Policy does not apply, and, therefore, the public access road should be considered ambient air.

As the public access road is ambient air, all emissions, modeling, and controls must be characterized and considered, and subject to the NAAQS.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue, Suite 155
Seattle, WA 98101

AIR & RADIATION
DIVISION

March 16, 2022

Ms. Kelli Wetzel
Idaho Department of Environmental Quality
1410 North Hilton
Boise, Idaho 83706-1255

Re: Perpetua Resources, Inc., Stibnite, Idaho, Docket No. AQ-1700

Dear Ms. Wetzel:

The U.S. Environmental Protection Agency (EPA), Region 10 has reviewed the proposed permit to construct and operate an open-pit gold mine located in Stibnite, Idaho, for Perpetua Resources Idaho, Inc. Docket No. AQ-1700. In addition to the proposed permit, the EPA has reviewed the proposed Statement of Basis, Response to Comments, and application materials, including the Stibnite Permit to Construct Application dated June 23, 2020, and the Stibnite Permit to Construct Application – TAP Addendum dated October 5, 2021, and submits the enclosed comments.

We would like to acknowledge the challenges presented when developing a mining air permit and Idaho's efforts to address the EPA's and other interested parties' substantive comments that were received during the previous public comment periods. The EPA remains concerned that the proposed permit does not include accurate permit conditions that are enforceable as a practical matter and that would achieve the objective of limiting the project's potential to emit such that it would be a synthetic minor source for the PSD construction permit program and Title V operating permit program as well as assure compliance with the applicable National Ambient Air Quality Standards (NAAQS).

The EPA appreciates the opportunity to review the proposed permit and is available to assist in the development of accurate, practically enforceable permit conditions sufficient to assure continuous compliance with the synthetic minor emission limits necessary to avoid major source permitting under PSD and Title V and also assure compliance with the applicable NAAQS. Please contact Bryan Holtrop at holtrop.bryan@epa.gov or (206) 553-4473 if you have any questions or would like to arrange a discussion of our comments.

Sincerely

KELLY MCFADDEN
Digitally signed by KELLY MCFADDEN
Date: 2022.03.16 11:24:25 -07'00'

Kelly McFadden, Branch Chief
Air Permit and Toxics Branch

cc: Mr. Mike Simon
Idaho Department of Environmental Quality

EPA'S COMMENTS ON DOCKET NO. AQ-1700
PERPETUA RESOURCES IDAHO, INC., STIBNITE GOLD PROJECT,
PROPOSED PERMIT TO CONSTRUCT AND OPERATE
AN AIR POLLUTION-EMITTING SOURCE
March 16, 2022

The U.S. Environmental Protection Agency, Region 10 has reviewed the proposed permit to construct and operate an open-pit gold mine located in Stibnite, Idaho, for Perpetua Resources Idaho, Inc. In addition to the proposed permit, the EPA has reviewed the proposed Statement of Basis, Response to Comments, and application materials, including the Stibnite Permit to Construct Application dated June 23, 2020, and the Stibnite Permit to Construct Application – TAP Addendum dated October 5, 2021.

As discussed in detail below, EPA has two overarching concerns: (1) the draft permit may not limit the source's potential to emit (PTE) to below prevention of significant deterioration (PSD) and Title V major source thresholds in a manner that is enforceable as a practical matter; and (2) the draft permit may not ensure the source will not cause or significantly contribute to a violation of the National Ambient Air Quality Standards.

General Requirements

EPA's longstanding position is that a permit limitation can legally restrict a source's PTE[1] if it meets two criteria: 1) the limitation is federally enforceable or legally and practicably enforceable by a state or local air pollution control agency; and 2) it is enforceable as a practical matter.[2]

In general, practical enforceability for a source-specific permit means that the provision must specify: (1) a technically accurate limitation and the portions of the source subject to the limitation; (2) the time period for the limitation (hourly, daily, monthly, annually); and (3) the method to determine compliance including appropriate monitoring, record keeping and reporting.[3] EPA made these comments in its March 19, 2021, comment letter to IDEQ regarding the previous Perpetua draft.

With respect to NAAQS compliance, in accordance with IDAPA 58.01.01.203.02: "No permit to construct shall be granted for a new or modified source unless the application shows to the satisfaction of the Department all of the following: NAAQS. The stationary source or

[1] IDAPA Section 58.01.01.107 (incorporating the definition of "potential to emit" in 40 C.F.R. § 52.21(b) and 40 C.F.R. Part 70; see also 58.01.01.006.88;
[2] Terrell E. Hunt and John S. Seitz, "Limiting Potential to Emit in New Source Permitting" (June 13, 1989) ("Hunt Memo") at 2; John Seitz and Robert Van Heuvelen, "Release of Interim Policy on Federal Enforceability of Limitations on Potential to Emit" (Jan. 22, 1996) at 3;
[3] John S. Seitz, "Options for Limiting the Potential to Emit (PTE) of a Stationary Source Under Section 112 and Title V of the Clean Air Act" (Jan. 25, 1995) ("Seitz Memo") at 5-6; Kathie Stein, "Guidance on Enforceability Requirements for Limiting Potential to Emit through SIP and § 112 Rules and General Permits" (January 25, 1995) ("Stein Memo") at 6; *In re Shell Offshore, Inc.*, 15 E.A.D. 526, 551 (March 30, 2012); Reclassification of Major Sources as Area Sources Under Section 112 of the Clean Air Act, 84 FR 36304, 36318 (July 26, 2019).

modification would not cause or significantly contribute to a violation of any ambient air quality standard." See also 40 CFR 52.670(c).

Limiting PTE for PSD, Title V (including HAP) and NAAQS Purposes

Many of the emission limits in the permit are derived from emissions factors. Similarly, the permit assumes control efficiencies for certain emission sources. However, the permit lacks conditions incorporating the numerous assumptions and parameters associated with the emissions factors and control efficiencies. Emission factors include numerous operating assumptions and variables regarding the source. Accordingly, the permit should contain conditions to ensure the operating assumptions and variables underlying the emission factor accurately reflect site-specific conditions and are enforceable.[4] Similarly, when permits require add-on controls operated at a specified efficiency level, permit writers should include, so that the operating efficiency condition is enforceable as a practical matter, those operating parameters and assumptions which the permitting agency depended upon to determine that the control equipment would have a given efficiency.[5]

The permit record does not demonstrate that the emission factors used to estimate the source's PTE and derive the emission limits are technically accurate. Emission factors used to derive a PTE limitation must be technically accurate.[6] In general, AP-42 emissions factors are based on averages and are not intended for establishing source-specific limits.[7] When using AP-42 emissions factors to establish limits on PTE, EPA recommends using these emissions factors only when source specific emissions factors are not available and selecting conservatively higher emissions factors.[8]

EPA states in AP-42, "Before simply applying AP-42 emission factors to predict emissions from new or proposed sources, or to make other source-specific emission assessments, the user should review the latest literature and technology to be aware of circumstances that might cause such sources to exhibit emission characteristics different from those of other, typical existing sources. Care should be taken to assure that the subject source type and design, controls, and raw material input are those of the source(s) analyzed to produce the emission factor. This fact should be

[4] Hunt Memo at 7-8; See also Peabody Western Coal, 12 E.A.D. at 38 n.38; In the Matter of Yuhuang Chemical Inc. Methanol Plant St. James Parish, Louisiana, Title V Petition Response Order, No. VI-2015-03 (August 31, 2016) ("Yuhuang Order") at 19, 28.

[5] Hunt Memo at 7, 20-21; see also Cash Creek General LLC, Title V Petition Response Order, No. IV-2010-4 (June 22, 2012) ("Cash Creek Order") at 17, 26 (granting in part because the permittee's claims of 90% control efficiency of PM emissions from storage piles and associated roadways was unsubstantiated and the permit lacked any requirements governing frequency of wet suppression, atmospheric or operations conditions under which wet suppression should applied the time of day that wet or chemical suppression should be applied, or the amount that should be applied).

[6] Peabody Western Coal, 12 E.A.D. at 39; *see also* In re Shell Offshore, Inc. 15 E.A.D. at 559; Yuhuang Order at 19, 28.

[7] Peabody Western Coal, 12 E.A.D. at 38 ("Peabody not only proposes to rely on the AP-42 factors to establish both its PTE limit and to demonstrate compliance with that limit, Peabody compounds the potential inaccuracy of this approach by using unverified emission control assumptions in both calculations."); see also John S. Seitz and Eric Schaeffer, "Potential to Emit (PTE) Guidance for Specific Source Categories" (April 14, 1998) at 4 n.4.

[8] In re Shell Offshore, Inc. 15 E.A.D. at 559.

considered, as well as the age of the information and the user's knowledge of technology advances."[9]

When permits contain emissions, production or operational PTE limitations, they should also have monitoring, recordkeeping, and reporting requirements that allow a permitting agency to verify a source's compliance with its limits.[10] The permit should provide for the collecting, maintaining, and reporting of information necessary to determine emissions of each pollutant as well as compliance with operating parameters.[11] The permit must include conditions that clearly specify the monitoring requirements and how the permittee must demonstrate compliance via the monitoring requirements.[12]

Limiting PTE for the Ore Processing and Lime Plant Operations for PSD, Title 5 (including HAP), Title V, and NAAQS Purposes

The Permit does not appear to specify technically accurate emission limitations and the portions of the source subject to the limitation because: (i) the permit may not adequately require compliance with all PTE emission limits for each emission source or include PTE emissions limits representing all emissions sources, (ii) the permit record may not adequately demonstrate that the emission limits are based on accurate emissions factors, and (iii) the permit may not contain monitoring, recordkeeping, and reporting conditions sufficient to ensure compliance with all emission limits and associated controls.

Examples of these specific issues with respect to the Ore Processing and Lime Plant Operations include, but may not be limited to, the following:

Ore Processing PTE Limitations**:**

1. A PTE limitation appears to be needed to restrict the amount of ore material storage piles consistent with the emission estimates in the permit application.
2. Per Table 1.1, the 80% control efficiency applicable to the associated ore storage piles, and source ID. No. OC9, OC10 and OC11 is not included.
3. Per the application Ore Processing Diagram (Figure 1), the 108 ton per day (tpd) process rate associated with the Sb Drying and Bagging, the 7.5 tpd process rate associated with the Carbon Regeneration, and the 6,980 tpd rate associated with the Autoclave are not included.
4. Per the application Ore Processing Diagram (Figure 1), emission sources Sb1 and Sb2 are not included in Table 1.1 or specified in the permit conditions.

Ore Processing PTE Emission Factors:

5. Some of the PTE limitations may not be technically accurate because they are not based on emission factors that are representative of the emission sources. For example, AP-42 Section 11.24 Metallic Minerals Processing emission factors applies to the processing of hard ores including gold. However, the application uses AP-42 emissions factors from Section 11.19.2 Crushed Stone Processing that is applicable to non-metallic mineral processing. The

[9] AP-42 Volume I at 4.
[10] Hunt Memo at 17; In re Shell Offshore, Inc. 15 E.A.D. at 551.
[11] 84 Fed. Reg. 36,304, 36,320.
[12] Yuhuang Order at 21.

permitting record does not provide a reasoned explanation as to why emission factors from Section 11.24 were selected over those from Section 11.19.2.

Ore Processing Monitoring, Recordkeeping and Reporting Requirements:

6. The monitoring method does not appear to specify how and where the PTE limitations will be measured consistent with the application's emissions calculations. For example, Permit Condition 3.18 specifies "The devices and methodologies used to measure weights shall be identified in the O&M Manual" for determining compliance with the input to the primary crusher. Per the application, this monitoring should apply at OC1 (Loader Transfer of ORE to Grizzly) and not OC7 (Primary Crusher) as specified in the permit condition. The permit also does not specify generally how the weight is measured such as by a truck scale or some other method but is to be developed in an O&M Manual after the permit is issued and is not enforceable to this permit condition (see permit conditions 2.20 and 2.21). The permit must include all monitoring, recordkeeping and reporting necessary to assure compliance with the permit emission limitations and applicable requirements. This comment is also applicable to permit conditions 3.16 through 3.20, 4.18 through 4.32, 4.34, and 5.16 through 5.24.
7. IDEQ required monitoring of baghouse pressure drop to assure compliance in permit condition 4.31. Though pressure drop monitoring can be an indicator of the source's maintenance program, monitoring experts within EPA have concluded that pressure drop is not a reliable approach for monitoring baghouse compliance. Alternatives to pressure drop include opacity monitoring/readings and bag leak detectors. Bag leak detectors are a good alternative for baghouses that require a more rigorous level of scrutiny than periodic observations provide. These monitoring techniques can be combined with a good operation and maintenance program to assure compliance. This comment is also applicable to permit conditions 5.21, 5.22, and 5.23.

Lime Plant PTE Limitations:

8. The following PTE limitations specified in Table 1.1 and the application do not appear to be included in the permit including: 267 tpd applicable to LK, LCR, and LS-L/U; 250 tpd applicable to LS1-L/U and MillS2-L/U; 1,000 tpd applicable to ACS1, ACS2, and ACS3; 500 tpd applicable to ACS4; and 70,000 tons per year applicable to LS1-L/U, MillS2-L/U, ACS1-L/U, ACS2-L/U, AC3-L/U and ACS4-L/U.
9. The PTE limitation of 1,130 tpd of limestone in permit condition 5.4 may not be technically accurate as it does not appear to account for all of the emissions sources comprising the lime plant subject to PSD and Title V permitting limits of a 100 tons per year. For example, the limestone mining activities (e.g., drilling, blasting, excavating, hauling, and storage piles) and all of the lime plant processing emission units and activities shown in the application's Figure 2 do not appear to be included in the emissions estimates. These emission units presented in Figure 2 include the dump truck unloading, stationary grizzly, rock breaker, primary crusher feed hopper, vibrating grizzly feeder, and the emission units and activities following the limestone ball mill and lime slaker (e.g., Milk of Lime Distribution Tank). Emissions from those aspects of the limestone handling and processing that would not happen if the lime plant did not exist must be accounted for as support activities to the lime plant. Furthermore, if the mining of limestone (including overburden removal) would not be done if the lime plant did not exist, emissions from those activities must also be included with the lime plant emission inventory. For example, IDEQ's SOB and Perpetua's letter

dated September 23, 2021, indicates that the limestone is overburden excavated from the Middle Marble Geologic Unit (MMGU) located in the northwest portion of the West End Pit and that the overburden must be removed to access the gold ore. However, Midas Gold documents from 2016 and 2020 indicate, contrary to this information, that the MMGU is located in the northeast portion of the West End Pit, is located beneath a 30 ft- to 250 ft-thick quartzite unit and requires the addition of a haul road to transport limestone to the lime plant processing facility. Because the limestone deposits are buried 30 to 250 feet below the surface, as noted above, it appears more than 1,130 tpd of material would need to be excavated to access the limestone deposit.

10. IDEQ's PSD applicability analysis in the Statement of Basis (SOB) does not appear to include all of these emission sources or provide the necessary information to support their Lime Plant PSD emission estimates.

Lime Plant PTE Emission Factors:

11. IDEQ's SOB Table 10 PSD emission estimates may not be technically accurate because they do not appear to be based on emission factors that are representative of the emission sources. For example, AP-42 Section 11.17 Lime Manufacturing emission factors applies to the processing of lime derived from marble. However, the application uses AP-42 emissions factors from Section 11.19.2 Crushed Stone Processing. In addition, the limestone excavating emission estimates (Material Load & Unload) appear to use emission factors from Section 11.19.2 Crushed Stone Processing instead of Section 11.9 Western Surface Coal Mining emission factors that are representative and specific to mining excavation activities. The permitting record does not explain why emission factors from 11.19.2 were selected over those from 11.17 and 11.9. If IDEQ does not have a good technical reason for their selection of emission factors, consistent with comment #5, the most conservative emission factor should be used for emission units that make verification difficult. Comment 19 would also apply to fugitive dust emissions resulting from limestone mining sources including limestone drilling, blasting, excavating, and haul road activities.

Lime Plant Monitoring, Recordkeeping, and Reporting (MRR) Requirements:

12. Consistent with comment #6 for ore processing, the lime plant MRR requirements appear to be unenforceable as Permit Condition 5.16 specifies "the permittee shall monitor and record" using the "devices and methodologies… identified in the O&M Manual" for the PTE limitation associated with the limestone primary crusher. The permit must include all monitoring, recordkeeping and reporting necessary to assure compliance with the permit emission limitations and applicable requirements.
13. If the O&M Manual is used to provide the monitoring, recordkeeping, and reporting (MRR) requirements for the applicable PTE limitations then the O&M Manual would need to be reviewed and approved by IDEQ, available for review during the public comment period and must be enforceable at all times upon issuance of the permit. Also, any changes to the O&M Manual that that would make the approved MRR requirements less stringent would be subject to the same IDEQ and public review approval process and need to be enforceable at all times upon issuance of the revised permit.

Other PTE Limitations:

14. Central Mixer Loading (Source ID No. CM) controls are unspecified in Table 1.1 and the permit consistent with the emission estimates in the permitting record.
15. Engine PTE limitations specifying the capacity of 1,000 bkW for the three emergency generators (EDG1, EDG2, and EDG3) should be specified in the permit. Also, the monitoring and recordkeeping requirement specified in permit condition 6.3 should include all hours of operation, not just non-emergency operating hours, and specify the devices and methodologies by which the monitoring and recordkeeping will be achieved.

Limiting PTE of the Mining Fugitive Dust Emissions for NAAQS and Title V HAP Purposes

The permit does not ensure that the fugitive dust emissions related to the mining of ore and limestone will not cause or significantly contribute to a violation of the NAAQS or exceedance of the Title V HAP major source permitting thresholds. The emission limits necessary to ensure compliance with the NAAQS and Title V HAP applicability limits do not appear to be enforceable as a practical matter. In particular (1) achieving 93.3% control efficiency for fugitive dust resulting from mining activities (excavation and haul roads) and 90% control efficiency for drilling activities are critical to ensuring no violation of the NAAQS and Title V HAP limits, (2) the permit does not contain the conditions necessary to ensure the permittee achieves those efficiencies at all times and (3) the permit record does not demonstrate that those efficiencies are achievable based on the site-specific conditions at the Perpetua mine. EPA made similar comments in its March 19, 2021, comment letter to IDEQ regarding the previous Perpetua draft.

Examples of these specific issues include, but may not be limited to, the following:

Mining Fugitive Dust PTE Permit Limitations**:**

16. PTE limitations consistent with the 93.3% control efficiency applicable to haul road and access road do not appear to be specified in the permit conditions. These PTE limitations may include permit conditions requiring control measures such as how frequently chemical suppressant supplemented with watering must be applied, the atmospheric and operational conditions under which magnesium chloride supplemented with watering should be applied, the time of day that magnesium chloride supplemented with watering should be applied, and/or the amount that should be applied. [13] The permit requires that fugitive road dust PTE limitations such as those indicated above are to be developed by the permittee after the permit is issued. The permit also allows these types of PTE limitations to be changed without IDEQ review and approval. PTE limitations addressing the 93.3% control efficiency must be reviewed and approved by IDEQ, subject to review by the public during the public comment period and must be enforceable at all times upon the issuance of the initial permit. Also, any changes to the approved PTE limitations after the permit is issued that are less stringent must go through IDEQ public review and approval and must be enforceable at all times upon the issuance of the revised permit.
17. PTE limitations to achieve a 93.3% control efficiency for fugitive dust emissions associated with the mining excavation activities as specified in Table 1.1 and Table 3.1 do not appear to be specified in the permit conditions. Although permit condition 3.10 requires the "permittee

[13] See Cash Creek Order at 17, 26.

shall control emissions from mining… emission sources (Table 3.1) in accordance with the Fugitive Dust Control Plan." it does not specify what those controls are and as such are unenforceable. These control measures must be specified as part of the permit consistent with the permitting record and subject to review during the public comment period. In addition, these control measures must be enforceable at all times upon issuance of the permit. Any changes that are less stringent than the approved control measures made after the initial permit is issued must be proposed for review using public notice procedures and must be enforceable at all times upon issuance of the revised permit.

18. To make the PTE limitations enforceable as a practical matter, the permit should include the parameters and assumptions used to develop the fugitive dust emission factors estimates for the haul roads and access roads (see AP-42 Section 13.2.2, Equation 1a).[14] Per AP-42 and the application, these parameters and assumptions include surface material silt content (%), mean vehicle weight (tons), speed limit (mph), and daily vehicle miles travelled.

Mining PTE Fugitive Dust Control Efficiencies and Emissions Factors:

19. IDEQ's permitting record does not appear to provide support for a 93.3% control efficiency applicable to fugitive dust emissions resulting from mining excavation operations and haul roads. IDEQ's permitting record cites three studies that address the control efficiencies associated with fugitive dust emissions associated with haul roads but not mining excavation activities. Based on these studies, IDEQ concludes that applying magnesium chloride will achieve a control efficiency of 90%. However, IDEQ's permitting record does not provide a reasoned analysis consistent with AP-42's control effectiveness factors (or equivalent) that this control efficiency and associated control measures identified by these studies would be representative of Perpetua's mining operation. In addition, IDEQ's permitting record does not identify the specific study details that support their conclusion and does not include copies of these studies for review during public comment period. (see Appendix A, Air Sciences 2020 application, page 339 of 421). IDEQ's permitting record indicates that a control efficiency of 90% is also supported by control efficiency limits established for 10 projects in the EPA RACT/BACT/LAER Clearinghouse (RBLC) database. However, IDEQ's permitting record does not provide a reasoned analysis consistent with AP-42's control effectiveness factors (or equivalent) that the control efficiencies and associated control measures identified by these permitting projects would be representative of Perpetua's mining operation. In addition, IDEQ's permitting record does not identify the specific details from the permitting projects and associated documentation that support their conclusions (IDEQ's 2021 TAP Addendum, page 37 of 226). Moreover, IDEQ's permitting record does not provide any technical studies showing that the supplementing magnesium chloride with watering will improve the control efficiency of magnesium chloride. Lastly, IDEQ's permitting record does not appear to provide support for a 10% opacity associated with a 93.3% control efficiency for haul roads as established in Permit Condition 2.5. To support the 93.3% claim of road dust control efficiency, a see-no see approach to opacity monitoring may be more appropriate.
20. IDEQ estimated fugitive dust emissions from haul roads based on a 4.0% surface material silt content.[15] However, the arithmetic average silt content for haul roads based on Perpetua's site-specific data is 4.3%. The silt content value can have a significant impact on the

[14] See footnotes 4 through 6, above.
[15] Statement of Basis at page 27 and Appendix A.

representativeness and conservativeness of the emissions factor and, thus, emissions estimate.[16] Use of the 4.3% average value results in about 7% more fugitive dust emissions from the haul roads than estimated using the median value. IDEQ's modeling sensitivity study showed values just below the NAAQS, such that an 7% increase in fugitive dust from haul roads would have resulted in 24-hour PM10 NAAQS violations. AP-42 values for similar operations show a wide range of silt fractions, with average values around 8% silt fraction for mine haul roads. The permit record does not include an adequate justification for using the 4.0% silt content figure to derive the fugitive dust haul roads emissions factor and whether a 4.3% is representative for the haul roads including inside the open pits.

21. As noted in Comment #15 and #16, the mining excavation PTE limitation of 180,000 tpd may not be technically accurate because it is not based on emission factors that are representative of mining emission sources. For example, AP-42 Section 11.9 Western Surface Coal Mining Section includes emission factors applicable to mining excavation operations. However, the application appears to use AP-42 emissions factors from Section 11.19.2 Crushed Stone Processing for truck loading and unloading of crushed stone.

Mining Fugitive Dust Monitoring, Recordkeeping, and Reporting Requirements:

22. No monitoring, recordkeeping and reporting (MRR) requirements appear to be specified for the excavation mining controls required by permit conditions 3.10 to ensure their enforceability.
23. No monitoring, recordkeeping, and reporting requirements appear to be specified for the 90% control efficiency applicable to the drilling activities required in permit condition 3.11.
24. The monitoring methods associated with the haul roads appear to be unenforceable as they do not specify how the monitoring and recordkeeping demonstrating compliance with the applicable PTE limitations will be achieved. For example, Permit Condition 3.16 specifies "the permittee shall monitor and record" using the "devices and methodologies… identified in the O&M Manual" for the PTE limitation associated with the 180,000 tpd hauling PTE limitation in permit condition 3.5. The permit must include all monitoring, recordkeeping and reporting necessary to assure compliance with the permit emission limitations and applicable requirements. The permit must include all monitoring, recordkeeping and reporting necessary to assure compliance with the permit emission limitations and applicable requirements.
25. Given the high level of uncertainty in the assumptions and requirements to ensure compliance with the PM10 24-hr NAAQS, the addition of post-construction ambient monitoring requirements is highly prudent. IDEQ may be able to require post-construction monitoring when determined to be necessary to determine the effect a stationary source may have on air quality in the vicinity of the source, especially when there is high uncertainty in project air quality impacts determined from modeling. The EPA recommends IDEQ add a permit requirement for the source to deploy a fenceline PM10 monitoring network, in a manner determined to be adequate by IDEQ, to demonstrate 24-hour and annual PM10 NAAQS compliance.

Mining Access Management Plan (AMP) for NAAQS Purposes:

26. Permit Condition 2.7 requires the development of an Access Management Plan (AMP) to address whether the NAAQS apply to the mine's access road through the Perpetua Mining

[16] AP-42 Chapter 13.2.2-4.

site given the extent of public access allowed. Permit Condition 2.8 allows the AMP to be developed after the permit is issued and does not require the AMP to be enforceable. For the AMP to preclude the applicability of the NAAQS along the access road, the AMP must be reviewed and approved by IDEQ, subject to review by the public during the public comment period and must be enforceable at all times upon issuance of the initial permit. Any changes to the AMP that are less stringent than the approved AMP must be reviewed and approved by IDEQ, subject to review by the public, and enforceable at all times upon issuance of the revised permit.

27. Given the unique situation with a public access road traversing the mine site, the key assumptions, parameters, and methodologies used to preclude public access from the mine site must be fully disclosed in the permit record and the necessary requirements be included in the permit and available for public review and comment. The State assumes measures taken to preclude public access will be appropriate and adequately comply with EPA's Revised Policy on Exclusions from Ambient Air (as specified in the December 2, 2019, memo from Andrew Wheeler to the EPA Regional Administrators). Section 2.7 of the permit provides requirements for the source to develop a plan to preclude public access, but these requirements offer a range of measures the source may choose to implement and are therefore ambiguous. Without full disclosure in the record of the exact measures and permit requirements to ensure compliance with national ambient air policy, it is not clear if the public access road can be excluded from ambient air protections. The state needs to provide sufficient justification to demonstrate the measures and requirements to preclude public access and ensure members of the public traversing the road can be classified as "guests of the mine" sufficiently complies with national ambient air policy. Given the uniqueness and ambiguity of the situation, a petition to the EPA national ambient air policy team for review and concurrence with the State's findings could be warranted.

Mining Dust Haul Road Capping Plan (HRCP) for NAAQS and Title V HAP Purposes:

28. Permit Condition 3.13 requires the development of a Haul Road Capping Plan (HRCP) to address fugitive dust emissions from the haul roads and development rock storage facilities after the permit is issued.
29. To the extent that this plan is being relied upon to limit fugitive dust emissions for Title V HAP applicability and NAAQS compliance purposes, the HRCP would need to be reviewed and approved by IDEQ prior to the public comment period, subject to review during the public comment period, and enforceable upon the issuance of the initial permit. Also, any changes to the HRCP after the permit is issued and that are less stringent than the approved HRCP would need IDEQ approval and public review and be enforceable at all times after the revised permit is issued. There does not appear to be a reason that the HRCP can't be developed and incorporated into the permit now.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue, Suite 155, 14-D12
Seattle, WA 98101-3144

REGIONAL
ADMINISTRATOR'S
DIVISION

January 10, 2023

Linda Jackson
Payette Forest Supervisor
Stibnite Gold Project
500 N. Mission Street, Building 2
McCall, Idaho 83638

Dear Linda Jackson:

The U.S. Environmental Protection Agency has reviewed the U.S. Forest Service's October 2022 Draft Supplemental Environmental Impact Statement (DSEIS) for the Stibnite Gold Project (CEQ Number 20220154, EPA R10 Project Number 17-0013-AFS). EPA has conducted its review pursuant to the National Environmental Policy Act and our review authority under Section 309 of the Clean Air Act. The CAA Section 309 role is unique to EPA and requires EPA to review and comment publicly on any proposed federal action subject to NEPA's environmental impact statement requirement.

As a Cooperating Agency, EPA is supporting the Forest Service in the EIS development including review and comment on administrative drafts of EIS documents. EPA provided Draft EIS comments to the Forest Service in November 2020. Most recently EPA has supported the preparation of the DSEIS for the revised proposal submitted by the project proponent, Perpetua Resources Ltd (formerly Midas Gold Idaho, Inc), which includes the Forest Service eliminating two of the previous DEIS action alternatives from further consideration.

The DSEIS evaluates the potential environmental impacts associated with mining operations located on the Payette and Boise National Forests in central Idaho. The proposed project will produce gold and silver doré, and antimony concentrate for commercial sale. The project includes three open pits, an ore processing facility, a lime plant and associated limestone mining, development rock storage facilities, a tailings storage facility, a water treatment facility, access and haul roads, electrical transmission lines, and other support infrastructure and facilities. The mine life will be 20 years, not including post reclamation monitoring, with active mining and ore processing occurring over approximately 15 years. The DSEIS identifies and evaluates a No Action Alternative and two Action Alternatives: 1) 2021 Modified Mine Plan (2021 MMP) Alternative, representing the Proposed Action and identified as the Agency Preferred Alternative, and 2) Johnson Creek Route Alternative.

EPA appreciates that the DSEIS addresses many concerns and recommendations raised in our earlier review of the project documents. Additionally, EPA identified environmental concerns and deficiencies in the analysis that should be addressed in the Final EIS. Our attached Detailed Comments include recommendations for protecting air quality, surface water and groundwater quality, stream temperatures, wetland and riparian resources, fish habitat, and communities with environmental justice concerns; addressing impacts from soil contaminants and reclamation cover materials, geological hazards, and greenhouse gas emissions; and additional analysis to strengthen the assessment of impacts between the different mine access routes/road alternatives and modeling for different parameters.

Key recommendations for the FEIS include:

- Clearly and sharply defining impacts from the mine access routes/road alternatives.
- Monitoring for fugitive dust and particulate matter air emissions, assessing airborne arsenic impacts, confirming consistency across proposed state and federal air quality measures, and addressing possible underestimations of mercury deposition.
- Addressing suitability of soils for reclamation and effects of soil contaminants on surface water quality.
- Implementing effective monitoring, corrective actions, and addressing uncertainty for effects to stream temperature.
- Ensuring impacts from groundwater and surface water contaminants (e.g., mercury, methylmercury, arsenic, and antimony) are not underestimated when demonstrating compliance with the Clean Water Act and determining if additional mitigation measures for potential impacts are needed.
- Including an estimated financial assurance amount and mechanism, the disclosure of which is particularly important in this project given the long-term water management needs at the site (including post-closure).
- Establishing an Independent Tailings Review Board (ITRB) for the tailings storage facility including the buttress dam and conducting regular independent reviews as a mitigation measure to ensure geotechnical stability and protection of surface resources.
- Including continuous monitoring and inspections to address uncertainty and potential underestimation of indirect impacts and functional loss to wetlands and riparian resources.
- Supplementing the environmental justice analysis with EJScreen and considering mitigation measures for impacts including but not limited to loss of access and effects to subsistence.
- For climate change:
    - Including science-based greenhouse gas emissions reduction targets.
    - Assessing the social cost of carbon.
    - Incorporating adaptation in project features, such as stream crossings, reconstruction, and riparian cover.

Thank you for the opportunity to review the DSEIS for this project. We appreciate the constructive ongoing engagement with the Forest Service during the NEPA process and look forward to working with you as you prepare the FEIS. If you have questions about this review, please contact Susan Sturges of my staff at 206-553-2117 and sturges.susan@epa.gov, or me, at (206) 553-1774 or at chu.rebecca@epa.gov.

Sincerely,

REBECCA CHU

Digitally signed by REBECCA CHU
Date: 2023.01.10 13:51:20 -08'00'

Rebecca Chu, Chief
Policy and Environmental Review Branch

Enclosure

Alternatives Analysis – Burntlog Route and the Johnson Creek Alternative

The material summarized in the Executive Summary and in Table 2.8.1 Alternative Comparison and Impact Summary[1] indicate that the Burntlog Route may result in greater impacts on several environmental and economic indicators, than as generally presented for the 2021 MMP Alternative (which includes the Burntlog Route). Examples include more greenhouse gas (GHG) emissions, soil impacts, stream crossings, forest disturbance, wetland loss, wildlife habitat disturbances, new roads, ground disturbance, impact on historical properties, higher inconsistency with designated Recreation Opportunity Spectrum, and lower contributions to employment trends. Further, the 2021 MMP Alternative will likely: impact roadless characteristics in three inventories roadless areas; increase non-native plant species spread; and create construction noise into the Frank Church River of No Return Wilderness. As the proposed mine access routes (Burntlog Route and the Johnson Creek Route Alternative) are the primary difference between the two Action Alternatives, EPA recommends the FEIS clearly and sharply define issues related to each access route and ensure the assessments are accurately reflected across the different sections.

Potential Impacts to Air Quality

Idaho Department of Environmental Quality (IDEQ) Air Quality Permit to Construct (PTC)

The DSEIS indicates on June 17, 2022, IDEQ issued a final PTC and Statement of Basis (SOB) stating that the Stibnite Gold Project (SGP) will not require a Title V permit.[2] Further that "[a] determination was made by the State of Idaho that the SGP satisfies the requirements of the PTC program, based on demonstration of the SGP's potential emissions and controls. This was based on the complete air emissions inventory of stationary sources that was submitted by Perpetua as part of its application to the IDEQ for an air quality permit."[3]

EPA formally commented during the public review process for IDEQ's draft air quality PTC that the draft PTC did not appear to sufficiently limit annual emissions to allow the SGP to avoid being subject to the Title V and Prevention of Significant Deterioration (PSD) programs and assure compliance with the National Ambient Air Quality Standards.[4] EPA continues to review the final PTC for compliance with the CAA. As a Cooperating Agency for this project's EIS, EPA shared our March 2022 draft PTC comments with the Forest Service. EPA recommends the FEIS include a summary of EPA's public comments. EPA is available to meet with the Forest Service and IDEQ, who is also a NEPA cooperating agency, to discuss our concerns and answer any questions.

---

[1] (DSEIS, p. 2-136).
[2] (DSEIS, p. 3-35).
[3] (DSEIS, p. 3-37).
[4] McFadden, Kelly. (March 16, 2022). [Letter from Kelly McFadden, US EPA Region 10 to Kelli Wetzel, Idaho Department of Environmental Quality, 2022].

Enclosure of Main Ore Processing Facility and Coarse Ore Stockpile

The DSEIS indicates the main ore processing facility building and coarse ore stockpile will be enclosed.[5] EPA notes that IDEQ's PTC does not include stipulations that the main ore processing facility building and coarse ore stockpile will be enclosed. Given the inconsistency, EPA recommends the FEIS clarify whether the main ore processing facility building and coarse ore stockpile will be enclosed, which EPA supports to reduce dust. If the main ore processing facility building and coarse ore stock will not be enclosed, correct its description throughout the FEIS. EPA also recommends adjusting the assessment analysis to account for the change.

Bag House Dust Collectors

The DSEIS indicates water sprays and/or bag house dust collectors will be installed at the ore-crushing system and at ore reclaim feeders that deliver ore to the grinding circuit.[6] EPA notes that IDEQ's PTC does not include baghouse dust collectors within the ore-crushing system and at ore reclaim feeders. EPA recommends that the FEIS clarify the measures that will be taken for the SGP, and adjust any inconsistencies in the FEIS, including the assessment analysis to account for the change.

Title V Permit

Regarding the DSEIS statement "[t]he regulation establishes mercury emissions limitations and work practice standards to control mercury emissions from gold production processes." [7] EPA recommends evaluating if this regulation would require a Title V permit for the SGP. If so, EPA recommends adding the following sentence in the same paragraph "This regulation also requires that the SGP obtain a Title V permit. See 40 CFR 63.11640(d). This requirement is separate and independent from whether a Title V permit is needed based on the project's potential air emissions."

Fugitive Dust and Particulate Matter (PM) Monitoring

Table 2.4-12 in the DSEIS indicates "[t]he Proponent will prepare a dust mitigation plan with appropriate schedule or triggers for control deemed adequate by IDEQ to achieve the level of control of 93 percent of dust (as submitted in the proponent's draft application for Permit to Construct from IDEQ). Alternatively, the proponent could employ particulate matter or opacity monitors deemed adequate by IDEQ and the Forest Service and immediately apply water or chemical dust control when PM or opacity monitors reach levels within 10 percent of the threshold determined by IDEQ."[8]

Since the final PTC has been issued by IDEQ, EPA recommends changing the reference to the draft application to a reference to the PTC for the FEIS. PTC permit condition 2.6 requires the proponent to develop and maintain a Fugitive Dust Control Plan (FDCP) and permit conditions 1.2 and 3.2 specifies 93% dust control must be met for the haul roads. The FDCP was not provided in the PTC before it was issued and has not been available for public review. EPA recommends the FEIS include a draft of the FDCP as an appendix or publicly available reference document.

The IDEQ PTC does not contain any requirements for PM monitoring as is stated above in the first paragraph. The EPA has recommended PM10 monitoring in previous cooperating agency NEPA comments and in comments to IDEQ during the draft air permit comment period.

---

[5] (DSEIS, p. 4-36).
[6] (DSEIS, p.4-36).
[7] (DSEIS, p. 3-36).
[8] (DSEIS, p. 2-94).

For the FEIS, EPA continues to recommend continuous PM10 monitoring at the facility fenceline, as a mitigation measure and integral part of the FDCP, to ensure the project will not cause a violation of the primary and secondary National Ambient Air Quality Standards. Monitoring is justified based on the high range of uncertainty in the estimates of fugitive dust emissions and high potential of potential impacts to resources in the project area.

Though the DSEIS modeling indicates that PM10 impacts will be below the NAAQS, the modeling was based on numerous assumptions, including achieving a 93% control efficiency on fugitive dust emitted from haul roads. Small errors and uncertainties in the emission inventory assumptions could lead to significantly more fugitive dust emissions than estimated. In its prior comments to IDEQ, EPA raised concerns about the feasibility and enforceability of achieving the 93% control efficiency.[9] PM10 monitoring would help to verify the estimated emissions in the assessments were correct or provide a measurement tool to gauge the effectiveness of post-project mitigation to address excessive emissions.

Access Road

The DSEIS states "[t]he EPA Region X has indicated that the access road could possibly be excluded from ambient air if sufficient measures are taken to comply with the 2019 revised policy (EPA 2019a)."[10] EPA recommends disclosing that formal EPA policy review of the proposed ambient air boundary was not requested by the state and was not conducted. The EPA does not typically engage in formal review of the ambient air boundary during NEPA review and usually only conducts such a review upon request of the state during air permitting.

For the FEIS, EPA suggests the following to add to the paragraph: "Exclusion of the public access road from ambient air protections is a unique case that relies on measures assumed to meet the standards inferred in the 2019 revised ambient air policy. However, a formal EPA policy review of the ambient air boundary for the project has not been conducted nor requested. A formal review is not necessarily required. The EPA did provide formal comment on IDEQ's air quality PTC recommending a review be requested by the state and that initial measures in the PTC were too ambiguous to determine compliance with the revised ambient air policy."

Arsenic Screening Analysis

The EPA continues to have concern that the arsenic screening analysis underestimates cumulative impacts of airborne arsenic to the environment in the vicinity of the project. The results presented on page 4-46 of the DSEIS, and Table 4.3-13 are compared to an annual acceptable ambient concentration for a carcinogen (AACC), the Idaho toxics screening threshold. However, this screening threshold is not necessarily intended to be compared against a 70-year lifetime scenario where 57 years of the period assumes zero exposure. The threshold is an annual average used for screening, prescribed as a de-minimus value based on lifetime risk. Under IDEQ's hazardous air pollutant program, in practice, project impacts from the maximum year of emissions would typically be compared to the annual average AACC for arsenic.

If the impacts were determined using annual average emissions during the period of the project only, the resulting arsenic concentrations would exceed the AACC. There is significant uncertainty in the

[9] McFadden, Kelly. (March 16, 2022). [Letter from Kelly McFadden, US EPA Region 10 to Kelli Wetzel, Idaho Department of Environmental Quality, 2022].

[10] (DSEIS, p. 3-30).

emission rates of fugitive dust associated with the project such that arsenic emissions could be underpredicted.

Based on these concerns, the EPA continues to recommend the FEIS include an expanded cumulative analysis to disclose project airborne arsenic impacts to the environment.

Retort Emissions

The DSEIS states "[t]he retort emissions are based on an average of two refinery reports in 2015/2016 (NDEP 2015, 2016). The corresponding calculations are 20 percent of the retort standard of 0.8 lb/ton."[11]

The process by which these emissions are derived is unclear. The two referenced documents (NDEP 2015, 2016) contain emission values for over 25 mining operations in Nevada. Depending on the mine, the emissions can be less than 1 lb/year to greater than 500 lbs/year. For the FEIS, EPA recommends providing information on which two refinery reports were averaged and why those two were selected to best represent conditions at Stibnite.

Gaseous Elemental Mercury (Hg0) Emissions

The DSEIS indicates that gaseous elemental Hg0 emission sources at the SGP will be controlled by activated carbon absorbers.[12] If Hg0 emissions are controlled by the activated carbon absorbers, EPA recommends the FEIS clarify if this means that the 13.6 lb/year of Hg released from the SGP project will consist of particulate bound and oxidized Hg. EPA further recommends clarifying for the AERMOD assessment, if all 13.6 lbs of Hg are included in this modeling.

Underestimations of Total Hg Deposition

The DSEIS states "[t]his analysis indicates a maximum estimated increase in Hg deposition rate of 0.4 percent or less of the existing background rate. However, it should be recognized that this rate underestimates the total Hg deposition, as the mechanism of Hg0 flux is not included in the screening model."[13]

While we appreciate the inclusion of the sentence indicating a reason why this percent increase is underestimated; the reason listed is only part of the reason for the underestimation. As mentioned in a previous section, the background Hg deposition values based on data from more than 10 years ago is also biased high due to subsequent emission controls. Therefore, the 0.4% increase underestimates Hg deposition because 1) it does not include Hg0 deposition; and 2) the background deposition rates are overestimated for current conditions.

Generally, when developing an EIS on the impacts of a proposed mine, the preference is to develop conservative estimates of potential impacts and provide caveats as to why these impacts may be overpredicted. For this SEIS there are several instances where impacts are underpredicted and then caveats are added indicating that there is a low bias in the analysis. The problem with this approach is that impacts may not be identified and properly mitigated. EPA suggests adjusting the Hg deposition assessment for the FEIS to conservatively estimate the potential impacts and then provide caveats as to why these impacts are likely overpredicted.

---

[11] (DSEIS, p. 4-40).
[12] (DSEIS, p. 4-50).
[13] (DSEIS, p. 4-50).

Contribution Above Estimated Hg Background

Table 4.3-18 SGP Contribution Above Estimated Hg Background indicates that SGP will result in Hg deposition of 0.056 g/km2/year. However, an earlier Table (4.3-6) indicates that the mine will release 13.6 lbs per year of Hg. The previous statement that Hg0 emissions will be controlled suggests that 13.6 lbs represents releases of oxidized and particulate bound fractions which will be deposited relatively locally.

Of the 6,200 grams of Hg released (which is mostly or entirely Hg2+ and HgP according to the previous statement in the SEIS), AERMOD predicts only 0.056 g/year is deposited with a square km. There seems to be a disconnect between the species of Hg emitted, the amount of Hg emitted, and the amount being deposited locally within this analysis. EPA recommends reevaluating these analyses, making appropriate corrections for the FEIS, and if potential significant deposition is identified, mitigating to reduce impacts.

Soils and Reclamation Cover Materials

Reclamation Cover Material

Table 2.4.-12 in the DSEIS indicates that reclamation cover material (e.g., growth media) used in places including but not limited to the TSF and tailings storage facility buttress (TSFB) would be evaluated for contaminants prior to use during reclamation. Acceptable metal/contaminant concentrations and sampling and testing would be documented in a sampling and analysis plan developed prior to reclamation. [14]

EPA recommends that the FEIS disclose the concentration limits that would be required by the Forest Service since these are directly relevant to the evaluation of environmental impacts for the project, including the analysis of the availability of and suitability of cover material (metals) and the analysis of potential reclamation and closure/post- closure impacts to wetlands, waters, wildlife, aquatic resources, and public health in subsequent EIS sections.

We have provided this same comment on previous versions of this section and the NEPA specialist report and reiterate the recommendation to disclose this information to support conclusions regarding impacts and mitigation effectiveness.

Suitable Soil Types for Reclamation

Under Suitable Soil Types for Reclamation, the DSEIS states "[t]he soils in this SMU [soil map unit typic halosparists (cTH)] also have elevated antimony, arsenic, and mercury concentrations (Tetra Tech 2021a)."[15] EPA recommends the FEIS discuss how soils with elevated concentrations of antimony, arsenic and mercury will impact predicted water quality concentrations of these contaminants. EPA also recommends specifying whether these values are elevated when compared to other background soils or in relation to soil criteria.

Soil Contamination/Chemistry

The DSEIS states "[t]he mean concentrations of antimony (14.88 ppm within a range of 0.04 to 2,580 ppm) and mercury (0.972 ppm within a range of 0.005 to 283 ppm) from the samples are high but are still within the highest screening-level phytotoxicity criteria concentrations from various literature

[14] (DSEIS, p.2-97).
[15] (DSEIS, p. 3-81).

references and federal agencies in U.S. and Canada cited in the Reclamation and Closure Plan (Tetra Tech 2021a)."[16]

While these concentrations may be below phytotoxicity criteria, EPA recommends the FEIS evaluate how elevated soil concentrations will impact surface water quality in the Environmental Consequences section of the FEIS.

Surface Water and Groundwater Quality

Riparian Vegetation Zones

The DSEIS includes a measure to establish 18-foot-wide vegetation zones consisting of willow, spruce, and other riparian species that effectively shade stream flows in the restored and native stream channels in the mine area.[17] Studies over the years have shown that riparian vegetation located outside of an 18-foot buffer is a critical component of riparian vegetation stream shade production. [18,19] That is, restored riparian buffer widths would need to be much wider than 18 feet to produce levels of stream shade that would result in the predicted post-closure stream temperature conditions illustrated in Figure 4.9-27. The DSEIS references to the Environmental Monitoring and Management Plan (EMMP) framework, however, specific actions were not provided that described how full potential stream shading from riparian vegetation within the Riparian Conservation Area[20] will be achieved for riparian areas located outside of 18 feet from the stream.

EPA recommends the FEIS include specific management and protection that will be implemented to ensure (shade producing) riparian vegetation is promoted outside of 18 feet from the stream. Describe the specific planned efforts to eliminate anthropogenic disturbance, and promotion of riparian restoration, within the entire riparian zone, including the "outer" riparian zone associated with stream shade production (i.e., outside of 18 feet from the stream).

Stream Temperature

The DSEIS states that predicted long-term post-closure cool stream temperature conditions depend on the successful implementation of "the lined Stibnite Lake lacustrine feature above the cover of the Yellow Pine pit backfill to moderate maximum stream temperatures."[21]

"Cooling" temperature properties of this lake is dependent on lake water residence time and depth,[22] both of which are impacted by upstream sediment delivery.[23] That is, sediment transport into the lake can result in sediment deposition on the lake bottom, reducing the water depth, and subsequently decreasing the lake residence time. Specifically, it was reported that "about 90 percent of coarse-grained sediment derived from upgradient is deposited in the Yellow Pine pit" along with approximately 20 percent of the fine-grained sediment (<0.0625 millimeter in diameter), and "[t]hus, the Yellow Pine pit

[16] (DSEIS, p. 3-85).
[17] (DSEIS, p. 4-269).
[18] Groom, J. D., Madsen, L. J., Jones, J. E., & Giovanini, J. N. (2018). Informing changes to riparian forestry rules with a Bayesian hierarchical model. Forest Ecology and Management, 419, 17-30.
[19] Barnowe-Meyer, S., Bilby, R., Groom, J., Lunde, C., Richardson, J., & Stednick, J. (2021). Review of current and proposed riparian management zone prescriptions in meeting westside Washington State anti-degradation temperature criterion FINAL REPORT.
[20] (DSEIS, p. 3-250).
[21] (DSEIS, p. 4-269).
[22] (DSEIS, p.4-274).
[23] (DSEIS, p.3-191)

is an effective sediment trap for coarse-grained particles but does not have a long enough residence time to deposit the majority of the fine-grained sediment load." In addition, "most of the sediment load discharged from the Meadow Creek reach is deposited in the Yellow Pine pit lake".[24]

Unless otherwise determined through modeling analysis, it can be expected that these same sediment transport/deposition dynamics will occur with the created East Fork South Fork Salmon River (EFSFSR)/Stibnite Lake complex. In addition, this material also highlights the likely need to understand sediment loading and transport in the EFSFSR watershed to maintain the future Stibnite Lake attributes that lead to "cooling" water temperatures.

Several potential sediment reduction and management measures are introduced on DSEIS page 4-274, and it is stated that the effectiveness of these measures will be evaluated through the EMMP. However, the EMMP does not provide specific examples on how current and future sediment loading is evaluated (i.e., status monitoring), as well as evaluate the effectiveness of the proposed actions to address any future sediment "issue" (i.e., effectiveness monitoring).

EPA recommends the FEIS include implementation of detailed monitoring strategies that will: 1) monitor and quantify the sources and amount of sediment loading (including both chronic and episodic) entering the EFSFSR river system upstream of the Stibnite Lake; 2) evaluate the transport of both suspended and bedload transport in the stream network upstream of the Stibnite Lake; and 3) monitor sediment deposition and bathometry conditions in Stibnite Lake.

Information collected as part of this monitoring effort is necessary to: 1) determine if a problem exists associated with excessive sediment loading and/or deposition in Stibnite Lake, and 2) provide the necessary information to produce plans intended to adequately address any future corrective action to address excessive sediment loading and/or deposition in Stibnite Lake.

EPA also recommends the FEIS include detailed corrective action strategies that outline actions to: 1) correct/eliminate any future "elevated" sediment sources (similar to what is proposed to excessive sediment from Blowout Creek[25]); 2) correct/eliminate the transport of the bed load and "coarse" sediment load that has entered the river network; and 3) potential mitigation measures to address potential future "shallowing" of Stibnite Lake resulting from sediment deposition.

Significant Temperature Mitigation Feature

Figure 4.9-27 illustrates that the most significant temperature mitigation feature in the EFSFSR river watershed is located between the TSFB and the East Fork Meadow Creek (EFMC). Specifically, modeled stream temperatures post mine closure (i.e., end of year 27) decrease up to 7° C within this short reach, which results in lower temperature to continue downstream in the EFSFSR.[26] The DSEIS later reports that without this upstream temperature reduction "stream temperatures downstream of the Yellow Pine pit area could also be greater than existing conditions."[27] The DSEIS lists several possible reasons for this "significant" stream cooling reach: 1) resumption of "baseline" cool groundwater discharge; 2) increase stream shade; and 3) underdrain flow from the TSF.[28]

---

[24] (DSEIS, p. 3-191).
[25] (DSEIS, p. 2-62).
[26] (DSEIS, p. 4-272).
[27] (DSEIS, 4-281).
[28] (DSEIS, p. 4-271).

PET 681

REC 1047

It is unlikely that the first two factors outlined on page 4-271 are meaningful factors in the creation of the "significant" stream cooling zone between the TSFB and the EFMC. The dashed line in Figure 4.9-27 indicates that stream temperatures currently increase within this reach, indicating that "baseline" groundwater influences within this reach are likely a relatively minor factor towards the creation of the "significant" temperature reduction zone. Additionally, it is unlikely that increase shade within this reach will result in the "significant" stream cooling zone because stream shade does not "cool" a river/stream. Stream shade reduces the amount of solar heat load (i.e., sun light) from reaching the stream water, and this lower heat load can result in a gradual loss of heat energy (i.e., temperature reduction) through the relatively slow evaporation/convection processes.

It is possible that cool underdrain flow from the TSF added into this stream reach could physically "dilute" the warm stream water advecting from upstream. The amount of cooling would be dependent on the volume and temperature of these underdrain inputs.

EPA recommends the FEIS: 1) provide additional analysis describing the potential uncertainty that the "cooling" feature will function as predicted, 2) ensure proposed monitoring assesses if the "cooling" feature functions as predicted, and 3) include a description of potential mitigation/corrective actions if the "cooling" feature does not occur as expected.

An acknowledgment of potential uncertainty of predicted ground water discharge volumes and "restored" shade conditions is on page 4-281. However, as described above, these two factors are unlikely a significant source of the cool water within the TSFB and the EFMC reach of Meadow Creek. The potential uncertainty associated with the predictions of the magnitude and duration of the cool underdrain flows were not provided in the DSEIS. Material presented on Page 2-56 indicates that these underdrain flows may be unavailable for stream cooling within this reach due to 1) the potential need for it to be treated prior to discharge into the stream; and/or 2) the potential need for it to be used as makeup water for the mill process. Thus, EPA recommends the FEIS include evaluations in this assessment that describe the potential uncertainty associated with the magnitude and duration of the predicted underdrain flows.

The DSEIS does not discuss potential mitigation measures associated with a lower production and/or elevated temperatures of the expected underdrain flows discharging into the "significant" stream cooling zone between the TSFB and the EFMC. EPA recommends the FEIS include evaluations in this assessment that describe potential mitigation/corrective actions needed to address any loss or reduced effectiveness from the underdrain flows expected within this reach.

Groundwater Analyte Concentrations

The DSEIS indicates groundwater analyte concentrations beneath the mine site, particularly in the vicinity of the TSF, TSFB, Hangar Flats pit backfill, and Yellow Pine pit backfill are expected to increase in response to constituent leaching from development rock. Existing groundwater in those areas typically does not meet regulatory criteria for use as drinking water due primarily to arsenic and antimony concentrations.[29]

To adequately describe the nature and extent of additional groundwater contamination contributed by SGP, EPA recommends the FEIS include a summary that describes the magnitude of groundwater concentrations above current baseline conditions and the geographic extent (in feet) over which baseline

[29] (DSEIS, p. ES-15).

concentrations are exceeded. Figures which depict the extent and magnitude of groundwater concentration changes in relation to mine facilities would be particularly helpful to disclose groundwater impacts.

Surface Water Methylmercury (MeHg) Concentrations

The DSEIS states "MeHg concentrations in SGP site streams are not appreciably different from those reported by the USGS nationwide study, and that historical mining activity in the analysis area has not increased MeHg concentrations above those observed at similar reference locations throughout the U.S."[30]

It is accurate that the USGS nationwide study did not identify an increase in MeHg in basins containing mines; however, the FEIS will need to include a caveat that this study only included one sample location from Idaho, and that location was outside of the Stibnite study area. As such, the statement that mining activity has not increased MeHg above "similar reference locations" is inaccurate. Instead, EPA recommends the FEIS state that MeHg concentrations in the Stibnite area were similar to those observed in non-mining impacted watersheds throughout the US.

It is important when comparing MeHg concentrations to other areas that these be interpreted in the context of the dissolved organic carbon (DOC) and sulfate levels present. The national USGS study referred to includes measures of these parameters. Because the amount of MeHg generated by an ecosystem is influenced by both DOC and sulfate, EPA recommends the FEIS include a comparison of not just the MeHg values, but the MeHg values in relation to existing DOC and sulfate concentrations in the Stibnite area and how those compare to other streams in the national assessment.

Major Ions, pH, and Total Dissolved Solids (TDS)

In the Surface Water - Major Ions, pH, and TDS section of the DSEIS,[31] EPA recommends the FEIS include in this discussion the levels of sulfate under existing conditions. This information is included in Table 3.9.9, but the significance and trends of this data are not described. Because the levels of sulfate may increase because of mining activity and there are important links between sulfate levels and MeHg production, EPA recommends the FEIS include a description of current sulfate levels. From the table, it appears that most sulfate levels are quite low (<10 mg/L), especially when compared to the national average from the USGS study at 45.9 mg/L.

Chemical Release Rates Temperature Correction

The DSEIS states "[t]he source terms were then scaled to field conditions to account for differences in reaction rates, temperatures, and liquid-to-solid ratios between laboratory tests and field conditions."[32]

EPA notes that the temperature correction will likely underestimate leaching rates encountered at the mine site. The Arrhenius equation is based on pyrite oxidation and is not specific to other metal/element release rates. Several metals have been shown to have higher release rates at lower temperatures.[33]

In addition to the inherent uncertainties in applying the temperature correction factor, an annual air temperature of 2.6°C should not be used for scaling. The annual average incorporates many months of sub-zero temperatures into this average when water is frozen and aqueous geochemical reactions are not occurring. A more conservative annual average would be based only on time periods when the

[30] (DSEIS, p. 3-188).
[31] (DSEIS, p. 3-176).
[32] (DSEIS, p. 4-182).
[33] SRK Consulting. 2006. Cold Temperature Effects of Geochemical Weathering.

temperature was greater than 0°C. A slightly less conservative approach would be based on an average that substituted 0's for time periods when the temperature was negative. In addition, temperatures below the surface are often higher than air temperatures, especially when they are insulated with snow cover. Furthermore, chemical reactions are exothermic and can also contribute to increases in subsurface temperatures in geochemically active areas. In addition, under future climatic conditions, the temperature is predicted to increase.

Overall, for the FEIS, EPA recommends the chemical release rates not be corrected for temperature during the water quality modeling.

Effects of Deposited Mercury to Watershed

The DSEIS indicates actual local mercury deposition rates from project emissions depend on the fractions of particulate versus gaseous mercury emissions. Particulate emissions generally deposit on the ground surface nearer to their source while gaseous emissions tend to deposit farther from the source or potentially become part of global atmospheric mercury burden.[34]

We appreciate this information being mentioned in the water quality section of the DSEIS. In the air section of the DSEIS, it suggests that most Hg0 will be captured, which suggests that most of the 13.6 lbs/year (6,200 g/year) that is released will be Hg2+ and HgP which would deposit locally. However, the results of the AERMOD predictions indicate that a much smaller amount or mercury (0.056 g/year) will be deposited within a square km around the mine site. There seems to be a disconnect between the amount and species of mercury emitted and the amount being deposited to the local watershed. EPA recommends the FEIS assess the potential for enhanced local deposition of Hg2+ and HgP of mercury to the local watershed and how this will impact water concentrations.

Ratios of Stream Mercury Loads to Atmospheric Mercury Deposition Rates

The DSEIS states "[r]atios of stream mercury loads to atmospheric mercury deposition rates have been reported in watersheds affected by gold and silver mining (Domagalski et al. 2016)... Therefore, aerial deposition would have a minor to moderate, long-term effect on particulate mercury loads in streams within the project area watershed."[35]

It is unclear what ratios are being used in the analysis that led to the conclusion of minor to moderate impacts. An earlier version of the DSEIS document stated that "[r]eported ratios of stream mercury loads to atmospheric mercury deposition rates have been reported to be approximately 50-to-1 in watersheds affected by gold and silver mining with a drainage areas less than 500 square kilometers (Domagalski et al. 2016). Application of that ratio to the total mass of mercury emission would suggest that aerial deposition could contribute up to approximately 0.3 pounds per year to streams within the watershed during the operations period, primarily in the form of particulate mercury."

At that time, the EPA commented the ratio of 50 to 1 is not applicable to this situation. Domagalski et al, 2016 is suggesting that the stream Hg loads are 50 times higher than the atmospheric deposition load due to the contribution of non-atmospheric sources in the watershed.

Applying the Domagalski ratio of 50 to 1, would indicate that deposition from the mine releases would be 0.006 pounds/ year and then multiplying value by 50 to come up with 0.3 pounds/year. But this large

[34] (DSEIS, p. 4-252).
[35] (DSEIS, p. 4-259).

multiplier is a function of untreated mine waste in the watersheds that is overwhelming the atmospheric deposition. This is not applicable to conditions presented in the DSEIS.

Our concern is that the DSEIS flips the intention of the 50 to 1 ratio to suggest that only 2% of atmospherically deposited mercury makes its ways into streams. This is inaccurate and opposite of what is presented in Domagalski for gold-silver mine impacted watersheds.

While the DSEIS does not make specific reference to the ratio used in the analysis, EPA remains concerned about the basis of the analysis that used the Domagalski ratio of 50 to 1 for these conclusions. EPA recommends the FEIS reassess the ratio used and make corrections accordingly.

Ratio to Predict Future MeHg Concentrations

The DSEIS states "a ratio method to estimate methylmercury concentrations from predicted total mercury concentrations was applied per the approach and data collection by Holloway et al. (2017) that showed methylmercury concentrations were up to two percent of total mercury concentrations in samples from Sugar Creek and the East Fork SFSR."[36]

EPA recommends the FEIS clarify if the ratio from Holloway is based on dissolved or whole water mercury concentrations and recommends utilizing dissolved concentrations since this is the form that is predicted to be released from the mine operations (i.e., "Predictive modeling indicates that mine facilities and water treatment would contribute dissolved mercury to surface waters primarily during the operating and early post-closure periods")

Also, the Holloway ratio is based on existing conditions between mercury and MeHg and will underpredict ratios that may exist if carbon and/or sulfate levels are increased.

Overall, using this ratio to predict future MeHg concentrations likely results in an underprediction of the impacts. For the FEIS, EPA recommends reassessing the use of this ratio and adjusting the assessment accordingly to avoid underpredicting impacts.

Model Sensitivity and Uncertainty

Air Temperature Correction Factors

The DSEIS states "[a]ir temperature correction factors used to scale laboratory reaction rates to field conditions by the model could underestimate actual reaction rates and chemical releases from mined materials, and hence, surface water quality impacts."[37]

We appreciate that the potential for underestimating reactions rates due to the temperature correction factor is mentioned in the DSEIS. However, for the FEIS, EPA suggests that the model be run without the temperature correction factor applied to the chemical source terms in order to provide an upper bound of leaching potential. In general, EPA suggests a preference to overpredict environmental impacts with a caveat that the predictions may be conservative rather than the other way around.

Later the DSEIS mentions "[t]he model is most sensitive to …increasing the reaction temperature" and "increasing the reaction temperature in mined materials and pit walls was shown to produce higher post-closure arsenic concentrations in the pit lakes and downstream assessment nodes."

---

[36] (DSEIS, p. 4-259).
[37] (DSEIS, p. 4-279).

Presumably, "increasing the reaction temperature" refers to using the humidity cell test (HCT) results that were obtained from the lab (at 25°C) without decreasing the reaction temperature to reflect the annual average measured at the mine site (2.6 °C). EPA recommends the FEIS provide details clarifying if they were still decreased from the lab, but less than had been done originally. It should also be taken into consideration that under future climate conditions, the annual average air temperature at the mine may increase, which would result in an underpredictions of chemical releases rates if the current rates are based on the average of historical temperature.

Presumably these results represent uncorrected laboratory-based source terms, as opposed to a dataset where the reaction temperature has been increased beyond what was measured in the lab. Given that the temperature correction factor was a significant variable impacting the water quality predictions (i.e. correcting the chemical release rates measured at 25 °C down to 2.6 °C), this underscores our comments for the FEIS to include the uncorrected rates in the model predictions unless specific evidence can be provided to support the use of the temperature corrections.

Atmospheric Mercury Deposition

The DSEIS states "[t]he surface water quality model predictions do not include mass loading inputs from permitted IPDES outfalls that would be required for the SGP. Additionally, mercury inputs from atmospheric deposition caused by the SGP have not been considered in the model. These additional loads were discussed qualitatively or semi-quantitatively in the analysis above but could modify future analyte concentrations compared to predicted values."[38]

As mentioned above, we appreciate disclosing this information in the DSEIS; however, for the FEIS, EPA recommends accounting for atmospheric deposition in the water quality predictions to provide a wholistic assessment of water quality impacts.

Site-wide Water Chemistry (SWWC) Model-predicted Concentrations

The DSEIS states "[m]odel-predicted concentrations generated by the SWWC Model are for the dissolved fraction only and may underpredict concentration levels for constituents such as mercury that have been shown to occur in particulate form."[39]

As mentioned previously, we appreciate disclosing this information in the DSEIS; however, for the FEIS, EPA recommends a preference to account for whole water concentrations (which is reflective of the 12 ng/L chronic criteria value for mercury).

There are multiple aspects of the analysis in the DSEIS where the estimated impacts represent underpredictions. While each individual aspect may represent a relatively minor underpredictions, collectively they could add up to the impacts to air and water being significantly higher than what is anticipated in the DSEIS. As noted in the comments above, we recommend that underpredictions be remedied to develop conservative predictions of water quality impacts. This is important in order to disclose impacts more accurately and also to ensure that water management, control, and treatment plans will be effective at protecting water quality.

[38] (DSEIS, p. 4-279).
[39] (DSEIS, p. 4-279).

Mitigation Measures for Mercury

Mercury concentrations in West End Creek will increase from the baseline of approximately 4 ng/l to approximately 53 ng/l during mining operations (for 10 years).[40] This represents an increase in mercury loading and likely impairment to West End Creek, which is fully supporting its beneficial uses and is a high-quality water under Idaho's antidegradation policy. Additionally, it will also increase loading downstream to Sugar Creek, which is already listed as impaired under Clean Water Act Section 303(d) for mercury. The increase is due to the diversion of West End Creek, which is a result of the proposed SGP. Even though West End Creek is elevated in mercury above the proposed West End pit, by diverting the Creek and mining the pit, the SGP is resulting in an increase in the amount of mercury into lower West End Creek and Sugar Creek from current conditions. For the FEIS, EPA recommends that a mitigation measure be developed to avoid the predicted mercury water quality standard exceedances during operations or offset the additional amount of mercury being added to the system (e.g., by removing other mercury sources) to avoid further water quality degradation. Because mercury is bioaccumulative, effects to the system will likely extend beyond the lifespan of the SGP.

Financial Assurance

According to the DSEIS, calculation of the initial bond amount would be completed following the Record of Decision (ROD) when enough information is available to adequately and accurately perform the calculation.[41] EPA continues to recommend that the FEIS provide a more specific discussion of the estimated financial assurance amount and mechanism, particularly given the water management needs at the site (including post-closure). This would provide a basis for evaluating whether the planned reclamation and closure activities would be effective (funded) in the event of a bankruptcy or compliance issues. Other mining EISs have included financial assurance estimates that comport with the draft reclamation and closure plans and acknowledge that the final financial assurance would be determined after the ROD. For example, see the Donlin Gold Project EIS, the Haile Gold Project EIS, and the Northmet Project EIS. This level of disclosure is also important for the SGP. Failure to obtain sufficient financial assurance at the Stibnite Mine Site in the past has resulted in significant, unaddressed contamination at the Site. If not for the NEPA process, there would be no public disclosure of financial assurance estimates. We understand that draft estimates are currently available.

Geologic Resources and Geotechnical Hazards

Mitigation Measures for Geotechnical Stability

The SDEIS analysis does not recommend any additional geotechnical stability mitigation measures beyond those identified in Section 2.4.9. Although the TSF dam is designed to meet and exceed regulatory stability criteria, recent studies of dam failures have established that the dominant cause of failures arises from deficiencies in engineering practice associated with the spectrum of activities embraced by design, construction, quality control, and quality assurance.[42] Therefore, there is credible information highlighting that, even assuming that the dam and buttress are adequately designed, dam incidents could still happen due to human-caused errors during construction and operations. A best practice to mitigate this, is the establishment of an Independent Tailings Review Board (ITRB) and regular independent reviews during design, construction, operations, and closure. An ITRB and regular

[40] (DSEIS, p.4-251).
[41] (DSEIS, p. 2-91).
[42] Morgenstern, N.R. 2018. Geotechnical Risk, Regulation, and Public Policy. Soils and Rocks, São Paulo, 41(2): 107-129.

independent review is a best practice for new tailings dam facilities (with high or greater consequence classifications) in the Global Industry Standard on Tailings Management.[43]

The State of Idaho's dam safety regulations do not appear to require independent review. Therefore, we recommend that the FEIS include a requirement that an ITRB be established and regularly conduct independent reviews as a mitigation measure to ensure geotechnical stability, including during seismic events, and protection of surface resources. We note that the Forest Service is requiring establishment of an ITRB in RODs for the Pinto Valley Mine (AZ) and Kensington Mine (AK), based on the global standard and FEMA Federal Guidelines for Dam Safety Risk Management.

Geotechnical Stability of Mine Access Roads

When comparing geotechnical stability related to mass wasting events (i.e., landslides, rockfalls, and avalanche paths) of the 2021 MMP Alternative's Burntlog Route and the Johnson Creek Route Alternative, EPA recommends the FEIS consider the implementation of proposed environmental design features (EDFs) for the two Action Alternatives in the alternatives analysis. For example, for existing areas of landslides and rockfalls, geotechnical design considerations and improvements to existing roads with EDFs could address the issues raised as concerns for the Johnson Creek Route Alternative with geotechnical stability potentially improving as a result of the alternative. EPA also recommends that the FEIS clearly state in Section 4.2.2.3 Johnson Creek Route Alternative that the EDFs proposed for the 2021 MMP Alternative's Burntlog Route also apply to the Johnson Creek Route Alternative.

Existing Versus New Stream Crossings from Mine Access Roads

Throughout the DSEIS, the number of estimated stream crossings for mine access roads are compared between the alternatives, but the context of these stream crossings (i.e., existing versus new) is not generally included in these analyses. For example, new stream crossings where a road did not previously exist has a different impact than reconstruction of current road stream crossings to higher environmental protection standards which may result in an improvement of aquatic conditions/upstream access. Where appropriate to meaningfully distinguish impacts between alternatives, in addition to estimated number of stream crossings, EPA recommends the FEIS evaluates the potential impacts from stream crossings that considers potential different responses associated with existing stream crossings and new stream crossings.

Impact Assessment of Public Access of Burntlog Route

According to the DSEIS, Burntlog Route will be open to public use[44]and it is not apparent that the 2021 MMP Alternative will necessarily promote the separation of the general public and heavy mining equipment during operations along Burntlog Route when compared to Johnson Creek Route Alternative. Accordingly, during operations the public will potentially have access and use the same roads as large mining equipment for both Action Alternatives. Therefore, EPA recommends that potential public safety risks and potential accidents resulting from public use of these road networks are assessed similarly for both Action Alternatives. EPA also recommends that this assessment accounts for the effects of proposed improvements to the road network that are described for the Johnson Creek Route Alternative (i.e., "wider roads, more cut/fill sections, and more switchbacks") when comparing these two alternatives.

[43] International Council on Mining & Metals, UN Environment Programme, Principles for Responsible Investment, August 2020.

[44] For example, (DSEIS, pgs. 2-18, 2-20, and 4-34).

Fish Resources and Fish Habitat

Fish Exposure to Interim Conditions

The DSEIS includes a summary of measures to avoid and minimize impacts to fish habitat and describes the fishway (with trap and haul capability) and direct and indirect impacts to individual fish.[45] Measures such as removal or blockage of access will be taken to ensure fish are not exposed to mining activities that are known to be potentially harmful or lethal such as noise and vibration. The DSEIS is unclear about whether reaches that are in sub-optimal/poor condition are accessible to fish (with consideration to both anadromous and non-anadromous salmonids). Fish will have access to the active area, if the fishway provides upstream and downstream passage as planned. The DSEIS indicates fish will have access to stream reaches recently impacted and have marginal/poor condition in terms of habitat quality, stability, temperature, etc.[46] EPA recommends the FEIS clarify whether there will be fish access to recently reclaimed reaches in marginal/poor condition and discuss related control measures to ensure fish protection.

Stream Construction and Enhancements

Successful stream reclamations and enhancements are constructed to function in relative equilibrium with inputs/transport of wood, water, and sediment/bedload that vary in time and space. Therefore, design and construction are dependent on adequate modeling of these three inputs. Even with careful effort, risk of improper function can result leading to negative outcomes, such as erosion, incision, bed aggradation, channel widening, etc. This risk has been acknowledged in the DSEIS stream design report.[47] Once completed, these stream constructions/restorations require ongoing evaluation and monitoring to ensure proper function until they are established and stable.

EPA encourages that the FEIS include the best available data and modeling methods for the stream reclamation/enhancement effort. EPA further recommends following a rigorous monitoring effort, particularly following large precipitation events (e.g., rain-on-snow) to ensure that this restoration can be realized in the long-term. We recommend that these measures be identified and committed to in the FEIS.

Mitigation for Tissue-based Mercury Criteria Exceedances

The DSEIS states "[f]or mercury, while the predicted concentrations do not exceed the aquatic life criterion based on water column, it is uncertain whether incremental change in water column concentrations beyond baseline would cause fish tissue concentrations to exceed the tissue-based criterion."[48]

This uncertainty directly relates to whether the SGP would result in exceedances of Idaho's EPA-approved fish tissue-based human health criterion for mercury. The 2014 NMFS Biological Opinion for Idaho's water quality standards for toxics concluded that the aquatic life criterion is not protective of aquatic life and that it is unlikely to be protective of the human health fish tissue criterion. Therefore, EPA recommends that this uncertainty be addressed by including a mitigation measure to section 4.12.3 that would require mercury monitoring and analysis to determine whether the incremental changes could result in exceedances of the tissue-based mercury human health criterion over time and that adaptive

---

[45] (SDEIS, pg. 2-107, 2-119 -120, and 4-334).

[46] (SDEIS, p. 4-334).

[47] Perpetua Resources. Sept. 2021. Stibnite Gold Project– Stream Design Report. Prepared by Rio Applied Science and Engineering, Boise, Idaho.

[48] (DSEIS, p. 4-438).

management occur if exceedances are predicted. EPA also recommends the FEIS include this mitigation along with a list of potential adaptive management measures or mercury offsets.

Access and Transportation

Context for Disturbance by Past Mining Activities

The DSEIS states "[t]here would be a long-term loss of access to land for exercising treaty rights within the Operations Area Boundary while the lands are occupied for mining; however, lands within the Operations Area Boundary have been highly disturbed by past mining activities."[49] EPA notes that the statement "lands within the Operations Area Boundary have been highly disturbed by past mining activities" does not serve a purpose in the context of public access and how it affects impacted Tribes without additional context. The first half of the sentence speaks to the loss of access to the land, and the underlined portion shifts to land disturbance and not access.

As written, it seems to suggest that additional land disturbance will not be as impactful to Tribes because the land has already been disturbed in the past. For the FEIS, EPA suggests either removing the identified portion of the text, or providing additional context after it, to clarify that past impacts to the land do not justify or reduce the concerns associated with future land disturbances.

Wetlands and Riparian Resources

Uncertainty and Underestimation of Indirect Effects

Regarding "[f]unctional loss due to other indirect effects, including changes in hydrology, water quality, and increase dust and/or mercury deposition has been examined through inspection of dewatering drawdown and distance to roadways, but is difficult to quantify precisely. As a result, functional units that would be lost if these indirect effects occur, may be underestimated."[50]

To address these uncertainties and underestimation of impacts, EPA recommends the FEIS include a mitigation measure to Section 4.12.2 that would require continuous monitoring and inspections to determine whether there are incremental changes that are contributing additional impacts to hydrology, water quality, increased dust/mercury deposition, etc. that are indicative of additional functional loss to wetlands or riparian resources. EPA further recommends that the monitoring and inspections be used to identify if additional best management practices, adaptive management, and/or compensatory mitigation are needed during project operations.

Conceptual Stream and Wetland Mitigation Plan

The DSEIS provides little information about the overall objectives and elements of the proposed Conceptual Stream and Wetland Mitigation Plan compared to descriptions of the other proposed mitigation plans developed for other resources. EPA recommends the FEIS provide more details about the actions proposed in this mitigation plan that demonstrates that this plan will provides adequate and appropriate compensatory mitigation. Language like what is found on page 4-322 (Section 4.11.3 - Mitigation Measures) – "Perpetua proposes to accomplish compensatory mitigation for impacts to wetlands through a combination of mitigation bank credits in the North Fork Payette subbasin and permittee-responsible on-site mitigation within the SFSR subbasin (Tetra Tech 2021b)", would be helpful to summarize earlier in the FEIS, such as in the Stibnite Gold Mitigation Plan section of the Alternatives chapter.

---

[49] (DSEIS, p. 4-492).

[50] (DSEIS, p. 4-308).

Environmental Justice

EJScreen

The Forest Service employs a clear methodology for identifying people of color and low-income populations in the SEIS analysis and considers the need for a state-specific threshold to identify these communities. In addition to the methodology outlined by the Forest Service, EPA continues to recommend the FEIS supplement the analysis by including an EJScreen analysis and considering its datasets with the most recent version of EJScreen, EJScreen 2.1.[51] EPA considers a project to be in an area of potential environmental justice (EJ) concern when an EJScreen for the impacted area shows one or more of the EJ Indexes at or above the 80th percentile in the nation and/or state.

Traditional Ecological Knowledge

EPA appreciates that the DSEIS includes ethnographies of the analysis area prepared by the Nez Perce Tribe, the Shoshone-Paiute Tribes, and the Shoshone-Bannock Tribes. EPA recommends the FEIS include the identification, inclusion, and integration of Traditional Ecological Knowledge (TEK) into the NEPA analysis. In addition to anticipated impacts from the project, as well as traditional hunting and land use patterns in the area, this can include the collection of local and traditional knowledge concerning the affected environment and could be used to support the understanding of how climate change has impacted local environmental resources and subsistence resources. In addition to reviewing any pertinent traditional environmental knowledge currently available, additional studies and outreach may be conducted as necessary to clearly identify potential impacts, including cumulative impacts, from the proposed project and project alternatives, and help inform avoidance, minimization, and compensation strategies across affected environmental resources. As an example, this could include potential impacts from increased noise and air emissions that may affect fish and wildlife that are of cultural and subsistence importance to communities with EJ concerns.

Mitigation

EPA notes that the DSEIS indicates that at this time, no mitigation measures have been identified for Environmental Justice and for several of the resource sections that are relevant to Environmental Justice. For the FEIS, EPA recommends including mitigation measures developed upon contribution and feedback from the communities with EJ concerns if the information can be publicly disclosed, or alternatively, note that mitigation measures have been developed or are contingent upon contribution and feedback from the communities with EJ concerns.

Access Mitigation

The ~14,221 acres of public lands within the Operations Area Boundary will become inaccessible to communities with EJ concerns. This restricted access has potential to result in additional adverse and disproportionate impacts by limiting subsistence or traditional use by communities with EJ concerns, including tribal members and indigenous peoples.[52] The DSEIS indicates that the action alternatives will remove access to a culturally important area for approximately 20 years.[53] The DSEIS indicates that a mitigation measure for access impact would be incorporated into any decision on the SGP due to long-term loss of access to land while the lands are occupied for mining.[54]

---

[51] https://www.epa.gov/ejscreen, accessed 1/10/2023.
[52] (DSEIS, p. 4-620).
[53] (DSEIS, p. 4-623).
[54] (DSEIS, p. 4-669 and 4-672).

To the extent information can be publicly disclosed, EPA recommends including in the FEIS additional information on proposed access mitigation. EPA continues to recommend working with communities with EJ concerns to identify priority areas that will be affected by SGP, and using input from these communities to identify access opportunities, develop mitigation plans, and developing plan to restore access at the conclusion of the project. If there is interest from communities with EJ concerns in maintaining partial access to specific high-priority areas within the Operations Area Boundary, then EPA encourages Forest Service to work with these communities and the project proponent to determine specific times that may be reserved for safe access, if possible.

Replacement Cost Method for Subsistence Foods

EPA recommends that the Forest Service consider the potential use of the replacement cost method (RCM) to quantify the monetary cost of replacing subsistence foods that may be lost because of SGP activities. RCM is a standard technique for evaluating the dollar value of an ecosystem service.[55] Subsistence harvest patterns could be disrupted by harvesters' self-imposed restrictions on resources considered to be tainted, or as a result of space-use conflicts (e.g., increased number of users resulting from changes to access), or due to the temporarily avoidance of subsistence use areas due to noise impacts and habitat loss expected from construction and operation. When subsistence foods are not available, nutritionally comparable substitutes must be purchased, placing a direct financial burden on subsistence users in the form of lost harvest, as well as an indirect burden from stranded assets that users purchase for harvest activities (e.g., fishing or hunting equipment, 4x4 vehicles). EPA recommends that Forest Service work with communities with EJ concerns to consider potentially developing and adopting mitigation measures that will compensate for potential losses in harvest using the RCM.

Climate Change

NEPA Guidance on Consideration of Greenhouse Gas Emissions and Climate Change

On January 9, 2023, Council on Environmental Quality (CEQ) published interim guidance to assist federal agencies in assessing and disclosing climate change impacts during environmental reviews.[56] CEQ developed this guidance in response to EO 13990, *Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis*. The interim guidance is effective immediately. CEQ indicated that agencies should use this interim guidance to inform the NEPA review for all new proposed actions and may use it for evaluations in process, as agencies deem appropriate, such as informing the consideration of alternatives or help address comments raised through the public comment process. EPA recommends the FEIS apply the interim guidance as appropriate, to ensure robust consideration of potential climate impacts, mitigation, and adaptation issues.

Science-based GHG Reductions Targets

The analysis in the DSEIS compares project emissions to Idaho state-level emissions as a percentage. EPA recommends the FEIS compare project emissions to science based GHG reductions targets. The United States has established a Paris-agreement target to reduce net GHG emissions economy-wide by 50-52% below 2005 levels, consistent with a pathway to net-zero by 2050. EO 14057 establishes a policy for the federal government to lead by example in order to achieve a carbon-pollution free electricity sector by 2035 and net-zero emissions economy-wide by no later than 2050. These and other policies reflect science based GHG reduction goals to avoid the worst impacts of climate change.

[55] (Brown & Burch, 1992; Hougner, Colding, & Soderqvist, 2006).

[56] https://www.federalregister.gov/documents/2023/01/09/2023-00158/national-environmental-policy-act-guidance-on-consideration-of-greenhouse-gas-emissions-and-climate, accessed 1/10/2023.

EPA recommends the FEIS discussion include whether and to what extent the estimated GHG emissions from the proposed alternatives are consistent with achieving these science based national GHG reduction targets and any relevant state or local goals.

Social Cost of Carbon

The DSEIS notes "[f]or purposes of this analysis, qualitative analysis is appropriate because quantifying the relative costs and benefits of the alternatives is not practically feasible and would be subject to high uncertainty as described below."[57] However, the DSEIS calculates estimates of direct and indirect emissions, and these estimates can be used to monetize those emissions using the Social Cost of Greenhouse Gases (SG-GHG). EPA encourages lead agencies to monetize impacts of GHG emissions using SG-GHG estimates in NEPA analyses. For transparency, EPA recommends the FEIS assess the climate impacts and disclose climate damages of the proposed project using the SC-GHG, which reflect the best available science and methodologies to monetize the value of net changes in direct and indirect GHG emissions resulting from a proposed action to society.

Estimated Emissions Speciated by Gas

The SDEIS presents estimates in CO_2e and not speciated by gas (CO_2, CH_4 and N_2O). To ensure transparency of the analysis, EPA recommends presenting emissions estimates individually by GHG, as well as aggregated in terms of total CO_2e in the FEIS.

Additionally, the DSEIS indicates that approximately 99.9 percent of all processing GHG emissions are CO_2. Similarly, construction, mining and commuting CO_2 emissions comprise approximately 99 percent of the total GHG emissions from those activities.[58] EPA recommends the FEIS include data to support this statement. Specifically, EPA recommends providing data showing the amount of each GHG emitted from each emission source (i.e., the activities included in Tables 4.4-2a and 4.4-2b).

Direct and Indirect GHG Emissions

EPA recommends including a data table in the FEIS to support the DSEIS statement that the direct and indirect GHG emissions are only a small increase over the current regional GHG emissions.[59] Much of the information to develop this table is already in the SEIS, but it is found in various sections and with differing units (e.g., MMT CO_2 (e) vs. tons CO_2 (e)). As an example, to produce a table to support this statement, Tables 4.4-2a and 4.4-2b could be augmented to include the estimated indirect emissions and the current Idaho GHG emissions inventory.

Access Road Alternatives

The DSEIS indicates that the magnitude of the GHG emissions difference between the access road alternatives will be small compared to total SGP construction emissions during the construction phase.[60] EPA recommends the FEIS support this statement with data demonstrating that the Johnson Creek Alternative has similar GHG emissions to the 2021 MMP Alternative. Preferably, the emissions data for this alternative would be presented the same as it is in Tables 4.4-2a and 4.4-2b so that the alternatives can be meaningfully compared.

---

[57] (DSEIS, p. 4-60).
[58] (DSEIS, p. 4-65).
[59] (DSEIS, p. 4-67).
[60] (DSEIS, p. 4-73).

Integration of Climate Science

Flow (quantity and timing), summer air temperatures, and snowpack are likely to be substantially different over the span of this project (i.e., the next 15 to 20 years or longer) due to climate change. Further, conditions from that point in time into the future will be even further from estimates that are based on past conditions. It does not appear that climate change related concepts/forecasting/modeling are incorporated in the relevant sections of the DSEIS beyond the acknowledgement that climate change presents uncertainty.[61] For example, the DSEIS indicates the 100-year flood recurrence interval has been the standard approach in culvert sizing,[62] but it is now important to state future projections of high flow magnitude to conservatively account for climate change; and that modeled flow future conditions are based on historic condition.[63]

For the FEIS, EPA recommends incorporating state-of-the-climate science forecasting/modeling to estimate local climate conditions for proposed work that uses estimates of flow, air temperature, and snowpack. Examples of activities that would benefit from sophisticated forecasting would be road crossings design, stream reconstruction, and growth of riparian vegetation for stream temperature attainment. If site specific models and data are not available, consider incorporating climate science literature/information to inform and adjust existing models to conservatively adjust for climate change. Consider climate science projections (knowledge from the literature, forecasting/modeling) in aspects for both ongoing and postmining operations.

Proposed Action and Alternatives

Agency Preferred Alternative

Rationale of 2021 MMP Identification

The Executive Summary highlights three reasons the Forest Service identified the 2021 MMP Alternative as the Agency Preferred Alternative, but the first two bullets (i.e., incorporates water management and closure activities to reduce the duration of long-term water treatment requirements and incorporate measures to manage stream temperatures) are also true for the Johnson Creek Alternative since the mining portion of the Action Alternatives are the same. Similarly, Section 2.7 highlights eight reasons the Forest Service identified the 2021 MMP as the Agency Preferred Alternative, but the first two are also true for Johnson Creek Alternative. For the FEIS, since the Action Alternatives differ by proposed mine access routes, EPA recommends replacing these first two reasons with other primary reasons that are exclusive for the 2021 MMP.

The Agency Preferred Alternative sections in the Executive Summary and Chapter 2, as presented, appear to imply that the Agency Preferred Alternative is environmentally superior to the Johnson Creek Alternative. For transparency, EPA recommends the FEIS provide additional context for the selection, such as if the reasons highlighted were given preference or prioritized over other potential negative impacts.

Least Environmentally Damaging Alternative (LEDPA)

Because the U.S. Army Corps of Engineers is planning to use this EIS to support its CWA Section 404 analysis, EPA recommends that the FEIS discuss whether the Agency Preferred Alternative is also the LEDPA.

[61] (DSEIS, p.4-280).
[62] (DSEIS, p.4-264).
[63] (DSEIS, p.4-326).

Environmentally Preferrable Alternative
EPA recommends the FEIS describe the criteria which will be used to ultimately determine the environmentally preferable alternative under NEPA.

Specific Comments – DSEIS

Ore Processing

- The DSEIS indicates grinding will occur within an enclosed building to reduce noise levels and facilitate maintenance of the milling equipment.[64] EPA recommends the FEIS confirm if the ore processing building will be enclosed, and if not, correct its description throughout the FEIS. EPA notes a similar statement regarding an enclosed ore processing facility building is included in the Environmental Design Features on page 2-112.

- The DSEIS indicates the limestone crusher, screens, conveyors, and feed bins would not be enclosed. Dust would be controlled in a similar manner to the ore crushing and conveying process using water sprays and/or bag house dust collectors.[65] EPA recommends FEIS confirm if the limestone processing would be controlled like the ore processing operation, and if so, correct its description throughout the FEIS.

Tailings Storage Facility

- Regarding "[t]he TSF would be designed and operated as a closed-circuit, zero-discharge facility meaning no tailings water would be discharged to the surface water or groundwater except in compliance with applicable permits and regulations"[66] and "[w]ater from the TSF and TSF Buttress underdrains may be discharged from two outfalls shown on Figure 2.4-15,…"[67]

  The first sentence implies that there will be no discharge from the TSF. Based on the other two sentences, this appears to be accurate for operational conditions, but not for closure. Therefore, for the FEIS, EPA recommends revising the first sentence as follows: "… no tailings water would be discharged during mining operations,…"

Dry Stack Tailings

- The DSEIS indicates the use of the dry stack method of tailings disposal was evaluated and determined to be technically and economically infeasible.[68] An additional consideration in the determination to not fully evaluate a dry stack option is that stability of the proposed TSF is enhanced by the waste rock buttress so the stability advantage of a dry stack over a tailings impoundment is not as prominent for the SGP as it might be for other projects. We recommend that this consideration be included in the FEIS.

Agency Preferred Alternative

- The rationale for Agency Preferred Alternative in Section 2.7 raises two travelway distances (i.e., 0.5 miles and 100ft) in comparison for potential spill contamination, sedimentation, and

[64] (DSEIS, p. 2-48).
[65] (DSEIS, p. 3-48).
[66] (DSEIS, p. 2-57).
[67] (DSEIS, p. 2-67).
[68] (DSEIS, p. 2-130).

turbidity to streams during operations.[69] As there is very likely covariance (i.e., connection) between the two travelway distance zones and that these two zones could be repeating the same information, EPA suggests the FEIS use only one distance zone in this comparison.

Table 2.8-1 Alternative Comparison and Impact Summary (for 2021 MMP)

- The DSEIS indicates low flow will be reduced at some locations during some periods of the SGP operations.[70] EPA recommends the FEIS add a sentence to the table describing how far downstream (in feet or miles) from the SGP low flow conditions would occur so that the geographic extent of low flow impacts to the EFSFSR are clearly disclosed. Note that this comment also applies to the same sentence on page ES-14.

- In the summary table 2.8-1 2021 MMP, the TSF area groundwater summary provides the estimated changes in groundwater concentrations.[71] EPA recommends the FEIS describe how far from each facility the groundwater concentrations would remain elevated above the baseline so that the geographic extent of groundwater contamination caused by the SGP is disclosed.

- The DSEIS states, "[f]or mercury, while the predicted concentrations do not exceed the aquatic life criterion based on water column, it is uncertain whether incremental change in water column concentrations beyond baseline would cause fish tissue concentrations to exceed the tissue-based criterion."[72] EPA recommends the FEIS add this sentence to the summary table 2.8-1 2021 MMP, for surface water quality since it relates to uncertainties associated with achieving Idaho's fish tissue-based mercury water quality criterion for human health.

- According to pg. 4-308, "[f]unctional loss due to other indirect effects, including changes in hydrology, water quality, and increase dust and/or mercury deposition has been examined through inspection of dewatering drawdown and distance to roadways, but is difficult to quantify precisely. As a result, functional units that would be lost if these indirect effects occur, may be underestimated." EPA recommends adding this statement or something similar to the summary table 2.8-1 2021 MMP, Wetlands for the FEIS. Otherwise, the exact acres of wetlands lost or changed provided in the table imply a level of certainty that does not exist since indirect (secondary) impacts are underestimated and not quantified. In addition, we recommend that a similar uncertainty statement be added to the Executive Summary on page ES-17.

Air Quality

- The SDEIS indicates deposition of mercury, and nitrogen and sulfur species were predicted to be less than Significant Impact Levels (SILs).[73] EPA notes that SILs are air quality screening thresholds not applicable to deposition of pollutants, so this statement is incorrect. For the FEIS, EPA recommends replacing this term with "applicable screening thresholds," or another appropriate term.

- The DSEIS states "SILs are defined concentrations of criteria pollutants in the ambient air that are considered inconsequential in comparison to the NAAQS. A project impact shown to be

[69] (DSEIS, p. 2-133).
[70] (DSEIS, p. 2-141).
[71] (DSEIS, p. 2-143).
[72] (DSEIS, p. 4-438).
[73] (DSEIS, p. ES-9).

below a SIL can be presumed to not cause or contribute to the violation of a NAAQS."[74] The first sentence in this paragraph is misleading. For the FEIS, EPA suggests the following language replace the first sentence: "SILs are screening thresholds of criteria air pollutant concentrations considered by the EPA as a level of de minimis impact to air quality. SILs are primarily used in air quality modeling assessments, where a project impact shown to be below a SIL can be presumed to not cause or contribute to the violation of a NAAQS."

- EPA recommends the FEIS clarify or note in Section 3.3.2 why the much larger "far-field" region's scope is of importance to the Tribes,[75] given the potential impacts of poor ambient air quality to wilderness areas of Tribal and cultural significance.

- The DSEIS states "[t]he New Source Review process requires facilities to undergo an EPA pre-construction review if they propose building new facilities or modifying existing facilities that would result in a "significant increase" of criteria pollutants per 40 CFR § 52.2376."[76] For the FEIS, EPA recommends changing the regulatory cite from "52.2376" to "52.21" and "criteria pollutants" to "regulated NSR pollutants."

- The DSEIS states "[a]pplicability of the PSD program to the SGP depends on the magnitude of annual emissions for criteria pollutants."[77] We recommend the FEIS revise this sentence to be more precise: "Applicability of the PSD program to the SGP depends on the project's potential to emit regulated NSR pollutants. Applicability is determined using maximum potential annual potential emissions of the project for each NSR pollutant."

- The DSEIS states "… the 2021 MMP analysis did include an assessment of the significance of SGP air quality impacts by comparison to the Class II PSD increments."[78] EPA suggests the FEIS add an additional sentence to disclose why the PSD increment is selected as a threshold to assess the significance of air quality impacts. For example, additional language could state: "The PSD increments may provide a reasonable significance threshold for NEPA assessment because, under the Clean Air Act, significant air quality deterioration is recognized to occur when the amount of new air pollution from a new or modified source would exceed the applicable PSD increment."

- The DSEIS includes a statement "…consistent with best available control technology for new surface mining and processing operations"[79] which is incorrect. The project did not go through BACT review under the IDEQ PTC process because it did not go through major-source PSD permitting. EPA recommends removing the reference to BACT in the FEIS. A similar statement is included at the top of page 4-59 which EPA recommends revising to remove the reference to BACT.

---

[74] (DSEIS, p. 4-27).
[75] (DSEIS, p. 3-30).
[76] (DSEIS, p. 3-34).
[77] (DSEIS, p.3-35).
[78] (DSEIS, p. 4-28).
[79] (DSEIS, p. 4-35).

- EPA suggests the FEIS revise the second sentence on page 4-38 to read "As shown in Table 4.3-4, *IDEQ determined that* these emissions are less than the annual threshold of 100 tpy that would trigger Title V or 250 tpy for PSD permitting status."

- Regarding DSEIS statement on page 4-43 "…it also is unlikely the SGP would cause or contribute to a violation of a PSD increment" and Table 4.3-9 column heading "PSD Increment Compliance", it is important to disclose that comparison to the PSD increment threshold in the EIS is not to determine compliance to the standard (this is not a full regulatory assessment of increment consumption) but as a measure of the significance of project impacts to air quality for purposes of NEPA review. Therefore, we recommend the FEIS add a sentence to state the results instead indicate the project does not cause a significant deterioration of air quality. Also, EPA suggests changing the column header for Table 4.3-9 from "PSD increment compliance" to more appropriate wording such as "Results below threshold" or something similar to show the comparison is used to judge significance of project impacts rather than compliance with a regulatory threshold.

- For the DSEIS statement "[t]he most recent measurements were between 2007 and 2010 and are provided in Table 3.3-10 to serve as an estimate of historical Hg deposition in the region surrounding the SGP area,"[80] EPA recommends the FEIS add the word "wet" before deposition to specify that these data do not include dry deposition.

- For Table 3.3-10 Historical Annual Average Concentration and Mercury Deposition Rates – Three Idaho MDN Sites,[81] EPA recommends the FEIS add "in precipitation" to this Table title.

- The DSEIS indicates the nearest geographic site to the SGP area is no longer active but was active from December 2008 to August 14, 2017.[82] For the FEIS, EPA recommends specifying that the nearest site is over 500 km away.

- EPA notes that the Table (3.3-11) Annual Average Mercury Concentration – Salt Lake City AMNet Site[83] contains an important error. The Table reports that the overall mean gaseous elemental mercury (GEM) concentrations is 12.91 ng/m3. This value is not accurate. All yearly averages shown above in the Table are less than 2.5 ng/m3; and if taking an overall mean of the annual means the value would be 1.88 ng/m3 which is much lower than the 12.91 ng/m3 value currently included in the Table. It appears that the values for particle bound mercury (PBM)2.5 and GEM were switched, because the PBM2.5 value listed is lower than all of the annual reported concentrations. EPA recommends the FEIS correct the error accordingly.

- Regarding the DSEIS statement "[e]stimates of these emissions were based on regulatory compliance emission test results available for several gold mines in Nevada that use the same type of extraction process (Nevada Division of Environmental Protection 2006, 2015, 2016),"[84] for the FEIS, EPA recommends the FEIS add whether the mercury content of the ore was significantly different in the comparison between Stibnite and the Nevada mines.

---

[80] (DSEIS, p. 3-47).
[81] (DSEIS, p. 3-56).
[82] (DSEIS, p. 3-56).
[83] (DSEIS, p. 3-57).
[84] (DSEIS, p. 4-25).

- The DSEIS states "[f]urther speciation of the particulate forms of Hg is possible such as fine [particle-borne Hg (HgP)], which is analogous to filterable and condensable PM10. Essentially, the PM10 associated with HgP is the mercury bound within the particles of the particulate smaller than 10 microns. Appropriate particle distribution of mercury can be established using proper test methods and techniques, but the overall percentage of HgP compared to total Hg is small, with HgP PM10 being even less (~14.1 percent vs 2.4 percent from a coal boiler as an example) (Peng 2021). However, as discussed below, and in further detail in Section 4.3.4.2, the approach applied for this analysis did not speciate HgP."[85] EPA notes that this statement appears superfluous, given that particulate bound Hg was not further speciated in the analysis. EPA suggests the FEIS include some context for why this information is included or consider removing it.

Surface Water and Groundwater Water Quality

- The SDEIS states that for copper and mercury, impacts may be minimal but uncertainties in predicting future conditions exist.[86] EPA recommends the FEIS describe the mitigation and monitoring that will occur to reduce the uncertainties and actions that would be taken if impacts are more than minimal and result in exceedances of Idaho's CWA aquatic life criteria for copper and mercury.

- For the FEIS, EPA recommends noting in a footnote of the Table 3.9-6a Average MWMP Results – Development Rock and Ore and in the text that refers to the Table[87] that the detection limit used for this test for mercury (100-200 ng/L) is significantly above the CWA aquatic life criterion of 12 ng/L. Therefore, while some concentrations were above 200 ng/L, when values were less than this it does not indicate that the leachate would meet criteria. The same comment also applies to cadmium, copper, selenium, silver, thallium and lead. If similar issues also exist in other Tables in the text, EPA recommends adding a similar note indicating where the detection limit of the analysis is above the regulatory criteria level.

- The DSEIS indicates, under existing conditions, streams in the SGP area (except for West End Creek) are listed as impaired in accordance with CWA Section 303(d). The causes for listing of these waters are associated with arsenic (plus antimony and mercury at some locations) for exceedances of Idaho's water quality standards (WQS). Operational and post-closure concentrations of these elements in the East Fork SFSR are predicted to be comparable to or less than the existing conditions.[88] EPA recommends the FEIS add a sentence to this statement in the Executive Summary that identifies that under the proposed action West End Creek is predicted to exceed Idaho's CWA mercury aquatic life criterion for approximately 10 years during operation. The predicted mercury Idaho CWA WQS exceedances are described in the main text of the SDEIS, but we recommend that they also be identified in the Executive Summary.

- For Table 3.9-10b, [89] EPA recommends the FEIS add Idaho's CWA mercury criteria to the table header row as is done for the other constituents.

---

[85] (DSEIS, p. 4-30).
[86] (DSEIS, p. ES-16).
[87] (DSEIS, p. 3-160).
[88] (DSEIS, p. ES-15).
[89] (DSEIS, p. 3-183).

- Since cyanide is predicted to be elevated in the tailings pond,[90] EPA recommends the FEIS include cyanide in Table 4.9.6. Predicted TSF Surface Water Chemistry so that predicted cyanide concentrations are disclosed.

- EPA recommends the FEIS add cyanide to Table 4.9-8 Predicted Groundwater Chemistry Underlying the TSF for the same reason as above.

Fish Resources and Fish Habitat

- The DSEIS states "[t]he SGP area could experience natural climate change impacts to fish resources…"[91] EPA recommends the FEIS clarify and/or rephrase this sentence to either remove "natural" from the sentence or clearly identify what is meant by "natural climate change."

[90] (DSEIS, p. 4-207).
[91] (DSEIS, p. 4-70).

Guideline for Performing Air Quality Impact Analyses

Stationary Source Program
AQ Division

State of Idaho
Department of Environmental Quality
July 2021

PET 701

REC 1067

Table of Contents

1 Introduction 1
1.1 Overview 1
1.2 Responsibility for Modeling Analyses 3
2 Use of the Modeling Guideline 4
2.1 This Guideline Most Useful in Common Instances 4
2.2 Level of Knowledge Required to Use This Guideline 5
3 Requirements to Perform Air Impact Analyses 6
3.1 Air Impact Analysis Regulatory Requirements for Permit Issuance 6
3.1.1 NAAQS and TAP Compliance Demonstration Requirements 6
3.1.2 Below Regulatory Concern Exemption from Demonstration Requirement 6
3.1.3 Regulatory Requirements of the Air Impact Analyses 7
3.2 Emission Thresholds Triggering Site-Specific Impact Analyses 7
3.3 Emission Increase Calculation for Project-Specific Modeling Applicability 12
3.3.1 Determining Whether Modeling is Needed for a New Source or Facility 13
3.3.2 Determining Whether Modeling is Needed for Modifications 13
4 Applicable Standards 16
4.1 Criteria Pollutants 16
4.2 TAPs Increments 17
4.3 Toxics 17
5 Modeling Methodology 18
5.1 Requirements for Permit Applications 18
5.1.1 Significant Impact Analysis 18
5.1.2 Cumulative NAAQS Analysis 19
5.2 Additional Requirements for PSD Applications 19
5.3 Facility Emission Cap (FEC) Permit Modeling 23
6 Performing a Modeling Analysis 23
6.1 Modeling Protocol 23
6.2 Choosing the Appropriate Models 25
6.2.1 Readily Available Models 25
6.2.2 Replacement of ISC by AERMOD 26
6.3 Pollutants and Sources to be Included in the Impact Analyses 27
6.3.1 Permits to Construct 30
6.3.2 Facility-Wide Tier II Operating Permits 32
6.3.3 FEC Permits 32

6.4 Source Information Required 32
6.4.1 Emission Rates 33
6.4.2 Source Parameters 34
6.4.3 Scaled Plot Plan 36
6.4.4 Building Downwash Parameters 37
6.4.5 Source, Building, and Receptor Coordinates and Elevations 37
6.5 Ambient Air Boundary 37
6.6 Receptor Network 39
6.7 Elevation Data 39
6.8 Meteorological Data 39
6.9 Land-Use Classification 41
6.10 Background Concentrations 41
6.11 Evaluation of Compliance with Standards 42
6.11.1 Approval Criteria 42
6.11.2 Adequacy of Analyses Results 44
6.12 Air Quality Modeling Report 45
7 DEQ Review of Modeling Analyses 47
8 Summary 48
References 48
Appendix A. Guidance for 1-Hour NO_2 Modeling of Intermittent Sources 50
Appendix B. Class I Areas 53
Appendix C. Idaho DEQ Air Dispersion Modeling Checklist 56
Appendix D. Modeling Protocol Checklists 58
Appendix E. Land-Use Classification Procedure 61
Appendix F. Example Tables for Air Quality Modeling Report 63

List of Tables

Table 1. Sections of the Guideline Used in Performing an Air Impact Analysis 3
Table 2. Modeling Applicability Thresholds (values in pounds/hour[(a)]) 9
Table 3. Significant Impact Levels (IDAPA 58.01.01.006) 16
Table 4. National Ambient Air Quality Standards 17
Table 5. Significant Emissions Rates (40 CFR 52.21 (b)(23); IDAPA 58.01.01.006)[(a)] 22
Table 6. Prevention of Significant Deterioration Increment Limits 22
Table 7. Modeled Impacts Above which Preconstruction Monitoring cannot be Exempted for PSD-Applicable Projects 23

PET 703
REC 1069

List of Figures

Figure 1. Pollutant-Specific Modeling Applicability Flow Chart for New Facilities in Attainment or Unclassifiable Areas 10
Figure 2 Pollutant-Specific Modeling Applicability Flow Chart for Modifications to Existing Facilities in Attainment or Unclassifiable Areas 11
Figure 3. Flow Chart for Criteria Pollutant Ambient Impact Analysis for Permit to Construct Application 20

Abbreviations, Acronyms, and Symbols

DEQ	Idaho Department of Environmental Quality
EPA	US Environmental Protection Agency
Acfm	actual cubic feet per minute
AERMIC	American Meteorological Society/Environmental Protection Agency Regulatory Model Improvement
AQCR	air quality control region
AQRV	air quality related value
BPIP	Building Profile Input Program
Btu	British thermal unit
CO	carbon monoxide
DEM	digital elevation model
DEQ	Department of Environmental Quality
EL	screening emission level
EPA	Environmental Protection Agency
FEC	facility emission cap
ft	feet
GEP	good engineering practice
H_2S	hydrogen sulfide
IBR	incorporate by reference
IDAPA	A numbering designation for all administrative rules in Idaho promulgated in accordance with the Idaho Administrative Procedures Act.
ISCST3	Industrial Source Complex, Short Term Ver. 3; a refined air pollution model
K	Kelvin
lb/hr	pounds per hour
m	meter
m/sec	meters per second
mg/m^3	milligrams per cubic meter
mrem/yr	millirem per year
NAA	nonattainment area
NAAQS	National Ambient Air Quality Standards
NO_2	nitrogen dioxide
NO_x	oxides of nitrogen

NWS	National Weather Service
Pb	lead
$PM_{2.5}$	Particulate matter with an aerodynamic diameter less than or equal to 2.5 micrometers
PM_{10}	Particulate matter with an aerodynamic diameter less than or equal to 10 micrometers
PSD	prevention of significant deterioration
PTC	permit to construct
SCREEN3	An air pollution model used to establish the general distance to the maximum concentration from the facility
SIL	significant impact level
SIP	state implementation plan
SO_2	sulfur dioxide
TAP	toxic air pollutant
T/yr	tons per year
URF	unit risk factor
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
VOC	volatile organic compounds
F	Degrees Fahrenheit
$\mu g/m^3$	micrograms per cubic meter

1 Introduction

1.1 Overview

This guideline is intended to assist air permit applicants, air quality specialists, and others who are reasonably proficient at performing atmospheric dispersion modeling analyses, in understanding the Idaho Department of Environmental Quality's (DEQ's) expectations for performing ambient air quality impact analyses associated with air quality permitting. This guideline does not have the force and effect of a rule and is not intended to supersede statutory or regulatory requirements or recommendations of the state of Idaho or the Environmental Protection Agency (EPA). It is provided as general guidance and does not alter the discretionary authority of DEQ to protect public health.

A working-level knowledge of air pollutant dispersion and air quality assessment is needed to understand and use this guideline. Applicants not proficient in atmospheric dispersion modeling are encouraged to use environmental consultants specializing in air quality modeling or other sufficiently experienced professionals having such modeling capabilities. DEQ does not have available resources to educate applicants or consultants in the fundamentals of performing atmospheric pollutant dispersion modeling analyses.

DEQ staff will not recommend a specific consultant; however, DEQ may provide a list of consultants used by applicants for recent permit applications for which dispersion modeling was required. Recent permit applications, DEQ-issued permits, and the Statement of Basis for issued permits are available on DEQ's website, and consultants used by specific applicants are often identified in application materials and the DEQ modeling memorandum (the modeling review memorandum is typically included as an appendix to the Statement of Basis). DEQ may perform the atmospheric dispersion modeling analyses for applicants in some circumstances. Section 1.2 of this guideline describes cases in which DEQ may perform the analyses.

Table 1 provides a basic step-by-step description of an air quality impact analysis, with specific sections of this guideline referenced for each step.

The purpose of an air quality impact analysis, performed in support of an air quality permit application, is to demonstrate that all applicable ambient air quality standards will be met if a proposed project is implemented or to demonstrate an existing facility's compliance with the standards.

Demonstration of compliance with the National Ambient Air Quality Standards (NAAQS), toxic air pollutant (TAP) increments, and prevention of significant deterioration (PSD) increments is required by the state of Idaho for permit issuance and certain exemptions. DEQ has determined this demonstration generally requires the applicant to perform air quality impact analyses using an atmospheric dispersion model, referred to as modeling analyses in this guideline.

The extent of the required modeling analyses will vary from one project to another depending on the type and magnitude of emissions and applicability of specific permitting requirements. For simple facilities (e.g., few sources and buildings), compliance may be shown by using screening- level techniques, including a screening-level model. No further analyses will be required if compliance can be adequately demonstrated with the use of an appropriate screening technique. Projects for which compliance cannot be demonstrated using screening techniques must use more refined methods. Complex multi-point emitting sources or sources with unusual pollutant dispersion environments, for

which screening techniques are not appropriate, are also required to use more refined modeling techniques. Facilities submitting applications for which the PSD requirements are applicable are required to perform more extensive analyses than when submitting a minor source application. This guideline focuses on the requirements for non-PSD applications. Facilities submitting a PSD application should refer to the New Source Review Workshop Manual (EPA 1990) and other available materials from EPA for additional guidance and should consult with DEQ before performing the required analyses.

This guideline follows the Rules for the Control of Air Pollution in Idaho (IDAPA 58.01.01 {Idaho Air Rules}), EPA guidance in the New Source Review Workshop Manual (EPA 1990), and the Guideline on Air Quality Models (EPA 2005). The 2005 version of the Guideline on Air Quality Models was used to develop this version of the guideline. However, the most current version of the Guideline on Air Quality Models should always be used when evaluating appropriate methods and data for a specific project.

The Guideline on Air Quality Models specifies:

"…air quality modeling techniques that should be applied to State Implementation Plan (SIP) revisions for existing sources and to new source reviews (NSR), including prevention of significant deterioration (PSD). Applicable only to criteria pollutants, it is intended for use by EPA Regional Offices, in judging the adequacy of modeling analyses performed by EPA, State and local agencies and by industry. The guidance is appropriate for use by other Federal agencies and by State agencies with air quality and land management responsibilities."

DEQ highly recommends that a modeling protocol be developed and submitted to DEQ for approval before performing any modeling analyses. A DEQ-approved protocol will help assure that methods and data used in the modeling analyses are appropriate and will be acceptable to DEQ reviewers. Guidance on the contents of a protocol is provided in Section 6.1.

Table 1. Sections of the Guideline Used in Performing an Air Impact Analysis

Step in Air Impact Analysis	Section
1) Determine whether professional assistance is needed for performance of the air impact analyses?	1.1, 1.2, 2.0
2) Review general modeling requirements and develop a methodology.	5.0, 6.0
3) Calculate the emissions increase for modeling applicability purposes.	3.3, 6.3
4) Determine whether dispersion modeling is required – compare applicability inventory to modeling thresholds.	3.1, 3.2
5) Select the appropriate model.	6.2, 5.0
6) Set up the modeling analysis, including facility layout, buildings, ambient air boundary, receptors, and elevation data.	6.4.3, 6.4.4, 6.4.5, 6.5, 6.6, 6.7, 6.9
7) Select meteorological data.	6.8
8) Determine background concentrations.	6.10
9) Prepare and submit protocol, and obtain DEQ approval.	6.1
10) Calculate emissions for significant impact analyses and TAPs analyses.	5.1.1, 6.3, 6.3.1, 6.3.2, 6.3.3, 6.4.1
11) Calculate/obtain emissions release parameters and document.	6.4.2
12) Evaluate model results for significant impact analyses and TAPs analyses.	4.1, 4.2, 4.3, 6.11
13) Calculate emissions for cumulative NAAQS analyses and document.	5.1.2, 6.3.1, 6.3.2, 6.3.3, 6.4.1
14) Evaluate model results for cumulative NAAQS analyses.	4.1, 6.11.1
15) Perform comprehensive quality assurance/control of the analyses and evaluation of results.	2.0, 6.11.2
16) Prepare permit application and modeling report.	6.12, 7.0

1.2 Responsibility for Modeling Analyses

The accuracy and representativeness of methods and data used in the modeling analyses is the responsibility of the applicant. DEQ may provide applicants with appropriate meteorological data (not always preprocessed and ready for model input) and default background pollutant concentration values, as described later in this guideline.

DEQ modeling staff may assist applicants or may perform the required modeling analyses in some instances. The following are cases in which DEQ may perform the modeling analyses for permit applicants:

- Renewal of a Tier II operating permit. If a facility has not been modified since issuance of a previous Tier II operating permit, DEQ may use the previously performed modeling results to demonstrate compliance with NAAQS. Previously conducted modeling analyses will not be acceptable if DEQ identifies errors in methods or data used, or if the model used is substantially outdated, such that compliance with NAAQS may be questionable. Changes in applicable standards would also trigger the need to remodel the facility.
- DEQ has current modeling files for the facility. In instances where DEQ has a current model for the facility, slight changes to account for a new source or modification can sometimes be easily made by DEQ modeling staff. The applicant will be responsible for providing, justifying, and

documenting all input parameters needed to adequately address the proposed changes. Modeling analyses performed by DEQ staff will be done outside of the regulatory time limit for permit application review and will be dependent on DEQ staff workload. The applicant must include justification and documentation of all parameters, even those provided in previously submitted analyses. DEQ's permitting process requires that each application be a complete package in itself and not merely reference previously submitted applications.
If compliance with standards cannot be easily demonstrated by DEQ's analyses it will be the applicant's responsibility to conduct more refined analyses.

- Simplistic modeling analyses for small businesses. DEQ may conduct the modeling analyses for small business in situations where there are a small number of sources and a simple facility layout. These decisions will be made on a case- by-case basis and will depend on current DEQ workload.

Modeling analyses performed by DEQ for permit applicants will typically be done outside of the regulatory review process and any review timelines. Data and results will typically be forwarded to the applicant for their review when the analyses are completed by DEQ staff. The applicant will then combine those analyses with other components of the application and submit the complete application to DEQ to initiate the agency review process.

Permit applicants will be responsible for submitting the following information/data to enable DEQ to perform modeling analyses:

- Detailed description of operations and equipment used.
- Requested allowable emissions rates for all criteria pollutants and TAPs for all applicable averaging periods.
- Maximum operational and material processing rates.
- Site description and scaled site plot plan, including a detailed description of any structures. Universal Transverse Mercator (UTM) coordinates, with the applicable datum listed, must be provided for all building corners, and heights of all building tiers must be provided.
- Emissions point information (stack location in UTM coordinates with the applicable datum listed, stack height, stack diameter, stack gas temperature, and flow rate) with thorough justification and documentation of such information.

If DEQ's analyses do not initially demonstrate compliance with applicable standards, it will be the applicant's responsibility to refine the analyses to achieve an adequate compliance demonstration.

DEQ has developed, or is in the process of developing, specific modeling approaches for several industrial types. For example, DEQ has conducted non-site-specific modeling for truck-mix concrete batch plants and portable hot-mix asphalt plants; and no source- specific modeling is require for these plants if they meet the production rate limits, minimum stack parameter specifications, and setback distances from specific receptors. DEQ air dispersion modeling staff should be consulted regarding availability and details of industry-specific modeling approaches.

2 Use of the Modeling Guideline

2.1 This Guideline Most Useful in Common Instances

This modeling guideline is presented as suggestions and instructions for performing a modeling analysis in the most common instances. The methods and data presented are not appropriate for all sources,

locations, and/or situations, and use of a method presented in the guideline does not necessarily assure DEQ approval of the method. DEQ may approve or require methods and/or data differing from those presented in this guideline, depending on the characteristics of the specific situation.

2.2 Level of Knowledge Required to Use This Guideline

This guideline is not intended to educate permit applicants or consultants in the basic principles of atmospheric dispersion or in the operation of various dispersion models, as stated in Section 1.1. A wide variety of commercially available courses are available for applicants to develop the level of knowledge needed to correctly perform pollutant dispersion modeling analyses.

If your specialist (your staff) or consultant and cannot easily answer the following questions, they may not be adequately skilled to properly perform an air impact analysis involving dispersion modeling for air permitting purposes:

1. Have you performed an atmospheric dispersion modeling analysis within the last five years?
2. Do you understand why a stack with a horizontal or rain-capped release is sometimes modeled using a stack flow velocity of 0.001 meters per second?
3. Do you know what a significant impact is, and its implications for modeled impacts?
4. Do you know when background concentrations are used in a modeling analysis and when they are not?
5. Do you understand the difference between a significant impact analysis and a cumulative NAAQS impact analysis?
6. Do you know what surface roughness, Bowen ratio, and surface albedo are and how they are used in the model programs and preprocessor programs?
7. Do you understand the difference in how point sources, area sources, and volume sources are treated in AERMOD, SCREEN3, and/or AERSCREEN?
8. Do you know whether AERMOD uses daily or hourly meteorological data?

Permitting regulations require the applicant to demonstrate that emissions will not cause or significantly contribute to a violation of a standard. The regulations do not require that the analyses estimate actual impacts to the greatest degree possible. Therefore, it is advised that applicants use reasonably conservative data and methods to demonstrate compliance – data and methods that both DEQ and the applicant agree will generate impacts greater than those that would be reasonably expected. However, overly conservative estimates of input parameters, especially emission quantities, may substantially overstate impacts. This could result in the inappropriate applicability of certain requirements and/or the imposition of unnecessary permit provisions and restrictions.

Use of unrealistic release parameters, such as stack flow rates or stack gas temperatures, could shift the location of maximum impacts. In situations where the modeling analyses involve numerous sources, this could result in either under-estimation or over-estimation of combined impacts. Therefore, it is recommended that reasonably accurate release parameters be used when modeling multiple sources, rather than overly conservative parameters. In some instances, where reasonably expected parameters are highly variable, it may be more appropriate to use multiple operational scenarios to evaluate the effects of varying parameters.

3 Requirements to Perform Air Impact Analyses

This section outlines the permitting requirement to demonstrate compliance with NAAQS and TAP increments, and it describes when project-specific air impact modeling analyses are needed for issuance of a PTC or Tier II Operating Permit. It discusses pollutant-specific regulatory applicability, regulatory requirements for permit issuance, and calculation of emission increases for project modeling applicability.

3.1 Air Impact Analysis Regulatory Requirements for Permit Issuance

3.1.1 NAAQS and TAP Compliance Demonstration Requirements

Idaho Air Rules Section 203.02 states that "no permit to construct shall be granted for a new or modified stationary source or modified stationary source unless the applicant shows to the satisfaction of the Department" that the source or modification "would not cause or significantly contribute to a violation of any ambient air quality standard." Section 203.03 similarly requires that no permit be issued unless it is demonstrated through the use of methods in Section 210 that the source or modification would not "injure or unreasonably affect human or animal life or vegetation as required by Section 161."

Air impact analyses are also required for the issuance of Tier II Operating Permits, with requirements of Idaho Air Rules Section 403.02 mirroring Section 203.02 for PTCs. There are no TAP impact analysis requirements for Tier II Operating Permits.

3.1.2 Below Regulatory Concern Exemption from Demonstration Requirement

Certain projects may be exempt from the requirement to demonstrate compliance with NAAQS or TAP increments. If a project would qualify for a Below Regulatory Concern (BRC) permit exemption as per Idaho Air Rules Section 221 if it were not for potential annual emissions of one or more pollutants exceeding the BRC threshold of 10 percent of emissions defined by Idaho Air Rules as "significant," then a NAAQS compliance demonstration may not be required for those pollutants with emissions below BRC levels. DEQ's regulatory interpretation policy of exemption provisions of Idaho Air Rules Section 221.01 is that: "A DEQ NAAQS compliance assertion will not be made by the DEQ modeling group for specific criteria pollutants having a project emissions increase below BRC levels, provided the proposed project would have qualified for a Category I Exemption for BRC emissions quantities except for the emissions of another criteria pollutant.[1]" The interpretation policy also states that the exemption criteria of uncontrolled potential to emit (PTE) not to exceed 100 ton/year (Idaho Air Rules Section 220.01.a.i) is not applicable when evaluating whether a NAAQS impact analysis is required. A permit will be issued limiting PTE below 100 ton/year, thereby negating the need to maintain calculated uncontrolled PTE under 100 ton/year.

The BRC exemption cannot generally be used to exempt a project from a pollutant-specific NAAQS compliance demonstration where a PTC is required for the action regardless of emission quantities, such as the modification of an existing emission or throughput limit.

However, in this instance, if post-project facility-wide annual emissions of the criteria pollutant are also below BRC thresholds, then a NAAQS compliance demonstration is not required.

3.1.3 Regulatory Requirements of the Air Impact Analyses

Once a permit is required for a proposed project, an air impact analysis is required for permit issuance unless the pollutant can be exempt from the requirement to demonstrate compliance with NAAQS and TAP increments, as described above in Section 3.1.2. Idaho Air Rules Section 203 for PTCs and Section 403 for Tier II Operating Permits require that air impact analyses demonstrate compliance with NAAQS and TAP increments "to the satisfaction of the Department." A key consideration is what constitutes DEQ satisfaction of compliance.

Use of unquestionably-conservative methods and data for all components of the analyses will generate predicted impacts that demonstrate compliance at near complete certainty. As analyses move back from methods and data that are highly conservative, then the certainty of NAAQS and TAP increment compliance decreases. Determining the point at which analyses no longer satisfactorily demonstrate compliance then becomes an important concern. This point is not defined in the regulations. DEQ asserts that a satisfactory compliance demonstration is an analysis where NAAQS and TAPs increment compliance is "highly confident," considering all variability and uncertainty in analytical methods and data.

The confidence level of compliance with air quality standards will be affected by the following:

- Magnitude and spatial extent of modeled impacts in comparison to applicable thresholds or standards.
- Potential for public exposure to impacts exceeding standards.
- Representativeness of meteorological data used, and the accuracy/conservatism of meteorological data processing methods used.
- Uncertainty and variability of estimated emissions. Emissions that will be verified by source testing will be considered as near certainty, while emissions based on low-ranked AP-42 factors (which usually represent an average across the industry) will be considered as low confidence.
- Method used to account for atmospheric chemistry (NO/NOx chemistry primarily).
- Representativeness and conservatism of background concentrations (note that using design value background levels with design value modeled results is more conservative for short-averaging periods than for annual averaging periods).
- Level of conservatism in modeling expected operational scenarios (handling variable load conditions, multiple intermittent sources, etc.).
- Representativeness/conservatism of methods used to handle complex emission points such as fugitive releases.
- Handling of building downwash.
- Handling of complex terrain.
- Methods use to hand co-contributing sources in a cumulative impact analysis.

3.2 Emission Thresholds Triggering Site-Specific Impact Analyses

Emission quantities from a source directly affect pollutant impacts to ambient air, and therefore affect the likelihood of a source to cause or contribute to a violation of an ambient air quality standard. Where emission rates are minimal, DEQ can be highly confident that the source will not cause or contribute to a standard violation without performing an impact analysis using pollutant dispersion modeling. Screening Emission Levels (ELs) are specified in the Idaho Air Rules as a de *minimis* TAP emission quantity, below which compliance with the TAP increment is assured. De *minimis* levels for criteria pollutants are not specified in Idaho Air Rules. However, this section presents criteria pollutant de *minimis* levels that DEQ

asserts will reasonably assure NAAQS compliance for various circumstances. These levels were established using the professional judgement of DEQ scientists and engineers, combined with results from computerized pollutant dispersion models for various generic configurations.

DEQ established emission de *minimis* levels as a function of the Significant Emission Rates (SERs) defined in Idaho Air Rules Section 005.108. The SERs are expressed as annual emission rates. To use SERs for NAAQS with short-term averaging periods, the SER is divided by 8,760 hours/year and compared to maximum hourly emissions for 1-hour standards or maximum daily emissions divided by 24 for 24-hour standards. DEQ also developed Significant Impact Level (SIL) thresholds for modification projects; emissions less than these rates are reasonably assured to have impacts less than the applicable SIL. SIL thresholds were developed by DEQ using dispersion modeling analyses of a generic facility with one point source.

Whether a specific emission quantity can cause or contribute to a violation greatly depends on whether those emissions occur from a new facility or are added to those of an existing facility, and whether the existing facility has recently demonstrated NAAQS compliance on a facility- wide basis through dispersion modeling. The confidence of NAAQS compliance is high where project emissions occur from a proposed new facility in an attainment area and predicted emission quantities are low. NAAQS compliance confidence is also high for projects at existing facilities where facility-wide air impact analyses were recently performed and emissions associated with the modification are minimal. Even if the increase in emissions at a previously modeled existing facility could cause impacts exceeding the SIL, it is unlikely that impacts could exceed the NAAQS when combined with co-contributing sources and background concentrations. This is because any high impacts from new sources are not likely to coincide in time and space with high impacts from the existing facility. In the unlikely event that such minimal emissions combine with a high background concentration and impacts from nearby sources to produce an impact exceeding the NAAQS, it is likely that such impacts would only occur in a small area, would only occur for limited periods, and would not affect areas where sensitive individuals could be present.

A modeling applicability threshold assuring project impacts less than the SIL is used for modification projects to facilities where facility-wide NAAQS compliance demonstrations have not been recently performed. This threshold assures with high confidence that the project will not significantly contribute to any potentially existing NAAQS violation. These threshold values were based on modeling of a generic DEQ-generated facility, using the AERMOD regulatory model with Idaho meteorological data. The analyses used the following parameters: stack height = 10 meters; stack diameter = 0.5 meters; velocity at stack exit = 10 meters/second; stack gas temperature at exit = 200 ^{o}F; ambient air is at a distance of 100 meters from the stack; the stack is centered on a 10 meter square building, 5 meters high. The SIL thresholds are emission rates that, when modeled using the generic DEQ-generated facility, result in impacts just below the applicable SIL.

Figures 1 and 2 show the project-specific air impact analysis applicability determination process for new facilities and modifications to existing facilities, respectively. This process should only be used for projects proposed in attainment or unclassifiable areas. DEQ should be consulted if a proposed project is located in a non-attainment area. Also, if DEQ observes project-specific conditions that suggest a threshold is not appropriate or protective of NAAQS, then DEQ may require project-specific air impact modeling even though emissions are below the listed threshold.

Table 2 lists the modeling applicability threshold values referenced in Figures 1 and 2.

Table 2. Modeling Applicability Thresholds (values in pounds/hour[(a)])

Pollutant and Averaging Period	SIL Threshold	BRC	1/8 SER	1/4 SER	SER
CO 1-hr	84	2.3[b,c]	2.9[b]	5.7[b]	100 ton/yr
CO 8-hr	26	2.3[b,c]	2.9[b]	5.7[b]	100 ton/yr
NO_2 1-hr	0.38	0.91[c]	1.14	2.3	40 ton/yr
NO_2 ann	0.43 (1.9 ton/yr)	4.0 ton/yr	5.0 ton/yr	10.0 ton/yr	40 ton/yr
SO_2 1-hr	0.40	0.91[c]	1.14	2.3	40 ton/yr
PM_{10} 24-hr	0.32	0.34[c]	0.43	0.86	15 ton/yr
$PM_{2.5}$ 24-hr	0.092	0.23[c]	0.29	0.57	10 ton/yr
$PM_{2.5}$ ann	0.085 (0.37ton/yr)	1.00 ton/yr	1.25 ton/yr	2.5 ton/yr	10 ton/yr
Pb 3-month	0.00102 (0.73 lb/mon)	9.9 lb/mon	12.3 lb/mon	24.7 lb/mon	0.6 ton/yr

a) Values in pounds/hour as averaged over the averaging period of the NAAQS, unless noted otherwise. Pound/hour values listed as a function of the SER were calculated by dividing the annual SER value by 8,760.

b) These values are more restrictive than the SIL Threshold. Therefore, the SIL Threshold may be used in place of these values.

c) BRC is based only on annual emissions. The pounds/hour values listed as BRC for short term standards are the annual BRC rate divided by 8,760 hours/year. Annual emissions from the project should be divided by 8,760 hours/year and then compared to the listed pounds/hour BRC threshold to evaluate whether the project can be exempt from NAAQS compliance demonstration requirements for the applicable pollutant.

d) These values are more restrictive than the SIL Threshold. Therefore, the SIL Threshold may be used in place of these values.

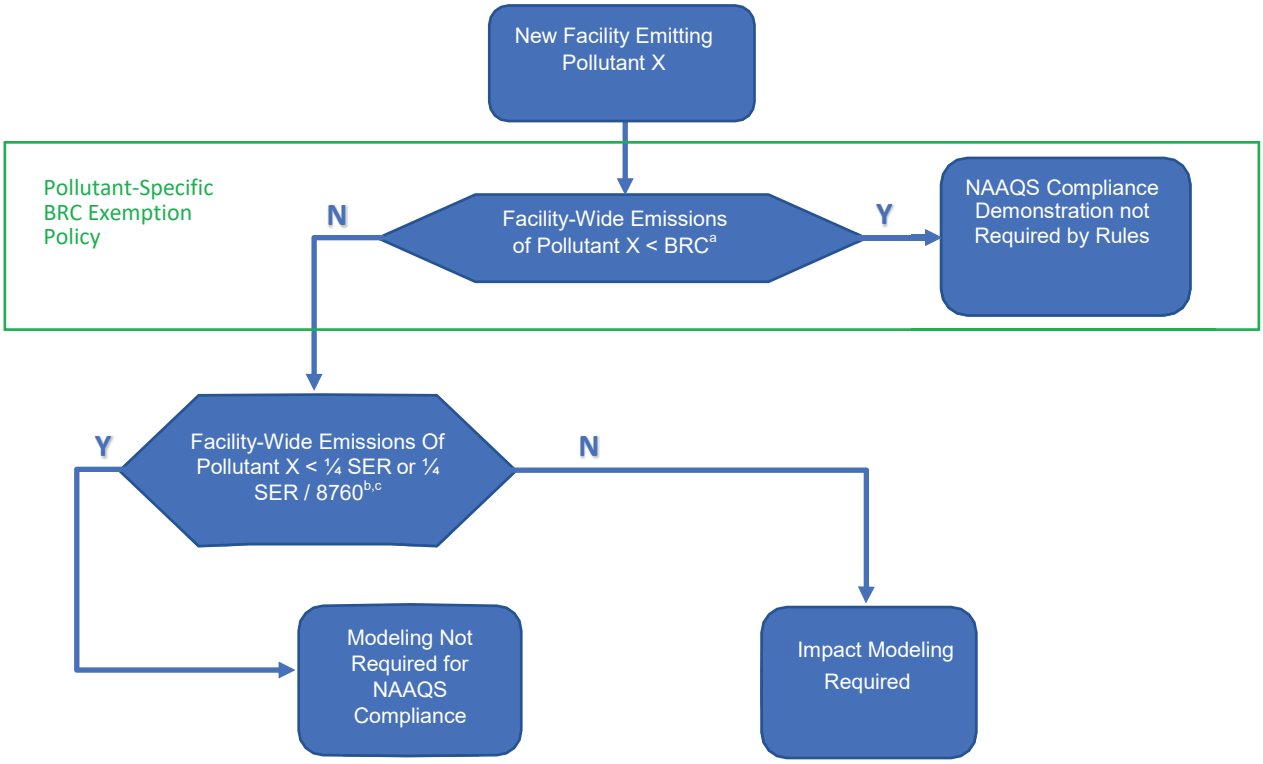


Figure 1. Pollutant-Specific Modeling Applicability Flow Chart for New Facilities in Attainment or Unclassifiable Areas

a) This evaluation is DEQ's regulatory interpretation of permit exemption rules, as described in: *Policy on NAAQS Compliance Demonstration Requirements*. Idaho Department of Environmental Quality Policy Memorandum. July 11, 2014. The evaluation is based only on annual emissions, and emissions qualifying as "fugitive" as defined by Idaho Air Rules for permit applicability are not included in the evaluation. Example: A company proposes to construct a widget maker facility. The project would qualify for a BRC permitting exemption under Idaho Air Rules Section 221.01, with emissions of Pollutant X below the BRC threshold, except that emissions of Pollutant Y exceed the BRC threshold and trigger the requirement to obtain a PTC. By DEQ regulatory interpretation, a NAAQS compliance demonstration for Pollutant X is not required by Idaho Air Rules for permit issuance.

b) Emissions calculated according to DEQ-specified methods. Fugitive emissions associated with the project are included in this evaluation. The threshold of 1/4 SER is applicable to NAAQS regulated on an annual average; and 1/4 SER/8760 is applicable to NAAQS on a short-term average, with the pound/hour threshold value compared to the maximum potential/allowable emission for the averaging period divided by the hours in the averaging period.

c) If DEQ observes project-specific conditions that suggest these thresholds are not appropriate or protective of NAAQS, then DEQ may require project-specific air impact modeling even though emissions are below listed thresholds.

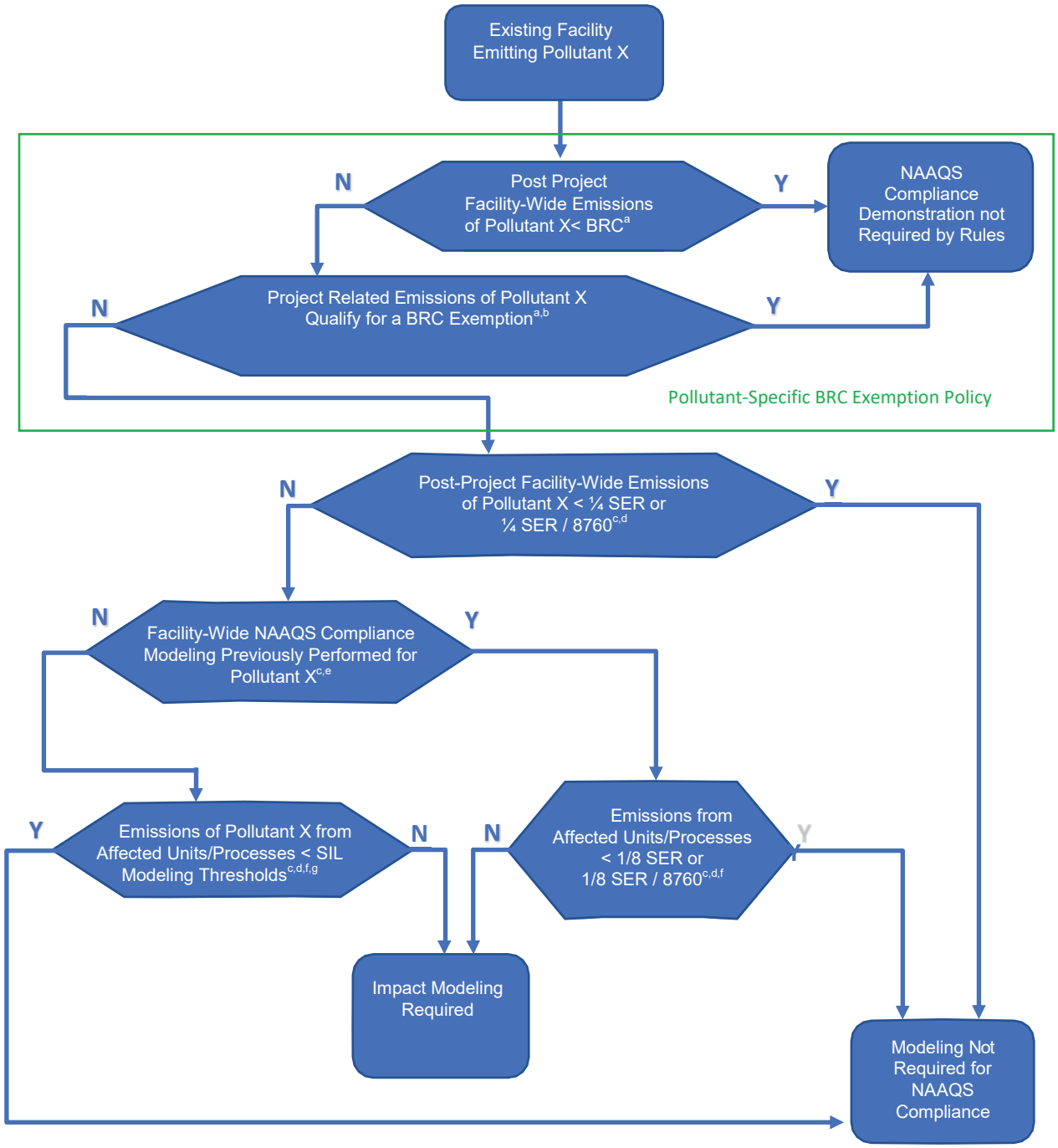


Figure 2 Pollutant-Specific Modeling Applicability Flow Chart for Modifications to Existing Facilities in Attainment or Unclassifiable Areas

a) This evaluation is DEQ's regulatory interpretation of permit exemption rules, as described in: Policy on NAAQS Compliance Demonstration Requirements. Idaho Department of Environmental Quality Policy Memorandum. July 11, 2014. The evaluation is based only on annual emissions, and emissions qualifying as "fugitive" as defined by Idaho Air Rules for permit applicability are not included in the evaluation.

b) Examples:

1. A company proposes to construct a widget maker at their existing facility. The project would qualify for a BRC permitting exemption under Idaho Air Rules Section 221.01, with emissions of Pollutant X below the BRC threshold, except emissions of Pollutant Y exceed the BRC threshold and trigger the

requirement to obtain a PTC. By DEQ regulatory interpretation, a NAAQS compliance demonstration for Pollutant X is not required by Idaho Air Rules for permit issuance.

2. A facility proposes to increase production at their existing, permitted widget maker. The existing permit limits widget production at 50 widgets per hour. The project proposes to increase production to 100 widgets per hour. The increase in emissions of Pollutant X is below the BRC threshold, but total emissions of Pollutant X from the unit are above the BRC threshold. A NAAQS compliance demonstration for Pollutant X is required because the project could not qualify for a permitting exemption, regardless of the emissions from other pollutants. The modification requires changing an existing permit condition, and therefore, could not qualify for a BRC exemption.

c) Fugitive emissions associated with the project are included in this evaluation.

d) If DEQ observes project-specific conditions that suggest these thresholds are not appropriate or protective of NAAQS, then DEQ may require project-specific air impact modeling even though emissions are below listed thresholds.

e) This applies if facility-wide modeling of the specific pollutant was performed for the averaging period of the NAAQS. Facility-wide modeling may be associated with a past permitting project or performed independently, and it may conservatively use allowable emissions or a more-refined reflection of actual emissions. Modeling must have been approved by DEQ, performed within the previous five years, be representative of the existing facility and operations, and include the pollutant of interest.

f) Emissions increase calculated according to DEQ-specified methods, including methods to handle projects involving relaxation of an emission-affecting permit limit.

g) SIL Modeling Threshold based on modeling of a generic hypothetical source.

3.3 Emission Increase Calculation for Project-Specific Modeling Applicability

Whether project-specific air impact modeling is required for a project depends on the increase in emissions resulting from implementation of the project. The emission increase for a new facility is simply the sum of potential or permit-allowable emissions from all emission sources associated with the project. The emission increase for a modification is defined in Idaho Air Rules as “the amount by which projected actual emissions exceed baseline actual emissions of an emissions unit.” Section 3.3.2 provides more details on calculating the emission increase associated with modifications for modeling applicability.

The following types of emissions sources should be included in the modeling applicability calculation:

- All emissions sources that may be included in the permitting analyses or the issued permit, regardless of whether those sources may have (or will be issued) emissions or operating limits. Sources that are exempt from permitting as per Idaho Air Rules Section 220-223 must normally be included in the modeling applicability calculation. DEQ’s modeling group should be consulted if there are questions regarding the inclusion or exclusion of emission sources in the modeling applicability determination.
- Process fugitive emissions from material handling, processing, etc. Fugitive emissions from vehicle traffic on facility roadways and wind erosion emissions from storage piles will not typically be considered for minor source permitting applicability unless DEQ determines such sources may have a substantial contribution to ambient concentrations. Mining facilities are typically in this category where such fugitive sources must be included.
- Intermittent sources such as batch processes, flaring, bin dumping, engine testing, etc. Emissions of NOx from intermittent testing of engines powering emergency generators and fire suppression water pumps can typically be excluded from the modeling applicability

determination for 1-hour NO2 NAAQS compliance demonstrations. Appendix A provides DEQ's final guidance on the modeling of NOx from intermittent testing and maintenance operations of engines powering emergency generators and fire suppression water pumps.

Sections 3.3.1 and 3.3.2 describe how emission quantities should be calculated for various scenarios to evaluate the need to conduct project-specific impact modeling. The modeling applicability emission inventory (used to determine whether modeling is needed) may be different than the modeling analysis emission inventory (used to conduct a significant impact analysis), as explained in Section 6.3.1.

3.3.1 Determining Whether Modeling is Needed for a New Source or Facility

Proposed allowable emissions, as specified in a permit application or calculated as potential to emit, of all new emissions sources will be used to evaluate the need for modeling a proposed new emissions source or new facility. No emission sources are typically exempt from the evaluation of whether modeling is needed. Also, any reductions in emissions at a different source cannot be considered at the modeling applicability stage.

3.3.2 Determining Whether Modeling is Needed for Modifications

Air impact modeling requirements for a modification hinge on the quantity of increased emissions that could occur as a result of the modification. For the purpose of project-specific applicability for performing an air impact analysis, any emission decreases are not typically considered. Creditable decreases may be considered in air impact modeling performed once the requirement to perform impact modeling has been established. If removal of an existing source or installation of control equipment on a source occurs concurrently with a modification, the emission reduction associated with such activities will not typically be considered in the evaluation of whether emissions exceed modeling applicability thresholds.

Emission increases for a modification must be carefully calculated to obtain an accurate or conservative assessment. From a regulatory standpoint, "Emissions Increase" is defined in Idaho Air Rules Section 007.04 as, "The amount by which projected actual emissions exceed baseline actual emissions of an emissions unit." Baseline actual emissions are a best-estimate of emissions that could realistically occur by operation of the source before modification. If the source is permitted, such emissions may be those allowed under the restrictions of the existing permit (using best available emission estimation methods and considering the permit limits that are the most restrictive to emission-causing operations). The following should be considered when calculating baseline actual emissions to evaluate the need for project-specific modeling:

- For a given process, the same emission calculation method and emission-affecting assumptions should be used for baseline actuals as is used for calculating future permit allowables, unless there are changes in the process that necessitate using different methods and assumptions. A change in emission factors or methods used to estimate emissions from a given process cannot be used to reduce the change in emissions associated with a proposed modification.
- Emissions considered as a conservative estimate for post-project allowable emissions (over-estimation of emissions), will result in an overestimate of baseline actual emissions for future projects. This may then result in an underestimation of the future project emission increase. DEQ approval of a conservatively high emission estimate of a source for initial permitting may not be appropriate for calculating baseline emissions for a future modification. However, the same emission factor or estimation method should be used for a given process, as noted in the previous bullet. For example, if a project involves increasing allowable throughput and the

emission generating mechanism does not change, the same emission factor should be used for both baseline actual emissions and post-project allowable emissions. Also, the applicant should use a factor they are confident does not underestimate post-project allowable emissions, even if it is suspected use of the factor overstates baseline actual emissions.

- Permit applicants should not simply use emission factors and other emission-affecting parameters from previous air impact analyses as a representation of baseline actual conditions. Many previous analyses were only required to demonstrate that the project will not cause a violation, and this was often accomplished by using simplistic estimates that substantially overestimate emissions. More accurate and updated emission rate data and release parameter information are frequently available for a source after initial permit issuance. This results from performance tests or from changes in emission factors. Baseline actual emissions should generally be calculated using the most accurate methods available. Overestimating baseline emissions will result in underestimation of the change in emissions resulting from a modification.
- Full operational levels (as allowed by the existing permit) can be considered in the calculation of baseline actual emissions, provided the facility/equipment could have accommodated such a level of operation. For example, a certain unit has a throughput limit of 1,000 units per day, and operational records indicate that only a maximum of 900 units per day has been processed. Baseline emissions can be calculated by assuming 1,000 units per day if it can be demonstrated that the facility could effectively attain those levels without a facility modification.
- Many permits contain both specific emission limits and limits on production. Baseline emissions must be based on the most restrictive limitation in the permit. As an example, consider a case where source testing has demonstrated that emissions per unit of production are lower than anticipated during initial permitting. As part of a proposed modification, the facility would like to raise the allowable production rate but not change the permitted emission rate. In this case, there will be an increase in allowable emissions because there is an increase in throughput. However, the applicant may calculate the increase in emissions using an updated emission factor that is based on recent source testing.

Future projected actual emissions will simply be permit-allowable emissions. Conservative emission estimates that overstate these emissions are acceptable and encouraged to facilitate expeditious DEQ approval of the modeling-applicability calculation.

Relaxation of Existing Permit Restrictions

Some modification projects involve the relaxation of an existing emission-affecting permit restriction, such as throughput limit, limit on hours of operation, material restriction on the type of material processed, or a direct emissions limit. In these cases, especially where the existing limit was needed to assure compliance with a NAAQS or a TAP increment, DEQ may require that the entirety of emissions from the unit be considered for modeling applicability rather than the increase alone. This approach is used because of the following:

- An increase in emissions at an existing emission point is more likely to cause or contribute to a NAAQS or TAP increment violation than if those emissions occurred at a new point. This is because emissions at two separate points must have overlapping plumes for their impacts to be additive.
- If a limit was needed on an emission point to assure NAAQS or TAP increment compliance, then increasing emissions at such a point would likely cause a violation.

This approach is intended to address potential "sham" permitting. A sham permit occurs when a facility originally intends to operate at a certain level, and equipment permitted is fully capable of operating at such levels, but NAAQS or TAP increment compliance cannot be demonstrated. As a result, the facility is issued a permit limit on the source(s) to assure compliance. Sometime after permit issuance, the facility then submits a permit application to relax the limit, addressing only the increase from the previous limit for impact analyses. This approach effectively circumvents the requirement to comply with NAAQS and/or TAP increments. To address this concern, the emission increase is calculated using a baseline associated with the facility prior to issuance of the permit establishing the limit that the facility now proposes to relax.

Generally, DEQ will use a 5-year period during which a project that involves relaxation of a limit (without a physical change at the facility) will be considered an adjustment/correction of previous permitting project rather than a new project. The emission increase will be calculated using the base emissions allowable prior to the previous permitting project (the project that established the limit to be relaxed) and the new proposed limit.

Replacement Projects

The need for modeling replacement projects that do not qualify as routine replacement is based on total allowable emissions from the proposed new source. The decrease in emissions associated with the removal of the old equipment is not generally considered for modeling applicability.

For example, if a sawmill proposes replacing an existing kiln with a new kiln (not routine replacement), modeling applicability would be based on the proposed allowable emissions of the new kiln without any consideration of the decrease in emissions associated with removal of the older kiln. The creditable emissions decrease associated with the kiln removed can be used in the air impact modeling to offset the emissions from the new kiln, modeled as negative values to evaluate the net impact of the project.

Modification of a Permitted Source

This scenario involves alteration of an existing and permitted emissions source. The need for modeling is normally based on the emission increase as determined by the difference between baseline actual emissions and future projected emissions (permit allowables). However, if the modification alters the release characteristics of the source (temperature, stack gas flow rate, stack height, etc.), then the entire allowable emissions from the modified source must be included for the purpose of modeling applicability. If the emission release characteristics do not change, then the applicable emissions will be considered as the increase resulting from the modification. An example of this is increased emissions-generating activities (that do not affect the temperature or volume of air exhausted) in a room where air is exhausted to the atmosphere through an existing stack. The emissions increase would be calculated as the difference between the current emissions rate and the new proposed allowable emissions rate. Determining the need for project-specific air impact modeling based on only the increase in emissions is approved by DEQ on a case-by-case basis, considering whether the point of release and release characteristics are very similar between the existing and modified emissions points.

A permit is not specifically required for instances where physical changes made at a facility affect dispersion but do not meet the definition of a "modification." Although such changes do not typically require a permit, they do effectively invalidate any dispersion modeling analyses performed prior to those changes and could alter the NAAQS compliance status of the facility. In some cases, DEQ may request facilities to perform air quality dispersion modeling analyses to affirm compliance with applicable standards.

4 Applicable Standards

This section discusses the applicable standards for assessing impacts on ambient air.

4.1 Criteria Pollutants

Table 3 lists the significant impact levels (SILs) used to determine whether or not the proposed project would have a significant impact on the air quality in the area. The proposed project has a significant impact on the ambient air quality if the resulting ambient concentrations exceed these levels due to an emissions increase.

Table 4 presents the NAAQS which are incorporated by reference (IBR) into Idaho Air Rules Section 107.03.b. Typically, there is about a year of lag time between when a new NAAQS is promulgated by EPA and the time when it is IBR into Idaho Air Rules. A NAAQS compliance demonstration involving modeling analyses for a specific standard is only required for permits issued after the date the standard is IBR into Idaho Air Rules. In cases where a NAAQS has been promulgated by EPA but not yet IBR to Idaho Air Rules, DEQ should be consulted for a determination on what specific analyses may be required for permit issuance.

Table 3. Significant Impact Levels (IDAPA 58.01.01.006)

Pollutant	Averaging Time	Significant Impact Levels (µg/m^3)[a]
CO	1-hour	2000
CO	8-hour	500
NO2	1-hour	4 ppb[b,c] (7.5 µg/m^3)[d]
NO2	Annual	1.0
SO2	1-hour	3 ppb[e] (7.9 µg/m^3)[d]
SO2	3-hour	25
SO2	24-hour	5
SO2	Annual	1.0
PM_{10}	24-hour	5.0
PM_{10}	Annual	1.0
$PM_{2.5}$	24-hour	1.2
$PM_{2.5}$	Annual	0.3[f]

a) Micrograms per cubic meter

b) ppb - parts per billion

c) Interim SIL (EPA 2010a)

d) µg/m3 value calculated for standard conditions

e) Interim SIL (EPA 2010b)

f) This value is the upper limit as listed in 40 CFR 51.165(b)(2). Without monitoring data supporting this value, DEQ will use the 0.2 µg/m^3 value recommended by EPA (EPA 2018)

Table 4. National Ambient Air Quality Standards

Pollutant	Averaging Time	Standard (µg/m^3)[a]
CO	1-hour	40,000[b]
CO	8-hour	10,000[b]
NO2	1-hour	100 ppb [c] (188 µg/m3)
NO2	Annual	100[d]
SO2	1-hour	75 ppb[e] (196 µg/m3)
SO2	3-hour	1,300[b]
SO2	24-hour	365[b]
SO2	Annual	80[c]
PM_{10}	24-hour	150[f]
PM_{10}	Annual	50[g]
$PM_{2.5}$	24-hour	35[h]
$PM_{2.5}$	Annual	12[i]
Pb	Quarterly	1.5[j]
Pb	3-month	0.15[k]

a) Micrograms per cubic meter.
b) Not to be exceeded more than once per year.
c) Three-year average of the 98th percentile of the annual distribution of 1-hour average daily maximum concentrations not to exceed standard.
d) Not to be exceeded in any calendar year.
e) Three-year average of the 99th percentile of the annual distribution of 1-hour average daily maximum concentrations not to exceed standard.
f) Never expected to be exceeded more than once in any calendar year.
g) Standard has been revoked.
h) Three-year average of the 98th percentile of the annual distribution of 24-hour average concentrations not to exceed standard,
i) Three-year average of the annual mean concentrations not to exceed standard.
j) Not to be exceeded in any quarter of any calendar year.
k) Not to be exceeded in any 3-month rolling average of any calendar year.

4.2 TAPs Increments

Applicable TAPs increments are listed in Idaho Air Rules Section 585 for non-carcinogens (AACs) and 586 for carcinogens (AACCs). The tables found in these sections of Idaho Air Rules list the ELs in pounds per hour (lb/hr) as well as the AACs for non-carcinogens and AACCs for carcinogens. Note that the concentrations for the non-carcinogens are in units of milligrams per cubic meter (mg/m3) and the concentrations for carcinogens are in units of micrograms per cubic meter (□g/m3).

4.3 Toxics

Idaho Air Rules Section 161 states, “Any contaminant which is by its nature toxic to human or animal life or vegetation shall not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation.” DEQ may

require toxics analyses as a case-by-case basis in instances where DEQ suspects impacts of toxics may have an unacceptable impact.

5 Modeling Methodology

The required level of analysis will generally depend on the complexity of the proposed construction or modification, surrounding emissions sources and terrain features, current air quality levels, and classification (attainment vs non-attainment) in the impact area. Screening techniques may be adequate for simplistic or isolated sources. Screening techniques are not appropriate in complex situations such as a large number of buildings in the immediate area that create downwash for a point source or the presence of complex terrain within the modeling domain. More refined modeling will be necessary when screening modeling is inappropriate or cannot demonstrate compliance with applicable air quality impact limits.

5.1 Requirements for Permit Applications

As recommended by EPA (EPA 1990), dispersion modeling analysis generally involves two distinct phases. The first phase is the preliminary analysis, also known as the significant impact analysis; the second phase is the full impact analysis, also known as the cumulative NAAQS analysis. These analyses may be performed with either a simple “screening model” or with a more complex “refined model.” A flowchart showing the general modeling methodology for permit modeling is presented in Figure 3.

5.1.1 Significant Impact Analysis

In the significant impact level (SIL) analysis, the highest estimated concentration in ambient air is compared to the SILs in Table 3. A five-year mean of the highest estimated concentration from each year can be used in the SIL analysis for pollutants with probabilistic standards. These pollutants include 24-hour PM2.5, annual PM2.5, 1-hour NO2, and 1-hour SO2. Only the changes in emissions associated with the proposed project are modeled in the significant impact analysis for new sources or modifications. Impacts from nearby and other background sources, including background concentrations, are not considered in the significant impact analysis. Section 6.3 provides guidance on sources and emissions to include in the significant impact analysis. No further analysis is generally required for the NAAQS or PSD increments if the estimated concentration is below applicable SILs. The source or modification is determined to have a significant impact on ambient air if the estimated impact exceeds the SILs. In this case, a cumulative NAAQS analysis will be necessary to demonstrate to the satisfaction of DEQ that the stationary source or modification would not cause or significantly contribute to a violation of any ambient air quality standard. Also, if DEQ has information that indicates existing facility emissions may not meet NAAQS, then DEQ may require the facility to demonstrate full NAAQS compliance at the time of the current permitting action or a later date.

The ambient concentration due to any proposed construction or modification cannot exceed the SILs listed in Table 3 for minor stationary sources in non-attainment areas (NAAs). Offsets are required even if the ambient impacts are below the SILs for major stationary sources or major modifications at major stationary sources in NAAs. The DEQ air modeling coordinator should be contacted for locations of NAAs in Idaho.

5.1.2 Cumulative NAAQS Analysis

In a cumulative NAAQS analysis, the scope of the analysis is expanded from the significant impact analysis to include impacts from all other sources at the facility and background concentrations. Assessing impacts from potential co-contributing sources may also be required in the cumulative NAAQS analyses. It is the applicant's responsibility to identify potential co- contributing sources. The factors to be reviewed include the type of source, distance between the facilities, location of potential impact, pollutants emitted, and emission rates of pollutants of interest. If impacts of neighboring sources, on receptors showing a significant impact from the sources subject to the permitting action, are not adequately accounted for by the background concentration used, then emissions from those sources must be modeled.

When conducting cumulative NAAQS modeling, the sources not explicitly included in the model (e.g., mobile sources; small, stationary sources; some fugitive sources; and large, distant sources) are accounted for by adding a background concentration representative of the air quality in the area. Background concentrations are based on ambient air monitoring data collected in the area or from similar areas determined to be reasonably representative. Section 6.10 provides a more detailed discussion of appropriate background concentrations. Background concentrations must account for all impacts not accounted for by sources specifically modeled. Current default background concentrations must be obtained from a DEQ air quality modeler.

Modeling assessments for major new source/modifications subject to the PSD program, and where project emissions cause an impact exceeding SILs, must include emissions from all point sources within the radius of significant impact and all sources outside the radius of significant impact that cause a significant impact within the radius of significant impact.

5.2 Additional Requirements for PSD Applications

Major facilities subject to PSD rules have many more responsibilities in the permitting process. DEQ engineers and analysts make the final determination of PSD applicability. If the proposed project is subject to PSD, the applicant should consult with DEQ during the early phases of the project development. If the proposed project is subject to PSD, the applicant should consult with DEQ during the early phases of the project development. This guideline only provides a brief summary of the PSD permitting program.

A PSD review is required if a proposed new facility is defined as a designated facility (Table 5) and emits or has projected actual emissions, after controls, of 100 tons per year (T/yr) or more of any regulated air pollutant. If the new facility is not one of the types listed in Table 5, then a PSD review is required if the facility emits or has projected actual emissions, after controls, of 250 T/yr or more of any regulated air pollutant. For PSD review, the potential to emit is defined as the maximum capacity of a stationary source to emit a pollutant under its physical and operational design (defined in Idaho Air Rules Section 006). A PSD review is also required if proposed emissions from a modification to an existing PSD major source are greater than the significant emissions rates listed in Table 6.

The location of the facility is important, as it determines the applicable increment of allowable air quality deterioration. Other factors, such as the topography and meteorology of the area and the proximity to a Class I area (specified areas of pristine air quality such as certain national parks, wilderness areas, etc.) or NAA, also determine the control requirements. The allowable increments, as of the publication of this document, for Class I, II, and III areas are listed in Table 7. Additional increment

limits can be promulgated by the EPA or DEQ, so it remains the applicant's responsibility to verify applicable PSD increment limits. The Class I areas in Idaho and surrounding states are shown in Appendix B. The remainder of the state is currently designated as Class II. There are no Class III areas in Idaho.

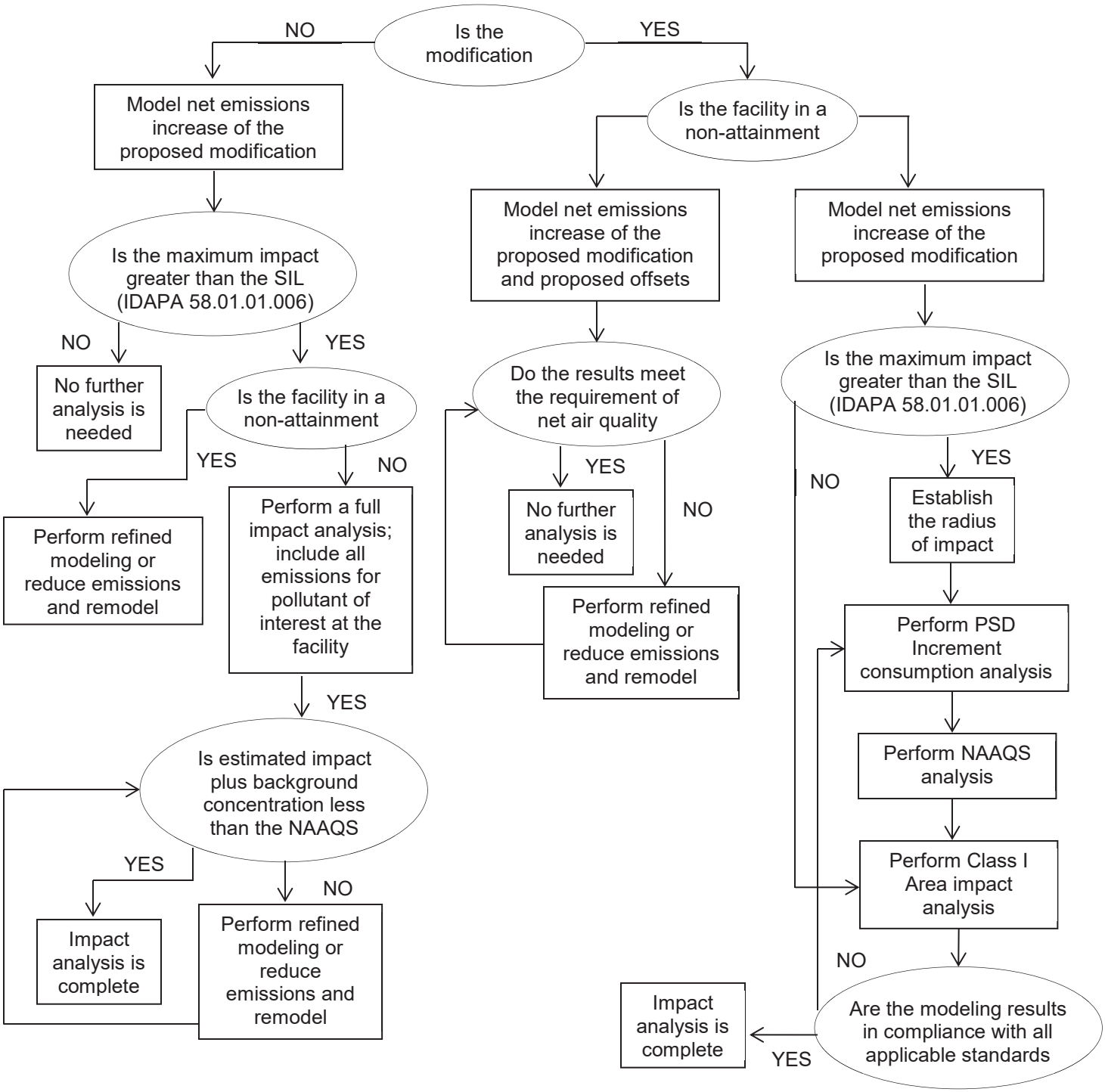


Figure 3. Flow Chart for Criteria Pollutant Ambient Impact Analysis for Permit to Construct Application

Pre-construction air quality is determined through ambient air monitoring. In some cases, there may already be enough data to establish the baseline. However, the applicant may be required to conduct up to one year of ambient monitoring at strategic locations if monitoring data are not available for the source area of the proposed construction site. Pre-construction monitoring will automatically be required if the model-predicted impact of the proposed source exceeds the levels in Table 8 and there are no current ambient air monitoring data available. DEQ may require pre-construction monitoring in other situations.

The following additional analyses are required in PSD applications:

- PSD increment consumption
- Class I area visibility and Air Quality Related Values (AQRVs) analysis
- Growth analysis
- Ambient air quality impact analysis (during construction)
- Soils and vegetation impacts
- Visibility impairment (in impact area, separate from the Class I area visibility analysis)

Refer to the *New Source Review Workshop Manual* (EPA 1990) for additional guidance.

Designated Facility Types as found in IDAPA.58.01.01.006:

1. Fossil fuel-fired, steam electric plants of more than 250 million British thermal units (Btu)per hour heat input
2. Coal cleaning plants (with thermal dryers)
3. Kraft pulp mills
4. Portland cement plants
5. Primary zinc smelters
6. Iron and steel mill plants
7. Primary aluminum ore reduction plants
8. Primary copper smelters
9. Municipal incinerators capable of charging more than 250 tons of refuse per day
10. Hydrofluoric acid plants
11. Sulfuric acid plants
12. Nitric acid plants
13. Petroleum refineries
14. Lime plants
15. Phosphate rock processing plants
16. Coke oven batteries
17. Sulfur recovery plants
18. Carbon black plants (furnace process)
19. Primary lead smelters
20. Fuel conversion plants
21. Sintering plants
22. Secondary metal production plants
23. Chemical process plants
24. Fossil fuel boilers (or combination thereof) totaling more than 250 million Btu/hour heat input
25. Petroleum storage and transfer units with a total storage capacity exceeding 300,000 barrels
26. Taconite ore processing plants
27. Glass fiber processing plants
28. Charcoal production plants

Table 5. Significant Emissions Rates (40 CFR 52.21 (b)(23); IDAPA 58.01.01.006)[a]

Pollutant	Emission Rate (T/yr)
CO	100
NOX	40
SO2	40
PM_{10}	15
$PM_{2.5}$	10 (40)[b]
Particulate matter	25
Ozone (VOC)	40 (of VOCs)
Pb	0.6
Asbestos	0.007
Beryllium	0.0004
Mercury	0.1
Vinyl chloride	1
Fluorides	3
Sulfuric Acid Mist	7
Hydrogen Sulfide (H_2S)	10
Total Reduced Sulfur (including H_2S)	10
Radionuclides from facilities regulated under40 CFR Par 61, Subpart H	0.1 mrem/yr
Reduced sulfur compounds (Including H_2S)	10
Any other pollutant regulated under the Clean Air Act including radionuclides	Any emission rate
Each regulated pollutant (from a major facility or major modification)	Emission rate that causes air quality impact of 1 µg/m3 or greater (24-hour basis) in any Class I area located within 10

a) A PSD review is required if the operation is modified and actual emissions of a pollutant will be greater than shown above

b) SO_2, NOx, and VOCs as precursors

Table 6. Prevention of Significant Deterioration Increment Limits

Pollutant	Averaging Period	Class I (µg/m^3)	Class II(µg/m^3)	Class III (µg/m^3)
NO_2	Annual[c]	2.5	25	50
SO_2	Annual[b]	2	20	40
SO_2	24-hour[c]	5	91	182
SO_2	3-hour[c]	25	512	700
PM_{10}	Annual[b]	4	17	34
PM_{10}	24-hour[c]	8	30	60
$PM_{2.5}$	Annual[b]	1	4	8
$PM_{2.5}$	24-hour[c]	2	9	18

a) The Class I, II, and III areas are defined and shown in Appendix A.

b) Never to be exceeded.
c) Not to be exceeded more than once a year.

Table 7. Modeled Impacts Above which Preconstruction Monitoring cannot be Exempted for PSD-Applicable Projects

Pollutant	Ambient Concentration ($\mu g/m^3$)	Averaging Period
CO	575	8-hour
NO2	14	Annual
SO2	13	24-hour
PM10	10	24-hour
PM2.5	4	24-hour
Ozone	100 T/yr increase of VOCs	N/A
Pb	0.1	Quarterly
Mercury	0.25	24-hour
Beryllium	0.0001	24-hour
Fluorides	0.25	24-hour
Vinyl chloride	15	24-hour
Hydrogen sulfide	0.2	1-hour

5.3 Facility Emission Cap (FEC) Permit Modeling

Contact DEQ for guidance on modeling requirements for FEC permits. In general, the modeling submitted must support all possible future emissions rates sources, and facility configuration.

6 Performing a Modeling Analysis

An application will be considered incomplete if it lacks sufficient information and/or a valid modeling analysis, supported by adequate documentation and justification of methods and data. Appendix C includes a copy of the DEQ modeling checklist, which is designed to help the applicant prepare the information necessary for a complete modeling package.

The procedures in this document, as well as the EPA documents *Guideline on Air Quality Models* (EPA 2005), *New Source Review Workshop Manual* (EPA 1990), and other more issue- specific guidance should typically be followed when conducting the modeling analysis. These documents provide guidance on appropriate model applications. DEQ will work with the applicant to determine acceptable impact assessment procedures where EPA or state policies are not clear cut or involve case-by-case review.

6.1 Modeling Protocol

Applicants are highly advised to contact the DEQ stationary source air quality modeling supervisor at (208) 373-0502 and submit a modeling protocol, as suggested in the modeling checklist (Appendix C), to ensure appropriate models, meteorological data, background concentrations, and procedures are applied. Use of a modeling protocol is a key component of DEQ's permit streamlining program, which

focuses on establishing mutually agreed upon methods and data prior to permit application submittal. This approach substantially reduces DEQ review time and the potential for the application to be determined incomplete or the permit denied because of problems with the modeling analyses.

The content of the modeling protocol is dependent on the type of permit application. A modeling protocol for a new, major source or a major modification at a major facility will be more detailed than one for a new, minor source or a minor modification. A modeling protocol checklist is presented in Appendix D. A description of the general methodology, as well as justification for assumptions and data used, should be included in the modeling protocol.

A modeling protocol, in written form and agreed upon by DEQ, provides the applicant the assurance that their approach and methodology as described will be accepted. However, the approval of a modeling protocol is not meant to imply approval of a completed modeling analysis. The facility should submit as much detailed information as possible in the modeling protocol to increase the likelihood of having the modeling analysis approved. The applicant should prepare the application with the understanding that DEQ will require a higher degree of documentation/justification of data and methods in cases where modeled concentrations are very near regulatory thresholds/standards.

A modeling protocol may be submitted in hard-copy format or may be emailed to the DEQ stationary source modeling coordinator. DEQ will typically provide comments on or approval of the protocol within two weeks from the date the protocol was received.

The following are key issues that should be addressed in the protocol:

- Ambient air boundary. It is the applicant's responsibility to accurately evaluate the ambient air boundary and identify any unique situations affecting the ambient air boundary that may exist at the facility. Such unique situations may include rivers bisecting the facility, easements or public roadways bisecting the facility, railways, lease agreements, and operating a business where the general public is allowed on site. See Section 6.5.
- Justification/documentation of stack parameters. The protocol should thoroughly describe how emissions release parameters (flow rates and stack temperatures) were measured or estimated, if such data are available at that time. A simple indication that parameters were checked will not be accepted as documentation and justification. Calculations of initial dispersion coefficients for volume sources should be provided such that DEQ reviewers can easily and quickly verify the values. See Section 6.4.2.
- Design concentrations. The protocol should clearly state what modeled concentrations will be used to evaluate compliance. For example, the maximum of 6th highest modeled concentrations at each receptor is typically used as the PM10 24-hour design value when modeling a five-year data set. See Section 6.11.1.
- Meteorological data. If meteorological data are not provided by DEQ, the applicant should thoroughly justify selection of the data, demonstrating how the data used are representative for the application site. The protocol should also describe the quality of the data, clearly demonstrating the data are adequate for use in an air impact analysis. See Section 6.8.
- Receptor grid. The receptor grid spacing proposed for the analyses should be thoroughly described. See Section 6.6.
- Background concentrations. Within the protocol, the applicant may either propose appropriate background concentrations or request that DEQ provide reasonably conservative background concentrations. See Section 6.10.
- Unique circumstances or scenarios used in the analyses. Any atypical conditions associated with the site or the project that could affect the results of the air impact analyses, or DEQ's approval

of the project, should be described in the protocol. Protocol approval only assures acceptability that those conditions or issues accurately described in the protocol are acceptable.

6.2 Choosing the Appropriate Models

Air quality models approved by the EPA for regulatory use are required (Idaho Air Rules Section 202.02 and 402.03). The DEQ modeling coordinator should be consulted to discuss or verify the model most appropriate for the release being simulated. Factors to consider when determining the appropriate model include, but are not limited to, type of release (e.g., elevated point or area), downwash, location of ambient air, meteorological conditions (e.g., stagnation), and availability of meteorological data. All modeling must use the current versions of models recommended in the EPA's *Guideline on Air Quality Models* (EPA 2005). Many of these models can be found on the EPA's Support Center for Regulatory Air Models (SCRAM) website (http://www.epa.gov/ttn/scram). Modeling performed with older versions may be rejected. Any modification or alteration of a guideline model must be approved by DEQ and, in most instances, the EPA. Approval of the use of other models is completely at the discretion of DEQ. When alternative models are used, DEQ may require the submittal of additional data (e.g., sensitivity analysis) for verification. The use of proprietary models (those models that are not available free of charge to the public) is generally not allowed for the demonstration of compliance with NAAQS, PSD increment, or TAPs increments. Proprietary graphical user interfaces (GUIs) that use unaltered publicly available regulatory models are not considered proprietary models. Results generated by such GUIs will be accepted provided input and output files are submitted and such files can be readily used as input for the publicly available model without the proprietary GUI.

6.2.1 Readily Available Models

The following is a summary of the most commonly used air quality models:

AERMOD – AERMIC (American Meteorological Society/Environmental Protection Agency Regulatory Model Improvement Committee) was formed to introduce state-of-the-art modeling concepts into EPA's air quality models. AERMIC's focus is on a new platform for regulatory steady-state plume modeling. This platform includes: 1) air turbulence structure, scaling, and concepts; 2) treatment of both surface and elevated sources; and 3) simple and complex terrain. The modeling system has three components: AERMOD - the air dispersion model; AERMET - the meteorological data preprocessor; and AERMAP - the terrain data preprocessor. AERMOD is the replacement model for ISCST3.

AERSCREEN – AERSCREEN is the screening-level model for applications where AERMOD would be appropriate.

SCREEN3 – SCREEN3 is a screening version of the ISCST3 model.

SCREEN3 is not considered an acceptable screening model for AERMOD, which is the model replacing ISCST3. *Analyses performed with SCREEN3 will no longer be accepted by DEQ for permitting purposes in most instances.*

CTSCREEN – (Complex Terrain Screening model) –A screening technique when complex terrain is important. CTSCREEN is a screening version of the CTDMPLUS model. CTSCREEN and CTDMPLUS are the same basic model. The primary difference is that CTSCREEN uses

an extensive array of predetermined meteorological conditions where site-specific meteorological data are not available.

AERMOD is considered a more refined model for complex terrain. AERSCREEN incorporates the same terrain algorithms as AERMOD, and may yield more favorable results than CTSCREEN.

ISCST3 – (Industrial Source Complex Model) – Historically, the most commonly used refined Gaussian plume model.

ISCST3 has been replaced as an EPA guideline model by AERMOD. *DEQ will generally no longer accept air quality analyses conducted with ISCST3 for permitting purposes.*

CTDMPLUS – (Complex Terrain Dispersion Model Plus Algorithms for Unstable Situations) – A refined air quality model for use in all atmospheric stabilities with sources located in or near complex topography. Since the model accounts for the three-dimensional nature of plume and terrain interaction, it requires detailed terrain and meteorological data that are representative of the modeling domain.

CALPUFF – A multi-layer, multi-species, non-steady-state, puff dispersion model that simulates the effects of time- and space-varying meteorological conditions on pollutant transport, transformation, and removal. CALPUFF is most commonly used to assess impacts on Class I areas and is applied at distances over 50 kilometers. It includes algorithms for subgrid scale effects (such as terrain impingement), as well as longer range effects (such as pollutant removal due to wet scavenging and dry deposition, chemical transformation, and visibility effects of particulate matter concentrations).

CALPUFF is not an EPA-approved model for near-field impact assessment (within 50 kilometers of a source). Any use of CALPUFF in the near-field must be thoroughly justified and approved specifically by DEQ and often by EPA.

VISCREEN – A screening model to assess visibility impacts on Class I areas. Calculates the potential impact of a plume of specified emissions for specific transport and dispersion conditions.

Screening models, such as SCREEN3 and AERSCREEN, are used to simulate the probable worst-case condition under normal, maximum operating conditions. They are generally simplistic representations, typically taking less computer time and yielding conservative impact predictions. A screening analysis must follow EPA guidance in *Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised* (EPA 1992) or any current EPA guidance for AERSCREEN. If a properly conducted screening analysis does not indicate an exceedance of the ambient standards from a proposed construction or modification, then a more refined analysis is not necessary to adequately demonstrate compliance.

6.2.2 Replacement of ISC by AERMOD

AERMOD was promulgated as the replacement model for ISC. During the one-year transitional period, between November 2005 and November 2006, applicants could use either ISCST3 or AERMOD to demonstrate compliance. After that, ISCST3 was no longer a guideline model and analyses conducted with ISCST3 were not typically accepted by DEQ.

There are several modeling scenarios that are problematic when using AERMOD:

1. Hot, buoyant plumes released horizontally or with a rain cap. With ISCST3 the typical approach is to set the exit velocity to 0.01 or 0.001 meters per second (m/sec) to effectively eliminate the plume vertical momentum flux, then increase the exit diameter to a point where the modeled volumetric flow is equal to that of the source. This approach cannot be used for AERMOD if plume downwash is considered because downwash behavior is a function of stack diameter in the PRIME downwash algorithm within AERMOD.

   Modeling with the actual stack diameter and a 0.001 m/sec exit velocity is recommended as a conservative measure. This method effectively eliminates vertical momentum of the plume; however, it also eliminates thermal buoyancy effects. In some instances, hand calculations of plume rise, using those equations in the AERMOD algorithms, may show that thermal buoyancy is overwhelmingly the dominant plume rise mechanism. In such cases, the source may be modeled as an uninterrupted vertical release. Use of this method or other methods should be discussed with DEQ prior to use.

   Methods to accurately model hot horizontal releases and capped vertical releases within AERMOD have been developed for Beta versions of AERMOD. Applicants should contact DEQ as to the availability of AERMOD versions to handle hot horizontal and capped releases.

2. Representative meteorological data are rather limited for many areas within Idaho. More site-specific meteorological and land surface characteristics are needed to run AERMOD than what is used for ISC. Therefore, using meteorological data from a distant station is more of a concern when using AERMOD.

   It is the applicant's responsibility to demonstrate the meteorological data used are representative of meteorological conditions at the application site. Applicants may be required to use specialized methods to demonstrate compliance in cases where available meteorological data are of questionable representativeness. Such methods could involve running additional modeling analyses using multiple meteorological data sets or otherwise providing a demonstration that use of on-site data could not reasonably be expected to give results that exceed applicable regulatory thresholds or standards.

6.3 Pollutants and Sources to be Included in the Impact Analyses

This section discusses what pollutants and sources should be included in modeling analyses submitted in support of applications for permits to construct (PTCs), Tier II operating permits, and FEC permits. Specific emissions sources that are exempt from permitting requirements are not necessarily exempt from a modeling analysis when a PTC or Tier II Operating Permit is required for other sources/reasons. DEQ modeling staff should be consulted before any emissions sources eliminated from the modeling analyses.

DEQ does have a list of activities that may be treated as "trivial" and are not required to be addressed in the permit application. In addition to the trivial activities listed below, Idaho Air Rules Section 317 list activities that are "presumptively insignificant emission units." DEQ has determined that these activities must generally be included in Tier II and PTC applications when facility-wide modeling is required. The list below was generated from an EPA white paper entitled Streamlined Development of Part 70 Permit Applications (EPA 1995).

Activities That May be Treated as "Trivial" (EPA 1995):

1. Combustion emissions from propulsion of mobile sources, except for vessel emissions from outer continental shelf sources.
2. Air-conditioning units used for human comfort that do not have applicable requirements under Title VI of the Clean Air Act.
3. Ventilating units used for human comfort that do not exhaust air pollutants into the ambient air from any manufacturing/industrial or commercial process.
4. Noncommercial food preparation.
5. Consumer use of office equipment and products, not including printers or businesses primarily involved in photographic reproduction.
6. Janitorial services and consumer use of janitorial products.
7. Internal combustion engines used for landscaping purposes.
8. Laundry activities, except for dry cleaning and steam boilers.
9. Bathroom/toilet vent emissions.
10. Emergency (backup) electrical generators at residential locations.
11. Tobacco smoking rooms and areas.
12. Blacksmith forges.
13. Plant maintenance and upkeep activities (e.g., grounds keeping, general repairs, cleaning, painting, welding, plumbing, re-tarring roofs, installing insulation, and paving parking lots) provided these activities are not conducted as part of a manufacturing process, are not related to the source's primary business activity, and do not otherwise trigger a permit modification.[(a)]
14. Repair or maintenance shop activities not related to the source's primary business activity, not including emissions from surface-coating or degreasing (solvent metal cleaning) activities, and not otherwise triggering a permit modification.
15. Portable electrical generators that can be moved by hand from one location to another.[(b)]
16. Hand-held equipment for buffing, polishing, cutting, drilling, sawing, grinding, turning or machining wood, metal or plastic.
17. Brazing, soldering and welding equipment, and cutting torches related to manufacturing and construction activities that do not result in emission of hazardous air pollutant metals.[(c)]
18. Air compressors and pneumatically operated equipment, including hand tools.
19. Batteries and battery charging stations, except at battery manufacturing plants.
20. Storage tanks, vessels, and containers holding or storing liquid substances that will not emit any volatile organic compound or hazardous air pollutant.[(d)]
21. Storage tanks, reservoirs, and pumping and handling equipment of any size containing soaps, vegetable oil, grease, animal fat, and nonvolatile aqueous salt solutions, provided appropriate lids and covers are utilized.
22. Equipment used to mix package soaps, vegetable oil, grease, animal fat, and nonvolatile aqueous salt solutions, provided appropriate lids and covers are utilized.
23. Drop hammers or hydraulic presses for forging or metalworking.
24. Equipment used exclusively to slaughter animals, but not including other equipment at slaughterhouses, such as rendering cookers, boilers, heating plants, incinerators, and electrical power generating equipment.
25. Vents from continuous emissions monitors and other analyzers.
26. Natural gas pressure-regulator vents, excluding venting at oil and gas production facilities.
27. Hand-held applicator equipment for hot-melt adhesives with no volatile organic compounds in the adhesive formulation.

28. Equipment used for surface coating, painting, dipping, or spraying operations, except those that will emit any volatile organic compound or hazardous air pollutant.
29. Carbon dioxide lasers, used only on metals and other materials that do not emit hazardous air pollutants in the process.
30. Consumer use of paper trimmers/binders.
31. Electric- or steam-heated drying ovens and autoclaves, but not the emissions from the articles or substances being processed in the ovens or autoclaves, or the boilers delivering the steam.
32. Salt baths using nonvolatile salts that do not result in emissions of any regulated air pollutant.
33. Laser trimmers using dust collection to prevent fugitive emissions.
34. Bench-scale, laboratory equipment used for physical or chemical analysis, but not for lab fume hoods or vents.[(e)]
35. Routine calibration and maintenance of laboratory equipment or other analytical instruments.
36. Equipment used for quality control/assurance or inspection purposes, including sampling equipment used to withdraw materials for analysis.
37. Hydraulic and hydrostatic testing equipment.
38. Environmental chambers not using hazardous air pollutant gasses.
39. Shock chambers.
40. Humidity chambers.
41. Solar simulators.
42. Fugitive emissions related to movement of passenger vehicles, provided the emissions are not counted for applicability purposes and any required fugitive-dust-control plan or its equivalent is submitted.
43. Process-water filtration systems and demineralizers.
44. Demineralized-water tanks and demineralizer vents.
45. Boiler-water treatment operations, not including cooling towers.
46. Oxygen scavenging (de-aeration) of water.
47. Ozone generators.
48. Fire suppression systems.
49. Emergency road flares.
50. Steam vents and safety relief valves.
51. Steam leaks.
52. Steam cleaning operations.
53. Steam sterilizers.

a) Cleaning and painting activities qualify as trivial they are not subject to volatile organic compound or hazardous air pollutant control requirements. Asphalt batch plant owners/operators must still get a permit if otherwise required.

b) “Moved by hand” means the generator can be moved without the assistance of any motorized or non-motorized vehicle, conveyance, or device.

c) Brazing, soldering and welding equipment, and cutting torches that emit hazardous air pollutant metals and are related to manufacturing and construction activities are more appropriate for treatment as insignificant activities instead of trivial activities based on size or production-level thresholds. Brazing, soldering, welding, and cutting torches that emit hazardous air pollutant metals and are directly related to plant maintenance, upkeep, and repair, or maintenance shop activities, are appropriately treated as trivial.

d) Consideration of storage tanks containing petroleum liquids or other volatile organic liquids as a trivial source should be based on size limits such as storage tank capacity and vapor pressure of liquids stored are not appropriate for this list.

e) Many lab fume hoods or vents might qualify for treatment as insignificant (depending on the applicable State Implementation Plan) or can be grouped together for purposes of description.

6.3.1 Permits to Construct

Criteria Pollutants

All increases in emissions of criteria pollutants are generally required to be accounted for in the significant impact analyses for PTC applications. However, the emissions sources and inventory used to evaluate the need for modeling, described in Section 3 of this guideline, may differ from the sources and inventory used for the significant impact analyses. All emissions changes associated with a proposed project are generally used in the significant impact analyses, including emissions reductions associated with sources removed from operation. Also, sources included in the significant impact analyses for minor source permitting may differ from sources included for PSD permitting. For minor source permitting, the significant impact analyses for criteria pollutants generally includes: all emissions increases and decreases associated with the proposed project. For PSD permitting, the net emissions increase, as defined in Idaho Air Rules Section 007, is modeled. The net emissions increase includes all increases and decreases that occurred within the previous five years or since the issuance of any PSD permit to the facility, whichever is a shorter period.

Cumulative impact analyses are required if impacts associated with the significant impact analyses exceed SILs, as described in Sections 5.1.1 and 5.1.2. A cumulative impact analysis involves modeling facility-wide emissions, modeling any co-contributing sources, and adding an appropriate background value to results.

DEQ highly suggests that applicants specify in a modeling protocol those sources to be included and/or excluded in the significant impact analyses with thorough justification and documentation. The following provides general guidance for the significant impact analyses performed for specific minor source scenarios:

- Modification to an existing emissions unit where the release parameters (flow rate, stack gas temperature, etc.) do not change. The emissions increase associated with the modification is modeled. If the existing source is currently permitted, the emissions increase will be calculated as the differences between the current permit limit (or whatever emissions rate was used in previous modeling analyses) and the future proposed limit. If the source is not currently regulated by a permit emissions limit, then current emissions should be based on actual emissions as defined by Idaho Air Rules.
- Modification to an existing emissions unit where the release parameters change as a result of the modification. Existing emissions for permitted and non-permitted sources should be calculated as described for scenario “a;” however, current emissions should be modeled as negative emissions (using the existing release parameters) and future allowable emissions modeled as positive emissions (using the new release parameters).
- Removal of, or emissions reductions from, an existing emissions unit. Emissions reductions from such units should be modeled as negative emissions to account for the net project impacts. Existing permit-allowable emissions rates may be used, or actual emissions (based on two years of operations within the previous ten years) for units not regulated by an existing emissions limit.

- Replacement or relocation of an existing emissions unit. Replaced units should be treated in the same manner as removed units, described in scenario "c."
- Addition or removal of units exempt from permitting. Units that are exempt from permitting should be included in the significant impact analyses in most instances, unless such units are considered as trivial per Table 9 in Section 6.3 of this guideline. Existing and future emissions should be based on maximum potential emissions unless otherwise directed or approved by DEQ.

TAPs

All TAPs, except those exempted under Idaho Air Rules Section 210.20, with project-total emissions increases above the DEQ TAP ELs (discussed in Section 4.0) must be included in the modeling analysis. The DEQ TAPs checklist, available on the DEQ website, should be used to demonstrate compliance with TAPs.

Fugitive Sources

Fugitive emissions are defined in Idaho Air Rules Section 006 as, "those emissions which could not reasonably pass through a stack, chimney, vent, or other functionally equivalent opening." This definition includes windblown dust from a stockpile. Generally, modeling is required for all fugitive emissions sources determined not to be unquantifiable. Fugitive emissions from vehicle traffic on roads and wind erosion from material storage piles are normally not included in the modeling analyses for minor source applications. However, DEQ may require modeling of these sources in instances where these emissions could substantially contribute to ambient concentrations and a potential exceedance of air quality standards. Process fugitive emissions such as those from material handling operations and equipment leaks should be included in the modeling analyses.

Intermittent Sources

Emissions sources that operate intermittently may be excluded from the SIL analysis and/or cumulative NAAQS analysis, approved by DEQ on a case-by-case basis, to the extent that it can be reasonably concluded that such sources could not measurably affect the compliance determination. If the intermittent sources are engines powering emergency generators or fire suppression water pumps, and operations are less than 100 hours/year for operational testing and maintenance, the sources can be excluded from compliance demonstrations for the 1-hour NO2 NAAQS, unless specifically required at the discretion of the DEQ Director. This guidance is explained in more detail in Appendix A.

Inconsequential Sources

The applicant may determine that some sources are "inconsequential" when estimating the design concentration (i.e., only contribute to a small percentage of the total, maximum, ambient impact for that project) and exclude them from the modeling analysis. If this is the case, the applicant must justify the exclusion of these sources. This justification, which is pollutant and averaging-period specific, must be based on emissions rates and a qualitative discussion of impacts. For example, if an emissions unit operates 24 hours per day but only 500 hours per year, the source may be "inconsequential" for the annual emissions, but not for the 24-hour emissions. The justification should include the following two phases:

1. Compare the emissions and operating conditions of each emissions source to the total emissions that would be modeled. If the uncontrolled emissions are "negligible" compared to the total emissions and are not expected to impact the maximum ambient concentration, the individual

PET 737
REC 1103

emissions source may be deemed as "inconsequential" and may be excluded from the modeling analysis.

Unless there are a large number of negligible sources that will substantially slow the model run time, it may be easier to include such sources in the analyses rather than provide justification for their exclusion.

2. If more than one emissions source is excluded from the modeling analysis, the total emissions of those sources excluded and the total estimated ambient concentration must be compared to the total modeled emissions and qualitatively evaluated for impacts. This will ensure that all of the excluded sources are still "inconsequential" as a whole.

Non-Attainment Areas

Facilities located in an a non-attainment area for a specified pollutant may be required to model all the emissions for that specified pollutant, even those emissions that are deemed to be inconsequential. This process will be treated on a case-by-case basis. It is recommended that the applicant meet with DEQ staff prior to beginning the modeling analysis to discuss what sources will be included.

6.3.2 Facility-Wide Tier II Operating Permits

All emissions for the entire facility, excluding those listed in Table 9, are required to be included in a facility-wide Tier II application. All criteria pollutant emissions are generally required to be included in the modeling analysis submitted with the Tier II operating permit application. Facility-wide TAPs emissions are not typically required to be included in the modeling analysis for the Tier II application. DEQ reserves the right to request additional information or analysis, including the modeling of other pollutants, under Idaho Air Rules Section 402.04, if there is a concern relative to compliance with Idaho Air Rules Section 161. Modeling of all fugitive emissions may be required if DEQ determines it necessary to protect ambient air quality standards.

As with the PTC application, the applicant may determine that some criteria pollutant sources are "inconsequential" when estimating the design concentration (i.e., only contribute to a small percentage of the total, maximum, ambient impact for that project) and exclude them from the modeling analysis. The applicant should use the process presented above in Section 6.3.1. Facilities located in non-attainment areas for a specified pollutant must contact the DEQ modeling coordinator at (208) 373-0112 prior to submitting the Tier II application. DEQ modeling staff will review the current SIP for the area to determine the appropriate level of analysis. This process will be treated on a case-by-case basis. It is recommended that the applicant meet with DEQ staff prior to beginning the modeling analysis to discuss what sources will be included.

6.3.3 FEC Permits

Permit applications utilizing a facility emissions cap (FEC) must provide sufficient modeling scenarios to reasonably assess maximum impacts of potential source configurations. The modeling requirements for these permits are facility-specific and will vary greatly depending on the operational flexibility desired by the permit applicant.

6.4 Source Information Required

This section discusses the source information that is required for a modeling analysis.

6.4.1 Emission Rates

Tables 8.1 and 8.2 in the *Guideline on Air Quality Models* (EPA 2005) present the emissions information required for air dispersion modeling. The emissions rate used in the modeling analysis must be that associated with maximum design capacity or a federally enforceable permit condition (40 CFR 51, Appendix W, Table 9-2). For a major modification, the emissions rate to be modeled in the significant impact analysis for criteria pollutants is the net emission rate increase, as defined in Idaho Air Rules Section 007. To demonstrate compliance with applicable standards, potential emissions must be used in the modeling analyses rather than future projected actual emissions. For minor modifications, the emissions modeled are the emissions changes associated with the proposed project, as described in Section 6.3.1 of this guideline. Emissions decreases are modeled as negative values in the significant impact analyses. However, in instances where NAAQS compliance may be questionable, DEQ may require facility-wide modeling even though results of the significant impact analysis indicate impacts are below SILs. When a cumulative NAAQS analysis is required, the potential emissions for all sources and, if requested, any co-contributing sources are used in the modeling analyses.

For PTCs, the project-wide emissions rate increase of TAPs is compared to the EL in Idaho Air Rules Section 585 and 586. Any TAP that has a total project emissions increase that exceeds the EL must be modeled.

The maximum emissions rate for each averaging period must be identified. For example, PM2.5 has both a 24-hour and an annual standard. If a source will only operate 7,000 hours per year but can operate for 24 hours in a single 24-hour period, then different emissions rates would be modeled for the 24-hour standard and annual standard.

If any pounds per hour emissions rate used in a modeling analysis differs from that used in the emissions inventory, the application should clearly show how the modeled rate was calculated. For example, a source has a maximum hourly emissions rate of 2.0 pounds per hour and a maximum daily operations rate of 12 hours per day (not restricted to any specific daily schedule). The modeled emissions rate for demonstrating compliance with a 24-hour standard would be 1.0 pounds per hour ((2.0 lb/hr x 12 hr/day) / 24 hr = 1.0 lb/hr).

Modeling intermittent sources in a representative and worst-case manner can present a challenge to the modeler. These sources can be modeled in two ways:

1. The allowable emissions can be modeled for a time period equal to that of the actual source. The emissions event is then selected to reasonably represent worst-case impacts or a series of potential operational scenarios are modeled.
2. The allowable emissions for the event are evenly divided over the pollutant averaging period of interest.

As an example, a mill may have fugitive PM2.5 emissions from periodic loadout of a waste bin. The emissions may occur for one hour, three times per week. Modeling must demonstrate compliance with both the 24-hour and annual standards. It is determined that only one loadout can occur during any 24-hour period. Since there is no specific time when the loadout is likely to occur, 24-hour modeling was conducted by evenly dividing the emissions from one loadout throughout the entire 24-hour period. Annual impacts were modeled by calculating annual allowable emissions, and evenly dividing those emissions among each hour of the year.

If it is known that emissions are most likely to occur during a certain time of the day, it may be appropriate to distribute emissions only over those hours of the day. The applicant should consult with DEQ modeling staff to obtain approval of such methods prior to modeling intermittent sources.

DEQ may allow exclusion of some very infrequent periodic emissions from the modeling analyses. Monthly testing of an emergency generator for 35 minutes could be an example of an infrequent periodic emissions source. Approval of excluding such sources from the modeling analyses will be made by DEQ on a case-by-case basis considering:

- The pollutant of interest and the averaging period of the standard
- Quantity of emissions from the source
- Frequency of the emissions
- Averaging period of standards associated with pollutants emitted
- Number of sources to be excluded
- Distance from source to ambient air receptors
- Nearby sensitive receptors (hospitals, schools, residences)
- Modeled impact of other sources in relation to applicable standards

As indicated in Section 6.3.1. Intermittent Sources, DEQ allows the exclusion of NOx emissions from intermittent testing and maintenance of engines powering emergency generators and fire suppression water pumps for demonstrating compliance with the 1-hour NO2 NAAQS.

6.4.2 Source Parameters

Stack parameters for each point source that are required to be modeled are as follows:

- Stack base elevation (feet or meters)
- Stack height (feet or meters)
- Stack inside diameter (feet or meters) (If the stack is not circular, use equivalent dimensions determined by Area = d2/4, where d is the stack's inner diameter)
- Stack exit velocity (meters/second) or exit flow rate (actual cubic feet per minute (acfm))
- Stack exit temperature (F or K)

Source parameters for area sources include the following:

- Source height (meters)
- Easterly dimension (meters)
- Northerly dimension (meters)
- Initial vertical dimension (meters)
- Angle from North (degrees)

Source parameters for volume sources include the following:

- Source height (meters)
- Initial horizontal dimension (meters)
- Initial vertical dimension (meters)

The application must provide detailed documentation and justification of all source parameters used in the analyses, including calculations where appropriate. Applications not providing sufficient documentation/justification of source parameters will be declared incomplete or denied. Stating that parameters were provided by the manufacturer or design engineer is not considered as adequate documentation/justification.

Flow Rates and Stack Gas Temperatures

Maximum flow rates and maximum stack gas temperatures should not typically be used in the modeling analyses unless the source predominantly operates at such a rate. Although maximum emissions are typically associated with maximum flow rates and stack gas temperatures, maximum impacts are often associated with lower emissions rates and lower stack gas flow rates and temperatures. Applicants should either use multiple scenarios of emissions, flow rates, and temperatures, or conservatively use maximum emissions with more typical stack gas flow rates and temperatures.

Submitted modeling analyses should provide detailed documentation and justification of all release parameters used in the analyses. Stack gas temperatures and flow rates substantially affect dispersion, and the application should clearly show how these parameters were calculated or measured. If gas temperatures are based on measurements made at locations other than near the stack exit, the temperature used in the model should be adjusted to derive a temperature appropriate for the stack exit. Stack gas exit velocities exceeding 50 m/sec will generally be viewed as suspect by DEQ reviewers, and greater documentation of values used will be required.

Unrealistic stack parameters submitted in applications are most commonly associated with internal combustion engines, and typically involve overly high exit velocities and stack temperatures. Applicants often use temperature and flow data obtained for the exhaust manifold rather than for the point of release to the atmosphere. Actual flows and temperatures at the release point will be substantially lower after heat loss through the walls of an exhaust pipe and through an exhaust muffler.

Stack Orientation

DEQ also requires the following be included in the application and modeling analysis:

- Orientation of the stack (horizontal or vertical)
- Indication of the presence or absence of a rain cap or other obstruction in the released flow from a stack

Stack orientation information is important because it affects the dispersion characteristics of the pollutants. If either a horizontal stack or rain cap (or other obstruction) is present, it must be accounted for in the modeling analysis, since upward plume momentum is zero because of either the obstruction or the orientation of the stack.

The method recommended by DEQ for modeling horizontal or rain-capped sources, when using the model AERMOD where downwash is not considered, is based on a procedure recommended by EPA (July 9, 1993, memorandum from Joseph A. Tikvart, Source Receptor Analysis Branch, to Ken Eng, Chief, Air Compliance Branch, Region II). The method involves setting the stack velocity to 0.001 meters per second to effectively turn off momentum plume rise. The memo also recommends turning stack tip downwash off for horizontal releases.

The recommended method for modeling point sources of non-buoyant emissions with horizontal release or vertical release with the presence of a rain cap is as follows:

1. Define the emissions source as a point source, entering in the model the actual height of release, stack gas temperature, and the Universal Transverse Mercator (UTM) coordinates.
2. Plumes from horizontal emissions releases or vertical stacks with rain caps experience no momentum induced plume rise. Set the stack gas exit velocity to 0.001 meters per second to effectively prevent the model from accounting for momentum plume rise.

3. Stack tip downwash is not appropriate for horizontally released emissions. If the emissions vent in the horizontal direction, the stack diameter can be set to 0.001 meters to prevent stack tip downwash effects. This step should not be used for sources that vent vertically with a rain cap over the stack, since the rain cap will not prevent stack tip downwash effects. The actual inside stack diameter should be used for rain-capped stacks.
4. Run the model as otherwise required.

By setting the flow velocity and/or stack diameter to 0.001, plume rise from hot, buoyant plumes is inappropriately eliminated. Since the PRIME downwash algorithm within AERMOD is affected by stack diameter, it is not acceptable to artificially increase the diameter by a substantial degree to generate a more accurate mass of hot stack gas emitted.

Non-regulatory versions of AERMOD allow the modeler to identify sources as a horizontal release or rain-capped source, and the model will consider the thermal buoyancy flux in the plume rise calculation while not considering a vertical momentum flux. To use the non- regulatory version, the actual temperature, stack diameter, and flow rate are entered into the model, then the source is identified in the AERMOD input file as a capped or horizontal release. DEQ must approve the use of any non-regulatory options in AERMOD.

Alternate methods may be approved by DEQ on a case-by-case basis if there are unique circumstances. In such cases, DEQ strongly advises that the permit applicant or consultant contact DEQ prior to modeling to discuss the issue, prepare a modeling protocol, and obtain prior approval from DEQ to use the proposed method.

Initial Plume Dimensions for Volume Sources

Initial horizontal plume dimensions for volume sources should be calculated as follows:

- Single volume source:
  $\sigma y0$ = side length of source divided by 4.3
- Line source represented as a series of volume sources (separated or adjacent):
  $\sigma y0$ = side length of source divided by 2.15

Initial vertical plume dimensions for volume sources should be calculated as follows:

- Surface based source:
  $\sigma z0$ = height of source divided by 2.15
- Elevated source on or adjacent to a building:
  $\sigma z0$ = building height divided by 2.15
- Elevated source not on or adjacent to a building:
  $\sigma z0$ = building height divided by 4.3

6.4.3 Scaled Plot Plan

A scaled plot plan showing emissions release locations, nearby buildings, property lines, fence lines, and roads is required (Section 8.1.2(b), *Guideline on Air Quality Models* (EPA 2005). The dimensions of the buildings (height, width, and length) should be noted either on the plot plan or in a table in the report. If building dimensions are listed in a table format, then it should be easy to cross-reference between the plot plan, model input file, and table.

The use of site plot plans generated directly from the modeling files does not meet the scaled plot plan submittal requirement. The submittal should include those scaled plot plans used to generate the modeling files.

6.4.4 Building Downwash Parameters

According to Section 6.2.2 in the *Guideline on Air Quality Models* (EPA 2005), the air quality impacts associated with cavity and wake effects due to the nearby building structures should be determined for any stacks with stack heights less than good engineering practice (GEP). If AERSCREEN is used with the option of entering dimensions of a single building, the building with the greatest corresponding GEP stack height should be analyzed. This may not necessarily be the building closest to the stack. When the EPA's AERMOD model is used and stacks are less than GEP stack height, building profile information is required for use in the modeling. The recommended building profile software is the EPA's *Building Profile Input Program* (BPIP). This program can also be used to determine which building should be used in the screening analysis. BPIP is available on EPA's SCRAM website.

6.4.5 Source, Building, and Receptor Coordinates and Elevations

UTM coordinates are typically used to define locations of emissions points, building corners, and receptor locations. The datum (e.g., NAD27, NAD83, WGS84) must be specified for the coordinates used, and the same datum must be used for all locations specified in the modeling analysis to assure consistency. The same coordinate system should also be used to evaluate elevations for emissions points, buildings, and receptors.

6.5 Ambient Air Boundary

The ambient air boundary must be determined before an ambient air assessment can be completed. The definition of ambient air in Idaho Air Rules Section 006 is, "that portion of the atmosphere, external to buildings, to which the general public has access." The EPA has further stated that "the exemption from ambient air is available only for the atmosphere over land owned or controlled by the source and to which public access is precluded by a fence or other physical barriers" (Costle 1980). Based on these definitions, DEQ has developed the following guidance to be used when determining the ambient air boundary for a facility.

It shall be assumed that the air within the facility boundaries is ambient air unless the facility can demonstrate that public access is precluded. The facility-proposed ambient air boundary must include justification that demonstrates the facility has reasonable control of the area and effectively precludes public access on a routine basis. The following criteria must be satisfied when developing a facility-proposed, ambient-air boundary justification. A justification must accompany the answers.

For the purpose of defining ambient air, the "general public" is considered anyone not directly associated with the facility. In general, if someone present at the site would not be subject to OSHA or other worker exposure regulations, then they are considered as the general public.

1. Facility Control
    - Is general public access precluded by a physical barrier (e.g., fence with a gate)? If "yes," the facility is assumed to be controlled and public access effectively precluded, and the ambient air boundary can be set at the fence line. Proceed to No. 2. If "no," then proceed to No. 1b. Rugged terrain or a water body is not typically considered as a physical barrier.

- Is general public access discouraged by the type of area (e.g., industrial park site away from residential or recreational areas), size of the facility (e.g., the facility is surrounded by a buffer zone that is controlled by the facility), or a remote location away from the proximity of human habitation or activities? Is the facility controlled by reasonable posting of the property with "no trespassing" signs, or reasonable patrol of the property by a security person who routinely asks trespassers to leave? If "yes" to BOTH questions, the facility is assumed to be controlled, with public access effectively precluded, and the ambient air boundary is determined to be at the property boundary. Proceed to No. 2. If "no," to EITHER question, proceed to No. 1c.
- If the facility is not controlled by a physical barrier AND/OR general public access is not discouraged by the type of area, size of the facility, or the remoteness of the facility location, then the ambient air boundary is determined to be inside the property boundary. The actual point at which the ambient air boundary occurs is dependent on several factors, such as the type of operation at the facility (e.g., are employees outside on a regular basis?) and whether employees have a clear view, from the location where the employees normally work, of the entire property (e.g., are trees blocking the sight?). The ambient air boundary is determined to be at a point where employees are not regularly present and where they do not have a clear view of the property. To meet this criteria, a very detailed description of the facility and property must be provided. If a justification cannot be provided, the ambient air boundary is determined to be all air that is external to the buildings. Proceed to No. 2.

2. Facility Business
   Is the general public invited as part of the normal business conducted on the facility site (e.g., the facility includes a commercial establishment or service provider)? If "yes," then the area into which the public is invited is determined to be ambient air. Adjust the ambient air boundary determined in No. 1. If "no," the ambient air boundary determined in No. 1 is not changed. Proceed to No. 3.
3. Right-of-Way Access
   Is the general public allowed on site as a part of a right-of-way easement or a common service road? If "yes," then the right-of-way is determined to be ambient air. Adjust the ambient air boundary determined in No. 1. If "no," the ambient air boundary determined in No. 1 is not changed. Any streams or rivers transecting a facility will be considered as ambient air at all locations between high water levels unless the applicant adequately demonstrates and documents that public access can be legally precluded. Idaho Department of Lands and Fish and Game rules governing public access should be used for such a demonstration.
4. Leased Property
   Does the facility lease a portion of their site to another industry, business, or individual OR does the facility lease property from another entity? For example, if a facility leases part of its property to a farmer for growing crops, that portion leased may be considered as ambient air. These situations are frequently complicated, and DEQ should be consulted regarding any specific case involving leased property as it affects the ambient air boundary.

Any area outside the facility's (or facilities' if they are under common ownership) control will be considered ambient air. This includes other industrial facilities. The employees of other facilities are considered to be general public for the facility in question. Evaluation of the ambient air quality must include all sources within facility control if the source or source modification exceeds the SILs defined in IDAPA 58.01.01.006 (definition of significant contribution).

6.6 Receptor Network

A receptor network establishes locations where the air dispersion model calculates a pollutant concentration. Each location is called a receptor, to represent a receptor that might be exposed to that concentration at that location. Receptors are required to be placed in all areas considered to be ambient air.

Modeling must be conducted using a sufficiently dense receptor grid to reasonably resolve the maximum modeled concentration and confidently demonstrate compliance with standards.

DEQ may determine an application incomplete or may deny a permit if DEQ is not confident the receptor grid spacing used is adequate to confidently demonstrate NAAQS compliance. DEQ may also include additional receptors during verification modeling if it is questionable whether the maximum concentrations have been resolved, and approval will not be granted if results do not comply with applicable standards. Adequacy of the receptor grid can be evaluated by reviewing a plot of modeled design value concentrations and considering the following:

- Maximum modeled concentrations in relation to a trigger value (SILs, NAAQS, or AACs/AACCs)
- Concentrations at receptors immediately adjacent to the maximum modeled concentration
- Terrain features within the modeling domain and areas beyond the domain if maximum modeled concentrations are near the boundary of the domain

6.7 Elevation Data

Terrain elevations for sources and receptors should be used when appropriate (EPA 2005). Where AERMOD is the model used to demonstrate compliance, the applicant should generally use the latest established procedures and guidance provided by EPA (see the SCRAM website on EPA's TTNWeb-Technology Transfer Network (*http://www.epa.gov/ttn/scram*). Prior to 2009, elevations of receptors, sources, and buildings used in the modeling analyses were determined from U.S. Geological Survey (USGS) Digital Elevation Model (DEM) files. AERMAP now supports processing terrain elevations from the National Elevation Dataset (NED) developed by the USGS. Since the DEM files will no longer be updated, NED represents more up-to-date and accurate data, and these should be used in preference to DEM files. These data can be downloaded in a seamless data set in GeoTiff format for use in AERMAP.

A single, consistent source of terrain data should be used to establish elevations for receptors, emissions sources, and site structures. Using different datums within a single modeling analysis can result in critical problems such as sources located beneath ground-level, buildings suspended above ground-level, or facilities located on hillsides rather than valley floors.

6.8 Meteorological Data

The meteorological data used in the modeling analysis should be representative of the meteorological conditions at the particular site of the proposed construction or modification. Section 8.3 in the *Guideline on Air Quality Models* (EPA 2005) states that representativeness of the meteorological data is dependent on the following: (1) the distance from the meteorological monitoring site to the area under consideration; (2) the complexity of the terrain surrounding both the meteorological monitoring site and the area under consideration; (3) the exposure of the meteorological monitoring site; and (4) the period of time during which data are collected.

When using AERMOD, representativeness will also depend on the similarity between the monitoring site and the application site for: 1) surface roughness; 2) land type characteristics that influence parameters such as albedo and Bowen Ratio (vegetative cover and moisture content). Consult with the DEQ air quality modeling coordinator to determine if representative meteorological data are available for the area under consideration. If the only available meteorological data are of questionable representativeness, DEQ may require applicants to perform modeling analyses using multiple meteorological data sets. Alternatively, site-specific data could be acquired by the facility. Site-specific meteorological data are typically only required for PSD applications or when DEQ has concern regarding NAAQS compliance.

The collection of site-specific meteorological data should follow the recommendations provided in *Meteorological Monitoring Guidance for Regulatory Modeling Applications* (EPA 2000), as well as Section 8.3.3 in the *Guideline on Air Quality Models* (EPA 2005). Site-specific meteorological data must be approved prior to use in a modeling analysis. Generally, following EPA recommendations and procedures is determined to be adequate for DEQ approval. To receive approval, the facility must provide DEQ staff with standard operating procedures, the quality assurance plan for operating the meteorological tower, and quality control audit reports that cover the entire year of data. DEQ will review this information and respond with either an approval or denial letter. The facility should either reference or include a copy of the approval letter when meteorological data are used in a modeling analysis. This will help to expedite the review process of the permit application. If DEQ does not approve the data for air modeling purposes, the analyses will not be approved and alternate approaches must be developed.

There are several sources of meteorological data besides on-site collected data. The National Weather Service (NWS) collects data throughout the country. Much of these data are collected at airports. These and other data are available through the National Climatic Data Center (*http://www.ncdc.noaa.gov/oa/ncdc.html*), through EPA's SCRAM website, or possibly through DEQ's modeling coordinator.

As stated in Section 8.3.1.1 in the *Guideline on Air Quality Models* (EPA 2005), the model user should "acquire enough meteorological data to ensure that worst-case meteorological conditions are adequately represented in the model results." Section 8.3.1.2 recommends using five years of NWS data or at least one year of site-specific data. If more than one year of site-specific data are available, then all years, up to five years, should be used (see Section 8.3.1.2(b) in EPA 2005). Site-specific meteorological data must be subjected to DEQ-approved quality assurance procedures.

The following should be considered when generating meteorological data with AERMET:

- Surface characteristics specified for landuse types in AERMET are based on the meteorological measurement site, not the facility application site.
- The EPA program AERSURFACE should be used, following recommendations specified in the user's guide, to define season- and sector-specific surface parameters (albedo, Bowen Ratio, and surface roughness).
- A current aerial photograph of the meteorological measurement site, or a detailed land- use map, should be used to check the accuracy of land-use files used in AERSURFACE.
- Sector-specific values of surface characteristics should be calculated for each season.
- Documentation of the surface characteristics analyses should be submitted with the application. Sufficient detail must be provided such that DEQ staff can regenerate the AERMET output meteorological files.

6.9 Land-Use Classification

Determining if the area surrounding the facility is urban or rural is necessary before a dispersion modeling analysis can be conducted correctly. Two methods of classifying an area as urban or rural are described in Section 7.2.3.c in the *Guideline on Air Quality Models* (EPA 2005). The first is the land-use method. The area is classified according to the current land usage (according to the meteorological land-use typing scheme proposed by Auer [1978]) of its surroundings in a three-kilometer (approximately 1.8-mile) radius centered at the source. If 50 percent or more of the surrounding area is classified as I1, I2, C1, R2, or R3 (using classifications listed in Auer 1978), the source would be considered an urban source. Otherwise, the source would be considered rural. Appendix E provides a summary of the meteorological land-use typing scheme proposed by Auer (1978).

A second method relies on population density. If the population density within a three-kilometer (approximately 1.8-mile) radius, centered at the facility, is greater than 750 people per square kilometer, the urban modeling option for the area can be used. However, the population density method of source classification should not be applied to highly industrialized areas. This is because highly industrialized areas typically have low population densities, but the presence of buildings and areas of asphalt and concrete make the source more urban in nature. The *Guideline on Air Quality Models*, Section 7.2.3.e, states that, of the two methods, the land-use procedure is more definitive (EPA 2005).

6.10 Background Concentrations

Section 8.2 in the *Guideline on Air Quality Models* (EPA 2005) discusses the use of background concentrations in a cumulative NAAQS analysis. Background concentrations of regulated criteria pollutants must be included in cumulative NAAQS analyses for both PSD and non-PSD applications. The modeler is required to contact DEQ prior to performing the modeling analysis to obtain the appropriate, reasonably conservative background concentration(s) for the area and time intervals of concern. A different pollutant-specific concentration is needed for each applicable averaging period.

Background concentrations are developed based on air quality monitoring data collected from the area of the proposed project or from similar areas determined to be reasonably representative. DEQ has developed applicable background concentrations for specific areas and default concentrations for areas where monitoring data are not available. Facilities may propose alternate/refined background concentrations based on their own analyses. Use of an alternate background concentration should be proposed within a modeling protocol submitted to DEQ. An alternate background concentration proposal analysis should include the following:

- Description of monitoring data proposed as representative of the proposed project area. The description should include the statistics of the data set and the quality control/assurance measures conducted for the data if data were not provided by DEQ.
- Description of all emissions sources in the area of the proposed project and sources in the area(s) where claimed representative monitoring data were obtained. This should include both point sources and area/mobile sources, and should also address emissions source density. A discussion should be provided that compares the two areas and supports the use of the monitoring data for the project site.
- A detailed assessment of the meteorology of the project area and the area where monitoring data were obtained. Differences between the areas should be assessed for the effects they may have on pollutant dispersion and concentrations in ambient air.

Air monitoring data for Idaho can be obtained at the following EPA website address: *http://www.epa.gov/air/data/index.html*. In most instances, background concentrations calculated in the following manner will be accepted by DEQ:

- 24-hour PM2.5: The maximum 3-year mean of 98th percentile of 24-hour average concentrations over 1-year periods.
- Annual PM2.5: The maximum 3-year mean of annual averages, using 5 consecutive years of data.
- Short term standards of PM10, SO2, and CO: The maximum 2nd highest monitored value over each year of applicable data.
- 1-hour NO2: The maximum 3-year mean of the 98th percentile of the daily maximum 1-hour average concentrations over 1-year periods.
- 1-hour SO2: The maximum 3-year mean of the 99th percentile of the daily maximum 1-hour average concentrations over 1-year periods.
- Annual Standards of SO2 and NO2: The maximum annual average for the applicable data. The most recent 5-year data set should be used.

Existing emissions from a facility may have a measurable impact to monitored concentrations in some instances. It is the facility's responsibility to assess their contribution to the background concentration. Prior to this assessment, a protocol must be submitted to, and approved by, DEQ. The assessment must then be done in accordance with the DEQ-approved protocol. In such cases, the facility's impact may be subtracted from the monitored value to establish an appropriate background concentration value. The following should be considered in such analyses:

- To evaluate a facility's impact on background monitored values, modeling must be performed using meteorological data collected during the same period when monitoring data were collected.
- Site-specific meteorological data must be used. These data must be highly representative for both the facility site and the monitoring site.
- Actual emissions for the period modeled must be used in the analyses.
- Monitored and modeled values must be paired in time and space; i.e. modeled values subtracted from monitoring results must be those values modeled at the site of the monitor for the averaging period associated with the monitored value.
- One suggested approach would be to start with the highest monitored value and model the facility's impact on that value. If the result is lower than the next-highest monitored value, this process should be repeated for that monitored value. This process is repeated until the highest adjusted value is greater than the next unadjusted value. The highest adjusted value is used for the background concentration.

Use of other methods to calculate a background concentration will be evaluated on a case-by- case basis. Proposals for such methods should be thoroughly described in the protocol.

6.11 Evaluation of Compliance with Standards

6.11.1 Approval Criteria

The applicant must demonstrate compliance with all other applicable impact limits in addition to demonstrating compliance with NAAQS. For PSD applications, these include impact limits for Class I areas within 300 kilometers, non-attainment area impact limits (when in or potentially significantly impacting a non-attainment area), and TAPs increment standards in Idaho Air Rules Sections 585 and

586 (when emitting TAPs above DEQ ELs). Federal land managers have the responsibility to protect the natural and cultural resources of Class I areas from adverse impacts of air pollution. Refer to the Federal Land Managers Air Quality Related Values Workgroup (FLAG) Phase I Report- Revised (USFS et al 2010). In some cases, deposition of airborne pollutants (e.g., radionuclides or fluorides, for example) or human risk pathways associated with deposition of airborne emissions may be subject to regulatory impact limits.

The highest modeled ambient concentration must be used for comparison against the SILs for all applicable criteria pollutants. A multi-year average, consistent with the years of meteorological data modeled, of the maximum modeled concentration of each year modeled can be used for the probabilistic standards, including 24-hour PM2.5, annual PM2.5, 1-hour NO2, and 1-hour SO2.

The following design concentrations must be used when demonstrating compliance with the cumulative NAAQS:

- CO
  - 1-hour averaging period – maximum of second highest ambient concentrations at each receptor
  - 8-hour averaging period – maximum of second highest ambient concentrations at each receptor
- NO2
  - 1-hour averaging period – maximum of 5-year averages (at each modeled receptor) of the 98th percentile of the annual distribution (equal to the 8th high) of maximum daily 1-hour ambient concentrations
  - Annual averaging period – maximum of ambient concentrations at each receptor
- SO2
  - 1-hour averaging period – maximum of 5-year averages (at each modeled receptor) of the 99th percentile of the annual distribution (equal to the 4th high) of maximum daily 1-hour ambient concentrations
  - 3-hour averaging period – maximum of second highest ambient concentrations at each receptor
  - 24-hour averaging period – maximum of second highest ambient concentrations at each receptor
  - Annual averaging period – maximum of ambient concentrations at each receptor
- PM10
  - 24-hour averaging period – “the projected 24-hour average concentrations will not exceed the 24-hour NAAQS more than once per year on average” (EPA 2005). The design concentration is dependent on the number of meteorological data years used in the analysis. For example, if five years of NWS data were used, then the design concentration would be the sixth highest 24-hour ambient concentration that occurred at each receptor over that five-year period.
- PM2.5
  - 24-hour averaging period – maximum of multi-year average of annual maximum 24- hour ambient concentrations at each receptor. Using the multi-year average of the 98th percentile of the annual distribution (equal to the 8th high) of 24-hour concentrations for both the modeled design value and background is not adequately conservative because background concentrations are frequently the controlling factor for PM2.5.
  - Annual Averaging Period - maximum of multi-year average of annual ambient concentrations at each receptor.

- Pb
  - Quarterly averaging period – maximum of ambient concentrations at each receptor
  - 3-month rolling average – maximum of ambient concentrations at each receptor

If meteorological data used in the analyses are of questionable representativeness, DEQ may require a more stringent design value. DEQ may also require analyses using multiple meteorological data sets to compensate somewhat for increased uncertainty.

The following design concentrations must be used when demonstrating compliance with TAPs requirements:

- Noncarcinogens – 24-hour averaging period – maximum of ambient concentrations at each receptor
- Carcinogens – total averaging period (1-5 years depending on meteorological data availability) – maximum of ambient concentrations at each receptor

6.11.2 Adequacy of Analyses Results

The submitted analyses must demonstrate to the satisfaction of DEQ that applicable emissions do not cause or significantly contribute to a violation of any air quality standard, as per Idaho Air Rules Section 203 for PTCs and Idaho Air Rules Section 403 for Tier II operating permits. Approvability of the submitted analyses will depend on the results of the analyses as well as the representativeness and quality of input data and parameters used. DEQ recognizes the uncertainty in typical dispersion modeling analyses and the variability and uncertainty associated with input parameters such as background concentrations, emission quantities, operational characteristics, etc. These uncertainties will be considered in DEQ's evaluation and determination of acceptability.

DEQ will evaluate model inputs and parameters more carefully as modeling results more closely approach applicable standards. Modeled concentrations within about 90 percent of the standard will be more closely reviewed by DEQ. At these concentrations, approval will be based on a "weight of evidence" type approach, considering the model results, input data/parameters, potentially exposed public, any monitoring requirements specified in the proposed permit, and operational variability. DEQ will not approve any modeling results that do not show compliance with applicable standards. The following provides discussion on how DEQ will evaluate compliance in situations where modeled concentrations are very near applicable standards:

- Modeled Concentrations: Results within about 90 percent of the air quality standard will generally trigger DEQ to more carefully evaluate the analyses. In some instances, the analysis may not adequately demonstrate compliance even though modeled concentrations are below a standard.
- Emissions Estimates: Estimates of emissions can be a substantial source of uncertainty and/or variability. It is important to evaluate both uncertainty in the estimate and variability, and to distinguish between them. Where estimates of maximum emissions are highly uncertain and the estimate is not necessarily conservative, DEQ may consider modeling results slightly below the standard as not adequately demonstrating compliance. Alternatively, if emissions are highly variable and the allowable emission rate is set at the maximum, DEQ will consider the likelihood of high emissions occurring concurrently with conditions of poor dispersion.
- Representativeness of Meteorological Data: Using meteorological data from a distant location where the representativeness is questionable will add to the uncertainty of the modeling analyses. Applicants may be requested by DEQ to provide a more detailed assessment of the area's meteorology and qualitative comparisons to data used in the analyses. Such assessments

should be performed by meteorologists or those having considerable knowledge in surface meteorology. In some instances, DEQ may request an applicant to install and operate a meteorological station to resolve concerns with data representativeness. In cases where meteorological data used in the analyses are of questionable representativeness, DEQ may require the use of multiple meteorological data sets in the analyses.

- Background Concentrations: Background concentrations are often a very large source of uncertainty and variability, especially for 1-hour NO2, PM10, and PM2.5, where background concentrations can be a considerable fraction of the standard. When modeled 1-hour NO2, PM10 and PM2.5 concentrations are very near the standard, applicants should review and compare the meteorological conditions associated with the modeled result and the background concentration.
- Modeled Emissions Release Parameters: Parameters characterizing the release of emissions (stack temperature, flow rate, initial plume dimensions for volume sources, etc.) greatly impact the modeling results. The conservatism of these parameters will be considered by DEQ during the review.
- Permit Requirements: As modeled concentrations approach applicable standards, DEQ may require more extensive emissions monitoring, source testing, and possibly ambient air monitoring.
- Areas with High Concentration Impacts: DEQ will consider the land use of areas where models project high concentrations. DEQ will require a higher degree of certainty for areas where there is a high potential for exposures to the public, such as actual residences, businesses, parks, etc. However, it is important to consider that dispersion models are reasonably accurate at predicting the magnitude of maximum concentrations but often perform poorly at predicting the location or time of maximum concentrations.

6.12 Air Quality Modeling Report

The applicant must supply an air quality modeling report that presents the case as to how the modeling results demonstrate compliance with all applicable air quality standards. The level of detail of the report will depend on the complexity of the proposed facility and the permitting project.

Each submitted application must be a complete package in itself. Referencing previously submitted materials, such as those submitted in an earlier application, will not generally be considered as meeting the stated requirements to provide documentation/justification of air quality analyses and data used as inputs for those analyses.

Below is an example annotated outline of an air quality modeling report. The report should thoroughly describe all aspects of the air impact analyses performed. Specific sections of this guideline should be consulted to evaluate the details needed for the modeling report regarding certain aspects of the analyses.

I Purpose

- State the purpose of the air quality modeling analyses (i.e., demonstrating compliance for a permit to construct or a Tier II operating permit).
- Provide a detailed description of regulatory requirements as they relate to modeling, citing specific applicable regulations.

II Model Description/Justification

- Discuss what model was chosen and justify why it is the appropriate model for the situation. This discussion may be very brief if the applicant is proposing to use AERMOD for near-field impacts.

III Emissions and Source Data

- Present tables showing the current (either actual or permit allowable) emission rates, future allowable emissions rates (maximum for each applicable averaging period), and the requested emission increase (future allowable minus actual or current allowable).
- If cumulative NAAQS impact analyses are required, the applicant must thoroughly document all emissions used in the model, even when such sources are not affected by the particular proposed project. Emissions calculations, source test data, and/or other information justifying the value used should be provided for all sources unless those emissions are based on a specific emissions limit presented in an issued permit.
- Provide justification for those sources and/or pollutants determined to be “inconsequential” (if applicable).
- Provide stack parameters (emissions rates, stack height, stack elevation, stack diameter, stack gas exit velocity, and stack gas exit temperature) for each modeled emissions point. Values for stack parameters should be justified and well documented, indicating whether values are estimated or measured.
- Provide a facility plot plan to scale showing the fence line, ambient air boundary, emission sources at the facility, and buildings. Include the height, width, and base elevation of each building at the facility.
- Provide UTM coordinates of all emissions points, and list the datum used.

IV Ambient air boundary

- Thoroughly describe how the public are precluded from accessing all areas excluded from the receptor network, describing any complicating ambient air issues such as rivers bisecting the facility, leasing agreements, retail sales operations at the site, right of ways, etc.

V Receptor Network

- Describe the receptor network used. Include the distance between receptors for the fine and coarse grids. Justify any deviation from minimum recommendations in EPA or state guidelines, and provide a demonstration that the receptor grid allows for resolution of the maximum modeled concentration.

VI Elevation Data

- Describe any elevation data used and the source of the information, including the datum for the coordinates used. If necessary, include a USGS 7.5-minute map showing the location of the facility. A justification must be provided if elevation data are not used.

VII Meteorological Data

- Describe the source of the meteorological data and present a representative analysis according to Section 6.8. Electronic copies of the files must be included with the modeling report if meteorological data were not provided in model-ready format to the applicant from DEQ. If site-specific data are used, provide documentation that DEQ has reviewed and approved the data.
- If the applicant has generated AERMOD input meteorological files by running AERMET, rather than using AERMOD input files provided by DEQ, supporting AERMET documentation must be submitted with the application. A detailed report on the processing of meteorological data

should be submitted, including a report on running AERSURFACE to evaluate surface characteristics and a detailed report on data collection and quality for any on-site data processed. Copies of the raw meteorological data must also be submitted to DEQ.

VIII Land-Use Classification

- State the land-use classification for the area surrounding the source and provide the justification.

IX Background Concentrations

- State whether background concentrations were used and identify the source of the information.
- If DEQ default background concentrations were not used, the report must thoroughly describe and document how background concentrations were determined.

X Evaluation of Compliance with Standards

- Include tables summarizing the air quality model output (example tables are shown in Appendix F).

XI Electronic Copies of the Modeling Files

- Provide modeling input/output files (including BPIP and meteorological data, and intermediate files generated by AERMET, AERMAP, and AERMOD) on compact disk or other means.

7 DEQ Review of Modeling Analyses

DEQ dispersion modeling staff will review the submitted air quality analyses prior to approval and issuance of the permit. Review of the analyses will occur in two phases: 1) completeness review; 2) technical review of submitted analyses. The completeness review will focus on evaluating whether the required analyses were performed and the primary components of the air quality analyses were submitted with the application. The technical review will evaluate whether the data and methods used in the analyses are accurate and appropriate for the project.

Several methods and approaches can be used by the applicant to ensure the submitted modeling analyses are approved by DEQ or, if there are problems with the analyses, such problems are identified early in the completeness review and will minimize delays to the project:

1. Submit a modeling analyses protocol prior to conducting the analyses. The protocol, as described in Section 6.1, should provide details on the proposed methods and data to the greatest degree possible.
2. Provide a detailed and well-organized modeling analyses report, as described in Section 6.12. This will allow DEQ staff to quickly assess the appropriateness and technical accuracy of the analyses. If a modeling protocol was submitted to DEQ prior to the application, a copy of the protocol and DEQ's protocol approval notification should be included with the application.
3. Provide clear justification for methods and data used, and provide supporting documentation. Calculations should be provided such that the DEQ reviewer can easily verify the calculated values.
4. Ensure that emissions sources are named consistently between the emissions inventory used for the permit application forms and the modeling analyses.

Conduct quality assurance/control measures to minimize error in the submitted analyses. The following are some measures that will help minimize or identify errors in the analyses:

- Print or view a three-dimensional representation of the sources, building, receptors, and the ambient air boundary. This will identify any errors in UTM coordinates and elevations.
- Check that all sources included in the application are included in the modeling analyses. If some sources are not included, a detailed justification should be provided. If facility-wide modeling is needed for a cumulative impact analysis, the emissions inventory of other sources, not directly addressed by the current permitting action, should be thoroughly documented.
- Emissions rates used in the modeling analyses should be identical to those listed in the permit application forms and the emissions calculation section of the application. Any differences between emissions rates should be thoroughly documented and all calculation steps should be shown. This will allow DEQ reviewers to quickly evaluate how emissions rates were calculated.

8 Summary

This document provides guidance for performing an ambient air assessment, for permitting purposes, in the state of Idaho. This document should be used in conjunction with the EPA's *Guideline on Air Quality Models* (EPA 2005) and *New Source Review Workshop Manual* (EPA 1990), and other applicable guidance materials. Following the guidance in this document, as well as EPA guidance, will help expedite DEQ's review of the application.

References

40 CFR 52.21, *Prevention of Significant Deterioration of Air Quality.*

Auer, A.H., Jr., 1978. *Correlation of Land Use and Cover with Meteorological Anomalies*. Journal of Applied Meteorology, 17(5): 636-643.

Costle, Douglas, M., 1980. *Correspondence to Senator Jennings Randolph*. December 19, 1980.

EPA, 1990. *New Source Review Workshop Manual, Prevention of Significant Deterioration and Nonattainment Area Permitting*. New Source Review Section, Noncriteria Pollutants Program Branch, Air Quality Management Division, U.S. Environmental Protection Agency, Research Triangle Park, NC.

EPA, 1992. *Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised*. EPA Publication No. EPA-454/R-92-019. U.S. Environmental Protection Agency, Research Triangle Park, NC.

EPA, 1995. *Streamlined Development of Part 70 Permit Applications*. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards.

EPA, 2000. *Meteorological Monitoring Guidance for Regulatory Modeling Applications*. EPA Publication No. EPA-454/R-99-005. U.S. Environmental Protection Agency, Research Triangle Park, NC.

EPA, 2004. *User's Guide for the AERMOD Terrain Preprocessor (AERMAP)*. EPA Publication No. EPA-454/B-03-003. U.S. Environmental Protection Agency, Research Triangle Park, NC.

EPA, 2005. *Guideline on Air Quality Models*. 40 CFR Part 51, Appendix W, Federal Register Vol 70, No. 216, Wednesday, November 9, 2005.

EPA, 2009a. *Addendum – User's Guide for the AERMOD Terrain Preprocessor (AERMAP)*. EPA Publication No. EPA-454/B-03-003. U.S. Environmental Protection Agency, Research Triangle Park, NC.

EPA 2009b. *AERMOD Implementation Guide*. AERMOD Implementation Workgroup. U.S. Environmental Protection Agency, Research Triangle Park, NC.

EPA 2010a. *General Guidance for Implementing the 1-hour NO2 National Ambient Air Quality Standard in Prevention of Significant Deterioration Permits, Including an Interim 1-hour NO2 Significant Impact Level*. EPA Memorandum from Anna Marie Wood, Acting Director, Air Quality Policy Division, to Regional Air Division Directors. U.S. Environmental Protection Agency, Research Triangle Park, NC. June 28, 2010.

EPA 2010b. *General Guidance for Implementing the 1-hour SO2 National Ambient Air Quality Standard in Prevention of Significant Deterioration Permits, Including an Interim 1-hour SO2 Significant Impact Level.* EPA Memorandum from Anna Marie Wood, Acting Director, Air Quality Policy Division. U.S. Environmental Protection Agency, Research Triangle Park, NC. August 23, 2010.

EPA 2018. Guidance on Significant Impact Levels for Ozone and Fine Particles in the Prevention of Significant Deterioration Permitting Program. EPA Memorandum from Peter Tsirigotis, Director, Office of Air Quality Planning and Standards. U.S. Environmental Protection Agency, Research Triangle Park, NC. April 17, 2018.

EPA's SCRAM website: http://www.epa.gov/scram001/index.htm

IDAPA 58.01.01, et seq. *Rules for the Control of Air Pollution in Idaho*

Idaho Department of Environmental Quality Policy Memorandum, *Policy on NAAQS Compliance Demonstration Requirements*, July 11, 2014.

Appendix A. Guidance for 1-Hour NO_2 Modeling of Intermittent Sources

DEQ Guidance for Minor New Source Review Modeling of 1-Hour NO_2 from Intermittent Testing of Emergency Engines



State of Idaho
Department of Environmental Quality

September 2013

Certain industrial facilities have internal combustion (IC) engines that are used only to power emergency generators or fire-suppression pumps. These engines only operate for periodic testing and during an actual emergency. As such, these sources with intermittent emissions are difficult to model in a way that accounts for impacts in a reasonably accurate but conservative manner. As a result, Tyler Fox, leader of Environmental Protection Agency's (EPA) Air Quality Modeling Group, developed a memorandum entitled "Additional Clarification Regarding Application of Appendix W Modeling Guideline for the 1-hour NO2 National Ambient Air Quality Standard, dated March 1, 2011. The memo provides states with the flexibility to exclude certain types of sources with intermittent emissions from Appendix W modeling.

Upon a review of other states' application of the Tyler Fox memo, comments from the public and Idaho industry, an internal review of Idaho sources, NO2 background levels, and various sample model runs; DEQ has determined that Nitrogen Oxides (NOx) emissions from the intermittent operational testing of engines powering emergency generators or fire-suppression water pumps may be excluded from the project-specific significant impact level (SIL) analysis and the cumulative NAAQS analysis for 1-hour NO2, providing the annual hours of operation from testing and maintenance are less than or equal to 100 hours per engine.

This determination is applicable to minor source air permitting projects and is not limited to any specific number of engines present at a facility. The Director may require deviation from this guidance if deemed appropriate to assure compliance with 1-hour NO2 NAAQS and IDAPA 58.01.01.203 or 01.403. DEQ will determine how emergency engines are included in permits for major sources, specifically those applicable to the Prevention of Significant Deterioration (PSD) program, on a case-by-case basis.

This guidance does not have the force and effect of a rule and is not intended to supersede statutory or regulatory requirements or recommendations of the state of Idaho or EPA. This guidance may be altered upon new or revised guidance from EPA, development of new methods to appropriately handle such emissions, or new information gained from technical analyses.

Contact the DEQ stationary source air modeling coordinator at (208) 373-0112 for any questions or additional information regarding data and methods for assessing air quality impacts from intermittently operated sources.

Appendix B. Class I Areas

Class I Areas

This appendix shows Class I areas in and near Idaho. The areas represent situations where air quality impact limits are stricter than the NAAQS. The information in this appendix is current as of the date of this document. Please check with DEQ to verify if it is still current.

Area Classifications

The Class I, II, and III areas are defined below (shown in Figure 1).

1. Class I - National park, recreation, and wilderness areas that were already established when the 1977 Clean Air Act was passed, and other designated parts of the country that now benefit from high quality air and where a high priority has been established for the maintenance of pristine conditions. Additional degradation of the air is severely restricted.
2. Class II - Areas that need reasonably or moderately good air quality protection. This is presently the class designation of most areas in the United States. Increments of deterioration have been stipulated that will generally accommodate most proposed development projects.
3. Class III - Areas that can, at the discretion of the states, be designated as allowing for larger increments of air quality degradation and therefore greater growth and development potential. No Class III areas have been designated in Idaho.

The Class I areas in Idaho include the following: Hells Canyon, Sawtooth, and Selway- Bitterroot wilderness areas, Craters of the Moon National Monument, and Yellowstone National Park.

Class I areas near Idaho's borders include the following: Spokane Indian Reservation, Washington; Hells Canyon and Eagle Cap Wilderness areas, Oregon; Cabinet Mountain and Anaconda-Pintler Wilderness areas, Red Rock Lakes, and Flathead Indian Reservation, Montana; Yellowstone National Park, Montana and Wyoming; Teton National Park, Wyoming; and Jarbidge Wilderness, Nevada.



Figure A-1. Class I areas in and near Idaho.

Appendix C. Idaho DEQ Air Dispersion Modeling Checklist

Idaho DEQ Stationary Source Air Dispersion Modeling Checklist

- ☐ Reviewed the Idaho Air Quality Modeling Guideline and have determined the appropriate methods and data for use in this permitting action, contacting DEQ as needed to provide clarification.
- ☐ A modeling applicability analysis was performed for all criteria pollutants emitted by the new facility or modification, and modeling was performed for those pollutants having a total increase in emissions exceeding DEQ modeling thresholds.
- ☐ A TAPs modeling applicability analysis was performed for all TAPs emissions increases associated with the project, and TAPs modeling was performed for those TAPs having a project total emissions rate exceeding the emissions screening levels.
- ☐ Provided a description of the ambient air boundary and demonstrated how public access will be precluded from all areas excluded from ambient air.
- ☐ The receptor grid used meets minimal requirements specified by DEQ AND is adequate to reasonably resolve the maximum modeled concentration and confidently demonstrate compliance with applicable standards.
- ☐ The modeling domain used is sufficiently large to resolve the maximum impacts, accounting for impacts on distant elevated terrain.
- ☐ A scaled site plot plan was included in the application, showing emissions sources, buildings, and the ambient air boundary.
- ☐ Thoroughly documented all release parameters used in the model and provided justification for their use.
- ☐ Emissions rates provided in the emissions inventory section of the application are identical to those used in the modeling analyses or, if emissions rates are not identical, thorough justification of modeled rates has been provided.
- ☐ A cumulative NAAQS impact analysis was performed for all criteria pollutants for which modeled impacts from the significant impact analysis exceeded SILs. The cumulative NAAQS impact analysis included facility-wide emissions, emissions from any co-contributing sources, and a DEQ approved background concentration. Documentation of all emissions rates and release parameters used in the cumulative NAAQS impact analyses are provided in the application.
- ☐ Included all input and output modeling files for all pollutants and averaging periods.
- ☐ If a modeling protocol was prepared and submitted to DEQ prior to performing the air impact analyses, the protocol and DEQ's protocol approval notice is included with the application.

Appendix D. Modeling Protocol Checklists

Modeling Protocol Checklist for New Minor Sources or Minor Modifications

The following should be thoroughly addressed in a modeling protocol submitted to DEQ:
Introduction and Purpose

- General overview, facility description, description of area where facility is located.
- Project overview.
- Goals of the air quality impact analysis (i.e., demonstrate compliance for a PTC for a modification, PTC for a new facility, or a Tier II operating permit).
- Applicable regulations and requirements.
- Pollutants of concern.

Emissions and Source Data

- Description of facility processes and emissions controls affected by the permitting action.
- List of emissions points that will be included in the modeling analyses. Present a table showing current actual/allowable and future allowable emission rates (using pounds per hour rates for all applicable averaging periods) and the requested emissions increase (future allowable minus current actual or allowable).
- Good engineering practice (GEP) stack-height analysis for any stacks approaching GEP height.
- Graphic showing the facility layout: location of sources, buildings, emissions points, and fence lines.
- Description of methods used to calculate or otherwise determine source parameters (emissions rates, UTM coordinates, stack height, stack elevation, stack diameter, stack- gas exit velocity, and stack-gas exit temperature) for each source included in the modeling analyses.
- Methodology for including area and volume sources in the modeling analysis, including justification and calculations of initial dispersion coefficients and release heights.
- Methodology for including/excluding sources from the modeling analyses.

Air Quality Modeling Methodology

- Description of model selection and justification. This may be minimal in cases where the regulatory guideline model is used (AERMOD in most cases).
- Description of model setup and application
  - Model options (i.e., regulatory default). Describe and provide justification for any non-default settings.
  - Averaging periods used in the analyses and how emissions rates were calculated for specific averaging periods.
  - Land-use analysis in all cases where “urban” is used and in cases where land use is not obviously “rural.”
  - Methods used to account for building downwash in the analyses.
  - Treatment of any chemical transformations (e.g., NO to NO2) accounted for in the analyses.
  - Any other unique methods or data used.Description of how elevations of sources, buildings, and receptors were determined.
- Receptor network
  - Description of receptor grids – include methodology for ensuring the maximum concentration will be estimated
  - Discussion/justification of ambient air boundary, including a description of how the general public will be excluded from areas not considered ambient air.

- Meteorological data
  - Selection of meteorological databases – justification of appropriateness of meteorological data to area of interest
  - Meteorological data processing
  - Meteorological data analysis (e.g., wind rose)
- Background concentrations

Applicable Regulatory Limits

- Methodology for evaluation of compliance with standards (i.e., determination of design concentration)
- Significant Impact analysis
  - Comparison to SILs
  - TAPs analysis
- Cumulative NAAQS impact analysis
  - NAAQS analysis
- Presentation of results – state how the results of the modeling analysis will be displayed (i.e., list what information will be included)

Appendix E. Land-Use Classification Procedure

Land-Use Classification Procedure

See Section 8.2.8.b of *Guideline on Air Quality Models* (EPA 2001) for additional information.

1. Determine a circular area centered on the source with a radius of three kilometers.
2. Classify the land use within this area using the meteorological land-use typing scheme presented in Table D-1.
3. If land-use types I1, I2, C1, R2, and R3 account for 50 percent or more of the area, use urban dispersion coefficients; otherwise, use rural dispersion coefficients.

Table D-1. Identification and Classification of Land-Use Types (Auer 1978)

Type	Use	Structures	Vegetation
I1	Heavy Industrial	Major chemical, steel, and fabrication industries; generally 3-5 story buildings, flat roofs	Grass and tree growth extremely rare; <5% vegetation
I2	Light-moderate Industrial	Rail yards, truck depots, warehouses, industrial parks, minor fabrications; generally 1-3 story buildings, flat roofs	Very limited grass, trees almost totally absent; <5% vegetation
C1	Commercial	Office and apartment buildings, hotels; >10 story heights, flat roofs	Limited grass and trees; <15% vegetation
R1	Common residential	Single family dwellings with normal easements; generally one story, pitched roof structures; frequent driveways	Abundant grass lawns and light-moderately wooded; >70% vegetation
R2	Compact residential	Single, some multiple, family dwellings with close spacing; generally <2 story, pitched roof structures; garages (via alley), no driveways	Limited lawn size and shade trees; <30% vegetation
R3	Compact residential	Old multi-family dwellings with close (<2m) lateral separation; generally 2 story, flat roof structures; garages (via alley) and ash pits, no driveways	Limited lawn size, old established shade trees; <35% vegetation
R4	Estate residential	Expansive family dwellings on multi-acre tracts	Abundant grass lawns and lightly wooded; >80% vegetation
A1	Metropolitan natural	Major municipal, state, or federal parks, golf courses, cemeteries, campuses; occasionally single story structures	Nearly total grass and lightly wooded; >95% vegetation
A2	Agricultural natural		Local crops (e.g., corn, soybeans); >95% vegetation
A3	Undeveloped	Uncultivated; wasteland	Mostly wild grasses and weeds, lightly wooded; >90% vegetation
A4	Undeveloped rural		Heavily wooded; >95% vegetation
A5	Water surfaces	Rivers, Lakes	Not applicable

Appendix F. Example Tables for Air Quality Modeling Report

Example Tables for Air Quality Modeling Reports

This appendix contains examples of tables that are useful in presenting information in modeling reports.

Table E-1. Example Stack Parameters Table

Parameter[a]	Generator Stack	Boiler Stack
Computer Model Identifier (Alias)		
Emissions Rate (lb/hr)		
Stack Height (ft)		
Stack Diameter (ft)		
Exit Temperature (°F)		
Exit Flow Rate (acfm)		

a) Provide thorough justification/documentation of values used in the model, including calculations used to generate values.

Table E-2. Example Significant Impacts Summary ($PM_{2.5}$)

Year	5-Year Mean of Highest Annual Concentration ($\mu g/m^3$)	Radius of Significant Annual Impact (m)	5-Year Mean of Highest 24-hour Concentration ($\mu g/m^3$)	Radius of Significant 24-hour Impact (m)
1987-1991				
Significant Impact Level	0.3	Not applicable	1.2	Not applicable

Table E-3. Example Maximum Impacts for Cumulative NAAQS Analysis (NO_2 impacts, 1-hour averaging period)

Years Modeled	Multi-Year Mean of 8th Highest Daily Maximum 1-Hour Concentration ($\mu g/m^3$)	Receptor Location		
		East (m)	North (m)	Elevation (m)

Table E-4. Example Maximum Impacts for Toxic Air Pollutants Analysis (Carcinogens)

TAPs	Period Average (5-year) Concentration ($\mu g/m^3$)	Receptor Location		
		East (m)	North (m)	Elevation (m)

Table E-5. Example Maximum Impacts for Toxic Air Pollutants Analysis (Noncarcinogens)

TAPs	Highest 24-hour Concentration ($\mu g/m^3$)	Receptor Location		
		East (m)	North (m)	Elevation (m)

Table E-6. Example NAAQS and Toxic Air Pollutants Impact Analysis Summary

Pollutant	Averaging Period	Total Ambient Impact (Baseline Plus Modification and Co-Contributing Sources) ($\mu g/m^3$)	Background Conc. ($\mu g/m^3$)	Total NAAQS Conc. ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)
CO	1-hour				40,000
CO	8-hour				10,000
NO_2	1-hour				188
NO_2	Annual				100
SO_2	1-hour				196
SO_2	3-hour				1,300
SO_2	24-hour				365
SO_2	Annual				80
$PM_{2.5}$	24-hour				35
$PM_{2.5}$	Annual				12
PM_{10}	24-hour				150

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

DEC 0 2 2019

THE ADMINISTRATOR

MEMORANDUM

SUBJECT: Revised Policy on Exclusions from "Ambient Air"

FROM: Andrew R. Wheeler

TO: Regional Administrators

The U.S. Environmental Protection Agency is updating its policy on the exclusion of certain areas from the scope of "ambient air." In the context of developing and implementing national ambient air quality standards under the *Clean Air Act*, the EPA defines "ambient air" at 40 CFR § 50.1(e) as "that portion of the atmosphere, external to buildings, to which the general public has access." In applying this definition, the EPA has long followed a policy that allows excluding certain areas of a source's property, located outside of a building, from ambient air. As described in a 1980 letter from then-Administrator Douglas Costle to Senator Jennings Randolph, this "exemption from ambient air is available only for the atmosphere over land owned or controlled by the source and to which public access is precluded by a fence or other physical barriers." In the attached revised policy, I am revising the "fence or other physical barriers" element of this ambient air policy, while maintaining public health protection.

This revision to the ambient air policy, like the 1980 letter, considers as eligible for exclusion only the atmosphere over "land owned or controlled by the [stationary] source." While the 1980 letter said such areas may only be excluded when public access is precluded by "a fence or other physical barriers," this limited revision more clearly recognizes that a *fence or other physical barrier* is not the only type of measure that may be used to establish that the general public does not "have access" to an area of land that is owned or controlled by the source. These other types of measures, potentially combined with physical barriers, may be used to support exclusion of an area from ambient air. Thus, the EPA's revised ambient air policy, consistent with its discretion available under the regulatory definition of ambient air, is that *the atmosphere over land owned or controlled by the stationary source may be excluded from ambient air where the source employs measures, which may include physical barriers, that are effective in precluding access to the land by the general public.*

The revised policy reflects input from stakeholders, and the EPA expects this policy to maintain the same level of public health protection that was originally intended by the 1980 letter. For example, under the Prevention of Significant Deterioration program air quality analysis requirement, the air agency[1] must still determine, based on the administrative record for the permit, that the general public does not have access to property in order to exclude an area from ambient air.

The revised policy reflected in the attachment is neither a regulation subject to notice-and-comment rulemaking requirements nor a final agency action. This action does not amend the definition of "ambient air" in EPA regulations at 40 CFR § 50.1(e) and does not create or change any legal requirements applicable to the EPA, air agencies or the public. This policy does not of its own force determine that any specific portion of any particular source's property may be excluded from ambient air on the basis of particular measures taken to preclude public access. Determinations concerning the adequacy of such measures can only be made by the EPA or another air agency on a case-by-case basis after consideration of the relevant administrative record. Air agencies are not required to apply this policy and retain the discretion to determine whether the steps taken by a source will be adequate to preclude public access.

Please share this memorandum and the attached revised policy with air agencies in your region. For any questions regarding this memorandum and the attached revised policy, please contact Scott Mathias, Acting Director of the Air Quality Policy Division in the Office of Air Quality Planning and Standards at (919) 541-5310 or mathias.scott@epa.gov.

Attachment

[1] "Air agency" refers to a state, local or tribal air permitting agency and may also refer to the EPA, depending on the context.

Revised Policy on Exclusions from "Ambient Air"

I. INTRODUCTION

In the context of developing and implementing national ambient air quality standards under the *Clean Air Act*, the U.S. Environmental Protection Agency defines "ambient air" at 40 CFR § 50.1(e) as "that portion of the atmosphere, external to buildings, to which the general public has access."[1] The regulatory definition plainly excludes from ambient air areas inside buildings, and these areas are not addressed further in this document. In addition, the EPA has long recognized that certain areas external to buildings may be excluded from the regulatory definition of ambient air because the general public does not have access to them. Based on this interpretation, the EPA has a longstanding policy in allowing an exclusion from "ambient air" of the atmosphere over certain areas external to buildings when particular conditions are satisfied. This interpretation and policy were affirmed in a 1980 letter from Administrator Costle, which stated that the EPA was retaining "the policy that the exemption from ambient air is available only for the atmosphere over land owned or controlled by the source and to which public access is precluded by a fence or other physical barriers."[2]

The 1980 policy was criticized by those who believed that allowing exclusions of atmosphere, even on a source's own property, resulted in inadequate public health protection. In a 1989 report, the U.S. General Accounting Office reviewed the EPA's implementation of its ambient air policy and found that, in some cases, EPA Regional offices approved ambient air exclusions that allowed sources to increase pollution where air quality modeling predicted violations of the NAAQS.[3] The report recommended that the EPA "initiate a formal rulemaking process to redefine ambient air in a manner that is more protective of the environment." The report criticized the EPA for allowing the use of land acquisition to exclude such land from determinations of compliance with the NAAQS. It equated such land acquisition practices to prohibited dispersion techniques – a comparison with which the EPA has disagreed.[4]

Notwithstanding the GAO report, the EPA left the policy in the 1980 letter in place and decided neither to redefine its regulatory definition of ambient air nor to issue guidance concerning land acquisition practices. The EPA has continued to apply the policy described in the 1980 letter for nearly 40 years, and the EPA has periodically provided guidance to address the application of the policy in specific situations.

---

[1] *See also Train v. NRDC*, 421 U.S. 60, 65 (1975) ("'ambient air' [is] the statute's term for the outdoor air used by the general public").

[2] Letter from EPA Administrator Douglas Costle to Senator Jennings Randolph, Chairman, Committee on Environment and Public Works, December 19, 1980 (1980 letter).

[3] "Air Pollution: EPA's Ambient Air Policy Results in Additional Pollution," United States General Accounting Office, GAO/RCED-89-144, July 1989, at 14-21.

[4] Policy statement on the definition of Ambient Air, David G. Hawkins, Assistant Administrator for Air, Noise, and Radiation, Draft, January 9, 1980.

In recent years, industry representatives have argued that the longstanding ambient air policy is overly restrictive because it purports to require the use of a fence to preclude public access and justify excluding an area. These stakeholders have identified situations arising in specific types of air quality analyses (*e.g.*, Prevention of Significant Deterioration (PSD) permitting) that the EPA may not have considered when it issued the 1980 letter.[5] Industry representatives have requested that, given the advances in surveillance and monitoring capabilities and the variety of ambient air situations that have arisen since 1980, the language from the 1980 letter should be updated to more readily allow regulatory authorities to consider additional types of measures that are effective in precluding public access to a source's property, consistent with the regulatory definition of ambient air.

The EPA has reviewed the general principles expressed in the 1980 letter and has concluded, after considering a wide range of stakeholder comments, that it is reasonable to update the language from the 1980 letter that calls for the use of "a fence or other physical barriers" to preclude public access. In summary, this policy statement describes a refinement to the language of the existing policy that recognizes that a variety of measures (including, but not limited to, physical barriers) could be appropriately considered effective, depending on site-specific circumstances, to preclude public access from property owned or controlled by a source. The limited exclusion in this updated ambient air policy continues to apply only to property "owned or controlled" by the source and reflects only an update to the criteria the EPA will apply when determining whether a source effectively precludes public access to its property for purposes of analyzing the source's impact on ambient air.

A draft of the revised policy was made available for public review and comment from November 18, 2018, through January 11, 2019.[6] A total of 37 sets of comments were received from individuals and stakeholders representing state, local and tribal government agencies, industry and environmental groups. Some of the comments are discussed below. After consideration of all comments received, the EPA believes the revised policy is appropriate and will maintain public health protection. The revised policy is fully consistent with the regulatory definition of ambient air and fulfills the objective of protecting the public from exposure to potentially adverse levels of air pollution in a manner no less effective than the "fence or other physical barriers" called for under the previous policy.

II. BACKGROUND

As discussed above, the EPA's longstanding policy is based on the view that the general public does not have access to land occupied by a stationary source (or that would be occupied by a proposed stationary source or modification) when the land meets both of the following conditions: (1) the land is owned or controlled by the owner or operator of the stationary source; and (2) the land is surrounded by a fence or other physical barriers that preclude general public access. For

---

[5] American Forestry and Paper Association/American Wood Council, NAAQS Permitting White Paper on Flexible Procedures (September 2014) (*see* relevant discussion in sections 2 and 3).

[6] *See https://www.epa.gov/nsr/forms/draft-guidance-revised-policy-exclusions-ambient-air.*

example, under this policy, the EPA allows a PSD permit applicant to exclude from its air quality analysis the site of the proposed source where the record shows that the site is owned or controlled by the source and surrounded by a fence or other physical barriers that do not allow public access.[7]

Although not expressly stated by Administrator Costle in 1980, it is clear that these dual conditions of the policy have been fundamentally grounded on an interpretation of the regulatory phrase "to which the general public has access." In a 2007 memorandum, the EPA explained that it uses "controlled" in the context of the first condition of the policy to mean that the owner or operator of the source has the legal right to use the land, and that its land-use right includes "the power to control public access" and "the power to exclude the general public."[8] The EPA explained that the second condition calls for a source to actually take steps to preclude the general public from accessing its property "by relying on some type of physical barrier (*e.g.*, a fence, wall, or natural obstruction)." Thus, the first condition calls for a consideration of whether the general public has access in a *legal* sense (whether the owner or controller of the land has the right to preclude the general public's access), while the second condition calls for a consideration of whether the general public has access in a *practical or physical* sense (whether the general public is able to enter). The EPA also recognized that some persons that have both legal and practical access to the source's property are not necessarily considered members of the general public, such as employees of the owner or operator who work at the site, or "business invitees," such as contractors or delivery persons.[9] Of all of these aspects of the analysis, the sole change to the EPA's ambient air policy reflected in this attachment is that the EPA no longer considers "a fence or other physical barriers" to be the only type of measure available to a source in order to preclude public access in a practical or physical sense.

Over the years, the EPA has provided clarifying guidance to explain how the definition of ambient air, and the associated ambient air policy, should be applied under specific circumstances for air quality analyses, such as analyses used to demonstrate compliance with the NAAQS and PSD increments within the PSD permitting process. For example, in the aforementioned 2007 memorandum, the EPA explained how it intended to apply the definitions of "ambient air" and "building, structure, facility or installation"[10] to arrangements where a source locates on property that it leases from another entity. The EPA has provided its views in other situations, on a case-by-case basis, concerning the adequacy of certain types of fencing or other physical barriers (*e.g.*, a steep cliff or rugged terrain) based on the EPA's understanding of the core concept of "access" to source property by the public, as this term is used in the regulatory definition of ambient air.

---

[7] *See, e.g., In re Hibbing Taconite*, 2 E.A.D. 838 (Admr. 1989). In this case, the EPA's Administrator called for additional review of whether physical barriers were present at all locations around the perimeter of excluded property.
[8] Memorandum from Stephen D. Page, EPA, OAQPS, to EPA Regional Air Division Directors, "Interpretation of 'Ambient Air' in Situations Involving Leased Land Under the Regulations for Prevention of Significant Deterioration (PSD)," attachment at 2-3, June 22, 2007. The memorandum refers to the 1980 letter, but this revised policy does not affect the interpretations expressed in the 2007 memorandum, as described above.
[9] *Id.*, attachment at 5-6.
[10] *See* 40 CFR 52.21(b)(6).

In its review of individual situations, the EPA has sometimes agreed that an area may qualify for exclusion from ambient air despite the fact that the specific property or facility at issue, or a certain portion of the property or facility, was not surrounded by a fence or other physical barriers. For example, five years after the 1980 letter, the EPA allowed an ambient air exclusion based on the cumulative effect of a company's extensive property holdings, installation of fences, posting of "No Trespassing" signs, security patrolling and the rugged mountainous terrain.[11] More recently, the EPA excluded an area from ambient air based on a source's proposal to preclude public access using measures other than a fence or other physical barriers. The United States Court of Appeals for the Ninth Circuit reviewed and upheld the exclusion, finding that, although fencing or other physical barriers were not used, other methods were used to effectively preclude public access, and "[t]he essence of the EPA's regulatory definition links ambient air to public access."[12] Although that case involved permitting of a source located over water, where installation of a fence or other physical barriers was not practical, the language of the regulatory definition of ambient air does not preclude extending this reasoning to other factual situations. For example, there may be situations over land where it is also impractical or unduly burdensome to require a source to install a fence or other physical barriers when other means of precluding public access may be equally effective. The EPA has thus not read the regulatory definition to require the use of physical barriers in all cases. After evaluating the specific circumstances, the EPA has in some cases supported excluding areas of land from ambient air that were not surrounded by physical barriers. The EPA has previously recognized that public access may be effectively precluded by means other than a fence or other physical barriers and still be consistent with the regulatory definition of ambient air.

In addition to seeking assistance from the EPA in case-specific permitting situations, organizations representing permit applicants have on various occasions requested that the EPA reconsider aspects of the ambient air policy that their membership considers to be inflexible or outdated, such as the need to demonstrate NAAQS attainment on railroad tracks and roadways on or just beyond their property boundary, in areas where these organizations assert few or no members of the general public are expected to be present. These requests resurfaced in comments on the draft revised policy that was made available for informal public comment. Furthermore, some commenters argued that the EPA's historic focus on a fence or other physical barriers is outdated in that it does not address or allow consideration of additional security technology and other measures by which public access may be precluded (*e.g.*, routine security patrols, remote surveillance cameras, drones). Some commenters also pointed out that a fence or physical barriers are not mandated by the regulatory definition of ambient air and, therefore, the EPA's ambient air policy should not consider them to be the only allowable means of precluding public access. On

---

[11] *See*, 50 FR 7056, 7057 (February 20, 1985). In this instance, Kennecott maintained that public access was precluded from ambient air by a combination of rugged terrain, dense vegetation, limited perimeter fencing, no-trespassing signs and security patrols.

[12] *See REDOIL v. EPA*, 716 F.3d 1155, 1164-65 (9th Cir. 2012) (a proposed offshore drill ship in the Arctic Ocean seeking a PSD permit was allowed to exempt from ambient air a "safety zone" surrounding the ship that was established by the U.S. Coast Guard and effectively precluded public access); *see also* EPA memorandum from Phil Millam, Region X, to Randy Poteet, ARCO Alaska, Inc., titled "Arco Alaska Permit Application for Beaufort Sea Exploratory Drill Project," March 1, 1993 (EPA regional comment letter asking ARCO to certify that an exclusionary safety zone exists with reasonable zone boundary control measures for EPA to consider the area to be controlled by the source, and therefore, excluded from being considered ambient air).

the other hand, some commenters argued that the EPA's 1980 policy allowing an exemption for fenced land owned or controlled by a source was contrary to law.[13] These stakeholders argued that the regulatory definition should be revised through rulemaking to eliminate or narrow the exclusion for areas external to buildings. Other commenters argued that the draft revised policy would further loosen the existing policy and therefore would be clearly inappropriate.

III. CORE ELEMENTS OF REGULATORY DEFINITION OF "AMBIENT AIR"

Considering these views of interested stakeholders, the EPA has evaluated the terms in the regulatory definition of ambient air and identified three core conceptual elements: "access," "general public," and "external to buildings." The EPA then considered how each of these terms or phrases has been applied under the existing ambient air policy and whether additional flexibility or clarification may be appropriate, consistent with the existing regulatory definition of ambient air. The EPA concluded that it is reasonable and appropriate to update its ambient air policy[14] concerning methods for precluding public access to source property in order to facilitate greater flexibility in light of developments and experience since the 1980 letter, while at the same time ensuring that the public health protection afforded by the 1980 letter is maintained.

Consistent with past practice and the discussion above, the EPA continues to interpret the term "access" to encompass two key concepts: legal access and physical or practical access.[15] Some commenters argued that the EPA's policy should allow areas to be excluded where there is no legal access, even if there is physical access, by the general public. They argued that physically precluding public access should not be necessary under the ambient air policy because it is not specifically required by the CAA or the regulatory definition of ambient air. Commenters also argued that persons entering private property without the owner's permission are trespassers and therefore their access is unlawful and irrelevant. While the regulatory definition of "ambient air" does not use some of the terms reflected in the EPA's ambient air policy, the definition also does not explicitly exclude any area external to buildings. The exclusion for such areas is reasonably inferred as the inverse of what is affirmatively covered ("areas ... to which the general public has access"). Nor does the regulatory definition prescribe specific criteria that are in conflict with the EPA's policy. The EPA 's view is that the approach advocated by these commenters of focusing only on legal access reads the term "access" too narrowly and ignores the EPA's longstanding

---

[13] One commenter cited memoranda issued in 1972 and 1977; *see* Appendix for the EPA's response.

[14] Some commenters refer to the 1980 letter as an EPA interpretation, but it also contains statements of EPA policy. The 1980 letter stated the EPA was retaining "the existing policy" that "the exemption from ambient air is available only for the atmosphere over land owned or controlled by the source and to which public access is precluded by a fence or other physical barriers." The policy clarified how the EPA intended to apply the concept in the regulatory definition of the general public having (or not having) "access" to property (and the air above it). Although not expressly stated in Administrator Costle's letter, that letter, and this revised policy, "interpret" the regulatory definition to be inapplicable to areas outside of buildings to which the general public does not have access and read the term "access" to encompass both legal and practical access. The 1980 letter and this revised policy then proceed to provide policy guidance as to the conditions under which the EPA believes it may be appropriate for one to conclude that general public does not have such access to an area. This revised policy describes how the EPA intends to exercise its discretion to determine whether the public has access based on record-based facts (and provides guidance for others to do likewise).

[15] The word "access" has a variety of meanings. As used for applying the regulatory definition of ambient air ("atmosphere . . . to which the public has access"), the EPA believes the term encompasses both the public's *legal right* and the public's *practical ability* to enter a particular parcel of land.

PET 778

REC 1144

understanding that the general public may have access based on, not only the right, but also the ability, to enter an area.

The first aspect of the access element (*i.e.*, legal access) concerns whether the general public has the right or permission to enter a specific property. Under the ambient air policy as described in the 1980 letter, an exclusion from ambient air is available only for areas owned or controlled by the source (*i.e.*, the source has legal authority, via ownership or control, to preclude access by the public).

Although the draft revised policy did not propose any change in this element of the ambient air policy, some commenters advocated that the EPA allow exclusions of property owned or controlled by other parties. These commenters argued that the regulatory definition of "ambient air" does not mandate that the *source* own or control the land from which the public is otherwise precluded. As discussed above, the EPA's policy allowing exclusion of some areas external to buildings is not based on language in the regulatory definition mandating exclusion or providing particular criteria for such an exclusion, but rather, is inferred as the inverse of what is affirmatively covered by that definition (*i.e.*, if "ambient air" is defined as that to which the general public has access, then that to which the general public does not have access is not ambient air). The EPA's view is that the general public has legal access to areas that are owned and controlled by parties other than the owner or operator of a stationary source. The EPA continues to view the "general public" to include any person(s) other than those who are permitted access to the property as employees or business invitees of a specific stationary source (including trespassers). Although a landowner who owns a stationary source downwind of another landowner's separate stationary source may restrict public access onto his or her private property, the owner and the individuals that are permitted access to his or her downwind property are, generally speaking, members of the general public relative to the upwind stationary source. An alternative reading of "general public" that excludes all persons on any private property to which access is restricted (*e.g.*, private homeowners with fenced yards) would expand the exclusion beyond reason and deny the protection of the NAAQS to large numbers of people. This revised policy makes no change to the "owned or controlled by the source" and "general public" elements of the policy.

The second aspect of the access element (*i.e.*, physical or practical access) addresses whether the general public is able to, under actual circumstances, enter a particular parcel of land. As discussed above, the EPA stated in the 1980 letter that for an area to be excluded from ambient air, public access should be precluded by means of a fence or other physical barriers. Since 1980, the EPA has found that a natural barrier (*e.g.*, steep cliff, rugged terrain or dense vegetation), was sufficient, in the absence of a man-made barrier like a wall or fence, to prevent public access, in some situations.[16]

---

[16] *See* 50 FR 7056, 7057 (February 20, 1985). On a related issue, one commenter cited two EPA memos from 1985 and 2000 for the conclusions that "a shoreline by itself is not a sufficient barrier to public access" and "publicly accessible areas such as highways and rivers may show violations of NAAQS," respectively. The EPA believes the revised policy would not necessarily result in different conclusions, depending on the facts presented. Relevant factors for an air agency to determine whether an unfenced "shoreline" is a sufficient barrier to preclude public access across the border of a source property may include: the ability of users of the water body (*e.g.*, boaters, to access the shore in that location, whether the general public has access to the water body, and whether the source uses any additional measures, such as signage and video surveillance). Regarding a highway or river, the revised policy makes no change

Based on concerns that a physical barrier is not always needed to restrict access, the EPA invited public comments on a draft revised ambient air policy that would replace the term "a fence or other physical barriers" in the "access" element of the policy with the broader term "measures, which may include physical barriers, that are effective in deterring or precluding access to the land by the general public."[17] Some commenters agreed that "fences or other physical barriers" should not always be necessary for precluding public access.

Recognizing advances in security technologies and greater experience in the diversity of ambient air scenarios since the 1980 letter, the EPA's view is that a source can in many instances employ measures, other than fencing or other physical barriers, or in combination with fencing or other physical barriers, to effectively preclude public access. While sources often use traditional fencing at the boundary of a facility, there are examples of other measures, of which more than one may be used in combination, that have been effective in precluding public access when adequate procedures are followed (*e.g.*, video surveillance, monitoring, clear signage, routine security patrols). Furthermore, the EPA recognizes that there will be future technologies such as drones and more advanced video surveillance capabilities, that will potentially be used to preclude public access.[18]

The EPA does not regard this revision as a fundamental change to the longstanding ambient air policy. For example, under the prior policy, it was always possible for some fences to be scaled and other types of barriers to be breached.[19] The EPA agrees with commenters who stated that a fence is an effective means of precluding public access, but even a fence, depending on factors such as its height, composition, scalability, resistance to damage or tunneling and remoteness of location, will not in all conceivable situations prevent persons who desire to gain access (although

---

to the "owned or controlled by the source" element, as stated above, so the EPA generally would not expect the revised policy to change a determination of whether an area should be excluded from ambient air, where it includes "publicly accessible areas such as highways and rivers" since such areas generally are not owned or controlled by the source. Thus, the EPA sees no conflict between past policy memorandums and the revised policy.

[17] In the draft revised policy made available for public comment, the EPA used the word "deter" in addition to "preclude." This was intended to acknowledge that non-physical measures might be defeated (perhaps temporarily) by a deliberate trespasser in a manner similar to a physical obstruction, but this scenario is appropriately defined through the word "preclude" such that the word "deter" is not necessary in this context. The EPA maintains its view that any type of measure employed by a source should preclude public access to justify excluding a portion of source property from ambient air and its effectiveness in doing so should be evaluated on a case-by-case basis.

[18] By listing examples in this paragraph, the EPA does not suggest that any such measure by itself will be effective in precluding access to any particular property without procedures that ensure that the measure will be used in a manner that effectively precludes public access. Nor, by listing examples, does the EPA intend to foreclose the possibility that some other measure or measures not listed as an example might be effective in precluding access to any particular property. The determination by an air agency of whether access to any particular property is precluded is fact-based and facility-specific.

[19] One commenter argued that "the fact that even 'physical barriers' conceivably could be scaled or breached means that 'the general public has access" within the meaning of 40 CFR § 50.1(e), even if a fence or other physical barrier is used. The EPA believes that the regulatory definition is reasonably read not to require absolute certainty that no one could ever overcome a fence or other physical (or non-physical) barriers around a source. Another commenter noted that some physical barriers such as "short walls, three-rail fences, [or] easily scaled walls or fences" may be insufficient to actually prevent access. The EPA believes that the effectiveness of particular measures, whether physical or non-physical, to preclude public access should be addressed by the source and the air agency on a case-by-case basis considering the totality of the circumstances.

unlawfully) to a source's property. Generally, the air agency[20] should be satisfied that the measures proposed by the source are adequate to assure that the general public will not have access under reasonably anticipated circumstances that could occur in the area. This revised policy does not prescribe, approve, or disallow any specific types of measures (physical barriers or otherwise) that may be used to preclude public access. Rather, this revised policy calls for staff at the EPA (and other air agencies as well) to carefully assess measures proposed by a source to preclude public access under specific, factual circumstances. The goal of such an assessment is to be satisfied that the measures (whether physical or not) proposed by a source are effective in precluding public access under the circumstances presented. Thus, under this revised policy, measures may be considered effective, under a given set of circumstances, even if there is not 100 percent certainty that they will prevent public access.[21]

The EPA will apply a rule of reason in evaluating the effectiveness of any measures proposed by a source. In doing so, this evaluation should address relevant factors, such as the nature of the measure used (*e.g.*, physical or non-physical), source location, type and size of source and property to be excluded, surrounding area (including the proximity, nature, and size of the population in the area), and other factors affecting whether members of the general public would readily be able to trespass upon or otherwise have access to the source's property. Air agencies should consider all relevant information provided by the source or other interested parties, or otherwise available to the air agencies, regarding the effectiveness of the measures to prevent public access. For instance, the use of clearly visible, well-spaced "No Trespassing" signs in conjunction with some degree of fencing or other physical and/or non-physical barriers, may potentially be effective to preclude access by the general public in appropriate situations. In other cases, such as in areas accessible to children (*e.g.*, areas adjacent to schools), or where the nature of the property offers an incentive for persons to access or trespass (*e.g.*, a short cut to a destination), it may be necessary to use a different combination of measures to effectively preclude public access.

Related to the use of measures (particularly non-physical measures) to preclude public access is the question of whether such measures should be addressed in enforceable conditions (*e.g.*, PSD permit conditions). Although the draft revised policy did not address this issue, a few commenters submitted comments either supporting or opposing inclusion of such measures as enforceable permit terms. One air agency commented that while a physical barrier such as existing source fencing can be reasonably considered to be fixed and to last for the operational life of the source, a non-physical measure may warrant consideration as a permit term, especially where the measure does not "correspond with the facility's [source's] operational footprint." EPA will consider the need for enforceable permit conditions on a case-by-case basis and other air agencies may similarly exercise discretion in determining whether a permit condition is appropriate to ensure that a source administers the selected measures in a way that maintains continued public health protection. For example, security procedures and maintenance of surveillance records might be considered as enforceable permit conditions to help ensure that a particular measure continues to be carried out in an effective manner. A permit condition may be appropriate if, for example, a

---

[20] "Air agency" refers to a state, local or tribal air permitting agency and may also refer to the EPA, depending on the context.

[21] *See* discussion at fn.17.

PET 781

REC 1147

decision was made to exclude a model receptor at a particular location where, prior to implementation of effective measures to preclude public access, there was an historic practice of allowing public access to the area of concern.

As previously stated, determinations concerning the adequacy of measures to preclude public access should be made on a case-by-case basis after consideration of information in the relevant administrative record. When an air agency, other than the EPA, is responsible for the determination, EPA Regional offices will be available to assist as needed.

IV. CONCLUSION

In setting forth this revised ambient air policy, the EPA is making a limited change to the way it applies the "access" element in the regulatory definition of ambient air, while maintaining the level of public health protection afforded by the original policy. This narrow change is that the EPA will no longer consider a fence or other physical barriers to be the exclusive means by which public access may be effectively precluded for purposes of excluding an area owned or controlled by the source from ambient air under the regulatory definition. Accordingly, the EPA is replacing a concept in the 1980 letter with a broader concept of measures, which may include physical barriers, that are effective in precluding access by the general public. Thus, the EPA's revised ambient air policy, consistent with its discretion available under the regulatory definition of ambient air, is that *the atmosphere over land owned or controlled by the stationary source may be excluded from ambient air where the source employs measures, which may include physical barriers, that are effective in precluding access to the land by the general public.*

This revised policy is intended to be implemented by EPA Regional offices and by those air agencies to which the EPA has delegated its authority to issue federal PSD permits under 40 CFR § 52.21(u). The EPA is also making this policy available as guidance for consideration by air agencies with SIP-approved programs. Depending on the particular regulatory context and wording of the applicable SIP, air agencies implementing a SIP-approved program may be able to use this revised policy. In addition to PSD permitting, the EPA intends, as appropriate, to apply the revised policy to other NAAQS-related assessments and characterizations of air quality.

This revised policy is neither a regulation subject to notice-and-comment rulemaking requirements nor a final agency action. This action does not amend the definition of "ambient air" in EPA regulations at 40 CFR § 50.1(e) and does not create or change any legal requirements on the EPA, on state, local and tribal agencies or on the public. This document does not determine that any particular area or type of area may be excluded from ambient air on the basis of particular measures taken to preclude public access. Determinations concerning the adequacy of such measures can only be made by air agencies on a case-by-case basis after consideration of the relevant administrative record in each case. State and local air agencies are not required to apply this policy and retain their existing discretion to require measures (including fences or physical barriers) that they consider appropriate in each circumstance to establish that the general public does not have access to all or a portion of a source's property.

PET 782

REC 1148

For any questions regarding this revised policy, please contact Scott Mathias, Acting Director of the Air Quality Policy Division in the Office of Air Quality Planning and Standards at (919) 541-5310 or mathias.scott@epa.gov.

Appendix

One commenter cited a May 23, 1977, memorandum from Walter C. Barber, Director of the Office of Air Quality Planning and Standards titled, "Applicability of PSD Increments over Company Property." That memorandum addressed the question of whether PSD increments apply over a proposed source's property if the general public is effectively precluded from access to that property. The response to this question has the word "yes" crossed out and "no" written in its place; the response also says "[t]his issue has been addressed with respect to the NAAQS" in an OAQPS Guideline and a 1972 memorandum from the Office of General Counsel. The response goes on to state that PSD increments should be treated the same as the NAAQS in this respect and "[t]herefore, as indicated in the OGC memorandum, the test for determining if public access is effectively precluded requires some kind of physical barrier." The response attaches a September 28, 1972, memorandum from Michael A. James, Attorney, OGC, Air Quality and Radiation Division, to Jack R. Farmer, Chief, Plans Management Branch, Standards Development and Implementation Division that states that, in the context of identifying sites for air monitoring equipment to be located near certain smelters that were the subject of a pending rulemaking, the phrase "to which the general public has access" in the EPA's regulatory definition of "ambient air" was "most reasonably interpreted as meaning property which members of the community at large are not physically barred in some way from entering." The "Discussion" section of the 1972 memorandum quotes 40 CFR § 50.1(e) and expresses the view that the regulatory definition limits the applicability of the NAAQS to the atmosphere outside the facility fenceline "since 'access' is the ability to enter," citing a dictionary definition of "access" as "permission, liberty, or ability to enter." Administrator Reilly referenced this portion of the memorandum in a 1989 decision on the appeal of a PSD permit. *In re Hibbing Taconite*, 2 E.A.D. 838 (Admr. 1989).

The 1972 memorandum further explains that areas to which access has not been restricted by physical means can be trespassed upon and that persons, whether knowing or innocent trespassers, would be exposed to air above the property. The memorandum disagrees with treating the property line, rather than the fenceline within the property, as the boundary for ambient air for two reasons: 1) "access" includes the right or the ability to enter; and 2) a definition of "ambient air" that excepts fenced private property is "probably inconsistent" with section 107 of the CAA, and expanding the exception is "clearly not legally supportable." The memorandum goes on to say that "an argument can be made" that 40 CFR § 50.1(e) is not inconsistent with section 107 of the CAA as to primary NAAQS but that no such argument applies to secondary NAAQS.

While Administrator Reilly subsequently relied on a portion of the 1972 attorney memorandum to support his decision in the *Hibbing Taconite* permit appeal, EPA decisionmakers have not endorsed all the views expressed in the memorandum. First, the 1972 memorandum does not express the official position of the EPA's General Counsel. Instead, it was a response from an EPA line attorney to questions posed by a program office branch chief, and as such, is more appropriately viewed as an internal communication rather than a statement of the EPA's position or views. While the memorandum advised that the existing, duly promulgated regulatory definition of ambient air, unchanged since its issuance, was "probably inconsistent" with section 107 of the CAA, the EPA did not subsequently take any action to revise the definition on this basis. The revised policy is intended to implement, not revise, the regulatory definition. In addition, the 1977 OAQPS memorandum attached to the 1972 memorandum, did not adopt or endorse all of the

discussion by the line attorney. It appears the attorney memorandum was attached merely to show that the issue in the 1977 memorandum (whether PSD increments apply over a proposed source's land) had already been addressed previously in the analogous context of whether NAAQS apply over a proposed source's land. The EPA's ambient air policy was authoritatively stated in the 1980 letter and 1989 adjudication by the EPA's Administrator, and thus the views expressed in the 1977 memoranda and portions of the 1972 memorandum that were not referenced in the 1989 adjudication did not become part of the EPA's ambient air policy.

The revised policy is consistent with the principal view expressed in the 1972 memorandum that the border of the ambient air surrounding a source is not automatically out at the property line, but rather is located where there is an effective measure, whether a physical barrier or not, to preclude public access. The only specific ambient air issue addressed in the 1972 memorandum was whether a property line or fenceline should be used as the border of ambient air, and the memorandum concluded a fenceline was more appropriate because "access" in the regulatory definition meant "the ability to enter" and trespassers could enter the property if there was no physical barrier.

The 1972 memorandum also asserted a policy conclusion that the only type of effective measure to preclude access was a physical barrier, which was essentially a factual conclusion rather than a legal interpretation of the regulatory language. Such a factual conclusion is inherently subject to change over time, as developments occur in the availability and effectiveness of measures to preclude public access to property. Although the incoming questions from the program branch chief refers to signage, the 1972 memorandum did not provide factual information to show that signs or other potential means of precluding access could never be effective to preclude access by the general public.

As explained in the body of this document, the EPA believes the clarification and flexibility provided in the revised policy is reasonable, appropriate, and consistent with the existing regulatory definition of ambient air in 40 CFR § 50.1(e).

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON. D.C. 20460

JAN 25 1995

OFFICE OF
ENFORCEMENT AND
COMPLIANCE ASSURANCE

SUBJECT: Guidance an Enforceability Requirements for Limiting Potential to Emit through SIP and §112 Rules and General Permits

FROM: Kathie A. Stein, Director
Air Enforcement. Division

TO: Director, Air and, Pesticides and Toxics
Management Division, Regions I and IV
Director, Air and Waste Management Division,
Region II
Director, Air, Radiation and Toxics Division,
Region III
Director, Air and Radiation Division,
Region V
Director, Air, Pesticides and Toxics Division,
Region VI
Director, Air and Toxics Division,
Regions VII, VIII, IX, and X

Attached is a guidance document developed over the past year by the former Stationary Source compliance Division in coordination with the Air Enforcement Division, Office of Air Quality Planning and Standards$ OAR's Office of Policy Analysis and Review, and the Office of General Counsel, as well-as with significant input from several Regions.

A number of permitting authorities have begun discussions with or have submitted programs for review by EPA that would provide alternative mechanisms for limiting potential to emit Several authorities have submitted SIP rules and at least one State has been developing a state general permit approach.; We believe that this guidance is important to assist the EPA Regions as well as States in approving and developing such approaches.

For additional information regarding this guidance, please contact me or Clara Poffenberger of my staff at (202) 564-8709.

cc: John Rasnic, Director
Manufacturing, Energy, and Transportation Division Office of Compliance

Air Branch Chiefs, Regions I -X

Enforceability Requirements for Limiting potential to Emit Through SIP and §112 Rules and General Permits

Introduction

As several EPA guidance describe, there are several mechanisms available for sources to limit potential to emit. EPA guidance have also describe the importance of practical enforceability or the means used to limit the Potential to Emit. This guidance is intended to provide additional guidance on practical enforceability for such limits. We provide references for guidance an practical enforceability for permits and rules in general and provide guidance in this document for application of the same principles to "limitations established by rule or general permit," as described in the guidance document issued January 25, 1995, entitled "Options for Limiting Potential to Emit (PTE) of a Stationary Source under section 112 and Title V of the Clean Air Act (Act)." The description is as follows:

> Limitations established by rules. For less complex plant sites, and for source categories involving relatively few operations that are similar in nature, case-by-case permitting may not be the most administratively efficient approach to establishing federally enforceable restrictions. One approach that has been used is to establish a general rule which creates federally enforceable restrictions at one time for many sources (these rules have been referred to as "prohibitory" or "exclusionary" rules). The concept of exclusionary rules is described in detail in the November 3, 1993 memorandum ["Approaches to Creating Federally Enforceable Emissions Limits," from John S. Seitz]. A specific suggested approach for VOC limits by rule was described in EPA's memorandum dated October 15, 1993 entitled "Guidance for State Rules for Optional Federally Enforceable Emissions Limits Base Upon Volatile Organic Compound (VOC) Use." An example of such an exclusionary rule is a model rule developed for use in California. (The California model rule is attached, along with a discussion of its applicability to other situations - see Attachment 2). Exclusionary rules are included in a State's SIP or 112 program and generally become effective upon approval by the EPA.

The EPA prefers the term "exclusionary rule" in that this phrase is a less ambiguous description of the overall purpose of these rules.

General permits -A concept similar to the exclusionary rule is the establishment Of a general permit for a given source type. A general permit is a single permit that establishes terms and conditions that must be complied with by all sources subject to that permit. The establishment of a general permit could provide for emission limitations in a one-time permitting process, and thus avoid the need to issue separate permits for each source. Although this concept is generally thought of as an element of Title V permit programs there in no reason that a state or local agency could not submit a general permit program as a SIP submittal Aimed at creating synthetic minor sources. Additionally FESOP [Federally Enforceable State Operating Permit usually reffering to Title I State OperatingPermit Programs approved under- the criteria established by EPA in the June 28, 1989 Federal Register notice, 54 FR 27274] programs can include general permits as an element of the FESOP program being approved into the SIP. The advantage of a SIP general permit, when compared to an exclusionary rule, is that upon approval by the EPA of the state's general permit program, a general permit could be written for an additional source type without triggering the need for the formal SIP revision process. (January 25, 1995 Seitz and Van Heuvelen memorandum, page 4.)

SIP or §112 Rules

Source-category standards 'approved in the. SIP. or under 112,if enforceable as a. practical matter, can be used as federally enforceable limits on potential to emit. Such provisions require public participation and EPA review. Once a specific source qualifies under the applicability requirements of the source category rule, additional public participation is not required to make the limits federally enforceable as a matter of legal sufficiency since the rule itself underwent public participation and EPA review. The rule must still be enforceable as practical matter in order to be considered federally enforceable. A source that violates this type of rule limiting potential to emit below major a source thresholds or is later determined not to qualify for coverage under the rule, could be subject to enforcement action for violation of the rule and for constructing or operating without a proper permit (a. part 70, a New Source Review permit, or operating without meeting §112 requirements, or any combination thereof).

General Permits

The title V regulations set out provisions for general permits covering numerous similar sources. The primary purpose of general permits is to provide a permitting alternative where

the normal permitting process would be overly burdensome, such as for area sources under section 112. General permits may be issued to cover any category of numerous similar sources, including major sources, provided that such sources meet certain criteria laid out in 40 CFR part 70. Sources may be issued general permits strictly for the purpose of avoiding classification as major source. in other words, general permits may be used to limit the potential to emit for numerous similar sources. However, general permits must also most both legal and practical federal enforceable requirements.

With respect to legal sufficiency, the operating permit regulations provide that once the general permit has been issued, after opportunity for public participation and, EPA and affected State review, the permitting authority may grant or deny a sources request to be covered by a general permit without further public participation or EPA or affected State review. The action of granting or denying the source's request is not subject to judicial review. A general permit does not carry a permit shield. A source may be subject to enforcement action for operating without a part 70 permit if the source is later determined not to qualify for coverage under the general permit. Sources covered by general permits must comply with all part 70 requirements.

State SIP or 112(l) General Permits

Another mechanism available to limit potential to emit is a general permit program approved into the SIP or under section 112(1), the hazardous air pollutant program authority. This mechanism allows permitting authorities to issue and revise general permits consistent with SIP or 112(1) program requirements without going through the SIP or 112(1) approval process for each general permit or revision of a general permit. The program is also separate from title V, like Title I state operating permits, and issuance and revisions of the permits are to comply with title V procedures.

Once a program is approved, issuing and revising general permits should be significantly less burdensome and time-consuming for State legislative and rulemaking authorities. The EPA review should also be less burdensome and time-consuming. After a program is approved, permitting authorities have the flexibility to submit and issue general permits as needed rather than submitting them all at once as part of a SIP submittal. Given the reduced procedural burden, permitting authorities should be able to issue general permits to small groups or categories or sources rather than attempt to cover broad categories with a generic rule. We anticipate that specific permit requirements or general permits may be readily developed with the assistance of interested industry groups.

The state general permit approach may allow sources to meet the federal the federal enforceability requirements more easily than other approaches. However, to use this approach, states must have a federally enforceable program that provides the state the authority, to issue such permits; to accomplish this, EPA must approve the program into the SIP or pursuant to section. 112(1) of the Clean Air Act.

Enforceability Principles

In 1989, in response to challenges from the Chemical Manufacturers Association and other industry groups, EPA reiterated its position that controls and limitations used to limit a source's Potential to emit must be federally enforceable. See 54 FR 27274 (June 28, 1989). Federally enforceable limits can be established by Clean Air Act programs such as NSPS, NESHAPs, MACTs, and SIP requirements. However, source-specific limits are generally set forth in permits. Generally, to be considered federally enforceable, the permitting program must be approved by EPA into the SIP and include provisions for public participation. "In addition, permit terms and conditions must be practicably enforceable to be considered federally enforceable. EPA provided specific guidance on federally enforceable permit conditions in a June 13, 1989 policy memo "Limiting Potential to Emit in New Source Permitting" from John Seitz and in the June 28, 1989 Federal Register notice (54 FR 27274) Additional guidance Can also be found in United states v. Louisiana Pacific,682 F. Supp 1122 (D. Colo. 1987) 682 F. Supp 1141 (D. Colo.1988), which led to these guidance statements and a number of other memoranda covering practicable enforceability as it relates to rolling averages, short-term averages, and emission caps. See "Use of Long Term Rolling Averages to Limit Potential to Emit," form John. B. Rasnic to David Kee, February 24, 1992; "Limiting Potential to Emit;" from Mamie Miller to George Czerniak, August, 1992; "Policy Determination an Limiting Potential to Emit for Koch Refining Company's Clean Fuels Project", from John B. Rasnic to David Kee, March 13, 1992; and "3M Tape Manufacturing Division Plant, St. Paul, Minnesota" from. John B. Rasnic to David Kee, July 14, 1992.

In 1987, EPA laid out enforceability criteria that SIP rules must meet. see "Review of State Implementation Plans and Revisions for Enforceability and Legal Sufficiency," from Michael Alushin, Alan Eckert, and John Seitz, September 3, 1987 (1997 SIP memo). The criteria include clear statements as to applicability, specificity as to the standard that must be met, explicit statements of the compliance time frames (e.g. hourly, daily, monthly, or 12-month averages, etc.), that the time frame and method of compliance employed must be sufficient to protect the standard involved, record keeping requirements must be specified, and equivalency provisions must meet certain requirements.

Based an these precedents this guidance describes six enforceability criteria which a rule or a general permit must meet to make limits enforceable as a practical matter. In general, practical enforceability for a source-specific permit term means that the provision must specify (1) a technically accurate limitation and the portions of the source subject to the limitation; (2) the time period for the limitation (hourly, daily, monthly, annually); and (3) the method to determine compliance including appropriate monitoring, record keeping and reporting. For rules and general permits that apply to categories of sources, practical enforceability additionally requires that the provision (4) identify the categories of sources that are covered by the rule; (5) where coverage is optional, provide for notice to the permitting authority of the source's election to be covered by the rule; and (6) recognize the enforcement consequences relevant to the rule.

This guidance will address requirements (4) "arid (5) first as they are concepts that are unique to rules and general' permits.

A. Specific Applicability

Rules and general permits designed to limit potential to emit must be specific as to the emission units or sources covered by the rule or permit. In other words, the rule or permit must clearly identify the category(ies) of the sources that qualify for the rule's coverage. The rule must apply to categories of sources that are defined specifically or narrowly enough so that specific limits and compliance monitoring can be identified and achieved by all sources in the categories defined.

A rule or general permit that covers, a homogeneous group of sources should allow standards to be set that limit potential to emit and provide the specific monitoring requirements. (Monitoring is more fully addressed in section D.) The State can allow for generic control efficiencies where technically sound and appropriate, depending on the extent of the application and ability to monitor compliance with resultant emission limits. Similarly, specific and narrow applicability may allow generic material usage or limits on hours of operation to be sufficient. For example, a rule or general permit that applies to fossil fuel fired boilers of a certain size may allow for limits on material usage, such as fuel-type and quantity. A rule or general permit that applies, only to standby diesel generators or emergency generators may allow restrictions on hours of operation to limit potential to emit. The necessary compliance terms (i.e., monitoring or record keeping) associated with any of these limits, such as with hours of operation, can readily be specified in the rule or the general permit itself.

General permits under Title V are assumed to include this

PET 791

REC 1157

enforceability principle because the Part 70 regulations set out specific criteria that states should consider in developing their general permit provisions (See 57 FR 32278). These factors include requirements that

> "categories of sources covered by general permits should be generally homogenous in terms of operations, processes, and emissions. All sources in the category should have essentially similar operations or processes and emit pollutants with similar characteristics."

Another factor stated is "sources should be subject to the same or substantially similar requirements governing operation, emissions, monitoring, reporting, or record keeping." Examples of source categories appropriate for general permits include: degreasers, dry cleaners, small heating systems, sheet fed printers, and VOC storage tanks (see 57 FR 32278).

B. Reporting or Notice to Permitting Authority

The rule or general permit should provide specific reporting requirements as part of the compliance method. Although the compliance method for all sources must include record keeping requirements, the permitting authority may make a determination that reporting requirements for small sources would provide minimal additional compliance assurance. Where ongoing reporting requirements are determined not to be reasonable for a category of sources, the rule or general permit should still provide that the source notify the permitting authority of its coverage by the rule or the permit. In the limited situation where all the sources described in a source category are required to comply with the all of the provisions of a rule or general permit, notice is not needed. However, where there are no reporting requirement's and no opt-in provisions, the permitting authority must provide the public with the names and locations of sources subject to the rule or permit.

For Title V general permits, Part 70 requires sources to submit an application for a general permit which must be approved or disapproved by the permitting authority. For SIP or §112 rules and SIP or §112 general permits, in response to receiving the notice or application, the permitting authority may issue an individual permit, or alternatively, a letter or certification. The permitting authority may also determine initially whether it will issue a response for each individual application or notice, and may initially specify a reasonable time period after which a source that has submitted an application or notice will be deemed to be authorized, to operate under the general permit or SIP or §112 rule.

C. Specific Technically Accurate Limits

The rule or general permit issued pursuant to the SIP or §112 must specify technically accurate limits on the potential to emit. The rule or general permit must clearly specify the limits that apply, and include the specific associated compliance monitoring. (The compliance monitoring requirements are discussed further in the next section.) The standards or limits must be technically specific and accurate to limit potential to emit, identifying any allowed deviations.

The 1987 policy on SIP enforceability states that limitations "must be sufficiently specific so that a source is fairly on notice as to the standard it must meet." For example, "alternative equivalent technique" provisions should not be approved without clarification concerning the time period over which equivalency is measured as wall as whether the equivalency applies on a per source or per line basis or is facility-wide.

Further, for potential to emit limitations, the standards set must be technically sufficient to provide assurance to EPA and the public that they actually represent a limitation on the potential to emit for the category of sources identified. Any presumption for control efficiency must be technically accurate and the rule must provide the specific parameters as enforceable limits to assure that the control efficiency will be met. For example, rules setting presumptive efficiencies for incineration controls applied to a specific or broad category must state the operating temperature limits or range, the air flow, or any other parameters that may affect the efficiency on which the presumptive efficiency is based. Similarly, material usage limits such as fuel limits, as stated above, require specifying the type of fuel and may require specifying other operating parameters.

A rule that allows sources to submit the specific parameters and associated limits to be monitored may not be enforceable because the rule itself does not set specific technical limits. The submission of these voluntarily accepted limits on parameters or monitoring requirements would need to be federally enforceable. Absent a source-specific permit and appropriate review and public participation of the limits, such a rule is not consistent with the EPA's enforceability principles.

D. Specific compliance Monitoring

The rule must specify the methods to determine compliance. Specifically, the rule must state the monitoring requirements, record keeping requirements, reporting requirements, and test methods as appropriate for each potential to emit limitation; and clarity which methods are used for making a direct determination of compliance with the potential to emit limitations.

PET 793

REC 1159

"Monitoring" refers to many different types of data collection, including continuous emission or opacity monitoring, and measurements of various of Parameters of process or control devices (e.g. temperature, pressure drop, fuel usage) and record keeping of parameters that been limited ,such as hours of operation, production levels, or raw material usage. Without a verifiable plantwide, verifiable emission limits must assigned to each unit or group of units subject to the subject to he rule or general permit. Where monitoring cannot be used to determine emissions directly, limits on appropriate operating parameters must be established for the units or source, and must the monitoring must be sufficient to yield data form the relevant time period that is representative of the source's compliance with the standard or limit. Continuous emissions monitoring, especially in the case of smaller sources, is not required.

E. Practicably Enforceable Averaging Times

The averaging time for all limits must be practicably enforceable. In other words, the averaging time period must readily allow for determination of compliance. EPA policy expresses a preference toward short term limits, generally daily but not to exceed one month. However, EPA policy allows for rolling limits not to exceed 12 months or 365 days where the permitting authority finds that the limit provides an assurance that compliance can be readily determined and verified. See June 13, 1989 "Guidance on Limiting Potential to Emit," February 24, 1992 memorandum "Use of Long Term Rolling Averages to Limit Potential to Emit" from John Rasnic to David Kee and March 13 1992 "Policy Determination on Limiting Potential to Emit for Koch Refining Company Clean Fuels Project" from John B. Rasnic to David Kee, stating that determinations to allow an annual rolling average versus a shorter term limit must be made on a case by case basis. Various, factors weigh in favor of allowing a long term rolling average, such as historically unpredictable emissions. Other factors may weigh in favor of shorter term limit, such as the inability to set interim limits during the first year. The permitting agency must make a determination as to what monitoring and averaging period is warranted for the particular source-category in light of how close the allowable emissions would be to the applicability threshold.

F. Clearly Recognized Enforcement

Violations of limits imposed by the rule or general permit that limit potential to emit constitute violations of major source requirements. In other words the source would be violating a "synthetic minor" requirement which may result in the source being treated as a major source under Titles I and V. The 1989 Federal Register Notice provides for separate enforcement

and permitting treatment depending on whether the source subsequently chooses to become a major or remain minor. Thus violations of the rule or general permit or violation of the specific conditions of the rule or general permit subjects the source to potential enforcement under the Clean Air Act and state law. The operating permit rule states that not withstanding the shield provisions of part 70, the source subject to a general permit may be subject to enforcement action for operating without a part 70 permit if the source is later determined not to qualify or the conditions and terms of the general permit. Moreover, violation of any of the conditions of the rule or general permit may result in a different determination of the source's potential to emit and thus may subject the source to major requirements and to enforcement action for failure to comply with major source requirements from the initial determination.

G. Rule Requirements for State General Permit Programs

As discussed above, general permit programs must be submitted to EPA for approval under SIP authority or under section 112(1), or both, depending on its particular pollutant application. SIP and §112(1) approval and rulemaking procedures must be met, including public notice and comment. The specific application of the enforceability principles for establishing State SIP or §112(1) general permit programs require that the rule establishing the program set out these principles as rule requirements. In other words, these principles must be specific rule requirements to be met by each general permit.

The rule establishing the program must require that (1)general permits apply to a specific and narrow category of sources; (2) sources electing coverage under general permits where coverage is not mandatory, provide notice or reporting to the permitting authority; (3) general permits provide specific and technically accurate(verifiable) limits that restrict the potential to emit; (4) general permits contain specific compliance requirements; (5) Limits in general permits are established based on practicably enforceable averaging times; and (6) violations of the permit are considered violations of the state and federal requirements and result in the source being subject to major source requirements.

In addition, since the rule establishing the program does not provide the specific standards to be met by the source, each general permit, but not each application under each general permit, must be issued pursuant to public and EPA notice and comment. The 1989 Federal Register notice covering enforceability of operating permits requires that SIP operating permit programs issue permits pursuant to public and EPA notice and comment. Title V requires that permits, including general permits, be issued subject to EPA objection.

Finally, sources remain liable or compliance with major source requirements if the specific application of a general permit to the source does not limit the source's potential to emit below major source or major modification thresholds. (The limits provided in these mechanisms may actually limit the potential to emit of sources but may not limit the potential to emit for some sources to below the threshold necessary to avoid major source requirements. For example, a general permit for industrial boilers may in fact provide limits that are sufficient to bring a source with only two or three boilers to below the subject thresholds but a source with more than three boilers may have a limited PTE but not limited below the major source threshold.) Also, where the source is required to use another mechanism to limit potential to emit, i.e., a construction permit, the general permit may not be relied upon by the source or the State, to limit potential to emit.

Permits issued pursuant to the approved program, meeting the above requirements, are adequate to provide federally enforceable limits on potential to emit for New Source Review, title V, and §112 programs as long as they are approved pursuant to SIP (section 110) and section 112(1) authorities.

PET 796

REC 1162

13.2.2 Unpaved Roads

13.2.2.1 General

When a vehicle travels an unpaved road, the force of the wheels on the road surface causes pulverization of surface material. Particles are lifted and dropped from the rolling wheels, and the road surface is exposed to strong air currents in turbulent shear with the surface. The turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed.

The particulate emission factors presented in the previous draft version of this section of AP-42, dated October 2001, implicitly included the emissions from vehicles in the form of exhaust, brake wear, and tire wear as well as resuspended road surface material[25]. EPA included these sources in the emission factor equation for unpaved public roads (equation 1b in this section) since the field testing data used to develop the equation included both the direct emissions from vehicles and emissions from resuspension of road dust.

This version of the unpaved public road emission factor equation only estimates particulate emissions from resuspended road surface material [23, 26]. The particulate emissions from vehicle exhaust, brake wear, and tire wear are now estimated separately using EPA's MOBILE6.2 [24]. This approach eliminates the possibility of double counting emissions. Double counting results when employing the previous version of the emission factor equation in this section and MOBILE6.2 to estimate particulate emissions from vehicle traffic on unpaved public roads. It also incorporates the decrease in exhaust emissions that has occurred since the unpaved public road emission factor equation was developed. The previous version of the unpaved public road emission factor equation includes estimates of emissions from exhaust, brake wear, and tire wear based on emission rates for vehicles in the 1980 calendar year fleet. The amount of PM released from vehicle exhaust has decreased since 1980 due to lower new vehicle emission standards and changes in fuel characteristics.

13.2.2.2 Emissions Calculation And Correction Parameters[1-6]

The quantity of dust emissions from a given segment of unpaved road varies linearly with the volume of traffic. Field investigations also have shown that emissions depend on source parameters that characterize the condition of a particular road and the associated vehicle traffic. Characterization of these source parameters allow for "correction" of emission estimates to specific road and traffic conditions present on public and industrial roadways.

Dust emissions from unpaved roads have been found to vary directly with the fraction of silt (particles smaller than 75 micrometers [μm] in diameter) in the road surface materials.[1] The silt fraction is determined by measuring the proportion of loose dry surface dust that passes a 200-mesh screen, using the ASTM-C-136 method. A summary of this method is contained in Appendix C of AP-42. Table 13.2.2-1 summarizes measured silt values for industrial unpaved roads. Table 13.2.2-2 summarizes measured silt values for public unpaved roads. It should be noted that the ranges of silt content vary over two orders of magnitude. Therefore, the use of data from this table can potentially introduce considerable error. Use of this data is strongly discouraged when it is feasible to obtain locally gathered data.

Since the silt content of a rural dirt road will vary with geographic location, it should be measured for use in projecting emissions. As a conservative approximation, the silt content of the parent soil in the area can be used. Tests, however, show that road silt content is normally lower than in the surrounding parent soil, because the fines are continually removed by the vehicle traffic, leaving a higher percentage of coarse particles.

PET 797
REC 1163

Other variables are important in addition to the silt content of the road surface material. For example, at industrial sites, where haul trucks and other heavy equipment are common, emissions are highly correlated with vehicle weight. On the other hand, there is far less variability in the weights of cars and pickup trucks that commonly travel publicly accessible unpaved roads throughout the United States. For those roads, the moisture content of the road surface material may be more dominant in determining differences in emission levels between, for example a hot, desert environment and a cool, moist location.

The PM-10 and TSP emission factors presented below are the outcomes from stepwise linear regressions of field emission test results of vehicles traveling over unpaved surfaces. Due to a limited amount of information available for PM-2.5, the expression for that particle size range has been scaled against the result for PM-10. Consequently, the quality rating for the PM-2.5 factor is lower than that for the PM-10 expression.

PET 798

REC 1164

Table 13.2.2-1. TYPICAL SILT CONTENT VALUES OF SURFACE MATERIAL ON INDUSTRIAL UNPAVED ROADS[a]

Industry	Road Use Or Surface Material	Plant Sites	No. Of Samples	Silt Content (%)	
				Range	Mean
Copper smelting	Plant road	1	3	16 - 19	17
Iron and steel production	Plant road	19	135	0.2 - 19	6.0
Sand and gravel processing	Plant road	1	3	4.1 - 6.0	4.8
	Material storage area	1	1	-	7.1
Stone quarrying and processing	Plant road	2	10	2.4 - 16	10
	Haul road to/from pit	4	20	5.0-15	8.3
Taconite mining and processing	Service road	1	8	2.4 - 7.1	4.3
	Haul road to/from pit	1	12	3.9 - 9.7	5.8
Western surface coal mining	Haul road to/from pit	3	21	2.8 - 18	8.4
	Plant road	2	2	4.9 - 5.3	5.1
	Scraper route	3	10	7.2 - 25	17
	Haul road (freshly graded)	2	5	18 - 29	24
Construction sites	Scraper routes	7	20	0.56-23	8.5
Lumber sawmills	Log yards	2	2	4.8-12	8.4
Municipal solid waste landfills	Disposal routes	4	20	2.2 - 21	6.4

[a]References 1,5-15.

PET 799
REC 1165

The following empirical expressions may be used to estimate the quantity in pounds (lb) of size-specific particulate emissions from an unpaved road, per vehicle mile traveled (VMT):

For vehicles traveling on unpaved surfaces at industrial sites, emissions are estimated from the following equation:

$$E = k\,(s/12)^a (W/3)^b \quad (1a)$$

and, for vehicles traveling on publicly accessible roads, dominated by light duty vehicles, emissions may be estimated from the following:

$$E = \frac{k\,(s/12)^a (S/30)^d}{(M/0.5)^c} - C \quad (1b)$$

where k, a, b, c and d are empirical constants (Reference 6) given below and

E = size-specific emission factor (lb/VMT)
s = surface material silt content (%)
W = mean vehicle weight (tons)
M = surface material moisture content (%)
S = mean vehicle speed (mph)
C = emission factor for 1980's vehicle fleet exhaust, brake wear and tire wear.

The source characteristics s, W and M are referred to as correction parameters for adjusting the emission estimates to local conditions. The metric conversion from lb/VMT to grams (g) per vehicle kilometer traveled (VKT) is as follows:

1 lb/VMT = 281.9 g/VKT

The constants for Equations 1a and 1b based on the stated aerodynamic particle sizes are shown in Tables 13.2.2-2 and 13.2.2-4. The PM-2.5 particle size multipliers (k-factors) are taken from Reference 27.

Table 13.2.2-2. CONSTANTS FOR EQUATIONS 1a AND 1b

Constant	Industrial Roads (Equation 1a)			Public Roads (Equation 1b)		
	PM-2.5	PM-10	PM-30*	PM-2.5	PM-10	PM-30*
k (lb/VMT)	0.15	1.5	4.9	0.18	1.8	6.0
a	0.9	0.9	0.7	1	1	1
b	0.45	0.45	0.45	-	-	-
c	-	-	-	0.2	0.2	0.3
d	-	-	-	0.5	0.5	0.3
Quality Rating	B	B	B	B	B	B

*Assumed equivalent to total suspended particulate matter (TSP)
"-" = not used in the emission factor equation

Table 13.2.2-2 also contains the quality ratings for the various size-specific versions of Equation 1a and 1b. The equation retains the assigned quality rating, if applied within the ranges of source conditions, shown in Table 13.2.2-3, that were tested in developing the equation:

Table 13.2.2-3. RANGE OF SOURCE CONDITIONS USED IN DEVELOPING EQUATION 1a AND 1b

Emission Factor	Surface Silt Content, %	Mean Vehicle Weight		Mean Vehicle Speed		Mean No. of Wheels	Surface Moisture Content, %
		Mg	ton	km/hr	mph		
Industrial Roads (Equation 1a)	1.8-25.2	1.8-260	2-290	8-69	5-43	4-17[a]	0.03-13
Public Roads (Equation 1b)	1.8-35	1.4-2.7	1.5-3	16-88	10-55	4-4.8	0.03-13

[a] See discussion in text.

As noted earlier, the models presented as Equations 1a and 1b were developed from tests of traffic on unpaved surfaces. Unpaved roads have a hard, generally nonporous surface that usually dries quickly after a rainfall or watering, because of traffic-enhanced natural evaporation. (Factors influencing how fast a road dries are discussed in Section 13.2.2.3, below.) The quality ratings given above pertain to the mid-range of the measured source conditions for the equation. A higher mean vehicle weight and a higher than normal traffic rate may be justified when performing a worst-case analysis of emissions from unpaved roads.

The emission factors for the exhaust, brake wear and tire wear of a 1980's vehicle fleet (*C*) was obtained from EPA's MOBILE6.2 model [23]. The emission factor also varies with aerodynamic size range

PET 801
REC 1167

as shown in Table 13.2.2-4

Table 13.2.2-4. EMISSION FACTOR FOR 1980'S VEHICLE FLEET EXHAUST, BRAKE WEAR AND TIRE WEAR

Particle Size Range[a]	*C*, Emission Factor for Exhaust, Brake Wear and Tire Wear[b] lb/VMT
$PM_{2.5}$	0.00036
PM_{10}	0.00047
PM_{30}[c]	0.00047

[a] Refers to airborne particulate matter (PM-x) with an aerodynamic diameter equal to or less than x micrometers.
[b] Units shown are pounds per vehicle mile traveled (lb/VMT).
[c] PM-30 is sometimes termed "suspendable particulate" (SP) and is often used as a surrogate for TSP.

It is important to note that the vehicle-related source conditions refer to the average weight, speed, and number of wheels for all vehicles traveling the road. For example, if 98 percent of traffic on the road are 2-ton cars and trucks while the remaining 2 percent consists of 20-ton trucks, then the mean weight is 2.4 tons. More specifically, Equations 1a and 1b are *not* intended to be used to calculate a separate emission factor for each vehicle class within a mix of traffic on a given unpaved road. That is, in the example, one should *not* determine one factor for the 2-ton vehicles and a second factor for the 20-ton trucks. Instead, only one emission factor should be calculated that represents the "fleet" average of 2.4 tons for all vehicles traveling the road.

Moreover, to retain the quality ratings when addressing a group of unpaved roads, it is necessary that reliable correction parameter values be determined for the road in question. The field and laboratory procedures for determining road surface silt and moisture contents are given in AP-42 Appendices C.1 and C.2. Vehicle-related parameters should be developed by recording visual observations of traffic. In some cases, vehicle parameters for industrial unpaved roads can be determined by reviewing maintenance records or other information sources at the facility.

In the event that site-specific values for correction parameters cannot be obtained, then default values may be used.In the absence of site-specific silt content information, an appropriate mean value from Table 13.2.2-1 may be used as a default value, but the quality rating of the equation is reduced by two letters. Because of significant differences found between different types of road surfaces and between different areas of the country, use of the default moisture content value of 0.5 percent in Equation 1b is discouraged. The quality rating should be downgraded two letters when the default moisture content value is used. (It is assumed that readers addressing industrial roads have access to the information needed to develop average vehicle information in Equation 1a for their facility.)

The effect of routine watering to control emissions from unpaved roads is discussed below in Section 13.2.2.3, “Controls”. However, all roads are subject to some natural mitigation because of rainfall and other precipitation. The Equation 1a and 1b emission factors can be extrapolated to annual

average uncontrolled conditions (but including natural mitigation) under the simplifying assumption that annual average emissions are inversely proportional to the number of days with measurable (more than 0.254 mm [0.01 inch]) precipitation:

$$E_{ext} = E\ [(365 - P)/365] \quad (2)$$

where:

E_{ext} = annual size-specific emission factor extrapolated for natural mitigation, lb/VMT

E = emission factor from Equation 1a or 1b

P = number of days in a year with at least 0.254 mm (0.01 in) of precipitation (see below)

Figure 13.2.2-1 gives the geographical distribution for the mean annual number of "wet" days for the United States.

Equation 2 provides an estimate that accounts for precipitation on an annual average basis for the purpose of inventorying emissions. It should be noted that Equation 2 does not account for differences in the temporal distributions of the rain events, the quantity of rain during any event, or the potential for the rain to evaporate from the road surface. In the event that a finer temporal and spatial resolution is desired for inventories of public unpaved roads, estimates can be based on a more complex set of assumptions. These assumptions include:

1. The moisture content of the road surface material is increased in proportion to the quantity of water added;
2. The moisture content of the road surface material is reduced in proportion to the Class A pan evaporation rate;
3. The moisture content of the road surface material is reduced in proportion to the traffic volume; and
4. The moisture content of the road surface material varies between the extremes observed in the area. The CHIEF Web site (http://www.epa.gov/ttn/chief/ap42/ch13/related/c13s02-2.html) has a file which contains a spreadsheet program for calculating emission factors which are temporally and spatially resolved. Information required for use of the spreadsheet program includes monthly Class A pan evaporation values, hourly meteorological data for precipitation, humidity and snow cover, vehicle traffic information, and road surface material information.

It is emphasized that the simple assumption underlying Equation 2 and the more complex set of assumptions underlying the use of the procedure which produces a finer temporal and spatial resolution have not been verified in any rigorous manner. For this reason, the quality ratings for either approach should be downgraded one letter from the rating that would be applied to Equation 1.

13.2.2.3 Controls[18-22]

A wide variety of options exist to control emissions from unpaved roads. Options fall into the following three groupings:

1. Vehicle restrictions that limit the speed, weight or number of vehicles on the road;

PET 803

REC 1169

2. Surface improvement, by measures such as (a) paving or (b) adding gravel or slag to a dirt road; and
3. Surface treatment, such as watering or treatment with chemical dust suppressants.

Available control options span broad ranges in terms of cost, efficiency, and applicability. For example, traffic controls provide moderate emission reductions (often at little cost) but are difficult to enforce. Although paving is highly effective, its high initial cost is often prohibitive. Furthermore, paving is not feasible for industrial roads subject to very heavy vehicles and/or spillage of material in transport. Watering and chemical suppressants, on the other hand, are potentially applicable to most industrial roads at moderate to low costs. However, these require frequent reapplication to maintain an acceptable level of control. Chemical suppressants are generally more cost-effective than water but not in cases of temporary roads (which are common at mines, landfills, and construction sites). In summary, then, one needs to consider not only the type and volume of traffic on the road but also how long the road will be in service when developing control plans.

Vehicle restrictions. These measures seek to limit the amount and type of traffic present on the road or to lower the mean vehicle speed. For example, many industrial plants have restricted employees from driving on plant property and have instead instituted bussing programs. This eliminates emissions due to employees traveling to/from their worksites. Although the heavier average vehicle weight of the busses increases the base emission factor, the decrease in vehicle-miles-traveled results in a lower overall emission rate.

PET 804
REC 1170

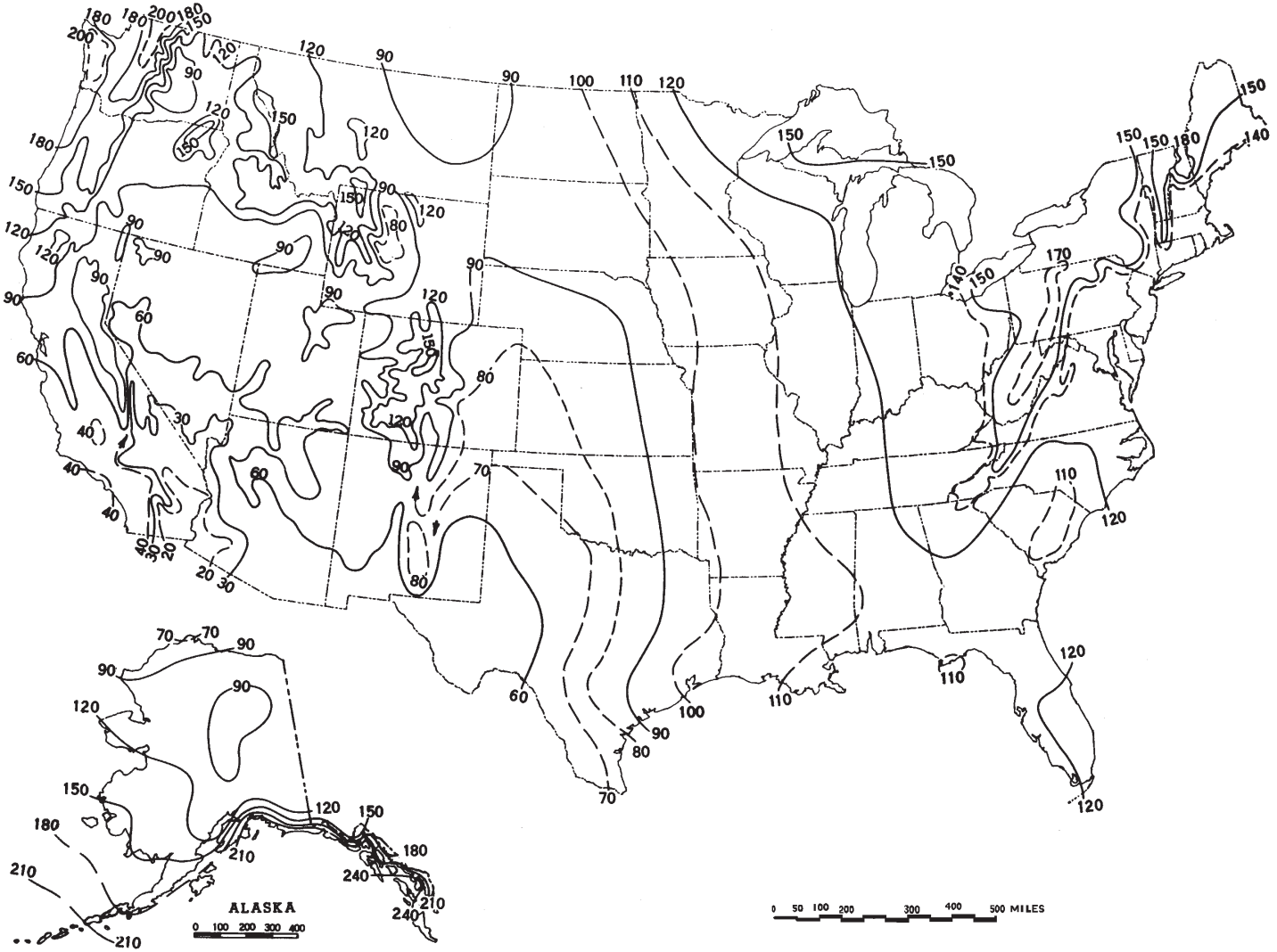


Figure 13.2.2-1. Mean number of days with 0.01 inch or more of precipitation in United States.

Surface improvements. Control options in this category alter the road surface. As opposed to the "surface treatments" discussed below, improvements are relatively "permanent" and do not require periodic retreatment.

The most obvious surface improvement is paving an unpaved road. This option is quite expensive and is probably most applicable to relatively short stretches of unpaved road with at least several hundred vehicle passes per day. Furthermore, if the newly paved road is located near unpaved areas or is used to transport material, it is essential that the control plan address routine cleaning of the newly paved road surface.

The control efficiencies achievable by paving can be estimated by comparing emission factors for unpaved and paved road conditions. The predictive emission factor equation for paved roads, given in Section 13.2.1, requires estimation of the silt loading on the traveled portion of the paved surface, which in turn depends on whether the pavement is periodically cleaned. Unless curbing is to be installed, the effects of vehicle excursion onto unpaved shoulders (berms) also must be taken into account in estimating the control efficiency of paving.

Other improvement methods cover the road surface with another material that has a lower silt content. Examples include placing gravel or slag on a dirt road. Control efficiency can be estimated by comparing the emission factors obtained using the silt contents before and after improvement. The silt content of the road surface should be determined after 3 to 6 months rather than immediately following placement. Control plans should address regular maintenance practices, such as grading, to retain larger aggregate on the traveled portion of the road.

Surface treatments refer to control options which require periodic reapplication. Treatments fall into the two main categories of (a) "wet suppression" (i. e., watering, possibly with surfactants or other additives), which keeps the road surface wet to control emissions and (b) "chemical stabilization/ treatment", which attempts to change the physical characteristics of the surface. The necessary reapplication frequency varies from several minutes for plain water under summertime conditions to several weeks or months for chemical dust suppressants.

Watering increases the moisture content, which conglomerates particles and reduces their likelihood to become suspended when vehicles pass over the surface. The control efficiency depends on how fast the road dries after water is added. This in turn depends on (a) the amount (per unit road surface area) of water added during each application; (b) the period of time between applications; (c) the weight, speed and number of vehicles traveling over the watered road during the period between applications; and (d) meteorological conditions (temperature, wind speed, cloud cover, etc.) that affect evaporation during the period.

Figure 13.2.2-2 presents a simple bilinear relationship between the instantaneous control efficiency due to watering and the resulting increase in surface moisture. The moisture ratio "M" (i.e., the x-axis in Figure 13.2.2-2) is found by dividing the surface moisture content of the watered road by the surface moisture content of the uncontrolled road. As the watered road surface dries, both the ratio M and the predicted instantaneous control efficiency (i.e., the y-axis in the figure) decrease. The figure shows that between the uncontrolled moisture content and a value twice as large, a small increase in moisture content results in a large increase in control efficiency. Beyond that, control efficiency grows slowly with increased moisture content.

Given the complicated nature of how the road dries, characterization of emissions from watered roadways is best done by collecting road surface material samples at various times between water truck passes. (Appendices C.1 and C.2 present the sampling and analysis procedures.) The moisture content measured can then be associated with a control efficiency by use of Figure 13.2.2-2. Samples that reflect average conditions during the watering cycle can take the form of either a series of samples between water applications or a single sample at the midpoint. It is essential that samples be collected during periods with active traffic on the road. Finally, because of different evaporation rates, it is recommended that samples be collected at various times during the year. If only one set of samples is to be collected, these must be collected during hot, summertime conditions.

When developing watering control plans for roads that do not yet exist, it is strongly recommended that the moisture cycle be established by sampling similar roads in the same geographic area. If the moisture cycle cannot be established by similar roads using established watering control plans, the more complex methodology used to estimate the mitigation of rainfall and other precipitation can be used to estimate the control provided by routine watering. An estimate of the maximum daytime Class A pan evaporation (based upon daily evaporation data published in the monthly Climatological Data for the state by the National Climatic Data Center) should be used to insure that adequate watering capability is available during periods of highest evaporation. The hourly precipitation values in the spreadsheet should be replaced with the equivalent inches of precipitation (where the equivalent of 1 inch of precipitation is provided by an application of 5.6 gallons of water per square yard of road). Information on the long term average annual evaporation and on the percentage that occurs between May and October was published in the Climatic Atlas (Reference 16). Figure 13.2.2-3 presents the geographical distribution for "Class A pan evaporation" throughout the United States. Figure 13.2.2-4 presents the geographical distribution of the percentage of this evaporation that occurs between May and October. The U. S. Weather Bureau Class A evaporation pan is a cylindrical metal container with a depth of 10 inches and a diameter of 48 inches. Periodic measurements are made of the changes of the water level.

The above methodology should be used only for prospective analyses and for designing watering programs for existing roadways. The quality rating of an emission factor for a watered road that is based on this methodology should be downgraded two letters. Periodic road surface samples should be collected and analyzed to verify the efficiency of the watering program.

As opposed to watering, chemical dust suppressants have much less frequent reapplication requirements. These materials suppress emissions by changing the physical characteristics of the existing road surface material. Many chemical unpaved road dust suppressants form a hardened surface that binds particles together. After several applications, a treated road often resembles a paved road except that the surface is not uniformly flat. Because the improved surface results in more grinding of small particles, the silt content of loose material on a highly controlled surface may be substantially higher than when the surface was uncontrolled. For this reason, the models presented as Equations 1a and 1b cannot be used to estimate emissions from chemically stabilized roads. Should the road be allowed to return to an

PET 807
REC 1173

uncontrolled state with no visible signs of large-scale cementing of material, the Equation 1a and 1b emission factors could then be used to obtain conservatively high emission estimates.

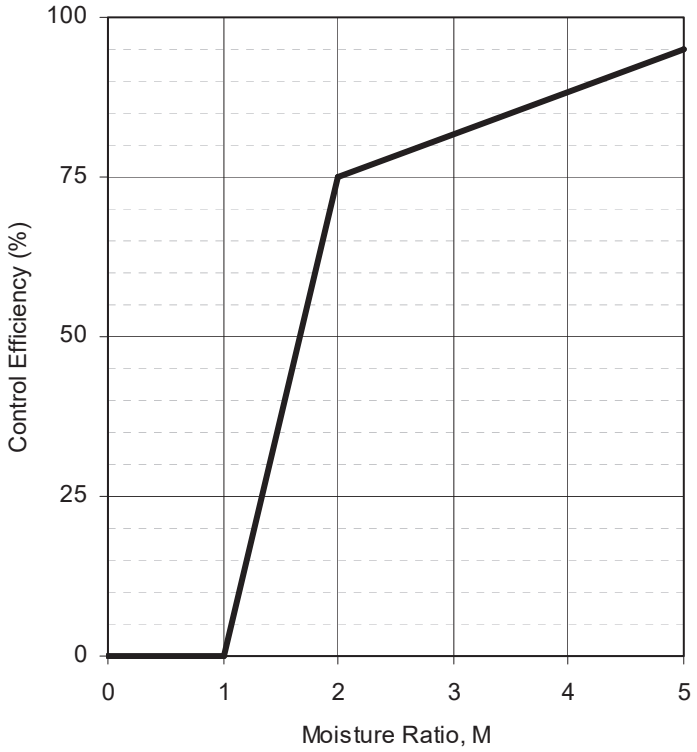


Figure 13.2.2-2. Watering control effectiveness for unpaved travel surfaces

The control effectiveness of chemical dust suppressants appears to depend on (a) the dilution rate used in the mixture; (b) the application rate (volume of solution per unit road surface area); (c) the time between applications; (d) the size, speed and amount of traffic during the period between applications; and (e) meteorological conditions (rainfall, freeze/thaw cycles, etc.) during the period. Other factors that affect the performance of dust suppressants include other traffic characteristics (e. g., cornering, track-on from unpaved areas) and road characteristics (e. g., bearing strength, grade). The variabilities in the above factors and differences between individual dust control products make the control efficiencies of chemical dust suppressants difficult to estimate. Past field testing of emissions from controlled unpaved roads has shown that chemical dust suppressants provide a PM-10 control efficiency of about 80 percent when applied at regular intervals of 2 weeks to 1 month.

PET 809
REC 1175

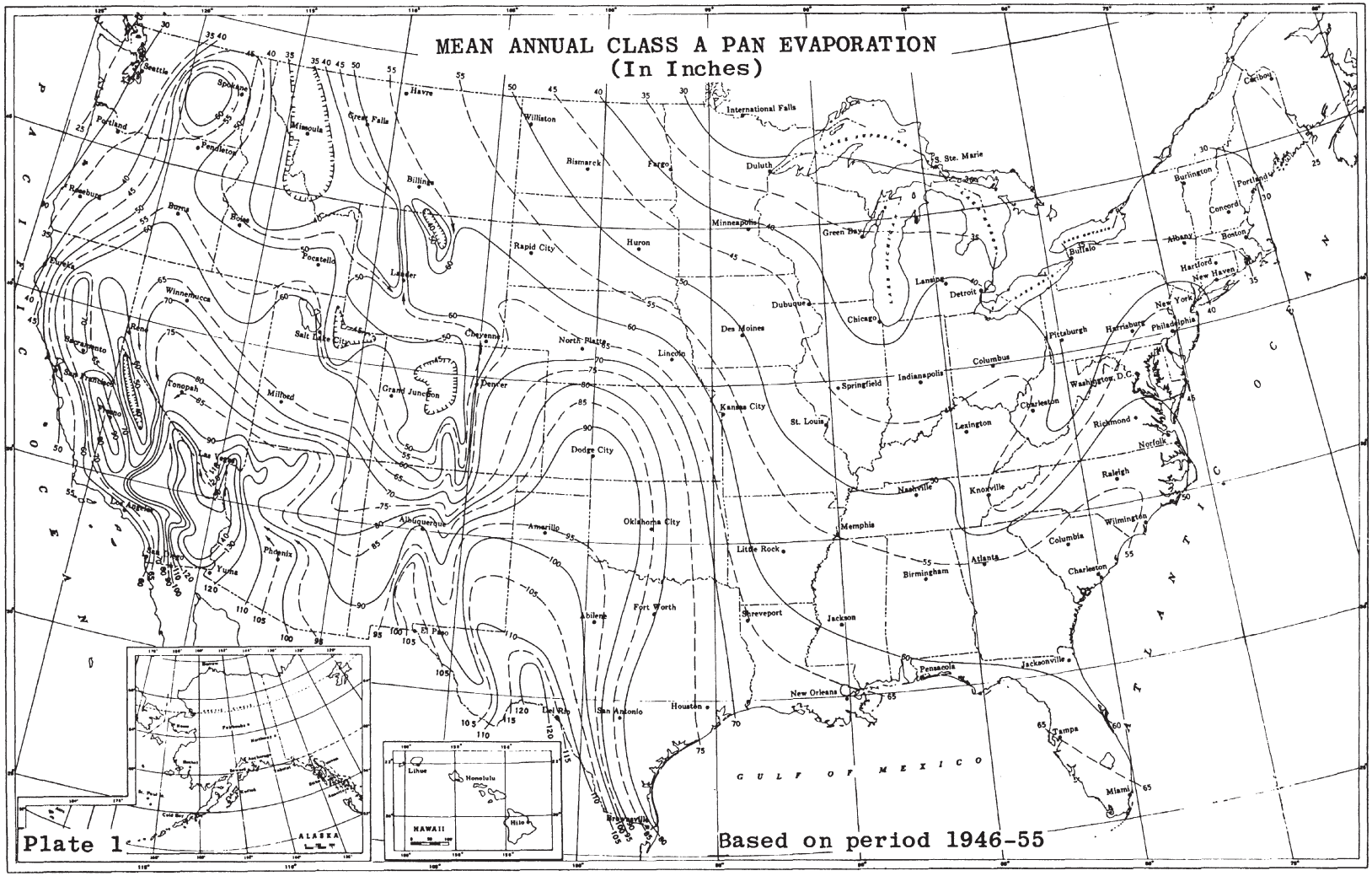


Figure 13.2.2-3. Annual evaporation data.

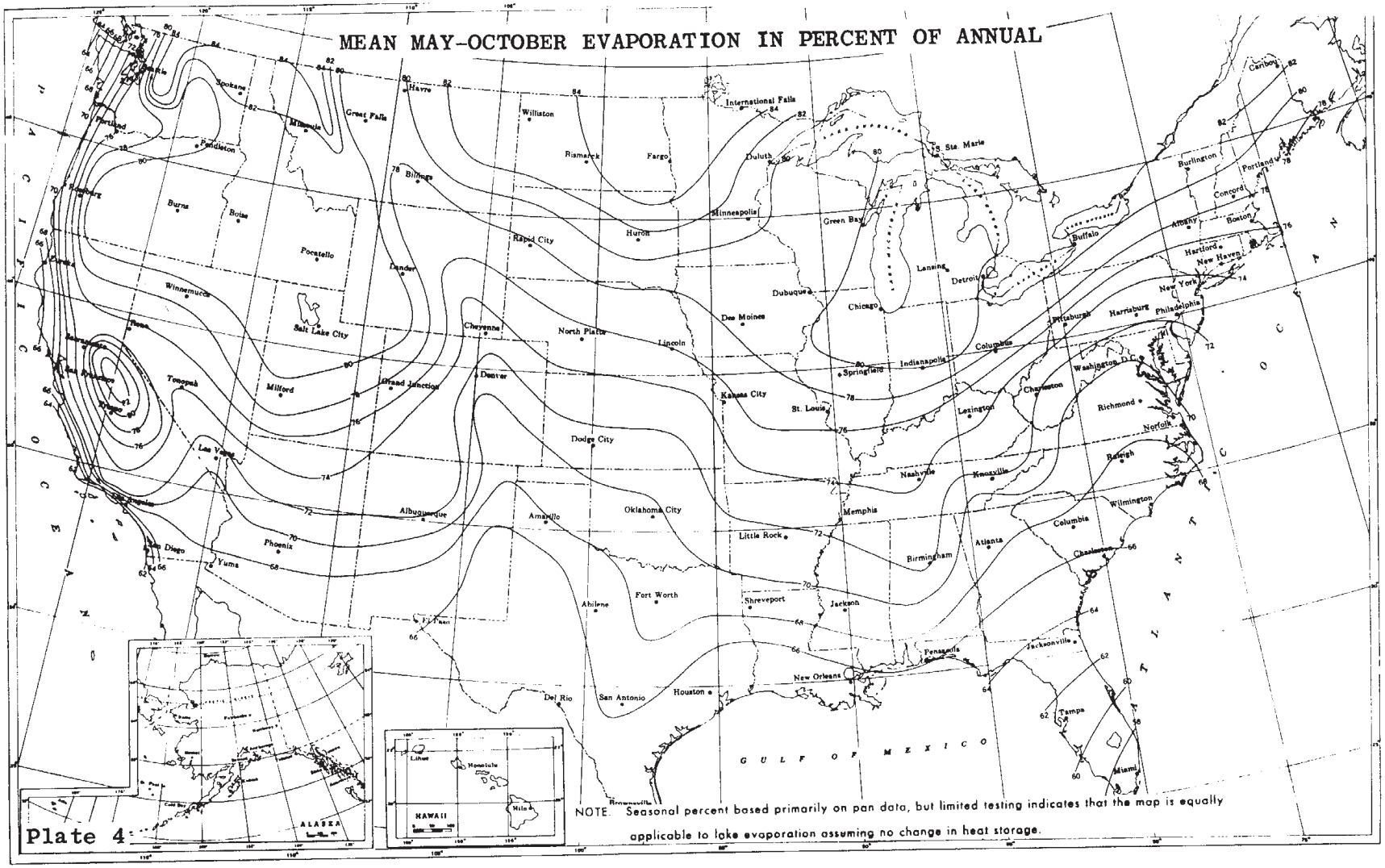


Figure 13.2.2-4. Geographical distribution of the percentage of evaporation occurring between May and October.

Petroleum resin products historically have been the dust suppressants (besides water) most widely used on industrial unpaved roads. Figure 13.2.2-5 presents a method to estimate average control efficiencies associated with petroleum resins applied to unpaved roads.[20] Several items should be noted:

1. The term "ground inventory" represents the total volume (per unit area) of petroleum resin concentrate (*not solution*) applied since the start of the dust control season.

2. Because petroleum resin products must be periodically reapplied to unpaved roads, the use of a time-averaged control efficiency value is appropriate. Figure 13.2.2-5 presents control efficiency values averaged over two common application intervals, 2 weeks and 1 month. Other application intervals will require interpolation.

3. Note that zero efficiency is assigned until the ground inventory reaches 0.05 gallon per square yard (gal/yd^2). Requiring a minimum ground inventory ensures that one must apply a reasonable amount of chemical dust suppressant to a road before claiming credit for emission control. Recall that the ground inventory refers to the amount of petroleum resin concentrate rather than the total solution.

As an example of the application of Figure 13.2.2-5, suppose that Equation 1a was used to estimate an emission factor of 7.1 lb/VMT for PM-10 from a particular road. Also, suppose that, starting on May 1, the road is treated with 0.221 gal/yd^2 of a solution (1 part petroleum resin to 5 parts water) on the first of each month through September. Then, the average controlled emission factors, shown in Table 13.2.2-5, are found.

Table 13.2-2-5. EXAMPLE OF AVERAGE CONTROLLED EMISSION FACTORS FOR SPECIFIC CONDITIONS

Period	Ground Inventory, gal/yd^2	Average Control Efficiency, %[a]	Average Controlled Emission Factor, lb/VMT
May	0.037	0	7.1
June	0.073	62	2.7
July	0.11	68	2.3
August	0.15	74	1.8
September	0.18	80	1.4

[a] From Figure 13.2.2-5, ≤10 µm. Zero efficiency assigned if ground inventory is less than 0.05 gal/yd^2. 1 lb/VMT = 281.9 g/VKT. 1 gal/yd^2 = 4.531 L/m^2.

Besides petroleum resins, other newer dust suppressants have also been successful in controlling emissions from unpaved roads. Specific test results for those chemicals, as well as for petroleum resins and watering, are provided in References 18 through 21.

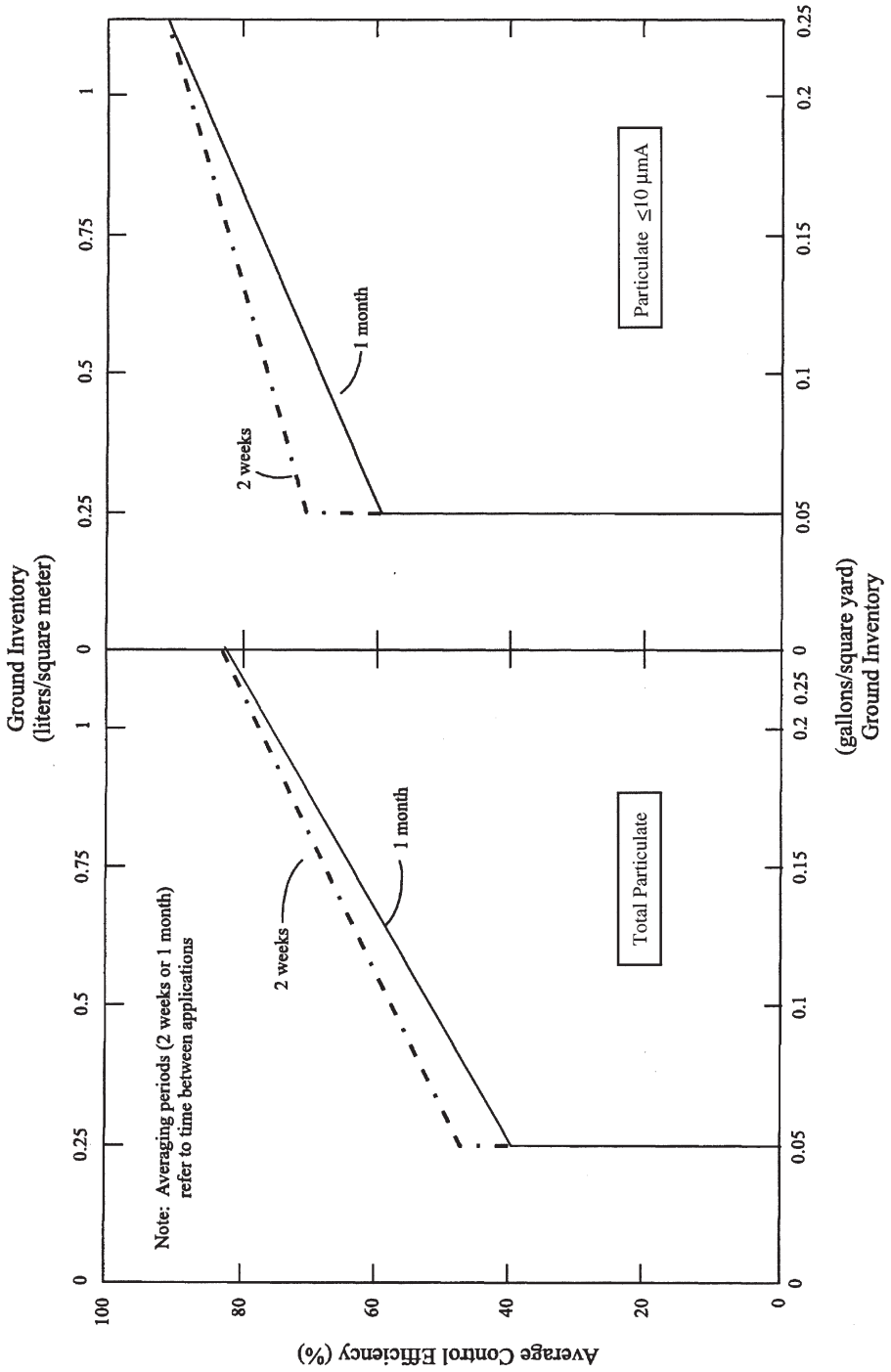


Figure 13.2.2-5. Average control efficiencies over common application intervals.

PET 813

REC 1179

13.2.2.4 Updates Since The Fifth Edition

The Fifth Edition was released in January 1995. Revisions to this section since that date are summarized below. For further detail, consult the background report for this section (Reference 6).

October 1998 (Supplement E)– This was a major revision of this section. Significant changes to the text and the emission factor equations were made.

October 2001 – Separate emission factors for unpaved surfaces at industrial sites and publicly accessible roads were introduced. Figure 13.2.2-2 was included to provide control effectiveness estimates for watered roads.

December 2003 – The public road emission factor equation (equation 1b) was adjusted to remove the component of particulate emissions from exhaust, brake wear, and tire wear. The parameter C in the new equation varies with aerodynamic size range of the particulate matter. Table 13.2.2-4 was added to present the new coefficients.

January 2006 – The PM-2.5 particle size multipliers (i.e., factors) in Table 13.2.2-2 were modified and the quality ratings were upgraded from C to B based on the wind tunnel studies of a variety of dust emitting surface materials.

References For Section 13.2.2

1. C. Cowherd, Jr., *et al., Development Of Emission Factors For Fugitive Dust Sources,* EPA-450/3-74-037, U. S. Environmental Protection Agency, Research Triangle Park, NC, June 1974.

2. R. J. Dyck and J. J. Stukel, "Fugitive Dust Emissions From Trucks On Unpaved Roads", *Environmental Science And Technology, 10*(10):1046-1048, October 1976.

3. R. O. McCaldin and K. J. Heidel, "Particulate Emissions From Vehicle Travel Over Unpaved Roads", Presented at the 71st Annual Meeting of the Air Pollution Control Association, Houston, TX, June 1978.

4. C. Cowherd, Jr, *et al., Iron And Steel Plant Open Dust Source Fugitive Emission Evaluation*, EPA-600/2-79-013, U. S. Environmental Protection Agency, Cincinnati, OH, May 1979.

5. G. Muleski, *Unpaved Road Emission Impact*, Arizona Department of Environmental Quality, Phoenix, AZ, March 1991.

6. *Emission Factor Documentation For AP-42, Section 13.2.2, Unpaved Roads, Final Report*, Midwest Research Institute, Kansas City, MO, September 1998.

7. T. Cuscino, Jr., *et al., Taconite Mining Fugitive Emissions Study*, Minnesota Pollution Control Agency, Roseville, MN, June 1979.

8. *Improved Emission Factors For Fugitive Dust From Western Surface Coal Mining Sources*, 2 Volumes, EPA Contract No. 68-03-2924, Office of Air Quality Planning and Standards, U. S. Environmental Protection Agency, Research Triangle Park, NC.

PET 814

REC 1180

9. T. Cuscino, Jr., *et al., Iron And Steel Plant Open Source Fugitive Emission Control Evaluation*, EPA-600/2-83-110, U. S. Environmental Protection Agency, Cincinnati, OH, October 1983.

10. *Size Specific Emission Factors For Uncontrolled Industrial And Rural Roads*, EPA Contract No. 68-02-3158, Midwest Research Institute, Kansas City, MO, September 1983.

11. C. Cowherd, Jr., and P. Englehart, *Size Specific Particulate Emission Factors For Industrial And Rural Roads*, EPA-600/7-85-038, U. S. Environmental Protection Agency, Cincinnati, OH, September 1985.

12. *PM-10 Emission Inventory Of Landfills In The Lake Calumet Area*, EPA Contract 68-02-3891, Work Assignment 30, Midwest Research Institute, Kansas City, MO, September 1987.

13. *Chicago Area Particulate Matter Emission Inventory — Sampling And Analysis*, EPA Contract No. 68-02-4395, Work Assignment 1, Midwest Research Institute, Kansas City, MO, May 1988.

14. *PM-10 Emissions Inventory Data For The Maricopa And Pima Planning Areas*, EPA Contract No. 68-02-3888, Engineering-Science, Pasadena, CA, January 1987.

15. *Oregon Fugitive Dust Emission Inventory*, EPA Contract 68-D0-0123, Midwest Research Institute, Kansas City, MO, January 1992.

16. *Climatic Atlas Of The United States*, U. S. Department Of Commerce, Washington, DC, June 1968.

17. National Climatic Data Center, *Solar And Meteorological Surface Observation Network 1961-1990*; 3 Volume CD-ROM. Asheville, NC, 1993.

18. C. Cowherd, Jr. *et al., Control Of Open Fugitive Dust Sources*, EPA-450/3-88-008, U. S. Environmental Protection Agency, Research Triangle Park, NC, September 1988.

19. G. E. Muleski, *et al., Extended Evaluation Of Unpaved Road Dust Suppressants In The Iron And Steel Industry*, EPA-600/2-84-027, U. S. Environmental Protection Agency, Cincinnati, OH, February 1984.

20. C. Cowherd, Jr., and J. S. Kinsey, *Identification, Assessment And Control Of Fugitive Particulate Emissions*, EPA-600/8-86-023, U. S. Environmental Protection Agency, Cincinnati, OH, August 1986.

21. G. E. Muleski and C. Cowherd, Jr., *Evaluation Of The Effectiveness Of Chemical Dust Suppressants On Unpaved Roads*, EPA-600/2-87-102, U. S. Environmental Protection Agency, Cincinnati, OH, November 1986.

22. *Fugitive Dust Background Document And Technical Information Document For Best Available Control Measures*, EPA-450/2-92-004, Office Of Air Quality Planning And Standards, U. S. Environmental Protection Agency, Research Triangle Park, NC, September 1992.

23. Written communication (Technical Memorandum) from P. Hemmer, E.H. Pechan & Associates, Inc., Durham, NC to B. Kuykendal, U. S. Environmental Protection Agency, Research Triangle Park, NC, August, 21, 2003.

PET 815

REC 1181

24. MOBILE6 User Guide, United States Environmental Protection Agency, Office of Transportation and Air Quality. EPA420-R-02-028, October 2002.

25. Written communication (Technical Memorandum) from G. Muleski, Midwest Research Institute, Kansas City, MO, to B. Kuykendal, U. S. Environmental Protection Agency, Research Triangle Park, NC, Subject "Unpaved Roads", September 27, 2001.

26. Written communication (Technical Memorandum) from W. Kuykendal, U. S. Environmental Protection Agency, to File, Subject "Decisions on Final AP-42 Section 13.2.2 Unpaved Roads", November 24, 2003.

27. C. Cowherd, *Background Document for Revisions to Fine Fraction Ratios &sed for AP-42 Fugitive Dust Emission Factors*. Prepared by Midwest Research Institute for Western Governors Association, Western Regional Air Partnership, Denver, CO, February 1, 2006.

ARSENIC MODELING ADDENDUM REVIEW, IDENTIFIED QUESTIONS, AND CONCERNS (as per Kevin Schilling)

1.0 Deficiencies of the Existing TAPs Analyses

1.1 NESHAP-Addressed Sources Incorrectly Identified

The latest TAPs Section 210 analyses DEQ received (prior to the special arsenic analysis) incorrectly excluded some carcinogenic TAP emissions from the inventory, screening emission level (EL) analyses, and modeling analysis using the provision that such emissions were addressed by a NESHAP. This included arsenic and a host of other carcinogenic TAPs. Arsenic is the controlling TAP, as it was confidently estimated that if the arsenic TAP increment could be met, then the increment for other TAPs could be easily met.

1.2 Ideas for Path Forward

DEQ modelers brainstormed ideas for refining the arsenic analyses, including:

1. Refining arsenic emissions from road dust by committing to use road base material having a lower arsenic concentration.
2. Looking at the life of the mine and making adjustments to account for a life-time (70-year) risk. DEQ would need legal opinion as to whether this meets requirements of Section 210.
3. Demonstrating that T-RACT is used for arsenic emission sources.
4. Account for operational scenarios at different stages of the mine life. For example, during years 3-5 maximum emissions might be 200 lbs/year from Source X and 50 lbs/year from Source Y, but in years 6-10 emissions might be 50 lbs/year from Source X and 200 lbs/year from Source Y. Without scenarios, we would be allowing 200 lbs/year from Source X and 200 lbs/year from source Y, thereby overestimating emissions by 150 lbs/year for each year. The challenge with this approach is that the permit would need to make the change in annual allowable emissions from specific sources reasonably enforceable.

The modelers' general idea would be that a revised Section 210 analysis would be done using some of the above refinements, while still only looking at Non-NESHAP sources. There would also be utility in Air Sciences performing a risk-based arsenic analysis considering all emission sources, since this is what the public is most concerned with.

PET 817

REC 1183

1.3 Discussion with Air Sciences

After identification of improper exclusion of TAP sources in Section 210 analyses, DEQ internal discussions on a path forward occurred on June 8. On July 9, I sent out a 1-page analysis approach that could be used for TAP compliance. This was an internal document only. This approach included: 1) identify sources that must be modeled and exclude those not applicable; 2) refine TAP emissions, perhaps using less conservative emission-affecting parameters (different road base, seasonality, additional operational scenarios); 3) refine dispersion-affecting parameters in the model, including deposition; 4) demonstrate T-RACT is implemented; 5) account for an exposure period of less than 70 years; 6) explore the idea of using a longer averaging period for emission and throughput limits in the permit; 7) evaluate use of a more refined model such as CALPUFF; 8) propose ambient sampling to demonstrate unacceptable levels are not generated.

A 1-hour meeting was held between Mike Simon, Kevin Schilling, Dale Kerner (Perpetua), and Kevin Lewis (Air Sciences) to discuss the issues and potential paths forward. The above mentioned ideas were brought up and seemed to be consistent with what Air Sciences was thinking.

Kevin Lewis contacted me on June 17th to discuss some issues/questions on the analyses they were performing. I was on vacation (he called my personal cell) during this week but indicated in an email reply that time could be made to discuss issues. I also indicated that Pao Baylon was available to discuss methods/data for the refined arsenic analysis. Kevin Lewis tried to contact me again on June 18th (I was still on vacation) about a brief discussion in the afternoon; however, I indicated the afternoon wouldn't work but an evening call could. Kevin Lewis then stated that he would contact me after I returned from vacation. Additional discussions did not occur and the arsenic analysis was submitted on July 8, 2021

2.0 Air Science's Special Arsenic Analysis Submittal

What DEQ received on July 8, 2021, was a complete rework for the arsenic emission inventory and an impact analysis considering all arsenic sources, T-RACT, source-by-source variable emissions by year in the life of the mine, adjustment of averaging periods to 16 years (life of mine) and 70 years (receptor lifetime exposure assumed for AACCs), and revised arsenic emissions from roadways. The operations were based on the SGP Refined Proposed Action – ModPRO2. Air Sciences stated that ModPRO2 is the basis of a Supplemental Draft EIS, currently in preparation by the Forest Service, and it is based on improvements and refinements with a smaller footprint of the mine.

The analysis modeled each of the 16 years of the mine life separately, with varying emissions of sources during each year. With over 400 sources in the model, this results in about 6,700 variables to evaluate (this is somewhat of an overstatement because some sources are modeled as a group of sources, such as road segments).

There were no analyses addressing the identified problems with the Section 210 analyses in the previous submittal, and this special analysis only addresses arsenic. In the introduction, Air Sciences says the submitted arsenic analysis address the public comment request that all TAP emission sources be modeled for a Section 161 analysis.

Year-by-year modeled impacts presented in the special arsenic analyses varied from 0.00017 $\mu g/m^3$ to 0.00208 $\mu g/m^3$, with a 16-year average impact of 0.00068 $\mu g/m^3$. This compares to the AACC of 0.00023 $\mu g/m^3$. However, the T-RACT AACC is 0.0023 $\mu g/m^3$. Also the maximum impact when averaged over a 70-year period is only 0.00015 $\mu g/m^3$. This modeled impact is limited to a small area northeast of the site, near the facility boundary. Within a few thousand meters, impacts drop to below 0.00005 $\mu g/m^3$.

3.0 Legal Question of whether a Different Section 161 Analysis can be used in Place of Section 210 Requirements

Idaho Air Rules Section 203.03 outlines TAP permit requirements for new stationary sources. The rule states:

"*Using the methods provided in Section 210, the emissions of toxic air pollutants from the stationary source or modification would not injure or unreasonably affect human or animal life or vegetation as required by Section 161. Compliance with all applicable toxic air pollutant carcinogenic increments and toxic air pollutant non-carcinogenic increments will also demonstrate preconstruction compliance with Section 161 with regards to the pollutants listed in Sections 585 and 586*."

The question is whether this section locks DEQ into requiring methods in Section 210. This is certainly how DEQ has used this section in the past, but I don't believe we have grappled with idea of using something other than Section 210. This is something our Attorney General should assist us in.

Section 210, may further lock DEQ into specific methods, as it states: "*In accordance with Subsection 203.03, the applicant shall demonstrate preconstruction compliance with Section*

PET 819

REC 1185

161 to the satisfaction of the Department. The accuracy, completeness, execution and results of the demonstration are all subject to review and approval by the Department."

Modeling methods are addressed in Section 210.03. In general it states the applicant may use methods provided in 202.02 to estimate ambient concentrations. Section 202.02 effectively links methods to 40 CFR 51, Appendix W (Guideline on Air Quality Models). Among other things, Appendix W requires modeled rates to be those under PTE or as limited by an enforceable permit condition. DEQ has consistently required TAPs modeling to be in accordance with Section 202.02.

How modeling results are handled is described in Idaho Air Rules Section 210.08, where it states: "*Compare the source's or modification's controlled ambient concentration at the point of compliance for the toxic air pollutant to the applicable acceptable ambient concentration listed in Sections 585 or 586.*" Note that in Section 586, the rules state that "*The AACC in this section are annual averages." The definition of Toxic Air Pollutant Carcinogenic Increments is defined in Section 005.125 as, "Those ambient air quality increments based on the probability of developing excess cancers over a seventy (70) year lifetime exposure to one (1) microgram per cubic meter (1 ug/m^3) of a given carcinogen and expressed in terms of a screening emission level or an acceptable ambient concentration for a carcinogenic toxic air pollutant. They are listed in Section 586.*" The AACCs are based on an acceptable risk of 1-in-1,000,000

4.0 DEQ Review of Arsenic Analysis

4.1 Level of Review

DEQ has not been able to provide a thorough review of submitted information. Although general methods (terrain, meteorological data, most source parameters, etc) have not changed, what was submitted is a substantial reworking of emissions and operational scenarios. Also, because of the workload, substantial review of this submitted analysis was not able to begin until around August 1.

The special arsenic analysis is largely based on emission estimates and operational schedules provided in ModPRO2, which has not been thoroughly reviewed by DEQ at this point. ModPRO2 is largely different from what was submitted in the permit application. It is my opinion that ModPRO2 and the submitted arsenic analysis should be thoroughly reviewed by the DEQ permit writer, as the majority of the revised information is emission rates of year-by-year operational scenarios. The permit writer should also review the T-RACT claims and the

permit writer will need to draft permit conditions to make the assumptions in the analyses reasonably enforceable.

4.2 Differences from Previous Arsenic Analyses

It's difficult to determine whether the submitted analysis is a supplemental analysis or a correction to previous deficiencies, or both. In general, it appears to mainly address the public request for a facility-wide Section 161 type assessment.

The previous TAP analyses did not use operational scenarios, but the PM_{10} and $PM_{2.5}$ analyses used limited operational scenarios, maintaining maximum annual allowable throughput rates. This special arsenic analysis provides year-by-year operational scenarios with each modeled source having different emission rates for each different year. It appears to me that this new analysis is not consistent with the draft permit at this point.

As an example, the current DEQ Statement of Basis lists facility-wide arsenic emissions at 2.4 ton/year, but ModPRO2 suggests arsenic emissions of only 0.217 ton/year (as averaged over the 16 year life of the mine).

4.3 Review Remaining to be Performed

At a minimum, the following of portions of the submitted arsenic analysis are still in need of review:

1. T-RACT documentation and justification, assuring that T-RACT requirements outlined in Section 210 are met.
2. Further review of year-by-year operational levels of various sources.
3. Thorough review of ModPRO2 documentation.
4. Draft questions on the special arsenic analysis and submit to Air Sciences.

5.0 Path Forward

5.1 Overall Thoughts/Concerns

I would have preferred that Air Science perform two separate arsenic analyses. One analysis would be a refined Section 210 analysis, looking only at applicable sources (excluding sources addressed by a NESHAP) but refining by scenarios and by long-term average exposure (70 year or the 16 year life of the mine). The other analysis would be along the lines of what we have

PET 821

REC 1187

now and would address the public's concern about the need to look at all arsenic sources for a comprehensive risk analysis.

For non-arsenic TAPs, a revised analysis should be submitted that addresses the deficiencies identified previously. Alternatively, DEQ could perform our own modeling or make an argument that arsenic is the worst-case TAP and correction of the improperly performed analyses could not result in an exceedance of a TAP increment.

Regardless of which path we take on what the submitted arsenic analysis can be used for, it still needs to be reviewed by the permit writer, who is most familiar with described operations and resulting emissions. The submitted analysis is actually more of an emission inventory revision and refinement than a modeling refinement.

If we move forward with the submitted special arsenic analysis satisfying TAP requirements for permit issuance, the permit writer must draft revised limits to reasonably address the year-to-year variability of operations, throughput, and emissions. As it currently stands, if they operate as allowed in the permit, they will not meet the arsenic AACC; but if they operate as claimed in ModPRO2 then impacts should be fine. Also, there is so much year-to-year and source-to-source variability in emission rates and source-specific throughput that making such parameters enforceable would require an exceptionally complex permit.

5.2 To-Do List

The following must be answered/addressed:

1. Can requirements outlined in Section 210 be disregarded for a Section 161 analysis?
2. Can a 70 year average concentration be used for comparison to AACCs rather than a single year average for Section 210 analyses?
3. For carcinogenic TAPs other than arsenic, we still only have Section 210 analyses that improperly excluded emission sources as being addressed by NESHAPS. Although we highly suspect those other TAPs will not be an issue, we don't have an analysis that shows this.
4. Decide whether we would like Air Sciences to perform a refined Section 220 analysis that excludes NESHAP sources but has less year-to-year variability of parameters to make permit-writing easier.
5. Determine how we handle the new special arsenic analysis. As currently submitted, it is a complete rework of the arsenic inventory. On other

PET 822

REC 1188

projects, we may have asked applicants to withdraw and resubmit, or, at a minimum, would require another public comment period after making the changes.

6. Finish review of the submitted analyses (if applicable), then generate questions for clarification and requests for additional information.
7. Revision of the modeling memo, the Statement of Basis, and the proposed permit.

==========

Additional Thoughts/Concerns

Appendix W Requirement

Idaho Air Rules, Section 202.02 states, "All estimates of ambient concentrations shall be based on the applicable air quality models, data bases, and other requirements specified in 40 CFR 51, Appendix W (Guideline on Air Quality Models). Appendix W, as federal rule, only discusses permitting from the perspective of PSD. It is assumed from Idaho Air Rules that we are to apply Appendix W guidance to minor source modeling to the extent that it can be.

Appendix W Section 8.2.2.c (Source Data Requirements) states that "the new or modifying stationary point source shall be modeled with "allowable" emissions in the regulatory dispersion modeling." Table 8-2 of Appendix W further states that the operating level of the proposed source must be at "design capacity or federally enforceable permit condition." This effectively requires DEQ modeling to use allowable emissions, and allowable emissions are not the same as estimated maximum emissions. Since 202.02 applies for all permitting, it would also apply to a Section 161 analysis as well.

Annual Risk Assessment Report

From Idaho Air Rules and Appendix W, the operational rates used to calculate emissions in either a Section 220 or 161 analysis must be maximum allowable as established by design capacity or by enforceable permit condition. This presents a substantial challenge for the case where emissions from a source vary with each year of mine operation, with some increasing and some decreasing with any particular year.

What is important for TAP compliance is the long-term emissions. Therefore, even restrictions on annual emissions and operations is not critical to compliance with AACCs, especially if we're

under Section 161 rather than 210. Therefore, we can establish something like a 10-year rolling for sources with variable operational rates. We would still need some compliance check at a more frequent interval, such as annually. Perhaps during the first 3 years, the operational rates could not exceed the long term average plus a multiple of the standard deviation.

An alternative approach would be to require an annual look at risk resulting from the previous year's actual operations. This would then be added to all previous years' risks to generate a cumulative risk to that point. The cumulative risk would have to remain below the level identified as acceptable.

Potential Problem with Section 161 Type Analysis

Because Section 161 does not have regulatory sideboards, it is open to considerable criticism on whatever methods and data we use. This would include the carcinogenic risk factors (we really should use the most recent risk factors in a Section 161 analysis). Also, for a real risk assessment we should look at all carcinogenic compounds and multiple paths, but I do believe we can scale back from that approach. Note that 161 reads, "*Any contaminant which is by its nature toxic to human or animal life or vegetation shall not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation.*"

If we're doing a true Section 161 analysis, we should have a toxicologist and/or risk assessment individual reviewing the approach. An alternate idea is that we are modifying Section 210 by accounting for all arsenic sources, but adjusting operational rates to something closer to actuals.

Submitted Arsenic Analysis vs PTC Application

The submitted operational plan in the special arsenic analysis is completely different than what was submitted in the PTC application. Effectively it is a different permitting approach, based on activity variation with time rather than different scenarios by location. It will take time to understand what is going on with ModPRO2 and how that might be made into enforceable permit conditions. Note that there were even some sources in the PTC application that were not modeled in the arsenic analysis (and they would have had arsenic emissions).

DEQ Position on the Arsenic Modeling Addendum To the Perpetua Resources Stibnite Gold Project Permit to Construct Application

(by Kevin Schilling, Stationary Source Air Modeling Supervisor)

1.0 Introduction

DEQ received an *Arsenic Modeling Addendum* from Air Science following discussions of concerns with existing Section 210 TAP analyses to support the Perpetua Resources Stibnite Gold Project (SGP) Permit to Construct application. This paper summarizes the process to this point, briefly describes the addendum, points out challenges working with the addendum within the context of existing sections of the application, and outlines potential paths forward.

2.0 Review of Permitting Project to this Point

2.1 First Two Comment Periods

In response to comments from the first public comment period and DEQ's further evaluation of TAP source applicability to Section 210 (and the exemption of NESHAP sources from analyses), a revised TAP emission inventory and air impact modeling analysis was performed. Results of these revisions and a new proposed Statement of Basis and draft permit were then put out for a second public comment period and public informational meeting.

Additional concerns of arsenic emissions and proper exclusion of NESHAP sources arose after the second public comment period in March 2021. In general, the issue was that certain TAP sources were excluded from the TAP increment compliance demonstration that should have been included. Of most importance was fugitive carcinogenic emissions from vehicle traffic on mining roads and other fugitive emission sources. Arsenic was the TAP driving the analyses.

2.2 Path Leading to Arsenic Modeling Addendum

Air Sciences (Perpetua's consultant) and Perpetua met with DEQ on June 17, 2021, to discuss potential options to achieve acceptable modeled impacts. Some of these "brainstorming ideas" discussed included: 1) demonstrate that T-RACT is used for arsenic sources, thereby increasing acceptable impacts by a factor of 10; 2) refine arsenic emission estimates for sources, and

especially for road dust fugitive emission sources; 3) adjust averaging periods of modeled TAP impacts to reflect a longer period, as Acceptable Ambient Concentrations of Carcinogens are based on a 70-year exposure and the life of the mine is only 16 years; 4) perhaps propose permit operation/production limits based on multiple years (such as a 5-year rolling average); 5) define operational levels closer to what is actually anticipated. Ambient monitoring was mentioned as a means to increase the level of confidence if compliance is still not confidently demonstrated.

2.3 Arsenic Modeling Addendum Contents

On July 8, 2021, Air Sciences submitted an *Arsenic Modeling Addendum* for DEQ review. The addendum states the purpose is to address a public comment request that analyses be provided to assure compliance with Idaho Air Rules Section 161 regarding total project-wide arsenic emissions. The addendum also states that it "provides additional information requested by IDEQ to support its determination that the HAP/TAP emissions from the SGP comply with applicable regulations."

The addendum is based on operations as described in the SGP Refined Proposed Action – ModPRO2, which is the basis of a Supplemental Draft EIS currently in preparation by the Forest Service. ModPRO2 accounts for project improvements and refinements, with a smaller footprint of the mine.

The mine operational model used for the *Arsenic Modeling Addendum* is vastly different than that used in the original application. The original permit application provides a description of maximum operations of numerous emission sources that may occur at the facility, with an air quality assessment of emissions from those operations. ModPRO2 does not use this approach, but alternatively provides a best estimate of actual operations over the life of the mine. For example, the current DEQ Statement of Basis lists facility-wide arsenic emissions at 2.4 ton/year, but ModPRO2 lists emissions at 0.22 ton/year (as averaged over the 16 year life of the mine).

3.0 Why DEQ cannot Move Forward with Permit Issuance at this Point

DEQ is at the point in the permitting process where finishing touches are typically put on a permit or, at the most, slight adjustments are made to analyses or supporting data. Instead, with the concern over Section 210 analyses for arsenic we have an *Arsenic Modeling Addendum*

that, when combined with the existing application, looks like the confused mess of a "dog's breakfast."

First, how is the *Arsenic Modeling Addendum* to be used? Is it to replace the Section 210 analyses in the existing application (which DEQ asserts is incorrect), is it to supplement those analyses, or is it to merely respond to public concern about facility-wide arsenic impacts. Secondly, the addendum uses a substantially different approach from what is described in the application, Statement of Basis, and the draft PTC. Operational rates used for the inventory supporting the addendum lack substantiation and are radically different than those presented in other sections of the application. We're left wondering what should be disregarded in the application because of conflicting statements in the addendum. At this point, how does DEQ handle issues and concerns we may have on methods and data used in the addendum? How will permit limits be crafted to make claims in the addendum legally and practically enforceable, even to a minimally acceptable level? How does DEQ establish a timeline for permitting milestones at this point?

3.1 DEQ Permitting Process

Idaho Air Rules are very clear on the permit issuance process. As stated in Section 209, within 30 days after application submittal DEQ must determine whether the application is complete or "whether more information must be submitted . . ." Then, within 60 days DEQ must either approve or deny the permit. Once the application is complete, then the permitting decision is made based on that information submitted. These deadlines form a critical component of DEQ's performance measures designed to assure timely permitting.

Submission of new information, data, and analyses after the application has been declared complete constitutes an "out of scope" change, and a new permit application must be submitted. This is done for two important reasons: 1) the opportunity for public comment is based on the scope, data, and analyses provided in the original application; 2) entertaining substantial changes during the permit drafting phase requires substantial reworking by DEQ permitting staff, and keeping staff priorities on reworking a project is not fair to other permit applications recently submitted that may be complete. DEQ does periodically accept complementary information or minor corrections/clarifications after the completeness determination, as those do not substantially alter the underlying technical and regulatory basis of permit issuance. However, DEQ typically requires application withdraw and resubmittal for substantial changes that affect the emission inventory and especially when such changes require remodeling of air impacts.

3.3 Incomplete or Inadequate TAPs Compliance Demonstration

DEQ determined, after the March 2021 comment period, that TAP analyses used to demonstrate compliance with Idaho Air Rules Section 210 had again incorrectly excluded some TAP sources. It was assumed the *Arsenic Modeling Addendum* would address this issue. The addendum attempts to address arsenic, but does not provide any analyses of other TAPs for either modeling applicability or results from impact modeling.

3.4 Substantial change in Regulatory Approach

The *Arsenic Modeling Addendum* is a complete change in the regulatory approach used to demonstrate compliance with toxics. It abandons the Section 210 approach used in the application for an arsenic Section 161/210 hybrid analysis. The methods used in this unique analysis should be thoroughly vetted by DEQ well before a permit application is submitted. A month before permit issuance is not the time for developing a creative permitting approach with new emission inventory approaches, new modeling analyses, and challenges for crafting enforceable permit provisions/limits.

3.5 Inconsistency between NAAQS Inventory and Inventory used for Addendum

Emission inventories are estimated using emission source identification (including location and number of like sources), emission factors, emission control measures, operational levels, and operational schedules. Typically and most simply, permitting is done using maximum applicable factors, minimum control measures, and maximum operational levels and schedules. This makes for a relatively simple permit where claimed emissions and operations are easily made into verifiable permit conditions and minimal monitoring can assure compliance with the permit and, therefore, the underlying assumptions used in analyses.

The originally submitted application and previous revisions largely used maximum rates, with use of some operational scenarios where compliance with NAAQS was challenging by assuming maximum rates of all sources. The *Arsenic Modeling Addendum* uses an inventory that mostly uses the established emission factors and emission control measures; however, it accounts for temporally and spatially varying operational levels and schedules such that emissions are vastly less than those listed in other parts of the application. The addendum accounts for different operations and operational rates for each year of mine operation. Not only is there a question on whether the operational levels and schedules in the addendum can be translated into reasonably enforceable permit conditions/limits, but it is uncertain how other portions of the application and draft permit may be affected.

4.0 Potential Path Forward

Considering what was presented in the *Arsenic Modeling Addendum*, which was based on planned actual operations as described in ModPRO2 (used in the latest version of the draft EIS), it seems highly likely that the Stibnite Gold Project is permittable, provided aggressive emission controls are implemented. The challenge is finding a path that results in compliance with permitting rules/regulations, provides needed operational flexibility, and results in a permit that is not unnecessarily burdensome for monitoring and recordkeeping.

4.1 Technical Path for either Section 210 or Section 161 Analyses

Refinements for TAP analyses may include the following (arranged somewhat in order of priority):

1. Demonstrate that T-RACT is used for TAP emission sources, thereby allowing impacts at 10 times the AACC. Some discussion may be needed with DEQ to determine what is necessary for such a demonstration.
2. Refine estimates of road base arsenic content and resulting fugitive emissions from vehicle traffic. The DEQ permit writer would need to verify such revisions.
3. Agree to take a permit limit on life of the mine (based either on total years at a given operational rate or total mine-life production).
4. Adjust modeling results to obtain a long-term average concentration, accounting for the life of the mine and the 70-year exposure period used for assessing life-time cancer risk. For example, total impact = (1 year impact)(16 year life of mine)/(70 years of exposure).
5. Explore the option of some sources having permit limits based on a multi-year average, such as rolling 5-year average production rates from a certain area at the mine, etc.
6. Explore options for operational rates and schedules that vary with time, provided those can be made into enforceable permit limits.

Where confidence of compliance with TAP increments may be decreased for any number of reasons, or where the effectiveness of operational monitoring is questionable to assure compliance, ambient monitoring can provide additional confidence of compliance to allow permit issuance.

4.2 Organized, Consistent, Accurate Application

Whether DEQ requires withdraw of the existing permit application and resubmission of a revised application or allows continuation under the current project, DEQ requests an updated

PET 829

REC 1195

and revised application document. The application must be accurate and consistent across regulatory evaluations, emission inventory assessment, and modeling of impacts.

Whichever path is chosen, considerable DEQ time and resources will be necessary to review new regulatory analyses, verify emission calculations, review modeling analyses, draft appropriate permit limits, revise the Statement of Basis, revise the draft permit, and go back through the public comment period.

PET 830

REC 1196

RAÚL R. LABRADOR
Attorney General

SCOTT L. CAMPBELL
Deputy Attorney General
Chief, Energy and Natural Resources Division

JOHN R. SHACKELFORD, ISB# 8647
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: (208) 373-0453
Facsimile: (208) 373-0481
john.shackelford@deq.idaho.gov

Attorneys for Respondent

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC. Intervenor.	CASE DOCKET NO. 0101-22-01 **RESPONSE TO PETITIONERS' FIRST DISCOVERY REQUESTS AND REQUESTS FOR PRODUCTION OF DOCUMENTS**

TO: Petitioners Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon and its attorney of record:

Respondent, the Idaho Department of Environmental Quality, after making a diligent search of its records, hereby responds to the Petitioners' discovery requests. The Respondent also hereby objects to Instruction number 7 as being unduly burdensome in this case. Nine responsive documents were withheld because they fall within the ambit of the Attorney-client Privilege.

INSTRUCTIONS

1. Unless otherwise indicated, these Interrogatories and Requests for Production refer to Air Quality Permit to Construct P-2019-0047.

2. In responding to this Discovery Request, base your responses on all information available to you, not merely information within your own personal knowledge; please include information in the possession of your attorneys, experts, employees, agents, representatives, members, and consultants, whether past or present.

3. If documents supporting a Request for Production have already been provided via the Project File, sent by IDEQ to the parties on or about October 22, 2022, there is no need to reproduce that information here. Instead, the Respondent may refer to the relevant document in the Project File by file name, including reference to relevant page(s) and/or section(s), if appropriate.

4. Whether for privilege or other reasons, if you do not provide a complete response to any Interrogatory or Request for Production, state with respect to such Interrogatory or Request for Production that a complete response is not provided and state the reason for the incomplete response.

5. If you contend that any information response to any of the following Interrogatories or Requests for Production is privileged, in whole or in part, or should otherwise

not be disclosed, or otherwise object to any part of the discovery request, you should identify with particularly each piece of information for which you claim a privilege or to which you object, state the grounds for exclusion or reasons for your objection, and describe the information withheld or objected to in terms of its subject matter, the time at which it was acquired or communicated, the parties who possessed and/or exchanged such information, and other information as may be reasonably needed by Petitioners to understand the basis of your objection to disclosure.

6. These Interrogatories and Requests for Production are deemed continuing in nature, and your answers are to be supplemented as additional information and knowledge become available to you.

7. Produce all documents in searchable PDF format with Bates numbers, with the exception of Microsoft Excel based files. These types of files are requested to be produced in their original Excel format. Provide input and output files for modeling simulations in format that can be opened with standard public-domain software, or provide the necessary software that

allows for proprietary format or other non-standard format files to be opened, viewed, and for the subject data to be comprehended by a human viewer.

RELATED INTERROGATORIES & REQUESTS FOR PRODUCTION

INTERROGATORY NO. 1: Identify and describe all air emissions inventory calculations conducted by IDEQ, or conducted by anyone else and which IDEQ is aware of, related to development of the PTC for which the results were not presented in the Statement of Basis, including by describing the results of the other emissions inventory calculations and by describing the inputs, data set(s), and/or assumptions used in the other emissions inventory calculations which differ from those for which the results are presented in the Statement of Basis.

RESPONSE: DEQ is unaware of any air emissions inventory calculations related to the

development of the PTC for which the results were not presented in the Statement of Basis.

REQUEST FOR PRODUCTION NO. 1: Provide all Documents that support or relate to your answer to Interrogatory No. 1.

RESPONSE: No responsive documents found.

INTERROGATORY NO. 2: Identify and describe all air dispersion modeling simulations conducted by IDEQ, or conducted by anyone else and which IDEQ is aware of, related to development of the PTC for which the results were not presented in the Statement of Basis, including by describing results of the modeling simulations and by describing the inputs, data set(s), and/or assumptions used in the modeling simulations which differ from those for which the results are presented in the Statement of Basis.

RESPONSE: Please see document titled "readme," which is found within the folder marked "Modeling Files for Interrogatory No. 2."

REQUEST FOR PRODUCTION NO. 2: Provide all Documents that support or relate to your answer to Interrogatory No. 2.

RESPONSE: Please see documents submitted herewith.

ADDITIONAL REQUESTS FOR PRODUCTION

INSTRUCTION FOR REQUESTS FOR PRODUCTION NOS. 3–6: "Communications" for Interrogatories Nos. 3 through 6 means all communications, including but not limited to all letters, emails, calls, voicemails, text messages, meetings, meeting notes, reports, status updates, memos to file, and all Documents included with such Communications, and includes those generated prior and up to the date of the issuance of the PTC as well as after the date of the issuance of the PTC and up to the present day.

REQUEST FOR PRODUCTION NO. 3: Provide all internal IDEQ communications

related to the development and issuance of the PTC

RESPONSE: Please see documents submitted herewith.

REQUEST FOR PRODUCTION NO. 4: Provide all Communications, both internal and external, related to or between IDEQ and EPA regarding the development and issuance of the PTC.

RESPONSE: Please see documents submitted herewith.

REQUEST FOR PRODUCTION NO. 5: Provide all Communications, both internal and external, related to or between IDEQ and Midas Gold, Perpetua Resources, or any of their consultants, experts, or contractors regarding development and issuance of the PTC.

RESPONSE: Please see documents submitted herewith.

REQUEST FOR PRODUCTION NO. 6: Provide all Communications, both internal and external, related to or between IDEQ and any other person, agency (local, state, or federal), or entity regarding the development and issuance of the PTC.

RESPONSE: Please see documents submitted herewith.

REQUEST FOR PRODUCTION NO. 7: Provide all guidance, policies, memos to file, or other Documents supporting use of a 70-year "lifetime" average for arsenic emissions in comparison to the AACC for the PTC.

RESPONSE: No responsive documents found.

REQUEST FOR PRODUCTION NO. 8: Provide all air permits issued by IDEQ, other than the PTC, that applied a 70-year "lifetime" average for any carcinogenic TAP in comparison to the associated AACC, including the statements of basis.

RESPONSE: No responsive documents found.

REQUEST FOR PRODUCTION NO. 9: Provide all guidance, policies, memos to file, or

other Documents related to defining an ambient air boundary.

RESPONSE: Please see documents submitted herewith.

REQUEST FOR PRODUCTION NO. 10: Provide all air permits issued by IDEQ, other than the PTC, for which the general public had regular, conditional access to any location within the facility's ambient air boundary, including the statements of basis.

RESPONSE: No responsive documents found.

REQUEST FOR PRODUCTION NO. 11: To the extent not previously disclosed in the Project File or in response to any of the above, provide all Documents stored in the project folder in IDEQ's electronic records management system for Project 62288.

RESPONSE: No responsive documents found.

REQUEST FOR PRODUCTION NO. 12: To the extent not previously disclosed in the Project File or in response to any of the above, provide all Documents stored under the facility folder for Midas Gold and/or Perpetua Resources (or any similar variation) in IDEQ's electronic records management system.

RESPONSE: Please see "Facility-Wide Classification Form P-2019.0047"

LINK TO FILES:

https://cloud.deq.idaho.gov/s/eMPBnxEdeMqSQws

Dated: February 21, 2023, FOR RESPONDENT:

STATE OF IDAHO, DEPARTMENT OF ENVIRONMENTAL QUALITY

By: /s/ *John R. Shackelford*
John R. Shackelford
Attorney for Respondent

CERTIFICATION OF SERVICE

I HEREBY CERTIFY that on this 21st day of February, 2023, a true and correct copy of the foregoing RESPONSE TO PETITIONERS' FIRST DISCOVERY REQUESTS AND REQUESTS FOR PRODUCTION OF DOCUMENTS was served on the following via electronic mail to the indicated address:

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

/s/ Patricia Jordan
Patricia Jordan, Legal Assistant

RAÚL R. LABRADOR
Attorney General

SCOTT L. CAMPBELL
Deputy Attorney General
Chief, Energy and Natural Resources Division

JOHN R. SHACKELFORD, ISB# 8647
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: (208) 373-0453
Facsimile: (208) 373-0481
john.shackelford@deq.idaho.gov

Attorneys for Respondent

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 _____ NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	Agency Case No. 0101-22-01 OAH Case No. 23-245-01 DEQ'S CROSS MOTION FOR SUMMARY JUDGMENT

COMES NOW, Respondent, the Idaho Department of Environmental Quality ("DEQ"), by and through the Office of the Attorney General, pursuant to IDAPA 04.11.01.260 and I.R.C.P. 56 and 7(b), hereby cross-moves for summary judgment against Petitioners, Nez Perce Tribe, Idaho Conservation League ("ICL"), and Save the South Fork Salmon ("SSFS"). Filed concurrently, in support of DEQ's Cross Motion for Summary Judgment is DEQ's Response to Petitioners' Motion for Summary Judgment and Brief in Support of Cross Motion for Summary Judgment, Declaration of Tiffany Floyd, Declaration of Mike Simon, and Declaration of Kevin Schilling, with exhibit.

Dated: May 12, 2023.

STATE OF IDAHO, DEPARTMENT OF ENVIRONMENTAL QUALITY

By: /s/ *John R. Shackelford*
John R. Shackelford
Attorney for Respondent

CERTIFICATION OF SERVICE

I HEREBY CERTIFY that on this 12th day of May 2023, a true and correct copy of the foregoing DEQ'S CROSS MOTION FOR SUMMARY JUDGMENT was served on the following via electronic mail to the indicated address:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Dylan Lawrence
Hearing Officer
Varin Thomas, LLC
242 N. 8th St., Suite 220
Boise, ID 83702
dylan@varinthomas.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Resources Division
Office of the Attorney General
1410 N. Hilton St.
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

/s/ John Shackelford
John Shackelford

RAÚL R. LABRADOR
Attorney General

SCOTT L. CAMPBELL
Deputy Attorney General
Chief, Energy and Natural Resources Division

JOHN R. SHACKELFORD, ISB# 8647
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: (208) 373-0453
Facsimile: (208) 373-0481
john.shackelford@deq.idaho.gov

Attorneys for Respondent

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 _____ NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	Agency Case No. 0101-22-01 OAH Case No. 23-245-01 DEQ'S RESPONSE TO PETITIONERS' MOTION FOR SUMMARY JUDGMENT AND BRIEF IN SUPPORT OF CROSS MOTION FOR SUMMARY JUDGMENT

Table of Contents

The Hearing Officer Must Grant Summary Judgment in Favor of DEQ Because Petitioners Lack Standing 5

I. The Hearing Officer must grant the DEQ's motion for summary judgment because Petitioners have failed to show that they will suffer personal injuries that are causally connected to the alleged errors in the PTC or that the claimed harm can be prevented by the requested relief.
……...**Error! Bookmark not defined.**

A. Petitioners do not have standing because they fail to allege—and prove—personal injuries particular to themselves and distinct from the general public. 6

B. Petitioners do not have standing because they fail to demonstrate how their alleged injuries are caused by the alleged errors in the PTC. 9

C. Petitioners do not have standing because they fail to show that the relief they seek will prevent their alleged injuries. ..... **Error! Bookmark not defined.**

The Hearing Officer Should Grant Summary Judgment in Favor of DEQ Because the PTC Analysis was a Lawful Expression of DEQ's Discretion and a Direct Result of its Diligent Investigation and Expertise..... **Error! Bookmark not defined.**

I. Standard of Review ..... **Error! Bookmark not defined.**

II. The Hearing Officer Must Grant Summary Judgment in Favor of DEQ Because DEQ Crafted the PTC Requirements to Control Dust Based on its Expertise, Following A Careful Investigation and Deliberate Decision-Making Process. ..... **Error! Bookmark not defined.**

A. Petitioners fail to demonstrate that any of the alleged errors in the PTC regarding dust emissions affect a substantial right. ..... **Error! Bookmark not defined.**

B. The Petitioners fail to demonstrate DEQ abused its discretion by requiring Perpetua to detail specific traffic-related parameters in the Fugitive Dust Control Plan rather than the PTC. ..... **Error! Bookmark not defined.**

C. The Petitioners fail to demonstrate DEQ abused its discretion by requiring Perpetua to achieve a 93.3% dust control efficiency. ..... **Error! Bookmark not defined.**

D. Petitioners fail to show that DEQ erred by requiring operating procedures to be detailed in an enforceable Operations and Maintenance Manual. ..... **Error! Bookmark not defined.**

E. Using precipitation data from EPA's AP-42 was not arbitrary or capricious. .....**Error! Bookmark not defined.**

III. The Hearing Officer Must Grant Summary Judgment in Favor of DEQ as it Relates to Arsenic from Various Sources. ..... **Error! Bookmark not defined.**

A. Petitioners fail to demonstrate that any of the alleged errors in the PTC regarding arsenic emissions affect a substantial right..... **Error! Bookmark not defined.**

B. DEQ's T-RACT analysis complies with the Air Rules.. **Error! Bookmark not defined.**

C. DEQ properly used its discretion and expertise to average arsenic emissions over the projected duration of the mine..... **Error! Bookmark not defined.**

D. Petitioners fail to demonstrate DEQ's decision to exclude the Stibnite Road Access Route from the ambient air boundary is arbitrary and capricious. ..... **Error! Bookmark not defined.**

IV. The Hearing Officer Must Grant Summary Judgment in Favor of DEQ Because Petitioners Have Failed to Show that DEQ's Customary Use of Operating Plans is Arbitrary and Capricious. ..... **Error! Bookmark not defined.**

Conclusion ..... **Error! Bookmark not defined.**

COMES NOW, Respondent, the Idaho Department of Environmental Quality ("DEQ"), by and through the Office of the Attorney General, and hereby submits this Response to Petitioners' Joint Motion for Summary Judgment and a brief in support of its Cross Motion for Summary Judgment.

SUMMARY

DEQ's Air Quality Program issues between sixty to eighty permits to construct ("PTCs") annually. ("Decl. of Mike Simon," p. 9). Typically, DEQ holds one public comment period, if it is requested, and issues a PTC within approximately 150 days of the application submission. ("Decl. of Tiffany Floyd," p. 3). Perpetua Resources submitted an application for a permit to construct for its Stibnite Mine Project on August 20, 2019. Id. DEQ expended extraordinary efforts to evaluate the application, consider public comments, and engage in highly technical decision-making to arrive at a legally and environmentally sound permit. See, id. DEQ engaged in three extended public comment periods and two public informational meetings and issued the PTC in June 2022, *nearly three years after submission of the application*. Id. at 4.

Petitioners, Nez Perce Tribe, Idaho Conservation League ("ICL"), and Save the South Fork Salmon ("SSFS"), filed a petition to contest DEQ's issuance of PTC to Perpetua Resources for its Stibnite Mine Project. The PTC in question covers a range of potential air emissions from anticipated mining activities, but Petitioners limit their challenge to the permitted dust emissions. Perpetua intervened in the action and filed a motion to dismiss the petition, which DEQ joined. The resultant "Order on Motion to Dismiss" categorized Petitioners' claims into four general issues: PM_{10} from haul trucks/road, (2) Arsenic from various sources, and (3) Ambient air boundary, and (4) Ambient air monitoring. Subsequently, Petitioners filed their "First Amended Petition to Initiate

Contested Case" on December 6, 2022 (hereinafter, "Amended Petition"). In the following response, DEQ addresses Petitioners' assignments of error as those allegations were categorized in the "Order on Motion to Dismiss" issued November 15, 2022. Before considering the merits of the case, however, DEQ will address the dispositive issue of standing because while all Petitioners claim the dust emissions will cause them injury, none explain how.

THE HEARING OFFICER MUST GRANT SUMMARY JUDGMENT IN FAVOR OF DEQ BECAUSE PETITIONERS LACK STANDING

Summary judgment must be granted when there is no genuine dispute as to any material fact and the movant is entitled to judgment as a matter of law. I.R.C.P. 56(a). The moving party bears the "initial burden of establishing the absence of a genuine issue of material fact." Venable v. Internet Auto Rent & Sales, Inc., 156 Idaho 574, 581, 329 P.3d 356, 363 (2014). "Once the moving party establishes the absence of a genuine issue, the burden shifts to the nonmoving party to show that a genuine issue of material fact on the challenged element of the claim does exist." MFG Fin., Inc. v. Vigos, 163 Idaho 252, 255, 409 P.3d 832, 835 (2018) (citation omitted). In other words, while a court must construe the record in the light most favorable to the party opposing the motion, the nonmoving party "may not rest upon mere allegations in the pleadings, but must set forth by affidavit specific facts showing there is a genuine issue for trial." Gagnon v. W. Bldg. Maint., Inc., 155 Idaho 112, 114, 306 P.3d 197, 199 (2013) (citation omitted).

The Idaho Environmental Protection and Health Act entitles "[a]ny person aggrieved by an action or inaction of the department" to a fair hearing. I.C. § 39-107(5). Pursuant to DEQ's regulations, an "aggrieved person" is a person or entity with legal standing. IDAPA 58.01.23.005.01. Whether a petitioner has standing is a fundamental issue that must be addressed before a tribunal can consider the merits of a petitioner's claim. See, Valencia v. Saint Alphonsus Med. Ctr. - Nampa, Inc., 167 Idaho 397, 401–02, 470 P.3d 1206, 1210–11 (2020) quoting State v. Philip Morris, Inc., 158 Idaho 874, 881, 354 P.3d 187, 194 (2015).

> The doctrine of standing focuses on the party seeking relief and not on the issues the party wishes to have adjudicated. In order to satisfy the requirement of standing, the petitioners must allege or demonstrate an injury in fact and a substantial likelihood that the judicial relief requested will prevent or redress the claimed injury . . . The petitioners must establish a peculiar or personal injury that is different than that suffered by any other member of the public.

Noh v. Cenarrusa, 137 Idaho 798, 800, 53 P.3d 1217, 1219 (2002) (quotations and citations omitted). See also, In the Matter of Section 401 Water Quality Certification for Relicensing of the C.J. Strike Hydroelectric Facility, Docket No. 0102-01-06, Order (November 4, 2002). A petitioner bears the burden of "showing [a] distinct palpable injury and fairly traceable causal connection between the claimed injury and the challenged conduct." Valencia v. Saint Alphonsus Med. Ctr. - Nampa, Inc., 167 Idaho 397, 401–02, 470 P.3d 1206, 1210–11 (2020) (quoting Haight v. Idaho Dep't of Transp., 163 Idaho 383, 392, 414 P.3d 205, 214 (2018)). An "aggrieved" person's injury must be "immediate, not merely some remote, possible consequence, or mere possibility arising from some unknown and future contingency." Application of Fernan Lake Vill., 80 Idaho 412, 415, 331 P.2d 278, 279 (1958) (citation omitted). Finally, the petitioner must demonstrate "a substantial likelihood the judicial relief requested will prevent or redress the claimed injury." Valencia,167 Idaho at 402, 470 P.3d at 1211 (2020).

I. The Hearing Officer must grant the DEQ's motion for summary judgment because Petitioners have failed to show that they will suffer personal injuries that are causally connected to the alleged errors in the PTC or that the claimed harm can be prevented by the requested relief.

A. *Petitioners do not have standing because they fail to allege—and prove—personal injuries particular to themselves and distinct from the general public.*

To have standing, a litigant must demonstrate they will suffer an injury which is "distinct and palpable and not be one suffered alike by all citizens in the jurisdiction." Selkirk-Priest Basin Ass'n, Inc. v. State ex rel. Batt, 128 Idaho 831, 833–34, 919 P.2d 1032, 1034–35 (1996) (citing Miles v. Idaho Power Co., 116 Idaho 635, 641, 778 P.2d 757, 763 (1989)). In Selkirk, a non-profit

organization called the Selkirk-Priest Basin Association ("SPBA") challenged the Land Board's decision to sell timber from state endowment lands. 128 Idaho at 832, 919 P.2d at 1033 (1996). The SPBA claimed its members worked in and used the affected area for aesthetic and recreational enjoyment, which would be diminished by the timber sale. In its analysis of the issue, the Idaho Supreme Court compared SPBA's claim of injury to that of an outfitter in Boundary Backpackers v. Boundary Cnty., 128 Idaho 371, 375, 913 P.2d 1141, 1145 (1996). In Boundary Backpackers, a county ordinance was challenged by three non-profit organizations and eighteen individuals. Id. The Court found that all the plaintiffs lacked standing except for one commercial guide who would suffer a significant pecuniary injury if the county ordinance were left intact because it could result in the loss of the open, natural spaces from which he derived a living. 128 Idaho at 375, 913 P.2d at 1145 (1996). The Selkirk Court distinguished the outfitter's personal injury in Boundary Backpackers from SPBA's aesthetic or recreational injury because the affidavits submitted by SPBA's members failed to "establish a peculiar or personal injury that is different than that suffered by any other member of the public." Id. 128 Idaho at 834, 919 P.2d at 1035. The Court characterized SPBA's alleged injury as, "at best a generalized grievance," and therefore affirmed the district court's order granting summary judgment on the issue of standing. Id. In Idaho, generalized grievances must be remedied through the political process, not litigation. Troutner v. Kempthorne, 142 Idaho 389, 392, 128 P.3d 926, 929 (2006) citing Gallagher v. State, 141 Idaho 665, 115 P.3d 756 (2005).

Like the plaintiffs in Selkirk, Petitioners fail to demonstrate they will suffer personal injuries, distinct from the public. The Nez Perce tribe claims it will "suffer physical, cultural, spiritual, and economic injury caused by excessive air pollutants resulting from DEQ's issuance of the PTC."[1] ("First Amended Petition" p. 5.) However, the Nez Perce Tribe fails to explain how the permitted

[1] It is unclear whether "excessive air pollutants" means *any* dust emissions from mining activity or only those dust emissions that are in excess of what Petitioners claim could be allowed by law.

dust emissions will cause them harm that is not just a "generalized grievance" shared by all. In particular, the Nez Perce Tribe fails to provide any concrete basis demonstrating that any one particular, alleged shortcoming in the PTC will cause a distinct "physical, cultural, spiritual, and economic injury." Moreover, there is absolutely no evidence in the record to support such a claim.

Likewise, ICL claims it has standing because its members visit the mining site and nearby areas for "professional, recreational, aesthetic, and other purposes." ("First Amended Petition" p. 6.) The decisions in Selkirk and Boundary Backpackers require an "aggrieved party" to allege more than general recreational and aesthetic injuries. Furthermore, ICL makes no effort to detail what "professional" or "other" uses its members make of the mining site and "nearby areas."[2] Again, ICL fails to connect the PTC to any particular injury and fails to adduce any evidence in support of its claims. Save the South Fork Salmon makes similar claims to the other two Petitioners, alleging generic and generally applicable environmental harms without specifically averring how the PTC creates those injuries. Like the other Petitioners, SSFS makes no effort to detail an immediate, personal injury and has provided no evidence in support of its claims.

The Petitioners in this case are like others that have come before the Board of Environmental Quality and failed to articulate a personal injury from a final agency action. In Simmons Sanitation, for example, the petitioner-citizen challenged DEQ's approval of a solid waste landfill on the grounds that the landfill could pollute a nearby creek and because the application was legally deficient. (Docket No. 0106-05-01, "Preliminary Order" 9/23/2005).[3] The Hearing Officer found, *sua sponte*, that the petitioner failed to demonstrate how the deficiencies of the permit analysis or

[2] It is unclear from the Petition what constitutes a "nearby area;" there is no claim, or evidence in the record, that permitted dust emissions will escape from the mine site and damage off-site natural resources.
[3] Available at https://www.deq.idaho.gov/public-information/laws-guidance-and-orders/petitions-for-review-and-precedential-orders/ (last accessed 5/4/23).

pollution of the creek would impact him personally, so he lacked standing to challenge the landfill permit. ("Preliminary Order," p. 9).

Petitioners fail to aver specific, personal injuries, and have also failed to supply any evidence supporting their generalized grievances. Therefore, there are no facts to dispute. The Hearing Officer should find Petitioners have not demonstrated they are "aggrieved persons" and therefore lack standing under Idaho law to challenge the PTC.

B. *Petitioners do not have standing because they fail to demonstrate how their alleged injuries are caused by the alleged errors in the PTC.*

In addition to showing a concrete, palpable injury, a petitioner must show "a sufficient causal connection between the injury and the conduct complained of . . .." State v. Philip Morris, Inc., 158 Idaho 874, 881, 354 P.3d 187, 194 (2015) (citation and quotation marks omitted). The failure to clearly delineate a causal connection is a common issue among unsuccessful litigants coming before the Board of Environmental Quality. For example, in Rebound v. Idaho Dep't of Health and Welfare, Docket No. 0101-99-07, the petitioner trade union organization challenged DEQ's modification to a power plant permit, which authorized the facility to operate a gas turbine for auxiliary power. ("Order Affirming Decision of the Hearing Officer," 2/28/2000).[4] The Board reviewed affidavits from the organization's members to determine whether the organization had standing to challenge the permit modification. (Id. at 3). One of the petitioner's members claimed the modified permit would result in air pollution that would impair the local air quality, and in turn, the enjoyment and value of his property. (Id. at 5). Another member claimed the power plant's emissions during the winter would impair air quality to the point that he would be prohibited from using his wood burning stove and be forced to heat his home with more expensive options. (Id.) The Board found, however, that neither affidavit demonstrated a causal link between increased emissions allowed under the challenged

[4] Available at https://www2.deq.idaho.gov/admin/LEIA/api/document/download/5548 (last accessed 5/4/23).

permit and a diminishment in the use and enjoyment of property, or increased heating expenses. (Id.) Like the alleged injuries in this case, the allegations in Rebound were too speculative and unsupported by specific facts to demonstrate a "fairly traceable link" to the challenged conduct.

In another contested case before the Board, a citizen-petitioner challenged DEQ's decision to issue two separate Tier I air permits for the Potlach lumber processing complex on the grounds that two permits would be more difficult to enforce than one and that hindered enforcement would result in unsafe levels of toxic air pollutants. Solomon v. Idaho Dep't of Environmental Quality, Docket No. 0101-03-01 ("Order," p. 6).[5] The citizen, who was a member of ICL, complained he could view and smell the facilities' air emissions from his home and on his visits to Lewiston. ("Order," p. 5.) The Board found that the petitioner failed to connect his alleged injury to the challenged agency action because there was simply no evidence that issuing two permits instead of one would expose the petitioner to unpermitted levels of air pollution. (Id. at 6). Neither the citizen-petitioner, nor ICL, had standing to challenge DEQ's permits. (Id. at 8).

The present case also bears a close resemblance to Rickards v. Idaho Dep't of Health and Welfare, in which the petitioner challenged an air permit issued to the Department of Energy for the Idaho National Engineering Laboratory on the grounds that the permit would allow for excessive radionuclide emissions. (Docket No. 0101-92-12). The petitioner claimed that the excessive radionuclide emissions could adversely affect him because he regularly used the highway near the laboratory and lived in the vicinity. ("Hearing Officer's Findings of Fact, Conclusions of Law, and Proposed Decision and Order on Motions for Summary Judgment," 12/21/1992).[6] The Board adopted the Hearing Officer's finding that the petitioner's claimed injury was "too speculative," and

[5] Available at https://www2.deq.idaho.gov/admin/LEIA/api/document/download/5554 (last accessed 5/4/23).
[6] Available at https://www2.deq.idaho.gov/admin/LEIA/api/document/download/5532 (last accessed 5/4/23)

that he failed to establish a causal connection between the claimed harm and the alleged deficiencies in DEQ's permit analysis. (Id. at 11.)[7]

Like the petitioners in the aforementioned cases, the Nez Perce Tribe, ICL and SSFS all fail to clearly articulate a traceable causal connection between the challenged conduct and their alleged injuries. For example, Petitioners argue DEQ inaccurately determined that the dust mitigation provisions in the PTC will successfully prevent a violation of the PM_{10} NAAQS. ("First Amended Petition," p. 13.) However, they neglect to explain how a hypothetical violation of the NAAQS for PM_{10} causes one of their alleged injuries. Moreover, the language employed in the First Amended Petition belies the speculative nature of the Petitioners' apprehensions: "Changing these variables . . . *could* cause a violation of the NAAQS" (id. at 15); "[a] lesser control efficiency . . . *could* exceed the NAAQS" (id. at 16); "DEQ's failure to use the most representative data . . . *increases the risk* of miscalculation . . .." (Id. at 17) (Emphasis added).

The problem for Petitioners is threefold: (1) they fail to connect a violation of the PM_{10} NAAQS to one of their amorphous injuries; (2) even if they were to demonstrate a causal connection between a PM_{10} NAAQS violation and an injury, they have not shown that there is a substantial likelihood that the PTC will result in such a NAAQS violation, and (3) they have provided no evidence in support of their allegations. In fact, their briefing seems to admit DEQ's modeling analysis was correct, but that in certain hypothetical situations, too much dust *could* be emitted. The Petitioners' arguments regarding dust-borne arsenic ("First Amended Petition," pp. 17- 22) are similarly deficient. Overall, Petitioners' allegations are speculative, hypothetical, and bear no connection to any specific provision in the PTC. Most importantly, even if Petitioners had sufficiently alleged causal connections to their alleged injuries, they have failed to supply any evidence in support. The Hearing Officer must find that Petitioners do not have standing in this case

[7] The "Order" is available at https://www2.deq.idaho.gov/admin/LEIA/api/document/download/5530 (as of 5/4/23).

as a matter of law because they have failed to demonstrate a causal link between the challenged conduct and their alleged injuries.

C. *Petitioners do not have standing because they fail to show that the relief they seek will prevent their alleged injuries*.

The Petitioners are required to demonstrate a "substantial likelihood" that the relief they request will prevent or redress their claimed injuries. Noh v. Cenarrusa, 137 Idaho 798, 800, 53 P.3d 1217, 1219 (2002). But while the requested relief is highly specific, Petitioners fail to show that if the relief were granted, their injuries would be prevented. As discussed above, the injuries alleged are general and vague and bear no connection to the PTC. For example, Petitioners fail to demonstrate that should the relief be provided, they would only then be able to recreate or enjoy any one specific water body, physical location, or potential use. This is true of each allegation in the First Amended Petition. For this third reason, the Hearing Officer should find that Petitioners lack standing to challenge the PTC for Perpetua's Stibnite Mine Project.

THE HEARING OFFICER SHOULD GRANT SUMMARY JUDGMENT IN FAVOR OF DEQ BECAUSE THE PTC ANALYSIS WAS A LAWFUL EXPRESSION OF DEQ'S DISCRETION AND A DIRECT RESULT OF ITS DILIGENT INVESTIGATION AND EXPERTISE

I. Standard of Review

In Idaho, state agencies are afforded great deference in choosing the manner in which they carry out their administrative duties. The Idaho Legislature requires Idaho courts to uphold agency actions except in very narrow circumstances, in which an aggrieved party proves the action (a) violates statutory or constitutional provisions; (b) exceeds the agency's statutory authority; (c) is made upon unlawful procedure; (d) is not supported by substantial evidence in the record; or (e) is arbitrary, capricious, or an abuse of discretion. I.C. § 67–5279(3). The challenging party must prove the agency erred in a manner specified in Idaho Code § 67–5279(3), and that a substantial right of

that party has been prejudiced. Peck v. State, Dep't of Transp., 153 Idaho 37, 42, 278 P.3d 439, 444 (Ct. App. 2012) citing I.C. § 67–5279(4).

The Idaho Supreme Court recognizes that agencies are "clothed with power to construe [the law] as a necessary precedent to administrative action" J.R. Simplot Co. v. Idaho State Tax Comm'n, 120 Idaho 849, 854, 820 P.2d 1206, 1211 (1991) and has "long followed the rule that the construction given to a statute by the executive and administrative officers of the State is entitled to great weight and will be followed by the courts unless there are cogent reasons for holding otherwise." Id. (citation omitted). "A strong presumption of validity favors an agency's actions." Chisholm v. Idaho Dep't of Water Res., 142 Idaho 159, 162, 125 P.3d 515, 518 (2005) citing Young Elec. Sign Co. v. State ex rel. Winder, 135 Idaho 804, 807, 25 P.3d 117, 120 (2001). And an "agency's factual determinations are binding on the reviewing court, even where there is conflicting evidence before the agency, so long as the determinations are supported by substantial and competent evidence in the record." Peck v. State, Dep't of Transp., 153 Idaho 37, 42, 278 P.3d 439, 444 (Ct. App. 2012) (citations omitted).

Summary judgment must be granted when there is no genuine dispute as to any material fact and the movant is entitled to judgment as a matter of law. I.R.C.P. 56(a). DEQ is entitled to judgment as a matter of law unless Petitioners prove, by a preponderance of the evidence, (1) the truth of their claims of error, (2) that the alleged errors fall within those enumerated in I.C. § 67–5279(3), and (3) that the alleged errors affect their substantial rights. I.C. § 67–5279(4); IDAPA 58.01.23.062 ("Unless otherwise provided by statute, the petitioner has the burden of proving by a preponderance of the evidence, the allegations in the petition.")

II. The Hearing Officer Should Grant Summary Judgment in Favor of DEQ Because DEQ Crafted the PTC Requirements to Control Dust Based on its Expertise, Following A Careful Investigation and Deliberate Decision-Making Process.[8]

A. *Petitioners fail to demonstrate that any of the alleged errors in the PTC regarding dust emissions affect a substantial right.*

[8] Claims 1-5 in the "Order on Motion to Dismiss" 11/15/22, p. 8.

Idaho law requires agency decisions be upheld absent a showing of one of the errors enumerated in I.C. § 67–5279(3) and proof that the error affects the challenging party's substantial rights. Noble v. Kootenai Cnty. ex rel. Kootenai Cnty. Bd. of Comm'rs, 148 Idaho 937, 943, 231 P.3d 1034, 1040 (2010) (appellant failed to show Board's denial of his application to build subdivision prejudiced his right to develop his property); I.C. § 67–5279(4) (An "agency action shall be affirmed unless substantial rights of the appellant have been prejudiced.")

Here, the Petitioners have failed to allege—let alone prove—that any of the alleged errors in DEQ's analysis of particle emissions affects their substantial rights. In fact, there is no evidence in the record that can support a finding that any alleged error impacts the Petitioners at all. This is a dispositive issue that entitles DEQ to judgment as a matter of law.

B. *The Petitioners fail to demonstrate DEQ abused its discretion by requiring Perpetua to detail specific traffic-related parameters in the Fugitive Dust Control Plan rather than the PTC.*

An agency does not abuse its discretion when it "(1) correctly perceives the issue as one of discretion; (2) acts within the outer boundaries of its discretion; (3) acts consistently with the legal standards applicable to the specific choices available to it; and (4) reaches its decision by the exercise of reason." Chambers v. Idaho Bd. of Pharmacy & Agency, 170 Idaho 701, 705, 516 P.3d 571, 575 (2022) citing Lunneborg v. My Fun Life, 163 Idaho 856, 863, 421 P.3d 187, 194 (2018).

The Petitioners fail to explain—let alone prove—how DEQ abused its discretion by requiring Perpetua to detail traffic-related parameters for the haul roads in the Fugitive Dust Control Plan ("FDCP"). Instead, Petitioners argue that the lack of specific haul road permit conditions undermines DEQ's conclusion that the project will comply with allowable emissions. (Pet. Br. p. 25). This argument does not provide the Hearing Officer with grounds to remand the PTC. Moreover, it is a customary practice for DEQ to require permit applicants to develop detailed operational plans after

a permit to construct is issued. ("Decl. of Mike Simon," p. 7). As Petitioners point out, DEQ is aware of which traffic-related parameters are "critical" to ensure Perpetua does not exceed modeled emissions, and DEQ will be able to enforce those requirements because they are incorporated into the PTC. DEQ has experience enforcing provision contained with fugitive dust control plans (id.) and there is no evidence in the record to support the contention that DEQ will allow Perpetua to operate with an inadequate and unenforceable FDCP.

C. *Petitioners fail to demonstrate DEQ abused its discretion by requiring Perpetua to achieve a 93.3% dust control efficiency.*[9]

An agency does not abuse its discretion when it "(1) correctly perceives the issue as one of discretion; (2) acts within the outer boundaries of its discretion; (3) acts consistently with the legal standards applicable to the specific choices available to it; and (4) reaches its decision by the exercise of reason." Chambers, 170 Idaho at 705, 516 P.3d at 575 (2022).

In this case, Petitioners argue the permit conditions restricting fugitive dust are insufficient. (Pet. Br. p. 23, "Perpetua's operations would cause a violation of the PM_{10} NAAQS and arsenic AACC, even while fully complying with the Permit."). According to Petitioners, the fugitive dust permit conditions are faulty for three reasons: (1) Petitioners are not convinced that a combination of water spray and chemical dust suppressants will achieve a 93.3% dust control efficiency, (2) even if the 93.3% is achievable, the permit conditions inadequately specify the procedures for applying water and chemical dust suppressants, (3) the specific procedures, which will be contained in the FDCP, will not be subject to public comment—only DEQ approval. These arguments concede DEQ had the discretion to make different choices, yet the Petitioners neglect to argue exactly how DEQ supposedly abused its discretion in making those choices.

[9] The "Order on Motion to Dismiss" 11/15/22 (p. 10) retained Claim No. 2 ("Assumption of 93.3% Emissions Control") because it seemed possible that Petitioners could show DEQ abused its discretion by declining to include additional and unspecified permit conditions to help ensure a 93.3% control efficiency; however, Petitioners have not argued—or demonstrated—that DEQ abused its discretion.

Moreover, the Petitioners' argument is illogical: Petitioners argue that requiring Perpetua to develop and maintain a plan to "ensure compliance with fugitive dust requirements" (Permit Condition 2.5) "in no way assures that Perpetua will both develop and follow" the plan. (Pet. Br. p. 21). This begs the question: what evidence do Petitioners have that adding more specific provisions to the permit—rather than the FDCP—will ensure that Perpetua controls its dust emissions? Furthermore, Petitioners' briefing and references to DEQ's analysis make it abundantly clear that DEQ knows that to be successful, the FDCP must contain specific provisions about haul road conditions and maintenance. Finally, Petitioners have failed to provide any evidence that a public comment period would improve the FDCP or compliance therewith. Overall, the record supports the conclusion that DEQ is aware of the operational variables that can impact Perpetua's compliance with NAAQS, and there is no evidence that DEQ will approve a FDCP that lacks the necessary controls.

In fact, DEQ carefully and conscientiously studied this complex issue to ensure air standards were met. (See, PET 558-59 "Response to Comments" *and* "Declaration of Kevin Schilling," pp. 15-16 and "Declaration of Mike Simon," pp. 5-6). Requiring Perpetua to achieve a 93% control efficiency was soundly within DEQ's discretion and supported by objective data that was reasonably relied upon.

D. Petitioners fail to show that DEQ erred by requiring operating procedures to be detailed in an enforceable Operations and Maintenance Manual.[10]

Petitioners argue that DEQ erred by requiring Perpetua to develop monitoring and recordkeeping procedures for haul road activities in the Operation and Maintenance Manual ("O&M"). However, this allegation appears to fall within the scope of Claim 3 or Claim 4, as discussed in the "Order on Motion to Dismiss" (pp. 11-14), and those claims were dismissed.

[10] Petitioners do not argue that use of the "O&M" plan is arbitrary or capricious or any other actionable error under I.C. § 67–5279(3).

E. *Using precipitation data from EPA's AP-42 was not arbitrary or capricious*.[11]

Perpetua's environmental consultants provided DEQ with precipitation data gathered at the mine site that showed 155 days of measurable precipitation per year. ("Decl. of Kevin Schilling," p. 13). DEQ declined to use those data because they were gathered over too short a timeframe to be reasonably relied upon to reflect climatic variability. Id. AP-42, however, is a compilation of emissions factors that EPA has published since the 1970s and is sufficiently detailed to support reasonably accurate emissions estimates. Id. The Taylor Ranch station is over forty kilometers away from the mine site, which undermines its utility for this project. Id. Moreover, the data from that station was essentially the same as provided by AP-42. Id. It was well within DEQ's discretion to use the AP-42 for its precipitation data, and Petitioners have offered no argument, or evidence, showing otherwise.

III. The Hearing Officer Should Grant Summary Judgment in Favor of DEQ as it Relates to Arsenic from Various Sources.[12]

A. *Petitioners fail to demonstrate that any of the alleged errors in the PTC regarding arsenic emissions affect a substantial right*.

Idaho law requires agency decisions be upheld absent a showing of one of the errors enumerated in I.C. § 67–5279(3) and proof that the error affects the challenging party's substantial rights. Noble, 148 Idaho 937, 231 P.3d 1034 (2010); I.C. § 67–5279(4).

Again, the Petitioners have failed to allege—let alone prove—that any of the alleged errors in DEQ's PTC analysis of arsenic emissions affect their substantial rights. There is no evidence in the record that can support a finding that any alleged error impacts the Petitioners at all.

B. *DEQ's T-RACT analysis complies with the Air Rules*

An agency decision is considered arbitrary or capricious only if made if it is made "without

[11] Again, Petitioners do not actually argue that this alleged error was arbitrary or capricious, only that it "undermines" DEQ's estimates of road emissions.
[12] Claims 6-10 in the "Order on Motion to Dismiss."

a rational basis, or in disregard of the facts and circumstances, or without adequate determining principles." Rouwenhorst v. Gem Cnty., 168 Idaho 657, 662, 485 P.3d 153, 158 (2021) (citation omitted). When an aggrieved party challenges an agency's interpretation of a rule or statute, the reviewing court employs a four-pronged test to determine the appropriate level of deference to the agency interpretation. Duncan v. State Bd. of Acct., 149 Idaho 1, 3, 232 P.3d 322, 324 (2010). The court must determine whether: (1) the agency is responsible for administration of the rule in issue; (2) the agency's construction is reasonable; (3) the language of the rule does not expressly treat the matter at issue; and (4) any of the rationales underlying the rule of agency deference are present. Id. citing Preston v. Idaho State Tax Comm'n, 131 Idaho 502, 960 P.2d 185 (1998).

Here, Petitioners argue DEQ acted arbitrarily and capriciously by failing to consider the economic costs and environmental impacts of Perpetua's plan to control arsenic-containing dust from the haul roads. (Pet. Br. p. 32). To support this contention, Petitioners argue that DEQ's approval of Perpetua's arsenic control plan violated DEQ's Air Rules 210.14.a-b because "DEQ *must* consider" effectiveness, economic costs, operational feasibility and unmitigated environmental impacts of the proposed control. Id. (Emphasis added). This is an inaccurate representation of the Air Rule, which does not use mandatory language but rather grants DEQ wide-ranging discretion in its consideration of available control technologies for toxic air pollutants, as discussed below.

Several provisions in the TAPs rules grant DEQ ample discretion to determine whether a control technology is appropriate for a particular project. First, a permit applicant is required to "demonstrate preconstruction compliance with Section 161 *to the satisfaction of the Department*." IDAPA 58.01.01.210 (emphasis added). This means that the applicant's proposal must satisfy DEQ that the relevant toxic air pollutant emissions will not "injure or unreasonably affect human or animal life or vegetation." IDAPA 58.01.01.161. Whether DEQ is satisfied is a matter of discretion. Second, DEQ has the discretion to determine whether a control technology is "reasonably available" based

on technological and economic feasibility. IDAPA 58.01.01.210. If DEQ decides a "control technology is not feasible, the emission standard may be based on the application of a design, equipment, work practice or operational requirement, or combination thereof." Id.

The Petitioners' entire argument that DEQ's T-RACT decision was arbitrary and capricious appears to hinge on the contention that the Air Rules require DEQ to consider—to an unknown extent and in unknown detail—environmental impacts, economic costs, and operational feasibility of proposed control technologies. This blanket argument incorrectly interprets the plain language of the rule, which allows DEQ to determine T-RACT on a "case-by-case basis." Id. at 210.14. These rules are meant to guide the permit applicant to submit the correct information to DEQ—not dictate DEQ's analysis of the information. If the rule were meant to require DEQ to consider environmental impacts and economic costs of proposed control technology (again, to an unspecified degree) then the rule would employ mandatory language that would render the analysis patently non-discretionary. Compare Section 214.a, where the applicant "must" submit information to DEQ and Section 210.14.c, in which technological feasibility "will" be determined based on various factors.

Idaho appellate courts have interpreted the plain language of statutes to determine whether a government function was non-discretionary. In Coeur D'Alene Tribe v. Denney, 161 Idaho 508, 521, 387 P.3d 761, 774 (2015), for instance, the Idaho Supreme Court held that the Secretary of State had a non-discretionary duty to certify a bill as law because the plain language of the statute said the "certificate *must* be signed by the Secretary of State and deposited with the laws in his office." citing I.C. § 67–505 (emphasis added). See also, State v. Thiel, 158 Idaho 103, 107, 343 P.3d 1110, 1114 (2015) (statutory language created ministerial, non-discretionary function for court to perform); Oppenheimer Indus., Inc. v. Johnson Cattle Co., 112 Idaho 423, 425, 732 P.2d 661, 663 (1986) (state brand inspector had no discretion to accept "fresh" brand as proof of cattle ownership when statute said fresh brands "shall not" be accepted); Saviers v. Richey, 96 Idaho 413, 415, 529 P.2d 1285,

1287 (1974) (ordinance terms requiring interpretation allowed city officials to use their discretion).

Furthermore, Petitioners' argument runs contrary to DEQ's interpretation of the rule. The Hearing Officer should defer to the agency's interpretation because DEQ is the responsible agency for administration of this rule and its construction is reasonable. As stated by Stationary Source Bureau Chief Mike Simon, DEQ approaches its T-RACT analysis in five steps:

1. Identify all available control options.
2. Eliminate technically infeasible options.
3. Rank Remaining Control Technologies.
4. Consider the energy, environmental and economic impacts.
5. Select the most effective control not eliminated in step 4.

("Decl. of Mike Simon," pp. 11-12). Perpetua proposed two controls for dust generated on the haul roads: paving, and a combination of water and chemical dust suppressants. Id. at 13. Paving was judged to be technologically infeasible due to the process and operating procedures of the mine. Id. That left chemical dust suppressants as the remaining option and obvious choice. Chemical dust suppressants are commonly used in the industry, and DEQ found no associated environmental impacts so long as manufacturer's instructions are followed. Id. Therefore, DEQ did not approve the use of chemical dust suppressants "without a rational basis, or in disregard of the facts and circumstances, or without adequate determining principles." Rouwenhorst, 168 Idaho 657, at 485 P.3d at 158 (2021). DEQ used its discretion and experience to approve a plan for controlling arsenic-laden dust with a proven technology in accordance with its traditional interpretation of Idaho's T-RACT rules.

C. *DEQ properly used its discretion and expertise to average arsenic emissions over the projected duration of the mine.*[13]

Petitioners argue that DEQ acted arbitrarily and capriciously when it "broke from its established practice" and employed multi-year averaging of arsenic dust emissions, which will create

[13] Claim No. 9 in the "Order on Motion to Dismiss."

"a real risk to public health." (Pet. Br. pp. 36-7). In other words, Petitioners accuse DEQ of acting without a rational basis or in disregard of the facts and circumstances before them, or without adequate determining principles. This accusation is false. DEQ developed its approach based on the facts and circumstances of the proposed project, employing a comparable adjustment factor used for other short-term projects.

DEQ's approach to modeling TAP compliance employed the Short-Term Source Factor rule (Section 210.15) by analogue. ("Decl. of Kevin Schilling," pp. 11-12). "This section allows an impact of 10 times the AACC for projects having an operational lifetime of no greater than five years. DEQ simply used this general approach to develop a project-specific adjustment factor for the SGP, using the 16-year maximum life of the project." Id. DEQ's calculations were as conservative as reasonably possible: the equation for calculating lifetime exposure risk to arsenic utilized the *highest* annual concentration from *fourteen* different models and repeated it over sixteen years, the lifetime of the mine. The annual arsenic emissions were based on 135,000 tons of per day, every day, for sixteen years. ("Statement of Basis, TAPs Addendum Modeling Review Attachment" PET 344). This total ore production is *over fifty percent greater* than the actual potential mine production. Id. Using worst-case scenarios, or overestimating expected emissions, is a common modeling strategy that ensures actual emissions do not exceed applicable air standards. (See, "Decl. of Kevin Schilling.")

Petitioners, on the other hand, offer absolutely no evidence that multi-year averaging presents a public health risk. There is no evidence that the general public will be exposed to any of the dust created at the isolated mine site, and the record is devoid of the data necessary to substantiate Petitioners' medical claim. For these reasons, DEQ is entitled to summary judgment on this issue.

D. *Petitioners fail to demonstrate DEQ's decision to exclude the Stibnite Road Access Route from the ambient air boundary is arbitrary and capricious*.[14]

[14] Claims 11, 12, and 13 in the "Order on Motion to Dismiss."

An agency decision is considered arbitrary or capricious only if made if it is made "without a rational basis, or in disregard of the facts and circumstances, or without adequate determining principles." Rouwenhorst v. Gem Cnty., 168 Idaho 657, 662, 485 P.3d 153, 158 (2021) (citation omitted).

Here, the Petitioners argue that DEQ's decision to allow Perpetua's registered guests to travel the Route means the air along the Route must be classified as "ambient air," as that term is defined at 40 CFR § 50.19(c) and IDAPA 58.01.01.006.10.[15] More specifically, the Petitioners argue that DEQ's decision to differentiate between Perpetua's registered guests and the "general public" was arbitrary and capricious. (Pet. Br. p. 18).[16] To support this proposition, Petitioners argue that DEQ violated its own written guidance and rule defining ambient air. In this way, the Petitioners are challenging DEQ's interpretation of its own rule defining a term of art. DEQ's interpretation is due substantial deference.

Petitioners also miscite EPA's 2019 "Revised Policy on Exclusions from 'Ambient Air,'" which does not require state agencies to apply the policy because they "retain the discretion to determine whether the steps taken by a source will be adequate to preclude public access." PET 773. The Petitioners misunderstand the scenario EPA warned "would expand the exclusion beyond reason," because that scenario involves two separate private properties, the first being the location of a stationary source, and the other being downwind. Under these specific circumstances, it would be unreasonable to exclude the guests of the downwind property from the "ambient air" just because they are located on private property not open to the general public. This scenario is also explained

[15] It is unclear from the Petitioners' argument exactly how far from the Route the "ambient air" boundary should extend from either side of the road.

[16] This appears to be a different argument than previously litigated; the Hearing Officer's "Order on Motion to Dismiss" 11/15/22 declined to dismiss Claim 11 on the grounds that Petitioners could possibly provide evidence that Perpetua does not have legal authority to exclude the "general public," and no such showing has been made.

in DEQ's guidelines: "employees of other facilities are considered to be general public for the facility in question." PET 744. More relevant to the current circumstances is that EPA's policy specifically excludes "business invitees" from the definition of "general public." PET 776.

DEQ's decision to differentiate between the "general public" and Perpetua's guests was not arbitrary, capricious, or an abuse of discretion, and DEQ's interpretation of the definition of "ambient air" merits considerable deference because (1) DEQ is responsible for administration of this rule in issue, (2) its construction is reasonable, and (3) the language of the rule does not expressly treat the matter at issue. See, Preston, 131 Idaho 502, 960 P.2d 185 (1998). DEQ excluded the Route from ambient air because Perpetua represented that it had legal authority to prohibit access by the "general public" and the practical ability to do so. ("Decl. of Mike Simon," p. 5 and "Decl. of Kevin Schilling pp. 4-8). The "general public" will be precluded from accessing the Route on a routine basis, and access for all guests will be carefully managed. The Route will not be, as Petitioners contend, a "public access road." Permit Condition 2.7 requires a combination of security escort vehicles, manned guardhouses, locked gates, barriers, warning signs, and registration of all guests to the mine site. These conditions are more than sufficient to notify a reasonable person that his presence is not permitted and therefore punishable under I.C. § 18-7008 for criminal trespass and actionable under I.C. § 6-202 for civil trespass. The DEQ guidance Petitioners cite regarding "right-of-way easements" or "common service roads" is inapplicable in these circumstances. PET 744. The "general public" retains no "right" to traverse the mine site, and access to guests will be strictly managed pursuant to Permit Condition 2.7 and the AMP.

E. *The Hearing Officer Should Grant Summary Judgment in Favor of DEQ Because Petitioners Have Failed to Show that DEQ's Customary Use of Operating Plans is Arbitrary and Capricious*.[17]

[17] This claim was introduced in Petitioners' "First Amended Petition to Initiate Contested Case" filed 12/6/22 following issuance of the "Order on Motion to Dismiss" 11/15/22.

Petitioners claim DEQ violated the Air Rule and acted arbitrarily and capriciously when it "rushed forward and issued Perpetua what is essentially a *partial, incomplete PTC*" so that it can subsequently review Perpetua's plans "outside the normal PTC process." (Pet. Br. p. 29). Again, Petitioners question DEQ's interpretation of its own rules and challenge a tried-and-tested permitting process that has governed Idaho's regulated community for years. The only aspect of the Stibnite PTC that falls "outside the normal PTC process" was the extraordinary and unprecedented three-year collaboration that preceded it.

Incorporating post-construction operational plans is common practice. According to Mike Simon, DEQ's Stationary Source Bureau Chief for the past nineteen years, DEQ commonly requires "certain plans, such as an O&M manual or FDCP to be prepared by the permittee post permit issuance." ("Decl. of Mike Simon" p. 10). The process "allows the permittee to prepare a specific plan or manual based on the actual equipment purchased and installed, the manufacturer's instructions and recommendations, as well as the operational characteristics of the facility after construction is completed." Id. This process also increases administrative efficiency because if specific conditions for a plan, such as the FDCP, "were instead listed in as permit conditions, any small change to the plan would trigger an administrative permit revision process." Id. at 7. DEQ can, and has, enforced the specific conditions contained in post-construction plans. Id. DEQ's practice of requiring and enforcing post-construction operational plans demonstrates that the requirements in this case are neither arbitrary nor capricious. DEQ takes very seriously its mission to protect public health and the environment, and it has a proven track record of doing just that.

CONCLUSION

The Hearing Officer should deny Petitioners' Motion for Summary Judgment. The Petitioners have failed to prove that they have standing to challenge the Stibnite PTC. Furthermore, the Petitioners have failed to prove that DEQ committed any errors in its thorough and diligent PTC

analysis that subject the permit to remand. Instead, the Hearing Officer should grant summary judgment in favor of DEQ because the Petitioners lack standing to challenge the PTC and because DEQ's analysis of dust and arsenic emissions comply with applicable statutes and conform with its customary permitting practice.

Dated: May 12, 2023, FOR RESPONDENT:

STATE OF IDAHO, DEPARTMENT OF ENVIRONMENTAL QUALITY

By: /s/ *John R. Shackelford*
John R. Shackelford
Attorney for Respondent

CERTIFICATION OF SERVICE

I HEREBY CERTIFY that on this 12th day of May, 2023, a true and correct copy of the foregoing RESPONDENT'S NOTICE OF DISCOVERY SERVICE was served on the following via electronic mail to the indicated address:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Dylan Lawrence
Hearing Officer
Varin Thomas, LLC
242 N. 8th St., Suite 220
Boise, ID 83702
dylan@varinthomas.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Resources Division
Office of the Attorney General
1410 N. Hilton St.
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

/s/ John Shackelford
John Shackelford

RAÚL R. LABRADOR
Attorney General

SCOTT L. CAMPBELL
Deputy Attorney General
Chief, Energy and Natural Resources Division

JOHN R. SHACKELFORD, ISB# 8647
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: (208) 373-0453
Facsimile: (208) 373-0481
john.shackelford@deq.idaho.gov

Attorneys for Respondent

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	Agency Case No. 0101-22-01 OAH Case No. 23-245-01 DECLARATION OF KEVIN SCHILLING

I, Kevin Schilling, hereby declare under penalty of perjury pursuant to the law of the State of Idaho that the following is true and correct:

My name is Kevin Schilling. I am currently the Stationary Source Air Modeling Supervisor for the Stationary Source Bureau at the State Air Quality Division Program Office of the Idaho Department of Environmental Quality (DEQ) in Boise. I have held this general position since September of 2004, although the position was transferred from the Monitoring, Modeling, and Emissions Inventory (MMEI) section to the Stationary Source section in August 2017.

I received a Bachelor of Science (BS) degree in Environmental Science, with a minor in chemistry, from Washington State University in 1986. I attended graduate school after graduation and was employed by Washington State University as a research assistant at the Laboratory for Atmospheric Research. I received a Master of Science (MS) degree in Environmental Engineering (specializing in atmospheric chemistry, meteorology, air pollution monitoring, and atmospheric pollutant dispersion) from Washington State University in 1988.

I initially began employment with DEQ (at that time the Division of Environmental Quality) in spring of 1989 and then left the agency in 1990 to work as an environmental consultant at Morrison Knudsen, a civil engineering and construction company. I worked within the environmental services group at Morrison Knudsen, providing air quality science and engineering services on a wide range of projects. Specific services included air permitting, pollutant emissions estimation, atmospheric dispersion modeling, air pollution monitoring, and industrial hygiene functions. I returned to DEQ in December of 2001, working in the Technical Services Division where I primarily reviewed air modeling analyses submitted as part of air permit applications. In 2004, I transferred to the Air Quality Program Office as the Stationary Source Air Modeling Coordinator. My basic duties are to coordinate and oversee the review of air impact modeling analyses submitted to DEQ as part of air quality permit applications. To do this, I must have a strong understanding of *Idaho Air Rules*, DEQ policy, and DEQ guidance materials as well as EPA rules, policy, and guidance (much of which formed the basis of Idaho's rules, policy, and guidance). Outside of drawing on my regulatory

knowledge obtained through extensive experience in air quality permit modeling in Idaho (having reviewed hundreds of impact modeling analyses), I frequently consult air quality permit modelers in other states, EPA air permit modelers, and EPA rules, policy, and guidance materials. My duties also involve proposing changes to guidance and analytical procedures used to demonstrate compliance with air quality standards.

Presently, two staff positions, both Air Quality Dispersion Modeling Analysts, report directly to me. Darrin Mehr fills one of those positions and the other has recently been vacated by Dr. Pao Baylon who left DEQ to work with a private environmental consulting company. Dr. Baylon was the Air Quality Dispersion Modeling Analyst who reviewed most of the Perpetua Resources Idaho, Inc. (PRI) Stibnite Gold Project (SGP) air impact analyses.

My role in the permitting of the SGP has been both supervisory and technical/policy review and evaluation. As mentioned above, Dr. Baylon was the lead in the review and verification of impact analyses and the generation of supplemental analyses used to boost DEQ's confidence that the SGP would not cause or contribute to violation of air quality standards or increments. Where air impact modeling methods used by PRI in the application were atypical or of questionable appropriateness, Dr. Baylon discussed the approach, data, and analyses with me. Prior to permit issuance, Dr. Baylon, DEQ Permit Writer Kelli Wetzel, Permitting Supervisor Darrin Pampaian, and Stationary Source Bureau Chief Mike Simon discussed the various aspects of the SGP, including proposed operations, emission calculations, and various monitoring and recordkeeping requirements. This was done to provide a comprehensive assessment of DEQ's confidence of NAAQS and TAP compliance in a weight-of-evidence type approach. At the conclusion, I was highly confident that operation of the SGP, as described in the application and as required by the DEQ Permit to Construct (PTC), will not cause or contribute to a violation of a National Ambient Air Quality Standard (NAAQS) or exceed an applicable Toxic Air Pollutant (TAP) increment.

DEQ's Decision to Exclude the Stibnite Access Route from Ambient Air

Facilities exclude all or a portion of their sites from access by the general public for either: 1) security reasons, preventing theft or damage to the property or equipment present; or 2) protection of non-employees from hazards that may be present at the site, dictating either special instruction to appropriately protect those in the area from the hazard or the exclusion of certain individuals determined to be too sensitive to those hazards. Once a facility is reasonably secure to prevent unauthorized access, it is the facility's discretion who they allow or do not allow to access their site.

Handling of the Stibnite Road Access Route in the New Source Review ambient air impact analyses presents the unique situation where those seeking access to the facility wish to do so only for the purpose of passing through to a different destination. As such, the issues it presents were not anticipated during the development of DEQ guidance nor even EPA guidance. Therefore, certain specific details of DEQ guidance and even EPA guidance cannot be relied on to provide adequate resolution to the claim. For example, the DEQ *Air Modeling Guideline* (*Guideline for Performing Air Quality Impact Analysis*. Stationary Source Program. Air Quality Division. State of Idaho Department of Environmental Quality. July, 2021) states, "For the purpose of defining ambient air, the 'general public' is considered anyone not directly associated with the facility." Obviously, those wishing to access the site for the purpose of more efficiently accessing another destination are not directly associated with the facility; however, an elementary school class taking a tour of the mine site are not directly associated with the facility either, but they are unquestionably excluded from consideration as the *general public*. Alternatively, if the facility operates a visitor center with unrestricted/uncontrolled access, those visitors would be considered as the *general public*.

It is important to note that the Stibnite Road Access Route is excluded from ambient air

consideration for carcinogenic TAPs, even if the road were a public roadway. *Idaho Air Rules* Section 210.03 states that "if the toxic air pollutant is listed in Section 586 (carcinogenic TAPs), the receptor site is not considered to be at a point of public access if the receptor site is located on or within a road, highway or other transportation corridor transecting the facility." This provision accounts for the negligible long-term exposure opportunities for such roadways. Therefore, Argument I is only applicable to criteria pollutants such as PM_{10} and $PM_{2.5}$.

Early in the permitting process, the permit applicant (Midas Gold at that time) engaged with DEQ on the issue. Midas Gold explained that maintaining efficient historical access to recreational areas was very valuable to a group of people who visit the area, and Midas Gold wanted to explore options for allowing this to the greatest extent possible. However, if the roadway were treated similarly to ambient air areas outside of a facility boundary, it would be exceedingly difficult to demonstrate compliance with applicable ambient air quality standards. There were two primary options for addressing the Stibnite Road Access Route in an air impact analysis:

1) Analyze the road as ambient air, with unrestricted access for the *general public* (understanding that the permittee would need to close access during certain mining activities deemed as unsafe). The close proximity of the road to certain emission points would require a more refined and less conservative impact analysis. However, because the pollutant exposure potential on the roadway is limited by the short time anyone would be traveling on the road, DEQ's required level of NAAQS compliance confidence for permit issuance is less than for other ambient air areas where there is a higher potential for longer term exposure (long-term in the context of the averaging period of the standard considered – 24 hours for the 24-hour PM_{10} and $PM_{2.5}$ NAAQS and annual for the annual $PM_{2.5}$ NAAQS).
2) Exclude the road from ambient air, providing procedures on how access to the facility will be controlled to prevent access by the *general public*. To accomplish this, the permittee must

first assert that they have sole control of access to the area with the legal right to refuse access to anyone at any time and for any reason. Secondly, the permittee must practically manage access. Key to this is that those accessing the area clearly understand they are leaving a public area (and the protections that affords) and entering an industrial facility where their safety is the responsibility of the facility.

It was anticipated that NAAQS compliance could be demonstrated using either option. Option 1 was used in the air impact analyses presented in the draft Environmental Impact Statement (EIS). NAAQS compliance was more easily demonstrated in the EIS because emissions in the EIS could be based on best estimates of mining operations and associated emission-affecting parameters. Impact analyses supporting the state-issued PTC must be based on maximum allowable operations as allowed by enforceable permit conditions. PTC conditions could be drafted to support further refinement of emission calculations to confidently demonstrate NAAQS compliance along the Stibnite Road Access Route, but this would require considerable analytical scenarios and an extensive number of permit conditions to make such scenarios enforceable. After consideration, Option 2, excluding the Stibnite Road Access Route from *general public* access and from ambient air, was selected as the preferred approach for permitting.

The first requirement for excluding an area from ambient air is that the permittee has the legal right to preclude access by the *general public*. Perpetua has asserted that they have sole and complete control of access to the Stibnite Road Access Route, including complete closure of the roadway to anyone except mining employees at any time for any reason. For this to hold, PRI must not be legally required to provide access to the *general public* by any contract or agreement, and PRI must be able to deny access to anyone at any time. This is explained in Section 3.3.10 of DEQ *Modeling Review Memorandum* (*Demonstration of Compliance with IDAPA 58.01.01.203.02 (NAAQS) and 203.03 (TAPs) as it relates to air quality impact analyses*. Memorandum from Pao Baylon, Modeling

Review Analyst, Air Program, DEQ, through Kevin Schilling, Modeling Supervisor, to Kelli Wetzel, Permit Writer. January 6, 2022).

In addition to the legal ability to preclude access, the permittee must have the practical ability to preclude access by the *general public* and then demonstrate that practical measures will be implemented during facility operations. To answer this, it was first necessary to evaluate what excludes someone from consideration as the *general public*. All employees of the mine and contractors having official business with the mine can obviously be excluded from consideration as the *general public*. Alternatively, if a facility operated a retail business with unrestricted access, those areas of unrestricted access would be considered as ambient air. Permittees may also periodically provide tours of their facilities. These tourists can only be excluded from consideration as the *general public* if their access is carefully managed. Ordinarily, DEQ-issued permits do not include requirements pertaining to access management for those not employed by the facility. Access management is left to the facility; however, simply opening the facility gate to allow anyone to walk through would not serve to reasonably preclude access by the *general public*. We considered the following as requirements for exclusion from consideration as the *general public*:

1) Those requesting access must be informed that they are leaving a public area and entering (if access is granted) an area exclusively controlled by the facility.
2) The evaluation of who is granted access to the facility must be made on an individual basis.

Beyond the above listed requirements, it is not DEQ's responsibility or authority to evaluate reasons a facility may grant access to or through their site. What is important is that those accessing the facility clearly understand that they are no longer in a public area and no longer afforded any protections associated with that (such as NAAQS). Permit condition 2.7 outlines this and requires PRI to develop an *Access Management Plan* (AMP) to establish finer details of how site access will be managed. The third bullet of condition 2.7 addresses the access for the purpose of passing through

the facility, stating, "Only registered guests of the facility will be allowed to access to or through the facility. Those seeking to be a guest for the sole purpose of passing through the facility to another destination shall be provided a registration sheet that explains Perpetua's requirements for accessing the site and identifies potential hazards of the site."

DEQ consulted with EPA during the permitting process to discuss excluding the Stibnite Road Access Route from consideration as ambient air. EPA Region 10 Meteorologist and Regional Modeling Contact, Dr. Jay McAlpine, responded to an email I had sent to him on March 23, 2020, regarding the road. He stated, "My understanding is the road is likely exempt from ambient air protections because it is fully under the control and surveillance of the source and unsupervised public access is precluded. It seems like a slam dunk, based on my understanding of EPA's revised ambient air policy." An accurate copy of this email is attached hereto, as Exhibit A.

DEQ's TAP Compliance Methodology

The regulatory air permitting process has been established to primarily regulate well-defined, consistent pollutant-emitting processes. An example is a manufacturing process occurring inside a factory where the same processes occur year-after-year to create a product, with market fluctuation as the main variable. Emissions occur from well-defined points that are consistent through time. A major challenge in assessing pollutant exposures for mining activities, in the context of establishing allowable emissions in an air permit for a mining operation, is the dynamic nature of emissions and types of emission-generating activities. A mining operation involves numerous operational phases, each with different emission generating activities and a different magnitude of emission quantities, occurring at different locations at the site and at differing times. Even the distinction between *construction* and *operation* for mining activities becomes very fuzzy, as new areas are continually developed, utilized, and then decommissioned. It is challenging to develop a workable permit that addresses all mining phases and is supported by air impact analyses that account for these dynamic

activities in a conservative manner while still allowing for reasonable operational flexibility, which is critical for continually changing mining operations. The typical permitting approach is to use worst-case assumptions and data in a limited number of analyses that will confidently show that allowable operations, as described and limited in the permit and permit-required plans and procedures, cannot result in impacts that exceed applicable standards. When this approach is applied to mining operations, results of the impact modeling tend to greatly overstate actual impacts that will occur or even could occur.

The initial PRI PTC application assessed arsenic impacts in a straightforward application of Idaho's TAP permitting rules in Section 210 of *Idaho Air Rules*. This involved the following for carcinogenic TAPs:

1. Calculation of maximum allowable annual-averaged emissions from applicable sources, excluding sources that are considered exempt from consideration by *Idaho Air Rules* Section 210.20 (Sources covered by or addressed by 40 CFR Part 60, 61, or 63).
2. Modeling of maximum allowable annual emissions, using the single year of meteorological data collected onsite, to evaluate the annual impact at ambient air locations.
3. From the air dispersion modeling results (annual concentrations predicted at more than 9,500 specific points surrounding the mine), the maximum impact was identified and compared to the AACC provided in *Idaho Air Rules* Section 586.
4. Compliance with Section 210 is demonstrated if the maximum ambient air impact is less than the AACC.

The number of TAP-applicable arsenic emission sources for the SGP was expanded late in the permit application review process, after it was determined that some sources had been incorrectly excluded from analysis as per *Idaho Air Rules* Section 210. The incorrect exclusion was confirmed by the DEQ Permit Writer, the DEQ Permitting Supervisor, and the DEQ Stationary Source Bureau

Chief after considering comments received during a public comment period. Without completely reworking the complex and still very conservative approach used to assess carcinogenic TAP impacts, compliance could not be demonstrated using the typical approach outlined above. I then undertook the task of evaluating whether a more refined approach could be used to demonstrate compliance with TAP rules of Section 210.

A first step in refinement of impacts or adjustment of allowable impacts was to assure that reasonably available control technologies were used for all sources of arsenic. This level of control is referred to as T-RACT and its use in the evaluation of carcinogenic TAPs is described in Idaho *Air Rules Section* 210.12. If T-RACT is used to control emissions from sources, then the allowable impact is ten times that of the AACCs, corresponding to a lifetime cancer risk of 1 in 100,000. The AACC conservatively represents a long-term exposure (70 years) that would result in a 1 in 1,000,000 cancer risk. The DEQ Permit Writer is responsible for review and approval of T-RACT.

Consideration of T-RACT in the analyses still resulted in modeled arsenic impacts exceeding a value of 10 times the AACC. Faced with this problem, there were effectively two options: 1) revision of the emission calculation and modeling methods, using those that would be less conservative (less of a tendency to overestimate emission quantities that could occur) and perhaps more complicated; or 2) refine the exposure calculation to better account for the dynamic nature of emission-generating activities and the limited project lifetime. Before undertaking an extensive revision of the conservative emission calculation approach used in the emission inventory and the air impact model, DEQ evaluated whether certain refinements in exposure calculations would be consistent with requirements of *Idaho Air Rules* and specifically with *Idaho Air Rules* Section 210 for carcinogenic TAPs.

A worst-case conservative but simplistic approach used for the SGP did not show compliance with the arsenic AACC, or even the AACC multiplied by a factor of ten to reflect the allowable

impact when using T-RACT. DEQ then reviewed the basis for the AACCs to further evaluate refinement of exposure calculations to provide a more representative comparison to the AACC. AACCs were established in *Idaho Air Rules* to protect against a project-caused lifetime excess cancer risk of more than 1-in-1,000,000, or 1-in-100,000 where T-RACT is used to control emissions from sources. Prior to a regulatory clean up in 2022, *Idaho Air Rules* Section 006.125 defined *Toxic Air Pollutant Carcinogenic Increments (AACCs)* as, "Those ambient air quality increments based on the probability of developing excess cancers over a seventy (70) year lifetime exposure to one (1) microgram per cubic meter (1 $\mu g/m^3$) of a given carcinogen and expressed in terms of a screening emission level or an acceptable ambient concentration for a carcinogenic toxic air Pollutant. They are listed in Section 586." Although a lifetime risk is the benchmark, DEQ listed annual averages for the AACCs in *Idaho Air Rules* because that timeframe 1) is long enough to establish a good representation of long-term impacts for most sources requiring a permit, 2) is short enough to provide compliance assurance early in the life of the industrial operation, and 3) is convenient for compliance monitoring and reporting, providing a practically enforceable limit on operations. Use of an annual limit is not key to attaining a limit on the lifetime cancer risk; and, since a lifetime risk is the benchmark, use of annual averaged emissions to show compliance with the AACC on an annual basis could be unnecessarily restrictive where processes vary considerably year-to-year and have a project lifetime substantially shorter than 70 years, such as mining processes.

PRI indicated that the SGP will have a 16-year maximum project lifetime. To calculate a project-based arsenic concentration representative of the project, appropriate for comparison to the AACC (based on a 70-year exposure), the modeled impact was adjusted by the factor 16/70.

TAPs rules in *Idaho Air Rules* Section 210 have already established means to allow an adjustment for short-term projects. Section 210.15 provides for a *Short-Term Source Factor*. This section allows an impact of 10 times the AACC for projects having an operational lifetime of no

greater than five years. DEQ simply used this general approach to develop a project-specific adjustment factor for the SGP, using the 16-year maximum life of the project.

As an atmospheric scientist, my approach for the refined calculation of exposure was based on what I believe to be the regulatory intent of the TAP rules. I am uniquely positioned to comment on this because I participated in the development of these rules during the 1990s. I worked as an environmental consultant for Morrison Knudsen, and I was working with DEQ on the development of the TAP rules through the Idaho Association of Commerce and Industry (IACI). However, since I am not an expert in environmental law, I felt it was critical that my approach for the SGP be thoroughly reviewed by my management and the Idaho Attorney General's office. Although I did not receive any written review of the approach, I was assured by my management that the Deputy Attorney General reviewed it and found it to be consistent with the rules.

Finally, DEQ specified a 5-year averaging period for calculating emissions from allowable operations to evaluate TAP compliance. This was done to better allow for the large year-to-year variability in emission-generating activities and operational rates. This is appropriate since the benchmark is a lifetime risk rather than an annual risk. A 5-year averaging-period still affords a reasonable window for periodic compliance assessment through monitoring and recordkeeping.

DEQ's Use of Precipitation Data for Calculating Annual $PM_{2.5}$ Emissions from Haul Roads

The DEQ stationary source air modeling group is not directly responsible for review and approval of particulate emission calculations, including those for fugitive emissions from haul roads; however, when these emissions are a primary driver in modeled impacts, we periodically provide feedback to the permit writer on the appropriateness, variability, and uncertainty of emission factors and inputs to emission calculation equations. Fugitive particulate emissions from vehicle traffic on unpaved roads were calculated for the SGP using methods provided in EPA's AP42, Section 13.2.2. For annual emissions only, this section provides for a control factor that is a function of precipitation

(number of days in a year with precipitation greater than 0.01 inches). To aid in this calculation, AP42 also provides a map of the United States with contours of days with precipitation greater than 0.01 inches. This map, based on climatological data, was used to select the 120-day number representing conditions at the SGP location. Although the map's resolution is somewhat coarse, it is not "generic" as suggested in the Petitioners' Opening Brief. The resolution provided by the AP42 map is adequate to provide reasonably accurate emission estimation, well within the general uncertainty of the factor and other inputs such as silt content, vehicle weight, and control efficiencies of various measures that can be taken to reduce emissions.

It was suggested in the Petitioners' Opening Brief that climatological data from Taylor Ranch station should have been used in the emission calculation equation rather than the AP42 map. This station is over 40 kilometers from the SGP site, making it questionably more representative than the AP42 map. Furthermore, the Taylor Ranch data indicated there was an average of 113 days each year with precipitation over 0.01 inches, effectively matching the 120-day value obtained from the AP42 map. One year of precipitation data were also collected at the SGP site along with other meteorological parameters used in the air dispersion modeling. Since the onsite data were only collected for one year, it is questionable whether it can be considered more representative than the AP42 map for typical conditions because of the year-to-year variability (for example, variability in precipitation caused by El Nino and La Nina climate pattens). Finally, review of onsite precipitation data for 2014 indicates there were 155 days with precipitation equal to or greater than 0.01 inches, well above the 120 days obtained from the AP42 map. Use of these data would have lowered emission estimates for annual $PM_{2.5}$ fugitive emissions from vehicle traffic on SGP haul roads.

I acknowledge the large uncertainty and potential variability in calculated particulate emissions from vehicle traffic on mine-site haul roads relative to other stack emissions that are more easily quantified. The criteria bar for permit issuance is not to assure that emissions and impacts

were estimated using the most accurate means possible. The bar is evaluating whether impact analyses (including emission estimates), using the methods and data presented in the application and any supplemental DEQ analyses, demonstrate compliance with applicable NAAQS and TAP increments to the satisfaction of DEQ. DEQ satisfaction is then considered to be met when the review analyst has a high level of confidence that standards will not be exceeded. The compliance confidence level is evaluated in a weight-of-evidence type approach considering all aspects of the analyses, including but not necessarily limited to the following: magnitude and extent of estimated impacts; uncertainty in methods and data used; variability in emission generating activities and emission-affecting parameters; conservatism in operational scenarios used; effectiveness of monitoring methods to verify data and emission control; potential for impacts to sensitive receptors. Lead DEQ modeling review analyst Dr. Pao Baylon and I, after review of the analyses conducted and submitted in support of the permit application, were highly confident that implementation of the SGP as described in the application and the DEQ *Modeling Review Memorandum* and as limited by the issued permit and subsequent permit-required plans and procedures, will not cause or contribute to a violation of any applicable NAAQS or TAP increment.

Ambient Air Monitoring

Recently, I was made aware of an EPA guideline on ambient air monitoring in permitting actions (*Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD)*. U.S. Environmental Protection Agency. Office of Air Quality Planning and Standards. Monitoring and Analysis Division. Research Triangle Park, NC. EPA 450/4-87-007. May 1987); however, this guideline was not specifically used during review of the SGP permitting process. As quoted from the guideline, postconstruction ambient air monitoring may be required in the following situations:

a. *NAAQS are threatened – The postconstruction air quality is projected to be so close to the NAAQS that monitoring is needed to certify attainment or to trigger SIP related actions if nonattainment results.*

b. *Source impact is uncertain or unknown – Factors such as complex terrain, fugitive emissions, and other uncertainties in source or emission characteristics result in significant uncertainties about the projected impact of the source or modification. Postconstruction data is justified as a permit condition on the basis that model refinement is necessary to assess the impact of future sources of a similar type and configuration.*

Although I did not specifically use the monitoring guideline to evaluate whether to recommend ambient air monitoring, the general procedure outlined by the guidance was used. A key consideration in the guideline is that ambient air monitoring is not required for a set of specific triggering conditions. Regarding postconstruction ambient air monitoring, the guideline states, "The PSD regulations include authority to require postconstruction monitoring. In general, EPA may require postconstruction monitoring from large sources or sources whose impacts will threaten standards or PSD increments. The permit granting authority will make this decision on a case-by-case basis."

The DEQ *Modeling Review Memorandum* describes the submitted impact analyses, DEQ's review of those, and DEQ's supplemental analyses. The impact analyses were performed using meteorological data collected onsite, unlike most minor source permitting projects where meteorological data are obtained from the closest existing meteorological station. However, PRI's consultant, Air Sciences, Inc. (Air Sciences), proposed to use a meteorological processing approach for permitting (referred to as the NON-BULKRN method) differing from what was used in analyses supporting the EIS (referred to as the BULKRN method). Both methods are considered acceptable by EPA modeling guidance, although the BULKRN method is more refined and uses the full extent

of meteorological parameters monitored at the site. I was somewhat uncomfortable with this approach as it generally went against recommendations from the EPA Region X Air Dispersion Modeler, Jay McAlpine, to use more refined methods where data needed for those methods had been collected. DEQ then requested Air Sciences to perform supplemental analyses with the BULKRN-processed data to provide further insight into the effect of meteorological data processing methods on modeled impacts. The analyses using the NON-BULKRN-processed data were considered as the primary compliance demonstration.

Maximum modeled PM_{10} 24-hour impacts, using the NON-BULKRN data, were at 75 percent of the NAAQS when combined with monitored background levels. Analyses using the BULKRN-processed meteorological data showed maximum impacts at 106 percent of the standard. With a modeled exceedance shown when using the supplemental analysis, DEQ was not highly confident of NAAQS compliance at this point. Further analysis was performed to evaluate the potential for exceeding the NAAQS.

DEQ further investigated the modeled exceedances shown when using the BULKRN-processed meteorological data. There were only five receptors (of 9,500 receptors modeled) that showed an exceedance of the 24-hour standard when assessing one year of hourly meteorological data. At the worst-case impact location, the standard was only exceeded by about 6 percent. The modeled exceedances were limited to an area northeast of the facility, and the frequency of days exceeding the 24-hour standard was less than 4 days out of 365 days in the year modeled.

Modeled high 24-hour PM_{10} impacts were found to be caused by the operational scenario of West End Pit activities, with onsite traffic on haul roads accounting for the majority of impacts that approach or exceed NAAQS. Next, we investigated those days where the model indicated an exceedance of the standard. All days when the 24-hour PM_{10} NAAQS was exceeded occurred during late December through mid-January. Not only is the potential for fugitive emissions less because of

higher precipitation and greater moisture levels during this period, especially on roadways, but background PM_{10} concentrations tend to be much lower (which was not accounted for in the analyses).

We also evaluated predicted impacts for operational rates closer to what would be expected. The 24-hour NAAQS compliance modeling used emissions associated with a production rate of 180,000 ton/day of development rock. This would correspond to 65,700,000 ton/year, which is considerably more than the expected peak rate of 42,692,000 ton/year (116,964 ton/day). DEQ then evaluated impacts for a rate of 120,000 ton/day, keeping other model variables constant. Results were at 148.5 $\mu g/m^3$, slightly below the 150 $\mu g/m^3$ NAAQS for the maximum impacting operational scenario and using the BULKRN-processed meteorological data.

Finally, we evaluated the importance of achieving a 93 percent control efficiency for fugitive emissions from haul road traffic. An analysis was performed using a 90 percent control efficiency for haul road traffic emissions along with a more typical mining production rate of 120,000 ton/day. Compliance with the 24-hour PM_{10} NAAQS was demonstrated for the case when NON_BULKRN-processed meteorological data were used. When BULKRN-processed data were used, NAAQS exceedances were still modeled at five receptors. These results prompted the modeling group to recommend "that the permit require aggressive implementation of measures to achieve above 93% control efficiency for fugitive particulate emissions from roadways."

Late in the review process, PRI determined that the West End Development Rock Storage Facility will not be constructed, thereby eliminating the modeling operational scenario W5. Scenario W5 was the scenario where modeled exceedances of the 24-hour PM_{10} NAAQS were shown when using the BULKRN-processed meteorological data. When Scenario W5 is removed, the highest impacting operational scenario is W3, which represents the transport of development rock from the West End Pit to the Hanger Flats Development Rock Storage Facility. Maximum impacts still

slightly exceed the NAAQS when using a single value background concentration value, but are well below NAAQS when seasonal backgrounds are used (82% of the NAAQS at 123.5 $\mu g/m^3$).

The uncertainty in emission estimation methods greatly affects the NAAQS compliance certainty of the air impact analyses, as impacts are directly proportional to emission quantities. Modeled 24-hour PM_{10} impacts are heavily affected by particulate emissions from traffic on haul roads. The base emission factor, before accounting for any emission control measures, is a function of the silt content of the road surface. The submitted application used a silt content of 4.0 percent. This was the calculated median silt content of core samples of material collected onsite. The detailed review of emission calculation methods is primarily the responsibility of the permit writer, and the modeling group was not aware of the non-conservative silt content number used in the emission calculation until later in the review process. After learning that the median silt content was used for calculating emissions used to demonstrate compliance with the 24-hour PM_{10} NAAQS, I expressed my belief that NAAQS compliance could not be assured at a sufficiently high confidence level for haul road emissions representative of median conditions, even though there are other areas of the analyses that are very conservative. The options at this point were: 1) recalculate PM_{10} emissions from haul roads using a more conservative statistic for road silt than the median value, then revise the air impact modeling analyses; 2) require post construction ambient air monitoring to increase the assurance of NAAQS compliance; 3) use the 4.0 percent silt value as a maximum allowable value in the permit, requiring periodic monitoring of the road silt content during mining operations; and/or 4) develop other means by which lower levels of fugitive emissions from vehicle traffic could be attained and assured through monitoring (monitoring other than ambient air monitoring).

Requiring ambient air monitoring for the SGP was discussed within the Air Division, including stationary source staff, ambient monitoring staff, and State Implementation Plan (SIP) staff. From the perspective of air permit modeling verification, I believe the requirement of PM_{10}

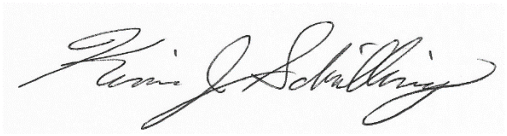
ambient air monitoring to assure NAAQS compliance is of limited value for the SGP because of the following:

- Monitored values showing compliance with the NAAQS only demonstrates compliance for that point in space and time. While a monitored exceedance likely indicates a failure to adequately control emissions (unless the exceedance may be caused by elevated background concentrations), compliance doesn't assure compliance at other ambient air locations.
- Selecting a single monitoring location to represent worst-case impacts is nearly impossible. In general, atmospheric dispersion models perform reasonably well at predicting the magnitude of maximum impacts (provided the inputs of emissions and emission release parameters is reasonably accurate); however, they perform poorly at predicting the location of maximum impacts in most cases. The accuracy of predicted locations of maximum impacts is even worse for analyses involving complex terrain, complex meteorological conditions, and emission sources involving atypical release characteristics (fugitive emissions from vehicle traffic, blasting operations, ore handling, etc.). Monitoring results that show compliance with NAAQS may portray a false confidence of NAAQS compliance on a facility-wide scale.
- No sensitive receptors have been identified near the facility. Sensitive receptors are locations where there is likely to be a concentration of the *general public* present. These include private residences, schools, hospitals, care centers, retail stores, parks, and resorts. DEQ believes the confidence of NAAQS compliance must be higher at these locations than at locations where there is a lower probability of public exposure. Ambient air monitoring at these locations can provide the additional assurance that air pollutant impacts from a neighboring industry will not violate standards and impact the health of the *general public* at sensitive receptor locations.

After internal discussions, Option 3 was selected, changing the 4.0 percent silt content limit from the median value to a maximum value. If the required sampling and testing of road material indicates a maximum silt content above 4.0 percent, it will be a permit violation. The permittee must then work with DEQ to develop a way to further reduce emissions, adjust operations, and/or revise impact analyses to enable NAAQS compliance to be demonstrated. This would likely require a permit modification.

Dated: May _11____, 2023

STATE OF IDAHO, DEPARTMENT OF ENVIRONMENTAL QUALITY



By: _____
Kevin Schilling

CERTIFICATION OF SERVICE

I HEREBY CERTIFY that on this _12th___ day of May, 2023, a true and correct copy of the foregoing DECLARATION OF KEVIN SCHILLING was served on the following via electronic mail to the indicated address:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Dylan Lawrence
Hearing Officer
Varin Thomas, LLC
242 N. 8th St., Suite 220
Boise, ID 83702
dylan@varinthomas.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Resources Division
Office of the Attorney General
1410 N. Hilton St.
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

/s/ John Shackelford
John Shackelford

Exhibit A

From: McAlpine, Jerrold
To: Kevin Schilling
Subject: RE: Excluding roadways from consideration as ambient air.
Date: Friday, March 27, 2020 10:29:28 AM
Attachments: image001.png

Kevin,

I apologize, I missed this email earlier this week. My understanding is the road is likely exempt from ambient air protections because it is fully under the control and surveillance of the source and unsupervised public access is precluded. It seems like a slam dunk, based on my understanding of EPA's revised ambient air policy. This is my opinion based on interpretation of the policy, though … I cannot provide an approval.

If Idaho concludes the decision still falls with a 'gray area,' a formal request to the EPA can be provided and I can assist with getting the request to the ambient air review team (a part of the headquarters OAQPS air policy group).

Feel free to give me a call if you have questions or with to discuss more,
Jay

Jay McAlpine, PhD
Meteorologist -- Regional Modeling Contact
206.553.0094
Division of Air and Radiation, Air Permits and Toxics Branch
U.S. Environmental Protection Agency, Region 10, Seattle, WA

From: Kevin.Schilling@deq.idaho.gov <Kevin.Schilling@deq.idaho.gov>
Sent: Monday, March 23, 2020 1:55 PM
To: McAlpine, Jerrold <McAlpine.Jay@epa.gov>
Subject: Excluding roadways from consideration as ambient air.

Hi Jay,

I hope things are going as smoothly as possible with you these days.

What are your thoughts on excluding a roadway that bisects a permitted facility from consideration as ambient air? During a NACCA call discussion on the recent changes in ambient air policy, there seemed to be some flexibility in how roadways could be considered. The case I'm most interested in involves a roadway that the permittee can legally control access, and access through the facility would not be a necessity for people (not needed to access homes, work, essential resources, etc - it would be used primarily to access a

recreational area). My thoughts were that the area could be excluded from ambient air by considering those using the roadway as guests of the industry. This would be accomplished by: 1) vehicles using the road would be escorted by the company through the area; 2) people wishing to use the road would be informed that they are considered as a guest of the facility while traveling through the area; 3) vehicles using the road would not be allowed to stop; 4) the facility would restrict use of the road during periods when high-emitting activities were performed that would likely cause high impacts to the roadway.

Thank you for any thoughts, suggestions, etc.

Best Regards,

Kevin

Kevin Schilling | Air Quality Dispersion Modeling Supervisor
Idaho Department of Environmental Quality
1410 North Hilton
Boise, Idaho 83706
Office: (208) 373-0112
http://www.deq.idaho.gov/

Our mission is to protect human health and the quality of Idaho's air, land, and water.

RAÚL R. LABRADOR
Attorney General

RAÚL R. LABRADOR
Attorney General

SCOTT L. CAMPBELL
Deputy Attorney General
Chief, Energy and Natural Resources Division

JOHN R. SHACKELFORD, ISB# 8647
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: (208) 373-0453
Facsimile: (208) 373-0481
john.shackelford@deq.idaho.gov

Attorneys for Respondent

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	Agency Case No. 0101-22-01 OAH Case No. 23-245-01 DECLARATION OF MIKE SIMON

I, Mike Simon, hereby declare under penalty of perjury pursuant to the law of the State of Idaho that the following is true and correct:

My name is Mike Simon. I am currently the Stationary Source Bureau Chief within the Air Division of the State of Idaho Department of Environmental Quality (DEQ). I have held this position since 2004. I have over 30 years of air quality experience conducting air quality analyses, writing air quality permits, processing air quality enforcement cases and managing air quality programs. I received a Bachelor of Science (BS) degree in Electrical Engineering from the University of Idaho in 1993. Prior to my work at DEQ, I served in the US Air Force from 1986 to 1990 as a meteorological and navigational aids maintenance technician. My primary responsibilities included installation, operation, calibration, and maintenance of monitoring equipment that provided weather and navigational data for flight operations. Specific weather equipment experience is with temperature and dewpoint systems, wind speed and direction systems, transmissometers, cloud height sensing equipment, and weather radar systems.

During my tenure at the DEQ, I have held positions as an air quality permit writer, operating permit supervisor, enforcement supervisor, permits and enforcement manager and bureau chief. My primary role as Bureau Chief is in staffing, budgeting, and ensuring state-wide consistency in the permitting and compliance decision making process for the regulated community. The Stationary Source Bureau has three sections: modeling, permitting and compliance assurance. The modeling section is composed of two modeling analysts and a supervisor. The primary function of the modeling section is in the review and approval of air impact modeling analysis from applicants seeking air quality permits. The permitting section

is composed of seven permit engineers, one permit writer and a permit engineering manager. The permit engineers are assigned air quality permit applications by the permit supervisor and develop the permit and statement of basis based on technical reviews of emissions inventory estimates, review of applicable state and federal rules, guidance, and policy, and public comment. The permit program issues well over 100 permitting actions a year (these include Permits to Construct for new and modified sources, Tier I Operating Permits, General Permits, Permit by Rule, and exemptions) for a wide variety of industrial sources across the state of Idaho. The compliance assurance section has two compliance analysts and a compliance supervisor. The primary function of this section is to provide policy and guidance oversight for the inspection process, provide compliance assistance, and to process enforcement cases for apparent violations on air permits, rules, and regulations, from the regulated community. Each section supervisor reports directly to me.

On August 20, 2019, Perpetua Resources Idaho, Inc. (PRI), formally Midas Gold Idaho, Inc., submitted an air quality Permit to Construct (PTC) application for the proposed construction and operation of the Stibnite Gold Project (SGP). The SGP is an open-pit mining, ore preparation, and gold extraction facility proposed in Valley County, Idaho. The application triggered the minor new source review permitting requirements. During the nearly three years of processing PRI's PTC application, the application was determined incomplete three times; two public informational meetings were conducted, and three public comment periods with extensions were held.

My role in permitting the SGP has been in the supervision of staff, providing technical and policy review oversight for bureau staff and supervisors and in ensuring the

administrative process for issuing permits was followed. The DEQ staff involved in the PTC development for the SGP included permit supervisor Darrin Pampaian, permit writers Morrie Lewis and Kelli Wetzel, modeling supervisor Kevin Schilling, and permit modelers Tom Swain and Dr. Pao Baylon. DEQ staff spent a considerable amount of time on this application as compared to most all other permitting actions in recent history. For example, a typical PTC is processed in 100 days with no public comment period and 150 days with a comment period. The DEQ staff time included many discussions with PRI's technical team on almost a weekly basis to obtain clarifications or receive additional information. This was done to provide a comprehensive assessment of all sources of emissions and develop an enforceable permit that ensures pre-construction compliance with applicable air quality standards and to address public comment. I am confident that the proposed operation of the SGP as required by the final PTC will not cause or contribute to a violation of any National Ambient Air Quality Standard (NAAQS) or exceed an applicable Toxic Air Pollutant (TAP) increment.

DEQ's Decision to exclude the Stibnite Access Route from Ambient Air

PRI (then Midas Gold) proposed in their PTC application to exclude the Stibnite Access Road from ambient air by asserting their complete and sole authority to control access to or through the facility, granting or excluding access at their direction to anyone requesting to visit the site or pass through the site. PRI explained their intention to explore ways to maintain certain access of the Stibnite Access Road to area recreationalists while excluding the road from the ambient air analysis. This presented a unique situation for DEQ to establish requirements in a PTC that to my knowledge has never been done before.

DEQ's modeling staff were satisfied that PRI had the legal authority to preclude

public access. DEQ modeling staff also evaluated EPA guidance on Ambient Air and outlined requirements the permit needed to address to manage access to the facility. This decision is documented in Section 3.3.10 of the January 6, 2022, Modeling Memorandum from Dr. Pao Baylon. [PET 256] The permit staff developed the Access Management Plan (AMP) in the PTC which requires PRI to identify all measures employed to discourage public access at the mining facility, including any and all access roads. These measures include, but are not limited to, posting warning signs, using personnel to establish security patrols and escorts, creating barriers, providing locked gates, manned guardhouses, as well as developing registration requirements and safety information for those seeking to pass through the facility. Perpetua is required to identify and describe all of these procedures in the AMP and submit for DEQ approval 30 days prior to startup. Once the AMP is approved by DEQ, it becomes incorporated by reference into the PTC and is enforceable. DEQ uses its authority to develop this permit condition in accordance with IDAPA 58.01.01.211.01 for reasonable conditions. DEQ asserts the AMP is sufficient, reasonable, and appropriate to establish requirements for excluding or restricting access to the site and which supports the NAAQS air impact analysis for the entire facility.

Chemical Dust Suppressant Control for Unpaved Roads

PRI's consultant, Air Sciences, Inc., provided information in their application from their research of AP-42: Compilation of Air Emission Factors, Section 13.2.2, emission factors for unpaved roads (EPA 2006). According to AP-42, test studies on various unpaved industrial roads where chemical dust suppressants were applied documented a range from 90 to 99 percent dust control efficiency for PM_{10}. Based on this data, PRI proposed to use a 90%

dust control efficiency for PM_{10} when utilizing chemical dust suppressants on unpaved roads. DEQ permit staff recognized that the control efficiency of a chemical dust suppressant decreases with time, the number of vehicle passes, road maintenance, and weather conditions. In order to ensure the high efficiency of PM_{10} fugitive dust control on unpaved haul roads is maintained on a daily and annual basis, DEQ developed several permit conditions. These permit conditions include the development and approval of a Fugitive Dust Control Plan (PTC condition 2.6), requiring monitoring records every 12 hours for methods used to control fugitives at the facility (PTC condition 2.2), requiring daily inspections of all sources of fugitive emissions at the facility (PTC condition 2.4), and requiring haul road traffic to comply with a 10% visible emissions opacity limit, on an instantaneous basis, on haul road traffic (PTC condition 2.5). This haul road opacity requirement is the most stringent ever imposed by DEQ for haul road fugitive dust. In addition, the daily inspection of fugitive emissions requirement is more stringent than other permits DEQ has issued which require inspections on a less frequent basis, i.e., weekly, monthly, or quarterly.

DEQ requires comprehensive Fugitive Dust Control Plan

In developing the FDCP, permit staff evaluated the key parameters that influence the dust control efficiency using chemical dust suppressants. These are mixture rate, application rate, time between applications, amount of traffic, and meteorological conditions. The PTC requires PRI to address these key parameters in the FDCP which is reviewed and approved by DEQ prior to facility startup. Developing a dust control plan post permit issuance allows the permittee to develop cost-effective dust control program designed for their specific operation. For example, the permittee can identify the specific chemical dust suppressant

manufacture, safety data sheet, instructions, and incorporate site specific procedures for their personnel to follow in the FDCP. If the specific conditions for a FDCP were instead listed in as permit conditions, any small change to the plan would trigger an administrative permit revision process that is not efficient to administer. It is a common practice for FDCP's to be developed and updated by the facility and submitted to DEQ for review and approval. These Dust Plans are incorporated by reference in permits and are enforceable. DEQ has issued many permits requiring fugitive dust control plans, these include mining operations such as Jervois Mining USA Limited – Idaho Cobalt Operations, Cyprus Thompson Creek Mining Company, and Itafos Conda LLC - Rasmussen Ridge Mine. Fugitive dust control plans are found in other industries as well, such as sand and gravel plants, concrete batch plants, and asphalt plants. These fugitive dust control plans are also enforceable, and DEQ has conducted an enforcement action on a facility for failure to comply with a fugitive dust plan.

In addition to unpaved haul roads, the PTC regulates all other sources of fugitive dust at the facility including drilling, blasting, excavating, crushing, rock dumps, ore handling and processing equipment, and storage piles. The FDCP must address the reasonable control of emissions from all fugitive emission sources on a facility-wide basis. The permit also includes a requirement that PRI conduct daily inspections of all fugitive sources on a facility-wide basis. If fugitive emissions are not being reasonably controlled, or not meeting prescribed requirements in the permit, PRI must take corrective action as expeditiously as practicable.

The permit specifies all the minimum requirements the FDCP must include. For example, the plan must address the posting of haul road speed limits, identifying the

frequency and application rates of water and/or chemical dust suppressants, installation of wind barriers and fences, and the training of certain personnel. PRI must also conduct an annual evaluation of the FDCP for its effectiveness. The PRI permit requires a more comprehensive and detailed FDCP than in any other minor source permit DEQ has issued.

Haul Road Fugitive Dust Factors

In addition to using the chemical dust suppressant, controlled PM_{10} emission calculations for unpaved haul roads also incorporate the control efficiency for water. For annual dust control from water, AP-42 accounts for this in an equation that uses annual precipitation data. When using the 120 days of precipitation obtained from AP-42 section 13.2.2, the precipitation term accounts for natural mitigation in calculating the annual unpaved road emissions. Staff reviewed and approved this methodology. The daily unpaved road emission calculations use an applied water control efficiency of 33%. This value was supported by permit staff based on an evaluation of figure 13.2.2-2 of AP-42 for water control effectiveness on unpaved roads.

The haul road PM_{10} emissions were calculated using equations from AP-42 Section, 13.2.2. This calculation approach is very commonly used for unpaved haul roads in permit applications. This haul road equation utilizes three key variables: percent (%) silt content of the roadway, mean vehicle weight, and annual precipitation data. These variables influence the results in pounds emitted per vehicle mile travelled. DEQ determined that of the three variables, silt content needed specific enforceable permit conditions. The silt content relied upon for the haul road emission calculations was limited in the permit to 4% (PTC condition 3.13). The silt sampling procedures to demonstrate compliance with the silt limit were

developed as part of the Haul Road Capping Plan (PTC condition 3.13).

In reviewing the mean vehicle weight variable used in calculating haul road emissions, PRI proposed the use of 20 large Cat 789D mining trucks and 12 smaller CAT 740B dump trucks. PRI stated that the ratio of large to small trucks would be 20:12. Mean vehicle weight used in the calculation for haul road emissions include the total mean vehicle weight from fully loaded trucks. Rather than developing a methodology in the permit to measure and determine average vehicle weight each day, DEQ developed a haul road usage limit of 180,000 tons of ore and development rock per day (PTC condition 3.5). This limit accounts for the average loaded vehicle weight of all trucks as well as the average round-trip distance traveled as presented in the application. The monitoring methodology required to measure daily ore and development rock hauling is addressed in the required Operations and Maintenance Manual (PTC condition 2.20).

DEQ's requirement to develop Manuals and Plans in the PTC process

The permit requires PRI to develop and submit for DEQ approval 30 days prior to startup a Fugitive Dust Control Plan (FDCP), Operations and Maintenance (O&M) Manual, Access Management Plan (AMP) and a Haul Road Capping Plan (HRCP). The permit details the minimum and substantive requirements that PRI must consider and evaluate when preparing each Plan and Manual. DEQ contends the requirement to review and approve each Plan and Manual after the permit is issued and prior to facility startup is sufficient, reasonable, and appropriate to ensure compliance with applicable requirements. These approved plans and manuals are incorporated by reference in the permit and all elements are enforceable as part of the permit. The permit program issues between 60 and 80 PTCs

annually for a wide variety of industrial sources in Idaho. It is common for the permit program to require certain plans, such as an O&M manual or FDCP to be prepared by the permittee post permit issuance. This allows the permittee to prepare a specific plan or manual based on the actual equipment purchased and installed, the manufacturer's instructions and recommendations, as well as the operational characteristics of the facility after construction is completed. DEQ uses its authority to require a permittee to develop and submit for DEQ approval Plans and Manuals in accordance with IDAPA 58.01.01.211.01 as reasonable permit conditions.

DEQ's Decision not to include a PM_{10} Ambient Air Monitor

DEQ did consider the option of requiring a PM_{10} ambient air monitor in the PRI PTC. In considering this option, staff reviewed DEQ's history of decisions requiring ambient air monitors in permits. Where DEQ did require an ambient monitor in a permit, the facility had already been in operation for many years and there was a recent modeled NAAQS (National Ambient Air Quality) violation. In these cases, DEQ negotiated with the facility to site and operate an ambient air monitor and develop a corrective action plan for the facility. This allowed the facility to monitor air quality while it made process changes and modified its permit to demonstrate a return to NAAQS compliance. Once the changes were implemented or approved, the facility would then demonstrate NAAQS compliance through modeling analysis. The monitor was eventually removed from their respective permits. In these few situations, DEQ never had an ambient air monitored violation.

In all cases where DEQ processed a PTC application for a new or modified facility, DEQ required the applicant to demonstrate NAAQS pre-construction compliance using

DEQ's approved modeling procedures as outlined in the "State of Idaho Guideline for Performing Air Quality Impact Analysis." DEQ will not issue a final PTC if the applicant has not demonstrated pre-construction NAAQS compliance to the satisfaction of the Department.

DEQ also considered the location of the proposed PRI facility, the proximity of nearby residences and the implementation costs of requiring an ambient monitor. Given all of these factors, DEQ ultimately decided not to require an ambient air monitor in the permit. DEQ did reach out to PRI prior to final PTC issuance to see if they would voluntarily install an ambient monitor but declined at that time.

DEQ's T-RACT Analysis

T-RACT is an emission standard based on the lowest emission of toxic air pollutants that a particular source is capable of meeting by the application of a control technology that is reasonably available, as determined by DEQ, considering technological and economic feasibility. T-RACT is an allowable analysis to demonstrate preconstruction compliance for toxic air pollutants in accordance with IDAPA 58.01.01.210.12. PRI submitted a T-RACT application to demonstrate compliance for arsenic as well as other TAPs.

Idaho's T-RACT rules were developed to follow the general principles of the major new source review requirements to determine Best Available Control Technology (BACT). The process for selecting BACT in a major new source review application generally follows a five-step approach, often referred to as a top-down approach, and is determined on a case-by-case basis by the state authority. These steps include:

1. Identify all available control options.

2. Eliminate technically infeasible options.
3. Rank Remaining Control Technologies.
4. Consider the energy, environmental and economic impacts.
5. Select the most effective control not eliminated in step 4.

Idaho's T-RACT requirements generally mirror the BACT approach and requires an applicant to identify all available control options. Once all control options are identified, those options that are demonstrated to be technically infeasible can be removed from the list. The remaining control options would be ranked by control effectiveness, typically the highest percentage of pollutant removed is first. Selection of the final control option is then determined when considering environmental, energy and economic impacts.

PRI proposed a T-RACT analysis for both drilling rigs and haul roads. In reviewing the T-RACT analysis for the drill rig component, PRI identified three possible control technologies:

1. Best Management Practices
2. Wet Drilling with water injection
3. Dry Drilling with dust collectors

Wet Drilling was eliminated as technically infeasible due to several issues identified by PRI. Staff agreed with PRI's assessment and the remaining control options were Dry drilling with dust collection and Best Management Practices. PRI selected the top control technology as dry drilling with dust collection. Permit staff approved this option. The permit addresses the dust collector in the Operations and Maintenance Manuel requirements (PTC condition 2.20)

In reviewing the T-RACT analysis for haul roads, PRI identified the following possible control options:

1. Paving roads
2. Application of chemical dust suppressants and water

Paving haul roads was determined to be technically infeasible by PRI and permit staff because paving is not feasible for mining roads utilizing very heavy trucks which would exceed the design limitations of paving. Application of chemical dust suppressants and water is an effective dust control method which is a common control technology for unpaved haul roads. Magnesium chloride and water combinations are widely used and effective dust suppressant by state, county, and industrial unpaved roadways. DEQ is not aware of any negative environmental impacts as long as the operators apply the dust suppressant according to manufacturer's recommendations. DEQ has adequately included the requirements for chemical dust suppressants in the FDCP previously discussed.

PRI also proposed capping the haul roads with low arsenic quartzite as an additional work practice standard in addition to the T-RACT application of dust suppressants. The implementation of haul road capping of low arsenic material is specifically listed in the permit (PTC condition 3.13). The permit requires a Haul Road Capping Plan (HRCP) be developed and submitted to DEQ for approved (PTC condition 3.13) which will contain the sampling plan procedures for arsenic concentration. This will be used to ensure the median arsenic concentration of the development rock applied to haul roads does not exceed 90 ppm.

Dated: May _11____, 2023

STATE OF IDAHO, DEPARTMENT OF ENVIRONMENTAL QUALITY

By: _____

Mike Simon

CERTIFICATION OF SERVICE

I HEREBY CERTIFY that on this __12th__ day of May, 2023, a true and correct copy of the foregoing DECLARATION OF MIKE SIMON was served on the following via electronic mail to the indicated address:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Dylan Lawrence
Hearing Officer
Varin Thomas, LLC
242 N. 8th St., Suite 220
Boise, ID 83702
dylan@varinthomas.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Resources Division
Office of the Attorney General
1410 N. Hilton St.
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

/s/ John Shackelford
John Shackelford

RAÚL R. LABRADOR
Attorney General

SCOTT L. CAMPBELL
Deputy Attorney General
Chief, Energy and Natural Resources Division

JOHN R. SHACKELFORD, ISB# 8647
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: (208) 373-0453
Facsimile: (208) 373-0481
john.shackelford@deq.idaho.gov

Attorneys for Respondent

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	CASE DOCKET NO. 0101-22-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC. Intervenor.	**DECLARATION OF TIFFANY FLOYD IN SUPPORT OF RESPONDENT'S CROSS MOTION FOR SUMMARY JUDGMENT**

I, Tiffany Floyd, hereby declare under penalty of perjury and pursuant to the law of the State of Idaho that the following is true and correct:

1. My name is Tiffany Floyd, and I am employed by the State of Idaho, Department of Environmental Quality ("the Department") as the Air Quality Division Administrator ("Air Administrator").

2. I have been working for the Department as the Air Administrator for 11 years.

3. I have worked for DEQ for nearly 24 years and have had the opportunity to work collaboratively with many agencies, businesses, and organizations both by being in Department regional offices and the 11 years in my current role.

4. I have a Bachelor of Science degree in engineering, specializing in civil engineering, from Idaho State University.

5. As the Air Administrator, I directly supervise four staff, and indirectly supervise thirty-two staff. The Air Quality Division has three bureaus: stationary source, planning, and data management.

6. One main responsibility within the Air Quality Division is to issue air pollution permits. The stationary source bureau is responsible for permitting, modeling, and compliance of air pollution sources. This bureau, comprised of sixteen staff members, works diligently to ensure businesses comply with federal and state air permitting rules. The permits issued provide for the greatest required level of protection of air quality.

7. The Department obtains delegated authority annually from the Environmental Protection Agency ("EPA") to implement the Clean Air Act in Idaho, which includes the authority to issue permits. The Department has had delegated authority for decades, and EPA approves our Clean Air Act program year after year.

8. In writing permits, staff use federal and state regulations as well as internal guiding practices outlined in standard operating procedures. Permit writers also use a peer review process wherein other permit writers review each other's permitting decisions to ensure permit conditions are appropriate for the type of source, are enforceable and comply with requirements, and lastly are documented in the Statement of Basis supporting the permit. These practices provide a structure that reinforces regulatory compliance while accounting for a broad range of stakeholder perspectives. With these mechanisms in place, and the expertise of these staff, I trust their decision making.

9. When the Department receives a permit application for a Permit to Construct, the Department strives to issue the permit within 150 days, which includes time for a public comment period. There is typically only one public comment period. The Department only holds a public hearing if one is specifically requested.

10. On August 20, 2019, Perpetua submitted its application to the Department for a Permit to Construct for the Stibnite gold mine site.

11. Upon review, the Department found more information was needed to support the permit application. After three incompleteness determinations and one addendum, Perpetua eventually provided the additional information the Department was seeking, and the Department began permit development.

12. It soon became apparent to the Department that this project was going to be one of the larger permitting actions by the Air Quality Division and was going to require greater involvement of the public, the Nez Perce Tribe, non-governmental organizations, EPA, and other federal agencies. To that end, over the next three years, the Department's permitting and modeling staff spent additional time providing opportunities for public involvement. In addition, permitting and modeling staff spent considerable time deliberating adherence to state and federal

requirements. The development of this permit took more than seven times the standard amount of time it takes to develop a permit to construct.

13. The Department held three extended public comment periods after three draft permits were prepared.

14. The Department held two public informational meetings to discuss the permit.

15. Staff crafted permit conditions in response to public comments received and the meetings from the many organizations mentioned above.

16. Additionally, the Department held frequent meetings with Perpetua and their consultant, sometimes monthly and eventually weekly, to ensure stakeholder concerns were vetted and addressed to reasonable satisfaction.

17. A final permit was eventually issued on June 17, 2022, almost three years after Perpetua submitted its permit application.

18. This effort was an unusual one, as most permitting projects don't often proceed this way with several informational meetings and extended public comment periods. This effort took almost three years, much longer than the typical 150-day timeframe for permit issuance.

19. The Air Quality Division prides itself on issuing permits in a timely manner. The Department does not often take years to complete permit projects because we are sensitive to the needs of balancing economic growth, support of business, and protection of the environment.

20. The Department took additional time than is typical in issuing this permit, time necessary to ensure the permit was reasonable and protective. It was a thoroughly vetted effort which followed guiding permitting principles and met state and federal requirements.

Tiffany Floyd

CERTIFICATION OF SERVICE

I HEREBY CERTIFY that on this 12 day of May, 2023, a true and correct copy of the foregoing DECLARATION OF TIFFANY FLOYD IN SUPPORT OF RESPONDENT'S CROSS MOTION FOR SUMMARY JUDGMENT was served on the following via electronic mail to the indicated address:

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

/s/ Patricia Jordan
Patricia Jordan, Legal Assistant

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 _____ NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	Case Docket No. 0101-22-01 **INTERVENOR-RESPONDENT'S MOTION FOR SUMMARY JUDGMENT**

COMES NOW Intervenor-Respondent Perpetua Resources Idaho, Inc. ("Perpetua"), by and through its counsel of record Stoel Rives LLP, moves the Board to enter summary judgment pursuant IDAPA 58.01.23, Idaho Rule of Civil Procedure 56, and the January 19, 2023 Scheduling Order in this matter. Perpetua is entitled to judgment as a matter of law on all of

Petitioners' claims for relief alleged in the Amended Petition to Initiate Contested Case: Air Quality Permit to Construct P-2019.0047 (June 17, 2022), filed December 6, 2022.

This motion is supported by Perpetua's accompanying Memorandum in Support of Motion for Summary Judgment and the Declaration of W. Christopher Pooser, as well as the documents and pleadings on file in this matter. For the reasons stated in Perpetua's accompanying memorandum, the Board should grant Perpetua summary judgment and dismiss the Petitioners' Amended Petition.

DATED: May 12, 2023.

STOEL RIVES LLP

/s/ *W. Christopher Pooser*
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

CERTIFICATE OF SERVICE

I hereby certify that on this 12th day of May 2023, a true and correct copy of the foregoing was served on the following:

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

/s/ *W. Christopher Pooser*
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047

NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,

Petitioners,

v.

IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,

Respondent,

and

PERPETUA RESOURCES IDAHO, INC.,

Intervenor-Respondent.

Case Docket No. 0101-22-01

MEMORANDUM IN SUPPORT OF INTERVENOR-RESPONDENT'S MOTION FOR SUMMARY JUDGMENT AND IN OPPOSITION TO PETITIONERS' MOTION FOR SUMMARY JUDGMENT

TABLE OF CONTENTS

TABLE OF AUTHORITIES iii

KEY TO TERMS AND ABBREVIATIONS VI

INTRODUCTION 1

DEQ'S PERMIT RECORD AND EVIDENCE RELIED ON 2

STATEMENT OF UNDISPUTED FACTS 2

I. The Project, the permit history, and Petitioners' contested case. 2

II. PM_{10} emissions from the Project were conservatively estimated by DEQ. 4

III. The Stibnite Access Route. 6

IV. DEQ adopted long-established and well recognized control measures to control arsenic emissions from the Project. 6

V. DEQ analyzed arsenic emissions and determined that they would not exceed the lifetime risk limit established by the Idaho Air Rules. 7

STANDARD OF REVIEW 9

I. The Board must decide, as a matter of law, whether DEQ's action was arbitrary and capricious, an abuse of discretion, or contrary to law. 9

II. The Board may defer to DEQ's technical expertise and special skill. 11

ARGUMENT 13

I. Petitioners have failed to demonstrate, as is their burden, that they are persons "aggrieved" by an action or inaction of DEQ. 13

II. DEQ did not violate the CAA or part 51 regulations. 14

III. DEQ followed EPA guidance and exercised its discretion in excluding the Stibnite Access Route from the Project's ambient air (Claims 11 and 12). 16

A. EPA guidance on ambient air and agency discretion. 17

B. DEQ reasonably exercised its discretion in determining that the Stibnite Access Route is exempt from the Project's ambient air. 19

IV. DEQ did not act arbitrary and capricious or violate the Idaho Air Rules in determining that fugitive dust emissions from the Project's roads will met the PM_{10} NAAQS and arsenic AACC. 22

A. DEQ reasonably determined that 93.3% control efficiency for fugitive dust from haul roads was attainable and enforceable (Claims 2 and 8). 22

1. Petitioners have not shown that DEQ's use of the 93.3% control efficiency was unsupported or unreasonable. 22

2. Petitioners have not shown that the Final Permit lacks enforceable conditions to ensure 93.3% control efficiency

when DEQ imposed daily monitoring and other substantive conditions. 23

B. Petitioners have not shown that DEQ is required to impose conditions restricting vehicle miles traveled and truck weights when DEQ imposed surrogate production limits and other requirements (Claims 1 and 8). 27

C. Petitioners have not shown that DEQ's use of 120 days of precipitation data to estimate fugitive dust emissions was counter to DEQ guidance or arbitrary and capricious (Claims 5 and 8). 30

D. Petitioners have not shown that the Final Permit's production limits are unenforceable when DEQ imposed monitoring and recordkeeping requirements to determine compliance (Claims 4 and 8). 32

V. The Final Permit requires Perpetua to develop work plans for DEQ approval and does not violate the CAA or the Idaho Air Rules (Claim 3). 34

A. The CAA and the Idaho Air Rules do not require work plans to be submitted with applications or circulated for public comment. 35

B. Petitioners' legal authority from the Clean Water Act is distinguishable and inapplicable to DEQ's preconstruction permitting process. 37

VI. DEQ did not violate the law by issuing a Final Permit that omitted ambient air monitoring (Claim 13). 38

VII. Because chemical dust suppressant and water are already established as reasonably available control technologies, DEQ was not required to conduct an technological or economic feasibility analysis (Claims 6 and 7). 41

VIII. DEQ reasonably exercised its discretion in evaluating the health risks from arsenic (Claim 9). 45

CONCLUSION 50

TABLE OF AUTHORITIES

Cases

Appalachian Power Co. v. EPA,
135 F.3d 791 (D.C. Cir. 1998) 12

Balt. Gas & Elec. Co. v. Nat. Res. Def. Council, Inc.,
462 U.S. 87 (1983) 12

Cal. Dump Truck Owners Ass'n v. Nichols,
784 F.3d 500 (9th Cir. 2015) 14, 16

Camp Easton Forever, Inc. v. Inland Nw. Council BSA,
156 Idaho 893, 332 P.3d 805 (2014) 14

Duncan v. State Bd. of Accountancy,
149 Idaho 1, 232 P.3d 322 (2010) 12

Env't. Def. Ctr., Inc. v. EPA,
344 F.3d 832 (9th Cir. 2003) 37

Floyd v. Bd. of Ada Cnty. Comm'rs,
164 Idaho 659, 434 P.3d 1265 (2019) 10, 11

Grindstone Butte Mut. Canal Co. v. Idaho Pub. Utils. Comm'n,
102 Idaho 175, 627 P.2d 804 (1981) 12

J.R. Simplot Co. v. Idaho State Tax Comm'n,
120 Idaho 849, 820 P.2d 1206 (1991) 11, 12

Michigan v. EPA,
268 F.3d 1075 (D.C. Cir. 2001) 14

NRDC v. S. Coast Air Quality Mgmt. Dist.,
694 F. Supp. 2d 1092 (C.D. Cal. 2010), *aff'd*, 651 F.3d 1066 (9th Cir. 2011) 15

In re: Permit Applicant Garnet Energy LLC (Permit No. 0027-00081),
Dkt. No. 0101-01-10, Order Granting Motion for Summary Judgment (Feb. 22, 2002) 13

Ranchers Cattlemen Action Legal Fund United Stockgrowers of Am. v. U.S. Dep't of Agric.,
415 F.3d 1078 (9th Cir. 2005) 11

REDOIL v. U.S. EPA,
716 F.3d 1155 (9th Cir. 2013) 18, 19, 21

Sierra Club v. U.S. EPA,
972 F.3d 290 (3d Cir. 2020).....44, 45

Solomon v. Idaho Department of Environmental Quality,
Docket No. 0101-03-01, Order at 4-5 (Dec. 17, 2003).....14

Thatcher v. Idaho Department of Environmental Quality,
Docket No. 0105-19-01, Amended Order at 4-6 (Sept. 24, 2019).....14

Train v. Nat. Res. Def. Council, Inc.,
421 U.S. 60 (1975).....15, 16, 37

Union Elec. Co. v. EPA,
427 U.S. 246 (1976).....15

Wheeler v. Idaho Dep't of Health & Welfare,
147 Idaho 257, 207 P.3d 988 (2009).....10

Statutes

33 U.S.C. § 1251.....37

42 U.S.C. § 7407(a).....14, 15

42 U.S.C. § 7410(a).....15

42 U.S.C. § 7410(k)(3).....15

Federal Clean Air Act, 42 U.S.C. § 7401, *et seq*. ..... passim

Idaho Administrative Procedure Act, Idaho Code § 5201, *et seq*..... passim

Idaho Code § 39-107(5).....9, 13

Idaho Code § 39-107(11).....16

Idaho Code § 39-115.....10

Idaho Code § 67-5251(4)(b).....11

Idaho Code § 67-5251(5).....11, 12

Idaho Code § 67-5279(3).....10, 27

Idaho Code § 67-5279(4).....10

Regulations

40 C.F.R. part 51.....14, 15, 16, 35

40 C.F.R. pt. 63, subpt. 34

40 C.F.R. § 50(e).....6

40 C.F.R. § 50.1(e).....17

40 C.F.R. § 51.161 35

40 C.F.R. § 63.11646(a).....34

40 C.F.R. § 63.11648(f) 34

37 Fed. Reg. 10,842 (May 31, 1972) 16

Other Authorities

EPA RACT/BACT/LAER Clearinghouse (RBLC Products), https://www.epa.gov/catc/ractbactlaer-clearinghouse-rblc-products…….....……43

U.S. EPA, Clean Air Technology Center, User's Manual for the RACT/BACT/LAER Clearinghouse (RBLC) Web (Nov. 2006), https://www.epa.gov/sites/production/files/2020-07/documents/rblcusr1-openaccessible.pdf.....42

U.S. EPA, *Fugitive Dust Background Document and Technical Information Document for Best Available Control Measures* (Sept. 1992), https://www.epa.gov/catc/clean-air-technology-center-products 43

U.S. EPA, Compilation of Air Pollutant Emissions Factors, Technical Air Pollution Rules, AP-42 (Aug. 2021), http://www.epa.gov/ttn/chief/ap42/index.html#toc.....passim

KEY TO TERMS AND ABBREVIATIONS

AACC	Acceptable Ambient Concentration for a Carcinogen
AMP	Access Management Plan
APA	Idaho Administrative Procedure Act, Idaho Code § 5201, *et seq*.
CAA	Clean Air Act, 42 U.S.C. § 7401, *et seq*.
DEQ	Respondent Idaho Department of Environmental Quality
EPA	United States Environmental Protection Agency
HAP	Hazardous air pollutant
FDCP	Fugitive Dust Control Plan
Final Permit	Air Quality Permit to Construct No. P-2019.0047, issued June 17, 2022
HRCP	Haul Road and Capping Plan
Idaho Air Rules	Rules for the Control of Air Pollution in Idaho, IDAPA 58.01.01, *et seq*.
NAAQS	National Ambient Air Quality Standards
O&M Manual	Operations and Maintenance Manual
Perpetua	Intervenor-Respondent Perpetua Resources Idaho, Inc.
Petitioners	Petitioners Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon
PM	Particulate matter
Project	Stibnite Gold Project
RBLC database	RACT/BACT/LAER Clearinghouse database
SIP	State implementation plan
TAP	Toxic air pollutant
T-RACT	Toxic air pollutant reasonably available control technology

INTRODUCTION

After nearly three years of repeated opinions and critiques, the Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon ("Petitioners") filed this contested case. Petitioners challenge the Idaho Department of Environmental Quality ("DEQ") Permit to Construct No. 2019.0047 (the "Final Permit") issued to Perpetua Resources Idaho, Inc. ("Perpetua")[1] for the Stibnite Gold Project (the "Project"). The Final Permit authorizes construction of a minor stationary source in a remote Idaho landscape that is designated in attainment with the National Ambient Air Quality Standards ("NAAQS"). Petitioners present the same opinions and critiques in this contested case that were previously presented to, and were addressed by, DEQ during the permitting process.

Ultimately, Petitioners reject DEQ's decision making and justifications for the conclusions reached in the Final Permit and ask that the Board of Environmental Quality ("Board") substitute their opinions and preferences for DEQ's substantive work and discretion. The Idaho Administrative Procedure Act ("APA") leaves agencies with the ability to judge how to interpret data and deal with scientific uncertainty and to decide which scientific and technical analyses to accept or reject. DEQ is delegated responsibility to make such determinations in air quality preconstruction permitting. After repeated attempts during the permitting process to substitute their preferences for DEQ's, Petitioners now ask the Board to second-guess the experience, expertise, scientific analyses, expert judgments, and reasoned conclusions of DEQ.

Respectfully, DEQ is better suited, and legally authorized, to make policy decisions based on scientific uncertainty. Petitioners' Amended Petition must be dismissed because DEQ's decisions were not arbitrary and capricious, an abuse of discretion, or contrary to law. Perpetua

[1] In the permit record, Perpetua is referred to as "PRI."

asks that the Board deny Petitioners' motion for summary judgment and instead grant Perpetua's motion for summary judgment as a matter of law.

DEQ'S PERMIT RECORD AND EVIDENCE RELIED ON

In opposition to Petitioner's motion for summary judgment and in support of its own motion for summary judgment, Perpetua relies on documents from DEQ's permit file supporting the Final Permit. Those documents include the exhibits submitted by Petitioners (cited as "PET [bates #]") and Perpetua (cited as "PRI [bates #]"). In addition, Perpetua cites to the Declarations of Kevin Schilling ("Schilling Decl.") and Mike Simon ("Simon Decl."), submitted by DEQ.

STATEMENT OF UNDISPUTED FACTS

I. The Project, the permit history, and Petitioners' contested case.

Perpetua designed the Project to develop gold and antimony resources from a previously mined landscape. PET 49, 51. The Project is located in central Idaho, approximately 10 miles east of the small community of Yellow Pine, Valley County, Idaho. PET 49. Perpetua has three distinct purposes for the Project: (1) to responsibly produce precious metals, as well as critical minerals necessary for the country's energy transformation; (2) to remediate and restore the legacy Stibnite mine site that was abandoned in 2012 by the federal government after decades of mining; and (3) to maintain a strong partnership with the local community.

In August 2019, Perpetua applied to DEQ for a permit to construct for a new source review minor source. PET 52. DEQ's review of Perpetua's application was thorough and comprehensive. Over the next three years, DEQ supplemented the application with additional information from Perpetua before determining the application complete, offered three extended comment opportunities to solicit public feedback and held two public informational meetings. PET 52-54, 93. Petitioners fully participated and repeatedly criticized DEQ's evaluations and proposed controls of particulate matter ("PM") and toxic air pollutant ("TAP") emissions. *See*

PET 549-634. Petitioners also engaged frequently and directly with DEQ staff and technical permit reviewers throughout the permitting process requesting information, analysis, and explanation of DEQ's ongoing work. *See*, *e.g.*, PRI 807-811, 812-816, 817, 970-974.

In response to Petitioners' formal comments during the three extended public comment periods, DEQ requested, and Perpetua provided, additional information such as updated hazardous air pollutant ("HAP") and TAP emission inventories and modeling analyses. *See* PET 52-54. With that information, DEQ conducted additional modeling evaluations of PM emissions, additional analyses of TAP emissions, and enhanced the enforceable permit requirements. *See* PET 53-54. All in all, DEQ asked Perpetua to supplement the application with additional information four times, prepared three draft permits (dated July 14, 2020, February 8, 2021, and December 9, 2021), and provided robust responses to Petitioners' public comments. This multi-year, comprehensive process culminated in the issuance of the Final Permit on June 17, 2022. *See* Amended Petition ¶¶ 23-26; PET 52-54.

Now Petitioners ask the Board to set aside and remand the Final Permit on the grounds that DEQ's issuance of the permit failed to comply with and violates the federal Clean Air Act ("CAA"), 42 U.S.C. § 7401, *et seq*., and Idaho rules, regulations, and guidance for permitting. In their Amended Petition, Petitioners repeat the same critiques pressed during the public review periods, seek more review and work by DEQ, and allege that DEQ's actions and the Final Permit are flawed. Notwithstanding their active participation, Petitioners are dissatisfied with the Final Permit issued by DEQ and urge the Board to substitute their suggestions for DEQ's reasoned decision making. While the Petitioners' Motion for Summary Judgment expresses differences of opinion and desired outcomes, the Petitioners fail to state facts or identify law sufficient to support allegations that DEQ failed to comply with or violated applicable law.

II. PM_{10} emissions from the Project were conservatively estimated by DEQ.

In accordance with Idaho law, DEQ implements air quality permitting through rules promulgated by the Board (the "Idaho Air Rules"). IDAPA 58.01.01. The Idaho Air Rules establish requirements for applicants and DEQ that govern the issuance of permits to construct for new and modified emissions sources. IDAPA 58.01.01.200-227. Under Section 203 of the rules, no permit to construct can be issued unless the applicant demonstrates "to the satisfaction of the Department" that the proposed project "would not cause or contribute to a violation of any ambient air quality standard" (or NAAQS) and that emissions of a TAP "would not injure or unreasonably affect human or animal life or vegetation." IDAPA 58.01.01.203.03.

PM_{10} emissions from the Project represent the largest pollutant emissions for this minor source. Emissions from stationary sources and fugitive sources of PM_{10} were estimated in the permit application materials. As DEQ recognized, air emission impact analyses for mining operations "typically involve considerable uncertainty and variability" in both emission-affecting parameters and dispersion-affecting parameters. PET 578-579. DEQ mitigated the uncertainties and variabilities with a conservative approach (i.e., overstating impacts) and analyzed the proposed emissions and modeling to fulfill the requirements of Section 203. PET 551-553, 561-562; *see generally* Schilling Decl.

There are four general steps for determinations based on modeling assessments.

Step 1: Calculate estimated air emissions from all appropriate sources of air pollution. This step typically utilizes the maximum capacity of each source of emissions, an emission factor that represents the best available information to estimate emissions, and an emission control efficiency if an emission control device or practice is used to reduce emissions. EPA's AP-42, *Compilation of Air Pollutant Emissions Factors*, is a commonly used reference for

emission factor information for air pollution sources, such as unpaved roads.[2] Acceptable emissions estimation methods vary and often require site-specific parameters.

Step 2: Characterize each air pollution source. Each emission source must be characterized by its initial air dispersion type (e.g., point, volume, or area) and initial air dispersion parameters (e.g., initial exhaust temperature and velocity, length, width, and height of the emitting source), and source location.

Step 3: Use the EPA approved air dispersion model to predict the downwind impacts of the emissions from all sources. The model inputs include the emissions from each source estimated in Step 1, the source characterizations from Step 2, the local terrain and meteorological conditions, and other model inputs.

Step 4: Run the model. The final step is running the model for all pollutants and the appropriate averaging periods to inform DEQ's determinations. In the case of PRI's permit, DEQ ran the model for many emissions scenarios to reflect the dynamic operational plan involved in mining activity.

DEQ issues a permit to construct when it is satisfied that the proposed emissions will not cause or contribute to a violation of a NAAQS and the TAP emissions would not injure or unreasonably harm human health, animal health, or vegetation. *See* IDAPA 58.01.01.203. The permitting record before DEQ, including the Final Permit, the Statement of Basis, and the Response to Comments, details the agency's analysis and decision making. As detailed below, that record shows that DEQ satisfied the requirement to produce and issue the Final Permit in conformity with the Idaho Air Rules.

[2] U.S. EPA, Technical Air Pollution Rules, AP-42 (Aug. 2021), http://www.epa.gov/ttn/chief/ap42/index.html#toc.

III. The Stibnite Access Route.

Because DEQ must be satisfied that a project's proposed emissions conform to the NAAQS, the boundary of the project's "ambient air" is important. Both EPA and the Idaho Air Rules define "ambient air" as "that portion of the atmosphere, external to buildings, to which the general public has access." 40 C.F.R. § 50(e); IDAPA 58.01.01.006.10. EPA's longstanding guidance provides that the ambient air boundary depends on the source's control of the area and the measures it takes to preclude the general public's access to the land. *See* PRI 1; PET 772.

The Stibnite Access Route refers to a road that will pass through the Project. PET 49. Public comments from local residents indicated a significant interest in access through the Project. PET 529. Individuals in the Johnson Creek and Yellow Pine areas who use Stibnite Road to access Thunder Mountain Road and points beyond were particularly concerned about access changes that would lengthen travel time. *Id*. In response to those concerns and at the direction of the U.S. Forest Service, Perpetua's predecessor, Midas Gold, evaluated numerous access options through and around the Project. *Id*. The Stibnite Access Route was identified as a route that would safely address local interests. *Id*.; *see also* PET 310.

Early in the permitting process, Midas Gold engaged with DEQ on the Stibnite Access Route because of the importance of establishing the ambient air boundary for the Project. *See* Schilling Decl. at 5. DEQ contacted EPA, who indicated that the Stibnite Access Route would be exempt from the Project's ambient air because it is fully under the control and surveillance of Perpetua and unsupervised public access would be precluded. PRI 10-11, 156-157.

IV. DEQ adopted long-established and well recognized control measures to control arsenic emissions from the Project.

Following the second public comment period and in response to Petitioners' comments, Perpetua modeled carcinogenic TAPs emissions using an emission inventory that included toxic

air pollutant reasonably available control technology ("T-RACT") controls, as authorized by Section 210 of the Idaho Air Rules. *See* PRI 604; IDAPA 58.01.01.007.12 (defining T-RACT). The Idaho Air Rules require that, when an applicant proposes to use T-RACT to demonstrate preconstruction compliance, that the applicant selects, and DEQ approves, control measures that are T-RACT. IDAPA 58.01.01.210.14. For a control measure to be approved as T-RACT, it must be reasonably available considering the technological and economic feasibility. *Id.*

Perpetua proposed, and DEQ approved, the following well recognized control measures as T-RACT:

- Installing and operating dust collection systems on drilling rigs;
- Capping the haul roads that are outside of the pits and development rock storage facilities with clean development rock; and
- Use of chemical dust suppressant with frequent watering on roads.

PET 70; PRI 604, 616. Perpetua considered, but rejected, paving the haul roads as technologically infeasible because the haul trucks exceeded the operational weight limit of paved roads. PRI 615, 617. Prior to being adopted as T-RACT, the use of chemical suppressants and watering had been included as conditions in the draft permit. PRI 620.

V. DEQ analyzed arsenic emissions and determined that they would not exceed the lifetime risk limit established by the Idaho Air Rules.

Under IDAPA 58.01.01.203, no permit to construct can be issued unless the applicant demonstrates "to the satisfaction of the Department" that the proposed emissions of a TAP "would not injure or unreasonably affect human or animal life or vegetation." Following the second public comment period, DEQ and Perpetua reevaluated TAP emissions in response to concerns expressed by Petitioners. PET 331. DEQ determined that a refined analysis of TAP

emissions, particularly arsenic, was needed to demonstrate preconstruction compliance with the Idaho Air Rules. *Id.*

On October 5, 2021, Perpetua submitted the *Stibnite Gold Project (SGP) Permit to Construct Application TAP Addendum* (the "TAP Addendum"). PET 331. The TAP Addendum reassessed source applicability to TAP permitting requirements, refined TAPs regulatory methods to demonstrate compliance with applicable TAP increments, revised and refined operations and operational parameters affecting TAP emissions, and refined TAP air impact analyses. *See id.* Specifically, the TAP Addendum evaluated arsenic emissions after considering the above-described T-RACT controls and operational adjustments. PET 333. The refined TAP analysis included many layers of conservative assumptions, including continual operation of the worst-case operational scenario; operation at maximum allowable rates for the entire averaging period; and no reduction in wintertime emissions from fugitive sources, thus discounting the emission suppression effects of increased moisture. *Id.*

Once the modeled carcinogenic TAP concentrations were obtained they were adjusted to account for the short, 16-year, life of the Project operations. PET 344; PRI 607. This was accomplished by multiplying the highest annual concentrations from the modeling scenarios by 16 years and then dividing by 70 years. PET 344; PRI 607. Multiplying the highest annual concentration of arsenic by 16 years allowed DEQ to determine the maximum concentration of arsenic an offsite receptor would be exposed to during the 16 year operational period. Dividing this maximum concentration by 70 years allowed DEQ to evaluate the lifetime health risk from that maximum exposure. PET 344; PRI 607.

DEQ and Perpetua determined that the maximum lifetime exposure concentration of arsenic would be 0.00095 $\mu g/m^3$, which is 41.3% of the lifetime exposure limit reflected as the acceptable ambient concentration for a carcinogen ("AACC") in Section 586. PET 348.

STANDARD OF REVIEW

I. The Board must decide, as a matter of law, whether DEQ's action was arbitrary and capricious, an abuse of discretion, or contrary to law.

The following discussion presents the Board with the appropriate standard of review in this contested case proceeding. Existing precedential orders lack clarity on the appropriate standard for the Board's review of a DEQ action that is based on a complete underlying record, developed over time and through the agency's routine work in the permit to construct review process. Both parties agree that it is the Board's role to conduct a review of the permitting record before DEQ and decide if DEQ acted lawfully under the Idaho Air Rules to issue the Final Permit. *See* Opening Br. at 13.

Under the Board's contested case rules, Petitioners have "the burden of proving by a preponderous of the evidence, the allegations in the petition." IDAPA 58.01.23.062. The rules also authorize the Board, or the hearing officer as its designee, to consider motions for summary judgment, governed by the Idaho Rules of Civil Procedure ("I.R.C.P."). IDAPA 58.01.23.162.02, .410; Idaho Code § 39-107(5). Thus the standards under I.R.C.P. 56 are appliable here. Based on Rule 56(a), the Board "must grant summary judgment if the movant shows that there is no genuine dispute as to any material fact and the movant is entitled to judgment as a matter of law." A moving party must support its assertion by citing particular materials in the record or by showing the "materials cited do not establish the … presence of a genuine dispute, or that an adverse party cannot produce admissible evidence to support the fact[s]." I.R.C.P. 56(c)(1)(B).

Here Petitioners challenge DEQ's action in issuing the Final Permit under the APA standard for judicial review for adjudicative agency actions. *See* Opening Br. at 13 (citing Idaho Code § 67-5279(3)). Under that standard, an agency action may only be overturned if it is (a) in violation of constitutional or statutory provisions, (b) in excess of statutory authority, (c) made on unlawful procedure, (d) not supported by substantial evidence, or (e) is arbitrary, capricious, or an abuse of discretion.[3] Idaho Code § 67-5279(3). The agency action must be upheld unless substantial rights of the petitioner have been prejudiced. Idaho Code § 67-5279(4).

There are additional principles regarding the APA standard worth addressing. The party challenging the agency decision must demonstrate that the agency erred in a manner specified in Section 67-5279. *Wheeler v. Idaho Dep't of Health & Welfare*, 147 Idaho 257, 260, 207 P.3d 988, 991 (2009). Thus, by relying on the APA standard, Petitioners invite a review process. Under Idaho law, it is DEQ's role to resolve factual issues in determining whether and under what conditions to issue a permit to construct, supported by the permitting record before it. *See* Idaho Code § 39-115. It follows that the Board's function is to decide whether, as a matter of law, DEQ's issuance of the Permit violated the law, was arbitrary and capricious, or was an abuse of discretion.

That means Petitioners present no true disputes of material fact—and indeed their opening brief identifies none—only question the legal conclusions drawn from the Final Permit's issuance. The Board's review is limited to determining whether DEQ acted as Petitioners allege. A violation of law speaks for itself. An "arbitrary and capricious decision occurs where the decision was reached in an unreasonable manner or based on clearly erroneous findings." *Floyd*

[3] Petitioners do not allege that DEQ's issuance of the Permit exceeded its statutory authority. *See* Opening Br. at 1, 14-37.

v. Bd. of Ada Cnty. Comm'rs, 164 Idaho 659, 668, 434 P.3d 1265, 1274 (2019). "Clearly erroneous applies where factual findings are not supported by substantial and competent evidence." *Id*. "An abuse of discretion standard examines whether the [agency] acted within the boundaries of its discretionary decision and applicable legal standards, and reached a decision by exercising reason." *Id*.

II. The Board may defer to DEQ's technical expertise and special skill.

In addition to those standards, the APA speaks to the deference the Board may afford DEQ in reaching a decision in a contested case: "[t]he agency's experience, technical competence, and specialized knowledge may be utilized in the evaluation of the evidence." Idaho Code § 67-5251(5); IDAPA 04.11.01.600.[4] Also the Board may take official notice of "generally recognized technical or scientific facts within the agency's specialized knowledge." Idaho Code § 67-5251(4)(b); IDAPA 04.11.01.602. Thus Idaho law explicitly recognizes that "the agency's repeated exposure to a specialized subject matter is a source of specialized knowledge that is useful in evaluating evidence." Michael S. Gilmore & Dale D. Goble, *The Idaho Administrative Procedure Act: A Primer for the Practitioner*, 30 Idaho L. Rev. 273, 319 (1994).

It follows that the Board, and the Hearing Officer as its designee, may give due consideration and deference to the technical expertise and special skill of DEQ. The deference the Board may give DEQ is illustrated by the deference courts give agencies, when reviewing an agency action.

First, Idaho courts defer to agency interpretations of law. *J.R. Simplot Co. v. Idaho State Tax Comm'n*, 120 Idaho 849, 862-63, 820 P.2d 1206, 1219-20 (1991); *see also Ranchers Cattlemen Action Legal Fund United Stockgrowers of Am. v. U.S. Dep't of Agric.*, 415 F.3d

[4] The Board's contested case rules incorporate the Idaho Rules of Administrative Procedure of the Attorney General, Sections 600 to 606. *See* IDAPA 58.01.23.003.13.

1078, 1093 (9th Cir. 2005) ("Regulations are presumed to be valid, and therefore review is deferential to the agency."). When an agency is entrusted with administering a statute, the courts may defer to the agency's interpretation of a statute or rule if the interpretation is reasonable and not contrary to its express language. *See Simplot*, 120 Idaho at 862, 820 P.2d at 1219.

Generally, the Idaho Supreme Court finds agency interpretations of statutes and rules are "reasonable unless the agency relied on erroneous facts or law in its determination." *Duncan v. State Bd. of Accountancy*, 149 Idaho 1, 4, 232 P.3d 322, 325 (2010) (citing cases). Stated differently, an agency's interpretation of a rule or statute is unreasonable when it "is so obscure and doubtful that it is entitled to no weight or consideration." *Simplot*, 120 Idaho at 862, 820 P.2d at 1219 (citation omitted).

Second, the reviewing courts defer to the agency when reviewing a scientific determination in its particular field of expertise. *See* Idaho Code § 67-5251(5); IDAPA 04.11.01.600; *see also Simplot*, 120 Idaho at 859, 820 P.2d at 1216 ("[T]he expertise of an agency is often useful in technical areas of the law where the risk of failing to understand all of the implications of a decision are great."); *Grindstone Butte Mut. Canal Co. v. Idaho Pub. Utils. Comm'n*, 102 Idaho 175, 182, 627 P.2d 804, 811 (1981) (noting that the Court will temper its review with deference to the expertise of the Idaho Public Utilities Commission when considering testimony that is technical in nature).

Indeed, when a court is reviewing a scientific determination, rather than a simple finding of fact, "a reviewing court must generally be at its most deferential," considering that the agency is making predictions, within its area of special expertise. *See Balt. Gas & Elec. Co. v. Nat. Res. Def. Council, Inc*., 462 U.S. 87, 103 (1983); *see also Appalachian Power Co. v. EPA*, 135 F.3d 791, 802 (D.C. Cir. 1998) (noting that deference is traditionally given to an agency when

reviewing a scientific analysis within its area of expertise). In other words, a scientific determination or analysis is not a finding of fact. Rather the agency is making a decision within its area of special expertise.

ARGUMENT

Applying those standards to this case, summary judgment is appropriate and is warranted in favor of DEQ and Perpetua as a matter of law. Petitioners appeal the issuance of the Final Permit based on alleged errors in the preconstruction permitting process. That process requires DEQ to reach decisions through the exercise of discretion and through its scientific and technical expertise. Summary judgment on contested cases has been found appropriate where the action being challenged involved a discretionary decision reached by the exercise of DEQ's special skill and expertise. *See, e.g*., *In re: Permit Applicant Garnet Energy LLC (Permit No. 0027-00081)*, Dkt. No. 0101-01-10, Order Granting Motion for Summary Judgment (Feb. 22, 2002).

For the Board's and the hearing officer's convenience, in the headings that follow, Perpetua identifies the "Claim" numbers as set out in the hearing officer's Order on Motion to Dismiss. *See* Order at 8-9, 25-26 (Nov. 15, 2022).[5]

I. Petitioners have failed to demonstrate, as is their burden, that they are persons "aggrieved" by an action or inaction of DEQ.

Perpetua joins in DEQ's argument that none of the Petitioners have demonstrated legal standing. Only persons "aggrieved by an action or inaction of the department" may initiate a contested case. *See* Idaho Code § 39-107(5). The Board's contested case rules explain that an "aggrieved person" is "[a]ny person or entity with legal standing to challenge an action or inaction of the Department." IDAPA 58.01.23.005.01. Legal standing, whether for a person or an

[5] Note that Claim 10, related to the impacts of future permitting actions on arsenic emissions, was dismissed and not revived in the Amended Petition.

organization, requires a showing of a real and actual injury in fact and a substantial likelihood that the claimed relief will prevent the claimed injury. *See Solomon v. Idaho Department of Environmental Quality*, Docket No. 0101-03-01, Order at 4-5 (Dec. 17, 2003).

At summary judgment, a plaintiff can no longer rest on mere allegations of standing but must set forth by affidavit or other evidence specific facts to demonstrate their legal standing. *Camp Easton Forever, Inc. v. Inland Nw. Council BSA*, 156 Idaho 893, 898, 332 P.3d 805, 810 (2014). Petitioners have not provided any evidence to show a real and actual injury, much less an injury that is causally connected to the challenged DEQ action and that will be redressed by a favorable decision. That failure alone requires the dismissal of the Petition. *See*, *e.g.*, *Solomon*, Order at 5-8; *Thatcher v. Idaho Department of Environmental Quality*, Docket No. 0105-19-01, Amended Order at 4-6 (Sept. 24, 2019).

II. DEQ did not violate the CAA or part 51 regulations.

At the start, the Board must reject Petitioners' allegations that DEQ's issuance of the Final Permit violates the CAA and 40 C.F.R. part 51. *See* Opening Br. at 18 (addressing the Project's "ambient air"), 28-30 (addressing "future plans"). Petitioners misconstrue the framework of federal and state obligations under the CAA. They cannot challenge a state agency action, such as issuance of a permit, for failure to comply with the statute.

The CAA creates a partnership between the federal government and the states to prevent and control air pollution. *Cal. Dump Truck Owners Ass'n v. Nichols*, 784 F.3d 500, 502 (9th Cir. 2015); *see also Michigan v. EPA*, 268 F.3d 1075, 1083 (D.C. Cir. 2001) (explaining that the CAA is "an experiment in cooperative federalism"). While EPA retains certain powers of supervision and enforcement, states hold "primary responsibility for assuring air quality" through the development of a state implementation plan ("SIP"). 42 U.S.C. § 7407(a). A SIP specifies

"the manner in which [NAAQS] will be achieved and maintained within each air quality control region in such State." *Id*.

The CAA and the part 51 regulations delineate the required contents of SIPs. *See* 42 U.S.C. § 7410(a). As one federal court amply explained, the federal provisions describe "the general *types* of emissions standards and limitations that a SIP must contain"—they establish "requirements for *SIPs*, not *sources*." *NRDC v. S. Coast Air Quality Mgmt. Dist.*, 694 F. Supp. 2d 1092, 1105, 1111 (C.D. Cal. 2010) (emphases in original) (addressing the CAA's scheme with respect to SIP requirements for non-attainment areas), *aff'd*, 651 F.3d 1066 (9th Cir. 2011). EPA must approve a SIP so long as it satisfies those requirements. *See* 42 U.S.C. § 7410(k)(3); *Train v. Nat. Res. Def. Council, Inc.*, 421 U.S. 60, 79-80 (1975).

This distinction between SIPs and sources is important here. EPA "is plainly charged by the Act with the responsibility for setting the [NAAQS]. Just as plainly, however, it is relegated by the Act to a secondary role in the process of determining and enforcing the specific, source-by-source emission limitations." *Train*, 421 U.S. at 79. Thus, EPA has "no authority to question the wisdom of a State's choices of emission limitations." *Id*. "[S]o long as the ultimate effect of a State's choice of emission limitations is compliance with the [NAAQS], the State is at liberty to adopt whatever mix of emission limitations it deems best suited to its particular situation." *Id*.; *see also Union Elec. Co. v. EPA*, 427 U.S. 246, 269 (1976) ("Congress plainly left with the States, so long as the national standards were met, the power to determine which sources would be burdened by regulation and to what extent.").

Choosing a mix of emission limitations is what DEQ did in the Final Permit. EPA approved Idaho's SIP, including DEQ's specific preconstruction rules for new source review

permits. IDAPA 58.01.01.200-223.[6] EPA approval is subject only to the condition that the SIP satisfy the general requirements applicable to implementation plans. *Train,* 421 U.S. at 80. It follows that DEQ achieved compliance with the CAA and the part 51 regulations. And because the federal provisions do not themselves establish enforceable emissions limitations, Petitioners cannot challenge DEQ's compliance with SIP requirements.[7] Given DEQ's primary responsibility to determine the Permit's emission limitations, the only question before the Board with respect to each of Petitioners' contested case claims is this: *did DEQ act lawfully under the Idaho Air Rules in issuing the Final Permit?*

III. DEQ followed EPA guidance and exercised its discretion in excluding the Stibnite Access Route from the Project's ambient air (Claims 11 and 12).

Petitioners assert that DEQ's decision to exclude the Stibnite Access Route from ambient air protections is unlawful and "cannot be squared with the CAA, the Idaho Air Rules, and EPA's national ambient air policy." Opening Br. at 14-15. As explained above, DEQ did not violate the CAA. It simply exercised its authority under the Idaho Air Rules, and Petitioners cannot now challenge DEQ's compliance with the CAA's SIP requirements. As for the Idaho Air Rules and EPA guidance, Petitioners simply disagree with DEQ's analysis and its exercise of discretion and take a view of ambient air that is far narrower than what EPA guidance allows.

[6] Idaho's SIP was originally approved in 1972, *see* 37 Fed. Reg. 10,842 (May 31, 1972), and has been amended since. EPA's approved Idaho Air Rules can be found at https://www.epa.gov/sips-id/epa-approved-regulations-idaho-sip#IDAPA580101.

[7] Moreover, Petitioners cannot challenge DEQ's compliance with the CAA and part 51 regulations because the Board lacks jurisdiction over such a claim. *See Cal. Dump Truck Owners Ass'n*, 784 F.3d at 502 (recognizing that the CAA vests federal circuit courts of appeals with exclusive jurisdiction over challenges to a SIP); *see also* Idaho Code § 39-107(11) (assigning the Board powers, which do not include deciding challenges to the Idaho SIP).

A. EPA guidance on ambient air and agency discretion.

The term "ambient air" is not defined in the CAA. EPA filled this gap by defining "ambient air" as "that portion of the atmosphere, external to buildings, *to which the general public has access*." 40 C.F.R. § 50.1(e) (emphasis added). Idaho similarly defines "ambient air" as "that portion of the atmosphere, external to buildings, to which the general public has access." IDAPA 58.01.01.006.05. EPA has long recognized that an applicant need not demonstrate the impact of a source's emissions on air within areas to which public access is restricted. *See* PRI 1; PET 772; *see also* PRI 465.

Thus, EPA has consistently exempted "the atmosphere over land [1] owned or controlled by the source and [2] to which the public access is precluded by a fence or other physical barriers" from "ambient air." PET 772. In 2019, EPA broadened the "fence or other physical barriers" element and recognized that physical boundaries are not the only way in which to preclude public access. PET 780. Specifically, EPA recognized that other measures (such as video surveillance, monitoring, clear signage, and routine security patrols) may be effective in deterring or precluding access to the land by the general public. *Id*. EPA gives the example that clearly visible "No Trespassing" signs in conjunction with some degree of fencing or other physical and/or non-physical barriers may be effective to preclude access by the general public in appropriate situations. PET 781.

Also important, EPA recognizes a source's "ambient air" is reviewed based on the individual, case-by-case basis after consideration of information in the relevant administrative record. PET 781-782. As EPA explains in the 2019 guidance:

> The EPA will apply a rule of reason in evaluating the effectiveness of any measure proposed by a source … this evaluation should address relevant factors, such as the nature of the measure used (e.g., physical or non-physical), source location, type and size of source and property to be excluded, surrounding area (including the proximity, nature, and size of the population in

> the area), and other factors affecting whether members of the general public would readily be able to trespass upon or otherwise have access to the source's properties.

PET 781. Air agencies "should consider all relevant information provided by the source or other interested parties, or otherwise available regarding the effectiveness of the measures to prevent public access." *Id*. Thus air agencies exercise discretion in determining whether a permit condition is appropriate to ensure that the source administers selected measures in a manner that maintains continued public health protection. *Id*.

That exercise of discretion has been recognized by the courts. *See REDOIL v. U.S. EPA*, 716 F.3d 1155, 1165 (9th Cir. 2013). In *REDOIL*, the Ninth Circuit denied a petition to review two air permits that authorized exploratory drilling operations by a drillship and support vessels. *Id*. at 1157-58. The petitioners challenged EPA's grant of a 500-meter radius ambient air exemption, which was contingent on the Coast Guard's establishment of an effective safety zone precluding public access to the area. *Id.* at 1164.

According to the Ninth Circuit, "[t]he relevant inquiry is whether the EPA's grant of the ambient air exemption to Shell is *plainly erroneous or inconsistent with its regulatory definition of ambient air*." *Id.* at 1165 (emphasis added). The Ninth Circuit also noted that when EPA first issued its guidance on ambient air, it did not have the occasion to consider how it would apply the exemption to an overwater situation. *Id.* Accordingly, that the agency "'requires some leeway'" in determining how to apply the ambient air rule and guidance to the situation at hand "is just common sense." *Id.* (citation omitted). The Ninth Circuit held that EPA's grant of an ambient air exemption conditioned on a safety zone was a permissible interpretation of the ambient air regulation and guidance. *Id.*

B. DEQ reasonably exercised its discretion in determining that the Stibnite Access Route is exempt from the Project's ambient air.

Following *REDOIL*, the relevant question here is whether DEQ's grant of an ambient air exemption to the Stibnite Access Route is plainly erroneous or inconsistent with its regulatory definition of ambient air. *Id.* at 1165. During the public comment period, Petitioners objected to DEQ's exclusion of the Stibnite Access Route from the ambient air boundary. PET 590-592. Petitioners repeat the same objections here. *See* Opening Br. at 14-18. As evidenced by the permit record, DEQ conducted a thorough review of this issue. In deciding that the air above the Stibnite Access Route is not ambient air, DEQ reached a reasonable determination consistent with the definition of ambient air and EPA's guidance.

From the beginning, both DEQ and Perpetua recognized that establishing the ambient air boundary was crucial to permitting the Project. *See* Schilling Decl. at 8. Given the importance of the issue, in 2018, DEQ contacted EPA Region 10, who gave this guidance via email: "If the public access road is only accessible to public traveling in automobiles under the escort, supervision, and monitoring of Midas personnel (they mentioned a pilot car as a possibility), and there are no stopping points with public access along the road, then the road is not ambient air." PRI 10. Then, in 2020, EPA Region 10 reiterated that the Stibnite Access Route would be exempt "because it is fully under the control and surveillance of the source and unsupervised public access is precluded. It seems like a slam dunk, based on my understanding of EPA's revised ambient air policy." PRI 156; Schilling Decl. at 8.

During the permitting process, Perpetua identified the following measures to preclude public access: Perpetua would (1) employ physical barriers at points of potential access, including the current Stibnite Road point of entry and proposed site access via the Burntlog Route, with locked gates and appropriate adjacent barriers such as fencing, boulders, or other

boundaries, in addition to natural features that serve as barriers or impediments to access; (2) post signs warning the public against entry into the site; (3) implement routine patrolling and surveillance for unauthorized individuals; and (4) only allow registered guests to access to or through the facility, including requiring all persons to receive a registration sheet that explains Perpetua's requirements for accessing the site and identifies potential hazards of the site. PET 310-311, PET 569-570; *see also* PRI 467-469.

DEQ analyzed the ambient air boundary issue using EPA's guidance. *See* PET 310-311, 569-570, 592. With respect to the first element (control), DEQ was satisfied with Perpetua's representation that it has sole and complete control of access to the Stibnite Access Route, including complete closure when necessary. PET 310-311, 570. As to the second element (measures precluding public access), DEQ evaluated how Perpetua would restrict access and prohibit the public from freely accessing the Stibnite Access Route. PET 310-311, 570. DEQ considered that Perpetua would preclude access to the Stibnite Access Route to the general public by posting signs warning the public against entry into the site and establishing manned access gates at points prior to the ambient air boundary. PET 310, 570. DEQ was satisfied that all persons seeking access will be required to register at the access gate and be instructed on procedures and any potential hazards of areas they may encounter while using the Stibnite Access Route. PET 311, 570.

Nevertheless, Petitioners liken the Stibnite Access Route to a right-of-way easement or common service road and argue that individuals traveling the Route are the general public. Opening Br. at 17. They also contend that the Final Permit does not preclude access to the general public. *Id*. at 16. But unlike a right-of-way or common service road, members of the general public will not be permitted to freely access the Stibnite Access Route. PET 10

(Condition 2.7); *see also* PET 310-311, 569-570. In Condition 2.7, DEQ conditioned the Final Permit on the establishment of an Access Management Plan ("AMP") prohibiting the general public from freely accessing the Stibnite Access Route. PET 10.

Condition 2.7 was updated based on public comment to state: "Only registered guests of the facility will be allowed to access to or through the facility. Those seeking to be a guest for the sole purpose of passing through the facility to another destination shall be provided a registration sheet that explains Perpetua's requirements for accessing the stie and identified potential hazards of the site." *Id*. Those that seek access must be required to register at the access gate and will be informed that they are proceeding as guests of Perpetua rather than members of the general public. *Id*. Perpetua must also install locked gates and barriers for the two primary access points, plus posted warning signs, require registration by users seeking access, and more. *Id*. Also the measures specified in the AMP will be incorporated by reference into the Final Permit and will be enforceable permit conditions. *Id.*

DEQ's decision not to exclude the Stibnite Access Route from the ambient air demonstration is no different than EPA's grant of an air boundary exemption in *REDOIL*. As in that case, DEQ dealt with a novel situation and conditioned its decision on an effective safety zone and procedures to restrict public access. *See* 716 F.3d at 1165. Accordingly, based on the situation here, DEQ made a well-reasoned and permissible interpretation of the Idaho Air Rules and EPA guidance. Schilling Decl. at 6-7. Just as the Ninth Circuit upheld EPA's decision in *REDOIL*, the Board should uphold DEQ's determination on the Project's ambient air boundary.

IV. DEQ did not act arbitrary and capricious or violate the Idaho Air Rules in determining that fugitive dust emissions from the Project's roads will met the PM_{10} NAAQS and arsenic AACC.

A. DEQ reasonably determined that 93.3% control efficiency for fugitive dust from haul roads was attainable and enforceable (Claims 2 and 8).

DEQ's evaluation to satisfy the requirements of Section 203 included estimates of fugitive dust emissions from the Project's haul roads, including a dust control efficiency of 93.3%. *See* PET 18 (Condition 3.2), 551. Conditions in the Final Permit ensure that control efficiency will be maintained through a combination of chemical dust suppressants (e.g., magnesium chloride or calcium chloride) and frequent watering, among other permit conditions. *Id*. Petitioners contend it is "highly questionable whether 93.3% fugitive dust control is realistically attainable" and that the Permit lacks enforceable conditions to ensure the control efficiency will be met. Opening Br. at 19-23. DEQ found otherwise, and Petitioners have not shown that DEQ's conclusion was unreasonable.

1. Petitioners have not shown that DEQ's use of the 93.3% control efficiency was unsupported or unreasonable.

The 93.3% control efficiency is based on a combination of dust suppressant chemical application (90% or higher) and watering (33% and higher) to increase road surface moisture.[8] *See* PET 143. Petitioners believe 80% is a more realistic control efficiency for chemical dust suppressants under AP-42 Section 13.2.2, Unpaved Roads (2006).[9] Opening Br. at 20 (citing PET 809). AP-42, however, does not provide a reference for that value or the chemical type. *See* PET 809. That led Perpetua to examine all the studies referenced in Section 13.2.2 pertaining to chemical dust suppressants. PRI 2-7, 498. The referenced test reports actually show a 90% to

[8] 93.3% control = (1-90%) * (1-33%).

[9] Petitioners do not contest DEQ's conservative use of a 33% control efficiency for watering. According to AP-42, watering that increases the surface moisture by 1% reduces fugitive dust by 75% to 95%. PET 808 (Figure 13.2.2-2); *see also* PET 548.

99% control efficiency for chemical dust suppressant alone and 98% for magnesium chloride in particular. PET 546.

Perpetua and DEQ also reviewed EPA's RACT/BACT/LAER Clearinghouse ("RBLC") database and identified 10 projects using chemical dust suppressant (with and without watering) using 90% to 98% control efficiency. PET 546-547. While Petitioners sought to discredit most of the 10 projects as unrepresentative in public comments, DEQ found the RBLC database provided additional support "that a control efficiency of 90% is achievable by treating unpaved roads with chemical suppressant in various states with similar operations." PET 557-559.

Petitioners also speculate that "the application of water *may* dissolve the bond between the chemical suppressant and road particles, thus decreasing the control efficiency—not increasing it." Opening Br. at 20 (emphasis added). They provide no support for that claim. Even so, Petitioners do not challenge that chemical and water dust suppressants are used in combination in practice. PET 557, 558. Nor, as DEQ noted, did Petitioners demonstrate that their assumptions "were more accurate or appropriate than data provided by" Perpetua and accepted by DEQ. PET 620.

In the end, DEQ reasonably supported its finding that the 93.3% control efficiency for chemical dust suppression and watering was both achievable and conservative, and Petitioners have not shown that conclusion was unreasonable based on the permit record.

2. Petitioners have not shown that the Final Permit lacks enforceable conditions to ensure 93.3% control efficiency when DEQ imposed daily monitoring and other substantive conditions.

Also without merit is Petitioners' contention that the Permit lacks enforceable conditions to ensure the 93.3% control efficiency will be met. Opening Br. at 20-23. Petitioners argue that DEQ should have included conditions on the type, quantity, application rate, and frequency of dust suppressants. *Id*. But they cite to no legal authority that DEQ was required to include those

conditions and instead rely on AP-42 Section 13.2.2 and the various factors that bear on the effectiveness of chemical dust suppressants. *Id*. at 20-21. Further, DEQ developed permit conditions to ensure the 93.3% control efficiency is maintained on a daily and annual basis, and Petitioners have not shown those conditions are unreasonable or unenforceable.

According to EPA guidance, for source-specific permit provisions to be practically enforceable, they must specify: (1) a technically accurate limitation and the portions of the source subject to the limitation; (2) the time period for the limitation (hourly, daily, monthly, annually); and (3) the method to determine compliance including appropriate monitoring, recordkeeping and reporting. PET 791. DEQ ensured those enforceability criteria were met with respect to the 93.3% control efficiency. Not only did DEQ include that level of control in the Final Permit and find it achievable (as just explained), it found that the Final Permit required the proper application of dust suppressant chemicals and watering as verified through daily visible emission monitoring and recordkeeping. PET 551, 555, 557, 568, 571.

DEQ's conclusion is well supported and reasonable. Condition 2.2 requires Perpetua to monitor the frequency and methods used to control fugitive dust at least once every 12 hours and maintain those records. PET 8. Condition 2.4 requires daily facility-wide inspections of hauling activities to ensure the expected control efficiency is achieved. *Id*. Condition 2.5 mandates that fugitive dust control measures be applied to haul roads "on a frequency such that visible emissions from vehicle traffic on a haul road do not exceed 10% opacity." PET 9. And if emissions exceed that level, Perpetua must take immediate corrective action until fugitive dust control is achieved. *Id*. The daily inspection and haul road opacity requirements are more stringent than in other permits that DEQ has issued. Simon Decl. at 6.

Moreover, the FDCP must be submitted to DEQ for approval 30 days prior to startup, and once approved, will be incorporated into the Permit and enforceable. PET 9-10 (Conditions 2.6 and 2.8). The FDCP itself ensures compliance with fugitive dust requirements. Condition 2.6 establishes minimum and substantive requirements for the FDCP, including:

- posting and limiting the maximum speed of haul trucks;
- applying water or suitable dust suppressant chemicals to haul roads during the dry season and at other times as necessary to control fugitive dust;
- prior to onset of winter conditions, maintenance of the roads and any preventative dust suppression activities before the roads are frozen;
- developing specific criteria to determine what frequency and type (water and/or chemical) of dust suppressant and appropriate suppressant application rates;
- applying chemical dust suppressants consistent with manufacturer's instructions and recommendations;
- providing training to all relevant employees and conducting visible emissions evaluations by certified employees who are visible emission observers; and
- at least once each year, evaluating FDCP requirements to identify additional requirements and evaluating the effectiveness of practices.

PET 9-10. Thus, DEQ did not give "vague direction" to consider type, quantity, and rates of dust suppressants later in its FDCP. *See* Opening Br. at 21. As DEQ explained in response to Petitioners' criticisms, the Final Permit requires Perpetua to apply dust suppressants in proper amounts and proper frequencies as local conditions dictate and also requires daily inspections to ensure the 93.3% control efficiency is met. PET 551, 555, 557, 568, 571. Ultimately the Final

Permit "requires a more comprehensive and detailed FDCP than in any other minor source permit DEQ has issued." Simon Decl. at 8.

DEQ also recognized the challenge of achieving fugitive dust controls at the 93.3% control efficiency. PET 90. Petitioners try to use DEQ's acknowledgment against it, *see* Opening Br. at 21-23, but it illustrates that DEQ's choices were deliberate, rational, and reasonable. The Permit mandates the "conscientious efforts, vigilant inspection and monitoring, and a comprehensive FDCP" necessary to achieve the 93.3% control efficiency. *See* PET 8-10 (Conditions 2.1 – 2.8). For instance, DEQ reasoned that frequent inspections "once every 12 hours ensures that both daytime and nighttime operations will be observed, to confirm that sufficient fugitive dust control measures are applied as assumed in demonstrations of compliance with NAAQS on a 24-hour basis." PET 358. DEQ also considered the Final Permit's surrogate production limits (discussed below) and that a 93.3% level of control could be met and likely exceeded during wintertime conditions, when modeling showed possible violations of the PM_{10} NAAQS. PET 558-559, 629-630.

DEQ's imposition of minimum and substantive requirements in the Final Permit and through the FCDP was not unreasonable. It understood how uncommon and impractical it would be to establish specific numeric limits to control efficiency variables advocated by Petitioners. Instead, the Final Permit, among other conditions, requires that chemical suppressants be applied in accordance with the manufacturer's instructions and recommendations and that the control effectiveness of the combination of dust suppressant chemicals and watering be verified daily. Petitioners have not satisfied their burden to show that the many permit conditions imposed by DEQ will not achieve the expected control efficiency.

B. Petitioners have not shown that DEQ is required to impose conditions restricting vehicle miles traveled and truck weights when DEQ imposed surrogate production limits and other requirements (Claims 1 and 8).

Under AP-42 Section 13.2.2, the emission estimation method for unpaved road dust emissions relies on a variety of site-specific parameters. *See* PET 797-803. Some of the parameters include the silt content of the road, the vehicle miles traveled, and the average weight of the haul truck fleet. PET 797-798, 800. Petitioners claim that DEQ should have developed Permit conditions based on parameters for miles traveled and truck weight, and because DEQ did not, its determination of compliance with the PM_{10} NAAQS and the arsenic AACC is flawed. Opening Br. at 23-25. Petitioners and EPA made similar claims during the public comment period, which DEQ rejected. *See* PET 556, 572-573.

Petitioners have not shown, and cannot show, that DEQ erred in a manner specified under Idaho Code § 67-5279(3) or that their substantial rights have been prejudiced. In the Statement of Basis, DEQ noted this about Perpetua's application:

> it was recognized that accurate determination of site-specific parameters characterizing road conditions and vehicle traffic was critical to estimating particulate matter emissions and ambient air impacts. PRI provided site-specific information to support parameters such as silt content, mean vehicle weight, and dust suppressant control efficiencies, and provided an analysis evaluating the conservatism of the resulting emission factor (AP-42).

PET 62. In excerpting that passage, Petitioners mischaracterize it. *See* Opening Br. at 23-24. They claim that because vehicle miles traveled and truck weights were "critical" to estimating fugitive dust emissions, the Permit must include limits on vehicles miles traveled and truck weights as enforceable conditions. *Id*.

Petitioners, however, cite no legal authority to support such a claim. Nor do they show how the absence of enforceable conditions for vehicle miles traveled and truck weights means

that DEQ lacked a reasonable basis to conclude the Project will comply with the PM_{10} NAAQS and the arsenic AACC. Under the Idaho Air Rules, DEQ has the discretion to impose "any reasonable conditions upon an approval." IDAPA 58.01.01.211.01; *see also* IDAPA 58.01.01.651 ("All reasonable precautions must be taken to prevent particulate matter from becoming airborne."). Here DEQ imposed many reasonable and enforceable conditions to control fugitive dust emissions from the haul roads and explained why it chose those conditions.

Petitioners largely ignore those conditions and why they were imposed. DEQ explained that emissions limits and parameters associated with estimating emissions (like vehicle miles traveled and truck weight) are not commonly included in permits for fugitive sources and are documented in the Statement of Basis and application materials. PET 557, 574. Instead, DEQ uses production limits and monitoring and recordkeeping requirements, which it did here. PET 557, 574. In particular, in Condition 3.5, DEQ established daily hauling and excavation limits of 180,000 tons/day and 135,000 tons/day on a five-year rolling basis (which is more restrictive than the 180,000 tons/day limit). PET 19; *see also* PET 573. It did so because daily production limits directly limit "hauling operations and associated emissions" and "serve as surrogate emissions limits for PM, PM_{10}, $PM_{2.5}$, HAP and TAP from fugitive sources." PET 356, 557, 574; *see also* Simon Decl. at 9.

DEQ also recognized the importance of the silt content parameter in estimating fugitive dust emissions and ensuring compliance with the PM_{10} NAAQS. PET 552. In response to Petitioners' and EPA's comments, DEQ imposed Condition 3.13, which requires Perpetua to cap haul roads with material having a maximum of 4% silt content and to develop the HRCP to ensure that limit is met. PET 19-20, 552, 572. Further, as noted above, DEQ imposed Conditions 2.1 to 2.8, which require fugitive dust emission limits (to ensure that visible emissions do not

exceed 10% opacity) and control requirements (such as the application of water and chemical dust suppressants to haul roads). PET 8-10, 90.

Equally important are the monitoring and recordkeeping requirements DEQ imposed. As DEQ explained, "[s]uch monitoring includes the monitoring of maximum road silt content [and] monitoring of production levels to verify estimated vehicle miles traveled (VMT) used in fugitive road dust emission calculations." PET 562. Indeed, Condition 3.13 requires sampling and monitoring of the maximum road silt content, and Condition 3.16 requires daily, monthly, and yearly hauling and excavating monitoring. PET 20. And, again, Condition 2.6 requires Perpetua to develop and maintain the FDCP to ensure compliance with Conditions 2.1 to 2.5. PET 9-10. The FCDP must include precautions to minimize fugitive dust emissions, such as maximum speed limits, monitoring and maintenance of haul roads, and frequency of chemical dust suppressant and watering. *Id*.

Finally, Petitioners ignore the conservative assumptions that overestimated fugitive dust emissions from the haul roads and modeled maximum PM_{10} impacts. EPA's method for estimating haul road fugitive dust emissions predicts higher emissions for more miles traveled and a heavier vehicle weight. *See* PET 798. Thus, DEQ also justified its choice of conditions because the emissions were "[c]alculated at maximum daily processing rates" and "would tend to be conservatively estimated." PET 65. That is true. At the 180,000 tons/day production limit (or 65,700,00 tons/year), DEQ modeled all hauling scenarios to capture the maximum case hauling distance of 16,415 miles per day (or approximately 500,000 miles per month). *Id*.

But the Project's peak production rate is actually 116,964 tons/day (or 42,692,000 tons/year), *id*., and the peak hauling mileage is approximately 116,700 miles per month, far less than modeled, PET 356. The average vehicle weight of the haul trucks (183 tons) was also

overestimated compared to the actual vehicle weight (180 tons) during peak production. *Compare* PET 142 *with* PRI 891. And where the conservatism of some emissions calculated was questioned, "DEQ required enhanced monitoring and record-keeping," such as Conditions 3.13 and 3.16. PET 562.

In sum, the entire premise of Petitioners' challenge is wrong – there is no legal requirement for DEQ to include vehicle miles traveled and truck weights as enforceable permit conditions to control fugitive dust emissions from the haul roads. Petitioners also ignore the actual conditions DEQ chose to impose and its justification for establishing surrogate production limits and enhanced monitoring and recordkeeping requirements. Petitioners may disagree with DEQ's choices, but they have not shown that DEQ lacked a reasonable basis for such conditions or that it was unreasonable to conclude that Perpetua's operations could cause a violation of the PM_{10} NAAQS or exceed the arsenic AACC.

C. Petitioners have not shown that DEQ's use of 120 days of precipitation data to estimate fugitive dust emissions was counter to DEQ guidance or arbitrary and capricious (Claims 5 and 8).

Another parameter AP-42 uses for estimating fugitive dust emissions from unpaved roads is the number of days of precipitation (rain and snow) with at least 0.01 inches at the site. PET 802-803. Because precipitation acts like "watering" to increase moisture on the surface, EPA recognizes that "all roads are subject to some natural mitigation because of rainfall and other precipitation." PET 802. EPA's emission estimation method predicts lower dust emissions for sites with higher precipitation and conversely higher dust emissions for sites with lower precipitation. *See* PET 802-803.

In AP-42, EPA also provides the mean annual number of "wet" days for the United States. *See* PET 803, 805. For the Project site, the number is 120 wet days per year. *See* PET 805. DEQ used the default 120 day per year value to calculate fugitive dust emissions from the

access road. *See* PET 146. According to Petitioners, DEQ should have used more representative local meteorological data.[10] Opening Br. at 25. Petitioners contend that DEQ's air modeling guidance prefers local data and thus the failure to use local data was arbitrary, counter to DEQ guidance, and "undermines DEQ's estimates of Project road emissions, and DEQ's determinations that the project will not cause or contribute to a violation of the PM_{10} NAAQS and arsenic AACC." *Id*. at 25-26.

Petitioners are wrong. One reason is that Petitioners confuse the calculation of fugitive dust emissions, on one hand, with the modeling of fugitive dust impacts, on the other. Precipitation data only affects fugitive dust emission calculations, not modeling. PRI 975. Thus contrary to Petitioners' contention, DEQ air modeling guidance does not directly apply to or affect its calculation of fugitive dust emissions from the access road. DEQ's use of the default 120 day per year value was consistent with AP-42 and not arbitrary. *See* PET 802-803, 805.

Even so, Petitioners are also wrong because they assume the use of local precipitation data would have resulted in higher fugitive dust emissions. But that is not true. Site-specific meteorological data from the Project collected in 2014 shows 168 days per year of precipitation, far more than EPA's default 120 wet days per year. PRI 12. Again, using more days of precipitation would result in lower estimates of fugitive dust emissions. Using the 120 days per year value is conservative, overestimated emissions, and ultimately resulted in more conservative PM_{10} NAAQS and arsenic AACC determinations. DEQ's use of 120 days per year precipitation value did not underestimate emissions or undermine DEQ's evaluation of the PM_{10} NAAQS and arsenic AACC.

[10] DEQ also used the 120 days per year precipitation value for calculating fugitive dust emissions from the haul roads. *See* PET 142-144. Petitioners do not challenge the use of the 120 day value for those calculations. *See* Opening Br. at 25 (citing PET 146).

D. Petitioners have not shown that the Final Permit's production limits are unenforceable when DEQ imposed monitoring and recordkeeping requirements to determine compliance (Claims 4 and 8).

Petitioners' final challenge to DEQ's assessment and regulation of fugitive dust emissions concerns Condition 3.5's hauling and excavation limits (180,000 tons/day and 135,000 tons/day on a five-year rolling basis) and associated monitoring and recordkeeping requirements. Petitioners contend that the Permit lacks developed and enforceable monitoring requirements to ensure the production limits are met and because compliance is not ensured, that DEQ lacked a reasonable basis to find the PM_{10} NAAQS and the TAPs AACCs will be met. Opening Br. at 26-28. DEQ considered and correctly rejected those criticisms. *See* PET 562-563, 566-567, 569.

As detailed earlier, practical enforceability means that source-specific permit provisions specify a technically accurate limitation, the time period for the limitation, and the method to determine compliance. PET 791. DEQ ensured those enforceability criteria were met with respect to Condition 3.5's production limits. Condition 3.5 includes accurate daily and annual production limits, based on both an annual and a rolling basis. PET 19. As DEQ noted, the Permit's monitoring and recordkeeping requirements establish a daily and monthly schedule for monitoring compliance with the production limits using devices and methodologies identified in the O&M Manual. PET 563-564. These details must be incorporated in the O&M Manual within 30 days of startup. *Id*.

All that is true, and Petitioners are simply wrong that Condition 3.5's production limits are not enforceable. The production limits are made enforceable by numerous monitoring and recordkeeping requirements, starting with Condition 3.16. Condition 3.16 requires that: "Each day, the permittee shall monitor and record the amount of ore and DR [development rock] transported on haul trucks (T/day)." PET 20. Each month, Perpetua must monitor and record the amounts transported in tons per month and per year to determine compliance with the 180,000

tons/day and 135,000 tons/day on a five-year rolling basis production limits. *Id*. Those records must be retained for a period of at least five years. PET 40 (Condition 7.10).

Condition 3.16 also requires that "[t]he devices and methodologies used to measure weights shall be identified in the O&M Manual." PET 20. Condition 2.20 mandates that the O&M Manual establish a regular schedule for operation, inspection, maintenance, and repair of devices that ensure compliance. PET 12-14. Not only that, in response to Petitioners' comments, DEQ required the O&M Manual be submitted for review and approval 30 days prior to startup, and any changes to the manual must likewise be reviewed and approved.[11] PET 14 (Condition 2.21); PET 566-567. Once approved, the requirements of the O&M will be incorporated into the Permit and "shall be enforceable permit conditions." PET 12 (Condition 2.20).

Thus the details on devices and measurement methodologies will be incorporated into the O&M Manual when available, but no later than 30 days prior to startup and then into the Permit as enforceable conditions. DEQ's compliance method is both reasonable and correct. It is common to include such information in an O&M Manual because, prior to construction and startup, the device and measurement methodology are often unknown and have yet to be selected. *See* PET 567 (observing that "certain operating parameters will not be determined or available until after control equipment has been installed"); Simon Decl. at 10. This is why Condition 2.21 does not require the O&M Manual to be submitted to DEQ for approval until 30 days before startup. *See id*.

EPA's own regulations illustrate this necessary flexibility and the monitoring and recordkeeping requirements necessary (and conversely those that are not necessary) to make

[11] Prior to this change, the draft Permit required Perpetua to submit the O&M Manual 60 days after startup. *See* PET 379, 380 (draft Conditions 2.19 and 2.20).

limitations enforceable. Take, for example, EPA's gold mining NESHAP (40 C.F.R. pt. 63, subpt. EEEEEEE), which is incorporated by reference in Condition 2.22. PET 14. Subpart EEEEEEE requires precious metal concentrate be measured and recorded daily. *See* 40 C.F.R. § 63.11646(a)(9), (11). It also requires the specific measurement equipment and procedures be documented and available for review by the permitting agency. *See* 40 C.F.R. § 63.11646(a)(10); 40 C.F.R. § 63.11648(f).

The minimum monitoring and recordkeeping requirements under subpart EEEEEEE are no different than the minimum requirements DEQ imposed in Condition 3.16 and Conditions 2.20, 2.21, and 7.10. Both require the permittee to document monitoring devices and the procedures used to measure compliance and to make that documentation available for agency review. Yet DEQ went further than EPA to provide the monitoring and recordkeeping framework for the enforceable limitations. The Final Permit requires approval and enforceability of the procedures in Conditions 2.21 and 2.20.

It follows that Petitioners have not shown that the Permit lacks enforceable monitoring requirements to ensure compliance with the production limits. The obligation to have a device and compliance methodology is enforceable at permit issuance. Further, the specific device and method become enforceable through incorporation into the Permit prior to operation. DEQ's basis for concluding the Project will comply with the PM_{10} NAAQS and the arsenic AACC deals was rational and reasonable.

V. The Final Permit requires Perpetua to develop work plans for DEQ approval and does not violate the CAA or the Idaho Air Rules (Claim 3).

Petitioners' allegation that DEQ's reliance on the FDCP, HRCP, AMP, and O&M Manual violates the CAA and Idaho Air Rules is legally untenable. Pursuant to DEQ's discretion, the Final Permit required Perpetua to develop work practice plans, include specific

provisions in the plans, and submit them to DEQ for approval at least 30 days prior to startup. PET 9-10 (Condition 2.6 (FDCP) and Condition 2.7 (AMP)), 12-14 (Condition 2.20 (O&M Manual)), 19-20 (Condition 3.13 (HRCP)). DEQ did not violate the CAA or Idaho Air Rules.

A. The CAA and the Idaho Air Rules do not require work plans to be submitted with applications or circulated for public comment.

The CAA and part 51 regulations require that SIPs provide for an opportunity for public comment on "information submitted by owners and operators [and] [t]he public information must include the agency's analysis of the effect of construction or modification on ambient air quality, including the agency's proposed approval or disapproval." 40 C.F.R. § 51.161. As noted already, the CAA and the part 51 regulations establish requirements for SIPs, not sources. And since EPA approved the Idaho SIP, the only relevant question is whether DEQ complied with the Idaho Air Rules.

The Idaho Air Rules do not require that source work plans be developed at all, let alone that they be prepared before construction commences or be available for public comment before a permit to construct can be issued. *See* IDAPA 58.01.01.211.01. Section 202 of the Idaho Air Rules specifies the requirements for a permit to construct application and identifies information required to be included in the application. IDAPA 58.01.01.202.01. Requisite information for new sources includes information related to the design of the source, nature and amount of emissions, the manner in which the source will be operated and controlled, and a schedule for construction. *Id.* DEQ may request any additional information necessary to make determinations under the Idaho Air Rules. IDAPA 58.01.01.202.03.

DEQ must provide an opportunity for public comment on its "proposed action, together with the information submitted by the applicant and the Department's analysis of the information." IDAPA 58.01.01.209.01.c.i. As such, Petitioners' argument that Perpetua's

application is "incomplete" or that these plans must be made available for public comment are legally incorrect. *See* Opening Br. at 29. Following the Idaho Air Rules, DEQ's review of Perpetua's application included four requests for additional information to supplement the application, three extended public comment opportunities to solicit feedback from the public and other stakeholders, two informational meetings requested by the public, and three iterations of draft permits. PET 52-53, 93.

During the public comment period, Petitioners submitted comments that raised concerns with the submission and review process of the FDCP, HRCP, AMP, and O&M Manual. PET 566-567. DEQ responded and explained that the permit specifies minimum and substantive requirements for the plans. *Id*. In addition, while these plans are not required to be submitted at all, DEQ will exercise oversight, review and approve the work plans, and publish the final plans on its website. *Id*. Perpetua shall submit the plans to DEQ for approval at least 30 days prior to startup. PET 10 (Condition 2.8), 14 (Condition 2.21), and 20 (Condition 3.13); *see also* PET 566. Furthermore, elements of the plans, including recordkeeping and reporting requirements, will be incorporated and enforceable through the Final Permit. PET 10 (Condition 2.8), 14 (Condition 2.21), and 20 (Condition 3.13); *see also* PET 566.

How DEQ addressed the work plans in the Final Permit is consistent with DEQ's practice and reasonable. *See* Simon Decl. at 10. It allows the permittee to prepare a specific plan or manual based on information that is not available at the permit to construct phase, such as the actual equipment purchased and operational characteristics of the facility. *Id*. Petitioners disagree with the approach executed by DEQ, but dislike is not the legal standard. DEQ exercised reasonable discretion in developing the permit conditions related to the work plans. DEQ's approach did not violate the CAA governing SIPs, nor the Idaho Air Rules governing sources.

B. Petitioners' legal authority from the Clean Water Act is distinguishable and inapplicable to DEQ's preconstruction permitting process.

Petitioners fail to cite any case law to support their position that public review is required for work plans under the CAA or Idaho Air Rules for permits to construct. This is not an oversight. The relevant CAA jurisprudence affords broad discretion to states to develop permit conditions. *See supra*, *Train*, 421 U.S. at 79. As demonstrated above, to issue the Final Permit lawfully, these plans need not be included with applications or published for public comment and review as part of the preconstruction review process.

Petitioners cite two Clean Water Act cases to support their position on the work plans. In the first case, *Waterkeeper Alliance, Inc. v. U.S. EPA*, the plaintiff sought review of the National Pollution Discharge Elimination System Permit Regulation and Effluent Limitation Guidelines and Standards for Concentrated Animal Feeding Operations (the "CAFO Rule"). 399 F.3d 486, 492 (2d Cir. 2005). The plaintiff argued that the permitting scheme established by the CAFO Rule violated the Clean Water Act's public participation requirements because it did not require nutrient management plans, which constitute effluent limitations, to be made available to the public. *Id.* at 503. Under the Clean Water Act, effluent limitations are specifically identified in the list of items that public participation should be provided for. 33 U.S.C. § 1251. As such, the Second Circuit held the CAFO Rule "violates the plain dictates of 33 U.S.C. § 1251(e)." *Waterkeeper Alliance*, 399 F.3d at 504.

Similarly, in *Environmental Defense Center, Inc. v. EPA,* the Ninth Circuit held that Notices of Intent ("NOI") are functional equivalents to permits under the Clean Water Act's general permit option, and EPA's failure to require review of NOIs available to the public contravened the express requirements of the Clean Water Act. *Env't. Def. Ctr., Inc. v. EPA*, 344 F.3d 832, 858 (9th Cir. 2003).

Both *Waterkeeper Alliance* and *Environmental Defense Center* rested their holdings on express requirements under the Clean Water Act for public review of specific materials. The decisions are clearly distinguishable from Perpetua's work plans, which are not required by any express provision of Idaho Air Rules (nor the CAA) to be included in the application, the Final Permit, or any part of the public comment process. The Board should accordingly not give any weight to Petitioners' cases because they are factually and legally distinguishable and have no analogy to the facts in the present case. Instead, the Idaho Air Rules support DEQ.

VI. DEQ did not violate the law by issuing a Final Permit that omitted ambient air monitoring (Claim 13).

Petitioners contend that "DEQ must require ambient air monitoring" and repeat their public comments urging DEQ to impose this obligation. *See* Opening Br. at 31-32. Petitioners' claim reflects another preference and opinion for a condition that DEQ did not include in the Final Permit. Applying the standard for review, DEQ's thorough review and justification for its decision complied with its obligations under the Idaho Air Rules.

To begin, Petitioners do not identify any Idaho Air Rule violated by DEQ's issuance of a Final Permit omitting ambient air monitoring. IDAPA 58.01.01.211.01.d states that DEQ "may impose any reasonable conditions upon an approval," including conditions requiring "[i]nstrumentation for ambient monitoring to determine the effect [of] emissions from the stationary source or facility." But the rule does not require it. Thus we are left with Petitioners' different opinion. Applying the standard for review, DEQ's thorough review and justification for its decisions complied with its obligations under the law.

Like all of the assertions raised in this contested case, Petitioners' ambient air monitoring demand was presented to DEQ many times in the permitting process. In the Response to

Comments, DEQ found that ambient air monitoring was not necessary to ensure NAAQS compliance. Among the many reasons why:

- "Although there are identified uncertainties in the analyses predicting air pollutant emissions and atmospheric dispersion of such emissions, DEQ is reasonably confident that impacts to ambient air will be below applicable standards. Furthermore, ambient monitoring would only be required where such monitoring would serve to protect a potentially exposed public residing in the area of impact. The areas where maximum potential impacts from the SGP are highest are remote, located far from areas where the general public live and reside. There are no public residences, public businesses, schools, hospitals, or other areas where members of the general public would be expected on a continual basis." PET 559.
- "DEQ is requiring extensive fugitive dust control measures in the permit and has reviewed or conducted modeling analyses that demonstrates compliance with NAAQS at a satisfactory level of confidence for permit issuance. Therefore, DEQ is not requiring any ambient air monitoring in the permit." PET 560.
- "The issued permit includes limits on operational levels and key parameters such as (but not limited to) ore excavation and hauling rates, silt content of roadway material, application of dust suppressant measures, etc. These limits represent values associated with maximum or upper-level emissions for the time interval consistent with the averaging period of the standard. The permit also includes monitoring and recordkeeping requirements to ensure compliance with permit limits and ultimately ensure compliance with NAAQS and TAP increments at a satisfactory level of confidence to support permit issuance." PET 561.

- "DEQ does not typically require ambient air pollutant monitoring for permit issuance, especially at facilities with emissions below major source thresholds. Ambient monitoring is not considered unless DEQ lacks a satisfactory confidence of NAAQS or TAP increment compliance (as specified by Idaho Air Rules Section 203.02 and 203.03) without such monitoring. [Listing conditions normally required to justify post-construction ambient air monitoring]. The SGP does not meet the above criteria to justify the requirement of ambient air monitoring. It has been indicated that PRI did not use convincingly conservative data and assumptions for some emission calculations. Where the conservatism of such data was in question, DEQ required enhanced monitoring and recordkeeping of such parameters. Such monitoring includes the monitoring of maximum road silt content, monitoring of production levels to verify estimated vehicle miles traveled (VMT) used in fugitive road dust emission calculations, and monitoring of the median arsenic content of road base material to help justify fugitive road dust arsenic emissions used in TAP analyses. Finally, there are no sensitive receptors identified near the ambient boundary of the facility, where elevated impacts of pollutants would be expected." PET 562.
- "As discussed previously in DEQ's response to Comment 6, the issued permit includes limits on operational levels and key parameters such as (but not limited to) ore excavation and hauling rates, silt content of roadway material, application of dust suppressant measures, etc. These limits represent values associated with maximum or upper-level emissions for the time interval consistent with the averaging period of the standard. The permit also includes monitoring and recordkeeping requirements to assure compliance with permit limits and ultimately assure compliance with NAAQS and TAP increments at

a satisfactory level of confidence to support permit issuance. Even though DEQ is not proposing a monitoring network, it should be noted that any violation of the permit would be processed in accordance with DEQ's enforcement procedures manual." PET 565. Further justification for the approach reflected in the Final Permit is stated in the Statement of Basis. *See* PET 325.

In the end, DEQ "may impose any reasonable conditions," including ambient monitoring, but it is not required to. IDAPA 58.01.01.211.01.d. In DEQ's analysis and judgment, there was no reason to impose ambient air monitoring in the Final Permit. The Idaho Air Rules do not require ambient air monitoring and omitting such conditions from the Final Permit did not violate an applicable law governing DEQ's review. In response to repeated suggestions, DEQ considered the idea and with reasoned analyses rejected it, consistent with applicable practice, deliberate criteria, and DEQ's judgment. Petitioners have not satisfied their burden to show the decision was unlawful, arbitrary, or capricious**.**

VII. Because chemical dust suppressant and water are already established as reasonably available control technologies, DEQ was not required to conduct an technological or economic feasibility analysis (Claims 6 and 7).

As discussed, Perpetua selected, and DEQ approved, haul road capping and the use of chemical dust suppressant with frequent watering to control arsenic emissions from the Project's haul roads. PET 70, PET 544-548. The use of chemical dust suppressant and watering were explicitly required by conditions in the initial draft permit, and by the Idaho Air Rules, to control fugitive dust and TAP emissions. PRI 620; IDAPA 58.01.01.651. Despite the requirement that Perpetua adopt these control measures, Petitioners now contend that DEQ should have conducted additional analyses to determine what every environmental regulatory agency in the country already knows—that these measures are reasonably available control technologies. *See* Opening Br. at 32.

The Idaho Air Rules allow an applicant to "use T-RACT to demonstrate preconstruction compliance for toxic air pollutants listed in Section 586." IDAPA 58.01.01.210.12.a. T-RACT is defined as

> An emission standard based on the lowest emission of toxic air pollutants that a particular source is capable of meeting by the application of control technology *that is reasonably available, as determined by the Department*, *considering technological and economic feasibility*.

IDAPA 58.01.01.210 (emphasis added). For a control measure to be determined to be "reasonably available," it must be both technologically feasible and economically feasible. IDAPA 58.01.01.007.12; IDAPA 58.01.01.210.14.c.-d.

Here, the control measures proposed as, and determined to be, T-RACT were selected based on a search of EPA's RBLC to identify available control technologies. PET 70. The RBLC contains over 6,000 air pollution prevention and control determinations that identify appropriate technologies to control emissions from stationary sources.[12] DEQ approved dry drilling with dust collectors, chemical dust suppressant with frequent watering on roads, and haul road capping as T-RACT for arsenic emissions. *Id*. The use of chemical dust suppressants and watering are required to be used by facilities to prevent the generation of fugitive dust. IDAPA 58.01.01.650, 651.02.

These measures are well recognized by both DEQ and EPA as reasonably available control technologies. In 1992, EPA published a technical document describing best available control measures for unpaved roads, which analyzed and recommended the use of chemical

[12] U.S. EPA, Clean Air Technology Center, User's Manual for the RACT/BACT/LAER Clearinghouse (RBLC) Web (Nov. 2006), https://www.epa.gov/sites/production/files/2020-07/documents/rblcusr1-openaccessible.pdf.

suppressants and water.[13] The RBLC contains at least 28 determinations for using chemical dust suppressant to control dust emissions from unpaved roads.[14] These determinations were created by an agency review process that examined the technological feasibility, economic impact, environmental impact, and energy impact of dust suppressant use on unpaved roads. Finally, between 2010 and today, DEQ has issued at least seven permits to construct, in addition to Perpetua's, that require the use of chemical dust suppressant to control fugitive dust from unpaved roads.[15]

Petitioners only take issue with approval of the use of chemical dust suppressant with frequent watering. *See* Opening Br. at 33. Notably, Petitioners do not suggest that this control measure is not "reasonably available."[16] Instead, Petitioners claim that DEQ failed to thoroughly analyze the operational feasibility, economic costs, and environmental impacts of these control measures. *Id*. at 32-33.

Petitioners myopically focus on Section 210.12.c and .d, which set forth the factors DEQ is to consider when determining whether a control technology is reasonably available. Under Section 210.12, the operational feasibility and environmental impacts of a control technology are to be considered when determining whether a control technology is technologically feasible. IDAPA 58.01.01.210.12.c. The economic costs are considered when determining whether the

---

[13] U.S. EPA, *Fugitive Dust Background Document and Technical Information Document for Best Available Control Measures* (Sept. 1992), https://www.epa.gov/catc/clean-air-technology-center-products.

[14] *See generally* EPA RACT/BACT/LAER Clearinghouse (RBLC Products), https://www.epa.gov/catc/ractbactlaer-clearinghouse-rblc-products (last accessed May 10, 2023).

[15] Permit No. P-2010.0111 (effective Oct. 20, 2010), Permit No. P-2009.0135 (effective Jan. 6, 2011), P-2013.0014 (effective May 28, 2014), Permit No. P-2012.0012 (effective Dec. 18, 2014), Permit No. P-2016.0025 (effective Sept. 12, 2016), Permit No. P-2013.0046 (effective Jan. 12, 2018), Permit No. P-2013.0051 (effective Mar. 8, 2018).

[16] Petitioners recognize that chemical dust suppressant and watering are well established control measures for fugitive dust from haul roads. Amended Pet. ¶ 38 (citing AP-42 Ch. 13.2.2).

control technology is economically feasible. IDAPA 58.01.01.210.12.d.[17] Nothing in Section 210.12 requires DEQ to reevaluate the technological and economic feasibility of established control measures. Section 210.14.b states that DEQ "shall review the information submitted by the applicant and determine whether the applicant has proposed T-RACT." It does not say that DEQ shall reevaluate the technological and economic feasibility of a proposed control technology, especially one required by the Idaho Air Rules, each time that control technology is proposed. Instead, the factors listed in Section 210.12.b. and c. are to be used by DEQ if it determines in its discretion, that a technological and economic feasibility analysis is required.

As discussed above, chemical dust suppressant and watering are required by the Idaho Air Rules and have long been recognized by both the EPA and DEQ as technologically feasible and reasonably available control technologies. No additional analysis was required for DEQ to rationally determine that, consistent with the Idaho Air Rules, the use of chemical dust suppressants and watering are technologically feasible and reasonably available control technologies.

Petitioners' reliance on *Sierra Club v. U.S. EPA,* 972 F.3d 290 (3d Cir. 2020), is misplaced. *See* Opening Br. at 33. In *Sierra Club*, the Third Circuit was considering whether EPA erred in approving Pennsylvania's SIP, and standards that governed emissions from coal-burning power plants. 972 F.3d at 300. This case only involved a challenge to a SIP under the CAA. It did not involve a challenge to an individual permit. Despite stating that the determination of whether a control measure as RACT required an economic and technological

[17] Typically, these factors are used to evaluate whether a more effective control technology an applicant describes as not reasonably available is actually technologically and economically feasible for the particular application.

feasibility analysis, *id.* at 295, the court never suggested that once RACT was adopted in the SIP it would have to be reevaluated on a facility-by-facility basis.

Petitioners also argue that DEQ was required to conduct an economic analysis to support Perpetua's determination that paving was not a reasonably available control technology. Opening Br. at 34. Not so. As previously explained, for a control technology to be reasonably available, it must be both technologically feasible *and* economically feasible. IDAPA 58.01.01.007.12. Perpetua determined, and DEQ agreed, that paving is not technologically feasible, because the loaded weight of haul trucks would exceed the capacity of paved roads and the haul roads are relocated frequently as mining progresses. PET 547. Therefore no determination needed to be made as to its economic feasibility.

The Air Rules vest DEQ with discretion to determine whether a control measure is T-RACT. Nothing in Section 210.14 requires DEQ to reevaluate a long-established control measure each time that measure is proposed as T-RACT.

VIII. DEQ reasonably exercised its discretion in evaluating the health risks from arsenic (Claim 9).

Petitioners allege that nothing in the Idaho Air Rules allows DEQ to conduct the refined TAPs analysis for demonstrating preconstruction compliance with the Idaho Air Rules.[18] Petitioners fixate on the TAP Carcinogenic Increments in Section 586, while ignoring the rest of Sections 203 and 210. The Idaho Air Rules vest DEQ with discretion to determine the method by which the applicant demonstrates preconstruction compliance for TAPs. *See* IDAPA 58.01.01.203.03, .210. In this case, DEQ rationally exercised its discretion to determine that the

[18] Despite three pages of briefing dedicated to this claim, Petitioners never state their legal theory entitling them to relief. *See* Opening Br. at 34-37. The heading of Section VI suggests that Petitioners believe that DEQ's TAPs analysis violated the Idaho Air Rules, but this is never explained in the body of the brief, nor in the Amended Petition.

arsenic emissions from the Project would not injure or unreasonably affect human or animal life or vegetation, as required by IDAPA 58.01.01.161.

Rule 161 provides that:

> Any contaminant that is by its nature toxic to human or animal life or vegetation must not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation.

Under Rule 203.03, the applicant must show "*to the satisfaction of the Department*" that:

> using the methods provided in Section 210, the emissions of toxic air pollutants from the stationary source or modification would not injure or unreasonably affect human or animal life or vegetation as required by Section 161. Compliance with all applicable toxic air pollutant carcinogenic increments and toxic air pollutant non-carcinogenic increments demonstrates preconstruction compliance with Section 161 with regards to the pollutants listed in Sections 585 and 586.

(Emphasis added.)

Under Section 210.04,

> The applicant *may* use any of the Department approved standard methods described in Subsections 210.05 through 210.08, and may use any applicable specialized method described in Subsections 210.09 through 210.12 to demonstrate preconstruction compliance for each identified toxic air pollutant.

(Emphasis added).

When demonstrating compliance using T-RACT under Section 210.12, as Perpetua did here, DEQ is directed to compare the source's

> approved T-RACT ambient concentration at the point of compliance for the toxic air pollutant to the amount of toxic air pollutant that would contribute an ambient air cancer risk probability of less than one to one hundred thousand (1:100,000) (which amount is equivalent to ten (10) times the applicable acceptable ambient concentration listed in Section 586).

IDAPA 58.01.01.210.12.b.

Section 210.12 gives DEQ discretion to determine the method by which an applicant demonstrates preconstruction compliance for carcinogenic TAPs. Petitioners focus only on the AACC under Section 586, instead of the language of Section 210.12. Under Section 210.12, DEQ is to determine whether ambient concentrations of a carcinogenic TAP create an unacceptable cancer risk, not whether the maximum annual TAP concentration is below the AACC.

Arsenic is a carcinogen, and the concerns for health impacts from arsenic exposure are from a long-term exposure basis. *See* PET 332. To reflect the long-term health impacts, the carcinogenic increments reflected in Section 586 are based on a 70-year lifetime exposure. *See* IDAPA 58.01.01.006.125; PET 597. While the AACC are stated in annual averages, these values were developed to be protective where a facility emits at the level reflected in the AACC over the entire 70-year exposure period. *See* PET 597; IDAPA 58.01.01.006.125. In other words, when adjusted for T-RACT, the concentration established by the AACC assumes that if 100,000 people spend a lifetime (24 hours per day, every day, for 70 years) at the maximum receptor point, one person "may" develop cancer.

Here, the Project will operate, and potentially generate arsenic emissions, for only 16 years. PET 332. Thus, there will be no arsenic generating activity at the Project after year 16. To account for the actual operational period, DEQ determined whether arsenic emissions would contribute less than a one in one hundred thousand cancer risk over a 70-year exposure period, as required by Section 210.12. PET 069, PET 353. Conservatively, DEQ took the highest annual modeled concentration of arsenic and assumed that that concentration would be repeated for each year of operations, 16 years. PET 344. DEQ then averaged this exposure across 70 years, which

is the lifetime exposure required to be evaluated by the Air Rules. PET 344, 597. DEQ then compared the lifetime arsenic exposure from the Project, on an annual basis, to the AACC for arsenic, as provided in Section 586, and determined that the maximum lifetime exposure would be approximately 41% of the AACC. PET 348. By conducting this analysis, DEQ normalized the arsenic emissions from the Project to accurately reflect lifetime exposure risk reflected in the AACC.

Petitioners argue that the Idaho Air Rules only allow DEQ to consider whether the annual maximum concentration of arsenic in any year will exceed the AACC listed in Section 586. Petitioners focus on the AACCs without discussing Section 210.12. As explained, the AACCs are based on and assume a full 70-year exposure to the pollutant concentration reflected in the AACC. Section 210.12 does not require DEQ to find that the maximum annual concentration in any year will not exceed the AACC. Instead, DEQ must determine whether the emissions from the Project would contribute an ambient air cancer risk probability of less than one to one hundred thousand. IDAPA 58.01.01.210.12. That is exactly what DEQ did here. It evaluated the maximum modeled arsenic emissions from the Project during the operational period and then evaluated whether that would exceed the AACC over 70 years, demonstrating that the cancer risk was less than one in one hundred thousand. PET 348.

Petitioners attempt to rely on two internal DEQ memoranda to call into question the approach taken by Perpetua and DEQ. Opening Br. at 35-36. Petitioners suggest that these memoranda call into question the approach DEQ ultimately determined was appropriate to evaluate TAPs compliance for the Project. *Id.* These memoranda appear to have been written shortly after Perpetua submitted its TAP Addendum and before DEQ had thoroughly reviewed the Addendum and the modeling underlying the Addendum. *See* PET 817-824, 825-830. These

memoranda demonstrate that DEQ conducted a thorough and searching review of Perpetua's TAP Addendum, modeling, and proposed T-RACT control measures. Later correspondence from DEQ to Ian von Lindern further confirms that DEQ conducted a thorough review of Perpetua's TAP Addendum, modeling, and control measures and assured itself that Perpetua had demonstrated preconstruction compliance for arsenic emissions. PRI 807-811.

DEQ's thorough review of Perpetua's potential arsenic emissions is also confirmed by DEQ's repeated requests for additional information related to TAPs emissions from the Project. *See* PET 53-54; PRI 586. At DEQ's request, Perpetua prepared a TAP Addendum that analyzed TAP emissions using T-RACT controls, production limits,[19] and emission inventory refinements. PRI 604. Also, at DEQ's request, Perpetua conducted an arsenic modeling analysis comparing the worst-case modeling analysis, used to determine preconstruction compliance, and an assessment of the actual arsenic concentrations expected from the actual mining operations. PRI 609. The arsenic emissions produced from the actual operating analysis are only 19% of the worst-case scenario. PRI 610.

Petitioners' reliance on EPA's comments to the U.S. Forest Service fares no better. *See* Opening Br. at 37 (citing PET 667). EPA's comments are irrelevant in determining whether DEQ correctly interpreted the Idaho Air Rules and acted within its discretion. First, the CAA covers implementation only of federal standards promulgated under the CAA for hazardous air pollutants and does not require states to develop or implement ambient air concentrations for state identified toxic air pollutants. *See* PET 274. EPA has no authority nor ability to determine

[19] DEQ set the life-of-mine hauling and excavating limit at 788.4 million tons of ore and development rock. Whether this amount is mined in 16-years, the life of the mine, or 70 years, the lifetime exposure period, the total arsenic emissions will be the same, they would just be spread out over more time. Thus, the total arsenic exposure to public receptors will be the same irrespective of how long the mine is in operation.

whether DEQ appropriately interpreted the Idaho Air Rules. Second, EPA did not comment on DEQ's TAPs analysis in its comments to DEQ. Irrespective of what EPA told the Forest Service, if it believed that DEQ's TAPs analysis was somehow deficient, EPA should have addressed this issue with DEQ. Finally, nothing in EPA's comments to the Forest Service suggest that DEQ failed to comply with the Idaho Air Rules.

As described in the Statement of Basis, the TAP Addendum Modeling Review Attachment, and the TAP Addendum, DEQ used a conservative approach to evaluate arsenic emissions that ensured public health and the environment would be adequately protected. This approach is entirely consistent with the Idaho Air Rules and well within DEQ's discretion. Petitioners have not demonstrated that DEQ acted contrary to the Idaho Air Rules or abused its discretion, and their claim should be dismissed.

CONCLUSION

The Board should deny Petitioners' motion for summary judgment and instead grant Perpetua's motion for summary judgment as a matter of law.

DATED: May 12, 2023.

STOEL RIVES LLP

/s/ *W. Christopher Pooser*
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

CERTIFICATE OF SERVICE

I hereby certify that on this 12th day of May 2023, a true and correct copy of the foregoing was served on the following:

Dylan B. Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

/s/ *W. Christopher Pooser*
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 _____ NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	Case Docket No. 0101-22-01 **DECLARATION OF W. CHRISTOPHER POOSER IN SUPPORT OF INTERVENOR-RESPONDENT'S MOTION FOR SUMMARY JUDGMENT**

I, W. CHRISTOPHER POOSER, declare as follows:

1. I am a partner at Stoel Rives LLP and an attorney of record for Intervenor-Respondent Perpetua Resources Idaho, Inc. ("Perpetua") in the above-entitled matter. As such, I have personal knowledge of the facts and statements contained in this Declaration. I submit this

Declaration in support of Intervenor-Respondent's Motion for Summary Judgment and in opposition to Petitioner's Motion for Summary Judgment.

2. Exhibit 1 (PRI 1) is a true and correct copy of EPA letter, dated December 19, 1980, on the agency's definition of "ambient air." The letter is available on the EPA's website at https://www.epa.gov/sites/default/files/2019-11/documents/1980_costle_letter_ambient_air.pdf.

3. Exhibits 2 through 14 are true and correct copies of the following documents, which were produced by the Department of Environmental Quality during discovery in this matter.

Doc. No.	Bates No.	Document Description
2	PRI 2- 9	Technical Memorandum, Unpaved Road Dusts Control Efficiency from Chemical Suppressants (Jan. 12, 2018)
3	PRI 10-11	Email re Ambient Air Question (Oct. 5, 2018)
4	PRI 12-155	2014 SGP Meteorological Data[1]
5	PRI 156-157	Email re Excluding roadways from consideration as ambient air (Mar. 27, 2020)
6	PRI 158-159	Email re SGP – ambient air determination? (Mar. 31, 2020)
7	PRI 160-580	Stibnite Gold Project Permit to Construct Application (June 23, 2020)
8	PRI 581-806	Stibnite Gold Project Permit to Construct Application, TAP Addendum (Oct. 5, 2021)
9	PRI 807- 811	Email re DEQ contacts (Feb. 2, 2022)
10	PRI 812-816	Email re DEQ Contacts (Feb. 23, 2022)
11	PRI 817	Email re NPT and Midas (Sept. 11, 2020)
12	PRI 818-969	Stibnite Gold Project, Air Quality Analysis Addendum (July 13, 2021)
13	PRI 970-974	Email re Public Records Request #221273—ambient air quality monitoring and air permitting documents (July 12, 2022)
14	PRI 975-976	Email re IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 - Motion to Dismiss [SRACTIVE. FID4433167] (Sept. 11, 2022)

[1] For ease of access, Perpetua is producing a PDF of the spreadsheet containing the 2014 meteorological data. Perpetua has also attached the native file to the email transmitting this declaration.

I declare under penalty of perjury under the laws of the state of Idaho that the foregoing is true and correct.

DATED: May 12, 2023.

/s/ *W. Christopher Pooser*
W. Christopher Pooser

CERTIFICATE OF SERVICE

I hereby certify that on this 12th day of May 2023, a true and correct copy of the foregoing was served on the following:

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

/s/ *W. Christopher Pooser*
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

DEC 19 1980

Honorable Jennings Randolph
Chairman, Committee on Environment
and Public Works
United States Senate
Washington, D.C. 20510

Dear Mr. Chairman:

Thank you for your letter of October 23, 1980 expressing your continued interest in the Agency's definition of "ambient air." During the time Since David Hawkins, my Assistant Administrator of Air, Noise, and Radiation, met with you last February, the definition has been extensively reviewed and debated.

After reviewing the issues and alternatives, I have determined that no change from the existing policy is necessary. We are retaining the policy that the exemption from ambient air is available only for the atmosphere over land owned or controlled by the source and to which public access is precluded by a fence or other physical barriers. EPA will continue to review individual situations on a case-by-case basis to ensure that the public is adequately protected and that there is no attempt by sources to circumvent the requirement of Section 123 of the Clean Air Act.

I hope that this has been responsive to your needs,

Sincerely yours,

/s/ Douglas M. Costle

Douglas M. Costle

AIR SCIENCES INC.
DENVER • PORTLAND • LOS ANGELES

TECHNICAL MEMORANDUM

UNPAVED ROAD DUST CONTROL EFFICIENCY FROM CHEMICAL SUPPRESSANTS

PREPARED FOR: Dale Kerner, Midas Gold Idaho, Inc.

PREPARED BY: Kevin Lewis, Air Sciences Inc.

PROJECT NO.: 335-1-1

DATE: January 12, 2018

This memorandum summarizes the review conducted by Air Sciences Inc. (Air Sciences) of AP-42, Section 13.2.2, Unpaved Roads (EPA 2006), with regard to the level of dust control afforded by the application of chemical dust suppressants to unpaved industrial roads. The review includes an examination of all the test studies referenced in Section 13.2.2 that include data pertaining to chemical dust suppressants.

The review concludes that the Section 13.2.2 test studies support the use of a 90 percent or greater control efficiency in estimating dust generation from unpaved roads where chemical dust suppressants will be applied. A summary of the Section 13.2.2 test studies is provided in Table 1. As shown by this table, the dust control efficiency from chemical dust suppressants ranges from 82 to 97 percent (average of 91 percent) for total suspended particulate (TSP), and 90 to 99 percent (average of 94 percent) for PM_{10}.

Several of the Section 13.2.2 test studies reported that the control efficiency of chemical dust suppressant application decreases with time, the number of vehicle passes, road maintenance, and/or weather conditions. Therefore, a Fugitive Dust Control Plan (FDCP) is recommended to maintain a dust control efficiency of 90 percent or greater from the periodic application of chemical dust suppressants.

PRI00000002

REC 1342

Table 1. Control Efficiencies from Chemical Dust Suppressant Application to Unpaved Roads

Study	TSP Control Efficiency	PM_{10} Control Efficiency	Comments
MRI and RTI 2005	87%	90%	The performance of a dust suppressant product on unpaved roads was evaluated over a one-year period based on tests conducted by Research Triangle Institute International (RTII) and the Midwest Research Institute (MRI). The report was verified by the Environmental Protection Agency's (EPA's) Environmental Technology Verification Program. The control efficiencies provided here are from the Maricopa County (MC) location test.[1]
CARB 2000	ND[2]	92%	A dust suppressant product composed of petroleum resins, water, emulsifiers, surfactants, and vacuum residuum was evaluated by the California Air Resources Board (CARB). The evaluation was based on tests conducted by MRI at 11, 12, 26, and 28 days after the second application of the dust suppressant on an unpaved road. The initial control efficiency was 99 percent, which dropped to 85 percent after 28 days and 7,000 vehicle passes (average of 92 percent).
DRI 1996	ND	99%	The petroleum emulsion and polymer mixture chemical dust suppressants studied by the Desert Research Institute (DRI) showed a control efficiency of 99 percent four to ten days after application on unpaved roads/shoulders.
		94%	The polymer emulsions chemical dust suppressants studied by DRI showed a control efficiency of 94 percent four to ten days after application on unpaved roads/shoulders.

[1] See Table 3, page iv of the verification statement (MRI and RTII 2005) for the MC location test results. The Fort Leonard Wood (FLW) location test results in this table (MRI and RTII 2005) were biased low by rain events.

[2] ND = No Data

Table 1. Control Efficiencies from Chemical Dust Suppressant Application to Unpaved Roads

Study	TSP Control Efficiency	PM_{10} Control Efficiency	Comments
		92%	The non-hazardous crude-oil-containing materials (NHCOCM) chemical dust suppressants studied by DRI showed a control efficiency of 92 percent eight months after application on unpaved roads/shoulders.[3]
EPA 1987	90%	93%	The calcium chloride ($CaCl_2$) chemical dust suppressants studied by MRI showed an average control efficiency of 90 percent for TSP and 93 percent for PM_{10} on unpaved roads across the two sites tested. The study reported that without chemical reapplication, the control efficiency would decrease over time.
	85%	90%	The petroleum resins, an emulsified asphalt, and an acrylic adhesive chemical dust suppressants studied by MRI showed an average control efficiency of 85 percent for TSP and 90 percent for PM_{10} on unpaved roads across the two sites tested. The study reported that without chemical reapplication, the control efficiency decreased over time.
MRI 1983a	94%	97%	This MRI study measured the long-term control effectiveness of petroleum resin application on unpaved roads. The control efficiencies shown here represent the test data after reapplication. The control efficiency after initial application was lower. The study reported that without chemical reapplication, the control efficiency decreased over time and with vehicle passes.
	82%	93%	This MRI study measured the long-term control effectiveness of emulsified asphalt application on unpaved roads. The study reported that without chemical reapplication, the control efficiency decreased over time and with vehicle passes.

[3] The fourth chemical studied was a biocatalyst product. This chemical was shown to be "ineffective in reducing PM_{10} emissions" (DRI 1996). Test results for this product showed a negative control efficiency after initial product application (for one of the six tests) and a negative control efficiency three to eleven months after product application (for all tests averaged) (DRI 1996).

PRI00000004

REC 1344

Table 1. Control Efficiencies from Chemical Dust Suppressant Application to Unpaved Roads

Study	TSP Control Efficiency	PM_{10} Control Efficiency	Comments
MRI 1983b	96% – 97%	95%	Control efficiencies for this MRI study were measured after the application of petroleum resins on unpaved roads. The study reported that without chemical reapplication, the control efficiency would decrease over time and with vehicle passes.
PEDCo and MRI 1981	95%	95%	This study by PEDCo Environmental, Inc. (PEDCo) and MRI indicated that 95 percent control efficiency was attained after three months following the application of $CaCl_2$ and subsequent watering on an unpaved access road.
EPA 1979	97%	ND	For this EPA report, initial control efficiency after application of petroleum resins on unpaved roads was 97 percent for TSP, which decreased with vehicle passes.
MRI 1979	88%	ND	Three tests of the application of lignin sulfate on unpaved roads showed TSP control efficiencies of 83 percent, 89 percent, and 91 percent (average of 88 percent).
Average	**91%**	**94%**	Average of all studies.

EPA AP-42, Section 13.2.2

The most commonly used resource in the United States for estimating uncontrolled particulate emissions from unpaved industrial roads is AP-42, Section 13.2.2, Unpaved Roads (EPA 2006). This document provides an equation (Equation 1a) for calculating uncontrolled particulate emissions (all size fractions) from unpaved industrial roads, such as haul roads at a mine site, based on site-specific conditions. This document also provides some general, but limited, information on control efficiency values, which can be applied to the uncontrolled particulate emissions equation to estimate the reduction in particulate emissions when utilizing chemical dust suppressants or water to manage road dust. For chemical dust suppressants, Section 13.2.2 provides the following general information:

1. "The control effectiveness of chemical dust suppressants appears to depend on (a) the dilution rate used in the mixture; (b) the application rate (volume of solution per unit road surface area); (c) the time between applications; (d) the size, speed and amount of

traffic during the period between applications; and (e) meteorological conditions (rainfall, freeze/thaw cycles, etc.) during the period. Other factors that affect the performance of dust suppressants include other traffic characteristics (e. g., cornering, track-on from unpaved areas) and road characteristics (e. g., bearing strength, grade). The variabilities in the above factors and differences between individual dust control products make the control efficiencies of chemical dust suppressants difficult to estimate. Past field testing of emissions from controlled unpaved roads has shown that chemical dust suppressants provide a PM-10 control efficiency of ***about*** *[Emphasis added]* 80 percent when applied at regular intervals of 2 weeks to 1 month" (EPA 2006).

2. Figure 13.2.2-5 shows maximum control efficiencies for total particulate and PM_{10} of 81 percent and 90 percent, respectively, from the application of petroleum resins (EPA 2006).

With regard to Item 1 above, in which EPA states a control efficiency of "about 80 percent," EPA does not provide a reference for this value or the chemical type. Nonetheless, the test studies referenced in Section 13.2.2[4] demonstrate that control efficiencies of greater than 90 percent are achievable.

With regard to Item 2 above, the document referenced for Figure 13.2.2-5 is the 1987 report prepared by MRI for the EPA (EPA 1987). As shown in Table 1 for EPA 1987, the control efficiencies provided in this study are 85 to 90 percent for TSP and 90 to 93 percent for PM_{10}. It appears that Figure 13.2.2-5 generally depicts a conservative graphical representation of the underlining empirical data.

In summary, the limited general information on control efficiency provided in Section 13.2.2 appears to be an overly conservative low approximation of the control effectiveness afforded by chemical dust suppressant application. An examination of the Section 13.2.2 test studies summarized in Table 1 shows that the control efficiency range for chemical dust suppressants is 82 to 97 percent (average of 91 percent) for TSP, and 90 to 99 percent (average of 94 percent) for PM_{10}.

Third-Party Expert Review

Greg Muleski of SACI LLC has reviewed Air Sciences' analysis of chemical dust suppressant control efficiency. Mr. Muleski's review concluded the following:

[4] The Section 13.2.2 test studies are summarized in Table 1.

PRI00000006

REC 1346

> *I agree with the assertion that "... studies support a 90 percent or greater control efficiency for chemical dust suppressants."* (SACI 2015)[5]

Mr. Muleski has conducted over a 1,000 fugitive dust tests during his years at MRIGlobal. He conducted the field programs in the early 1980s through the early 2000s to characterize controlled and uncontrolled particulate emissions from unpaved industrial roads, which were used by EPA to develop AP-42, Section 13.2.2.

Recommendation

Based on the AP-42, Section 13.2.2 test studies described above, Air Sciences recommends the following approach for estimating particulate emissions from unpaved industrial roads that are controlled by the periodic application of chemical dust suppressants in accordance with a site-specific FDCP:

1. Use AP-42, Section 13.2.2, Equation 1a to estimate uncontrolled particulate emissions.

2. Use a control factor of 90 to 95 percent to estimate controlled particulate emissions from the application of chemical dust suppressants.

3. The application of water to supplement chemical dust suppressants will provide additional dust control. Although this memorandum does not provide a numerical value for the increased control level, using a control factor of 90 to 95 percent for the periodic application of both water and chemical dust suppressants is conservative (i.e., potentially overestimating dust emissions).

References

CARB. 2000. Equipment and Process Precertification Program: Evaluation of the Air Quality Performance Claims for Pennzoil-Quaker State Company PennzSuppress D® Dust Suppressant. Prepared by the California Environmental Protection Agency's Air Resources Board. August. Accessed December 29, 2017. http://www.arb.ca.gov/eqpr/pennzoil/pennzEvalRpt.PDF.

DRI. 1996. Effectiveness Demonstration of Fugitive Dust Control Methods for Public Unpaved Roads and Unpaved Shoulders on Paved Roads – Final Report. DRI Document No. 685-5200.1F1. Prepared by Dr. John G. Watson, et al. of the Desert Research Institute for the California Regional Particulate Air Quality Study. December 31. Accessed December 29, 2017. http://www.arb.ca.gov/airways/Documents/reports/dri_dustcontrol.pdf.

[5] Mr. Muleski's review in 2015 was of the longer and more detailed version of this memorandum written for another client in 2015. The information provided in this memorandum is abridged, but identical.

EPA. 1979. Iron and Steel Plant Open Source Fugitive Emission Evaluation. EPA-600/2-79-103. Prepared by Chatten Cowherd, Jr., Russell Bohn, and Thomas Cuscino, Jr. of the Midwest Research Institute for the U. S. Environmental Protection Agency's Industrial Environmental Research Laboratory, Washington, DC. May. Accessed December 29, 2017. http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=20015HM8.TXT.

EPA. 1987. Evaluation of the Effectiveness of Chemical Dust Suppressants on Unpaved Roads. EPA-600/2-87-102. Prepared by Gregory E. Muleski and Chatten Cowherd, Jr. of the Midwest Research Institute for the U. S. Environmental Protection Agency's Office of Research and Development, Washington, DC. November. Accessed December 29, 2017. Hyperlink to Project Summary of reference (see page 3 for details to order complete report).

EPA. 2006. AP-42, Fifth Edition, Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, Section 13.2.2, Unpaved Roads. November. Accessed December 29, 2017. http://www.epa.gov/ttn/chief/ap42/ch13/final/c13s0202.pdf.

MRI. 1979. Taconite Mining Fugitive Emissions Study – Final Report. MRI Project No. 4523-L(1). Prepared by Thomas Cuscino, Jr. of the Midwest Research Institute for the Minnesota Pollution Control Agency, Division of Air Quality, Roseville, MN. June 7.

MRI. 1983a. Extended Evaluation of Unpaved Road Dust Suppressants in the Iron and Steel Industry. EPA Contract No. 68-02-3177. Prepared by Gregory E. Muleski, Thomas Cuscino, Jr., and Chatten Cowherd, Jr. of the Midwest Research Institute for the U S. Environmental Protection Agency's Industrial Environmental Research Laboratory. October 7. Accessed December 29, 2017. Hyperlink to Project Summary of reference (see page 4 for details to order complete report).

MRI. 1983b. Iron and Steel Plant Open Source Fugitive Emission Control Evaluation – Final Report. EPA Contract No. 68-02-3177, Assignment No. 4. MRI Project No. 4862-L(4). Prepared by Thomas Cuscino, Jr., Gregory E. Muleski, and Chatten Cowherd, Jr. of the Midwest Research Institute for the U. S. Environmental Protection Agency, Industrial Environmental Research Laboratory, Research Triangle Park, NC. August 31.

MRI and RTII. 2005. Environmental Technology Verification Report, Dust Suppressant Products, Midwest Industrial Supply, Inc.'s EK35. Complete report prepared by MRI and RTI International under a Cooperative Agreement with the U. S. Environmental Protection Agency. September. (Joint Verification Statement for the complete report prepared by the Environmental Technology Verification [ETV] Program. EPA/600/R-05/128. January 2006.) Accessed December 29, 2017. http://nepis.epa.gov/Adobe/PDF/P1001GVV.pdf.

PEDCo and MRI. 1981. Improved Emission Factors for Fugitive Dust from Western Surface Coal Mining Sources, Volume II – Emission Factors. Contract No. 68-03-2924. Prepared by Kenneth Axetell, Jr. of PEDCo Environmental, Inc. and Chatten Cowherd, Jr. of the Midwest Research Institute for the Environmental Protection Agency. November.

Accessed December 29, 2017. Hyperlink to Project Summary of reference (see page 7 for details to order complete report).

SACI. 2015. Prepared by Greg Muleski (SACI). Technical Memorandum – Control of Unpaved Road Dust using Chemical Suppressants. May 4.

To: Kevin Schilling[Kevin.Schilling@deq.idaho.gov]
Cc: Bray, Dave[Bray.Dave@epa.gov]
From: McAlpine, Jerrold[McAlpine.Jay@epa.gov]
Sent: Fri 10/5/2018 1:24:50 PM (UTC-06:00)
Subject: RE: Ambient Air question

Kevin, a quick update … I am continuing the investigation and hope to hear back from OAQPS soon:

I have not heard back from OAQPS yet, but have had brief discussion with Dave Bray here at R10. This is our understanding so far, but we need to confirm these points with OAQPS: If public access occurs at any time at a location, then it is considered ambient air all the time. Therefore, ambient air receptors must be modeled all hours of the year – the modeler cannot turn off receptors in periods when public access is not allowed.

Regarding State minor programs though, I assume the Federal definition of ambient air applies to all approved SIP minor air permitting programs also, but may be wrong. I'll discuss this element with Dave (cc'd).

Note, I have more specific questions regarding the Midas Stibnite project included in my request to OAQPS. Region 10 believes the following applies, but we need to confirm these with the policy division:

a. If the public access road is only accessible to public traveling in automobiles under the escort, supervision, and monitoring of Midas personnel (they mentioned a pilot car as a possibility), and there are no stopping points with public access along the road, then the road is not ambient air.
b. If the public is not under the supervision and monitoring of Midas while accessing the road then the road is ambient air. Also, if the road is not entirely fenced or access precluded by another method, then the entire unfenced/un-precluded Midas property may possibly be considered ambient air.

Thank you,
Jay

Jay McAlpine, PhD
Atmospheric Scientist, Regional Modeling Contact
Office of Air and Waste
U.S. Environmental Protection Agency, Region 10
1200 Sixth Avenue, Suite 155, OAW-150
Seattle, WA 98101
206.553.0094
McAlpine.Jay@epa.gov

From: Kevin.Schilling@deq.idaho.gov [mailto:Kevin.Schilling@deq.idaho.gov]
Sent: Thursday, October 04, 2018 8:10 AM
To: McAlpine, Jerrold <McAlpine.Jay@epa.gov>
Subject: RE: Ambient Air question

Thank you very much Jay. I know my question mainly regards minor source permitting, but I really don't see why there should be a difference between minor source permitting and PSD in this instance - there are no differences in applicable rules or definitions in the rules.

From: McAlpine, Jerrold [McAlpine.Jay@epa.gov]
Sent: Thursday, October 04, 2018 9:06 AM
To: Kevin Schilling
Subject: RE: Ambient Air question

Kevin,

I'll be forwarding this question on to EPA air policy and will respond as soon as I hear back.

Jay

Jay McAlpine, PhD
Atmospheric Scientist, Regional Modeling Contact
Office of Air and Waste
U.S. Environmental Protection Agency, Region 10
1200 Sixth Avenue, Suite 155, OAW-150
Seattle, WA 98101
206.553.0094
McAlpine.Jay@epa.gov

From: Kevin.Schilling@deq.idaho.gov [mailto:Kevin.Schilling@deq.idaho.gov]
Sent: Wednesday, October 03, 2018 3:50 PM
To: McAlpine, Jerrold <McAlpine.Jay@epa.gov>
Subject: Ambient Air question

Good afternoon Jay,

I have another question I would appreciate your thoughts on. I am somewhat unsure of some fine points on how to treat ambient air with regard to areas that only have infrequent periods of public access. In the past, for minor source permitting, DEQ would allow applicants to exclude time periods during which public access was precluded. In other words, if public access was only allowed during the day, then we would exclude night-time hours from the analyses. Is this practice acceptable? Are there any examples where this has been addressed? Also, if this practice isn't acceptable for PSD applications, do you see EPA having an issue with Idaho using it for minor source permitting? Would a better approach be to consider the access as controlled site visitation (not ambient air at all) rather than public access?

Thank you,

Kevin Schilling
Stationary Source Air Modeling Coordinator
Idaho Department of Environmental Quality
208 373-0112

2014	1	1	1	-7.4	-6.6	0	92.9	0	0.89	250.3	0.73	8003.3
2014	1	1	2	-9	-8.1	0	95.7	0	1.53	234.6	0.83	8008.7
2014	1	1	3	-9.9	-8.8	0	93.1	0	1.26	245.3	1.08	8010
2014	1	1	4	-11.3	-10.1	0	94.3	0	1.83	234.1	1.13	8015.3
2014	1	1	5	-11.6	-10.7	0	93.2	0	1.58	244.3	0.92	8020.7
2014	1	1	6	-12.4	-11.2	0	90.7	0	1.44	241.7	1.24	8022
2014	1	1	7	-13.2	-11.9	0	91.2	0	1.95	237	1.27	8024.7
2014	1	1	8	-13.3	-11.9	0	92.8	0	1.7	237.1	1.4	8026
2014	1	1	9	-13.1	-11.8	0	91	0	1.68	232.3	1.25	8027.3
2014	1	1	10	-13	-11.7	9.4	91.8	0	1.75	237.6	1.28	8028.7
2014	1	1	11	-12.1	-10.9	36.1	92.2	0	1.19	245	1.22	8034
2014	1	1	12	-10.8	-9.3	149.9	79.3	0	1.14	239.1	1.47	8039.3
2014	1	1	13	-7.5	-6.5	293.6	55.2	0	0.28	203.7	1.07	8040.7
2014	1	1	14	-5.4	-5.1	343.4	73	0.02	0.5	96.3	0.35	8034
2014	1	1	15	-4.4	-4.3	335.1	64.2	0.04	2.18	82.5	0.07	8028.7
2014	1	1	16	-2.6	-2.6	308.6	49	0.04	0.53	96.5	0.04	8024.7
2014	1	1	17	-3.2	-2.6	175.4	71.7	0.02	0.7	226.1	0.6	8024.7
2014	1	1	18	-5.3	-4.2	58.1	81.1	0	1.78	237.7	1.11	8024.7
2014	1	1	19	-6.9	-5.9	1.4	87.5	0	2.01	234.3	0.99	8026
2014	1	1	20	-8.5	-7.3	0	88	0	1.97	239.3	1.13	8027.3
2014	1	1	21	-8.9	-7.7	0	89.5	0	1.74	238.8	1.24	8027.3
2014	1	1	22	-8.7	-7.7	0	89.3	0	1.64	238.5	1.02	8028.7
2014	1	1	23	-9.1	-8	0	92.8	0	1.57	235.4	1.09	8028.7
2014	1	1	24	-9.1	-7.8	0	93.2	0	1.4	238	1.26	8030
2014	1	2	1	-8.9	-7.7	0	90	0	1.29	234.2	1.16	8031.3
2014	1	2	2	-8.7	-7.8	0	89.4	0	1.1	239.7	0.93	8030
2014	1	2	3	-9.1	-7.7	0	96.5	0	1.2	236.5	1.41	8027.3
2014	1	2	4	-8.6	-7.8	0	88.8	0	1.25	241.1	0.89	8024.7
2014	1	2	5	-9.2	-8.2	0	88.3	0	1.3	236.1	1.06	8027.3
2014	1	2	6	-8.6	-7.6	0	90.2	0	0.93	251.3	0.92	8024.7
2014	1	2	7	-8.2	-7.2	0	85.8	0	1.4	236.1	1.05	8024.7
2014	1	2	8	-8.8	-7.9	0	90.8	0	1.21	245.5	0.89	8018
2014	1	2	9	-10.2	-8.8	0	86.5	0	1.53	240.6	1.38	8016.7
2014	1	2	10	-10	-8.8	6.1	89.2	0	1.37	242.1	1.17	8015.3
2014	1	2	11	-10.1	-8.9	19.6	84.9	0	1.6	236.5	1.15	8016.7
2014	1	2	12	-8.4	-7.1	170.4	69	0	0.8	233.9	1.39	8018
2014	1	2	13	-5	-4.4	350.6	52.5	0	0.56	144.5	0.65	8018
2014	1	2	14	-2.3	-2.2	402.5	51.2	0	0.9	87.2	0.12	8014
2014	1	2	15	-0.8	-0.8	337.5	54.2	0	0.45	89.7	0.02	8004.7
2014	1	2	16	-0.1	0.1	307.1	67.8	0.01	1.56	92.2	0.23	7996.7
2014	1	2	17	0.2	0.5	193.5	64.2	0.01	0.95	93.9	0.27	7992.7
2014	1	2	18	-1.3	-0.6	65.6	78.4	0	0.97	230.6	0.7	7990
2014	1	2	19	-1.8	-0.9	2.3	81.9	0	0.95	247.8	0.88	7988.7
2014	1	2	20	-2.4	-1.6	0	81	0	1.18	237.1	0.88	7986
2014	1	2	21	-2.6	-1.9	0	83.6	0	0.97	243.4	0.73	7982
2014	1	2	22	-2.4	-1.7	0	85.5	0	1.28	54.8	0.66	7975.3
2014	1	2	23	-1.7	-0.4	0	89.6	0	1.56	226.3	1.37	7970
2014	1	2	24	-1.9	-1.1	0	77.4	0	1.11	51.5	0.71	7963.3
2014	1	3	1	-1.7	-1	0	74.4	0	1.05	130.2	0.72	7954
2014	1	3	2	2	2.1	0	65.8	0	6.35	228.7	0.16	7948.7
2014	1	3	3	1.8	1.9	0	64.8	0	7.25	230	0.09	7934
2014	1	3	4	2.1	2.1	0	61.1	0	5.83	208	0	7930
2014	1	3	5	2.4	2.4	0	71.1	0	3.72	217.6	-0.01	7920.7
2014	1	3	6	2	1.9	0	78.6	0	5.22	199.9	-0.07	7915.4
2014	1	3	7	0.9	0.9	0	75	0	2.81	239.8	-0.05	7899.4
2014	1	3	8	0.8	0.7	0	80.5	0	2.31	231.2	-0.05	7898
2014	1	3	9	0.4	0.3	0	73.3	0	4.27	237.6	-0.05	7900.7
2014	1	3	10	0	0	12.4	66.5	0	5.96	236.7	-0.02	7899.4
2014	1	3	11	-0.7	-0.7	81.5	59.6	0	5.06	232.8	-0.01	7904.7
2014	1	3	12	-1.4	-1.3	193.4	42.3	0	4.71	224.3	0.11	7908.7
2014	1	3	13	-1.8	-1.7	380.9	37.3	0	6.51	221.5	0.05	7915.4

2014	1	3	14	-1.9	-2	424.9	36	0	5.33	214.7	-0.05	7906
2014	1	3	15	-2	-2	414.6	34.9	0	4.94	216.6	-0.02	7899.4
2014	1	3	16	-2.4	-2.4	281.1	38.9	0	3.16	182.8	0.02	7899.4
2014	1	3	17	-3.4	-3.3	62.2	41.4	0	4.11	209	0.1	7902
2014	1	3	18	-4.5	-4.3	13.1	47	0	2.42	223.5	0.18	7904.7
2014	1	3	19	-5.6	-5.3	2	37.2	0	1.8	238.3	0.36	7906
2014	1	3	20	-6.6	-6.1	0	40.3	0	3.34	230.4	0.52	7908.7
2014	1	3	21	-6.8	-6.6	0	49.5	0	1.24	304.1	0.22	7910
2014	1	3	22	-8.5	-8	0	55.7	0	0.74	211.2	0.46	7915.4
2014	1	3	23	-9.3	-8.9	0	64	0	1.3	272.8	0.48	7919.4
2014	1	3	24	-9.9	-9.3	0	65.6	0	1.08	232.7	0.65	7926
2014	1	4	1	-11.4	-10.6	0	68.8	0	1.4	239.2	0.79	7924.7
2014	1	4	2	-12.6	-11.7	0	72.5	0	1.31	245.9	0.89	7928.7
2014	1	4	3	-12.2	-11.5	0	74.8	0	0.8	254.2	0.71	7934
2014	1	4	4	-12	-11.4	0	80	0	0.71	8.2	0.62	7932.7
2014	1	4	5	-10.6	-10	0	72.8	0	0.64	272	0.61	7942
2014	1	4	6	-9.7	-9.2	0	68.5	0	1	42.1	0.43	7943.3
2014	1	4	7	-11.8	-11	0	75.9	0	1.61	238	0.79	7944.7
2014	1	4	8	-10.5	-10.1	0	69.9	0	1.16	244.4	0.46	7946
2014	1	4	9	-9.7	-9.4	0	66.4	0	0.85	55.9	0.3	7950
2014	1	4	10	-9.8	-9.7	9.4	60.9	0	1.82	178	0.13	7948.7
2014	1	4	11	-9.5	-9.5	42.4	62.9	0	4.52	226.6	-0.04	7954
2014	1	4	12	-9.5	-9.6	92.5	59	0	3.6	223.5	-0.09	7963.3
2014	1	4	13	-9.3	-9.5	149.2	59.4	0	2.09	194.3	-0.12	7971.3
2014	1	4	14	-9.4	-9.6	182.1	60	0	4.65	233.9	-0.13	7970
2014	1	4	15	-8.9	-9.1	458.2	49.4	0	5.22	226.5	-0.21	7971.3
2014	1	4	16	-8.8	-8.9	323.6	54.8	0	3.43	112.7	-0.13	7974
2014	1	4	17	-9.3	-9.3	189.7	52.9	0	3.05	86.9	-0.03	7978
2014	1	4	18	-9.4	-9.5	85.2	59	0	1.35	183.1	-0.05	7980.7
2014	1	4	19	-10.6	-10.5	3.2	66.8	0	0.58	252	0.19	7982
2014	1	4	20	-12.5	-12	0	72.3	0	0.89	234.8	0.53	7982
2014	1	4	21	-12	-11.5	0	70.2	0	1.46	251.4	0.45	7984.7
2014	1	4	22	-12.3	-11.9	0	74.1	0	0.56	271.9	0.46	7988.7
2014	1	4	23	-14.2	-13	0	79.7	0	0.85	253	1.21	7990
2014	1	4	24	-14.4	-13.4	0	76.9	0	0.58	258.6	1.04	7990
2014	1	5	1	-14.9	-13.7	0	73.5	0	1.06	242.7	1.21	7992.7
2014	1	5	2	-15.4	-14.1	0	79.2	0	1.23	235.7	1.27	7994
2014	1	5	3	-14.9	-13.5	0	77.7	0	0.72	242.9	1.43	7995.3
2014	1	5	4	-15.1	-13.2	0	80	0	1	247.9	1.89	7998
2014	1	5	5	-13.8	-11.8	0	65.4	0	1.17	254.5	1.97	7999.3
2014	1	5	6	-12.5	-10.7	0	67.2	0	1.17	249.9	1.77	8006
2014	1	5	7	-11.3	-10	0	59.7	0	1	267.3	1.3	8007.3
2014	1	5	8	-11.8	-10.4	0	64.9	0	1.42	251	1.48	8011.3
2014	1	5	9	-12.3	-10.8	0.1	67.5	0	1.22	242.5	1.52	8012.7
2014	1	5	10	-13.2	-11.3	6.5	68.8	0	1.8	240.7	1.85	8014
2014	1	5	11	-13.5	-11.6	20.5	68.1	0	2.33	235.8	1.9	8023.3
2014	1	5	12	-9.5	-8.4	191.5	27.6	0	2.28	156.7	1.02	8028.7
2014	1	5	13	-5.8	-5.7	385.5	22.1	0	3.86	94.7	0.05	8030
2014	1	5	14	-5	-5.1	428.9	21.6	0	3.9	90.6	-0.04	8030
2014	1	5	15	-4.5	-4.5	417.2	17.2	0	2.43	114.5	-0.04	8026
2014	1	5	16	-4.1	-4.1	351	17.1	0	1.88	114.3	0.04	8026
2014	1	5	17	-4.3	-4.2	230.5	20.2	0	2.66	215.1	0.12	8028.7
2014	1	5	18	-6.1	-5.3	53	28.5	0	2.64	240.6	0.8	8034
2014	1	5	19	-8.8	-8.2	3	39.5	0	1.14	229.8	0.59	8036.7
2014	1	5	20	-11.1	-10	0	49.2	0	1.13	240.7	1.16	8042
2014	1	5	21	-12.5	-11.3	0	52	0	1.46	241.4	1.16	8042
2014	1	5	22	-13.4	-12.2	0	52.9	0	1.8	237	1.19	8047.3
2014	1	5	23	-13.6	-12.3	0	53.7	0	1.62	238	1.28	8046
2014	1	5	24	-13.8	-12.8	0	52.8	0	1.68	237.6	0.95	8047.3
2014	1	6	1	-14.2	-12.8	0	56.3	0	1.8	236.8	1.33	8052.7
2014	1	6	2	-14.3	-13.2	0	57.9	0	1.02	245.6	1.08	8050

2014	1	6	3	-14.6	-13.2	0	59.6	0	1.78	233.3	1.34	8051.3
2014	1	6	4	-14.2	-13	0	52.3	0	1.54	236.6	1.17	8051.3
2014	1	6	5	-14.2	-12.9	0	63.2	0	1.1	236.1	1.28	8052.7
2014	1	6	6	-14.1	-12.8	0	69.5	0	1.54	234.7	1.33	8054
2014	1	6	7	-13.8	-12.5	0	74	0	1.34	241.4	1.31	8051.3
2014	1	6	8	-13.7	-12.5	0	71.4	0	0.93	240.9	1.19	8047.3
2014	1	6	9	-13.7	-12.3	0.1	80.9	0	1.66	235.3	1.45	8050
2014	1	6	10	-12.8	-11.6	6.8	83.6	0	1.64	235.5	1.24	8046
2014	1	6	11	-11.6	-10.4	71.4	80.7	0	1.1	242.6	1.18	8050
2014	1	6	12	-9.1	-8.2	196.5	62.6	0	0.91	235.7	0.86	8047.3
2014	1	6	13	-5.1	-4.9	386.4	39.1	0	0.5	111.4	0.23	8044.7
2014	1	6	14	-2.7	-2.5	405.4	42.2	0	0.37	147.5	0.18	8034
2014	1	6	15	-0.4	-0.1	357.8	35.8	0	0.39	104	0.24	8024.7
2014	1	6	16	1	1.1	282.1	42.9	0	0.77	82.1	0.07	8016.7
2014	1	6	17	1.6	1.6	178.9	47.7	0.01	0.6	75.2	0.02	8011.3
2014	1	6	18	-0.6	0.4	53	62.3	0	0.97	230.5	0.98	8010
2014	1	6	19	-2.1	-1.3	1.8	70.1	0	1.4	240.6	0.78	8006
2014	1	6	20	-2.8	-2	0	71.3	0	1.19	244.9	0.87	8000.7
2014	1	6	21	-3.8	-2.8	0	75.9	0	1.03	261.2	1.02	7998
2014	1	6	22	-4.2	-3.3	0	79.9	0	1.23	250.4	0.9	7995.3
2014	1	6	23	-5.6	-4.4	0	82.5	0	1.19	247.1	1.22	7990
2014	1	6	24	-6	-4.8	0	78.9	0	1.29	238.8	1.16	7984.7
2014	1	7	1	-6.3	-5.2	0	78	0	1.11	267.6	1.05	7980.7
2014	1	7	2	-6.6	-5.6	0	82.3	0	1.01	262.4	1.01	7976.7
2014	1	7	3	-5.9	-4.9	0	78.8	0	0.86	249.2	0.96	7974
2014	1	7	4	-6.1	-5	0	74.1	0	0.86	257.5	1	7971.3
2014	1	7	5	-5.7	-4.8	0	75.1	0	0.95	246.8	0.88	7975.3
2014	1	7	6	-5.7	-5.1	0	70.5	0	1.2	233.7	0.61	7974
2014	1	7	7	-5.8	-5.3	0	75.5	0	1.15	242.8	0.57	7972.7
2014	1	7	8	-5.8	-5.2	0	72.8	0	0.81	249.1	0.58	7966
2014	1	7	9	-6.4	-5.6	0	75.9	0	1.23	238.7	0.72	7966
2014	1	7	10	-6	-5.6	8.9	69.5	0	0.78	255.6	0.42	7964.7
2014	1	7	11	-5.6	-5.2	59.8	60	0	0.64	256.9	0.35	7968.7
2014	1	7	12	-4.2	-3.8	168.7	59	0	0.23	278	0.32	7970
2014	1	7	13	-2.9	-2.9	333.2	59.8	0	1.13	90.8	-0.01	7966
2014	1	7	14	-1.3	-1.3	375.8	51.4	0	1.94	77.9	-0.03	7958
2014	1	7	15	-0.3	-0.2	223.5	49.6	0	2.13	57.1	0.08	7950
2014	1	7	16	-0.1	-0.2	156.8	60.4	0	3.31	216.3	-0.02	7946
2014	1	7	17	-1.8	-1.9	74.6	74.6	0	2.48	245.1	-0.11	7952.7
2014	1	7	18	-2.3	-2.4	32.4	75.1	0	0.42	310.6	-0.08	7955.3
2014	1	7	19	-2.7	-2.5	1.5	77.6	0	0.91	233.2	0.11	7952.7
2014	1	7	20	-2.7	-2.7	0	76.6	0	0.64	247.6	0.04	7951.3
2014	1	7	21	-2.9	-2.8	0	79.2	0	0.78	51.8	0.05	7946
2014	1	7	22	-3.1	-3	0	80.6	0	0.44	71.1	0.02	7944.7
2014	1	7	23	-3.2	-3.2	0	81.1	0	0.38	45.8	0.02	7942
2014	1	7	24	-3.3	-3.2	0	81.7	0	0.45	240.3	0.1	7942
2014	1	8	1	-3.4	-3.4	0	85	0	0.6	47.4	-0.03	7942
2014	1	8	2	-3.9	-3.9	0	94.4	0	0.72	225.3	-0.04	7939.3
2014	1	8	3	-4.3	-4.3	0	95.9	0	0.59	229.8	0.06	7936.7
2014	1	8	4	-4.3	-4.3	0	96.4	0	0.2	251.4	0	7935.3
2014	1	8	5	-4.4	-4.4	0	97	0	0.41	286.2	0	7938
2014	1	8	6	-4.4	-4.4	0	97.4	0	0.64	21.2	0	7938
2014	1	8	7	-4.4	-4.3	0	97.5	0	0.49	243.9	0.12	7936.7
2014	1	8	8	-4.3	-4.2	0	97.6	0	0.6	239.5	0.13	7936.7
2014	1	8	9	-4.3	-4.2	0	97.4	0	0.42	259.4	0.14	7936.7
2014	1	8	10	-4.8	-4.6	3	94.8	0	1.1	235.5	0.24	7939.3
2014	1	8	11	-4.2	-4	21.1	93.4	0	1.05	237.1	0.2	7943.3
2014	1	8	12	-3.4	-3.4	42	90.6	0	0.82	215.8	0.07	7946
2014	1	8	13	-2.7	-2.7	65.5	85.9	0	1.21	69.8	0	7947.3
2014	1	8	14	-1.3	-1.4	95	72	0	3.38	230.2	-0.1	7940.7
2014	1	8	15	-1.2	-1.3	107.2	76.7	0	4.32	230.4	-0.1	7935.3

2014	1	8	16	-1.4	-1.5	115.6	74.7	0	2.33	225.1	-0.13	7932.7
2014	1	8	17	-1.1	-1.2	89.9	70.7	0	1.88	232.7	-0.1	7931.3
2014	1	8	18	-1.3	-1.3	26	79.1	0	2.66	236.5	-0.08	7928.7
2014	1	8	19	-1.7	-1.8	1	90	0	1.96	225.4	-0.04	7928.7
2014	1	8	20	-2	-2	0	81.5	0	3.42	240.6	-0.03	7926
2014	1	8	21	-1.5	-1.5	0	86.4	0	3.26	227.7	-0.04	7916.7
2014	1	8	22	-2.1	-2.1	0	93.7	0	0.87	283.6	-0.01	7911.4
2014	1	8	23	-1.7	-1.6	0	80.6	0	1.99	241.2	0.03	7908.7
2014	1	8	24	-1.1	-1.1	0	85.9	0	3.95	232.4	-0.02	7899.4
2014	1	9	1	-1.6	-1.6	0	91.5	0	3.24	233.7	-0.04	7894
2014	1	9	2	-1.7	-1.8	0	96.3	0	3.07	234.5	-0.06	7888.7
2014	1	9	3	-1.9	-2	0	95.5	0	1.8	262.7	-0.08	7879.4
2014	1	9	4	-2	-2	0	93.9	0.01	0.92	248	-0.06	7874
2014	1	9	5	-2.1	-2.2	0	97	0.02	2.62	246.6	-0.09	7871.4
2014	1	9	6	-2.8	-2.9	0	97.1	0.07	1.57	62.7	-0.1	7875.4
2014	1	9	7	-3	-3	0	95.5	0.02	0.57	27.4	-0.01	7870
2014	1	9	8	-3.3	-3.4	0	88.4	0.02	1.19	31.5	-0.09	7866
2014	1	9	9	-3.3	-3.3	0	74.4	0.01	4.84	232.8	0.03	7868.7
2014	1	9	10	-4.3	-4.2	3.9	77.5	0	2.84	250	0.07	7871.4
2014	1	9	11	-4.9	-4.9	21.3	71.2	0	1.93	157	0	7884.7
2014	1	9	12	-4.8	-4.8	47.9	77.4	0	4.65	224.7	-0.04	7894
2014	1	9	13	-5.7	-5.8	67.1	80.8	0.01	4.52	226.3	-0.11	7900.7
2014	1	9	14	-4.9	-5.1	319.6	69.1	0.03	4.43	217.6	-0.12	7902
2014	1	9	15	-5.3	-5.2	156.5	67	0	4.84	217.1	0.07	7899.4
2014	1	9	16	-5	-5	146.7	61.1	0	3.95	217.7	0.01	7899.4
2014	1	9	17	-5.3	-5.4	79.9	76.5	0	3.1	232.7	-0.08	7902
2014	1	9	18	-5.7	-5.7	34.8	73.3	0	3.14	241.9	-0.06	7906
2014	1	9	19	-5.9	-6	1	77.2	0	2.17	261.5	-0.06	7911.4
2014	1	9	20	-6.5	-6.6	0	88.2	0	1.8	243.6	-0.06	7911.4
2014	1	9	21	-7	-6.9	0	80.2	0	1.04	37.9	0.06	7908.7
2014	1	9	22	-7	-6.9	0	78.9	0	1.74	230.4	0.06	7906
2014	1	9	23	-6.1	-6.2	0	81.1	0	4.07	228.8	-0.06	7900.7
2014	1	9	24	-5.8	-5.8	0	81.4	0	2.42	198.4	-0.07	7898
2014	1	10	1	-5.5	-5.6	0	82.5	0	6.13	225.2	-0.09	7895.4
2014	1	10	2	-5.3	-5.4	0	85.6	0	5.5	231.6	-0.09	7888.7
2014	1	10	3	-4.9	-5	0	87.5	0	4.92	242.8	-0.11	7884.7
2014	1	10	4	-4	-4.1	0	85.3	0	7.81	239	-0.09	7882
2014	1	10	5	-3.2	-3.3	0	82.9	0	3.92	247.5	-0.12	7880.7
2014	1	10	6	-2.7	-2.9	0	81.3	0	2.15	283.5	-0.12	7886
2014	1	10	7	-2.6	-2.7	0	79.5	0.01	2.19	243.8	-0.11	7890
2014	1	10	8	-2.6	-2.7	0	79.6	0	1.72	242.8	-0.1	7891.4
2014	1	10	9	-2.5	-2.6	0	73.9	0	1.91	252.6	-0.07	7898
2014	1	10	10	-2.5	-2.6	10.1	73.6	0	2.05	218.8	-0.05	7900.7
2014	1	10	11	-2.4	-2.5	60.6	72.3	0	2.01	224.8	-0.06	7908.7
2014	1	10	12	-2.3	-2.3	96.7	75	0.01	1.93	190.8	-0.06	7919.4
2014	1	10	13	-2	-2.1	120.6	73.5	0	3.71	219.7	-0.11	7924.7
2014	1	10	14	-1.9	-2	143.7	71	0.01	5.25	222.2	-0.09	7927.3
2014	1	10	15	-1.9	-2	155.6	78.6	0.01	5.23	221.1	-0.11	7927.3
2014	1	10	16	-2.1	-2.3	107.5	78.3	0	3.94	225.8	-0.12	7927.3
2014	1	10	17	-2	-2.1	83.4	79.6	0	4.59	231	-0.11	7931.3
2014	1	10	18	-2.6	-2.7	35.4	89.2	0	2.36	235.4	-0.09	7939.3
2014	1	10	19	-3.1	-3.2	1.3	95.2	0	1.15	45.9	-0.04	7942
2014	1	10	20	-3.3	-3.3	0	85.7	0.01	2.11	63.5	0	7943.3
2014	1	10	21	-2.7	-2.7	0	82.9	0	2.4	256.4	0	7943.3
2014	1	10	22	-2.6	-2.6	0	84.4	0	1.46	48.5	-0.01	7944.7
2014	1	10	23	-2.6	-2.7	0	92.8	0	1.44	35.9	-0.03	7944.7
2014	1	10	24	-3	-2.9	0	97.3	0	1.72	49.5	0.11	7947.3
2014	1	11	1	-3.6	-3.7	0	98.2	0	2.4	71.2	-0.11	7943.3
2014	1	11	2	-3.4	-3.5	0	98.5	0	2.69	79.3	-0.1	7940.7
2014	1	11	3	-3.3	-3.4	0	98.4	0.01	0.98	64.5	-0.1	7939.3
2014	1	11	4	-3.1	-3	0	98.8	0.02	0.87	51.2	0.12	7932.7

2014	1	11	5	-2.4	-2.1	0	99.2	0.04	0.47	326.7	0.31	7931.3
2014	1	11	6	-1	-0.9	0	97.2	0.03	1.15	271.5	0.09	7926
2014	1	11	7	-0.2	-0.1	0	99.4	0.03	1.08	276	0.05	7920.7
2014	1	11	8	0.7	0.7	0	88.1	0.02	2.08	261.9	0	7914
2014	1	11	9	2.2	2.2	0	83.2	0.02	7.31	215.6	-0.03	7898
2014	1	11	10	2.3	2.3	4.5	87.6	0.03	7.31	223.2	-0.02	7884.7
2014	1	11	11	2.3	2.3	17.1	87	0.04	6.72	235.1	-0.03	7872.7
2014	1	11	12	2	1.9	23.6	91.2	0.05	6.25	220.1	-0.06	7866
2014	1	11	13	1.8	1.7	28.9	90	0.03	7.88	218.2	-0.08	7863.4
2014	1	11	14	1	0.9	26.9	95.4	0.02	5.77	208	-0.11	7848.7
2014	1	11	15	1.3	1.2	62	83.8	0.02	5.42	210.1	-0.08	7844.7
2014	1	11	16	1.2	1.1	66.1	76.6	0.01	6.32	221.5	-0.04	7830
2014	1	11	17	1	1	57.3	76.7	0.01	7.71	227.2	0.02	7830
2014	1	11	18	0.3	0.3	26.9	66	0.01	4.82	246.3	0	7831.4
2014	1	11	19	-0.8	-0.7	3.5	74.2	0	5.01	231.1	0.04	7839.4
2014	1	11	20	-2.3	-2.4	0	80.3	0	4.73	217.2	-0.05	7838
2014	1	11	21	-2.4	-2.4	0	70.8	0.01	4.49	215	-0.07	7839.4
2014	1	11	22	-2.4	-2.4	0	71.6	0	3.21	237.9	-0.04	7839.4
2014	1	11	23	-2.8	-2.8	0	84.1	0	5.82	226.2	-0.03	7834
2014	1	11	24	-3.6	-3.6	0	78.3	0	5.94	226.2	-0.07	7832.7
2014	1	12	1	-3.9	-4	0	84.1	0	6.38	228.1	-0.07	7831.4
2014	1	12	2	-4.3	-4.4	0	76.8	0	5.29	223.8	-0.08	7838
2014	1	12	3	-4.5	-4.5	0	84.7	0	5.14	224.7	-0.06	7836.7
2014	1	12	4	-4.7	-4.7	0	74.1	0	5	233.4	-0.05	7839.4
2014	1	12	5	-4.9	-5	0	77.1	0	4.58	239.5	-0.06	7850
2014	1	12	6	-5.4	-5.5	0	91	0	2.11	250.4	-0.1	7858
2014	1	12	7	-5.7	-5.8	0	82.2	0	1.36	145.3	-0.1	7868.7
2014	1	12	8	-5.6	-5.7	0	90.2	0.01	1.53	253.6	-0.07	7878
2014	1	12	9	-6	-6.1	0	83.9	0	1.66	148.5	-0.09	7888.7
2014	1	12	10	-5.8	-5.9	9.9	74.8	0.01	2.8	230.3	-0.04	7904.7
2014	1	12	11	-6	-6.1	37.4	78.9	0	2.97	237.7	-0.09	7915.4
2014	1	12	12	-5.9	-6	81.9	76.9	0	1.24	249.5	-0.11	7924.7
2014	1	12	13	-5.6	-5.7	140.2	82	0.01	1.47	153.7	-0.07	7935.3
2014	1	12	14	-5.2	-5.3	166.7	78	0.01	3.35	211.2	-0.11	7942
2014	1	12	15	-4.5	-4.7	212.7	70.9	0.01	3.86	223	-0.13	7939.3
2014	1	12	16	-4.2	-4.3	159.9	79	0.01	4.63	224.4	-0.11	7942
2014	1	12	17	-4.6	-4.7	102.5	82.9	0	4.23	229.8	-0.12	7946
2014	1	12	18	-4.9	-5	27.2	92.7	0	1.93	230.4	-0.12	7955.3
2014	1	12	19	-5.3	-5.4	1.9	92.8	0	1.41	63.8	-0.09	7962
2014	1	12	20	-5.4	-5.5	0	93.5	0.01	2.01	59.3	-0.11	7967.3
2014	1	12	21	-5.4	-5.5	0	95.3	0.01	1.4	50.3	-0.09	7970
2014	1	12	22	-5.1	-5.1	0	96.5	0.02	0.9	34.4	-0.02	7976.7
2014	1	12	23	-5.1	-5.1	0	97.2	0.02	2.17	61	0.04	7979.3
2014	1	12	24	-5.3	-5.4	0	97.3	0.01	2.46	80.4	-0.06	7982
2014	1	13	1	-4.9	-4.9	0	96.9	0.01	2.76	68.8	-0.05	7986
2014	1	13	2	-4.6	-4.7	0	96.8	0.01	3.35	72.7	-0.08	7987.3
2014	1	13	3	-4.4	-4.4	0	97.4	0	2.75	68.2	-0.06	7992.7
2014	1	13	4	-2.8	-2.6	0	87	0	1.17	64.3	0.28	7995.3
2014	1	13	5	-3.1	-3.1	0	96.4	0.01	1.9	68.9	0.04	8000.7
2014	1	13	6	-2.7	-2.6	0	96.1	0	2.29	73.5	0.15	8004.7
2014	1	13	7	-2.7	-2.6	0	94.7	0	1.26	55.8	0.11	8012.7
2014	1	13	8	-2.6	-2.4	0	93.6	0.01	1.37	59.9	0.23	8015.3
2014	1	13	9	-1.3	-1.2	0	82.4	0	2.95	248.7	0.1	8012.7
2014	1	13	10	-1.5	-1.4	20.4	80.1	0	1.27	256.9	0.16	8012.7
2014	1	13	11	-0.7	-0.7	117.2	77.2	0.01	3.58	235.6	-0.03	8019.3
2014	1	13	12	-0.3	-0.3	201.3	78.4	0.01	5.88	232.1	-0.07	8023.3
2014	1	13	13	-0.3	-0.4	284	73.7	0.02	6.43	229.4	-0.1	8024.7
2014	1	13	14	-0.3	-0.3	275.8	73.7	0.01	7.89	230.2	-0.07	8024.7
2014	1	13	15	0	-0.1	278.4	69.1	0.01	5.6	226.3	-0.1	8023.3
2014	1	13	16	0.1	0	221.1	67.4	0.01	5.41	230.9	-0.09	8019.3
2014	1	13	17	-0.1	-0.2	108.2	70.8	0	3.85	226.4	-0.1	8022

2014	1	13	18	-0.3	-0.4	30.3	72.8	0	2.68	228.6	-0.06	8028.7
2014	1	13	19	-0.8	-0.8	1.6	75.7	0	1.83	251.3	-0.06	8036.7
2014	1	13	20	-1	-1.1	0	76.3	0	1.74	271.6	-0.07	8040.7
2014	1	13	21	-1.3	-1.4	0	87.3	0	1.73	259.7	-0.07	8048.7
2014	1	13	22	-2.3	-2.3	0	94.6	0	0.51	58.7	0.02	8056.7
2014	1	13	23	-2.6	-2.5	0	93.8	0	0.84	232	0.05	8063.3
2014	1	13	24	-3.2	-3	0	92.9	0	0.99	88.9	0.16	8063.3
2014	1	14	1	-2.1	-1.9	0	79.7	0	3.1	212.6	0.22	8068.7
2014	1	14	2	-2.4	-2.3	0	90	0	1.47	70.1	0.08	8074
2014	1	14	3	-3.1	-3.1	0	95.3	0	0.92	66.8	0	8078
2014	1	14	4	-3.8	-3.6	0	91.8	0	0.48	188.1	0.15	8079.3
2014	1	14	5	-4.8	-4.6	0	92.4	0	0.87	245.3	0.21	8088.7
2014	1	14	6	-6	-5.5	0	95.7	0	0.83	49.7	0.47	8090
2014	1	14	7	-7.4	-6.7	0	97.8	0	0.94	248.6	0.77	8091.3
2014	1	14	8	-8.4	-7.5	0	96.3	0	1.36	241.1	0.88	8090
2014	1	14	9	-9.5	-8.4	0.1	96.2	0	1.23	239.9	1.12	8091.3
2014	1	14	10	-9.5	-8.6	8.3	95	0	1.35	250.5	0.91	8096.7
2014	1	14	11	-9.9	-8.2	25.5	92.6	0	1.54	239.3	1.74	8103.3
2014	1	14	12	-7.5	-6.3	229.4	70.3	0	1.57	252.9	1.22	8106
2014	1	14	13	-4.4	-3.9	395.2	65.2	0	0.63	100.8	0.46	8110
2014	1	14	14	-1.9	-1.8	441.8	49.6	0.02	0.58	94.4	0.01	8107.3
2014	1	14	15	-0.3	-0.3	436.6	48.3	0.05	0.65	128.9	-0.03	8104.7
2014	1	14	16	1.2	1.5	372.9	58	0.02	2.83	33.5	0.26	8099.3
2014	1	14	17	1.6	1.7	267.2	58.1	0.01	2.67	48	0.16	8096.7
2014	1	14	18	-1.8	-1	95.6	82	0	1.83	235	0.73	8094
2014	1	14	19	-4.4	-3.4	4.6	83.9	0	2.14	242.2	0.92	8098
2014	1	14	20	-6.1	-4.9	0	89.8	0	2.05	236	1.15	8095.3
2014	1	14	21	-6.7	-5.6	0	91.5	0	1.7	234	1.09	8094
2014	1	14	22	-7.7	-6.4	0	92	0	1.69	236.7	1.36	8098
2014	1	14	23	-7.9	-7	0	86.9	0	1.86	238.8	0.96	8098
2014	1	14	24	-9.1	-7.6	0	92.9	0	1.49	244.1	1.53	8094
2014	1	15	1	-9.6	-7.9	0	91	0	2.08	232.1	1.66	8098
2014	1	15	2	-9.5	-8.2	0	92.5	0	1.82	236.4	1.3	8096.7
2014	1	15	3	-9.5	-8.4	0	94.9	0	1.39	239.6	1.17	8091.3
2014	1	15	4	-10.3	-8.7	0	91.8	0	1.71	235.6	1.59	8088.7
2014	1	15	5	-10.5	-8.9	0	95	0	1.67	237.5	1.58	8090
2014	1	15	6	-10.3	-8.8	0	94.9	0	1.61	236.7	1.54	8088.7
2014	1	15	7	-10.5	-8.9	0	91.5	0	1.31	242.5	1.55	8083.3
2014	1	15	8	-11	-9.4	0	93.5	0	1.66	236.5	1.6	8079.3
2014	1	15	9	-11.1	-9.3	0	91.7	0	1.84	238.4	1.78	8080.7
2014	1	15	10	-10.6	-9	6	88.6	0	1.65	237	1.55	8080.7
2014	1	15	11	-9.7	-8.2	25.2	87.6	0	1.42	237.9	1.53	8082
2014	1	15	12	-8.3	-6.6	224.9	55.8	0	0.72	243.2	1.64	8086
2014	1	15	13	-4.4	-3.6	383.5	44.8	0	0.37	114.5	0.78	8080.7
2014	1	15	14	-1.7	-1.2	430.6	41.2	0	0.82	68.4	0.57	8075.3
2014	1	15	15	0.7	1.2	422.7	36.1	0	0.35	152.3	0.51	8071.3
2014	1	15	16	2.8	3.1	371.5	29.9	0	0.75	190.9	0.31	8070
2014	1	15	17	2.5	2.8	231.4	42.9	0.01	1.04	117.2	0.24	8067.3
2014	1	15	18	1.3	1.9	89.4	53.2	0	1.04	57.7	0.62	8068.7
2014	1	15	19	-1.4	-0.7	6.3	69.2	0	0.6	273.7	0.65	8070
2014	1	15	20	-3.8	-3	0	72.7	0	1.56	243.9	0.84	8075.3
2014	1	15	21	-5.5	-4.5	0	79	0	1.65	236.5	0.94	8075.3
2014	1	15	22	-7.1	-5.8	0	78.5	0	1.91	239.6	1.34	8076.7
2014	1	15	23	-7.5	-6.5	0	85.5	0	1.66	238.4	1.05	8076.7
2014	1	15	24	-8.3	-7.1	0	82	0	1.74	240.2	1.2	8078
2014	1	16	1	-8.6	-7.4	0	79	0	1.74	240.4	1.23	8082
2014	1	16	2	-9.2	-7.6	0	88.9	0	1.5	239.4	1.57	8083.3
2014	1	16	3	-9.4	-8	0	85.2	0	1.57	232.2	1.35	8086
2014	1	16	4	-9.9	-8.3	0	86.6	0	2.01	234.7	1.54	8086
2014	1	16	5	-9.6	-8.3	0	86.4	0	1.76	234.5	1.36	8084.7
2014	1	16	6	-9.9	-8.1	0	87.1	0	1.44	239.9	1.78	8084.7

2014	1	16	7	-9.7	-8.3	0	86.9	0	1.28	241.9	1.47	8082
2014	1	16	8	-10.2	-8.6	0	89.3	0	1.27	236.2	1.58	8084.7
2014	1	16	9	-10.7	-9	0.1	87.6	0	1.73	236.5	1.66	8087.3
2014	1	16	10	-10.6	-8.6	11.3	89.1	0	2.01	236.6	1.95	8084.7
2014	1	16	11	-9.4	-7.8	39.6	80.3	0	1.59	237.6	1.59	8087.3
2014	1	16	12	-7.1	-5.4	236.2	49.5	0	0.9	244.6	1.71	8091.3
2014	1	16	13	-3.3	-2.6	399.2	35.3	0	0.17	209.1	0.79	8090
2014	1	16	14	-0.7	-0.2	445.4	25.7	0	0.34	160.5	0.47	8084.7
2014	1	16	15	1.5	1.6	450.5	40	0	1.11	79.1	0.1	8076.7
2014	1	16	16	2.6	2.8	396.1	33.1	0	1.2	75.5	0.16	8070
2014	1	16	17	2.7	2.9	271.1	35.4	0.01	1.21	85.1	0.27	8067.3
2014	1	16	18	-1	0.1	102.8	64.6	0.01	2.07	233.8	1.08	8066
2014	1	16	19	-3.8	-2.4	4	69.5	0	2.26	238.1	1.45	8068.7
2014	1	16	20	-5.3	-3.8	0	73	0	2.1	239.7	1.46	8067.3
2014	1	16	21	-6.1	-4.8	0	75.7	0	1.96	236.4	1.32	8067.3
2014	1	16	22	-6.9	-5.3	0	77.5	0	1.83	233.6	1.58	8066
2014	1	16	23	-7.2	-5.5	0	79.1	0	1.88	241.5	1.71	8064.7
2014	1	16	24	-7.3	-5.7	0	76.2	0	1.67	236.3	1.61	8064.7
2014	1	17	1	-7.6	-6	0	78.8	0	1.7	237.4	1.57	8066
2014	1	17	2	-7.9	-6.4	0	80	0	1.74	235	1.55	8062
2014	1	17	3	-8.7	-6.9	0	82	0	1.68	238.1	1.84	8055.3
2014	1	17	4	-8.7	-6.8	0	77.5	0	1.54	239.7	1.89	8054
2014	1	17	5	-8.9	-7	0	78.2	0	1.54	236.6	1.85	8055.3
2014	1	17	6	-9.2	-7.3	0	78.3	0	1.97	237.8	1.84	8054
2014	1	17	7	-9.2	-7.3	0	77.4	0	1.95	232.2	1.8	8050
2014	1	17	8	-9	-7.5	0	83.4	0	1.53	239.1	1.51	8048.7
2014	1	17	9	-9.5	-7.7	0.1	79.4	0	1.68	234	1.81	8048.7
2014	1	17	10	-9.7	-7.7	7.8	84.4	0	1.63	239.1	1.96	8048.7
2014	1	17	11	-9	-7.3	23.7	78.3	0	1.92	235.5	1.68	8046
2014	1	17	12	-6.7	-4.8	254.7	47.7	0	1.24	240.5	1.93	8046
2014	1	17	13	-2.2	-1.2	418.6	40.6	0	0.26	203.1	1.04	8043.3
2014	1	17	14	0.7	1.2	461.8	31.6	0	0.61	167	0.45	8038
2014	1	17	15	3.2	3.1	463.5	28.8	0	0.68	73.7	-0.04	8034
2014	1	17	16	4.6	4.7	399.8	32.7	0	0.89	64.2	0.11	8028.7
2014	1	17	17	4	4.4	272.1	31.9	0	1.45	76	0.38	8026
2014	1	17	18	0.4	1.7	102.4	49.5	0.01	1.89	233.4	1.28	8026
2014	1	17	19	-1.9	-0.8	7.8	61.4	0	1.69	238.9	1.05	8026
2014	1	17	20	-3.9	-2.8	0	65	0	2.09	238.2	1.18	8028.7
2014	1	17	21	-5.1	-3.7	0	66.8	0	1.85	238.8	1.35	8030
2014	1	17	22	-5.8	-4.2	0	68.9	0	1.98	236.1	1.57	8030
2014	1	17	23	-6.5	-5	0	71.3	0	1.75	234.7	1.54	8028.7
2014	1	17	24	-7.1	-5.3	0	65.3	0	1.58	237.4	1.75	8032.7
2014	1	18	1	-7.3	-5.7	0	71.9	0	1.95	234.5	1.58	8032.7
2014	1	18	2	-7.6	-5.8	0	74.3	0	1.9	240.8	1.75	8036.7
2014	1	18	3	-7.6	-5.9	0	61.8	0	1.7	233.1	1.7	8034
2014	1	18	4	-8.2	-6.2	0	69.1	0	1.88	234.1	1.96	8034
2014	1	18	5	-8.1	-6.4	0	64.6	0	1.97	231.8	1.74	8036.7
2014	1	18	6	-7.7	-6.3	0	73.8	0	1.31	247.5	1.46	8035.3
2014	1	18	7	-8.7	-6.5	0	75.9	0	2.03	233.9	2.2	8036.7
2014	1	18	8	-8.1	-6.2	0	66.8	0	2.1	236.5	1.91	8038
2014	1	18	9	-7.7	-6	0.1	65.2	0	1.78	234.3	1.72	8038
2014	1	18	10	-7.5	-6.2	7.9	59.9	0	1.26	235.5	1.32	8036.7
2014	1	18	11	-7.7	-5.8	23.2	61.1	0	1.7	239.6	1.92	8039.3
2014	1	18	12	-4.7	-2.7	255.8	26.8	0	0.89	253.4	1.99	8040.7
2014	1	18	13	-1.3	-0.3	406.7	24.5	0	0.47	141.6	0.99	8042
2014	1	18	14	2.2	2.4	459.9	23.5	0	0.66	95.8	0.21	8038
2014	1	18	15	4.1	4.2	466.3	19.3	0	1.06	71.5	0.09	8031.3
2014	1	18	16	5.3	5.4	392.2	16.3	0	0.28	61.6	0.05	8024.7
2014	1	18	17	5.3	5.8	291.4	31.8	0.01	0.76	89.3	0.46	8022
2014	1	18	18	1.4	3	109.7	50.8	0	2.37	234.6	1.54	8022
2014	1	18	19	-0.5	0.7	9.5	62.1	0	1.95	238.3	1.16	8022

2014	1	18	20	-2.4	-1.1	0	63.2	0	2.1	235.3	1.34	8020.7
2014	1	18	21	-3.9	-2.4	0	63.7	0	2.05	236.9	1.53	8022
2014	1	18	22	-4.5	-3.2	0	61.5	0	2	234.1	1.28	8020.7
2014	1	18	23	-5.7	-4	0	70.6	0	2.03	237.4	1.73	8020.7
2014	1	18	24	-6.1	-4.4	0	68.6	0	1.38	243.5	1.71	8018
2014	1	19	1	-6.6	-4.8	0	59.1	0	1.94	236	1.86	8016.7
2014	1	19	2	-7.3	-5.5	0	71.3	0	1.58	238.8	1.72	8012.7
2014	1	19	3	-7.1	-5.6	0	63.5	0	1.73	238.8	1.52	8010
2014	1	19	4	-7.9	-6.2	0	62.9	0	1.76	236.4	1.77	8004.7
2014	1	19	5	-7.9	-5.9	0	62.6	0	1.72	241.2	1.99	8007.3
2014	1	19	6	-8.2	-6.4	0	65.1	0	1.07	241.6	1.73	8004.7
2014	1	19	7	-8.6	-6.8	0	68.2	0	1.88	237.1	1.84	8004.7
2014	1	19	8	-8.2	-6.6	0	57.2	0	1.96	238.8	1.58	8007.3
2014	1	19	9	-8.7	-6.9	0.1	61	0	1.32	240.2	1.85	8006
2014	1	19	10	-8.6	-6.8	14.5	70.7	0	1.96	233.3	1.83	8004.7
2014	1	19	11	-7.6	-6	67.6	63.4	0	1.02	241.4	1.59	8002
2014	1	19	12	-4.9	-3.4	310.5	38.9	0	1.04	242.5	1.48	8000.7
2014	1	19	13	-0.1	0.2	400.4	30.3	0	1.02	69.7	0.31	7998
2014	1	19	14	2.3	2.8	469.8	30.8	0	1.05	86.6	0.48	7995.3
2014	1	19	15	4.9	5.6	464.6	23.8	0	2.67	80.4	0.7	7988.7
2014	1	19	16	6.8	7	401.7	27.4	0	4.24	220.6	0.26	7983.3
2014	1	19	17	6.6	6.9	293.9	24.7	0	3.79	224	0.3	7983.3
2014	1	19	18	5.6	5.7	127	38.5	0	1.39	223.1	0.13	7983.3
2014	1	19	19	0.5	1.5	5.9	51.7	0	1.38	314.5	1.04	7987.3
2014	1	19	20	-2.5	-1.7	0	57.8	0	2.27	242.8	0.83	7992.7
2014	1	19	21	-3.7	-2.8	0	60.9	0	1.76	237.6	0.84	7991.3
2014	1	19	22	-3.6	-2.7	0	60.7	0	1.43	255.6	0.97	7996.7
2014	1	19	23	-3.9	-2.9	0	67.9	0	1.6	245	1.02	8002
2014	1	19	24	-4.1	-3.2	0	65.5	0	2.21	235.2	0.93	8006
2014	1	20	1	-3.7	-2.6	0	73.4	0	1.21	246.4	1.11	8008.7
2014	1	20	2	-4	-2.9	0	75.8	0	1.34	230.4	1.15	8014
2014	1	20	3	-3.4	-2.3	0	78.6	0	0.95	251.1	1.09	8018
2014	1	20	4	-4.1	-3	0	87	0	1.47	242.5	1.08	8020.7
2014	1	20	5	-4.9	-3.9	0	87.3	0	1.58	246	1.03	8023.3
2014	1	20	6	-6.5	-5.3	0	93	0	2.08	238.8	1.22	8030
2014	1	20	7	-6.8	-5.8	0	85.5	0	1.87	242.5	0.94	8032.7
2014	1	20	8	-7.9	-6.6	0	91	0	2.13	237.5	1.35	8038
2014	1	20	9	-8.6	-7	0.1	94	0	2.01	233.4	1.53	8042
2014	1	20	10	-8.6	-6.9	8.6	92.3	0	2.24	235.9	1.63	8043.3
2014	1	20	11	-8.2	-6.3	24.1	88.7	0	2.64	234.3	1.92	8047.3
2014	1	20	12	-5.5	-3	280.4	69.6	0	2.13	235.5	2.42	8051.3
2014	1	20	13	-1.1	0.3	429.2	42.3	0	0.93	239.6	1.44	8058
2014	1	20	14	2.6	2.9	483.5	37.9	0	1.13	50.2	0.33	8058
2014	1	20	15	4.2	4.3	477.4	33.6	0	1.42	125.8	0.04	8054
2014	1	20	16	5.3	5.5	414.5	30.1	0	0.53	49	0.13	8052.7
2014	1	20	17	4.3	4.7	304.2	36	0	1.1	89.5	0.47	8051.3
2014	1	20	18	0	1.9	136.4	59	0	2.59	235.2	1.92	8052.7
2014	1	20	19	-2.1	-0.9	5.1	62.6	0	2.36	239.5	1.25	8052.7
2014	1	20	20	-3.7	-2.3	0	64.9	0	1.85	243.4	1.36	8055.3
2014	1	20	21	-5	-3.5	0	67.1	0	2.02	235.6	1.57	8060.7
2014	1	20	22	-5.4	-3.9	0	72.2	0	1.76	237	1.5	8063.3
2014	1	20	23	-6.4	-4.7	0	76.9	0	1.95	232.4	1.72	8066
2014	1	20	24	-6.6	-5.2	0	80.1	0	1.9	236.5	1.47	8068.7
2014	1	21	1	-6.9	-5.5	0	79.8	0	1.85	235.2	1.38	8070
2014	1	21	2	-7.3	-5.8	0	79.6	0	1.76	234.5	1.48	8070
2014	1	21	3	-7.8	-6.1	0	76.6	0	1.88	234.7	1.67	8070
2014	1	21	4	-7.8	-6.2	0	80.4	0	1.93	232.8	1.59	8067.3
2014	1	21	5	-8	-6.2	0	82.7	0	1.88	232.2	1.78	8063.3
2014	1	21	6	-8	-6.3	0	83.1	0	1.89	234.5	1.65	8062
2014	1	21	7	-8	-6.5	0	82.4	0	1.93	232.3	1.56	8062
2014	1	21	8	-8.3	-6.6	0	83.9	0	1.83	239.3	1.71	8058

2014	1	21	9	-8.4	-6.4	0.2	82.8	0	1.66	233.5	2	8056.7
2014	1	21	10	-8	-6.6	8.7	82.8	0	1.93	234.6	1.45	8056.7
2014	1	21	11	-7.6	-6.2	23.6	70.7	0	1.81	237.2	1.39	8055.3
2014	1	21	12	-5.6	-3.3	285.4	59.5	0	1.27	241.4	2.29	8054
2014	1	21	13	-1.1	-0.4	425.1	35.9	0	0.43	213.8	0.7	8052.7
2014	1	21	14	2.2	2.4	477.2	23.5	0	0.58	85.7	0.21	8047.3
2014	1	21	15	4.2	4.3	473.8	32.2	0	0.5	146.1	0.09	8039.3
2014	1	21	16	5	5.6	407.6	29.4	0	1.45	65.3	0.65	8030
2014	1	21	17	5.1	5.4	301.8	30.9	9999	1.02	121.4	0.31	8023.3
2014	1	21	18	2	3	140.6	56.8	9999	1.72	228.7	1.06	8026
2014	1	21	19	-1.7	-0.5	5.3	59.3	0	2.44	239.1	1.17	8024.7
2014	1	21	20	-3.2	-1.8	0	66.8	0	2.1	243.2	1.36	8026
2014	1	21	21	-4.4	-3.1	0	69.6	0	2.02	238.2	1.28	8027.3
2014	1	21	22	-5	-3.5	0	70.8	0	1.92	235.9	1.52	8023.3
2014	1	21	23	-5.7	-4.2	0	74.9	0	2.08	236.6	1.5	8022
2014	1	21	24	-5.8	-4.3	0	72.7	0	1.98	235.9	1.44	8019.3
2014	1	22	1	-5.8	-4.6	0	72.9	0	1.83	233.3	1.23	8016.7
2014	1	22	2	-6.2	-4.6	0	73.1	0	1.93	236.5	1.61	8016.7
2014	1	22	3	-6.7	-5.2	0	78.2	0	1.85	238.1	1.56	8011.3
2014	1	22	4	-7.2	-5.9	0	75.7	0	1.8	238.7	1.23	8008.7
2014	1	22	5	-6.9	-5.6	0	74.4	0	1.78	236.9	1.36	8007.3
2014	1	22	6	-6.4	-4.8	0	76.5	0	1.83	230.9	1.57	8003.3
2014	1	22	7	-6	-4.9	0	80.2	0	1.16	242.5	1.12	7996.7
2014	1	22	8	-6.3	-5.3	0	77.7	0	1.54	234.5	0.99	7992.7
2014	1	22	9	-7	-5.9	0.2	75.7	0	1.53	243.8	1.07	7988.7
2014	1	22	10	-7.8	-6.5	21.5	76.7	0	1.56	237.6	1.34	7991.3
2014	1	22	11	-6.8	-5.5	44.4	75.2	0	1.02	246.6	1.26	7988.7
2014	1	22	12	-5.1	-3.8	294.8	43.4	0	0.73	222.2	1.22	7986
2014	1	22	13	-2	-1.8	358.4	47.5	0	0.97	82.9	0.26	7983.3
2014	1	22	14	-0.6	-0.4	261.2	43.9	0	1.92	74.4	0.21	7980.7
2014	1	22	15	1	1.3	476.2	39.3	0	3.91	83.7	0.27	7975.3
2014	1	22	16	2.6	2.6	390.5	40.3	0	3.64	89	0.05	7971.3
2014	1	22	17	2.5	2.6	269.7	44.6	0	4.57	90.6	0.07	7975.3
2014	1	22	18	2	2.1	100.1	49	0	5.84	84.6	0.08	7976.7
2014	1	22	19	0.8	1	7.8	59.8	0	2.16	90.8	0.17	7982
2014	1	22	20	0.1	0.3	0.1	59.9	0	1.77	86.9	0.18	7987.3
2014	1	22	21	0	0.2	0	68.1	0	1.55	43.9	0.21	7990
2014	1	22	22	-2.1	-1.7	0.1	74.9	0	1.08	264.5	0.4	7991.3
2014	1	22	23	-3.7	-3.2	0	72.4	0	1.45	249.5	0.49	7996.7
2014	1	22	24	-4.5	-3.4	0	77.8	0	1.32	241.4	1.15	8002
2014	1	23	1	-3.9	-2.7	0	78.4	0	1.08	300.9	1.15	8007.3
2014	1	23	2	-3.6	-2.5	0	76.8	0	0.7	288.9	1.09	8011.3
2014	1	23	3	-3.8	-3	0	85.2	0	2.18	53.4	0.8	8015.3
2014	1	23	4	-8	-6.3	0	86.8	0	2.84	236.9	1.71	8019.3
2014	1	23	5	-8.6	-7.2	0	85.6	0	2.48	236.6	1.32	8024.7
2014	1	23	6	-9.4	-8.3	0	89.7	0	2.18	239.3	1.1	8030
2014	1	23	7	-9.5	-8.4	0	86.9	0	2.1	240.9	1.06	8034
2014	1	23	8	-10	-8.7	0	90.9	0	1.84	237.5	1.31	8039.3
2014	1	23	9	-10.6	-9.6	0.2	91.3	0	1.87	239.1	1.08	8044.7
2014	1	23	10	-11.1	-9.8	9.3	92.7	0	2.02	245.6	1.22	8050
2014	1	23	11	-11.2	-9.2	24.1	90.6	0	2.15	236.2	1.91	8054
2014	1	23	12	-8.2	-5.8	307.7	71.7	0	1.69	241.9	2.44	8054
2014	1	23	13	-3.7	-2.3	439.5	45.6	0	0.65	234.4	1.32	8056.7
2014	1	23	14	-0.4	0.2	496.1	40.3	0	0.42	163.7	0.59	8055.3
2014	1	23	15	0.5	1.2	491.1	43.5	0	2.03	81.4	0.66	8051.3
2014	1	23	16	1.9	2	427.8	29.2	0	1.46	101.4	0.11	8051.3
2014	1	23	17	2.2	2.2	318.9	31	0	0.81	85.3	0.02	8051.3
2014	1	23	18	-1.7	-0.6	160.9	51.6	0	2.48	236.7	1.03	8051.3
2014	1	23	19	-4.5	-3.3	6.4	58.5	0	2.27	238.6	1.18	8055.3
2014	1	23	20	-6.9	-5.3	0.1	61.4	0	2.4	237.9	1.68	8056.7
2014	1	23	21	-7.9	-6.3	0	63.5	0	2.35	237.4	1.69	8064.7

2014	1	23	22	-8.4	-6.6	0	66.3	0	2.38	238.6	1.78	8066
2014	1	23	23	-8.5	-7.2	0	63.9	0	2.05	236.8	1.33	8070
2014	1	23	24	-9.5	-7.4	0	64	0	2.05	234.5	2.06	8075.3
2014	1	24	1	-9.5	-7.9	0	60.4	0	2.12	234.6	1.63	8079.3
2014	1	24	2	-9.6	-7.8	0	59.8	0	2.16	232.7	1.8	8082
2014	1	24	3	-9.9	-7.9	0	55.5	0	1.89	235.6	1.95	8086
2014	1	24	4	-10.1	-8.1	0	58.9	0	1.49	239.1	2.01	8082
2014	1	24	5	-10.7	-8.6	0	57.5	0	1.41	233.3	2.1	8087.3
2014	1	24	6	-10.7	-8.7	0	61.7	0	1.66	238	1.98	8087.3
2014	1	24	7	-10.5	-8.5	0	58.4	0	1.81	235.5	2.06	8087.3
2014	1	24	8	-10.3	-8.3	0	51	0	1.78	234.8	2.01	8086
2014	1	24	9	-10.4	-8.2	0.2	58	0	1.29	236.2	2.12	8084.7
2014	1	24	10	-9.5	-7.7	16.2	52.6	0	1.68	236.3	1.83	8087.3
2014	1	24	11	-8.4	-7	34.5	44	0	1.35	238.5	1.36	8087.3
2014	1	24	12	-5.3	-3.8	315.6	22.5	0	0.74	240.5	1.46	8088.7
2014	1	24	13	-2.2	-1.2	409.7	13.4	0	0.58	223.5	1.09	8091.3
2014	1	24	14	1.3	1.6	476.3	23.4	0	1.63	89	0.29	8083.3
2014	1	24	15	2.7	3	482.6	13.4	0	0.85	163.2	0.33	8076.7
2014	1	24	16	4.7	5.1	419	16.4	0	1.56	75.7	0.36	8070
2014	1	24	17	5.1	5.3	312.3	15.3	0	1.87	70.8	0.24	8064.7
2014	1	24	18	3.1	3.8	161.1	33.8	0	1.5	90.3	0.65	8066
2014	1	24	19	-0.8	0.3	6.1	40	0	1.91	236.6	1.12	8066
2014	1	24	20	-2.3	-1.2	0.1	48.7	0	1.83	236.3	1.05	8068.7
2014	1	24	21	-3.6	-2.4	0	50	0	1.84	238.2	1.21	8072.7
2014	1	24	22	-4.4	-2.9	0	51	0	1.91	239.4	1.52	8072.7
2014	1	24	23	-4.8	-3.4	0	54.5	0	2	235.1	1.41	8074
2014	1	24	24	-5.2	-3.7	0	52.7	0	1.71	236.1	1.48	8074
2014	1	25	1	-5.3	-4	0	47.8	0	1.76	236.1	1.31	8070
2014	1	25	2	-5.5	-3.9	0	54.3	0	1.92	235.7	1.63	8070
2014	1	25	3	-5.8	-3.9	0	53.7	0	1.86	231.9	1.94	8064.7
2014	1	25	4	-5.3	-3.9	0	58	0	1.01	238.2	1.34	8060.7
2014	1	25	5	-6.3	-4.5	0.1	56.8	0	1.73	229.4	1.83	8062
2014	1	25	6	-6.1	-4.7	0.1	51.7	0	2.1	233.3	1.33	8058
2014	1	25	7	-6	-4.7	0.1	54.5	0	1.19	240.8	1.31	8055.3
2014	1	25	8	-7.2	-5.5	0.1	59.6	0	1.42	237.2	1.72	8054
2014	1	25	9	-7.3	-5.8	0.3	54.6	0	2.12	235.6	1.55	8052.7
2014	1	25	10	-7	-5.3	9.4	54.6	0	1.71	240	1.72	8051.3
2014	1	25	11	-6.4	-4.8	23.4	48.2	0	1.74	236.3	1.59	8050
2014	1	25	12	-3.7	-1.8	321.2	29.5	0	0.72	231.7	1.9	8050
2014	1	25	13	0.1	0.9	435.2	15.5	0	0.35	196.5	0.81	8047.3
2014	1	25	14	3.1	3.4	488.8	15.2	0	1.39	87.2	0.29	8043.3
2014	1	25	15	4.9	5.1	499.7	15.4	0	1.69	84.5	0.28	8035.3
2014	1	25	16	6.2	6.3	430.8	13.6	0	1.46	80.4	0.05	8027.3
2014	1	25	17	5.9	6.3	318.8	13.2	0	1.95	79.9	0.36	8023.3
2014	1	25	18	4	4.8	167.7	30.5	0	1.24	204.4	0.78	8022
2014	1	25	19	0.3	1.4	6.5	32.8	0	1.56	238.6	1.14	8020.7
2014	1	25	20	-1.8	-0.7	0.1	41.3	0	1.9	234.8	1.06	8022
2014	1	25	21	-2.8	-1.7	0	51.2	0	1.68	241.6	1.18	8020.7
2014	1	25	22	-4.4	-3	0	47.7	0	1.93	237.3	1.34	8018
2014	1	25	23	-5.3	-3.9	0	51.9	0	1.87	232.7	1.48	8015.3
2014	1	25	24	-6.3	-4.8	0	49.6	0	2.12	235.1	1.52	8011.3
2014	1	26	1	-6.6	-5.4	0.1	54.8	0	1.57	238.5	1.19	8006
2014	1	26	2	-7.6	-5.9	0.1	53.6	0	1.76	236	1.69	8004.7
2014	1	26	3	-7.9	-6.2	0	51.6	0	1.93	234.6	1.64	8000.7
2014	1	26	4	-8	-6.3	0	61.1	0	1.58	235.6	1.65	7999.3
2014	1	26	5	-8	-6.3	0	55.4	0	1.75	237.8	1.71	7999.3
2014	1	26	6	-7.7	-6.2	0	58.6	0	1.82	236.4	1.49	7996.7
2014	1	26	7	-7.4	-5.9	0	63.8	0	1.25	239.4	1.47	7992.7
2014	1	26	8	-7.6	-6.2	0	63.4	0	1.23	236.2	1.44	7988.7
2014	1	26	9	-7.7	-6.3	0.3	67.9	0	1.58	232.7	1.38	7987.3
2014	1	26	10	-7.6	-6.3	9.7	64.5	0	1.29	235.5	1.35	7988.7

2014	1	26	11	-7.4	-5.8	28.2	64.9	0	1.35	234.4	1.58	7987.3
2014	1	26	12	-4.8	-3.3	328.8	44.2	0	0.77	234	1.49	7986
2014	1	26	13	-0.7	-0.3	452.8	29	0	0.69	114	0.4	7984.7
2014	1	26	14	1.9	2	491.2	33.1	0	1.73	94.7	0.04	7979.3
2014	1	26	15	3.5	3.6	486.1	34.9	0	1.55	74.6	0.14	7972.7
2014	1	26	16	5.7	5.7	449.5	38.9	0	2.4	184.2	0.06	7963.3
2014	1	26	17	5.2	5.5	241.3	40.1	0	5.51	228.6	0.33	7959.3
2014	1	26	18	4.1	4.6	74.1	45	0	4.36	229.5	0.5	7958
2014	1	26	19	2.2	3	11.4	58.3	0	4.56	226.7	0.78	7956.7
2014	1	26	20	1	1.3	0.1	54.7	0	0.71	240.1	0.32	7958
2014	1	26	21	0.1	0.7	0.1	64.2	0	0.7	266.7	0.61	7956.7
2014	1	26	22	-0.3	0.1	0.1	59.4	0	0.83	246.6	0.42	7955.3
2014	1	26	23	-1.3	-0.7	0.1	72.1	0	0.92	34.3	0.62	7951.3
2014	1	26	24	-2.3	-1.6	0.1	71.2	0	0.63	254.4	0.74	7954
2014	1	27	1	-2.9	-2.2	0	73.4	0	0.45	213.2	0.61	7954
2014	1	27	2	-4.2	-3.3	0.1	78.1	0	1.03	239.3	0.89	7954
2014	1	27	3	-5.2	-4.2	0.1	78	0	1.32	238.4	1.01	7952.7
2014	1	27	4	-5.9	-4.9	0	77.2	0	1.41	235.7	1.07	7952.7
2014	1	27	5	-6.1	-4.6	0	82	0	0.73	239.1	1.47	7954
2014	1	27	6	-4.9	-3.9	0	76.9	0	0.63	246.7	1.07	7954
2014	1	27	7	-4.2	-3.4	0.1	80.6	0	1.35	57	0.83	7952.7
2014	1	27	8	-4.6	-3.9	0	80.5	0	1.87	56.2	0.74	7952.7
2014	1	27	9	-5.6	-4.4	0.4	90.7	0	0.85	241.9	1.17	7954
2014	1	27	10	-6	-4.7	11.8	86.5	0	0.7	330.6	1.28	7960.7
2014	1	27	11	-6.1	-5.2	45.2	83.6	0	1.79	66.3	0.83	7964.7
2014	1	27	12	-4	-3.6	328.8	66.2	0	0.63	101.1	0.39	7970
2014	1	27	13	-1.2	-0.9	417.8	49.9	0	4.13	61.8	0.23	7971.3
2014	1	27	14	0.1	0.2	472.2	39.7	0	3.85	65.2	0.13	7971.3
2014	1	27	15	0.4	0.6	337.2	42.8	0	4.06	58.3	0.23	7964.7
2014	1	27	16	0.7	0.9	383.3	38.8	0	4.15	60.5	0.22	7966
2014	1	27	17	0.6	0.6	267.2	30.5	0	2.08	105.9	0.03	7970
2014	1	27	18	-0.2	0	119.7	30.9	0	1.64	211.4	0.18	7974
2014	1	27	19	-2	-1.7	13.2	40	0	1.11	188.9	0.29	7983.3
2014	1	27	20	-5.1	-4.7	0.1	46.2	0	1.88	248.3	0.41	7987.3
2014	1	27	21	-7.7	-7.2	0.1	54	0	1.86	244.6	0.49	7990
2014	1	27	22	-9	-8.1	0.1	57.7	0	2.02	241.9	0.97	7994
2014	1	27	23	-9.5	-8.5	0.1	57.7	0	1.84	238.3	1	7991.3
2014	1	27	24	-10.3	-9.3	0.1	51.1	0	2.04	242.3	0.97	7998
2014	1	28	1	-11.4	-10.3	0.1	59.4	0	2.2	236.7	1.14	8002
2014	1	28	2	-11.9	-11.1	0.1	52.6	0	1.97	243.5	0.83	8004.7
2014	1	28	3	-13.1	-11.9	0.1	47.2	0	2.12	241.2	1.17	8003.3
2014	1	28	4	-13.8	-11.9	0	52.8	0	1.77	237.8	1.85	8003.3
2014	1	28	5	-13.9	-12.3	0	53.1	0	1.94	238.2	1.61	8003.3
2014	1	28	6	-13.9	-12.5	0	52.9	0	1.26	241.2	1.39	8002
2014	1	28	7	-14.5	-12.9	0	57.3	0	1.86	233.7	1.61	8007.3
2014	1	28	8	-14.7	-13.2	0	50.1	0	2.24	233.1	1.49	8006
2014	1	28	9	-14	-12.6	0.5	50.2	0	1.87	238.6	1.46	8004.7
2014	1	28	10	-13.8	-12.2	11.4	52.8	0	1.77	237.2	1.61	8004.7
2014	1	28	11	-12.9	-11.4	56.2	46.2	0	1.62	241.5	1.49	8004.7
2014	1	28	12	-9.7	-8.2	330.3	21	0	0.89	228	1.52	8003.3
2014	1	28	13	-5.6	-5.2	344.8	19	0	0.61	79.7	0.35	7999.3
2014	1	28	14	-3	-3	278.1	16.5	0	0.91	65.9	-0.01	8000.7
2014	1	28	15	-1.8	-1.8	220.1	16.9	0	0.24	78.5	0.01	7998
2014	1	28	16	-1.1	-0.9	204.3	20	0	1.79	75.3	0.16	7995.3
2014	1	28	17	-0.5	-0.4	151.9	23.1	0	0.65	61.5	0.03	7984.7
2014	1	28	18	-0.7	-0.6	62.3	27	0	1.48	53.9	0.15	7987.3
2014	1	28	19	-1.2	-0.9	7.6	33.1	0	1	199.6	0.26	7982
2014	1	28	20	-1.8	-1.4	0.1	42.9	0	0.74	244.9	0.34	7984.7
2014	1	28	21	-2.3	-2.1	0.1	44.7	0	0.52	251.4	0.17	7982
2014	1	28	22	-2.5	-2.3	0.1	50.4	0	0.64	233.4	0.18	7986
2014	1	28	23	-3.1	-2.8	0.1	49.6	0	1.58	233	0.38	7987.3

2014	1	28	24	-3.5	-3.3	0.1	59.4	0	0.61	231.6	0.26	7975.3
2014	1	29	1	-4	-3.6	0.1	56.3	0	0.56	232.9	0.41	7968.7
2014	1	29	2	-3.9	-3.5	0	61.3	0	0.98	237.3	0.42	7964.7
2014	1	29	3	-4.4	-4.3	0.1	84.6	0	0.87	57.9	0.06	7959.3
2014	1	29	4	-5.4	-5.4	0.1	93.8	0	0.61	240.3	-0.06	7948.7
2014	1	29	5	-5.4	-5.5	0.1	95.7	0	0.38	90.8	-0.09	7942
2014	1	29	6	-5.3	-5.4	0.1	96.3	0	0.6	238.1	-0.04	7932.7
2014	1	29	7	-4.9	-4.7	0.1	97.4	0	0.45	295.8	0.16	7922
2014	1	29	8	-4.2	-4	0.1	97.9	0	0.72	38.8	0.28	7912.7
2014	1	29	9	-3.2	-2.8	0.1	98.8	0	0.8	59.7	0.4	7902
2014	1	29	10	-2.2	-1.6	1.9	99.7	0.01	0.5	304.9	0.54	7895.4
2014	1	29	11	-1.4	-1.1	9	98	0.03	0.62	78.7	0.3	7887.4
2014	1	29	12	-0.5	-0.2	12.4	98.6	0.04	1	36.6	0.25	7879.4
2014	1	29	13	-0.6	-0.4	12.4	99.4	0.03	1.85	67	0.24	7871.4
2014	1	29	14	-0.2	-0.1	15.3	99	0.06	1.63	76.3	0.06	7867.4
2014	1	29	15	-0.5	-0.6	15.4	98	0.03	1.38	126.7	-0.1	7863.4
2014	1	29	16	-1.7	-1.9	13	96.7	0.04	9999	9999	-0.14	7866
2014	1	29	17	-2.1	-2.1	13.8	89	0.01	9999	9999	-0.04	7871.4
2014	1	29	18	-2.2	-1.8	8.6	85.1	0.01	9999	9999	0.4	7862
2014	1	29	19	-2.9	-2.5	1.4	88.3	0	9999	9999	0.45	7854
2014	1	29	20	-4	-3.5	0.1	86.2	0	9999	9999	0.42	7855.4
2014	1	29	21	-3	-2.5	0.1	85.6	0	9999	9999	0.46	7852.7
2014	1	29	22	-2.6	-2.4	0.1	88	0	9999	9999	0.19	7847.4
2014	1	29	23	-2.2	-2.1	0.1	85.7	0	9999	9999	0.05	7844.7
2014	1	29	24	-1.9	-2	0.1	82.9	0	9999	9999	-0.04	7842
2014	1	30	1	-2	-2.1	0.1	80.3	0	9999	9999	-0.04	7839.4
2014	1	30	2	-2.4	-2.4	0.1	83.9	0.01	9999	9999	-0.06	7842
2014	1	30	3	-2.5	-2.6	0.1	82.8	0	9999	9999	-0.03	7846
2014	1	30	4	-2.9	-2.9	0.1	85.9	0	9999	9999	-0.05	7846
2014	1	30	5	-3.1	-3.2	0.1	84.2	0.01	9999	9999	-0.06	7847.4
2014	1	30	6	-3	-3	0.1	82.9	0.01	9999	9999	-0.07	7847.4
2014	1	30	7	-3.4	-3.5	0.1	85.4	0	9999	9999	-0.08	7848.7
2014	1	30	8	-3.6	-3.7	0.1	94.4	0.01	9999	9999	-0.04	7848.7
2014	1	30	9	-4.4	-4.4	0.1	97.8	0	9999	9999	-0.02	7850
2014	1	30	10	-4.7	-4.6	8.6	92.4	0.01	9999	9999	0.07	7851.4
2014	1	30	11	-3.8	-3.8	22.7	84.5	0	9999	9999	0.02	7855.4
2014	1	30	12	-3.6	-3.6	42.1	83.2	0.02	9999	9999	-0.05	7859.4
2014	1	30	13	-2.8	-2.9	118.2	66.6	0.04	0.97	58.3	-0.08	7862
2014	1	30	14	-2.5	-2.6	106.1	53.5	0.02	3.2	216.5	-0.11	7862
2014	1	30	15	-2	-2.2	306.2	50	0.03	3.94	226.6	-0.17	7856.7
2014	1	30	16	-2.2	-2.4	489.1	54.3	0.02	5.13	226.8	-0.13	7851.4
2014	1	30	17	-2.8	-2.9	191.9	58.4	0	3.43	232.1	-0.08	7852.7
2014	1	30	18	-3.2	-3.1	126	58.3	0	2.82	214.5	0.03	7852.7
2014	1	30	19	-3.9	-3.9	17.8	68.9	0	2.4	240.7	0.08	7855.4
2014	1	30	20	-5.2	-5	0.1	75.1	0	1.97	244.4	0.19	7858
2014	1	30	21	-7	-6.6	0.1	84	0	0.98	236.6	0.35	7863.4
2014	1	30	22	-10.1	-9.1	0.1	86.3	0	1.53	232.7	0.98	7867.4
2014	1	30	23	-10.1	-9.5	0	85	0	1.54	240.5	0.56	7871.4
2014	1	30	24	-9.4	-8.7	0	86.4	0	1.46	234.4	0.7	7874
2014	1	31	1	-10.5	-10	0.1	86.7	0	1.52	236.6	0.47	7874
2014	1	31	2	-10.8	-10.1	0.1	87	0	1.27	241.5	0.66	7876.7
2014	1	31	3	-10.9	-10.4	0	84.2	0	1.42	240.2	0.53	7876.7
2014	1	31	4	-11.1	-10.5	0	88.2	0	1.04	248	0.57	7875.4
2014	1	31	5	-12	-11.3	0.1	86.5	0	1.8	235	0.71	7875.4
2014	1	31	6	-13.6	-13.1	0	85.3	0	1.31	245	0.56	7876.7
2014	1	31	7	-13.7	-13.1	0	81.8	0	1.32	243.6	0.61	7878
2014	1	31	8	-12.2	-11.7	0.1	84	0	0.78	230.7	0.48	7878
2014	1	31	9	-12.4	-11.8	0.5	88.2	0	1.12	0.3	0.6	7879.4
2014	1	31	10	-12.9	-12.2	26.3	84.2	0	1.15	274.9	0.66	7880.7
2014	1	31	11	-11.5	-11.1	98.5	72.5	0	0.71	221.6	0.32	7883.4
2014	1	31	12	-9.7	-9.6	221.3	77.1	0	1.5	77.6	0.13	7886

2014	1	31	13	-7.7	-7.8	207.3	68	0	1.7	61.7	-0.06	7888.7
2014	1	31	14	-6.7	-6.7	269.8	71.7	0	2.78	56.5	-0.05	7887.4
2014	1	31	15	-6.1	-6.1	283.5	62.6	0	2.83	55.9	-0.06	7880.7
2014	1	31	16	-5.3	-5.4	278.2	63.5	0	4.99	229.1	-0.05	7879.4
2014	1	31	17	-5.8	-5.9	178.7	64.3	0	4.45	226.3	-0.07	7880.7
2014	1	31	18	-6	-6	90.8	71.8	0	4.03	224.6	-0.02	7883.4
2014	1	31	19	-6.4	-6.3	16.4	79	0	2.81	228.9	0.07	7886
2014	1	31	20	-7.1	-7	0.1	82.2	0	0.72	240.8	0.1	7888.7
2014	1	31	21	-7.8	-7.6	0	90.1	0	0.5	75.5	0.13	7890
2014	1	31	22	-8.1	-8	0.1	92.6	0	0.65	256.2	0.05	7890
2014	1	31	23	-8	-7.9	0.1	85.3	0	0.8	263.9	0.12	7891.4
2014	1	31	24	-7.3	-7.3	0.1	79.1	0	2.63	233.1	0.08	7892.7
2014	2	1	1	-7.3	-7.2	0.1	84.9	0	2.9	217.3	0.05	7894
2014	2	1	2	-8	-8	0	90.1	0	0.96	50.9	-0.02	7896.7
2014	2	1	3	-7.8	-7.8	0	77.9	0	1.26	277	0.02	7896.7
2014	2	1	4	-7.6	-7.6	0	80.1	0	2.28	237.9	0	7896.7
2014	2	1	5	-8.1	-8.1	0	92.6	0	1.17	323.3	-0.01	7899.4
2014	2	1	6	-8.3	-8.1	0	81.7	0	0.67	303.4	0.17	7902
2014	2	1	7	-9	-8.8	0	94	0	0.77	78.4	0.26	7903.4
2014	2	1	8	-9.1	-9.1	0.1	86.2	0	1.42	66	0.04	7906
2014	2	1	9	-9.3	-8.9	0.4	85.1	0	2.05	76.3	0.38	7908.7
2014	2	1	10	-9.2	-8.9	17.1	71.6	0	1.09	270.4	0.27	7914
2014	2	1	11	-8.2	-8.3	90.2	69	0	4.3	226.5	-0.02	7916.7
2014	2	1	12	-8	-8.1	191.6	64.6	0	4.48	223.3	-0.08	7922
2014	2	1	13	-7.6	-7.7	216	60.9	0	4.79	225.8	-0.1	7926
2014	2	1	14	-7.1	-7.3	317.3	58.2	0	3.61	236.7	-0.12	7924.7
2014	2	1	15	-6.7	-6.9	339.3	51.1	0	2.37	227.2	-0.12	7923.4
2014	2	1	16	-6.8	-6.8	239.7	56.8	0	2.65	62.4	0.02	7922
2014	2	1	17	-6.6	-6.6	186.2	56.9	0	2.4	56.5	-0.03	7920.7
2014	2	1	18	-6.4	-6.5	100.5	53.5	0	1.84	169.1	-0.04	7923.4
2014	2	1	19	-6.8	-6.8	20.7	66.5	0	0.98	176.5	0.04	7924.7
2014	2	1	20	-7.4	-7.3	0.2	71.6	0	0.42	253.4	0.1	7926
2014	2	1	21	-8.1	-7.9	0.1	72.5	0	0.66	271.1	0.22	7926
2014	2	1	22	-8.1	-7.9	0.1	69.7	0	0.53	270.2	0.17	7927.3
2014	2	1	23	-8.2	-8.2	0	66.5	0	1.4	209.6	0.08	7927.3
2014	2	1	24	-9.6	-9.4	0.1	73.3	0	1.2	250.9	0.24	7927.3
2014	2	2	1	-12.4	-11.9	0.1	77.9	0	1.22	239.5	0.45	7926
2014	2	2	2	-13.1	-12.2	0.1	83.3	0	1.26	234.6	0.86	7926
2014	2	2	3	-12.7	-12.1	0.1	84	0	0.93	244.2	0.59	7923.4
2014	2	2	4	-12.3	-11.7	0.1	79.2	0	0.95	236.1	0.56	7922
2014	2	2	5	-11.8	-11.1	0	81.5	0	0.71	245	0.65	7922
2014	2	2	6	-11.2	-10.5	0.1	83.1	0	0.67	43.8	0.67	7920.7
2014	2	2	7	-10.3	-10.1	0.1	78.1	0	0.38	34.7	0.28	7918
2014	2	2	8	-10	-9.9	0.1	74.6	0	1.05	201.7	0.08	7916.7
2014	2	2	9	-10	-10	0.5	78.4	0	0.74	353.9	0.08	7911.4
2014	2	2	10	-10.4	-10.2	20.6	79.5	0	0.65	243.4	0.22	7912.7
2014	2	2	11	-9.7	-9.6	86.6	68.4	0	0.51	247.2	0.19	7914
2014	2	2	12	-8.1	-8.1	146.2	62.4	0	0.84	53.7	0.01	7911.4
2014	2	2	13	-7	-7.1	187.5	59.1	0	2.3	219.2	-0.12	7910
2014	2	2	14	-6.1	-6.3	264.4	55.3	0	2.21	221.3	-0.17	7903.4
2014	2	2	15	-5.6	-5.7	232.2	63.9	0	4.91	228.9	-0.11	7892.7
2014	2	2	16	-5.4	-5.5	225.5	57.9	0	2.89	226.2	-0.15	7887.4
2014	2	2	17	-5.5	-5.6	155.2	64.4	0	3.91	218.8	-0.11	7879.4
2014	2	2	18	-5.5	-5.6	68.8	61.4	0	2.47	235.2	-0.07	7879.4
2014	2	2	19	-6.1	-6.2	8	80.8	0	2.3	242.6	-0.05	7878
2014	2	2	20	-6.8	-6.8	0.2	85.4	0	1.05	312.8	-0.04	7878
2014	2	2	21	-7	-7	0	86.9	0	0.86	17.5	0.02	7876.7
2014	2	2	22	-6.9	-6.8	0.1	77.8	0	0.91	253.7	0.04	7872.7
2014	2	2	23	-6.5	-6.6	0.1	73.5	0	2.64	233.2	-0.02	7868.7
2014	2	2	24	-6.4	-6.5	0	76.6	0	3.23	230.1	-0.03	7866
2014	2	3	1	-6.7	-6.7	0.1	78.6	0	2.09	232	-0.03	7863.4

2014	2	3	2	-6.7	-6.6	0.1	73.8	0	1.56	214.3	0.03	7862
2014	2	3	3	-6.6	-6.6	0	78.4	0	3.41	234.5	-0.06	7859.4
2014	2	3	4	-7.5	-7.5	0.1	88.6	0	1.04	70.8	-0.05	7856.7
2014	2	3	5	-7.7	-7.7	0.1	92.3	0	0.43	221.2	0.01	7852.7
2014	2	3	6	-7.9	-7.9	0.1	88.5	0	0.48	15.2	0.01	7847.4
2014	2	3	7	-7.9	-8	0	93	0	0.29	306.8	-0.02	7842
2014	2	3	8	-8.1	-8.2	0.1	94	0	0.46	53.3	-0.08	7839.4
2014	2	3	9	-8.3	-8.3	0.1	93.4	0	0.52	92.3	-0.05	7840.7
2014	2	3	10	-8.7	-8.8	7	90.2	0	3.55	79.2	-0.09	7843.4
2014	2	3	11	-9.2	-9.3	19.7	83	0.01	2.8	98.5	-0.12	7852.7
2014	2	3	12	-9.3	-9.5	50.9	81.6	0	2.83	83.9	-0.13	7858
2014	2	3	13	-9.1	-9.2	77.7	83.9	0.02	3.57	67.2	-0.13	7859.4
2014	2	3	14	-9	-9.1	83.2	70.9	0.01	3.52	78.6	-0.07	7859.4
2014	2	3	15	-8.5	-8.6	252.4	59.7	0.01	3.81	96.2	-0.11	7859.4
2014	2	3	16	-8.9	-9	280.3	69.3	0.02	2.73	67.8	-0.09	7859.4
2014	2	3	17	-9.3	-9.3	156.2	73.9	0	2.65	87	-0.04	7859.4
2014	2	3	18	-9.4	-9.3	82.7	70.4	0	2.15	73.8	0.01	7860.7
2014	2	3	19	-10.1	-9.8	16	72.6	0	1.13	80.7	0.26	7860.7
2014	2	3	20	-12.3	-11.8	0.3	81.1	0	1.03	259.2	0.52	7864.7
2014	2	3	21	-13.6	-13.3	0	83	0	1.02	335.6	0.35	7867.4
2014	2	3	22	-15.1	-14.6	0	83.1	0	1.32	240	0.56	7870
2014	2	3	23	-16	-15.5	0	86.5	0	1.34	239.9	0.51	7871.4
2014	2	3	24	-17.9	-17	0	86.3	0	1.82	238	0.83	7872.7
2014	2	4	1	-18.5	-17.5	0	86.7	0	1.64	239.3	0.94	7872.7
2014	2	4	2	-19.2	-18.3	0	86.4	0	1.66	238.8	0.98	7875.4
2014	2	4	3	-20.2	-19	0	89.3	0	1.97	236.9	1.24	7878
2014	2	4	4	-19.6	-18.3	0	86.1	0	1.47	248.3	1.31	7879.4
2014	2	4	5	-19.8	-18.7	0	86.5	0	1.6	243.7	1.1	7883.4
2014	2	4	6	-19.6	-18.5	0	86.1	0	1.46	233.1	1.17	7884.7
2014	2	4	7	-19.4	-18.6	0.1	86.9	0	1.33	245.7	0.79	7887.4
2014	2	4	8	-19.5	-18.8	0	84.5	0	1.54	241.2	0.72	7888.7
2014	2	4	9	-20.9	-19.9	0.8	82.7	0	1.68	242	1.01	7891.4
2014	2	4	10	-21.2	-20.4	13.7	84.5	0	1.65	238.3	0.89	7895.4
2014	2	4	11	-20.5	-19.4	112.5	81.2	0	1.67	238.9	1.16	7899.4
2014	2	4	12	-17	-16.5	206.9	70.4	0	0.91	233.4	0.52	7903.4
2014	2	4	13	-14	-13.8	263.2	59.8	0	0.48	307.2	0.2	7906
2014	2	4	14	-12.6	-12.8	309.3	56.8	0	0.8	17.8	-0.14	7907.4
2014	2	4	15	-12.2	-12.3	312.8	63.4	0	2.87	47.9	-0.11	7900.7
2014	2	4	16	-12	-12.1	259.7	66.3	0	2.95	41.2	-0.07	7896.7
2014	2	4	17	-11.9	-12	157.6	76.7	0	2.36	65.7	-0.11	7898
2014	2	4	18	-12.4	-12.6	68.4	82.5	0	1.12	67.2	-0.11	7900.7
2014	2	4	19	-12.8	-12.9	15.4	80.5	0	1.47	59.3	-0.04	7903.4
2014	2	4	20	-13.3	-13.4	0.2	88.5	0	1.94	44.2	-0.1	7906
2014	2	4	21	-14	-14.1	0	80.7	0	2.45	42.9	-0.07	7910
2014	2	4	22	-14.7	-14.7	0	89.4	0	2.62	77.4	-0.04	7912.7
2014	2	4	23	-15.6	-15.5	0	89.4	0	2.15	71.6	0.1	7916.7
2014	2	4	24	-16.4	-16.3	0	87	0	0.95	27.2	0.18	7922
2014	2	5	1	-17.9	-17.6	0	85	0	1.37	240.1	0.21	7922
2014	2	5	2	-18.3	-18.1	0	83.9	0	1.23	241.5	0.22	7923.4
2014	2	5	3	-18.3	-18	0	86	0	1.19	242.9	0.29	7924.7
2014	2	5	4	-18.4	-18.1	0	87.9	0	0.94	161	0.28	7923.4
2014	2	5	5	-18.4	-18.3	0	86.5	0	0.72	266.3	0.11	7928.7
2014	2	5	6	-19.5	-19.3	0	85.7	0	0.96	243.8	0.19	7927.3
2014	2	5	7	-21.3	-20.6	0	84.4	0	1.39	233.6	0.79	7928.7
2014	2	5	8	-20.4	-19.8	0	85.8	0	1.2	237.9	0.62	7928.7
2014	2	5	9	-21.2	-20.5	0.5	83.6	0	1.48	236.7	0.75	7926
2014	2	5	10	-22	-21.4	19.7	81.6	0	1.71	241.5	0.63	7930
2014	2	5	11	-20.1	-19.6	56.5	79.4	0	0.87	137.2	0.48	7932.7
2014	2	5	12	-18.5	-18.4	182	60.6	0	1.2	73.8	0.03	7935.3
2014	2	5	13	-16.1	-16.3	262.9	44.9	0	0.47	86.6	-0.15	7934
2014	2	5	14	-14.6	-14.7	324.9	54.7	0.04	0.66	52.7	-0.13	7930

2014	2	5	15	-14.2	-14.3	310.2	58.6	0.01	2.31	60.1	-0.09	7922
2014	2	5	16	-13.9	-14	238.3	58.8	0	2.72	57	-0.05	7918
2014	2	5	17	-13.9	-13.9	160.4	58.4	0	2.2	63.9	0.01	7915.4
2014	2	5	18	-13.7	-13.7	107.1	55.7	0	1.14	74.3	-0.01	7916.7
2014	2	5	19	-14.2	-14	37.7	65.4	0	1.04	0.1	0.18	7916.7
2014	2	5	20	-16.1	-15.6	0.3	73.4	0	1.81	20.4	0.55	7915.4
2014	2	5	21	-19.3	-18.9	0	80.5	0	1.55	237.2	0.39	7920.7
2014	2	5	22	-21.4	-20.9	0	80.4	0	1.6	244.2	0.56	7922
2014	2	5	23	-23.8	-22.6	0	81.7	0	2.17	234.5	1.16	7920.7
2014	2	5	24	-24.4	-22.8	0	83	0	2.26	229.8	1.52	7919.4
2014	2	6	1	-24.7	-23.3	0	79.9	0	2.18	228.5	1.39	7915.4
2014	2	6	2	-25.5	-23.6	0	81.8	0	2.22	233.9	1.91	7915.4
2014	2	6	3	-26	-23.9	0	81.4	0	1.94	238.8	2.06	7915.4
2014	2	6	4	-26.1	-24.1	0	78.9	0	1.43	235.4	2.06	7912.7
2014	2	6	5	-25.2	-23.5	0	81.7	0	1.84	232.2	1.78	7911.4
2014	2	6	6	-23.8	-22.9	0	81.9	0	2.12	234.2	0.86	7906
2014	2	6	7	-22.7	-21.8	0	82.9	0	1.69	236	0.94	7903.4
2014	2	6	8	-21.6	-20.7	0	84.3	0	1.68	239.3	0.86	7898
2014	2	6	9	-22.2	-21.6	1.6	82.2	0	2.29	243.7	0.59	7894
2014	2	6	10	-23.8	-22.6	30.9	81.5	0	1.55	235.8	1.26	7895.4
2014	2	6	11	-21.9	-20.6	151.2	68.8	0	1.18	252	1.38	7894
2014	2	6	12	-18.1	-18.2	286	64.7	0	2.42	252.6	-0.05	7894
2014	2	6	13	-15.8	-16	450.4	49	0	1.41	229.5	-0.23	7892.7
2014	2	6	14	-14.4	-14.6	461.2	53.9	0	2.05	198.1	-0.2	7886
2014	2	6	15	-12.5	-12.7	430.9	57.6	0	1.99	93.4	-0.15	7876.7
2014	2	6	16	-11.8	-12	276.5	69.3	0.01	3.53	173.9	-0.14	7868.7
2014	2	6	17	-11.3	-11.5	151.5	69.8	0	1.17	213.9	-0.15	7863.4
2014	2	6	18	-11.7	-11.8	80.1	72	0	2.16	178.3	-0.11	7860.7
2014	2	6	19	-11.8	-11.9	22.5	82.6	0	0.73	221.4	-0.11	7856.7
2014	2	6	20	-12.3	-12.3	0.2	89.2	0	1.58	242.6	-0.02	7852.7
2014	2	6	21	-12.4	-12.3	0.1	89.7	0	1.54	229.5	0.06	7847.4
2014	2	6	22	-12	-12.1	0.1	90.4	0	0.98	232.9	-0.09	7846
2014	2	6	23	-12.1	-12.2	0	91	0	0.61	60.4	-0.07	7838
2014	2	6	24	-12	-12	0	91.3	0	0.57	67.1	-0.08	7834
2014	2	7	1	-11.8	-11.9	0.1	91.9	0	0.45	70.6	-0.1	7827.4
2014	2	7	2	-11.5	-11.5	0.1	92.2	0	0.81	233.3	-0.05	7823.4
2014	2	7	3	-10.7	-10.5	0	92.8	0.02	0.63	266.5	0.16	7819.4
2014	2	7	4	-10.2	-9.9	0.1	94.3	0.01	0.95	43	0.25	7818
2014	2	7	5	-7.4	-7.3	0.1	93.4	0.02	2.1	249.6	0.09	7816.7
2014	2	7	6	-7.2	-7.2	0	90	0.05	1	92.5	-0.06	7815.4
2014	2	7	7	-7.2	-7.3	0.1	90.1	0.01	1.96	226.8	-0.09	7820.7
2014	2	7	8	-7.9	-7.9	0	90.4	0.02	1.52	55.7	0	7827.4
2014	2	7	9	-8.1	-8.1	0.2	81.3	0.03	1.08	104.9	-0.07	7823.4
2014	2	7	10	-7.9	-8	16.7	66.9	0.02	4.55	230.6	-0.04	7826
2014	2	7	11	-8.1	-8.2	90.5	66.3	0	3.69	243.7	-0.09	7838
2014	2	7	12	-7.8	-7.9	261.3	59.6	0.03	3.5	223.2	-0.09	7843.4
2014	2	7	13	-7.5	-7.7	401.8	65.4	0.02	4.8	217.9	-0.17	7847.4
2014	2	7	14	-7.6	-7.8	346.9	62.5	0.02	4.88	223.7	-0.15	7852.7
2014	2	7	15	-7.2	-7.3	363	57.3	0.01	4.44	214.8	-0.15	7851.4
2014	2	7	16	-7	-7.1	262.2	55.5	0.01	4.19	223.7	-0.09	7852.7
2014	2	7	17	-6.8	-6.9	207.1	55.4	0	3.77	235	-0.07	7851.4
2014	2	7	18	-6.9	-7	92.9	53.9	0	2.8	223.9	-0.03	7852.7
2014	2	7	19	-7.9	-8	20.4	70	0	2.86	235.1	-0.04	7854
2014	2	7	20	-8.9	-8.9	0.3	85.9	0	1.16	236.4	0.01	7852.7
2014	2	7	21	-9.7	-9.6	0.1	91.2	0	0.67	249.8	0.04	7855.4
2014	2	7	22	-9.9	-9.9	0	91.2	0	0.86	239.2	-0.02	7851.4
2014	2	7	23	-9.9	-9.8	0	92	0	1.11	243.9	0.14	7844.7
2014	2	7	24	-9.7	-9.7	0	92.8	0	1.21	243.4	0	7838
2014	2	8	1	-9.6	-9.6	0	92.6	0	1.19	250.5	-0.03	7827.4
2014	2	8	2	-9.5	-9.6	0	93.7	0	1.08	126.3	-0.1	7820.7
2014	2	8	3	-9.3	-9.2	0	93.3	0.01	0.98	42	0.09	7815.4

2014	2	8	4	-6.3	-5.7	0	90.4	0.04	1.58	30.4	0.64	7811.4
2014	2	8	5	-2.9	-2.9	0	89.7	0.03	2.54	238.7	-0.06	7815.4
2014	2	8	6	-3.2	-3.3	0	92.3	0.03	1.54	60.2	-0.05	7823.4
2014	2	8	7	-2.8	-2.8	0	83.7	0.01	1.78	86	-0.03	7834
2014	2	8	8	-2.3	-2.3	0	74.8	0.01	2.71	243.3	-0.03	7844.7
2014	2	8	9	-2.2	-2.3	0.4	81.8	0.01	2.57	242.1	-0.07	7850
2014	2	8	10	-3.5	-3.5	18.4	86.7	0.01	1.56	52.5	-0.03	7859.4
2014	2	8	11	-3.4	-3.5	53.7	91.6	0.01	1.66	21.6	-0.04	7868.7
2014	2	8	12	-4	-4.1	80.7	92.3	0.02	1.79	47.2	-0.02	7878
2014	2	8	13	-3.8	-3.8	130.7	88.8	0.02	1.81	57.8	0	7883.4
2014	2	8	14	-3.7	-3.7	158.7	79.9	0.02	1.14	72.1	-0.02	7888.7
2014	2	8	15	-3.6	-3.7	129.9	87.7	0.01	0.55	49.3	-0.1	7888.7
2014	2	8	16	-3.6	-3.7	113.2	92.5	0.03	0.77	42	-0.1	7888.7
2014	2	8	17	-3.8	-3.9	61.8	91.9	0.01	0.75	62.5	-0.11	7888.7
2014	2	8	18	-4	-4	16.6	94.9	0.03	0.46	348	-0.08	7891.4
2014	2	8	19	-4.1	-4.1	3.3	98	0.01	0.75	58.7	-0.04	7891.4
2014	2	8	20	-4.2	-4.2	0.1	97.5	0.02	0.53	247.3	-0.08	7886
2014	2	8	21	-4.3	-4.3	0	98.4	0.02	0.7	51.4	-0.05	7883.4
2014	2	8	22	-4.4	-4.5	0	97.8	0.02	0.59	115.9	-0.08	7875.4
2014	2	8	23	-4.3	-4.4	0	98	0.03	0.82	240.1	-0.07	7870
2014	2	8	24	-4.2	-4	0.1	97.9	0.02	1.05	158.7	0.14	7868.7
2014	2	9	1	-2.7	-2.3	0	94.5	0.01	1.48	47.8	0.46	7872.7
2014	2	9	2	-0.7	-0.6	0	89.2	0.01	1.45	317.6	0.09	7872.7
2014	2	9	3	-0.7	-0.7	0.1	93.5	0.02	1.2	127.1	0.01	7867.4
2014	2	9	4	-0.3	-0.4	0	90.6	0.02	2.42	230.6	-0.05	7867.4
2014	2	9	5	-0.1	-0.2	0.1	89.2	0.02	1.68	258.5	-0.08	7868.7
2014	2	9	6	0	0	0.1	79.5	0.02	3.32	238.3	-0.01	7875.4
2014	2	9	7	-0.8	-0.8	0	84	0.01	2.79	244.4	-0.03	7883.4
2014	2	9	8	-1.4	-1.4	0	82.6	0.02	1.97	255.6	-0.06	7892.7
2014	2	9	9	-2	-2.1	0.3	96	0.02	1.64	234.7	-0.04	7898
2014	2	9	10	-2	-1.9	16.3	77.9	0	1.66	252.3	0.12	7902
2014	2	9	11	-1.5	-1.5	44.2	78.7	0.01	4.47	233.9	0.01	7908.7
2014	2	9	12	-2.5	-2.6	66	78.9	0.03	2.05	189.5	-0.09	7919.4
2014	2	9	13	-1.2	-1.3	196.8	71.1	0.02	6.3	230	-0.06	7922
2014	2	9	14	-1.3	-1.4	233.1	69.5	0.02	7.06	225.9	-0.03	7923.4
2014	2	9	15	-1.4	-1.4	179.7	65	0	5.97	225	0	7923.4
2014	2	9	16	-1.3	-1.4	172.2	67.4	0	4.03	229.5	-0.06	7922
2014	2	9	17	-1.7	-1.7	129.4	73.1	0	5.14	231.3	-0.05	7924.7
2014	2	9	18	-2.2	-2.2	86.5	79.1	0	2.58	234.6	-0.04	7926
2014	2	9	19	-2.2	-2	36.8	88.8	0	1.37	43.7	0.13	7924.7
2014	2	9	20	-3	-3	0.2	88.6	0	1.06	112.8	-0.02	7927.3
2014	2	9	21	-3.4	-3.3	0	92.1	0	1.34	58.6	0.1	7931.3
2014	2	9	22	-4.2	-3.9	0.1	94.2	0	0.6	81.3	0.31	7927.3
2014	2	9	23	-5.4	-4.8	0	92	0	0.66	234.5	0.62	7928.7
2014	2	9	24	-6.6	-5.6	0	90.9	0	0.98	252.1	0.96	7931.3
2014	2	10	1	-7.9	-6.2	0	88.4	0	1.87	231.2	1.66	7935.3
2014	2	10	2	-7.5	-6.4	0	88.5	0	1.42	230.8	1.07	7938
2014	2	10	3	-7.2	-6.5	0	87.8	0	0.81	236.1	0.66	7939.3
2014	2	10	4	-7	-6.1	0	91	0	0.69	244	0.88	7939.3
2014	2	10	5	-6.6	-6	0	90.9	0	0.56	253.2	0.57	7942
2014	2	10	6	-6.6	-6.1	0	92.3	0	0.88	237.2	0.44	7944.7
2014	2	10	7	-6.2	-5.8	0	90	0	0.83	240.3	0.32	7947.3
2014	2	10	8	-6.6	-6.3	0	91.5	0	0.72	56.4	0.28	7950
2014	2	10	9	-6.8	-6.7	1.1	92.5	0	0.87	257.3	0.15	7955.3
2014	2	10	10	-7.3	-6.7	31.8	94	0	0.94	242.5	0.58	7960.7
2014	2	10	11	-6.4	-6	194.6	62.8	0	0.79	209.9	0.41	7966
2014	2	10	12	-4.1	-4	296.4	64.9	0	0.82	74.2	0.11	7968.7
2014	2	10	13	-1.8	-2	484.3	61.2	0.01	3.88	215.9	-0.16	7971.3
2014	2	10	14	-1.1	-1.2	544.8	56.2	0.03	4.81	215.1	-0.16	7972.7
2014	2	10	15	-0.6	-0.7	591.2	54.7	0.03	4.9	218.6	-0.11	7971.3
2014	2	10	16	-0.1	-0.2	521.1	55.5	0.01	5.21	220.3	-0.1	7968.7

2014	2	10	17	-0.2	-0.3	276.2	60.5	0.01	5.29	225.8	-0.07	7970
2014	2	10	18	-0.7	-0.8	113.4	65.3	0	4.46	225.3	-0.04	7971.3
2014	2	10	19	-1.2	-1.1	16	69.7	0	2.38	234.8	0.08	7972.7
2014	2	10	20	-1.8	-1.6	0.4	72.6	0	2.58	232.4	0.18	7974
2014	2	10	21	-1.6	-1.5	0.1	75.9	0	1.39	220.7	0.01	7974
2014	2	10	22	-1.7	-1.6	0.1	76.4	0	0.88	228.8	0.05	7970
2014	2	10	23	-1.7	-1.6	0.1	78.4	0	0.54	19.7	0.11	7966
2014	2	10	24	-1.6	-1.5	0.1	76.9	0	1.47	235.3	0.07	7964.7
2014	2	11	1	-1.4	-1.5	0.1	79.3	0	2.08	239.7	-0.02	7964.7
2014	2	11	2	-1.7	-1.8	0	89.8	0	1.24	265.4	-0.02	7962
2014	2	11	3	-1.5	-1.4	0	80.7	0	1.96	227.8	0.03	7959.3
2014	2	11	4	-1.3	-1.3	0	80.4	0	2.14	273.5	-0.02	7955.3
2014	2	11	5	-1.3	-1.3	0	77.6	0	1.53	45.9	0.07	7954
2014	2	11	6	-1.1	-1.1	0	87.4	0	4.59	236.6	-0.04	7948.7
2014	2	11	7	-1.5	-1.5	0	84.9	0	2.94	246.4	-0.05	7946
2014	2	11	8	-1.5	-1.6	0	78.3	0	4.35	241.8	-0.03	7946
2014	2	11	9	-1.9	-2	0.5	90.1	0	2.3	247.8	-0.07	7944.7
2014	2	11	10	-2	-2	30.4	78.9	0	3.75	237.9	-0.03	7946
2014	2	11	11	-1.7	-1.8	81.7	75.7	0	5.49	232.3	-0.05	7944.7
2014	2	11	12	-1.2	-1.2	181.9	75.9	0	6.77	228	-0.03	7946
2014	2	11	13	-1.2	-1.3	224.6	84	0	5.97	230.7	-0.09	7943.3
2014	2	11	14	-1.9	-2	171.2	86.9	0	1.36	122.4	-0.14	7954
2014	2	11	15	-1.5	-1.6	342.8	70.3	0	2.12	39.1	-0.13	7955.3
2014	2	11	16	-0.5	-0.6	439	62.7	0.02	4.95	221.2	-0.14	7956.7
2014	2	11	17	-0.4	-0.5	271.4	62.2	0	5.44	223.6	-0.07	7955.3
2014	2	11	18	-0.7	-0.7	222.1	59.1	0.01	3.93	208.4	-0.03	7960.7
2014	2	11	19	-1.6	-1.4	32.1	68.4	0	1.81	225.6	0.23	7966
2014	2	11	20	-2.8	-2.5	0.4	77.2	0	0.79	236.6	0.37	7968.7
2014	2	11	21	-3.2	-3	0.1	79.3	0	0.86	246.7	0.25	7967.3
2014	2	11	22	-4	-3.7	0	83.4	0	0.47	166.8	0.3	7963.3
2014	2	11	23	-4.2	-3.7	0	80.2	0	0.79	222.4	0.51	7963.3
2014	2	11	24	-3	-2.7	0	80	0	0.86	193.5	0.31	7960.7
2014	2	12	1	-1.9	-1.8	0	74.4	0	3.52	235.6	0.04	7955.3
2014	2	12	2	-2.4	-2.4	0	91.7	0	2.07	199.2	-0.04	7946
2014	2	12	3	-3.1	-3.2	0	90.2	0	1.43	63.9	-0.05	7936.7
2014	2	12	4	-2.7	-2.7	0	87.3	0	1.62	66.7	-0.02	7928.7
2014	2	12	5	-1.2	-1.2	0.1	78.3	0	6.14	248.6	-0.02	7920.7
2014	2	12	6	-1.2	-1.2	0	86.9	0	7.86	230	-0.02	7912.7
2014	2	12	7	-1.5	-1.6	0	90.9	0	6.36	236.3	-0.04	7903.4
2014	2	12	8	-1.8	-1.8	0	85.3	0	2.9	247.2	-0.05	7903.4
2014	2	12	9	-1.1	-1.1	0.4	80.4	0	3.6	244.4	-0.03	7902
2014	2	12	10	-0.2	-0.2	16	85.8	0	4.96	224	-0.03	7898
2014	2	12	11	-0.9	-1	45.2	95.2	0.01	1.29	242	-0.1	7900.7
2014	2	12	12	-0.9	-0.9	46.6	93.5	0.03	1.04	262.1	-0.05	7903.4
2014	2	12	13	-0.6	-0.7	53.3	94.5	0.04	0.77	262.6	-0.11	7903.4
2014	2	12	14	-0.2	-0.3	101.2	87.9	0.05	0.66	7	-0.11	7907.4
2014	2	12	15	0.4	0.3	159.3	88.1	0.03	1.82	238.3	-0.13	7906
2014	2	12	16	0.7	0.6	161.4	88.3	0.01	2.1	235	-0.09	7904.7
2014	2	12	17	0.6	0.5	138	87.4	0.01	2.97	236.3	-0.1	7904.7
2014	2	12	18	1.1	1	126.4	85.6	0	3.22	239.6	-0.11	7908.7
2014	2	12	19	0.8	0.8	34.7	84.1	0.01	1.86	248.4	0.01	7910
2014	2	12	20	0.2	0.4	0.5	92.1	0	1.05	22.7	0.19	7914
2014	2	12	21	-0.4	-0.3	0.1	91.7	0	0.6	49.3	0.15	7919.4
2014	2	12	22	-0.4	-0.3	0.1	95.5	0	0.65	308.3	0.12	7920.7
2014	2	12	23	-0.7	-0.5	0.1	99	0	0.64	22.5	0.15	7919.4
2014	2	12	24	-0.4	-0.1	0	97.4	0	0.88	291	0.36	7918
2014	2	13	1	1	1.2	0.1	86.5	0	1.36	268.7	0.19	7915.4
2014	2	13	2	1.6	1.6	0.1	89.4	0	2.92	225.3	-0.04	7912.7
2014	2	13	3	1.3	1.2	0	95.8	0	2.53	230.2	-0.06	7912.7
2014	2	13	4	1	1	0.1	80	0.01	1.84	97.3	0.02	7910
2014	2	13	5	1	1.1	0.1	84.8	0.01	2.41	151.4	0.07	7910

2014	2	13	6	0.8	0.8	0.1	99	0.01	1.56	36.5	-0.01	7907.4
2014	2	13	7	0.8	0.8	0.1	82.4	0.02	1.96	63.4	0.03	7902
2014	2	13	8	1.4	1.4	0.1	78.2	0.01	2.25	218.8	0	7900.7
2014	2	13	9	1.1	1.1	0.9	79.8	0.01	2.15	215	0.03	7904.7
2014	2	13	10	0.8	0.7	21.6	78.4	0	3.08	236.1	-0.04	7900.7
2014	2	13	11	1.1	1.1	102	71	0.04	5.66	234.4	0.01	7908.7
2014	2	13	12	1.2	1.1	256.4	57	0.04	5.96	234.2	-0.03	7915.4
2014	2	13	13	1.3	1.3	487.6	49.6	0.03	8.81	228.8	0.06	7923.4
2014	2	13	14	1.1	1.1	514.6	52.6	0.02	6.73	220.6	-0.04	7928.7
2014	2	13	15	0.8	0.8	390.4	48	0.01	6.3	217.7	0	7935.3
2014	2	13	16	0.8	0.9	418.5	44.3	0	6.77	223.1	0.01	7934
2014	2	13	17	0.6	0.7	300.8	42.8	0	6.35	223.1	0.08	7935.3
2014	2	13	18	0.4	0.4	228.9	49	0	3.87	224.4	0.06	7936.7
2014	2	13	19	-0.7	-0.5	61.6	56.5	0	3.74	234.1	0.18	7942
2014	2	13	20	-2	-1.7	0.6	61.8	0	1.89	274.1	0.23	7947.3
2014	2	13	21	-3	-2.5	0	72.7	0	1.09	273	0.55	7956.7
2014	2	13	22	-5.4	-4.3	0	78.8	0	2.17	238.3	1.03	7958
2014	2	13	23	-6.7	-6.3	0	79.5	0	1.5	234.3	0.32	7950
2014	2	13	24	-7.5	-6.6	0	84.6	0	1.4	245.1	0.9	7960.7
2014	2	14	1	-7.4	-6.6	0	82.9	0	1.4	239.8	0.75	7964.7
2014	2	14	2	-7.2	-6.6	0	82.4	0	1.02	240.5	0.63	7959.3
2014	2	14	3	-7.6	-7	0	81.5	0	0.66	230.6	0.58	7954
2014	2	14	4	-7.7	-7	0.1	80.7	0	0.76	240.5	0.66	7948.7
2014	2	14	5	-7	-6.4	0	76.9	0	1.19	238.5	0.59	7940.7
2014	2	14	6	-6.2	-5.8	0	69.2	0	0.82	249.9	0.43	7930
2014	2	14	7	-4.8	-4.6	0	91.5	0	1.49	29.2	0.16	7927.3
2014	2	14	8	-5.6	-5.5	0	96.4	0	0.74	243.2	0.11	7924.7
2014	2	14	9	-5.2	-5.1	0.6	94.5	0	0.93	249	0.09	7914
2014	2	14	10	-6	-6	11.5	95.9	0	0.92	60.3	-0.09	7911.4
2014	2	14	11	-5.3	-5.4	26.5	93.7	0	0.62	268.6	-0.12	7912.7
2014	2	14	12	-4.3	-4.1	45.7	95.1	0.01	0.66	237.7	0.15	7914
2014	2	14	13	-0.9	-0.5	51.8	93	0.02	0.93	342.8	0.33	7908.7
2014	2	14	14	1.1	1.1	77.6	89.3	0.03	1.32	173.2	-0.02	7904.7
2014	2	14	15	0.9	1	104.1	94.4	0.04	1.39	53.6	0.03	7896.7
2014	2	14	16	0.7	0.7	57.1	98.4	0.07	2.01	55.5	0.02	7896.7
2014	2	14	17	0.4	0.5	55.9	98.6	0.07	1.99	56.6	0.15	7902
2014	2	14	18	0.7	0.7	34.5	98.4	0.04	2.15	47.1	0.06	7902
2014	2	14	19	0.2	0.2	9.6	99.6	0.05	1.51	44.3	-0.02	7902
2014	2	14	20	-0.1	-0.1	0.2	98.9	0.01	1.46	73	-0.05	7902
2014	2	14	21	-0.5	-0.6	0	97.7	0.01	0.89	72.4	-0.05	7910
2014	2	14	22	-1.4	-1.4	0	98.2	0	0	0	-0.04	7916.7
2014	2	14	23	-1.7	-1.7	0	99.6	0	0	0	-0.02	7916.7
2014	2	14	24	-1.8	-1.9	0.1	99.8	0.01	0	0	-0.08	7919.4
2014	2	15	1	-2	-2.1	0.1	100	0.01	0	0	-0.04	7919.4
2014	2	15	2	-2.3	-2.2	0.1	100	0	0	0	0.07	7918
2014	2	15	3	-2.7	-2.6	0	100	0.01	0	0	0.07	7920.7
2014	2	15	4	-2.9	-2.8	0	99.1	0	0	0	0.09	7920.7
2014	2	15	5	-3.2	-3.1	0	99.4	0	0	0	0.08	7927.3
2014	2	15	6	-3.2	-3.1	0	99.1	0	0	0	0.03	7923.4
2014	2	15	7	-3.4	-3.3	0	99.5	0	0	0	0.11	7924.7
2014	2	15	8	-3.7	-3.5	0	98.3	0	0	0	0.2	7924.7
2014	2	15	9	-4	-3.8	0.7	98.4	0	0	0	0.2	7924.7
2014	2	15	10	-3.8	-3.5	15.3	95.1	0	0	0	0.3	7924.7
2014	2	15	11	-3.7	-3.5	44.6	93.4	0.03	0	0	0.15	7923.4
2014	2	15	12	-1.8	-1.5	76.6	80.6	0.04	0.05	33.9	0.27	7920.7
2014	2	15	13	-0.3	-0.3	179.2	84	0.02	0.48	74.5	-0.04	7916.7
2014	2	15	14	0.1	0	150.8	94.4	0.03	0.89	33.9	-0.03	7911.4
2014	2	15	15	0.8	0.8	136.9	93.3	0.03	1.02	352.8	0.06	7903.4
2014	2	15	16	2.6	2.7	86.2	83.8	0.02	5.73	225.5	0.09	7892.7
2014	2	15	17	2.4	2.4	45.7	89.5	0.02	5.34	220.7	0.05	7887.4
2014	2	15	18	2.6	2.7	26.2	84.1	0.03	4.85	217.4	0.08	7887.4

2014	2	15	19	4	4.2	9.9	57.3	0.01	4.4	231.1	0.2	7884.7
2014	2	15	20	5	5.3	0.4	48.3	0	4.88	245.8	0.24	7875.4
2014	2	15	21	5.4	5.6	0.1	55.4	0.01	6.74	217	0.21	7875.4
2014	2	15	22	4.4	4.6	0	68.3	0	5.56	213.3	0.13	7872.7
2014	2	15	23	4.3	4.4	0	63.3	0	5.27	245.6	0.11	7866
2014	2	15	24	4.4	4.6	0.1	70.8	0	7.11	236	0.12	7858
2014	2	16	1	2.5	2.5	0	90.7	0	5.71	222.3	0.03	7858
2014	2	16	2	1.5	1.5	0	84	0.01	4.71	225.2	0.01	7855.4
2014	2	16	3	1.4	1.4	0.1	90.4	0.01	8.14	219	-0.04	7851.4
2014	2	16	4	0.8	0.7	0	93.6	0.01	6.89	218	-0.05	7848.7
2014	2	16	5	0.4	0.3	0.1	91.4	0	6.71	223.3	-0.06	7844.7
2014	2	16	6	-0.2	-0.3	0	96.9	0.01	4.46	226.6	-0.08	7838
2014	2	16	7	-0.9	-1	0	99.1	0.02	3.44	226.7	-0.11	7835.4
2014	2	16	8	-1.4	-1.5	0	92.9	0.03	1.71	248.3	-0.09	7843.4
2014	2	16	9	-2	-2.1	0.8	77.9	0.04	2.35	286.8	-0.07	7846
2014	2	16	10	-2.6	-2.5	19.9	81.7	0	1.46	263	0.08	7859.4
2014	2	16	11	-4.3	-4.4	91.1	74.9	0.01	5.5	238.5	-0.1	7866
2014	2	16	12	-4	-4.1	335.4	65.5	0.03	5.23	217.1	-0.1	7884.7
2014	2	16	13	-4.3	-4.3	441.3	60	0.02	6.96	221.3	-0.03	7890
2014	2	16	14	-4.2	-4.3	377.8	61.4	0.01	6.64	221.5	-0.05	7900.7
2014	2	16	15	-4.2	-4.4	426.2	61	0	5.15	228.2	-0.16	7904.7
2014	2	16	16	-5	-5.1	237	77.7	0.01	5.38	225.9	-0.14	7907.4
2014	2	16	17	-4.4	-4.4	320.4	63.9	0	6.24	226.2	-0.06	7922
2014	2	16	18	-4.3	-4.3	277	57.9	0.01	4.59	219	-0.04	7932.7
2014	2	16	19	-5	-4.9	25.3	67.5	0	3.51	231.6	0.12	7939.3
2014	2	16	20	-5.6	-5.5	1.2	75	0	1.88	263.4	0.13	7950
2014	2	16	21	-6.7	-6.4	0	72.4	0	1.75	260.2	0.34	7958
2014	2	16	22	-6.2	-6	0	70	0	3.45	246.9	0.22	7962
2014	2	16	23	-6.2	-5.9	0	67.5	0	1.18	213.2	0.24	7960.7
2014	2	16	24	-4.5	-4.4	0	63.4	0	4.65	244.7	0.05	7960.7
2014	2	17	1	-4	-4	0	65.7	0	6.05	237.1	0.01	7955.3
2014	2	17	2	-3.6	-3.6	0	60.9	0	5.34	239	0.06	7950
2014	2	17	3	-3	-2.9	0	61.6	0	6.69	243.1	0.05	7943.3
2014	2	17	4	-2.5	-2.5	0	60.2	0	8.05	236.8	0.08	7934
2014	2	17	5	-1.8	-1.7	0	55.4	0	8.04	241.3	0.11	7926
2014	2	17	6	-2	-1.8	0	58.8	0	7.25	238.5	0.14	7920.7
2014	2	17	7	-2.2	-2.1	0	56.1	0	7.55	234.7	0.1	7919.4
2014	2	17	8	-2	-1.9	0	56.6	0	7.97	241.7	0.1	7912.7
2014	2	17	9	-2.1	-2	2.5	60	0	7.3	229.6	0.11	7910
2014	2	17	10	-2.1	-2	46.1	56.7	0	7.21	234.8	0.09	7912.7
2014	2	17	11	-1.6	-1.5	143.2	52.1	0	8.65	224.2	0.12	7911.4
2014	2	17	12	-1.3	-1.2	212.3	51.4	0	9.21	214.5	0.12	7907.4
2014	2	17	13	-0.8	-0.7	475.9	49.9	0	9.08	221.6	0.04	7902
2014	2	17	14	-0.4	-0.4	519.7	50	0.01	8.81	226.8	0.02	7900.7
2014	2	17	15	0.1	0.1	508	53.4	0.01	7.15	226.6	-0.01	7892.7
2014	2	17	16	-0.1	-0.1	282.3	56.7	0	6.33	223	-0.04	7890
2014	2	17	17	-1	-1	118.5	69	0.01	6.23	227.1	-0.05	7890
2014	2	17	18	-1.8	-1.8	54.6	75.4	0	6.24	214.9	-0.05	7890
2014	2	17	19	-1.8	-1.9	14.9	77.8	0	5.89	207.9	-0.06	7888.7
2014	2	17	20	-1.6	-1.7	0.8	79.7	0	6.81	210.5	-0.05	7884.7
2014	2	17	21	-2	-2	0.1	91.3	0	4.21	228.1	-0.07	7876.7
2014	2	17	22	-2.2	-2.3	0	97.4	0	1.29	32.5	-0.12	7871.4
2014	2	17	23	-2.2	-2.2	0	93.4	0.06	2.62	47.6	-0.08	7874
2014	2	17	24	-2.7	-2.8	0	96.8	0.05	2.07	64.6	-0.11	7875.4
2014	2	18	1	-2.9	-2.9	0	95.5	0.02	1.78	62.4	-0.04	7883.4
2014	2	18	2	-3.2	-3.1	0	80.7	0.01	2.33	37.8	0.01	7890
2014	2	18	3	-3	-3	0	78.9	0.01	2.34	214.2	0.02	7902
2014	2	18	4	-3.2	-3.2	0	66.9	0	1.56	282.6	0.06	7911.4
2014	2	18	5	-4	-3.8	0.1	79.1	0.01	1.28	222.5	0.19	7920.7
2014	2	18	6	-5.1	-5	0	95.6	0.01	1.58	241.1	0.07	7926
2014	2	18	7	-5.2	-5	0.1	87.4	0.01	0.82	259.1	0.19	7931.3

2014	2	18	8	-5	-4.8	0.1	83.2	0	1.66	254	0.19	7934
2014	2	18	9	-4.6	-4.6	2.2	84.9	0	1.31	257.1	0	7936.7
2014	2	18	10	-4.7	-4.7	27.8	84.9	0.01	0.73	39.1	0.02	7940.7
2014	2	18	11	-3.4	-3.5	109.2	76.2	0	3.08	225.1	-0.05	7944.7
2014	2	18	12	-2.6	-2.7	226.9	72	0.02	3.7	226.9	-0.09	7946
2014	2	18	13	-2	-2.1	330.7	71.6	0.01	5.88	224.9	-0.08	7942
2014	2	18	14	-1.6	-1.7	370.5	74.6	0.02	5.5	229.3	-0.12	7940.7
2014	2	18	15	-1.4	-1.5	280.9	77.3	0.01	7.76	240.7	-0.07	7934
2014	2	18	16	-1.5	-1.6	216.6	76.2	0	6.34	232.4	-0.09	7928.7
2014	2	18	17	-1.3	-1.3	167.5	71.1	0	7.25	232.5	-0.04	7923.4
2014	2	18	18	-1.1	-1.1	97.5	73.1	0	7.38	246.5	-0.04	7912.7
2014	2	18	19	-1	-1.1	33.7	82.9	0	6.07	258.7	-0.07	7902
2014	2	18	20	-1.1	-1.1	0.9	86.3	0	5.48	226.7	-0.04	7898
2014	2	18	21	-1.3	-1.3	0.1	82.4	0	2.45	212.9	-0.05	7891.4
2014	2	18	22	-0.2	-0.2	0.1	75.2	0	6.38	227.7	-0.02	7882
2014	2	18	23	0.4	0.4	0.1	73.5	0	9.75	240.8	0.04	7870
2014	2	18	24	0.1	0.1	0.1	81.3	0	8.35	231.4	0	7862
2014	2	19	1	-0.7	-0.7	0.1	86.4	0	7.76	211.8	-0.04	7858
2014	2	19	2	-1.3	-1.4	0.1	93	0.01	4.93	210.4	-0.08	7850
2014	2	19	3	-2	-2.2	0.1	93.7	0.03	2.64	238.7	-0.12	7842
2014	2	19	4	-3.3	-3.4	0	93.8	0.02	3.73	242.5	-0.12	7848.7
2014	2	19	5	-4.9	-4.9	0.1	80.6	0.01	4.67	212.6	-0.06	7852.7
2014	2	19	6	-6	-5.6	0	80.9	0	1.31	249.8	0.42	7859.4
2014	2	19	7	-6.7	-6.1	0.1	81.8	0	0.75	275.1	0.61	7860.7
2014	2	19	8	-7.4	-6.8	0.1	86.9	0	0.63	313.1	0.6	7867.4
2014	2	19	9	-9.9	-9.1	3.4	86.5	0	0.95	248.6	0.74	7874
2014	2	19	10	-11.2	-10.4	63	80.3	0	0.83	231.9	0.82	7880.7
2014	2	19	11	-9.6	-8.9	270.5	67.3	0	0.97	84.3	0.78	7884.7
2014	2	19	12	-7.6	-7.5	385.3	60.9	0.02	2.36	123.9	0.02	7888.7
2014	2	19	13	-6.6	-6.7	345.5	58.2	0.01	5.62	224.1	-0.11	7888.7
2014	2	19	14	-6.5	-6.6	314.7	60.9	0	5.05	209.5	-0.09	7887.4
2014	2	19	15	-6.7	-6.9	308.3	74.8	0.01	3.32	191.1	-0.13	7890
2014	2	19	16	-6.6	-6.7	362.4	58.9	0.01	6.07	220.8	-0.1	7887.4
2014	2	19	17	-7.7	-7.8	118.5	87.4	0	3.99	202.1	-0.1	7891.4
2014	2	19	18	-7.8	-7.9	129.3	67.5	0	2.14	170.8	-0.06	7902
2014	2	19	19	-7.5	-7.6	70.3	67.2	0	4.31	226.4	-0.02	7906
2014	2	19	20	-9	-8.7	2.6	72.1	0	1.81	244.8	0.36	7914
2014	2	19	21	-9.9	-9.6	0	88.4	0	0.75	251	0.28	7919.4
2014	2	19	22	-9.7	-9.5	0	85.7	0	0.36	152.3	0.23	7924.7
2014	2	19	23	-9.9	-9.4	0	89.3	0	0.75	58.6	0.47	7927.3
2014	2	19	24	-10.8	-10.2	0	86.9	0	1.34	66.7	0.56	7932.7
2014	2	20	1	-10.8	-10.2	0	90.7	0	0.59	57.7	0.66	7936.7
2014	2	20	2	-10.1	-9.5	0	87.3	0	1.06	255.4	0.6	7940.7
2014	2	20	3	-10.6	-10.3	0	91.2	0	1.27	45.9	0.28	7943.3
2014	2	20	4	-10.6	-10.3	0	91.1	0	0.79	41.5	0.25	7950
2014	2	20	5	-10.3	-10.1	0	92	0	0.92	46	0.18	7954
2014	2	20	6	-10	-9.6	0	88.4	0	0.73	277.9	0.43	7954
2014	2	20	7	-9.4	-8.9	0	90.5	0	0.7	45.7	0.5	7952.7
2014	2	20	8	-9.5	-9.1	0.1	90.7	0	0.67	61.7	0.35	7952.7
2014	2	20	9	-8.5	-8.3	7.3	88.8	0	0.87	43.1	0.24	7950
2014	2	20	10	-7.6	-7.6	28.2	77.2	0	1.22	231.2	0	7947.3
2014	2	20	11	-6.5	-6.6	82.2	78.7	0	4.47	233.1	-0.08	7946
2014	2	20	12	-6.3	-6.4	148.5	78.6	0	5.61	230.3	-0.09	7946
2014	2	20	13	-5.9	-6	183.7	76.7	0	5.7	231.2	-0.09	7943.3
2014	2	20	14	-5.7	-5.9	160.9	81.2	0	4.84	230.5	-0.11	7939.3
2014	2	20	15	-5.5	-5.6	166.2	80.5	0	4.86	230.5	-0.11	7934
2014	2	20	16	-5.1	-5.2	203.6	75.9	0.01	6.12	233.4	-0.09	7931.3
2014	2	20	17	-4.7	-4.8	131.2	77.9	0	5.5	234.7	-0.1	7928.7
2014	2	20	18	-4.5	-4.6	60.6	80.7	0	4.42	228.9	-0.09	7926
2014	2	20	19	-4.6	-4.7	28.2	81.2	0	2.38	232.4	-0.09	7923.4
2014	2	20	20	-4.5	-4.6	1.3	84	0	0.92	97.5	-0.06	7922

2014	2	20	21	-4.3	-4.3	0	91.2	0	1.16	21.8	-0.02	7922
2014	2	20	22	-5	-5	0.1	92.4	0	1.15	68	0	7926
2014	2	20	23	-5.1	-4.9	0	80.6	0.01	1.39	280.9	0.18	7931.3
2014	2	20	24	-5.1	-5	0	77.9	0	0.73	328.5	0.14	7934
2014	2	21	1	-5.1	-4.9	0	76.3	0	0.85	280.2	0.25	7936.7
2014	2	21	2	-5.2	-4.9	0	78.3	0	0.72	60.2	0.3	7932.7
2014	2	21	3	-5.1	-5	0	75.8	0	2.87	252.8	0.1	7931.3
2014	2	21	4	-4.9	-4.9	0	72.7	0	4.47	240.5	0.08	7930
2014	2	21	5	-4.7	-4.7	0.1	74.2	0	4.34	240.6	-0.02	7930
2014	2	21	6	-4.8	-4.8	0.1	71.9	0	3.43	246	-0.01	7931.3
2014	2	21	7	-5	-4.9	0.1	72	0	3.95	245.7	0.04	7931.3
2014	2	21	8	-5.4	-5.2	0.1	73.1	0	2.45	257.9	0.12	7928.7
2014	2	21	9	-5.5	-5.4	10.5	70.7	0	2.31	267.2	0.09	7926
2014	2	21	10	-5.2	-5.1	98	67.6	0	2.89	244	0.01	7926
2014	2	21	11	-4.4	-4.4	348.1	63.1	0.01	5.14	216.8	-0.06	7928.7
2014	2	21	12	-3.9	-3.9	346.2	56.6	0.01	5.59	224.4	-0.07	7930
2014	2	21	13	-3.4	-3.5	521	52.8	0.02	6.09	222.6	-0.12	7932.7
2014	2	21	14	-3.2	-3.2	548.5	51.7	0.02	6.54	223.3	-0.08	7930
2014	2	21	15	-3	-3	493.1	53.1	0.01	7.02	223.5	-0.04	7927.3
2014	2	21	16	-3	-3	354.7	55	0	6.55	223.7	0	7924.7
2014	2	21	17	-3.1	-3.1	219.3	54.8	0	5.71	224.9	0.01	7922
2014	2	21	18	-3.7	-3.7	119	65.2	0	5.44	229.5	-0.01	7926
2014	2	21	19	-4.6	-4.6	46.6	78.4	0	3.27	233.8	-0.02	7923.4
2014	2	21	20	-5	-5.1	1.9	86.9	0	0.66	153.6	-0.04	7923.4
2014	2	21	21	-5.6	-5.6	0	88.1	0	1.39	52.3	0.03	7922
2014	2	21	22	-5.4	-5.3	0.1	86.5	0	1.15	22.3	0.12	7922
2014	2	21	23	-6	-5.8	0.1	89	0	1.22	41	0.21	7919.4
2014	2	21	24	-5.9	-5.7	0.1	87.8	0	0.42	59.4	0.19	7916.7
2014	2	22	1	-5.9	-5.7	0	80.3	0	0.48	245.8	0.21	7914
2014	2	22	2	-6	-6	0	87.7	0	0.9	266.4	0.02	7911.4
2014	2	22	3	-6.4	-6.3	0	86.8	0	0.56	314	0.11	7911.4
2014	2	22	4	-6.9	-6.8	0	92.8	0	0.55	60.6	0.09	7910
2014	2	22	5	-7.5	-7.1	0	88.3	0	0.57	290	0.41	7908.7
2014	2	22	6	-7.5	-7.2	0	93	0	0.37	63.2	0.26	7906
2014	2	22	7	-7.5	-7.5	0	94.6	0	0.16	27.9	0.05	7907.4
2014	2	22	8	-7.9	-7.7	0	95.1	0	0.38	64.3	0.12	7906
2014	2	22	9	-7.4	-7.3	1.3	89.8	0	1.53	40.3	0.12	7904.7
2014	2	22	10	-7.6	-7.6	15.3	91.9	0	3.02	49.8	-0.01	7906
2014	2	22	11	-7.7	-7.8	57.9	87.1	0	3.2	37	-0.07	7908.7
2014	2	22	12	-7.3	-7.4	103.4	86.2	0	2.72	38.6	-0.1	7911.4
2014	2	22	13	-6.7	-6.8	193	84.3	0	2.24	49	-0.12	7912.7
2014	2	22	14	-5.8	-6	352.5	83.2	0	3.07	168.6	-0.18	7911.4
2014	2	22	15	-6	-6.1	309.7	86.2	0.01	2.8	47	-0.12	7907.4
2014	2	22	16	-5.8	-5.9	296.7	71.6	0.01	2.77	58.2	-0.14	7906
2014	2	22	17	-5.1	-5.2	242.4	71.5	0.01	5	230.1	-0.1	7903.4
2014	2	22	18	-5.4	-5.5	126.5	75.1	0	4.25	226.3	-0.1	7904.7
2014	2	22	19	-5.8	-6	40.2	79.6	0	2.35	239.7	-0.11	7904.7
2014	2	22	20	-6.3	-6.4	1.6	90.3	0	1.49	207.1	-0.08	7904.7
2014	2	22	21	-6.7	-6.7	0	94.9	0	1.38	55.1	0	7903.4
2014	2	22	22	-6.9	-6.8	0	95.7	0	1.44	61.3	0.14	7903.4
2014	2	22	23	-6.8	-6.8	0	95.9	0	1.1	59.9	0.08	7903.4
2014	2	22	24	-7	-7	0	95.9	0	1.17	63.3	-0.06	7904.7
2014	2	23	1	-6.9	-6.9	0.1	95.8	0	0.62	31.1	-0.06	7903.4
2014	2	23	2	-6.9	-6.9	0.1	96.1	0	0.47	286.5	-0.03	7904.7
2014	2	23	3	-6.9	-6.8	0	95.7	0	0.61	41.5	0.05	7904.7
2014	2	23	4	-6.6	-6.6	0	96.7	0	1.16	68.3	0.07	7903.4
2014	2	23	5	-5.6	-5.4	0	95.5	0	0.85	60.9	0.28	7907.4
2014	2	23	6	-4.8	-4.4	0	96.5	0	0.99	68.2	0.39	7902
2014	2	23	7	-3.6	-3.5	0	87.6	0.01	1.6	251.1	0	7906
2014	2	23	8	-3	-3.1	0	84.1	0.01	2.25	250.4	-0.05	7910
2014	2	23	9	-2.8	-2.8	2.1	83.6	0.01	2.16	256.2	-0.05	7911.4

2014	2	23	10	-3	-3	16.6	92.6	0.02	1.16	259.4	-0.04	7914
2014	2	23	11	-2.4	-2.5	51.3	79.5	0.03	2.57	255.6	-0.06	7919.4
2014	2	23	12	-1.2	-1.3	130.1	72.7	0.01	5.72	230.6	-0.07	7920.7
2014	2	23	13	-0.8	-0.8	278.1	74.3	0.02	7.39	223.7	-0.01	7919.4
2014	2	23	14	-0.9	-1	206.6	80.4	0.01	5.3	233.5	-0.08	7923.4
2014	2	23	15	-0.7	-0.8	222.4	76.7	0	6.33	233.5	-0.07	7922
2014	2	23	16	-0.5	-0.5	194.8	73.9	0.01	7.38	229.4	-0.02	7918
2014	2	23	17	-0.3	-0.3	185.1	73.2	0	8.54	230.8	0	7915.4
2014	2	23	18	-0.2	-0.2	131.2	70.4	0	6.76	229.4	-0.03	7918
2014	2	23	19	-0.4	-0.4	34	72	0	4.7	236	-0.03	7918
2014	2	23	20	-0.7	-0.7	1.2	78.7	0	3.9	227	-0.01	7916.7
2014	2	23	21	-1.6	-1.7	0	92	0	2.01	239.4	-0.07	7916.7
2014	2	23	22	-2	-2.1	0.1	94.1	0	1.35	224.5	-0.07	7914
2014	2	23	23	-1.6	-1.7	0.1	82.1	0.01	1.39	28.3	-0.04	7915.4
2014	2	23	24	-1	-1	0.1	88	0	1.38	220.4	-0.02	7919.4
2014	2	24	1	-0.7	-0.7	0.1	83.9	0.01	1.36	233.3	-0.02	7923.4
2014	2	24	2	0	0	0.1	80.8	0.01	3.93	238.3	-0.02	7923.4
2014	2	24	3	0.4	0.4	0.1	79.9	0	6.52	231.9	-0.01	7922
2014	2	24	4	0.6	0.6	0.1	81.7	0	5.06	233.8	-0.04	7924.7
2014	2	24	5	0.5	0.5	0.1	79.1	0	1.94	257.3	-0.02	7927.3
2014	2	24	6	0.5	0.6	0.1	78.4	0.01	0.84	245	0.03	7930
2014	2	24	7	0.7	0.7	0.1	77.3	0	1.95	266.1	-0.04	7936.7
2014	2	24	8	0.3	0.5	0.1	77.8	0	1.65	269.8	0.22	7940.7
2014	2	24	9	-1.6	-0.9	11.3	84.2	0	1.67	242	0.7	7942
2014	2	24	10	-1.9	-1.2	122.8	75.1	0	1.03	48.2	0.65	7948.7
2014	2	24	11	-1.9	-1.2	264.3	74	0	1.49	75.5	0.71	7954
2014	2	24	12	0.9	1	347.2	60	0.02	3.07	63.9	0.06	7955.3
2014	2	24	13	2.3	2	600.3	53.2	0.04	2.27	198.7	-0.22	7958
2014	2	24	14	2.9	2.7	644.4	56.7	0.03	3.37	220.6	-0.18	7958
2014	2	24	15	3.4	3.2	686.7	51.2	0.02	4.18	224.1	-0.13	7955.3
2014	2	24	16	3.9	3.8	613.3	54	0.02	4.99	219.4	-0.08	7951.3
2014	2	24	17	3.9	3.9	448.8	54.7	0	4.36	224.3	-0.07	7950
2014	2	24	18	3.7	3.6	256.6	61.3	0	4.22	223.3	-0.01	7950
2014	2	24	19	2.8	2.8	55.3	67.5	0	3.21	229.9	0.02	7951.3
2014	2	24	20	2.6	2.6	2.4	70.3	0	2.25	242.5	0	7950
2014	2	24	21	2	1.9	0.1	85.1	0	2.9	250.8	-0.07	7950
2014	2	24	22	0.4	0.3	0.1	95.6	0	1.32	47.1	-0.04	7950
2014	2	24	23	0.1	0.3	0.1	96.4	0	0.57	333	0.13	7948.7
2014	2	24	24	0.4	0.6	0.1	97.6	0	0.68	64.3	0.21	7948.7
2014	2	25	1	-0.2	-0.3	0.1	99.5	0	2.36	79.2	-0.11	7948.7
2014	2	25	2	-0.4	-0.5	0.1	100	0	1.95	67.8	-0.11	7948.7
2014	2	25	3	-0.3	-0.4	0.1	100	0	1.42	49.4	-0.1	7948.7
2014	2	25	4	-0.2	-0.2	0.1	100	0	0.4	24.4	-0.08	7950
2014	2	25	5	-0.3	-0.3	0.1	100	0	0	0	-0.04	7948.7
2014	2	25	6	-0.3	-0.3	0.1	100	0	0.37	37.2	-0.06	7944.7
2014	2	25	7	-0.2	-0.3	0.1	100	0	0.33	30.9	-0.05	7946
2014	2	25	8	-0.1	-0.1	0.1	100	0	0.43	61.2	-0.05	7948.7
2014	2	25	9	0	-0.1	3.3	100	0	0.19	331	-0.05	7951.3
2014	2	25	10	0	0	25	99.7	0	0.16	88.3	-0.08	7954
2014	2	25	11	0.2	0.1	172	96	0	1.75	71.5	-0.09	7962
2014	2	25	12	1.2	1.1	377.4	83.9	0	2.66	72.2	-0.14	7966
2014	2	25	13	2.9	2.9	556.4	60.8	0	3.6	56.5	-0.02	7966
2014	2	25	14	3.8	3.9	630.6	49.3	0.03	2.29	80.2	0.02	7967.3
2014	2	25	15	4.6	4.8	650.3	42.1	0.03	3.24	65.5	0.21	7962
2014	2	25	16	5.2	5.4	608.8	44.4	0.02	2.78	55.2	0.19	7956.7
2014	2	25	17	5.1	5.4	497.6	49.8	0	3.66	43.5	0.29	7954
2014	2	25	18	4.8	5	333.1	55.8	0.01	3.5	38.4	0.17	7954
2014	2	25	19	4.1	4.2	117.3	63	0	3.77	17.2	0.13	7952.7
2014	2	25	20	0.1	0.4	3.2	80.5	0	1.47	229.9	0.38	7956.7
2014	2	25	21	-2.2	-1.8	0	83.3	0	1.87	239.6	0.4	7962
2014	2	25	22	-3.6	-3.1	0	85.8	0	1.77	238.9	0.52	7964.7

2014	2	25	23	-5	-4.3	0	88.9	0	1.8	240.6	0.73	7964.7
2014	2	25	24	-5.7	-4.8	0	89.7	0	1.79	237	0.85	7966
2014	2	26	1	-6.2	-5.2	0.1	91.4	0	1.4	238	0.99	7964.7
2014	2	26	2	-6.4	-5.4	0.1	92.5	0	1.9	234.5	1.01	7964.7
2014	2	26	3	-6.8	-5.5	0.1	94.4	0	1.5	238.3	1.35	7963.3
2014	2	26	4	-7.1	-5.6	0.1	98	0	1.47	237	1.56	7959.3
2014	2	26	5	-6.6	-5.6	0.1	97	0	1	239.2	0.99	7958
2014	2	26	6	-7.3	-6.1	0.1	96	0	1.52	235.4	1.17	7958
2014	2	26	7	-7.5	-6.4	0.1	98	0	1.57	235.3	1.13	7956.7
2014	2	26	8	-7.6	-6.3	0.1	99.1	0	1.28	240	1.3	7954
2014	2	26	9	-7	-6.1	7.5	97.3	0	1.47	245.8	0.87	7955.3
2014	2	26	10	-6.9	-5.2	123.9	92	0	1.45	233.4	1.65	7954
2014	2	26	11	-4.3	-2.6	296.6	72.5	0	1.08	238.6	1.65	7952.7
2014	2	26	12	0.2	0.6	500.6	48.6	0	0.44	206.2	0.39	7950
2014	2	26	13	3.7	4	613.7	50.5	0	0.67	33.4	0.25	7947.3
2014	2	26	14	5.2	5.6	697	51.5	0	1.99	70.9	0.4	7942
2014	2	26	15	6.5	6.9	494.2	48.5	0	2.26	60.7	0.4	7935.3
2014	2	26	16	7	7.4	512.2	49	0	3.05	53.4	0.37	7926
2014	2	26	17	7.4	7.7	512.5	53.4	0	3.43	84	0.36	7920.7
2014	2	26	18	6.8	7.3	200	48.5	0	2.49	220.6	0.45	7920.7
2014	2	26	19	5.9	6.3	105.7	71.3	0	0.8	234.9	0.32	7915.4
2014	2	26	20	2.7	3.2	3.7	79.2	0	1.63	237.8	0.48	7911.4
2014	2	26	21	1.4	1.9	0	84.1	0	1.3	242.6	0.46	7912.7
2014	2	26	22	0.1	0.7	0	86.5	0	1.34	238.9	0.58	7908.7
2014	2	26	23	-1.3	-0.5	0	89.1	0	1.56	238	0.82	7906
2014	2	26	24	-1.9	-1.1	0.1	88.9	0	1.94	239.8	0.77	7904.7
2014	2	27	1	-2	-1.1	0.1	91.7	0	1.86	237.6	0.87	7900.7
2014	2	27	2	-1.8	-1	0.1	90.9	0	1.17	240.3	0.83	7895.4
2014	2	27	3	-2	-0.9	0.1	89.1	0	1.2	248	1.03	7888.7
2014	2	27	4	-1.4	-0.3	0.1	88.8	0	1.29	251.2	1.08	7883.4
2014	2	27	5	-0.9	0.1	0.1	86.4	0	1.6	237.7	1.06	7875.4
2014	2	27	6	-1	-0.3	0.1	90.5	0	1.05	234.6	0.73	7870
2014	2	27	7	-1.3	-0.7	0.1	91.7	0	1.25	250.3	0.61	7863.4
2014	2	27	8	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	2	27	9	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	2	27	10	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	2	27	11	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	2	27	12	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	2	27	13	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	2	27	14	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	2	27	15	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	2	27	16	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	2	27	17	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	2	27	18	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	2	27	19	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	2	27	20	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	2	27	21	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	2	27	22	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	2	27	23	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	2	27	24	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	2	28	1	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	2	28	2	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	2	28	3	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	2	28	4	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	2	28	5	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	2	28	6	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	2	28	7	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	2	28	8	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	2	28	9	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	2	28	10	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	2	28	11	0.1	0.1	228.1	71.5	0.02	4.37	241.9	-0.07	7846

2014	2	28	12	1	0.9	377.3	67.5	0.02	4.33	232.7	-0.1	7844.7
2014	2	28	13	0.9	0.8	315.9	74.6	0.01	3.44	217.2	-0.11	7843.4
2014	2	28	14	1.4	1.3	330	67.6	0.02	3.48	217.4	-0.11	7842
2014	2	28	15	1.4	1.3	404.9	65.4	0.01	3.34	217.5	-0.12	7835.4
2014	2	28	16	2.5	2.4	552.9	63.9	0.02	4.29	237	-0.13	7827.4
2014	2	28	17	2	1.9	235.6	61.9	0	4.92	246.5	-0.1	7826
2014	2	28	18	1.9	1.8	173.6	64.4	0	2.94	235.6	-0.08	7826
2014	2	28	19	1.6	1.6	44.3	66.8	0	2.82	227.4	-0.03	7818
2014	2	28	20	1.3	1.4	4.5	74.5	0	1.66	231.6	0.04	7808.7
2014	2	28	21	0.2	0.3	0.1	85.2	0	1.23	234.9	0.07	7807.4
2014	2	28	22	-0.8	-0.8	0.1	95	0	0.88	249.8	-0.03	7807.4
2014	2	28	23	-1.1	-1.1	0.1	99.1	0	0.35	35.2	-0.07	7804.7
2014	2	28	24	-1.3	-1.4	0.1	100	0	0.51	65.9	-0.07	7806
2014	3	1	1	-1.6	-1.7	0.1	100	0	0.86	85.3	-0.1	7803.4
2014	3	1	2	-1.8	-1.8	0.1	99.9	0	0.76	241.6	-0.03	7794
2014	3	1	3	-1.9	-1.8	0.1	98.6	0.01	0.95	237.9	0.05	7790
2014	3	1	4	-2	-1.8	0.1	98.9	0	1.09	244.8	0.21	7787.4
2014	3	1	5	-2.4	-2.2	0.1	98.9	0	0.82	284.2	0.21	7782
2014	3	1	6	-2.8	-2.7	0.1	98.7	0	0.58	92	0.15	7780.7
2014	3	1	7	-2.7	-2.6	0.1	97.9	0	0.83	232.8	0.07	7778
2014	3	1	8	-2.4	-2.4	0.1	98.6	0	0.55	283.5	0	7778
2014	3	1	9	-2.3	-2.3	4.7	99.3	0	0.7	40.4	-0.01	7780.7
2014	3	1	10	-1.7	-1.8	11.1	98.4	0	0.37	270.7	-0.12	7784.7
2014	3	1	11	-1.3	-1.4	22	95.8	0.06	0.84	68.2	-0.12	7792.7
2014	3	1	12	-0.9	-1	23.5	98.1	0.05	1.78	66.2	-0.12	7796.7
2014	3	1	13	-0.5	-0.6	39.5	95.8	0.04	3.01	55.2	-0.06	7804.7
2014	3	1	14	-0.3	-0.4	83.2	91.6	0.03	1.68	65.9	-0.09	7812.7
2014	3	1	15	0.2	0.1	275.7	91.6	0.02	2.33	59.7	-0.05	7819.4
2014	3	1	16	-0.2	-0.3	190.6	94.6	0.01	3.57	57.2	-0.07	7820.7
2014	3	1	17	-1.2	-1.2	162.8	91.2	0.01	4.86	65.6	-0.07	7824.7
2014	3	1	18	-1.8	-1.9	96.5	92.8	0	3.89	53.8	-0.08	7838
2014	3	1	19	-2	-2	83.1	87.8	0	1.97	62.8	0	7844.7
2014	3	1	20	-2.6	-2.3	6.7	92	0	0.94	255.3	0.33	7848.7
2014	3	1	21	-3.2	-3	0.1	94.3	0	0.67	255.3	0.18	7858
2014	3	1	22	-3.6	-3.4	0.1	93.3	0	0.66	264.2	0.19	7863.4
2014	3	1	23	-3.8	-3.5	0.1	95.4	0	0.61	231.1	0.27	7866
2014	3	1	24	-4.1	-3.8	0.1	96.9	0	0.55	39.2	0.31	7866
2014	3	2	1	-4	-3.7	0.1	95.4	0	0.32	237.8	0.32	7867.4
2014	3	2	2	-3.1	-2.9	0.1	98.4	0.01	0.6	56.6	0.19	7867.4
2014	3	2	3	-3.5	-3.5	0.1	99.1	0	0.18	48.1	-0.04	7870
2014	3	2	4	-3.3	-3.2	0.1	99.5	0.01	0.57	244	0.02	7875.4
2014	3	2	5	-2.7	-2.5	0.1	97.1	0.02	0.79	338.2	0.19	7875.4
2014	3	2	6	-2.5	-2.3	0.1	98.1	0.01	0.8	275.1	0.25	7874
2014	3	2	7	-2.6	-2.3	0.1	99.3	0.01	1.01	40.3	0.25	7879.4
2014	3	2	8	-2.6	-2.3	0.1	99.5	0.01	0.77	8.2	0.32	7883.4
2014	3	2	9	-2.3	-1.9	3.4	97.2	0.01	0.96	264.6	0.37	7883.4
2014	3	2	10	-1.9	-1.6	15.8	95.7	0.01	0.53	4	0.31	7887.4
2014	3	2	11	-0.9	-0.8	37.2	81.9	0.03	0.66	35.8	0.1	7891.4
2014	3	2	12	1.3	1.2	217.5	75.5	0.02	3.17	229.9	-0.1	7892.7
2014	3	2	13	1.8	1.7	282.6	72.7	0.02	4.71	219.1	-0.06	7892.7
2014	3	2	14	2	2	242.5	76.1	0.01	4.5	218	-0.07	7894
2014	3	2	15	1.5	1.4	224.2	78.8	0.01	5.05	228.8	-0.07	7892.7
2014	3	2	16	1.6	1.5	231.5	80.2	0	5.42	222	-0.08	7891.4
2014	3	2	17	1.3	1.2	148.5	84.1	0	4.96	227.6	-0.07	7891.4
2014	3	2	18	1	0.9	87.4	90.5	0	4.77	225.8	-0.08	7892.7
2014	3	2	19	0.8	0.8	47.1	89.5	0	4.24	228.4	-0.03	7895.4
2014	3	2	20	0.9	0.9	3.6	81.7	0	5.15	228.3	-0.02	7894
2014	3	2	21	1	1	0.1	93.1	0	5.8	222	-0.03	7894
2014	3	2	22	0.7	0.7	0.1	93	0	3.6	218.7	-0.02	7892.7
2014	3	2	23	0.6	0.6	0.1	98.9	0	2.36	242.6	-0.04	7892.7
2014	3	2	24	0.2	0.1	0.1	100	0.02	1.3	71.2	-0.05	7898

2014	3	3	1	1.3	1.3	0.1	91.8	0.01	2.56	251.8	0.01	7898
2014	3	3	2	1.2	1.3	0.1	84.9	0.01	2.7	233	0.06	7902
2014	3	3	3	1.1	1.3	0.1	81	0	1.42	288.9	0.14	7904.7
2014	3	3	4	1.1	1.1	0.1	77.7	0	2.16	246.6	0	7911.4
2014	3	3	5	0.8	0.7	0.1	85.9	0.01	3.48	236.5	-0.02	7914
2014	3	3	6	0.5	0.5	0.1	79.9	0	3.68	231.1	0.01	7916.7
2014	3	3	7	0.2	0.2	0.1	85.3	0	3.45	234.1	0.03	7922
2014	3	3	8	-0.5	-0.5	0.1	87.1	0.01	1.9	250.1	0.01	7923.4
2014	3	3	9	-0.7	-0.7	5.3	92	0	1.01	259	0	7922
2014	3	3	10	-1.1	-1.1	21.3	94.6	0	0.46	335.8	0.03	7919.4
2014	3	3	11	-0.9	-1	24.1	95.5	0.03	0.64	30.3	-0.08	7918
2014	3	3	12	-0.3	-0.5	40	91.3	0.05	1.16	40.9	-0.11	7916.7
2014	3	3	13	0.6	0.5	83.3	88.5	0.08	1.51	245.1	-0.1	7915.4
2014	3	3	14	1.4	1.3	159.5	82.8	0.02	5.63	227.6	-0.05	7912.7
2014	3	3	15	1.4	1.4	168.7	81.7	0	7.3	228.9	-0.06	7910
2014	3	3	16	1.5	1.4	172.9	86	0.01	4.84	220.6	-0.12	7908.7
2014	3	3	17	1.1	1	98.4	94.8	0	3.28	227.9	-0.12	7906
2014	3	3	18	0.2	0.1	46.2	97.3	0.03	0.83	302.8	-0.11	7904.7
2014	3	3	19	0.7	0.7	21.8	94	0.02	1.68	263.6	-0.06	7903.4
2014	3	3	20	1	1	3.2	93.1	0.01	1.04	57.2	0.01	7903.4
2014	3	3	21	0.4	0.4	0.1	95.6	0	0.75	7.8	0.02	7907.4
2014	3	3	22	0.4	0.6	0.1	98.1	0.01	1.26	44.7	0.12	7907.4
2014	3	3	23	0.6	0.6	0.1	99.4	0.02	1.56	304.5	0.08	7908.7
2014	3	3	24	-0.2	-0.3	0.1	100	0.04	0.31	82.7	-0.07	7914
2014	3	4	1	-0.4	-0.4	0.1	100	0.04	0	0	0	7916.7
2014	3	4	2	-0.3	0	0.1	96.8	0	0	0	0.22	7919.4
2014	3	4	3	-1.8	-1.5	0.1	99.1	0	0	0	0.27	7922
2014	3	4	4	-3.3	-2.8	0.1	99.2	0	0	0	0.51	7922
2014	3	4	5	-3.7	-3.3	0.1	97.7	0	0	0	0.41	7923.4
2014	3	4	6	-3.5	-3.3	0.1	98.6	0	0	0	0.19	7923.4
2014	3	4	7	-4	-3.7	0.1	96.9	0.01	0	0	0.29	7924.7
2014	3	4	8	-5	-4.6	0.1	96.6	0	0	0	0.4	7927.3
2014	3	4	9	-5.4	-4.7	3.6	96.2	0	0	0	0.72	7932.7
2014	3	4	10	-4.6	-4	26.7	93.6	0	0	253.1	0.62	7932.7
2014	3	4	11	-3.1	-2.8	62.6	91.9	0.02	0.27	59.8	0.22	7938
2014	3	4	12	-1.2	-1.2	111.8	78.2	0.02	0.92	70.3	-0.01	7939.3
2014	3	4	13	0.4	0.3	396.1	67.2	0.03	3.96	238.4	-0.11	7942
2014	3	4	14	0.6	0.5	431.7	64.6	0.01	4.94	231.7	-0.05	7944.7
2014	3	4	15	1	1	512.3	66.2	0.01	5.96	224.8	-0.07	7946
2014	3	4	16	0.2	0.1	327.1	66.6	0.01	3.3	218.7	-0.15	7950
2014	3	4	17	1.4	1.3	456.9	62.4	0.01	4.76	229.6	-0.09	7947.3
2014	3	4	18	1.1	1.1	160.1	72.7	0	4.67	227.3	-0.02	7943.3
2014	3	4	19	0.1	0	47.6	81.3	0	2.69	224.6	-0.06	7944.7
2014	3	4	20	0.1	0.1	4.9	83.2	0	0.91	240.5	0.03	7948.7
2014	3	4	21	-0.5	-0.3	0.1	86.7	0	0.6	2.6	0.22	7954
2014	3	4	22	-0.9	-0.5	0.1	84.1	0	0.43	341.4	0.37	7955.3
2014	3	4	23	-0.7	-0.2	0.1	86.8	0	0.68	37.5	0.41	7955.3
2014	3	4	24	-1.2	-0.8	0.1	85	0	0.41	106.7	0.41	7955.3
2014	3	5	1	-1.7	-1.1	0.1	90.3	0	0.48	316.2	0.63	7956.7
2014	3	5	2	-2.1	-1.1	0.1	92.3	0	0.6	254.5	1	7954
2014	3	5	3	-1.9	-1.1	0.1	92.1	0	0.69	237	0.71	7951.3
2014	3	5	4	-1.8	-1.1	0.1	93.4	0	1.1	55.4	0.7	7954
2014	3	5	5	-1.6	-0.9	0.1	97.4	0	0.84	51.7	0.67	7950
2014	3	5	6	-2.1	-1.8	0.1	95.6	0	1.16	61.5	0.3	7947.3
2014	3	5	7	-0.7	-0.4	0.1	83.3	0	1.88	256	0.32	7946
2014	3	5	8	1.8	2	0.1	73.7	0	5.78	229.5	0.13	7944.7
2014	3	5	9	1.2	1.6	18.3	76.3	0	2.79	225.5	0.39	7939.3
2014	3	5	10	2.4	2.5	80.3	61.6	0	3.96	239.7	0.15	7939.3
2014	3	5	11	3.9	3.9	220.1	55.1	0	4.19	253.3	-0.02	7935.3
2014	3	5	12	4.2	4.2	383.8	55.3	0	7.68	235.4	0	7934
2014	3	5	13	3.2	3.2	267.5	83.4	0	7.26	226	0	7930

2014	3	5	14	2.2	2.2	340	78.1	0	6.27	233.3	-0.05	7939.3
2014	3	5	15	1.8	1.7	209.4	82.5	0	4.88	235	-0.05	7932.7
2014	3	5	16	2.2	2.2	177.1	86.9	0	4.07	232.4	-0.03	7931.3
2014	3	5	17	2.8	2.7	190.6	84	0	5	242.6	-0.02	7926
2014	3	5	18	2.7	2.7	91.8	90.1	0	3.06	246.3	-0.01	7920.7
2014	3	5	19	2.4	2.4	26.7	92.1	0	3.28	240.7	0.05	7920.7
2014	3	5	20	2.1	2.2	2.5	84.1	0	1.65	211.4	0.09	7919.4
2014	3	5	21	3.3	3.4	0.1	87.9	0.01	3.36	240.2	0.11	7918
2014	3	5	22	3	3.2	0.1	85.6	0	1.66	43.3	0.18	7906
2014	3	5	23	3.7	3.8	0.1	82.4	0.01	4.19	237.2	0.14	7902
2014	3	5	24	4.3	4.4	0.1	83.2	0.03	6.46	256.2	0.07	7895.4
2014	3	6	1	3.9	3.9	0.1	84.5	0.05	6.41	249.9	0.05	7898
2014	3	6	2	4.1	4.2	0.1	88.8	0.05	4.8	241	0.14	7895.4
2014	3	6	3	4.6	4.8	0.1	84.5	0.03	6.22	228.1	0.16	7888.7
2014	3	6	4	4.8	5	0.1	84.1	0.04	7.12	226.4	0.16	7884.7
2014	3	6	5	4.6	4.8	0.1	90.8	0.08	6.78	229.9	0.17	7880.7
2014	3	6	6	5.1	5.3	0.1	83	0.04	9.12	216.7	0.2	7875.4
2014	3	6	7	4	4.1	0.1	88.5	0.07	2.9	233.2	0.14	7872.7
2014	3	6	8	4.1	4.2	0.1	82.3	0.01	1.79	248	0.07	7875.4
2014	3	6	9	3.7	3.8	11.6	67.9	0	5.19	226.6	0.09	7882
2014	3	6	10	3.1	3.2	48.9	63.3	0.01	7.11	221.6	0.07	7890
2014	3	6	11	1.8	1.9	86.6	69.3	0	7.77	227.5	0.03	7900.7
2014	3	6	12	1.2	1.1	182	72.6	0	5.52	230.9	-0.04	7903.4
2014	3	6	13	1.4	1.4	290.2	70.3	0	7.34	229.3	-0.01	7904.7
2014	3	6	14	1.6	1.6	337.8	67.3	0.01	6.75	233.6	-0.04	7906
2014	3	6	15	1.8	1.8	357.3	65.3	0	5.15	221.5	-0.05	7904.7
2014	3	6	16	0.8	0.8	303.1	73.2	0.02	4.29	225.9	-0.08	7896.7
2014	3	6	17	1.6	1.5	229.3	70.4	0	6.28	232.5	-0.05	7898
2014	3	6	18	0.9	0.8	95.2	88.9	0	4.7	236.8	-0.07	7900.7
2014	3	6	19	0.8	0.7	54	78.7	0	3.71	235.7	-0.04	7904.7
2014	3	6	20	0	-0.1	4.9	84.3	0	2.32	240.1	-0.08	7903.4
2014	3	6	21	-0.3	-0.4	0.1	94.9	0	1.64	221.5	-0.01	7911.4
2014	3	6	22	-0.2	-0.1	0.1	79.1	0	1.37	269.7	0.04	7916.7
2014	3	6	23	0.3	0.4	0.1	77.6	0	1.6	271.6	0.09	7920.7
2014	3	6	24	-0.7	-0.5	0.1	88.6	0	1.3	75	0.16	7924.7
2014	3	7	1	-0.8	-0.7	0.1	86.3	0	1.11	267.5	0.04	7934
2014	3	7	2	-1.9	-1.9	0.1	93.3	0	0.87	14.1	-0.02	7938
2014	3	7	3	-2	-1.9	0.1	88.5	0	0.75	78.5	0.08	7943.3
2014	3	7	4	-2.1	-2.1	0.1	95.1	0	0.42	179.2	-0.06	7948.7
2014	3	7	5	-2.7	-2.7	0.1	97.6	0.01	0.8	239.4	-0.02	7950
2014	3	7	6	-3.4	-3.2	0.1	95.7	0	0.61	33.9	0.2	7954
2014	3	7	7	-3.6	-3.2	0.1	92	0	0.82	41.5	0.35	7959.3
2014	3	7	8	-4.6	-4.3	0.1	93.1	0	0.83	238.8	0.33	7964.7
2014	3	7	9	-4.7	-4.4	11.1	93.6	0	0.66	261.8	0.27	7971.3
2014	3	7	10	-4.2	-4	55.8	85.1	0	0.74	236.7	0.23	7974
2014	3	7	11	-2.7	-2.8	112.2	90	0	1.43	72.3	-0.1	7978
2014	3	7	12	-1.5	-1.7	224.4	70.1	0.01	1.25	97.1	-0.2	7982
2014	3	7	13	-0.4	-0.4	292.4	71.1	0.02	2.65	84.8	-0.06	7987.3
2014	3	7	14	0.1	0.1	273.7	67.4	0.01	2.89	87.4	-0.04	7990
2014	3	7	15	0.3	0.3	274.2	63.6	0	3.21	74.3	-0.02	7998
2014	3	7	16	0.8	0.7	290.2	64.5	0.01	2.21	205.7	-0.12	7996.7
2014	3	7	17	1.1	1	314.8	61.7	0.01	2.82	220.6	-0.12	7999.3
2014	3	7	18	1.2	1.2	187.9	62	0	1.32	135.7	-0.04	8000.7
2014	3	7	19	0.7	1	96.9	67.9	0.01	2.07	46.5	0.3	8000.7
2014	3	7	20	-1.3	-0.7	12.7	77	0	1.89	263.1	0.6	8000.7
2014	3	7	21	-3.5	-3.2	0.1	82.8	0	1.69	245	0.39	8003.3
2014	3	7	22	-5.5	-4.6	0.1	88.5	0	1.75	241.6	0.89	8010
2014	3	7	23	-6.7	-5.9	0.1	90.3	0	1.74	247	0.8	8015.3
2014	3	7	24	-7.7	-6.5	0.1	94.8	0	1.55	240.1	1.2	8020.7
2014	3	8	1	-7.4	-6.8	0.1	93.2	0	1.7	245.7	0.59	8024.7
2014	3	8	2	-8.6	-7.6	0.1	91.1	0	1.79	244.1	0.98	8024.7

2014	3	8	3	-8.8	-7.7	0.1	95.1	0	1.69	238.3	1.17	8027.3
2014	3	8	4	-9.1	-8.1	0.1	96.4	0	1.54	241.4	1	8026
2014	3	8	5	-9.6	-8	0.1	94.3	0	1.62	239.1	1.56	8019.3
2014	3	8	6	-10.1	-8.8	0.1	92.9	0	1.77	237.6	1.33	8019.3
2014	3	8	7	-10.4	-9	0	91.7	0	2.2	238.5	1.36	8015.3
2014	3	8	8	-10.1	-9	0.3	93.8	0	1.19	245.4	1.07	8018
2014	3	8	9	-10.1	-9	24.9	88.4	0	1.64	233.8	1.09	8026
2014	3	8	10	-8.9	-7.7	213.4	73.2	0	1.56	238.5	1.21	8027.3
2014	3	8	11	-5.1	-4.4	365.2	54.6	0	0.57	144	0.7	8022
2014	3	8	12	-1.4	-1.4	498.5	54.9	0	1.19	75.4	0.04	8020.7
2014	3	8	13	2.2	2.2	552	32.9	0	1.08	74.5	0.1	8019.3
2014	3	8	14	5.8	5.9	589.5	25	0.01	3.67	219.3	0.14	8011.3
2014	3	8	15	6.1	6.3	475.2	28.2	0.01	6.16	231.9	0.13	8006
2014	3	8	16	5.8	5.9	356.3	28.7	0.01	7.23	237.4	0.11	8003.3
2014	3	8	17	5.8	5.9	241.1	29	0	5.54	229.5	0.09	8006
2014	3	8	18	6	6.1	159.9	27.6	0	4.73	240.1	0.07	8002
2014	3	8	19	5.9	6	73.1	23.6	0	6.02	239.6	0.12	7999.3
2014	3	8	20	5.4	5.6	10.2	30.8	0	5.01	243.6	0.2	7992.7
2014	3	8	21	4.8	5	0.1	31.7	0	2.99	241.9	0.27	7992.7
2014	3	8	22	4.8	5.1	0.1	34.8	0	3.79	232.7	0.28	7994
2014	3	8	23	5.3	5.5	0.1	35.4	0	5.51	233.3	0.24	7995.3
2014	3	8	24	5.5	5.8	0.1	39.7	0	6.31	222.6	0.23	7992.7
2014	3	9	1	5.3	5.5	0.1	41.3	0	4.72	239	0.24	7992.7
2014	3	9	2	5.7	5.9	0.1	38.7	0	5.58	223.8	0.21	7991.3
2014	3	9	3	5.6	5.8	0.1	54.3	0	4.62	220.1	0.14	7988.7
2014	3	9	4	3.7	3.7	0.1	78.4	0	6.37	211.3	0.02	7990
2014	3	9	5	2.6	2.6	0.1	80.8	0	4.59	220.7	0	7987.3
2014	3	9	6	2.3	2.2	0.1	87.9	0	5.47	237.4	-0.02	7984.7
2014	3	9	7	2	2	0.1	88.9	0	1.67	207	0.02	7980.7
2014	3	9	8	2.6	2.6	0.1	91	0	3.39	223.1	0.08	7976.7
2014	3	9	9	1.5	1.7	13.2	91.7	0	1.22	70.4	0.19	7974
2014	3	9	10	2.6	2.6	56.8	88.5	0	2.62	254.3	0.02	7974
2014	3	9	11	2.3	2.4	83.4	94.3	0.02	1.14	59.2	0.07	7972.7
2014	3	9	12	1.8	1.9	112	90.5	0.04	1.22	248.1	0.12	7975.3
2014	3	9	13	3.1	3.1	183.8	81.4	0.03	3.91	231.4	-0.01	7982
2014	3	9	14	3.5	3.5	179.2	84.9	0.01	4.97	236.8	0.01	7979.3
2014	3	9	15	3.4	3.4	200.6	87.8	0.01	3.57	241.3	0.04	7978
2014	3	9	16	2.9	3	99.3	93.3	0	2.92	241.2	0.08	7975.3
2014	3	9	17	2.9	3	120.2	91.2	0.01	3.44	244.3	0.08	7976.7
2014	3	9	18	3.1	3.1	58.1	93.4	0.01	2.91	246.4	0.01	7974
2014	3	9	19	3.1	3.3	29.3	93	0	1.69	254.2	0.23	7970
2014	3	9	20	2.6	2.7	3	99.4	0.01	0.85	243.8	0.14	7966
2014	3	9	21	2.1	2.5	0.1	97.9	0.02	0.77	288.6	0.41	7962
2014	3	9	22	2.1	2.3	0.1	99.5	0.02	0.65	276.6	0.27	7954
2014	3	9	23	1.5	1.6	0.1	100	0.08	0.62	43.9	0.11	7950
2014	3	9	24	0.8	0.7	0.1	100	0.07	1.35	77.6	-0.04	7946
2014	3	10	1	0.1	0	0.1	100	0.06	1.14	69.6	-0.1	7939.3
2014	3	10	2	0.1	0.1	0.1	100	0.04	1.04	241.3	0.03	7932.7
2014	3	10	3	1.1	1.3	0.1	100	0.04	0.76	253.8	0.29	7924.7
2014	3	10	4	2.4	2.8	0.1	88.3	0.05	4.51	231	0.36	7915.4
2014	3	10	5	2.7	3	0.1	86.7	0.06	7.81	235.2	0.29	7908.7
2014	3	10	6	2.5	2.5	0.1	87.2	0.03	5.79	231.9	0.01	7902
2014	3	10	7	1.8	1.8	0.1	89.8	0.04	4.41	225.2	0.02	7896.7
2014	3	10	8	0.9	0.9	0.1	100	0.04	1.62	327.8	-0.02	7896.7
2014	3	10	9	-0.1	-0.2	1.6	100	0.07	1.38	81.6	-0.09	7896.7
2014	3	10	10	-0.7	-0.8	12.6	100	0.02	0	0	-0.12	7900.7
2014	3	10	11	-1	-1.2	29.4	100	0.02	0	0	-0.13	7898
2014	3	10	12	-1	-1.1	44.3	100	0.1	0	0	-0.14	7900.7
2014	3	10	13	-0.9	-1	81	98.3	0.04	0	0	-0.11	7896.7
2014	3	10	14	-0.8	-0.9	80	96.5	0.03	1.22	48.4	-0.13	7895.4
2014	3	10	15	-1.1	-1.3	85.6	86.5	0.01	5.04	234.7	-0.12	7898

2014	3	10	16	-1.4	-1.5	146.9	88.6	0.01	4.41	231.5	-0.14	7902
2014	3	10	17	-2	-2.1	91.9	86.8	0	2.19	231.8	-0.14	7911.4
2014	3	10	18	-1.9	-2	84.1	83	0.01	1.24	155.3	-0.11	7918
2014	3	10	19	-1.5	-1.5	51	82.5	0	3.56	225	-0.02	7920.7
2014	3	10	20	-2.2	-2.3	5.4	81.7	0	4.8	221.6	-0.02	7923.4
2014	3	10	21	-2.6	-2.6	0.1	94.2	0	4.99	215.4	0.01	7935.3
2014	3	10	22	-3.4	-3.4	0.1	77.8	0	1.6	263	0.03	7946
2014	3	10	23	-3.9	-3.9	0.1	96.2	0	1.97	268	-0.08	7947.3
2014	3	10	24	-4	-4.1	0.1	84.2	0	2.12	90.2	-0.04	7959.3
2014	3	11	1	-3.5	-3.5	0.1	82.6	0.01	2.09	251.7	-0.02	7964.7
2014	3	11	2	-4.3	-4.3	0.1	92.4	0	0.97	62.4	0.06	7970
2014	3	11	3	-4.6	-4.5	0.1	96.1	0	0.67	58.5	0.05	7972.7
2014	3	11	4	-4.8	-4.8	0.1	98	0	0.98	64.1	-0.02	7979.3
2014	3	11	5	-4.7	-4.8	0.1	97.2	0.01	1.6	80.6	-0.04	7983.3
2014	3	11	6	-5.1	-5.1	0.1	97.3	0.01	1.19	58.2	0.09	7987.3
2014	3	11	7	-5.1	-5.1	0.1	98.1	0	1.31	58.1	0.09	7995.3
2014	3	11	8	-5.8	-5.5	0.2	96.6	0	0.61	293.3	0.29	8003.3
2014	3	11	9	-5.8	-5.5	9.7	93.4	0	0.72	323.7	0.32	8012.7
2014	3	11	10	-5.4	-5.1	69.1	78.6	0.01	2.88	86.6	0.33	8020.7
2014	3	11	11	-3.4	-3.6	264.7	62.5	0.01	4.93	62.1	-0.18	8031.3
2014	3	11	12	-3.1	-3.2	260.9	62.2	0.02	4.31	55.3	-0.08	8038
2014	3	11	13	-2.7	-2.7	376.8	58.2	0.01	3.79	48.1	-0.08	8046
2014	3	11	14	-2.2	-2.3	495.4	53.9	0.01	3.64	47	-0.11	8047.3
2014	3	11	15	-1.4	-1.6	641.1	51.8	0.02	2.97	68.8	-0.16	8048.7
2014	3	11	16	-0.9	-1.1	700.7	50.1	0.02	3.53	91.2	-0.17	8044.7
2014	3	11	17	-0.5	-0.6	635.8	48.8	0.02	1.89	46	-0.08	8043.3
2014	3	11	18	-0.3	-0.4	415.2	51.3	0.02	0.77	32.7	-0.05	8043.3
2014	3	11	19	-1.1	-1	171.9	77.1	0.01	1.58	303.1	0.12	8047.3
2014	3	11	20	-4.9	-4.4	8.6	81.8	0	2.49	229.3	0.52	8051.3
2014	3	11	21	-7.1	-6.6	0.1	89.2	0	1.9	242.2	0.47	8047.3
2014	3	11	22	-8.8	-8.2	0.1	90.2	0	1.91	238.2	0.69	8052.7
2014	3	11	23	-10.1	-9.2	0.1	89.4	0	1.9	240.8	0.88	8055.3
2014	3	11	24	-11	-9.9	0.1	90.8	0	1.97	240.9	1.07	8058
2014	3	12	1	-11.5	-10.3	0.1	93.6	0	1.9	239.3	1.17	8059.3
2014	3	12	2	-11.8	-10.7	0.1	94.2	0	1.89	239	1.09	8059.3
2014	3	12	3	-12.2	-10.9	0.1	88.5	0	1.97	239.5	1.34	8059.3
2014	3	12	4	-12.3	-11	0.1	93	0	1.61	239.9	1.25	8058
2014	3	12	5	-12.8	-11.4	0.1	91	0	1.76	235.7	1.34	8056.7
2014	3	12	6	-13.1	-11.5	0.1	91.3	0	1.65	243.1	1.56	8054
2014	3	12	7	-13.2	-11.7	0.1	90	0	1.7	241	1.43	8056.7
2014	3	12	8	-13.4	-12	0.5	92	0	1.83	237.5	1.32	8058
2014	3	12	9	-13.1	-11.8	41.9	88.7	0	1.68	237.5	1.36	8055.3
2014	3	12	10	-11.8	-10.2	212.8	77.5	0	1.25	243.8	1.58	8054
2014	3	12	11	-7.6	-7.2	395.7	58.3	0	0.57	228	0.45	8052.7
2014	3	12	12	-3.7	-3.6	599.1	41.3	0	0.36	128.4	0.18	8051.3
2014	3	12	13	-0.5	-0.5	710.8	26.2	0	0.27	189	0.05	8048.7
2014	3	12	14	1.6	1.8	757	37.9	0	1.56	74.3	0.18	8040.7
2014	3	12	15	3.4	3.8	745.7	33.7	0	2.72	67.2	0.4	8032.7
2014	3	12	16	5	5.2	678.7	30	0	2.5	60.2	0.22	8023.3
2014	3	12	17	5.6	5.8	559.3	35.5	0	2.47	49.4	0.23	8016.7
2014	3	12	18	5.6	5.8	393.8	39.8	0.01	2.74	23.8	0.18	8012.7
2014	3	12	19	4.4	4.8	165.1	71.5	0	1.39	348.4	0.42	8008.7
2014	3	12	20	0.2	0.8	9.6	79	0	1.68	233.4	0.59	8007.3
2014	3	12	21	-1.5	-1	0.1	81.9	0	1.61	241.8	0.47	8003.3
2014	3	12	22	-3.3	-2.7	0.1	84.2	0	1.85	241.1	0.65	8003.3
2014	3	12	23	-5.2	-4.3	0.1	84.3	0	1.87	240.9	0.86	8004.7
2014	3	12	24	-6.7	-5.7	0.1	89.4	0	1.97	237.3	0.99	8004.7
2014	3	13	1	-7.5	-6.4	0.1	88.1	0	1.99	237.2	1.11	7998
2014	3	13	2	-8.5	-7	0.1	86.9	0	1.43	244.5	1.48	7990
2014	3	13	3	-9.5	-7.8	0.1	79.5	0	2.05	232.2	1.62	7986
2014	3	13	4	-9.8	-8.5	0.1	80.8	0	1.8	239	1.35	7982

2014	3	13	5	-10.3	-8.6	0.1	83.7	0	1.41	236.6	1.63	7976.7
2014	3	13	6	-10.9	-8.9	0.1	78.8	0	2.09	233.5	1.98	7975.3
2014	3	13	7	-10.4	-9.2	0.1	82.5	0	1.59	238.4	1.19	7972.7
2014	3	13	8	-11.1	-9.1	0.8	87	0	1.49	240.1	1.93	7967.3
2014	3	13	9	-10.5	-9.3	55.4	79.4	0	1.62	238.5	1.21	7968.7
2014	3	13	10	-8.8	-7.4	260.3	47.5	0	1.1	239.4	1.36	7967.3
2014	3	13	11	-4.9	-4.4	450.5	34.6	0	0.79	216.6	0.51	7967.3
2014	3	13	12	-0.5	-0.4	612.5	39.4	0	0.69	68.1	0.15	7966
2014	3	13	13	2.8	2.9	712.5	35.9	0	4.14	57.3	0.1	7962
2014	3	13	14	4	4	785	30.2	0	4.12	184.1	0.02	7959.3
2014	3	13	15	4.6	4.6	767.7	27.2	0	3.47	231	0.02	7955.3
2014	3	13	16	5.1	5.1	704.9	26.3	0	2.15	154.1	0	7955.3
2014	3	13	17	5.2	5.3	539	28.3	0	2.31	78.8	0.06	7955.3
2014	3	13	18	5.1	5.3	390.1	28.7	0	2.66	62	0.2	7954
2014	3	13	19	4.6	4.9	144	37.3	0	1.95	22.6	0.29	7952.7
2014	3	13	20	1	1.7	10.9	61.5	0	1.85	239	0.71	7954
2014	3	13	21	-1.6	-1.1	0.1	70.5	0	1.99	240.9	0.5	7954
2014	3	13	22	-3.5	-2.9	0.1	70.9	0	2.03	242.9	0.64	7954
2014	3	13	23	-4.7	-4	0.1	75.7	0	1.63	244.6	0.75	7955.3
2014	3	13	24	-5.8	-5	0.1	70.6	0	1.74	239.8	0.77	7958
2014	3	14	1	-6.7	-5.5	0.1	80.2	0	1.68	240.3	1.25	7956.7
2014	3	14	2	-7.2	-5.9	0.1	80.8	0	1.58	236.2	1.31	7958
2014	3	14	3	-7.6	-6.3	0.1	85.4	0	1.31	233.6	1.25	7958
2014	3	14	4	-7.9	-6.5	0.1	87.7	0	1.33	239.7	1.41	7958
2014	3	14	5	-8.2	-6.6	0.1	88.4	0	1.71	230.7	1.6	7955.3
2014	3	14	6	-6.7	-5.5	0.1	77	0	1.01	242.4	1.17	7951.3
2014	3	14	7	-5.9	-4.9	0.1	76.9	0	0.32	295.2	0.99	7948.7
2014	3	14	8	-5.5	-4.6	0.6	76.7	0	0.74	244.6	0.96	7948.7
2014	3	14	9	-4.8	-3.8	40.4	76.5	0	0.92	242.5	1.01	7950
2014	3	14	10	-3.2	-2.8	138.6	65	0	0.79	57.9	0.41	7946
2014	3	14	11	-1.2	-0.6	177.5	54	0	1.46	59.5	0.54	7947.3
2014	3	14	12	2.3	2.3	259	58.4	0	4.49	225.5	0.05	7948.7
2014	3	14	13	1.3	1.2	248.9	72.2	0	4.58	234.1	-0.09	7950
2014	3	14	14	0.7	0.6	240.6	79.3	0	3.07	230.2	-0.16	7951.3
2014	3	14	15	0.2	0	217.1	86.6	0	1.63	186.8	-0.12	7951.3
2014	3	14	16	0.7	0.5	165.8	90.9	0	2.43	233.3	-0.13	7951.3
2014	3	14	17	0.5	0.4	171.3	75.9	0	2.37	183.9	-0.06	7955.3
2014	3	14	18	1.1	1.1	160.8	75.7	0	3.46	235.1	-0.06	7958
2014	3	14	19	1.5	1.5	62.4	70.5	0	2.1	236.4	-0.02	7956.7
2014	3	14	20	1.1	1.1	10.9	73.6	0	2.16	247.6	0.01	7963.3
2014	3	14	21	0.9	1	0.1	65.3	0	2.18	250.5	0.12	7966
2014	3	14	22	0.3	0.5	0.1	66.7	0	1.24	162.8	0.18	7970
2014	3	14	23	-0.7	-0.6	0.1	68.9	0	1.81	154.2	0.17	7978
2014	3	14	24	-2.2	-1.9	0.1	60.3	0	1.22	239.1	0.36	7987.3
2014	3	15	1	-2.2	-1.9	0.1	64.8	0	0.7	325.2	0.24	7991.3
2014	3	15	2	-2.5	-2.4	0.1	65.2	0	0.42	132.2	0.13	7994
2014	3	15	3	-3.6	-3.1	0.1	72.3	0	1.01	238.1	0.47	7998
2014	3	15	4	-7.1	-6.2	0.1	79.8	0	1.96	232.3	0.97	8003.3
2014	3	15	5	-8.8	-7.8	0.1	81	0	2.48	229.8	0.96	8011.3
2014	3	15	6	-8.9	-8.4	0.1	82.5	0	1.45	236.9	0.47	8018
2014	3	15	7	-9.6	-8.8	0.1	85.2	0	1.33	237.8	0.78	8024.7
2014	3	15	8	-10.2	-9.4	1.2	87.2	0	1.11	251.9	0.79	8031.3
2014	3	15	9	-11.5	-10.2	67.5	85.3	0	1.5	234.3	1.3	8038
2014	3	15	10	-9.4	-8.2	269.4	64.3	0	0.99	237.7	1.18	8042
2014	3	15	11	-5.6	-5.5	458.7	45.1	0	0.44	101.9	0.13	8044.7
2014	3	15	12	-2.3	-2.3	611	49.5	0	2.13	81.1	-0.04	8048.7
2014	3	15	13	0.4	0.3	718.8	35.8	0	2.95	67.1	-0.03	8050
2014	3	15	14	2.1	2.2	742.2	30	0	3.1	60.3	0.03	8052.7
2014	3	15	15	3.5	3.5	622.1	24.5	0	2.63	61.1	0.04	8051.3
2014	3	15	16	4.5	4.4	499.9	20.4	0	2.21	231.7	-0.08	8048.7
2014	3	15	17	4.4	4.5	330	27.5	0.01	2.63	175.3	0.08	8051.3

2014	3	15	18	4.5	4.6	193.5	28	0	2.28	195.4	0.09	8052.7
2014	3	15	19	4	4.3	85.6	32.1	0	2.61	232.3	0.3	8051.3
2014	3	15	20	3.1	3.5	22.8	50.1	0	0.99	250.4	0.37	8051.3
2014	3	15	21	0.1	0.5	0.1	59.4	0	1.29	240.3	0.37	8050
2014	3	15	22	-1.4	-0.8	0.1	64	0	1.39	234.5	0.6	8054
2014	3	15	23	-2.7	-1.7	0.1	64.9	0	1.46	237.4	1.09	8054
2014	3	15	24	-3.6	-2.6	0.1	70.7	0	1.45	242.6	0.96	8058
2014	3	16	1	-4.6	-3.6	0.1	72.3	0	1.45	239.9	1.02	8059.3
2014	3	16	2	-5.1	-3.9	0.1	67.5	0	1	239.9	1.16	8054
2014	3	16	3	-5.3	-4.1	0.1	71.3	0	1.4	240.4	1.22	8050
2014	3	16	4	-5.1	-3.9	0.1	72.3	0	0.83	242.5	1.23	8048.7
2014	3	16	5	-5	-3.7	0.1	77.5	0	0.78	238.3	1.38	8046
2014	3	16	6	-4.5	-2.9	0.1	69.8	0	0.83	255.5	1.59	8036.7
2014	3	16	7	-4.2	-2.7	0.1	65.5	0	1.01	266.3	1.47	8031.3
2014	3	16	8	-0.5	1.6	1	48.6	0	1.21	339	2.14	8024.7
2014	3	16	9	0.5	2.3	84	38.1	0	1.06	34.3	1.78	8022
2014	3	16	10	4.6	4.9	219.7	28	0	4.07	234.8	0.37	8023.3
2014	3	16	11	5.6	5.8	269.4	28.2	0	6.55	233.4	0.23	8020.7
2014	3	16	12	6.5	6.6	406	25.6	0	5	236	0.12	8019.3
2014	3	16	13	7.1	7.3	520.5	23.4	0	6.49	230.7	0.15	8014
2014	3	16	14	8	8.1	568.5	26.4	0	5.71	230.6	0.13	8006
2014	3	16	15	8.1	8.2	583.2	26.4	0	4.5	212.7	0.12	8000.7
2014	3	16	16	8.1	8.3	522.5	24.6	0	6.52	230.7	0.19	7988.7
2014	3	16	17	8	8.3	344.5	24	0	6.13	228.1	0.31	7979.3
2014	3	16	18	7.8	8.1	173.7	26	0	4.56	211.3	0.32	7972.7
2014	3	16	19	7	7.3	63.4	30.6	0	4.05	204.7	0.32	7964.7
2014	3	16	20	6.7	7	13.8	37.5	0	3.89	191.1	0.27	7952.7
2014	3	16	21	6.5	6.9	0.1	32.6	0	3.43	226.8	0.4	7940.7
2014	3	16	22	7.4	7.8	0.1	29.9	0	5.38	215.6	0.42	7923.4
2014	3	16	23	7.4	7.8	0.1	29.6	0	5.93	206.4	0.43	7914
2014	3	16	24	7.6	8	0.1	31.7	0	6.49	207.6	0.37	7900.7
2014	3	17	1	7.3	7.7	0.1	29.5	0	5.58	210	0.4	7891.4
2014	3	17	2	6.8	7.1	0.1	28	0	4.54	212.6	0.32	7875.4
2014	3	17	3	6.2	6.5	0.1	32	0	4.33	211	0.24	7860.7
2014	3	17	4	5.2	5.4	0.1	40.6	0	4.66	209	0.18	7851.4
2014	3	17	5	3.7	3.7	0.1	60.1	0	6.28	245.7	0.06	7836.7
2014	3	17	6	0.5	0.4	0.1	84.3	0	3.05	251.4	-0.09	7835.4
2014	3	17	7	-1.6	-1.7	0.1	98.5	0	1.23	201.7	-0.12	7826
2014	3	17	8	-1.8	-1.9	0.1	93.5	0	1.65	83.8	-0.09	7820.7
2014	3	17	9	-3.4	-3.5	10.2	88	0	4.64	133.4	-0.1	7827.4
2014	3	17	10	-3.9	-3.9	97	68.7	0	3.65	157.8	-0.09	7844.7
2014	3	17	11	-4.5	-4.6	149	67.7	0.01	4.4	223.2	-0.1	7852.7
2014	3	17	12	-4.7	-4.8	275.4	75.7	0	3.56	217.3	-0.16	7867.4
2014	3	17	13	-5.1	-5.2	326.2	75.1	0.01	5.53	230.7	-0.15	7876.7
2014	3	17	14	-4.7	-4.9	418.4	62.6	0.01	2.98	216.3	-0.21	7886
2014	3	17	15	-3.7	-4	615.1	63.6	0.02	2.79	193.2	-0.27	7894
2014	3	17	16	-4.5	-4.6	280.1	57.8	0.01	3.49	173.2	-0.14	7899.4
2014	3	17	17	-3.8	-3.9	382.6	54.1	0	3.53	154.7	-0.12	7907.4
2014	3	17	18	-4.2	-4.2	226.2	54.2	0	3.42	151.1	-0.05	7915.4
2014	3	17	19	-4.6	-4.7	122.7	58.4	0	3.4	78.4	-0.01	7920.7
2014	3	17	20	-5.1	-5	30.7	59.1	0	2.32	97.3	0.06	7926
2014	3	17	21	-5.9	-5.7	0.2	62.4	0	1.47	207.2	0.13	7930
2014	3	17	22	-6.2	-6.1	0.1	72.9	0	1.98	219.8	0.12	7934
2014	3	17	23	-7.3	-7.1	0.1	82.1	0	1.15	304	0.15	7939.3
2014	3	17	24	-7.5	-7.3	0.1	83.6	0	0.93	280.2	0.16	7943.3
2014	3	18	1	-7.5	-7.4	0.1	84.9	0	0.89	22.4	0.1	7944.7
2014	3	18	2	-7.9	-7.7	0.1	88.2	0	0.68	30.2	0.19	7947.3
2014	3	18	3	-8.6	-8.5	0.1	87.1	0	1.04	252.2	0.12	7947.3
2014	3	18	4	-9	-8.8	0.1	90	0	0.67	241.5	0.24	7950
2014	3	18	5	-10.2	-9.8	0.1	83.2	0	1.78	243.8	0.37	7950
2014	3	18	6	-11.2	-10.9	0.1	86.8	0	1.71	243.7	0.32	7951.3

2014	3	18	7	-11.6	-11.4	0.1	84.7	0	1.55	229.3	0.17	7954
2014	3	18	8	-11.3	-11	1.7	86.3	0	1.05	225.4	0.3	7956.7
2014	3	18	9	-11.8	-11.4	67.9	84.2	0	1.42	236.5	0.44	7959.3
2014	3	18	10	-11.6	-11.1	273.2	68.3	0	1.15	235	0.57	7963.3
2014	3	18	11	-8.1	-7.9	491.9	54.3	0	0.7	172.4	0.18	7966
2014	3	18	12	-4.8	-5	597.4	45.4	0.01	2.44	85.2	-0.21	7966
2014	3	18	13	-4	-4.2	542.3	46.1	0	2.66	84.4	-0.18	7966
2014	3	18	14	-3	-3.3	790.6	41.6	0	1.78	133.5	-0.25	7966
2014	3	18	15	-2.4	-2.6	584.8	39	0.02	1.36	205.7	-0.29	7962
2014	3	18	16	-2.2	-2.3	297.6	43.2	0.01	3.09	64.5	-0.12	7959.3
2014	3	18	17	-1.6	-1.8	391	43	0	3.83	72.8	-0.12	7962
2014	3	18	18	-1.8	-1.9	314.1	47.3	0	2.56	76.1	-0.1	7964.7
2014	3	18	19	-2.5	-2.5	121.5	48.9	0	2.41	74.9	0	7966
2014	3	18	20	-2.7	-2.7	26.6	51.5	0	2.31	83.6	-0.01	7968.7
2014	3	18	21	-4	-3.7	0.2	60.2	0	1.21	255.1	0.3	7970
2014	3	18	22	-7.4	-7.1	0.1	67.8	0	1.6	244.1	0.27	7974
2014	3	18	23	-10.1	-9.5	0.1	73.2	0	1.8	240.3	0.58	7975.3
2014	3	18	24	-11.5	-10.8	0.1	77.2	0	1.93	241.8	0.69	7976.7
2014	3	19	1	-12	-11.2	0.1	79.4	0	1.87	240.9	0.79	7974
2014	3	19	2	-12.3	-11.4	0.1	83.1	0	1.53	240	0.89	7972.7
2014	3	19	3	-12.6	-11.6	0.1	87.6	0	1.4	239.7	1.04	7968.7
2014	3	19	4	-12.6	-11.6	0.1	80.7	0	1.37	242.8	1.01	7970
2014	3	19	5	-12.8	-11.6	0.1	86	0	1.56	235.5	1.25	7967.3
2014	3	19	6	-13	-11.8	0.1	89.9	0	1.22	242.9	1.14	7964.7
2014	3	19	7	-13.3	-12.1	0.1	86	0	1.28	240.7	1.24	7964.7
2014	3	19	8	-13	-12	1.7	82.8	0	1.74	237.3	1.02	7972.7
2014	3	19	9	-11.6	-10.7	56.5	78.6	0	1.66	234.4	0.93	7967.3
2014	3	19	10	-10.1	-9.4	266.6	63.7	0	0.99	47	0.71	7966
2014	3	19	11	-5.7	-5.3	491.2	44	0	1.33	93.9	0.32	7959.3
2014	3	19	12	-1.7	-1.8	641.3	45	0	4.63	232.7	-0.12	7958
2014	3	19	13	-0.7	-0.8	754.9	42.6	0	5.98	232.3	-0.13	7954
2014	3	19	14	-0.1	-0.2	819	41.3	0	6.51	235.4	-0.13	7950
2014	3	19	15	0.5	0.4	784.8	42.6	0	6.5	236.3	-0.12	7947.3
2014	3	19	16	0.8	0.8	718.8	45.3	0	7.23	233	-0.08	7944.7
2014	3	19	17	1.4	1.3	588	39.6	0.01	7.25	232.8	-0.04	7939.3
2014	3	19	18	1.6	1.6	357.5	36.6	0	6.7	228.5	0.02	7938
2014	3	19	19	1.2	1.2	167.6	40.5	0	7.33	237.2	0.01	7936.7
2014	3	19	20	0.5	0.6	29.4	45.2	0	4.23	237.9	0.1	7936.7
2014	3	19	21	0.1	0.2	0.2	44.2	0	4.28	211.1	0.11	7936.7
2014	3	19	22	-0.2	0	0.1	47	0	3.52	229.5	0.16	7935.3
2014	3	19	23	0.1	0.3	0.1	43.5	0	3.56	241	0.17	7932.7
2014	3	19	24	0.3	0.5	0.1	46.2	0	2.82	235.7	0.26	7930
2014	3	20	1	-0.1	0.2	0.1	51.2	0	1.5	235.2	0.35	7927.3
2014	3	20	2	-1.2	-0.6	0.1	51.7	0	1.15	314.4	0.66	7926
2014	3	20	3	-0.4	0.1	0.1	44.3	0	1.54	37.5	0.44	7920.7
2014	3	20	4	0.2	0.2	0.1	50.9	0	3.09	233.3	0.08	7920.7
2014	3	20	5	-1.1	-0.8	0.1	57.1	0	1.12	258	0.29	7923.4
2014	3	20	6	-1.8	-1.6	0.1	61.5	0	1.71	252.2	0.23	7922
2014	3	20	7	-2.1	-2	0.1	64.6	0	1.63	254.3	0.07	7922
2014	3	20	8	-2.5	-2.4	2.8	67.5	0	3.3	238.1	0.04	7924.7
2014	3	20	9	-3.4	-3.4	28.8	73.4	0	5.2	228.9	-0.03	7927.3
2014	3	20	10	-3.8	-3.8	192.3	57.2	0	5.4	223.4	-0.07	7932.7
2014	3	20	11	-3.3	-3.5	624.3	54	0	7.48	224	-0.17	7934
2014	3	20	12	-3.2	-3.4	604.8	48.1	0	6.81	227.2	-0.2	7939.3
2014	3	20	13	-2.6	-2.9	731.3	44.2	0	6.53	224.3	-0.23	7939.3
2014	3	20	14	-2	-2.3	787.4	34.9	0	5.57	220	-0.24	7940.7
2014	3	20	15	-1.7	-1.9	731.8	29.8	0	3.98	234.8	-0.22	7943.3
2014	3	20	16	-1.5	-1.7	724.9	25.4	0	2.74	211.2	-0.23	7943.3
2014	3	20	17	-1.5	-1.7	606.6	22.6	0	3.34	210	-0.17	7943.3
2014	3	20	18	-1.9	-2	437.7	25.7	0	4.01	238.7	-0.08	7944.7
2014	3	20	19	-2.8	-2.8	191.2	29.1	0	3.74	224.5	-0.05	7946

2014	3	20	20	-4.2	-4	13.2	34	0	3.47	239.2	0.19	7951.3
2014	3	20	21	-5.5	-5.3	0.3	41.5	0	0.73	154.3	0.23	7955.3
2014	3	20	22	-7.3	-6.8	0.1	48.4	0	1.04	252.5	0.52	7959.3
2014	3	20	23	-9.7	-9.3	0.1	61	0	0.83	223	0.41	7964.7
2014	3	20	24	-11.1	-10.7	0.1	66.2	0	1.23	245.2	0.37	7968.7
2014	3	21	1	-12.9	-12.4	0.1	72.5	0	1.64	240.5	0.56	7971.3
2014	3	21	2	-13.8	-13.2	0.1	74.5	0	1.62	240.9	0.67	7974
2014	3	21	3	-14.8	-13.9	0.1	77.7	0	1.89	236.5	0.89	7976.7
2014	3	21	4	-15.3	-14.5	0.1	78.7	0	1.52	245.7	0.82	7976.7
2014	3	21	5	-15.9	-15	0.1	82.9	0	1.93	239.3	0.93	7971.3
2014	3	21	6	-16.3	-15.4	0.1	83.1	0	1.8	240.6	0.87	7972.7
2014	3	21	7	-16.6	-15.7	0.1	84	0	1.94	239	0.93	7970
2014	3	21	8	-16.5	-15.7	3.2	82.9	0	1.83	239.2	0.82	7970
2014	3	21	9	-16.1	-14.8	97	77.2	0	1.67	236.4	1.27	7970
2014	3	21	10	-13.2	-12.3	291.3	55.8	0	1.38	227.7	0.88	7968.7
2014	3	21	11	-8.1	-8	406.5	45.3	0	1.98	236.9	0.07	7964.7
2014	3	21	12	-6.3	-6.5	501.8	39.6	0	1.4	198.2	-0.26	7962
2014	3	21	13	-5.1	-5.3	649.1	30.9	0	1	128.6	-0.29	7958
2014	3	21	14	-3.4	-3.7	714.2	24.6	0	2.51	226.1	-0.32	7955.3
2014	3	21	15	-2.3	-2.6	655.2	30	0	3.24	233.3	-0.24	7950
2014	3	21	16	-2	-2.1	583.3	27.5	0	4.32	50.9	-0.08	7946
2014	3	21	17	-1.8	-1.8	501.8	23.4	0	3.89	51.6	0.02	7944.7
2014	3	21	18	-1.5	-1.5	401.3	25.2	0	2.32	63.8	0.03	7943.3
2014	3	21	19	-1.5	-1.5	106.8	23.4	0	2.23	87.6	0	7942
2014	3	21	20	-2.5	-2.4	16.9	41.9	0	2.65	237	0.1	7943.3
2014	3	21	21	-3.6	-3.4	0.3	51.1	0	1.56	245.8	0.17	7942
2014	3	21	22	-5.9	-5.5	0.1	55.5	0	1.59	239.9	0.34	7946
2014	3	21	23	-8	-7.6	0.1	62.5	0	1.84	242.7	0.44	7950
2014	3	21	24	-9.7	-9.2	0.1	64.8	0	1.71	245.7	0.54	7956.7
2014	3	22	1	-11.2	-10.5	0.1	70.5	0	1.78	236.7	0.72	7960.7
2014	3	22	2	-12	-11.4	0.1	75.6	0	1.58	244.6	0.62	7962
2014	3	22	3	-13.2	-12.4	0.1	81.2	0	1.66	235.6	0.82	7963.3
2014	3	22	4	-13.8	-12.9	0.1	83	0	1.55	240.5	0.89	7966
2014	3	22	5	-14.8	-13.6	0.1	81.9	0	1.79	241.8	1.17	7964.7
2014	3	22	6	-15.2	-14.1	0.1	82.5	0	1.64	238.2	1.02	7967.3
2014	3	22	7	-15.7	-14.6	0.1	86.9	0	1.83	237.7	1.14	7974
2014	3	22	8	-15.9	-14.8	3	83.9	0	2.04	239.1	1.06	7976.7
2014	3	22	9	-15.5	-13.9	105.2	77.2	0	1.78	240.7	1.62	7980.7
2014	3	22	10	-12.6	-11.5	315.9	61	0	1.3	227.3	1.13	7983.3
2014	3	22	11	-7.7	-7.4	505.5	43.4	0	1.03	233.1	0.32	7983.3
2014	3	22	12	-4.3	-4.5	646	38.1	0	1.67	257.9	-0.16	7984.7
2014	3	22	13	-2.4	-2.7	760.9	25.8	0	0.99	224	-0.34	7984.7
2014	3	22	14	-0.7	-0.8	810	9999	0	0.7	38.1	-0.1	7983.3
2014	3	22	15	0.9	0.9	799.4	9999	0	1.56	18.8	-0.09	7979.3
2014	3	22	16	1.9	1.8	729.5	9999	0.01	3.82	225.7	-0.12	7976.7
2014	3	22	17	2.3	2.2	574.4	9999	0.01	3.02	202.8	-0.06	7975.3
2014	3	22	18	2.3	2.3	414.9	23.9	0	3.96	228.2	0.03	7974
2014	3	22	19	1.7	1.8	179.3	24.2	0	4.5	222.8	0.13	7972.7
2014	3	22	20	0.3	0.5	28.4	41.7	0	1.37	252.7	0.26	7972.7
2014	3	22	21	-3	-2.1	0.4	48.4	0	1.17	241.3	0.89	7974
2014	3	22	22	-5.5	-4.5	0.1	54.4	0	1.83	229	0.99	7976.7
2014	3	22	23	-6.5	-5.4	0.1	62.9	0	1.55	235.2	1.17	7979.3
2014	3	22	24	-6.6	-5.3	0.1	64.4	0	1.05	239.3	1.29	7978
2014	3	23	1	-7.4	-5.8	0.1	60.1	0	1	249	1.65	7976.7
2014	3	23	2	-7.9	-6.5	0.1	57.4	0	1.25	240.4	1.37	7975.3
2014	3	23	3	-8.7	-7.4	0.1	60.7	0	1.33	237.6	1.33	7975.3
2014	3	23	4	-9.1	-7.7	0.1	63.7	0	1.32	239.2	1.42	7972.7
2014	3	23	5	-9.6	-8	0.1	63.2	0	1.29	239	1.58	7968.7
2014	3	23	6	-9.3	-7.8	0.1	65.6	0	0.88	243.5	1.49	7968.7
2014	3	23	7	-9.7	-8.1	0.1	68	0	0.77	249.8	1.58	7968.7
2014	3	23	8	-9.4	-7.8	3.4	72	0	1.12	240.2	1.58	7968.7

2014	3	23	9	-9	-7.7	106.7	55.1	0	0.53	245.4	1.25	7971.3
2014	3	23	10	-6.8	-5.8	313.6	42.8	0	1.24	65	0.95	7974
2014	3	23	11	-2.3	-2.2	500.5	40.3	0	1.98	74.4	0.15	7976.7
2014	3	23	12	0.1	-0.1	652.4	32.9	0	2.58	215.2	-0.15	7979.3
2014	3	23	13	1.1	0.9	689.7	30.2	0	2.78	218.1	-0.14	7980.7
2014	3	23	14	1.8	1.7	684.9	30.1	0	3.25	203.4	-0.12	7982
2014	3	23	15	2.5	2.4	734.3	31.8	0	3.26	208.4	-0.08	7978
2014	3	23	16	3	2.9	692.8	26.4	0	2.86	215.6	-0.07	7974
2014	3	23	17	3	3	573.6	27.7	0	3.15	237.9	-0.03	7971.3
2014	3	23	18	2.8	2.9	389.6	32.6	0	4.19	212.7	0.07	7972.7
2014	3	23	19	2.5	2.4	199.8	37.9	0.01	2.84	237.4	-0.01	7975.3
2014	3	23	20	1.3	1.5	17.1	45.2	0	1.21	265.1	0.18	7976.7
2014	3	23	21	-0.5	0.2	0.4	60.1	0	0.78	254	0.66	7980.7
2014	3	23	22	-2.6	-1.7	0.1	67.5	0	0.54	232.9	0.92	7984.7
2014	3	23	23	-4.5	-3.4	0.1	70.8	0	1.53	233.3	1.06	7988.7
2014	3	23	24	-5.6	-5	0.1	71.8	0	1.76	240.8	0.64	7992.7
2014	3	24	1	-6.2	-5.7	0.1	75.4	0	1.69	239	0.55	7996.7
2014	3	24	2	-7.5	-6.4	0.1	79	0	1.82	235.8	1.1	7998
2014	3	24	3	-7.9	-6.8	0.1	78.9	0	1.68	237.3	1.11	7998
2014	3	24	4	-8.7	-7.7	0.1	80.7	0	1.57	238.7	1.04	8000.7
2014	3	24	5	-9.5	-8.5	0.1	78.5	0	2.04	238	1.07	8002
2014	3	24	6	-9.9	-8.8	0.1	79.5	0	1.72	238.9	1.13	8000.7
2014	3	24	7	-10.4	-8.9	0.1	72.8	0	1.84	236.1	1.45	8000.7
2014	3	24	8	-10.5	-8.9	4	77.3	0	1.42	239.4	1.62	8003.3
2014	3	24	9	-10	-8.7	104.9	60.9	0	1.65	231	1.35	8007.3
2014	3	24	10	-6.9	-6.2	318.2	41.9	0	0.56	222.5	0.71	8007.3
2014	3	24	11	-3	-2.8	497	28.5	0	0.54	132.1	0.29	8007.3
2014	3	24	12	0.6	0.6	652.7	19.7	0	1.18	74.7	0.05	8006
2014	3	24	13	3.8	3.8	757.3	23.9	0	2.51	66.4	0.08	8003.3
2014	3	24	14	5.5	5.5	801	24.6	0	2.19	178.6	0.07	8003.3
2014	3	24	15	6.5	6.6	791.7	22	0	3.94	209.9	0.1	8003.3
2014	3	24	16	6.8	7	717.9	23.9	0	5.04	223.7	0.22	7998
2014	3	24	17	6.9	7.1	591.4	22.6	0	4.82	224.9	0.26	7998
2014	3	24	18	7	7.5	433.2	22.4	0	5.22	220.9	0.42	7994
2014	3	24	19	6.7	7	191.7	29.9	0	3.61	238.9	0.31	7991.3
2014	3	24	20	4.3	5	23.5	52	0	2.02	243.2	0.67	7988.7
2014	3	24	21	0.7	1.1	0.3	52.7	0	1.78	238.9	0.36	7987.3
2014	3	24	22	-1.1	-0.4	0	60.5	0	1.84	240.5	0.72	7987.3
2014	3	24	23	-1.6	-0.8	0.1	64.9	0	1.41	250.1	0.75	7983.3
2014	3	24	24	-2.9	-1.8	0.1	64.9	0	1.81	243.3	1.1	7984.7
2014	3	25	1	-3.5	-2.5	0.1	68.9	0	1.49	238	1	7979.3
2014	3	25	2	-4.4	-2.9	0.1	65.1	0	1.47	239.9	1.54	7975.3
2014	3	25	3	-4.9	-3.4	0.1	64.5	0	1.86	237.9	1.56	7968.7
2014	3	25	4	-4.4	-3.1	0.1	65.8	0	1.4	241.9	1.28	7962
2014	3	25	5	-4.1	-2.8	0.1	62	0	0.94	237.5	1.31	7954
2014	3	25	6	-4.1	-2.4	0.1	69.3	0	1.48	241.7	1.73	7947.3
2014	3	25	7	-3.6	-2.1	0.1	64.8	0	1.17	243.6	1.49	7940.7
2014	3	25	8	-4.2	-2.8	4.6	66.4	0	1.17	239.8	1.35	7935.3
2014	3	25	9	-3.6	-2	88.8	60.4	0	1.7	242	1.58	7931.3
2014	3	25	10	0.8	2	184.5	33.1	0	1.22	249.6	1.24	7926
2014	3	25	11	5.9	6.2	435.7	25.6	0	1.56	158.9	0.31	7918
2014	3	25	12	8.5	8.8	638.1	20.5	0	5.91	229.4	0.26	7908.7
2014	3	25	13	8.9	9.2	735.7	20.6	0	8.84	236.6	0.36	7899.4
2014	3	25	14	9.2	9.5	750.7	19.4	0	8.54	230.4	0.38	7892.7
2014	3	25	15	9.1	9.6	588	21.9	0	8.75	228.2	0.43	7880.7
2014	3	25	16	8.5	8.9	452.1	24.9	0	8.07	217.7	0.38	7875.4
2014	3	25	17	8.1	8.5	290.6	27.1	0	7	222.8	0.4	7870
2014	3	25	18	7.4	7.7	178.8	32.3	0	6.21	231.8	0.29	7862
2014	3	25	19	6.5	6.9	95.2	34.1	0	5.39	232.8	0.36	7856.7
2014	3	25	20	5.1	5.3	19	35	0	4.69	237.8	0.24	7855.4
2014	3	25	21	3.6	3.7	0.2	49.2	0	4.73	233.3	0.11	7860.7

2014	3	25	22	1.7	1.7	0.1	81.5	0	4.9	254.1	-0.04	7860.7
2014	3	25	23	-0.6	-0.7	0.1	88.1	0	1.28	250.9	-0.06	7862
2014	3	25	24	-0.8	-0.4	0.1	92.2	0	0.87	3.1	0.37	7850
2014	3	26	1	-0.7	-0.3	0.1	82.5	0	0.71	6.6	0.37	7846
2014	3	26	2	-1.5	-1	0.1	88.6	0	1.42	63.1	0.49	7840.7
2014	3	26	3	-1.6	-1.2	0.1	87.1	0	0.63	282.7	0.36	7839.4
2014	3	26	4	-2	-1.6	0.1	84.6	0	0.77	55.4	0.38	7834
2014	3	26	5	-2.2	-1.6	0.1	84	0	0.87	238.8	0.68	7830
2014	3	26	6	-2.9	-2.2	0.1	86.1	0	1.36	237.6	0.75	7826
2014	3	26	7	-2.7	-2.2	0.1	91.8	0	0.99	250.1	0.46	7824.7
2014	3	26	8	-2.9	-2.8	3.9	96.4	0	1.17	256.6	0.16	7819.4
2014	3	26	9	-2.5	-2.5	39.6	93.7	0	1.23	242.3	0.02	7818
2014	3	26	10	-2.3	-2.4	103.1	95	0	1.41	77.9	-0.1	7818
2014	3	26	11	-1.5	-1.6	205.4	83.4	0	1.71	85.1	-0.09	7819.4
2014	3	26	12	-0.1	-0.2	457.5	60.1	0	4.73	228.2	-0.12	7820.7
2014	3	26	13	-0.1	-0.2	474.8	76.5	0	4.37	140	-0.12	7819.4
2014	3	26	14	-1.9	-2	304.1	72.9	0	2.18	272.8	-0.14	7822
2014	3	26	15	-0.3	-0.5	363	59.6	0	2.1	247.7	-0.19	7822
2014	3	26	16	0.3	0.2	334	77.8	0	4.11	247.9	-0.11	7819.4
2014	3	26	17	0.1	0	346.8	58.4	0.01	2.61	46.9	-0.07	7820.7
2014	3	26	18	1.4	1.3	386.4	59.8	0	1.9	221.5	-0.14	7816.7
2014	3	26	19	0.9	1	120.9	53	0	2.32	172.8	0.09	7815.4
2014	3	26	20	0.2	0.4	14.1	61.9	0	1.48	261.4	0.18	7815.4
2014	3	26	21	-2.3	-1.6	0.4	69.6	0	1.22	248.2	0.66	7815.4
2014	3	26	22	-3.1	-2.7	0	80.8	0	2.01	245.9	0.41	7819.4
2014	3	26	23	-2.4	-2.4	0.1	96.3	0	1.44	246.5	-0.02	7820.7
2014	3	26	24	-2	-1.8	0.1	89	0	0.87	9.1	0.15	7822
2014	3	27	1	-2.4	-1.9	0.1	79.9	0	0.66	46	0.57	7816.7
2014	3	27	2	-2.3	-2	0.1	83.1	0	0.83	212.6	0.27	7814
2014	3	27	3	-2.7	-2.8	0.1	97.5	0	0.67	234.6	-0.05	7812.7
2014	3	27	4	-2.8	-2.9	0.1	97.7	0	0.17	207.4	-0.08	7812.7
2014	3	27	5	-2.8	-2.8	0.1	98.5	0.01	0.31	329.5	-0.04	7811.4
2014	3	27	6	-2.7	-2.8	0.1	96.3	0.04	0.82	259.6	-0.11	7814
2014	3	27	7	-3.1	-3.2	0.1	96.8	0.02	1.4	122.8	-0.1	7818
2014	3	27	8	-3.2	-3.2	0.7	93.8	0.01	1.05	182.7	-0.08	7823.4
2014	3	27	9	-3.3	-3.3	20.2	69.6	0.01	1.67	244	-0.03	7831.4
2014	3	27	10	-3.8	-3.9	22.1	91	0.01	1.73	213.6	-0.11	7838
2014	3	27	11	-2.6	-2.7	113	62.7	0.03	3.04	207.3	-0.11	7843.4
2014	3	27	12	-1.7	-1.8	193.8	69.2	0.02	5.88	223.5	-0.13	7846
2014	3	27	13	-1.2	-1.3	557.5	65.7	0.02	6.76	227	-0.1	7851.4
2014	3	27	14	-0.9	-0.9	728	61.5	0.01	8.15	232.2	-0.05	7854
2014	3	27	15	-1.2	-1.3	445.8	70.3	0.01	6.75	228	-0.14	7856.7
2014	3	27	16	-1.6	-1.8	326.3	73.2	0	6.89	231.9	-0.12	7858
2014	3	27	17	-1.9	-2	288.6	66.3	0	5.95	229.9	-0.13	7862
2014	3	27	18	-1.8	-1.9	170.1	84.1	0	4.71	227.8	-0.13	7867.4
2014	3	27	19	-1.9	-2	100.3	69.1	0	4.26	226.9	-0.04	7870
2014	3	27	20	-2	-2.1	18.8	81.5	0	3.43	235.3	-0.03	7875.4
2014	3	27	21	-3.5	-3.6	0.2	94.2	0	1.11	246.3	-0.12	7883.4
2014	3	27	22	-3.8	-3.8	0.1	95.5	0	0.7	66.5	0.04	7890
2014	3	27	23	-3.9	-3.9	0.1	89.4	0	1.14	71.8	0.01	7896.7
2014	3	27	24	-4.4	-4.2	0.1	97.3	0	0.82	69.5	0.15	7902
2014	3	28	1	-5.1	-4.7	0.1	94.6	0	0.56	286	0.39	7908.7
2014	3	28	2	-5.2	-4.7	0.1	90.7	0	0.57	251.9	0.56	7914
2014	3	28	3	-4.9	-4.4	0.1	87.7	0	0.63	356.4	0.43	7919.4
2014	3	28	4	-4.8	-4.3	0.1	91.3	0	0.69	316.3	0.57	7922
2014	3	28	5	-4.9	-4.5	0.1	88.8	0	0.68	305.9	0.44	7920.7
2014	3	28	6	-3.8	-3.6	0.1	83.5	0	0.43	286.9	0.27	7926
2014	3	28	7	-3.7	-3.4	0.1	85.7	0	0.57	3.4	0.26	7931.3
2014	3	28	8	-4.5	-4.3	4.6	90.3	0	0.88	244	0.24	7932.7
2014	3	28	9	-3.9	-3.7	44.3	77.4	0	0.67	285.4	0.15	7935.3
2014	3	28	10	-2.8	-2.7	54.3	78.3	0	1.08	236.1	0.04	7936.7

2014	3	28	11	-1.2	-1.3	147.1	72.1	0	3.53	229	-0.1	7939.3
2014	3	28	12	-0.2	-0.3	329.2	71	0.01	4.8	233.9	-0.13	7940.7
2014	3	28	13	0.1	0	346	70.6	0	6.92	239.1	-0.09	7943.3
2014	3	28	14	0.9	0.8	548.5	68.6	0.02	7.23	249.8	-0.11	7943.3
2014	3	28	15	1.6	1.5	500.6	65.7	0.01	7.24	250	-0.11	7938
2014	3	28	16	1.8	1.7	414.1	73.7	0.01	6.68	242.5	-0.1	7932.7
2014	3	28	17	1.3	1.2	233.9	79.2	0	6.5	243.1	-0.1	7931.3
2014	3	28	18	1	1	129.3	80.3	0	5.25	234.8	-0.08	7930
2014	3	28	19	0.8	0.7	74	83.2	0	4.67	228	-0.07	7930
2014	3	28	20	1.1	1.1	20.7	85.2	0	4.59	226.3	-0.05	7931.3
2014	3	28	21	1.2	1.1	0.3	89.1	0	3.5	238.4	-0.04	7927.3
2014	3	28	22	1.5	1.5	0.1	81.9	0	5.29	244.7	-0.04	7926
2014	3	28	23	1.6	1.6	0.1	79.4	0	4.41	242.9	0	7926
2014	3	28	24	2	1.9	0.1	84.9	0	5.81	252.9	-0.07	7920.7
2014	3	29	1	1.9	1.9	0.1	76.7	0	6.19	261.5	-0.04	7918
2014	3	29	2	2.6	2.6	0.1	83.1	0	7.86	261.2	-0.04	7911.4
2014	3	29	3	1.9	1.8	0.1	82.7	0	4.4	252.1	-0.02	7910
2014	3	29	4	2.3	2.3	0.1	82.3	0	5.23	255.9	-0.04	7904.7
2014	3	29	5	1.6	1.5	0.1	90.1	0	5.11	266.4	-0.05	7898
2014	3	29	6	1.2	1.2	0.1	88.6	0	4.28	258.1	-0.05	7892.7
2014	3	29	7	1	1	0.1	93.1	0.01	4.29	227.5	-0.04	7891.4
2014	3	29	8	0.8	0.8	2.3	92.4	0	3.83	229	-0.03	7892.7
2014	3	29	9	0.5	0.4	22.2	96.9	0.01	3.35	225.6	-0.04	7895.4
2014	3	29	10	0.3	0.3	34.6	98	0.02	1.68	283.6	-0.07	7899.4
2014	3	29	11	0	-0.1	18.9	99.3	0.05	0	0	-0.11	7902
2014	3	29	12	-0.3	-0.5	13.7	98.9	0.06	0.79	221.6	-0.13	7906
2014	3	29	13	-0.1	-0.1	47	92.4	0.07	0.87	43	-0.06	7908.7
2014	3	29	14	0.8	0.7	80.1	78.1	0.07	2.19	208.6	-0.05	7904.7
2014	3	29	15	1.5	1.4	117.7	74.6	0.01	3.68	227.6	-0.03	7906
2014	3	29	16	1.3	1.3	189.9	66.7	0.01	3.88	228.2	-0.02	7903.4
2014	3	29	17	0.7	0.6	163	78.9	0	3.44	230.9	-0.08	7902
2014	3	29	18	0	-0.1	110.6	87.2	0.01	2.25	221.2	-0.1	7900.7
2014	3	29	19	-0.1	-0.2	76.4	82.4	0	1.71	241.5	-0.07	7898
2014	3	29	20	-0.2	-0.2	21.5	86.3	0	1.18	253.8	0.02	7894
2014	3	29	21	-0.9	-0.7	0.3	92.7	0	0.83	348.6	0.26	7891.4
2014	3	29	22	-1.5	-1.2	0.1	95	0	0.88	296.7	0.29	7891.4
2014	3	29	23	-1.2	-0.9	0.1	87.3	0	1.41	251.7	0.23	7892.7
2014	3	29	24	-1.5	-1.1	0.1	92.9	0	0.82	252.9	0.44	7892.7
2014	3	30	1	-1.9	-1.9	0.1	95	0	2.51	239.8	0.01	7890
2014	3	30	2	-2.5	-2.5	0.1	97.5	0	1.49	241.6	-0.05	7888.7
2014	3	30	3	-3	-3.1	0.1	97.9	0	0.78	234.9	-0.08	7886
2014	3	30	4	-3.2	-3.3	0.1	98.3	0	0.88	241	-0.04	7880.7
2014	3	30	5	-3.4	-3.4	0.1	98.8	0	0.55	238.7	0.02	7875.4
2014	3	30	6	-3.4	-3.4	0.1	98.7	0	0.12	206.5	-0.08	7870
2014	3	30	7	-3.4	-3.5	0.1	95.3	0.04	0.65	88.7	-0.1	7871.4
2014	3	30	8	-4.1	-4.1	2.9	97.9	0.04	1.6	150.7	-0.07	7872.7
2014	3	30	9	-4.3	-4.3	30	95.1	0.01	2.42	62.7	-0.05	7875.4
2014	3	30	10	-4.2	-4.3	95.1	93.7	0	2.9	66.4	-0.09	7876.7
2014	3	30	11	-3.7	-3.8	205.8	87.7	0.01	2.67	76.5	-0.14	7878
2014	3	30	12	-2.2	-2.3	400.4	69.8	0.02	3.12	86.8	-0.14	7878
2014	3	30	13	-1	-1.3	633	68	0.02	3.51	85.3	-0.22	7879.4
2014	3	30	14	-0.7	-0.8	482.2	73.4	0.02	3.77	63.6	-0.12	7878
2014	3	30	15	-1.1	-1.2	467.2	64.7	0	4.1	82	-0.11	7876.7
2014	3	30	16	-0.6	-0.7	483.2	62.2	0.01	3.44	176.1	-0.13	7878
2014	3	30	17	0.4	0.3	810	53.9	0.02	5.36	218.8	-0.11	7880.7
2014	3	30	18	0.1	0	303.5	55.5	0	2.94	227.1	-0.1	7880.7
2014	3	30	19	-1.7	-1.8	191.5	72	0.01	3.05	36.5	-0.09	7886
2014	3	30	20	-1.6	-1.6	60.1	65.1	0	2.11	187.2	0.02	7894
2014	3	30	21	-2.7	-2.5	0.8	81.6	0	1.16	241.7	0.14	7903.4
2014	3	30	22	-4.8	-4.4	0.1	86.6	0	1.3	242.3	0.39	7911.4
2014	3	30	23	-6.2	-5.6	0.1	87.7	0	1.31	227	0.59	7919.4

2014	3	30	24	-6.9	-6.5	0.1	91.3	0	1.6	243	0.48	7923.4
2014	3	31	1	-8.7	-8	0.1	91.3	0	1.76	246.3	0.75	7924.7
2014	3	31	2	-10.3	-9.6	0.1	89.2	0	1.6	246	0.65	7926
2014	3	31	3	-11.6	-10.7	0.1	91	0	1.67	240.8	0.84	7928.7
2014	3	31	4	-12.1	-11	0.1	92.8	0	1.75	238.6	1.13	7928.7
2014	3	31	5	-12.7	-11.4	0.1	91.1	0	1.8	234.9	1.33	7927.3
2014	3	31	6	-12.4	-11.3	0.1	91.6	0	1.64	243.3	1.19	7926
2014	3	31	7	-12.2	-11.1	0.1	92.3	0	1.73	241.6	1.12	7924.7
2014	3	31	8	-11.4	-9.9	10.3	86.7	0	1.68	244.2	1.5	7923.4
2014	3	31	9	-9.4	-8.4	98.7	82.5	0	1.39	230.7	1.07	7923.4
2014	3	31	10	-6.1	-5.7	316.9	59.4	0	0.9	236.1	0.43	7920.7
2014	3	31	11	-3	-3.2	472	64.1	0	1.72	202.8	-0.16	7919.4
2014	3	31	12	-2	-2.3	640.8	68.5	0	2.89	214.9	-0.31	7918
2014	3	31	13	-1.8	-2.1	589.8	74.9	0	2.73	228.8	-0.28	7915.4
2014	3	31	14	-0.7	-0.9	634.9	56.1	0	2.8	223.4	-0.19	7911.4
2014	3	31	15	-0.6	-0.7	507.4	54.2	0	5.38	250.7	-0.16	7902
2014	3	31	16	0.1	-0.1	330.6	73.8	0	3.58	214.8	-0.16	7898
2014	3	31	17	-0.4	-0.6	435.3	65.4	0	2.74	237.9	-0.18	7894
2014	3	31	18	0.3	0.2	228.3	65.8	0	2.56	214.4	-0.13	7888.7
2014	3	31	19	-0.6	-0.6	106.3	65.6	0	2.5	244.9	-0.09	7886
2014	3	31	20	-0.7	-0.7	35.9	76.7	0	1.53	222.5	-0.01	7883.4
2014	3	31	21	-2.4	-2.2	1	79.1	0	1.16	257.1	0.17	7882
2014	3	31	22	-3.7	-3.5	0.1	82.7	0	1.16	243.1	0.21	7882
2014	3	31	23	-5.9	-5.5	0.1	84.1	0	1.62	249	0.4	7879.4
2014	3	31	24	-7.7	-7	0.1	89	0	1.86	240.9	0.68	7876.7
2014	4	1	1	-8.4	-7.5	0.1	85.7	0	1.55	243.5	0.88	7872.7
2014	4	1	2	-8.9	-7.7	0.1	88.1	0	1.82	237.6	1.11	7870
2014	4	1	3	-9.3	-8.4	0.1	94.1	0	1.98	239.4	0.97	7864.7
2014	4	1	4	-9.6	-8.6	0.1	92.1	0	1.93	241	1	7859.4
2014	4	1	5	-9.6	-8.6	0.1	92.9	0	1.69	245.4	1.03	7856.7
2014	4	1	6	-10.5	-9.4	0.1	95	0	1.88	237.7	1.11	7851.4
2014	4	1	7	-10.5	-9.2	0.1	94.7	0	2.05	241.7	1.23	7847.4
2014	4	1	8	-10.1	-9.1	23	91.3	0	2.03	236.3	1.01	7847.4
2014	4	1	9	-8.6	-7.7	113.2	83.3	0	1.26	239.8	0.93	7848.7
2014	4	1	10	-5.4	-4.9	241	70.3	0	0.58	248.8	0.45	7846
2014	4	1	11	-2.7	-2.6	325	60.4	0	1.08	64.4	0.13	7843.4
2014	4	1	12	-0.8	-0.9	616	59.6	0	1.88	47	-0.16	7847.4
2014	4	1	13	-0.4	-0.5	392.8	50.9	0	1.37	61.3	-0.09	7844.7
2014	4	1	14	0.5	0.4	470.1	57.2	0	1.58	65.5	-0.15	7843.4
2014	4	1	15	0.6	0.5	355.8	57.8	0.01	2.06	266.7	-0.14	7842
2014	4	1	16	0.8	0.6	414.1	71.6	0	2.24	34.7	-0.15	7842
2014	4	1	17	0.7	0.6	332	64.4	0	2.93	62	-0.12	7840.7
2014	4	1	18	1.2	1.1	272.1	63.3	0	2.98	66.4	-0.09	7838
2014	4	1	19	1.3	1.2	126.2	61.9	0	3.22	49	-0.05	7838
2014	4	1	20	1.2	1.2	40.6	60.9	0	2.84	57.7	-0.03	7839.4
2014	4	1	21	0.4	0.5	0.8	78.1	0	1.56	57.1	0.11	7839.4
2014	4	1	22	-0.7	-0.7	0.1	82.5	0	1.61	88	0.04	7840.7
2014	4	1	23	-1.1	-1.2	0.1	87	0	0.38	77.4	-0.02	7843.4
2014	4	1	24	-1.6	-1.6	0.1	92.1	0	0.94	80.1	-0.04	7843.4
2014	4	2	1	-1.8	-1.8	0.1	92.1	0	0.86	25.2	0.03	7842
2014	4	2	2	-2.1	-2.2	0.1	92.7	0	1.52	90.9	-0.07	7843.4
2014	4	2	3	-2.2	-2.3	0.1	97.2	0	1.16	96.1	-0.11	7843.4
2014	4	2	4	-2.4	-2.5	0.1	97.8	0	2.37	90.8	-0.11	7844.7
2014	4	2	5	-2.8	-2.8	0.1	98.8	0	2.81	89.9	-0.02	7844.7
2014	4	2	6	-2.8	-2.9	0.1	98.9	0	1.29	94.5	-0.1	7846
2014	4	2	7	-3	-3	0.1	99.4	0	1.9	95.2	-0.05	7848.7
2014	4	2	8	-3	-3.1	8.2	99.7	0	3	95.4	-0.04	7854
2014	4	2	9	-3	-3	47.6	97.1	0	2.72	93.1	-0.04	7858
2014	4	2	10	-2.2	-2.3	170.9	74.6	0	4.92	90.2	-0.07	7863.4
2014	4	2	11	-1.8	-1.8	205.6	66.6	0	4.26	84.4	-0.07	7870
2014	4	2	12	-1	-1.1	307.8	60.6	0	4.02	87.5	-0.08	7876.7

2014	4	2	13	-0.5	-0.7	497.1	59.6	0	3.65	86.4	-0.14	7880.7
2014	4	2	14	0.3	0.1	587	45	0	3.72	108	-0.17	7882
2014	4	2	15	0.4	0.3	586.7	46	0	3.99	94.3	-0.1	7883.4
2014	4	2	16	1.4	1.2	720.4	40.5	0.01	2.99	168.8	-0.16	7886
2014	4	2	17	1.2	1.1	615.7	70.9	0.02	4.46	97	-0.11	7887.4
2014	4	2	18	-0.1	-0.2	388.7	55.8	0	4.29	81.5	-0.09	7894
2014	4	2	19	0.2	0.1	262	53.7	0.01	4.47	85.5	-0.09	7896.7
2014	4	2	20	-1.3	-1.3	64.3	69	0	1.96	119.8	-0.09	7906
2014	4	2	21	-2	-1.8	1.2	73	0	0.99	269.6	0.25	7911.4
2014	4	2	22	-3.7	-3.3	0.1	77.8	0	0.65	212.8	0.36	7916.7
2014	4	2	23	-5.9	-5.4	0.1	84.1	0	1.31	235.5	0.54	7923.4
2014	4	2	24	-7.8	-7.1	0.1	83.8	0	1.78	242.6	0.73	7927.3
2014	4	3	1	-8.9	-7.9	0.1	85.4	0	2.05	234.1	1.04	7930
2014	4	3	2	-8.8	-8.2	0.1	85.6	0	1.64	244	0.61	7932.7
2014	4	3	3	-9.4	-8.4	0.1	88.4	0	1.93	234.4	1.02	7934
2014	4	3	4	-10.2	-9.4	0.1	86.9	0	1.78	238.4	0.78	7935.3
2014	4	3	5	-10.7	-9.7	0.1	90.1	0	1.41	237.8	0.92	7936.7
2014	4	3	6	-11.6	-10.2	0.1	89.1	0	1.82	238.8	1.35	7938
2014	4	3	7	-11.7	-10.7	0.1	88.7	0	1.67	236.6	1.04	7940.7
2014	4	3	8	-12.5	-11.1	8.2	91.6	0	1.76	238.1	1.38	7943.3
2014	4	3	9	-11.2	-9.9	181.2	82.8	0	1.63	242	1.35	7946
2014	4	3	10	-7.5	-7.1	389.9	64.1	0	1.15	93.1	0.42	7946
2014	4	3	11	-3.6	-3.5	579.2	38.5	0	0.73	70.4	0.06	7947.3
2014	4	3	12	0.2	0	731	37.2	0	1.38	216.7	-0.21	7946
2014	4	3	13	1.7	1.6	817	26.6	0	4.64	239.2	-0.1	7944.7
2014	4	3	14	2.5	2.4	857	26	0	5.3	239.9	-0.08	7944.7
2014	4	3	15	2.9	2.8	827	30.8	0	4.79	233.6	-0.06	7943.3
2014	4	3	16	3.3	3.3	760.5	26.6	0	4.39	232	-0.04	7942
2014	4	3	17	3.5	3.4	510.2	35.3	0	4.76	238.3	-0.03	7940.7
2014	4	3	18	3.3	3.3	343.9	35.9	0.01	4.05	233.7	-0.03	7939.3
2014	4	3	19	2.8	2.9	161.6	34.3	0	4.68	220.3	0.07	7938
2014	4	3	20	2.1	2.3	51.7	44.6	0	3.3	217.2	0.17	7938
2014	4	3	21	0.5	0.9	1.6	62.1	0	1.42	256.4	0.43	7938
2014	4	3	22	-2.4	-2	0	60.3	0	1.11	224.9	0.41	7938
2014	4	3	23	-2.6	-2.2	0.1	58.4	0	0.93	236.4	0.33	7938
2014	4	3	24	-3.3	-2.9	0.1	66.1	0	1.35	231.9	0.43	7936.7
2014	4	4	1	-4.1	-3	0.1	69.4	0	1.56	237.1	1.06	7935.3
2014	4	4	2	-4.9	-3.9	0.1	67.9	0	2.04	232	1.04	7934
2014	4	4	3	-4.8	-3.9	0.1	66.6	0	1.57	238.2	0.96	7928.7
2014	4	4	4	-3	-2.2	0.1	59.8	0	1.79	240.1	0.82	7926
2014	4	4	5	-1.2	-0.9	0.1	62.9	0	2.2	218	0.27	7920.7
2014	4	4	6	-0.7	-0.6	0.1	73.1	0	4.22	228.2	0.11	7918
2014	4	4	7	-1.4	-1.3	0.1	77.3	0	1.57	281.3	0.11	7916.7
2014	4	4	8	-2.4	-2.2	9	76.9	0	0.85	65	0.28	7912.7
2014	4	4	9	-0.8	-0.7	85.9	69.3	0	4.87	246	0.06	7914
2014	4	4	10	-1.1	-1.2	150.1	76.2	0	3.34	232.7	-0.1	7912.7
2014	4	4	11	-0.3	-0.5	259.7	71	0	4.31	233.1	-0.12	7915.4
2014	4	4	12	-0.4	-0.5	297.7	90.9	0	4.35	246.5	-0.16	7912.7
2014	4	4	13	-0.6	-0.7	366.2	81.2	0	3.57	228.4	-0.16	7914
2014	4	4	14	0.4	0.3	592.5	66.2	0	5.24	233.2	-0.13	7911.4
2014	4	4	15	0.9	0.8	441.8	66.4	0	5.6	239.9	-0.1	7907.4
2014	4	4	16	0.8	0.7	510.9	60	0	6.24	235.2	-0.06	7903.4
2014	4	4	17	1.9	1.9	451.4	57.8	0	5.29	237.1	-0.05	7900.7
2014	4	4	18	1.7	1.6	189.4	62.2	0	4.6	232	-0.06	7899.4
2014	4	4	19	1	1	99.7	69.3	0	4.48	229	-0.03	7899.4
2014	4	4	20	-0.2	-0.3	16	95.8	0	2.76	229.9	-0.1	7902
2014	4	4	21	-1.8	-1.7	1.1	96.3	0	0.84	316.4	0.05	7906
2014	4	4	22	-1.9	-2	0.1	99.1	0.02	0.83	97.3	-0.07	7906
2014	4	4	23	-1.9	-1.9	0.1	99.4	0.05	0.55	42.7	0.02	7908.7
2014	4	4	24	-2.7	-2.4	0.1	98.3	0.01	1.15	245.7	0.28	7910
2014	4	5	1	-2.6	-2.4	0.1	99	0.02	1.02	25.2	0.19	7911.4

2014	4	5	2	-3.2	-2.9	0.1	99.2	0	0.76	250.9	0.3	7914
2014	4	5	3	-3.5	-3.1	0.1	97.4	0.01	0.53	260.2	0.34	7914
2014	4	5	4	-4	-3.6	0.1	96.7	0	1.11	241.3	0.42	7915.4
2014	4	5	5	-4	-3.7	0.1	96.1	0	1.25	238.4	0.22	7915.4
2014	4	5	6	-3.9	-3.7	0.1	98.5	0	0.8	255	0.24	7914
2014	4	5	7	-4	-3.8	0.1	98.3	0.01	0.8	232.1	0.2	7915.4
2014	4	5	8	-5	-4.6	2.9	95.9	0	0.94	229.5	0.41	7916.7
2014	4	5	9	-4.4	-3.9	49.1	90.3	0.01	0.93	241.9	0.48	7923.4
2014	4	5	10	-2.4	-2.5	154.5	87	0.03	1.6	87.9	-0.1	7926
2014	4	5	11	-1.3	-1.3	131.3	89.1	0.01	1.27	84	-0.03	7927.3
2014	4	5	12	-0.6	-0.7	393	62.2	0.02	2.54	171	-0.14	7934
2014	4	5	13	0.5	0.3	584.5	46	0.03	3.41	219.1	-0.19	7935.3
2014	4	5	14	0.8	0.6	561	67.9	0.01	3.66	222.5	-0.17	7938
2014	4	5	15	-0.1	-0.2	530.8	48.5	0.01	1.69	53	-0.1	7942
2014	4	5	16	-0.2	-0.3	531.6	64.4	0.01	4.11	48.3	-0.11	7942
2014	4	5	17	1.1	1	606.1	60.6	0	3.83	206.1	-0.11	7943.3
2014	4	5	18	1.5	1.4	307.3	58.5	0.01	5.1	229.4	-0.06	7940.7
2014	4	5	19	0.7	0.6	121.5	67.5	0	2.56	219.1	-0.1	7946
2014	4	5	20	0	0	40.9	82	0	1.73	85.3	-0.02	7947.3
2014	4	5	21	-0.1	-0.1	0.9	76.5	0	1.11	338.9	0.01	7948.7
2014	4	5	22	-0.6	-0.7	0.1	87.8	0	1.44	264.2	-0.06	7952.7
2014	4	5	23	-1.5	-1.4	0.1	95	0	1.08	59.5	0.05	7954
2014	4	5	24	-1.5	-1.6	0.1	92.8	0	0.8	46.9	-0.01	7952.7
2014	4	6	1	-1.4	-1.2	0.1	89.6	0	0.83	53.9	0.11	7952.7
2014	4	6	2	-1	-0.8	0.1	89.7	0	0.47	272.7	0.25	7950
2014	4	6	3	-0.9	-0.7	0.1	95.2	0	0.98	77.2	0.17	7948.7
2014	4	6	4	-1.7	-1.8	0.1	98.9	0	2.19	78.1	-0.1	7947.3
2014	4	6	5	-1.8	-1.9	0.1	99.6	0	1.33	66.3	-0.1	7946
2014	4	6	6	-1.8	-1.9	0.1	99.9	0	1.12	65.2	-0.05	7947.3
2014	4	6	7	-1.7	-1.7	0.1	99.9	0	0.42	242.9	-0.01	7950
2014	4	6	8	-1.7	-1.6	5.2	99.9	0	0.61	62.7	0.08	7954
2014	4	6	9	-1.3	-1.3	36.3	98.2	0	1.1	73.2	0.03	7956.7
2014	4	6	10	-0.4	-0.4	112.6	88.8	0	0.94	62.1	0.03	7962
2014	4	6	11	0.5	0.5	206.9	80.4	0	2.32	68.4	0.02	7963.3
2014	4	6	12	1.8	1.8	305.8	73.8	0	2.68	85.2	-0.02	7966
2014	4	6	13	2.4	2.3	558.2	64	0	3.97	165.7	-0.05	7970
2014	4	6	14	2.7	2.6	589.3	61.3	0.01	4.19	171.3	-0.09	7974
2014	4	6	15	3	3	521.7	63.5	0.01	5.01	212.9	-0.02	7979.3
2014	4	6	16	2.4	2.4	392.2	61.2	0	2.96	52.6	0.01	7982
2014	4	6	17	3.7	3.7	464.8	68	0.01	4.82	210.1	0.04	7987.3
2014	4	6	18	3.5	3.6	333.4	58.8	0	4.69	216.5	0.04	7986
2014	4	6	19	3.5	3.5	143.1	63.2	0	4.67	217.4	0.06	7990
2014	4	6	20	2.9	3	41.1	65.5	0	5.06	223.8	0.09	7996.7
2014	4	6	21	2.3	2.4	2.4	66.6	0	3.97	229.3	0.12	8002
2014	4	6	22	2	2.2	0.1	69.6	0	1.88	121.8	0.2	8007.3
2014	4	6	23	1.8	2	0.1	68.9	0	0.77	273.4	0.19	8012.7
2014	4	6	24	1.3	1.6	0.1	77.1	0	0.86	233.4	0.24	8019.3
2014	4	7	1	1	1.3	0.1	76.6	0	0.62	71.9	0.33	8018
2014	4	7	2	-0.3	0.1	0.1	79.6	0	0.51	219.5	0.38	8020.7
2014	4	7	3	-1	-0.5	0.1	82.4	0	1.03	249.6	0.52	8024.7
2014	4	7	4	-1.6	-1.1	0.1	86.2	0	1.55	235.4	0.46	8024.7
2014	4	7	5	-2.4	-2	0.1	87.4	0	0.81	229	0.39	8027.3
2014	4	7	6	-3.6	-3	0.1	88.9	0	1.31	234.7	0.59	8031.3
2014	4	7	7	-4.4	-3.8	0.1	89.2	0	1.43	239.9	0.59	8034
2014	4	7	8	-4.9	-4.2	17.6	88.2	0	1.49	237.9	0.77	8036.7
2014	4	7	9	-3.7	-3.3	223.8	78.4	0	0.88	254.4	0.41	8039.3
2014	4	7	10	-0.8	-0.7	407.3	63.1	0	0.98	108.2	0.11	8039.3
2014	4	7	11	2.4	2.5	579.8	53.5	0	2.22	77	0.15	8040.7
2014	4	7	12	5.1	5.2	720.5	49.4	0	2.4	66.1	0.05	8040.7
2014	4	7	13	6.4	6.6	822	46.8	0.01	2.81	60.5	0.15	8040.7
2014	4	7	14	7.7	7.9	846	39.4	0.01	1.93	129.1	0.13	8038

2014	4	7	15	8.5	8.7	838	40.2	0.02	2.85	166.3	0.27	8035.3
2014	4	7	16	8.9	9.3	754.8	39.4	0.01	3.78	197.7	0.47	8032.7
2014	4	7	17	9.3	9.8	638.8	38.2	0.01	4.75	227.7	0.47	8030
2014	4	7	18	9.4	9.8	479.7	39.1	0	4.07	224.9	0.43	8027.3
2014	4	7	19	9.2	9.6	214.9	42.8	0	3.09	240.9	0.44	8027.3
2014	4	7	20	7.6	8.1	29.3	58.5	0	1.51	253	0.52	8028.7
2014	4	7	21	3.9	4.8	2.4	68.3	0	1.55	239.2	0.89	8026
2014	4	7	22	2.5	3.1	0	75.6	0	1.61	241.1	0.62	8027.3
2014	4	7	23	1	2	0.1	82.5	0	1.53	238.8	0.92	8030
2014	4	7	24	0.5	1.6	0.1	85	0	1.03	246.5	1.09	8031.3
2014	4	8	1	0	1	0.1	87.6	0	1.08	242.1	1.02	8032.7
2014	4	8	2	-0.7	0.2	0.1	84.7	0	1.42	235.5	0.88	8034
2014	4	8	3	-1.6	-0.3	0.1	89.5	0	1.46	236.5	1.25	8032.7
2014	4	8	4	-2.1	-0.9	0.1	86.8	0	1.37	237.4	1.18	8028.7
2014	4	8	5	-2.6	-1.3	0.1	86.2	0	1.65	231.6	1.31	8028.7
2014	4	8	6	-2.2	-1.2	0.1	86.1	0	1.26	243	1.05	8027.3
2014	4	8	7	-3.1	-1.5	0.1	88.4	0	1.66	234.3	1.59	8023.3
2014	4	8	8	-2.2	-1.4	21.6	85.2	0	1.09	244.4	0.88	8022
2014	4	8	9	-1.7	-0.4	185.8	78.3	0	0.99	236.3	1.26	8024.7
2014	4	8	10	1.9	2.3	335.5	54	0	0.54	215.1	0.4	8024.7
2014	4	8	11	5.7	5.9	543.8	44.6	0	0.95	77.8	0.16	8022
2014	4	8	12	9.9	10.2	732.2	36.5	0	3.45	208.2	0.3	8019.3
2014	4	8	13	11.4	11.8	833	35.1	0	6.04	237.1	0.36	8015.3
2014	4	8	14	11.7	12.3	847	33.1	0	5.75	223.8	0.55	8010
2014	4	8	15	12.1	12.5	749.2	33.2	0	5.96	238.6	0.47	8007.3
2014	4	8	16	12	12.6	679.7	35	0.01	5.7	229	0.53	8003.3
2014	4	8	17	12.2	12.8	525.2	32.1	0	5.68	238	0.55	7998
2014	4	8	18	12.3	12.8	437	33.4	0	5.04	238.8	0.48	7992.7
2014	4	8	19	11.8	12.2	208.5	35.6	0	3.87	244.3	0.42	7990
2014	4	8	20	10.7	11.3	43.1	41.4	0	3	242.8	0.53	7986
2014	4	8	21	8.7	9.6	2.3	50.1	0	1.06	208.5	0.86	7982
2014	4	8	22	5.7	6.9	0.1	65.1	0	1.04	247.3	1.28	7982
2014	4	8	23	4.1	5.6	0.1	66.7	0	1.04	244.1	1.55	7982
2014	4	8	24	3.4	4.9	0.1	72.3	0	1.19	241.3	1.56	7978
2014	4	9	1	3	4.2	0.1	76.2	0	1.72	234.9	1.27	7975.3
2014	4	9	2	2.6	3.8	0.1	74.8	0	1.16	241	1.19	7975.3
2014	4	9	3	2.8	4.5	0.1	70.8	0	0.77	244.7	1.69	7972.7
2014	4	9	4	1.8	3.5	0.1	79.4	0	1.2	246.5	1.77	7967.3
2014	4	9	5	2.7	4	0.1	79.2	0	1.16	242.7	1.33	7963.3
2014	4	9	6	2.5	3.8	0.1	77.5	0	1.19	236.2	1.24	7959.3
2014	4	9	7	2.5	3.6	0.2	76.8	0	1.11	231.9	1.08	7956.7
2014	4	9	8	3.1	4.8	31	65.8	0	0.81	271.5	1.7	7958
2014	4	9	9	5	5.9	169.6	43.7	0	0.99	256.6	0.9	7956.7
2014	4	9	10	7.1	7.4	377.1	39.7	0	4.35	220.2	0.31	7958
2014	4	9	11	7.6	7.9	609.3	39.5	0	5.73	225.4	0.28	7958
2014	4	9	12	7.5	7.8	531.1	42	0	5.93	220.5	0.31	7960.7
2014	4	9	13	7.5	7.8	387.8	48	0	5.82	226.8	0.31	7960.7
2014	4	9	14	7.1	7.5	392.7	51	0	6.84	226.4	0.37	7959.3
2014	4	9	15	6.5	6.9	350.7	59.7	0	6.78	225.9	0.37	7958
2014	4	9	16	5.8	6	391.1	72.7	0	5.4	241.1	0.21	7959.3
2014	4	9	17	4.5	4.8	266.8	69.4	0	5.58	228.6	0.23	7959.3
2014	4	9	18	5.8	6	260.8	58.6	0	4.78	221.6	0.27	7960.7
2014	4	9	19	6	6.2	120.6	65.6	0	4.17	239.4	0.17	7955.3
2014	4	9	20	4.7	5	39.2	81.1	0	1.68	247.1	0.28	7958
2014	4	9	21	3.1	3.7	4.3	87.7	0	0.66	259.4	0.61	7959.3
2014	4	9	22	1.8	2.6	0	88.5	0	0.59	228.5	0.84	7958
2014	4	9	23	0.9	1.6	0	86.3	0	0.49	241.8	0.72	7963.3
2014	4	9	24	-0.1	0.5	0	89.6	0	1.3	238.5	0.61	7964.7
2014	4	10	1	-0.7	-0.2	0	85.4	0	1.11	242.7	0.46	7964.7
2014	4	10	2	-1.4	-0.8	0.1	92.8	0	1.38	243.5	0.58	7966
2014	4	10	3	-2.4	-1.7	0.1	91.4	0	1.35	240.7	0.67	7966

2014	4	10	4	-2.8	-2.2	0	93.5	0	1.31	239.7	0.64	7964.7
2014	4	10	5	-2.9	-2.5	0	91.9	0	0.93	242	0.46	7963.3
2014	4	10	6	-3.4	-2.8	0.1	92.9	0	0.75	242.9	0.56	7964.7
2014	4	10	7	-3.6	-3	0.2	91.6	0	0.99	243.9	0.53	7966
2014	4	10	8	-4.6	-3.8	17.4	95.8	0	1.86	240.2	0.84	7971.3
2014	4	10	9	-3.6	-2.8	231.5	71.9	0	1.39	234.6	0.75	7972.7
2014	4	10	10	-0.8	-0.5	418.3	53	0	0.63	76.3	0.26	7975.3
2014	4	10	11	2.4	2.4	590.9	25.6	0	0.92	70.3	-0.02	7974
2014	4	10	12	4.4	4.3	749.3	27.3	0	2.64	233.2	-0.14	7975.3
2014	4	10	13	5.5	5.5	849	21	0	3.62	223.2	0.03	7976.7
2014	4	10	14	6.4	6.5	895	24.5	0	2.01	58.9	0.07	7975.3
2014	4	10	15	7.3	7.5	874	23.6	0	2.64	41.4	0.19	7974
2014	4	10	16	7.8	8.1	742.1	28.8	0	4.2	222.8	0.26	7974
2014	4	10	17	8.1	8.5	677.9	30.4	0.01	4.07	223.1	0.43	7971.3
2014	4	10	18	8.3	8.7	492.9	28	0	3.75	224.9	0.39	7967.3
2014	4	10	19	8.2	8.5	217.5	27.2	0	2.41	240.4	0.3	7967.3
2014	4	10	20	7.8	7.9	67.7	38.1	0	0.82	239.4	0.12	7968.7
2014	4	10	21	5.5	6	3.1	49.5	0	1.48	259.6	0.51	7967.3
2014	4	10	22	2.1	2.8	0.1	62.4	0	1.66	235.4	0.7	7970
2014	4	10	23	0.9	1.3	0	68.2	0	1.55	236.2	0.37	7974
2014	4	10	24	-0.2	0.3	0	72.9	0	1.55	240.5	0.5	7975.3
2014	4	11	1	-1	-0.3	0	76.8	0	1.45	240.1	0.7	7971.3
2014	4	11	2	-1.6	-0.9	0	72.8	0	1.68	234	0.71	7970
2014	4	11	3	-1.9	-1.2	0	73.9	0	1.31	240.6	0.71	7966
2014	4	11	4	-2.2	-1.4	0	74.5	0	0.86	245.7	0.82	7963.3
2014	4	11	5	-2.9	-2.1	0	72.4	0	1.14	239.7	0.82	7960.7
2014	4	11	6	-3.4	-2.4	0	77.2	0	1.48	236	1.04	7960.7
2014	4	11	7	-3.3	-2.3	0.3	73.4	0	1.29	245.5	1	7956.7
2014	4	11	8	-3.7	-2.9	19.5	74.2	0	1.1	241.8	0.85	7956.7
2014	4	11	9	-2.2	-1.4	218.6	58.5	0	0.58	174.6	0.85	7955.3
2014	4	11	10	1.3	1.5	411.3	53.4	0	1.66	79.1	0.22	7951.3
2014	4	11	11	5.5	5.7	594.1	37.4	0	2.87	66.2	0.17	7952.7
2014	4	11	12	7.2	7.2	729.2	36.3	0	2.26	208.8	0	7952.7
2014	4	11	13	7.8	8	838	37.2	0	2.96	216.8	0.2	7950
2014	4	11	14	8.7	8.9	892	35.1	0	2.98	202.1	0.2	7944.7
2014	4	11	15	9.2	9.5	880	33.7	0	3.83	226.7	0.3	7942
2014	4	11	16	9.3	9.8	802	35.6	0	6.25	223.4	0.51	7938
2014	4	11	17	9.5	10	682.3	35.7	0.01	6.32	223.8	0.51	7934
2014	4	11	18	9.7	10.1	517.1	31.8	0	5.51	232.1	0.43	7931.3
2014	4	11	19	9.4	9.8	260.8	33.8	0	4.86	226.8	0.4	7926
2014	4	11	20	8.6	8.8	23.4	37	0	2.65	250.8	0.28	7927.3
2014	4	11	21	7.8	8.1	2.8	42.7	0	2.54	278.2	0.31	7926
2014	4	11	22	4.9	5.7	0.1	62.3	0	1.1	251.3	0.82	7926
2014	4	11	23	2.6	3.5	0	70.3	0	0.6	242.3	0.9	7927.3
2014	4	11	24	1.4	2.4	0	74.5	0	1.08	232.8	0.93	7923.4
2014	4	12	1	0.9	1.5	0	71.9	0	1.04	235	0.62	7920.7
2014	4	12	2	-0.1	0.7	0	80.7	0	1.07	25.6	0.82	7919.4
2014	4	12	3	-1.2	-0.4	0	81.9	0	1.23	242.6	0.84	7918
2014	4	12	4	-1.7	-1	0	83.3	0	1.44	238.3	0.68	7914
2014	4	12	5	-2.6	-2.1	0	84.4	0	1.5	239.2	0.59	7912.7
2014	4	12	6	-3.5	-2.6	0	83.3	0	1.54	240	0.96	7912.7
2014	4	12	7	-4.1	-3.4	0.4	87.2	0	1.4	242.3	0.71	7907.4
2014	4	12	8	-4.8	-4	31.1	80.1	0	1.53	235.3	0.82	7910
2014	4	12	9	-3.3	-2.7	207.3	69.4	0	1.04	239	0.57	7911.4
2014	4	12	10	0.1	0.2	438.1	55.1	0	0.81	92.1	0.1	7910
2014	4	12	11	2.9	2.8	645	43.5	0	3.89	74.8	-0.09	7906
2014	4	12	12	3.8	3.7	804	32.9	0	3.41	81.4	-0.08	7904.7
2014	4	12	13	4.6	4.6	919	34.8	0	3.29	81.1	-0.03	7902
2014	4	12	14	5.2	5.2	912	27.3	0	2.65	115	0.04	7899.4
2014	4	12	15	5.6	5.7	897	28.7	0	3.29	197.8	0.16	7896.7
2014	4	12	16	5.7	6	852	26.1	0	4.65	221.6	0.26	7894

2014	4	12	17	6	6.2	716.9	29.7	0	4.12	66.3	0.17	7891.4
2014	4	12	18	5.5	5.6	382.5	31.6	0	4.01	81.3	0.08	7891.4
2014	4	12	19	4.6	4.8	91.9	37.3	0	2.69	131.5	0.18	7892.7
2014	4	12	20	3.4	3.5	53.5	54	0	4.44	88	0.15	7895.4
2014	4	12	21	1.6	1.7	4.6	60.3	0	5.45	74.1	0.1	7902
2014	4	12	22	0.6	0.7	0	61.7	0	4.7	77.6	0.12	7907.4
2014	4	12	23	0	0	0	62.5	0	4.88	76.1	0.05	7915.4
2014	4	12	24	-0.4	-0.4	0	63.6	0	4.62	71	-0.05	7918
2014	4	13	1	-0.6	-0.6	0	64.9	0	5.68	69.4	-0.06	7918
2014	4	13	2	-1.1	-1	0	65.8	0	3.33	82.3	0.07	7922
2014	4	13	3	-2.3	-2.1	0	71.7	0	2.1	85	0.17	7922
2014	4	13	4	-1.9	-1.9	0	64.5	0	4.77	89.2	-0.01	7926
2014	4	13	5	-2	-2	0.1	63.1	0	6.01	71.4	-0.07	7931.3
2014	4	13	6	-2.4	-2.5	0	64.9	0	4.76	82.4	-0.04	7938
2014	4	13	7	-3	-3	0.4	63.3	0	5.85	73.5	0	7943.3
2014	4	13	8	-3.7	-3.6	19.1	67.4	0	4.55	83.4	0.06	7947.3
2014	4	13	9	-4	-3.9	52.6	61.3	0	4.14	85	0.03	7959.3
2014	4	13	10	-3.6	-3.7	205.2	57.3	0	4.51	59.3	-0.11	7967.3
2014	4	13	11	-2.4	-2.5	438.4	50.4	0	4.84	48.7	-0.13	7974
2014	4	13	12	-0.9	-1.3	771.2	38.7	0	6.64	63.7	-0.4	7979.3
2014	4	13	13	0.1	-0.2	870	27.4	0	8.18	58.7	-0.32	7982
2014	4	13	14	1	0.7	913	28.4	0	7.05	64.2	-0.31	7986
2014	4	13	15	1.7	1.5	898	21.5	0	5.95	75.2	-0.24	7988.7
2014	4	13	16	2.4	2.3	825	21.6	0	5.81	74.4	-0.16	7991.3
2014	4	13	17	2.8	2.7	702	24.1	0	3.95	65	-0.1	7992.7
2014	4	13	18	2.9	2.8	541.4	21.9	0	5.13	70.9	-0.11	7994
2014	4	13	19	2.5	2.6	267.7	24	0	4.83	63.4	0.1	7996.7
2014	4	13	20	1.8	2	18.5	30.6	0	2.09	72.4	0.16	7998
2014	4	13	21	0	0.2	3.8	45	0	0.71	262.4	0.29	8002
2014	4	13	22	-2.7	-2.2	0	55.5	0	1.74	241.5	0.49	8008.7
2014	4	13	23	-4.4	-3.9	0.1	62.6	0	1.75	239	0.48	8016.7
2014	4	13	24	-5.8	-5.1	0.1	60.8	0	1.7	242.8	0.68	8020.7
2014	4	14	1	-6.7	-6.1	0	57.7	0	1.55	247.5	0.57	8024.7
2014	4	14	2	-7.7	-7	0.1	66.2	0	1.74	237.3	0.65	8024.7
2014	4	14	3	-8.5	-7.8	0.1	72.3	0	1.77	240.1	0.75	8024.7
2014	4	14	4	-9	-8.1	0.1	68.8	0	1.77	237.9	0.86	8023.3
2014	4	14	5	-9.7	-8.6	0.1	71.5	0	1.7	237.7	1.02	8020.7
2014	4	14	6	-9.8	-8.9	0.1	70.1	0	1.43	242.9	0.96	8020.7
2014	4	14	7	-9.7	-8.8	0.7	68.4	0	1.82	234.4	0.99	8019.3
2014	4	14	8	-10	-8.9	25.8	64.8	0	1.29	234.9	1.04	8019.3
2014	4	14	9	-7.7	-6.8	247.9	38	0	0.87	238.1	0.85	8020.7
2014	4	14	10	-4	-4	448.1	33.7	0	0.46	76.7	0.06	8020.7
2014	4	14	11	-0.1	-0.4	626.2	30.5	0	1.9	79	-0.31	8015.3
2014	4	14	12	2.7	2.4	767.6	23.7	0	2.79	61.9	-0.35	8011.3
2014	4	14	13	4.4	4.5	865	24.6	0	4.12	229.8	0.05	8008.7
2014	4	14	14	5.4	5.6	907	21.7	0	5.07	232.3	0.16	8006
2014	4	14	15	6.2	6.5	892	23.7	0	5.48	233.8	0.25	8000.7
2014	4	14	16	6.9	7.2	818	23.1	0	4.59	223.9	0.33	7998
2014	4	14	17	7.3	7.7	664.8	25.4	0	4.77	221	0.42	7991.3
2014	4	14	18	7.5	7.8	468.5	27	0	5.26	226.6	0.27	7987.3
2014	4	14	19	7.2	7.5	198.8	28.7	0	4.53	237.2	0.35	7984.7
2014	4	14	20	6.3	6.6	61.2	33	0	2.81	241.2	0.32	7980.7
2014	4	14	21	4.9	5.3	7.9	33.9	0	1.54	253.7	0.42	7978
2014	4	14	22	2.8	3.2	0	58.3	0	0.6	212.6	0.45	7978
2014	4	14	23	0.9	1.7	0	65	0	0.77	246.9	0.76	7979.3
2014	4	14	24	-0.5	0.5	0	61.5	0	1.32	238.9	1.05	7975.3
2014	4	15	1	-0.7	0	0	53.6	0	1.44	247.9	0.7	7971.3
2014	4	15	2	-1.2	-0.5	0	60.1	0	0.73	259.4	0.65	7966
2014	4	15	3	-1	-0.5	0	54.4	0	2.12	245.2	0.51	7966
2014	4	15	4	-1.4	-0.7	0	65.5	0	1.78	241.5	0.68	7946
2014	4	15	5	-2	-1.4	0	71.8	0	0.96	250.7	0.64	7940.7

2014	4	15	6	-2.1	-1.4	0.1	74.1	0	0.74	68.1	0.64	7932.7
2014	4	15	7	-2	-1.3	0.4	67.7	0	0.94	246.4	0.68	7928.7
2014	4	15	8	0.4	1.6	26.6	43.3	0	0.71	263.1	1.23	7916.7
2014	4	15	9	3.1	3.4	69.7	38.9	0	4.22	230.2	0.36	7915.4
2014	4	15	10	3	3	119.2	49.2	0	3.62	265.8	0.04	7914
2014	4	15	11	0.6	0.5	134	85	0	2.22	8.6	-0.1	7916.7
2014	4	15	12	0	-0.2	207.4	80.3	0	3.92	233.7	-0.14	7919.4
2014	4	15	13	0.7	0.5	492	71.5	0	3.91	222.7	-0.16	7923.4
2014	4	15	14	1.2	1	574.9	59.1	0	4.15	214.4	-0.15	7922
2014	4	15	15	1.7	1.6	512.6	59.1	0	5.5	203.9	-0.12	7920.7
2014	4	15	16	2.3	2.3	641.3	39.1	0	6.16	211	-0.05	7920.7
2014	4	15	17	2.6	2.6	590.6	34.5	0	7.34	211.9	0.02	7919.4
2014	4	15	18	2.6	2.6	518.3	29.7	0	5.92	209.6	-0.05	7920.7
2014	4	15	19	2	2	217	32.2	0	3.13	151.1	0	7923.4
2014	4	15	20	1	1.1	34.8	40.5	0	2.14	135.4	0.1	7926
2014	4	15	21	0.1	0.3	7.3	39.6	0	0.87	61.5	0.12	7931.3
2014	4	15	22	-1.1	-0.8	0	51.8	0	0.95	275.5	0.3	7935.3
2014	4	15	23	-3.5	-3.3	0	56.4	0	1.21	230.9	0.29	7942
2014	4	15	24	-5.3	-4.8	0.1	65.1	0	2.02	232.3	0.45	7944.7
2014	4	16	1	-5.6	-5.4	0.1	68.6	0	1.22	251.4	0.18	7946
2014	4	16	2	-6.2	-5.7	0.1	69.4	0	1.42	239.4	0.55	7950
2014	4	16	3	-6.7	-6	0.1	74.7	0	1.57	244.9	0.63	7950
2014	4	16	4	-7.3	-6.6	0.1	75.9	0	1.46	241.5	0.65	7948.7
2014	4	16	5	-7.3	-6.7	0.1	80.1	0	1.44	242.1	0.65	7946
2014	4	16	6	-8	-7.3	0.1	80.7	0	1.75	239.2	0.65	7947.3
2014	4	16	7	-8.6	-7.9	0.7	81.3	0	1.74	241.2	0.7	7944.7
2014	4	16	8	-8.7	-8.1	37.5	72.5	0	1.36	237.5	0.63	7946
2014	4	16	9	-6.7	-6.5	250.4	61	0	0.45	127.9	0.16	7948.7
2014	4	16	10	-3.7	-3.9	335	53.6	0	1.02	78	-0.13	7951.3
2014	4	16	11	-0.8	-1.1	459	38.1	0	0.99	145.1	-0.28	7951.3
2014	4	16	12	0.5	0.2	554.3	34	0	1.3	60.1	-0.24	7948.7
2014	4	16	13	1.6	1.3	715.8	38.6	0	1.57	67.2	-0.29	7950
2014	4	16	14	2.3	2.2	746.6	37.6	0	3.58	224.2	-0.17	7948.7
2014	4	16	15	3	2.9	640.1	41.8	0	4.86	223.2	-0.06	7946
2014	4	16	16	3.4	3.3	642.4	37.4	0	4.32	229.6	-0.07	7947.3
2014	4	16	17	3.9	3.9	529.5	40.3	0	3.93	223	-0.01	7946
2014	4	16	18	3.7	3.7	255.8	41.4	0	3.49	224.3	0.05	7942
2014	4	16	19	3.7	3.8	166.5	43.9	0	2.84	216.5	0.08	7944.7
2014	4	16	20	3.5	3.7	70.6	46.9	0	3.03	228.6	0.17	7944.7
2014	4	16	21	2.2	2.5	6.8	58	0	2.36	243.9	0.33	7944.7
2014	4	16	22	-0.2	0.2	0	66.2	0	1.98	230	0.36	7947.3
2014	4	16	23	-1.2	-1	0	72	0	1.44	250.3	0.21	7952.7
2014	4	16	24	-2.3	-1.9	0.1	73.8	0	1.28	245.8	0.43	7951.3
2014	4	17	1	-3.2	-2.8	0.1	75.4	0	1.43	238.5	0.4	7952.7
2014	4	17	2	-4.2	-3.4	0.1	78.5	0	1.81	238.8	0.77	7954
2014	4	17	3	-3.7	-3.1	0.1	75.6	0	1.45	240	0.53	7948.7
2014	4	17	4	-3.7	-3.1	0.1	81.5	0	0.71	235.6	0.58	7946
2014	4	17	5	-4.2	-3.6	0.1	79.3	0	1.04	241.6	0.62	7946
2014	4	17	6	-4.3	-3.6	0.1	82.8	0	1.49	234.5	0.66	7942
2014	4	17	7	-4.1	-3.5	1.8	83.2	0	0.61	242.8	0.59	7940.7
2014	4	17	8	-4.1	-3.2	40.4	81.4	0	1.27	238	0.9	7939.3
2014	4	17	9	-2.5	-2	195.4	73.2	0	1.1	169.5	0.5	7936.7
2014	4	17	10	0.4	0.3	405.3	49.9	0	0.75	81.7	-0.03	7935.3
2014	4	17	11	4.8	4.7	567.3	48.4	0.48	2.76	192.2	-0.05	7931.3
2014	4	17	12	5.8	5.8	395.2	47.4	0.02	4.2	222.5	0.01	7928.7
2014	4	17	13	6.5	6.5	577.4	46.6	0.01	3.82	220.3	-0.02	7927.3
2014	4	17	14	7.4	7.5	616.1	46.9	0.01	5.79	232	0.1	7920.7
2014	4	17	15	8.4	8.5	849	42.6	0.02	4.74	212	0.01	7918
2014	4	17	16	9	9.1	542.1	43.3	0.01	4.78	235.5	0.09	7911.4
2014	4	17	17	9.3	9.4	322.5	43.5	0	4.28	231.7	0.1	7906
2014	4	17	18	9.5	9.6	205.9	43.1	0	4.01	252.7	0.11	7902

2014	4	17	19	9.5	9.7	113.9	45.7	0.01	2.48	229	0.24	7896.7
2014	4	17	20	9	9.3	42.4	49.7	0	0.9	209.7	0.35	7887.4
2014	4	17	21	8.5	9	5.8	54.2	0	3.85	222.1	0.58	7880.7
2014	4	17	22	6.2	6.4	0.1	87.1	0	3.55	236.7	0.2	7884.7
2014	4	17	23	5.2	5.4	0.1	76.4	0	3.61	241.4	0.21	7892.7
2014	4	17	24	5.5	5.7	0.1	86.6	0	3.07	236.9	0.17	7888.7
2014	4	18	1	3.7	3.8	0.1	94	0.01	1.91	40.1	0.1	7888.7
2014	4	18	2	2.3	2.4	0.1	99	0.04	0.69	237.1	0.08	7899.4
2014	4	18	3	1.7	1.7	0.1	99.9	0.01	0.45	70.7	-0.04	7896.7
2014	4	18	4	1.5	1.4	0.1	100	0.01	1.32	57.8	-0.05	7900.7
2014	4	18	5	1.2	1.2	0.1	100	0.01	1.01	60.4	-0.05	7899.4
2014	4	18	6	1.4	1.3	0.1	89.6	0	0.89	264.4	-0.06	7903.4
2014	4	18	7	1.1	0.5	0.4	72.6	0	3.18	228.6	-0.63	7904.7
2014	4	18	8	0.5	0.2	24.3	77.3	0	2.83	232.9	-0.24	7911.4
2014	4	18	9	0.3	0.3	57	68.5	0	3.97	219.8	-0.06	7916.7
2014	4	18	10	0.7	0.6	239.9	62.8	0	6.83	233.5	-0.1	7916.7
2014	4	18	11	1.1	1	326.6	62	0.01	6.55	236.1	-0.13	7916.7
2014	4	18	12	1.8	1.6	775.7	54.1	0.01	8.15	218.5	-0.16	7923.4
2014	4	18	13	2.3	2.2	922	45.3	0.01	8.89	221.8	-0.1	7924.7
2014	4	18	14	2.7	2.6	886	41.5	0.01	7.76	226.6	-0.09	7928.7
2014	4	18	15	2.8	2.8	856	37.9	0.01	8.61	222.5	-0.03	7932.7
2014	4	18	16	3	3	566.9	29.4	0.01	7.4	217.7	0.02	7936.7
2014	4	18	17	3.9	3.7	669.2	27.9	0	3.81	194.5	-0.15	7938
2014	4	18	18	4.1	4	476.9	30.7	0.01	2.92	113.9	-0.18	7938
2014	4	18	19	3.7	3.7	188.2	32.5	0	2.38	198.9	0	7942
2014	4	18	20	3.3	3.3	65.5	37.8	0	1.23	207.1	0.03	7942
2014	4	18	21	1.6	1.9	6.2	54.6	0	0.96	283.2	0.4	7943.3
2014	4	18	22	-1.2	-1	0.1	55.8	0	1.26	243.1	0.22	7947.3
2014	4	18	23	-2.2	-1.9	0.1	61.6	0	1.35	241.7	0.29	7951.3
2014	4	18	24	-3.6	-3	0.1	68.1	0	1.68	235.5	0.55	7952.7
2014	4	19	1	-4	-3.5	0.1	67	0	1.63	234.6	0.47	7952.7
2014	4	19	2	-4.4	-4	0.1	65	0	1.52	240.5	0.41	7952.7
2014	4	19	3	-4.7	-4.1	0.1	71	0	1.43	240.2	0.51	7951.3
2014	4	19	4	-4.6	-4.1	0.1	69.8	0	0.87	236	0.54	7950
2014	4	19	5	-5.3	-4.5	0.1	76.3	0	1.28	234.5	0.82	7947.3
2014	4	19	6	-5.6	-4.9	0.1	70.3	0	1.45	233.8	0.66	7947.3
2014	4	19	7	-5.7	-4.8	1.8	72.4	0	1.26	234.6	0.91	7948.7
2014	4	19	8	-5.7	-4.9	43.2	64.3	0	1.13	238.3	0.81	7948.7
2014	4	19	9	-3.7	-3.3	250.3	46.4	0	0.4	236.3	0.39	7948.7
2014	4	19	10	0.1	0	449	42.6	0	0.5	134.1	-0.06	7948.7
2014	4	19	11	5.3	5.3	625.1	27.1	0	2.63	152.9	-0.06	7944.7
2014	4	19	12	7.7	7.5	734.1	28	0	2.85	191.4	-0.21	7943.3
2014	4	19	13	8.3	8.5	720	27.9	0	6.22	240	0.15	7943.3
2014	4	19	14	9.1	9.1	813	23.9	0.01	3.96	215.9	-0.01	7942
2014	4	19	15	9.9	9.8	903	22.8	0	4.28	204	-0.13	7942
2014	4	19	16	10.2	10.4	801	19.4	0.02	6.82	229	0.22	7939.3
2014	4	19	17	10.5	10.7	661.3	23.8	0.01	6.45	230.4	0.21	7938
2014	4	19	18	10.3	10.6	251.7	24.8	0	5.2	229.9	0.3	7935.3
2014	4	19	19	10	10.4	120.4	25.4	0	4.3	226.9	0.41	7935.3
2014	4	19	20	10	10.3	63.7	28.7	0	1.86	243.3	0.26	7935.3
2014	4	19	21	6.7	7.7	3.7	44.5	0	1.04	250.2	0.99	7932.7
2014	4	19	22	6.8	7.6	0.1	31.8	0	1.04	343.8	0.83	7935.3
2014	4	19	23	8.2	8.9	0.1	39.2	0	1.15	241.5	0.64	7939.3
2014	4	19	24	7.1	7.8	0.1	45.4	0	1.59	245.5	0.74	7942
2014	4	20	1	6.2	6.2	0.1	54.1	0	3.23	232	0.04	7951.3
2014	4	20	2	4.3	4.2	0.1	61	0	2.14	359.6	-0.06	7963.3
2014	4	20	3	2.6	2.7	0.1	71.2	0	1.15	246.1	0.14	7972.7
2014	4	20	4	0.9	1.2	0.1	79.9	0	0.91	254.3	0.28	7979.3
2014	4	20	5	-1.4	-1	0.1	80.1	0	1.57	233.7	0.38	7984.7
2014	4	20	6	-2.2	-2.1	0.1	81.4	0	1.01	243.2	0.17	7990
2014	4	20	7	-3.3	-3.1	1.6	83.1	0	1.52	237.2	0.3	7994

2014	4	20	8	-4.3	-3.9	45.3	75.8	0	1.27	241.5	0.38	7998
2014	4	20	9	-3.1	-2.8	269.9	60.3	0	0.85	231	0.31	8002
2014	4	20	10	0.5	0.3	471.7	36.1	0	0.67	99.2	-0.2	8006
2014	4	20	11	3.1	2.5	646.7	28.4	0	1.59	65.2	-0.57	8007.3
2014	4	20	12	4.6	4	788.6	17.4	0	2.34	93.1	-0.63	8010
2014	4	20	13	5.5	5.1	887	24	0	1.73	87.3	-0.46	8012.7
2014	4	20	14	5.8	5.6	904	23.1	0	4.02	226.8	-0.15	8014
2014	4	20	15	6.2	6.2	751.3	26.1	0	4.48	229.3	-0.04	8011.3
2014	4	20	16	7	6.9	773.3	18.7	0	3.95	219.9	-0.08	8011.3
2014	4	20	17	7.3	7.4	582.1	22.5	0	3.71	229.7	0.07	8010
2014	4	20	18	7.9	7.8	487.7	24.8	0	2.6	206.4	-0.15	8008.7
2014	4	20	19	7.7	7.7	272.4	27.1	0	2.66	45.4	0.01	8012.7
2014	4	20	20	7	7.1	39.6	40.9	0	0.58	77.7	0.13	8015.3
2014	4	20	21	4.2	4.6	6.9	58	0	1.4	244.6	0.46	8015.3
2014	4	20	22	1.9	2.2	0.1	62.1	0	1.33	243.2	0.33	8019.3
2014	4	20	23	0.2	0.7	0.1	64.7	0	1.66	240.8	0.43	8023.3
2014	4	20	24	-0.8	-0.3	0.1	69	0	1.59	236.1	0.49	8026
2014	4	21	1	-1.5	-1.1	0.1	70.7	0	1.74	237.9	0.43	8024.7
2014	4	21	2	-1.9	-1.2	0.1	75.3	0	1.6	239.1	0.71	8023.3
2014	4	21	3	-2.3	-1.6	0.1	76.1	0	1.64	236	0.69	8023.3
2014	4	21	4	-3	-2	0.1	73.1	0	1.62	238	0.99	8022
2014	4	21	5	-3.4	-2.2	0.1	75.2	0	1.64	238.9	1.12	8019.3
2014	4	21	6	-3.4	-2.4	0.1	75.4	0	1.89	232.1	1.04	8014
2014	4	21	7	-2.9	-1.9	1.9	70.8	0	1.76	241.4	1.01	8011.3
2014	4	21	8	-2.8	-1.8	61.7	67.6	0	1.71	238.4	0.99	8006
2014	4	21	9	0.6	1.9	271.1	42.5	0	2.08	233.8	1.23	8003.3
2014	4	21	10	5.6	5.9	465.7	29.6	0	2.48	247	0.3	7998
2014	4	21	11	7.7	7.4	631	29.1	0	1.66	207	-0.32	7991.3
2014	4	21	12	9.1	9	779.2	24.7	0	2.47	227.6	-0.14	7990
2014	4	21	13	10.4	10.1	879	22.8	0	2.49	216.4	-0.24	7986
2014	4	21	14	11.3	11.1	821	20.5	0	3.89	213.8	-0.22	7978
2014	4	21	15	11.4	11.5	633.1	21.1	0	5.35	241.9	0.06	7972.7
2014	4	21	16	11.2	11.3	410.1	22.1	0	4.71	239.6	0.1	7967.3
2014	4	21	17	11.5	11.5	420.6	21.7	0.01	3.92	234.7	0.06	7962
2014	4	21	18	11.8	11.8	382.1	24.2	0	3.64	249.5	0.06	7955.3
2014	4	21	19	11.5	11.7	172.2	24.6	0	3.49	240.7	0.13	7947.3
2014	4	21	20	9.1	9.7	59	43.2	0	1.7	223.4	0.67	7943.3
2014	4	21	21	8.1	8.7	10.5	48.8	0	2.21	227.8	0.63	7942
2014	4	21	22	6.8	7.5	0.1	35.8	0	2.45	219.2	0.71	7935.3
2014	4	21	23	7.7	8.5	0.1	40.8	0	2.05	228.5	0.77	7938
2014	4	21	24	7.8	8.5	0.1	43.2	0	2.19	229.2	0.73	7932.7
2014	4	22	1	5.2	5.9	0.1	63.3	0	1.03	240.5	0.72	7923.4
2014	4	22	2	4.1	5.1	0.1	63.3	0	1.22	246.5	0.98	7918
2014	4	22	3	3.3	4.2	0.1	68.1	0	0.97	244.4	0.96	7910
2014	4	22	4	2.8	3.7	0.1	59.6	0	1.35	243.5	0.88	7899.4
2014	4	22	5	3.2	4.5	0.1	57.4	0	1.78	243.1	1.26	7890
2014	4	22	6	4.5	5.6	0.1	60.4	0	1.16	257.7	1.1	7883.4
2014	4	22	7	5.4	6.4	2.2	47.9	0	1.58	216.1	0.94	7875.4
2014	4	22	8	5.6	5.8	21.9	81.6	0	6.88	229.7	0.2	7870
2014	4	22	9	2.2	2.2	44.2	90.6	0	1.54	246.8	-0.08	7887.4
2014	4	22	10	1	0.9	37.5	96.7	0	0.14	205.6	-0.11	7880.7
2014	4	22	11	0.2	0.2	63.4	96.6	0.01	0.03	330.9	-0.02	7876.7
2014	4	22	12	0.2	0.1	98.2	98.4	0.06	0.71	63.3	-0.04	7871.4
2014	4	22	13	0.2	0.1	115.3	97.3	0.07	1.39	47.6	-0.12	7870
2014	4	22	14	0.4	0.3	158.9	96.2	0.04	1.96	47	-0.08	7867.4
2014	4	22	15	0.7	0.6	246.3	96.3	0.02	2.19	53.2	-0.14	7862
2014	4	22	16	0.6	0.3	152.1	97.4	0.02	1.99	67	-0.3	7856.7
2014	4	22	17	1	0.8	157.6	93.5	0.01	2.03	51	-0.23	7856.7
2014	4	22	18	0.6	0.4	94.2	94.3	0.01	1.55	55.1	-0.21	7854
2014	4	22	19	0.3	0.1	76.4	95.6	0.01	2.16	114.8	-0.25	7860.7
2014	4	22	20	-0.6	-0.8	24.9	97.2	0	2.98	102.4	-0.16	7862

2014	4	22	21	-1.8	-2	1.5	94.9	0.01	3.51	100.1	-0.15	7867.4
2014	4	22	22	-3.4	-3.6	0.1	93.2	0	3.94	246.1	-0.13	7874
2014	4	22	23	-4.2	-4.4	0.1	87.9	0.35	2.59	61.2	-0.13	7892.7
2014	4	22	24	-4.8	-4.9	0.1	94.3	0.09	1.93	67.3	-0.1	7894
2014	4	23	1	-4.8	-4.9	0.1	88.1	0	0.92	250.6	-0.03	7896.7
2014	4	23	2	-4.6	-4.5	0.1	90	0	0.71	275.8	0.14	7899.4
2014	4	23	3	-5.3	-5.2	0.1	96.1	0	0.76	42.8	0.08	7903.4
2014	4	23	4	-5.5	-5.5	0.1	96.9	0	0.35	68.8	0.03	7902
2014	4	23	5	-7.9	-7.5	0.1	91.1	0	1.56	234.1	0.39	7902
2014	4	23	6	-9.4	-9	0.1	91.9	0	1.4	242.7	0.37	7904.7
2014	4	23	7	-10.2	-9.6	1.7	93.3	0	1.19	250.6	0.62	7910
2014	4	23	8	-9.9	-9.1	31.8	91.6	0	0.93	243.3	0.75	7911.4
2014	4	23	9	-7.5	-7.1	103.5	81.9	0	1.28	244.5	0.36	7915.4
2014	4	23	10	-4.3	-4.2	177.9	75	0	2.2	238.1	0.09	7914
2014	4	23	11	-2.6	-2.8	407.9	74.6	0	4.59	240.5	-0.17	7912.7
2014	4	23	12	-2.6	-2.8	368.8	79	0	3.77	237.8	-0.19	7914
2014	4	23	13	-1.9	-2.1	456.8	79.8	0	4.18	235.2	-0.21	7916.7
2014	4	23	14	-1.3	-1.5	579.6	74.8	0	5.01	235.5	-0.22	7919.4
2014	4	23	15	-0.9	-1.2	625.8	66.2	0	5.65	230.9	-0.24	7919.4
2014	4	23	16	-0.3	-0.5	546.3	63.7	0	7.2	226.9	-0.23	7919.4
2014	4	23	17	0.3	0.1	615.9	65.3	0	6.56	237	-0.2	7919.4
2014	4	23	18	-0.5	-0.8	257.6	83.2	0	3.62	228.9	-0.24	7920.7
2014	4	23	19	-0.3	-0.5	130.3	77.4	0	2.61	218.1	-0.2	7924.7
2014	4	23	20	-0.4	-0.5	46	75.1	0	3.14	222.1	-0.13	7923.4
2014	4	23	21	0.1	0	8.4	71	0	3.98	206.3	-0.11	7926
2014	4	23	22	0.4	0.3	0.1	74	0	4.36	207.9	-0.08	7924.7
2014	4	23	23	0	-0.1	0.1	77.4	0	4.24	226.6	-0.09	7926
2014	4	23	24	0.2	0.1	0.1	75.1	0	2.61	230	-0.06	7927.3
2014	4	24	1	0.3	0.2	0.1	76.4	0	2.72	225.3	-0.05	7926
2014	4	24	2	0.5	0.4	0.1	76.6	0	2.78	219	-0.07	7924.7
2014	4	24	3	0.7	0.7	0.1	76.4	0	5.03	217.1	-0.07	7920.7
2014	4	24	4	0.7	0.7	0.1	75.2	0	6.61	230.8	-0.06	7916.7
2014	4	24	5	0.8	0.7	0.1	79.8	0	5.59	244.2	-0.07	7915.4
2014	4	24	6	0.2	0.2	0.1	82.6	0	3.13	226.9	-0.04	7914
2014	4	24	7	0.3	0.2	1.1	86	0	2.49	222.9	-0.06	7910
2014	4	24	8	-0.3	-0.4	26.8	88.8	0	0.62	246.2	-0.1	7906
2014	4	24	9	-0.2	-0.3	48	92.4	0	3.27	238.3	-0.12	7908.7
2014	4	24	10	-0.2	-0.3	135.5	91.5	0	2.17	230.2	-0.12	7910
2014	4	24	11	0.7	0.5	318.9	78	0	2.91	234.4	-0.14	7911.4
2014	4	24	12	1.8	1.6	370.2	82.8	0	4.76	235.5	-0.17	7911.4
2014	4	24	13	2	1.8	474.4	75.8	0	4.5	237	-0.2	7916.7
2014	4	24	14	2	1.8	396.7	78	0	3.51	237.8	-0.2	7918
2014	4	24	15	3.3	3.1	626.5	79.6	0	5.71	230.4	-0.18	7916.7
2014	4	24	16	3.7	3.4	645.8	70.1	0	5.06	228.1	-0.24	7918
2014	4	24	17	2.6	2.5	122.9	86.3	0	3.28	237.9	-0.12	7915.4
2014	4	24	18	0.4	0.4	15.8	98.9	0	1.43	232.9	-0.08	7916.7
2014	4	24	19	0.6	0.6	28.9	93.2	0	0.65	61.8	-0.01	7920.7
2014	4	24	20	1.2	1.4	24.4	90.8	0	0.83	359.2	0.22	7919.4
2014	4	24	21	0.2	0.3	2.3	98.9	0	0.78	63.6	0.14	7915.4
2014	4	24	22	-0.2	-0.2	0.1	99.4	0	0.95	237	0.05	7914
2014	4	24	23	-0.2	-0.3	0.1	100	0	0.55	66.3	-0.04	7915.4
2014	4	24	24	-0.4	-0.5	0.1	99.6	0	0.95	229.3	-0.08	7912.7
2014	4	25	1	-0.7	-0.8	0.1	99.8	0	1.24	235.3	-0.1	7910
2014	4	25	2	-0.9	-1	0.1	100	0	0.94	232.3	-0.08	7903.4
2014	4	25	3	-1.1	-1.1	0.1	100	0	0.56	227.8	-0.06	7899.4
2014	4	25	4	-1.1	-1.1	0.1	99.7	0	0.85	243.4	-0.04	7892.7
2014	4	25	5	-1.1	-1.1	0.1	100	0	0.68	258.9	0.02	7888.7
2014	4	25	6	-1.6	-1.5	0.1	100	0	0.65	226	0.09	7883.4
2014	4	25	7	-2.2	-1.9	0.6	100	0	1.36	233.8	0.28	7876.7
2014	4	25	8	-1.7	-1.6	12.5	98.6	0	0.93	246.9	0.16	7872.7
2014	4	25	9	-0.6	-0.6	61.7	92.2	0	1.33	234.7	0.01	7870

2014	4	25	10	1	1	102.8	81.8	0	0.77	178.6	-0.03	7866
2014	4	25	11	1.1	1	115.9	94.8	0	0.84	29.4	-0.11	7864.7
2014	4	25	12	0.4	0.3	141	90.7	0.04	0.4	297.7	-0.04	7863.4
2014	4	25	13	0.7	0.8	235.3	89.9	0.05	0.4	261.2	0.04	7862
2014	4	25	14	1.3	1.3	183.5	95.2	0.03	0.88	257.9	-0.04	7856.7
2014	4	25	15	0.7	0.6	237	86.8	0.04	1.01	223.9	-0.13	7854
2014	4	25	16	1.1	1.1	229.8	93	0.21	1.12	56.7	-0.03	7850
2014	4	25	17	1.6	1.4	166.9	91.9	0	1.18	60.1	-0.13	7846
2014	4	25	18	1.9	1.9	145.8	97.1	0	1.68	63.1	-0.05	7843.4
2014	4	25	19	1.3	1	101.3	98.7	0	2.05	85.5	-0.21	7844.7
2014	4	25	20	1.1	1	33	100	0	1.78	74.8	-0.14	7843.4
2014	4	25	21	0.4	0.2	4.3	100	0	1.13	95.1	-0.15	7842
2014	4	25	22	0	-0.1	0.1	100	0	0.54	68.3	-0.12	7840.7
2014	4	25	23	0	-0.1	0.1	100	0	0.67	65.4	-0.12	7842
2014	4	25	24	-0.1	-0.2	0.1	100	0	0.6	87.1	-0.13	7840.7
2014	4	26	1	-0.1	-0.2	0.1	100	0	0.98	351	-0.12	7835.4
2014	4	26	2	-0.3	-0.4	0.1	100	0	0.69	92	-0.12	7834
2014	4	26	3	-0.4	-0.6	0.1	100	0	1.35	48.7	-0.13	7826
2014	4	26	4	-0.6	-0.7	0.1	100	0	1.47	44.1	-0.09	7831.4
2014	4	26	5	-0.8	-0.9	0.1	100	0	1.2	56	-0.11	7830
2014	4	26	6	-1	-1.1	0.1	100	0	1.91	37.6	-0.1	7834
2014	4	26	7	-1.2	-1.3	0.6	99.8	0	3.64	59.6	-0.11	7830
2014	4	26	8	-1.4	-1.5	21.2	97.9	0	3.42	59.2	-0.1	7834
2014	4	26	9	-1.6	-1.7	78.9	97.4	0	3.67	74.6	-0.16	7835.4
2014	4	26	10	-1.1	-1.3	181	83.6	0	2.42	90	-0.25	7835.4
2014	4	26	11	-0.7	-1	358.8	79	0	2.67	79.3	-0.33	7835.4
2014	4	26	12	0.2	-0.3	498.8	79.4	0	2.66	86.4	-0.52	7836.7
2014	4	26	13	0.5	0	478.1	76.1	0	3.5	68.6	-0.58	7835.4
2014	4	26	14	0.9	0.2	549.3	82.4	0	3.94	64.7	-0.69	7835.4
2014	4	26	15	1.2	0.6	453.3	71.9	0	3.55	73.1	-0.64	7834
2014	4	26	16	1.3	0.9	342	77.7	0	3.27	99.5	-0.43	7835.4
2014	4	26	17	0.2	-0.2	290.9	92.9	0	2.73	103.4	-0.42	7842
2014	4	26	18	-0.5	-1	292.7	93.8	0	3.32	61.4	-0.47	7847.4
2014	4	26	19	-1	-1.1	193.9	85.2	0	4.1	46.2	-0.16	7851.4
2014	4	26	20	-0.9	-1	58.9	97.3	0	2.2	40.9	-0.1	7851.4
2014	4	26	21	-2	-2.1	11.7	94.1	0	1.12	356	-0.06	7855.4
2014	4	26	22	-2.3	-2.2	0.1	96.7	0	0.69	242.9	0.06	7858
2014	4	26	23	-2.9	-2.7	0.1	97.3	0	0.61	250.6	0.23	7864.7
2014	4	26	24	-4.4	-4.2	0.1	93.8	0	1.28	255.2	0.25	7868.7
2014	4	27	1	-6.1	-5.7	0.1	91.6	0	1.61	241.2	0.44	7871.4
2014	4	27	2	-8	-7.3	0.1	92.6	0	2.16	238.8	0.65	7874
2014	4	27	3	-8.5	-7.9	0.1	91.7	0	1.77	242.5	0.62	7875.4
2014	4	27	4	-9	-8.4	0.1	91.7	0	1.84	240.7	0.6	7871.4
2014	4	27	5	-9.5	-8.8	0.1	92.7	0	2.01	237.2	0.77	7868.7
2014	4	27	6	-8.9	-8.2	0.1	92.2	0	1.33	246.3	0.67	7871.4
2014	4	27	7	-8.2	-7.7	4.8	92.4	0	0.8	242.8	0.46	7870
2014	4	27	8	-7.5	-7.1	46.4	89.3	0	0.61	245.5	0.46	7870
2014	4	27	9	-5.6	-5.3	129.9	79.7	0	0.6	231.8	0.29	7871.4
2014	4	27	10	-2.1	-2.1	171.6	77.2	0	3.84	232.7	-0.05	7872.7
2014	4	27	11	-1.7	-1.9	257.1	78.8	0	2.37	251.1	-0.19	7872.7
2014	4	27	12	-0.4	-0.6	497	66.1	0	3.24	249.4	-0.22	7872.7
2014	4	27	13	0.8	0.5	794.2	61.2	0	5.53	233.3	-0.32	7874
2014	4	27	14	0.8	0.4	738.2	63.9	0	4.39	224.2	-0.4	7868.7
2014	4	27	15	-2.2	-2.4	102.7	94.1	0	6.61	232.1	-0.15	7867.4
2014	4	27	16	-2.6	-2.8	715.9	73.5	0	3.4	40.1	-0.25	7888.7
2014	4	27	17	-2.1	-2.3	289.3	89.3	0	4.8	219.3	-0.23	7887.4
2014	4	27	18	-3.6	-3.8	145.2	84.8	0	3.07	235.8	-0.17	7895.4
2014	4	27	19	-2.9	-3.2	194	82.7	0	1.89	223.1	-0.23	7900.7
2014	4	27	20	-2.8	-2.7	54.1	80.2	0	1.46	29.4	0.08	7906
2014	4	27	21	-4.1	-3.8	5.5	85.2	0	0.96	268.4	0.3	7908.7
2014	4	27	22	-5.6	-5.4	0.1	93.7	0	1.05	260.2	0.17	7914

2014	4	27	23	-6.5	-6.2	0.1	91.1	0	1.76	235.5	0.27	7919.4
2014	4	27	24	-7.9	-7.3	0.1	91.6	0	1.58	239.7	0.6	7922
2014	4	28	1	-9.5	-8.6	0.1	91.5	0	2.03	236.9	0.91	7926
2014	4	28	2	-8.6	-8.3	0.1	92.7	0	0.81	242.5	0.35	7930
2014	4	28	3	-9.4	-8.5	0.1	93.8	0	1.23	235.5	0.84	7935.3
2014	4	28	4	-7.9	-7.7	0.1	91	0	1.1	247.6	0.29	7938
2014	4	28	5	-9.2	-8.4	0.1	89.1	0	2.26	232.9	0.84	7943.3
2014	4	28	6	-8.4	-8.1	0.1	91.3	0	0.99	221.3	0.32	7948.7
2014	4	28	7	-8.4	-8	1.9	94.9	0	0.75	235.8	0.4	7954
2014	4	28	8	-9	-8.4	26.1	91.1	0	1.11	236.1	0.61	7960.7
2014	4	28	9	-6.9	-6.8	93.8	82.5	0	0.35	331.3	0.1	7968.7
2014	4	28	10	-5	-5.2	213.5	72.5	0	0.39	122.7	-0.18	7974
2014	4	28	11	-3.4	-3.7	399.9	64.5	0	2.39	75.3	-0.26	7980.7
2014	4	28	12	-2.4	-2.8	612.9	56.7	9999	3.75	105	-0.44	7986
2014	4	28	13	-1.4	-2	771.4	54.5	9999	4.31	166.9	-0.53	7990
2014	4	28	14	-0.7	-1.1	854	45.8	9999	4.5	218.2	-0.41	7992.7
2014	4	28	15	0.4	-0.2	809	46.8	9999	2.71	203.2	-0.6	7995.3
2014	4	28	16	0.5	-0.1	626.4	47.9	9999	3.35	154.8	-0.56	8000.7
2014	4	28	17	0.5	0.1	313.1	49.7	0	2.49	125.2	-0.45	8006
2014	4	28	18	1.1	0.6	366	47.5	0	2.74	108.2	-0.42	8012.7
2014	4	28	19	1.1	0.8	226	38.6	0	2.38	162.6	-0.26	8016.7
2014	4	28	20	0.6	0.5	56.8	52.4	0	1.69	97.6	-0.1	8023.3
2014	4	28	21	-0.3	-0.2	12.1	58.7	0	0.8	204.9	0.07	8028.7
2014	4	28	22	-2.2	-1.9	0.1	69.9	0	1.27	203.5	0.25	8036.7
2014	4	28	23	-4.6	-4.4	0.1	77.9	0	2.67	226.7	0.23	8046
2014	4	28	24	-6	-5.8	0.1	81.1	0	1.85	239	0.2	8051.3
2014	4	29	1	-7.5	-7	0.1	83.6	0	1.88	239.3	0.47	8059.3
2014	4	29	2	-8.2	-7.8	0.1	85.4	0	1.8	242.3	0.33	8062
2014	4	29	3	-9.1	-8.6	0.1	88.1	0	1.7	237	0.53	8067.3
2014	4	29	4	-9.6	-8.9	0.1	88.9	0	1.84	241.3	0.67	8071.3
2014	4	29	5	-9.9	-9.2	0.1	88.1	0	2	238.1	0.71	8074
2014	4	29	6	-10.1	-9.3	0.1	89.6	0	1.81	240.9	0.8	8075.3
2014	4	29	7	-10.4	-9.7	4.8	90	0	1.88	240.4	0.7	8079.3
2014	4	29	8	-9.5	-8.9	75.2	76.6	0	1.48	239.8	0.63	8083.3
2014	4	29	9	-6.5	-6.1	312.8	59.8	0	0.82	224.4	0.35	8088.7
2014	4	29	10	-2.1	-2.3	513.5	41.7	0	0.61	87.9	-0.16	8094
2014	4	29	11	1.1	0.7	691.2	33.7	0	1.3	56.6	-0.38	8095.3
2014	4	29	12	2.9	2.4	830	32.9	0	1.65	108.1	-0.55	8095.3
2014	4	29	13	4.4	3.8	923	26.6	0	2.57	104.6	-0.65	8096.7
2014	4	29	14	5.5	5	960	25.3	0	2.28	72.4	-0.51	8094
2014	4	29	15	6.5	6	944	20.5	0	2.8	73.2	-0.52	8094
2014	4	29	16	7.4	6.9	870	19.5	0.01	3.17	68.2	-0.51	8092.7
2014	4	29	17	7.7	7.4	744.2	23	0.01	3.47	52.4	-0.37	8092.7
2014	4	29	18	7.9	7.6	580.1	20.6	0.01	3.73	65.7	-0.31	8092.7
2014	4	29	19	7.8	7.7	315	26.2	0.01	2.6	56.4	-0.11	8092.7
2014	4	29	20	6.9	7	25.6	31.4	0	0.95	133.7	0.09	8090
2014	4	29	21	4.1	4.6	8.3	57.8	0	1.28	248	0.49	8090
2014	4	29	22	0.6	1.1	0.1	57.3	0	1.71	237.7	0.51	8094
2014	4	29	23	-0.8	-0.3	0.1	67.5	0	1.33	239.9	0.46	8096.7
2014	4	29	24	-1.9	-1.5	0.1	70.8	0	1.64	240.4	0.43	8102
2014	4	30	1	-2.8	-2.2	0.1	72.6	0	1.67	237.8	0.59	8104.7
2014	4	30	2	-3.7	-3	0.1	77.2	0	1.76	239	0.66	8104.7
2014	4	30	3	-4.3	-3.6	0.1	75.6	0	1.8	240.2	0.63	8104.7
2014	4	30	4	-4.8	-3.9	0.1	78.3	0	1.91	236.7	0.88	8104.7
2014	4	30	5	-5.2	-4.4	0.1	75	0	1.88	240.8	0.89	8104.7
2014	4	30	6	-5.3	-4.4	0.1	76.7	0	1.62	244	0.96	8106
2014	4	30	7	-5.8	-4.8	4.3	79.9	0	1.97	236	1	8104.7
2014	4	30	8	-4.7	-3.8	77.6	64.4	0	1.77	238	0.92	8103.3
2014	4	30	9	-1.3	-0.5	324.9	45.7	0	1.41	234.9	0.81	8103.3
2014	4	30	10	3.7	3.8	524.1	29.7	0	0.36	212	0.05	8102
2014	4	30	11	7.2	6.8	697.4	22.9	0	0.59	131.6	-0.39	8099.3

2014	4	30	12	9.5	8.9	836	23.1	0	1.59	106.2	-0.61	8095.3
2014	4	30	13	11	10.4	928	18	0	2.33	101.9	-0.67	8092.7
2014	4	30	14	12.3	11.5	963	16.7	0	2.07	134.1	-0.78	8088.7
2014	4	30	15	12.7	12.2	944	18.3	0	1.89	199.9	-0.41	8084.7
2014	4	30	16	13.8	13.1	867	15.7	0	2.65	118.3	-0.69	8080.7
2014	4	30	17	14.1	13.6	740.8	18.6	0	3.03	102.4	-0.52	8075.3
2014	4	30	18	14.3	13.8	579.8	18.7	0.01	2.03	121.8	-0.42	8068.7
2014	4	30	19	13.6	13.6	315.9	23.6	0	1.13	141	-0.07	8066
2014	4	30	20	11.7	12.2	23.9	37.1	0	0.91	248.5	0.51	8062
2014	4	30	21	6	7.3	8.5	47.4	0	2.23	231	1.24	8063.3
2014	4	30	22	4.4	5	0.1	55	0	2.19	237.4	0.59	8063.3
2014	4	30	23	3	3.7	0	64.9	0	1.7	240.8	0.68	8068.7
2014	4	30	24	1.8	3.1	0	61.2	0	1.92	240.6	1.26	8068.7
2014	5	1	1	1.4	2.1	0.1	68.5	0	1.76	242.6	0.73	8066
2014	5	1	2	0.9	1.7	0.1	70.6	0	1.88	237.6	0.8	8063.3
2014	5	1	3	0.1	1.1	0.1	71.2	0	1.9	236.7	1.03	8063.3
2014	5	1	4	0.2	1.1	0.1	68.9	0	1.71	239.1	0.9	8058
2014	5	1	5	-0.3	0.8	0.1	73.7	0	1.5	235.6	1.1	8056.7
2014	5	1	6	-0.9	0.4	0.1	76.5	0	1.69	239.5	1.34	8056.7
2014	5	1	7	-1.2	0.1	4.3	75.9	0	1.59	234.8	1.32	8055.3
2014	5	1	8	-0.3	0.7	75.4	67.6	0	1.43	232.9	0.9	8054
2014	5	1	9	2.7	3.4	320.1	43.9	0	0.52	230.6	0.7	8052.7
2014	5	1	10	7.8	7.5	512.2	31.3	0	0.47	133	-0.21	8048.7
2014	5	1	11	11.3	10.7	679.4	28.1	0	1.69	76.6	-0.63	8043.3
2014	5	1	12	14.2	13	789.8	25.9	0	3.5	70.6	-1.25	8038
2014	5	1	13	15.7	14.6	891	27	0	3.66	77.6	-1.1	8036.7
2014	5	1	14	16.6	15.2	940	25	0	3.62	74.1	-1.37	8032.7
2014	5	1	15	16.7	16	872	24.6	0	3.28	77.4	-0.7	8030
2014	5	1	16	17	16.4	832	22.5	0	3.49	84.5	-0.57	8027.3
2014	5	1	17	17.3	16.8	731.7	23.1	0.01	3.01	144.8	-0.48	8022
2014	5	1	18	17.1	16.8	556.8	21	0.01	2.41	102.9	-0.32	8018
2014	5	1	19	16.6	16.7	255.7	26	0.01	1.41	251.2	0.07	8012.7
2014	5	1	20	12.6	13.7	63.5	45.7	0	1.58	247.4	1.11	8010
2014	5	1	21	8.2	9.7	16.3	48.3	0	3	231	1.53	8008.7
2014	5	1	22	6.9	7.4	0.1	57.2	0	1.64	240.7	0.51	8011.3
2014	5	1	23	4.7	5.7	0.1	67.5	0	2.01	235.8	0.99	8015.3
2014	5	1	24	3.9	5.1	0.1	66.2	0	1.78	236.4	1.16	8014
2014	5	2	1	3.7	4.5	0	69.3	0	1.85	239.6	0.78	8012.7
2014	5	2	2	2.8	3.9	0.1	71	0	1.77	238.8	1.13	8011.3
2014	5	2	3	2.4	3.4	0.1	77.5	0	1.48	236.2	0.92	8010
2014	5	2	4	1.6	2.7	0.1	79.9	0	1.44	233	1.12	8008.7
2014	5	2	5	1	2.2	0.1	80.2	0	1.78	231.9	1.21	8008.7
2014	5	2	6	1	2.1	0.1	81.3	0	1.53	235.2	1.1	8008.7
2014	5	2	7	0.5	2	4.4	82.1	0	1.51	234.1	1.42	8007.3
2014	5	2	8	1	2.1	83.3	71.3	0	0.81	244	1.04	8006
2014	5	2	9	4.6	4.8	324.1	48.6	0	0.68	199.6	0.29	8007.3
2014	5	2	10	8.7	8.6	521.6	41	0	0.77	122.8	-0.13	8003.3
2014	5	2	11	13.2	12.6	683.4	22.5	0	3.01	140.2	-0.6	8000.7
2014	5	2	12	13.6	13.6	814	23.6	0	4.58	226.8	0	8000.7
2014	5	2	13	14	13.9	888	23.4	0	6.13	224.9	-0.04	7999.3
2014	5	2	14	15.6	14.9	925	21.2	0	4.43	207.6	-0.75	7995.3
2014	5	2	15	16	15.4	922	20.2	0	5.05	218.1	-0.51	7991.3
2014	5	2	16	16.8	16.1	758.1	22	0	3.04	147.6	-0.64	7986
2014	5	2	17	16.2	15.9	616.3	23.8	0	4.51	213.8	-0.29	7979.3
2014	5	2	18	15.8	15.8	403.1	30.9	0	5.14	223.3	0	7974
2014	5	2	19	14.6	15.1	220.8	30.4	0	4.04	223	0.41	7970
2014	5	2	20	13.7	14	99.2	31.4	0	2.51	241.1	0.32	7966
2014	5	2	21	9.5	10.4	17.4	48.4	0	1.39	234.5	0.9	7962
2014	5	2	22	6.3	7.1	0.1	59.6	0	2.2	236.5	0.81	7959.3
2014	5	2	23	5	5.8	0.1	61.8	0	2.26	239.1	0.78	7956.7
2014	5	2	24	4.5	5.3	0.1	61.9	0	2.1	235.7	0.81	7952.7

2014	5	3	1	4.4	5.2	0.1	62.1	0	1.92	236.8	0.75	7948.7
2014	5	3	2	4	5	0.1	68.5	0	1.47	244.4	1.03	7944.7
2014	5	3	3	3.3	4.7	0.1	70.2	0	0.95	249.2	1.32	7942
2014	5	3	4	3.4	4.9	0.1	67.9	0	1.25	251.6	1.49	7935.3
2014	5	3	5	2.7	4	0.1	74.1	0	0.72	257.7	1.3	7930
2014	5	3	6	2.6	3.7	0.1	70.6	0	1.15	246.3	1.12	7930
2014	5	3	7	2.2	3.6	7.9	69.3	0	1.07	245	1.43	7924.7
2014	5	3	8	3.2	4.3	95.9	65.2	0	0.65	211.2	1.18	7923.4
2014	5	3	9	7.2	8	299.7	45.3	0	2.49	237.3	0.79	7924.7
2014	5	3	10	10.4	10.4	458.1	45.1	0	4.36	223.9	-0.07	7923.4
2014	5	3	11	10.9	10.7	591	45	0	5.28	223.5	-0.23	7920.7
2014	5	3	12	11.6	11.2	800	41.8	0	6.33	223.4	-0.43	7920.7
2014	5	3	13	11.9	11.6	828	40.7	0	6.51	232	-0.27	7920.7
2014	5	3	14	11.8	11.6	822	39.5	0	7.43	230.9	-0.2	7918
2014	5	3	15	11.6	11.5	482.9	33.7	0	6.85	225.4	-0.12	7918
2014	5	3	16	11.5	11.3	437.7	32.2	0	5.58	229.2	-0.17	7916.7
2014	5	3	17	11.8	11.6	464.9	34.2	0	5.21	231	-0.17	7916.7
2014	5	3	18	12.1	11.9	422.1	31.6	0	5.43	229.1	-0.16	7914
2014	5	3	19	12	12	184.4	29.7	0	6.13	228.9	0.01	7912.7
2014	5	3	20	11.3	11.5	79.4	35.2	0	3.73	218.3	0.23	7910
2014	5	3	21	8.3	9	17.2	54.3	0	1.41	229.1	0.64	7902
2014	5	3	22	5	5.4	0.1	60.1	0	1.81	237.8	0.42	7902
2014	5	3	23	3.6	4.2	0.1	68	0	1.56	239.9	0.59	7903.4
2014	5	3	24	2.2	2.9	0.1	72.4	0	1.84	236.8	0.74	7900.7
2014	5	4	1	1.8	2.6	0	71.4	0	2.02	236	0.76	7898
2014	5	4	2	2	2.8	0	70.1	0	1.94	235.9	0.75	7892.7
2014	5	4	3	2.5	3.4	0.1	66.5	0	1.63	239.2	0.89	7888.7
2014	5	4	4	4.4	5.4	0.1	48.6	0	1.18	224.1	0.98	7884.7
2014	5	4	5	4.7	5	0.1	69.7	0	2.49	110	0.35	7883.4
2014	5	4	6	2.7	2.7	0.1	72.3	0	1.1	65.8	-0.03	7892.7
2014	5	4	7	2.1	2.2	2.4	95.2	0	0.75	241.4	0.15	7896.7
2014	5	4	8	2.5	2.6	67.3	83.4	0	0.7	46.4	0.1	7907.4
2014	5	4	9	4.2	4.1	242.2	74.8	0	4.2	231.2	-0.11	7907.4
2014	5	4	10	5.2	4.9	477.6	63.8	0	4.94	227.7	-0.3	7912.7
2014	5	4	11	5.7	5.3	521.1	58	0	5.47	225.7	-0.37	7911.4
2014	5	4	12	6.4	5.9	511.4	58.9	0	5.84	216.7	-0.47	7915.4
2014	5	4	13	6.5	6.1	606	64.3	0	7.1	226	-0.42	7916.7
2014	5	4	14	6.9	6.5	728.9	48.7	0	5.75	224.6	-0.46	7916.7
2014	5	4	15	7.1	6.9	490.4	47.3	0	5.62	234	-0.27	7916.7
2014	5	4	16	7	6.8	283.7	48.9	0	4.63	239	-0.19	7914
2014	5	4	17	7.7	7.4	332	47.6	0	3.76	234.9	-0.29	7911.4
2014	5	4	18	8.2	7.8	350.1	41.4	0	4.3	212.5	-0.42	7908.7
2014	5	4	19	7.9	7.5	229.1	50.6	0	4.41	188.9	-0.37	7910
2014	5	4	20	7.5	7.3	67.9	47.9	0	3.7	200.3	-0.2	7908.7
2014	5	4	21	6.8	6.7	13.2	56.8	0	1.91	194.2	-0.04	7906
2014	5	4	22	5.5	5.8	0.2	66.8	0	1.14	234.5	0.31	7906
2014	5	4	23	3.5	4.1	0.1	68.5	0	0.76	247.7	0.59	7908.7
2014	5	4	24	3.1	3.8	0.1	68.9	0	0.89	256.8	0.67	7910
2014	5	5	1	3	3.7	0.1	72.5	0	1.07	251.9	0.73	7910
2014	5	5	2	3	3.8	0.1	67.7	0	0.81	250.9	0.79	7911.4
2014	5	5	3	2.8	3.7	0.1	78.9	0	0.67	104.3	0.94	7911.4
2014	5	5	4	1.6	2.3	0.1	81	0	0.85	286.4	0.66	7912.7
2014	5	5	5	1.5	2	0.1	79.9	0	1	245.8	0.51	7911.4
2014	5	5	6	2.7	3	0.1	76.1	0	1.92	241.6	0.3	7912.7
2014	5	5	7	1.7	1.6	3.1	95	0	2.11	233.9	-0.07	7914
2014	5	5	8	0.4	0.3	58.5	97.8	0	1.03	60.7	-0.07	7918
2014	5	5	9	1.1	0.8	134.3	95.4	0	0.9	77.8	-0.26	7915.4
2014	5	5	10	3.1	2.8	204.8	67.7	0	2.72	212.8	-0.27	7915.4
2014	5	5	11	3.6	3.3	275.6	67.1	0	3.6	235.1	-0.29	7915.4
2014	5	5	12	4.2	3.8	347.1	58.5	0	3.35	224.5	-0.41	7916.7
2014	5	5	13	4.2	3.8	407.1	55.6	0	3.22	237.9	-0.36	7916.7

2014	5	5	14	4.4	3.9	379.2	69.5	0	2.87	236.3	-0.48	7914
2014	5	5	15	4.8	4.3	626.4	55.4	0	3.89	238.7	-0.46	7914
2014	5	5	16	5.6	5.1	596.2	53.9	0	4.01	225.6	-0.53	7912.7
2014	5	5	17	5.5	5	508.2	69.5	0	5.04	233.5	-0.5	7908.7
2014	5	5	18	5.3	4.6	635.4	60.9	0	3.34	235.2	-0.7	7910
2014	5	5	19	5.3	4.8	311.7	76.9	0	2.72	234.7	-0.48	7908.7
2014	5	5	20	3.5	3.4	65.3	75.2	0	4.05	37.8	-0.14	7906
2014	5	5	21	2.7	2.5	7.6	94.6	0	3.03	45.7	-0.19	7911.4
2014	5	5	22	0.7	0.6	0.2	97.5	0	2.02	37.1	-0.13	7915.4
2014	5	5	23	0.4	0.1	0.1	99.3	0	2.1	75.1	-0.28	7918
2014	5	5	24	0.2	0	0.1	100	0	1.89	97.6	-0.25	7916.7
2014	5	6	1	-0.1	-0.3	0.1	100	0	1.24	81.8	-0.2	7914
2014	5	6	2	-0.7	-0.8	0.1	100	0	0.89	42.3	-0.11	7910
2014	5	6	3	-1.4	-1.6	0.1	100	0	1	79.8	-0.17	7908.7
2014	5	6	4	-1.8	-1.9	0.1	100	0	0.67	62.7	-0.15	7907.4
2014	5	6	5	-0.9	-1	0.1	76.2	0	2.42	69	-0.15	7906
2014	5	6	6	-0.1	-0.2	0.1	68.6	0	3.14	68.7	-0.1	7903.4
2014	5	6	7	0.4	0.3	18.7	66.3	0.01	4.09	50.1	-0.12	7900.7
2014	5	6	8	0.5	0.3	104.8	65.4	0	4.5	57.2	-0.17	7899.4
2014	5	6	9	0.8	0.6	134.6	62.1	0	4.59	60.3	-0.22	7899.4
2014	5	6	10	1.3	1	192.2	57.7	0	5.36	53.3	-0.23	7898
2014	5	6	11	1.7	1.4	230.5	54.6	0	5.96	58.5	-0.3	7899.4
2014	5	6	12	2.4	2	348	57.1	0	5.33	58.9	-0.39	7898
2014	5	6	13	2.6	2.2	387.2	57.1	0	5.64	55.2	-0.37	7898
2014	5	6	14	3.3	2.8	441	51	0	4.39	53.5	-0.44	7895.4
2014	5	6	15	3.7	3.2	395.4	51.5	0	4.28	56.2	-0.44	7891.4
2014	5	6	16	4.4	3.7	385.1	44.2	0	3.63	69	-0.61	7891.4
2014	5	6	17	4.7	4.2	381.2	44.1	0	3.29	62	-0.45	7890
2014	5	6	18	5	4.6	316.6	49.9	0	3.91	58.1	-0.36	7888.7
2014	5	6	19	4.5	4.2	157.7	52.6	0	4.24	60.8	-0.3	7888.7
2014	5	6	20	4.2	4	81.8	48.6	0	2.46	81.7	-0.22	7890
2014	5	6	21	3.7	3.7	12.4	57.1	0	3.58	63.1	-0.04	7891.4
2014	5	6	22	2.9	2.8	0.2	64.8	0	3.59	70	-0.06	7894
2014	5	6	23	1.4	1.4	0.1	72.5	0	2.06	88.6	0.06	7898
2014	5	6	24	0.3	0.4	0.1	75.7	0	0.88	134.7	0.13	7899.4
2014	5	7	1	-0.4	-0.2	0.1	78.8	0	0.95	266	0.21	7900.7
2014	5	7	2	-1	-0.8	0.1	83.9	0	0.83	354	0.22	7898
2014	5	7	3	-1.2	-1.1	0.1	84.8	0	0.52	300.5	0.12	7898
2014	5	7	4	-0.8	-0.6	0.1	83.8	0	0.61	45.7	0.13	7896.7
2014	5	7	5	-0.4	-0.5	0.1	81.8	0	0.93	53.7	-0.09	7895.4
2014	5	7	6	-0.1	-0.3	0.1	80.5	0	0.87	89	-0.11	7894
2014	5	7	7	0.3	0.2	5.6	73.3	0	3.72	91.3	-0.14	7894
2014	5	7	8	0.6	0.4	91	72	0	3.4	82.3	-0.2	7895.4
2014	5	7	9	1.1	0.8	182.2	62.8	0	4.66	63.2	-0.26	7896.7
2014	5	7	10	1.6	1.2	232.1	67.2	0	4.63	58.4	-0.35	7899.4
2014	5	7	11	1.6	1.2	206.6	63.3	0	3.76	71.2	-0.39	7900.7
2014	5	7	12	2.7	2.2	395.6	53.6	0	3.4	87.2	-0.56	7903.4
2014	5	7	13	3.6	3	372	45.1	0	3.36	84.3	-0.56	7903.4
2014	5	7	14	4.6	3.9	618.9	40.2	0	3.86	78.3	-0.73	7902
2014	5	7	15	5.1	4.3	482	52	0	5.05	79.4	-0.72	7899.4
2014	5	7	16	5.3	4.5	660.9	43.6	0	4.2	87.9	-0.76	7902
2014	5	7	17	5.4	4.6	489.7	48	0	3.37	108.1	-0.8	7903.4
2014	5	7	18	5.6	4.9	450.2	43	0	3.54	84	-0.66	7904.7
2014	5	7	19	5.3	4.9	253.2	40.6	0	2.4	110.4	-0.36	7906
2014	5	7	20	4.9	4.7	56.9	40.8	0	1.31	138.8	-0.14	7907.4
2014	5	7	21	4.2	4.1	19.2	51.1	0	2.2	97.6	-0.02	7910
2014	5	7	22	2.1	2.2	0.2	57.5	0	0.94	92.2	0.12	7914
2014	5	7	23	-0.4	-0.3	0.1	67.8	0	1.7	237.2	0.12	7920.7
2014	5	7	24	-1.7	-1.6	0.1	73.8	0	1.39	242.9	0.1	7924.7
2014	5	8	1	-2.7	-2.5	0.1	75	0	1.53	240.6	0.17	7923.4
2014	5	8	2	-3.6	-3.4	0.1	79.1	0	1.62	240	0.24	7926

2014	5	8	3	-4.4	-4	0.1	78.7	0	1.48	241.9	0.35	7926
2014	5	8	4	-4.9	-4.6	0.1	77.2	0	1.87	240.5	0.32	7922
2014	5	8	5	-5.3	-4.8	0.1	84.2	0	1.67	239.2	0.44	7920.7
2014	5	8	6	-5.5	-5	0.1	81.1	0	1.65	243.4	0.48	7920.7
2014	5	8	7	-5.7	-5.1	9.7	83.9	0	1.88	241	0.58	7920.7
2014	5	8	8	-4.4	-4.1	107.4	72.7	0	1.16	241.8	0.28	7920.7
2014	5	8	9	-1.6	-1.9	334.7	58	0	0.45	97.5	-0.21	7923.4
2014	5	8	10	2.5	2	529	41.1	0	1.76	90.3	-0.47	7922
2014	5	8	11	4.5	4	704.7	37.8	0	4.09	238.9	-0.49	7920.7
2014	5	8	12	5.6	5	795.2	33.7	0	4.54	231.8	-0.63	7920.7
2014	5	8	13	6.8	6	925	33.4	0	5.27	228.8	-0.81	7920.7
2014	5	8	14	7.6	6.6	868	38.2	0	6.44	221.6	-1	7919.4
2014	5	8	15	7.8	7	533.6	40.9	0	4.89	224	-0.73	7915.4
2014	5	8	16	8	7.3	653	38.6	0	4.73	236.7	-0.62	7914
2014	5	8	17	8.2	7.7	387.2	39.6	0	4.3	231.2	-0.55	7910
2014	5	8	18	8.4	7.9	360.2	42.2	0	5.2	232.3	-0.46	7906
2014	5	8	19	7.6	7.2	141.9	43.9	0	4.75	229.6	-0.34	7904.7
2014	5	8	20	7.2	7	74.9	40	0	3.56	222.7	-0.25	7902
2014	5	8	21	6.3	6.1	15.7	64	0	4.6	215.8	-0.17	7899.4
2014	5	8	22	4.2	4	0.2	71.6	0	3.15	246.4	-0.15	7900.7
2014	5	8	23	3.7	3.6	0.1	78	0	1.07	213.1	-0.17	7898
2014	5	8	24	3.2	3.2	0.1	81	0	0.26	52.4	-0.04	7894
2014	5	9	1	2.9	3	0.1	87.3	0	0.43	192.7	0.04	7888.7
2014	5	9	2	2.5	2.4	0.1	94.8	0	0.6	267.3	-0.09	7884.7
2014	5	9	3	1.5	1.4	0.1	96.4	0	0.6	266.4	-0.12	7882
2014	5	9	4	1	0.8	0.1	99.5	0	0.53	96.2	-0.16	7878
2014	5	9	5	0.7	0.5	0.1	100	0	0.64	82.8	-0.19	7876.7
2014	5	9	6	0.5	0.5	0.1	100	0	0.85	56.4	-0.07	7876.7
2014	5	9	7	0.6	0.6	1.4	99.9	0	1.44	49.1	0.03	7882
2014	5	9	8	0	-0.1	17.8	100	0.07	1.38	74.9	-0.13	7887.4
2014	5	9	9	0.7	0.6	140.4	98.4	0.04	0.93	39.9	-0.17	7892.7
2014	5	9	10	1.8	1.4	200.8	92.9	0.01	2.11	84.6	-0.42	7894
2014	5	9	11	2.1	1.7	245.9	96.8	0	2.54	141	-0.36	7896.7
2014	5	9	12	1.3	0.9	257.9	92.1	0.02	3.87	56.9	-0.38	7899.4
2014	5	9	13	1.1	0.6	335.3	81.9	0.02	2.89	67.4	-0.47	7904.7
2014	5	9	14	1.7	1.4	309	96.6	0.02	3.96	243.1	-0.34	7907.4
2014	5	9	15	1.4	1	375.5	90.8	0.02	3.08	43	-0.45	7911.4
2014	5	9	16	2	1.6	471.9	89.2	0.02	3.99	39.2	-0.33	7910
2014	5	9	17	2.6	2.2	350.6	83.3	0.01	3.87	5.3	-0.34	7907.4
2014	5	9	18	3.1	2.6	571.4	74.6	0.01	2.34	114.2	-0.5	7914
2014	5	9	19	3.1	2.8	248.6	79.1	0.01	2.74	19	-0.25	7911.4
2014	5	9	20	2.2	1.9	90.9	81	0	2.52	89	-0.27	7914
2014	5	9	21	1.2	1.1	9.1	90.8	0	1.16	64.4	-0.16	7915.4
2014	5	9	22	1	1	0.3	84.2	0	0.57	82.9	-0.05	7915.4
2014	5	9	23	0.4	0.3	0.1	98.2	0	1.31	88.9	-0.13	7915.4
2014	5	9	24	-0.5	-0.6	0.1	99.5	0	0.86	178.9	-0.13	7919.4
2014	5	10	1	-0.6	-0.7	0.1	99.6	0	0.51	188.2	-0.11	7916.7
2014	5	10	2	-0.9	-1.1	0.1	98.9	0.01	1.62	88.3	-0.16	7914
2014	5	10	3	-1.9	-2	0.1	99.5	0	1.32	96.2	-0.16	7914
2014	5	10	4	-1.9	-2.1	0.1	99	0.01	1.6	90.1	-0.14	7912.7
2014	5	10	5	-2.3	-2.5	0.1	98.6	0	1.65	74.4	-0.14	7912.7
2014	5	10	6	-2.6	-2.7	0.1	99	0.01	0.47	134.5	-0.1	7912.7
2014	5	10	7	-2.6	-2.8	5.1	99.2	0	0.45	97.2	-0.12	7912.7
2014	5	10	8	-2.3	-2.5	38.5	93.2	0	1.11	64.5	-0.16	7912.7
2014	5	10	9	-2.1	-2.2	70.7	84.9	0.05	1.33	63.2	-0.13	7915.4
2014	5	10	10	-1.3	-1.6	172.2	87.5	0.02	2.67	62.7	-0.33	7916.7
2014	5	10	11	-0.8	-1.2	284.6	82.9	0.01	3.81	66.9	-0.44	7915.4
2014	5	10	12	0.3	-0.4	605.5	69.6	0.01	3.12	80.5	-0.69	7915.4
2014	5	10	13	1	0.2	522.5	57.1	0.01	4.57	71	-0.84	7914
2014	5	10	14	0.3	-0.3	307.9	87.8	0.01	4.36	84	-0.57	7915.4
2014	5	10	15	-0.6	-1.1	164.2	85.5	0	3.05	238.9	-0.43	7919.4

2014	5	10	16	-1.2	-1.6	166.1	94.3	0.01	2.02	187.4	-0.37	7923.4
2014	5	10	17	-0.8	-1.2	248.7	91.6	0.01	0.98	223.2	-0.44	7928.7
2014	5	10	18	0.4	-0.2	335.5	88.3	0	3.2	92	-0.59	7932.7
2014	5	10	19	-0.1	-0.4	139.3	94.4	0.01	1.96	87	-0.34	7935.3
2014	5	10	20	-0.3	-0.6	71.8	82.4	0.02	2.69	97.7	-0.28	7939.3
2014	5	10	21	-0.6	-0.9	18.6	92.9	0	3.22	92.7	-0.23	7943.3
2014	5	10	22	-0.8	-1	0.3	93.8	0	1.81	91.8	-0.23	7948.7
2014	5	10	23	-0.9	-1	0.1	86.8	0	4.22	84.4	-0.12	7954
2014	5	10	24	-0.3	-0.4	0.1	79.9	0	4.48	78.3	-0.11	7956.7
2014	5	11	1	-0.3	-0.4	0.1	81.8	0	3.21	82.2	-0.11	7959.3
2014	5	11	2	-0.4	-0.5	0.1	80.6	0	5.11	64	-0.07	7962
2014	5	11	3	-0.5	-0.6	0.1	76.6	0	3.38	75.7	-0.04	7964.7
2014	5	11	4	-0.6	-0.7	0.1	82.7	0	4	99.1	-0.07	7966
2014	5	11	5	-0.7	-0.8	0.1	77.7	0	3.33	111.3	-0.09	7970
2014	5	11	6	-1.1	-1.2	0.1	85.3	0	1.59	82.4	-0.06	7972.7
2014	5	11	7	-1.7	-1.6	12.8	92.2	0	0.52	329.5	0.1	7976.7
2014	5	11	8	-1.1	-1.2	69.7	77.2	0	2.29	87.3	-0.06	7982
2014	5	11	9	-0.2	-0.4	200.6	65.2	0	1.31	91.6	-0.14	7986
2014	5	11	10	1.6	1.1	535.4	61.7	0	3.59	73.5	-0.57	7987.3
2014	5	11	11	2.9	2.3	607.3	58.6	0.01	4.76	59.8	-0.63	7984.7
2014	5	11	12	2.6	2.2	415.4	55.3	0	4.39	59.2	-0.46	7986
2014	5	11	13	3.4	2.9	458.8	59.6	0	4.87	72	-0.53	7990
2014	5	11	14	4.1	3.4	671.1	53	0.01	3.66	72.8	-0.76	7990
2014	5	11	15	3.5	2.9	414	65.2	0	3.86	69.3	-0.58	7987.3
2014	5	11	16	2.8	2.2	313.1	77.4	0.03	3.9	89.8	-0.52	7990
2014	5	11	17	3.4	2.9	391.3	58.4	0	2.06	91.5	-0.44	7994
2014	5	11	18	4	3.6	211.1	61.2	0.01	4.92	64.5	-0.35	7990
2014	5	11	19	3.8	3.5	134.4	55	0	4.08	79.6	-0.25	7992.7
2014	5	11	20	2.9	2.7	73.5	65.1	0	5.71	77	-0.21	7995.3
2014	5	11	21	2.1	2.1	16.7	65.4	0	3.48	93.1	-0.09	8000.7
2014	5	11	22	1.3	1.3	0.3	66.6	0	4.14	83	-0.02	8003.3
2014	5	11	23	0.6	0.6	0.1	71.3	0	4.1	76.9	-0.01	8008.7
2014	5	11	24	-0.4	-0.4	0.1	83.1	0	0.68	209.1	0.05	8014
2014	5	12	1	-1.4	-1.4	0.1	80.1	0	1.64	248.6	-0.01	8015.3
2014	5	12	2	-2.3	-2.3	0.1	81.1	0	1.43	237.5	0.03	8018
2014	5	12	3	-2.6	-2.5	0.1	86.2	0	0.86	247.7	0.09	8019.3
2014	5	12	4	-2.7	-2.3	0.1	77.9	0	0.99	267.6	0.38	8022
2014	5	12	5	-4.2	-3.8	0.1	85.9	0	1.29	238.6	0.39	8023.3
2014	5	12	6	-5.2	-5.1	0.1	81.5	0	2.15	239.4	0.11	8027.3
2014	5	12	7	-6.1	-6.2	11.5	86.3	0	1.7	236.5	-0.03	8032.7
2014	5	12	8	-5.4	-5.5	109.3	73.6	0	0.89	242	-0.08	8040.7
2014	5	12	9	-2.1	-2.3	367.3	58.2	0	1	42	-0.23	8042
2014	5	12	10	0	-0.5	556.7	57.6	0	1.82	44.5	-0.42	8042
2014	5	12	11	1.9	1.1	722.7	49.1	0	2.87	88.6	-0.77	8042
2014	5	12	12	3.6	2.8	859	36.6	0	2.46	104.8	-0.78	8039.3
2014	5	12	13	4.8	4	943	31.1	0	2.32	103.9	-0.77	8042
2014	5	12	14	5.6	5	971	31.6	0	1.88	206.9	-0.65	8047.3
2014	5	12	15	6.8	5.9	957	30.1	0	2.69	205.8	-0.89	8046
2014	5	12	16	7.9	7.1	885	24.7	0	2.77	147.2	-0.81	8048.7
2014	5	12	17	8.2	7.6	767.1	20.8	0.02	3.6	51.3	-0.59	8048.7
2014	5	12	18	8.4	7.9	603.1	19	0.01	3.46	60.8	-0.56	8048.7
2014	5	12	19	8.4	8	371	19.9	0	2.52	44.6	-0.34	8048.7
2014	5	12	20	7.5	7.5	27.2	37.2	0.01	1.48	79.6	-0.03	8048.7
2014	5	12	21	5	5.2	12.9	51.6	0	1.36	251.2	0.23	8048.7
2014	5	12	22	2.1	2.3	0.6	58.4	0	1.83	236.5	0.25	8054
2014	5	12	23	0.6	0.8	0	63.9	0	1.5	243.2	0.2	8062
2014	5	12	24	-0.7	-0.5	0.1	69.1	0	1.82	239.7	0.22	8066
2014	5	13	1	-1.4	-1.1	0.1	68.4	0	1.65	244.6	0.28	8070
2014	5	13	2	-2.1	-1.8	0.1	74.1	0	1.77	240.8	0.33	8070
2014	5	13	3	-2.8	-2.2	0.1	69.9	0	1.64	242.7	0.62	8068.7
2014	5	13	4	-3.4	-2.9	0.1	74.1	0	1.89	240.2	0.49	8070

2014	5	13	5	-3.5	-3.1	0.1	73.8	0	1.96	241.3	0.37	8071.3
2014	5	13	6	-3.5	-3.1	0.1	72.5	0	1.35	240.9	0.43	8071.3
2014	5	13	7	-4.1	-3.5	9.3	73.7	0	1.39	240.3	0.65	8071.3
2014	5	13	8	-2.8	-2.4	132	59.5	0	1.24	240.9	0.39	8074
2014	5	13	9	0.8	0.6	344.6	44.5	0	0.6	79.6	-0.26	8076.7
2014	5	13	10	4.8	4	553.1	42.1	0	2.23	76.3	-0.8	8075.3
2014	5	13	11	7.1	6.5	695.1	32.6	0	3.38	50.9	-0.63	8076.7
2014	5	13	12	9	8.1	821	29.6	0	2.76	105	-0.91	8078
2014	5	13	13	9.8	8.9	938	27.7	0	2.45	179	-0.82	8076.7
2014	5	13	14	10.6	9.7	905	29.7	0	1.95	121.9	-0.88	8076.7
2014	5	13	15	11	10.1	755	29.4	0	3.34	181.2	-0.87	8074
2014	5	13	16	11.4	10.5	751.3	30	0	3.39	223.6	-0.9	8074
2014	5	13	17	12.2	11.3	729.6	29.4	0	3.53	207.8	-0.98	8070
2014	5	13	18	12.4	11.6	604.2	28.3	0	3.16	224.3	-0.83	8067.3
2014	5	13	19	12	11.4	374	26.5	0	2.91	236	-0.59	8064.7
2014	5	13	20	11.1	10.8	81	31.2	0	2.39	239	-0.24	8063.3
2014	5	13	21	9	9.3	15.4	53.2	0	1.09	236.2	0.22	8064.7
2014	5	13	22	5.1	5.2	0.6	58.3	0	1.45	227.5	0.14	8067.3
2014	5	13	23	4.1	4.2	0	66.9	0	1.16	241.9	0.11	8072.7
2014	5	13	24	2.9	3.2	0.1	69.5	0	1.51	240.5	0.31	8074
2014	5	14	1	1.6	2	0.1	76.3	0	1.53	241.1	0.46	8075.3
2014	5	14	2	0.9	1.5	0.1	76.4	0	1.43	243.3	0.63	8076.7
2014	5	14	3	0.4	1	0.1	78	0	1.39	241.2	0.62	8076.7
2014	5	14	4	0	0.5	0.1	79.5	0	1.52	235	0.54	8074
2014	5	14	5	-0.5	0.3	0.1	83.1	0	1.56	236.7	0.82	8075.3
2014	5	14	6	-0.8	0	0.1	85	0	1.39	237.5	0.77	8072.7
2014	5	14	7	-0.9	-0.1	11.5	87.5	0	1.33	241.4	0.8	8071.3
2014	5	14	8	0.2	0.8	132.4	73.1	0	1.21	232.6	0.56	8072.7
2014	5	14	9	4.2	3.9	349.6	54.6	0	0.73	218.2	-0.3	8074
2014	5	14	10	8.5	7.6	535.6	42.1	0	1.61	87	-0.84	8071.3
2014	5	14	11	11.2	9.9	701.8	34.8	0	2.82	63.2	-1.29	8068.7
2014	5	14	12	12.1	11.2	835	31.9	0	2.1	115	-0.94	8068.7
2014	5	14	13	13.2	12.2	912	32.6	0	2.71	73.5	-1.01	8067.3
2014	5	14	14	14.4	13.2	950	29.6	0	2.94	169	-1.19	8063.3
2014	5	14	15	14.8	13.7	937	31.2	0	3.96	222.9	-1.16	8060.7
2014	5	14	16	15.1	14.3	858	28.2	0	2.99	178.5	-0.8	8056.7
2014	5	14	17	15.6	14.7	750.7	32	0.03	4.84	83.3	-0.91	8054
2014	5	14	18	15.6	14.8	598.5	31.5	0	3.41	75.4	-0.77	8051.3
2014	5	14	19	15	14.6	271.6	32.6	0	3.79	82.1	-0.39	8050
2014	5	14	20	14	14	30.3	33.3	0	3.39	87.4	-0.08	8047.3
2014	5	14	21	9.6	10.5	24	56	0	1.98	234.5	0.92	8044.7
2014	5	14	22	7.3	7.3	0.9	65	0	1.32	232.1	0.09	8046
2014	5	14	23	5.4	5.8	0.1	69.5	0	1.43	237.7	0.45	8051.3
2014	5	14	24	4	4.7	0.1	72.6	0	1.62	240.5	0.72	8054
2014	5	15	1	3.1	3.8	0.1	79	0	1.74	238.5	0.66	8054
2014	5	15	2	2.4	3.1	0.1	83.1	0	1.79	238.6	0.72	8055.3
2014	5	15	3	2.1	2.8	0	82.1	0	1.72	238.8	0.7	8051.3
2014	5	15	4	1.5	2.1	0.1	83.8	0	1.81	239.6	0.62	8050
2014	5	15	5	0.9	1.8	0.1	84	0	1.43	245.6	0.92	8046
2014	5	15	6	0.4	1.4	0.1	83.4	0	1.63	232.4	1.02	8043.3
2014	5	15	7	0.4	1.4	12.2	86.1	0	1.46	241.6	0.94	8040.7
2014	5	15	8	1.6	2.3	148.5	70.2	0	1.24	230.3	0.7	8042
2014	5	15	9	5.4	5.3	352.8	50.9	0	0.42	214.6	-0.13	8042
2014	5	15	10	9.5	9	547.8	41.8	0	1.18	66.4	-0.55	8040.7
2014	5	15	11	12.3	11.6	521.5	34.2	0	1.65	78.4	-0.68	8038
2014	5	15	12	14.6	13.7	608.6	24	0	2.16	75.8	-0.93	8036.7
2014	5	15	13	16.2	15.6	758.3	20.5	0	1.12	73.8	-0.61	8034
2014	5	15	14	17.7	16.6	961	20.1	0	4.57	201.3	-1.09	8028.7
2014	5	15	15	18.3	17.1	924	21.5	0	5.32	217.3	-1.15	8024.7
2014	5	15	16	18.4	17.5	833	23.4	0	5.79	223.2	-0.96	8023.3
2014	5	15	17	18.8	17.8	705.8	18.6	0	5.17	216.1	-1	8018

2014	5	15	18	18.6	17.9	480	17.6	0	5.1	221.7	-0.75	8012.7
2014	5	15	19	18	17.5	265.6	22.5	0	4.55	217.7	-0.47	8011.3
2014	5	15	20	15.9	15.9	99.2	42.2	0	1.86	230.7	-0.01	8010
2014	5	15	21	11	11.1	26.3	52.4	0	2.21	241.8	0.12	8008.7
2014	5	15	22	8.6	8.7	0.4	56	0	1.81	241.8	0.15	8010
2014	5	15	23	7.1	7.6	0.1	69.2	0	1.9	239.4	0.49	8011.3
2014	5	15	24	6.3	6.8	0.1	71	0	1.67	239	0.51	8011.3
2014	5	16	1	6.5	6.9	0.1	64.3	0	1.67	237.5	0.38	8008.7
2014	5	16	2	7.5	7.8	0.1	57	0	2.13	252.4	0.36	8012.7
2014	5	16	3	7.5	7.9	0.1	65	0	1.56	257.7	0.42	7999.3
2014	5	16	4	7.6	8.3	0.1	68.9	0	1.82	240	0.67	8011.3
2014	5	16	5	6.1	6.3	0.1	75.9	0	2.29	236.6	0.23	8000.7
2014	5	16	6	5.4	5.9	0.1	74.5	0	1.79	235.9	0.46	7995.3
2014	5	16	7	5.2	5.4	5.3	79.3	0	1.18	241.7	0.2	7994
2014	5	16	8	5.4	5.6	18.6	81.1	0	1.76	252.8	0.16	7998
2014	5	16	9	6.3	6.1	172.3	76.9	0	2.32	235.2	-0.16	7998
2014	5	16	10	10.4	10.1	441.2	48.5	0	0.56	342.2	-0.26	7996.7
2014	5	16	11	13.2	12.6	542.4	47.2	0	1.77	200.3	-0.57	7992.7
2014	5	16	12	14.3	13.7	555.4	40.7	0	2.09	195	-0.69	7988.7
2014	5	16	13	15.7	14.9	762.1	38.1	0	2.24	195.7	-0.8	7984.7
2014	5	16	14	16.4	15.6	614.1	35.4	0	3.58	210.3	-0.8	7980.7
2014	5	16	15	17.2	16.3	690.9	35.2	0	4.86	220	-0.85	7975.3
2014	5	16	16	17.6	16.8	682.4	32.1	0	6.35	228.4	-0.82	7968.7
2014	5	16	17	17.4	16.7	453	32	0	6.25	221.6	-0.66	7966
2014	5	16	18	16.6	16.1	304.2	34.6	0	6.05	221.7	-0.5	7963.3
2014	5	16	19	16.2	15.7	335.6	35	0	5.94	221.4	-0.55	7960.7
2014	5	16	20	15.1	14.8	109.3	38.9	0	4.52	214.9	-0.25	7958
2014	5	16	21	12.7	13	30.1	56.6	0	1.42	255.2	0.26	7959.3
2014	5	16	22	8.2	8.4	0.6	60.1	0	1.76	233.2	0.22	7960.7
2014	5	16	23	6.3	6.4	0.1	62.9	0	1.71	243.2	0.19	7963.3
2014	5	16	24	5	5.5	0.1	61.8	0	1.33	237.4	0.48	7963.3
2014	5	17	1	4	4.7	0.1	72.2	0	1.44	235.2	0.71	7966
2014	5	17	2	3.5	4.2	0.1	74.9	0	1.4	240	0.73	7966
2014	5	17	3	2.8	3.4	0.1	85.2	0	1.61	234.5	0.57	7966
2014	5	17	4	2.6	3.2	0	82.9	0	1.47	242.6	0.56	7964.7
2014	5	17	5	2.2	2.8	0.1	90.3	0	1.6	237.9	0.58	7963.3
2014	5	17	6	1.8	2.5	0.2	89.4	0	1.65	237.6	0.7	7960.7
2014	5	17	7	1.8	2.4	17.3	88.5	0	1.62	238.6	0.58	7958
2014	5	17	8	3.2	3.6	142.3	80.9	0	1.42	235.4	0.44	7958
2014	5	17	9	6.3	5.8	356.5	67.7	0	1.5	70	-0.51	7954
2014	5	17	10	10	9.3	544.2	39.6	0	2.38	82.6	-0.7	7951.3
2014	5	17	11	12.7	12	713.3	32.7	0	4.93	226.6	-0.65	7948.7
2014	5	17	12	13.4	12.6	842	32	0	5.01	235.6	-0.75	7946
2014	5	17	13	13.8	13	923	29.4	0	5.49	236.7	-0.82	7942
2014	5	17	14	14.3	13.4	932	27.9	0	5.95	226.9	-0.97	7940.7
2014	5	17	15	14.7	13.8	908	23.4	0	4.61	229.8	-0.86	7936.7
2014	5	17	16	15	14.2	768	21.4	0	5.26	208.4	-0.78	7934
2014	5	17	17	15.3	14.5	719.1	21.6	0	5.58	240.3	-0.8	7928.7
2014	5	17	18	15.2	14.4	597.8	23.4	0	5.98	227.8	-0.83	7924.7
2014	5	17	19	14.7	14.1	360.4	19.7	0	4.47	229.9	-0.57	7923.4
2014	5	17	20	13	12.9	35.9	25	0	5.03	246.1	-0.16	7922
2014	5	17	21	11.3	11.4	18.1	39.7	0	2.28	234.1	0.03	7922
2014	5	17	22	7.5	7.7	1	56.7	0	1.13	238.6	0.22	7918
2014	5	17	23	5.8	5.8	0.1	56.7	0	1.33	237.1	0.03	7920.7
2014	5	17	24	4.6	4.8	0.1	69	0	1.37	239.3	0.27	7922
2014	5	18	1	3.7	3.7	0.1	67.7	0	1.51	242.2	0.03	7918
2014	5	18	2	3.5	3.7	0.1	72.3	0	1.41	247.1	0.21	7912.7
2014	5	18	3	3.2	3.4	0.1	70.1	0	1.52	239.9	0.27	7907.4
2014	5	18	4	3.9	4.1	0.1	71.6	0	1.31	245.6	0.29	7899.4
2014	5	18	5	4	4.2	0.1	64.8	0	2.42	31.8	0.15	7894
2014	5	18	6	4.2	4.3	0.2	67	0	2.53	240.9	0.07	7898

2014	5	18	7	3.4	3.4	12.4	73	0	1.2	250.1	0.01	7892.7
2014	5	18	8	3.7	3.6	59.4	67.2	0	1.38	66.7	-0.15	7895.4
2014	5	18	9	4.8	4.5	134.1	70.5	0	2.04	63.8	-0.34	7896.7
2014	5	18	10	4.7	4.5	130.5	85.6	0	3.78	46.7	-0.25	7892.7
2014	5	18	11	3.1	2.8	118.5	95.3	0	2.46	47.3	-0.29	7895.4
2014	5	18	12	3.2	2.7	353.4	83.7	0	1.45	65.3	-0.5	7896.7
2014	5	18	13	5.3	4.8	476.9	67.9	0	4.81	228.3	-0.53	7895.4
2014	5	18	14	6	5.5	352.8	88	0	5.2	235.9	-0.5	7890
2014	5	18	15	5.3	4.6	782.5	59.8	0	3.4	165.5	-0.68	7896.7
2014	5	18	16	6	5.4	527.1	78.7	0.03	5.85	222.4	-0.63	7891.4
2014	5	18	17	6	5.6	299.3	73.1	0	3.83	226.5	-0.46	7898
2014	5	18	18	3.1	2.7	123.5	95	0.02	3.37	306.4	-0.37	7903.4
2014	5	18	19	3	2.5	227.3	86.1	0.02	1.93	68.1	-0.46	7910
2014	5	18	20	3.9	3.6	73.8	94.7	0	1.28	84.4	-0.31	7908.7
2014	5	18	21	3.1	2.9	20	94.9	0	1.28	101.8	-0.22	7911.4
2014	5	18	22	2.4	2.3	0.9	98.1	0	0.61	40.4	-0.13	7912.7
2014	5	18	23	1.8	1.7	0.1	98.1	0.01	0.51	216.5	-0.07	7916.7
2014	5	18	24	1	1	0.1	98.6	0	0.39	256.3	-0.01	7918
2014	5	19	1	0.7	0.6	0.1	97.9	0	0.55	264.5	-0.09	7916.7
2014	5	19	2	0.6	0.4	0.1	94.2	0	1.04	223.1	-0.22	7919.4
2014	5	19	3	0.4	0.1	0.1	97.2	0	1.26	222.8	-0.24	7919.4
2014	5	19	4	-0.1	-0.4	0.1	93.7	0	1.25	233.2	-0.22	7918
2014	5	19	5	-0.4	-0.5	0.1	96.1	0	0.73	252.8	-0.07	7919.4
2014	5	19	6	-0.4	-0.5	0.2	97.6	0	0.6	249.4	-0.05	7922
2014	5	19	7	-0.4	-0.5	14.3	96.3	0	1.02	233.7	-0.14	7923.4
2014	5	19	8	0.4	0.1	116	88.5	0	0.56	160.5	-0.26	7928.7
2014	5	19	9	1.6	1	157	93.4	0	2.97	62.6	-0.55	7930
2014	5	19	10	2.7	2.3	465	70.4	0	1.12	76.7	-0.46	7932.7
2014	5	19	11	4.5	4.1	279.1	66.7	0	1.6	46.4	-0.49	7932.7
2014	5	19	12	4.9	4.3	574.3	77.7	0	2.43	44.8	-0.59	7934
2014	5	19	13	5.2	4.5	587	78.3	0	2.58	119.5	-0.72	7936.7
2014	5	19	14	3.4	2.9	351.1	87.6	0.01	4.57	222.5	-0.57	7938
2014	5	19	15	5.3	4.8	675.5	67.3	0.01	1.42	191.1	-0.56	7942
2014	5	19	16	6.3	5.9	365	56	0.01	1.99	273.2	-0.48	7940.7
2014	5	19	17	7	6.4	303.5	55.7	0.01	2.34	218.3	-0.58	7939.3
2014	5	19	18	7	6.6	306.2	63.1	0	3.14	75.6	-0.44	7938
2014	5	19	19	6.9	6.5	173.8	63.5	0	2.5	14.6	-0.4	7940.7
2014	5	19	20	6	5.8	38.5	70.5	0	1.86	240.1	-0.2	7943.3
2014	5	19	21	5.3	5.1	21.9	76.9	0	1.4	80.5	-0.11	7944.7
2014	5	19	22	3.7	3.7	1.1	86.4	0	0.64	320	0.07	7948.7
2014	5	19	23	1.7	1.8	0.1	91.7	0	0.95	242.6	0.16	7952.7
2014	5	19	24	0.5	0.6	0.1	93.5	0	1.24	241.6	0.13	7955.3
2014	5	20	1	-0.3	-0.2	0	92.3	0	1.3	241	0.13	7955.3
2014	5	20	2	-0.8	-0.4	0.1	94.3	0	1.25	243.8	0.32	7955.3
2014	5	20	3	-1.2	-1	0.1	92.4	0	1.41	233.9	0.21	7954
2014	5	20	4	-1.3	-1.1	0.1	94.5	0	1.33	241.2	0.22	7952.7
2014	5	20	5	-1.7	-1.5	0.1	95.4	0	1.88	237.2	0.17	7951.3
2014	5	20	6	-1.5	-1.3	0.3	97.3	0	1.18	253	0.16	7951.3
2014	5	20	7	-1.5	-1.3	11.8	95	0	1.37	241.5	0.24	7951.3
2014	5	20	8	-0.4	-0.2	169.9	85.5	0	0.86	239.4	0.19	7954
2014	5	20	9	3.4	3	372.8	69.4	0	0.71	201.1	-0.36	7956.7
2014	5	20	10	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	5	20	11	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	5	20	12	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	5	20	13	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	5	20	14	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	5	20	15	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	5	20	16	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	5	20	17	13.9	12.9	709.4	31.7	0	3.97	66.3	-0.94	7943.3
2014	5	20	18	13.3	12.7	505.5	31.2	0	3.36	53.6	-0.64	7944.7
2014	5	20	19	12.9	12.6	277	34.6	0	5.42	66.9	-0.38	7942

2014	5	20	20	12.1	12	33.8	37.1	0	5.41	77	-0.13	7943.3
2014	5	20	21	11.3	11.2	15.9	40.4	0	4.89	74.9	-0.06	7947.3
2014	5	20	22	10.3	10.3	1.3	44.5	0	5.41	53.1	0.06	7951.3
2014	5	20	23	9.6	9.8	0.1	49.8	0	5.55	49.6	0.16	7956.7
2014	5	20	24	5.9	6.3	0.1	67.5	0	1.69	221	0.34	7962
2014	5	21	1	4.4	4.8	0.1	71.2	0	1.1	233.6	0.4	7963.3
2014	5	21	2	3.6	3.8	0.1	69.2	0	1.49	244.6	0.21	7963.3
2014	5	21	3	2.6	3	0.1	77.8	0	1.55	242.7	0.47	7962
2014	5	21	4	1.9	2.3	0.1	87.9	0	1.4	244	0.41	7962
2014	5	21	5	1.2	1.8	0.1	82.2	0	1.54	238.6	0.66	7964.7
2014	5	21	6	0.7	1.4	0.3	78.9	0	1.68	239	0.74	7967.3
2014	5	21	7	0.9	1.6	13.6	82.2	0	1.51	240.4	0.66	7967.3
2014	5	21	8	2.4	2.8	161.4	66.6	0	1.12	236.7	0.4	7968.7
2014	5	21	9	6.9	6.6	371	52.6	0	0.71	149.7	-0.31	7967.3
2014	5	21	10	10.8	10	559.5	39.2	0	2.17	78.8	-0.81	7966
2014	5	21	11	12.3	11.5	726.2	37	0	2.57	82.4	-0.87	7968.7
2014	5	21	12	13.6	12.6	860	33.5	0	3.07	75	-0.93	7966
2014	5	21	13	14.6	13.6	939	32.7	0	3.85	60	-0.96	7964.7
2014	5	21	14	15.2	14.3	966	30.1	0	5.11	53.3	-0.9	7962
2014	5	21	15	16.2	15.1	952	28.4	0	4.15	57.4	-1.01	7962
2014	5	21	16	16.8	15.9	889	26	0	3.53	71.9	-0.95	7960.7
2014	5	21	17	17.2	16.4	769	26.3	0	3.82	57.1	-0.76	7960.7
2014	5	21	18	17.3	16.5	586.5	26.8	0	4.68	59.8	-0.77	7956.7
2014	5	21	19	16.7	16.3	358.2	27.5	0	4.3	72.2	-0.45	7960.7
2014	5	21	20	13.8	13.6	49	54.4	0	3.97	194.8	-0.26	7964.7
2014	5	21	21	11.5	11.3	31.8	56	0	2.91	269.4	-0.19	7984.7
2014	5	21	22	10.7	10.6	0.9	64.2	0	1.7	258.3	-0.13	7990
2014	5	21	23	8.9	8.9	0.1	72.4	0	1.32	241.4	-0.04	7995.3
2014	5	21	24	7.3	7.2	0.1	77.1	0	1.74	239.5	-0.1	7996.7
2014	5	22	1	5.9	5.9	0.1	78	0	1.56	236.2	-0.09	8000.7
2014	5	22	2	5.7	5.8	0.1	81.2	0	1.56	239.9	0.07	7998
2014	5	22	3	5.8	5.8	0.1	77.9	0	1.36	231.6	-0.01	7994
2014	5	22	4	5	5.2	0.1	83	0	1.96	237.2	0.23	7992.7
2014	5	22	5	3.9	4.1	0.1	84.4	0	1.48	238.2	0.22	7992.7
2014	5	22	6	2.8	3.1	0.4	88.8	0	1.62	235.5	0.35	7994
2014	5	22	7	2.4	2.9	12.2	86.8	0	1.92	236.8	0.55	7998
2014	5	22	8	4.4	4.6	169.4	74.8	0	1.45	232.7	0.27	8002
2014	5	22	9	8.4	8.1	383.3	54.4	0	0.47	203.9	-0.34	8003.3
2014	5	22	10	12.2	11.6	570.7	44.6	0	1.63	225.7	-0.62	8003.3
2014	5	22	11	13.9	13.3	737.9	33	0	1.58	215.4	-0.64	8003.3
2014	5	22	12	15.9	15	871	24.1	0	2.8	169.5	-0.91	8002
2014	5	22	13	16.8	15.9	953	20.8	0	4.1	216.1	-0.92	8000.7
2014	5	22	14	17.6	16.6	979	18.5	0	3.59	228.6	-0.99	8002
2014	5	22	15	18	17	965	17.3	0	3.44	231.2	-0.97	8000.7
2014	5	22	16	18.8	17.8	907	15.8	0	3.52	219.4	-0.96	7999.3
2014	5	22	17	18.7	18	781.1	16.4	0	2.5	254.6	-0.7	7998
2014	5	22	18	19.1	18.3	536.8	17.1	0	2.82	196.9	-0.72	7994
2014	5	22	19	18.6	18.1	253.8	20.3	0	2.19	219.7	-0.43	7991.3
2014	5	22	20	17.1	17.2	31	30.9	0	1.04	298.9	0.13	7988.7
2014	5	22	21	13.6	13.8	16.5	44.4	0	1.31	232.9	0.18	7991.3
2014	5	22	22	10.3	10.4	1.4	46.1	0	1.8	229.9	0.1	7996.7
2014	5	22	23	8.2	8.5	0.1	59	0	1.35	237	0.33	8002
2014	5	22	24	6.2	6.4	0.1	67.8	0	1.63	238.6	0.28	8006
2014	5	23	1	5.3	6	0	68.6	0	1.78	238.9	0.71	8008.7
2014	5	23	2	5	5.7	0	73.2	0	1.64	240.9	0.69	8008.7
2014	5	23	3	4.2	5	0.1	81.5	0	1.9	237.6	0.83	8007.3
2014	5	23	4	4.1	4.7	0.1	82.9	0	1.63	242.5	0.62	8006
2014	5	23	5	3.8	4.7	0.1	82.9	0	1.95	241.5	0.89	8006
2014	5	23	6	3.5	4.5	0.4	80.3	0	1.72	240.1	0.99	8004.7
2014	5	23	7	3.5	4.6	13	80.3	0	1.63	236.9	1.09	8002
2014	5	23	8	5.3	5.8	168.3	69.5	0	0.91	243.3	0.51	8002

2014	5	23	9	8.5	8.1	376	52.9	0	1.02	73.3	-0.4	8000.7
2014	5	23	10	12.4	11.8	562.4	41.8	0	1.17	80.7	-0.57	7998
2014	5	23	11	16.3	15.4	729	22.7	0	1.92	77.9	-0.88	7994
2014	5	23	12	18.1	17.2	868	21.6	0	4.11	209.9	-0.92	7991.3
2014	5	23	13	18.6	17.6	945	19	0	3.23	215.5	-0.98	7990
2014	5	23	14	19.2	18.1	1006	19.5	0	3.9	211.1	-1.08	7987.3
2014	5	23	15	19.3	18.3	872	23.1	0	4.38	231.5	-0.98	7986
2014	5	23	16	19.2	18.4	776.5	20.7	0	3.6	217.7	-0.83	7980.7
2014	5	23	17	19.6	18.8	576	19.2	0	3.82	238.5	-0.79	7976.7
2014	5	23	18	19.6	18.8	607.8	18.7	0	4.41	223.7	-0.8	7970
2014	5	23	19	19.2	18.5	359.9	19.8	0	4.23	237.7	-0.61	7966
2014	5	23	20	17.6	17.5	53.8	26.9	0	2.36	266.8	-0.04	7962
2014	5	23	21	14.8	14.9	19.9	41.6	0	2.11	215.9	0.12	7960.7
2014	5	23	22	13.3	13.5	1.3	56.1	0	1.52	95	0.18	7967.3
2014	5	23	23	9.3	9.3	0.1	68.7	0	1.55	238.8	0.05	7974
2014	5	23	24	7.3	7.4	0.1	75.8	0	1.38	237.8	0.11	7976.7
2014	5	24	1	6.1	6.2	0.1	81.7	0	1.27	238.9	0.17	7976.7
2014	5	24	2	5.3	5.6	0	83.6	0	1.13	241.1	0.26	7980.7
2014	5	24	3	4.9	5.2	0	84	0	0.97	238.9	0.23	7980.7
2014	5	24	4	5.2	5.3	0.1	86.5	0	0.82	240.3	0.1	7983.3
2014	5	24	5	5.6	5.6	0	86.1	0	1.09	250.3	-0.09	7980.7
2014	5	24	6	5.7	5.5	0.2	84.8	0	0.71	245.4	-0.13	7982
2014	5	24	7	5.5	5.5	11.3	83.8	0	0.99	237.4	-0.03	7975.3
2014	5	24	8	6.3	6	92.1	84.4	0	0.89	66.9	-0.31	7976.7
2014	5	24	9	7.1	6.8	109.1	79.8	0	0.37	155.1	-0.31	7979.3
2014	5	24	10	9	8.3	351.4	70.8	0	1.75	79.4	-0.69	7980.7
2014	5	24	11	11.7	10.3	755.1	59.3	0	3.09	63.7	-1.48	7979.3
2014	5	24	12	13.6	12.3	961	52.8	0	2.62	73.5	-1.3	7975.3
2014	5	24	13	14	13	540.2	53.9	0	2.75	57.4	-1.02	7975.3
2014	5	24	14	15.2	14	1023	41.4	0	2.91	214.8	-1.16	7972.7
2014	5	24	15	15.6	14.5	784.8	37.2	0	2.45	66.7	-1.07	7974
2014	5	24	16	16.2	15.4	892	32.8	0	2.69	250.5	-0.87	7970
2014	5	24	17	17	15.9	812	32	0	4.83	225	-1.08	7967.3
2014	5	24	18	16.5	15.7	480.6	36.3	0	3.9	228.9	-0.83	7966
2014	5	24	19	15.9	15.3	303.1	37.8	0	2.98	253.5	-0.58	7966
2014	5	24	20	15.1	14.7	114.6	42.6	0	4.12	234.9	-0.38	7966
2014	5	24	21	13.7	13.5	42	50.6	0	2.74	222.2	-0.21	7970
2014	5	24	22	11.8	11.8	1.4	61.9	0	1.07	271.4	0.02	7975.3
2014	5	24	23	8.3	8.2	0.1	73	0	1.49	238.8	-0.05	7982
2014	5	24	24	6.3	6.3	0.1	80.2	0	1.15	237.8	0	7987.3
2014	5	25	1	5.3	5.4	0	84.2	0	1.01	242.3	0.13	7992.7
2014	5	25	2	4.2	4.4	0	87.1	0	0.98	243.6	0.16	7991.3
2014	5	25	3	3.7	3.8	0	89.2	0	1.33	239	0.13	7994
2014	5	25	4	3.4	3.6	0.1	90.9	0	1.19	239.6	0.23	7990
2014	5	25	5	2.7	3	0	93.1	0	1.32	235.7	0.28	7990
2014	5	25	6	2.6	2.8	0.6	93	0	1.38	242.6	0.2	7988.7
2014	5	25	7	2	2.3	19.4	92.8	0	1.28	239.8	0.26	7987.3
2014	5	25	8	3.9	3.9	168.4	82.6	0	0.66	233.1	0.02	7990
2014	5	25	9	8	7.6	369.9	64	0	0.42	183.2	-0.39	7990
2014	5	25	10	11.5	11	517.7	47.6	0	0.91	214.4	-0.5	7986
2014	5	25	11	13.7	12.9	665.7	24.5	0	1.86	178.8	-0.73	7983.3
2014	5	25	12	14.7	13.9	740.2	30.9	0	4.5	228.7	-0.81	7983.3
2014	5	25	13	15.4	14.6	838	31.3	0	4.39	239.9	-0.79	7980.7
2014	5	25	14	15.7	14.8	713.4	36.4	0	4.59	233.7	-0.86	7979.3
2014	5	25	15	16.3	15.4	736.3	34.2	0	4.53	226.5	-0.88	7976.7
2014	5	25	16	17	16.1	831	34.4	0	5.25	226.6	-0.97	7974
2014	5	25	17	16.9	16.1	580.2	33.6	0	5.39	234.6	-0.75	7972.7
2014	5	25	18	16.8	16	467.1	35.5	0	3.98	211.4	-0.81	7972.7
2014	5	25	19	16.6	15.9	355.2	38.1	0	3.44	237.8	-0.67	7970
2014	5	25	20	15.6	15.3	96.1	42.5	0	3.98	222.1	-0.28	7968.7
2014	5	25	21	14.5	14.4	38.3	46.5	0	4.06	208.8	-0.14	7970

2014	5	25	22	11.4	11.5	1.9	61.5	0	2.6	227.4	0.04	7972.7
2014	5	25	23	8.5	8.5	0.1	67.6	0	1.38	239	-0.02	7976.7
2014	5	25	24	6.7	6.8	0	74.3	0	1.76	234	0.05	7979.3
2014	5	26	1	5.5	6	0	76.7	0	2.38	239.6	0.45	7974
2014	5	26	2	5.1	5.5	0.1	76.4	0	2.27	236.6	0.42	7971.3
2014	5	26	3	5.1	5.7	0.1	76.3	0	1.77	234.7	0.63	7967.3
2014	5	26	4	4.7	5.1	0.1	79.2	0	1.39	235	0.37	7967.3
2014	5	26	5	4.4	5	0.1	81	0	0.78	242.9	0.63	7967.3
2014	5	26	6	3.6	4.1	0.3	81.4	0	1.22	238.5	0.54	7967.3
2014	5	26	7	3.7	4.3	26.2	76.9	0	1.03	247.5	0.59	7968.7
2014	5	26	8	5.1	5.3	124	75.9	0	1.01	230.3	0.2	7970
2014	5	26	9	8	7.4	319	59.9	0	2.07	74.8	-0.55	7970
2014	5	26	10	12.4	11.6	556.3	44.8	0	3.38	81.3	-0.8	7972.7
2014	5	26	11	14.1	13.4	688.6	38.8	0	5.36	235.5	-0.68	7974
2014	5	26	12	14.7	13.9	872	38.6	0	5.49	234.6	-0.78	7975.3
2014	5	26	13	15.3	14.5	635.3	39	0	5.55	231.1	-0.75	7975.3
2014	5	26	14	15.8	14.8	856	36.4	0	5.65	217.3	-0.96	7974
2014	5	26	15	15.9	15.1	549.4	38.7	0	5.56	238.3	-0.71	7974
2014	5	26	16	15.7	15	542.2	35.9	0	5.83	232	-0.69	7976.7
2014	5	26	17	15.9	15.1	612.7	36	0	6.17	229.3	-0.73	7976.7
2014	5	26	18	15.7	15	458.4	36	0	5.93	232.4	-0.7	7976.7
2014	5	26	19	15.3	14.8	339.6	33.3	0	5.38	226.3	-0.49	7979.3
2014	5	26	20	14.5	14.2	58.8	38.1	0	4.14	221.4	-0.22	7979.3
2014	5	26	21	13.8	13.7	30.2	42.1	0	3.77	205.9	-0.1	7980.7
2014	5	26	22	10.4	10.4	1.9	57.7	0	1.97	221.9	0.01	7982
2014	5	26	23	7.8	7.8	0.1	65.4	0	1.1	239.7	-0.02	7986
2014	5	26	24	6.3	6.5	0	71.7	0	1.46	244.3	0.27	7990
2014	5	27	1	5.1	5.3	0	76.8	0	1.39	238.3	0.18	7990
2014	5	27	2	4.1	4.5	0.1	82.8	0	1.24	239.4	0.32	7990
2014	5	27	3	3.7	4.2	0.1	85.2	0	1.3	241.3	0.5	7987.3
2014	5	27	4	2.8	3.2	0.1	86.7	0	1.29	238.2	0.37	7984.7
2014	5	27	5	2.5	3	0.1	85.9	0	1.06	237.9	0.5	7984.7
2014	5	27	6	2.5	2.9	0.5	89.7	0	0.94	241.8	0.44	7986
2014	5	27	7	2.8	3.4	29.9	86.5	0	1.03	241.6	0.59	7986
2014	5	27	8	4.8	4.8	139.6	69.6	0	1.08	237.7	0.04	7983.3
2014	5	27	9	9.6	9.1	354.6	45.9	0	0.66	208.2	-0.45	7980.7
2014	5	27	10	12.9	12.3	511.1	39.6	0	1.57	224.9	-0.6	7978
2014	5	27	11	14.4	13.7	571.4	34.6	0	2.27	204.2	-0.65	7975.3
2014	5	27	12	15.2	14.6	609.7	32.1	0	2.94	183.6	-0.64	7972.7
2014	5	27	13	16.3	15.6	708.7	29.3	0	3.47	248.4	-0.71	7970
2014	5	27	14	17.6	16.6	886	29.9	0	4.31	210.1	-0.94	7966
2014	5	27	15	17.9	17.1	915	31	0	5.3	235.6	-0.79	7960.7
2014	5	27	16	18	17.3	442.8	32	0	4.49	230.4	-0.7	7955.3
2014	5	27	17	18	17.4	477.8	32.5	0	6.76	228.9	-0.61	7955.3
2014	5	27	18	18	17.3	581.5	27.2	0	6.77	228	-0.69	7954
2014	5	27	19	17.7	17.1	403.5	24.7	0	5.48	226.4	-0.57	7958
2014	5	27	20	16.7	16.6	59.7	27	0	3.58	227.8	-0.17	7952.7
2014	5	27	21	15.7	15.8	40.9	41.2	0	1.9	235.5	0.03	7947.3
2014	5	27	22	11.8	11.9	2.5	47.9	0	1.34	232.3	0.14	7944.7
2014	5	27	23	10	10.1	0.1	54.4	0	1.21	237.9	0.14	7942
2014	5	27	24	9.6	9.7	0.1	57.4	0	0.96	241.5	0.14	7939.3
2014	5	28	1	9.2	9.4	0	58.8	0	1.05	229.8	0.23	7932.7
2014	5	28	2	8.5	8.6	0	61.9	0	0.69	211.6	0.11	7934
2014	5	28	3	7.7	8.3	0	67.7	0	0.63	275.8	0.52	7936.7
2014	5	28	4	6.6	6.9	0	67	0	0.98	244.7	0.26	7940.7
2014	5	28	5	6.4	6.5	0.1	75.2	0	1.22	2.4	0.07	7942
2014	5	28	6	5.3	5.6	0.4	80.7	0	0.9	248.1	0.28	7946
2014	5	28	7	4.7	4.9	27.4	81.7	0	0.65	246.5	0.14	7946
2014	5	28	8	5.8	5.5	167.1	75.1	0	0.51	64.2	-0.25	7948.7
2014	5	28	9	7.8	7.3	319.3	74.5	0	0.97	97.2	-0.49	7946
2014	5	28	10	10.6	9.7	553.7	47.1	0	3.29	83.3	-0.83	7943.3

2014	5	28	11	12.6	11.9	732.5	36.8	0	5.5	248.5	-0.64	7938
2014	5	28	12	13.3	12.6	810	34.3	0	5.71	242	-0.68	7934
2014	5	28	13	14.5	13.7	937	25.9	0	5.68	230	-0.81	7932.7
2014	5	28	14	14.5	13.9	728.7	27.7	0	7.88	247.3	-0.65	7932.7
2014	5	28	15	14.7	13.8	896	32.5	0	7.73	238.6	-0.88	7932.7
2014	5	28	16	14.6	13.7	873	31.8	0	7.3	231.7	-0.93	7932.7
2014	5	28	17	14.1	13.4	597.5	40.8	0	6.79	233.3	-0.75	7935.3
2014	5	28	18	12.2	11.5	546.9	45.8	0	7.67	237.7	-0.72	7939.3
2014	5	28	19	10.6	9.9	347.2	51	0	8.01	230.1	-0.72	7946
2014	5	28	20	8.8	8.5	45.1	51	0	6.25	241.1	-0.29	7948.7
2014	5	28	21	7.6	7.4	20.3	53.9	0	4.11	242.3	-0.23	7958
2014	5	28	22	6.2	6.1	2.4	58.1	0	1.46	263.7	-0.05	7964.7
2014	5	28	23	5.1	5.1	0.1	65.7	0	1.15	274.6	0.04	7971.3
2014	5	28	24	3.9	4	0.1	63.4	0	0.63	233.2	0.09	7975.3
2014	5	29	1	2.8	3.1	0.1	64.7	0	0.68	252.4	0.25	7976.7
2014	5	29	2	1.3	1.4	0.1	80.7	0	0.79	237.5	0.07	7979.3
2014	5	29	3	0.1	0.1	0.1	82.4	0	0.83	247.2	0.02	7984.7
2014	5	29	4	-0.8	-0.7	0.1	87.4	0	0.81	250	0.07	7987.3
2014	5	29	5	-1.5	-1.5	0.1	88.1	0	0.83	241.3	-0.06	7990
2014	5	29	6	-1.7	-1.7	0.5	90.8	0	0.78	244	-0.02	7991.3
2014	5	29	7	-2.1	-2.1	19.5	89.4	0	0.93	240.1	-0.02	7992.7
2014	5	29	8	-1	-1.3	186.4	77.9	0	0.3	171.2	-0.26	7995.3
2014	5	29	9	1.8	1.3	388.8	64.6	0	0.63	121.6	-0.46	7996.7
2014	5	29	10	4.6	3.9	577.2	39.9	0	1.18	101.7	-0.67	7995.3
2014	5	29	11	6.4	5.7	741.3	29.9	0	1.37	306.8	-0.68	7996.7
2014	5	29	12	7.8	6.9	877	22.7	0	2.88	231.2	-0.92	7995.3
2014	5	29	13	9.3	8.2	956	22.3	0	3.02	192.5	-1.03	7996.7
2014	5	29	14	10.3	9.2	983	22.9	0	3.15	197.9	-1.08	7995.3
2014	5	29	15	11.2	10.2	973	21.7	0	3.63	230.9	-1.01	7994
2014	5	29	16	12.3	11.2	917	17.6	0	3.58	214	-1.14	7992.7
2014	5	29	17	12.4	11.5	794.9	19.8	0	3.58	201.8	-0.94	7992.7
2014	5	29	18	12.9	12.1	635.4	19.4	0	3.32	254.1	-0.82	7991.3
2014	5	29	19	12.9	12.2	435.8	22.1	0	3.24	262.3	-0.68	7988.7
2014	5	29	20	11.6	11.5	39	22.3	0	2.37	269.4	-0.11	7987.3
2014	5	29	21	10.3	10.4	20.5	35.5	0	1.19	265.4	0.11	7988.7
2014	5	29	22	7.6	7.7	2.8	43.6	0	0.98	226.9	0.14	7990
2014	5	29	23	5.4	5.5	0.1	53.6	0	1.38	234.2	0.09	7995.3
2014	5	29	24	3.6	3.7	0.1	57	0	1.4	242.5	0.09	7999.3
2014	5	30	1	2.2	2.3	0.1	67	0	1.38	237.7	0.12	8000.7
2014	5	30	2	1	1.3	0.1	68.4	0	1.51	240	0.24	8000.7
2014	5	30	3	0.3	0.6	0.1	67.4	0	1.49	240.3	0.25	7999.3
2014	5	30	4	-0.2	0	0.1	69.2	0	1.4	234.8	0.24	8000.7
2014	5	30	5	-0.8	-0.3	0.1	75.6	0	1.63	242.8	0.48	7999.3
2014	5	30	6	-0.9	-0.5	0.6	72.2	0	1.64	241.9	0.48	7998
2014	5	30	7	-1	-0.4	32.1	72.7	0	1.48	239.7	0.53	7995.3
2014	5	30	8	1.2	1.3	151.1	65.5	0	1.14	233.3	0.12	7994
2014	5	30	9	5.9	5.4	329.6	37.4	0	1.06	223.8	-0.46	7991.3
2014	5	30	10	9.4	8.9	530.8	30.4	0	1.72	213.6	-0.52	7988.7
2014	5	30	11	11.4	10.7	725	22.7	0	2.55	203.6	-0.77	7987.3
2014	5	30	12	12.3	11.6	646.2	22.1	0	2.14	246	-0.7	7982
2014	5	30	13	14	13.2	781.9	15.8	0	2.3	209	-0.79	7979.3
2014	5	30	14	15.6	14.7	929	13	0	3.57	234.5	-0.86	7975.3
2014	5	30	15	16.3	15.6	749.9	12.6	0	4.03	219	-0.78	7972.7
2014	5	30	16	16.5	15.8	565.5	12.7	0	3.8	241.5	-0.64	7968.7
2014	5	30	17	16.7	16.2	393.1	12.9	0	2.9	202.6	-0.5	7963.3
2014	5	30	18	16.6	16	303	16.9	0	2.61	44.7	-0.51	7962
2014	5	30	19	16.4	16	186	22.3	0	3.43	228.6	-0.34	7958
2014	5	30	20	15.3	15	86.3	24.9	0	2.15	269.9	-0.27	7955.3
2014	5	30	21	14.1	14	25.3	26.3	0	2.3	80.5	-0.16	7958
2014	5	30	22	13	13	0.9	32.7	0	2.25	2.1	-0.03	7962
2014	5	30	23	11.2	11.1	0	42	0	1.66	234	-0.05	7958

2014	5	30	24	9.8	9.8	0	46.4	0	1.82	228.3	-0.06	7964.7
2014	5	31	1	9.1	9.1	0	51.1	0	1.21	241.5	0.04	7963.3
2014	5	31	2	9.1	9.2	0.1	46.2	0	2	256.4	0.03	7963.3
2014	5	31	3	8.9	9	0.1	43.7	0	2.08	244.7	0.15	7958
2014	5	31	4	7.2	7.5	0.1	55.9	0	1.88	234.9	0.3	7954
2014	5	31	5	6.4	6.5	0.1	61.7	0	1.35	237	0.1	7954
2014	5	31	6	5.4	5.8	0.4	62.8	0	1.76	237.4	0.34	7951.3
2014	5	31	7	4.7	5.1	13.8	65.7	0	1.2	230.5	0.32	7952.7
2014	5	31	8	4.7	5	133.6	59.7	0	1.04	237.4	0.25	7954
2014	5	31	9	9.5	9.1	384.1	36.2	0	1.12	221.2	-0.47	7950
2014	5	31	10	13.8	13	570	34.5	0	1.15	160.5	-0.75	7946
2014	5	31	11	15	13.8	753.4	27.6	0	4.14	52.9	-1.17	7944.7
2014	5	31	12	16	14.9	879	27.2	0	4.65	94	-1.15	7943.3
2014	5	31	13	16.3	15	961	23.5	0	4.45	200.8	-1.21	7944.7
2014	5	31	14	16.3	15.4	975	25.2	0	3.43	200.9	-0.94	7947.3
2014	5	31	15	16	15.3	353.7	27	0	2.69	196.7	-0.65	7943.3
2014	5	31	16	15.9	15.2	395.6	27.3	0	2.82	182.9	-0.75	7943.3
2014	5	31	17	13.9	13.4	138.7	40.9	0	4.59	63	-0.5	7940.7
2014	5	31	18	13	12.3	457.4	39.2	0	3.79	60.4	-0.64	7946
2014	5	31	19	11.4	11	66.9	49.2	0	3.66	62.3	-0.37	7947.3
2014	5	31	20	10.1	9.8	110.2	51.5	0	4.87	51.7	-0.31	7955.3
2014	5	31	21	9.3	9	32.7	57.8	0	3.04	78.4	-0.24	7954
2014	5	31	22	8.6	8.4	1	70.1	0	2.24	197.4	-0.22	7960.7
2014	5	31	23	7.1	6.9	0	81.7	0	1.53	68.2	-0.2	7972.7
2014	5	31	24	6.6	6.5	0.1	84.6	0	2.07	75.2	-0.07	7970
2014	6	1	1	5.2	5.2	0.1	86.6	0	1.49	300.2	0.04	7970
2014	6	1	2	3.7	3.7	0.1	88.3	0	1.33	238.4	0.01	7970
2014	6	1	3	2.7	2.8	0.1	91.9	0	0.81	245.7	0.04	7968.7
2014	6	1	4	1.9	2.1	0.1	93.8	0	0.96	250.7	0.25	7968.7
2014	6	1	5	1.1	1.4	0.1	94.8	0	1.15	241.5	0.3	7971.3
2014	6	1	6	0.9	1.3	0.6	92.2	0	1.17	244.5	0.43	7971.3
2014	6	1	7	1.1	1.5	21.7	93.8	0	1.09	245.4	0.44	7971.3
2014	6	1	8	3.3	3.3	196.4	75.3	0	0.61	207.4	-0.03	7974
2014	6	1	9	5.9	5.4	384.5	63.5	0	1.47	72.5	-0.55	7975.3
2014	6	1	10	10.1	9.3	554.5	42.3	0	2.54	73.7	-0.72	7975.3
2014	6	1	11	10.7	10.1	303.4	38.5	0	4.25	62	-0.65	7978
2014	6	1	12	11.7	10.9	723.9	33.4	0	2.35	61.3	-0.8	7978
2014	6	1	13	13.1	12	766.4	35.1	0	3.23	79.3	-1.1	7978
2014	6	1	14	13.3	12.3	629	30.7	0	2.83	65.9	-0.92	7976.7
2014	6	1	15	14.1	13.2	591.1	29.2	0	2.75	72.8	-0.88	7975.3
2014	6	1	16	14.3	13.6	384.6	27.6	0	1.88	191.1	-0.71	7971.3
2014	6	1	17	14.9	14.2	519.7	27.1	0	1.71	220.6	-0.7	7970
2014	6	1	18	14.9	14.4	196.5	26.4	0	1.82	213.8	-0.43	7967.3
2014	6	1	19	15.1	14.6	247.2	25.4	0	1.67	79.8	-0.44	7964.7
2014	6	1	20	15	14.7	112.8	27.6	0	1.5	114.5	-0.28	7963.3
2014	6	1	21	13.8	13.8	37	34.7	0	1.34	256.7	0	7964.7
2014	6	1	22	10.9	11	3.2	49.9	0	0.9	232.8	0.1	7967.3
2014	6	1	23	8.3	8.3	0.1	59.2	0	1.12	237.2	0.02	7972.7
2014	6	1	24	6.2	6.3	0.1	66.6	0	1.36	238.4	0.08	7978
2014	6	2	1	5	5.3	0.1	71.9	0	1.47	236.6	0.28	7978
2014	6	2	2	4.1	4.5	0.1	73.9	0	1.56	237.9	0.38	7978
2014	6	2	3	3.5	3.9	0.1	76.8	0	1.7	237.4	0.37	7978
2014	6	2	4	3	3.5	0.1	81.8	0	1.74	240.4	0.58	7976.7
2014	6	2	5	2.6	3.4	0.1	80.3	0	1.74	238.2	0.76	7975.3
2014	6	2	6	2.2	2.8	0.8	82.1	0	1.62	238.5	0.59	7974
2014	6	2	7	2.2	2.8	14.7	82.5	0	1.5	238.1	0.62	7974
2014	6	2	8	4.8	5	191.1	65.4	0	0.95	238.8	0.14	7975.3
2014	6	2	9	8	7.6	390.1	52.5	0	1.35	78.5	-0.45	7975.3
2014	6	2	10	12.7	12.3	578.9	33	0	0.67	65.6	-0.45	7972.7
2014	6	2	11	15.3	14.4	740.1	30.2	0	2.1	129.9	-0.88	7968.7
2014	6	2	12	15.9	15.1	756.5	27	0	2.39	252.9	-0.78	7966

2014	6	2	13	17.3	16.3	796.5	23	0	2.33	145.4	-0.97	7963.3
2014	6	2	14	17.4	16.6	643.9	23.1	0	2.9	185	-0.83	7960.7
2014	6	2	15	17.2	16.6	570.1	26.1	0	3.46	179	-0.64	7958
2014	6	2	16	17.9	17.1	732.1	22.7	0	3.01	231.4	-0.86	7956.7
2014	6	2	17	18.2	17.5	489.4	23.4	0	3.27	205.1	-0.73	7948.7
2014	6	2	18	18.6	17.8	604.2	21.8	0	2.83	198.6	-0.79	7944.7
2014	6	2	19	18.6	18	348.9	21.8	0	1.51	47.1	-0.55	7940.7
2014	6	2	20	17.8	17.6	75.1	28.3	0	2	302.8	-0.14	7934
2014	6	2	21	15.7	16	32.6	39.4	0	1.13	267.3	0.35	7932.7
2014	6	2	22	13.3	13.3	3.2	41.2	0	2.09	245.8	0.08	7932.7
2014	6	2	23	11.9	11.9	0.1	46.9	0	1.4	231.4	-0.04	7934
2014	6	2	24	11.5	11.5	0.1	47.2	0	2.76	253	0.05	7934
2014	6	3	1	12.4	12.3	0	50.9	0	2.29	60.4	-0.13	7943.3
2014	6	3	2	10.3	10.4	0	64.8	0	1.66	254.5	0.08	7936.7
2014	6	3	3	7.6	7.7	0.1	70.4	0	1.15	238.6	0.06	7936.7
2014	6	3	4	6.5	6.6	0.1	75.2	0	1.09	246.4	0.1	7935.3
2014	6	3	5	5.4	5.6	0.1	79.5	0	1.46	238.7	0.19	7932.7
2014	6	3	6	4.5	4.7	0.7	82.7	0	1.48	237.8	0.2	7928.7
2014	6	3	7	3.9	4.2	14.9	85.6	0	1.1	241.5	0.35	7930
2014	6	3	8	5.4	5.3	190.6	67.4	0	0.65	204.2	-0.11	7938
2014	6	3	9	8.8	8.2	388.4	59.1	0	1.36	77.9	-0.6	7939.3
2014	6	3	10	12.1	11.1	569.7	46.5	0	2.54	81.3	-0.94	7942
2014	6	3	11	14.3	13.2	749.9	37.4	0	2.54	104.4	-1.05	7942
2014	6	3	12	15	14.1	785.8	34.6	0	3.84	214.8	-0.98	7944.7
2014	6	3	13	15.4	14.6	562.7	32.6	0	3.55	243.1	-0.73	7946
2014	6	3	14	16.2	15.2	824	28.4	0	4.38	222.1	-0.94	7946
2014	6	3	15	17.1	16.1	855	19.9	0	4.98	236.3	-0.96	7946
2014	6	3	16	17.3	16.3	682.7	24.7	0	5.27	221.7	-1	7944.7
2014	6	3	17	17.4	16.6	740.3	24.9	0	5.42	243	-0.75	7944.7
2014	6	3	18	15.8	15.1	343.3	38.3	0	5.93	186.7	-0.66	7943.3
2014	6	3	19	14.9	14.1	452.2	37.2	0	3.72	50.2	-0.74	7950
2014	6	3	20	14.7	14.4	65.8	39.2	0	2.62	59.1	-0.28	7947.3
2014	6	3	21	13.8	13.8	32.4	43.2	0	1.95	28.3	-0.03	7950
2014	6	3	22	12.1	12.2	2	49.5	0	2.78	67.2	0.05	7952.7
2014	6	3	23	10.5	10.5	0.1	54.3	0	1.93	28.3	0.02	7963.3
2014	6	3	24	8.8	8.8	0	63.4	0	1.25	229.2	-0.08	7966
2014	6	4	1	7.1	7.1	0.1	68.8	0	1.15	245	-0.03	7967.3
2014	6	4	2	5.9	6	0.1	74.1	0	1.25	234.6	0.07	7968.7
2014	6	4	3	5.2	5.4	0.1	76.8	0	0.86	247.7	0.23	7967.3
2014	6	4	4	4.2	4.6	0.1	80.1	0	0.9	247.2	0.38	7968.7
2014	6	4	5	3.8	4	0.1	80.7	0	1.33	243.4	0.22	7970
2014	6	4	6	3.1	3.4	0.8	86.4	0	1.13	239.1	0.35	7970
2014	6	4	7	2.6	2.9	13.6	84.6	0	1.16	235	0.26	7971.3
2014	6	4	8	4.4	4.4	194.6	66.8	0	0.33	215.4	-0.02	7975.3
2014	6	4	9	8.4	7.8	392.8	54.8	0	0.99	106.6	-0.55	7978
2014	6	4	10	11.9	10.9	588.9	29.1	0	2.57	79.9	-0.95	7978
2014	6	4	11	13.5	12.3	751.1	27.8	0	3.52	69	-1.26	7979.3
2014	6	4	12	14.2	13.2	880	27.4	0	3.18	99.2	-1.07	7978
2014	6	4	13	15.2	13.9	903	28.7	0	4.2	80.2	-1.25	7979.3
2014	6	4	14	16	14.8	819	25.9	0	3.49	90.1	-1.22	7978
2014	6	4	15	16.8	15.6	971	23.8	0	4.5	207	-1.28	7976.7
2014	6	4	16	17.3	16.3	907	23	0	3.6	232.4	-1.04	7975.3
2014	6	4	17	17.9	16.8	794.5	23.7	0	5.14	215.1	-1.09	7971.3
2014	6	4	18	18.1	17.2	644.8	22	0	3.02	169.6	-0.86	7970
2014	6	4	19	18	17.2	464.4	20.8	0	3.78	234	-0.75	7968.7
2014	6	4	20	16.3	16.2	26.9	21	0	1.7	259.1	-0.07	7968.7
2014	6	4	21	14.8	15.1	14.7	29.5	0	1.24	263.1	0.31	7971.3
2014	6	4	22	11.4	11.5	2.8	44.3	0	1.44	227.8	0.14	7972.7
2014	6	4	23	9.4	9.4	0	51.1	0	1.35	239.4	0.02	7975.3
2014	6	4	24	7.8	8	0	59.2	0	1.57	233.3	0.21	7978
2014	6	5	1	6.9	7.2	0	64.6	0	1.35	238.9	0.31	7976.7

2014	6	5	2	6.1	6.6	0.1	66.7	0	1.16	243.2	0.45	7976.7
2014	6	5	3	5.2	5.5	0.1	70.9	0	1.4	233.9	0.32	7975.3
2014	6	5	4	4.3	5	0.1	77	0	1.18	239.4	0.72	7972.7
2014	6	5	5	3.9	4.4	0.1	74.3	0	1.2	244.3	0.5	7970
2014	6	5	6	3.2	3.8	0.8	80.7	0	1.12	237.8	0.6	7968.7
2014	6	5	7	2.6	3.2	12.5	77.9	0	0.79	235.2	0.62	7968.7
2014	6	5	8	4.7	4.9	199.3	61.1	0	0.79	235	0.26	7971.3
2014	6	5	9	8.3	7.6	398.3	48	0	1.83	68	-0.65	7971.3
2014	6	5	10	13	12.1	581.5	30.5	0	2.52	59.8	-0.91	7970
2014	6	5	11	14.8	13.9	740.3	24.1	0	3.56	230.7	-0.94	7971.3
2014	6	5	12	15.7	14.7	871	21.8	0	4.59	212.6	-1.04	7970
2014	6	5	13	16.4	15.4	953	21.1	0	4.58	211.1	-1.08	7970
2014	6	5	14	17.2	16	984	18.9	0	4.71	211.4	-1.24	7971.3
2014	6	5	15	17.6	16.4	974	18.5	0	5.98	216.5	-1.21	7968.7
2014	6	5	16	17.7	16.6	911	18.2	0	6.3	219.2	-1.09	7968.7
2014	6	5	17	18.2	17.2	795.3	20.1	0	4.31	219.6	-0.95	7964.7
2014	6	5	18	18.1	17.2	646.3	18.4	0	5.29	225	-0.87	7963.3
2014	6	5	19	17.5	16.8	466.4	21.3	0	6.5	228.3	-0.78	7963.3
2014	6	5	20	16	15.8	30.4	23.5	0	4.34	244.8	-0.2	7960.7
2014	6	5	21	15	15	15	26.2	0	2.62	262.4	0	7963.3
2014	6	5	22	12.9	13.3	3.9	40.5	0	1.86	265.4	0.36	7964.7
2014	6	5	23	9.5	9.7	0.1	48.4	0	1.18	244.8	0.19	7967.3
2014	6	5	24	7.6	7.8	0.1	56	0	1.03	241.4	0.19	7970
2014	6	6	1	6.2	6.4	0	63.9	0	1.25	241.7	0.12	7970
2014	6	6	2	5.2	5.4	0	66.5	0	1.29	242.5	0.24	7968.7
2014	6	6	3	4.4	4.6	0	70	0	1.17	240	0.18	7968.7
2014	6	6	4	3.5	3.9	0	76	0	1.12	239.9	0.39	7968.7
2014	6	6	5	2.9	3.2	0.1	83.4	0	0.95	246	0.3	7970
2014	6	6	6	2.3	2.6	1	80.4	0	1.1	239.9	0.35	7970
2014	6	6	7	2.3	2.5	18.4	83.4	0	1.14	243.1	0.29	7971.3
2014	6	6	8	3.8	3.8	193.2	63.6	0	0.49	212.8	0.02	7974
2014	6	6	9	7.7	7	391.4	47.3	0	1.78	88.3	-0.69	7974
2014	6	6	10	10.3	9.4	573	42.4	0	2.62	95.9	-0.91	7972.7
2014	6	6	11	11.9	10.9	744.8	34.6	0	2.1	84.4	-0.93	7972.7
2014	6	6	12	13.5	12.4	949	32.6	0	2.65	73.7	-1.14	7971.3
2014	6	6	13	14.7	13.4	920	28.3	0	3.38	71.7	-1.27	7970
2014	6	6	14	14.9	14	608.6	24	0	2.7	119.8	-0.91	7968.7
2014	6	6	15	16.3	15.2	972	19	0	3.27	160.8	-1.09	7968.7
2014	6	6	16	16.7	15.6	914	17.1	0	3.76	187.7	-1.11	7967.3
2014	6	6	17	16.8	15.7	800	19.8	0	4.24	198.4	-1.03	7967.3
2014	6	6	18	16.8	15.9	643.6	19	0	4.44	55.8	-0.91	7964.7
2014	6	6	19	16.2	15.6	451	19.8	0	2.89	68.6	-0.54	7966
2014	6	6	20	14.9	14.7	68.1	23	0	2.88	85.7	-0.25	7966
2014	6	6	21	14	13.8	36.8	27.1	0	3.4	100.2	-0.13	7972.7
2014	6	6	22	12.1	12.1	3.3	33.9	0	1.02	154.5	-0.01	7975.3
2014	6	6	23	10.3	10.5	0	42	0	0.87	326.5	0.2	7978
2014	6	6	24	7.5	7.5	0	52.8	0	1.2	240	0	7983.3
2014	6	7	1	5.5	5.5	0	58.5	0	0.96	240.9	0.07	7984.7
2014	6	7	2	4.2	4.3	0	60.8	0	1.35	238.1	0.08	7987.3
2014	6	7	3	3.3	3.5	0	69.6	0	1.29	239.8	0.24	7986
2014	6	7	4	2.6	2.8	0	66	0	1.34	246.8	0.19	7987.3
2014	6	7	5	1.9	2.2	0	75.2	0	1.5	236.9	0.32	7987.3
2014	6	7	6	1.3	1.7	1.1	78.3	0	1.46	238.6	0.4	7986
2014	6	7	7	1.3	1.7	17.8	74.3	0	1.45	240.7	0.41	7986
2014	6	7	8	3.6	3.6	195.2	54.7	0	0.87	234.2	0.04	7988.7
2014	6	7	9	8	7.5	391.8	39	0	0.78	111.8	-0.46	7987.3
2014	6	7	10	11.6	10.6	570.8	30.9	0	1.96	70.7	-0.95	7987.3
2014	6	7	11	13	12	720.7	27.1	0	1.85	65.8	-0.94	7986
2014	6	7	12	14.3	13.2	852	27.6	0	2.88	68.2	-1.08	7982
2014	6	7	13	15.6	14.2	940	24.4	0	3.39	81.8	-1.36	7979.3
2014	6	7	14	16.3	15	898	25.1	0	3.64	75.3	-1.34	7978

2014	6	7	15	16.6	15.7	719.6	22.9	0	3.72	212.4	-0.93	7974
2014	6	7	16	16.6	15.7	524.5	23.1	0	4.22	225.2	-0.9	7972.7
2014	6	7	17	16.1	15.4	326.5	26.6	0	2.7	100.4	-0.64	7975.3
2014	6	7	18	15.5	14.7	365.9	28.3	0	5.22	62.2	-0.83	7975.3
2014	6	7	19	15.4	14.7	326.4	28.2	0	4.5	73.8	-0.77	7975.3
2014	6	7	20	14.5	14.2	103	30.7	0	4.85	74.7	-0.35	7974
2014	6	7	21	13.8	13.5	42.1	34.5	0	2.4	199.8	-0.23	7976.7
2014	6	7	22	12.1	12.1	3	42.9	0	2.59	83.3	-0.01	7980.7
2014	6	7	23	9.9	10	0	49.7	0	0.53	63	0.18	7986
2014	6	7	24	8.5	8.9	0	58.6	0	0.49	322.7	0.44	7991.3
2014	6	8	1	6.6	6.7	0	61.1	0	0.96	259.4	0.17	7992.7
2014	6	8	2	5.4	5.5	0	65.9	0	1.03	255.4	0.16	7994
2014	6	8	3	4	4.3	0	72.8	0	1.01	246.2	0.29	7996.7
2014	6	8	4	3.3	3.7	0	73.1	0	1.1	241.6	0.46	8000.7
2014	6	8	5	2.5	3	0	77	0	1.27	236.9	0.48	8000.7
2014	6	8	6	2.3	2.7	0.8	78.6	0	1.18	239.5	0.39	8003.3
2014	6	8	7	1.8	2.2	17.7	81.5	0	1.27	241.3	0.35	8007.3
2014	6	8	8	4	4	190.8	60.1	0	0.63	237.8	0.05	8010
2014	6	8	9	8.7	8.1	395.1	48.1	0	1.68	79.8	-0.6	8011.3
2014	6	8	10	11.1	10.3	449.6	43.5	0	2.86	74	-0.84	8012.7
2014	6	8	11	11.8	11.1	508.6	36.9	0	2.83	77.8	-0.74	8014
2014	6	8	12	13	12.1	795.1	33.6	0	2.19	86.4	-0.89	8012.7
2014	6	8	13	14.7	13.4	1003	30.5	0	3.09	80.3	-1.34	8012.7
2014	6	8	14	15.4	14.3	998	26.1	0	2.99	136.5	-1.05	8011.3
2014	6	8	15	16.7	15.5	890	24.4	0	3.22	119	-1.18	8007.3
2014	6	8	16	17.2	16.1	806	25.6	0	3.71	92.5	-1.06	8003.3
2014	6	8	17	17.8	16.7	763.8	24.3	0	4.13	75	-1.15	8002
2014	6	8	18	17.9	16.9	612	22.6	0	3.58	64.6	-0.98	7998
2014	6	8	19	17.7	17.1	412.7	21.5	0	2.54	63.1	-0.6	7995.3
2014	6	8	20	16.9	16.6	92.4	25.5	0	1.9	91.5	-0.28	7994
2014	6	8	21	15.5	15.7	44.5	32.2	0	0.72	323.9	0.2	7991.3
2014	6	8	22	13	13	5.2	44.8	0	0.79	211.3	0.06	7992.7
2014	6	8	23	10.6	10.6	0	49.7	0	1.09	236.4	0.02	7996.7
2014	6	8	24	8.9	9	0	57.6	0	1.38	238.4	0.14	7999.3
2014	6	9	1	7.5	7.6	0	62	0	1.43	236.8	0.17	7999.3
2014	6	9	2	6.7	7.1	0	65.2	0	1.39	237.7	0.35	7996.7
2014	6	9	3	5.9	6.3	0	66.1	0	1.4	239.5	0.42	7995.3
2014	6	9	4	5.3	5.8	0	69.3	0	1.2	237.9	0.52	7991.3
2014	6	9	5	4.8	5.6	0	73.4	0	0.82	237.1	0.8	7990
2014	6	9	6	4.4	5.2	0.7	72	0	1.07	240.8	0.83	7987.3
2014	6	9	7	4.2	5.1	16.9	80.2	0	1.15	240.9	0.92	7986
2014	6	9	8	6.1	6.4	187.1	61.2	0	0.38	194.9	0.33	7986
2014	6	9	9	9.9	9.4	384.1	48.3	0	1.37	71	-0.58	7984.7
2014	6	9	10	14.4	13.7	559.9	37.5	0	2.9	88.2	-0.72	7982
2014	6	9	11	15.9	15.2	529.8	36.5	0	4.87	224.2	-0.67	7978
2014	6	9	12	16.7	15.9	754.9	31.8	0	6.48	226.9	-0.8	7975.3
2014	6	9	13	17.6	16.7	918	28.2	0	7.19	225.1	-0.94	7972.7
2014	6	9	14	18.1	17.1	762.6	29.5	0	6.63	223.1	-1.01	7968.7
2014	6	9	15	18.3	17.6	618.5	24.6	0	5.62	222.6	-0.79	7967.3
2014	6	9	16	19.2	18.2	829	22.3	0	5.9	228.6	-0.98	7964.7
2014	6	9	17	19.3	18.3	832	24.7	0	6.19	217.4	-0.99	7963.3
2014	6	9	18	18.9	18.1	441	28.5	0	6.27	222.9	-0.79	7959.3
2014	6	9	19	18.3	17.8	284.5	27.7	0	4.31	223	-0.52	7958
2014	6	9	20	17.7	17.5	72.8	30	0	3.22	244.8	-0.24	7955.3
2014	6	9	21	16.5	16.7	22.8	36.1	0	1.7	257.4	0.19	7955.3
2014	6	9	22	14.1	14.4	3.3	48.7	0	0.76	222.5	0.32	7954
2014	6	9	23	11.6	11.6	0	56.7	0	0.81	238.3	-0.01	7955.3
2014	6	9	24	9.5	9.7	0	64.6	0	1.34	240.8	0.17	7958
2014	6	10	1	8.5	8.6	0	68.8	0	0.97	245.9	0.13	7956.7
2014	6	10	2	7.2	7.4	0	74.6	0	1.35	241.2	0.26	7955.3
2014	6	10	3	6.7	7	0	79.2	0	1.09	241.5	0.33	7954

2014	6	10	4	5.7	6	0	82.5	0	1.12	241.7	0.25	7952.7
2014	6	10	5	4.7	5.1	0	85.4	0	1.22	234.2	0.41	7954
2014	6	10	6	4.3	4.6	1.3	84.5	0	1.27	241.8	0.3	7952.7
2014	6	10	7	3.8	4.2	18	86.6	0	1.13	238.7	0.44	7951.3
2014	6	10	8	5.7	5.7	198	70.8	0	0.59	234.5	0.04	7951.3
2014	6	10	9	9.3	8.5	399.8	59.4	0	1.92	73.2	-0.74	7950
2014	6	10	10	11.7	10.7	485.7	54.2	0	3.07	50.8	-0.98	7946
2014	6	10	11	13.6	12.5	694.9	45.7	0	2.92	59.1	-1.17	7944.7
2014	6	10	12	14.7	13.5	777.2	35.9	0	4.26	181.3	-1.26	7943.3
2014	6	10	13	15.6	14.6	983	30.3	0	4.14	216.8	-1.09	7940.7
2014	6	10	14	16.2	15.2	930	22.2	0	5.77	232.5	-0.96	7942
2014	6	10	15	17	15.8	912	20.7	0	5.73	227.2	-1.17	7940.7
2014	6	10	16	17.1	16	843	21.4	0	6.49	227.8	-1.07	7938
2014	6	10	17	16.7	15.9	531.1	21.8	0	5.27	229.6	-0.78	7940.7
2014	6	10	18	16.6	15.9	473.5	22.4	0	6.05	221.3	-0.73	7942
2014	6	10	19	15.4	14.9	175.1	33.9	0	6.13	226.5	-0.51	7939.3
2014	6	10	20	14.4	14	84.6	36.9	0	3.04	201.8	-0.35	7942
2014	6	10	21	13.5	13.2	35.2	41.1	0	2.62	151.4	-0.25	7943.3
2014	6	10	22	12	11.8	7.1	42.2	0	4.17	91.1	-0.2	7948.7
2014	6	10	23	10.9	10.8	0	47	0	3.06	104.9	-0.1	7954
2014	6	10	24	9.5	9.5	0	54.5	0	1.18	260	0.02	7962
2014	6	11	1	7.3	7.5	0	62.4	0	0.68	17.1	0.24	7963.3
2014	6	11	2	5.4	5.7	0	67.7	0	0.95	258.2	0.3	7966
2014	6	11	3	3.9	4	0	73	0	1.25	239.7	0.07	7964.7
2014	6	11	4	2.6	2.7	0	79.8	0	1.2	238.5	0.11	7967.3
2014	6	11	5	2	2.2	0	80.3	0	1.26	236	0.16	7968.7
2014	6	11	6	1.5	1.6	1.1	83.3	0	1.17	236	0.11	7971.3
2014	6	11	7	0.9	1.1	12.6	83.5	0	1.13	240.4	0.18	7972.7
2014	6	11	8	2.9	2.9	206.9	65.3	0	0.87	227.4	-0.02	7975.3
2014	6	11	9	7.5	7	404.3	43.1	0	1	63.2	-0.43	7974
2014	6	11	10	10.1	9.2	587.4	33.4	0	2.04	72.5	-0.88	7972.7
2014	6	11	11	11.5	10.6	746.1	33.8	0	2.19	163.3	-0.97	7972.7
2014	6	11	12	12.6	11.7	875	27.2	0	1.73	62.5	-0.89	7972.7
2014	6	11	13	13.9	13	951	23.4	0	1.37	286.5	-0.88	7971.3
2014	6	11	14	15.5	14.5	987	21.8	0	2.28	229.9	-0.97	7968.7
2014	6	11	15	16.9	15.8	971	18.2	0	2.81	235.8	-1.04	7964.7
2014	6	11	16	17.7	16.8	903	17.9	0	2.41	191.6	-0.95	7962
2014	6	11	17	18.5	17.6	794.6	16.5	0	2.96	223.7	-0.95	7958
2014	6	11	18	18.9	18	635.8	15.7	0	3.58	228.9	-0.94	7954
2014	6	11	19	18.8	18.1	425	16.6	0	2.7	244.1	-0.74	7952.7
2014	6	11	20	17.7	17.5	97	23.9	0	2.17	279.4	-0.2	7950
2014	6	11	21	16.7	16.7	38.1	32	0	1.51	279.6	0.05	7948.7
2014	6	11	22	13.6	13.6	4.5	40.3	0	0.74	210.9	0	7950
2014	6	11	23	10.6	10.6	0	46.1	0	1.38	237.9	-0.01	7954
2014	6	11	24	8.7	8.8	0	51.7	0	1.53	239.5	0.13	7956.7
2014	6	12	1	7.4	7.6	0	57	0	1.55	239	0.2	7954
2014	6	12	2	6.1	6.6	0	60.2	0	1.4	245.9	0.49	7950
2014	6	12	3	5.1	5.7	0	63.7	0	1.45	239.3	0.59	7950
2014	6	12	4	4.8	5.4	0	67.2	0	1.15	242	0.61	7950
2014	6	12	5	4.4	5	0	67.9	0	1.56	240.2	0.66	7950
2014	6	12	6	4	4.8	0.6	62.3	0	1.51	237.4	0.84	7947.3
2014	6	12	7	4.5	5.5	24.7	66.2	0	1.46	240.5	1.05	7944.7
2014	6	12	8	7.1	7.6	138.1	46.6	0	1.52	239.5	0.54	7943.3
2014	6	12	9	12.8	12.6	325.2	30.3	0	1.39	227.4	-0.25	7939.3
2014	6	12	10	15.5	15	408.4	24	0	2.07	241	-0.46	7934
2014	6	12	11	17.4	16.8	588.2	21.2	0	2.35	213.2	-0.63	7931.3
2014	6	12	12	19.5	18.8	852	19.1	0	5.07	221.3	-0.74	7924.7
2014	6	12	13	20	19.3	926	20.4	0	10.16	245.7	-0.64	7918
2014	6	12	14	20.6	19.7	921	20.8	0	6.86	221.3	-0.91	7918
2014	6	12	15	20.2	19.4	889	18.7	0	7.09	238.5	-0.85	7912.7
2014	6	12	16	20.3	19.4	756.9	20.2	0	6.86	234.4	-0.83	7914

2014	6	12	17	20.6	19.8	726.1	20.7	0	6.06	224.5	-0.79	7912.7
2014	6	12	18	20.4	19.9	272.1	22.6	0	5.87	241.5	-0.49	7902
2014	6	12	19	20.3	19.9	294	20.4	0	3.71	241	-0.47	7896.7
2014	6	12	20	19.9	19.7	121.8	20.6	0	4.44	244.3	-0.27	7890
2014	6	12	21	17.8	17.7	52.4	33.5	0	3.12	263	-0.12	7884.7
2014	6	12	22	15.4	15.7	3.1	35.6	0	0.81	30.7	0.28	7888.7
2014	6	12	23	13.2	13.6	0	47.8	0	0.95	236.8	0.41	7891.4
2014	6	12	24	11.1	11.3	0	53	0	1.27	245	0.14	7892.7
2014	6	13	1	11.7	11.8	0	51	0	1.92	43.1	0.12	7894
2014	6	13	2	10.1	10.3	0	76.6	0	1.17	8.5	0.18	7898
2014	6	13	3	8.4	8.6	0	76.9	0	1.52	302.4	0.17	7902
2014	6	13	4	7.5	7.7	0	83.2	0	0.64	276.9	0.21	7904.7
2014	6	13	5	7.1	7.3	0	82.1	0	0.73	250.2	0.18	7907.4
2014	6	13	6	7.9	8.1	0.7	44.5	0	3.11	236.2	0.19	7903.4
2014	6	13	7	8.1	8.1	15.8	53.7	0	4.54	221.6	0.01	7906
2014	6	13	8	7.6	7.4	178.2	49.1	0	6.44	225.9	-0.2	7908.7
2014	6	13	9	7.9	7.5	366	44.9	0	6.52	240.2	-0.35	7911.4
2014	6	13	10	8.2	7.7	422.1	43.7	0	6.22	236.2	-0.54	7912.7
2014	6	13	11	8.3	7.7	532.8	42.4	0	6.18	243.3	-0.56	7914
2014	6	13	12	8.5	7.8	580.6	45	0	6.25	232.5	-0.74	7915.4
2014	6	13	13	8.7	7.8	699.7	40.4	0	7.54	222.7	-0.91	7916.7
2014	6	13	14	9.3	8.2	912	35.3	0	7.07	219.5	-1.11	7919.4
2014	6	13	15	9.3	8.3	656.3	39.1	0	6.77	218.7	-0.99	7920.7
2014	6	13	16	8.4	7.4	698.6	43.3	0	6.92	224.8	-0.98	7922
2014	6	13	17	8.7	7.8	620.2	46.3	0	6.49	232.5	-0.83	7923.4
2014	6	13	18	7.1	6.5	251.3	75.6	0	7.69	224.1	-0.61	7926
2014	6	13	19	4.7	4.2	200.4	61.5	0	3.67	218	-0.42	7939.3
2014	6	13	20	5.8	5.4	127.5	64.5	0	2.76	222.5	-0.35	7935.3
2014	6	13	21	5.9	5.6	18.6	64.7	0	2.45	227	-0.28	7938
2014	6	13	22	3.9	3.6	5	85.3	0	3.93	231.8	-0.29	7936.7
2014	6	13	23	2.9	2.7	0	93.1	0.05	1.25	267.4	-0.25	7940.7
2014	6	13	24	0.6	0.4	0	98.5	0.01	0.03	350.3	-0.18	7944.7
2014	6	14	1	0.7	0.5	0	99.2	0	0.13	102.6	-0.24	7942
2014	6	14	2	1.1	0.8	0	99.5	0.03	0.76	106.3	-0.28	7942
2014	6	14	3	1.1	0.8	0	99.5	0.03	0.78	107.1	-0.27	7943.3
2014	6	14	4	1.3	1	0	98.9	0.02	0.75	86.3	-0.27	7943.3
2014	6	14	5	1.5	1.2	0	99.1	0.01	1.25	80.7	-0.31	7943.3
2014	6	14	6	1.5	1.3	0.4	99	0	0.67	128.2	-0.23	7944.7
2014	6	14	7	1.7	1.4	13.3	99.2	0	1.46	76.6	-0.35	7943.3
2014	6	14	8	2	1.7	57.4	94.9	0	0.73	72.3	-0.33	7944.7
2014	6	14	9	3.3	2.8	194.8	89.5	0	1.38	75.4	-0.5	7946
2014	6	14	10	3.7	3.2	191.9	87	0	2.26	50.2	-0.5	7944.7
2014	6	14	11	4.5	3.9	379.5	77.2	0	2.77	69.3	-0.67	7948.7
2014	6	14	12	5.9	5.1	430.5	69.5	0	3.39	58.5	-0.86	7948.7
2014	6	14	13	6.5	5.8	470	65.8	0	2.56	80	-0.72	7950
2014	6	14	14	7.3	6.7	408.1	62.8	0	2.49	64.3	-0.65	7948.7
2014	6	14	15	8.5	7.8	458.5	59.1	0	4.3	226.8	-0.66	7948.7
2014	6	14	16	7.5	7	267.5	77.2	0	4.34	320.8	-0.5	7947.3
2014	6	14	17	8.3	7.7	413.7	60.5	0	3.18	75.1	-0.64	7955.3
2014	6	14	18	8.6	8	363.1	65.9	0	4.49	73.2	-0.59	7951.3
2014	6	14	19	9.3	8.5	518.2	56	0	4.15	223.8	-0.79	7951.3
2014	6	14	20	9	8.5	111.4	59.9	0	3.38	221.9	-0.42	7950
2014	6	14	21	8.2	8	33.5	69.8	0	1.34	170.1	-0.2	7951.3
2014	6	14	22	6.7	6.8	4.1	80.3	0	0.58	83.9	0.1	7948.7
2014	6	14	23	4.9	4.9	0	87.8	0	0.45	238.2	0.05	7950
2014	6	14	24	3.3	3.3	0	87.9	0	0.97	238.4	0.01	7950
2014	6	15	1	2.1	2.3	0	91	0	1.2	238.3	0.21	7946
2014	6	15	2	1.5	1.6	0	92	0	1.16	242.3	0.14	7942
2014	6	15	3	1	1.2	0	94.7	0	1.11	239.7	0.19	7936.7
2014	6	15	4	0.2	0.5	0	95.9	0	1.23	238.4	0.28	7934
2014	6	15	5	0	0.3	0	93.3	0	1.55	236.1	0.37	7931.3

2014	6	15	6	-0.3	0	1.5	92.9	0	1.88	234.1	0.24	7924.7
2014	6	15	7	-0.3	0	27.3	96.2	0	0.53	302.6	0.24	7923.4
2014	6	15	8	0.8	0.6	104.8	91.1	0	0.4	245.8	-0.15	7922
2014	6	15	9	2.8	2.5	174.9	80.6	0	0.33	84.1	-0.28	7922
2014	6	15	10	4.9	4.5	322.2	63.5	0	0.56	120.3	-0.35	7920.7
2014	6	15	11	8.5	8.1	362	38.2	0	2.09	206.6	-0.38	7918
2014	6	15	12	9.7	9.2	414.2	42.6	0	3.31	245.5	-0.51	7914
2014	6	15	13	9.6	9.1	330.9	44.2	0	2.44	236.3	-0.43	7911.4
2014	6	15	14	9.9	9.3	386.5	46.8	0	3.53	200.3	-0.57	7907.4
2014	6	15	15	8.8	8.3	327.4	66.7	0	5.44	238.8	-0.45	7906
2014	6	15	16	7.5	7.1	323	74.7	0	4.72	245.1	-0.39	7910
2014	6	15	17	6.7	6.4	216.7	77.8	0.01	2.91	208.8	-0.32	7911.4
2014	6	15	18	6.9	6.6	170.1	69.6	0	2.33	223.9	-0.3	7908.7
2014	6	15	19	7.9	7.5	305.7	59.9	0	1.61	132.8	-0.39	7904.7
2014	6	15	20	8.6	8.6	65.7	67.3	0	1.68	289.8	-0.03	7898
2014	6	15	21	7.6	8	28.6	71.2	0	0.61	326.8	0.39	7892.7
2014	6	15	22	7	7.1	3.5	75.7	0	0.9	290.6	0.14	7891.4
2014	6	15	23	6.5	6.5	0	78.7	0	0.91	265	0.06	7891.4
2014	6	15	24	5.5	5.4	0	94.8	0.04	2.01	239.3	-0.01	7891.4
2014	6	16	1	3.7	3.5	0	95.3	0	1.42	41.6	-0.17	7895.4
2014	6	16	2	3	2.9	0	98.6	0	1.07	317.7	-0.06	7894
2014	6	16	3	2.2	2.1	0	99.5	0.01	0.88	231.7	-0.12	7890
2014	6	16	4	2.6	2.4	0	99.1	0.02	0.9	221.4	-0.16	7887.4
2014	6	16	5	2.9	2.7	0	95.5	0.01	1.2	287.4	-0.16	7886
2014	6	16	6	2.9	2.8	0.2	98.1	0.01	1.09	291.8	-0.16	7880.7
2014	6	16	7	2.4	2.3	3.3	96.3	0.14	0.63	281.5	-0.14	7884.7
2014	6	16	8	0.5	0.4	22.5	100	0.02	1.06	255.9	-0.07	7887.4
2014	6	16	9	1.3	1	93.8	98.6	0.04	0.52	168.2	-0.24	7883.4
2014	6	16	10	2.4	2.1	156.8	94.4	0	0.74	199.9	-0.34	7882
2014	6	16	11	4.1	3.5	260.8	81.3	0	1.5	71.3	-0.53	7880.7
2014	6	16	12	5.4	4.9	481.2	76.2	0.01	3.02	233.3	-0.52	7879.4
2014	6	16	13	5.5	5	326	66.1	0	1.86	110.3	-0.51	7876.7
2014	6	16	14	4.2	3.7	344.2	87.4	0.04	3.97	239.3	-0.46	7875.4
2014	6	16	15	5.7	5.1	542.8	69.1	0	2.91	134.1	-0.58	7883.4
2014	6	16	16	3.4	3	252.3	84.8	0.04	4.33	236.8	-0.42	7876.7
2014	6	16	17	5.4	4.7	656	64.2	0	2.17	223.3	-0.66	7886
2014	6	16	18	7.1	6.6	411.2	55.8	0	4.95	231.6	-0.56	7883.4
2014	6	16	19	7.1	6.7	222.4	51.8	0	4.65	237.2	-0.39	7880.7
2014	6	16	20	5.9	5.6	107.7	75	0	2.94	1.6	-0.25	7883.4
2014	6	16	21	4.1	3.8	67.1	87.4	0	3.46	15.5	-0.25	7888.7
2014	6	16	22	2.6	2.4	3.4	93.9	0.01	2.52	32.6	-0.23	7895.4
2014	6	16	23	0.5	0.3	0	99.5	0.02	1.14	57.2	-0.21	7902
2014	6	16	24	0.4	0.2	0	100	0	0.86	67.6	-0.25	7904.7
2014	6	17	1	0.4	0.1	0	100	0	1.25	86.8	-0.31	7903.4
2014	6	17	2	0.2	0	0	100	0	1.41	6.2	-0.24	7903.4
2014	6	17	3	0.2	0	0	99.6	0	1.27	50	-0.28	7903.4
2014	6	17	4	0.2	-0.1	0	100	0	1.18	107.9	-0.27	7904.7
2014	6	17	5	0	-0.2	0	100	0	2.36	53.9	-0.27	7904.7
2014	6	17	6	0	-0.3	0.4	99.7	0	1.66	64.2	-0.31	7906
2014	6	17	7	-0.1	-0.5	12.7	99.7	0	2.57	39.5	-0.36	7908.7
2014	6	17	8	0.1	-0.3	67.7	95.2	0.01	1.56	51.9	-0.46	7911.4
2014	6	17	9	0.9	0.1	257.5	87	0.02	2.29	70.8	-0.86	7912.7
2014	6	17	10	2.3	1.7	384.4	75.9	0	2.77	83.7	-0.66	7915.4
2014	6	17	11	3.1	2.4	434.4	66.8	0	2.65	73	-0.71	7916.7
2014	6	17	12	3.6	3	461.2	75.5	0	3.51	71	-0.62	7916.7
2014	6	17	13	2	1.3	446.8	93.5	0	6.04	53.8	-0.66	7922
2014	6	17	14	2.6	2	390	68.2	0	2.87	98.9	-0.63	7928.7
2014	6	17	15	3.3	2.8	323.5	81.4	0.01	5	63	-0.48	7926
2014	6	17	16	3.8	3	596.1	69.7	0	5.43	52	-0.76	7927.3
2014	6	17	17	5.8	4.9	656	49	0	5	62.2	-0.9	7927.3
2014	6	17	18	5.8	5.4	128.4	70.3	0	3.26	132.1	-0.36	7924.7

2014	6	17	19	2.5	2.2	44.8	92	0.01	5.28	234.6	-0.3	7930
2014	6	17	20	2.6	2.3	105.1	83.8	0	1.47	43.1	-0.32	7938
2014	6	17	21	2.7	2.5	23.6	94.7	0.01	1.32	231.8	-0.24	7942
2014	6	17	22	1.5	1.2	1.3	95.9	0	1.15	69.9	-0.27	7947.3
2014	6	17	23	1.5	1.2	0	98.4	0	1.14	79.4	-0.28	7948.7
2014	6	17	24	1.2	1	0	99.3	0	0.94	80.4	-0.25	7947.3
2014	6	18	1	1	0.8	0	100	0	0.99	72.5	-0.26	7943.3
2014	6	18	2	0.7	0.5	0	100	0	0.56	34.5	-0.21	7943.3
2014	6	18	3	0.5	0.3	0	99	0	0.62	223.3	-0.19	7940.7
2014	6	18	4	0.3	0	0	100	0	0.56	79.6	-0.23	7939.3
2014	6	18	5	0.4	0.2	0	99.9	0	0.72	193.3	-0.21	7938
2014	6	18	6	0.4	0.2	0.3	100	0	0.25	65.5	-0.2	7942
2014	6	18	7	0.5	0.3	15.7	99.4	0	0.59	226.7	-0.22	7943.3
2014	6	18	8	0.9	0.6	71.8	94.5	0.01	0.93	228.3	-0.27	7942
2014	6	18	9	2	1.7	123.5	94.7	0.01	1.03	74.7	-0.34	7938
2014	6	18	10	3	2.5	427.3	73.5	0	1.74	92.6	-0.51	7944.7
2014	6	18	11	3.6	3	293.7	86.2	0	3.36	44.3	-0.59	7948.7
2014	6	18	12	4.8	4.1	542.3	74.3	0	2.2	142	-0.65	7951.3
2014	6	18	13	5.1	4.7	539.9	65.9	0	1.03	92.8	-0.4	7951.3
2014	6	18	14	6.7	6	521.5	66	0	3.04	51.4	-0.73	7950
2014	6	18	15	8.3	7.5	733.5	68.6	0	5.04	230.5	-0.79	7947.3
2014	6	18	16	7.3	6.5	639.7	72.9	0	5.4	224.9	-0.78	7954
2014	6	18	17	7.6	7.1	409.3	63.9	0	3.25	244	-0.48	7958
2014	6	18	18	9.6	8.8	620.7	51.5	0	4.67	222.8	-0.83	7959.3
2014	6	18	19	9.3	8.9	182.7	54.3	0	2.47	262.1	-0.34	7959.3
2014	6	18	20	8.6	8.3	95.1	64.8	0	5.15	228.4	-0.31	7964.7
2014	6	18	21	7.5	7.3	31.3	65.1	0	5.32	223.8	-0.24	7968.7
2014	6	18	22	6.9	6.7	4.8	70	0	3.23	226.9	-0.19	7972.7
2014	6	18	23	6.5	6.3	0	71.5	0	1.42	261.8	-0.18	7978
2014	6	18	24	5.6	5.7	0	81.8	0	0.65	272.2	0.07	7979.3
2014	6	19	1	4.5	4.5	0	86.8	0	1.11	310.9	-0.03	7983.3
2014	6	19	2	4.1	4	0	87.1	0	0.42	251.6	-0.06	7987.3
2014	6	19	3	2.9	3	0	90.6	0	1.35	235.8	0.06	7986
2014	6	19	4	1.6	1.8	0	96.6	0	0.82	248.1	0.19	7984.7
2014	6	19	5	0.6	0.9	0	94.7	0	0.97	241.5	0.22	7982
2014	6	19	6	0.1	0.4	0.8	97.5	0	0.99	239.3	0.27	7984.7
2014	6	19	7	0	0.3	12.6	96.1	0	0.86	240.6	0.3	7984.7
2014	6	19	8	1.6	1.6	216.4	84.7	0	0.47	216.9	-0.03	7990
2014	6	19	9	4.5	4.1	379.6	77	0	1.04	72.1	-0.42	7992.7
2014	6	19	10	8	7.4	571.7	53.9	0	1.41	82.5	-0.55	7992.7
2014	6	19	11	11.9	11.3	714.1	49.5	0	3.74	214.3	-0.67	7990
2014	6	19	12	13	12.5	641.1	44.3	0	5.45	223.8	-0.58	7988.7
2014	6	19	13	14	13.5	596.1	39.5	0	6.99	231.7	-0.53	7988.7
2014	6	19	14	15.1	14.4	878	35.1	0	6.59	231.6	-0.67	7988.7
2014	6	19	15	16.1	15.4	951	31.9	0	6.26	239.8	-0.73	7986
2014	6	19	16	16.8	16.1	931	31.1	0	6.25	244.9	-0.71	7987.3
2014	6	19	17	17.1	16.4	621.5	34.7	0	5.79	231.6	-0.69	7987.3
2014	6	19	18	16.7	16.3	190.5	37.9	0	5.52	223.8	-0.38	7986
2014	6	19	19	17	16.6	280	34.5	0	5.98	219.8	-0.41	7984.7
2014	6	19	20	16.1	16	60.8	38.7	0	3.78	250.8	-0.06	7983.3
2014	6	19	21	15.3	15.4	18.4	46.6	0	2.78	264	0.09	7986
2014	6	19	22	12.9	13.2	4.9	58.1	0	0.81	223.7	0.3	7987.3
2014	6	19	23	10.7	10.7	0.1	66.2	0	0.91	241	0.05	7991.3
2014	6	19	24	8.9	9.1	0	70.9	0	0.92	245.1	0.23	7992.7
2014	6	20	1	7.2	7.5	0	73.8	0	1.27	230.5	0.33	7991.3
2014	6	20	2	6.5	7	0	77.9	0	1.54	240.4	0.45	7988.7
2014	6	20	3	6.5	7.2	0.1	79.1	0	1.37	245	0.63	7986
2014	6	20	4	6.5	7	0.1	75.8	0	1.35	242	0.47	7982
2014	6	20	5	6.1	6.9	0	79.4	0	0.94	243.3	0.74	7984.7
2014	6	20	6	5.9	6.8	0.6	79.7	0	1.27	238.9	0.96	7986
2014	6	20	7	6.7	7.4	19.9	73.7	0	1.18	240.6	0.7	7984.7

2014	6	20	8	7.7	8.1	115	71.7	0	0.68	242.5	0.43	7983.3
2014	6	20	9	11	10.9	286.1	55.3	0	1.08	227.9	-0.09	7979.3
2014	6	20	10	13.6	12.8	561.3	42.7	0	4.59	53.1	-0.78	7982
2014	6	20	11	16.2	15.2	609.4	39.7	0	2.92	67.3	-1	7978
2014	6	20	12	17.5	16.8	689.7	30.6	0	2.98	48.4	-0.73	7972.7
2014	6	20	13	18.7	17.9	953	30.6	0	6.31	230.2	-0.77	7970
2014	6	20	14	19.3	18.6	855	30.4	0	5.36	234.1	-0.74	7968.7
2014	6	20	15	19.5	18.8	717.1	33.1	0	5.92	241.5	-0.7	7964.7
2014	6	20	16	19.2	18.6	557.2	33.3	0	5.81	234.8	-0.62	7963.3
2014	6	20	17	19.3	18.8	543.2	35.1	0	6.22	230.8	-0.58	7963.3
2014	6	20	18	19.1	18.4	550.3	32.5	0	6.55	231.8	-0.63	7963.3
2014	6	20	19	18.7	18.1	430.9	30.7	0	6.76	226.7	-0.57	7964.7
2014	6	20	20	17.6	17.4	91.2	34.7	0	4.94	244.7	-0.21	7963.3
2014	6	20	21	16.4	16.4	38.6	39	0	2.23	263.2	0.02	7967.3
2014	6	20	22	15	15.3	8.2	51.2	0	1.1	277.3	0.31	7968.7
2014	6	20	23	12	12.4	0.1	58.5	0	1.08	240.9	0.35	7970
2014	6	20	24	10.5	10.7	0	68.3	0	0.89	257.9	0.24	7974
2014	6	21	1	8.8	9.1	0	78.2	0	0.96	243.1	0.29	7974
2014	6	21	2	7.6	8	0	84.3	0	0.97	238.6	0.38	7978
2014	6	21	3	6.7	7	0	90.7	0	1.12	247.8	0.27	7979.3
2014	6	21	4	5.9	6.1	0	89.6	0	1.09	244.7	0.19	7980.7
2014	6	21	5	5	5.4	0.1	94	0	1.32	236.4	0.38	7978
2014	6	21	6	4.4	4.8	0.9	96	0	1.27	241.1	0.43	7979.3
2014	6	21	7	4.2	4.5	14.3	92.4	0	1.17	241.1	0.24	7980.7
2014	6	21	8	5.8	5.8	202.5	84.2	0	0.67	223.8	-0.04	7979.3
2014	6	21	9	8.6	8.1	315.8	78.9	0	1.39	68.6	-0.53	7976.7
2014	6	21	10	12	11.4	565.6	29.8	0	2.25	101.1	-0.63	7976.7
2014	6	21	11	15.2	14.6	728.9	28.9	0	5.97	230.2	-0.62	7972.7
2014	6	21	12	16.2	15.5	878	22.9	0	5.09	236.1	-0.73	7970
2014	6	21	13	16.9	16.1	882	22.4	0	5.33	234.5	-0.8	7970
2014	6	21	14	17.5	16.6	815	20.9	0	5.01	232.1	-0.84	7968.7
2014	6	21	15	17.8	17	909	23.2	0	4.55	237	-0.8	7970
2014	6	21	16	18.6	17.7	922	20.6	0	5.74	241.4	-0.87	7967.3
2014	6	21	17	18.8	18	822	20.4	0	5.54	229.5	-0.83	7966
2014	6	21	18	18.8	18	640.8	19.8	0	4.57	239.7	-0.77	7963.3
2014	6	21	19	18.8	18.1	480.4	20.6	0	3.31	233.1	-0.74	7962
2014	6	21	20	17.3	17.3	66.1	25.3	0	2.07	264.5	0	7960.7
2014	6	21	21	15.8	16.3	25	28.5	0	2.06	248.5	0.44	7963.3
2014	6	21	22	13.7	14.2	4.9	36.2	0	0.84	271.1	0.43	7966
2014	6	21	23	11.2	11.6	0.1	45.8	0	0.73	243	0.39	7967.3
2014	6	21	24	9.9	10.2	0	59.3	0	0.83	251.7	0.33	7974
2014	6	22	1	9.2	9.6	0	65.7	0	1.03	250.5	0.39	7976.7
2014	6	22	2	8.8	9	0	72.9	0	1.19	244.5	0.23	7979.3
2014	6	22	3	8.2	8.4	0	72.6	0	1.24	243.9	0.19	7976.7
2014	6	22	4	7.3	7.7	0	82.6	0	1.05	338.6	0.37	7976.7
2014	6	22	5	6.2	6.5	0.1	78.5	0	1.37	236.9	0.24	7976.7
2014	6	22	6	5	5.4	0.6	83.7	0	1.25	238.1	0.33	7976.7
2014	6	22	7	4.5	4.9	12.6	82.4	0	1.2	238.8	0.46	7978
2014	6	22	8	6.6	6.6	194.2	67.2	0	0.84	242.5	-0.02	7980.7
2014	6	22	9	9.7	9.1	280.4	61.7	0	1.39	74.5	-0.53	7980.7
2014	6	22	10	11.8	11	515.1	49.6	0	2.1	77.9	-0.77	7983.3
2014	6	22	11	15.6	14.6	712.8	35.3	0	2.23	69.1	-0.96	7983.3
2014	6	22	12	16.7	15.9	600.3	27.6	0	3.86	133.5	-0.83	7980.7
2014	6	22	13	17.3	16.5	889	24	0	4.11	221.3	-0.79	7982
2014	6	22	14	18	17.1	770	25.2	0	4.85	222.9	-0.88	7980.7
2014	6	22	15	17.8	17.2	475.8	23.3	0	3.83	233.7	-0.61	7979.3
2014	6	22	16	18.3	17.6	643	22.5	0	4	225	-0.7	7979.3
2014	6	22	17	18.6	17.9	466.6	24.6	0	3.94	230	-0.69	7976.7
2014	6	22	18	18.9	18.2	610.2	22.9	0	2.75	224.1	-0.7	7975.3
2014	6	22	19	19.1	18.4	497.2	23.2	0	3.05	231.2	-0.73	7974
2014	6	22	20	18	17.7	104	27.5	0	1.84	227.2	-0.25	7974

2014	6	22	21	16.4	16.8	34.2	33.3	0	1.22	272.6	0.32	7976.7
2014	6	22	22	13.8	14	4.6	45.7	0	1.08	235	0.2	7979.3
2014	6	22	23	11.2	11.5	0	52.7	0	1.8	239.3	0.31	7983.3
2014	6	22	24	10	10.2	0	60.4	0	1.53	243.8	0.24	7990
2014	6	23	1	8.7	9.1	0	70.4	0	1.46	238.6	0.41	7990
2014	6	23	2	7.8	8.1	0	70.5	0	1.45	237.9	0.32	7990
2014	6	23	3	6.9	7.3	0	76.3	0	1.78	238.3	0.4	7990
2014	6	23	4	6.6	7	0	74.8	0	1.45	238.5	0.34	7990
2014	6	23	5	6.3	6.7	0.1	78.9	0	1.39	236.9	0.45	7990
2014	6	23	6	6.9	7.7	1.1	81.3	0	1.3	242.8	0.83	7988.7
2014	6	23	7	6.5	7	12.6	75.9	0	1.54	239.6	0.47	7987.3
2014	6	23	8	8.7	8.8	191.4	62	0	1.21	240.4	0.13	7990
2014	6	23	9	12.8	12.4	388.8	44.2	0	0.75	78.4	-0.38	7991.3
2014	6	23	10	15.5	15	571.6	34.9	0	1.37	58.2	-0.53	7991.3
2014	6	23	11	17.4	16.6	724.4	22.8	0	3.71	212.9	-0.73	7991.3
2014	6	23	12	18.3	17.4	861	25.2	0	3.23	219.9	-0.95	7991.3
2014	6	23	13	19.2	18	934	23	0	2.81	53	-1.15	7992.7
2014	6	23	14	20	19.1	991	22.9	0	2.62	223.4	-0.91	7991.3
2014	6	23	15	20.6	19.7	971	20.9	0	3.32	247.1	-0.97	7988.7
2014	6	23	16	21.6	20.5	975	22.7	0	2.65	233.5	-1.12	7984.7
2014	6	23	17	21.5	20.7	579.6	22.4	0	2.49	235.4	-0.77	7980.7
2014	6	23	18	21.1	20.6	415.1	22.4	0	2.82	209.4	-0.51	7979.3
2014	6	23	19	21.6	20.9	474.7	22.9	0	3.84	224.3	-0.73	7976.7
2014	6	23	20	20.6	20.3	117	28	0	2.22	220.8	-0.29	7976.7
2014	6	23	21	19.6	19.7	50.3	28	0	1.44	261.8	0.06	7979.3
2014	6	23	22	17.1	17.3	5.2	44.6	0	1.35	236.6	0.21	7980.7
2014	6	23	23	14.6	14.7	0.1	50.9	0	0.69	245.5	0.05	7986
2014	6	23	24	12.4	12.7	0	56.3	0	1.29	238.1	0.29	7988.7
2014	6	24	1	11.3	11.6	0.1	62.2	0	1.3	238.6	0.3	7987.3
2014	6	24	2	10.3	10.9	0.1	69.6	0	1.42	245.5	0.62	7986
2014	6	24	3	9.7	10.1	0	65.1	0	1.65	244	0.44	7983.3
2014	6	24	4	8.6	9.2	0	74.3	0	1.6	242.2	0.54	7983.3
2014	6	24	5	8.6	9.1	0	74	0	1.6	243.8	0.58	7982
2014	6	24	6	9	9.6	0.6	66.9	0	1.63	242	0.6	7979.3
2014	6	24	7	10	10.6	13.7	64.8	0	1.85	237	0.61	7979.3
2014	6	24	8	12.4	12.6	61.3	49.3	0	1.61	265	0.25	7979.3
2014	6	24	9	14.1	14	150.8	58.7	0	1.36	343.4	-0.14	7984.7
2014	6	24	10	14.7	14.3	336.7	37.2	0	1.36	348.7	-0.42	7982
2014	6	24	11	18.5	18	514.6	27.1	0	1.34	245	-0.49	7980.7
2014	6	24	12	18.9	18.1	633.6	32.5	0	4.35	56.5	-0.83	7978
2014	6	24	13	20.1	19	703.6	27.9	0	4.28	49.6	-1.03	7974
2014	6	24	14	20	19.2	461.8	30.3	0	4.45	63.5	-0.79	7971.3
2014	6	24	15	20.4	19.5	550.1	30	0	5.25	53.4	-0.92	7968.7
2014	6	24	16	20.6	20	464.2	30.9	0	3.29	19.3	-0.58	7967.3
2014	6	24	17	20.9	20.2	582.4	29.9	0	2.7	240.6	-0.64	7966
2014	6	24	18	20.8	20.2	422.5	33.5	0	5.6	228.4	-0.68	7964.7
2014	6	24	19	19.8	19.2	318.1	36.9	0	5.06	224.3	-0.56	7964.7
2014	6	24	20	18.6	18.3	140.6	40.3	0	4.65	228.3	-0.35	7964.7
2014	6	24	21	17.2	17.2	31.1	46.1	0	1.09	262.5	0.07	7968.7
2014	6	24	22	15.3	15.8	6	52.8	0	1.71	234.6	0.44	7970
2014	6	24	23	13.7	13.9	0.1	63.1	0	0.92	34	0.2	7974
2014	6	24	24	11.8	12.1	0.1	73	0	0.69	242	0.28	7976.7
2014	6	25	1	10.7	11	0.1	78.4	0	0.48	334.1	0.32	7978
2014	6	25	2	10.4	10.6	0	81.4	0	0.98	272.7	0.24	7979.3
2014	6	25	3	9.5	9.7	0.1	80.6	0	1.31	243.1	0.21	7976.7
2014	6	25	4	9.4	9.4	0	83.5	0	0.74	246.5	0.02	7976.7
2014	6	25	5	9.1	9.2	0	85.7	0	1	253.8	0.12	7975.3
2014	6	25	6	8.7	8.7	0.4	84.1	0	0.48	245	0.05	7972.7
2014	6	25	7	8.1	8.2	25.8	86.7	0	1.18	235.4	0.09	7974
2014	6	25	8	9.2	9	149.1	80.9	0	0.87	60.2	-0.18	7974
2014	6	25	9	11.7	10.7	368.8	68.1	0	2.9	75.9	-0.97	7972.7

2014	6	25	10	13.2	12.7	324.6	54.8	0	1.08	92.5	-0.51	7968.7
2014	6	25	11	15.1	14.7	395.6	49.2	0	3.53	244.6	-0.46	7967.3
2014	6	25	12	16.1	15.4	660.2	40.9	0	3.94	242.8	-0.67	7964.7
2014	6	25	13	17.2	16.4	783.6	37.8	0	4.38	233.7	-0.81	7963.3
2014	6	25	14	17.5	16.8	585.3	34.4	0	5.6	235.7	-0.7	7960.7
2014	6	25	15	17	16.5	318.2	41.3	0	4.66	219.6	-0.56	7958
2014	6	25	16	15.8	15.3	282.1	51.6	0	4.26	190.4	-0.51	7960.7
2014	6	25	17	13.2	12.9	162.1	68.9	0	4.48	243.9	-0.28	7962
2014	6	25	18	12.3	12	178	74	0	2.07	306.4	-0.33	7962
2014	6	25	19	12.1	11.8	131.4	71	0	2.39	42.3	-0.32	7955.3
2014	6	25	20	12.2	11.9	86.7	75.4	0	2.82	52.4	-0.31	7948.7
2014	6	25	21	11.8	11.5	26.4	76.8	0	1.98	58	-0.24	7948.7
2014	6	25	22	11.1	10.9	1.3	87.9	0	0.66	68.3	-0.23	7944.7
2014	6	25	23	10.4	10.1	0	95.5	0.01	0.58	56.2	-0.22	7943.3
2014	6	25	24	9.7	9.5	0	97.8	0.1	0.81	54.7	-0.24	7942
2014	6	26	1	9.2	8.9	0.1	98.8	0	1.25	69.4	-0.25	7936.7
2014	6	26	2	8.8	8.5	0	99.8	0.04	0.85	72.6	-0.27	7932.7
2014	6	26	3	8.8	8.5	0	99.8	0.02	0.77	84.4	-0.25	7927.3
2014	6	26	4	8.7	8.5	0.1	100	0.05	0.53	154.9	-0.2	7920.7
2014	6	26	5	8.9	8.7	0	100	0.02	0.77	32.1	-0.18	7918
2014	6	26	6	8.5	8.3	0.1	100	0.07	1.74	79.8	-0.25	7916.7
2014	6	26	7	8.5	8.3	5.9	100	0.02	1.17	77.2	-0.2	7918
2014	6	26	8	9.2	9.1	36.6	87.2	0	2.51	203.5	-0.13	7919.4
2014	6	26	9	9.8	9.6	160.1	82.7	0	3.14	241.5	-0.23	7920.7
2014	6	26	10	9.8	9.6	121	79.9	0	3.03	240.2	-0.25	7920.7
2014	6	26	11	10.6	10.3	346.3	74.4	0	4.84	238.7	-0.36	7920.7
2014	6	26	12	10.4	10.1	268.5	74.2	0.01	3.67	246.9	-0.31	7920.7
2014	6	26	13	11.8	11.3	524.2	70.1	0	6.06	243	-0.43	7920.7
2014	6	26	14	11.9	11.5	455.7	63.3	0	5.25	251.6	-0.4	7920.7
2014	6	26	15	12.2	11.6	653.5	65.7	0	5.42	234.9	-0.6	7920.7
2014	6	26	16	12.8	12.3	527.2	61.7	0	6.23	240.4	-0.53	7919.4
2014	6	26	17	13	12.5	375.3	59	0	4.65	235	-0.48	7919.4
2014	6	26	18	13.5	13.1	305.2	64.9	0	4.03	227.7	-0.43	7916.7
2014	6	26	19	13	12.6	177.4	66.2	0	2.83	201.8	-0.36	7918
2014	6	26	20	11.9	11.7	72	75.8	0	2.14	212.2	-0.26	7920.7
2014	6	26	21	10.4	10.3	41.3	84	0	0.98	242.2	-0.11	7924.7
2014	6	26	22	9.3	9.3	3.9	90	0	0.78	249.6	0.01	7926
2014	6	26	23	8.5	8.6	0.1	91	0	0.78	237.9	0.04	7928.7
2014	6	26	24	8.5	8.4	0.1	92.4	0	0.71	355.4	-0.12	7934
2014	6	27	1	7.5	7.6	0.1	97	0	0.6	283.1	0.09	7932.7
2014	6	27	2	6.6	6.5	0.1	94.6	0	1.11	231.4	-0.07	7930
2014	6	27	3	6.4	6.3	0.1	95.6	0	0.35	201.7	-0.09	7931.3
2014	6	27	4	6.3	6.3	0.1	96.4	0	1.12	244	0.02	7931.3
2014	6	27	5	6.1	6.2	0.1	95.7	0	0.86	251.5	0.05	7931.3
2014	6	27	6	6.2	6.1	0.5	98.1	0	0.69	277.9	-0.03	7932.7
2014	6	27	7	6.2	6.2	14.5	98.2	0	0.62	273.6	-0.03	7931.3
2014	6	27	8	6.7	6.5	87.6	92.9	0	0.62	102	-0.22	7930
2014	6	27	9	7.9	7.7	141.9	83.5	0	0.54	210.9	-0.28	7934
2014	6	27	10	9.7	9.3	222.5	74.8	0	1.34	244.9	-0.32	7931.3
2014	6	27	11	10.5	10.2	188.7	71.4	0	3.26	222.8	-0.29	7930
2014	6	27	12	10.8	10.4	242	78.8	0.01	4.33	227.4	-0.37	7930
2014	6	27	13	8.6	8.3	171.2	94.2	0.05	1.95	45.4	-0.3	7932.7
2014	6	27	14	9.8	9.2	403.9	82.9	0.01	2.62	63.3	-0.56	7934
2014	6	27	15	9.5	9.1	318.2	80	0.01	5.42	238.6	-0.35	7935.3
2014	6	27	16	10.7	10.1	682.5	69.9	0	5.69	232.9	-0.54	7938
2014	6	27	17	11.3	10.7	608.9	70	0	5.44	229.7	-0.66	7936.7
2014	6	27	18	11.2	10.8	241.8	62.7	0	2.71	229.1	-0.41	7938
2014	6	27	19	12	11.6	229.4	59.1	0	2.09	234.8	-0.36	7936.7
2014	6	27	20	11.1	10.9	36.5	86.3	0.01	2.73	252.8	-0.18	7932.7
2014	6	27	21	8.4	8.3	6.4	91.4	0.12	2.36	266	-0.16	7938
2014	6	27	22	7.2	7.1	3.5	96.4	0.01	1.23	207.5	-0.15	7947.3

2014	6	27	23	7	6.9	0.1	93.6	0.09	1.14	240.6	-0.2	7943.3
2014	6	27	24	6.8	6.7	0	97.1	0	1.08	294.1	-0.09	7948.7
2014	6	28	1	6	5.8	0	98.7	0	0.86	234.7	-0.12	7947.3
2014	6	28	2	5.1	5	0	97.9	0	1.23	270.1	-0.09	7943.3
2014	6	28	3	5.3	5.2	0.1	98.2	0	1.01	341.1	-0.12	7943.3
2014	6	28	4	4.8	4.7	0	100	0	0.72	296.9	-0.08	7943.3
2014	6	28	5	4.6	4.5	0	100	0	1.16	232.3	-0.13	7943.3
2014	6	28	6	4.2	4.3	0.5	100	0	0.67	254.2	0.04	7943.3
2014	6	28	7	3.9	3.9	14.2	100	0	0.6	247.9	-0.04	7946
2014	6	28	8	4.9	4.7	130.7	97.1	0	0.59	237	-0.14	7948.7
2014	6	28	9	6.6	6.3	173.5	95.3	0	2.09	90	-0.29	7951.3
2014	6	28	10	8.4	8	300.8	74.5	0	3.39	222.9	-0.33	7955.3
2014	6	28	11	7.7	7.4	236	87.8	0.01	2.29	259	-0.3	7959.3
2014	6	28	12	8.7	8.1	669.2	77	0	3.75	40.5	-0.63	7962
2014	6	28	13	10.3	9.8	635.9	54.7	0	2.94	286	-0.55	7962
2014	6	28	14	11.3	10.8	501.3	61.6	0	4.04	217.8	-0.52	7963.3
2014	6	28	15	12.3	11.6	922	50.6	0	4.56	234.3	-0.68	7964.7
2014	6	28	16	13.4	12.6	773.7	46.1	0	5.34	227.2	-0.79	7966
2014	6	28	17	13.7	12.9	560.2	44.3	0	4.41	222.4	-0.73	7966
2014	6	28	18	13.6	13.1	295.7	43.8	0	4.74	230.7	-0.49	7964.7
2014	6	28	19	13.8	13.3	383.9	39.7	0	3.66	231.9	-0.48	7964.7
2014	6	28	20	13.3	13.1	108.5	44.5	0	3.18	244.6	-0.16	7962
2014	6	28	21	12.3	12.4	24.3	45.3	0	1.84	269.1	0.05	7966
2014	6	28	22	10	10.6	4	69.4	0	0.87	259.8	0.51	7968.7
2014	6	28	23	7.4	7.6	0.1	77.2	0	1.2	236.2	0.18	7971.3
2014	6	28	24	6	6.2	0.1	82.9	0	1.39	237	0.19	7974
2014	6	29	1	5.4	5.7	0.1	87	0	0.84	247.6	0.21	7972.7
2014	6	29	2	4.7	5.1	0.1	92.4	0	0.99	241.7	0.4	7972.7
2014	6	29	3	4	4.4	0	87.6	0	1.16	238.8	0.46	7972.7
2014	6	29	4	3.6	4	0	94.6	0	0.82	246.1	0.46	7972.7
2014	6	29	5	3	3.4	0	92.9	0	1.15	241.5	0.33	7975.3
2014	6	29	6	2.7	3.1	0.7	94.4	0	0.95	239.7	0.43	7978
2014	6	29	7	2.3	2.8	12	95.6	0	1.27	241.2	0.48	7980.7
2014	6	29	8	4	4	154.1	88	0	0.65	231.4	0.06	7982
2014	6	29	9	6.9	6.6	388.4	70.6	0	0.96	74.6	-0.35	7983.3
2014	6	29	10	10.8	10.2	591.4	55.1	0	3.38	99.6	-0.69	7982
2014	6	29	11	12.5	11.9	740	39.7	0	6.19	227.3	-0.6	7983.3
2014	6	29	12	13.3	12.6	882	36.5	0	5.87	221.1	-0.79	7982
2014	6	29	13	14.2	13.5	956	36	0	5.29	242.6	-0.68	7983.3
2014	6	29	14	15	14.1	989	33.2	0	6.89	226.1	-0.94	7982
2014	6	29	15	15.7	14.7	976	30.2	0	7.08	223.5	-1	7982
2014	6	29	16	16	15.1	918	31.3	0	6.42	223.4	-0.92	7980.7
2014	6	29	17	16.1	15.2	831	30.5	0	6.28	226.3	-0.9	7982
2014	6	29	18	15.8	15.1	544.7	31	0	7.56	227	-0.76	7982
2014	6	29	19	15.4	14.8	332.9	34.9	0	5.64	224	-0.57	7984.7
2014	6	29	20	14.3	14.1	74.3	37.9	0	3.85	228.7	-0.25	7984.7
2014	6	29	21	13.7	13.5	45.4	39.4	0	2.33	238.4	-0.16	7988.7
2014	6	29	22	12.4	12.5	5.7	46.8	0	1.73	256.2	0.09	7991.3
2014	6	29	23	10.8	10.8	0.1	52.3	0	1.55	31.6	0.03	8000.7
2014	6	29	24	9	9.2	0	64	0	1	0.4	0.19	8006
2014	6	30	1	7	7.3	0	76.9	0	0.5	245.4	0.31	8010
2014	6	30	2	5.5	5.7	0	80	0	1.05	246	0.24	8011.3
2014	6	30	3	4.3	4.4	0.1	82.2	0	1.01	252.6	0.11	8012.7
2014	6	30	4	2.9	3.1	0	88.2	0	1.4	238.5	0.18	8016.7
2014	6	30	5	2.4	2.6	0	88.1	0	1.05	243.2	0.19	8020.7
2014	6	30	6	1.5	1.7	0.7	91.3	0	1.29	236.6	0.2	8023.3
2014	6	30	7	1.1	1.4	10.1	94	0	1.3	238.2	0.31	8024.7
2014	6	30	8	2.5	2.9	145.9	79.9	0	0.71	255.8	0.35	8027.3
2014	6	30	9	7.2	6.8	394.9	58.4	0	1.69	63	-0.41	8030
2014	6	30	10	9.2	8.7	576.3	47.3	0	1.74	6.5	-0.47	8030
2014	6	30	11	10.9	10.4	738.6	43.9	0	1.64	342.9	-0.54	8030

2014	6	30	12	12.9	12.3	873	35.1	0	1.6	310.9	-0.62	8026
2014	6	30	13	15	14.2	955	29.4	0	1.66	78.3	-0.82	8026
2014	6	30	14	16.8	15.9	989	25.9	0	1.86	100.5	-0.89	8024.7
2014	6	30	15	18.2	17.1	975	22.9	0	3.14	72.1	-1.19	8023.3
2014	6	30	16	19.5	18.1	923	20.8	0	4.61	68.1	-1.44	8020.7
2014	6	30	17	19.8	18.7	813	21.8	0	3.44	67	-1.09	8019.3
2014	6	30	18	20.3	19.5	671.3	24	0	2.78	169.4	-0.77	8019.3
2014	6	30	19	20	19.3	494.2	21.4	0	2.85	56.1	-0.61	8016.7
2014	6	30	20	18.8	18.6	98.1	26.4	0	1.58	61.4	-0.15	8016.7
2014	6	30	21	16.9	17.1	21.7	38.9	0	0.66	80.5	0.22	8020.7
2014	6	30	22	14.3	14.6	3.9	53.2	0	0.82	251.7	0.32	8022
2014	6	30	23	11.5	11.6	0.1	60.6	0	1.28	238.5	0.07	8026
2014	6	30	24	9.4	9.8	0	60.2	0	1.59	244	0.35	8027.3
2014	7	1	1	8.4	8.8	0	70.8	0	1.6	237.2	0.32	8027.3
2014	7	1	2	7.5	8.1	0	69.1	0	1.45	246.3	0.53	8027.3
2014	7	1	3	6.6	7.1	0	74.6	0	1.8	236.5	0.49	8026
2014	7	1	4	6.3	6.9	0.1	76.2	0	1.82	242.3	0.66	8023.3
2014	7	1	5	5.9	6.7	0.1	72.2	0	1.92	237.2	0.8	8022
2014	7	1	6	6	6.8	0.7	75.4	0	2.21	235.2	0.76	8018
2014	7	1	7	5.6	6.3	9.3	74.8	0	2.3	232.9	0.7	8018
2014	7	1	8	8.2	8.6	186.4	60.4	0	1.7	240	0.46	8019.3
2014	7	1	9	13.2	13.1	390.5	33.9	0	0.7	253.1	-0.08	8019.3
2014	7	1	10	17.1	16.7	571.6	29.7	0	0.89	31	-0.41	8019.3
2014	7	1	11	19.5	18.9	731	25.9	0	1.89	148.1	-0.63	8016.7
2014	7	1	12	20.7	20	863	23	0	3.38	244.7	-0.7	8014
2014	7	1	13	21.8	20.8	941	23	0	3.37	222.7	-0.98	8012.7
2014	7	1	14	22.5	21.7	974	22.2	0	3.32	249.7	-0.79	8011.3
2014	7	1	15	23.3	22.5	965	19.1	0	3.32	235.6	-0.88	8008.7
2014	7	1	16	24.1	23.2	908	19.4	0	3.32	235.3	-0.93	8006
2014	7	1	17	24.7	23.8	803	18.1	0	3.32	253.5	-0.83	8004.7
2014	7	1	18	24.9	24.1	657.5	16.6	0	2.31	235.3	-0.8	8000.7
2014	7	1	19	24.9	24.3	485.7	18	0	1.75	43.7	-0.56	7998
2014	7	1	20	23.1	23.6	67.4	21.3	0	1.5	335.3	0.52	7994
2014	7	1	21	20.9	21.5	13.7	33.9	0	1.06	254.7	0.58	7992.7
2014	7	1	22	17.4	17.6	4.1	40.7	0	1.38	236.7	0.21	7994
2014	7	1	23	15.5	15.8	0.1	49	0	1.4	236.8	0.26	7995.3
2014	7	1	24	13.1	13.7	0	55.9	0	1.84	236.9	0.6	8000.7
2014	7	2	1	12.2	12.8	0	53.2	0	1.73	241.2	0.56	8000.7
2014	7	2	2	11.2	12	0	60.9	0	1.73	240.4	0.78	7998
2014	7	2	3	10.4	11.4	0.1	61.8	0	1.75	237.4	0.98	7998
2014	7	2	4	9.9	10.8	0.1	63.9	0	1.74	237.8	0.85	7998
2014	7	2	5	9.5	10.4	0	64.7	0	1.65	237.2	0.87	7996.7
2014	7	2	6	8.8	10	0.7	64.6	0	1.52	238.9	1.16	7996.7
2014	7	2	7	8.9	9.7	11.2	66.3	0	1.42	237.7	0.82	8000.7
2014	7	2	8	10.8	11.6	182.6	50.5	0	1.13	239	0.82	8002
2014	7	2	9	15.7	15.8	396	37.6	0	0.68	244.2	0.01	7999.3
2014	7	2	10	21.2	20.7	567.7	24	0	1.34	221.2	-0.5	7999.3
2014	7	2	11	23.1	22.3	732.4	20.1	0	2.17	188.3	-0.81	7995.3
2014	7	2	12	24.5	23.7	862	19.1	0	2.05	139.1	-0.85	7992.7
2014	7	2	13	25.4	24.6	944	18.2	0	2.09	198	-0.83	7991.3
2014	7	2	14	26.1	25.3	858	17	0	3.19	242.5	-0.78	7988.7
2014	7	2	15	26.7	25.9	829	15	0	2.49	239.2	-0.76	7987.3
2014	7	2	16	27.1	26.4	778.2	16	0	3.72	247.7	-0.69	7984.7
2014	7	2	17	27.4	26.6	788.5	18.9	0	3.99	244.5	-0.76	7983.3
2014	7	2	18	26.9	26.2	491.2	16.9	0	4.47	237	-0.68	7980.7
2014	7	2	19	26.8	26.2	470.7	16.9	0	2.61	63.9	-0.59	7979.3
2014	7	2	20	26	25.7	137.8	19.1	0	2.26	54.4	-0.24	7974
2014	7	2	21	24.1	24	47.7	23.8	0	2.84	93.3	-0.12	7976.7
2014	7	2	22	22.1	22.2	2.5	31.4	0	2.31	55.1	0.19	7983.3
2014	7	2	23	19.4	19.7	0	47.4	0	2.13	135.4	0.31	7987.3
2014	7	2	24	15.5	15.9	0	54.4	0	1.93	237.1	0.38	7994

2014	7	3	1	14.6	15	0	53.9	0	1.68	239.7	0.48	7988.7
2014	7	3	2	14.6	15	0.1	52.1	0	1.46	247.7	0.41	7990
2014	7	3	3	12.7	13.1	0	68.8	0	1.33	232.6	0.43	7990
2014	7	3	4	11.8	12.2	0	63.8	0	1.7	243.6	0.49	7987.3
2014	7	3	5	11.1	11.7	0	67.9	0	1.54	241.8	0.58	7986
2014	7	3	6	10.2	10.9	0.4	71.3	0	1.79	238.5	0.76	7984.7
2014	7	3	7	10.2	10.7	11.2	71.4	0	1.64	237.6	0.56	7984.7
2014	7	3	8	11.9	12.5	171.4	57.7	0	0.88	240.7	0.6	7988.7
2014	7	3	9	15.6	15.1	371	49.1	0	1.46	102.4	-0.52	7990
2014	7	3	10	18.2	17.5	550.1	37.9	0	1.44	95.5	-0.69	7990
2014	7	3	11	22.4	21.5	712.7	26.9	0	2.27	94.7	-0.92	7990
2014	7	3	12	23.9	23.2	846	25.4	0	3.81	238.6	-0.71	7988.7
2014	7	3	13	24.8	23.9	954	24.1	0	3.38	238.6	-0.85	7991.3
2014	7	3	14	25.5	24.4	1000	22.9	0	5.28	225.8	-1.1	7991.3
2014	7	3	15	25.8	24.9	998	20.9	0	5.54	244.7	-0.85	7991.3
2014	7	3	16	26.3	25.4	944	19.7	0	5.74	247.4	-0.93	7988.7
2014	7	3	17	26.1	25.3	726.8	18.4	0	5.57	225.8	-0.86	7986
2014	7	3	18	26	25.2	637.4	16.5	0	6.08	230.9	-0.8	7983.3
2014	7	3	19	25.6	25	483.9	17.2	0	5.35	241	-0.64	7980.7
2014	7	3	20	24.1	24	78.3	19.4	0	3.15	254.6	-0.12	7982
2014	7	3	21	22.2	22.8	22.6	27.9	0	1.06	266.5	0.52	7982
2014	7	3	22	18.9	19.4	3.3	37.3	0	1.3	244.3	0.47	7984.7
2014	7	3	23	16.2	16.5	0	45.2	0	1.42	240.1	0.29	7990
2014	7	3	24	14.5	14.9	0	56.7	0	1.39	239.9	0.42	7995.3
2014	7	4	1	12.9	13.4	0	58.2	0	1.73	239.5	0.52	7996.7
2014	7	4	2	12.2	12.8	0	64	0	1.68	239.4	0.53	7999.3
2014	7	4	3	11.8	12.3	0	65.5	0	1.77	238.4	0.49	7998
2014	7	4	4	10.9	11.5	0	70.8	0	1.88	236.6	0.6	7999.3
2014	7	4	5	10.6	11.3	0	65.5	0	1.51	239.2	0.76	7999.3
2014	7	4	6	10.4	11	0.4	68.2	0	1.44	234.5	0.67	8000.7
2014	7	4	7	10.2	11.1	15.3	69.2	0	1.19	236.2	0.88	8000.7
2014	7	4	8	11.4	11.7	159.1	59.2	0	0.8	228.5	0.23	8000.7
2014	7	4	9	15.7	15.4	353.4	43	0	0.43	203.4	-0.36	8000.7
2014	7	4	10	19.9	19.2	531.5	31.8	0	1.56	71.7	-0.7	7996.7
2014	7	4	11	24	23.3	653.3	24.1	0	2.32	143.5	-0.65	7994
2014	7	4	12	25	24.4	666.9	23.2	0	3.95	214.5	-0.65	7991.3
2014	7	4	13	25.8	25	870	22.5	0	6.85	238.9	-0.72	7991.3
2014	7	4	14	26.3	25.4	960	21.4	0	6.6	227.3	-0.88	7992.7
2014	7	4	15	26.3	25.5	917	19.4	0	7.42	230.2	-0.83	7992.7
2014	7	4	16	26.6	25.8	854	19.9	0	7.38	242.6	-0.76	7994
2014	7	4	17	26	25.5	430.3	19.6	0	6.25	242.5	-0.52	7992.7
2014	7	4	18	25.2	24.7	308.2	22.3	0	5.79	240.1	-0.43	7991.3
2014	7	4	19	24.7	24.3	330.8	22.5	0	5.59	241.4	-0.44	7991.3
2014	7	4	20	23.9	23.8	94.7	24.5	0	3.27	265.1	-0.13	7990
2014	7	4	21	22.6	22.9	17.2	33.4	0	1.87	271.7	0.3	7990
2014	7	4	22	19.1	19.4	4.7	43.8	0	1	246	0.26	7991.3
2014	7	4	23	16.6	16.9	0	50.4	0	1.59	237.3	0.36	7994
2014	7	4	24	15.3	15.8	0	53.5	0	1.84	235.1	0.5	7998
2014	7	5	1	14.7	15.2	0	55.3	0	1.91	238	0.49	7996.7
2014	7	5	2	13.7	14.4	0.1	55.7	0	1.88	235.4	0.68	7998
2014	7	5	3	13.8	14.5	0.1	55.6	0	0.73	248.9	0.66	8000.7
2014	7	5	4	12.8	13.5	0	64.7	0	0.75	242.3	0.73	8003.3
2014	7	5	5	11.6	12.5	0.1	60.9	0	1.38	238.7	0.85	8007.3
2014	7	5	6	10.6	11.4	0.4	69.7	0	1.15	255.2	0.8	8011.3
2014	7	5	7	9.8	10.5	23.8	69.8	0	1.46	236.2	0.69	8014
2014	7	5	8	12	12.4	142.4	55.2	0	1.19	241.3	0.42	8020.7
2014	7	5	9	15.6	15.2	346.8	43	0	0.79	79.9	-0.33	8022
2014	7	5	10	20	19.5	504.4	26.6	0	2.83	190.4	-0.5	8023.3
2014	7	5	11	22.2	21.5	655.1	24.8	0	4.95	223.4	-0.73	8026
2014	7	5	12	22.8	22	808	22.4	0	6.02	222.6	-0.86	8028.7
2014	7	5	13	23.1	22.2	893	21.3	0	8.09	227.6	-0.87	8031.3

2014	7	5	14	23.7	22.8	934	19.5	0	7.73	233.6	-0.88	8032.7
2014	7	5	15	24.1	23	963	20.6	0	7.49	224.2	-1.12	8032.7
2014	7	5	16	24.2	23.4	856	21.7	0	5.84	239.7	-0.87	8034
2014	7	5	17	24.7	23.8	777.4	21.4	0	6.14	229.3	-0.98	8032.7
2014	7	5	18	24.8	23.9	643	20.6	0	5.4	224.4	-0.83	8031.3
2014	7	5	19	24.6	23.9	471.4	21.2	0	4.37	231.4	-0.71	8028.7
2014	7	5	20	23.1	23.1	64.1	25.5	0	2.2	256.2	-0.03	8028.7
2014	7	5	21	21.4	21.9	14.4	32.8	0	1.01	276.8	0.48	8028.7
2014	7	5	22	19	19.2	3.9	39.1	0	0.73	224.2	0.21	8030
2014	7	5	23	16.3	16.4	0	44.5	0	1.26	235.2	0.17	8035.3
2014	7	5	24	14.2	14.5	0	49.7	0	1.61	238.7	0.31	8039.3
2014	7	6	1	13	13.5	0	49.7	0	1.73	240.2	0.52	8042
2014	7	6	2	12.2	12.6	0	58.4	0	1.62	239.1	0.45	8043.3
2014	7	6	3	11.2	12	0	62.4	0	1.57	236.5	0.73	8044.7
2014	7	6	4	10.7	11.5	0	60.8	0	1.69	239	0.78	8044.7
2014	7	6	5	10.2	11.3	0	62.7	0	1.55	239.6	1.04	8043.3
2014	7	6	6	9.9	10.9	0.5	61.4	0	1.81	234.2	1.01	8042
2014	7	6	7	9.8	10.7	9.7	68.2	0	1.66	238.5	0.88	8042
2014	7	6	8	12	12.7	166.1	52.9	0	1.12	232.2	0.67	8043.3
2014	7	6	9	15	14.6	370.5	41.1	0	1.31	69.8	-0.41	8043.3
2014	7	6	10	18.9	18.2	548.2	33.3	0	1.24	84.6	-0.66	8042
2014	7	6	11	23.2	22.2	709.1	20.4	0	3.89	95.1	-1	8040.7
2014	7	6	12	24.8	24.1	842	20.6	0	5.45	230.3	-0.72	8036.7
2014	7	6	13	25.5	24.7	927	20.5	0	5.42	241.2	-0.79	8038
2014	7	6	14	25.9	25.2	961	19.6	0	5.15	243.4	-0.78	8036.7
2014	7	6	15	26.7	25.7	956	17.6	0	6.23	227.9	-1.03	8032.7
2014	7	6	16	27.1	26	901	16.3	0	6.77	218.5	-1.13	8030
2014	7	6	17	27.4	26.4	794.2	16.5	0	5.49	218.8	-1.01	8024.7
2014	7	6	18	27.2	26.4	647.4	17.5	0	4.53	224.7	-0.85	8022
2014	7	6	19	26.8	26.1	475.1	16.8	0	3.98	229.1	-0.69	8018
2014	7	6	20	25.2	25.2	64.3	21.1	0	2.93	247	-0.03	8015.3
2014	7	6	21	23.9	24.2	15.5	29.7	0	1.8	250	0.25	8015.3
2014	7	6	22	22.4	22.8	4.1	37.6	0	1.11	30.6	0.36	8016.7
2014	7	6	23	18.8	19.2	0.1	45.5	0	0.63	261	0.4	8022
2014	7	6	24	16.5	16.7	0	53	0	1.01	239.3	0.18	8026
2014	7	7	1	14.7	15	0	61.7	0	1.1	241	0.28	8027.3
2014	7	7	2	13.6	13.9	0	65.1	0	1.02	239.7	0.39	8028.7
2014	7	7	3	12.3	12.7	0	67.6	0	1.21	242	0.39	8028.7
2014	7	7	4	10.9	11.7	0	71.1	0	1.06	242.8	0.77	8028.7
2014	7	7	5	10.4	10.8	0	76.4	0	1.27	239.3	0.39	8028.7
2014	7	7	6	9.6	10.1	0.5	78.2	0	1.16	237.7	0.44	8030
2014	7	7	7	8.6	9.3	8.8	80	0	1.24	241.9	0.62	8031.3
2014	7	7	8	10.5	10.7	168.2	68	0	0.81	243	0.22	8034
2014	7	7	9	14.6	14.2	375.6	53	0	0.8	120.9	-0.43	8034
2014	7	7	10	18	17.3	557.6	38.1	0	1.29	75.5	-0.69	8032.7
2014	7	7	11	19.8	18.9	721.3	35.1	0	1.75	77.7	-0.88	8030
2014	7	7	12	21.2	20.3	859	27.6	0	1.7	65.4	-0.99	8027.3
2014	7	7	13	22.9	21.9	943	22.1	0	1.73	58.7	-1.05	8024.7
2014	7	7	14	24.6	23.3	976	20	0	2.79	78.4	-1.27	8022
2014	7	7	15	25.6	24.4	967	18.3	0	3.2	82	-1.22	8016.7
2014	7	7	16	26.4	25.1	904	19.8	0	3.62	82.9	-1.27	8014
2014	7	7	17	26.9	25.6	800	21.3	0	4.36	67.5	-1.29	8010
2014	7	7	18	27	26.1	657.2	17.2	0	3.54	230.3	-0.9	8006
2014	7	7	19	26.8	26.1	480.9	19.6	0	3.04	235.7	-0.72	8003.3
2014	7	7	20	25	25	63.5	24.4	0	1.13	289.4	-0.01	8002
2014	7	7	21	22.9	23.3	14.1	32.6	0	0.65	315.7	0.46	8002
2014	7	7	22	20	20.3	4	41.7	0	1.19	233.9	0.36	8003.3
2014	7	7	23	17.4	17.5	0.1	48	0	1.36	236	0.11	8010
2014	7	7	24	15.3	15.5	0	54.2	0	1.23	246.2	0.26	8012.7
2014	7	8	1	13.6	14.2	0	56.9	0	1.47	236.4	0.63	8015.3
2014	7	8	2	12.7	13.1	0	62.1	0	1.42	238.3	0.37	8016.7

2014	7	8	3	11.8	12.4	0	69.3	0	1.67	236.2	0.55	8016.7
2014	7	8	4	11.2	11.8	0	69.2	0	1.63	237.3	0.6	8016.7
2014	7	8	5	10.6	11.3	0.1	74.6	0	1.45	240.1	0.75	8012.7
2014	7	8	6	9.9	10.7	0.5	76.4	0	1.59	238.3	0.75	8012.7
2014	7	8	7	9.6	10.4	8.7	73.2	0	1.54	238.4	0.81	8012.7
2014	7	8	8	11.2	11.7	165.5	64.1	0	1.12	240.9	0.53	8015.3
2014	7	8	9	15.6	15.2	374	48.8	0	0.79	97.5	-0.43	8012.7
2014	7	8	10	19.2	18.4	555.4	39.8	0	1.49	73.2	-0.77	8012.7
2014	7	8	11	22.4	21.3	720	32.4	0	2.46	77.5	-1.15	8010
2014	7	8	12	24.3	23.1	852	30.3	0	3.78	55	-1.23	8007.3
2014	7	8	13	25.1	23.9	931	21.1	0	4.28	51.1	-1.25	8007.3
2014	7	8	14	27	25.4	972	18.4	0	4.73	63.8	-1.59	8006
2014	7	8	15	28	26.3	969	15.3	0	5.32	68.5	-1.69	8003.3
2014	7	8	16	28.4	27.2	911	15	0	3.05	151.1	-1.17	8000.7
2014	7	8	17	28.5	27.4	813	15.6	0	4.6	218.3	-1.14	7998
2014	7	8	18	28.5	27.5	658	18.2	0	3.55	209.7	-0.99	7995.3
2014	7	8	19	28.2	27.4	475.6	20.6	0	3.59	225.1	-0.77	7991.3
2014	7	8	20	26.5	26.4	69.1	26.7	0	1.16	235.6	-0.11	7988.7
2014	7	8	21	24.7	24.9	23.4	29.9	0	1.54	68.3	0.13	7991.3
2014	7	8	22	22.6	23.1	5.3	36.2	0	0.71	306.4	0.49	7994
2014	7	8	23	19.3	19.7	0.1	45.4	0	1.06	230.4	0.43	7999.3
2014	7	8	24	17.1	17.5	0.1	46.6	0	1.25	243.6	0.41	8003.3
2014	7	9	1	15.3	15.8	0	56.1	0	1.53	235.1	0.48	8004.7
2014	7	9	2	14.2	14.7	0	65.3	0	1.58	238.5	0.49	8004.7
2014	7	9	3	13.4	13.9	0	61.8	0	1.54	239.2	0.53	8006
2014	7	9	4	12.5	13.2	0.1	66.1	0	1.71	238	0.69	8003.3
2014	7	9	5	11.7	12.5	0	74.2	0	1.61	234.4	0.76	8002
2014	7	9	6	11.4	12	0.5	72.1	0	1.5	237.7	0.6	8000.7
2014	7	9	7	11.4	12	28.3	75	0	1.45	231.5	0.59	8002
2014	7	9	8	13.2	13.6	104.8	61.6	0	0.91	243.4	0.46	8000.7
2014	7	9	9	16.2	15.8	267.6	58.1	0	1.46	99.2	-0.38	8000.7
2014	7	9	10	18	17.4	465.9	44.6	0	1.17	87.9	-0.59	8002
2014	7	9	11	21.3	20.3	365.9	41.4	0	3.18	54.9	-0.97	8000.7
2014	7	9	12	22	21.3	401.2	34.6	0	2.09	84.7	-0.68	8000.7
2014	7	9	13	24	23.3	531.3	25.1	0	4.07	213.4	-0.75	7999.3
2014	7	9	14	22.8	22.4	219.2	34.4	0	4.39	233.4	-0.4	8000.7
2014	7	9	15	19.3	19.1	125.8	60.1	0	2.54	229.3	-0.19	8004.7
2014	7	9	16	17.8	17.5	136	52.7	0	2.66	55.8	-0.29	8010
2014	7	9	17	16.3	16.1	81.3	77	0.01	1.96	233.7	-0.19	8014
2014	7	9	18	14.3	14.1	39.3	93.2	0.06	1.06	237	-0.21	8015.3
2014	7	9	19	13.4	13.2	45.9	91.2	0.05	1.27	315.3	-0.2	8011.3
2014	7	9	20	13.8	13.6	91.1	75.7	0	1.28	245	-0.28	7996.7
2014	7	9	21	13.5	13.3	19.8	93.6	0	1.15	258	-0.12	7994
2014	7	9	22	12.2	12.1	3.7	95.9	0	1.06	232.5	-0.1	7992.7
2014	7	9	23	11	11	0.1	96.2	0	0.78	249.7	-0.08	7992.7
2014	7	9	24	10.2	10.2	0	98.6	0	0.63	246.3	0.03	7994
2014	7	10	1	9.3	9.4	0	98.1	0	1.01	242.9	0.11	7992.7
2014	7	10	2	8.9	9	0	98.9	0	1.3	239.2	0.14	7991.3
2014	7	10	3	8.5	8.7	0	97.4	0	1.31	239.8	0.22	7990
2014	7	10	4	8.3	8.6	0.1	98.5	0	1.19	244.3	0.35	7988.7
2014	7	10	5	7.9	8.3	0.1	97.3	0	1.32	236.6	0.44	7987.3
2014	7	10	6	7.7	8.2	0.4	99.3	0	0.99	243.7	0.5	7987.3
2014	7	10	7	7.4	8.2	9.1	98.1	0	1.32	237.9	0.71	7988.7
2014	7	10	8	8.9	9.3	164.5	89	0	0.91	237.2	0.42	7991.3
2014	7	10	9	12.3	12.1	341.7	79	0	0.47	97.1	-0.24	7991.3
2014	7	10	10	15.5	14.9	519.2	62.2	0	1.41	70.7	-0.6	7991.3
2014	7	10	11	19.1	18.4	703.2	40.6	0	1.57	75.4	-0.7	7990
2014	7	10	12	21.9	21.2	845	29.4	0	3.91	219.7	-0.7	7988.7
2014	7	10	13	22.9	22.1	927	26.8	0	3.57	223.2	-0.78	7986
2014	7	10	14	23.7	22.9	929	26.1	0	4.86	233	-0.8	7983.3
2014	7	10	15	24.5	23.5	959	21.9	0	5.09	225	-0.96	7979.3

2014	7	10	16	24.7	23.9	856	23.3	0	4.95	229.5	-0.85	7976.7
2014	7	10	17	25.3	24.5	803	23	0	5.16	223.6	-0.86	7974
2014	7	10	18	25.3	24.6	593.1	19.2	0	4.97	235.6	-0.79	7971.3
2014	7	10	19	25.3	24.6	471.8	21.6	0	3.41	248.6	-0.64	7970
2014	7	10	20	23.7	23.7	64.9	22	0	2.47	266.8	0.04	7970
2014	7	10	21	21.7	22.3	14.9	38	0	1.34	261.8	0.52	7974
2014	7	10	22	18.1	18.3	3.9	45.9	0	1.51	238.3	0.26	7976.7
2014	7	10	23	16.5	16.7	0	51.4	0	1.13	243.1	0.14	7984.7
2014	7	10	24	14.3	14.7	0	66.6	0	1.69	241.1	0.48	7988.7
2014	7	11	1	12.9	13.4	0	59.4	0	1.7	237.3	0.5	7990
2014	7	11	2	12	12.6	0	60.9	0	1.53	239.6	0.6	7991.3
2014	7	11	3	11.2	11.9	0	57.4	0	1.59	244.2	0.75	7991.3
2014	7	11	4	9.9	11.4	0	66.9	0	1.4	241.5	1.44	7992.7
2014	7	11	5	9.6	10.6	0	78.7	0	1.43	240.6	1	7994
2014	7	11	6	9.1	10.2	0.3	74.3	0	1.7	237.8	1.17	7995.3
2014	7	11	7	9	9.8	8.9	79	0	1.72	237.9	0.82	7998
2014	7	11	8	10.9	11.8	156.5	64.6	0	1.13	237.6	0.89	8000.7
2014	7	11	9	15.3	15.1	364	50.4	0	0.56	208.4	-0.22	8002
2014	7	11	10	18.4	17.5	542.7	39.1	0	2.26	76.7	-0.92	8002
2014	7	11	11	22.4	21.3	703.4	21.8	0	2.66	75.2	-1.09	8000.7
2014	7	11	12	24.7	23.6	841	20.8	0	3.7	54.2	-1.19	8000.7
2014	7	11	13	25.4	24.4	921	21.5	0	3.26	164.1	-0.95	8000.7
2014	7	11	14	26.1	25	967	19.2	0	4.51	222.3	-1.07	8002
2014	7	11	15	26.5	25.3	957	19.7	0	4.79	222.7	-1.17	8000.7
2014	7	11	16	26.7	25.7	912	17.5	0	3.56	222.8	-0.94	7999.3
2014	7	11	17	26.8	25.9	502.1	18.8	0	2.94	184.1	-0.84	7996.7
2014	7	11	18	27	26.1	567	19.3	0	3.24	208.9	-0.83	7995.3
2014	7	11	19	26.5	25.7	460	20.1	0	4.39	219.1	-0.73	7996.7
2014	7	11	20	25	24.6	105.5	22.8	0	3.7	223.7	-0.32	7998
2014	7	11	21	23.4	23.4	39	25.5	0	1.28	255.4	-0.02	8000.7
2014	7	11	22	21.6	21.9	2.8	32.3	0	0.83	307.8	0.3	8006
2014	7	11	23	19.5	19.9	0	42.8	0	0.79	233.2	0.37	8015.3
2014	7	11	24	17.7	18	0	43.9	0	1.05	261.7	0.26	8018
2014	7	12	1	17.1	17.3	0	49.9	0	1.38	266	0.27	8022
2014	7	12	2	15.8	16.1	0	46.3	0	1.52	244	0.29	8026
2014	7	12	3	14.4	14.7	0	48.4	0	1.02	244.6	0.35	8028.7
2014	7	12	4	13.3	13.6	0.1	57	0	1.25	242	0.28	8027.3
2014	7	12	5	12.4	12.8	0.1	58.5	0	1.37	237.5	0.39	8030
2014	7	12	6	11.4	12	0.4	53.3	0	1.65	238.5	0.54	8032.7
2014	7	12	7	11.7	12.2	13.2	56	0	1.28	245.8	0.51	8034
2014	7	12	8	11.7	12.1	120.1	48.7	0	1.06	247.3	0.41	8038
2014	7	12	9	14.5	14.4	101.3	56.3	0	0.64	7	-0.07	8043.3
2014	7	12	10	17.2	16.7	392.7	31.5	0	0.59	208.6	-0.51	8046
2014	7	12	11	19.9	19.4	472.8	23.4	0	0.67	170.3	-0.52	8047.3
2014	7	12	12	24	23	893	19.9	0	2.65	65.1	-0.99	8044.7
2014	7	12	13	25.3	23.8	1047	16.1	0	4.76	51.2	-1.48	8046
2014	7	12	14	25.8	24.4	932	20.3	0	5.38	50.1	-1.39	8046
2014	7	12	15	26	25	834	19.2	0	3.39	114	-1.09	8046
2014	7	12	16	26.8	25.6	956	17.8	0	2.86	80.9	-1.2	8044.7
2014	7	12	17	27.2	26.1	801	18.5	0	2.93	97.7	-1.06	8042
2014	7	12	18	27.1	26.2	534.6	16.9	0	2.83	71	-0.92	8039.3
2014	7	12	19	26.9	26.2	336.7	19.7	0	3.16	164.8	-0.71	8036.7
2014	7	12	20	25.7	25.6	83.5	22.8	0	1.08	186.7	-0.09	8036.7
2014	7	12	21	24	24.3	22.7	27.6	0	1.03	244.6	0.29	8038
2014	7	12	22	21.1	21.4	4.4	38.3	0	1.06	228.5	0.37	8040.7
2014	7	12	23	19.2	19.6	0.1	44.9	0	0.88	239.9	0.39	8047.3
2014	7	12	24	17.1	17.5	0	47.7	0	1.53	246.5	0.41	8054
2014	7	13	1	15.6	16	0	55.4	0	1.27	245.4	0.41	8058
2014	7	13	2	14.2	14.8	0	55.1	0	1.42	241	0.58	8059.3
2014	7	13	3	13.2	14	0	57.9	0	1.41	240.7	0.74	8059.3
2014	7	13	4	12.6	13.3	0.1	59.9	0	1.74	235.7	0.67	8056.7

2014	7	13	5	11.9	12.8	0	63.7	0	1.65	235.6	0.89	8056.7
2014	7	13	6	11.6	12.5	0.3	70.7	0	1.31	243.6	0.9	8058
2014	7	13	7	11	12.2	10.2	62.8	0	1.44	241	1.19	8062
2014	7	13	8	12.5	13	145.7	55.5	0	1.11	235.7	0.44	8063.3
2014	7	13	9	17	16.7	353.6	42.2	0	0.71	188.7	-0.3	8063.3
2014	7	13	10	20.7	20	530.9	32.9	0	1.66	81.1	-0.72	8062
2014	7	13	11	23.1	22.1	561.6	31.1	0	2.3	78.6	-1.05	8059.3
2014	7	13	12	25.1	23.9	710.1	21.8	0	3.02	53.9	-1.17	8058
2014	7	13	13	26	24.9	783.8	20.8	0	3.41	101.7	-1.11	8056.7
2014	7	13	14	26.6	25.5	904	19.9	0	3.86	181	-1.05	8056.7
2014	7	13	15	27.4	26.3	902	18	0	2.86	123.5	-1.05	8052.7
2014	7	13	16	27.8	26.5	820	18.3	0	3.96	68.4	-1.29	8048.7
2014	7	13	17	27.8	26.8	724.1	17.9	0	3.59	72	-0.99	8044.7
2014	7	13	18	27.9	27.1	585	16	0	2.86	65	-0.81	8039.3
2014	7	13	19	27.7	27.2	331.7	16.7	0	1.9	75.2	-0.53	8036.7
2014	7	13	20	27	26.7	123.7	22.1	0	2.18	76.6	-0.26	8031.3
2014	7	13	21	25.2	25.3	47.4	30.7	0	1.2	46.5	0.12	8032.7
2014	7	13	22	22.3	22.5	4.6	39.4	0	1.2	255.5	0.13	8035.3
2014	7	13	23	20.1	20.4	0.1	43.3	0	1.43	246.9	0.25	8040.7
2014	7	13	24	20.4	20.9	0.1	41.5	0	1.93	243.9	0.56	8038
2014	7	14	1	20	20.2	0.1	44.7	0	1.64	357.7	0.23	8039.3
2014	7	14	2	19.7	20.1	0	40.4	0	1.59	267.4	0.4	8047.3
2014	7	14	3	17.2	17.7	0	43.5	0	1.43	243.9	0.55	8032.7
2014	7	14	4	16.4	16.9	0	43.6	0	2.12	227.9	0.47	8028.7
2014	7	14	5	16.8	17.3	0	54	0	2.06	248.5	0.53	8032.7
2014	7	14	6	15.8	16.4	0.1	55.8	0	2.14	34	0.59	8038
2014	7	14	7	14.2	14.8	10.1	63.2	0	2.66	236.6	0.62	8031.3
2014	7	14	8	16.1	16.6	95.1	50.1	0	2.56	276.7	0.43	8031.3
2014	7	14	9	18.2	18.2	160.6	45.9	0	2.65	257.6	0.02	8036.7
2014	7	14	10	21	20.5	493.7	34	0	1.69	62.9	-0.49	8035.3
2014	7	14	11	22.8	22.1	532	32.7	0	2.83	53.7	-0.72	8030
2014	7	14	12	24.7	23.6	821	29.6	0	3.06	73.3	-1.09	8024.7
2014	7	14	13	26.5	25.5	906	25.7	0	3.63	94.2	-1.06	8019.3
2014	7	14	14	27.9	27	721.8	25.6	0	2.53	215	-0.9	8008.7
2014	7	14	15	28.8	28	838	25.4	0	5.74	242.6	-0.77	8002
2014	7	14	16	29.2	28.3	908	23.7	0	7.31	243.1	-0.89	8000.7
2014	7	14	17	28.9	28.1	798.6	22.1	0	6.42	233.5	-0.81	8000.7
2014	7	14	18	28.5	27.7	571.4	21.4	0	5.23	236	-0.78	7999.3
2014	7	14	19	28.3	27.6	483.9	21.2	0	5.33	230.6	-0.72	7996.7
2014	7	14	20	26.8	26.6	68.7	24.8	0	2.67	245.8	-0.17	7996.7
2014	7	14	21	24.6	24.6	19.4	41.3	0	2.53	203.2	-0.06	7996.7
2014	7	14	22	22.6	22.5	4.5	48	0	3.04	102.9	-0.03	8003.3
2014	7	14	23	20.6	20.7	0	53.4	0	1.09	141.4	0.08	8008.7
2014	7	14	24	18.8	19	0	59.4	0	0.65	240.5	0.24	8014
2014	7	15	1	16.7	16.9	0.1	66.4	0	0.74	271.4	0.19	8018
2014	7	15	2	14.9	15.1	0.1	70.6	0	1.38	241.2	0.21	8019.3
2014	7	15	3	13.7	14	0	73	0	1.44	237.9	0.25	8019.3
2014	7	15	4	12.8	13.2	0	73.2	0	1.37	239.3	0.39	8019.3
2014	7	15	5	12	12.4	0	72.4	0	1.42	239.7	0.32	8018
2014	7	15	6	11.2	11.7	0.1	74.5	0	1.3	239.2	0.44	8019.3
2014	7	15	7	10.5	11.1	10.3	76.4	0	1.41	236.9	0.63	8019.3
2014	7	15	8	11.8	12	137.6	64.2	0	0.93	232.4	0.2	8020.7
2014	7	15	9	15.6	15.1	336.9	51.7	0	1.34	70.6	-0.54	8023.3
2014	7	15	10	19.3	18.5	520.6	35.2	0	3.19	101.5	-0.77	8022
2014	7	15	11	20.2	19.3	627.9	33.7	0	6.94	216	-0.86	8019.3
2014	7	15	12	20.8	19.9	786.1	35.3	0	5.38	220.9	-0.91	8016.7
2014	7	15	13	21.4	20.3	702	33.6	0	4.52	87.2	-1.11	8016.7
2014	7	15	14	22	20.9	669.7	31.8	0	3.68	89.6	-1.11	8014
2014	7	15	15	23	22	690	32	0	3.44	122.7	-1.03	8011.3
2014	7	15	16	23.3	22.3	833	31	0	4.78	209.4	-1	8008.7
2014	7	15	17	23.7	22.6	761.2	33.7	0	5.35	212.6	-1.09	8004.7

2014	7	15	18	23.1	22.3	522.4	32.8	0	3.58	199.3	-0.8	8003.3
2014	7	15	19	22.9	22.1	468.5	32.4	0	3.9	70.8	-0.72	8003.3
2014	7	15	20	21.6	21.2	95.9	40.3	0	3.02	206.4	-0.37	8002
2014	7	15	21	20.2	20.1	23.8	43.8	0	3.79	86.3	-0.17	8006
2014	7	15	22	19.4	19.3	3	43.5	0	4.67	84.6	-0.09	8006
2014	7	15	23	17.9	18	0.1	51.6	0	3.19	84.6	0.01	8011.3
2014	7	15	24	15.8	15.9	0	59.7	0	0.55	311.4	0.17	8016.7
2014	7	16	1	13.7	13.9	0	68.3	0	1.3	240.3	0.15	8018
2014	7	16	2	12.7	12.9	0	72.2	0	1.35	245.2	0.21	8019.3
2014	7	16	3	11.8	12	0	76	0	1.16	246.7	0.26	8019.3
2014	7	16	4	10.5	11	0	82.8	0	1.29	247.2	0.49	8019.3
2014	7	16	5	10.1	10.4	0	83.6	0	1.49	238.3	0.26	8019.3
2014	7	16	6	9.6	10	0.1	87.8	0	1.44	242.2	0.37	8020.7
2014	7	16	7	9.1	9.8	17.8	85.6	0	1.58	243	0.69	8022
2014	7	16	8	10.7	11	139	74.1	0	0.82	244.6	0.35	8022
2014	7	16	9	14.7	14.2	324.2	58.7	0	0.61	206.3	-0.45	8022
2014	7	16	10	18.3	17.6	502.8	44.3	0	1.19	94.3	-0.63	8022
2014	7	16	11	21.1	20.1	655.2	37.5	0	3.18	80.7	-1.02	8019.3
2014	7	16	12	22.4	21.1	794.8	32.3	0	4.55	74.8	-1.29	8019.3
2014	7	16	13	23.2	22	853	26.7	0	4.35	76.4	-1.21	8018
2014	7	16	14	24	22.7	900	28.2	0	3.53	75.8	-1.3	8016.7
2014	7	16	15	24.6	23.3	870	27.8	0	3.62	84.6	-1.33	8012.7
2014	7	16	16	24.4	23.5	451.4	26.3	0	2.7	86.4	-0.83	8008.7
2014	7	16	17	25.1	24.2	510.1	26.9	0	3.26	88.1	-0.89	8004.7
2014	7	16	18	24.9	24.1	449.9	25.6	0	4.18	78.9	-0.79	8003.3
2014	7	16	19	24.7	24.1	386.8	27.8	0	3.24	80.1	-0.63	7998
2014	7	16	20	23.9	23.6	114.7	32.3	0	4.24	64.1	-0.32	7994
2014	7	16	21	22.6	22.5	39.3	38.9	0	3.94	80.4	-0.14	7995.3
2014	7	16	22	20.4	20.6	4.3	45	0	1.04	132.8	0.18	7996.7
2014	7	16	23	18.1	18.5	0.1	54.4	0	1.33	279.3	0.33	8002
2014	7	16	24	15.7	15.8	0	55.1	0	1.53	238.7	0.15	8006
2014	7	17	1	14	14.2	0	60.7	0	1.57	236.8	0.23	8006
2014	7	17	2	12.6	13	0	64.5	0	1.86	235.4	0.41	8006
2014	7	17	3	11.9	12.3	0	63.2	0	1.64	240.1	0.41	8006
2014	7	17	4	11.1	11.8	0	69.9	0	1.58	237.3	0.69	8003.3
2014	7	17	5	10.6	11.4	0.1	66.8	0	1.73	236	0.84	8003.3
2014	7	17	6	10.2	10.9	0.2	70.9	0	1.65	237.1	0.75	8000.7
2014	7	17	7	10.2	11	11.1	69.4	0	1.34	239.7	0.78	7998
2014	7	17	8	10.7	11.3	127.5	61.3	0	1.03	239	0.59	8000.7
2014	7	17	9	15.1	14.7	321	43.1	0	0.55	207.6	-0.41	8000.7
2014	7	17	10	18.9	18.2	472.4	35.8	0	1.36	80.4	-0.66	7998
2014	7	17	11	22	21	624.6	26	0	2.19	79.5	-1	7996.7
2014	7	17	12	24.2	23.3	733.1	23.7	0	5.16	220.9	-0.88	7992.7
2014	7	17	13	24.7	23.8	817	25.6	0	5.61	216.3	-0.95	7990
2014	7	17	14	25.4	24.3	1003	23.3	0	7.24	226.1	-1.11	7988.7
2014	7	17	15	25.9	24.7	859	23.9	0	7.82	221.8	-1.2	7984.7
2014	7	17	16	25.8	24.8	678.3	24.1	0	7.7	227.1	-0.99	7982
2014	7	17	17	25.8	25	660.2	23.4	0	7.98	227.6	-0.84	7978
2014	7	17	18	25.7	25	544.2	22.8	0	6.27	227.3	-0.78	7972.7
2014	7	17	19	25.6	24.9	413.7	21.1	0	6.62	225.5	-0.72	7970
2014	7	17	20	24.5	24.3	71.1	17.9	0	3.8	240.3	-0.17	7968.7
2014	7	17	21	23	23.4	42.2	17.9	0	1.27	276.3	0.37	7970
2014	7	17	22	20.1	20.7	6.7	28.2	0	1.45	246.5	0.52	7970
2014	7	17	23	16.8	17.3	0	36.1	0	1.11	236.9	0.5	7972.7
2014	7	17	24	15	15.4	0	39.9	0	1.46	241.2	0.43	7976.7
2014	7	18	1	13.6	14.1	0	48.1	0	1.32	244.3	0.44	7980.7
2014	7	18	2	11.8	12.8	0	49.7	0	1.62	237.5	1	7983.3
2014	7	18	3	11.3	12	0	51.5	0	1.54	243.9	0.67	7983.3
2014	7	18	4	10.6	11.2	0	60.8	0	1.65	238.3	0.59	7982
2014	7	18	5	9.7	10.6	0	59.8	0	1.54	243.5	0.85	7980.7
2014	7	18	6	8.9	9.8	0.1	66.5	0	1.19	244.5	0.93	7982

2014	7	18	7	8.2	9.3	12.4	67.9	0	1.44	234.4	1.03	7984.7
2014	7	18	8	9.4	10.1	126.9	57.3	0	1.22	238.2	0.68	7986
2014	7	18	9	13.4	13.2	326.3	43	0	0.57	109.1	-0.24	7986
2014	7	18	10	17.1	16.2	516.8	30.3	0	2.32	80	-0.89	7986
2014	7	18	11	21.1	20	687	19.2	0	3.2	101.3	-1.07	7987.3
2014	7	18	12	22.1	21.3	659.4	17.5	0	4.76	223.1	-0.83	7984.7
2014	7	18	13	22.9	22.1	875	15.4	0	4.32	233.5	-0.8	7986
2014	7	18	14	24	22.9	949	14.5	0	4.53	218.6	-1.15	7984.7
2014	7	18	15	24.7	23.5	937	17.2	0	5.15	216.7	-1.18	7984.7
2014	7	18	16	24.8	23.8	740	15.1	0	5.09	224.4	-1.02	7983.3
2014	7	18	17	25.3	24.2	783.6	18.3	0	5.13	213.9	-1.09	7984.7
2014	7	18	18	25.2	24.3	555.9	18.8	0	4.13	228.4	-0.93	7982
2014	7	18	19	24.9	24.1	459.3	17	0	3.83	221.3	-0.73	7980.7
2014	7	18	20	23.2	22.9	100.1	20.5	0	3.33	219.9	-0.3	7980.7
2014	7	18	21	21.7	21.6	48.7	24.7	0	2.5	227.7	-0.12	7983.3
2014	7	18	22	19.6	19.8	2.5	30.2	0	0.97	257.8	0.22	7987.3
2014	7	18	23	16.5	16.6	0	37.1	0	1.01	241.4	0.08	7991.3
2014	7	18	24	14.2	14.4	0	45.1	0	1.19	239.5	0.21	7995.3
2014	7	19	1	12.4	12.7	0	49	0	1.46	240.1	0.34	7996.7
2014	7	19	2	11.7	12	0	48.7	0	1.47	238.2	0.34	7998
2014	7	19	3	11	11.5	0	58.2	0	1.27	243.9	0.44	7995.3
2014	7	19	4	9.9	10.4	0	62.5	0	1.34	242.7	0.51	7996.7
2014	7	19	5	9	9.6	0	63.8	0	1.34	239.6	0.59	7996.7
2014	7	19	6	8.4	9.1	0.1	63.8	0	1.44	243	0.71	7996.7
2014	7	19	7	8.4	8.8	7.5	60.6	0	1.47	247.2	0.37	7995.3
2014	7	19	8	8.8	9.1	129.3	55.6	0	0.65	250.1	0.39	7996.7
2014	7	19	9	12.9	12.4	348.5	39.4	0	0.7	118.5	-0.46	7996.7
2014	7	19	10	16.7	15.9	456.3	33.9	0	1.5	75.1	-0.74	7999.3
2014	7	19	11	19.6	18.3	669.2	29.4	0	3.09	75.1	-1.24	7998
2014	7	19	12	20.6	19.7	821	29.3	0	3.11	221.6	-0.93	7999.3
2014	7	19	13	21.7	20.5	839	29.7	0	4.47	220.2	-1.11	7998
2014	7	19	14	22.6	21.3	941	27.3	0	5.54	223.8	-1.25	7996.7
2014	7	19	15	23.5	22.2	937	26.1	0	4.37	214.5	-1.24	7994
2014	7	19	16	24.1	22.9	891	27.5	0	5.32	230.7	-1.2	7992.7
2014	7	19	17	24.3	23.2	785.9	27.4	0	6.22	224.9	-1.19	7987.3
2014	7	19	18	24.1	23	606.3	27.4	0	6.38	227.4	-1.08	7988.7
2014	7	19	19	23.6	22.9	419.8	26.5	0	3.55	216.4	-0.74	7987.3
2014	7	19	20	22.5	22.2	51.1	30.2	0	2.93	233.2	-0.26	7984.7
2014	7	19	21	21.2	21.4	15.5	31.5	0	1.64	259.1	0.12	7984.7
2014	7	19	22	19	19.4	3.5	44.6	0	1.57	241.3	0.36	7983.3
2014	7	19	23	16	16.1	0	50.5	0	1.35	230	0.11	7986
2014	7	19	24	14.7	14.9	0	55.4	0	1.15	247.2	0.19	7988.7
2014	7	20	1	13.1	13.2	0	56.6	0	1.39	239	0.17	7988.7
2014	7	20	2	12.3	12.4	0.1	59.3	0	1.42	241.1	0.15	7987.3
2014	7	20	3	11.3	11.8	0	65.6	0	1.5	239.1	0.46	7987.3
2014	7	20	4	10.2	11	0	69.3	0	1.42	238.6	0.84	7984.7
2014	7	20	5	9.6	10.3	0	67.4	0	1.73	236.1	0.69	7982
2014	7	20	6	8.9	9.4	0.1	70.8	0	1.63	237.9	0.56	7982
2014	7	20	7	8.3	8.9	9.1	68.5	0	1.71	240.7	0.61	7982
2014	7	20	8	9.1	9.6	121.2	59.3	0	0.88	238.3	0.55	7983.3
2014	7	20	9	13.8	13.7	323.3	33.6	0	1.3	235.6	-0.1	7983.3
2014	7	20	10	19.1	18.5	517.4	26.3	0	4.48	223.4	-0.54	7980.7
2014	7	20	11	20.4	19.8	693.6	22.1	0	5.66	239.2	-0.63	7979.3
2014	7	20	12	21.4	20.5	828	24.1	0	6	228.3	-0.86	7979.3
2014	7	20	13	22.2	21.2	905	26.4	0	6.33	221.9	-1.03	7979.3
2014	7	20	14	22.9	21.9	928	25	0	6.27	237.6	-0.99	7976.7
2014	7	20	15	23.6	22.6	914	25	0	6.4	233.4	-1.01	7972.7
2014	7	20	16	24.3	23.3	821	22.3	0	6.26	239.3	-0.96	7968.7
2014	7	20	17	24.4	23.5	756.3	23.8	0	7.07	238.1	-0.86	7963.3
2014	7	20	18	24.3	23.6	573.9	23.8	0	7.7	232.6	-0.78	7958
2014	7	20	19	24.2	23.6	402.3	25.1	0	6.39	240.1	-0.63	7955.3

2014	7	20	20	23.3	23	101	28.8	0	4.54	244.4	-0.32	7951.3
2014	7	20	21	22.6	22.5	44.6	32.4	0	2.88	229.1	-0.15	7951.3
2014	7	20	22	20.7	20.9	3.1	39.4	0	1.08	237.8	0.16	7948.7
2014	7	20	23	17.5	17.8	0	44.9	0	1.31	242.6	0.33	7948.7
2014	7	20	24	18.2	18.4	0	40.6	0	4.59	248.6	0.26	7947.3
2014	7	21	1	18.9	18.8	0.1	43	0	7.2	247.2	-0.14	7955.3
2014	7	21	2	18.1	18	0.1	49.5	0	4.04	224.7	-0.12	7963.3
2014	7	21	3	17.4	17.3	0	52.8	0	3.24	229.4	-0.12	7962
2014	7	21	4	15.9	16.1	0.1	60.2	0	2.54	232.7	0.14	7960.7
2014	7	21	5	16	16.1	0.1	58.2	0	4.22	242.2	0.05	7958
2014	7	21	6	15.8	15.7	0.1	62.7	0	4.97	241.7	-0.1	7959.3
2014	7	21	7	15.7	15.5	9.4	63.5	0	6.51	229.7	-0.13	7964.7
2014	7	21	8	15.6	15.4	69.8	63.3	0	5.92	216.4	-0.22	7970
2014	7	21	9	15.8	15.4	180.1	61.4	0	6.04	225.9	-0.38	7976.7
2014	7	21	10	15.8	15.4	237.8	54.7	0	7.36	231.4	-0.4	7984.7
2014	7	21	11	16.9	16.3	468.1	49.7	0	5.18	233.8	-0.6	7987.3
2014	7	21	12	16.9	16.5	314.9	48.3	0	6.16	248.7	-0.43	7990
2014	7	21	13	17.6	17	394	45.5	0	5.13	233.6	-0.6	7994
2014	7	21	14	17.8	17.2	390.2	46.4	0	5.5	239.2	-0.61	7996.7
2014	7	21	15	17.6	17.1	312.3	45.9	0	6.57	236.8	-0.53	7999.3
2014	7	21	16	17.9	17.4	374.4	42.3	0	5.15	246.8	-0.54	8002
2014	7	21	17	19.1	18.3	652.6	36.4	0	5.22	234.4	-0.83	8002
2014	7	21	18	19.3	18.6	416.1	35.9	0	5.17	238.5	-0.69	8000.7
2014	7	21	19	18.8	18.2	243.2	37.8	0	4.3	232.5	-0.54	7999.3
2014	7	21	20	18.2	17.9	89.9	41.7	0	3.05	249.7	-0.32	8000.7
2014	7	21	21	17.5	17.4	38.7	44.3	0	1.97	267.8	-0.12	8003.3
2014	7	21	22	16	16.1	2.3	52.5	0	1	257.4	0.1	8006
2014	7	21	23	15	15.1	0.1	57.5	0	0.54	244.8	0.14	8010
2014	7	21	24	14.4	14.5	0.1	60.9	0	0.74	250.1	0.09	8015.3
2014	7	22	1	14.5	14.7	0.1	61.6	0	0.79	243.3	0.2	8018
2014	7	22	2	14.5	14.7	0.1	66.7	0	1.45	246.5	0.17	8022
2014	7	22	3	13.6	13.9	0.1	72.5	0	0.55	47.3	0.28	8023.3
2014	7	22	4	12.9	13.2	0.1	75	0	0.54	255.8	0.3	8026
2014	7	22	5	13.2	13.3	0.1	76.3	0	0.65	260.8	0.11	8023.3
2014	7	22	6	12.6	12.8	0.1	80.3	0	0.7	252.3	0.17	8023.3
2014	7	22	7	11.3	11.5	8	81.8	0	1.45	239.2	0.26	8027.3
2014	7	22	8	10.9	11.1	112.8	72.4	0	1.15	239.9	0.19	8027.3
2014	7	22	9	15.2	14.8	328.4	51.8	0	1.1	220.2	-0.36	8031.3
2014	7	22	10	18	17.4	505.1	43.9	0	1.92	152.8	-0.62	8032.7
2014	7	22	11	19.5	18.8	575.4	41	0	5.17	234.5	-0.68	8032.7
2014	7	22	12	19.6	19.1	471.4	34.8	0	6.08	243	-0.56	8036.7
2014	7	22	13	20.5	19.8	577.4	39.4	0	4.92	218.8	-0.74	8039.3
2014	7	22	14	21.2	20.4	756.3	34	0	5.05	232.9	-0.81	8039.3
2014	7	22	15	22.5	21.5	938	31.4	0	6.65	241.8	-0.96	8038
2014	7	22	16	22.7	22	520.3	31.6	0	5.5	230	-0.75	8038
2014	7	22	17	22.7	22	471.9	33.7	0	5.29	245.7	-0.63	8036.7
2014	7	22	18	22.2	21.7	290.4	32.3	0	4.32	246.3	-0.46	8039.3
2014	7	22	19	22.7	22.2	336.7	30.5	0	2.59	259.2	-0.56	8032.7
2014	7	22	20	22.3	22	114.6	28.8	0	2.25	252.1	-0.3	8027.3
2014	7	22	21	21.6	21.7	48.9	33.1	0	1.33	239.5	0.03	8024.7
2014	7	22	22	19.3	19.6	1.9	40	0	0.82	125.5	0.26	8027.3
2014	7	22	23	17.5	17.5	0	51	0	0.68	240.9	0.03	8028.7
2014	7	22	24	16.1	16.2	0	46.6	0	1.55	254.8	0.11	8022
2014	7	23	1	17.6	17.7	0.1	51.8	0	4.51	236.1	0.06	8020.7
2014	7	23	2	13.6	13.8	0.1	81.8	0.16	2.07	332.9	0.16	8046
2014	7	23	3	12	11.9	0	94.6	0	2.38	269.1	-0.04	8032.7
2014	7	23	4	11.3	11.1	0	95.5	0	1.42	40	-0.19	8035.3
2014	7	23	5	11.3	11.1	0	95.4	0.04	2.17	38.4	-0.14	8047.3
2014	7	23	6	11	10.9	0	97.9	0	1.29	7.9	-0.15	8044.7
2014	7	23	7	11	11	15.7	81.1	0	2.48	235.5	-0.02	8030
2014	7	23	8	11.9	11.9	28.6	88.6	0	2.47	207.3	-0.01	8028.7

2014	7	23	9	13.4	13.2	268.7	71.2	0	2.23	229.9	-0.28	8026
2014	7	23	10	14.9	14.6	384	61.1	0	2.65	235	-0.35	8032.7
2014	7	23	11	16.8	16.4	587.6	54.9	0	2.98	264.6	-0.46	8023.3
2014	7	23	12	19.1	18.5	746.2	53	0	3.26	225.8	-0.59	8018
2014	7	23	13	20.8	20.2	897	40.9	0	3.11	222.6	-0.58	8015.3
2014	7	23	14	22.4	21.7	769.1	29.2	0	3.28	205.8	-0.67	8010
2014	7	23	15	23.7	23.1	802	26.5	0	4.84	209.9	-0.65	8002
2014	7	23	16	24.2	23.5	696.8	30.8	0	5.97	219.7	-0.69	8002
2014	7	23	17	22.8	22.4	558.3	49.8	0.06	6.65	253.7	-0.47	7996.7
2014	7	23	18	18.8	18.7	327.9	30.9	0	2.57	227.1	-0.17	7996.7
2014	7	23	19	22.2	22.1	190.6	32.4	0	4.32	237.9	-0.13	7984.7
2014	7	23	20	21.3	21.3	54.5	34.2	0	4.98	253.9	-0.03	7984.7
2014	7	23	21	20.2	20.3	21.7	41.9	0	2.22	253.1	0.13	7983.3
2014	7	23	22	17.1	17.7	2.9	54.3	0	0.68	235	0.58	7982
2014	7	23	23	14.7	15.4	0.1	63.1	0	0.87	235.6	0.7	7986
2014	7	23	24	14	14.7	0.1	64.8	0	0.65	241	0.65	7984.7
2014	7	24	1	12.9	13.5	0	60.1	0	1.13	244.7	0.65	7983.3
2014	7	24	2	12	12.5	0	67.3	0	0.95	248	0.51	7982
2014	7	24	3	10.8	11.3	0	71.4	0	0.71	193.5	0.49	7980.7
2014	7	24	4	9.5	10.1	0	80.1	0	0.77	19.9	0.59	7983.3
2014	7	24	5	8	8.8	0.1	89.2	0	0.53	264	0.8	7987.3
2014	7	24	6	7.5	7.9	0.1	87.7	0	0.75	298.6	0.44	7990
2014	7	24	7	7.7	8.3	10.4	81.9	0	1.14	266.2	0.65	7991.3
2014	7	24	8	10.2	10.6	38.4	60.2	0	1.49	253.8	0.42	7990
2014	7	24	9	11.4	11.3	192.3	45.2	0	4.45	229.8	-0.13	7994
2014	7	24	10	12	11.6	531.5	38.3	0	7.61	234.3	-0.38	7996.7
2014	7	24	11	12.3	11.7	697.9	31	0	6.85	230.4	-0.6	8000.7
2014	7	24	12	12.6	11.8	842	25.4	0	6.47	227	-0.81	8008.7
2014	7	24	13	13.8	12.7	930	23.6	0	5.32	218	-1.1	8010
2014	7	24	14	14.5	13.4	962	25.9	0	5.71	224.2	-1.06	8010
2014	7	24	15	15.3	14.3	953	26.1	0	4.86	228.4	-1.03	8014
2014	7	24	16	16.6	15.5	902	19.2	0	4.4	219.4	-1.06	8010
2014	7	24	17	17.5	16.6	795	16.2	0	3.48	222	-0.92	8006
2014	7	24	18	17.6	16.8	645.9	17.2	0	3.96	230.3	-0.84	8003.3
2014	7	24	19	17.6	16.8	467	18.5	0	4.51	224	-0.79	8000.7
2014	7	24	20	16	15.8	37.6	25.7	0	2.42	254.2	-0.15	7998
2014	7	24	21	14.7	14.8	12.7	30.3	0	1.41	256.9	0.13	7999.3
2014	7	24	22	13	13.2	2.2	29.5	0	1.67	240.7	0.21	8003.3
2014	7	24	23	11	11.3	0	47.7	0	1.13	251.7	0.39	8008.7
2014	7	24	24	8.2	8.4	0	60.4	0	1.04	242.1	0.23	8010
2014	7	25	1	6.5	6.8	0	60.6	0	1.3	248.2	0.27	8008.7
2014	7	25	2	5.3	5.7	0	71	0	1.2	242.8	0.36	8010
2014	7	25	3	4.4	4.8	0	74.4	0	1.58	238	0.3	8008.7
2014	7	25	4	4.1	4.4	0	71.9	0	1.33	240	0.29	8004.7
2014	7	25	5	3.1	3.6	0	79.5	0	1.17	238.2	0.55	8003.3
2014	7	25	6	2.5	3.1	0.1	83.5	0	1.33	239.1	0.52	8003.3
2014	7	25	7	2	2.5	6.4	79.4	0	1.25	240.7	0.5	8003.3
2014	7	25	8	2.8	3.1	110.6	67.9	0	0.86	240.2	0.28	8004.7
2014	7	25	9	6.9	6.5	343.5	48.5	0	0.69	98.8	-0.39	8006
2014	7	25	10	10.7	9.8	529.2	41.5	0	1.9	82.5	-0.89	8004.7
2014	7	25	11	14.1	12.7	696.5	33.5	0	3.05	70.2	-1.36	8003.3
2014	7	25	12	16.1	15.1	836	26.1	0	3.65	228	-0.98	8002
2014	7	25	13	17.3	16.2	923	23.7	0	3.91	223.5	-1.05	8002
2014	7	25	14	18.2	17.2	960	20.7	0	3.63	235.4	-0.99	8000.7
2014	7	25	15	19.2	18.2	952	21.7	0	3.9	227.4	-1.06	7999.3
2014	7	25	16	20.1	19	896	17.9	0	4.3	222	-1.14	7999.3
2014	7	25	17	20.7	19.7	785.1	18.2	0	4.52	232.5	-1.01	7995.3
2014	7	25	18	20.9	20	636.8	15.6	0	4.59	219.8	-0.96	7994
2014	7	25	19	20.8	20	462.8	16.8	0	4.22	229.9	-0.82	7995.3
2014	7	25	20	18.9	18.9	33.9	20.4	0	2.84	250.9	-0.07	7994
2014	7	25	21	17.1	17.5	12.3	32.3	0	1.09	268.1	0.38	7998

2014	7	25	22	13.4	13.6	2.1	38.3	0	1.5	230.7	0.17	8000.7
2014	7	25	23	11.8	12	0.1	41.9	0	1.11	248	0.25	8006
2014	7	25	24	9.8	10.2	0	49.8	0	1.31	237.7	0.39	8011.3
2014	7	26	1	8.4	8.9	0	61.5	0	1.52	238.2	0.59	8016.7
2014	7	26	2	7.7	8	0	62.4	0	1.51	237.8	0.36	8020.7
2014	7	26	3	6.7	7.1	0.1	69.1	0	1.7	235.6	0.45	8020.7
2014	7	26	4	6.1	6.5	0	71.5	0	1.67	235.8	0.44	8022
2014	7	26	5	5.3	5.9	0	79.5	0	1.56	236	0.58	8023.3
2014	7	26	6	4.7	5.4	0.1	74.4	0	1.59	241.3	0.78	8026
2014	7	26	7	4.6	5.3	6.2	75.3	0	1.71	240.5	0.66	8027.3
2014	7	26	8	5.7	6	106.3	68	0	1.37	237.7	0.32	8030
2014	7	26	9	10	9.6	341.3	46.1	0	0.57	187.2	-0.42	8034
2014	7	26	10	14.2	13.3	528.7	36.4	0	2	75.6	-0.93	8035.3
2014	7	26	11	18.4	17.1	696.3	22	0	3.67	69.7	-1.31	8036.7
2014	7	26	12	19.5	18.4	834	18.8	0	4.9	179.9	-1.12	8036.7
2014	7	26	13	20.4	19.3	926	19.9	0	3.64	163.4	-1.06	8039.3
2014	7	26	14	21.7	20	959	18.7	0	5.4	65.1	-1.73	8038
2014	7	26	15	22.1	20.9	952	16.5	0	3.16	66.2	-1.18	8036.7
2014	7	26	16	22.8	21.7	896	16.5	0	2.61	70.2	-1.07	8035.3
2014	7	26	17	23.3	22.3	779.3	16.6	0	3.14	55.8	-0.97	8032.7
2014	7	26	18	24	23.1	629.5	15.8	0	2.79	26.3	-0.93	8028.7
2014	7	26	19	24	23.3	455.1	16.7	0	1.81	221.7	-0.71	8028.7
2014	7	26	20	22.1	22.3	32.5	19.5	0	0.99	294.6	0.25	8028.7
2014	7	26	21	19.7	20.1	12.1	32.1	0	1	257.6	0.43	8028.7
2014	7	26	22	16.3	16.4	1.9	34.8	0	1.47	242.1	0.13	8034
2014	7	26	23	14	14.3	0	45.1	0	1.5	238.2	0.22	8038
2014	7	26	24	12	12.5	0	47.8	0	1.74	234.6	0.44	8043.3
2014	7	27	1	10.6	11.3	0	53.5	0	1.81	234.3	0.74	8044.7
2014	7	27	2	10	10.7	0	51	0	1.77	238.2	0.77	8047.3
2014	7	27	3	9	10.1	0	61.9	0	1.59	236.1	1.17	8047.3
2014	7	27	4	8.5	9.5	0.1	62	0	1.9	234.5	0.93	8050
2014	7	27	5	8.2	9.2	0	60.4	0	1.87	238.8	0.97	8052.7
2014	7	27	6	8.3	9.2	0.1	64.2	0	1.83	237.2	0.89	8052.7
2014	7	27	7	7.7	9.3	5.6	61.6	0	1.68	232.4	1.53	8054
2014	7	27	8	8.9	9.9	101	51.7	0	1.6	238.5	0.95	8055.3
2014	7	27	9	13.8	13.7	337	37.7	0	1.17	240.5	-0.09	8055.3
2014	7	27	10	19.6	19	524.6	25.5	0	1.46	95.8	-0.61	8055.3
2014	7	27	11	22.3	21.4	691.1	20.4	0	2.5	104.3	-0.96	8056.7
2014	7	27	12	23.8	22.8	828	16.1	0	2.11	172.2	-1.01	8055.3
2014	7	27	13	24.6	23.6	919	15.9	0	2.27	159.8	-0.97	8054
2014	7	27	14	25.8	24.7	956	14.3	0	2.09	107	-1.07	8052.7
2014	7	27	15	26.9	25.6	971	13.8	0	2.85	69.2	-1.29	8050
2014	7	27	16	27.4	26.3	917	12.3	0	3.07	75.2	-1.12	8044.7
2014	7	27	17	27.9	26.8	755.1	11.4	0	2.98	86.6	-1.09	8040.7
2014	7	27	18	27.6	27	603.6	11.7	0	1.61	209.1	-0.66	8035.3
2014	7	27	19	27.5	26.9	390.6	14.2	0	2.42	240.3	-0.63	8032.7
2014	7	27	20	26	26	68.8	17	0	1.07	297.4	0	8031.3
2014	7	27	21	24.1	24.5	28.8	24.5	0	0.45	235.4	0.43	8032.7
2014	7	27	22	20.7	21.3	1.8	28.8	0	1.16	238.8	0.62	8035.3
2014	7	27	23	18.1	18.7	0.1	38	0	1.41	248.7	0.59	8040.7
2014	7	27	24	16.2	16.8	0	38.4	0	1.71	242.8	0.64	8046
2014	7	28	1	15.1	15.6	0	43.9	0	1.73	242.7	0.49	8044.7
2014	7	28	2	14.1	15	0	51.6	0	1.51	238.3	0.9	8047.3
2014	7	28	3	13.5	14.3	0	47.5	0	1.76	240.4	0.77	8046
2014	7	28	4	12.7	13.7	0.1	50.8	0	1.76	234.3	0.97	8044.7
2014	7	28	5	12.2	12.9	0.1	56.8	0	1.91	238.1	0.77	8043.3
2014	7	28	6	11.5	12.4	0.1	55.8	0	1.79	241.6	0.87	8044.7
2014	7	28	7	11.2	12.2	5.7	56.3	0	1.8	237.9	1.02	8046
2014	7	28	8	11.6	12.4	86.1	47.1	0	1.68	241.9	0.76	8047.3
2014	7	28	9	15.3	15.3	230.7	44.9	0	0.6	250.3	0.07	8048.7
2014	7	28	10	19.8	19.4	403.4	31	0	0.55	126	-0.43	8046

2014	7	28	11	22.1	21.4	423.4	25.8	0	1.71	70	-0.74	8046
2014	7	28	12	24.4	23.5	627.5	23.1	0	1.88	66.7	-0.9	8044.7
2014	7	28	13	26	25.2	695.6	22.6	0	3.11	199.1	-0.81	8044.7
2014	7	28	14	25.6	25.1	282.3	30.8	0	3.06	225.7	-0.58	8042
2014	7	28	15	19.8	20	127	74.8	0.02	3.09	14.6	0.24	8044.7
2014	7	28	16	17.1	17.8	46.2	81.7	0.08	2.67	264.2	0.72	8046
2014	7	28	17	16.8	16.8	148.4	58.3	0.02	1.89	241.7	0.02	8054
2014	7	28	18	17.7	17.7	60.2	60.4	0	1.59	249.2	0.02	8056.7
2014	7	28	19	18.1	18	196.7	50.1	0	2.15	48.9	-0.17	8052.7
2014	7	28	20	18.5	18.5	72.8	61	0	2.01	244.2	0	8051.3
2014	7	28	21	17	17.3	21	80.8	0	1.31	315.3	0.3	8047.3
2014	7	28	22	14.4	14.6	1.3	81	0	1.66	237	0.22	8050
2014	7	28	23	13.7	13.9	0.1	83.8	0	0.98	243.1	0.13	8051.3
2014	7	28	24	13.2	13.4	0	87.1	0	1.12	233.3	0.21	8051.3
2014	7	29	1	12.1	12.4	0	85.9	0	1.75	242.3	0.33	8051.3
2014	7	29	2	11.7	12.2	0	77.2	0	1.73	239.9	0.43	8051.3
2014	7	29	3	11.1	11.7	0	88.6	0	1.56	237.3	0.61	8048.7
2014	7	29	4	10.7	11.5	0.1	82.8	0	1.64	238.7	0.82	8048.7
2014	7	29	5	11.4	12.4	0.1	84.7	0	1.31	236	0.92	8047.3
2014	7	29	6	11.3	12.3	0.1	83.8	0	1.78	239.5	0.99	8046
2014	7	29	7	11.4	12.1	12.8	88.1	0	1.34	238.8	0.74	8047.3
2014	7	29	8	11.9	12.4	59.7	81	0	0.94	241.4	0.49	8050
2014	7	29	9	13.6	13.8	83.4	78.1	0	1.24	237	0.25	8052.7
2014	7	29	10	15	15.2	134.4	70.8	0	1.02	245.3	0.19	8052.7
2014	7	29	11	17.1	16.9	239.5	53.9	0	1.21	203.6	-0.22	8051.3
2014	7	29	12	19.2	18.8	356.5	45.7	0	1.34	75.1	-0.38	8050
2014	7	29	13	21.6	21.1	414.4	29.5	0	1.28	97.8	-0.47	8050
2014	7	29	14	23.2	22.7	395.1	26.1	0	2.27	186.9	-0.55	8044.7
2014	7	29	15	23.6	23.1	503.5	23.3	0	2.67	72.7	-0.47	8043.3
2014	7	29	16	24.9	24.1	741.6	19.8	0	2.69	77.2	-0.75	8038
2014	7	29	17	25.6	24.9	658.8	17.8	0	2.58	108.4	-0.68	8032.7
2014	7	29	18	25.6	25	441.7	22.2	0	3.72	78.7	-0.59	8028.7
2014	7	29	19	24.7	24.3	227.8	27.2	0	4.04	79	-0.42	8026
2014	7	29	20	23.2	23	83.5	29.5	0	2.22	213.8	-0.18	8026
2014	7	29	21	22.1	22.2	39.3	36.5	0	1.18	12.8	0.18	8026
2014	7	29	22	20	20.3	3	47.5	0	1.09	229.6	0.29	8030
2014	7	29	23	17.8	17.8	0	53.5	0	1.25	234.1	0.06	8036.7
2014	7	29	24	16.5	16.9	0	59.5	0	1.28	241.2	0.36	8040.7
2014	7	30	1	15.7	16.2	0	49	0	1.38	237.4	0.49	8040.7
2014	7	30	2	14.6	15.1	0	60.4	0	1.69	238	0.45	8042
2014	7	30	3	14	14.4	0.1	56.7	0	1.54	241.6	0.49	8042
2014	7	30	4	13.3	14.3	0.1	69.9	0	1.01	243.1	0.91	8042
2014	7	30	5	12.5	13.3	0	64	0	1.1	267.1	0.86	8042
2014	7	30	6	11.8	12.5	0.1	68.1	0	1.18	241.1	0.64	8046
2014	7	30	7	11.6	12.3	5.7	72.8	0	1.01	248.8	0.68	8044.7
2014	7	30	8	11.9	12.3	84	70.1	0	1.24	242	0.35	8047.3
2014	7	30	9	15.3	15.1	317.8	46	0	0.7	194	-0.22	8046
2014	7	30	10	19.3	18.8	484.8	34.9	0	0.9	81.2	-0.51	8046
2014	7	30	11	22.1	21.1	654.2	27.4	0	2.24	83.5	-1.01	8044.7
2014	7	30	12	23.8	23	799	23.7	0	1.68	82	-0.81	8042
2014	7	30	13	24.1	23.6	384.5	35.2	0	1.43	150.1	-0.58	8038
2014	7	30	14	21.2	21.2	133.1	48.2	0.01	1.92	240.4	0.03	8038
2014	7	30	15	19.4	19.4	114.7	36	0.01	2.88	117	0	8047.3
2014	7	30	16	17.2	17.6	34.6	70	0	2.33	233.5	0.34	8047.3
2014	7	30	17	16.7	16.7	67.4	65.4	0	1.47	237.9	0.05	8050
2014	7	30	18	17.9	18	155.6	44.9	0	2.56	239	0.03	8051.3
2014	7	30	19	19.5	19.2	367.9	41.6	0	2.84	78.6	-0.31	8050
2014	7	30	20	18.9	18.9	53.1	46.7	0	2.55	244.2	0.04	8051.3
2014	7	30	21	17.4	17.8	15	64.3	0	1.4	235.7	0.38	8048.7
2014	7	30	22	14.2	14.5	0.8	71.2	0	1.22	241.7	0.27	8050
2014	7	30	23	12.6	12.8	0.1	80.9	0	1.4	240.2	0.17	8051.3

2014	7	30	24	11.1	11.4	0.1	81.4	0	1.73	238	0.37	8055.3
2014	7	31	1	10.4	10.9	0	81.7	0	1.52	237.8	0.47	8056.7
2014	7	31	2	10	10.5	0	79	0	1.58	237.9	0.48	8056.7
2014	7	31	3	9.6	10.2	0	77.7	0	1.36	238	0.62	8054
2014	7	31	4	8.9	9.7	0	85	0	1.35	238.1	0.84	8051.3
2014	7	31	5	8.5	9.4	0.1	78.6	0	1.55	240.6	0.9	8050
2014	7	31	6	8.6	9.1	0.1	75.2	0	1.67	245.1	0.54	8050
2014	7	31	7	8.1	9	6.5	81.7	0	1.82	234.8	0.87	8050
2014	7	31	8	9.2	10	80.7	80	0	1.31	237.8	0.83	8050
2014	7	31	9	12.5	12.5	300.5	57.6	0	0.83	234.1	-0.02	8047.3
2014	7	31	10	16.7	16.2	484.3	46.7	0	0.92	88.8	-0.51	8047.3
2014	7	31	11	20.6	19.9	653.5	31.4	0	1.2	88.1	-0.66	8047.3
2014	7	31	12	23.5	22.6	610.5	22.4	0	3.77	64.6	-0.85	8046
2014	7	31	13	23.2	22.7	457.8	19.9	0	3.44	55.9	-0.55	8044.7
2014	7	31	14	24.5	23.6	834	18.8	0	2.81	79.3	-0.87	8042
2014	7	31	15	25.2	24.3	982	18.1	0	2.55	104.4	-0.88	8036.7
2014	7	31	16	24.7	23.8	484.9	26.4	0	2.67	104.5	-0.88	8032.7
2014	7	31	17	23.9	23.4	266	23.9	0	2.8	212	-0.56	8030
2014	7	31	18	23.5	23.1	171.2	26.5	0	4.83	220.5	-0.41	8027.3
2014	7	31	19	23.3	23	139.3	24.7	0	5.03	224.3	-0.3	8028.7
2014	7	31	20	22.7	22.5	80	29.8	0	4.2	220.1	-0.16	8027.3
2014	7	31	21	21.7	21.7	28.8	34	0	1.7	255.1	0.01	8028.7
2014	7	31	22	18.7	18.9	0.9	44.6	0	1.12	243.4	0.21	8031.3
2014	7	31	23	16.6	16.8	0	52.9	0	1.01	250.4	0.21	8035.3
2014	7	31	24	15.4	16.2	0.1	53.9	0	1.41	243	0.82	8038
2014	8	1	1	14.5	15.2	0.1	54	0	1.85	239.8	0.71	8038
2014	8	1	2	14	14.4	0.1	57.9	0	1.02	243.8	0.32	8040.7
2014	8	1	3	12.6	13.1	0.1	64.4	0	1.5	240.2	0.53	8040.7
2014	8	1	4	11.7	12.1	0	64.7	0	1.44	241	0.43	8038
2014	8	1	5	11.5	12.1	0	69.7	0	1.69	236.8	0.56	8036.7
2014	8	1	6	11.3	12	0.1	74.5	0	1.44	243.9	0.67	8034
2014	8	1	7	10.7	11.2	7.5	76.2	0	1.37	241.8	0.58	8034
2014	8	1	8	10.7	11.5	34.7	73	0	1.43	240.1	0.79	8036.7
2014	8	1	9	13.3	13.1	297.6	50.5	0	0.58	76.7	-0.22	8036.7
2014	8	1	10	17.5	16.9	496.8	36.3	0	1.11	193.9	-0.57	8039.3
2014	8	1	11	21.4	20.7	644.6	32.4	0	1.73	164.7	-0.75	8035.3
2014	8	1	12	22.3	21.5	790.9	28.8	0	2.06	237.6	-0.79	8035.3
2014	8	1	13	23.2	22.4	533.9	31.7	0	1.92	214.4	-0.78	8034
2014	8	1	14	23.8	22.9	690.7	29.3	0	2.73	126.1	-0.9	8030
2014	8	1	15	23.6	22.6	573.9	29.9	0	4.29	56.5	-0.99	8026
2014	8	1	16	24.7	23.7	834	26.5	0	4.09	238.4	-0.98	8024.7
2014	8	1	17	24.8	24	601.6	29.7	0	3.56	239.7	-0.76	8020.7
2014	8	1	18	23.5	22.6	397	32.5	0	4.83	61.4	-0.86	8019.3
2014	8	1	19	22.1	21.7	106.6	47.5	0	2.72	65.9	-0.38	8020.7
2014	8	1	20	20.5	20.3	58.1	38.7	0	1.27	74.1	-0.27	8019.3
2014	8	1	21	20.2	20	18.4	39.7	0	2.07	94.1	-0.22	8024.7
2014	8	1	22	19.2	19.2	0.5	42.5	0	1.81	237.9	-0.07	8030
2014	8	1	23	16.8	17.3	0	56.7	0	1.2	245.9	0.52	8035.3
2014	8	1	24	14.7	15	0	60.7	0	2.28	237.8	0.36	8035.3
2014	8	2	1	14.3	14.7	0	63.4	0	1.52	243.6	0.38	8032.7
2014	8	2	2	13.9	14.1	0	59.9	0	1.59	241.2	0.21	8028.7
2014	8	2	3	13.8	14.2	0	62.8	0	1.02	244.6	0.35	8027.3
2014	8	2	4	12.8	13.5	0.1	67.3	0	1.07	240	0.66	8027.3
2014	8	2	5	12.3	12.5	0.1	69.1	0	1.5	239.8	0.23	8028.7
2014	8	2	6	12.7	13.2	0.1	64.1	0	1.66	248.2	0.52	8031.3
2014	8	2	7	12.6	13.1	6.2	93	0.03	1.8	290	0.48	8035.3
2014	8	2	8	12.1	12	65.5	89.5	0	1.63	213.3	-0.11	8038
2014	8	2	9	13.4	13.2	120.2	69.1	0.01	1.66	60.7	-0.19	8044.7
2014	8	2	10	13.6	13.4	152.8	71.4	0	2.75	166.2	-0.19	8044.7
2014	8	2	11	16.2	15.7	556.1	46.3	0	0.85	196.9	-0.51	8043.3
2014	8	2	12	20.2	19.2	740.9	34.4	0	2.09	77.2	-0.97	8039.3

2014	8	2	13	22.6	21.8	824	31.4	0	1.89	113.4	-0.81	8035.3
2014	8	2	14	23.6	22.8	731.4	30.8	0	2.57	161.1	-0.83	8031.3
2014	8	2	15	24.3	23	788.7	27.9	0	3.77	63.8	-1.38	8028.7
2014	8	2	16	25.1	23.8	814	26.4	0	3.8	66.5	-1.27	8024.7
2014	8	2	17	25.2	24.1	574.8	24.8	0	2.99	68.9	-1.05	8020.7
2014	8	2	18	25	24.2	405.3	26.5	0	2.38	140.6	-0.72	8016.7
2014	8	2	19	24.6	24	253.4	28.4	0	2.92	62.2	-0.61	8012.7
2014	8	2	20	24	23.8	94.8	31.4	0	1.72	101.5	-0.23	8010
2014	8	2	21	21.8	21.9	40.8	44.4	0	0.98	234	0.08	8014
2014	8	2	22	19	19.1	0.8	52.2	0	1.28	228.6	0.1	8014
2014	8	2	23	16.4	16.6	0	56.8	0	1.54	237.6	0.24	8018
2014	8	2	24	14.8	15.1	0	57.7	0	1.51	237.9	0.26	8020.7
2014	8	3	1	14	14.2	0	64.1	0	1.47	237.5	0.28	8026
2014	8	3	2	14.5	14.8	0	56.4	0	1.92	249.9	0.32	8024.7
2014	8	3	3	14.7	15.1	0.1	61.2	0	1.9	359.7	0.39	8028.7
2014	8	3	4	12.9	13.4	0.1	65.7	0	1.49	239.8	0.5	8026
2014	8	3	5	12	12.7	0.1	64.2	0	1.61	246.2	0.68	8028.7
2014	8	3	6	12.2	12.6	0.1	59.9	0	2.33	229.5	0.39	8030
2014	8	3	7	13.3	13.6	4.2	64.1	0	2.12	39.1	0.34	8027.3
2014	8	3	8	13.7	13.8	28.4	64.7	0	1.96	267.1	0.18	8027.3
2014	8	3	9	14.4	14.4	103.5	62.3	0	1.61	238.8	0.04	8028.7
2014	8	3	10	15.4	15.2	158.7	53.7	0	1.7	344.7	-0.17	8036.7
2014	8	3	11	18.9	18.4	544.3	32.6	0	1.19	318.2	-0.48	8039.3
2014	8	3	12	21.1	20.5	522.2	29.2	0	2.92	54.5	-0.62	8035.3
2014	8	3	13	22.8	22	725.2	28.8	0	2.09	209.8	-0.81	8030
2014	8	3	14	23.7	22.7	732.7	25.5	0	2.12	229.3	-0.94	8026
2014	8	3	15	24.6	23.7	555.6	24.9	0	1.83	11.3	-0.83	8022
2014	8	3	16	25.3	24.5	631.5	25.5	0	2.72	69.2	-0.88	8016.7
2014	8	3	17	25.9	24.8	582.4	23.9	0	3.19	70	-1.06	8011.3
2014	8	3	18	25.9	25.1	437.7	24	0	2.85	59.9	-0.75	8004.7
2014	8	3	19	25.6	25.1	233.8	23.8	0	2.33	63.9	-0.52	8000.7
2014	8	3	20	24.9	24.6	102.2	27.5	0	2.67	63.1	-0.26	7999.3
2014	8	3	21	23.4	23.4	22	31.5	0	1.54	301.8	0.03	8000.7
2014	8	3	22	20.7	20.9	0.4	43.6	0	1.59	301.7	0.24	8003.3
2014	8	3	23	20.3	20.5	0.1	36.5	0	1.16	285.6	0.17	8011.3
2014	8	3	24	19.5	19.7	0.1	42.6	0	1.65	205.5	0.24	8014
2014	8	4	1	16.6	17.4	0	54.5	0	1.34	252.8	0.84	8014
2014	8	4	2	14.5	15.4	0	53	0	1.21	242.2	0.87	8015.3
2014	8	4	3	14.3	14.7	0	61.3	0	1.72	239.1	0.42	8014
2014	8	4	4	13.8	14.1	0	64.3	0	1.04	243.7	0.37	8010
2014	8	4	5	12.4	12.9	0.1	70	0	1.55	232.2	0.56	8010
2014	8	4	6	11.9	12.8	0.1	69.9	0	1.78	237.3	0.89	8008.7
2014	8	4	7	11.8	12.8	4.6	69.3	0	1.29	245.1	0.93	8010
2014	8	4	8	12.4	12.7	62.9	60.6	0	1	253.7	0.28	8010
2014	8	4	9	14.8	14.7	244.1	47.9	0	0.55	213.7	-0.13	8011.3
2014	8	4	10	17.4	17	214.4	45.3	0	0.78	99.7	-0.38	8010
2014	8	4	11	20.4	19.7	621.1	33.1	0	1.31	92.9	-0.7	8008.7
2014	8	4	12	23	22	670.1	32.8	0	2.64	179.1	-0.99	8007.3
2014	8	4	13	23.2	22.3	628.6	32.2	0	2.92	195.6	-0.93	8002
2014	8	4	14	23.2	22.5	402	35.9	0	3.53	99.8	-0.68	7999.3
2014	8	4	15	20	19.5	122.6	43.2	0	6.09	87.4	-0.49	7996.7
2014	8	4	16	18.5	18.1	151.5	65.2	0	2.46	106.8	-0.41	8004.7
2014	8	4	17	17.3	16.9	162.2	53.4	0	1.83	218.3	-0.38	8008.7
2014	8	4	18	18.2	17.9	154.3	51.9	0	1.02	167.2	-0.36	8000.7
2014	8	4	19	19.4	19	321.3	45.4	0	1.46	62.1	-0.46	7998
2014	8	4	20	19.1	18.9	51.2	50.7	0	1.83	100.7	-0.26	7998
2014	8	4	21	18.2	18	25.2	59.7	0	1.78	28	-0.21	7998
2014	8	4	22	16.5	16.5	2	65.7	0	1.84	44.3	-0.01	7998
2014	8	4	23	14.3	14.3	0	74	0	1.25	238	-0.01	8002
2014	8	4	24	12.6	12.7	0	79.6	0	1.23	248.6	0.11	8004.7
2014	8	5	1	11.3	11.5	0.1	80.4	0	1.36	240.7	0.23	8003.3

2014	8	5	2	10.8	11.1	0	81	0	1.06	247.3	0.29	8004.7
2014	8	5	3	9.7	10	0	83.3	0	1.46	241.1	0.33	8000.7
2014	8	5	4	9.6	9.9	0	86.3	0	1.47	243.2	0.32	8000.7
2014	8	5	5	9	9.7	0	87.6	0	1.36	238.3	0.72	8002
2014	8	5	6	9	9.4	0	86.2	0	1.39	236.7	0.46	8000.7
2014	8	5	7	8.2	9.1	6.2	87.3	0	1.59	239.9	0.89	8002
2014	8	5	8	9.2	9.6	66.4	83.7	0	1.17	239.3	0.41	8004.7
2014	8	5	9	11.7	11.6	223.4	67.1	0	0.85	232.9	-0.09	8004.7
2014	8	5	10	16	15.4	418.3	50.5	0	0.81	96.1	-0.54	8006
2014	8	5	11	19.6	18.6	545.3	41.4	0	2.43	76.6	-0.96	8004.7
2014	8	5	12	21.3	20.2	576	31.3	0	4.4	69.4	-1.11	8003.3
2014	8	5	13	22	20.9	782.8	28.3	0	5.28	52.6	-1.08	8003.3
2014	8	5	14	22.4	21.5	601.5	29.2	0	3.01	74.3	-0.9	8002
2014	8	5	15	22.9	22	522	30.8	0	3.79	68.9	-0.85	7998
2014	8	5	16	22.9	22.1	539.3	27.1	0	3.59	74.6	-0.74	7998
2014	8	5	17	23.8	22.9	530.6	26	0	4.07	70.2	-0.9	7995.3
2014	8	5	18	23.6	22.9	349.7	28.2	0	5.13	58.7	-0.67	7990
2014	8	5	19	23	22.5	295.1	30.5	0	5.08	59.4	-0.46	7988.7
2014	8	5	20	22.5	22.3	100.2	31.3	0	3.94	79.7	-0.28	7991.3
2014	8	5	21	21.5	21.4	33.2	33.1	0	3.97	89.2	-0.09	7994
2014	8	5	22	19.4	19.6	0.7	43.4	0	0.79	238.3	0.19	7995.3
2014	8	5	23	17.2	17.5	0	46.5	0	0.88	252.9	0.27	8000.7
2014	8	5	24	16.5	16.8	0	48.5	0	1.28	253.9	0.26	8003.3
2014	8	6	1	15.5	15.8	0	53.1	0	1.52	244.1	0.28	8002
2014	8	6	2	14.1	14.5	0	59.8	0	1.31	240.8	0.42	8004.7
2014	8	6	3	13.5	13.9	0.1	64.3	0	1.19	240.7	0.42	8004.7
2014	8	6	4	13.5	14.2	0.1	64.9	0	1.09	244.3	0.67	8006
2014	8	6	5	13.4	13.7	0.1	60.7	0	0.98	244.1	0.36	8007.3
2014	8	6	6	12.5	13	0.1	68.6	0	1.04	240.5	0.59	8007.3
2014	8	6	7	11.7	12.2	3.6	70.2	0	1.3	241.4	0.49	8006
2014	8	6	8	11.5	11.9	59.8	64.1	0	1.34	232.4	0.35	8007.3
2014	8	6	9	14.1	13.9	218.8	49.8	0	0.55	225.3	-0.14	8008.7
2014	8	6	10	17.3	16.8	391.7	42.8	0	1.03	71.2	-0.55	8010
2014	8	6	11	20.4	19.5	596.8	34.8	0	2.42	73.9	-0.86	8007.3
2014	8	6	12	21.7	20.9	490.1	31.9	0	2.65	64.4	-0.78	8004.7
2014	8	6	13	21.7	21.2	212.8	32.3	0	2.2	67.4	-0.53	8000.7
2014	8	6	14	22.2	21.7	264	29.2	0	1.97	92.4	-0.55	8000.7
2014	8	6	15	23.4	22.6	730.1	30.1	0	2.37	173.9	-0.86	7999.3
2014	8	6	16	23.6	22.8	359.6	29	0	2.68	110.8	-0.74	7992.7
2014	8	6	17	23.4	22.9	216.2	28.4	0	2.82	103.9	-0.47	7990
2014	8	6	18	23.1	22.7	244.6	28.2	0	4.56	220.4	-0.44	7987.3
2014	8	6	19	21.4	21.1	97.8	39	0	5.88	231.6	-0.34	7986
2014	8	6	20	19.8	19.6	44.3	50.4	0	3.98	209.5	-0.26	7991.3
2014	8	6	21	17.7	17.5	7.4	59.1	0	1.95	177.8	-0.2	8003.3
2014	8	6	22	16.7	16.5	0.7	65.4	0	2	174.7	-0.19	8007.3
2014	8	6	23	15.7	15.6	0	72.4	0	0.84	62.1	-0.09	8011.3
2014	8	6	24	13.9	13.9	0	82	0	0.86	244.5	0.03	8012.7
2014	8	7	1	12.5	12.6	0.1	88.1	0	0.98	253.7	0.16	8014
2014	8	7	2	11.3	11.5	0.1	89.3	0	0.8	239.8	0.12	8014
2014	8	7	3	10.6	10.8	0.1	90	0	0.91	245.3	0.15	8014
2014	8	7	4	9.8	10.2	0	92.5	0	1.36	237.8	0.42	8011.3
2014	8	7	5	9.4	9.7	0	93.9	0	1.38	238.4	0.32	8011.3
2014	8	7	6	9.4	9.7	0	94.6	0	1.08	248.4	0.31	8012.7
2014	8	7	7	9.4	9.7	6.3	91.9	0	0.96	238.2	0.39	8011.3
2014	8	7	8	9.9	10	49	90.8	0	1.04	244.5	0.16	8011.3
2014	8	7	9	12	11.7	239.4	74.8	0	0.58	161.5	-0.22	8011.3
2014	8	7	10	15.2	14.7	381.6	63.2	0	0.89	96.4	-0.48	8010
2014	8	7	11	17.8	17.2	448.4	37.1	0	0.79	98	-0.56	8008.7
2014	8	7	12	20.5	19.8	729.1	28.9	0	1.21	40.3	-0.7	8006
2014	8	7	13	21.2	20.6	459.1	31	0	1.32	166.3	-0.62	8003.3
2014	8	7	14	22.5	21.6	736	27.9	0	2.29	134	-0.92	7999.3

2014	8	7	15	22.6	22	322.1	27.8	0	1.47	140.2	-0.6	7995.3
2014	8	7	16	23.1	22.4	439.5	25.4	0	2.77	197.3	-0.67	7991.3
2014	8	7	17	24.1	23.2	616.1	25.3	0	3.65	213.9	-0.89	7986
2014	8	7	18	23.9	23.2	424.4	25.7	0	3.48	225.1	-0.72	7983.3
2014	8	7	19	23.3	22.7	278.3	25.4	0	5.92	230.3	-0.59	7980.7
2014	8	7	20	21.9	21.7	66.4	27.1	0	5.23	231.5	-0.22	7983.3
2014	8	7	21	20.6	20.7	48.8	33	0	1.96	260	0.08	7987.3
2014	8	7	22	17.5	18.2	1.4	49.2	0	1.96	232.2	0.64	7991.3
2014	8	7	23	15.4	16	0	57.4	0	1.41	232.4	0.53	7998
2014	8	7	24	14.3	14.6	0	56.1	0	1.51	242.6	0.28	7999.3
2014	8	8	1	12.8	13.1	0.1	63.3	0	1.48	242.2	0.39	7999.3
2014	8	8	2	11.7	12.3	0	64.5	0	1.53	238.2	0.55	8002
2014	8	8	3	10.9	11.3	0	65.1	0	1.52	239	0.43	8002
2014	8	8	4	10	10.6	0	71	0	1.33	239	0.68	8002
2014	8	8	5	9.1	10	0	74.4	0	1.67	236.9	0.89	8000.7
2014	8	8	6	9.1	9.6	0	74	0	1.67	239.9	0.52	7999.3
2014	8	8	7	8.4	9.2	1.9	78.8	0	1.67	234	0.76	7999.3
2014	8	8	8	8.8	9.6	55.8	69.3	0	1.58	234.1	0.75	7998
2014	8	8	9	12.3	12.1	252	58.4	0	1.05	213.9	-0.16	7998
2014	8	8	10	15.2	14.4	431.8	43.5	0	2.21	83.6	-0.86	7999.3
2014	8	8	11	19.5	18.4	599.1	32	0	2.34	75.8	-1.16	7998
2014	8	8	12	21.4	20.7	693.8	29	0	1.32	115.6	-0.73	7996.7
2014	8	8	13	22.5	21.7	587.4	27.9	0	3.16	212	-0.84	7991.3
2014	8	8	14	20.8	20.4	241.7	42.9	0.04	4.3	197.4	-0.37	7990
2014	8	8	15	19.3	19.1	402.9	36.9	0	4.4	217.8	-0.25	7991.3
2014	8	8	16	20.9	20.2	682.1	33.2	0	6.4	217.5	-0.7	7995.3
2014	8	8	17	21.8	21	696.8	28	0	5.72	227.9	-0.79	7990
2014	8	8	18	21.9	21.1	454.6	31.4	0	4.74	224.6	-0.79	7988.7
2014	8	8	19	21.8	21.3	292.4	30.7	0	3.86	229.9	-0.51	7987.3
2014	8	8	20	20.7	20.6	54.4	35	0	3.63	237.3	-0.18	7987.3
2014	8	8	21	18.9	19.1	13.3	45.3	0	1.69	252.8	0.15	7990
2014	8	8	22	17.4	17.6	0.5	48.8	0	1.59	260.3	0.2	7994
2014	8	8	23	16	16.3	0	56.1	0	0.62	308.3	0.31	8003.3
2014	8	8	24	13.3	13.7	0	69.4	0	1.52	239.3	0.35	8006
2014	8	9	1	11.6	11.8	0.1	72.3	0	1.41	244	0.12	8008.7
2014	8	9	2	10.3	10.6	0.1	78	0	1.51	242.2	0.33	8010
2014	8	9	3	9.5	10.1	0	77.5	0	1.57	238.9	0.57	8012.7
2014	8	9	4	9.3	9.8	0	81.9	0	1.79	237.3	0.46	8012.7
2014	8	9	5	8.7	9	0	85.5	0	1.69	237.9	0.29	8012.7
2014	8	9	6	8.3	8.8	0.1	86.5	0	1.92	236.4	0.48	8014
2014	8	9	7	7.9	8.4	3.9	88.4	0	1.64	237	0.51	8016.7
2014	8	9	8	8.1	8.7	55.3	82.2	0	0.86	241.9	0.57	8019.3
2014	8	9	9	10.8	10.6	262.2	67.4	0	0.28	191.4	-0.21	8024.7
2014	8	9	10	14.7	14.1	449.9	55.2	0	1.15	96.8	-0.6	8027.3
2014	8	9	11	18.5	17.5	614	36.7	0	2.56	75.6	-1.07	8026
2014	8	9	12	21	20.2	746.5	30.1	0	4.28	221.9	-0.79	8026
2014	8	9	13	21.8	20.9	750.4	29.5	0	5.03	220.1	-0.89	8027.3
2014	8	9	14	22.6	21.5	728.4	26.6	0	3.51	156.4	-1.04	8028.7
2014	8	9	15	23.1	22.2	610.2	25.1	0	3.22	155.7	-0.92	8026
2014	8	9	16	23.5	22.6	590.1	24.4	0	2.45	151.3	-0.81	8026
2014	8	9	17	24	23.2	640	22.4	0	3.07	186.5	-0.8	8024.7
2014	8	9	18	23.8	23.2	333.9	23.6	0	4.05	215.6	-0.66	8020.7
2014	8	9	19	23.4	22.9	206	31	0	3.77	225.3	-0.49	8020.7
2014	8	9	20	21.7	21.5	89.5	35	0	4.26	236.6	-0.26	8022
2014	8	9	21	19.9	19.9	19.8	42.9	0	2.26	227	0.04	8024.7
2014	8	9	22	18.6	18.7	0.4	49.4	0	1.34	230.8	0.04	8031.3
2014	8	9	23	16.4	16.6	0	53.4	0	1.26	249.8	0.16	8036.7
2014	8	9	24	14.4	14.5	0	54.7	0	1.67	240.4	0.15	8039.3
2014	8	10	1	13.3	13.5	0	59.5	0	1.39	241.9	0.22	8042
2014	8	10	2	11.9	12.3	0	68.6	0	1.68	239.3	0.44	8042
2014	8	10	3	11.4	12.1	0.1	64.1	0	1.58	244.1	0.62	8044.7

2014	8	10	4	10.5	11.1	0.1	70.7	0	1.48	237.1	0.59	8046
2014	8	10	5	9.8	10.7	0	68.3	0	1.74	238	0.91	8046
2014	8	10	6	9.9	10.5	0	63.2	0	1.59	242.7	0.63	8047.3
2014	8	10	7	9.1	10.3	3.8	70.2	0	1.33	246.3	1.26	8046
2014	8	10	8	9.3	10.3	53.5	70.8	0	1.58	238.7	1.06	8050
2014	8	10	9	12.7	12.9	234.4	50.6	0	1.07	236	0.19	8052.7
2014	8	10	10	17.4	17	418	36.7	0	0.52	159.1	-0.45	8054
2014	8	10	11	21.2	20.6	593.3	29.7	0	1.47	239.2	-0.61	8052.7
2014	8	10	12	22.6	21.7	740.7	29.4	0	3.1	208.6	-0.9	8052.7
2014	8	10	13	23.7	22.7	910	25.9	0	2.79	231.5	-0.98	8051.3
2014	8	10	14	24.7	23.5	866	25.4	0	3.26	206.3	-1.15	8048.7
2014	8	10	15	24.7	23.7	657.9	26.1	0	3.44	228.6	-0.97	8046
2014	8	10	16	24.9	24.2	466.6	25.6	0	1.91	213.4	-0.73	8044.7
2014	8	10	17	24.9	24.3	293.8	25.1	0	1.84	98.5	-0.56	8040.7
2014	8	10	18	25.6	24.9	454.4	22.6	0	1.55	177.1	-0.65	8038
2014	8	10	19	25.3	24.8	216.6	24.6	0	2.1	210.1	-0.48	8031.3
2014	8	10	20	24.9	24.7	97	31.1	0	1.55	195.6	-0.21	8028.7
2014	8	10	21	23.4	23.6	19.9	30.3	0	0.72	271.5	0.18	8028.7
2014	8	10	22	20.1	20.2	0.3	41.8	0	1.46	232.7	0.08	8032.7
2014	8	10	23	19.1	19.4	0.1	42	0	1.26	240.9	0.26	8042
2014	8	10	24	17.5	17.8	0.1	48.8	0	1.7	238.9	0.34	8042
2014	8	11	1	15.4	15.7	0	49.4	0	1.65	238.7	0.34	8043.3
2014	8	11	2	13.9	14.5	0	51.7	0	1.87	237.9	0.61	8047.3
2014	8	11	3	13.5	14	0	58.9	0	1.6	240.9	0.51	8046
2014	8	11	4	12.5	13.1	0.1	61	0	1.63	239.7	0.65	8043.3
2014	8	11	5	11.9	12.6	0	58.8	0	1.81	236.9	0.75	8043.3
2014	8	11	6	11.6	12.4	0	66.5	0	1.99	237.7	0.84	8043.3
2014	8	11	7	11.4	12.1	3.4	65	0	1.59	242.3	0.66	8043.3
2014	8	11	8	11.7	12.6	51.2	65.4	0	1.31	242	0.84	8046
2014	8	11	9	14.9	14.9	254.8	47.1	0	1.12	233.5	0.03	8047.3
2014	8	11	10	20.6	20.1	439.8	30.3	0	0.64	233	-0.43	8048.7
2014	8	11	11	23.9	23.2	612.6	28.1	0	1.73	165.7	-0.7	8046
2014	8	11	12	25	24	766.4	24.6	0	3.44	200.9	-0.94	8046
2014	8	11	13	26.1	25.2	934	20.9	0	1.91	217.4	-0.91	8042
2014	8	11	14	26.8	25.8	842	19	0	3.32	194.7	-0.99	8038
2014	8	11	15	26.7	25.9	500.6	18.2	0	4.32	32.5	-0.85	8034
2014	8	11	16	26.8	26.2	460.3	19.8	0	1.86	280.8	-0.63	8031.3
2014	8	11	17	27.1	26.5	365.7	21.4	0	2.25	254.1	-0.6	8024.7
2014	8	11	18	26.5	26.1	194.8	21.3	0	3.11	239.9	-0.37	8023.3
2014	8	11	19	25.5	25.3	118.2	24.1	0	2.29	300.7	-0.23	8020.7
2014	8	11	20	22.6	23	28	42.5	0	2.5	357.4	0.41	8022
2014	8	11	21	18.8	19	10.6	62.2	0	1.95	225.5	0.2	8026
2014	8	11	22	17.7	17.8	0.1	72.8	0	0.84	163.2	0.16	8030
2014	8	11	23	16.4	16.5	0	67.1	0	1.51	234	0.14	8031.3
2014	8	11	24	15.7	16	0	71.7	0	0.93	263.6	0.36	8030
2014	8	12	1	13.6	13.9	0	77.9	0	1.26	234.5	0.37	8030
2014	8	12	2	13.2	13.7	0	76.4	0	1.32	241.9	0.56	8028.7
2014	8	12	3	13.5	14	0.1	64.4	0	1.41	249.6	0.51	8026
2014	8	12	4	13	13.6	0.1	77.3	0	0.69	251.9	0.58	8023.3
2014	8	12	5	11.8	12.5	0.1	77.5	0	1.73	235.1	0.74	8023.3
2014	8	12	6	11.7	12.3	0.1	76	0	1.37	241.1	0.61	8023.3
2014	8	12	7	12.3	13	2.7	65.9	0	0.63	297.3	0.73	8027.3
2014	8	12	8	14.8	15.3	8.3	71.4	0.01	1.34	222.3	0.51	8031.3
2014	8	12	9	16	16	147.1	60.8	0	2.4	79.4	-0.01	8032.7
2014	8	12	10	17.9	17.6	376.2	51.3	0	2.61	66.2	-0.36	8026
2014	8	12	11	19	18.3	550	46.8	0	3.03	62.1	-0.66	8022
2014	8	12	12	17.8	17.5	224.6	54.9	0	2.61	134	-0.32	8022
2014	8	12	13	17.3	17	199.9	64.3	0.01	2.33	212.2	-0.31	8024.7
2014	8	12	14	16.2	15.9	381.2	63.9	0	2.42	60.7	-0.32	8027.3
2014	8	12	15	18.8	17.9	747.8	51.7	0	3.63	80.4	-0.93	8018
2014	8	12	16	20.1	19.5	472	50.3	0	3.43	99	-0.67	8006

2014	8	12	17	15.9	15.7	114.6	83.6	0.07	3.39	237.4	-0.27	7998
2014	8	12	18	16.2	15.7	395.6	66.8	0	2.23	49.4	-0.51	8006
2014	8	12	19	18	17.6	300	61.6	0	3.31	40.5	-0.39	8003.3
2014	8	12	20	18.2	18.1	53.8	65.9	0	2.33	245.9	-0.1	7996.7
2014	8	12	21	17	17.1	21.8	83.8	0	1.87	147	0.07	8002
2014	8	12	22	14.6	14.7	0.2	86.7	0	1.33	239.7	0.1	7999.3
2014	8	12	23	13.5	13.7	0	87.4	0	1.33	242	0.14	8003.3
2014	8	12	24	13.1	13.3	0	87	0	1.57	243	0.22	8003.3
2014	8	13	1	12.4	12.7	0.1	91.1	0	0.85	254.9	0.31	8002
2014	8	13	2	10.7	11.2	0.1	93.9	0	1.11	240.6	0.45	8004.7
2014	8	13	3	9.8	10.2	0	94.2	0	1.79	237.6	0.38	8006
2014	8	13	4	9.8	10.2	0.1	94.7	0	0.97	240.8	0.41	8004.7
2014	8	13	5	9.7	10.3	0.1	92.6	0	1.32	240.5	0.58	8003.3
2014	8	13	6	9.9	10.5	0	94.5	0	1.47	237.5	0.63	8003.3
2014	8	13	7	10.3	10.7	3.8	93.9	0	1.34	242.2	0.36	8000.7
2014	8	13	8	10.2	10.6	48.8	89.2	0	1.41	234.7	0.43	8002
2014	8	13	9	13.3	13.2	283.7	72.2	0	0.62	226.4	-0.13	8000.7
2014	8	13	10	17.2	16.8	422.1	50.9	0	1.67	229.7	-0.45	7999.3
2014	8	13	11	18.6	18.1	480.7	49.3	0	1.81	221.6	-0.53	7998
2014	8	13	12	18.2	17.8	225.9	62.2	0	4.39	214.9	-0.4	7998
2014	8	13	13	17	16.6	283.6	58.2	0	3.94	246.5	-0.4	8000.7
2014	8	13	14	13.6	13.4	21.8	92.3	0.13	5.07	245.7	-0.19	8003.3
2014	8	13	15	12.2	11.7	342.7	81.7	0.01	2.05	48.2	-0.43	8011.3
2014	8	13	16	14.8	14.1	762.2	68	0	1.02	65.4	-0.64	8000.7
2014	8	13	17	16.4	15.9	288.9	73.8	0	1.23	71.7	-0.52	7992.7
2014	8	13	18	17	16.5	188	75	0	2.02	71.8	-0.5	7987.3
2014	8	13	19	16.5	16.4	14.6	75.6	0	1.5	222.5	-0.14	7982
2014	8	13	20	13.6	13.5	4.1	86.3	0.17	2.91	216.2	-0.08	7990
2014	8	13	21	10.9	10.9	3.7	95.8	0.01	1.55	315.7	-0.04	7996.7
2014	8	13	22	10.1	10	0.1	96	0	1.34	216.4	-0.11	7990
2014	8	13	23	10	9.8	0	94.2	0	1.44	47.4	-0.12	7998
2014	8	13	24	9.9	9.8	0	97.3	0	1.17	230.1	-0.14	8000.7
2014	8	14	1	10.3	10.4	0.1	93.8	0	2.14	243.5	0.08	7995.3
2014	8	14	2	9.5	9.5	0.1	94.9	0	2.53	242.3	0.01	7988.7
2014	8	14	3	8.6	8.7	0.1	97.6	0	1.35	235.8	0.04	7983.3
2014	8	14	4	10.1	10	0.1	98.3	0.25	3.41	273.8	-0.04	7984.7
2014	8	14	5	9.8	9.7	0.1	94.2	0.15	2.82	43.7	-0.05	8004.7
2014	8	14	6	9.1	9	0.1	99.3	0	1.26	280.1	-0.04	7988.7
2014	8	14	7	9	8.9	0.7	98.8	0.11	1.99	25.4	-0.11	7994
2014	8	14	8	9.1	8.9	19.8	98.8	0	1.72	231.5	-0.19	7996.7
2014	8	14	9	9.4	9.2	61.4	93.8	0	1.25	218.4	-0.23	7998
2014	8	14	10	10.2	10	131	91.8	0.04	1.64	226.8	-0.24	7995.3
2014	8	14	11	11.7	11.3	294.8	92.7	0	1.26	88.1	-0.37	7996.7
2014	8	14	12	12.8	12.3	533.7	77.1	0	1.91	68.8	-0.48	7998
2014	8	14	13	15.5	14.7	675.7	74.7	0	2.25	18.3	-0.72	7995.3
2014	8	14	14	16.1	15.5	330.2	81	0	3.58	42.1	-0.55	7988.7
2014	8	14	15	15.4	14.9	464.8	67.5	0	2.45	72.7	-0.52	7987.3
2014	8	14	16	16.2	15.8	384.7	66.9	0	2.26	58.2	-0.43	7983.3
2014	8	14	17	16.7	16.3	200.3	53.8	0	2.42	60.9	-0.36	7979.3
2014	8	14	18	18.4	18.3	226.3	39.6	0	3.79	220.7	-0.18	7976.7
2014	8	14	19	18.7	18.5	306.5	33.1	0	4.96	235.9	-0.29	7978
2014	8	14	20	17.1	17.2	23.3	43.9	0	2.96	238.8	0.14	7983.3
2014	8	14	21	14.5	15	9.5	69.6	0	1.81	237.1	0.48	7986
2014	8	14	22	11.9	12	0.1	76.5	0	1.1	235.2	0.02	7990
2014	8	14	23	10	10.2	0	84.8	0	1.6	234.2	0.19	7994
2014	8	14	24	9	9.2	0	87.7	0	1.5	242.4	0.21	7994
2014	8	15	1	9.2	9.5	0	87.9	0	1.21	247.6	0.32	7992.7
2014	8	15	2	9.6	10.1	0.1	89.2	0	0.79	245.3	0.51	7992.7
2014	8	15	3	9.5	9.7	0.1	91.7	0	0.85	235.6	0.21	7992.7
2014	8	15	4	9.6	9.9	0.1	90.9	0	0.88	249.5	0.22	7992.7
2014	8	15	5	9.7	10	0.1	89.9	0	1.17	235.1	0.29	7991.3

2014	8	15	6	9.8	10.1	0.1	89.2	0	1.34	243.7	0.31	7994
2014	8	15	7	8.7	8.7	1.7	93.5	0	1.04	263.6	0.05	7992.7
2014	8	15	8	8.8	8.8	16.7	92.4	0.01	1.32	111.8	-0.03	7996.7
2014	8	15	9	9.4	9.4	47.9	97	0.03	1.45	47	0.08	8008.7
2014	8	15	10	10.1	10	138.9	85.8	0	1.47	260.8	-0.13	8004.7
2014	8	15	11	12.7	12.6	162.5	73.5	0	1.64	54.5	-0.15	8006
2014	8	15	12	13.9	13.6	218.6	67.5	0	2.49	74.9	-0.3	8008.7
2014	8	15	13	14.5	14.2	362.2	53.5	0	2.82	244.3	-0.32	8010
2014	8	15	14	16.1	15.6	681	48.1	0	3.05	252.3	-0.48	8010
2014	8	15	15	16.9	16.5	380.2	49.7	0	3.98	241.3	-0.41	8004.7
2014	8	15	16	17.6	17.1	476.5	46.9	0	5.04	248	-0.42	8002
2014	8	15	17	17	16.7	276	51.2	0	5.32	247.8	-0.26	8000.7
2014	8	15	18	17.3	17	281.7	48.5	0	3.99	241.7	-0.33	8000.7
2014	8	15	19	17.3	17.1	173.3	48.9	0	4.28	218.9	-0.2	8000.7
2014	8	15	20	17	16.9	64.2	50.5	0	2.74	237.3	-0.09	8000.7
2014	8	15	21	15.5	15.7	14.3	66.7	0	0.83	239.2	0.21	8002
2014	8	15	22	12.8	13.3	0.1	81.3	0	0.94	239.1	0.52	8006
2014	8	15	23	11.2	11.4	0	80	0	1.36	237	0.19	8010
2014	8	15	24	10.9	11.3	0	79.3	0	1.16	243.6	0.38	8010
2014	8	16	1	10.1	10.4	0	82.4	0	1.31	230.8	0.32	8007.3
2014	8	16	2	9.4	9.8	0	85.4	0	1.04	234.1	0.34	8010
2014	8	16	3	8.6	9	0	86.2	0	1.26	237.3	0.4	8008.7
2014	8	16	4	8	8.6	0.1	91.6	0	0.94	241.7	0.55	8010
2014	8	16	5	7.3	7.9	0.1	94.7	0	0.83	240.1	0.66	8010
2014	8	16	6	6.8	7.3	0.1	91	0	1.16	240.4	0.55	8014
2014	8	16	7	6.4	7.1	2.1	92.3	0	0.98	237.5	0.69	8015.3
2014	8	16	8	6.6	7.2	45.4	91.2	0	0.65	241.3	0.62	8018
2014	8	16	9	8	8.1	153.7	76.2	0	0.54	238.5	0.13	8022
2014	8	16	10	12.6	12.2	422.8	50.2	0	1.55	129.6	-0.46	8022
2014	8	16	11	16.4	16	562	47	0	5.47	227.4	-0.42	8020.7
2014	8	16	12	17.3	16.9	764.7	40.8	0	5.95	247.4	-0.45	8022
2014	8	16	13	18.1	17.6	831	32.8	0	5.76	243.1	-0.58	8023.3
2014	8	16	14	19	18.3	887	34.1	0	5.96	235.1	-0.76	8022
2014	8	16	15	19.5	18.8	807	31.3	0	5.88	233.8	-0.72	8020.7
2014	8	16	16	20.2	19.4	818	31.2	0	5.55	233.6	-0.81	8020.7
2014	8	16	17	20.4	19.6	581.5	33.8	0	5.12	227.4	-0.75	8019.3
2014	8	16	18	20.5	19.7	550.7	32.6	0	4.8	226	-0.72	8016.7
2014	8	16	19	20.2	19.6	315.1	36.7	0	3.81	228.5	-0.58	8015.3
2014	8	16	20	18.8	18.7	31.8	42.6	0	2.37	255.1	-0.09	8015.3
2014	8	16	21	17.1	17.3	10.4	51.2	0	0.87	259.4	0.23	8015.3
2014	8	16	22	14.5	14.7	0.1	67.2	0	1.01	237.9	0.19	8018
2014	8	16	23	12.4	12.6	0.1	73.2	0	1.25	235.7	0.2	8023.3
2014	8	16	24	11	11.3	0.1	73.6	0	1.46	235.5	0.36	8022
2014	8	17	1	10.2	10.6	0	80.5	0	1.63	238.8	0.45	8022
2014	8	17	2	9.7	10.2	0	79.2	0	1.49	239.3	0.46	8023.3
2014	8	17	3	9.2	9.8	0	82.7	0	1.3	241.1	0.6	8022
2014	8	17	4	8.4	9	0.1	84.3	0	1.4	236.3	0.64	8022
2014	8	17	5	8	8.6	0.1	87.4	0	1.17	243.2	0.57	8020.7
2014	8	17	6	7.3	8.1	0.1	85.4	0	1.13	236.3	0.75	8023.3
2014	8	17	7	7	7.8	1.6	89.5	0	1.03	244.2	0.79	8024.7
2014	8	17	8	7	7.8	39.6	87.3	0	1.07	240	0.81	8027.3
2014	8	17	9	9.7	9.6	250.4	67.8	0	0.55	212.4	-0.04	8028.7
2014	8	17	10	13.4	12.8	433.6	54.9	0	0.95	103.5	-0.53	8031.3
2014	8	17	11	17.4	16.6	602.6	43.3	0	2.32	77	-0.84	8028.7
2014	8	17	12	19.6	18.8	693.2	38.5	0	3.74	217.7	-0.79	8028.7
2014	8	17	13	20.3	19.6	647.2	34.8	0	3.3	227.9	-0.65	8030
2014	8	17	14	21.3	20.6	787.4	29.7	0	3.27	231.8	-0.74	8028.7
2014	8	17	15	22.1	21.2	777	27.5	0	4.36	228.5	-0.85	8024.7
2014	8	17	16	22.7	21.7	847	23.9	0	5.2	223.7	-1.01	8022
2014	8	17	17	22.7	21.9	617.7	24.4	0	4.34	218.8	-0.8	8019.3
2014	8	17	18	22.7	22	478.8	26.5	0	3.22	200.7	-0.74	8016.7

2014	8	17	19	22.5	21.8	284.9	28.4	0	2.81	231.2	-0.64	8012.7
2014	8	17	20	20.5	20.6	37.9	39.1	0	1.05	266.3	0.08	8011.3
2014	8	17	21	17.1	17.1	10.2	52.5	0	1.68	226.3	0.02	8011.3
2014	8	17	22	15.1	15.2	0.1	61.6	0	0.81	241.6	0.1	8014
2014	8	17	23	12.7	13	0.1	62.1	0	1.41	238.9	0.3	8018
2014	8	17	24	11.8	12.3	0.1	70.5	0	1.52	236.7	0.55	8018
2014	8	18	1	10.9	11.3	0	81.4	0	1.64	240.5	0.43	8018
2014	8	18	2	10.4	10.9	0	82.6	0	1.54	238.5	0.43	8018
2014	8	18	3	9.9	10.3	0	84.2	0	1.35	244.9	0.41	8015.3
2014	8	18	4	9.1	9.6	0.1	84.7	0	1.64	238.7	0.5	8014
2014	8	18	5	8.9	9.5	0.1	84.9	0	1.53	239.4	0.57	8012.7
2014	8	18	6	8.4	9	0.1	89.9	0	1.8	237.7	0.59	8010
2014	8	18	7	8.3	9	2	90.1	0	1.73	237.7	0.72	8008.7
2014	8	18	8	8.5	9.1	38.3	86.2	0	1.28	241.3	0.57	8007.3
2014	8	18	9	11.2	11.3	239.8	68	0	1.45	237.6	0.07	8007.3
2014	8	18	10	15.8	15.4	427.5	56.5	0	0.91	107.4	-0.44	8004.7
2014	8	18	11	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	8	18	12	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	8	18	13	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	8	18	14	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	8	18	15	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	8	18	16	24.2	23.4	732.3	20.2	0	3.59	216.3	-0.87	7986
2014	8	18	17	24.7	23.8	766.9	19.1	0	3.21	207	-0.98	7982
2014	8	18	18	24.8	24.1	466.6	17.7	0	2.65	218.6	-0.72	7975.3
2014	8	18	19	24.3	23.8	329.6	20.3	0	3.07	233.5	-0.5	7971.3
2014	8	18	20	22.4	22.6	25.5	24.3	0	0.95	305.3	0.19	7968.7
2014	8	18	21	18.7	19	8	43.6	0	1.64	232.6	0.32	7966
2014	8	18	22	16.1	16.2	0.1	49.8	0	1.17	246.1	0.08	7970
2014	8	18	23	13.8	14.3	0	58	0	1.43	235.9	0.56	7974
2014	8	18	24	12.4	12.9	0	62.7	0	1.6	236.7	0.49	7972.7
2014	8	19	1	12	12.6	0	71.5	0	1.54	238.2	0.53	7971.3
2014	8	19	2	11	11.5	0	71.4	0	1.6	238.5	0.46	7970
2014	8	19	3	10.4	11	0.1	76.2	0	1.64	234.5	0.57	7966
2014	8	19	4	9.9	10.5	0.1	79.5	0	1.71	237.7	0.54	7963.3
2014	8	19	5	9.5	10.3	0.1	75.9	0	1.42	241.1	0.76	7963.3
2014	8	19	6	9.1	9.7	0.1	80.4	0	1.85	237	0.65	7963.3
2014	8	19	7	8.8	9.6	1.8	78.7	0	1.9	236	0.8	7959.3
2014	8	19	8	9.5	10	38.3	72.1	0	1.36	243	0.48	7958
2014	8	19	9	11.6	11.6	234.9	60.8	0	0.61	223.2	0.03	7956.7
2014	8	19	10	15.3	14.7	424.7	46.8	0	1.04	80.2	-0.52	7955.3
2014	8	19	11	19.1	18.3	587.6	39.3	0	1.96	77.2	-0.84	7952.7
2014	8	19	12	21.7	21.1	389.8	30.6	0	3.93	236.1	-0.57	7948.7
2014	8	19	13	20.2	19.7	382.4	28.5	0	2.97	237.9	-0.43	7950
2014	8	19	14	21.9	21.3	567.8	28.9	0	3.92	222	-0.66	7944.7
2014	8	19	15	22.1	21.6	281.3	30.7	0	4.46	226	-0.46	7940.7
2014	8	19	16	20.1	19.7	446.7	33.7	0	4.06	50.2	-0.42	7936.7
2014	8	19	17	20	19.7	282.9	38.7	0	3.53	19.5	-0.32	7932.7
2014	8	19	18	19.6	19	557.4	42.9	0	3.52	37.3	-0.62	7935.3
2014	8	19	19	18.9	18.4	161.2	43.9	0	3.34	64.2	-0.48	7928.7
2014	8	19	20	18.4	18.1	63.5	53.9	0	1.89	68.7	-0.31	7932.7
2014	8	19	21	16.5	16.6	6.2	52.6	0	1.75	66.8	0.08	7934
2014	8	19	22	14.9	15	0.1	62.6	0	1.44	313	0.15	7938
2014	8	19	23	13.8	13.7	0	60.2	0	3.25	77.3	-0.11	7948.7
2014	8	19	24	12.5	12.4	0	77.2	0	1.34	75.3	-0.14	7950
2014	8	20	1	10.4	10.4	0	82.7	0	1.01	240.3	0	7947.3
2014	8	20	2	9.8	9.8	0	77.6	0	1.11	243.3	0.07	7950
2014	8	20	3	9	9.2	0	80.5	0	1.2	238.2	0.19	7947.3
2014	8	20	4	8.3	8.5	0	83.7	0	1.1	239.4	0.2	7947.3
2014	8	20	5	7.6	8	0	86.6	0	1.01	248.9	0.44	7947.3
2014	8	20	6	6.8	7.6	0	88.1	0	1.63	236.8	0.76	7946
2014	8	20	7	7.4	7.7	1.1	84.9	0	1.41	238.6	0.32	7947.3

2014	8	20	8	7.7	8.2	28.4	89.2	0	1.24	233.2	0.56	7948.7
2014	8	20	9	8.9	8.8	172.8	75.6	0	0.57	77.9	-0.1	7951.3
2014	8	20	10	12.2	11.7	385.1	66.7	0	1.29	78.9	-0.56	7952.7
2014	8	20	11	15.9	15.3	374.1	47.6	0	1.84	108.9	-0.53	7950
2014	8	20	12	16.9	16.4	343.6	45.4	0	3.54	229.4	-0.47	7952.7
2014	8	20	13	17.8	17.1	641.1	43.4	0	5.63	225.4	-0.7	7951.3
2014	8	20	14	17.6	17.1	490.9	46.8	0	5.52	231.1	-0.55	7950
2014	8	20	15	16.8	16.2	428.1	47.5	0	5.48	227.3	-0.54	7950
2014	8	20	16	17.4	16.8	456.9	47.4	0	3.9	228.9	-0.64	7952.7
2014	8	20	17	17.8	17.3	275.1	47.5	0	4.63	228.7	-0.52	7947.3
2014	8	20	18	17.8	17.3	271.9	39.5	0	3	201.5	-0.48	7948.7
2014	8	20	19	18.2	17.8	211.4	37.8	0	3.57	225.9	-0.42	7946
2014	8	20	20	17.3	17.1	51.5	42	0	2.47	241.1	-0.13	7947.3
2014	8	20	21	15.1	15.4	9.8	62.2	0	1.48	254	0.28	7948.7
2014	8	20	22	13	13	0.1	66.3	0	0.85	250.4	0.06	7951.3
2014	8	20	23	12.2	12.4	0.1	66.6	0	1.69	67	0.19	7956.7
2014	8	20	24	13.2	13.3	0.1	58.6	0	1.74	124.1	0.02	7962
2014	8	21	1	12.5	12.5	0.1	67.8	0	1.12	17.3	0	7966
2014	8	21	2	11.3	11.3	0.1	74.7	0	1.25	230.9	0.06	7964.7
2014	8	21	3	9.6	9.7	0.1	79.5	0	1.09	242.1	0.12	7966
2014	8	21	4	8	8.1	0.1	78.4	0	1.38	240.8	0.06	7968.7
2014	8	21	5	7.5	7.7	0.1	84.8	0	1.69	238.9	0.22	7970
2014	8	21	6	7.5	7.8	0.1	85.8	0	1.37	234.8	0.28	7972.7
2014	8	21	7	7.1	7.3	0.9	89.9	0	1.72	233.5	0.27	7971.3
2014	8	21	8	7	7.3	33.8	88.4	0	1.33	234.5	0.29	7974
2014	8	21	9	9.3	9.7	127.5	76	0	0.68	272	0.41	7978
2014	8	21	10	12.6	12	380.8	62.5	0	1.32	65.6	-0.54	7980.7
2014	8	21	11	14.7	14.1	420.4	54	0	3.5	227.9	-0.57	7978
2014	8	21	12	15.1	14.7	436.4	49.1	0	5.15	242.6	-0.44	7979.3
2014	8	21	13	16.7	16	778.3	38.9	0	5.44	245.1	-0.63	7978
2014	8	21	14	17.6	16.8	593.3	38.9	0	5.12	232.8	-0.75	7975.3
2014	8	21	15	17.9	17.2	588	38.4	0	5.31	236.4	-0.69	7975.3
2014	8	21	16	18.3	17.6	665.9	34.1	0	5.35	234.4	-0.77	7975.3
2014	8	21	17	18.6	17.9	635.1	32.5	0	5.2	237.7	-0.75	7970
2014	8	21	18	18.6	18	431.6	28.2	0	4.2	239.1	-0.68	7968.7
2014	8	21	19	18.1	17.7	199.1	30.6	0	3.55	241.2	-0.43	7967.3
2014	8	21	20	17.2	17.1	69.3	28.9	0	2.71	252.3	-0.18	7967.3
2014	8	21	21	14.5	14.9	8.4	40	0	1.07	245.6	0.38	7966
2014	8	21	22	11.5	11.6	0.1	50	0	0.95	237.9	0.07	7970
2014	8	21	23	9.5	9.7	0.1	58.6	0	1.19	239.7	0.19	7972.7
2014	8	21	24	8.5	8.8	0.1	58.2	0	1.45	237.2	0.26	7971.3
2014	8	22	1	7.3	7.5	0.1	66.5	0	1.5	237.4	0.26	7970
2014	8	22	2	6.3	6.8	0.1	65.1	0	1.72	239.3	0.49	7970
2014	8	22	3	5.7	6.2	0.1	70.1	0	1.41	236.7	0.46	7968.7
2014	8	22	4	4.8	5.7	0.1	75.6	0	1.37	237.4	0.84	7967.3
2014	8	22	5	4.5	5.1	0.1	68.2	0	1.78	236.7	0.58	7967.3
2014	8	22	6	4.1	4.8	0.1	73	0	1.5	236.6	0.65	7964.7
2014	8	22	7	3.7	4.4	0.8	71.9	0	1.57	234.6	0.72	7963.3
2014	8	22	8	4.1	5	41.2	68.2	0	1.82	236.5	0.9	7963.3
2014	8	22	9	7.8	8	132.3	49.7	0	1.46	239.6	0.25	7960.7
2014	8	22	10	8.6	8.6	81.1	59.3	0	2.25	59.8	-0.04	7964.7
2014	8	22	11	9.7	9.4	236.5	48.9	0	0.79	177.6	-0.3	7966
2014	8	22	12	13.3	12.6	615.8	40.2	0	2.47	91.3	-0.65	7966
2014	8	22	13	12.6	12.1	175.3	58.2	0	3.75	175.5	-0.5	7960.7
2014	8	22	14	11.4	10.9	475.5	59.8	0	4.17	76.8	-0.52	7970
2014	8	22	15	11.3	10.9	217.3	59.2	0	3.05	55.3	-0.44	7964.7
2014	8	22	16	10.4	10.1	39.4	72.2	0	2.7	191.2	-0.23	7968.7
2014	8	22	17	8.6	8.4	118.9	69	0	3.18	89.3	-0.25	7972.7
2014	8	22	18	9.4	8.9	274.4	65.9	0	2.57	3.2	-0.45	7974
2014	8	22	19	10.5	10.1	253.8	61.3	0	1.98	72.1	-0.46	7971.3
2014	8	22	20	11.1	10.8	94.8	59.7	0	1.02	63.8	-0.26	7964.7

2014	8	22	21	10	10	14.5	70.7	0	2.19	39	-0.02	7966
2014	8	22	22	8.4	8.4	0.1	79.4	0	1.19	278.5	0	7970
2014	8	22	23	6.7	6.9	0.1	86.6	0	0.62	237.7	0.16	7975.3
2014	8	22	24	5.4	5.5	0.1	86.1	0	1.06	239.9	0.05	7975.3
2014	8	23	1	5.7	5.8	0.1	89	0	0.53	272.1	0.05	7979.3
2014	8	23	2	5.3	5.3	0.1	91	0	0.72	236.7	0.01	7976.7
2014	8	23	3	4.9	4.9	0.1	91.3	0	1.12	234.7	0.02	7975.3
2014	8	23	4	4.4	4.6	0.1	93.1	0	0.71	244.2	0.22	7975.3
2014	8	23	5	4.5	4.6	0.1	93.6	0	0.46	247.6	0.07	7976.7
2014	8	23	6	4.8	4.8	0.1	93.7	0	0.4	250.8	0.02	7975.3
2014	8	23	7	4.9	4.9	0.2	92	0	0.6	241.6	-0.02	7976.7
2014	8	23	8	5.4	5.2	5.6	96.2	0	0.51	68	-0.27	7979.3
2014	8	23	9	5.5	5.3	30.7	95.3	0	0.44	215.1	-0.26	7982
2014	8	23	10	6.3	5.9	168.2	93.6	0	0.86	94.2	-0.39	7984.7
2014	8	23	11	7.4	6.8	197.1	88.7	0	2.45	75	-0.54	7984.7
2014	8	23	12	8.7	8.2	273.8	73.6	0	3.18	64.4	-0.47	7987.3
2014	8	23	13	10.2	9.5	426.2	68.9	0	3.22	75.3	-0.64	7990
2014	8	23	14	10.7	10	383	70.4	0	3.85	59.1	-0.7	7990
2014	8	23	15	10.8	10	469.3	70.7	0	4.84	54.2	-0.79	7990
2014	8	23	16	10	9.4	232.6	73.5	0	4.57	59.4	-0.62	7994
2014	8	23	17	9.8	9.3	192.5	78.6	0	3.59	59	-0.52	7995.3
2014	8	23	18	10.4	9.9	284.5	62.6	0	2.44	118.3	-0.49	7998
2014	8	23	19	10.7	10.3	133.9	71.6	0	3.42	76.3	-0.44	7994
2014	8	23	20	10.3	10	36	67.9	0	2.12	63.7	-0.29	7996.7
2014	8	23	21	9.9	9.6	4.2	71.6	0	2.84	43.6	-0.23	7995.3
2014	8	23	22	9	8.7	0.1	77.6	0	2.81	59.3	-0.24	7996.7
2014	8	23	23	8.8	8.6	0.1	70.7	0	2.58	55.8	-0.2	7998
2014	8	23	24	8.7	8.5	0.1	70.8	0	3.13	55.4	-0.19	7996.7
2014	8	24	1	8.4	8.3	0.1	72	0	3.11	42.5	-0.19	7995.3
2014	8	24	2	8	7.8	0.1	73.3	0	1.05	76.3	-0.16	7995.3
2014	8	24	3	7.7	7.5	0.1	72.2	0	2.28	77.5	-0.18	7991.3
2014	8	24	4	7.4	7.2	0.1	77.2	0	1.94	53.7	-0.12	7990
2014	8	24	5	5.8	6	0.1	82.9	0	0.63	318	0.25	7987.3
2014	8	24	6	4.3	4.5	0.1	90.5	0	0.9	248.6	0.27	7986
2014	8	24	7	3	3.1	0.7	91.9	0	1.35	238	0.1	7984.7
2014	8	24	8	2.5	2.7	27.8	89.9	0	1.37	235.8	0.21	7984.7
2014	8	24	9	5.3	5.1	240.8	73.9	0	1.07	235.1	-0.21	7983.3
2014	8	24	10	8.4	7.9	425.3	62.8	0	1.06	53.8	-0.5	7984.7
2014	8	24	11	10.6	10	613.2	54.4	0	1.07	149.3	-0.59	7980.7
2014	8	24	12	12.5	11.8	635.4	51	0	2.44	217.4	-0.76	7978
2014	8	24	13	13	12.2	395.2	50.8	0	3.37	60.5	-0.86	7975.3
2014	8	24	14	13	12.6	202.7	50.5	0	2.37	52.3	-0.45	7972.7
2014	8	24	15	13.7	13.1	398.9	51.1	0	3.02	191.7	-0.55	7968.7
2014	8	24	16	14.7	13.8	610.6	53.6	0	3.87	128.5	-0.94	7964.7
2014	8	24	17	13.6	13	277.6	55.9	0	2.45	47.6	-0.59	7963.3
2014	8	24	18	11.6	11.3	75.6	73.9	0.13	3.11	74	-0.34	7962
2014	8	24	19	9.7	9.5	49.4	88.3	0.03	2.11	39.8	-0.2	7968.7
2014	8	24	20	8.6	8.4	16	91.8	0.05	1.86	329.2	-0.15	7968.7
2014	8	24	21	7.8	7.5	0.4	97.1	0.12	2.05	47.9	-0.22	7976.7
2014	8	24	22	7.2	7	0.1	97.5	0.03	2.66	73.2	-0.2	7978
2014	8	24	23	6.5	6.4	0.1	97.7	0	1.42	248.4	-0.07	7978
2014	8	24	24	5.9	5.8	0.1	97.8	0	1.18	235.5	-0.14	7978
2014	8	25	1	4.9	5	0.1	99.4	0	0.57	237.2	0.06	7980.7
2014	8	25	2	4.2	4.2	0.1	99.2	0	1.02	236.1	0.06	7976.7
2014	8	25	3	3.7	3.7	0.1	99.3	0	1.16	243.6	0.02	7976.7
2014	8	25	4	3.6	3.7	0.1	99.2	0	1.44	240.4	0.08	7974
2014	8	25	5	4	4.2	0.1	94.2	0	1.67	255.2	0.23	7974
2014	8	25	6	3.4	3.7	0	99.4	0	1.31	242.9	0.27	7975.3
2014	8	25	7	2.7	3	0.9	99.7	0	1.39	236.4	0.31	7975.3
2014	8	25	8	2.8	3.4	20.4	99.2	0	1.11	252.1	0.61	7980.7
2014	8	25	9	4.2	4.5	160.1	90.4	0	0.92	254.5	0.28	7986

2014	8	25	10	6.7	6.4	258.4	90.7	0	1.34	183.6	-0.36	7984.7
2014	8	25	11	8.3	7.9	374.4	80.6	0	1.26	175.3	-0.45	7986
2014	8	25	12	10.6	9.9	616.2	70.3	0	1.82	100.1	-0.72	7986
2014	8	25	13	12.1	11.7	407.9	62.6	0	1.85	137.1	-0.47	7986
2014	8	25	14	13.7	13.2	385.5	57.1	0	2.34	76.9	-0.51	7983.3
2014	8	25	15	13.7	13.3	167.2	61.9	0	2.81	72.5	-0.36	7982
2014	8	25	16	12.6	12.3	152.8	77.4	0	2.92	211.4	-0.26	7980.7
2014	8	25	17	13.7	13.2	445.3	48.2	0	2.84	236.8	-0.44	7980.7
2014	8	25	18	13.4	13.1	175.6	53.6	0	3.18	61	-0.33	7979.3
2014	8	25	19	13	12.7	136.8	65.3	0	1.72	54.7	-0.31	7982
2014	8	25	20	12.2	12.1	41.8	74.2	0	1.76	68.5	-0.1	7984.7
2014	8	25	21	10.9	10.9	4.9	76.8	0	2.82	68.8	-0.08	7988.7
2014	8	25	22	9.9	9.8	0.1	87	0	1.01	73.4	-0.06	7994
2014	8	25	23	9.1	9.1	0.1	89.7	0	0.66	310	0.03	8000.7
2014	8	25	24	8	8.2	0.1	92.1	0	0.93	247.8	0.14	8002
2014	8	26	1	7	7.1	0.1	91.2	0	1.33	239.6	0.12	8004.7
2014	8	26	2	6.3	6.5	0.1	92.8	0	0.86	240.2	0.22	8006
2014	8	26	3	5.2	5.5	0.1	95.7	0	1	238.3	0.28	8010
2014	8	26	4	4.9	5.1	0.1	93.7	0	1.35	238.5	0.24	8008.7
2014	8	26	5	4.4	4.8	0.1	98	0	1.36	240.3	0.38	8008.7
2014	8	26	6	4	4.5	0.1	97.9	0	1.18	236.9	0.48	8010
2014	8	26	7	3.8	4.3	0.7	97.5	0	1.51	240.3	0.52	8014
2014	8	26	8	3.9	4.4	26.1	97.4	0	1.38	240.4	0.49	8016.7
2014	8	26	9	6.2	6.1	243	82	0	1.03	219	-0.08	8018
2014	8	26	10	9.8	9.3	417.4	70.2	0	0.99	84.6	-0.48	8019.3
2014	8	26	11	13.2	12.5	616.2	56.6	0	1.81	77.2	-0.7	8020.7
2014	8	26	12	14.3	14	137.9	52	0	0.93	23.5	-0.32	8022
2014	8	26	13	15	14.7	232.6	47.9	0	1.23	274.8	-0.26	8020.7
2014	8	26	14	16.4	15.9	777.8	40	0	1.09	178.3	-0.55	8019.3
2014	8	26	15	17.5	16.8	930	38.6	0	1.91	198.3	-0.73	8018
2014	8	26	16	17.9	17.4	371	37.1	0	1.96	162.3	-0.57	8015.3
2014	8	26	17	18	17.6	220.7	37.3	0	1.73	83.8	-0.43	8012.7
2014	8	26	18	18.4	17.9	371.3	36.1	0	2.12	208.4	-0.53	8010
2014	8	26	19	18.4	18.1	177.6	35.9	0	3.33	227.4	-0.32	8008.7
2014	8	26	20	17.4	17.4	64	46.8	0	1.06	239.6	0.01	8007.3
2014	8	26	21	14.7	14.9	18.3	59.7	0	1	225.5	0.12	8008.7
2014	8	26	22	12.6	12.7	0.1	64.5	0	1.01	238.9	0.14	8014
2014	8	26	23	10.5	10.8	0.1	74.4	0	1.36	234.8	0.31	8020.7
2014	8	26	24	9.2	9.5	0.1	78.3	0	1.54	237.1	0.35	8023.3
2014	8	27	1	8.3	8.6	0.1	79.8	0	1.59	235.9	0.33	8024.7
2014	8	27	2	7.5	8	0.1	83.1	0	1.55	237.5	0.53	8026
2014	8	27	3	7.1	7.6	0.1	82.9	0	1.56	239.3	0.52	8026
2014	8	27	4	6.6	7.3	0.1	82.2	0	1.28	237.7	0.61	8026
2014	8	27	5	5.9	6.8	0.1	83.4	0	1.53	235.8	0.91	8027.3
2014	8	27	6	5.7	6.5	0.1	84.9	0	1.38	239.9	0.78	8027.3
2014	8	27	7	5.4	6.3	0.7	86.2	0	1.21	232	0.93	8027.3
2014	8	27	8	5.4	6.2	22.5	83.6	0	1.12	241.2	0.83	8032.7
2014	8	27	9	7.2	7.5	231.7	75.2	0	0.7	229.8	0.3	8034
2014	8	27	10	11.5	11.1	419.2	52.3	0	0.66	121.2	-0.44	8034
2014	8	27	11	15.5	14.7	588.3	39.1	0	1.68	67.8	-0.8	8034
2014	8	27	12	18.4	17.6	723.4	33.4	0	3.33	130	-0.81	8032.7
2014	8	27	13	19.3	18.5	820	30.8	0	2.94	194.9	-0.86	8031.3
2014	8	27	14	20.3	19.3	860	28.8	0	3.35	160.9	-1.06	8028.7
2014	8	27	15	20.8	19.9	847	27.4	0	3.15	56.2	-0.99	8026
2014	8	27	16	21.8	20.5	780.7	27.3	0	3.82	65.3	-1.23	8023.3
2014	8	27	17	22.2	21.1	643.8	25.1	0	4.4	65.1	-1.09	8019.3
2014	8	27	18	22.4	21.6	499	25.7	0	3.45	87	-0.79	8018
2014	8	27	19	21.7	21.4	252.4	30.3	0	1.91	284.3	-0.31	8018
2014	8	27	20	19.9	20.4	15.9	44.1	0	1.49	269	0.44	8016.7
2014	8	27	21	15.9	16.3	3.9	55.8	0	2.05	229	0.41	8019.3
2014	8	27	22	14.1	14.3	0.1	62.6	0	1.1	234.8	0.24	8023.3

2014	8	27	23	12.1	12.5	0.1	67.7	0	1.56	235.7	0.42	8028.7
2014	8	27	24	10.7	11.3	0.1	80.7	0	1.45	238	0.59	8027.3
2014	8	28	1	9.8	10.5	0.1	74.2	0	1.73	236.2	0.71	8027.3
2014	8	28	2	9.2	9.8	0.1	75.3	0	1.61	236.8	0.64	8027.3
2014	8	28	3	8.5	9.4	0.1	74.7	0	1.53	238.8	0.92	8026
2014	8	28	4	8	8.8	0.1	79.5	0	1.64	236.7	0.85	8024.7
2014	8	28	5	7.4	8.5	0.1	84.3	0	1.47	236.9	1.12	8026
2014	8	28	6	7.3	8.3	0.1	78.3	0	1.5	235.2	1.07	8026
2014	8	28	7	7	8.2	0.6	79.2	0	1.14	235.6	1.15	8024.7
2014	8	28	8	7.4	8.6	37.3	73.5	0	0.88	236	1.16	8024.7
2014	8	28	9	10.5	10.5	260.6	52.3	0	0.94	223.7	0.01	8027.3
2014	8	28	10	13.7	13.3	290.1	50.8	0	0.99	80.3	-0.43	8023.3
2014	8	28	11	17.4	16.5	543.4	31.3	0	2.37	79.7	-0.85	8018
2014	8	28	12	21	20.4	712.5	31.6	0	6.33	226.8	-0.62	8018
2014	8	28	13	21.8	20.9	810	29.1	0	6.53	219.6	-0.88	8016.7
2014	8	28	14	22.4	21.4	874	28.2	0	6.66	219.1	-1.01	8012.7
2014	8	28	15	22.8	22	851	21	0	5.65	232.8	-0.82	8008.7
2014	8	28	16	23.2	22.3	777.2	18.8	0	5.57	222.3	-0.9	8006
2014	8	28	17	23.2	22.5	623.2	20.2	0	5.07	214.7	-0.77	8002
2014	8	28	18	23.2	22.4	498.5	23	0	5.38	222.5	-0.77	7998
2014	8	28	19	22.3	21.9	245.9	25	0	4.08	227.1	-0.48	7998
2014	8	28	20	20.9	20.9	31.9	28	0	2.86	249.4	-0.03	7996.7
2014	8	28	21	18.4	18.7	3.4	43.6	0	1.41	238.8	0.32	7998
2014	8	28	22	15.9	16.2	0.1	47.3	0	0.81	247.3	0.27	7999.3
2014	8	28	23	13.4	13.7	0	52.4	0	1.14	236.5	0.33	8002
2014	8	28	24	12.1	12.4	0	57.7	0	1.49	239.6	0.35	8002
2014	8	29	1	10.4	11.1	0.1	63.3	0	1.27	228.4	0.67	8003.3
2014	8	29	2	9.5	10.2	0.1	72	0	1.35	235.8	0.72	8003.3
2014	8	29	3	9.1	9.8	0.1	71.8	0	1.43	242.3	0.66	8003.3
2014	8	29	4	8.3	9	0.1	77.3	0	1.7	232.3	0.65	8003.3
2014	8	29	5	7.9	8.7	0.1	78.8	0	1.38	234.8	0.77	7999.3
2014	8	29	6	7.4	8.4	0.1	82.2	0	1.14	236.3	0.97	7999.3
2014	8	29	7	7.3	8.1	0.5	84.3	0	1.53	234.7	0.75	7999.3
2014	8	29	8	6.9	7.6	20.7	82	0	1.45	237	0.7	7998
2014	8	29	9	9	9	220.8	64.7	0	0.48	222.1	0.02	7998
2014	8	29	10	12.8	12.3	407.7	48	0	0.84	109	-0.46	7996.7
2014	8	29	11	17.3	16.8	576.9	29.7	0	2.11	101.5	-0.55	7994
2014	8	29	12	20	19.4	713.1	26.5	0	6.15	234.7	-0.56	7990
2014	8	29	13	20.9	20.3	808	25.7	0	6.02	240.9	-0.62	7987.3
2014	8	29	14	21.6	20.8	851	25	0	6.9	239.1	-0.73	7984.7
2014	8	29	15	22.6	21.6	839	25.2	0	6.48	222.4	-1.01	7979.3
2014	8	29	16	22.9	22	787.1	24	0	7.5	232.3	-0.91	7975.3
2014	8	29	17	22.8	22.1	633.8	24.2	0	6.78	237.6	-0.67	7970
2014	8	29	18	22.9	22.2	479.1	23.3	0	6.28	235	-0.65	7966
2014	8	29	19	21.9	21.5	133.4	25	0	4.61	235.3	-0.31	7963.3
2014	8	29	20	20.8	20.7	39	30.4	0	2.87	254.7	-0.05	7960.7
2014	8	29	21	17.2	17.6	2.9	46	0	0.9	238.7	0.4	7958
2014	8	29	22	14.3	14.6	0.1	48	0	1.41	242.3	0.26	7958
2014	8	29	23	12.9	13.3	0	50.1	0	1.71	240.9	0.34	7958
2014	8	29	24	12.5	13	0	58.2	0	1.01	241.3	0.44	7954
2014	8	30	1	16	16.2	0.1	39	0	4.08	238.2	0.17	7952.7
2014	8	30	2	14.4	14.4	0.1	75.8	0.01	2.92	258.3	-0.04	7955.3
2014	8	30	3	10	9.8	0	94.3	0.02	1.66	82.5	-0.16	7967.3
2014	8	30	4	9.8	9.7	0.1	96.8	0.03	0.98	209.3	-0.09	7960.7
2014	8	30	5	9.3	9.1	0.1	98.9	0	0.76	84	-0.14	7959.3
2014	8	30	6	8.8	8.7	0.1	99.5	0	0.69	251.4	-0.06	7952.7
2014	8	30	7	8.1	8.2	0.2	99.2	0	0.78	234.8	0.06	7951.3
2014	8	30	8	7.7	7.6	17.3	99.3	0	0.44	246.6	-0.02	7948.7
2014	8	30	9	8	7.8	67	98.5	0	0.63	346.4	-0.2	7950
2014	8	30	10	9.1	8.8	215.3	86.6	0	0.3	171.6	-0.28	7952.7
2014	8	30	11	11.1	10.6	301.5	86.7	0	1.2	110.6	-0.54	7951.3

2014	8	30	12	13.3	12.4	515.2	67	0	3.43	47.1	-0.84	7950
2014	8	30	13	14	13.5	375.7	52.7	0	3.69	87.8	-0.55	7947.3
2014	8	30	14	15	14.4	548.7	44.4	0	3.67	213.8	-0.6	7946
2014	8	30	15	15.6	15	362.2	44.9	0	5.57	219.8	-0.6	7943.3
2014	8	30	16	15.3	14.8	337.1	45.2	0	5.28	221.9	-0.52	7940.7
2014	8	30	17	15	14.5	245.3	49.3	0	5.29	221.6	-0.45	7940.7
2014	8	30	18	14.6	14.3	169.5	49	0	3.97	231.5	-0.34	7940.7
2014	8	30	19	13	12.9	90	66.1	0.02	1.83	19.3	-0.09	7938
2014	8	30	20	12.4	12.4	51.2	70.3	0	1.84	138.7	-0.04	7938
2014	8	30	21	11.1	11.1	3.6	75.7	0.12	1.91	48.3	-0.02	7936.7
2014	8	30	22	8.1	8	0.1	83.4	0.07	2.34	322.2	-0.08	7947.3
2014	8	30	23	7.2	7	0.1	95.6	0	0.69	255.6	-0.19	7951.3
2014	8	30	24	7.1	6.9	0.1	96.8	0	0.7	71.9	-0.25	7950
2014	8	31	1	7	6.7	0.1	98.4	0	0.78	62	-0.26	7951.3
2014	8	31	2	6.8	6.5	0.1	97.7	0	0.81	58.5	-0.28	7950
2014	8	31	3	6.8	6.5	0.1	98.7	0	0.54	72.3	-0.24	7950
2014	8	31	4	6.6	6.3	0.1	99.2	0	0.75	51.4	-0.28	7950
2014	8	31	5	6.5	6.3	0.1	99.6	0	0.58	72.5	-0.25	7951.3
2014	8	31	6	6.5	6.3	0.1	99.6	0.02	1.01	80.8	-0.24	7952.7
2014	8	31	7	6.4	6.1	0.2	98.7	0	2.61	60.1	-0.25	7956.7
2014	8	31	8	6.2	5.9	21.3	98.5	0	2.05	65.2	-0.29	7962
2014	8	31	9	6.7	6.4	128	88.9	0	0.68	166.5	-0.27	7963.3
2014	8	31	10	8.4	7.8	458.7	69.6	0	0.79	129.2	-0.51	7966
2014	8	31	11	9.6	9	539.5	66.9	0	1.63	156.8	-0.61	7966
2014	8	31	12	10.2	9.7	493.7	52.3	0	2.63	229.3	-0.53	7970
2014	8	31	13	11.1	10.5	612.1	54.7	0	3.7	235.7	-0.6	7970
2014	8	31	14	11.6	11.1	542.7	49.5	0	4.01	237.2	-0.52	7970
2014	8	31	15	12.9	12.1	986	44.6	0	4.86	229.2	-0.86	7971.3
2014	8	31	16	12.7	12.1	402.2	43.2	0	3.53	246.5	-0.55	7970
2014	8	31	17	13.5	12.8	604.8	40.9	0	3.93	223.9	-0.73	7967.3
2014	8	31	18	13.8	13.2	479.3	41.6	0	2.71	209	-0.66	7964.7
2014	8	31	19	13.4	12.9	184.6	43.9	0	3.63	219	-0.47	7963.3
2014	8	31	20	12.3	12.1	43.4	52	0	2.94	234.4	-0.2	7966
2014	8	31	21	10.8	10.8	4.2	62.9	0	0.76	247.4	0.07	7970
2014	8	31	22	8.7	9.1	0.1	69.8	0	1.61	242.7	0.37	7971.3
2014	8	31	23	6.9	7.1	0	80.7	0	1.38	230.6	0.24	7974
2014	8	31	24	5.9	6	0.1	85.7	0	0.89	240.2	0.19	7972.7
2014	9	1	1	5	5	0.1	85.3	0	0.91	242.6	0.04	7975.3
2014	9	1	2	3.9	4	0.1	89.1	0	1.47	235	0.15	7976.7
2014	9	1	3	3.3	3.5	0	89.1	0	1.3	239.8	0.12	7976.7
2014	9	1	4	2.7	2.9	0.1	92.2	0	1.14	233.9	0.18	7976.7
2014	9	1	5	2.2	2.4	0.1	92.7	0	1	242.7	0.21	7978
2014	9	1	6	1.3	1.7	0.1	95.9	0	1.02	237.8	0.41	7980.7
2014	9	1	7	1	1.5	0.3	93.7	0	1.12	238.2	0.42	7983.3
2014	9	1	8	1.2	1.4	17.7	93.7	0	1.06	237.8	0.25	7983.3
2014	9	1	9	2.7	2.5	229.2	81.6	0	0.43	109.4	-0.15	7986
2014	9	1	10	5.9	5.4	405.9	65	0	0.57	134.1	-0.46	7990
2014	9	1	11	9.7	8.9	576.9	49.9	0	1.7	76.4	-0.82	7988.7
2014	9	1	12	12.2	11.5	714.7	33	0	2.68	236.3	-0.67	7988.7
2014	9	1	13	13.9	13	809	32.8	0	2.85	204.7	-0.92	7988.7
2014	9	1	14	15.1	14.2	845	31.5	0	3.56	200.1	-0.93	7986
2014	9	1	15	16.1	15.1	738.4	31.5	0	3.1	154.5	-0.99	7984.7
2014	9	1	16	16.6	15.7	772.1	31.1	0	3.16	223.3	-0.88	7983.3
2014	9	1	17	17.1	16.3	641	28.5	0	3.16	223.3	-0.77	7980.7
2014	9	1	18	17.2	16.4	487.9	28.2	0	4.25	226.8	-0.85	7980.7
2014	9	1	19	16.5	16	230.7	32.9	0	3.72	235.8	-0.55	7982
2014	9	1	20	14.7	14.8	13.9	36.4	0	1.99	264.2	0.08	7982
2014	9	1	21	11.4	11.7	2.5	58.6	0	1.57	225.5	0.27	7982
2014	9	1	22	9.3	9.3	0.1	66.3	0	1.04	236.6	0.04	7984.7
2014	9	1	23	7.6	7.8	0.1	69.2	0	1.3	242	0.17	7987.3
2014	9	1	24	6	6.5	0.1	80.9	0	1.54	235.7	0.45	7988.7

2014	9	2	1	5.3	5.8	0	78.8	0	1.68	237.7	0.55	7988.7
2014	9	2	2	4.5	4.8	0.1	79.2	0	1.77	235.5	0.28	7986
2014	9	2	3	4.1	4.5	0.1	84.6	0	1.28	238.4	0.42	7982
2014	9	2	4	3.2	4	0.1	85.4	0	1.07	237.7	0.79	7979.3
2014	9	2	5	2.8	3.6	0.1	88.8	0	1.06	245.5	0.83	7978
2014	9	2	6	2.4	3.2	0.1	87.8	0	1.1	235.7	0.79	7976.7
2014	9	2	7	2.4	3.2	0.3	88.6	0	1.26	238.2	0.71	7975.3
2014	9	2	8	2.3	3.1	13.6	86.2	0	1.1	240.2	0.84	7974
2014	9	2	9	4.3	4.5	219.5	71.8	0	0.78	224.1	0.2	7974
2014	9	2	10	8.4	7.8	406	51.9	0	1.15	81.3	-0.59	7971.3
2014	9	2	11	13.8	13.3	576.6	37.3	0	2.94	210.3	-0.51	7966
2014	9	2	12	15.6	15	711.8	33.3	0	5.36	221.3	-0.58	7963.3
2014	9	2	13	17	16.2	804	29.5	0	5.2	217.3	-0.77	7959.3
2014	9	2	14	17.8	17	847	28.7	0	6.26	224.5	-0.88	7954
2014	9	2	15	18.4	17.5	829	27.9	0	6.67	233.1	-0.82	7950
2014	9	2	16	19	18.2	756.8	26.4	0	6.65	231.5	-0.79	7947.3
2014	9	2	17	19.5	18.8	640.9	20.8	0	5.99	236	-0.67	7938
2014	9	2	18	19.4	18.7	488.5	20.6	0	6.21	223.1	-0.72	7934
2014	9	2	19	18.7	18.3	225.2	22.5	0	5.12	245.2	-0.4	7931.3
2014	9	2	20	17.4	17.3	13.1	25.6	0	5.04	239.5	-0.08	7928.7
2014	9	2	21	15.1	15.3	2.2	41.9	0	1.1	244.2	0.22	7924.7
2014	9	2	22	11.3	11.9	0.1	54.9	0	1.36	231.4	0.56	7924.7
2014	9	2	23	9.2	9.9	0.1	52.2	0	1.78	235.7	0.68	7922
2014	9	2	24	8.6	9.3	0.1	54.5	0	1.75	240.4	0.75	7915.4
2014	9	3	1	8.4	9.3	0.1	60.3	0	1.65	239.1	0.84	7914
2014	9	3	2	8.4	9.6	0.1	58.9	0	1.02	239.8	1.2	7910
2014	9	3	3	8.1	9.8	0.1	66.7	0	1.11	240.6	1.7	7906
2014	9	3	4	8.4	9.5	0.1	59.4	0	0.7	280.3	1.13	7902
2014	9	3	5	8.4	9.2	0.1	60.6	0	0.47	244.3	0.82	7904.7
2014	9	3	6	8.7	9.1	0.1	57.3	0	2.15	240.3	0.36	7908.7
2014	9	3	7	8.3	8.5	0.3	67.9	0	2.88	233.2	0.24	7910
2014	9	3	8	5.5	6.1	10.2	73.6	0	1.55	49.6	0.61	7916.7
2014	9	3	9	5.7	6	55.4	59.7	0	1.18	265.1	0.33	7924.7
2014	9	3	10	8.1	7.5	402.2	48.2	0	4.88	212.9	-0.5	7930
2014	9	3	11	8.8	8.1	572	43.8	0	4.3	216.2	-0.74	7934
2014	9	3	12	9	8.5	258.6	36	0	4.12	227.8	-0.5	7939.3
2014	9	3	13	10.3	9.3	879	28.2	0	5.72	218.5	-1.01	7946
2014	9	3	14	10.9	9.9	736.9	28.2	0	4.18	209.1	-0.99	7946
2014	9	3	15	11.2	10.3	590	30.9	0	3.74	195.1	-0.9	7948.7
2014	9	3	16	11.9	11.1	723.1	29.7	0	2.99	180.5	-0.84	7951.3
2014	9	3	17	11.9	11.2	469.5	31.8	0	3.96	229.6	-0.74	7952.7
2014	9	3	18	11.7	11.1	323.6	31.4	0	3.08	191.3	-0.61	7952.7
2014	9	3	19	11.3	10.8	218.1	34.1	0	3.65	60.4	-0.5	7955.3
2014	9	3	20	10.4	10.3	24.4	36.3	0	1.78	188.5	-0.14	7959.3
2014	9	3	21	9.2	9.2	1.9	45.8	0	1.14	117.7	0.03	7962
2014	9	3	22	7.1	7.3	0.1	55.2	0	0.66	7.8	0.23	7968.7
2014	9	3	23	4.8	5.1	0.1	65.9	0	0.79	275.3	0.34	7975.3
2014	9	3	24	3.3	3.4	0.1	69.9	0	1.44	241.5	0.11	7982
2014	9	4	1	2.1	2.2	0.1	76.9	0	1.17	248.5	0.12	7984.7
2014	9	4	2	0.9	1.1	0.1	80.1	0	1.25	238.2	0.23	7984.7
2014	9	4	3	0.5	0.7	0.1	84.6	0	1.34	234.1	0.25	7986
2014	9	4	4	-0.2	-0.1	0.1	88	0	1.2	239.2	0.1	7988.7
2014	9	4	5	-0.7	-0.5	0	89.5	0	1.51	238.4	0.17	7991.3
2014	9	4	6	-1	-0.8	0	90.6	0	1.34	238.7	0.16	7990
2014	9	4	7	-1.7	-1.3	0.3	91.2	0	1.66	235.5	0.33	7991.3
2014	9	4	8	-1.7	-1.4	13.5	87.8	0	1.57	238.3	0.29	7995.3
2014	9	4	9	0.5	0.4	213.2	71.6	0	1.01	229.6	-0.09	7999.3
2014	9	4	10	4.7	4.2	401.2	51	0	0.57	184.7	-0.46	8000.7
2014	9	4	11	7.8	7.2	572	44.6	0	1.65	242.8	-0.6	8000.7
2014	9	4	12	9.8	8.8	709.3	31.5	0	2.61	217.5	-0.92	8002
2014	9	4	13	10.8	10.1	803	26.2	0	1.97	247.9	-0.74	8000.7

2014	9	4	14	12.3	11.5	842	24	0	1.51	229.7	-0.75	7998
2014	9	4	15	13.7	12.9	826	23.7	0	1.46	85.7	-0.87	7995.3
2014	9	4	16	15.2	14.1	752.1	21.2	0	2.27	55.4	-1.05	7995.3
2014	9	4	17	15.6	14.9	632.3	20.4	0	1.1	94.7	-0.7	7990
2014	9	4	18	16.1	15.3	475.4	21.1	0	1.57	87	-0.73	7990
2014	9	4	19	15.5	15.1	211.2	24.5	0	1.38	28.4	-0.43	7988.7
2014	9	4	20	13.7	13.7	14.3	31.4	0	0.82	120.1	0.07	7988.7
2014	9	4	21	11	11.2	1.9	47.5	0	0.92	237.9	0.25	7992.7
2014	9	4	22	8.1	8.2	0.1	52.3	0	1.44	238.3	0.14	7999.3
2014	9	4	23	6.3	6.6	0.1	55.3	0	1.21	243.4	0.34	8003.3
2014	9	4	24	5	5.3	0.1	61.7	0	1.54	233.7	0.34	8006
2014	9	5	1	3.8	4.3	0.1	63.4	0	1.65	235.8	0.51	8010
2014	9	5	2	2.9	3.8	0.1	71.2	0	1.71	236.3	0.9	8014
2014	9	5	3	2.8	3.4	0.1	68.6	0	1.67	236.3	0.63	8014
2014	9	5	4	2.2	2.8	0.1	77.7	0	1.56	239.3	0.63	8012.7
2014	9	5	5	1.5	2.3	0.1	77.4	0	1.79	237.5	0.86	8016.7
2014	9	5	6	1.4	2.2	0	75.8	0	1.82	236.8	0.71	8018
2014	9	5	7	1.2	2.1	0.2	76.2	0	1.73	239.9	0.83	8019.3
2014	9	5	8	1.2	2	11.9	81.8	0	1.73	240.5	0.84	8022
2014	9	5	9	3.5	4.2	210.6	57.9	0	1.35	238.7	0.68	8027.3
2014	9	5	10	8.6	8.3	398.4	35.8	0	0.75	213.8	-0.31	8027.3
2014	9	5	11	12.5	12	570.9	30.5	0	0.81	259.3	-0.45	8026
2014	9	5	12	14.9	14.1	709.3	23	0	1.96	198.7	-0.83	8027.3
2014	9	5	13	15.9	14.9	802	19.7	0	2.28	206.8	-0.95	8027.3
2014	9	5	14	16.8	15.8	839	19.3	0	2.43	229	-0.97	8026
2014	9	5	15	17.5	16.8	823	17.4	0	1.31	58.3	-0.67	8023.3
2014	9	5	16	18.6	17.9	750.2	17.1	0	1.45	67.1	-0.7	8020.7
2014	9	5	17	19.3	18.6	629	16	0	1.84	242.6	-0.76	8016.7
2014	9	5	18	19.5	18.9	470.1	16.8	0	1.24	185.8	-0.63	8016.7
2014	9	5	19	18.9	18.6	205.7	18	0	1.47	40.5	-0.25	8014
2014	9	5	20	17.3	17.4	14.1	27.4	0	1.33	323.7	0.11	8014
2014	9	5	21	12.3	12.7	1.7	38.6	0	2.29	230.9	0.39	8016.7
2014	9	5	22	9.6	10	0.1	45.6	0	1.66	240.3	0.35	8023.3
2014	9	5	23	7.3	8.1	0.1	48.9	0	1.85	237.2	0.72	8030
2014	9	5	24	6.7	7.7	0.1	48.3	0	1.72	238	0.97	8032.7
2014	9	6	1	6.1	6.9	0	48	0	1.81	238.9	0.88	8034
2014	9	6	2	5.4	6.4	0.1	59.2	0	1.67	236.9	0.99	8035.3
2014	9	6	3	4.6	5.8	0.1	60.5	0	1.78	236.7	1.17	8036.7
2014	9	6	4	4.5	5.6	0.1	53.9	0	1.79	238	1.09	8036.7
2014	9	6	5	4.2	5.3	0.1	55.6	0	1.84	239.7	1.05	8036.7
2014	9	6	6	4	5.1	0.1	64.2	0	1.82	236.9	1.15	8036.7
2014	9	6	7	3.4	4.5	0.2	66	0	1.76	239.4	1.14	8036.7
2014	9	6	8	2.6	4.6	11.1	65.9	0	2.02	237.6	2	8038
2014	9	6	9	5.6	6.3	208.1	48.4	0	1.86	235.9	0.68	8036.7
2014	9	6	10	11	10.9	395.6	30.5	0	1.03	222.3	-0.08	8036.7
2014	9	6	11	16.2	15.6	570.5	20.1	0	0.87	141.4	-0.61	8032.7
2014	9	6	12	18	17.3	710.6	14.4	0	2.41	176.8	-0.74	8031.3
2014	9	6	13	19.1	18.2	804	14.6	0	2.81	183.9	-0.89	8028.7
2014	9	6	14	19.9	19	836	14.7	0	2.7	167.1	-0.91	8023.3
2014	9	6	15	20.8	20	822	13.5	0	2.99	203.6	-0.81	8019.3
2014	9	6	16	21.1	20.4	742.3	14.6	0	3.82	241.6	-0.74	8015.3
2014	9	6	17	21.6	20.9	621.7	13.3	0	3.92	247.2	-0.69	8010
2014	9	6	18	21.7	21	461.8	13.2	0	4.02	242.2	-0.74	8006
2014	9	6	19	20.7	20.4	199.2	15.4	0	2.82	267.3	-0.25	8002
2014	9	6	20	18	18.3	14.7	28.1	0	2.16	248.6	0.3	7998
2014	9	6	21	13.6	13.9	1.4	30.5	0	1.63	235.8	0.28	7998
2014	9	6	22	10.6	11	0.1	37.4	0	2.02	235.4	0.44	8000.7
2014	9	6	23	9	9.7	0.1	46.8	0	1.9	232.9	0.68	8003.3
2014	9	6	24	7.7	8.5	0.1	47.3	0	1.74	238	0.79	8002
2014	9	7	1	6.5	7.4	0.1	52.4	0	1.95	234.6	0.9	8002
2014	9	7	2	6.4	7.4	0.1	58.2	0	1.59	239.2	0.97	8002

2014	9	7	3	5.6	6.5	0.1	61	0	1.72	235.1	0.88	8004.7
2014	9	7	4	4.7	5.9	0.1	61.6	0	1.9	234.2	1.12	8002
2014	9	7	5	4.6	5.6	0.1	60.3	0	1.67	234.3	1	7999.3
2014	9	7	6	4.4	6	0.1	57	0	1.75	235.2	1.68	7996.7
2014	9	7	7	5.1	6.2	0.2	54.2	0	1.48	234.7	1.04	7995.3
2014	9	7	8	4.9	6.1	22.7	59.7	0	1.04	260.6	1.18	7995.3
2014	9	7	9	6.8	7.4	192.1	42.3	0	1.49	235.2	0.58	7996.7
2014	9	7	10	11.3	11.1	364	27.9	0	0.38	134.9	-0.25	7995.3
2014	9	7	11	15.8	15.3	552.7	22.9	0	0.84	98.1	-0.52	7992.7
2014	9	7	12	20	19.4	691.9	14.5	0	1.05	80.6	-0.58	7988.7
2014	9	7	13	22.1	21.2	791.4	15	0	4.74	215.1	-0.85	7983.3
2014	9	7	14	22.5	21.6	742.7	14.6	0	4.24	232.1	-0.83	7980.7
2014	9	7	15	23.2	22.3	786.4	14.2	0	5.42	219.8	-0.88	7976.7
2014	9	7	16	22.4	21.8	335.8	14.4	0	4.58	219.4	-0.54	7974
2014	9	7	17	21.8	21.5	166.3	16.4	0	4.08	206.8	-0.36	7970
2014	9	7	18	22.1	21.8	227	14.8	0	4.11	207.9	-0.33	7968.7
2014	9	7	19	22	21.7	173.9	15.8	0	4.81	236.7	-0.26	7964.7
2014	9	7	20	20.4	20.6	15.9	18.6	0	2.09	255.8	0.16	7963.3
2014	9	7	21	16.6	17.2	1.1	33.8	0	1.2	237.9	0.65	7960.7
2014	9	7	22	12.4	12.9	0.1	39.1	0	2.41	236.7	0.52	7963.3
2014	9	7	23	10.8	11.4	0.1	42.4	0	1.82	238.8	0.59	7966
2014	9	7	24	9.8	10.5	0.1	43.9	0	1.52	239.6	0.63	7966
2014	9	8	1	8.4	9.3	0.1	45.5	0	1.77	234.7	0.93	7968.7
2014	9	8	2	7.5	8.6	0.1	46.4	0	2.28	235.3	1.11	7967.3
2014	9	8	3	7.4	8.4	0.1	51.7	0	1.67	239.3	0.99	7964.7
2014	9	8	4	6.7	7.9	0	47.7	0	1.74	231.1	1.23	7967.3
2014	9	8	5	6.4	7.7	0.1	50	0	1.39	238.1	1.35	7966
2014	9	8	6	6.1	7.6	0.1	51.5	0	1.17	240.4	1.48	7964.7
2014	9	8	7	5	6.7	0.1	52.7	0	1.41	238.1	1.7	7963.3
2014	9	8	8	5	6.4	13.1	51.2	0	1.78	234.8	1.38	7963.3
2014	9	8	9	6.9	8	183.4	53.5	0	1.11	240	1.09	7963.3
2014	9	8	10	11	10.8	366.1	29.9	0	0.52	224.7	-0.2	7963.3
2014	9	8	11	16.1	15.4	531.8	23.3	0	2.38	93.2	-0.73	7959.3
2014	9	8	12	19.9	19.2	661.8	17.2	0	4.1	186	-0.72	7958
2014	9	8	13	20.7	20.1	739.6	15.8	0	6.16	230.3	-0.67	7956.7
2014	9	8	14	20.6	20	531.8	17.3	0	5.42	220.6	-0.66	7955.3
2014	9	8	15	21.1	20.4	663.7	15.9	0	4.89	221	-0.71	7952.7
2014	9	8	16	21.6	20.7	647.7	16.7	0	6.62	221.1	-0.82	7948.7
2014	9	8	17	21.5	20.8	550.5	16.5	0	6.26	222.1	-0.68	7944.7
2014	9	8	18	21.2	20.7	402.1	16.7	0	6.25	225.8	-0.57	7940.7
2014	9	8	19	20.7	20.3	194.1	19.4	0	4.63	227.2	-0.39	7936.7
2014	9	8	20	19	19.1	28.2	23	0	1.83	258.8	0.18	7936.7
2014	9	8	21	14.7	15.4	0.8	37.7	0	1.8	231.6	0.63	7938
2014	9	8	22	11.8	12.2	0.1	38	0	1.72	235.5	0.38	7942
2014	9	8	23	10.3	10.7	0.1	40.5	0	1.82	236.8	0.41	7946
2014	9	8	24	9.5	9.8	0.1	43.8	0	1.51	238.1	0.32	7946
2014	9	9	1	7.7	8.6	0.1	53.7	0	1.73	233.1	0.86	7948.7
2014	9	9	2	7.1	7.9	0	50	0	1.94	236.9	0.78	7948.7
2014	9	9	3	7.2	8	0.1	55.7	0	1.16	240.8	0.84	7947.3
2014	9	9	4	6.2	7.3	0.1	62.5	0	1.42	228	1.1	7947.3
2014	9	9	5	6	7	0.1	54.5	0	1.32	238.1	0.97	7948.7
2014	9	9	6	4.9	6.1	0.1	55.6	0	1.54	234.2	1.15	7947.3
2014	9	9	7	4.2	5.5	0.1	55	0	1.43	234.8	1.36	7947.3
2014	9	9	8	3.8	4.9	11.4	59.5	0	1.41	238.5	1.17	7948.7
2014	9	9	9	5	5.7	181.9	49.8	0	1.06	247.6	0.72	7951.3
2014	9	9	10	9.8	9.4	383.6	34.6	0	0.87	198	-0.4	7950
2014	9	9	11	14.4	13.7	548.5	20.7	0	4.26	157.8	-0.72	7948.7
2014	9	9	12	16.1	15.2	682	18.7	0	6.02	222.5	-0.85	7950
2014	9	9	13	16.4	15.6	770.6	16.9	0	6.01	233	-0.78	7952.7
2014	9	9	14	17.2	16.2	805	19.1	0	5.15	223.2	-1.03	7951.3
2014	9	9	15	17.5	16.4	792.6	18.2	0	4.96	218.7	-1.04	7951.3

2014	9	9	16	17.6	16.7	641.2	21.8	0	4.77	221.2	-0.93	7951.3
2014	9	9	17	17.4	16.7	598.6	24.6	0	3.62	243.8	-0.7	7948.7
2014	9	9	18	17.3	16.5	439.7	24.2	0	3.92	230.1	-0.79	7950
2014	9	9	19	16.1	15.6	181	38.2	0	3.88	233.7	-0.55	7952.7
2014	9	9	20	13.6	13.4	13.4	45.9	0	2.99	73.5	-0.18	7958
2014	9	9	21	12.1	12.1	0.8	52	0	1.16	137.7	-0.06	7962
2014	9	9	22	10.5	10.5	0.1	59	0	1.81	82.5	0.08	7970
2014	9	9	23	8.7	9	0	66.5	0	0.51	218.7	0.28	7979.3
2014	9	9	24	7	7.1	0.1	73.1	0	0.96	271.1	0.08	7980.7
2014	9	10	1	5.2	5.4	0	78.7	0	1.41	245.4	0.12	7984.7
2014	9	10	2	4.1	4.4	0	82.4	0	1.35	241.9	0.24	7987.3
2014	9	10	3	3.2	3.3	0	83.7	0	1.26	237.4	0.15	7988.7
2014	9	10	4	2.3	2.6	0.1	86.7	0	1.23	240.5	0.3	7988.7
2014	9	10	5	1.4	1.7	0.1	87.3	0	1.45	238.1	0.27	7988.7
2014	9	10	6	1	1.3	0	89.1	0	1.38	240.4	0.3	7990
2014	9	10	7	0.9	1.2	0.1	88.5	0	1.17	241	0.26	7991.3
2014	9	10	8	0.6	0.8	10.2	90.1	0	1.43	240.2	0.22	7995.3
2014	9	10	9	2.3	2.4	183.3	75.4	0	1.24	249.2	0.13	7998
2014	9	10	10	6.5	6	369.3	58.2	0	0.94	215	-0.52	7994
2014	9	10	11	9.7	8.3	536.1	43.1	0	3.92	67.4	-1.35	7994
2014	9	10	12	10.6	9.6	591.3	41.4	0	3.79	134.3	-1.03	7995.3
2014	9	10	13	11.5	10.4	757.9	35.7	0	4.65	199.5	-1.11	7995.3
2014	9	10	14	12.5	11.6	665.2	33.8	0	2.37	115.9	-0.91	7992.7
2014	9	10	15	13.6	12.7	574.5	31.4	0	2.83	191.5	-0.85	7988.7
2014	9	10	16	13.7	12.8	518.5	31.7	0	4.37	208.5	-0.88	7987.3
2014	9	10	17	13.9	12.9	639.9	30.6	0	6.52	222.3	-0.98	7984.7
2014	9	10	18	13	12.4	329.9	32.6	0	4.12	200.5	-0.6	7986
2014	9	10	19	11.8	11.3	148.8	39.9	0	3.74	89.4	-0.47	7986
2014	9	10	20	10.3	10	21	41.5	0	3.61	85.2	-0.23	7990
2014	9	10	21	9	9	0.7	43.7	0	1.89	95.9	-0.02	7992.7
2014	9	10	22	7.1	7.3	0.1	54.3	0	1.36	29.4	0.16	7996.7
2014	9	10	23	4.7	5.1	0.1	62.8	0	0.86	304.4	0.35	8000.7
2014	9	10	24	3.2	3.3	0.1	67.8	0	1.54	249.1	0.01	8003.3
2014	9	11	1	1.8	1.9	0	71.9	0	1.19	243.3	0.1	8004.7
2014	9	11	2	0.4	0.5	0	78.1	0	1.27	232.5	0.15	8006
2014	9	11	3	-0.6	-0.3	0	77.4	0	1.42	241	0.22	8008.7
2014	9	11	4	-1.1	-1	0	78.9	0	1.56	235.2	0.1	8008.7
2014	9	11	5	-1.7	-1.6	0	81.9	0	1.32	236.4	0.11	8008.7
2014	9	11	6	-2.3	-2.2	0.1	82.5	0	1.2	238.9	0.16	8011.3
2014	9	11	7	-3	-2.7	0.1	84.6	0	1.02	235.8	0.27	8012.7
2014	9	11	8	-3.4	-3.2	8.8	82.4	0	1.16	240	0.22	8019.3
2014	9	11	9	-2.2	-2.2	182.4	64.4	0	0.97	233.7	0	8022
2014	9	11	10	1.9	1.2	311.3	53.8	0	2.17	79.8	-0.65	8027.3
2014	9	11	11	3.7	2.9	541.8	45.8	0	3.09	73.3	-0.79	8030
2014	9	11	12	5.2	4.4	685.7	37.1	0	3.54	57.7	-0.88	8034
2014	9	11	13	7.3	6.1	778.8	28.7	0	3.29	57.1	-1.18	8036.7
2014	9	11	14	8.7	7.5	817	26.2	0	3.36	75	-1.15	8035.3
2014	9	11	15	9.5	8.6	802	19.4	0	3.17	52.6	-0.91	8034
2014	9	11	16	11	9.9	729.4	14.8	0	4.18	77.3	-1.15	8032.7
2014	9	11	17	11.3	10.4	610.3	12.8	0	3.36	63.8	-0.85	8030
2014	9	11	18	11.2	10.6	449.6	13.9	0	2.74	61.6	-0.59	8028.7
2014	9	11	19	11	10.6	176	15.5	0	1.55	18.3	-0.41	8028.7
2014	9	11	20	8.6	9	10.9	32.6	0	0.97	336.2	0.43	8030
2014	9	11	21	4.5	4.8	0.6	36	0	1.86	236.9	0.31	8028.7
2014	9	11	22	2.5	2.6	0	39.4	0	2.05	238.6	0.17	8034
2014	9	11	23	1.2	1.5	0	42.4	0	1.87	238.6	0.31	8038
2014	9	11	24	0.2	0.5	0	49.3	0	1.77	239	0.31	8036.7
2014	9	12	1	-0.6	0.3	0	49.2	0	1.75	240.7	0.93	8039.3
2014	9	12	2	-0.6	-0.1	0	49.8	0	2.09	237.4	0.53	8038
2014	9	12	3	-0.6	-0.3	0	50.6	0	1.83	241.2	0.25	8038
2014	9	12	4	-1.4	-0.8	0.1	58.3	0	2.19	235.2	0.62	8038

2014	9	12	5	-1.7	-0.9	0.1	58.2	0	2.46	231.1	0.78	8036.7
2014	9	12	6	-1.9	-1.3	0.1	62.4	0	2.23	235.3	0.61	8035.3
2014	9	12	7	-1.9	-1.2	0.1	63.2	0	2.13	233.8	0.72	8032.7
2014	9	12	8	-1.9	-1.3	8.1	64.7	0	1.64	242.6	0.61	8032.7
2014	9	12	9	-0.4	0	183.4	47.3	0	1.8	233.9	0.4	8031.3
2014	9	12	10	3.9	3.4	375.2	36.4	0	0.69	113.2	-0.45	8027.3
2014	9	12	11	8.8	8.3	548.9	28.7	0	1.19	138	-0.55	8024.7
2014	9	12	12	11.4	10.4	684.2	24.8	0	2.46	179.5	-0.93	8020.7
2014	9	12	13	13.3	12.5	774	22	0	1.87	231.9	-0.81	8015.3
2014	9	12	14	15.1	14.3	809	17.9	0	4.5	236.8	-0.78	8006
2014	9	12	15	16.3	15.4	789.8	20.4	0	4.99	239.1	-0.85	7998
2014	9	12	16	17	16.2	715.8	15.7	0	5.9	244.8	-0.78	7995.3
2014	9	12	17	17.2	16.4	596.3	17.3	0	6.24	235.5	-0.75	7994
2014	9	12	18	17.3	16.6	433.2	17.3	0	5.05	218.4	-0.72	7990
2014	9	12	19	16.6	16.2	164.6	18.1	0	4.05	236.3	-0.43	7987.3
2014	9	12	20	14.4	14.7	10.5	23.9	0	0.95	289.3	0.28	7986
2014	9	12	21	9.6	10.4	0.5	36.8	0	1.17	237.1	0.76	7986
2014	9	12	22	8	8.3	0.1	38.9	0	1.24	242.5	0.29	7988.7
2014	9	12	23	6.2	6.6	0.1	46.2	0	1.65	236.5	0.46	7992.7
2014	9	12	24	4.7	5.3	0.1	52.2	0	1.84	232	0.67	7995.3
2014	9	13	1	3.9	4.7	0	49.1	0	1.71	235.5	0.77	7996.7
2014	9	13	2	2.8	3.8	0	54.8	0	1.31	243.1	0.91	7995.3
2014	9	13	3	2.1	3.2	0	58.7	0	1.78	238	1.13	7996.7
2014	9	13	4	2	3.1	0	57.4	0	1.33	240	1.16	7995.3
2014	9	13	5	1.6	2.7	0	58.1	0	1.63	231.2	1.12	7996.7
2014	9	13	6	1.1	2.3	0	60.2	0	1.71	234	1.2	7994
2014	9	13	7	0.9	2.1	0.1	67	0	1.41	234.3	1.21	7992.7
2014	9	13	8	0.8	2.1	7.8	55.3	0	1.41	235.1	1.27	7994
2014	9	13	9	2.3	3.3	175	50.2	0	1.12	235	1.01	7995.3
2014	9	13	10	6.9	6.6	363.6	32.5	0	0.6	188.5	-0.23	7994
2014	9	13	11	11.9	11.1	533.7	27.2	0	1.52	93.8	-0.83	7991.3
2014	9	13	12	16.5	15.6	670.6	22.2	0	3.71	189.1	-0.9	7988.7
2014	9	13	13	17.9	17.1	757.4	18.1	0	5.55	228.6	-0.83	7984.7
2014	9	13	14	19	18.1	794.4	18.7	0	5.41	219.2	-0.91	7980.7
2014	9	13	15	19.7	18.7	774.5	18.9	0	5.72	211	-0.98	7979.3
2014	9	13	16	20	19.1	684	18	0	7.41	216.9	-0.98	7976.7
2014	9	13	17	20.2	19.4	569.7	16.4	0	6.15	218.4	-0.8	7975.3
2014	9	13	18	20.1	19.5	408	15.4	0	5.52	228.7	-0.66	7972.7
2014	9	13	19	19.3	19	156.5	20.4	0	3.04	241.4	-0.32	7971.3
2014	9	13	20	16.5	17	16.6	31.5	0	1.57	251.3	0.49	7970
2014	9	13	21	11.9	12.2	0.4	35.6	0	1.94	232.4	0.32	7970
2014	9	13	22	10.4	10.7	0.1	39.3	0	0.94	248.8	0.29	7974
2014	9	13	23	8.5	9.1	0.1	45.8	0	1.7	236.5	0.63	7975.3
2014	9	13	24	6.9	7.7	0.1	49.1	0	1.98	234.4	0.79	7978
2014	9	14	1	6.3	7	0.1	52.8	0	1.85	232.2	0.73	7978
2014	9	14	2	5.7	6.7	0.1	50.2	0	1.48	235.7	0.96	7978
2014	9	14	3	4.7	6.1	0.1	57.2	0	1.6	231.4	1.38	7980.7
2014	9	14	4	4.3	5.4	0	59.4	0	1.55	233.5	1.08	7979.3
2014	9	14	5	4.2	5.5	0.1	54.6	0	1.44	232.3	1.22	7980.7
2014	9	14	6	3.7	5	0	66.2	0	1.03	235.1	1.35	7980.7
2014	9	14	7	3.5	4.9	0.1	52.8	0	1.93	224.5	1.46	7984.7
2014	9	14	8	3.5	4.6	11.3	58.8	0	1.12	240.9	1.13	7986
2014	9	14	9	4.8	5.7	155.1	50.1	0	0.95	235.9	0.96	7988.7
2014	9	14	10	8.9	8.8	335.9	33.9	0	0.52	180.5	-0.08	7990
2014	9	14	11	14.1	13.2	510.1	26	0	2.39	82.2	-0.96	7990
2014	9	14	12	18.4	17.4	649.7	17	0	2.99	61.7	-1.03	7990
2014	9	14	13	20.1	19.2	743.3	19.4	0	3.7	193.3	-0.91	7990
2014	9	14	14	20.6	19.6	777	18.3	0	5.43	216.3	-0.98	7990
2014	9	14	15	21.1	20.1	757.9	16.9	0	4.9	218.9	-0.95	7990
2014	9	14	16	21.6	20.6	679.1	17.6	0	4.1	202.1	-1.02	7987.3
2014	9	14	17	21.5	20.8	561.4	17.1	0	3.23	218.6	-0.75	7986

2014	9	14	18	21.4	20.8	395.6	17	0	3.29	224.6	-0.59	7984.7
2014	9	14	19	20.6	20.3	143.7	19.8	0	1.61	260.7	-0.27	7986
2014	9	14	20	17.3	17.8	14.7	32	0	1.3	233.8	0.44	7986
2014	9	14	21	13.3	13.5	0.3	34.4	0	1.65	234	0.24	7987.3
2014	9	14	22	11.2	11.7	0.1	41.1	0	1.81	232.2	0.43	7992.7
2014	9	14	23	9.7	10.3	0.1	41.7	0	1.73	235.7	0.61	7995.3
2014	9	14	24	8.1	9.1	0	44.7	0	1.94	235.4	1.02	7998
2014	9	15	1	7.6	8.5	0	49.2	0	1.83	236.6	0.89	8000.7
2014	9	15	2	6.9	7.9	0.1	49.3	0	1.9	236	0.95	8004.7
2014	9	15	3	6	7.2	0.1	50.9	0	1.87	238.4	1.18	8007.3
2014	9	15	4	5.8	6.9	0.1	51.4	0	1.89	233.3	1.09	8007.3
2014	9	15	5	5.3	6.6	0.1	55.3	0	1.76	235.6	1.23	8008.7
2014	9	15	6	5	6.1	0.1	56	0	1.85	236.5	1.17	8010
2014	9	15	7	4.4	5.8	0.1	59.6	0	1.87	235.6	1.49	8014
2014	9	15	8	4.9	6	8.5	57.8	0	1.82	232.9	1.14	8014
2014	9	15	9	6.2	7.2	152.6	48.4	0	1.18	237.6	0.99	8016.7
2014	9	15	10	10	9.9	339.3	35.7	0	0.33	154	-0.13	8019.3
2014	9	15	11	14.9	14.3	509.4	27.9	0	0.92	104.1	-0.57	8018
2014	9	15	12	19.5	18.8	645.5	18.2	0	1.3	150	-0.65	8015.3
2014	9	15	13	21.2	20.4	724.3	19.5	0	2.71	202.3	-0.81	8012.7
2014	9	15	14	21.3	20.5	422	19.2	0	3.55	73.7	-0.8	8012.7
2014	9	15	15	21.9	21.2	570	17.8	0	2.77	44.1	-0.71	8010
2014	9	15	16	22.6	21.8	630.3	19.9	0	3.26	231.2	-0.81	8006
2014	9	15	17	22.9	22.2	528.3	18.6	0	4.15	239.4	-0.67	8002
2014	9	15	18	22.6	22.1	261.7	21.4	0	4.46	238.4	-0.42	7998
2014	9	15	19	21.7	21.4	130.2	22	0	5.61	230.9	-0.26	7998
2014	9	15	20	20.2	20.1	28.7	23.3	0	4	214.9	-0.02	7999.3
2014	9	15	21	16.9	17.1	0.2	34.6	0	1.71	237.6	0.19	8000.7
2014	9	15	22	13	13.4	0.1	42	0	2.09	238.5	0.42	8002
2014	9	15	23	12	13	0.1	42.7	0	1.27	240.6	0.97	8002
2014	9	15	24	11.9	13.4	0.1	47.7	0	1.11	236.1	1.46	8003.3
2014	9	16	1	11.3	12.2	0.1	51.7	0	1.64	231.3	0.97	8003.3
2014	9	16	2	11.7	12.6	0.1	46.5	0	1.5	241.1	0.82	8004.7
2014	9	16	3	11.1	11.9	0.1	47.2	0	1.15	241.6	0.79	8007.3
2014	9	16	4	10.1	11.1	0.1	52.8	0	1.47	236	0.94	8008.7
2014	9	16	5	10.3	11.1	0.1	61.6	0	0.84	251.2	0.86	8006
2014	9	16	6	9.9	10.8	0.1	57.9	0	1.99	233	0.83	8000.7
2014	9	16	7	9.8	10.8	0.1	54.8	0	1.65	234.7	0.99	8003.3
2014	9	16	8	10.8	11.9	7.5	54.9	0	1.08	240.3	1.04	8004.7
2014	9	16	9	11.2	12.2	45.9	56.1	0	0.84	50.6	0.98	8007.3
2014	9	16	10	12.7	12.7	165.2	46	0	0.77	55.7	0.02	8010
2014	9	16	11	15.7	15.3	184.5	47.3	0	1.63	88.6	-0.37	8011.3
2014	9	16	12	14.7	14.6	92.6	65	0	3.09	83.1	-0.11	8012.7
2014	9	16	13	15.2	15	254.4	55.2	0	1.53	48.3	-0.25	8007.3
2014	9	16	14	17.9	17.6	356.9	45.3	0	2.7	206	-0.34	8003.3
2014	9	16	15	20.5	19.9	694.6	35.4	0	3.95	227.5	-0.62	7999.3
2014	9	16	16	21.3	20.8	396.7	35	0	4.96	237.2	-0.55	7991.3
2014	9	16	17	22.2	21.7	482.2	32.7	0	4.65	242.9	-0.54	7984.7
2014	9	16	18	22.1	21.7	289.7	30.9	0	5.27	243.5	-0.39	7979.3
2014	9	16	19	21.5	21.3	126.1	32.8	0	4.17	238.9	-0.24	7978
2014	9	16	20	19.3	19.7	11.9	44.8	0	1.22	244.6	0.35	7978
2014	9	16	21	15.3	15.7	0.1	51.7	0	1.11	241.4	0.46	7978
2014	9	16	22	13.3	14	0.1	61.4	0	1.76	239.4	0.74	7980.7
2014	9	16	23	11.8	12.4	0.1	60.8	0	2.22	237.9	0.67	7980.7
2014	9	16	24	11	11.9	0	62.6	0	2.11	236.4	0.93	7979.3
2014	9	17	1	10.7	11.5	0.1	59.8	0	1.62	239.4	0.79	7978
2014	9	17	2	10	11	0.1	66.8	0	1.6	238.5	0.98	7978
2014	9	17	3	10	10.9	0.1	68.5	0	1.58	237.2	0.92	7978
2014	9	17	4	9.5	10.7	0.1	66.9	0	1.63	238.8	1.18	7975.3
2014	9	17	5	9.7	10.6	0.1	66.9	0	1.85	238.4	0.98	7974
2014	9	17	6	10	11.1	0.1	70.1	0	1.8	239.8	1.07	7972.7

2014	9	17	7	10.1	10.9	0.1	65.1	0	1.65	239.3	0.88	7971.3
2014	9	17	8	10	11.3	10.6	67.1	0	1.54	236.9	1.3	7971.3
2014	9	17	9	11.4	12.6	81.7	62.8	0	1.28	243.4	1.24	7972.7
2014	9	17	10	14.9	15	259.7	43	0	0.86	225.2	0.15	7972.7
2014	9	17	11	19.2	19.1	297.2	32.5	0	1.05	203.6	-0.15	7970
2014	9	17	12	21.1	20.7	312.3	25.9	0	3.9	205.8	-0.4	7971.3
2014	9	17	13	21	20.7	296.1	24	0	4.3	230.3	-0.34	7972.7
2014	9	17	14	21.5	21.1	322.7	24.6	0	4.88	226.8	-0.4	7970
2014	9	17	15	21.4	21.1	246	22.7	0	3.49	231.9	-0.31	7968.7
2014	9	17	16	22.4	21.8	460.7	21.4	0	4.5	238.2	-0.52	7963.3
2014	9	17	17	22.6	22.3	329.6	19.9	0	4.55	246.1	-0.35	7958
2014	9	17	18	23	22.6	346.5	21.3	0	3.72	236.9	-0.43	7952.7
2014	9	17	19	22.4	22.2	133	23.2	0	3.38	245	-0.23	7951.3
2014	9	17	20	20	20.3	18.5	35.6	0	1.85	236.3	0.31	7948.7
2014	9	17	21	16.8	16.9	0.1	37.6	0	1.38	234.8	0.15	7950
2014	9	17	22	14.9	15.4	0.1	44.5	0	1.59	234.5	0.48	7950
2014	9	17	23	13.4	14.1	0.1	48	0	1.46	232.1	0.72	7947.3
2014	9	17	24	12	13	0.1	50.1	0	1.72	237.7	0.98	7946
2014	9	18	1	11.4	12.4	0.1	51.2	0	1.81	231.5	1.01	7943.3
2014	9	18	2	11.5	12.6	0.1	52.3	0	2.04	237.5	1.04	7936.7
2014	9	18	3	14	15	0.1	37.6	0	1.73	249.9	0.97	7940.7
2014	9	18	4	13.8	14.6	0.1	50.8	0	1.11	230.9	0.87	7938
2014	9	18	5	13.9	14.8	0.1	56.6	0	2.27	231.5	0.86	7934
2014	9	18	6	15.2	15.5	0.1	51	0	2.79	240.9	0.29	7934
2014	9	18	7	13.8	14.4	0.1	61.5	0	0.51	255.2	0.56	7938
2014	9	18	8	11.7	12.8	4	64.4	0	1.52	234.3	1.09	7938
2014	9	18	9	12.5	12.9	54.4	60	0	0.88	33	0.42	7943.3
2014	9	18	10	14.5	14.5	64.3	48.4	0	2.65	228.8	0.08	7950
2014	9	18	11	14.7	14.6	105.9	45.9	0	2.78	230.2	-0.1	7956.7
2014	9	18	12	15.8	15.6	255.3	40.5	0	5.89	240.1	-0.26	7955.3
2014	9	18	13	17.2	16.7	531.9	33.8	0	5.76	242.5	-0.49	7952.7
2014	9	18	14	18.3	17.5	656.3	33.7	0	4.85	226.5	-0.75	7948.7
2014	9	18	15	19.1	18.4	575.1	30.9	0	4.9	231.9	-0.7	7942
2014	9	18	16	19.3	18.7	410.2	31.4	0	5.3	234	-0.6	7938
2014	9	18	17	19.1	18.7	301.5	30.4	0	6	240.8	-0.45	7936.7
2014	9	18	18	18.5	18.1	219.2	31	0	6.51	219.1	-0.43	7936.7
2014	9	18	19	18.1	17.8	98.6	32.9	0	5.82	230.4	-0.28	7935.3
2014	9	18	20	16.9	16.9	9.2	37.3	0	1.84	247.6	0.01	7939.3
2014	9	18	21	14.7	15	0.1	48	0	1.11	243.1	0.32	7943.3
2014	9	18	22	11.6	11.9	0.1	54.1	0	1.58	235.6	0.35	7948.7
2014	9	18	23	9.6	10.4	0.1	58.5	0	1.79	234.7	0.83	7952.7
2014	9	18	24	8.9	9.9	0	65.3	0	1.72	233.4	0.91	7956.7
2014	9	19	1	8.6	9.3	0	62.9	0	1.16	238.7	0.65	7958
2014	9	19	2	8.1	8.5	0.1	69.6	0	1.16	241.7	0.49	7963.3
2014	9	19	3	7.3	7.8	0	70.6	0	1.38	244.6	0.59	7968.7
2014	9	19	4	6.4	7	0.1	82.6	0	1.25	243.3	0.65	7971.3
2014	9	19	5	5.6	6.2	0.1	81.2	0	1.19	241	0.59	7974
2014	9	19	6	4.7	5.6	0.1	83.5	0	1.4	233.6	0.86	7979.3
2014	9	19	7	4.7	5.2	0.1	82.9	0	1.49	237.8	0.53	7980.7
2014	9	19	8	4.3	5	6.4	87.5	0	1.43	233.9	0.65	7986
2014	9	19	9	5	5.6	138	75.9	0	1.36	239.7	0.61	7994
2014	9	19	10	8.5	8.3	323	61.3	0	0.63	140.4	-0.27	7995.3
2014	9	19	11	13.1	12.1	484.7	46.7	0	2.95	64.5	-1.04	7995.3
2014	9	19	12	15.3	14.2	621.3	43.4	0	3.95	50.6	-1.16	7998
2014	9	19	13	17.1	15.9	708.7	38.8	0	3.09	80.7	-1.18	8000.7
2014	9	19	14	18.2	17.1	742.4	36.3	0	2.95	171.1	-1.11	7998
2014	9	19	15	19.3	18.1	724.4	31.8	0	3.17	89.1	-1.19	7998
2014	9	19	16	19.9	18.8	651.4	30.3	0	3.47	63.3	-1.07	7994
2014	9	19	17	20.3	19.5	532.9	30.9	0	3.96	195.1	-0.85	7992.7
2014	9	19	18	19.8	19.3	322.6	31.9	0	2.28	242.8	-0.47	7992.7
2014	9	19	19	19.2	18.8	127.8	36.2	0	2.23	231	-0.36	7995.3

2014	9	19	20	17.7	17.6	15.3	43.4	0	1.45	201.8	-0.02	7998
2014	9	19	21	15.5	15.7	0.1	51.6	0	1.35	57.8	0.12	8000.7
2014	9	19	22	13.1	13.2	0.1	59.1	0	0.84	239	0.11	8007.3
2014	9	19	23	10.7	11	0	67.1	0	1.27	245.4	0.31	8011.3
2014	9	19	24	9.3	9.7	0	70.8	0	1.2	246.3	0.46	8016.7
2014	9	20	1	8.3	8.8	0.1	72.3	0	1.42	240	0.46	8022
2014	9	20	2	7.1	7.8	0	77.3	0	1.59	232.7	0.69	8022
2014	9	20	3	6.5	7.2	0	79.8	0	1.4	240.5	0.69	8024.7
2014	9	20	4	6	6.7	0	80.6	0	1.6	238.6	0.62	8026
2014	9	20	5	5.5	6.2	0	83.5	0	1.55	235.3	0.64	8027.3
2014	9	20	6	5.3	5.8	0.1	82.4	0	1.84	238.4	0.55	8028.7
2014	9	20	7	5.4	5.9	0.1	85.4	0	1.77	240.5	0.49	8030
2014	9	20	8	5.1	5.9	4.7	86.2	0	2	236.3	0.76	8030
2014	9	20	9	6.3	7.1	142.9	76.1	0	1.86	235.8	0.73	8034
2014	9	20	10	10.7	10.6	330.2	58.6	0	1	229	-0.09	8034
2014	9	20	11	15.2	14.6	499.3	43.6	0	0.9	223.8	-0.6	8032.7
2014	9	20	12	18.1	17.2	630.4	38.4	0	1.79	109.4	-0.83	8032.7
2014	9	20	13	20.5	19.5	715.2	32.4	0	2.21	92.1	-1.04	8031.3
2014	9	20	14	21.8	20.8	740.9	30.1	0	2.06	62.1	-0.99	8027.3
2014	9	20	15	22.5	21.5	721.9	28.4	0	2.46	50.1	-0.97	8024.7
2014	9	20	16	23.2	22.1	644.5	27.4	0	3.93	50.7	-1.1	8019.3
2014	9	20	17	23.6	22.8	523.6	25.2	0	2.9	48.7	-0.79	8016.7
2014	9	20	18	23.5	23	358.6	24.9	0	2.16	70.2	-0.57	8012.7
2014	9	20	19	22.6	22.4	111.8	29.4	0	1.57	329.1	-0.17	8012.7
2014	9	20	20	18.9	19.2	9	41.7	0	1.31	239.8	0.31	8012.7
2014	9	20	21	15.8	16.1	0.1	46.3	0	1.51	235.2	0.21	8014
2014	9	20	22	13.6	14.2	0.1	51.5	0	1.65	241	0.54	8018
2014	9	20	23	12.3	13	0	51.4	0	1.78	238	0.76	8019.3
2014	9	20	24	11.4	12.1	0	56.2	0	1.59	241.2	0.65	8022
2014	9	21	1	10.3	11.1	0	58.3	0	1.92	235.7	0.82	8023.3
2014	9	21	2	9.5	10.6	0	62.7	0	1.96	237.4	1.05	8020.7
2014	9	21	3	9.3	10.6	0.1	62.1	0	1.84	234.7	1.3	8020.7
2014	9	21	4	9.2	10.6	0	62.6	0	2.3	233.2	1.41	8023.3
2014	9	21	5	9.7	10.3	0.1	62	0	1.67	241.6	0.65	8019.3
2014	9	21	6	8.9	9.7	0.1	64.7	0	2.06	234.3	0.8	8018
2014	9	21	7	8.9	9.9	0.1	62	0	2.09	238.5	0.95	8018
2014	9	21	8	8.7	9.6	10.4	61.8	0	2.07	236.3	0.91	8015.3
2014	9	21	9	9.5	10.7	96.4	54.2	0	1.85	233.4	1.17	8016.7
2014	9	21	10	13.3	14.2	176.7	43.3	0	1.29	245.4	0.83	8018
2014	9	21	11	16.2	16.2	297.4	34.3	0	0.69	246.9	-0.08	8018
2014	9	21	12	20.4	19.5	641.6	30.8	0	2.18	166.2	-0.88	8015.3
2014	9	21	13	21.8	20.8	606.3	29.3	0	2.83	95.9	-1	8014
2014	9	21	14	21.9	21.2	497.3	26.4	0	2.51	209.3	-0.73	8008.7
2014	9	21	15	22.9	22.2	626.2	22.3	0	1.52	202.5	-0.69	8003.3
2014	9	21	16	22.9	22.4	266.1	22.3	0	1.51	134.6	-0.51	7998
2014	9	21	17	22.4	22	198	27.9	0	2.25	214	-0.41	7995.3
2014	9	21	18	21.6	21.3	97.6	31.7	0	3.34	219.1	-0.27	7992.7
2014	9	21	19	20.5	20.3	33.3	38.1	0	4.1	226.5	-0.16	7992.7
2014	9	21	20	18.9	19	7.1	40.5	0	1.68	239.6	0.02	7991.3
2014	9	21	21	18.2	18.3	0.1	42.9	0	1.32	257	0.02	7991.3
2014	9	21	22	16.5	16.9	0.1	50.9	0	0.96	139.9	0.35	7994
2014	9	21	23	14.6	14.9	0	55.1	0	1.09	238.3	0.31	7994
2014	9	21	24	13.1	13.5	0	58.5	0	1.25	236.8	0.36	7992.7
2014	9	22	1	12.6	12.9	0	60.1	0	0.83	249.8	0.32	7990
2014	9	22	2	11.9	12.6	0	65.1	0	0.63	242.1	0.71	7990
2014	9	22	3	11.8	12.3	0.1	65.4	0	0.82	234.9	0.5	7992.7
2014	9	22	4	11.6	12	0.1	67	0	0.73	245.4	0.33	7992.7
2014	9	22	5	11.3	11.6	0.1	66.1	0	0.93	239.9	0.26	7994
2014	9	22	6	10.9	11.2	0.1	73.5	0	0.56	247.6	0.33	7995.3
2014	9	22	7	10.5	10.8	0.1	69.8	0	0.62	242	0.31	7996.7
2014	9	22	8	10.5	10.8	3.1	71.6	0	0.53	239.9	0.31	7998

2014	9	22	9	10.5	10.7	51.2	68.5	0	0.42	235.4	0.14	7998
2014	9	22	10	11.7	11.5	137.7	70.9	0	0.52	196.3	-0.21	8000.7
2014	9	22	11	13.1	12.6	346.5	58.3	0	0.81	99.4	-0.49	8002
2014	9	22	12	15.9	14.9	453.5	54.5	0	2.75	60.9	-0.95	8000.7
2014	9	22	13	16.6	15.8	348.1	52.4	0	3.9	49.9	-0.79	7999.3
2014	9	22	14	18.5	17.3	689.2	42.5	0	3.65	64	-1.25	7998
2014	9	22	15	19	18	475.1	36.9	0	3.2	70.5	-0.99	7995.3
2014	9	22	16	19.6	18.9	398	37.5	0	1.7	177.7	-0.66	7992.7
2014	9	22	17	19.6	19.1	244.7	47.7	0	2.35	194.8	-0.51	7987.3
2014	9	22	18	15	14.6	39.5	75.4	0	3.32	230.7	-0.31	7988.7
2014	9	22	19	13.8	13.6	34.7	82	0	1.34	246.9	-0.2	7996.7
2014	9	22	20	13	12.9	7.8	87.5	0	1.67	227.9	-0.17	7998
2014	9	22	21	11.2	11.1	0	89.6	0	1.65	232.3	-0.07	8000.7
2014	9	22	22	9.9	10.3	0	91	0	1.39	237.8	0.36	7999.3
2014	9	22	23	9	9.4	0.1	93.2	0	1.46	235	0.43	8000.7
2014	9	22	24	8.1	8.6	0	94.9	0	1.02	231.1	0.48	8003.3
2014	9	23	1	7.5	7.8	0.1	93.1	0	1.37	238.9	0.32	8008.7
2014	9	23	2	7.5	8	0.1	94.2	0	1.15	236.2	0.46	8008.7
2014	9	23	3	7.8	8.3	0	89.4	0	0.91	246.3	0.46	8008.7
2014	9	23	4	7.4	7.9	0	94.2	0	0.83	240.5	0.5	8006
2014	9	23	5	7.2	7.7	0.1	96.8	0	1.28	242.3	0.52	8004.7
2014	9	23	6	7.3	7.6	0.1	94.9	0	1.33	245.8	0.29	8000.7
2014	9	23	7	6.9	7.6	0.1	93.7	0	1.31	237.1	0.74	7999.3
2014	9	23	8	6.5	7.3	15.3	96.6	0	1.61	236	0.77	7999.3
2014	9	23	9	8.1	8.7	77.3	91.5	0	1.61	236.1	0.58	8002
2014	9	23	10	10.8	10.9	184.4	77.3	0	1.19	235.1	0.05	8002
2014	9	23	11	13.7	13.4	298.4	65.9	0	0.75	75.6	-0.33	8002
2014	9	23	12	17.4	16.9	461	46.2	0	2.13	169.4	-0.55	8000.7
2014	9	23	13	19.3	18.7	504	42	0	4.3	211.6	-0.6	7996.7
2014	9	23	14	19.4	18.9	345.7	42.1	0	6.59	234.4	-0.46	7994
2014	9	23	15	19.6	19.2	266.3	40.2	0	5.83	219.3	-0.43	7992.7
2014	9	23	16	20.2	19.7	403.2	36.6	0	5.29	225.4	-0.52	7991.3
2014	9	23	17	19.9	19.5	243.2	38.1	0	5.3	225.4	-0.4	7988.7
2014	9	23	18	19.7	19.4	161.2	39.5	0	5.59	235	-0.34	7987.3
2014	9	23	19	19.3	19.1	77.6	39	0	3.78	197.4	-0.19	7986
2014	9	23	20	18.4	18.5	4.3	46	0	2.58	216.9	0.03	7986
2014	9	23	21	16.4	16.6	0.1	55	0	1.18	229.2	0.21	7987.3
2014	9	23	22	15.3	15.8	0.1	59.8	0	1.16	241.6	0.58	7988.7
2014	9	23	23	14	14.9	0.1	62.6	0	1.47	244.5	0.91	7990
2014	9	23	24	13.4	14.7	0.1	63.5	0	1.47	246.1	1.27	7990
2014	9	24	1	13.8	14.9	0	61.3	0	1.11	240.6	1.12	7988.7
2014	9	24	2	13.7	14.8	0.1	57.4	0	1.08	247.1	1.1	7986
2014	9	24	3	13.6	14.7	0.1	57.5	0	1.33	248.7	1.14	7986
2014	9	24	4	12.2	13.7	0.1	62.7	0	1.16	249.4	1.49	7986
2014	9	24	5	11.2	12.6	0.1	69.3	0	0.7	260.1	1.37	7986
2014	9	24	6	10.6	11.9	0.1	63.3	0	1.5	239	1.32	7986
2014	9	24	7	10	11.5	0.1	59.6	0	1.96	237.5	1.52	7986
2014	9	24	8	10.4	12.2	4.2	54.4	0	2	238.4	1.84	7986
2014	9	24	9	11.7	13.1	118.3	51.7	0	1.59	248.8	1.36	7986
2014	9	24	10	15.1	16	301.9	36.3	0	1.15	239	0.89	7987.3
2014	9	24	11	19.9	19.4	473.5	29.1	0	2.42	168.8	-0.52	7988.7
2014	9	24	12	21.8	21	606.7	26.5	0	4.1	195.1	-0.72	7986
2014	9	24	13	22.9	22.3	693.8	25.1	0	5.85	229	-0.67	7983.3
2014	9	24	14	23.2	22.6	713.1	24	0	7.77	240.4	-0.62	7979.3
2014	9	24	15	24.3	23.5	706.7	20.9	0	6.57	233	-0.78	7978
2014	9	24	16	24.5	23.9	632.7	20	0	7.33	238.5	-0.69	7974
2014	9	24	17	24.7	24.1	510.3	19	0	5.74	222.3	-0.63	7970
2014	9	24	18	24.5	24.1	352.2	17.1	0	4.31	216.3	-0.47	7967.3
2014	9	24	19	23.7	23.5	98.6	19.8	0	4.42	229.3	-0.24	7964.7
2014	9	24	20	21.1	21.6	5.6	29.3	0	2.72	230.8	0.51	7963.3
2014	9	24	21	16.7	17.6	0.1	30.6	0	1.61	228.1	0.91	7964.7

2014	9	24	22	15.7	17.2	0.1	36.6	0	1.97	247.3	1.49	7964.7
2014	9	24	23	15.7	17.3	0.1	31.8	0	2.17	249.4	1.55	7966
2014	9	24	24	15.6	17	0	36.4	0	2.02	250.3	1.41	7964.7
2014	9	25	1	14.7	16.5	0	40.1	0	1.9	244.7	1.81	7966
2014	9	25	2	13.7	15.4	0.1	46.4	0	2.07	241.2	1.78	7966
2014	9	25	3	14.6	16.7	0.1	41.5	0	1.28	262.8	2.12	7966
2014	9	25	4	13.8	16.2	0.1	40.7	0	1.62	249.5	2.43	7962
2014	9	25	5	15.1	16.6	0.1	38.5	0	1.44	258.5	1.47	7958
2014	9	25	6	14.2	15.4	0.1	38.6	0	1.86	255.7	1.18	7955.3
2014	9	25	7	13.8	15.3	0.1	40	0	1.53	249.6	1.46	7954
2014	9	25	8	12.1	14.3	4	43.6	0	1.68	247.7	2.28	7954
2014	9	25	9	12.6	14.1	127.7	43.1	0	1.25	257.7	1.49	7955.3
2014	9	25	10	15.1	15.4	317.1	23	0	1.48	141.7	0.33	7959.3
2014	9	25	11	20.3	19.8	486.1	20	0	3.11	199.5	-0.46	7954
2014	9	25	12	21.5	20.7	616.3	19.2	0	3.53	166.4	-0.79	7955.3
2014	9	25	13	22.2	21.4	697.5	14.2	0	3.8	196.4	-0.77	7950
2014	9	25	14	22.8	22.2	731.7	14.2	0	9.81	251	-0.57	7942
2014	9	25	15	23.1	22.5	715.8	14.7	0	6.41	238.8	-0.66	7943.3
2014	9	25	16	23.6	23	638.9	15.5	0	6.2	237	-0.68	7939.3
2014	9	25	17	23.3	22.8	368.1	17	0	6.67	245.6	-0.48	7936.7
2014	9	25	18	22.7	22.4	165.2	16.9	0	4.96	237.5	-0.27	7932.7
2014	9	25	19	22.4	22.1	78.4	21.4	0	4.78	243.7	-0.21	7928.7
2014	9	25	20	19.4	19.2	3.5	34.8	0	5.51	231.6	-0.18	7926
2014	9	25	21	16.3	16.2	0.1	39.2	0	2.65	52.5	-0.14	7939.3
2014	9	25	22	14.2	14.2	0.1	46.5	0	3.52	257.9	0.03	7932.7
2014	9	25	23	12.8	12.8	0	56.4	0	2.24	259.5	0.06	7942
2014	9	25	24	11.5	11.5	0	63.7	0	1.61	130.5	-0.08	7954
2014	9	26	1	10.5	10.4	0	82.9	0.02	2.11	220.7	-0.1	7950
2014	9	26	2	8.9	8.6	0	91.4	0	1.25	93	-0.22	7955.3
2014	9	26	3	8.7	8.5	0	82.6	0	1.74	155.4	-0.21	7959.3
2014	9	26	4	8.4	8.2	0.1	80	0	2.17	34.9	-0.18	7964.7
2014	9	26	5	7.9	7.8	0	84.4	0	2.11	46.7	-0.16	7967.3
2014	9	26	6	7.7	7.5	0.1	85.3	0	1.19	44.4	-0.11	7974
2014	9	26	7	7.1	7.2	0.1	85.2	0	0.84	250.3	0.14	7968.7
2014	9	26	8	7.6	7.7	4.9	65.6	0	0.98	253.1	0.18	7966
2014	9	26	9	8	8	79.1	70.7	0	0.43	248.8	-0.01	7970
2014	9	26	10	9.1	8.8	260.4	51.2	0	1.51	221.4	-0.36	7974
2014	9	26	11	10.7	10.3	412.2	42.4	0	4.39	240.6	-0.4	7976.7
2014	9	26	12	11.9	11.4	586.1	37.8	0	5.37	239.8	-0.54	7975.3
2014	9	26	13	13.1	12.3	690.6	32.2	0	4.4	231.3	-0.74	7976.7
2014	9	26	14	14.2	13.5	715.6	25.5	0	3.5	237.8	-0.77	7974
2014	9	26	15	15	14.3	545.7	25.9	0	4.86	249.5	-0.62	7971.3
2014	9	26	16	15.1	14.6	418.4	26.4	0	5.42	248.5	-0.51	7971.3
2014	9	26	17	14.9	14.5	200.8	27	0	4.34	246.5	-0.39	7971.3
2014	9	26	18	14.9	14.5	164.7	30.3	0	2.54	255.9	-0.37	7971.3
2014	9	26	19	13.7	13.5	50.7	32.4	0	2.81	45.1	-0.2	7970
2014	9	26	20	11.5	11.7	2.8	45.3	0	1.08	283.2	0.17	7970
2014	9	26	21	8.6	8.7	0.1	56.9	0	1.32	236.5	0.09	7967.3
2014	9	26	22	6.7	6.9	0.1	63	0	1.13	242.5	0.27	7970
2014	9	26	23	6.4	6.8	0	62.6	0	1.06	247.9	0.36	7970
2014	9	26	24	6.7	7	0	67.4	0	0.69	238.1	0.31	7970
2014	9	27	1	6.6	6.8	0	64.4	0	1.19	246.9	0.15	7963.3
2014	9	27	2	7	7.2	0.1	68	0	1.01	311.9	0.22	7964.7
2014	9	27	3	7.3	7.3	0.1	71	0	1.6	117.3	0.01	7963.3
2014	9	27	4	6.8	6.6	0.1	78.2	0	1.79	74	-0.18	7958
2014	9	27	5	6.5	6.4	0.1	86.9	0.02	1.4	246.9	-0.13	7950
2014	9	27	6	5.8	5.7	0.1	97.5	0.08	2.13	82	-0.15	7956.7
2014	9	27	7	5.6	5.3	0.1	98.1	0.01	0.88	89.6	-0.26	7956.7
2014	9	27	8	5.6	5.4	2.3	97.9	0	0.76	67.1	-0.21	7951.3
2014	9	27	9	6	5.8	9.2	97.9	0.01	0.85	228.1	-0.2	7948.7
2014	9	27	10	6.4	6.1	39.2	97.6	0.06	1.57	68.5	-0.3	7952.7

2014	9	27	11	7.1	6.8	112.6	93.6	0	0.92	81.6	-0.31	7952.7
2014	9	27	12	8.6	8.2	238.2	88.5	0	1.3	46.2	-0.44	7954
2014	9	27	13	10	9.4	383.1	83.5	0	2.18	48.4	-0.64	7951.3
2014	9	27	14	11.3	10.7	437.3	71.8	0	2.47	59.7	-0.68	7954
2014	9	27	15	12.1	11.7	319.6	71.9	0	1.87	71.9	-0.47	7952.7
2014	9	27	16	12.7	12.3	283	75.2	0	2.91	104.7	-0.4	7946
2014	9	27	17	12.3	12	130.2	73.9	0	2.43	80.2	-0.37	7943.3
2014	9	27	18	12.2	11.9	60.4	76.2	0	2.25	117.2	-0.24	7943.3
2014	9	27	19	11.8	11.6	14.8	77.2	0	3.03	79.1	-0.2	7947.3
2014	9	27	20	11.5	11.4	2.1	75.4	0	3.14	58.1	-0.14	7947.3
2014	9	27	21	11.4	11.3	0.1	75	0	2.66	65.2	-0.13	7943.3
2014	9	27	22	11.3	11.2	0.1	73.8	0	3.29	75	-0.09	7947.3
2014	9	27	23	11.2	11.1	0.1	74.5	0	2.92	79.7	-0.08	7951.3
2014	9	27	24	11	10.8	0.1	75.3	0	2.31	83.3	-0.11	7950
2014	9	28	1	10.9	10.7	0.1	75.6	0	1.16	65.5	-0.12	7952.7
2014	9	28	2	10.4	10.3	0.1	78.5	0	2.22	66.9	-0.13	7955.3
2014	9	28	3	10	9.9	0.1	78.3	0	1.92	66.4	-0.15	7958
2014	9	28	4	9.7	9.6	0.1	80.2	0	1.85	76.9	-0.15	7959.3
2014	9	28	5	9.1	9	0.1	83.2	0	1.72	122.4	-0.12	7958
2014	9	28	6	8.8	8.7	0.1	87	0	0.77	243.2	-0.03	7954
2014	9	28	7	9.1	9	0.1	81.6	0	0.98	94.3	-0.11	7954
2014	9	28	8	8.8	8.7	2.2	88.5	0	1.06	189.4	-0.11	7958
2014	9	28	9	9.1	8.9	25.5	81	0	1.78	89.4	-0.14	7956.7
2014	9	28	10	9.5	9.3	92.2	77.4	0	1.58	133.3	-0.22	7960.7
2014	9	28	11	10.2	9.9	183.9	77.6	0	2.07	81.5	-0.34	7962
2014	9	28	12	10.9	10.5	149	74	0	2.15	61.7	-0.36	7962
2014	9	28	13	11.3	10.9	213.3	71.8	0	2.54	62.1	-0.4	7960.7
2014	9	28	14	11.5	11.1	187.9	69.8	0	2.89	69.6	-0.41	7959.3
2014	9	28	15	11.9	11.4	204.2	67.3	0	3.12	70.6	-0.48	7956.7
2014	9	28	16	12.6	12.1	207.7	66	0	1.73	60.1	-0.43	7952.7
2014	9	28	17	12.8	12.4	171.9	65.2	0	1.9	49.8	-0.39	7948.7
2014	9	28	18	12.8	12.5	103.6	65.6	0	1.47	54.5	-0.27	7947.3
2014	9	28	19	12.4	12.2	21.1	69.6	0	1.59	98.7	-0.21	7944.7
2014	9	28	20	11.7	11.5	1.9	74.2	0	1.58	114.7	-0.16	7943.3
2014	9	28	21	10.9	10.8	0.1	80.3	0	1.95	81.7	-0.15	7942
2014	9	28	22	9.6	9.5	0.1	88	0.02	1.03	89.2	-0.12	7943.3
2014	9	28	23	8.7	8.6	0.1	94.7	0.02	0.86	26.7	-0.12	7942
2014	9	28	24	8.3	8.1	0.1	98.2	0	0.79	75.7	-0.22	7942
2014	9	29	1	8.2	8	0.1	98.3	0.01	0.55	42	-0.19	7940.7
2014	9	29	2	8.1	7.8	0.1	99.3	0	0.73	58.3	-0.26	7939.3
2014	9	29	3	8.2	8.1	0.1	94.9	0	1.07	257.2	-0.12	7938
2014	9	29	4	7.7	7.6	0.1	92.7	0.01	0.85	259.3	-0.14	7939.3
2014	9	29	5	7.2	7.2	0.1	98.1	0	0.75	296.6	-0.05	7940.7
2014	9	29	6	6.3	6.3	0.1	91.6	0	1.35	237.8	-0.02	7935.3
2014	9	29	7	5.8	5.7	0.1	97.8	0	0.55	209.4	-0.05	7938
2014	9	29	8	5.2	5.1	1.2	95.2	0	0.71	224.8	-0.17	7942
2014	9	29	9	5.5	5.4	30.9	86.6	0	0.66	242.4	-0.15	7942
2014	9	29	10	6.7	6.4	149.9	77.4	0	0.7	119.5	-0.27	7944.7
2014	9	29	11	7.8	7.4	264.4	70.2	0	1.07	72	-0.42	7943.3
2014	9	29	12	8.9	8.4	346.4	75.8	0	1.82	63.8	-0.48	7942
2014	9	29	13	8.7	8.3	224.7	77.6	0	3.83	43	-0.48	7940.7
2014	9	29	14	8.3	8	85.7	78.8	0	2.95	43	-0.3	7942
2014	9	29	15	8.8	8.5	126.8	69.8	0	1.68	63.7	-0.37	7942
2014	9	29	16	9.3	9	186	71	0	1.79	212.3	-0.32	7938
2014	9	29	17	9.1	8.8	65.1	87.9	0	2.96	232.3	-0.28	7934
2014	9	29	18	7.7	7.4	38.1	94.8	0.01	2.22	51.9	-0.28	7938
2014	9	29	19	7.5	7.3	23.5	95.7	0	1.2	35.5	-0.21	7938
2014	9	29	20	6.7	6.5	1.1	98	0.02	1.23	85.5	-0.21	7940.7
2014	9	29	21	6.2	6	0.1	98.2	0.01	1.07	68.1	-0.22	7943.3
2014	9	29	22	5.9	5.8	0.1	97.2	0	0.95	5	-0.1	7942
2014	9	29	23	5.3	5.1	0.1	98.7	0	0.54	250.2	-0.18	7943.3

2014	9	29	24	4.6	4.6	0.1	99.7	0	0.49	241.9	0.03	7944.7
2014	9	30	1	4	3.9	0	98.8	0	0.76	279.2	-0.05	7946
2014	9	30	2	3.8	3.7	0	98.1	0	0.54	240.5	-0.13	7944.7
2014	9	30	3	3.6	3.6	0	99.9	0	0.63	263.9	-0.07	7943.3
2014	9	30	4	3.9	3.8	0.1	99.2	0.01	0.69	235	-0.14	7940.7
2014	9	30	5	4.2	4.1	0.1	98.8	0.01	0.76	239.1	-0.16	7932.7
2014	9	30	6	4.4	4.2	0.1	100	0.01	0.49	275.4	-0.17	7930
2014	9	30	7	4.7	4.6	0.1	98.8	0.03	0.46	73.6	-0.05	7926
2014	9	30	8	4.6	4.4	0.6	100	0.01	1.51	76	-0.14	7924.7
2014	9	30	9	4.8	4.6	19.8	91.9	0.02	0.93	59.9	-0.17	7926
2014	9	30	10	5.9	5.6	224.1	73.8	0	2.24	248.1	-0.24	7930
2014	9	30	11	7.1	6.5	454.1	67.4	0	3.94	220	-0.62	7930
2014	9	30	12	5.6	5.1	203.8	92.9	0	3.6	48.9	-0.43	7931.3
2014	9	30	13	4.9	4.5	287.4	88.2	0.05	3.29	23.3	-0.44	7934
2014	9	30	14	4.5	4	243	91.8	0.01	3.69	68	-0.49	7938
2014	9	30	15	4.6	4.1	228.2	89	0	3.92	78.3	-0.49	7938
2014	9	30	16	5.1	4.6	284.7	77.2	0	3.07	56	-0.47	7939.3
2014	9	30	17	5.7	5.1	371.7	59.1	0	3.71	64.5	-0.55	7939.3
2014	9	30	18	6.2	5.8	220.8	60.4	0	4.07	219.8	-0.44	7938
2014	9	30	19	4.8	4.6	31.7	67.5	0	2.09	188.3	-0.2	7942
2014	9	30	20	3.9	3.8	3.3	72.7	0	2.29	123.8	-0.06	7944.7
2014	9	30	21	3.3	3.3	0.1	66.3	0	3.28	104	-0.08	7952.7
2014	9	30	22	2.2	2.2	0	84.1	0	1.04	54.9	0.01	7958
2014	9	30	23	0.9	1	0.1	91	0	0.53	315.1	0.1	7962
2014	9	30	24	0.4	0.6	0	91.1	0	0.54	242.5	0.2	7962
2014	10	1	1	0.4	0.4	0.1	90.7	0	0.57	273	0.03	7962
2014	10	1	2	0.4	0.3	0	94.2	0	0.44	64.7	-0.1	7960.7
2014	10	1	3	0.1	0.2	0	94.5	0	0.36	261.9	0.1	7962
2014	10	1	4	0.4	0.3	0.1	94	0	0.63	44.6	-0.15	7962
2014	10	1	5	0.6	0.4	0.1	91.5	0	1.11	34.4	-0.16	7963.3
2014	10	1	6	0.6	0.5	0.1	94.1	0	1.14	57.6	-0.19	7966
2014	10	1	7	0.7	0.5	0.1	97.5	0	1.92	60.2	-0.17	7968.7
2014	10	1	8	0.3	0.1	2.4	98.1	0	0.77	284.1	-0.12	7974
2014	10	1	9	0.3	0.1	49.6	98.4	0	1.04	69.2	-0.2	7980.7
2014	10	1	10	1.2	0.9	178	83.4	0	0.59	117.2	-0.31	7983.3
2014	10	1	11	3.3	2.6	321.1	74.2	0	2.32	80.5	-0.62	7988.7
2014	10	1	12	4.5	3.8	441.4	62.5	0	2.98	81.1	-0.78	7990
2014	10	1	13	5	4.3	473.9	49	0	1.78	84.3	-0.62	7991.3
2014	10	1	14	6	5.2	565.6	44.7	0	2.33	87.9	-0.78	7990
2014	10	1	15	7	6.2	581.5	44.7	0	2.7	24.6	-0.7	7986
2014	10	1	16	7.7	7	537.2	38.1	0	3.45	222.3	-0.73	7983.3
2014	10	1	17	7.8	7.2	306.8	40.8	0	3.55	201.2	-0.55	7983.3
2014	10	1	18	8	7.5	299.6	45.8	0	3.43	226.2	-0.5	7984.7
2014	10	1	19	6.8	6.6	32	56.4	0	1.5	279	-0.16	7987.3
2014	10	1	20	5.5	5.6	5.4	59.9	0	1.17	266.6	0.11	7988.7
2014	10	1	21	3.4	3.9	0.1	72.3	0	0.6	246.2	0.51	7991.3
2014	10	1	22	1.9	2.4	0.1	76.7	0	0.78	254.3	0.57	7994
2014	10	1	23	1.2	1.7	0	78.1	0	0.95	249.4	0.52	7998
2014	10	1	24	0.7	1.1	0	82.6	0	0.97	253.9	0.42	8000.7
2014	10	2	1	0.1	0.6	0	85.7	0	1.08	247.8	0.55	7998
2014	10	2	2	-0.6	0	0	90.1	0	0.99	242.1	0.6	8000.7
2014	10	2	3	-1	-0.6	0.1	89	0	1.02	240.3	0.39	8000.7
2014	10	2	4	-1.2	-0.7	0.1	92.2	0	1.36	240.6	0.51	8002
2014	10	2	5	-1.4	-0.9	0.1	90.4	0	0.84	240.1	0.49	8002
2014	10	2	6	-1.9	-1.3	0.1	94.6	0	0.82	261.6	0.67	7999.3
2014	10	2	7	-1.6	-1.3	0	91.1	0	1.32	239.8	0.32	7999.3
2014	10	2	8	-1.2	-0.8	3	95.9	0	0.8	94.8	0.41	8000.7
2014	10	2	9	-0.9	-0.8	66.5	91.6	0	0.76	239.2	0.1	8003.3
2014	10	2	10	1.6	1.2	287.1	69.9	0	0.92	158.8	-0.37	8004.7
2014	10	2	11	5.7	4.8	455	53.2	0	3.24	74.3	-0.94	8011.3
2014	10	2	12	8.1	7.2	584.6	31.9	0	3.3	61.2	-0.91	8012.7

2014	10	2	13	10	9.2	670.5	24.9	0	3.89	211.3	-0.79	8015.3
2014	10	2	14	10.6	9.9	698.4	24.3	0	3.5	199.9	-0.76	8012.7
2014	10	2	15	11.3	10.5	674.5	27.9	0	3.45	191.7	-0.82	8014
2014	10	2	16	11.6	10.6	594.2	30.2	0	5.64	212.7	-0.92	8012.7
2014	10	2	17	11.6	10.8	465.9	30.4	0	5.97	216.6	-0.82	8015.3
2014	10	2	18	11.2	10.7	301.8	33	0	5.36	224.2	-0.55	8018
2014	10	2	19	10.3	10	71.2	35.9	0	3.65	240.4	-0.25	8023.3
2014	10	2	20	8.7	8.8	3.8	36.3	0	1.3	16.1	0.13	8030
2014	10	2	21	5.3	5.4	0.1	55.7	0	1.37	230.1	0.11	8036.7
2014	10	2	22	3	3.1	0	60.7	0	1.29	233.7	0.07	8043.3
2014	10	2	23	1.8	2.1	0	65.4	0	1.44	240.2	0.26	8046
2014	10	2	24	0.7	1	0	71.5	0	1.68	235.6	0.29	8051.3
2014	10	3	1	0.2	0.5	0	74.9	0	1.58	235.1	0.26	8054
2014	10	3	2	-0.3	0	0.1	73.6	0	1.48	236.1	0.27	8056.7
2014	10	3	3	-0.8	-0.4	0	80	0	1.68	235.2	0.44	8058
2014	10	3	4	-1	-0.7	0.1	77.3	0	1.44	235.9	0.36	8060.7
2014	10	3	5	-1.3	-0.7	0.1	78.4	0	1.1	236.5	0.6	8060.7
2014	10	3	6	-1.9	-1.4	0.1	85	0	0.9	235.8	0.53	8060.7
2014	10	3	7	-2.1	-1.4	0.1	85.8	0	1.31	233.9	0.69	8064.7
2014	10	3	8	-2	-1.2	3.9	82.1	0	1.1	241.7	0.82	8064.7
2014	10	3	9	-1.9	-1.1	84.1	71.4	0	1.12	233.2	0.79	8068.7
2014	10	3	10	0.8	1.2	278.2	48.8	0	0.92	227.7	0.4	8072.7
2014	10	3	11	5.6	5	439.3	33.6	0	0.89	139.9	-0.57	8071.3
2014	10	3	12	9.5	8.3	560.9	25.9	0	3.25	73.7	-1.12	8068.7
2014	10	3	13	11.9	10.7	658.9	20.9	0	3.85	51.9	-1.18	8067.3
2014	10	3	14	13.2	12.2	696	20	0	3.13	51.3	-0.97	8066
2014	10	3	15	14.1	13.2	662.3	23.7	0	4.71	50.3	-0.89	8063.3
2014	10	3	16	14.6	13.8	589	25	0	4.05	49.4	-0.8	8062
2014	10	3	17	14.8	14.3	446.6	26.9	0	3.46	41.7	-0.56	8059.3
2014	10	3	18	14.8	14.5	284.5	29.4	0	2.67	46.7	-0.34	8056.7
2014	10	3	19	13.8	13.8	67.8	39.7	0	1.42	294.6	0.08	8056.7
2014	10	3	20	9.7	10.1	2.8	50.8	0	1.35	240.1	0.4	8059.3
2014	10	3	21	7	7.3	0.1	58.1	0	1.61	236.3	0.38	8060.7
2014	10	3	22	5.5	5.9	0.1	63.6	0	1.67	239.4	0.43	8062
2014	10	3	23	4.4	5	0.1	64.7	0	1.75	239	0.62	8060.7
2014	10	3	24	3.6	4.2	0.1	71.7	0	1.43	238.2	0.53	8062
2014	10	4	1	2.5	3.4	0	76.6	0	1.54	239.3	0.86	8064.7
2014	10	4	2	2	3	0	80.9	0	1.55	238.6	0.93	8064.7
2014	10	4	3	1.6	2.4	0	79.5	0	1.53	234.5	0.8	8063.3
2014	10	4	4	1.3	2.2	0.1	80.2	0	1.57	230.2	0.96	8063.3
2014	10	4	5	1.2	1.8	0	78.3	0	1.4	232.8	0.62	8062
2014	10	4	6	0.8	2.1	0.1	81.8	0	1.03	236.8	1.27	8060.7
2014	10	4	7	0.3	1.6	0.1	83	0	1.58	231.4	1.26	8059.3
2014	10	4	8	0.2	1.3	2	85.5	0	1.62	234.4	1.09	8056.7
2014	10	4	9	1.2	2.1	82.5	79.1	0	1.28	230.4	0.92	8055.3
2014	10	4	10	3.1	3.6	281.1	60.9	0	0.95	225.7	0.54	8054
2014	10	4	11	8.1	7.7	444.7	43.8	0	0.68	149.8	-0.44	8054
2014	10	4	12	13.1	12.2	569.8	28.9	0	2.15	81.4	-0.92	8050
2014	10	4	13	15.6	14.8	649.7	26.8	0	4.49	199.2	-0.85	8047.3
2014	10	4	14	16	15.2	684	27.8	0	5.54	224.5	-0.75	8046
2014	10	4	15	16.6	15.7	611.4	29.3	0	5.77	225.3	-0.87	8040.7
2014	10	4	16	16.6	15.8	524.5	29	0	5.1	225.4	-0.8	8035.3
2014	10	4	17	16.9	16.2	379.8	31.7	0	3.55	219.3	-0.72	8034
2014	10	4	18	15.9	15.5	137.2	35.1	0	4.76	66.3	-0.46	8031.3
2014	10	4	19	14.9	14.7	32	39.4	0	2.81	86.2	-0.2	8032.7
2014	10	4	20	14.1	14	2.2	46.7	0	2.44	94.2	-0.03	8032.7
2014	10	4	21	12.3	12.5	0.1	56.6	0	1	60.3	0.24	8034
2014	10	4	22	9.4	9.9	0.1	64.8	0	0.75	240	0.47	8034
2014	10	4	23	8.1	8.3	0.1	70.7	0	0.86	240.1	0.27	8035.3
2014	10	4	24	7.8	8.4	0.1	67.3	0	1.27	238.6	0.57	8036.7
2014	10	5	1	7.1	7.5	0.1	70	0	1.28	236.7	0.33	8031.3

2014	10	5	2	6.6	7	0.1	73.4	0	1.15	233.2	0.45	8030
2014	10	5	3	5.3	6	0.1	78.2	0	1.13	235.5	0.7	8030
2014	10	5	4	4.5	5.1	0.1	84.3	0	1.39	235.3	0.6	8031.3
2014	10	5	5	4.1	4.9	0.1	87.9	0	1.33	240	0.76	8028.7
2014	10	5	6	4.3	5.1	0.1	84.3	0	1.61	235	0.77	8031.3
2014	10	5	7	4.9	5.6	0.1	87.5	0	0.95	235.3	0.69	8031.3
2014	10	5	8	4.4	5.1	2	87.1	0	1.43	238.6	0.7	8032.7
2014	10	5	9	4.2	4.9	73.6	87.3	0	1.04	237.9	0.67	8030
2014	10	5	10	5.8	6	270.7	69.2	0	0.75	221.5	0.24	8032.7
2014	10	5	11	10.4	9.9	438.1	48.5	0	0.61	151.2	-0.52	8034
2014	10	5	12	14.4	13.5	568.4	40.3	0	2.19	98.3	-0.94	8032.7
2014	10	5	13	15.8	14.8	651.3	36.1	0	3.63	207.9	-1.01	8031.3
2014	10	5	14	16.5	15.6	676	34.2	0	3.83	217.5	-0.89	8028.7
2014	10	5	15	17.4	16.3	649.2	33.9	0	5.35	212.7	-1.08	8026
2014	10	5	16	17.8	16.8	570.9	32.1	0	6.2	218.3	-1.02	8020.7
2014	10	5	17	18.1	17.3	447.1	33	0	5.08	223.7	-0.82	8018
2014	10	5	18	17.9	17.3	275.3	31.6	0	3.3	225.2	-0.55	8015.3
2014	10	5	19	16.6	16.5	59.5	38.9	0	0.75	269.9	-0.1	8014
2014	10	5	20	12.7	13.4	2	52.6	0	1.67	237.9	0.67	8012.7
2014	10	5	21	10.3	10.7	0.1	60.1	0	2.07	229.9	0.37	8015.3
2014	10	5	22	9	9.2	0.1	63.5	0	1.84	231.6	0.21	8018
2014	10	5	23	8.1	8.2	0	69.1	0	1.37	240.9	0.17	8019.3
2014	10	5	24	7	7.5	0	73.6	0	1.05	245.4	0.52	8020.7
2014	10	6	1	6.4	7.2	0	74.8	0	1.05	237.6	0.78	8020.7
2014	10	6	2	6.2	7.3	0.1	78.7	0	1.5	236.1	1.09	8019.3
2014	10	6	3	5.7	6.4	0.1	77.8	0	1.7	234.4	0.68	8018
2014	10	6	4	6	6.5	0.1	83.5	0	1.07	241.5	0.49	8016.7
2014	10	6	5	4.9	6.1	0.1	87.8	0	1.18	237.4	1.17	8012.7
2014	10	6	6	4.9	5.7	0.1	85.6	0	1.24	236.7	0.83	8011.3
2014	10	6	7	3.8	4.7	0.1	91.6	0	1.2	239.2	0.91	8011.3
2014	10	6	8	3.4	4.3	1.5	91.6	0	1.67	231.4	0.84	8011.3
2014	10	6	9	4	4.6	63.8	88.7	0	1.32	235.2	0.67	8012.7
2014	10	6	10	5.4	6.1	234.5	71.8	0	1.24	230.6	0.67	8015.3
2014	10	6	11	10.6	10	418.5	53.8	0	0.94	117.4	-0.54	8016.7
2014	10	6	12	14.9	13.7	536.6	39.1	0	2.85	74.4	-1.15	8015.3
2014	10	6	13	16.8	15.6	648.4	33.9	0	2.66	72.6	-1.18	8012.7
2014	10	6	14	17.7	16.6	672.9	30.1	0	2.68	75.2	-1.09	8008.7
2014	10	6	15	18.6	17.7	649	29.3	0	2.2	184.5	-0.85	8003.3
2014	10	6	16	19.3	18.3	569.2	26.9	0	4.32	217.8	-1.06	7998
2014	10	6	17	19.6	18.8	443.9	26.5	0	2.87	216.5	-0.8	7992.7
2014	10	6	18	19.2	18.7	280	29.8	0	2.4	274.1	-0.43	7990
2014	10	6	19	17.3	17.4	55.9	43.3	0	1.57	282.5	0.14	7990
2014	10	6	20	12.6	13.3	1.8	55.5	0	2.47	232	0.77	7988.7
2014	10	6	21	11	11.9	0.1	56.3	0	1.8	234.7	0.89	7991.3
2014	10	6	22	10.6	11	0.1	60.7	0	1.15	236.9	0.45	7996.7
2014	10	6	23	8.9	9.4	0	66.7	0	1.87	236	0.51	7999.3
2014	10	6	24	7.7	8.2	0	71.5	0	1.62	235.7	0.5	7999.3
2014	10	7	1	6.7	7.4	0.1	74.8	0	1.56	232	0.64	8000.7
2014	10	7	2	6.2	7	0	78.8	0	1.28	239.2	0.72	8000.7
2014	10	7	3	5.1	6.1	0.1	83	0	1.82	237.5	1.07	8003.3
2014	10	7	4	5.7	6.2	0.1	79.4	0	1.45	240.3	0.57	8002
2014	10	7	5	4.5	5.6	0.1	85.7	0	1.36	235.1	1.09	7998
2014	10	7	6	4.1	5	0.1	87.5	0	1.36	237.1	0.83	7999.3
2014	10	7	7	3.7	4.7	0.1	87.6	0	1.47	239.6	0.98	7999.3
2014	10	7	8	3.4	4.4	1.6	87.3	0	1.66	237	1.01	7999.3
2014	10	7	9	3.5	4.6	62.6	85.8	0	1.55	238.8	1.05	8000.7
2014	10	7	10	5.8	6.7	265.6	69.5	0	1.26	232.1	0.87	8003.3
2014	10	7	11	11	10.6	431.4	52.7	0	0.62	154.5	-0.47	8002
2014	10	7	12	15.7	14.5	560.9	35.2	0	2.1	74.3	-1.12	7999.3
2014	10	7	13	18	16.8	645.8	30	0	3.41	60.6	-1.15	7998
2014	10	7	14	18.8	17.7	667.1	26.7	0	3.92	162.3	-1.08	7992.7

2014	10	7	15	19.1	18.1	646.9	26.1	0	3.92	188.3	-0.96	7990
2014	10	7	16	19.5	18.4	569.3	21.5	0	3.99	78.8	-1.01	7984.7
2014	10	7	17	19.5	18.8	442.5	22.4	0	2.92	194.9	-0.72	7983.3
2014	10	7	18	19.1	18.6	279.2	24.4	0	3.59	234.5	-0.54	7979.3
2014	10	7	19	16.7	16.8	54	35	0	1.66	249.9	0.1	7979.3
2014	10	7	20	12.3	12.9	1.5	45.6	0	1.83	235	0.68	7978
2014	10	7	21	10	10.3	0.1	50.7	0	1.61	234.8	0.33	7980.7
2014	10	7	22	8.2	8.7	0	56.5	0	1.56	234.6	0.47	7983.3
2014	10	7	23	6.8	7.6	0	56.8	0	1.99	232.9	0.79	7984.7
2014	10	7	24	6.4	7	0	59.4	0	1.84	236.3	0.64	7986
2014	10	8	1	5.5	6.4	0.1	64.8	0	1.54	234	0.89	7987.3
2014	10	8	2	4.6	5.9	0	64.9	0	1.67	233.3	1.33	7988.7
2014	10	8	3	4.3	5.5	0.1	70.4	0	1.62	234.9	1.16	7986
2014	10	8	4	4.7	5.5	0.1	65.2	0	1.39	236.3	0.77	7984.7
2014	10	8	5	3.9	5.1	0.1	73.3	0	1.37	233.6	1.17	7984.7
2014	10	8	6	3.4	4.9	0.1	69.8	0	1.31	239.9	1.44	7984.7
2014	10	8	7	3.7	4.8	0.1	68.4	0	1.33	234.4	1.1	7983.3
2014	10	8	8	3.2	4.3	1.6	70.6	0	1.4	236.4	1.15	7982
2014	10	8	9	3.4	4.6	57.1	71.5	0	1.39	231.8	1.23	7983.3
2014	10	8	10	5.8	6.6	263.7	52.8	0	0.95	230.4	0.84	7983.3
2014	10	8	11	11	10.4	428.3	35.2	0	1.14	91.3	-0.58	7979.3
2014	10	8	12	16.5	15.6	558	25.3	0	3.07	140.8	-0.91	7978
2014	10	8	13	18.6	17.8	642.4	22.9	0	5.34	212.9	-0.86	7976.7
2014	10	8	14	19.1	18.5	597.8	22.1	0	5.07	242.1	-0.62	7974
2014	10	8	15	19.4	18.7	641.6	21.1	0	5.57	233.9	-0.72	7971.3
2014	10	8	16	19.6	18.8	565.5	21.8	0	5.95	237.2	-0.78	7967.3
2014	10	8	17	19.4	18.8	453.6	20.6	0	5.17	241.6	-0.64	7966
2014	10	8	18	19	18.5	275.2	21.2	0	4.72	235.8	-0.47	7966
2014	10	8	19	17.9	17.7	62.7	24.9	0	3.13	243.9	-0.14	7963.3
2014	10	8	20	14.6	14.9	1.6	37.9	0	1.28	237.9	0.27	7964.7
2014	10	8	21	11.3	11.6	0.1	44.1	0	1.86	235.2	0.29	7968.7
2014	10	8	22	9.9	10.3	0.1	49.2	0	1.18	243.5	0.34	7970
2014	10	8	23	8.4	9.1	0.1	53.7	0	1.33	237.1	0.66	7971.3
2014	10	8	24	7.6	8.1	0	59.2	0	1.49	236	0.53	7974
2014	10	9	1	6.4	7.1	0.1	68.6	0	1.49	239.8	0.65	7974
2014	10	9	2	5.1	5.8	0.1	70.3	0	1.34	234.8	0.69	7976.7
2014	10	9	3	4.3	5.1	0.1	73.5	0	1.54	236.4	0.85	7978
2014	10	9	4	3.8	4.5	0.1	74.4	0	1.72	238.7	0.63	7982
2014	10	9	5	3.3	4.1	0.1	79	0	1.84	234.5	0.78	7979.3
2014	10	9	6	3.2	4.1	0.1	79.3	0	1.57	239	0.93	7976.7
2014	10	9	7	3.9	4.7	0.1	79.8	0	1.55	232.7	0.83	7975.3
2014	10	9	8	3.8	4.3	1.3	78.8	0	1.03	244.6	0.53	7974
2014	10	9	9	2.9	3.7	48.4	79.1	0	1.11	234	0.8	7975.3
2014	10	9	10	4.5	5.1	250.8	62.5	0	1.21	234.3	0.61	7978
2014	10	9	11	9.8	9.2	415.1	46.9	0	0.87	123.1	-0.55	7978
2014	10	9	12	13.4	11.9	537.3	39.8	0	3.58	74.1	-1.47	7979.3
2014	10	9	13	15.2	14	663.7	35.8	0	4.13	49.8	-1.16	7976.7
2014	10	9	14	15.4	14.6	297.6	35.7	0	3.13	72.1	-0.8	7976.7
2014	10	9	15	15.5	14.9	409.5	31.6	0	2.25	112.2	-0.62	7976.7
2014	10	9	16	16.7	15.6	525.8	29.4	0	3.16	61.9	-1.05	7972.7
2014	10	9	17	16.9	16.2	438.1	28.4	0	2.59	219.3	-0.78	7971.3
2014	10	9	18	16.5	16	281.6	30.3	0	2.82	87.4	-0.48	7970
2014	10	9	19	15.3	15.2	59.5	36.1	0	1.44	197.6	-0.12	7970
2014	10	9	20	12.7	13	2.2	47.7	0	1.54	235.9	0.28	7974
2014	10	9	21	9.8	9.8	0.1	53.6	0	1.13	241.4	0.03	7978
2014	10	9	22	7.8	8.1	0.1	61.3	0	1.42	238.3	0.28	7980.7
2014	10	9	23	6.4	6.8	0	67.1	0	1.56	236.5	0.42	7984.7
2014	10	9	24	5.5	6	0	69.9	0	1.55	233.5	0.5	7986
2014	10	10	1	4.9	5.5	0	75.7	0	1.6	237	0.63	7987.3
2014	10	10	2	4.3	4.8	0.1	80.1	0	1.69	235.7	0.55	7988.7
2014	10	10	3	3.9	4.6	0.1	82.1	0	1.38	241.9	0.76	7988.7

2014	10	10	4	3.2	3.9	0.1	85.2	0	1.56	234.1	0.69	7988.7
2014	10	10	5	2.9	3.6	0.1	83.8	0	1.6	232.4	0.69	7987.3
2014	10	10	6	2.5	3.4	0.1	87.3	0	1.33	236.1	0.86	7986
2014	10	10	7	2.1	2.9	0	87.7	0	1.25	229.2	0.83	7987.3
2014	10	10	8	1.5	2.3	1.1	87.8	0	1.11	237.9	0.85	7988.7
2014	10	10	9	1.3	2.4	44.7	86.9	0	1.51	228.8	1.07	7991.3
2014	10	10	10	3.5	4	245.1	67.7	0	1.04	219.6	0.46	7992.7
2014	10	10	11	7.7	7.1	406.8	54.6	0	0.98	96.4	-0.57	7994
2014	10	10	12	11.9	10.5	534.4	47.5	0	3.45	66.4	-1.39	7994
2014	10	10	13	13.7	12.7	595.9	42	0	3.91	46.1	-0.99	7992.7
2014	10	10	14	14.1	13.5	330.8	40.6	0	3.92	46	-0.62	7990
2014	10	10	15	14.9	14	465.7	38	0	3.74	51.6	-0.82	7986
2014	10	10	16	15	14.5	272.2	35.5	0	3.1	65.9	-0.51	7984.7
2014	10	10	17	15.7	15.1	375.8	33.2	0	3.56	233.1	-0.63	7983.3
2014	10	10	18	15.4	15	242	33.1	0	2.52	252.4	-0.43	7982
2014	10	10	19	13.8	13.8	44.8	38.9	0	2.09	242.7	-0.01	7983.3
2014	10	10	20	10.4	10.9	0.8	52.1	0	1.4	230.8	0.49	7986
2014	10	10	21	7.6	8.1	0.1	58.6	0	1.5	235.2	0.5	7990
2014	10	10	22	6.3	6.6	0.1	60.9	0	1.2	240.2	0.33	7994
2014	10	10	23	5.1	5.7	0	62.2	0	1.49	236.1	0.53	7996.7
2014	10	10	24	4.8	5.1	0.1	64.8	0	1.39	242.4	0.34	7996.7
2014	10	11	1	3.4	3.9	0	71.7	0	1.59	230.8	0.58	7998
2014	10	11	2	3.3	3.9	0.1	73.4	0	1.36	236.6	0.61	7995.3
2014	10	11	3	2.9	3.6	0.1	71.7	0	1.38	235.2	0.72	7996.7
2014	10	11	4	2.4	3.2	0	77.3	0	0.94	230.3	0.85	7996.7
2014	10	11	5	2.2	3	0	77.2	0	1.44	241.8	0.79	7991.3
2014	10	11	6	1.7	2.5	0	78.7	0	1.18	249.1	0.83	7991.3
2014	10	11	7	1.5	2.6	0	79.2	0	0.88	241	1.06	7987.3
2014	10	11	8	1.9	2.6	0.5	83.7	0	1.11	236.3	0.7	7987.3
2014	10	11	9	2.3	3.1	37.9	80.1	0	1.06	239.2	0.75	7987.3
2014	10	11	10	4.8	5	162.9	61.9	0	0.96	240	0.27	7983.3
2014	10	11	11	9.6	9.5	270.9	43.2	0	2	204.8	-0.11	7976.7
2014	10	11	12	11.9	11.3	479.7	40.2	0	5.87	221.5	-0.66	7974
2014	10	11	13	12.4	11.9	461	41.3	0	6.58	240	-0.54	7968.7
2014	10	11	14	12.1	11.6	366.5	44.3	0	7.97	231	-0.52	7963.3
2014	10	11	15	12.1	11.5	381.8	47.2	0	7.1	224	-0.59	7956.7
2014	10	11	16	11.6	11.1	226.1	50.5	0	6.55	235.5	-0.43	7951.3
2014	10	11	17	9.4	9.2	80.6	80.3	0.01	6.67	225.2	-0.21	7947.3
2014	10	11	18	8.4	8.2	73.2	68.3	0	1.99	238.8	-0.19	7950
2014	10	11	19	6.8	6.7	11.2	82.9	0.05	4.63	218.2	-0.08	7946
2014	10	11	20	5.1	5.3	0.8	92.1	0	1.85	246.2	0.18	7952.7
2014	10	11	21	4.6	5.2	0.1	90.8	0	1.41	249.7	0.67	7950
2014	10	11	22	3.3	3.8	0.1	84.8	0	2.22	240.1	0.53	7948.7
2014	10	11	23	3.2	3.7	0	78.7	0	2.08	234.1	0.5	7950
2014	10	11	24	1.5	1.4	0	97.6	0.03	1.53	44.7	-0.13	7955.3
2014	10	12	1	1.7	1.7	0	86	0	1.07	63.9	0.05	7956.7
2014	10	12	2	2.4	2.3	0	79.5	0.01	4.29	184.5	-0.06	7958
2014	10	12	3	1.9	1.9	0	77.7	0	2.59	56.7	0.03	7967.3
2014	10	12	4	2.2	2.1	0.1	75.3	0	1.37	241.8	-0.08	7972.7
2014	10	12	5	2.4	2.3	0.1	74.1	0	4.66	231.6	-0.06	7974
2014	10	12	6	2	2	0.1	80.7	0	3.67	237.7	-0.08	7979.3
2014	10	12	7	1.5	1.5	0.1	84.4	0	1.28	281.9	-0.04	7982
2014	10	12	8	1.3	1.3	0.3	87.4	0	1.27	227.1	0.02	7988.7
2014	10	12	9	1.1	0.9	21.6	83.2	0	1.48	54	-0.13	7996.7
2014	10	12	10	2.2	1.7	198	82.5	0	2.78	68.5	-0.52	8000.7
2014	10	12	11	3.2	2.6	237.1	71.2	0	3.53	72.2	-0.58	8006
2014	10	12	12	3.4	3	189.7	65.9	0	2.71	88.2	-0.42	8010
2014	10	12	13	4.1	3.6	342.6	56.5	0	2.05	214.5	-0.48	8014
2014	10	12	14	4.6	4.1	369.9	53.7	0	2.81	80.2	-0.59	8016.7
2014	10	12	15	5.6	4.9	537.8	47.9	0	2.28	73.1	-0.77	8011.3
2014	10	12	16	6	5.4	256.2	46.6	0	2.12	97.6	-0.55	8010

2014	10	12	17	6.2	5.8	148.1	49.1	0	2.11	88.4	-0.39	8010
2014	10	12	18	6.1	5.8	94.8	52.6	0	1.98	67.3	-0.28	8010
2014	10	12	19	5.7	5.6	24.5	65.3	0	1.22	13.9	-0.09	8007.3
2014	10	12	20	4	4.1	0.6	73.8	0	0.6	248	0.06	8011.3
2014	10	12	21	3.1	3.2	0.1	71.3	0	0.56	259.5	0.15	8012.7
2014	10	12	22	1.9	2.1	0	81.7	0	1.01	237.4	0.16	8014
2014	10	12	23	0.8	1	0	82.8	0	1.01	242.6	0.2	8016.7
2014	10	12	24	-0.2	0.2	0	82.9	0	1.05	240.3	0.39	8014
2014	10	13	1	-0.2	0.1	0	82.4	0	1.25	244.9	0.27	8008.7
2014	10	13	2	0	0.4	0	89	0	0.72	243	0.32	8010
2014	10	13	3	0.3	0.5	0.1	86.6	0	0.84	255	0.18	8011.3
2014	10	13	4	-0.7	-0.3	0.1	92.1	0	0.95	240.5	0.44	8014
2014	10	13	5	-1	-0.6	0	90.7	0	0.84	229.5	0.33	8010
2014	10	13	6	-0.9	-0.6	0.1	90.1	0	0.63	249.6	0.32	8007.3
2014	10	13	7	-1.4	-0.9	0.1	92.1	0	0.54	251.3	0.55	8008.7
2014	10	13	8	-1.8	-1.2	0.9	92.4	0	0.87	238.7	0.59	8011.3
2014	10	13	9	-1.7	-1.2	29.7	87.7	0	0.72	238.8	0.51	8012.7
2014	10	13	10	-0.6	-0.3	159.7	84.7	0	0.72	230	0.32	8016.7
2014	10	13	11	2.2	2	292	63.8	0	0.65	199.1	-0.21	8016.7
2014	10	13	12	6.8	6.2	505.4	44	0	1.11	83.4	-0.59	8012.7
2014	10	13	13	10.7	10.1	502.4	35.1	0	2.15	183.2	-0.6	8008.7
2014	10	13	14	12.6	11.9	590.2	29	0	4.95	225.3	-0.67	8007.3
2014	10	13	15	13.8	13.1	573.9	30.1	0	4.86	229	-0.67	8002
2014	10	13	16	14.7	14	514.7	30.4	0	4.39	230.8	-0.64	7996.7
2014	10	13	17	14.8	14.3	264.7	30.1	0	4.59	233.8	-0.43	7992.7
2014	10	13	18	14.5	14.3	135.2	28.9	0	4.63	239.8	-0.19	7990
2014	10	13	19	13.7	13.8	25.1	37.9	0	3.76	232.5	0.08	7987.3
2014	10	13	20	10.9	11.2	0.3	49.4	0	1.4	218.8	0.34	7983.3
2014	10	13	21	7.9	8.7	0.1	59.1	0	1.93	240	0.85	7984.7
2014	10	13	22	7.7	8.9	0.1	48	0	1.59	242.9	1.21	7984.7
2014	10	13	23	8.7	9.9	0.1	55.3	0	1.31	261.1	1.28	7980.7
2014	10	13	24	8	9.4	0.1	39.3	0	1.01	18.4	1.41	7978
2014	10	14	1	13.9	14.2	0.1	28.8	0	6.07	237.1	0.29	7974
2014	10	14	2	11.8	12.6	0.1	34	0	2.34	220.3	0.71	7971.3
2014	10	14	3	10.3	11.2	0.1	43.4	0	1.09	249.3	0.9	7971.3
2014	10	14	4	7.6	9	0.1	44.7	0	1.31	242.3	1.35	7967.3
2014	10	14	5	7.4	9	0.1	42.6	0	1.44	238.3	1.59	7967.3
2014	10	14	6	10.2	11.4	0.1	38.9	0	1.11	8.4	1.21	7962
2014	10	14	7	10.9	11.7	0.1	35.3	0	0.75	269.5	0.89	7960.7
2014	10	14	8	10.2	11.3	0.5	40.4	0	1.06	315.7	1.09	7960.7
2014	10	14	9	10.2	11.2	38.5	34.9	0	0.84	39.3	1.05	7958
2014	10	14	10	13	13.3	117.5	26.6	0	3.85	221	0.3	7955.3
2014	10	14	11	14.5	14.3	257.8	26.6	0	7	241.7	-0.11	7954
2014	10	14	12	14.5	14.3	304.3	26.8	0	6.24	234.8	-0.22	7951.3
2014	10	14	13	14.9	14.5	373.2	26.2	0	6.28	225.2	-0.34	7951.3
2014	10	14	14	15.6	15.1	593.6	24.7	0	7.04	236.4	-0.5	7947.3
2014	10	14	15	15.9	15.4	464.8	24.2	0	7.03	235.8	-0.5	7938
2014	10	14	16	15.5	15	391	25.4	0	6.55	235.1	-0.47	7932.7
2014	10	14	17	15.2	14.8	221.7	26.5	0	4.77	234.7	-0.34	7926
2014	10	14	18	14.9	14.7	91.8	25.4	0	4.83	241.4	-0.16	7923.4
2014	10	14	19	14.3	14.3	22	28.3	0	3.31	225.6	-0.01	7923.4
2014	10	14	20	12.6	13.1	0.3	36.3	0	0.63	207.4	0.5	7919.4
2014	10	14	21	11.1	12.1	0.1	41.9	0	1.04	262	1	7918
2014	10	14	22	11.3	12.1	0.1	32.5	0	1.24	235.9	0.78	7912.7
2014	10	14	23	12.2	12.8	0.1	30	0	0.92	193.2	0.59	7907.4
2014	10	14	24	12.7	13	0.1	27.1	0	2.46	97.9	0.39	7898
2014	10	15	1	12.8	13.2	0.1	27.6	0	1.33	142.3	0.4	7892.7
2014	10	15	2	13.1	13.6	0.1	27.9	0	1.07	151.5	0.46	7890
2014	10	15	3	13.8	14.2	0.1	26.3	0	1.55	202.7	0.36	7884.7
2014	10	15	4	14.5	14.6	0.1	25.5	0	4.92	231.2	0.11	7883.4
2014	10	15	5	13.4	13.3	0.1	30	0	6.18	237.7	-0.01	7880.7

2014	10	15	6	12.1	12.3	0.1	32.3	0	3.82	227.6	0.12	7883.4
2014	10	15	7	11.2	11.4	0.1	33	0	3.74	226.1	0.18	7882
2014	10	15	8	10	10.5	0.2	37.9	0	2.81	235.8	0.49	7880.7
2014	10	15	9	10	10.2	16.7	33.5	0	3.06	227.5	0.29	7880.7
2014	10	15	10	10	9.9	29.4	39.5	0	4.48	229.4	-0.04	7876.7
2014	10	15	11	8	7.8	125.6	49.6	0	2.62	215.7	-0.2	7888.7
2014	10	15	12	7.6	7.4	58.4	86.4	0.04	4.1	211.9	-0.18	7886
2014	10	15	13	4.1	3.9	77.9	86.1	0.06	3.47	210.9	-0.21	7899.4
2014	10	15	14	3.9	3.7	99	84.4	0.05	4.46	210.6	-0.21	7902
2014	10	15	15	2.8	2.6	117.6	77.4	0.01	4.33	221.8	-0.26	7914
2014	10	15	16	2.9	2.6	170.3	76.8	0	4.62	222	-0.31	7916.7
2014	10	15	17	2.5	2.2	132	87	0	4.67	207.8	-0.29	7928.7
2014	10	15	18	2.2	1.9	34.6	92	0.01	3.36	225	-0.23	7932.7
2014	10	15	19	0.5	0.4	4	98.7	0	0.77	70.4	-0.13	7939.3
2014	10	15	20	0.7	0.8	0.2	94.4	0	0.87	49.7	0.13	7948.7
2014	10	15	21	0.7	0.8	0	98.1	0	0.84	304.6	0.16	7956.7
2014	10	15	22	1	1.2	0	93.5	0	0.76	55	0.24	7960.7
2014	10	15	23	1.3	1.6	0	96.5	0	0.9	46.7	0.32	7968.7
2014	10	15	24	0.8	1	0	97.2	0	0.69	257.2	0.17	7975.3
2014	10	16	1	0.3	0.5	0	94.7	0	1.06	243	0.17	7978
2014	10	16	2	-0.3	-0.2	0.1	97.1	0	1.2	230.3	0.15	7982
2014	10	16	3	-0.8	-0.6	0	98	0	0.82	239.9	0.16	7988.7
2014	10	16	4	-1.5	-1.3	0.1	99.4	0	0.85	240.9	0.17	7991.3
2014	10	16	5	-1.7	-1.6	0.1	96	0	1.12	242.2	0.07	7991.3
2014	10	16	6	-2	-1.9	0.1	97	0	1.12	244.1	0.15	7986
2014	10	16	7	-2.2	-2	0.1	93	0	1.63	238.1	0.19	7986
2014	10	16	8	-2.2	-2	0.2	95.3	0	1.37	237.6	0.14	7984.7
2014	10	16	9	-1.9	-1.7	14.3	97.4	0	1.27	242.4	0.21	7983.3
2014	10	16	10	-0.9	-0.8	67.1	95.9	0	1.29	230.5	0.1	7986
2014	10	16	11	1.1	1.2	156.7	91.5	0	0.51	53	0.06	7988.7
2014	10	16	12	1.6	1.2	221.1	89.6	0.06	1.41	78.7	-0.38	7990
2014	10	16	13	3	2.6	249.3	78.4	0	1.37	95	-0.39	7992.7
2014	10	16	14	4.2	3.9	213.5	62.4	0	1.36	236.7	-0.31	7991.3
2014	10	16	15	5	4.7	319.1	55.1	0	1.04	231.9	-0.35	7984.7
2014	10	16	16	5.8	5.4	255.8	59.7	0	2.27	239.9	-0.41	7982
2014	10	16	17	5.9	5.5	163.1	59.8	0	2.25	241.7	-0.31	7982
2014	10	16	18	5.7	5.5	87.7	61.5	0	1.79	207.8	-0.26	7980.7
2014	10	16	19	5.3	5.2	22.3	69.6	0	1.69	137.1	-0.16	7979.3
2014	10	16	20	3.4	3.6	0.3	83.4	0	1.47	227.1	0.16	7976.7
2014	10	16	21	1.1	1.2	0.1	89.6	0	1.34	244.8	0.13	7980.7
2014	10	16	22	0	0.1	0	91.8	0	1.23	234.8	0.11	7982
2014	10	16	23	-0.5	-0.4	0	90.7	0	1.33	240.7	0.11	7980.7
2014	10	16	24	-0.8	-0.6	0	93.5	0	1.29	236	0.15	7980.7
2014	10	17	1	-0.9	-0.8	0.1	93.8	0	0.97	240.5	0.16	7978
2014	10	17	2	-1.4	-1	0.1	94.9	0	1.11	239.9	0.41	7978
2014	10	17	3	-1.9	-1.4	0.1	95.9	0	1.5	232.8	0.48	7975.3
2014	10	17	4	-1.8	-1.4	0	92.9	0	1.81	228.5	0.43	7976.7
2014	10	17	5	-1.6	-1.2	0.1	90.7	0	1.44	231	0.45	7974
2014	10	17	6	-1.8	-1.2	0.1	91.2	0	2.2	230.5	0.57	7972.7
2014	10	17	7	-1.6	-1	0.1	91.7	0	2.18	231.8	0.6	7974
2014	10	17	8	-1.4	-1.1	1.1	91.5	0	1.94	236.6	0.32	7972.7
2014	10	17	9	-1.2	-0.7	37.7	89.2	0	1.18	236.2	0.52	7974
2014	10	17	10	0.5	1.5	175.6	85.9	0	1.51	232.6	1.03	7974
2014	10	17	11	5.5	5.7	370.9	44.8	0	0.99	220.3	0.19	7972.7
2014	10	17	12	9.3	8.8	500.5	44.2	0	1.94	120.4	-0.51	7971.3
2014	10	17	13	11.4	10.8	587.5	37.6	0	3	175.1	-0.67	7970
2014	10	17	14	12.2	11.6	522.3	38.4	0	2.38	172.2	-0.57	7966
2014	10	17	15	13.5	12.8	612.1	39.1	0	2.96	194.9	-0.64	7959.3
2014	10	17	16	14.2	13.7	360.9	39	0	2.55	157.8	-0.49	7959.3
2014	10	17	17	14.5	14.1	292.7	35.5	0	3.05	222.9	-0.37	7956.7
2014	10	17	18	14.3	14.2	146.4	41.3	0	2.78	220.1	-0.07	7955.3

2014	10	17	19	12.1	12.3	35.3	56.4	0	1.9	231.6	0.27	7955.3
2014	10	17	20	8.2	8.4	0.2	59.4	0	1.39	231.6	0.17	7956.7
2014	10	17	21	7.6	8.1	0.1	63.8	0	1.07	241.7	0.48	7960.7
2014	10	17	22	8	8.7	0.1	54.5	0	2.09	251	0.62	7967.3
2014	10	17	23	8.1	8.3	0.1	74.9	0	1.75	231.6	0.2	7978
2014	10	17	24	6	6.4	0.1	80.9	0	1.4	239	0.34	7968.7
2014	10	18	1	4.7	5.1	0.1	84.9	0	1.47	237.7	0.42	7968.7
2014	10	18	2	3.8	4.5	0	81.3	0	1.35	233.1	0.71	7971.3
2014	10	18	3	3	3.7	0.1	81.9	0	1.35	245	0.68	7974
2014	10	18	4	2.3	3	0	77.4	0	1.63	234.9	0.67	7975.3
2014	10	18	5	1.8	2.7	0	81.1	0	1.87	233.2	0.88	7974
2014	10	18	6	1.8	2.6	0	83	0	1.87	233.8	0.74	7974
2014	10	18	7	1.8	2.5	0	79	0	1.47	235.3	0.66	7978
2014	10	18	8	0.9	2	0.4	85.4	0	1.96	231.2	1.16	7979.3
2014	10	18	9	1.3	2.2	51.3	86.8	0	1.2	241.9	0.93	7980.7
2014	10	18	10	3.1	3.8	177.8	72.8	0	1.12	234.9	0.71	7986
2014	10	18	11	6.3	6	373.4	54.4	0	0.77	96.3	-0.27	7988.7
2014	10	18	12	10.5	9.8	498.1	36.5	0	1.61	95	-0.75	7990
2014	10	18	13	12.9	12.2	579.3	38.3	0	2.11	72	-0.75	7986
2014	10	18	14	14.2	13.4	614.8	38.6	0	2.55	207.1	-0.83	7984.7
2014	10	18	15	14	13.5	511.2	40.3	0	4.25	55	-0.58	7982
2014	10	18	16	13.8	13.5	316.6	39.2	0	3.31	41.4	-0.37	7980.7
2014	10	18	17	14.6	14.1	377.9	36.3	0	2.51	32.5	-0.44	7979.3
2014	10	18	18	14.6	14.3	219.3	40.1	0	1.85	129.9	-0.31	7978
2014	10	18	19	11.1	11.4	18	56.5	0	1.07	225.2	0.21	7979.3
2014	10	18	20	8.1	8.4	0.3	66.3	0	1.52	237.8	0.33	7982
2014	10	18	21	6.2	6.7	0.1	74.5	0	1.82	235.8	0.47	7984.7
2014	10	18	22	4.7	5.4	0.1	80	0	1.67	239.4	0.62	7988.7
2014	10	18	23	4	4.6	0.1	84.4	0	1.74	238.2	0.56	7991.3
2014	10	18	24	3.2	4.1	0.1	85	0	1.66	239.4	0.86	7991.3
2014	10	19	1	2.8	3.5	0	84.6	0	1.8	238.7	0.72	7988.7
2014	10	19	2	2.3	3	0	86	0	1.76	236.6	0.69	7986
2014	10	19	3	1.9	2.5	0	88	0	1.95	235.8	0.64	7986
2014	10	19	4	1.9	2.7	0	85.8	0	2.03	233.3	0.75	7987.3
2014	10	19	5	2.1	2.6	0	86.9	0	1.61	239.6	0.56	7984.7
2014	10	19	6	1	2.1	0	88.3	0	1.56	236.7	1.06	7983.3
2014	10	19	7	1	2	0	85.8	0	1.42	241.1	1.03	7983.3
2014	10	19	8	0.5	1.6	0.4	83.6	0	1.55	236.2	1.15	7983.3
2014	10	19	9	0.2	1.6	13	83.4	0	1.52	236.7	1.31	7986
2014	10	19	10	1.9	3.2	194.6	72	0	1.54	237.2	1.28	7986
2014	10	19	11	5.6	5.8	377.4	47	0	0.49	183.2	0.2	7986
2014	10	19	12	11.2	10.7	505.7	24.9	0	0.96	110	-0.46	7984.7
2014	10	19	13	15.6	14.9	588.1	24.7	0	2.51	151.2	-0.71	7982
2014	10	19	14	16.4	15.7	610.7	22.2	0	2.85	179.4	-0.66	7978
2014	10	19	15	17.4	16.7	584.7	19.3	0	3.84	181	-0.64	7971.3
2014	10	19	16	17.9	17.3	501.5	15.8	0	5.21	227.2	-0.6	7967.3
2014	10	19	17	17.8	17.4	370.8	19.4	0	4.84	222.3	-0.47	7964.7
2014	10	19	18	17.3	17.1	207.6	22.4	0	5.15	225.9	-0.23	7962
2014	10	19	19	13.8	14.8	14.8	40.1	0	2.79	231.1	0.94	7960.7
2014	10	19	20	9.5	10.1	0.2	45.1	0	1.96	231.1	0.6	7960.7
2014	10	19	21	8.1	9	0	48.1	0	1.57	244.1	0.93	7963.3
2014	10	19	22	6.8	8.1	0	57.7	0	2.07	234	1.34	7963.3
2014	10	19	23	6.5	7.8	0.1	58	0	1.49	238.2	1.28	7963.3
2014	10	19	24	6	7.3	0.1	55	0	1.32	240.9	1.26	7960.7
2014	10	20	1	5.2	6.6	0.1	61.8	0	1.47	239.7	1.4	7962
2014	10	20	2	5.3	6.7	0	66.4	0	1.49	240.8	1.47	7958
2014	10	20	3	5.6	7.3	0.1	56.1	0	2.07	242.3	1.71	7956.7
2014	10	20	4	6.1	8	0.1	59.6	0	1.61	252.4	1.86	7955.3
2014	10	20	5	6.1	7.7	0.1	58.7	0	1.85	247.1	1.52	7954
2014	10	20	6	5.6	6.8	0.1	61.2	0	2.2	243.7	1.21	7952.7
2014	10	20	7	5	6.4	0.1	66.6	0	1.57	234.9	1.44	7951.3

2014	10	20	8	4.8	6.3	0.4	66.7	0	1.02	245.3	1.58	7950
2014	10	20	9	4.4	5.5	12.3	70.8	0	0.98	232	1.11	7947.3
2014	10	20	10	5.4	7	179	51.6	0	1.59	241.2	1.64	7948.7
2014	10	20	11	12.6	13.2	365.6	33.4	0	1.36	191.9	0.56	7948.7
2014	10	20	12	16.4	15.7	492.9	32.1	0	3.39	179.8	-0.64	7944.7
2014	10	20	13	17.6	17	572	28.9	0	5.25	224	-0.62	7940.7
2014	10	20	14	18	17.4	518.3	27.3	0	6.47	234.7	-0.51	7935.3
2014	10	20	15	17.9	17.5	399.7	27.9	0	5.74	229.4	-0.46	7930
2014	10	20	16	17.2	17	168.7	30.4	0	5.45	232	-0.28	7924.7
2014	10	20	17	17.3	17	311.6	29.3	0	5.44	237.6	-0.36	7924.7
2014	10	20	18	17	16.7	172.3	33	0	4.68	227.2	-0.25	7923.4
2014	10	20	19	15.7	15.8	15.1	32.4	0	3.57	229	0.07	7920.7
2014	10	20	20	12.5	13.1	0.1	47.6	0	1.66	224.9	0.57	7918
2014	10	20	21	11.4	12	0.1	45.8	0	2.63	242.9	0.61	7916.7
2014	10	20	22	12.3	12.4	0.1	58.4	0	4.98	217.6	0.14	7911.4
2014	10	20	23	9.5	9.8	0.1	81	0.07	2.21	339.6	0.31	7914
2014	10	20	24	6.7	7.1	0.1	95.7	0	1.2	241.4	0.39	7918
2014	10	21	1	5.1	5.4	0.1	95.5	0	1.83	232.1	0.36	7910
2014	10	21	2	5.9	6.1	0.1	90.5	0.07	1.62	234.3	0.18	7903.4
2014	10	21	3	5.8	5.9	0.1	97.2	0.06	1.09	275.4	0.05	7914
2014	10	21	4	5.3	5.2	0.1	84.6	0.04	1.76	238.4	-0.08	7911.4
2014	10	21	5	4.3	4.2	0.1	90	0.1	3.46	242.2	-0.12	7911.4
2014	10	21	6	3.1	2.9	0.1	92.6	0.07	1.22	206.6	-0.15	7910
2014	10	21	7	2.6	2.4	0.1	95.3	0.06	1.92	37.7	-0.19	7916.7
2014	10	21	8	2.1	1.9	0.1	97.8	0.04	1.79	225.5	-0.2	7906
2014	10	21	9	1.9	1.6	4.5	98.7	0.03	1.12	232.5	-0.2	7915.4
2014	10	21	10	0.9	0.8	14.5	99.9	0.06	1.46	69.8	-0.18	7918
2014	10	21	11	0.6	0.5	55.1	100	0.05	0.4	17.9	-0.08	7924.7
2014	10	21	12	0.7	0.5	81	99.7	0.05	1.36	57.9	-0.22	7930
2014	10	21	13	3.3	2.8	121.7	97.4	0.02	0.25	164.1	-0.53	7935.3
2014	10	21	14	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	10	21	15	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	10	21	16	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	10	21	17	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	10	21	18	9999	9999	9999	9999	9999	9999	9999	9999	9999
2014	10	21	19	0.7	0.6	4.3	100	0	3.18	36.6	-0.08	7959.3
2014	10	21	20	0.5	0.4	0.1	100	0	0.7	256	-0.11	7966
2014	10	21	21	0.5	0.4	0.1	100	0	0.53	182	-0.15	7968.7
2014	10	21	22	0.5	0.4	0	100	0	0.74	233.5	-0.09	7970
2014	10	21	23	0.3	0.3	0	100	0	1.2	235.4	-0.02	7970
2014	10	21	24	0	0	0	100	0	1	234.5	-0.02	7972.7
2014	10	22	1	-0.5	-0.5	0.1	96.9	0	1.45	237.2	-0.04	7974
2014	10	22	2	-1	-1	0.1	97.8	0	1.29	236.5	-0.01	7974
2014	10	22	3	-1.6	-1.6	0	98.7	0	1.4	238.8	-0.04	7974
2014	10	22	4	-1.3	-1.3	0	97.2	0	1.01	241.1	0.01	7975.3
2014	10	22	5	-1	-1	0	98.9	0	1.27	237.2	0.02	7975.3
2014	10	22	6	-0.8	-0.6	0	97.4	0	1.25	247.1	0.26	7976.7
2014	10	22	7	-1.2	-0.8	0	99.4	0	1.03	245.3	0.35	7975.3
2014	10	22	8	-1.7	-1.5	0.2	98.5	0	1.24	239	0.19	7974
2014	10	22	9	-2.1	-2	6.6	97.3	0	0.65	252.4	0.12	7975.3
2014	10	22	10	-2	-1.9	103.5	91.4	0	1.16	228.2	0.14	7979.3
2014	10	22	11	0.2	0.2	304.6	93.3	0	1.05	171.9	0	7980.7
2014	10	22	12	4	3.5	471.7	59.3	0	1.55	171.9	-0.51	7980.7
2014	10	22	13	5.6	5.1	350.8	58.5	0.01	4.21	233.2	-0.42	7980.7
2014	10	22	14	6	5.6	534.7	54	0	5.84	239.2	-0.46	7982
2014	10	22	15	6.5	6	571.9	50.3	0	6.44	244.8	-0.45	7978
2014	10	22	16	7	6.5	460.9	48.5	0	5	243.1	-0.51	7975.3
2014	10	22	17	6.7	6.3	218.5	51.7	0.03	4.48	249.6	-0.35	7970
2014	10	22	18	6.4	6.1	71.3	50.3	0	4.02	254.1	-0.23	7972.7
2014	10	22	19	6.2	6.1	12.4	54.7	0	3.01	246.1	-0.11	7968.7
2014	10	22	20	5	5.1	0.1	65.8	0	0.93	223.3	0.11	7967.3

2014	10	22	21	4.8	5	0.1	57.3	0	1.76	208	0.29	7967.3
2014	10	22	22	7	7	0.1	57.4	0	5.63	248.9	-0.06	7963.3
2014	10	22	23	6.5	6.4	0.1	66.1	0	5.58	242.5	-0.07	7963.3
2014	10	22	24	6.1	6	0.1	73.2	0	6.59	248.4	-0.08	7964.7
2014	10	23	1	5.4	5.4	0.1	75.9	0	7.56	251.8	-0.07	7963.3
2014	10	23	2	4.9	4.8	0.1	81	0	7.16	246	-0.06	7962
2014	10	23	3	4.6	4.5	0.1	79.5	0	6.57	243.7	-0.06	7966
2014	10	23	4	4.5	4.5	0.1	83.6	0	4.88	243.5	-0.04	7964.7
2014	10	23	5	3.9	3.9	0	89	0	1.66	219.8	-0.03	7962
2014	10	23	6	3.6	3.6	0	89.8	0	1.01	95.8	0.06	7960.7
2014	10	23	7	4.4	4.3	0.1	81.9	0	4.18	238.9	-0.02	7958
2014	10	23	8	4.3	4.3	0.1	91	0	4.58	239.6	-0.03	7960.7
2014	10	23	9	4.1	4.1	6.8	89.9	0	2.75	216.9	0	7964.7
2014	10	23	10	3.9	3.9	29.5	83.6	0.15	1.91	242.9	-0.05	7967.3
2014	10	23	11	5.2	5.1	80.7	82.9	0.05	4.27	238.1	-0.08	7972.7
2014	10	23	12	4.9	4.8	82.6	85.9	0.03	2.08	229.6	-0.14	7970
2014	10	23	13	4.9	4.7	117	87.9	0.02	1.46	257	-0.19	7970
2014	10	23	14	5.1	4.8	190.1	87.1	0.02	1.49	93.5	-0.31	7966
2014	10	23	15	5.5	5.2	153.5	88.8	0.02	2.04	216.4	-0.28	7962
2014	10	23	16	5.2	5	54.4	83.1	0.04	5.19	219	-0.18	7956.7
2014	10	23	17	4.5	4.4	17.1	90.8	0.04	3.43	236.6	-0.08	7960.7
2014	10	23	18	4.6	4.4	31.6	83.4	0.02	2.3	232.7	-0.15	7954
2014	10	23	19	5	4.9	5	85.8	0.03	5.41	240.4	-0.03	7955.3
2014	10	23	20	4.6	4.6	0.1	93.4	0.03	3.17	246.7	-0.02	7958
2014	10	23	21	4	4	0.1	98.4	0.04	0.54	280	-0.04	7960.7
2014	10	23	22	3.7	3.6	0.1	96.9	0.04	0.51	269.9	-0.06	7963.3
2014	10	23	23	3.4	3.2	0.1	95.8	0.02	0.33	253.1	-0.16	7967.3
2014	10	23	24	3.6	3.5	0	89.7	0.02	2.55	242.5	-0.05	7968.7
2014	10	24	1	3.7	3.7	0.1	90.2	0	2.2	257.4	-0.01	7968.7
2014	10	24	2	3.6	3.5	0.1	90.9	0.01	1.13	248.4	-0.03	7972.7
2014	10	24	3	3.9	3.8	0.1	96.5	0	1.17	249.6	-0.02	7972.7
2014	10	24	4	3.6	3.6	0.1	99.5	0	1.09	220.7	-0.05	7974
2014	10	24	5	2.9	2.7	0.1	100	0.01	1.35	91.7	-0.2	7974
2014	10	24	6	2.9	2.8	0	100	0.01	0.5	75.6	-0.19	7974
2014	10	24	7	3	2.8	0.1	100	0.02	0.13	247.7	-0.18	7974
2014	10	24	8	2.6	2.4	0.1	99.3	0.04	1.05	268.1	-0.19	7976.7
2014	10	24	9	2.3	2.1	4.7	99.6	0.02	0.95	224.4	-0.23	7976.7
2014	10	24	10	2.1	1.8	26	99.7	0.04	0.42	140.1	-0.23	7984.7
2014	10	24	11	1.9	1.6	62.7	97.7	0.03	0.83	230.1	-0.28	7988.7
2014	10	24	12	2.4	2	97.3	99.8	0.03	1.34	175.1	-0.34	7988.7
2014	10	24	13	3.1	2.7	137.5	100	0.02	1.85	82.6	-0.4	7988.7
2014	10	24	14	3.5	3.1	128.7	100	0.02	1.83	80.5	-0.41	7988.7
2014	10	24	15	4.3	3.8	172.2	98.8	0.01	1.81	68.8	-0.5	7983.3
2014	10	24	16	5.3	4.9	217.4	95.7	0.01	1.22	91.3	-0.43	7976.7
2014	10	24	17	7.4	7.2	122.2	63.6	0.01	2.46	245.9	-0.15	7975.3
2014	10	24	18	8.6	8.6	80.3	63.3	0.01	3.48	239.7	0.02	7975.3
2014	10	24	19	6.4	6.7	7.1	91.8	0	1.74	231.2	0.26	7974
2014	10	24	20	4	4.4	0.1	93.1	0	0.66	247.2	0.36	7972.7
2014	10	24	21	2.3	2.7	0.1	96.7	0	0.84	237.7	0.33	7975.3
2014	10	24	22	1.5	2	0.1	98.4	0	0.79	239.1	0.53	7974
2014	10	24	23	1.4	2	0.1	99.9	0	0.99	242.6	0.69	7974
2014	10	24	24	1.5	2.4	0.1	97.6	0	1.19	243.1	0.84	7972.7
2014	10	25	1	1.7	2.4	0	98	0	0.79	239.9	0.75	7970
2014	10	25	2	2.1	3.1	0.1	87.7	0	1.75	246.8	0.97	7968.7
2014	10	25	3	2.2	3.2	0.1	86.4	0	1.89	240.3	0.99	7962
2014	10	25	4	1.4	2.2	0	97.2	0	0.98	244.4	0.74	7960.7
2014	10	25	5	1.3	2.4	0.1	88.8	0	1.77	236.1	1.08	7954
2014	10	25	6	1.5	2.4	0	89.8	0	1.25	243	0.9	7948.7
2014	10	25	7	1.4	2.6	0	87.4	0	1.82	242.3	1.24	7940.7
2014	10	25	8	2.7	4.5	0.2	76.9	0	2.32	246.2	1.8	7936.7
2014	10	25	9	3.8	6	19.3	57	0	1.83	247.3	2.21	7934

2014	10	25	10	9.2	10.5	115.4	37.7	0	1.23	215.8	1.33	7930
2014	10	25	11	11.6	12.1	150.8	36	0	2.5	196.6	0.48	7931.3
2014	10	25	12	13.2	13.3	299.2	28	0.02	4.72	234.4	0.06	7928.7
2014	10	25	13	13.8	13.7	352.6	29.2	0.03	6.33	244.6	-0.09	7926
2014	10	25	14	13.7	13.6	267	30	0.01	6.92	252.9	-0.11	7923.4
2014	10	25	15	13.5	13.4	265.6	30.1	0	6.63	258.6	-0.1	7920.7
2014	10	25	16	14.2	14	392	30.6	0.01	5.9	243.6	-0.25	7915.4
2014	10	25	17	13.4	13.3	64.8	33.5	0.01	5.59	237.5	-0.04	7911.4
2014	10	25	18	11.2	11.2	25.1	44	0	6.39	220.3	-0.01	7911.4
2014	10	25	19	11.3	11.4	6.6	40.1	0	4.94	230.6	0.08	7907.4
2014	10	25	20	9.8	9.8	0.1	58	0	5.37	220.5	0.05	7906
2014	10	25	21	8.4	8.5	0	46.7	0	5.66	220.9	0.06	7910
2014	10	25	22	8.9	8.9	0.1	47.8	0	5.72	205.4	0.04	7907.4
2014	10	25	23	7.9	8	0	49.4	0	4.03	213.9	0.1	7907.4
2014	10	25	24	7.5	7.5	0	51.2	0	4.25	211	0.04	7908.7
2014	10	26	1	6.9	6.8	0	61.7	0	5.79	213.3	-0.03	7910
2014	10	26	2	5.5	5.5	0.1	65.1	0	6.63	210.7	-0.04	7910
2014	10	26	3	3.7	3.6	0.1	82.2	0	5.01	218.4	-0.05	7910
2014	10	26	4	3.5	3.5	0.1	74.7	0	4.55	225.8	-0.03	7916.7
2014	10	26	5	2.9	2.8	0.1	89.7	0	3.47	227.4	-0.07	7918
2014	10	26	6	2.1	2	0.1	92.3	0	3.9	230.2	-0.07	7916.7
2014	10	26	7	1.7	1.7	0	81.6	0	3.74	234.6	-0.05	7919.4
2014	10	26	8	1.9	1.8	0.1	79.8	0	4.01	237.1	-0.08	7923.4
2014	10	26	9	1.5	1.4	10.8	72	0	3.72	233.8	-0.05	7923.4
2014	10	26	10	1.1	0.9	76.1	90.3	0	4.27	221.4	-0.15	7928.7
2014	10	26	11	0.9	0.6	172.4	71.2	0	3.65	195.2	-0.28	7934
2014	10	26	12	-1.1	-1.3	24.1	97.5	0	2.49	121.1	-0.15	7935.3
2014	10	26	13	-1.4	-1.4	87.4	92.4	0	1.26	61.2	-0.06	7939.3
2014	10	26	14	-0.6	-0.7	237.1	68.7	0	0.97	74.2	-0.15	7938
2014	10	26	15	1	0.8	534.9	68.2	0.04	6.07	220.5	-0.16	7934
2014	10	26	16	0.2	0	130.2	90.9	0.01	4.58	224.8	-0.16	7932.7
2014	10	26	17	0.1	0	123.9	70.3	0	2.43	239.4	-0.14	7935.3
2014	10	26	18	-0.2	-0.3	28.9	93.5	0	3.25	244.5	-0.11	7934
2014	10	26	19	-0.8	-0.8	8.7	79.2	0	1.78	245.4	-0.03	7934
2014	10	26	20	-0.7	-0.6	0.1	76.1	0	1.29	266.2	0.06	7935.3
2014	10	26	21	-1.2	-1.1	0.1	92.1	0	1.17	271.3	0.08	7939.3
2014	10	26	22	-2.2	-2.4	0.1	98.3	0	1	86.2	-0.15	7942
2014	10	26	23	-2.3	-2.3	0	98.4	0.01	1.04	341.8	0.01	7943.3
2014	10	26	24	-2.3	-2.4	0	98.8	0.01	0.3	238.1	-0.06	7946
2014	10	27	1	-2.5	-2.4	0	97.8	0.01	0.56	318.1	0.04	7946
2014	10	27	2	-2.7	-2.7	0.1	99.2	0.01	0.9	57.1	-0.05	7946
2014	10	27	3	-2.5	-2.6	0.1	99.3	0	0.51	42	-0.06	7950
2014	10	27	4	-2.8	-2.9	0.1	97.2	0	3.48	46.3	-0.05	7954
2014	10	27	5	-3.6	-3.6	0	94.5	0.01	2.72	57.3	-0.03	7960.7
2014	10	27	6	-3.8	-3.9	0	97.8	0	1.13	97.9	-0.03	7963.3
2014	10	27	7	-3.9	-3.9	0	93.8	0	0.44	231.1	0	7964.7
2014	10	27	8	-4.3	-4.2	0.1	91.1	0	0.63	338.6	0.14	7970
2014	10	27	9	-4.9	-4.8	14.3	89.5	0	1.06	239.3	0.09	7970
2014	10	27	10	-4.3	-4.3	86.6	84.4	0	0.56	250.3	0.03	7974
2014	10	27	11	-3.2	-3.2	175.3	67.1	0.01	0.8	243.1	-0.08	7978
2014	10	27	12	-1.9	-2	300.7	58.3	0.03	1.14	47.6	-0.14	7982
2014	10	27	13	-1.5	-1.7	321.3	60.2	0.03	2.61	43	-0.15	7984.7
2014	10	27	14	-1.2	-1.4	334.2	67.3	0.02	2.79	44.2	-0.14	7984.7
2014	10	27	15	-1.2	-1.3	266.7	67.8	0	3.21	37.2	-0.12	7982
2014	10	27	16	-0.6	-0.8	377.4	67	0.01	2.81	38.8	-0.16	7979.3
2014	10	27	17	-0.5	-0.6	204.9	64.1	0.01	2.98	26.7	-0.1	7979.3
2014	10	27	18	-0.7	-0.8	83.9	78.1	0	1.87	63.7	-0.1	7978
2014	10	27	19	-1.2	-1.3	11	82.2	0	0.9	68.3	-0.09	7979.3
2014	10	27	20	-2	-1.9	0.1	86.3	0	0.65	238.3	0.03	7979.3
2014	10	27	21	-2.6	-2.6	0	82.6	0	0.89	238	-0.02	7980.7
2014	10	27	22	-4	-4	0	84.8	0	1.55	233.6	0	7982

2014	10	27	23	-5.9	-5.9	0	87.5	0	1.43	239	-0.03	7986
2014	10	27	24	-7.2	-7.1	0	90.6	0	1.61	240.7	0.02	7988.7
2014	10	28	1	-7.7	-7.6	0	90.3	0	1.41	241.6	0.13	7988.7
2014	10	28	2	-8.1	-7.8	0	89.2	0	1.28	237.6	0.23	7988.7
2014	10	28	3	-7.8	-7.5	0	86.7	0	1.1	236.7	0.3	7991.3
2014	10	28	4	-7.1	-7.1	0	88.1	0	0.96	244.3	0.05	7991.3
2014	10	28	5	-6	-6.1	0	86.3	0	0.73	224	-0.13	7990
2014	10	28	6	-5.2	-5.4	0	84.5	0	0.5	230.9	-0.11	7988.7
2014	10	28	7	-4.9	-4.9	0	83.9	0	1.15	233.2	-0.01	7992.7
2014	10	28	8	-5.9	-5.6	0.1	88.6	0	0.91	254.2	0.34	7991.3
2014	10	28	9	-6.7	-6.4	8.5	89.6	0	1.1	245	0.29	7994
2014	10	28	10	-6.3	-5.8	97.6	79.3	0	1.13	234	0.46	7999.3
2014	10	28	11	-4	-3.9	335.7	65.9	0	0.63	223.6	0.09	8003.3
2014	10	28	12	-0.3	-0.7	461.8	63.1	0	1.11	97.8	-0.43	8002
2014	10	28	13	2.5	1.6	523.2	64.2	0	2.58	81.4	-0.83	8002
2014	10	28	14	4.1	3.6	372.6	63.5	0.01	1.58	84.3	-0.48	8003.3
2014	10	28	15	5.2	4.8	395.7	58.9	0.01	1.78	78.6	-0.42	7996.7
2014	10	28	16	7	6.6	371.6	55.2	0.02	3.45	219.8	-0.41	7992.7
2014	10	28	17	7.7	7.2	355.8	59.2	0.02	3.26	231.9	-0.45	7992.7
2014	10	28	18	6.6	6.5	75.1	66.7	0	2.65	218	-0.11	7995.3
2014	10	28	19	4.7	5.3	13.9	76.6	0	2.1	238.7	0.63	7991.3
2014	10	28	20	3.6	4.3	0.1	78.8	0	1.07	242.9	0.76	7991.3
2014	10	28	21	3	3.8	0.1	74	0	0.75	269.3	0.87	7991.3
2014	10	28	22	2.2	3.2	0.1	92.1	0	0.8	53.3	1.04	7990
2014	10	28	23	1.8	2.3	0.1	75.1	0	1.04	200.9	0.54	7987.3
2014	10	28	24	4.3	4.5	0.1	88.5	0	4.92	234.5	0.16	7988.7
2014	10	29	1	3.3	3.4	0.1	87.2	0	2.35	247.8	0.12	7994
2014	10	29	2	3.9	3.9	0.1	86.3	0	5.03	223.8	-0.01	7991.3
2014	10	29	3	3.3	3.3	0.1	87.3	0	2.17	243.1	-0.01	7994
2014	10	29	4	4	4	0.1	77	0	4.87	230.1	0	7994
2014	10	29	5	3.3	3.5	0.1	91.4	0	0.99	271.1	0.22	7991.3
2014	10	29	6	2.1	2.2	0	97.3	0	0.88	75	0.11	7991.3
2014	10	29	7	1.9	2.1	0	95.8	0	0.67	242.6	0.15	7994
2014	10	29	8	2.2	2.7	0.1	95.6	0	0.82	263.5	0.47	7998
2014	10	29	9	2	2.3	10.7	97.6	0	0.91	245.3	0.35	8000.7
2014	10	29	10	2.1	2.1	30.6	97.1	0	0.41	206.3	-0.04	8002
2014	10	29	11	2.9	2.8	105.5	88	0	0.87	230.2	-0.16	8008.7
2014	10	29	12	4.5	4.2	133.4	80.4	0	1.02	227	-0.24	8012.7
2014	10	29	13	4.6	4.2	238.3	86.2	0	2.2	229.4	-0.35	8014
2014	10	29	14	5.8	5.2	432.6	71	0	2.86	219.8	-0.56	8018
2014	10	29	15	6.5	6.1	275.8	63.6	0	3.21	215	-0.45	8016.7
2014	10	29	16	6.7	6.4	193.4	66.2	0	3.98	233.9	-0.32	8015.3
2014	10	29	17	6.6	6.4	130.9	64.7	0	2.31	222	-0.28	8016.7
2014	10	29	18	6.6	6.5	82	60.5	0	2.31	220.7	-0.16	8018
2014	10	29	19	5	5.2	4.7	75.3	0	1.47	218.8	0.18	8014
2014	10	29	20	3.5	3.6	0.1	85.3	0	1.13	242.6	0.2	8016.7
2014	10	29	21	1.9	2.2	0.1	86.6	0	1.35	242.4	0.31	8019.3
2014	10	29	22	1.5	1.9	0.1	86.9	0	1.36	244.7	0.45	8019.3
2014	10	29	23	1.5	1.9	0.1	92	0	1.19	247.1	0.49	8022
2014	10	29	24	0.6	1.2	0.1	91.8	0	1.51	237.2	0.59	8022
2014	10	30	1	0.3	0.7	0.1	93.5	0	0.89	246.6	0.37	8023.3
2014	10	30	2	0.6	1.1	0	93.4	0	0.55	257.5	0.44	8023.3
2014	10	30	3	1.1	1.4	0.1	93.7	0	1.02	248.1	0.34	8024.7
2014	10	30	4	1.6	1.8	0.1	92.7	0	1.64	239.9	0.27	8024.7
2014	10	30	5	1.2	1.6	0.1	91.7	0	1.48	236.9	0.38	8022
2014	10	30	6	0.9	1.3	0.1	89.9	0	1.86	231.2	0.4	8019.3
2014	10	30	7	0.5	1.3	0	90.4	0	1.83	237.8	0.84	8018
2014	10	30	8	0.4	0.6	0.1	91.1	0	1.67	225.2	0.22	8015.3
2014	10	30	9	0.2	0.6	11.3	91.6	0	1.58	225.6	0.42	8015.3
2014	10	30	10	0.7	1.3	86.6	84.1	0	1.94	228.1	0.63	8016.7
2014	10	30	11	4.4	5.2	250.8	67.4	0	1.9	240.3	0.82	8016.7

2014	10	30	12	8.9	9	350.2	43.8	0	0.69	254.6	0.08	8015.3
2014	10	30	13	11.2	10.9	464.9	41.9	0.01	2.59	236.5	-0.36	8014
2014	10	30	14	11.8	11.5	354	46.8	0.01	3.2	231.2	-0.33	8010
2014	10	30	15	12.5	12.2	373.3	38.8	0.01	2.76	239.6	-0.31	8002
2014	10	30	16	13.3	13	328.3	42.8	0.02	2.44	271.6	-0.3	7994
2014	10	30	17	13.5	13.3	163	41.8	0.01	1.47	229.5	-0.2	7987.3
2014	10	30	18	12.2	12.4	63	62.8	0	1.05	117.3	0.24	7984.7
2014	10	30	19	8.9	9.5	6	69.4	0	1.82	238	0.56	7980.7
2014	10	30	20	7	7.7	0.1	72.6	0	1.88	237.3	0.62	7976.7
2014	10	30	21	6.5	7.8	0.1	69.9	0	2.2	242.6	1.27	7972.7
2014	10	30	22	6.7	7.7	0	65.6	0	2.25	251.2	1	7971.3
2014	10	30	23	5.5	7.3	0	64.1	0	2.3	242.2	1.76	7967.3
2014	10	30	24	5.1	7	0	67	0	2.38	245	1.94	7964.7
2014	10	31	1	3.5	5.9	0	75.1	0	2.61	237.2	2.45	7962
2014	10	31	2	4.1	5.9	0.1	66.1	0	2.56	241.5	1.77	7954
2014	10	31	3	4	5.9	0.1	65.9	0	1.87	243.1	1.86	7950
2014	10	31	4	4.5	6	0.1	69.7	0	2.33	246.8	1.46	7946
2014	10	31	5	3	4.7	0	71.9	0	2.27	239.6	1.69	7940.7
2014	10	31	6	2.5	4.2	0.1	74.9	0	3.01	241.2	1.66	7935.3
2014	10	31	7	2.5	4	0.1	74.4	0	3.14	240.7	1.48	7928.7
2014	10	31	8	2.8	4	0.1	67.9	0	2.79	242.7	1.15	7923.4
2014	10	31	9	2.5	3.8	6.2	73.6	0	2.94	241	1.32	7919.4
2014	10	31	10	3.1	4.7	69.7	58.7	0	2.23	242.9	1.56	7920.7
2014	10	31	11	9.6	10.1	296.7	31.3	0	4.98	239.7	0.53	7924.7
2014	10	31	12	11.9	11.7	359.8	32.3	0	5.58	233.1	-0.19	7923.4
2014	10	31	13	11.6	11.3	382.5	33.9	0	5.39	233.3	-0.26	7922
2014	10	31	14	12	11.7	463.5	32.3	0	5.41	235	-0.34	7918
2014	10	31	15	12.1	11.7	416.5	35.5	0	6.71	226.1	-0.4	7914
2014	10	31	16	11.1	10.9	195.5	37.8	0	5.32	245.5	-0.2	7914
2014	10	31	17	11.6	11.3	319	33.4	0	3.71	237.6	-0.34	7914
2014	10	31	18	11.4	11.3	137.8	39.4	0	3.58	228.1	-0.13	7911.4
2014	10	31	19	8	8.5	4.9	53.5	0	1.98	235.7	0.47	7907.4
2014	10	31	20	4.8	5.4	0.1	62.9	0	1.66	239.2	0.61	7904.7
2014	10	31	21	3.2	3.8	0	70.5	0	1.67	237.9	0.54	7904.7
2014	10	31	22	2.3	2.9	0	75.3	0	1.82	242.5	0.62	7902
2014	10	31	23	1.7	2.5	0	77.1	0	1.56	238	0.74	7898
2014	10	31	24	1.8	2.5	0	72.2	0	1.61	242.7	0.68	7894
2014	11	1	1	1	1.9	0	80.6	0	1.85	237.2	0.91	7887.4
2014	11	1	2	1.9	2.5	0.1	74.9	0	2.1	240.1	0.58	7878
2014	11	1	3	2.2	2.8	0	75.3	0	1.19	236.5	0.63	7871.4
2014	11	1	4	2	3.7	0.1	64.6	0	2.77	243.3	1.68	7864.7
2014	11	1	5	3.4	5.7	0.1	62	0	3.14	247.4	2.24	7859.4
2014	11	1	6	2.7	5	0.1	60	0	2.4	245.1	2.3	7855.4
2014	11	1	7	2.1	4.6	0.1	72.1	0	2.75	242.3	2.48	7852.7
2014	11	1	8	2.2	4	0.1	56.9	0	2.49	240	1.81	7848.7
2014	11	1	9	7.5	7.9	4.1	50.7	0	2.54	253.7	0.4	7843.4
2014	11	1	10	8.2	8.2	44.5	51.9	0	2.36	238.5	-0.01	7844.7
2014	11	1	11	8.5	8.5	83.2	49.8	0	1.46	12	0.05	7835.4
2014	11	1	12	6.2	6.8	77.4	71.4	0	2	4.3	0.6	7831.4
2014	11	1	13	6.1	6.2	68.4	82.6	0	2.4	355.1	0.06	7835.4
2014	11	1	14	4.2	4.1	20	90.7	0	1.97	60.7	-0.03	7834
2014	11	1	15	2.5	2.4	46.6	96.2	0.03	1.54	278.5	-0.13	7828.7
2014	11	1	16	2.6	2.3	84.3	94.7	0.02	0.83	170.5	-0.26	7827.4
2014	11	1	17	2.9	2.7	38.5	91.7	0	0.77	289	-0.2	7818
2014	11	1	18	3	2.9	20.5	94.6	0.01	1	244	-0.17	7816.7
2014	11	1	19	2.8	2.7	0.7	99.3	0	0.84	86.3	-0.11	7814
2014	11	1	20	1.1	1	0	100	0.09	1.3	113.4	-0.12	7814
2014	11	1	21	0	0	0	100	0.08	9999	9999	-0.07	7828.7
2014	11	1	22	-0.3	-0.4	0	100	0.03	9999	9999	-0.14	7836.7
2014	11	1	23	-0.4	-0.5	0	100	0.03	9999	9999	-0.1	7846
2014	11	1	24	-0.7	-0.8	0.1	100	0.01	9999	9999	-0.11	7858

2014	11	2	1	-0.9	-1	0.1	100	0.01	9999	9999	-0.12	7864.7
2014	11	2	2	-1.1	-1.1	0.1	90.9	0.01	9999	9999	-0.08	7874
2014	11	2	3	-1.3	-1.3	0	96.5	0	9999	9999	-0.07	7880.7
2014	11	2	4	-1.6	-1.7	0	98.6	0	9999	9999	-0.08	7890
2014	11	2	5	-1.6	-1.7	0.1	89	0.01	9999	9999	-0.08	7896.7
2014	11	2	6	-1.5	-1.5	0	84.6	0	9999	9999	-0.01	7904.7
2014	11	2	7	-2.1	-2.1	0	82.8	0	9999	9999	0.01	7912.7
2014	11	2	8	-2.7	-2.6	0	89.9	0	9999	9999	0.06	7919.4
2014	11	2	9	-3.3	-3.1	1.3	83.2	0	9999	9999	0.18	7926
2014	11	2	10	-3.9	-3.8	9	90.9	0	9999	9999	0.16	7935.3
2014	11	2	11	-3.7	-3.7	39.6	80.4	0	9999	9999	0.01	7943.3
2014	11	2	12	-2.4	-2.5	54.2	67.7	0.07	9999	9999	-0.12	7946
2014	11	2	13	-2	-2.1	56.1	70.3	0.13	9999	9999	-0.12	7950
2014	11	2	14	-1.6	-1.8	99.2	70.5	0.04	9999	9999	-0.12	7951.3
2014	11	2	15	-1.6	-1.7	65.6	73	0.01	9999	9999	0	7951.3
2014	11	2	16	-1.2	-1.3	138.5	73.3	0.03	9999	9999	-0.02	7952.7
2014	11	2	17	-1.6	-1.4	49.1	76.5	0.01	9999	9999	0.17	7955.3
2014	11	2	18	-1.7	-1.6	21.5	85.3	0	9999	9999	0.12	7959.3
2014	11	2	19	-2.2	-2.1	2.1	83.8	0	9999	9999	0.07	7963.3
2014	11	2	20	-2.8	-2.8	0.1	90.5	0	9999	9999	0.02	7967.3
2014	11	2	21	-4.5	-4.3	0.1	90.3	0	9999	9999	0.2	7970
2014	11	2	22	-5.4	-5.3	0.1	90.8	0	9999	9999	0.11	7975.3
2014	11	2	23	-6.3	-6.1	0	93.9	0	9999	9999	0.23	7979.3
2014	11	2	24	-7	-6.8	0	92.1	0	9999	9999	0.19	7980.7
2014	11	3	1	-8.1	-7.7	0	92.8	0	9999	9999	0.39	7983.3
2014	11	3	2	-8.6	-8.4	0.1	89.6	0	9999	9999	0.25	7983.3
2014	11	3	3	-8.9	-8.5	0	93.4	0	9999	9999	0.45	7986
2014	11	3	4	-8.5	-8.1	0	93.3	0	9999	9999	0.41	7984.7
2014	11	3	5	-7.6	-7.4	0	93.1	0	9999	9999	0.14	7987.3
2014	11	3	6	-6.6	-6.6	0	93.3	0	9999	9999	0.02	7987.3
2014	11	3	7	-6.1	-6.3	0	92.3	0	9999	9999	-0.15	7987.3
2014	11	3	8	-5.4	-5.5	0	94	0	9999	9999	-0.13	7994
2014	11	3	9	-5	-5.2	1.4	92.5	0	9999	9999	-0.15	7996.7
2014	11	3	10	-4.6	-4.8	14	91.8	0	9999	9999	-0.19	7999.3
2014	11	3	11	-4	-4.3	36.1	80.5	0	9999	9999	-0.23	8006
2014	11	3	12	-2.9	-3.2	49.9	80.4	0	9999	9999	-0.24	8008.7
2014	11	3	13	-1.8	-2.1	63.8	77.4	0	9999	9999	-0.23	8011.3
2014	11	3	14	-0.9	-1.1	107.9	83.7	0	1.63	75.4	-0.18	8012.7
2014	11	3	15	-0.3	-0.5	150.8	80.1	0	2.45	76.6	-0.19	8011.3
2014	11	3	16	0.3	0.1	181.4	85.7	0	1.35	63.4	-0.16	8011.3
2014	11	3	17	0.6	0.5	143.4	90.7	0	1.56	59.6	-0.13	8014
2014	11	3	18	0.5	0.4	50.2	94.5	0	1.18	66.3	-0.09	8018
2014	11	3	19	0	0	3	97.6	0	0.54	48.9	-0.07	8020.7
2014	11	3	20	-0.4	-0.3	0.1	94.1	0	0.97	249	0.06	8019.3
2014	11	3	21	-0.7	-0.7	0	95.8	0	0.9	243	-0.01	8020.7
2014	11	3	22	-0.6	-0.6	0.1	96	0	0.45	220.8	-0.03	8022
2014	11	3	23	-0.2	-0.2	0	89.8	0	1.08	250	0.05	8026
2014	11	3	24	0.1	0.2	0.1	88.8	0	0.9	253.2	0.04	8030
2014	11	4	1	0.3	0.3	0	91.1	0	0.73	38.5	0.07	8027.3
2014	11	4	2	0.5	0.5	0.1	89.6	0	1.29	36.4	-0.05	8027.3
2014	11	4	3	-0.2	-0.3	0	98.7	0	0.82	60.5	-0.02	8026
2014	11	4	4	-0.9	-0.9	0	100	0	1.08	65.2	0	8023.3
2014	11	4	5	-0.7	-0.8	0	100	0	0.58	248.8	-0.1	8020.7
2014	11	4	6	0.3	0.4	0	87.5	0	1.59	235.5	0.1	8016.7
2014	11	4	7	1.2	1.2	0	85.4	0	1.77	253.6	-0.01	8015.3
2014	11	4	8	1.5	1.5	0.1	89.2	0	3.33	221.8	-0.04	8012.7
2014	11	4	9	1.7	1.7	3	82.7	0	3.05	217.7	0.02	8010
2014	11	4	10	1.9	1.8	39.3	85.8	0	3.09	209.5	-0.07	8010
2014	11	4	11	2.1	2	66.2	81.7	0	3.11	212.1	-0.1	8012.7
2014	11	4	12	2.3	2.2	94.2	86	0	2.07	184.1	-0.1	8014
2014	11	4	13	2.4	2.3	116.5	78.8	0	3.27	220.8	-0.11	8019.3

2014	11	4	14	2.6	2.4	144.5	82.4	0	4.4	229.7	-0.15	8016.7
2014	11	4	15	2.7	2.5	165.4	80.4	0	4.71	226.9	-0.18	8011.3
2014	11	4	16	2.6	2.4	159.7	83.6	0	4.75	235.8	-0.21	8007.3
2014	11	4	17	2.7	2.5	72.4	84	0	3.55	242.5	-0.18	8008.7
2014	11	4	18	2	1.9	27.2	96.9	0	2.41	210.7	-0.14	8011.3
2014	11	4	19	1	0.9	2.8	98.7	0	2.16	91.8	-0.15	8018
2014	11	4	20	0.9	0.7	0	99.4	0	2.06	76.2	-0.17	8023.3
2014	11	4	21	0.8	0.6	0	99.6	0	1.41	61.2	-0.18	8023.3
2014	11	4	22	0.8	0.6	0	100	0	1.23	80.5	-0.19	8027.3
2014	11	4	23	0.7	0.5	0	100	0	0.94	64.6	-0.18	8035.3
2014	11	4	24	0.7	0.6	0	100	0	0.68	81.6	-0.12	8039.3
2014	11	5	1	0.7	0.7	0	100	0	0.37	248.2	-0.08	8043.3
2014	11	5	2	0.9	0.9	0	99.8	0	0.72	257.8	-0.04	8046
2014	11	5	3	1	1.2	0	99.6	0	0.97	219.5	0.18	8047.3
2014	11	5	4	1	1	0	100	0	0.42	278.7	0.03	8047.3
2014	11	5	5	0.7	0.7	0	100	0	0.83	10.2	0.04	8048.7
2014	11	5	6	0.4	0.6	0	100	0	1.09	237.2	0.24	8051.3
2014	11	5	7	0.3	0.6	0	100	0	0.78	250.2	0.27	8047.3
2014	11	5	8	-0.1	0.3	0.1	100	0	1.09	240.7	0.35	8052.7
2014	11	5	9	-0.2	0.1	6.8	99.5	0	0.99	239.2	0.23	8050
2014	11	5	10	0	0.1	62.6	97.4	0	0.81	252.4	0.12	8055.3
2014	11	5	11	1.4	1.5	257.7	90.7	0	1.25	187.8	0.06	8062
2014	11	5	12	3.2	2.7	224.1	85.3	0	2.15	79.7	-0.54	8068.7
2014	11	5	13	5	4.8	219.3	72.8	0	1.33	220.7	-0.29	8067.3
2014	11	5	14	5.7	5.4	198.4	74.1	0	2.72	238.1	-0.28	8067.3
2014	11	5	15	6.3	5.9	297.4	71.3	0.01	2.62	240.1	-0.38	8066
2014	11	5	16	6.6	6.3	236.8	70.7	0	2.74	249.8	-0.31	8066
2014	11	5	17	7.3	6.9	177.2	68.9	0.01	1.21	222.3	-0.34	8060.7
2014	11	5	18	6.1	5.9	85.2	85.2	0	1.3	80.5	-0.19	8060.7
2014	11	5	19	3.9	4	6.9	92.8	0	0.94	240	0.1	8060.7
2014	11	5	20	1.9	2	0.1	94.9	0	1.2	235.4	0.09	8060.7
2014	11	5	21	1	1.3	0.1	98	0	1.11	242.7	0.31	8063.3
2014	11	5	22	0.1	0.6	0.1	97.7	0	1.62	237.9	0.46	8064.7
2014	11	5	23	-0.1	0.3	0.1	96.3	0	1.34	238.6	0.41	8066
2014	11	5	24	-0.1	0.3	0.1	98.3	0	1.2	238.1	0.45	8063.3
2014	11	6	1	-0.3	0.3	0	98	0	0.75	237.7	0.57	8063.3
2014	11	6	2	-0.5	0	0.1	99.5	0	0.89	243.9	0.44	8062
2014	11	6	3	-0.3	0.2	0.1	99.8	0	0.62	267	0.49	8056.7
2014	11	6	4	-0.4	0.2	0.1	99.9	0	0.88	250.9	0.52	8051.3
2014	11	6	5	0.1	0.6	0	98.9	0	0.88	240.2	0.49	8048.7
2014	11	6	6	0.3	0.8	0.1	99	0	0.88	239.5	0.49	8043.3
2014	11	6	7	0.5	1	0	99.3	0	0.83	252.5	0.45	8040.7
2014	11	6	8	0.5	1	0.1	96.8	0	0.86	244.8	0.52	8036.7
2014	11	6	9	0.5	1.3	6.6	98.3	0	1.21	242.4	0.81	8036.7
2014	11	6	10	0.9	1.3	70.3	96.7	0	0.83	230.3	0.41	8035.3
2014	11	6	11	2.1	2.5	125.1	87.6	0	0.7	240.8	0.36	8031.3
2014	11	6	12	3.8	3.9	213.9	86.6	0	0.76	91.6	0.12	8027.3
2014	11	6	13	6.6	6.3	332.6	64.4	0	1.06	96.6	-0.33	8022
2014	11	6	14	11.8	11.5	473.8	45.9	0.01	7.31	249	-0.22	8010
2014	11	6	15	12.4	12.1	489.1	45.5	0.02	8.24	242.7	-0.27	8000.7
2014	11	6	16	12.2	12	375.2	47.9	0.02	8.57	232.3	-0.27	7996.7
2014	11	6	17	11.7	11.5	221.5	50.8	0	5.76	205.5	-0.22	7995.3
2014	11	6	18	10.6	10.6	60	54.9	0	5.82	206.4	-0.04	7996.7
2014	11	6	19	9.7	9.7	3.2	59.6	0	3.17	224.3	0.04	7999.3
2014	11	6	20	9.4	9.3	0.1	61.3	0	3.65	187.3	-0.02	8003.3
2014	11	6	21	9.3	9.3	0.1	62.3	0	2.85	207.9	-0.01	8000.7
2014	11	6	22	9.2	9.3	0.1	64.5	0	2.25	181	0.11	7996.7
2014	11	6	23	9.5	9.5	0.1	58.9	0	3.33	223.6	0.02	7998
2014	11	6	24	9.3	9.3	0.1	61.1	0	3.49	222.2	0.06	7996.7
2014	11	7	1	9.1	9	0.1	60	0	4.29	234.8	-0.01	8002
2014	11	7	2	8.5	8.5	0.1	61.9	0	5.03	232.8	0.03	8000.7

2014	11	7	3	7.8	7.8	0.1	65.7	0	3.73	232.3	0.01	8004.7
2014	11	7	4	7.2	7.2	0.1	64.1	0	4.14	236.1	0.02	8000.7
2014	11	7	5	6.8	6.8	0	66	0	2.61	238.9	-0.01	8010
2014	11	7	6	6	6	0.1	65.4	0	3.65	267.2	-0.01	8010
2014	11	7	7	5.1	5.3	0	69.1	0	1.26	33	0.21	8012.7
2014	11	7	8	3.2	3.6	0.1	83.2	0	0.68	226	0.44	8019.3
2014	11	7	9	1.4	2	8.5	87.9	0	1.03	241	0.52	8023.3
2014	11	7	10	1.2	1.6	52.3	83.9	0	0.83	249.5	0.37	8032.7
2014	11	7	11	2.6	2.6	229.9	78.1	0	0.66	141.9	0.07	8040.7
2014	11	7	12	5.1	4.6	404.2	59	0	1.49	115	-0.57	8043.3
2014	11	7	13	6.2	5.6	494.3	56.8	0	1.66	115.2	-0.64	8047.3
2014	11	7	14	7.4	6.6	518.6	48.4	0	2.18	60.1	-0.82	8047.3
2014	11	7	15	8.5	7.6	481.6	38.9	0	2.66	62	-0.94	8046
2014	11	7	16	8.9	8.3	383.8	34.6	0.01	2.65	42.1	-0.58	8043.3
2014	11	7	17	8.6	8.4	284.5	33.4	0	3.13	32.2	-0.2	8043.3
2014	11	7	18	6.9	6.8	105.8	60.5	0.01	2.26	243.5	-0.1	8046
2014	11	7	19	2.9	3.3	3.4	74.5	0	1.61	240.4	0.38	8051.3
2014	11	7	20	1.1	1.4	0	73.2	0	1.59	237	0.35	8054
2014	11	7	21	0.3	0.6	0	76.4	0	1.6	238.1	0.33	8058
2014	11	7	22	-0.5	0	0	86	0	1.98	236	0.48	8056.7
2014	11	7	23	-1	-0.2	0	78.9	0	2.4	237.5	0.75	8055.3
2014	11	7	24	-0.5	0	0.1	79.6	0	1.65	236.6	0.44	8055.3
2014	11	8	1	-0.6	-0.3	0	80.6	0	1.01	243.6	0.26	8055.3
2014	11	8	2	-1.5	-0.9	0.1	84.3	0	0.97	235.9	0.59	8056.7
2014	11	8	3	-2	-1.2	0.1	89.1	0	0.91	235.6	0.8	8055.3
2014	11	8	4	-2.1	-1.4	0	85.1	0	0.96	244.5	0.64	8054
2014	11	8	5	-2.5	-1.6	0	87.1	0	1.42	236.7	0.88	8054
2014	11	8	6	-2.4	-1.6	0	88.2	0	1.01	251.7	0.81	8051.3
2014	11	8	7	-2.6	-1.7	0	84.4	0	1.18	238.3	0.92	8051.3
2014	11	8	8	-2.4	-1.5	0	80.6	0	1.57	239.8	0.9	8051.3
2014	11	8	9	-2	-1.3	7.1	81.5	0	0.86	242.2	0.69	8047.3
2014	11	8	10	-2.2	-1	44.1	82.5	0	1.47	236.4	1.17	8048.7
2014	11	8	11	0.2	0.6	223.5	67.5	0	0.71	82.2	0.44	8047.3
2014	11	8	12	3.1	3.1	388.4	54.5	0	0.52	192.9	-0.06	8047.3
2014	11	8	13	7.7	7.1	476	39.7	0	2.3	101.7	-0.68	8043.3
2014	11	8	14	9.8	9.1	503.9	29.2	0	2.02	71.6	-0.66	8042
2014	11	8	15	11	10.4	471.4	30.9	0	2.67	55.5	-0.52	8032.7
2014	11	8	16	11.2	10.9	365.9	30.4	0	3.21	44.8	-0.32	8028.7
2014	11	8	17	10.1	10	168.7	36.5	0	1.77	88.3	-0.18	8026
2014	11	8	18	7.2	7.6	54.8	64.6	0	1.07	234.1	0.39	8022
2014	11	8	19	4.4	5.1	4.1	63.5	0	1.62	238.1	0.7	8020.7
2014	11	8	20	2.7	3.4	0.1	73	0	1.5	237	0.67	8019.3
2014	11	8	21	1.7	2.4	0	76.1	0	1.53	236.1	0.73	8016.7
2014	11	8	22	1	1.8	0	71.1	0	1.32	234.9	0.8	8014
2014	11	8	23	0.4	1.2	0	73.3	0	1.07	243.8	0.85	8014
2014	11	8	24	0.1	0.9	0.1	68.3	0	1.14	249.4	0.72	8011.3
2014	11	9	1	-0.4	0.2	0.1	76.1	0	1.09	249.3	0.63	8007.3
2014	11	9	2	-0.8	0.1	0.1	79.5	0	1.22	235.6	0.9	8006
2014	11	9	3	-0.6	0.2	0.1	74.1	0	1.1	241.5	0.82	8002
2014	11	9	4	-0.2	0.8	0	78.7	0	0.73	239.4	0.98	7995.3
2014	11	9	5	0.3	1.1	0.1	72.7	0	1.26	237.6	0.75	7991.3
2014	11	9	6	1.1	1.8	0.1	77.2	0	1.15	243.1	0.66	7982
2014	11	9	7	1.2	2.1	0.1	80.9	0	0.8	246.3	0.89	7972.7
2014	11	9	8	1.1	1.8	0.1	83	0	1.32	237.4	0.71	7966
2014	11	9	9	1.6	2.4	3.4	83.5	0	0.99	246.3	0.77	7958
2014	11	9	10	2.7	4	48.3	73	0	0.92	261.3	1.24	7948.7
2014	11	9	11	7.6	7.8	78.7	59.3	0	3.13	233.2	0.28	7936.7
2014	11	9	12	8.7	8.7	152.6	57.2	0	4.94	208.4	-0.05	7927.3
2014	11	9	13	9	8.8	137.9	58.6	0	4.62	213.8	-0.13	7916.7
2014	11	9	14	8.7	8.6	123.8	58.6	0	5.23	229.4	-0.13	7906
2014	11	9	15	8.5	8.4	73.4	59.4	0	5.21	221.9	-0.09	7891.4

2014	11	9	16	7.2	7.2	28.7	80.3	0	5.36	226.5	-0.07	7882
2014	11	9	17	4.6	4.5	27.3	86	0	4.62	232.3	-0.05	7875.4
2014	11	9	18	4.1	4.1	16.9	85	0	1.41	27.3	-0.02	7871.4
2014	11	9	19	4.6	4.6	1.8	83.1	0	2.36	262.3	-0.03	7858
2014	11	9	20	3.7	3.6	0.1	93.1	0	2.85	246	-0.05	7851.4
2014	11	9	21	1.6	1.6	0.1	83.3	0	4.29	217.1	-0.06	7855.4
2014	11	9	22	1	1	0	75.1	0	1.79	212.4	-0.03	7858
2014	11	9	23	0	0.2	0.1	78.1	0	1.76	272.5	0.14	7855.4
2014	11	9	24	-0.5	-0.5	0	74.3	0	1.88	244.3	0.01	7854
2014	11	10	1	-1.4	-1.5	0	93.6	0	1.42	75.3	-0.13	7856.7
2014	11	10	2	-1.2	-1.3	0.1	90.1	0	2.5	202.4	-0.08	7856.7
2014	11	10	3	-1.9	-2.1	0.1	92.7	0	3.53	85.4	-0.12	7859.4
2014	11	10	4	-2.4	-2.5	0	80.8	0	5.5	97.3	-0.11	7864.7
2014	11	10	5	-2.7	-2.8	0	71.3	0	3.92	103.5	-0.08	7876.7
2014	11	10	6	-3.6	-3.4	0	67.5	0	1.72	255.6	0.17	7884.7
2014	11	10	7	-3.8	-3.7	0	71.6	0	2.12	99.6	0.11	7888.7
2014	11	10	8	-4	-4.1	0	73.6	0	1.06	269.1	-0.09	7899.4
2014	11	10	9	-4.5	-4.5	8	67	0	1.31	227.9	0.09	7906
2014	11	10	10	-4.3	-4.3	65.2	65.9	0	1.05	240.5	-0.07	7910
2014	11	10	11	-3.8	-4	174	63.8	0	2.22	90.5	-0.19	7922
2014	11	10	12	-3.5	-3.7	94.5	70.6	0	1.2	88.1	-0.19	7927.3
2014	11	10	13	-3.6	-3.8	148.7	73.5	0	2.09	57.5	-0.21	7930
2014	11	10	14	-3.1	-3.4	325.5	58.1	0	2.05	80.4	-0.25	7930
2014	11	10	15	-2.6	-2.8	190.7	60	0.01	1.66	164.2	-0.21	7924.7
2014	11	10	16	-2.5	-2.7	147.4	56.2	0	2.08	224.3	-0.19	7924.7
2014	11	10	17	-2.6	-2.8	115.5	58.3	0	1.9	19.2	-0.15	7924.7
2014	11	10	18	-3	-3.1	34.1	65.3	0	1.01	313.9	-0.09	7926
2014	11	10	19	-3.6	-3.6	2.9	76	0	1.38	302.9	0.03	7924.7
2014	11	10	20	-3.9	-4	0	82.5	0	1.15	211.5	-0.07	7923.4
2014	11	10	21	-4.7	-4.8	0	63.1	0	3.36	96.7	-0.1	7926
2014	11	10	22	-5.9	-5.8	0	74.2	0	1.21	258.9	0.1	7924.7
2014	11	10	23	-6.9	-6.6	0	66.4	0	0.98	215	0.24	7924.7
2014	11	10	24	-7	-6.8	0	67.4	0	0.95	247.6	0.12	7926
2014	11	11	1	-8.9	-8.7	0	76.3	0	1.49	261.4	0.13	7926
2014	11	11	2	-11	-10.9	0	79.6	0	1.69	234.3	0.07	7926
2014	11	11	3	-12.2	-12.1	0	81.3	0	1.4	241.8	0.13	7926
2014	11	11	4	-13.2	-13	0.1	84.7	0	1.75	236.5	0.24	7924.7
2014	11	11	5	-13.4	-13.2	0.1	84.6	0	1.45	239.9	0.16	7926
2014	11	11	6	-12.6	-12.3	0	86	0	0.87	240.6	0.27	7926
2014	11	11	7	-11.7	-11.7	0.1	87.8	0	0.64	258.9	0.05	7928.7
2014	11	11	8	-11.7	-11.5	0.1	90.1	0	0.5	63.5	0.21	7932.7
2014	11	11	9	-12.4	-12.1	4.5	83.1	0	0.79	286.1	0.3	7932.7
2014	11	11	10	-13.1	-12.6	30.1	85.2	0	0.84	131.6	0.54	7942
2014	11	11	11	-11.9	-12	201.3	64.5	0	2.75	96.1	-0.02	7947.3
2014	11	11	12	-10.6	-11	407.8	61.8	0	3.82	103.8	-0.4	7950
2014	11	11	13	-9.8	-10.2	490.9	56.6	0	2.93	70.2	-0.4	7955.3
2014	11	11	14	-9.2	-9.6	521	57.4	0	2.58	21.3	-0.35	7954
2014	11	11	15	-8.6	-9	488.9	50.7	0.01	1.87	49.9	-0.43	7952.7
2014	11	11	16	-8.4	-8.8	387.6	51.9	0.03	2.39	113.8	-0.46	7950
2014	11	11	17	-9.1	-9.5	211.5	54.7	0	3.51	100.6	-0.4	7952.7
2014	11	11	18	-10.4	-10.7	86.1	59.9	0	3.18	88.4	-0.3	7958
2014	11	11	19	-12	-12.2	2.9	64.1	0	1.97	86.8	-0.16	7962
2014	11	11	20	-13.3	-13.4	0	68.6	0	1.25	177.6	-0.03	7966
2014	11	11	21	-15.5	-15.3	0	74.9	0	2.03	244.2	0.15	7970
2014	11	11	22	-16.6	-16.1	0	76.2	0	1.31	248.8	0.48	7974
2014	11	11	23	-17.6	-17.2	0	80.8	0	1.45	241.7	0.39	7978
2014	11	11	24	-18.3	-18.2	0	82.8	0	1.52	236.6	0.17	7980.7
2014	11	12	1	-18.4	-18	0	81.7	0	1.21	238.4	0.36	7983.3
2014	11	12	2	-18.6	-18.5	0.1	80.4	0	1.39	240.3	0.18	7983.3
2014	11	12	3	-18.7	-18.4	0	73.4	0	0.98	247.9	0.33	7986
2014	11	12	4	-19.3	-19.2	0.1	77.9	0	1.38	246.2	0.15	7986

2014	11	12	5	-19.7	-19.5	0.1	79.2	0	1.29	237.7	0.17	7986
2014	11	12	6	-20.2	-20.1	0.1	79.7	0	1.5	233.5	0.13	7984.7
2014	11	12	7	-20.6	-20.3	0	79.5	0	1.46	236	0.21	7984.7
2014	11	12	8	-21	-20.8	0	81.9	0	1.33	239.2	0.27	7983.3
2014	11	12	9	-21.4	-21.1	3.4	76.7	0	1.43	230.3	0.28	7984.7
2014	11	12	10	-21.1	-20.8	17.6	79.5	0	1.31	236.9	0.27	7986
2014	11	12	11	-19.1	-18.3	191.7	57.4	0	1.44	251.8	0.83	7987.3
2014	11	12	12	-14.8	-15.3	403.5	51.8	0	2.17	201.2	-0.49	7986
2014	11	12	13	-12.7	-13.2	485.8	39.4	0	2.47	178.1	-0.54	7986
2014	11	12	14	-11.3	-11.7	514.8	31.6	0	0.71	251	-0.4	7982
2014	11	12	15	-9.8	-10.1	482.7	31.2	0	1.15	258.3	-0.37	7976.7
2014	11	12	16	-8.3	-8.7	398.1	33.8	0.01	1.66	234.5	-0.41	7970
2014	11	12	17	-7.7	-8.1	272.4	31.7	0.01	2.13	211.2	-0.39	7966
2014	11	12	18	-9.3	-9.1	89.4	60.8	0	1.93	220.7	0.15	7964.7
2014	11	12	19	-13	-12.6	2.3	66.1	0	1.88	232	0.35	7964.7
2014	11	12	20	-14.4	-14.2	0.1	71.1	0	1.97	235.1	0.25	7966
2014	11	12	21	-15.6	-15.2	0	72.6	0	2.01	235	0.4	7967.3
2014	11	12	22	-16.1	-15.8	0	74.4	0	2.03	230.2	0.28	7968.7
2014	11	12	23	-16.8	-16.5	0	75.4	0	1.89	235.1	0.3	7968.7
2014	11	12	24	-16.6	-15.9	0	72.1	0	1.78	237.3	0.65	7966
2014	11	13	1	-17	-15.7	0	75.7	0	1.91	247.2	1.31	7964.7
2014	11	13	2	-17.4	-16.6	0	77.2	0	2.07	235.4	0.78	7964.7
2014	11	13	3	-17.2	-16.6	0	78.2	0	1.53	234.3	0.64	7959.3
2014	11	13	4	-16.2	-15	0	75.6	0	1.09	253.5	1.21	7954
2014	11	13	5	-16.5	-15.7	0.1	78.2	0	1.05	232.3	0.75	7951.3
2014	11	13	6	-16.7	-15.9	0.1	81.7	0	0.92	247.7	0.8	7943.3
2014	11	13	7	-15.5	-15	0	80.1	0	1.34	252	0.53	7936.7
2014	11	13	8	-14.8	-14.3	0.1	73.3	0	0.99	240.3	0.41	7934
2014	11	13	9	-14.4	-13.8	3.7	81.3	0	1.08	232.3	0.54	7928.7
2014	11	13	10	-12.9	-12.6	52.5	64.3	0	1.53	249.1	0.26	7926
2014	11	13	11	-10.6	-10.8	93.1	45.5	0	1.77	235.3	-0.22	7920.7
2014	11	13	12	-8.9	-9.1	88.4	46.1	0	2.62	217.9	-0.23	7915.4
2014	11	13	13	-8.9	-9.2	127.5	74.1	0	1.52	49.6	-0.29	7912.7
2014	11	13	14	-8.7	-9.1	245.5	71.3	0	0.92	239.4	-0.36	7911.4
2014	11	13	15	-7.3	-7.7	149	80	0	1.45	64.7	-0.37	7900.7
2014	11	13	16	-7.1	-7.4	101.6	87.3	0	2.31	71	-0.31	7895.4
2014	11	13	17	-7.4	-7.7	66.3	91.6	0	1.79	81.4	-0.29	7891.4
2014	11	13	18	-7.3	-7.5	17.1	93.8	0	0.98	73.7	-0.22	7892.7
2014	11	13	19	-7.1	-7.3	1	94.9	0	1.9	69.3	-0.19	7890
2014	11	13	20	-7	-7.1	0.1	94.1	0	2.1	74.5	-0.09	7888.7
2014	11	13	21	-7.1	-7.2	0.1	95.4	0	2.6	80.3	-0.14	7887.4
2014	11	13	22	-6.9	-7	0	95.3	0	1.99	80	-0.17	7886
2014	11	13	23	-6.7	-6.9	0	95.2	0	1.07	83.5	-0.17	7886
2014	11	13	24	-6.6	-6.7	0.1	95	0	1.28	81.2	-0.16	7887.4
2014	11	14	1	-6.3	-6.5	0	95.5	0	1.76	65.6	-0.15	7888.7
2014	11	14	2	-6.2	-6.3	0.1	96	0	1.46	55	-0.12	7887.4
2014	11	14	3	-6.1	-6.2	0	96.4	0	1.56	274.9	-0.1	7883.4
2014	11	14	4	-6	-6.1	0.1	96.4	0	0.83	80.9	-0.16	7880.7
2014	11	14	5	-5.9	-6	0.1	96.4	0.01	0.54	228.9	-0.09	7879.4
2014	11	14	6	-5.9	-6	0.1	96.6	0.01	0.37	246.8	-0.06	7875.4
2014	11	14	7	-5.7	-5.6	0.1	96.5	0.02	0.9	233.3	0.05	7872.7
2014	11	14	8	-5.6	-5.6	0	96.9	0.01	1.02	58.7	-0.05	7871.4
2014	11	14	9	-5.4	-5.3	0.5	96.9	0.01	0.75	331.9	0.06	7870
2014	11	14	10	-4.9	-4.7	9.2	95.7	0	0.77	277.4	0.22	7868.7
2014	11	14	11	-4.1	-3.7	24.6	95.5	0.01	1.23	58.8	0.38	7866
2014	11	14	12	-3	-3	32.7	90.9	0.02	0.61	1.2	-0.04	7867.4
2014	11	14	13	-2.1	-2.2	24.5	77	0.02	2.17	235.1	-0.09	7864.7
2014	11	14	14	-2.4	-2.5	42.5	87	0.01	1.23	198.3	-0.08	7863.4
2014	11	14	15	-2.9	-3	42.3	72.3	0.02	1.99	162.2	-0.1	7860.7
2014	11	14	16	-2.5	-2.6	51.7	69.5	0.01	3.24	247.7	-0.12	7860.7
2014	11	14	17	-3.5	-3.5	81.4	65.5	0	3.06	240.4	-0.04	7860.7

2014	11	14	18	-4.8	-4.9	24.2	79.6	0	3.08	224.9	-0.05	7864.7
2014	11	14	19	-6.5	-6.5	1.5	85	0	1.54	90	0.02	7870
2014	11	14	20	-7.8	-7.8	0.1	92.2	0	2.62	73.2	0.02	7875.4
2014	11	14	21	-8.4	-8.5	0	82.8	0	3.72	77.1	-0.05	7880.7
2014	11	14	22	-8.9	-8.9	0	82.7	0	3.28	88	-0.05	7886
2014	11	14	23	-9.8	-9.8	0.1	86.7	0	1.41	111.5	0.02	7891.4
2014	11	14	24	-10.5	-10.4	0	85	0	1.7	86.2	0.01	7898
2014	11	15	1	-11.4	-11.3	0	84.1	0	1.59	99.5	0.12	7906
2014	11	15	2	-12.9	-12.6	0	86.1	0	0.73	3.4	0.26	7914
2014	11	15	3	-13.2	-12.9	0.1	84.9	0	0.43	307.2	0.25	7918
2014	11	15	4	-13	-12.9	0	81	0	0.82	104.2	0.1	7919.4
2014	11	15	5	-12.5	-12.4	0	78.3	0	1.71	100.9	0.04	7927.3
2014	11	15	6	-12.3	-12.3	0	77.8	0	1.58	85.5	-0.01	7932.7
2014	11	15	7	-12.4	-12.5	0	80.9	0	0.75	51	-0.02	7935.3
2014	11	15	8	-12.7	-12.6	0	77.6	0	1.03	55	0.05	7939.3
2014	11	15	9	-12.9	-12.7	2.7	79.5	0	1.18	39.3	0.13	7944.7
2014	11	15	10	-12.9	-12.8	43.6	69.7	0	1.63	40.3	0.1	7952.7
2014	11	15	11	-12.4	-12.5	133.1	65.8	0	1.29	44.2	-0.11	7958
2014	11	15	12	-12	-12.2	254.2	63.9	0	2.53	99.5	-0.16	7963.3
2014	11	15	13	-11.6	-11.7	308.7	51.3	0	1.24	100.6	-0.14	7966
2014	11	15	14	-10.6	-10.9	479	43.7	0.01	0.77	128.5	-0.25	7967.3
2014	11	15	15	-9.6	-9.8	486.4	55.3	0.05	1.54	103.9	-0.2	7967.3
2014	11	15	16	-9.2	-9.3	397.4	50.3	0.01	2.97	55.1	-0.11	7970
2014	11	15	17	-9.4	-9.4	258	51.2	0.01	2.19	92.3	0.02	7975.3
2014	11	15	18	-10.7	-10.3	76.5	71.6	0	1.42	101.3	0.4	7980.7
2014	11	15	19	-14.9	-14.2	2.2	74.6	0	2.28	236.3	0.66	7987.3
2014	11	15	20	-16.7	-16.1	0.1	80.4	0	2.02	239.2	0.64	7996.7
2014	11	15	21	-18.2	-17.3	0	81.9	0	2	239.6	0.91	8003.3
2014	11	15	22	-18.9	-18	0	81.7	0	2.11	238.1	0.97	8007.3
2014	11	15	23	-19.3	-18.5	0	82.8	0	2.04	237.5	0.8	8011.3
2014	11	15	24	-19.5	-18.6	0	83.4	0	1.88	237	0.92	8012.7
2014	11	16	1	-19.5	-18.5	0	85.7	0	1.69	238.5	1.06	8015.3
2014	11	16	2	-19.2	-18.2	0	81.4	0	1.42	241.4	1.07	8018
2014	11	16	3	-19.3	-18.4	0	80.7	0	1.41	238	0.93	8026
2014	11	16	4	-19.7	-18.3	0.1	82.7	0	1.68	237.8	1.41	8032.7
2014	11	16	5	-19.2	-18.2	0	83.8	0	1.49	237.6	0.99	8036.7
2014	11	16	6	-18.9	-18	0	82.6	0	1.37	239.4	0.89	8042
2014	11	16	7	-19.1	-18	0.1	84.8	0	1.51	236	1.11	8044.7
2014	11	16	8	-18.4	-17.4	0	80.7	0	1.41	241.3	1.02	8046
2014	11	16	9	-18.2	-17.1	2.5	85.9	0	1.19	238.4	1.18	8046
2014	11	16	10	-18.3	-17.2	17.9	82.6	0	1.13	244.2	1.15	8050
2014	11	16	11	-16.6	-15.3	143.2	66.9	0	1.22	240.8	1.3	8051.3
2014	11	16	12	-12	-11.7	379.8	39.4	0	0.66	100.8	0.31	8047.3
2014	11	16	13	-8.7	-9	462.3	48.3	0	1.26	83.9	-0.26	8044.7
2014	11	16	14	-6.9	-7	485	26.6	0	1.5	75.6	-0.13	8044.7
2014	11	16	15	-5	-5	454.3	33.9	0.01	1.7	78.4	-0.07	8039.3
2014	11	16	16	-4.4	-4.3	371.3	29.7	0.01	2.69	77.2	0.05	8036.7
2014	11	16	17	-4.1	-3.8	249.7	32.7	0.01	2.5	71.2	0.3	8035.3
2014	11	16	18	-5.9	-5.3	71.2	54.8	0	1.49	228.9	0.6	8035.3
2014	11	16	19	-8.7	-7.8	2	69.3	0	1.63	236.4	0.87	8038
2014	11	16	20	-10.4	-9.4	0	69	0	1.89	233.3	0.95	8039.3
2014	11	16	21	-11.2	-10.4	0.1	75.4	0	1.72	237.9	0.86	8040.7
2014	11	16	22	-11.7	-10.8	0.1	76.6	0	1.71	236.1	0.9	8042
2014	11	16	23	-12.3	-11	0.1	78.5	0	1.43	239.2	1.37	8046
2014	11	16	24	-12.7	-11.6	0	79.7	0	1.79	235.7	1.11	8047.3
2014	11	17	1	-12.8	-11.6	0	80.1	0	1.56	234.3	1.25	8047.3
2014	11	17	2	-12.9	-11.7	0	79.8	0	1.46	234.6	1.21	8047.3
2014	11	17	3	-13.2	-12	0	82.5	0	1.43	232	1.2	8047.3
2014	11	17	4	-13.4	-12.2	0	83.4	0	1.52	234.1	1.25	8043.3
2014	11	17	5	-13.3	-12.1	0	81.9	0	1.41	233.9	1.17	8043.3
2014	11	17	6	-13.6	-12.4	0	86.7	0	1.4	234.4	1.13	8042

2014	11	17	7	-13.3	-12.1	0	86.4	0	1.64	233.4	1.18	8039.3
2014	11	17	8	-13.6	-12.4	0	84.8	0	1.7	230.8	1.2	8038
2014	11	17	9	-13.9	-12.1	2.4	85	0	1.54	238.5	1.74	8038
2014	11	17	10	-13	-11.9	16.4	81.4	0	1.71	234.6	1.09	8038
2014	11	17	11	-12	-10.6	127.4	67.2	0	1.51	239.5	1.43	8040.7
2014	11	17	12	-7.4	-6.8	373.4	35.8	0	0.26	178.5	0.61	8039.3
2014	11	17	13	-4.3	-4.2	457.5	31.1	0	0.5	95.6	0.07	8039.3
2014	11	17	14	-2.1	-2.2	480.6	38	0	1.8	78.6	-0.09	8038
2014	11	17	15	-0.6	-0.6	448.8	37.2	0	2.65	84.4	0.01	8032.7
2014	11	17	16	0.1	0.2	366.9	41.1	0.01	2.71	84.7	0.11	8027.3
2014	11	17	17	0.1	0.3	246.6	42.5	0.01	1.73	88.1	0.22	8024.7
2014	11	17	18	-2.5	-1.8	68.1	62.8	0.01	1.72	236.6	0.76	8024.7
2014	11	17	19	-4.9	-4.2	1.7	73.1	0	1.76	240.6	0.76	8024.7
2014	11	17	20	-7.1	-5.8	0.1	78.9	0	2.11	233.8	1.32	8027.3
2014	11	17	21	-7.7	-6.6	0	79.6	0	1.81	238.6	1.11	8030
2014	11	17	22	-8.6	-7.4	0.1	84	0	1.75	239.4	1.2	8030
2014	11	17	23	-9.3	-8	0.1	82.5	0	1.82	238.7	1.31	8031.3
2014	11	17	24	-9.4	-8.3	0	83.5	0	1.72	238	1.17	8030
2014	11	18	1	-9.8	-8.5	0	84.5	0	1.78	236.1	1.27	8030
2014	11	18	2	-10.2	-8.8	0	84.6	0	1.72	233.2	1.4	8028.7
2014	11	18	3	-10.5	-9	0	84.3	0	1.9	232.5	1.51	8028.7
2014	11	18	4	-10.5	-8.9	0	85.9	0	1.86	232.1	1.57	8026
2014	11	18	5	-10.2	-8.9	0	84.8	0	1.69	235.8	1.39	8023.3
2014	11	18	6	-10.7	-9.2	0	87.5	0	1.49	236.3	1.53	8019.3
2014	11	18	7	-10.9	-9.2	0	91.1	0	1.93	233.5	1.7	8019.3
2014	11	18	8	-10.4	-9.1	0	81.4	0	1.69	237.7	1.34	8015.3
2014	11	18	9	-10.7	-9	2.4	88.2	0	1.77	230.7	1.68	8015.3
2014	11	18	10	-9.9	-8.8	26.8	84.2	0	1.25	242.1	1.13	8016.7
2014	11	18	11	-9	-7.4	124.6	69.6	0	1.49	236.8	1.62	8018
2014	11	18	12	-5.5	-4.5	346.3	53.6	0	0.65	221.6	1.01	8018
2014	11	18	13	-1.9	-1.7	450.1	34.3	0	0.8	207.2	0.25	8018
2014	11	18	14	1.4	1.5	427.2	40.4	0	2.61	83.2	0.11	8011.3
2014	11	18	15	2.3	2.6	319.8	35.5	0	2.54	79.8	0.26	8003.3
2014	11	18	16	3.3	3.5	253.3	35.8	0	1.39	95	0.21	7999.3
2014	11	18	17	3.1	3.2	161.7	37.6	0	0.67	164.6	0.09	7994
2014	11	18	18	0.1	1	41.3	50.6	0	1.52	239.1	0.83	7994
2014	11	18	19	-2.1	-1.5	1.1	61.8	0	1.53	242	0.65	7992.7
2014	11	18	20	-3.8	-2.9	0.1	65.5	0	1.71	240.2	0.91	7995.3
2014	11	18	21	-4.5	-3.4	0.1	64.9	0	1.91	236.9	1.1	7994
2014	11	18	22	-4.7	-3.7	0.1	69	0	1.23	241.7	0.95	7992.7
2014	11	18	23	-5.8	-4.5	0.1	68.9	0	1.57	240.3	1.34	7994
2014	11	18	24	-6.4	-5.4	0.1	65.7	0	1.83	235.1	0.95	7994
2014	11	19	1	-6.9	-5.8	0.1	70.3	0	1.64	236.4	1.12	7992.7
2014	11	19	2	-7.4	-6.3	0.1	73.9	0	1.65	235.7	1.14	7991.3
2014	11	19	3	-7.6	-6.4	0.1	76.1	0	1.63	237.9	1.14	7992.7
2014	11	19	4	-7.9	-6.7	0.1	71	0	1.67	236.4	1.15	7990
2014	11	19	5	-7.9	-6.7	0	73	0	1.61	239.3	1.19	7990
2014	11	19	6	-7.9	-6.8	0.1	72	0	1.67	237.2	1.11	7988.7
2014	11	19	7	-8.1	-7	0.1	71.2	0	1.74	242.2	1.02	7986
2014	11	19	8	-8.6	-7.4	0.1	66.9	0	1.88	240.4	1.21	7984.7
2014	11	19	9	-9.1	-7.7	2.2	75	0	1.67	234.5	1.44	7982
2014	11	19	10	-8.4	-7.2	34.5	67.8	0	1.9	240.9	1.25	7983.3
2014	11	19	11	-7	-5.6	110.7	47.5	0	1.26	250.1	1.39	7980.7
2014	11	19	12	-3.9	-3.1	323.1	45.9	0	0.47	205.9	0.72	7978
2014	11	19	13	-0.5	-0.5	367.2	34	0	0.56	124.5	0	7976.7
2014	11	19	14	2.2	2.1	471.5	34.3	0	1.95	94.5	-0.12	7971.3
2014	11	19	15	3.8	4	442.5	31.1	0	2.36	79.7	0.16	7962
2014	11	19	16	3.9	4.1	241.6	33.4	0	2	96.8	0.23	7954
2014	11	19	17	2.5	3.1	59.9	41.1	0	0.5	208.4	0.57	7952.7
2014	11	19	18	0.7	1.3	41.2	46.4	0	1.16	240.9	0.59	7955.3
2014	11	19	19	0.3	1	1.8	63.2	0	0.92	250.9	0.64	7955.3

2014	11	19	20	-0.7	-0.1	0	61.4	0	1.33	237.2	0.59	7955.3
2014	11	19	21	-0.8	-0.4	0.1	65.2	0	1.32	235.2	0.34	7954
2014	11	19	22	-1.8	-1.3	0.1	66.4	0	1.01	245.4	0.58	7954
2014	11	19	23	-2.3	-1.7	0.1	67.4	0	1.23	251.6	0.65	7955.3
2014	11	19	24	-2.2	-1.4	0	68.8	0	1.41	238.4	0.78	7955.3
2014	11	20	1	-2.6	-1.8	0.1	67.6	0	1.22	234.4	0.82	7955.3
2014	11	20	2	-3	-2.1	0	69.3	0	0.89	241.8	0.93	7955.3
2014	11	20	3	-3.1	-2	0.1	68.8	0	1.1	234.5	1.13	7954
2014	11	20	4	-2.7	-1.7	0.1	65.9	0	1	237.2	0.95	7951.3
2014	11	20	5	-1	0	0.1	47.2	0	2.5	241.5	1.05	7951.3
2014	11	20	6	1.5	1.6	0.1	63.9	0	3.26	246	0.09	7948.7
2014	11	20	7	1.2	1.2	0.1	68.5	0	2.43	224.7	0.03	7947.3
2014	11	20	8	1	1	0.1	71.7	0	2.39	240.2	-0.04	7947.3
2014	11	20	9	0.8	0.8	1.1	73	0	1.17	229.9	-0.03	7947.3
2014	11	20	10	0.5	0.5	27.8	73.4	0	1.99	258.5	-0.01	7947.3
2014	11	20	11	0.2	0.2	40.7	78.3	9999	2.24	229	-0.04	7952.7
2014	11	20	12	0	-0.2	101.8	79.6	9999	3.3	212.2	-0.14	7954
2014	11	20	13	-0.4	-0.5	163.6	78.6	0.01	2.35	70.6	-0.13	7955.3
2014	11	20	14	0.1	0	176.1	79.4	0.01	2.31	65.8	-0.11	7952.7
2014	11	20	15	0.3	0.2	114.7	82.2	0.01	1.86	56.5	-0.07	7947.3
2014	11	20	16	0.1	0	72.8	82.6	0	1.32	54.7	-0.09	7948.7
2014	11	20	17	0.4	0.2	161.8	86.7	0.01	1.71	68.1	-0.11	7946
2014	11	20	18	-0.3	-0.2	26.4	89.3	0	0.88	56.7	0.02	7944.7
2014	11	20	19	-0.4	-0.3	0.8	86.7	0	0.78	259.1	0.13	7946
2014	11	20	20	-0.5	-0.3	0.1	84.2	0	0.75	54.5	0.21	7944.7
2014	11	20	21	0	0.1	0.1	78.1	0	0.56	275.1	0.08	7944.7
2014	11	20	22	-0.5	-0.3	0.1	84.8	0	0.61	249.6	0.19	7943.3
2014	11	20	23	-1.1	-0.8	0.1	88.8	0	0.47	242.1	0.22	7942
2014	11	20	24	-1.9	-1.6	0.1	90.5	0	0.66	243.6	0.32	7940.7
2014	11	21	1	-2.4	-2.1	0.1	90.1	0	0.57	247.1	0.33	7942
2014	11	21	2	-2.3	-2	0.1	88.4	0	0.51	274.6	0.25	7943.3
2014	11	21	3	-2.3	-2	0.1	88.7	0	0.31	261.5	0.31	7940.7
2014	11	21	4	-2.3	-2	0.1	89.1	0	0.73	240.5	0.31	7938
2014	11	21	5	-2.2	-1.8	0.1	88	0	0.65	223.7	0.34	7935.3
2014	11	21	6	-1.6	-1.2	0.1	80.1	0	0.64	57.6	0.4	7935.3
2014	11	21	7	-1.8	-1.1	0.1	87.2	0	0.71	259.8	0.68	7934
2014	11	21	8	-2.7	-2.1	0.1	89	0	0.71	54.2	0.58	7931.3
2014	11	21	9	-3.5	-3	1.1	89.3	0	0.79	211	0.49	7930
2014	11	21	10	-3.1	-3	16.7	85	0	0.95	2.9	0.15	7935.3
2014	11	21	11	-1.3	-1	84.1	74.5	0	1.71	244.3	0.33	7931.3
2014	11	21	12	1	0.9	75.1	77.7	0	4.3	227	-0.1	7932.7
2014	11	21	13	1.3	1.2	92.3	74.3	0	4.32	234.4	-0.1	7926
2014	11	21	14	1.6	1.5	154.8	74.2	0	6.42	234.1	-0.11	7924.7
2014	11	21	15	1.7	1.6	129.7	76	0	6.05	244.7	-0.12	7919.4
2014	11	21	16	1.5	1.4	114.9	68.7	0	6.04	245.8	-0.11	7915.4
2014	11	21	17	1.6	1.5	70.7	66	0	6.94	235.2	-0.07	7911.4
2014	11	21	18	1.4	1.3	18.6	65.8	0	5.15	242.2	-0.07	7907.4
2014	11	21	19	1.1	1.1	0.6	69.1	0	6.38	247.3	-0.08	7900.7
2014	11	21	20	1.2	1.1	0.1	69.6	0	6.54	230.6	-0.06	7895.4
2014	11	21	21	1.2	1.1	0	76.8	0	8.24	229.7	-0.06	7890
2014	11	21	22	0.6	0.5	0	84.5	0	8.41	239.2	-0.08	7883.4
2014	11	21	23	0.7	0.6	0.1	73.6	0	7.92	237.6	-0.08	7879.4
2014	11	21	24	1.3	1.2	0	78.1	0	7.88	245.9	-0.08	7874
2014	11	22	1	1.2	1.1	0.1	81.2	0	6.42	246.7	-0.08	7863.4
2014	11	22	2	0.8	0.8	0.1	91.4	0	4.53	251.5	-0.08	7864.7
2014	11	22	3	0.3	0.3	0.1	94.3	0	4.75	238.6	-0.09	7855.4
2014	11	22	4	0.7	0.6	0.1	87.1	0	5.6	230.1	-0.07	7850
2014	11	22	5	1.2	1.1	0.1	91.1	0	5.84	220.4	-0.05	7843.4
2014	11	22	6	1.1	1.1	0.1	92.3	0	4.19	211.1	-0.04	7838
2014	11	22	7	1.4	1.3	0.1	91.5	0.02	2.42	217.3	-0.08	7828.7
2014	11	22	8	0.8	0.8	0.1	98.9	0.02	1.57	83.9	-0.02	7827.4

2014	11	22	9	0.6	0.6	0.3	94.6	0.03	2	66.5	-0.03	7834
2014	11	22	10	0.9	0.9	10.4	80.5	0.01	2.35	196.5	-0.02	7832.7
2014	11	22	11	1.1	1	42.9	75.8	0.01	3.12	229.7	-0.06	7832.7
2014	11	22	12	0.1	0	55.9	86.8	0.02	2.84	237.7	-0.11	7835.4
2014	11	22	13	-0.3	-0.4	149.2	74.8	0.04	3.58	227.5	-0.1	7847.4
2014	11	22	14	-0.5	-0.5	181.6	65.6	0.01	4.13	212.3	-0.05	7854
2014	11	22	15	-0.8	-0.9	272.2	49.7	0.03	3.44	95	-0.07	7858
2014	11	22	16	-1.3	-1.2	230	41.2	0.02	1.23	117	0.03	7858
2014	11	22	17	-1.2	-1.2	97.7	60.6	0.01	0.93	82.2	0.02	7863.4
2014	11	22	18	-1.8	-1.6	23.3	72.7	0	0.88	265.6	0.14	7867.4
2014	11	22	19	-2.2	-2.2	0.5	74.3	0	1.71	258.1	-0.03	7868.7
2014	11	22	20	-3.9	-4	0	95	0	2.22	36.8	-0.1	7872.7
2014	11	22	21	-4.4	-4.5	0.1	95.3	0	0.96	109.9	-0.06	7879.4
2014	11	22	22	-4.2	-4.1	0	96.6	0	1.08	246.4	0.12	7880.7
2014	11	22	23	-3.9	-3.8	0.1	94.8	0	0.95	244.2	0.06	7886
2014	11	22	24	-3.9	-4	0.1	94.8	0	1.62	82.9	-0.09	7895.4
2014	11	23	1	-3.8	-3.9	0.1	74.2	0.01	4.38	207.4	-0.07	7904.7
2014	11	23	2	-4.8	-4.8	0.1	94.5	0.01	3.43	179.6	-0.08	7919.4
2014	11	23	3	-5.3	-5.3	0.1	85.1	0	1.98	75.6	-0.06	7932.7
2014	11	23	4	-5.4	-5.3	0.1	89.1	0	1.52	349.4	0.09	7939.3
2014	11	23	5	-5.5	-5.3	0.1	82.1	0.01	0.93	278.3	0.11	7950
2014	11	23	6	-5.1	-5.1	0.1	81.9	0	1.3	235.7	0	7955.3
2014	11	23	7	-5	-5	0.1	81.4	0	1.29	231.6	-0.02	7960.7
2014	11	23	8	-5.3	-5.2	0.1	81.6	0	0.61	277.8	0.05	7966
2014	11	23	9	-5.6	-5.5	0.6	88.5	0	1.2	57.7	0.15	7972.7
2014	11	23	10	-6	-6.1	9.7	94.8	0	0.94	62	-0.05	7975.3
2014	11	23	11	-5.7	-5.7	34.1	93	0	2.01	58.5	-0.01	7982
2014	11	23	12	-5	-5.1	57	81.4	0.01	0.55	269.6	-0.08	7986
2014	11	23	13	-3.8	-3.9	112.3	74.3	0.01	3.19	230.3	-0.09	7991.3
2014	11	23	14	-3.4	-3.5	307.7	73.5	0.03	5.21	234.4	-0.12	7990
2014	11	23	15	-3.2	-3.3	254	77.9	0.02	5.11	229.4	-0.12	7982
2014	11	23	16	-3.6	-3.7	122.8	86.7	0	4.46	232	-0.12	7976.7
2014	11	23	17	-3.8	-3.9	64.3	81.4	0	3.7	235.2	-0.12	7975.3
2014	11	23	18	-3.7	-3.8	13.2	84.1	0	3.39	238.3	-0.11	7970
2014	11	23	19	-3.6	-3.7	0.5	78.4	0	2.85	235.4	-0.08	7964.7
2014	11	23	20	-3.5	-3.5	0.1	77	0	4.99	233.4	-0.07	7964.7
2014	11	23	21	-3.6	-3.7	0.1	82.4	0	3.54	242.8	-0.09	7960.7
2014	11	23	22	-3.9	-4	0	94.8	0	1.76	233.9	-0.11	7954
2014	11	23	23	-4	-3.9	0.1	85.5	0	1.38	60.1	0.05	7959.3
2014	11	23	24	-3.8	-3.8	0	91.2	0	1.78	233.8	-0.02	7963.3
2014	11	24	1	-4.6	-4.6	0	90.4	0	1.06	254.2	0.02	7967.3
2014	11	24	2	-4.5	-4.5	0	85.1	0	1.92	224.4	-0.01	7968.7
2014	11	24	3	-4.5	-4.5	0	78.1	0	2.91	209.5	0.04	7975.3
2014	11	24	4	-4.9	-4.8	0	81	0	1.3	90.5	0.09	7979.3
2014	11	24	5	-5.6	-5.2	0	83	0	0.69	241	0.39	7990
2014	11	24	6	-5.9	-5.5	0	80.3	0	0.87	295.3	0.46	7995.3
2014	11	24	7	-6.4	-5.7	0	83	0	0.65	315	0.71	7996.7
2014	11	24	8	-8.4	-7.4	0	89.3	0	1.23	235.8	0.94	8003.3
2014	11	24	9	-8.8	-8	1.9	86.8	0	0.85	228.4	0.82	8011.3
2014	11	24	10	-9.9	-8.9	18.7	86.5	0	1.65	231.9	1.06	8019.3
2014	11	24	11	-10.1	-9.2	63.7	71.1	0	0.71	22.2	0.84	8026
2014	11	24	12	-8.4	-7.8	352.8	47.7	0	0.45	110.3	0.63	8031.3
2014	11	24	13	-6	-5.6	430.7	64.8	0.06	1.27	110.2	0.42	8032.7
2014	11	24	14	-3.7	-3.7	413.4	64.5	0.02	3.03	55.5	0.06	8031.3
2014	11	24	15	-3.2	-3.2	341.5	69.1	0.01	2.87	43.2	-0.01	8031.3
2014	11	24	16	-3.2	-3.1	197.7	71.5	0.01	1.24	42.1	0.04	8031.3
2014	11	24	17	-3.5	-3.3	84.5	82.4	0	2.06	73.6	0.14	8030
2014	11	24	18	-3.7	-3.7	24.2	82.1	0	1.1	100	0	8028.7
2014	11	24	19	-3.9	-4	0.6	84.4	0	0.57	66.6	-0.01	8027.3
2014	11	24	20	-4.8	-4.6	0.1	83	0	0.64	339.7	0.19	8026
2014	11	24	21	-5.2	-4.9	0.1	87	0	0.73	245.9	0.28	8023.3

2014	11	24	22	-5.1	-5	0	86.5	0	0.91	27.2	0.11	8018
2014	11	24	23	-5.1	-5	0	95.9	0	1.57	51.2	0.04	8016.7
2014	11	24	24	-4.8	-4.7	0.1	96.8	0	0.94	39.6	0.08	8010
2014	11	25	1	-5.1	-5.2	0	96.9	0.01	1.12	69.2	-0.03	8003.3
2014	11	25	2	-4.6	-4.3	0	97.7	0.05	1.38	57.2	0.31	7999.3
2014	11	25	3	-4.2	-4.1	0	97.8	0.03	2.08	68.1	0.05	7995.3
2014	11	25	4	-3.9	-4.1	0	98.1	0.02	2.03	80.7	-0.13	7992.7
2014	11	25	5	-3.8	-3.9	0	98.2	0.02	1.65	66.4	-0.13	7992.7
2014	11	25	6	-3.6	-3.8	0	98.3	0.02	2.52	67.9	-0.11	7990
2014	11	25	7	-3.5	-3.7	0	98.4	0.02	2.84	71.3	-0.14	7983.3
2014	11	25	8	-3.3	-3.4	0	98.8	0.04	2.53	70.5	-0.13	7983.3
2014	11	25	9	-2.9	-3.1	0.2	99	0.03	2.38	69.6	-0.13	7986
2014	11	25	10	-2.6	-2.7	7.3	99.2	0.04	2.52	68.4	-0.09	7987.3
2014	11	25	11	-2.1	-2.2	37	99.5	0.05	2.17	60.9	-0.09	7988.7
2014	11	25	12	-1.3	-1.5	55.8	99.7	0.06	1.99	73.4	-0.13	7987.3
2014	11	25	13	-0.5	-0.6	94.4	99.8	0.05	2.76	88.3	-0.13	7987.3
2014	11	25	14	0.3	0.3	129.1	99.8	0.03	2.05	82.9	-0.02	7983.3
2014	11	25	15	0.6	0.8	119.1	99.9	0.03	2	87.8	0.14	7982
2014	11	25	16	0.8	1	76.6	100	0.02	1.93	86.9	0.18	7980.7
2014	11	25	17	1	1.4	43.9	100	0.02	1.43	73.6	0.43	7984.7
2014	11	25	18	2.3	2.8	9	97.3	0.01	1.01	27.4	0.51	7990
2014	11	25	19	2.9	3.3	0.3	91.8	0.01	1.07	282.9	0.35	7990
2014	11	25	20	3.6	3.7	0.1	92.1	0.01	1.42	255.2	0.11	7994
2014	11	25	21	3.5	3.8	0.1	85.2	0	0.93	241	0.32	7995.3
2014	11	25	22	2.2	2.5	0.1	98.9	0.01	1.15	73.6	0.31	7999.3
2014	11	25	23	1.8	2.2	0.1	97.8	0	1.27	63.4	0.44	7998
2014	11	25	24	1.8	2.4	0.1	99.3	0.01	0.65	56.3	0.57	8003.3
2014	11	26	1	2.2	2.5	0.1	96.8	0	0.38	95.2	0.37	8002
2014	11	26	2	1.8	2.5	0	98.8	0.15	0.72	77.1	0.7	8003.3
2014	11	26	3	1.8	2.4	0.1	96.8	0.09	1.06	64.5	0.59	8007.3
2014	11	26	4	2.4	2.8	0.1	92.5	0	0.79	226.5	0.42	8007.3
2014	11	26	5	1.9	2.5	0.1	99.4	0	0.83	79.9	0.58	8010
2014	11	26	6	1.4	1.9	0.1	100	0	1.25	55.6	0.46	8012.7
2014	11	26	7	1.7	2	0.1	95.5	0	0.81	65	0.31	8016.7
2014	11	26	8	2.6	2.8	0.1	87	0	1.5	254.7	0.18	8020.7
2014	11	26	9	2.6	2.6	0.8	94.2	0	1.99	248.8	0.08	8018
2014	11	26	10	1.1	1.4	34.9	99.7	0	1.5	61.4	0.22	8022
2014	11	26	11	1.1	1.1	86.2	95.8	0	1.54	68.5	0.01	8024.7
2014	11	26	12	1.6	1.6	166.5	92.2	0	1.51	81	0.07	8028.7
2014	11	26	13	2.1	2.1	237.7	91	0	2.35	86.9	0.06	8031.3
2014	11	26	14	2.6	2.7	232.9	88.3	0	2.01	83	0.12	8028.7
2014	11	26	15	3.7	3.8	238.4	67.5	0	1.23	77.9	0.08	8024.7
2014	11	26	16	4.6	4.7	137.7	89.9	0	1.98	264.3	0.08	8019.3
2014	11	26	17	2.7	2.8	83.1	90.4	0	1.17	68	0.05	8015.3
2014	11	26	18	2.4	2.6	28.3	94.1	0	0.79	20.2	0.21	8016.7
2014	11	26	19	1.3	1.6	0.5	94.2	0	0.4	42.6	0.34	8015.3
2014	11	26	20	0.3	0.6	0	96.9	0	0.77	41.5	0.32	8014
2014	11	26	21	0.3	1	0.1	86.4	0	0.96	52.1	0.69	8011.3
2014	11	26	22	0.3	1.4	0	91.7	0	0.76	47.9	1.1	8010
2014	11	26	23	0.3	1.3	0	90.7	0	0.95	59	0.96	8004.7
2014	11	26	24	1.4	2.4	0	76	0	0.8	22.6	1.04	8004.7
2014	11	27	1	4	4.3	0	63.2	0	2.18	258.6	0.35	8002
2014	11	27	2	4.8	5	0.1	63.9	0	2.69	249.5	0.13	8003.3
2014	11	27	3	4.9	5	0.1	59.1	0	2.68	254.2	0.17	8003.3
2014	11	27	4	4.8	5.2	0	61.7	0	1.56	262.7	0.35	7996.7
2014	11	27	5	4.7	5.2	0.1	56.3	0	0.97	291.7	0.5	7999.3
2014	11	27	6	5.5	5.6	0.1	55.6	0	1.97	254.7	0.16	7994
2014	11	27	7	4.9	4.9	0.1	75.7	0	4.07	249.6	0.04	7995.3
2014	11	27	8	3.5	3.7	0	73	0	2.48	199.9	0.17	7998
2014	11	27	9	4.1	4.2	0.4	73.1	0	4.5	216	0.09	7994
2014	11	27	10	5	5.2	21.6	60.1	0	4.9	235.8	0.25	7991.3

2014	11	27	11	5.6	5.8	91.2	61.8	0	7.88	239.4	0.14	7990
2014	11	27	12	5.9	6.1	285.8	61.2	0	5.88	228.6	0.18	7991.3
2014	11	27	13	6.1	6.3	263.6	58.8	0	5.47	228.5	0.14	7991.3
2014	11	27	14	6.6	6.7	320.7	52	0	7.09	231.7	0.15	7988.7
2014	11	27	15	6.7	6.9	129.8	52.3	0	5.78	229.7	0.17	7979.3
2014	11	27	16	4.8	4.8	54	80.3	0	8.14	226.1	0.08	7970
2014	11	27	17	3	3.1	27	90.1	0	4.02	230.1	0.07	7972.7
2014	11	27	18	2.1	2.1	3.9	92.7	0	2.33	236.1	0.02	7974
2014	11	27	19	1.8	2	0.2	95.8	0	2.03	116.4	0.12	7976.7
2014	11	27	20	1.2	1.3	0	96	0	1.48	45.6	0.15	7971.3
2014	11	27	21	0.6	0.6	0	99.6	0.01	1.31	60.1	0.05	7968.7
2014	11	27	22	0.1	0.1	0	100	0	0.63	223.5	-0.06	7964.7
2014	11	27	23	0.5	0.6	0	100	0	1.37	59.5	0.15	7958
2014	11	27	24	2.8	3	0.1	87.5	0	3.85	230.6	0.2	7952.7
2014	11	28	1	2.8	2.8	0.1	83.6	0.01	6.14	217.9	0.02	7951.3
2014	11	28	2	2.4	2.4	0	80.2	0.02	6.15	228.3	0.02	7946
2014	11	28	3	3.2	3.3	0.1	78.6	0.01	7.54	237.3	0.02	7935.3
2014	11	28	4	1.6	1.5	0.1	96.2	0	5.16	224.1	-0.05	7932.7
2014	11	28	5	1.2	1.2	0	88.9	0.01	2.54	243.8	0.04	7934
2014	11	28	6	2	2	0	90.4	0	4.31	226	0.01	7922
2014	11	28	7	1.4	1.4	0.1	82	0	2.49	234.4	0.02	7918
2014	11	28	8	1.3	1.2	0.1	83.6	0.01	4.41	214.4	-0.04	7920.7
2014	11	28	9	1.2	1.1	0.3	84.8	0	4	232.1	-0.03	7914
2014	11	28	10	1.2	1.2	10.9	86.2	0	5.54	230.9	-0.04	7908.7
2014	11	28	11	0.8	0.7	30.5	85.4	0	4.26	218.7	-0.06	7911.4
2014	11	28	12	0.7	0.6	62.5	90.5	0.01	5.07	219.6	-0.07	7907.4
2014	11	28	13	1.8	1.7	237.3	70.2	0.01	6.1	254.4	-0.04	7902
2014	11	28	14	3.4	3.5	213.2	46.2	0.02	6.17	235.5	0.08	7884.7
2014	11	28	15	3.8	3.9	152.1	47.6	0.01	5.46	227.4	0.11	7875.4
2014	11	28	16	2.9	2.9	113.8	58.7	0	7.3	222.8	0.03	7872.7
2014	11	28	17	1.5	1.4	33.6	73.4	0	6.13	231.5	-0.04	7868.7
2014	11	28	18	-0.4	-0.5	8.3	89.2	0	4.8	249.2	-0.1	7866
2014	11	28	19	0	0	0.2	68.7	0	3.32	236	-0.02	7863.4
2014	11	28	20	1.8	1.7	0.1	66.7	0	5.71	221.2	-0.05	7850
2014	11	28	21	2	2	0.1	67.3	0.01	6.33	214.8	-0.03	7840.7
2014	11	28	22	2.2	2.1	0.1	88.5	0.02	6.07	211.3	-0.07	7836.7
2014	11	28	23	1.8	1.7	0.1	86	0.04	3.88	221.8	-0.04	7828.7
2014	11	28	24	1.6	1.5	0.1	90	0.04	2.24	216.2	-0.06	7822
2014	11	29	1	1.9	1.9	0.1	83.2	0.05	5.32	229	-0.06	7820.7
2014	11	29	2	1.9	1.9	0.1	83.1	0.03	4.53	224	-0.06	7818
2014	11	29	3	2	1.9	0.1	85	0.01	5.47	214.2	-0.07	7808.7
2014	11	29	4	1.7	1.6	0.1	85.3	0.03	5.3	218.6	-0.06	7807.4
2014	11	29	5	1.6	1.6	0.1	84.4	0.04	5.83	210.7	-0.01	7800.7
2014	11	29	6	1.3	1.3	0.1	89.6	0.04	6.47	205.6	0.05	7791.4
2014	11	29	7	0.7	0.6	0.1	98.6	0.04	3.34	215.1	-0.1	7780.7
2014	11	29	8	0.5	0.5	0.1	98.7	0.03	2.67	222.5	-0.08	7783.4
2014	11	29	9	0.3	0.2	0.1	99.8	0.02	3.18	221.6	-0.11	7783.4
2014	11	29	10	0.6	0.5	2.3	98.7	0.02	4.39	209	-0.08	7782
2014	11	29	11	0.7	0.6	81	81.6	0.04	6.32	221.8	-0.06	7786
2014	11	29	12	1.2	1.2	286	66.6	0.07	10.05	225.4	0.03	7786
2014	11	29	13	1	1	310.1	70.2	0.03	8.94	226.2	0.03	7795.4
2014	11	29	14	-1.3	-1.4	103.3	81.4	0	6.78	224.3	-0.07	7794
2014	11	29	15	-1.6	-1.7	130.4	76.2	0.01	4.01	223	-0.1	7799.4
2014	11	29	16	-0.9	-1	89.4	59.1	0.01	7.17	231.4	-0.03	7795.4
2014	11	29	17	-1	-1	66.8	61.5	0	5.63	229.2	-0.02	7795.4
2014	11	29	18	-1.8	-1.8	24.2	70.6	0	3.6	235.1	-0.07	7803.4
2014	11	29	19	-2.8	-2.9	0.5	61.8	0	2.83	234.5	-0.09	7811.4
2014	11	29	20	-3.7	-3.8	0.1	80.8	0	3.67	237	-0.09	7818
2014	11	29	21	-5.3	-5.4	0.1	92.6	0	1.86	218.3	-0.13	7820.7
2014	11	29	22	-7	-7.1	0.1	89.6	0	3.34	209.4	-0.12	7836.7
2014	11	29	23	-8.1	-8.2	0.1	86.8	0	2.83	64.6	-0.09	7846

2014	11	29	24	-8.7	-8.7	0.1	75.3	0	3.56	60.8	-0.06	7859.4
2014	11	30	1	-9.8	-9.8	0	68.7	0	2.27	66.5	0.04	7872.7
2014	11	30	2	-12	-11.4	0	75.9	0	1.62	319	0.57	7884.7
2014	11	30	3	-15.6	-15.2	0	82	0	1.81	244	0.37	7891.4
2014	11	30	4	-17.5	-17	0	84.9	0	1.75	242.6	0.56	7898
2014	11	30	5	-19	-18.3	0	82.8	0	1.82	240.8	0.72	7906
2014	11	30	6	-20.4	-19.4	0	85	0	2.12	236.2	0.97	7910
2014	11	30	7	-20.4	-19.7	0	86.1	0	1.83	241	0.66	7915.4
2014	11	30	8	-21.5	-20.3	0	85.7	0	2.12	240.5	1.16	7919.4
2014	11	30	9	-21.2	-20.3	0.7	83.6	0	1.95	239.4	0.91	7927.3
2014	11	30	10	-21.7	-20.3	11.4	79.4	0	1.54	236.9	1.39	7934
2014	11	30	11	-21.4	-19.7	31.5	80.6	0	2.2	234.3	1.71	7939.3
2014	11	30	12	-17.5	-15.6	319.4	51.2	0	1.79	227.7	1.94	7942
2014	11	30	13	-13.4	-12.9	426.1	39.5	0	0.61	168.4	0.53	7943.3
2014	11	30	14	-10.5	-9.8	438	33.9	0.03	1.02	228	0.71	7940.7
2014	11	30	15	-7.8	-7.5	396.6	37.9	0.04	2.04	77.6	0.3	7938
2014	11	30	16	-7.7	-7.4	328	52.2	0.02	1.55	82	0.27	7940.7
2014	11	30	17	-9.5	-8.9	211.8	65.3	0.02	1.67	230.9	0.62	7939.3
2014	11	30	18	-13.2	-12.4	29.7	73.3	0	2.69	235	0.86	7940.7
2014	11	30	19	-14.7	-13.7	0.7	77	0	2.27	237.8	1	7943.3
2014	11	30	20	-16	-14.9	0	79.4	0	2.22	235.5	1.05	7946
2014	11	30	21	-17.2	-15.6	0	78.3	0	2.53	230	1.6	7948.7
2014	11	30	22	-16.6	-15.5	0	78.7	0	1.62	242.9	1.15	7951.3
2014	11	30	23	-17.2	-15.9	0	80.1	0	1.74	241.1	1.27	7954
2014	11	30	24	-17.7	-16	0	79	0	1.76	237.2	1.68	7958
2014	12	1	1	-17.7	-16.1	0	84.1	0	1.52	239.4	1.56	7956.7
2014	12	1	2	-17.8	-16.2	0	85.5	0	1.48	243.3	1.59	7959.3
2014	12	1	3	-18.1	-16.5	0.1	81.7	0	1.54	242.2	1.65	7960.7
2014	12	1	4	-18.4	-16.8	0.1	82.2	0	1.53	242.2	1.62	7960.7
2014	12	1	5	-18.3	-16.6	0.1	81.4	0	1.73	237.1	1.74	7958
2014	12	1	6	-17.2	-15.9	0.1	75.9	0	1.25	252.4	1.31	7958
2014	12	1	7	-14.5	-13	0	77.1	0	1.79	244	1.48	7958
2014	12	1	8	-12.8	-12.4	0	79.8	0	1.14	28.7	0.36	7947.3
2014	12	1	9	-11.6	-10.9	0.6	83.2	0	0.94	241	0.61	7948.7
2014	12	1	10	-10.1	-9.6	20.3	83.2	0	0.78	311.4	0.5	7951.3
2014	12	1	11	-8.8	-8.4	71.8	86.5	0	1.64	59.5	0.44	7954
2014	12	1	12	-7.2	-6.9	161.7	88.6	0	2.22	61.2	0.26	7954
2014	12	1	13	-3.1	-3.1	232.3	83.5	0	3.81	229.7	0.02	7954
2014	12	1	14	-1.9	-2.1	126	84.2	0	2.8	237.4	-0.13	7951.3
2014	12	1	15	-1.7	-1.9	90.2	83.5	0	3.91	218	-0.13	7946
2014	12	1	16	-2	-2.1	55.3	91.4	0	2.46	234.8	-0.12	7943.3
2014	12	1	17	-2.2	-2.3	38.2	91.8	0	0.84	28.2	-0.08	7938
2014	12	1	18	-2.2	-2.3	9.3	96.4	0	0.81	1	-0.05	7939.3
2014	12	1	19	-2.6	-2.6	0.2	96.3	0	0.73	323.3	-0.04	7938
2014	12	1	20	-2.6	-2.6	0.1	95.4	0	1.05	47.2	0.01	7940.7
2014	12	1	21	-2.2	-2.1	0.1	89.4	0	0.76	19.6	0.16	7943.3
2014	12	1	22	-1.7	-1.6	0	82.9	0	1.03	42	0.14	7944.7
2014	12	1	23	-2	-1.8	0	87	0	0.64	313.4	0.24	7946
2014	12	1	24	-3.1	-2.6	0.1	85.2	0	0.42	60.5	0.57	7950
2014	12	2	1	-3.9	-3.1	0	81.9	0	1.11	273.5	0.75	7950
2014	12	2	2	-3.4	-3	0	81.4	0	2.11	255.3	0.33	7952.7
2014	12	2	3	-4	-3.6	0	86.9	0	1.62	255.4	0.39	7952.7
2014	12	2	4	-7.2	-6.3	0	95.4	0	1.42	54.7	0.86	7951.3
2014	12	2	5	-7.8	-6.7	0	97.3	0	0.96	246.4	1.05	7956.7
2014	12	2	6	-8	-7	0	96.7	0	0.66	55.9	1.01	7955.3
2014	12	2	7	-9	-8.1	0	94.7	0	1.26	128	0.9	7954
2014	12	2	8	-9.5	-8.5	0	92.5	0	1.7	233.1	0.96	7955.3
2014	12	2	9	-9.6	-8.6	0.3	93.1	0	0.86	241	0.97	7959.3
2014	12	2	10	-10.1	-8.8	5.6	95.6	0	1.13	239.5	1.27	7960.7
2014	12	2	11	-9.8	-8.4	18.6	95	0	1.49	241.7	1.38	7964.7
2014	12	2	12	-7.4	-6.5	193.1	75.4	0	1.02	118.4	0.92	7964.7

2014	12	2	13	-5.1	-4.3	346.5	62.7	0.01	0.52	98	0.74	7967.3
2014	12	2	14	-3	-2.7	337.1	55.4	0.04	0.53	114.9	0.29	7964.7
2014	12	2	15	-1.7	-1.5	342.3	58.4	0.05	0.67	98.6	0.23	7960.7
2014	12	2	16	-1.5	-1.3	212	67.5	0.01	0.8	80.8	0.16	7952.7
2014	12	2	17	-1.7	-1.5	113.3	72.3	0.01	0.6	7.1	0.22	7947.3
2014	12	2	18	-3.7	-2.9	30.5	82.5	0	1.9	233.1	0.8	7950
2014	12	2	19	-5.4	-4.8	0.5	83.7	0	1.88	238.4	0.6	7947.3
2014	12	2	20	-7.3	-6.6	0.1	85.4	0	2.23	239.5	0.74	7947.3
2014	12	2	21	-7.9	-7.1	0.1	87.9	0	1.86	239.6	0.88	7943.3
2014	12	2	22	-7.6	-6.3	0	86.6	0	2.04	238.7	1.39	7946
2014	12	2	23	-7.8	-6.4	0	87.5	0	2.85	234	1.37	7947.3
2014	12	2	24	-7	-6.1	0.1	85.6	0	1.77	237.8	0.97	7940.7
2014	12	3	1	-7.2	-5.8	0	82.1	0	2.15	237	1.38	7935.3
2014	12	3	2	-6.6	-5.6	0	87.5	0	1.4	269.5	0.95	7938
2014	12	3	3	-7.8	-6.9	0	85.1	0	1.45	237.3	0.85	7935.3
2014	12	3	4	-7.1	-6.4	0	85.5	0	1.28	241.8	0.76	7930
2014	12	3	5	-6.5	-5.6	0	82.3	0	1.61	242.7	0.9	7920.7
2014	12	3	6	-6	-5.5	0.1	85.9	0	0.76	251.4	0.47	7922
2014	12	3	7	-6.3	-5.5	0	82.8	0	0.88	244.4	0.79	7918
2014	12	3	8	-4.9	-4.3	0	71.1	0	1.3	242.5	0.58	7908.7
2014	12	3	9	-3	-2.9	0.1	88.8	0	1.85	232	0.14	7915.4
2014	12	3	10	-3.9	-3.6	15.8	88.6	0	0.5	292.5	0.24	7916.7
2014	12	3	11	-3.7	-3.7	95.5	84.8	0	0.14	204.9	0	7918
2014	12	3	12	-2.9	-2.9	135.4	83.6	0	0.39	52.7	-0.01	7918
2014	12	3	13	-0.4	-0.3	197.6	83.4	0	1.25	219.5	0.09	7918
2014	12	3	14	-1.2	-1.1	141.3	86.1	0	1.83	66.8	0.08	7912.7
2014	12	3	15	-0.8	-0.7	153.7	85.9	0	1.73	75	0.05	7914
2014	12	3	16	0	0.1	116.4	88.2	0	1.35	63.9	0.02	7908.7
2014	12	3	17	0.3	0.4	80.9	91.4	0	1.52	65	0.11	7910
2014	12	3	18	0.3	0.4	9	92.8	0	0.6	45.5	0.08	7911.4
2014	12	3	19	-0.2	-0.3	0.3	98.6	0	0.3	110	-0.04	7911.4
2014	12	3	20	-0.6	-0.6	0.1	99.8	0	0.53	239.7	-0.01	7912.7
2014	12	3	21	-0.7	-0.5	0.1	99.7	0	1.17	238.3	0.13	7911.4
2014	12	3	22	-0.4	-0.2	0.1	100	0	1.02	242.7	0.14	7908.7
2014	12	3	23	-0.5	-0.5	0.1	100	0	0.52	255.5	0.07	7906
2014	12	3	24	-0.5	-0.2	0.1	100	0	0.54	314.2	0.21	7903.4
2014	12	4	1	0	0.3	0.1	100	0	0.59	272.9	0.33	7900.7
2014	12	4	2	0.8	1.2	0.1	97.4	0	0.75	29.1	0.41	7900.7
2014	12	4	3	1.3	1.5	0.1	94.7	0	0.97	23.5	0.27	7896.7
2014	12	4	4	0.9	1.1	0.1	95.5	0.05	1.14	42.5	0.26	7895.4
2014	12	4	5	2.8	2.8	0.1	87.5	0.01	5	223.2	0.03	7898
2014	12	4	6	2.5	2.5	0.1	86.5	0.01	5.37	221.2	0.04	7896.7
2014	12	4	7	2.3	2.3	0.1	88.5	0.15	3.57	227.3	0.05	7898
2014	12	4	8	2	2	0.1	90.8	0.07	2.63	238.9	0.01	7903.4
2014	12	4	9	1.6	1.6	0.3	95	0	1.55	253.9	-0.03	7907.4
2014	12	4	10	1.4	1.3	16	93.5	0	0.95	267.6	-0.01	7910
2014	12	4	11	1.8	1.7	57.3	87.9	0	0.81	271	-0.07	7914
2014	12	4	12	2.2	2.2	129.5	93.2	0	0.83	173	-0.02	7916.7
2014	12	4	13	2.6	2.5	249.8	84.9	0	1.66	221.8	-0.07	7920.7
2014	12	4	14	2.9	2.8	219.4	87.5	0	2.65	240.5	-0.06	7919.4
2014	12	4	15	2.2	2.2	91.4	92.3	0	1.08	13.4	0.01	7918
2014	12	4	16	2.2	2.2	92.7	89.8	0	0.68	256	-0.06	7920.7
2014	12	4	17	1.6	1.5	35.5	99.6	0	0.93	65	-0.05	7923.4
2014	12	4	18	1	1.1	12.1	99.6	0	0.44	48.1	0.09	7931.3
2014	12	4	19	0.6	0.7	0.3	100	0	0.71	54.8	0.02	7935.3
2014	12	4	20	0.5	0.6	0.1	100	0	0.49	285.9	0.14	7940.7
2014	12	4	21	0.3	0.5	0.1	100	0	0.61	262.7	0.14	7943.3
2014	12	4	22	0.4	0.5	0.1	99.8	0	0.67	251.1	0.08	7946
2014	12	4	23	0.5	0.6	0.1	99	0	0.61	253.8	0.1	7948.7
2014	12	4	24	0.5	0.5	0	99.3	0	0.8	254.8	0.04	7951.3
2014	12	5	1	0.3	0.4	0	100	0	0.85	245.5	0.09	7956.7

2014	12	5	2	0.2	0.2	0.1	100	0	0.66	240.4	0.08	7959.3
2014	12	5	3	0.3	0.5	0	100	0	0.91	245.8	0.15	7960.7
2014	12	5	4	0.2	0.3	0.1	100	0	0.84	255	0.03	7964.7
2014	12	5	5	0.6	0.9	0.1	93.5	0	0.67	24.2	0.28	7968.7
2014	12	5	6	0.8	1.2	0.1	98.3	0	0.58	336.9	0.43	7971.3
2014	12	5	7	0.2	0.4	0.1	99.6	0	0.78	232.9	0.22	7974
2014	12	5	8	0.4	0.7	0.1	96.2	0	1.05	252	0.35	7976.7
2014	12	5	9	0	0.3	0.3	100	0	1.03	51.9	0.31	7983.3
2014	12	5	10	0.2	0.3	9.9	94.7	0	1.01	254.3	0.13	7987.3
2014	12	5	11	0.6	0.8	42.2	95.2	0	0.52	230.7	0.24	7990
2014	12	5	12	1.6	1.7	147.4	76.6	0	0.8	234	0.04	7995.3
2014	12	5	13	3.2	3.1	123	71.2	0	3.62	242.9	-0.07	7998
2014	12	5	14	3.4	3.3	121.7	68.6	0	3.12	244.7	-0.08	7995.3
2014	12	5	15	3.6	3.5	130.8	65.9	0	3.44	249.5	-0.09	7992.7
2014	12	5	16	3.7	3.7	109.3	66.3	0	1.31	196.7	-0.06	7992.7
2014	12	5	17	3.6	3.7	75.8	74.4	0	1.16	139.8	0.04	7991.3
2014	12	5	18	2.3	2.5	30.3	88.4	0	1.1	51.1	0.15	7992.7
2014	12	5	19	0.4	0.6	0.4	93.8	0	1.7	236.7	0.2	7994
2014	12	5	20	-0.5	-0.3	0	92.8	0	1.88	240.8	0.2	7994
2014	12	5	21	-0.5	-0.2	0	90.3	0	1.53	249.5	0.33	7992.7
2014	12	5	22	-1.1	-0.4	0.1	96.5	0	1.65	237.7	0.67	7991.3
2014	12	5	23	-1.3	-0.4	0	93.3	0	1.7	238	0.98	7988.7
2014	12	5	24	-1.3	-0.5	0.1	95.3	0	1.55	244.1	0.74	7987.3
2014	12	6	1	-0.9	-0.2	0	92.7	0	1.57	249.8	0.71	7986
2014	12	6	2	-0.4	-0.3	0.1	88.6	0	1.65	253.3	0.14	7986
2014	12	6	3	-0.5	0	0.1	87	0	1.64	253.1	0.5	7983.3
2014	12	6	4	-1.4	-0.9	0.1	91.6	0	2.28	242.4	0.57	7980.7
2014	12	6	5	-2	-1.5	0.1	91.2	0	2.79	243.4	0.49	7982
2014	12	6	6	-2.1	-1.7	0.1	90.6	0	2.46	246.8	0.33	7979.3
2014	12	6	7	-2.4	-1.5	0	93.3	0	2.18	243	0.86	7976.7
2014	12	6	8	-0.5	0.4	0.1	73.8	0	1.39	243.2	0.88	7975.3
2014	12	6	9	3	3.5	0.2	75.6	0	2.22	214.2	0.51	7974
2014	12	6	10	3.1	3.1	9.4	90.2	0	3.19	233.9	0.01	7972.7
2014	12	6	11	2.6	2.6	34.7	92.5	0	2.08	209.8	0.05	7975.3
2014	12	6	12	2.9	2.9	45.5	92.2	0	4.1	241.1	0	7978
2014	12	6	13	2.3	2.3	102.6	90.5	0	3.64	244.3	-0.04	7986
2014	12	6	14	1.5	1.5	81.4	83.5	0.01	3.83	236.8	-0.07	7987.3
2014	12	6	15	2	1.9	128.2	83.6	0.01	5.76	240.8	-0.1	7988.7
2014	12	6	16	2.2	2.1	115.4	76.7	0.01	3.95	250.4	-0.08	7990
2014	12	6	17	1.7	1.7	43.4	73.6	0	3.38	246.3	-0.04	7995.3
2014	12	6	18	1.2	1.2	10.7	85.9	0	3.01	247.3	-0.01	7998
2014	12	6	19	0.1	0.1	0.4	84.8	0	1.98	243.8	0.05	8003.3
2014	12	6	20	-0.5	-0.2	0.1	86.8	0	0.65	332.5	0.36	8007.3
2014	12	6	21	-0.7	-0.4	0.1	92.7	0	1.38	333	0.38	8014
2014	12	6	22	-1.7	-1.1	0.1	94.2	0	1.08	240.4	0.54	8016.7
2014	12	6	23	-2.5	-1.8	0.1	94.3	0	1.61	230.2	0.71	8019.3
2014	12	6	24	-3.8	-3.4	0.1	92.2	0	1.88	233.9	0.43	8023.3
2014	12	7	1	-5.2	-4.5	0.1	96.4	0	1.62	237.5	0.65	8024.7
2014	12	7	2	-6	-5.5	0	92	0	1.79	246.4	0.45	8028.7
2014	12	7	3	-6.7	-6	0	97.4	0	1.66	238.9	0.71	8027.3
2014	12	7	4	-6.9	-6.2	0	94.5	0	1.38	239.6	0.64	8030
2014	12	7	5	-7.9	-6.9	0	93.9	0	1.81	240.4	0.95	8039.3
2014	12	7	6	-8	-7	0	94.8	0	2.03	238	1	8038
2014	12	7	7	-8.4	-7	0	95.1	0	1.55	238.8	1.4	8035.3
2014	12	7	8	-8.1	-7	0	96.7	0	1.32	240.3	1.11	8034
2014	12	7	9	-8.6	-7.3	0.7	95.7	0	1.32	234.1	1.28	8036.7
2014	12	7	10	-8.1	-7.1	18.3	95.9	0	1.4	237.1	0.97	8039.3
2014	12	7	11	-7.3	-6.3	51.6	95.7	0	1.25	243.2	1.08	8042
2014	12	7	12	-5.5	-4.2	213	77.3	0	1.13	236.9	1.26	8040.7
2014	12	7	13	-2.2	-1.6	377.3	69.4	0	0.55	228.1	0.61	8039.3
2014	12	7	14	0.6	0.9	411.9	69.9	0.04	0.98	49.9	0.35	8031.3

2014	12	7	15	2.9	2.9	367.3	64.2	0.03	2.08	144.3	0.03	8028.7
2014	12	7	16	3.1	3.1	142	68.8	0.01	1.39	172.2	-0.02	8026
2014	12	7	17	2.7	2.8	92.8	71.9	0	1.33	49.8	0.04	8024.7
2014	12	7	18	1.6	2	21.5	81.9	0	0.67	287.5	0.4	8026
2014	12	7	19	0.3	0.7	0.4	87.8	0	1.24	248.3	0.38	8027.3
2014	12	7	20	-1.2	-0.8	0.1	94.2	0	1.69	240.5	0.48	8024.7
2014	12	7	21	-2.2	-1.9	0	93.2	0	1.08	242.2	0.25	8023.3
2014	12	7	22	-3.3	-2.6	0	95.2	0	1.73	235.8	0.77	8026
2014	12	7	23	-3.7	-2.9	0	93.4	0	2.01	235.2	0.82	8024.7
2014	12	7	24	-3.6	-3.1	0.1	96.3	0	1.03	246	0.52	8024.7
2014	12	8	1	-4.3	-3.5	0.1	95.1	0	1.46	234.8	0.79	8024.7
2014	12	8	2	-4.6	-3.7	0.1	92.8	0	1.18	239.2	0.91	8024.7
2014	12	8	3	-4.2	-3.4	0	95.3	0	1.01	241.6	0.83	8022
2014	12	8	4	-4.7	-3.7	0.1	96.5	0	1.2	238.5	1	8020.7
2014	12	8	5	-4.5	-3.5	0.1	93.5	0	0.99	246	0.97	8020.7
2014	12	8	6	-3.9	-3.1	0.1	94.6	0	1.2	242.8	0.87	8018
2014	12	8	7	-3.4	-2.8	0.1	95	0	0.88	257	0.6	8015.3
2014	12	8	8	-4.6	-3.6	0.1	98.6	0	1.34	246.3	0.97	8012.7
2014	12	8	9	-5	-4	0.2	99.1	0	1.58	237.1	0.94	8014
2014	12	8	10	-4.8	-3.6	18.3	94.4	0	1.67	237.6	1.19	8018
2014	12	8	11	-3.3	-2.5	72.1	88.9	0	1	248.6	0.85	8016.7
2014	12	8	12	-2.3	-1.3	134.1	86.7	0	1.24	244.9	1.02	8018
2014	12	8	13	-0.1	0.1	243.6	78	0	1.44	60.8	0.18	8019.3
2014	12	8	14	1.6	1.7	167.7	71.7	0	1.83	78	0.09	8014
2014	12	8	15	3.6	3.6	120.9	72.4	0	5.46	228.6	0.01	8011.3
2014	12	8	16	3	3	140.4	79.6	0	5.51	234.2	-0.05	8011.3
2014	12	8	17	3	2.9	94	75.9	0	2.13	263.2	-0.1	8014
2014	12	8	18	2.8	2.9	35.7	85.2	0	1.07	113.4	0.09	8012.7
2014	12	8	19	1	1.3	0.5	90.1	0	1.15	253.8	0.28	8012.7
2014	12	8	20	-0.2	0.1	0.1	91.2	0	0.82	245.7	0.35	8016.7
2014	12	8	21	0	0.3	0	90.3	0	1.09	256.8	0.28	8016.7
2014	12	8	22	0.3	0.9	0	92.7	0	0.74	20	0.59	8016.7
2014	12	8	23	-0.7	-0.2	0	93.8	0	0.83	244.6	0.42	8016.7
2014	12	8	24	-1.2	-0.5	0.1	94.1	0	1.29	242.3	0.77	8015.3
2014	12	9	1	-1.7	-1	0	90.4	0	1.9	244.1	0.65	8016.7
2014	12	9	2	-2.3	-1.6	0.1	96.1	0	1.62	238.2	0.75	8014
2014	12	9	3	-2.6	-1.9	0.1	95.6	0	1.75	243.5	0.77	8012.7
2014	12	9	4	-3	-2.3	0.1	91.4	0	1.14	252.7	0.67	8011.3
2014	12	9	5	-3.4	-2.5	0.1	93.4	0	1.27	250.1	0.9	8011.3
2014	12	9	6	-3	-1.7	0.1	98.2	0	1.62	242.8	1.29	8008.7
2014	12	9	7	-2.1	-1.1	0.1	94.7	0	1.28	247.1	0.96	8004.7
2014	12	9	8	-1.7	-0.9	0.1	91.1	0	0.92	329.6	0.8	8004.7
2014	12	9	9	-1.1	-0.2	0.4	91.2	0	1.04	261.8	0.86	8007.3
2014	12	9	10	-0.3	0.3	29.7	91.9	0	1	278.8	0.64	8007.3
2014	12	9	11	3.3	3.4	102.8	75.4	0	1.32	201.3	0.18	8004.7
2014	12	9	12	3.1	3.2	98.1	85.4	0	2.18	107.7	0.1	8002
2014	12	9	13	3.1	3.2	103.9	82.3	0	1.39	83	0.15	8006
2014	12	9	14	4.6	4.7	140.6	75.1	0	2.99	218.5	0.12	7998
2014	12	9	15	5.2	5.3	137.9	73.1	0	3.21	224.9	0.08	7996.7
2014	12	9	16	5.3	5.5	122	73.7	0	4.47	228.6	0.13	7991.3
2014	12	9	17	5.1	5.2	58.1	74.7	0	3.32	231.4	0.13	7994
2014	12	9	18	4.9	5	16.4	70.1	0	3.55	232.1	0.12	7996.7
2014	12	9	19	3.8	4	0.4	83.9	0	1.5	263.2	0.22	7998
2014	12	9	20	1.6	2.1	0.1	86.4	0	1.8	240.1	0.45	7992.7
2014	12	9	21	1.2	1.9	0.1	90.5	0	1.41	243.4	0.68	7992.7
2014	12	9	22	1	1.7	0.1	88.4	0	0.77	254.8	0.79	7990
2014	12	9	23	1.3	2	0	76.7	0	0.79	231.5	0.71	7992.7
2014	12	9	24	1.2	1.6	0	88	0	1.23	50.6	0.4	7990
2014	12	10	1	1	1.4	0	92.4	0	0.76	271.7	0.41	7990
2014	12	10	2	1	1.5	0	93	0	0.92	246.3	0.55	7988.7
2014	12	10	3	-0.2	0.6	0	88.4	0	1.51	239.5	0.81	7986

2014	12	10	4	0.9	1.7	0	85.7	0	1.24	256.5	0.77	7983.3
2014	12	10	5	1.3	2.3	0	94.2	0	1.05	62.1	1	7982
2014	12	10	6	-1	-0.5	0.1	94.2	0	1.31	236.8	0.53	7976.7
2014	12	10	7	-1.3	-0.5	0.1	92.3	0	1.13	279.1	0.76	7975.3
2014	12	10	8	-1.3	-0.2	0	93.8	0	1.06	238.4	1.05	7968.7
2014	12	10	9	-1.6	-0.5	0.2	90.3	0	1.74	240	1.03	7976.7
2014	12	10	10	-1.4	-0.5	13.3	83.8	0	0.99	251.9	0.9	7971.3
2014	12	10	11	-1.4	-0.7	65.6	87.2	0	0.72	258.2	0.69	7971.3
2014	12	10	12	-0.5	0.4	115.4	82.9	0	1.83	235.4	0.88	7972.7
2014	12	10	13	3.2	3.7	225.4	67.8	0	1.33	239.3	0.51	7967.3
2014	12	10	14	5.6	6.1	230.3	52.8	0	1.16	53.5	0.53	7955.3
2014	12	10	15	7.4	7.5	213.5	52.4	0	2.09	245.4	0.03	7947.3
2014	12	10	16	7.1	7.2	125.3	57.3	0	1.67	164.8	0.08	7942
2014	12	10	17	6.5	6.8	63	61.8	0	1.19	130.6	0.32	7934
2014	12	10	18	5.6	6.1	16.3	67.2	0	1.1	66.6	0.52	7930
2014	12	10	19	5.5	6.1	0.3	53.5	0	1.58	55.9	0.59	7926
2014	12	10	20	6.5	6.7	0.1	63.5	0	2.24	103.5	0.27	7915.4
2014	12	10	21	5.9	6.3	0.1	54.7	0	1.73	69.2	0.37	7906
2014	12	10	22	5.8	6.2	0	59.8	0	1.89	71.1	0.48	7899.4
2014	12	10	23	4.9	6.1	0	50.7	0	1.58	311.6	1.21	7896.7
2014	12	10	24	8.5	9	0	37	0	5.16	243.3	0.42	7895.4
2014	12	11	1	9	9.2	0	37.4	0	7.15	247	0.16	7892.7
2014	12	11	2	7.8	7.9	0.1	52.9	0	8.37	235.4	0.13	7894
2014	12	11	3	5.2	5.2	0.1	75.1	0	10	236	0.04	7899.4
2014	12	11	4	4.3	4.4	0.1	73.9	0	6.81	252.3	0.02	7908.7
2014	12	11	5	4.5	4.6	0	70	0	5.36	249.3	0.05	7907.4
2014	12	11	6	5.4	5.4	0	62.6	0	5.36	241.8	0.07	7902
2014	12	11	7	6	6.1	0.1	56.6	0	4.73	235.8	0.08	7888.7
2014	12	11	8	6.1	6.3	0.1	57.4	0	2.3	171	0.14	7887.4
2014	12	11	9	7	7.2	0.2	47.7	0	3.99	242.2	0.19	7887.4
2014	12	11	10	7.1	7.3	9	46.8	0	4.65	228.7	0.16	7879.4
2014	12	11	11	7	7.4	74	42.3	0	2.82	199.9	0.33	7875.4
2014	12	11	12	8.1	8.3	97.8	43.3	0	3.37	211.1	0.13	7879.4
2014	12	11	13	8.2	8.3	167.5	43.4	0	4.24	226.3	0.14	7878
2014	12	11	14	8.1	8.1	178.4	55.8	0	9.47	259.4	0.07	7867.4
2014	12	11	15	6.8	6.8	166.2	59	0	8.66	255.9	0.04	7867.4
2014	12	11	16	6	6.1	121.1	62.6	0	7.37	253.2	0.03	7867.4
2014	12	11	17	6.5	6.5	53.5	55.2	0	5.56	246.4	0.04	7868.7
2014	12	11	18	6.1	6.1	20.3	66.6	0	7.32	256.6	0.04	7867.4
2014	12	11	19	5.6	5.7	0.2	65.5	0	4.11	213.9	0.05	7871.4
2014	12	11	20	5.6	5.7	0.1	67.7	0	1.82	166.7	0.12	7870
2014	12	11	21	5.8	6	0	61.6	0	1.38	183	0.21	7868.7
2014	12	11	22	5.8	6	0	60.9	0	3.63	96.5	0.15	7868.7
2014	12	11	23	5.5	5.8	0.1	64.2	0	2.5	93.6	0.26	7866
2014	12	11	24	6.1	6.3	0.1	51.5	0	1.74	186.8	0.16	7868.7
2014	12	12	1	6	6.3	0	53.3	0	1.55	211.6	0.3	7867.4
2014	12	12	2	5.8	6.2	0	57.4	0	1.39	197.8	0.4	7868.7
2014	12	12	3	6.7	6.9	0.1	48.5	0	1.55	206.8	0.25	7867.4
2014	12	12	4	7.2	7.4	0	46.2	0	2.55	224.4	0.16	7866
2014	12	12	5	6.8	7.1	0	53.4	0	1.9	241.9	0.24	7867.4
2014	12	12	6	6.2	6.6	0.1	48.1	0	1.3	324.4	0.35	7867.4
2014	12	12	7	6	6.3	0	47.3	0	1.26	246.1	0.29	7866
2014	12	12	8	6.1	6.3	0.1	51	0	1.78	157.9	0.29	7868.7
2014	12	12	9	5.2	5.8	0.1	53.1	0	1.25	203.6	0.59	7870
2014	12	12	10	5.3	5.7	31.9	49.2	0	2.2	216.3	0.47	7871.4
2014	12	12	11	6.3	6.4	84.9	46	0	2.88	193	0.1	7871.4
2014	12	12	12	6.7	6.8	114.4	43.7	0	2.8	207.5	0.05	7870
2014	12	12	13	7.1	7.1	140.7	44	0	3.91	237.4	0.06	7870
2014	12	12	14	6.7	6.7	144.2	50	0	4.2	238.2	0.03	7863.4
2014	12	12	15	6.1	6.1	117.9	61.3	0	5.74	242	0	7860.7
2014	12	12	16	4	4	78	77	0	2.76	228.9	-0.04	7863.4

2014	12	12	17	3.6	3.6	50.3	72.5	0	1.62	358.7	0	7866
2014	12	12	18	4.2	4.1	17.2	70.6	0	2.25	256.3	-0.05	7864.7
2014	12	12	19	3.8	3.7	0.4	75.1	0	1.8	303.9	-0.05	7867.4
2014	12	12	20	3.3	3.3	0.1	78.1	0	1.94	24.3	-0.03	7867.4
2014	12	12	21	3.1	3.1	0.1	78.2	0	2.16	69.3	-0.05	7870
2014	12	12	22	3.2	3.2	0	76.6	0	1.61	115.3	0.02	7866
2014	12	12	23	3.3	3.3	0	77.3	0	2.27	93.9	0.02	7867.4
2014	12	12	24	2.7	2.8	0	88.9	0	1.21	193.9	0.07	7867.4
2014	12	13	1	0.5	0.4	0	98.8	0	1.26	86.1	-0.05	7870
2014	12	13	2	-0.3	-0.4	0	99.3	0	1.29	48.9	-0.11	7875.4
2014	12	13	3	-1.5	-1.6	0	99.1	0.01	3.66	81.7	-0.1	7880.7
2014	12	13	4	-2.1	-2.2	0	99.2	0.01	2.22	73.1	-0.11	7887.4
2014	12	13	5	-2.3	-2.4	0	98.5	0.03	2.67	59.8	-0.08	7895.4
2014	12	13	6	-2.7	-2.8	0	99	0.01	1.06	121	-0.1	7900.7
2014	12	13	7	-3	-3.1	0	98.3	0.01	2.15	47.8	-0.08	7906
2014	12	13	8	-3.3	-3.4	0	99	0	1.16	64.3	-0.09	7910
2014	12	13	9	-3.5	-3.5	0.1	98.8	0	1.8	61.7	-0.06	7916.7
2014	12	13	10	-3.4	-3.4	3.7	98.2	0	1.65	45.6	-0.06	7920.7
2014	12	13	11	-3.4	-3.5	26.9	98	0.01	0.64	80.5	-0.09	7927.3
2014	12	13	12	-3.1	-3.1	57.6	95.8	0	1.94	68.1	-0.09	7934
2014	12	13	13	-2.6	-2.7	80.2	90.6	0.01	2.68	80.8	-0.12	7938
2014	12	13	14	-2.3	-2.4	101	78.4	0.03	1.87	102.1	-0.1	7936.7
2014	12	13	15	-2	-2.1	101.8	77.6	0.01	2.03	172.4	-0.11	7938
2014	12	13	16	-2	-2.1	82.4	71.2	0.01	2.21	215.1	-0.1	7939.3
2014	12	13	17	-2.5	-2.5	48.7	83.6	0	1.06	21.8	-0.08	7943.3
2014	12	13	18	-3.2	-3.2	17.9	88.6	0	0.63	81.4	0.01	7947.3
2014	12	13	19	-3.6	-3.6	0.4	93.4	0	1.09	62.6	0.02	7950
2014	12	13	20	-3.9	-4	0.1	93.5	0	2.07	46.9	-0.02	7952.7
2014	12	13	21	-4.3	-4.3	0.1	95	0	1.59	74.3	-0.05	7955.3
2014	12	13	22	-4.6	-4.5	0.1	80.3	0	2.09	73.1	0.02	7956.7
2014	12	13	23	-5.1	-5.1	0	85.2	0	0.89	74.6	0.06	7958
2014	12	13	24	-5.5	-5.5	0	90.2	0	0.84	53.1	0.01	7960.7
2014	12	14	1	-5.6	-5.6	0.1	89.5	0	0.68	58	-0.01	7962
2014	12	14	2	-5.6	-5.6	0	88.3	0	0.9	50.9	0.02	7963.3
2014	12	14	3	-5.3	-5.3	0.1	84.1	0	2.28	70	0.01	7960.7
2014	12	14	4	-5.9	-5.8	0.1	90.4	0	1.15	81.9	0.1	7960.7
2014	12	14	5	-5.8	-5.8	0.1	88.3	0	1.52	72.8	0.01	7962
2014	12	14	6	-5.3	-5.4	0	76.3	0	3.4	45	-0.08	7962
2014	12	14	7	-5.4	-5.5	0.1	78.3	0	2.01	34.1	-0.06	7963.3
2014	12	14	8	-5.8	-5.7	0.1	84.3	0	1.25	30.1	0.04	7964.7
2014	12	14	9	-7.4	-7.3	0.1	88	0	1.42	272.2	0.2	7964.7
2014	12	14	10	-8.9	-8.6	21.8	84.7	0	1.54	239.3	0.28	7967.3
2014	12	14	11	-9	-8.5	61.3	83.3	0	1.88	244.8	0.47	7970
2014	12	14	12	-7.9	-7.4	257.3	71.2	0	1.65	234.6	0.46	7974
2014	12	14	13	-5.7	-5.2	381	51.5	0.01	0.42	190.3	0.54	7972.7
2014	12	14	14	-3.9	-3.8	413.4	54.9	0.04	0.67	231	0.07	7966
2014	12	14	15	-3	-2.9	369.7	43.2	0.04	1.04	229.1	0.1	7960.7
2014	12	14	16	-2.1	-2.2	364.4	42	0.03	0.49	107.9	-0.09	7956.7
2014	12	14	17	-2.2	-2	272.6	62.2	0.03	1.54	229.8	0.21	7952.7
2014	12	14	18	-2.4	-2.4	65.9	67	0	1.51	225.7	0.07	7955.3
2014	12	14	19	-3.5	-3.3	1.8	75.4	0	0.96	254.4	0.2	7956.7
2014	12	14	20	-5	-4.4	0	79.6	0	1.14	232.9	0.55	7958
2014	12	14	21	-5.9	-5.4	0	83.9	0	1.78	240.2	0.5	7960.7
2014	12	14	22	-6	-5.7	0	82.6	0	1.26	244.7	0.27	7963.3
2014	12	14	23	-6.2	-5.7	0	83.7	0	1.16	257.3	0.44	7963.3
2014	12	14	24	-8.8	-8	0	90.4	0	2.03	237	0.79	7967.3
2014	12	15	1	-10.8	-9.9	0	90.1	0	2.43	229.7	0.9	7968.7
2014	12	15	2	-11.2	-10.4	0	92.2	0	2.2	232.9	0.79	7970
2014	12	15	3	-11.7	-10.6	0	91.4	0	2.24	237	1.04	7970
2014	12	15	4	-12.2	-11	0	92.9	0	1.92	234.3	1.25	7970
2014	12	15	5	-12.1	-10.9	0.1	86.2	0	1.42	238.6	1.18	7971.3

2014	12	15	6	-12.2	-10.4	0	89	0	1.52	237.3	1.8	7970
2014	12	15	7	-12.4	-10.4	0	87.1	0	1.65	243.5	1.95	7966
2014	12	15	8	-12.8	-11.1	0	93.4	0	2.25	241.3	1.63	7963.3
2014	12	15	9	-13	-10.8	0.2	86.3	0	1.92	243.7	2.26	7964.7
2014	12	15	10	-12.8	-10.9	9.2	96.1	0	1.97	248.4	1.84	7966
2014	12	15	11	-11.9	-10.5	44.5	92.7	0	1.63	244.7	1.37	7971.3
2014	12	15	12	-10	-9	194.5	79.9	0	1.7	224.1	1.03	7975.3
2014	12	15	13	-7.1	-7.2	344.7	77	0	3.35	175.4	-0.11	7970
2014	12	15	14	-5.8	-5.8	400.8	63.2	0	1.4	184	-0.04	7963.3
2014	12	15	15	-3.9	-4	385.5	56.5	0	1.19	152.8	-0.1	7955.3
2014	12	15	16	-3.2	-3.2	296.4	64.5	0	2.9	188.2	-0.02	7948.7
2014	12	15	17	-4.1	-3.6	157.1	73.3	0	2.44	204.2	0.45	7944.7
2014	12	15	18	-6.4	-5.5	27	76.5	0	2.48	236	0.88	7943.3
2014	12	15	19	-8.9	-7.5	0.6	80.8	0	2.04	246.2	1.36	7942
2014	12	15	20	-9.4	-8.3	0	83.7	0	2.09	248.7	1.14	7942
2014	12	15	21	-9.6	-8	0.1	82.4	0	1.84	246.1	1.57	7939.3
2014	12	15	22	-7.1	-6.4	0	80.2	0	2.58	246.9	0.76	7936.7
2014	12	15	23	-5.5	-4.7	0	66.5	0	2.04	245.5	0.83	7932.7
2014	12	15	24	-4.7	-4.5	0.1	79.2	0	1.6	209.1	0.15	7932.7
2014	12	16	1	-5.5	-5.6	0.1	93.1	0	1.42	233.2	-0.06	7934
2014	12	16	2	-6.2	-6.1	0.1	86.7	0	2.08	237.1	0.09	7932.7
2014	12	16	3	-5.2	-5.1	0.1	79.9	0	1.38	256.2	0.09	7927.3
2014	12	16	4	-4.4	-4.4	0.1	72.5	0	1.95	262.6	-0.03	7922
2014	12	16	5	-4.6	-4.5	0.1	73.2	0	1.04	216.3	0.07	7922
2014	12	16	6	-4.4	-4.3	0.1	77.2	0	0.88	265.5	0.08	7916.7
2014	12	16	7	-4.4	-4.4	0.1	74.2	0	1.12	270.2	0.06	7914
2014	12	16	8	-4.5	-4.3	0.1	84.5	0	1.06	256.4	0.19	7915.4
2014	12	16	9	-5.6	-5.2	0.1	84.1	0	1.55	240.8	0.44	7912.7
2014	12	16	10	-5.5	-5.2	8.8	82.1	0	1.09	248.2	0.24	7914
2014	12	16	11	-4.4	-4.1	58.3	74.9	0	1.43	229.7	0.31	7914
2014	12	16	12	-3.1	-3.2	102.3	70.8	0	1.56	222.5	-0.08	7915.4
2014	12	16	13	-2	-2.2	88.8	70.6	0	2.69	240.7	-0.11	7915.4
2014	12	16	14	-1.9	-2	94.2	70.5	0	0.94	98.4	-0.09	7911.4
2014	12	16	15	-1.4	-1.5	61.6	78.9	0	1.95	193.9	-0.09	7908.7
2014	12	16	16	-2.2	-2.1	53.3	82.3	0	1.83	69	0.11	7906
2014	12	16	17	-1.3	-1.5	32.5	79.5	0	2.12	246.6	-0.12	7904.7
2014	12	16	18	-2	-2	19.1	88.4	0	1.01	66.4	-0.03	7908.7
2014	12	16	19	-2.1	-2.1	0.6	86.4	0	0.62	62.2	0.01	7912.7
2014	12	16	20	-2.1	-2	0.1	84.1	0	1.32	232.4	0.04	7914
2014	12	16	21	-2	-1.9	0.1	75.7	0	0.96	221.4	0.01	7916.7
2014	12	16	22	-2.2	-2.1	0.1	83	0	0.81	313	0.16	7916.7
2014	12	16	23	-2.9	-2.9	0.1	90.2	0	0.66	208.4	0.01	7919.4
2014	12	16	24	-3.1	-3	0	90.8	0	0.68	348	0.14	7920.7
2014	12	17	1	-3.5	-3.3	0.1	85.9	0	0.95	242.1	0.16	7919.4
2014	12	17	2	-3.7	-3.6	0.1	87.1	0	0.61	240.2	0.1	7920.7
2014	12	17	3	-4.1	-4	0.1	85.7	0	0.92	234.5	0.15	7919.4
2014	12	17	4	-4.2	-4.1	0	89.6	0	0.94	238.9	0.16	7916.7
2014	12	17	5	-3.9	-3.5	0.1	83.7	0	0.69	269	0.45	7920.7
2014	12	17	6	-4.6	-4.1	0.1	85.4	0	0.9	253.2	0.43	7919.4
2014	12	17	7	-4.5	-4.2	0	89	0	1.33	253.6	0.32	7916.7
2014	12	17	8	-4.6	-4.2	0.1	87	0	1.19	242.8	0.43	7916.7
2014	12	17	9	-5.1	-4.9	0.1	83.9	0	1.7	258.4	0.14	7919.4
2014	12	17	10	-4.9	-4.5	14.4	89.7	0	1.31	251.2	0.37	7922
2014	12	17	11	-4.2	-3.8	72.5	82.3	0	1.09	236	0.38	7922
2014	12	17	12	-2.7	-2.5	136.9	67.4	0	0.48	241.3	0.17	7924.7
2014	12	17	13	-1.1	-1.2	226.4	64.1	0	0.91	209.5	-0.11	7926
2014	12	17	14	-0.5	-0.6	170.1	59.8	0	1.72	194.3	-0.13	7920.7
2014	12	17	15	-0.2	-0.3	159.2	58.3	0	1.79	188	-0.12	7919.4
2014	12	17	16	-0.1	-0.2	184.9	65.8	0	2.55	200.6	-0.1	7915.4
2014	12	17	17	-0.4	-0.5	111.1	66.9	0	2.06	207.7	-0.04	7914
2014	12	17	18	-1	-0.9	32.3	69.8	0	1.64	222.7	0.08	7916.7

2014	12	17	19	-1.9	-1.8	0.9	75	0	1.25	228.1	0.08	7922
2014	12	17	20	-2.2	-2	0.1	75.5	0	1.13	231.9	0.2	7927.3
2014	12	17	21	-1.9	-1.8	0.1	77.2	0	0.5	239.6	0.12	7930
2014	12	17	22	-3.2	-2.9	0	80.2	0	1.45	245.1	0.28	7930
2014	12	17	23	-4.1	-3.9	0.1	81.8	0	1.57	234.9	0.22	7932.7
2014	12	17	24	-3.8	-3.5	0.1	82.2	0	1.43	241.7	0.29	7934
2014	12	18	1	-3.1	-2.8	0	78.1	0	0.93	248.9	0.34	7935.3
2014	12	18	2	-2.9	-2.6	0	84.2	0	0.61	248.9	0.31	7935.3
2014	12	18	3	-3.4	-3.2	0.1	89.5	0	0.55	244.9	0.14	7932.7
2014	12	18	4	-3.5	-3.5	0.1	94	0	0.71	66.3	0.05	7935.3
2014	12	18	5	-3.4	-3.1	0	89.2	0	0.94	297.8	0.35	7936.7
2014	12	18	6	-2.7	-2.4	0	84.4	0	0.55	301.3	0.25	7939.3
2014	12	18	7	-2.4	-2.2	0	78.5	0	0.95	261.6	0.16	7940.7
2014	12	18	8	-2.1	-2	0	81	0	0.91	250.7	0.06	7939.3
2014	12	18	9	-2.2	-2.1	0.1	84.3	0	0.63	264.1	0.1	7940.7
2014	12	18	10	-1.8	-1.7	5.6	77.3	0	0.92	16.1	0.1	7943.3
2014	12	18	11	-1.1	-1.2	51.3	71.6	0	3.43	238.2	-0.06	7943.3
2014	12	18	12	-0.5	-0.6	123.6	69.6	0	5.57	246.8	-0.1	7946
2014	12	18	13	-0.4	-0.5	137.7	73.3	0	6.04	242.1	-0.11	7947.3
2014	12	18	14	-0.5	-0.6	159.4	74.5	0	6.07	236.5	-0.1	7947.3
2014	12	18	15	-0.6	-0.7	123.1	86.7	0	4.01	240.9	-0.1	7943.3
2014	12	18	16	-1.4	-1.5	68.3	92.5	9999	1.36	255	-0.09	7943.3
2014	12	18	17	-0.9	-1	41.5	80.1	9999	2.32	230	-0.08	7943.3
2014	12	18	18	-1	-1.1	11	84.1	0	2.74	210.1	-0.11	7944.7
2014	12	18	19	-1.3	-1.4	0.2	86.3	0	1.47	229.4	-0.08	7946
2014	12	18	20	-1.3	-1.4	0.1	85.5	0	1.61	250.5	-0.07	7947.3
2014	12	18	21	-1.2	-1.2	0.1	84.2	0	1.43	228.2	-0.07	7948.7
2014	12	18	22	-1.1	-1.2	0	82.1	0	2.68	204	-0.1	7950
2014	12	18	23	-0.9	-1	0.1	80.6	0	2.88	226.6	-0.1	7950
2014	12	18	24	-0.7	-0.8	0.1	81.8	0	3.92	220	-0.1	7950
2014	12	19	1	-0.8	-0.9	0.1	82.8	0	2.95	224.6	-0.11	7952.7
2014	12	19	2	-0.7	-0.8	0	81.6	0	3.26	237.9	-0.11	7952.7
2014	12	19	3	-0.9	-0.9	0	82.3	0	2.4	262.4	-0.07	7951.3
2014	12	19	4	-0.6	-0.6	0	83.6	0	3.18	238.3	-0.09	7947.3
2014	12	19	5	-1.5	-1.5	0	95.5	0	1.12	248.7	-0.02	7947.3
2014	12	19	6	-2	-2	0.1	97.7	0	0.64	250.8	0.04	7947.3
2014	12	19	7	-2.3	-2.3	0	97.3	0	0.7	51.9	-0.01	7944.7
2014	12	19	8	-2.3	-2.3	0.1	97.5	0	0.8	252.7	0.07	7940.7
2014	12	19	9	-1.6	-1.5	0.1	85.1	0	0.83	227.5	0.12	7939.3
2014	12	19	10	-1.2	-1	3.9	86.3	0	0.85	50.7	0.13	7936.7
2014	12	19	11	-0.5	-0.5	50.8	81.6	0	1.39	57.7	-0.04	7934
2014	12	19	12	0.3	0.2	109	82	0	2.06	180.1	-0.08	7930
2014	12	19	13	-0.7	-0.7	84.7	80	0.01	2.44	107.4	-0.02	7930
2014	12	19	14	-0.4	-0.5	87.5	84.5	0	4.99	237.8	-0.1	7928.7
2014	12	19	15	-0.7	-0.8	81.7	89.6	0.01	2.73	235.1	-0.1	7927.3
2014	12	19	16	-1	-1.1	75.1	89.6	0	1.01	257.1	-0.09	7924.7
2014	12	19	17	-0.5	-0.5	58.9	78.3	0.01	2.16	250.9	-0.04	7926
2014	12	19	18	-0.3	-0.3	19.5	76.1	0	4.35	241.7	-0.02	7930
2014	12	19	19	-0.7	-0.7	0.5	80.1	0	3.97	243.3	-0.03	7932.7
2014	12	19	20	-1.3	-1.2	0	78.2	0	1.4	249.1	0.05	7936.7
2014	12	19	21	-2	-1.9	0	86.2	0	0.79	251.6	0.12	7938
2014	12	19	22	-2.2	-2	0.1	84.9	0	1.05	115.2	0.18	7943.3
2014	12	19	23	-3.1	-3.1	0	98.1	0	1.2	80	0.04	7944.7
2014	12	19	24	-3.1	-3.1	0	96.8	0	0.7	31.1	0.02	7946
2014	12	20	1	-3.3	-3.3	0	97.1	0	0.56	28	0.02	7948.7
2014	12	20	2	-3.1	-3	0	81	0	1.1	240.7	0.12	7946
2014	12	20	3	-2	-2	0	83.2	0	1.71	240.8	0.08	7940.7
2014	12	20	4	-2	-2	0	77.1	0	3.11	213	0	7938
2014	12	20	5	-2	-2.1	0.1	78.6	0	1.76	201.9	-0.06	7939.3
2014	12	20	6	-2	-2.1	0.1	77.1	0	3.6	211.2	-0.05	7935.3
2014	12	20	7	-2.2	-2.2	0.1	79.7	0	2.66	212.1	-0.02	7930

2014	12	20	8	-2.6	-2.6	0	85.3	0	1.57	121.2	-0.04	7924.7
2014	12	20	9	-2.9	-3	0.1	94	0	0.96	64	-0.07	7923.4
2014	12	20	10	-3.3	-3.2	5.6	92.7	0	0.73	314.2	0.07	7920.7
2014	12	20	11	-2.6	-2.6	41.6	85	0	1.03	36.3	0.09	7919.4
2014	12	20	12	-1.6	-1.6	87.4	82.2	0	1.29	78.4	-0.04	7919.4
2014	12	20	13	-0.3	-0.4	115.3	76.4	0.01	3.51	199.6	-0.07	7918
2014	12	20	14	0.1	-0.1	214.4	76.6	0.01	5.82	226.4	-0.11	7912.7
2014	12	20	15	0.1	0	134	83	0.01	3.56	226.8	-0.12	7906
2014	12	20	16	0.2	0.1	89.2	78.7	0.01	3.8	227.3	-0.1	7903.4
2014	12	20	17	0.2	0.1	56.9	82.8	0	3.73	228.5	-0.08	7903.4
2014	12	20	18	-0.1	-0.1	13.1	83.1	0	3.45	227.7	-0.08	7902
2014	12	20	19	-0.4	-0.4	0.3	85.8	0	2.44	215.3	-0.07	7895.4
2014	12	20	20	-0.5	-0.6	0.1	85.2	0	3.2	229.4	-0.07	7895.4
2014	12	20	21	-0.3	-0.3	0.1	85.5	0	5.77	231.6	-0.08	7890
2014	12	20	22	-0.3	-0.4	0	86	0	4.53	229.3	-0.08	7887.4
2014	12	20	23	-0.9	-1	0.1	91.7	0	2.52	231.7	-0.1	7886
2014	12	20	24	-1	-1.1	0.1	93.6	0.01	2.15	232.6	-0.1	7884.7
2014	12	21	1	-1	-1.1	0	95.4	0.01	2.55	231.5	-0.1	7879.4
2014	12	21	2	-1.3	-1.3	0	95.2	0.04	0.85	25.3	-0.09	7880.7
2014	12	21	3	-1	-1	0	98	0.03	1.03	250.9	-0.08	7874
2014	12	21	4	-0.4	-0.5	0.1	96.6	0.03	1.15	248.6	-0.05	7868.7
2014	12	21	5	0	-0.1	0	97.3	0.03	1.14	265	-0.08	7868.7
2014	12	21	6	0.3	0.2	0.1	99	0.03	1.02	99.2	-0.07	7860.7
2014	12	21	7	0.9	0.9	0.1	95.6	0.03	1.46	46.3	-0.01	7855.4
2014	12	21	8	1.2	1.2	0.1	98.1	0.02	1.31	45.8	-0.03	7852.7
2014	12	21	9	0.7	0.7	0	97.2	0.03	2.24	52.8	0.03	7860.7
2014	12	21	10	0.6	0.6	0.4	99.1	0.03	3.26	45.6	-0.02	7870
2014	12	21	11	0.6	0.6	2.5	91	0.01	1.89	93.5	-0.03	7875.4
2014	12	21	12	0.7	0.7	6.2	95.1	0.01	1.15	113.5	-0.06	7891.4
2014	12	21	13	0.3	0.3	10.7	82.9	0.03	9999	9999	-0.07	7899.4
2014	12	21	14	0.2	0.2	12	87.9	0.02	9999	9999	-0.02	7902
2014	12	21	15	-0.3	-0.3	11	87.6	0.01	9999	9999	-0.02	7903.4
2014	12	21	16	-0.8	-0.9	11.2	88.1	0.01	9999	9999	-0.04	7906
2014	12	21	17	-1.1	-1.2	11.2	87.3	0.01	9999	9999	-0.06	7906
2014	12	21	18	-1.1	-1.1	2.9	93.3	0.01	9999	9999	-0.04	7916.7
2014	12	21	19	-1.4	-1.4	0.1	84.3	0	9999	9999	0.05	7923.4
2014	12	21	20	-1.7	-1.6	0.1	84.2	0	9999	9999	0.11	7926
2014	12	21	21	-1.6	-1.5	0	81	0	9999	9999	0.03	7931.3
2014	12	21	22	-1.5	-1.3	0	76.4	0	9999	9999	0.12	7934
2014	12	21	23	-1.6	-1.6	0	85.8	0	9999	9999	0.06	7934
2014	12	21	24	-1.8	-1.8	0	83.2	0	9999	9999	0.03	7931.3
2014	12	22	1	-2	-1.9	0	88	0	9999	9999	0.1	7936.7
2014	12	22	2	-2.3	-2.2	0	89.3	0	9999	9999	0.04	7932.7
2014	12	22	3	-2.4	-2.5	0	96.8	0.01	9999	9999	-0.1	7927.3
2014	12	22	4	-2.5	-2.5	0	96.7	0.02	9999	9999	-0.08	7926
2014	12	22	5	-2.5	-2.5	0	96	0.02	9999	9999	-0.06	7932.7
2014	12	22	6	-2.5	-2.6	0	86.5	0.01	9999	9999	-0.08	7934
2014	12	22	7	-3	-3.1	0	91	0.01	9999	9999	-0.09	7938
2014	12	22	8	-3.9	-4	0	94.9	0.01	9999	9999	-0.05	7938
2014	12	22	9	-4.5	-4.6	0.1	96.8	0	9999	9999	-0.1	7939.3
2014	12	22	10	-4.6	-4.7	1.4	97.1	0.02	9999	9999	-0.08	7942
2014	12	22	11	-4.3	-4.3	10.7	89.8	0.01	9999	9999	-0.05	7939.3
2014	12	22	12	-3.2	-3.3	27.9	81.2	0.03	9999	9999	-0.08	7950
2014	12	22	13	-3	-3.1	33.5	79.5	0.02	9999	9999	-0.08	7954
2014	12	22	14	-3.7	-3.8	46.9	86.7	0.07	9999	9999	-0.13	7962
2014	12	22	15	-3.8	-3.9	51.9	67.8	0.02	9999	9999	-0.08	7964.7
2014	12	22	16	-4	-3.9	46.8	68.6	0.01	9999	9999	0.07	7971.3
2014	12	22	17	-4.2	-4.2	22.4	84.2	0	9999	9999	0.01	7971.3
2014	12	22	18	-4.9	-5	3.6	89.9	0	2.08	102.4	-0.03	7979.3
2014	12	22	19	-4.9	-4.9	0.3	69.2	0	1.64	247.4	0.07	7988.7
2014	12	22	20	-6	-5.6	0.1	78.5	0	1	304.6	0.48	7995.3

2014	12	22	21	-8.7	-8	0	84.4	0	1.37	258.3	0.68	7995.3
2014	12	22	22	-11	-10.3	0	93.6	0	1.38	246.1	0.68	8008.7
2014	12	22	23	-12.2	-11.6	0	90.1	0	1.57	240.6	0.63	8012.7
2014	12	22	24	-13.3	-12.3	0	88.1	0	1.68	244.3	1.02	8016.7
2014	12	23	1	-13.5	-12.5	0	86.4	0	1.56	239.1	1	8022
2014	12	23	2	-14.2	-13.1	0	92.7	0	1.67	238.9	1.1	8027.3
2014	12	23	3	-14.2	-13	0	93.8	0	1.45	242.4	1.18	8024.7
2014	12	23	4	-14.3	-13.2	0	92.1	0	1.29	241.1	1.1	8026
2014	12	23	5	-14.8	-13.6	0	90.9	0	1.66	237.9	1.16	8030
2014	12	23	6	-14.3	-13.4	0	92.9	0	1.34	236.3	0.95	8028.7
2014	12	23	7	-14.6	-13.6	0	89.5	0	1.58	237.3	0.99	8028.7
2014	12	23	8	-14.6	-13.6	0	90.1	0	1.17	241.9	1.01	8026
2014	12	23	9	-14.6	-13.6	0.1	89.8	0	1.29	235.8	1.06	8030
2014	12	23	10	-12.9	-12	4.6	87	0	1.1	237.5	0.89	8028.7
2014	12	23	11	-11.9	-11.2	13.1	91.6	0	0.91	235.3	0.67	8032.7
2014	12	23	12	-10.2	-9.7	49.7	72	0	1	237.7	0.57	8036.7
2014	12	23	13	-8.2	-8.1	65.6	54.3	0	0.43	60.3	0.1	8038
2014	12	23	14	-6.3	-6.3	236.1	46	0.01	0.36	85	0.02	8032.7
2014	12	23	15	-4.9	-4.9	252	53.7	0.03	0.27	92.2	-0.09	8028.7
2014	12	23	16	-4.1	-4.1	182.8	57.8	0.02	0.1	255.9	-0.06	8022
2014	12	23	17	-3.7	-3.7	104.4	64.4	0.01	9999	9999	-0.06	8016.7
2014	12	23	18	-3.8	-3.8	26.9	68.5	0	9999	9999	0.03	8012.7
2014	12	23	19	-4.9	-4.7	0.8	88.8	0	9999	9999	0.28	8008.7
2014	12	23	20	-5.2	-5	0.1	88.6	0	9999	9999	0.21	8006
2014	12	23	21	-5.1	-5.1	0	89.9	0	9999	9999	0.09	8003.3
2014	12	23	22	-4.9	-4.9	0	91.2	0	9999	9999	0	8004.7
2014	12	23	23	-4.8	-4.8	0	90.9	0	9999	9999	-0.05	7995.3
2014	12	23	24	-4.8	-4.9	0	94	0	9999	9999	-0.12	7988.7
2014	12	24	1	-4.9	-5	0	93.9	0	9999	9999	-0.13	7980.7
2014	12	24	2	-4.9	-5	0	96.1	0	9999	9999	-0.1	7967.3
2014	12	24	3	-3.3	-2.9	0	83.6	0	0.04	209.1	0.36	7960.7
2014	12	24	4	0.1	0.1	0	78.7	0	4.66	244.3	-0.02	7950
2014	12	24	5	0	0	0	79.9	0	2.28	242.3	0.02	7944.7
2014	12	24	6	0	0.1	0	82.9	0	1.49	260.9	0.13	7935.3
2014	12	24	7	-2.9	-2.6	0.1	95.8	0	1.5	65.6	0.31	7915.4
2014	12	24	8	-2.5	-2	0	95.6	0	0.9	42.9	0.59	7907.4
2014	12	24	9	-1.8	-1.2	0.1	84.6	0	1.41	348	0.51	7896.7
2014	12	24	10	0.3	0.6	8.4	76.3	0	3.53	240.5	0.32	7884.7
2014	12	24	11	1.3	1.2	30.5	75.4	0	5.03	224.5	-0.05	7872.7
2014	12	24	12	0.4	0.3	38.3	92.3	0	4.76	240.3	-0.06	7867.4
2014	12	24	13	-1	-1.1	31.1	97.1	0	1.98	249.9	-0.09	7859.4
2014	12	24	14	-1	-1.1	38.2	96.9	0.02	1.32	243.5	-0.12	7840.7
2014	12	24	15	-1	-1.1	36.2	96.8	0.02	1.99	227.6	-0.1	7824.7
2014	12	24	16	-0.9	-1	32.6	92.2	0.02	0.78	152.7	-0.08	7810
2014	12	24	17	-1	-1.1	18.1	97.6	0.01	0.9	65.2	-0.09	7798
2014	12	24	18	-1.7	-1.7	4.8	99.7	0.01	0.8	93.8	-0.07	7788.7
2014	12	24	19	-1.7	-1.7	0.1	98.8	0.02	2.51	31.4	-0.01	7784.7
2014	12	24	20	-1.9	-2	0	97.6	0.04	3.21	64.7	-0.1	7783.4
2014	12	24	21	-3.2	-3.3	0	87.7	0.01	5.04	74.7	-0.09	7784.7
2014	12	24	22	-5.2	-5.3	0	86.5	0.01	5.24	73.5	-0.08	7798
2014	12	24	23	-6.1	-6.2	0.1	88.6	0	2.74	72.4	-0.11	7807.4
2014	12	24	24	-6.2	-6.3	0	89.6	0	2.72	78.7	-0.09	7808.7
2014	12	25	1	-6.4	-6.5	0	92	0	3.04	90.8	-0.08	7814
2014	12	25	2	-6.6	-6.7	0.1	94.8	0	3.07	89.8	-0.09	7818
2014	12	25	3	-6.7	-6.8	0	95.5	0	2.68	68.1	-0.09	7822
2014	12	25	4	-6.9	-6.9	0.1	95.7	0	3.59	72	-0.09	7824.7
2014	12	25	5	-6.8	-6.9	0	92.6	0	3.69	75.2	-0.07	7828.7
2014	12	25	6	-6.8	-6.9	0.1	92.4	0	2.79	99	-0.08	7834
2014	12	25	7	-6.9	-7	0.1	93.3	0	3.75	92.5	-0.07	7840.7
2014	12	25	8	-7.1	-7.2	0.1	92.2	0	3.79	78.6	-0.08	7848.7
2014	12	25	9	-7.2	-7.3	0.1	89.1	0	3.73	94	-0.09	7856.7

2014	12	25	10	-7.4	-7.4	5.7	86.6	0	3.44	100	0.03	7863.4
2014	12	25	11	-7.8	-7.8	50.1	85.4	0	2.96	85.8	-0.03	7872.7
2014	12	25	12	-7.7	-7.7	113.4	87.4	0	3.1	88.9	-0.08	7883.4
2014	12	25	13	-7.1	-7.2	138.9	78.5	0	3.46	90.9	-0.08	7891.4
2014	12	25	14	-6.7	-6.8	235.7	76.2	0.01	4.18	91	-0.09	7894
2014	12	25	15	-6.3	-6.4	398.2	60.7	0.03	3.88	84.9	-0.11	7896.7
2014	12	25	16	-6.2	-6.2	373.9	61.4	0.02	4.29	74.6	-0.04	7898
2014	12	25	17	-6.6	-6.6	201.6	67.1	0.01	4.51	75	0	7900.7
2014	12	25	18	-7.5	-7.5	32.2	69.6	0	3.8	59.1	0.01	7910
2014	12	25	19	-8.4	-8.4	1	83.6	0	1.14	104.4	0.02	7914
2014	12	25	20	-9.3	-9.2	0.1	88.5	0	0.51	98.4	0.05	7918
2014	12	25	21	-9.1	-9	0	86.4	0	1.3	60.8	0.04	7920.7
2014	12	25	22	-9	-9	0	85.4	0	0.84	263.1	0	7924.7
2014	12	25	23	-9.1	-9.1	0	87.6	0	0.65	3.6	0	7927.3
2014	12	25	24	-9.5	-9.4	0.1	90.9	0	1.15	240.5	0.06	7928.7
2014	12	26	1	-9.7	-9.6	0	90.5	0	0.61	38.8	0.06	7930
2014	12	26	2	-9.8	-9.8	0	91	0	0.81	252.1	0.08	7931.3
2014	12	26	3	-9.9	-9.8	0	93.1	0	0.76	67.7	0.09	7930
2014	12	26	4	-10	-9.9	0	92.3	0	0.71	273.1	0.05	7928.7
2014	12	26	5	-10	-10	0	92.7	0	0.34	1	0.02	7931.3
2014	12	26	6	-10.3	-10.1	0	92.2	0	0.98	301.7	0.2	7932.7
2014	12	26	7	-10.6	-10.4	0	89.4	0	0.74	232.1	0.18	7932.7
2014	12	26	8	-12.2	-11.9	0	91.3	0	1.56	239.7	0.32	7932.7
2014	12	26	9	-12.8	-12.4	0.1	88.9	0	0.86	248.5	0.44	7936.7
2014	12	26	10	-12.3	-11.9	3.2	87.9	0	0.67	243.9	0.34	7939.3
2014	12	26	11	-11.6	-11.4	40.3	88.1	0	0.94	240.2	0.21	7943.3
2014	12	26	12	-10.2	-10.1	114.7	71.2	0	0.55	218	0.1	7948.7
2014	12	26	13	-8.7	-8.8	177.2	78.8	0	1.35	56.4	-0.06	7951.3
2014	12	26	14	-8.3	-8.3	184	71.7	0	2.12	74.6	-0.05	7951.3
2014	12	26	15	-7.2	-7.4	334.9	66.9	0	1.78	158.7	-0.14	7952.7
2014	12	26	16	-7.3	-7.4	203.1	69	0	4.61	224.6	-0.07	7950
2014	12	26	17	-7.7	-7.8	156.3	69.7	0	3.29	235	-0.06	7956.7
2014	12	26	18	-8.5	-8.4	29.1	72.7	0	0.65	242.8	0.11	7962
2014	12	26	19	-8.9	-8.8	1.1	77.3	0	0.93	56.2	0.13	7967.3
2014	12	26	20	-10.7	-10.4	0.1	82.4	0	0.78	250.7	0.37	7968.7
2014	12	26	21	-11.6	-11.2	0.1	82.7	0	0.83	237.3	0.37	7972.7
2014	12	26	22	-12.1	-11.7	0.1	86.5	0	1.12	246.8	0.47	7976.7
2014	12	26	23	-12	-11.6	0	86.7	0	1.12	237.5	0.36	7978
2014	12	26	24	-12.4	-12	0.1	89	0	1.05	241.6	0.32	7980.7
2014	12	27	1	-13.7	-13.3	0	86.6	0	1.34	240	0.4	7986
2014	12	27	2	-13.8	-13.3	0	88.3	0	1.16	249.6	0.51	7986
2014	12	27	3	-13.2	-12.7	0	87.1	0	0.61	234.6	0.54	7984.7
2014	12	27	4	-12.9	-12.4	0	88.8	0	1.55	239.4	0.53	7983.3
2014	12	27	5	-15	-14.4	0	87.7	0	2.32	238.8	0.59	7987.3
2014	12	27	6	-16.5	-15.4	0	90.1	0	1.98	240.6	1.08	7988.7
2014	12	27	7	-15.6	-14.9	0	87	0	1.48	246.3	0.72	7987.3
2014	12	27	8	-15.6	-14.7	0	89.1	0	1.2	242.8	0.84	7986
2014	12	27	9	-14.5	-13.8	0.1	88.4	0	1.26	243.8	0.63	7984.7
2014	12	27	10	-14.7	-14	11.7	89.1	0	0.91	248	0.72	7983.3
2014	12	27	11	-13.9	-13.5	62.6	85.8	0	0.73	239.8	0.37	7986
2014	12	27	12	-12.4	-12.3	113	80.2	0	1.11	230.8	0.16	7982
2014	12	27	13	-10.9	-11	175.6	82.2	0	1.16	69.2	-0.11	7979.3
2014	12	27	14	-10	-10.1	170.6	86.8	0	0.93	66	-0.13	7975.3
2014	12	27	15	-9.1	-9.2	165.4	88.3	0	1.61	71.4	-0.13	7968.7
2014	12	27	16	-8.4	-8.5	95.5	92.1	0	1.3	76.3	-0.13	7963.3
2014	12	27	17	-8.2	-8.2	47.3	92.5	0	1	71.3	-0.06	7959.3
2014	12	27	18	-7.9	-7.9	9.3	92.3	0	0.53	231.2	-0.04	7956.7
2014	12	27	19	-7.8	-7.8	0.3	85.1	0	1.39	72.6	-0.05	7952.7
2014	12	27	20	-7.3	-7.4	0	79.5	0	2.62	225.3	-0.08	7948.7
2014	12	27	21	-6.8	-6.9	0	76.2	0	5.7	240.9	-0.09	7940.7
2014	12	27	22	-7.1	-7.2	0	77.4	0.01	5.93	239.4	-0.09	7938

2014	12	27	23	-7.2	-7.3	0	86.2	0	6.53	235.9	-0.08	7932.7
2014	12	27	24	-7.7	-7.8	0	91.9	0	2.92	255.1	-0.11	7930
2014	12	28	1	-8.2	-8.2	0	90	0	0.95	43.6	0.03	7926
2014	12	28	2	-7.4	-7.4	0	85.8	0	1.83	256.5	0	7918
2014	12	28	3	-7.2	-7.1	0.1	88.4	0	0.86	356.3	0.01	7914
2014	12	28	4	-6.9	-6.9	0	86	0	1.15	256.2	0.02	7912.7
2014	12	28	5	-7.4	-7.2	0	88.7	0	0.77	221.6	0.23	7914
2014	12	28	6	-7.4	-7.3	0	83.3	0	1.08	261.5	0.2	7912.7
2014	12	28	7	-7.9	-7.8	0	94.7	0	0.69	126.4	0.15	7908.7
2014	12	28	8	-8.1	-8.1	0	96	0	0.46	13.2	0.01	7908.7
2014	12	28	9	-9.2	-8.9	0.1	95.2	0	0.58	267.8	0.29	7911.4
2014	12	28	10	-10.1	-9.7	5.9	93.8	0	1.06	245.4	0.45	7912.7
2014	12	28	11	-9.8	-9.3	30	91	0	0.41	26.7	0.43	7915.4
2014	12	28	12	-8.8	-8.6	78	89.5	0	1.38	70.8	0.16	7918
2014	12	28	13	-7.8	-7.9	71.7	89.7	0.02	1.76	68.1	-0.05	7920.7
2014	12	28	14	-7	-7	85.9	83.8	0.02	1.82	67.9	-0.02	7920.7
2014	12	28	15	-6.4	-6.5	73.3	76	0.01	1.72	61.6	-0.04	7918
2014	12	28	16	-6.2	-6.2	98.2	64.5	0.01	0.82	61.4	-0.04	7916.7
2014	12	28	17	-6.3	-6.2	54.9	64.5	0.02	0.71	54.7	0.08	7916.7
2014	12	28	18	-7	-6.8	18.8	80.9	0	0.87	353.6	0.17	7918
2014	12	28	19	-7.6	-7.5	0.8	91.8	0	0.94	359.3	0.08	7919.4
2014	12	28	20	-9	-8.8	0	89.8	0	1.39	247.2	0.21	7923.4
2014	12	28	21	-9.3	-9.1	0	90	0	1.1	236	0.19	7923.4
2014	12	28	22	-9.9	-9.7	0	88.6	0	1.07	245.6	0.22	7924.7
2014	12	28	23	-10	-9.6	0	89.4	0	1	247.6	0.38	7926
2014	12	28	24	-11.1	-10.7	0	88.2	0	1.17	253.2	0.37	7927.3
2014	12	29	1	-13.1	-12.6	0	90	0	1.56	242.5	0.51	7928.7
2014	12	29	2	-13.9	-13.2	0	91	0	1.35	240.8	0.75	7928.7
2014	12	29	3	-13.3	-12.8	0.1	90.5	0	0.95	248.4	0.5	7927.3
2014	12	29	4	-13.5	-12.8	0	92.2	0	0.97	244.8	0.67	7926
2014	12	29	5	-14.7	-14	0	91.9	0	1.58	237.3	0.73	7930
2014	12	29	6	-14.7	-14	0.1	89.1	0	1.47	239.3	0.75	7928.7
2014	12	29	7	-13.7	-13	0	89.3	0	0.86	243.8	0.72	7928.7
2014	12	29	8	-13	-12.5	0.1	90.5	0	0.58	240.7	0.51	7927.3
2014	12	29	9	-12.6	-12.1	0.1	93.5	0	0.8	226.6	0.49	7928.7
2014	12	29	10	-12.3	-11.9	4.7	91.3	0	1.04	242.1	0.43	7931.3
2014	12	29	11	-11.9	-11.4	20.3	91	0	1.16	234.8	0.49	7934
2014	12	29	12	-10.7	-10.5	26.5	91.6	0	1.39	235.9	0.17	7939.3
2014	12	29	13	-10	-10	40.7	87.9	0	1.57	236	-0.08	7942
2014	12	29	14	-9.2	-9.3	86.9	80.6	0	1.11	211.9	-0.11	7940.7
2014	12	29	15	-8.5	-8.6	97.1	71.9	0.17	1.62	57.6	-0.12	7936.7
2014	12	29	16	-8.4	-8.4	49.6	70.9	0	2.78	66.1	-0.04	7935.3
2014	12	29	17	-8.8	-8.8	30.5	76.3	0	1.53	83.7	0.05	7938
2014	12	29	18	-9.6	-9.6	16.3	74.2	0	3.21	106.5	0.01	7943.3
2014	12	29	19	-10.4	-10.5	0.6	75.2	0	3.67	113.7	-0.07	7948.7
2014	12	29	20	-11.5	-11.5	0.1	76.4	0	3.21	110.2	0.01	7954
2014	12	29	21	-12.4	-12.4	0.1	78.9	0	1.3	36.7	0.04	7963.3
2014	12	29	22	-12.3	-12.4	0.1	76.1	0	2.49	101.8	-0.06	7971.3
2014	12	29	23	-12.6	-12.7	0.1	77.5	0	0.98	353.5	-0.09	7975.3
2014	12	29	24	-13.1	-13.2	0.1	79	0	1.1	36.2	-0.06	7980.7
2014	12	30	1	-13.6	-13.7	0.1	80.9	0	1.25	59.9	-0.06	7988.7
2014	12	30	2	-14	-14.1	0.1	80.8	0	2.18	169.2	-0.07	7991.3
2014	12	30	3	-14.9	-14.8	0.1	79.1	0	1.06	193.6	0.02	7995.3
2014	12	30	4	-15.6	-15.5	0	81.3	0	1.25	137.7	0.04	8002
2014	12	30	5	-16.7	-16.5	0	82.2	0	1.01	263.1	0.14	8010
2014	12	30	6	-18.8	-18.6	0	85.7	0	1.47	251.5	0.26	8014
2014	12	30	7	-21.2	-20.4	0.1	85.9	0	1.85	234	0.77	8018
2014	12	30	8	-22.6	-21.7	0	83.7	0	2.18	234.9	0.87	8020.7
2014	12	30	9	-23.5	-22.4	0.1	85.1	0	2.31	235.8	1.08	8024.7
2014	12	30	10	-23.9	-22.8	4.4	83.9	0	2.01	231.4	1.13	8028.7
2014	12	30	11	-23.7	-22.4	14.3	81.8	0	2	237.5	1.28	8034

2014	12	30	12	-22	-20.3	155.6	71.4	0	1.65	237.8	1.68	8038
2014	12	30	13	-18	-17.3	305.9	55.1	0	0.61	210.6	0.75	8039.3
2014	12	30	14	-15.2	-15.1	310.6	43.1	0	0.32	158.6	0.06	8036.7
2014	12	30	15	-13.3	-13.3	412.5	34.6	0	0.35	122.1	0.05	8031.3
2014	12	30	16	-13.7	-13.5	341.9	63.2	0	1.82	76.3	0.22	8028.7
2014	12	30	17	-14.3	-14.1	235.2	54.8	0	1.27	77.4	0.26	8028.7
2014	12	30	18	-16.9	-16.2	52.2	80.3	0	1.64	234.9	0.75	8034
2014	12	30	19	-19	-17.9	1.9	82.3	0	1.64	235.7	1.08	8039.3
2014	12	30	20	-20.3	-19	0.1	84.1	0	1.84	236.1	1.33	8043.3
2014	12	30	21	-20.5	-19.1	0	82.7	0	1.76	240.9	1.38	8043.3
2014	12	30	22	-20.5	-19	0	85.3	0	1.7	243.1	1.52	8040.7
2014	12	30	23	-20.3	-19	0	82.5	0	1.85	240.9	1.31	8043.3
2014	12	30	24	-20	-18.6	0	84.9	0	1.5	236.5	1.37	8040.7
2014	12	31	1	-19.7	-18.6	0	81.7	0	1.08	242.4	1.04	8042
2014	12	31	2	-19.9	-18.7	0	85.3	0	0.7	243.8	1.17	8040.7
2014	12	31	3	-19	-18.1	0	79.2	0	0.93	231.9	0.95	8038
2014	12	31	4	-18.5	-17.7	0	81.7	0	0.62	263.4	0.8	8034
2014	12	31	5	-18	-17.4	0	81.1	0	1.06	248.4	0.65	8032.7
2014	12	31	6	-17	-16.5	0	82.4	0	0.51	227.3	0.44	8028.7
2014	12	31	7	-17.4	-16.7	0.1	87.2	0	1	238.7	0.73	8027.3
2014	12	31	8	-17	-16.3	0	86.8	0	1.23	208.7	0.72	8018
2014	12	31	9	-17.6	-16.6	0.1	89.6	0	0.81	75.5	0.93	8016.7
2014	12	31	10	-17.9	-17.1	9.6	87.8	0	0.41	240.7	0.73	8020.7
2014	12	31	11	-17.1	-16.2	68	82.4	0	0.81	252.5	0.91	8020.7
2014	12	31	12	-15.8	-15.5	207.2	59.9	0	0.6	90.5	0.3	8019.3
2014	12	31	13	-13.3	-12.9	373.9	56	0	0.35	115.2	0.4	8015.3
2014	12	31	14	-11.5	-11.5	413.7	53.4	0	1.42	77.1	-0.04	8010
2014	12	31	15	-9.3	-9.3	405.5	38.7	0	0.45	157.4	0.05	8002
2014	12	31	16	-8.9	-8.7	337.9	65.5	0	1.96	80.2	0.18	7995.3
2014	12	31	17	-9.8	-9.6	228.8	61.2	0	1.25	73.8	0.18	7992.7
2014	12	31	18	-11	-10.5	53.6	78.5	0	0.92	231	0.57	7994
2014	12	31	19	-12.6	-11.6	2	86	0	1.45	234.1	1	7996.7
2014	12	31	20	-13.3	-12.2	0	87.7	0	1.02	232.9	1.07	7995.3
2014	12	31	21	-13.9	-12.8	0	90	0	1.13	245.1	1.03	7996.7
2014	12	31	22	-14.2	-13	0	88.5	0	0.96	247	1.25	7994
2014	12	31	23	-14.8	-13.3	0	89.5	0	1.26	237.4	1.5	7992.7
2014	12	31	24	-14.1	-13.3	0	90.5	0	1.15	225.7	0.85	7987.3

To: Kevin Schilling[Kevin.Schilling@deq.idaho.gov]
From: McAlpine, Jerrold[McAlpine.Jay@epa.gov]
Sent: Fri 3/27/2020 10:29:25 AM (UTC-06:00)
Subject: RE: Excluding roadways from consideration as ambient air.

Kevin,

I apologize, I missed this email earlier this week. My understanding is the road is likely exempt from ambient air protections because it is fully under the control and surveillance of the source and unsupervised public access is precluded. It seems like a slam dunk, based on my understanding of EPA's revised ambient air policy. This is my opinion based on interpretation of the policy, though … I cannot provide an approval.

If Idaho concludes the decision still falls with a 'gray area,' a formal request to the EPA can be provided and I can assist with getting the request to the ambient air review team (a part of the headquarters OAQPS air policy group).

Feel free to give me a call if you have questions or with to discuss more,
Jay

Jay McAlpine, PhD
Meteorologist -- Regional Modeling Contact
206.553.0094
Division of Air and Radiation, Air Permits and Toxics Branch
U.S. Environmental Protection Agency, Region 10, Seattle, WA

From: Kevin.Schilling@deq.idaho.gov <Kevin.Schilling@deq.idaho.gov>
Sent: Monday, March 23, 2020 1:55 PM
To: McAlpine, Jerrold <McAlpine.Jay@epa.gov>
Subject: Excluding roadways from consideration as ambient air.

Hi Jay,

I hope things are going as smoothly as possible with you these days.

What are your thoughts on excluding a roadway that bisects a permitted facility from consideration as ambient air? During a NACCA call discussion on the recent changes in ambient air policy, there seemed to be some flexibility in how roadways could be considered. The case I'm most interested in involves a roadway that the permittee can legally control access, and access through the facility would not be a necessity for people (not needed to access homes, work, essential resources, etc - it would be used primarily to access a recreational area). My thoughts were that the area could be excluded from ambient air by considering those using the roadway as guests of the industry. This would be accomplished by: 1) vehicles using the road would be escorted by the company through the area; 2) people wishing to use the road would be informed that they are considered as a guest of the facility while traveling through the area; 3) vehicles using the road would not be allowed to stop; 4) the facility would restrict use of the road during periods when high-emitting activities were performed that would likely cause high impacts to the roadway.

Thank you for any thoughts, suggestions, etc.

Best Regards,

Kevin

Kevin Schilling | Air Quality Dispersion Modeling Supervisor
Idaho Department of Environmental Quality
1410 North Hilton
Boise, Idaho 83706
Office: (208) 373-0112
http://www.deq.idaho.gov/

Our mission is to protect human health and the quality of Idaho's air, land, and water.

To: Goessel, Kathryn M -FS[kathryn.goessel@usda.gov]; 'Mebane, Ann - FS'[ann.mebane@usda.gov]
Cc: Morrie Lewis[Morrie.Lewis@deq.idaho.gov]; Pao Baylon[Pao.Baylon@deq.idaho.gov]; Michael Simon[Michael.Simon@deq.idaho.gov]; Aaron Scheff[Aaron.Scheff@deq.idaho.gov]
From: Kevin Schilling[/O=DEQ/OU=FIRST ADMINISTRATIVE GROUP/CN=RECIPIENTS/CN=KSCHILLI]
Sent: Tue 3/31/2020 2:57:35 PM (UTC-06:00)
Subject: RE: SGP - ambient air determination?

Piper,

In New Source Review (NSR) permitting, the permit application must demonstrate that emissions from the project do not cause a NAAQS violation to areas considered as "Ambient Air." Idaho Air Rules Section 006 defines ambient air as "that portion of the atmosphere, external to buildings, to which the general public has access." Public roadways with unrestricted access that bisect industrial facilities have typically been considered as ambient air for all NAAQS, including long-term averaging period NAAQS. Although most of these areas are technically considered as ambient air, DEQ's primary concern for attaining a high confidence of NAAQS compliance is for areas outside of the site perimeter boundary. This is because the potential for ongoing exposure is considerably less on roadways bisecting facilities.

If a roadway is part of the land owned or leased by the permitted facility, then the exclusion from ambient air is more straight forward. Where the permittee has legal authority to control access, the governing question becomes who is considered as "general public." For example, guests of a facility are not considered as the "general public." The roadway bisecting the Stibnite Gold Project mine site is under the control of Midas Gold Idaho, Inc. (Midas) and is not a public roadway.

Midas has proposed allowing controlled roadway access through the Stibnite Gold Project site while still excluding the roadway from consideration as ambient air. The following will be considered/implemented to exclude the roadway from ambient air:

1) Midas has complete control over access to the roadway.
2) Access to the roadway through the site will be actively controlled using a manned gate.
3) Those requesting to travel through the area are considered as invitees of Midas rather than members of the general public.
4) DEQ will require Midas to prepare a Roadway Access Control Plan that will outline procedures to control access through the site on the roadway, assuring that those entering are considered facility guests rather than members of the general public. The Roadway Access Control Plan will be submitted to DEQ for comment and approval.

The final details of how public access through the site will be addressed is still in development and will be specified in the issued Permit to Construct and the Roadway Access Control Plan.

Please contact me if you have any questions regarding this ambient air consideration,

Best Regards,

Kevin

Kevin Schilling | Air Quality Dispersion Modeling Supervisor
Idaho Department of Environmental Quality
1410 North Hilton
Boise, Idaho 83706
Office: (208) 373-0112
http://www.deq.idaho.gov/

Our mission is to protect human health and the quality of Idaho's air, land, and water.

From: Aaron Scheff
Sent: Thursday, March 12, 2020 3:27 PM
To: Michael Simon; Morrie Lewis; Kevin Schilling
Cc: Goessel, Kathryn M -FS
Subject: FW: SGP - ambient air determination?

Gentlemen,
This looks like an inquiry better answered from your group. Thank you

Sent from my Verizon, Samsung Galaxy smartphone

-------- Original message --------
From: "Goessel, Kathryn M -FS" <kathryn.goessel@usda.gov>
Date: 3/12/20 2:33 PM (GMT-07:00)
To: Aaron Scheff <Aaron.Scheff@deq.idaho.gov>
Cc: "Mebane, Ann - FS" <ann.mebane@usda.gov>, "Goessel, Kathryn M -FS" <kathryn.goessel@usda.gov>
Subject: SGP - ambient air determination?

Hi Aaron – wondering if DEQ had finalized a call on whether the State would consider public traffic through active operational areas, as contemplated in DEIS Alternatives 2 and 4, to subject the mine site to NAAQS? If the call is public access within the mine site would not constitute ambient air, would that be unconditioned? Or would an exemption from NAAQS be dependent on any particular management of such public use (e.g. private vehicles being escorted through, etc.)? If DEQ has made any such determination, is there documentation that you could share? Thanks!

Piper Goessel
Physical Scientist

Forest Service
Payette National Forest

p: 208-634-0760
f: 208-634-0744
kathryn.goessel@usda.gov

500 N Mission St, Bldg 2
McCall, ID 83638
www.fs.fed.us

Caring for the land and serving people

This electronic message contains information generated by the USDA solely for the intended recipients. Any unauthorized interception of this message or the use or disclosure of the information it contains may violate the law and subject the violator to civil or criminal penalties. If you believe you have received this message in error, please notify the sender and delete the email immediately.

AIR SCIENCES INC.

DENVER • PORTLAND • LOS ANGELES

Stibnite Gold Project Permit to Construct Application

PREPARED FOR:
MIDAS GOLD IDAHO, INC.

PROJECT NO. 335-1
JUNE 23, 2020

PRI00000160

REC 1500

TABLE OF CONTENTS

1.0 Application Forms/Checklist....1
1.1 Form CSPTC – Cover Sheet for Air Permit Application – Permit to Construct....1
1.2 Form GI – Facility Information....3
1.3 Form EU0 – Emissions Units – General (57 forms)....5
1.4 Form EU1 – Emission Units Industrial IC Engine Information (4 forms)....65
1.5 Form EU2– Emissions Units Nonmetallic Mineral Processing Plant....70
1.6 Form EU5 – Emissions Units Industrial Boiler Information (15 forms)....73
1.7 Form CA – Carbon Adsorber (4 forms)....89
1.8 Form BCE – Baghouses Control Equipment (14 forms)....98
1.9 Form SCE – Scrubbers Control Equipment (3 forms)....113
1.10 Forms EI – Emissions Inventory....117
1.11 PP – Plot Plan....125
1.12 Forms MI1-MI4 – Modeling – Excel workbook, 4 sheets....130
1.13 Form FRA – Federal Regulation Applicability....140
2.0 Process Description....215
3.0 Process Flow Diagram....216
4.0 Regulatory Analysis....217
4.1 Rules for the Control of Air Pollution in Idaho....217
58.01.01 - RULES FOR THE CONTROL OF AIR POLLUTION IN IDAHO....217
123. CERTIFICATION OF DOCUMENTS.....217
157. TEST METHODS AND PROCEDURES.....217
200. PROCEDURES AND REQUIREMENTS FOR PERMITS TO CONSTRUCT. [200 THROUGH 228]....217
201. PERMIT TO CONSTRUCT REQUIRED.....217
202. APPLICATION PROCEDURES.....217
202.01.a.ii. Schedule for Construction....218
203. PERMIT REQUIREMENTS FOR NEW AND MODIFIED STATIONARY SOURCES.....218
209. PROCEDURE FOR ISSUING PERMITS.....218
210. DEMONSTRATION OF PRECONSTRUCTION COMPLIANCE WITH TOXIC STANDARDS....218
210.20. NSPS and NESHAP Sources....218

PRI00000161

REC 1501

211. CONDITIONS FOR PERMITS TO CONSTRUCT. 219
212. OBLIGATION TO COMPLY. 219
215. MERCURY EMISSION STANDARD FOR NEW OR MODIFIED SOURCES. 219
224. PERMIT TO CONSTRUCT APPLICATION FEE. 219
225. PERMIT TO CONSTRUCT PROCESSING FEE. 219
226. PAYMENT OF FEES FOR PERMITS TO CONSTRUCT. 220
300. PROCEDURES AND REQUIREMENTS FOR TIER I OPERATING PERMITS. [300 through 399] 220
301. REQUIREMENT TO OBTAIN TIER I OPERATING PERMIT. 220
313. TIMELY APPLICATION. 220
400. PROCEDURES AND REQUIREMENTS FOR TIER II OPERATING PERMITS. [400 through 410] 221
401. TIER II OPERATING PERMIT. 221
575. AIR QUALITY STANDARDS AND AREA CLASSIFICATION. [575 THROUGH 587] 221
576. GENERAL PROVISIONS FOR AMBIENT AIR QUALITY STANDARDS. 221
578. DESIGNATION OF ATTAINMENT, UNCLASSIFIABLE, AND NONATTAINMENT AREAS. 221
581. PREVENTION OF SIGNIFICANT DETERIORATION (PSD) INCREMENTS. 221
585. TOXIC AIR POLLUTANTS NON-CARCINOGENIC INCREMENTS. 221
586. TOXIC AIR POLLUTANTS CARCINOGENIC INCREMENTS. 221
590. NEW SOURCE PERFORMANCE STANDARDS. 222
591. NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLUTANTS. 222
625. VISIBLE EMISSIONS. 222
650. RULES FOR CONTROL OF FUGITIVE DUST. 222
675. FUEL BURNING EQUIPMENT -- PARTICULATE MATTER. [675 through 681] 223
676. STANDARDS FOR NEW SOURCES. 223
677. STANDARDS FOR MINOR AND EXISTING SOURCES. 223
700. PARTICULATE MATTER -- PROCESS WEIGHT LIMITATIONS. [700 through 703] 225
701. PARTICULATE MATTER -- NEW EQUIPMENT PROCESS WEIGHT LIMITATIONS. 225
725. RULES FOR SULFUR CONTENT OF FUELS. 225
790. RULES FOR THE CONTROL OF NONMETALLIC MINERAL PROCESSING PLANTS. [790 through 799] 225
791. GENERAL CONTROL REQUIREMENTS. 225

PRI00000162

REC 1502

792. EMISSIONS STANDARDS FOR NONMETALLIC MINERAL PROCESSING PLANTS SUBJECT TO 40 CFR 60, SUBPART OOO. 225
4.2 Applicable Federal Regulations 226
4.2.1 NSPS, Subpart LL – Standards of Performance for Metallic Mineral Processing Plants 226
4.2.2 NSPS, Subpart OOO – Standards of Performance for Nonmetallic Mineral Processing Plants 227
4.2.3 NSPS, Subpart IIII – Standards of Performance for Stationary Compression Ignition Internal Combustion Engines 228
4.2.4 NESHAP, Subpart ZZZZ – National Emissions Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines 229
4.2.5 NESHAP, Subpart CCCCCC – National Emission Standards for Hazardous Air Pollutants for Source Category: Gasoline Dispensing Facilities 229
4.2.6 NESHAP, Subpart EEEEEEE – National Emission Standards for Hazardous Air Pollutants: Gold Mine Ore Processing and Production Area Source Category 229
4.3 Inapplicable Federal Regulations 230
4.3.1 NSPS, Subpart Dc – Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units 230
4.3.2 NSPS, Subpart HH - Standards of Performance for Lime Manufacturing Plants 231
4.3.3 NSPS, Subpart OOO - Standards of Performance for Nonmetallic Mineral Processing Plants 231
4.3.4 NESHAP, Subpart AAAAA (5A) – National Emission Standards for Hazardous Air Pollutants for Lime Manufacturing Plants 232
4.3.5 40 CFR Part 70 – Title V Permitting Program 232
5.0 Ambient Impact Assessment 234

Tables

Table 1. General Emission Units 5
Table 2. Industrial IC Engines 65
Table 3. Nonmetallic Mineral Processing Plant Emission Units – Fugitive Emissions Only 70
Table 4. Industrial Boiler Emission Units 73
Table 5. Sources Controlled by a Carbon Adsorber 89
Table 6. Sources Controlled by a Baghouse 98
Table 7. Sources Controlled by a Wet Scrubber 113
Table 8. Facility-Wide Potential to Emit for NSR Regulated Pollutants 118

PRI00000163

REC 1503

Table 9. Facility-Wide HAP Potential to Emit Emissions Summary 120
Table 10. Non-Carcinogenic TAP Emissions Summary Potential to Emit 121
Table 11. Carcinogenic TAP Emissions Summary Potential to Emit 122
Table 12. Ambient Impact Assessment Emission Inventory - Proposed Emissions 123
Table 13. Applicable Federal Regulations 140
Table 14. SGP Regulated Pollutant Emissions Total 220
Table 15. SGP Fuel Burning Equipment PM Standards 223
Table 16. NSPS, Subpart LL Sources 226
Table 17. NSPS, Subpart OOO Sources 227
Table 18. NSPS, Subpart IIII Sources 228
Table 19. NESHAP, Subpart 6C Sources 229
Table 20. NESHAP, Subpart 7E Sources 230
Table 21. Sources Not Subject to NSPS, Subpart OOO 232

Figures

Figure 1. SGP Mining Operation and Stibnite Road Access Route 126
Figure 2. SGP Process & Refining Area Buildings and Emission Points 127
Figure 3. SGP Administration, Warehouse & Storage Area Buildings and Emission Points 128
Figure 4. SGP Worker Housing Facility Buildings and Emission Points 129

Attachments

Attachment A – Ambient Impact Assessment: Stibnite Gold Project Air Quality Modeling Report

PRI00000164

REC 1504

1.0 APPLICATION FORMS/CHECKLIST

1.1 Form CSPTC – Cover Sheet for Air Permit Application – Permit to Construct

The Idaho Department of Environmental Quality (IDEQ) air quality program application forms are provided here for the Permit to Construct (PTC) application for the Midas Gold Idaho, Inc. (Midas Gold) Stibnite Gold Project (SGP). This cover sheet provides a summary of the forms included with this application.

PRI00000165

REC 1505

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Cover Sheet for Air Permit Application – Permit to Construct **Form CSPTC**

Please see instructions on page 2 before filling out the form.

COMPANY NAME, FACILITY NAME, AND FACILITY ID NUMBER

1. Company Name	Midas Gold Idaho, Inc.		
2. Facility Name	Stibnite Gold Project	3. Facility ID No.	
4. Brief Project Description - One sentence or less	Conventional open-pit mining and ore preparation and gold extraction processes.		

PERMIT APPLICATION TYPE

5. ☒ New Source ☐ New Source at Existing Facility ☐ PTC for a Tier I Source Processed Pursuant to IDAPA 58.01.01.209.05.c
☐ Unpermitted Existing Source ☐ Facility Emissions Cap ☐ Modify Existing Source: Permit No.:_____ Date Issued:_____
☐ Required by Enforcement Action: Case No.:_____

6. ☒ Minor PTC ☐ Major PTC

FORMS INCLUDED

Included	N/A	Forms		DEQ Verify
☒	☐	Form CSPTC – Cover Sheet		☐
☒	☐	Form GI – Facility Information		☐
☒	☐	Form EU0 – Emissions Units General	Please specify number of EU0s attached: 57	☐
☒	☐	Form EU1– Industrial Engine Information	Please specify number of EU1s attached: 4	☐
☒	☐	Form EU2– Nonmetallic Mineral Processing Plants	Please specify number of EU2s attached: 1	☐
☐	☒	Form EU3– Spray Paint Booth Information	Please specify number of EU3s attached: 0	☐
☐	☒	Form EU4– Cooling Tower Information	Please specify number of EU4s attached: 0	☐
☒	☐	Form EU5 – Boiler Information	Please specify number of EU5s attached: 15	☐
☐	☒	Form CBP– Concrete Batch Plant	Please specify number of CBPs attached: 0	☐
☐	☒	Form HMAP – Hot Mix Asphalt Plant	Please specify number of HMAPs attached: 0	☐
☐	☒	PERF – Portable Equipment Relocation Form		☐
☐	☒	Form AO – Afterburner/Oxidizer		☐
☒	☐	Form CA – Carbon Adsorber	Please specify number of CAs attached: 4	☐
☐	☒	Form CYS – Cyclone Separator		☐
☐	☒	Form ESP – Electrostatic Precipitator		☐
☒	☐	Form BCE– Baghouses Control Equipment	Please specify number of BCEs attached: 14	☐
☒	☐	Form SCE– Scrubbers Control Equipment	Please specify number of SCEs attached: 3	☐
☐	☒	Form VSCE – Venturi Scrubber Control Equipment		☐
☐	☒	Form CAM – Compliance Assurance Monitoring		☐
☒	☐	Forms EI-– Emissions Inventory		☐
☒	☐	PP – Plot Plan		☐
☒	☐	Forms MI1 – MI4 – Modeling	(Excel workbook, all 4 worksheets)	☐
☒	☐	Form FRA – Federal Regulation Applicability		☐

1.2 Form GI – Facility Information

The general facility and permit information is provided on the form GI. This form also includes the certification of truth, accuracy, and completeness signed by a responsible official, in accordance with IDAPA 58.01.01.123 and 124.

PRI00000167

REC 1507

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Please see instructions on second page before filling out the form.

FACILITY AND PERMIT INFORMATION

1. Facility Name:	2. Facility ID Number:
Stibnite Gold Project	

3. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

4. Facility Contact Name:	5. Facility Contact Title:
Alan Haslam	Vice President – Permitting
6. Facility Contact Telephone Number:	**7. Facility Contact Email:**
208-901-3053	ahaslam@midasgoldinc.com
8. Mailing address where permit will be sent (street/city/state/zip code):	**9. Physical address of facility (if different than mailing address) (street/city/state/zip code):**
405 South 8th Street, Suite 201 Boise, ID 83702	Intersection of FS Road NF-374 and NF-412 Stibnite, ID 83611

10. County Facility is located	Valley	
11. Is the equipment portable?	☒ No ☐ Yes	
12. NAICS codes	Primary NAICS: 212221 – Gold Ore Mining Or 21222 – Gold Ore and Silber Ore Mining	Secondary NAICS (if applicable): 327410 - Lime Manufacturing
13. Brief business description and principal product produced:	Redevelopment of portions of the Stibnite Mining District. The Stibnite Gold Project consists of cleaning up legacy impacts, restore the salmon fishery, and the building, operating and proper closure of a new mine. The estimated mineral resources at the project are gold and antimony.	
14. Describe any contiguous or adjacent facility this company owns or operates:	N/A	
15. Permit Application Type. Provide Permit Number for existing permit. For a PTC, an application fee is required.	☒ Initial Permit to Construct (PTC) ☐ PTC Modification	PTC No. _____ Issued Date _____
	☐ Initial Tier II ☐ Tier II Modification ☐ Tier II Renewal	Tier II No. _____ Issued Date _____
	☐ Initial Tier I ☐ Tier I Administrative Amendment ☐ Tier I Minor Modification ☐ Tier I Significant Modification ☐ Tier I Renewal	Tier I No. _____ Issued Date _____

16. **For Tier I permitted facilities only:** If you are applying for a PTC then you must specify how the PTC will be incorporated into the Tier I permit.	☐ Incorporate PTC at the time of Tier I renewal (IDAPA 58.01.01.209.05.a) ☐ Co-process PTC with Tier I Modification (IDAPA 58.01.01.209.05.b) ☐ Administrative amend the Tier I to incorporate PTC upon applicant's request (IDAPA 58.01.01.209.05.c)

17. ☒ Check here to request facility draft permit before final issuance.

Certification of Truth, Accuracy, and Completeness (by Responsible Official)
I hereby certify that based on information and belief formed after reasonable inquiry, the statements and information contained in this and any attached and/or referenced document(s) are true, accurate, and complete in accordance with IDAPA 58.01.01.123 124.

	Vice President - Permitting	
Responsible Official Signature	*Responsible Official Title*	*Date*
Alan Haslam		
Print or Type Responsible Official Name		

1.3 Form EU0 – Emissions Units – General (57 forms)

Table 1 provides a list of the general emission units. Emissions data for each unit can be found in the detailed emission inventory in the "Stibnite Gold Project Air Quality Modeling Report," Attachment A of this application. Supporting documentation can be found on the digital media provided with this application.

Table 1. General Emission Units

Form #	Source ID	Description	Control	Process Rate
1	OC1	Loader Transfer of Ore to Grizzly	Water Sprays	25,000 ton/day, Ore
2	OC2	Grizzly to Apron Feeder	Moisture Carry-Over	25,000 ton/day, Ore
3	OC3	Apron Feeder to Dribble Conveyor	Moisture Carry-Over	25,000 ton/day, Ore
4	OC4	Apron Feeder to Vibrating Grizzly	Moisture Carry-Over	25,000 ton/day, Ore
5	OC5	Dribble Conveyor to Vibrating Grizzly	Moisture Carry-Over	25,000 ton/day, Ore
6	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	Moisture Carry-Over	25,000 ton/day, Ore
7	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	Water Sprays	25,000 ton/day, Ore
8	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	Moisture Carry-Over	25,000 ton/day, Ore
9	OC9	Stockpile Transfers to Reclaim Conveyors	Underground	27,600 ton/day, Ore
10	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	Underground	27,600 ton/day, Ore
11	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	Enclosure	27,600 ton/day, Ore
12	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	Water Sprays	27,600 ton/day, Ore
13	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	Moisture Carry-Over	27,600 ton/day, Ore
14	LS1L	Mill Lime Silo #1 Loading	Bin Vent Filter	250 ton/day, 4,375 ton/yr, Lime
15	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	None	250 ton/day, 4,375 ton/yr, Lime
16	MillS2L	Mill Lime Silo #2 Loading	Bin Vent Filter	250 ton/day, 4,375 ton/yr, Lime
17	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	None	250 ton/day, 4,375 ton/yr, Lime
18	Sb2	Sb Bagging	Baghouse (BH1)	4.5 ton/hr, Stib. Conc.
19	AC	Autoclave	Wet Scrubber (WS1)	290 ton/hr, Float Conc.
20	ACS1L	AC Lime Silo #1 Loading	Bin Vent Filter	1,000 ton/day, 17,500 ton/yr, Lime

PRI00000169

REC 1509

Form #	Source ID	Description	Control	Process Rate
21	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	None	17,500 ton/yr, Lime
22	ACS2L	AC Lime Silo #2 Loading	Bin Vent Filter	1,000 ton/day, 17,500 ton/yr, Lime
23	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	None	17,500 ton/yr, Lime
24	ACS3L	AC Lime Silo #3 Loading	Bin Vent Filter	1,000 ton/day, 17,500 ton/yr, Lime
25	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	None	1,7500 ton/yr, Lime
26	ACS4L	AC Lime Silo #4 Loading	Bin Vent Filter	500 ton/day, 8,750 ton/yr, Lime
27	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	None	8,750 ton/yr, Lime
28	CKD	Carbon Regeneration Kiln (Drum)	Wet Scrubber (WS2) / Carbon Filter (CA1)	0.3 ton/hr, Carbon
29	EW	Electrowinning Cells & Pregnant Solution Tank	Shared Carbon Filter (CA2)	100 gpm, Au Conc.
30	MR	Mercury Retort	Condenser / Carbon Filter (CA3)	0.5 ton/batch, 21 ton/yr, Au Conc.
31	MF	Induction Melting Furnace	Baghouse (BH2) / Carbon Filter (CA4)	0.5 ton/batch, 21 ton/yr, Au Conc.
32	PSL	Prill Silos Loading (2 x 100 ton)	None	7,300 ton/yr, combined, Prill
33	PSU	Prill Silos Unloading (2 x 100 ton)	None	7,300 ton/yr, combined, Prill
34	CS1L	Cement/Shotcrete Silo #1 Loading	Bin Vent Filter	80 ton/day, 60,000 ton/yr, Cement
35	CS1U	Cement/Shotcrete Silo #1 Unloading	None	80 ton/day, 60,000 ton/yr, Cement
36	CS2L	Cement/Shotcrete Silo #2 Loading	Bin Vent Filter	80 ton/day, 60,000 ton/yr, Cement
37	CS2U	Cement/Shotcrete Silo #2 Unloading	None	80 ton/day, 60,000 ton/yr, Cement
38	CAL	Aggregate Bin Loading	None	2,400 ton/day, 500,000 ton/yr, Aggregate
39	CAU	Aggregate Bin Unloading	None	2,400 ton/day, 500,000 ton/yr, Aggregate
40	CM	Central Mixer Loading	TBD*	2,480 ton/day, 560,000 ton/yr, Cement + Aggregate
41	TG1	Mine Site Gasoline Tank #1	None	250,000 gal/yr, Gasoline
42	TG2	Mine Site Gasoline Tank #2	None	250,000 gal/yr, Gasoline
43	TD3	Mine Site Diesel Tank #3	None	725,000 gal/yr, Diesel
44	TD4	Mine Site Diesel Tank #4	None	725,000 gal/yr, Diesel

PRI00000170

REC 1510

Form #	Source ID	Description	Control	Process Rate
45	TD5	Mine Site Diesel Tank #5	None	725,000 gal/yr, Diesel
46	TD6	Mine Site Diesel Tank #6	None	725,000 gal/yr, Diesel
47	TD7	Mine Site Diesel Tank #7	None	725,000 gal/yr, Diesel
48	TD8	Mine Site Diesel Tank #8	None	725,000 gal/yr, Diesel
49	TD9	Mine Site Diesel Tank #9	None	725,000 gal/yr, Diesel
50	TD10	Mine Site Diesel Tank #10	None	725,000 gal/yr, Diesel
51	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	Water Sprays/Moisture Carry-Over	2,000 ton/day, Aggregate
52	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	Water Sprays/Moisture Carry-Over	2,000 ton/day, Aggregate
53	LSBM	Limestone Ball Mill	Baghouse (BH3)	1,130 ton/day, Limestone
54	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	Baghouse (BH4)	169 ton/day, 52,377 ton/yr, Lime
55	LCR	Lime Mill Crushing and associated transfers In and Out	Baghouse (BH5)	169 ton/day, 52,377 ton/yr, Lime
56	LSL	Pebble Lime Silo Loading via Bucket Elevator	Bin Vent Filter	169 ton/day, 52,377 ton/yr, Lime
57	LSU	Pebble Lime Silo discharge to Lime Slaker	Wet Scrubber (WS3)	169 ton/day, 52,377 ton/yr, Lime

* Types of controls used may include water sprays, enclosures, hoods, curtains, shrouds, movable and telescoping chutes, central duct collection systems, and the like.

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	
4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.	

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	LOADER TRANSFER OF ORE TO GRIZZLY
6.	EU ID Number:	OC1
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	25,000 TON/DAY
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	Water Sprays		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	OC1		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	In EF	In EF				

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. Control efficiency included in emission factors, AP42, Tab. 11.19.2-2, conveyor transfer, controlled

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	25,000 TON/DAY, ORE
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	ORE PROCESSING DESIGN RATE

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	
4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.	

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	GRIZZLY TO APRON FEEDER
6.	EU ID Number:	OC2
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	25,000 TON/DAY
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	Moisture Carry-over		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	OC2		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	In EF	In EF				

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. Control efficiency included in emission factors, AP42, Tab. 11.19.2-2, conveyor transfer, controlled

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	25,000 TON/DAY, ORE
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	ORE PROCESSING DESIGN RATE

PRI00000173

REC 1513

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	APRON FEEDER TO DRIBBLE CONVEYOR
6.	EU ID Number:	OC3
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	25,000 TON/DAY
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	Moisture Carry-over		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	OC3		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	In EF	In EF				

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. Control efficiency included in emission factors, AP42, Tab. 11.19.2-2, conveyor transfer, controlled

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	25,000 TON/DAY, ORE
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	ORE PROCESSING DESIGN RATE

PRI00000174

REC 1514

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	
4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.	

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	APRON FEEDER TO VIBRATING GRIZZLY
6.	EU ID Number:	OC4
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	25,000 TON/DAY
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	Moisture Carry-over		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	OC4		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	In EF	In EF				

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. Control efficiency included in emission factors, AP42, Tab. 11.19.2-2, conveyor transfer, controlled

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	25,000 TON/DAY, ORE
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	ORE PROCESSING DESIGN RATE

PRI00000175

REC 1515

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	DRIBBLE CONVEYOR TO VIBRATING GRIZZLY
6.	EU ID Number:	OC5
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	25,000 TON/DAY
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	Moisture Carry-over		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	OC5		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	In EF	In EF				

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. Control efficiency included in emission factors, AP42, Tab. 11.19.2-2, conveyor transfer, controlled

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	25,000 TON/DAY, ORE
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	ORE PROCESSING DESIGN RATE

PRI00000176

REC 1516

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	VIBRATING GRIZZLY TO PRIMARY CRUSHER OR STOCKPILE
6.	EU ID Number:	OC6
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	25,000 TON/DAY
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	Moisture Carry-over		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	OC6		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	In EF	In EF				

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. Control efficiency included in emission factors, AP42, Tab. 11.19.2-2, conveyor transfer, controlled

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	25,000 TON/DAY, ORE
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	ORE PROCESSING DESIGN RATE

PRI00000177

REC 1517

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	PRIMARY CRUSHER AND ASSOCIATED TRANSFERS
6.	EU ID Number:	OC7
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	25,000 TON/DAY
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	Water Sprays		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	OC7		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	In EF	In EF				

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. Control efficiency included in emission factors, AP42, Tab. 11.19.2-2, tertiary crushing, controlled

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	25,000 TON/DAY, ORE
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	ORE PROCESSING DESIGN RATE

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	ORE STOCKPILE FEED CONVEYOR TRANSFER TO STOCKPILE
6.	EU ID Number:	OC8
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	25,000 TON/DAY
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	Moisture Carry-over		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	OC8		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	In EF	In EF				

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. Control efficiency included in emission factors, AP42, Tab. 11.19.2-2, conveyor transfer, controlled

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	25,000 TON/DAY, ORE
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	ORE PROCESSING DESIGN RATE

PRI00000179

REC 1519

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	
4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.	

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	STOCKPILE TRANSFERS TO RECLAIM CONVEYORS
6.	EU ID Number:	OC9
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	27,600 TON/DAY
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	Underground		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	OC9		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	80%	80%				

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. Control efficiency based on AP42, Chapter 13.2.4, reduction in EF due to wind speed

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	27,600 TON/DAY, ORE
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	RECLAIM CONVEYOR DESIGN RATE

PRI00000180

REC 1520

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	RECLAIM CONVEYORS TO SAG MILL FEED CONVEYOR
6.	EU ID Number:	OC10
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	27,600 TON/DAY
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	Underground		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	OC10		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	80%	80%				

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. Control efficiency based on AP42, Chapter 13.2.4, reduction in EF due to wind speed

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	27,600 TON/DAY, ORE
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	SAG MILL FEED CONVEYOR DESIGN RATE

PRI00000181

REC 1521

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	SAG MILL FEED CONVEYOR TRANSFER TO SAG MILL
6.	EU ID Number:	OC11
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	27,600 TON/DAY
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	ENCLOSURE		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	OC11		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	80%	80%				

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. Control efficiency based on AP42, Chapter 13.2.4, reduction in EF due to wind speed

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	27,600 TON/DAY, ORE
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	SAG MILL DESIGN RATE

PRI00000182

REC 1522

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	PEBBLE CRUSHER AND ASSOCIATED TRANSFERS
6.	EU ID Number:	OC12
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	27,600 TON/DAY
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	Water Sprays		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	OC12		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	In EF	In EF				

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. Control efficiency included in emission factors, AP42, Tab. 11.19.2-2, tertiary crushing, controlled

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	27,600 TON/DAY, ORE
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	PEBBLE CRUSHER DESIGN RATE

PRI00000183

REC 1523

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	
4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.	

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	PEBBLE DISCHARGE CONVEYOR TO SAG MILL CONVEYOR
6.	EU ID Number:	OC13
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	27,600 TON/DAY
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	Moisture Carry-over		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	OC13		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	In EF	In EF				

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. Control efficiency included in emission factors, AP42, Tab. 11.19.2-2, conveyor transfer, controlled

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	27,600 TON/DAY, ORE
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	PEBBLE CRUSHER DESIGN RATE

PRI00000184

REC 1524

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	
4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.	

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	MILL LIME SILO #1 LOADING
6.	EU ID Number:	LS1L
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	60 TON/HR
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	Bin Vent Filter		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	LS1L		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	In EF	In EF				

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. Control efficiency included in emission factors, AP42, Tab. 11.12-2, pneumatic loading, controlled

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	250 TON/DAY, 4,375 TON/YR, LIME
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BASED ON ORE PROCESSING DESIGN RATE

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	MILL LIME SILO #1 UNLOADING TO SAG MILL CONVEYOR
6.	EU ID Number:	LS1U
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	20 TON/HR
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☒ No ☐ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:			
15. Date of Installation:		16. Date of Modification (if any):	
17. Manufacturer and Model Number:			
18. ID(s) of Emission Unit Controlled:			
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☐ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☐ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency						

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency.

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	250 TON/DAY, 4,375 TON/YR, LIME
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BASED ON ORE PROCESSING DESIGN RATE

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	
4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.	

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	MILL LIME SILO #2 LOADING
6.	EU ID Number:	MILLS2L
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	60 TON/HR
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	Bin Vent Filter		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	MILLS2L		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	In EF	In EF				

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. Control efficiency included in emission factors, AP42, Tab. 11.12-2, pneumatic loading, controlled

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	250 TON/DAY, 4,375 TON/YR, LIME
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BASED ON ORE PROCESSING DESIGN RATE

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	MILL LIME SILO #2 UNLOADING TO SAG MILL CONVEYOR
6.	EU ID Number:	MILLS2U
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	20 TON/HR
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☒ No ☐ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:			
15. Date of Installation:		16. Date of Modification (if any):	
17. Manufacturer and Model Number:			
18. ID(s) of Emission Unit Controlled:			
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☐ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☐ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency						

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency.

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	250 TON/DAY, 4,375 TON/YR, LIME
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BASED ON ORE PROCESSING DESIGN RATE

PRI00000188

REC 1528

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	
4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.	

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	ANTIMONY (SB) BAGGING
6.	EU ID Number:	SB2
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	4.5 TON/HR
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	BAGHOUSE (BH1)		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	SB2		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	In EF	In EF				

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. Control efficiency included in emission factor

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☐ Yes ☒ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☐ Production Limit(s):	
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	AUTOCLAVE
6.	EU ID Number:	AC
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	290 TON/HR
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	WET SCRUBBER (WS1)		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	AC		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	In EF	In EF				

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. PM control efficiency included in emission factors

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☐ Yes ☒ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☐ Production Limit(s):	
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	
4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.	

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	AC LIME SILO #1 LOADING
6.	EU ID Number:	ACS1L
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	120 TON/HR
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	Bin Vent Filter		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	ACS1L		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	In EF	In EF				

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. Control efficiency included in emission factors, AP42, Tab. 11.12-2, pneumatic loading, controlled

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	1,000 TON/DAY, 17,500 TON/YR, LIME
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BASED ON ORE PROCESSING DESIGN RATE

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	AC SILO #1 UNLOADING TO LIME SLAKER
6.	EU ID Number:	ACS1U
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	20 TON/HR
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☒ No ☐ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:			
15. Date of Installation:		16. Date of Modification (if any):	
17. Manufacturer and Model Number:			
18. ID(s) of Emission Unit Controlled:			
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☐ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☐ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency						

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency.

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	17,500 TON/YR, LIME
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BASED ON ORE PROCESSING DESIGN RATE

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	
4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.	

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	AC LIME SILO #2 LOADING
6.	EU ID Number:	ACS2L
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	120 TON/HR
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	Bin Vent Filter		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	ACS2L		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	In EF	In EF				

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. Control efficiency included in emission factors, AP42, Tab. 11.12-2, pneumatic loading, controlled

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	1,000 TON/DAY, 17,500 TON/YR, LIME
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BASED ON ORE PROCESSING DESIGN RATE

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	AC SILO #2 UNLOADING TO LIME SLAKER
6.	EU ID Number:	ACS2U
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	20 TON/HR
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☒ No ☐ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:			
15. Date of Installation:		16. Date of Modification (if any):	
17. Manufacturer and Model Number:			
18. ID(s) of Emission Unit Controlled:			
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☐ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☐ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency						

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency.

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	17,500 TON/YR, LIME
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BASED ON ORE PROCESSING DESIGN RATE

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	
4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.	

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	AC LIME SILO #3 LOADING
6.	EU ID Number:	ACS3L
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	120 TON/HR
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	Bin Vent Filter		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	ACS3L		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	In EF	In EF				

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. Control efficiency included in emission factors, AP42, Tab. 11.12-2, pneumatic loading, controlled

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	1,000 TON/DAY, 17,500 TON/YR, LIME
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BASED ON ORE PROCESSING DESIGN RATE

PRI00000195

REC 1535

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	AC SILO #3 UNLOADING TO LIME SLAKER
6.	EU ID Number:	ACS3U
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	20 TON/HR
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☒ No ☐ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:			
15. Date of Installation:		16. Date of Modification (if any):	
17. Manufacturer and Model Number:			
18. ID(s) of Emission Unit Controlled:			
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☐ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☐ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency						

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency.

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	17,500 TON/YR, LIME
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BASED ON ORE PROCESSING DESIGN RATE

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	AC LIME SILO #4 LOADING
6.	EU ID Number:	ACS4L
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	120 TON/HR
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	Bin Vent Filter		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	ACS4L		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	In EF	In EF				

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. Control efficiency included in emission factors, AP42, Tab. 11.12-2, pneumatic loading, controlled

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	500 TON/DAY, 8,750 TON/YR, LIME
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BASED ON ORE PROCESSING DESIGN RATE

PRI00000197

REC 1537

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	AC SILO #4 UNLOADING TO LIME SLAKER
6.	EU ID Number:	ACS42U
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	20 TON/HR
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☒ No ☐ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:			
15. Date of Installation:		16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:			
18. ID(s) of Emission Unit Controlled:			
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☐ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☐ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency						

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency.

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	8,750 TON/YR, LIME
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BASED ON ORE PROCESSING DESIGN RATE

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	CARBON REGENERATION KILN (DRUM)
6.	EU ID Number:	CKD
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	0.3 TON/HR
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	WET SCRUBBER (WS2)/CARBON FILTER (CA1)		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	CKD		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	In EF	In EF				

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. PM control efficiency included in emission factor, Mercury control efficiency TBD.

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☐ Yes ☒ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☐ Production Limit(s):	
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	

PRI00000199

REC 1539

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	
4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.	

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	ELECTROWINNING CELLS & PREGNANT SOLUTION TANK
6.	EU ID Number:	EW
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	100 GALLON/MINUTE
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	SHARED CARBON FILTER (CA2)		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	EW		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	N/A	N/A	N/A	N/A	N/A	N/A

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. Mercury control efficiency TBD

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☐ Yes ☒ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☐ Production Limit(s):	
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	
4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.	

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	MERCURY RETORT
6.	EU ID Number:	MR
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	0.5 TON/BATCH
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	CONDENSER/CARBON FILTER (CA3)		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	MR		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	N/A	N/A	N/A	N/A	N/A	N/A

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. Mercury control efficiency TBD

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	24 HRS/DAY, 1,248 HR/YR
23.	Maximum Operation:	24 HRS/DAY, 1,248 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☒ Operation Hour Limit(s):	1,248 HR/YR
	☐ Production Limit(s):	
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	52 BATCHES PER YEAR

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	
4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.	

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	INDUCTION MELTING FURNACE
6.	EU ID Number:	MF
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	0.5 TON/BATCH
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	BAGHOUSE (BH2)/CARBON FILTER (CA4)		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	MF		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	In EF	In EF	N/A	N/A	N/A	N/A

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. PM control efficiency included in emission factor. Mercury control efficiency TBD.

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	12 HR/DAY, 624 HR/YR
23.	Maximum Operation:	12 HR/DAY, 624 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☒ Operation Hour Limit(s):	624 HR/YR
	☐ Production Limit(s):	
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	52 BATCHES PER YEAR

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	PRILL SILOS LOADING (2 X 100 TON)
6.	EU ID Number:	PSL
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	100 TON/HR, EACH
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☒ No ☐ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:			
15. Date of Installation:		16. Date of Modification (if any):	
17. Manufacturer and Model Number:			
18. ID(s) of Emission Unit Controlled:			
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☐ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☐ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency						

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency.

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	7,300 TON/YR, TOTAL, PRILL
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BASED ON ORE MINING DESIGN RATE

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	PRILL SILOS UNLOADING (2 X 100 TON)
6.	EU ID Number:	PSU
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	100 TON/HR, EACH
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☒ No ☐ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:			
15. Date of Installation:		16. Date of Modification (if any):	
17. Manufacturer and Model Number:			
18. ID(s) of Emission Unit Controlled:			
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☐ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☐ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency						

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency.

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	7,300 TON/YR, TOTAL, PRILL
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BASED ON ORE MINING DESIGN RATE

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	CEMENT/SHOTCRETE SILO #1 LOADING
6.	EU ID Number:	CS1L
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	80 TON/HR
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	Bin Vent Filter		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	CS1L		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	In EF	In EF				

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. Control efficiency included in emission factors, AP42, Tab. 11.12-2, pneumatic loading, controled

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	80 TON/DAY, 60,000 TON/YR, CEMENT
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BATCH PLANT DESIGN RATE

PRI00000205

REC 1545

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	CEMENT/SHOTCRETE SILO #1 UNLOADING
6.	EU ID Number:	CS1U
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	20 TON/HR
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☒ No ☐ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:			
15. Date of Installation:		16. Date of Modification (if any):	
17. Manufacturer and Model Number:			
18. ID(s) of Emission Unit Controlled:			
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☐ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☐ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency						

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency.

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	80 TON/DAY, 60,000 TON/YR, CEMENT
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BATCH PLANT DESIGN RATE

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	CEMENT/SHOTCRETE SILO #2 LOADING
6.	EU ID Number:	CS2L
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	80 TON/HR
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	Bin Vent Filter		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	CS2L		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	In EF	In EF				

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. Control efficiency included in emission factors, AP42, Tab. 11.12-2, pneumatic loading, controlled

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	80 TON/DAY, 60,000 TON/YR, CEMENT
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BATCH PLANT DESIGN RATE

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	CEMENT/SHOTCRETE SILO #2 UNLOADING
6.	EU ID Number:	CS2U
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	20 TON/HR
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☒ No ☐ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:			
15. Date of Installation:		16. Date of Modification (if any):	
17. Manufacturer and Model Number:			
18. ID(s) of Emission Unit Controlled:			
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☐ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☐ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency						

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency.

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	80 TON/DAY, 60,000 TON/YR, CEMENT
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BATCH PLANT DESIGN RATE

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	
4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.	

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	AGGREGATE BIN LOADING
6.	EU ID Number:	CAL
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	100 TON/HR
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☒ No ☐ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:			
15. Date of Installation:		16. Date of Modification (if any):	
17. Manufacturer and Model Number:			
18. ID(s) of Emission Unit Controlled:			
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☐ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☐ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency						

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency.

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	2,400 TON/DAY, 500,000 TON/YR, AGGREGATE
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BATCH PLANT DESIGN RATE

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	AGGREGATE BIN UNLOADING
6.	EU ID Number:	CAU
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	100 TON/HR
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☒ No ☐ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:			
15. Date of Installation:		16. Date of Modification (if any):	
17. Manufacturer and Model Number:			
18. ID(s) of Emission Unit Controlled:			
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☐ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☐ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency						

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency.

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	2,400 TON/DAY, 500,000 TON/YR, AGGREGATE
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BATCH PLANT DESIGN RATE

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	CENTRAL MIXER LOADING
6.	EU ID Number:	CM
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	(20 CEMENT + 100 AGGREGATE) 120 TON/HR
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	TBD		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	CM		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	In EF	In EF				

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. Control efficiency included in emission factors, AP42, Tab. 11.12-2, central mixer, controlled

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	2,480 TON/DAY, 560,000 TON/YR, CEMENT + AGG
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BATCH PLANT DESIGN RATE

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	MINE SITE GASOLINE TANK #1
6.	EU ID Number:	TG1
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	5,000 GALLONS
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☒ No ☐ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:			
15. Date of Installation:		16. Date of Modification (if any):	
17. Manufacturer and Model Number:			
18. ID(s) of Emission Unit Controlled:			
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☐ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☐ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency						

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency.

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☐ Production Limit(s):	
	☒ Material Usage Limit(s):	250,000 GAL/YR, GASOLINE
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BASED ON MINE PLAN

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	MINE SITE GASOLINE TANK #2
6.	EU ID Number:	TG2
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	5,000 GALLONS
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☒ No ☐ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:			
15. Date of Installation:		16. Date of Modification (if any):	
17. Manufacturer and Model Number:			
18. ID(s) of Emission Unit Controlled:			
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☐ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☐ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency						

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency.

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☐ Production Limit(s):	
	☒ Material Usage Limit(s):	250,000 GAL/YR, GASOLINE
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BASED ON MINE PLAN

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	
4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.	

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	MINE SITE DIESEL TANK #3
6.	EU ID Number:	TD3
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	25,000 GALLONS
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☒ No ☐ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:			
15. Date of Installation:		16. Date of Modification (if any):	
17. Manufacturer and Model Number:			
18. ID(s) of Emission Unit Controlled:			
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☐ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☐ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency						

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency.

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☐ Production Limit(s):	
	☒ Material Usage Limit(s):	725,000 GAL/YR, DIESEL
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BASED ON MINE PLAN

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	
4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.	

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	MINE SITE DIESEL TANK #4
6.	EU ID Number:	TD4
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	25,000 GALLONS
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☒ No ☐ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:			
15. Date of Installation:		16. Date of Modification (if any):	
17. Manufacturer and Model Number:			
18. ID(s) of Emission Unit Controlled:			
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☐ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☐ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency						

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency.

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☐ Production Limit(s):	
	☒ Material Usage Limit(s):	725,000 GAL/YR, DIESEL
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BASED ON MINE PLAN

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	MINE SITE DIESEL TANK #5
6.	EU ID Number:	TD5
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	25,000 GALLONS
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☒ No ☐ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:			
15. Date of Installation:		16. Date of Modification (if any):	
17. Manufacturer and Model Number:			
18. ID(s) of Emission Unit Controlled:			
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☐ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☐ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency						

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency.

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☐ Production Limit(s):	
	☒ Material Usage Limit(s):	725,000 GAL/YR, DIESEL
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BASED ON MINE PLAN

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	MINE SITE DIESEL TANK #6
6.	EU ID Number:	TD6
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	25,000 GALLONS
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☒ No ☐ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:			
15. Date of Installation:		16. Date of Modification (if any):	
17. Manufacturer and Model Number:			
18. ID(s) of Emission Unit Controlled:			
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☐ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☐ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency						

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency.

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☐ Production Limit(s):	
	☒ Material Usage Limit(s):	725,000 GAL/YR, DIESEL
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BASED ON MINE PLAN

PRI00000217

REC 1557

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	MINE SITE DIESEL TANK #7
6.	EU ID Number:	TD7
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	25,000 GALLONS
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☒ No ☐ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:			
15. Date of Installation:		16. Date of Modification (if any):	
17. Manufacturer and Model Number:			
18. ID(s) of Emission Unit Controlled:			
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☐ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☐ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency						

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency.

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☐ Production Limit(s):	
	☒ Material Usage Limit(s):	725,000 GAL/YR, DIESEL
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BASED ON MINE PLAN

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	MINE SITE DIESEL TANK #8
6.	EU ID Number:	TD8
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	25,000 GALLONS
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☒ No ☐ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:			
15. Date of Installation:		16. Date of Modification (if any):	
17. Manufacturer and Model Number:			
18. ID(s) of Emission Unit Controlled:			
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☐ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☐ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency						

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency.

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☐ Production Limit(s):	
	☒ Material Usage Limit(s):	725,000 GAL/YR, DIESEL
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BASED ON MINE PLAN

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	
4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.	

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	MINE SITE DIESEL TANK #9
6.	EU ID Number:	TD9
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	25,000 GALLONS
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☒ No ☐ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:			
15. Date of Installation:		16. Date of Modification (if any):	
17. Manufacturer and Model Number:			
18. ID(s) of Emission Unit Controlled:			
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☐ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☐ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency						

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency.

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☐ Production Limit(s):	
	☒ Material Usage Limit(s):	725,000 GAL/YR, DIESEL
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BASED ON MINE PLAN

PRI00000220

REC 1560

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	MINE SITE DIESEL TANK #10
6.	EU ID Number:	TD10
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	25,000 GALLONS
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☒ No ☐ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:			
15. Date of Installation:		16. Date of Modification (if any):	
17. Manufacturer and Model Number:			
18. ID(s) of Emission Unit Controlled:			
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☐ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☐ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency						

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency.

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☐ Production Limit(s):	
	☒ Material Usage Limit(s):	725,000 GAL/YR, DIESEL
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BASED ON MINE PLAN

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	
4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.	

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	PORTABLE CRUSHING & SCREENING PLANT 1
6.	EU ID Number:	PCSP1
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	2,000 TON/DAY
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	Water Sprays & Moisture Carry-Over		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	PCSP1		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	In EF	In EF				

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. Control efficiency included in emission factors, AP42, Tab. 11.19.2-2, controlled

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	2,000 TON/DAY, AGGREGATE
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	DESIGN RATE

PRI00000222

REC 1562

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	PORTABLE CRUSHING & SCREENING PLANT 2
6.	EU ID Number:	PCSP2
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	2,000 TON/DAY
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	Water Sprays & Moisture Carry-Over		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	PCSP2		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	In EF	In EF				

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. Control efficiency included in emission factors, AP42, Tab. 11.19.2-2, controlled

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	2,000 TON/DAY, AGGREGATE
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	DESIGN RATE

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	LIMESTONE BALL MILL
6.	EU ID Number:	LSBM
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	TBD
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	BAGHOUSE (BH3)		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	LSBM		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	In EF	In EF				

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. Control efficiency included in emission factors, AP42, Tab. 11.19.2-4, dry grind. w/fabric filter

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	1,130 TON/DAY, LIMESTONE
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BASED ON LIFE OF MINE LIME USAGE

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	PARALLEL FLOW REGENERATIVE (PFR) SHAFT LIME KILN
6.	EU ID Number:	LK
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	TBD
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	BAGHOUSE (BH4)		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	LK		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	In EF	In EF				

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. Control efficiency included in emission factors, AP42, Table 11.17-2, 6: gas-fired PFR kiln w/fabric filter

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	169 TON/DAY, 52,377 TON/YR, LIME
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BASED ON LIFE OF MINE LIME USAGE

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	LIME MILL CRUSHING AND ASSOCIATED TRANSFERS
6.	EU ID Number:	LCR
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	TBD
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	BAGHOUSE (BH5)		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	LCR		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	In EF	In EF				

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. Control efficiency included in emission factors, AP42, Tab. 11.19.2-4, dry grind. w/fabric filter

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	169 TON/DAY, 52,377 TON/YR, LIME
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	BASED ON LIFE OF MINE LIME USAGE

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	PEBBLE LIME SILO LOADING VIA BUCKET ELEVATOR
6.	EU ID Number:	LSL
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	TBD
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	Bin Vent Filter		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	LSL		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	In EF	In EF				

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. Control efficiency included in emission factors, AP42, Tab. 11.12-4, crushed material conveyor transfer w/fabric filter

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	169 TON/DAY, 52,377 TON/YR, LIME
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	LIME MILL CRUSHING DISCHARGE RATE

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Unit - General **Form EU0**
Revision 4
08/28/08

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	

4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

EMISSIONS UNIT (PROCESS) IDENTIFICATION & DESCRIPTION

5.	Emissions Unit (EU) Name:	PEBBLE LIME SILO DISCHARGE TO LIME SLAKER
6.	EU ID Number:	LSU
7.	EU Type:	☒ New Source ☐ Unpermitted Existing Source ☐ Modification to a Permitted Source -- Previous Permit #: Date Issued:
8.	Manufacturer:	TBD
9.	Model:	TBD
10..	Maximum Capacity:	TBD
11.	Date of Construction:	TBD
12.	Date of Modification (if any):	N/A
13.	Is this a Controlled Emission Unit?	☐ No ☒ Yes If Yes, complete the following section. If No, go to line 22.

EMISSIONS CONTROL EQUIPMENT

14. Control Equipment Name and ID:	Wet Scrubber (WS3)		
15. Date of Installation:	TBD	16. Date of Modification (if any):	N/A
17. Manufacturer and Model Number:	TBD		
18. ID(s) of Emission Unit Controlled:	LSU		
19. Is operating schedule different than emission units(s) involved?	☐ Yes ☒ No		
20. Does the manufacturer guarantee the control efficiency of the control equipment?	☐ Yes ☒ No (If Yes, attach and label manufacturer guarantee)		

	Pollutant Controlled					
	PM	PM10	SO_2	NOx	VOC	CO
Control Efficiency	In EF	In EF				

21. If manufacturer's data is not available, attach a separate sheet of paper to provide the control equipment design specifications and performance data to support the above mentioned control efficiency. Control efficiency included in emission factors, AP42, Tab. 11.12-4, crushed material conveyor transfer w/ fabric filter

EMISSION UNIT OPERATING SCHEDULE (hours/day, hours/year, or other)

22.	Actual Operation:	8,760 HR/YR
23.	Maximum Operation:	8,760 HR/YR

REQUESTED LIMITS

24.	Are you requesting any permit limits?	☒ Yes ☐ No (If Yes, indicate all that apply below)
	☐ Operation Hour Limit(s):	
	☒ Production Limit(s):	169 TON/YR, 52,377 TON/YR, LIME
	☐ Material Usage Limit(s):	
	☐ Limits Based on Stack Testing:	Please attach all relevant stack testing summary reports
	☐ Other:	
25.	Rationale for Requesting the Limit(s):	LIME MILL CRUSHING DISCHARGE RATE

1.4 Form EU1 – Emission Units Industrial IC Engine Information (4 forms)

Table 2 provides a list of the industrial internal combustion (IC) emission units. The actual manufacturer and model are to be determined. IC engine exhaust stack parameters used for the ambient impact assessment are provided on the forms. Emissions data for each unit can be found in the detailed emission inventory in the "Stibnite Gold Project Air Quality Modeling Report," Attachment A of this application. Supporting documentation can be found on the digital media provided with this application.

Table 2. Industrial IC Engines

Form #	Source ID	Description	Power Rating	Ignition Type	Fuel	Assumed Displacement
1	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	1,000 kW	Compression	Diesel	<10 liters/cylinder
2	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	1,000 kW	Compression	Diesel	<10 liters/cylinder
3	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	1,000 kW	Compression	Diesel	<10 liters/cylinder
4	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	200 kW	Compression	Diesel	<10 liters/cylinder

PRI00000229

REC 1569

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Units Industrial IC Engine Information - Form EU1

Revision 9
10/23/13

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description:	Conventional open-pit mining and onsite ore preparation and gold extraction processes. This form is for: Source ID: EDG1, Camp Emergency Generator (1,000 kW)

IC ENGINE DESCRIPTION AND SPECIFICATIONS

4. Type of unit:

- ☒ New unit ☐ Unpermitted existing unit ☐ Modification to an existing permitted unit? Permit number: _____
- ☐ Full-time operation (non-emergency standby use)?
- ☒ Emergency standby use only (operation limited to 100 hrs/yr for maintenance and testing and emergency use only)?
- ☐ Emergency fire pump use only?
- ☐ Stationary test cell/stand operation only (as defined in NSPS Subpart ZZZZ)?
- ☐ National security operation only (as defined in NSPS Subpart ZZZZ)?
- ☐ Institutional emergency standby IC engine (as defined in NSPS Subpart ZZZZ)?

IC ENGINE SPECIFICATIONS

Questions 5 through 15 apply to **all IC engines**.

5. IC Engine Manufacturer: TBD 6. Model: TBD 7. Date manufactured: After 2007 8. Model year: After 2007
9. Date of installation (if an existing IC engine): TBD 10. IC Engine cylinder displacement: < 10 liters per cylinder
11. Maximum rated horsepower (per the data plate/manufacturer specifications): 1,341 bhp
12. EPA Certification: Tier certification number TBD or ☐ None/not tier certified
13. Ignition type: ☐ Spark ☒ Compression
14. Fuel combusted in the IC engine? ☒ Distillate fuel oil ☐ Natural gas/LNG ☐ LPG/propane
    If distillate fuel oil (#1, #2, or a mixture) is used, what is the maximum sulfur content? ☒ 15 ppm (0.0015% by weight) ☐ 500 ppm (0.05% by weight)
15. IC engine exhaust stack parameters: Diameter 18 inches Height 7 feet Temperature 1,100 ºF Flow rate 10,328 acfm

IC ENGINE EMISSIONS PARAMETERS

Questions 16 through 27 apply to **full-time** non-Tier certified IC engines or Tier certified IC engines manufactured prior to July 11, 2005. If you are proposing a Tier certified IC engine manufactured on and after July 11, 2005 or an emergency standby IC engine do not answer questions 17 through 27.

16. Testing schedule (for emergency standby IC engines only): 24 hrs/day _____ hrs/mon _____ hrs/qtr 100 hrs/yr
17. Maximum daily operation: _____ hrs/day 18. Maximum annual operation: _____ hrs/yr **Note:** These operational limits will be placed in the permit.
19. Will CO emissions be limited to a specific ppmvd (i.e. 49 or 23 ppmvd)? ☐ Yes ☐ No 20. What will the CO emissions limit be? _____ ppmvd
21. Will CO emissions be reduced by 70% or more? ☐ Yes ☐ No
22. Will a CEMS (Continuous Emissions Monitoring System) be used to measure pollutants in the IC engine exhaust stream? ☐ Yes ☐ No
23. Will a CPMS (Continuous Parameters Monitoring System) be used to measure parameters of the IC engine exhaust stream? ☐ Yes ☐ No
24. Will the IC engine be equipped with an oxidation catalyst? ☐ Yes ☐ No
25. If applicable, will the oxidation catalyst be equipped with a temperature measurement system to ensure it is operating properly? ☐ Yes ☐ No
26. Will the IC engine be equipped with a diesel particulate filter? ☐ Yes ☐ No
27. If applicable, will the diesel particulate filter be equipped with a backpressure monitor that notifies the owner or operator when the high backpressure limit of the engine is approached? ☐ Yes ☐ No

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Units Industrial IC Engine Information - Form EU1

Revision 9
10/23/13

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description:	Conventional open-pit mining and onsite ore preparation and gold extraction processes. This form is for: Source ID: EDG2, Plant Emergency Generator #1 (1,000 kW)

IC ENGINE DESCRIPTION AND SPECIFICATIONS

4. Type of unit:

- ☒ New unit ☐ Unpermitted existing unit ☐ Modification to an existing permitted unit? Permit number: _____
- ☐ Full-time operation (non-emergency standby use)?
- ☒ Emergency standby use only (operation limited to 100 hrs/yr for maintenance and testing and emergency use only)?
- ☐ Emergency fire pump use only?
- ☐ Stationary test cell/stand operation only (as defined in NSPS Subpart ZZZZ)?
- ☐ National security operation only (as defined in NSPS Subpart ZZZZ)?
- ☐ Institutional emergency standby IC engine (as defined in NSPS Subpart ZZZZ)?

IC ENGINE SPECIFICATIONS

Questions 5 through 15 apply to **all IC engines**.

5. IC Engine Manufacturer: TBD 6. Model: TBD 7. Date manufactured: After 2007 8. Model year: After 2007
9. Date of installation (if an existing IC engine): TBD 10. IC Engine cylinder displacement: < 10 liters per cylinder
11. Maximum rated horsepower (per the data plate/manufacturer specifications): 1,341 bhp
12. EPA Certification: Tier certification number TBD or ☐ None/not tier certified
13. Ignition type: ☐ Spark ☒ Compression
14. Fuel combusted in the IC engine? ☒ Distillate fuel oil ☐ Natural gas/LNG ☐ LPG/propane
    If distillate fuel oil (#1, #2, or a mixture) is used, what is the maximum sulfur content? ☒ 15 ppm (0.0015% by weight) ☐ 500 ppm (0.05% by weight)
15. IC engine exhaust stack parameters: Diameter 18 inches Height 7 feet Temperature 1,100 ºF Flow rate 10,328 acfm

IC ENGINE EMISSIONS PARAMETERS

Questions 16 through 27 apply to **full-time** non-Tier certified IC engines or Tier certified IC engines manufactured prior to July 11, 2005. If you are proposing a Tier certified IC engine manufactured on and after July 11, 2005 or an emergency standby IC engine do not answer questions 17 through 27.

16. Testing schedule (for emergency standby IC engines only): 24 hrs/day _____ hrs/mon _____ hrs/qtr 100 hrs/yr
17. Maximum daily operation: _____ hrs/day 18. Maximum annual operation: _____ hrs/yr **Note:** These operational limits will be placed in the permit.
19. Will CO emissions be limited to a specific ppmvd (i.e. 49 or 23 ppmvd)? ☐ Yes ☐ No 20. What will the CO emissions limit be? _____ ppmvd
21. Will CO emissions be reduced by 70% or more? ☐ Yes ☐ No
22. Will a CEMS (Continuous Emissions Monitoring System) be used to measure pollutants in the IC engine exhaust stream? ☐ Yes ☐ No
23. Will a CPMS (Continuous Parameters Monitoring System) be used to measure parameters of the IC engine exhaust stream? ☐ Yes ☐ No
24. Will the IC engine be equipped with an oxidation catalyst? ☐ Yes ☐ No
25. If applicable, will the oxidation catalyst be equipped with a temperature measurement system to ensure it is operating properly? ☐ Yes ☐ No
26. Will the IC engine be equipped with a diesel particulate filter? ☐ Yes ☐ No
27. If applicable, will the diesel particulate filter be equipped with a backpressure monitor that notifies the owner or operator when the high backpressure limit of the engine is approached? ☐ Yes ☐ No

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Units Industrial IC Engine Information - Form EU1

Revision 9
10/23/13

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description:	Conventional open-pit mining and onsite ore preparation and gold extraction processes. This form is for: Source ID: EDG3, Plant Emergency Generator #2 (1,000 kW)

IC ENGINE DESCRIPTION AND SPECIFICATIONS

4. Type of unit:

- ☒ New unit ☐ Unpermitted existing unit ☐ Modification to an existing permitted unit? Permit number: _____
- ☐ Full-time operation (non-emergency standby use)?
- ☒ Emergency standby use only (operation limited to 100 hrs/yr for maintenance and testing and emergency use only)?
- ☐ Emergency fire pump use only?
- ☐ Stationary test cell/stand operation only (as defined in NSPS Subpart ZZZZ)?
- ☐ National security operation only (as defined in NSPS Subpart ZZZZ)?
- ☐ Institutional emergency standby IC engine (as defined in NSPS Subpart ZZZZ)?

IC ENGINE SPECIFICATIONS

Questions 5 through 15 apply to **all IC engines**.

5. IC Engine Manufacturer: TBD 6. Model: TBD 7. Date manufactured: After 2007 8. Model year: After 2007
9. Date of installation (if an existing IC engine): TBD 10. IC Engine cylinder displacement: < 10 liters per cylinder
11. Maximum rated horsepower (per the data plate/manufacturer specifications): 1,341 bhp
12. EPA Certification: Tier certification number TBD or ☐ None/not tier certified
13. Ignition type: ☐ Spark ☒ Compression
14. Fuel combusted in the IC engine? ☒ Distillate fuel oil ☐ Natural gas/LNG ☐ LPG/propane
    If distillate fuel oil (#1, #2, or a mixture) is used, what is the maximum sulfur content? ☒ 15 ppm (0.0015% by weight) ☐ 500 ppm (0.05% by weight)
15. IC engine exhaust stack parameters: Diameter 18 inches Height 7 feet Temperature 1,100 ºF Flow rate 10,328 acfm

IC ENGINE EMISSIONS PARAMETERS

Questions 16 through 27 apply to **full-time** non-Tier certified IC engines or Tier certified IC engines manufactured prior to July 11, 2005. If you are proposing a Tier certified IC engine manufactured on and after July 11, 2005 or an emergency standby IC engine do not answer questions 17 through 27.

16. Testing schedule (for emergency standby IC engines only): 24 hrs/day _____ hrs/mon _____ hrs/qtr 100 hrs/yr
17. Maximum daily operation: _____ hrs/day 18. Maximum annual operation: _____ hrs/yr **Note:** These operational limits will be placed in the permit.
19. Will CO emissions be limited to a specific ppmvd (i.e. 49 or 23 ppmvd)? ☐ Yes ☐ No 20. What will the CO emissions limit be? _____ ppmvd
21. Will CO emissions be reduced by 70% or more? ☐ Yes ☐ No
22. Will a CEMS (Continuous Emissions Monitoring System) be used to measure pollutants in the IC engine exhaust stream? ☐ Yes ☐ No
23. Will a CPMS (Continuous Parameters Monitoring System) be used to measure parameters of the IC engine exhaust stream? ☐ Yes ☐ No
24. Will the IC engine be equipped with an oxidation catalyst? ☐ Yes ☐ No
25. If applicable, will the oxidation catalyst be equipped with a temperature measurement system to ensure it is operating properly? ☐ Yes ☐ No
26. Will the IC engine be equipped with a diesel particulate filter? ☐ Yes ☐ No
27. If applicable, will the diesel particulate filter be equipped with a backpressure monitor that notifies the owner or operator when the high backpressure limit of the engine is approached? ☐ Yes ☐ No

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Units Industrial IC Engine Information - **Form EU1**
Revision 9
10/23/13

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description:	Conventional open-pit mining and onsite ore preparation and gold extraction processes. This form is for: Source ID: EDFP, Mill Fire Pump (200 kW)

IC ENGINE DESCRIPTION AND SPECIFICATIONS

4. Type of unit:

☒ New unit ☐ Unpermitted existing unit ☐ Modification to an existing permitted unit? Permit number: _____
☐ Full-time operation (non-emergency standby use)?
☐ Emergency standby use only (operation limited to 100 hrs/yr for maintenance and testing and emergency use only)?
☒ Emergency fire pump use only?
☐ Stationary test cell/stand operation only (as defined in NSPS Subpart ZZZZ)?
☐ National security operation only (as defined in NSPS Subpart ZZZZ)?
☐ Institutional emergency standby IC engine (as defined in NSPS Subpart ZZZZ)?

IC ENGINE SPECIFICATIONS

Questions 5 through 15 apply to **all IC engines**.

5. IC Engine Manufacturer: TBD 6. Model: TBD 7. Date manufactured: After 2009 8. Model year: After 2009
9. Date of installation (if an existing IC engine): TBD 10. IC Engine cylinder displacement: < 10 liters per cylinder
11. Maximum rated horsepower (per the data plate/manufacturer specifications): 268 bhp
12. EPA Certification: Tier certification number TBD or ☐ None/not tier certified
13. Ignition type: ☐ Spark ☒ Compression
14. Fuel combusted in the IC engine? ☒ Distillate fuel oil ☐ Natural gas/LNG ☐ LPG/propane
    If distillate fuel oil (#1, #2, or a mixture) is used, what is the maximum sulfur content? ☒ 15 ppm (0.0015% by weight) ☐ 500 ppm (0.05% by weight)
15. IC engine exhaust stack parameters: Diameter 9 inches Height 7 feet Temperature 1,100 ºF Flow rate 2,066 acfm

IC ENGINE EMISSIONS PARAMETERS

Questions 16 through 27 apply to **full-time** non-Tier certified IC engines or Tier certified IC engines manufactured prior to July 11, 2005. If you are proposing a Tier certified IC engine manufactured on and after July 11, 2005 or an emergency standby IC engine do not answer questions 17 through 27.

16. Testing schedule (for emergency standby IC engines only): _____ hrs/day _____ hrs/mon _____ hrs/qtr _____ hrs/yr
17. Maximum daily operation: _____ hrs/day 18. Maximum annual operation: _____ hrs/yr **Note:** These operational limits will be placed in the permit.
19. Will CO emissions be limited to a specific ppmvd (i.e. 49 or 23 ppmvd)? ☐ Yes ☐ No 20. What will the CO emissions limit be? _____ ppmvd
21. Will CO emissions be reduced by 70% or more? ☐ Yes ☐ No
22. Will a CEMS (Continuous Emissions Monitoring System) be used to measure pollutants in the IC engine exhaust stream? ☐ Yes ☐ No
23. Will a CPMS (Continuous Parameters Monitoring System) be used to measure parameters of the IC engine exhaust stream? ☐ Yes ☐ No
24. Will the IC engine be equipped with an oxidation catalyst? ☐ Yes ☐ No
25. If applicable, will the oxidation catalyst be equipped with a temperature measurement system to ensure it is operating properly? ☐ Yes ☐ No
26. Will the IC engine be equipped with a diesel particulate filter? ☐ Yes ☐ No
27. If applicable, will the diesel particulate filter be equipped with a backpressure monitor that notifies the owner or operator when the high backpressure limit of the engine is approached? ☐ Yes ☐ No

1.5 Form EU2– Emissions Units Nonmetallic Mineral Processing Plant

This form requests information about equipment at a nonmetallic mineral processing plant, as defined in 40 CFR 60.671, that **generates fugitive emissions only**. Table 3 provides a list of the Stibnite Gold Project nonmetallic mineral processing plant fugitive emission sources.

In addition to form EU2, forms EU0 and BCE have been provided for the Limestone Ball Mill and associated baghouse (BH3) as part of this application.

Emissions data for each unit can be found in the detailed emission inventory in the "Stibnite Gold Project Air Quality Modeling Report," Attachment A of this application. Supporting documentation can be found on the digital media provided with this application.

Table 3. Nonmetallic Mineral Processing Plant Emission Units – Fugitive Emissions Only

Source ID	Description	Source Type	Control
LS1	Limestone transfer to Primary Crusher Hopper	Conveyor	None
LS2	Primary Crushing and Associated Transfers In and Out	Crusher	None
LS3	Primary Screening and Associated Transfers In and Out	Screen	None
LS4	Secondary Crushing and Associated Transfers In and Out	Crusher	None
LS5	Secondary Screening and Associated Transfers In and Out	Screen	None
LS6	Limestone transfer to Ball Mill Feed Bin	Conveyor	None
LS7	Limestone transfer to Ball Mill Feed Conveyor	Conveyor	None
LS8	Ball Mill Feed transfer to Ball Mill	Conveyor	None
LS9	Limestone transfer to Kiln Feed Bin	Conveyor	None
LS10	Limestone transfer to Lime Kiln Feed Conveyor	Conveyor	None
LS11	Fines Screening and Associated Transfers In and Out	Screen	None
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	Conveyor	None

PRI00000234

REC 1574

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Units - Nonmetallic Mineral Processing Plant **Form EU2**
Revision 5
08/28/08

Please see instructions on page 3 before filling out the form.

This form requests information about equipment at a nonmetallic mineral processing plant, as defined in 40 CFR 60.671, that generates fugitive emissions only.

In addition, Form EU0 and appropriate control equipment forms should be used for each stack emission point from the same plant.

IDENTIFICATION		
1. Company Name:	2. Facility Name:	3. Facility ID No:
Midas Gold Idaho, Inc.	Stibnite Gold Project	
4. Brief Project Description:	Open-pit mining and onsite onsite ore preparation and gold extraction processes.	

EQUIPMENT (EMISSION UNIT) DESCRIPTION AND SPECIFICATIONS					
5. Equipment Description	6. Construction Date	7. Serial Number	8. Equipment ID Number (company's)	9. Rated Capacity	10. Emission Control Type
Transfer to Primary Crusher Hopper	TBD	TBD	LS1	1,130 ton/day	None
Primary Crusher	TBD	TBD	LS2	1,130 ton/day	None
Primary Screen	TBD	TBD	LS3	1,130 ton/day	None
Secondary Crusher	TBD	TBD	LS4	1,130 ton/day	None
Secondary Screen	TBD	TBD	LS5	1,130 ton/day	None
Transfer to Ball Mill Feed Bin	TBD	TBD	LS6	1,130 ton/day	None
Transfer to Ball Mill Feed Conveyor	TBD	TBD	LS7	1,130 ton/day	None
Ball Mill Feed transfer to Ball Mill	TBD	TBD	LS8	1,130 ton/day	None
Transfer to Kiln Feed Bin	TBD	TBD	LS9	267 ton/day	None
Transfer to Lime Kiln Feed Conveyor	TBD	TBD	LS10	267 ton/day	None
Fines Screen	TBD	TBD	LS11	267 ton/day	None
Kiln Feed transfer to PFR Shaft Lime Kiln	TBD	TBD	LS12	267 ton/day	None

OPERATING SCHEDULE (hours/day, or hours/week, or months/year, or other)					
11 Actual Operation	TBD				
12. Maximum Operation	24 hr/day, 8,760 hr/yr				

1.6 Form EU5 – Emissions Units Industrial Boiler Information (15 forms)

Table 4 provides a list of the industrial boiler emission units. The actual manufacturer and model are to be determined. Exhaust stack parameters used for the ambient impact assessment are provided on the forms. Emissions data for each unit can be found in the detailed emission inventory in the "Stibnite Gold Project Air Quality Modeling Report," Attachment A of this application. Supporting documentation can be found on the digital media provided with this application.

Table 4. Industrial Boiler Emission Units

Form #	Source ID	Description	MMBtu/hr	Fuel
1	Sb1	Sb Dryer	2.72	Propane
2	ACB	POX Boiler	17	Propane
3	CKB	Carbon Regeneration Kiln	2.255	Propane
4	PV	Propane Vaporizer	0.1	Propane
5	HS	Strip Circuit Solution Heater	5	Propane
6	H1M	Mine Air Heater #1	4	Propane
7	H2M	Mine Air Heater #2	4	Propane
8	HM	Mill HVAC Heaters	4 x 1.0	Propane
9	HAC	Autoclave HVAC Heater	0.25	Propane
10	HR	Refinery HVAC Heater	0.25	Propane
11	HA	Admin HVAC Heater	0.25	Propane
12	HMO	Mine Ops. HVAC Heaters	2 x 0.25	Propane
13	HTS	Truck Shop HVAC Heaters	2 x 1.0	Propane
14	HW	Warehouse HVAC Heaters	3 x 1.0	Propane
15	LKC	PFR Shaft Lime Kiln Combustion	22.0	Propane

PRI00000237

REC 1577

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Units Industrial Boiler Information - **Form EU5**
Revision 6
11/26/18

Please see instructions on page 3 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description:	Conventional open-pit mining and onsite ore preparation and gold extraction processes. This form is for: Source ID: Sb1, Sb Dryer (2.72 MMBtu/hr Propane Fired)

BOILER UNIT SPECIFICATIONS

4. Type of Unit: ☒ New unit ☐ Unpermitted existing unit ☐ Modification to an existing permitted unit? Permit number: _____

5. Manufacturer: TBD 6. Model: TBD 7. Manufacture Date: TBD

8. Date of installation: TBD 9. Serial Number: TBD 10. Boiler ID Number: Sb1

11. Control Device (if any) None (Baghouse, ESP, or Scrubber) **Note:** Attach applicable control equipment FORM BCE, ESP, or SCE

12. Fuel Meter Used: ☐ Gaseous ☐ Liquid ☒ None

13. Boiler Exhaust Stack Parameters:

Diameter: 12 inches Height: 150 feet Temperature: 360 ºF Flow rate: 1073 acfm
Exhaust Orientation: ☒ Vertical (unobstructed upward) ☐ Vertical (obstructed upward) ☐ Horizontal ☐ Other _____

14. Primary Burner: Manufacturer: TBD Model: TBD Max Heat Input Rating: 2.72 MMBtu/hr

15. Secondary Burner (if applicable): Manufacturer: N/A Model: N/A Max Heat Input Rating: N/A MMBtu/hr

FUEL SPECIFICATION AND EMISSION FACTORS

16. Primary Fuel Type: ☐ Natural Gas ☐ Diesel Fuel (#) ☒ LPG/Propane ☐ Other Fuel: _____

17. Secondary Fuel Type (if applicable): ☐ Natural Gas ☐ Diesel Fuel (#) ☐ LPG/Propane ☐ Other Fuel: _____

Fuel Type		Primary Fuel			Secondary Fuel		
18. Fuel Heat Value (Btu/unit, LHV)		91,500 Btu/gal					
19. Sulfur Content (ppmv, wt%)		185 ppm					
20. Manufacture's Rated or Source Test Emission Factors (if applicable) **Note:** Include supporting documentation		**Operational Mode**			**Operational Mode**		
		Steady State (lbs/MMBtu)	Start Up (lb/hr)	Shut Down (lb/hr)	Steady State (lbs/MMBtu)	Start Up (lnb/hr)	Shut Down (lb/hr)
	PM_{10}	AP42					
	$PM_{2.5}$	AP42					
	$N0_x$	AP42					
	CO	AP42					
	$S0_2$	AP42					
	VOC	AP42					
21. Other Pollutant(s): NA		NA					
22. Duration Operational Mode:		N/A	NA hr/day NA hr/yr	NA hr/day NA hr/yr	N/A	NA hr/day NA hr/yr	NA hr/day NA hr/yr

OPERATING LIMITS & SCHEDULE

23. Proposed Operating Limits: (hr/day, hr/yr, gal/yr, MMscf/yr, etc) **Note:** These limits will be placed in the permit:
24 hr/day, 8,760 hr/yr

FEDERAL RULES APPLICABLITY

24. NSPS or MACT Applicability: ☐ Yes ☒ No	If "yes", which subpart applies?: _____ **Note:** Form FRA must be completed.

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Units Industrial Boiler Information - **Form EU5**
Revision 6
11/26/18

Please see instructions on page 3 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes This form is for: Source ID: ACB, POX Boiler (17 MMBtu/hr Propane Fired)

BOILER UNIT SPECIFICATIONS

4. Type of Unit: ☒ New unit ☐ Unpermitted existing unit ☐ Modification to an existing permitted unit? Permit number: _____

5. Manufacturer: TBD 6. Model: TBD 7. Manufacture Date: TBD

8. Date of installation: TBD 9. Serial Number: TBD 10. Boiler ID Number: ACB

11. Control Device (if any) None (Baghouse, ESP, or Scrubber) **Note:** Attach applicable control equipment FORM BCE, ESP, or SCE

12. Fuel Meter Used: ☐ Gaseous ☐ Liquid ☐ None

13. Boiler Exhaust Stack Parameters:

Diameter: 24 inches Height: 77 feet Temperature: 360 ºF Flow rate: 6703 acfm
Exhaust Orientation: ☒ Vertical (unobstructed upward) ☐ Vertical (obstructed upward) ☐ Horizontal ☐ Other _____

14. Primary Burner: Manufacturer: TBD Model: TBD Max Heat Input Rating: 17 MMBtu/hr

15. Secondary Burner (if applicable): Manufacturer: N/A Model: N/A Max Heat Input Rating: N/A MMBtu/hr

FUEL SPECIFICATION AND EMISSION FACTORS

16. Primary Fuel Type: ☐ Natural Gas ☐ Diesel Fuel (#) ☒ LPG/Propane ☐ Other Fuel: _____

17. Secondary Fuel Type (if applicable): ☐ Natural Gas ☐ Diesel Fuel (#) ☐ LPG/Propane ☐ Other Fuel: _____

Fuel Type		Primary Fuel			Secondary Fuel		
18. Fuel Heat Value (Btu/unit, LHV)		91,500 Btu/gal					
19. Sulfur Content (ppmv, wt%)		185 ppm					
20. Manufacture's Rated or Source Test Emission Factors (if applicable) **Note:** Include supporting documentation		**Operational Mode**			**Operational Mode**		
		Steady State (lbs/MMBtu)	Start Up (lb/hr)	Shut Down (lb/hr)	Steady State (lbs/MMBtu)	Start Up (lnb/hr)	Shut Down (lb/hr)
	PM_{10}	AP42					
	$PM_{2.5}$	AP42					
	$N0_x$	AP42					
	CO	AP42					
	$S0_2$	AP42					
	VOC	AP42					
21. Other Pollutant(s): NA		NA					
22. Duration Operational Mode:		N/A	NA hr/day NA hr/yr	NA hr/day NA hr/yr	N/A	NA hr/day NA hr/yr	NA hr/day NA hr/yr

OPERATING LIMITS & SCHEDULE

23. Proposed Operating Limits: (hr/day, hr/yr, gal/yr, MMscf/yr, etc) **Note:** These limits will be placed in the permit:
30 hr/yr

FEDERAL RULES APPLICABLITY

24. NSPS or MACT Applicability: ☐ Yes ☒ No	If "yes", which subpart applies?: _____ **Note:** Form FRA must be completed.

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Units Industrial Boiler Information - **Form EU5**
Revision 6
11/26/18

Please see instructions on page 3 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description:	Conventional open-pit mining and onsite ore preparation and gold extraction processes. This form is for: Source ID: CKB, Carbon Regeneration Kiln (Burners) (2.255 MMBtu/hr Propane Fired)

BOILER UNIT SPECIFICATIONS

4. Type of Unit: ☒ New unit ☐ Unpermitted existing unit ☐ Modification to an existing permitted unit? Permit number: _____

5. Manufacturer: TBD 6. Model: TBD 7. Manufacture Date: TBD

8. Date of installation: TBD 9. Serial Number: TBD 10. Boiler ID Number: CKB

11. Control Device (if any) None (Baghouse, ESP, or Scrubber) **Note:** Attach applicable control equipment FORM BCE, ESP, or SCE

12. Fuel Meter Used: ☐ Gaseous ☐ Liquid ☒ None

13. Boiler Exhaust Stack Parameters:

Diameter: 12 inches Height: 46 feet Temperature: 360 ºF Flow rate: 889 acfm
Exhaust Orientation: ☒ Vertical (unobstructed upward) ☐ Vertical (obstructed upward) ☐ Horizontal ☐ Other _____

14. Primary Burner: Manufacturer: TBD Model: TBD Max Heat Input Rating: 2.255 MMBtu/hr

15. Secondary Burner (if applicable): Manufacturer: N/A Model: N/A Max Heat Input Rating: N/A MMBtu/hr

FUEL SPECIFICATION AND EMISSION FACTORS

16. Primary Fuel Type: ☐ Natural Gas ☐ Diesel Fuel (#) ☒ LPG/Propane ☐ Other Fuel: _____

17. Secondary Fuel Type (if applicable): ☐ Natural Gas ☐ Diesel Fuel (#) ☐ LPG/Propane ☐ Other Fuel: _____

Fuel Type		Primary Fuel			Secondary Fuel		
18. Fuel Heat Value (Btu/unit, LHV)		91,500 Btu/gal					
19. Sulfur Content (ppmv, wt%)		185 ppm					
20. Manufacture's Rated or Source Test Emission Factors (if applicable) **Note:** Include supporting documentation		**Operational Mode**			**Operational Mode**		
		Steady State (lbs/MMBtu)	Start Up (lb/hr)	Shut Down (lb/hr)	Steady State (lbs/MMBtu)	Start Up (lnb/hr)	Shut Down (lb/hr)
	PM_{10}	AP42					
	$PM_{2.5}$	AP42					
	$N0_x$	AP42					
	CO	AP42					
	$S0_2$	AP42					
	VOC	AP42					
21. Other Pollutant(s): NA		NA					
22. Duration Operational Mode:		N/A	NA hr/day NA hr/yr	NA hr/day NA hr/yr	N/A	NA hr/day NA hr/yr	NA hr/day NA hr/yr

OPERATING LIMITS & SCHEDULE

23. Proposed Operating Limits: (hr/day, hr/yr, gal/yr, MMscf/yr, etc) **Note:** These limits will be placed in the permit:
24 hr/day, 8,760 hr/yr

FEDERAL RULES APPLICABLITY

24. NSPS or MACT Applicability: ☐ Yes ☒ No	If "yes", which subpart applies?: _____ **Note:** Form FRA must be completed.

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Units Industrial Boiler Information - **Form EU5**
Revision 6
11/26/18

Please see instructions on page 3 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes. This form is for: Source ID: PV, Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)

BOILER UNIT SPECIFICATIONS

4. Type of Unit: ☒ New unit ☐ Unpermitted existing unit ☐ Modification to an existing permitted unit? Permit number: _____

5. Manufacturer: TBD 6. Model: TBD 7. Manufacture Date: TBD

8. Date of installation: TBD 9. Serial Number: TBD 10. Boiler ID Number: PV

11. Control Device (if any) None (Baghouse, ESP, or Scrubber) **Note:** Attach applicable control equipment FORM BCE, ESP, or SCE

12. Fuel Meter Used: ☐ Gaseous ☐ Liquid ☒ None

13. Boiler Exhaust Stack Parameters:

Diameter: 5 inches Height: 68 feet Temperature: 360 ºF Flow rate: 39 acfm
Exhaust Orientation: ☒ Vertical (unobstructed upward) ☐ Vertical (obstructed upward) ☐ Horizontal ☐ Other _____

14. Primary Burner: Manufacturer: TBD Model: TBD Max Heat Input Rating: 0.1 MMBtu/hr

15. Secondary Burner (if applicable): Manufacturer: N/A Model: N/A Max Heat Input Rating: N/A MMBtu/hr

FUEL SPECIFICATION AND EMISSION FACTORS

16. Primary Fuel Type: ☐ Natural Gas ☐ Diesel Fuel (#) ☒ LPG/Propane ☐ Other Fuel: _____

17. Secondary Fuel Type (if applicable): ☐ Natural Gas ☐ Diesel Fuel (#) ☐ LPG/Propane ☐ Other Fuel: _____

Fuel Type		Primary Fuel			Secondary Fuel		
18. Fuel Heat Value (Btu/unit, LHV)		91,500 Btu/gal			NA		
19. Sulfur Content (ppmv, wt%)		185 ppm			NA		
20. Manufacture's Rated or Source Test Emission Factors (if applicable) **Note:** Include supporting documentation		**Operational Mode**			**Operational Mode**		
		Steady State (lbs/MMBtu)	Start Up (lb/hr)	Shut Down (lb/hr)	Steady State (lbs/MMBtu)	Start Up (lnb/hr)	Shut Down (lb/hr)
	PM_{10}	AP42					
	$PM_{2.5}$	AP42					
	$N0_x$	AP42					
	CO	AP42					
	$S0_2$	AP42					
	VOC	AP42					
21. Other Pollutant(s): NA		NA					
22. Duration Operational Mode:		N/A	NA hr/day NA hr/yr	NA hr/day NA hr/yr	N/A	NA hr/day NA hr/yr	NA hr/day NA hr/yr

OPERATING LIMITS & SCHEDULE

23. Proposed Operating Limits: (hr/day, hr/yr, gal/yr, MMscf/yr, etc) **Note:** These limits will be placed in the permit:
24 hr/day, 8,760 hr/yr

FEDERAL RULES APPLICABLITY

24. NSPS or MACT Applicability: ☐ Yes ☒ No	If "yes", which subpart applies?: _____ **Note:** Form FRA must be completed.

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Units Industrial Boiler Information - **Form EU5**
Revision 6
11/26/18

Please see instructions on page 3 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description:	Conventional open-pit mining and onsite ore preparation and gold extraction processes. This form is for: Source ID: HS, Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)

BOILER UNIT SPECIFICATIONS

4. Type of Unit: ☒ New unit ☐ Unpermitted existing unit ☐ Modification to an existing permitted unit? Permit number: _____

5. Manufacturer: TBD 6. Model: TBD 7. Manufacture Date: TBD

8. Date of installation: TBD 9. Serial Number: TBD 10. Boiler ID Number: HS

11. Control Device (if any) None (Baghouse, ESP, or Scrubber) **Note:** Attach applicable control equipment FORM BCE, ESP, or SCE

12. Fuel Meter Used: ☐ Gaseous ☐ Liquid ☒ None

13. Boiler Exhaust Stack Parameters:

Diameter: 16 inches Height: 46 feet Temperature: 360 ºF Flow rate: 1,972 acfm
Exhaust Orientation: ☒ Vertical (unobstructed upward) ☐ Vertical (obstructed upward) ☐ Horizontal ☐ Other _____

14. Primary Burner: Manufacturer: TBD Model: TBD Max Heat Input Rating: 5 MMBtu/hr

15. Secondary Burner (if applicable): Manufacturer: N/A Model: N/A Max Heat Input Rating: N/A MMBtu/hr

FUEL SPECIFICATION AND EMISSION FACTORS

16. Primary Fuel Type: ☐ Natural Gas ☐ Diesel Fuel (#) ☒ LPG/Propane ☐ Other Fuel: _____

17. Secondary Fuel Type (if applicable): ☐ Natural Gas ☐ Diesel Fuel (#) ☐ LPG/Propane ☐ Other Fuel: _____

Fuel Type		Primary Fuel			Secondary Fuel		
18. Fuel Heat Value (Btu/unit, LHV)		91,500 Btu/gal			NA		
19. Sulfur Content (ppmv, wt%)		185 ppm			NA		
20. Manufacture's Rated or Source Test Emission Factors (if applicable) **Note:** Include supporting documentation		**Operational Mode**			**Operational Mode**		
		Steady State (lbs/MMBtu)	Start Up (lb/hr)	Shut Down (lb/hr)	Steady State (lbs/MMBtu)	Start Up (lnb/hr)	Shut Down (lb/hr)
	PM_{10}	AP42					
	$PM_{2.5}$	AP42					
	$N0_x$	AP42					
	CO	AP42					
	$S0_2$	AP42					
	VOC	AP42					
21. Other Pollutant(s): NA		NA					
22. Duration Operational Mode:		N/A	NA hr/day NA hr/yr	NA hr/day NA hr/yr	N/A	NA hr/day NA hr/yr	NA hr/day NA hr/yr

OPERATING LIMITS & SCHEDULE

23. Proposed Operating Limits: (hr/day, hr/yr, gal/yr, MMscf/yr, etc) **Note:** These limits will be placed in the permit:
24 hr/day, 8,760 hr/yr

FEDERAL RULES APPLICABLITY

24. NSPS or MACT Applicability: ☐ Yes ☒ No	If "yes", which subpart applies?: _____ **Note:** Form FRA must be completed.

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Units Industrial Boiler Information - **Form EU5**
Revision 6
11/26/18

Please see instructions on page 3 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes. This form is for: Source ID: H1M, Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)

BOILER UNIT SPECIFICATIONS

4. Type of Unit: ☒ New unit ☐ Unpermitted existing unit ☐ Modification to an existing permitted unit? Permit number: _____

5. Manufacturer: TBD 6. Model: TBD 7. Manufacture Date: TBD

8. Date of installation: TBD 9. Serial Number: TBD 10. Boiler ID Number: H1M

11. Control Device (if any) None (Baghouse, ESP, or Scrubber) **Note:** Attach applicable control equipment FORM BCE, ESP, or SCE

12. Fuel Meter Used: ☐ Gaseous ☐ Liquid ☒ None

13. Boiler Exhaust Stack Parameters:

Diameter: 16 inches Height: 7 feet Temperature: 360 ºF Flow rate: 1,577 acfm
Exhaust Orientation: ☒ Vertical (unobstructed upward) ☐ Vertical (obstructed upward) ☐ Horizontal ☐ Other _____

14. Primary Burner: Manufacturer: TBD Model: TBD Max Heat Input Rating: 4 MMBtu/hr

15. Secondary Burner (if applicable): Manufacturer: N/A Model: N/A Max Heat Input Rating: N/A MMBtu/hr

FUEL SPECIFICATION AND EMISSION FACTORS

16. Primary Fuel Type: ☐ Natural Gas ☐ Diesel Fuel (#) ☒ LPG/Propane ☐ Other Fuel: _____

17. Secondary Fuel Type (if applicable): ☐ Natural Gas ☐ Diesel Fuel (#) ☐ LPG/Propane ☐ Other Fuel: _____

Fuel Type		Primary Fuel			Secondary Fuel		
18. Fuel Heat Value (Btu/unit, LHV)		91,500 Btu/gal			NA		
19. Sulfur Content (ppmv, wt%)		185 ppm			NA		
20. Manufacture's Rated or Source Test Emission Factors (if applicable) **Note:** Include supporting documentation		**Operational Mode**			**Operational Mode**		
		Steady State (lbs/MMBtu)	Start Up (lb/hr)	Shut Down (lb/hr)	Steady State (lbs/MMBtu)	Start Up (lnb/hr)	Shut Down (lb/hr)
	PM_{10}	AP42					
	$PM_{2.5}$	AP42					
	$N0_x$	AP42					
	CO	AP42					
	$S0_2$	AP42					
	VOC	AP42					
21. Other Pollutant(s): NA		NA					
22. Duration Operational Mode:		N/A	NA hr/day NA hr/yr	NA hr/day NA hr/yr	N/A	NA hr/day NA hr/yr	NA hr/day NA hr/yr

OPERATING LIMITS & SCHEDULE

23. Proposed Operating Limits: (hr/day, hr/yr, gal/yr, MMscf/yr, etc) **Note:** These limits will be placed in the permit:
24 hr/day, 8,760 hr/yr

FEDERAL RULES APPLICABLITY

24. NSPS or MACT Applicability: ☐ Yes ☒ No	If "yes", which subpart applies?: _____ **Note:** Form FRA must be completed.

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Units Industrial Boiler Information - Form EU5

Revision 6
11/26/18

Please see instructions on page 3 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description:	Conventional open-pit mining and onsite ore preparation and gold extraction processes. This form is for: Source ID: H2M, Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)

BOILER UNIT SPECIFICATIONS

4. Type of Unit: ☒ New unit ☐ Unpermitted existing unit ☐ Modification to an existing permitted unit? Permit number: _____

5. Manufacturer: TBD 6. Model: TBD 7. Manufacture Date: TBD

8. Date of installation: TBD 9. Serial Number: TBD 10. Boiler ID Number: H2M

11. Control Device (if any) None (Baghouse, ESP, or Scrubber) **Note:** Attach applicable control equipment FORM BCE, ESP, or SCE

12. Fuel Meter Used: ☐ Gaseous ☐ Liquid ☒ None

13. Boiler Exhaust Stack Parameters:

Diameter: 8 inches Height: 7 feet Temperature: 360 ºF Flow rate: 1,577 acfm
Exhaust Orientation: ☒ Vertical (unobstructed upward) ☐ Vertical (obstructed upward) ☐ Horizontal ☐ Other _____

14. Primary Burner: Manufacturer: TBD Model: TBD Max Heat Input Rating: 4 MMBtu/hr

15. Secondary Burner (if applicable): Manufacturer: N/A Model: N/A Max Heat Input Rating: N/A MMBtu/hr

FUEL SPECIFICATION AND EMISSION FACTORS

16. Primary Fuel Type: ☐ Natural Gas ☐ Diesel Fuel (#) ☒ LPG/Propane ☐ Other Fuel: _____

17. Secondary Fuel Type (if applicable): ☐ Natural Gas ☐ Diesel Fuel (#) ☐ LPG/Propane ☐ Other Fuel: _____

Fuel Type		Primary Fuel			Secondary Fuel		
18. Fuel Heat Value (Btu/unit, LHV)		91,500 Btu/gal			NA		
19. Sulfur Content (ppmv, wt%)		185 ppm			NA		
20. Manufacture's Rated or Source Test Emission Factors (if applicable) **Note:** Include supporting documentation		**Operational Mode**			**Operational Mode**		
		Steady State (lbs/MMBtu)	Start Up (lb/hr)	Shut Down (lb/hr)	Steady State (lbs/MMBtu)	Start Up (lnb/hr)	Shut Down (lb/hr)
	PM_{10}	AP42					
	$PM_{2.5}$	AP42					
	$N0_x$	AP42					
	CO	AP42					
	$S0_2$	AP42					
	VOC	AP42					
21. Other Pollutant(s): NA		NA					
22. Duration Operational Mode:		N/A	NA hr/day NA hr/yr	NA hr/day NA hr/yr	N/A	NA hr/day NA hr/yr	NA hr/day NA hr/yr

OPERATING LIMITS & SCHEDULE

23. Proposed Operating Limits: (hr/day, hr/yr, gal/yr, MMscf/yr, etc) **Note:** These limits will be placed in the permit:
24 hr/day, 8,760 hr/yr

FEDERAL RULES APPLICABLITY

24. NSPS or MACT Applicability: ☐ Yes ☒ No	If "yes", which subpart applies?: _____ **Note:** Form FRA must be completed.

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Units Industrial Boiler Information - **Form EU5**
Revision 6
11/26/18

Please see instructions on page 3 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description:	Conventional open-pit mining and onsite ore preparation and gold extraction processes. This form is for: Source ID: HM, Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)

BOILER UNIT SPECIFICATIONS

4. Type of Unit: ☒ New unit ☐ Unpermitted existing unit ☐ Modification to an existing permitted unit? Permit number: _____

5. Manufacturer: TBD 6. Model: TBD 7. Manufacture Date: TBD

8. Date of installation: TBD 9. Serial Number: TBD 10. Boiler ID Number: HM1, HM2, HM3, HM4

11. Control Device (if any) None (Baghouse, ESP, or Scrubber) **Note:** Attach applicable control equipment FORM BCE, ESP, or SCE

12. Fuel Meter Used: ☐ Gaseous ☐ Liquid ☒ None

13. Boiler Exhaust Stack Parameters:

Diameter: 4 inches Height: 141 feet Temperature: 360 ºF Flow rate: 394 acfm
Exhaust Orientation: ☒ Vertical (unobstructed upward) ☐ Vertical (obstructed upward) ☐ Horizontal ☐ Other _____

14. Primary Burner: Manufacturer: TBD Model: TBD Max Heat Input Rating: 1, each MMBtu/hr

15. Secondary Burner (if applicable): Manufacturer: N/A Model: N/A Max Heat Input Rating: N/A MMBtu/hr

FUEL SPECIFICATION AND EMISSION FACTORS

16. Primary Fuel Type: ☐ Natural Gas ☐ Diesel Fuel (#) ☒ LPG/Propane ☐ Other Fuel: _____

17. Secondary Fuel Type (if applicable): ☐ Natural Gas ☐ Diesel Fuel (#) ☐ LPG/Propane ☐ Other Fuel: _____

Fuel Type		Primary Fuel			Secondary Fuel		
18. Fuel Heat Value (Btu/unit, LHV)		91,500 Btu/gal			NA		
19. Sulfur Content (ppmv, wt%)		185 ppm			NA		
20. Manufacture's Rated or Source Test Emission Factors (if applicable) **Note:** Include supporting documentation		**Operational Mode**			**Operational Mode**		
		Steady State (lbs/MMBtu)	Start Up (lb/hr)	Shut Down (lb/hr)	Steady State (lbs/MMBtu)	Start Up (lnb/hr)	Shut Down (lb/hr)
	PM_{10}	AP42					
	$PM_{2.5}$	AP42					
	$N0_x$	AP42					
	CO	AP42					
	$S0_2$	AP42					
	VOC	AP42					
21. Other Pollutant(s): NA		NA					
22. Duration Operational Mode:		N/A	NA hr/day NA hr/yr	NA hr/day NA hr/yr	N/A	NA hr/day NA hr/yr	NA hr/day NA hr/yr

OPERATING LIMITS & SCHEDULE

23. Proposed Operating Limits: (hr/day, hr/yr, gal/yr, MMscf/yr, etc) **Note:** These limits will be placed in the permit:
24 hr/day, 8,760 hr/yr

FEDERAL RULES APPLICABLITY

24. NSPS or MACT Applicability: ☐ Yes ☒ No	If "yes", which subpart applies?: _____ **Note:** Form FRA must be completed.

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Units Industrial Boiler Information - **Form EU5**
Revision 6
11/26/18

Please see instructions on page 3 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description:	Conventional open-pit mining and onsite ore preparation and gold extraction processes. This form is for: Source ID: HAC, Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)

BOILER UNIT SPECIFICATIONS

4. Type of Unit: ☒ New unit ☐ Unpermitted existing unit ☐ Modification to an existing permitted unit? Permit number: _____

5. Manufacturer: TBD 6. Model: TBD 7. Manufacture Date: TBD

8. Date of installation: TBD 9. Serial Number: TBD 10. Boiler ID Number: HAC

11. Control Device (if any) None (Baghouse, ESP, or Scrubber) **Note:** Attach applicable control equipment FORM BCE, ESP, or SCE

12. Fuel Meter Used: ☐ Gaseous ☐ Liquid ☒ None

13. Boiler Exhaust Stack Parameters:

Diameter: 4 inches Height: 68 feet Temperature: 360 ºF Flow rate: 99 acfm
Exhaust Orientation: ☒ Vertical (unobstructed upward) ☐ Vertical (obstructed upward) ☐ Horizontal ☐ Other _____

14. Primary Burner: Manufacturer: TBD Model: TBD Max Heat Input Rating: 0.25 MMBtu/hr

15. Secondary Burner (if applicable): Manufacturer: N/A Model: N/A Max Heat Input Rating: N/A MMBtu/hr

FUEL SPECIFICATION AND EMISSION FACTORS

16. Primary Fuel Type: ☐ Natural Gas ☐ Diesel Fuel (#) ☒ LPG/Propane ☐ Other Fuel: _____

17. Secondary Fuel Type (if applicable): ☐ Natural Gas ☐ Diesel Fuel (#) ☐ LPG/Propane ☐ Other Fuel: _____

Fuel Type		Primary Fuel			Secondary Fuel		
18. Fuel Heat Value (Btu/unit, LHV)		91,500 Btu/gal			NA		
19. Sulfur Content (ppmv, wt%)		185 ppm			NA		
20. Manufacture's Rated or Source Test Emission Factors (if applicable) **Note:** Include supporting documentation		**Operational Mode**			**Operational Mode**		
		Steady State (lbs/MMBtu)	Start Up (lb/hr)	Shut Down (lb/hr)	Steady State (lbs/MMBtu)	Start Up (lnb/hr)	Shut Down (lb/hr)
	PM_{10}	AP42					
	$PM_{2.5}$	AP42					
	$N0_x$	AP42					
	CO	AP42					
	$S0_2$	AP42					
	VOC	AP42					
21. Other Pollutant(s): NA		NA					
22. Duration Operational Mode:		N/A	NA hr/day NA hr/yr	NA hr/day NA hr/yr	N/A	NA hr/day NA hr/yr	NA hr/day NA hr/yr

OPERATING LIMITS & SCHEDULE

23. Proposed Operating Limits: (hr/day, hr/yr, gal/yr, MMscf/yr, etc) **Note:** These limits will be placed in the permit:
24 hr/day, 8,760 hr/yr

FEDERAL RULES APPLICABLITY

24. NSPS or MACT Applicability: ☐ Yes ☒ No	If "yes", which subpart applies?: _____ **Note:** Form FRA must be completed.

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Units Industrial Boiler Information - **Form EU5**
Revision 6
11/26/18

Please see instructions on page 3 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description:	Conventional open-pit mining and onsite ore preparation and gold extraction processes. This form is for: Source ID: HR, Refinery HVAC Heater (0.25 MMBtu Propane-Fired)

BOILER UNIT SPECIFICATIONS

4. Type of Unit: ☒ New unit ☐ Unpermitted existing unit ☐ Modification to an existing permitted unit? Permit number: _____

5. Manufacturer: TBD 6. Model: TBD 7. Manufacture Date: TBD

8. Date of installation: TBD 9. Serial Number: TBD 10. Boiler ID Number: HR

11. Control Device (if any) None (Baghouse, ESP, or Scrubber) **Note:** Attach applicable control equipment FORM BCE, ESP, or SCE

12. Fuel Meter Used: ☐ Gaseous ☐ Liquid ☒ None

13. Boiler Exhaust Stack Parameters:

Diameter: 4 inches Height: 46 feet Temperature: 360 ºF Flow rate: 99 acfm
Exhaust Orientation: ☒ Vertical (unobstructed upward) ☐ Vertical (obstructed upward) ☐ Horizontal ☐ Other _____

14. Primary Burner: Manufacturer: TBD Model: TBD Max Heat Input Rating: 0.25 MMBtu/hr

15. Secondary Burner (if applicable): Manufacturer: N/A Model: N/A Max Heat Input Rating: N/A MMBtu/hr

FUEL SPECIFICATION AND EMISSION FACTORS

16. Primary Fuel Type: ☐ Natural Gas ☐ Diesel Fuel (#) ☒ LPG/Propane ☐ Other Fuel: _____

17. Secondary Fuel Type (if applicable): ☐ Natural Gas ☐ Diesel Fuel (#) ☐ LPG/Propane ☐ Other Fuel: _____

Fuel Type		Primary Fuel			Secondary Fuel		
18. Fuel Heat Value (Btu/unit, LHV)		91,500 Btu/gal			NA		
19. Sulfur Content (ppmv, wt%)		185 ppm			NA		
20. Manufacture's Rated or Source Test Emission Factors (if applicable) **Note:** Include supporting documentation		**Operational Mode**			**Operational Mode**		
		Steady State (lbs/MMBtu)	Start Up (lb/hr)	Shut Down (lb/hr)	Steady State (lbs/MMBtu)	Start Up (lnb/hr)	Shut Down (lb/hr)
	PM_{10}	AP42					
	$PM_{2.5}$	AP42					
	$N0_x$	AP42					
	CO	AP42					
	$S0_2$	AP42					
	VOC	AP42					
21. Other Pollutant(s): NA		NA					
22. Duration Operational Mode:		N/A	NA hr/day NA hr/yr	NA hr/day NA hr/yr	N/A	NA hr/day NA hr/yr	NA hr/day NA hr/yr

OPERATING LIMITS & SCHEDULE

23. Proposed Operating Limits: (hr/day, hr/yr, gal/yr, MMscf/yr, etc) **Note:** These limits will be placed in the permit:
24 hr/day, 8,760 hr/yr

FEDERAL RULES APPLICABLITY

24. NSPS or MACT Applicability: ☐ Yes ☒ No	If "yes", which subpart applies?: _____ **Note:** Form FRA must be completed.

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Units Industrial Boiler Information - **Form EU5**
Revision 6
11/26/18

Please see instructions on page 3 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description:	Conventional open-pit mining and onsite ore preparation and gold extraction processes. This form is for: Source ID: HA, Admin HVAC Heater (0.25 MMBtu Propane-Fired)

BOILER UNIT SPECIFICATIONS

4. Type of Unit: ☒ New unit ☐ Unpermitted existing unit ☐ Modification to an existing permitted unit? Permit number: _____

5. Manufacturer: TBD 6. Model: TBD 7. Manufacture Date: TBD

8. Date of installation: TBD 9. Serial Number: TBD 10. Boiler ID Number: HA

11. Control Device (if any) None (Baghouse, ESP, or Scrubber) **Note:** Attach applicable control equipment FORM BCE, ESP, or SCE

12. Fuel Meter Used: ☐ Gaseous ☐ Liquid ☒ None

13. Boiler Exhaust Stack Parameters:

Diameter: 4 inches Height: 21 feet Temperature: 360 ºF Flow rate: 99 acfm
Exhaust Orientation: ☒ Vertical (unobstructed upward) ☐ Vertical (obstructed upward) ☐ Horizontal ☐ Other _____

14. Primary Burner: Manufacturer: TBD Model: TBD Max Heat Input Rating: 0.25 MMBtu/hr

15. Secondary Burner (if applicable): Manufacturer: N/A Model: N/A Max Heat Input Rating: N/A MMBtu/hr

FUEL SPECIFICATION AND EMISSION FACTORS

16. Primary Fuel Type: ☐ Natural Gas ☐ Diesel Fuel (#) ☒ LPG/Propane ☐ Other Fuel: _____

17. Secondary Fuel Type (if applicable): ☐ Natural Gas ☐ Diesel Fuel (#) ☐ LPG/Propane ☐ Other Fuel: _____

Fuel Type		Primary Fuel			Secondary Fuel		
18. Fuel Heat Value (Btu/unit, LHV)		91,500 Btu/gal			NA		
19. Sulfur Content (ppmv, wt%)		185 ppm			NA		
20. Manufacture's Rated or Source Test Emission Factors (if applicable) **Note:** Include supporting documentation		**Operational Mode**			**Operational Mode**		
		Steady State (lbs/MMBtu)	Start Up (lb/hr)	Shut Down (lb/hr)	Steady State (lbs/MMBtu)	Start Up (lnb/hr)	Shut Down (lb/hr)
	PM_{10}	AP42					
	$PM_{2.5}$	AP42					
	$N0_x$	AP42					
	CO	AP42					
	$S0_2$	AP42					
	VOC	AP42					
21. Other Pollutant(s): NA		NA					
22. Duration Operational Mode:		N/A	NA hr/day NA hr/yr	NA hr/day NA hr/yr	N/A	NA hr/day NA hr/yr	NA hr/day NA hr/yr

OPERATING LIMITS & SCHEDULE

23. Proposed Operating Limits: (hr/day, hr/yr, gal/yr, MMscf/yr, etc) **Note:** These limits will be placed in the permit:
24 hr/day, 8,760 hr/yr

FEDERAL RULES APPLICABLITY

24. NSPS or MACT Applicability: ☐ Yes ☒ No	If "yes", which subpart applies?: _____ **Note:** Form FRA must be completed.

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Units Industrial Boiler Information - **Form EU5**
Revision 6
11/26/18

Please see instructions on page 3 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description:	Conventional open-pit mining and onsite ore preparation and gold extraction processes. This form is for: Source ID: HMO, Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)

BOILER UNIT SPECIFICATIONS

4. Type of Unit: ☒ New unit ☐ Unpermitted existing unit ☐ Modification to an existing permitted unit? Permit number: _____

5. Manufacturer: TBD 6. Model: TBD 7. Manufacture Date: TBD

8. Date of installation: TBD 9. Serial Number: TBD 10. Boiler ID Number: HMO1, HMO2

11. Control Device (if any) None (Baghouse, ESP, or Scrubber) **Note:** Attach applicable control equipment FORM BCE, ESP, or SCE

12. Fuel Meter Used: ☐ Gaseous ☐ Liquid ☒ None

13. Boiler Exhaust Stack Parameters:

Diameter: 8 inches Height: 41 feet Temperature: 360 ºF Flow rate: 99 acfm
Exhaust Orientation: ☒ Vertical (unobstructed upward) ☐ Vertical (obstructed upward) ☐ Horizontal ☐ Other _____

14. Primary Burner: Manufacturer: TBD Model: TBD Max Heat Input Rating: 0.25, each MMBtu/hr

15. Secondary Burner (if applicable): Manufacturer: N/A Model: N/A Max Heat Input Rating: N/A MMBtu/hr

FUEL SPECIFICATION AND EMISSION FACTORS

16. Primary Fuel Type: ☐ Natural Gas ☐ Diesel Fuel (#) ☒ LPG/Propane ☐ Other Fuel: _____

17. Secondary Fuel Type (if applicable): ☐ Natural Gas ☐ Diesel Fuel (#) ☐ LPG/Propane ☐ Other Fuel: _____

Fuel Type		Primary Fuel			Secondary Fuel		
18. Fuel Heat Value (Btu/unit, LHV)		91,500 Btu/gal			NA		
19. Sulfur Content (ppmv, wt%)		185 ppm			NA		
20. Manufacture's Rated or Source Test Emission Factors (if applicable) **Note:** Include supporting documentation		**Operational Mode**			**Operational Mode**		
		Steady State (lbs/MMBtu)	Start Up (lb/hr)	Shut Down (lb/hr)	Steady State (lbs/MMBtu)	Start Up (lnb/hr)	Shut Down (lb/hr)
	PM_{10}	AP42					
	$PM_{2.5}$	AP42					
	$N0_x$	AP42					
	CO	AP42					
	$S0_2$	AP42					
	VOC	AP42					
21. Other Pollutant(s): NA		NA					
22. Duration Operational Mode:		N/A	NA hr/day NA hr/yr	NA hr/day NA hr/yr	N/A	NA hr/day NA hr/yr	NA hr/day NA hr/yr

OPERATING LIMITS & SCHEDULE

23. Proposed Operating Limits: (hr/day, hr/yr, gal/yr, MMscf/yr, etc) **Note:** These limits will be placed in the permit:
24 hr/day, 8,760 hr/yr

FEDERAL RULES APPLICABLITY

24. NSPS or MACT Applicability: ☐ Yes ☒ No	If "yes", which subpart applies?: _____ **Note:** Form FRA must be completed.

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Units Industrial Boiler Information - **Form EU5**
Revision 6
11/26/18

Please see instructions on page 3 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description:	Conventional open-pit mining and onsite ore preparation and gold extraction processes. This form is for: Source ID: HTS, Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)

BOILER UNIT SPECIFICATIONS

4. Type of Unit: ☒ New unit ☐ Unpermitted existing unit ☐ Modification to an existing permitted unit? Permit number: _____

5. Manufacturer: TBD 6. Model: TBD 7. Manufacture Date: TBD

8. Date of installation: TBD 9. Serial Number: TBD 10. Boiler ID Number: HTS1, HTS2

11. Control Device (if any) None (Baghouse, ESP, or Scrubber) **Note:** Attach applicable control equipment FORM BCE, ESP, or SCE

12. Fuel Meter Used: ☐ Gaseous ☐ Liquid ☒ None

13. Boiler Exhaust Stack Parameters:

Diameter: 8 inches Height: 41 feet Temperature: 360 ºF Flow rate: 394 acfm
Exhaust Orientation: ☒ Vertical (unobstructed upward) ☐ Vertical (obstructed upward) ☐ Horizontal ☐ Other _____

14. Primary Burner: Manufacturer: TBD Model: TBD Max Heat Input Rating: 1, each MMBtu/hr

15. Secondary Burner (if applicable): Manufacturer: N/A Model: N/A Max Heat Input Rating: N/A MMBtu/hr

FUEL SPECIFICATION AND EMISSION FACTORS

16. Primary Fuel Type: ☐ Natural Gas ☐ Diesel Fuel (#) ☒ LPG/Propane ☐ Other Fuel: _____

17. Secondary Fuel Type (if applicable): ☐ Natural Gas ☐ Diesel Fuel (#) ☐ LPG/Propane ☐ Other Fuel: _____

Fuel Type		Primary Fuel			Secondary Fuel		
18. Fuel Heat Value (Btu/unit, LHV)		91,500 Btu/gal			NA		
19. Sulfur Content (ppmv, wt%)		185 ppm			NA		
20. Manufacture's Rated or Source Test Emission Factors (if applicable) **Note:** Include supporting documentation		**Operational Mode**			**Operational Mode**		
		Steady State (lbs/MMBtu)	Start Up (lb/hr)	Shut Down (lb/hr)	Steady State (lbs/MMBtu)	Start Up (lnb/hr)	Shut Down (lb/hr)
	PM_{10}	AP42					
	$PM_{2.5}$	AP42					
	$N0_x$	AP42					
	CO	AP42					
	$S0_2$	AP42					
	VOC	AP42					
21. Other Pollutant(s): NA		NA					
22. Duration Operational Mode:		N/A	NA hr/day NA hr/yr	NA hr/day NA hr/yr	N/A	NA hr/day NA hr/yr	NA hr/day NA hr/yr

OPERATING LIMITS & SCHEDULE

23. Proposed Operating Limits: (hr/day, hr/yr, gal/yr, MMscf/yr, etc) **Note:** These limits will be placed in the permit:
24 hr/day, 8,760 hr/yr

FEDERAL RULES APPLICABLITY

24. NSPS or MACT Applicability: ☐ Yes ☒ No	If "yes", which subpart applies?: _____ **Note:** Form FRA must be completed.

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Units Industrial Boiler Information - Form EU5

Revision 6
11/26/18

Please see instructions on page 3 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description:	Conventional open-pit mining and onsite ore preparation and gold extraction processes. This form is for: Source ID: HW, Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)

BOILER UNIT SPECIFICATIONS

4. Type of Unit: ☒ New unit ☐ Unpermitted existing unit ☐ Modification to an existing permitted unit? Permit number: _____

5. Manufacturer: TBD 6. Model: TBD 7. Manufacture Date: TBD

8. Date of installation: TBD 9. Serial Number: TBD 10. Boiler ID Number: HW1, HW2, HW3

11. Control Device (if any) None (Baghouse, ESP, or Scrubber) **Note:** Attach applicable control equipment FORM BCE, ESP, or SCE

12. Fuel Meter Used: ☐ Gaseous ☐ Liquid ☒ None

13. Boiler Exhaust Stack Parameters:

Diameter: 8 inches Height: 41 feet Temperature: 360 ºF Flow rate: 394 acfm
Exhaust Orientation: ☒ Vertical (unobstructed upward) ☐ Vertical (obstructed upward) ☐ Horizontal ☐ Other _____

14. Primary Burner: Manufacturer: TBD Model: TBD Max Heat Input Rating: 1, each MMBtu/hr

15. Secondary Burner (if applicable): Manufacturer: N/A Model: N/A Max Heat Input Rating: N/A MMBtu/hr

FUEL SPECIFICATION AND EMISSION FACTORS

16. Primary Fuel Type: ☐ Natural Gas ☐ Diesel Fuel (#) ☒ LPG/Propane ☐ Other Fuel: _____

17. Secondary Fuel Type (if applicable): ☐ Natural Gas ☐ Diesel Fuel (#) ☐ LPG/Propane ☐ Other Fuel: _____

Fuel Type		Primary Fuel			Secondary Fuel		
18. Fuel Heat Value (Btu/unit, LHV)		91,500 Btu/gal			NA		
19. Sulfur Content (ppmv, wt%)		185 ppm			NA		
20. Manufacture's Rated or Source Test Emission Factors (if applicable) **Note:** Include supporting documentation		**Operational Mode**			**Operational Mode**		
		Steady State (lbs/MMBtu)	Start Up (lb/hr)	Shut Down (lb/hr)	Steady State (lbs/MMBtu)	Start Up (lnb/hr)	Shut Down (lb/hr)
	PM_{10}	AP42					
	$PM_{2.5}$	AP42					
	$N0_x$	AP42					
	CO	AP42					
	$S0_2$	AP42					
	VOC	AP42					
21. Other Pollutant(s): NA		NA					
22. Duration Operational Mode:		N/A	NA hr/day NA hr/yr	NA hr/day NA hr/yr	N/A	NA hr/day NA hr/yr	NA hr/day NA hr/yr

OPERATING LIMITS & SCHEDULE

23. Proposed Operating Limits: (hr/day, hr/yr, gal/yr, MMscf/yr, etc) **Note:** These limits will be placed in the permit:
24 hr/day, 8,760 hr/yr

FEDERAL RULES APPLICABLITY

24. NSPS or MACT Applicability: ☐ Yes ☒ No	If "yes", which subpart applies?: _____ **Note:** Form FRA must be completed.

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Emissions Units Industrial Boiler Information - Form EU5

Revision 6
11/26/18

Please see instructions on page 3 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description:	Conventional open-pit mining and onsite ore preparation and gold extraction processes. This form is for: Source ID: LKC, PFR Shaft Lime Kiln Combustion

BOILER UNIT SPECIFICATIONS

4. Type of Unit: ☒ New unit ☐ Unpermitted existing unit ☐ Modification to an existing permitted unit? Permit number: _____

5. Manufacturer: TBD 6. Model: TBD 7. Manufacture Date: TBD

8. Date of installation: TBD 9. Serial Number: TBD 10. Boiler ID Number: LKC

11. Control Device (if any) None (Baghouse, ESP, or Scrubber) **Note:** Attach applicable control equipment FORM BCE, ESP, or SCE

12. Fuel Meter Used: ☐ Gaseous ☐ Liquid ☒ None

13. Boiler Exhaust Stack Parameters:

Diameter: 24 inches Height: 150 feet Temperature: 350 ºF Flow rate: 16,300 acfm
Exhaust Orientation: ☒ Vertical (unobstructed upward) ☐ Vertical (obstructed upward) ☐ Horizontal ☐ Other _____

14. Primary Burner: Manufacturer: TBD Model: TBD Max Heat Input Rating: 22.0 MMBtu/hr

15. Secondary Burner (if applicable): Manufacturer: N/A Model: N/A Max Heat Input Rating: N/A MMBtu/hr

FUEL SPECIFICATION AND EMISSION FACTORS

16. Primary Fuel Type: ☐ Natural Gas ☐ Diesel Fuel (#) ☒ LPG/Propane ☐ Other Fuel: _____

17. Secondary Fuel Type (if applicable): ☐ Natural Gas ☐ Diesel Fuel (#) ☐ LPG/Propane ☐ Other Fuel: _____

Fuel Type		Primary Fuel			Secondary Fuel		
18. Fuel Heat Value (Btu/unit, LHV)		91,500 Btu/gal					
19. Sulfur Content (ppmv, wt%)		185 ppm					
20. Manufacture's Rated or Source Test Emission Factors (if applicable) **Note:** Include supporting documentation		**Operational Mode**			**Operational Mode**		
		Steady State (lbs/MMBtu)	Start Up (lb/hr)	Shut Down (lb/hr)	Steady State (lbs/MMBtu)	Start Up (lnb/hr)	Shut Down (lb/hr)
	PM_{10}	AP42					
	$PM_{2.5}$	AP42					
	$N0_x$	AP42					
	CO	AP42					
	$S0_2$	AP42					
	VOC	AP42					
21. Other Pollutant(s): NA		NA					
22. Duration Operational Mode:		N/A	NA hr/day NA hr/yr	NA hr/day NA hr/yr	N/A	NA hr/day NA hr/yr	NA hr/day NA hr/yr

OPERATING LIMITS & SCHEDULE

23. Proposed Operating Limits: (hr/day, hr/yr, gal/yr, MMscf/yr, etc) **Note:** These limits will be placed in the permit:
24 hr/day, 8,760 hr/yr

FEDERAL RULES APPLICABLITY

24. NSPS or MACT Applicability: ☐ Yes ☒ No	If "yes", which subpart applies?: _____ **Note:** Form FRA must be completed.

1.7 Form CA – Carbon Adsorber (4 forms)

Table 5 provides a list of all emission units controlled by a carbon adsorber. The actual carbon adsorber information is to be determined along with operational parameters. Emissions data for each unit can be found in the detailed emission inventory in the "Stibnite Gold Project Air Quality Modeling Report," Attachment A of this application. Supporting documentation can be found on the digital media provided with this application.

Table 5. Sources Controlled by a Carbon Adsorber

Form #	Source ID	Description	Control
1	CKD	Carbon Regeneration Kiln (Drum)	Carbon Filter (CA1)
2	EW	Electrowinning Cells & Pregnant Solution Tank	Carbon Filter (CA2)
3	MR	Mercury Retort	Carbon Filter (CA3)
4	MF	Induction Melting Furnace	Carbon Filter (CA4)

PRI00000253

REC 1593

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Carbon Adsorber - **Form CA**
Revision 2
08/28/08

Please see instructions on page 3 before filling out the form.

IDENTIFICATION

1. Company Name:	Midas Gold Idaho, Inc.	2. Facility Name:	Stibnite Gold Project	3. Facility ID No.:	
4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.				

CARBON ADSORBER INFORMATION

Equipment Description

5. Manufacturer:	TBD	6. Model Number:	TBD	7. Make:	TBD

8. Type	☐ Fixed regenerative beds ☐ Disposable/rechargeable canisters ☐ Traveling bed adsorbers/rotary concentrators ☐ Fluidized adsorbers	Number of beds: TBD Capacity of each bed: TBD pounds of adsorbent
9. Adsorbent Material	☒ Granulated activated carbon ☐ Zeolite, molecular sieve ☐ Synthetic adsorbent Trade name: ☐ Other:	Adsorbent capacity: TBD (pound of vapor/pound of carbon)
10. Dimensions	Adsorbent vessel diameter: TBD feet	Depth of carbon in bed: TBD feet

Waste Gas Stream Characteristics

11. Brief Description of Process	Carbon loaded with gold from the ore leaching process is stripped with a caustic solution. The stripped carbon must be periodically regenerated in the carbon regeneration kiln. The exhaust from the kiln drum passes through a carbon adsorption bed, where any mercury is adsorbed onto activated carbon before being emitted, through a stack, into the atmosphere. This form is for the Carbon Regeneration Kiln (drum), Carbon Filter CA1

12. Waste Gas Stream	Material: Mercury Check box if material is a hazardous air pollutant (HAP) ☒ ☐ ☐ ☐	**Flow rate scfm** **(standard conditions are 68 degrees F and 14.7 psia)** Minimum: TBD Average: Maximum: Average concentration ppmv:
	Are reactive organics present? (e.g., ketone, aldehydes) ☐ Yes ☒ No	Relative humidity: % Cycle time for adsorption: hour(s) Lower explosive limit of mixture: ppmv or % volume
	Is the adsorbent material regenerated on-site? ☐ Yes ☒ No Regeneration rate: lb/min	On-site regeneration by: ☐ Steam ☐ Air ☐ Inert gas ☐ Process gas Other: Cycle time for regeneration: hour(s)
13. Regeneration	N/A	
14. Instrumentation Data	Exhaust temperature will be measured at the carbon adsorber inlet per 63.11647(g).	
15. Operating Schedule	Normal: 24 hours/day 7 days/week 52 weeks/year Maximum: 24 hours/day 7 days/week 52 weeks/year	

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Carbon Adsorber - **Form CA**
Revision 2
08/28/08

Please see instructions on page 3 before filling out the form.

IDENTIFICATION

1. Company Name:	Midas Gold Idaho, Inc.	2. Facility Name:	Stibnite Gold Project	3. Facility ID No.:	
4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.				

CARBON ADSORBER INFORMATION

Equipment Description

5. Manufacturer:	TBD	6. Model Number:	TBD	7. Make:	TBD

8. Type	☐ Fixed regenerative beds ☐ Disposable/rechargeable canisters ☐ Traveling bed adsorbers/rotary concentrators ☐ Fluidized adsorbers	Number of beds: TBD Capacity of each bed: TBD pounds of adsorbent
9. Adsorbent Material	☒ Granulated activated carbon ☐ Zeolite, molecular sieve ☐ Synthetic adsorbent Trade name: ☐ Other:	Adsorbent capacity: TBD (pound of vapor/pound of carbon)
10. Dimensions	Adsorbent vessel diameter: TBD feet	Depth of carbon in bed: TBD feet

Waste Gas Stream Characteristics

11. Brief Description of Process	Carbon loaded with gold from the ore leaching process is stripped with a caustic solution. This gold-bearing solution is then sent to the electrowinning (EW) plating process. The EW cells remove the gold from the solution by plating it onto cathodes consisting of stainless-steel plates with steel wool. The EW cells exhaust passes through a carbon adsorption column, where any remaining vapor mercury is adsorbed onto activated carbon before being emitted, through a stack, into the atmosphere. This form is for the Electrowinning Cells & Pregnant Solution Tank, Carbon Filter CA2

<table>
<tr><td rowspan="4">12. Waste Gas Stream</td><td>Material:
Mercury

Check box if material is a hazardous air pollutant (HAP)
☒
☐
☐
☐</td><td colspan="2">Flow rate scfm
(standard conditions are 68 degrees F and 14.7 psia)

Minimum
TBD

Average

Maximum

Average concentration ppmv</td></tr>
<tr><td>Are reactive organics present? (e.g., ketone, aldehydes)
☐ Yes ☒ No</td><td colspan="2">Relative humidity: %
Cycle time for adsorption: hour(s)
Lower explosive limit of mixture: ppmv or % volume</td></tr>
<tr><td>Is the adsorbent material regenerated on-site?
☐ Yes ☒ No
Regeneration rate: lb/min</td><td colspan="2">On-site regeneration by: ☐ Steam ☐ Air ☐ Inert gas
☐ Process gas Other:
Cycle time for regeneration: hour(s)</td></tr>
<tr><td></td><td colspan="2"></td></tr>
<tr><td>13. Regeneration</td><td colspan="3">N/A</td></tr>
<tr><td>14. Instrumentation Data</td><td colspan="3">Exhaust temperature will be measured at the carbon adsorber inlet per 63.11647(g).</td></tr>
<tr><td>15. Operating Schedule</td><td colspan="3">Normal: 24 hours/day 7 days/week 52 weeks/year
Maximum: 24 hours/day 7 days/week 52 weeks/year</td></tr>
</table>

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Carbon Adsorber - **Form CA**
Revision 2
08/28/08

Please see instructions on page 3 before filling out the form.

IDENTIFICATION

1. Company Name:	Midas Gold Idaho, Inc.	2. Facility Name:	Stibnite Gold Project	3. Facility ID No.:	
4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.				

CARBON ADSORBER INFORMATION

Equipment Description

5. Manufacturer:	TBD	6. Model Number:	TBD	7. Make:	TBD

8. Type	☐ Fixed regenerative beds ☐ Disposable/rechargeable canisters ☐ Traveling bed adsorbers/rotary concentrators ☐ Fluidized adsorbers	Number of beds: TBD Capacity of each bed: TBD pounds of adsorbent
9. Adsorbent Material	☒ Granulated activated carbon ☐ Zeolite, molecular sieve ☐ Synthetic adsorbent Trade name: ☐ Other:	Adsorbent capacity: TBD (pound of vapor/pound of carbon)
10. Dimensions	Adsorbent vessel diameter: TBD feet	Depth of carbon in bed: TBD feet

Waste Gas Stream Characteristics

11. Brief Description of Process	The gold concentrate is loaded into the retort, where it is heated under vacuum to drive off the mercury. The retort exhaust passes through a shell and tube condenser to cool the exhaust and condense the vapor mercury into a liquid, which is collected by the mercury trap. The exhaust passes through a carbon adsorption column, where any remaining vapor mercury is adsorbed onto sulfur-impregnated activated carbon before being emitted, through a stack, into the atmosphere. This form is for the Mercury Retort, Carbon Filter CA3

<table>
<tr><td rowspan="4">12. Waste Gas Stream</td><td>Material:
Mercury

Check box if material is a hazardous air pollutant (HAP)
☒
☐
☐
☐</td><td colspan="2">Flow rate scfm
(standard conditions are 68 degrees F and 14.7 psia)

Minimum
TBD

Average

Maximum

Average concentration ppmv</td></tr>
<tr><td>Are reactive organics present? (e.g., ketone, aldehydes)
☐ Yes ☒ No</td><td colspan="2">Relative humidity: %
Cycle time for adsorption: hour(s)
Lower explosive limit of mixture: ppmv or % volume</td></tr>
<tr><td>Is the adsorbent material regenerated on-site?
☐ Yes ☒ No
Regeneration rate: lb/min</td><td colspan="2">On-site regeneration by: ☐ Steam ☐ Air ☐ Inert gas
☐ Process gas Other:
Cycle time for regeneration: hour(s)</td></tr>
<tr><td></td><td colspan="2"></td></tr>
<tr><td>13. Regeneration</td><td colspan="3">N/A</td></tr>
<tr><td>14. Instrumentation Data</td><td colspan="3">Exhaust temperature will be measured at the carbon adsorber inlet per 63.11647(g).</td></tr>
<tr><td>15. Operating Schedule</td><td colspan="3">Normal: 24 hours/day 7 days/week 52 weeks/year
Maximum: 24 hours/day 7 days/week 52 weeks/year</td></tr>
</table>

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Carbon Adsorber - **Form CA**
Revision 2
08/28/08

Please see instructions on page 3 before filling out the form.

IDENTIFICATION

1. Company Name:	Midas Gold Idaho, Inc.	2. Facility Name:	Stibnite Gold Project	3. Facility ID No.:	
4. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.				

CARBON ADSORBER INFORMATION

Equipment Description

5. Manufacturer:	TBD	6. Model Number:	TBD	7. Make:	TBD

8. Type	☐ Fixed regenerative beds ☐ Disposable/rechargeable canisters ☐ Traveling bed adsorbers/rotary concentrators ☐ Fluidized adsorbers	Number of beds: TBD Capacity of each bed: TBD pounds of adsorbent
9. Adsorbent Material	☒ Granulated activated carbon ☐ Zeolite, molecular sieve ☐ Synthetic adsorbent Trade name: ☐ Other:	Adsorbent capacity: TBD (pound of vapor/pound of carbon)
10. Dimensions	Adsorbent vessel diameter: TBD feet	Depth of carbon in bed: TBD feet

Waste Gas Stream Characteristics

11. Brief Description of Process	After retorting, the gold concentrate is transferred to the electric induction melting furnace. Only retorted concentrate may be melted in the furnace. The exhaust passes through a carbon adsorption column, where any remaining vapor mercury is adsorbed onto activated carbon before being emitted, through a stack, into the atmosphere. This form is for the Induction Melting Furnace, Carbon Filter CA4.

PRI00000260

REC 1600

<table>
<tr><td rowspan="3">12. Waste Gas Stream</td><td>Material:
Mercury

Check box if material is a hazardous air pollutant (HAP)
☒
☐
☐
☐</td><td colspan="2">Flow rate scfm
(standard conditions are 68 degrees F and 14.7 psia)

Minimum
TBD

Average

Maximum

Average concentration ppmv</td></tr>
<tr><td>Are reactive organics present? (e.g., ketone, aldehydes)
☐ Yes ☒ No</td><td colspan="2">Relative humidity: %
Cycle time for adsorption: hour(s)
Lower explosive limit of mixture: ppmv or % volume</td></tr>
<tr><td>Is the adsorbent material regenerated on-site?
☐ Yes ☒ No
Regeneration rate: lb/min</td><td colspan="2">On-site regeneration by: ☐ Steam ☐ Air ☐ Inert gas
☐ Process gas Other:
Cycle time for regeneration: hour(s)</td></tr>
<tr><td>13. Regeneration</td><td colspan="3">N/A</td></tr>
<tr><td>14. Instrumentation Data</td><td colspan="3">Exhaust temperature will be measured at the carbon adsorber inlet per 63.11647(g).</td></tr>
<tr><td>15. Operating Schedule</td><td colspan="3">Normal: 24 hours/day 7 days/week 52 weeks/year
Maximum: 24 hours/day 7 days/week 52 weeks/year</td></tr>
</table>

1.8 Form BCE – Baghouses Control Equipment (14 forms)

Table 6 provides a list of all controls provided on a baghouse control form. This list includes both the baghouse controls and the bin vent filters located on silos for loading emissions. The noted references, along with the particulate matter emission concentrations can be found in the detailed emission inventory in the "Stibnite Gold Project Air Quality Modeling Report," Attachment A of this application. Supporting documentation can be found on the digital media provided with this application.

Table 6. Sources Controlled by a Baghouse

Form #	Source ID	Description	Control
1	Sb2	Sb Bagging	Baghouse (BH1)
2	MF	Induction Melting Furnace	Baghouse (BH2)
3	LSBM	Limestone Ball Mill	Baghouse (BH3)
4	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	Baghouse (BH4)
5	LCR	Lime Mill Crushing and associated transfers In and Out	Baghouse (BH5)
6	LS1L	Mill Lime Silo #1 Loading	Bin Vent Filter
7	MillS2L	Mill Lime Silo #2 Loading	Bin Vent Filter
8	ACS1L	AC Lime Silo #1 Loading	Bin Vent Filter
9	ACS2L	AC Lime Silo #2 Loading	Bin Vent Filter
10	ACS3L	AC Lime Silo #3 Loading	Bin Vent Filter
11	ACS4L	AC Lime Silo #4 Loading	Bin Vent Filter
12	CS1L	Cement/Shotcrete Silo #1 Loading	Bin Vent Filter
13	CS2L	Cement/Shotcrete Silo #2 Loading	Bin Vent Filter
14	LSL	Pebble Lime Silo Loading via Bucket Elevator	Bin Vent Filter

PRI00000262

REC 1602

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Baghouse Control Equipment **Form BCE**
Revision 6
2/18/10

Complete this form for each baghouse. Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description: Conventional open-pit mining and onsite ore preparation and gold extraction processes.
This form is for: Source ID: Sb2 - Sb Bagging - Baghouse (BH1)

BAGHOUSE INFORMATION

4. Baghouse Manufacturer: TBD	5. Baghouse Model: TBD	6. Baghouse Equipment ID: BH1

7 (a). Baghouse particulate matter emission concentration. **Note: Provide information in 7(a)-(c) or answer question #8 below.**	0.017 gr/dscf	*Manufacturers typically provide guarantees in grains per dry standard cubic foot (gr/dscf). Provide a copy of the guarantee, or other documentation, with the application along with a description of the types of bags that must be used to achieve the emission concentration.* ***Emission concentrations less than 0.01 gr/dscf will receive additional scrutiny by DEQ and a source test of the baghouse may be required.*** *If a guarantee is not provided then you must document how you obtained the emission concentration. Without documentation the application is not complete.*
7 (b). Percentage PM_{10} Or Provide PM_{10} Emission Concentration	100 % _____ gr/dscf	*What percentage of the PM concentration listed in question #7(a) is PM_{10}. You must provide documentation as to how the percentage was determined (i.e per the baghouse manufacturer). Without documentation the application is not complete.*
7 (c). Baghouse flow rate	800 dscfm	*Provide the baghouse flow rate in dry standard cubic feet per minute. Actual cubic feet per minute may be given in lieu of dscfm* ***if it is documented*** *that moisture content is insignificant. You must provide documentation as to how this flow rate was determined (i.e. per the exhaust fan manufacturer, combustion evaluation, etc.). Without documentation the application is not complete.*
8. Baghouse particulate matter control efficiency. **Note: Not needed if section #7 is completed.**	_____ % PM control _____ % PM_{10} control	*Applicant's providing the control efficiency of the baghouse must provide control efficiency for both PM and PM_{10}. Provide a copy of the control efficiency documentation with the application. Documentation must include a description of the types of bags that must be used to achieve the control efficiency. Without documentation the application is not complete.*
9. Is the baghouse equipped with a bag leak detector?	☐ Yes ☒ No	*If a bag leak detector is installed provide documentation on the leak detector, including; how the leak detector functions and what level of the output signal indicates that a bag is leaking. Without documentation the application is not complete.*

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Baghouse Control Equipment **Form BCE**
Revision 6
2/18/10

Complete this form for each baghouse. Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description: Conventional open-pit mining and onsite ore preparation and gold extraction processes.
This form is for: Source ID: MF - Induction Melting Furnace - Baghouse (BH2)

BAGHOUSE INFORMATION

4. Baghouse Manufacturer: TBD	5. Baghouse Model: TBD	6. Baghouse Equipment ID: BH2

7 (a). Baghouse particulate matter emission concentration. **Note: Provide information in 7(a)-(c) or answer question #8 below.**	0.095 gr/dscf	*Manufacturers typically provide guarantees in grains per dry standard cubic foot (gr/dscf). Provide a copy of the guarantee, or other documentation, with the application along with a description of the types of bags that must be used to achieve the emission concentration.* ***Emission concentrations less than 0.01 gr/dscf will receive additional scrutiny by DEQ and a source test of the baghouse may be required.*** *If a guarantee is not provided then you must document how you obtained the emission concentration. Without documentation the application is not complete.*
7 (b). Percentage PM_{10} Or Provide PM_{10} Emission Concentration	100 % _____ gr/dscf	*What percentage of the PM concentration listed in question #7(a) is PM_{10}. You must provide documentation as to how the percentage was determined (i.e per the baghouse manufacturer). Without documentation the application is not complete.*
7 (c). Baghouse flow rate	3500 dscfm	*Provide the baghouse flow rate in dry standard cubic feet per minute. Actual cubic feet per minute may be given in lieu of dscfm* ***if it is documented*** *that moisture content is insignificant. You must provide documentation as to how this flow rate was determined (i.e. per the exhaust fan manufacturer, combustion evaluation, etc.). Without documentation the application is not complete.*
8. Baghouse particulate matter control efficiency. **Note: Not needed if section #7 is completed.**	_____ % PM control _____ % PM_{10} control	*Applicant's providing the control efficiency of the baghouse must provide control efficiency for both PM and PM_{10}. Provide a copy of the control efficiency documentation with the application. Documentation must include a description of the types of bags that must be used to achieve the control efficiency. Without documentation the application is not complete.*
9. Is the baghouse equipped with a bag leak detector?	☐ Yes ☒ No	*If a bag leak detector is installed provide documentation on the leak detector, including; how the leak detector functions and what level of the output signal indicates that a bag is leaking. Without documentation the application is not complete.*

PRI00000264

REC 1604

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Baghouse Control Equipment **Form BCE**
Revision 6
2/18/10

Complete this form for each baghouse. Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description: Conventional open-pit mining and onsite ore preparation and gold extraction processes.
This form is for: Source ID: LSBM - Limestone Ball Mill - Baghouse (BH3)

BAGHOUSE INFORMATION

4. Baghouse Manufacturer: TBD	5. Baghouse Model: TBD	6. Baghouse Equipment ID: BH3

7 (a). Baghouse particulate matter emission concentration. **Note: Provide information in 7(a)-(c) or answer question #8 below.**	0.017 gr/dscf	*Manufacturers typically provide guarantees in grains per dry standard cubic foot (gr/dscf). Provide a copy of the guarantee, or other documentation, with the application along with a description of the types of bags that must be used to achieve the emission concentration.* ***Emission concentrations less than 0.01 gr/dscf will receive additional scrutiny by DEQ and a source test of the baghouse may be required.*** *If a guarantee is not provided then you must document how you obtained the emission concentration. Without documentation the application is not complete.*
7 (b). Percentage PM_{10} Or Provide PM_{10} Emission Concentration	_____ % 0.014 gr/dscf	*What percentage of the PM concentration listed in question #7(a) is PM_{10}. You must provide documentation as to how the percentage was determined (i.e per the baghouse manufacturer). Without documentation the application is not complete.*
7 (c). Baghouse flow rate	13000 dscfm	*Provide the baghouse flow rate in dry standard cubic feet per minute. Actual cubic feet per minute may be given in lieu of dscfm* ***if it is documented*** *that moisture content is insignificant. You must provide documentation as to how this flow rate was determined (i.e. per the exhaust fan manufacturer, combustion evaluation, etc.). Without documentation the application is not complete.*
8. Baghouse particulate matter control efficiency. **Note: Not needed if section #7 is completed.**	_____ % PM control _____ % PM_{10} control	*Applicant's providing the control efficiency of the baghouse must provide control efficiency for both PM and PM_{10}. Provide a copy of the control efficiency documentation with the application. Documentation must include a description of the types of bags that must be used to achieve the control efficiency. Without documentation the application is not complete.*
9. Is the baghouse equipped with a bag leak detector?	☐ Yes ☒ No	*If a bag leak detector is installed provide documentation on the leak detector, including; how the leak detector functions and what level of the output signal indicates that a bag is leaking. Without documentation the application is not complete.*

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Baghouse Control Equipment **Form BCE**
Revision 6
2/18/10

Complete this form for each baghouse. Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description: Conventional open-pit mining and onsite ore preparation and gold extraction processes.
This form is for: Source ID: LK - Parallel Flow Regenerative (PFR) Shaft Lime Kiln - Baghouse (BH4)

BAGHOUSE INFORMATION

4. Baghouse Manufacturer: TBD	5. Baghouse Model: TBD	6. Baghouse Equipment ID: BH4

7 (a). Baghouse particulate matter emission concentration. **Note: Provide information in 7(a)-(c) or answer question #8 below.**	0.013 gr/dscf	*Manufacturers typically provide guarantees in grains per dry standard cubic foot (gr/dscf). Provide a copy of the guarantee, or other documentation, with the application along with a description of the types of bags that must be used to achieve the emission concentration.* ***Emission concentrations less than 0.01 gr/dscf will receive additional scrutiny by DEQ and a source test of the baghouse may be required.*** *If a guarantee is not provided then you must document how you obtained the emission concentration. Without documentation the application is not complete.*
7 (b). Percentage PM_{10} Or Provide PM_{10} Emission Concentration	100 % _____ gr/dscf	*What percentage of the PM concentration listed in question #7(a) is PM_{10}. You must provide documentation as to how the percentage was determined (i.e per the baghouse manufacturer). Without documentation the application is not complete.*
7 (c). Baghouse flow rate	8000 dscfm	*Provide the baghouse flow rate in dry standard cubic feet per minute. Actual cubic feet per minute may be given in lieu of dscfm* ***if it is documented*** *that moisture content is insignificant. You must provide documentation as to how this flow rate was determined (i.e. per the exhaust fan manufacturer, combustion evaluation, etc.). Without documentation the application is not complete.*
8. Baghouse particulate matter control efficiency. **Note: Not needed if section #7 is completed.**	_____ % PM control _____ % PM_{10} control	*Applicant's providing the control efficiency of the baghouse must provide control efficiency for both PM and PM_{10}. Provide a copy of the control efficiency documentation with the application. Documentation must include a description of the types of bags that must be used to achieve the control efficiency. Without documentation the application is not complete.*
9. Is the baghouse equipped with a bag leak detector?	☐ Yes ☒ No	*If a bag leak detector is installed provide documentation on the leak detector, including; how the leak detector functions and what level of the output signal indicates that a bag is leaking. Without documentation the application is not complete.*

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Baghouse Control Equipment **Form BCE**
Revision 6
2/18/10

Complete this form for each baghouse. Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description: Conventional open-pit mining and onsite ore preparation and gold extraction processes.
This form is for: Source ID: LCR - Lime Mill Crushing and associated transfers In and Out - Baghouse (BH5)

BAGHOUSE INFORMATION

4. Baghouse Manufacturer: TBD	5. Baghouse Model: TBD	6. Baghouse Equipment ID: BH5

7 (a). Baghouse particulate matter emission concentration. **Note: Provide information in 7(a)-(c) or answer question #8 below.**	0.017 gr/dscf	*Manufacturers typically provide guarantees in grains per dry standard cubic foot (gr/dscf). Provide a copy of the guarantee, or other documentation, with the application along with a description of the types of bags that must be used to achieve the emission concentration.* ***Emission concentrations less than 0.01 gr/dscf will receive additional scrutiny by DEQ and a source test of the baghouse may be required.*** *If a guarantee is not provided then you must document how you obtained the emission concentration. Without documentation the application is not complete.*
7 (b). Percentage PM_{10} Or Provide PM_{10} Emission Concentration	_____ % 0.014 gr/dscf	*What percentage of the PM concentration listed in question #7(a) is PM_{10}. You must provide documentation as to how the percentage was determined (i.e per the baghouse manufacturer). Without documentation the application is not complete.*
7 (c). Baghouse flow rate	2000 dscfm	*Provide the baghouse flow rate in dry standard cubic feet per minute. Actual cubic feet per minute may be given in lieu of dscfm* ***if it is documented*** *that moisture content is insignificant. You must provide documentation as to how this flow rate was determined (i.e. per the exhaust fan manufacturer, combustion evaluation, etc.). Without documentation the application is not complete.*
8. Baghouse particulate matter control efficiency. **Note: Not needed if section #7 is completed.**	_____ % PM control _____ % PM_{10} control	*Applicant's providing the control efficiency of the baghouse must provide control efficiency for both PM and PM_{10}. Provide a copy of the control efficiency documentation with the application. Documentation must include a description of the types of bags that must be used to achieve the control efficiency. Without documentation the application is not complete.*
9. Is the baghouse equipped with a bag leak detector?	☐ Yes ☒ No	*If a bag leak detector is installed provide documentation on the leak detector, including; how the leak detector functions and what level of the output signal indicates that a bag is leaking. Without documentation the application is not complete.*

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Baghouse Control Equipment **Form BCE**
Revision 6
2/18/10

Complete this form for each baghouse. Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description: Conventional open-pit mining and onsite ore preparation and gold extraction processes.
This form is for: Source ID: LS1L - Mill Lime Silo #1 Loading - Bin Vent Filter

BAGHOUSE INFORMATION

4. Baghouse Manufacturer: NA	5. Baghouse Model: NA	6. Baghouse Equipment ID: NA

7 (a). Baghouse particulate matter emission concentration. **Note: Provide information in 7(a)-(c) or answer question #8 below.**	0.01 gr/dscf	*Manufacturers typically provide guarantees in grains per dry standard cubic foot (gr/dscf). Provide a copy of the guarantee, or other documentation, with the application along with a description of the types of bags that must be used to achieve the emission concentration.* ***Emission concentrations less than 0.01 gr/dscf will receive additional scrutiny by DEQ and a source test of the baghouse may be required.*** *If a guarantee is not provided then you must document how you obtained the emission concentration. Without documentation the application is not complete.*
7 (b). Percentage PM_{10} Or Provide PM_{10} Emission Concentration	_____ % 0.003 gr/dscf	*What percentage of the PM concentration listed in question #7(a) is PM_{10}. You must provide documentation as to how the percentage was determined (i.e per the baghouse manufacturer). Without documentation the application is not complete.*
7 (c). Baghouse flow rate	700 dscfm	*Provide the baghouse flow rate in dry standard cubic feet per minute. Actual cubic feet per minute may be given in lieu of dscfm* ***if it is documented*** *that moisture content is insignificant. You must provide documentation as to how this flow rate was determined (i.e. per the exhaust fan manufacturer, combustion evaluation, etc.). Without documentation the application is not complete.*
8. Baghouse particulate matter control efficiency. **Note: Not needed if section #7 is completed.**	_____ % PM control _____ % PM_{10} control	*Applicant's providing the control efficiency of the baghouse must provide control efficiency for both PM and PM_{10}. Provide a copy of the control efficiency documentation with the application. Documentation must include a description of the types of bags that must be used to achieve the control efficiency. Without documentation the application is not complete.*
9. Is the baghouse equipped with a bag leak detector?	☐ Yes ☒ No	*If a bag leak detector is installed provide documentation on the leak detector, including; how the leak detector functions and what level of the output signal indicates that a bag is leaking. Without documentation the application is not complete.*

PRI00000268

REC 1608

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Baghouse Control Equipment **Form BCE**
Revision 6
2/18/10

Complete this form for each baghouse. Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description: Conventional open-pit mining and onsite ore preparation and gold extraction processes.
This form is for: Source ID: MillS2L - Mill Lime Silo #2 Loading - Bin Vent Filter

BAGHOUSE INFORMATION

4. Baghouse Manufacturer: NA	5. Baghouse Model: NA	6. Baghouse Equipment ID: NA

7 (a). Baghouse particulate matter emission concentration. **Note: Provide information in 7(a)-(c) or answer question #8 below.**	0.01 gr/dscf	*Manufacturers typically provide guarantees in grains per dry standard cubic foot (gr/dscf). Provide a copy of the guarantee, or other documentation, with the application along with a description of the types of bags that must be used to achieve the emission concentration.* ***Emission concentrations less than 0.01 gr/dscf will receive additional scrutiny by DEQ and a source test of the baghouse may be required.*** *If a guarantee is not provided then you must document how you obtained the emission concentration. Without documentation the application is not complete.*
7 (b). Percentage PM_{10} Or Provide PM_{10} Emission Concentration	_____ % 0.003 gr/dscf	*What percentage of the PM concentration listed in question #7(a) is PM_{10}. You must provide documentation as to how the percentage was determined (i.e per the baghouse manufacturer). Without documentation the application is not complete.*
7 (c). Baghouse flow rate	700 dscfm	*Provide the baghouse flow rate in dry standard cubic feet per minute. Actual cubic feet per minute may be given in lieu of dscfm* ***if it is documented*** *that moisture content is insignificant. You must provide documentation as to how this flow rate was determined (i.e. per the exhaust fan manufacturer, combustion evaluation, etc.). Without documentation the application is not complete.*
8. Baghouse particulate matter control efficiency. **Note: Not needed if section #7 is completed.**	_____ % PM control _____ % PM_{10} control	*Applicant's providing the control efficiency of the baghouse must provide control efficiency for both PM and PM_{10}. Provide a copy of the control efficiency documentation with the application. Documentation must include a description of the types of bags that must be used to achieve the control efficiency. Without documentation the application is not complete.*
9. Is the baghouse equipped with a bag leak detector?	☐ Yes ☒ No	*If a bag leak detector is installed provide documentation on the leak detector, including; how the leak detector functions and what level of the output signal indicates that a bag is leaking. Without documentation the application is not complete.*

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Baghouse Control Equipment **Form BCE**
Revision 6
2/18/10

Complete this form for each baghouse. Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description: Conventional open-pit mining and onsite ore preparation and gold extraction processes.
This form is for: Source ID: ACS1L - AC Lime Silo #1 Loading - Bin Vent Filter

BAGHOUSE INFORMATION

4. Baghouse Manufacturer: NA	5. Baghouse Model: NA	6. Baghouse Equipment ID: NA

7 (a). Baghouse particulate matter emission concentration. **Note: Provide information in 7(a)-(c) or answer question #8 below.**	0.01 gr/dscf	*Manufacturers typically provide guarantees in grains per dry standard cubic foot (gr/dscf). Provide a copy of the guarantee, or other documentation, with the application along with a description of the types of bags that must be used to achieve the emission concentration.* ***Emission concentrations less than 0.01 gr/dscf will receive additional scrutiny by DEQ and a source test of the baghouse may be required.*** *If a guarantee is not provided then you must document how you obtained the emission concentration. Without documentation the application is not complete.*
7 (b). Percentage PM_{10} Or Provide PM_{10} Emission Concentration	_____ % 0.003 gr/dscf	*What percentage of the PM concentration listed in question #7(a) is PM_{10}. You must provide documentation as to how the percentage was determined (i.e per the baghouse manufacturer). Without documentation the application is not complete.*
7 (c). Baghouse flow rate	1400 dscfm	*Provide the baghouse flow rate in dry standard cubic feet per minute. Actual cubic feet per minute may be given in lieu of dscfm* ***if it is documented*** *that moisture content is insignificant. You must provide documentation as to how this flow rate was determined (i.e. per the exhaust fan manufacturer, combustion evaluation, etc.). Without documentation the application is not complete.*
8. Baghouse particulate matter control efficiency. **Note: Not needed if section #7 is completed.**	_____ % PM control _____ % PM_{10} control	*Applicant's providing the control efficiency of the baghouse must provide control efficiency for both PM and PM_{10}. Provide a copy of the control efficiency documentation with the application. Documentation must include a description of the types of bags that must be used to achieve the control efficiency. Without documentation the application is not complete.*
9. Is the baghouse equipped with a bag leak detector?	☐ Yes ☒ No	*If a bag leak detector is installed provide documentation on the leak detector, including; how the leak detector functions and what level of the output signal indicates that a bag is leaking. Without documentation the application is not complete.*

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Baghouse Control Equipment **Form BCE**
Revision 6
2/18/10

Complete this form for each baghouse. Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description: Conventional open-pit mining and onsite ore preparation and gold extraction processes.
This form is for: Source ID: ACS2L - AC Lime Silo #2 Loading - Bin Vent Filter

BAGHOUSE INFORMATION

4. Baghouse Manufacturer: NA	5. Baghouse Model: NA	6. Baghouse Equipment ID: NA

7 (a). Baghouse particulate matter emission concentration. **Note: Provide information in 7(a)-(c) or answer question #8 below.**	0.01 gr/dscf	*Manufacturers typically provide guarantees in grains per dry standard cubic foot (gr/dscf). Provide a copy of the guarantee, or other documentation, with the application along with a description of the types of bags that must be used to achieve the emission concentration.* ***Emission concentrations less than 0.01 gr/dscf will receive additional scrutiny by DEQ and a source test of the baghouse may be required.*** *If a guarantee is not provided then you must document how you obtained the emission concentration. Without documentation the application is not complete.*
7 (b). Percentage PM_{10} Or Provide PM_{10} Emission Concentration	_____ % 0.003 gr/dscf	*What percentage of the PM concentration listed in question #7(a) is PM_{10}. You must provide documentation as to how the percentage was determined (i.e per the baghouse manufacturer). Without documentation the application is not complete.*
7 (c). Baghouse flow rate	1400 dscfm	*Provide the baghouse flow rate in dry standard cubic feet per minute. Actual cubic feet per minute may be given in lieu of dscfm* ***if it is documented*** *that moisture content is insignificant. You must provide documentation as to how this flow rate was determined (i.e. per the exhaust fan manufacturer, combustion evaluation, etc.). Without documentation the application is not complete.*
8. Baghouse particulate matter control efficiency. **Note: Not needed if section #7 is completed.**	_____ % PM control _____ % PM_{10} control	*Applicant's providing the control efficiency of the baghouse must provide control efficiency for both PM and PM_{10}. Provide a copy of the control efficiency documentation with the application. Documentation must include a description of the types of bags that must be used to achieve the control efficiency. Without documentation the application is not complete.*
9. Is the baghouse equipped with a bag leak detector?	☐ Yes ☒ No	*If a bag leak detector is installed provide documentation on the leak detector, including; how the leak detector functions and what level of the output signal indicates that a bag is leaking. Without documentation the application is not complete.*

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Baghouse Control Equipment **Form BCE**
Revision 6
2/18/10

Complete this form for each baghouse. Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description: Conventional open-pit mining and onsite ore preparation and gold extraction processes.
This form is for: Source ID: ACS3L - AC Lime Silo #3 Loading - Bin Vent Filter

BAGHOUSE INFORMATION

4. Baghouse Manufacturer: NA	5. Baghouse Model: NA	6. Baghouse Equipment ID: NA

7 (a). Baghouse particulate matter emission concentration. **Note: Provide information in 7(a)-(c) or answer question #8 below.**	0.01 gr/dscf	*Manufacturers typically provide guarantees in grains per dry standard cubic foot (gr/dscf). Provide a copy of the guarantee, or other documentation, with the application along with a description of the types of bags that must be used to achieve the emission concentration.* ***Emission concentrations less than 0.01 gr/dscf will receive additional scrutiny by DEQ and a source test of the baghouse may be required.*** *If a guarantee is not provided then you must document how you obtained the emission concentration. Without documentation the application is not complete.*
7 (b). Percentage PM_{10} Or Provide PM_{10} Emission Concentration	_____ % 0.003 gr/dscf	*What percentage of the PM concentration listed in question #7(a) is PM_{10}. You must provide documentation as to how the percentage was determined (i.e per the baghouse manufacturer). Without documentation the application is not complete.*
7 (c). Baghouse flow rate	1400 dscfm	*Provide the baghouse flow rate in dry standard cubic feet per minute. Actual cubic feet per minute may be given in lieu of dscfm* ***if it is documented*** *that moisture content is insignificant. You must provide documentation as to how this flow rate was determined (i.e. per the exhaust fan manufacturer, combustion evaluation, etc.). Without documentation the application is not complete.*
8. Baghouse particulate matter control efficiency. **Note: Not needed if section #7 is completed.**	_____ % PM control _____ % PM_{10} control	*Applicant's providing the control efficiency of the baghouse must provide control efficiency for both PM and PM_{10}. Provide a copy of the control efficiency documentation with the application. Documentation must include a description of the types of bags that must be used to achieve the control efficiency. Without documentation the application is not complete.*
9. Is the baghouse equipped with a bag leak detector?	☐ Yes ☒ No	*If a bag leak detector is installed provide documentation on the leak detector, including; how the leak detector functions and what level of the output signal indicates that a bag is leaking. Without documentation the application is not complete.*

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Baghouse Control Equipment **Form BCE**
Revision 6
2/18/10

Complete this form for each baghouse. Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description: Conventional open-pit mining and onsite ore preparation and gold extraction processes.
This form is for: Source ID: ACS4L - AC Lime Silo #4 Loading - Bin Vent Filter

BAGHOUSE INFORMATION

4. Baghouse Manufacturer: NA	5. Baghouse Model: NA	6. Baghouse Equipment ID: NA

7 (a). Baghouse particulate matter emission concentration. **Note: Provide information in 7(a)-(c) or answer question #8 below.**	0.01 gr/dscf	*Manufacturers typically provide guarantees in grains per dry standard cubic foot (gr/dscf). Provide a copy of the guarantee, or other documentation, with the application along with a description of the types of bags that must be used to achieve the emission concentration.* ***Emission concentrations less than 0.01 gr/dscf will receive additional scrutiny by DEQ and a source test of the baghouse may be required.*** *If a guarantee is not provided then you must document how you obtained the emission concentration. Without documentation the application is not complete.*
7 (b). Percentage PM_{10} Or Provide PM_{10} Emission Concentration	_____ % 0.003 gr/dscf	*What percentage of the PM concentration listed in question #7(a) is PM_{10}. You must provide documentation as to how the percentage was determined (i.e per the baghouse manufacturer). Without documentation the application is not complete.*
7 (c). Baghouse flow rate	1400 dscfm	*Provide the baghouse flow rate in dry standard cubic feet per minute. Actual cubic feet per minute may be given in lieu of dscfm* ***if it is documented*** *that moisture content is insignificant. You must provide documentation as to how this flow rate was determined (i.e. per the exhaust fan manufacturer, combustion evaluation, etc.). Without documentation the application is not complete.*
8. Baghouse particulate matter control efficiency. **Note: Not needed if section #7 is completed.**	_____ % PM control _____ % PM_{10} control	*Applicant's providing the control efficiency of the baghouse must provide control efficiency for both PM and PM_{10}. Provide a copy of the control efficiency documentation with the application. Documentation must include a description of the types of bags that must be used to achieve the control efficiency. Without documentation the application is not complete.*
9. Is the baghouse equipped with a bag leak detector?	☐ Yes ☒ No	*If a bag leak detector is installed provide documentation on the leak detector, including; how the leak detector functions and what level of the output signal indicates that a bag is leaking. Without documentation the application is not complete.*

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Baghouse Control Equipment **Form BCE**
Revision 6
2/18/10

Complete this form for each baghouse. Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description: Conventional open-pit mining and onsite ore preparation and gold extraction processes.
This form is for: Source ID: CS1L - Cement/Shotcrete Silo #1 Loading - Bin Vent Filter

BAGHOUSE INFORMATION

4. Baghouse Manufacturer: NA	5. Baghouse Model: NA	6. Baghouse Equipment ID: NA

7 (a). Baghouse particulate matter emission concentration. **Note: Provide information in 7(a)-(c) or answer question #8 below.**	0.01 gr/dscf	*Manufacturers typically provide guarantees in grains per dry standard cubic foot (gr/dscf). Provide a copy of the guarantee, or other documentation, with the application along with a description of the types of bags that must be used to achieve the emission concentration.* ***Emission concentrations less than 0.01 gr/dscf will receive additional scrutiny by DEQ and a source test of the baghouse may be required.*** *If a guarantee is not provided then you must document how you obtained the emission concentration. Without documentation the application is not complete.*
7 (b). Percentage PM_{10} Or Provide PM_{10} Emission Concentration	_____ % 0.003 gr/dscf	*What percentage of the PM concentration listed in question #7(a) is PM_{10}. You must provide documentation as to how the percentage was determined (i.e per the baghouse manufacturer). Without documentation the application is not complete.*
7 (c). Baghouse flow rate	930 dscfm	*Provide the baghouse flow rate in dry standard cubic feet per minute. Actual cubic feet per minute may be given in lieu of dscfm* ***if it is documented*** *that moisture content is insignificant. You must provide documentation as to how this flow rate was determined (i.e. per the exhaust fan manufacturer, combustion evaluation, etc.). Without documentation the application is not complete.*
8. Baghouse particulate matter control efficiency. **Note: Not needed if section #7 is completed.**	_____ % PM control _____ % PM_{10} control	*Applicant's providing the control efficiency of the baghouse must provide control efficiency for both PM and PM_{10}. Provide a copy of the control efficiency documentation with the application. Documentation must include a description of the types of bags that must be used to achieve the control efficiency. Without documentation the application is not complete.*
9. Is the baghouse equipped with a bag leak detector?	☐ Yes ☒ No	*If a bag leak detector is installed provide documentation on the leak detector, including; how the leak detector functions and what level of the output signal indicates that a bag is leaking. Without documentation the application is not complete.*

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Baghouse Control Equipment **Form BCE**
Revision 6
2/18/10

Complete this form for each baghouse. Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description: Conventional open-pit mining and onsite ore preparation and gold extraction processes.
This form is for: Source ID: CS2L - Cement/Shotcrete Silo #2 Loading - Bin Vent Filter

BAGHOUSE INFORMATION

4. Baghouse Manufacturer: NA	5. Baghouse Model: NA	6. Baghouse Equipment ID: NA

7 (a). Baghouse particulate matter emission concentration. **Note: Provide information in 7(a)-(c) or answer question #8 below.**	0.01 gr/dscf	*Manufacturers typically provide guarantees in grains per dry standard cubic foot (gr/dscf). Provide a copy of the guarantee, or other documentation, with the application along with a description of the types of bags that must be used to achieve the emission concentration.* ***Emission concentrations less than 0.01 gr/dscf will receive additional scrutiny by DEQ and a source test of the baghouse may be required.*** *If a guarantee is not provided then you must document how you obtained the emission concentration. Without documentation the application is not complete.*
7 (b). Percentage PM_{10} Or Provide PM_{10} Emission Concentration	_____ % 0.003 gr/dscf	*What percentage of the PM concentration listed in question #7(a) is PM_{10}. You must provide documentation as to how the percentage was determined (i.e per the baghouse manufacturer). Without documentation the application is not complete.*
7 (c). Baghouse flow rate	930 dscfm	*Provide the baghouse flow rate in dry standard cubic feet per minute. Actual cubic feet per minute may be given in lieu of dscfm* ***if it is documented*** *that moisture content is insignificant. You must provide documentation as to how this flow rate was determined (i.e. per the exhaust fan manufacturer, combustion evaluation, etc.). Without documentation the application is not complete.*
8. Baghouse particulate matter control efficiency. **Note: Not needed if section #7 is completed.**	_____ % PM control _____ % PM_{10} control	*Applicant's providing the control efficiency of the baghouse must provide control efficiency for both PM and PM_{10}. Provide a copy of the control efficiency documentation with the application. Documentation must include a description of the types of bags that must be used to achieve the control efficiency. Without documentation the application is not complete.*
9. Is the baghouse equipped with a bag leak detector?	☐ Yes ☒ No	*If a bag leak detector is installed provide documentation on the leak detector, including; how the leak detector functions and what level of the output signal indicates that a bag is leaking. Without documentation the application is not complete.*

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Baghouse Control Equipment **Form BCE**
Revision 6
2/18/10

Complete this form for each baghouse. Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project

3. Brief Project Description: Conventional open-pit mining and onsite ore preparation and gold extraction processes.
This form is for: Source ID: LSL - Pebble Lime Silo Loading via Bucket Elevator - Bin Vent Filter

BAGHOUSE INFORMATION

4. Baghouse Manufacturer: NA	5. Baghouse Model: NA	6. Baghouse Equipment ID: NA

7 (a). Baghouse particulate matter emission concentration. **Note: Provide information in 7(a)-(c) or answer question #8 below.**	0.01 gr/dscf	*Manufacturers typically provide guarantees in grains per dry standard cubic foot (gr/dscf). Provide a copy of the guarantee, or other documentation, with the application along with a description of the types of bags that must be used to achieve the emission concentration.* ***Emission concentrations less than 0.01 gr/dscf will receive additional scrutiny by DEQ and a source test of the baghouse may be required.*** *If a guarantee is not provided then you must document how you obtained the emission concentration. Without documentation the application is not complete.*
7 (b). Percentage PM_{10} Or Provide PM_{10} Emission Concentration	100 % _____ gr/dscf	*What percentage of the PM concentration listed in question #7(a) is PM_{10}. You must provide documentation as to how the percentage was determined (i.e per the baghouse manufacturer). Without documentation the application is not complete.*
7 (c). Baghouse flow rate	70 dscfm	*Provide the baghouse flow rate in dry standard cubic feet per minute. Actual cubic feet per minute may be given in lieu of dscfm* ***if it is documented*** *that moisture content is insignificant. You must provide documentation as to how this flow rate was determined (i.e. per the exhaust fan manufacturer, combustion evaluation, etc.). Without documentation the application is not complete.*
8. Baghouse particulate matter control efficiency. **Note: Not needed if section #7 is completed.**	_____ % PM control _____ % PM_{10} control	*Applicant's providing the control efficiency of the baghouse must provide control efficiency for both PM and PM_{10}. Provide a copy of the control efficiency documentation with the application. Documentation must include a description of the types of bags that must be used to achieve the control efficiency. Without documentation the application is not complete.*
9. Is the baghouse equipped with a bag leak detector?	☐ Yes ☒ No	*If a bag leak detector is installed provide documentation on the leak detector, including; how the leak detector functions and what level of the output signal indicates that a bag is leaking. Without documentation the application is not complete.*

1.9 Form SCE – Scrubbers Control Equipment (3 forms)

Table 7 provides a list of all emission units controlled by a wet scrubber. The actual scrubber types are to be determined along with operational parameters. Emissions data for each unit can be found in the detailed emission inventory found in the "Stibnite Gold Project Air Quality Modeling Report" found in Attachment A of this application. Supporting documentation can be found on the digital media provided with this application.

Table 7. Sources Controlled by a Wet Scrubber

Form #	Source ID	Description	Control
1	AC	Autoclave	Wet Scrubber (WS1)
2	CKD	Carbon Regeneration Kiln (Drum)	Wet Scrubber (WS2)
3	LSU	Pebble Lime Silo discharge to Lime Slaker	Wet Scrubber (WS3)

PRI00000277

REC 1617

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Scrubber Control Equipment - **Form SCE**
Revision 6
6/11/15

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project
3. Emissions Unit ID (unit being controlled by the scrubber)	4. Exhaust Stack ID of the Scrubber:
AC - Autoclave	WS1
5. Project Description	Conventional open-pit mining and onsite ore preparation and gold extraction processes. This form is for: Source ID: AC - Autoclave - Wet Scrubber (WS1)

EQUIPMENT DESCRIPTION

Equipment	6. Manufacturer: TBD	7. Model.: TBD		
Scrubber Type	8. ☒ Wet Scrubber (indicate type)	☐ Venturi	☐ Packed Bed	☐ Condensation Scrubbing
		☐ Tray/Plate	☐ Orifice	☐ Spray Chamber
	9. ☐ Dry Scrubber			
	10. ☐ Other (please provide details):			
Operation	**Packed Bed (if applicable)**	11. Type of Packing Material: TBD		
	Venturi (if applicable)	12. Pressure Drop Across Throat: TBD in w.g.		
	Spray Chamber (if applicable)	13. Pressure in Spray Nozzles: TBD in psi		
	14. Operating Pressure Range (all scrubber types): TBD to TBD in w.g.			
	15. Other Operating Parameters (if neccessary): TBD			
Scrubbing Media (as required)	16. Recirculation Rate: TBD gpm	17. Flow Meter? ☐ Yes ☐ No		
	18. pH of Scrubbing Media (range): _____ to _____	19. pH Meter? ☐ Yes ☐ No		
	20. ORP of Scrubbing Media (range): _____ to _____ mv	21. ORP Meter? ☐ Yes ☐ No		
Pollutant (being removed)	22. ☒ Particulates (PM_{10}/$PM_{2.5}$)	23. ☐ VOC		
	24. ☐ SO_2	25. ☐ H_2S		
	26. ☐ Odor	27. ☐ Inorganic Fumes		
	28. Other:			

Emissions Data	**Pollutant**	**Control Efficiency %**	**Source of Data**
	29. Particulates (PM_{10})	Control in EF	37. ☐ Manufacturer's Specifications
	30. Particulates ($PM_{2.5}$)	Control in EF	38. ☐ Emissions Source Test (provide source test report)
	31. VOC		39. ☐ AP-42 Section _____
	32. SO_2		40. ☒ Other
	33. H_2S		*Note: Supporting documentation must be provided.*
	34. Odor		*"Supporting documentation must be provided" in this section means the following information shall be available for DEQ staff review:*
	35. Inorganic Fume		• *Control equipment manufacturer guarantees (if applicable),*
	36. Other		• *Source test reports (if applicable)*
			• *All sources of emissions factors used to perform emissions calculations (i.e. continuous emissions monitoring system (CEMS) data, source testing, and/or US EPA's AP-42), and*
			• *All assumptions used to perform emissions calculations.*

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Scrubber Control Equipment - **Form SCE**
Revision 6
6/11/15

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project
3. Emissions Unit ID (unit being controlled by the scrubber)	4. Exhaust Stack ID of the Scrubber:
CKD - Carbon Regeneration Kiln (Drum)	WS2

5. Project Description	Conventional open-pit mining and onsite ore preparation and gold extraction processes. This form is for: Source ID: CDK - Carbon Regeneration Kiln (Drum) - Wet Scrubber (WS2)

EQUIPMENT DESCRIPTION

Equipment

6. Manufacturer: TBD 7. Model.: TBD

Scrubber Type

8. ☒ Wet Scrubber (indicate type)	☐ Venturi	☐ Packed Bed	☐ Condensation Scrubbing
	☐ Tray/Plate	☐ Orifice	☐ Spray Chamber

9. ☐ Dry Scrubber

10. ☐ Other (please provide details): _____

Operation

Packed Bed (if applicable)	11. Type of Packing Material: TBD
Venturi (if applicable)	12. Pressure Drop Across Throat: TBD in w.g.
Spray Chamber (if applicable)	13. Pressure in Spray Nozzles: TBD in psi

14. Operating Pressure Range (all scrubber types): TBD to TBD in w.g.

15. Other Operating Parameters (if neccessary): TBD

Scrubbing Media (as required)

16. Recirculation Rate: TBD gpm	17. Flow Meter? ☐ Yes ☐ No
18. pH of Scrubbing Media (range): _____ to _____	19. pH Meter? ☐ Yes ☐ No
20. ORP of Scrubbing Media (range): _____ to _____ mv	21. ORP Meter? ☐ Yes ☐ No

Pollutant (being removed)

22. ☒ Particulates (PM_{10}/$PM_{2.5}$)	23. ☐ VOC
24. ☐ SO_2	25. ☐ H_2S
26. ☐ Odor	27. ☐ Inorganic Fumes

28. Other: _____

Emissions Data

Pollutant	Control Efficiency %
29. Particulates (PM_{10})	Control in EF
30. Particulates ($PM_{2.5}$)	Control in EF
31. VOC	
32. SO_2	
33. H_2S	
34. Odor	
35. Inorganic Fume	
36. Other	

Source of Data

37. ☐ Manufacturer's Specifications
38. ☐ Emissions Source Test (provide source test report)
39. ☐ AP-42 Section _____
40. ☒ Other

Note: Supporting documentation must be provided.

"Supporting documentation must be provided" in this section means the following information shall be available for DEQ staff review:

- *Control equipment manufacturer guarantees (if applicable),*
- *Source test reports (if applicable)*
- *All sources of emissions factors used to perform emissions calculations (i.e. continuous emissions monitoring system (CEMS) data, source testing, and/or US EPA's AP-42), and*
- *All assumptions used to perform emissions calculations.*

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Scrubber Control Equipment - **Form SCE**
Revision 6
6/11/15

Please see instructions on page 2 before filling out the form.

IDENTIFICATION

1. Company Name	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project
3. Emissions Unit ID (unit being controlled by the scrubber)	4. Exhaust Stack ID of the Scrubber:
LSU - Pebble Lime Silo discharge to Lime Slaker	WS3
5. Project Description	Conventional open-pit mining and onsite ore preparation and gold extraction processes. This form is for: Source ID: LSU - Pebble Lime Silo discharge to Lime Slaker - Wet Scrubber (WS3)

EQUIPMENT DESCRIPTION

Equipment

6. Manufacturer: TBD 7. Model.: TBD

Scrubber Type

8. ☒ Wet Scrubber (indicate type)	☐ Venturi	☐ Packed Bed	☐ Condensation Scrubbing
	☐ Tray/Plate	☐ Orifice	☐ Spray Chamber

9. ☐ Dry Scrubber

10. ☐ Other (please provide details): _____

Operation

Packed Bed (if applicable)	11. Type of Packing Material: TBD
Venturi (if applicable)	12. Pressure Drop Across Throat: TBD in w.g.
Spray Chamber (if applicable)	13. Pressure in Spray Nozzles: TBD in psi

14. Operating Pressure Range (all scrubber types): TBD to TBD in w.g.

15. Other Operating Parameters (if neccessary): TBD

Scrubbing Media (as required)

16. Recirculation Rate: TBD gpm	17. Flow Meter? ☐ Yes ☐ No
18. pH of Scrubbing Media (range): _____ to _____	19. pH Meter? ☐ Yes ☐ No
20. ORP of Scrubbing Media (range): _____ to _____ mv	21. ORP Meter? ☐ Yes ☐ No

Pollutant (being removed)

22. ☒ Particulates (PM_{10}/$PM_{2.5}$)	23. ☐ VOC
24. ☐ SO_2	25. ☐ H_2S
26. ☐ Odor	27. ☐ Inorganic Fumes

28. Other: _____

Emissions Data

Pollutant	Control Efficiency %
29. Particulates (PM_{10})	Controlled EF
30. Particulates ($PM_{2.5}$)	Controlled EF
31. VOC	
32. SO_2	
33. H_2S	
34. Odor	
35. Inorganic Fume	
36. Other	

Source of Data

37. ☐ Manufacturer's Specifications
38. ☐ Emissions Source Test (provide source test report)
39. ☒ AP-42 Section Table 11.17-4
40. ☐ Other

Note: Supporting documentation must be provided.

"Supporting documentation must be provided" in this section means the following information shall be available for DEQ staff review:

- *Control equipment manufacturer guarantees (if applicable),*
- *Source test reports (if applicable)*
- *All sources of emissions factors used to perform emissions calculations (i.e. continuous emissions monitoring system (CEMS) data, source testing, and/or US EPA's AP-42), and*
- *All assumptions used to perform emissions calculations.*

1.10 Forms EI – Emissions Inventory

The IDEQ facility wide potential to emit emission inventory tables for new source review (NSR) regulated pollutants (Table 8), hazardous air pollutants (HAP) (Table 9), and toxic air pollutants (TAP) (Table 10 and Table 11) are provided here. In addition, the ambient impact assessment emission inventory table is provided (Table 12).

The detailed emission inventory and full ambient impact assessment can be found in the "Stibnite Gold Project Air Quality Modeling Report," Attachment A of this application. Supporting documentation for the emission inventory can be found on the digital media provided with this application.

PRI00000281

REC 1621

Facility Wide Potential to Emit Emission Inventory

Table 8. POTENTIAL TO EMIT FOR NSR REGULATED POLLUTANTS

Emissions	PM	PM10	PM2.5	CO	Pb	NO2	VOC	SO2	CO2e
Unit	T/yr	T/yr	T/yr	T/yr	T/yr	T/yr	T/yr	T/yr	T/yr
Process & Ancillary Point Sources									
LS1L	2.2E-3	7.4E-4	1.1E-4		--				--
MillS2L	2.2E-3	7.4E-4	1.1E-4		--				--
Sb1	0.09	0.09	0.09	0.98	--	1.69	0.10	0.21	1,658
Sb2	0.52	0.52	0.52		--				--
AC	22.23	22.23	22.23		--			2.86	47,316
ACB	2.0E-3	2.0E-3	2.0E-3	0.02	--	0.04	2.2E-3	4.4E-3	35.49
ACS1L	8.7E-3	3.0E-3	4.4E-4		--				--
ACS2L	8.7E-3	3.0E-3	4.4E-4		--				--
ACS3L	8.7E-3	3.0E-3	4.4E-4		--				--
ACS4L	4.3E-3	1.5E-3	2.2E-4		--				--
CKD	1.84	1.84	1.84	0.53	--	0.05	0.48		--
CKB	0.08	0.08	0.08	0.81	--	1.40	0.09	0.17	1,375
EW	0.31	0.31	0.31		--				--
MR	6.2E-3	6.2E-3	6.2E-3		--				--
MF	0.89	0.89	0.89		--				--
EDG1	0.02	0.02	0.02	0.39	--	0.71	0.14	7.2E-4	76.79
EDG2	0.02	0.02	0.02	0.39	--	0.71	0.14	7.2E-4	76.79
EDG3	0.02	0.02	0.02	0.39	--	0.71	0.14	7.2E-4	76.79
EDFP	4.4E-3	4.4E-3	4.4E-3	0.08	--	0.09	0.09	1.4E-4	15.36
PV	3.4E-3	3.4E-3	3.4E-3	0.04	--	0.06	3.8E-3	7.6E-3	60.95
HS	0.17	0.17	0.17	1.80	--	3.11	0.19	0.38	3,048
H1M	0.13	0.13	0.13	1.44	--	2.49	0.15	0.30	2,438
H2M	0.13	0.13	0.13	1.44	--	2.49	0.15	0.30	2,438
HM	0.13	0.13	0.13	1.44	--	2.49	0.15	0.30	2,438
HAC	8.4E-3	8.4E-3	8.4E-3	0.09	--	0.16	9.6E-3	0.02	152
HR	8.4E-3	8.4E-3	8.4E-3	0.09	--	0.16	9.6E-3	0.02	152
HA	8.4E-3	8.4E-3	8.4E-3	0.09	--	0.16	9.6E-3	0.02	152
HMO	0.02	0.02	0.02	0.18	--	0.31	0.02	0.04	305
HTS	0.07	0.07	0.07	0.72	--	1.24	0.08	0.15	1,219
HW	0.10	0.10	0.10	1.08	--	1.87	0.11	0.23	1,829
PSL	0.07	0.03	3.9E-3		--				--
CS1L	0.03	0.01	1.5E-3		2.2E-5				--
CS2L	0.03	0.01	1.5E-3		2.2E-5				--
TG1					--		0.96		--
TG2					--		0.96		--
TD3					--		7.3E-3		--
TD4					--		7.3E-3		--
TD5					--		7.3E-3		--
TD6					--		7.3E-3		--
TD7					--		7.3E-3		--
TD8					--		7.3E-3		--
TD9					--		7.3E-3		--
TD10					--		7.3E-3		--
LS6	0.48	0.17	0.03		--				--
LSBM	6.42	5.39	1.92		--				--
LS9	0.12	0.05	7.0E-3		--				--
LK	3.40	3.40	3.40	11.78	--	6.29		0.03	30,311
LKC	0.63	0.63	0.63	6.72	--	11.65	0.72	1.42	11,407
LCR	1.06	0.89	0.32		--				--
LSL	0.02	0.02	0.02		--				--

Facility Wide Potential to Emit Emission Inventory

Table 8. POTENTIAL TO EMIT FOR NSR REGULATED POLLUTANTS

Emissions	PM	PM10	PM2.5	CO	Pb	NO2	VOC	SO2	CO2e
Unit	T/yr	T/yr	T/yr	T/yr	T/yr	T/yr	T/yr	T/yr	T/yr
Process & Ancillary Fugitive Sources									
OC1	0.64	0.21	0.06		5.1E-6				--
OC2	0.64	0.21	0.06		5.1E-6				--
OC3	0.64	0.21	0.06		5.1E-6				--
OC4	0.64	0.21	0.06		5.1E-6				--
OC5	0.64	0.21	0.06		5.1E-6				--
OC6	0.64	0.21	0.06		5.1E-6				--
OC7	5.48	2.46	0.46		4.4E-5				--
OC8	0.64	0.21	0.06		5.1E-6				--
OC9	3.02	1.11	0.17		2.4E-5				--
OC10	3.02	1.11	0.17		2.4E-5				--
OC11	3.02	1.11	0.17		2.4E-5				--
OC12	6.04	2.72	0.50		4.8E-5				--
OC13	0.71	0.23	0.07		5.6E-6				--
LS1U	0.01	6.1E-3	9.2E-4		--				--
MillS2U	0.01	6.1E-3	9.2E-4		--				--
ACS1U	0.04	0.02	3.5E-3		--				--
ACS2U	0.04	0.02	3.5E-3		--				--
ACS3U	0.04	0.02	3.5E-3		--				--
ACS42U	0.02	0.01	1.8E-3		--				--
PSU	0.07	0.03	3.9E-3		--				--
CS1U	0.14	0.08	0.01		--				--
CS2U	0.14	0.08	0.01		--				--
CAL	1.73	0.83	0.13		--				--
CAU	1.73	0.83	0.13		--				--
CM	0.55	0.17	0.02		1.1E-5				--
PCSP1	2.74	1.02	0.13		--				--
PCSP2	2.74	1.02	0.13		--				--
LS1	0.48	0.17	0.03		--				--
LS2	0.86	0.38	0.06		--				--
LS3	3.97	1.38	0.21		--				--
LS4	0.86	0.38	0.06		--				--
LS5	3.97	1.38	0.21		--				--
LS7	0.48	0.17	0.03		--				--
LS8	0.48	0.17	0.03		--				--
LS10	0.12	0.05	7.0E-3		--				--
LS11	1.03	0.36	0.05		--				--
LS12	0.12	0.05	7.0E-3		--				--
LSU	2.3E-3	2.3E-3	2.3E-3		--				--
Mining Fugitive Sources Model Scenario: W3									
YPP	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
HFP	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
WEP	345	162	14.53	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
BT	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
TSF	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
UGEXP	1.5E-3	7.3E-4	1.1E-4	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
YPPBL	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
HFPBL	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
WEPBL	117	61.02	3.52	636		17.08	0.0E+0	0.03	
BTBL	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
STKP	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
FDRSF	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
HFDRSF	52.91	10.42	5.52	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
YPDRSF	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
WEDRSF	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
HR	3,047	751	75.12	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
ACCRD	6.95	1.72	0.17	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
Totals	**3,656**	**1,042**	**135**	**666**	**2.6E-4**	**54.93**	**4.78**	**6.51**	**106,580**

PRI00000283

REC 1623

Facility Wide HAP Potential to Emit

Table 9. HAP POTENTIAL TO EMIT EMISSIONS SUMMARY

CAS No.	HAP	Process T/yr	Mining T/yr	Total T/yr
106-99-0	1,3-Butadiene	3.67E-6	--	3.67E-6
91-57-6	2-Methylnaphthalene	4.85E-6	--	4.85E-6
56-49-5	3-Methylchloranthrene	3.64E-7	--	3.64E-7
57-97-6	7,12-Dimethylbenz(a)anthrace	3.24E-6	--	3.24E-6
83-32-9	Acenaphthene	7.09E-6	--	7.09E-6
208-96-8	Acenaphthylene	1.38E-5	--	1.38E-5
75-07-0	Acetaldehyde	1.07E-4	--	1.07E-4
107-02-8	Acrolein	1.98E-5	--	1.98E-5
120-12-7	Anthracene	2.39E-6	--	2.39E-6
7440-36-0	Antimony	3.00E-1	--	3.00E-1
7440-38-2	Arsenic	1.76E-2	--	1.76E-2
56-55-3	Benz(a)anthracene	1.40E-6	--	1.40E-6
71-43-2	Benzene	1.60E-3	--	1.60E-3
50-32-8	Benzo(a)pyrene	6.22E-7	--	6.22E-7
205-99-2	Benzo(b)fluoranthene	1.94E-6	--	1.94E-6
191-24-2	Benzo(g,h,i)perylene	1.07E-6	--	1.07E-6
207-08-9	Benzo(k)fluoranthene	6.86E-7	--	6.86E-7
7440-41-7	Beryllium	8.59E-5	--	8.59E-5
7440-43-9	Cadmium	2.50E-4	--	2.50E-4
75-15-0	Carbon disulfide	6.33E-2	--	6.33E-2
7440-47-3	Chromium	5.73E-4	--	5.73E-4
218-01-9	Chrysene	2.55E-6	--	2.55E-6
7440-48-4	Cobalt	1.20E-4	--	1.20E-4
592-01-8	Cyanide	9.73E-1	--	9.73E-1
53-70-3	Dibenz(a,h)anthracene	7.85E-7	--	7.85E-7
106-46-7	Dichlorobenzene	2.43E-4	--	2.43E-4
206-44-0	Fluoranthene	7.00E-6	--	7.00E-6
86-73-7	Fluorene	2.13E-5	--	2.13E-5
50-00-0	Formaldehyde	1.54E-2	--	1.54E-2
110-54-3	Hexane	3.64E-1	--	3.64E-1
193-39-5	Indeno(1,2,3-cd)pyrene	9.82E-7	--	9.82E-7
7439-92-1	Lead	2.62E-4	--	2.62E-4
7439-96-5	Manganese	2.17E-2	--	2.17E-2
7439-97-6	Mercury	1.24E-2	3.54E-3	1.60E-2
91-20-3	Naphthalene	3.14E-4	--	3.14E-4
7440-02-0	Nickel	1.63E-3	--	1.63E-3
85-01-8	Phenanthrene	6.36E-5	--	6.36E-5
7723-14-0	Phosphorus	1.81E-2	--	1.81E-2
129-00-0	Pyrene	6.68E-6	--	6.68E-6
7782-49-2	Selenium	4.85E-6	--	4.85E-6
108-88-3	Toluene	1.12E-3	--	1.12E-3
1330-20-7	Xylene	2.99E-4	--	2.99E-4
Total HAP		1.79	3.54E-3	1.80

PRI00000284

REC 1624

TAP Emissions Inventory

Table 10. NON-CARCINOGENIC TAP EMISSIONS SUMMARY POTENTIAL TO EMIT

CAS No.	TAP	Total lb/hr	Non-Carcinogenic EL lb/hr	Exceeds Screening Level Y/N
7440-36-0	Antimony	6.86E-2	3.30E-2	Yes
75-15-0	Carbon disulfide	1.45E-2	2.00E+0	No
7440-47-3	Chromium	2.14E-4	3.30E-2	No
7440-48-4	Cobalt	2.91E-5	3.30E-3	No
592-01-8	Cyanide	2.22E-1	3.33E-1	No
106-46-7	Dichlorobenzene	7.93E-5	3.00E+1	No
110-54-3	Hexane	1.19E-1	1.20E+1	No
7439-96-5	Manganese	3.53E-2	6.70E-2	No
91-20-3	Naphthalene	4.03E-5	3.33E+0	No
7723-14-0	Phosphorus	6.12E-3	7.00E-3	No
7782-49-2	Selenium	1.59E-6	1.30E-2	No
108-88-3	Toluene	2.25E-4	2.50E+1	No
7440-39-3	Barium	5.00E-3	3.30E-2	No
7440-50-8	Copper	8.55E-5	6.70E-2	No
7783-06-4	Hydrogen Sulfide	9.00E-1	9.33E-1	No
7439-98-7	Molybdenum	7.85E-5	3.33E-1	No
109-66-0	Pentane	1.72E-1	1.18E+2	No
7440-22-4	Silver	2.94E-6	7.00E-3	No
7664-93-9	Sulfuric Acid	2.03E+0	6.70E-2	Yes
7440-28-0	Thallium	5.88E-5	7.00E-3	No
7440-61-1	Uranium	5.88E-5	1.30E-2	No
7440-62-2	Vanadium	1.52E-4	3.00E-3	No
7440-66-6	Zinc	1.92E-3	6.67E-1	No

Diesel engine HAP are regulated by 40CFR63, Subpart ZZZZ and therefore exempt from TAP analysis per IDAPA 58.01.01 Section 210.20.

TAP Emissions Inventory

Table 11. CARCINOGENIC TAP EMISSIONS SUMMARY POTENTIAL TO EMIT

CAS No.	TAP	Total lb/hr	Carcinogenic EL lb/hr	Exceeds Screening Level Y/N
56-49-5	3-Methylchloranthrene	1.19E-7	2.50E-6	No
7440-38-2	Arsenic	4.37E-3	1.50E-6	Yes
71-43-2	Benzene	1.39E-4	8.00E-4	No
50-32-8	Benzo(a)pyrene	7.93E-8	2.00E-6	No
7440-41-7	Beryllium	2.25E-5	2.80E-5	No
7440-43-9	Cadmium	1.13E-4	3.70E-6	Yes
50-00-0	Formaldehyde	4.95E-3	5.10E-4	Yes
7440-02-0	Nickel	3.03E-3	2.70E-5	Yes

Diesel engine HAP are regulated by 40CFR63, Subpart ZZZZ and therefore exempt from TAP analysis per IDAPA 58.01.01 Section 210.20.

Ambient Impact Assessment Emission Inventory
Table 12. PROPOSED EMISSIONS

Emissions Unit	Stack or Emissions Point ID	PM_{10}	$PM_{2.5}$		SO_2		NO_x		CO	
		gps 24-hr Avg.	gps 24-hr Avg.	gps Annual Avg.	gps Max.	gps 3-hr Avg.	gps Max.	gps Annual Avg.	gps Max.	gps 8-hr Avg.
Process & Ancillary Point Sources										
LS1L	LS1L	4.5E-4	6.6E-5	3.1E-6						
MillS2L	MillS2L	4.5E-4	6.6E-5	3.1E-6						
Sb1	Sb1	2.6E-3	2.6E-3	2.6E-3	6.0E-3	6.0E-3	4.9E-2	4.9E-2	2.8E-2	2.8E-2
Sb2	Sb2	1.5E-2	1.5E-2	1.5E-2						
AC	AC	6.4E-1	6.4E-1	6.4E-1	8.2E-2	8.2E-2				
ACB	ACB	6.8E-4	6.8E-4	5.6E-5	3.7E-2	3.7E-2	3.0E-1	1.0E-3	1.8E-1	1.8E-1
ACS1L	ACS1L	1.8E-3	2.6E-4	1.3E-5						
ACS2L	ACS2L	1.8E-3	2.6E-4	1.3E-5						
ACS3L	ACS3L	1.8E-3	2.6E-4	1.3E-5						
ACS4L	ACS4L	8.9E-4	1.3E-4	6.3E-6						
CKD	CKD	5.3E-2	5.3E-2	5.3E-2			1.5E-3	1.5E-3	1.5E-2	1.5E-2
CKB	CKB	2.2E-3	2.2E-3	2.2E-3	4.9E-3	4.9E-3	4.0E-2	4.0E-2	2.3E-2	2.3E-2
EW	EW	8.8E-3	8.8E-3	8.8E-3						
MR	MR	1.3E-3	1.3E-3	1.8E-4						
MF	MF	1.8E-1	1.8E-1	2.5E-2						
EDG1	EDG1	2.3E-3	2.3E-3	6.3E-4	1.8E-3	1.8E-3	2.0E-2	2.0E-2	9.7E-1	9.7E-1
EDG2	EDG2	2.3E-3	2.3E-3	6.3E-4	1.8E-3	1.8E-3	2.0E-2	2.0E-2	9.7E-1	9.7E-1
EDG3	EDG3	2.3E-3	2.3E-3	6.3E-4	1.8E-3	1.8E-3	2.0E-2	2.0E-2	9.7E-1	9.7E-1
EDFP	EDFP	4.6E-4	4.6E-4	1.3E-4	3.6E-4	3.6E-4	2.5E-3	2.5E-3	1.9E-1	1.9E-1
PV	PV	9.6E-5	9.6E-5	9.6E-5	2.2E-4	2.2E-4	1.8E-3	1.8E-3	1.0E-3	1.0E-3
HS	HS	4.8E-3	4.8E-3	4.8E-3	1.1E-2	1.1E-2	9.0E-2	9.0E-2	5.2E-2	5.2E-2
H1M	H1M	3.9E-3	3.9E-3	3.9E-3	8.8E-3	8.8E-3	7.2E-2	7.2E-2	4.1E-2	4.1E-2
H2M	H2M	3.9E-3	3.9E-3	3.9E-3	8.8E-3	8.8E-3	7.2E-2	7.2E-2	4.1E-2	4.1E-2
HM	HM	3.9E-3	3.9E-3	3.9E-3	8.8E-3	8.8E-3	7.2E-2	7.2E-2	4.1E-2	4.1E-2
HAC	HAC	2.4E-4	2.4E-4	2.4E-4	5.5E-4	5.5E-4	4.5E-3	4.5E-3	2.6E-3	2.6E-3
HR	HR	2.4E-4	2.4E-4	2.4E-4	5.5E-4	5.5E-4	4.5E-3	4.5E-3	2.6E-3	2.6E-3
HA	HA	2.4E-4	2.4E-4	2.4E-4	5.5E-4	5.5E-4	4.5E-3	4.5E-3	2.6E-3	2.6E-3
HMO	HMO	4.8E-4	4.8E-4	4.8E-4	1.1E-3	1.1E-3	9.0E-3	9.0E-3	5.2E-3	5.2E-3
HTS	HTS	1.9E-3	1.9E-3	1.9E-3	4.4E-3	4.4E-3	3.6E-2	3.6E-2	2.1E-2	2.1E-2
HW	HW	2.9E-3	2.9E-3	2.9E-3	6.6E-3	6.6E-3	5.4E-2	5.4E-2	3.1E-2	3.1E-2
PSL	PSL	7.3E-3	1.1E-3	1.1E-4						
CS1L	CS1L	1.4E-4	2.1E-5	4.3E-5						
CS2L	CS2L	1.4E-4	2.1E-5	4.3E-5						
TG1	TG1									
TG2	TG2									
TD3	TD3									
TD4	TD4									
TD5	TD5									
TD6	TD6									
TD7	TD7									
TD8	TD8									
TD9	TD9									
TD10	TD10									
LS6	LS6	6.5E-3	1.0E-3	7.8E-4						
LSBM	LSBM	2.0E-1	7.2E-2	5.5E-2						
LS9	LS9	1.5E-3	2.4E-4	2.0E-4						
LK	LK	1.2E-1	1.2E-1	9.8E-2	1.1E-3	1.1E-3	2.1E-1	1.8E-1	4.0E-1	4.0E-1
LKC	LKC	2.1E-2	2.1E-2	1.8E-2	4.8E-2	4.8E-2	3.9E-1	3.4E-1	2.3E-1	2.3E-1
LCR	LCR	3.0E-2	1.1E-2	9.1E-3						
LSL	LSL	7.8E-4	7.8E-4	6.6E-4						

PRI00000287

REC 1627

Ambient Impact Assessment Emission Inventory
Table 12. PROPOSED EMISSIONS

Emissions Unit	Stack or Emissions Point ID	PM_{10}	$PM_{2.5}$		SO_2		NO_x		CO	
		gps	gps	gps	gps	gps	gps	gps	gps	gps
		24-hr Avg.	24-hr Avg.	Annual Avg.	Max.	3-hr Avg.	Max.	Annual Avg.	Max.	8-hr Avg.
Process & Ancillary Fugitive Sources										
OC1	OC1	6.0E-3	1.7E-3	1.7E-3						
OC2	OC2	6.0E-3	1.7E-3	1.7E-3						
OC3	OC3	6.0E-3	1.7E-3	1.7E-3						
OC4	OC4	6.0E-3	1.7E-3	1.7E-3						
OC5	OC5	6.0E-3	1.7E-3	1.7E-3						
OC6	OC6	6.0E-3	1.7E-3	1.7E-3						
OC7	OC7	7.1E-2	1.3E-2	1.3E-2						
OC8	OC8	6.0E-3	1.7E-3	1.7E-3						
OC9	OC9	3.2E-2	4.9E-3	4.9E-3						
OC10	OC10	3.2E-2	4.9E-3	4.9E-3						
OC11	OC11	3.2E-2	4.9E-3	4.9E-3						
OC12	OC12	7.8E-2	1.4E-2	1.4E-2						
OC13	OC13	6.7E-3	1.9E-3	1.9E-3						
LS1U	LS1U	3.7E-3	5.5E-4	2.6E-5						
MillS2U	MillS2U	3.7E-3	5.5E-4	2.6E-5						
ACS1U	ACS1U	7.1E-3	1.0E-3	1.0E-4						
ACS2U	ACS2U	7.1E-3	1.0E-3	1.0E-4						
ACS3U	ACS3U	7.1E-3	1.0E-3	1.0E-4						
ACS42U	ACS42U	7.1E-3	1.0E-3	5.0E-5						
PSU	PSU	7.3E-3	1.1E-3	1.1E-4						
CS1U	CS1U	1.2E-3	1.7E-4	3.5E-4						
CS2U	CS2U	1.2E-3	1.7E-4	3.5E-4						
CAL	CAL	4.2E-2	6.3E-3	3.6E-3						
CAU	CAU	4.2E-2	6.3E-3	3.6E-3						
CM	CM	2.3E-3	3.4E-4	6.9E-4						
PCSP1	PCSP1	2.9E-2	3.8E-3	3.8E-3						
PCSP2	PCSP2	2.9E-2	3.8E-3	3.8E-3						
LS1	LS1	6.5E-3	1.0E-3	7.8E-4						
LS2	LS2	1.4E-2	2.1E-3	1.6E-3						
LS3	LS3	5.2E-2	7.8E-3	6.0E-3						
LS4	LS4	1.4E-2	2.1E-3	1.6E-3						
LS5	LS5	5.2E-2	7.8E-3	6.0E-3						
LS7	LS7	6.5E-3	1.0E-3	7.8E-4						
LS8	LS8	6.5E-3	1.0E-3	7.8E-4						
LS10	LS10	1.5E-3	2.4E-4	2.0E-4						
LS11	LS11	1.2E-2	1.9E-3	1.6E-3						
LS12	LS12	1.5E-3	2.4E-4	2.0E-4						
LSU	LSU	7.8E-5	7.8E-5	6.6E-5						
Mining Fugitive Sources Model Scenario: W3										
YPP	YPP	--	--	--			--	--	--	--
HFP	HFP	--	--	--			--	--	--	--
WEP	WEP	4.65	0.42	0.42			--	--	--	--
BT	BT	--	--	--			--	--	--	--
TSF	TSF	--	--	--			--	--	--	--
UGEXP	UGEXP	0.000021	0.000003	0.000003			--	--	--	--
YPPBL	YPPBL	--	--	--			--	--	--	--
HFPBL	HFPBL	--	--	--			--	--	--	--
WEPBL	WEPBL	1.76	0.10	0.10			5.90	0.49	219.49	219.49
BTBL	BTBL	--	--	--			--	--	--	--
STKP	STKP	--	--	--			--	--	--	--
FDRSF	FDRSF	--	--	--			--	--	--	--
HFDRSF	HFDRSF	0.30	0.16	0.16			--	--	--	--
YPDRSF	YPDRSF	--	--	--			--	--	--	--
WEDRSF	WEDRSF	--	--	--			--	--	--	--
HR	HR	21.56	2.16	2.16			--	--	--	--
ACCRD	ACCRD	0.05	0.005	0.005			--	--	--	--

PRI00000288

REC 1628

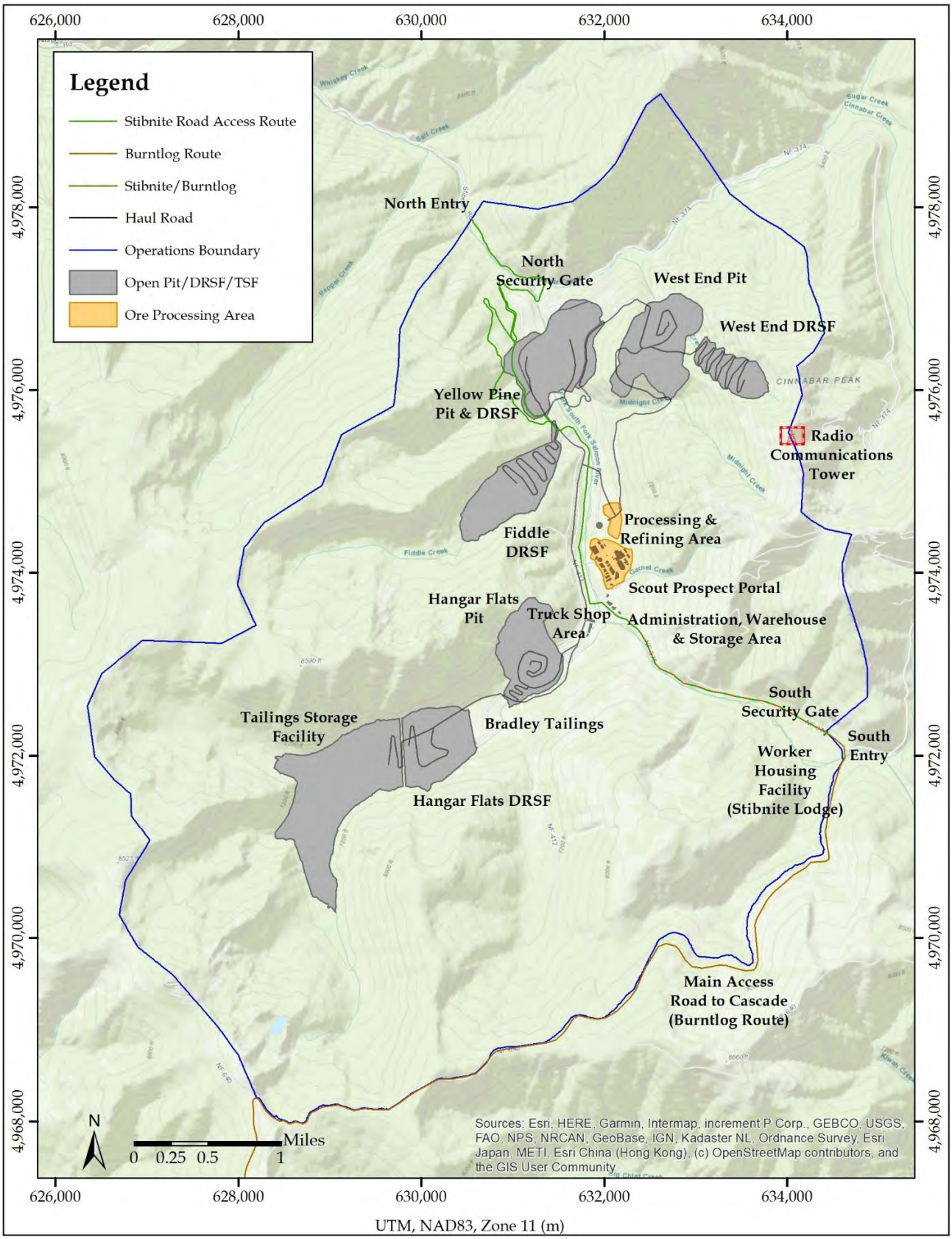
1.11 PP – Plot Plan

A scaled plot plan of the entire facility can be found here. Figure 1 shows the SGP mining operations with the haul roads and operations boundary. Figure 2 shows the SGP processing and refining area, Figure 3 shows the administration, warehouse and storage area, and Figure 4 shows the worker housing facility. Figures 2, 3 and 4 show the buildings and emission points with identification numbers. The building heights can be found on the Modeling Information – Buildings and Structures Form MI4. The location of the gasoline and diesel tanks is to be determined so these emission points are excluded from the figures.

PRI00000289

REC 1629

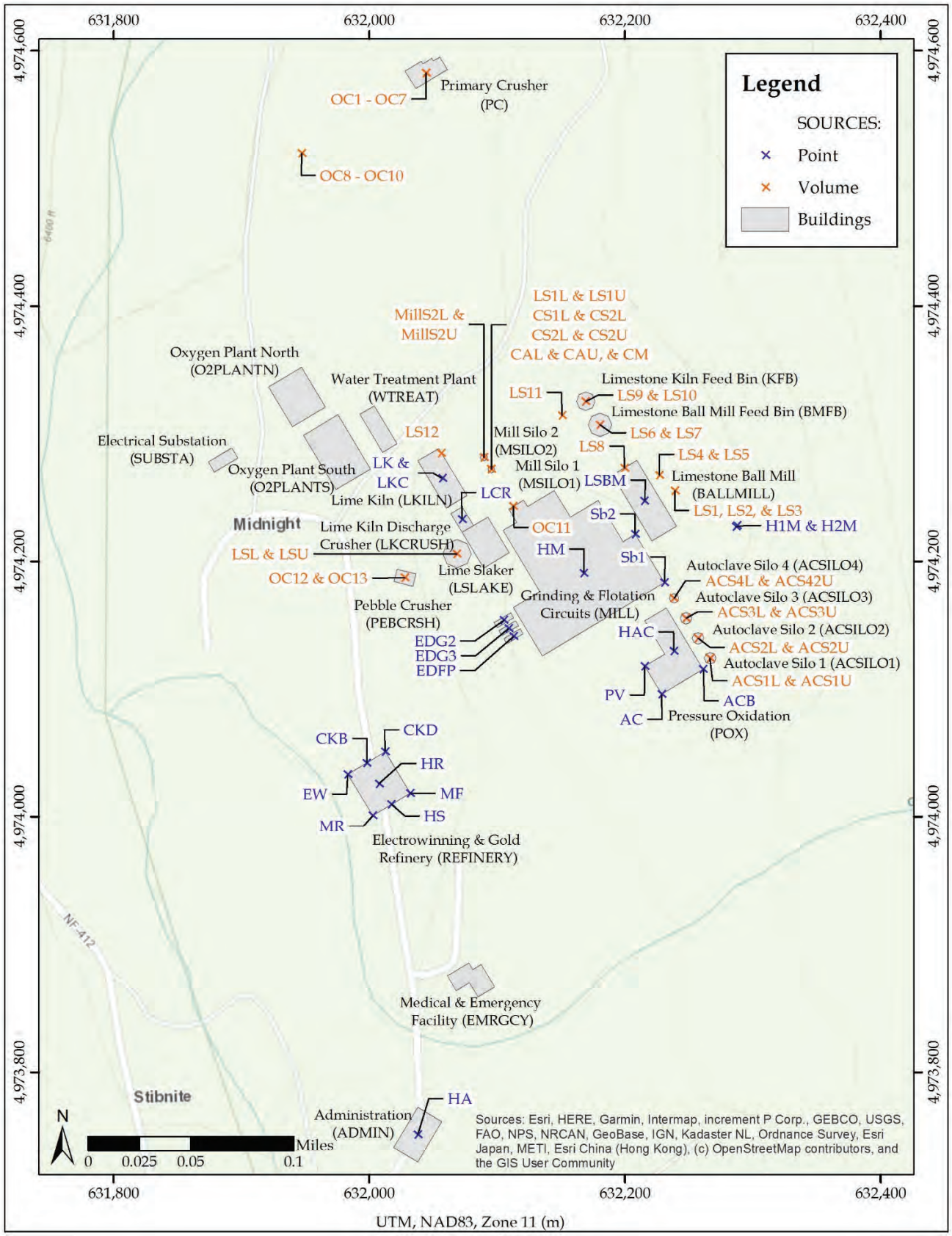
Figure 1. SGP Mining Operation and Stibnite Road Access Route



PRI00000290

REC 1630

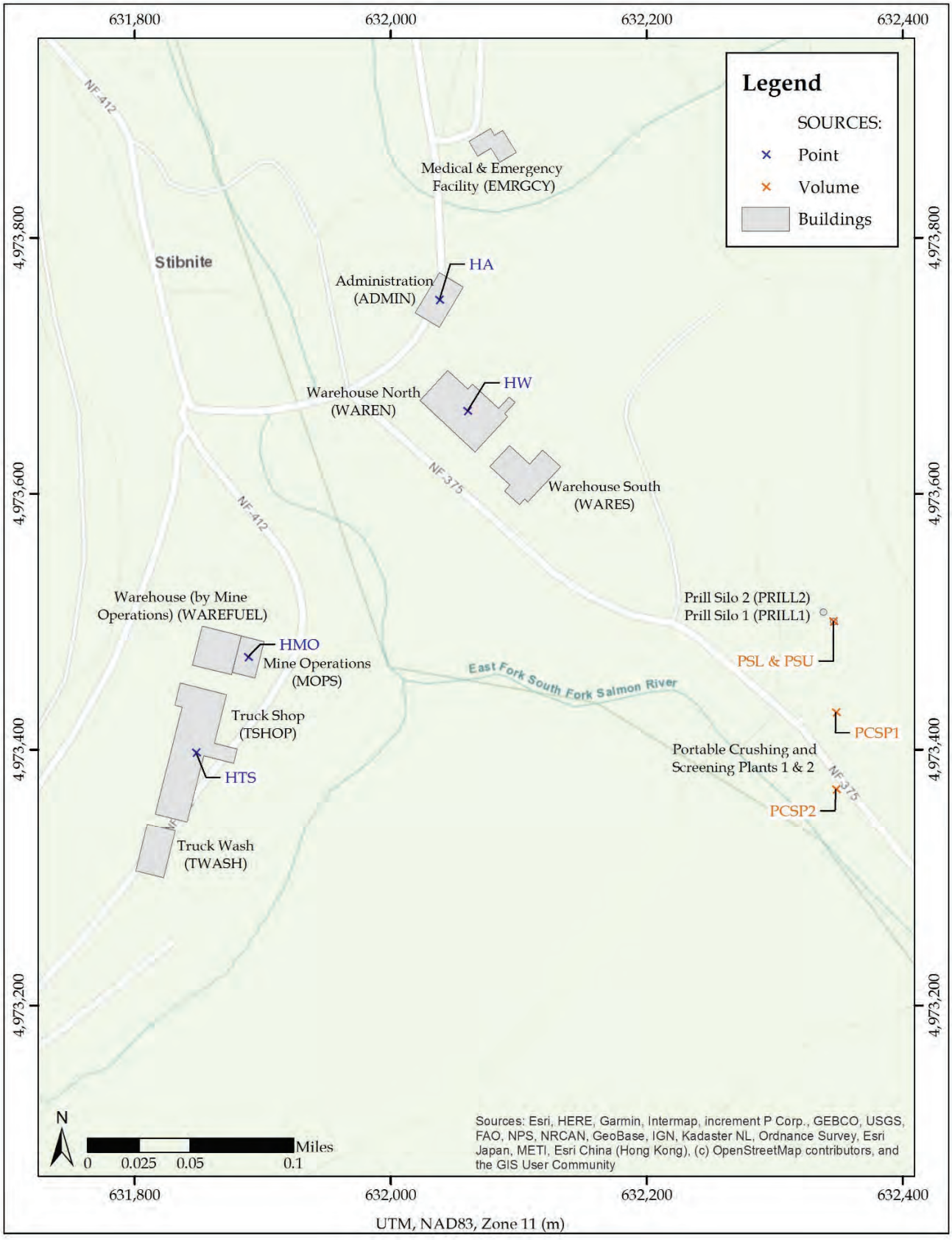
Figure 2. SGP Process & Refining Area Buildings and Emission Points



PRI00000291

REC 1631

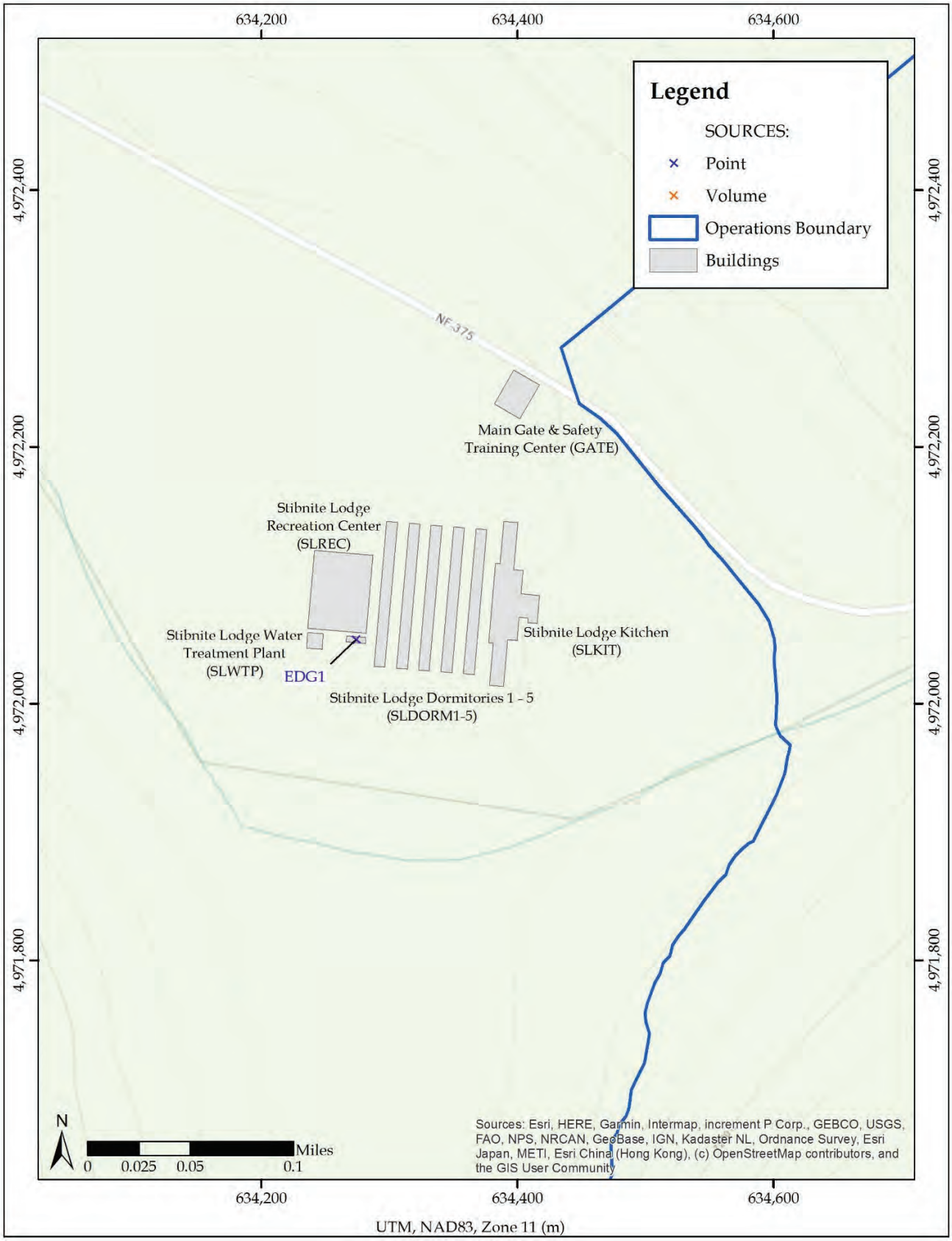
Figure 3. SGP Administration, Warehouse & Storage Area Buildings and Emission Points



PRI00000292

REC 1632

Figure 4. SGP Worker Housing Facility Buildings and Emission Points



PRI00000293

REC 1633

1.12 Forms MI1-MI4 – Modeling – Excel workbook, 4 sheets

The following DEQ Air Quality Program Permit to Construct Application forms are provided here.

- Modeling Information - Impact Analysis Form MI1 (1 page)
- Modeling Information - Point Source Stack Parameters Form MI2 (3 pages)
- Modeling Information - Fugitive Source Parameters Form MI3 (4 pages)
- Modeling Information – Buildings and Structures Form MI4 (1 page)

PRI00000294

REC 1634

	DEQ AIR QUALITY PROGRAM 1410 N. Hilton, Boise, ID 83706 For assistance, call the **Air Permit Hotline - 1-877-5PERMIT**	**PERMIT TO CONSTRUCT APPLICATION** Revision 3 4/5/2007

Please see instructions on page 2 before filling out the form.

Company Name:	Midas Gold Idaho, Inc.
Facility Name:	Stibnite Gold Project
Facility ID No.:	
Brief Project Description:	Conventional open-pit mining operations and onsite ore preparation and gold extraction processes.

SUMMARY OF AIR IMPACT ANALYSIS RESULTS - CRITERIA POLLUTANTS

		1.		2.	3.	4.		5.
Criteria Pollutants	**Averaging Period**	**Significant Impact Analysis Results (µg/m3)**	**Significant Contribution Level (µg/m3)**	**Full Impact Analysis Results (µg/m3)**	**Background Concentration (µg/m3)**	**Total Ambient Impact (µg/m3)**	**NAAQS (µg/m3)**	**Percent of NAAQS**
PM_{10}	24-hour		5	75.7	37	112.7	150	75%
	Annual		1	Revoked in 2006		0	50	0%
SO_2	3-hr		25	1.8	16.8	18.6	1300	1%
	24-hr		5	Revoked in 2010		0	365	0%
	Annual		1	Revoked in 2010		0	80	0%
NO_2	Annual		1	2.3	0.9	3.2	100	3%
CO	1-hr		2000	17,054	1,740	18,794	40000	47%
	8-hr		500	6,218	1,110	7,328	10000	73%
Additional NAAQS and Results								
$PM_{2.5}$	24-hour			11.0	15	26.0	35	74%
	Annual			4.2	3.5	7.7	12	64%
NO_2	1-hr			116.7	4.3	121.0	188	64%
SO_2	1-hr			3.2	12.3	15.5	196	8%

	DEQ AIR QUALITY PROGRAM 1410 N. Hilton, Boise, ID 83706 For assistance, call the **Air Permit Hotline - 1-877-5PERMIT**	**PERMIT TO CONSTRUCT APPLICATION** Revision 3 3/27/2007

Please see instructions on page 2 before filling out the form.

Company Name:	Midas Gold Idaho, Inc.
Facility Name:	Stibnite Gold Project
Facility ID No.:	
Brief Project Description:	Conventional open-pit mining operations and onsite ore preparation and gold extraction processes.

POINT SOURCE STACK PARAMETERS

1.	2.	3a.	3b.	4.	5.	6.	7.	8.	9.	10.
Emissions units	**Stack ID**	**UTM Easting (m)**	**UTM Northing (m)**	**Base Elevation (m)**	**Stack Height (m)**	**Modeled Diameter (m)**	**Stack Exit Temperature (K)**	**Stack Exit Flowrate (acfm)**	**Stack Exit Velocity (m/s)**	**Stack orientation (e.g., horizontal, rain cap)**
Point Source(s)										
Mill Lime Silo #1 Loading	LS1L	632,095	4,974,272	1,992	13.32	0.15	0.00	700	18.1	Vertical
Mill Lime Silo #2 Loading	MillS2L	632,090	4,974,282	1,990	13.32	0.15	0.00	700	18.1	Vertical
Sb Dryer (2.72 MMBtu/hr Propane-Fired)	Sb1	632,231	4,974,183	2,001	45.72	0.30	455.37	1,073	6.9	Vertical
Sb Bagging	Sb2	632,208	4,974,221	2,001	45.72	0.30	0.00	1,000	6.5	Vertical
Autoclave	AC	632,229	4,974,096	2,007	23.47	1.52	364.26	28,680	7.4	Vertical
POX Boiler (17 MMBtu/hr Propane-Fired)	ACB	632,261	4,974,116	2,007	23.47	0.61	455.37	6,703	10.8	Vertical
AC Lime Silo #1 Loading	ACS1L	632,267	4,974,124	2,007	17.44	0.23	0.00	1,400	16.1	Vertical
AC Lime Silo #2 Loading	ACS2L	632,257	4,974,140	2,007	17.44	0.23	0.00	1,400	16.1	Vertical
AC Lime Silo #3 Loading	ACS3L	632,248	4,974,156	2,007	17.44	0.23	0.00	1,400	16.1	Vertical
AC Lime Silo #4 Loading	ACS4L	632,238	4,974,171	2,007	14.49	0.23	0.00	1,400	16.1	Vertical
Carbon Regeneration Kiln (Drum)	CKD	632,013	4,974,051	1,970	16.76	0.15	338.71	180	5.1	Vertical
Carbon Regeneration Kiln (Burners)	CKB	631,998	4,974,042	1,970	14.02	0.30	455.37	889	5.8	Vertical
Electrowinning Cells and Pregnant Solution Tank	EW	631,983	4,974,033	1,970	16.76	0.30	310.93	3,740	24.2	Vertical
Mercury Retort	MR	632,003	4,974,001	1,970	16.76	0.09	338.71	20	1.5	Vertical
Induction Melting Furnace	MF	632,032	4,974,019	1,970	16.76	0.38	338.71	5,200	21.5	Vertical
Camp Emergency Generator (Mfr. Yr. >2007; diesel)	EDG1	634,274	4,972,050	2,114	2.13	0.46	866.48	10,328	29.7	Vertical
Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	EDG2	632,105	4,974,154	2,001	2.13	0.46	866.48	10,328	29.7	Vertical
Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	EDG3	632,109	4,974,148	2,002	2.13	0.46	866.48	10,328	29.7	Vertical

POINT SOURCE STACK PARAMETERS										
1.	2.	3a.	3b.	4.	5.	6.	7.	8.	9.	10.
Emissions units	Stack ID	UTM Easting (m)	UTM Northing (m)	Base Elevation (m)	Stack Height (m)	Modeled Diameter (m)	Stack Exit Temperature (K)	Stack Exit Flowrate (acfm)	Stack Exit Velocity (m/s)	Stack orientation (e.g., horizontal, rain cap)
Point Source(s)										
Mill Fire Pump (Mfr. Yr. >2009; diesel)	EDFP	632,113	4,974,141	2,003	2.13	0.23	866.48	2,066	23.8	Vertical
Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	PV	632,216	4,974,118	2,007	20.73	0.12	455.37	39	1.6	Vertical
Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	HS	632,017	4,974,010	1,970	14.02	0.40	455.37	1,972	7.5	Vertical
Mine Air Heater #1 (4 MMBtu/hr Propane-	H1M	632,287	4,974,227	2,000	2.13	0.40	455.37	1,577	6.0	Vertical
Mine Air Heater #2 (4 MMBtu/hr Propane-	H2M	632,288	4,974,228	2,000	2.13	0.21	455.37	1,577	20.8	Vertical
Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	HM	632,168	4,974,191	2,001	42.98	0.09	455.37	394	28.3	Vertical
Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	HAC	632,238	4,974,130	2,007	20.73	0.09	455.37	99	7.1	Vertical
Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	HR	632,008	4,974,026	1,970	14.02	0.09	455.37	99	7.1	Vertical
Admin HVAC Heater (0.25 MMBtu Propane-Fired)	HA	632,038	4,973,751	1,979	6.40	0.09	455.37	99	7.1	Vertical
Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	HMO	631,889	4,973,472	1,989	12.50	0.21	455.37	99	1.3	Vertical
Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	HTS	631,848	4,973,398	1,992	12.50	0.21	455.37	394	5.2	Vertical
Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	HW	632,060	4,973,664	1,984	12.50	0.21	455.37	394	5.2	Vertical
Prill Silos Loading (2 x 100 ton)	PSL	632,346	4,973,500	2,010	7.77	0.15	0.00	700	18.1	Vertical
Cement/Shotcrete Silo #1 Loading	CS1L	632,095	4,974,272	1,992	13.32	0.15	0.00	930	24.1	Vertical
Cement/Shotcrete Silo #2 Loading	CS2L	632,095	4,974,272	1,992	13.32	0.15	0.00	930	24.1	Vertical
Limestone transfer to Ball Mill Feed Bin	LS6	632,181	4,974,307	1,996	8.84	0.30	0.00	0.2	0.001	Horizontal
Limestone Ball Mill	LSBM	632,215	4,974,248	1,996	21.34	0.61	0.00	16,500	26.7	Vertical
Limestone transfer to Kiln Feed Bin	LS9	632,169	4,974,325	1,996	8.84	0.30	0.00	0.2	0.001	Horizontal
Parallel Flow Regenerative (PFR) Shaft Lime Kiln	LK	632,057	4,974,265	1,984	45.72	0.61	449.82	16,300	26.4	Vertical
PFR Shaft Lime Kiln Combustion	LKC	632,057	4,974,265	1,984	45.72	0.61	449.82	16,300	26.4	Vertical
Lime Mill Crushing and associated transfers In and Out	LCR	632,073	4,974,233	1,990	15.24	0.23	0.00	2,500	28.7	Vertical

POINT SOURCE STACK PARAMETERS										
1.	2.	3a.	3b.	4.	5.	6.	7.	8.	9.	10.
Emissions units	Stack ID	UTM Easting (m)	UTM Northing (m)	Base Elevation (m)	Stack Height (m)	Modeled Diameter (m)	Stack Exit Temperature (K)	Stack Exit Flowrate (acfm)	Stack Exit Velocity (m/s)	Stack orientation (e.g., horizontal, rain cap)
Point Source(s)										
Pebble Lime Silo Loading via Bucket Elevator	LSL	632,069	4,974,206	1,996	8.84	0.10	0.00	70	4.1	Vertical

	DEQ AIR QUALITY PROGRAM 1410 N. Hilton, Boise, ID 83706 For assistance, call the **Air Permit Hotline - 1-877-5PERMIT**	**PERMIT TO CONSTRUCT APPLICATION** Revision 3 4/5/2007

Please see instructions on page 2 before filling out the form.

Company Name:	Midas Gold Idaho, Inc.
Facility Name:	Stibnite Gold Project
Facility ID No.:	
Brief Project Description:	Conventional open-pit mining operations and onsite ore preparation and gold extraction processes.

FUGITIVE SOURCE PARAMETERS

1.	2.	3a.	3b.	4.	5.	6.	7.	8.	9.	10.
Emissions units	**Stack ID**	**UTM Easting (m)**	**UTM Northing (m)**	**Base Elevation (m)**	**Release Height (m)**	**Easterly Length (m)**	**Northerly Length (m)**	**Angle from North (°)**	**Initial Vertical Dimension (m)**	**Initial Horizontal Dimension (m)**
Area Source(s)										
Mining Activity Sources										
Yellow Pine Pit	YPP	631,160	4,975,865	1,832	4.75	881.99	881.99	-8.00	4.42	
Hangar Flats Pit	HFP	630,925	4,972,884	1,993	4.75	490.99	490.99	0.00	4.42	
West End Pit	WEP	632,398	4,976,290	2,192	4.75	376.22	376.22	0.00	4.42	
Bradley Tailings	BT	630,110	4,972,105	2,012	4.75	820.00	420.00	0.00	4.42	
Tailing Storage Facility	TSF	628,496	4,971,000	2,097	0.00	1,156.79	1,156.79	0.00	0.00	
Scout Portal	UGEXP	632,362	4,973,690	2,018	0.00	4.88	4.88	0.00	0.00	
Volume Source(s)										
Process & Ancillary Sources										
Loader Transfer of Ore to Grizzly	OC1	632,045	4,974,583	1,969	19.51				18.15	3.75
Grizzly to Apron Feeder	OC2	632,045	4,974,583	1,969	19.51				18.15	3.75
Apron Feeder to Dribble	OC3	632,045	4,974,583	1,969	19.51				18.15	3.75
Apron Feeder to Vibrating Grizzly	OC4	632,045	4,974,583	1,969	19.51				18.15	3.75
Dribble Conveyor to Vibrating Grizzly	OC5	632,045	4,974,583	1,969	19.51				18.15	3.75
Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	OC6	632,045	4,974,583	1,969	19.51				18.15	3.75

FUGITIVE SOURCE PARAMETERS										
1.	2.	3a.	3b.	4.	5.	6.	7.	8.	9.	10.
Emissions units	Stack ID	UTM Easting (m)	UTM Northing (m)	Base Elevation (m)	Release Height (m)	Easterly Length (m)	Northerly Length (m)	Angle from North (°)	Initial Vertical Dimension (m)	Initial Horizontal Dimension (m)
Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	OC7	632,045	4,974,583	1,969	19.51				18.15	3.75
Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	OC8	631,947	4,974,520	1,957	10.91				10.15	0.21
Stockpile Transfers to Reclaim Conveyors	OC9	631,947	4,974,520	1,957	1.22				1.13	0.57
Reclaim Conveyors to SAG Mill Feed Conveyor	OC10	631,947	4,974,520	1,957	1.22				1.13	0.57
SAG Mill Feed Conveyor Transfer to SAG Mill	OC11	632,113	4,974,243	2,001	20.73				0.57	0.28
Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	OC12	632,028	4,974,187	1,973	3.05				2.84	2.32
Pebble Discharge Conveyor to SAG Mill Feed Conveyor	OC13	632,028	4,974,187	1,973	3.05				2.84	2.32
Mill Lime Silo #1 Unloading to SAG Mill Conveyor	LS1U	632,095	4,974,272	1,992	1.37				0.14	0.07
Mill Lime Silo #1 Unloading to SAG Mill Conveyor	LS1U	632,095	4,974,272	1,992	1.37				0.14	0.07
Mill Lime Silo #2 Unloading to SAG Mill Conveyor	MillS2U	632,090	4,974,282	1,990	1.37				0.14	0.07
AC Lime Silo #1 Unloading to Lime Slaker	ACS1U	632,267	4,974,124	2,007	1.37				0.14	0.07
AC Lime Silo #2 Unloading to Lime Slaker	ACS2U	632,257	4,974,140	2,007	1.37				0.14	0.07
AC Lime Silo #3 Unloading to Lime Slaker	ACS3U	632,248	4,974,156	2,007	1.37				0.14	0.07
AC Lime Silo #4 Unloading to Lime Slaker	ACS42U	632,238	4,974,171	2,007	1.37				0.14	0.07
AC Lime Silo #1 Unloading to Lime Slaker	ACS1U	632,267	4,974,124	2,007	1.37				0.14	0.07
AC Lime Silo #2 Unloading to Lime Slaker	ACS2U	632,257	4,974,140	2,007	1.37				0.14	0.07

FUGITIVE SOURCE PARAMETERS										
1.	2.	3a.	3b.	4.	5.	6.	7.	8.	9.	10.
Emissions units	Stack ID	UTM Easting (m)	UTM Northing (m)	Base Elevation (m)	Release Height (m)	Easterly Length (m)	Northerly Length (m)	Angle from North (°)	Initial Vertical Dimension (m)	Initial Horizontal Dimension (m)
AC Lime Silo #3 Unloading to Lime Slaker	ACS3U	632,248	4,974,156	2,007	1.37				0.14	0.07
AC Lime Silo #4 Unloading to Lime Slaker	ACS42U	632,238	4,974,171	2,007	1.37				0.14	0.07
Prill Silos Unloading (2 x 100 ton)	PSU	632,346	4,973,500	2,010	1.37				0.14	0.07
Cement/Shotcrete Silo #1 Unloading	CS1U	632,095	4,974,272	1,992	1.52				1.42	5.12
Cement/Shotcrete Silo #2 Unloading	CS2U	632,095	4,974,272	1,992	1.52				1.42	5.12
Aggregate Bin Loading	CAL	632,095	4,974,272	1,992	1.52				1.42	5.12
Aggregate Bin Unloading	CAU	632,095	4,974,272	1,992	1.52				1.42	5.12
Central Mixer Loading	CM	632,095	4,974,272	1,992	1.52				1.42	5.12
Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	PCSP1	632,348	4,973,429	2,009	2.13				1.98	13.13
Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	PCSP2	632,348	4,973,369	2,007	2.13				1.98	13.13
Limestone transfer to Primary Crusher Hopper	LS1	632,239	4,974,256	1,996	3.44				3.20	1.60
Primary Crushing and Associated Transfers In and Out	LS2	632,239	4,974,256	1,996	3.44				3.20	1.60
Primary Screening and Associated Transfers In and Out	LS3	632,239	4,974,256	1,996	3.44				3.20	1.60
Secondary Crushing and Associated Transfers In and Out	LS4	632,227	4,974,268	1,996	3.44				3.20	1.60

FUGITIVE SOURCE PARAMETERS										
1.	2.	3a.	3b.	4.	5.	6.	7.	8.	9.	10.
Emissions units	Stack ID	UTM Easting (m)	UTM Northing (m)	Base Elevation (m)	Release Height (m)	Easterly Length (m)	Northerly Length (m)	Angle from North (°)	Initial Vertical Dimension (m)	Initial Horizontal Dimension (m)
Secondary Screening and Associated Transfers In and Out	LS5	632,227	4,974,268	1,996	3.44				3.20	1.60
Limestone transfer to Ball Mill Feed Conveyor	LS7	632,181	4,974,307	1,996	1.07				0.43	0.07
Ball Mill Feed transfer to Ball Mill	LS8	632,200	4,974,273	1,996	8.53				0.57	0.28
Limestone transfer to Lime Kiln Feed Conveyor	LS10	632,169	4,974,325	1,996	1.07				0.43	0.07
Fines Screening and Associated Transfers In and Out	LS11	632,151	4,974,314	1,996	0.76				0.71	0.57
Kiln Feed transfer to PFR Shaft Lime Kiln	LS12	632,056	4,974,285	1,984	20.73				0.57	0.28
Pebble Lime Silo discharge to Lime Slaker	LSU	632,069	4,974,206	1,996	1.07				0.43	0.07
Mining Activity Sources										
Yellow Pine Pit Blasting	YPPBL	631,471	4,976,374	1,717	15.00				6.98	20.23
Hangar Flats Pit Blasting	HFPBL	631,171	4,973,129	1,891	15.00				6.98	20.23
West End Pit Blasting	WEPBL	632,586	4,976,478	1,994	15.00				6.98	20.23
Bradley Tailings Blasting	BTBL	630,520	4,972,315	2,012	15.00				6.98	20.23
PC Stockpile	STKP	632,112	4,974,616	1,980	4.75				4.42	53.35
Fiddle DRSF	FDRSF	630,981	4,974,903	2,115	4.75				4.42	180.22
Hangar Flats DRSF	HFDRSF	630,158	4,972,124	2,080	4.75				4.42	174.81
Yellow Pine DRSF	YPDRSF	631,491	4,976,383	1,904	4.75				4.42	182.21
West End DRSF	WEDRSF	633,392	4,976,207	2,376	4.75				4.42	124.05
Onsite Hauling	HR	Variable, provided in AERMOD files			4.75				4.42	15.14
Access Roads	ACCRD	Variable, provided in AERMOD files			2.98				2.77	6.10

	DEQ AIR QUALITY PROGRAM 1410 N. Hilton, Boise, ID 83706 For assistance, call the **Air Permit Hotline - 1-877-5PERMIT**	**PERMIT TO CONSTRUCT APPLICATION** Revision 3 4/5/2007

Please see instructions on page 2 before filling out the form.

Company Name:	Midas Gold Idaho, Inc.
Facility Name:	Stibnite Gold Project
Facility ID No.:	
Brief Project Description:	Conventional open-pit mining operations and onsite ore preparation and gold extraction processes.

BUILDING AND STRUCTURE INFORMATION

1.	2.	3.	4.	5.	6.	7.
Building ID Number	**Length (ft)**	**Width (ft)**	**Base Elevation (m)**	**Building Height (m)**	**Number of Tiers**	**Description/Comments**
PC			1,969	39.01	1	Dimensions and coordinates are provided in AERMOD and BPIP files
WTREAT			1,967	6.10	1	
O2PLANTN			1,957	6.10	1	
O2PLANTS			1,962	6.10	1	
SUBSTA			1,956	6.10	1	
MILL			2,001	42.67	1	
REFINERY			1,970	13.72	1	
EMRGCY			1,979	6.10	1	
ADMIN			1,979	6.10	1	
WAREN			1,984	12.19	1	
WARES			1,986	12.19	1	
MOPS			1,989	12.19	1	
WAREFUEL			1,988	12.19	1	
TSHOP			1,992	12.19	1	
TWASH			1,993	12.19	1	
PEBCRSH			1,973	6.10	1	
POX			2,007	20.42	1	
MSILO1			1,992	12.41	1	
MSILO2			1,990	12.41	1	
ACSILO1			2,007	16.52	1	
ACSILO2			2,007	16.52	1	
ACSILO3			2,007	16.52	1	
ACSILO4			2,007	13.58	1	
PRILL1			2,010	6.85	1	
PRILL2			2,008	6.85	1	
GATE			2,123	3.66	1	
SLKIT			2,122	7.62	1	
SLDORM1			2,122	10.67	1	
SLDORM2			2,120	10.67	1	
SLDORM3			2,118	10.67	1	
SLDORM4			2,117	10.67	1	
SLDORM5			2,116	10.67	1	
SLREC			2,114	10.67	1	
SLWTP			2,114	7.62	1	
BALLMILL			1,996	18.29	1	
LKILN			1,984	42.67	1	
LKCRUSH			1,990	12.19	1	
LSLAKE			1,996	6.10	1	
KFB			1,996	7.92	1	
BMFB			1,996	7.92	1	

1.13 Form FRA – Federal Regulation Applicability

Table 13 provides a list of federal regulations determined to be applicable to the Midas Gold – SGP. A detailed regulatory review has been provided for each regulation, with the exception of NESHAP, Subpart ZZZZ.[1] Additional details on the regulatory analysis can be found in Section 4.0 of this application.

Table 13. Applicable Federal Regulations

Regulation	Description
NSPS, Subpart LL 40 CFR §60.380	Standards of Performance for Metallic Mineral Processing Plants
NSPS, Subpart OOO 40 CFR §60.670	Standards of Performance for Nonmetallic Mineral Processing Plants
NSPS, Subpart IIII 40 CFR §60.4200	Standards of Performance for Stationary Compression Ignition Internal Combustion Engines
NESHAP, Subpart ZZZZ 40 CFR §63.6580	National Emissions Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines
NESHAP, Subpart CCCCCC 40 CFR §63.11110	National Emission Standards for Hazardous Air Pollutants for Source Category: Gasoline Dispensing Facilities
NESHAP, Subpart EEEEEEE 40 CFR §63.11640	National Emission Standards for Hazardous Air Pollutants: Gold Mine Ore Processing and Production Area Source Category

[1] As discussed in Section 4.0 of this application, for the proposed sources, compliance with NESHAP, Subpart ZZZZ is accomplished by complying with the requirements of NSPS, Subpart IIII. No further requirements under NESHAP apply.

PRI00000304

REC 1644

DEQ AIR QUALITY PROGRAM
1410 N. Hilton, Boise, ID 83706
For assistance, call the
Air Permit Hotline – 1-877-5PERMIT

Federal Rule Applicability **– Form FRA**
6/7/2018

In each box in the table below, CTRL+click on the blue underlined text for instructions and information.

IDENTIFICATION	
1. Company Name:	2. Facility Name:
Midas Gold Idaho, Inc.	Stibnite Gold Project
3. Brief Project Description:	Conventional open-pit mining and ore preparation and gold extraction processes.

APPLICABILITY DETERMINATION	
4. List all applicable subparts of the New Source Performance Standards (NSPS) (40 CFR part 60). List all non-applicable subparts of the NSPS which may appear to apply to the facility but do not. Examples of NSPS-affected emissions units include internal combustion engines, boilers, turbines, etc. Applicant must thoroughly review the list of affected emissions units.	List of all applicable subpart(s): 40 CFR 60.380, 40 CFR 60.670, 40 CFR 60.4200 List of all non-applicable subpart(s) which may appear to apply but do not: 40 CFR 60.40c, 40 CFR 60.340 ☐ Not Applicable
5. List applicable subpart(s) of the National Emission Standards for Hazardous Air Pollutants (NESHAPs) (40 CFR part 61 and 40 CFR part 63). List all non-applicable subparts of the NESHAP which may appear to apply to the facility but do not. Examples of affected emission units include solvent cleaning operations, industrial cooling towers, paint stripping and miscellaneous surface coating. Reference EPA's webpage on NESHAPs for more information.	List of all applicable subpart(s): 40 CFR 63.6580, 40 CFR 63.11110, 40 CFR List of all non-applicable subpart(s) which may appear to apply but do not: 40 CFR 63.7080 ☐ Not Applicable
6. For each subpart identified above, conduct a complete regulatory analysis using the instructions and referencing the example on the following pages. **Note**: Regulatory reviews must be submitted with sufficient detail so that DEQ can verify applicability and document in legal terms why the regulation does or does not apply. Regulatory reviews submitted with insufficient detail will be determined incomplete.	☒ A detailed regulatory review has been provided ☐ DEQ has already been provided a detailed regulatory review (please provide a reference)

IF YOU ARE UNSURE HOW TO ANSWER ANY OF THESE QUESTIONS, CALL THE AIR PERMIT HOTLINE AT 1-877-5PERMIT.

It is emphasized that it is the applicant's responsibility to satisfy all technical and regulatory requirements, and that DEQ will help the applicant understand those requirements prior to submittal of the application but that DEQ will not perform the required technical or regulatory analyses on the applicant's behalf.

NSPS, Subpart LL – Standards of Performance for Metallic Mineral Processing Plants

PRI00000306

REC 1646

ELECTRONIC CODE OF FEDERAL REGULATIONS

e-CFR data is current as of January 18, 2019

Title 40 → Chapter I → Subchapter C → Part 60 → Subpart LL

Title 40: Protection of Environment
PART 60—STANDARDS OF PERFORMANCE FOR NEW STATIONARY SOURCES

Subpart LL—Standards of Performance for Metallic Mineral Processing Plants

Contents

§60.380 Applicability and designation of affected facility.
§60.381 Definitions.
§60.382 Standard for particulate matter.
§60.383 Reconstruction.
§60.384 Monitoring of operations.
§60.385 Recordkeeping and reporting requirements.
§60.386 Test methods and procedures.

SOURCE: 49 FR 6464, Feb. 21, 1984, unless otherwise noted.

§60.380 Applicability and designation of affected facility.

(a) The provisions of this subpart are applicable to the following affected facilities in metallic mineral processing plants: ~~Each crusher and screen in open-pit mines;~~ each crusher, ~~screen, bucket elevator,~~ conveyor belt transfer point, ~~thermal dryer, product packaging station, storage bin, enclosed storage area, truck loading station,~~ truck unloading station, ~~railcar loading station, and railcar unloading station~~ at the mill ~~or concentrator with the following exceptions. All facilities located in underground mines are exempted from the provisions of this subpart. At uranium ore processing plants, all facilities subsequent to and including the beneficiation of uranium ore are exempted from the provisions of this subpart.~~

(b) An affected facility under paragraph (a) of this section that commences construction ~~or modification~~ after August 24, 1982, is subject to the requirements of this part.

Midas Gold is proposing to operate a metallic mineral processing plant at the Stibnite Gold Project, where they will operate a combination of equipment to produce gold and silver concentrates from ore. Therefore, the provisions of this subpart will be applicable per §60.380(a). The metallic mineral processing plant will include crushers, conveyor belt transfer points, and a truck unloading station. The proposed metallic mineral processing plant will be subject to the requirements of this subpart as it will commence construction after August 24, 1982, per §60.380(b).

§60.381 Definitions.

All terms used in this subpart, but not specifically defined in this section, shall have the meaning given them in the Act and in subpart A of this part.

~~*Bucket elevator* means a conveying device for metallic minerals consisting of a head and foot assembly that supports and drives an endless single or double strand chain or belt to which buckets are attached.~~

~~*Capture system* means the equipment used to capture and transport particulate matter generated by one or more affected facilities to a control device.~~

Control device means the air pollution control equipment used to reduce particulate matter emissions released to the atmosphere from one or more affected facilities at a metallic mineral processing plant.

Conveyor belt transfer point means a point in the conveying operation where the metallic mineral or metallic mineral concentrate is transferred to or from a conveyor belt except where the metallic mineral is being transferred to a stockpile.

Crusher means a machine used to crush any metallic mineral and includes feeders or conveyors located immediately below the crushing surfaces. Crushers include, but are not limited to, the following types: jaw, gyratory, cone, and hammermill.

~~*Enclosed storage area* means any area covered by a roof under which metallic minerals are stored prior to further processing or loading.~~

Metallic mineral concentrate means a material containing metallic compounds in concentrations higher than naturally occurring in ore but requiring additional processing if pure metal is to be isolated. A metallic mineral concentrate contains at least one of the following metals in any of its oxidation states and at a concentration that contributes to the concentrate's commercial value: ~~Aluminum, copper,~~ gold, ~~iron, lead, molybdenum~~, silver, ~~titanium, tungsten, uranium, zinc, and zirconium.~~ This definition shall not be construed as requiring that material containing metallic compounds be refined to a pure metal in order for the material to be considered a metallic mineral concentrate to be covered by the standards.

Metallic mineral processing plant means any combination of equipment that produces metallic mineral concentrates from ore. Metallic mineral processing commences with the mining of ore and includes all operations either up to and including the loading of wet or dry concentrates or solutions of metallic minerals for transfer to facilities at non-adjacent locations that will subsequently process metallic concentrates into purified metals (or other products), or up to and including all material transfer and storage operations that precede the operations that produce refined metals (or other products) from metallic mineral concentrates at facilities adjacent to the metallic mineral processing plant. This definition shall not be construed as requiring that mining of ore be conducted in order for the combination of equipment to be considered a metallic mineral processing plant. (See also the definition of *metallic mineral concentrate*.)

Process fugitive emissions means particulate matter emissions from an affected facility that are not collected by a capture system.

~~*Product packaging station* means the equipment used to fill containers with metallic compounds or metallic mineral concentrates.~~

~~*Railcar loading station* means that portion of a metallic mineral processing plant where metallic minerals or metallic mineral concentrates are loaded by a conveying system into railcars.~~

~~*Railcar unloading station* means that portion of a metallic mineral processing plant where metallic ore is unloaded from a railcar into a hopper, screen, or crusher.~~

~~*Screen* means a device for separating material according to size by passing undersize material through one or more mesh surfaces (screens) in series and retaining oversize material on the mesh surfaces (screens).~~

~~*Stack emissions* means the particulate matter captured and released to the atmosphere through a stack, chimney, or flue.~~

Storage bin means a facility for storage (including surge bins and hoppers) of metallic minerals prior to further processing or loading.

Surface moisture means water that is not chemically bound to a metallic mineral or metallic mineral concentrate.

~~*Thermal dryer* means a unit in which the surface moisture content of a metallic mineral or a metallic mineral concentrate is reduced by direct or indirect contact with a heated gas stream.~~

~~*Truck loading station* means that portion of a metallic mineral processing plant where metallic minerals or metallic mineral concentrates are loaded by a conveying system into trucks.~~

Truck unloading station means that portion of a metallic mineral processing plant where metallic ore is unloaded from a truck into a hopper, screen, or crusher.

[49 FR 6464, Feb. 21, 1984, as amended at 65 FR 61760, Oct. 17, 2000]

The highlighted definitions in §60.381 will apply to the Stibnite Gold Project affected facilities under this subpart.

§60.382 Standard for particulate matter.

~~(a) On and after the date on which the performance test required to be conducted by §60.8 is completed, no owner or operator subject to the provisions of this subpart shall cause to be discharged into the atmosphere from an affected facility any stack emissions that:~~

~~(1) Contain particulate matter in excess of 0.05 grams per dry standard cubic meter (0.05 g/dscm).~~

~~(2) Exhibit greater than 7 percent opacity, unless the stack emissions are discharged from an affected facility using a wet scrubbing emission control device.~~

(b) On and after the sixtieth day after achieving the maximum production rate at which the affected facility will be operated, but not later than 180 days after initial startup, no owner or operator subject to the provisions of this subpart shall cause to be discharged into the atmosphere from an affected facility any process fugitive emissions that exhibit greater than 10 percent opacity.

[49 FR 6464, Feb. 21, 1984, as amended at 65 FR 61760, Oct. 17, 2000; 79 FR 11250, Feb. 27, 2014]

§60.382(a) will not apply to the Stibnite Gold Project as it will not have any affected facilities subject to this subpart with stack emissions.

§60.382(b) will apply to the Stibnite Gold Project affected facilities subject to this subpart. The affected facilities' process fugitive emissions may not exhibit greater than 10 percent opacity.

§60.383 Reconstruction.

(a) The cost of replacement of ore-contact surfaces on processing equipment shall not be considered in calculating either the "fixed capital cost of the new components" or the "fixed capital cost that would be required to construct a comparable new facility" under §60.15. Ore-contact surfaces are: Crushing surfaces; screen meshes, bars, and plates; conveyor belts; elevator buckets; and pan feeders.

(b) Under §60.15, the "fixed capital cost of the new components" includes the fixed capital cost of all depreciable components (except components specified in paragraph (a) of this section) that are or will be replaced pursuant to all continuous programs of component replacement commenced within any 2-year period following August 24, 1982.

§60.383 will not apply as the Stibnite Gold Project affected facilities subject to this subpart are not being reconstructed.

§60.384 Monitoring of operations.

(a) The owner or operator subject to the provisions of this subpart shall install, calibrate, maintain, and operate a monitoring device for the continuous measurement of the change in pressure of the gas stream through the scrubber for any affected facility using a wet scrubbing emission control device. The monitoring device must be certified by the manufacturer to be accurate within ±250 pascals (±1 inch water) gauge pressure and must be calibrated on an annual basis in accordance with manufacturer's instructions.

(b) The owner or operator subject to the provisions of this subpart shall install, calibrate, maintain, and operate a monitoring device for the continuous measurement of the scrubbing liquid flow rate to a wet scrubber for any affected facility using any type of wet scrubbing emission control device. The monitoring device must be certified by the manufacturer to be accurate within ±5 percent of design scrubbing liquid flow rate and must be calibrated on at least an annual basis in accordance with manufacturer's instructions.

§60.384 will not apply as Midas Gold is not proposing to use a wet scrubbing emission control device on the affected facilities subject to this subpart.

§60.385 Recordkeeping and reporting requirements.

(a) The owner or operator subject to the provisions of this subpart shall conduct a performance test and submit to the Administrator a written report of the results of the test as specified in §60.8(a).

(b) During the initial performance test of a wet scrubber, and at least weekly thereafter, the owner or operator shall record the measurements of both the change in pressure of the gas stream across the scrubber and the scrubbing liquid flow rate.

(c) After the initial performance test of a wet scrubber, the owner or operator shall submit semiannual reports to the Administrator of occurrences when the measurements of the scrubber pressure loss (or gain) or liquid flow rate differ by more than ±30 percent from the average obtained during the most recent performance test.

(d) The reports required under paragraph (c) shall be postmarked within 30 days following the end of the second and fourth calendar quarters.

(e) The requirements of this subsection remain in force until and unless the Agency, in delegating enforcement authority to a State under section 111(c) of the Act, approves reporting requirements or an alternative means of compliance surveillance adopted by such States. In that event, affected sources within the State will be relieved of the obligation to comply with this subsection, provided that they comply with requirements established by the State.

[49 FR 6464, Feb. 21, 1984, as amended at 54 FR 6676, Feb. 14, 1989; 65 FR 61760, Oct. 17, 2000]

§60.385(a) will apply to the Stibnite Gold Project affected facilities subject to this subpart, and therefore Midas Gold will be required to submit written reports of the results of the performance tests conducted.

§60.385(b)-(d) will not apply as Midas Gold is not proposing the use of a wet scrubber on the affected facilities subject to this subpart.

§60.385(e) will apply to the Stibnite Gold Project affected facilities subject to this subpart and will serve as informative.

§60.386 Test methods and procedures.

(a) In conducting the performance tests required in §60.8, the owner or operator shall use as reference methods and procedures the test methods in appendix A of this part or other methods and procedures as specified in this section, except as provided in §60.8(b).

(b) The owner or operator shall determine compliance with the particulate matter standards §60.382 as follows:

~~(1) Method 5 or 17 shall be used to determine the particulate matter concentration. The sample volume for each run shall be at least 1.70 dscm (60 dscf). The sampling probe and filter holder of Method 5 may be operated without heaters if the gas stream being sampled is at ambient temperature. For gas streams above ambient temperature, the Method 5 sampling train shall be operated with a probe and filter temperature slightly above the effluent temperature (up to a maximum filter temperature of 121 °C (250 °F)) in order to prevent water condensation on the filter.~~

(2) Method 9 and the procedures in §60.11 shall be used to determine opacity from ~~stack emissions and~~ process fugitive emissions. The observer shall read opacity only when emissions are clearly identified as emanating solely from the affected facility being observed. A single visible emission observer may conduct visible emission observations for up to three fugitive, ~~stack, or vent~~ emission points within a 15-second interval. This option is subject to the following limitations:

(i) No more than three emission points are read concurrently;

(ii) All three emission points must be within a 70° viewing sector or angle in front of the observer such that the proper sun position can be maintained for all three points; and

(iii) If an opacity reading for any one of the three emission points is within 5 percent opacity of the application standard, then the observer must stop taking readings for the other two points and continue reading just that single point.

~~(c) To comply with §60.385(c), the owner or operator shall use the monitoring devices in §60.384(a) and (b) to determine the pressure loss of the gas stream through the scrubber and scrubbing liquid flow rate at any time during each particulate matter run, and the average of the three determinations shall be computed.~~

[54 FR 6676, Feb. 14, 1989, as amended at 65 FR 61760, Oct. 17, 2000; 79 FR 11250, Feb. 27, 2014]

§60.386(a) and (b)(2) will apply to the Stibnite Gold Project affected facilities subject to this subpart and Midas Gold will be required to conduct performance test using the specified test methods and procedures.

§60.386(b)(1) will not apply as the Stibnite Gold Project affected facilities subject to this subpart are not subject to the PM concentration standard in §60.382(a), and therefore Midas Gold will not be required to conduct a performance test to determine PM concentration.

§60.386(c) will not apply as Midas Gold is not proposing the use of a wet scrubber on the affected facilities subject to this subpart and is therefore not subject to §60.385(c).

NSPS, Subpart OOO – Standards of Performance for Nonmetallic Mineral Processing Plants

PRI00000311

REC 1651

Title 40: Protection of Environment
PART 60—STANDARDS OF PERFORMANCE FOR NEW STATIONARY SOURCES (CONTINUED)

Subpart OOO—Standards of Performance for Nonmetallic Mineral Processing Plants

Contents

§60.670 Applicability and designation of affected facility.
§60.671 Definitions.
§60.672 Standard for particulate matter (PM).
§60.673 Reconstruction.
§60.674 Monitoring of operations.
§60.675 Test methods and procedures.
§60.676 Reporting and recordkeeping.
Table 1 to Subpart OOO of Part 60—Exceptions to Applicability of Subpart A to Subpart OOO
Table 2 to Subpart OOO of Part 60—Stack Emission Limits for Affected Facilities With Capture Systems
Table 3 to Subpart OOO of Part 60—Fugitive Emission Limits

SOURCE: 74 FR 19309, Apr. 28, 2009, unless otherwise noted.

§60.670 Applicability and designation of affected facility.

(a)(1) Except as provided in paragraphs (a)(2), (b), (c), and (d) of this section, the provisions of this subpart are applicable to the following affected facilities in fixed or portable nonmetallic mineral processing plants: each crusher, grinding mill, screening operation, ~~bucket elevator,~~ belt conveyor, ~~bagging operation,~~ storage bin, ~~enclosed truck or railcar loading station~~. ~~Also, crushers and grinding mills at hot mix asphalt facilities that reduce the size of nonmetallic minerals embedded in recycled asphalt pavement and subsequent affected facilities up to, but not including, the first storage silo or bin are subject to the provisions of this subpart.~~

~~(2) The provisions of this subpart do not apply to the following operations: All facilities located in underground mines; plants without crushers or grinding mills above ground; and wet material processing operations (as defined in §60.671).~~

~~(b) An affected facility that is subject to the provisions of subparts F or I of this part or that follows in the plant process any facility subject to the provisions of subparts F or I of this part is not subject to the provisions of this subpart.~~

(c) Facilities at the following plants are not subject to the provisions of this subpart:

~~(1) Fixed sand and gravel plants and crushed stone plants with capacities, as defined in §60.671, of 23 megagrams per hour (25 tons per hour) or less;~~

(2) Portable sand and gravel plants and crushed stone plants with capacities, as defined in §60.671, of 136 megagrams per hour (150 tons per hour) or less; and

~~(3) Common clay plants and pumice plants with capacities, as defined in §60.671, of 9 megagrams per hour (10 tons per hour) or less.~~

~~(d)(1) When an existing facility is replaced by a piece of equipment of equal or smaller size, as defined in §60.671, having the same function as the existing facility, and there is no increase in the amount of emissions, the new facility is exempt from the provisions of §§60.672, 60.674, and 60.675 except as provided for in paragraph (d)(3) of this section.~~

~~(2) An owner or operator complying with paragraph (d)(1) of this section shall submit the information required in §60.676(a).~~

~~(3) An owner or operator replacing all existing facilities in a production line with new facilities does not qualify for the exemption described in paragraph (d)(1) of this section and must comply with the provisions of §§60.672, 60.674 and 60.675.~~

(e) An affected facility under paragraph (a) of this section that commences construction, ~~modification, or reconstruction~~ after August 31, 1983, is subject to the requirements of this part.

(f) Table 1 of this subpart specifies the provisions of subpart A of this part 60 that do not apply to owners and operators of affected facilities subject to this subpart or that apply with certain exceptions.

Midas Gold is proposing to operate a nonmetallic mineral processing plant at the Stibnite Gold Project, where they will process limestone. Therefore, the provisions of this subpart will apply per §60.670(a)(1). The limestone mineral processing will consist of a primary and secondary crusher, a primary and secondary screening operation, a ball mill, storage bins and conveyors. The proposed nonmetallic mineral processing plants will be subject to the requirements of this subpart as it will commence construction after August 31, 1983 per §60.670(e). Table 1 of this subpart provides exceptions to applicability per §60.670(f).
In addition, certain construction and maintenance activities during operations may require sized aggregate. To allow for the operational flexibility to produce construction aggregate onsite, Midas Gold is including two portable crushing and screening plants in this application. Each portable plant may include primary and secondary crushers and screens, and multiple conveyors. Each portable plant will be rated at less than 150 ton/hr and therefore exempt from requirements of this subpart per §60.670(c)(2).

§60.671 Definitions.

All terms used in this subpart, but not specifically defined in this section, shall have the meaning given them in the Act and in subpart A of this part.

~~*Bagging operation* means the mechanical process by which bags are filled with nonmetallic minerals.~~

Belt conveyor means a conveying device that transports material from one location to another by means of an endless belt that is carried on a series of idlers and routed around a pulley at each end.

~~*Bucket elevator* means a conveying device of nonmetallic minerals consisting of a head and foot assembly which supports and drives an endless single or double strand chain or belt to which buckets are attached.~~

Building means any frame structure with a roof.

Capacity means the cumulative rated capacity of all initial crushers that are part of the plant.

Capture system means the equipment (including enclosures, hoods, ducts, fans, dampers, etc.) used to capture and transport particulate matter generated by one or more affected facilities to a control device.

Control device means the air pollution control equipment used to reduce particulate matter emissions released to the atmosphere from one or more affected facilities at a nonmetallic mineral processing plant.

Conveying system means a device for transporting materials from one piece of equipment or location to another location within a plant. Conveying systems include but are not limited to the following: Feeders, belt conveyors, bucket elevators and pneumatic systems.

Crush or *Crushing* means to reduce the size of nonmetallic mineral material by means of physical impaction of the crusher or grinding mill upon the material.

Crusher means a machine used to crush any nonmetallic minerals, and includes, but is not limited to, the following types: Jaw, gyratory, cone, roll, rod mill, hammermill, and impactor.

~~*Enclosed truck or railcar loading station* means that portion of a nonmetallic mineral processing plant where nonmetallic minerals are loaded by an enclosed conveying system into enclosed trucks or railcars.~~

Fixed plant means any nonmetallic mineral processing plant at which the processing equipment specified in §60.670(a) is attached by a cable, chain, turnbuckle, bolt or other means (except electrical connections) to any anchor, slab, or structure including bedrock.

Fugitive emission means particulate matter that is not collected by a capture system and is released to the atmosphere at the point of generation.

Grinding mill means a machine used for the wet or dry fine crushing of any nonmetallic mineral. Grinding mills include, but are not limited to, the following types: Hammer, roller, rod, pebble and ball, and fluid energy. The grinding mill includes the air conveying system, air separator, or air classifier, where such systems are used.

Initial crusher means any crusher into which nonmetallic minerals can be fed without prior crushing in the plant.

Nonmetallic mineral means any of the following minerals or any mixture of which the majority is any of the following minerals:

~~(1)~~ Crushed and Broken Stone, including Limestone, ~~Dolomite, Granite, Traprock, Sandstone, Quartz, Quartzite, Marl, Marble, Slate, Shale, Oil Shale, and Shell.~~

~~(2) Sand and Gravel.~~

~~(3) Clay including Kaolin, Fireclay, Bentonite, Fuller's Earth, Ball Clay, and Common Clay.~~

~~(4) Rock Salt.~~

~~(5) Gypsum (natural orsynthetic).~~

~~(6) Sodium Compounds, including Sodium Carbonate, Sodium Chloride, and Sodium Sulfate.~~

~~(7) Pumice.~~

~~(8) Gilsonite.~~

~~(9) Talc and Pyrophyllite.~~

~~(10) Boron, including Borax, Kernite, and Colemanite.~~

~~(11) Barite.~~

~~(12) Fluorospar.~~

~~(13) Feldspar.~~

~~(14) Diatomite.~~

~~(15) Perlite.~~

~~(16) Vermiculite.~~

~~(17) Mica.~~

~~(18) Kyanite, including Andalusite, Sillimanite, Topaz, and Dumortierite.~~

Nonmetallic mineral processing plant means any combination of equipment that is used to crush or grind any nonmetallic mineral wherever located, including lime plants, ~~power plants, steel mills, asphalt concrete plants, portland cement plants, or any other facility processing nonmetallic minerals except as provided in §60.670 (b) and (c).~~

~~*Portable plant* means any nonmetallic mineral processing plant that is mounted on any chassis or skids and may be moved by the application of a lifting or pulling force. In addition, there shall be no cable, chain, turnbuckle, bolt or other means (except electrical connections) by which any piece of equipment is attached or clamped to any anchor, slab, or structure, including bedrock that must be removed prior to the application of a lifting or pulling force for the purpose of transporting the unit.~~

Production line means all affected facilities (crushers, grinding mills, screening operations, ~~bucket elevators,~~ belt conveyors, ~~bagging operations,~~ storage bins, ~~and enclosed truck and railcar loading stations~~) which are directly connected or are connected together by a conveying system.

Saturated material means, for purposes of this subpart, mineral material with sufficient surface moisture such that particulate matter emissions are not generated from processing of the material through screening operations, bucket elevators and belt conveyors. Material that is wetted solely by wet suppression systems is not considered to be “saturated” for purposes of this definition.

Screening operation means a device for separating material according to size by passing undersize material through one or more mesh surfaces (screens) in series, and retaining oversize material on the mesh surfaces (screens). Grizzly feeders associated with truck dumping and static (non-moving) grizzlies used anywhere in the nonmetallic mineral processing plant are not considered to be screening operations.

~~*Seasonal shut down* means shut down of an affected facility for a period of at least 45 consecutive days due to weather or seasonal market conditions.~~

Size means the rated capacity in tons per hour of a crusher, grinding mill, ~~bucket elevator, bagging operation, or enclosed~~

~~truck or railcar loading station;~~ the total surface area of the top screen of a screening operation; the width of a conveyor belt; and the rated capacity in tons of a storage bin.

Stack emission means the particulate matter that is released to the atmosphere from a capture system.

Storage bin means a facility for storage (including surge bins) of nonmetallic minerals prior to further processing or loading.

Transfer point means a point in a conveying operation where the nonmetallic mineral is transferred to or from a belt conveyor except where the nonmetallic mineral is being transferred to a stockpile.

Truck dumping means the unloading of nonmetallic minerals from movable vehicles designed to transport nonmetallic minerals from one location to another. Movable vehicles include but are not limited to: Trucks, front end loaders, skip hoists, and railcars.

Vent means an opening through which there is mechanically induced air flow for the purpose of exhausting from a building air carrying particulate matter emissions from one or more affected facilities.

~~*Wet material processing operation(s)* means any of the following:~~

~~(1) Wet screening operations (as defined in this section) and subsequent screening operations, bucket elevators and belt conveyors in the production line that process saturated materials (as defined in this section) up to the first crusher, grinding mill or storage bin in the production line; or~~

~~(2) Screening operations, bucket elevators and belt conveyors in the production line downstream of wet mining operations (as defined in this section) that process saturated materials (as defined in this section) up to the first crusher, grinding mill or storage bin in the production line.~~

~~*Wet mining operation* means a mining or dredging operation designed and operated to extract any nonmetallic mineral regulated under this subpart from deposits existing at or below the water table, where the nonmetallic mineral is saturated with water.~~

~~*Wet screening operation* means a screening operation at a nonmetallic mineral processing plant which removes unwanted material or which separates marketable fines from the product by a washing process which is designed and operated at all times such that the product is saturated with water.~~

The highlighted definitions in §60.671 will apply to the Stibnite Gold Project affected facilities subject to this subpart.

§60.672 Standard for particulate matter (PM).

(a) Affected facilities must meet the stack emission limits and compliance requirements in Table 2 of this subpart within 60 days after achieving the maximum production rate at which the affected facility will be operated, but not later than 180 days after initial startup as required under §60.8. The requirements in Table 2 of this subpart apply for affected facilities with capture systems used to capture and transport particulate matter to a control device.

(b) Affected facilities must meet the fugitive emission limits and compliance requirements in Table 3 of this subpart within 60 days after achieving the maximum production rate at which the affected facility will be operated, but not later than 180 days after initial startup as required under §60.11. The requirements in Table 3 of this subpart apply for fugitive emissions from affected facilities without capture systems and for fugitive emissions escaping capture systems.

~~(c) [Reserved]~~

(d) Truck dumping of nonmetallic minerals into any screening operation, feed hopper, or crusher is exempt from the requirements of this section.

(e) If any transfer point on a conveyor belt or any other affected facility is enclosed in a building, then each enclosed affected facility must comply with the emission limits in paragraphs (a) and (b) of this section, or the building enclosing the affected facility or facilities must comply with the following emission limits:

(1) Fugitive emissions from the building openings (except for vents as defined in §60.671) must not exceed 7 percent opacity; and

(2) Vents (as defined in §60.671) in the building must meet the applicable stack emission limits and compliance requirements in Table 2 of this subpart.

~~(f) Any baghouse that controls emissions from only an individual, enclosed storage bin is exempt from the applicable stack PM concentration limit (and associated performance testing) in Table 2 of this subpart but must meet the applicable stack opacity limit and compliance requirements in Table 2 of this subpart. This exemption from the stack PM concentration limit does~~

not apply for multiple storage bins with combined stack emissions.

The Stibnite Gold Project Limestone Ball Mill (Source ID LSBM) affected facility will be subject to the stack emission limits and compliance requirements in Table 2 of this subpart as required by §60.672(a), within 60 days after achieving the maximum production rate, but no later than 180 days after initial startup.

Except as discussed below, all other affected facilities in the Stibnite Gold Project nonmetallic mineral processing plant will be subject to the fugitive emission limits and compliance requirements in Table 3 of this subpart as required by §60.672(b), within 60 days after achieving the maximum production rate, but no later than 180 days after initial startup.

§60.672(d) will apply to the Limestone transfer to Primary Crusher Hopper (Source ID LS1), which will therefore be exempt from the particulate matter standards in this subpart.

§60.672(e) will apply to any Stibnite Gold Project affected facility subject to this subpart that is enclosed in a building. Per §60.672(e), any such affected facility must comply with the stated standards individually, or the building enclosing the affected facilities must comply with the standards in §60.672(e)(1) or (2), as applicable.

§60.672(f) will not apply as Midas Gold is not proposing the use of a baghouse on an individual, enclosed storage bin.

§60.673 Reconstruction.

(a) The cost of replacement of ore-contact surfaces on processing equipment shall not be considered in calculating either the "fixed capital cost of the new components" or the "fixed capital cost that would be required to construct a comparable new facility" under §60.15. Ore-contact surfaces are crushing surfaces; screen meshes, bars, and plates; conveyor belts; and elevator buckets.

(b) Under §60.15, the "fixed capital cost of the new components" includes the fixed capital cost of all depreciable components (except components specified in paragraph (a) of this section) which are or will be replaced pursuant to all continuous programs of component replacement commenced within any 2-year period following August 31, 1983.

§60.673 will not apply as the Stibnite Gold Project affected facilities are not being reconstructed.

§60.674 Monitoring of operations.

(a) The owner or operator of any affected facility subject to the provisions of this subpart which uses a wet scrubber to control emissions shall install, calibrate, maintain and operate the following monitoring devices:

(1) A device for the continuous measurement of the pressure loss of the gas stream through the scrubber. The monitoring device must be certified by the manufacturer to be accurate within ±250 pascals ±1 inch water gauge pressure and must be calibrated on an annual basis in accordance with manufacturer's instructions.

(2) A device for the continuous measurement of the scrubbing liquid flow rate to the wet scrubber. The monitoring device must be certified by the manufacturer to be accurate within ±5 percent of design scrubbing liquid flow rate and must be calibrated on an annual basis in accordance with manufacturer's instructions.

(b) The owner or operator of any affected facility for which construction, modification, or reconstruction commenced on or after April 22, 2008, that uses wet suppression to control emissions from the affected facility must perform monthly periodic inspections to check that water is flowing to discharge spray nozzles in the wet suppression system. The owner or operator must initiate corrective action within 24 hours and complete corrective action as expediently as practical if the owner or operator finds that water is not flowing properly during an inspection of the water spray nozzles. The owner or operator must record each inspection of the water spray nozzles, including the date of each inspection and any corrective actions taken, in the logbook required under §60.676(b).

(1) If an affected facility relies on water carryover from upstream water sprays to control fugitive emissions, then that affected facility is exempt from the 5-year repeat testing requirement specified in Table 3 of this subpart provided that the affected facility meets the criteria in paragraphs (b)(1)(i) and (ii) of this section:

(i) The owner or operator of the affected facility conducts periodic inspections of the upstream water spray(s) that are responsible for controlling fugitive emissions from the affected facility. These inspections are conducted according to paragraph (b) of this section and §60.676(b), and

(ii) The owner or operator of the affected facility designates which upstream water spray(s) will be periodically inspected at the time of the initial performance test required under §60.11 of this part and §60.675 of this subpart.

(2) If an affected facility that routinely uses wet suppression water sprays ceases operation of the water sprays or is using a control mechanism to reduce fugitive emissions other than water sprays during the monthly inspection (for example, water from recent rainfall), the logbook entry required under §60.676(b) must specify the control mechanism being used instead of the water sprays.

(c) Except as specified in paragraph (d) ~~or (e)~~ of this section, the owner or operator of any affected facility for which construction, ~~modification, or reconstruction~~ commenced on or after April 22, 2008, that uses a baghouse to control emissions must conduct quarterly 30-minute visible emissions inspections using EPA Method 22 (40 CFR part 60, appendix A-7). The Method 22 (40 CFR part 60, appendix A-7) test shall be conducted while the baghouse is operating. The test is successful if no visible emissions are observed. If any visible emissions are observed, the owner or operator of the affected facility must initiate corrective action within 24 hours to return the baghouse to normal operation. The owner or operator must record each Method 22 (40 CFR part 60, appendix A-7) test, including the date and any corrective actions taken, in the logbook required under §60.676(b). The owner or operator of the affected facility may establish a different baghouse-specific success level for the visible emissions test (other than no visible emissions) by conducting a PM performance test according to §60.675(b) simultaneously with a Method 22 (40 CFR part 60, appendix A-7) to determine what constitutes normal visible emissions from that affected facility's baghouse when it is in compliance with the applicable PM concentration limit in Table 2 of this subpart. The revised visible emissions success level must be incorporated into the permit for the affected facility.

(d) As an alternative to the periodic Method 22 (40 CFR part 60, appendix A-7) visible emissions inspections specified in paragraph (c) of this section, the owner or operator of any affected facility for which construction~~, modification, or reconstruction~~ commenced on or after April 22, 2008, that uses a baghouse to control emissions may use a bag leak detection system. The owner or operator must install, operate, and maintain the bag leak detection system according to paragraphs (d)(1) through (3) of this section.

(1) Each bag leak detection system must meet the specifications and requirements in paragraphs (d)(1)(i) through (viii) of this section.

(i) The bag leak detection system must be certified by the manufacturer to be capable of detecting PM emissions at concentrations of 1 milligram per dry standard cubic meter (0.00044 grains per actual cubic foot) or less.

(ii) The bag leak detection system sensor must provide output of relative PM loadings. The owner or operator shall continuously record the output from the bag leak detection system using electronic or other means (*e.g.*, using a strip chart recorder or a data logger).

(iii) The bag leak detection system must be equipped with an alarm system that will sound when the system detects an increase in relative particulate loading over the alarm set point established according to paragraph (d)(1)(iv) of this section, and the alarm must be located such that it can be heard by the appropriate plant personnel.

(iv) In the initial adjustment of the bag leak detection system, the owner or operator must establish, at a minimum, the baseline output by adjusting the sensitivity (range) and the averaging period of the device, the alarm set points, and the alarm delay time.

(v) Following initial adjustment, the owner or operator shall not adjust the averaging period, alarm set point, or alarm delay time without approval from the Administrator or delegated authority except as provided in paragraph (d)(1)(vi) of this section.

(vi) Once per quarter, the owner or operator may adjust the sensitivity of the bag leak detection system to account for seasonal effects, including temperature and humidity, according to the procedures identified in the site-specific monitoring plan required by paragraph (d)(2) of this section.

(vii) The owner or operator must install the bag leak detection sensor downstream of the fabric filter.

(viii) Where multiple detectors are required, the system's instrumentation and alarm may be shared among detectors.

(2) The owner or operator of the affected facility must develop and submit to the Administrator or delegated authority for approval of a site-specific monitoring plan for each bag leak detection system. The owner or operator must operate and maintain the bag leak detection system according to the site-specific monitoring plan at all times. Each monitoring plan must describe the items in paragraphs (d)(2)(i) through (vi) of this section.

(i) Installation of the bag leak detection system;

(ii) Initial and periodic adjustment of the bag leak detection system, including how the alarm set-point will be established;

(iii) Operation of the bag leak detection system, including quality assurance procedures;

(iv) How the bag leak detection system will be maintained, including a routine maintenance schedule and spare parts inventory list;

(v) How the bag leak detection system output will be recorded and stored; and

(vi) Corrective action procedures as specified in paragraph (d)(3) of this section. In approving the site-specific monitoring plan, the Administrator or delegated authority may allow owners and operators more than 3 hours to alleviate a specific

condition that causes an alarm if the owner or operator identifies in the monitoring plan this specific condition as one that could lead to an alarm, adequately explains why it is not feasible to alleviate this condition within 3 hours of the time the alarm occurs, and demonstrates that the requested time will ensure alleviation of this condition as expeditiously as practicable.

(3) For each bag leak detection system, the owner or operator must initiate procedures to determine the cause of every alarm within 1 hour of the alarm. Except as provided in paragraph (d)(2)(vi) of this section, the owner or operator must alleviate the cause of the alarm within 3 hours of the alarm by taking whatever corrective action(s) are necessary. Corrective actions may include, but are not limited to the following:

(i) Inspecting the fabric filter for air leaks, torn or broken bags or filter media, or any other condition that may cause an increase in PM emissions;

(ii) Sealing off defective bags or filter media;

(iii) Replacing defective bags or filter media or otherwise repairing the control device;

(iv) Sealing off a defective fabric filter compartment;

(v) Cleaning the bag leak detection system probe or otherwise repairing the bag leak detection system; or

(vi) Shutting down the process producing the PM emissions.

~~(e) As an alternative to the periodic Method 22 (40 CFR part 60, appendix A-7) visible emissions inspections specified in paragraph (c) of this section, the owner or operator of any affected facility that is subject to the requirements for processed stone handling operations in the Lime Manufacturing NESHAP (40 CFR part 63, subpart AAAAA) may follow the continuous compliance requirements in row 1 items (i) through (iii) of table 6 to subpart AAAAA of 40 CFR part 63.~~

§60.674(a) will not apply as Midas Gold is not proposing to use a wet scrubber to control emissions from the affected facilities subject to this subpart.

§60.674(b) will not apply as Midas Gold is not proposing the use of wet suppression to control emissions from the affected facilities subject to this subpart.

§60.674(c) will apply as the Stibnite Gold Project nonmetallic mineral processing plant will commence construction after April 22, 2008, and Midas Gold is proposing to use a baghouse to control emissions from the Limestone Ball Mill. Midas Gold will be required to conduct quarterly Method 22 30-minute visible emission inspections or use an alternate method per §60.674(d).

§60.674(d) will apply and provides an alternative to the Method 22 inspections required by §60.674(c).

§60.674(e) will not apply as the Stibnite Gold Project is not a major source of HAP emission, and therefore the nonmetallic mineral processing plant is not subject to the requirements for processed stone handling operations in the Lime Manufacturing NESHAP (40 CFR part 63, subpart AAAAA).

§60.675 Test methods and procedures.

(a) In conducting the performance tests required in §60.8, the owner or operator shall use as reference methods and procedures the test methods in appendices A-1 through A-7 of this part or other methods and procedures as specified in this section, except as provided in §60.8(b). Acceptable alternative methods and procedures are given in paragraph (e) of this section.

(b) The owner or operator shall determine compliance with the PM standards in §60.672(a) as follows:

(1) Except as specified in paragraphs (e)(3) and (4) of this section, Method 5 of appendix A-3 of this part or Method 17 of appendix A-6 of this part shall be used to determine the particulate matter concentration. The sample volume shall be at least 1.70 dscm (60 dscf). For Method 5 (40 CFR part 60, appendix A-3), if the gas stream being sampled is at ambient temperature, the sampling probe and filter may be operated without heaters. If the gas stream is above ambient temperature, the sampling probe and filter may be operated at a temperature high enough, but no higher than 121 °C (250 °F), to prevent water condensation on the filter.

(2) Method 9 of appendix A-4 of this part and the procedures in §60.11 shall be used to determine opacity.

(c)(1) In determining compliance with the particulate matter standards in §60.672(b) or §60.672(e)(1), the owner or operator shall use Method 9 of appendix A-4 of this part and the procedures in §60.11, with the following additions:

(i) The minimum distance between the observer and the emission source shall be 4.57 meters (15 feet).

(ii) The observer shall, when possible, select a position that minimizes interference from other fugitive emission sources

(*e.g.,* road dust). The required observer position relative to the sun (Method 9 of appendix A-4 of this part, Section 2.1) must be followed.

~~(iii) For affected facilities using wet dust suppression for particulate matter control, a visible mist is sometimes generated by the spray. The water mist must not be confused with particulate matter emissions and is not to be considered a visible emission. When a water mist of this nature is present, the observation of emissions is to be made at a point in the plume where the mist is no longer visible.~~

~~(2)(i) In determining compliance with the opacity of stack emissions from any baghouse that controls emissions only from an individual enclosed storage bin under §60.672(f) of this subpart, using Method 9 (40 CFR part 60, appendix A-4), the duration of the Method 9 (40 CFR part 60, appendix A-4) observations shall be 1 hour (ten 6-minute averages).~~

~~(ii) The duration of the Method 9 (40 CFR part 60, appendix A-4) observations may be reduced to the duration the affected facility operates (but not less than 30 minutes) for baghouses that control storage bins or enclosed truck or railcar loading stations that operate for less than 1 hour at a time.~~

(3) When determining compliance with the fugitive emissions standard for any affected facility described under §60.672(b) or §60.672(e)(1) of this subpart, the duration of the Method 9 (40 CFR part 60, appendix A-4) observations must be 30 minutes (five 6-minute averages). Compliance with the applicable fugitive emission limits in Table 3 of this subpart must be based on the average of the five 6-minute averages.

(d) To demonstrate compliance with the fugitive emission limits for buildings specified in §60.672(e)(1), the owner or operator must complete the testing specified in paragraph (d)(1) and (2) of this section. Performance tests must be conducted while all affected facilities inside the building are operating.

(1) If the building encloses any affected facility that commences construction, modification, or reconstruction on or after April 22, 2008, the owner or operator of the affected facility must conduct an initial Method 9 (40 CFR part 60, appendix A-4) performance test according to this section and §60.11.

~~(2) If the building encloses only affected facilities that commenced construction, modification, or reconstruction before April 22, 2008, and the owner or operator has previously conducted an initial Method 22 (40 CFR part 60, appendix A-7) performance test showing zero visible emissions, then the owner or operator has demonstrated compliance with the opacity limit in §60.672(e)(1). If the owner or operator has not conducted an initial performance test for the building before April 22, 2008, then the owner or operator must conduct an initial Method 9 (40 CFR part 60, appendix A-4) performance test according to this section and §60.11 to show compliance with the opacity limit in §60.672(e)(1).~~

(e) The owner or operator may use the following as alternatives to the reference methods and procedures specified in this section:

(1) For the method and procedure of paragraph (c) of this section, if emissions from two or more facilities continuously interfere so that the opacity of fugitive emissions from an individual affected facility cannot be read, either of the following procedures may be used:

(i) Use for the combined emission stream the highest fugitive opacity standard applicable to any of the individual affected facilities contributing to the emissions stream.

(ii) Separate the emissions so that the opacity of emissions from each affected facility can be read.

(2) A single visible emission observer may conduct visible emission observations for up to three fugitive, stack, or vent emission points within a 15-second interval if the following conditions are met:

(i) No more than three emission points may be read concurrently.

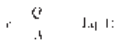
(ii) All three emission points must be within a 70 degree viewing sector or angle in front of the observer such that the proper sun position can be maintained for all three points.

(iii) If an opacity reading for any one of the three emission points equals or exceeds the applicable standard, then the observer must stop taking readings for the other two points and continue reading just that single point.

(3) Method 5I of appendix A-3 of this part may be used to determine the PM concentration as an alternative to the methods specified in paragraph (b)(1) of this section. Method 5I (40 CFR part 60, appendix A-3) may be useful for affected facilities that operate for less than 1 hour at a time such as (but not limited to) storage bins or enclosed truck or railcar loading stations.

(4) In some cases, velocities of exhaust gases from building vents may be too low to measure accurately with the type S pitot tube specified in EPA Method 2 of appendix A-1 of this part [*i.e.,* velocity head <1.3 mm H_2O (0.05 in. H_2O)] and referred to in EPA Method 5 of appendix A-3 of this part. For these conditions, the owner or operator may determine the average gas flow rate produced by the power fans (*e.g.,* from vendor-supplied fan curves) to the building vent. The owner or operator may calculate the

average gas velocity at the building vent measurement site using Equation 1 of this section and use this average velocity in determining and maintaining isokinetic sampling rates.



View or download PDF

Where:

V_e = average building vent velocity (feet per minute);

Q_f = average fan flow rate (cubic feet per minute); and

A_e = area of building vent and measurement location (square feet).

~~(f) To comply with §60.676(d), the owner or operator shall record the measurements as required in §60.676(c) using the monitoring devices in §60.674 (a)(1) and (2) during each particulate matter run and shall determine the averages.~~

(g) For performance tests involving only Method 9 (40 CFR part 60 appendix A-4) testing, the owner or operator may reduce the 30-day advance notification of performance test in §60.7(a)(6) and 60.8(d) to a 7-day advance notification.

~~(h) [Reserved]~~

~~(i) If the initial performance test date for an affected facility falls during a seasonal shut down (as defined in §60.671 of this subpart) of the affected facility, then with approval from the permitting authority, the owner or operator may postpone the initial performance test until no later than 60 calendar days after resuming operation of the affected facility.~~

The highlighted portions of §60.675 will apply as Midas Gold will be required to determine compliance with the PM standards in Tables 2 and 3 using the specified methods, or an acceptable alternate method provided in §60.675.

§60.676 Reporting and recordkeeping.

~~(a) Each owner or operator seeking to comply with §60.670(d) shall submit to the Administrator the following information about the existing facility being replaced and the replacement piece of equipment.~~

~~(1) For a crusher, grinding mill, bucket elevator, bagging operation, or enclosed truck or railcar loading station:~~

~~(i) The rated capacity in megagrams or tons per hour of the existing facility being replaced and~~

~~(ii) The rated capacity in tons per hour of the replacement equipment.~~

~~(2) For a screening operation:~~

~~(i) The total surface area of the top screen of the existing screening operation being replaced and~~

~~(ii) The total surface area of the top screen of the replacement screening operation.~~

~~(3) For a conveyor belt:~~

~~(i) The width of the existing belt being replaced and~~

~~(ii) The width of the replacement conveyor belt.~~

~~(4) For a storage bin:~~

~~(i) The rated capacity in megagrams or tons of the existing storage bin being replaced and~~

~~(ii) The rated capacity in megagrams or tons of replacement storage bins.~~

(b)(1) Owners or operators of affected facilities (as defined in §§60.670 and 60.671) for which construction, ~~modification, or reconstruction~~ commenced on or after April 22, 2008, must record each periodic inspection required under §60.674~~(b)~~ or (c), including dates and any corrective actions taken, in a logbook (in written or electronic format). The owner or operator must keep the logbook onsite and make hard or electronic copies (whichever is requested) of the logbook available to the Administrator upon request.

(2) For each bag leak detection system installed and operated according to §60.674(d), the owner or operator must keep the records specified in paragraphs (b)(2)(i) through (iii) of this section.

(i) Records of the bag leak detection system output;

(ii) Records of bag leak detection system adjustments, including the date and time of the adjustment, the initial bag leak detection system settings, and the final bag leak detection system settings; and

(iii) The date and time of all bag leak detection system alarms, the time that procedures to determine the cause of the alarm were initiated, the cause of the alarm, an explanation of the actions taken, the date and time the cause of the alarm was alleviated, and whether the cause of the alarm was alleviated within 3 hours of the alarm.

~~(3) The owner or operator of each affected facility demonstrating compliance according to §60.674(e) by following the requirements for processed stone handling operations in the Lime Manufacturing NESHAP (40 CFR part 63, subpart AAAAA) must maintain records of visible emissions observations required by §63.7132(a)(3) and (b) of 40 CFR part 63, subpart AAAAA.~~

~~(c) During the initial performance test of a wet scrubber, and daily thereafter, the owner or operator shall record the measurements of both the change in pressure of the gas stream across the scrubber and the scrubbing liquid flow rate.~~

~~(d) After the initial performance test of a wet scrubber, the owner or operator shall submit semiannual reports to the Administrator of occurrences when the measurements of the scrubber pressure loss and liquid flow rate decrease by more than 30 percent from the average determined during the most recent performance test.~~

~~(e) The reports required under paragraph (d) of this section shall be postmarked within 30 days following end of the second and fourth calendar quarters.~~

(f) The owner or operator of any affected facility shall submit written reports of the results of all performance tests conducted to demonstrate compliance with the standards set forth in §60.672 of this subpart, including reports of opacity observations made using Method 9 (40 CFR part 60, appendix A-4) to demonstrate compliance with §60.672(b), (e) and (f).

~~(g)The owner or operator of any wet material processing operation that processes saturated and subsequently processes unsaturated materials, shall submit a report of this change within 30 days following such change. At the time of such change, this screening operation, bucket elevator, or belt conveyor becomes subject to the applicable opacity limit in §60.672(b) and the emission test requirements of §60.11.~~

(h) The subpart A requirement under §60.7(a)(1) for notification of the date construction or reconstruction commenced is waived for affected facilities under this subpart.

(i) A notification of the actual date of initial startup of each affected facility shall be submitted to the Administrator.

(1) For a combination of affected facilities in a production line that begin actual initial startup on the same day, a single notification of startup may be submitted by the owner or operator to the Administrator. The notification shall be postmarked within 15 days after such date and shall include a description of each affected facility, equipment manufacturer, and serial number of the equipment, if available.

~~(2) For portable aggregate processing plants, the notification of the actual date of initial startup shall include both the home office and the current address or location of the portable plant.~~

(j) The requirements of this section remain in force until and unless the Agency, in delegating enforcement authority to a State under section 111(c) of the Act, approves reporting requirements or an alternative means of compliance surveillance adopted by such States. In that event, affected facilities within the State will be relieved of the obligation to comply with the reporting requirements of this section, provided that they comply with requirements established by the State.

(k) Notifications and reports required under this subpart and under subpart A of this part to demonstrate compliance with this subpart need only to be sent to the EPA Region or the State which has been delegated authority according to §60.4(b).

§60.676(a) will not apply as the Stibnite Gold Project affected facilities are not existing.

§60.676(b)(1) will apply as the Stibnite Gold Project nonmetallic mineral processing plant will commence construction after April 22, 2008, and Midas Gold is proposing to use a baghouse to control emissions from the Limestone Ball Mill. Midas Gold will be required to record the periodic inspections required under §60.674(c) unless a bag leak detection system is used as an alternate method per §60.674(d).

§60.676(b)(2) will apply to the Stibnite Gold Project Limestone Ball Mill, if a bag leak detection system is installed and operated as an alternative to the visible emissions inspection requirements in §60.674(c).

§60.676(b)(3) will not apply as the Stibnite Gold Project nonmetallic mineral processing plant is not subject to the requirements for processed stone handling operations in the Lime Manufacturing NESHAP (40 CFR part 63, subpart AAAAA).

§60.676(c) – (e) will not apply as Midas Gold is not proposing to use a wet scrubber to control emissions from the affected facilities subject to this subpart.

§60.676(f) will apply to the Stibnite Gold Project affected facilities, and therefore Midas Gold will be required to submit written reports of the results of all performance tests conducted.

§60.676(g) will not apply as Midas Gold is not proposing any wet material processing operation.

§60.676(h) will apply to the Stibnite Gold Project affected facilities. Midas Gold will not be required to submit a notification of the date of construction.

§60.676(i)(1) will apply to the Stibnite Gold Project affected facilities; the notification of the actual date of initial startup will be required to be submitted to the Administrator within 15 days after startup.

§60.676(i)(2) will not apply as Midas Gold is not proposing to operate a portable aggregate processing plant.

§60.676(j) and (k) will apply to the Stibnite Gold Project affected facilities and serve as informative.

Table 1 to Subpart OOO of Part 60—Exceptions to Applicability of Subpart A to Subpart OOO

Subpart A reference	Applies to subpart OOO	Explanation
60.4, Address	Yes	Except in §60.4(a) and (b) submittals need not be submitted to both the EPA Region and delegated State authority (§60.676(k)).
60.7, Notification and recordkeeping	Yes	Except in (a)(1) notification of the date construction or reconstruction commenced (§60.676(h)).
		Also, except in (a)(6) performance tests involving only Method 9 (40 CFR part 60, appendix A-4) require a 7-day advance notification instead of 30 days (§60.675(g)).
60.8, Performance tests	Yes	Except in (d) performance tests involving only Method 9 (40 CFR part 60, appendix A-4) require a 7-day advance notification instead of 30 days (§60.675(g)).
60.11, Compliance with standards and maintenance requirements	Yes	Except in (b) under certain conditions (§§60.675(c)), Method 9 (40 CFR part 60, appendix A-4) observation is reduced from 3 hours to 30 minutes for fugitive emissions.
~~60.18, General control device~~	~~No~~	~~Flares will not be used to comply with the emission limits.~~

The exceptions to applicability of Subpart A to Subpart OOO are highlighted in Table 1.

Table 2 to Subpart OOO of Part 60—Stack Emission Limits for Affected Facilities With Capture Systems

For * * *	The owner or operator must meet a PM limit of * * *	And the owner or operator must meet an opacity limit of * * *	The owner or operator must demonstrate compliance with these limits by conducting * * *
~~Affected facilities (as defined in §§60.670 and 60.671) that commenced construction, modification, or reconstruction after August 31, 1983 but before April 22, 2008~~	~~0.05 g/dscm (0.022 gr/dscf)[a]~~	~~7 percent for dry control devices[b]~~	~~An initial performance test according to §60.8 of this part and §60.675 of this subpart; and~~ ~~Monitoring of wet scrubber parameters according to §60.674(a) and §60.676(c), (d), and (e).~~
Affected facilities (as defined in §§60.670 and 60.671) that commence construction, modification, or reconstruction on or after April 22, 2008	0.032 g/dscm (0.014 gr/dscf)[a]	Not applicable ~~(except for individual enclosed storage bins)~~ ~~7 percent for dry control devices on individual enclosed storage bins~~	An initial performance test according to §60.8 of this part and §60.675 of this subpart; and ~~Monitoring of wet scrubber parameters according to §60.674(a) and §60.676(c), (d), and (e); and~~
			Monitoring of baghouses according to §60.674(c), (d), ~~or (e)~~ and §60.676(b).

[a]Exceptions to the PM limit apply for ~~individual enclosed storage bins and~~ other equipment. See §60.672~~(d) through~~ (f).

~~[b]The stack opacity limit and associated opacity testing requirements do not apply for affected facilities using wet scrubbers.~~

Since the Stibnite Gold Project nonmetallic mineral processing plant will commence construction after April 22, 2008, and is proposing to use a baghouse to control emissions from the Limestone Ball Mill, the baghouse stack will be required to meet the PM limit of 0.032 g/dscm. In addition, there will not be an opacity limit for the ball mill baghouse stack. The Stibnite Gold Project nonmetallic mineral processing plant will not have a baghouse controlling emissions on an individual enclosed storage bin, therefore the 7 percent opacity limit will not apply. Midas Gold will be required to demonstrate compliance on the baghouse with an initial performance test, monitoring visible emissions (or operating a bag leak detection system) and maintaining records.

Table 3 to Subpart OOO of Part 60—Fugitive Emission Limits

For * * *	The owner or operator must meet the following fugitive emissions limit for grinding mills, screening operations, ~~bucket elevators~~, transfer points on belt conveyors, ~~bagging operations~~, storage bins, ~~enclosed truck or railcar loading stations~~ or from any other affected facility (as defined in §§60.670 and 60.671) * * *	The owner or operator must meet the following fugitive emissions limit for crushers at which a capture system is not used * * *	The owner or operator must demonstrate compliance with these limits by conducting * * *
~~Affected facilities (as defined in §§60.670 and 60.671) that commenced construction, modification, or reconstruction after August 31, 1983 but before April 22, 2008~~	~~10 percent opacity~~	~~15 percent opacity~~	~~An initial performance test according to §60.11 of this part and §60.675 of this subpart.~~
Affected facilities (as defined in §§60.670 and 60.671) that commence construction, modification, or reconstruction on or after April 22, 2008	7 percent opacity	12 percent opacity	An initial performance test according to §60.11 of this part and §60.675 of this subpart; ~~and~~ ~~Periodic inspections of water sprays according to §60.674(b) and §60.676(b); and~~
			A repeat performance test according to §60.11 of this part and §60.675 of this subpart within 5 years from the previous performance test for fugitive emissions from affected facilities without water sprays. ~~Affected facilities controlled by water carryover from upstream water sprays that are inspected according to the requirements in §60.674(b) and §60.676(b) are exempt from this 5-year repeat testing requirement.~~

Since the Stibnite Gold Project nonmetallic mineral processing plant will commence construction after April 22, 2008, Midas Gold will be required to meet the fugitive emission limit of 7 percent opacity for all affected facilities subject to this subpart, with the exception of the Limestone Ball Mill (subject to the limits in Table 2), any crusher without a capture system, and any truck dumping. For the Primary Crushing (Source ID LS2) and Secondary Crushing (Source ID LS4) which will not have a capture system, Midas Gold will be required to meet the limit of 12 percent opacity. The Limestone transfer to Primary Crusher Hopper will meet the definition of truck dumping and is exempt from the requirements in Table 3. Midas Gold will be required to demonstrate compliance with the applicable opacity limits with initial performance tests and repeat performance tests every 5 years.

NSPS, Subpart IIII – Standards of Performance for Stationary Compression Ignition Internal Combustion Engines

PRI00000324

REC 1664

ELECTRONIC CODE OF FEDERAL REGULATIONS

e-CFR data is current as of January 10, 2019

Title 40: Protection of Environment
PART 60—STANDARDS OF PERFORMANCE FOR NEW STATIONARY SOURCES (CONTINUED)

Subpart IIII—Standards of Performance for Stationary Compression Ignition Internal Combustion Engines

Contents

WHAT THIS SUBPART COVERS

§60.4200 Am I subject to this subpart?

EMISSION STANDARDS FOR MANUFACTURERS

§60.4201 What emission standards must I meet for non-emergency engines if I am a stationary CI internal combustion engine manufacturer?
§60.4202 What emission standards must I meet for emergency engines if I am a stationary CI internal combustion engine manufacturer?
§60.4203 How long must my engines meet the emission standards if I am a manufacturer of stationary CI internal combustion engines?

EMISSION STANDARDS FOR OWNERS AND OPERATORS

§60.4204 What emission standards must I meet for non-emergency engines if I am an owner or operator of a stationary CI internal combustion engine?
§60.4205 What emission standards must I meet for emergency engines if I am an owner or operator of a stationary CI internal combustion engine?
§60.4206 How long must I meet the emission standards if I am an owner or operator of a stationary CI internal combustion engine?

FUEL REQUIREMENTS FOR OWNERS AND OPERATORS

§60.4207 What fuel requirements must I meet if I am an owner or operator of a stationary CI internal combustion engine subject to this subpart?

OTHER REQUIREMENTS FOR OWNERS AND OPERATORS

§60.4208 What is the deadline for importing or installing stationary CI ICE produced in previous model years?
§60.4209 What are the monitoring requirements if I am an owner or operator of a stationary CI internal combustion engine?

COMPLIANCE REQUIREMENTS

§60.4210 What are my compliance requirements if I am a stationary CI internal combustion engine manufacturer?
§60.4211 What are my compliance requirements if I am an owner or operator of a stationary CI internal combustion engine?

TESTING REQUIREMENTS FOR OWNERS AND OPERATORS

§60.4212 What test methods and other procedures must I use if I am an owner or operator of a stationary CI internal combustion engine with a displacement of less than 30 liters per cylinder?
§60.4213 What test methods and other procedures must I use if I am an owner or operator of a stationary CI internal combustion engine with a displacement of greater than or equal to 30 liters per cylinder?

NOTIFICATION, REPORTS, AND RECORDS FOR OWNERS AND OPERATORS

§60.4214 What are my notification, reporting, and recordkeeping requirements if I am an owner or operator of a stationary CI internal combustion engine?

Special Requirements

§60.4215 What requirements must I meet for engines used in Guam, American Samoa, or the Commonwealth of the Northern Mariana Islands?
§60.4216 What requirements must I meet for engines used in Alaska?
§60.4217 What emission standards must I meet if I am an owner or operator of a stationary internal combustion engine using special fuels?

General Provisions

§60.4218 What parts of the General Provisions apply to me?

Definitions

§60.4219 What definitions apply to this subpart?
Table 1 to Subpart IIII of Part 60—Emission Standards for Stationary Pre-2007 Model Year Engines With a Displacement of <10 Liters per Cylinder and 2007-2010 Model Year Engines >2,237 KW (3,000 HP) and With a Displacement of <10 Liters per Cylinder
Table 2 to Subpart IIII of Part 60—Emission Standards for 2008 Model Year and Later Emergency Stationary CI ICE <37 KW (50 HP) With a Displacement of <10 Liters per Cylinder
Table 3 to Subpart IIII of Part 60—Certification Requirements for Stationary Fire Pump Engines
Table 4 to Subpart IIII of Part 60—Emission Standards for Stationary Fire Pump Engines
Table 5 to Subpart IIII of Part 60—Labeling and Recordkeeping Requirements for New Stationary Emergency Engines
Table 6 to Subpart IIII of Part 60—Optional 3-Mode Test Cycle for Stationary Fire Pump Engines
Table 7 to Subpart IIII of Part 60—Requirements for Performance Tests for Stationary CI ICE With a Displacement of ≥30 Liters per Cylinder
Table 8 to Subpart IIII of Part 60—Applicability of General Provisions to Subpart IIII

Source: 71 FR 39172, July 11, 2006, unless otherwise noted.

Back to Top

What This Subpart Covers

Back to Top

§60.4200 Am I subject to this subpart?

(a) The provisions of this subpart are applicable to ~~manufacturers,~~ owners, and operators of stationary compression ignition (CI) internal combustion engines (ICE) and other persons as specified in paragraphs (a)(1) through (4) of this section. For the purposes of this subpart, the date that construction commences is the date the engine is ordered by the owner or operator.

~~(1) Manufacturers of stationary CI ICE with a displacement of less than 30 liters per cylinder where the model year is:~~

~~(i) 2007 or later, for engines that are not fire pump engines;~~

~~(ii) The model year listed in Table 3 to this subpart or later model year, for fire pump engines.~~

(2) Owners and operators of stationary CI ICE that commence construction after July 11, 2005, where the stationary CI ICE are:

(i) Manufactured after April 1, 2006, and are not fire pump engines, or

(ii) Manufactured as a certified National Fire Protection Association (NFPA) fire pump engine after July 1, 2006.

~~(3) Owners and operators of any stationary CI ICE that are modified or reconstructed after July 11, 2005 and any person that modifies or reconstructs any stationary CI ICE after July 11, 2005.~~

(4) The provisions of §60.4208 of this subpart are applicable to all owners and operators of stationary CI ICE that commence construction after July 11, 2005.

~~(b) The provisions of this subpart are not applicable to stationary CI ICE being tested at a stationary CI ICE test cell/stand.~~

(c) If you are an owner or operator of an area source subject to this subpart, you are exempt from the obligation to obtain a permit under 40 CFR part 70 ~~or 40 CFR part 71~~, provided you are not required to obtain a permit under 40 CFR 70.3(a) ~~or 40~~

~~CFR 71.3(a)~~ for a reason other than your status as an area source under this subpart. Notwithstanding the previous sentence, you must continue to comply with the provisions of this subpart applicable to area sources.

~~(d) Stationary CI ICE may be eligible for exemption from the requirements of this subpart as described in 40 CFR part 1068, subpart C (or the exemptions described in 40 CFR part 89, subpart J and 40 CFR part 94, subpart J, for engines that would need to be certified to standards in those parts), except that owners and operators, as well as manufacturers, may be eligible to request an exemption for national security.~~

~~(e) Owners and operators of facilities with CI ICE that are acting as temporary replacement units and that are located at a stationary source for less than 1 year and that have been properly certified as meeting the standards that would be applicable to such engine under the appropriate nonroad engine provisions, are not required to meet any other provisions under this subpart with regard to such engines.~~

[71 FR 39172, July 11, 2006, as amended at 76 FR 37967, June 28, 2011]

Midas Gold proposes to own and operate at the Stibnite Gold Project, three emergency stationary CI ICEs that will be subject to this subpart per §60.4200(a)(2)(i) as they will commence construction after July 11, 2005, will be manufactured after April 1, 2006, and are not fire pumps. In addition, Midas Gold proposes to own and operate at the Stibnite Gold Project, one stationary fire pump CI ICE, that will be subject to this subpart per §60.4200(a)(2)(ii) as it will commence construction after July 11, 2005, and will be manufactured as a certified NFPA fire pump engine after July 1, 2006.

The three emergency stationary CI ICE will be subject to §60.4200(a)(4) as they will commence construction after July 11, 2005. The three new emergency engines will be installed after December 31, 2008, and will therefore meet the applicable requirements for 2007 model year engines per §60.4208(a).

Because the Stibnite Gold Project is an area source, per §60.4200(c), Midas Gold is not required to obtain a permit under 40 CFR part 70 (i.e., Title V permit) solely due to being subject to this subpart.

Emission Standards for Manufacturers

~~§60.4201 What emission standards must I meet for non-emergency engines if I am a stationary CI internal combustion engine manufacturer?~~

~~(a) Stationary CI internal combustion engine manufacturers must certify their 2007 model year and later non-emergency stationary CI ICE with a maximum engine power less than or equal to 2,237 kilowatt (KW) (3,000 horsepower (HP)) and a displacement of less than 10 liters per cylinder to the certification emission standards for new nonroad CI engines in 40 CFR 89.112, 40 CFR 89.113, 40 CFR 1039.101, 40 CFR 1039.102, 40 CFR 1039.104, 40 CFR 1039.105, 40 CFR 1039.107, and 40 CFR 1039.115, as applicable, for all pollutants, for the same model year and maximum engine power.~~

~~(b) Stationary CI internal combustion engine manufacturers must certify their 2007 through 2010 model year non-emergency stationary CI ICE with a maximum engine power greater than 2,237 KW (3,000 HP) and a displacement of less than 10 liters per cylinder to the emission standards in table 1 to this subpart, for all pollutants, for the same maximum engine power.~~

~~(c) Stationary CI internal combustion engine manufacturers must certify their 2011 model year and later non-emergency stationary CI ICE with a maximum engine power greater than 2,237 KW (3,000 HP) and a displacement of less than 10 liters per cylinder to the certification emission standards for new nonroad CI engines in 40 CFR 1039.101, 40 CFR 1039.102, 40 CFR 1039.104, 40 CFR 1039.105, 40 CFR 1039.107, and 40 CFR 1039.115, as applicable, for all pollutants, for the same maximum engine power.~~

~~(d) Stationary CI internal combustion engine manufacturers must certify the following non-emergency stationary CI ICE to the certification emission standards for new marine CI engines in 40 CFR 94.8, as applicable, for all pollutants, for the same displacement and maximum engine power:~~

~~(1) Their 2007 model year through 2012 non-emergency stationary CI ICE with a displacement of greater than or equal to 10 liters per cylinder and less than 30 liters per cylinder;~~

~~(2) Their 2013 model year non-emergency stationary CI ICE with a maximum engine power greater than or equal to 3,700 KW (4,958 HP) and a displacement of greater than or equal to 10 liters per cylinder and less than 15 liters per cylinder; and~~

~~(3) Their 2013 model year non-emergency stationary CI ICE with a displacement of greater than or equal to 15 liters per cylinder and less than 30 liters per cylinder.~~

~~(e) Stationary CI internal combustion engine manufacturers must certify the following non-emergency stationary CI ICE to the certification emission standards and other requirements for new marine CI engines in 40 CFR 1042.101, 40 CFR 1042.107, 40 CFR 1042.110, 40 CFR 1042.115, 40 CFR 1042.120, and 40 CFR 1042.145, as applicable, for all pollutants, for the same displacement and maximum engine power:~~

(1) Their 2013 model year non-emergency stationary CI ICE with a maximum engine power less than 3,700 KW (4,958 HP) and a displacement of greater than or equal to 10 liters per cylinder and less than 15 liters per cylinder; and

(2) Their 2014 model year and later non-emergency stationary CI ICE with a displacement of greater than or equal to 10 liters per cylinder and less than 30 liters per cylinder.

(f) Notwithstanding the requirements in paragraphs (a) through (c) of this section, stationary non-emergency CI ICE identified in paragraphs (a) and (c) may be certified to the provisions of 40 CFR part 94 or, if Table 1 to 40 CFR 1042.1 identifies 40 CFR part 1042 as being applicable, 40 CFR part 1042, if the engines will be used solely in either or both of the following locations:

(1) Remote areas of Alaska; and

(2) Marine offshore installations.

(g) Notwithstanding the requirements in paragraphs (a) through (f) of this section, stationary CI internal combustion engine manufacturers are not required to certify reconstructed engines; however manufacturers may elect to do so. The reconstructed engine must be certified to the emission standards specified in paragraphs (a) through (e) of this section that are applicable to the model year, maximum engine power, and displacement of the reconstructed stationary CI ICE.

(h) Stationary CI ICE certified to the standards in 40 CFR part 1039 and equipped with auxiliary emission control devices (AECDs) as specified in 40 CFR 1039.665 must meet the Tier 1 certification emission standards for new nonroad CI engines in 40 CFR 89.112 while the AECD is activated during a qualified emergency situation. A qualified emergency situation is defined in 40 CFR 1039.665. When the qualified emergency situation has ended and the AECD is deactivated, the engine must resume meeting the otherwise applicable emission standard specified in this section.

[71 FR 39172, July 11, 2006, as amended at 76 FR 37967, June 28, 2011; 81 FR 44219, July 7, 2016]

Midas Gold is not a stationary CI engine manufacturer nor will it own or operate any non-emergency stationary CI ICE; therefore, this section is not applicable.

§60.4202 What emission standards must I meet for emergency engines if I am a stationary CI internal combustion engine manufacturer?

(a) Stationary CI internal combustion engine manufacturers must certify their 2007 model year and later emergency stationary CI ICE with a maximum engine power less than or equal to 2,237 KW (3,000 HP) and a displacement of less than 10 liters per cylinder that are not fire pump engines to the emission standards specified in paragraphs (a)(1) through (2) of this section.

(1) For engines with a maximum engine power less than 37 KW (50 HP):

(i) The certification emission standards for new nonroad CI engines for the same model year and maximum engine power in 40 CFR 89.112 and 40 CFR 89.113 for all pollutants for model year 2007 engines, and

(ii) The certification emission standards for new nonroad CI engines in 40 CFR 1039.104, 40 CFR 1039.105, 40 CFR 1039.107, 40 CFR 1039.115, and table 2 to this subpart, for 2008 model year and later engines.

(2) For engines with a maximum engine power greater than or equal to 37 KW (50 HP), the certification emission standards for new nonroad CI engines for the same model year and maximum engine power in 40 CFR 89.112 and 40 CFR 89.113 for all pollutants beginning in model year 2007.

(b) Stationary CI internal combustion engine manufacturers must certify their 2007 model year and later emergency stationary CI ICE with a maximum engine power greater than 2,237 KW (3,000 HP) and a displacement of less than 10 liters per cylinder that are not fire pump engines to the emission standards specified in paragraphs (b)(1) through (2) of this section.

(1) For 2007 through 2010 model years, the emission standards in table 1 to this subpart, for all pollutants, for the same maximum engine power.

(2) For 2011 model year and later, the certification emission standards for new nonroad CI engines for engines of the same model year and maximum engine power in 40 CFR 89.112 and 40 CFR 89.113 for all pollutants.

(c) [Reserved]

(d) Beginning with the model years in table 3 to this subpart, stationary CI internal combustion engine manufacturers must certify their fire pump stationary CI ICE to the emission standards in table 4 to this subpart, for all pollutants, for the same model year and NFPA nameplate power.

(e) Stationary CI internal combustion engine manufacturers must certify the following emergency stationary CI ICE that are

not fire pump engines to the certification emission standards for new marine CI engines in 40 CFR 94.8, as applicable, for all pollutants, for the same displacement and maximum engine power:

(1) Their 2007 model year through 2012 emergency stationary CI ICE with a displacement of greater than or equal to 10 liters per cylinder and less than 30 liters per cylinder;

(2) Their 2013 model year and later emergency stationary CI ICE with a maximum engine power greater than or equal to 3,700 KW (4,958 HP) and a displacement of greater than or equal to 10 liters per cylinder and less than 15 liters per cylinder;

(3) Their 2013 model year emergency stationary CI ICE with a displacement of greater than or equal to 15 liters per cylinder and less than 30 liters per cylinder; and

(4) Their 2014 model year and later emergency stationary CI ICE with a maximum engine power greater than or equal to 2,000 KW (2,682 HP) and a displacement of greater than or equal to 15 liters per cylinder and less than 30 liters per cylinder.

(f) Stationary CI internal combustion engine manufacturers must certify the following emergency stationary CI ICE to the certification emission standards and other requirements applicable to Tier 3 new marine CI engines in 40 CFR 1042.101, 40 CFR 1042.107, 40 CFR 1042.115, 40 CFR 1042.120, and 40 CFR 1042.145, for all pollutants, for the same displacement and maximum engine power:

(1) Their 2013 model year and later emergency stationary CI ICE with a maximum engine power less than 3,700 KW (4,958 HP) and a displacement of greater than or equal to 10 liters per cylinder and less than 15 liters per cylinder; and

(2) Their 2014 model year and later emergency stationary CI ICE with a maximum engine power less than 2,000 KW (2,682 HP) and a displacement of greater than or equal to 15 liters per cylinder and less than 30 liters per cylinder.

(g) Notwithstanding the requirements in paragraphs (a) through (d) of this section, stationary emergency CI internal combustion engines identified in paragraphs (a) and (c) may be certified to the provisions of 40 CFR part 94 or, if Table 2 to 40 CFR 1042.101 identifies Tier 3 standards as being applicable, the requirements applicable to Tier 3 engines in 40 CFR part 1042, if the engines will be used solely in either or both of the following locations:

(1) Remote areas of Alaska; and

(2) Marine offshore installations.

(h) Notwithstanding the requirements in paragraphs (a) through (f) of this section, stationary CI internal combustion engine manufacturers are not required to certify reconstructed engines; however manufacturers may elect to do so. The reconstructed engine must be certified to the emission standards specified in paragraphs (a) through (f) of this section that are applicable to the model year, maximum engine power and displacement of the reconstructed emergency stationary CI ICE.

[71 FR 39172, July 11, 2006, as amended at 76 FR 37968, June 28, 2011; 81 FR 44219, July 7, 2016]

Midas Gold is not a stationary CI engine manufacturer however, as required by §60.4205(b), the proposed emergency stationary CI ICE must comply with the emission standards in §60.4202. The three emergency engines will each have a maximum power less than 2,237 KW and greater than 37 KW, with a displacement of less than 10 liters per cylinder, and therefore per §60.4202(a)(2), must meet the certification emission standards in 40 CFR 89.112 and 40 CFR 89.113 for new nonroad CI engines beginning in model year 2007.

40 CFR 89.112 (Oxides of nitrogen, carbon monoxide, hydrocarbon, and particulate matter exhaust emission standards) will apply to the three emergency engines according to model year and maximum engine power.

40 CFR 89.113 (Smoke emission standard) will apply to the three emergency engines.

§60.4203 How long must my engines meet the emission standards if I am a manufacturer of stationary CI internal combustion engines?

Engines manufactured by stationary CI internal combustion engine manufacturers must meet the emission standards as required in §§60.4201 and 60.4202 during the certified emissions life of the engines.

[76 FR 37968, June 28, 2011]

Midas Gold is not a stationary CI engine manufacturer; therefore, this section is not applicable.

EMISSION STANDARDS FOR OWNERS AND OPERATORS

§60.4204 What emission standards must I meet for non-emergency engines if I am an owner or operator of a stationary CI internal combustion engine?

(a) Owners and operators of pre-2007 model year non-emergency stationary CI ICE with a displacement of less than 10 liters per cylinder must comply with the emission standards in table 1 to this subpart. Owners and operators of pre-2007 model year non-emergency stationary CI ICE with a displacement of greater than or equal to 10 liters per cylinder and less than 30 liters per cylinder must comply with the emission standards in 40 CFR 94.8(a)(1).

(b) Owners and operators of 2007 model year and later non-emergency stationary CI ICE with a displacement of less than 30 liters per cylinder must comply with the emission standards for new CI engines in §60.4201 for their 2007 model year and later stationary CI ICE, as applicable.

(c) Owners and operators of non-emergency stationary CI engines with a displacement of greater than or equal to 30 liters per cylinder must meet the following requirements:

(1) For engines installed prior to January 1, 2012, limit the emissions of NO_x in the stationary CI internal combustion engine exhaust to the following:

(i) 17.0 grams per kilowatt-hour (g/KW-hr) (12.7 grams per horsepower-hr (g/HP-hr)) when maximum engine speed is less than 130 revolutions per minute (rpm);

(ii) $45 \cdot n^{-0.2}$ g/KW-hr ($34 \cdot n^{-0.2}$ g/HP-hr) when maximum engine speed is 130 or more but less than 2,000 rpm, where n is maximum engine speed; and

(iii) 9.8 g/KW-hr (7.3 g/HP-hr) when maximum engine speed is 2,000 rpm or more.

(2) For engines installed on or after January 1, 2012 and before January 1, 2016, limit the emissions of NO_x in the stationary CI internal combustion engine exhaust to the following:

(i) 14.4 g/KW-hr (10.7 g/HP-hr) when maximum engine speed is less than 130 rpm;

(ii) $44 \cdot n^{-0.23}$ g/KW-hr ($33 \cdot n^{-0.23}$ g/HP-hr) when maximum engine speed is greater than or equal to 130 but less than 2,000 rpm and where n is maximum engine speed; and

(iii) 7.7 g/KW-hr (5.7 g/HP-hr) when maximum engine speed is greater than or equal to 2,000 rpm.

(3) For engines installed on or after January 1, 2016, limit the emissions of NO_x in the stationary CI internal combustion engine exhaust to the following:

(i) 3.4 g/KW-hr (2.5 g/HP-hr) when maximum engine speed is less than 130 rpm;

(ii) $9.0 \cdot n^{-0.20}$ g/KW-hr ($6.7 \cdot n^{-0.20}$ g/HP-hr) where n (maximum engine speed) is 130 or more but less than 2,000 rpm; and

(iii) 2.0 g/KW-hr (1.5 g/HP-hr) where maximum engine speed is greater than or equal to 2,000 rpm.

(4) Reduce particulate matter (PM) emissions by 60 percent or more, or limit the emissions of PM in the stationary CI internal combustion engine exhaust to 0.15 g/KW-hr (0.11 g/HP-hr).

(d) Owners and operators of non-emergency stationary CI ICE with a displacement of less than 30 liters per cylinder who conduct performance tests in-use must meet the not-to-exceed (NTE) standards as indicated in §60.4212.

(e) Owners and operators of any modified or reconstructed non-emergency stationary CI ICE subject to this subpart must meet the emission standards applicable to the model year, maximum engine power, and displacement of the modified or reconstructed non-emergency stationary CI ICE that are specified in paragraphs (a) through (d) of this section.

(f) Owners and operators of stationary CI ICE certified to the standards in 40 CFR part 1039 and equipped with AECDs as specified in 40 CFR 1039.665 must meet the Tier 1 certification emission standards for new nonroad CI engines in 40 CFR 89.112 while the AECD is activated during a qualified emergency situation. A qualified emergency situation is defined in 40 CFR 1039.665. When the qualified emergency situation has ended and the AECD is deactivated, the engine must resume meeting the otherwise applicable emission standard specified in this section.

[71 FR 39172, July 11, 2006, as amended at 76 FR 37968, June 28, 2011; 81 FR 44219, July 7, 2016]

Midas Gold will not own or operate any non-emergency stationary CI ICE; therefore, this section is not applicable.

§60.4205 What emission standards must I meet for emergency engines if I am an owner or operator of a stationary CI internal combustion engine?

(a) Owners and operators of pre-2007 model year emergency stationary CI ICE with a displacement of less than 10 liters per cylinder that are not fire pump engines must comply with the emission standards in Table 1 to this subpart. Owners and

~~operators of pre-2007 model year emergency stationary CI ICE with a displacement of greater than or equal to 10 liters per cylinder and less than 30 liters per cylinder that are not fire pump engines must comply with the emission standards in 40 CFR 94.8(a)(1).~~

(b) Owners and operators of 2007 model year and later emergency stationary CI ICE with a displacement of less than 30 liters per cylinder that are not fire pump engines must comply with the emission standards for new nonroad CI engines in §60.4202, for all pollutants, for the same model year and maximum engine power for their 2007 model year and later emergency stationary CI ICE.

(c) Owners and operators of fire pump engines with a displacement of less than 30 liters per cylinder must comply with the emission standards in table 4 to this subpart, for all pollutants.

~~(d) Owners and operators of emergency stationary CI engines with a displacement of greater than or equal to 30 liters per cylinder must meet the requirements in this section.~~

~~(1) For engines installed prior to January 1, 2012, limit the emissions of NO_x in the stationary CI internal combustion engine exhaust to the following:~~

~~(i) 17.0 g/KW-hr (12.7 g/HP-hr) when maximum engine speed is less than 130 rpm;~~

~~(ii) $45 \cdot n^{-0.2}$ g/KW-hr ($34 \cdot n^{-0.2}$ g/HP-hr) when maximum engine speed is 130 or more but less than 2,000 rpm, where n is maximum engine speed; and~~

~~(iii) 9.8 g/kW-hr (7.3 g/HP-hr) when maximum engine speed is 2,000 rpm or more.~~

~~(2) For engines installed on or after January 1, 2012, limit the emissions of NO_x in the stationary CI internal combustion engine exhaust to the following:~~

~~(i) 14.4 g/KW-hr (10.7 g/HP-hr) when maximum engine speed is less than 130 rpm;~~

~~(ii) $44 \cdot n^{-0.23}$ g/KW-hr ($33 \cdot n^{-0.23}$ g/HP-hr) when maximum engine speed is greater than or equal to 130 but less than 2,000 rpm and where n is maximum engine speed; and~~

~~(iii) 7.7 g/KW-hr (5.7 g/HP-hr) when maximum engine speed is greater than or equal to 2,000 rpm.~~

~~(3) Limit the emissions of PM in the stationary CI internal combustion engine exhaust to 0.40 g/KW-hr (0.30 g/HP-hr).~~

(e) Owners and operators of emergency stationary CI ICE with a displacement of less than 30 liters per cylinder who conduct performance tests in-use must meet the NTE standards as indicated in §60.4212.

~~(f) Owners and operators of any modified or reconstructed emergency stationary CI ICE subject to this subpart must meet the emission standards applicable to the model year, maximum engine power, and displacement of the modified or reconstructed CI ICE that are specified in paragraphs (a) through (e) of this section.~~

[71 FR 39172, July 11, 2006, as amended at 76 FR 37969, June 28, 2011]

The three emergency stationary CI ICEs will be model year 2007 or later with a displacement of less than 10 liters per cylinder and subject to §60.4205(b). The engines must comply with the emission standards for new nonroad CI engines in §60.4202(a)(2).

The stationary fire pump CI ICE will be model year model year 2009 or later with a displacement of less than 10 liters per cylinder and subject to §60.4205(c). The fire pump engine must comply with the emission standards in table 4 to this subpart, for all pollutants.

If Midas Gold chooses not to install and operate any stationary CI ICE according to the manufacturer's emission-related written instructions, according to §60.4211(g), performance testing will be required to demonstrate compliance. In this case, §60.4202(e) will apply to the proposed engines.

§60.4206 How long must I meet the emission standards if I am an owner or operator of a stationary CI internal combustion engine?

Owners and operators of stationary CI ICE must operate and maintain stationary CI ICE that achieve the emission standards as required in ~~§§60.4204 and~~ 60.4205 over the entire life of the engine.

[76 FR 37969, June 28, 2011]

As required by §60.4206, Midas Gold must operate and maintain the three emergency engines and one fire pump engine so they achieve the standards in §60.4205 for the entire life of the each engine.

Fuel Requirements for Owners and Operators

§60.4207 What fuel requirements must I meet if I am an owner or operator of a stationary CI internal combustion engine subject to this subpart?

(a) ~~Beginning October 1, 2007, owners and operators of stationary CI ICE subject to this subpart that use diesel fuel must use diesel fuel that meets the requirements of 40 CFR 80.510(a).~~

(b) Beginning October 1, 2010, owners and operators of stationary CI ICE subject to this subpart with a displacement of less than 30 liters per cylinder that use diesel fuel must use diesel fuel that meets the requirements of 40 CFR 80.510(b) for nonroad diesel fuel, ~~except that any existing diesel fuel purchased (or otherwise obtained) prior to October 1, 2010, may be used until depleted.~~

(c) ~~[Reserved]~~

(d) ~~Beginning June 1, 2012, owners and operators of stationary CI ICE subject to this subpart with a displacement of greater than or equal to 30 liters per cylinder are no longer subject to the requirements of paragraph (a) of this section, and must use fuel that meets a maximum per gallon sulfur content of 1,000 parts per million (ppm).~~

(e) ~~Stationary CI ICE that have a national security exemption under §60.4200(d) are also exempt from the fuel requirements in this section.~~

[71 FR 39172, July 11, 2006, as amended at 76 FR 37969, June 28, 2011; 78 FR 6695, Jan. 30, 2013]

The three emergency engines and one fire pump engine will be subject to §60.4207(b), and Midas Gold must use diesel fuel that meets the sulfur and cetane index or aromatic content requirements of 40 CFR 80.510(b). Per 40 CFR 80.510(b)(1)(i), the fuel sulfur content cannot exceed 15 ppm.

Other Requirements for Owners and Operators

§60.4208 What is the deadline for importing or installing stationary CI ICE produced in previous model years?

(a) After December 31, 2008, owners and operators may not install stationary CI ICE (excluding fire pump engines) that do not meet the applicable requirements for 2007 model year engines.

~~(b) After December 31, 2009, owners and operators may not install stationary CI ICE with a maximum engine power of less than 19 KW (25 HP) (excluding fire pump engines) that do not meet the applicable requirements for 2008 model year engines.~~

~~(c) After December 31, 2014, owners and operators may not install non-emergency stationary CI ICE with a maximum engine power of greater than or equal to 19 KW (25 HP) and less than 56 KW (75 HP) that do not meet the applicable requirements for 2013 model year non-emergency engines.~~

~~(d) After December 31, 2013, owners and operators may not install non-emergency stationary CI ICE with a maximum engine power of greater than or equal to 56 KW (75 HP) and less than 130 KW (175 HP) that do not meet the applicable requirements for 2012 model year non-emergency engines.~~

~~(e) After December 31, 2012, owners and operators may not install non-emergency stationary CI ICE with a maximum engine power of greater than or equal to 130 KW (175 HP), including those above 560 KW (750 HP), that do not meet the applicable requirements for 2011 model year non-emergency engines.~~

~~(f) After December 31, 2016, owners and operators may not install non-emergency stationary CI ICE with a maximum engine power of greater than or equal to 560 KW (750 HP) that do not meet the applicable requirements for 2015 model year non-emergency engines.~~

(g) ~~After December 31, 2018, owners and operators may not install non-emergency stationary CI ICE with a maximum engine power greater than or equal to 600 KW (804 HP) and less than 2,000 KW (2,680 HP) and a displacement of greater than or equal to 10 liters per cylinder and less than 30 liters per cylinder that do not meet the applicable requirements for 2017 model year non-emergency engines~~.

(h) In addition to the requirements specified in §§~~60.4201,~~ 60.4202, ~~60.4204,~~ and 60.4205, it is prohibited to import stationary CI ICE with a displacement of less than 30 liters per cylinder that do not meet the applicable requirements specified in paragraphs (a) through (g) of this section after the dates specified in paragraphs (a) through (g) of this section.

(i) The requirements of this section do not apply to owners or operators of stationary CI ICE ~~that have been modified, reconstructed, and do not apply to engines~~ that were removed from one existing location and reinstalled at a new location.

[71 FR 39172, July 11, 2006, as amended at 76 FR 37969, June 28, 2011]

The three emergency engines will be installed after December 31, 2008, and must therefore meet the applicable requirements for 2007 model year engines per §60.4208(a).

§60.4208(b)-(g) will not apply to Midas Gold given the proposed stationary CI ICE.

In accordance with §60.4208(h), Midas Gold must not import stationary CI ICE that do not meet the requirement of §60.4208(a). However, per §60.4208(i), the deadlines for importing and installing CI ICE do not apply to engines that are moved from one existing location to another.

§60.4209 What are the monitoring requirements if I am an owner or operator of a stationary CI internal combustion engine?

If you are an owner or operator, you must meet the monitoring requirements of this section. In addition, you must also meet the monitoring requirements specified in §60.4211.

(a) If you are an owner or operator of an emergency stationary CI internal combustion engine that does not meet the standards applicable to non-emergency engines, you must install a non-resettable hour meter prior to startup of the engine.

~~(b) If you are an owner or operator of a stationary CI internal combustion engine equipped with a diesel particulate filter to comply with the emission standards in §60.4204, the diesel particulate filter must be installed with a backpressure monitor that notifies the owner or operator when the high backpressure limit of the engine is approached.~~

[71 FR 39172, July 11, 2006, as amended at 76 FR 37969, June 28, 2011]

The three emergency engines and one fire pump engine will be required to install a non-resettable hour meter prior to startup of the engines per §60.4209(a).

Because none of the proposed CI ICE are subject to the emission standards for non-emergency engines in §60.4204, §60.4209(b) will not apply.

Compliance Requirements

~~**§60.4210 What are my compliance requirements if I am a stationary CI internal combustion engine manufacturer?**~~

~~(a) Stationary CI internal combustion engine manufacturers must certify their stationary CI ICE with a displacement of less than 10 liters per cylinder to the emission standards specified in §60.4201(a) through (c) and §60.4202(a), (b) and (d) using the certification procedures required in 40 CFR part 89, subpart B, or 40 CFR part 1039, subpart C, as applicable, and must test their engines as specified in those parts. For the purposes of this subpart, engines certified to the standards in table 1 to this subpart shall be subject to the same requirements as engines certified to the standards in 40 CFR part 89. For the purposes of this subpart, engines certified to the standards in table 4 to this subpart shall be subject to the same requirements as engines certified to the standards in 40 CFR part 89, except that engines with NFPA nameplate power of less than 37 KW (50 HP) certified to model year 2011 or later standards shall be subject to the same requirements as engines certified to the standards in 40 CFR part 1039.~~

~~(b) Stationary CI internal combustion engine manufacturers must certify their stationary CI ICE with a displacement of greater than or equal to 10 liters per cylinder and less than 30 liters per cylinder to the emission standards specified in §60.4201(d) and (e) and §60.4202(e) and (f) using the certification procedures required in 40 CFR part 94, subpart C, or 40 CFR part 1042, subpart C, as applicable, and must test their engines as specified in 40 CFR part 94 or 1042, as applicable.~~

~~(c) Stationary CI internal combustion engine manufacturers must meet the requirements of 40 CFR 1039.120, 1039.125, 1039.130, and 1039.135, and 40 CFR part 1068 for engines that are certified to the emission standards in 40 CFR part 1039. Stationary CI internal combustion engine manufacturers must meet the corresponding provisions of 40 CFR part 89, 40 CFR part 94 or 40 CFR part 1042 for engines that would be covered by that part if they were nonroad (including marine) engines. Labels on such engines must refer to stationary engines, rather than or in addition to nonroad or marine engines, as appropriate. Stationary CI internal combustion engine manufacturers must label their engines according to paragraphs (c)(1) through (3) of this section.~~

~~(1) Stationary CI internal combustion engines manufactured from January 1, 2006 to March 31, 2006 (January 1, 2006 to June 30, 2006 for fire pump engines), other than those that are part of certified engine families under the nonroad CI engine regulations, must be labeled according to 40 CFR 1039.20.~~

~~(2) Stationary CI internal combustion engines manufactured from April 1, 2006 to December 31, 2006 (or, for fire pump engines, July 1, 2006 to December 31 of the year preceding the year listed in table 3 to this subpart) must be labeled according to paragraphs (c)(2)(i) through (iii) of this section:~~

(i) Stationary CI internal combustion engines that are part of certified engine families under the nonroad regulations must meet the labeling requirements for nonroad CI engines, but do not have to meet the labeling requirements in 40 CFR 1039.20.

(ii) Stationary CI internal combustion engines that meet Tier 1 requirements (or requirements for fire pumps) under this subpart, but do not meet the requirements applicable to nonroad CI engines must be labeled according to 40 CFR 1039.20. The engine manufacturer may add language to the label clarifying that the engine meets Tier 1 requirements (or requirements for fire pumps) of this subpart.

(iii) Stationary CI internal combustion engines manufactured after April 1, 2006 that do not meet Tier 1 requirements of this subpart, or fire pumps engines manufactured after July 1, 2006 that do not meet the requirements for fire pumps under this subpart, may not be used in the U.S. If any such engines are manufactured in the U.S. after April 1, 2006 (July 1, 2006 for fire pump engines), they must be exported or must be brought into compliance with the appropriate standards prior to initial operation. The export provisions of 40 CFR 1068.230 would apply to engines for export and the manufacturers must label such engines according to 40 CFR 1068.230.

(3) Stationary CI internal combustion engines manufactured after January 1, 2007 (for fire pump engines, after January 1 of the year listed in table 3 to this subpart, as applicable) must be labeled according to paragraphs (c)(3)(i) through (iii) of this section.

(i) Stationary CI internal combustion engines that meet the requirements of this subpart and the corresponding requirements for nonroad (including marine) engines of the same model year and HP must be labeled according to the provisions in 40 CFR parts 89, 94, 1039 or 1042, as appropriate.

(ii) Stationary CI internal combustion engines that meet the requirements of this subpart, but are not certified to the standards applicable to nonroad (including marine) engines of the same model year and HP must be labeled according to the provisions in 40 CFR parts 89, 94, 1039 or 1042, as appropriate, but the words “stationary” must be included instead of “nonroad” or “marine” on the label. In addition, such engines must be labeled according to 40 CFR 1039.20.

(iii) Stationary CI internal combustion engines that do not meet the requirements of this subpart must be labeled according to 40 CFR 1068.230 and must be exported under the provisions of 40 CFR 1068.230.

(d) An engine manufacturer certifying an engine family or families to standards under this subpart that are identical to standards applicable under 40 CFR parts 89, 94, 1039 or 1042 for that model year may certify any such family that contains both nonroad (including marine) and stationary engines as a single engine family and/or may include any such family containing stationary engines in the averaging, banking and trading provisions applicable for such engines under those parts.

(e) Manufacturers of engine families discussed in paragraph (d) of this section may meet the labeling requirements referred to in paragraph (c) of this section for stationary CI ICE by either adding a separate label containing the information required in paragraph (c) of this section or by adding the words “and stationary” after the word “nonroad” or “marine,” as appropriate, to the label.

(f) Starting with the model years shown in table 5 to this subpart, stationary CI internal combustion engine manufacturers must add a permanent label stating that the engine is for stationary emergency use only to each new emergency stationary CI internal combustion engine greater than or equal to 19 KW (25 HP) that meets all the emission standards for emergency engines in §60.4202 but does not meet all the emission standards for non-emergency engines in §60.4201. The label must be added according to the labeling requirements specified in 40 CFR 1039.135(b). Engine manufacturers must specify in the owner's manual that operation of emergency engines is limited to emergency operations and required maintenance and testing.

(g) Manufacturers of fire pump engines may use the test cycle in table 6 to this subpart for testing fire pump engines and may test at the NFPA certified nameplate HP, provided that the engine is labeled as “Fire Pump Applications Only”.

(h) Engine manufacturers, including importers, may introduce into commerce uncertified engines or engines certified to earlier standards that were manufactured before the new or changed standards took effect until inventories are depleted, as long as such engines are part of normal inventory. For example, if the engine manufacturers' normal industry practice is to keep on hand a one-month supply of engines based on its projected sales, and a new tier of standards starts to apply for the 2009 model year, the engine manufacturer may manufacture engines based on the normal inventory requirements late in the 2008 model year, and sell those engines for installation. The engine manufacturer may not circumvent the provisions of §60.4201 or §60.4202 by stockpiling engines that are built before new or changed standards take effect. Stockpiling of such engines beyond normal industry practice is a violation of this subpart.

(i) The replacement engine provisions of 40 CFR 89.1003(b)(7), 40 CFR 94.1103(b)(3), 40 CFR 94.1103(b)(4) and 40 CFR 1068.240 are applicable to stationary CI engines replacing existing equipment that is less than 15 years old.

(j) Stationary CI ICE manufacturers may equip their stationary CI internal combustion engines certified to the emission standards in 40 CFR part 1039 with AECDs for qualified emergency situations according to the requirements of 40 CFR 1039.665. Manufacturers of stationary CI ICE equipped with AECDs as allowed by 40 CFR 1039.665 must meet all of the

requirements in 40 CFR 1039.665 that apply to manufacturers. Manufacturers must document that the engine complies with the Tier 1 standard in 40 CFR 89.112 when the AECD is activated. Manufacturers must provide any relevant testing, engineering analysis, or other information in sufficient detail to support such statement when applying for certification (including amending an existing certificate) of an engine equipped with an AECD as allowed by 40 CFR 1039.665.

[71 FR 39172, July 11, 2006, as amended at 76 FR 37969, June 28, 2011; 81 FR 44219, July 7, 2016]

Midas Gold is not a stationary CI engine manufacturer; therefore, this section is not applicable.

§60.4211 What are my compliance requirements if I am an owner or operator of a stationary CI internal combustion engine?

(a) If you are an owner or operator and must comply with the emission standards specified in this subpart, you must do all of the following, except as permitted under paragraph (g) of this section:

(1) Operate and maintain the stationary CI internal combustion engine and control device according to the manufacturer's emission-related written instructions;

(2) Change only those emission-related settings that are permitted by the manufacturer; and

(3) Meet the requirements of 40 CFR parts 89, 94[Marine Engines] and/or 1068, as they apply to you.

(b) If you are an owner or operator of a pre-2007 model year stationary CI internal combustion engine and must comply with the emission standards specified in §§60.4204(a) or 60.4205(a), or if you are an owner or operator of a CI fire pump engine that is manufactured prior to the model years in table 3 to this subpart and must comply with the emission standards specified in §60.4205(c), you must demonstrate compliance according to one of the methods specified in paragraphs (b)(1) through (5) of this section.

(1) Purchasing an engine certified according to 40 CFR part 89 or 40 CFR part 94, as applicable, for the same model year and maximum engine power. The engine must be installed and configured according to the manufacturer's specifications.

(2) Keeping records of performance test results for each pollutant for a test conducted on a similar engine. The test must have been conducted using the same methods specified in this subpart and these methods must have been followed correctly.

(3) Keeping records of engine manufacturer data indicating compliance with the standards.

(4) Keeping records of control device vendor data indicating compliance with the standards.

(5) Conducting an initial performance test to demonstrate compliance with the emission standards according to the requirements specified in §60.4212, as applicable.

(c) If you are an owner or operator of a 2007 model year and later stationary CI internal combustion engine and must comply with the emission standards specified in §60.4204(b) or §60.4205(b), or if you are an owner or operator of a CI fire pump engine that is manufactured during or after the model year that applies to your fire pump engine power rating in table 3 to this subpart and must comply with the emission standards specified in §60.4205(c), you must comply by purchasing an engine certified to the emission standards in §60.4204(b), or §60.4205(b) or (c), as applicable, for the same model year and maximum (or in the case of fire pumps, NFPA nameplate) engine power. The engine must be installed and configured according to the manufacturer's emission-related specifications, except as permitted in paragraph (g) of this section.

(d) If you are an owner or operator and must comply with the emission standards specified in §60.4204(c) or §60.4205(d), you must demonstrate compliance according to the requirements specified in paragraphs (d)(1) through (3) of this section.

(1) Conducting an initial performance test to demonstrate initial compliance with the emission standards as specified in §60.4213.

(2) Establishing operating parameters to be monitored continuously to ensure the stationary internal combustion engine continues to meet the emission standards. The owner or operator must petition the Administrator for approval of operating parameters to be monitored continuously. The petition must include the information described in paragraphs (d)(2)(i) through (v) of this section.

(i) Identification of the specific parameters you propose to monitor continuously;

(ii) A discussion of the relationship between these parameters and NO_x and PM emissions, identifying how the emissions of these pollutants change with changes in these parameters, and how limitations on these parameters will serve to limit NO_x and PM emissions;

(iii) A discussion of how you will establish the upper and/or lower values for these parameters which will establish the limits

on these parameters in the operating limitations;

(iv) A discussion identifying the methods and the instruments you will use to monitor these parameters, as well as the relative accuracy and precision of these methods and instruments; and

(v) A discussion identifying the frequency and methods for recalibrating the instruments you will use for monitoring these parameters.

(3) For non-emergency engines with a displacement of greater than or equal to 30 liters per cylinder, conducting annual performance tests to demonstrate continuous compliance with the emission standards as specified in §60.4213.

(e) If you are an owner or operator of a modified or reconstructed stationary CI internal combustion engine and must comply with the emission standards specified in §60.4204(e) or §60.4205(f), you must demonstrate compliance according to one of the methods specified in paragraphs (e)(1) or (2) of this section.

(1) Purchasing, or otherwise owning or operating, an engine certified to the emission standards in §60.4204(e) or §60.4205(f), as applicable.

(2) Conducting a performance test to demonstrate initial compliance with the emission standards according to the requirements specified in §60.4212 or §60.4213, as appropriate. The test must be conducted within 60 days after the engine commences operation after the modification or reconstruction.

(f) If you own or operate an emergency stationary ICE, you must operate the emergency stationary ICE according to the requirements in paragraphs (f)(1) through (3) of this section. In order for the engine to be considered an emergency stationary ICE under this subpart, any operation other than emergency operation, maintenance and testing, emergency demand response, and operation in non-emergency situations for 50 hours per year, as described in paragraphs (f)(1) through (3) of this section, is prohibited. If you do not operate the engine according to the requirements in paragraphs (f)(1) through (3) of this section, the engine will not be considered an emergency engine under this subpart and must meet all requirements for non- emergency engines.

(1) There is no time limit on the use of emergency stationary ICE in emergency situations.

(2) You may operate your emergency stationary ICE for any combination of the purposes specified in paragraphs (f)(2)(i) through (iii) of this section for a maximum of 100 hours per calendar year. Any operation for non-emergency situations as allowed by paragraph (f)(3) of this section counts as part of the 100 hours per calendar year allowed by this paragraph (f)(2).

(i) Emergency stationary ICE may be operated for maintenance checks and readiness testing, provided that the tests are recommended by federal, state or local government, the manufacturer, the vendor, the regional transmission organization or equivalent balancing authority and transmission operator, or the insurance company associated with the engine. The owner or operator may petition the Administrator for approval of additional hours to be used for maintenance checks and readiness testing, but a petition is not required if the owner or operator maintains records indicating that federal, state, or local standards require maintenance and testing of emergency ICE beyond 100 hours per calendar year.

(ii) Emergency stationary ICE may be operated for emergency demand response for periods in which the Reliability Coordinator under the North American Electric Reliability Corporation (NERC) Reliability Standard EOP-002-3, Capacity and Energy Emergencies (incorporated by reference, see §60.17), or other authorized entity as determined by the Reliability Coordinator, has declared an Energy Emergency Alert Level 2 as defined in the NERC Reliability Standard EOP-002-3.

(iii) Emergency stationary ICE may be operated for periods where there is a deviation of voltage or frequency of 5 percent or greater below standard voltage or frequency.

(3) Emergency stationary ICE may be operated for up to 50 hours per calendar year in non-emergency situations. The 50 hours of operation in non-emergency situations are counted as part of the 100 hours per calendar year for maintenance and testing and emergency demand response provided in paragraph (f)(2) of this section. Except as provided in paragraph (f)(3)(i) of this section, the 50 hours per calendar year for non-emergency situations cannot be used for peak shaving or non-emergency demand response, or to generate income for a facility to an electric grid or otherwise supply power as part of a financial arrangement with another entity.

(i) The 50 hours per year for non-emergency situations can be used to supply power as part of a financial arrangement with another entity if all of the following conditions are met:

(A) The engine is dispatched by the local balancing authority or local transmission and distribution system operator;

(B) The dispatch is intended to mitigate local transmission and/or distribution limitations so as to avert potential voltage collapse or line overloads that could lead to the interruption of power supply in a local area or region.

(C) The dispatch follows reliability, emergency operation or similar protocols that follow specific NERC, regional, state,

~~public utility commission or local standards or guidelines.~~

~~(D) The power is provided only to the facility itself or to support the local transmission and distribution system.~~

~~(E) The owner or operator identifies and records the entity that dispatches the engine and the specific NERC, regional, state, public utility commission or local standards or guidelines that are being followed for dispatching the engine. The local balancing authority or local transmission and distribution system operator may keep these records on behalf of the engine owner or operator.~~

~~(ii) [Reserved]~~

(g) If you do not install, configure, operate, and maintain your engine and control device according to the manufacturer's emission-related written instructions, or you change emission-related settings in a way that is not permitted by the manufacturer, you must demonstrate compliance as follows:

(1) ~~If you are an owner or operator of a stationary CI internal combustion engine with maximum engine power less than 100 HP, you must keep a maintenance plan and records of conducted maintenance to demonstrate compliance and must, to the extent practicable, maintain and operate the engine in a manner consistent with good air pollution control practice for minimizing emissions. In addition, if you do not install and configure the engine and control device according to the manufacturer's emission-related written instructions, or you change the emission-related settings in a way that is not permitted by the manufacturer, you must conduct an initial performance test to demonstrate compliance with the applicable emission standards within 1 year of such action~~.

(2) If you are an owner or operator of a stationary CI internal combustion engine greater than or equal to 100 HP and less than or equal to 500 HP, you must keep a maintenance plan and records of conducted maintenance and must, to the extent practicable, maintain and operate the engine in a manner consistent with good air pollution control practice for minimizing emissions. In addition, you must conduct an initial performance test to demonstrate compliance with the applicable emission standards within 1 year of startup, or within 1 year after an engine and control device is no longer installed, configured, operated, and maintained in accordance with the manufacturer's emission-related written instructions, or within 1 year after you change emission-related settings in a way that is not permitted by the manufacturer.

(3) If you are an owner or operator of a stationary CI internal combustion engine greater than 500 HP, you must keep a maintenance plan and records of conducted maintenance and must, to the extent practicable, maintain and operate the engine in a manner consistent with good air pollution control practice for minimizing emissions. In addition, you must conduct an initial performance test to demonstrate compliance with the applicable emission standards within 1 year of startup, or within 1 year after an engine and control device is no longer installed, configured, operated, and maintained in accordance with the manufacturer's emission-related written instructions, or within 1 year after you change emission-related settings in a way that is not permitted by the manufacturer. You must conduct subsequent performance testing every 8,760 hours of engine operation or 3 years, whichever comes first, thereafter to demonstrate compliance with the applicable emission standards.

~~(h) The requirements for operators and prohibited acts specified in 40 CFR 1039.665 apply to owners or operators of stationary CI ICE equipped with AECDs for qualified emergency situations as allowed by 40 CFR 1039.665.~~

[71 FR 39172, July 11, 2006, as amended at 76 FR 37970, June 28, 2011; 78 FR 6695, Jan. 30, 2013; 81 FR 44219, July 7, 2016]

§60.4211(a) will be applicable. Except as permitted in §60.4211(g), Midas Gold must operate and maintain the three emergency engines and one fire pump engine according to the manufacturer's emission-related written instructions, only change emission-related settings that are permitted by the manufacturer and meet the requirements of 40 CFR 89 and 1068, as they apply.

§60.4211(b) will not apply because Midas Gold will not own or operate any pre-2007 model year stationary CI ICE or a CI fire pump engine that is manufactured prior to 2009.

§60.4211(c) will be applicable. Midas Gold must purchase emergency stationary CI ICE certified to the emission standards in §60.4205(b) and fire pump CI ICE certified to the emission standards in §60.4205(c). Except as permitted in §60.4211(g), the engines must be installed and configured according to the manufacturer's emission-related specifications.

§60.4211(d) will not apply because Midas Gold will not own or operate any stationary CI ICE with a displacement of greater than or equal to 30 liters per cylinder.

§60.4211(e) will not apply because Midas Gold will not own or operate any modified or reconstructed stationary CI ICE.

§60.4211(f) will be applicable. Midas Gold will not be allowed to operate the three emergency engines or fire pump engine for more than 50 hours per year in non-emergency situations, and no more than 100 hours per year for maintenance checks and readiness testing. Any operation for non-emergency situations is counted towards the 100 hours per year allowed for maintenance and testing. There is no time limit on the use of the CI ICE in emergency situations. Midas Gold will not operate any stationary CI ICE for emergency demand response nor as part of a financial arrangement with another entity, and therefore §60.4211(f)(2)(ii) and (iii) and §60.4211(f)(3)(i) will not apply.

If Midas Gold does not install, configure, operate and maintain the stationary CI ICE according to the manufacturer's emission-related

instructions, §60.4211(g)(2) will be applicable to the fire pump engine and §60.4211(g)(3) will be applicable the three emergency engines. Midas Gold will be required to keep a maintenance plan and records, and maintain and operate the CI ICE in a manner consistent with good air pollution control practices. In addition, they will be required to conduct an initial performance test. Midas Gold will also be required to conduct subsequent performance tests on the three emergency engines every 8,760 hours of engine operation or every 3 years.

It is proposed that the three emergency engines and one fire pump engine will not be equipped with AECDs, therefore §60.4211(h) will not apply.

Testing Requirements for Owners and Operators

§60.4212 What test methods and other procedures must I use if I am an owner or operator of a stationary CI internal combustion engine with a displacement of less than 30 liters per cylinder?

Owners and operators of stationary CI ICE with a displacement of less than 30 liters per cylinder who conduct performance tests pursuant to this subpart must do so according to paragraphs (a) through (e) of this section.

(a) The performance test must be conducted according to the in-use testing procedures in 40 CFR part 1039, subpart F, for stationary CI ICE with a displacement of less than 10 liters per cylinder, ~~and according to 40 CFR part 1042, subpart F, for stationary CI ICE with a displacement of greater than or equal to 10 liters per cylinder and less than 30 liters per cylinder.~~

~~(b) Exhaust emissions from stationary CI ICE that are complying with the emission standards for new CI engines in 40 CFR part 1039[Non-Road CI Engines] must not exceed the not-to-exceed (NTE) standards for the same model year and maximum engine power as required in 40 CFR 1039.101(e) and 40 CFR 1039.102(g)(1), except as specified in 40 CFR 1039.104(d). This requirement starts when NTE requirements take effect for nonroad diesel engines under 40 CFR part 1039.~~

(c) Exhaust emissions from stationary CI ICE that are complying with the emission standards for new CI engines in 40 CFR 89.112 or ~~40 CFR 94.8 [Marine Engines], as applicable~~, must not exceed the NTE numerical requirements, rounded to the same number of decimal places as the applicable standard in 40 CFR 89.112 ~~or 40 CFR 94.8, as applicable,~~ determined from the following equation:

NTE requirement for each pollutant = (1.25) x (STD) (Eq. 1)

Where:

STD = The standard specified for that pollutant in 40 CFR 89.112 ~~or 40 CFR 94.8, as applicable~~.

Alternatively, stationary CI ICE that are complying with the emission standards for new CI engines in 40 CFR 89.112 ~~or 40 CFR 94.8~~ may follow the testing procedures specified in §60.4213 of this subpart, as appropriate.

~~(d) Exhaust emissions from stationary CI ICE that are complying with the emission standards for pre-2007 model year engines in §60.4204(a), §60.4205(a), or §60.4205(c) must not exceed the NTE numerical requirements, rounded to the same number of decimal places as the applicable standard in §60.4204(a), §60.4205(a), or §60.4205(c), determined from the equation in paragraph (c) of this section.~~

~~Where:~~

~~STD = The standard specified for that pollutant in §60.4204(a), §60.4205(a), or §60.4205(c).~~

~~Alternatively, stationary CI ICE that are complying with the emission standards for pre-2007 model year engines in §60.4204(a), §60.4205(a), or §60.4205(c) may follow the testing procedures specified in §60.4213, as appropriate.~~

~~(e) Exhaust emissions from stationary CI ICE that are complying with the emission standards for new CI engines in 40 CFR part 1042 must not exceed the NTE standards for the same model year and maximum engine power as required in 40 CFR 1042.101(c).~~

[71 FR 39172, July 11, 2006, as amended at 76 FR 37971, June 28, 2011]

If Midas Gold must demonstrate compliance per §60.4211(g)(2) or (g)(3), §60.4212(a), and (c) will apply to the performance testing to demonstrate compliance with the applicable emission standards.

§60.4212(b), (d) and (e) will not apply to the proposed Midas Gold stationary CI ICE.

~~§60.4213 What test methods and other procedures must I use if I am an owner or operator of a stationary CI internal combustion engine with a displacement of greater than or equal to 30 liters per cylinder?~~

~~Owners and operators of stationary CI ICE with a displacement of greater than or equal to 30 liters per cylinder must conduct performance tests according to paragraphs (a) through (f) of this section.~~

~~(a) Each performance test must be conducted according to the requirements in §60.8 and under the specific conditions that this subpart specifies in table 7. The test must be conducted within 10 percent of 100 percent peak (or the highest achievable)~~

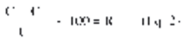
load.

(b) You may not conduct performance tests during periods of startup, shutdown, or malfunction, as specified in §60.8(c).

(c) You must conduct three separate test runs for each performance test required in this section, as specified in §60.8(f). Each test run must last at least 1 hour.

(d) To determine compliance with the percent reduction requirement, you must follow the requirements as specified in paragraphs (d)(1) through (3) of this section.

(1) You must use Equation 2 of this section to determine compliance with the percent reduction requirement:



View or download PDF

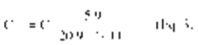
Where:

C_i = concentration of NO_X or PM at the control device inlet,

C_o = concentration of NO_X or PM at the control device outlet, and

R = percent reduction of NO_X or PM emissions.

(2) You must normalize the NO_X or PM concentrations at the inlet and outlet of the control device to a dry basis and to 15 percent oxygen (O_2) using Equation 3 of this section, or an equivalent percent carbon dioxide (CO_2) using the procedures described in paragraph (d)(3) of this section.



View or download PDF

Where:

C_{adj} = Calculated NO_x or PM concentration adjusted to 15 percent O_2.

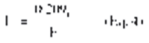
C_d = Measured concentration of NO_X or PM, uncorrected.

5.9 = 20.9 percent O_2 − 15 percent O_2, the defined O_2 correction value, percent.

$\%O_2$ = Measured O_2 concentration, dry basis, percent.

(3) If pollutant concentrations are to be corrected to 15 percent O_2 and CO_2 concentration is measured in lieu of O_2 concentration measurement, a CO_2 correction factor is needed. Calculate the CO_2 correction factor as described in paragraphs (d)(3)(i) through (iii) of this section.

(i) Calculate the fuel-specific F_o value for the fuel burned during the test using values obtained from Method 19, Section 5.2, and the following equation:



View or download PDF

Where:

F_o = Fuel factor based on the ratio of O_2 volume to the ultimate CO_2 volume produced by the fuel at zero percent excess air.

0.209 = Fraction of air that is O_2, percent/100.

F_d = Ratio of the volume of dry effluent gas to the gross calorific value of the fuel from Method 19, dsm^3/J ($dscf/10^6$ Btu).

F_c = Ratio of the volume of CO_2 produced to the gross calorific value of the fuel from Method 19, dsm^3/J ($dscf/10^6$ Btu).

(ii) Calculate the CO_2 correction factor for correcting measurement data to 15 percent O_2, as follows:

$$X_{CO_2} = \frac{5.9}{F_o} \quad \text{(Eq. 5)}$$

View or download PDF

Where:

X_{CO2} = CO_2 correction factor, percent.

5.9 = 20.9 percent O_2 − 15 percent O_2, the defined O_2 correction value, percent.

(iii) Calculate the NO_X and PM gas concentrations adjusted to 15 percent O_2 using CO_2 as follows:

$$C_{adj} = C_d \frac{X_{co_2}}{\%CO_2} \quad \text{(Eq. 6)}$$

View or download PDF

Where:

C_{adj} = Calculated NO_X or PM concentration adjusted to 15 percent O_2.

C_d = Measured concentration of NO_X or PM, uncorrected.

$\%CO_2$ = Measured CO_2 concentration, dry basis, percent.

(e) To determine compliance with the NO_X mass per unit output emission limitation, convert the concentration of NO_X in the engine exhaust using Equation 7 of this section:

$$ER = \frac{C_{adj} \times Q \times T}{KW\text{-}hour} \quad \text{(Eq. 7)}$$

View or download PDF

Where:

ER = Emission rate in grams per KW-hour.

C_d = Measured NO_X concentration in ppm.

1.912×10^{-3} = Conversion constant for ppm NO_X to grams per standard cubic meter at 25 degrees Celsius.

Q = Stack gas volumetric flow rate, in standard cubic meter per hour.

T = Time of test run, in hours.

KW-hour = Brake work of the engine, in KW-hour.

(f) To determine compliance with the PM mass per unit output emission limitation, convert the concentration of PM in the engine exhaust using Equation 8 of this section:

$$ER = \frac{C_{adj} \times Q \times T}{KW\text{-}hour} \quad \text{(Eq. 8)}$$

View or download PDF

Where:

ER = Emission rate in grams per KW-hour.

C_{adj} = Calculated PM concentration in grams per standard cubic meter.

Q = Stack gas volumetric flow rate, in standard cubic meter per hour.

T = Time of test run, in hours.

KW-hour = Energy output of the engine, in KW.

[71 FR 39172, July 11, 2006, as amended at 76 FR 37971, June 28, 2011]

Midas Gold is not proposing to own or operate any stationary CI ICEs with a displacement of greater than or equal to 30 liters per cylinder; therefore, this section is not applicable.

Notification, Reports, and Records for Owners and Operators

§60.4214 What are my notification, reporting, and recordkeeping requirements if I am an owner or operator of a stationary CI internal combustion engine?

(a) Owners and operators of non-emergency stationary CI ICE that are greater than 2,237 KW (3,000 HP), or have a displacement of greater than or equal to 10 liters per cylinder, or are pre-2007 model year engines that are greater than 130 KW (175 HP) and not certified, must meet the requirements of paragraphs (a)(1) and (2) of this section.

(1) Submit an initial notification as required in §60.7(a)(1). The notification must include the information in paragraphs (a)(1)(i) through (v) of this section.

(i) Name and address of the owner or operator;

(ii) The address of the affected source;

(iii) Engine information including make, model, engine family, serial number, model year, maximum engine power, and engine displacement;

(iv) Emission control equipment; and

(v) Fuel used.

(2) Keep records of the information in paragraphs (a)(2)(i) through (iv) of this section.

(i) All notifications submitted to comply with this subpart and all documentation supporting any notification.

(ii) Maintenance conducted on the engine.

(iii) If the stationary CI internal combustion is a certified engine, documentation from the manufacturer that the engine is certified to meet the emission standards.

(iv) If the stationary CI internal combustion is not a certified engine, documentation that the engine meets the emission standards.

(b) If the stationary CI internal combustion engine is an emergency stationary internal combustion engine, the owner or operator is not required to submit an initial notification. Starting with the model years in table 5 to this subpart, if the emergency engine does not meet the standards applicable to non-emergency engines in the applicable model year, the owner or operator must keep records of the operation of the engine in emergency and non-emergency service that are recorded through the non-resettable hour meter. The owner must record the time of operation of the engine and the reason the engine was in operation during that time.

(c) If the stationary CI internal combustion engine is equipped with a diesel particulate filter, the owner or operator must keep records of any corrective action taken after the backpressure monitor has notified the owner or operator that the high backpressure limit of the engine is approached.

(d) If you own or operate an emergency stationary CI ICE with a maximum engine power more than 100 HP that operates or is contractually obligated to be available for more than 15 hours per calendar year for the purposes specified in §60.4211(f)(2)(ii) and (iii) or that operates for the purposes specified in §60.4211(f)(3)(i), you must submit an annual report according to the requirements in paragraphs (d)(1) through (3) of this section. The report must contain the following information:

(i) Company name and address where the engine is located.

(ii) Date of the report and beginning and ending dates of the reporting period.

(iii) Engine site rating and model year.

(iv) Latitude and longitude of the engine in decimal degrees reported to the fifth decimal place.

(v) Hours operated for the purposes specified in §60.4211(f)(2)(ii) and (iii), including the date, start time, and end time for engine operation for the purposes specified in §60.4211(f)(2)(ii) and (iii).

(vi) Number of hours the engine is contractually obligated to be available for the purposes specified in §60.4211(f)(2)(ii) and (iii).

(vii) Hours spent for operation for the purposes specified in §60.4211(f)(3)(i), including the date, start time, and end time for engine operation for the purposes specified in §60.4211(f)(3)(i). The report must also identify the entity that dispatched the engine and the situation that necessitated the dispatch of the engine.

(2) The first annual report must cover the calendar year 2015 and must be submitted no later than March 31, 2016. Subsequent annual reports for each calendar year must be submitted no later than March 31 of the following calendar year.

(3) The annual report must be submitted electronically using the subpart specific reporting form in the Compliance and Emissions Data Reporting Interface (CEDRI) that is accessed through EPA's Central Data Exchange (CDX) (*www.epa.gov/cdx*). However, if the reporting form specific to this subpart is not available in CEDRI at the time that the report is due, the written report must be submitted to the Administrator at the appropriate address listed in §60.4.

(e) Owners or operators of stationary CI ICE equipped with AECDs pursuant to the requirements of 40 CFR 1039.665 must report the use of AECDs as required by 40 CFR 1039.665(e).

[71 FR 39172, July 11, 2006, as amended at 78 FR 6696, Jan. 30, 2013; 81 FR 44219, July 7, 2016]

§60.4214(a) will not apply to the proposed Midas Gold stationary CI ICE.

§60.4214(b) will be applicable. Midas Gold will not be required to submit an initial notification for the three emergency engines and one fire pump engine. Because the emergency engines will not meet the standards applicable to non-emergency engines, Midas Gold must keep records of the time of operation in emergency and non-emergency service and reason for operation.

It is proposed that the three emergency engines and one fire pump engine will not be equipped with diesel particulate filters, therefore §60.4214(c) will not apply.

Midas Gold will not operate any stationary CI ICE for emergency demand response per §60.4211(f)(2)(ii) and (iii) nor as part of a financial arrangement with another entity per §60.4211(f)(3)(i), and therefore §60.4214(d) will not apply.

It is proposed that the three emergency engines and one fire pump engine will not be equipped with AECDs, therefore §60.4214(e) will not apply.

Special Requirements

§60.4215 What requirements must I meet for engines used in Guam, American Samoa, or the Commonwealth of the Northern Mariana Islands?

(a) Stationary CI ICE with a displacement of less than 30 liters per cylinder that are used in Guam, American Samoa, or the Commonwealth of the Northern Mariana Islands are required to meet the applicable emission standards in §§60.4202 and 60.4205.

(b) Stationary CI ICE that are used in Guam, American Samoa, or the Commonwealth of the Northern Mariana Islands are not required to meet the fuel requirements in §60.4207.

(c) Stationary CI ICE with a displacement of greater than or equal to 30 liters per cylinder that are used in Guam, American Samoa, or the Commonwealth of the Northern Mariana Islands are required to meet the following emission standards:

(1) For engines installed prior to January 1, 2012, limit the emissions of NO_X in the stationary CI internal combustion engine exhaust to the following:

(i) 17.0 g/KW-hr (12.7 g/HP-hr) when maximum engine speed is less than 130 rpm;

(ii) $45 \cdot n^{-0.2}$ g/KW-hr ($34 \cdot n^{-0.2}$ g/HP-hr) when maximum engine speed is 130 or more but less than 2,000 rpm, where n is maximum engine speed; and

(iii) 9.8 g/KW-hr (7.3 g/HP-hr) when maximum engine speed is 2,000 rpm or more.

(2) For engines installed on or after January 1, 2012, limit the emissions of NO_X in the stationary CI internal combustion engine exhaust to the following:

(i) 14.4 g/KW-hr (10.7 g/HP-hr) when maximum engine speed is less than 130 rpm;$44 \cdot n^{-0.23}$ g/KW-hr ($33 \cdot n^{-0.23}$ g/HP-hr) when maximum engine speed is greater than or equal to 130 but less than 2,000 rpm and where n is maximum engine speed; and

(ii) 7.7 g/KW-hr (5.7 g/HP-hr) when maximum engine speed is greater than or equal to 2,000 rpm.

(3) Limit the emissions of PM in the stationary CI internal combustion engine exhaust to 0.40 g/KW-hr (0.30 g/HP-hr).

[71 FR 39172, July 11, 2006, as amended at 76 FR 37971, June 28, 2011]

Midas Gold is not proposing to use any engines in Guam, American Samoa, or the Commonwealth of the Northern Mariana Islands; therefore, this section is not applicable.

§60.4216 What requirements must I meet for engines used in Alaska?

(a) Prior to December 1, 2010, owners and operators of stationary CI ICE with a displacement of less than 30 liters per cylinder located in areas of Alaska not accessible by the FAHS should refer to 40 CFR part 69 to determine the diesel fuel requirements applicable to such engines.

(b) Except as indicated in paragraph (c) of this section, manufacturers, owners and operators of stationary CI ICE with a displacement of less than 10 liters per cylinder located in remote areas of Alaska may meet the requirements of this subpart by

manufacturing and installing engines meeting the requirements of 40 CFR parts 94 or 1042, as appropriate, rather than the otherwise applicable requirements of 40 CFR parts 89 and 1039, as indicated in §§60.4201(f) and 60.4202(g).

(c) Manufacturers, owners and operators of stationary CI ICE that are located in remote areas of Alaska may choose to meet the applicable emission standards for emergency engines in §§60.4202 and 60.4205, and not those for non-emergency engines in §§60.4201 and 60.4204, except that for 2014 model year and later non-emergency CI ICE, the owner or operator of any such engine that was not certified as meeting Tier 4 PM standards, must meet the applicable requirements for PM in §§60.4201 and 60.4204 or install a PM emission control device that achieves PM emission reductions of 85 percent, or 60 percent for engines with a displacement of greater than or equal to 30 liters per cylinder, compared to engine-out emissions.

(d) The provisions of §60.4207 do not apply to owners and operators of pre-2014 model year stationary CI ICE subject to this subpart that are located in remote areas of Alaska.

(e) The provisions of §60.4208(a) do not apply to owners and operators of stationary CI ICE subject to this subpart that are located in areas of Alaska not accessible by the FAHS until after December 31, 2009.

(f) The provisions of this section and §60.4207 do not prevent owners and operators of stationary CI ICE subject to this subpart that are located in remote areas of Alaska from using fuels mixed with used lubricating oil, in volumes of up to 1.75 percent of the total fuel. The sulfur content of the used lubricating oil must be less than 200 parts per million. The used lubricating oil must meet the on-specification levels and properties for used oil in 40 CFR 279.11.

[76 FR 37971, June 28, 2011, as amended at 81 FR 44219, July 7, 2016]

Midas Gold is not proposing to use any engines in Alaska; therefore, this section is not applicable.

§60.4217 What emission standards must I meet if I am an owner or operator of a stationary internal combustion engine using special fuels?

Owners and operators of stationary CI ICE that do not use diesel fuel may petition the Administrator for approval of alternative emission standards, if they can demonstrate that they use a fuel that is not the fuel on which the manufacturer of the engine certified the engine and that the engine cannot meet the applicable standards required in §60.4204 or §60.4205 using such fuels and that use of such fuel is appropriate and reasonably necessary, considering cost, energy, technical feasibility, human health and environmental, and other factors, for the operation of the engine.

[76 FR 37972, June 28, 2011]

Midas Gold is not proposing to own or operate any engines using special fuels; therefore, this section is not applicable.

General Provisions

§60.4218 What parts of the General Provisions apply to me?

Table 8 to this subpart shows which parts of the General Provisions in §§60.1 through 60.19 apply to you.

See Table 8 of this subpart for the applicable General Provisions to this subpart.

Definitions

§60.4219 What definitions apply to this subpart?

As used in this subpart, all terms not defined herein shall have the meaning given them in the CAA and in subpart A of this part.

Alaska Railbelt Grid means the service areas of the six regulated public utilities that extend from Fairbanks to Anchorage and the Kenai Peninsula. These utilities are Golden Valley Electric Association; Chugach Electric Association; Matanuska Electric Association; Homer Electric Association; Anchorage Municipal Light & Power; and the City of Seward Electric System.

Certified emissions life means the period during which the engine is designed to properly function in terms of reliability and fuel consumption, without being remanufactured, specified as a number of hours of operation or calendar years, whichever comes first. The values for certified emissions life for stationary CI ICE with a displacement of less than 10 liters per cylinder are given in 40 CFR 1039.101(g). The values for certified emissions life for stationary CI ICE with a displacement of greater than or equal to 10 liters per cylinder and less than 30 liters per cylinder are given in 40 CFR 94.9(a).

Combustion turbine means all equipment, including but not limited to the turbine, the fuel, air, lubrication and exhaust gas systems, control systems (except emissions control equipment), and any ancillary components and sub-components comprising any simple cycle combustion turbine, any regenerative/recuperative cycle combustion turbine, the combustion

turbine portion of any cogeneration cycle combustion system, or the combustion turbine portion of any combined cycle steam/electric generating system.

Compression ignition means relating to a type of stationary internal combustion engine that is not a spark ignition engine.

Date of manufacture means one of the following things:

(1) For freshly manufactured engines and modified engines, date of manufacture means the date the engine is originally produced.

(2) For reconstructed engines, date of manufacture means the date the engine was originally produced, except as specified in paragraph (3) of this definition.

(3) Reconstructed engines are assigned a new date of manufacture if the fixed capital cost of the new and refurbished components exceeds 75 percent of the fixed capital cost of a comparable entirely new facility. An engine that is produced from a previously used engine block does not retain the date of manufacture of the engine in which the engine block was previously used if the engine is produced using all new components except for the engine block. In these cases, the date of manufacture is the date of reconstruction or the date the new engine is produced.

Diesel fuel means any liquid obtained from the distillation of petroleum with a boiling point of approximately 150 to 360 degrees Celsius. One commonly used form is number 2 distillate oil.

Diesel particulate filter means an emission control technology that reduces PM emissions by trapping the particles in a flow filter substrate and periodically removes the collected particles by either physical action or by oxidizing (burning off) the particles in a process called regeneration.

Emergency stationary internal combustion engine means any stationary reciprocating internal combustion engine that meets all of the criteria in paragraphs (1) through (3) of this definition. All emergency stationary ICE must comply with the requirements specified in §60.4211(f) in order to be considered emergency stationary ICE. If the engine does not comply with the requirements specified in §60.4211(f), then it is not considered to be an emergency stationary ICE under this subpart.

(1) The stationary ICE is operated to provide electrical power or mechanical work during an emergency situation. Examples include stationary ICE used to produce power for critical networks or equipment (including power supplied to portions of a facility) when electric power from the local utility (or the normal power source, if the facility runs on its own power production) is interrupted, or stationary ICE used to pump water in the case of fire or flood, etc.

(2) The stationary ICE is operated under limited circumstances for situations not included in paragraph (1) of this definition, as specified in §60.4211(f).

(3) The stationary ICE operates as part of a financial arrangement with another entity in situations not included in paragraph (1) of this definition only as allowed in §60.4211(f)(2)(ii) or (iii) and §60.4211(f)(3)(i).

Engine manufacturer means the manufacturer of the engine. See the definition of "manufacturer" in this section.

Fire pump engine means an emergency stationary internal combustion engine certified to NFPA requirements that is used to provide power to pump water for fire suppression or protection.

Freshly manufactured engine means an engine that has not been placed into service. An engine becomes freshly manufactured when it is originally produced.

Installed means the engine is placed and secured at the location where it is intended to be operated.

Manufacturer has the meaning given in section 216(1) of the Act. In general, this term includes any person who manufactures a stationary engine for sale in the United States or otherwise introduces a new stationary engine into commerce in the United States. This includes importers who import stationary engines for sale or resale.

Maximum engine power means maximum engine power as defined in 40 CFR 1039.801.

Model year means the calendar year in which an engine is manufactured (see "date of manufacture"), except as follows:

(1) Model year means the annual new model production period of the engine manufacturer in which an engine is manufactured (see "date of manufacture"), if the annual new model production period is different than the calendar year and includes January 1 of the calendar year for which the model year is named. It may not begin before January 2 of the previous calendar year and it must end by December 31 of the named calendar year.

(2) For an engine that is converted to a stationary engine after being placed into service as a nonroad or other non-stationary engine, model year means the calendar year or new model production period in which the engine was manufactured

(see “date of manufacture”).

Other internal combustion engine means any internal combustion engine, except combustion turbines, which is not a reciprocating internal combustion engine or rotary internal combustion engine.

Reciprocating internal combustion engine means any internal combustion engine which uses reciprocating motion to convert heat energy into mechanical work.

Remote areas of Alaska means areas of Alaska that meet either paragraph (1) or (2) of this definition.

(1) Areas of Alaska that are not accessible by the Federal Aid Highway System (FAHS).

(2) Areas of Alaska that meet all of the following criteria:

(i) The only connection to the FAHS is through the Alaska Marine Highway System, or the stationary CI ICE operation is within an isolated grid in Alaska that is not connected to the statewide electrical grid referred to as the Alaska Railbelt Grid.

(ii) At least 10 percent of the power generated by the stationary CI ICE on an annual basis is used for residential purposes.

(iii) The generating capacity of the source is less than 12 megawatts, or the stationary CI ICE is used exclusively for backup power for renewable energy.

Rotary internal combustion engine means any internal combustion engine which uses rotary motion to convert heat energy into mechanical work.

Spark ignition means relating to a gasoline, natural gas, or liquefied petroleum gas fueled engine or any other type of engine with a spark plug (or other sparking device) and with operating characteristics significantly similar to the theoretical Otto combustion cycle. Spark ignition engines usually use a throttle to regulate intake air flow to control power during normal operation. Dual-fuel engines in which a liquid fuel (typically diesel fuel) is used for CI and gaseous fuel (typically natural gas) is used as the primary fuel at an annual average ratio of less than 2 parts diesel fuel to 100 parts total fuel on an energy equivalent basis are spark ignition engines.

Stationary internal combustion engine means any internal combustion engine, except combustion turbines, that converts heat energy into mechanical work and is not mobile. Stationary ICE differ from mobile ICE in that a stationary internal combustion engine is not a nonroad engine as defined at 40 CFR 1068.30 (excluding paragraph (2)(ii) of that definition), and is not used to propel a motor vehicle, aircraft, or a vehicle used solely for competition. Stationary ICE include reciprocating ICE, rotary ICE, and other ICE, except combustion turbines.

Subpart means 40 CFR part 60, subpart IIII.

[71 FR 39172, July 11, 2006, as amended at 76 FR 37972, June 28, 2011; 78 FR 6696, Jan. 30, 2013; 81 FR 44219, July 7, 2016]

The definitions applicable to Midas Gold have been highlighted in §60.4219.

Table 1 to Subpart IIII of Part 60—Emission Standards for Stationary Pre-2007 Model Year Engines With a Displacement of <10 Liters per Cylinder and 2007-2010 Model Year Engines >2,237 KW (3,000 HP) and With a Displacement of <10 Liters per Cylinder

[As stated in §§60.4201(b), 60.4202(b), 60.4204(a), and 60.4205(a), you must comply with the following emission standards]

Maximum engine power	Emission standards for stationary pre-2007 model year engines with a displacement of <10 liters per cylinder and 2007-2010 model year engines >2,237 KW (3,000 HP) and with a displacement of <10 liters per cylinder in g/KW-hr (g/HP-hr)				
	NMHC + NO_x	HC	NO_x	CO	PM
KW<8 (HP<11)	10.5 (7.8)			8.0 (6.0)	1.0 (0.75)
8≤KW<19 (11≤HP<25)	9.5 (7.1)			6.6 (4.9)	0.80 (0.60)
19≤KW<37 (25≤HP<50)	9.5 (7.1)			5.5 (4.1)	0.80 (0.60)
37≤KW<56 (50≤HP<75)			9.2 (6.9)		
56≤KW<75 (75≤HP<100)			9.2 (6.9)		
75≤KW<130 (100≤HP<175)			9.2 (6.9)		
130≤KW<225 (175≤HP<300)		1.3 (1.0)	9.2 (6.9)	11.4 (8.5)	0.54 (0.40)
225≤KW<450 (300≤HP<600)		1.3 (1.0)	9.2 (6.9)	11.4 (8.5)	0.54 (0.40)
450≤KW≤560 (600≤HP≤750)		1.3 (1.0)	9.2 (6.9)	11.4 (8.5)	0.54 (0.40)
KW>560 (HP>750)		1.3 (1.0)	9.2 (6.9)	11.4 (8.5)	0.54 (0.40)

Table 1 will not apply because the proposed stationary CI ICEs to be operated at the Stibnite Gold Project are not Pre-2007, or model year 2007-2010 greater than 2,237 KW (3,000 HP).

Table 2 to Subpart IIII of Part 60—Emission Standards for 2008 Model Year and Later Emergency Stationary CI ICE <37 KW (50 HP) With a Displacement of <10 Liters per Cylinder

[As stated in §60.4202(a)(1), you must comply with the following emission standards]

Engine power	Emission standards for 2008 model year and later emergency stationary CI ICE <37 KW (50 HP) with a displacement of <10 liters per cylinder in g/KW-hr (g/HP-hr)			
	Model year(s)	NO_x + NMHC	CO	PM
KW<8 (HP<11)	2008 +	7.5 (5.6)	8.0 (6.0)	0.40 (0.30)
8≤KW<19 (11≤HP<25)	2008 +	7.5 (5.6)	6.6 (4.9)	0.40 (0.30)
19≤KW<37 (25≤HP<50)	2008 +	7.5 (5.6)	5.5 (4.1)	0.30 (0.22)

Table 2 will not apply because the stationary CI ICEs at the Stibnite Gold Project are proposed to be greater than 37 KW.

Table 3 to Subpart IIII of Part 60—Certification Requirements for Stationary Fire Pump Engines

As stated in §60.4202(d), you must certify new stationary fire pump engines beginning with the following model years:

Engine power	Starting model year engine manufacturers must certify new stationary fire pump engines according to §60.4202(d)[1]
KW<75 (HP<100)	2011
75≤KW<130 (100≤HP<175)	2010
130≤KW≤560 (175≤HP≤750)	2009
KW>560 (HP>750)	2008

[1]Manufacturers of fire pump stationary CI ICE with a maximum engine power greater than or equal to 37 kW (50 HP) and less than 450 KW (600 HP) and a rated speed of greater than 2,650 revolutions per minute (rpm) are not required to certify such engines until three model years following the model year indicated in this Table 3 for engines in the applicable engine power category.

[71 FR 39172, July 11, 2006, as amended at 76 FR 37972, June 28, 2011]

Table 3 will not apply as Midas Gold is not a stationary CI ICE manufacturer.

Table 4 to Subpart IIII of Part 60—Emission Standards for Stationary Fire Pump Engines

[As stated in ~~§§60.4202(d) and~~ 60.4205(c), you must comply with the following emission standards for stationary fire pump engines]

Maximum engine power	Model year(s)	NMHC + NO_X	CO	PM
~~KW<8 (HP<11)~~	~~2010 and earlier~~	~~10.5 (7.8)~~	~~8.0 (6.0)~~	~~1.0 (0.75)~~
	~~2011 +~~	~~7.5 (5.6)~~		~~0.40 (0.30)~~
~~8≤KW<19 (11≤HP<25)~~	~~2010 and earlier~~	~~9.5 (7.1)~~	~~6.6 (4.9)~~	~~0.80 (0.60)~~
	~~2011 +~~	~~7.5 (5.6)~~		~~0.40 (0.30)~~
~~19≤KW<37 (25≤HP<50)~~	~~2010 and earlier~~	~~9.5 (7.1)~~	~~5.5 (4.1)~~	~~0.80 (0.60)~~
	~~2011 +~~	~~7.5 (5.6)~~		~~0.30 (0.22)~~
~~37≤KW<56 (50≤HP<75)~~	~~2010 and earlier~~	~~10.5 (7.8)~~	~~5.0 (3.7)~~	~~0.80 (0.60)~~
	~~2011 +[1]~~	~~4.7 (3.5)~~		~~0.40 (0.30)~~
~~56≤KW<75 (75≤HP<100)~~	~~2010 and earlier~~	~~10.5 (7.8)~~	~~5.0 (3.7)~~	~~0.80 (0.60)~~
	~~2011 +[1]~~	~~4.7 (3.5)~~		~~0.40 (0.30)~~
~~75≤KW<130 (100≤HP<175)~~	~~2009 and earlier~~	~~10.5 (7.8)~~	~~5.0 (3.7)~~	~~0.80 (0.60)~~
	~~2010 +[2]~~	~~4.0 (3.0)~~		~~0.30 (0.22)~~
130≤KW<225 (175≤HP<300)	2008 and earlier	10.5 (7.8)	3.5 (2.6)	0.54 (0.40)
	2009 +[3]	4.0 (3.0)		0.20 (0.15)
~~225≤KW<450 (300≤HP<600)~~	~~2008 and earlier~~	~~10.5 (7.8)~~	~~3.5 (2.6)~~	~~0.54 (0.40)~~
	~~2009 +[3]~~	~~4.0 (3.0)~~		~~0.20 (0.15)~~
~~450≤KW≤560 (600≤HP≤750)~~	~~2008 and earlier~~	~~10.5 (7.8)~~	~~3.5 (2.6)~~	~~0.54 (0.40)~~
	~~2009 +~~	~~4.0 (3.0)~~		~~0.20 (0.15)~~
~~KW>560 (HP>750)~~	~~2007 and earlier~~	~~10.5 (7.8)~~	~~3.5 (2.6)~~	~~0.54 (0.40)~~
	~~2008 +~~	~~6.4 (4.8)~~		~~0.20 (0.15)~~

~~[1]For model years 2011-2013, manufacturers, owners and operators of fire pump stationary CI ICE in this engine power category with a rated speed of greater than 2,650 revolutions per minute (rpm) may comply with the emission limitations for 2010 model year engines.~~

~~[2]For model years 2010-2012, manufacturers, owners and operators of fire pump stationary CI ICE in this engine power category with a rated speed of greater than 2,650 rpm may comply with the emission limitations for 2009 model year engines~~.

~~[3]In model years 2009-2011, manufacturers of fire pump stationary CI ICE in this engine power category with a rated speed of greater than 2,650 rpm may comply with the emission limitations for 2008 model year engines.~~

Table 4 will apply to the new stationary fire pump CI ICE to be installed at the Stibnite Gold Project per §60.4205(c).

Table 5 to Subpart IIII of Part 60—Labeling and Recordkeeping Requirements for New Stationary Emergency Engines

[You must comply with ~~the labeling requirements in §60.4210(f) and~~ the recordkeeping requirements in §60.4214(b) for new emergency stationary CI ICE beginning in the following model years:]

Engine power	Starting model year
~~19≤KW<56 (25≤HP<75)~~	~~2013~~
~~56≤KW<130 (75≤HP<175)~~	~~2012~~
KW≥130 (HP≥175)	2011

Table 5 will apply to the emergency engines if they do not meet the standards applicable to non-emergency engines. The labeling requirements in §60.4210(f) will apply to the manufacturer and the recordkeeping requirements in §60.4214(b) will apply to Midas Gold.

~~**Table 6 to Subpart IIII of Part 60—Optional 3-Mode Test Cycle for Stationary Fire Pump Engines**~~

~~[As stated in §60.4210(g), manufacturers of fire pump engines may use the following test cycle for testing fire pump engines:]~~

~~Mode No.~~	~~Engine speed[1]~~	~~Torque (percent)[2]~~	~~Weighting factors~~
~~1~~	~~Rated~~	~~100~~	~~0.30~~
~~2~~	~~Rated~~	~~75~~	~~0.50~~
~~3~~	~~Rated~~	~~50~~	~~0.20~~

~~[1]Engine speed: ±2 percent of point.~~

[2]Torque: NFPA certified nameplate HP for 100 percent point. All points should be ±2 percent of engine percent load value.

Table 6 will not apply because Midas Gold is not a stationary CI engine manufacturer.

Table 7 to Subpart IIII of Part 60—Requirements for Performance Tests for Stationary CI ICE With a Displacement of ≥30 Liters per Cylinder

As stated in §60.4213, you must comply with the following requirements for performance tests for stationary CI ICE with a displacement of ≥30 liters per cylinder:

Each	Complying with the requirement to	You must	Using	According to the following requirements
1. Stationary CI internal combustion engine with a displacement of ≥ 30 liters per cylinder	a. Reduce NO_x emissions by 90 percent or more;	i. Select the sampling port location and number/location of traverse points at the inlet and outlet of the control device;		(a) For NO_x, O_2, and moisture measurement, ducts ≤6 inches in diameter may be sampled at a single point located at the duct centroid and ducts >6 and ≤12 inches in diameter may be sampled at 3 traverse points located at 16.7, 50.0, and 83.3% of the measurement line ('3-point long line'). If the duct is >12 inches in diameter *and* the sampling port location meets the two and half-diameter criterion of Section 11.1.1 of Method 1 of 40 CFR part 60, appendix A-1, the duct may be sampled at '3-point long line'; otherwise, conduct the stratification testing and select sampling points according to Section 8.1.2 of Method 7E of 40 CFR part 60, appendix A-4.
		ii. Measure O_2 at the inlet and outlet of the control device;	(1) Method 3, 3A, or 3B of 40 CFR part 60, appendix A-2	(b) Measurements to determine O_2 concentration must be made at the same time as the measurements for NO_x concentration.
		iii. If necessary, measure moisture content at the inlet and outlet of the control device; and	(2) Method 4 of 40 CFR part 60, appendix A-3, Method 320 of 40 CFR part 63, appendix A, or ASTM D 6348-03 (incorporated by reference, see §60.17)	(c) Measurements to determine moisture content must be made at the same time as the measurements for NO_x concentration.
		iv. Measure NO_x at the inlet and outlet of the control device.	(3) Method 7E of 40 CFR part 60, appendix A-4, Method 320 of 40 CFR part 63, appendix A, or ASTM D 6348-03 (incorporated by reference, see §60.17)	(d) NO_x concentration must be at 15 percent O_2, dry basis. Results of this test consist of the average of the three 1-hour or longer runs.
	b. Limit the concentration of NO_x in the stationary CI internal combustion engine exhaust.	i. Select the sampling port location and number/location of traverse points at the exhaust of the stationary internal combustion engine;		(a) For NO_x, O_2, and moisture measurement, ducts ≤6 inches in diameter may be sampled at a single point located at the duct centroid and ducts >6 and ≤12 inches in diameter may be sampled at 3 traverse points located at 16.7, 50.0, and 83.3% of the measurement line ('3-point long line'). If the duct is >12 inches in diameter *and* the sampling port location meets the two and half-diameter criterion of Section 11.1.1 of Method 1 of 40 CFR part 60, appendix A-1, the duct may be sampled at '3-point long line'; otherwise, conduct the stratification testing and select sampling points according to Section 8.1.2 of Method 7E of 40 CFR part 60, appendix A-4.
		ii. Determine the O_2 concentration of the stationary internal combustion engine exhaust at the sampling port location;	(1) Method 3, 3A, or 3B of 40 CFR part 60, appendix A-2	(b) Measurements to determine O_2 concentration must be made at the same time as the measurement for NO_x concentration.
		iii. If necessary, measure moisture content of the stationary internal combustion engine exhaust at the sampling port location; and	(2) Method 4 of 40 CFR part 60, appendix A-3, Method 320 of 40 CFR part 63, appendix A, or ASTM D 6348-03 (incorporated by reference, see §60.17)	(c) Measurements to determine moisture content must be made at the same time as the measurement for NO_x concentration.
		iv. Measure NO_x at the exhaust of the stationary internal combustion engine; if using a control device, the sampling site must be located at the outlet of the control device.	(3) Method 7E of 40 CFR part 60, appendix A-4, Method 320 of 40 CFR part 63, appendix A, or ASTM D 6348-03 (incorporated by reference, see §60.17)	(d) NO_x concentration must be at 15 percent O_2, dry basis. Results of this test consist of the average of the three 1-hour or longer runs.

	c. Reduce PM emissions by 60 percent or more	i. Select the sampling port location and the number of traverse points;	(1) Method 1 or 1A of 40 CFR part 60, appendix A-1	(a) Sampling sites must be located at the inlet and outlet of the control device.
		ii. Measure O_2 at the inlet and outlet of the control device;	(2) Method 3, 3A, or 3B of 40 CFR part 60, appendix A-2	(b) Measurements to determine O_2 concentration must be made at the same time as the measurements for PM concentration.
		iii. If necessary, measure moisture content at the inlet and outlet of the control device; and	(3) Method 4 of 40 CFR part 60, appendix A-3	(c) Measurements to determine and moisture content must be made at the same time as the measurements for PM concentration.
		iv. Measure PM at the inlet and outlet of the control device.	(4) Method 5 of 40 CFR part 60, appendix A-3	(d) PM concentration must be at 15 percent O_2, dry basis. Results of this test consist of the average of the three 1-hour or longer runs.
	d. Limit the concentration of PM in the stationary CI internal combustion engine exhaust	i. Select the sampling port location and the number of traverse points;	(1) Method 1 or 1A of 40 CFR part 60, appendix A-1	(a) If using a control device, the sampling site must be located at the outlet of the control device.
		ii. Determine the O_2 concentration of the stationary internal combustion engine exhaust at the sampling port location;	(2) Method 3, 3A, or 3B of 40 CFR part 60, appendix A-2	(b) Measurements to determine O_2 concentration must be made at the same time as the measurements for PM concentration.
		iii. If necessary, measure moisture content of the stationary internal combustion engine exhaust at the sampling port location; and	(3) Method 4 of 40 CFR part 60, appendix A-3	(c) Measurements to determine moisture content must be made at the same time as the measurements for PM concentration.
		iv. Measure PM at the exhaust of the stationary internal combustion engine.	(4) Method 5 of 40 CFR part 60, appendix A-3	(d) PM concentration must be at 15 percent O_2, dry basis. Results of this test consist of the average of the three 1-hour or longer runs.

[79 FR 11251, Feb. 27, 2014]

Table 7 will not apply because Midas Gold will not own or operate any stationary CI ICE with a displacement of ≥30 liters per cylinder.

Table 8 to Subpart IIII of Part 60—Applicability of General Provisions to Subpart IIII

[As stated in §60.4218, you must comply with the following applicable General Provisions:]

General Provisions citation	Subject of citation	Applies to subpart	Explanation
§60.1	General applicability of the General Provisions	Yes	
§60.2	Definitions	Yes	Additional terms defined in §60.4219.
§60.3	Units and abbreviations	Yes	
§60.4	Address	Yes	
§60.5	Determination of construction or modification	Yes	
§60.6	Review of plans	Yes	
§60.7	Notification and Recordkeeping	Yes	Except that §60.7 only applies as specified in §60.4214(a).
§60.8	Performance tests	Yes	Except that §60.8 only applies to stationary CI ICE with a displacement of (≥30 liters per cylinder and engines that are not certified.
§60.9	Availability of information	Yes	
§60.10	State Authority	Yes	
§60.11	Compliance with standards and maintenance requirements	No	Requirements are specified in subpart IIII.
§60.12	Circumvention	Yes	
§60.13	Monitoring requirements	Yes	Except that §60.13 only applies to stationary CI ICE with a displacement of (≥30 liters per cylinder.
§60.14	Modification	Yes	
§60.15	Reconstruction	Yes	
§60.16	Priority list	Yes	
§60.17	Incorporations by reference	Yes	
§60.18	General control device requirements	No	
§60.19	General notification and reporting requirements	Yes	

The applicable General Provisions are highlighted in Table 8.

NESHAP, Subpart CCCCCC – National Emission Standards for Hazardous Air Pollutants for Source Category: Gasoline Dispensing Facilities

PRI00000350

REC 1690

ELECTRONIC CODE OF FEDERAL REGULATIONS

e-CFR data is current as of January 18, 2019

Title 40 → Chapter I → Subchapter C → Part 63 → Subpart CCCCCC

Title 40: Protection of Environment
PART 63—NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLUTANTS FOR SOURCE CATEGORIES (CONTINUED)

Subpart CCCCCC—National Emission Standards for Hazardous Air Pollutants for Source Category: Gasoline Dispensing Facilities

Contents

WHAT THIS SUBPART COVERS

§63.11110 What is the purpose of this subpart?
§63.11111 Am I subject to the requirements in this subpart?
§63.11112 What parts of my affected source does this subpart cover?
§63.11113 When do I have to comply with this subpart?

EMISSION LIMITATIONS AND MANAGEMENT PRACTICES

§63.11115 What are my general duties to minimize emissions?
§63.11116 Requirements for facilities with monthly throughput of less than 10,000 gallons of gasoline.
§63.11117 Requirements for facilities with monthly throughput of 10,000 gallons of gasoline or more.
§63.11118 Requirements for facilities with monthly throughput of 100,000 gallons of gasoline or more.

TESTING AND MONITORING REQUIREMENTS

§63.11120 What testing and monitoring requirements must I meet?

NOTIFICATIONS, RECORDS, AND REPORTS

§63.11124 What notifications must I submit and when?
§63.11125 What are my recordkeeping requirements?
§63.11126 What are my reporting requirements?

OTHER REQUIREMENTS AND INFORMATION

§63.11130 What parts of the General Provisions apply to me?
§63.11131 Who implements and enforces this subpart?
§63.11132 What definitions apply to this subpart?
Table 1 to Subpart CCCCCC of Part 63—Applicability Criteria and Management Practices for Gasoline Dispensing Facilities With Monthly Throughput of 100,000 Gallons of Gasoline or More
Table 2 to Subpart CCCCCC of Part 63—Applicability Criteria and Management Practices for Gasoline Cargo Tanks Unloading at Gasoline Dispensing Facilities With Monthly Throughput of 100,000 Gallons of Gasoline or More
Table 3 to Subpart CCCCCC of Part 63—Applicability of General Provisions

SOURCE: 73 FR 1945, Jan. 10, 2008, unless otherwise noted.

Back to Top

WHAT THIS SUBPART COVERS

§63.11110 What is the purpose of this subpart?

This subpart establishes national emission limitations and management practices for hazardous air pollutants (HAP) emitted from the loading of gasoline storage tanks at gasoline dispensing facilities (GDF). This subpart also establishes requirements to demonstrate compliance with the emission limitations and management practices.

§63.11111 Am I subject to the requirements in this subpart?

(a) The affected source to which this subpart applies is each GDF that is located at an area source. The affected source includes each gasoline cargo tank during the delivery of product to a GDF and also includes each storage tank.

~~(b) If your GDF has a monthly throughput of less than 10,000 gallons of gasoline, you must comply with the requirements in §63.11116.~~

(c) If your GDF has a monthly throughput of 10,000 gallons of gasoline or more, you must comply with the requirements in §63.11117.

~~(d) If your GDF has a monthly throughput of 100,000 gallons of gasoline or more, you must comply with the requirements in §63.11118.~~

(e) An affected source shall, upon request by the Administrator, demonstrate that their monthly throughput is less than ~~the 10,000-gallon or~~ the 100,000-gallon threshold level, as applicable. For new ~~or reconstructed~~ affected sources, as specified in §63.11112(b) ~~and (c),~~ recordkeeping to document monthly throughput must begin upon startup of the affected source. ~~For existing sources, as specified in §63.11112(d), recordkeeping to document monthly throughput must begin on January 10, 2008. For existing sources that are subject to this subpart only because they load gasoline into fuel tanks other than those in motor vehicles, as defined in §63.11132, recordkeeping to document monthly throughput must begin on January 24, 2011.~~ Records required under this paragraph shall be kept for a period of 5 years.

(f) If you are an owner or operator of affected sources, as defined in paragraph (a) of this section, you are not required to obtain a permit under 40 CFR part 70 ~~or 40 CFR part 71~~ as a result of being subject to this subpart. However, you must still apply for and obtain a permit under 40 CFR part 70 ~~or 40 CFR part 71~~ if you meet one or more of the applicability criteria found in 40 CFR 70.3(a) and (b) ~~or 40 CFR 71.3(a) and (b).~~

~~(g) The loading of aviation gasoline into storage tanks at airports, and the subsequent transfer of aviation gasoline within the airport, is not subject to this subpart.~~

(h) Monthly throughput is the total volume of gasoline loaded into, or dispensed from, all the gasoline storage tanks located at a single affected GDF. If an area source has two or more GDF at separate locations within the area source, each GDF is treated as a separate affected source.

(i) If your affected source's throughput ever exceeds an applicable throughput threshold, the affected source will remain subject to the requirements for sources above the threshold, even if the affected source throughput later falls below the applicable throughput threshold.

(j) The dispensing of gasoline from a fixed gasoline storage tank at a GDF into a portable gasoline tank for the on-site delivery and subsequent dispensing of the gasoline into the fuel tank of a motor vehicle or other gasoline-fueled engine or equipment used within the area source is only subject to §63.11116 of this subpart.

(k) For any affected source subject to the provisions of this subpart and another Federal rule, you may elect to comply only with the more stringent provisions of the applicable subparts. You must consider all provisions of the rules, including monitoring, recordkeeping, and reporting. You must identify the affected source and provisions with which you will comply in your Notification of Compliance Status required under §63.11124. You also must demonstrate in your Notification of Compliance Status that each provision with which you will comply is at least as stringent as the otherwise applicable requirements in this subpart. You are responsible for making accurate determinations concerning the more stringent provisions, and noncompliance with this rule is not excused if it is later determined that your determination was in error, and, as a result, you are violating this subpart. Compliance with this rule is your responsibility and the Notification of Compliance Status does not alter or affect that responsibility.

[73 FR 1945, Jan. 10, 2008, as amended at 76 FR 4181, Jan. 24, 2011]

Per §63.11111(a), Midas Gold will be subject to this subpart as they are proposing to operate two Gasoline Dispensing Facilities (GDF) located at the Stibnite Gold Project, which will be an area source. Each GDF will be an affected source subject to this subpart. It is proposed that the Stibnite Gold Project will have two GDFs, each with a monthly throughput of greater than 10,000 gallons of gasoline but less than 100,000 gallons of gasoline and must comply with the requirements in §63.11117 per §63.11111(c). Based on the monthly throughput, §63.11111(b) and (d) will not apply. Midas Gold will be required to demonstrate that the monthly throughput of each GDF is less than the 100,000-gallon threshold level by recording monthly throughput upon startup and keeping records for a period of 5 years per §63.11111(e). Per §63.11111(f) Midas Gold will not be required to obtain a permit under 40 CFR part 70 (i.e., Title V permit) as a result of being subject to this subpart.

§63.11111(g) will not apply as Midas Gold will not load or transfer aviation gasoline.

§63.11111(h) - (k) will apply to Midas Gold as informative requirements.

§63.11112 What parts of my affected source does this subpart cover?

(a) The emission sources to which this subpart applies are gasoline storage tanks and associated equipment components in vapor or liquid gasoline service at new, ~~reconstructed, or existing~~ GDF that meet the criteria specified in §63.11111. Pressure/Vacuum vents on gasoline storage tanks and the equipment necessary to unload product from cargo tanks into the storage tanks at GDF are covered emission sources. The equipment used for the refueling of motor vehicles is not covered by this subpart.

(b) An affected source is a new affected source if you commenced construction on the affected source after November 9, 2006, and you meet the applicability criteria in §63.11111 at the time you commenced operation.

~~(c) An affected source is reconstructed if you meet the criteria for reconstruction as defined in §63.2.~~

~~(d) An affected source is an existing affected source if it is not new or reconstructed.~~

§63.11112(a) will apply to the two Stibnite Gold Project affected sources.
§63.11112(b) will apply to the two Stibnite Gold Project affected sources as construction will commence after November 9, 2006.
§63.11112(c) will not apply because the two Stibnite Gold Project affected sources will not be reconstructed.
§63.11112(d) will not apply because the two Stibnite Gold Project affected sources are not existing.

§63.11113 When do I have to comply with this subpart?

(a) If you have a new ~~or reconstructed~~ affected source, you must comply with this subpart according to paragraphs (a)~~(1) and~~ (2) of this section, ~~except as specified in paragraph (d) of this section.~~

~~(1) If you start up your affected source before January 10, 2008, you must comply with the standards in this subpart no later than January 10, 2008.~~

(2) If you start up your affected source after January 10, 2008, you must comply with the standards in this subpart upon startup of your affected source.

~~(b) If you have an existing affected source, you must comply with the standards in this subpart no later than January 10, 2011.~~

~~(c) If you have an existing affected source that becomes subject to the control requirements in this subpart because of an increase in the monthly throughput, as specified in §63.11111(c) or §63.11111(d), you must comply with the standards in this subpart no later than 3 years after the affected source becomes subject to the control requirements in this subpart.~~

~~(d) If you have a new or reconstructed affected source and you are complying with Table 1 to this subpart, you must comply according to paragraphs (d)(1) and (2) of this section.~~

~~(1) If you start up your affected source from November 9, 2006 to September 23, 2008, you must comply no later than September 23, 2008.~~

~~(2) If you start up your affected source after September 23, 2008, you must comply upon startup of your affected source.~~

~~(e) The initial compliance demonstration test required under §63.11120(a)(1) and (2) must be conducted as specified in paragraphs (e)(1) and (2) of this section.~~

~~(1) If you have a new or reconstructed affected source, you must conduct the initial compliance test upon installation of the complete vapor balance system.~~

~~(2) If you have an existing affected source, you must conduct the initial compliance test as specified in paragraphs (e)(2)(i) or (e)(2)(ii) of this section.~~

~~(i) For vapor balance systems installed on or before December 15, 2009, you must test no later than 180 days after the applicable compliance date specified in paragraphs (b) or (c) of this section.~~

~~(ii) For vapor balance systems installed after December 15, 2009, you must test upon installation of the complete vapor balance system.~~

~~(f) If your GDF is subject to the control requirements in this subpart only because it loads gasoline into fuel tanks other than those in motor vehicles, as defined in §63.11132, you must comply with the standards in this subpart as specified in paragraphs (f)(1) or (f)(2) of this section.~~

~~(1) If your GDF is an existing facility, you must comply by January 24, 2014.~~

~~(2) If your GDF is a new or reconstructed facility, you must comply by the dates specified in paragraphs (f)(2)(i) and (ii) of this section.~~

~~(i) If you start up your GDF after December 15, 2009, but before January 24, 2011, you must comply no later than January 24, 2011.~~

~~(ii) If you start up your GDF after January 24, 2011, you must comply upon startup of your GDF.~~

[73 FR 1945, Jan. 10, 2008, as amended at 73 FR 35944, June 25, 2008; 76 FR 4181, Jan. 24, 2011]

§63.11113(a)(2) will apply because the two Stibnite Gold Project GDFs will start up after January 10, 2008, and Midas Gold will be required to comply with the standards in this subpart upon startup of the affected sources.

§63.11113(b) and (c) will not apply because the two Stibnite Gold Project GDFs are not existing.

§63.11113(d) will not apply because the two Stibnite Gold Project GDFs are not proposing to have a monthly throughput of 100,000 gallons of gasoline or more and are therefore not subject to the requirements in Table 1.

§63.11113(e) will not apply to the two Stibnite Gold Project GDFs, as they will not be required to install a vapor balance system as they are not proposing to have a monthly throughput of 100,000 gallons of gasoline or more.

§63.11113(f) will not apply because the two Stibnite Gold Project GDFs will load gasoline into fuel tanks in motor vehicles.

Emission Limitations and Management Practices

§63.11115 What are my general duties to minimize emissions?

Each owner or operator of an affected source under this subpart must comply with the requirements of paragraphs (a) and (b) of this section.

(a) You must, at all times, operate and maintain any affected source, including associated air pollution control equipment and monitoring equipment, in a manner consistent with safety and good air pollution control practices for minimizing emissions. Determination of whether such operation and maintenance procedures are being used will be based on information available to the Administrator which may include, but is not limited to, monitoring results, review of operation and maintenance procedures, review of operation and maintenance records, and inspection of the source.

(b) You must keep applicable records and submit reports as specified in §63.11125(d) and §63.11126(b).

[76 FR 4182, Jan. 24, 2011]

§63.11115(a) and (b) will apply to Midas Gold. Midas Gold will be required to operate and maintain each GDF in a manner consistent with safety and good air pollution control practices to minimize emissions. They will also be required to keep applicable records and submit specified reports for each GDF.

~~§63.11116 Requirements for facilities with monthly throughput of less than 10,000 gallons of gasoline.~~

(a) You must not allow gasoline to be handled in a manner that would result in vapor releases to the atmosphere for extended periods of time. Measures to be taken include, but are not limited to, the following:

(1) Minimize gasoline spills;

(2) Clean up spills as expeditiously as practicable;

(3) Cover all open gasoline containers and all gasoline storage tank fill-pipes with a gasketed seal when not in use;

(4) Minimize gasoline sent to open waste collection systems that collect and transport gasoline to reclamation and recycling devices, such as oil/water separators.

~~(b) You are not required to submit notifications or reports as specified in §63.11125, §63.11126, or subpart A of this part, but you must have records available within 24 hours of a request by the Administrator to document your gasoline throughput.~~

~~(c) You must comply with the requirements of this subpart by the applicable dates specified in §63.11113.~~

~~(d) Portable gasoline containers that meet the requirements of 40 CFR part 59, subpart F, are considered acceptable for compliance with paragraph (a)(3) of this section.~~

[73 FR 1945, Jan. 10, 2008, as amended at 76 FR 4182, Jan. 24, 2011]

§63.11116(a) will apply to the two Stibnite Gold Project GDFs per §63.11117(a) below.

§63.11117 Requirements for facilities with monthly throughput of 10,000 gallons of gasoline or more.

(a) You must comply with the requirements in section §63.11116(a).

(b) ~~Except as specified in paragraph (c) of this section~~, you must only load gasoline into storage tanks at your facility by utilizing submerged filling, as defined in §63.11132, and as specified in paragraphs ~~(b)(1),~~ (b)(2), or (b)(3) of this section. The applicable distances in paragraphs (b)(1) and (2) shall be measured from the point in the opening of the submerged fill pipe that is the greatest distance from the bottom of the storage tank.

~~(1) Submerged fill pipes installed on or before November 9, 2006, must be no more than 12 inches from the bottom of the tank.~~

(2) Submerged fill pipes installed after November 9, 2006, must be no more than 6 inches from the bottom of the tank.

(3) Submerged fill pipes not meeting the specifications of paragraphs ~~(b)(1) or~~ (b)(2) of this section are allowed if the owner or operator can demonstrate that the liquid level in the tank is always above the entire opening of the fill pipe. Documentation providing such demonstration must be made available for inspection by the Administrator's delegated representative during the course of a site visit.

~~(c) Gasoline storage tanks with a capacity of less than 250 gallons are not required to comply with the submerged fill requirements in paragraph (b) of this section, but must comply only with all of the requirements in §63.11116.~~

(d) You must have records available within 24 hours of a request by the Administrator to document your gasoline throughput.

(e) You must submit the applicable notifications as required under §63.11124(a).

(f) You must comply with the requirements of this subpart by the applicable dates contained in §63.11113.

[73 FR 1945, Jan. 10, 2008, as amended at 73 FR 12276, Mar. 7, 2008; 76 FR 4182, Jan. 24, 2011]

The highlighted portions of §63.11117 will apply to the two Stibnite Gold Project GDFs as they are proposing to have a monthly throughput of 10,000 gallons or more.

~~**§63.11118 Requirements for facilities with monthly throughput of 100,000 gallons of gasoline or more.**~~

~~(a) You must comply with the requirements in §§63.11116(a) and 63.11117(b).~~

~~(b) Except as provided in paragraph (c) of this section, you must meet the requirements in either paragraph (b)(1) or paragraph (b)(2) of this section.~~

~~(1) Each management practice in Table 1 to this subpart that applies to your GDF.~~

~~(2) If, prior to January 10, 2008, you satisfy the requirements in both paragraphs (b)(2)(i) and (ii) of this section, you will be deemed in compliance with this subsection.~~

~~(i) You operate a vapor balance system at your GDF that meets the requirements of either paragraph (b)(2)(i)(A) or paragraph (b)(2)(i)(B) of this section.~~

~~(A) Achieves emissions reduction of at least 90 percent.~~

~~(B) Operates using management practices at least as stringent as those in Table 1 to this subpart.~~

~~(ii) Your gasoline dispensing facility is in compliance with an enforceable State, local, or tribal rule or permit that contains requirements of either paragraph (b)(2)(i)(A) or paragraph (b)(2)(i)(B) of this section.~~

~~(c) The emission sources listed in paragraphs (c)(1) through (3) of this section are not required to comply with the control requirements in paragraph (b) of this section, but must comply with the requirements in §63.11117.~~

~~(1) Gasoline storage tanks with a capacity of less than 250 gallons that are constructed after January 10, 2008.~~

~~(2) Gasoline storage tanks with a capacity of less than 2,000 gallons that were constructed before January 10, 2008.~~

~~(3) Gasoline storage tanks equipped with floating roofs, or the equivalent.~~

(d) Cargo tanks unloading at GDF must comply with the management practices in Table 2 to this subpart.

(e) You must comply with the applicable testing requirements contained in §63.11120.

(f) You must submit the applicable notifications as required under §63.11124.

(g) You must keep records and submit reports as specified in §63.11125 and §63.11126.

(h) You must comply with the requirements of this subpart by the applicable dates contained in §63.11113.

[73 FR 1945, Jan. 10, 2008, as amended at 73 FR 12276, Mar. 7, 2008]

§63.11118 will not apply because Midas Gold is not proposing to operate a GDF with a monthly throughput of 100,000 gallons of gasoline or more.

Testing and Monitoring Requirements

§63.11120 What testing and monitoring requirements must I meet?

(a) Each owner or operator, at the time of installation, as specified in §63.11113(e), of a vapor balance system required under §63.11118(b)(1), and every 3 years thereafter, must comply with the requirements in paragraphs (a)(1) and (2) of this section.

(1) You must demonstrate compliance with the leak rate and cracking pressure requirements, specified in item 1(g) of Table 1 to this subpart, for pressure-vacuum vent valves installed on your gasoline storage tanks using the test methods identified in paragraph (a)(1)(i) or paragraph (a)(1)(ii) of this section.

(i) California Air Resources Board Vapor Recovery Test Procedure TP-201.1E, Leak Rate and Cracking Pressure of Pressure/Vacuum Vent Valves, adopted October 8, 2003 (incorporated by reference, see §63.14).

(ii) Use alternative test methods and procedures in accordance with the alternative test method requirements in §63.7(f).

(2) You must demonstrate compliance with the static pressure performance requirement specified in item 1(h) of Table 1 to this subpart for your vapor balance system by conducting a static pressure test on your gasoline storage tanks using the test methods identified in paragraphs (a)(2)(i), (a)(2)(ii), or (a)(2)(iii) of this section.

(i) California Air Resources Board Vapor Recovery Test Procedure TP-201.3, Determination of 2-Inch WC Static Pressure Performance of Vapor Recovery Systems of Dispensing Facilities, adopted April 12, 1996, and amended March 17, 1999 (incorporated by reference, see §63.14).

(ii) Use alternative test methods and procedures in accordance with the alternative test method requirements in §63.7(f).

(iii) Bay Area Air Quality Management District Source Test Procedure ST-30 Static Pressure Integrity Test Underground Storage Tanks, adopted November 30, 1983, and amended December 21, 1994 (incorporated by reference, *see* §63.14).

(b) Each owner or operator choosing, under the provisions of §63.6(g), to use a vapor balance system other than that described in Table 1 to this subpart must demonstrate to the Administrator or delegated authority under paragraph §63.11131(a) of this subpart, the equivalency of their vapor balance system to that described in Table 1 to this subpart using the procedures specified in paragraphs (b)(1) through (3) of this section.

(1) You must demonstrate initial compliance by conducting an initial performance test on the vapor balance system to demonstrate that the vapor balance system achieves 95 percent reduction using the California Air Resources Board Vapor Recovery Test Procedure TP-201.1, Volumetric Efficiency for Phase I Vapor Recovery Systems, adopted April 12, 1996, and amended February 1, 2001, and October 8, 2003, (incorporated by reference, see §63.14).

(2) You must, during the initial performance test required under paragraph (b)(1) of this section, determine and document alternative acceptable values for the leak rate and cracking pressure requirements specified in item 1(g) of Table 1 to this subpart and for the static pressure performance requirement in item 1(h) of Table 1 to this subpart.

(3) You must comply with the testing requirements specified in paragraph (a) of this section.

(c) Conduct of performance tests. Performance tests conducted for this subpart shall be conducted under such conditions as the Administrator specifies to the owner or operator based on representative performance (*i.e.*, performance based on normal operating conditions) of the affected source. Upon request, the owner or operator shall make available to the Administrator such records as may be necessary to determine the conditions of performance tests.

(d) Owners and operators of gasoline cargo tanks subject to the provisions of Table 2 to this subpart must conduct annual certification testing according to the vapor tightness testing requirements found in §63.11092(f).

[73 FR 1945, Jan. 10, 2008, as amended at 76 FR 4182, Jan. 24, 2011]

§63.11120 will not apply because the Stibnite Gold Project GDFs will not be required to install a vapor balance system as they are not proposing to have a monthly throughput of 100,000 gallons of gasoline or more. Therefore, they will not be required to demonstrate compliance with the requirements of §63.11120.

Notifications, Records, and Reports

§63.11124 What notifications must I submit and when?

(a) Each owner or operator subject to the control requirements in §63.11117 must comply with paragraphs (a)(1) through (3) of this section.

(1) You must submit an Initial Notification that you are subject to this subpart ~~by May 9, 2008, or~~ at the time you become subject to the control requirements in §63.11117, ~~unless you meet the requirements in paragraph (a)(3) of this section. If your affected source is subject to the control requirements in §63.11117 only because it loads gasoline into fuel tanks other than those in motor vehicles, as defined in §63.11132, you must submit the Initial Notification by May 24, 2011.~~ The Initial Notification must contain the information specified in paragraphs (a)(1)(i) through (iii) of this section. The notification must be submitted to the applicable EPA Regional Office and delegated State authority as specified in §63.13.

(i) The name and address of the owner and the operator.

(ii) The address (i.e., physical location) of the GDF.

(iii) A statement that the notification is being submitted in response to this subpart and identifying the requirements in paragraphs (a) through (c) of §63.11117 that apply to you.

(2) You must submit a Notification of Compliance Status to the applicable EPA Regional Office and the delegated State authority, as specified in §63.13, within 60 days of the applicable compliance date specified in §63.11113, ~~unless you meet the requirements in paragraph (a)(3) of this section~~. The Notification of Compliance Status must be signed by a responsible official who must certify its accuracy, must indicate whether the source has complied with the requirements of this subpart, and must indicate whether the facilities' monthly throughput is calculated based on the volume of gasoline loaded into all storage tanks or on the volume of gasoline dispensed from all storage tanks. If your facility is in compliance with the requirements of this subpart at the time the Initial Notification required under paragraph (a)(1) of this section is due, the Notification of Compliance Status may be submitted in lieu of the Initial Notification provided it contains the information required under paragraph (a)(1) of this section.

(3) ~~If, prior to January 10, 2008, you are operating in compliance with an enforceable State, local, or tribal rule or permit that requires submerged fill as specified in §63.11117(b), you are not required to submit an Initial Notification or a Notification of Compliance Status under paragraph (a)(1) or paragraph (a)(2) of this section.~~

~~(b) Each owner or operator subject to the control requirements in §63.11118 must comply with paragraphs (b)(1) through (5) of this section.~~

~~(1) You must submit an Initial Notification that you are subject to this subpart by May 9, 2008, or at the time you become subject to the control requirements in §63.11118. If your affected source is subject to the control requirements in §63.11118 only because it loads gasoline into fuel tanks other than those in motor vehicles, as defined in §63.11132, you must submit the Initial Notification by May 24, 2011. The Initial Notification must contain the information specified in paragraphs (b)(1)(i) through (iii) of this section. The notification must be submitted to the applicable EPA Regional Office and delegated State authority as specified in §63.13.~~

~~(i) The name and address of the owner and the operator.~~

~~(ii) The address (i.e., physical location) of the GDF.~~

~~(iii) A statement that the notification is being submitted in response to this subpart and identifying the requirements in paragraphs (a) through (c) of §63.11118 that apply to you.~~

~~(2) You must submit a Notification of Compliance Status to the applicable EPA Regional Office and the delegated State authority, as specified in §63.13, in accordance with the schedule specified in §63.9(h). The Notification of Compliance Status must be signed by a responsible official who must certify its accuracy, must indicate whether the source has complied with the requirements of this subpart, and must indicate whether the facility's throughput is determined based on the volume of gasoline loaded into all storage tanks or on the volume of gasoline dispensed from all storage tanks. If your facility is in compliance with the requirements of this subpart at the time the Initial Notification required under paragraph (b)(1) of this section is due, the Notification of Compliance Status may be submitted in lieu of the Initial Notification provided it contains the information required under paragraph (b)(1) of this section.~~

~~(3) If, prior to January 10, 2008, you satisfy the requirements in both paragraphs (b)(3)(i) and (ii) of this section, you are not required to submit an Initial Notification or a Notification of Compliance Status under paragraph (b)(1) or paragraph (b)(2) of this subsection.~~

~~(i) You operate a vapor balance system at your gasoline dispensing facility that meets the requirements of either paragraphs (b)(3)(i)(A) or (b)(3)(i)(B) of this section.~~

~~(A) Achieves emissions reduction of at least 90 percent.~~

~~(B) Operates using management practices at least as stringent as those in Table 1 to this subpart.~~

~~(ii) Your gasoline dispensing facility is in compliance with an enforceable State, local, or tribal rule or permit that contains requirements of either paragraphs (b)(3)(i)(A) or (b)(3)(i)(B) of this section.~~

~~(4) You must submit a Notification of Performance Test, as specified in §63.9(e), prior to initiating testing required by §63.11120(a) and (b).~~

~~(5) You must submit additional notifications specified in §63.9, as applicable.~~

[73 FR 1945, Jan. 10, 2008, as amended at 73 FR 12276, Mar. 7, 2008; 76 FR 4182, Jan. 24, 2011]

§63.11124(a) will apply as Midas Gold is proposing to operate two GDFs subject to the control requirements in §63.11117. They will be required to submit an Initial Notification upon startup. In addition, they will be required to submit a Notification of Compliance Status within 60 days of startup of each affected source.

§63.11124(b) will not apply as the Stibnite Gold Project GDFs will not be subject to control requirements in §63.11118.

§63.11125 What are my recordkeeping requirements?

~~(a) Each owner or operator subject to the management practices in §63.11118 must keep records of all tests performed under §63.11120(a) and (b).~~

~~(b) Records required under paragraph (a) of this section shall be kept for a period of 5 years and shall be made available for inspection by the Administrator's delegated representatives during the course of a site visit.~~

~~(c) Each owner or operator of a gasoline cargo tank subject to the management practices in Table 2 to this subpart must keep records documenting vapor tightness testing for a period of 5 years. Documentation must include each of the items specified in §63.11094(b)(2)(i) through (viii). Records of vapor tightness testing must be retained as specified in either paragraph (c)(1) or paragraph (c)(2) of this section.~~

~~(1) The owner or operator must keep all vapor tightness testing records with the cargo tank.~~

~~(2) As an alternative to keeping all records with the cargo tank, the owner or operator may comply with the requirements of paragraphs (c)(2)(i) and (ii) of this section.~~

~~(i) The owner or operator may keep records of only the most recent vapor tightness test with the cargo tank, and keep records for the previous 4 years at their office or another central location.~~

~~(ii) Vapor tightness testing records that are kept at a location other than with the cargo tank must be instantly available (*e.g.*, via e-mail or facsimile) to the Administrator's delegated representative during the course of a site visit or within a mutually agreeable time frame. Such records must be an exact duplicate image of the original paper copy record with certifying signatures.~~

(d) Each owner or operator of an affected source under this subpart shall keep records as specified in paragraphs (d)(1) and (2) of this section.

(1) Records of the occurrence and duration of each malfunction of operation (*i.e.*, process equipment) or the air pollution control and monitoring equipment.

(2) Records of actions taken during periods of malfunction to minimize emissions in accordance with §63.11115(a), including corrective actions to restore malfunctioning process and air pollution control and monitoring equipment to its normal or usual manner of operation.

[73 FR 1945, Jan. 10, 2008, as amended at 76 FR 4183, Jan. 24, 2011]

§63.11125(a)-(b) will not apply as the Stibnite Gold Project GDFs will not be subject to the management practices in §63.11118.

§63.11125(c) will not apply as the Stibnite Gold Project GDFs will be not subject to the management practices in Table 2, as they are not

gasoline cargo tanks.

§63.11125(d) will apply to the two Stibnite Gold Project GDFs and Midas Gold will be required to keep records of each malfunction, including occurrence, duration, and actions taken during periods of malfunction to minimize emission, and corrective actions to restore to normal operation.

§63.11126 What are my reporting requirements?

~~(a) Each owner or operator subject to the management practices in §63.11118 shall report to the Administrator the results of all volumetric efficiency tests required under §63.11120(b). Reports submitted under this paragraph must be submitted within 180 days of the completion of the performance testing.~~

(b) Each owner or operator of an affected source under this subpart shall report, by March 15 of each year, the number, duration, and a brief description of each type of malfunction which occurred during the previous calendar year and which caused or may have caused any applicable emission limitation to be exceeded. The report must also include a description of actions taken by an owner or operator during a malfunction of an affected source to minimize emissions in accordance with §63.11115(a), including actions taken to correct a malfunction. No report is necessary for a calendar year in which no malfunctions occurred.

[76 FR 4183, Jan. 24, 2011]

§63.11126(a) will not apply as the Stibnite Gold Project GDFs will not be subject to the management practices in §63.11118.

§63.11126(b) will apply to the two Stibnite Gold Project GDFs and Midas Gold will be required to submit a report by March 15 of each year, if any malfunctions occurred.

Other Requirements and Information

§63.11130 What parts of the General Provisions apply to me?

Table 3 to this subpart shows which parts of the General Provisions apply to you.

See Table 3 of this subpart for the applicable General Provisions to this subpart.

§63.11131 Who implements and enforces this subpart?

(a) This subpart can be implemented and enforced by the U.S. EPA or a delegated authority such as the applicable State, local, or tribal agency. If the U.S. EPA Administrator has delegated authority to a State, local, or tribal agency, then that agency, in addition to the U.S. EPA, has the authority to implement and enforce this subpart. Contact the applicable U.S. EPA Regional Office to find out if implementation and enforcement of this subpart is delegated to a State, local, or tribal agency.

(b) In delegating implementation and enforcement authority of this subpart to a State, local, or tribal agency under subpart E of this part, the authorities contained in paragraph (c) of this section are retained by the Administrator of U.S. EPA and cannot be transferred to the State, local, or tribal agency.

(c) The authorities that cannot be delegated to State, local, or tribal agencies are as specified in paragraphs (c)(1) through (3) of this section.

(1) Approval of alternatives to the requirements in §§63.11116 through 63.11118 and 63.11120.

(2) Approval of major alternatives to test methods under §63.7(e)(2)(ii) and (f), as defined in §63.90, and as required in this subpart.

(3) Approval of major alternatives to recordkeeping and reporting under §63.10(f), as defined in §63.90, and as required in this subpart.

The implementation and enforcement of this subpart per §63.11131 will apply.

§63.11132 What definitions apply to this subpart?

As used in this subpart, all terms not defined herein shall have the meaning given them in the Clean Air Act (CAA), or in subparts A and BBBBBB of this part. For purposes of this subpart, definitions in this section supersede definitions in other parts or subparts.

~~*Dual-point vapor balance system* means a type of vapor balance system in which the storage tank is equipped with an entry port for a gasoline fill pipe and a separate exit port for a vapor connection.~~

Gasoline means any petroleum distillate or petroleum distillate/alcohol blend having a Reid vapor pressure of 27.6 kilopascals or greater, which is used as a fuel for internal combustion engines.

~~*Gasoline cargo tank* means a delivery tank truck or railcar which is loading or unloading gasoline, or which has loaded or unloaded gasoline on the immediately previous load.~~

Gasoline dispensing facility (GDF) means any stationary facility which dispenses gasoline into the fuel tank of a motor vehicle, motor vehicle engine, nonroad vehicle, or nonroad engine, including a nonroad vehicle or nonroad engine used solely for competition. These facilities include, but are not limited to, facilities that dispense gasoline into on- and off-road, street, or highway motor vehicles, lawn equipment, boats, test engines, landscaping equipment, generators, pumps, and other gasoline-fueled engines and equipment.

Monthly throughput means the total volume of gasoline that is loaded into, or dispensed from, all gasoline storage tanks at each GDF during a month. Monthly throughput is calculated by summing the volume of gasoline loaded into, or dispensed from, all gasoline storage tanks at each GDF during the current day, plus the total volume of gasoline loaded into, or dispensed from, all gasoline storage tanks at each GDF during the previous 364 days, and then dividing that sum by 12.

Motor vehicle means any self-propelled vehicle designed for transporting persons or property on a street or highway.

Nonroad engine means an internal combustion engine (including the fuel system) that is not used in a motor vehicle or a vehicle used solely for competition, or that is not subject to standards promulgated under section 7411 of this title or section 7521 of this title.

Nonroad vehicle means a vehicle that is powered by a nonroad engine, and that is not a motor vehicle or a vehicle used solely for competition.

Submerged filling means, for the purposes of this subpart, the filling of a gasoline storage tank through a submerged fill pipe whose discharge is no more than the applicable distance specified in §63.11117(b) from the bottom of the tank. Bottom filling of gasoline storage tanks is included in this definition.

~~*Vapor balance system* means a combination of pipes and hoses that create a closed system between the vapor spaces of an unloading gasoline cargo tank and a receiving storage tank such that vapors displaced from the storage tank are transferred to the gasoline cargo tank being unloaded.~~

~~*Vapor tight* means equipment that allows no loss of vapors. Compliance with vapor tight requirements can be determined by checking to ensure that the concentration at a potential leak source is not equal to or greater than 100 percent of the Lower Explosive Limit when measured with a combustible gas detector, calibrated with propane, at a distance of 1 inch from the source.~~

~~*Vapor tight gasoline cargo tank* means a gasoline cargo tank which has demonstrated within the 12 preceding months that it meets the annual certification test requirements in §63.11092(f) of this part.~~

[73 FR 1945, Jan. 10, 2008, as amended at 76 FR 4183, Jan. 24, 2011]

The highlighted definitions in §63.11132 will apply to the Stibnite Gold Project GDFs subject to this subpart.

~~Table 1 to Subpart CCCCCC of Part 63—Applicability Criteria and Management Practices for Gasoline Dispensing Facilities With Monthly Throughput of 100,000 Gallons of Gasoline or More~~[1]

~~If you own or operate~~	~~Then you must~~
~~1. A new, reconstructed, or existing GDF subject to §63.11118~~	~~Install and operate a vapor balance system on your gasoline storage tanks that meets the design criteria in paragraphs (a) through (h).~~
	~~(a) All vapor connections and lines on the storage tank shall be equipped with closures that seal upon disconnect.~~
	~~(b) The vapor line from the gasoline storage tank to the gasoline cargo tank shall be vapor-tight, as defined in §63.11132.~~
	~~(c) The vapor balance system shall be designed such that the pressure in the tank truck does not exceed 18 inches water pressure or 5.9 inches water vacuum during product transfer.~~
	~~(d) The vapor recovery and product adaptors, and the method of connection with the delivery elbow, shall be designed so as to prevent the over-tightening or loosening of fittings during normal delivery operations.~~
	~~(e) If a gauge well separate from the fill tube is used, it shall be provided with a submerged drop tube that extends the same distance from the bottom of the storage tank as specified in §63.11117(b).~~
	~~(f) Liquid fill connections for all systems shall be equipped with vapor-tight caps.~~
	~~(g) Pressure/vacuum (PV) vent valves shall be installed on the storage tank vent pipes. The pressure specifications for PV vent valves shall be: a positive pressure setting of 2.5 to 6.0 inches of water and a negative pressure setting of 6.0 to 10.0 inches of water. The total leak rate of all PV vent valves at an affected facility, including connections, shall not exceed 0.17 cubic foot per hour at a pressure of 2.0 inches of water and 0.63 cubic foot per hour at a vacuum of 4 inches of water.~~
	~~(h) The vapor balance system shall be capable of meeting the static pressure performance requirement of the following equation:~~
	~~$Pf = 2e^{-500.887/v}$~~
	~~Where:~~
	~~Pf = Minimum allowable final pressure, inches of water.~~

	v = Total ullage affected by the test, gallons.
	e = Dimensionless constant equal to approximately 2.718.
	2 = The initial pressure, inches water.
2. A new or reconstructed GDF, or any storage tank(s) constructed after November 9, 2006, at an existing affected facility subject to §63.11118	Equip your gasoline storage tanks with a dual-point vapor balance system, as defined in §63.11132, and comply with the requirements of item 1 in this Table.

[1]The management practices specified in this Table are not applicable if you are complying with the requirements in §63.11118(b)(2), except that if you are complying with the requirements in §63.11118(b)(2)(i)(B), you must operate using management practices at least as stringent as those listed in this Table.

[73 FR 1945, Jan. 10, 2008, as amended at 73 FR 35944, June 25, 2008; 76 FR 4184, Jan. 24, 2011]

Table 1 will not apply as Midas Gold is not proposing to operate a GDF with a monthly throughput of 100,000 gallons of gasoline or more.

Table 2 to Subpart CCCCCC of Part 63—Applicability Criteria and Management Practices for Gasoline Cargo Tanks Unloading at Gasoline Dispensing Facilities With Monthly Throughput of 100,000 Gallons of Gasoline or More

If you own or operate	Then you must
A gasoline cargo tank	Not unload gasoline into a storage tank at a GDF subject to the control requirements in this subpart unless the following conditions are met:
	(i) All hoses in the vapor balance system are properly connected,
	(ii) The adapters or couplers that attach to the vapor line on the storage tank have closures that seal upon disconnect,
	(iii) All vapor return hoses, couplers, and adapters used in the gasoline delivery are vapor-tight,
	(iv) All tank truck vapor return equipment is compatible in size and forms a vapor-tight connection with the vapor balance equipment on the GDF storage tank, and
	(v) All hatches on the tank truck are closed and securely fastened.
	(vi) The filling of storage tanks at GDF shall be limited to unloading from vapor-tight gasoline cargo tanks. Documentation that the cargo tank has met the specifications of EPA Method 27 shall be carried with the cargo tank, as specified in §63.11125(c).

[73 FR 1945, Jan. 10, 2008, as amended at 76 FR 4184, Jan. 24, 2011]

Table 2 will not apply as Midas Gold is not proposing to operate a gasoline cargo tank at a GDF with a monthly throughput of 100,000 gallons of gasoline or more.

Table 3 to Subpart CCCCCC of Part 63—Applicability of General Provisions

Citation	Subject	Brief description	Applies to subpart CCCCCC
§63.1	Applicability	Initial applicability determination; applicability after standard established; permit requirements; extensions, notifications	Yes, specific requirements given in §63.11111.
§63.1(c)(2)	Title V Permit	Requirements for obtaining a title V permit from the applicable permitting authority	Yes, §63.11111(f) of subpart CCCCCC exempts identified area sources from the obligation to obtain title V operating permits.
§63.2	Definitions	Definitions for part 63 standards	Yes, additional definitions in §63.11132.
§63.3	Units and Abbreviations	Units and abbreviations for part 63 standards	Yes.
§63.4	Prohibited Activities and Circumvention	Prohibited activities; Circumvention, severability	Yes.
§63.5	Construction/Reconstruction	Applicability; applications; approvals	Yes, except that these notifications are not required for facilities subject to §63.11116
§63.6(a)	Compliance with Standards/Operation & Maintenance—Applicability	General Provisions apply unless compliance extension; General Provisions apply to area sources that become major	Yes.
§63.6(b)(1)-(4)	Compliance Dates for New and Reconstructed Sources	Standards apply at effective date; 3 years after effective date; upon startup; 10 years after construction or reconstruction commences for CAA section 112(f)	Yes.
§63.6(b)(5)	Notification	Must notify if commenced construction or reconstruction after proposal	Yes.
§63.6(b)(6)	[Reserved]		
§63.6(b)(7)	Compliance Dates for New and Reconstructed Area Sources That Become Major	Area sources that become major must comply with major source standards immediately upon becoming major, regardless of whether required to comply when they were an area source	No.
§63.6(c)(1)-(2)	Compliance Dates for Existing Sources	Comply according to date in this subpart, which must be no later than 3 years after effective date; for CAA section 112(f) standards, comply within 90 days of effective date unless compliance extension	No, §63.11113 specifies the compliance dates.
§63.6(c)(3)-(4)	[Reserved]		

§63.6(c)(5)	Compliance Dates for Existing Area Sources That Become Major	Area sources That become major must comply with major source standards by date indicated in this subpart or by equivalent time period (e.g., 3 years)	No.
§63.6(d)	[Reserved]		
63.6(e)(1)(i)	General duty to minimize emissions	Operate to minimize emissions at all times; information Administrator will use to determine if operation and maintenance requirements were met.	No. *See* §63.11115 for general duty requirement.
63.6(e)(1)(ii)	Requirement to correct malfunctions ASAP	Owner or operator must correct malfunctions as soon as possible.	No.
§63.6(e)(2)	[Reserved]		
§63.6(e)(3)	Startup, Shutdown, and Malfunction (SSM) Plan	Requirement for SSM plan; content of SSM plan; actions during SSM	No.
§63.6(f)(1)	Compliance Except During SSM	You must comply with emission standards at all times except during SSM	No.
§63.6(f)(2)-(3)	Methods for Determining Compliance	Compliance based on performance test, operation and maintenance plans, records, inspection	Yes.
§63.6(g)(1)-(3)	Alternative Standard	Procedures for getting an alternative standard	Yes.
§63.6(h)(1)	Compliance with Opacity/Visible Emission (VE) Standards	You must comply with opacity/VE standards at all times except during SSM	No.
§63.6(h)(2)(i)	Determining Compliance with Opacity/VE Standards	If standard does not State test method, use EPA Method 9 for opacity in appendix A of part 60 of this chapter and EPA Method 22 for VE in appendix A of part 60 of this chapter	No.
§63.6(h)(2)(ii)	[Reserved]		
§63.6(h)(2)(iii)	Using Previous Tests To Demonstrate Compliance With Opacity/VE Standards	Criteria for when previous opacity/VE testing can be used to show compliance with this subpart	No.
§63.6(h)(3)	[Reserved]		
§63.6(h)(4)	Notification of Opacity/VE Observation Date	Must notify Administrator of anticipated date of observation	No.
§63.6(h)(5)(i), (iii)-(v)	Conducting Opacity/VE Observations	Dates and schedule for conducting opacity/VE observations	No.
§63.6(h)(5)(ii)	Opacity Test Duration and Averaging Times	Must have at least 3 hours of observation with 30 6-minute averages	No.
§63.6(h)(6)	Records of Conditions During Opacity/VE Observations	Must keep records available and allow Administrator to inspect	No.
§63.6(h)(7)(i)	Report Continuous Opacity Monitoring System (COMS) Monitoring Data From Performance Test	Must submit COMS data with other performance test data	No.
§63.6(h)(7)(ii)	Using COMS Instead of EPA Method 9	Can submit COMS data instead of EPA Method 9 results even if rule requires EPA Method 9 in appendix A of part 60 of this chapter, but must notify Administrator before performance test	No.
§63.6(h)(7)(iii)	Averaging Time for COMS During Performance Test	To determine compliance, must reduce COMS data to 6-minute averages	No.
§63.6(h)(7)(iv)	COMS Requirements	Owner/operator must demonstrate that COMS performance evaluations are conducted according to §63.8(e); COMS are properly maintained and operated according to §63.8(c) and data quality as §63.8(d)	No.
§63.6(h)(7)(v)	Determining Compliance with Opacity/VE Standards	COMS is probable but not conclusive evidence of compliance with opacity standard, even if EPA Method 9 observation shows otherwise. Requirements for COMS to be probable evidence-proper maintenance, meeting Performance Specification 1 in appendix B of part 60 of this chapter, and data have not been altered	No.
§63.6(h)(8)	Determining Compliance with Opacity/VE Standards	Administrator will use all COMS, EPA Method 9 (in appendix A of part 60 of this chapter), and EPA Method 22 (in appendix A of part 60 of this chapter) results, as well as information about operation and maintenance to determine compliance	No.
§63.6(h)(9)	Adjusted Opacity Standard	Procedures for Administrator to adjust an opacity standard	No.
§63.6(i)(1)-(14)	Compliance Extension	Procedures and criteria for Administrator to grant compliance extension	Yes.
§63.6(j)	Presidential Compliance Exemption	President may exempt any source from requirement to comply with this subpart	Yes.
§63.7(a)(2)	Performance Test Dates	Dates for conducting initial performance testing; must conduct 180 days after compliance date	Yes.
§63.7(a)(3)	CAA Section 114 Authority	Administrator may require a performance test under CAA section 114 at any time	Yes.
§63.7(b)(1)	Notification of Performance Test	Must notify Administrator 60 days before the test	Yes.
§63.7(b)(2)	Notification of Re-scheduling	If have to reschedule performance test, must notify Administrator of rescheduled date as soon as practicable and without delay	Yes.
§63.7(c)	Quality Assurance (QA)/Test Plan	Requirement to submit site-specific test plan 60 days before the test or on date Administrator agrees with; test plan approval procedures; performance audit requirements; internal and external QA procedures for testing	Yes.
§63.7(d)	Testing Facilities	Requirements for testing facilities	Yes.
63.7(e)(1)	Conditions for Conducting Performance Tests	Performance test must be conducted under representative conditions	No, §63.11120(c) specifies conditions for conducting performance tests.

§63.7(e)(2)	Conditions for Conducting Performance Tests	Must conduct according to this subpart and EPA test methods unless Administrator approves alternative	Yes.
§63.7(e)(3)	Test Run Duration	Must have three test runs of at least 1 hour each; compliance is based on arithmetic mean of three runs; conditions when data from an additional test run can be used	Yes.
§63.7(f)	Alternative Test Method	Procedures by which Administrator can grant approval to use an intermediate or major change, or alternative to a test method	Yes.
§63.7(g)	Performance Test Data Analysis	Must include raw data in performance test report; must submit performance test data 60 days after end of test with the Notification of Compliance Status; keep data for 5 years	Yes.
§63.7(h)	Waiver of Tests	Procedures for Administrator to waive performance test	Yes.
§63.8(a)(1)	Applicability of Monitoring Requirements	Subject to all monitoring requirements in standard	Yes.
§63.8(a)(2)	Performance Specifications	Performance Specifications in appendix B of 40 CFR part 60 apply	Yes.
§63.8(a)(3)	[Reserved]		
§63.8(a)(4)	Monitoring of Flares	Monitoring requirements for flares in §63.11 apply	Yes.
§63.8(b)(1)	Monitoring	Must conduct monitoring according to standard unless Administrator approves alternative	Yes.
§63.8(b)(2)-(3)	Multiple Effluents and Multiple Monitoring Systems	Specific requirements for installing monitoring systems; must install on each affected source or after combined with another affected source before it is released to the atmosphere provided the monitoring is sufficient to demonstrate compliance with the standard; if more than one monitoring system on an emission point, must report all monitoring system results, unless one monitoring system is a backup	No.
§63.8(c)(1)	Monitoring System Operation and Maintenance	Maintain monitoring system in a manner consistent with good air pollution control practices	No.
§63.8(c)(1)(i)-(iii)	Operation and Maintenance of Continuous Monitoring Systems (CMS)	Must maintain and operate each CMS as specified in §63.6(e)(1); must keep parts for routine repairs readily available; must develop a written SSM plan for CMS, as specified in §63.6(e)(3)	No.
§63.8(c)(2)-(8)	CMS Requirements	Must install to get representative emission or parameter measurements; must verify operational status before or at performance test	No.
§63.8(d)	CMS Quality Control	Requirements for CMS quality control, including calibration, etc.; must keep quality control plan on record for 5 years; keep old versions for 5 years after revisions	No.
§63.8(e)	CMS Performance Evaluation	Notification, performance evaluation test plan, reports	No.
§63.8(f)(1)-(5)	Alternative Monitoring Method	Procedures for Administrator to approve alternative monitoring	No.
§63.8(f)(6)	Alternative to Relative Accuracy Test	Procedures for Administrator to approve alternative relative accuracy tests for continuous emissions monitoring system (CEMS)	No.
§63.8(g)	Data Reduction	COMS 6-minute averages calculated over at least 36 evenly spaced data points; CEMS 1 hour averages computed over at least 4 equally spaced data points; data that cannot be used in average	No.
§63.9(a)	Notification Requirements	Applicability and State delegation	Yes.
§63.9(b)(1)-(2), (4)-(5)	Initial Notifications	Submit notification within 120 days after effective date; notification of intent to construct/reconstruct, notification of commencement of construction/reconstruction, notification of startup; contents of each	Yes.
§63.9(c)	Request for Compliance Extension	Can request if cannot comply by date or if installed best available control technology or lowest achievable emission rate	Yes.
§63.9(d)	Notification of Special Compliance Requirements for New Sources	For sources that commence construction between proposal and promulgation and want to comply 3 years after effective date	Yes.
§63.9(e)	Notification of Performance Test	Notify Administrator 60 days prior	Yes.
§63.9(f)	Notification of VE/Opacity Test	Notify Administrator 30 days prior	No.
§63.9(g)	Additional Notifications when Using CMS	Notification of performance evaluation; notification about use of COMS data; notification that exceeded criterion for relative accuracy alternative	Yes, however, there are no opacity standards.
§63.9(h)(1)-(6)	Notification of Compliance Status	Contents due 60 days after end of performance test or other compliance demonstration, except for opacity/VE, which are due 30 days after; when to submit to Federal vs. State authority	Yes, however, there are no opacity standards.
§63.9(i)	Adjustment of Submittal Deadlines	Procedures for Administrator to approve change when notifications must be submitted	Yes.
§63.9(j)	Change in Previous Information	Must submit within 15 days after the change	Yes.
§63.10(a)	Recordkeeping/Reporting	Applies to all, unless compliance extension; when to submit to Federal vs. State authority; procedures for owners of more than one source	Yes.
§63.10(b)(1)	Recordkeeping/Reporting	General requirements; keep all records readily available; keep for 5 years	Yes.
§63.10(b)(2)(i)	Records related to SSM	Recordkeeping of occurrence and duration of startups and shutdowns	No.
§63.10(b)(2)(ii)	Records related to SSM	Recordkeeping of malfunctions	No. *See* §63.11125(d) for recordkeeping of (1) occurrence and duration and (2) actions taken during malfunction.
§63.10(b)(2)(iii)	Maintenance records	Recordkeeping of maintenance on air pollution control and monitoring equipment	Yes.
§63.10(b)(2)(iv)	Records Related to SSM	Actions taken to minimize emissions during SSM	No.
§63.10(b)(2)(v)	Records Related to SSM	Actions taken to minimize emissions during SSM	No.

§63.10(b)(2)(vi)-(xi)	CMS Records	Malfunctions, inoperative, out-of-control periods	No.
§63.10(b)(2)(xii)	Records	Records when under waiver	Yes.
§63.10(b)(2)(xiii)	Records	Records when using alternative to relative accuracy test	Yes.
§63.10(b)(2)(xiv)	Records	All documentation supporting Initial Notification and Notification of Compliance Status	Yes.
§63.10(b)(3)	Records	Applicability determinations	Yes.
§63.10(c)	Records	Additional records for CMS	No.
§63.10(d)(1)	General Reporting Requirements	Requirement to report	Yes.
§63.10(d)(2)	Report of Performance Test Results	When to submit to Federal or State authority	Yes.
§63.10(d)(3)	Reporting Opacity or VE Observations	What to report and when	No.
§63.10(d)(4)	Progress Reports	Must submit progress reports on schedule if under compliance extension	Yes.
§63.10(d)(5)	SSM Reports	Contents and submission	No. *See* §63.11126(b) for malfunction reporting requirements.
§63.10(e)(1)-(2)	Additional CMS Reports	Must report results for each CEMS on a unit; written copy of CMS performance evaluation; two-three copies of COMS performance evaluation	No.
§63.10(e)(3)(i)-(iii)	Reports	Schedule for reporting excess emissions	No.
§63.10(e)(3)(iv)-(v)	Excess Emissions Reports	Requirement to revert to quarterly submission if there is an excess emissions and parameter monitor exceedances (now defined as deviations); provision to request semiannual reporting after compliance for 1 year; submit report by 30th day following end of quarter or calendar half; if there has not been an exceedance or excess emissions (now defined as deviations), report contents in a statement that there have been no deviations; must submit report containing all of the information in §§63.8(c)(7)-(8) and 63.10(c)(5)-(13)	No.
§63.10(e)(3)(iv)-(v)	Excess Emissions Reports	Requirement to revert to quarterly submission if there is an excess emissions and parameter monitor exceedances (now defined as deviations); provision to request semiannual reporting after compliance for 1 year; submit report by 30th day following end of quarter or calendar half; if there has not been an exceedance or excess emissions (now defined as deviations), report contents in a statement that there have been no deviations; must submit report containing all of the information in §§63.8(c)(7)-(8) and 63.10(c)(5)-(13)	No, §63.11130(K) specifies excess emission events for this subpart.
§63.10(e)(3)(vi)-(viii)	Excess Emissions Report and Summary Report	Requirements for reporting excess emissions for CMS; requires all of the information in §§63.10(c)(5)-(13) and 63.8(c)(7)-(8)	No.
§63.10(e)(4)	Reporting COMS Data	Must submit COMS data with performance test data	No.
§63.10(f)	Waiver for Recordkeeping/Reporting	Procedures for Administrator to waive	Yes.
§63.11(b)	Flares	Requirements for flares	No.
§63.12	Delegation	State authority to enforce standards	Yes.
§63.13	Addresses	Addresses where reports, notifications, and requests are sent	Yes.
§63.14	Incorporations by Reference	Test methods incorporated by reference	Yes.
§63.15	Availability of Information	Public and confidential information	Yes.

[73 FR 1945, Jan. 10, 2008, as amended at 76 FR 4184, Jan. 24, 2011]

The applicable General Provisions are highlighted in Table 3.

NESHAP, Subpart EEEEEEE – National Emission Standards for Hazardous Air Pollutants: Gold Mine Ore Processing and Production Area Source Category

PRI00000365

REC 1705

ELECTRONIC CODE OF FEDERAL REGULATIONS

e-CFR data is current as of January 10, 2019

Title 40: Protection of Environment
PART 63—NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLUTANTS FOR SOURCE CATEGORIES (CONTINUED)

Subpart EEEEEEE—National Emission Standards for Hazardous Air Pollutants: Gold Mine Ore Processing and Production Area Source Category

Contents

APPLICABILITY AND COMPLIANCE DATES

§63.11640 Am I subject to this subpart?
§63.11641 What are my compliance dates?

STANDARDS AND COMPLIANCE REQUIREMENTS

§63.11645 What are my mercury emission standards?
§63.11646 What are my compliance requirements?
§63.11647 What are my monitoring requirements?
§63.11648 What are my notification, reporting, and recordkeeping requirements?

OTHER REQUIREMENTS AND INFORMATION

§63.11650 What General Provisions apply to this subpart?
§63.11651 What definitions apply to this subpart?
§63.11652 Who implements and enforces this subpart?
§63.11653 [Reserved]
Table 1 to Subpart EEEEEEE of Part 63—Applicability of General Provisions to Subpart EEEEEE

SOURCE: 76 FR 9480, Feb. 17, 2011, unless otherwise noted.

APPLICABILITY AND COMPLIANCE DATES

§63.11640 Am I subject to this subpart?

(a) You are subject to this subpart if you own or operate a gold mine ore processing and production facility as defined in §63.11651, that is an area source.

(b) This subpart applies to each new ~~or existing~~ affected source. The affected sources are each collection of "ore pretreatment processes" at a gold mine ore processing and production facility, each collection of "carbon processes with mercury retorts" at a gold mine ore processing and production facility~~, each collection of "carbon processes without mercury retorts" at a gold mine ore processing and production facility, and each collection of "non-carbon concentrate processes" at a gold mine ore processing and production facility,~~ as defined in §63.11651.

~~(1) An affected source is existing if you commenced construction or reconstruction of the affected source on or before April 28, 2010.~~

(2) An affected source is new if you commenced construction or reconstruction of the affected source after April 28, 2010.

~~(c) This subpart does not apply to research and development facilities, as defined in section 112(c)(7) of the Clean Air Act (CAA).~~

(d) If you own or operate a source subject to this subpart, you must have or you must obtain a permit under 40 CFR part 70 ~~or 40 CFR part 71.~~

Midas Gold is proposing to operate a gold mine ore processing and production facility at the Stibnite Gold Project, and as an area source, will therefore be subject to this subpart per §63.11640(a). The affected sources are each collection of "ore pretreatment processes" at a gold mine ore processing and production facility, and each collection of "carbon processes with mercury retorts" at a gold mine ore processing and production facility, per §63.11640(b). The affected sources will be new as they will commence construction after April 28, 2010, per §63.11640(b)(2). Midas Gold will be required to obtain a permit under 40 CFR part 70 (i.e., Title V permit) for the affected sources subject to this subpart, per §63.11640(d).

§63.11641 What are my compliance dates?

~~(a) If you own or operate an existing affected source, you must comply with the applicable provisions of this subpart no later than February 17, 2014.~~

~~(b) If you own or operate a new affected source, and the initial startup of your affected source is on or before February 17, 2011, you must comply with the provisions of this subpart no later than February 17, 2011.~~

(c) If you own or operate a new affected source, and the initial startup of your affected source is after February 17, 2011, you must comply with the provisions of this subpart upon startup of your affected source.

The Stibnite Gold Project will include two new affected sources, each with an initial startup after February 17, 2011, therefore Midas Gold must comply with the provisions of this subpart upon startup of the affected sources per §63.11641(c).

STANDARDS AND COMPLIANCE REQUIREMENTS

§63.11645 What are my mercury emission standards?

~~(a) For existing ore pretreatment processes, you must emit no more than 127 pounds of mercury per million tons of ore processed.~~

~~(b) For existing carbon processes with mercury retorts, you must emit no more than 2.2 pounds of mercury per ton of concentrate processed.~~

~~(c) For existing carbon processes without mercury retorts, you must emit no more than 0.17 pounds of mercury per ton of concentrate processed.~~

~~(d) For existing non-carbon concentrate processes, you must emit no more than 0.2 pounds of mercury per ton of concentrate processed.~~

(e) For new ore pretreatment processes, you must emit no more than 84 pounds of mercury per million tons of ore processed.

(f) For new carbon processes with mercury retorts, you must emit no more than 0.8 pounds of mercury per ton of concentrate processed.

~~(g) For new carbon processes without mercury retorts, you must emit no more than 0.14 pounds of mercury per ton of concentrate processed.~~

~~(h) For new non-carbon concentrate processes, you must emit no more than 0.1 pounds of mercury per ton of concentrate processed.~~

(i) The standards set forth in this section apply at all times.

Midas Gold proposes to operate one new ore pretreatment processes affected source, which must emit no more than 84 pounds of mercury per million tons of ore processed per §63.11645(e). Midas Gold also proposes to operate one new carbon processes with mercury retorts affected source, which must emit no more than 0.8 pounds of mercury per ton of concentrate processed per §63.11645(f). These standards will apply at all times per §63.11645(i).

§63.11646 What are my compliance requirements?

(a) Except as provided in paragraph (b) of this section, you must conduct a mercury compliance emission test within 180 days of the compliance date for all process units at new ~~and existing~~ affected sources according to the requirements in paragraphs (a)(1) through (a)(13) of this section. This compliance testing must be repeated annually thereafter, with no two consecutive annual compliance tests occurring less than 3 months apart or more than 15 months apart.

(1) You must determine the concentration of mercury and the volumetric flow rate of the stack gas according to the following test methods and procedures:

(i) Method 1 or 1A (40 CFR part 60, appendix A-1) to select sampling port locations and the number of traverse points in each stack or duct. Sampling sites must be located at the outlet of the control device (or at the outlet of the emissions source if no control device is present) and prior to any releases to the atmosphere.

(ii) Method 2, 2A, 2C, 2D, 2F (40 CFR part 60, appendix A-1), or Method 2G (40 CFR part 60, appendix A-2) to determine the volumetric flow rate of the stack gas.

(iii) Method 3, 3A, or 3B (40 CFR part 60, appendix A-2) to determine the dry molecular weight of the stack gas. You may use ANSI/ASME PTC 19.10, "Flue and Exhaust Gas Analyses" (incorporated by reference-see §63.14) as an alternative to EPA Method 3B.

(iv) Method 4 (40 CFR part 60, appendix A-3) to determine the moisture content of the stack gas.

(v) Method 29 (40 CFR part 60, appendix A-8) to determine the concentration of mercury, except as provided in paragraphs (a)(1)(vi) and (vii) of this section.

(vi) Upon approval by the permitting authority, ASTM D6784; "Standard Test Method for Elemental, Oxidized, Particle-Bound and Total Mercury in Flue Gas Generated from Coal-Fired Stationary Sources (Ontario Hydro Method)" (incorporated by reference—see §63.14) may be used as an alternative to Method 29 to determine the concentration of mercury.

(vii) Upon approval by the permitting authority, Method 30B (40 CFR part 60, appendix A-8) may be used as an alternative to Method 29 to determine the concentration of mercury for those process units with relatively low particulate-bound mercury as specified in Section 1.2 of Method 30B.

(2) A minimum of three test runs must be conducted for each performance test of each process unit. Each test run conducted with Method 29 must collect a minimum sample volume of 0.85 dry standard cubic meters (30 dry standard cubic feet). If conducted with Method 30B or ASTM D6784, determine sample time and volume according to the testing criteria set forth in the relevant method. If the emission testing results for any of the emission points yields a non-detect value, then the minimum detection limit (MDL) must be used to calculate the mass emissions rate (lb/hr) used to calculate the emissions factor (lb/ton) for that emission point and, in turn, for calculating the sum of the emissions (in units of pounds of mercury per ton of concentrate, or pounds of mercury per million tons of ore) for all emission points subject to the emission standard for determining compliance. If the resulting mercury emissions are greater than the MACT emission standard, the owner or operator may use procedures that produce lower MDL results and repeat the mercury emissions testing one additional time for any emission point for which the measured result was below the MDL. If this additional testing is performed, the results from that testing must be used to determine compliance (*i.e.,* there are no additional opportunities allowed to lower the MDL).

(3) Performance tests shall be conducted under such conditions as the Administrator specifies to the owner or operator based on representative performance of the affected source for the period being tested. Upon request, the owner or operator shall make available to the Administrator such records as may be necessary to determine the conditions of performance tests. Performance tests must be conducted under operating conditions (including process or production throughputs) that are based on representative performance. Record and report to the permit authority the process throughput for each test run. For sources with multiple emission units (*e.g.,* two roasters, or a furnace, electrowinning circuit and a mercury retort) ducted to a common control device and stack, compliance testing must be performed either by conducting a single compliance test with all affected emissions units in operation or by conducting a separate compliance test on each emissions unit. Alternatively, the owner or operator may request approval from the permit authority for an alternative testing approach. If the units are tested separately, any emissions unit that is not tested initially must be tested as soon as is practicable. If the performance test is conducted when all affected units are operating, then the number of hours of operation used for calculating emissions pursuant to paragraphs (a)(6) and (7) of this section must be the total number of hours for the unit that has the greatest total operating hours for that period of time, or based on an appropriate alternative method approved by the permit authority to account for the hours of operation for each separate unit in these calculations.

(4) Calculate the mercury emission rate (lb/hr), based on the average of 3 test run values, for each process unit (or combination of units that are ducted to a common stack and are tested when all affected sources are operating pursuant to paragraph (a)(3) of this section) using Equation (1) of this section:

$$E = Cs * Qs * K \quad \text{(Eq. 1)}$$

View or download PDF

Where:

E = mercury emissions in lb/hr;

Cs = concentration of mercury in the stack gas, in grains per dry standard cubic foot (gr/dscf);

Qs = volumetric flow rate of the stack gas, in dry standard cubic feet per hour; and

K = conversion factor for grains (gr) to pounds (lb), 1.43×10^{-4}.

(5) Monitor and record the number of one-hour periods each process unit operates during each month.

(6) For the initial compliance determination for both new and existing sources, determine the total mercury emissions for all the full calendar months between the compliance date and the date of the initial compliance test by multiplying the emission rate in lb/hr for each process unit (or combination of units ducted to a common stack that are tested together) by the number of one-hour periods each process unit (or the unit that had the greatest total operating hours among the combination of multiple units with one stack that are tested together, or an alternative method approved by the permit authority, pursuant to paragraph (a)(3) of this section) operated during those full calendar months prior to the initial compliance test. This initial period must include at least 1 full month of operations. After the initial compliance test, for subsequent compliance tests, determine the mercury mass emissions for the 12 full calendar months prior to the compliance test in accordance with the procedures in paragraph (a)(7) of this section. ~~Existing sources may use a previous emission test for their initial compliance determination in lieu of conducting a new test if the test was conducted within one year of the compliance date using the methods specified in paragraphs (a)(1) through (a)(4) of this section, and the tests were representative of current operating processes and conditions. If a previous test is used for their initial compliance determination, 3 to 12 full months of data on hours of operation and production (*i.e.*, million tons of ore or tons of concentrate), including the month the test was conducted, must be used to calculate the emissions rate (in units of pounds of mercury per million tons of ore for the ore pretreatment affected sources, or in units of pounds of mercury per tons of concentrate for the other affected sources).~~

(7) For compliance determinations following the initial compliance test for new and existing sources, determine the total mercury mass emissions for each process unit for the 12 full calendar months preceding the performance test by multiplying the emission rate in lb/hr for each process unit (or combination of units ducted to a common stack that are tested together) by the number of one-hour periods each process unit (or the unit that had the greatest total operating hours among the combination of multiple units with one stack that are tested together, or an alternative method approved by the permit authority, pursuant to paragraph (a)(3) of this section) operated during the 12 full calendar months preceding the completion of the performance tests.

(8) You must install, calibrate, maintain and operate an appropriate weight measurement device, mass flow meter, or densitometer and volumetric flow meter to measure ore throughput for each ~~roasting operation and~~ autoclave and calculate hourly, daily and monthly totals in tons of ore according to paragraphs (a)(8)(i) and (a)(8)(ii) of this section.

~~(i) Measure the weight or the density and volumetric flow rate of the oxidized ore slurry as it exits the roaster oxidation circuit(s) and before the carbon-in-leach tanks. Alternatively, the weight of the ore can be measured "as fed" if approved by the permit authority as an acceptable equivalent method to measure amount of ore processed.~~

(ii) Measure the weight or the density and volumetric flow rate of the ore slurry as it is fed to the autoclave(s). Alternatively, the weight or the density and volumetric flow rate of the oxidized ore slurry can be measured as it exits the autoclave and before the carbon-in-leach tanks if approved by the permit authority as an acceptable equivalent method to measure amount of ore processed.

(9) Measure the weight of concentrate (produced by electrowinning, Merrill Crowe process, gravity feed, or other methods) using weigh scales for each batch prior to processing in mercury retorts ~~or melt furnaces~~. For facilities with mercury retorts, the concentrate must be weighed in the same state and condition as it is when fed to the mercury retort. ~~For facilities without mercury retorts, the concentrate must be weighed prior to being fed to the melt furnace before drying in any ovens. For facilities that ship concentrate offsite, measure the weight of concentrate as shipped offsite.~~ You must keep accurate records of the weights of each batch of concentrate processed and calculate, and record the total weight of concentrate processed each month.

(10) You must maintain the systems for measuring density, volumetric flow rate, and weight within ±5 percent accuracy. You must describe the specific equipment used to make measurements at your facility and how that equipment is periodically calibrated. You must also explain, document, and maintain written procedures for determining the accuracy of the measurements and make these written procedures available to your permitting authority upon request. You must determine, record, and maintain a record of the accuracy of the measuring systems before the beginning of your initial compliance test and during each subsequent quarter of affected source operation.

(11) Record the weight in tons of ore for ore pretreatment processes and concentrate for carbon processes with mercury retorts, ~~carbon processes without mercury retorts, and for non-carbon concentrate processes~~ on a daily and monthly basis.

(12) Calculate the emissions from each new and existing affected source for the sum of all full months between the compliance date and the date of the initial compliance test in pounds of mercury per ton of process input using the procedures in paragraphs (a)(12)(i) through (a)(12)(iv) of this section to determine initial compliance with the emission standards in §63.11645. This must include at least 1 full month of data. ~~Or, if a previous test is used pursuant to paragraph (a)(6) of this section for the initial compliance test, use a period of time pursuant to paragraph (a)(6) of this section to calculate the emissions for the affected source. After this initial compliance test period, determine annual compliance using the procedures in paragraph (a)(13) of this section for existing sources.~~

(i) For ore pretreatment processes, divide the sum of mercury mass emissions (in pounds) from all ~~roasting operations and~~ autoclaves during the number of full months between the compliance date and the initial compliance test by the sum of the total amount of gold mine ore processed (in million tons) in these process units during those same full months following the compliance date. ~~Or, if a previous test is used to determine initial compliance, pursuant to paragraph (a)(6) of this section, then the same 3 to 12 full months of production data (i.e., million tons of ore) and hours of operation referred to in paragraph (a)(6) of this section, must be used to determine the emissions in pounds of mercury per million tons of ore.~~

(ii) For carbon processes with mercury retorts, divide the sum of mercury mass emissions (in pounds) from all carbon kilns, preg tanks, electrowinning, mercury retorts, and melt furnaces during the initial number of full months between the compliance date and the initial compliance tests by the total amount of concentrate (in tons) processed in these process units during those same full months following the compliance date. ~~If a previous test is used to determine initial compliance, pursuant to paragraph (a)(6) of this section, then the same 3 to 12 full months of production data (*i.e.*, tons of concentrate) and hours of operation referred to in paragraph (a)(6) of this section, must be used to determine the emissions in pounds of mercury per tons of concentrate.~~

~~(iii) For carbon processes without mercury retorts, divide the sum of mercury mass emissions (in pounds) from all carbon kilns, preg tanks, electrowinning, and melt furnaces during the initial number of full months between the compliance date and the initial compliance tests by the total amount of concentrate (in tons) processed in these process units during those same full months following the compliance date. If a previous test is used to determine initial compliance, pursuant to paragraph (a)(6) of this section, then the same 3 to 12 full months of production data (*i.e.*, tons of concentrate) and hours of operation referred to in paragraph (a)(6) of this section, must be used to determine the emissions in pounds of mercury per tons of concentrate.~~

~~(iv) For non-carbon concentrate processes, divide the sum of mercury mass emissions (in pounds) from mercury retorts and melt furnaces during the initial number of full months between the compliance date and the initial compliance tests by the total amount of concentrate (in tons) processed in these process units during those same full months following the compliance date. If a previous test is used to determine initial compliance, pursuant to paragraph (a)(6) of this section, then the same 3 to 12 full months of production data (*i.e.*, tons of concentrate) and hours of operation referred to in paragraph (a)(6) of this section, must be used to determine the emissions in pounds of mercury per tons of concentrate.~~

(13) After the initial compliance test, calculate the emissions from each new and existing affected source for each 12-month period preceding each subsequent compliance test in pounds of mercury per ton of process input using the procedures in paragraphs (a)(13)(i) through (iv) of this section to determine compliance with the emission standards in §63.11645.

(i) For ore pretreatment processes, divide the sum of mercury mass emissions (in pounds) from all ~~roasting operations and~~ autoclaves in the 12-month period preceding a compliance test by the sum of the total amount of gold mine ore processed (in million tons) in that 12-month period.

(ii) For carbon processes with mercury retorts, divide the sum of mercury mass emissions (in pounds) from all carbon kilns, preg tanks, electrowinning, mercury retorts, and melt furnaces in the 12-month period preceding a compliance test by the total amount of concentrate (in tons) processed in these process units in that 12-month period.

~~(iii) For carbon processes without mercury retorts, divide the sum of mercury mass emissions (in pounds) from all carbon kilns, preg tanks, electrowinning, and melt furnaces in the 12-month period preceding a compliance test by the total amount of concentrate (in tons) processed in these process units in that 12-month period.~~

~~(iv) For non-carbon concentrate processes, divide the sum of mercury mass emissions (in pounds) from mercury retorts and melt furnaces in the 12-month period preceding a compliance test by the total amount of concentrate (in tons) processed in these process units in that 12-month period.~~

(b) At all times, you must operate and maintain any affected source, including associated air pollution control equipment and monitoring equipment, in a manner consistent with safety and good air pollution control practices for minimizing emissions. Determination of whether such operation and maintenance procedures are being used will be based on information available to the Administrator which may include, but is not limited to, monitoring results, review of operation and maintenance procedures, review of operation and maintenance records, and inspection of the source.

Midas Gold will be required to conduct mercury compliance emission tests within 180 days of startup of the two affected sources. The process units to be tested will be the Autoclave, the Carbon Regeneration Kiln, the Electrowinning Cells and Pregnant Solution Tank (combined stack), the Mercury Retort and the Melting Furnace. The compliance tests will be repeated annually thereafter. Compliance with the emission standards in §63.11645(e) and (f) for the ore pretreatment processes affected source and the carbon processes with mercury retorts affected source, respectively, will be determined according to the highlighted methods and procedures in §63.11646(a)(1)-(13). The affected sources will be required to operate consistent with good air pollution control practices per §63.11646(b).

§63.11647 What are my monitoring requirements?

~~(a) Except as provided in paragraph (a)(5) of this section, you must monitor each roaster for mercury emissions using one of the procedures in paragraphs (a)(1), (a)(2), or (a)(3) of this section and establish operating limits for mercury concentration as~~

described in paragraph (a)(4) of this section.

(1) Perform sampling and analysis of the roaster's exhaust for mercury concentration using EPA Performance Specification 12B (40 CFR part 60, appendix B and Procedure 5 of appendix F) or EPA Method 30B (40 CFR part 60, appendix A-8) at least twice per month. A minimum of two measurements must be taken per month that are at least 11 days apart from other consecutive tests. The mercury concentration must be maintained below the operating limit established in paragraph (a)(4) of this section. The results of the sampling must be obtained within 72 hours of the time the sample is taken.

(i) To determine the appropriate sampling duration, you must review the available data from previous stack tests to determine the upper 99th percentile of the range of mercury concentrations in the exit stack gas. Based on this upper end of expected concentrations, select an appropriate sampling duration that is likely to provide a valid sample and not result in breakthrough of the sampling tubes. If breakthrough of the sampling tubes occurs, you must re-sample within 7 days using a shorter sampling duration.

(ii) If any mercury concentration measurement from the twice per month sampling with PS 12B or Method 30B is higher than the operating limit, the exceedance must be reported to the permit authority as a deviation and corrective actions must be implemented within 48 hours upon receipt of the sampling results. Moreover, within 96 hours of the exceedance, the owner or operator must measure the concentration again (with PS 12B (40 CFR part 60, appendix B and Procedure 5 of appendix F), Method 30B or Method 29 (40 CFR part 60, appendix A-8), or ASTM D6784(incorporated by reference—see §63.14)) and demonstrate to the permit authority that the mercury concentration is no higher than the operating limit, or inform the permit authority that the limit continues to be exceeded. If the measured mercury concentration exceeds the operating limit for mercury concentration after these 96 hours, the exceedance must be reported as a deviation within 24 hours to the permitting authority. The owner or operator must conduct a full compliance test pursuant to §63.11646(a) for the roaster operations within 40 days to determine if the affected source is in compliance with the MACT emission standard. For facilities that have roasters and autoclaves, the owner or operator can use the results of the previous compliance test for the autoclaves to determine the emissions for those process units to be used in the calculations of the emissions for the affected source. If the source is determined to be in compliance, the compliance test may also be used to establish a new operating limit for mercury concentration (in accordance with paragraph (e) of this section).

(2) Install, operate, calibrate, and maintain a continuous emissions monitoring system (CEMS) to continuously measure the mercury concentration in the final exhaust stream from each roaster according to the requirements of Performance Specification 12A (40 CFR part 60, appendix B) except that calibration standards traceable to the National Institute of Standards and Technology are not required. You must perform a data accuracy assessment of the CEMS according to section 5 of Appendix F in part 60 and follow the applicable monitoring requirements in §63.8 as provided in Table 1 to subpart EEEEEEE.

(i) You must continuously monitor the daily average mercury concentration from the roaster and maintain the daily average concentration below the operating limit established in paragraph (a)(4) of this section.

(ii) If the daily average mercury concentration from the CEMs is higher than the operating limit, the exceedance must be reported to the permit authority as a deviation and corrective actions must be implemented within 48 hours upon receipt of the sampling results. Moreover, within 96 hours of the exceedance, the owner or operator must measure the concentration again (with the CEMs (40 CFR part 60, appendix B and Procedure 5 of appendix F) and demonstrate to the permit authority that the mercury concentration is no higher than the operating limit, or inform the permit authority that the limit continues to be exceeded. If the measured mercury concentration exceeds the operating limit for mercury concentration after these 96 hours, the exceedance must be reported as a deviation within 24 hours to the permitting authority, and the owner or operator must conduct a full compliance test pursuant to §63.11646(a) for the roaster operations within 40 days to determine if the affected source is in compliance with the MACT emission standard. For facilities that have roasters and autoclaves, the owner or operator can use the results of the previous compliance test for the autoclaves to determine the emissions for those process units to be used in the calculations of the emissions for the affected source. If the source is determined to be in compliance, the compliance test results may also be used to establish a new operating limit for mercury concentration (in accordance with paragraph (e) of this section).

(iii) You must submit a monitoring plan that includes quality assurance and quality control (QA/QC) procedures sufficient to demonstrate the accuracy of the CEMS to your permitting authority for approval 180 days prior to your initial compliance test. At a minimum, the QA/QC procedures must include daily calibrations and an annual accuracy test for the CEMS.

(3) Continuously measure the mercury concentration in the final exhaust stream from each roaster using EPA Performance Specification 12B (40 CFR part 60 appendix B and Procedure 5 of appendix F).

(i) You must continuously measure the mercury concentration in the roaster exhaust and maintain the average daily mercury concentration below the operating limit established in paragraph (a)(4) of this section. To determine the appropriate sampling duration, you must review the available data from previous stack tests to determine the upper 99th percentile of the range of mercury concentrations in the exit stack gas. Based on this upper end of expected concentrations, select an appropriate sampling duration that is likely to provide a valid sample and not result in breakthrough of the sampling tubes. If

breakthrough of the sampling tubes occurs, you must re-sample within 7 days using a shorter sampling duration.

(ii) If the daily average mercury concentration is higher than the operating limit, the exceedance must be reported to the permit authority as a deviation and corrective actions must be implemented within 48 hours upon receipt of the sampling results. Moreover, within 96 hours of the exceedance, the owner or operator must measure the concentration again with PS–12B (40 CFR part 60, appendix B and Procedure 5 of appendix F), Method 30B or Method 29 (40 CFR part 60, appendix A-8), or ASTM D6784(incorporated by reference—see §63.14) and demonstrate to the permit authority that the mercury concentration is no higher than the operating limit, or inform the permit authority that the limit continues to be exceeded. If the measured mercury concentration exceeds the operating limit for mercury concentration after these 96 hours, the exceedance must be reported as a deviation within 24 hours to the permitting authority and the owner or operator must conduct a full compliance test pursuant to §63.11646(a) for the roaster operations within 40 days to determine if the affected source is in compliance with the MACT emission standard. For facilities that have roasters and autoclaves, the owner or operator can use the results of the previous compliance test for the autoclaves to determine the emissions for those process units to be used in the calculations of the emissions for the affected source. If the source is determined to be in compliance, the compliance test results may also be used to establish a new operating limit for mercury concentration (in accordance with paragraph (e) of this section).

(4) Use Equation (2) of this section to establish an upper operating limit for mercury concentration as determined by using the procedures in paragraphs (a)(1), (a)(2), or (a)(3) of this section concurrently while you are conducting your annual compliance performance stack tests according to the procedures in §63.11646(a).

$$OLR = C_{test} * (EL/CT) \qquad \text{(Eq 2)}$$

View or download PDF

Where:

OLR = mercury concentration operating limit for the roaster (or roasters that share a common stack) (in micrograms per cubic meter);

C_{test} = average mercury concentration measured by the monitoring procedures (PS-12A or PS-12B or 30B) during the compliance performance stack test (in micrograms per cubic meter);

EL = emission standard for ore pretreatment processes (in lb/million tons of ore);

CT = compliance test results for ore pretreatment processes (in lb/million tons of ore).

(5) For roasters that utilize calomel-based mercury control systems for emissions controls, you are not required to perform the monitoring for mercury emissions in paragraphs (a)(1), (a)(2), or (a)(3) of this section if you demonstrate to the satisfaction of your permitting authority that mercury emissions from the roaster are less than 10 pounds of mercury per million tons of ore throughput. If you make this demonstration, you must conduct the parametric monitoring as described below in paragraphs (b) and (c) of this section.

(i) The initial demonstration must include three or more consecutive independent stack tests for mercury at least one month apart on the roaster exhaust stacks. Subsequent demonstrations may be based upon the single stack test required in paragraph (a) of section §63.11646. The results of each of the tests must be less than 10 pounds of mercury per million tons of ore. The testing must be performed according to the procedures in §63.11646(a)(1) through (a)(4) to determine mercury emissions in pounds per hour.

(ii) Divide the mercury emission rate in pounds per hour by the ore throughput rate during the test expressed in millions of tons per hour to determine the emissions in pounds per million tons of ore.

(b) For facilities with roasters and a calomel-based mercury control system that choose to monitor for mercury emissions using the procedures in paragraph (a)(1) of this section or that qualify for and choose to follow the requirements in paragraph (a)(5) of this section, you must establish operating parameter limits for scrubber liquor flow (or line pressure) and scrubber inlet gas temperature and monitor these parameters. You may establish your operating parameter limits from the initial compliance test, according to the manufacturer's specifications, or based on limits established by the permitting authority. If you choose to establish your operating parameter limits from the initial compliance test, monitor the scrubber liquor flow (or line pressure) and scrubber inlet gas temperature during each run of your initial compliance test. The minimum operating limit for scrubber liquor flow rate (or line pressure) is either the lowest value during any run of the initial compliance test or 10 percent less than the average value measured during the compliance test, and your maximum scrubber inlet temperature limit is the highest temperature measured during any run of the initial compliance test or 10 percent higher than the average value measured during the compliance test. You must monitor the scrubber liquor flow rate (or line pressure) and scrubber inlet gas temperature hourly and maintain the scrubber liquor flow (or line pressure) at or above the established operating parameter and maintain the inlet gas temperature below the established operating parameter limit.

(c) For facilities with roasters and a calomel-based mercury control system that choose to monitor for mercury emissions using the procedures in paragraph (a)(1) of this section or that qualify for and follow the requirements in paragraph (a)(5) of this section, you must establish operating parameter ranges for mercuric ion and chloride ion concentrations or for oxidation

reduction potential and pH using the procedures in paragraph (c)(1) or (c)(2) of this section respectively.

(1) Establish the mercuric ion concentration and chloride ion concentration ranges for each calomel-based mercury control system. The mercuric ion concentration and chloride ion concentration ranges for each calomel-based mercury control system must be based on the manufacturer's specifications, or based on approval by your permitting authority. Measure the mercuric ion concentration and chloride ion concentrations at least once during each run of your initial compliance test. The measurements must be within the established concentration range for mercuric ion concentration and chloride ion concentration. Subsequently, you must sample at least once daily and maintain the mercuric ion concentration and chloride ion concentrations within their established range.

(2) Establish the oxidation reduction potential and pH range for each calomel-based mercury control system. The oxidation reduction potential and pH range for each calomel-based mercury control system must be based on the manufacturer's specifications, or based on approval by your permitting authority. Install monitoring equipment to continuously monitor the oxidation reduction potential and pH of the calomel-based mercury control system scrubber liquor. Measure the oxidation reduction potential and pH of the scrubber liquor during each run of your initial compliance test. The measurements must be within the established range for oxidation reduction potential and pH. Subsequently, you must monitor the oxidation reduction potential and pH of the scrubber liquor continuously and maintain it within the established operating range.

(d) If you have an exceedance of a control device operating parameter range provided in paragraphs (b) or (c) of this section, you must take corrective action and bring the parameters back into the established parametric ranges. If the corrective actions taken following an exceedance do not result in the operating parameter value being returned within the established range within 48 hours, a mercury concentration measurement (with PS 12B or PS 12A CEMS (40 CFR part 60, appendix B and Procedure 5 of appendix F), Method 30B or Method 29 (40 CFR part 60, appendix A-8), or ASTM D6784 (incorporated by reference—see §63.14)) must be made to determine if the operating limit for mercury concentration is being exceeded. The measurement must be performed and the mercury concentration determined within 48 hours (after the initial 48 hours, or a total of 96 hours from the time the parameter range was exceeded). If the measured mercury concentration meets the operating limit for mercury concentration established under §63.11647(a)(4), the corrective actions are deemed successful, and the owner or operator can request the permit authority to establish a new limit or range for the parameter. If the measured mercury concentration exceeds the operating limit for mercury concentration after these 96 hours, the exceedance must be reported as a deviation within 24 hours to the permitting authority and the owner or operator must conduct a full compliance test pursuant to §63.11646(a) for the roaster operations within 40 days to determine if the affected source is in compliance with the MACT emission standard. For facilities that have roasters and autoclaves, the owner or operator can use the results of the previous compliance test for the autoclaves to determine the emissions for those process units to be used in the calculations of the emissions for the affected source. If the source is determined to be in compliance with the MACT emission standard, the compliance test may also be used to establish a new operating limit for mercury concentration (see paragraph (e) of this section).

(e) You may submit a request to your permitting authority for approval to change the operating limits established under paragraph (a)(4) of this section for the monitoring required in paragraph (a)(1),(a)(2), or (a)(3) of this section. In the request, you must demonstrate that the proposed change to the operating limit detects changes in levels of mercury emission control. An approved change to the operating limit under this paragraph only applies until a new operating limit is established during the next annual compliance test.

(f) You must monitor each process unit at each new and existing affected source that uses a carbon adsorber to control mercury emissions using the procedures in paragraphs (f)(1) or (f)(2) of this section. A carbon adsorber may include a fixed carbon bed, carbon filter packs or modules, carbon columns, and other variations.

(1) Continuously sample and analyze the exhaust stream from the carbon adsorber for mercury using Method 30B (40 CFR part 60, appendix A-8) for a duration of at least the minimum sampling time specified in Method 30B and up to one week that includes the period of the annual performance test.

(i) Establish an upper operating limit for the process as determined using the mercury concentration measurements from the sorbent trap (Method 30B) as calculated from Equation (3) of this section.

$$OLC = C_{trap} * (EL/CT) \qquad \text{(Eq 3)}$$

View or download PDF

Where:

OLC = mercury concentration operating limit for the carbon adsorber control device on the process as measured using the sorbent trap, (micrograms per cubic meter);

C_{trap} = average mercury concentration measured using the sorbent trap during the week that includes the compliance performance test, (micrograms per cubic meter);

EL = emission standard for the affected sources (lb/ton of concentrate);

CT = compliance test results for the affected sources (lb/ton of concentrate).

~~(ii) Sample and analyze the exhaust stream from the carbon adsorber for mercury at least monthly using Method 30B (40 CFR part 60, appendix A-8). When the mercury concentration reaches 75 percent of the operating limit, begin weekly sampling and analysis. When the mercury concentration reaches 90 percent of the operating limit, replace the carbon in the carbon adsorber within 30 days. If mercury concentration exceeds the operating limit, change the carbon in the carbon adsorber within 30 days and report the deviation to your permitting authority.~~

(2) Conduct an initial sampling of the carbon in the carbon bed for mercury 90 days after the replacement of the carbon. A representative sample must be collected from the inlet of the bed and the exit of the bed and analyzed using SW-846 Method 7471B (incorporated by reference—see §63.14). The depth to which the sampler is inserted must be recorded. The design capacity is established by calculating the average carbon loading from the inlet and outlet measurements. Sampling and analysis of the carbon bed for mercury must be performed quarterly thereafter. When the carbon loading reaches 50 percent of the design capacity of the carbon, monthly sampling must be performed until 90 percent of the carbon loading capacity is reached. The carbon must be removed and replaced with fresh carbon no later than 30 days after reaching 90 percent of capacity. For carbon designs where there may be multiple carbon columns or beds, a representative sample may be collected from the first and last column or bed instead of the inlet or outlet. If the carbon loading exceeds the design capacity of the carbon, change the carbon within 30 days and report the deviation to your permitting authority.

(g) You must monitor gas stream temperature at the inlet to the carbon adsorber for each process unit (*i.e.,* carbon kiln, melt furnace, *etc.*) equipped with a carbon adsorber. Establish a maximum value for the inlet temperature either during the annual performance test (required in §63.11646(a)), according to the manufacturer's specifications, or as approved by your permitting authority. If you choose to establish the temperature operating limit during the performance test, establish the temperature operating limit based on either the highest reading during the test or at 10 °F higher than the average temperature measured during the performance test. Monitor the inlet temperature once per shift. If an inlet temperature exceeds the temperature operating limit, you must take corrective actions to get the temperature back within the parameter operating limit within 48 hours. If the exceedance persists, within 144 hours of the exceedance, ~~you must sample and analyze the exhaust stream from the carbon adsorber using Method 30B (40 CFR part 60, appendix A-8) and compare to an operating limit (calculated pursuant to (f)(1)(i)) or~~ you must conduct carbon sampling pursuant to (f)(2) of this section. If ~~the concentration measured with Method 30B is below 90 percent of the operating limit or~~ the carbon sampling results are below 90 percent of the carbon loading capacity, you may set a new temperature operating limit 10 °F above the previous operating limit or at an alternative level approved by your permit authority. If the concentration is ~~above 90 percent of the operating limit or~~ above 90 percent of the carbon loading capacity you must change the carbon in the bed within 30 days and report the event to your permitting authority, and reestablish an appropriate maximum temperature limit based on approval of your permit authority.

(h) For each wet scrubber at each new and existing affected source not followed by a mercury control system, you must monitor the water flow rate (or line pressure) and pressure drop. Establish a minimum value as the operating limit for water flow rate (or line pressure) and pressure drop either during the performance test required in §63.11646(a), according to the manufacturer's specifications, or as approved by your permitting authority. If you choose to establish the operating limit based on the results of the performance test, the new operating limit must be established based on either the lowest value during any test run or 10 percent less than the average value measured during the test. For wet scrubbers on an autoclave, establish the pressure drop range according to manufacturer's specifications. You must monitor the water flow rate and pressure drop once per shift and take corrective action within 24 hours if any daily average is less than the operating limit. If the parameters are not in range within 72 hours, the owner or operator must report the deviation to the permitting authority and perform a compliance test for the process unit(s) controlled with the wet scrubber that has the parameter exceedance within 40 days to determine if the affected source is in compliance with the MACT limit. For the other process units included in the affected source, the owner or operator can use the results of the previous compliance test to determine the emissions for those process units to be used in the calculations of the emissions for the affected source.

(i) You may conduct additional compliance tests according to the procedures in §63.11646 and re-establish the operating limits required in paragraphs ~~(a) through (c) and~~ (f) through (h) of this section at any time. You must submit a request to your permitting authority for approval to re-establish the operating limits. In the request, you must demonstrate that the proposed change to the operating limit detects changes in levels of mercury emission control. An approved change to the operating limit under this paragraph only applies until a new operating limit is established during the next annual compliance test.

Midas Gold is not proposing to operate a roaster, therefore the §63.11647(a)-(e) monitoring requirements will not apply. The Carbon Regeneration Kiln, the Electrowinning Cells and Pregnant Solution Tank combined stack, the Mercury Retort and the Melting Furnace will each have a carbon adsorber to control mercury. Each carbon adsorber will be monitored per §63.11647(f)(2) with an initial sampling of the carbon, continued sampling and analysis and replacement of the carbon as described. For each sampling of the carbon, the average carbon loading will be calculated from the inlet and outlet measurements and compared to the carbon loading capacity provided by the manufacturer. The gas stream temperature at the inlet of each carbon adsorber will be monitored, a maximum value will be established, and corrective actions will be taken for any exceedance per the highlighted portions of §63.11647(g).

The Autoclave will be controlled by a wet scrubber not followed by a mercury control system, therefore §63.11647(h) will apply. The Autoclave wet scrubber water flow rate and pressure drop will be monitored, operating limits will be established, and corrective actions will be taken for any exceedance per §63.11647(h). The Carbon Regeneration Kiln will also be controlled by a wet scrubber, however the wet scrubber will be followed by a mercury control system (carbon adsorber), therefore §63.11647(h) will not apply to the kiln.

The carbon adsorber and wet scrubber operating limits may be re-established per §63.11647(i).

§63.11648 What are my notification, reporting, and recordkeeping requirements?

(a) You must submit the Initial Notification required by §63.9(b)(2) ~~no later than 120 calendar days after the date of publication of the final rule in the FEDERAL REGISTER or~~ within 120 days after the source becomes subject to the standard. The Initial Notification must include the information specified in §63.9(b)(2)(i) through (b)(2)(iv).

(b) You must submit an initial Notification of Compliance Status as required by §63.9(h).

(c) If a deviation occurs during a semiannual reporting period, you must submit a deviation report to your permitting authority according to the requirements in paragraphs (c)(1) and (2) of this section.

(1) The first reporting period covers the period beginning on the compliance date specified in §63.11641 and ending on June 30 or December 31, whichever date comes first after your compliance date. Each subsequent reporting period covers the semiannual period from January 1 through June 30 or from July 1 through December 31. Your deviation report must be postmarked or delivered no later than July 31 or January 31, whichever date comes first after the end of the semiannual reporting period.

(2) A deviation report must include the information in paragraphs (c)(2)(i) through (c)(2)(iv) of this section.

(i) Company name and address.

(ii) Statement by a responsible official, with the official's name, title, and signature, certifying the truth, accuracy and completeness of the content of the report.

(iii) Date of the report and beginning and ending dates of the reporting period.

(iv) Identification of the affected source, the pollutant being monitored, applicable requirement, description of deviation, and corrective action taken.

(d) If you had a malfunction during the reporting period, the compliance report required in §63.11648(b) *[It is assumed this reference is a typographical error and should be §63.11648(c)]* must include the number, duration, and a brief description for each type of malfunction which occurred during the reporting period and which caused or may have caused any applicable emission limitation to be exceeded. The report must also include a description of actions taken by an owner or operator during a malfunction of an affected source to minimize emissions in accordance with §63.11646(b), including actions taken to correct a malfunction.

(e) You must keep the records specified in paragraphs (e)(1) through (e)(3) of this section. The form and maintenance of records must be consistent with the requirements in section 63.10(b)(1) of the General Provisions.

(1) As required in §63.10(b)(2)(xiv), you must keep a copy of each notification that you submitted to comply with this subpart and all documentation supporting any Initial Notification, Notification of Compliance Status, and semiannual compliance certifications that you submitted.

(2) You must keep the records of all performance tests, measurements, monitoring data, and corrective actions required by §§63.11646 and 63.11647, and the information identified in paragraphs (c)(2)(i) through (c)(2)(vi) of this section for each corrective action required by §63.11647.

(i) The date, place, and time of the monitoring event requiring corrective action;

(ii) Technique or method used for monitoring;

(iv) Operating conditions during the activity;

(v) Results, including the date, time, and duration of the period from the time the monitoring indicated a problem to the time that monitoring indicated proper operation; and

(vi) Maintenance or corrective action taken (if applicable).

(3) You must keep records of operating hours for each process as required by §63.11646(a)(5) and records of the monthly quantity of ore and concentrate processed or produced as required by §63.11646(a)(10).

(f) Your records must be in a form suitable and readily available for expeditious review, according to §63.10(b)(1). As specified in §63.10(b)(1), you must keep each record for 5 years following the date of each recorded action. You must keep each record onsite for at least 2 years after the date of each recorded action according to §63.10(b)(1). You may keep the records offsite for the remaining 3 years.

(g) After December 31, 2011, within 60 days after the date of completing each performance evaluation conducted to demonstrate compliance with this subpart, the owner or operator of the affected facility must submit the test data to EPA by entering the data electronically into EPA's WebFIRE data base through EPA's Central Data Exchange. The owner or operator of an affected facility shall enter the test data into EPA's data base using the Electronic Reporting Tool or other compatible electronic spreadsheet. Only performance evaluation data collected using methods compatible with ERT are subject to this requirement to be submitted electronically into EPA's WebFIRE database.

Midas Gold will be subject to all notification, reporting and recordkeeping requirements in §63.11648.

Other Requirements and Information

§63.11650 What General Provisions apply to this subpart?

Table 1 to this subpart shows which parts of the General Provisions in §§63.1 through 63.16 apply to you.

See Table 1 of this subpart for the applicable General Provisions to this subpart.

§63.11651 What definitions apply to this subpart?

Terms used in this subpart are defined in the Clean Air Act, in §63.2, and in this section as follows:

Autoclave means a pressure oxidation vessel that is used to treat gold ores (primarily sulfide refractory ore) and involves pumping a slurry of milled ore into the vessel which is highly pressurized with oxygen and heated to temperatures of approximately 350° to 430 °F.

~~*Calomel-based mercury control system* means a mercury emissions control system that uses scrubbers to remove mercury from the gas stream of a roaster or combination of roasters by complexing the mercury from the gas stream with mercuric chloride to form mercurous chloride (calomel). These scrubbers are also referred to as "mercury scrubbers."~~

Carbon adsorber means a control device consisting of a single fixed carbon bed, multiple carbon beds or columns, carbon filter packs or modules, and other variations that uses activated carbon to remove pollutants from a gas stream.

Carbon kiln means a kiln or furnace where carbon is regenerated by heating, usually in the presence of steam, after the gold has been stripped from the carbon.

Carbon processes with mercury retorts means the affected source that includes carbon kilns, preg tanks, electrowinning cells, mercury retorts, and melt furnaces at gold mine ore processing and production facilities that use activated carbon, or resins that can be used as a substitute for activated carbon, to recover (adsorb) gold from the pregnant cyanide solution.

~~*Carbon processes without mercury retorts* means the affected source that includes carbon kilns, preg tanks, electrowinning cells, and melt furnaces, but has no retorts, at gold mine ore processing and production facilities that use activated carbon, or resins that can be used as a substitute for activated carbon, to recover (adsorb) gold from the pregnant cyanide solution.~~

Concentrate means the sludge-like material that is loaded with gold along with various other metals (such as silver, copper, and mercury) and various other substances, that is produced by electrowinning, the Merrill-Crowe process, flotation and gravity separation processes. *Concentrate* is measured as the input to mercury retorts, or for facilities without mercury retorts, as the input to melt furnaces before any drying takes place. For facilities without mercury retorts or melt furnaces, *concentrate* is measured as the quantity shipped.

Deviation means any instance where an affected source subject to this subpart, or an owner or operator of such a source:

(1) Fails to meet any requirement or obligation established by this subpart, including but not limited to any emissions limitation or work practice standard;

(2) Fails to meet any term or condition that is adopted to implement an applicable requirement in this subpart and that is included in the operating permit for any affected source required to obtain such a permit; or

(3) Exceeds any operating limit established under this subpart.

Electrowinning means a process that uses induced voltage on anode and cathode plates to remove metals from the continuous flow of solution, where the gold in solution is plated onto the cathode. Steel wool is typically used as the plating surface.

Electrowinning Cells means a tank in which the electrowinning takes place.

Gold mine ore processing and production facility means any industrial facility engaged in the processing of gold mine ore that uses any of the following processes: ~~Roasting operations~~, autoclaves, carbon kilns, preg tanks, electrowinning, mercury retorts, or melt furnaces. Laboratories (see CAA section 112(c)(7)), ~~individual prospectors, and very small pilot scale mining~~

operations that processes or produces less than 100 pounds of concentrate per year are not a gold mine ore processing and production facility. A facility that produces primarily metals other than gold, such as copper, lead, zinc, or nickel (where these metals other than gold comprise 95 percent or more of the total metal production) that may also recover some gold as a byproduct is not a gold mine ore processing and production facility. Those facilities whereby 95 percent or more of total mass of metals produced are metals other than gold, whether final metal production is onsite or offsite, are not part of the gold mine ore processing and production source category.

Melt furnace means a furnace (typically a crucible furnace) that is used for smelting the gold-bearing material recovered from mercury retorting, or the gold-bearing material from electrowinning, the Merrill-Crowe process, or other processes for facilities without mercury retorts.

Mercury retort means a vessel that is operated under a partial vacuum at approximately 1,100° to 1,300 °F to remove mercury and moisture from the gold bearing sludge material that is recovered from electrowinning, the Merrill-Crowe process, or other processes. Mercury retorts are usually equipped with condensers that recover liquid mercury during the processing.

Merrill-Crowe process means a precipitation technique using zinc oxide for removing gold from a cyanide solution. Zinc dust is added to the solution, and gold is precipitated to produce a concentrate.

Non-carbon concentrate processes means the affected source that includes mercury retorts and melt furnaces at gold mine ore processing and production facilities that use the Merrill-Crowe process or other processes and do not use carbon (or resins that substitute for carbon) to recover (adsorb) gold from the pregnant cyanide solution.

Ore dry grinding means a process in which the gold ore is ground and heated (dried) prior to additional preheating or prior to entering the roaster.

Ore preheating means a process in which ground gold ore is preheated prior to entering the roaster.

Ore pretreatment processes means the affected source that includes roasting operations and autoclaves that are used to pre-treat gold mine ore at gold mine ore processing and production facilities prior to the cyanide leaching process.

Pregnant solution tank (or preg tank) means a storage tank for pregnant solution, which is the cyanide solution that contains gold-cyanide complexes that is generated from leaching gold ore with cyanide solution.

Pregnant cyanide solution means the cyanide solution that contains gold-cyanide complexes that are generated from leaching gold ore with a dilute cyanide solution.

Quenching means a process in which the hot calcined ore is cooled and quenched with water after it leaves the roaster.

Roasting operation means a process that uses an industrial furnace in which milled ore is combusted across a fluidized bed to oxidize and remove organic carbon and sulfide mineral grains in refractory gold ore. The emissions points of the roasting operation subject to this subpart include ore dry grinding, ore preheating, the roaster stack, and quenching.

The highlighted definitions in §63.11651 will apply to the Stibnite Gold Project.

§63.11652 Who implements and enforces this subpart?

(a) This subpart can be implemented and enforced by the U.S. EPA or a delegated authority, such as your state, local, or tribal agency. If the U.S. EPA Administrator has delegated authority to your state, local, or tribal agency, then that agency has the authority to implement and enforce this subpart. You should contact your U.S. EPA Regional Office to find out if this subpart is delegated to your state, local, or tribal agency.

(b) In delegating implementation and enforcement authority of this subpart to a state, local, or tribal agency under 40 CFR part 63, subpart E, the authorities contained in paragraph (c) of this section are retained by the Administrator of the U.S. EPA and are not transferred to the state, local, or tribal agency.

(c) The authorities that will not be delegated to state, local, or tribal agencies are listed in paragraphs (c)(1) through (4) of this section.

(1) Approval of alternatives to the applicability requirements in §63.11640, the compliance date requirements in §63.11641, and the applicable standards in §63.11645.

(2) Approval of an alternative nonopacity emissions standard under §63.6(g).

(3) Approval of a major change to a test method under §63.7(e)(2)(ii) and (f). A “major change to test method” is defined in §63.90(a).

(4) Approval of a major change to monitoring under §63.8(f). A “major change to monitoring” is defined in §63.90(a).

(5) Approval of a waiver of recordkeeping or reporting requirements under §63.10(f), or another major change to recordkeeping/reporting. A “major change to recordkeeping/reporting” is defined in §63.90(a).

This implementation and enforcement of this subpart per §63.11652 will apply.

~~§63.11653 [Reserved]~~

Table 1 to Subpart EEEEEEE of Part 63—Applicability of General Provisions to Subpart EEEEEE

As stated in §63.11650, you must comply with the applicable General Provisions requirements according to the following table

Citation	Subject	Applies to subpart EEEEEEE	Explanation
§63.1(a)(1), (a)(2), (a)(3), (a)(4), (a)(6), (a)(10)-(a)(12), (b)(1), (b)(3), (c)(1), (c)(2), (c)(5), (e)	Applicability	Yes	
~~§63.1(a)(5), (a)(7)-(a)(9), (b)(2), (c)(3), (c)(4), (d)~~	~~Reserved~~	~~No~~	
§63.2	Definitions	Yes	
§63.3	Units and Abbreviations	Yes	
§63.4	Prohibited Activities and Circumvention	Yes	
§63.5	Preconstruction Review and Notification Requirements	Yes	
§63.6(a), (b)(1)-(b)(5), (b)(7), (c)(1), (c)(2), (c)(5), (e)(1)(iii), (f)(2), (f)(3), (g), (i), (j)	Compliance with Standards and Maintenance Requirements	Yes	
~~§63.6(e)(1)(i) and (ii), (e)(3), and (f)(1)~~	~~Startup, Shutdown and Malfunction Requirements (SSM)~~	~~No~~	~~Subpart EEEEEEE standards apply at all times.~~
~~§63.6(h)(1), (h)(2), (h)(4),(h)(5)(i), (ii), (iii) and (v), (h)(6)-(h)(9)~~	~~Compliance with Opacity and Visible Emission Limits~~	~~No~~	~~Subpart EEEEEEE does not contain opacity or visible emission limits.~~
~~§63.6(b)(6), (c)(3), (c)(4), (d), (e)(2), (e)(3)(ii), (h)(3), (h)(5)(iv)~~	~~Reserved~~	~~No~~	
§63.7, except (e)(1)	Applicability and Performance Test Dates	Yes	
~~§63.7(e)(1)~~	~~Performance Testing Requirements Related to SSM~~	~~No~~	
§63.8(a)(1), (b)(1), (f)(1)-(5), (g)	Monitoring Requirements	Yes	
~~§63.8(a)(2), (a)(4), (b)(2)-(3), (c), (d), (e), (f)(6), (g)~~	~~Continuous Monitoring Systems~~	~~Yes~~	~~Except cross references to SSM requirements in §63.6(e)(1) and (3) do not apply.~~
~~§63.8(a)(3)~~	~~[Reserved]~~	~~No~~	
§63.9(a), (b)(1), (b)(2)(i)-(v), (b)(4), (b)(5), (c), (d), (e), (g), (h)(1)-(h)(3), (h)(5), (h)(6), (i), (j)	Notification Requirements	Yes	
~~§63.9(f)~~		~~No~~	
~~§63.9(b)(3), (h)(4)~~	~~Reserved~~	~~No~~	
§63.10(a), (b)(1), (b)(2)(vi)-(xiv), (b)(3), (c), (d)(1)-(4), (e), (f)	Recordkeeping and Reporting Requirements	Yes	
~~§63.10(b)(2)(i)-(v), (d)(5)~~	~~Recordkeeping/Reporting Associated with SSM~~	~~No~~	
~~§63.10(c)(2)-(c)(4), (c)(9)~~	~~Reserved~~	~~No~~	
~~§63.11~~	~~Control Device Requirements~~	~~No~~	
§63.12	State Authority and Delegations	Yes	
§§63.13-63.16	Addresses, Incorporation by Reference, Availability of Information, Performance Track Provisions	Yes	

The applicable General Provisions are highlighted in Table 1.

2.0 PROCESS DESCRIPTION

The process description can be found in the "Stibnite Gold Project Air Quality Modeling Report" found in Attachment A of this application.

PRI00000379

REC 1719

3.0 PROCESS FLOW DIAGRAM

The process flow diagram can be found in the "Stibnite Gold Project Air Quality Modeling Report" found in Attachment A of this application.

PRI00000380

REC 1720

4.0 REGULATORY ANALYSIS

This section provides a regulatory analysis of the applicable Idaho Air Pollution Rules and Federal regulations to the Midas Gold – SGP. In addition, a few Idaho rules and Federal regulations that could appear to be applicable are discussed and an explanation is provided as to why they have been determined to not apply.

4.1 Rules for the Control of Air Pollution in Idaho

Below is a list of Idaho Administrative Code, IDAPA 58 - Department of Environmental Quality Rules that will apply to the Midas Gold – SGP and require a demonstration of compliance. For each applicable Rule, identification of the emission units to which the rule applies and a statement of how Midas Gold will demonstrate compliance is provided.

58.01.01 - RULES FOR THE CONTROL OF AIR POLLUTION IN IDAHO

123. CERTIFICATION OF DOCUMENTS.

All documents, as stated in 58.01.01.123, will contain a certification by a Midas Gold responsible official. The certification will state that, based on information and belief formed after reasonable inquiry, the statements and information in the document are true, accurate, and complete.

157. TEST METHODS AND PROCEDURES.

Midas Gold will follow all testing procedures and requirements specified in 58.01.01.157 for each performance test conducted to comply with the requirements of the PTC or with state or federal regulations.

200. PROCEDURES AND REQUIREMENTS FOR PERMITS TO CONSTRUCT. [200 THROUGH 228]

Midas Gold is proposing to construct a new non-major facility, and therefore, all requirements specific to major facilities or major modifications do not apply.

201. PERMIT TO CONSTRUCT REQUIRED.

In accordance with 58.01.01.201, Midas Gold will obtain a PTC prior to commencing construction of any stationary source.

202. APPLICATION PROCEDURES.

In accordance with 58.01.01.202, Midas Gold is submitting this application for a PTC for a new non-major facility. This application uses the forms furnished by the IDEQ and attempts to provide all required information in the appropriate application sections and attachments.

PRI00000381

REC 1721

202.01.a.ii. Schedule for Construction

Midas Gold is seeking a PTC in hopes of commencing construction in June 2021. This schedule is tentative and is primarily dictated by the issuance of the final record of decision on the U.S. Forest Service Environmental Impact Statement.

203. PERMIT REQUIREMENTS FOR NEW AND MODIFIED STATIONARY SOURCES.

In accordance with 58.01.01.203, the "Stibnite Gold Project Air Quality Modeling Report" provided in Attachment A, demonstrates that the proposed Midas Gold – SGP will be in compliance with all applicable emission standards, National Ambient Air Quality Standards (NAAQS), and the TAP increments.

209. PROCEDURE FOR ISSUING PERMITS.

Midas Gold reviewed the procedure for issuing permits with the IDEQ during the pre-application meeting on April 4, 2019.

210. DEMONSTRATION OF PRECONSTRUCTION COMPLIANCE WITH TOXIC STANDARDS.

A detailed analysis of the quantification of TAP emission rates and ambient concentrations, if applicable, as well as a demonstration of preconstruction compliance can be found in the "Stibnite Gold Project Air Quality Modeling Report" found in Attachment A of this application. A summary of the facility-wide potential TAP emissions with a determination of compliance/modeling applicability is provided in Table 5 of the "Stibnite Gold Project Air Quality Modeling Report." Further discussion of the TAP analyses is provided under Sections 585 and 586 below.

210.20. NSPS and NESHAP Sources

In accordance with 58.01.01.210.20.b, TAPs regulated by the EPA at the time of permit issuance under 40 CFR part 60 or 40 CFR part 63, do not require further procedures for demonstrating preconstruction compliance for those TAPs as part of the application process, provided that the PTC contains provisions implementing the applicable federal standards, as requested by Midas Gold.

Diesel internal combustion engine HAP emissions are regulated by NESHAP, Subpart ZZZZ and are, therefore, exempt from further TAP analysis. Midas Gold is proposing to operate three emergency generators (Source IDs EDG1, EDG2, and EDG3) and one fire pump (Source ID EDFP) subject to NESHAP, Subpart ZZZZ. In addition, mercury emissions from the Gold Mine Ore Processing and Production affected sources are regulated by NESHAP, Subpart EEEEEEE (NESHAP, Subpart 7E), and are therefore exempt from further TAP analysis. Midas Gold is

PRI00000382

REC 1722

proposing to operate an autoclave (Source ID AC) and refinery (Source IDs CKD, EW, MR, and MF) subject to NESHAP, Subpart 7E.

211. CONDITIONS FOR PERMITS TO CONSTRUCT.

Midas Gold understands that the IDEQ may impose any reasonable conditions upon approval, including conditions, as described in 58.01.01.211.01, for sampling, instrumentation to monitor and record emissions data, instrumentation for ambient monitoring and any other sampling as deemed reasonable. In addition, Midas Gold understands that the IDEQ may cancel a PTC if construction has not begun within two years from date of issuance, or if during the construction, work is suspended for one year. Midas Gold will provide written notification to the IDEQ of the anticipated date of initial start-up and the actual date of initial start-up of the stationary source within the timelines specified in 58.01.01.211.03. Should the IDEQ require performance testing at the SGP, it will be conducted in accordance with 58.01.01.211.04.

212. OBLIGATION TO COMPLY.

In accordance with 58.01.01.212, Midas Gold will comply with all applicable local, state and federal statutes, rules and regulations.

215. MERCURY EMISSION STANDARD FOR NEW OR MODIFIED SOURCES.

In accordance with 58.01.01.215.01, the Midas Gold is exempt from the requirements of 58.01.01.215 as the autoclave (Source ID AC) and refinery (Source IDs CKD, EW, MR, and MF) are within a source category subject to 40 CFR part 63 (i.e., subject to NESHAP, Subpart 7E).

224. PERMIT TO CONSTRUCT APPLICATION FEE.

In accordance with 58.01.01.224, Midas Gold will pay a PTC application fee of $1,000 for this application.

225. PERMIT TO CONSTRUCT PROCESSING FEE.

In accordance with 58.01.01.225, Midas Gold will pay a PTC processing fee in the amount of $7,500 for non-major new sources with an increase of emissions of one hundred tons per year or more. Table 14 provides the total increase of regulated pollutant emissions, excluding fugitive emissions, for the SGP.

PRI00000383

REC 1723

Table 14. SGP Regulated Pollutant Emissions Total

Regulated Pollutant	ton/yr *
PM_{10}	56.3
CO	30.5
NO_X	37.9
SO_2	6.5
VOC	4.8
Total	136.0

* Excluding fugitive emissions

226. PAYMENT OF FEES FOR PERMITS TO CONSTRUCT.

In accordance with 58.01.01.226, Midas Gold is submitting the PTC application fee of $1,000 with this application. The PTC processing fee will be paid upon receipt of an assessment from the IDEQ.

300. PROCEDURES AND REQUIREMENTS FOR TIER I OPERATING PERMITS. [300 through 399]

301. REQUIREMENT TO OBTAIN TIER I OPERATING PERMIT.

The proposed autoclave (Source ID AC) and refinery (Source IDs CKD, EW, MR, and MF) will be subject to the NESHAP, Subpart 7E Gold Mine Ore Processing and Production Area Source Category, and Midas Gold will be required to obtain a Part 70 permit for these emissions units per 63.11640(d). Accordingly, per 58.01.01.006.122.c., the SPG will be a Tier I source for these five emission units. As specified in 58.01.01.301.02.b.iv, Tier I sources not located at major facilities do not require a Tier I operating permit until the source becomes a Tier I source as defined under 58.01.01.006. The Tier I application for applicable sources will be submitted in accordance with 58.01.01.313.01.b.

313. TIMELY APPLICATION.

In accordance with 58.01.01.313.01.b., Midas Gold will submit a complete application for an original Tier I operating permit within twelve months after becoming a Tier I source. 40 CFR 70.3(c)(2) specifies that "[f]or any nonmajor source subject to the part 70 program … the permitting authority shall include in the permit all applicable requirements applicable to emissions units that cause the source to be subject to the part 70 program." Therefore, as further outlined in the EPA's July 10, 1995, *White Paper for Streamlined Development of Part 70 Permit Applications*, only the affected sources are required to be included in a Title V (i.e., Tier I) permit.

PRI00000384

REC 1724

400. PROCEDURES AND REQUIREMENTS FOR TIER II OPERATING PERMITS. [400 through 410]

401. TIER II OPERATING PERMIT.

58.01.01.401.02.a.i, requires a Tier II operating permit for any stationary source not subject to Sections 300 through 399 with a PTC which establishes any emission standard different from those in the 58.01.01 rules. At this time, it is believed that Midas Gold will not be required to obtain a Tier II operating permit for the stationary sources not subject to Sections 300 through 399. As discussed above, Midas Gold will submit an application for a Tier I operating permit for the affected sources that are required to obtain a Title V permit. Midas Gold will further discuss the necessary operating permits with the IDEQ after the commencement of operation.

575. AIR QUALITY STANDARDS AND AREA CLASSIFICATION. [575 THROUGH 587]

576. GENERAL PROVISIONS FOR AMBIENT AIR QUALITY STANDARDS.

In accordance with 58.01.01.576, the general provisions for ambient air quality standards will apply to the Midas Gold - SGP.

578. DESIGNATION OF ATTAINMENT, UNCLASSIFIABLE, AND NONATTAINMENT AREAS.

In accordance with 58.01.01.578, the IDEQ has identified Valley County, where the SGP will be located, as in compliance with the NAAQS; therefore, it is classified as an attainment area for all criteria pollutants.

581. PREVENTION OF SIGNIFICANT DETERIORATION (PSD) INCREMENTS.

The proposed SGP does not have facility-wide emissions of any regulated NSR pollutant that exceed 250 tons per year and is not a major stationary source as defined in 40 CFR 52.21(b)(1)(i). Therefore, PSD requirements, including PSD increments, are not applicable to the SGP.

585. TOXIC AIR POLLUTANTS NON-CARCINOGENIC INCREMENTS.

A comparison of the facility-wide potential uncontrolled emissions for each non-carcinogenic TAP to the applicable TAP non-carcinogenic screening emissions levels (EL) can be found in Table 5 of the "Stibnite Gold Project Air Quality Modeling Report" found in Attachment A of this application. The SGP potential uncontrolled emissions exceed the respective non-carcinogenic screening EL for antimony and sulfuric acid. Therefore, TAP analyses were performed to demonstrate compliance with the Acceptable Ambient Concentrations (AAC, 24 hours averaging period) for these pollutants. Results of these analyses are summarized in Table 1 in Attachment A.

PRI00000385

REC 1725

586. TOXIC AIR POLLUTANTS CARCINOGENIC INCREMENTS.

A comparison of the facility-wide potential uncontrolled emissions for each carcinogenic TAP to the applicable TAP carcinogenic screening EL can be found in Table 5 of the "Stibnite Gold Project Air Quality Modeling Report" found in Attachment A of this application. Based on the TAP analysis determination provided in Table 5, the SGP facility-wide potential uncontrolled emissions exceed the respective carcinogenic screening EL for arsenic, cadmium, formaldehyde, and nickel. Therefore, TAP analyses were performed to demonstrate compliance with the Acceptable Ambient Concentrations for Carcinogens (AACC, annual averaging period) for arsenic, cadmium, formaldehyde, and nickel. Results of these analyses are provided in Table 1 of the "Stibnite Gold Project Air Quality Modeling Report".

For the carcinogenic TAPs with facility-wide uncontrolled emissions below the applicable carcinogenic screening EL, per 58.01.01.210.05, no additional compliance demonstration is needed. For arsenic, cadmium, formaldehyde, and nickel, where the uncontrolled ambient concentrations are below the applicable AACC, per 58.01.01.210.06, no additional compliance demonstration is needed.

590. NEW SOURCE PERFORMANCE STANDARDS.

The New Source Performance Standards (NSPS) applicable to the SGP can be found below in Section 4.2 of this application.

591. NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLUTANTS.

The National Emission Standards for Hazardous Air Pollutants (NESHAP) applicable to the SGP can be found below in Section 4.2 of this application.

625. VISIBLE EMISSIONS.

In accordance with 58.01.01.625, Midas Gold will not discharge any air pollutant into the atmosphere from any point of emission for a period or periods aggregating more than three (3) minutes in any sixty (60) minute period which is greater than twenty percent (20%) opacity as determined by this section. Midas Gold will demonstrate compliance with this rule by conducting periodic visible emissions observations and EPA Method 9 opacity testing, with opacity calculated as specified in 58.01.01.625.04.b, as required in the PTC.

650. RULES FOR CONTROL OF FUGITIVE DUST.

In accordance with 58.01.01.650, Midas Gold will take reasonable precautions to prevent fugitive particulate matter from becoming airborne at the SGP. Midas Gold will develop a Fugitive Dust Control Plan to include good operating practices and reasonable precautions as described in 58.01.01.651.

675. FUEL BURNING EQUIPMENT -- PARTICULATE MATTER. [675 through 681]

676. STANDARDS FOR NEW SOURCES.

In accordance with 58.01.01.676, Midas Gold will not discharge into the atmosphere from any fuel burning equipment with a maximum rated input of 10 MMBtu/hr or more, particulate matter in excess of the concentrations shown below. Table 15 provides the PM standards that apply to each fuel burning equipment proposed to be installed at SGP. The compliance demonstration for the sources greater than 10 MMBtu/hr can be found in the detailed emission inventory conversions worksheet.

677. STANDARDS FOR MINOR AND EXISTING SOURCES.

In accordance with 58.01.01.677, Midas Gold will not discharge into the atmosphere from any fuel burning equipment with a maximum rated input of less than 10 MMBtu/hr, particulate matter in excess of the concentrations shown below. Table 15 provides the PM standards that apply to each fuel burning equipment proposed to be installed at SGP. The compliance demonstration for the sources less than 10 MMBtu/hr can be found in the detailed emission inventory conversions worksheet.

Table 15. SGP Fuel Burning Equipment PM Standards

Source ID	Description	Rating	Fuel	PM Standard gr/dscf	IDAPA 58.01.01 Citation
Sb1	Sb Dryer	2.72 MMBtu/hr	Propane	0.015	§677
ACB	POX Boiler	17 MMBtu/hr	Propane	0.015	§676
CKB	Carbon Regeneration Kiln (Burners)	2.255 MMBtu/hr	Propane	0.015	§677
PV	Propane Vaporizer	0.4 MMBtu/hr	Propane	0.015	§677
HS	Strip Circuit Solution Heater	5 MMBtu/hr	Propane	0.015	§677
H1M	Mine Air Heater #1	4 MMBtu/hr	Propane	0.015	§677
H2M	Mine Air Heater #2	4 MMBtu/hr	Propane	0.015	§677
HM	Mill HVAC Heaters	4 x 1.0 MMBtu/hr	Propane	0.015	§677
HAC	Autoclave HVAC Heater	0.25 MMBtu/hr	Propane	0.015	§677
HR	Refinery HVAC Heater	0.25 MMBtu/hr	Propane	0.015	§677
HA	Admin HVAC Heaters	0.25 MMBtu/hr	Propane	0.015	§677
HMO	Mine Ops. HVAC Heaters	2 x 0.25 MMBtu/hr	Propane	0.015	§677
HTS	Truck Shop HVAC Heaters	2 x 1.0 MMBtu/hr	Propane	0.015	§677
HW	Warehouse HVAC Heaters	3 x 1.0 MMBtu/hr	Propane	0.015	§677
LKC	PFR Shaft Lime Kiln Combustion	22.0 MMBtu/hr	Propane	0.015	§676
EDG1	Camp Emergency Generator	1,000 kW (9.39 MMBtu/hr)	Diesel	0.050	§677
EDG2	Plant Emergency Generator #1	1,000 kW (9.39 MMBtu/hr)	Diesel	0.050	§677

Source ID	Description	Rating	Fuel	PM Standard gr/dscf	IDAPA 58.01.01 Citation
EDG3	Plant Emergency Generator #2	1,000 kW (9.39 MMBtu/hr)	Diesel	0.050	§677
EDFP	Mill Fire Pump	200 kW (1.88 MMBtu/hr)	Diesel	0.050	§677

PRI00000388

REC 1728

700. PARTICULATE MATTER -- PROCESS WEIGHT LIMITATIONS. [700 through 703]

In accordance with 58.01.01.700.02, no source shall be required to meet a particulate emission limit of less than one pound per hour.

701. PARTICULATE MATTER -- NEW EQUIPMENT PROCESS WEIGHT LIMITATIONS.

In accordance with 58.01.01.701, Midas Gold will not emit into the atmosphere from any process or process equipment, particulate matter in excess of the amounts shown by the equations in section 701.a and 701.b. This weight limitation does not apply to fuel burning equipment.

Per 58.01.01.006.94, process weight is defined as the total weight of all materials introduced into any source operation which may cause any emissions of particulate matter. Process weight includes solid fuels charged, but does not include liquid and gaseous fuels charged or combustion air. Water which occurs naturally in the feed material shall be considered part of the process weight.

This particulate matter weight limitation will apply to various processes at the SGP. The compliance demonstration for the sources subject can be found in the detailed emission inventory "Process Activity and Emissions" sheets.

725. RULES FOR SULFUR CONTENT OF FUELS.

In accordance with 58.01.01.725, Midas Gold will only use ASTM Grade 2 distillate fuel oil containing no more than 0.5% by weight of sulfur. Midas Gold plans to use ultra-low sulfur diesel with a maximum sulfur content of 15 ppm (0.0015% by weight). They will demonstrate compliance with the distillate fuel oil sulfur content limit by only purchasing ultra-low sulfur diesel.

790. RULES FOR THE CONTROL OF NONMETALLIC MINERAL PROCESSING PLANTS. [790 through 799]

791. GENERAL CONTROL REQUIREMENTS.

In accordance with 58.01.01.791, Midas Gold will take reasonable precautions to prevent the generation of fugitive dust from the nonmetallic mineral processing plant at the SGP.

792. EMISSIONS STANDARDS FOR NONMETALLIC MINERAL PROCESSING PLANTS SUBJECT TO 40 CFR 60, SUBPART OOO.

Midas Gold is proposing to operate a nonmetallic mineral processing plant at the SGP that is subject to NSPS, Subpart OOO. The emission units included in the nonmetallic mineral processing plant are shown in Table 17. As detailed below in Section 4.2 of this application,

PRI00000389

REC 1729

Midas Gold will comply with all applicable emissions standards, monitoring requirements, test methods and procedures, and reporting and recordkeeping requirements of Subpart OOO.

4.2 Applicable Federal Regulations

The sections that follow provide an explanation for the NSPS part 60, and the NESHAP part 63 subparts from the Code of Federal Regulations (CFR) that are applicable to the Midas Gold – Stibnite Gold Project. The Federal Rule Applicability (Form FRA) has been provided in Section 1.13 of the application forms, along with the detailed regulatory review.

4.2.1 NSPS, Subpart LL – Standards of Performance for Metallic Mineral Processing Plants

Midas Gold is proposing to operate a metallic mineral processing plant at the Stibnite Gold Project, where they will operate a combination of equipment to produce gold and silver concentrates from ore. Therefore, the provisions of NSPS, Subpart LL will be applicable per §60.380(a). The metallic mineral processing plant will include crushers, conveyor belt transfer points, and a truck unloading station. The proposed metallic mineral processing plant will be subject to the requirements of this subpart as it will commence construction after August 24, 1982, per §60.380(b). Table 16 lists all the affected facilities subject to NSPS, Subpart LL.

Table 16. NSPS, Subpart LL Sources

Source ID	Description	Source Type
OC1	Loader Transfer of Ore to Grizzly	Truck Unloading Station
OC2	Grizzly to Apron Feeder	Conveyor Belt Transfer Point
OC3	Apron Feeder to Dribble Conveyor	Conveyor Belt Transfer Point
OC4	Apron Feeder to Vibrating Grizzly	Conveyor Belt Transfer Point
OC5	Dribble Conveyor to Vibrating Grizzly	Conveyor Belt Transfer Point
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	Conveyor Belt Transfer Point
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	Crusher
OC9	Stockpile Transfers to Reclaim Conveyors	Conveyor Belt Transfer Point
OC10	Reclaim Conveyers to SAG Mill Feed Conveyor	Conveyor Belt Transfer Point
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	Conveyor Belt Transfer Point
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	Crusher
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	Conveyor Belt Transfer Point

PRI00000390

REC 1730

Based on the definition found in §60.381, a conveyor belt transfer point means a point in the conveying operation where the metallic mineral or metallic mineral concentrate is transferred to or from a conveyor belt ***except where the metallic mineral is being transferred to a stockpile***. Therefore, Source ID OC8, Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile is not subject to NSPS, Subpart LL.

4.2.2 NSPS, Subpart OOO – Standards of Performance for Nonmetallic Mineral Processing Plants

Midas Gold is proposing to operate a nonmetallic mineral processing plant at the Stibnite Gold Project, where they will process limestone. Therefore, the provisions of NSPS, Subpart OOO will be applicable per §60.670(a)(1). The limestone mineral processing will consist of a primary and secondary crusher, a primary and secondary screening operation, a ball mill, storage bins and conveyors. The proposed nonmetallic mineral processing plant will be subject to the requirements of this subpart as it will commence construction after August 31, 1983 per §60.670(e). Table 17 list all the affected facilities subject to NSPS, Subpart OOO.

Table 17. NSPS, Subpart OOO Sources

Source ID	Description	Source Type	Control
LS1	Limestone transfer to Primary Crusher Hopper	Storage Bin	None
LS2	Primary Crushing and Associated Transfers In and Out	Crusher	None
LS3	Primary Screening and Associated Transfers In and Out	Screen	None
LS4	Secondary Crushing and Associated Transfers In and Out	Crusher	None
LS5	Secondary Screening and Associated Transfers In and Out	Screen	None
LS6	Limestone transfer to Ball Mill Feed Bin	Conveyor & Storage Bin	None
LS7	Limestone transfer to Ball Mill Feed Conveyor	Conveyor	None
LS8	Ball Mill Feed transfer to Ball Mill	Conveyor	None
LSBM	Limestone Ball Mill	Grinding Mill	Baghouse (BH3)
LS9	Limestone transfer to Kiln Feed Bin	Conveyor & Storage Bin	None
LS10	Limestone transfer to Lime Kiln Feed Conveyor	Conveyor	None
LS11	Fines Screening and Associated Transfers In and Out	Screen	None
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	Conveyor	None

PRI00000391

REC 1731

Per §60.672(d), truck dumping into a feed hopper is exempt from the standards for particulate matter provided in §60.672. Therefore, Source ID LS1, Limestone transfer to Primary Crusher Hopper, is not subject to the emission limits and compliance requirements in Table 3 of NSPS, Subpart OOO.

Midas Gold is also proposing to operate a cement batch plant that will include an aggregate storage bin, which will process nonmetallic minerals, however, the cement batch plant does not meet the definition per §60.671 of a nonmetallic mineral processing plant as it does not include any crushing or grinding. Therefore, Source IDs CAL and CAU, Aggregate Bin Loading and Aggregate Bin Unloading, are not subject to NSPS, Subpart OOO.

In addition, certain construction and maintenance activities during operations may require sized aggregate. To allow for the operational flexibility to produce construction aggregate onsite, Midas Gold is including two portable crushing and screening plants in this application. Each portable plant may include primary and secondary crushers and screens, and multiple conveyors. Each portable plant will be rated at less than 150 ton/hr and therefore exempt from requirements of this subpart per §60.670(c)(2). Therefore, Source IDs PCSP1 and PCSP2, Portable Crushing and Screening Plants 1 and 2, are not subject to NSPS, Subpart OOO.

4.2.3 NSPS, Subpart IIII – Standards of Performance for Stationary Compression Ignition Internal Combustion Engines

Midas Gold proposes to own and operate at the Stibnite Gold Project, three emergency stationary compression ignition (CI) internal combustion engines (ICE) that will be subject to NSPS, Subpart IIII per §60.4200(a)(2)(i) as they will commence construction after July 11, 2005, will be manufactured after April 1, 2006, and are not fire pumps. In addition, Midas Gold proposes to own and operate at the Stibnite Gold Project, one stationary fire pump CI ICE, that will be subject to this subpart per §60.4200(a)(2)(ii) as it will commence construction after July 11, 2005, and will be manufactured as a certified NFPA fire pump engine after July 1, 2006. Table 18 list all the sources subject to NSPS, Subpart IIII.

Table 18. NSPS, Subpart IIII Sources

Source ID	Description	Power Rating kW	Displacement
EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	1,000	<10 l/cylinder
EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	1,000	<10 l/cylinder
EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	1,000	<10 l/cylinder
EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	200	<10 l/cylinder

PRI00000392

REC 1732

4.2.4 NESHAP, Subpart ZZZZ – National Emissions Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines

NESHAP, Subpart ZZZZ, applies to all stationary reciprocating internal combustion engines (RICE) operated at a major or area source of HAP emissions. For new (constructed after June 12, 2006, per §63.6590(a)(2)(iii)) stationary CI RICE operated at an area source of HAP emissions, the compliance requirements of NESHAP, Subpart ZZZZ, are met by complying with the requirements of NSPS, Subpart IIII per §63.6590(c)(1). No further requirements apply under NESHAP.

The Midas Gold proposes to own and operate at the Stibnite Gold Project, three emergency stationary and one stationary fire pump CI ICE that will be subject to NSPS, Subpart IIII. These stationary CI RICEs will be classified as new sources under NESHAP, Subpart ZZZZ, and therefore will meet the requirements of Subpart ZZZZ by meeting the requirements of NSPS, Subpart IIII.

4.2.5 NESHAP, Subpart CCCCCC – National Emission Standards for Hazardous Air Pollutants for Source Category: Gasoline Dispensing Facilities

Midas Gold is proposing to operate two Gasoline Dispensing Facilities (GDF) at the Stibnite Gold Project, and as an area source, will be subject to NESHAP, Subpart CCCCCC (NESHAP, Subpart 6C) per §63.11111(a). Each GDF will be an affected source subject to this subpart. It is proposed that the Stibnite Gold Project will have two GDFs, each with a monthly throughput of greater than 10,000 gallons but less than 100,000 gallons and must comply with the requirements in §63.11117 per §63.11111(c). Table 19 list all the sources subject to NESHAP, Subpart 6C.

Table 19. NESHAP, Subpart 6C Sources

Source ID	Description	Capacity gal	Throughput gal/month
TG1	Mine Site Gasoline Tank #1	5,000	20,833
TG2	Mine Site Gasoline Tank #2	5,000	20,833

4.2.6 NESHAP, Subpart EEEEEEE – National Emission Standards for Hazardous Air Pollutants: Gold Mine Ore Processing and Production Area Source Category

Midas Gold is proposing to operate a gold mine ore processing and production facility at the Stibnite Gold Project, and as an area source, will therefore be subject to NESHAP, Subpart EEEEEEE (NESHAP, Subpart 7E) per §63.11640(a). The affected sources are each collection of

PRI00000393

REC 1733

"ore pretreatment processes" at a gold mine ore processing and production facility, and each collection of "carbon processes with mercury retorts" at a gold mine ore processing and production facility, per §63.11640(b). The affected sources will be new as they will commence construction after April 28, 2010, per §63.11640(b)(2). Midas Gold will be required to obtain a permit under 40 CFR part 70 (i.e., Title V permit) for the affected sources subject to this subpart, per §63.11640(d). Table 20 lists all the sources subject to NESHAP, Subpart 7E.

Table 20. NESHAP, Subpart 7E Sources

Source ID	Description	Affected Source
CKD	Carbon Regeneration Kiln (Drum)	Carbon Processes with Mercury Retorts
EW	Electrowinning Cells & Pregnant Solution Tank	Carbon Processes with Mercury Retorts
MR	Mercury Retort	Carbon Processes with Mercury Retorts
MF	Induction Melting Furnace	Carbon Processes with Mercury Retorts
AC	Autoclave	Ore Pretreatment Processes

4.3 Inapplicable Federal Regulations

The sections that follow provide an explanation for a few federal regulations that could appear to be applicable to the Midas Gold – Stibnite Gold Project but have been determined to not apply.

4.3.1 NSPS, Subpart Dc – Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units

In accordance with §60.40c(a), the affected facility to which NSPS, Subpart Dc applies is each steam generating unit for which construction, modification, or reconstruction is commenced after June 9, 1989 and that has a maximum design heat input capacity of 100 million British thermal units per hour (MMBtu/hr) or less, but greater than or equal to 10 MMBtu/hr.

Based on the definitions in §60.41c, a steam generating unit means a device that combusts any fuel and produces steam or heats water or heats any heat transfer medium. ***This term does not include process heaters as defined in this subpart.*** A process heater means a device that is primarily used to heat a material to initiate or promote a chemical reaction in which the material participates as a reactant or catalyst.

Midas Gold is proposing to install a 17 MMBtu/hr Pressure Oxidation (POX) Boiler, however this boiler meets the definition of a process heater because the steam produced by the boiler acts as a catalyst to promote the oxidation of the refractory ore by increasing the temperature and pressure in the autoclave. The purpose of the boiler is to heat the ore to cause oxidation of the sulfide minerals.

PRI00000394

REC 1734

Midas Gold is also proposing to install a 22.0 MMBtu/hr Parallel Flow Regenerative (PFR) shaft lime kiln, that will combust propane to provide heat for the calcination of limestone to produce lime. Because the kiln does not produce steam or heat any heat transfer medium, it does not meet the definition of steam generating unit.

Therefore, NSPS, Subpart Dc does not apply to the POX Boiler, PFR Shaft Lime Kiln, nor any other units proposed to be installed at the Midas Gold – Stibnite Gold Project.

4.3.2 NSPS, Subpart HH - Standards of Performance for Lime Manufacturing Plants

In accordance with §60.340(a), NSPS, Subpart HH does not apply to the proposed PFR Shaft Lime Kiln, as this kiln is not a rotary lime kiln as defined in §60.341(d).

4.3.3 NSPS, Subpart OOO - Standards of Performance for Nonmetallic Mineral Processing Plants

NSPS, Subpart OOO is applicable to nonmetallic mineral processing plants that process limestone, but not to equipment that handles or processes lime. The following excerpts from the EPA Applicability Determination Index (ADI) clarify this interpretation:

- ADI Control Number NR14:
    - Abstract:

      Does Subpart OOO apply to a process which pneumatically conveys crushed lime into lime storage silos and exhausting the displaced air through a small baghouse?

      There is no equipment used to crush or grind any non-metallic mineral at this plant. Therefore, the plant is not classified as a non-metallic mineral processing plant, and Subpart OOO does not apply to this lime storage silo facility.
- ADI Control Number 0400016:
    - Abstract:

      Q: Is the processing of lime product at the Greer Lime Company in Riverton, West Virginia subject to 40 CFR part 60, subpart OOO?

      A: No, equipment used to process lime product is not subject to New Source Performance Standards (NSPS) subpart OOO.

PRI00000395

REC 1735

Q: Is a limestone dryer at the Greer Lime Company in Riverton, West Virginia subject to 40 CFR part 60, subpart UUU?

A: No, limestone is not a listed mineral in the definition of a "mineral processing plant," as defined in section 60.730, and therefore is not subject to NSPS subpart UUU.

Table 21 list the lime handling and processing sources that are not subject to NSPS, Subpart OOO.

Table 21. Sources Not Subject to NSPS, Subpart OOO

Source ID	Description
MillS2L	Mill Lime Silo #2 Loading
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor
ACS1L	AC Lime Silo #1 Loading
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker
ACS2L	AC Lime Silo #2 Loading
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker
ACS3L	AC Lime Silo #3 Loading
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker
ACS4L	AC Lime Silo #4 Loading
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker
LCR	Lime Mill Crushing and associated transfers In and Out
LSL	Pebble Lime Silo Loading via Bucket Elevator
LSU	Pebble Lime Silo discharge to Lime Slaker

4.3.4 NESHAP, Subpart AAAAA (5A) – National Emission Standards for Hazardous Air Pollutants for Lime Manufacturing Plants

In accordance with §63.7081(a), NESHAP, Subpart AAAAA does not apply to the Stibnite Gold Project as Midas Gold is not proposing to operate a lime manufacturing plant (LMP) that is a major source, or that is located at, or is part of, a major source of hazardous air pollutant (HAP) emissions.

4.3.5 40 CFR Part 70 – Title V Permitting Program

As discussed in Section 4.2.6, the sources subject to NESHAP, Subpart EEEEEEE are required to obtain a Title V permit. However, this requirement is limited to these affected sources because

PRI00000396

REC 1736

the Stibnite Gold Project is a nonmajor source. Per 40 CFR 70.3(c)(2): "For any nonmajor source subject to the part 70 program under paragraph (a) or (b) of this section, the permitting authority shall include in the permit all applicable requirements applicable to emissions units that cause the source to be subject to the part 70 program." Therefore, all other emissions units that do not cause the source to be subject to the part 70 program do not require a Title V permit.

PRI00000397

REC 1737

5.0 AMBIENT IMPACT ASSESSMENT

The "Stibnite Gold Project Air Quality Modeling Protocol" was submitted to IDEQ on May 24, 2019. IDEQ provided comments on June 27, 2019, and stated that "*DEQ modeling staff considers the submitted dispersion modeling protocol, with consideration and resolution of the additional items noted above, to be approved*." In accordance with the "State of Idaho Guideline for Performing Air Quality Impact Analyses," Air Sciences has prepared an air quality analysis report, showing the project's compliance with the applicable ambient standards. The "Stibnite Gold Project Air Quality Modeling Report" can be found in Attachment A of this application.

PRI00000398

REC 1738

Attachment A – Ambient Impact Assessment: Stibnite Gold Project Air Quality Modeling Report

AIR SCIENCES INC.

DENVER • PORTLAND • LOS ANGELES

Attachment A

Stibnite Gold Project

Air Quality Modeling Report

PREPARED FOR:
MIDAS GOLD IDAHO, INC.

PROJECT NO. 335-1-4
JUNE 23, 2020

TABLE OF CONTENTS

List of Abbreviations vi
1.0 Summary 1
2.0 Project Description and Background as it Relates to Modeling Analyses 3
2.1 General Facility/Project Description 3
2.2 Location of Project 7
2.3 Site Characteristics 10
2.4 Site Attainment Status and Ambient Air Quality Standards 11
2.5 Coordinate System 11
2.6 Existing Permits and Modeling Analyses Performed 11
3.0 Modeling Analyses Applicability and Protocol 12
3.1 Applicable Standards 14
3.2 Criteria Pollutant Modeling Applicability 15
3.3 TAP Modeling Applicability 15
3.4 Modeling Protocol 15
4.0 Modeled Emissions Sources 17
4.1 Emission Factors and Controls 20
4.1.1 Emission Factors 20
4.1.2 Emission Controls 23
4.2 Pollutant Emissions 26
4.3 Modeling Scenarios 26
4.4 Modeled Sources and Characterization 29
4.4.1 Processing, Refining, and Ancillary Sources 29
4.4.2 Fugitive Sources: Blasting, Material Origin and Destination and Underground Exploration Emissions 29
4.4.3 Fugitive Sources: Haul Roads 33
4.4.4 Fugitive Sources: Burntlog Route Access Road 36
4.5 Short- and Long-Term Emissions for Model Input 36
4.6 Criteria Pollutants 36
4.6.1 Modeled Emission Rates for Significant Impact Level Analyses 37
4.6.2 Modeled Emission Rates for Cumulative Impact Analyses 37
4.6.3 NO_2/NO_X Ratio for NO_X Chemistry Modeling 38

PRI00000401

REC 1741

4.6.4 Special Methods for Modeling Criterial Pollutant Emissions 38
4.7 Toxic Air Pollutants 38
4.8 Emission Release Parameters 42
5.0 Modeling Methodology 51
5.1 Model Selection 51
5.2 Meteorological Data 52
5.2.1 Surface Characteristics for AERMET Processing 52
5.3 Effects of Terrain 57
5.4 Facility Layout 57
5.5 Effects of Building Downwash 57
5.6 Ambient Air Boundary 57
5.7 Receptor Network 61
5.8 Background Concentrations 63
5.8.1 Onsite Particulate Monitoring 63
5.8.2 Gaseous Pollutant Background Concentrations 63
5.8.3 Medium Traffic Pollutant Background Concentrations 65
5.9 NOx Chemistry 65
5.9.1 Treatment of Intermittent Sources for NO_2 1-Hour Analyses 66
5.10 Particulate Deposition 67
5.11 Mobile Equipment Tailpipe Emissions 71
6.0 Results and Discussion 73
6.1 Criteria Pollutant Impact Results 73
6.2 TAP Impact Analyses 75
7.0 Quality Assurance/Control 78
8.0 References 79

Tables

Table 1. Modeling Analyses Results Summary 2
Table 2. Process and Ancillary Source Potential Emissions Summary (ton/yr) 4
Table 3. Project Area Seasonal Temperature, Precipitation, and Snow Depth Data 11
Table 4. Criteria Pollutant Modeling Applicability Determination 12
Table 5. TAP Modeling Applicability Determination 12

PRI00000402

REC 1742

Table 6. Applicable NAAQS for SGP Air Quality Analyses 14
Table 7. Applicable AACC for SGP TAP Analyses 14
Table 8. Mining Activity Rates for Potential Emission Calculations 18
Table 9. Process Source EF from AP-42 20
Table 10. Process Source EF from Similar Source Test Data/Permit Limits or Regulations 21
Table 11. EF Used to Calculate Mining Emissions 22
Table 12. Control Techniques and Efficiencies in Emission Calculations 23
Table 13. Maximum Annual Potential Emissions Summary 26
Table 14. Modeling Scenarios for $PM_{2.5}$ and PM_{10} Analyses 28
Table 15. Modeled Fugitive Activity Locations 31
Table 16. Model Input Parameters for Fugitive Activity Locations 31
Table 17. Haul Road Emission Distribution Grid for HFP Scenarios 35
Table 18. Criteria Pollutant Modeled Emission Rates 37
Table 19. NO_2/NO_X Ratios 38
Table 20. Propane Combustion TAP Emission Factors and Emissions 39
Table 21. Cement Handling TAP Emission Factors and Emissions 40
Table 22. Cement Mixer TAP Emission Factors and Emissions 40
Table 23. Ore Processing TAP Concentrations and Emissions 40
Table 24. Stibnite Concentrate Processing Antimony Concentration and Emissions 41
Table 25. Autoclave TAP Emission Factors and Emissions 41
Table 26. Reagent Use TAP Emissions 42
Table 27. TAP Emissions Used for Modeling 42
Table 28. Process and Ancillary Sources Modeled 42
Table 29. Process and Ancillary Sources Modeled as POINT Sources 45
Table 30. Process and Ancillary Sources Modeled as VOLUME Sources 47
Table 31. Key Modeling Parameters 51
Table 32. 2014 Monthly Season and Moisture Classification, and Calculated r and B_o 53
Table 33. Calculated Seasonal z_o Values (m) 54
Table 34. IDEQ-Approved $PM_{2.5}$ and PM_{10} Background Concentrations for SGP 63
Table 35. IDEQ-Recommended Gaseous Pollutant Background Concentrations for SGP 64
Table 36. Medium Traffic Background Concentrations 65
Table 37. References Used to Develop Deposition Parameters 67
Table 38. Deposition Parameters by Source Category 69

PRI00000403

REC 1743

Table 39. Pit-Specific Ore and DR Densities for Deposition 70
Table 40. SGP NAAQS Impact Analyses Results 73
Table 41. SGP NAAQS Impact Analyses Results with Medium Traffic Background Concentrations 74
Table 42. SGP TAP Analyses Results 75

Figures

Figure 1. Ore Processing and Refining Flow Diagram 5
Figure 2. Lime Production Flow Diagram 6
Figure 3. SGP Facility Location Map 8
Figure 4. SGP Site Layout and Stibnite Road Access Route 9
Figure 5. Processing and Refining Area Building and Source Layout 30
Figure 6. Haul Road Network and Sections 34
Figure 7. Wind Frequency Distribution for 2014 SGP Meteorological Data 55
Figure 8. Meteorological Station Locations for SGP Modeling 56
Figure 9. SGP Operations Boundary and Modeling Receptor Grid 62
Figure 10. SGP Cumulative Impacts (µg/m^3) and Locations 76
Figure 11. SGP TAP Impacts (µg/m^3) and Locations 77

Appendix A – Model Parameter / Assumption / Data Level of Conservatism IDEQ Forms
Appendix B – Emissions Inventory and Modeling Parameters
Appendix C – Modeling Scenario Result Tables
Appendix D – Electronic Files
Attachment 1 – Modeling Protocol and IDEQ Approval
Attachment 2 – Stibnite Road Access Management Plan

PRI00000404

REC 1744

LIST OF ABBREVIATIONS

°	Degrees
°F	Degrees Fahrenheit
µg/m^3	Micrograms per Cubic Meter
µm	Microns/Micrometers
AACC	Acceptable Ambient Concentrations for Carcinogens
ADJ_U*	AERMOD Adjusted Friction Velocity Model Option
AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
amsl	Above Mean Sea Level
ANFO	Ammonium Nitrate Fuel Oil
B_o	Bowen Ratio
BNF	Boise National Forest
BPIP	Building Profile Input Program
BT	Bradley Tailings
CAPCOA	California Air Pollution Control Officers Association
CFR	Code of Federal Regulations
CO	Carbon Monoxide
CSIRO	Commonwealth Scientific and Industrial Research Organization
DR	Development Rock
DRSF	Development Rock Storage Facility
EF	Emission Factors
EFSFSR	East Fork of the South Fork of the Salmon River
EL	Screening Emission Levels
EPA	United States Environmental Protection Agency
FDRSF	Fiddle Development Rock Storage Facility

PRI00000405

REC 1745

g/cm^3	Grams per Cubic Centimeter
H_2SO_4	Sulfuric Acid Gas
HAP	Hazardous Air Pollutant
HFDRSF	Hangar Flats Development Rock Storage Facility
HFP	Hangar Flats Pit
Hg	Mercury
IDAPA	Idaho Administrative Procedures Act
IDEQ	Idaho Department of Environmental Quality
in	Inches
km	Kilometers
lb/yr	Pounds per Year
LOM	Life of Mine
m	Meters
MERPs	Modeled Emission Rates for Precursors
mg/m^3	Milligrams per Cubic Meter
Midas Gold	Midas Gold Idaho, Inc.
MM	Million
mph	Miles per Hour
NAAQS	National Ambient Air Quality Standards
NAD83	North American Datum of 1983
NDEP	Nevada Division of Environmental Protection
NESHAP	National Emission Standards for Hazardous Air Pollutants
NO	Nitric Oxide
NO_2	Nitrogen Dioxide
NO_X	Oxides of Nitrogen
NSR	New Source Review

PRI00000406

REC 1746

NW AIRQUEST	Northwest International Air Quality Environmental Science and Technology Consortium
NWS	National Weather Service
O_3	Ozone
OLM	Ozone Limiting Method
Pb	Lead
PM_{10}	Particulate Matter less than 10 Microns in Aerodynamic Diameter
$PM_{2.5}$	Particulate Matter less than 2.5 Microns in Aerodynamic Diameter
PNF	Payette National Forest
ppb	Parts per Billion
ppm	Parts per Million
PRIME	Plume Rise Model Enhancement
PRO	Midas Gold Plan of Restoration and Operations
PTC	Permit to Construct
r	Albedo
SED	Segment Emission Denominator
SGP	Stibnite Gold Project
SO_2	Sulfur Dioxide
STKP	Crusher Stockpile
TAP	Toxic Air Pollutants
ton/day	Tons per Day
ton/yr	Tons per Year
TSF	Tailings Storage Facility
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
VOC	Volatile Organic Compounds
WBAN	Weather-Bureau-Army-Navy

PRI00000407

REC 1747

WEDRSF	West End Development Rock Storage Facility
WEP	West End Pit
YPDRSF	Yellow Pine Development Rock Storage Facility
YPP	Yellow Pine Pit
z_o	Surface Roughness Length

PRI00000408

REC 1748

1.0 SUMMARY

Midas Gold Idaho, Inc., proposes to construct and operate the Stibnite Gold Project in Valley County, Idaho, located approximately 100 miles northeast of Boise. The Stibnite Gold Project is in an area that is classified as in attainment with all criteria pollutants and is designated as a Class II area.

The Stibnite Gold Project will consist of conventional open-pit mining operations and onsite ore preparation and gold extraction processes. The potential air emissions from the Stibnite Gold Project are less than the applicable major source thresholds for both criteria and hazardous air pollutants, and therefore, it is expected to be designated as a minor source for Title V and New Source Review requirements, and an area source for National Emission Standards for Hazardous Air Pollutants applicability.

This air quality analyses report provides a detailed description of methods, techniques, and datasets used by Midas Gold Idaho, Inc. for conducting air quality modeling analyses to fulfill the applicable requirements of Idaho Administrative Procedures Act 58.01.01 – Rules of Control of Air Pollution in Idaho, and to obtain a minor source permit to construct for the Stibnite Gold Project.

The results of modeling analyses provided in this report are summarized in Table 1. All concentrations and standards are listed in units of micrograms per cubic meter ($\mu g/m^3$).

PRI00000409

REC 1749

Table 1. Modeling Analyses Results Summary

Pollutant	Averaging Time	Max. Conc. ($\mu g/m^3$)	Back. Conc. ($\mu g/m^3$)	Total Conc. ($\mu g/m^3$)	NAAQS/ AAC/ AACC ($\mu g/m^3$)	In Compliance
CO	8 hours	6,218	1,110	7,328	10,000	Yes
	1 hour	17,054	1,740	18,794	40,000	Yes
NO_2	1 year	2.3	0.9	3.2	100	Yes
	1 hour	116.7	4.3	121.0	188	Yes
$PM_{2.5}$	1 year	4.2	3.5	7.7	12	Yes
	24 hours	11.0	15.0	26.0	35	Yes
PM_{10}	24 hours	75.7	37.0	112.7	150	Yes
SO_2	3 hours	1.8	16.8	18.6	1,300	Yes
	1 hour	3.2	12.3	15.5	196	Yes
Antimony	24 hours	0.02705	--	0.02705	25	Yes
Arsenic	Annual	0.00008	--	0.00008	0.00023	Yes
Cadmium	Annual	0.00001	--	0.00001	0.00056	Yes
Formaldehyde	Annual	0.00076	--	0.00076	0.077	Yes
Nickel	Annual	0.00006	--	0.00006	0.0042	Yes
Sulfuric Acid	24 hours	0.52563	--	0.52563	50	Yes

Max. Conc. = maximum modeled concentration; Back. Conc. = background concentration; Total Conc. = total (modeled + background) concentration; NAAQS = National Ambient Air Quality Standards; AAC = Acceptable Ambient Concentrations; AACC = Acceptable Ambient Concentrations for Carcinogens; CO = carbon monoxide; NO_2 = nitrogen dioxide; $PM_{2.5}$ = particulate matter less than 2.5 microns; PM_{10} = particulate matter less than 10 microns; SO_2 = sulfur dioxide

Table 1 shows that the estimated ambient air impacts from the Stibnite Gold Project emissions are expected to show compliance with the applicable standards for both criteria and toxic air pollutants.

The organization of this report follows the Idaho Department of Environmental Quality's "Air Impact Modeling Analyses Report Template Form," version 1, July 2015, and addresses the applicable modeling requirements of the Idaho Department of Environmental Quality's modeling guidelines, version September 2013 (IDEQ 2013b).

The checklist statements indicated in the Idaho Department of Environmental Quality report template are included at the end of relevant sections in an *italicized* font.

PRI00000410

REC 1750

2.0 PROJECT DESCRIPTION AND BACKGROUND AS IT RELATES TO MODELING ANALYSES

Midas Gold Idaho, Inc. (Midas Gold) proposes to construct and operate the Stibnite Gold Project (SGP) in Valley County, Idaho. The SGP will consist of conventional open-pit mining operations and onsite ore preparation and gold extraction processes, along with offsite infrastructure that includes a power transmission line and a site access road. A detailed description of the SGP is provided in Midas Gold's Plan of Restoration and Operations (PRO) (Midas Gold 2016), submitted to the relevant reviewing agencies in September 2016. Relevant information from the SGP PRO is provided in this report.

2.1 General Facility/Project Description

The SGP will require the construction of significant infrastructure, including a power transmission line, a primary mine site access road, onsite haul roads, an ore processing facility, onsite workspaces, employee housing and recreation, water storage and distribution facilities, and sewage disposal facilities.

The SGP will include three years of pre-mining development and construction activities, followed by an operating mine life of approximately 12 years. Mining will occur in three open pits: Yellow Pine pit (YPP), Hangar Flats pit (HFP), and West End pit (WEP). The general sequence of mining will be the YPP deposit, followed by the HFP and WEP deposits. Legacy tailings from the Meadow Creek valley (Bradley Tailings [BT]) also will be reclaimed and reprocessed during the initial project schedule. Surface exploration drilling will continue within the pits and the Scout Prospect decline (underground exploration) throughout the mine operation period. Restoration and reclamation of other legacy mining features will occur prior to mining, throughout the life of the mine, and as part of the mine closure.

Conventional open-pit methods including drilling, blasting, excavating, and hauling will be used to extract ore and waste rock, termed development rock (DR). Hydraulic shovels and front-end loaders will be used to load ore and DR into haul trucks. DR will be used for construction, restoration, and backfilling, or hauled to the dedicated development rock storage facilities (DRSF). Approximately 340 million tons of DR will be handled over the life of the mine. Ore will be hauled to the primary crusher area, where it will be fed directly into the crusher dump pocket or stockpiled. The ore crushing plant will be designed to operate at a maximum rate of 25,000 tons per day (ton/day). Approximately 100 million tons of ore will be mined from the three pits over the life of the project.

The metal-recovery process from ore will include conventional crushing and grinding, followed by froth-flotation circuits that will generate separate gold-silver and antimony-silver concentrates. The antimony-silver concentrate will be shipped offsite for refining, whereas

PRI00000411

REC 1751

additional onsite processing of the gold-silver concentrate will include pressure oxidation, carbon-in-leach circuits, and refining processes to recover gold and minor amounts of silver. The finely ground leftover ore material from the mineral-recovery process, termed tailings, will be neutralized, thickened, and transported via a pipeline to the tailings storage facility (TSF). A simplified ore processing and refining flow diagram is presented in Figure 1. This figure also shows the throughput monitoring locations. In some cases, throughput is monitored at process bottlenecks for monitoring a group of sources.

Lime used in the ore processing will either be purchased or manufactured onsite from limestone available at the site. A simplified lime production flow diagram is presented in Figure 2. This figure also shows the throughput monitoring locations. In addition, certain construction and maintenance activities during operations may require sized aggregate. To allow for the operational flexibility to produce construction aggregate onsite, this application includes two portable crushing and screening plants.

The following air pollutants are expected from operations at the SGP facility:

- Criteria air pollutants: carbon monoxide (CO), oxides of nitrogen (NO_X), particulate matter less than 2.5 microns (μm) and 10 μm ($PM_{2.5}$ and PM_{10}), sulfur dioxide (SO_2), lead (Pb), and ozone (O_3) precursor volatile organic compounds (VOC)
- Hazardous air pollutants (HAP), including mercury (Hg)
- Other non-HAP toxic air pollutants (TAP)
- Greenhouse gases

A summary of SGP facility-wide process and ancillary source maximum potential emissions in tons per year (ton/yr) is provided in Table 2. Emission details are provided in Section 4.0.

Table 2. Process and Ancillary Source Potential Emissions Summary (ton/yr)

CO	NO_X	$PM_{2.5}$	PM_{10}	SO_2	VOC	HAP[1]
30.5	37.9	36.4	56.3	6.5	4.8	1.79

[1] Maximum facility-wide potential emissions for all HAP combined, maximum single HAP emissions are 0.97 ton/yr for cyanide compounds.

The potential emissions from the SGP are less than the applicable major source thresholds for both criteria (100 ton/yr per pollutant) and hazardous air pollutants (HAP) (25 ton/yr aggregate and 10 ton/yr per single HAP); therefore, it is expected to be designated a minor source for Title V and New Source Review (NSR) (applicable threshold is 250 ton/yr per criteria pollutant) requirements and an area source for National Emission Standards for Hazardous Air Pollutants (NESHAP) applicability.

PRI00000412

REC 1752

Figure 1. Ore Processing and Refining Flow Diagram

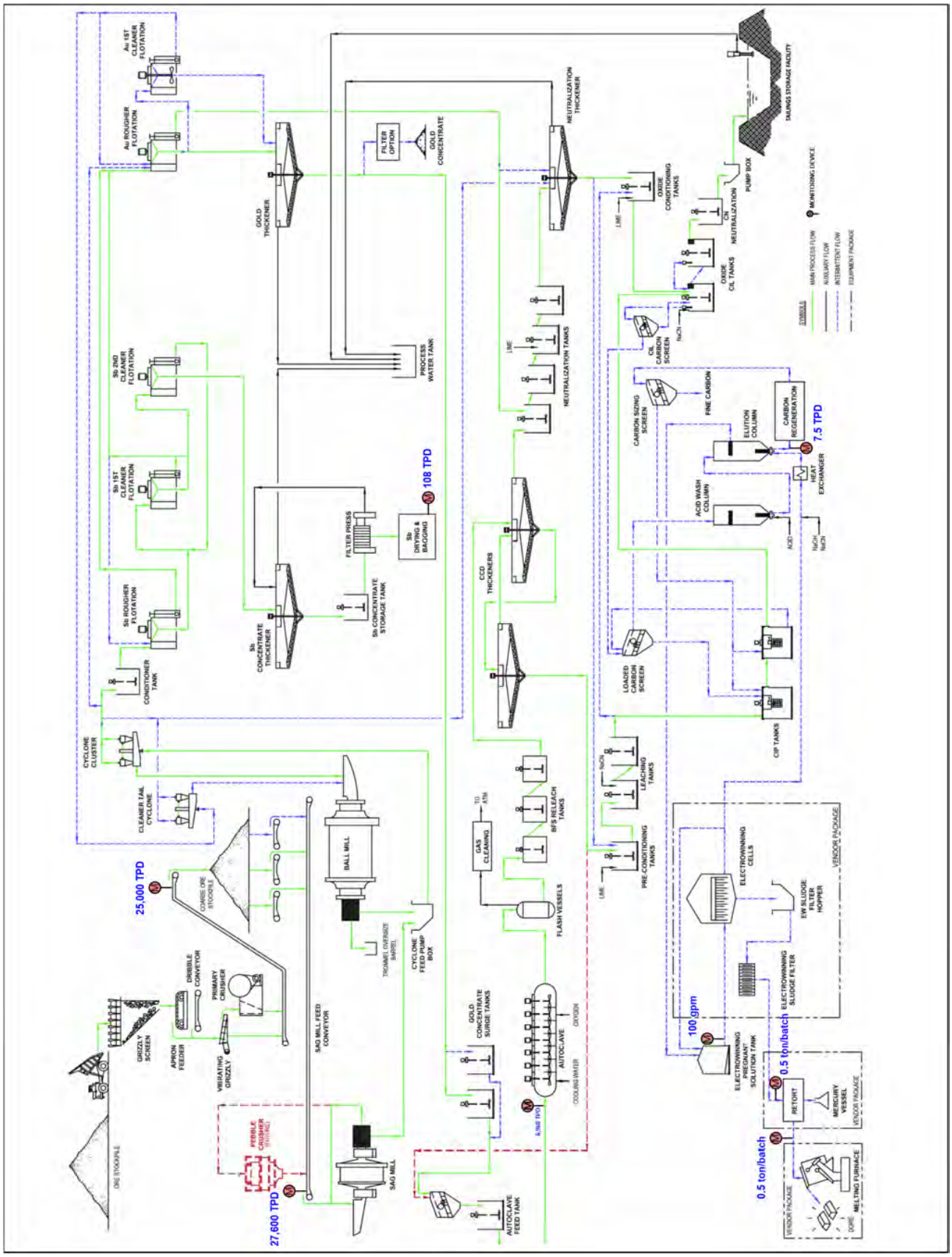
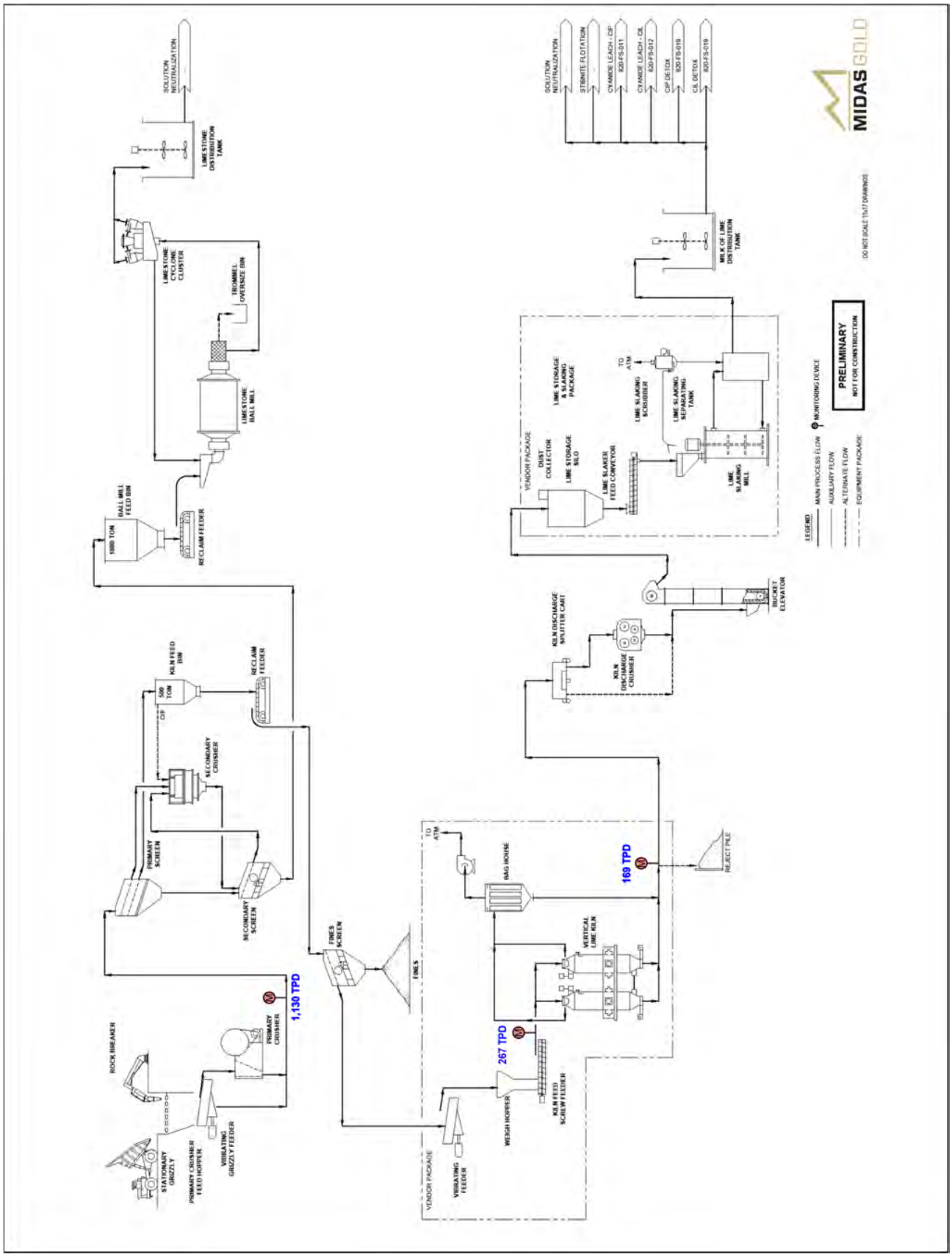


Figure 2. Lime Production Flow Diagram



2.2 Location of Project

The SGP is located in Valley County in central Idaho, approximately 100 miles northeast of Boise, 38 miles east of McCall, and approximately 10 miles east of Yellow Pine. A facility location map for the SGP is presented in Figure 3. This figure also shows the proposed Burntlog Route (access road) that will provide a year-round safe access to the site. The project area comprises a combination of public national forest and private lands. The SGP PRO comprises a comprehensive restoration, operation, and reclamation plan by which an existing heavily disturbed brownfield site will be redeveloped, old tailings will be reprocessed, and the habitat will be enhanced to help rehabilitate an important salmon fishery. Simultaneously, the local economy of Valley County in particular, and of Idaho as a whole, will improve. Over the years, Midas Gold has conducted extensive technical studies to determine the environmental, social, and economic feasibility of redeveloping the SGP. The results of these studies are detailed in the SGP PRO.

The SGP site layout is presented in Figure 4.

☒ *A map showing the geographical location of the facility is provided in this section or a reference is provided to another location in the application where a map is provided.*

PRI00000415

REC 1755

Figure 3. SGP Facility Location Map

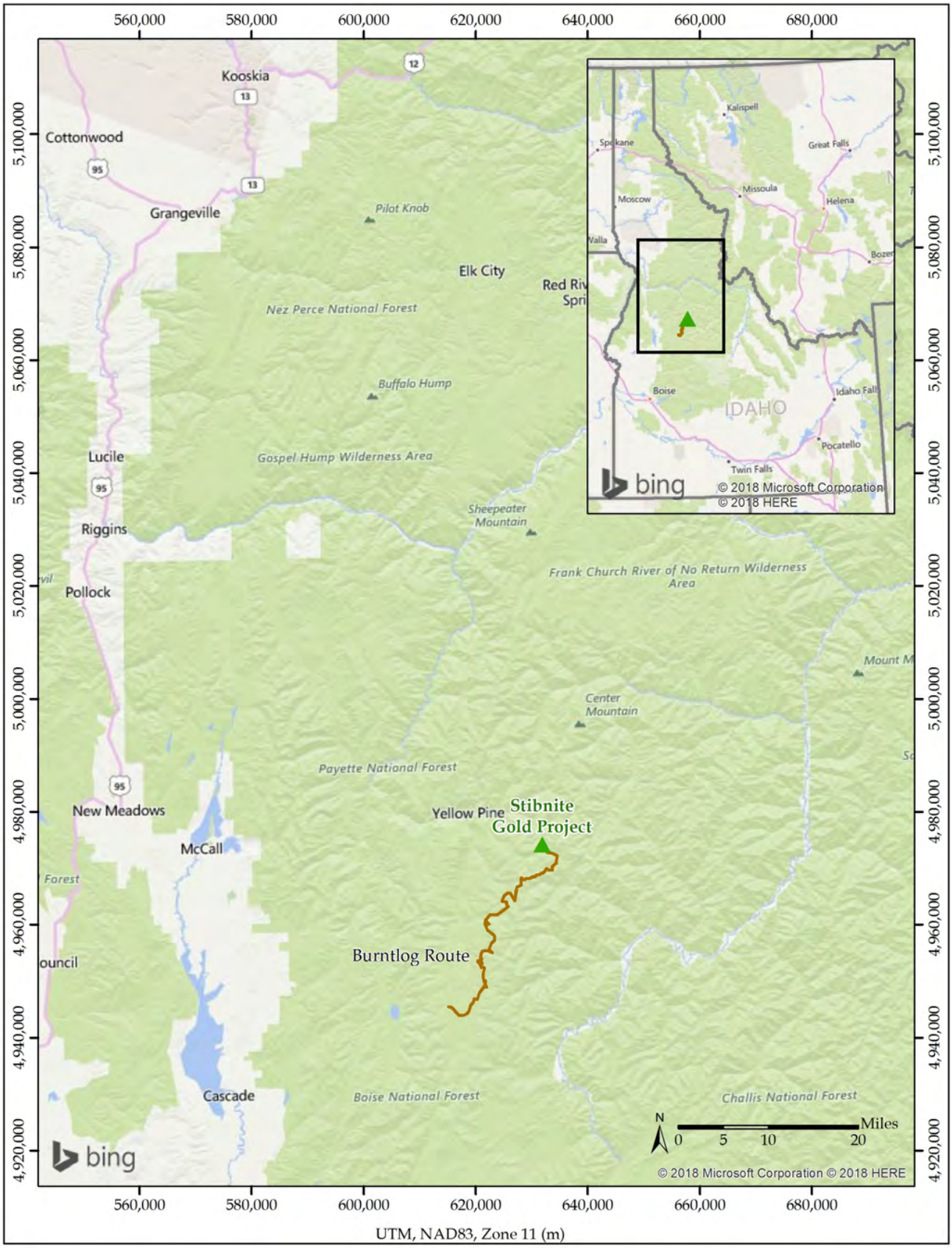
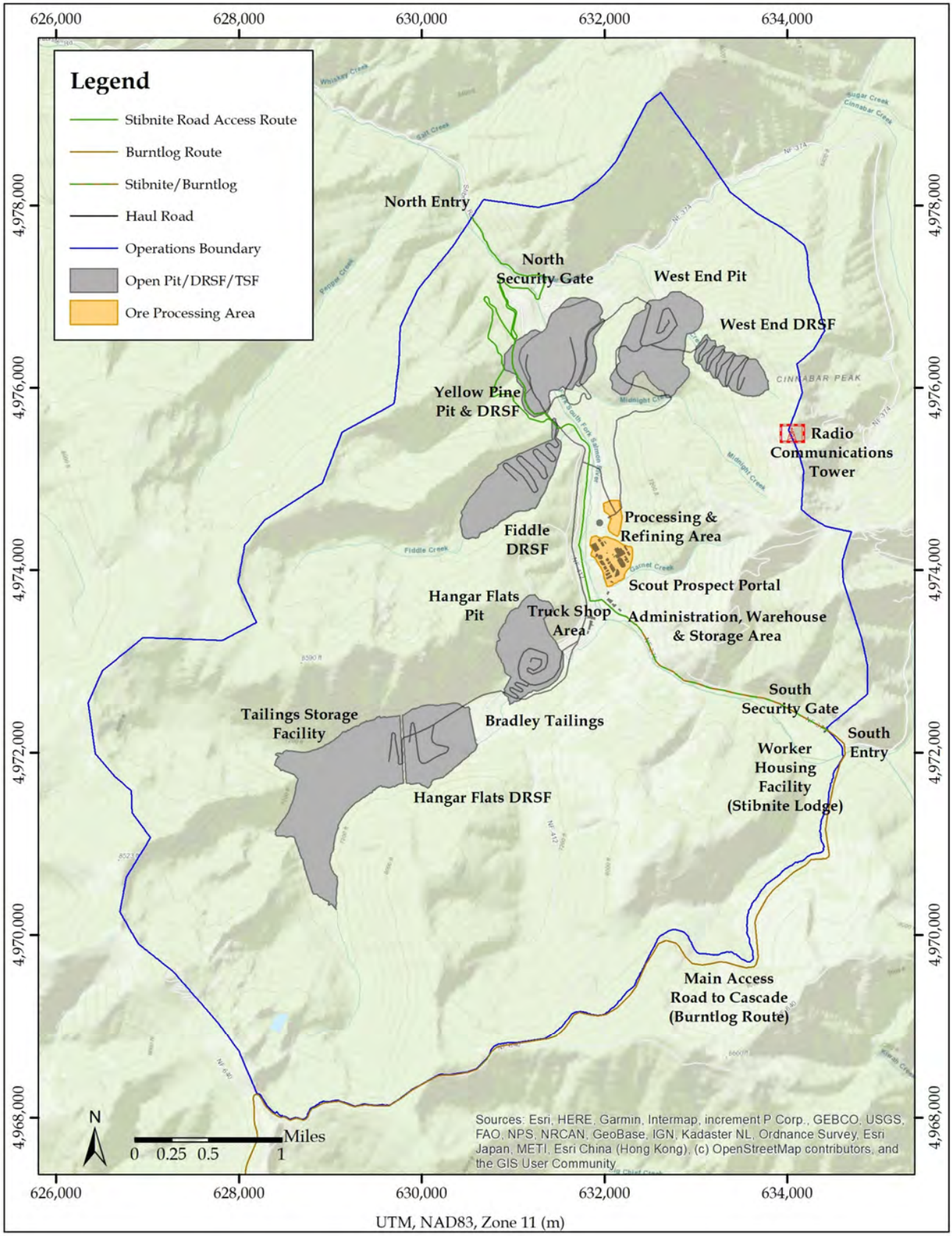


Figure 4. SGP Site Layout and Stibnite Road Access Route



PRI00000417

REC 1757

2.3 Site Characteristics

Midas Gold has prepared an Air Quality Baseline Study Report (Midas Gold 2017a) (SGP baseline study) that provides comprehensive details of the project area's existing site characteristics, including climate and air quality. The following site characterization of the project area is adopted from the SGP baseline study and the SGP PRO.

The SGP is located in the Stibnite-Yellow Pine Mining District in central Idaho, approximately 10 air miles east of the village of Yellow Pine. Located in Valley County, the district is characterized by historic mining activities and unpatented (federal land) and patented (private land) mining claims that include deposits of gold, silver, tungsten, and antimony. The Stibnite-Yellow Pine Mining District lies in both Boise National Forest (BNF) and Payette National Forest (PNF), but is administered by the PNF's Krassel Ranger District (Midas Gold 2017a). The project area terrain is characterized by narrow valleys 6,000 to 6,600 feet above mean sea level (amsl), surrounded by steep mountains ranging over 8,500 feet amsl. The main drainage basin in the project area is the East Fork of the South Fork of the Salmon River (EFSFSR).

The EFSFSR joins Johnson Creek 16 miles downstream, near the village of Yellow Pine. The project area is encompassed by the watersheds of EFSFSR tributaries, including Sugar Creek, Meadow Creek, Johnson Creek, Riordan Creek, Burntlog Creek, Midnight Creek, and Trout Creek. Primary commercial activity in the area comprises mineral exploration, mining, logging, and dispersed recreation.

Currently, the project site can be accessed from State Highway 55 via the Warm Lake, Johnson Creek, and Stibnite Roads. The proposed Burntlog Route, which will include an extension and upgrade of the existing Burntlog Road and portions of Thunder Mountain Road, will provide safe, year-round access to the project site. The Burntlog Route is shown in Figure 3.

At the request of local community citizens, Midas Gold is evaluating an alternative to provide restricted seasonal access through the SGP site between Stibnite Road at Sugar Creek and Thunder Mountain Road at Meadow Creek. This alternative would allow limited access to the Thunder Mountain recreational area from the town of Yellow Pine similar to the existing seasonal route.

The project area climate is characterized as semi-arid due to the proximity of the Cascade and Sierra Nevada Mountains to the west and the Bitterroot and Rocky Mountains to the north, which effectively block large-scale intrusion of Pacific Ocean moisture. Summer monsoonal moisture intrusions are infrequent and significantly modified by the arid Great Basin of Utah and Nevada. The Bitterroot and Rocky Mountains form the headwaters of the Snake and Salmon Rivers and receive copious amounts of winter snow. The Salmon River Range that surrounds the site lies at a slightly lower elevation than either of these other greater ranges, and as a result, it receives less overall snowfall.

PRI00000418

REC 1758

Data on the seasonal average temperatures in degrees (°) Fahrenheit (F), precipitation, and snow depth in inches (in) are provided in Table 3. These seasonal statistics were derived from data provided in the SGP baseline study (Midas Gold 2017a).

Table 3. Project Area Seasonal Temperature, Precipitation, and Snow Depth Data

Season	Months	Average Temperature (°F)	Average Precipitation (in)	Average Snow Depth (in)
Winter	December – February	10 – 33	6.0	21 – 68
Spring	March – May	17 – 59	6.1	66 – 84
Summer	June – August	38 – 80	2.5	0 – 21
Fall	September – November	19 – 68	4.5	0 – 3

2.4 Site Attainment Status and Ambient Air Quality Standards

The United States Environmental Protection Agency (EPA) classifies geographical regions as attainment, maintenance, or nonattainment based on prevailing air quality in the region. The SGP area is in compliance with National Ambient Air Quality Standards (NAAQS) for applicable pollutants; therefore, it is classified as in attainment with all criteria pollutants and designated as a Class II area (EPA 2018c) (IDEQ n.d.).

2.5 Coordinate System

The Universal Transverse Mercator (UTM) North American Datum of 1983 (NAD83), Zone 11 coordinate system was used in this modeling analysis to define all locations in the modeling domain (sources, buildings, and receptors).

General SGP facility NAD83, UTM Zone 11 coordinates are 632,038 meters east and 4,973,751 meters north (administration building).

2.6 Existing Permits and Modeling Analyses Performed

The SGP is a proposed new facility and does not have any existing air quality permits or modeling analyses.

☐ *Any existing air quality permits are listed and described in this section, and any associated air quality modeling analyses have been described and referenced, and submitted if appropriate.*

PRI00000419

REC 1759

3.0 MODELING ANALYSES APPLICABILITY AND PROTOCOL

A comparison of the criteria pollutant Level I modeling thresholds from Table 2 of the Idaho Department of Environmental Quality (IDEQ) modeling guidelines (IDEQ 2013b), with applicable facility-wide maximum potential to emit estimates, is provided in Table 4.

Table 4. Criteria Pollutant Modeling Applicability Determination

Source Category	CO	NO_X		$PM_{2.5}$		PM_{10}	SO_2		Pb
	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	lb/hr	ton/yr	lb/hr	lb/month
Process and ancillary	33.5	37.9	55.4	36.4	13.4	21.7	6.5	1.88	0.0437
Mining fugitive	1,742.0	17.1	46.8	98.9	22.5	224.7	0.03	0.09	--
Total	1,775.5	55.0	102.2	135.3	35.9	246.4	6.5	1.97	0.0437
Level I threshold	15.0	1.2	0.2	0.35	0.054	0.22	1.2	0.21	14.0
Modeling required	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

Table 4 shows that the SGP facility-wide maximum potential to emit are greater than the respective Level I thresholds for all criteria pollutants and averaging periods except for Pb. Therefore, modeling is triggered for applicable averaging periods for CO, NO_X, $PM_{2.5}$, PM_{10}, and SO_2; and modeling is not required for Pb.

A comparison of the applicable non-carcinogenic and carcinogenic screening emission levels (EL) for the TAP from Idaho Administrative Procedures Act (IDAPA) 58.01.01, Sections 585 and 586, respectively, with applicable facility-wide maximum potential TAP emissions is provided in Table 5.

Table 5. TAP Modeling Applicability Determination

CAS No.	TAP	Emissions (lb/hr)				EL (lb/hr)		Determination
		(1)	(2)	(3)	Total	(4)	(5)	
106-99-0	1,3-Butadiene	--	--	--	--	--	2.4E-5	EL not exceeded
56-49-5	3-Methylchloranthrene	1.2E-7	--	--	1.2E-7	--	2.5E-6	EL not exceeded
75-07-0	Acetaldehyde	--	--	--	--	--	3.0E-3	EL not exceeded
107-02-8	Acrolein	--	--	--	--	1.7E-2	--	EL not exceeded
7440-36-0	Antimony	--	--	6.9E-2	6.9E-2	3.3E-2	--	Non-carcinogenic EL exceeded
7440-38-2	Arsenic	1.3E-5	--	4.4E-3	4.4E-3	--	1.5E-6	Carcinogenic EL exceeded
71-43-2	Benzene	1.4E-4	--	--	1.4E-4	--	8.0E-4	EL not exceeded
50-32-8	Benzo(a)pyrene	7.9E-8	--	--	7.9E-8	--	2.0E-6	EL not exceeded
7440-41-7	Beryllium	7.9E-7	--	2.2E-5	2.2E-5	--	2.8E-5	EL not exceeded

CAS No.	TAP	Emissions (lb/hr)				EL (lb/hr)		Determination
		(1)	(2)	(3)	Total	(4)	(5)	
7440-43-9	Cadmium	7.3E-5	--	4.1E-5	1.1E-4	--	3.7E-6	Carcinogenic EL exceeded
75-15-0	Carbon disulfide	--	--	1.4E-2	1.4E-2	2.0E+0	--	EL not exceeded
7440-47-3	Chromium	9.2E-5	--	1.2E-4	2.1E-4	3.3E-2	--	EL not exceeded
7440-48-4	Cobalt	5.5E-6	--	2.4E-5	2.9E-5	3.3E-3	--	EL not exceeded
592-01-8	Cyanide	--	--	2.2E-1	2.2E-1	3.3E-1	--	EL not exceeded
106-46-7	Dichlorobenzene	7.9E-5	--	--	7.9E-5	3.0E+1	--	EL not exceeded
50-00-0	Formaldehyde	5.0E-3	--	--	5.0E-3	--	5.1E-4	Carcinogenic EL exceeded
110-54-3	Hexane	1.2E-1	--	--	1.2E-1	1.2E+1	--	EL not exceeded
7439-96-5	Manganese	2.5E-5	--	3.5E-2	3.5E-2	6.7E-2	--	EL not exceeded
91-20-3	Naphthalene	4.0E-5	--	--	4.0E-5	3.3E+0	--	EL not exceeded
7440-02-0	Nickel	1.4E-4	--	2.9E-3	3.0E-3	--	2.7E-5	Carcinogenic EL exceeded
7723-14-0	Phosphorus	--	--	6.1E-3	6.1E-3	7.0E-3	--	EL not exceeded
7782-49-2	Selenium	1.6E-6	--	--	1.6E-6	1.3E-2	--	EL not exceeded
108-88-3	Toluene	2.2E-4	--	--	2.2E-4	2.5E+1	--	EL not exceeded
1330-20-7	Xylene	--	--	--	--	2.9E+1	--	EL not exceeded
7440-39-3	Barium	2.9E-4	--	4.7E-3	5.0E-3	3.3E-2	--	EL not exceeded
7440-50-8	Copper	5.6E-5	--	2.9E-5	8.6E-5	6.7E-2	--	EL not exceeded
7783-06-4	Hydrogen Sulfide	--	--	9.0E-1	9.0E-1	9.3E-1	--	EL not exceeded
7439-98-7	Molybdenum	7.3E-5	--	5.9E-6	7.9E-5	3.3E-1	--	EL not exceeded
109-66-0	Pentane	1.7E-1	--	--	1.7E-1	1.2E+2	--	EL not exceeded
7440-22-4	Silver	--	--	2.9E-6	2.9E-6	7.0E-3	--	EL not exceeded
7664-93-9	Sulfuric Acid	--	--	2.0E+0	2.0E+0	6.7E-2	--	Non-carcinogenic EL exceeded
7440-28-0	Thallium	--	--	5.9E-5	5.9E-5	7.0E-3	--	EL not exceeded
7440-61-1	Uranium	--	--	5.9E-5	5.9E-5	1.3E-2	--	EL not exceeded
7440-62-2	Vanadium	1.5E-4	--	--	1.5E-4	3.0E-3	--	EL not exceeded
7440-66-6	Zinc	1.9E-3	--	--	1.9E-3	6.7E-1	--	EL not exceeded

(1) TAP emissions from propane combustion.

(2) TAP emissions from diesel combustion. Diesel engine HAP emissions are regulated by Code of Federal Regulations, Title 40, Part 63 (40 CFR 63), Subpart ZZZZ and therefore exempt from TAP analysis per IDAPA 58.01.01 Section 210.20.

(3) TAP emissions from material processing.

(4) Non-carcinogenic EL from IDAPA 58.01.01 Section 585.

(5) Carcinogenic EL from IDAPA 58.01.01 Section 586.

Table 5 shows that the SGP facility-wide potential TAP emissions exceed the respective EL for antimony, arsenic, cadmium, formaldehyde, nickel, and sulfuric acid.

PRI00000421

REC 1761

3.1 Applicable Standards

Based on the criteria pollutant modeling applicability determination provided in Table 4, the SGP facility-wide maximum potential emissions were evaluated to demonstrate compliance with applicable NAAQS provided in Table 6. NAAQS are provided in applicable units of parts per billion (ppb) and/or micrograms per cubic meter (µg/m^3). Table 6 also shows design value for each NAAQS. Applicable modeled values (form or rank) were used for compliance determination for each pollutant-averaging time combination.

Table 6. Applicable NAAQS for SGP Air Quality Analyses

Pollutant	Averaging Time	NAAQS		NAAQS Form/Design Value Rank
		(ppb)	(µg/m^3)	
CO	8 hours	9,000	10,000	Not to be exceeded more than once per year
	1 hour	35,000	40,000	
NO_2	1 year	53	100	Annual mean
	1 hour	100	188	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
$PM_{2.5}$	1 year	--	12	Annual mean, averaged over 3 years
	24 hours	--	35	98th percentile, averaged over 3 years
PM_{10}	24 hours	--	150	Not to be exceeded more than once per year on average over 3 years
SO_2	3 hours	500	1,300	Not to be exceeded more than once per year
	1 hour	75	196	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years

Based on the TAP modeling applicability determination provided in Table 5, TAP analyses were performed to show compliance with the applicable Acceptable Ambient Concentrations (AAC, in milligrams per cubic meter (mg/m^3), 24-hour averaging time) for non-carcinogenic TAP and Acceptable Ambient Concentrations for Carcinogens (AACC, in µg/m^3, annual averaging time) for carcinogenic TAP provided in Table 7.

Table 7. Applicable AACC for SGP TAP Analyses

CAS No.	TAP	Averaging Time	AAC[1] (mg/m^3)	AACC[2] (µg/m^3)
7440-36-0	Antimony	24 hours	2.5E-2	--
7440-38-2	Arsenic	Annual	--	2.3E-4
7440-43-9	Cadmium	Annual	--	5.6E-4
50-00-0	Formaldehyde	Annual	--	7.7E-2
7440-02-0	Nickel	Annual	--	4.2E-3
7664-93-9	Sulfuric Acid	24 hours	5.0E-2	--

[1] IDAPA 58.01.01 Section 585.

[2] IDAPA 58.01.01 Section 586.

Modeled 24-hour and annual average concentrations were used to demonstrate compliance with applicable AAC and AACC respectively.

☒ *All TAPs identified in the emissions inventory for the project are listed in the TAPs EL and AAC/AACC Table in this section.*

3.2 Criteria Pollutant Modeling Applicability

A comparison of criteria pollutant level I modeling thresholds from Table 2 of the Idaho Department of Environmental Quality (IDEQ) modeling guidelines (IDEQ 2013b) with applicable facility-wide maximum potential to emit estimates is provided in Table 4.

Table 4 shows that the SGP facility-wide maximum potential emissions are greater than the respective level I thresholds for all criteria pollutants and averaging times, except that for Pb. Therefore, modeling is triggered for applicable averaging times for CO, NO_X, $PM_{2.5}$, PM_{10}, and SO_2, whereas modeling is not required for Pb.

☒ *Explanations/documentation why modeling was or was not performed for each criteria pollutant are provided in this section.*

☒ *Emissions calculations that clearly show how the modeling applicability determination was performed are provided in this section.*

3.3 TAP Modeling Applicability

Based on the TAP modeling applicability determination provided in Table 5, the SGP facility-wide potential TAP emissions exceed the respective carcinogenic EL for antimony, arsenic, cadmium, formaldehyde, nickel, and sulfuric acid. The facility-wide potential emissions for the remaining TAP identified in Table 5 are below their respective EL and therefore do not require modeling.

☒ *Explanation/documentation on why modeling was or was not performed for emissions of each TAP identified in the emissions inventory of the application are provided in this section.*

3.4 Modeling Protocol

A modeling protocol for the SGP analyses was submitted to IDEQ prior to the application, on May 30, 2019. The protocol was submitted by Brown and Caldwell on behalf of Midas Gold. Conditional IDEQ protocol approval (IDEQ 2019) was provided to Brown and Caldwell on June 27, 2019. Project-specific modeling and other required impact analyses were generally conducted using the data and methods described in the protocol and in the Idaho Air Quality Modeling Guideline.

PRI00000423

REC 1763

☒ *If a protocol was submitted to DEQ prior to performing the modeling analyses, the protocol and DEQ's conditional protocol approval notice is included in Attachment 1 of this Modeling Report.*

☒ *Concerns identified by DEQ in the protocol approval notice have been addressed in the analyses performed and in this Modeling Report.*

PRI00000424

REC 1764

4.0 MODELED EMISSIONS SOURCES

Detailed SGP facility-wide potential emissions calculations (including uncontrolled emissions for process and ancillary sources) are provided in Appendix B. The air emissions inventory contains detailed emission calculations of the potential to emit for the SGP mining operations (including haul roads) and ore processing (including refining) activities. Emissions were estimated for the following:

- Criteria air pollutants: CO, NO_X, $PM_{2.5}$, PM_{10}, SO_2, Pb, and O_3 precursor VOC
- Applicable HAP from Section 112(b) of the Clean Air Act
- Applicable TAP listed in IDAPA 58.01.01 Sections 585 and 586
- Greenhouse gases: Carbon dioxide, methane, nitrous oxide, and carbon dioxide equivalent

The SGP emissions calculations were based on project-specific activity rates (e.g., production rates, materials hauled, blasting agent consumption), operation methods (e.g., open-pit mining, refining methods), design criteria (e.g., equipment type and size, hauling distances), emission abatement techniques (e.g., watering, baghouse, carbon filter), material characteristics (e.g., moisture content, silt content, density), and site characteristics (e.g., wind, precipitation) obtained from the following resources:

- SGP Prefeasibility Study (M3 2014)
- SGP Soil Resources Baseline Study (Midas Gold 2015)
- SGP PRO (Midas Gold 2016)
- SGP Mine Plan and Equipment Schedule (Midas Gold 2017b)
- SGP Baseline Study (Midas Gold 2017a)
- SGP Geographic Information System files (Midas Gold 2017d)
- Other technical information received from Midas Gold and M3 (Midas Gold 2017c) (Midas Gold 2017e) (Midas Gold 2017f) (Midas Gold 2018a) (Midas Gold 2018b) (Midas Gold 2018c) (Midas Gold 2018e) (Midas Gold 2018f) (Midas Gold 2018d) (Midas Gold 2018g) (Midas Gold 2019a) (Midas Gold 2019b) (Midas Gold 2019c) (Midas Gold 2019d) (M3 2017a) (M3 2017b) (M3 2017c) (M3 2017d) (M3 2019)

PRI00000425

REC 1765

Activity-specific (e.g., drilling, blasting, material crushing and conveying, refining, and other ancillary sources) emissions were estimated based on maximum activity rates, coupled with applicable emission estimation techniques. Maximum emissions were calculated on a short-term (hourly and daily) and long-term (annual) basis for ore processing and mining operations, as discussed below.

The ore-processing rate will range from 20,000 ton/day to 25,000 ton/day at full production. Therefore, maximum potential daily ore processing emissions were based on the maximum design rate of 25,000 ton/day. Maximum potential annual emissions were based on potential daily emissions multiplied by 365 days per year.

Emissions from mining operations (drilling, blasting, material extraction and movement, mobile mine machinery use, and other ancillary sources) vary for each year of the life of the mine (LOM). However, for the modeling analyses, the mining operation potential emissions were estimated using conservatively high maximum activity rates provided in Table 8.

Table 8. Mining Activity Rates for Potential Emission Calculations

Activity	Maximum Rate[1]		Comments
Drilling	600	drill holes per blast	
Blasting	2	blasts per day	
	1	blast per hour	
Material extraction and hauling	180,000	tons per day	Ore or DR
Onsite dozing	144	hours per day	6 dozers operating continuously
Onsite grading	72	hours per day	3 graders operating continuously
Onsite water trucking	48	hours per day	2 trucks operating continuously

[1] A conservatism analysis for the mining rates is provided in Appendix A.

The potential hourly emission rates for ore processing and mining operation activities were calculated by dividing the daily rate by the 24 hour per day operation schedule, and annual rates were calculated by multiplying maximum daily emissions with 365 days per year. This is conservative because the mine is expected to operate for only 355 days per year.

The maximum mine production rate is approximately 42.7 million (MM) tons per year (ton/yr); however, a maximum daily production rate of 180,000 ton/day used for potential emission calculations results in a conservatively higher production rate of approximately 65.7 MMton/yr, approximately 50 percent higher than the projected production rate.

Midas will employ newer model year mining and maintenance machines (excavators, shovels, haul trucks, dozers, graders, portable light plants, etc.) that are expected to meet or exceed applicable regulatory emission standards. Nonroad mobile equipment engines are exempt from

PRI00000426

REC 1766

permitting requirements; therefore, the tailpipe emissions resulting from fuel combustion in the nonroad mobile equipment are not quantified for the SGP facility.

The approximately 38-mile long Burntlog Route mine access road will be outside the project ambient air boundary and open to the public. Traffic emissions on public roads generally are considered to be part of background concentrations. Therefore, emissions on the Burntlog Route mine access road that are outside of the project boundary are not included in the SGP analyses. However, the emissions associated with the portion of the Burntlog Route mine access road that is within project boundary (from the south gate to the process area) are included in the SGP analyses. These include dust emissions generated from travel of maintenance equipment, light-duty pickup trucks and buses used for employee, visitor, and contractor transportation, and heavy-duty trucks used for cargo (including fuel, consumables, machine parts, ore processing supplies, ore concentrate, etc.) and services (including food supplies, trash, recyclables, etc.) transportation.

The emission estimation methods were based on activity-specific emission factors (EF) and techniques provided in governmental, scientific, and industry technical documents, including, but not limited to, the following:

- EPA AP-42: "Compilation of Air Pollutant Emission Factors" and associated background documents (EPA 1995)
- Published emission estimation reports (including reports from the EPA and other environmental experts) (Card, T. 2009) (Eckley 2010) (EPA 1994) (EPA 2009) (Schmidt 2010)
- EPA emission estimation models, such as TANKS (EPA 1999)
- Applicable regulatory emission requirements from Title 40 of the Code of Federal Regulations (CFR 2018a) (CFR 2018b) (CFR 2018c)
- EPA reference method performance test data or permit limits from similar gold ore processing operations (APT 2009) (APT 2010) (APT 2013) (APT 2016) (APT 2017) (NDEP 2012) (NDEP 2015a) (NDEP 2015b) (NDEP 2016)
- Other technical documents (Air Sciences 2018) (Air Sciences 2020) (Caterpillar 2011) (Caterpillar 2016) (Maerz 2018)

A bibliography of the information sources listed in this section is detailed in the References section (Section 8.0) of this report.

PRI00000427

REC 1767

4.1 Emission Factors and Controls

The emission factors and controls used to calculate process and fugitive emissions are discussed in the following sections.

4.1.1 Emission Factors

The AP-42 EF used to calculate the process source emissions are provided in Table 9.

Table 9. Process Source EF from AP-42

Source/Activity	Pollutant	EF	Pollutant	Reference
Material transfer, controlled	$PM_{2.5}$	0.000013	$PM_{2.5}$	AP-42, Table 11.19.2-2 (08/04); conveyor transfer, controlled.
	PM_{10}	0.000046	PM_{10}	
Material transfer, uncontrolled	$PM_{2.5}$	0.00017	$PM_{2.5}$	AP-42, Table 11.19.2-2 (08/04); conveyor transfer, uncontrolled(1).
	PM_{10}	0.0011	PM_{10}	
Material crushing, controlled	$PM_{2.5}$	0.0001	$PM_{2.5}$	AP-42, Table 11.19.2-2 (08/04); tertiary crushing, controlled.
	PM_{10}	0.00054	PM_{10}	
Material crushing, uncontrolled	$PM_{2.5}$	0.00036	$PM_{2.5}$	AP-42, Table 11.19.2-2 (08/04); tertiary crushing, uncontrolled(1).
	PM_{10}	0.0024	PM_{10}	
Material screening, controlled	$PM_{2.5}$	0.00005	$PM_{2.5}$	AP-42, Table 11.19.2-2 (08/04); screening, controlled.
	PM_{10}	0.00074	PM_{10}	
Material screening, uncontrolled	$PM_{2.5}$	0.00132	$PM_{2.5}$	AP-42, Table 11.19.2-2 (08/04); screening, uncontrolled(1).
	PM_{10}	0.0087	PM_{10}	
Ball mill, controlled with fabric filter	$PM_{2.5}$	0.0121	$PM_{2.5}$	AP-42, Table 11.19.2-4 (08/04); dry grinding with fabric filter.
	PM_{10}	0.0339	PM_{10}	
Lime kiln, controlled with fabric filter	CO	0.45	CO	AP-42 Tables 11.17-2 (5× PM EF), 6; gas-fired parallel flow regenerative kiln with fabric filter.
	NO_X	0.24	NO_X	
	$PM_{2.5}$	0.13	$PM_{2.5}$	
	PM_{10}	0.13	PM_{10}	
	SO_2	0.0012	SO_2	
Lime crushing, controlled with fabric filter	$PM_{2.5}$	0.0121	$PM_{2.5}$	AP-42 Table 11.19.2-4; dry grinding with fabric filter.
	PM_{10}	0.0339	PM_{10}	
Lime transfer, controlled with fabric filter	$PM_{2.5}$	0.00088	$PM_{2.5}$	AP-42 Table 11.17-4 (10× PM EF); crushed material conveyor transfer with fabric filter.
	PM_{10}	0.00088	PM_{10}	
Lime/cement/shotcrete silo loading, pneumatic	$PM_{2.5}$	0.00005	$PM_{2.5}$	AP-42, Table 11.12-2 (6/06); pneumatic loading, controlled(1).
	PM_{10}	0.00034	PM_{10}	
Lime/cement/shotcrete silo unloading, uncontrolled	$PM_{2.5}$	0.00042	$PM_{2.5}$	AP-42, Table 11.12-2 (6/06); weigh hopper loading, uncontrolled(1).
	PM_{10}	0.0028	PM_{10}	
Prill silo loading/unloading, uncontrolled	$PM_{2.5}$	0.00106	$PM_{2.5}$	AP-42, Table 8.3-2 (7/93); bulk loading, uncontrolled(2).
	PM_{10}	0.007	PM_{10}	
Aggregate bin loading/unloading, uncontrolled	$PM_{2.5}$	0.0005	$PM_{2.5}$	AP-42, Table 11.12-2 (6/06); aggregate transfer, uncontrolled.
	PM_{10}	0.0033	PM_{10}	

Source/Activity	Pollutant	EF	Pollutant	Reference
Central mixer, controlled	$PM_{2.5}$	0.0008	$PM_{2.5}$	AP-42, Table 11.12-2 (6/06); central mixer, controlled.
	PM_{10}	0.0055	PM_{10}	
Propane-fired heater/boiler, uncontrolled	CO	7.5	CO	AP-42, Table 1.5-1 (7/08); industrial/commercial boilers; S = sulfur content = 15.9 gr/100ft^3.
	NO_X	13	NO_X	
	$PM_{2.5}$	0.7	$PM_{2.5}$	
	PM_{10}	0.7	PM_{10}	
	SO_2	0.1S	SO_2	
	VOC	0.8	VOC	

(1) $PM_{2.5}$ scaled from PM_{10} based on $PM_{2.5}$ to PM_{10} ratio provided in AP-42, Chapter 13.2.4.

(2) $PM_{2.5}$ and PM_{10} scaled from PM based on $PM_{2.5}$ to PM and PM_{10} to PM ratios provided in AP-42, Chapter 13.2.4.

Process source EF that were adopted from similar source test data or permit limits or applicable regulations are provided in Table 10.

Table 10. Process Source EF from Similar Source Test Data/Permit Limits or Regulations

Source/Activity	Pollutant	EF	Units	Reference
Antimony bagging	$PM_{2.5}$	0.118	lb/hr	Nevada Division of Environmental Protection (NDEP) permit for clay bagging operation (NDEP 2015b).
	PM_{10}	0.118	lb/hr	
Autoclave	H_2S	0.9	lb/hr	NDEP permits/test data for autoclaves at gold mine: $PM_{2.5}$, PM_{10}, SO_2 (NDEP 2012), H_2S (APT 2013), H_2SO_4 (APT 2010).
	H_2SO_4	0.007	lb/ton	
	$PM_{2.5}$	5.075	lb/hr	
	PM_{10}	5.075	lb/hr	
	SO_2	0.653	lb/hr	
Carbon regeneration kiln	CO	0.12	lb/hr	NDEP permit for carbon regeneration kiln at gold mine (NDEP 2012).
	NO_X	0.012	lb/hr	
	$PM_{2.5}$	0.42	lb/hr	
	PM_{10}	0.42	lb/hr	
	VOC	0.11	lb/hr	
Electrowinning cells and pregnant solution Tank	$PM_{2.5}$	0.07	lb/hr	Based on similar source stack test data and 5× safety factor (APT 2016)
	PM_{10}	0.07	lb/hr	
Mercury retort	$PM_{2.5}$	0.01	lb/hr	Based on similar source stack test and data 5× safety factor (APT 2017)
	PM_{10}	0.01	lb/hr	
Induction melting furnace	$PM_{2.5}$	2.84	lb/hr	IDAPA 58.01.01.701.
	PM_{10}	2.84	lb/hr	

The EF used to develop mining activity emissions are provided in Table 11.

Table 11. EF Used to Calculate Mining Emissions

Source/Activity	Pollutant	EF	Units	Reference
Drilling	$PM_{2.5}$	0.039	lb/hole	AP-42 Table 11.9-4 (7/98); drilling, overburden. PM EF × blasting scaling factors from AP-42 Table 11.9-1.
	PM_{10}	0.676	lb/hole	
Blasting	CO	67	lb/ton-ANFO	AP-42 Table 13.3-1 (2/80); ANFO.
	NO_X	1.8	lb/ton-ANFO	Commonwealth Scientific and Industrial Research Organization (CSIRO 2008).
	$PM_{2.5}$	9.6	lb/blast	AP-42 Table 11.9-1 (7/98); blasting, overburden.
	PM_{10}	167.2	lb/blast	
	SO_2	0.0036	lb/ton-ANFO	Mass balance: 6% diesel in ANFO, 15 ppm sulfur content in diesel.
Truck hauling (annual)	$PM_{2.5}$	0.24	lb/VMT	AP-42 Chapter 13.2.2, Eq. 1a and 2 (11/06).
	PM_{10}	2.38	lb/VMT	
Truck hauling (daily)[1]	$PM_{2.5}$	0.35	lb/VMT	AP-42 Chapter 13.2.2, Eq. 1a (11/06).
	PM_{10}	3.55	lb/VMT	
Truck loading	$PM_{2.5}$	1.5E-5	lb/ton	AP-42 Table 11.19.2-2 (8/04); truck loading. $PM_{2.5}$ scaled from PM_{10} based on $PM_{2.5}$ to PM_{10} ratio provided in AP-42, Chapter 13.2.4.
	PM_{10}	0.0001	lb/ton	
Truck unloading	$PM_{2.5}$	2.4E-6	lb/ton	AP-42 Table 11.19.2-2 (8/04); truck unloading. $PM_{2.5}$ scaled from PM_{10} based on $PM_{2.5}$ to PM_{10} ratio provided in AP-42, Chapter 13.2.4.
	PM_{10}	1.6E-5	lb/ton	
Dozing	$PM_{2.5}$	0.41	lb/hr	AP-4 Table 11.9-1 (7/98); bulldozing, overburden.
	PM_{10}	0.75	lb/hr	
Grading	$PM_{2.5}$	0.13	lb/VMT	AP-4 Table 11.9-1 (7/98); grading.
	PM_{10}	1.29	lb/VMT	
Water truck (annual)	$PM_{2.5}$	0.20	lb/VMT	AP-42 Chapter 13.2.2, Eq. 1a and 2 (11/06).
	PM_{10}	2.04	lb/VMT	
Water truck (daily)	$PM_{2.5}$	0.30	lb/VMT	AP-42 Chapter 13.2.2, Eq. 1a (11/06).
	PM_{10}	3.04	lb/VMT	
Access road (annual)	$PM_{2.5}$	0.08	lb/VMT	AP-42 Chapter 13.2.2, Eq. 1a and 2 (11/06).
	PM_{10}	0.85	lb/VMT	
Access road (daily)	$PM_{2.5}$	0.13	lb/VMT	AP-42 Chapter 13.2.2, Eq. 1a (11/06).
	PM_{10}	1.26	lb/VMT	
Construction during exploration	$PM_{2.5}$	0.064	ton/acre/month	AP-42 Page 13.2.3-1 01/95); wet drilling. $PM_{2.5}$ and PM_{10} scaling factors from AP-42, Chapter 13.2.4.
	PM_{10}	0.42	ton/acre/month	
Wet drilling	$PM_{2.5}$	0.0092	lb/hole	AP-42 Table 11.19.2-2 (8/04). $PM_{2.5}$ fraction from AP-42, Chapter 13.2.4.
	PM_{10}	0.061	lb/hole	

[1] A conservatism analysis for the unpaved road emission factor equation is provided in Appendix A. This analysis also addresses road silt content and mean vehicle weight.

The following emission calculation methods were used in addition to the EF provided in Tables 9 through 11:

- The stationary internal combustion engine (emergency generators and a fire pump) emissions were calculated based on applicable EF from new source performance standards, depending on engine specifications.

- Fuel storage tank (diesel and gasoline) emissions were calculated from the EPA TANKS program, version 4.0.9d (EPA 1999).

- Emissions from the use of xanthate and sodium cyanide reagents used in the ore processing facility have potential to produce carbon disulfide and cyanide compounds emissions, respectively. The calculation methods for these pollutants are as follows:

    - Emissions of carbon disulfide from the decomposition of xanthate used in the rougher flotation circuit were calculated based on measurements of carbon disulfide generation in a laboratory scale ore pulp flotation reactor detailed in a technical memorandum by Air Sciences Inc. (Air Sciences 2020).

    - Emissions of cyanide compounds from the use of sodium cyanide in the mill process tanks (cyanide detox tanks, carbon-in-pulp leach tanks, and carbon-in-leach tanks) and the carbon stripping and electrowinning processes were calculated based on cyanide measurements directed by EPA at several Nevada gold mines (Card, T. 2009) (EPA 2009) (Schmidt 2010) (APT 2009).

4.1.2 Emission Controls

The emission control techniques and associated control efficiencies used in the SGP emission inventory calculations are presented in Table 12.

Table 12. Control Techniques and Efficiencies in Emission Calculations

Source Category	Control	Efficiency
Unpaved roads	Chemical application	90%
	Watering (daily emissions only; annual emissions rely on the precipitation equation)	33%
Underground/ enclosed transfers	Enclosure	80%
Material handling	Water sprays/moisture carryover	Included in controlled EF
Silo loading	Bin vent	Included in controlled EF
Antimony bagging	Baghouse	Included in controlled EF
Autoclave	Wet scrubber	Included in controlled EF
Carbon kiln	Wet scrubber	Included in controlled EF

PRI00000431

REC 1771

Source Category	Control	Efficiency
Induction melting furnace	Baghouse	Included in controlled EF
Central mixer	Bin vent or enclosure	Included in controlled EF
Lime ball mill	Fabric filter	Included in controlled EF
Lime kiln	Fabric filter	Included in controlled EF
Lime crushing	Fabric filter	Included in controlled EF
Lime silo transfers	Fabric filter	Included in controlled EF

The control efficiency on unpaved roads from watering and chemical suppressant application is based on AP-42 Chapter 13.2.2, and details are provided in a separate memorandum (Air Sciences 2018). A conservatism analysis of the control efficiencies attributed to watering and chemical suppressant application is provided in Appendix A. This conservatism analysis addresses the potential use of magnesium chloride as the chemical suppressant.

The 90 percent control efficiency was applied to the graders because they will be traveling on unpaved roads that have been treated (prior to grading) for dust control by periodic application of water and chemical dust suppressant. This is the same control efficiency applied to all traffic traveling on these unpaved roads.

Continuous application of water and chemical dust suppressant in front of a grader is not consistent with standard industry practices. Grading is an important part of road surface preparation prior to chemical application. Grading immediately following the chemical application may remove or displace the freshly applied suppressant, rendering it ineffective. Also, the displaced chemical may end up in roadside drains and/or vegetation creating environmental concerns. Following are excerpts from the U. S. Department of Transportation unpaved road management guidance that provides additional details.

"*The process of preparing an unpaved road before applying a chemical treatment generally follows standard procedures and uses standard road construction and maintenance equipment.*"

"*Spraying chemical treatments onto unprepared roads is a waste of time and money. The dust control effect will be short lived, ride quality will not be improved, and the road will soon require some form of maintenance, which will reduce the life of the treatment. Conversely, spraying a chemical treatment onto a well-prepared road should slow the rate of deterioration, providing improved and safer driving conditions for extended periods before maintenance is required. Prior to any spray-on application, shape the road to ensure an adequate crown is present, and then blade to provide a quality driving surface*" (U. S. DOT 2013).

Treatment of unpaved roads with chemical dust suppressant creates a hard-packed surface on the road, which reduces dust from forming. The purpose of road maintenance with graders is to smooth this surface with minimal disturbance to the treated crustal surface. In addition, grading

PRI00000432

REC 1772

is typically performed when the road surface is moist, either from natural moisture (light rain, morning dew, etc.) or from watering. A moist surface is slightly softer and easier for the grader to smooth. Midas Gold's standard operating practice will be to visually assess the road surface moisture (wetness) prior to road maintenance grading. If surface moisture is insufficient for proper grading conditions, then a water truck will be called to wet the road surface.

In addition to road maintenance (smoothing), graders at the SGP will also be used for road cleanup, i.e., removing snow and/or large rocks. Road cleanup is conservatively assumed (in the emission inventory) to emit the same amount of dust as road maintenance grading, even though it is expected to create significantly less dust.

With respect to continuous application of water spray, this is also potentially wasteful and impractical to implement. Midas Gold will apply water for dust suppressant, as needed, to control dust with reasonable precautions, as prescribed in IDAPA 58.01.01.650.

Lastly, it is important to note that the emission inventory uses the AP-42 Section 11.9 emission factor equations for grading, and these equations "*conservatively overestimate*" the "*grading emission factors*" (MRI 1998).

The 80 percent control efficiency for the underground/enclosed material transfers was calculated from the wind speed-based material handling emission calculation empirical equation (Equation 1) provided in AP-42 Chapter 13.2.4. Using this equation, material handling EF were calculated for the average onsite SGP wind speed of 5.17 miles per hour (mph) and the lowest wind speed applicable to this equation at 1.3 mph. The control efficiency was calculated as:

$$Control\ Efficiency\ (\%) = 1 - \frac{AP-42\ 13.2.4\ Eq1\ EF_{1.3\ mph}}{AP-42\ 13.2.4\ Eq1\ EF_{5.17\ mph}}$$

For the remaining control techniques listed in Table 12, controlled EF were used instead of applying control efficiencies to uncontrolled EF.

The EF and control efficiencies described in this section were chosen based on the following criteria: representativeness to the activity being characterized, prior use in similar projects, robustness of the scientific techniques used in their derivation, and the entity (e.g., EPA) publishing the information. As described in this section, most of the EF and control efficiencies stem from published EPA data, models, regulations, and test methods. This information was supplemented with data from air permits for similar sources, scientific papers, and relevant technical information.

PRI00000433

REC 1773

4.2 Pollutant Emissions

For the SGP analyses, several modeling scenarios were considered to evaluate the worst-case air impacts from the SGP facility. The different modeling scenarios are discussed in Section 4.3. The annual potential emissions summary for each criteria pollutant and HAP (including TAP) for the highest emission modeling scenario (Section 4.3) is provided in Table 13. Hg emissions are provided in units of pounds per year (lb/yr); all other emissions are provided in units of ton/yr.

Table 13. Maximum Annual Potential Emissions Summary

Source Category	CO	NO_X	$PM_{2.5}$	PM_{10}	SO_2	VOC	Pb	HAP[1]	Hg
	(ton/yr)								(lb/yr)
Process and ancillary	30.5	37.9	36.4	56.3	6.5	4.8	0.0003	1.8	24.9
Mining fugitive	635.8	17.1	98.9	985.6	0.03	--	--	0.004	7.1
SGP Total	666.3	55.0	135.3	1,041.9	6.53	4.8	0.0003	1.804	32.0

[1] Includes Pb and Hg. Maximum facility-wide potential emissions for a single HAP are 0.97 ton/yr for cyanide compounds.

It is important to note that the process and ancillary source emissions remain the same for each modeling scenario discussed in Section 4.3.

4.3 Modeling Scenarios

As discussed in Section 2.1, conventional open-pit methods will be used to extract ore and DR from three pits: YPP, HFP, and WEP, and legacy tailings from BT. Ore will be hauled to the crushing area, and the DR will be moved to four DRSF: Yellow Pine (YPDRSF), Hangar Flats (HFDRSF), West End (WEDRSF), and Fiddle (FDRSF). The SGP site layout provided in Figure 4 shows these facilities' locations.

Midas Gold plans for an up to three-year construction schedule to build mine site facilities and infrastructure, as well as the power transmission line, followed by 12 years of mining operations (i.e., LOM Years 1 through 12). Depending on the mine design and operating schedule, mining activity rates will vary temporally and spatially during the 12 years of mine production and operation. For example, ore production varies from approximately 6.8 MMton in LOM Year 1 (67% in YPP, 26% in WEP, and 7% in BT) to 9 MMton in LOM 3 (78% in YPP, 10% in BT, 7% in WEP, and 5% in HFP). Similarly, DR production varies from approximately 4.8 MMton in LOM Year 12 (100% in WEP) to 34 MMton in each of LOM Years 4 through 9, with varying distribution among the four DRSF for each LOM Year. The total material (ore and DR) production varies from approximately 12.5 MMton in LOM Year 12 to 42.7 MMton in LOM Year 4.

PRI00000434

REC 1774

Similar to the material production, the distribution and hauling of DR to the four destinations (YPDRSF, HFDRSF, WEDRSF, FDRSF) also will vary for each LOM year. Depending on the material origin (pits and BT) and destination (crushing area and DRSF), material hauling distances also will vary for each LOM year.

Therefore, depending on material production rates and origin, DR destination, and hauling distances, mining emissions will vary spatially and temporally throughout the mine life. For permitting purposes, Midas Gold has decided to use a maximum production rate of 180,000 tons of material (ore and/or DR) per day, for an annual production rate of 65.7 MMton/yr. This annual production rate is more than 50% higher than the estimated maximum total material production rate of 42.7 MMton/yr. A conservatism analysis of the mining production rate is provided in Appendix A.

In order to allow Midas Gold with operation flexibility and to capture variability in material origin and destination in the air quality analyses, several pit scenarios were developed for the SGP air quality analyses. Each pit scenario uses the maximum production rate of 180,000 ton/day in a single pit and uses a single material destination. Each pit has a dedicated ore scenario that assumes all material produced is ore and is hauled to the crusher area; and depending on mine design multiple DR destination scenarios each assuming all material produced is DR and is transported to a single DRSF. For example, most of the DR from HFP will be moved to HFDRSF and during LOM Years 2 through 10, but a fraction of this rock will be moved to FDRSF during LOM Years 3 and 8, and a fraction to YPDRSF during LOM Year 9. Therefore, in order to evaluate all hauling scenarios originating from HFP, the following four (one for ore hauling, three for DR hauling) HFP scenarios were modeled:

1. HFP Scenario 1 – 180,000 ton/day of ore produced and hauled to the crusher area
2. HFP Scenario 2 – 180,000 ton/day of DR produced and hauled to the FDRSF
3. HFP Scenario 3 – 180,000 ton/day of DR produced and hauled to the HFDRSF
4. HFP Scenario 4 – 180,000 ton/day of DR produced and hauled to the YPDRSF

Overall, 14 scenarios were modeled for $PM_{2.5}$ and PM_{10} analyses to cover all possible origin and destination combinations. Each modeling scenario included processing and ancillary source potential emissions discussed in this section and shown in Table 13. The multiple scenarios modeled for $PM_{2.5}$ and PM_{10} analyses are presented in Table 14. This table also shows the six origin/destination options that are not applicable to the Project as denoted by "0 ton/day."

PRI00000435

REC 1775

Table 14. Modeling Scenarios for $PM_{2.5}$ and PM_{10} Analyses

Scenario ID	Pit/Origin (ton/day)				Ore Destination (ton/day)	DR Destination (ton/day)			
	YPP	HFP	WEP	BT	STKP	FDRSF	HFDRSF	YPDRSF	WEDRSF
Y1	180,000	--	--	--	180,000	--	--	--	--
Y2	180,000	--	--	--	--	180,000	--	--	--
Y3	180,000	--	--	--	--	--	180,000	--	--
Y4	0	--	--	--	--	--	--	0	--
Y5	0	--	--	--	--	--	--	--	0
H1	--	180,000	--	--	180,000	--	--	--	--
H2	--	180,000	--	--	--	180,000	--	--	--
H3	--	180,000	--	--	--	--	180,000	--	--
H4	--	180,000	--	--	--	--	--	180,000	--
H5	--	0	--	--	--	--	--	--	0
W1	--	--	180,000	--	180,000	--	--	--	--
W2	--	--	180,000	--	--	180,000	--	--	--
W3	--	--	180,000	--	--	--	180,000	--	--
W4	--	--	180,000	--	--	--	--	180,000	--
W5	--	--	180,000	--	--	--	--	--	180,000
B1	--	--	--	180,000	180,000	--	--	--	--
B2	--	--	--	180,000	--	--	180,000	--	--
B3	--	--	--	0	--	0	--	--	--
B4	--	--	--	0	--	--	--	0	--
B5	--	--	--	0	--	--	--	--	0

Scenario Y4 is not applicable because the YPDRSF and the YPP are in the same area; therefore, the pit cannot be backfilled with development rock until after mining of the pit is completed. Scenarios Y5 and H5 are not applicable because the WEDRSF will only be utilized by the WEP because of its proximity; it is only accessible from the WEP. Scenarios B3, B4 and B5 are not applicable because the development rock from the BT will only be hauled to the HFDRSF because of its proximity. All other development rock storage facilities are significantly farther away from BT.

The fugitive CO, NO_2, and SO_2 emissions are limited to pits only, and they do not vary by ore and/or DR hauling and destinations. Therefore, for these pollutants, one scenario for each pit, including processing and ancillary source potential emissions, was modeled, i.e., scenarios Y1, H1, W1, and B1.

PRI00000436

REC 1776

The TAP emissions are limited to processing and ancillary sources, so a single scenario was modeled for each applicable TAP analysis.

4.4 Modeled Sources and Characterization

All emission sources and activities described in previous sections were included in the modeling analyses for SGP. Source characterization and parameters for model input for different source categories are discussed in this section.

4.4.1 Processing, Refining, and Ancillary Sources

The processing, refining, and ancillary sources with exhaust stacks, such as baghouse-equipped sources, generators, process and building heaters, autoclave, retort, smelting furnace, carbon kiln, lime kiln, etc., were modeled as POINT sources. The process sources without exhaust stacks, such as material transfers, ore screening and crushing, etc., were modeled as VOLUME sources. A plot plan showing the processing and refining area buildings and sources is provided in Figure 5. Process and ancillary source model input physical parameters and associated documentation are provided in Appendix B.

4.4.2 Fugitive Sources: Blasting, Material Origin and Destination and Underground Exploration Emissions

Blasting emissions were represented by a VOLUME source located inside a pit. Each material origin location (YPP, HFP, WEP, BT) was modeled as an AREA source and comprised appropriate emissions from drilling, material loading, dozing, and surface exploration. Ore destination – crusher area was modeled as a VOLUME source and comprised ore unloading emissions. Each DR destination (FDRSF, HFDRSF, YPDRSF, WEDRSF) was modeled as a VOLUME source comprising appropriate emissions from DR unloading, dozing, and wind erosion. Emissions from underground core sampling drilling (UGEXP) in the Scout prospect decline were represented by an AREA source characterized by the portal opening dimensions.

Model input physical characteristics for blasting and possible material origin and destination locations, and Scout portal are presented in Table 15. This table also shows the source type and associated dimensions for each of the modeled fugitive source/location.

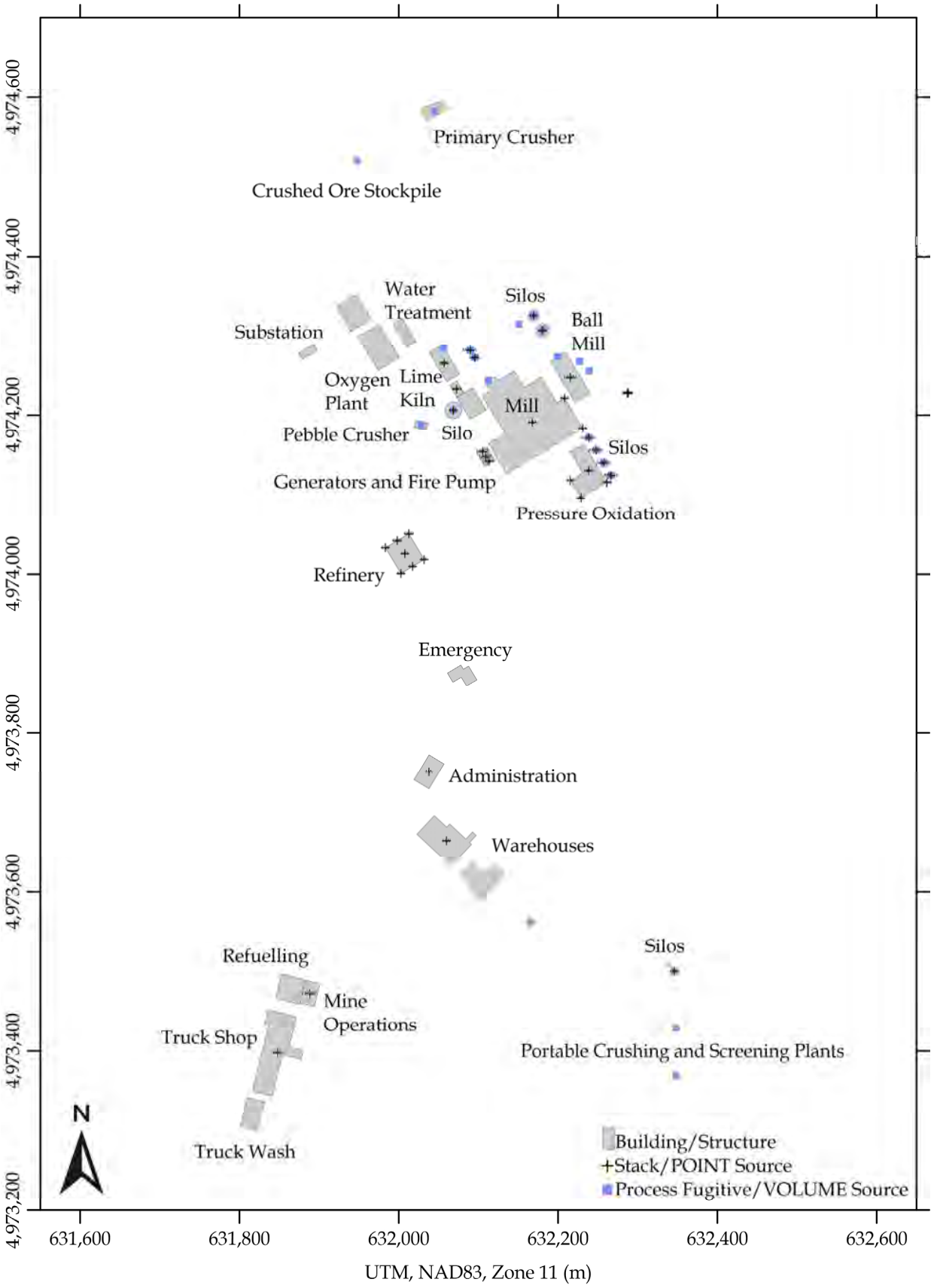
The VOLUME source dimensions for blasting provided in Table 15 were based on an estimated blast area. For the remaining AREA and VOLUME sources listed in Table 15, the dimensions were developed by reasonably fitting an equal-area rectangle within the actual footprint of each fugitive source.

Blasting is not expected to occur in BT. However, blasting emissions were modeled in BT (BTBL) per IDEQ's suggestion in order to streamline the permitting process.

PRI00000437

REC 1777

Figure 5. Processing and Refining Area Building and Source Layout



PRI00000438

REC 1778

Table 15. Modeled Fugitive Activity Locations

Model ID	Activity Location	Type	Lateral Dimensions (m)	Emission Sources
YPP	Yellow Pine Pit	AREA	882 × 882	Drilling, loading, dozing, surface exploration
HFP	Hangar Flats Pit	AREA	491 × 491	Drilling, loading, dozing, surface exploration
WEP	West End Pit	AREA	376 × 376	Drilling, loading, dozing, surface exploration
BT	Bradley Tailings	AREA	820 × 420	Loading, dozing, wind erosion
YPPBL	Yellow Pine Pit (Blasting)	VOLUME	87 × 87	Blasting
HFPBL	Hangar Flats Pit (Blasting)	VOLUME	87 × 87	Blasting
WEPBL	West End Pit (Blasting)	VOLUME	87 × 87	Blasting
BTBL	Bradley Tailings (Blasting)	VOLUME	87 × 87	Blasting
STKP	PC Stockpile	VOLUME	229 × 229	Unloading, dozing, wind erosion
FDRSF	Fiddle DRSF	VOLUME	775 × 775	Unloading, dozing, wind erosion
HFDRSF	Hangar Flats DRSF	VOLUME	752 × 752	Unloading, dozing, wind erosion
YPDRSF	Yellow Pine DRSF	VOLUME	784 × 784	Unloading, dozing, wind erosion
WEDRSF	West End DRSF	VOLUME	533 × 533	Unloading, dozing, wind erosion
UGEXP	Scout Portal	AREA	4.9 × 4.9	Sample core drilling

The model input physical parameters for blasting, material origin and destination locations, and Scout portal are provided in Table 16.

Table 16. Model Input Parameters for Fugitive Activity Locations

Model ID	Base Elevation (m)	Release Height (m)	Initial Lateral Dispersion (m)	Initial Vertical Dispersion (m)
YPP	1,832.4	4.7	N/A	4.4
HFP	1,993.3	4.7	N/A	4.4
WEP	2,191.8	4.7	N/A	4.4
BT	2,011.7	4.7	N/A	4.4
YPPBL	1,717.2	15.0	20.2	7.0
HFPBL	1,890.6	15.0	20.2	7.0
WEPBL	1,994.0	15.0	20.2	7.0
BTBL	2,011.7	15.0	20.2	7.0
STKP	1,979.8	4.7	53.3	4.4
FDRSF	2,115.2	4.7	180.2	4.4

PRI00000439

REC 1779

Model ID	Base Elevation (m)	Release Height (m)	Initial Lateral Dispersion (m)	Initial Vertical Dispersion (m)
HFDRSF	2,079.8	4.7	174.8	4.4
YPDRSF	1,904.1	4.7	182.2	4.4
WEDRSF	2,376.5	4.7	124.1	4.4
UGEXP	2,018.0	0	N/A	0

The blasting physical parameters were developed from dimensions (provided in Table 15) based on blast area used in the emission calculation. The blasting release height is the midpoint of the blasting height (30 m).

The initial lateral and vertical dispersion dimensions for blasting were calculated per methods specified in (EPA 2018d), as:

$$Initial\ Lateral\ Dispersion\ = \frac{Width\ (87\ m)}{4.3}$$

$$Initial\ Vertical\ Dispersion\ = \frac{Height\ (30\ m)}{4.3}$$

For the pit and DRSF fugitive activity locations listed in Table 15, i.e., YPP, HFP, WEP, BT, FDRSF, HFDRSF, and WEDRSF, the release height was based on the haul truck height (weighted based on model-specific usage) and calculated using the recommendations provided in the Haul Road Workgroup Report (EPA 2012), as:

$$Release\ Height = \frac{Plume\ Top\ (Weighted\ Truck\ Height\ \times 1.7)}{2}$$

The applicable initial lateral dispersion for each VOLUME source was calculated from the respective shorter dimension and EPA-specified methods (EPA 2018d) (EPA 2016) as follows:

$$Initial\ Lateral\ Dispersion\ = \frac{Shorter\ Lateral\ Dimension}{2.15}$$

The applicable initial vertical dispersion for each AREA and VOLUME source was calculated from the respective vertical dimension and EPA-specified methods (EPA 2018d) (EPA 2016) as follows:

$$Initial\ Vertical\ Dispersion\ = \frac{Plume\ Top\ (Weighted\ Truck\ Height\ \times 1.7)}{2.15}$$

Scout portal was modeled as a surface-based AREA source with zero release height.

PRI00000440

REC 1780

4.4.3 Fugitive Sources: Haul Roads

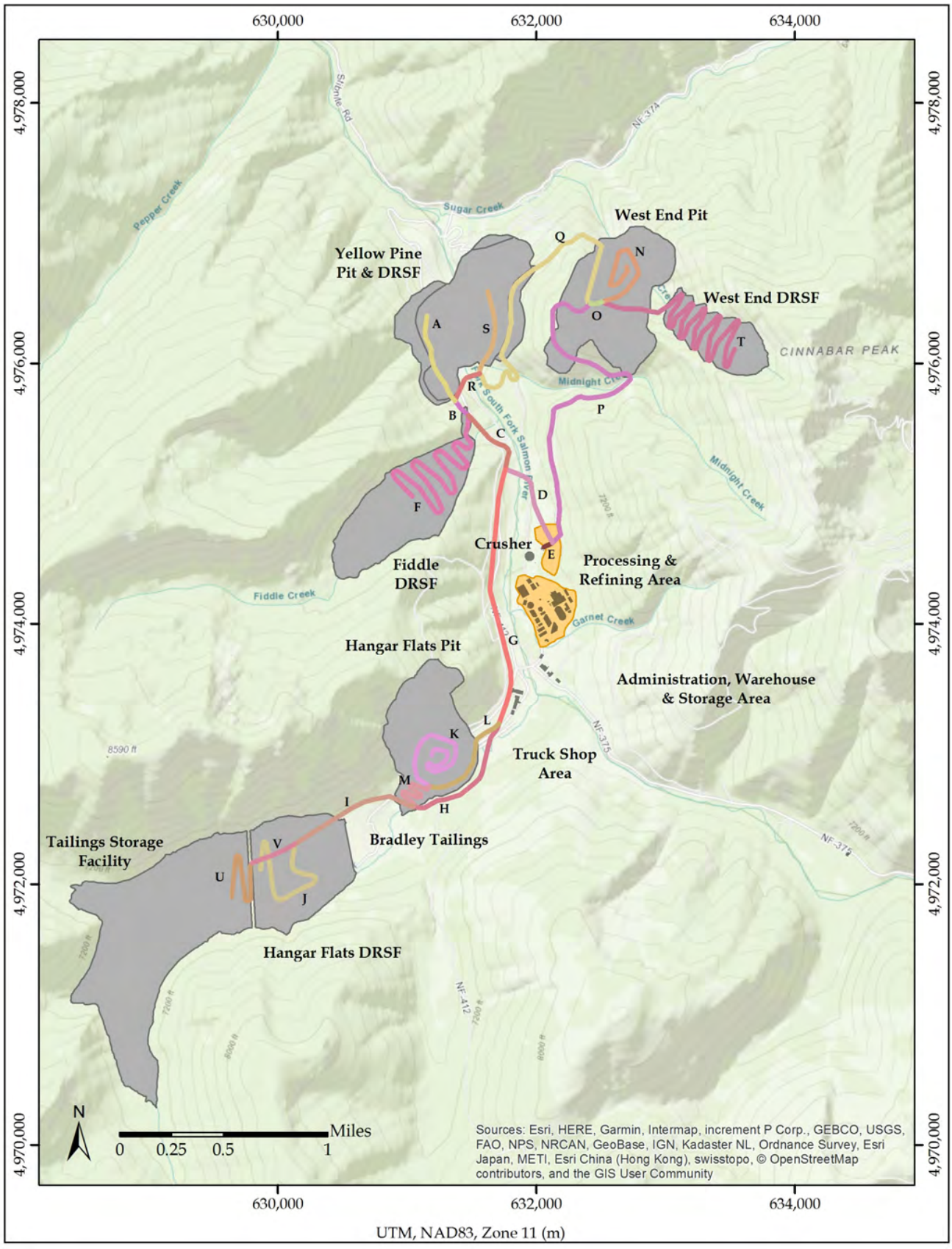
A representative haul road network for hauling material from inside the pit (or origin) to various destinations was developed for each pit scenario provided in Table 14. The haul road network is presented in Figure 6.

As shown in Figure 6, the haul road network was divided into 22 sections, A through V. Each section was further divided into multiple segments with a length equal to twice the adjusted haul road width of 32.5 m (26 m road width plus 6 m (EPA 2012)). Each of the segments was characterized as an individual VOLUME source in the model, with a release height of 4.75 m (weighted-average truck height times 1.7, divided by 2 (EPA 2012)), an initial lateral dispersion of 15.1 m (adjusted road width divided by 2.15 (EPA 2012)), and an initial vertical dispersion of 4.42 m (weighted-average top-of-plume height divided by 2.15 (EPA 2012)). Material hauling emissions associated with each origin-destination route were assigned to each segment along the route based on estimated total emissions along the route and traffic distribution along each section, as provided in Table 17 for the five HFP scenarios.

PRI00000441

REC 1781

Figure 6. Haul Road Network and Sections



PRI00000442

REC 1782

Table 17. Haul Road Emission Distribution Grid for HFP Scenarios

Pit Scenario		H1	H2	H3	H4
Route: Origin-Destination		HFP-STKP	HFP-FDRSF	HFP-HFDRSF	HFP-YPDRSF
Segment Emission Denominator		96	148	87	115
Section	No. of Segments	Traffic Distribution per Route			
A	37	--	--	--	--
B	3	--	--	--	1
C	11	--	1	--	1
D	14	1	--	--	--
E	2	--	--	--	--
F	55	--	1	--	--
G	38	1	1	--	1
H	20	--	--	--	--
I	20	--	--	1	--
J	27	--	--	1	--
K	28	1	1	1	1
L	16	1	1	--	1
M	12	--	--	1	--
N	22	--	--	--	--
O	2	--	--	--	--
P	57	--	--	--	--
Q	49	--	--	--	--
R	6	--	--	--	1
S	13	--	--	--	1
T	72	--	--	--	--
U	19	--	--	--	--
V	7	--	--	--	--

The top row in Table 17 shows the pit scenarios, and the next two rows show hauling route and the associated segment emission denominator (SED) used to distribute segment emissions along each route. The remainder of Table 17 presents the number of segments for each road section (shown in Figure 6) and the associated traffic distribution factor for each route. The emission distribution for each applicable segment is illustrated in the following example.

Route: HFP–STKP (Hangar Flats pit to crusher stockpile): Figure 6 shows that material from HFP will be hauled to the crusher area following the route along Sections K, L, G, and D. All (100%) of the ore from HFP will travel on each of these sections; therefore, each of these sections has a traffic distribution factor of 1.0 for this route.

PRI00000443

REC 1783

The SED for each route is the sum-product of the number of segments and traffic distribution for the applicable sections. The SED for the HFP–STKP route is calculated as:

$$SED_{(HFP-STKP)} = (28 \times 1) + (16 \times 1) + (38 \times 1) + (14 \times 1) = 96$$

Emissions for each section-segment were estimated by dividing the total emissions along the route by its SED and multiplying by the section distribution factor. For example, the emission rate for each of the 28 segments along Section K was calculated as:

$$Emission\ Rate - Section\ K\ _{(Segments\ 1-28)} = \frac{Total\ Emissions_{(HFP-STKP)}}{96} \times 1$$

4.4.4 Fugitive Sources: Burntlog Route Access Road

The access road portion within the operations boundary was characterized by a series of LINE sources laid along the actual route. These sources were assigned a release height of 3 m and an initial vertical dispersion of 2.8 m. These release parameters were based on an estimated average vehicle height of 3.5 m, which is representative of an overall approximation of anticipated vehicle heights (grader – 3.7 m, heavy-duty truck – 3.6 m, and pickup truck – 3.2 m) and the AREA source parameterization recommendations provided in the Haul Road Workgroup Report (EPA 2012). The AERMOD emission input units for AREA source are grams per meter square. The access road emissions were evenly distributed along the road by dividing the total access road emissions by its total area, i.e., the Burntlog Route section within the operations boundary (2,950 m) multiplied by the road width (6.1 m).

4.5 Short- and Long-Term Emissions for Model Input

Short-term (up to 24-hour averaging period) model input emission rates for the process sources, including ore processing, refining, and other support activities, were based on the equipment/process-specific maximum hourly or daily design throughput rates. Short-term model input emission rates for the fugitive sources associated with mining activity were based on short-term activity rates provided in Table 8. Long-term (annual) model input rates for both process and fugitive sources were based on continuous operation (24 hours per day, 365 days per year) and the respective maximum hourly or daily throughput rates.

☒ *The modeling emissions inventory and the emissions inventory presented in other parts of the permit application are consistent, and if they are not identical numbers, it is clearly shown, with calculations submitted, how the modeled value was derived from the value provided in the emissions inventory.*

4.6 Criteria Pollutants

The criteria pollutant emission rates used in the modeling analyses described in this section were determined as described in Sections 4.0 through 4.5.

PRI00000444

REC 1784

4.6.1 Modeled Emission Rates for Significant Impact Level Analyses

Based on the magnitude of the facility-wide emissions and preliminary modeling analyses, it was determined that the impacts from the SGP emissions exceeded the Significant Impact Levels (SIL) for most criteria pollutants. Therefore, SIL analyses were considered redundant and not performed for this report.

4.6.2 Modeled Emission Rates for Cumulative Impact Analyses

The modeled emission rates used in the cumulative impact analyses were determined as described in Sections 4.0 through 4.5, and the emission calculation details are provided in Appendix B. For 1-, 3-, and 8-hour averaging times, hourly emission rates provided in pounds per hour were used. For 24-hour averaging time, daily emission rates provided in pounds per day were used. For the annual averaging time, annual emission rates provided in tons per year were used. The total model input emission rates (highest emission scenario) are shown in Table 18.

Table 18. Criteria Pollutant Modeled Emission Rates

Pollutant	Averaging Time	Emissions[(1)]	
CO	8 hours	1,775.50	lb/hr
	1 hour	1,775.50	lb/hr
NO_2	1 year	54.93	ton/yr
	1 hour	58.07	lb/hr
$PM_{2.5}$	1 year	135.23	ton/yr
	24 hours	781.69	lb/day
PM_{10}	24 hours	5,768.93	lb/day
SO_2	3 hours	1.97	lb/hr
	1 hour	1.97	lb/hr

[(1)] Combined process, ancillary, and fugitive emissions modeled. Fugitive emissions vary by pit scenario, maximum pit scenario emissions are shown.

The nearest significant permitted facility to SGP is Tamarack Mill, located more than 75 km west. This facility is located too far away to cause a significant concentration gradient along the periphery of the SGP and was therefore not included in the cumulative impact analyses for SGP.

☒ *Emissions rates in Appendix B are identical to those in the model input files for the cumulative NAAQS impact analyses.*

☒ *Calculation of modeled emissions are thoroughly documented in Appendix B, and any unique handling of emissions in the model have been described.*

PRI00000445

REC 1785

4.6.3 NO_2/NO_X Ratio for NO_X Chemistry Modeling

The default option of the Ozone Limiting Method (OLM), a third-tier method from 40 CFR 51, Appendix W, was used to estimate the NO_2 1-hour and annual impacts for these analyses. The OLM method requires an input of in-stack NO_2/NO_X ratio for each modeled source.

An in-depth literature review was conducted to identify reasonable NO_2/NO_X ratios for different combustion source categories. Based on this research, the NO_2/NO_X ratio recommended for the heavy-duty diesel trucks in the California Air Pollution Control Officers Association (CAPCOA) Guidance Document (CAPCOA 2011) was selected for stationary diesel combustion sources. This NO_2/NO_X ratio (11 percent) is conservatively higher than the diesel combustion NO_2/NO_X ratio provided in the EPA ISR (In-Stack Ratio) database: 6 percent average, 9.8 percent maximum. The CAPCOA document and the EPA ISR database do not provide an NO_2/NO_X ratio for propane boilers. The CAPCOA-recommended NO_2/NO_X ratio for natural gas boilers was selected for the propane boilers. The natural gas boilers NO_2/NO_X ratio is considered appropriate for the propane boilers because both are gaseous fuels with relatively similar combustion characteristics and are expected to have similar NO_2/NO_X ratios. The NO_2/NO_X ratio for blasting is based on blasting plume measurements provided in the Australian study (CSIRO 2008). The NO_2/NO_X ratios used for the SGP NO_2 analyses are presented in Table 19.

Table 19. NO_2/NO_X Ratios

Source Type	NO_2/NO_X Ratio	Reference/Comments
Blasting	0.036	Commonwealth Scientific and Industrial Research Organization (CSIRO 2008)
Diesel Engines	0.11	CAPCOA Guidance Document, heavy-duty diesel trucks (CAPCOA 2011)
Propane Heaters	0.10	CAPCOA Guidance Document, natural gas boilers (CAPCOA 2011)

4.6.4 Special Methods for Modeling Criterial Pollutant Emissions

- Multiple pit scenarios were modeled, as described in Section 4.3.
- The alternately processed meteorological dataset described in Section 5.2 was used for the select analyses addressed in Section 6.1.

4.7 Toxic Air Pollutants

SGP facility-wide TAP emissions for different source categories are provided in Table 5. TAP emissions from propane-fired heaters were calculated using the emission factors provided in AP-42, Tables 1.4-3 and 1.4-4. These emission factors along with estimated TAP emissions for propane-fired heaters at SGP are provided in Table 20.

PRI00000446

REC 1786

Table 20. Propane Combustion TAP Emission Factors and Emissions

CAS No.	TAP	Emission Factor (lb/MMScf)	Emission Factor (lb/MMBtu)[1]	Emissions (lb/hr)	Emissions (ton/yr)
56-49-5	3-Methylchloranthrene	< 1.8E-06	1.76E-09	1.19E-07	3.64E-07
7440-38-2	Arsenic	2.0E-04	1.96E-07	1.32E-05	4.04E-05
71-43-2	Benzene	2.1E-03	2.06E-06	1.39E-04	4.25E-04
50-32-8	Benzo(a)pyrene	< 1.2E-06	1.18E-09	7.93E-08	2.43E-07
7440-41-7	Beryllium	< 1.2E-05	1.18E-08	7.93E-07	2.43E-06
7440-43-9	Cadmium	1.1E-03	1.08E-06	7.26E-05	2.22E-04
7440-47-3	Chromium	1.4E-03	1.37E-06	9.25E-05	2.83E-04
7440-48-4	Cobalt	8.4E-05	8.24E-08	5.55E-06	1.70E-05
106-46-7	Dichlorobenzene	1.2E-03	1.18E-06	7.93E-05	2.43E-04
50-00-0	Formaldehyde	7.5E-02	7.35E-05	4.95E-03	1.52E-02
110-54-3	Hexane	1.8E+00	1.76E-03	1.19E-01	3.64E-01
7439-96-5	Manganese	3.8E-04	3.73E-07	2.51E-05	7.69E-05
91-20-3	Naphthalene	6.1E-04	5.98E-07	4.03E-05	1.23E-04
7440-02-0	Nickel	2.1E-03	2.06E-06	1.39E-04	4.25E-04
7782-49-2	Selenium	< 2.4E-05	2.35E-08	1.59E-06	4.85E-06
108-88-3	Toluene	3.4E-03	3.33E-06	2.25E-04	6.88E-04
109-66-0	Pentane	2.6E+00	2.55E-03	1.72E-01	5.26E-01
7440-39-3	Barium	4.4E-03	4.31E-06	2.91E-04	8.90E-04
7440-50-8	Copper	8.5E-04	8.33E-07	5.61E-05	1.72E-04
7439-98-7	Molybdenum	1.1E-03	1.08E-06	7.26E-05	2.22E-04
7440-62-2	Vanadium	2.3E-03	2.25E-06	1.52E-04	4.65E-04
7440-66-6	Zinc	2.9E-02	2.84E-05	1.92E-03	5.86E-03

[1] Based on 1,020 million British thermal units (MMBtu) per million standard cubic feet (MMScf) per Table 1.4-3 footnote a.

TAP emissions from cement handling were calculated using the uncontrolled emission factors provided in AP-42, Table 11.12-8. These emission factors along with estimated TAP emissions from cement handling at SGP are provided in Table 21.

PRI00000447

REC 1787

Table 21. Cement Handling TAP Emission Factors and Emissions

CAS No.	TAP	EF	Emissions	
		(lb/ton)	(lb/hr)	(ton/yr)
7440-38-2	Arsenic	1.68E-06	2.69E-04	1.01E-04
7440-41-7	Beryllium	1.79E-08	2.86E-06	1.07E-06
7440-43-9	Cadmium	2.34E-07	3.74E-05	1.40E-05
7440-47-3	Chromium	2.52E-07	4.03E-05	1.51E-05
7439-96-5	Manganese	2.02E-04	3.23E-02	1.21E-02
7440-02-0	Nickel	1.76E-05	2.82E-03	1.06E-03
7723-14-0	Phosphorus	1.18E-05	1.89E-03	7.08E-04

TAP emissions from cement mixer were calculated using the uncontrolled emission factors provided in AP-42, Table 11.12-7. These emission factors along with estimated TAP emissions from cement mixer at SGP are provided in Table 22.

Table 22. Cement Mixer TAP Emission Factors and Emissions

CAS No.	TAP	EF	Emissions	
		(lb/ton)	(lb/hr)	(ton/yr)
7440-38-2	Arsenic	8.38E-06	1.68E-04	2.51E-04
7440-43-9	Cadmium	1.18E-08	2.36E-07	3.54E-07
7440-47-3	Chromium	1.42E-06	2.84E-05	4.26E-05
7439-96-5	Manganese	6.12E-05	1.22E-03	1.84E-03
7440-02-0	Nickel	3.28E-06	6.56E-05	9.84E-05
7723-14-0	Phosphorus	2.02E-05	4.04E-04	6.06E-04

TAP emissions from ore processing (dust emissions) were calculated using the ore TAP concentrations. These concentrations along with estimated TAP emissions from ore processing at SGP are provided in Table 23.

Table 23. Ore Processing TAP Concentrations and Emissions

CAS No.	TAP	Concentration	Emissions	
		(ppm)	(lb/hr)	(ton/yr)
7440-38-2	Arsenic	667	0.00392	0.01718
7440-41-7	Beryllium	3.2	0.00002	0.00008
7440-43-9	Cadmium	0.5	0.000003	0.00001
7440-48-4	Cobalt	4	0.00002	0.00010
7440-47-3	Chromium	9	0.00005	0.00023
7439-96-5	Manganese	299	0.00176	0.00770

PRI00000448

REC 1788

CAS No.	TAP	Concentration	Emissions	
		(ppm)	(lb/hr)	(ton/yr)
7440-02-0	Nickel	2	0.00001	0.00005
7440-36-0	Antimony	23	0.00014	0.00059
7723-14-0	Phosphorus	650	0.00382	0.01675
7440-22-4	Silver	0.5	0.000003	0.00001
7440-39-3	Barium	800	0.00471	0.02061
7440-50-8	Copper	5	0.00003	0.00013
7439-98-7	Molybdenum	1	0.00001	0.00003
7440-28-0	Thallium	10	0.00006	0.00026
7440-61-1	Uranium	10	0.00006	0.00026

Antimony emissions from stibnite concentrate were calculated using the concentrate antimony concentration. The antimony concentration and estimated emissions from stibnite concentrate processing at SGP are provided in Table 24.

Table 24. Stibnite Concentrate Processing Antimony Concentration and Emissions

CAS No.	TAP	Concentration	Emissions	
		(ppm)	(lb/hr)	(ton/yr)
7440-36-0	Antimony	580,000	0.068	0.3

Emission factors and potential TAP emissions from the autoclaving process are provided in Table 25.

Table 25. Autoclave TAP Emission Factors and Emissions

CAS No.	TAP	Emission Factor [1]		Emissions	
				(lb/hr)	(ton/yr)
7783-06-4	Hydrogen Sulfide	0.9	lb/hr	0.9	3.9
7664-93-9	Sulfuric Acid	0.007	lb/ton	2.0	8.9

[1] (APT 2010) (APT 2013)

Potential TAP emissions from the reagents use are provided in Table 26.

PRI00000449

REC 1789

Table 26. Reagent Use TAP Emissions

CAS No.	TAP	Emissions[1]	
		(lb/hr)	(ton/yr)
75-15-0	Carbon Disulfide	0.01	0.06
592-01-8	Cyanide Compounds	0.22	0.97

[1] (Air Sciences 2020) (Card, T. 2009) (EPA 2009) (Schmidt 2010) (APT 2009)

It is important to note that diesel engine TAP are regulated by 40 CFR 63, Subpart ZZZZ and therefore, exempt from TAP analysis per IDAPA 58.01.01 Section 210.20. Therefore, TAP emissions from diesel combustion were not included in TAP analyses for SGP.

The TAP modeling applicability determination provided in Table 5 shows that TAP analyses were required for arsenic, cadmium, formaldehyde, and nickel. All four TAP that require modeling are carcinogenic pollutants and require modeling for annual averaging time. The annual emission rates for TAP used for modeling are provided in Table 27.

Table 27. TAP Emissions Used for Modeling

CAS No.	TAP	Emissions	
7440-36-0	Antimony	0.0686	lb/hr
7440-38-2	Arsenic	0.0176	ton/yr
7440-43-9	Cadmium	0.0002	ton/yr
50-00-0	Formaldehyde	0.0152	ton/yr
7440-02-0	Nickel	0.0016	ton/yr
7664-93-9	Sulfuric Acid	2.03	lb/hr

☒ *TAP emissions rates have been listed for each TAP that has project cumulative emissions exceeding the applicable EL.*

☒ *Emissions rates in Table 27 are identical to those in the model input file for TAP analyses.*

4.8 Emission Release Parameters

The process and ancillary sources, along with their respective model identification codes, source types, and location coordinates, are listed in Table 28.

Table 28. Process and Ancillary Sources Modeled

Source Description	Model ID	Source Type	UTM East (m)	UTM North (m)	Elevation (m)
Mill Lime Silo #1 Loading	LS1L	POINT	632,095	4,974,272	1,992
Mill Lime Silo #2 Loading	MillS2L	POINT	632,090	4,974,282	1,990

PRI00000450

REC 1790

Source Description	Model ID	Source Type	UTM East (m)	UTM North (m)	Elevation (m)
Sb Dryer (2.72 MMBtu/hr Propane-Fired)	Sb1	POINT	632,231	4,974,183	2,001
Sb Bagging	Sb2	POINT	632,208	4,974,221	2,001
Autoclave	AC	POINT	632,229	4,974,096	2,007
POX Boiler (17 MMBtu/hr Propane-Fired)	ACB	POINT	632,261	4,974,116	2,007
AC Lime Silo #1 Loading	ACS1L	POINT	632,267	4,974,124	2,007
AC Lime Silo #2 Loading	ACS2L	POINT	632,257	4,974,140	2,007
AC Lime Silo #3 Loading	ACS3L	POINT	632,248	4,974,156	2,007
AC Lime Silo #4 Loading	ACS4L	POINT	632,238	4,974,171	2,007
Carbon Regeneration Kiln (Drum)	CKD	POINT	632,013	4,974,051	1,970
Carbon Regeneration Kiln (Burners)	CKB	POINT	631,998	4,974,042	1,970
Electrowinning Cells and Pregnant Solution Tank	EW	POINT	631,983	4,974,033	1,970
Mercury Retort	MR	POINT	632,003	4,974,001	1,970
Induction Melting Furnace	MF	POINT	632,032	4,974,019	1,970
Camp Emergency Generator (Mfr. Yr. >2007; diesel)	EDG1	POINT	634,274	4,972,050	2,114
Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	EDG2	POINT	632,105	4,974,154	2,001
Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	EDG3	POINT	632,109	4,974,148	2,002
Mill Fire Pump (Mfr. Yr. >2009; diesel)	EDFP	POINT	632,113	4,974,141	2,003
Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	PV	POINT	632,216	4,974,118	2,007
Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	HS	POINT	632,017	4,974,010	1,970
Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	H1M	POINT	632,287	4,974,227	2,000
Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	H2M	POINT	632,288	4,974,228	2,000
Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	HM	POINT	632,168	4,974,191	2,001
Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	HAC	POINT	632,238	4,974,130	2,007
Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	HR	POINT	632,008	4,974,026	1,970
Admin HVAC Heater (0.25 MMBtu Propane-Fired)	HA	POINT	632,038	4,973,751	1,979
Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	HMO	POINT	631,889	4,973,472	1,989
Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	HTS	POINT	631,848	4,973,398	1,992
Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	HW	POINT	632,060	4,973,664	1,984
Prill Silos Loading (2 x 100 ton)	PSL	POINT	632,346	4,973,500	2,010
Cement/Shotcrete Silo #1 Loading	CS1L	POINT	632,095	4,974,272	1,992
Cement/Shotcrete Silo #2 Loading	CS2L	POINT	632,095	4,974,272	1,992

PRI00000451

REC 1791

Source Description	Model ID	Source Type	UTM East (m)	UTM North (m)	Elevation (m)
Limestone transfer to Ball Mill Feed Bin	LS6	POINT	632,181	4,974,307	1,996
Limestone Ball Mill	LSBM	POINT	632,215	4,974,248	1,996
Limestone transfer to Kiln Feed Bin	LS9	POINT	632,169	4,974,325	1,996
Parallel Flow Regenerative (PFR) Shaft Lime Kiln	LK	POINT	632,057	4,974,265	1,984
PFR Shaft Lime Kiln Combustion	LKC	POINT	632,057	4,974,265	1,984
Lime Mill Crushing and associated transfers In and Out	LCR	POINT	632,073	4,974,233	1,990
Pebble Lime Silo Loading via Bucket Elevator	LSL	POINT	632,069	4,974,206	1,996
Loader Transfer of Ore to Grizzly	OC1	VOLUME	632,045	4,974,583	1,969
Grizzly to Apron Feeder	OC2	VOLUME	632,045	4,974,583	1,969
Apron Feeder to Dribble Conveyor	OC3	VOLUME	632,045	4,974,583	1,969
Apron Feeder to Vibrating Grizzly	OC4	VOLUME	632,045	4,974,583	1,969
Dribble Conveyor to Vibrating Grizzly	OC5	VOLUME	632,045	4,974,583	1,969
Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	OC6	VOLUME	632,045	4,974,583	1,969
Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	OC7	VOLUME	632,045	4,974,583	1,969
Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	OC8	VOLUME	631,947	4,974,520	1,957
Stockpile Transfers to Reclaim Conveyors	OC9	VOLUME	631,947	4,974,520	1,957
Reclaim Conveyors to SAG Mill Feed Conveyor	OC10	VOLUME	631,947	4,974,520	1,957
SAG Mill Feed Conveyor Transfer to SAG Mill	OC11	VOLUME	632,113	4,974,243	2,001
Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	OC12	VOLUME	632,028	4,974,187	1,973
Pebble Discharge Conveyor to SAG Mill Feed Conveyor	OC13	VOLUME	632,028	4,974,187	1,973
Mill Lime Silo #1 Unloading to SAG Mill Conveyor	LS1U	VOLUME	632,095	4,974,272	1,992
Mill Lime Silo #2 Unloading to SAG Mill Conveyor	MillS2U	VOLUME	632,090	4,974,282	1,990
AC Lime Silo #1 Unloading to Lime Slaker	ACS1U	VOLUME	632,267	4,974,124	2,007
AC Lime Silo #2 Unloading to Lime Slaker	ACS2U	VOLUME	632,257	4,974,140	2,007
AC Lime Silo #3 Unloading to Lime Slaker	ACS3U	VOLUME	632,248	4,974,156	2,007
AC Lime Silo #4 Unloading to Lime Slaker	ACS42U	VOLUME	632,238	4,974,171	2,007
Prill Silos Unloading (2 x 100 ton)	PSU	VOLUME	632,346	4,973,500	2,010
Cement/Shotcrete Silo #1 Unloading	CS1U	VOLUME	632,095	4,974,272	1,992
Cement/Shotcrete Silo #2 Unloading	CS2U	VOLUME	632,095	4,974,272	1,992
Aggregate Bin Loading	CAL	VOLUME	632,095	4,974,272	1,992
Aggregate Bin Unloading	CAU	VOLUME	632,095	4,974,272	1,992
Central Mixer Loading	CM	VOLUME	632,095	4,974,272	1,992

PRI00000452

REC 1792

Source Description	Model ID	Source Type	UTM East (m)	UTM North (m)	Elevation (m)
Portable Crushing and Screening Plant 1	PCSP1	VOLUME	632,348	4,973,429	2,009
Portable Crushing and Screening Plant 2	PCSP2	VOLUME	632,348	4,973,369	2,007
Limestone transfer to Primary Crusher Hopper	LS1	VOLUME	632,239	4,974,256	1,996
Primary Crushing and Associated Transfers In and Out	LS2	VOLUME	632,239	4,974,256	1,996
Primary Screening and Associated Transfers In and Out	LS3	VOLUME	632,239	4,974,256	1,996
Secondary Crushing and Associated Transfers In and Out	LS4	VOLUME	632,227	4,974,268	1,996
Secondary Screening and Associated Transfers In and Out	LS5	VOLUME	632,227	4,974,268	1,996
Limestone transfer to Ball Mill Feed Conveyor	LS7	VOLUME	632,181	4,974,307	1,996
Ball Mill Feed transfer to Ball Mill	LS8	VOLUME	632,200	4,974,273	1,996
Limestone transfer to Lime Kiln Feed Conveyor	LS10	VOLUME	632,169	4,974,325	1,996
Fines Screening and Associated Transfers In and Out	LS11	VOLUME	632,151	4,974,314	1,996
Kiln Feed transfer to PFR Shaft Lime Kiln	LS12	VOLUME	632,056	4,974,285	1,984
Pebble Lime Silo discharge to Lime Slaker	LSU	VOLUME	632,069	4,974,206	1,996

Model input release parameters for the process and ancillary sources modeled as POINT sources are provided in Table 29.

Table 29. Process and Ancillary Sources Modeled as POINT Sources

Model ID	Release Height (m)	Exit Temperature (K)[1]	Exit Velocity (m/s)	Exit Diameter (m)
LS1L	13.3	0.0	18.1	0.2
MillS2L	13.3	0.0	18.1	0.2
Sb1	45.7	455.4	6.9	0.3
Sb2	45.7	0.0	6.5	0.3
AC	23.5	364.3	7.4	1.5
ACB	23.5	455.4	10.8	0.6
ACS1L	17.4	0.0	16.1	0.2
ACS2L	17.4	0.0	16.1	0.2
ACS3L	17.4	0.0	16.1	0.2
ACS4L	14.5	0.0	16.1	0.2
CKD	16.8	338.7	5.1	0.1
CKB	14.0	455.4	5.8	0.3
EW	16.8	310.9	24.2	0.3

PRI00000453

REC 1793

Model ID	Release Height (m)	Exit Temperature (K)[1]	Exit Velocity (m/s)	Exit Diameter (m)
MR	16.8	338.7	1.5	0.1
MF	16.8	338.7	21.5	0.4
EDG1	2.1	866.5	29.7	0.5
EDG2	2.1	866.5	29.7	0.5
EDG3	2.1	866.5	29.7	0.5
EDFP	2.1	866.5	23.8	0.2
PV	20.7	455.4	1.6	0.1
HS	14.0	455.4	7.5	0.4
H1M	2.1	455.4	6.0	0.4
H2M	2.1	455.4	20.8	0.2
HM	43.0	455.4	28.3	0.1
HAC	20.7	455.4	7.1	0.1
HR	14.0	455.4	7.1	0.1
HA	6.4	455.4	7.1	0.1
HMO	12.5	455.4	1.3	0.2
HTS	12.5	455.4	5.2	0.2
HW	12.5	455.4	5.2	0.2
PSL	7.8	0.0	18.1	0.2
CS1L	13.3	0.0	24.1	0.2
CS2L	13.3	0.0	24.1	0.2
LS6	8.8	0.0	0.0	0.3
LSBM	21.3	0.0	26.7	0.6
LS9	8.8	0.0	0.0	0.3
LK	45.7	449.8	26.4	0.6
LKC	45.7	449.8	26.4	0.6
LCR	15.2	0.0	28.7	0.2
LSL	8.8	0.0	4.1	0.1

[1] 0K represents ambient temperature in model.

The pneumatic transfer silo loadings and bin transfers (LS1L, MillS2L, ACS1L, ACS2L, ACS3L, ACS4L, PSL, CS1L, CS2L, LS6, LSBM, LS9, LSL) were modeled as POINT sources with a 3-foot bin vent above standard silo height as release height. Exit velocity was estimated using the standard stack diameter and flow rates for similar sources (NDEP 2019) or 0.001 meter per second for horizontal exhaust. These sources were modeled with ambient exhaust temperature.

For propane-fired process (Sb1, ACB, CKB, PV, HS) and building heaters (H1M, H2M, HM, HAC, HR, HA, HMO, HTS, HW), exhaust flow rates were calculated using EPA Method 9 with 3% oxygen content and 15% moisture content. Standard stack diameters were selected based on the heater rating. The process heaters were modeled with a 10-foot stack above the building,

PRI00000454

REC 1794

whereas the building heaters were modeled with a release height of 1 foot above the respective buildings.

Similar source exhaust temperature, flow, and diameter from (NDEP 2017) were used for refinery sources, including the carbon regeneration kiln (CKD), electrowinning cells (EW), mercury retort (MR), and induction furnace (MF). Each of these sources was modeled with a 10-foot stack above the refinery building.

For emergency generators (EDG1, EDG2, EDG3) and the fire pump (EDFP), the exhaust flow rates were calculated using EPA Method 9 with 9% oxygen content and 8% moisture content. Standard stack diameters were selected based on engine rating. Each engine was modeled with a 7-foot-high stack.

Antimony bagging (Sb2), autoclave (AC), lime kiln (LK) (common stack with kiln burner (LKC)), and lime crushing (LCR) were characterized with similar source parameters from (NDEP 2015b), (APT 2013), and (NDEP 2010). Each of these sources was modeled with a 10-foot stack above its respective building.

The model input release parameters for the process and ancillary sources modeled as VOLUME sources are provided in Table 30.

Table 30. Process and Ancillary Sources Modeled as VOLUME Sources

Model ID	Release Height (m)	Sigma-Y (m)	Sigma-Z (m)
OC1	19.5	3.8	18.1
OC2	19.5	3.8	18.1
OC3	19.5	3.8	18.1
OC4	19.5	3.8	18.1
OC5	19.5	3.8	18.1
OC6	19.5	3.8	18.1
OC7	19.5	3.8	18.1
OC8	10.9	0.2	10.2
OC9	1.2	0.6	1.1
OC10	1.2	0.6	1.1
OC11	20.7	0.3	0.6
OC12	3.0	2.3	2.8
OC13	3.0	2.3	2.8
LS1U	1.4	0.1	0.1
MillS2U	1.4	0.1	0.1
ACS1U	1.4	0.1	0.1

PRI00000455

REC 1795

Model ID	Release Height (m)	Sigma-Y (m)	Sigma-Z (m)
ACS2U	1.4	0.1	0.1
ACS3U	1.4	0.1	0.1
ACS42U	1.4	0.1	0.1
PSU	1.4	0.1	0.1
CS1U	1.5	5.1	1.4
CS2U	1.5	5.1	1.4
CAL	1.5	5.1	1.4
CAU	1.5	5.1	1.4
CM	1.5	5.1	1.4
PCSP1	2.1	13.1	2.0
PCSP2	2.1	13.1	2.0
LS1	3.4	1.6	3.2
LS2	3.4	1.6	3.2
LS3	3.4	1.6	3.2
LS4	3.4	1.6	3.2
LS5	3.4	1.6	3.2
LS7	1.1	0.1	0.4
LS8	8.5	0.3	0.6
LS10	1.1	0.1	0.4
LS11	0.8	0.6	0.7
LS12	20.7	0.3	0.6
LSU	1.1	0.1	0.4

For the following VOLUME source characterization discussion, release height was estimated as half of the vertical length (for example, building height), initial vertical dispersion was calculated by dividing the vertical length by the applicable EPA-recommended constant (EPA 2018d) for a single VOLUME source (4.3), and initial lateral dispersion was determined using the lesser lateral dimension (for example, building width) divided by the applicable EPA-recommended constant (EPA 2018d) for the surface source or elevated source with a building (2.15).

The sources associated with the primary crusher building, including loader transfer (OC1), grizzly feeder (OC2), apron feeders (OC3, OC4), ore transfers (OC5, OC6), and primary crusher (OC7), were characterized by the primary crusher building dimensions: 128′ high and 52.9′ wide.

The stockpile height (71.6′) and the conveyor width (3′) were used to determine the VOLUME source parameters for the stockpile feed conveyor (OC8).

PRI00000456

REC 1796

Tunnel exit dimensions (8′ high and 8′ wide) were used to estimate the VOLUME release parameters for the stockpile transfer points (OC9, OC10). The SAG mill feed conveyor transfer (OC11) was characterized by a building opening (4′ high and 4′ wide) at the mid-height (70′) of the mill building.

Pebble crusher building dimensions (20′ high and 32.7′ wide) were used to characterize the pebble crusher-associated sources (OC12, OC13).

Silo/bin unloading sources (LS1U, Mill2SU, ACS1U, ACS2U, ACS3U, ACS42U, PSU) were characterized by a typical screw discharge feeder characteristic, i.e., 5′ above the ground with a 1′ diameter.

Aggregate transfer and handling sources (CS1U, CS2U, CAL, CAU, CM) were characterized by the aggregate stockpile dimensions: 20′ high and 72.2′ wide.

Each portable crushing and screening plant was characterized by typical portable crushing and screening plant dimensions: 14′ high and 185′ wide.

Sources associated with limestone crushing (LS1, LS2, LS3, LS4, LS5) were characterized by the associated crusher building dimensions: 22.6′ high and 22.6′ wide.

The crushed limestone/pebble lime transfers (LS7, LS10, LSU) were characterized by a typical screw discharge to a conveyor characteristic, i.e., 5′ above the ground, 3′ drop, and a 1′ diameter.

The limestone ball mill feed discharge (LS8) was characterized by a building opening (4′ high and 4′ wide) at the mid-height (30′) of the ball mill building.

The limestone fines screening (LS11) was characterized by screen dimensions: 5′ drop and 8′ wide.

The limestone kiln feed (LS12) was characterized by a building opening (4′ high and 4′ wide) at the mid-height (70′) of the kiln building.

Model input source characterization for fugitive emissions is described in Section 4.4. Fugitive activity locations and their respective dimensions are provided in Table 15 and associated release parameters are listed in Table 16.

☒ *Thorough justification/documentation of release parameters for all modeled sources is provided in this section.*

☒ *The specific methods used to determine/calculate given release parameters is described in this section.*

PRI00000457

REC 1797

☒ *The release orientation of all point source stacks (horizontal, rain-capped, or uninterrupted vertical release) has been verified and is documented in this section.*

PRI00000458

REC 1798

5.0 MODELING METHODOLOGY

Refined modeling techniques using the preferred air quality models were used to estimate pollutant concentrations at receptor locations resulting from the SGP air emissions to demonstrate that air emissions resulting from the SGP activities do not cause or significantly contribute to a violation of applicable NAAQS, or AACC as identified in Tables 6 and 7. The methods and techniques, regulatory options, and datasets for these air quality analyses are detailed in the following subsections.

Key modeling parameters used in the SGP impact analyses are presented in Table 31.

Table 31. Key Modeling Parameters

Parameter	Description/Value	Documentation/Additional Description
General facility location	Attainment	See Section 2.4
Analysis type	NAAQS and TAP	SIL analysis was not performed, See Section 4.6.1
Model	AERMOD	Version 19191, see Section 5.1
Meteorological data	AERMET	Version 19191, see Section 5.2
	Surface: Onsite	IDEQ-approved, see Section 5.2
	Upper air: Boise, ID	WBAN 24131, see Section 5.2
	Surface: McCall, ID	See Section 5.2
Terrain	Considered	Processed with AERMAP version 18081, see Section 5.3
Building downwash	Considered	BPIP-PRIME version 04274, see Section 5.5
NO_X chemistry	OLM	See Section 5.9
Receptors	Boundary	25-m spacing, see Section 5.7
	Grid 1	50-m spacing, 0.25 km out
	Grid 2	100-m spacing, 0.25 km to 1.25 km out
	Grid 3	500-m spacing, 1.25 km to 5 km out
	Grid 4	1,000-m spacing, 5 km to 10 km out
	Hot-spot	25-m spacing, 200-m × 200-m around highest model impacts

5.1 Model Selection

The most recent version (19191) of the AERMOD (American Meteorological Society/ Environmental Protection Agency Regulatory Model) modeling system was used for the SGP air quality analyses. AERMOD is an enhanced steady-state, Gaussian plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources and both simple and

PRI00000459

REC 1799

complex terrains. The AERMOD modeling system is listed as the recommended model for short-range analysis (up to 50 km) in 40 CFR 51, Appendix W.

☒ *The current versions of all models and associated programs were used in analyses, or alternate versions were specifically approved by DEQ.*

☒ *Any non-default model options used were approved by DEQ in advance.*

5.2 Meteorological Data

AERMOD requires an input of hourly meteorological data to estimate pollutant concentrations in ambient air resulting from modeled source emissions. For the analyses provided in herein, one year (January 1, 2014 to December 31, 2014) of site-specific hourly surface meteorological data collected at the Stibnite monitoring station were used. This dataset has been approved by IDEQ (IDEQ 2015b) for SGP air quality analyses. The data quality protocols and IDEQ approval references are provided in Section 5.8.

The site-specific surface data were supplemented with the twice-daily upper-air data (all levels) collected at the National Weather Service (NWS) station in Boise, Idaho (WBAN 24131).

These meteorological datasets were processed with the most recent version (19191) of the AERMOD meteorological pre-processor, AERMET, to produce AERMOD-input-ready hourly surface and profile meteorological files. The default option of adjusted surface friction velocity (ADJ_U*) and the Bulk Richardson (BULKRN) method for boundary layer parameter calculations was used for this meteorological data processing.

Additionally, an alternative meteorological dataset was processed without using the BULKRN method. This alternate processing used the onsite and upper air datasets discussed above, supplemented with the cloud-cover data collected at the NWS station in McCall, Idaho (WBAN 94182).

Both processing methods (with and without BULKRN) are considered default for regulatory modeling analyses.

5.2.1 Surface Characteristics for AERMET Processing

AERMET requires the input of three surface boundary layer parameters: midday Bowen ratio (B_o), midday albedo (r), and surface roughness length (z_o). These parameters are dependent on the land use and vegetative cover of the area being evaluated.

The EPA-recommended model, AERSURFACE, was used to estimate these surface parameters for the Stibnite meteorological data processing. AERSURFACE uses 1992 National Land Cover Data to determine these surface characteristics.

PRI00000460

REC 1800

The determination of B_o is dependent on ambient moisture conditions (i.e., wet, average, or dry). For this purpose, historic 30-year (1985–2014) precipitation data from the Taylor Ranch station in Idaho (the closest station from which this type of data is available) were used.

The 70th and 30th percentile values estimated from the 30-year precipitation data were used to assign a moisture class to each calendar month per the following scheme: monthly precipitation greater than the 70th percentile was considered "wet"; between the 70th and 30th percentiles was considered "average"; and less than the 30th percentile was considered "dry." The monthly season and moisture classifications and estimated r and B_o for 2014 Stibnite meteorological data processing are presented in Table 32.

Table 32. 2014 Monthly Season and Moisture Classification, and Calculated r and B_o

Month	Season	r	30-Year Precipitation Percentile (in)		2014 Precipitation (in)	Moisture Classification	B_o
			30th	70th			
January	Winter	0.38	0.64	1.29	0.74	Average	0.50
February	Winter	0.38	0.40	0.81	0.99	Wet	0.50
March	Spring	0.13	0.83	1.23	2.33	Wet	0.34
April	Spring	0.13	1.11	1.57	0.99	Dry	1.57
May	Spring	0.13	1.43	2.23	0.74	Dry	1.57
June	Summer	0.13	1.17	1.80	1.32	Average	0.37
July	Summer	0.13	0.46	1.45	0.40	Dry	0.76
August	Summer	0.13	0.42	1.11	2.03	Wet	0.25
September	Fall	0.13	0.27	1.23	0.43	Average	0.87
October	Fall	0.13	0.59	1.69	1.75	Wet	0.35
November	Fall	0.13	0.72	1.44	3.73	Wet	0.35
December	Winter	0.38	0.64	1.16	0.83	Average	0.50

The seasonal z_o values in m for each 30-degree sector of the 1-km radius for the Stibnite monitoring station are provided in Table 33. (i.e., Sector 1 is 0° to 30° clockwise from the north, Sector 2 is 30° to 60° clockwise from the north, etc.).

PRI00000461

REC 1801

Table 33. Calculated Seasonal z_o Values (m)

Sector	Winter	Spring	Summer	Fall
1	0.410	0.564	0.610	0.607
2	0.212	0.347	0.392	0.387
3	0.517	0.640	0.671	0.669
4	0.769	0.865	0.894	0.894
5	0.989	1.044	1.055	1.055
6	0.741	0.874	0.918	0.915
7	0.400	0.563	0.617	0.614
8	0.414	0.522	0.552	0.550
9	0.049	0.171	0.244	0.243
10	0.060	0.197	0.274	0.274
11	0.183	0.372	0.449	0.449
12	0.576	0.710	0.743	0.742

Winter = December, January, February
Spring = March, April, May
Summer = June, July, August
Fall = September, October, November

Wind frequency distribution for the 2014 Stibnite meteorological dataset is presented in Figure 7, and a map showing the location of the meteorological monitoring stations used for this meteorological data processing is presented in Figure 8.

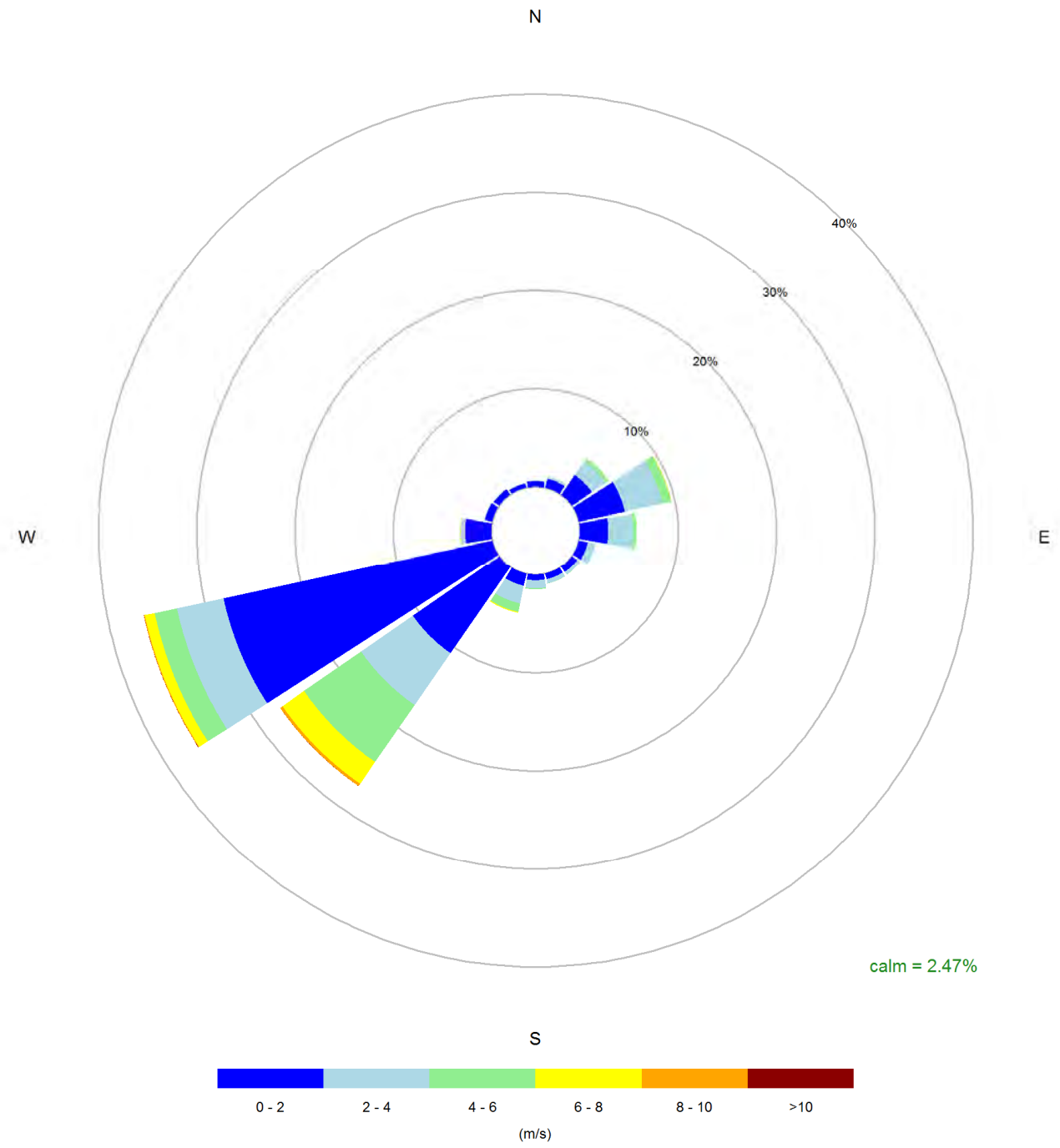
☒ *Meteorological data files are provided with the application.*

☒ *If meteorological data used for modeling were not provided by DEQ, then a detailed discussion of the data is provided along with documentation of the processing steps.*

PRI00000462

REC 1802

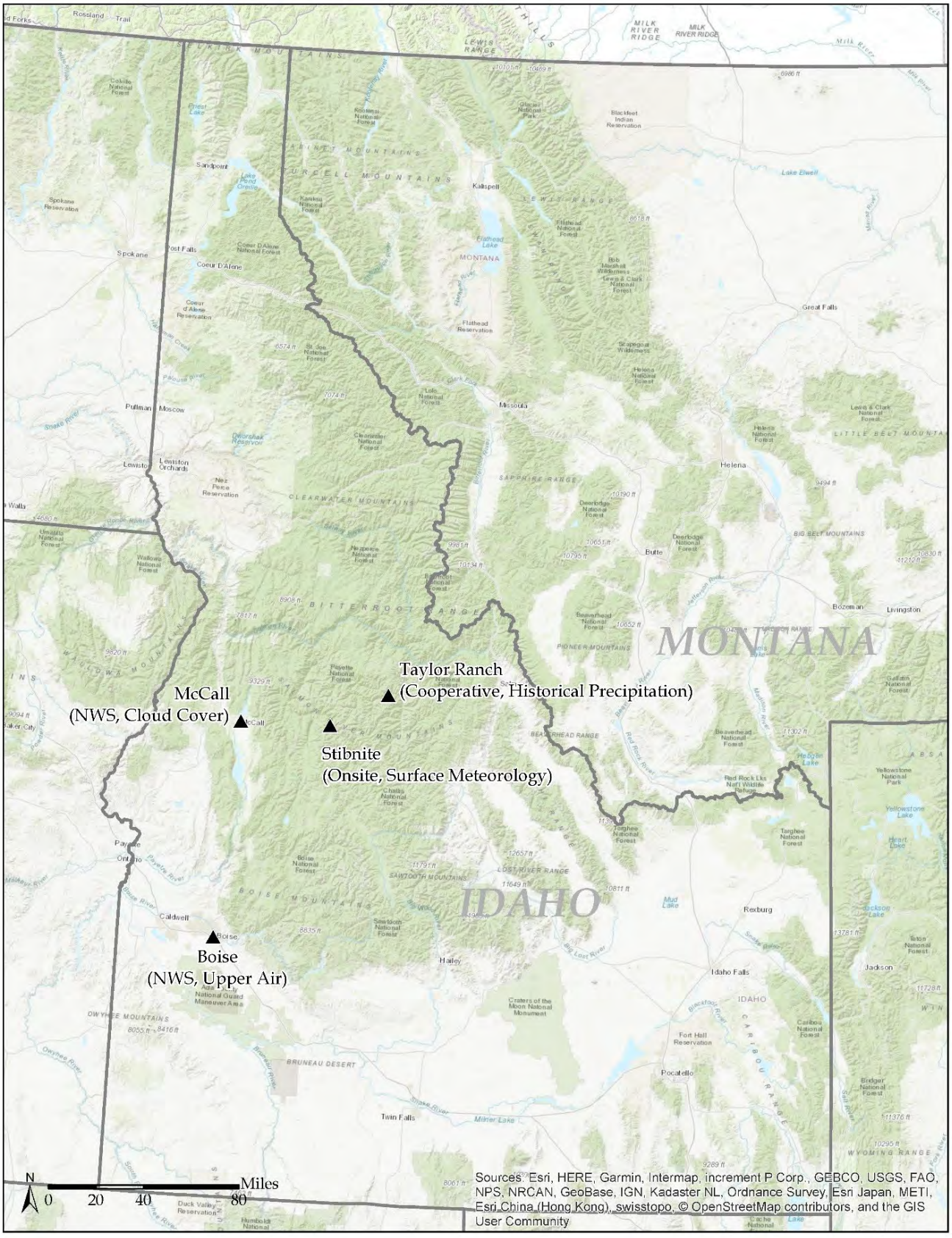
Figure 7. Wind Frequency Distribution for 2014 SGP Meteorological Data



PRI00000463

REC 1803

Figure 8. Meteorological Station Locations for SGP Modeling



PRI00000464

REC 1804

5.3 Effects of Terrain

The most recent version of the AERMOD terrain preprocessor, AERMAP (Version 18081), was used to develop receptor elevations and hill heights. U.S. Geological Survey (USGS) fine-resolution, one-third-arc-second or 10-m resolution National Elevation Dataset files were used to process receptors for the SGP analyses.

☒ *The datum of terrain data, building corner locations, emissions sources, and the ambient air boundary are specified and are consistent such that the modeled plot plan accurately represents the facility and surroundings.*

5.4 Facility Layout

A facility-wide plot plan showing an overall layout of pits, DRSF, process area and ambient air boundary is provided in Figure 4. A detailed layout of the process area showing buildings and sources is supplied in Figure 5, and the haul road network is depicted in Figure 6.

☒ *The facility layout plot plan is provided in this section that clearly and accurately depicts buildings, emissions points, and the ambient air boundary.*

☒ *This section of the Modeling Report has thoroughly described how locations of emissions sources, building corners, and the ambient air boundary were determined, specifying the datum used.*

5.5 Effects of Building Downwash

The effects of building-induced downwash were incorporated into the modeling analyses. The building downwash parameters were calculated using the most recent version of the Building Profile Input Program (BPIP) with the Plume Rise Model Enhancement (PRIME) algorithm (BPIP-PRIME Version 04274).

Building locations, orientation and dimensions were obtained from project drawings (Midas Gold 2017d).

5.6 Ambient Air Boundary

EPA defines ambient air as "*that portion of the atmosphere, external to buildings, to which the general public has access*" (40 CFR 50.1(e)). EPA also recognizes that some areas external to buildings are not covered by this definition. The EPA's longstanding policy on "ambient air" was that the atmosphere over land that is owned or controlled by the source and where public access is precluded by a fence or other physical barriers can be excluded from the definition of ambient air. Recently EPA proposed a restatement of its longstanding policy for public comment, "Draft Revised Policy on Exclusions from Ambient Air" (EPA 2018b). Without changing the underlying definition, EPA's updated policy allows consideration of additional methods to restrict public access. It replaces the phrase "*a fence or other physical barriers*" with "*measures, which may include physical barriers, that are effective in deterring or precluding access to the land by the*

PRI00000465

REC 1805

general public." To keep up with practical considerations, and technological advancements in surveillance and security, the revised policy states:

"*… the EPA believes there are various measures other than fencing or other physical barriers that a facility can employ to serve as an effective deterrent to public access. These measures may include traditional fencing, but may also include video surveillance and monitoring, clear signage, routine security patrols, drones, and other potential future technologies.*"

This revised policy provides guidance to reviewing agencies to make ambient air determinations:

"*Air agencies should evaluate the effectiveness of a "measure" in precluding public access based on the relevant, specific circumstances. This evaluation should address relevant factors, such as the nature of the measure used (e.g., physical or non-physical), facility location (e.g., rural or urban), type and size of facility and property to be excluded, surrounding area (including the proximity, nature, and size of the population in the area), and other factors affecting the extent to which persons would be likely or able to trespass upon or otherwise have access to the facility's land. Air agencies should consider any information provided by the regulated entity, or otherwise available to the air agencies, regarding the effectiveness of the measures to prevent public access. For instance, the use of clearly visible, well-spaced "No Trespassing" signs, either with or without fencing, may be effective in certain areas. Another example of an effective measure may involve atypical public access such as swamps and large tracts of undeveloped private land.*"

"*Air agencies are expected to apply a rule of reason in assessing the effectiveness of proposed measures.*"

"*… measures should provide reasonable assurance that the general public will not have access.*"

"*… determinations concerning the adequacy of such measures can only be made by air agencies on a case-by-case basis after consideration of the relevant administrative record in each case.*"

The second aspect of the access evaluation did not change in EPA's restatement; that is whether the source has the legal authority to preclude access by the public to the area of land it owns. In the conclusion section, the revised policy states:

"*This change replaces the specific concept of a fence or other physical barriers with the more general concept of measures, which may include physical barriers, that are effective in deterring or precluding access by the general public. Accordingly, the EPA's revised ambient air policy, consistent with its discretion available under the regulatory definition of ambient air, is that it is appropriate to exclude the atmosphere over land owned or controlled by the stationary source, where the owner or operator of the source employs measures, which may include physical barriers, that are effective in deterring or precluding access to the land by the general public.*"

Midas Gold will legally control the SGP, an active industrial site where mining activities will occur, such as heavy equipment operation. Most areas of the mine will require strict safety protocols and controlled access. Midas Gold has established an operations boundary to identify the area where public access will be excluded. Public access inside the operations boundary will be restricted for the life of the mine by physical barriers at points of potential access, including the current Stibnite Road point of entry and proposed site access via the Burntlog Route, as well as natural features of the landscape that prevent access. Consistent with the guidance provided in the EPA's draft revised policy on ambient air (EPA 2018b), public access control will include the following measures:

- Primary Access Points: The Stibnite Road (north) and Burntlog Route (south) access points will include locked gates. The southern access point also will include a guard shack that onsite personnel will monitor continuously. Security staff at the southern access point will monitor the gate at the northern access point using video camera surveillance. Each gate also will include appropriate adjacent barriers (i.e., fencing, bollards, boulders, or other barriers) to prevent any vehicle from circumventing the gate and gaining site access. These primary access points are also controlled by adjacent natural features, such as streams and creeks, steep topography, and areas of thick vegetation and undergrowth that serve as natural barriers or impediments to access.

- Secondary Access Points: Other potential access points, such as secondary roadways and trails, will include posted signs warning the public against entry into the site. At these locations, boulders will be placed across the trail and at an appropriate width adjacent to the trail to prevent any vehicle from circumventing the barrier. These secondary access points also incorporate adjacent natural features, such as streams and creeks, steep topography, and areas of thick vegetation and undergrowth that serve as natural barriers or impediments to access. Some mine features, such as the TSF and process plant areas, will include perimeter fencing.

- Surveillance: Midas Gold security personnel will routinely patrol mine facilities and roadways for unauthorized individuals. In addition, all onsite personnel will be trained on the necessity of restricting public access to areas within the operations boundary. Any suspected trespassing by unauthorized individuals will be reported immediately to security, and trespassers will be escorted off the site.

In response to comments from local community citizens, Midas Gold will manage an access route to provide the general public with limited access through the SGP site between Stibnite Road at Sugar Creek and Thunder Mountain Road at Meadow Creek (shown in Figure 4). This route will be managed in accordance with the Stibnite Road Access Management Plan provided in Attachment 2 and summarized as follows:

PRI00000467

REC 1807

The proposed Stibnite Road access route through the SGP site is meant to provide controlled through-site access that is safe, provides travel-time comparable to current conditions and is consistent with the United States Forest Service travel management plan. The Stibnite Road access route extends from the north entry point southward to the Administration, Warehouse and Storage Area. Continuing southward, the Stibnite Road access route incorporates the Burntlog access road segment that occurs within the operations area and extends to the south entry point as shown on Figure 4. Midas Gold has the legal authority to control access to the Stibnite Road access route and would provide seasonal (non-winter conditions) access only. At the discretion of Midas Gold, additional access controls may occur during various phases of construction, during mine operations that present potential safely hazards such as blasting, due to inclement weather, or under any other circumstances that may present a threat to the protection of public or employee health and safety. Midas Gold has the legal and practical ability to enforce its control over roadway access and to monitor traffic passing through the SGP site. Signage will be placed at the North Security Gate (near the bridge over Sugar Creek) and the South Security Gate (near the Stibnite Lodge) to provide information to travelers, and guard shacks will be located at each gate to monitor all vehicle ingress/egress. Persons wishing to traverse the SGP site on the Stibnite Road access route will be required to check in at the security gate to receive a safety briefing and to alert mine staff of their presence. Travelers will be required to check out upon exiting the site to ensure passage through the site in a safe and timely manner. Travelers will not be allowed to stop or loiter while traveling though the operations area. Along its full length, the Stibnite Road access route would have appropriate signage to direct travelers and would be separated from mine haul roads and areas of mine operations by fencing, berms, or gates to prevent travelers from straying from the route. When possible and to the degree practicable, anticipated public access restrictions will be communicated to the public in a timely manner so that they may plan appropriately. Receptors on the Stibnite Road access route were not included in the SGP air quality analyses as this road is not considered ambient air.

The worker housing facility will be located within the project operations boundary, near the south access security gate. This housing facility will be used strictly for accommodating employees, contractors, and official visitors, and it will not be accessible to the general public. Therefore, the atmosphere over the land occupied by the worker housing facility is not considered ambient air, and receptors were not placed at this location for the air quality analyses.

The operations boundary, shown in Figures 4 and 9, was used to define the ambient air boundary for the air dispersion modeling purposes.

☒ *If any of the following apply, the effect on areas excluded from ambient air is thoroughly described in this section: a river/stream bisecting the facility; the facility is on leased property or is leasing property to*

PRI00000468

REC 1808

another entity; the facility is not completely fenced; there are right-of-way areas on the facility; the nature of business is such that the general public have access to part or all of the facility.

☒ *This section thoroughly describes how the facility can legally preclude public access (and practically preclude access) to areas excluded from ambient air in the modeling analyses.*

5.7 Receptor Network

The SGP air quality analyses was performed using the following receptor spacing and extents:

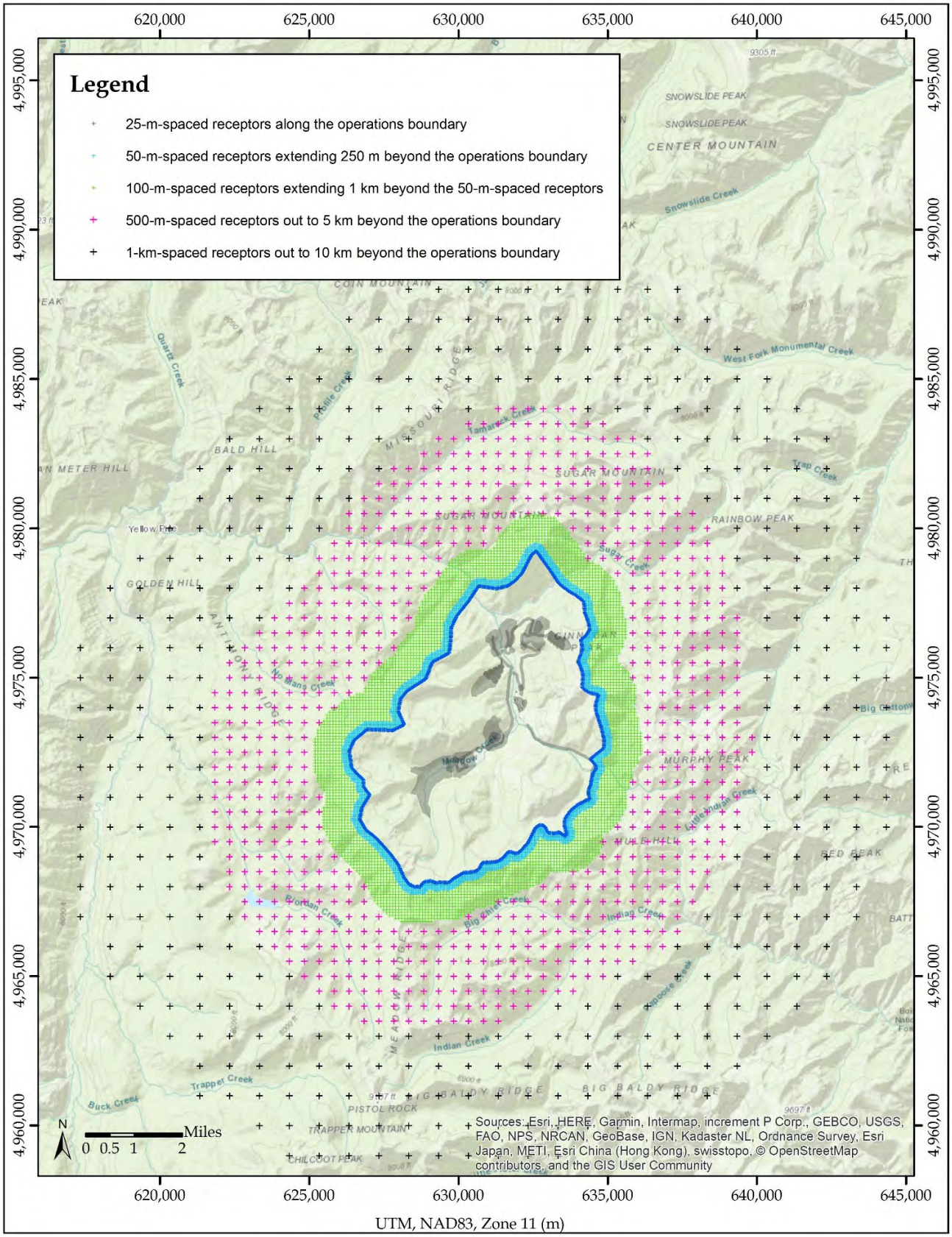
- 25-meter (m)-spaced receptors placed along the ambient air boundary;
- 50-m-spaced receptors extending 250 m beyond the ambient air boundary;
- 100-m-spaced receptors extending 1 km beyond the 50-m-spaced receptors;
- 500-m-spaced receptors extending 5 km beyond the ambient air boundary; and
- 1-km-spaced receptors extending 10 km beyond the ambient air boundary.

In addition, each highest modeled impact was evaluated further by performing a hot-spot analysis using a finer 25m-spacing receptor grid. The modeling receptor grid is shown in Figure 9.

PRI00000469

REC 1809

Figure 9. SGP Operations Boundary and Modeling Receptor Grid



☒ *This section of the Modeling Report provides justification that receptor spacing used in the air impact analyses was adequate to reasonably resolve the maximum modeled concentrations to the point that NAAQS or TAP compliance is assured.*

5.8 Background Concentrations

This section describes the background concentrations representative of the SGP area.

5.8.1 Onsite Particulate Monitoring

To establish background ambient air conditions for the SGP area, Midas Gold developed an onsite monitoring program to collect site-specific meteorological parameters and determine ambient particulate matter ($PM_{2.5}$ and PM_{10}) concentrations at its Stibnite monitoring station (shown in Figure 8). Midas Gold submitted the "Monitoring Protocol and Quality Assurance Project Plan" (JBR 2013) for this monitoring station to the IDEQ, and it was approved formally in December 2013 (IDEQ 2013a).

In September 2015, Midas Gold submitted the data collected at the Stibnite monitoring station for the period of November 2013 through June 2015 to IDEQ. After reviewing the data and associated quality control procedures, IDEQ concluded that the $PM_{2.5}$ and PM_{10} data collected at the Stibnite monitoring station satisfied the applicable regulatory requirements and approved the data to be used for background concentrations in the SGP air quality analyses (IDEQ 2015b). In its conclusions, IDEQ recommended that the $PM_{2.5}$ and PM_{10} background concentrations should be based on calendar year 2014 instead of the complete dataset (November 2013 through June 2015).

IDEQ-approved $PM_{2.5}$ and PM_{10} background concentrations, in units of micrograms per cubic meter ($\mu g/m^3$), are provided in Table 34.

Table 34. IDEQ-Approved $PM_{2.5}$ and PM_{10} Background Concentrations for SGP

Pollutant	Averaging Time	Background Concentration ($\mu g/m^3$)	Design Value Rank
$PM_{2.5}$	1 year	3.5	Weighted average of quarterly means
	24 hours	15	98th percentile/8th high
PM_{10}	24 hours	37	Highest 2nd high

5.8.2 Gaseous Pollutant Background Concentrations

With a few exceptions of very large facilities or facilities located in nonattainment areas, regulatory agencies do not require the collection of gaseous criteria pollutants, including CO, NO_X (and/or nitrogen dioxide [NO_2]), O_3, and SO_2. For these gaseous pollutants, data collected at government-regulated monitoring stations located in settings similar to the project area in

PRI00000471

REC 1811

terms of terrain, land use, and proximity of emission sources are typically used to establish background concentrations.

To determine representative background concentrations of CO, NO_X, O_3, and SO_2 for the SGP site, which is located in a remote rural area, the IDEQ-maintained ambient monitoring network was reviewed. This review revealed that IDEQ only conducts limited trace monitoring for CO, NO_X, O_3, and SO_2 in the Boise metropolitan area along the Interstate 84 corridor. Thus, the data collected at these monitors are exposed to high emissions from industrial, urban, and transportation sources (IDEQ 2015a) (IDEQ 2018). For this reason, the gaseous pollutant concentrations recorded at these urban monitoring locations were not considered to be representative of a rural area, like the SGP site.

The EPA-maintained monitoring stations (EPA 2018a) in Idaho and surrounding states also were reviewed to determine representative gaseous pollutant background concentrations for the SGP site. This review also did not identify any representative monitoring station to establish background gaseous pollutant concentrations for the SGP site.

The IDEQ-recommended (IDEQ 2019) CO, NO_X, O_3, and SO_2 background concentrations for the SGP air quality analyses in units of parts per billion (ppb) and $\mu g/m^3$, are provided in Table 35.

Table 35. IDEQ-Recommended Gaseous Pollutant Background Concentrations for SGP

Pollutant	Averaging Time	Background Concentration		Reference
		(ppb)	($\mu g/m^3$)	
CO	8 hours	970	1,110	NW AIRQUEST, 2014-2017 design value
	1 hour	1,520	1,740	
NO_2	1 year	0.5	0.9	
	1 hour	2.3	4.3	
O_3 (for NO_2 modeling)	8 hours	55	107.9	
SO_2	3 hours	6.4	16.8	
	1 hour	4.7	12.3	

The IDEQ-provided gaseous pollutant concentrations shown in Table 35 were determined using the Northwest International Air Quality Environmental Science and Technology Consortium (NW AIRQUEST) online tool provided through Washington State University. The NW AIRQUEST tool uses regional scale modeling of pollutants in Washington, Oregon, and Idaho, with model results adjusted according to available monitoring data.

PRI00000472

REC 1812

5.8.3 Medium Traffic Pollutant Background Concentrations

For additional information, background concentrations were obtained from NW AIRQUEST for the road section between mile markers 143 and 144 on Highway 55 passing through the town of McCall. This site (latitude 44.906° N, longitude 116.098° W) is approximately 38 miles west of the SGP. The annual average daily traffic count for this road section is over 10,000 vehicles per day. Table 36 provides the background concentrations for this medium traffic site. Although these concentrations are not representative of the rural SGP area, they do provide additional information regarding the relative contribution of traffic emissions.

Table 36. Medium Traffic Background Concentrations

Pollutant	Averaging Time	Background Concentration		Reference
		(ppb)	(μg/m³)	
CO	8 hours	1,000	1,145	NW AIRQUEST, 2014-2017 design value, near McCall, ID (44.91°N, 116.10°W)
	1 hour	1,570	1,797	
NO_2	1 year	1.4	2.6	
	1 hour	7.6	14.3	
$PM_{2.5}$	1 year	--	5.1	
	24 hours	--	17.5	
PM_{10}	24 hours	--	60.1	
SO_2	3 hours	6.4	16.8	
	1 hour	4.7	12.3	

☒ *Background concentrations have been thoroughly documented and justified for all criteria pollutants where a cumulative NAAQS impact analysis was performed.*

5.9 NOx Chemistry

The NO_X emissions from the combustion sources principally are composed of NO (nitric oxide) and NO_2. Once in the atmosphere, NO can convert to NO_2 through chemical reactions with ambient O_3. To address this atmospheric conversion process, the Guideline on Air Quality Models (40 CFR 51, Appendix W) recommends the following three-tiered screening approach for evaluating NO_2 impacts:

i. A first-tier (most conservative) "full" conversion approach;

ii. A second-tier approach that assumes ambient equilibrium between NO and NO_2; and

PRI00000473

REC 1813

iii. A third-tier approach consisting of several detailed screening techniques that account for ambient O_3 and the relative amount of NO and NO_2 emitted from a source.

The default third-tier OLM method with the combined plume option (keywords OLMGROUP ALL) was used in modeling the NO_2 1-hour and annual impacts for these analyses.

The use of OLM requires the following additional input parameters:

- Ambient Equilibrium NO_2/NO_X Ratio: The AERMOD default NO_2/NO_X ambient equilibrium ratio of 0.90 was used for these analyses.

- In-Stack NO_2/NO_X Ratio: The NO_2/NO_X ratios used for the SGP analyses are listed in Table 19 in Section 4.6.3.

- Background O_3 Concentrations: The use of the OLM option in AERMOD requires the input of hourly O_3 concentrations. The O_3 concentration values may be entered as a single value, as hourly values corresponding with meteorological data, or as temporally varying profiles. For the SGP NO2 analyses, a single O_3 concentration of 55 ppb provided by IDEQ (IDEQ 2019) was used.

☒ *If OLM or PVMRM was used to address NOx chemistry, reasons for selecting one algorithm over the other are provided in this section.*

5.9.1 Treatment of Intermittent Sources for NO_2 1-Hour Analyses

In its most recent guidance on NO_2 1-hour modeling (EPA 2011), the EPA has recognized that intermittent sources that do not operate continuously or frequently enough, specifically emergency generators, are less likely to contribute significantly to the annual distribution of daily maximum 1-hour values. The EPA also recommends "*that compliance demonstrations for the 1-hour NO_2 NAAQS be based on emission scenarios that can logically be assumed to be relatively continuous or which occur frequently enough to contribute significantly to the annual distribution of daily maximum 1-hour concentrations*" (EPA 2011). Also, "*EPA believes the most appropriate data to use for compliance demonstration for the 1-hour NO_2 NAAQS are those based on emission scenarios that are continuous enough or frequent enough to contribute significantly to the annual distribution of daily maximum 1-hour concentrations*" (EPA 2011).

The emergency equipment for the SGP includes backup power generators and a fire pump. This equipment is essential to ensure safety and uninterrupted essential operations in case of unforeseen power failures and/or other emergency situations. This equipment is proposed to operate for 100 hours per year for purposes of determining potential emissions, but it may operate for far fewer hours and on a random schedule. Thus, operation of emergency equipment will not be frequent enough to contribute significantly to the annual distribution of

PRI00000474

REC 1814

daily maximum 1-hour concentrations, and inclusion of the equipment's maximum hourly emissions does not represent a logical emission scenario.

After reviewing the EPA guidance, and public and industry comments, as well as conducting its internal review and test model runs, the IDEQ has determined that NO_2 emissions from emergency equipment may be excluded from the NAAQS analyses (IDEQ 2013b).

Based on guidance provided by IDEQ on the intermittent source modeling for NO_2 1-hour NAAQS emissions from emergency equipment were not included for NO_2 1-hour NAAQS analyses. However, for the other pollutants, the emergency equipment short-term (up to 24 hours) emissions were based on one hour of operation and the annual emissions were based on 100 hours of operation.

5.10 Particulate Deposition

For $PM_{2.5}$ and PM_{10} analyses default particulate modeling methods, including deposition (Method 1, to account for depletion due to particulate settling), were used. To account for particulate settling, AERMOD requires the following source-specific variables:

1. Mass-mean aerodynamic particle diameter (PARTDIAM) for each particle size bin
2. Mass fraction (MASSFRAX) for each particle size bin
3. Particle density (PARTDENS) for each particle size bin

A list of references that were used to develop the broad source category particle size bins and associated mass fractions is provided in Table 37. This table also provides material type and associated density in grams per cubic centimeter (g/cm^3) for each source category.

Midas Gold (Midas Gold 2017b) provided the ore and DR material densities. The diesel and propane combustion particulate densities were adopted from technical literature (UMN 2002) and (Khalizov et al. 2012), respectively. Densities for the remaining materials listed in Table 37 were obtained from the Engineering Toolbox.[1] An average density was used when a material-specific density range was available.

Table 37. References Used to Develop Deposition Parameters

Source Category/Type	Mass Fraction Reference	Material Type	Density (g/cm^3)
Vehicle Travel Road Dust	AP-42, Sec. 13.2.2, (11/06), Eqs. 1a and 2, Tab. 13.2.2-2	YP, HF, WE DR average	2.46
Ore Handling	AP-42, Pg. 13.2.4-4, (11/06)	Pit-specific ore, see Table 39	
DR Handling	AP-42, Pg. 13.2.4-4, (11/06)	Pit-specific DR, see Table 39	

[1] https://www.engineeringtoolbox.com/density-materials-d_1652.html

PRI00000475

REC 1815

Source Category/Type	Mass Fraction Reference	Material Type	Density (g/cm^3)
Limestone Handling	AP-42, Pg. 13.2.4-4, (11/06)	Limestone dust	1.09
Baghouses	AP-42, App. B-1, Pg. B.1-77, Sec. 11.21, (01/95), (phosphate rock processing: roller mill and bowl mill grinding)	Pit-specific ore, see Table 39	
Diesel Engines	AP-42, App. B-2, Tab. B.2-2, Pg. B.2-11, (01/95), (Category 1, stationary internal combustion engines, gasoline and diesel fuel)	Diesel combustion particulate	1.00
Heaters and Boilers	AP-42, App. B-2, Tab. B.2.2, Pg. B.2-12, (01/95), (Category 2, combustion, mixed fuels, boilers)	Propane combustion particulate	1.24
Quick Lime Handling	AP-42, Table 11.12-2, (6/06), (pneumatic loading, controlled)	Quick lime	0.44
Pebble Lime Handling	AP-42, Table 11.12-2, (6/06), (pneumatic loading, controlled)	Pebble lime	0.96
Cement Handling	AP-42, Table 11.12-2, (6/06), (pneumatic loading, controlled)	Portland cement	1.44
Aggregate Handling	AP-42, Table 11.12-2, (06/06), (aggregate transfer, uncontrolled)	Gravel	1.28
Prill Handling	AP-42, Table 8.3-2, (07/93), (bulk loading, uncontrolled)	Ammonium nitrate prill	0.84
Furnace/Refinery	AP-42, App. B-2, Tab. B.2.2, Pg. B.2-18, (01/95), (Category 8, melting, smelting, refining, metals, except aluminum)	Diesel combustion particulate	1.00
Portable Crushing and Screening Plant	AP-42, Table 11.19.2-2 (08/04): Tert. Crushing - ctrl. × 2 + Screening - ctrl. × 2 + Conv. Transfer - ctrl. × 5	YP, HF, WE DR average	2.46
Lime Kiln	AP-42, Sec. 11.17, Tab. 11.17-7, (02/98) (rotary kiln with fabric filter)	Limestone dust	1.09
Limestone Ball Mill	AP-42, Sec. 11.17, Tab. 11.17-7, (02/98), (rotary kiln with fabric filter)	Limestone dust	1.09
Blasting	AP-42, Sec. 11.9, Tab. 11.9-1, (07/98), (blasting, overburden)	Pit-specific ore or DR, see Table 39	
Drilling	AP-42, Tab. 11.9-1, (07/98), (scaling factors for overburden blasting)	Pit-specific ore or DR, see Table 39	

For sources that were aggregated and modeled as activity locations as discussed in Section 4.4.2, deposition parameters were selected for the dominant source within the activity location. For open-pits (YPP, HFP, WEP), approximately 90% of emissions were associated with drilling; therefore, drilling deposition parameters were assigned to these sources. Similarly, emissions from dozing accounted for over 70% of emissions in the DRSF (FDRSF, HFDRSF, WEDRSF) and BT; therefore, these sources were assigned deposition parameters based on a dozing particulate profile.

The deposition parameters including mass fractions, mass mean diameters, and densities for broader source categories/groups are provided in Table 38.

PRI00000476

REC 1816

Table 38. Deposition Parameters by Source Category

Source Category	Parameter	PM_{10}				$PM_{2.5}$	
		Bin 1	Bin 2	Bin 3	Bin 4	Bin 1	Bin 2
Haul Roads	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction	0.10	0.90	--	--	1.00	--
	Mass Mean Diameter (µm)	2.50	10.00	--	--	2.50	--
	Density (g/cm^3) (YP, HF, WE DR average)	2.46	2.46	--	--	2.46	--
Material Handling (Ore, DR, Limestone)	Bin Upper Diameter (µm)	2.50	5.00	10.00	--	2.50	--
	Mass Fraction	0.15	0.42	0.43	--	1.00	--
	Mass Mean Diameter (µm)	2.50	5.00	10.00	--	2.50	--
	Density (g/cm^3) (Ore)	Pit-specific, see Table 39					
	Density (g/cm^3) (DR)	Pit-specific, see Table 39					
	Density (g/cm^3) (Limestone)	1.09	1.09	1.09	--	1.09	--
Baghouses	Bin Upper Diameter (µm)	2.50	6.00	10.00	--	2.50	--
	Mass Fraction	0.28	0.50	0.22	--	1.00	--
	Mass Mean Diameter (µm)	2.50	6.00	10.00	--	2.50	--
	Density (g/cm^3) (Ore)	Pit-specific, see Table 39					
Diesel Engines	Bin Upper Diameter (µm)	1.00	2.50	6.00	10.00	1.00	2.50
	Mass Fraction	0.85	0.08	0.03	0.03	0.91	0.09
	Mass Mean Diameter (µm)	1.00	2.50	6.00	10.00	1.00	2.50
	Density (g/cm^3) (Diesel Combustion)	1.00	1.00	1.00	1.00	1.00	1.00
Heaters and Boilers	Bin Upper Diameter (µm)	1.00	2.50	6.00	10.00	1.00	2.50
	Mass Fraction	0.29	0.28	0.32	0.11	0.51	0.49
	Mass Mean Diameter (µm)	1.00	2.50	6.00	10.00	1.00	2.50
	Density (g/cm^3) (Propane Combustion)	1.24	1.24	1.24	1.24	1.24	1.24
Lime Loading and Unloading (Quick, Pebble)	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction	0.15	0.85	--	--	1.00	--
	Mass Mean Diameter	2.50	10.00	--	--	2.50	--
	Density (g/cm^3) (Quick)	0.44	0.44	--	--	0.44	--
	Density (g/cm^3) (Pebble)	0.96	0.96	--	--	0.96	--
Lime Unloading (Quick, Pebble)	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction	0.15	0.85	--	--	1.00	--
	Mass Mean Diameter (µm)	2.50	10.00	--	--	2.50	--
	Density (g/cm^3) (Quick)	0.44	0.44	--	--	0.44	--
	Density (g/cm^3) (Pebble)	0.96	0.96	--	--	0.96	--
Cement and Aggregate Loading and Unloading	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction	0.15	0.85	--	--	1.00	--
	Mass Mean Diameter (µm)	2.50	10.00	--	--	2.50	--
	Density (g/cm^3) (Cement)	1.44	1.44	--	--	1.44	--
	Density (g/cm^3) (Aggregate)	1.28	1.28	--	--	1.28	--

PRI00000477

REC 1817

Source Category	Parameter	PM_{10}				$PM_{2.5}$	
		Bin 1	Bin 2	Bin 3	Bin 4	Bin 1	Bin 2
Prill Loading and Unloading	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction	0.15	0.85	--	--	1.00	--
	Mass Mean Diameter (µm)	2.50	10.00	--	--	2.50	--
	Density (g/cm^3) (Prill)	0.84	0.84	--	--	0.84	--
Refining Processes	Bin Upper Diameter (µm)	1.00	2.50	6.00	10.00	1.00	2.50
	Mass Fraction	0.78	0.11	0.08	0.03	0.88	0.12
	Mass Mean Diameter (µm)	1.00	2.50	6.00	10.00	1.00	2.50
	Density (g/cm^3) (Diesel Combustion)	1.00	1.00	1.00	1.00	1.00	1.00
Portable Crushing and Screening Plant	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction	0.13	0.87	--	--	1.00	--
	Mass Mean Diameter (µm)	2.50	10.00	--	--	2.50	--
	Density (g/cm^3) (YP, HF, WE DR average)	2.46	2.46	--	--	2.46	--
Lime Kiln and Ball Mill	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction (Kiln)	0.49	0.51	--	--	1.00	--
	Mass Fraction (Ball Mill)	0.36	0.64	--	--	1.00	--
	Mass Mean Diameter (µm)	2.50	10.00	--	--	2.50	--
	Density (g/cm^3)	1.09	1.09	--	--	1.09	--
Blasting and Drilling	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction	0.06	0.94	--	--	1.00	--
	Mass Mean Diameter (µm)	2.50	10.00	--	--	2.50	--
	Density (g/cm^3) (Ore or DR)	Pit-specific, see Table 39					
Dozing	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction	0.55	0.45	--	--	1.00	--
	Mass Mean Diameter (µm)	2.50	10.00	--	--	2.50	--
	Density (g/cm^3) (DR)	Pit-specific, see Table 39					

In order to account for variability in ore and DR densities for different pits, pit-specific densities were used for the ore and DR for each modeling scenario, with the following exception – for haul roads, access roads, and portable crushers, the average DR density from YP, HF, and WE pits was used. Note, the BT density was excluded from those sources because the BT material will not be used for roads or construction. The pit-specific ore and DR densities are provided in Table 39.

Table 39. Pit-Specific Ore and DR Densities for Deposition

Pit	Material	Density (g/cm^3)
YP	Ore	2.59
BT	Ore	2.00

PRI00000478

REC 1818

Pit	Material	Density (g/cm^3)
HF	Ore	2.59
WE	Ore	2.68
YP	DR	2.48
BT	DR	2.00
HF	DR	2.34
WE	DR	2.57
Average (YP, HF, WE)	DR	2.46

5.11 Mobile Equipment Tailpipe Emissions

In its comments letter (IDEQ 2019) on the Midas modeling protocol, IDEQ recognizes that tailpipe emissions from mobile sources are not subject to permitting requirements and are therefore not considered for impact analyses. Traditionally, mobile source emissions are considered a part of background concentrations. Because the SGP facility is not constructed yet, IDEQ believes that the resulting tailpipe emissions are not a part of current background concentrations. Therefore, IDEQ suggested that at the least, the impacts from the SGP-related tailpipe emissions must be addressed qualitatively by demonstrating that the conservative aspects of modeling analyses ensure NAAQS compliance even if tailpipe emissions were not specifically included in the model.

Midas believes that even though SGP-related mobile equipment tailpipe emissions were not included in the modeling analyses, the results provided in this report are conservatively high, ensuring NAAQS compliance, for the following reasons:

- Inherent conservatism built into the regulatory dispersion modeling system.
- The estimated total ambient concentrations (maximum modeled design concentration plus the applicable design background concentration) from the SGP emissions were compared with applicable ambient standards for compliance demonstration. The estimated total ambient concentrations are expected to be conservatively high because the applicable design background concentrations were added to the maximum design model outputs, even though the two are not expected to be temporally or spatially paired.
- The modeled emissions were based on maximum short-term activity rates occurring continuously, including blasting emissions based on one blast occurring every hour for the applicable 1-hour standards, and two blasts occurring every day for the applicable 24-hour standards. The actual blasting is not expected to exceed one blast per day. Inflated daily production and mining activity rates were also used to estimate the conservatively high emissions from processing and mining sources.

PRI00000479

REC 1819

- Applicable mining activity fugitive emissions were concentrated in a single pit, a single material destination (crusher area or a DRSF), and a single hauling route for each of the multiple modeling scenarios. The actual mining activity fugitive emissions will be spread out over multiple pits, material destinations, and hauling routes for a given LOM year.

- The higher background concentrations that include medium traffic emissions discussed in Section 5.8.3 may be combined with the SGP model-predicted maximum design concentrations in Section 6.1 to provide an additional level of conservatism in demonstrating compliance.

Portable light plants powered by diesel-fired generators will be used to support nighttime operations at the SGP. The portable light plants will be operated within the SGP stationary source year-round and will not remain at any single location within the stationary source for more than 12 consecutive months. Therefore, these light plant generator engines will meet the following criteria of nonroad engines from 40 CFR 1068.30:

a) Mounted on a piece of equipment (i.e., skid, trailer, or platform) that is portable; and

b) Not remain at a single location for more than 12 consecutive months.

PRI00000480

REC 1820

6.0 RESULTS AND DISCUSSION

This section provides the SGP air quality analyses results for the criteria pollutants and TAP. The model input, output, and the associated processing files are provided on a digital media in Appendix D.

6.1 Criteria Pollutant Impact Results

As discussed in Section 4.6.1, SIL analyses were not performed for this report. The results (highest of 14 scenarios) from AERMOD dispersion modeling performed for the SGP NAAQS impact analyses are provided in Table 40. See Appendix C for the results of each scenario.

Table 40. SGP NAAQS Impact Analyses Results

Pollutant	Averaging Time[1]	Max. Conc. (μg/m³)	Model Scenario	Back. Conc. (μg/m³)	Total Conc. (μg/m³)	NAAQS (μg/m³)	In Compliance
CO	8 hours	6,218	W1	1,110	7,328	10,000	Yes
	1 hour	17,054	W1	1,740	18,794	40,000	Yes
NO_2	1 year	2.3	W1	0.9	3.2	100	Yes
	1 hour	116.7	B1	4.3	121.0	188	Yes
$PM_{2.5}$[2]	1 year	4.2	W5	3.5	7.7	12	Yes
	24 hours	11.0	W5	15.0	26.0	35	Yes
PM_{10}[2]	24 hours	75.7	W5	37.0	112.7	150	Yes
SO_2	3 hours	1.8	B1	16.8	18.6	1,300	Yes
	1 hour	3.2	B1	12.3	15.5	196	Yes

Max. Conc. = maximum modeled design concentration; Back. Conc. = background concentration; Total Conc. = total (modeled + background) concentration

[1] See Table 6 for the design values/ranks.

[2] Results with alternate meteorological data.

Table 40 provides the model-predicted maximum design concentration (including the hot-spot analyses) and the associated modeling scenario, the background concentration, and the estimated total concentration (SGP impact plus background) for each pollutant-averaging time combination. A comparison of the estimated total concentrations with the applicable NAAQS is also provided in this table.

As shown in Table 40, the estimated total concentrations from the SGP cumulative analyses do not exceed the applicable NAAQS.

The PM_{10} modeling with the meteorological dataset processed with the BULKRN method shows up to two receptors for three modeling scenarios (W1, W3, and W5) with slight exceedance of NAAQS. For these three scenarios, the PM_{10} 24-hour hot-spot analyses were performed with the

PRI00000481

REC 1821

alternate meteorological dataset processed without the BULKRN method (discussed in Section 5.2). The hot-spot analyses results show compliance with the PM_{10} 24-hour NAAQS, and the highest impact from the hot-spot analyses is shown in Table 40. For consistency purpose, the $PM_{2.5}$ results provided in Table 40 are also from the hot-spot analyses performed with alternate meteorological data.

The locations of the maximum impacts for each pollutant and averaging time are illustrated in Figure 10. The results presented in this figure include the hot-spot analysis conducted for each applicable pollutant-averaging time combination.

As discussed in Section 5.11, the higher background concentrations that include medium traffic emissions provided in Section 5.8.3 may be combined with the SGP model-predicted maximum design concentrations (Table 40) to provide an additional level of conservatism in demonstrating compliance. These results are shown in Table 41.

Table 41. SGP NAAQS Impact Analyses Results with Medium Traffic Background Concentrations

Pollutant	Averaging Time[(1)]	Max. Conc. (μg/m³)	Model Scenario	Back. Conc. (μg/m³)	Total Conc. (μg/m³)	NAAQS (μg/m³)	In Compliance
CO	8 hours	6,218	W1	1,145	7,363	10,000	Yes
	1 hour	17,054	W1	1,797	18,851	40,000	Yes
NO_2	1 year	2.3	W1	2.6	4.9	100	Yes
	1 hour	116.7	B1	14.3	131.0	188	Yes
$PM_{2.5}$[(2)]	1 year	4.2	W5	5.1	9.3	12	Yes
	24 hours	11.0	W5	17.5	28.5	35	Yes
PM_{10}[(2)]	24 hours	75.7	W5	60.1	135.8	150	Yes
SO_2	3 hours	1.8	B1	16.8	18.6	1,300	Yes
	1 hour	3.2	B1	12.3	15.5	196	Yes

Max. Conc. = maximum modeled design concentration; Back. Conc. = background concentration; Total Conc. = total (modeled + background) concentration

(1) See Table 6 for the design values/ranks.

(2) Results with alternate meteorological data.

Modeling for ozone and secondary $PM_{2.5}$ were not performed for this minor stationary source. These analyses are typically associated with applications for major stationary sources. Nonetheless, ratioing the VOC, NO_X, and SO_2 emissions from Table 2 and Table 4 by the emissions and resulting concentrations of O_3 and secondary $PM_{2.5}$ from EPA's modeled emission rates for precursors (MERPs) guidance yields estimated O_3 and secondary $PM_{2.5}$ concentrations of less than 1 ppb of O_3 and less than 0.1 μg/m³ of $PM_{2.5}$ (24-hour and annual)

PRI00000482

REC 1822

for the SGP. These estimated concentrations will have a negligible effect on compliance demonstration with the NAAQS.

☒ *Model input and output files for the cumulative NAAQS impact analyses are provided with the application.*

☒ *If there were modeled NAAQS violations, all violations were analyzed and clearly show that the project did not significantly contribute to those modeled violations. If there were multiple violations at a given receptor, all cumulative impacts (including background) for the averaging period analyzed were ranked along with the project contribution, and the project contributions were below the applicable SIL. A table was included to show all ranked impacts above the NAAQS along with the project contribution.*

6.2 TAP Impact Analyses

The SGP TAP modeling results and their comparison with the applicable AACC are provided in Table 42.

Table 42. SGP TAP Analyses Results

Pollutant	Averaging Time	Maximum Modeled Concentration (µg/m³)	Model Scenario	AAC (µg/m³)	AACC (µg/m³)	In Compliance
Antimony	24 hours	0.02705	B1	25	--	Yes
Arsenic	Annual	0.00008	All	--	0.00023	Yes
Cadmium	Annual	0.00001	All	--	0.00056	Yes
Formaldehyde	Annual	0.00076	All	--	0.077	Yes
Nickel	Annual	0.00006	All	--	0.0042	Yes
Sulfuric Acid	24 hours	0.52563	All	50	--	Yes

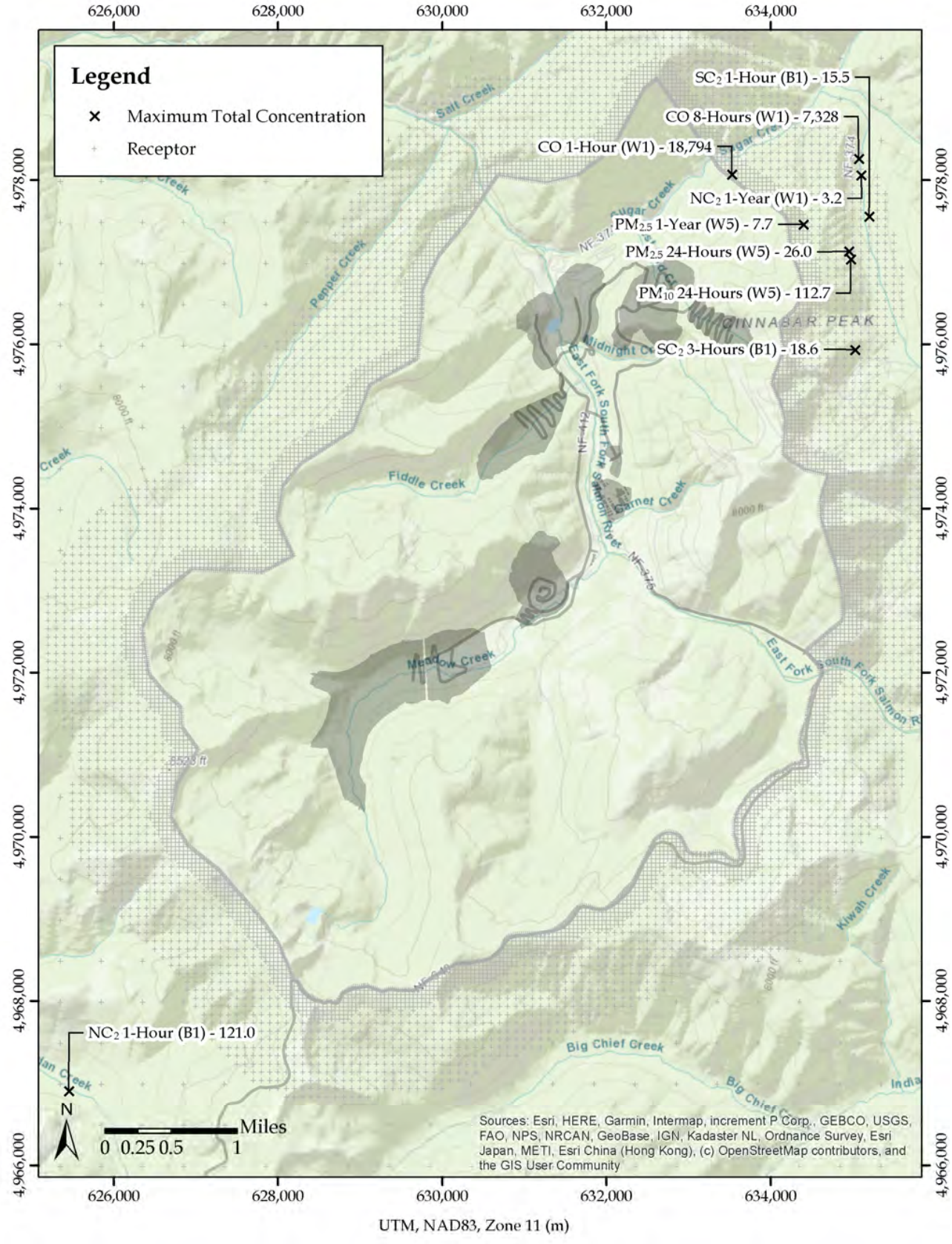
Table 42 shows that the modeled TAP impacts from the SGP sources do not exceed the applicable AACC.

The locations of the maximum impacts for each TAP are presented in Figure 11.

PRI00000483

REC 1823

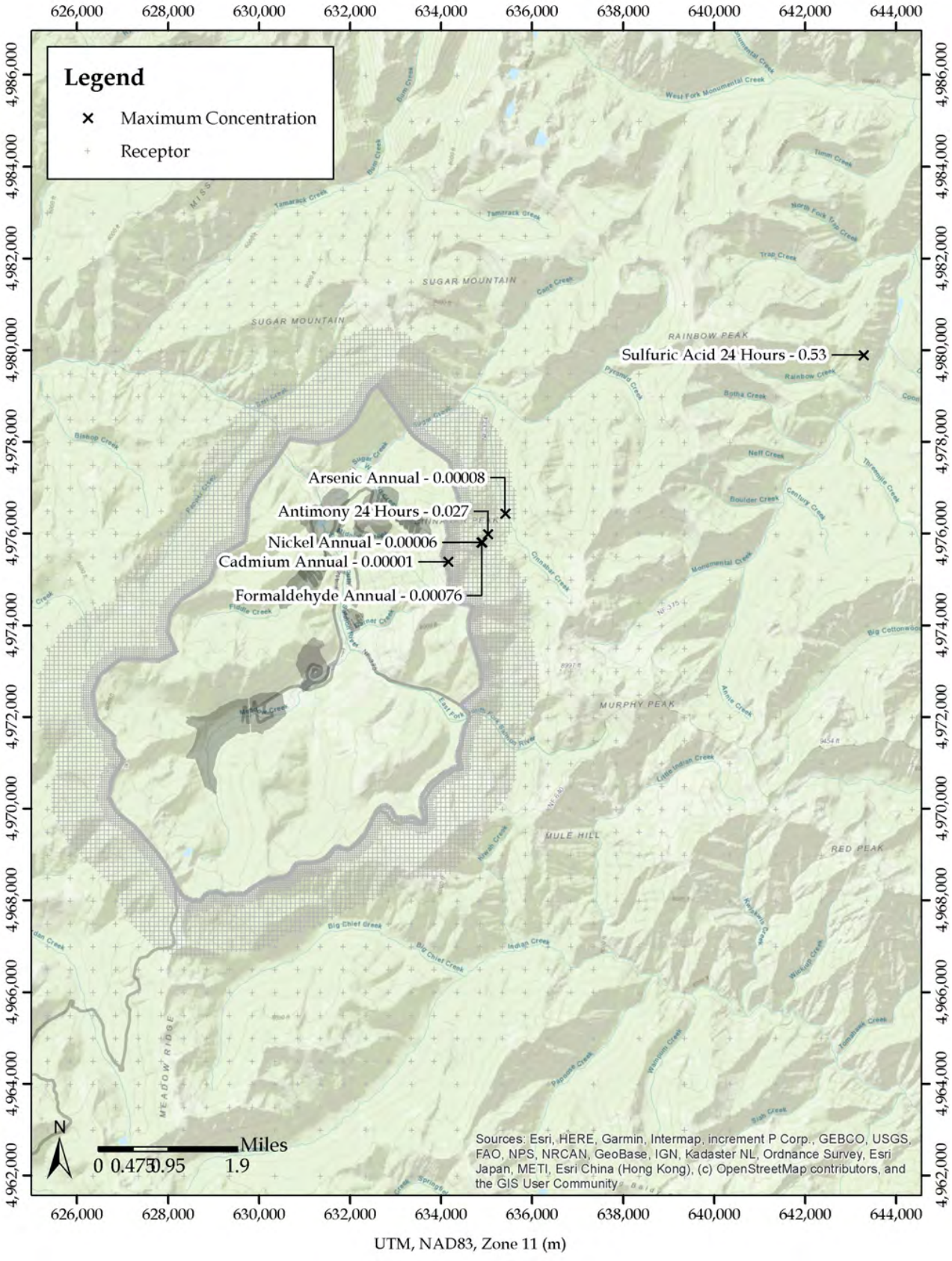
Figure 10. SGP Cumulative Impacts (µg/m³) and Locations



PRI00000484

REC 1824

Figure 11. SGP TAP Impacts (µg/m³) and Locations



PRI00000485

REC 1825

7.0 QUALITY ASSURANCE/CONTROL

Proven and standard quality assurance and quality control methods were used to ensure that possible errors were identified and eliminated. Applicable agency-reviewed and approved datasets (meteorological, background) were used. Utmost care and caution were exercised during each step of the emission and source characterization, model setup, and data processing (AERMAP, AERSURFACE, AERMET, BPIP, etc.)

The emission factors, underlying assumptions, calculations, and characterizations for the model input were peer and/or agency-reviewed for accuracy and appropriateness. The model input building and source characterization were carefully reviewed using the Air Sciences visual model tool available at https://aerearth.airsci.com/. This tool generates a three-dimensional depiction of the buildings and sources from AERMOD input files that can be reviewed on Google Earth. Other in-house tools were utilized to verify if the emission rates and source parameters were accurately imported into the AERMOD input files. Model output files and results were carefully reviewed to identify and eliminate possible errors. Additional modeling tools like source contributions, were used to logically verify the modeling results.

PRI00000486

REC 1826

8.0 REFERENCES

Air Sciences. 2018. "Unpaved Road Dust Control Efficiency from Chemical Suppressants." Memorandum from Kevin Lewis, Air Sciences Inc. to Dale Kerner, Midas Gold Idaho, Inc., January 12.

—. 2020. "Analysis of Potential Air Emissions from PAX." Technical Memorandum to Midas Gold Idaho, Inc. from Air Sciences Inc., January 23.

APT. 2009. "Source Emissions Testing Report, Barrick Cortez, Inc." *Hydrogen Cyanide Emissions, Electrowinning Cells #1 & #2.* November 11.

—. 2010. "Source Emissions Test Report for Barrick Goldstrike Mines, Inc.: Carlin, Nevada Facility. Diagnostic Testing and Title V Compliance Testing Operating Permit No. AP1041-0739.02." Report prepared for: Barrick Goldstrike Mines, Inc. APT Project: BAR0058, May 6.

—. 2013. "Source Emissions Test Report for Barrick Goldstrike Mines, Inc.: Carlin, Nevada Facility Title V Compliance Testing Operating Permit No. AP1041-0739.02." Report prepared for: Barrick Goldstrike Mines, Inc., August 28.

—. 2016. "Source Emissions Test Report, Round Mountain Gold Corporation." *Mercury Testing - EPA Method 29, System 35 - Carbon Stripping/EW.* Air Pollution Testing, Inc., October 4. Accessed January 20, 2020. https://documentviewerpublic.ndep.nv.gov/AppExtender/ViewDocument.aspx?chunks=1.

—. 2017. "Source Emissions Test Report, Klondex Midas Operations Inc." *Mercury Test Report - EPA Method 29.* Air Pollution Testing, Inc. (APT), August 29. Accessed January 20, 2020. https://documentviewerpublic.ndep.nv.gov/AppExtender/ViewDocument.aspx?chunks=1.

CAPCOA. 2011. "Modeling Compliance of The Federal 1-Hour NO2 NAAQS." California Air Pollution Control Officers Association, October 27.

Card, T. 2009. "Quality Assurance Project Plan Comprehensive Air Emissions Testing for Hydrogen Cyanide at Three Nevada Gold Mine Sites Using The USEPA Surface Isolation Flux Chamber Technology." Docket ID: EPA-HQ-OAR-2010-0239-0102. T. Card and C.E. Schmidt, October 7. Accessed June 6, 2018. https://www.regulations.gov/docketBrowser?rpp=25&so=DESC&sb=commentDueDate&po=0&dct=SR&D=EPA-HQ-OAR-2010-0239.

Caterpillar. 2011. "740B Articulated Truck." Caterpillar Inc. AEHQ6129 (2-2011), February.

—. 2016. "Caterpillar Performance Handbook." Version 46, January.

CFR. 2018a. "Title 40: Protection of Environment. Part 60 - Standard of Performance for New Stationary Sources. Subpart IIII—Standards of Performance for Stationary Compression Ignition Internal Combustion Engines." Office of the Federal Register and the Government Publishing Office.

—. 2018b. "Title 40: Protection of Environment. Part 63-National Emission Standards for Hazardous Air Pollutants for Source Categories. Subpart EEEEEEE—National Emission Standards for HAP: Gold Mine Ore Processing and Production Area Source Category." Office of the Federal Register and the Government Publishing Office.

—. 2018c. "Title 40: Protection of Environment. Part 98 - Mandatory Greenhouse Gas Reporting." Office of the Federal Register and the Government Publishing Office.

CSIRO. 2008. "NOx Emissions from Blasting Operations in Open-Cut Coal Mining." *Atmospheric Environment.* November.

Eckley, C.S. 2010. "Scaling Non-Point-Source Mercury Emissions from Two Active Industrial Gold Mines: Influential Variables and Annual Emission Estimates." *Environ. Sci. Technol.* November 17.

EPA. 1994. "Modeling Fugitive Dust Impacts from Surface Coal Mining Operations - Phase II." October.

—. 1995. "Compilation of Air Pollutant Emission Factors. Volume I: Stationary Point and Area Sources." *AP-42 Fifth Edition.* Office of Air Quality Planning and Standards. Office Of Air and Radiation. U.S. Environmental Protection Agency. Research Triangle Park, NC 2711, January. https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emission-factors.

—. 1999. "User's Guide to TANKS. Storage Tank Emission Calculation Software Version 4.0." Emission Factor and Inventory Group. Emissions, Monitoring, and Analysis Division. Office of Air Quality Planning and Standards. U.S. Environmental Protection Agency, September 30. https://www3.epa.gov/ttn/chief/software/tanks/index.html.

—. 2009. "Quality Assurance Project Plan (QAPP) Approval." Docket ID: EPA-HQ-OAR-2010-0239-0103. Letter from P. Tsirigotis, EPA, to M. Barbanell, Barrick Goldstrike, November 19. Accessed June 6, 2018. https://www.regulations.gov/docketBrowser?rpp=25&so=DESC&sb=commentDueDate&po=0&dct=SR&D=EPA-HQ-OAR-2010-0239.

—. 2011. "Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO2 National Ambient Air Quality Standard." Memorandum from Tyler Fox (EPA Air Quality Modeling Group Leader) to Regional Air Division Directors, March 1. Accessed July 15, 2015. http://www.epa.gov/ttn/scram/guidance/clarification/Additional_Clarifications_AppendixW_Hourly-NO2-NAAQS_FINAL_03-01-2011.pdf.

—. 2012. "Haul Road Workgroup Final Report Submission to EPA-OAQPS." Memorandum from Tyler Fox (EPA Air Quality Modeling Group Leader) to Regional Office Modeling Contacts, March 2. Accessed July 2, 2015. http://www.epa.gov/scram001/reports/Haul_Road_Workgroup-Final_Report_Package-20120302.pdf.

—. 2016. "AERMOD Implementation Guide." EPA-454/B-16-013. Office of Air Quality Planning and Standards Air Quality Assessment Division AERMOD Implementation Workgroup. Research Triangle Park, North Carolina, December.

—. 2018a. "Air Data: Air Quality Data Collected at Outdoor Monitors Across the US." Accessed March 17, 2018. https://www.epa.gov/outdoor-air-quality-data.

—. 2018b. "Draft. Revised Policy on Exclusions from Ambient Air." United States Environmental Protection Agency, November.

—. 2018c. "Idaho Nonattainment/Maintenance Status for Each County by Year for All Criteria Pollutants." February 28. Accessed March 17, 2018. https://www3.epa.gov/airquality/greenbook/anayo_id.html.

—. 2018d. "User's Guide for the AMS/EPA Regulatory Model (AERMOD)." EPA-454/B-18-001. Office of Air Quality Planning and Standards Air Quality Assessment Division Air Quality Modeling Group. Research Triangle Park, North Carolina, April.

IDEQ. 2013a. "Approval Re: Midas Gold, Inc. Monitoring Protocol and Quality Assurance Project Plan for Conducting Ambient Air Quality and Meteorological Monitoring for the Proposed Golden Meadows Mine Project." December 10.
—. 2013b. "State of Idaho Guidelines for Performing Air Quality Impact Analyses." Doc. ID AQ-011, September. Accessed March 17, 2018. https://www.deq.idaho.gov/media/1029/modeling-guideline.pdf.
—. 2015a. "2013 Air Quality Monitoring Data Summary." April. https://www.deq.idaho.gov/air-quality/monitoring/monitoring-network/.
—. 2015b. "Approval Re: Meteorological and Air Quality Data Summary - Stibnite Gold Project Monitoring Network." 2015, October 8.
—. 2018. "Real-Time Air Monitoring." Accessed March 17, 2018. http://airquality.deq.idaho.gov/.
—. 2019. "Modeling Protocol for Midas." Idaho Department of Environmental Quality, June 27.
—. n.d. "Nonattainment and Maintenance Areas in Idaho." Accessed March 17, 2018. https://www.deq.idaho.gov/air-quality/monitoring/attainment-versus-nonattainment/.
JBR. 2013. "Midas Gold." *Midas Gold, Inc. Monitoring Protocol and Quality Assurance Project Plan for Conducting Ambient Air Quality and Meteorological Monitoring for the Proposed Golden Meadows Mine Project.* JBR Environmental Consultants, Inc. 7669 West Riverside Dr. Boise, ID 83714, November.
Khalizov et al. 2012. "Characterization of Soot Aerosol Produced from Combustion of Propane in a Shock Tube." Alexei F. Khalizov, Brian Hogan, Chong Qiu, Eric L. Petersen, and Renyi Zhang. Aerosol Science and Technology, 46:925–936, 2012. https://doi.org/10.1080/02786826.2012.683839.
M3. 2014. "Prefeasibility Study Technical Report." Prepared for Midas Gold, December 15.
—. 2017a. "Midas Gold Operations Information." Telephone conversation between A. Ibrado and F. Camarena, M3, and E. Huelson, Air Sciences, October 10.
—. 2017b. "Midas Gold-Stibnite Gold Project NEPA EI Process Info Request." Email from L. Becker, M3, to S. Pryor and E. Huelson, Air Sciences, October 5.
—. 2017c. "Midas Gold-Stibnite Gold Project NEPA EI Process Info Request." Email from A. Ibrado, M3, to E. Huelson, Air Sciences. Autoclave CO2, October 11.
—. 2017d. "Midas Gold-Stibnite Gold Project NEPA EI Process Info Request." Email from A. Ibrado, M3, to E. Huelson, Air Sciences. Equipment Capacities, October 11.
—. 2019. "Autoclave Vent Stack Emissions. Hydromet Vent Emission flowstrams.xlsx." Email from R. Zimmerman, M3, D. Kerner, Midas Gold, 2 12.
Maerz. 2018. "PFR Kilns for soft-burnt lime - Maerz Ofenbau AG." January 25. Accessed January 25, 2018. https://www.maerz.com/portfolio/pfr-kilns-for-soft-burnt-lime/.
Midas Gold. 2015. "Soil Resources Baseline Study, Stibnite Gold Project." Reid, Samuel B., Assistant Geology Supervisor, Midas Gold, Inc., April.
—. 2016. "Stibnite Gold Project Valley County, Idaho Plan of Restoration and Operations." Midas Gold Idaho, Inc., September.
—. 2017a. "Air Quality Baseline Study. Stibnite Gold Project." Stantec Consulting Services, Inc. And Trinity Consultants, Inc. December 2015 - Revised April 2017, April.
—. 2017b. "Equipment Fuel Burn." *Attachment: Midas Stibnite Mine Plan and Equipment Schedule (13Sep17).xlsx.* Email from R. McCluskey, Midas Gold Idaho, to E. Memon, Air Sciences., September 12.

—. 2017c. "Geochemistry Statistics." Email from R. McCluskey, Midas Gold Idaho, to E. Memon, Air Sciences, September 26.
—. 2017d. "Midas Gold GIS Files." *File: PRO_Vector_Data.gdb.zip.* File Transfer from R. McCluskey, Midas Gold Idaho, to E. Memon, Air Sciences, September 7.
—. 2017e. "Midas Gold ANFO Diesel Content, Mobile Equipment Average Speed." Telephone conversation between R. McCluskey, Midas Gold Idaho, and E. Memon, Air Sciences, September 12.
—. 2017f. "Midas Gold Tailings Exposed Surface, Meteorological Data, Antimony Concentrate Transport." Telephone conversation between R. McCluskey, Midas Gold Idaho, and E. Memon, Air Sciences, September 27.
—. 2018a. "Air Modeling: Project Timeline." *Attachment: 2018_0321_Reclamation and Mitigation Timeline and Milestones.xlsm.* Email from D. Kerner, Midas Gold Idaho, to K. Goessel, FS, May 8.
—. 2018b. "Construction Activities." Email from R. McCluskey, Midas Gold Idaho, to E. Memon, Air Sciences, April 16.
—. 2018c. "Fuel Tanks." Email from R. McCluskey, Midas Gold Idaho, to E. Memon, Air Sciences, April 17.
—. 2018d. "Lime Kiln Production values and traffic reduction." Email from D. Kerner, Midas Gold Inc., to E. Memon, Air Sciences, June 11.
—. 2018e. "Ore Hg vs Waste Hg." Email from R. McCluskey, Midas Gold Idaho, to K. Lewis, Air Sciences, April 11.
—. 2018f. "Surface Exploration." Email from R. McCluskey, Midas Gold Idaho, to E. Memon, Air Sciences, April 25.
—. 2018g. "SGP - COMMENTS to Air Quality Modeling Report and SCHEDULE." Email from R. McCluskey, Midas Gold Inc., to E. Memon, Air Sciences, September 17.
—. 2019a. "Air PTC - Mine Limits Model Input Data." File: PTC_EI_20190129-MineLimits (RM).pdf. Email from D. Kerner, Midas Gold Idaho, to K. Lewis, Air Sciences, February 4.
—. 2019b. "Record of Communication." Conference call with D. Kerner, R. McCluskey, and J. Meyer of Midas Gold and K. Lewis and S. Pryor of Air Sciences, February 5.
—. 2019c. "Portable Crushing and Screening Plant Throughput." Email from D. Kerner, Midas Gold Idaho, to E. Memon, Air Sciences, November 12.
—. 2019d. "Sb concentration in Sb processing dust." Emails from J. Meyer, Midas Gold Idaho, to E. Memon, Air Sciences, March 20.
MRI. 1998. "Revision of Emission Factors for AP-42 Section 11.9 Western Surface Coal Mining. Revised Final Report." Prepared for US EPA AQPS Emission Factor and Inventory Group. MRI Project No. 4604-02., September.
NDEP. 2010. "Class I Air Quality Operating Permit No. AP3274-1329.01. Issued to Graymont Western US Inc." Nevada Department of Conservation and Natural Resources. Division of Environmental Protection. Bureau of Air Pollution Control, May 7.
—. 2012. "Class I Air Quality Operating Permit No. AP1041-0739.02. Issued to Barrick Goldstrike Mines, Inc." Nevada Department of Conservation and Natural Resources. Division of Environmental Protection. Bureau of Air Pollution Control, March 2.
—. 2015a. "Calendar Year 2015 Actual Production/Emission Reporting Spreadsheet for Mercury Emissions from the Precious Metals Mining Industry." *Nevada Mercury Control Program (NMCP) - Annual Emissions Reporting.* Nevada Division of Environmental Protection

(NDEP). Accessed June 6, 2018. https://ndep.nv.gov/air/nevada-mercury-control-program-nmcp/reporting.

—. 2015b. "Class II Air Quality Operating Permit No. AP3295-3398. Issued to Hectatone, Inc." Nevada Department of Conservation and Natural Resources. Division of Environmental Protection. Bureau of Air Pollution Control, April 6.

—. 2016. "Calendar Year 2016 Actual Production/Emission Reporting Spreadsheet for Mercury Emissions from the Precious Metals Mining Industry." *Nevada Mercury Control Program (NMCP) - Annual Emissions Reporting.* Nevada Division of Environmental Protection (NDEP). Accessed June 6, 2018. https://ndep.nv.gov/air/nevada-mercury-control-program-nmcp/reporting.

—. 2017. "Mercury Operating Permit to Construct: Phase 2." Issued to: Smokey Valley Common Operation - Round Mountain Gold Corporation." Nevada Division of Environmental Protection (NDEP) Bureau of Air Pollution Control, July 5.

—. 2019. "Class II Air Quality Operating Permit AP1041-3955." Issued to: Round Mountain Gold Corporation." Nevada Department of Conservation and Natural Resources. Division of Environmental Protection (NDEP). Bureau of Air Pollution Control, June 17. Accessed June 28, 2019. , June 17.

Schmidt. 2010. "Evaluation of Air Emissions of Hydrogen Cyanide from Fugitive Sources at Nevada Gold Mines Using the USEPA Surface Isolation Flux Chamber Technology." Docket ID: EPA-HQ-OAR-2010-0239-0163. C.E. Schmidt and T. Card, April. Accessed June 6, 2018. https://www.regulations.gov/docketBrowser?rpp=25&so=DESC&sb=commentDueDate&po=0&dct=SR&D=EPA-HQ-OAR-2010-0239.

U. S. DOT. 2013. "Unpaved Road Dust Management. A Successful Practitioner's Handbook ." U. S. Department of Transportation, Federal Highway Administration. Publication No. FHWA-CFL/TD-13-001., January.

UMN. 2002. "Diesel Aerosol Sampling Methodology - CRC E-43." University of Minnesota Department of Mechanical Engineering, August 19.

Appendix A – Model Parameter / Assumption / Data Level of Conservatism IDEQ Forms

APPENDIX A TABLE OF CONTENTS

1.0 Introduction A-2
2.0 Unpaved Road Daily Emission Factor A-3
3.0 Unpaved Road Control Efficiency A-6
4.0 Mining Production Rate A-7
5.0 AERMOD Model A-8
6.0 References A-9

Tables

Table 1. Summary of Parameters and Conservatism A-2

PRI00000493

REC 1833

1.0 Introduction

This appendix provides conservatism analyses, requested by DEQ, for four key parameters used in the modeling analyses:

- Unpaved Road Daily Emission Factor
- Unpaved Road Control Efficiency
- Mining Production Rate
- AERMOD Model

These analyses are presented on the DEQ form provided to Midas Gold during the October 15, 2019 application meeting. The level of conservatism of each parameter is summarized in Table 1.

Table 1. Summary of Parameters and Conservatism

Parameter	Value Used in Application	Comparative Value	Comparative Value Basis
Unpaved Road Daily Emission Factor	3.55 lb PM_{10}/VMT	0.683 lb PM_{10}/VMT	Wyoming Division of Air Quality
Unpaved Road Control Efficiency			
• Chemical suppressants (all tpyes)	90%	90% - 99%	AP-42 Section 13.2.2 referenced test reports
• $MgCl_2$	90%	98%	AP-42 Section 13.2.2 referenced test reports
• Watering	33%	75% - 95%	AP-42 Figure 13.2.2-2
Mining Production Rate	65,700,000 ton/yr 2 blast/day	42,692,000 ton/yr 1 blast/day	Actual peak production rates
	Unit Model Results	**Unit Observed Results**	
AERMOD Model	**1.41 – 3.21**	**1**	EPA evaluation studies

As shown in Table 1, the parameters used in the application are conservative.

PRI00000494

REC 1834

2.0 Unpaved Road Daily Emission Factor

Parameter / Assumption / Data**:** Unpaved Road Daily Emission Factor
Description: AP-42 Section 13.2.2. Unpaved Roads, $E = k (s/12)^a (W/3)^b$ where • E = 3.55 lb PM_{10}/VMT • k, a, b = empirical constants provided in AP-42 Table 13.2.2-1 • s = surface material silt content (4%) • W = mean vehicle weight (182.6 tons)
Sensitivity of Results to Parameter: Haul truck travel on haul roads accounts for 50% of the total daily PM_{10} emissions and 32% of the total daily $PM_{2.5}$ emissions (based on Scenario W5; the highest PM_{10} and $PM_{2.5}$ modeling scenarios).
Uncertainty Associated with Parameter Value: The EPA quality rating for this emission factor is B. This quality code is retained because of the following: • The silt content used comes from onsite data.[1,2] • The silt content (4%) is in the AP-42 range of 1.8%–25.2%. • The mean vehicle weight (182.6 tons) is in the AP-42 range of 2–290 tons. [1] Note that the use of non-onsite, default silt values from AP-42 Table 13.2.2-1 would reduce the quality code by two letters (EPA 2006). [2] The use of onsite parent soil silt data is conservative because tests "show that road silt is normally lower than in the surrounding parent soil" (EPA 2006).
Variability of Parameter: The emission factor varies by silt content and mean vehicle weight. The applicable ranges for these parameters are as follows: • Silt – 3.5%–4%[1] • Mean vehicle weight – 59.4–256.6 tons[2] [1] The silt value is derived from site-specific soil data: a geomean of 3.5% and a median value of 4.0% (Midas Gold 2015). See the soil data calculation following this form. As noted in the background documentation for EPA AP-42 Section 13.2.2, EPA uses the geomean to average environmental measurements, as these measurements vary widely and do not yield a normal distribution curve (MRI 1998) (MRI 2006); however, this application uses the higher median value for a more conservative estimate. [2] A weight of 182.6 tons was used in this application, and it is based on a 20:12 ratio of 200- and 44-ton haul trucks with average weights of 256.6 and 59.4 tons, respectively. A higher ratio of 200-ton trucks would result in a higher emission factor. However, it would also reduce the number of hauling trips and vehicle miles traveled (VMT), which would lower emissions.
Conservatism of Parameter: The conservatism of the emission factor can be assessed by comparing the emission factor used in the application with the Wyoming Division of Air Quality (WDAQ) unpaved road emission factor: $E = k*0.81s(S/30)^2(0.62)(2.5)$. where • E = 0.683 lb PM_{10}/VMT • k = PM_{10} size fraction factor; 1.5/4.9 = 0.306 (EPA 2006)

PRI00000495

REC 1835

- s = surface material silt content; 4%
- S = vehicle speed; 20 mph

The application value of 3.55 lb PM_{10}/VMT is more conservative than the WDAQ value of 0.683 lb PM_{10}/VMT.

Other Notes/Considerations: AP-42 suggests that the silt content of a chemically treated road may be increased through the grinding of small particles by vehicles. AP-42 provides no information as to what this increase might be or how it is calculated. AP-42 also states that the same vehicles will decrease the road silt content because "fines are continually removed by the vehicle traffic" (EPA 2006).

Neither AP-42 nor the AP-42 background documents provide any quantification of the competing vehicle processes that both increase road silt (vehicle grinding) and at the same time decrease it (vehicle traffic). Midas Gold knows of no methodology that has been used in air quality analyses to quantify the net effect of vehicles on the silt content of chemically treated roads.

It is, however, a common and accepted practice to apply control efficiency for chemical suppressant application and/or watering to the unpaved road emission factor and to use a silt value from the following sources, presented from most to least representative:

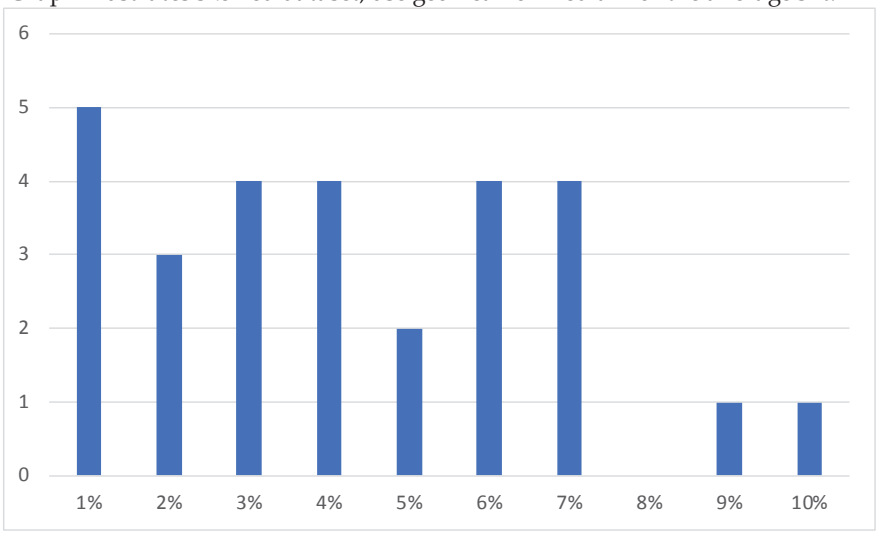
- Onsite data; parent soil silt is a conservative approximation of road surface silt
- EPA default values by state; Idaho
- AP-42 default values from Table 13.2.2-1; "use of this data is strongly discouraged when it is feasible to obtain locally gathered data" (EPA 2006)

Soil Resources Baseline Study (Midas Gold 2015)
Stibnite Gold Project
Midas Gold, Inc.
Apr-2015

	<#200
PT1-1019	2%
PT1-1042	7%
PT1-1062	10%
PT1-1080	3%
PT1-1096	3%
PT1-1107	7%
PT1-1121	4%
PT1-1154	7%
1174	3%
1196	1%
1407	2%
1420	5%
1676	6%
1685	7%
1698	6%
1433	1%
1475	6%
1522	4%
1530	1%
1549	1%
1554	1%
1577	4%
1912	9%
1931	6%
1948	4%
1956	2%
1978	5%
1992	3%
Median	4.0%
Count	28
Geomean	3.5%

Frequency Distribution	
1%	5
2%	3
3%	4
4%	4
5%	2
6%	4
7%	4
8%	0
9%	1
10%	1

Graph illustrates skewed dataset; use geomean or median for the average silt.



3.0 Unpaved Road Control Efficiency

Parameter / Assumption / Data: Unpaved Road Control Efficiency

Description:

- 90% control efficiency for dust from chemical dust suppressant application
- 33% control efficiency for dust from watering for daily emissions
- 0% control efficiency for dust from watering for annual emissions (the precipitation equation is used instead of a control efficiency factor)

Sensitivity of Results to Parameter: See the discussion in Section 2.0.

Uncertainty Associated with Parameter Value: The control efficiency is dependent on proper application, which can be verified through monitoring and record keeping.

Variability of Parameter:

Chemical Suppressant Application

Air Sciences' memorandum dated January 12, 2018 (Air Sciences 2018) provides the range of control efficiencies published in the chemical suppressant test studies referenced by AP-42 Section 13.2.2. These test studies measured a variety of chemicals and showed the following ranges of control efficiencies for PM_{10}:

- All chemicals: 90% to 99%
- Hygroscopic chloride salts (e.g., $CaCl_2$ and $MgCl_2$): 93% to 98%[1]

[1] The DRI 1996 test study (DRI 1996) cited a 1994 test study that showed a 98% reduction in PM_{10} emissions from unpaved roads treated with $MgCl_2$ (Flocchini et al. 1994). This data point was not included in the Air Sciences' memorandum because the memorandum only included the results from the actual test studies conducted for the purpose of the report and not data cited from other documents for comparative purposes.

Midas Gold currently plans to use $MgCl_2$ (Midas Gold 2016), but it may use other chemicals that are equally effective and environmentally safe.

Watering

Watering reduces dust by 75% to 95%. See AP-42 Figure 13.2.2-2 (EPA 2006) for moisture ratios ranging from 2 to 5. Because the unpaved road emission factor in AP-42 Section 13.2.2 is based on a very dry surface moisture of 0.2% (MRI 1998), increasing the surface moisture to only 1% moisture is all that is required to achieve 95% control.

Conservatism of Parameter: The conservatism of the control efficiency can be assessed by comparing the values used in this application with the AP-42 data discussed above:

- **The application value of 90% for chemical suppressant is more conservative than the AP-42 referenced test data of 90% to 99% (98% for $MgCl_2$).**
- **The application value of 33% for watering is more conservative than the AP-42 range of 75% to 95%.**

Other Notes/Considerations:

PRI00000498

REC 1838

4.0 Mining Production Rate

Parameter / Assumption / Data: Mining Production Rate
Description: This application is based on the following mining production rates: • 180,000 ton/day, total of ore and development rock • 2 blast/day
Sensitivity of Results to Parameter: Mining activities account for 95% of the total PM_{10} emissions and 73% of the total $PM_{2.5}$ emissions (Scenario W3).
Uncertainty Associated with Parameter Value: None – These production rates are highly conservative maximums, which can be verified through monitoring and record keeping.
Variability of Parameter: None – These production rates are highly conservative maximums.
Conservatism of Parameter: The conservatism of the mining production rates can be assessed by comparing the values used in this application with the actual production rates for the peak mining year. During the peak mining year, the production will be 42,692,000 ton/yr and 1 blast/day. **The application values of 62,700,000 ton/yr (180,000 ton/day * 365 day/yr) and 2 blast/day are more conservative than the actual peak production rates of 42,692,000 ton/yr and 1 blast/day.**
Other Notes/Considerations:

5.0 AERMOD Model

Parameter / Assumption / Data: AERMOD Model

Description:
This application utilized the AERMOD model to predict ambient air pollutant concentrations. The meteorological data processing (met processing) utilized the default options of the adjusted surface friction velocity (ADJ_U*) and the Bulk Richardson (BULKRN) method for boundary-layer parameter calculations or the non-BULKRN method that included McCall cloud cover data.

Sensitivity of Results to Parameter: Not applicable

Uncertainty Associated with Parameter Value: None – The model and met processing options are EPA-approved default methods.

Variability of Parameter: None – The maximum design value (a single value for each pollutant and averaging time) is used to determine compliance.

Conservatism of Parameter: The conservatism of the model and met processing was evaluated by EPA as a part of its approval process. This evaluation quantified the bias of the model compared to the actual observed concentrations. The results of the evaluation for the same modeling conditions[1] used in this application are provided below:

Evaluation	Modeled/Observed[2]
Tracy Power Plant, NV	1.7
Lovett Power Plant, NY	2.21–3.21
Oak Ridge, TN	1.41
Cordero Rojo Mine, WY	1.72
Idaho Falls, ID	2.08

[1] The modeling conditions for the above evaluation studies are as follows: complex terrain and/or low-level sources, 10-meter tower meteorological data, and met processing with ADJ_U*, no turbulence, and non-BULKRN (EPA 2018) (EPA 2017) (EPA 2016). The conditions match those used in the application.
[2] (EPA 2017)

The AERMOD modeling performed for the application has a conservative bias to over predict impacts by a factor of 1.41 to 3.21.

Other Notes/Considerations: As discussed above, modeling was performed using the following two methods:

- ADJ_U*/BULKRN
- ADJ_U*/non-BULKRN (the same method as that in the EPA evaluation studies)

For all model runs, the ADJ_U*/BULKRN method resulted in higher design value concentrations than the ADJ_U*/non-BULKRN method did; therefore, the percentage of conservatism for the ADJ_U*/BULKRN method is higher.

PRI00000500

REC 1840

6.0 References

Air Sciences. 2018. "Unpaved Road Dust Control Efficiency from Chemical Suppressants." Memorandum prepared by K. Lewis, Air Sciences, Inc., January 12.

DRI. 1996. "Effectiveness Demonstration of Fugitive Dust Control Methods for Public Unpaved Roads and Unpaved Shoulders on Paved Roads – Final Report." *DRI Document No. 685-5200.1F1.* Prepared by Dr. John G. Watson, et al. of the Desert Research Institute for the California Regional Particulate Air Quality Study., December 31. Accessed December 29, 2017. http://www.arb.ca.gov/airways/Documents/reports/dri_dustcontrol.pdf.

EPA. 2016. "AERMOD Implementation Guide." *EPA-454/B-16-013.* Office of Air Quality Planning and Standards Air Quality Assessment Division AERMOD Implementation Workgroup, December.

—. 2017. "AERMOD Model Formulation and Evaluation." *EPA-454/ R-17-001.* U.S. Environmental Protection Agency (EPA), Office of Air Quality Planning and Standards, Air Quality Assessment Division, Research Triangle Park, NC, May.

—. 2018. "BULKRN in AERMOD Evaluation Studies." Email from R. Brode, EPA, to M. Hampson, Air Sciences Inc., March 30.

—. 2006. "Compilation of Air Pollutant Emission Factors. Volume I: Stationary Point and Area Sources." *AP-42 Fifth Edition, Section 13.2.2, Unpaved Roads.* Office of Air Quality Planning and Standards. Office of Air and Radiation. U.S. Environmental Protection Agency. Research Triangle Park, NC 2711, November. https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emission-factors.

Flocchini et al. 1994. "Evaluation of the Emissions of PM10 Particulates from Unpaved Roads in San Joaquin Valley." *Final report prepared for the San Joaquin Valley Unified Air Pollution Control District, U.S. EPA and California Air Resources Board.* Flocchini, R.G.; Cahill, T.A.; Matsamura, R.T.; Caravacho, O.; Lu, Z.-Q, April. p. 61.

Midas Gold. 2015. "Soil Resources Baseline Study, Stibnite Gold Project." Reid, Samuel B., Assistant Geology Supervisor, Midas Gold, Inc., April.

—. 2016. "Stibnite Gold Project Valley County, Idaho Plan of Restoration and Operations." Midas Gold Idaho, Inc., September.

MRI. 2006. "Background Document for Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors." *Prepared by Midwest Research Institute (Chatten Cowherd, MRI Project Leader).* Midwest Research Institute (MRI), November 1. Accessed Spetember 20, 2019. https://www3.epa.gov/ttn/chief/ap42/ch13/bgdocs/b13s02.pdf.

—. 1998. "Emission Factor Documentation for AP-42 Section 13.2.2 Unpaved Roads Final Report." Midwest Research Institute (MRI), September. Accessed September 20, 2019. https://www3.epa.gov/ttn/chief/ap42/ch13/bgdocs/b13s02-2.pdf.

Appendix B – Emissions Inventory and Modeling Parameters

EI TABLE OF CONTENTS

Facility-Wide Emissions Summary and Applicability Determinations 2
Ore Processing Sources - Criteria Pollutant Controlled Emissions 6
Ore Processing Sources - HAP and GHG Emissions 21
Fuel Storage Tank Emissions 31
Maximum Production/Activity Rates and Modeling Scenarios 36
Mining Fugitive - Criteria Pollutant Emissions 38
Mining Fugitive Mercury Emissions 58
Conversions and Constants 60
Ore Processing Sources - Criteria Pollutant Uncontrolled Emissions 64

PRI00000503

REC 1843

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis/E. Memon
	PROJECT NO: 335-1-4	PAGE: 1 OF: 4 SHEET: Summary
AIR EMISSION CALCULATIONS	SUBJECT: Emissions Summary	DATE: June 22, 2020

Facility-Wide Criteria Pollutant PTE

	PM	PM10		PM2.5		CO		NOX		SO2		VOC
Activity	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr
Process & Ancillary	87.3	21.7	56.3	13.4	36.4	33.5	30.5	55.4	37.9	1.9	6.5	4.8
Mining Fugitive	3,569	225	986	22.5	98.9	1,742	636	46.8	17.1	9.4E-02	3.4E-02	0.0E+00
Total	3,656	246	1,042	35.9	135	1,776	666	102	54.9	2.0	6.5	4.8

Mining fugitive emissions are for model scenario: W3

Permitting Applicability

	PM	PM10	PM2.5	CO	NOX	SO2
	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr
Total Process & Ancillary	87.3	56.3	36.4	30.5	37.9	6.5
Significant Threshold [1]	25	15	10	100	40	40
	Above	Above	Above	Minor	Minor	Minor
Regulatory Concern Threshold (10% of Significant) [2]						
	2.5	1.5	1	10	4	4
	Permit	Permit	Permit	Permit	Permit	Permit
Major Source Determination		100	100	100	100	100
		Minor	Minor	Minor	Minor	Minor

[1] *IDAPA 58.01.01.006.108.a.*

[2] *IDAPA 58.01.01.221.01*

Modeling Applicability

	PM10	PM2.5		CO	NOX		SO2		Pb
	lb/hr	lb/hr	ton/yr	lb/hr	lb/hr	ton/yr	lb/hr	ton/yr	lb/month
Process & Ancillary	21.7	13.4	36.4	33.5	55.4	37.9	1.9	6.5	4.4E-02
Mining Fugitive	225	22.5	98.9	1,742	46.8	17.1	9.4E-02	3.4E-02	0.0E+00
Total	246	35.9	135	1,776	102	54.9	2.0	6.5	4.4E-02
Level I Thresholds [1]	0.22	0.054	0.35	15	0.20	1.20	0.21	1.2	14
Modeling Triggered?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No

[1] *IDEQ, Guideline for Performing Air Quality Impact Analyses Table 2, September-2013*

Permit to Construct Processing Fee Determination [1]

Regulated Pollutant	ton/yr
PM10	56.3
CO	30.5
NOX	37.9
SO2	6.5
VOC	4.8
Total [2]	136

[1] *Process & Ancillary Sources Only*

[2] *In accordance with 58.01.01.225, the Permit to Construct Processing Fee will be $7,500. This is for a non major new source with an increase of emissions of 100 tpy or more.*

Conversions
2,000 lb/ton
8,760 hr/yr

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis/E. Memon
	PROJECT NO: 335-1-4	PAGE: 2 OF: 4 SHEET: Summary
AIR EMISSION CALCULATIONS	SUBJECT: Emissions Summary	DATE: June 22, 2020

total-ton/yr fug-ton/yr

Facility-Wide HAP PTE and Major Source Determination

CAS No.	HAP	Process ton/yr	Mining ton/yr	Total ton/yr
106-99-0	1,3-Butadiene	3.67E-6	--	3.67E-6
91-57-6	2-Methylnaphthalene	4.85E-6	--	4.85E-6
56-49-5	3-Methylchloranthrene	3.64E-7	--	3.64E-7
57-97-6	7,12-Dimethylbenz(a)anthracene	3.24E-6	--	3.24E-6
83-32-9	Acenaphthene	7.09E-6	--	7.09E-6
208-96-8	Acenaphthylene	1.38E-5	--	1.38E-5
75-07-0	Acetaldehyde	1.07E-4	--	1.07E-4
107-02-8	Acrolein	1.98E-5	--	1.98E-5
120-12-7	Anthracene	2.39E-6	--	2.39E-6
7440-36-0	Antimony	3.00E-1	--	3.00E-1
7440-38-2	Arsenic	1.76E-2	--	1.76E-2
56-55-3	Benz(a)anthracene	1.40E-6	--	1.40E-6
71-43-2	Benzene	1.60E-3	--	1.60E-3
50-32-8	Benzo(a)pyrene	6.22E-7	--	6.22E-7
205-99-2	Benzo(b)fluoranthene	1.94E-6	--	1.94E-6
191-24-2	Benzo(g,h,i)perylene	1.07E-6	--	1.07E-6
207-08-9	Benzo(k)fluoranthene	6.86E-7	--	6.86E-7
7440-41-7	Beryllium	8.59E-5	--	8.59E-5
7440-43-9	Cadmium	2.50E-4	--	2.50E-4
75-15-0	Carbon disulfide	6.33E-2	--	6.33E-2
7440-47-3	Chromium	5.73E-4	--	5.73E-4
218-01-9	Chrysene	2.55E-6	--	2.55E-6
7440-48-4	Cobalt	1.20E-4	--	1.20E-4
592-01-8	Cyanide	9.73E-1	--	**9.73E-1**
53-70-3	Dibenz(a,h)anthracene	7.85E-7	--	7.85E-7
106-46-7	Dichlorobenzene	2.43E-4	--	2.43E-4
206-44-0	Fluoranthene	7.00E-6	--	7.00E-6
86-73-7	Fluorene	2.13E-5	--	2.13E-5
50-00-0	Formaldehyde	1.54E-2	--	1.54E-2
110-54-3	Hexane	3.64E-1	--	3.64E-1
193-39-5	Indeno(1,2,3-cd)pyrene	9.82E-7	--	9.82E-7
7439-92-1	Lead	2.62E-4	--	2.62E-4
7439-96-5	Manganese	2.17E-2	--	2.17E-2
7439-97-6	Mercury	1.24E-2	3.54E-3	1.60E-2
91-20-3	Naphthalene	3.14E-4	--	3.14E-4
7440-02-0	Nickel	1.63E-3	--	1.63E-3
85-01-8	Phenanthrene	6.36E-5	--	6.36E-5
7723-14-0	Phosphorus	1.81E-2	--	1.81E-2
129-00-0	Pyrene	6.68E-6	--	6.68E-6
7782-49-2	Selenium	4.85E-6	--	4.85E-6
108-88-3	Toluene	1.12E-3	--	1.12E-3
1330-20-7	Xylene	2.99E-4	--	2.99E-4
Total HAP		1.79	3.54E-3	1.80
Major Source Threshold				25
Major Source of HAP				No

TRUE

Maximum Single HAP PTE and Major Source Determination

CAS No.	HAP	ton/yr
592-01-8	Cyanide	0.97
Major Source Threshold		10
Major Source of HAP		No

PRI00000505

REC 1845

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis/E. Memon
	PROJECT NO: 335-1-4	PAGE: 3 OF: 4 SHEET: Summary
AIR EMISSION CALCULATIONS	SUBJECT: Emissions Summary	DATE: June 22, 2020

Toxic Air Pollutant Analysis prop-lb/hr dies mpro-lb/hr fug-lb/hr

		Emissions (lb/hr)					Screening Level (lb/hr)		Determination
CAS No.	HAP/TAP	(1)	(2)	(3)	(4)	Total	(5)	(6)	
106-99-0	1,3-Butadiene	--		--	--	--	--	2.40E-5	EL not exceeded
91-57-6	2-Methylnaphthalene	1.59E-6		--	--	1.59E-6	--	--	--
56-49-5	3-Methylchloranthrene	1.19E-7		--	--	1.19E-7	--	2.50E-6	EL not exceeded
57-97-6	7,12-Dimethylbenz(a)anthracene	1.06E-6		--	--	1.06E-6	--	--	--
83-32-9	Acenaphthene	1.19E-7		--	--	1.19E-7	--	--	--
208-96-8	Acenaphthylene	1.19E-7		--	--	1.19E-7	--	--	--
75-07-0	Acetaldehyde	--		--	--	--	--	3.00E-3	EL not exceeded
107-02-8	Acrolein	--		--	--	--	1.70E-2	--	EL not exceeded
120-12-7	Anthracene	1.59E-7		--	--	1.59E-7	--	--	--
7440-36-0	Antimony	--		6.86E-2	--	6.86E-2	3.30E-2	--	Non-carcinogenic EL exceeded
7440-38-2	Arsenic	1.32E-5		4.36E-3	--	4.37E-3	--	1.50E-6	Carcinogenic EL exceeded
56-55-3	Benz(a)anthracene	1.19E-7		--	--	1.19E-7	--	--	--
71-43-2	Benzene	1.39E-4		--	--	1.39E-4	--	8.00E-4	EL not exceeded
50-32-8	Benzo(a)pyrene	7.93E-8		--	--	7.93E-8	--	2.00E-6	EL not exceeded
205-99-2	Benzo(b)fluoranthene	1.19E-7		--	--	1.19E-7	--	--	--
191-24-2	Benzo(g,h,i)perylene	7.93E-8		--	--	7.93E-8	--	--	--
207-08-9	Benzo(k)fluoranthene	1.19E-7		--	--	1.19E-7	--	--	--
7440-41-7	Beryllium	7.93E-7		2.17E-5	--	2.25E-5	--	2.80E-5	EL not exceeded
7440-43-9	Cadmium	7.26E-5		4.06E-5	--	1.13E-4	--	3.70E-6	Carcinogenic EL exceeded
75-15-0	Carbon disulfide	--		1.45E-2	--	1.45E-2	2.00E+0	--	EL not exceeded
7440-47-3	Chromium	9.25E-5		1.22E-4	--	2.14E-4	3.30E-2	--	EL not exceeded
218-01-9	Chrysene	1.19E-7		--	--	1.19E-7	--	--	--
7440-48-4	Cobalt	5.55E-6		2.35E-5	--	2.91E-5	3.30E-3	--	EL not exceeded
592-01-8	Cyanide	--		2.22E-1	--	2.22E-1	3.33E-1	--	EL not exceeded
53-70-3	Dibenz(a,h)anthracene	7.93E-8		--	--	7.93E-8	--	--	--
106-46-7	Dichlorobenzene	7.93E-5		--	--	7.93E-5	3.00E+1	--	EL not exceeded
206-44-0	Fluoranthene	1.98E-7		--	--	1.98E-7	--	--	--
86-73-7	Fluorene	1.85E-7		--	--	1.85E-7	--	--	--
50-00-0	Formaldehyde	4.95E-3		--	--	4.95E-3	--	5.10E-4	Carcinogenic EL exceeded
110-54-3	Hexane	1.19E-1		--	--	1.19E-1	1.20E+1	--	EL not exceeded
193-39-5	Indeno(1,2,3-cd)pyrene	1.19E-7		--	--	1.19E-7	--	--	--
7439-92-1	Lead	--		1.72E-4	--	1.72E-4	--	--	--
7439-96-5	Manganese	2.51E-5		3.53E-2	--	3.53E-2	6.70E-2	--	EL not exceeded
7439-97-6	Mercury	1.72E-5		5.13E-3	8.08E-4	5.96E-3	--	--	--
91-20-3	Naphthalene	4.03E-5		--	--	4.03E-5	3.33E+0	--	EL not exceeded
7440-02-0	Nickel	1.39E-4		2.89E-3	--	3.03E-3	--	2.70E-5	Carcinogenic EL exceeded
85-01-8	Phenanthrene	1.12E-6		--	--	1.12E-6	--	--	--
7723-14-0	Phosphorus	--		6.12E-3	--	6.12E-3	7.00E-3	--	EL not exceeded
129-00-0	Pyrene	3.30E-7		--	--	3.30E-7	--	--	--
7782-49-2	Selenium	1.59E-6		--	--	1.59E-6	1.30E-2	--	EL not exceeded
108-88-3	Toluene	2.25E-4		--	--	2.25E-4	2.50E+1	--	EL not exceeded
1330-20-7	Xylene	--		--	--	--	2.90E+1	--	EL not exceeded

(1) *HAP/TAP from propane combustion. Detailed emission calculations are provided in ProcHAP sheet.*

(2) *HAP/TAP from diesel combustion. Detailed emission calculations are provided in ProcHAP sheet.*
Diesel engine HAP are regulated by 40CFR63, Subpart ZZZZ and therefore exempt from TAP analysis per IDAPA 58.01.01 Section 210.20.

(3) *HAP/TAP from material processing. Detailed emission calculations are provided in ProcHAP sheet.*

(4) *Fugitive HAP/TAP from mining activity. Detailed emission calculations are provided in MineHg sheet.*

(5) *Non-carcinogenic emission screening level (EL) from IDAPA 58.01.01 Section 585.*

(6) *Carcinogenic EL from IDAPA 58.01.01 Section 586.*

TRUE

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis/E. Memon
	PROJECT NO: 335-1-4	PAGE: 4 OF: 4 SHEET: Summary
AIR EMISSION CALCULATIONS	SUBJECT: Emissions Summary	DATE: June 22, 2020

Toxic Air Pollutant Analysis prop-lb/hr dies-lb/hr mpro-lb/h fug-lb/hr

		Emissions (lb/hr)					Screening Level (lb/h		Determination
CAS No.	Non-HAP TAP	(1)	(2)	(3)	(4)	Total	(5)	(6)	
7440-39-3	Barium	2.91E-4	--	4.71E-3	--	5.00E-3	3.30E-2	--	EL not exceeded
7440-50-8	Copper	5.61E-5	--	2.94E-5	--	8.55E-5	6.70E-2	--	EL not exceeded
7783-06-4	Hydrogen Sulfide	--	--	9.00E-1	--	9.00E-1	9.33E-1	--	EL not exceeded
7439-98-7	Molybdenum	7.26E-5	--	5.88E-6	--	7.85E-5	3.33E-1	--	EL not exceeded
109-66-0	Pentane	1.72E-1	--	--	--	1.72E-1	1.18E+2	--	EL not exceeded
7440-22-4	Silver	--	--	2.94E-6	--	2.94E-6	7.00E-3	--	EL not exceeded
7664-93-9	Sulfuric Acid	--	--	2.03E+0	--	2.03E+0	6.70E-2	--	Non-carcinogenic EL exceeded
7440-28-0	Thallium	--	--	5.88E-5	--	5.88E-5	7.00E-3	--	EL not exceeded
7440-61-1	Uranium	--	--	5.88E-5	--	5.88E-5	1.30E-2	--	EL not exceeded
7440-62-2	Vanadium	1.52E-4	--	--	--	1.52E-4	3.00E-3	--	EL not exceeded
7440-66-6	Zinc	1.92E-3	--	--	--	1.92E-3	6.67E-1	--	EL not exceeded

(1) *HAP/TAP from propane combustion. Detailed emission calculations are provided in ProcHAP sheet.*

(2) *HAP/TAP from diesel combustion. Detailed emission calculations are provided in ProcHAP sheet.*

(3) *HAP/TAP from material processing. Detailed emission calculations are provided in ProcHAP sheet.*

(4) *Fugitive HAP/TAP from mining activity. Detailed emission calculations are provided in MineHg sheet.*

(5) *Non-carcinogenic emission screening level (EL) from IDAPA 58.01.01 Section 585.*

(6) *Carcinogenic EL from IDAPA 58.01.01 Section 586.*

TRUE

SOURCE DESCRIPTION		OPERATING LIMITS							EMISSION FACTORS									EMISSION CON	
Model	Source Description	Design Throughput						Throughput reference	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	unit	reference	control	efficiency
ID		unit/hr	unit/day	unit/yr	units	Material	hr/yr											system	
OC1	Loader Transfer of Ore to Grizzly	1,042	25,000	9,125,000	ton	Ore	8,760	(Midas Gold 2016), Sec. 10.1	0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.	Water Sprays	
OC2	Grizzly to Apron Feeder	1,042	25,000	9,125,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.	Moisture Carry-Over	
OC3	Apron Feeder to Dribble Conveyor	1,042	25,000	9,125,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.	Moisture Carry-Over	
OC4	Apron Feeder to Vibrating Grizzly	1,042	25,000	9,125,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.	Moisture Carry-Over	
OC5	Dribble Conveyor to Vibrating Grizzly	1,042	25,000	9,125,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.	Moisture Carry-Over	
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	1,042	25,000	9,125,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.	Moisture Carry-Over	
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	1,042	25,000	9,125,000	ton	Ore	8,760		0.0012	0.00054	0.0001					lb/ton	AP-42, Table 11.19.2-2 (08/04) Tert. Crushing - ctrl.	Water Sprays	
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	1,042	25,000	9,125,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.	Moisture Carry-Over	
OC9	Stockpile Transfers to Reclaim Conveyors	1,150	27,600	10,074,000	ton	Ore	8,760	(M3 2017b)	0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - unctrl.; PM2.5 Ch. 13.2.4	Undergrnd	80%
OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	1,150	27,600	10,074,000	ton	Ore	8,760		0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - unctrl.; PM2.5 Ch. 13.2.4	Undergrnd	80%
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	1,150	27,600	10,074,000	ton	Ore	8,760		0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - unctrl.; PM2.5 Ch. 13.2.4	Enclosure	80%
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	1,150	27,600	10,074,000	ton	Ore	8,760		0.0012	0.00054	0.0001					lb/ton	AP-42, Table 11.19.2-2 (08/04) Tert. Crushing - ctrl.	Water Sprays	
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	1,150	27,600	10,074,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.	Moisture Carry-Over	
LS1L	Mill Lime Silo #1 Loading	60	250	4,375	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.00099	0.00034	0.00005					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4	Bin Vent Filter	
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	20	250	4,375	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.00042					lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4	None	0%
MillS2L	Mill Lime Silo #2 Loading	60	250	4,375	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.00099	0.00034	0.00005					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4	Bin Vent Filter	
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	20	250	4,375	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.00042					lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4	None	0%
Sb1	Sb Dryer (2.72 MMBtu/hr Propane-Fired)	2.72	65.28	23,827	MMBtu	Propane	8,760	(M3 2017d)	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal	None	NA
Sb2	Sb Bagging	4.5	108	39,420	ton	Stib. Conc.	8,760	(M3 2017d)	0.118	0.118	0.118					lb/hr	Based on NDEP-BAPC Permit for Clay Bagging Operation (Hectatone) (NDEP 2015b)	Baghouse (BH1)	NA
AC	Autoclave	290	6,960	2,540,400	ton	Float Conc.	8,760	(M3 2017b)	5.075	5.075	5.075			0.6525		lb/hr	Based on NDEP-BAPC Permits/test data for Autoclaves: PM & SO2 - [Goldstrike (NDEP 2012)]. Negligible CO due to no organic carbon in the feed (M3 2017a)	Wet Scrubber (WS1)	NA
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	17	17	510	MMBtu	Propane	30	(M3 2017b)	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Ind. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal	None	NA
ACS1L	AC Lime Silo #1 Loading	120	1,000	17,500	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.00099	0.00034	0.00005					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4	Bin Vent Filter	
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	20	480	17,500	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.0004					lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4	None	0%
ACS2L	AC Lime Silo #2 Loading	120	1,000	17,500	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.00099	0.00034	0.00005					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4	Bin Vent Filter	
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	20	480	17,500	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.0004					lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4	None	0%
ACS3L	AC Lime Silo #3 Loading	120	1,000	17,500	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.00099	0.00034	0.00005					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4	Bin Vent Filter	
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	20	480	17,500	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.0004					lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4	None	0%
ACS4L	AC Lime Silo #4 Loading	120	500	8,750	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.00099	0.00034	0.00005					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4	Bin Vent Filter	
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	20	480	8,750	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.0004					lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4	None	0%
CKD	Carbon Regeneration Kiln (Drum)	0.3	7.2	2,628	ton	Carbon	8,760	(M3 2017b)	0.42	0.42	0.42	0.12	0.012		0.11	lb/hr	Based on NDEP-BAPC Permit for Carbon Regeneration Kiln [Goldstrike (NDEP 2012)]	Wet Scrubber (WS2) / Carbon Filter (CA1)	NA
CKB	Carbon Regeneration Kiln (Burners)	2.255	54.12	19,754	MMBtu	Propane	8,760	(M3 2017b)	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal	None	NA
EW	Electrowinning Cells and Pregnant Solution Tank	100	24 hr		gpm	Au Sol.	8,760	Typical Ind. Oper.	0.07	0.07	0.07					lb/hr	Based on similar source stack test data and 5× safety factor (APT 2016)	Shared Carbon Filter (CA2)	
MR	Mercury Retort	0.5/batch	24 hr	21	ton	Au Conc.	1,248	(M3 2017b) & (M3 2017a)	0.01	0.01	0.01					lb/hr	Based on similar source stack test data and 5× safety factor (APT 2017)	Condenser / Carbon Filter (CA3)	
MF	Induction Melting Furnace	0.5/batch	12 hr	21	ton	Au Conc.	624	(M3 2017b) & (M3 2017a)	2.84	2.84	2.84					lb/hr	Based on IDAPA 58.01.01.701 PM Weight Limit	Baghouse (BH2) / Carbon Filter (CA4)	NA

SOURCE DESCRIPTION		TROLS	HOURLY EMISSIONS							DAILY EMISSIONS							ANNUAL EMISSIONS								
Model	Source Description	reference	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	UTM E	UTM N
ID			lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	m	m
OC1	Loader Transfer of Ore to Grizzly	Control efficiency included in emission factor	0.146	0.0479	0.0135					3.50	1.15	0.325					0.639	0.210	0.0593					632,045	4,974,583
OC2	Grizzly to Apron Feeder	Control efficiency included in emission factor	0.146	0.0479	0.0135					3.50	1.15	0.325					0.639	0.210	0.0593					632,045	4,974,583
OC3	Apron Feeder to Dribble Conveyor	Control efficiency included in emission factor	0.146	0.0479	0.0135					3.50	1.15	0.325					0.639	0.210	0.0593					632,045	4,974,583
OC4	Apron Feeder to Vibrating Grizzly	Control efficiency included in emission factor	0.146	0.0479	0.0135					3.50	1.15	0.325					0.639	0.210	0.0593					632,045	4,974,583
OC5	Dribble Conveyor to Vibrating Grizzly	Control efficiency included in emission factor	0.146	0.0479	0.0135					3.50	1.15	0.325					0.639	0.210	0.0593					632,045	4,974,583
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	Control efficiency included in emission factor	0.146	0.0479	0.0135					3.50	1.15	0.325					0.639	0.210	0.0593					632,045	4,974,583
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	Control efficiency included in emission factor	1.25	0.563	0.104					30.0	13.5	2.50					5.48	2.46	0.456					632,045	4,974,583
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	Control efficiency included in emission factor	0.146	0.0479	0.0135					3.50	1.15	0.325					0.639	0.210	0.0593					631,947	4,974,520
OC9	Stockpile Transfers to Reclaim Conveyors	Based on AP-42, Chapter 13.2.4, reduction in EF due to wind speed reduction	0.690	0.253	0.0391					16.6	6.07	0.938					3.02	1.11	0.171					631,947	4,974,520
OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	Based on AP-42, Chapter 13.2.4, reduction in EF due to wind speed reduction	0.690	0.253	0.0391					16.6	6.07	0.938					3.02	1.11	0.171					631,947	4,974,520
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	Based on AP-42, Chapter 13.2.4, reduction in EF due to wind speed reduction	0.690	0.253	0.0391					16.6	6.07	0.94					3.02	1.11	0.171					632,113	4,974,243
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	Control efficiency included in emission factor	1.380	0.621	0.1150					33.12	14.90	2.760					6.04	2.720	0.504					632,028	4,974,187
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	Control efficiency included in emission factor	0.1610	0.0529	0.01495					3.864	1.270	0.3588					0.705	0.2317	0.0655					632,028	4,974,187
LS1L	Mill Lime Silo #1 Loading	Control efficiency included in emission factor	0.0594	0.0204	0.00300					0.248	0.0850	0.0125					0.00217	7.44E-4	1.09E-4					632,095	4,974,272
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor		0.0960	0.0560	0.00840					1.20	0.700	0.105					0.0105	0.00613	9.19E-4					632,095	4,974,272
MillS2L	Mill Lime Silo #2 Loading	Control efficiency included in emission factor	0.0594	0.0204	0.00300					0.248	0.0850	0.0125					0.00217	7.44E-4	1.09E-4					632,090	4,974,282
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor		0.0960	0.0560	0.00840					1.20	0.700	0.105					0.0105	0.00613	9.19E-4					632,090	4,974,282
Sb1	Sb Dryer (2.72 MMBtu/hr Propane-Fired)		0.0208	0.0208	0.0208	0.223	0.386	0.0473	0.0238	0.499	0.499	0.499	5.35	9.27	1.13	0.571	0.0911	0.0911	0.0911	0.977	1.69	0.207	0.104	632,231	4,974,183
Sb2	Sb Bagging	Control efficiency included in emission factor	0.118	0.118	0.118					2.83	2.83	2.83					0.517	0.517	0.517					632,208	4,974,221
AC	Autoclave	PM control efficiency included in emission factor	5.08	5.08	5.08			0.653		122	122	122			15.7		22.2	22.2	22.2			2.86		632,229	4,974,096
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)		0.130	0.130	0.130	1.39	2.42	0.295	0.149	0.130	0.130	0.130	1.39	2.42	0.295	0.149	0.00195	0.00195	0.00195	0.0209	0.0362	0.00443	0.00223	632,261	4,974,116
ACS1L	AC Lime Silo #1 Loading	Control efficiency included in emission factor	0.119	0.0408	0.00600					0.990	0.340	0.0500					0.00866	0.00298	4.38E-4					632,267	4,974,124
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker		0.0960	0.0560	0.00800					2.30	1.34	0.192					0.0420	0.0245	0.00350					632,267	4,974,124
ACS2L	AC Lime Silo #2 Loading	Control efficiency included in emission factor	0.119	0.0408	0.00600					0.990	0.340	0.0500					0.00866	0.00298	4.38E-4					632,257	4,974,140
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker		0.0960	0.0560	0.00800					2.30	1.34	0.192					0.0420	0.0245	0.00350					632,257	4,974,140
ACS3L	AC Lime Silo #3 Loading	Control efficiency included in emission factor	0.119	0.0408	0.00600					0.990	0.340	0.0500					0.00866	0.00298	4.38E-4					632,248	4,974,156
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker		0.0960	0.0560	0.00800					2.30	1.34	0.192					0.0420	0.0245	0.00350					632,248	4,974,156
ACS4L	AC Lime Silo #4 Loading	Control efficiency included in emission factor	0.119	0.0408	0.00600					0.495	0.170	0.0250					0.00433	0.00149	2.19E-4					632,238	4,974,171
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker		0.0960	0.0560	0.00800					2.30	1.34	0.192					0.0210	0.0123	0.00175					632,238	4,974,171
CKD	Carbon Regeneration Kiln (Drum)	PM control efficiency included in emission factor	0.420	0.420	0.420	0.120	0.0120		0.110	10.1	10.1	10.1	2.88	0.288	0	2.64	1.84	1.84	1.84	0.526	0.0526		0.482	632,013	4,974,051
CKB	Carbon Regeneration Kiln (Burners)		0.0173	0.0173	0.0173	0.185	0.320	0.0392	0.0197	0.414	0.414	0.414	4.44	7.69	0.940	0.473	0.0756	0.0756	0.0756	0.810	1.40	0.172	0.0864	631,998	4,974,042
EW	Electrowinning Cells and Pregnant Solution Tank		0.07	0.07	0.07					1.68	1.68	1.68					0.31	0.31	0.31					631,983	4,974,033
MR	Mercury Retort		0.01	0.01	0.01					0.24	0.24	0.24					0.006	0.006	0.006					632,003	4,974,001
MF	Induction Melting Furnace	Control efficiency included in emission factor	2.84	2.84	2.84					34.1	34.1	34.1					0.89	0.89	0.89					632,032	4,974,019

SOURCE DESCRIPTION		NAD 83 LOCATION		
Model	Source Description	reference	elev	reference
ID			m	
OC1	Loader Transfer of Ore to Grizzly	PC building center	1,968.5	PC building base
OC2	Grizzly to Apron Feeder	PC building center	1,968.5	PC building base
OC3	Apron Feeder to Dribble Conveyor	PC building center	1,968.5	PC building base
OC4	Apron Feeder to Vibrating Grizzly	PC building center	1,968.5	PC building base
OC5	Dribble Conveyor to Vibrating Grizzly	PC building center	1,968.5	PC building base
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	PC building center	1,968.5	PC building base
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	PC building center	1,968.5	PC building base
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	Stockpile center	1,957.0	Stockpile base
OC9	Stockpile Transfers to Reclaim Conveyors	Stockpile center	1,957.0	Stockpile base
OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	Stockpile center	1,957.0	Stockpile base
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	Mill building wall opening	2,000.6	Mill building base
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	Pebble crusher building center	1,973.3	Pebble crusher building base
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	Pebble crusher building center	1,973.3	Pebble crusher building base
LS1L	Mill Lime Silo #1 Loading	Mill Silo #1 center	1,992.0	Mill Silo #1 base
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	Mill Silo #1 center	1,992.0	Mill Silo #1 base
MillS2L	Mill Lime Silo #2 Loading	Mill Silo #2 center	1,990.0	Mill Silo #2 base
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	Mill Silo #2 center	1,990.0	Mill Silo #2 base
Sb1	Sb Dryer (2.72 MMBtu/hr Propane-Fired)	Mill building corner	2,000.6	Mill building base
Sb2	Sb Bagging	Mill building corner	2,000.6	Mill building base
AC	Autoclave	POX building corner	2,007.2	POX building base
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	POX building corner	2,007.2	POX building base
ACS1L	AC Lime Silo #1 Loading	AC Silo #1 center	2,007.2	AC Silo #1 base
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	AC Silo #1 center	2,007.2	AC Silo #1 base
ACS2L	AC Lime Silo #2 Loading	AC Silo #2 center	2,007.2	AC Silo #2 base
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	AC Silo #2 center	2,007.2	AC Silo #2 base
ACS3L	AC Lime Silo #3 Loading	AC Silo #3 center	2,007.2	AC Silo #3 base
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	AC Silo #3 center	2,007.2	AC Silo #3 base
ACS4L	AC Lime Silo #4 Loading	AC Silo #4 center	2,007.2	AC Silo #4 base
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	AC Silo #4 center	2,007.2	AC Silo #4 base
CKD	Carbon Regeneration Kiln (Drum)	Refinery building corner	1,970.3	Refinery building base
CKB	Carbon Regeneration Kiln (Burners)	Along Refinery building wall	1,970.3	Refinery building base
EW	Electrowinning Cells and Pregnant Solution Tank	Refinery building corner	1,970.3	Refinery building base
MR	Mercury Retort	Refinery building corner	1,970.3	Refinery building base
MF	Induction Melting Furnace	Refinery building corner	1,970.3	Refinery building base

SOURCE DESCRIPTION		RELEASE PARAMETERS INPUT						
Model	Source Description	POINT	rel ht (ft)	temp (F)	flow (dscfm)	flow (acfm)	dia (ft)	reference
ID		VOLUME	rel ht (ft)	width (ft)	vert. ln (ft)	grnd ht (ft)	oz type	
OC1	Loader Transfer of Ore to Grizzly	VOLUME	64	52.9	128	128	srf src	PC bldg height and width
OC2	Grizzly to Apron Feeder	VOLUME	64	52.9	128	128	srf src	PC bldg height and width
OC3	Apron Feeder to Dribble Conveyor	VOLUME	64	52.9	128	128	srf src	PC bldg height and width
OC4	Apron Feeder to Vibrating Grizzly	VOLUME	64	52.9	128	128	srf src	PC bldg height and width
OC5	Dribble Conveyor to Vibrating Grizzly	VOLUME	64	52.9	128	128	srf src	PC bldg height and width
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	VOLUME	64	52.9	128	128	srf src	PC bldg height and width
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	VOLUME	64	52.9	128	128	srf src	PC bldg height and width
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	VOLUME	35.8	3	71.6	71.6	srf src	36" wide belt; 50,000 ton stockpile height
OC9	Stockpile Transfers to Reclaim Conveyors	VOLUME	4	8	8	8	srf src	8' x 8' tunnel exit
OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	VOLUME	4	8	8	8	srf src	8' x 8' tunnel exit
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	VOLUME	68	4	4	70	elev src w/ bldg	4' x 4' opening at mid (Mill) bldg height
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	VOLUME	10	32.7	20	20	srf src	Pebble Crusher bldg height and width
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	VOLUME	10	32.7	20	20	srf src	Pebble Crusher bldg height and width
LS1L	Mill Lime Silo #1 Loading	POINT	43.7	Ambient	700	700	0.500	Ht - 3' above silo top; dia & flow from (NDEP 2019)
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	VOLUME	4.5	1	1	5	elev src w/ bldg	1' screw discharge; 1' drop to conveyor; 5' above grade
MillS2L	Mill Lime Silo #2 Loading	POINT	43.7	Ambient	700	700	0.500	Ht - 3' above silo top; dia & flow from (NDEP 2019)
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	VOLUME	4.5	1	1	5	elev src w/ bldg	1' screw discharge; 1' drop to conveyor; 5' above grade
Sb1	Sb Dryer (2.72 MMBtu/hr Propane-Fired)	POINT	150	360	461	1,073	1.0	Flow - EPA M19 (3% O2, 15% moist); 10' above bldg top; 12-in dia; T - std propane boiler exhst
Sb2	Sb Bagging	POINT	150	Ambient	800	1,000	1.0	Ht - 10' above bldg top; Flow - (NDEP 2015b)
AC	Autoclave	POINT	77	196	3,101	28,680	5.0	Ht - 10' above bldg top, Flow & Temp. - (APT 2013)
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	POINT	77	360	2,881	6,703	2.0	Flow - EPA M19 (3% O2, 15% moist); 10' above bldg top; 24-in dia; T - std propane boiler exhst
ACS1L	AC Lime Silo #1 Loading	POINT	57.2	Ambient	1400	1400	0.75	Ht - 3' above silo top; dia & flow from (NDEP 2019)
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	VOLUME	4.5	1	1	5	elev src w/ bldg	1' screw discharge; 1' drop to conveyor; 5' above grade
ACS2L	AC Lime Silo #2 Loading	POINT	57.2	Ambient	1400	1400	0.75	Ht - 3' above silo top; dia & flow from (NDEP 2019)
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	VOLUME	4.5	1	1	5	elev src w/ bldg	1' screw discharge; 1' drop to conveyor; 5' above grade
ACS3L	AC Lime Silo #3 Loading	POINT	57.2	Ambient	1400	1400	0.75	Ht - 3' above silo top; dia & flow from (NDEP 2019)
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	VOLUME	4.5	1	1	5	elev src w/ bldg	1' screw discharge; 1' drop to conveyor; 5' above grade
ACS4L	AC Lime Silo #4 Loading	POINT	47.5	Ambient	1400	1400	0.75	Ht - 3' above silo top; dia & flow from (NDEP 2019)
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	VOLUME	4.5	1	1	5	elev src w/ bldg	1' screw discharge; 1' drop to conveyor; 5' above grade
CKD	Carbon Regeneration Kiln (Drum)	POINT	55	150	120	180	0.48	Ht - 10' above bldg top; Temp, Flow, Dia - (NDEP 2017)
CKB	Carbon Regeneration Kiln (Burners)	POINT	46	360	382	889	1.0	Flow - EPA M19 (3% O2, 15% moist); 1' above bldg top; 12-in dia; T - std propane boiler exhst
EW	Electrowinning Cells and Pregnant Solution Tank	POINT	55	100	2,660	3,740	1	Ht - 10' above bldg top; Temp, Flow, Dia - (NDEP 2017)
MR	Mercury Retort	POINT	55	150	16	20	0.29	Ht - 10' above bldg top; Temp, Flow, Dia - (NDEP 2017)
MF	Induction Melting Furnace	POINT	55	150	3,500	5,200	1.25	Ht - 10' above bldg top; Temp, Flow, Dia - (NDEP 2017)

SOURCE DESCRIPTION		MODEL EMISSION RATES / RELEASE PARAMETERS														IDAPA 58.01.01.701 PM Weight Limit			
Model	Source Description	PM_{10}-24	$PM_{2.5}$-24	CO-ALL	NO_2-1	SO_2-1	SO_2-3	PM_{10}-AN	$PM_{2.5}$-AN	NO_2-AN	SO_2-AN	ht (m)	temp (K)	vel (m/s)	dia (m)	Process Weight	Allowable PM	Proposed PM	Compliance
ID		gps	gps	gps	gps	gps	gps	gps	gps	gps	gps	ht (m)	oy (m)	oz (m)		lb/hr	lb/hr	lb/hr	Demonstration
OC1	Loader Transfer of Ore to Grizzly	6.04E-03	1.71E-3					6.04E-3	1.71E-3			19.5	3.75	18.1		2,083,333	41.79	0.146	In Compliance
OC2	Grizzly to Apron Feeder	6.04E-03	1.71E-3					6.04E-3	1.71E-3			19.5	3.75	18.1		2,083,333	41.79	0.146	In Compliance
OC3	Apron Feeder to Dribble Conveyor	6.04E-03	1.71E-3					6.04E-3	1.71E-3			19.5	3.75	18.1		2,083,333	41.79	0.146	In Compliance
OC4	Apron Feeder to Vibrating Grizzly	6.04E-03	1.71E-3					6.04E-3	1.71E-3			19.5	3.75	18.1		2,083,333	41.79	0.146	In Compliance
OC5	Dribble Conveyor to Vibrating Grizzly	6.04E-03	1.71E-3					6.04E-3	1.71E-3			19.5	3.75	18.1		2,083,333	41.79	0.146	In Compliance
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	6.04E-03	1.71E-3					6.04E-3	1.71E-3			19.5	3.75	18.1		2,083,333	41.79	0.146	In Compliance
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	7.09E-02	1.31E-2					7.09E-2	1.31E-2			19.5	3.75	18.1		2,083,333	41.79	1.25	In Compliance
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	6.04E-03	1.71E-3					6.04E-3	1.71E-3			10.9	0.21	10.2		2,083,333	41.79	0.146	In Compliance
OC9	Stockpile Transfers to Reclaim Conveyors	3.19E-02	4.93E-3					3.19E-2	4.93E-3			1.2	0.57	1.1		2,300,000	42.84	0.690	In Compliance
OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	3.19E-02	4.93E-3					3.19E-2	4.93E-3			1.2	0.57	1.1		2,300,000	42.84	0.690	In Compliance
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	3.19E-02	4.93E-3					3.19E-2	4.93E-3			20.7	0.28	0.6		2,300,000	42.84	0.690	In Compliance
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	7.82E-02	1.45E-2					7.82E-2	1.45E-2			3.0	2.32	2.8		2,300,000	42.84	1.380	In Compliance
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	6.67E-03	1.88E-3					6.67E-3	1.88E-3			3.0	2.32	2.8		2,300,000	42.84	0.1610	In Compliance
LS1L	Mill Lime Silo #1 Loading	4.46E-04	6.56E-5					2.14E-5	3.15E-6			13.3	0.00	18.1	0.152	120,000	20.47	0.0594	In Compliance
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	3.67E-03	5.51E-4					1.76E-4	2.64E-5			1.4	0.07	0.1		40,000	15.56	0.0960	In Compliance
MillS2L	Mill Lime Silo #2 Loading	4.46E-04	6.56E-5					2.14E-5	3.15E-6			13.3	0.00	18.1	0.152	120,000	20.47	0.0594	In Compliance
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	3.67E-03	5.51E-4					1.76E-4	2.64E-5			1.4	0.07	0.1		40,000	15.56	0.0960	In Compliance
Sb1	Sb Dryer (2.72 MMBtu/hr Propane-Fired)	2.62E-03	2.62E-3	2.81E-2	4.87E-2	5.95E-3	5.95E-3	2.62E-3	2.62E-3	4.87E-2	5.95E-3	45.7	455.37	6.9	0.305	-	-	0.0208	N/A
Sb2	Sb Bagging	1.49E-02	1.49E-2					1.49E-2	1.49E-2			45.7	0.00	6.5	0.305	9,000	10.61	0.118	In Compliance
AC	Autoclave	6.39E-01	6.39E-1			8.22E-2	8.22E-2	6.39E-1	6.39E-1		8.22E-2	23.5	364.26	7.4	1.524	580,000	30.36	5.08	In Compliance
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	6.83E-04	6.83E-4	1.76E-1	3.04E-1	3.72E-2	3.72E-2	5.61E-5	5.61E-5	1.04E-3	1.27E-4	23.5	455.37	10.8	0.610	-	-	0.130	N/A
ACS1L	AC Lime Silo #1 Loading	1.78E-03	2.62E-4					8.56E-5	1.26E-5			17.4	0.00	16.1	0.229	240,000	24.35	0.119	In Compliance
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	7.06E-03	1.01E-3					7.05E-4	1.01E-4			1.4	0.07	0.1		40,000	15.56	0.0960	In Compliance
ACS2L	AC Lime Silo #2 Loading	1.78E-03	2.62E-4					8.56E-5	1.26E-5			17.4	0.00	16.1	0.229	240,000	24.35	0.119	In Compliance
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	7.06E-03	1.01E-3					7.05E-4	1.01E-4			1.4	0.07	0.1		40,000	15.56	0.0960	In Compliance
ACS3L	AC Lime Silo #3 Loading	1.78E-03	2.62E-4					8.56E-5	1.26E-5			17.4	0.00	16.1	0.229	240,000	24.35	0.119	In Compliance
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	7.06E-03	1.01E-3					7.05E-4	1.01E-4			1.4	0.07	0.1		40,000	15.56	0.0960	In Compliance
ACS4L	AC Lime Silo #4 Loading	8.92E-04	1.31E-4					4.28E-5	6.29E-6			14.5	0.00	16.1	0.229	240,000	24.35	0.119	In Compliance
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	7.06E-03	1.01E-3					3.52E-4	5.03E-5			1.4	0.07	0.1		40,000	15.56	0.0960	In Compliance
CKD	Carbon Regeneration Kiln (Drum)	5.29E-02	5.29E-2	1.51E-2	1.51E-3			5.29E-2	5.29E-2	1.51E-3		16.8	338.71	5.1	0.146	600	2.09	0.420	In Compliance
CKB	Carbon Regeneration Kiln (Burners)	2.17E-03	2.17E-3	2.33E-2	4.04E-2	4.94E-3	4.94E-3	2.17E-3	2.17E-3	4.04E-2	4.94E-3	14.0	455.37	5.8	0.305	-	-	0.0173	N/A
EW	Electrowinning Cells and Pregnant Solution Tank	8.82E-03	8.82E-3					8.82E-3	8.82E-3			16.8	310.93	24.2	0.305	-	-	0.07	N/A
MR	Mercury Retort	1.26E-03	1.26E-3					1.80E-4	1.80E-4			16.8	338.71	1.5	0.088	1,000	2.84	0.01	In Compliance
MF	Induction Melting Furnace	1.79E-01	1.79E-1					2.55E-2	2.55E-2			16.8	338.71	21.5	0.381	1,000	2.84	2.84	In Compliance

SOURCE DESCRIPTION		OPERATING LIMITS							EMISSION FACTORS									EMISSION CON	
Model	Source Description	Design Throughput						Throughput reference	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	unit	reference	control	efficiency
ID		unit/hr	unit/day	unit/yr	units	Material	hr/yr											system	
EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	1,000	1 hr	100,000	bkW	Diesel	100	(M3 2017a)	0.2	0.2	0.2	3.5	6.4	0.00657	1.3	g/kW-hr	40 CFR Subpart 60.4202(a)(2); SO2 - mass balance (15ppm ULSD) (CFR 2018a)	None	NA
EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	1,000	1 hr	100,000	bkW	Diesel	100	(M3 2017a)	0.2	0.2	0.2	3.5	6.4	0.00657	1.3	g/kW-hr	40 CFR Subpart 60.4202(a)(2); SO2 - mass balance (15ppm ULSD) (CFR 2018a)	None	NA
EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	1,000	1 hr	100,000	bkW	Diesel	100	(M3 2017a)	0.2	0.2	0.2	3.5	6.4	0.00657	1.3	g/kW-hr	40 CFR Subpart 60.4202(a)(2); SO2 - mass balance (15ppm ULSD) (CFR 2018a)	None	NA
EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	200	1 hr	20,000	bkW	Diesel	100	Typical Ind. Oper.	0.2	0.2	0.2	3.5	4	0.00657	4	g/kW-hr	Table 4 to Subpart IIII of Part 60 — 130≤KW<225 (175≤HP<300); SO2 - mass balance (15ppm ULSD) (CFR 2018a)	None	NA
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0.10	2.4	876	MMBtu	Propane	8,760	(M3 2017a)	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal	None	NA
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	5.00	120	43,800	MMBtu	Propane	8,760	(M3 2017b)	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal	None	NA
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	4.00	96	35,040	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal	None	NA
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	4.00	96	35,040	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal	None	NA
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	4.00	96	35,040	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal	None	NA
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0.25	6	2,190	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal	None	NA
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0.25	6	2,190	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal	None	NA
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0.25	6	2,190	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal	None	NA
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0.50	12	4,380	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal	None	NA
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	2.00	48	17,520	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal	None	NA
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	3.00	72	26,280	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal	None	NA
PSL	Prill Silos Loading (2 x 100 ton)	200	200	7,300	ton	Prill	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.02	0.007	0.00106					lb/ton	AP-42, Table 8.3-2 (7/93), Bulk Loading - unctrl; PM10/PM2.5 Ch. 13.2.4	None	0%
PSU	Prill Silos Unloading (2 x 100 ton)	200	200	7,300	ton	Prill	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.02	0.007	0.00106					lb/ton	AP-42, Table 8.3-2 (7/93), Bulk Loading - unctrl; PM10/PM2.5 Ch. 13.2.4	None	0%
CS1L	Cement/Shotcrete Silo #1 Loading	80	80	60,000	ton	Cement	8,760	Typical Ind. Oper.	0.00099	0.00034	0.00005					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4.	Bin Vent Filter	
CS1U	Cement/Shotcrete Silo #1 Unloading	20	80	60,000	ton	Cement	8,760	Typical Ind. Oper.	0.0048	0.0028	0.0004					lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4.	None	0%
CS2L	Cement/Shotcrete Silo #2 Loading	80	80	60,000	ton	Cement	8,760	Typical Ind. Oper.	0.00099	0.00034	0.00005					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4.	Bin Vent Filter	
CS2U	Cement/Shotcrete Silo #2 Unloading	20	80	60,000	ton	Cement	8,760	Typical Ind. Oper.	0.0048	0.0028	0.0004					lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4.	None	0%
CAL	Aggregate Bin Loading	100	2,400	500,000	ton	Aggregate	8,760	Typical Ind. Oper.	0.0069	0.0033	0.0005					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4.	None	0%
CAU	Aggregate Bin Unloading	100	2,400	500,000	ton	Aggregate	8,760	Typical Ind. Oper.	0.0069	0.0033	0.0005					lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4.	None	0%
CM	Central Mixer Loading	20 (120)	80 (2,480)	60,000 (560K)	ton-cement (tot.)	Cement (mix)	8,760	Typical Ind. Oper.	0.0184	0.0055	0.0008					lb/ton	AP-42, Table 11.12-2 (6/06), central mixer-ctrl.; PM2.5 Ch. 13.2.4.	Types of controls used may include water sprays, enclosures, hoods, curtains, shrouds, movable and telescoping chutes, central duct collection systems, and the like.	
TG1	Mine Site Gasoline Tank #1			250,000	gal	Gasoline	8,760	(Midas Gold 2016), Table 12-4, annual use.							0.219	lb/hr	EPA Tanks 4.0.9d	None	NA
TG2	Mine Site Gasoline Tank #2			250,000	gal	Gasoline	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide tank capacity)							0.219	lb/hr	EPA Tanks 4.0.9d	None	NA
TD3	Mine Site Diesel Tank #3			725,000	gal	Diesel	8,760	(Midas Gold 2016), (Midas Gold 2018c)							0.002	lb/hr	EPA Tanks 4.0.9d	None	NA
TD4	Mine Site Diesel Tank #4			725,000	gal	Diesel	8,760	(Midas Gold 2016), (Midas Gold 2018c)							0.002	lb/hr	EPA Tanks 4.0.9d	None	NA
TD5	Mine Site Diesel Tank #5			725,000	gal	Diesel	8,760	(Midas Gold 2016), (Midas Gold 2018c)							0.002	lb/hr	EPA Tanks 4.0.9d	None	NA
TD6	Mine Site Diesel Tank #6			725,000	gal	Diesel	8,760	(Midas Gold 2016), (Midas Gold 2018c)							0.002	lb/hr	EPA Tanks 4.0.9d	None	NA
TD7	Mine Site Diesel Tank #7			725,000	gal	Diesel	8,760	(Midas Gold 2016), (Midas Gold 2018c)							0.002	lb/hr	EPA Tanks 4.0.9d	None	NA
TD8	Mine Site Diesel Tank #8			725,000	gal	Diesel	8,760	(Midas Gold 2016), (Midas Gold 2018c)							0.002	lb/hr	EPA Tanks 4.0.9d	None	NA

SOURCE DESCRIPTION		TROLS	HOURLY EMISSIONS							DAILY EMISSIONS							ANNUAL EMISSIONS								
Model	Source Description	reference	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	UTM E	UTM N
ID			lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	m	m
EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)		0.441	0.441	0.441	7.72	14.1	0.0145	2.87	0.441	0.441	0.441	7.72	14.11	0.01448	2.866	0.0220	0.0220	0.0220	0.386	0.705	7.24E-4	0.143	634,274	4,972,050
EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)		0.441	0.441	0.441	7.72	14.1	0.0145	2.87	0.441	0.441	0.441	7.72	14.11	0.01448	2.866	0.0220	0.0220	0.0220	0.386	0.705	7.24E-4	0.143	632,105	4,974,154
EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)		0.441	0.441	0.441	7.72	14.1	0.0145	2.87	0.441	0.441	0.441	7.72	14.11	0.01448	2.866	0.0220	0.0220	0.0220	0.386	0.705	7.24E-4	0.143	632,109	4,974,148
EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)		0.0882	0.0882	0.0882	1.54	1.76	0.00290	1.76	0.0882	0.0882	0.0882	1.543	1.764	2.90E-3	1.764	0.00441	0.00441	0.00441	0.0772	0.0882	1.45E-4	0.0882	632,113	4,974,141
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)		7.65E-4	7.65E-4	7.65E-4	0.00820	0.0142	0.00174	8.74E-4	0.0184	0.0184	0.0184	0.197	0.341	0.0417	0.0210	0.00335	0.00335	0.00335	0.0359	0.0622	0.00761	0.00383	632,216	4,974,118
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)		0.0383	0.0383	0.0383	0.410	0.710	0.0869	0.0437	0.918	0.918	0.918	9.84	17.0	2.09	1.05	0.168	0.168	0.168	1.80	3.11	0.381	0.191	632,017	4,974,010
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)		0.0306	0.0306	0.0306	0.328	0.568	0.0695	0.0350	0.734	0.734	0.734	7.87	13.6	1.67	0.839	0.134	0.134	0.134	1.44	2.49	0.304	0.153	632,287	4,974,227
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)		0.0306	0.0306	0.0306	0.328	0.568	0.0695	0.0350	0.734	0.734	0.734	7.87	13.6	1.67	0.839	0.134	0.134	0.134	1.44	2.49	0.304	0.153	632,288	4,974,228
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)		0.0306	0.0306	0.0306	0.328	0.568	0.0695	0.0350	0.734	0.734	0.734	7.87	13.6	1.67	0.839	0.134	0.134	0.134	1.44	2.49	0.304	0.153	632,168	4,974,191
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)		0.00191	0.00191	0.00191	0.0205	0.0355	0.00434	0.00219	0.0459	0.0459	0.0459	0.492	0.852	0.104	0.0525	0.00838	0.00838	0.00838	0.0898	0.156	0.0190	0.00957	632,238	4,974,130
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)		0.00191	0.00191	0.00191	0.0205	0.0355	0.00434	0.00219	0.0459	0.0459	0.0459	0.492	0.852	0.104	0.0525	0.00838	0.00838	0.00838	0.0898	0.156	0.0190	0.00957	632,008	4,974,026
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)		0.00191	0.00191	0.00191	0.0205	0.0355	0.00434	0.00219	0.0459	0.0459	0.0459	0.492	0.852	0.104	0.0525	0.00838	0.00838	0.00838	0.0898	0.156	0.0190	0.00957	632,038	4,973,751
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)		0.00383	0.00383	0.00383	0.0410	0.0710	0.00869	0.00437	0.0918	0.0918	0.0918	0.984	1.70	0.209	0.105	0.0168	0.0168	0.0168	0.180	0.311	0.0381	0.0191	631,889	4,973,472
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)		0.0153	0.0153	0.0153	0.164	0.284	0.0348	0.0175	0.367	0.367	0.367	3.93	6.82	0.834	0.420	0.0670	0.0670	0.0670	0.718	1.24	0.152	0.0766	631,848	4,973,398
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)		0.0230	0.0230	0.0230	0.246	0.426	0.0521	0.0262	0.551	0.551	0.551	5.90	10.2	1.25	0.630	0.101	0.101	0.101	1.08	1.87	0.228	0.115	632,060	4,973,664
PSL	Prill Silos Loading (2 x 100 ton)		4.00	1.40	0.212					4.00	1.40	0.212					0.0730	0.0256	0.00387					632,346	4,973,500
PSU	Prill Silos Unloading (2 x 100 ton)		4.00	1.40	0.212					4.00	1.40	0.212					0.0730	0.0256	0.00387					632,346	4,973,500
CS1L	Cement/Shotcrete Silo #1 Loading	Control efficiency included in emission factor	0.0792	0.0272	0.00400					0.0792	0.0272	0.00400					0.0297	0.0102	0.00150					632,095	4,974,272
CS1U	Cement/Shotcrete Silo #1 Unloading		0.0960	0.0560	0.00800					0.384	0.224	0.0320					0.144	0.0840	0.0120					632,095	4,974,272
CS2L	Cement/Shotcrete Silo #2 Loading	Control efficiency included in emission factor	0.0792	0.0272	0.00400					0.0792	0.0272	0.00400					0.0297	0.0102	0.00150					632,095	4,974,272
CS2U	Cement/Shotcrete Silo #2 Unloading		0.0960	0.0560	0.00800					0.384	0.224	0.0320					0.144	0.0840	0.0120					632,095	4,974,272
CAL	Aggregate Bin Loading		0.690	0.330	0.0500					16.6	7.92	1.20					1.73	0.825	0.125					632,095	4,974,272
CAU	Aggregate Bin Unloading		0.690	0.330	0.0500					16.6	7.92	1.20					1.73	0.825	0.125					632,095	4,974,272
CM	Central Mixer Loading	Control efficiency included in emission factor	0.368	0.110	0.0160					1.47	0.440	0.0640					0.552	0.165	0.0240					632,095	4,974,272
TG1	Mine Site Gasoline Tank #1								0.219							5.25							0.957		
TG2	Mine Site Gasoline Tank #2								0.219							5.25							0.957		
TD3	Mine Site Diesel Tank #3								0.00167							0.0400							0.00730		
TD4	Mine Site Diesel Tank #4								0.00167							0.0400							0.00730		
TD5	Mine Site Diesel Tank #5								0.00167							0.0400							0.00730		
TD6	Mine Site Diesel Tank #6								0.00167							0.0400							0.00730		
TD7	Mine Site Diesel Tank #7								0.00167							0.0400							0.00730		
TD8	Mine Site Diesel Tank #8								0.00167							0.0400							0.00730		

SOURCE DESCRIPTION		NAD 83 LOCATION		
Model	Source Description	reference	elev	reference
ID			m	
EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	Outside Recreation building	2,114.0	Recreation building base
EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	Outside Mill building	2,001.0	Mill building base
EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	Outside Mill building	2,002.0	Mill building base
EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	Outside Mill building	2,003.0	Mill building base
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	POX building corner	2,007.2	POX building base
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	Along Refinery building wall	1,970.3	Refinery building base
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	Near underground mine shaft	2,000.0	Mine shaft base
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	Near underground mine shaft	2,000.0	Mine shaft base
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	Mill building center	2,000.6	Mill building base
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	POX building center	2,007.2	POX building base
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	Refinery building center	1,970.3	Refinery building base
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	Admin building center	1,979.0	Admin building base
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	Mine Ops building center	1,988.5	Mine Ops building base
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	Truck Shop building center	1,991.8	Truck Shop building base
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	Warehouse building center	1,983.9	Warehouse building base
PSL	Prill Silos Loading (2 x 100 ton)	Prill Silo #1 center	2,010.0	Prill Silo #1 base
PSU	Prill Silos Unloading (2 x 100 ton)	Prill Silo #1 center	2,010.0	Prill Silo #1 base
CS1L	Cement/Shotcrete Silo #1 Loading	Aggregate stockpile center	1,992.0	Aggregate stockpile base
CS1U	Cement/Shotcrete Silo #1 Unloading	Aggregate stockpile center	1,992.0	Aggregate stockpile base
CS2L	Cement/Shotcrete Silo #2 Loading	Aggregate stockpile center	1,992.0	Aggregate stockpile base
CS2U	Cement/Shotcrete Silo #2 Unloading	Aggregate stockpile center	1,992.0	Aggregate stockpile base
CAL	Aggregate Bin Loading	Aggregate stockpile center	1,992.0	Aggregate stockpile base
CAU	Aggregate Bin Unloading	Aggregate stockpile center	1,992.0	Aggregate stockpile base
CM	Central Mixer Loading	Aggregate stockpile center	1,992.0	Aggregate stockpile base
TG1	Mine Site Gasoline Tank #1			
TG2	Mine Site Gasoline Tank #2			
TD3	Mine Site Diesel Tank #3			
TD4	Mine Site Diesel Tank #4			
TD5	Mine Site Diesel Tank #5			
TD6	Mine Site Diesel Tank #6			
TD7	Mine Site Diesel Tank #7			
TD8	Mine Site Diesel Tank #8			

SOURCE DESCRIPTION		RELEASE PARAMETERS INPUT						
Model	Source Description	POINT	rel ht (ft)	temp (F)	flow (dscfm)	flow (acfm)	dia (ft)	reference
ID		VOLUME	rel ht (ft)	width (ft)	vert. ln (ft)	grnd ht (ft)	σz type	
EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	POINT	7	1,100	1,894	10,328	1.5	Flow - EPA M19 (9% O2, 8% moist; 75% load); 7' high, 18-in dia; T - std diesel engine exhst
EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	POINT	7	1,100	1,894	10,328	1.5	Flow - EPA M19 (9% O2, 8% moist); 7' high, 18-in dia; T - std diesel engine exhst
EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	POINT	7	1,100	1,894	10,328	1.5	Flow - EPA M19 (9% O2, 8% moist); 7' high, 18-in dia; T - std diesel engine exhst
EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	POINT	7	1,100	379	2,066	0.75	Flow - EPA M19 (9% O2, 8% moist); 7' high, 9-in dia; T - std diesel engine exhst
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	POINT	68	360	17	39	0.4	Flow - EPA M19 (3% O2, 15% moist); 1' above bldg top; 5-in dia; T - std propane boiler exhst
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	POINT	46	360	847	1,972	1.3	Flow - EPA M19 (3% O2, 15% moist); 1' above bldg top; 16-in dia; T - std propane boiler exhst
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	POINT	7	360	678	1,577	1.3	Flow - EPA M19 (3% O2, 15% moist); 1' above bldg top; 16-in dia; T - std propane boiler exhst
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	POINT	7	360	678	1,577	0.7	Flow - EPA M19 (3% O2, 15% moist); 1' above bldg top; 8-in dia; T - std propane boiler exhst
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	POINT	141	360	678	394	0.3	Flow - EPA M19 (3% O2, 15% moist); 1' above bldg top; 4-in dia; T - std propane boiler exhst - single stack param
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	POINT	68	360	42	99	0.3	Flow - EPA M19 (3% O2, 15% moist); 1' above bldg top; 4-in dia; T - std propane boiler exhst
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	POINT	46	360	42	99	0.3	Flow - EPA M19 (3% O2, 15% moist); 1' above bldg top; 4-in dia; T - std propane boiler exhst
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	POINT	21	360	42	99	0.3	Flow - EPA M19 (3% O2, 15% moist); 1' above bldg top; 4-in dia; T - std propane boiler exhst
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	POINT	41	360	85	99	0.7	Flow - EPA M19 (3% O2, 15% moist); 1' above bldg top; 8-in dia; T - std propane boiler exhst - single stack param
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	POINT	41	360	339	394	0.7	Flow - EPA M19 (3% O2, 15% moist); 1' above bldg top; 8-in dia; T - std propane boiler exhst - single stack param
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	POINT	41	360	508	394	0.7	Flow - EPA M19 (3% O2, 15% moist); 1' above bldg top; 8-in dia; T - std propane boiler exhst - single stack param
PSL	Prill Silos Loading (2 x 100 ton)	POINT	25.5	Ambient		700	0.5	Ht - 3' above silo top; dia & flow from (NDEP 2019)
PSU	Prill Silos Unloading (2 x 100 ton)	VOLUME	4.5	1	1	5	elev src w/ bldg	1' screw discharge; 1' drop to conveyor; 5' above grade
CS1L	Cement/Shotcrete Silo #1 Loading	POINT	43.7	Ambient	930	930	0.5	Ht - 3' above silo top; dia & flow from (NDEP 2019)
CS1U	Cement/Shotcrete Silo #1 Unloading	VOLUME	5	72.2	10	10	srf src	Ht - 3' above silo top; dia & flow from (NDEP 2019)
CS2L	Cement/Shotcrete Silo #2 Loading	POINT	43.7	Ambient	930	930	0.5	Ht - 3' above silo top; dia & flow from (NDEP 2019)
CS2U	Cement/Shotcrete Silo #2 Unloading	VOLUME	5	72.2	10	10	srf src	Ht - 3' above silo top; dia & flow from (NDEP 2019)
CAL	Aggregate Bin Loading	VOLUME	5	72.2	10	10	srf src	Ht - 3' above silo top; dia & flow from (NDEP 2019)
CAU	Aggregate Bin Unloading	VOLUME	5	72.2	10	10	srf src	Ht - 3' above silo top; dia & flow from (NDEP 2019)
CM	Central Mixer Loading	VOLUME	5	72.2	10	10	srf src	Ht - 3' above silo top; dia & flow from (NDEP 2019)
TG1	Mine Site Gasoline Tank #1							
TG2	Mine Site Gasoline Tank #2							
TD3	Mine Site Diesel Tank #3							
TD4	Mine Site Diesel Tank #4							
TD5	Mine Site Diesel Tank #5							
TD6	Mine Site Diesel Tank #6							
TD7	Mine Site Diesel Tank #7							
TD8	Mine Site Diesel Tank #8							

SOURCE DESCRIPTION		MODEL EMISSION RATES / RELEASE PARAMETERS														IDAPA 58.01.01.701 PM Weight Limit			
Model	Source Description	PM_{10}-24	$PM_{2.5}$-24	CO-ALL	NO_2-1	SO_2-1	SO_2-3	PM_{10}-AN	$PM_{2.5}$-AN	NO_2-AN	SO_2-AN	ht (m)	temp (K)	vel (m/s)	dia (m)	Process Weight	Allowable PM	Proposed PM	Compliance
ID		gps	gps	gps	gps	gps	gps	gps	gps	gps	gps	ht (m)	oy (m)	oz (m)		lb/hr	lb/hr	lb/hr	Demonstration
EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	2.31E-03	2.31E-3	9.72E-1	2.03E-2	1.82E-3	1.82E-3	6.34E-4	6.34E-4	2.03E-2	2.08E-5	2.1	866.48	29.7	0.457	-	-	0.441	N/A
EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	2.31E-03	2.31E-3	9.72E-1	2.03E-2	1.82E-3	1.82E-3	6.34E-4	6.34E-4	2.03E-2	2.08E-5	2.1	866.48	29.7	0.457	-	-	0.441	N/A
EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	2.31E-03	2.31E-3	9.72E-1	2.03E-2	1.82E-3	1.82E-3	6.34E-4	6.34E-4	2.03E-2	2.08E-5	2.1	866.48	29.7	0.457	-	-	0.441	N/A
EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	4.63E-04	4.63E-4	1.94E-1	2.54E-3	3.65E-4	3.65E-4	1.27E-4	1.27E-4	2.54E-3	4.16E-6	2.1	866.48	23.8	0.229	-	-	0.0882	N/A
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	9.64E-05	9.64E-5	1.03E-3	1.79E-3	2.19E-4	2.19E-4	9.64E-5	9.64E-5	1.79E-3	2.19E-4	20.7	455.37	1.6	0.122	-	-	7.65E-4	N/A
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	4.82E-03	4.82E-3	5.16E-2	8.95E-2	1.09E-2	1.09E-2	4.82E-3	4.82E-3	8.95E-2	1.09E-2	14.0	455.37	7.5	0.396	-	-	0.0383	N/A
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	3.86E-03	3.86E-3	4.13E-2	7.16E-2	8.76E-3	8.76E-3	3.86E-3	3.86E-3	7.16E-2	8.76E-3	2.1	455.37	6.0	0.396	-	-	0.0306	N/A
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	3.86E-03	3.86E-3	4.13E-2	7.16E-2	8.76E-3	8.76E-3	3.86E-3	3.86E-3	7.16E-2	8.76E-3	2.1	455.37	20.8	0.213	-	-	0.0306	N/A
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	3.86E-03	3.86E-3	4.13E-2	7.16E-2	8.76E-3	8.76E-3	3.86E-3	3.86E-3	7.16E-2	8.76E-3	43.0	455.37	28.3	0.091	-	-	0.0306	N/A
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	2.41E-04	2.41E-4	2.58E-3	4.48E-3	5.47E-4	5.47E-4	2.41E-4	2.41E-4	4.48E-3	5.47E-4	20.7	455.37	7.1	0.091	-	-	0.00191	N/A
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	2.41E-04	2.41E-4	2.58E-3	4.48E-3	5.47E-4	5.47E-4	2.41E-4	2.41E-4	4.48E-3	5.47E-4	14.0	455.37	7.1	0.091	-	-	0.00191	N/A
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	2.41E-04	2.41E-4	2.58E-3	4.48E-3	5.47E-4	5.47E-4	2.41E-4	2.41E-4	4.48E-3	5.47E-4	6.4	455.37	7.1	0.091	-	-	0.00191	N/A
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	4.82E-04	4.82E-4	5.16E-3	8.95E-3	1.09E-3	1.09E-3	4.82E-4	4.82E-4	8.95E-3	1.09E-3	12.5	455.37	1.3	0.213	-	-	0.00383	N/A
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	1.93E-03	1.93E-3	2.07E-2	3.58E-2	4.38E-3	4.38E-3	1.93E-3	1.93E-3	3.58E-2	4.38E-3	12.5	455.37	5.2	0.213	-	-	0.0153	N/A
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	2.89E-03	2.89E-3	3.10E-2	5.37E-2	6.57E-3	6.57E-3	2.89E-3	2.89E-3	5.37E-2	6.57E-3	12.5	455.37	5.2	0.213	-	-	0.0230	N/A
PSL	Prill Silos Loading (2 x 100 ton)	7.35E-03	1.11E-3					7.35E-4	1.11E-4			7.8	0.00	18.1	0.152	400,000	27.66	4.00	In Compliance
PSU	Prill Silos Unloading (2 x 100 ton)	7.35E-03	1.11E-3					7.35E-4	1.11E-4			1.4	0.07	0.1		400,000	27.66	4.00	In Compliance
CS1L	Cement/Shotcrete Silo #1 Loading	1.43E-04	2.10E-5					2.93E-4	4.32E-5			13.3	0.00	24.1	0.152	160,000	22.00	0.0792	In Compliance
CS1U	Cement/Shotcrete Silo #1 Unloading	1.18E-03	1.68E-4					2.42E-3	3.45E-4			1.5	5.12	1.4		40,000	15.56	0.0960	In Compliance
CS2L	Cement/Shotcrete Silo #2 Loading	1.43E-04	2.10E-5					2.93E-4	4.32E-5			13.3	0.00	24.1	0.152	160,000	22.00	0.0792	In Compliance
CS2U	Cement/Shotcrete Silo #2 Unloading	1.18E-03	1.68E-4					2.42E-3	3.45E-4			1.5	5.12	1.4		40,000	15.56	0.0960	In Compliance
CAL	Aggregate Bin Loading	4.16E-02	6.30E-3					2.37E-2	3.60E-3			1.5	5.12	1.4		200,000	23.26	0.690	In Compliance
CAU	Aggregate Bin Unloading	4.16E-02	6.30E-3					2.37E-2	3.60E-3			1.5	5.12	1.4		200,000	23.26	0.690	In Compliance
CM	Central Mixer Loading	2.31E-03	3.36E-4					4.75E-3	6.90E-4			1.5	5.12	1.4		-	-	0.368	N/A
TG1	Mine Site Gasoline Tank #1															-	-	-	N/A
TG2	Mine Site Gasoline Tank #2															-	-	-	N/A
TD3	Mine Site Diesel Tank #3															-	-	-	N/A
TD4	Mine Site Diesel Tank #4															-	-	-	N/A
TD5	Mine Site Diesel Tank #5															-	-	-	N/A
TD6	Mine Site Diesel Tank #6															-	-	-	N/A
TD7	Mine Site Diesel Tank #7															-	-	-	N/A
TD8	Mine Site Diesel Tank #8															-	-	-	N/A

SOURCE DESCRIPTION		OPERATING LIMITS							EMISSION FACTORS									EMISSION CON	
Model	Source Description	Design Throughput						Throughput reference	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	unit	reference	control	efficiency
ID		unit/hr	unit/day	unit/yr	units	Material	hr/yr											system	
TD9	Mine Site Diesel Tank #9			725,000	gal	Diesel	8,760	(Midas Gold 2016), (Midas Gold 2018c)							0.002	lb/hr	EPA Tanks 4.0.9d	None	NA
TD10	Mine Site Diesel Tank #10			725,000	gal	Diesel	8,760	(Midas Gold 2016), (Midas Gold 2018c)							0.002	lb/hr	EPA Tanks 4.0.9d	None	NA
PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	83	2,000	730,000	ton	Aggregate	8,760	(Midas Gold 2019c)	0.0075	0.00279	0.00037					lb/ton	AP-42, Table 11.19.2-2 (08/04): Tert. Crushing - ctrl. × 2 + Screening - ctrl. × 2 + Conv. Transfer - ctrl. × 5	Water Sprays/Moisture Carry-Over	
PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	83	2,000	730,000	ton	Aggregate	8,760	(Midas Gold 2019c)	0.0075	0.00279	0.00037					lb/ton	AP-42, Table 11.19.2-2 (08/04): Tert. Crushing - ctrl. × 2 + Screening - ctrl. × 2 + Conv. Transfer - ctrl. × 5	Water Sprays/Moisture Carry-Over	
TRUE	LIME PRODUCTION																		
LS1	Limestone transfer to Primary Crusher Hopper	47.08	1,130	317,907	ton	Limestone	8,760	(Midas Gold 2018d)	0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4	None	0
LS2	Primary Crushing and Associated Transfers In and Out	47.08	1,130	317,907	ton	Limestone	8,760		0.0054	0.0024	0.00036					lb/ton	AP-42, Table 11.19.2-2 (08/04) Tert. Crush - unctrl.; PM2.5 Ch. 13.2.4	None	0
LS3	Primary Screening and Associated Transfers In and Out	47.08	1,130	317,907	ton	Limestone	8,760		0.025	0.0087	0.00132					lb/ton	AP-42, Table 11.19.2-2 (08/04) Screening - unctrl.; PM2.5 Ch. 13.2.4	None	0
LS4	Secondary Crushing and Associated Transfers In and Out	47.08	1,130	317,907	ton	Limestone	8,760		0.0054	0.0024	0.00036					lb/ton	AP-42, Table 11.19.2-2 (08/04) Tert. Crush - unctrl.; PM2.5 Ch. 13.2.4	None	0
LS5	Secondary Screening and Associated Transfers In and Out	47.08	1,130	317,907	ton	Limestone	8,760		0.025	0.0087	0.00132					lb/ton	AP-42, Table 11.19.2-2 (08/04) Screening - unctrl.; PM2.5 Ch. 13.2.4	None	0
LS6	Limestone transfer to Ball Mill Feed Bin	47.08	1,130	317,907	ton	Limestone	8,760		0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4	None	0
LS7	Limestone transfer to Ball Mill Feed Conveyor	47.08	1,130	317,907	ton	Limestone	8,760		0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4	None	0
LS8	Ball Mill Feed transfer to Ball Mill	47.08	1,130	317,907	ton	Limestone	8,760		0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4	None	0
LSBM	Limestone Ball Mill	47.08	1,130	317,907	ton	Limestone	8,760		0.0404	0.0339	0.0121					lb/ton	AP-42, Table 11.19.2-4 (08/04) Dry Grind. with Fabric Filter	Baghouse (BH3)	NA
LS9	Limestone transfer to Kiln Feed Bin	11.13	267	82,688	ton	Limestone	8,760		0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4	None	0
LS10	Limestone transfer to Lime Kiln Feed Conveyor	11.13	267	82,688	ton	Limestone	8,760		0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4	None	0
LS11	Fines Screening and Associated Transfers In and Out	11.13	267	82,688	ton	Limestone	8,760		0.025	0.0087	0.00132					lb/ton	AP-42, Table 11.19.2-2 (08/04) Screening - unctrl.; PM2.5 Ch. 13.2.4	None	0
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	11.13	267	82,688	ton	Limestone	8,760	(Midas Gold 2018d)	0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4	None	0
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	7.04	169	52,377	ton	Lime	8,760	(Midas Gold 2018d)	0.13	0.13	0.13	0.45	0.24	0.0012		lb/ton	AP-42 Tables 11.17-2, 6 : Gas-Fired Parallel Flow Regenetive Kiln with Fabric Filter (PM = 5x EF)	Baghouse (BH4)	NA
LKC	PFR Shaft Lime Kiln Combustion	22.04	529	163,935	MMBtu	Propane	8,760	Based on 870 kcal/kg (Maerz 2018)	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal	None	0
LCR	Lime Mill Crushing and associated transfers In and Out	7.04	169	52,377	ton	Lime	8,760		0.0404	0.0339	0.0121					lb/ton	AP-42, Table 11.19.2-4 (08/04) Dry Grind. with Fabric Filter	Baghouse (BH5)	NA
LSL	Pebble Lime Silo Loading via Bucket Elevator	7.04	169	52,377	ton	Lime	8,760		0.00088	0.00088	0.00088					lb/ton	AP-42 Table 11.17-4: Crushed Material Conveyor Transfer with Fabric Filter (PM = 10 x EF)	Bin Vent Filter	NA
LSU	Pebble Lime Silo discharge to Lime Slaker	7.04	169	52,377	ton	Lime	8,760		8.8E-05	8.8E-05	8.8E-05					lb/ton	AP-42 Table 11.17-4: Crushed Material Conveyor Transfer with Fabric Filter	Wet Scrubber (WS3)	NA
Total																			

SOURCE DESCRIPTION		TROLS	HOURLY EMISSIONS							DAILY EMISSIONS							ANNUAL EMISSIONS								
Model	Source Description	reference	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	UTM E	UTM N
ID			lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	m	m
TD9	Mine Site Diesel Tank #9								0.00167							0.0400							0.00730		
TD10	Mine Site Diesel Tank #10								0.00167							0.0400							0.00730		
PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	Control efficiency included in emission factor	0.63	0.233	0.030					15.0	5.6	0.73					2.74	1.02	0.133					632,348	4,973,429
PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	Control efficiency included in emission factor	0.625	0.2325	0.0304					15.00	5.58	0.730					2.738	1.018	0.1332					632,348	4,973,369
TRUE	LIME PRODUCTION																								
LS1	Limestone transfer to Primary Crusher Hopper		0.141	0.0518	0.0080					3.39	1.24	0.192	0	0	0	0	0.477	0.175	0.0270					632,239	4,974,256
LS2	Primary Crushing and Associated Transfers In and Out		0.254	0.113	0.0169					6.10	2.71	0.407	0	0	0	0	0.86	0.381	0.057					632,239	4,974,256
LS3	Primary Screening and Associated Transfers In and Out		1.18	0.410	0.0621					28.2	9.8	1.49	0	0	0	0	3.97	1.38	0.210					632,239	4,974,256
LS4	Secondary Crushing and Associated Transfers In and Out		0.254	0.113	0.0169					6.10	2.71	0.407	0	0	0	0	0.86	0.381	0.057					632,227	4,974,268
LS5	Secondary Screening and Associated Transfers In and Out		1.18	0.410	0.0621					28.2	9.8	1.49	0	0	0	0	3.97	1.38	0.210					632,227	4,974,268
LS6	Limestone transfer to Ball Mill Feed Bin		0.141	0.0518	0.0080					3.39	1.24	0.192	0	0	0	0	0.477	0.175	0.0270					632,181	4,974,307
LS7	Limestone transfer to Ball Mill Feed Conveyor		0.141	0.0518	0.00800					3.39	1.243	0.192	0	0	0	0	0.477	0.175	0.0270					632,181	4,974,307
LS8	Ball Mill Feed transfer to Ball Mill		0.141	0.0518	0.00800					3.39	1.243	0.192	0	0	0	0	0.477	0.175	0.0270					632,200	4,974,273
LSBM	Limestone Ball Mill	Control efficiency included in emission factor	1.902	1.5959	0.56964					45.65	38.303	13.671	0	0	0	0	6.422	5.389	1.9233					632,215	4,974,248
LS9	Limestone transfer to Kiln Feed Bin		0.033	0.0122	0.0019					0.80	0.29	0.045	0	0	0	0	0.124	0.045	0.0070					632,169	4,974,325
LS10	Limestone transfer to Lime Kiln Feed Conveyor		0.033	0.0122	0.00189					0.80	0.294	0.045	0	0	0	0	0.124	0.045	0.0070					632,169	4,974,325
LS11	Fines Screening and Associated Transfers In and Out		0.28	0.097	0.0147					6.7	2.3	0.35	0	0	0	0	1.03	0.36	0.055					632,151	4,974,314
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln		0.033	0.0122	0.00189					0.80	0.294	0.045	0	0	0	0	0.124	0.045	0.0070					632,056	4,974,285
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	Control efficiency included in emission factor	0.915	0.915	0.915	3.17	1.69	0.0085		21.97	21.97	21.97	76.05	40.6	0.203	0.00	3.40	3.40	3.40	11.8	6.29	0.0314		632,057	4,974,265
LKC	PFR Shaft Lime Kiln Combustion		0.169	0.169	0.169	1.81	3.13	0.383	0.193	4.05	4.05	4.05	43.4	75.2	9.2	4.62	0.627	0.627	0.627	6.72	11.6	1.42	0.72	632,057	4,974,265
LCR	Lime Mill Crushing and associated transfers In and Out	Control efficiency included in emission factor	0.28448	0.23871	0.08520					6.828	5.729	2.045	0	0	0	0	1.0580	0.8878	0.3169					632,073	4,974,233
LSL	Pebble Lime Silo Loading via Bucket Elevator	Control efficiency included in emission factor	6.20E-3	6.20E-3	6.20E-3					0.1487	0.1487	0.1487	0	0	0	0	0.02305	0.02305	0.02305					632,069	4,974,206
LSU	Pebble Lime Silo discharge to Lime Slaker	Control efficiency included in emission factor	6.20E-4	6.20E-4	6.20E-4					0.0149	0.0149	0.0149	0	0	0	0	0.00230	0.00230	0.00230					632,069	4,974,206
Total			**35.8**	**21.7**	**13.4**	**33.5**	**55.4**	**1.88**	**11.5**	**578**	**376**	**241**	**204**	**259**	**37.2**	**34.5**	**87.3**	**56.3**	**36.4**	**30.5**	**37.9**	**6.48**	**4.78**		

SOURCE DESCRIPTION		NAD 83 LOCATION		
Model	Source Description	reference	elev	reference
ID			m	
TD9	Mine Site Diesel Tank #9			
TD10	Mine Site Diesel Tank #10			
PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	30 m north of access road start point	2,009.0	Google Earth
PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	30 m south of access road start point	2,007.0	Google Earth
TRUE	LIME PRODUCTION			
LS1	Limestone transfer to Primary Crusher Hopper	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS2	Primary Crushing and Associated Transfers In and Out	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS3	Primary Screening and Associated Transfers In and Out	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS4	Secondary Crushing and Associated Transfers In and Out	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS5	Secondary Screening and Associated Transfers In and Out	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS6	Limestone transfer to Ball Mill Feed Bin	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS7	Limestone transfer to Ball Mill Feed Conveyor	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS8	Ball Mill Feed transfer to Ball Mill	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LSBM	Limestone Ball Mill	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS9	Limestone transfer to Kiln Feed Bin	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS10	Limestone transfer to Lime Kiln Feed Conveyor	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS11	Fines Screening and Associated Transfers In and Out	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	Drawing SK-OPTION 3b, 06/06/2018	1,984.0	Google Earth
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	Drawing SK-OPTION 3b, 06/06/2018	1,984.0	Google Earth
LKC	PFR Shaft Lime Kiln Combustion	Drawing SK-OPTION 3b, 06/06/2018	1,984.0	Google Earth
LCR	Lime Mill Crushing and associated transfers In and Out	Drawing SK-OPTION 3b, 06/06/2018	1,990.0	Google Earth
LSL	Pebble Lime Silo Loading via Bucket Elevator	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LSU	Pebble Lime Silo discharge to Lime Slaker	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
Total				

SOURCE DESCRIPTION		RELEASE PARAMETERS INPUT						
Model	Source Description	POINT	rel ht (ft)	temp (F)	flow (dscfm)	flow (acfm)	dia (ft)	reference
ID		VOLUME	rel ht (ft)	width (ft)	vert. ln (ft)	grnd ht (ft)	σz type	
TD9	Mine Site Diesel Tank #9							
TD10	Mine Site Diesel Tank #10							
PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	VOLUME	7.0	185.2	14	14	srf src	Typical portable crushing and screening plant parameters
PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	VOLUME	7.0	185.2	14.0	14.0	srf src	Typical portable crushing and screening plant parameters
TRUE	LIME PRODUCTION							
LS1	Limestone transfer to Primary Crusher Hopper	VOLUME	11.3	22.6	22.6	22.6	srf src	PC width. Height equal to width.
LS2	Primary Crushing and Associated Transfers In and Out	VOLUME	11.3	22.6	22.6	22.6	srf src	PC width. Height equal to width.
LS3	Primary Screening and Associated Transfers In and Out	VOLUME	11.3	22.6	22.6	22.6	srf src	PC width. Height equal to width.
LS4	Secondary Crushing and Associated Transfers In and Out	VOLUME	11.3	22.6	22.6	22.6	srf src	PC width. Height equal to width.
LS5	Secondary Screening and Associated Transfers In and Out	VOLUME	11.3	22.6	22.6	22.6	srf src	PC width. Height equal to width.
LS6	Limestone transfer to Ball Mill Feed Bin	POINT	29.0	Ambient		0.155	1.0	Ht - 3' above silo top; dia - 1'; vel - 0.001 m/s for horz
LS7	Limestone transfer to Ball Mill Feed Conveyor	VOLUME	3.5	1	3	5	elev src w/ bldg	1' screw discharge; 3' drop to conveyor; 5' above grade
LS8	Ball Mill Feed transfer to Ball Mill	VOLUME	28	4	4	30	elev src w/ bldg	4' x 4' opening at mid Ball Mill building height
LSBM	Limestone Ball Mill	POINT	70.0	Ambient	13,000	16,500	2.0	Ht - 10' above bldg top; Flow & Temp. - (NDEP 2010)
LS9	Limestone transfer to Kiln Feed Bin	POINT	29.0	Ambient		0.155	1.0	Ht - 3' above silo top; dia - 1'; vel - 0.001 m/s for horz
LS10	Limestone transfer to Lime Kiln Feed Conveyor	VOLUME	3.5	1	3	5	elev src w/ bldg	1' screw discharge; 3' drop to conveyor; 5' above grade
LS11	Fines Screening and Associated Transfers In and Out	VOLUME	2.5	8	5	5	srf src	8' wide screen; 5' drop; 5' above grade
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	VOLUME	68	4	4	70	elev src w/ bldg	4' x 4' opening at mid Kiln building height
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	POINT	150	350	8,000	16,300	2.0	Ht - 10' above bldg top; typical industry exhaust param
LKC	PFR Shaft Lime Kiln Combustion	POINT	150	350	8,000	16,300	2.0	Common stack with LK
LCR	Lime Mill Crushing and associated transfers In and Out	POINT	50	Ambient	2,000	2,500	0.75	Ht - 10' above bldg top; typical industry exhaust param
LSL	Pebble Lime Silo Loading via Bucket Elevator	POINT	29.0	Ambient	70	70	0.333	Ht - 3' above silo top; dia & flow from (NDEP 2019)
LSU	Pebble Lime Silo discharge to Lime Slaker	VOLUME	3.5	1	3	5	elev src w/ bldg	1' screw discharge; 3' drop to conveyor; 5' above grade
Total								

SOURCE DESCRIPTION		MODEL EMISSION RATES / RELEASE PARAMETERS														IDAPA 58.01.01.701 PM Weight Limit			
Model	Source Description	PM_{10}-24	$PM_{2.5}$-24	CO-ALL	NO_2-1	SO_2-1	SO_2-3	PM_{10}-AN	$PM_{2.5}$-AN	NO_2-AN	SO_2-AN	ht (m)	temp (K)	vel (m/s)	dia (m)	Process Weight	Allowable PM	Proposed PM	Compliance
ID		gps	gps	gps	gps	gps	gps	gps	gps	gps	gps	ht (m)	oy (m)	oz (m)		lb/hr	lb/hr	lb/hr	Demonstration
TD9	Mine Site Diesel Tank #9															-	-	-	N/A
TD10	Mine Site Diesel Tank #10															-	-	-	N/A
PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	2.93E-02	3.83E-3					2.93E-2	3.83E-3			2.1	13.13	2.0		166,667	22.23	0.63	In Compliance
PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	2.93E-02	3.83E-3					2.93E-2	3.83E-3			2.1	13.13	2.0		166,667	22.23	0.625	In Compliance
TRUE	LIME PRODUCTION																		
LS1	Limestone transfer to Primary Crusher Hopper	6.52E-03	1.01E-3					5.03E-3	7.77E-4			3.4	1.60	3.2		94,156	19.27	0.141	In Compliance
LS2	Primary Crushing and Associated Transfers In and Out	1.42E-02	2.14E-3					1.10E-2	1.65E-3			3.4	1.60	3.2		94,156	19.27	0.254	In Compliance
LS3	Primary Screening and Associated Transfers In and Out	5.16E-02	7.83E-3					3.98E-2	6.04E-3			3.4	1.60	3.2		94,156	19.27	1.18	In Compliance
LS4	Secondary Crushing and Associated Transfers In and Out	1.42E-02	2.14E-3					1.10E-2	1.65E-3			3.4	1.60	3.2		94,156	19.27	0.254	In Compliance
LS5	Secondary Screening and Associated Transfers In and Out	5.16E-02	7.83E-3					3.98E-2	6.04E-3			3.4	1.60	3.2		94,156	19.27	1.18	In Compliance
LS6	Limestone transfer to Ball Mill Feed Bin	6.52E-03	1.01E-3					5.03E-3	7.77E-4			8.8	0.00	0.0	0.305	94,156	19.27	0.141	In Compliance
LS7	Limestone transfer to Ball Mill Feed Conveyor	6.52E-03	1.01E-3					5.03E-3	7.77E-4			1.1	0.07	0.4		94,156	19.27	0.141	In Compliance
LS8	Ball Mill Feed transfer to Ball Mill	6.52E-03	1.01E-3					5.03E-3	7.77E-4			8.5	0.28	0.6		94,156	19.27	0.141	In Compliance
LSBM	Limestone Ball Mill	2.01E-01	7.18E-2					1.55E-1	5.53E-2			21.3	0.00	26.7	0.610	94,156	19.27	1.902	In Compliance
LS9	Limestone transfer to Kiln Feed Bin	1.54E-03	2.38E-4					1.31E-3	2.02E-4			8.8	0.00	0.0	0.305	22,250	13.43	0.033	In Compliance
LS10	Limestone transfer to Lime Kiln Feed Conveyor	1.54E-03	2.38E-4					1.31E-3	2.02E-4			1.1	0.07	0.4		22,250	13.43	0.033	In Compliance
LS11	Fines Screening and Associated Transfers In and Out	1.22E-02	1.85E-3					1.03E-2	1.57E-3			0.8	0.57	0.7		22,250	13.43	0.28	In Compliance
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	1.54E-03	2.38E-4					1.31E-3	2.02E-4			20.7	0.28	0.6		22,250	13.43	0.033	In Compliance
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	1.15E-01	1.15E-1	3.99E-1	2.13E-1	1.06E-3	1.06E-3	9.79E-2	9.79E-2	1.81E-1	9.04E-4	45.7	449.82	26.4	0.610	14,083	11.98	0.915	In Compliance
LKC	PFR Shaft Lime Kiln Combustion	2.12E-02	2.12E-2	2.28E-1	3.95E-1	4.83E-2	4.83E-2	1.80E-2	1.80E-2	3.35E-1	4.10E-2	45.7	449.82	26.4	0.610	-	-	0.169	N/A
LCR	Lime Mill Crushing and associated transfers In and Out	3.01E-02	1.07E-2					2.55E-2	9.12E-3			15.2	0.00	28.7	0.229	14,083	11.98	0.28448	In Compliance
LSL	Pebble Lime Silo Loading via Bucket Elevator	7.81E-04	7.81E-4					6.63E-4	6.63E-4			8.8	0.00	4.1	0.102	14,083	11.98	6.20E-3	In Compliance
LSU	Pebble Lime Silo discharge to Lime Slaker	7.81E-05	7.81E-5					6.63E-5	6.63E-5			1.1	0.07	0.4		14,083	11.98	6.20E-4	In Compliance
Total		1.97	1.26	4.22	1.48	0.237	0.237	1.62	1.046	1.09	0.186								

prop-lb/hr prop-ton/yr dies-lb/hr dies-ton/yr mpro-lb/hr mpro-ton/yr total-lb/hr total-lb/yr total-ton/yr

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary

		Emissions										
		Propane Combustion		Diesel Combustion		Material Processing		Total[1]				
CAS	HAP/TAP	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	lb/yr	ton/yr	HAP	TAP
106-99-0	1,3-Butadiene	--	--	7.34E-5	3.67E-6	--	--	7.34E-5	7.34E-3	3.67E-6	Y	Y
91-57-6	2-Methylnaphthalene	1.59E-6	4.85E-6	--	--	--	--	1.59E-6	9.71E-3	4.85E-6	Y	N
56-49-5	3-Methylchloranthrene	1.19E-7	3.64E-7	--	--	--	--	1.19E-7	7.28E-4	3.64E-7	Y	Y
57-97-6	7,12-Dimethylbenz(a)anthracene	1.06E-6	3.24E-6	--	--	--	--	1.06E-6	6.47E-3	3.24E-6	Y	N
83-32-9	Acenaphthene	1.19E-7	3.64E-7	1.34E-4	6.72E-6	--	--	1.35E-4	1.42E-2	7.09E-6	Y	N
208-96-8	Acenaphthylene	1.19E-7	3.64E-7	2.69E-4	1.35E-5	--	--	2.70E-4	2.77E-2	1.38E-5	Y	N
75-07-0	Acetaldehyde	--	--	2.15E-3	1.07E-4	--	--	2.15E-3	2.15E-1	1.07E-4	Y	Y
107-02-8	Acrolein	--	--	3.96E-4	1.98E-5	--	--	3.96E-4	3.96E-2	1.98E-5	Y	Y
120-12-7	Anthracene	1.59E-7	4.85E-7	3.81E-5	1.91E-6	--	--	3.83E-5	4.79E-3	2.39E-6	Y	N
7440-36-0	Antimony	--	--	--	--	6.86E-2	3.00E-1	6.86E-2	6.01E+2	3.00E-1	Y	Y
7440-38-2	Arsenic	1.32E-5	4.04E-5	--	--	4.36E-3	1.75E-2	4.37E-3	3.52E+1	1.76E-2	Y	Y
56-55-3	Benz(a)anthracene	1.19E-7	3.64E-7	2.07E-5	1.03E-6	--	--	2.08E-5	2.80E-3	1.40E-6	Y	N
71-43-2	Benzene	1.39E-4	4.25E-4	2.36E-2	1.18E-3	--	--	2.37E-2	3.21E+0	1.60E-3	Y	Y
50-32-8	Benzo(a)pyrene	7.93E-8	2.43E-7	7.59E-6	3.80E-7	--	--	7.67E-6	1.24E-3	6.22E-7	Y	Y
205-99-2	Benzo(b)fluoranthene	1.19E-7	3.64E-7	3.14E-5	1.57E-6	--	--	3.16E-5	3.87E-3	1.94E-6	Y	N
191-24-2	Benzo(g,h,i)perylene	7.93E-8	2.43E-7	1.66E-5	8.29E-7	--	--	1.67E-5	2.14E-3	1.07E-6	Y	N
207-08-9	Benzo(k)fluoranthene	1.19E-7	3.64E-7	6.43E-6	3.22E-7	--	--	6.55E-6	1.37E-3	6.86E-7	Y	N
7440-41-7	Beryllium	7.93E-7	2.43E-6	--	--	2.17E-5	8.35E-5	2.25E-5	1.72E-1	8.59E-5	Y	Y
7440-43-9	Cadmium	7.26E-5	2.22E-4	--	--	4.06E-5	2.73E-5	1.13E-4	4.99E-1	2.50E-4	Y	Y
75-15-0	Carbon disulfide	--	--	--	--	1.45E-2	6.33E-2	1.45E-2	1.27E+2	6.33E-2	Y	Y
7440-47-3	Chromium	9.25E-5	2.83E-4	--	--	1.22E-4	2.90E-4	2.14E-4	1.15E+0	5.73E-4	Y	Y
218-01-9	Chrysene	1.19E-7	3.64E-7	4.37E-5	2.19E-6	--	--	4.39E-5	5.10E-3	2.55E-6	Y	N
7440-48-4	Cobalt	5.55E-6	1.70E-5	--	--	2.35E-5	1.03E-4	2.91E-5	2.40E-1	1.20E-4	Y	Y
592-01-8	Cyanide	--	--	--	--	2.22E-1	9.73E-1	2.22E-1	1.95E+3	**9.73E-1**	Y	Y
53-70-3	Dibenz(a,h)anthracene	7.93E-8	2.43E-7	1.08E-5	5.42E-7	--	--	1.09E-5	1.57E-3	7.85E-7	Y	N
106-46-7	Dichlorobenzene	7.93E-5	2.43E-4	--	--	--	--	7.93E-5	4.85E-1	2.43E-4	Y	Y
206-44-0	Fluoranthene	1.98E-7	6.07E-7	1.28E-4	6.39E-6	--	--	1.28E-4	1.40E-2	7.00E-6	Y	N
86-73-7	Fluorene	1.85E-7	5.66E-7	4.15E-4	2.08E-5	--	--	4.15E-4	4.27E-2	2.13E-5	Y	N
50-00-0	Formaldehyde	4.95E-3	1.52E-2	4.44E-3	2.22E-4	--	--	9.39E-3	3.08E+1	1.54E-2	Y	Y
110-54-3	Hexane	1.19E-1	3.64E-1	--	--	--	--	1.19E-1	7.28E+2	3.64E-1	Y	Y
193-39-5	Indeno(1,2,3-cd)pyrene	1.19E-7	3.64E-7	1.24E-5	6.18E-7	--	--	1.25E-5	1.96E-3	9.82E-7	Y	N
7439-92-1	Lead	--	--	--	--	1.72E-4	2.62E-4	1.72E-4	5.23E-1	2.62E-4	Y	N
7439-96-5	Manganese	2.51E-5	7.69E-5	--	--	3.53E-2	2.17E-2	3.53E-2	4.35E+1	2.17E-2	Y	Y
7439-97-6	Mercury	1.72E-5	5.26E-5	--	--	5.13E-3	1.24E-2	5.15E-3	2.49E+1	1.24E-2	Y	N
91-20-3	Naphthalene	4.03E-5	1.23E-4	3.82E-3	1.91E-4	--	--	3.86E-3	6.29E-1	3.14E-4	Y	Y
7440-02-0	Nickel	1.39E-4	4.25E-4	--	--	2.89E-3	1.21E-3	3.03E-3	3.26E+0	1.63E-3	Y	Y
85-01-8	Phenanthrene	1.12E-6	3.44E-6	1.20E-3	6.02E-5	--	--	1.21E-3	1.27E-1	6.36E-5	Y	N
7723-14-0	Phosphorus	--	--	--	--	6.12E-3	1.81E-2	6.12E-3	3.61E+1	1.81E-2	Y	Y
129-00-0	Pyrene	3.30E-7	1.01E-6	1.13E-4	5.67E-6	--	--	1.14E-4	1.34E-2	6.68E-6	Y	N
7782-49-2	Selenium	1.59E-6	4.85E-6	--	--	--	--	1.59E-6	9.71E-3	4.85E-6	Y	Y
108-88-3	Toluene	2.25E-4	6.88E-4	8.68E-3	4.34E-4	--	--	8.91E-3	2.24E+0	1.12E-3	Y	Y
1330-20-7	Xylene	--	--	5.97E-3	2.99E-4	--	--	5.97E-3	5.97E-1	2.99E-4	Y	Y
Total HAP		1.25E-1	3.82E-1	5.16E-2	2.58E-3	3.59E-1	1.41E+0	5.36E-1	3.59E+3	1.79E+0		

[1] *Includes autoclave and refinery source mercury emissions provided on page 10.*

TRUE

prop-lb/hr prop-ton/yr dies-lb/hr dies-ton/yr mpro-lb/hr mpro-ton/yr total-lb/hr total-lb/yr total-ton/yr

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary - continue

		Emissions										
		Propane Combustion		Diesel Combustion		Material Processing [1]		Total				
CAS	Non-HAP TAP	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	lb/yr	ton/yr	HAP	TAP
7440-39-3	Barium	2.91E-4	8.90E-4	--	--	4.71E-3	2.06E-2	5.00E-3	4.30E+1	2.15E-2	N	Y
7440-50-8	Copper	5.61E-5	1.72E-4	--	--	2.94E-5	1.29E-4	8.55E-5	6.01E-1	3.01E-4	N	Y
7783-06-4	Hydrogen Sulfide	--	--	--	--	0.900	3.942	0.900	7,884	3.942	N	Y
7439-98-7	Molybdenum	7.26E-5	2.22E-4	--	--	5.88E-6	2.58E-5	7.85E-5	4.96E-1	2.48E-4	N	Y
109-66-0	Pentane	1.72E-1	5.26E-1	--	--	--	--	1.72E-1	1.05E+3	5.26E-1	N	Y
7440-22-4	Silver	--	--	--	--	2.94E-6	1.29E-5	2.94E-6	2.58E-2	1.29E-5	N	Y
7664-93-9	Sulfuric Acid	--	--	--	--	2.030	8.891	2.030	17,783	8.891	N	Y
7440-28-0	Thallium	--	--	--	--	5.88E-5	2.58E-4	5.88E-5	5.15E-1	2.58E-4	N	Y
7440-61-1	Uranium	--	--	--	--	5.88E-5	2.58E-4	5.88E-5	5.15E-1	2.58E-4	N	Y
7440-62-2	Vanadium	1.52E-4	4.65E-4	--	--	--	--	1.52E-4	9.30E-1	4.65E-4	N	Y
7440-66-6	Zinc	1.92E-3	5.86E-3	--	--	--	--	1.92E-3	1.17E+1	5.86E-3	N	Y
Total Non-HAP TAP		1.74E-1	5.33E-1	--	--	2.93E+0	1.29E+1	3.11	26,776.27	13.39		

[1] *Material Processing includes Autoclave and Cement Handling and Mixing.*

GHG Emissions Summary

Source Category	CO2e *(ton/yr)*
Propane Combustion	28,708
Diesel Combustion	246
Autoclaving	47,316
Lime Kiln	30,311
Total GHGs	**106,580**

GHG and Emission Summary by Source

ID Description CO2e_tpy

Source ID	Description	CO2e ton/yr
Sb1	Sb Dryer (2.72 MMBtu/hr Propane-Fired)	1,658
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	35
CKB	Carbon Regeneration Kiln (Burners)	1,375
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	61
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	3,048
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	2,438
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	2,438
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	2,438
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	152
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	152
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	152
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	305
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	1,219
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	1,829
LKC	PFR Shaft Lime Kiln Combustion	11,407
EDG1	Camp Emergency Generator	77
EDG2	Plant Emergency Generator #1	77
EDG3	Plant Emergency Generator #2	77
EDFP	Mill Fire Pump	15
AC	Autoclave	47,316
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	30,311
Total		106,580

PROPANE COMBUSTION

GHG EMISSIONS

Propane GHG Emission Factors:

		Global Warming Potential*	Reference
CO2	62.87 *kg/MMBtu*	1	*40 CFR Part 98, Table C-1 to Subpart C (11/2013) Propane (CFR 2018c)*
CH4	3.0E-03 *kg/MMBtu*	25	*40 CFR Part 98, Table C-2 to Subpart C (11/2013) Petroleum (CFR 2018c)*
N2O	6.0E-04 *kg/MMBtu*	298	*40 CFR Part 98, Table C-2 to Subpart C (11/2013) Petroleum (CFR 2018c)*

** 40 CFR 98, Table A-1 (12/2014) (CFR 2018c)*

					CO2_tpy	CH4_tpy	N2O_tpy	CO2e_tpy
					CO2	CH4	N2O	CO2e
Source ID	**Description**	MMBtu/hr	hr/yr	MMBtu/yr	ton/yr	ton/yr	ton/yr	ton/yr
Sb1	Sb Dryer (2.72 MMBtu/hr Propane-Fired)	2.7	8,760	23,827	1,651	7.88E-2	1.58E-2	1,658
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	17.0	30	510	35	1.69E-3	3.37E-4	35
CKB	Carbon Regeneration Kiln (Burners)	2.3	8,760	19,754	1,369	6.53E-2	1.31E-2	1,375
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0.1	8,760	876	61	2.90E-3	5.79E-4	61
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	5.0	8,760	43,800	3,035	1.45E-1	2.90E-2	3,048
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	4.0	8,760	35,040	2,428	1.16E-1	2.32E-2	2,438
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	4.0	8,760	35,040	2,428	1.16E-1	2.32E-2	2,438
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	4.0	8,760	35,040	2,428	1.16E-1	2.32E-2	2,438
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0.3	8,760	2,190	152	7.24E-3	1.45E-3	152
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0.3	8,760	2,190	152	7.24E-3	1.45E-3	152
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0.3	8,760	2,190	152	7.24E-3	1.45E-3	152
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0.5	8,760	4,380	304	1.45E-2	2.90E-3	305
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	2.0	8,760	17,520	1,214	5.79E-2	1.16E-2	1,219
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	3.0	8,760	26,280	1,821	8.69E-2	1.74E-2	1,829
LKC	PFR Shaft Lime Kiln Combustion	22.0	8,760	163,935	11,361	5.42E-1	1.08E-1	11,407
Total		67.4		412,572	28,592	1.36	0.27	28,708

**Propane heating value* 91,500 *Btu/gal*

Conversions

2,000	lb/ton	1.341	hp/kW
907.18582	kg/ton	1E+6	Btu/MMBtu

PROPANE COMBUSTION - CONTINUED

HAP/TAP Emissions - Propane Heaters

		Emission Factor*		Emissions	
CAS	**Pollutant**	lb/MMScf	lb/MMBtu**	lb/hr	ton/yr
91-57-6	2-Methylnaphthalene	2.4E-05	2.35E-8	1.6E-6	4.9E-6
56-49-5	3-Methylchloranthrene	< 1.8E-06	1.76E-9	1.2E-7	3.6E-7
57-97-6	7,12-Dimethylbenz(a)anthracene	< 1.6E-05	1.57E-8	1.1E-6	3.2E-6
83-32-9	Acenaphthene	< 1.8E-06	1.76E-9	1.2E-7	3.6E-7
208-96-8	Acenaphthylene	< 1.8E-06	1.76E-9	1.2E-7	3.6E-7
120-12-7	Anthracene	< 2.4E-06	2.35E-9	1.6E-7	4.9E-7
7440-38-2	Arsenic	2.0E-04	1.96E-7	1.3E-5	4.0E-5
56-55-3	Benz(a)anthracene	< 1.8E-06	1.76E-9	1.2E-7	3.6E-7
71-43-2	Benzene	2.1E-03	2.06E-6	1.4E-4	4.2E-4
50-32-8	Benzo(a)pyrene	< 1.2E-06	1.18E-9	7.9E-8	2.4E-7
205-99-2	Benzo(b)fluoranthene	< 1.8E-06	1.76E-9	1.2E-7	3.6E-7
191-24-2	Benzo(g,h,i)perylene	< 1.2E-06	1.18E-9	7.9E-8	2.4E-7
207-08-9	Benzo(k)fluoranthene	< 1.8E-06	1.76E-9	1.2E-7	3.6E-7
7440-41-7	Beryllium	< 1.2E-05	1.18E-8	7.9E-7	2.4E-6
7440-43-9	Cadmium	1.1E-03	1.08E-6	7.3E-5	2.2E-4
7440-47-3	Chromium	1.4E-03	1.37E-6	9.2E-5	2.8E-4
218-01-9	Chrysene	< 1.8E-06	1.76E-9	1.2E-7	3.6E-7
7440-48-4	Cobalt	8.4E-05	8.24E-8	5.5E-6	1.7E-5
53-70-3	Dibenz(a,h)anthracene	< 1.2E-06	1.18E-9	7.9E-8	2.4E-7
106-46-7	Dichlorobenzene	1.2E-03	1.18E-6	7.9E-5	2.4E-4
206-44-0	Fluoranthene	3.0E-06	2.94E-9	2.0E-7	6.1E-7
86-73-7	Fluorene	2.8E-06	2.75E-9	1.8E-7	5.7E-7
50-00-0	Formaldehyde	7.5E-02	7.35E-5	5.0E-3	1.5E-2
110-54-3	Hexane	1.8E+00	1.76E-3	0.12	0.36
193-39-5	Indeno(1,2,3-cd)pyrene	< 1.8E-06	1.76E-9	1.2E-7	3.6E-7
7439-96-5	Manganese	3.8E-04	3.73E-7	2.5E-5	7.7E-5
7439-97-6	Mercury	2.6E-04	2.55E-7	1.7E-5	5.3E-5
91-20-3	Naphthalene	6.1E-04	5.98E-7	4.0E-5	1.2E-4
7440-02-0	Nickel	2.1E-03	2.06E-6	1.4E-4	4.2E-4
85-01-8	Phenanthrene	1.7E-05	1.67E-8	1.1E-6	3.4E-6
129-00-0	Pyrene	5.0E-06	4.90E-9	3.3E-7	1.0E-6
7782-49-2	Selenium	< 2.4E-05	2.35E-8	1.6E-6	4.9E-6
108-88-3	Toluene	3.4E-03	3.33E-6	2.2E-4	6.9E-4
Total HAP				0.12	0.38
Non-HAP TAP Emissions - Propane Heaters					
109-66-0	Pentane	2.6E+00	2.55E-3	0.17	0.53
7440-39-3	Barium	4.4E-03	4.31E-6	2.9E-4	8.9E-4
7440-50-8	Copper	8.5E-04	8.33E-7	5.6E-5	1.7E-4
7439-98-7	Molybdenum	1.1E-03	1.08E-6	7.3E-5	2.2E-4
7440-62-2	Vanadium	2.3E-03	2.25E-6	1.5E-4	4.7E-4
7440-66-6	Zinc	2.9E-02	2.84E-5	1.9E-3	5.9E-3
Total Non-HAP TAP				0.17	0.53

**AP-42, Table 1.4-3 & 1.4-4 (7/98) Natural Gas Combustion*

***Natural Gas Higher Heating Value* 1,020 *MMBtu/MMScf*

DIESEL COMBUSTION

GHG EMISSIONS

Diesel CO2e Emission Factors:

		Global Warming Potential*	References
CO2	73.96 *kg CO_2/MMBtu*	1	*40 CFR Part 98, Table C-1 to Subpart C (11/2013) No.2*
CH4	3.0E-03 *kg CH_4/MMBtu*	25	*40 CFR Part 98, Table C-2 to Subpart C (11/2013) Petroleum*
N2O	6.0E-04 *kg N_2O/MMBtu*	298	*40 CFR Part 98, Table C-2 to Subpart C (11/2013) Petroleum*

** 40 CFR 98, Table A-1 (CFR 2018c)*

Source Data

		Power Rating		Operation	Fuel Consumption		CO2_tpy	CH4_tpy	N2O_tpy	CO2e_tpy
Source ID	Description	kW	hp	hr/yr	MMBtu/hr*	MMBtu/yr	CO2 ton/yr	CH4 ton/yr	N2O ton/yr	CO2e ton/yr
EDG1	Camp Emergency Generator	1,000	1,341	100	9.39	938.7	76.53	3.10E-3	6.21E-4	76.79
EDG2	Plant Emergency Generator #1	1,000	1,341	100	9.39	938.7	76.53	3.10E-3	6.21E-4	76.79
EDG3	Plant Emergency Generator #2	1,000	1,341	100	9.39	938.7	76.53	3.10E-3	6.21E-4	76.79
EDFP	Mill Fire Pump	200	268	100	1.88	187.7	15.31	6.21E-4	1.24E-4	15.36
Total					30.0	3,003.8	244.89	9.93E-3	1.99E-3	245.73

** Based on brake specific fuel consumption for diesel generators* 7,000 *Btu/hp-hr* *AP-42 Tbl 3.3-1*

*** Heat Content of* 0.137 *MMBtu/gal*

HAP Emissions - Diesel Engines

		Emission Factor (lb/MMBtu)		Emissions (≤600 hp)		Emissions (>600 hp)		Emissions (Total)		lb/hr	ton/yr
	Pollutant	≤600 hp*	>600hp**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr		
106-99-0	1,3-Butadiene	3.91E-5		7.34E-5	3.67E-6	0.00E+0	0.00E+0	7.34E-5	3.67E-6		
83-32-9	Acenaphthene	1.42E-6	4.68E-6	2.67E-6	1.33E-7	1.32E-4	6.59E-6	1.34E-4	6.72E-6		
208-96-8	Acenaphthylene	5.06E-6	9.23E-6	9.50E-6	4.75E-7	2.60E-4	1.30E-5	2.69E-4	1.35E-5		
75-07-0	Acetaldehyde	7.67E-4	2.52E-5	1.44E-3	7.20E-5	7.10E-4	3.55E-5	2.15E-3	1.07E-4		
107-02-8	Acrolein	9.25E-5	7.88E-6	1.74E-4	8.68E-6	2.22E-4	1.11E-5	3.96E-4	1.98E-5		
120-12-7	Anthracene	1.87E-6	1.23E-6	3.51E-6	1.76E-7	3.46E-5	1.73E-6	3.81E-5	1.91E-6		
56-55-3	Benz(a)anthracene	1.68E-6	6.22E-7	3.15E-6	1.58E-7	1.75E-5	8.76E-7	2.07E-5	1.03E-6		
71-43-2	Benzene	9.33E-4	7.76E-4	1.75E-3	8.76E-5	2.19E-2	1.09E-3	2.36E-2	1.18E-3		
50-32-8	Benzo(a)pyrene	1.88E-7	2.57E-7	3.53E-7	1.76E-8	7.24E-6	3.62E-7	7.59E-6	3.80E-7		
205-99-2	Benzo(b)fluoranthene	9.91E-8	1.11E-6	1.86E-7	9.30E-9	3.13E-5	1.56E-6	3.14E-5	1.57E-6		
191-24-2	Benzo(g,h,i)perylene	4.89E-7	5.56E-7	9.18E-7	4.59E-8	1.57E-5	7.83E-7	1.66E-5	8.29E-7		
207-08-9	Benzo(k)fluoranthene	1.55E-7	2.18E-7	2.91E-7	1.45E-8	6.14E-6	3.07E-7	6.43E-6	3.22E-7		
218-01-9	Chrysene	3.53E-7	1.53E-6	6.63E-7	3.31E-8	4.31E-5	2.15E-6	4.37E-5	2.19E-6		
53-70-3	Dibenz(a,h)anthracene	5.83E-7	3.46E-7	1.09E-6	5.47E-8	9.74E-6	4.87E-7	1.08E-5	5.42E-7		
206-44-0	Fluoranthene	7.61E-6	4.03E-6	1.43E-5	7.14E-7	1.13E-4	5.67E-6	1.28E-4	6.39E-6		
86-73-7	Fluorene	2.92E-5	1.28E-5	5.48E-5	2.74E-6	3.60E-4	1.80E-5	4.15E-4	2.08E-5		
50-00-0	Formaldehyde	1.18E-3	7.89E-5	2.22E-3	1.11E-4	2.22E-3	1.11E-4	4.44E-3	2.22E-4		
193-39-5	Indeno(1,2,3-cd)pyrene	3.75E-7	4.14E-7	7.04E-7	3.52E-8	1.17E-5	5.83E-7	1.24E-5	6.18E-7		
91-20-3	Naphthalene	8.48E-5	1.30E-4	1.59E-4	7.96E-6	3.66E-3	1.83E-4	3.82E-3	1.91E-4		
85-01-8	Phenanthrene	2.94E-5	4.08E-5	5.52E-5	2.76E-6	1.15E-3	5.74E-5	1.20E-3	6.02E-5		
129-00-0	Pyrene	4.78E-6	3.71E-6	8.97E-6	4.49E-7	1.04E-4	5.22E-6	1.13E-4	5.67E-6		
108-88-3	Toluene	4.09E-4	2.81E-4	7.68E-4	3.84E-5	7.91E-3	3.96E-4	8.68E-3	4.34E-4		
1330-20-7	Xylene	2.85E-4	1.93E-4	5.35E-4	2.68E-5	5.44E-3	2.72E-4	5.97E-3	2.99E-4		
Total HAP				7.27E-3	3.64E-4	4.43E-2	2.22E-3	5.16E-2	2.58E-3		
										TRUE	TRUE

**AP-42, Tab. 3.3-2, 10/96, diesel engines (≤ 600 hp)*

***AP-42, Tabs. 3.4-3 & 3.4-4, 10/96, large diesel engines (> 600 hp)*

AUTOCLAVE CO_2 EMISSIONS

CO2 Emissions

		Operation	CO2 Emissions	
Source ID	**Description**	hr/yr	ton/hr*	ton/yr
AC	Autoclave	8,760	5.40	47,316

**Per M3 Engineering, 10/11/2017; based on ore feed carbonate values and conservatively assuming limestone for neutralization. (M3 2017c)*

LIME KILN CO_2 EMISSIONS

CO2 Emissions

		Operation	Feed	Product	Mass Loss	CO2
Source ID	**Description**	hr/yr	ton/yr	ton/yr	ton/yr	ton/yr
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	8,760	82,688	52,377	30,311	30,311

PRI00000528

REC 1868

MATERIAL PROCESSING HAP/TAP EMISSIONS

Cement Handling

Source ID	Description	Throughput ton/hr	ton/yr	Activity
CS1L	Cement/Shotcrete Silo #1 Loading	80	60,000	Cement Handling
CS2L	Cement/Shotcrete Silo #2 Loading	80	60,000	Cement Handling
CM	Central Mixer Loading	20	60,000.00	Cement Mixer

Activity Information

Activity	Material Processed	Throughput ton/hr	ton/yr
Cement Handling	Cement	160	120,000
Cement Mixer	Cement	20	60,000

Cement Handlir Cement Mixer

HAP/TAP Emission Factors and Emissions

lb/hr ton/yr

CAS No.	HAP/TAP	(1) lb/ton	(2) lb/ton	Cement Handling lb/hr	Cement Handling ton/yr	Cement Mixer lb/hr	Cement Mixer ton/yr	Total lb/hr	Total ton/yr
7440-38-2	Arsenic	1.68E-06	8.38E-06	2.69E-4	1.01E-4	1.68E-4	2.51E-4	4.36E-4	3.52E-4
7440-41-7	Beryllium	1.79E-08		2.86E-6	1.07E-6	--	--	2.86E-6	1.07E-6
7440-43-9	Cadmium	2.34E-07	1.18E-08	3.74E-5	1.40E-5	2.36E-7	3.54E-7	3.77E-5	1.44E-5
7440-47-3	Chromium	2.52E-07	1.42E-06	4.03E-5	1.51E-5	2.84E-5	4.26E-5	6.87E-5	5.77E-5
7439-92-1	Lead	7.36E-07	3.82E-07	1.18E-4	4.42E-5	7.64E-6	1.15E-5	1.25E-4	5.56E-5
7439-96-5	Manganese	2.02E-04	6.12E-05	3.23E-2	1.21E-2	1.22E-3	1.84E-3	3.35E-2	1.40E-2
7440-02-0	Nickel	1.76E-05	3.28E-06	2.82E-3	1.06E-3	6.56E-5	9.84E-5	2.88E-3	1.15E-3
7723-14-0	Phosphorus	1.18E-05	2.02E-05	1.89E-3	7.08E-4	4.04E-4	6.06E-4	2.29E-3	1.31E-3
Total HAP								3.94E-2	1.69E-2

(1) *Cement Handling - AP-42, Table 11.12-8, (06/06) Cement Silo Filing, Uncontrolled.*

(2) *Cement Mixer - AP-42, Table 11.12-8, (06/06) Central Mix Batching, Uncontrolled.*

Autoclave Non-HAP TAP Emissions

CAS No.	Pollutant	Throughpu ton/hr	Operation hr/yr	Emission Factor		Emissions lb/hr	Emissions ton/yr
7664-93-9	Sulfuric Acid	290	8,760	0.007	lb/ton(1)	2.03	8.9
7783-06-4	Hydrogen Sulfide		8,760	0.9	lb/hr(2)	0.9	3.9

(1) *H2SO4 is based on Acidic Autoclave test data (APT 2010)*

(2) *H2S is based on Acidic Autoclave test data (APT 2013)*

Conversions

2,000 lb/ton

MATERIAL PROCESSING HAP/TAP EMISSIONS

Ore Processing PM Emissions 5.9 lb/hr
25.8 ton/yr

Ore Dust HAP Concentrations[1] and Emissions

		Concentration	Emissions	
CAS No.	Pollutant	ppm	lb/hr	ton/yr
7440-38-2	Arsenic	667	0.003923	0.0172
7440-41-7	Beryllium	3.2	0.000019	0.0001
7440-43-9	Cadmium	0.5	0.000003	0.00001
7440-48-4	Cobalt	4	0.000024	0.0001
7440-47-3	Chromium	9	0.000053	0.0002
7439-97-6	Mercury	0.96	0.000006	0.00002
7439-96-5	Manganese	299	0.001759	0.0077
7440-02-0	Nickel	2	0.000012	0.0001
7439-92-1	Lead	8	0.000047	0.0002
7440-36-0	Antimony	23	0.000135	0.0006
7723-14-0	Phosphorus	650	0.003823	0.0167
Dust HAP Total			0.009803	0.0429

[1] *(Midas Gold 2017c)*

Ore Dust Non-HAP TAP Concentrations[1] and Emissions

		Concentration	Emissions	
CAS No.	Pollutant	ppm	lb/hr	ton/yr
7440-22-4	Silver	0.5	0.000003	0.00001
7440-39-3	Barium	800	0.004705	0.0206
7440-50-8	Copper	5	0.000029	0.0001
7439-98-7	Molybdenum	1	0.000006	0.00003
7440-28-0	Thallium	10	0.000059	0.00026
7440-61-1	Uranium	10	0.000059	0.0003
Dust HAP Total			0.004861	0.0213

[1] *(Midas Gold 2017c)*

Sb Concentrate Processing PM Emissions 0.12 lb/hr
0.52 ton/yr

Stib. Conc.

Sb Concentrate Dust Non-HAP TAP Concentrations[1] and Emissions

		Concentration	Emissions	
CAS No.	Pollutant	ppm	lb/hr	ton/yr
7440-36-0	Antimony	580,000	0.0684	0.2998

[1] *(Midas Gold 2019d)*

Carbon Disulfide Emissions from Xanthate Decomposition

		Xanthate[1]	Molar	CS_2 MW	Temperature	Emissions	
CAS No.	Pollutant	ton/yr	Decomp.[2]	Ratio	Adj. Factor[3]	lb/hr	ton/yr
75-15-0	Carbon Disulfide	1,700	0.99%	0.376	0.01	0.0145	0.063

[1] *(Midas Gold 2016) p. 12-11*

[2] *(Air Sciences 2020) molar decomposition of of xanthate in solution to CS2 gas*

[3] *(Air Sciences 2020) based on the comparison of CS2 generation at 50C and 70C*

Conversions			MW	
2,000	lb/ton	Xanthate (PAX)	202.37	$C_6H_{11}KOS_2$
8,760	hr/yr	Carbon difulfide	76.139	CS_2

MATERIAL PROCESSING HAP/TAP EMISSIONS

Lead Emission by Source

	Source ID	Description	TRUE Pb_tpy Pb ton/yr
	CS1L	Cement/Shotcrete Silo #1 Loading	2.21E-5
	CS2L	Cement/Shotcrete Silo #2 Loading	2.21E-5
	CM	Central Mixer Loading	1.15E-5
1	OC1	Loader Transfer of Ore to Grizzly	5.11E-6
1	OC2	Grizzly to Apron Feeder	5.11E-6
1	OC3	Apron Feeder to Dribble Conveyor	5.11E-6
1	OC4	Apron Feeder to Vibrating Grizzly	5.11E-6
1	OC5	Dribble Conveyor to Vibrating Grizzly	5.11E-6
1	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	5.11E-6
5	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	4.38E-5
1	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	5.11E-6
3	OC9	Stockpile Transfers to Reclaim Conveyors	2.42E-5
3	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	2.42E-5
3	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	2.42E-5
6	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	4.84E-5
1	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	5.64E-6
	Total		2.62E-4

Cyanide Emissions from Mill Process Tanks, Carbon Stripping and Electrowinning Process

CAS No.	Source	Dia. ft	pH	Free CN- g/m3	T C	pKa	a0	H	kG m/s	Fa*Fw	g/s	lb/hr	ton/yr
592-01-8	CN Detox Tank 1	40	8.5	25	25	9.250	0.8490	0.0055	0.000311	0.688	0.00289	0.0229	0.101
592-01-8	CN Detox Tank 2	40	8.5	25	25	9.250	0.8490	0.0055	0.000311	0.688	0.00289	0.0229	0.101
592-01-8	CIP Leach Tank 1	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.00143	0.0114	0.050
592-01-8	CIP Leach Tank 2	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.00143	0.0114	0.050
592-01-8	CIP Leach Tank 3	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.00143	0.0114	0.050
592-01-8	CIP Leach Tank 4	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.00143	0.0114	0.050
592-01-8	CIL Tank 1	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.00248	0.0197	0.086
592-01-8	CIL Tank 2	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.00248	0.0197	0.086
592-01-8	CIL Tank 3	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.00248	0.0197	0.086
592-01-8	CIL Tank 4	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.00248	0.0197	0.086
592-01-8	CIL Tank 5	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.00248	0.0197	0.086
592-01-8	CIL Tank 6	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.00248	0.0197	0.086
592-01-8	CIP Tank 1	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.00024	0.0019	0.008
592-01-8	CIP Tank 2	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.00024	0.0019	0.008
592-01-8	CIP Tank 3	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.00024	0.0019	0.008
592-01-8	CIP Tank 4	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.00024	0.0019	0.008
592-01-8	CIP Tank 5	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.00024	0.0019	0.008
592-01-8	CIP Tank 6	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.00024	0.0019	0.008
592-01-8	EW Cells											0.0006	0.003
592-01-8	Preg/Barren Tanks											0.0006	0.003
												0.222	0.973

References for Open Leach and Detox Tanks emission calculations: (Card, T. 2009)(EPA 2009)(Schmidt 2010)

Reference for EW Cells and Preg/Barren Tanks emission factor: (APT 2009)

Conversions

8,760	hr/yr	453.5929 g/lb	Wind adjustment factor Fw	1
2,000	lb/ton	3.28084 ft/m		
		3,600 s/hr		

40 CFR 63 Subpart 7E MERCURY SOURCES

Mercury Emissions

Description	Subpart 7E Hg Emissions ton/yr	Oper. hr/yr	% of Subpart 7E for Controlled Systems* %	Controlled Hg Emissions* lb/hr	lb/yr	ton/yr
Autoclave **	0.107	8,760	10.0%	0.002	21.34	0.011
Refinery Sources (Kiln, EW, Retort, Furnace)	0.008	1,248	20.0%	0.003	3.36	0.002
Total 7439-97-6	0.115			0.005	24.70	0.012

**Based on Similar Source Hg Reporting Levels provided below*

***Expected actual emissions from Autoclave:* 0.0105 g/hr 2.3E-05 lb/hr 0.20 lb/yr *(M3 2019)*

Subpart 7E Limit - Ore Pretreatment Processes *(CFR 2018b)*

$$\frac{84 \text{ lb}}{\text{MMton}} \times \frac{2{,}540{,}400 \text{ ton}}{\text{yr}} \times \frac{\text{MMton}}{1.0\text{E+6 ton}} = \frac{213.39 \text{ lb}}{\text{yr}}$$

Subpart 7E Limit - Carbon Processes with Mercury Retorts

$$\frac{0.8 \text{ lb}}{\text{ton}} \times \frac{21 \text{ ton}}{\text{yr}} = \frac{16.8 \text{ lb}}{\text{yr}}$$

Similar Source Hg Reporting Levels

Goldstrike Autoclaves 2 & 3 (2015 & 2016 Hg Reports) *(NDEP 2015a) (NDEP 2016)*

$$\frac{28.79 \text{ lb}}{\text{yr}} \times \frac{\text{yr}}{3.13 \text{ MMton}} = \frac{9.18 \text{ lb}}{\text{MMton}} \times \frac{\text{MMton}}{84 \text{ lb}} = 10.9\%$$

Twin Creeks Autoclaves 1 & 2 (2015 & 2016 Hg Reports) *(NDEP 2015a) (NDEP 2016)*

$$\frac{1.01 \text{ lb}}{\text{yr}} \times \frac{\text{yr}}{7.63 \text{ MMton}} = \frac{0.13 \text{ lb}}{\text{MMton}} \times \frac{\text{MMton}}{84 \text{ lb}} = 0.2\%$$

Goldstrike Refinery (2015 & 2016 Hg Reports) *(NDEP 2015a) (NDEP 2016)*

$$\frac{28.79 \text{ lb}}{\text{yr}} \times \frac{\text{yr}}{251.00 \text{ ton}} = \frac{0.11 \text{ lb}}{\text{MMton}} \times \frac{\text{MMton}}{0.8 \text{ lb}} = 14.3\%$$

Twin Creeks Refinery (2015 & 2016 Hg Reports) *(NDEP 2015a) (NDEP 2016)*

$$\frac{31.27 \text{ lb}}{\text{yr}} \times \frac{\text{yr}}{142.77 \text{ ton}} = \frac{0.22 \text{ lb}}{\text{MMton}} \times \frac{\text{MMton}}{0.8 \text{ lb}} = 27.4\%$$

Fuel Storage Tanks

	Dimensions				VOC Emissions[1]		
	Capacity	Diameter	Length	Throughput			Reference
Storage Tank	gal	ft	ft	gal/yr	lb/yr	ton/yr	
Mine Site Gasoline Tank #1	5,000	8.5	14.33	250,000	1,914.73	0.96	*(Midas Gold 2016), Table 12-4, annual use*
Mine Site Gasoline Tank #2	5,000	8.5	14.33	250,000	1,914.73	0.96	*(Midas Gold 2016), Table 12-4, annual use*
Mine Site Diesel Tank #3	25,000	12	29.70	725,000	14.60	0.007	*(Midas Gold 2016), (Midas Gold 2018c)*
Mine Site Diesel Tank #4	25,000	12	29.70	725,000	14.60	0.007	*(Midas Gold 2016), (Midas Gold 2018c)*
Mine Site Diesel Tank #5	25,000	12	29.70	725,000	14.60	0.007	*(Midas Gold 2016), (Midas Gold 2018c)*
Mine Site Diesel Tank #6	25,000	12	29.70	725,000	14.60	0.007	*(Midas Gold 2016), (Midas Gold 2018c)*
Mine Site Diesel Tank #7	25,000	12	29.70	725,000	14.60	0.007	*(Midas Gold 2016), (Midas Gold 2018c)*
Mine Site Diesel Tank #8	25,000	12	29.70	725,000	14.60	0.007	*(Midas Gold 2016), (Midas Gold 2018c)*
Mine Site Diesel Tank #9	25,000	12	29.70	725,000	14.60	0.007	*(Midas Gold 2016), (Midas Gold 2018c)*
Mine Site Diesel Tank #10	25,000	12	29.70	725,000	14.60	0.007	*(Midas Gold 2016), (Midas Gold 2018c)*

[1] *Emissions calculated using EPA Tanks 4.0.9d (EPA 1999)*

Conversions

2,000 lb/ton

Mine Site Gasoline Tanks #1, #2

TANKS 4.0 Report

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	Midas Gasoline Tank - 5,000 gal
City:	
State:	Idaho
Company:	Midas Gold
Type of Tank:	Horizontal Tank
Description:	

Tank Dimensions

Shell Length (ft):	14.33
Diameter (ft):	8.50
Volume (gallons):	5,000.00
Turnovers:	50.00
Net Throughput(gal/yr):	250,000.00
Is Tank Heated (y/n):	N
Is Tank Underground (y/n):	N

Paint Characteristics

Shell Color/Shade:	White/White
Shell Condition	Good

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Boise, Idaho (Avg Atmospheric Pressure = 13.28 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

Midas Gasoline Tank - 5,000 gal - Horizontal Tank

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Gasoline (RVP 9)	All	52.81	46.86	58.74	50.94	3.9950	3.5284	4.4980	67.0000			92.00	Option 4: RVP=9, ASTM Slope=7

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

Midas Gasoline Tank - 5,000 gal - Horizontal Tank

Annual Emission Calculations	
Standing Losses (lb)	809.2867
Vapor Space Volume (cu ft)	517.9808
Vapor Density (lb/cu ft)	0.0467
Vapor Space Expansion Factor	0.1451
Vented Vapor Saturation Factor	0.5264
Tank Vapor Space Volume	
Vapor Space Volume (cu ft)	517.9808
Tank Diameter (ft)	8.5000
Effective Diameter (ft)	12.4985
Vapor Space Outage (ft)	4.2500
Tank Shell Length (ft)	14.3300
Vapor Density	
Vapor Density (lb/cu ft)	0.0467
Vapor Molecular Weight (lb/lb-mole)	67.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia)	3.9950
Daily Avg. Liquid Surface Temp. (deg. R)	512.4800
Daily Average Ambient Temp. (deg. F)	50.9200
Ideal Gas Constant R (psia cuft / (lb-mol-deg R))	10.731
Liquid Bulk Temperature (deg. R)	510.6100
Tank Paint Solar Absorptance (Shell)	0.1700
Daily Total Solar Insolation Factor (Btu/sqft day)	1,409.5300

file:///C|/Program Files (x86)/Tanks409d/summarydisplay.htm[10/5/2017 9:35:37 AM]

Mine Site Gasoline Tanks #1, #2 - continued

TANKS 4.0 Report

Vapor Space Expansion Factor	
Vapor Space Expansion Factor	0.1481
Daily Vapor Temperature Range (deg R)	33.7125
Daily Vapor Pressure Range (psia)	0.9999
Breather Vent Press. Setting Range(psia)	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia)	3.9950
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia)	3.5084
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia)	4.4900
Daily Avg. Liquid Surface Temp. (deg R)	512.4889
Daily Min. Liquid Surface Temp. (deg R)	506.5548
Daily Max. Liquid Surface Temp. (deg R)	518.4111
Daily Ambient Temp. Range (deg. R)	29.675
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor	0.9264
Vapor Pressure at Daily Average Liquid Surface Temperature (psia)	3.9950
Vapor Space Outage (ft)	4.2500
Working Losses (lb)	1,221.4895
Vapor Molecular Weight (lb/lb-mole)	67.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia)	3.9950
Annual Net Throughput (gal/yr.)	250,000.0000
Annual Turnovers	50.0000
Turnover Factor	0.7667
Tank Diameter (ft)	6.5000
Working Loss Product Factor	1.0000
Total Losses (lb)	1,914.7295

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

Midas Gasoline Tank - 5,000 gal - Horizontal Tank

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Gasoline (RVP 9)	1,221.49	693.24	1,914.73

file:///C|/Program Files (x86)/Tanks409d/summarydisplay.htm[10/5/2017 9:35:37 AM]

Mine Site Diesel Tanks #3 - #10

TANKS 4.0 Report

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	25,000 gallon diesel storage tank
City:	Boise
State:	Idaho
Company:	Midas Gold
Type of Tank:	Vertical Fixed Roof Tank
Description:	Midas Gold Mine Site offroad diesel storage tanks

Tank Dimensions

Shell Height (ft):	29.70
Diameter (ft):	12.00
Liquid Height (ft) :	29.00
Avg. Liquid Height (ft):	14.50
Volume (gallons):	25,000.00
Turnovers:	29.00
Net Throughput(gal/yr):	725,000.00
Is Tank Heated (y/n):	N

Paint Characteristics

Shell Color/Shade:	White/White
Shell Condition	Good
Roof Color/Shade:	White/White
Roof Condition:	Good

Roof Characteristics

Type:	Dome
Height (ft)	1.00
Radius (ft) (Dome Roof)	12.00

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Boise, Idaho (Avg Atmospheric Pressure = 13.28 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

25,000 gallon diesel storage tank - Vertical Fixed Roof Tank
Boise, Idaho

Mixture/Component	Month	Daily Liquid Surf Temperature (deg F) Avg	Min	Max	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg	Min	Max	Vapor Mol. Weight	Liquid Mass Fract	Vapor Mass Fract	Mol. Weight	Basis for Vapor Pressure Calculations
Distillate fuel oil no. 2	All	52.81	40.66	65.16	59.94	0.0051	0.0041	0.0062	130.0000			130.00	Option 1: VP50 = .0045 VP60 = .0062

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

25,000 gallon diesel storage tank - Vertical Fixed Roof Tank
Boise, Idaho

Annual Emission Calculations	
Standing Losses (lb):	3.2883
Vapor Space Volume (cu ft):	1,776.1518
Vapor Density (lb/cu ft):	0.0001
Vapor Space Expansion Factor:	0.0419
Vented Vapor Saturation Factor:	0.9959
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,776.1518
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	15.7045
Tank Shell Height (ft):	29.7000
Average Liquid Height (ft):	14.0000

Mine Site Diesel Tanks #3 - #10 - continued

TANKS 4.0 Report

Roof Outage (ft)	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft)	0.5046
Dome Radius (ft)	12.0000
Shell Radius (ft)	6.0000
Vapor Density	
Vapor Density (lb/cu ft)	0.0001
Vapor Molecular Weight (lb/lb-mole)	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia)	0.0051
Daily Avg. Liquid Surface Temp. (deg. R)	510.4850
Daily Average Ambient Temp. (deg. F)	50.4900
Ideal Gas Constant R (psia cuft / (lb-mol-deg R))	10.731
Liquid Bulk Temperature (deg. R)	510.5185
Tank Paint Solar Absorptance (Shell)	0.1700
Tank Paint Solar Absorptance (Roof)	0.1700
Daily Total Solar Insolation Factor (Btu/sq ft day)	1,400.5369
Vapor Space Expansion Factor	
Vapor Space Expansion Factor	0.0419
Daily Vapor Temperature Range (deg. R)	29.7525
Daily Vapor Pressure Range (psia)	0.0022
Breather Vent Press. Setting Range(psia)	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia)	0.0051
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia)	0.0041
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia)	0.0062
Daily Avg. Liquid Surface Temp. (deg R)	510.4850
Daily Min. Liquid Surface Temp. (deg R)	506.5588
Daily Max. Liquid Surface Temp. (deg R)	536.4111
Daily Ambient Temp. Range (deg. R)	23.6700
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor	0.9998
Vapor Pressure at Daily Average Liquid Surface Temperature (psia)	0.0051
Vapor Space Outage (ft)	15.7046
Working Losses (lb)	11.3607
Vapor Molecular Weight (lb/lb-mole)	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia)	0.0051
Annual Net Throughput (gal/yr.)	25,000.0000
Annual Turnovers	29.8000
Turnover Factor	1.0000
Maximum Liquid Volume (gal)	25,000.0000
Maximum Liquid Height (ft)	29.0000
Tank Diameter (ft)	12.0000
Working Loss Product Factor	1.0000
Total Losses (lb)	14.5990

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

25,000 gallon diesel storage tank - Vertical Fixed Roof Tank
Boise, Idaho

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Distillate fuel oil no. 2	11.36	3.24	14.60

file:///C|/Program Files (x86)/Tanks409d/summarydisplay.htm[4/18/2018 11:40:56 AM]

AIR EMISSION CALCULATIONS	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-1-4	PAGE: 1 OF: 2 SHEET: MineLimits
	SUBJECT: Max Case Operation	DATE: June 22, 2020

Maximum Mining Activity Rate

Maximum Operating Schedule

24 hr/day
365 day/yr

Maximum Production

180,000 ton/day, ore and rock *(Midas Gold 2019b)*
180,000 ton/day, ore *(Midas Gold 2019b)*
180,000 ton/day, rock *(Midas Gold 2019b)*

2 blasts per day *(Midas Gold 2019b)*
600 holes per blast *(Midas Gold 2019a)*

Modeling Scenarios

		Pit				Ore Destination		Development Rock Destination			
	Model	YPP	HFP	WEP	BT	PC	STKP	FDRSF	HFDRSF	YPDRSF	WEDRSF
	Scenario	ton/day	ton/day	ton/day	ton/day	ton/day	ton/day	ton/day	ton/day	ton/day	ton/day
YP	Y1	180,000	--	--	--	--	180,000	--	--	--	--
YP	Y2	180,000	--	--	--	--	--	180,000	--	--	--
YP	Y3	180,000	--	--	--	--	--	--	180,000	--	--
HF	H1	--	180,000	--	--	--	180,000	--	--	--	--
HF	H2	--	180,000	--	--	--	--	180,000	--	--	--
HF	H3	--	180,000	--	--	--	--	--	180,000	--	--
HF	H4	--	180,000	--	--	--	--	--	--	180,000	--
WE	W1	--	--	180,000	--	--	180,000	--	--	--	--
WE	W2	--	--	180,000	--	--	--	180,000	--	--	--
WE	W3	--	--	180,000	--	--	--	--	180,000	--	--
WE	W4	--	--	180,000	--	--	--	--	--	180,000	--
WE	W5	--	--	180,000	--	--	--	--	--	--	180,000
BT	B1	--	--	--	180,000	--	180,000	--	--	--	--
BT	B2	--	--	--	180,000	--	--	--	180,000	--	--

Daily maximum mining equipment

Equipment		Units	
Truck Fleet	Cat 789D	20	*(Midas Gold 2017b)*
Truck Fleet	Cat 740B	12	*(Midas Gold 2019b)*
Water truck	Cat 777D	2	*(Midas Gold 2017b)*
Dozer		6	*(Midas Gold 2017b)*
Grader		3	*(Midas Gold 2017b)*

Daily maximum access road traffic

	One-Way Trips per Day	
Road maintenance equipment	4	*(Midas Gold 2016); Table 12-2*
Light vehicles	19	*(Midas Gold 2016); Table 12-2*
Heavy vehicles	45	*(Midas Gold 2016); Table 12-2*
Total	68	

Acronyms

YPP	Yellow Pine Pit
HFP	Hangar Flats Pit
WEP	West End Pit
BT	Bradley Tailings
FDRSF	Fiddle DRSF
HFDRSF	Hangar Flats DRSF
YPDRSF	Yellow Pine DRSF
WEDRSF	West End DRSF
PC	Primary Crusher
STKP	Primary Crusher Stockpile

PRI00000538

REC 1878

Dozer Location Percentages

	Pit				Ore Destination		Waste Destination			
Model Run	*YPP*	*HFP*	*WEP*	*BT*	*PC*	*STKP*	*FDRSF*	*HFDRSF*	*YPDRSF*	*WEDRSF*
Y1	50%	--	--	--	--	50%	--	--	--	--
Y2	50%	--	--	--	--	--	50%	--	--	--
Y3	50%	--	--	--	--	--	--	50%	--	--
H1	--	50%	--	--	--	50%	--	--	--	--
H2	--	50%	--	--	--	--	50%	--	--	--
H3	--	50%	--	--	--	--	--	50%	--	--
H4	--	50%	--	--	--	--	--	--	50%	--
W1	--	--	50%	--	--	50%	--	--	--	--
W2	--	--	50%	--	--	--	50%	--	--	--
W3	--	--	50%	--	--	--	--	50%	--	--
W4	--	--	50%	--	--	--	--	--	50%	--
W5	--	--	50%	--	--	--	--	--	--	50%
B1	--	--	--	50%	--	50%	--	--	--	--
B2	--	--	--	50%	--	--	--	50%	--	--

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis/E. Memon
	PROJECT NO: 335-1-4	PAGE: 1 OF: 20 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 22, 2020

Model Scenario W3

Mining Activity and Emissions Emissions Summary

By Area/Model ID

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	CO_PPH	CO_TPY	NOX_PPH	NOX_TPY	SO2_PPH	SO2_TPY	VOC_TPY
Area/	Location of	PM	PM10		PM2.5		CO		NOX		SO2		VOC
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr
YPP	Yellow Pine Pit	--	--	--	--	--	--	--	--	--	--	--	--
HFP	Hangar Flats Pit	--	--	--	--	--	--	--	--	--	--	--	--
WEP	West End Pit	344.54	885.54	161.61	79.64	14.53	--	--	--	--	--	--	--
BT	Bradley Tailings	--	--	--	--	--	--	--	--	--	--	--	--
YPPBL	Yellow Pine Pit Blasting	--	--	--	--	--	--	--	--	--	--	--	--
HFPBL	Hangar Flats Pit Blasting	--	--	--	--	--	--	--	--	--	--	--	--
WEPBL	West End Pit Blasting	117.35	334.38	61.02	19.29	3.52	1,742.00	635.83	46.80	17.08	0.09	0.03	--
BTBL	Bradley Tailings Blasting	--	--	--	--	--	--	--	--	--	--	--	--
STKP	PC Stockpile	--	--	--	--	--	--	--	--	--	--	--	--
FDRSF	Fiddle DRSF	--	--	--	--	--	--	--	--	--	--	--	--
HFDRSF	Hangar Flats DRSF	52.91	57.12	10.42	30.23	5.52	--	--	--	--	--	--	--
YPDRSF	Yellow Pine DRSF	--	--	--	--	--	--	--	--	--	--	--	--
WEDRSF	West End DRSF	--	--	--	--	--	--	--	--	--	--	--	--
TSF	Tailing Storage Facility	--	--	--	--	--	--	--	--	--	--	--	--
HR	Haul Roads	3,047.34	4,106.76	750.84	410.88	75.12	--	--	--	--	--	--	--
ACCRD	Access Roads	6.95	9.38	1.72	0.94	0.17	--	--	--	--	--	--	--
UGEXP	Scout Portal	0.002	0.004	0.001	0.001	0.0001	--	--	--	--	--	--	--
Total		3,569.10	5,393.19	985.62	540.98	98.87	1,742.00	635.83	46.80	17.08	0.09	0.03	--

See worksheet ROADS for haul road (HR) emissions by Model ID.

By Activity

	chk	chk-12	chk	chk	chk	chk	chk	chk	chk	chk	chk	chk
	PM	PM10		PM2.5		CO		NOX		SO2		VOC
Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr
Open Pit Drilling	284.70	811.20	148.04	46.80	8.54							
Open Pit Blasting	117.35	334.38	61.02	19.29	3.52	1,742.00	635.83	46.80	17.08	0.09	0.03	
Onsite Hauling	2,901.27	3,899.39	712.95	389.94	71.29							
Material Load / Unload	8.06	20.88	3.81	3.16	0.58							
Dozing	103.56	108.40	19.78	59.58	10.87							
Grading	36.80	60.51	11.04	6.25	1.14							
Water Truck Travel	109.27	146.86	26.85	14.69	2.69							
Access Road	6.95	9.38	1.72	0.94	0.17							
Wind Erosion	0.02	0.04	0.01	0.01	0.00							
Surface Exploration	1.12	2.14	0.39	0.32	0.06							
Underground Exploration	0.002	0.004	0.0007	0.0006	0.0001							
Total	3,569.10	5,393.19	985.62	540.98	98.87	1,742.00	635.83	46.80	17.08	0.09	0.03	--

W3 Model Input Emission Rates (g/s)

By Area/Model ID

		CO_PPH	NOX_TPY	NOX_PPH	PM2.5_TPY	PM2.5_PPD	PM10_PPD	SO2_PPH
Area/	Location of	CO	NO_X		$PM_{2.5}$		PM_{10}	SO_2
Model ID	Activity	8, 1-hr	Annual	1-hr	Annual	24-hr	24-hr	3, 1-hr
YPP	Yellow Pine Pit	--	--	--	--	--	--	--
HFP	Hangar Flats Pit	--	--	--	--	--	--	--
WEP	West End Pit	--	--	--	0.42	0.42	4.65	--
BT	Bradley Tailings	--	--	--	--	--	--	--
YPPBL	Yellow Pine Pit Blasting	--	--	--	--	--	--	--
HFPBL	Hangar Flats Pit Blasting	--	--	--	--	--	--	--
WEPBL	West End Pit Blasting	219.49	0.49	5.90	0.10	0.10	1.76	0.01
BTBL	Bradley Tailings Blasting	--	--	--	--	--	--	--
STKP	PC Stockpile	--	--	--	--	--	--	--
FDRSF	Fiddle DRSF	--	--	--	--	--	--	--
HFDRSF	Hangar Flats DRSF	--	--	--	0.16	0.16	0.30	--
YPDRSF	Yellow Pine DRSF	--	--	--	--	--	--	--
WEDRSF	West End DRSF	--	--	--	--	--	--	--
TSF	Tailing Storage Facility	--	--	--	--	--	--	--
HR	Haul Roads	--	--	--	2.16	2.16	21.56	--
ACCRD	Access Roads	--	--	--	0.00	0.00	0.05	--
UGEXP	Scout Portal	--	--	--	0.000003	0.000003	0.000021	--
Total		219.49	0.49	5.90	2.844043237	2.84	28.31	0.01
		TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE

PRI00000540

REC 1880

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis/E. Memon
	PROJECT NO: 335-1-4	PAGE: 2 OF: 20 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 22, 2020

Model Scenario W3

Mining Activity and Emissions Source Parameters Summary

ID	description	TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	SIG_Y_M	SIG_Z_M	PITVOL_M3	SXINIT_M	SYINIT_M	ANGL_DEG
Model ID	Location of Activity	Source Type	UTM NAD 83 E m	UTM NAD 83 N m	Elev. m	Rel. Ht. m	S-y/Width m	S-z m	Pit Vol. m^3	Len X m	Len Y m	Angle deg
YPP	Yellow Pine Pit	AREA	631,160	4,975,865	1,832	4.7		4.4		882	882	-8
HFP	Hangar Flats Pit	AREA	630,925	4,972,884	1,993	4.7		4.4		491.0	491.0	-
WEP	West End Pit	AREA	632,398	4,976,290	2,192	4.7		4.4		376.2	376.2	-
BT	Bradley Tailings	AREA	630,110	4,972,105	2,012	4.7		4.4		820	420	-
YPPBL	Yellow Pine Pit Blasting	VOLUME	631,471	4,976,374	1,717	15.0	20.2	7.0				
HFPBL	Hangar Flats Pit Blasting	VOLUME	631,171	4,973,129	1,891	15.0	20.2	7.0				
WEPBL	West End Pit Blasting	VOLUME	632,586	4,976,478	1,994	15.0	20.2	7.0				
BTBL	Bradley Tailings Blasting	VOLUME	630,520	4,972,315	2,012	15.0	20.2	7.0				
STKP	PC Stockpile	VOLUME	632,112	4,974,616	1,980	4.7	53.3	4.4				
FDRSF	Fiddle DRSF	VOLUME	630,981	4,974,903	2,115	4.7	180.2	4.4				
HFDRSF	Hangar Flats DRSF	VOLUME	630,158	4,972,124	2,080	4.7	174.8	4.4				
YPDRSF	Yellow Pine DRSF	VOLUME	631,491	4,976,383	1,904	4.7	182.2	4.4				
WEDRSF	West End DRSF	VOLUME	633,392	4,976,207	2,376	4.7	124.1	4.4				
TSF	Tailing Storage Facility	AREA	628,496	4,971,000	2,097	0				1,157	1,157	-
HR	Onsite Hauling	VOLUME	See worksheet: ROADS			4.7	15.1	4.4				
ACCRD	Access Roads	LINE	Variable			3.0	6.1	2.8				
UGEXP	Scout Portal	AREA	632,362	4,973,690	2,018	0.0		0.0		4.9	4.9	

Updat

Emissions by Model Scenario (ton/yr) Calculated on: 06/22/20

	PM	PM10		PM2.5		CO		NOX		SO2		VOC
Scenario	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr
Y1	1,484.1	2,607.5	476.3	264.1	48.2	**1,742.0**	**635.8**	**46.8**	**17.1**	**0.1**	**0.0**	-
Y2	1,922.8	3,180.5	581.1	319.7	58.4	**1,742.0**	**635.8**	**46.8**	**17.1**	**0.1**	**0.0**	-
Y3	2,794.1	4,351.6	795.2	436.8	79.8	**1,742.0**	**635.8**	**46.8**	**17.1**	**0.1**	**0.0**	-
H1	2,073.0	3,399.0	621.0	343.3	62.7	**1,742.0**	**635.8**	**46.8**	**17.1**	**0.1**	**0.0**	-
H2	2,824.9	4,393.0	802.7	441.0	80.6	**1,742.0**	**635.8**	**46.8**	**17.1**	**0.1**	**0.0**	-
H3	1,931.6	3,192.3	583.2	320.9	58.6	**1,742.0**	**635.8**	**46.8**	**17.1**	**0.1**	**0.0**	-
H4	2,327.9	3,724.9	680.6	374.2	68.4	**1,742.0**	**635.8**	**46.8**	**17.1**	**0.1**	**0.0**	-
W1	1,856.7	3,108.4	567.9	314.2	57.4	**1,742.0**	**635.8**	**46.8**	**17.1**	**0.1**	**0.0**	-
W2	2,649.1	4,156.7	759.5	417.3	76.3	**1,742.0**	**635.8**	**46.8**	**17.1**	**0.1**	**0.0**	-
W3	**3,569.1**	**5,393.2**	**985.6**	**541.0**	**98.9**	**1,742.0**	**635.8**	**46.8**	**17.1**	**0.1**	**0.0**	-
W4	1,896.3	3,144.9	574.5	316.2	57.8	**1,742.0**	**635.8**	**46.8**	**17.1**	**0.1**	**0.0**	-
W5	2,039.1	3,336.8	609.6	335.3	61.3	**1,742.0**	**635.8**	**46.8**	**17.1**	**0.1**	**0.0**	-
B1	2,284.9	3,683.2	673.0	371.6	67.9	**1,742.0**	**635.8**	**46.8**	**17.1**	**0.1**	**0.0**	-
B2	934.8	1,852.0	338.2	186.8	34.1	**1,742.0**	**635.8**	**46.8**	**17.1**	**0.1**	**0.0**	-

Highest emissions are highlighted in red.

PRI00000541

REC 1881

Model Scenario W3

Open Pit Drilling

Activity Information

Operating schedule 365 day/yr

Total drill holes per year 1,200 hole/day 2 blast/day 600 hole/blast

Annual LOM-W3 rates		Material blasted	Drilling
YPP	Yellow Pine Pit	0 ton/day	0 hole/day
HFP	Hangar Flats Pit	0 ton/day	0 hole/day
WEP	West End Pit	180,000 ton/day	1,200 hole/day
BT	Bradley Tailings	0 ton/day	0 hole/day
	Total	180,000 ton/day	1,200 hole/day

Emission Factors

TSP (PM) 1.3 lb/hole *AP-42, Tab. 11.9-4, 7/98 (overburden)*

PM Scaling Factors

PM 1

PM10 0.52 *AP-42, Tab. 11.9-1, 7/98 (blasting, overburden)*

PM2.5 0.03 *AP-42, Tab. 11.9-1, 7/98 (blasting, overburden)*

Emissions by Model ID

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY
	Location of	PM	PM10		PM2.5	
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr
YPP	Yellow Pine Pit	--	--	--	--	--
HFP	Hangar Flats Pit	--	--	--	--	--
WEP	West End Pit	284.70	811.20	148.04	46.80	8.54
BT	Bradley Tailings	--	--	--	--	--
Total	Open Pit Drilling	284.70	811.20	148.04	46.80	8.54

Source Parameters [1]

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	PITVOL_M3	SXINIT_M	SYINIT_M	SIG_Z_M	ANGL_DEG	Area
		Source	UTM NAD 83		Elev.	Rel. Ht.	Pit Vol.	Len X	Len Y	S-z	Angle	
Model ID	Activity	Type	E m	N m	m	m	m^3	m	m	m	deg	m2
YPP	Yellow Pine Pit	AREA	631,160	4,975,865	1,832	4.75		882.0	882.0	4.42	-8.0	777906
HFP	Hangar Flats Pit	AREA	630,925	4,972,884	1,993	4.75		491.0	491.0	4.42	0.0	241069
WEP	West End Pit	AREA	632,398	4,976,290	2,192	4.75		376.2	376.2	4.42	0.0	141544

[1] *UTM - (Midas Gold 2017d); Rel. Ht. - (EPA 2012); Len X, Len Y, Angle - best-fit equal area rectangle; Elev. - (Midas Gold 2018g)*

Source Parameters [1]

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M		SXINIT_M	SYINIT_M	SIG_Z_M	ANGL_DEG	
		Source	UTM NAD 83		Elev.	Rel. Ht.	Pit Vol.	Len X	Len Y	S-z	Angle	
Model ID	Activity	Type	E m	N m	m	m	m^3	m	m	m	deg	
BT	Bradley Tailings	AREA	630,110	4,972,105	2,012	4.75		820	420	4.42	0.0	344400

[1] *UTM, Elev. - (Midas Gold 2017d); Rel. Ht. - (EPA 2012); Len X, Len Y - best-fit equal area rectangle*

Conversions

2,000 lb/ton

Model Scenario W3

Open Pit Blasting

Activity Information

Operating schedule	365	day/yr	24	hr/day	
Blast area	80,795	ft^2/blast	*(Midas Gold 2017b)*		
Blast frequency	1	blast/hr	2	blast/day	730 blast/yr
ANFO use	26	ton/blast	*(Midas Gold 2017b)*		18,980 ton/yr

Annual LOM-W3 rates	Material blasted		Blasting		ANFO use		
Yellow Pine Pit	0	ton/day	0	blast/day	0	ton ANFO/hr	*(Midas Gold 2017b)*
Hangar Flats Pit	0	ton/day	0	blast/day	0	ton ANFO/hr	*(Midas Gold 2017b)*
West End Pit	180,000	ton/day	2	blast/day	26	ton ANFO/hr	*(Midas Gold 2017b)*
Bradley Tailings	0	ton/day	0	blast/day	0	ton ANFO/hr	
Total	180,000	ton/day	2	blast/day	26	ton ANFO/hr	

Emission Factors

Emission factor equation	TSP (lb/blast) = 0.000014 x $A^{1.5}$	*AP-42, Tab. 11.9-1, 7/98 (blasting, overburden)*	
A = Area per blast	80,795 ft^2		
TSP (PM)	321.52 lb/blast		
CO	67 lb/ton-ANFO	*AP-42, Tab. 13.3-1, 2/80 (ANFO)*	
NOX	0.9 kg/t-ANFO	*(CSIRO 2008)*	
	1.8 lb/ton-ANFO		
SO2	3.6E-03 lb/ton-ANFO	*Based on:* 6% *diesel content in ANFO*	*(Midas Gold 2017e)*

$$\frac{1.5E\text{-}05\ \cancel{\text{lb S}}}{\cancel{\text{lb FO}}} \times \frac{2\ \text{lb SO2}}{\cancel{\text{lb S}}} \times \frac{6\%\ \cancel{\text{lb FO}}}{\cancel{\text{lb ANFO}}} \times \frac{2{,}000\ \cancel{\text{lb ANFO}}}{\text{ton ANFO}} = \frac{3.6E\text{-}03\ \text{lb SO2}}{\text{ton ANFO}}$$

PM Scaling Factors

PM10	0.52	*AP-42, Tab. 11.9-1, 7/98 (blasting, overburden)*
PM2.5	0.03	*AP-42, Tab. 11.9-1, 7/98 (blasting, overburden)*

Emissions by Model ID

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	CO_PPH	CO_TPY	NOX_PPH	NOX_TPY	SO2_PPH	SO2_TPY
		PM	PM10		PM2.5		CO		NOX[1]		SO2	
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
YPPBL	Yellow Pine Pit Blasting	--	--	--	--	--	--	--	--	--	--	--
HFPBL	Hangar Flats Pit Blasting	--	--	--	--	--	--	--	--	--	--	--
WEPBL	West End Pit Blasting	117.35	334.38	61.02	19.29	3.52	1,742.00	635.83	46.80	17.08	0.0936	0.0342
BTBL	Bradley Tailings Blasting	--	--	--	--	--	--	--	--	--	--	--
Total	Open Pit Blasting	117.35	334.38	61.02	19.29	3.52	1,742	635.83	46.80	17.08	0.0936	0.0342

(1) *NO2/NOX:* 0.0357 *(CSIRO 2008)*

Source Parameters (1)

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	SIG_Y_M	SIG_Z_M
		Source	UTM NAD 83		Elev.	Rel. Ht.	S-y	S-z
Model ID	Activity	Type	E m	N m	m	m	m	m
YPPBL	Yellow Pine Pit Blasting	VOLUME	631,471	4,976,374	1,717	15	20.23	6.98
HFPBL	Hangar Flats Pit Blasting	VOLUME	631,171	4,973,129	1,891	15	20.23	6.98
WEPBL	West End Pit Blasting	VOLUME	632,586	4,976,478	1,994	15	20.23	6.98
BTBL	Bradley Tailings Blasting	VOLUME	630,520	4,972,315	2,012	15	20.23	6.98

(1) *UTM, Elev. - (Midas Gold 2017d); Rel. Ht. - (CSIRO 2008); S-y, S-z factors - (EPA 2016)*

Blast height (BH)	30	m	*(CSIRO 2008)/5 for conservatism*	Sigma divider			
Blast width	87	m	*sqrt(blast area)*	Rel. Ht.	2	of BH	*(EPA 2016)*
Blast depth	87	m	*sqrt(blast area)*	S-y	4.3	of SL	*(EPA 2016)*
Equal area side length (SL)	87	m		S-z	4.3	of BH	*(EPA 2016)*

Conversions

2,000	lb/ton
2.205	lb/kg
1.102	ton/t
3.281	ft/m

Model Scenario W3
Onsite Hauling

Activity Information
Operating schedule 365 day/yr 24 hr/day

Hauling Routes, Production Rates and Distances

Route Origin		Destination		Material Hauled [1] Material Type	Rate ton/day	One-Way Hauling [2] mi	Truck Loads [3] load/day	Total Travel [4] VMT/day
Unpaved Roads								
YPP-: Yellow Pine Pit	YPP	Process PC	PC	Ore	--	1.84	--	--
YPP-: Yellow Pine Pit	YPP	PC Stockpile	STKP	Ore	--	1.80	--	--
YPP-: Yellow Pine Pit	YPP	Fiddle DRSF	FDRSF	Rock	--	2.81	--	--
YPP-: Yellow Pine Pit	YPP	Hangar Flats DRSF	HFDRSF	Rock	--	4.76	--	--
YPP-: Yellow Pine Pit	YPP	Yellow Pine DRSF	YPDRSF	Rock	--		--	--
YPP-: Yellow Pine Pit	YPP	West End DRSF	WEDRSF	Rock	--		--	--
HFP-: Hangar Flats Pit	HFP	Process PC	PC	Ore	--	3.16	--	--
HFP-: Hangar Flats Pit	HFP	PC Stockpile	STKP	Ore	--	3.12	--	--
HFP-: Hangar Flats Pit	HFP	Fiddle DRSF	FDRSF	Rock	--	4.83	--	--
HFP-: Hangar Flats Pit	HFP	Hangar Flats DRSF	HFDRSF	Rock	--	2.83	--	--
HFP-: Hangar Flats Pit	HFP	Yellow Pine DRSF	YPDRSF	Rock	--	3.72	--	--
HFP-: Hangar Flats Pit	HFP	West End DRSF	WEDRSF	Rock	--		--	--
WEP: West End Pit	WEP	Process PC	PC	Ore	--	2.68	--	--
WEP: West End Pit	WEP	PC Stockpile	STKP	Ore	--	2.63	--	--
WEP: West End Pit	WEP	Fiddle DRSF	FDRSF	Rock	--	4.43	--	--
WEP: West End Pit	WEP	Hangar Flats DRSF	HFDRSF	Rock	180,000	6.49	1,264	16,415
WEP: West End Pit	WEP	Yellow Pine DRSF	YPDRSF	Rock	--	2.75	--	--
WEP: West End Pit	WEP	West End DRSF	WEDRSF	Rock	--	3.07	--	--
BT-P: Bradley Tailings	BT	Process PC	PC	Ore	--		--	--
BT-S: Bradley Tailings	BT	PC Stockpile	STKP	Ore	--	3.59	--	--
BT-FI: Bradley Tailings	BT	Fiddle DRSF	FDRSF	Rock	--		--	--
BT-H: Bradley Tailings	BT	Hangar Flats DRSF	HFDRSF	Rock	--	0.60	--	--
BT-Y: Bradley Tailings	BT	Yellow Pine DRSF	YPDRSF	Rock	--		--	--
BT-W: Bradley Tailings	BT	West End DRSF	WEDRSF	Rock	--		--	--
Total					180,000			16,415

(1) *(Midas Gold 2019b)*
(2) *(Midas Gold 2017d)*
(3) *See truck fleet information below.*
(4) *Truck loads* × *One-way hauling* × 2 *(round-trip)*

Truck Fleet

Truck	Payload Capacity [1] ton	Empty Weight [1] ton	Units [2]	Average Weight ton
Cat 789D	201.8	155.7	20	256.6
Cat 740B	43.5	37.6	12	59.4
Weighted Average	142.4		32	182.6

(1) *789D: (Caterpillar 2016), page 10-14*
740B: (Caterpillar 2011), page 13
(2) *(Midas Gold 2017b)* *(Midas Gold 2019b)*

Conversions
2,000 lb/ton

Model Scenario W3
Onsite Hauling - continued

Hauling Emissions by Route

Route Origin		Destination		Material Hauled Material Type	PM_TPY PM ton/yr	PM10_PPD PM10 lb/day	PM10_TPY PM10 ton/yr	PM2.5_PPD PM2.5 lb/day	PM2.5_TPY PM2.5 ton/yr
Unpaved Roads									
YPP- Yellow Pine Pit	YPP	Process PC	PC	Ore	--	--	--	--	--
YPP- Yellow Pine Pit	YPP	PC Stockpile	STKP	Ore	--	--	--	--	--
YPP- Yellow Pine Pit	YPP	Fiddle DRSF	FDRSF	Rock	--	--	--	--	--
YPP- Yellow Pine Pit	YPP	Hangar Flats DRSF	HFDRSF	Rock	--	--	--	--	--
YPP- Yellow Pine Pit	YPP	Yellow Pine DRSF	YPDRSF	Rock	--	--	--	--	--
YPP- Yellow Pine Pit	YPP	West End DRSF	WEDRSF	Rock	--	--	--	--	--
HFP- Hangar Flats Pit	HFP	Process PC	PC	Ore	--	--	--	--	--
HFP- Hangar Flats Pit	HFP	PC Stockpile	STKP	Ore	--	--	--	--	--
HFP- Hangar Flats Pit	HFP	Fiddle DRSF	FDRSF	Rock	--	--	--	--	--
HFP- Hangar Flats Pit	HFP	Hangar Flats DRSF	HFDRSF	Rock	--	--	--	--	--
HFP- Hangar Flats Pit	HFP	Yellow Pine DRSF	YPDRSF	Rock	--	--	--	--	--
HFP- Hangar Flats Pit	HFP	West End DRSF	WEDRSF	Rock	--	--	--	--	--
WEP West End Pit	WEP	Process PC	PC	Ore	--	--	--	--	--
WEP West End Pit	WEP	PC Stockpile	STKP	Ore	--	--	--	--	--
WEP West End Pit	WEP	Fiddle DRSF	FDRSF	Rock	--	--	--	--	--
WEP West End Pit	WEP	Hangar Flats DRSF	HFDRSF	Rock	2,901.27	3,906.57	712.95	390.66	71.29
WEP West End Pit	WEP	Yellow Pine DRSF	YPDRSF	Rock	--	--	--	--	--
WEP West End Pit	WEP	West End DRSF	WEDRSF	Rock	--	--	--	--	--
BT-P Bradley Tailings	BT	Process PC	PC	Ore	--	--	--	--	--
BT-S Bradley Tailings	BT	PC Stockpile	STKP	Ore	--	--	--	--	--
BT-F Bradley Tailings	BT	Fiddle DRSF	FDRSF	Rock	--	--	--	--	--
BT-H Bradley Tailings	BT	Hangar Flats DRSF	HFDRSF	Rock	--	--	--	--	--
BT-Y Bradley Tailings	BT	Yellow Pine DRSF	YPDRSF	Rock	--	--	--	--	--
BT-W Bradley Tailings	BT	West End DRSF	WEDRSF	Rock	--	--	--	--	--
Pit Subtotal					2,901.27	3,906.57	712.95	390.66	71.29

Emission Factors

Unpaved roads

Annual emission factor equation	$E = k(s/12)^a (W/3)^b [(365-P)/365]$	*AP-42, Sec. 13.2.2, Eq. 1a, 11/06*
Daily emission factor equation	$E = k(s/12)^a (W/3)^b$	*AP-42, Sec. 13.2.2, Eq. 1a, 11/06*
s = Surface material silt content	4 %	*(Midas Gold 2015)*
W = Mean vehicle weight	182.6 ton	
P = Days/year with ≥0.01 in precip	120 day/yr	*AP-42 Fig. 13.2.2-1, 11/06*

	PM	PM10	PM2.5		
k = Size-specific empirical constant	4.9	1.5	0.15		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
a = Size-specific empirical constant	0.7	0.9	0.9		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
b = Size-specific empirical constant	0.45	0.45	0.45		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
E = Size-specific emission factor					
Annual	9.68	2.38	0.24	lb/VMT	
Daily	14.43	3.55	0.35	lb/VMT	

Emission Controls

Unpaved roads - periodic application of water and chemical dust suppressant

Control efficiency: 90% *(Air Sciences 2018)* for chemical suppressant; annual and daily
33% *Conservative estimate* for watering; daily only

Model Scenario W3
Onsite Hauling - continued

Emissions by Area

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY
		PM	PM10		PM2.5	
Area ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr
HR	Onsite Hauling	2,901.27	3,899.39	712.95	389.94	71.29

See worksheet ROADS for haul road (HR) emissions by Model ID.

Source Parameters [1]

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	SIG_Y_M	SIG_Z_M
		Source	UTM NAD 83		Elev.	Rel. Ht.	S-y	S-z
Model ID	Activity	Type	E m	N m	m	m	m	m
HR	Onsite Hauling	VOLUME	*See worksheet: ROADS*			4.75	15.14	4.42

[1] *UTM, Elev. - (Midas Gold 2017d); Rel. Ht., Sy, Sz - (EPA 2012)*

Truck	Height		Reference
Cat 789D	6.5	m	*(Caterpillar 2016), page 10-14*
Cat 740B	4.1	m	*(Caterpillar 2011), page 14*
Weighted	5.58	m	
Road width (RW)	26.5	m	*(Midas Gold 2016), Fig. 9-1*

Plume Parameter	Calculation	Value (m)	Const.
Plume top (PT) - unpaved	1.7 x VH	9.49	1.7
Release height - unpaved	0.5 x PT	4.75	0.5
Plume width (PW)	RW + 6 m	32.55	6
Sigma-z - unpaved	PT / 2.15	4.42	2.15
Sigma-y	PW / 2.15	15.14	2.15

(EPA 2012)

Conversions
2,000 lb/ton
3.28 ft/m
12 in/ft

Model Scenario W3

Material Load / Unload

Activity Information

Operating schedule 365 day/yr

Throughput Rates chk

Model ID	Location of Activity	No. of Xfers	Rate ton/day	Total Rate ton/day	Xfer Description
YPP	Yellow Pine Pit	1	0	0	Load
HFP	Hangar Flats Pit	1	0	0	Load
WEP	West End Pit	1	180,000	180,000	Load
BT	Bradley Tailings	1	0	0	Load
PC	Process PC (1)	0	0	0	Unload
STKP	PC Stockpile	2	0	0	Unload & Reload
FDRSF	Fiddle DRSF	1	0	0	Unload
HFDRSF	Hangar Flats DRSF	1	180,000	180,000	Unload
YPDRSF	Yellow Pine DRSF	1	0	0	Unload
WEDRSF	West End DRSF	1	0	0	Unload

(1) *Ore unloading at primary crusher is accounted for in process sources*

Emission Factors

		PM	PM10	PM2.5		
k = Particle size multiplier		0.74	0.35	0.053		*AP-42, Sec. 13.2.4, Pg. 4, 11/06*
E = Emission factor	Load	0.00021	0.0001	0.000015	lb/ton	*AP-42, Tab. 11.19.2-2, 8/04 (truck loading - crushed stone)*
	Unload	0.00003	0.000016	0.0000024	lb/ton	*AP-42, Tab. 11.19.2-2, 8/04 (truck unloading - fragmented stone)*
	Unload &	0.00012	0.00006	0.00001	lb/ton	*Average of loading and unloading EF*

Emissions by Model ID chk PM_TPY PM10_PPD PM10_TPY PM2.5_PPD PM2.5_TPY

Model ID	Location of Activity	Total Rate ton/day	PM ton/yr	PM10 lb/day	PM10 ton/yr	PM2.5 lb/day	PM2.5 ton/yr
YPP	Yellow Pine Pit	--	--	--	--	--	--
HFP	Hangar Flats Pit	--	--	--	--	--	--
WEP	West End Pit	180,000	6.95	18.00	3.29	2.73	0.50
BT	Bradley Tailings	--	--	--	--	--	--
PC	Process PC	--	--	--	--	--	--
STKP	PC Stockpile	--	--	--	--	--	--
FDRSF	Fiddle DRSF	--	--	--	--	--	--
HFDRSF	Hangar Flats DRSF	180,000	1.11	2.88	0.53	0.44	0.08
YPDRSF	Yellow Pine DRSF	--	--	--	--	--	--
WEDRSF	West End DRSF	--	--	--	--	--	--
Total	Material Load / Unload	360,000	8.06	20.88	3.81	3.16	0.58

Conversions

2.237 mi/hr per m/s

2,000 lb/ton

Model Scenario W3

Material Load / Unload - continued

Source Parameters		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	PITVOL_M3	SXINIT_M	SYINIT_M	SIG_Z_M	ANGL_DEG	
	Location of	Source	UTM NAD 83		Elev.	Rel. Ht.	Pit Vol.	Len X	Len Y	S-z	Angle	
Model ID	Activity	Type	E m	N m	m	m	m^3	m	m	m	deg	
YPP	Yellow Pine Pit	AREA	631,160	4,975,865	1,832	4.75		882	882	4.42	-8	Pits
HFP	Hangar Flats Pit	AREA	630,925	4,972,884	1,993	4.75		491	491	4.42	0	Pits
WEP	West End Pit	AREA	632,398	4,976,290	2,192	4.75		376	376	4.42	0	Pits
BT	Bradley Tailings	AREA	630,110	4,972,105	2,012	4.75		820	420	4.42	0	

Source Parameters [1]		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	SIG_Y_M	SIG_Z_M	Surface		
	Location of	Source	UTM NAD 83		Elev.	Rel. Ht.	S-y	S-z	Area	Length	
Model ID	Activity	Type	E m	N m	m	m	m	m	m^2	m	
STKP	PC Stockpile	VOLUME	632,112	4,974,616	1,980	4.75	53.35	4.42	5.26E+04	229.4	Stockpile
FDRSF	Fiddle DRSF	VOLUME	630,981	4,974,903	2,115	4.75	180.22	4.42	6.01E+05	774.9	DRSF
HFDRSF	Hangar Flats DRSF	VOLUME	630,158	4,972,124	2,080	4.75	174.81	4.42	5.65E+05	751.7	DRSF
YPDRSF	Yellow Pine DRSF	VOLUME	631,491	4,976,383	1,904	4.75	182.21	4.42	6.14E+05	783.5	DRSF
WEDRSF	West End DRSF	VOLUME	633,392	4,976,207	2,376	4.75	124.05	4.42	2.85E+05	533.4	DRSF

[1] *UTM, Elev., Area - (Midas Gold 2017d); Rel. Ht. - (EPA 2012); S-y, S-z factors - (EPA 2016)*

Vehicle height (VH): Reference

Weighted Average 5.58 m *(Caterpillar 2016), page 10-14, (Caterpillar 2*

Plume Parameter	Calculation	Value (m)	Const.
Plume top (PT)	1.7 x VH	9.49	1.7
Release height	0.5 x PT	4.75	0.5
Sigma-z	PT / 2.15	4.42	2.15

(EPA 2012)

Sample calculation for PC Stockpile

Plume Parameter	Calculation	Value (m)	Const.
Surface area (SA)	Map	52,623	
Side length (SL)	SA^0.5	229.4	0.5
Sigma-y	SL / 4.3	53.35	4.3

(EPA 2016)

Model Scenario W3

Dozing and Grading

Activity Information

Operating schedule 365 day/yr 24 hr/day

Dozer and Grader Fleet

Equipment Category	Units	Activity	
Dozer	6	144 hr/day	*(Midas Gold 2017b)*
Grader	3	72 hr/day	*(Midas Gold 2017b)*
		468 VMT/day	

Dozing Emission Factors

Emission Factor Equation	TSP (lb/hr) = 5.7 $(s)^{1.2}/(M)^{1.3}$	*AP-42, Tab. 11.9-1, 07/98, (bulldozing, overburden)*
	PM15 (lb/hr) = 1.0 $(s)^{1.5}/(M)^{1.4}$	*AP-42, Tab. 11.9-1, 07/98, (bulldozing, overburden)*
s = Surface material silt content	6.9 %	*AP-42, Table 11.9-3, 07/98, (bulldozers, overburden)*
M = Material moisture content	7.9 %	*AP-42, Table 11.9-3, 07/98, (bulldozers, overburden)*
TSP(PM)	3.941 lb/hr	
PM15	1.004 lb/hr	

Dozing PM Scaling Factors

PM10	0.75	*AP-42, Tab. 11.9-1, 07/98, (applies to PM15 EF, footnote d)*
PM2.5	0.105	*AP-42, Tab. 11.9-1, 07/98, (applies to TSP EF, footnote e)*

Grading Emission Factors

Emission Factor Equation	TSP (lb/VMT) = 0.04 $(S)^{2.5}$	*AP-42, Tab. 11.9-1, 07/98, (grading)*
	PM15 (lb/VMT) = 0.051 $(S)^{2}$	*AP-42, Tab. 11.9-1, 07/98, (grading)*
S - Grader average speed	6.5 mph	*(Caterpillar 2016), Road Maintenance, page 11-6, Average*
TSP(PM)	4.309 lb/VMT	
PM15	2.155 lb/VMT	

Grading PM Scaling Factors

PM10	0.6	*AP-42, Tab. 11.9-1, 07/98, (applies to PM15 EF, footnote d)*
PM2.5	0.031	*AP-42, Tab. 11.9-1, 07/98, (applies to TSP EF, footnote e)*

Emission Controls

Grading Periodic application of water and chemical dust suppressant

Control efficiency: 90% *See Onsite Hauling*

Emissions by Area

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY
		PM	PM10		PM2.5	
Area ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr
ALL	Dozing	103.56	108.40	19.78	59.58	10.87
HR	Grading	36.80	60.51	11.04	6.25	1.14

Conversions

2,000 lb/ton

Model Scenario W3

Dozing and Grading - continued

		chk	chk	chk	chk	chk
Emissions by Model ID		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY
		PM	PM10		PM2.5	
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr
YPP	Dozing	--	--	--	--	--
HFP	Dozing	--	--	--	--	--
WEP	Dozing	51.78	54.20	9.89	29.79	5.44
BT	Dozing	--	--	--	--	--
PC	Dozing	--	--	--	--	--
STKP	Dozing	--	--	--	--	--
FDRSF	Dozing	--	--	--	--	--
HFDRSF	Dozing	51.78	54.20	9.89	29.79	5.44
YPDRSF	Dozing	--	--	--	--	--
WEDRSF	Dozing	--	--	--	--	--
HR	Grading	36.80	60.51	11.04	6.25	1.14

See worksheet ROADS for haul road (HR) emissions by Model ID.

Source Parameters

Dozing: See Open Pit Drilling and Material Load / Unload for source parameters.

Grading: See Onsite Hauling for source parameters.

Model Scenario W3

Water Truck Travel

Activity Information

Operating schedule 365 day/yr 24 hr/day

Truck Fleet

Water Truck	Payload Capacity ton	Empty Weight ton	Gross Weight ton	Units	Oper. hr/day	Reference	Average Weight ton
Cat 777D	100	80	180	2	48	*(Caterpillar 2016), page 10-12*	130

Average truck speed 15 mph *(Midas Gold 2018b)*

Total vehicle miles traveled (VMT) 720 VMT/day

Emission Factors

Annual emission factor equation $E = k(s/12)^a (W/3)^b [(365-P)/365]$ *AP-42, Sec. 13.2.2, Eq. 1a, 11/06*

Daily emission factor equation $E = k(s/12)^a (W/3)^b$ *AP-42, Sec. 13.2.2, Eq. 1a, 11/06*

s = Surface material silt content 4 % *(Midas Gold 2015)*

W = Mean vehicle weight 130.17 ton

P = Days/year with ≥0.01 in precip. 120 day/yr *AP-42 Fig. 13.2.2-1, 11/06*

		PM	PM10	PM2.5		
k = Size-specific empirical constant		4.9	1.5	0.15		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
a = Size-specific empirical constant		0.7	0.9	0.9		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
b = Size-specific empirical constant		0.45	0.45	0.45		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
E = Size-specific emission factor						
	Annual	8.32	2.04	0.20	lb/VMT	
	Daily	12.39	3.04	0.30	lb/VMT	

Emission Controls

Periodic application of water and chemical dust suppressant

Control efficiency: 90% *for chemical suppressant; annual and daily* *See Onsite Hauling*

33% *for watering; daily only*

Emissions by Area

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY
		PM	PM10		PM2.5	
Area ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr
HR	Water Truck Travel	109.27	146.86	26.85	14.69	2.69

Source Parameters

See Onsite Hauling for source parameters.

Conversions

2,000 lb/ton

Model Scenario W3

Access Road

Activity Information

Operating schedule 365 day/yr 24 hr/day

Maintenance Equipment, Light and Heavy Truck Specifications and Traffic

Equipment	Equipment Model[1]	Notes	AADT[2]	Annual Traffic	Travel[3] VMT/yr	Vehicle Weight[4] Empty ton	Gross ton	Average Weight ton
Maintenance Equipment	Caterpillar 725C		3	1,095	1,772	25.6	51.6	38.6
Light Vehicles	Ford F-350	5	19	6,935	11,223	4.0	7.9	6.0
Heavy Trucks	Caterpillar CT660 (8X6)	6	45	16,425	26,581	10.1	34.5	22.3
Weighted Average Vehicle Weight								18.4

(1) *Appropriate equipment model from (Midas Gold 2017b)*

(2) *AADT = annual average daily traffic (Midas Gold 2016) Tab. 12-2;*
75% of total maintanance AADT (4) assigned to non-grader maintenance equipment and 25% assigned to grader

(3) *Based on access road length of:* 1.6 *mi (within project boundary)* *(Midas Gold 2017d)*

(4) *(Caterpillar 2016)/manufacturer specifications*

(5) *Light vehicles include visitor and employee vehicles.*

(6) *Heavy trucks include buses, supply, product shipment and trash trucks . 2917 lime delivery trips ((Midas Gold 2017a) Tab. 12-4) are excluded.*

Emission Factors

Annual emission factor equation	$E = k(s/12)^a (W/3)^b [(365-P)/365]$				*AP-42, Sec. 13.2.2, Eq. 1a, 11/06*
Daily emission factor equation	$E = k(s/12)^a (W/3)^b$				*AP-42, Sec. 13.2.2, Eq. 1a, 11/06*
s = Surface material silt content	4 %				*(Midas Gold 2015)*
W = Mean vehicle weight	18.42 ton				
P = Days/year with ≥0.01 in precip.	120 day/yr				*AP-42 Fig. 13.2.2-1, 11/06*
	PM	PM10	PM2.5		
k = Size-specific empirical constant	4.9	1.5	0.15		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
a = Size-specific empirical constant	0.7	0.9	0.9		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
b = Size-specific empirical constant	0.45	0.45	0.45		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
E = Size-specific emission factor					
Annual	3.45	0.85	0.08	lb/VMT	
Daily	5.14	1.26	0.13	lb/VMT	

Emission Controls

Periodic application of water and chemical dust suppressant

Control efficiency: 90% *for chemical suppressant; annual and daily* *See Onsite Hauling*
33% *for watering; daily only*

Emissions by Area

				PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY
				PM	PM10		PM2.5	
Area ID	Activity	VMT/day	VMT/yr	ton/yr	lb/day	ton/yr	lb/day	ton/yr
ACCRD	Vehicle Travel	108.4	39,576	6.83	9.17	1.68	0.92	0.17

Conversions
2,000 lb/ton
1,609 m/mi

PRI00000552

REC 1892

Model Scenario W3

Access Road

Grading Traffic

Equipment	AADT	Annual Traffic	VMT/day	VMT/yr
Grader	1	365	1.6	591

Emission Factors *Detailed emission factor calculations are provided on page 10*

PM 4.3 lb/VMT
PM10 1.3 lb/VMT
PM2.5 0.1 lb/VMT

Emission Controls

Periodic application of water and chemical dust suppressant
Control efficiency: 90% *See Onsite Hauling*

Emissions by Area

				PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY
				PM	PM10		PM2.5	
Area ID	Activity	VMT/day	VMT/yr	ton/yr	lb/day	ton/yr	lb/day	ton/yr
ACCRD	Grading	1.6	591	0.13	0.21	0.04	0.02	0.004

Source Parameters [1]

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	SIG_Y_M	SIG_Z_M
		Source	UTM NAD 83		Elev.	Rel. Ht.	Width	S-z
Model ID	Activity	Type	E m	N m	m	m	m	m
ACCRD	*Access Roads*	LINE		*Variable*		2.98	6.10	2.77

[1] *UTM, Elev. - (Midas Gold 2017d); Rel. Ht., Sz - (EPA 2012)*

Vehicle	Height	
Average	3.5	m
Grader	3.7	m
HD Truck	3.6	m
LD Truck	3.2	m
Road width (RW)	6.1	m
Road length	2,590	m

(Midas Gold 2016), Fig. 7-2

Plume Parameter	Calculation	Value (m)	Const.
Plume top (PT) - unpaved	1.7 x VH	5.95	1.7
Release height - unpaved	0.5 x PT	2.98	0.5
Plume width (PW)	RW + 6 m	12.096	6
Sigma-z - unpaved	PT / 2.15	2.77	2.15

(EPA 2012)

Source Parameters

See Onsite Hauling for source parameters.

Conversions
3.28084 ft/m

Model Scenario W3

Wind Erosion

Activity Information

Operating schedule 365 day/yr

Erodible Area

Model ID	Location of Activity	Surface Type	Erodible Area [3] Total Rate ton/yr	Flat acre/yr	Pile acre/yr	Surface Footprint
STKP	PC Stockpile	Pile	--		--	13
FDRSF	Fiddle DRSF	Pile	--		--	148
HFDRSF	Hangar Flats DRSF	Pile	180,000		20	140
YPDRSF	Yellow Pine DRSF	Pile	--		--	152
WEDRSF	West End DRSF	Pile	--		--	70
BT	Bradley Tailings	Flat		85		85
TSF	Tailing Storage Facility	Flat		331		331
HR	Haul Roads [1]	Flat		582		582
ACCRD	Access Roads [2]	Flat		4		4

[1] *Based on scenario haul road length of 55 mi and width of 26.5 m (Midas Gold 2016), Fig. 9-1*

[2] *Based on access road (within boundary) length of 1.6 mi and width of 6.1 m (Midas Gold 2016), Fig. 7-2*

[3] *Pile surface area calculations:*

Truck dump (TD) size 142.4 ton

Material density 150.2 lb/ft^3 *(Midas Gold 2017b), Average Ore & Waste (YP, HF, WE, BT)*

0.075 ton/ft^3

Material specific volume 13.3 ft^3/ton

TD volume (V) 1,896 ft^3

Conical surface calculations

Side slope 38 deg *Typical*

0.7 rad

Conical surface area (SA) Π × r × (h^2 + r^2)^0.5

Conical volume (V) (Π × h × r^2) ÷ 3

Conical base radius r = s × cos(slope)

Conical height h = s × sin(slope)

Sloped side length s = (h^2 + r^2)^0.5

Solution of conical volume equation

Replacing h and r with s × sin(slope) and s × cos(slope), respectively:

s = [3 × V/(pi × sin(slope) × cos^2(slope)]^(1/3) 16.8 ft

r 13.2 ft

h 10.3 ft

SA 698 ft^2

0.016 acre

1.1E-4 acre/ton-TD

Scaling Factors

PM10 0.5 *AP-42, Pg. 13.2.5-3, 11/06*

PM2.5 0.075 *AP-42, Pg. 13.2.5-3, 11/06*

Conversions

4,046.86 m^2/acre 2,000 lb/ton

43,560 ft^2/acre 12 in/ft

1,609.34 m/mi

3.28 ft/m

PRI00000554

REC 1894

Model Scenario W3

Wind Erosion - continued ***Wind erosion potential calculations based on Aug-2014 through Aug-2015 Midas Gold on site meteorological data***

Stockpile Surface Wind Erosion Event Emission Calculations

Based on 1 acre/yr 8,760 hr/yr 0.00011 acre/hr

Threshold Wind Event	Date / Hour	u10 (m/s) (1)	u10+ (m/s) (2)	u* (m/s) ID-A (3)	u* (m/s) ID-B (3)	u* (m/s) ID-C (3)	Hours Elapsed ID-A (4)	Hours Elapsed ID-B (4)	Hours Elapsed ID-C (4)	Erodible Surface Area (acre) ID-A (5)	Erodible Surface Area (acre) ID-B (5)	Erodible Surface Area (acre) ID-C (5)
0	6/12/2014 13:00											
1	9/25/2014 14:00	9.810	11.772	1.059	0.706	0.235	2,521	2,521	2,521	0.03453	0.1381	0.1151
2	11/29/2014 12:00	10.050	12.060	1.085	0.724	0.241	1,558	4,079	4,079	0.02134	0.2235	0.1863
3	12/11/2014 03:00	10.000	12.000	1.080	0.720	0.240	279	4,358	4,358	0.00382	0.2388	0.1990
4	12/11/2014 14:00	9.470	11.364	1.023	0.682	0.227	11	4,369	4,369	0.00015	0.2394	0.1995
5	2/5/2015 14:00	10.400	12.480	1.123	0.749	0.250	1,344	5,713	5,713	0.01841	0.3130	0.2609
6	2/6/2015 07:00	10.270	12.324	1.109	0.739	0.246	17	5,730	5,730	0.00023	0.3140	0.2616
7	8/21/2015 14:00	9.610	11.532	1.038	0.692	0.231	4,711	10,441	10,441	0.06453	0.5721	0.4768
8	8/21/2015 15:00	9.530	11.436	1.029	0.686	0.229	1	10,442	10,442	0.00001	0.5722	0.4768
Flat Surface Wind Erosion Event Emission Calculations				Flat			Flat			Flat		
N/A	No wind events above 16.04 m/s											

Stockpile Surface Wind Erosion Event Emission Calculations - continued

Threshold Wind Event	Erosion Potential (lb/acre)[1] ID-A (6)	ID-B (6)	ID-C (6)	PM Emissions (lb) ID-A (7)	ID-B (7)	ID-C (7)	Total (8)	PM10 (lb) Total (9)	PM2.5 (lb) Total (10)
1	9.61	--	--	0.332	--	--	0.332	0.166	0.025
2	16.80	--	--	0.359	--	--	0.359	0.179	0.027
3	15.25	--	--	0.058	--	--	0.058	0.029	0.004
4	0.62	--	--	9.34E-5	--	--	9.34E-5	4.67E-5	7.00E-6
5	28.5	--	--	0.525	--	--	0.525	0.263	0.039
6	24.00	--	--	0.006	--	--	0.006	0.003	0.000
7	4.15	--	--	0.268	--	--	0.268	0.134	0.020
8	2.11	--	--	2.88E-5	--	--	2.88E-5	1.44E-5	2.16E-6
Stockpile Subtotal							1.548	0.774	0.116
Flat Surface Wind Erosion Event Emission Calculations - continued									
N/A	No wind events above 16.04 m/s						--	--	--

Zero denotes winds did not exceed the threshold for a surface regime.

Final Emission Factors (lb/acre-yr)

Surface Type	PM	PM10	PM2.5
Pile	1.55	0.77	0.12
Flat	--	--	--

Model Scenario W3

Wind Erosion - continued

Stockpile Surface Wind Erosion Event Emission Calculations - Notes

(1) u10 = wind speed at 10 meters reference height, m/s

(2) u10+ = fastest-mile wind speed, m/s
Based on hourly to fastest-mile wind speed conversion factor of 1.2 *(EPA 1994)*

(3) Pile: u* = friction velocity, m/s = (us/ur) × 0.1 × u10+ *AP-42, Sec. 13.2.5, Eqs. 6 & 7, 11/06*

Area ID	A	B	C
(us/ur)	0.9	0.6	0.2

AP-42, Page 13.2.5-10, 11/06

Flat surface:
u* = friction velocity, m/s = 0.053 × u10+ *AP-42, Sec. 13.2.5, Eq. 4, 11/06*

(4) Hours elapsed since previous wind erosion event

(5) Erodible surface area = hours elapsed since previous erosion event × hourly erodible surface area (acre) × surface regime area fraction Surface regime area fractions:

Area ID	A	B	C
% Surface	0.12	0.48	0.4

AP-42, Page 13.2.5-10, 11/06

(6) Erosion potential, g/m^2, = P = 58(u* - ut*)^2 + 25(u* - ut*); P = 0 for u* ≤ ut*
where, ut* = threshold friction velocity = 1.02 m/s *AP-42, Page 13.2.5-5 (overburden), 11/06*
P converted to lb/acre by multiplying with: 0.002205 lb/g and 4,046.86 m^2/acre
Solving u* = (us/ur) × 0.1 × u10+ for u10, when u* = ut* = 1.02 m/s and u10+ = u* × 1.2
yields the following minimum wind speeds to disturb the each stockpile surface regime:
ID-A 9.44 m/s
ID-B 14.17 m/s
ID-C 42.50 m/s
The threshold wind speed to disturbe flat surfaces is 1.02/0.053/1.2
Flat surface 16.04 m/s
The maximum hourly wind speed in the onsite data is 10.4 m/s, which is less than the threshold wind speeds to cause a disturbance of stockpile regimes ID-B and ID-C, and flat surfaces.

(7) PM emissions, lb = P (lb/acre) × erodible surface area (acre)

(8) Total PM emissions, lb = PM (ID-A), lb + PM (ID-B), lb + PM(ID-C), lb

(9) Total PM10 emissions, lb = total PM emissions, lb × PM10 scaling factors of 0.5 *AP-42, Page 13.2.5-3, 11/06*

(10) Total PM2.5 emissions, lb = total PM emissions, lb × PM2.5 scaling factors of 0.075 *AP-42, Page 13.2.5-3, 11/06*

Model Scenario W3

Wind Erosion - continued

Emissions by Model ID

				chk PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY
	Location of	Control[1]		PM	PM10		PM2.5	
Model ID	Activity		Type	ton/yr	lb/day	ton/yr	lb/day	ton/yr
STKP	PC Stockpile	--	Pile	--	--	--	--	--
FDRSF	Fiddle DRSF	--	Pile	--	--	--	--	--
HFDRSF	Hangar Flats DRSF	--	Pile	0.016	0.043	0.008	0.006	0.001
YPDRSF	Yellow Pine DRSF	--	Pile	--	--	--	--	--
WEDRSF	West End DRSF	--	Pile	--	--	--	--	--
BT	Bradley Tailings	--	Flat	--	--	--	--	--
TSF	Tailing Storage Facility	67%	Flat	--	--	--	--	--
HR	Haul Roads	90%	Flat	--	--	--	--	--
ACCRD	Access Roads	90%	Flat	--	--	--	--	--
Total	Wind Erosion			0.016	0.043	0.008	0.006	0.001

[1] *Bradley Tailings - maximum one-third of the total surface exposed* *(Midas Gold 2017f)*

Roads - see note on page 6

Conversions

2,000 lb/ton

Model Scenario W3

Surface Exploration

Activity Information

Operating schedule	365	day/yr	24 hr/day	
Duration	14	yr	168 mo	*(Midas Gold 2018a)*
Construction disturbance	13	acres	0.08 acre/mo	*(Midas Gold 2016), p. 13-1*
Total wet drilling (maximum)	700	holes	50 holes/yr	*(Midas Gold 2016), p. 13-1*
Material blasted	724.9	ton/hole		

Construction Emission Calculations

Emission Factors

PM	1.2	ton/acre	per month of activity	*AP-42, Page 13.2.3-1, 1/95*

PM Scaling Factors

PM10	0.35	*AP-42, Sec. 13.2.4, Pg. 4, 11/06*
PM2.5	0.053	*AP-42, Sec. 13.2.4, Pg. 4, 11/06*

Construction Emissions

Activity	PM	PM10		PM2.5	
	ton/yr	lb/day	ton/yr	lb/day	ton/yr
Drill Pad and Temporary Road Construction	1.1	2.1	0.4	0.3	0.1

Wet Drilling Emission Calculations

Emission Factors

PM10	8.0E-5	lb/ton (material blasted)	*AP-42, Table 11.19.2-2 (wet drilling), Rev. 8/04*
	0.058	lb/hole	

PM Scaling Factors

PM	0.74	*AP-42, Sec. 13.2.4-4, 11/06*
PM10	0.35	*AP-42, Sec. 13.2.4-4, 11/06*
PM2.5	0.053	*AP-42, Sec. 13.2.4-4, 11/06*

Wet Drilling Emissions

Activity	PM	PM10		PM2.5	
	ton/yr	lb/day	ton/yr	lb/day	ton/yr
Wet Drilling	0.0031	0.0079	0.0015	0.0012	0.00022

Surface Exploration Total Emissions

PM	PM10		PM2.5	
ton/yr	lb/day	ton/yr	lb/day	ton/yr
1.12	2.14	0.39	0.32	0.06

Emissions by Model ID [1]

		chk PM_TPY	chk PM10_PPD	chk PM10_TPY	chk PM2.5_PPD	chk PM2.5_TPY
		PM	PM10		PM2.5	
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr
WEP	Surface Exploration	1.12	2.14	0.39	0.32	0.06

Conversions

12	in/ft
2,000	lb/ton
12	mo/yr
1.341	hp/kW

Model Scenario W3

Underground Exploration

Activity Information

Operating schedule	365	day/yr	
Wet drilling	25	holes/yr	*(Midas Gold 2020)*

Wet Drilling Emission Calculations

Emission Factors

PM10	8.0E-5	lb/ton (material blasted)	*AP-42, Table 11.19.2-2 (wet drilling), Rev. 8/04*
	0.058	lb/hole	

PM Scaling Factors

PM	0.74	*AP-42, Sec. 13.2.4-4, 11/06*
PM10	0.35	*AP-42, Sec. 13.2.4-4, 11/06*
PM2.5	0.053	*AP-42, Sec. 13.2.4-4, 11/06*

Wet Drilling Emissions

Activity	PM	PM10		PM2.5	
	ton/yr	lb/day	ton/yr	lb/day	ton/yr
Wet Drilling	0.0015	0.0040	0.0007	0.0006	0.00011

Source Parameters [1]

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	SIG_Y_M	SIG_Z_M	SXINIT_M	SYINIT_M
		Source	UTM NAD 83		Elev.	Rel. Ht.	S-y	S-z	Length	Width
Model ID	Activity	Type	E m	N m	m	m	m	m	m	m
UGEXP	*Scout Portal*	AREA	632,362	4,973,690	2018	0	0	0	4.88	4.88

UTM, Elev. - (Midas Gold 2017d)

Conversions

907,186	g/ton
2,000	lb/ton
3.28084	ft/m

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: S. Pryor/E. Memon
	PROJECT NO: 335-1-4	PAGE: 1 OF: 2 SHEET: MineHg
AIR EMISSION CALCULATIONS	SUBJECT: Mining Fugitive Hg Emissions	DATE: June 22, 2020

Model Scenario W3

fug-lb/hr PPH | fug-lb/day PPD | fug-lb/yr PPY | fug-ton/yr TPY

Mining Fugitive Mercury Emissions Summary

		Emissions			
CAS No.	Pollutant/Group	lb/hr	lb/day	lb/yr	ton/yr
7439-97-6	Mercury	8.1E-4	1.9E-2	7.1E+0	3.5E-3
Total HAP		8.1E-4	1.9E-2	7.1E+0	3.5E-3

Conversions

2,000 lb/ton

1.10231 ton/t

PRI00000560

REC 1900

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: S. Pryor/E. Memon
	PROJECT NO: 335-1-4	PAGE: 2 OF: 2 SHEET: MineHg
AIR EMISSION CALCULATIONS	SUBJECT: Mining Fugitive Hg Emissions	DATE: June 22, 2020

Model Scenario W3

Fugitive Mercury Emissions

Fugitive Mercury Flux and Emissions

CAS No.	Pollutant	Source	Area m^2	Area ha	Hg Flux µg/m^2-yr	Emissions[1] lb/hr	Emissions[1] lb/yr	Emissions[1] ton/yr
		Stockpiles	52,623	5.3	556	7.37E-6	6.5E-2	3.2E-5
		Rock Dumps	2,063,990	206.4	76.2	3.96E-5	0.35	1.7E-4
		Tailings	1,338,158	133.8	2,144	7.22E-4	6.32	3.2E-3
		Pits	1,160,519	116.1	132.3	3.86E-5	0.34	1.7E-4
7439-97-6	Mercury					8.1E-4	7.07	3.5E-3

[1] *Hourly emissions based o* 8,760 *hours per year of operation*

Fugitive Mercury Emission Factors

Source	Twin Creeks (TC) Hg Flux [1] µg/m^2-yr	Twin Creeks (TC) Hg [2] µg/g	Ore Hg Adjusted µg/m^2/yr TC	Stibnite Hg Flux [3] µg/m^2-yr	Stibnite Hg [4] µg/g
Stockpiles	5,609	33	556	556	0.96
Rock Dumps	768	3.5	76.2	76.2	0.60
Tailings	21,621	33	2,144	2,144	0.96
Pits	1,334	9.5	132	132.3	0.60

[1] *(Eckley 2010) Table 1: Hg flux µg/m^2-yr*

[2] *(Eckley 2010) Table 1: Average Hg flux mg/g: " Stockpiles - high-grade stockpiles, Rock Dumps - waste rock dumps, Tailings - high-grade stockpiles as a surrogate; Pits - pit"*

[3] *(Eckley 2010) Figure 2: log(y) = m*log(x) + b*

y = Hg Flux (ng/m^2-d)

x = material Hg concentration (µg/g)]

Slope =	*Solar*	*TC*
	Low	*0.59*
	Medium	*0.6*
	High	*0.77*
	Average	*0.65*

[4] *(Midas Gold 2018e) Stockpiles - Ore, Rock Dumps - Rock, Tailings - Ore as a surrogate, Pits - Ore and Rock combined average*

Sample Calculation: m = log (y1/y2) / log(x1/x2)

m=	0.65	unit less
y1=	5,609	µg/m^2-yr
x1=	33	µg/m^2-yr
x2=	0.96	µg/m^2-yr
log(x1/x2)=	1.5362427	unit less
log(y1/y2)=	1.0036786	unit less
y1/y2=	10.085062	unit less
y2=	556.2	µg/m^2-yr

$$\frac{1\ \text{ng}}{\text{m2-d}} \times \frac{\mu\text{g}}{1{,}000\ \text{ng}} \times \frac{365\ \text{d}}{\text{yr}} = \frac{0.37\ \mu\text{g/m2-yr}}{\mu\text{g/g}}$$

Conversions

2,000	lb/ton
10,000	m2/ha
453.593	g/lb
1,000	ng/µg
365	day/yr

0.365 (µg/m^2-yr) / (ng/m^2-d)

PRI00000561

REC 1901

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis/E. Memon
	PROJECT NO: 335-1-4	PAGE: 1 OF: 4 SHEET: Conv
AIR EMISSION CALCULATIONS	SUBJECT: Conversions and Constants	DATE: June 22, 2020

Conversions

60	sec/min
60	min/hr
24	hr/day
365	day/yr
8,760	hr/yr
3,600	s/hr
2,000	lb/ton
453.593	g/lb
3.28084	ft/m
35.3147	ft^3/m^3
7,000	gr/lb
1.341	hp/kW
7.05	lb/gal distillate oi
907.1858189	kg/ton
459.67	°R at 0°F
68	°F, standard
7,000	BTU/hp-hr
2.2369	mi/hr per m/s
7.48052	gal/ft^3
1.10231	ton/t
2.20462	lb/kg
1609.34	m/mi
137,000	BTU/gal
4046.9	m^2/acre
43,560	ft^2/acre
12	in/ft
1.10231	ton/mt
1.0E+6	g/mt
3	ft/yd
1.0E+6	scf/MMscf
10,000	m^2/ha
1,000	kg/mt
273.15	°K at 0°C
32	°F at 0°C
1.8	°F/°C
1,000	ng/µg
0.293297222	MW-hr/MMBtu
12	mo/yr

Fuel Specifications

15	ppm S content	*40 CFR 80.510 (Non-road diesel)*	0.0015%	by weight
7.05	lb/gal-fuel	*AP-42, App. A*		
32.065	lb/lb-mol S, and			
64.06	lb/lb-mol SO2			
7,000	Btu/hp-hr	*AP-42, Sec. 3.3, (Diesel engine)*		
0.00939	MMBtu/kW-hr	*Diesel*		
0.137	MMBtu/gal	*AP-42, App. A (Diesel)*		
0.0915	MMBtu/gal Propane			

AP-42 Appendix A "Weights of Selected Substances" (Distillate oil)

AP-42, Sec. 3.3, (Diesel)

AP-42, App. A (Diesel)

Constants

M.W. SO2	64.06
M.W. S	32.07
M.W. O	16

Diesel SO2

$$\frac{15 \text{ parts S}}{1.0E+06} \times \frac{7.05 \text{ lb}}{\text{gal diese}} \times \frac{64.06 \text{ SO2}}{32.065 \text{ S}} \times \frac{\text{gal}}{0.137 \text{ MMBtu}} \times \frac{0.00939 \text{ MMBtu}}{\text{kW-hr}} \times \frac{453.593 \text{ g}}{\text{lb}} = 6.57E\text{-}03 \frac{\text{g SO2}}{\text{kW-hr}}$$

Propane SO2 Calculation

$$\frac{185 \text{ lb S}}{1.00E+06 \text{ lb C3H8}} \times \frac{44.08 \text{ lb C3H8}}{\text{lb mol}} \times \frac{\text{lb mol}}{359.05 \text{ SCF (0C)}} \times \frac{7{,}000 \text{ gr}}{\text{lb}} \times \frac{100 \text{ SCF}}{100\text{SCF}} = 15.90 \frac{\text{gr S}}{100 \text{ SCF}}$$

Propane heating value 91,500 *Btu/gal* *AP-42, Table 1.5-1 (07/08) Footnote a*

AP-42, Chapter 13.2.4 Particle Size Fractions

0.35	PM10
0.053	PM2.5

Fuel Combustion Exhaust Flow (EPA Method 19, Ffactor)

Propane Heater

F-factor	8,710	dscf/MMBtu	Propane, dry
O2%dry	3	%	
Heat input	1	MMBtu/hr	
Standard exhaust flow	10,170	dscf/hr	
	169	dscfm	
Vol % moisture	15.0%	standard for propane boilers	
Temperature	360	°F, Engineering Toolbox* (LPG heating appliances)	
Pressure, site	0.79	atm	
Actual exhaust flow	394	acfm (wet)/MMBtu	

Diesel Engine

F-factor	9,190	dscf/MMBtu	Oil, dry	
O2%dry	9	%		
Heat input	0.007	MMBtu/hp-hr	AP-42, Sec. 3.3, (Diesel engine)	
Standard exhaust flow	113	dscf/hp-hr		
	1.9	dscfm/hp	2.5	dscfm/kW
Vol % moisture	8.0%	standard for diesel engines		
Temperature	1,100	°F, Engineering Toolbox* (diesel exhaust)		
Pressure, site	0.79	atm		
Actual exhaust flow	7.7	acfm (wet)/hp	10.3	acfm (wet)/kW

* *http://www.engineeringtoolbox.com/fuels-exhaust-temperatures-d_168.html*

Exhaust Parameters

				dscfm	acfm	temp_F		dia_ft
				Exhaust Parameters				
	Hourly			Flow		Temp	Velocity	Dia
Source	Design Rate	Ref.	Water	dscfm	acfm	F	ft/s	ft
Carbon Regeneration Kiln (Drum)	0.3 ton	*(NDEP 2017)*	1%	120	180	150	17	0.48
Electrowinning Cells and Pregnant Solution Ta	100 gpm	*(NDEP 2017)*	4%	2,660	3,740	100	79	1
Mercury Retort	0.5/batch	*(NDEP 2017)*	1%	16	20	150	5	0.29
Induction Melting Furnace	0.5/batch	*(NDEP 2017)*	1%	3,500	5,200	150	71	1.25
Autoclave	290 ton	*(APT 2013)*	83%	3,101	28,680	196	24	5
Sb Bagging		*(NDEP 2015b)*	0%	800	1,000	68	21	1
Limestone Ball Mill		*(NDEP 2010)*	0%	13,000	16,500	68	88	2
Parallel Flow Regenerative (PFR) Shaft Lime Kiln		*(NDEP 2010)*	4%	8,000	16,300	350	86	2
Lime Mill Crushing and associated transfers In and Out		*(NDEP 2010)*	0%	2,000	2,500	68	119	0.6667

Site Pressure Calculation

http://www.sensorsone.com/altitude-pressure-units-conversion/

6000	23.978	6531.9	
7000	23.088	23.505	
0		29.921	0.78556

Lime Kiln Specifications

810 *kcal/kg*	100 ton/day	*(Maerz 2018)*	3.96567 *btu/kcal*
870 *kcal/kg*	400 ton/day	*(Maerz 2018)*	
870 *kcal/kg*	169 ton/day	*Midas Gold Kiln Throughput, maximum-case fuel assumption*	

Lime kiln heat requirements

870 kcal / kg	907.186 kg / ton	3.96567 Btu / kcal	MMBtu / 1.E+06 Btu	=	3.13 MMBtu / ton

Dyno Nobel 2010 "Blasting and Explosives Quick Reference Guide"

Dyno Nobel 2010 "Blasting and Explosives Quick Reference Guide" (Ratio of total of blast volume to drilled hole volume)

(B*S*BH*N)/(PI()*D^2/4000*L)

		B - Drilled Burden (m)	=(25 to 40) x D
		S - Drilled Spacing (m)	=1.15 x B
BH	10 m	BH - Bench Height (m)	≥D/15
		N - Number of Holes in a Blast	
N	100	D - Hole Diameter (mm)	
		L - Hole Length	
D	0.15 m		
B	4.9 m		
S	5.6 m		
L	10 m		
V	27,330 m3		
Material density	150.2 lb/ft^3		*(Midas Gold 2017b), Average Ore & Waste (YP, HF, WE, BT)*
M	72,493 ton	724.9 ton/hole	

Enclosure Control Efficiency Calculation

Emission factor equation	$E = 0.0032k(U/5)^{1.3}/(M/2)^{1.4}$					*AP-42, Sec. 13.2.4, Eq. 1, 11/06*
U = Mean wind speed	5.167 mph		2.31 m/s			*(Midas Gold 2017f), Fig. 4-3 (2014 onsite meteorological data)*
U = Mean wind speed	1.3 mph					*Lowest wind speed for Eq. 1, AP-42, Sec. 13.2.4, Eq. 1, 11/06*
M = Moisture content	2.5 %					
	PM	PM10	PM2.5			
k = Particle size multiplier	0.74	0.35	0.053			*AP-42, Sec. 13.2.4, Pg. 4, 11/06*
E = Emission factor	0.00181	0.00086	0.00013	lb/ton	U =	5.167
E = Emission factor	0.00030	0.00014	0.00002	lb/ton	U =	1.300
Control Efficiency	83.4%	83.4%	83.4%			

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis/E. Memon		
	PROJECT NO: 335-1-4	PAGE: 4	OF: 4	SHEET: Conv
AIR EMISSION CALCULATIONS	SUBJECT: Conversions and Constants	DATE: June 22, 2020		

Fuel Burning Equipment Emissions

	Source	MMBtu/hr	Flow Rate dscfm	PM lb/hr	PM gr/dscf	PM Limit [1] gr/dscf	
Sb1	Sb Dryer (2.72 MMBtu/hr Propane-Fired)	2.72	461	0.021	0.005	0.015	In Compliance
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	17	2,881	0.130	0.005	0.015	In Compliance
CKB	Carbon Regeneration Kiln (Burners)	2.255	382	0.017	0.005	0.015	In Compliance
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0.1	17	0.001	0.005	0.015	In Compliance
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	5	847	0.038	0.005	0.015	In Compliance
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	4	678	0.031	0.005	0.015	In Compliance
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	4	678	0.031	0.005	0.015	In Compliance
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	4	678	0.031	0.005	0.015	In Compliance
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0.25	42	0.002	0.005	0.015	In Compliance
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0.25	42	0.002	0.005	0.015	In Compliance
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0.25	42	0.002	0.005	0.015	In Compliance
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0.5	85	0.004	0.005	0.015	In Compliance
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	2	339	0.015	0.005	0.015	In Compliance
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	3	508	0.023	0.005	0.015	In Compliance
LKC	PFR Shaft Lime Kiln Combustion	22.0	8,000	0.169	0.002	0.015	In Compliance
EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	9.39	1,259	0.441	0.041	0.05	In Compliance
EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	9.39	1,259	0.441	0.041	0.05	In Compliance
EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	9.39	1,259	0.441	0.041	0.05	In Compliance
EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	1.88	252	0.088	0.041	0.05	In Compliance

[1] *58.01.01.676, Fuel Type: Gas, Emission Oxygen 3%*

Baghouse/Bin Vent Filter PM Emission Concentration

	Source	Control	Flow Rate dscfm	PM lb/hr	PM gr/dscf	PM10 lb/hr	PM10 gr/dscf
Sb2	Sb Bagging	Baghouse (BH1)	800	0.118	0.017	0.118	0.017
MF	Induction Melting Furnace	Baghouse (BH2)	3,500	2.839	0.095	2.839	0.095
LSBM	Limestone Ball Mill	Baghouse (BH3)	13,000	1.902	0.017	1.596	0.014
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	Baghouse (BH4)	8,000	0.915	0.013	0.915	0.013
LCR	Lime Mill Crushing and associated transfers In and Out	Baghouse (BH5)	2,000	0.284	0.017	0.239	0.014
LS1L	Mill Lime Silo #1 Loading	Bin Vent Filter	700	0.059	0.010	0.020	0.003
MillS2L	Mill Lime Silo #2 Loading	Bin Vent Filter	700	0.059	0.010	0.020	0.003
ACS1L	AC Lime Silo #1 Loading	Bin Vent Filter	1,400	0.119	0.010	0.041	0.003
ACS2L	AC Lime Silo #2 Loading	Bin Vent Filter	1,400	0.119	0.010	0.041	0.003
ACS3L	AC Lime Silo #3 Loading	Bin Vent Filter	1,400	0.119	0.010	0.041	0.003
ACS4L	AC Lime Silo #4 Loading	Bin Vent Filter	1,400	0.119	0.010	0.041	0.003
CS1L	Cement/Shotcrete Silo #1 Loading	Bin Vent Filter	930	0.079	0.010	0.027	0.003
CS2L	Cement/Shotcrete Silo #2 Loading	Bin Vent Filter	930	0.079	0.010	0.027	0.003
LSL	Pebble Lime Silo Loading via Bucket Elevator	Bin Vent Filter	70	0.006	0.010	0.006	0.010

PRI00000565

REC 1905

Process Activity Uncontrolled Emissions

SOURCE DESCRIPTION		OPERATING LIMITS							EMISSION FACTORS								
Model	Source Description	Design Throughput						reference	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	unit	reference
ID		unit/hr	unit/day	unit/yr	units	Material	hr/yr										
OC1	Loader Transfer of Ore to Grizzly	1,042	25,000	9,125,000	ton	Ore	8,760	(Midas Gold 2016), Sec. 10.1	0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
OC2	Grizzly to Apron Feeder	1,042	25,000	9,125,000	ton	Ore	8,760	0	0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
OC3	Apron Feeder to Dribble Conveyor	1,042	25,000	9,125,000	ton	Ore	8,760	0	0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
OC4	Apron Feeder to Vibrating Grizzly	1,042	25,000	9,125,000	ton	Ore	8,760	0	0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
OC5	Dribble Conveyor to Vibrating Grizzly	1,042	25,000	9,125,000	ton	Ore	8,760	0	0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	1,042	25,000	9,125,000	ton	Ore	8,760	0	0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	1,042	25,000	9,125,000	ton	Ore	8,760	0	0.0054	0.0024	0.00036					lb/ton	AP-42, Table 11.19.2-2 (08/04) Tert. Crush - unctrl.; PM2.5 Ch. 13.2.4
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	1,042	25,000	9,125,000	ton	Ore	8,760	0	0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
OC9	Stockpile Transfers to Reclaim Conveyors	1,150	27,600	10,074,000	ton	Ore	8,760	(M3 2017b)	0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	1,150	27,600	10,074,000	ton	Ore	8,760	0	0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	1,150	27,600	10,074,000	ton	Ore	8,760	0	0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	1150.0	27,600	10,074,000	ton	Ore	8,760	0	0.0054	0.0024	0.00036					lb/ton	AP-42, Table 11.19.2-2 (08/04) Tert. Crush - unctrl.; PM2.5 Ch. 13.2.4
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	1150.0	27,600	10,074,000	ton	Ore	8,760	0	0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
LS1L	Mill Lime Silo #1 Loading	60	250	4,375	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.73	0.47	0.07117					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading; PM2.5 Ch. 13.2.4
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	20	250	4,375	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.00042					lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4
MillS2L	Mill Lime Silo #2 Loading	60	250	4,375	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.73	0.47	0.07117					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading; PM2.5 Ch. 13.2.4
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	20	250	4,375	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.00042					lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4
Sb1	Sb Dryer (2.72 MMBtu/hr Propane-Fired)	2.72	65.28	23,827	MMBtu	Propane	8,760	(M3 2017d)	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
Sb2	Sb Bagging	4.5	108	39,420	ton	Stib. Conc.	8,760	(M3 2017d)	1.178	1.178	1.178					lb/hr	Based on NDEP-BAPC Permit for Clay Bagging Operation (Hectatone) (NDEP 2015b), Assumed 90% BH ctrl.
AC	Autoclave	290	6,960	2,540,400	ton	Float Conc.	8,760	(M3 2017b)	16.916667	16.91667	16.91667			0.6525		lb/hr	Based on NDEP-BAPC Permits/test data for Autoclaves: PM & SO2 - [Goldstrike (NDEP 2012)], Assumed 70% PM ctrl. Negligible CO due to no organic carbon in the feed (M3 2017a)
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	17	17	510	MMBtu	Propane	30	(M3 2017b)	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Ind. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
ACS1L	AC Lime Silo #1 Loading	120	1,000	17,500	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.73	0.47	0.07117					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading; PM2.5 Ch. 13.2.4
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	20	480	17,500	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.0004					lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4
ACS2L	AC Lime Silo #2 Loading	120	1,000	17,500	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.73	0.47	0.07117					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading; PM2.5 Ch. 13.2.4
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	20	480	17,500	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.0004					lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4
ACS3L	AC Lime Silo #3 Loading	120	1,000	17,500	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.73	0.47	0.07117					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading; PM2.5 Ch. 13.2.4

SOURCE DESCRIPTION		HOURLY EMISSIONS							DAILY EMISSIONS							ANNUAL EMISSIONS						
Model	Source Description	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC
ID		lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr
OC1	Loader Transfer of Ore to Grizzly	3.13	1.15	0.18					75.00	27.50	4.25					13.69	5.02	0.78				
OC2	Grizzly to Apron Feeder	3.13	1.15	0.18					75.00	27.50	4.25					13.69	5.02	0.78				
OC3	Apron Feeder to Dribble Conveyor	3.13	1.15	0.18					75.00	27.50	4.25					13.69	5.02	0.78				
OC4	Apron Feeder to Vibrating Grizzly	3.13	1.15	0.18					75.00	27.50	4.25					13.69	5.02	0.78				
OC5	Dribble Conveyor to Vibrating Grizzly	3.13	1.15	0.18					75.00	27.50	4.25					13.69	5.02	0.78				
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	3.13	1.15	0.18					75.00	27.50	4.25					13.69	5.02	0.78				
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	5.63	2.50	0.38					135	60.00	9.00					24.64	10.95	1.64				
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	3.13	1.15	0.18					75.00	27.50	4.25					13.69	5.02	0.78				
OC9	Stockpile Transfers to Reclaim Conveyors	3.45	1.27	0.20					82.80	30.36	4.69					15.11	5.54	0.86				
OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	3.45	1.27	0.20					82.80	30.36	4.69					15.11	5.54	0.86				
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	3.45	1.27	0.20					82.80	30.36	4.69					15.11	5.54	0.86				
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	6.21	2.76	0.41					149	66.24	9.94					27.20	12.09	1.81				
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	3.45	1.27	0.20					82.80	30.36	4.69					15.11	5.54	0.86				
LS1L	Mill Lime Silo #1 Loading	43.80	28.20	4.27					183	118	17.79					1.60	1.03	0.16				
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	9.60E-2	5.60E-2	8.40E-3					1.20	0.70	0.11					1.05E-2	6.13E-3	9.19E-4				
MillS2L	Mill Lime Silo #2 Loading	43.80	28.20	4.27					183	118	17.79					1.60	1.03	0.16				
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	9.60E-2	5.60E-2	8.40E-3					1.20	0.70	0.11					1.05E-2	6.13E-3	9.19E-4				
Sb1	Sb Dryer (2.72 MMBtu/hr Propane-Fired)	2.08E-2	2.08E-2	2.08E-2	0.22	0.39	4.73E-2	2.38E-2	0.50	0.50	0.50	5.35	9.27	1.13	0.57	9.11E-2	9.11E-2	9.11E-2	0.98	1.69	0.21	0.10
Sb2	Sb Bagging	1.18	1.18	1.18					28.27	28.27	28.27					5.16	5.16	5.16				
AC	Autoclave	16.92	16.92	16.92			0.65		406	406	406			15.66		74.10	74.10	74.10			2.86	
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0.13	0.13	0.13	1.39	2.42	0.30	0.15	0.13	0.13	0.13	1.39	2.42	0.30	0.15	1.95E-3	1.95E-3	1.95E-3	2.09E-2	3.62E-2	4.43E-3	2.23E-3
ACS1L	AC Lime Silo #1 Loading	87.60	56.40	8.54					730	470	71.17					6.39	4.11	0.62				
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	9.60E-2	5.60E-2	8.00E-3					2.30	1.34	0.19					4.20E-2	2.45E-2	3.50E-3				
ACS2L	AC Lime Silo #2 Loading	87.60	56.40	8.54					730	470	71.17					6.39	4.11	0.62				
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	9.60E-2	5.60E-2	8.00E-3					2.30	1.34	0.19					4.20E-2	2.45E-2	3.50E-3				
ACS3L	AC Lime Silo #3 Loading	87.60	56.40	8.54					730	470	71.17					6.39	4.11	0.62				

SOURCE DESCRIPTION		OPERATING LIMITS							EMISSION FACTORS								
Model	Source Description	Design Throughput						reference	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	unit	reference
ID		unit/hr	unit/day	unit/yr	units	Material	hr/yr										
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	20	480	17,500	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.0004					lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4
ACS4L	AC Lime Silo #4 Loading	120	500	8,750	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.73	0.47	0.07117					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading; PM2.5 Ch. 13.2.4
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	20	480	8,750	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.0004					lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4
CKD	Carbon Regeneration Kiln (Drum)	0.3	7.2	2,628	ton	Carbon	8,760	(M3 2017b)	1.4	1.4	1.4	0.12	0.012		0.11	lb/hr	Based on NDEP-BAPC Permit for Carbon Regeneration Kiln [Goldstrike (NDEP 2012)], Assumed 70% PM ctrl.
CKB	Carbon Regeneration Kiln (Burners)	2.255	54.12	19,754	MMBtu	Propane	8,760	(M3 2017b)	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
EW	Electrowinning Cells and Pregnant Solution Tank	100 gpm	24		gpm	Au Sol.	8,760	Typical Ind. Oper.	0.07	0.07	0.07					lb/hr	Based on similar source stack test data and 5× safety factor (APT 2016)
MR	Mercury Retort	0.5/batch	24 hr	21	ton	Au Conc.	1,248	(M3 2017b) & (M3 2017a)	0.01	0.01	0.01					lb/hr	Based on similar source stack test data and 5× safety factor (APT 2017)
MF	Induction Melting Furnace	0.5/batch	12 hr	21	ton	Au Conc.	624	(M3 2017b) & (M3 2017a)	5.68	5.68	5.68					lb/hr	Based on IDAPA 58.01.01.701 PM Weight Limit. Assumed unctrl = 2 x ctrl
EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	1000	1 hr	100,000	bkW	Diesel	100	(M3 2017a)	0.2	0.2	0.2	3.5	6.4	0.00657	1.3	g/kW-hr	40 CFR Subpart 60.4202(a)(2); SO2 - mass balance (15ppm ULSD) (CFR 2018a)
EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	1000	1 hr	100,000	bkW	Diesel	100	(M3 2017a)	0.2	0.2	0.2	3.5	6.4	0.00657	1.3	g/kW-hr	40 CFR Subpart 60.4202(a)(2); SO2 - mass balance (15ppm ULSD) (CFR 2018a)
EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	1000	1 hr	100,000	bkW	Diesel	100	(M3 2017a)	0.2	0.2	0.2	3.5	6.4	0.00657	1.3	g/kW-hr	40 CFR Subpart 60.4202(a)(2); SO2 - mass balance (15ppm ULSD) (CFR 2018a)
EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	200	1 hr	20,000	bkW	Diesel	100	Typical Ind. Oper.	0.2	0.2	0.2	3.5	4	0.00657	4	g/kW-hr	Table 4 to Subpart IIII of Part 60— 130≤KW<225 (175≤HP<300); SO2 - mass balance (15ppm ULSD) (CFR 2018a)
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0.10	2.4	876	MMBtu	Propane	8,760	(M3 2017a)	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	5.00	120	43,800	MMBtu	Propane	8,760	(M3 2017b)	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	4.00	96	35,040	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	4.00	96	35,040	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	4.00	96	35,040	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0.25	6	2,190	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0.25	6	2,190	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0.25	6	2,190	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0.50	12	4,380	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	2.00	48	17,520	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	3.00	72	26,280	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
PSL	Prill Silos Loading (2 x 100 ton)	200	200	7,300	ton	Prill	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.02	0.007	0.00106					lb/ton	AP-42, Table 8.3-2 (7/93), Bulk Loading - unctrl; PM10/PM2.5 Ch. 13.2.4
PSU	Prill Silos Unloading (2 x 100 ton)	200	200	7,300	ton	Prill	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.02	0.007	0.00106					lb/ton	AP-42, Table 8.3-2 (7/93), Bulk Loading - unctrl; PM10/PM2.5 Ch. 13.2.4
CS1L	Cement/Shotcrete Silo #1 Loading	80	80	60,000	ton	Cement	8,760	Typical Ind. Oper.	0.73	0.47	0.07117					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading; PM2.5 Ch. 13.2.4
CS1U	Cement/Shotcrete Silo #1 Unloading	20	80	60,000	ton	Cement	8,760	Typical Ind. Oper.	0.0048	0.0028	0.0004					lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4.
CS2L	Cement/Shotcrete Silo #2 Loading	80	80	60,000	ton	Cement	8,760	Typical Ind. Oper.	0.73	0.47	0.07117					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading; PM2.5 Ch. 13.2.4
CS2U	Cement/Shotcrete Silo #2 Unloading	20	80	60,000	ton	Cement	8,760	Typical Ind. Oper.	0.0048	0.0028	0.0004					lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4.
CAL	Aggregate Bin Loading	100	2,400	500,000	ton	Aggregate	8,760	Typical Ind. Oper.	0.0069	0.0033	0.0005					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4.
CAU	Aggregate Bin Unloading	100	2,400	500,000	ton	Aggregate	8,760	Typical Ind. Oper.	0.0069	0.0033	0.0005					lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4.
CM	Central Mixer Loading	20 (120)	80 (2,480)	60,000 (560K)	ton-cement (tot.)	Cement (mix)	8,760	Typical Ind. Oper.	0.572	0.156	0.0236					lb/ton	AP-42, Table 11.12-2 (6/06), central mixer

SOURCE DESCRIPTION		HOURLY EMISSIONS							DAILY EMISSIONS							ANNUAL EMISSIONS						
Model ID	Source Description	PM lb/hr	PM_{10} lb/hr	$PM_{2.5}$ lb/hr	CO lb/hr	NOx lb/hr	SO_2 lb/hr	VOC lb/hr	PM lb/day	PM_{10} lb/day	$PM_{2.5}$ lb/day	CO lb/day	NOx lb/day	SO_2 lb/day	VOC lb/day	PM ton/yr	PM_{10} ton/yr	$PM_{2.5}$ ton/yr	CO ton/yr	NOx ton/yr	SO_2 ton/yr	VOC ton/yr
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	9.60E-2	5.60E-2	8.00E-3					2.30	1.34	0.19					4.20E-2	2.45E-2	3.50E-3				
ACS4L	AC Lime Silo #4 Loading	87.60	56.40	8.54					365	235	35.59					3.19	2.06	0.31				
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	9.60E-2	5.60E-2	8.00E-3					2.30	1.34	0.19					2.10E-2	1.23E-2	1.75E-3				
CKD	Carbon Regeneration Kiln (Drum)	1.40	1.40	1.40	0.12	1.20E-2		0.11	33.60	33.60	33.60	2.88	0.29	0.00E+0	2.64	6.13	6.13	6.13	0.53	5.26E-2		0.48
CKB	Carbon Regeneration Kiln (Burners)	1.73E-2	1.73E-2	1.73E-2	0.18	0.32	3.92E-2	1.97E-2	0.41	0.41	0.41	4.44	7.69	0.94	0.47	7.56E-2	7.56E-2	7.56E-2	0.81	1.40	0.17	8.64E-2
EW	Electrowinning Cells and Pregnant Solution Tank																					
MR	Mercury Retort																					
MF	Induction Melting Furnace	5.68	5.68	5.68					68.14	68.14	68.14					1.77	1.77	1.77				
EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0.44	0.44	0.44	7.72	14.11	1.45E-2	2.87	0.44	0.44	0.44	7.72	14.11	1.45E-2	2.87	2.20E-2	2.20E-2	2.20E-2	0.39	0.71	7.24E-4	0.14
EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0.44	0.44	0.44	7.72	14.11	1.45E-2	2.87	0.44	0.44	0.44	7.72	14.11	1.45E-2	2.87	2.20E-2	2.20E-2	2.20E-2	0.39	0.71	7.24E-4	0.14
EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0.44	0.44	0.44	7.72	14.11	1.45E-2	2.87	0.44	0.44	0.44	7.72	14.11	1.45E-2	2.87	2.20E-2	2.20E-2	2.20E-2	0.39	0.71	7.24E-4	0.14
EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	8.82E-2	8.82E-2	8.82E-2	1.54	1.76	2.90E-3	1.76	8.82E-2	8.82E-2	8.82E-2	1.54	1.76	2.90E-3	1.76	4.41E-3	4.41E-3	4.41E-3	7.72E-2	8.82E-2	1.45E-4	8.82E-2
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7.65E-4	7.65E-4	7.65E-4	8.20E-3	1.42E-2	1.74E-3	8.74E-4	1.84E-2	1.84E-2	1.84E-2	0.20	0.34	4.17E-2	2.10E-2	3.35E-3	3.35E-3	3.35E-3	3.59E-2	6.22E-2	7.61E-3	3.83E-3
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	3.83E-2	3.83E-2	3.83E-2	0.41	0.71	8.69E-2	4.37E-2	0.92	0.92	0.92	9.84	17.05	2.09	1.05	0.17	0.17	0.17	1.80	3.11	0.38	0.19
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	3.06E-2	3.06E-2	3.06E-2	0.33	0.57	6.95E-2	3.50E-2	0.73	0.73	0.73	7.87	13.64	1.67	0.84	0.13	0.13	0.13	1.44	2.49	0.30	0.15
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	3.06E-2	3.06E-2	3.06E-2	0.33	0.57	6.95E-2	3.50E-2	0.73	0.73	0.73	7.87	13.64	1.67	0.84	0.13	0.13	0.13	1.44	2.49	0.30	0.15
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	3.06E-2	3.06E-2	3.06E-2	0.33	0.57	6.95E-2	3.50E-2	0.73	0.73	0.73	7.87	13.64	1.67	0.84	0.13	0.13	0.13	1.44	2.49	0.30	0.15
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	1.91E-3	1.91E-3	1.91E-3	2.05E-2	3.55E-2	4.34E-3	2.19E-3	4.59E-2	4.59E-2	4.59E-2	0.49	0.85	0.10	5.25E-2	8.38E-3	8.38E-3	8.38E-3	8.98E-2	0.16	1.90E-2	9.57E-3
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	1.91E-3	1.91E-3	1.91E-3	2.05E-2	3.55E-2	4.34E-3	2.19E-3	4.59E-2	4.59E-2	4.59E-2	0.49	0.85	0.10	5.25E-2	8.38E-3	8.38E-3	8.38E-3	8.98E-2	0.16	1.90E-2	9.57E-3
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	1.91E-3	1.91E-3	1.91E-3	2.05E-2	3.55E-2	4.34E-3	2.19E-3	4.59E-2	4.59E-2	4.59E-2	0.49	0.85	0.10	5.25E-2	8.38E-3	8.38E-3	8.38E-3	8.98E-2	0.16	1.90E-2	9.57E-3
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	3.83E-3	3.83E-3	3.83E-3	4.10E-2	7.10E-2	8.69E-3	4.37E-3	9.18E-2	9.18E-2	9.18E-2	0.98	1.70	0.21	0.10	1.68E-2	1.68E-2	1.68E-2	0.18	0.31	3.81E-2	1.91E-2
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	1.53E-2	1.53E-2	1.53E-2	0.16	0.28	3.48E-2	1.75E-2	0.37	0.37	0.37	3.93	6.82	0.83	0.42	6.70E-2	6.70E-2	6.70E-2	0.72	1.24	0.15	7.66E-2
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	2.30E-2	2.30E-2	2.30E-2	0.25	0.43	5.21E-2	2.62E-2	0.55	0.55	0.55	5.90	10.23	1.25	0.63	0.10	0.10	0.10	1.08	1.87	0.23	0.11
PSL	Prill Silos Loading (2 x 100 ton)	4.00	1.40	0.21					4.00	1.40	0.21					7.30E-2	2.56E-2	3.87E-3				
PSU	Prill Silos Unloading (2 x 100 ton)	4.00	1.40	0.21					4.00	1.40	0.21					7.30E-2	2.56E-2	3.87E-3				
CS1L	Cement/Shotcrete Silo #1 Loading	58.40	37.60	5.69					58.40	37.60	5.69					21.90	14.10	2.14				
CS1U	Cement/Shotcrete Silo #1 Unloading	9.60E-2	5.60E-2	8.00E-3					0.38	0.22	3.20E-2					0.14	8.40E-2	1.20E-2				
CS2L	Cement/Shotcrete Silo #2 Loading	58.40	37.60	5.69					58.40	37.60	5.69					21.90	14.10	2.14				
CS2U	Cement/Shotcrete Silo #2 Unloading	9.60E-2	5.60E-2	8.00E-3					0.38	0.22	3.20E-2					0.14	8.40E-2	1.20E-2				
CAL	Aggregate Bin Loading	0.69	0.33	5.00E-2					16.56	7.92	1.20					1.73	0.83	0.13				
CAU	Aggregate Bin Unloading	0.69	0.33	5.00E-2					16.56	7.92	1.20					1.73	0.83	0.13				
CM	Central Mixer Loading	11.44	3.12	0.47					45.76	12.48	1.89					17.16	4.68	0.71				

SOURCE DESCRIPTION		OPERATING LIMITS							EMISSION FACTORS								
Model	Source Description	Design Throughput						reference	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	unit	reference
ID		unit/hr	unit/day	unit/yr	units	Material	hr/yr										
TG1	Mine Site Gasoline Tank #1			250,000	gal	Gasoline	8,760	(Midas Gold 2016), Table 12-4, annual use.							0.219	lb/hr	EPA Tanks 4.0.9d
TG2	Mine Site Gasoline Tank #2			250,000	gal	Gasoline	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide tank capacity)							0.219	lb/hr	EPA Tanks 4.0.9d
TD3	Mine Site Diesel Tank #3			725,000	gal	Diesel	8,760	(Midas Gold 2016), (Midas Gold 2018c)							0.002	lb/hr	EPA Tanks 4.0.9d
TD4	Mine Site Diesel Tank #4			725,000	gal	Diesel	8,760	(Midas Gold 2016), (Midas Gold 2018c)							0.002	lb/hr	EPA Tanks 4.0.9d
TD5	Mine Site Diesel Tank #5			725,000	gal	Diesel	8,760	(Midas Gold 2016), (Midas Gold 2018c)							0.002	lb/hr	EPA Tanks 4.0.9d
TD6	Mine Site Diesel Tank #6			725,000	gal	Diesel	8,760	(Midas Gold 2016), (Midas Gold 2018c)							0.002	lb/hr	EPA Tanks 4.0.9d
TD7	Mine Site Diesel Tank #7			725,000	gal	Diesel	8,760	(Midas Gold 2016), (Midas Gold 2018c)							0.002	lb/hr	EPA Tanks 4.0.9d
TD8	Mine Site Diesel Tank #8			725,000	gal	Diesel	8,760	(Midas Gold 2016), (Midas Gold 2018c)							0.002	lb/hr	EPA Tanks 4.0.9d
TD9	Mine Site Diesel Tank #9			725,000	gal	Diesel	8,760	(Midas Gold 2016), (Midas Gold 2018c)							0.002	lb/hr	EPA Tanks 4.0.9d
TD10	Mine Site Diesel Tank #10			725,000	gal	Diesel	8,760	(Midas Gold 2016), (Midas Gold 2018c)							0.002	lb/hr	EPA Tanks 4.0.9d
PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	83	2,000	730,000	ton	Aggregate	8,760	(Midas Gold 2019c)	0.0758	0.0277	0.00421					lb/ton	AP-42, Table 11.19.2-2 (08/04): Tert. Crushing - ctrl. × 2 + Screening - ctrl. × 2 + Conv. Transfer - ctrl. × 5
PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	83	2,000	730,000	ton	Aggregate	8,760	(Midas Gold 2019c)	0.0758	0.0277	0.00421					lb/ton	AP-42, Table 11.19.2-2 (08/04): Tert. Crushing - ctrl. × 2 + Screening - ctrl. × 2 + Conv. Transfer - ctrl. × 5
TRUE	LIME PRODUCTION																
LS1	Limestone transfer to Primary Crusher Hopper	47.08	1,130	317,907	ton	Limestone	8,760	(Midas Gold 2018d)	0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
LS2	Primary Crushing and Associated Transfers In and Out	47.08	1,130	317,907	ton	Limestone	8,760		0.0054	0.0024	0.00036					lb/ton	AP-42, Table 11.19.2-2 (08/04) Tert. Crush - unctrl.; PM2.5 Ch. 13.2.4
LS3	Primary Screening and Associated Transfers In and Out	47.08	1,130	317,907	ton	Limestone	8,760		0.025	0.0087	0.00132					lb/ton	AP-42, Table 11.19.2-2 (08/04) Screening - unctrl.; PM2.5 Ch. 13.2.4
LS4	Secondary Crushing and Associated Transfers In and Out	47.08	1,130	317,907	ton	Limestone	8,760		0.0054	0.0024	0.00036					lb/ton	AP-42, Table 11.19.2-2 (08/04) Tert. Crush - unctrl.; PM2.5 Ch. 13.2.4
LS5	Secondary Screening and Associated Transfers In and Out	47.08	1,130	317,907	ton	Limestone	8,760		0.025	0.0087	0.00132					lb/ton	AP-42, Table 11.19.2-2 (08/04) Screening - unctrl.; PM2.5 Ch. 13.2.4
LS6	Limestone transfer to Ball Mill Feed Bin	47.08	1,130	317,907	ton	Limestone	8,760	0	0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
LS7	Limestone transfer to Ball Mill Feed Conveyor	47.08	1,130	317,907	ton	Limestone	8,760		0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
LS8	Ball Mill Feed transfer to Ball Mill	47.08	1,130	317,907	ton	Limestone	8,760	0	0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
LSBM	Limestone Ball Mill	47.08	1,130	317,907	ton	Limestone	8,760		0.404	0.339	0.121					lb/ton	AP-42, Table 11.19.2-4 (08/04) Dry Grind. with Fabric Filter, Assumed 90% BH ctrl
LS9	Limestone transfer to Kiln Feed Bin	11.13	267	82,688	ton	Limestone	8,760		0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
LS10	Limestone transfer to Lime Kiln Feed Conveyor	11.13	267	82,688	ton	Limestone	8,760		0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
LS11	Fines Screening and Associated Transfers In and Out	11.13	267	82,688	ton	Limestone	8,760		0.025	0.0087	0.00132					lb/ton	AP-42, Table 11.19.2-2 (08/04) Screening - unctrl.; PM2.5 Ch. 13.2.4
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	11.13	267	82,688	ton	Limestone	8,760	(Midas Gold 2018d)	0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	7.04	169	52,377	ton	Lime	8,760	(Midas Gold 2018d)	1.3	1.3	1.3	0.45	0.24	0.0012		lb/ton	AP-42 Tables 11.17-2, 6 : Gas-Fired Parallel Flow Regenetive Kiln with Fabric Filter (PM = 5x EF), Assumed 90% BH ctrl.
LKC	PFR Shaft Lime Kiln Combustion	22.04	529	163,935	MMBtu	Propane	8,760	Based on 870 kcal/kg (Maerz 2018)	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
LCR	Lime Mill Crushing and associated transfers In and Out	7.04	169	52,377	ton	Lime	8,760		0.404	0.339	0.121					lb/ton	AP-42, Table 11.19.2-4 (08/04) Dry Grind. with Fabric Filter, Assumed 90% BH ctrl.
LSL	Pebble Lime Silo Loading via Bucket Elevator	7.04	169	52,377	ton	Lime	8,760		0.0088	0.0088	0.0088					lb/ton	AP-42 Table 11.17-4: Crushed Material Conveyor Transfer with Fabric Filter (PM = 10 x EF), Assumed 90% BH ctrl.
LSU	Pebble Lime Silo discharge to Lime Slaker	7.04	169	52,377	ton	Lime	8,760		0.00088	0.00088	0.00088					lb/ton	AP-42 Table 11.17-4: Crushed Material Conveyor Transfer with Fabric Filter, Assumed 90% BH ctrl.
Total																	

SOURCE DESCRIPTION		HOURLY EMISSIONS							DAILY EMISSIONS							ANNUAL EMISSIONS						
Model ID	Source Description	PM lb/hr	PM_{10} lb/hr	$PM_{2.5}$ lb/hr	CO lb/hr	NOx lb/hr	SO_2 lb/hr	VOC lb/hr	PM lb/day	PM_{10} lb/day	$PM_{2.5}$ lb/day	CO lb/day	NOx lb/day	SO_2 lb/day	VOC lb/day	PM ton/yr	PM_{10} ton/yr	$PM_{2.5}$ ton/yr	CO ton/yr	NOx ton/yr	SO_2 ton/yr	VOC ton/yr
TG1	Mine Site Gasoline Tank #1							0.22							5.25							0.96
TG2	Mine Site Gasoline Tank #2							0.22							5.25							0.96
TD3	Mine Site Diesel Tank #3							1.67E-3							4.00E-2							7.30E-3
TD4	Mine Site Diesel Tank #4							1.67E-3							4.00E-2							7.30E-3
TD5	Mine Site Diesel Tank #5							1.67E-3							4.00E-2							7.30E-3
TD6	Mine Site Diesel Tank #6							1.67E-3							4.00E-2							7.30E-3
TD7	Mine Site Diesel Tank #7							1.67E-3							4.00E-2							7.30E-3
TD8	Mine Site Diesel Tank #8							1.67E-3							4.00E-2							7.30E-3
TD9	Mine Site Diesel Tank #9							1.67E-3							4.00E-2							7.30E-3
TD10	Mine Site Diesel Tank #10							1.67E-3							4.00E-2							7.30E-3
PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	6.32	2.31	0.35					152	55.40	8.42					27.67	10.11	1.54				
PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	6.32	2.31	0.35					152	55.40	8.42					27.67	10.11	1.54				
TRUE	LIME PRODUCTION																					
LS1	Limestone transfer to Primary Crusher Hopper	0.14	5.18E-2	8.00E-3					3.39	1.24	0.19					0.48	0.17	2.70E-2				
LS2	Primary Crushing and Associated Transfers In and Out	0.25	0.11	1.69E-2					6.10	2.71	0.41					0.86	0.38	5.72E-2				
LS3	Primary Screening and Associated Transfers In and Out	1.18	0.41	6.21E-2					28.25	9.83	1.49					3.97	1.38	0.21				
LS4	Secondary Crushing and Associated Transfers In and Out	0.25	0.11	1.69E-2					6.10	2.71	0.41					0.86	0.38	5.72E-2				
LS5	Secondary Screening and Associated Transfers In and Out	1.18	0.41	6.21E-2					28.25	9.83	1.49					3.97	1.38	0.21				
LS6	Limestone transfer to Ball Mill Feed Bin	0.14	5.18E-2	8.00E-3					3.39	1.24	0.19					0.48	0.17	2.70E-2				
LS7	Limestone transfer to Ball Mill Feed Conveyor	0.14	5.18E-2	8.00E-3					3.39	1.24	0.19					0.48	0.17	2.70E-2				
LS8	Ball Mill Feed transfer to Ball Mill	0.14	5.18E-2	8.00E-3					3.39	1.24	0.19					0.48	0.17	2.70E-2				
LSBM	Limestone Ball Mill	19.02	15.96	5.70					456	383	137					64.22	53.89	19.23				
LS9	Limestone transfer to Kiln Feed Bin	3.34E-2	1.22E-2	1.89E-3					0.80	0.29	4.54E-2					0.12	4.55E-2	7.03E-3				
LS10	Limestone transfer to Lime Kiln Feed Conveyor	3.34E-2	1.22E-2	1.89E-3					0.80	0.29	4.54E-2					0.12	4.55E-2	7.03E-3				
LS11	Fines Screening and Associated Transfers In and Out	0.28	9.68E-2	1.47E-2					6.68	2.32	0.35					1.03	0.36	5.46E-2				
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	3.34E-2	1.22E-2	1.89E-3					0.80	0.29	4.54E-2					0.12	4.55E-2	7.03E-3				
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	9.15	9.15	9.15	3.17	1.69	8.45E-3		220	220	220	76.05	40.56	0.20		34.05	34.05	34.05	11.78	6.29	3.14E-2	
LKC	PFR Shaft Lime Kiln Combustion	0.17	0.17	0.17	1.81	3.13	0.38	0.19	4.05	4.05	4.05	43.36	75.15	9.19	4.62	0.63	0.63	0.63	6.72	11.65	1.42	0.72
LCR	Lime Mill Crushing and associated transfers In and Out	2.84	2.39	0.85					68.28	57.29	20.45					10.58	8.88	3.17				
LSL	Pebble Lime Silo Loading via Bucket Elevator	6.20E-2	6.20E-2	6.20E-2					1.49	1.49	1.49					0.23	0.23	0.23				
LSU	Pebble Lime Silo discharge to Lime Slaker	6.20E-3	6.20E-3	6.20E-3					0.15	0.15	0.15					2.30E-2	2.30E-2	2.30E-2				
Total		**699**	**443**	**102**	**33.50**	**55.37**	**1.88**	**11.51**	**5,964**	**3,786**	**1,316**	**204**	**259**	**37.21**	**34.53**	**565**	**342**	**169**	**30.45**	**37.85**	**6.48**	**4.78**

Appendix C – Modeling Scenario Result Tables

Scenario B1 Modeling Results Summary

Pollutant	Averaging Time	Maximum Modeled Concentration (µg/m³)	
		BULKRN	Non-BULKRN
CO	8 hours	986	723
	1 hour	7,407	3,772
NO_2	1 year	1.8	1.4
	1 hour	116.7	56.2
$PM_{2.5}$	1 year	1.1	0.7
	24 hours	2.8	2.0
PM_{10}	24 hours	11.5	8.4
SO_2	3 hours	1.8	1.2
	1 hour	3.2	2.7

Scenario B2 Modeling Results Summary

Pollutant	Averaging Time	Maximum Modeled Concentration (µg/m³)	
		BULKRN	Non-BULKRN
CO	8 hours	--	--
	1 hour	--	--
NO_2	1 year	--	--
	1 hour	--	--
$PM_{2.5}$	1 year	0.7	0.5
	24 hours	2.1	1.5
PM_{10}	24 hours	7.9	7.9
SO_2	3 hours	--	--
	1 hour	--	--

Scenario H1 Modeling Results Summary

Pollutant	Averaging Time	Maximum Modeled Concentration (µg/m³)	
		BULKRN	Non-BULKRN
CO	8 hours	1,023	580
	1 hour	4,884	4,643
NO_2	1 year	1.8	1.4
	1 hour	73.0	53.3
$PM_{2.5}$	1 year	1.1	0.8
	24 hours	3.0	2.1
PM_{10}	24 hours	9.9	9.1
SO_2	3 hours	1.8	1.2
	1 hour	3.2	2.6

PRI00000573

REC 1913

Scenario H2 Modeling Results Summary

Pollutant	Averaging Time	Maximum Modeled Concentration (µg/m³)	
		BULKRN	Non-BULKRN
CO	8 hours	--	--
	1 hour	--	--
NO_2	1 year	--	--
	1 hour	--	--
$PM_{2.5}$	1 year	2.0	1.3
	24 hours	4.6	3.0
PM_{10}	24 hours	24.5	14.8
SO_2	3 hours	--	--
	1 hour	--	--

Scenario H3 Modeling Results Summary

Pollutant	Averaging Time	Maximum Modeled Concentration (µg/m³)	
		BULKRN	Non-BULKRN
CO	8 hours	--	--
	1 hour	--	--
NO_2	1 year	--	--
	1 hour	--	--
$PM_{2.5}$	1 year	1.0	0.7
	24 hours	2.7	2.1
PM_{10}	24 hours	9.3	9.3
SO_2	3 hours	--	--
	1 hour	--	--

Scenario H4 Modeling Results Summary

Pollutant	Averaging Time	Maximum Modeled Concentration (µg/m³)	
		BULKRN	Non-BULKRN
CO	8 hours	--	--
	1 hour	--	--
NO_2	1 year	--	--
	1 hour	--	--
$PM_{2.5}$	1 year	1.0	0.7
	24 hours	2.8	2.0
PM_{10}	24 hours	8.9	8.9
SO_2	3 hours	--	--
	1 hour	--	--

PRI00000574

REC 1914

Scenario W1 Modeling Results Summary

Pollutant	Averaging Time	Maximum Modeled Concentration (µg/m³)	
		BULKRN	Non-BULKRN
CO	8 hours	6,218	3,516
	1 hour	17,054	9,467
NO_2	1 year	2.3	1.4
	1 hour	114.9	111.0
$PM_{2.5}$	1 year	7.1	4.0
	24 hours	17.2	10.3
PM_{10}	24 hours	116.6	73.6
SO_2	3 hours	1.8	1.2
	1 hour	3.2	2.6

Scenario W2 Modeling Results Summary

Pollutant	Averaging Time	Maximum Modeled Concentration (µg/m³)	
		BULKRN	Non-BULKRN
CO	8 hours	--	--
	1 hour	--	--
NO_2	1 year	--	--
	1 hour	--	--
$PM_{2.5}$	1 year	6.1	3.6
	24 hours	14.5	8.8
PM_{10}	24 hours	102.6	62.9
SO_2	3 hours	--	--
	1 hour	--	--

Scenario W3 Modeling Results Summary

Pollutant	Averaging Time	Maximum Modeled Concentration (µg/m³)	
		BULKRN	Non-BULKRN
CO	8 hours	--	--
	1 hour	--	--
NO_2	1 year	--	--
	1 hour	--	--
$PM_{2.5}$	1 year	7.0	4.0
	24 hours	17.1	10.3
PM_{10}	24 hours	116.9	73.4
SO_2	3 hours	--	--
	1 hour	--	--

PRI00000575

REC 1915

Scenario W4 Modeling Results Summary

Pollutant	Averaging Time	Maximum Modeled Concentration (µg/m³)	
		BULKRN	Non-BULKRN
CO	8 hours	--	--
	1 hour	--	--
NO_2	1 year	--	--
	1 hour	--	--
$PM_{2.5}$	1 year	6.0	3.3
	24 hours	14.5	8.6
PM_{10}	24 hours	102.0	62.7
SO_2	3 hours	--	--
	1 hour	--	--

Scenario W5 Modeling Results Summary

Pollutant	Averaging Time	Maximum Modeled Concentration (µg/m³)	
		BULKRN	Non-BULKRN
CO	8 hours	--	--
	1 hour	--	--
NO_2	1 year	--	--
	1 hour	--	--
$PM_{2.5}$	1 year	7.7	4.2
	24 hours	18.6	11.0
PM_{10}	24 hours	121.5	75.7
SO_2	3 hours	--	--
	1 hour	--	--

Scenario Y1 Modeling Results Summary

Pollutant	Averaging Time	Maximum Modeled Concentration (µg/m³)	
		BULKRN	Non-BULKRN
CO	8 hours	652	652
	1 hour	5,217	5,217
NO_2	1 year	1.8	1.4
	1 hour	59.8	59.8
$PM_{2.5}$	1 year	0.6	0.6
	24 hours	1.4	1.2
PM_{10}	24 hours	10.0	9.8
SO_2	3 hours	1.8	1.2
	1 hour	3.2	2.6

PRI00000576

REC 1916

Scenario Y2 Modeling Results Summary

Pollutant	Averaging Time	Maximum Modeled Concentration (µg/m³)	
		BULKRN	Non-BULKRN
CO	8 hours	--	--
	1 hour	--	--
NO_2	1 year	--	--
	1 hour	--	--
$PM_{2.5}$	1 year	2.0	1.2
	24 hours	4.7	3.0
PM_{10}	24 hours	25.3	15.2
SO_2	3 hours	--	--
	1 hour	--	--

Scenario Y3 Modeling Results Summary

Pollutant	Averaging Time	Maximum Modeled Concentration (µg/m³)	
		BULKRN	Non-BULKRN
CO	8 hours	--	--
	1 hour	--	--
NO_2	1 year	--	--
	1 hour	--	--
$PM_{2.5}$	1 year	0.8	0.6
	24 hours	2.2	1.6
PM_{10}	24 hours	10.4	9.9
SO_2	3 hours	--	--
	1 hour	--	--

PRI00000577

REC 1917

Scenario B1 TAP Modeling Results Summary

Pollutant	Averaging Time	Maximum Modeled Concentration (µg/m³)	
		BULKRN	Non-BULKRN
Antimony	24 hours	0.0271	0.0208
Arsenic	Annual	0.00008	0.00012
Cadmium	Annual	0.00001	0.00001
Formaldehyde	Annual	0.00076	0.00039
Nickel	Annual	0.00006	0.00004
Sulfuric Acid	24 hours	0.526	0.463

Scenario H1 TAP Modeling Results Summary

Pollutant	Averaging Time	Maximum Modeled Concentration (µg/m³)	
		BULKRN	Non-BULKRN
Antimony	24 hours	0.0270	0.0207
Arsenic	Annual	0.00008	0.00011
Cadmium	Annual	0.00001	0.00001
Formaldehyde	Annual	0.00076	0.00039
Nickel	Annual	0.00006	0.00004
Sulfuric Acid	24 hours	0.526	0.463

Scenario W1 TAP Modeling Results Summary

Pollutant	Averaging Time	Maximum Modeled Concentration (µg/m³)	
		BULKRN	Non-BULKRN
Antimony	24 hours	0.0270	0.0207
Arsenic	Annual	0.00008	0.00011
Cadmium	Annual	0.00001	0.00001
Formaldehyde	Annual	0.00076	0.00039
Nickel	Annual	0.00006	0.00004
Sulfuric Acid	24 hours	0.526	0.463

PRI00000578

REC 1918

Scenario Y1 TAP Modeling Results Summary

Pollutant	Averaging Time	Maximum Modeled Concentration (µg/m³)	
		BULKRN	Non-BULKRN
Antimony	24 hours	0.0270	0.0207
Arsenic	Annual	0.00008	0.00011
Cadmium	Annual	0.00001	0.00001
Formaldehyde	Annual	0.00076	0.00039
Nickel	Annual	0.00006	0.00004
Sulfuric Acid	24 hours	0.526	0.463

PRI00000579

REC 1919

Appendix D – Electronic Files

Perpetua Resources Corp.
405 S. 8th Street, Ste 201
Boise, ID 83702
Tel: 208.901.3060
www.perpetuaresources.com

October 6, 2021

Kelli Wetzel
Permit Writer, Air Quality Division
Idaho Department of Environmental Quality
1410 North Hilton
Boise, ID 83706

Subject: **Facility ID No. 085-00011, Perpetua Resources Idaho, Inc., Stibnite Gold Project –TAP Addendum Report**

Dear **Ms. Wetzel**:

Perpetual Resources, Inc. is providing the enclosed TAP Addendum report (Addendum) for the Stibnite Gold Project. The Addendum contains the hazardous air pollutant (HAP) and toxic air pollutant (TAP) emissions calculations provided in the PTC application and as requested by IDEQ, supplements that information to support IDEQ's responses to comments.

If you have any questions regarding this submittal, please contact me at 208-901-3053 or alan.haslam@perpetua.us.

Thank you for reviewing this information.

Sincerely,
Perpetua Resources

Alan Haslam
Vice President – Permitting

Enclosure: TAP Addendum Report

AIR SCIENCES INC.

DENVER • PORTLAND • LOS ANGELES

Stibnite Gold Project Permit to Construct Application

TAP Addendum

Prepared For:

PERPETUA RESOURCES IDAHO, INC.

PROJECT NO. 335-21-404
OCTOBER 5, 2021

TABLE OF CONTENTS

1.0 Introduction 1

2.0 HAP/TAP Emissions 2

2.1 Description of HAP Source Status 3

2.1.1 Controlled HAP Emissions 3

2.1.2 Uncontrolled HAP Emissions 3

2.2 Description of HAP/TAP Emission Calculations 3

2.2.1 Metal Emissions from Mining Fugitive Dust 3

2.2.2 Metal Emissions from Ore Processing and Lime/Aggregate Production 4

2.2.2.1 Crushing, Screening, and Material Handling 4

2.2.2.2 Lime Kiln 5

2.2.2.3 Autoclave 5

2.2.2.4 EW Cells, Pregnant Solution Tank, Retort, Furnace, and Carbon Kiln 5

2.2.2.5 Antimony Dryer and Dry Bagging 6

2.2.3 Metal Emissions from Concrete Production 6

2.2.4 H_2SO_4 and H_2S Emissions from the Autoclave 6

2.2.5 HCl Emissions from the Lime Kiln 6

2.2.6 HCN Emissions from Cyanide Leaching and Tailings Storage Facility 6

2.2.7 HAP/TAP Emissions from Fuel Storage and Fuel Combustion 6

2.2.8 Carbon Disulfide Emissions from Xanthate 7

2.2.9 Evaporative Mercury Emissions from Mining Surfaces 7

3.0 TAP Analysis 8

3.1 Equipment or Activities Covered or Addressed by NESHAP or NSPS 8

3.1.1 NESHAP Subpart ZZZZ 8

3.1.2 NESHAP Subpart AAAAA 9

3.1.3 NESHAP Subpart CCCCCC 9

3.1.4 NESHAP Subpart EEEEEEE 9

3.1.5 NSPS Subpart LL 10

3.1.6 NSPS Subpart OOO 10

3.2 Metals Review for TAP Provisions Applicability 10

3.3 Screening Level Analysis of TAP Emissions 12

3.4 Modeling of TAP Emissions 13

3.4.1 Meteorological Data and Deposition 13
3.4.2 Modeling for Non-Carcinogenic TAPs 16
3.4.3 Modeling Carcinogenic TAPs 19
3.4.4 Carcinogenic TAP Modeling Lifetime Exposure Adjustment 22
3.4.5 Arsenic Compliance Demonstration for Modeling Scenarios W1–W5 22
4.0 Comparison of Actual Arsenic Modeling to Potential Arsenic Modeling 24
5.0 Emission Inventory for Carcinogenic TAPs 27
5.1 Drilling Dust Control System 27
5.2 Haul Road Capping 27
5.3 Long-Term Mining Production Limits 27
5.4 Burntlog Access Road Refinement 28
5.5 Bulldozing Refinement 28
6.0 T-RACT Analysis 29
6.1 Drilling Dust Control System 29
6.2 Haul Road Dust and Arsenic Control 30
6.2.1 Dust Control Technologies 30
6.2.2 Arsenic Control Technologies 33
7.0 Proposed Permit Conditions for Carcinogenic TAP Compliance 34
7.1 Conditions per IDAPA 58.01.01.210.12(d) 34
7.2 Conditions per IDAPA 58.01.01.210.14(e) 34
8.0 Mercury Emissions Analysis 36
9.0 References 38

Tables

Table 1. Metal TAP Concentrations for Limestone and Lime 4
Table 2. Metals Comparison to IDAPA 58.01.01.585-586 TAPs 10
Table 3. TAPs Exceeding the Screening Emission Level 13
Table 4. PM Deposition Parameters by Source Category 14
Table 5. Pit-Specific Ore and DR Densities for Deposition 16
Table 6. Compliance Demonstration for Non-Carcinogenic TAPs 17
Table 7. Comparison of 180,000 T/day and T-RACT Emissions 19
Table 8. Compliance Demonstration for Carcinogenic TAPs 20

PRI00000584

REC 1924

Table 9. Actual Analysis vs. Potential Analysis for Arsenic Lifetime Exposure.....24
Table 10. EPA RBLC Determinations for 90% or Greater Control Efficiency of Unpaved Roads 32
Table 11. Mercury Source and Emissions Summary.....37

Figures

Figure 1. Non-Carcinogenic Maximum TAP Concentration (µg/m^3) Locations.....18
Figure 2. Carcinogenic Maximum TAP Concentration (µg/m^3) Locations.....21
Figure 3. Actual Arsenic Mining Emissions vs. Potential Arsenic Mining Emissions.....26
Figure 4. Actual Arsenic Concentrations (µg/m^3) and Maximum Location.....26
Figure 5. Potential Arsenic Concentrations (µg/m^3) and Maximum Location.....26
Figure 6. Quartzite Rock Areas.....33

Appendices

Appendix A – HAP/TAP Emission Calculations
Appendix B – Modeled Emissions per Modeling Scenario and Source
Appendix C – TAP Modeling Results
Appendix D – Electronic Files

PRI00000585

REC 1925

1.0 INTRODUCTION

On September 10, 2020 and February 18, 2021, the Idaho Department of Environmental Quality (IDEQ) provided notices for public comment on the Perpetua Resources Idaho, Inc. (hereafter referred to as Perpetua Resources) Stibnite Gold Project (SGP) complete application materials (Application), draft permit to construct (Draft PTC), and statement of basis (SOB). The public comments received included requests for additional information regarding hazardous air pollutant (HAP) and toxic air pollutant (TAP) emission estimates and modeling.

The purpose of this TAP Addendum (Addendum) is to provide that additional information to support IDEQ's responses to comments. The information provided in this Addendum confirms the following determinations made by Perpetua Resources and IDEQ at the time of the public notices:

1. The SGP is an area source for HAP emissions.
2. The SGP complies with the Idaho TAP provisions (IDAPA 58.01.01.210).
3. The SGP complies with the Idaho mercury rule (IDAPA 58.01.01.215).

This Addendum supplements information in the complete Application and supports those determinations highlighted during the public comment. Section 2.0 provides a description of the HAP/TAP emission calculations and source status. Section 3.0 provides a TAP emissions evaluation and modeling analysis, including TAP emission sources covered by IDAPA 58.01.01.210.20. Section 4.0 compares arsenic modeling analyses for actual and potential arsenic emissions. Section 5.0 provides a discussion of the emission reductions that demonstrate compliance with carcinogenic TAPs. Section 6.0 provides a Toxic Air Pollutant Reasonably Available Control Technology (T-RACT) analysis. Section 7.0 provides proposed permit conditions for demonstrating compliance with carcinogenic TAPs, and Section 8.0 provides a discussion of mercury emissions, including mercury emission sources covered by IDAPA 58.01.01.215.01.

IDAPA 58.01.01.210 and 215 reduce the information required from a PTC applicant and streamline the PTC review required by IDEQ in those circumstances where the HAP/TAP emissions are covered or addressed by federal regulations (IDAPA 58.01.01.210) or the mercury emissions are below a specific exemption threshold (IDAPA 58.01.01.215). Perpetua Resources referenced these rules in the Application and relied on these provisions to present a complete HAP/TAP emissions inventory that aligned with these rules. To support IDEQ's responses to public comments, IDEQ requested that Perpetua Resources expand its HAP/TAP analyses beyond the requirements of these rules and reconfirm compliance with TAP thresholds. This additional work reconfirms IDEQ's earlier findings that the SGP is an area source, and the proposed HAP/TAP emissions comply with IDAPA 58.01.01.210 and 215.

PRI00000586

REC 1926

2.0 HAP/TAP EMISSIONS

During the two IDEQ public comment periods, IDEQ received comments regarding the following:

1. SGP source status for HAPs
2. Metal HAP/TAP emissions from fugitive dust
3. Metal HAP/TAP emissions from the autoclave and lime kiln processes
4. Fugitive emissions of hydrogen cyanide (HCN)

To support IDEQ's responses to comments and confirm the SGP area source status, the potential-to-emit (PTE)[1] HAP/TAP emission inventory in Appendix A of this Addendum contains emission calculations for all HAPs and TAPs emitted from all the SGP processes, including:

- Metals from mining fugitive dust emissions
- Metals from ore processing, ore concentration and refining, and lime, aggregate, and concrete production
- Antimony (Sb) emissions from the Sb drying and bagging circuit
- Sulfuric acid (H_2SO_4) and hydrogen sulfide (H_2S) from the autoclave, and hydrochloric acid (HCl) emissions and lime kiln
- Evaporative HCN from cyanide leaching and the tailings storage facility
- Various HAPs/TAPs from fuel storage and combustion
- Carbon disulfide emissions from the use of xanthate
- Evaporative mercury from mining surfaces

This HAP/TAP emission inventory was conducted for all 14 modeling scenarios evaluated in the Application. The emissions provided in Appendix A reflect the highest emissions scenario (HAP/TAP Emission Calculations – Scenario W3, 180,000 T/day).[2]

[1] PTE in this Addendum refers to the potential emissions after applying all proposed *air pollution control equipment and restrictions on hours of operation or on the type or amount of material combusted, stored or processed* per IDAPA 58.01.01.006.88 (i.e., PTE is the proposed permitted emissions).

[2] HAP/TAP Emission Calculations – Scenario W3, 180,000 T/day: HAP/TAP emissions based on the potential mining production rate of 180,000 tons per day (T/day) and the highest emissions scenario (Modeling Scenario W3).

PRI00000587

REC 1927

2.1 Description of HAP Source Status

2.1.1 Controlled HAP Emissions

The controlled HAP emissions (PTE) from the SGP are below the major source thresholds; therefore, the SOB classified the SGP as an area source for HAP emissions. This is consistent with EPA's determination that all U.S. gold mine ore processing and production facilities are area sources.[3] The emissions inventory provided in Appendix A shows the total HAP emissions are 3.67 tons per year (ton/yr) for a single HAP and 12.56 ton/yr for all the HAPs combined for the highest emissions scenario (Modeling Scenario W3). The major source levels are 10 ton/yr for a single HAP and/or 25 ton/yr for all the HAPs combined.

2.1.2 Uncontrolled HAP Emissions

Uncontrolled HAP emissions are estimated to exceed 25 ton/yr, combined; therefore, to support the area source designation, Perpetua Resources committed to operational limitations and emission controls in the Application that achieve area source status.

2.2 Description of HAP/TAP Emission Calculations

This section provides a brief description of the methods used to calculate the HAP/TAP emissions provided in Appendix A. The references used for the HAP/TAP calculations were presented in the Application. Any new references are provided in this section.

2.2.1 Metal Emissions from Mining Fugitive Dust

The metal HAP/TAP emissions from fugitive dust generated by mining activities (drilling, blasting, excavating, hauling, etc.) were calculated by multiplying the HAP/TAP-specific median metal concentration in the ore[4] by the activity-specific total particulate matter (PM) emissions. The median metal concentrations were derived from over 55,000 core samples taken primarily from the more mineralized zones of the SGP pits (i.e., in and around gold ore deposits).

This emissions inventory does not reflect any of the emission reductions described in Section 5.0 for carcinogenic TAP compliance.

[3] *EPA recently gathered data and evaluated emissions of other HAP, including cyanide and non-mercury metals. The data indicate that the gold mining processing and production category consists of only area sources (i.e., facilities that emit less than ten tons per year of any one HAP and less than 25 tons per year of any combination of HAP)* (EPA 2010).

[4] Iron (Fe) and selenium (Se) were not included in the Application because the concentrations of these metals were similar to typical crustal abundance levels. In response to comments on HAPs/TAPs emissions, the concentrations of these metals (18,200 ppm of Fe and 0.4 ppm of Se) are provided (Midas Gold 2020).

PRI00000588

REC 1928

2.2.2 Metal Emissions from Ore Processing and Lime/Aggregate Production

2.2.2.1 Crushing, Screening, and Material Handling

The metal HAP/TAP emissions generated by process and production sources (the crushing, screening, and handling of ore, limestone, lime, and aggregate) were calculated by multiplying the PM emissions from these sources by the median concentration of metals in the ore, limestone, lime, or aggregate. The ore median metal concentrations are discussed in Section 2.2.1. The limestone, lime, and aggregate metal concentrations are provided in Table 1.

The limestone metal concentrations were measured from core hole samples through the middle marble formation in the proposed limestone quarry's footprint. These rock samples were specifically analyzed to assess the formation as a viable limestone source. As a conservative estimate, the limestone metal profile was also used for aggregate production.

Table 1. Metal TAP Concentrations for Limestone and Lime

CAS	TAP Name	Concentration (ppm) [1]
7440-38-2	Arsenic	23
7440-41-7	Beryllium	0.8
7440-43-9	Cadmium	0.25
7440-48-4	Cobalt	4
7440-47-3	Chromium	15
7439-97-6	Mercury	0.02
7439-96-5	Manganese	236.5
7440-02-0	Nickel	5
7439-92-1	Lead	3
7440-36-0	Antimony	2.5
7723-14-0	Phosphorus	130
7440-22-4	Silver	0
7429-90-5	Aluminum	22,600
7440-39-3	Barium	145
1317-65-3	Calcium Carbonate [2]	274,500
1305-78-8	Calcium Oxide [3]	740,000
7440-50-8	Copper	5
7439-89-6	Iron	10,350
7439-98-7	Molybdenum	0.5
7440-28-0	Thallium	5
7440-61-1	Uranium	5

PRI00000589

REC 1929

CAS	TAP Name	Concentration (ppm) [1]
7440-62-2	Vanadium	15.5
7440-33-7	Tungsten	5
7440-66-6	Zinc	18

[1] Median of 98 samples of the SGP limestone material (M3 2018).
[2] Calcium carbonate ($CaCO_3$) is used for limestone processing.
[3] Calcium oxide (CaO) is used for lime processing. 40% to 74% CaO (NLA 2007).

2.2.2.2 Lime Kiln

The non-mercury metal HAP/TAP emissions from the lime kiln were calculated by multiplying the PM emissions by the median concentration of metals in the limestone shown in Table 1. The mercury emissions from the lime kiln were conservatively estimated by assuming all mercury in the limestone feed is volatilized and emitted.

2.2.2.3 Autoclave

Mercury emissions from the SGP autoclave were based on the SysCAD modeling of the SGP autoclave performed by Perpetua Resources' engineering contractor: M3 Engineering. This modeling predicted 0.0105 grams per second of mercury emissions exiting the autoclave mercury control system, which is comprised of a venturi scrubber, a vent gas cleaning tower, a vent gas steam condensation tower, and one or more sulfur-impregnated activated carbon filters.

The non-mercury metal HAP/TAP emissions from the autoclave mercury control system are expected to be less than the mercury emissions because non-mercury HAP/TAP emissions are only particulates and more easily controlled by the emissions control system. Mercury emissions move through the control system as both particulate and gas. For this review, the non-mercury HAP/TAP emissions were conservatively assumed to be equal to the mercury emissions.

2.2.2.4 EW Cells, Pregnant Solution Tank, Retort, Furnace, and Carbon Kiln

Mercury emissions from the SGP electrowinning (EW) cells, pregnant solution tank, mercury retort, induction melting furnace, and carbon regeneration kiln were calculated based on stack test data from similar sources utilizing similar mercury control systems at Nevada gold mines.

The non-mercury metal HAP/TAP emissions exiting these mercury control systems are expected to be less than the mercury emissions because non-mercury HAP/TAP emissions are only particulates and more easily controlled by the emissions control system. Mercury emissions move through the control system as both particulate and gas. For this review, the non-mercury HAP/TAP emissions were conservatively assumed to be equal to the respective mercury emissions.

PRI00000590

REC 1930

2.2.2.5 Antimony Dryer and Dry Bagging

The Sb circuit proposed in the Application was replaced with a new dewatering/packaging circuit. The new circuit eliminates the potential for metal emissions from dust and mercury evaporation emissions from concentrate heating. Instead, the Sb concentrate will be dewatered using a filter press and then bagged as a wet (damp) product. There are no HAP/TAP emissions associated with this new circuit.

2.2.3 Metal Emissions from Concrete Production

The metal HAP/TAP emissions from concrete production were calculated using EPA emission factors from AP-42 Section 11.12, Concrete Batching. This section provides controlled emission factors for cement silo filling and central mix batching. There are no emission factors for cement silo unloading. Therefore, the cement silo filling factors were used for cement silo unloading as a conservative estimate.

Chromium (VI) percentages of the total chromium were provided by IDEQ for cement silo filling and central mix batching. These percentages were used to calculate chromium (VI) emissions from cement silo filling and unloading and central mix batching.

There are no HAP/TAP emission factors for the dust generated from aggregate handling in the concrete production process. As a conservative estimate, the limestone metals profile provided in Table 1 of Section 2.2.2.1 was used to estimate the HAP/TAP emissions from aggregate handling.

2.2.4 H_2SO_4 and H_2S Emissions from the Autoclave

H_2SO_4 and H_2S emissions from the SGP autoclave were calculated based on source test data from similar autoclaves at gold mines in Nevada.

2.2.5 HCl Emissions from the Lime Kiln

The HCl emissions from the lime kiln were calculated using the HCl emission factor obtained from EPA's EPCRA Section 313 Guidance for Reporting Hydrochloric Acid (EPA 1999b).

2.2.6 HCN Emissions from Cyanide Leaching and Tailings Storage Facility

The evaporative HCN emissions from cyanide leaching and the tailings storage facility were calculated using the flux methodology developed by EPA and the Nevada Mining Association as part of the 40 CFR 63 rule-making process. The methodology is based on empirical measurements at several gold mines in Nevada taken under the direction of EPA. Numerous gold mines in several states have used this method since its development in 2010.

2.2.7 HAP/TAP Emissions from Fuel Storage and Fuel Combustion

HAP/TAP emissions from fuel combustion (propane and diesel) were calculated using fuel combustion rates and the applicable EPA AP-42 emission factors.

PRI00000591

REC 1931

HAP/TAP emissions from fuel storage (gasoline) were calculated from the tank volatile organic compound (VOC) emissions multiplied by the weight percentages of HAP/TAP in the fuel. The percentages were obtained from EPA's EPCRA Section 313 Industry Guidance Metal Mining Facilities, Table 3-8 for gasoline (EPA 1999a).

2.2.8 Carbon Disulfide Emissions from Xanthate

Carbon disulfide (CS_2) emissions from potassium amyl xanthate (PAX) use were calculated based on the decomposition of xanthate to CS_2 gas. The decomposition rate was determined from published experimental data.

2.2.9 Evaporative Mercury Emissions from Mining Surfaces

Mercury can evaporate from rock surfaces in pits, tailings facilities, development rock storage facilities, and stockpiles. The rate of mercury evaporation (or flux) is a function of the mercury concentration in the material. Mercury flux rates and concentration measurements taken at a gold mine in Nevada were adjusted for the SGP mercury concentrations to estimate mercury flux emissions from the SGP pits, tailings facility, development rock storage facilities, and ore stockpiles.

PRI00000592

REC 1932

3.0 TAP ANALYSIS

A complete inventory of the PTE TAP emissions is provided in Appendix A, as discussed in Section 2.0. Appendix A also identifies the applicability of IDAPA 58.01.01.210.20. According to IDAPA 58.01.01.210.20, no further demonstration of compliance with the TAP provisions is required to obtain a PTC for new source emissions, such as the SGP, from:

a. The equipment or activities covered by a New Source Performance Standards (NSPS) or National Emissions Standards for Hazardous Air Pollutants (NESHAP); or

b. The source category of equipment or activities addressed by a NSPS or NESHAP even if the specific equipment or activity is not subject to compliance requirements under the federal rule.

After applying IDAPA 58.01.01.210.20 as described in Section 3.1, the remaining TAP emissions are subject to further compliance demonstration and are compared to the screening emission levels (EL) described in Section 3.3. TAP emissions that below the screening EL, require no further demonstration of compliance with the TAP provisions. TAP emissions above the screening EL require modeling, as described in Section 3.4. To identify the TAPs subject to review, Section 3.2 provides a comparison of the metals analyzed in the SGP ore, development rock, and limestone to the TAPs listed in IDAPA 58.01.01.585 and IDAPA 58.01.01.586.

3.1 Equipment or Activities Covered or Addressed by NESHAP or NSPS

In accordance with IDAPA 58.01.01.210.20, the equipment and activities at the SGP that are either covered or addressed by NESHAP or NSPS are discussed in the following subsections. TAPs emitted from these sources that are also HAPs require no further evaluation to demonstrate compliance with the TAP provisions. TAP emissions from these sources that are not HAPs require additional review to demonstrate compliance with the TAP provisions.

3.1.1 NESHAP Subpart ZZZZ

40 CFR 63, Subpart ZZZZ, NESHAP for Stationary Reciprocating Internal Combustion Engines covers HAP emissions from the SGP emergency generators and fire pump (Source ID No. EDG1, EDG2, EDG3, and EDFP). IDAPA 58.01.01.210.20(a) applies to Source ID No. EDG1, EDG2, EDG3, and EDFP.

PRI00000593

REC 1933

3.1.2 NESHAP Subpart AAAAA

40 CFR 63, Subpart AAAAA, NESHAP for Lime Manufacturing Plants addresses HAP emissions from the SGP lime manufacturing sources (Source ID No. LS12, LK, LS-L/U, LCR, and LKC).[5] IDAPA 58.01.01.210.20(b) applies to Source ID No. LS12, LK, LS-L/U, LCR, and LKC.

3.1.3 NESHAP Subpart CCCCCC

40 CFR 63, Subpart CCCCCC, NESHAP for Source Category: Gasoline Dispensing Facilities covers the SGP gasoline storage tanks (Source ID No. TG1 and TG2). IDAPA 58.01.01.210.20(a) applies to Source ID No. TG1 and TG2.

3.1.4 NESHAP Subpart EEEEEEE

40 CFR 63, Subpart EEEEEEE, NESHAP: Gold Mine Ore Processing and Production Area Source Category covers HAP emissions from the SGP autoclave (Source ID No. AC) and the EW cells, pregnant solution tank, mercury retort, induction melting furnace, and carbon regeneration kiln (Source ID No. EW, MR, MF, and CKD). IDAPA 58.01.01.210.20(a) applies to Source ID No. AC, EW, MR, MF, and CKD.

The NESHAP source category addresses HAP emissions from mining activities, specifically fugitive dust-generating activities (drilling, blasting, excavating, hauling, etc.), explosives use and storage (Source ID No. PS), cyanide leaching (Source ID No. CIP Leach 1-4, CIL 1-6, CIP 1-6, and CN Detox 1-2), tailings storage, ore processing (Source ID No. OC1-13), ore processing heating (Source ID No. ACB, CKB, PV, and HS), and the ore processing reagent use of PAX and sodium cyanide (NaCN). The NESHAP source category is defined as "*Gold Ore Mining ..., NAICS code 212221, Establishments primarily engaged in developing the mine site, mining, and/or beneficiating (i.e., preparing) ores valued chiefly for their gold content. Establishments primarily engaged in transformation of the gold into bullion or doré bar in combination with mining activities are included in this industry*" (EPA 2011b). EPA's rule-making docket (Docket ID EPA-HQ-OAR-2010-0239) provides documents evaluating HAP metal emissions from mining fugitive dust, HCN emissions from cyanide leaching, and downwind HCN ambient concentrations.[6]

---

[5] NESHAP Subpart AAAAA defines the affected source as follows: *each lime kiln and its associated cooler, each individual PSH [processed stone handling] system. The individual types of emission units in a PSH system are conveying system transfer points, bulk loading or unloading systems, screening operations, bucket elevators, and belt conveyors-if they follow the processed stone storage bin or storage pile in the sequence of PSH operations. The materials processing operations (MPO) associated with lime products (such as quicklime and hydrated lime), lime kiln dust handling, quarry or mining operations, limestone sizing operations, and fuels are not subject to today's final NESHAP. Processed stone handling operations are further distinguished in the final NESHAP as follows: (1) whether their emissions are vented through a stack, (2) whether their emissions are fugitive emissions, (3) whether their emissions are vented through a stack with some fugitive emissions from the partial enclosure, and/or (4) whether the source is enclosed in a building* (69 Fed. Reg. 394, 397 (January 5, 2004)).

[6] EPA-HQ-OAR-2010-0239-0132, *Profile of the Metal Mining Industry;* EPA-HQ-OAR-2010-0239-0157, *Recommended Methodology for Quantification of Fugitive Dust Metals Emissions from Mining Activities for Title V Applicability;* EPA-HQ-OAR-2010-0239-0102, *QAPP Comprehensive Air Emissions Testing for Hydrogen Cyanide;* EPA-HQ-OAR-2010-0239-0134, -0135 -0136 -0137 -0161 -0162 -0378, *Meteorological and Hydrogen Cyanide (HCN) Fence Line Monitoring* reports.

PRI00000594

REC 1934

In response to public comments, this Addendum applies IDAPA 58.01.01.210.20(a) to those sources of HAP emissions at the SGP that are covered by Subpart EEEEEEE. This Addendum provides further evaluation of the sources of HAP emissions that are addressed by the NESHAP per IDAPA 58.01.01.210.20(b) – the mining emissions.[7]

3.1.5 NSPS Subpart LL

40 CFR 60, Subpart LL, Standards of Performance for Metallic Mineral Processing Plant covers the SGP ore processing (Source ID No. OC1-13). IDAPA 58.01.01.210.20(a) applies to Source ID No. OC1-13.

3.1.6 NSPS Subpart OOO

40 CFR 60, Subpart OOO, Standards of Performance for Nonmetallic Mineral Processing Plants covers the SGP limestone processing sources (Source ID LS1-11 and LSBM), aggregate production (Source ID No. PCSP1 and PCSP2), and aggregate handling in the concrete production process (Source ID No. CA-L/U). IDAPA 58.01.01.210.20(a) applies to Source ID No. LS1-11, LSBM, PCSP1, PCSP2, CA-L/U.

3.2 Metals Review for TAP Provisions Applicability

Table 2 provides a comparison of the metals analyzed in the SGP ore, development rock, and limestone to the TAPs listed in IDAPA 58.01.01.585 and IDAPA 58.01.01.586.

Table 2. Metals Comparison to IDAPA 58.01.01.585-586 TAPs

Metal			TAP		
CAS	**Name**	**HAP?**	**CAS**	**Name**	**Is the Metal a TAP?**
7440-57-5	Gold	No	7440-57-5	Not listed	No
7440-22-4	Silver	No	7440-22-4	Silver - Including metal soluble compounds, as Ag	Yes, same CAS Yes, similar form No
7429-90-5	Aluminum	No	7429-90-5	Aluminum, including: Metal & Oxide Pyro powders Soluble salts	Yes, same CAS Yes, similar form No No
7440-36-0	Antimony	Yes	7440-36-0	Antimony & compounds, as Sb (handling & use)	Yes, same CAS
7440-38-2	Arsenic	Yes	7440-38-2	Arsenic compounds	Yes, same CAS
7440-39-3	Barium	No	7440-39-3	Barium, soluble compounds, as Ba	Yes, same CAS
7440-41-7	Beryllium	Yes	7440-41-7	Beryllium & compounds	Yes, same CAS

[7] A demonstration of compliance that applied IDAPA 58.01.01.210.20(a) and (b) to the sources of HAP emissions covered and addressed by the NESHAP is presented in the SOB (February 18, 2021).

PRI00000595

REC 1935

Metal			TAP		
CAS	**Name**	**HAP?**	**CAS**	**Name**	**Is the Metal a TAP?**
7440-69-9	Bismuth	No	1304-82-1	Bismuth telluride undoped Bismuth telluride if selenium doped	No, Bi compounds are expected to be bismuthinite ($Bi2S_3$) and bismite (Bi_2O_3) [1]
7440-43-9	Cadmium	Yes	7440-43-9	Cadmium and compounds	Yes, same CAS
7440-70-2	Calcium	No	1317-65-3 156-62-7 1305-62-0 1305-78-8 1344-95-2 13397-24-5	Calcium carbonate Calcium cyanamide Calcium hydroxide Calcium oxide Calcium silicate (synthetic) Calcium sulfate	Yes [2] No, different CAS No, different CAS Yes [2] No, different CAS No, different CAS
7440-47-3	Chromium	Yes	7440-47-3 7440-47-3 16065-83-1 18540-29-9	Chromium metal, including: Chromium (II) compounds, as Cr Chromium (III) compounds, as Cr Chromium (VI) & compounds, as Cr+6	Yes, same CAS Yes, same CAS No, different CAS No, different CAS
7440-48-4	Cobalt	Yes	10210-68-1 16842-03-8 7440-48-4	Cobalt carbonyl, as Co Cobalt hydro carbonyl, as Co Cobalt metal, dust, and fume	No, different CAS No, different CAS Yes, same CAS
7440-50-8	Copper	No	7440-50-8	Copper: Fume Dusts & mists, as Cu	Yes, same CAS No Yes, similar form
7440-55-3	Gallium	No		Not listed	No
7439-89-6	Iron	No	1309-37-1 13463-40-6 7439-89-6	Iron oxide fume (Fe2O3), as Fe Iron pentacarbonyl, as Fe Iron salts, soluble, as Fe	No, different CAS No, different CAS Yes, same CAS
7439-91-0	Lanthanum	No		Not listed	No
7440-09-7	Potassium	No	1310-58-3	Potassium hydroxide	No, different CAS
7439-92-1	Lead	Yes		Not listed	No, criteria pollutant
7439-95-4	Magnesium	No	1309-48-4	Magnesium oxide fume	No, different CAS
7439-96-5	Manganese	Yes	7439-96-5	Manganese, as Mn, including: Dust & compounds Fume	Yes, same CAS Yes, similar form No
7439-97-6	Mercury	Yes		Not listed	No, regulated by mercury rules
7439-98-7	Molybdenum	No	7439-98-7	Molybdenum, as Mo, including: Soluble compounds Insoluble compounds	Yes, same CAS No Yes, similar form
7440-02-0	Nickel	Yes	7440-02-0 12035-72-2 7440-02-0	Nickel Nickel Subsulfide Nickel Refinery Dust	No, see Ni refinery dust No, different CAS Yes, same CAS and form

PRI00000596

REC 1936

Metal			TAP		
CAS	Name	HAP?	CAS	Name	Is the Metal a TAP?
7723-14-0	Phosphorus	Yes	7723-14-0	Phosphorus	Yes, same CAS
			10025-87-3	Phosphorus oxychloride	No, different CAS
			10026-13-8	Phosphorus penta-chloride	No, different CAS
			1313-80-3	Phosphorus penta-sulfide	No, different CAS
			1314-56-3	Phosphorus pentoxide (ID)	No, different CAS
			7719-12-2	Phosphorus trichloride	No, different CAS
7782-49-2	Selenium	Yes	7782-49-2	Selenium and compounds, as Se	Yes, same CAS
7440-23-5	Sodium	No	26628-22-8	Sodium azide (CL)	No, different CAS
			7631-90-5	Sodium bisulfite	No, different CAS
			136-78-7	Sodium 2,4-dichloro-phenoxyethyl sulfate; see Sesone	No, different CAS
			62-74-8	Sodium fluoroacetate	No, different CAS
			1310-73-2	Sodium hydroxide	No, different CAS
			7681-57-4	Sodium metabisulfite	No, different CAS
7440-20-2	Scandium	No		Not listed	No
7440-24-6	Strontium	No		Not listed	No
7440-28-0	Thallium	No	7440-28-0	Thallium, soluble compounds, as Tl	Yes, same CAS
7440-29-1	Thorium	No		Not listed	No
7440-32-6	Titanium	No		Not listed	No
7440-33-7	Tungsten	No	7440-33-7	Tungsten, including: Insoluble compounds Soluble compounds	Yes, same CAS Yes, similar form No
7440-61-1	Uranium	No	7440-61-1	Uranium (natural) soluble & insoluble compounds, as U	Yes, same CAS
7440-62-2	Vanadium	No	1314-62-1	Vanadium, as V_2O_5 Respirable dust & fume	No, different CAS [3]
			12604-58-9	Ferrovanadium dust	No, different CAS
7440-66-6	Zinc	No	7440-66-6	Zinc metal (ID)	Yes, same CAS
			7646-85-7	Zinc chloride fume	No, different CAS
			1314-13-2	Zinc oxide fume	No, different CAS
			1314-13-2	Zinc oxide dust	No, different CAS

[1] Over 95% of the samples were at or below the detection limit for Bismuth of 2 ppm. Limited sampling for tellurium indicates 90% of the samples are below 0.5 ppm. Mineralogical studies have not identified telluride minerals as a significant phase in the deposits. Based on these low levels and deposit mineralogy, no significant bismuth telluride is expected to be found in the ore body or development rock.

[2] Although the CAS numbers do not match, the calcium in the ore, limestone, and aggregate is expected to be in the form of calcium carbonate ($CaCO_3$). For lime, the calcium will be in the form of calcium oxide (CaO).

[3] The principal vanadium mineral in Idaho shale-hosted vanadium deposits is metahewettite ($CaV_6O_{162} \bullet H2O$) (USGS n.d.). Although not a TAP, vanadium in the ore, limestone, and aggregate is conservatively assumed to be V_2O_5 for the purpose of the TAP evaluation included in this HAP/TAP Addendum.

3.3 Screening Level Analysis of TAP Emissions

As discussed in Section 2.0, the highest TAP emissions scenario is Model Scenario W3, that estimates emissions from a potential throughput of 180,000 T/day. Table A in Appendix A

PRI00000597

REC 1937

provides a summary of the TAP emissions for Model Scenario W3, identifies whether the sources are covered or addressed by IDAPA 58.01.01.210.20(a) or (b) (Section 3.1), and notes the TAP screening EL. TAPs that exceed the screening EL are highlighted in Table A. These TAPs require further demonstrations of compliance with the applicable ambient air concentration (AAC) and are listed in Table 3 below.

Table 3. TAPs Exceeding the Screening Emission Level

CAS	TAP Name	Carcinogenic	SGP PTE (lb/hr) [1]	Screening EL (lb/hr)
7429-90-5	Aluminum	No	58.50	0.667
7440-38-2	Arsenic	Yes	0.544	0.0000015
7440-39-3	Barium	No	0.659	0.033
7440-41-7	Beryllium	Yes	0.00261	0.000028
7440-43-9	Cadmium	Yes	0.000435	0.0000037
1317-65-3	Calcium Carbonate	No	13.65	0.667
1305-78-8	Calcium Oxide	No	0.696	0.133
592-01-8	Cyanide	No	0.453	0.333
50-00-0	Formaldehyde	Yes	0.00189	0.00051
7439-89-6	Iron	No	15.04	0.067
7439-96-5	Manganese	No	0.244	0.067
7440-02-0	Nickel	Yes	0.00169	0.000027
7723-14-0	Phosphorus	No	0.530	0.007
7664-93-9	Sulfuric Acid	No	2.03	0.067
7440-28-0	Thallium	No	0.00867	0.007
7440-62-2	Vanadium	No	0.0237	0.003

[1] Model Scenario W3, 180,000 T/day Emissions

3.4 Modeling of TAP Emissions

To maintain consistency with the National Ambient Air Quality Standards (NAAQS) compliance analyses reviewed by IDEQ, the TAP modeling was performed using the same IDEQ-approved datasets and model versions described in the SOB from February 18, 2021. TAP modeling was conducted for the 14 modeling scenarios consistent with the NAAQS analyses. Scenario W5 was eliminated from the arsenic modeling, as discussed in Section 3.4.5.

3.4.1 Meteorological Data and Deposition

The meteorological dataset used for the TAP modeling was processed using EPA's Qian and Venkatram (Q&V) meteorological processing method. This method, which does not use the BULKRN keyword, is approved by EPA as a default method.

PRI00000598

REC 1938

As discussed in the PTC application, EPA evaluated the performance of the model with the Q&V processed meteorological dataset as part of its model approval determination. This evaluation quantified the bias between the modeled concentrations and the actual observed concentrations. The results of EPA's evaluation showed a conservative bias of the model to overpredict concentrations by a factor of 1.41 to 3.21 (Air Sciences 2020, A-8 of Attachment A). Therefore, the meteorological dataset used in the TAP modeling is expected to predict conservatively high concentrations.

The particulate deposition parameters used in the NAAQS compliance analysis were derived for PM_{10} and $PM_{2.5}$. See Tables 24 and 25 in the SOB from February 18, 2021. Dust-related metal TAP emissions include total particulates (all size fractions of PM up to PM_{30}). Therefore, the deposition parameters for PM were calculated using the same methodology and EPA references used for PM_{10} and $PM_{2.5}$ in the NAAQS compliance analysis. The PM deposition parameters are provided in Table 4.

Table 4. PM Deposition Parameters by Source Category

Source Category	Parameter	PM				
		Bin 1	**Bin 2**	**Bin 3**	**Bin 4**	**Bin5**
Haul Roads	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.02	0.23	0.75	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3) (DR average of YP, HF, WE)	2.46	2.46	2.46	--	--
Material Handling (Ore, DR, Limestone)	Bin Upper Diameter (µm)	2.50	5.00	10.00	30.00	--
	Mass Fraction	0.07	0.20	0.20	0.53	--
	Mass Mean Diameter (µm)	2.50	5.00	10.00	30.00	--
	Density (g/cm^3) (Ore)	Pit-specific, see Table 5				
	Density (g/cm^3) (DR)	Pit-specific, see Table 5				
	Density (g/cm^3) (Limestone)	1.09	1.09	1.09	1.09	--
Baghouses	Bin Upper Diameter (µm)	2.50	6.00	10.00	30.00	--
	Mass Fraction	0.25	0.45	0.20	0.10	--
	Mass Mean Diameter (µm)	2.50	6.00	10.00	30.00	--
	Density (g/cm^3) (Ore)	Pit-specific, see Table 5				
Diesel Engines	Bin Upper Diameter (µm)	1.00	2.50	6.00	10.00	30.00
	Mass Fraction	0.82	0.08	0.03	0.03	0.04
	Mass Mean Diameter (µm)	1.00	2.50	6.00	10.00	30.00
	Density (g/cm^3) (Diesel Combustion)	1.00	1.00	1.00	1.00	1.00
Heaters and Boilers	Bin Upper Diameter (µm)	1.00	2.50	6.00	10.00	30.00
	Mass Fraction	0.23	0.22	0.25	0.09	0.21
	Mass Mean Diameter (µm)	1.00	2.50	6.00	10.00	30.00
	Density (g/cm^3) (Propane Combustion)	1.24	1.24	1.24	1.24	1.24
	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--

Source Category	Parameter	PM				
		Bin 1	Bin 2	Bin 3	Bin 4	Bin5
Lime Loading and Unloading (Quick, Pebble)	Mass Fraction	0.05	0.29	0.66	--	--
	Mass Mean Diameter	2.50	10.00	30.00	--	--
	Density (g/cm^3) (Quick)	0.44	0.44	0.44	--	--
	Density (g/cm^3) (Pebble)	0.96	0.96	0.96	--	--
Lime Unloading (Quick, Pebble)	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.09	0.49	0.42	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3) (Quick)	0.44	0.44	0.44	--	--
	Density (g/cm^3) (Pebble)	0.96	0.96	0.96	--	--
Cement and Aggregate Loading and Unloading	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.05	0.29	0.66	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3) (Cement)	1.44	1.44	1.44	--	--
	Density (g/cm^3) (Aggregate)	1.28	1.28	1.28	--	--
Prill Loading and Unloading	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.05	0.30	0.65	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3) (Prill)	0.84	0.84	0.84	--	--
Refining Processes	Bin Upper Diameter (µm)	1.00	2.50	6.00	10.00	30.00
	Mass Fraction	0.72	0.10	0.07	0.03	0.08
	Mass Mean Diameter (µm)	1.00	2.50	6.00	10.00	30.00
	Density (g/cm^3) (Diesel Combustion)	1.00	1.00	1.00	1.00	1.00
Portable Crushing and Screening Plant	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.05	0.32	0.63	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3) (DR average of YP, HF, WE)	2.46	2.46	2.46	--	--
Lime Kiln and Ball Mill	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction (Kiln)	0.27	0.28	0.45	--	--
	Mass Fraction (Ball Mill)	0.30	0.54	0.16	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3)	1.09	1.09	1.09	--	--
Blasting and Drilling	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.03	0.49	0.48	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3) (Ore or DR)	Pit-specific, see Table 5				
Dozing	Bin Upper Diameter (µm)	2.50	10.00	15.00	30.00	--
	Mass Fraction	0.11	0.08	0.06	0.75	--
	Mass Mean Diameter (µm)	2.50	10.00	15.00	30.00	--
	Density (g/cm^3) (Waste)	Pit-specific, see Table 5				

Table 5. Pit-Specific Ore and DR Densities for Deposition

Pit	Material	Density (g/cm^3)
YP	Ore	2.59
BT	Ore	2.00
HF	Ore	2.59
WE	Ore	2.68
YP	DR	2.48
BT	DR	2.00
HF	DR	2.34
WE	DR	2.57
Average (YP, HF, WE)	DR	2.46

3.4.2 Modeling for Non-Carcinogenic TAPs

The non-carcinogenic TAPs subject to the AACs per IDAPA 58.01.01.585 were modeled at the emission levels shown in Table 3 above. The maximum 24-hour modeled concentration for each of the 14 modeling scenarios demonstrates compliance with the applicable AAC, as summarized in Table 6.

PRI00000601

REC 1941

Table 6. Compliance Demonstration for Non-Carcinogenic TAPs

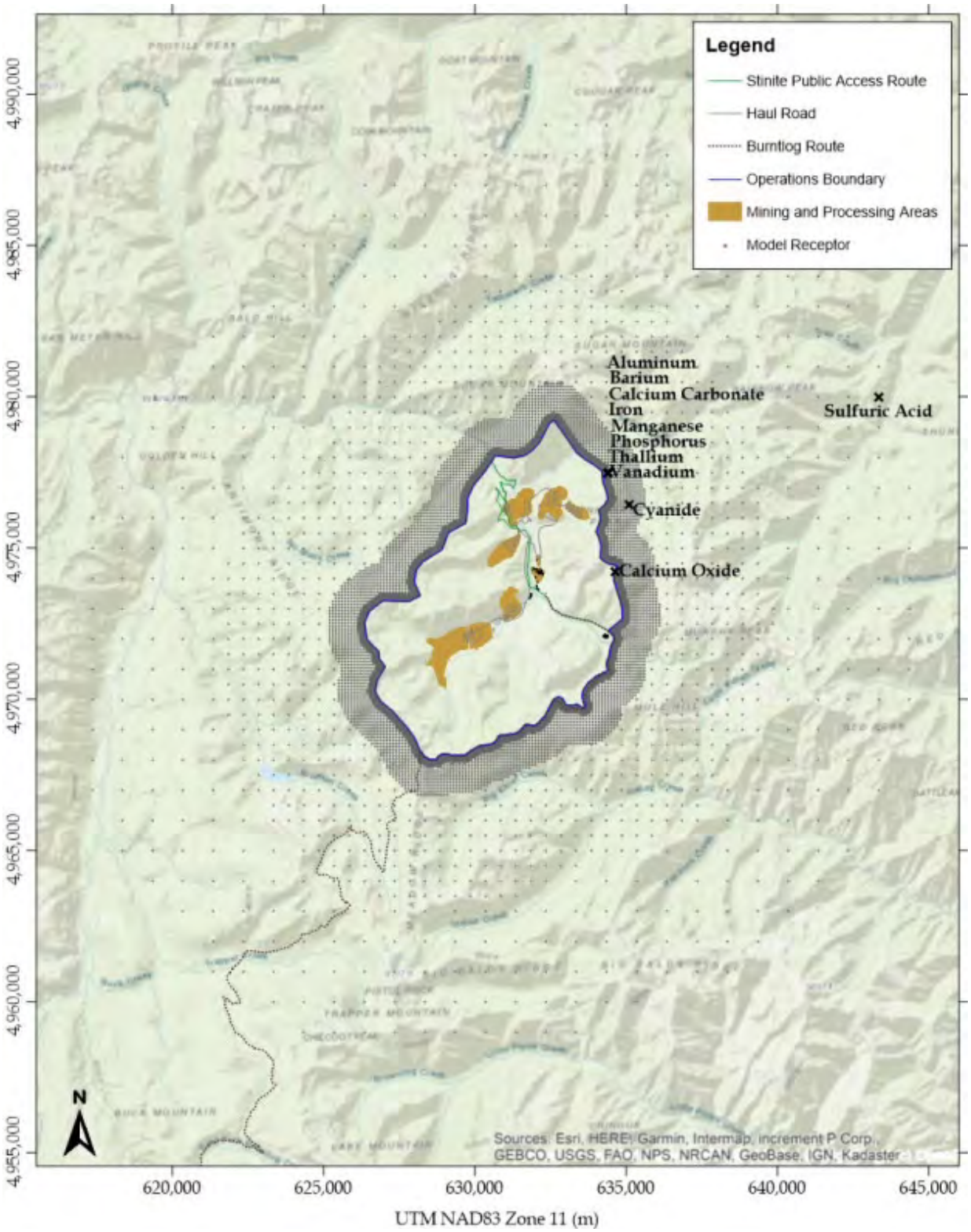
CAS	TAP Name	Highest Model Scenario	SGP Maximum 24-hr Concentration (µg/m³)	AAC (µg/m³)	TAP Compliance
7429-90-5	Aluminum	W5	6.17	500	Yes
7440-39-3	Barium	W5	0.07	25	Yes
1317-65-3	Calcium Carbonate	W5	1.22	500	Yes
1305-78-8	Calcium Oxide	ALL	0.15	100	Yes
592-01-8	Cyanide	ALL	0.20	250	Yes
7439-89-6	Iron	W5	1.58	50	Yes
7439-96-5	Manganese	W5	0.03	250	Yes
7723-14-0	Phosphorus	W5	0.06	5	Yes
7664-93-9	Sulfuric Acid	ALL	0.41	50	Yes
7440-28-0	Thallium	W5	0.001	5	Yes
7440-62-2	Vanadium	W5	0.002	2.5	Yes

The modeled emissions for each modeling scenario and source are provided in Appendix B. The modeled concentration per modeling scenario is provided in Appendix C. The predicted locations of the maximum concentrations for each non-carcinogenic TAP are presented in Figure 1.

PRI00000602

REC 1942

Figure 1. Non-Carcinogenic Maximum TAP Concentration (µg/m³) Locations



PRI00000603

REC 1943

3.4.3 Modeling Carcinogenic TAPs

The carcinogenic TAPs subject to the acceptable ambient concentrations for carcinogens (AACC) per IDAPA 58.01.01.586 were modeled using an emission inventory that includes the following T-RACT controls, long-term mining production limits, and other emission inventory refinements, as described below:

- Installing and operating dust collection systems on drilling rigs (T-RACT)
- Capping the haul roads that are outside of the pits and development rock storage facilities (DRSFs) with clean development rock (T-RACT)
- Limiting long-term mining production to 135,000 T/day (5-year rolling total)
- Constructing the Burntlog access road with offsite materials containing background level arsenic concentrations
- Updating the bulldozing emission factor using the SGP site-specific silt content.

The above emission inventory reductions are discussed in more detail in Section 5.0. The T-RACT analysis is provided in Section 6.0. A comparison of the 180,000 T/day TAP emissions shown in Table 3 and the T-RACT TAP emissions is shown in Table 7.

Table 7. Comparison of 180,000 T/day and T-RACT Emissions

CAS	TAP Name	Carcinogenic	180,000 T/day Emissions (lb/hr) [1]	T-RACT Emissions (lb/hr) [2]
7440-38-2	Arsenic	Yes	0.544	0.232
7440-41-7	Beryllium	Yes	0.00261	0.00185
7440-43-9	Cadmium	Yes	0.000435	0.000317
50-00-0	Formaldehyde	Yes	0.00189	0.00189
7440-02-0	Nickel	Yes	0.00169	0.00121

[1] Model Scenario W3 emissions from Table 3
[2] T-RACT emission levels for the demonstration of carcinogenic TAP compliance. See Table A-W3, T-RACT Emissions in Appendix A, pp. A-45 to A-49.

The maximum modeled concentration for each of the 14 modeling scenarios demonstrated compliance with the applicable AACC, as summarized in Table 8. The AACCs listed in Table 8 were increased by a factor of ten (10) per IDAPA 58.01.01.210.12(b); T-RACT adjustment. The SGP maximum concentrations were adjusted to account for the life-of-mine (LOM) production limits, which affect the lifetime exposure, and to account for the elimination of Modeling Scenario W5. See Sections 3.4.4 and 3.4.5 for more detail.

PRI00000604

REC 1944

Table 8. Compliance Demonstration for Carcinogenic TAPs

CAS	TAP Name	Model Scenario	SGP Maximum Lifetime Exposure Concentration (µg/m³) [1]	AACC (µg/m³) [2]	TAP Compliance
7440-38-2	Arsenic	W2	0.00095	0.0023	Yes
7440-41-7	Beryllium	W1	0.00001	0.042	Yes
7440-43-9	Cadmium	W1	0.000002	0.0056	Yes
50-00-0	Formaldehyde	ALL	0.00007	0.77	Yes
7440-02-0	Nickel	W1	0.00001	0.42	Yes

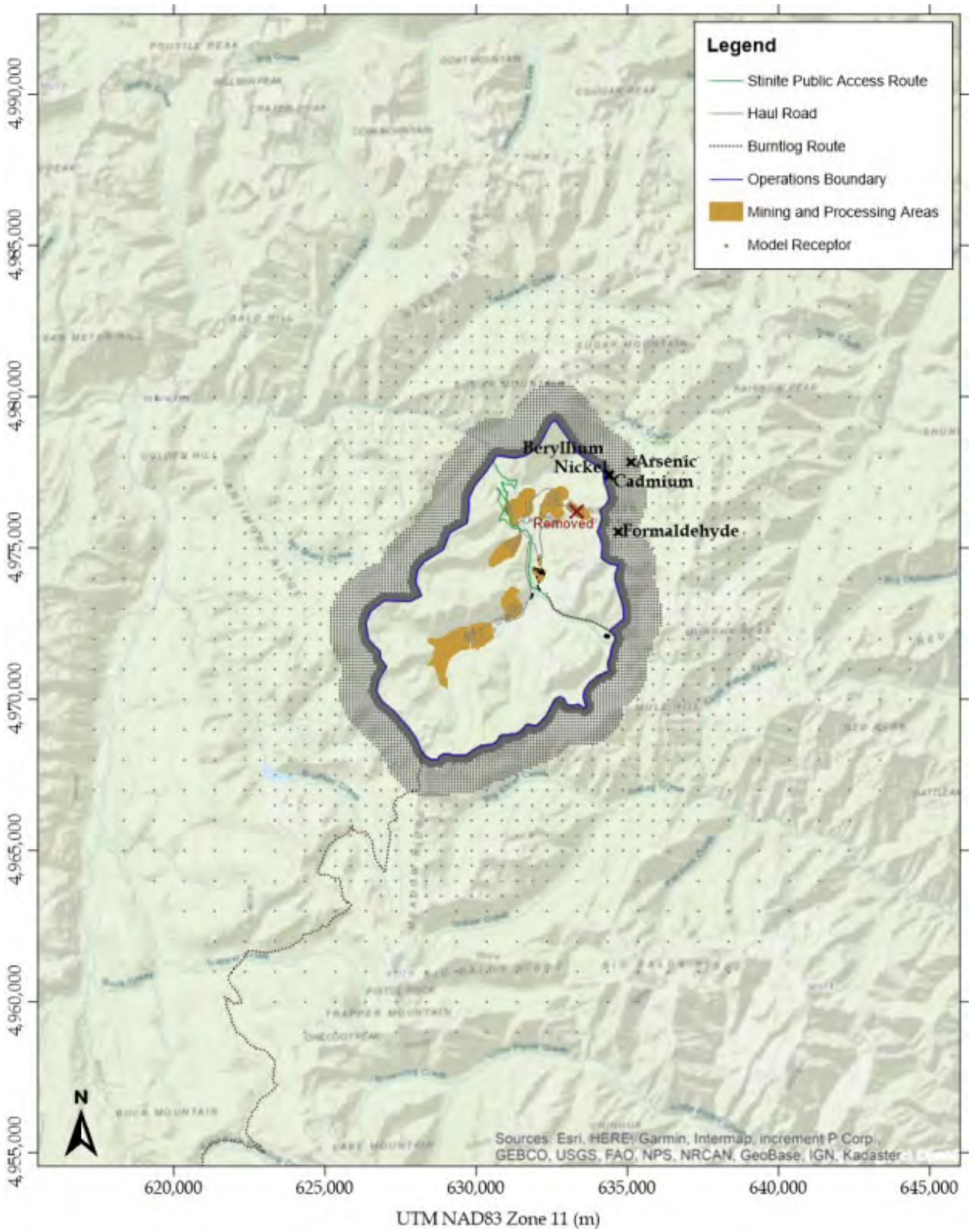
[1] The lifetime exposure concentrations are based on the proposed restrictions discussed in Sections 3.4.4 and 3.4.5.
[2] The AACCs are increased by a factor of ten per IDAPA 58.01.01.210.12(b); T-RACT adjustment.

The modeled emissions for each modeling scenario and source are provided in Appendix B. The modeled concentration per modeling scenario is provided in Appendix C. The locations of the maximum concentrations for each carcinogenic TAP are presented in Figure 2.

PRI00000605

REC 1945

Figure 2. Carcinogenic Maximum TAP Concentration (µg/m³) Locations



PRI00000606

REC 1946

3.4.4 Carcinogenic TAP Modeling Lifetime Exposure Adjustment

The AACCs provided in IDAPA 58.01.01.586 were developed *based on the probability of developing excess cancers over a seventy (70) year lifetime exposure to one (1) microgram per cubic meter (1 ug/m3) of a given carcinogen and expressed in terms of a screening emission level or an acceptable ambient concentration for a carcinogenic toxic air pollutant* (IDAPA 58.01.01.006.125). Therefore, the highest modeled annual carcinogenic TAP concentration from each of the 14 modeling scenarios was evaluated for lifetime exposure as follows:

$$Lifetime\ expsoure\ \left(\frac{\mu g}{m^3}\right) = \frac{Highest\ annual\ concentration\ \left(\frac{\mu g}{m^3}\right) \times 16\ (mine\ operation\ years)}{70\ (years, lifetime\ exposure)}$$

This equation conservatively assumes that the highest annual concentration from the 14 modeling scenarios is repeated for 16 years of mining operation. This is then averaged over 70 years to calculate the 70-year lifetime exposure.

Calculating lifetime exposure based on 16 years of mining operation is also conservative. The annual emissions for carcinogenic TAP modeling are based on 135,000 T/day (see Section 3.4.3) and 365 days per year. Over 16 years, this equates to a potential mining production of 788.4 million tons:

$$\frac{135{,}000\left(\frac{ton}{day}\right) \times 365\left(\frac{day}{year}\right) \times 16\ years}{1{,}000{,}000\left(\frac{ton}{million\ ton}\right)} = 788.4\ million\ tons$$

The actual LOM total production as described in the SGP Refined Proposed Action (ModPRO2) mine plan is only 402.86 million tons (Perpetua 2021a), which is 51.1% of the potential LOM production represented in the above equation and related emissions evaluations.

3.4.5 Arsenic Compliance Demonstration for Modeling Scenarios W1–W5

To demonstrate compliance with the AACC for arsenic, two addition operating limitations were applied:

- The removal of Modeling Scenario W5 as a potential operating scenario
- Limiting the West End pit's LOM potential mining production to 50% of the total LOM potential mining production of 788.4 million tons: 50% * 788.4 = 394.2 million tons

Perpetua Resources has determined that the West End DRSF will not be constructed. This change eliminated Modeling Scenario W5 from the arsenic modeling evaluation. The remaining four West End pit modeling scenarios (W1–W4) are evaluated using the 70-year lifetime exposure equation from Section 3.4.4 and adjusting for the proposed West End pit LOM production limit of 50% of the total production as follows:

PRI00000607

REC 1947

$$lifetime\ expsoure\ \left(\frac{\mu g}{m^3}\right) = \left(\frac{\left[Wi\left(\frac{\mu g}{m^3}\right)(50\%) + nonW\left(\frac{\mu g}{m^3}\right)(50\%)\right] \times 16\ (mine\ operation\ years)}{70\ (years, lifetime\ exposure)}\right)$$

Where:

$Wi = the\ modeled\ annual\ arsenic\ concentration\ from\ Scenario\ Wi;\ i = 1\ to\ 4$

$nonW = the\ modeled\ annual\ arsenic\ concentration\ of\ the\ highest\ nonW\ scenario;$

B1, B2, H1, H2, H3, H4, Y1, Y2, or Y3

The above equation was used to calculate the lifetime arsenic exposure from the West End pit scenarios (W1–W4) on a receptor-by-receptor basis. Combining the concentrations from Modeling Scenarios W1–W4 with the highest concentration from the remaining non-West End pit scenarios (B1, B2, H1, H2, H3, H4, Y1, Y2, or Y3) ensures that the maximum concentration is evaluated.

Calculating lifetime arsenic exposure based on the proposed West End pit LOM production limit of 50% of the total production is conservative. The actual LOM total production from the West End pit as described in the ModPRO2 mine plan is only 198.26 million tons (Perpetua 2021a), which is 50.3% of the proposed West End pit LOM production limit of 394.2 million tons.

PRI00000608

REC 1948

4.0 COMPARISON OF ACTUAL ARSENIC MODELING TO POTENTIAL ARSENIC MODELING

Additional analyses of arsenic emissions were prompted by public comments on the draft PTC. IDEQ requested that Perpetua Resources conduct an arsenic modeling analysis based on the actual mining operation and production described in the ModPRO2 mine plan. Those modeling results were submitted to IDEQ in a report on July 8, 2021, titled "Stibnite Gold Project Permit to Construct Application Arsenic Modeling Addendum" (Air Sciences 2021).

While that report provided an assessment of the actual arsenic concentrations expected from the actual mining operation and production over the life of the SGP ("actual analysis"), the analysis described in Section 3.0 above is based on potential operating scenarios ("potential analysis"). These analyses ensure that public health is protected under all operating conditions.

A comparison between the actual analysis and the potential analysis for the lifetime exposure of arsenic is summarized in Table 9.

Table 9. Actual Analysis vs. Potential Analysis for Arsenic Lifetime Exposure

Model Parameter	Actual Data	Potential Data	Actual Data Basis	Potential Data Basis
Process emissions (lb/hr)	0.004514	0.004514	Equipment design rate	Equipment design rate
Mining emissions (lb/hr); varies	Max: 0.0854 Min: 0.0058 Avg: 0.0451	Max: 0.232 Min: 0.061	ModPRO2 – 16 years of operation	14 potential worst-case scenarios
Emissions included in modeling (lb/yr)	100%	98%	Actual analysis of all emissions	Includes IDAPA 58.01.01.210.20
LOM production (million tons)	402.86	788.4	ModPRO2	135,000 ton/day * 365 day/yr * 16 years
Lifetime exposure modeling	Average concentration over 16 years of operation	Highest scenario concentration assumed for 16 years	Actual analysis	Potential worst-case analysis
Maximum modeled concentration ($\mu g/m^3$)	0.00015	0.00095	Actual analysis	Potential worst-case analysis
Applicable AACC ($\mu g/m^3$)	0.0023	0.0023	IDAPA 58.01.01. 210.12(b) and .586	IDAPA 58.01.01. 210.12(b) and .586

PRI00000609

REC 1949

A brief discussion of Table 9 is provided below:

- AACC Results: In both the actual and potential analyses, the maximum modeled arsenic concentrations are below the AACC, demonstrating compliance with IDAPA 58.01.01.210.

- Process emissions: The process arsenic emissions in both analyses are identical. This is because both emission inventories were based on the maximum design rates of the process equipment.

- Mining emissions: The arsenic emissions in the actual analysis (0.0451 lb/hr average) are only 19% of the arsenic emissions in the potential analysis (0.232 lb/hr highest scenario). This is because the actual mining operation and production activities (e.g., drilling, blasting, material product, hauling miles, etc.) in ModPRO2 are far less than the potential mining (PTC) operating scenarios. Figure 3 compares the ModPRO2 arsenic emissions from mining for each year of operation (actual analysis) to the PTC arsenic emissions from mining for each worst-case operating scenario (potential analysis).

- In both analyses, all the arsenic emissions are included in the modeling, except emissions from covered or addressed sources, IDAPA 58.01.01210.20(a) and (b). See Section 3.1.

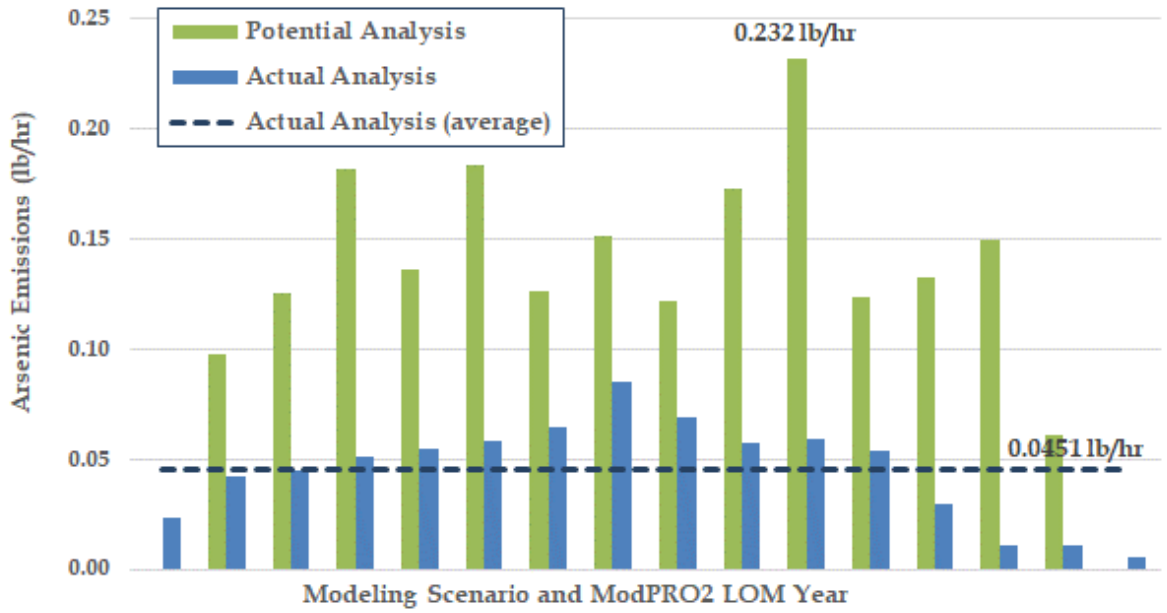
- The actual analysis LOM production of 402.86 million tons is 51.1% of the potential analysis production of 788.4 million tons.

- When modeling the lifetime arsenic exposure, the actual analysis is based on modeling each year of the ModPRO2 mine plan and then averaging the yearly results on a receptor-by-receptor basis. In addition to the lower actual arsenic emissions, the mining activity locations vary, which reduced the average arsenic concentration at any given location outside the operations boundary. In contrast, the potential analysis is based on higher (potential) emissions and the highest modeling scenario, which are assumed to occur for 16 consecutive years. This potential approach resulted in significantly higher and more conservative arsenic hot-spot concentrations.

PRI00000610

REC 1950

Figure 3. Actual Arsenic Mining Emissions vs. Potential Arsenic Mining Emissions



The concentrations and maximum locations of the arsenic lifetime exposure (70 years) are presented in Figure 4 for the actual analysis and Figure 5 for the potential analysis. As shown in these figures, the maximum arsenic concentrations are below the applicable AACC per IDAPA 58.01.01.210.12(b) and 586.

Figure 4. Actual Arsenic Concentrations (µg/m³) and Maximum Location

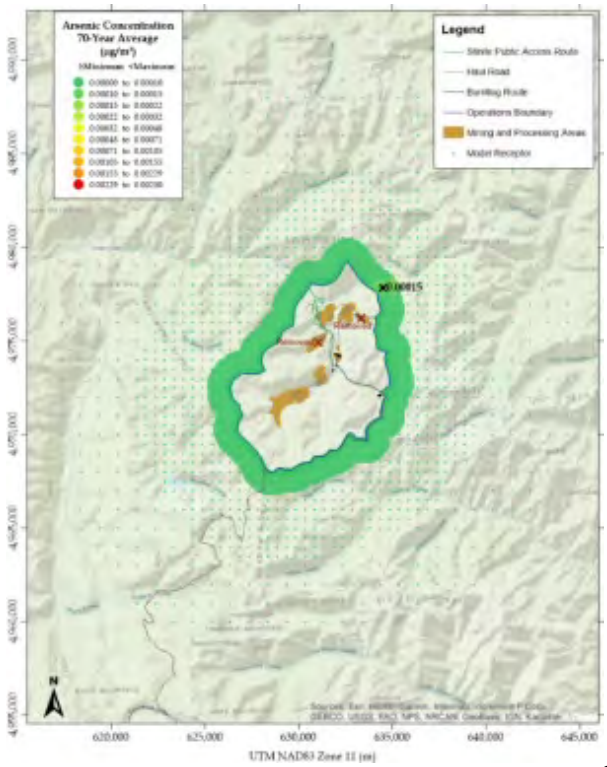
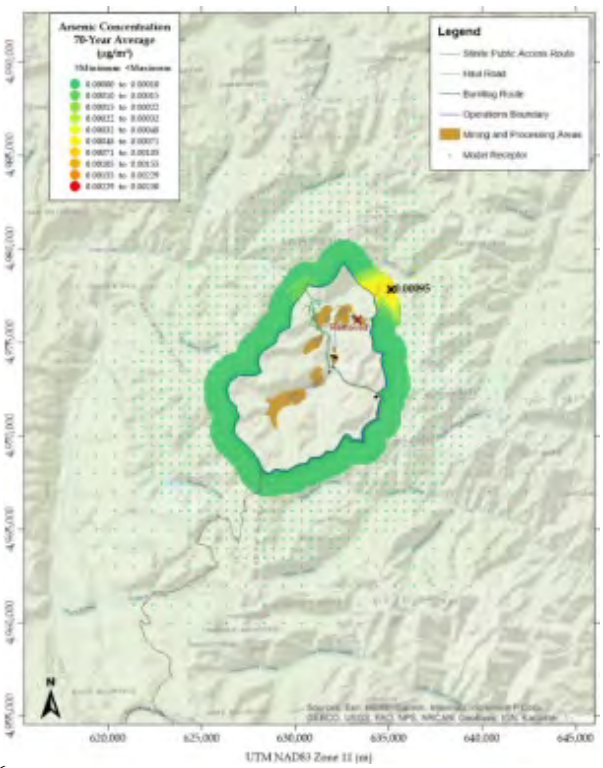


Figure 5. Potential Arsenic Concentrations (µg/m³) and Maximum Location



5.0 EMISSION INVENTORY FOR CARCINOGENIC TAPS

As discussed in Section 3.4.3, carcinogenic TAPs were modeled using an emission inventory adjusted for T-RACT controls, long-term mining production limits, and other refinements. These emission inventory changes are described in the following sections. The detailed emission calculations for the T-RACT emission inventory are provided in Appendix A (HAP/TAP Emission Calculations – Scenario W3, T-RACT Emissions).[8] The changes to these emission inventory inputs are highlighted on page A-41 of Appendix A.

5.1 Drilling Dust Control System

To reduce dust-related metal TAP emissions from drilling, Perpetua Resources will install and operate drilling rigs mounted with dust collection systems. *These systems have the ability to operate in various climates, i.e., they are not subject to freezing at lower temperatures as with the use of water, and they can be up to 99 percent efficient if properly maintained* (CDC 2012). The arsenic emissions inventory in Appendix A conservatively assumes a dust control efficiency of 90% for these systems.

5.2 Haul Road Capping

To reduce dust-related arsenic emissions from haul roads, Perpetua Resources will cap the haul roads that are outside of the pits and DRSFs with clean (low arsenic) development rock. Haul roads within the pits and DRSFs cannot be capped with this material because of steep grades and periodic road rerouting as mining areas develop. The median arsenic concentration of the clean development rock is 90 parts per million (ppm) (Perpetua 2021g).

5.3 Long-Term Mining Production Limits

To limit long-term dust-related metal TAP emissions, Perpetua Resources proposes limiting mining production to 135,000 T/day based on a 5-year rolling averaging period. This long-term mining production limit will be in addition to the current short-term daily limit of 180,000 T/day.

Limiting the long-term mining production limit to 135,000 T/day (5-year rolling average) is conservative. The highest 5-year rolling average mining production rate as described in ModPRO2 is only 95,700 T/day (Perpetua 2021a), which is 70.9% of the proposed limit.

[8] HAP/TAP Emission Calculations – Scenario W3, T-RACT: The HAP and TAP emissions based on T-RACT controls, a long-term mining production limit of 135,000 T/day (5-year rolling average), other refinements, and the highest emissions scenario (Modeling Scenario W3).

PRI00000612

REC 1952

5.4 Burntlog Access Road Refinement

To reduce dust-related arsenic emissions from vehicle travel on the Burntlog access road, Perpetua Resources will construct this road with borrow material located outside of the mine site ambient air boundary. Analyses of the borrow sites show low arsenic levels of 2.5 ppm (ALS 2018), which are consistent with the background soil levels (DHHS 2007).

5.5 Bulldozing Refinement

Perpetua Resources and Air Sciences conducted a thorough review of the SGP emissions inventory to identify any potential dust-related metal TAP emission control measures (as discussed in the previous sections) and emission factor refinements. The only emission factor refinement identified was changing the bulldozing emission factor silt content from the EPA default of 6.9% to the SGP site-specific silt content of 4.0% (Midas Gold 2015). EPA recommends the use of site-specific data when available.[9]

[9] *In using the equations to estimate emissions from sources found in a specific western surface mine, it is necessary that reliable values for correction parameters be determined for the specific sources of interest if the assigned quality ratings of the equations are to be applicable. For example, actual silt content of coal or overburden measured at a facility should be used instead of estimated values. In the event that site-specific values for correction parameters cannot be obtained, the appropriate geometric mean values from Table 11.9-3 may be used, but the assigned quality rating of each emission factor equation should be reduced by 1 level (e.g., A to B)* (EPA 1998).

PRI00000613

REC 1953

6.0 T-RACT ANALYSIS

Per IDAPA 58.01.01.210.14(a), this section documents the T-RACT control technologies.

6.1 Drilling Dust Control System

As discussed in Section 5.1, Perpetua Resources will install and operate drilling rigs mounted with dust collection systems. The following paragraphs evaluate this control as T-RACT:

Identification of all possible control technologies

Drilling operations create dust-related metal TAP emissions. The possible control technologies for these emissions are as follows:

- Applying best management practices
- Wet drilling with water injection
- Dry drilling with dust collectors

Best management practices include: (1) avoiding drilling operations during high dust conditions, and (2) shrouding drill areas to limit dust emissions.

Wet drilling includes injected water flows through the center of the drill and out though the drill bit to reduce dust emissions by 96% to 98%.[10]

Dry drilling includes rigs equipped with dust collection systems that shroud dust generated from the drilling area, capture, and remove dust through a dust collection system composed of an exhaust fan and filters that can achieve up to 99% control efficiency (CDC 2012).

Elimination of technologically infeasible or unreasonable technologies

Wet drilling at the SGP has the following disadvantages:

- It is subject to freezing at the low temperatures expected for the SGP location.
- It can result in drill bit plugging, drill rotation binding, and drill bit degradation.
- A wet drill hole can interfere with the blasting agent.

Based on the above disadvantages of wet drilling, it is considered an infeasible or unreasonable technology for the SGP.

[10] *Testing has demonstrated that dust control efficiencies of up to 98 percent can be obtained using the water separator sub while dust control efficiencies of wet drilling without the water separator sub were 96 percent* (CDC 2012).

PRI00000614

REC 1954

Ranking the remaining technologies by control effectiveness

The ranking of the possible control technologies for drilling by control effectiveness is as follows (highest to lowest):

1. Dry drilling with dust collectors – up to 99% control efficiency
2. Best management practices

Evaluation of the most effective control technology and selection of T-RACT

Perpetua Resources selects the top (most effective) control technology of dry drilling with dust collectors as T-RACT. Selecting the top control negates the need for considering economic, energy, and environmental impacts regarding the other control technologies.

6.2 Haul Road Dust and Arsenic Control

Dust emissions from unpaved roads are caused by vehicle traffic on these roads. Particles are lifted and dropped from the rolling wheels, and the turbulent wake behind the vehicles causes these particulates to become air borne. Dust control options include surface improvement (paving) or surface treatment (chemical suppressant application or watering).

As discussed in the SOB from February 18, 2021, Perpetua Resources will control dust emissions from haul roads by treating the surface with frequent watering and the periodic application of a chemical suppressant. Reducing dust emissions reduces dust-related metal TAP emissions. In addition, Perpetua Resources will reduce arsenic emissions by capping the haul roads outside of the pits and DRSFs with clean (low arsenic) development rock, as discussed in Section 5.2. The following sections evaluate these control measures as T-RACT.

6.2.1 Dust Control Technologies

Identification of all possible control technologies

Vehicle traffic on unpaved haul roads creates dust-related metal TAP emissions. The possible control technologies for these emissions are as follows:

- Paving
- Application of a chemical dust suppressant
- Watering

Paving: *The control efficiencies achievable by paving can be estimated by comparing emission factors for unpaved and paved road conditions* (EPA 2006). The particulate emission factor for a paved road with a silt loading of 0.2 g/m² (based on the EPA default value for the SGP average daily traffic of 500–5,000 trips per day) (EPA 2011a) and the SGP average vehicle weight of 182.6 tons is

PRI00000615

REC 1955

0.515 lb/VMT. The SGP unpaved road particulate emission factor is 14.43 lb/VMT (uncontrolled). Based on these emission factors, the estimated control efficiency of paving the haul roads is 96%.

Dust suppressant and watering: The SGP dust emissions from unpaved haul roads are calculated based on a surface treatment control efficiency of 90% (annual basis) for the application of a chemical dust suppressant supplemented with frequent watering. As discussed in the SGP Application, this control efficiency is supported by EPA's AP-42 13.2.2 referenced test reports, which show that a chemical dust suppressant alone can achieve 90% to 99% control efficiency and 98% for magnesium chloride in particular (Air Sciences 2020, Appendix A to Attachment A). A control efficiency of 90% is also supported by the control efficiency limits established under Reasonable Achievable Control Technology (RACT), Best Available Control Technology (BACT), and Lowest Achievable Emission Rate (LAER) determinations under EPA's New Source Review permitting program.

The EPA RACT/BACT/LAER Clearinghouse (RBLC) database contains case-specific information on the air pollution technologies required by major stationary sources seeking a permit under EPA's New Source Review (NSR) program. This database was queried for all listings of air pollution technologies for unpaved roads using chemical dust suppressants or a combination of chemical dust suppressants and watering. The results of the query identified 10 projects containing a control efficiency of 90% or greater for unpaved roads. These determinations are listed in Table 10.

PRI00000616

REC 1956

Table 10. EPA RBLC Determinations for 90% or Greater Control Efficiency of Unpaved Roads

State	Facility Name	RBLC-ID	Dust Control	Dust Control Efficiency
AK	Donlin Gold Project	AK-0084	water/chem	90%
AR	Turk Power Plant	AR-0094	water/chem	90%
CO	Rio Grande Portland Cement Corp.	CO-0043	water/chem	90%
IN	Nucor Steel	IN-0034	chem	90%
LA	Nucor Steel Louisiana	LA-0239	water/chem	90%
MO	Lafarge Corp.	MO-0048	chem	90%
NV	Sloan Quarry	NV-0045	chem	98%
NV	Nellis Air Force Base	NV-0047	water/chem	90%
OH	Unlimited Concrete	OH-0126	water/chem	90%
OH	Unlimited Concrete	OH-0131	water/chem	90%

(EPA 2021)

Elimination of technologically infeasible or unreasonable technologies

Paving haul roads at the SGP has the following disadvantages:

- The paving of haul roads is not conventional practice at mining operations.
- Paved highway weight limits are only approximately 20,000 pounds (10 tons).
- Paving is costly.

The conventional practice for mining operations is to utilize unpaved haul roads with treated surfaces to control fugitive dust. Haul trucks are single axle vehicles with a gross loaded weight of 60 tons to 685 tons. The loaded weight range for the SGP haul trucks is 60 to 260 tons. These weights significantly exceed regulatory weight limits for paved highways of 10 tons. Furthermore, the SGP mining activity locations move as mining progresses. This requires haul roads to be rerouted as necessary. Due to the temporary nature of hauling routes and the heavy weight of haul trucks, paving is considered an infeasible or unreasonable technology for the SGP.

Ranking the remaining technologies by control effectiveness

The ranking of the possible control technologies for drilling by control effectiveness is as follows (highest to lowest):

1. Application of a chemical dust suppressant – 90% to 99% control efficiency

2. Watering – 75% to 95% control efficiency (EPA 2006, Figure 13.2.2-2)

Evaluation of the most effective control technology and selection of T-RACT

After eliminating paving as a viable control option, Perpetua Resources selects the next most effective control technologies of the application of a chemical dust suppressant supplemented with frequent watering as T-RACT.

6.2.2 Arsenic Control Technologies

After applying T-RACT for dust control, as discussed in Section 6.2.1, dust-related arsenic emissions can only be further reduced by capping the haul roads with clean (low-arsenic) development rock. The median arsenic concentration of the SPG onsite material is 667 ppm (Midas Gold 2017c). However, there are quartzite rock deposits at the West End pit that have significantly lower mineralization and, thus, lower arsenic levels. The median arsenic concentration of this quartzite rock is 90 ppm (Perpetua 2021g), and there is approximately 3 million tons of this material available. Figure 6 shows the locations of the quartzite rock deposits.

Figure 6. Quartzite Rock Areas



Perpetua Resources proposes capping the haul roads that are outside of the pits and DRSFs with clean (low-arsenic) development rock as a T-RACT work practice, in addition to the T-RACT dust control measures discussed in Section 6.2.1. Haul roads within the pits and DRSFs cannot be capped with this material because of steep grades and periodic road rerouting as mining areas develop.

PRI00000618

REC 1958

7.0 PROPOSED PERMIT CONDITIONS FOR CARCINOGENIC TAP COMPLIANCE

IDEQ is required to establish limits and standards as part of the permit to construct to ensure compliance with the TAP provisions in accordance with IDAPA 58.01.01.210.12(d) and 14(e). Per these two rules, Perpetua Resources proposes the following permit conditions:

7.1 Conditions per IDAPA 58.01.01.210.12(d)

Per IDAPA 58.01.01.210.12(d), *[t]he Department shall include emission limits and other permit terms for the toxic air pollutant in the permit to construct that assure that the facility will be operated in the manner described in the preconstruction compliance demonstration*. As discussed in Section 5.2, Perpetua Resources is proposing long-term mining production limits to demonstrate compliance with carcinogenic TAPs. The following are proposed permit conditions to address this TAP provision:

- The permittee shall haul no more than 135,000 tons per day (T/day) of ore and rock, based on a 5-year rolling average.
    - Each year, the permittee shall monitor and record the amount of ore and rock transported on haul trucks in tons per year (T/yr), and calculate the 5-year rolling average (T/day) based on 365 days per year.
- The permittee shall haul no more than 788.4 million tons (MT) of ore and rock from all deposits over the life of the mine.
- The permittee shall haul no more than 394.2 MT of ore and rock from the West End deposit over the life of the mine.
    - Each year, the permittee shall monitor and record the amount of ore and rock transported on haul trucks (T/yr) from all deposits and the amount of ore and rock transported on haul trucks (T/yr) from the West End deposit, and calculate the life-of-mine rolling total (MT) for each.

7.2 Conditions per IDAPA 58.01.01.210.14(e)

Per IDAPA 58.01.01.210.14(e), *[i]f the Department determines that the applicant has proposed T-RACT, the Department shall determine which of the options, or combination of options, will result in the lowest emission of toxic air pollutants, develop the emission standards constituting T-RACT and incorporate the emission standards into the permit to construct.* As discussed in Section 6.2, Perpetua Resources is proposing T-RACT controls to demonstrate compliance with carcinogenic TAPs. The following are proposed permit conditions to address this TAP provision:

PRI00000619

REC 1959

- The permittee shall use drilling rigs equipped with dust collection systems. Control efficiency: 90%.
    - Within 60 days after startup, the permittee shall develop and maintain an Operation and Maintenance (O&M) manual. The O&M manual shall be a permittee-developed document based upon, but independent from, manufacturer-supplied operating manuals. The permittee shall operate the dust collection systems in accordance with the O&M manual at all times. The requirements in the O&M manual shall be incorporated by reference to this permit and shall be enforceable permit conditions. The O&M manual shall be submitted to DEQ within 60 days after initial startup.
- The permittee shall cap haul roads that are outside of the pits and DRSFs with low-arsenic material.
    - The permittee shall develop and maintain a plan that:
        - identifies the low-arsenic quartzite rock deposits in the West End pit based on core sample analyses,
        - requires periodic inspections (at least quarterly) of the capped haul roads and recapping as needed, and
        - includes record keeping of the inspections and any recapping of roads, noting the date and road section.
    - The permittee shall use the low-arsenic quartzite rock deposits from the West End pit, or other material with equal or lower arsenic concentration, as capping material.
        - If other material is used, it must be analyzed for arsenic concentration and a record of the median arsenic concentration shall be maintained.

The Draft PTC currently includes conditions for treating haul road surfaces with a chemical suppressant and water to control 90% of the dust (on an annual basis). See Conditions 1.2, 2.1–2.6, 2.8, 3.2, and 3.9. Therefore, no new conditions are needed or proposed for this dust control practice.

PRI00000620

REC 1960

8.0 MERCURY EMISSIONS ANALYSIS

A complete inventory of mercury emissions is provided in Appendix A, as discussed in Section 2.0. This section categorizes these emissions into mercury emissions covered or not covered by IDAPA 58.01.01.215. According to IDAPA 58.01.01.215:

No owner or operator may commence construction or modification of a stationary source or facility that results in an increase in annual potential emissions of mercury of twenty-five (25) pounds or more unless the owner or operator has obtained a permit to construct under Sections 200 through 228 of these rules. The permit to construct application shall include an MBACT analysis for the new source or sources for review and approval by the Department. A determination of applicability under Section 215 shall be based upon the best available information. Fugitive emissions shall not be included in a determination of applicability under Section 215.

01. Exemptions. New or modified stationary sources within a source category subject to 40 CFR Part 63 are exempt from the requirements of Section 215.

Table 11 summarizes the SGP mercury sources and potential emissions for the highest emissions year (Model Scenario W3, 180,000 T/day Emissions). This table also provides the mercury emissions without considering the above exemptions, the exemption criteria, and the non-exempt mercury emissions for each source. As shown in this table, under IDAPA 58.01.01.215.01, the total potential non-exempt mercury emissions are 5.40E-5 ton/yr (0.108 lb/yr), which is well below the 25 lb/yr emission threshold.

PRI00000621

REC 1961

Table 11. Mercury Source and Emissions Summary

Source	All Emissions ton/yr	Fugitive/ NESHAP Exemption	Non-Exempt Emissions ton/yr
Mining			
Fugitive Dust (drilling, blasting, excavating, hauling, etc.)	0.0021	Fugitive	0
Fugitive Evaporative (pits, tailings, DRSFs, stockpiles)	0.0036	Fugitive	0
Ore Processing			
Crushing, Screening, and Transfers	2.47E-05		2.47E-05
Prill Silos	0		0
Ore Concentration and Refining			
Autoclave	0.00010	7E	0
EW, Pregnant Tank, Retort, Furnace, Carbon Kiln	0.0017	7E	0
Process Heating			
POX, Carbon Kiln, Propane Vaporizers, Solution Heater	8.28E-06		8.28E-06
Lime Production			
Lime Kiln Combustion	2.09E-05	5A	0
Limestone Crushers, Screens, Mill, and Transfers	3.86E-07		3.86E-07
Lime Kiln, Kiln Feed, Lime Mill, and Pebble Lime Silo	0.0010	5A	0
Lime Silos and Lime Mill Crushing	4.05E-09		4.05E-09
Aggregate Production			
Portable Crushers, Screens, and Transfers	1.10E-07		1.10E-07
Concrete Production			
Central Mixer	0		0
Cement Silo Loading and Unloading	0		0
Aggregate Bin	6.90E-08		6.90E-08
HVAC			
Heaters	2.04E-05		2.04E-05
Emergency Power			
Emergency Generators and Fire Pump	0	4Z	0
Fuel Storage			
Gasoline Fuel Tanks	0	6C	0
Total	**0.00863**		**5.40E-05**

PRI00000622

REC 1962

9.0 REFERENCES

Air Sciences. 2020. "Stibnite Gold Project Permit to Construct Application." *Prepared for: Midas Gold Idaho, Inc.* June 23.

—. 2021. "Stibnite Gold Project Permit to Construct Application Arsenic Modeling Addendum." *Prepared For: Perpetua Resources, Inc. (Formerly Midas Gold Idaho, Inc.* July 8.

ALS. 2018. "Project: Midas Gold - Burntlog Route." 8 rock samples submitted to the ALS USA Inc. Reno, NV lab on September 4, 2018, September 26.

CDC. 2012. "Dust Control Handbook for Industrial Minerals Mining and Processing." *RI 9689. Report of Investigations/2012.* Department of Health and Human Services, Centers for Disease Control and Prevention (CDC), January. Accessed June 28, 2021. https://www.cdc.gov/niosh/mining/UserFiles/works/pdfs/2012-112.pdf.

DHHS. 2007. "Toxicological Profile for Arsenic." U.S. Department of Health and Human Services (DHHS), August.

EPA. 1998. "AP-42 Section 11.9 Western Surface Coal Mining." U.S. Environmental Protection Agency (EPA), October.

—. 1999a. "EPCRA Section 313 Industry Guidance, Metal Mining Facilities." *EPA 745-B-99-001.* Section 313 of the Emergency Planning and Community Right-to-Know Act, Toxic Chemical Release Inventory, Table 3-8 (Gasoline). Environmental Protection Agency, January.

—. 1999b. "Guidance for Reporting Hydrochloric Acid (acid aerosols including mists, vapors, gas, fog, and other airborne forms of any particle size)." *EPA-745-B-99-014.* Emergency Planning and Community Right-to-Know Act - Section 313. Environmental Protection Agency, December.

—. 2006. "AP-42 Section 13.2.2 Unpaved Roads." U.S. Environmental Protection Agency (EPA), November. Accessed October 12, 2020. https://www3.epa.gov/ttn/chief/ap42/ch13/related/c13s02-2.html.

—. 2010. "Part III, 40 CFR Parts 9 and 63, National Emission Standards for Hazardous Air Pollutants: Gold Mine Ore Processing and Production Area Source Category and Addition to Source Category List for Standards; Proposed Rule." *Federal Register / Vol. 75, No. 81 / Wednesday, April 28, 2010 / Proposed Rules 22479.* Environmental Protection Agency, April 28.

—. 2011a. "AP-42 Section 13.2.1 Paved Roads." U.S. Environmental Protection Agency (EPA), January.

—. 2011b. "Part III, 40 CFR Parts 9 and 63, National Emission Standards for Hazardous Air Pollutants: Gold Mine Ore Processing and Production Area Source Category; and Addition to Source Category List for Standards; Final Rule." *9450 Federal Register / Vol. 76, No. 33 / Thursday, February 17, 2011 / Rules and Regulations.* Environmental Protection Agency, February 17.

—. 2021. "RACT/BACT/LAER Clearinghouse (RBLC)." United States Environmental Protection Agency (EPA). Accessed April 2021. https://cfpub.epa.gov/rblc/index.cfm?action=Home.Home&lang=en.

M3. 2018. "M3-PN170045 Stibnite Gold Feasibility Study RE: M3-MGI-029E Lime Kiln Analysis Memo." *File: Copy of MGI-17-431-FullGeochem - MB.XLSX.* Email from L. Becker, M3, to D. Kerner, Midas Gold, June 14.

Midas Gold. 2015. "Soil Resources Baseline Study, Stibnite Gold Project." Reid, Samuel B., Assistant Geology Supervisor, Midas Gold, Inc., April.

—. 2017c. "Geochemistry Statistics." Email from R. McCluskey, Midas Gold Idaho, to E. Memon, Air Sciences, September 26.
—. 2020. "Te-2." *File: 2020-12-09_Fe and Se data.xlsx.* Email from A. Zinsser, Midas Gold Idaho, Inc., to K. Lewis, Air Sciences Inc., December 9.
NLA. 2007. "FACT SHEET: Lime, The Versatile Chemical, Lime Terminology, Standards & Properties." National Lime Association (NLA), January. Accessed December 10, 2020. https://www.lime.org/documents/publications/free_downloads/fact-properties2007rev.pdf.
Perpetua. 2021a. "ModPRO2 Mine Plan." *File: Midas Stibnite Mine Plan and Equipment Schedule (10Feb21).xlsx.* Email from R. McCluskey, Perpetua Resources Inc., to E. Memon, Air Sciences Inc., February 11.
—. 2021g. "RE: As values feeding Haul Road Geochem runoff calculations." *Attachment: Upper Quartzite_DH_ICP data_Medians.xlsx.* Email from A. Zinsser, Perpetua Resources, to D. Kerner, Perpetua Resources, June 7.
USGS. n.d. "Vanadium, Chapter U of Critical Mineral Resources of the United States—Economic and Environmental Geology and Prospects for Future Supply." *Professional Paper 1802–U.* U.S. Department of the Interior, U.S. Geological Survey. Accessed December 5, 2020. https://pubs.usgs.gov/pp/1802/u/pp1802u.pdf.

PRI00000624

REC 1964

Appendix A – HAP/TAP Emission Calculations

Appendix A Table of Contents

HAP/TAP Emission Calculations – Scenario W3, 180,000 T/day Emissions.....A-2

Table A-W3. HAP/TAP Emissions and Exemptions – Scenario W3, 180,000 T/day Emissions .A-21

HAP/TAP Emission Calculations – Scenario W3, T-RACT Emissions.....A-26

Table A-W3. HAP/TAP Emissions and Exemptions – Scenario W3, T-RACT Emissions A-45

PRI00000626

REC 1966

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 1 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021

Model Scenario W3 180,000 T/day Emissions

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	HAP/TAP	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
106-99-0	1,3-Butadiene	8.4E-07	3.7E-06	0	0	0	0	8.4E-07	3.7E-06	Y	Y
91-57-6	2-Methylnaphthalene	1.1E-06	4.6E-06	0	0	0	0	1.1E-06	4.6E-06	Y	N
56-49-5	3-Methylchloranthrene	7.8E-08	3.4E-07	0	0	0	0	7.8E-08	3.4E-07	Y	Y
57-97-6	7,12-Dimethylbenz(a)anthracene	7.6E-07	3.0E-06	0	0	0	0	7.6E-07	3.0E-06	Y	N
83-32-9	Acenaphthene	5.7E-06	7.1E-06	0	0	0	0	5.7E-06	7.1E-06	Y	N
208-96-8	Acenaphthylene	1.1E-05	1.4E-05	0	0	0	0	1.1E-05	1.4E-05	Y	N
75-07-0	Acetaldehyde	2.5E-05	1.1E-04	0	0	0	0	2.5E-05	1.1E-04	Y	Y
107-02-8	Acrolein	1.6E-05	2.0E-05	0	0	0	0	1.6E-05	2.0E-05	Y	Y
120-12-7	Anthracene	1.7E-06	2.4E-06	0	0	0	0	1.7E-06	2.4E-06	Y	N
7440-36-0	Antimony	0	0	5.7E-04	2.5E-03	1.9E-02	8.2E-02	1.9E-02	8.5E-02	Y	Y
7440-38-2	Arsenic	8.7E-06	3.8E-05	4.5E-03	2.0E-02	0.54	2.38	0.55	2.40	Y	Y
56-55-3	Benz(a)anthracene	3.1E-07	1.4E-06	0	0	0	0	3.1E-07	1.4E-06	Y	Y
71-43-2	Benzene	3.6E-04	1.6E-03	7.0E-03	3.1E-02	0	0	7.4E-03	3.2E-02	Y	Y
50-32-8	Benzo(a)pyrene	1.4E-07	6.1E-07	0	0	0	0	1.4E-07	6.1E-07	Y	Y
205-99-2	Benzo(b)fluoranthene	4.4E-07	1.9E-06	0	0	0	0	4.4E-07	1.9E-06	Y	Y
191-24-2	Benzo(g,h,i)perylene	7.5E-07	1.1E-06	0	0	0	0	7.5E-07	1.1E-06	Y	N
207-08-9	Benzo(k)fluoranthene	1.5E-07	6.6E-07	0	0	0	0	1.5E-07	6.6E-07	Y	Y
7440-41-7	Beryllium	5.2E-07	2.3E-06	4.3E-04	1.9E-03	2.6E-03	1.1E-02	3.0E-03	1.3E-02	Y	Y
92-52-4	Biphenyl	0	0	4.4E-05	1.9E-04	0	0	4.4E-05	1.9E-04	Y	Y
7440-43-9	Cadmium	4.8E-05	2.1E-04	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.7E-04	3.8E-03	Y	Y
75-15-0	Carbon Disulfide	0	0	1.4E-02	6.3E-02	0	0	1.4E-02	6.3E-02	Y	Y
7440-47-3	Chromium	6.6E-05	2.7E-04	6.1E-04	2.5E-03	7.3E-03	3.2E-02	8.0E-03	3.5E-02	Y	Y
18540-29-9	Cr (VI)	0	0	3.4E-07	1.5E-06	0	0	3.4E-07	1.5E-06	Y	Y
218-01-9	Chrysene	5.8E-07	2.5E-06	0	0	0	0	5.8E-07	2.5E-06	Y	Y
7440-48-4	Cobalt	4.0E-06	1.6E-05	4.7E-04	2.0E-03	3.3E-03	1.4E-02	3.7E-03	1.6E-02	Y	Y
592-01-8	Cyanide	0	0	0.45	1.99	0	0	0.45	1.99	Y	Y
53-70-3	Dibenzo(a,h)anthracene	1.8E-07	7.7E-07	0	0	0	0	1.8E-07	7.7E-07	Y	Y
106-46-7	Dichlorobenzene	5.7E-05	2.3E-04	0	0	0	0	5.7E-05	2.3E-04	Y	Y
206-44-0	Fluoranthene	5.5E-06	7.0E-06	0	0	0	0	5.5E-06	7.0E-06	Y	N
86-73-7	Fluorene	1.7E-05	2.1E-05	0	0	0	0	1.7E-05	2.1E-05	Y	N
50-00-0	Formaldehyde	3.3E-03	1.5E-02	0	0	0	0	3.3E-03	1.5E-02	Y	Y
110-54-3	Hexane	8.5E-02	0.34	3.1E-02	0.14	0	0	0.12	0.48	Y	Y
7647-01-0	Hydrogen Chloride	0	0	0.99	3.67	0	0	0.99	**3.67**	Y	Y
193-39-5	Indeno(1,2,3-cd)pyrene	2.2E-07	9.6E-07	0	0	0	0	2.2E-07	9.6E-07	Y	Y
7439-92-1	Lead	0	0	4.8E-04	2.1E-03	6.5E-03	2.9E-02	7.0E-03	3.1E-02	Y	N
7439-96-5	Manganese	1.8E-05	7.2E-05	4.6E-03	1.7E-02	0.24	1.07	0.25	1.08	Y	Y
7439-97-6	Mercury	1.2E-05	5.0E-05	6.9E-04	2.9E-03	1.3E-03	5.7E-03	2.0E-03	8.6E-03	Y	N
91-20-3	Naphthalene	1.9E-04	3.1E-04	1.9E-03	8.5E-03	0	0	2.1E-03	8.8E-03	Y	Y
7440-02-0	Nickel	9.1E-05	4.0E-04	4.6E-04	2.0E-03	1.6E-03	7.1E-03	2.2E-03	9.5E-03	Y	Y
85-01-8	Phenanthrene	5.1E-05	6.3E-05	0	0	0	0	5.1E-05	6.3E-05	Y	N
108-95-2	Phenol	0	0	2.4E-04	1.1E-03	0	0	2.4E-04	1.1E-03	Y	Y
7723-14-0	Phosphorus	0	0	5.6E-03	2.3E-02	0.53	2.32	0.54	2.34	Y	Y
129-00-0	Pyrene	5.0E-06	6.6E-06	0	0	0	0	5.0E-06	6.6E-06	Y	N
7782-49-2	Selenium	1.1E-06	4.6E-06	4.1E-04	1.8E-03	3.3E-04	1.4E-03	7.4E-04	3.2E-03	Y	Y
108-88-3	Toluene	5.2E-04	1.1E-03	3.2E-02	0.14	0	0	3.2E-02	0.14	Y	Y
1330-20-7	Xylene	2.5E-04	3.0E-04	3.1E-02	0.14	0	0	3.2E-02	0.14	Y	Y
Total HAP		9.0E-02	0.36	1.58	6.25	1.36	5.95	3.03	12.56		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

		0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
TRUE		0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
		chk	chk	chk-15	chk	chk	chk	chk	chk

PRI00000627

REC 1967

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary - continued

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**Non-HAP TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
7429-90-5	Aluminum	0	0	0.65	2.58	57.86	253.41	58.50	255.98	N	Y
7440-39-3	Barium	2.1E-04	8.4E-04	6.6E-03	2.7E-02	0.65	2.86	0.66	2.88	N	Y
1317-65-3	Calcium Carbonate	0	0	2.24	8.12	11.41	49.97	13.65	58.09	N	Y
1305-78-8	Calcium Oxide	0	0	0.70	0.95	0	0	0.70	0.95	N	Y
7440-50-8	Copper	4.0E-05	1.6E-04	4.9E-04	2.1E-03	4.1E-03	1.8E-02	4.6E-03	2.0E-02	N	Y
110-82-7	Cyclohexane	0	0	1.0E-03	4.6E-03	0	0	1.0E-03	4.6E-03	N	Y
7783-06-4	Hydrogen Sulfide	0	0	0.90	3.94	0	0	0.90	3.94	N	Y
7439-89-6	Iron	0	0	0.21	0.81	14.83	64.96	15.04	65.77	N	Y
7439-98-7	Molybdenum	5.2E-05	2.1E-04	4.2E-04	1.8E-03	8.1E-04	3.6E-03	1.3E-03	5.6E-03	N	Y
109-66-0	Pentane	0.12	0.50	0	0	0	0	0.12	0.50	N	Y
7440-22-4	Silver	0	0	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.2E-04	3.6E-03	N	Y
7664-93-9	Sulfuric Acid	0	0	2.03	8.89	0	0	2.03	8.89	N	Y
7440-28-0	Thallium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-61-1	Uranium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-62-2	Vanadium	1.1E-04	4.4E-04	7.3E-04	3.0E-03	2.3E-02	1.0E-01	2.4E-02	0.10	N	Y
25551-13-7	Trimethyl benzene	0	0	1.1E-02	4.8E-02	0	0	1.1E-02	4.8E-02	N	Y
7440-33-7	Tungsten	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-66-6	Zinc	1.4E-03	5.5E-03	8.0E-04	3.3E-03	2.9E-02	0.12	3.1E-02	0.13	N	Y
Total Non-HAP TAP		0.13	0.50	6.75	25.40	84.83	371.54	91.71	397.44		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

Conversions

2,000 lb/ton
8,760 hr/yr
24 hr/day

PRI00000628

REC 1968

PROPANE COMBUSTION

Source Data

Source ID	Description	MMBtu/day	MMBtu/yr
Lime Process Heating			
LKC	PFR Shaft Lime Kiln Combustion	529.0	163,935
Ore Process Heating			
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	17.0	510
CKB	Carbon Regeneration Kiln (Burners)	54.1	19,754
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	2.4	876
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	120.0	43,800
Subtotal		193.5	64,940
HVAC			
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	96.0	35,040
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	96.0	35,040
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	96.0	35,040
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	12.0	4,380
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	48.0	17,520
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	72.0	26,280
Subtotal		438.0	159,870

PROPANE COMBUSTION - CONTINUED

HAP/TAP Emission Factors and Emissions

O.Heat_pph O.Heat_tpy L.Heat_pph L.Heat_tpy HVAC_pph HVAC_tpy lb/hr ton/yr

		Emission Factor[2]		Emissions[1] Ore Proc Heat		Lime Proc Heat		HVAC		Total			
CAS	Pollutant	lb/MMscf	lb/MMBtu[3]	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	TAP	A/C
91-57-6	2-Methylnaphthalene	2.4E-05	2.35E-8	1.9E-07	7.6E-07	5.2E-07	1.9E-06	4.3E-07	1.9E-06	1.1E-06	4.6E-06	N	
56-49-5	3-Methylchloranthrene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
57-97-6	7,12-Dimethylbenz(a)ant	< 1.6E-05	1.57E-8	1.3E-07	5.1E-07	3.5E-07	1.3E-06	2.9E-07	1.3E-06	7.6E-07	3.0E-06	N	
83-32-9	Acenaphthene	< 1.8E-06	1.76E-9	1.4E-08	5.7E-08	3.9E-08	1.4E-07	3.2E-08	1.4E-07	8.5E-08	3.4E-07	N	
208-96-8	Acenaphthylene	< 1.8E-06	1.76E-9	1.4E-08	5.7E-08	3.9E-08	1.4E-07	3.2E-08	1.4E-07	8.5E-08	3.4E-07	N	
120-12-7	Anthracene	< 2.4E-06	2.35E-9	1.9E-08	7.6E-08	5.2E-08	1.9E-07	4.3E-08	1.9E-07	1.1E-07	4.6E-07	N	
7440-38-2	Arsenic	2.0E-04	1.96E-7	1.5E-06	6.4E-06	3.7E-06	1.6E-05	3.6E-06	1.6E-05	8.7E-06	3.8E-05	Y	C
56-55-3	Benz(a)anthracene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
71-43-2	Benzene	2.1E-03	2.06E-6	1.5E-05	6.7E-05	3.9E-05	1.7E-04	3.8E-05	1.6E-04	9.1E-05	4.0E-04	Y	C
50-32-8	Benzo(a)pyrene	< 1.2E-06	1.18E-9	8.7E-09	3.8E-08	2.2E-08	9.6E-08	2.1E-08	9.4E-08	5.2E-08	2.3E-07	Y	C
205-99-2	Benzo(b)fluoranthene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
191-24-2	Benzo(g,h,i)perylene	< 1.2E-06	1.18E-9	9.5E-09	3.8E-08	2.6E-08	9.6E-08	2.1E-08	9.4E-08	5.7E-08	2.3E-07	N	
207-08-9	Benzo(k)fluoranthene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
7440-41-7	Beryllium	< 1.2E-05	1.18E-8	8.7E-08	3.8E-07	2.2E-07	9.6E-07	2.1E-07	9.4E-07	5.2E-07	2.3E-06	Y	C
7440-43-9	Cadmium	1.1E-03	1.08E-6	8.0E-06	3.5E-05	2.0E-05	8.8E-05	2.0E-05	8.6E-05	4.8E-05	2.1E-04	Y	C
7440-47-3	Chromium	1.4E-03	1.37E-6	1.1E-05	4.5E-05	3.0E-05	1.1E-04	2.5E-05	1.1E-04	6.6E-05	2.7E-04	Y	A
218-01-9	Chrysene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
7440-48-4	Cobalt	8.4E-05	8.24E-8	6.6E-07	2.7E-06	1.8E-06	6.8E-06	1.5E-06	6.6E-06	4.0E-06	1.6E-05	Y	A
53-70-3	Dibenzo(a,h)anthracene	< 1.2E-06	1.18E-9	8.7E-09	3.8E-08	2.2E-08	9.6E-08	2.1E-08	9.4E-08	5.2E-08	2.3E-07	Y	C
106-46-7	Dichlorobenzene	1.2E-03	1.18E-6	9.5E-06	3.8E-05	2.6E-05	9.6E-05	2.1E-05	9.4E-05	5.7E-05	2.3E-04	Y	A
206-44-0	Fluoranthene	3.0E-06	2.94E-9	2.4E-08	9.5E-08	6.5E-08	2.4E-07	5.4E-08	2.4E-07	1.4E-07	5.7E-07	N	
86-73-7	Fluorene	2.8E-06	2.75E-9	2.2E-08	8.9E-08	6.1E-08	2.3E-07	5.0E-08	2.2E-07	1.3E-07	5.3E-07	N	
50-00-0	Formaldehyde	7.5E-02	7.35E-5	5.5E-04	2.4E-03	1.4E-03	6.0E-03	1.3E-03	5.9E-03	3.3E-03	1.4E-02	Y	C
110-54-3	Hexane	1.8E+00	1.76E-3	1.4E-02	5.7E-02	3.9E-02	1.4E-01	3.2E-02	1.4E-01	8.5E-02	3.4E-01	Y	A
193-39-5	Indeno(1,2,3-cd)pyrene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
7439-96-5	Manganese	3.8E-04	3.73E-7	3.0E-06	1.2E-05	8.2E-06	3.1E-05	6.8E-06	3.0E-05	1.8E-05	7.2E-05	Y	A
7439-97-6	Mercury	2.6E-04	2.55E-7	2.1E-06	8.3E-06	5.6E-06	2.1E-05	4.7E-06	2.0E-05	1.2E-05	5.0E-05	N	
91-20-3	Naphthalene	6.1E-04	5.98E-7	4.8E-06	1.9E-05	1.3E-05	4.9E-05	1.1E-05	4.8E-05	2.9E-05	1.2E-04	Y	A
7440-02-0	Nickel	2.1E-03	2.06E-6	1.5E-05	6.7E-05	3.9E-05	1.7E-04	3.8E-05	1.6E-04	9.1E-05	4.0E-04	Y	C
85-01-8	Phenanthrene	1.7E-05	1.67E-8	1.3E-07	5.4E-07	3.7E-07	1.4E-06	3.0E-07	1.3E-06	8.1E-07	3.2E-06	N	
129-00-0	Pyrene	5.0E-06	4.90E-9	4.0E-08	1.6E-07	1.1E-07	4.0E-07	8.9E-08	3.9E-07	2.4E-07	9.5E-07	N	
7782-49-2	Selenium	< 2.4E-05	2.35E-8	1.9E-07	7.6E-07	5.2E-07	1.9E-06	4.3E-07	1.9E-06	1.1E-06	4.6E-06	Y	A
108-88-3	Toluene	3.4E-03	3.33E-6	2.7E-05	1.1E-04	7.3E-05	2.7E-04	6.1E-05	2.7E-04	1.6E-04	6.5E-04	Y	A
109-66-0	Pentane	2.6E+00	2.55E-3	2.1E-02	8.3E-02	5.6E-02	2.1E-01	4.7E-02	2.0E-01	1.2E-01	5.0E-01	Y	A
7440-39-3	Barium	4.4E-03	4.31E-6	3.5E-05	1.4E-04	9.5E-05	3.5E-04	7.9E-05	3.4E-04	2.1E-04	8.4E-04	Y	A
7440-50-8	Copper	8.5E-04	8.33E-7	6.7E-06	2.7E-05	1.8E-05	6.8E-05	1.5E-05	6.7E-05	4.0E-05	1.6E-04	Y	A
7439-98-7	Molybdenum	1.1E-03	1.08E-6	8.7E-06	3.5E-05	2.4E-05	8.8E-05	2.0E-05	8.6E-05	5.2E-05	2.1E-04	Y	A
7440-62-2	Vanadium	2.3E-03	2.25E-6	1.8E-05	7.3E-05	5.0E-05	1.8E-04	4.1E-05	1.8E-04	1.1E-04	4.4E-04	Y	A
7440-66-6	Zinc	2.9E-02	2.84E-5	2.3E-04	9.2E-04	6.3E-04	2.3E-03	5.2E-04	2.3E-03	1.4E-03	5.5E-03	Y	A
Total				3.6E-02	1.4E-01	9.8E-02	3.6E-01	8.1E-02	3.5E-01	2.1E-01	8.6E-01		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *AP-42, Table 1.4-3 & 1.4-4 (7/98) Natural Gas Combustion* 1.0766 1.0766

[3] *Natural Gas Higher Heating Value* 1,020 *MMBtu/MMscf* chk

DIESEL COMBUSTION

Source Data

Source ID	Description	Power Rating kW	Power Rating hp	Operation hr/day	Operation hr/yr	Fuel Consumption[1] & [2] MMBtu/day	Fuel Consumption[1] & [2] MMBtu/yr
EDG1	Camp Emergency Generator	1,000	1,341	1	100	9.39	938.70
EDG2	Plant Emergency Generator #1	1,000	1,341	1	100	9.39	938.7
EDG3	Plant Emergency Generator #2	1,000	1,341	1	100	9.39	938.7
EDFP	Mill Fire Pump	200	268	1	100	1.88	187.7
Total						30.0	3,003.8

[1] *Based on brake specific fuel consumption for diesel generators* 7,000 *Btu/hp-hr* *AP-42 Tbl 3.3-1*

[2] *Heat Content of* 0.137 *MMBtu/gal* 1E+6 *Btu/MMBtu* 1.341 *hp/kW*

HAP/TAP Emission Factors and Emissions

	Pollutant	Factor (lb/MMBtu) ≤600 hp[2]	Factor (lb/MMBtu) >600hp[3]	Emissions (≤600 hp) lb/hr	Emissions (≤600 hp) ton/yr	Emissions (>600 hp) lb/hr	Emissions (>600 hp) ton/yr	Total Emissions[1] lb/hr	Total Emissions[1] ton/yr	TAP	A/C
106-99-0	1,3-Butadiene	< 3.9E-05		8.4E-07	3.7E-06	0.0E+00	0.0E+00	8.4E-07	3.7E-06	Y	C
83-32-9	Acenaphthene	< 1.4E-06	4.7E-06	1.1E-07	1.3E-07	5.5E-06	6.6E-06	5.6E-06	6.7E-06	N	
208-96-8	Acenaphthylene	< 5.1E-06	9.2E-06	4.0E-07	4.7E-07	1.1E-05	1.3E-05	1.1E-05	1.3E-05	N	
75-07-0	Acetaldehyde	7.7E-04	2.5E-05	1.6E-05	7.2E-05	8.1E-06	3.5E-05	2.5E-05	1.1E-04	Y	C
107-02-8	Acrolein	< 9.3E-05	7.9E-06	7.2E-06	8.7E-06	9.2E-06	1.1E-05	1.6E-05	2.0E-05	Y	A
120-12-7	Anthracene	1.9E-06	1.2E-06	1.5E-07	1.8E-07	1.4E-06	1.7E-06	1.6E-06	1.9E-06	N	
56-55-3	Benz(a)anthracene	1.7E-06	6.2E-07	3.6E-08	1.6E-07	2.0E-07	8.8E-07	2.4E-07	1.0E-06	Y	C
71-43-2	Benzene	9.3E-04	7.8E-04	2.0E-05	8.8E-05	2.5E-04	1.1E-03	2.7E-04	1.2E-03	Y	C
50-32-8	Benzo(a)pyrene	< 1.9E-07	< 2.6E-07	4.0E-09	1.8E-08	8.3E-08	3.6E-07	8.7E-08	3.8E-07	Y	C
205-99-2	Benzo(b)fluoranthene	< 9.9E-08	< 1.1E-06	2.1E-09	9.3E-09	3.6E-07	1.6E-06	3.6E-07	1.6E-06	Y	C
191-24-2	Benzo(g,h,i)perylene	< 4.9E-07	< 5.6E-07	3.8E-08	4.6E-08	6.5E-07	7.8E-07	6.9E-07	8.3E-07	N	
207-08-9	Benzo(k)fluoranthene	< 1.6E-07	< 2.2E-07	3.3E-09	1.5E-08	7.0E-08	3.1E-07	7.3E-08	3.2E-07	Y	C
218-01-9	Chrysene	3.5E-07	1.5E-06	7.6E-09	3.3E-08	4.9E-07	2.2E-06	5.0E-07	2.2E-06	Y	C
53-70-3	Dibenzo(a,h)anthracene	< 5.8E-07	< 3.5E-07	1.2E-08	5.5E-08	1.1E-07	4.9E-07	1.2E-07	5.4E-07	Y	C
206-44-0	Fluoranthene	7.6E-06	4.0E-06	6.0E-07	7.1E-07	4.7E-06	5.7E-06	5.3E-06	6.4E-06	N	
86-73-7	Fluorene	2.9E-05	1.3E-05	2.3E-06	2.7E-06	1.5E-05	1.8E-05	1.7E-05	2.1E-05	N	
50-00-0	Formaldehyde	1.2E-03	7.9E-05	2.5E-05	1.1E-04	2.5E-05	1.1E-04	5.1E-05	2.2E-04	Y	C
193-39-5	Indeno(1,2,3-cd)pyrene	< 3.8E-07	< 4.1E-07	8.0E-09	3.5E-08	1.3E-07	5.8E-07	1.4E-07	6.2E-07	Y	C
91-20-3	Naphthalene	8.5E-05	1.3E-04	6.6E-06	8.0E-06	1.5E-04	1.8E-04	1.6E-04	1.9E-04	Y	A
85-01-8	Phenanthrene	2.9E-05	4.1E-05	2.3E-06	2.8E-06	4.8E-05	5.7E-05	5.0E-05	6.0E-05	N	
129-00-0	Pyrene	4.8E-06	3.7E-06	3.7E-07	4.5E-07	4.4E-06	5.2E-06	4.7E-06	5.7E-06	N	
108-88-3	Toluene	4.1E-04	2.8E-04	3.2E-05	3.8E-05	3.3E-04	4.0E-04	3.6E-04	4.3E-04	Y	A
1330-20-7	Xylene	2.9E-04	1.9E-04	2.2E-05	2.7E-05	2.3E-04	2.7E-04	2.5E-04	3.0E-04	Y	A
Total				1.4E-04	3.6E-04	1.1E-03	2.2E-03	1.2E-03	2.6E-03		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *AP-42, Tab. 3.3-2, 10/96, diesel engines (≤ 600 hp)*

[3] *AP-42, Tabs. 3.4-3 & 3.4-4, 10/96, large diesel engines (> 600 hp)*

chk chk

ORE PROCESSING

Source Data

Source ID	Description	PM Emissions lb/day	PM Emissions ton/yr
OC1	Loader Transfer of Ore to Grizzly	3.500	0.639
OC2	Grizzly to Apron Feeder	3.500	0.639
OC3	Apron Feeder to Dribble Conveyor	3.500	0.639
OC4	Apron Feeder to Vibrating Grizzly	3.500	0.639
OC5	Dribble Conveyor to Vibrating Grizzly	3.500	0.639
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	3.500	0.639
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	30.000	5.475
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	3.500	0.639
OC9	Stockpile Transfers to Reclaim Conveyors	16.560	3.022
OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	16.560	3.022
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	16.560	3.022
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge C	33.120	6.044
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	3.864	0.705
Total		141.164	25.762

HAP/TAP Emission Factors and Emissions

CAS No.	Pollutant	Concentration ppm[2]	Emissions[1] lb/hr	Emissions[1] ton/yr	TAP	A/C
7440-38-2	Arsenic	667	3.9E-03	1.7E-02	Y	C
7440-41-7	Beryllium	3.2	1.9E-05	8.2E-05	Y	C
7440-43-9	Cadmium	0.50	2.9E-06	1.3E-05	Y	C
7440-48-4	Cobalt	4	2.4E-05	1.0E-04	Y	A
7440-47-3	Chromium	9	5.3E-05	2.3E-04	Y	A
7439-97-6	Mercury [3]	0.96	5.6E-06	2.5E-05	N	
7439-96-5	Manganese	299	1.8E-03	7.7E-03	Y	A
7440-02-0	Nickel	2	1.2E-05	5.2E-05	Y	C
7439-92-1	Lead	8	4.7E-05	2.1E-04	N	
7440-36-0	Antimony	23	1.4E-04	5.9E-04	Y	A
7723-14-0	Phosphorus	650	3.8E-03	1.7E-02	Y	A
7782-49-2	Selenium [4]	0.40	2.4E-06	1.0E-05	Y	A
7440-22-4	Silver	0.50	2.9E-06	1.3E-05	Y	A
7429-90-5	Aluminum	71,000	4.2E-01	1.8E+00	Y	A
7440-39-3	Barium	800	4.7E-03	2.1E-02	Y	A
1317-65-3	Calcium Carbonate	14,000	8.2E-02	3.6E-01	Y	A
7440-50-8	Copper	5	2.9E-05	1.3E-04	Y	A
7439-89-6	Iron [4]	18,200	1.1E-01	4.7E-01	Y	A
7439-98-7	Molybdenum	1	5.9E-06	2.6E-05	Y	A
7440-28-0	Thallium	10	5.9E-05	2.6E-04	Y	A
7440-61-1	Uranium	10	5.9E-05	2.6E-04	Y	A
7440-62-2	Vanadium	28	1.6E-04	7.2E-04	Y	A
7440-33-7	Tungsten	10	5.9E-05	2.6E-04	Y	A
7440-66-6	Zinc	35	2.1E-04	9.0E-04	Y	A
Total			6.2E-01	2.7E+00		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *(Midas Gold 2017c) Median concentration of 55,000 SGP samples.*

[3] *(Midas Gold 2018e) Median ore concentration of 151,000 SGP samples; resource block model.*

[4] *(Midas Gold 2020) Median concentration of 56,000 SGP samples for Fe and 1,500 SGP samples for Se.*

1E+6 parts/ppm

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 7 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021

ORE CONCETRATION AND REFINING

Source Data

Source ID	Description	Subpart 7E Allowable Limit lb/yr[1]	Oper. hr/yr	% of Subpart 7E for Controlled Systems %		Controlled Hg Emissions lb/hr	ton/yr	lb/yr
AC	Autoclave	213.4	8,760	[2]		0.000023	0.00010	0.20
EW,MR,MF,CKD	Refinery Sources (C. Kiln, EW, Retort, Furr	16.8		20%	[3]	0.000384	0.00168	3.36
7439-97-6 Mercury	Total	230.2				0.000407	0.00178	3.56

[1] *Subpart 7E Limit - Ore Pretreatment Processes (CFR 2018b)*

84 lb / ~~MMton~~ × 2,540,400 ~~ton~~ / yr × ~~MMton~~ / 1.0E+6 ~~ton~~ = 213.4 lb / yr

[1] *Subpart 7E Limit - Carbon Processes with Mercury Retorts*

0.8 lb / ~~ton~~ × 21 ~~ton~~ / yr = 16.8 lb / yr

[2] *Controlled SysCAD modeled emissions from Autoclave:* 0.0105 g/hr 2.3E-05 lb/hr 0.20 lb/yr (M3 2019)

[3] *Based on similar source (but with much higher ore Hg content) Hg reporting levels provided below:*

Goldstrike Refinery (2015 & 2016 Hg Reports) *(NDEP 2015a) (NDEP 2016)*

28.79 lb / yr × yr / 251.00 ton = 0.11 lb / MMton × ton / 0.8 lb = 14.3%

Twin Creeks Refinery (2015 & 2016 Hg Reports) *(NDEP 2015a) (NDEP 2016)*

31.27 lb / yr × yr / 142.77 ton = 0.22 lb / MMton × ton / 0.8 lb = 27.4%

HAP/TAP Emission Factors and Emission

AC_pph AC_tpy Refin_pph Refin_tpy lb/hr ton/yr

CAS No.	Pollutant	Emission Factor[1]	Autoclave lb/hr	Autoclave ton/yr	Refinery lb/hr	Refinery ton/yr	Total Emissions lb/hr	Total Emissions ton/yr	TAP	A/C
7440-38-2	Arsenic	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	C
7440-41-7	Beryllium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	C
7440-43-9	Cadmium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	C
7440-48-4	Cobalt	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-47-3	Chromium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7439-97-6	Mercury	see above	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	N	
7439-96-5	Manganese	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-02-0	Nickel	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	C
7439-92-1	Lead	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	N	
7440-36-0	Antimony	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7723-14-0	Phosphorus	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7782-49-2	Selenium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-22-4	Silver	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7429-90-5	Aluminum	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-39-3	Barium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
1317-65-3	Calcium Carbonate	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-50-8	Copper	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7439-89-6	Iron	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7439-98-7	Molybdenum	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-28-0	Thallium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-61-1	Uranium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-62-2	Vanadium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-33-7	Tungsten	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-66-6	Zinc	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
Total			5.5E-04	2.4E-03	9.2E-03	4.0E-02	9.8E-03	4.3E-02		

[1] *Hg is the most difficult metal to control due to it existing in both particulate and gaseous form. Therefore, all other metals are conservatively estimated to be equal to or less than the Hg emissions.*

0.0525 0.0525 chk

7664-93-9	Sulfuric Acid	Autoclave	2.03	8.89			2.03	8.89
7783-06-4	Hydrogen Sulfid	Autoclave	0.90	3.94			0.90	3.94
592-01-8	Cyanide	Point Sources - S EW Cells			0.0012	0.0053	0.00	0.01
Total			2.93	12.84	0.01	0.05	2.94	12.88

PRI00000633

REC 1973

ORE CONCETRATION AND REFINING - CONTINUED

Source Data

Source ID	Description	Throughput ton/day	Throughput ton/yr	Operation hr/day	Operation hr/yr
AC	Autoclave	6,960	2,540,400	24	8,760

Autoclave HAP/TAP Emission Factors and Emission lb/hr ton/yr

CAS No.	Pollutant	Emission Factor		Emissions[1] lb/hr	Emissions[1] ton/yr
7664-93-9	Sulfuric Acid	0.007	lb/ton[2]	2.03	8.89
7783-06-4	Hydrogen Sulfide	0.9	lb/hr[3]	0.90	3.94

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *H2SO4 is based on Acidic Autoclave test data (APT 2010)*

[3] *H2S is based on Acidic Autoclave test data (APT 2013)*

LEACHING OPERATION

Cyanide (HCN) Source Data, Emission Factors, and Emissions

Source	ID	Description	Dia. ft[1]	pH[1]	Free CN- g/m3[1]	T C[1]	pKa	a0	H	kG[2] m/s	Fa*Fw	g/s	lb/hr	ton/yr
TSF		***Fugitive Sources***												
TSF		Tailings Maint. Pond	76	7.75	1	3.74	9.803	0.9912	0.0025	1.89E-05	0.641	1.27E-05	0.0001	0.0004
MILLTA		CN Detox Tank 1	40	8.5	25	25	9.250	0.8490	0.0055	0.000311	0.688	0.002891	0.0229	0.101
MILLTA		CN Detox Tank 2	40	8.5	25	25	9.250	0.8490	0.0055	0.000311	0.688	0.002891	0.0229	0.101
MILLTA		CIP Leach Tank 1	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	0.0114	0.050
MILLTA		CIP Leach Tank 2	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	0.0114	0.050
MILLTA		CIP Leach Tank 3	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	0.0114	0.050
MILLTA		CIP Leach Tank 4	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	0.0114	0.050
MILLTA		CIL Tank 1	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA		CIL Tank 2	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA		CIL Tank 3	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA		CIL Tank 4	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA		CIL Tank 5	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA		CIL Tank 6	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA		CIP Tank 1	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA		CIP Tank 2	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA		CIP Tank 3	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA		CIP Tank 4	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA		CIP Tank 5	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA		CIP Tank 6	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
			Acres[1]											
TSF		Tails, Aqueous Surface	110.222	7.75	1	3.74	9.803	0.9912	0.0025	1.89E-05	0.421	0.008845	0.0702	0.307
TSF		Tails, Wet Sediment	110.222							5.31E-08	0.421	0.009961	0.0791	0.346
TSF		Tails, Dry Sediment	110.222							2.33E-08	1	0.010375	0.0823	0.361
			330.666											
592-01-8		Cyanide Fugitive Sources - Subtotal											0.4527	1.983
75-15-0		Carbon Disulfide											0.01446	0.06332
		Point Sources												
EW		EW Cells	[3]										0.0006	0.003
EW		Preg/Barren Tanks	[3]										0.0006	0.003
592-01-8		Cyanide Point Sources - Subtotal											0.0012	0.0053
Total													0.454	1.988

[1] *(Midas Gold 2016)(M3 2017c)(M3 2017d)*

[2] *The emission factors and caculation methodology are from the EPA directed HCN study: (Card, T. 2009)(EPA 2009)(Schmidt 2010)*

[3] *(APT 2009)*

Carbon Disulfide Emissions from Xanthate Decomposition

CAS No.	Pollutant	Xanthate[1] ton/yr	Molar Decomp.[2]	CS_2 MW Ratio	Temperature Adj. Factor[3]	Emissions lb/hr	Emissions ton/yr
75-15-0	Carbon Disulfide	1,700	0.99%	0.376	1%	0.0145	0.063

	MW	
Xanthate (PAX)	202.37	$C_6H_{11}KOS_2$
Carbon disulfide	76.139	CS_2

[1] *(Midas Gold 2016) p. 12-11*

[2] *(Air Sciences 2020) molar decomposition of xanthate in solution to CS2 gas*

[3] *(Air Sciences 2020) based on the comparison of CS2 generation at 25C and 70C*

Conversions

8,760	hr/yr	453.5929	g/lb	Wind adjustment factor Fw	1
2,000	lb/ton	3.28084	ft/m		
4,046.86	m2/acre	3,600	s/hr		

LIME PRODUCTION

Source Data

Source ID	Description	Throughput ton/day	Throughput ton/yr	PM Emissions lb/day	PM Emissions ton/yr
LS1	Limestone transfer to Primary Crusher Hopper			3.39	0.48
LS2	Primary Crushing and Associated Transfers In and Out			6.10	0.86
LS3	Primary Screening and Associated Transfers In and Out			28.25	3.97
LS4	Secondary Crushing and Associated Transfers In and Out			6.10	0.86
LS5	Secondary Screening and Associated Transfers In and Out			28.25	3.97
LS6	Limestone transfer to Ball Mill Feed Bin			3.39	0.48
LS7	Limestone transfer to Ball Mill Feed Conveyor			3.39	0.48
LS8	Ball Mill Feed transfer to Ball Mill			3.39	0.48
LSBM	Limestone Ball Mill			45.65	6.42
LS9	Limestone transfer to Kiln Feed Bin			0.80	0.12
LS10	Limestone transfer to Lime Kiln Feed Conveyor			0.80	0.12
LS11	Fines Screening and Associated Transfers In and Out			6.68	1.03
Subtotal	LS1-11			136.18	19.28
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln			0.80	0.12
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	169	52,377	21.97	3.40
Subtotal	LS12,LK			22.77	3.53
Total				158.95	22.80

HAP/TAP Emission Factors and Emissions

LS_pph LS_tpy LS12_pph LS12_tpy LK_pph LK_tpy lb/hr ton/yr

CAS No.	Pollutant	Concentration ppm[2]	LS1-11,LSBM lb/hr	LS1-11,LSBM ton/yr	LS12 lb/hr	LS12 ton/yr	Lime Kiln lb/hr	Lime Kiln ton/yr	Emissions[1] lb/hr	Emissions[1] ton/yr	TAP	A/C
7440-38-2	Arsenic	23	1.01E-04	4.43E-04	6.51E-07	2.85E-06	1.79E-05	7.83E-05	1.20E-04	5.24E-04	Y	C
7440-41-7	Beryllium	0.8	3.52E-06	1.54E-05	2.27E-08	9.92E-08	6.22E-07	2.72E-06	4.17E-06	1.82E-05	Y	C
7440-43-9	Cadmium	0.25	1.10E-06	4.82E-06	7.08E-09	3.10E-08	1.94E-07	8.51E-07	1.30E-06	5.70E-06	Y	C
7440-48-4	Cobalt	4	2.27E-05	7.71E-05	1.34E-07	4.96E-07	3.66E-06	1.36E-05	2.65E-05	9.12E-05	Y	A
7440-47-3	Chromium	15	8.51E-05	2.89E-04	5.01E-07	1.86E-06	1.37E-05	5.11E-05	9.93E-05	3.42E-04	Y	A
7439-97-6	Mercury [3]	0.02	1.13E-07	3.86E-07	6.68E-10	2.48E-09	2.82E-04	1.05E-03	2.82E-04	1.05E-03	N	
7439-96-5	Manganese	236.5	1.34E-03	4.56E-03	7.89E-06	2.93E-05	2.16E-04	8.05E-04	1.57E-03	5.39E-03	Y	A
7440-02-0	Nickel	5	2.20E-05	9.64E-05	1.42E-07	6.20E-07	3.89E-06	1.70E-05	2.60E-05	1.14E-04	Y	C
7439-92-1	Lead	3	1.70E-05	5.78E-05	1.00E-07	3.72E-07	2.75E-06	1.02E-05	1.99E-05	6.84E-05	N	
7440-36-0	Antimony	2.5	1.42E-05	4.82E-05	8.34E-08	3.10E-07	2.29E-06	8.51E-06	1.66E-05	5.70E-05	Y	A
7723-14-0	Phosphorus	130	7.38E-04	2.51E-03	4.34E-06	1.61E-05	1.19E-04	4.43E-04	8.61E-04	2.96E-03	Y	A
7440-22-4	Silver	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	Y	A
7429-90-5	Aluminum	22600	1.28E-01	4.36E-01	7.54E-04	2.80E-03	2.07E-02	7.69E-02	1.50E-01	5.15E-01	Y	A
7440-39-3	Barium	145	8.23E-04	2.79E-03	4.84E-06	1.80E-05	1.33E-04	4.94E-04	9.60E-04	3.31E-03	Y	A
1317-65-3	Calcium Carbonate	274500	1.56E+00	5.29E+00	9.16E-03	3.40E-02	2.51E-01	9.35E-01	1.82E+00	6.26E+00	Y	A
7440-50-8	Copper	5	2.84E-05	9.64E-05	1.67E-07	6.20E-07	4.58E-06	1.70E-05	3.31E-05	1.14E-04	Y	A
7439-89-6	Iron	10350	5.87E-02	1.99E-01	3.45E-04	1.28E-03	9.47E-03	3.52E-02	6.85E-02	2.36E-01	Y	A
7439-98-7	Molybdenum	0.5	2.84E-06	9.64E-06	1.67E-08	6.20E-08	4.58E-07	1.70E-06	3.31E-06	1.14E-05	Y	A
7440-28-0	Thallium	5	2.84E-05	9.64E-05	1.67E-07	6.20E-07	4.58E-06	1.70E-05	3.31E-05	1.14E-04	Y	A
7440-61-1	Uranium	5	2.84E-05	9.64E-05	1.67E-07	6.20E-07	4.58E-06	1.70E-05	3.31E-05	1.14E-04	Y	A
7440-62-2	Vanadium	15.5	8.79E-05	2.99E-04	5.17E-07	1.92E-06	1.42E-05	5.28E-05	1.03E-04	3.53E-04	Y	A
7440-33-7	Tungsten	5	2.84E-05	9.64E-05	1.67E-07	6.20E-07	4.58E-06	1.70E-05	3.31E-05	1.14E-04	Y	A
7440-66-6	Zinc	18	1.02E-04	3.47E-04	6.01E-07	2.23E-06	1.65E-05	6.13E-05	1.19E-04	4.10E-04	Y	A
Subtotal			1.75E+00	5.94E+00	1.03E-02	3.82E-02	2.82E-01	1.05E+00	2.04E+00	7.03E+00	9.0667	9.0667
7647-01-0	Hydrogen Chloride	0.14 lb/ton product[4]					0.99	3.67	0.99	3.67		chk

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *(M3 2018) Median concentrations of SGP limestone material. Metals with medians below the detection limit (DL) are set to 1/2DL.*

(3) *Hg emissions from the Lime Kiln are conservatively estimated assuming 100% volatilization of all Hg in the limestone*

(4) *(EPA 1999b)*

1E+6 parts/ppm

LIME PRODUCTION - CONTINUED

Source Data

Source ID	Description	PM_ppd PM Emissions lb/day	PM_tpy PM Emissions ton/yr
LS1L	Mill Lime Silo #1 Loading	0.248	0.002
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	1.200	0.011
MillS2L	Mill Lime Silo #2 Loading	0.248	0.002
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	1.200	0.011
ACS1L	AC Lime Silo #1 Loading	0.990	0.009
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.304	0.042
ACS2L	AC Lime Silo #2 Loading	0.990	0.009
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.304	0.042
ACS3L	AC Lime Silo #3 Loading	0.990	0.009
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.304	0.042
ACS4L	AC Lime Silo #4 Loading	0.495	0.004
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	2.304	0.021
Subtotal - Mill & AC Lime Silos		15.576	0.203
LCR	Lime Mill Crushing and associated transfers In and Out	6.828	1.058
LSL	Pebble Lime Silo Loading via Bucket Elevator	0.149	0.023
LSU	Pebble Lime Silo discharge to Lime Slaker	0.015	0.002
Subtotal - Lime Mfg		6.991	1.083
Total		22.567	1.286

HAP/TAP Emission Factors and Emissions

CAS No.	Pollutant	Concentration ppm[2]	MillAC_pph Mill and AC lb/hr	MillAC_tpy Mill and AC ton/yr	LimeM_pph Lime Mfg lb/hr	LimeM_tpy Lime Mfg ton/yr	lb/hr Emissions[1] lb/hr	ton/yr Emissions[1] ton/yr	TAP	A/C
7440-38-2	Arsenic	23	1.06E-06	4.66E-06	5.69E-06	2.49E-05	6.75E-06	2.96E-05	Y	C
7440-41-7	Beryllium	0.8	3.70E-08	1.62E-07	1.98E-07	8.67E-07	2.35E-07	1.03E-06	Y	C
7440-43-9	Cadmium	0.25	1.16E-08	5.07E-08	6.18E-08	2.71E-07	7.34E-08	3.22E-07	Y	C
7440-48-4	Cobalt	4	2.60E-06	8.11E-07	1.17E-06	4.33E-06	3.76E-06	5.14E-06	Y	A
7440-47-3	Chromium	15	9.74E-06	3.04E-06	4.37E-06	1.63E-05	1.41E-05	1.93E-05	Y	A
7439-97-6	Mercury	0.02	1.30E-08	4.05E-09	5.83E-09	2.17E-08	1.88E-08	2.57E-08	N	
7439-96-5	Manganese	236.5	1.53E-04	4.79E-05	6.89E-05	2.56E-04	2.22E-04	3.04E-04	Y	A
7440-02-0	Nickel	5	2.31E-07	1.01E-06	1.24E-06	5.42E-06	1.47E-06	6.43E-06	Y	C
7439-92-1	Lead	3	1.95E-06	6.08E-07	8.74E-07	3.25E-06	2.82E-06	3.86E-06	N	
7440-36-0	Antimony	2.5	1.62E-06	5.07E-07	7.28E-07	2.71E-06	2.35E-06	3.22E-06	Y	A
7723-14-0	Phosphorus	130	8.44E-05	2.63E-05	3.79E-05	1.41E-04	1.22E-04	1.67E-04	Y	A
7440-22-4	Silver	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	Y	A
7429-90-5	Aluminum	22,600	1.47E-02	4.58E-03	6.58E-03	2.45E-02	2.13E-02	2.91E-02	Y	A
7440-39-3	Barium	145	9.41E-05	2.94E-05	4.22E-05	1.57E-04	1.36E-04	1.86E-04	Y	A
1305-78-8	Calcium Oxide	740,000 [3]	4.80E-01	1.50E-01	2.16E-01	8.02E-01	6.96E-01	9.52E-01	Y	A
7440-50-8	Copper	5	3.25E-06	1.01E-06	1.46E-06	5.42E-06	4.70E-06	6.43E-06	Y	A
7439-89-6	Iron	10350	6.72E-03	2.10E-03	3.01E-03	1.12E-02	9.73E-03	1.33E-02	Y	A
7439-98-7	Molybdenum	0.5	3.25E-07	1.01E-07	1.46E-07	5.42E-07	4.70E-07	6.43E-07	Y	A
7440-28-0	Thallium	5	3.25E-06	1.01E-06	1.46E-06	5.42E-06	4.70E-06	6.43E-06	Y	A
7440-61-1	Uranium	5	3.25E-06	1.01E-06	1.46E-06	5.42E-06	4.70E-06	6.43E-06	Y	A
7440-62-2	Vanadium	15.5	1.01E-05	3.14E-06	4.52E-06	1.68E-05	1.46E-05	1.99E-05	Y	A
7440-33-7	Tungsten	5	3.25E-06	1.01E-06	1.46E-06	5.42E-06	4.70E-06	6.43E-06	Y	A
7440-66-6	Zinc	18	1.17E-05	3.65E-06	5.24E-06	1.95E-05	1.69E-05	2.31E-05	Y	A
Total			5.02E-01	1.57E-01	2.25E-01	8.38E-01	7.27E-01	9.95E-01		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *See LIME PRODUCTION, page 10*

(3) *(NLA 2007) 40% to 74% CaO in lime*

1E+6 parts/ppm

AGGREGATE PRODUCTION

Source Data

Source ID	Description	PM Emissions lb/day	PM Emissions ton/yr
PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conve	15.00	2.74
PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conve	15.00	2.74
Total		30.00	5.48

HAP/TAP Emission Factors and Emissions

CAS No.	Pollutant	Concentration ppm[2]	Emissions[1] lb/hr	Emissions[1] ton/yr	TAP	A/C
7440-38-2	Arsenic	23	2.88E-05	1.26E-04	Y	C
7440-41-7	Beryllium	0.8	1.00E-06	4.38E-06	Y	C
7440-43-9	Cadmium	0.25	3.13E-07	1.37E-06	Y	C
7440-48-4	Cobalt	4	5.00E-06	2.19E-05	Y	A
7440-47-3	Chromium	15	1.88E-05	8.21E-05	Y	A
7439-97-6	Mercury	0.02	2.50E-08	1.10E-07	N	
7439-96-5	Manganese	236.5	2.96E-04	1.29E-03	Y	A
7440-02-0	Nickel	5	6.25E-06	2.74E-05	Y	C
7439-92-1	Lead	3	3.75E-06	1.64E-05	N	
7440-36-0	Antimony	2.5	3.13E-06	1.37E-05	Y	A
7723-14-0	Phosphorus	130	1.63E-04	7.12E-04	Y	A
7440-22-4	Silver	0	0.00E+00	0.00E+00	Y	A
7429-90-5	Aluminum	22600	2.83E-02	1.24E-01	Y	A
7440-39-3	Barium	145	1.81E-04	7.94E-04	Y	A
1317-65-3	Calcium Carbonate	274500	3.43E-01	1.50E+00	Y	A
7440-50-8	Copper	5	6.25E-06	2.74E-05	Y	A
7439-89-6	Iron	10350	1.29E-02	5.67E-02	Y	A
7439-98-7	Molybdenum	0.5	6.25E-07	2.74E-06	Y	A
7440-28-0	Thallium	5	6.25E-06	2.74E-05	Y	A
7440-61-1	Uranium	5	6.25E-06	2.74E-05	Y	A
7440-62-2	Vanadium	15.5	1.94E-05	8.49E-05	Y	A
7440-33-7	Tungsten	5	6.25E-06	2.74E-05	Y	A
7440-66-6	Zinc	18	2.25E-05	9.86E-05	Y	A
Total			3.85E-01	1.69E+00		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *See LIME PRODUCTION, page 10*

1E+6 parts/ppm

CONCRETE PRODUCTION

Source Data

Source ID	Description	Throughput ton/day	Throughput ton/yr
	description	TP_unit/day	TP_unit/yr
CS1L	Cement/Shotcrete Silo #1 Loading	164	60,000
CS1U	Cement/Shotcrete Silo #1 Unloading	164	60,000
CS2L	Cement/Shotcrete Silo #2 Loading	164	60,000
CS2U	Cement/Shotcrete Silo #2 Unloading	164	60,000
CM	Central Mixer Loading	164	60,000
	Subtotal Cement Silo Filling	658	240,000
	Subtotal Central Mix Batching	164	60,000

HAP/TAP Emission Factors and Emissions

CAS No.	HAP/TAP	Silo Fill lb/ton[2]	Central Mixer lb/ton[3]	Cement Silo L/U lb/hr	Cement Silo L/U ton/yr	Central Mix Batching lb/hr	Central Mix Batching ton/yr	Total Emissions[3] lb/hr	Total Emissions[3] ton/yr	TAP	A/C
		CF_pph		CF_tpy		CM_pph	CM_tpy	lb/hr	ton/yr		
7440-38-2	Arsenic	4.24E-09	2.96E-07	1.16E-7	5.09E-7	2.03E-6	8.88E-6	2.14E-6	9.39E-6	Y	C
7440-41-7	Beryllium	4.86E-10		1.33E-8	5.83E-8	--	--	1.33E-8	5.83E-8	Y	C
7440-43-9	Cadmium		7.10E-10	--	--	4.86E-9	2.13E-8	4.86E-9	2.13E-8	Y	C
7440-47-3	Chromium	2.90E-08	1.27E-07	7.95E-7	3.48E-6	8.70E-7	3.81E-6	1.66E-6	7.29E-6	Y	A
18540-29-9	Cr (VI)	5.80E-09	2.70E-08	1.59E-7	6.96E-7	1.85E-7	8.11E-7	3.44E-7	1.51E-6	Y	C
7439-92-1	Lead	1.09E-08	3.66E-08	2.99E-7	1.31E-6	2.51E-7	1.10E-6	5.49E-7	2.41E-6	N	
7439-96-5	Manganese	1.17E-07	3.78E-06	3.21E-6	1.40E-5	2.59E-5	1.13E-4	2.91E-5	1.27E-4	Y	A
7440-02-0	Nickel	4.18E-08	2.48E-07	1.15E-6	5.02E-6	1.70E-6	7.44E-6	2.84E-6	1.25E-5	Y	C
7723-14-0	Phosphorus		1.20E-06	--	--	8.22E-6	3.60E-5	8.22E-6	3.60E-5	Y	A
Total				5.73E-6	2.51E-5	3.91E-5	1.71E-4	4.49E-5	1.97E-4		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *AP-42, Table 11.12-8, (06/06) Cement Silo Filing, Controlled.* 20% *Cr (VI), IDEQ email on 11/23/2020* 0.0002 0.0002

(3) *AP-42, Table 11.12-8, (06/06) Central Mix Batching, Controlled.* 21.29% *Cr (VI), IDEQ email on 11/23/2020* chk

Conversions

24 hr/day

PRI00000639

REC 1979

CONCRETE PRODUCTION - CONTINUED

Source Data

Source ID	Description	PM Emissions lb/day	PM Emissions ton/yr
CAL	Aggregate Bin Loading	16.56	1.73
CAU	Aggregate Bin Unloading	16.56	1.73
Total		33.12	3.45

HAP/TAP Emission Factors and Emissions

CAS No.	Pollutant	Concentration ppm[2]	Emissions[1] lb/hr	Emissions[1] ton/yr	TAP	A/C
7440-38-2	Arsenic	23	1.81E-05	7.94E-05	Y	C
7440-41-7	Beryllium	0.8	6.30E-07	2.76E-06	Y	C
7440-43-9	Cadmium	0.25	1.97E-07	8.63E-07	Y	C
7440-48-4	Cobalt	4	5.52E-06	1.38E-05	Y	A
7440-47-3	Chromium	15	2.07E-05	5.18E-05	Y	A
7439-97-6	Mercury	0.02	2.76E-08	6.90E-08	N	
7439-96-5	Manganese	236.5	3.26E-04	8.16E-04	Y	A
7440-02-0	Nickel	5	3.94E-06	1.73E-05	Y	C
7439-92-1	Lead	3	4.14E-06	1.04E-05	N	
7440-36-0	Antimony	2.5	3.45E-06	8.63E-06	Y	A
7723-14-0	Phosphorus	130	1.79E-04	4.49E-04	Y	A
7440-22-4	Silver	0	0.00E+00	0.00E+00	Y	A
7429-90-5	Aluminum	22600	3.12E-02	7.80E-02	Y	A
7440-39-3	Barium	145	2.00E-04	5.00E-04	Y	A
7440-50-8	Copper	5	6.90E-06	1.73E-05	Y	A
7439-89-6	Iron	10350	1.43E-02	3.57E-02	Y	A
7439-98-7	Molybdenum	0.5	6.90E-07	1.73E-06	Y	A
7440-28-0	Thallium	5	6.90E-06	1.73E-05	Y	A
7440-61-1	Uranium	5	6.90E-06	1.73E-05	Y	A
7440-62-2	Vanadium	15.5	2.14E-05	5.35E-05	Y	A
7440-33-7	Tungsten	5	6.90E-06	1.73E-05	Y	A
7440-66-6	Zinc	18	2.48E-05	6.21E-05	Y	A
Total			4.63E-02	1.16E-01		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *See LIME PRODUCTION, page 10*

1E+6 parts/ppm

FUEL STORAGE - GASOLINE

Source Data

Source ID	Description	VOC Emissions lb/day	VOC Emissions ton/yr
TG1	Mine Site Gasoline Tank #1	5.25	0.96
TG2	Mine Site Gasoline Tank #2	5.25	0.96
Total		10.49	1.91

HAP/TAP Emission Factors and Emissions

CAS No.	Pollutant	Concentration wt. %[2]	Emissions[1] lb/hr	Emissions[1] ton/yr	TAP	A/C
71-43-2	Benzene	1.608%	7.03E-03	3.08E-02	Y	C
92-52-4	Biphenyl	0.010%	4.37E-05	1.91E-04	Y	A
110-82-7	Cyclohexane	0.240%	1.05E-03	4.60E-03	Y	A
110-54-3	Hexane	7.138%	3.12E-02	1.37E-01	Y	A
91-20-3	Naphthalene	0.444%	1.94E-03	8.50E-03	Y	A
108-95-2	Phenol	0.055%	2.40E-04	1.05E-03	Y	A
108-88-3	Toluene	7.212%	3.15E-02	1.38E-01	Y	A
25551-13-7	Trimethyl benzene	2.500%	1.09E-02	4.79E-02	Y	A
1330-20-7	Xylene	7.170%	3.13E-02	1.37E-01	Y	A
Total			1.15E-01	5.05E-01		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *(EPA 1999a)*

MINING FUGITIVE EMISSIONS

Dust Emissions

Source Data **Model Scenario** **W3** **180,000 T/day Emissions**

Operating schedule 365 day/yr

Clean rock cap (CR) >0% [1]

[1] *(Perpetua 2021h) Percent of VMTs on haul roads capped with CR*
Roads outside of the pits and DRSFs are capped with CR

Source ID	Description	PM Emissions lb/day	PM Emissions ton/yr
YPP	Yellow Pine Pit	--	--
HFP	Hangar Flats Pit	--	--
WEP	West End Pit	1,887.91	344.54
BT	Bradley Tailings	--	--
YPPBL	Yellow Pine Pit Blasting	--	--
HFPBL	Hangar Flats Pit Blasting	--	--
WEPBL	West End Pit Blasting	643.03	117.35
BTBL	Bradley Tailings Blasting	--	--
STKP	PC Stockpile	--	--
FDRSF	Fiddle DRSF	--	--
HFDRSF	Hangar Flats DRSF	289.91	52.91
YPDRSF	Yellow Pine DRSF	--	--
WEDRSF	West End DRSF	--	--
HR000	Haul Roads	16,697.74	3,047.34
TSF	Tailing Storage Facility	--	--
ACCRD	Access Roads	38.10	6.95
UGEXP	Scout Portal	0.008	0.002
Total		19,556.71	3,569.10

TSF, ACCRD, UGEXP 38.11 6.95 chk 3569.10

CAS No.	Pollutant	ORE Concentration ppm[1]	DR Concentration ppm[1]	CR Concentration ppm[3]	HRD Concentration ppm[4]	Borrow Concentration ppm[5]	AR Concentration ppm
HAP/TAP Emission Factors							
7440-38-2	Arsenic	667	667	90	667	2.5	667
7440-41-7	Beryllium	3.2	3.2		3.2		3.2
7440-43-9	Cadmium	0.5	0.5		0.5		0.5
7440-48-4	Cobalt	4	4		4		4
7440-47-3	Chromium	9	9		9		9
7439-97-6	Mercury [2]	0.96	0.6		0.6		0.6
7439-96-5	Manganese	299	299		299		299
7440-02-0	Nickel	2	2		2		2
7439-92-1	Lead	8	8		8		8
7440-36-0	Antimony	23	23		23		23
7723-14-0	Phosphorus	650	650		650		650
7782-49-2	Selenium	0.4	0.4		0.4		0.4
7440-22-4	Silver	0.5	0.5		0.5		0.5
7429-90-5	Aluminum	71000	71000		71000		71000
7440-39-3	Barium	800	800		800		800
1317-65-3	Calcium Carbonate	14000	14000		14000		14000
7440-50-8	Copper	5	5		5		5
7439-89-6	Iron	18200	18200		18200		18200
7439-98-7	Molybdenum	1	1		1		1
7440-28-0	Thallium	10	10		10		10
7440-61-1	Uranium	10	10		10		10
7440-62-2	Vanadium	28	28		28		28
7440-33-7	Tungsten	10	10		10		10
7440-66-6	Zinc	35	35		35		35

[1] *(Midas Gold 2017c)* *Median concentration of 55,000 SGP samples.* *1E+6 parts/ppm*
[2] *(Midas Gold 2018e)* *Median ore and development rock (DR) concentrations of 151,000 samples; resource block model.*
[3] *(Perpetua 2021g)* *Median concentration of 265 SGP samples.*
[4] *HRD: haul road - emissions calculated based on 0% of the total VMT occuring on CR*
[5] *(ALS 2018)* *Median concentration of 8 SGP samples.*

DR DR DR DR DR DR DR DR ORE DR DR DR DR HRD DR/AR

MINING FUGITIVE EMISSIONS - CONTINUED **Model Scenario W3** DR **180,000 T/day Emissions**

HAP/TAP Emissions

Hourly [1]

YPP_pph HFP_pph WEP_pph BT_pph YPPBL_pph HFPBL_pph WEPBL_ppl BTBL_pph STKP_pph FDRSF_pph HFDRSF_pph YPDRSF_pph WEDRSF_pph HR000_pph CRD, UGE lb/hr

CAS No.	Pollutant	YPP lb/hr	HFP lb/hr	WEP lb/hr	BT lb/hr	YPPBL lb/hr	HFPBL lb/hr	WEPBL lb/hr	BTBL lb/hr	STKP lb/hr	FDRSF lb/hr	HFDRSF lb/hr	YPDRSF lb/hr	WEDRSF lb/hr	HR000 lb/hr	TSF, ACCRD, UGEXP lb/hr	Total lb/hr
7440-38-2	Arsenic	0	0	0.052	0	0	0	0.018	0	0	0	8.1E-3	0	0	0.464	1.1E-3	0.544
7440-41-7	Beryllium	0	0	2.5E-4	0	0	0	8.6E-5	0	0	0	3.9E-5	0	0	2.2E-3	5.1E-6	2.6E-3
7440-43-9	Cadmium	0	0	3.9E-5	0	0	0	1.3E-5	0	0	0	6.0E-6	0	0	3.5E-4	7.9E-7	4.1E-4
7440-48-4	Cobalt	0	0	3.1E-4	0	0	0	1.1E-4	0	0	0	4.8E-5	0	0	2.8E-3	6.4E-6	3.3E-3
7440-47-3	Chromium	0	0	7.1E-4	0	0	0	2.4E-4	0	0	0	1.1E-4	0	0	6.3E-3	1.4E-5	7.3E-3
7439-97-6	Mercury	0	0	4.7E-5	0	0	0	1.6E-5	0	0	0	7.2E-6	0	0	4.2E-4	9.5E-7	4.9E-4
7439-96-5	Manganese	0	0	0.024	0	0	0	8.0E-3	0	0	0	3.6E-3	0	0	0.208	4.7E-4	0.244
7440-02-0	Nickel	0	0	1.6E-4	0	0	0	5.4E-5	0	0	0	2.4E-5	0	0	1.4E-3	3.2E-6	1.6E-3
7439-92-1	Lead	0	0	6.3E-4	0	0	0	2.1E-4	0	0	0	9.7E-5	0	0	5.6E-3	1.3E-5	6.5E-3
7440-36-0	Antimony	0	0	1.8E-3	0	0	0	6.2E-4	0	0	0	2.8E-4	0	0	0.016	3.7E-5	0.019
7723-14-0	Phosphorus	0	0	0.051	0	0	0	0.017	0	0	0	7.9E-3	0	0	0.452	1.0E-3	0.530
7782-49-2	Selenium	0	0	3.1E-5	0	0	0	1.1E-5	0	0	0	4.8E-6	0	0	2.8E-4	6.4E-7	3.3E-4
7440-22-4	Silver	0	0	3.9E-5	0	0	0	1.3E-5	0	0	0	6.0E-6	0	0	3.5E-4	7.9E-7	4.1E-4
7429-90-5	Aluminum	0	0	5.585	0	0	0	1.902	0	0	0	0.858	0	0	49.397	0.113	57.855
7440-39-3	Barium	0	0	0.063	0	0	0	0.021	0	0	0	9.7E-3	0	0	0.557	1.3E-3	0.652
1317-65-3	Calcium Ca	0	0	1.101	0	0	0	0.375	0	0	0	0.169	0	0	9.740	0.022	11.408
7440-50-8	Copper	0	0	3.9E-4	0	0	0	1.3E-4	0	0	0	6.0E-5	0	0	3.5E-3	7.9E-6	4.1E-3
7439-89-6	Iron	0	0	1.432	0	0	0	0.488	0	0	0	0.220	0	0	12.662	0.029	14.831
7439-98-7	Molybdenur	0	0	7.9E-5	0	0	0	2.7E-5	0	0	0	1.2E-5	0	0	7.0E-4	1.6E-6	8.1E-4
7440-28-0	Thallium	0	0	7.9E-4	0	0	0	2.7E-4	0	0	0	1.2E-4	0	0	7.0E-3	1.6E-5	8.1E-3
7440-61-1	Uranium	0	0	7.9E-4	0	0	0	2.7E-4	0	0	0	1.2E-4	0	0	7.0E-3	1.6E-5	8.1E-3
7440-62-2	Vanadium	0	0	2.2E-3	0	0	0	7.5E-4	0	0	0	3.4E-4	0	0	0.019	4.4E-5	0.023
7440-33-7	Tungsten	0	0	7.9E-4	0	0	0	2.7E-4	0	0	0	1.2E-4	0	0	7.0E-3	1.6E-5	8.1E-3
7440-66-6	Zinc	0	0	2.8E-3	0	0	0	9.4E-4	0	0	0	4.2E-4	0	0	0.024	5.6E-5	0.029
Total		0	0	8.320	0	0	0	2.834	0	0	0	1.278	0	0	73.586	0.168	86.185

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.* chk 86.1849 86.1849

DR DR DR DR DR DR DR DR ORE DR DR DR DR HRD DR/AR

MINING FUGITIVE EMISSIONS - CONTINUED **Model Scenario W3** DR **180,000 T/day Emissions**

HAP/TAP Emissions

Annual

		YPP_tpy	HFP_tpy	WEP_tpy	BT_tpy	YPPBL_tpy	HFPBL_tpy	WEPBL_tpy	BTBL_tpy	STKP_tpy	FDRSF_tpy	HFDRSF_tpy	YPDRSF_tpy	WEDRSF_tpy	HR000_tpy	CCRD, UGE	ton/yr
		YPP	HFP	WEP	BT	YPPBL	HFPBL	WEPBL	BTBL	STKP	FDRSF	HFDRSF	YPDRSF	WEDRSF	HR000	TSF, ACCRD, UGEXP	Total
CAS No.	Pollutant	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr
7440-38-2	Arsenic	0	0	0.230	0	0	0	0.078	0	0	0	0.035	0	0	2.033	4.6E-3	2.381
7440-41-7	Beryllium	0	0	1.1E-3	0	0	0	3.8E-4	0	0	0	1.7E-4	0	0	9.8E-3	2.2E-5	0.011
7440-43-9	Cadmium	0	0	1.7E-4	0	0	0	5.9E-5	0	0	0	2.6E-5	0	0	1.5E-3	3.5E-6	1.8E-3
7440-48-4	Cobalt	0	0	1.4E-3	0	0	0	4.7E-4	0	0	0	2.1E-4	0	0	0.012	2.8E-5	0.014
7440-47-3	Chromium	0	0	3.1E-3	0	0	0	1.1E-3	0	0	0	4.8E-4	0	0	0.027	6.3E-5	0.032
7439-97-6	Mercury	0	0	2.1E-4	0	0	0	7.0E-5	0	0	0	3.2E-5	0	0	1.8E-3	4.2E-6	2.1E-3
7439-96-5	Manganese	0	0	0.103	0	0	0	0.035	0	0	0	0.016	0	0	0.911	2.1E-3	1.067
7440-02-0	Nickel	0	0	6.9E-4	0	0	0	2.3E-4	0	0	0	1.1E-4	0	0	6.1E-3	1.4E-5	7.1E-3
7439-92-1	Lead	0	0	2.8E-3	0	0	0	9.4E-4	0	0	0	4.2E-4	0	0	0.024	5.6E-5	0.029
7440-36-0	Antimony	0	0	7.9E-3	0	0	0	2.7E-3	0	0	0	1.2E-3	0	0	0.070	1.6E-4	0.082
7723-14-0	Phosphorus	0	0	0.224	0	0	0	0.076	0	0	0	0.034	0	0	1.981	4.5E-3	2.320
7782-49-2	Selenium	0	0	1.4E-4	0	0	0	4.7E-5	0	0	0	2.1E-5	0	0	1.2E-3	2.8E-6	1.4E-3
7440-22-4	Silver	0	0	1.7E-4	0	0	0	5.9E-5	0	0	0	2.6E-5	0	0	1.5E-3	3.5E-6	1.8E-3
7429-90-5	Aluminum	0	0	24.463	0	0	0	8.332	0	0	0	3.756	0	0	216	0.494	253
7440-39-3	Barium	0	0	0.276	0	0	0	0.094	0	0	0	0.042	0	0	2.438	5.6E-3	2.855
1317-65-3	Calcium Ca	0	0	4.824	0	0	0	1.643	0	0	0	0.741	0	0	42.663	0.097	49.967
7440-50-8	Copper	0	0	1.7E-3	0	0	0	5.9E-4	0	0	0	2.6E-4	0	0	0.015	3.5E-5	0.018
7439-89-6	Iron	0	0	6.271	0	0	0	2.136	0	0	0	0.963	0	0	55.462	0.127	64.958
7439-98-7	Molybdenur	0	0	3.4E-4	0	0	0	1.2E-4	0	0	0	5.3E-5	0	0	3.0E-3	7.0E-6	3.6E-3
7440-28-0	Thallium	0	0	3.4E-3	0	0	0	1.2E-3	0	0	0	5.3E-4	0	0	0.030	7.0E-5	0.036
7440-61-1	Uranium	0	0	3.4E-3	0	0	0	1.2E-3	0	0	0	5.3E-4	0	0	0.030	7.0E-5	0.036
7440-62-2	Vanadium	0	0	9.6E-3	0	0	0	3.3E-3	0	0	0	1.5E-3	0	0	0.085	1.9E-4	0.100
7440-33-7	Tungsten	0	0	3.4E-3	0	0	0	1.2E-3	0	0	0	5.3E-4	0	0	0.030	7.0E-5	0.036
7440-66-6	Zinc	0	0	0.012	0	0	0	4.1E-3	0	0	0	1.9E-3	0	0	0.107	2.4E-4	0.125
Total		0	0	36.441	0	0	0	12.412	0	0	0	5.596	0	0	322	0.736	377
															chk	377.4900	377.4900

MINING FUGITIVE EMISSIONS - CONTINUED

Mercury Evaporative Flux Emissions

Fugitive Mercury Flux and Emissions

			Area		Hg Flux	Emissions[1] lb/hr	Emissions[1] ton/yr	Emissions[1] lb/yr
CAS No.	Pollutant	Source	m^2	ha	$\mu g/m^2$-yr	lb/hr	ton/yr	lb/yr
		Stockpiles	52,623	5.3	556	7.37E-6	3.2E-5	6.5E-2
		Rock Dumps	2,063,990	206.4	76.2	3.96E-5	1.7E-4	0.35
		Tailings	1,338,158	133.8	2,144	7.22E-4	3.2E-3	6.32
		Pits	1,504,919	150.5	132.3	5.01E-5	2.2E-4	0.44
7439-97-6	Mercury					8.2E-4	3.6E-3	7.17

(1) *Hourly emissions based on:* 8,760 *hours per year of operation*

Fugitive Mercury Emission Factors

	Twin Creeks (TC)		Ore Hg Adjusted	Stibnite	
	Hg Flux (1)	Hg (2)	$\mu g/m^2$/yr	Hg Flux (3)	Hg (4)
Source	$\mu g/m^2$-yr	$\mu g/g$	TC	$\mu g/m^2$-yr	$\mu g/g$
Stockpiles	5,609	33	556	556	0.96
Rock Dumps	768	3.5	76.2	76.2	0.60
Tailings	21,621	33	2,144	2,144	0.96
Pits	1,334	9.5	132	132.3	0.60

(1) *(Eckley 2010)* *Table 1: Hg flux* $\mu g/m^2$*-yr*

(2) *(Eckley 2010)* *Table 1: Average Hg flux mg/g: " Stockpiles - high-grade stockpiles, Rock Dumps - waste rock dumps, Tailings - high-grade stockpiles as a surrogate; Pits - pit"*

(3) *(Eckley 2010)* *Figure 2: log(y) = m*log(x) + b*

y = Hg Flux (ng/m^2*-d)*

x = material Hg concentration (µg/g)]

Slope =	*Solar*	*TC*
	Low	*0.59*
	Medium	*0.6*
	High	*0.77*
	Average	*0.65*

(4) *(Midas Gold 2018e)*

Sample Calculation: m = log (y1/y2) / log(x1/x2)

m=	0.65	unitless
y1=	5,609	$\mu g/m^2$-yr
x1=	33	$\mu g/m^2$-yr
x2=	0.96	$\mu g/m^2$-yr
log(x1/x2)=	1.536243	unitless
log(y1/y2)=	1.003679	unitless
y1/y2=	10.08506	unitless
y2=	556.2	$\mu g/m^2$-yr

Conversions

2,000 lb/ton
10,000 m2/ha
453.593 g/lb

PRI00000645

REC 1985

TABLE A-W3. HAP/TAP Emissions and Exemptions

180,000 T/day Emissions						**MINING**										**LEACHING**	
chk						*Mining*		*Model Scenario W3*								*CN Leach/PAX*	
						YPP,HFP,WEP,BT		YPPBL,HFPBL,WEPBL,BTBL		HR000		STKP, FDRSF, HFDRSF, YPDRSF, WEDRSF		TSF,ACCRD,UGEXP			
CAS	HAP/TAP	HAP	TAP			Pits		Blasting		Haul Roads		Stockpiles and DRFS		Tails, Access Road, Exploration		CN Leach and PAX	
	NSPS or NESHAP HAP/TAP -->			*Y*													
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				*A/C*	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
106-99-0	1,3-Butadiene	Y	Y	Y	C				0	0	0		0				
91-57-6	2-Methylnaphthalene	Y	N	n/a								0					
56-49-5	3-Methylchloranthrene	Y	Y	Y	C												
57-97-6	7,12-Dimethylbenz(a)anthracene	Y	N	n/a													
83-32-9	Acenaphthene	Y	N	n/a													
208-96-8	Acenaphthylene	Y	N	n/a													
75-07-0	Acetaldehyde	Y	Y	Y	C												
107-02-8	Acrolein	Y	Y	Y	A												
120-12-7	Anthracene	Y	N	n/a													
7440-36-0	Antimony	Y	Y	Y	A	1.8E-3	7.9E-3	6.2E-4	2.7E-3	0.016	0.070	2.8E-4	1.2E-3	3.7E-5	1.6E-4		
7440-38-2	Arsenic	Y	Y	Y	C	0.052	0.230	0.018	0.078	0.464	2.033	8.1E-3	0.035	1.1E-3	4.6E-3		
71-43-2	Benzene	Y	Y	Y	C												
50-32-8	Benzo(a)pyrene	Y	Y	Y	C												
56-55-3	Benz(a)anthracene	Y	Y	Y	C												
205-99-2	Benzo(b)fluoranthene	Y	Y	Y	C												
207-08-9	Benzo(k)fluoranthene	Y	Y	Y	C												
218-01-9	Chrysene	Y	Y	Y	C												
53-70-3	Dibenzo(a,h)anthracene	Y	Y	Y	C												
193-39-5	Indeno(1,2,3-cd)pyrene	Y	Y	Y	C												
191-24-2	Benzo(g,h,i)perylene	Y	N	n/a													
7440-41-7	Beryllium	Y	Y	Y	C	2.5E-4	1.1E-3	8.6E-5	3.8E-4	2.2E-3	9.8E-3	3.9E-5	1.7E-4	5.1E-6	2.2E-5		
92-52-4	Biphenyl	Y	Y	Y	A												
7440-43-9	Cadmium	Y	Y	Y	C	3.9E-5	1.7E-4	1.3E-5	5.9E-5	3.5E-4	1.5E-3	6.0E-6	2.6E-5	7.9E-7	3.5E-6		
75-15-0	Carbon Disulfide	Y	Y	Y	A											0.014	0.063
7440-47-3	Chromium	Y	Y	Y	A	7.1E-4	3.1E-3	2.4E-4	1.1E-3	6.3E-3	0.027	1.1E-4	4.8E-4	1.4E-5	6.3E-5		
18540-29-9	Cr (VI)	Y	Y	Y	C												
7440-48-4	Cobalt	Y	Y	Y	A	3.1E-4	1.4E-3	1.1E-4	4.7E-4	2.8E-3	0.012	4.8E-5	2.1E-4	6.4E-6	2.8E-5		
592-01-8	Cyanide	Y	Y	Y	A											0.453	1.983
106-46-7	Dichlorobenzene	Y	Y	Y	A												
206-44-0	Fluoranthene	Y	N	n/a													
86-73-7	Fluorene	Y	N	n/a													
50-00-0	Formaldehyde	Y	Y	Y	C												
110-54-3	Hexane	Y	Y	Y	A												
7647-01-0	Hydrogen Chloride	Y	Y	Y	A												
7439-92-1	Lead	Y	N	n/a		6.3E-4	2.8E-3	2.1E-4	9.4E-4	5.6E-3	0.024	9.7E-5	4.2E-4	1.3E-5	5.6E-5		
7439-96-5	Manganese	Y	Y	Y	A	0.024	0.103	8.0E-3	0.035	0.208	0.911	3.6E-3	0.016	4.7E-4	2.1E-3		
7439-97-6	Mercury	Y	N	n/a		9.7E-5	4.3E-4	1.6E-5	7.0E-5	4.2E-4	1.8E-3	5.4E-5	2.4E-4	7.2E-4	3.2E-3		
91-20-3	Naphthalene	Y	Y	Y	A												
7440-02-0	Nickel	Y	Y	Y	C	1.6E-4	6.9E-4	5.4E-5	2.3E-4	1.4E-3	6.1E-3	2.4E-5	1.1E-4	3.2E-6	1.4E-5		
85-01-8	Phenanthrene	Y	N	n/a													
108-95-2	Phenol	Y	Y	Y	A												
7723-14-0	Phosphorus	Y	Y	Y	A	0.051	0.224	0.017	0.076	0.452	1.981	7.9E-3	0.034	1.0E-3	4.5E-3		
129-00-0	Pyrene	Y	N	n/a													
7782-49-2	Selenium	Y	Y	Y	A	3.1E-5	1.4E-4	1.1E-5	4.7E-5	2.8E-4	1.2E-3	4.8E-6	2.1E-5	6.4E-7	2.8E-6		
108-88-3	Toluene	Y	Y	Y	A												
1330-20-7	Xylene	Y	Y	Y	A												
7429-90-5	Aluminum	N	Y	N	A	5.585	24.463	1.902	8.332	49.397	216	0.858	3.756	0.113	0.494		
7440-39-3	Barium	N	Y	N	A	0.063	0.276	0.021	0.094	0.557	2.438	9.7E-3	0.042	1.3E-3	5.6E-3		
1317-65-3	Calcium Carbonate	N	Y	N	A	1.101	4.824	0.375	1.643	9.740	42.663	0.169	0.741	0.022	0.097		
1305-78-8	Calcium Oxide	N	Y	N	A												
7440-50-8	Copper	N	Y	N	A	3.9E-4	1.7E-3	1.3E-4	5.9E-4	3.5E-3	0.015	6.0E-5	2.6E-4	7.9E-6	3.5E-5		
110-82-7	Cyclohexane	N	Y	N	A												
7783-06-4	Hydrogen Sulfide	N	Y	N	A												
7439-89-6	Iron	N	Y	N	A	1.432	6.271	0.488	2.136	12.662	55.462	0.220	0.963	0.029	0.127		
7439-98-7	Molybdenum	N	Y	N	A	7.9E-5	3.4E-4	2.7E-5	1.2E-4	7.0E-4	3.0E-3	1.2E-5	5.3E-5	1.6E-6	7.0E-6		
109-66-0	Pentane	N	Y	N	A												
7440-22-4	Silver	N	Y	N	A	3.9E-5	1.7E-4	1.3E-5	5.9E-5	3.5E-4	1.5E-3	6.0E-6	2.6E-5	7.9E-7	3.5E-6		
7664-93-9	Sulfuric Acid	N	Y	N	A												
7440-28-0	Thallium	N	Y	N	A	7.9E-4	3.4E-3	2.7E-4	1.2E-3	7.0E-3	0.030	1.2E-4	5.3E-4	1.6E-5	7.0E-5		
7440-61-1	Uranium	N	Y	N	A	7.9E-4	3.4E-3	2.7E-4	1.2E-3	7.0E-3	0.030	1.2E-4	5.3E-4	1.6E-5	7.0E-5		
7440-62-2	Vanadium	N	Y	N	A	2.2E-3	9.6E-3	7.5E-4	3.3E-3	0.019	0.085	3.4E-4	1.5E-3	4.4E-5	1.9E-4		
25551-13-7	Trimethyl benzene	N	Y	N	A												
7440-33-7	Tungsten	N	Y	N	A	7.9E-4	3.4E-3	2.7E-4	1.2E-3	7.0E-3	0.030	1.2E-4	5.3E-4	1.6E-5	7.0E-5		
7440-66-6	Zinc	N	Y	N	A	2.8E-3	0.012	9.4E-4	4.1E-3	0.024	0.107	4.2E-4	1.9E-3	5.6E-5	2.4E-4		
HAP TOTAL						***0.131***	***0.574***	***0.045***	***0.196***	***1.160***	***5.079***	***0.020***	***0.088***	***3.4E-3***	***0.015***	***0.467***	***2.046***
MERCURY TOTAL (exempt)						***9.7E-5***	***4.3E-4***	***1.6E-5***	***7.0E-5***	***4.2E-4***	***1.8E-3***	***5.4E-5***	***2.4E-4***	***7.2E-4***	***3.2E-3***		
MERCURY TOTAL (non-exempt)																	
TAP TOTAL (HAP-TAP addressed by NSPS/NESHAP)																	
TAP TOTAL (For EL Evaluation)						***8.319***	***36.438***	***2.834***	***12.411***	***73.580***	***322***	***1.278***	***5.595***	***0.168***	***0.735***	***0.467***	***2.046***

PRI00000646

REC 1986

TABLE A-W3. HAP/TAP Emissions and Exemptions

180,000 T/day Emissions						**PROCESSING AND PRODUCTION**											
chk						*Ore Processing*				*Ore Concentration and Refining*				*Process Heating*			
						OC1-13		PS		AC		EW,MR,MF,CKD		ACB, CKB, PV, HS		LKC	
CAS	HAP/TAP	HAP	TAP			Crushers & Xfers		Prill Silos		Autoclave		EW, Preg Tank, Retort, Furnace, Carbon Kiln		POX Boiler, C. Kiln Comb., Prop. Vap., Sol'n Heater		Lime Kiln Combustion	
	NSPS or NESHAP HAP/TAP -->	*Y*				*LL*	*LL*			*7E*	*7E*	*7E*	*7E*			*5A*	*5A*
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				A/C	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
106-99-0	1,3-Butadiene	Y	Y	Y	C												
91-57-6	2-Methylnaphthalene	Y	N	n/a										1.9E-7	7.6E-7	5.2E-7	1.9E-6
56-49-5	3-Methylchloranthrene	Y	Y	Y	C									1.3E-8	5.7E-8	3.3E-8	1.4E-7
57-97-6	7,12-Dimethylbenz(a)anthracene	Y	N	n/a										1.3E-7	5.1E-7	3.5E-7	1.3E-6
83-32-9	Acenaphthene	Y	N	n/a										1.4E-8	5.7E-8	3.9E-8	1.4E-7
208-96-8	Acenaphthylene	Y	N	n/a										1.4E-8	5.7E-8	3.9E-8	1.4E-7
75-07-0	Acetaldehyde	Y	Y	Y	C												
107-02-8	Acrolein	Y	Y	Y	A												
120-12-7	Anthracene	Y	N	n/a										1.9E-8	7.6E-8	5.2E-8	1.9E-7
7440-36-0	Antimony	Y	Y	Y	A	1.4E-4	5.9E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7440-38-2	Arsenic	Y	Y	Y	C	3.9E-3	0.017			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.5E-6	6.4E-6	3.7E-6	1.6E-5
71-43-2	Benzene	Y	Y	Y	C									1.5E-5	6.7E-5	3.9E-5	1.7E-4
50-32-8	Benzo(a)pyrene	Y	Y	Y	C									8.7E-9	3.8E-8	2.2E-8	9.6E-8
56-55-3	Benz(a)anthracene	Y	Y	Y	C									1.3E-8	5.7E-8	3.3E-8	1.4E-7
205-99-2	Benzo(b)fluoranthene	Y	Y	Y	C									1.3E-8	5.7E-8	3.3E-8	1.4E-7
207-08-9	Benzo(k)fluoranthene	Y	Y	Y	C									1.3E-8	5.7E-8	3.3E-8	1.4E-7
218-01-9	Chrysene	Y	Y	Y	C									1.3E-8	5.7E-8	3.3E-8	1.4E-7
53-70-3	Dibenzo(a,h)anthracene	Y	Y	Y	C									8.7E-9	3.8E-8	2.2E-8	9.6E-8
193-39-5	Indeno(1,2,3-cd)pyrene	Y	Y	Y	C									1.3E-8	5.7E-8	3.3E-8	1.4E-7
191-24-2	Benzo(g,h,i)perylene	Y	N	n/a										9.5E-9	3.8E-8	2.6E-8	9.6E-8
7440-41-7	Beryllium	Y	Y	Y	C	1.9E-5	8.2E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	8.7E-8	3.8E-7	2.2E-7	9.6E-7
92-52-4	Biphenyl	Y	Y	Y	A												
7440-43-9	Cadmium	Y	Y	Y	C	2.9E-6	1.3E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	8.0E-6	3.5E-5	2.0E-5	8.8E-5
75-15-0	Carbon Disulfide	Y	Y	Y	A												
7440-47-3	Chromium	Y	Y	Y	A	5.3E-5	2.3E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.1E-5	4.5E-5	3.0E-5	1.1E-4
18540-29-9	Cr (VI)	Y	Y	Y	C												
7440-48-4	Cobalt	Y	Y	Y	A	2.4E-5	1.0E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3	6.6E-7	2.7E-6	1.8E-6	6.8E-6
592-01-8	Cyanide	Y	Y	Y	A							1.2E-3	5.3E-3				
106-46-7	Dichlorobenzene	Y	Y	Y	A									9.5E-6	3.8E-5	2.6E-5	9.6E-5
206-44-0	Fluoranthene	Y	N	n/a										2.4E-8	9.5E-8	6.5E-8	2.4E-7
86-73-7	Fluorene	Y	N	n/a										2.2E-8	8.9E-8	6.1E-8	2.3E-7
50-00-0	Formaldehyde	Y	Y	Y	C									5.5E-4	2.4E-3	1.4E-3	6.0E-3
110-54-3	Hexane	Y	Y	Y	A									0.014	0.057	0.039	0.145
7647-01-0	Hydrogen Chloride	Y	Y	Y	A												
7439-92-1	Lead	Y	N	n/a		4.7E-5	2.1E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7439-96-5	Manganese	Y	Y	Y	A	1.8E-3	7.7E-3			2.3E-5	1.0E-4	3.8E-4	1.7E-3	3.0E-6	1.2E-5	8.2E-6	3.1E-5
7439-97-6	Mercury	Y	N	n/a		5.6E-6	2.5E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	2.1E-6	8.3E-6	5.6E-6	2.1E-5
91-20-3	Naphthalene	Y	Y	Y	A									4.8E-6	1.9E-5	1.3E-5	4.9E-5
7440-02-0	Nickel	Y	Y	Y	C	1.2E-5	5.2E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.5E-5	6.7E-5	3.9E-5	1.7E-4
85-01-8	Phenanthrene	Y	N	n/a										1.3E-7	5.4E-7	3.7E-7	1.4E-6
108-95-2	Phenol	Y	Y	Y	A												
7723-14-0	Phosphorus	Y	Y	Y	A	3.8E-3	0.017			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
129-00-0	Pyrene	Y	N	n/a										4.0E-8	1.6E-7	1.1E-7	4.0E-7
7782-49-2	Selenium	Y	Y	Y	A	2.4E-6	1.0E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.9E-7	7.6E-7	5.2E-7	1.9E-6
108-88-3	Toluene	Y	Y	Y	A									2.7E-5	1.1E-4	7.3E-5	2.7E-4
1330-20-7	Xylene	Y	Y	Y	A												
7429-90-5	Aluminum	N	Y	N	A	0.418	1.829			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7440-39-3	Barium	N	Y	N	A	4.7E-3	0.021			2.3E-5	1.0E-4	3.8E-4	1.7E-3	3.5E-5	1.4E-4	9.5E-5	3.5E-4
1317-65-3	Calcium Carbonate	N	Y	N	A	0.082	0.361			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
1305-78-8	Calcium Oxide	N	Y	N	A												
7440-50-8	Copper	N	Y	N	A	2.9E-5	1.3E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3	6.7E-6	2.7E-5	1.8E-5	6.8E-5
110-82-7	Cyclohexane	N	Y	N	A												
7783-06-4	Hydrogen Sulfide	N	Y	N	A					0.900	3.942						
7439-89-6	Iron	N	Y	N	A	0.107	0.469			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7439-98-7	Molybdenum	N	Y	N	A	5.9E-6	2.6E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	8.7E-6	3.5E-5	2.4E-5	8.8E-5
109-66-0	Pentane	N	Y	N	A									0.021	0.083	0.056	0.209
7440-22-4	Silver	N	Y	N	A	2.9E-6	1.3E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7664-93-9	Sulfuric Acid	N	Y	N	A					2.030	8.891						
7440-28-0	Thallium	N	Y	N	A	5.9E-5	2.6E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7440-61-1	Uranium	N	Y	N	A	5.9E-5	2.6E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7440-62-2	Vanadium	N	Y	N	A	1.6E-4	7.2E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.8E-5	7.3E-5	5.0E-5	1.8E-4
25551-13-7	Trimethyl benzene	N	Y	N	A												
7440-33-7	Tungsten	N	Y	N	A	5.9E-5	2.6E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7440-66-6	Zinc	N	Y	N	A	2.1E-4	9.0E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3	2.3E-4	9.2E-4	6.3E-4	2.3E-3
HAP TOTAL						***9.8E-3***	***0.043***			***2.8E-4***	***1.2E-3***	***5.8E-3***	***0.025***	***0.015***	***0.060***	***0.041***	***0.152***
MERCURY TOTAL (exempt)										***2.3E-5***	***1.0E-4***	***3.8E-4***	***1.7E-3***			***5.6E-6***	***2.1E-5***
MERCURY TOTAL (non-exempt)						***5.6E-6***	***2.5E-5***							***2.1E-6***	***8.3E-6***		
TAP TOTAL (HAP-TAP addressed by NSPS/NESHAP)						***9.8E-3***	***0.043***			***2.3E-4***	***1.0E-3***	***5.0E-3***	***0.022***			***0.041***	***0.152***
TAP TOTAL (For EL Evaluation)						***0.612***	***2.682***			***2.930***	***12.835***	***4.6E-3***	***0.020***	***0.036***	***0.144***	***0.057***	***0.212***

PRI00000647

REC 1987

TABLE A-W3. HAP/TAP Emissions and Exemptions

180,000 T/day Emissions

chk

CAS	HAP/TAP	HAP	TAP		
	NSPS or NESHAP HAP/TAP -->			*Y*	
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				*A/C*
106-99-0	1,3-Butadiene	Y	Y	Y	C
91-57-6	2-Methylnaphthalene	Y	N	n/a	
56-49-5	3-Methylchloranthrene	Y	Y	Y	C
57-97-6	7,12-Dimethylbenz(a)anthracene	Y	N	n/a	
83-32-9	Acenaphthene	Y	N	n/a	
208-96-8	Acenaphthylene	Y	N	n/a	
75-07-0	Acetaldehyde	Y	Y	Y	C
107-02-8	Acrolein	Y	Y	Y	A
120-12-7	Anthracene	Y	N	n/a	
7440-36-0	Antimony	Y	Y	Y	A
7440-38-2	Arsenic	Y	Y	Y	C
71-43-2	Benzene	Y	Y	Y	C
50-32-8	Benzo(a)pyrene	Y	Y	Y	C
56-55-3	Benz(a)anthracene	Y	Y	Y	C
205-99-2	Benzo(b)fluoranthene	Y	Y	Y	C
207-08-9	Benzo(k)fluoranthene	Y	Y	Y	C
218-01-9	Chrysene	Y	Y	Y	C
53-70-3	Dibenzo(a,h)anthracene	Y	Y	Y	C
193-39-5	Indeno(1,2,3-cd)pyrene	Y	Y	Y	C
191-24-2	Benzo(g,h,i)perylene	Y	N	n/a	
7440-41-7	Beryllium	Y	Y	Y	C
92-52-4	Biphenyl	Y	Y	Y	A
7440-43-9	Cadmium	Y	Y	Y	C
75-15-0	Carbon Disulfide	Y	Y	Y	A
7440-47-3	Chromium	Y	Y	Y	A
18540-29-9	Cr (VI)	Y	Y	Y	C
7440-48-4	Cobalt	Y	Y	Y	A
592-01-8	Cyanide	Y	Y	Y	A
106-46-7	Dichlorobenzene	Y	Y	Y	A
206-44-0	Fluoranthene	Y	N	n/a	
86-73-7	Fluorene	Y	N	n/a	
50-00-0	Formaldehyde	Y	Y	Y	C
110-54-3	Hexane	Y	Y	Y	A
7647-01-0	Hydrogen Chloride	Y	Y	Y	A
7439-92-1	Lead	Y	N	n/a	
7439-96-5	Manganese	Y	Y	Y	A
7439-97-6	Mercury	Y	N	n/a	
91-20-3	Naphthalene	Y	Y	Y	A
7440-02-0	Nickel	Y	Y	Y	C
85-01-8	Phenanthrene	Y	N	n/a	
108-95-2	Phenol	Y	Y	Y	A
7723-14-0	Phosphorus	Y	Y	Y	A
129-00-0	Pyrene	Y	N	n/a	
7782-49-2	Selenium	Y	Y	Y	A
108-88-3	Toluene	Y	Y	Y	A
1330-20-7	Xylene	Y	Y	Y	A
7429-90-5	Aluminum	N	Y	N	A
7440-39-3	Barium	N	Y	N	A
1317-65-3	Calcium Carbonate	N	Y	N	A
1305-78-8	Calcium Oxide	N	Y	N	A
7440-50-8	Copper	N	Y	N	A
110-82-7	Cyclohexane	N	Y	N	A
7783-06-4	Hydrogen Sulfide	N	Y	N	A
7439-89-6	Iron	N	Y	N	A
7439-98-7	Molybdenum	N	Y	N	A
109-66-0	Pentane	N	Y	N	A
7440-22-4	Silver	N	Y	N	A
7664-93-9	Sulfuric Acid	N	Y	N	A
7440-28-0	Thallium	N	Y	N	A
7440-61-1	Uranium	N	Y	N	A
7440-62-2	Vanadium	N	Y	N	A
25551-13-7	Trimethyl benzene	N	Y	N	A
7440-33-7	Tungsten	N	Y	N	A
7440-66-6	Zinc	N	Y	N	A
HAP TOTAL					
MERCURY TOTAL (exempt)					
MERCURY TOTAL (non-exempt)					
TAP TOTAL (HAP-TAP addressed by NSPS/NESHAP)					
TAP TOTAL (For EL Evaluation)					

PROCESSING AND PRODUCTION - Continued

Lime Production						*Aggregate Prod.*		*Concrete Production*					
LS1-11,LSBM		LK,LS12,LCR,LS-L/U		LS1-L/U,MillS2-L/U,ACS1-4		PCSP1,PCSP2		CM		CS1L,CS1U,CS2L, CS2U		CA-L/U	
Limestone Crushers, Screens, Mill, Xfers		Lime Kiln, Kiln Feed, Lime Mill, Pebble Lime Silo		Lime Silos and Lime Mill Crushing		Portable Crushers, Screens, Xfers		Central Mixer		Cement Silo #1 and #2 L/U		Aggregate Bin	
OOO	*OOO*	*5A*	*5A*			*OOO*	*OOO*					*OOO*	*OOO*
lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
1.4E-5	4.8E-5	3.1E-6	1.2E-5	1.6E-6	5.1E-7	3.1E-6	1.4E-5					3.5E-6	8.6E-6
1.0E-4	4.4E-4	2.4E-5	1.1E-4	1.1E-6	4.7E-6	2.9E-5	1.3E-4	2.0E-6	8.9E-6	1.2E-7	5.1E-7	1.8E-5	7.9E-5
3.5E-6	1.5E-5	8.4E-7	3.7E-6	3.7E-8	1.6E-7	1.0E-6	4.4E-6			1.3E-8	5.8E-8	6.3E-7	2.8E-6
1.1E-6	4.8E-6	2.6E-7	1.2E-6	1.2E-8	5.1E-8	3.1E-7	1.4E-6	4.9E-9	2.1E-8			2.0E-7	8.6E-7
8.5E-5	2.9E-4	1.9E-5	6.9E-5	9.7E-6	3.0E-6	1.9E-5	8.2E-5	8.7E-7	3.8E-6	7.9E-7	3.5E-6	2.1E-5	5.2E-5
								1.9E-7	8.1E-7	1.6E-7	7.0E-7		
2.3E-5	7.7E-5	5.0E-6	1.8E-5	2.6E-6	8.1E-7	5.0E-6	2.2E-5					5.5E-6	1.4E-5
0	0	0.986	3.666										
1.7E-5	5.8E-5	3.7E-6	1.4E-5	1.9E-6	6.1E-7	3.8E-6	1.6E-5	2.5E-7	1.1E-6	3.0E-7	1.3E-6	4.1E-6	1.0E-5
1.3E-3	4.6E-3	2.9E-4	1.1E-3	1.5E-4	4.8E-5	3.0E-4	1.3E-3	2.6E-5	1.1E-4	3.2E-6	1.4E-5	3.3E-4	8.2E-4
1.1E-7	3.9E-7	2.8E-4	1.0E-3	1.3E-8	4.1E-9	2.5E-8	1.1E-7					2.8E-8	6.9E-8
2.2E-5	9.6E-5	5.3E-6	2.3E-5	2.3E-7	1.0E-6	6.3E-6	2.7E-5	1.7E-6	7.4E-6	1.1E-6	5.0E-6	3.9E-6	1.7E-5
7.4E-4	2.5E-3	1.6E-4	6.0E-4	8.4E-5	2.6E-5	1.6E-4	7.1E-4	8.2E-6	3.6E-5			1.8E-4	4.5E-4
0.128	0.436	0.028	0.104	0.015	4.6E-3	0.028	0.124					0.031	0.078
8.2E-4	2.8E-3	1.8E-4	6.7E-4	9.4E-5	2.9E-5	1.8E-4	7.9E-4					2.0E-4	5.0E-4
1.558	5.291	0.260	0.969			0.343	1.503						
		0.216	0.802	0.480	0.150								
2.8E-5	9.6E-5	6.2E-6	2.3E-5	3.2E-6	1.0E-6	6.3E-6	2.7E-5					6.9E-6	1.7E-5
0.059	0.199	0.013	0.048	6.7E-3	2.1E-3	0.013	0.057					0.014	0.036
2.8E-6	9.6E-6	6.2E-7	2.3E-6	3.2E-7	1.0E-7	6.3E-7	2.7E-6					6.9E-7	1.7E-6
0	0												
2.8E-5	9.6E-5	6.2E-6	2.3E-5	3.2E-6	1.0E-6	6.3E-6	2.7E-5					6.9E-6	1.7E-5
2.8E-5	9.6E-5	6.2E-6	2.3E-5	3.2E-6	1.0E-6	6.3E-6	2.7E-5					6.9E-6	1.7E-5
8.8E-5	3.0E-4	1.9E-5	7.1E-5	1.0E-5	3.1E-6	1.9E-5	8.5E-5					2.1E-5	5.3E-5
2.8E-5	9.6E-5	6.2E-6	2.3E-5	3.2E-6	1.0E-6	6.3E-6	2.7E-5					6.9E-6	1.7E-5
1.0E-4	3.5E-4	2.2E-5	8.3E-5	1.2E-5	3.6E-6	2.3E-5	9.9E-5					2.5E-5	6.2E-5
2.3E-3	***8.1E-3***	***0.987***	***3.669***	***2.6E-4***	***8.5E-5***	***5.3E-4***	***2.3E-3***	***3.9E-5***	***1.7E-4***	***5.7E-6***	***2.5E-5***	***5.6E-4***	***1.4E-3***
0	***0***	***2.8E-4***	***1.0E-3***										
1.1E-7	***3.9E-7***			***1.3E-8***	***4.1E-9***	***2.5E-8***	***1.1E-7***					***2.8E-8***	***6.9E-8***
2.3E-3	***8.0E-3***	***0.986***	***3.668***			***5.2E-4***	***2.3E-3***					***5.6E-4***	***1.4E-3***
1.746	***5.930***	***0.517***	***1.923***	***0.502***	***0.157***	***0.385***	***1.684***	***3.9E-5***	***1.7E-4***	***5.4E-6***	***2.4E-5***	***0.046***	***0.114***

PRI00000648

REC 1988

TABLE A-W3. HAP/TAP Emissions and Exemptions

180,000 T/day Emissions						PROCESSING AND PRODUCTION - Continued						MINING and LEACHING - Totals							
chk						*HVAC*		*Emer. Power/Fire*		*Fuel Storage*		*HAP Total*		*Mercury Total*		*Mercury Total*		*TAP Total*	*TAP Total*
						H1M,H2M,HM,HAC,HR,HA,HMO,HTS,HW		EDG1,EDG2,EDG3,EDFP		TG1,TG2				*Exempt*		*Non-Exempt*		*HAP-TAP addressed by NSPS/NESHAP*	*For EL Evaluation*
CAS	HAP/TAP	HAP	TAP			Heaters		Emergency Generators and Fire Pump		Gasoline Fuel Tanks									
	NSPS or NESHAP HAP/TAP -->			*Y*				*4Z*	*4Z*	*6C*	*6C*								
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				*A/C*	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
106-99-0	1,3-Butadiene	Y	Y	Y	C			8.4E-7	3.7E-6			0	0					0	0	0	0
91-57-6	2-Methylnaphthalene	Y	N	n/a		4.3E-7	1.9E-6														
56-49-5	3-Methylchloranthrene	Y	Y	Y	C	3.2E-8	1.4E-7														
57-97-6	7,12-Dimethylbenz(a)anthracene	Y	N	n/a		2.9E-7	1.3E-6														
83-32-9	Acenaphthene	Y	N	n/a		3.2E-8	1.4E-7	5.6E-6	6.7E-6												
208-96-8	Acenaphthylene	Y	N	n/a		3.2E-8	1.4E-7	1.1E-5	1.3E-5												
75-07-0	Acetaldehyde	Y	Y	Y	C			2.5E-5	1.1E-4												
107-02-8	Acrolein	Y	Y	Y	A			1.6E-5	2.0E-5												
120-12-7	Anthracene	Y	N	n/a		4.3E-8	1.9E-7	1.6E-6	1.9E-6												
7440-36-0	Antimony	Y	Y	Y	A							0.019	0.082							0.019	0.082
7440-38-2	Arsenic	Y	Y	Y	C	3.6E-6	1.6E-5					0.544	2.381							0.544	2.381
71-43-2	Benzene	Y	Y	Y	C	3.8E-5	1.6E-4	2.7E-4	1.2E-3	7.0E-3	0.031										
50-32-8	Benzo(a)pyrene	Y	Y	Y	C	2.1E-8	9.4E-8	8.7E-8	3.8E-7												
56-55-3	Benz(a)anthracene	Y	Y	Y	C	3.2E-8	1.4E-7	2.4E-7	1.0E-6												
205-99-2	Benzo(b)fluoranthene	Y	Y	Y	C	3.2E-8	1.4E-7	3.6E-7	1.6E-6												
207-08-9	Benzo(k)fluoranthene	Y	Y	Y	C	3.2E-8	1.4E-7	7.3E-8	3.2E-7												
218-01-9	Chrysene	Y	Y	Y	C	3.2E-8	1.4E-7	5.0E-7	2.2E-6												
53-70-3	Dibenzo(a,h)anthracene	Y	Y	Y	C	2.1E-8	9.4E-8	1.2E-7	5.4E-7												
193-39-5	Indeno(1,2,3-cd)pyrene	Y	Y	Y	C	3.2E-8	1.4E-7	1.4E-7	6.2E-7												
191-24-2	Benzo(g,h,i)perylene	Y	N	n/a		2.1E-8	9.4E-8	6.9E-7	8.3E-7												
7440-41-7	Beryllium	Y	Y	Y	C	2.1E-7	9.4E-7					2.6E-3	0.011							2.6E-3	0.011
92-52-4	Biphenyl	Y	Y	Y	A					4.4E-5	1.9E-4										
7440-43-9	Cadmium	Y	Y	Y	C	2.0E-5	8.6E-5					4.1E-4	1.8E-3							4.1E-4	1.8E-3
75-15-0	Carbon Disulfide	Y	Y	Y	A							0.014	0.063							0.014	0.063
7440-47-3	Chromium	Y	Y	Y	A	2.5E-5	1.1E-4					7.3E-3	0.032							7.3E-3	0.032
18540-29-9	Cr (VI)	Y	Y	Y	C																
7440-48-4	Cobalt	Y	Y	Y	A	1.5E-6	6.6E-6					3.3E-3	0.014							3.3E-3	0.014
592-01-8	Cyanide	Y	Y	Y	A							0.453	1.983							0.453	1.983
106-46-7	Dichlorobenzene	Y	Y	Y	A	2.1E-5	9.4E-5														
206-44-0	Fluoranthene	Y	N	n/a		5.4E-8	2.4E-7	5.3E-6	6.4E-6												
86-73-7	Fluorene	Y	N	n/a		5.0E-8	2.2E-7	1.7E-5	2.1E-5												
50-00-0	Formaldehyde	Y	Y	Y	C	1.3E-3	5.9E-3	5.1E-5	2.2E-4												
110-54-3	Hexane	Y	Y	Y	A	0.032	0.141			0.031	0.137										
7647-01-0	Hydrogen Chloride	Y	Y	Y	A																
7439-92-1	Lead	Y	N	n/a								6.5E-3	0.029								
7439-96-5	Manganese	Y	Y	Y	A	6.8E-6	3.0E-5					0.244	1.067							0.244	1.067
7439-97-6	Mercury	Y	N	n/a		4.7E-6	2.0E-5					1.3E-3	5.7E-3	1.3E-3	5.7E-3	0	0	0	0	0	0
91-20-3	Naphthalene	Y	Y	Y	A	1.1E-5	4.8E-5	1.6E-4	1.9E-4	1.9E-3	8.5E-3	0	0					0	0	0	0
7440-02-0	Nickel	Y	Y	Y	C	3.8E-5	1.6E-4					1.6E-3	7.1E-3					0	0	1.6E-3	7.1E-3
85-01-8	Phenanthrene	Y	N	n/a		3.0E-7	1.3E-6	5.0E-5	6.0E-5			0	0					0	0	0	0
108-95-2	Phenol	Y	Y	Y	A					2.4E-4	1.1E-3	0	0					0	0	0	0
7723-14-0	Phosphorus	Y	Y	Y	A							0.530	2.320					0	0	0.530	2.320
129-00-0	Pyrene	Y	N	n/a		8.9E-8	3.9E-7	4.7E-6	5.7E-6			0	0					0	0	0	0
7782-49-2	Selenium	Y	Y	Y	A	4.3E-7	1.9E-6					3.3E-4	1.4E-3					0	0	3.3E-4	1.4E-3
108-88-3	Toluene	Y	Y	Y	A	6.1E-5	2.7E-4	3.6E-4	4.3E-4	0.032	0.138	0	0					0	0	0	0
1330-20-7	Xylene	Y	Y	Y	A			2.5E-4	3.0E-4	0.031	0.137	0	0					0	0	0	0
7429-90-5	Aluminum	N	Y	N	A							0	0					0	0	57.855	253
7440-39-3	Barium	N	Y	N	A	7.9E-5	3.4E-4					0	0					0	0	0.652	2.855
1317-65-3	Calcium Carbonate	N	Y	N	A							0	0					0	0	11.408	49.967
1305-78-8	Calcium Oxide	N	Y	N	A							0	0					0	0	0	0
7440-50-8	Copper	N	Y	N	A	1.5E-5	6.7E-5					0	0					0	0	4.1E-3	0.018
110-82-7	Cyclohexane	N	Y	N	A					1.0E-3	4.6E-3	0	0					0	0	0	0
7783-06-4	Hydrogen Sulfide	N	Y	N	A							0	0					0	0	0	0
7439-89-6	Iron	N	Y	N	A							0	0					0	0	14.831	64.958
7439-98-7	Molybdenum	N	Y	N	A	2.0E-5	8.6E-5					0	0					0	0	8.1E-4	3.6E-3
109-66-0	Pentane	N	Y	N	A	0.047	0.204					0	0					0	0	0	0
7440-22-4	Silver	N	Y	N	A							0	0					0	0	4.1E-4	1.8E-3
7664-93-9	Sulfuric Acid	N	Y	N	A							0	0					0	0	0	0
7440-28-0	Thallium	N	Y	N	A							0	0					0	0	8.1E-3	0.036
7440-61-1	Uranium	N	Y	N	A							0	0					0	0	8.1E-3	0.036
7440-62-2	Vanadium	N	Y	N	A	4.1E-5	1.8E-4					0	0					0	0	0.023	0.100
25551-13-7	Trimethyl benzene	N	Y	N	A					0.011	0.048	0	0					0	0	0	0
7440-33-7	Tungsten	N	Y	N	A							0	0					0	0	8.1E-3	0.036
7440-66-6	Zinc	N	Y	N	A	5.2E-4	2.3E-3					0	0					0	0	0.029	0.125
HAP TOTAL						***0.034***	***0.148***	***1.2E-3***	***2.6E-3***	***0.103***	***0.453***	***1.826***	***7.998***								
MERCURY TOTAL (exempt)														***1.3E-3***	***5.7E-3***						
MERCURY TOTAL (non-exempt)						***4.7E-6***	***2.0E-5***									***0***	***0***				
TAP TOTAL (HAP-TAP addressed by NSPS/NESHAP)								***1.1E-3***	***2.5E-3***	***0.103***	***0.453***							***0***	***0***		
TAP TOTAL (For EL Evaluation)						***0.081***	***0.355***			***0.012***	***0.052***									***86.645***	***380***

PRI00000649

REC 1989

TABLE A-W3. HAP/TAP Emissions and Exemptions 1 1 0 0

180,000 T/day Emissions						PROCESSING AND PRODUCTION - Totals										ALL	ALL	ALL	TAP EL	
chk						HAP Total		Mercury Total Exempt		Mercury Total Non-Exempt		TAP Total HAP-TAP addressed by NSPS/NESHAP		TAP Total For EL Evaluation		HAP	Hg Non-Exempt	TAP For EL Evaluation	TAP Emission Screening Level (EL)	
CAS	HAP/TAP	HAP	TAP																Non-car	Carcin
	NSPS or NESHAP HAP/TAP -->	Y																		
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				A/C	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr	ton/yr	lb/hr	lb/hr	lb/hr
106-99-0	1,3-Butadiene	Y	Y	Y	C	8.4E-7	3.7E-6					8.4E-7	3.7E-6			3.7E-6		0	--	2.4E-5
91-57-6	2-Methylnaphthalene	Y	N	n/a		1.1E-6	4.6E-6									4.6E-6			--	--
56-49-5	3-Methylchloranthrene	Y	Y	Y	C	7.8E-8	3.4E-7					3.3E-8	1.4E-7	4.5E-8	2.0E-7	3.4E-7		4.5E-8	--	2.5E-6
57-97-6	7,12-Dimethylbenz(a)anthracene	Y	N	n/a		7.6E-7	3.0E-6									3.0E-6			--	--
83-32-9	Acenaphthene	Y	N	n/a		5.7E-6	7.1E-6									7.1E-6			--	--
208-96-8	Acenaphthylene	Y	N	n/a		1.1E-5	1.4E-5									1.4E-5			--	--
75-07-0	Acetaldehyde	Y	Y	Y	C	2.5E-5	1.1E-4					2.5E-5	1.1E-4			1.1E-4			--	3.0E-3
107-02-8	Acrolein	Y	Y	Y	A	1.6E-5	2.0E-5					1.6E-5	2.0E-5			2.0E-5			0.017	--
120-12-7	Anthracene	Y	N	n/a		1.7E-6	2.4E-6									2.4E-6			--	--
7440-36-0	Antimony	Y	Y	Y	A	5.7E-4	2.5E-3					5.7E-4	2.5E-3	1.6E-6	5.1E-7	0.085		0.019	0.033	--
7440-38-2	Arsenic	Y	Y	Y	C	4.5E-3	0.020					4.5E-3	0.020	8.2E-6	3.6E-5	2.400		0.544	--	1.5E-6
71-43-2	Benzene	Y	Y	Y	C	7.4E-3	0.032					7.3E-3	0.032	5.3E-5	2.3E-4	0.032		5.3E-5	--	8.0E-4
50-32-8	Benzo(a)pyrene	Y	Y	Y	C	1.4E-7	6.1E-7					1.1E-7	4.8E-7	3.0E-8	1.3E-7	6.1E-7				
56-55-3	Benz(a)anthracene	Y	Y	Y	C	3.1E-7	1.4E-6					2.7E-7	1.2E-6	4.5E-8	2.0E-7	1.4E-6				
205-99-2	Benzo(b)fluoranthene	Y	Y	Y	C	4.4E-7	1.9E-6					3.9E-7	1.7E-6	4.5E-8	2.0E-7	1.9E-6				
207-08-9	Benzo(k)fluoranthene	Y	Y	Y	C	1.5E-7	6.6E-7					1.1E-7	4.7E-7	4.5E-8	2.0E-7	6.6E-7		2.9E-7	--	2.0E-6
218-01-9	Chrysene	Y	Y	Y	C	5.8E-7	2.5E-6					5.3E-7	2.3E-6	4.5E-8	2.0E-7	2.5E-6				
53-70-3	Dibenzo(a,h)anthracene	Y	Y	Y	C	1.8E-7	7.7E-7					1.5E-7	6.4E-7	3.0E-8	1.3E-7	7.7E-7				
193-39-5	Indeno(1,2,3-cd)pyrene	Y	Y	Y	C	2.2E-7	9.6E-7					1.7E-7	7.6E-7	4.5E-8	2.0E-7	9.6E-7				
191-24-2	Benzo(g,h,i)perylene	Y	N	n/a		7.5E-7	1.1E-6									1.1E-6			--	--
7440-41-7	Beryllium	Y	Y	Y	C	4.3E-4	1.9E-3					4.3E-4	1.9E-3	3.5E-7	1.5E-6	0.013		2.6E-3	--	2.8E-5
92-52-4	Biphenyl	Y	Y	Y	A	4.4E-5	1.9E-4					4.4E-5	1.9E-4			1.9E-4			0.100	--
7440-43-9	Cadmium	Y	Y	Y	C	4.6E-4	2.0E-3					4.3E-4	1.9E-3	2.8E-5	1.2E-4	3.8E-3		4.4E-4	--	3.7E-6
75-15-0	Carbon Disulfide	Y	Y	Y	A											0.063		0.014	2.000	--
7440-47-3	Chromium	Y	Y	Y	A	6.8E-4	2.8E-3					6.3E-4	2.6E-3	4.8E-5	1.6E-4	0.035		7.4E-3	0.033	--
18540-29-9	Cr (VI)	Y	Y	Y	C	3.4E-7	1.5E-6							3.4E-7	1.5E-6	1.5E-6		3.4E-7	--	5.6E-7
7440-48-4	Cobalt	Y	Y	Y	A	4.7E-4	2.0E-3					4.7E-4	2.0E-3	4.8E-6	1.0E-5	0.016		3.3E-3	3.3E-3	--
592-01-8	Cyanide	Y	Y	Y	A	1.2E-3	5.3E-3					1.2E-3	5.3E-3			1.988		0.453	0.333	--
106-46-7	Dichlorobenzene	Y	Y	Y	A	5.7E-5	2.3E-4					2.6E-5	9.6E-5	3.1E-5	1.3E-4	2.3E-4		3.1E-5	30.000	--
206-44-0	Fluoranthene	Y	N	n/a		5.5E-6	7.0E-6									7.0E-6			--	--
86-73-7	Fluorene	Y	N	n/a		1.7E-5	2.1E-5									2.1E-5			--	--
50-00-0	Formaldehyde	Y	Y	Y	C	3.3E-3	0.015					1.4E-3	6.2E-3	1.9E-3	8.3E-3	0.015		1.9E-3	--	5.1E-4
110-54-3	Hexane	Y	Y	Y	A	0.117	0.480					0.070	0.281	0.046	0.198	0.480		0.046	12.000	--
7647-01-0	Hydrogen Chloride	Y	Y	Y	A	0.986	3.666					0.986	3.666			3.666			0.050	--
7439-92-1	Lead	Y	N	n/a		4.8E-4	2.1E-3									0.031			--	--
7439-96-5	Manganese	Y	Y	Y	A	4.6E-3	0.017					4.4E-3	0.017	1.9E-4	2.2E-4	1.085		0.244	0.067	--
7439-97-6	Mercury	Y	N	n/a		7.1E-4	2.9E-3	6.9E-4	2.8E-3	1.3E-5	5.4E-5					8.6E-3	5.4E-5		--	--
91-20-3	Naphthalene	Y	Y	Y	A	2.1E-3	8.8E-3					2.1E-3	8.7E-3	1.6E-5	6.7E-5	8.8E-3		1.6E-5	3.330	--
7440-02-0	Nickel	Y	Y	Y	C	5.5E-4	2.4E-3					4.9E-4	2.2E-3	5.6E-5	2.4E-4	9.5E-3		1.7E-3	--	2.7E-5
85-01-8	Phenanthrene	Y	N	n/a		5.1E-5	6.3E-5									6.3E-5			--	--
108-95-2	Phenol	Y	Y	Y	A	2.4E-4	1.1E-3					2.4E-4	1.1E-3			1.1E-3			1.270	--
7723-14-0	Phosphorus	Y	Y	Y	A	5.6E-3	0.023					5.5E-3	0.023	9.3E-5	6.2E-5	2.343		0.530	7.0E-3	--
129-00-0	Pyrene	Y	N	n/a		5.0E-6	6.6E-6									6.6E-6			--	--
7782-49-2	Selenium	Y	Y	Y	A	4.1E-4	1.8E-3					4.1E-4	1.8E-3	6.2E-7	2.6E-6	3.2E-3		3.3E-4	0.013	--
108-88-3	Toluene	Y	Y	Y	A	0.032	0.139					0.032	0.139	8.8E-5	3.7E-4	0.139		8.8E-5	25.000	--
1330-20-7	Xylene	Y	Y	Y	A	0.032	0.138					0.032	0.138			0.138			29.000	--
7429-90-5	Aluminum	N	Y	N	A									0.648	2.577			58.504	0.667	--
7440-39-3	Barium	N	Y	N	A									6.8E-3	0.028			0.659	0.033	--
1317-65-3	Calcium Carbonate	N	Y	N	A									2.244	8.125			13.652	0.667	--
1305-78-8	Calcium Oxide	N	Y	N	A									0.696	0.952			0.696	0.133	--
7440-50-8	Copper	N	Y	N	A									5.3E-4	2.2E-3			4.6E-3	0.067	--
110-82-7	Cyclohexane	N	Y	N	A									1.0E-3	4.6E-3			1.0E-3	70.000	--
7783-06-4	Hydrogen Sulfide	N	Y	N	A									0.900	3.942			0.900	0.933	--
7439-89-6	Iron	N	Y	N	A									0.213	0.812			15.043	0.067	--
7439-98-7	Molybdenum	N	Y	N	A									4.7E-4	2.0E-3			1.3E-3	0.333	--
109-66-0	Pentane	N	Y	N	A									0.123	0.495			0.123	118	--
7440-22-4	Silver	N	Y	N	A									4.1E-4	1.8E-3			8.2E-4	7.0E-3	--
7664-93-9	Sulfuric Acid	N	Y	N	A									2.030	8.891			2.030	0.067	--
7440-28-0	Thallium	N	Y	N	A									5.2E-4	2.2E-3			8.7E-3	7.0E-3	--
7440-61-1	Uranium	N	Y	N	A									5.2E-4	2.2E-3			8.7E-3	0.013	--
7440-62-2	Vanadium	N	Y	N	A									8.4E-4	3.5E-3			0.024	3.0E-3	--
25551-13-7	Trimethyl benzene	N	Y	N	A									0.011	0.048			0.011	8.200	--
7440-33-7	Tungsten	N	Y	N	A									5.2E-4	2.2E-3	0		8.7E-3	0.333	--
7440-66-6	Zinc	N	Y	N	A									2.2E-3	8.8E-3	0		0.031	0.667	--
HAP TOTAL						*1.200*	*4.566*									*12.564*				
MERCURY TOTAL (exempt)								*6.9E-4*	*2.8E-3*											
MERCURY TOTAL (non-exempt)										*1.3E-5*	*5.4E-5*						*5.4E-5*			
TAP TOTAL (HAP-TAP addressed by NSPS/NESHAP)												*1.150*	*4.353*							
TAP TOTAL (For EL Evaluation)														*6.928*	*26.109*			*93.573*		

PRI00000650

REC 1990

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 1 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021

Model Scenario W3 T-RACT Emissions

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	HAP/TAP	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
106-99-0	1,3-Butadiene	8.4E-07	3.7E-06	0	0	0	0	8.4E-07	3.7E-06	Y	Y
91-57-6	2-Methylnaphthalene	1.1E-06	4.6E-06	0	0	0	0	1.1E-06	4.6E-06	Y	N
56-49-5	3-Methylchloranthrene	7.8E-08	3.4E-07	0	0	0	0	7.8E-08	3.4E-07	Y	Y
57-97-6	7,12-Dimethylbenz(a)anthracene	7.6E-07	3.0E-06	0	0	0	0	7.6E-07	3.0E-06	Y	N
83-32-9	Acenaphthene	5.7E-06	7.1E-06	0	0	0	0	5.7E-06	7.1E-06	Y	N
208-96-8	Acenaphthylene	1.1E-05	1.4E-05	0	0	0	0	1.1E-05	1.4E-05	Y	N
75-07-0	Acetaldehyde	2.5E-05	1.1E-04	0	0	0	0	2.5E-05	1.1E-04	Y	Y
107-02-8	Acrolein	1.6E-05	2.0E-05	0	0	0	0	1.6E-05	2.0E-05	Y	Y
120-12-7	Anthracene	1.7E-06	2.4E-06	0	0	0	0	1.7E-06	2.4E-06	Y	N
7440-36-0	Antimony	0	0	5.7E-04	2.5E-03	1.3E-02	5.8E-02	1.4E-02	6.1E-02	Y	Y
7440-38-2	Arsenic	8.7E-06	3.8E-05	4.5E-03	2.0E-02	0.23	1.02	0.24	1.04	Y	Y
56-55-3	Benz(a)anthracene	3.1E-07	1.4E-06	0	0	0	0	3.1E-07	1.4E-06	Y	Y
71-43-2	Benzene	3.6E-04	1.6E-03	7.0E-03	3.1E-02	0	0	7.4E-03	3.2E-02	Y	Y
50-32-8	Benzo(a)pyrene	1.4E-07	6.1E-07	0	0	0	0	1.4E-07	6.1E-07	Y	Y
205-99-2	Benzo(b)fluoranthene	4.4E-07	1.9E-06	0	0	0	0	4.4E-07	1.9E-06	Y	Y
191-24-2	Benzo(g,h,i)perylene	7.5E-07	1.1E-06	0	0	0	0	7.5E-07	1.1E-06	Y	N
207-08-9	Benzo(k)fluoranthene	1.5E-07	6.6E-07	0	0	0	0	1.5E-07	6.6E-07	Y	Y
7440-41-7	Beryllium	5.2E-07	2.3E-06	4.3E-04	1.9E-03	1.9E-03	8.1E-03	2.3E-03	1.0E-02	Y	Y
92-52-4	Biphenyl	0	0	4.4E-05	1.9E-04	0	0	4.4E-05	1.9E-04	Y	Y
7440-43-9	Cadmium	4.8E-05	2.1E-04	4.1E-04	1.8E-03	2.9E-04	1.3E-03	7.5E-04	3.3E-03	Y	Y
75-15-0	Carbon Disulfide	0	0	1.4E-02	6.3E-02	0	0	1.4E-02	6.3E-02	Y	Y
7440-47-3	Chromium	6.6E-05	2.7E-04	6.1E-04	2.5E-03	5.2E-03	2.3E-02	5.9E-03	2.6E-02	Y	Y
18540-29-9	Cr (VI)	0	0	3.4E-07	1.5E-06	0	0	3.4E-07	1.5E-06	Y	Y
218-01-9	Chrysene	5.8E-07	2.5E-06	0	0	0	0	5.8E-07	2.5E-06	Y	Y
7440-48-4	Cobalt	4.0E-06	1.6E-05	4.7E-04	2.0E-03	2.3E-03	1.0E-02	2.8E-03	1.2E-02	Y	Y
592-01-8	Cyanide	0	0	0.45	1.99	0	0	0.45	1.99	Y	Y
53-70-3	Dibenzo(a,h)anthracene	1.8E-07	7.7E-07	0	0	0	0	1.8E-07	7.7E-07	Y	Y
106-46-7	Dichlorobenzene	5.7E-05	2.3E-04	0	0	0	0	5.7E-05	2.3E-04	Y	Y
206-44-0	Fluoranthene	5.5E-06	7.0E-06	0	0	0	0	5.5E-06	7.0E-06	Y	N
86-73-7	Fluorene	1.7E-05	2.1E-05	0	0	0	0	1.7E-05	2.1E-05	Y	N
50-00-0	Formaldehyde	3.3E-03	1.5E-02	0	0	0	0	3.3E-03	1.5E-02	Y	Y
110-54-3	Hexane	8.5E-02	0.34	3.1E-02	0.14	0	0	0.12	0.48	Y	Y
7647-01-0	Hydrogen Chloride	0	0	0.99	3.67	0	0	0.99	**3.67**	Y	Y
193-39-5	Indeno(1,2,3-cd)pyrene	2.2E-07	9.6E-07	0	0	0	0	2.2E-07	9.6E-07	Y	Y
7439-92-1	Lead	0	0	4.8E-04	2.1E-03	4.6E-03	2.0E-02	5.1E-03	2.2E-02	Y	N
7439-96-5	Manganese	1.8E-05	7.2E-05	4.6E-03	1.7E-02	0.17	0.76	0.18	0.78	Y	Y
7439-97-6	Mercury	1.2E-05	5.0E-05	6.9E-04	2.9E-03	1.2E-03	5.1E-03	1.9E-03	8.0E-03	Y	N
91-20-3	Naphthalene	1.9E-04	3.1E-04	1.9E-03	8.5E-03	0	0	2.1E-03	8.8E-03	Y	Y
7440-02-0	Nickel	9.1E-05	4.0E-04	4.6E-04	2.0E-03	1.2E-03	5.1E-03	1.7E-03	7.5E-03	Y	Y
85-01-8	Phenanthrene	5.1E-05	6.3E-05	0	0	0	0	5.1E-05	6.3E-05	Y	N
108-95-2	Phenol	0	0	2.4E-04	1.1E-03	0	0	2.4E-04	1.1E-03	Y	Y
7723-14-0	Phosphorus	0	0	5.6E-03	2.3E-02	0.38	1.65	0.38	1.67	Y	Y
129-00-0	Pyrene	5.0E-06	6.6E-06	0	0	0	0	5.0E-06	6.6E-06	Y	N
7782-49-2	Selenium	1.1E-06	4.6E-06	4.1E-04	1.8E-03	2.3E-04	1.0E-03	6.4E-04	2.8E-03	Y	Y
108-88-3	Toluene	5.2E-04	1.1E-03	3.2E-02	0.14	0	0	3.2E-02	0.14	Y	Y
1330-20-7	Xylene	2.5E-04	3.0E-04	3.1E-02	0.14	0	0	3.2E-02	0.14	Y	Y
Total HAP		9.0E-02	0.36	1.58	6.25	0.81	3.56	2.48	10.17		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

	0.2155	0.8650	8.3307	31.6474	61.0803	267.5316	69.6264	300.0439
TRUE	0.2155	0.8650	8.3307	31.6474	61.0803	267.5316	69.6264	300.0439
	chk	chk	chk-15	chk	chk	chk	chk-14	chk

PRI00000651

REC 1991

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary - continued

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**Non-HAP TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
7429-90-5	Aluminum	0	0	0.65	2.58	41.11	180.04	41.75	182.62	N	Y
7440-39-3	Barium	2.1E-04	8.4E-04	6.6E-03	2.7E-02	0.46	2.03	0.47	2.06	N	Y
1317-65-3	Calcium Carbonate	0	0	2.24	8.12	8.11	35.50	10.35	43.63	N	Y
1305-78-8	Calcium Oxide	0	0	0.70	0.95	0	0	0.70	0.95	N	Y
7440-50-8	Copper	4.0E-05	1.6E-04	4.9E-04	2.1E-03	2.9E-03	1.3E-02	3.4E-03	1.5E-02	N	Y
110-82-7	Cyclohexane	0	0	1.0E-03	4.6E-03	0	0	1.0E-03	4.6E-03	N	Y
7783-06-4	Hydrogen Sulfide	0	0	0.90	3.94	0	0	0.90	3.94	N	Y
7439-89-6	Iron	0	0	0.21	0.81	10.54	46.15	10.75	46.96	N	Y
7439-98-7	Molybdenum	5.2E-05	2.1E-04	4.2E-04	1.8E-03	5.8E-04	2.5E-03	1.0E-03	4.6E-03	N	Y
109-66-0	Pentane	0.12	0.50	0	0	0	0	0.12	0.50	N	Y
7440-22-4	Silver	0	0	4.1E-04	1.8E-03	2.9E-04	1.3E-03	7.0E-04	3.1E-03	N	Y
7664-93-9	Sulfuric Acid	0	0	2.03	8.89	0	0	2.03	8.89	N	Y
7440-28-0	Thallium	0	0	5.2E-04	2.2E-03	5.8E-03	2.5E-02	6.3E-03	2.8E-02	N	Y
7440-61-1	Uranium	0	0	5.2E-04	2.2E-03	5.8E-03	2.5E-02	6.3E-03	2.8E-02	N	Y
7440-62-2	Vanadium	1.1E-04	4.4E-04	7.3E-04	3.0E-03	1.6E-02	7.1E-02	1.7E-02	7.4E-02	N	Y
25551-13-7	Trimethyl benzene	0	0	1.1E-02	4.8E-02	0	0	1.1E-02	4.8E-02	N	Y
7440-33-7	Tungsten	0	0	5.2E-04	2.2E-03	5.8E-03	2.5E-02	6.3E-03	2.8E-02	N	Y
7440-66-6	Zinc	1.4E-03	5.5E-03	8.0E-04	3.3E-03	2.0E-02	8.9E-02	2.2E-02	9.8E-02	N	Y
Total Non-HAP TAP		0.13	0.50	6.75	25.40	60.27	263.98	67.15	289.88		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

Conversions

2,000 lb/ton
8,760 hr/yr
24 hr/day

PRI00000652

REC 1992

PROPANE COMBUSTION

Source Data

Source ID	Description	MMBtu/day	MMBtu/yr
Lime Process Heating			
LKC	PFR Shaft Lime Kiln Combustion	529.0	163,935
Ore Process Heating			
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	17.0	510
CKB	Carbon Regeneration Kiln (Burners)	54.1	19,754
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	2.4	876
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	120.0	43,800
Subtotal		193.5	64,940
HVAC			
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	96.0	35,040
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	96.0	35,040
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	96.0	35,040
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	12.0	4,380
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	48.0	17,520
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	72.0	26,280
Subtotal		438.0	159,870

PROPANE COMBUSTION - CONTINUED

HAP/TAP Emission Factors and Emissions

O.Heat_pph O.Heat_tpy L.Heat_pph L.Heat_tpy HVAC_pph HVAC_tpy lb/hr ton/yr

		Emission Factor[2]		Emissions[1] Ore Proc Heat		Lime Proc Heat		HVAC		Total			
CAS	Pollutant	lb/MMscf	lb/MMBtu[3]	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	TAP	A/C
91-57-6	2-Methylnaphthalene	2.4E-05	2.35E-8	1.9E-07	7.6E-07	5.2E-07	1.9E-06	4.3E-07	1.9E-06	1.1E-06	4.6E-06	N	
56-49-5	3-Methylchloranthrene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
57-97-6	7,12-Dimethylbenz(a)antl	< 1.6E-05	1.57E-8	1.3E-07	5.1E-07	3.5E-07	1.3E-06	2.9E-07	1.3E-06	7.6E-07	3.0E-06	N	
83-32-9	Acenaphthene	< 1.8E-06	1.76E-9	1.4E-08	5.7E-08	3.9E-08	1.4E-07	3.2E-08	1.4E-07	8.5E-08	3.4E-07	N	
208-96-8	Acenaphthylene	< 1.8E-06	1.76E-9	1.4E-08	5.7E-08	3.9E-08	1.4E-07	3.2E-08	1.4E-07	8.5E-08	3.4E-07	N	
120-12-7	Anthracene	< 2.4E-06	2.35E-9	1.9E-08	7.6E-08	5.2E-08	1.9E-07	4.3E-08	1.9E-07	1.1E-07	4.6E-07	N	
7440-38-2	Arsenic	2.0E-04	1.96E-7	1.5E-06	6.4E-06	3.7E-06	1.6E-05	3.6E-06	1.6E-05	8.7E-06	3.8E-05	Y	C
56-55-3	Benz(a)anthracene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
71-43-2	Benzene	2.1E-03	2.06E-6	1.5E-05	6.7E-05	3.9E-05	1.7E-04	3.8E-05	1.6E-04	9.1E-05	4.0E-04	Y	C
50-32-8	Benzo(a)pyrene	< 1.2E-06	1.18E-9	8.7E-09	3.8E-08	2.2E-08	9.6E-08	2.1E-08	9.4E-08	5.2E-08	2.3E-07	Y	C
205-99-2	Benzo(b)fluoranthene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
191-24-2	Benzo(g,h,i)perylene	< 1.2E-06	1.18E-9	9.5E-09	3.8E-08	2.6E-08	9.6E-08	2.1E-08	9.4E-08	5.7E-08	2.3E-07	N	
207-08-9	Benzo(k)fluoranthene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
7440-41-7	Beryllium	< 1.2E-05	1.18E-8	8.7E-08	3.8E-07	2.2E-07	9.6E-07	2.1E-07	9.4E-07	5.2E-07	2.3E-06	Y	C
7440-43-9	Cadmium	1.1E-03	1.08E-6	8.0E-06	3.5E-05	2.0E-05	8.8E-05	2.0E-05	8.6E-05	4.8E-05	2.1E-04	Y	C
7440-47-3	Chromium	1.4E-03	1.37E-6	1.1E-05	4.5E-05	3.0E-05	1.1E-04	2.5E-05	1.1E-04	6.6E-05	2.7E-04	Y	A
218-01-9	Chrysene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
7440-48-4	Cobalt	8.4E-05	8.24E-8	6.6E-07	2.7E-06	1.8E-06	6.8E-06	1.5E-06	6.6E-06	4.0E-06	1.6E-05	Y	A
53-70-3	Dibenzo(a,h)anthracene	< 1.2E-06	1.18E-9	8.7E-09	3.8E-08	2.2E-08	9.6E-08	2.1E-08	9.4E-08	5.2E-08	2.3E-07	Y	C
106-46-7	Dichlorobenzene	1.2E-03	1.18E-6	9.5E-06	3.8E-05	2.6E-05	9.6E-05	2.1E-05	9.4E-05	5.7E-05	2.3E-04	Y	A
206-44-0	Fluoranthene	3.0E-06	2.94E-9	2.4E-08	9.5E-08	6.5E-08	2.4E-07	5.4E-08	2.4E-07	1.4E-07	5.7E-07	N	
86-73-7	Fluorene	2.8E-06	2.75E-9	2.2E-08	8.9E-08	6.1E-08	2.3E-07	5.0E-08	2.2E-07	1.3E-07	5.3E-07	N	
50-00-0	Formaldehyde	7.5E-02	7.35E-5	5.5E-04	2.4E-03	1.4E-03	6.0E-03	1.3E-03	5.9E-03	3.3E-03	1.4E-02	Y	C
110-54-3	Hexane	1.8E+00	1.76E-3	1.4E-02	5.7E-02	3.9E-02	1.4E-01	3.2E-02	1.4E-01	8.5E-02	3.4E-01	Y	A
193-39-5	Indeno(1,2,3-cd)pyrene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
7439-96-5	Manganese	3.8E-04	3.73E-7	3.0E-06	1.2E-05	8.2E-06	3.1E-05	6.8E-06	3.0E-05	1.8E-05	7.2E-05	Y	A
7439-97-6	Mercury	2.6E-04	2.55E-7	2.1E-06	8.3E-06	5.6E-06	2.1E-05	4.7E-06	2.0E-05	1.2E-05	5.0E-05	N	
91-20-3	Naphthalene	6.1E-04	5.98E-7	4.8E-06	1.9E-05	1.3E-05	4.9E-05	1.1E-05	4.8E-05	2.9E-05	1.2E-04	Y	A
7440-02-0	Nickel	2.1E-03	2.06E-6	1.5E-05	6.7E-05	3.9E-05	1.7E-04	3.8E-05	1.6E-04	9.1E-05	4.0E-04	Y	C
85-01-8	Phenanthrene	1.7E-05	1.67E-8	1.3E-07	5.4E-07	3.7E-07	1.4E-06	3.0E-07	1.3E-06	8.1E-07	3.2E-06	N	
129-00-0	Pyrene	5.0E-06	4.90E-9	4.0E-08	1.6E-07	1.1E-07	4.0E-07	8.9E-08	3.9E-07	2.4E-07	9.5E-07	N	
7782-49-2	Selenium	< 2.4E-05	2.35E-8	1.9E-07	7.6E-07	5.2E-07	1.9E-06	4.3E-07	1.9E-06	1.1E-06	4.6E-06	Y	A
108-88-3	Toluene	3.4E-03	3.33E-6	2.7E-05	1.1E-04	7.3E-05	2.7E-04	6.1E-05	2.7E-04	1.6E-04	6.5E-04	Y	A
109-66-0	Pentane	2.6E+00	2.55E-3	2.1E-02	8.3E-02	5.6E-02	2.1E-01	4.7E-02	2.0E-01	1.2E-01	5.0E-01	Y	A
7440-39-3	Barium	4.4E-03	4.31E-6	3.5E-05	1.4E-04	9.5E-05	3.5E-04	7.9E-05	3.4E-04	2.1E-04	8.4E-04	Y	A
7440-50-8	Copper	8.5E-04	8.33E-7	6.7E-06	2.7E-05	1.8E-05	6.8E-05	1.5E-05	6.7E-05	4.0E-05	1.6E-04	Y	A
7439-98-7	Molybdenum	1.1E-03	1.08E-6	8.7E-06	3.5E-05	2.4E-05	8.8E-05	2.0E-05	8.6E-05	5.2E-05	2.1E-04	Y	A
7440-62-2	Vanadium	2.3E-03	2.25E-6	1.8E-05	7.3E-05	5.0E-05	1.8E-04	4.1E-05	1.8E-04	1.1E-04	4.4E-04	Y	A
7440-66-6	Zinc	2.9E-02	2.84E-5	2.3E-04	9.2E-04	6.3E-04	2.3E-03	5.2E-04	2.3E-03	1.4E-03	5.5E-03	Y	A
Total				3.6E-02	1.4E-01	9.8E-02	3.6E-01	8.1E-02	3.5E-01	2.1E-01	8.6E-01		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *AP-42, Table 1.4-3 & 1.4-4 (7/98) Natural Gas Combustion* 1.0766 1.0766

(3) *Natural Gas Higher Heating Value* 1,020 *MMBtu/MMscf* chk

DIESEL COMBUSTION

Source Data

Source ID	Description	Power Rating kW	Power Rating hp	Operation hr/day	Operation hr/yr	Fuel Consumption[1] & [2] MMBtu/day	Fuel Consumption[1] & [2] MMBtu/yr
EDG1	Camp Emergency Generator	1,000	1,341	1	100	9.39	938.70
EDG2	Plant Emergency Generator #1	1,000	1,341	1	100	9.39	938.7
EDG3	Plant Emergency Generator #2	1,000	1,341	1	100	9.39	938.7
EDFP	Mill Fire Pump	200	268	1	100	1.88	187.7
Total						30.0	3,003.8

(1) *Based on brake specific fuel consumption for diesel generators* 7,000 *Btu/hp-hr* *AP-42 Tbl 3.3-1*

(2) *Heat Content of* 0.137 *MMBtu/gal* 1E+6 *Btu/MMBtu* 1.341 *hp/kW*

HAP/TAP Emission Factors and Emissions

		Factor (lb/MMBtu)		Emissions (≤600 hp)		Emissions (>600 hp)		Total Emissions[1]			
	Pollutant	≤600 hp[2]	>600hp[3]	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	TAP	A/C
106-99-0	1,3-Butadiene	< 3.9E-05		8.4E-07	3.7E-06	0.0E+00	0.0E+00	8.4E-07	3.7E-06	Y	C
83-32-9	Acenaphthene	< 1.4E-06	4.7E-06	1.1E-07	1.3E-07	5.5E-06	6.6E-06	5.6E-06	6.7E-06	N	
208-96-8	Acenaphthylene	< 5.1E-06	9.2E-06	4.0E-07	4.7E-07	1.1E-05	1.3E-05	1.1E-05	1.3E-05	N	
75-07-0	Acetaldehyde	7.7E-04	2.5E-05	1.6E-05	7.2E-05	8.1E-06	3.5E-05	2.5E-05	1.1E-04	Y	C
107-02-8	Acrolein	< 9.3E-05	7.9E-06	7.2E-06	8.7E-06	9.2E-06	1.1E-05	1.6E-05	2.0E-05	Y	A
120-12-7	Anthracene	1.9E-06	1.2E-06	1.5E-07	1.8E-07	1.4E-06	1.7E-06	1.6E-06	1.9E-06	N	
56-55-3	Benz(a)anthracene	1.7E-06	6.2E-07	3.6E-08	1.6E-07	2.0E-07	8.8E-07	2.4E-07	1.0E-06	Y	C
71-43-2	Benzene	9.3E-04	7.8E-04	2.0E-05	8.8E-05	2.5E-04	1.1E-03	2.7E-04	1.2E-03	Y	C
50-32-8	Benzo(a)pyrene	< 1.9E-07	< 2.6E-07	4.0E-09	1.8E-08	8.3E-08	3.6E-07	8.7E-08	3.8E-07	Y	C
205-99-2	Benzo(b)fluoranthene	< 9.9E-08	< 1.1E-06	2.1E-09	9.3E-09	3.6E-07	1.6E-06	3.6E-07	1.6E-06	Y	C
191-24-2	Benzo(g,h,i)perylene	< 4.9E-07	< 5.6E-07	3.8E-08	4.6E-08	6.5E-07	7.8E-07	6.9E-07	8.3E-07	N	
207-08-9	Benzo(k)fluoranthene	< 1.6E-07	< 2.2E-07	3.3E-09	1.5E-08	7.0E-08	3.1E-07	7.3E-08	3.2E-07	Y	C
218-01-9	Chrysene	3.5E-07	1.5E-06	7.6E-09	3.3E-08	4.9E-07	2.2E-06	5.0E-07	2.2E-06	Y	C
53-70-3	Dibenzo(a,h)anthracene	< 5.8E-07	< 3.5E-07	1.2E-08	5.5E-08	1.1E-07	4.9E-07	1.2E-07	5.4E-07	Y	C
206-44-0	Fluoranthene	7.6E-06	4.0E-06	6.0E-07	7.1E-07	4.7E-06	5.7E-06	5.3E-06	6.4E-06	N	
86-73-7	Fluorene	2.9E-05	1.3E-05	2.3E-06	2.7E-06	1.5E-05	1.8E-05	1.7E-05	2.1E-05	N	
50-00-0	Formaldehyde	1.2E-03	7.9E-05	2.5E-05	1.1E-04	2.5E-05	1.1E-04	5.1E-05	2.2E-04	Y	C
193-39-5	Indeno(1,2,3-cd)pyrene	< 3.8E-07	< 4.1E-07	8.0E-09	3.5E-08	1.3E-07	5.8E-07	1.4E-07	6.2E-07	Y	C
91-20-3	Naphthalene	8.5E-05	1.3E-04	6.6E-06	8.0E-06	1.5E-04	1.8E-04	1.6E-04	1.9E-04	Y	A
85-01-8	Phenanthrene	2.9E-05	4.1E-05	2.3E-06	2.8E-06	4.8E-05	5.7E-05	5.0E-05	6.0E-05	N	
129-00-0	Pyrene	4.8E-06	3.7E-06	3.7E-07	4.5E-07	4.4E-06	5.2E-06	4.7E-06	5.7E-06	N	
108-88-3	Toluene	4.1E-04	2.8E-04	3.2E-05	3.8E-05	3.3E-04	4.0E-04	3.6E-04	4.3E-04	Y	A
1330-20-7	Xylene	2.9E-04	1.9E-04	2.2E-05	2.7E-05	2.3E-04	2.7E-04	2.5E-04	3.0E-04	Y	A
Total				1.4E-04	3.6E-04	1.1E-03	2.2E-03	1.2E-03	2.6E-03		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *AP-42, Tab. 3.3-2, 10/96, diesel engines (≤ 600 hp)*

(3) *AP-42, Tabs. 3.4-3 & 3.4-4, 10/96, large diesel engines (> 600 hp)*

ORE PROCESSING

Source Data

Source ID	Description	PM Emissions lb/day	PM Emissions ton/yr
OC1	Loader Transfer of Ore to Grizzly	3.500	0.639
OC2	Grizzly to Apron Feeder	3.500	0.639
OC3	Apron Feeder to Dribble Conveyor	3.500	0.639
OC4	Apron Feeder to Vibrating Grizzly	3.500	0.639
OC5	Dribble Conveyor to Vibrating Grizzly	3.500	0.639
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	3.500	0.639
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	30.000	5.475
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	3.500	0.639
OC9	Stockpile Transfers to Reclaim Conveyors	16.560	3.022
OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	16.560	3.022
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	16.560	3.022
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Cc	33.120	6.044
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	3.864	0.705
Total		141.164	25.762

HAP/TAP Emission Factors and Emissions

CAS No.	Pollutant	Concentration ppm[2]	Emissions[1] lb/hr	Emissions[1] ton/yr	TAP	A/C
7440-38-2	Arsenic	667	3.9E-03	1.7E-02	Y	C
7440-41-7	Beryllium	3.2	1.9E-05	8.2E-05	Y	C
7440-43-9	Cadmium	0.50	2.9E-06	1.3E-05	Y	C
7440-48-4	Cobalt	4	2.4E-05	1.0E-04	Y	A
7440-47-3	Chromium	9	5.3E-05	2.3E-04	Y	A
7439-97-6	Mercury [3]	0.96	5.6E-06	2.5E-05	N	
7439-96-5	Manganese	299	1.8E-03	7.7E-03	Y	A
7440-02-0	Nickel	2	1.2E-05	5.2E-05	Y	C
7439-92-1	Lead	8	4.7E-05	2.1E-04	N	
7440-36-0	Antimony	23	1.4E-04	5.9E-04	Y	A
7723-14-0	Phosphorus	650	3.8E-03	1.7E-02	Y	A
7782-49-2	Selenium [4]	0.40	2.4E-06	1.0E-05	Y	A
7440-22-4	Silver	0.50	2.9E-06	1.3E-05	Y	A
7429-90-5	Aluminum	71,000	4.2E-01	1.8E+00	Y	A
7440-39-3	Barium	800	4.7E-03	2.1E-02	Y	A
1317-65-3	Calcium Carbonate	14,000	8.2E-02	3.6E-01	Y	A
7440-50-8	Copper	5	2.9E-05	1.3E-04	Y	A
7439-89-6	Iron [4]	18,200	1.1E-01	4.7E-01	Y	A
7439-98-7	Molybdenum	1	5.9E-06	2.6E-05	Y	A
7440-28-0	Thallium	10	5.9E-05	2.6E-04	Y	A
7440-61-1	Uranium	10	5.9E-05	2.6E-04	Y	A
7440-62-2	Vanadium	28	1.6E-04	7.2E-04	Y	A
7440-33-7	Tungsten	10	5.9E-05	2.6E-04	Y	A
7440-66-6	Zinc	35	2.1E-04	9.0E-04	Y	A
Total			6.2E-01	2.7E+00		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *(Midas Gold 2017c) Median concentration of 55,000 SGP samples.*

[3] *(Midas Gold 2018e) Median ore concentration of 151,000 SGP samples; resource block model.*

[4] *(Midas Gold 2020) Median concentration of 56,000 SGP samples for Fe and 1,500 SGP samples for Se.*

1E+6 parts/ppm

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 7 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021

ORE CONCETRATION AND REFINING

Source Data

Source ID	Description	Subpart 7E Allowable Limit lb/yr[1]	Oper. hr/yr	% of Subpart 7E for Controlled Systems %		Controlled Hg Emissions lb/hr	ton/yr	lb/yr
AC	Autoclave	213.4	8,760	[2]		0.000023	0.00010	0.20
EW,MR,MF,CKD	Refinery Sources (C. Kiln, EW, Retort, Furn	16.8		20%	[3]	0.000384	0.00168	3.36
7439-97-6 Mercury	Total	230.2				0.000407	0.00178	3.56

[1] *Subpart 7E Limit - Ore Pretreatment Processes (CFR 2018b)*

$$\frac{84\ lb}{MMton} \times \frac{2{,}540{,}400\ ton}{yr} \times \frac{MMton}{1.0E+6\ ton} = 213.4\ \frac{lb}{yr}$$

[1] *Subpart 7E Limit - Carbon Processes with Mercury Retorts*

$$\frac{0.8\ lb}{ton} \times \frac{21\ ton}{yr} = 16.8\ \frac{lb}{yr}$$

[2] *Controlled SysCAD modeled emissions from Autoclave:* 0.0105 g/hr 2.3E-05 lb/hr 0.20 lb/yr (M3 2019)

[3] *Based on similar source (but with much higher ore Hg content) Hg reporting levels provided below:*

Goldstrike Refinery (2015 & 2016 Hg Reports) *(NDEP 2015a) (NDEP 2016)*

$$\frac{28.79\ lb}{yr} \times \frac{yr}{251.00\ ton} = \frac{0.11\ lb}{MMton} \times \frac{ton}{0.8\ lb} = 14.3\%$$

Twin Creeks Refinery (2015 & 2016 Hg Reports) *(NDEP 2015a) (NDEP 2016)*

$$\frac{31.27\ lb}{yr} \times \frac{yr}{142.77\ ton} = \frac{0.22\ lb}{MMton} \times \frac{ton}{0.8\ lb} = 27.4\%$$

HAP/TAP Emission Factors and Emissions

AC_pph AC_tpy Refin_pph Refin_tpy lb/hr ton/yr

CAS No.	Pollutant	Emission Factor[1]	Autoclave lb/hr	Autoclave ton/yr	Refinery lb/hr	Refinery ton/yr	Total Emissions lb/hr	Total Emissions ton/yr	TAP	A/C
7440-38-2	Arsenic	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	C
7440-41-7	Beryllium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	C
7440-43-9	Cadmium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	C
7440-48-4	Cobalt	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-47-3	Chromium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7439-97-6	Mercury	see above	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	N	
7439-96-5	Manganese	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-02-0	Nickel	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	C
7439-92-1	Lead	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	N	
7440-36-0	Antimony	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7723-14-0	Phosphorus	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7782-49-2	Selenium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-22-4	Silver	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7429-90-5	Aluminum	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-39-3	Barium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
1317-65-3	Calcium Carbonate	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-50-8	Copper	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7439-89-6	Iron	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7439-98-7	Molybdenum	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-28-0	Thallium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-61-1	Uranium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-62-2	Vanadium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-33-7	Tungsten	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-66-6	Zinc	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
Total			5.5E-04	2.4E-03	9.2E-03	4.0E-02	9.8E-03	4.3E-02		

[1] *Hg is the most difficult metal to control due to it existing in both particulate and gaseous form. Therefore, all other metals are conservatively estimated to be equal to or less than the Hg emissions.*

0.0525 0.0525 chk

7664-93-9	Sulfuric Acid	Autoclave	2.03	8.89			2.03	8.89
7783-06-4	Hydrogen Sulfic	Autoclave	0.90	3.94			0.90	3.94
592-01-8	Cyanide	Point Sources - S EW Cells			0.0012	0.0053	0.00	0.01
Total			2.93	12.84	0.01	0.05	2.94	12.88

PRI00000657

REC 1997

ORE CONCETRATION AND REFINING - CONTINUED

Source Data

Source ID	Description	Throughput ton/day	Throughput ton/yr	Operation hr/day	Operation hr/yr
AC	Autoclave	6,960	2,540,400	24	8,760

Autoclave HAP/TAP Emission Factors and Emissions lb/hr ton/yr

CAS No.	Pollutant	Emission Factor		Emissions[1] lb/hr	Emissions[1] ton/yr
7664-93-9	Sulfuric Acid	0.007	lb/ton[2]	2.03	8.89
7783-06-4	Hydrogen Sulfide	0.9	lb/hr[3]	0.90	3.94

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *H2SO4 is based on Acidic Autoclave test data (APT 2010)*

[3] *H2S is based on Acidic Autoclave test data (APT 2013)*

LEACHING OPERATION

Cyanide (HCN) Source Data, Emission Factors, and Emissions

Source	II	Description	Dia. ft[1]	pH[1]	Free CN- g/m3[1]	T C[1]	pKa	a0	H	kG[2] m/s	Fa*Fw	g/s	lb/hr	ton/yr
TSF		***Fugitive Sources***												
TSF		Tailings Maint. Pond	76	7.75	1	3.74	9.803	0.9912	0.0025	1.89E-05	0.641	1.27E-05	0.0001	0.0004
MILLTA		CN Detox Tank 1	40	8.5	25	25	9.250	0.8490	0.0055	0.000311	0.688	0.002891	0.0229	0.101
MILLTA		CN Detox Tank 2	40	8.5	25	25	9.250	0.8490	0.0055	0.000311	0.688	0.002891	0.0229	0.101
MILLTA		CIP Leach Tank 1	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	0.0114	0.050
MILLTA		CIP Leach Tank 2	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	0.0114	0.050
MILLTA		CIP Leach Tank 3	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	0.0114	0.050
MILLTA		CIP Leach Tank 4	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	0.0114	0.050
MILLTA		CIL Tank 1	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA		CIL Tank 2	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA		CIL Tank 3	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA		CIL Tank 4	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA		CIL Tank 5	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA		CIL Tank 6	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA		CIP Tank 1	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA		CIP Tank 2	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA		CIP Tank 3	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA		CIP Tank 4	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA		CIP Tank 5	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA		CIP Tank 6	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
			Acres[1]											
TSF		Tails, Aqueous Surface	110.222	7.75	1	3.74	9.803	0.9912	0.0025	1.89E-05	0.421	0.008845	0.0702	0.307
TSF		Tails, Wet Sediment	110.222							5.31E-08	0.421	0.009961	0.0791	0.346
TSF		Tails, Dry Sediment	110.222							2.33E-08	1	0.010375	0.0823	0.361
			330.666											
592-01-8		Cyanide Fugitive Sources - Subtotal											0.4527	1.983
75-15-0		Carbon Disulfide											0.01446	0.06332
		Point Sources												
EW		EW Cells	[3]										0.0006	0.003
EW		Preg/Barren Tanks	[3]										0.0006	0.003
592-01-8		Cyanide Point Sources - Subtotal											0.0012	0.0053
Total													0.454	1.988

[1] *(Midas Gold 2016)(M3 2017c)(M3 2017d)*

[2] *The emission factors and caculation methodology are from the EPA directed HCN study: (Card, T. 2009)(EPA 2009)(Schmidt 2010)*

[3] *(APT 2009)*

Carbon Disulfide Emissions from Xanthate Decomposition

CAS No.	Pollutant	Xanthate[1] ton/yr	Molar Decomp.[2]	CS_2 MW Ratio	Temperature Adj. Factor[3]	Emissions lb/hr	Emissions ton/yr
75-15-0	Carbon Disulfide	1,700	0.99%	0.376	1%	0.0145	0.063

	MW	
Xanthate (PAX)	202.37	$C_6H_{11}KOS_2$
Carbon disulfide	76.139	CS_2

[1] *(Midas Gold 2016) p. 12-11*

[2] *(Air Sciences 2020) molar decomposition of xanthate in solution to CS2 gas*

[3] *(Air Sciences 2020) based on the comparison of CS2 generation at 25C and 70C*

Conversions

8,760	hr/yr	453.5929	g/lb	Wind adjustment factor Fw	1
2,000	lb/ton	3.28084	ft/m		
4,046.86	m2/acre	3,600	s/hr		

LIME PRODUCTION

Source Data

Source ID	Description	Throughput ton/day	Throughput ton/yr	PM Emissions lb/day	PM Emissions ton/yr
LS1	Limestone transfer to Primary Crusher Hopper			3.39	0.48
LS2	Primary Crushing and Associated Transfers In and Out			6.10	0.86
LS3	Primary Screening and Associated Transfers In and Out			28.25	3.97
LS4	Secondary Crushing and Associated Transfers In and Out			6.10	0.86
LS5	Secondary Screening and Associated Transfers In and Out			28.25	3.97
LS6	Limestone transfer to Ball Mill Feed Bin			3.39	0.48
LS7	Limestone transfer to Ball Mill Feed Conveyor			3.39	0.48
LS8	Ball Mill Feed transfer to Ball Mill			3.39	0.48
LSBM	Limestone Ball Mill			45.65	6.42
LS9	Limestone transfer to Kiln Feed Bin			0.80	0.12
LS10	Limestone transfer to Lime Kiln Feed Conveyor			0.80	0.12
LS11	Fines Screening and Associated Transfers In and Out			6.68	1.03
Subtotal LS1-11				136.18	19.28
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln			0.80	0.12
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	169	52,377	21.97	3.40
Subtotal LS12,LK				22.77	3.53
Total				158.95	22.80

HAP/TAP Emission Factors and Emissions

LS_pph LS_tpy LS12_pph LS12_tpy LK_pph LK_tpy lb/hr ton/yr

CAS No.	Pollutant	Concentration ppm[2]	LS1-11,LSBM lb/hr	LS1-11,LSBM ton/yr	LS12 lb/hr	LS12 ton/yr	Lime Kiln lb/hr	Lime Kiln ton/yr	Emissions[1] lb/hr	Emissions[1] ton/yr	TAP	A/C
7440-38-2	Arsenic	23	1.01E-04	4.43E-04	6.51E-07	2.85E-06	1.79E-05	7.83E-05	1.20E-04	5.24E-04	Y	C
7440-41-7	Beryllium	0.8	3.52E-06	1.54E-05	2.27E-08	9.92E-08	6.22E-07	2.72E-06	4.17E-06	1.82E-05	Y	C
7440-43-9	Cadmium	0.25	1.10E-06	4.82E-06	7.08E-09	3.10E-08	1.94E-07	8.51E-07	1.30E-06	5.70E-06	Y	C
7440-48-4	Cobalt	4	2.27E-05	7.71E-05	1.34E-07	4.96E-07	3.66E-06	1.36E-05	2.65E-05	9.12E-05	Y	A
7440-47-3	Chromium	15	8.51E-05	2.89E-04	5.01E-07	1.86E-06	1.37E-05	5.11E-05	9.93E-05	3.42E-04	Y	A
7439-97-6	Mercury [3]	0.02	1.13E-07	3.86E-07	6.68E-10	2.48E-09	2.82E-04	1.05E-03	2.82E-04	1.05E-03	N	
7439-96-5	Manganese	236.5	1.34E-03	4.56E-03	7.89E-06	2.93E-05	2.16E-04	8.05E-04	1.57E-03	5.39E-03	Y	A
7440-02-0	Nickel	5	2.20E-05	9.64E-05	1.42E-07	6.20E-07	3.89E-06	1.70E-05	2.60E-05	1.14E-04	Y	C
7439-92-1	Lead	3	1.70E-05	5.78E-05	1.00E-07	3.72E-07	2.75E-06	1.02E-05	1.99E-05	6.84E-05	N	
7440-36-0	Antimony	2.5	1.42E-05	4.82E-05	8.34E-08	3.10E-07	2.29E-06	8.51E-06	1.66E-05	5.70E-05	Y	A
7723-14-0	Phosphorus	130	7.38E-04	2.51E-03	4.34E-06	1.61E-05	1.19E-04	4.43E-04	8.61E-04	2.96E-03	Y	A
7440-22-4	Silver	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	Y	A
7429-90-5	Aluminum	22600	1.28E-01	4.36E-01	7.54E-04	2.80E-03	2.07E-02	7.69E-02	1.50E-01	5.15E-01	Y	A
7440-39-3	Barium	145	8.23E-04	2.79E-03	4.84E-06	1.80E-05	1.33E-04	4.94E-04	9.60E-04	3.31E-03	Y	A
1317-65-3	Calcium Carbonate	274500	1.56E+00	5.29E+00	9.16E-03	3.40E-02	2.51E-01	9.35E-01	1.82E+00	6.26E+00	Y	A
7440-50-8	Copper	5	2.84E-05	9.64E-05	1.67E-07	6.20E-07	4.58E-06	1.70E-05	3.31E-05	1.14E-04	Y	A
7439-89-6	Iron	10350	5.87E-02	1.99E-01	3.45E-04	1.28E-03	9.47E-03	3.52E-02	6.85E-02	2.36E-01	Y	A
7439-98-7	Molybdenum	0.5	2.84E-06	9.64E-06	1.67E-08	6.20E-08	4.58E-07	1.70E-06	3.31E-06	1.14E-05	Y	A
7440-28-0	Thallium	5	2.84E-05	9.64E-05	1.67E-07	6.20E-07	4.58E-06	1.70E-05	3.31E-05	1.14E-04	Y	A
7440-61-1	Uranium	5	2.84E-05	9.64E-05	1.67E-07	6.20E-07	4.58E-06	1.70E-05	3.31E-05	1.14E-04	Y	A
7440-62-2	Vanadium	15.5	8.79E-05	2.99E-04	5.17E-07	1.92E-06	1.42E-05	5.28E-05	1.03E-04	3.53E-04	Y	A
7440-33-7	Tungsten	5	2.84E-05	9.64E-05	1.67E-07	6.20E-07	4.58E-06	1.70E-05	3.31E-05	1.14E-04	Y	A
7440-66-6	Zinc	18	1.02E-04	3.47E-04	6.01E-07	2.23E-06	1.65E-05	6.13E-05	1.19E-04	4.10E-04	Y	A
Subtotal			1.75E+00	5.94E+00	1.03E-02	3.82E-02	2.82E-01	1.05E+00	2.04E+00	7.03E+00	9.0667	9.0667
7647-01-0	Hydrogen Chloride	0.14 lb/ton product[4]					0.99	3.67	0.99	3.67		chk

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *(M3 2018) Median concentrations of SGP limestone material. Metals with medians below the detection limit (DL) are set to 1/2DL.*

(3) *Hg emissions from the Lime Kiln are conservatively estimated assuming 100% volatilization of all Hg in the limestone*

(4) *(EPA 1999b)*

1E+6 parts/ppm

LIME PRODUCTION - CONTINUED

Source Data

Source ID	Description	PM_ppd PM Emissions lb/day	PM_tpy PM Emissions ton/yr
LS1L	Mill Lime Silo #1 Loading	0.248	0.002
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	1.200	0.011
MillS2L	Mill Lime Silo #2 Loading	0.248	0.002
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	1.200	0.011
ACS1L	AC Lime Silo #1 Loading	0.990	0.009
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.304	0.042
ACS2L	AC Lime Silo #2 Loading	0.990	0.009
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.304	0.042
ACS3L	AC Lime Silo #3 Loading	0.990	0.009
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.304	0.042
ACS4L	AC Lime Silo #4 Loading	0.495	0.004
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	2.304	0.021
Subtotal - Mill & AC Lime Silos		15.576	0.203
LCR	Lime Mill Crushing and associated transfers In and Out	6.828	1.058
LSL	Pebble Lime Silo Loading via Bucket Elevator	0.149	0.023
LSU	Pebble Lime Silo discharge to Lime Slaker	0.015	0.002
Subtotal - Lime Mfg		6.991	1.083
Total		22.567	1.286

HAP/TAP Emission Factors and Emissions

CAS No.	Pollutant	Concentration ppm[2]	MillAC_pph Mill and AC lb/hr	MillAC_tpy Mill and AC ton/yr	LimeM_pph Lime Mfg lb/hr	LimeM_tpy Lime Mfg ton/yr	lb/hr Emissions[1] lb/hr	ton/yr Emissions[1] ton/yr	TAP	A/C
7440-38-2	Arsenic	23	1.06E-06	4.66E-06	5.69E-06	2.49E-05	6.75E-06	2.96E-05	Y	C
7440-41-7	Beryllium	0.8	3.70E-08	1.62E-07	1.98E-07	8.67E-07	2.35E-07	1.03E-06	Y	C
7440-43-9	Cadmium	0.25	1.16E-08	5.07E-08	6.18E-08	2.71E-07	7.34E-08	3.22E-07	Y	C
7440-48-4	Cobalt	4	2.60E-06	8.11E-07	1.17E-06	4.33E-06	3.76E-06	5.14E-06	Y	A
7440-47-3	Chromium	15	9.74E-06	3.04E-06	4.37E-06	1.63E-05	1.41E-05	1.93E-05	Y	A
7439-97-6	Mercury	0.02	1.30E-08	4.05E-09	5.83E-09	2.17E-08	1.88E-08	2.57E-08	N	
7439-96-5	Manganese	236.5	1.53E-04	4.79E-05	6.89E-05	2.56E-04	2.22E-04	3.04E-04	Y	A
7440-02-0	Nickel	5	2.31E-07	1.01E-06	1.24E-06	5.42E-06	1.47E-06	6.43E-06	Y	C
7439-92-1	Lead	3	1.95E-06	6.08E-07	8.74E-07	3.25E-06	2.82E-06	3.86E-06	N	
7440-36-0	Antimony	2.5	1.62E-06	5.07E-07	7.28E-07	2.71E-06	2.35E-06	3.22E-06	Y	A
7723-14-0	Phosphorus	130	8.44E-05	2.63E-05	3.79E-05	1.41E-04	1.22E-04	1.67E-04	Y	A
7440-22-4	Silver	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	Y	A
7429-90-5	Aluminum	22,600	1.47E-02	4.58E-03	6.58E-03	2.45E-02	2.13E-02	2.91E-02	Y	A
7440-39-3	Barium	145	9.41E-05	2.94E-05	4.22E-05	1.57E-04	1.36E-04	1.86E-04	Y	A
1305-78-8	Calcium Oxide	740,000 [3]	4.80E-01	1.50E-01	2.16E-01	8.02E-01	6.96E-01	9.52E-01	Y	A
7440-50-8	Copper	5	3.25E-06	1.01E-06	1.46E-06	5.42E-06	4.70E-06	6.43E-06	Y	A
7439-89-6	Iron	10350	6.72E-03	2.10E-03	3.01E-03	1.12E-02	9.73E-03	1.33E-02	Y	A
7439-98-7	Molybdenum	0.5	3.25E-07	1.01E-07	1.46E-07	5.42E-07	4.70E-07	6.43E-07	Y	A
7440-28-0	Thallium	5	3.25E-06	1.01E-06	1.46E-06	5.42E-06	4.70E-06	6.43E-06	Y	A
7440-61-1	Uranium	5	3.25E-06	1.01E-06	1.46E-06	5.42E-06	4.70E-06	6.43E-06	Y	A
7440-62-2	Vanadium	15.5	1.01E-05	3.14E-06	4.52E-06	1.68E-05	1.46E-05	1.99E-05	Y	A
7440-33-7	Tungsten	5	3.25E-06	1.01E-06	1.46E-06	5.42E-06	4.70E-06	6.43E-06	Y	A
7440-66-6	Zinc	18	1.17E-05	3.65E-06	5.24E-06	1.95E-05	1.69E-05	2.31E-05	Y	A
Total			5.02E-01	1.57E-01	2.25E-01	8.38E-01	7.27E-01	9.95E-01		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *See LIME PRODUCTION, page 10*

(3) *(NLA 2007) 40% to 74% CaO in lime*

1E+6 parts/ppm

AGGREGATE PRODUCTION

Source Data

Source ID	Description (PM_ppd / PM_tpy)	PM Emissions lb/day	PM Emissions ton/yr
PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conve	15.00	2.74
PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conve	15.00	2.74
Total		30.00	5.48

HAP/TAP Emission Factors and Emissions

CAS No.	Pollutant	Concentration ppm[2]	Emissions[1] lb/hr	Emissions[1] ton/yr	TAP	A/C
7440-38-2	Arsenic	23	2.88E-05	1.26E-04	Y	C
7440-41-7	Beryllium	0.8	1.00E-06	4.38E-06	Y	C
7440-43-9	Cadmium	0.25	3.13E-07	1.37E-06	Y	C
7440-48-4	Cobalt	4	5.00E-06	2.19E-05	Y	A
7440-47-3	Chromium	15	1.88E-05	8.21E-05	Y	A
7439-97-6	Mercury	0.02	2.50E-08	1.10E-07	N	
7439-96-5	Manganese	236.5	2.96E-04	1.29E-03	Y	A
7440-02-0	Nickel	5	6.25E-06	2.74E-05	Y	C
7439-92-1	Lead	3	3.75E-06	1.64E-05	N	
7440-36-0	Antimony	2.5	3.13E-06	1.37E-05	Y	A
7723-14-0	Phosphorus	130	1.63E-04	7.12E-04	Y	A
7440-22-4	Silver	0	0.00E+00	0.00E+00	Y	A
7429-90-5	Aluminum	22600	2.83E-02	1.24E-01	Y	A
7440-39-3	Barium	145	1.81E-04	7.94E-04	Y	A
1317-65-3	Calcium Carbonate	274500	3.43E-01	1.50E+00	Y	A
7440-50-8	Copper	5	6.25E-06	2.74E-05	Y	A
7439-89-6	Iron	10350	1.29E-02	5.67E-02	Y	A
7439-98-7	Molybdenum	0.5	6.25E-07	2.74E-06	Y	A
7440-28-0	Thallium	5	6.25E-06	2.74E-05	Y	A
7440-61-1	Uranium	5	6.25E-06	2.74E-05	Y	A
7440-62-2	Vanadium	15.5	1.94E-05	8.49E-05	Y	A
7440-33-7	Tungsten	5	6.25E-06	2.74E-05	Y	A
7440-66-6	Zinc	18	2.25E-05	9.86E-05	Y	A
Total			3.85E-01	1.69E+00		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *See LIME PRODUCTION, page 10*

1E+6 parts/ppm

CONCRETE PRODUCTION

Source Data

Source ID	Description	Throughput ton/day	Throughput ton/yr
	description	TP_unit/day	TP_unit/yr
CS1L	Cement/Shotcrete Silo #1 Loading	164	60,000
CS1U	Cement/Shotcrete Silo #1 Unloading	164	60,000
CS2L	Cement/Shotcrete Silo #2 Loading	164	60,000
CS2U	Cement/Shotcrete Silo #2 Unloading	164	60,000
CM	Central Mixer Loading	164	60,000
	Subtotal Cement Silo Filling	658	240,000
	Subtotal Central Mix Batching	164	60,000

HAP/TAP Emission Factors and Emissions

CAS No.	HAP/TAP	Silo Fill lb/ton[2]	Central Mixer lb/ton[3]	Cement Silo L/U lb/hr	Cement Silo L/U ton/yr	Central Mix Batching lb/hr	Central Mix Batching ton/yr	Total Emissions[3] lb/hr	Total Emissions[3] ton/yr	TAP	A/C
		CF_pph		CF_tpy		CM_pph	CM_tpy	lb/hr	ton/yr		
7440-38-2	Arsenic	4.24E-09	2.96E-07	1.16E-7	5.09E-7	2.03E-6	8.88E-6	2.14E-6	9.39E-6	Y	C
7440-41-7	Beryllium	4.86E-10		1.33E-8	5.83E-8	--	--	1.33E-8	5.83E-8	Y	C
7440-43-9	Cadmium		7.10E-10	--	--	4.86E-9	2.13E-8	4.86E-9	2.13E-8	Y	C
7440-47-3	Chromium	2.90E-08	1.27E-07	7.95E-7	3.48E-6	8.70E-7	3.81E-6	1.66E-6	7.29E-6	Y	A
18540-29-9	Cr (VI)	5.80E-09	2.70E-08	1.59E-7	6.96E-7	1.85E-7	8.11E-7	3.44E-7	1.51E-6	Y	C
7439-92-1	Lead	1.09E-08	3.66E-08	2.99E-7	1.31E-6	2.51E-7	1.10E-6	5.49E-7	2.41E-6	N	
7439-96-5	Manganese	1.17E-07	3.78E-06	3.21E-6	1.40E-5	2.59E-5	1.13E-4	2.91E-5	1.27E-4	Y	A
7440-02-0	Nickel	4.18E-08	2.48E-07	1.15E-6	5.02E-6	1.70E-6	7.44E-6	2.84E-6	1.25E-5	Y	C
7723-14-0	Phosphorus		1.20E-06	--	--	8.22E-6	3.60E-5	8.22E-6	3.60E-5	Y	A
Total				5.73E-6	2.51E-5	3.91E-5	1.71E-4	4.49E-5	1.97E-4		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *AP-42, Table 11.12-8, (06/06) Cement Silo Filing, Controlled.* 20% *Cr (VI), IDEQ email on 11/23/2020* 0.0002 0.0002

(3) *AP-42, Table 11.12-8, (06/06) Central Mix Batching, Controlled.* 21.29% *Cr (VI), IDEQ email on 11/23/2020* chk

Conversions

24 hr/day

PRI00000663

REC 2003

CONCRETE PRODUCTION - CONTINUED

Source Data

Source ID	description Description	PM_ppd PM Emissions lb/day	PM_tpy ton/yr
CAL	Aggregate Bin Loading	16.56	1.73
CAU	Aggregate Bin Unloading	16.56	1.73
Total		33.12	3.45

HAP/TAP Emission Factors and Emissions

CAS No.	Pollutant	Concentration ppm[2]	lb/hr Emissions[1] lb/hr	ton/yr ton/yr	TAP	A/C
7440-38-2	Arsenic	23	1.81E-05	7.94E-05	Y	C
7440-41-7	Beryllium	0.8	6.30E-07	2.76E-06	Y	C
7440-43-9	Cadmium	0.25	1.97E-07	8.63E-07	Y	C
7440-48-4	Cobalt	4	5.52E-06	1.38E-05	Y	A
7440-47-3	Chromium	15	2.07E-05	5.18E-05	Y	A
7439-97-6	Mercury	0.02	2.76E-08	6.90E-08	N	
7439-96-5	Manganese	236.5	3.26E-04	8.16E-04	Y	A
7440-02-0	Nickel	5	3.94E-06	1.73E-05	Y	C
7439-92-1	Lead	3	4.14E-06	1.04E-05	N	
7440-36-0	Antimony	2.5	3.45E-06	8.63E-06	Y	A
7723-14-0	Phosphorus	130	1.79E-04	4.49E-04	Y	A
7440-22-4	Silver	0	0.00E+00	0.00E+00	Y	A
7429-90-5	Aluminum	22600	3.12E-02	7.80E-02	Y	A
7440-39-3	Barium	145	2.00E-04	5.00E-04	Y	A
7440-50-8	Copper	5	6.90E-06	1.73E-05	Y	A
7439-89-6	Iron	10350	1.43E-02	3.57E-02	Y	A
7439-98-7	Molybdenum	0.5	6.90E-07	1.73E-06	Y	A
7440-28-0	Thallium	5	6.90E-06	1.73E-05	Y	A
7440-61-1	Uranium	5	6.90E-06	1.73E-05	Y	A
7440-62-2	Vanadium	15.5	2.14E-05	5.35E-05	Y	A
7440-33-7	Tungsten	5	6.90E-06	1.73E-05	Y	A
7440-66-6	Zinc	18	2.48E-05	6.21E-05	Y	A
Total			4.63E-02	1.16E-01		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *See LIME PRODUCTION, page 10*

1E+6 parts/ppm

FUEL STORAGE - GASOLINE

Source Data

Source ID	description Description	VOC_ppd VOC Emissions lb/day	VOC_tpy VOC Emissions ton/yr
TG1	Mine Site Gasoline Tank #1	5.25	0.96
TG2	Mine Site Gasoline Tank #2	5.25	0.96
Total		10.49	1.91

HAP/TAP Emission Factors and Emissions

CAS No.	Pollutant	Concentration wt. %[2]	lb/hr Emissions[1] lb/hr	ton/yr Emissions[1] ton/yr	TAP	A/C
71-43-2	Benzene	1.608%	7.03E-03	3.08E-02	Y	C
92-52-4	Biphenyl	0.010%	4.37E-05	1.91E-04	Y	A
110-82-7	Cyclohexane	0.240%	1.05E-03	4.60E-03	Y	A
110-54-3	Hexane	7.138%	3.12E-02	1.37E-01	Y	A
91-20-3	Naphthalene	0.444%	1.94E-03	8.50E-03	Y	A
108-95-2	Phenol	0.055%	2.40E-04	1.05E-03	Y	A
108-88-3	Toluene	7.212%	3.15E-02	1.38E-01	Y	A
25551-13-7	Trimethyl benzene	2.500%	1.09E-02	4.79E-02	Y	A
1330-20-7	Xylene	7.170%	3.13E-02	1.37E-01	Y	A
Total			1.15E-01	5.05E-01		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *(EPA 1999a)*

MINING FUGITIVE EMISSIONS

Dust Emissions

Source Data **Model Scenario** **W3** **T-RACT Emissions**

Operating schedule 365 day/yr

Clean rock cap (CR) >50% [1]

[1] *(Perpetua 2021h) Percent of VMTs on haul roads capped with CR Roads outside of the pits and DRSFs are capped with CR*

Source ID	Description	PM Emissions lb/day	PM Emissions ton/yr
YPP	Yellow Pine Pit	--	--
HFP	Hangar Flats Pit	--	--
WEP	West End Pit	338.16	61.71
BT	Bradley Tailings	--	--
YPPBL	Yellow Pine Pit Blasting	--	--
HFPBL	Hangar Flats Pit Blasting	--	--
WEPBL	West End Pit Blasting	643.03	117.35
BTBL	Bradley Tailings Blasting	--	--
STKP	PC Stockpile	--	--
FDRSF	Fiddle DRSF	--	--
HFDRSF	Hangar Flats DRSF	152.12	27.76
YPDRSF	Yellow Pine DRSF	--	--
WEDRSF	West End DRSF	--	--
HR000	Haul Roads	12,723.41	2,322.02
TSF	Tailing Storage Facility	--	--
ACCRD	Access Roads	38.10	6.95
UGEXP	Scout Portal	0.008	0.002
Total		13,894.82	2,535.81
TSF, ACCRD, UGEXP		38.11	6.95

chk 2535.81

HAP/TAP Emission Factors

CAS No.	Pollutant	ORE Concentration ppm[1]	DR Concentration ppm[1]	CR Concentration ppm[3]	HRD Concentration ppm[4]	Borrow Concentration ppm[5]	AR Concentration ppm
7440-38-2	Arsenic	667	667	90	378.5	2.5	2.5
7440-41-7	Beryllium	3.2	3.2		3.2		3.2
7440-43-9	Cadmium	0.5	0.5		0.5		0.5
7440-48-4	Cobalt	4	4		4		4
7440-47-3	Chromium	9	9		9		9
7439-97-6	Mercury [2]	0.96	0.6		0.6		0.6
7439-96-5	Manganese	299	299		299		299
7440-02-0	Nickel	2	2		2		2
7439-92-1	Lead	8	8		8		8
7440-36-0	Antimony	23	23		23		23
7723-14-0	Phosphorus	650	650		650		650
7782-49-2	Selenium	0.4	0.4		0.4		0.4
7440-22-4	Silver	0.5	0.5		0.5		0.5
7429-90-5	Aluminum	71000	71000		71000		71000
7440-39-3	Barium	800	800		800		800
1317-65-3	Calcium Carbonate	14000	14000		14000		14000
7440-50-8	Copper	5	5		5		5
7439-89-6	Iron	18200	18200		18200		18200
7439-98-7	Molybdenum	1	1		1		1
7440-28-0	Thallium	10	10		10		10
7440-61-1	Uranium	10	10		10		10
7440-62-2	Vanadium	28	28		28		28
7440-33-7	Tungsten	10	10		10		10
7440-66-6	Zinc	35	35		35		35

[1] *(Midas Gold 2017c)* *Median concentration of 55,000 SGP samples.* *1E+6 parts/ppm*

[2] *(Midas Gold 2018e)* *Median ore and development rock (DR) concentrations of 151,000 samples; resource block model.*

[3] *(Perpetua 2021g)* *Median concentration of 265 SGP samples.*

[4] *HRD: haul road - emissions calculated based on 50% of the total VMT occuring on CR*

[5] *(ALS 2018)* *Median concentration of 8 SGP samples.*

DR DR DR DR DR DR DR DR ORE DR DR DR DR HRD DR/AR

MINING FUGITIVE EMISSIONS - CONTINUED **Model Scenario W3** DR **T-RACT Emissions**

HAP/TAP Emissions

Hourly [1]

		YPP_pph	HFP_pph	WEP_pph	BT_pph	YPPBL_pph	HFPBL_pph	WEPBL_pph	BTBL_pph	STKP_pph	FDRSF_pph	HFDRSF_pph	YPDRSF_pph	WEDRSF_pph	HR000_pph	CCRD, UGE	lb/hr
		YPP	HFP	WEP	BT	YPPBL	HFPBL	WEPBL	BTBL	STKP	FDRSF	HFDRSF	YPDRSF	WEDRSF	HR000	TSF, ACCRD, UGEXP	Total
CAS No.	Pollutant	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr
7440-38-2	Arsenic	0	0	9.4E-3	0	0	0	0.018	0	0	0	4.2E-3	0	0	0.201	4.2E-6	0.232
7440-41-7	Beryllium	0	0	4.5E-5	0	0	0	8.6E-5	0	0	0	2.0E-5	0	0	1.7E-3	5.1E-6	1.9E-3
7440-43-9	Cadmium	0	0	7.0E-6	0	0	0	1.3E-5	0	0	0	3.2E-6	0	0	2.7E-4	7.9E-7	2.9E-4
7440-48-4	Cobalt	0	0	5.6E-5	0	0	0	1.1E-4	0	0	0	2.5E-5	0	0	2.1E-3	6.4E-6	2.3E-3
7440-47-3	Chromium	0	0	1.3E-4	0	0	0	2.4E-4	0	0	0	5.7E-5	0	0	4.8E-3	1.4E-5	5.2E-3
7439-97-6	Mercury	0	0	8.5E-6	0	0	0	1.6E-5	0	0	0	3.8E-6	0	0	3.2E-4	9.5E-7	3.5E-4
7439-96-5	Manganese	0	0	4.2E-3	0	0	0	8.0E-3	0	0	0	1.9E-3	0	0	0.159	4.7E-4	0.173
7440-02-0	Nickel	0	0	2.8E-5	0	0	0	5.4E-5	0	0	0	1.3E-5	0	0	1.1E-3	3.2E-6	1.2E-3
7439-92-1	Lead	0	0	1.1E-4	0	0	0	2.1E-4	0	0	0	5.1E-5	0	0	4.2E-3	1.3E-5	4.6E-3
7440-36-0	Antimony	0	0	3.2E-4	0	0	0	6.2E-4	0	0	0	1.5E-4	0	0	0.012	3.7E-5	0.013
7723-14-0	Phosphorus	0	0	9.2E-3	0	0	0	0.017	0	0	0	4.1E-3	0	0	0.345	1.0E-3	0.376
7782-49-2	Selenium	0	0	5.6E-6	0	0	0	1.1E-5	0	0	0	2.5E-6	0	0	2.1E-4	6.4E-7	2.3E-4
7440-22-4	Silver	0	0	7.0E-6	0	0	0	1.3E-5	0	0	0	3.2E-6	0	0	2.7E-4	7.9E-7	2.9E-4
7429-90-5	Aluminum	0	0	1.000	0	0	0	1.902	0	0	0	0.450	0	0	37.640	0.113	41.106
7440-39-3	Barium	0	0	0.011	0	0	0	0.021	0	0	0	5.1E-3	0	0	0.424	1.3E-3	0.463
1317-65-3	Calcium Ca	0	0	0.197	0	0	0	0.375	0	0	0	0.089	0	0	7.422	0.022	8.105
7440-50-8	Copper	0	0	7.0E-5	0	0	0	1.3E-4	0	0	0	3.2E-5	0	0	2.7E-3	7.9E-6	2.9E-3
7439-89-6	Iron	0	0	0.256	0	0	0	0.488	0	0	0	0.115	0	0	9.649	0.029	10.537
7439-98-7	Molybdenu	0	0	1.4E-5	0	0	0	2.7E-5	0	0	0	6.3E-6	0	0	5.3E-4	1.6E-6	5.8E-4
7440-28-0	Thallium	0	0	1.4E-4	0	0	0	2.7E-4	0	0	0	6.3E-5	0	0	5.3E-3	1.6E-5	5.8E-3
7440-61-1	Uranium	0	0	1.4E-4	0	0	0	2.7E-4	0	0	0	6.3E-5	0	0	5.3E-3	1.6E-5	5.8E-3
7440-62-2	Vanadium	0	0	3.9E-4	0	0	0	7.5E-4	0	0	0	1.8E-4	0	0	0.015	4.4E-5	0.016
7440-33-7	Tungsten	0	0	1.4E-4	0	0	0	2.7E-4	0	0	0	6.3E-5	0	0	5.3E-3	1.6E-5	5.8E-3
7440-66-6	Zinc	0	0	4.9E-4	0	0	0	9.4E-4	0	0	0	2.2E-4	0	0	0.019	5.6E-5	0.020
Total		0	0	1.490	0	0	0	2.834	0	0	0	0.670	0	0	55.918	0.167	61.079

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.* chk 61.0794 61.0794

DR DR DR DR DR DR DR DR ORE DR DR DR DR HRD DR/AR

MINING FUGITIVE EMISSIONS - CONTINUED **Model Scenario W3** DR **T-RACT Emissions**

HAP/TAP Emissions

Annual

		YPP_tpy	HFP_tpy	WEP_tpy	BT_tpy	YPPBL_tpy	HFPBL_tpy	WEPBL_tpy	BTBL_tpy	STKP_tpy	FDRSF_tpy	HFDRSF_tpy	YPDRSF_tpy	WEDRSF_tpy	HR000_tpy	CCRD, UGE	ton/yr
		YPP	HFP	WEP	BT	YPPBL	HFPBL	WEPBL	BTBL	STKP	FDRSF	HFDRSF	YPDRSF	WEDRSF	HR000	TSF, ACCRD, UGEXP	Total
CAS No.	Pollutant	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr
7440-38-2	Arsenic	0	0	0.041	0	0	0	0.078	0	0	0	0.019	0	0	0.879	1.8E-5	1.017
7440-41-7	Beryllium	0	0	2.0E-4	0	0	0	3.8E-4	0	0	0	8.9E-5	0	0	7.4E-3	2.2E-5	8.1E-3
7440-43-9	Cadmium	0	0	3.1E-5	0	0	0	5.9E-5	0	0	0	1.4E-5	0	0	1.2E-3	3.5E-6	1.3E-3
7440-48-4	Cobalt	0	0	2.5E-4	0	0	0	4.7E-4	0	0	0	1.1E-4	0	0	9.3E-3	2.8E-5	0.010
7440-47-3	Chromium	0	0	5.6E-4	0	0	0	1.1E-3	0	0	0	2.5E-4	0	0	0.021	6.3E-5	0.023
7439-97-6	Mercury	0	0	3.7E-5	0	0	0	7.0E-5	0	0	0	1.7E-5	0	0	1.4E-3	4.2E-6	1.5E-3
7439-96-5	Manganese	0	0	0.018	0	0	0	0.035	0	0	0	8.3E-3	0	0	0.694	2.1E-3	0.758
7440-02-0	Nickel	0	0	1.2E-4	0	0	0	2.3E-4	0	0	0	5.6E-5	0	0	4.6E-3	1.4E-5	5.1E-3
7439-92-1	Lead	0	0	4.9E-4	0	0	0	9.4E-4	0	0	0	2.2E-4	0	0	0.019	5.6E-5	0.020
7440-36-0	Antimony	0	0	1.4E-3	0	0	0	2.7E-3	0	0	0	6.4E-4	0	0	0.053	1.6E-4	0.058
7723-14-0	Phosphorus	0	0	0.040	0	0	0	0.076	0	0	0	0.018	0	0	1.509	4.5E-3	1.648
7782-49-2	Selenium	0	0	2.5E-5	0	0	0	4.7E-5	0	0	0	1.1E-5	0	0	9.3E-4	2.8E-6	1.0E-3
7440-22-4	Silver	0	0	3.1E-5	0	0	0	5.9E-5	0	0	0	1.4E-5	0	0	1.2E-3	3.5E-6	1.3E-3
7429-90-5	Aluminum	0	0	4.382	0	0	0	8.332	0	0	0	1.971	0	0	165	0.494	180
7440-39-3	Barium	0	0	0.049	0	0	0	0.094	0	0	0	0.022	0	0	1.858	5.6E-3	2.029
1317-65-3	Calcium Ca	0	0	0.864	0	0	0	1.643	0	0	0	0.389	0	0	32.508	0.097	35.501
7440-50-8	Copper	0	0	3.1E-4	0	0	0	5.9E-4	0	0	0	1.4E-4	0	0	0.012	3.5E-5	0.013
7439-89-6	Iron	0	0	1.123	0	0	0	2.136	0	0	0	0.505	0	0	42.261	0.127	46.152
7439-98-7	Molybdenu	0	0	6.2E-5	0	0	0	1.2E-4	0	0	0	2.8E-5	0	0	2.3E-3	7.0E-6	2.5E-3
7440-28-0	Thallium	0	0	6.2E-4	0	0	0	1.2E-3	0	0	0	2.8E-4	0	0	0.023	7.0E-5	0.025
7440-61-1	Uranium	0	0	6.2E-4	0	0	0	1.2E-3	0	0	0	2.8E-4	0	0	0.023	7.0E-5	0.025
7440-62-2	Vanadium	0	0	1.7E-3	0	0	0	3.3E-3	0	0	0	7.8E-4	0	0	0.065	1.9E-4	0.071
7440-33-7	Tungsten	0	0	6.2E-4	0	0	0	1.2E-3	0	0	0	2.8E-4	0	0	0.023	7.0E-5	0.025
7440-66-6	Zinc	0	0	2.2E-3	0	0	0	4.1E-3	0	0	0	9.7E-4	0	0	0.081	2.4E-4	0.089
Total		0	0	6.527	0	0	0	12.412	0	0	0	2.936	0	0	245	0.731	268
															chk	267.5280	267.5280

MINING FUGITIVE EMISSIONS - CONTINUED

Mercury Evaporative Flux Emissions

Fugitive Mercury Flux and Emissions

			Area		Hg Flux	Emissions[1] lb/hr	Emissions[1] ton/yr	Emissions[1] lb/yr
CAS No.	Pollutant	Source	m^2	ha	$\mu g/m^2$-yr	lb/hr	ton/yr	lb/yr
		Stockpiles	52,623	5.3	556	7.37E-6	3.2E-5	6.5E-2
		Rock Dumps	2,063,990	206.4	76.2	3.96E-5	1.7E-4	0.35
		Tailings	1,338,158	133.8	2,144	7.22E-4	3.2E-3	6.32
		Pits	1,504,919	150.5	132.3	5.01E-5	2.2E-4	0.44
7439-97-6	Mercury					8.2E-4	3.6E-3	7.17

(1) *Hourly emissions based on:* 8,760 *hours per year of operation*

Fugitive Mercury Emission Factors

	Twin Creeks (TC)		Ore Hg Adjusted	Stibnite	
	Hg Flux (1)	Hg (2)	$\mu g/m^2/yr$	Hg Flux (3)	Hg (4)
Source	$\mu g/m^2$-yr	$\mu g/g$	TC	$\mu g/m^2$-yr	$\mu g/g$
Stockpiles	5,609	33	556	556	0.96
Rock Dumps	768	3.5	76.2	76.2	0.60
Tailings	21,621	33	2,144	2,144	0.96
Pits	1,334	9.5	132	132.3	0.60

(1) *(Eckley 2010)* *Table 1: Hg flux □g/m² -yr*

(2) *(Eckley 2010)* *Table 1: Average Hg flux mg/g: " Stockpiles - high-grade stockpiles, Rock Dumps - waste rock dumps, Tailings - high-grade stockpiles as a surrogate; Pits - pit"*

(3) *(Eckley 2010)* *Figure 2: log(y) = m*log(x) + b*

y = Hg Flux (ng/m² -d)

x = material Hg concentration (µg/g)]

Slope =	*Solar*	*TC*
	Low	*0.59*
	Medium	*0.6*
	High	*0.77*
	Average	*0.65*

(4) *(Midas Gold 2018e)*

Sample Calculation: m = log (y1/y2) / log(x1/x2)

m=	0.65	unitless
y1=	5,609	$\mu g/m^2$-yr
x1=	33	$\mu g/m^2$-yr
x2=	0.96	$\mu g/m^2$-yr
log(x1/x2)=	1.536243	unitless
log(y1/y2)=	1.003679	unitless
y1/y2=	10.08506	unitless
y2=	556.2	$\mu g/m^2$-yr

Conversions

2,000	lb/ton
10,000	m2/ha
453.593	g/lb

TABLE A-W3. HAP/TAP Emissions and Exemptions

T-RACT Emissions						MINING										LEACHING	
chk						*Mining*		*Model Scenario W3*								*CN Leach/PAX*	
						YPP,HFP,WEP,BT		YPPBL,HFPBL,WEPBL,BTBL		HR000		STKP, FDRSF, HFDRSF, YPDRSF, WEDRSF		TSF,ACCRD,UGEXP			
CAS	HAP/TAP	HAP	TAP			Pits		Blasting		Haul Roads		Stockpiles and DRFS		Tails, Access Road, Exploration		CN Leach and PAX	
	NSPS or NESHAP HAP/TAP -->			*Y*													
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				A/C	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
7440-38-2	Arsenic	Y	Y	Y	C	9.4E-3	0.041	0.018	0.078	0.201	0.879	4.2E-3	0.019	4.2E-6	1.8E-5		
7440-41-7	Beryllium	Y	Y	Y	C	4.5E-5	2.0E-4	8.6E-5	3.8E-4	1.7E-3	7.4E-3	2.0E-5	8.9E-5	5.1E-6	2.2E-5		
7440-43-9	Cadmium	Y	Y	Y	C	7.0E-6	3.1E-5	1.3E-5	5.9E-5	2.7E-4	1.2E-3	3.2E-6	1.4E-5	7.9E-7	3.5E-6		
50-00-0	Formaldehyde	Y	Y	Y	C												
7440-02-0	Nickel	Y	Y	Y	C	2.8E-5	1.2E-4	5.4E-5	2.3E-4	1.1E-3	4.6E-3	1.3E-5	5.6E-5	3.2E-6	1.4E-5		

PRI00000670

TABLE A-W3. HAP/TAP Emissions and Exemptions

T-RACT Emissions						0	0	0	0	1	1	1	1	0	0	1	1
chk						**PROCESSING AND PRODUCTION**											
						Ore Processing				***Ore Concentration and Refining***				***Process Heating***			
						OC1-13		PS		AC		EW,MR,MF,CKD		ACB, CKB, PV, HS		LKC	
CAS	HAP/TAP	HAP	TAP			Crushers & Xfers		Prill Silos		Autoclave		EW, Preg Tank, Retort, Furnace, Carbon Kiln		POX Boiler, C. Kiln Comb., Prop. Vap., Sol'n Heater		Lime Kiln Combustion	
	NSPS or NESHAP HAP/TAP -->			***Y***		***LL***	***LL***			***7E***	***7E***	***7E***	***7E***			***5A***	***5A***
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				A/C	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
7440-38-2	Arsenic	Y	Y	Y	C	3.9E-3	0.017			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.5E-6	6.4E-6	3.7E-6	1.6E-5
7440-41-7	Beryllium	Y	Y	Y	C	1.9E-5	8.2E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	8.7E-8	3.8E-7	2.2E-7	9.6E-7
7440-43-9	Cadmium	Y	Y	Y	C	2.9E-6	1.3E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	8.0E-6	3.5E-5	2.0E-5	8.8E-5
50-00-0	Formaldehyde	Y	Y	Y	C									5.5E-4	2.4E-3	1.4E-3	6.0E-3
7440-02-0	Nickel	Y	Y	Y	C	1.2E-5	5.2E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.5E-5	6.7E-5	3.9E-5	1.7E-4

TABLE A-W3. HAP/TAP Emissions and Exemptions

T-RACT Emissions						PROCESSING AND PRODUCTION - Continued													
chk						*Lime Production*						*Aggregate Prod.*		*Concrete Production*					
CAS	HAP/TAP	HAP	TAP			LS1-11,LSBM		LK,LS12,LCR,LS-L/U		LS1-L/U,MillS2-L/U,ACS1-4		PCSP1,PCSP2		CM		CS1L,CS1U,CS2L, CS2U		CA-L/U	
						Limestone Crushers, Screens, Mill, Xfers		Lime Kiln, Kiln Feed, Lime Mill, Pebble Lime Silo		Lime Silos and Lime Mill Crushing		Portable Crushers, Screens, Xfers		Central Mixer		Cement Silo #1 and #2 L/U		Aggregate Bin	
	NSPS or NESHAP HAP/TAP --> Y					*OOO*	*OOO*	*5A*	*5A*			*OOO*	*OOO*					*OOO*	*OOO*
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				A/C	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
7440-38-2	Arsenic	Y	Y	Y	C	1.0E-4	4.4E-4	2.4E-5	1.1E-4	1.1E-6	4.7E-6	2.9E-5	1.3E-4	2.0E-6	8.9E-6	1.2E-7	5.1E-7	1.8E-5	7.9E-5
7440-41-7	Beryllium	Y	Y	Y	C	3.5E-6	1.5E-5	8.4E-7	3.7E-6	3.7E-8	1.6E-7	1.0E-6	4.4E-6			1.3E-8	5.8E-8	6.3E-7	2.8E-6
7440-43-9	Cadmium	Y	Y	Y	C	1.1E-6	4.8E-6	2.6E-7	1.2E-6	1.2E-8	5.1E-8	3.1E-7	1.4E-6	4.9E-9	2.1E-8			2.0E-7	8.6E-7
50-00-0	Formaldehyde	Y	Y	Y	C														
7440-02-0	Nickel	Y	Y	Y	C	2.2E-5	9.6E-5	5.3E-6	2.3E-5	2.3E-7	1.0E-6	6.3E-6	2.7E-5	1.7E-6	7.4E-6	1.1E-6	5.0E-6	3.9E-6	1.7E-5

TABLE A-W3. HAP/TAP Emissions and Exemptions

T-RACT Emissions						PROCESSING AND PRODUCTION - Continued						MINING and LEACHING - Totals							
chk						*HVAC*		*Emer. Power/Fire*		*Fuel Storage*		*HAP Total*		*Mercury Total*		*Mercury Total*		*TAP Total*	*TAP Total*
CAS	HAP/TAP	HAP	TAP			H1M,H2M,HM,HAC,HR,HA,HMO,HTS,HW		EDG1,EDG2,EDG3,EDFP		TG1,TG2				*Exempt*		*Non-Exempt*		*HAP-TAP addressed by NSPS/NESHAP*	*For EL Evaluation*
						Heaters		Emergency Generators and Fire Pump		Gasoline Fuel Tanks									
	NSPS or NESHAP HAP/TAP -->			*Y*				*4Z*	*4Z*	*6C*	*6C*								
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				*A/C*	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
7440-38-2	Arsenic	Y	Y	Y	C	3.6E-6	1.6E-5					0.232	1.017							0.232	1.017
7440-41-7	Beryllium	Y	Y	Y	C	2.1E-7	9.4E-7					1.9E-3	8.1E-3							1.9E-3	8.1E-3
7440-43-9	Cadmium	Y	Y	Y	C	2.0E-5	8.6E-5					2.9E-4	1.3E-3							2.9E-4	1.3E-3
50-00-0	Formaldehyde	Y	Y	Y	C	1.3E-3	5.9E-3	5.1E-5	2.2E-4												
7440-02-0	Nickel	Y	Y	Y	C	3.8E-5	1.6E-4					1.2E-3	5.1E-3					0	0	1.2E-3	5.1E-3

PRI00000673

TABLE A-W3. HAP/TAP Emissions and Exemptions 1 1 0 0

T-RACT Emissions						PROCESSING AND PRODUCTION - Totals										ALL	ALL	ALL	TAP EL	
chk						*HAP Total*		*Mercury Total*		*Mercury Total*		*TAP Total*		*TAP Total*		*HAP*	*Hg*	*TAP*	*TAP*	
								Exempt		*Non-Exempt*		*HAP-TAP addressed by NSPS/NESHAP*		*For EL Evaluation*			*Non-Exempt*	*For EL Evaluation*	*Emission Screening Level (EL)*	
CAS	HAP/TAP	HAP	TAP																Non-car	Carcin
	NSPS or NESHAP HAP/TAP -->			*Y*																
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				*A/C*	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr	ton/yr	lb/hr	lb/hr	lb/hr
7440-38-2	Arsenic	Y	Y	Y	C	4.5E-3	0.020					4.5E-3	0.020	8.2E-6	3.6E-5	1.037		0.232	--	1.5E-6
7440-41-7	Beryllium	Y	Y	Y	C	4.3E-4	1.9E-3					4.3E-4	1.9E-3	3.5E-7	1.5E-6	0.010		1.9E-3	--	2.8E-5
7440-43-9	Cadmium	Y	Y	Y	C	4.6E-4	2.0E-3					4.3E-4	1.9E-3	2.8E-5	1.2E-4	3.3E-3		3.2E-4	--	3.7E-6
50-00-0	Formaldehyde	Y	Y	Y	C	3.3E-3	0.015					1.4E-3	6.2E-3	1.9E-3	8.3E-3	0.015		1.9E-3	--	5.1E-4
7440-02-0	Nickel	Y	Y	Y	C	5.5E-4	2.4E-3					4.9E-4	2.2E-3	5.6E-5	2.4E-4	7.5E-3		1.2E-3	--	2.7E-5

Appendix B – Modeled Emissions per Modeling Scenario and Source

Appendix B Table of Contents

Non-Carcinogenic TAP Modeling

Table B-Y1, 180,000 T/day Emissions B-2
Table B-Y2, 180,000 T/day Emissions B-8
Table B-Y3, 180,000 T/day Emissions B-14
Table B-H1, 180,000 T/day Emissions B-20
Table B-H2, 180,000 T/day Emissions B-26
Table B-H3, 180,000 T/day Emissions B-32
Table B-H4, 180,000 T/day Emissions B-38
Table B-W1, 180,000 T/day Emissions B-44
Table B-W2, 180,000 T/day Emissions B-50
Table B-W3, 180,000 T/day Emissions B-56
Table B-W4, 180,000 T/day Emissions B-62
Table B-W5, 180,000 T/day Emissions B-68
Table B-B1, 180,000 T/day Emissions B-74
Table B-B2, 180,000 T/day Emissions B-80

Carcinogenic TAP Modeling

Table B-Y1, T-RACT Emissions B-86
Table B-Y2, T-RACT Emissions B-89
Table B-Y3, T-RACT Emissions B-92
Table B-H1, T-RACT Emissions B-95
Table B-H2, T-RACT Emissions B-98
Table B-H3, T-RACT Emissions B-101
Table B-H4, T-RACT Emissions B-104
Table B-W1, T-RACT Emissions B-107
Table B-W2, T-RACT Emissions B-110
Table B-W3, T-RACT Emissions B-113
Table B-W4, T-RACT Emissions B-116
Table B-W5, T-RACT Emissions B-119
Table B-B1, T-RACT Emissions B-122
Table B-B2, T-RACT Emissions B-125

PRI00000676

REC 2016

TABLE B-Y1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to		LL	LL	0.010	1.2E-4	2.0E-3
	OC2	Grizzly to Apron Feeder		LL	LL	0.010	1.2E-4	2.0E-3
	OC3	Apron Feeder to Dribble Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC4	Apron Feeder to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC5	Dribble Conveyor to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor		LL	LL	0.089	1.0E-3	0.018
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile		LL	LL	0.010	1.2E-4	2.0E-3
	OC9	Stockpile Transfers to Reclaim Conveyors		LL	LL	0.049	5.5E-4	9.7E-3
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor		LL	LL	0.049	5.5E-4	9.7E-3
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	LL	LL	0.049	5.5E-4	9.7E-3
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	LL	LL	0.098	1.1E-3	0.019
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	LL	LL	0.011	1.3E-4	2.3E-3
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0.221	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	7E	7E	2.3E-5	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MR	Mercury Retort	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	2.6E-7	0	0	3.1E-6	0
	CKB	Carbon Regeneration Kiln (Burners)	0	8.4E-7	0	0	9.7E-6	0
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	3.7E-8	0	0	4.3E-7	0
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	1.9E-6	0	0	2.2E-5	0
	LKC	PFR Shaft Lime Kiln Combustion	0	5A	5A	0	9.5E-5	0
	LS1	Limestone transfer to Primary Crusher Hopper	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS2	Primary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS3	Primary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323
	LS4	Secondary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS5	Secondary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323

PRI00000677

TABLE B-Y1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS8	Ball Mill Feed transfer to Ball	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LSBM	Limestone Ball Mill	0	OOO	OOO	0.043	2.8E-4	0.522
	LS9	Limestone transfer to Kiln Feed Bin	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS11	Fines Screening and Associated Transfers In and Out	0	OOO	OOO	6.3E-3	4.0E-5	0.076
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	5A	5A	7.5E-4	4.8E-6	9.2E-3
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	5A	5A	0.021	1.3E-4	0.251
	LCR	Lime Mill Crushing and associated transfers In and Out	0	5A	5A	6.4E-3	4.1E-5	0
	LSL	Pebble Lime Silo Loading via Bucket Elevator	0	5A	5A	1.4E-4	9.0E-7	0
	LSU	Pebble Lime Silo discharge to Lime Slaker	0	5A	5A	1.4E-5	9.0E-8	0
	LS1L	Mill Lime Silo #1 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	MillS2L	Mill Lime Silo #2 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	ACS1L	AC Lime Silo #1 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS2L	AC Lime Silo #2 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS3L	AC Lime Silo #3 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS4L	AC Lime Silo #4 Loading	0	4.9E-6	2.7E-6	4.7E-4	3.0E-6	0
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
Concrete Production	CM	Central Mixer Loading	0	2.6E-5	8.2E-6	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	8.0E-7	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	8.0E-7	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	8.0E-7	0	0	0	0

PRI00000678

TABLE B-Y1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	8.0E-7	0	0	0	0
	CAL	Aggregate Bin Loading	0	OOO	OOO	0.016	1.0E-4	0
	CAU	Aggregate Bin Unloading	0	OOO	OOO	0.016	1.0E-4	0
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	1.9E-7	0	0	2.2E-6	0
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	7.5E-7	0	0	8.6E-6	0
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	1.1E-6	0	0	1.3E-5	0
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	4Z	4Z	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	6C	6C	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	6C	6C	0	0	0
Mining - Modeling Scenario: Y1	YPP	Yellow Pine Pit	0	0.024	0.051	5.585	0.063	1.101
	HFP	Hangar Flats Pit	0	0	0	0	0	0
	WEP	West End Pit	0	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	8.0E-3	0.017	1.902	0.021	0.375
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0	0
	STKP	PC Stockpile	0	4.5E-3	9.7E-3	1.063	0.012	0.210
	FDRSF	Fiddle DRSF	0	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0	0
	HR000	Haul Roads	0	0.065	0.141	15.394	0.173	3.035
	TSF	Tailing Storage Facility	0.232	0	0	0	0	0
	ACCRD	Access Roads	0	4.7E-4	1.0E-3	0.113	1.3E-3	0.022
	UGEXP	Scout Portal	0	1.0E-7	2.3E-7	2.5E-5	2.8E-7	4.9E-6
		Total	**0.453**	**0.102**	**0.220**	**24.705**	**0.278**	**6.987**

PRI00000679

TABLE B-Y1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	2.9E-3	0	1.6E-6	4.5E-6
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	0	0	0	0	5.0E-5
	LS1	Limestone transfer to Primary Crusher Hopper	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5

PRI00000680

TABLE B-Y1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	0	0	0	0

PRI00000681

TABLE B-Y1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	0	0	0	0
	CAL	Aggregate Bin Loading	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	0	0	0	6.8E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	0	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	0	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	0	0	0	0
Mining - Modeling Scenario: Y1	YPP	Yellow Pine Pit	0	1.432	0	7.9E-4	2.2E-3
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0.488	0	2.7E-4	7.5E-4
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0.272	0	1.5E-4	4.2E-4
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0	3.946	0	2.2E-3	6.1E-3
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**0.696**	**6.380**	**2.030**	**3.9E-3**	**0.010**

PRI00000682

TABLE B-Y2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to		LL	LL	0.010	1.2E-4	2.0E-3
	OC2	Grizzly to Apron Feeder		LL	LL	0.010	1.2E-4	2.0E-3
	OC3	Apron Feeder to Dribble Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC4	Apron Feeder to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC5	Dribble Conveyor to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor		LL	LL	0.089	1.0E-3	0.018
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile		LL	LL	0.010	1.2E-4	2.0E-3
	OC9	Stockpile Transfers to Reclaim Conveyors		LL	LL	0.049	5.5E-4	9.7E-3
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor		LL	LL	0.049	5.5E-4	9.7E-3
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	LL	LL	0.049	5.5E-4	9.7E-3
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	LL	LL	0.098	1.1E-3	0.019
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	LL	LL	0.011	1.3E-4	2.3E-3
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0.221	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	7E	7E	2.3E-5	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MR	Mercury Retort	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	2.6E-7	0	0	3.1E-6	0
	CKB	Carbon Regeneration Kiln (Burners)	0	8.4E-7	0	0	9.7E-6	0
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	3.7E-8	0	0	4.3E-7	0
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	1.9E-6	0	0	2.2E-5	0
	LKC	PFR Shaft Lime Kiln Combustion	0	5A	5A	0	9.5E-5	0
	LS1	Limestone transfer to Primary Crusher Hopper	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS2	Primary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS3	Primary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323
	LS4	Secondary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS5	Secondary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323

PRI00000683

TABLE B-Y2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS8	Ball Mill Feed transfer to Ball	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LSBM	Limestone Ball Mill	0	OOO	OOO	0.043	2.8E-4	0.522
	LS9	Limestone transfer to Kiln Feed Bin	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS11	Fines Screening and Associated Transfers In and Out	0	OOO	OOO	6.3E-3	4.0E-5	0.076
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	5A	5A	7.5E-4	4.8E-6	9.2E-3
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	5A	5A	0.021	1.3E-4	0.251
	LCR	Lime Mill Crushing and associated transfers In and Out	0	5A	5A	6.4E-3	4.1E-5	0
	LSL	Pebble Lime Silo Loading via Bucket Elevator	0	5A	5A	1.4E-4	9.0E-7	0
	LSU	Pebble Lime Silo discharge to Lime Slaker	0	5A	5A	1.4E-5	9.0E-8	0
	LS1L	Mill Lime Silo #1 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	MillS2L	Mill Lime Silo #2 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	ACS1L	AC Lime Silo #1 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS2L	AC Lime Silo #2 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS3L	AC Lime Silo #3 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS4L	AC Lime Silo #4 Loading	0	4.9E-6	2.7E-6	4.7E-4	3.0E-6	0
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
Concrete Production	CM	Central Mixer Loading	0	2.6E-5	8.2E-6	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	8.0E-7	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	8.0E-7	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	8.0E-7	0	0	0	0

PRI00000684

TABLE B-Y2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	8.0E-7	0	0	0	0
	CAL	Aggregate Bin Loading	0	OOO	OOO	0.016	1.0E-4	0
	CAU	Aggregate Bin Unloading	0	OOO	OOO	0.016	1.0E-4	0
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	1.9E-7	0	0	2.2E-6	0
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	7.5E-7	0	0	8.6E-6	0
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	1.1E-6	0	0	1.3E-5	0
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	4Z	4Z	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	6C	6C	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	6C	6C	0	0	0
Mining - Modeling Scenario: Y2	YPP	Yellow Pine Pit	0	0.024	0.051	5.585	0.063	1.101
	HFP	Hangar Flats Pit	0	0	0	0	0	0
	WEP	West End Pit	0	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	8.0E-3	0.017	1.902	0.021	0.375
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	3.6E-3	7.9E-3	0.858	9.7E-3	0.169
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0	0
	HR000	Haul Roads	0	0.096	0.208	22.711	0.256	4.478
	TSF	Tailing Storage Facility	0.232	0	0	0	0	0
	ACCRD	Access Roads	0	4.7E-4	1.0E-3	0.113	1.3E-3	0.022
	UGEXP	Scout Portal	0	1.0E-7	2.3E-7	2.5E-5	2.8E-7	4.9E-6
		Total	**0.453**	**0.131**	**0.285**	**31.817**	**0.358**	**8.390**

PRI00000685

TABLE B-Y2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	2.9E-3	0	1.6E-6	4.5E-6
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	0	0	0	0	5.0E-5
	LS1	Limestone transfer to Primary Crusher Hopper	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5

PRI00000686

TABLE B-Y2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	0	0	0	0

PRI00000687

REC 2027

TABLE B-Y2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	0	0	0	0
	CAL	Aggregate Bin Loading	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	0	0	0	6.8E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	0	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	0	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	0	0	0	0
Mining - Modeling Scenario: Y2	YPP	Yellow Pine Pit	0	1.432	0	7.9E-4	2.2E-3
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0.488	0	2.7E-4	7.5E-4
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0.220	0	1.2E-4	3.4E-4
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0	5.822	0	3.2E-3	9.0E-3
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**0.696**	**8.203**	**2.030**	**4.9E-3**	**0.013**

PRI00000688

REC 2028

TABLE B-Y3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to		LL	LL	0.010	1.2E-4	2.0E-3
	OC2	Grizzly to Apron Feeder		LL	LL	0.010	1.2E-4	2.0E-3
	OC3	Apron Feeder to Dribble Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC4	Apron Feeder to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC5	Dribble Conveyor to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor		LL	LL	0.089	1.0E-3	0.018
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile		LL	LL	0.010	1.2E-4	2.0E-3
	OC9	Stockpile Transfers to Reclaim Conveyors		LL	LL	0.049	5.5E-4	9.7E-3
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor		LL	LL	0.049	5.5E-4	9.7E-3
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	LL	LL	0.049	5.5E-4	9.7E-3
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	LL	LL	0.098	1.1E-3	0.019
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	LL	LL	0.011	1.3E-4	2.3E-3
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0.221	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	7E	7E	2.3E-5	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MR	Mercury Retort	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	2.6E-7	0	0	3.1E-6	0
	CKB	Carbon Regeneration Kiln (Burners)	0	8.4E-7	0	0	9.7E-6	0
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	3.7E-8	0	0	4.3E-7	0
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	1.9E-6	0	0	2.2E-5	0
	LKC	PFR Shaft Lime Kiln Combustion	0	5A	5A	0	9.5E-5	0
	LS1	Limestone transfer to Primary Crusher Hopper	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS2	Primary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS3	Primary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323
	LS4	Secondary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS5	Secondary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323

PRI00000689

REC 2029

TABLE B-Y3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS8	Ball Mill Feed transfer to Ball	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LSBM	Limestone Ball Mill	0	OOO	OOO	0.043	2.8E-4	0.522
	LS9	Limestone transfer to Kiln Feed Bin	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS11	Fines Screening and Associated Transfers In and Out	0	OOO	OOO	6.3E-3	4.0E-5	0.076
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	5A	5A	7.5E-4	4.8E-6	9.2E-3
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	5A	5A	0.021	1.3E-4	0.251
	LCR	Lime Mill Crushing and associated transfers In and Out	0	5A	5A	6.4E-3	4.1E-5	0
	LSL	Pebble Lime Silo Loading via Bucket Elevator	0	5A	5A	1.4E-4	9.0E-7	0
	LSU	Pebble Lime Silo discharge to Lime Slaker	0	5A	5A	1.4E-5	9.0E-8	0
	LS1L	Mill Lime Silo #1 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	MillS2L	Mill Lime Silo #2 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	ACS1L	AC Lime Silo #1 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS2L	AC Lime Silo #2 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS3L	AC Lime Silo #3 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS4L	AC Lime Silo #4 Loading	0	4.9E-6	2.7E-6	4.7E-4	3.0E-6	0
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
Concrete Production	CM	Central Mixer Loading	0	2.6E-5	8.2E-6	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	8.0E-7	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	8.0E-7	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	8.0E-7	0	0	0	0

PRI00000690

TABLE B-Y3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	8.0E-7	0	0	0	0
	CAL	Aggregate Bin Loading	0	OOO	OOO	0.016	1.0E-4	0
	CAU	Aggregate Bin Unloading	0	OOO	OOO	0.016	1.0E-4	0
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	1.9E-7	0	0	2.2E-6	0
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	7.5E-7	0	0	8.6E-6	0
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	1.1E-6	0	0	1.3E-5	0
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	4Z	4Z	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	6C	6C	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	6C	6C	0	0	0
Mining - Modeling Scenario: Y3	YPP	Yellow Pine Pit	0	0.024	0.051	5.585	0.063	1.101
	HFP	Hangar Flats Pit	0	0	0	0	0	0
	WEP	West End Pit	0	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	8.0E-3	0.017	1.902	0.021	0.375
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	3.6E-3	7.9E-3	0.858	9.7E-3	0.169
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0	0
	HR000	Haul Roads	0	0.155	0.337	36.835	0.415	7.263
	TSF	Tailing Storage Facility	0.232	0	0	0	0	0
	ACCRD	Access Roads	0	4.7E-4	1.0E-3	0.113	1.3E-3	0.022
	UGEXP	Scout Portal	0	1.0E-7	2.3E-7	2.5E-5	2.8E-7	4.9E-6
		Total	**0.453**	**0.191**	**0.415**	**45.941**	**0.517**	**11.175**

PRI00000691

REC 2031

TABLE B-Y3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	2.9E-3	0	1.6E-6	4.5E-6
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	0	0	0	0	5.0E-5
	LS1	Limestone transfer to Primary Crusher Hopper	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5

PRI00000692

TABLE B-Y3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	0	0	0	0

PRI00000693

REC 2033

TABLE B-Y3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	0	0	0	0
	CAL	Aggregate Bin Loading	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	0	0	0	6.8E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	0	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	0	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	0	0	0	0
Mining - Modeling Scenario: Y3	YPP	Yellow Pine Pit	0	1.432	0	7.9E-4	2.2E-3
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0.488	0	2.7E-4	7.5E-4
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0.220	0	1.2E-4	3.4E-4
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0	9.442	0	5.2E-3	0.015
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**0.696**	**11.823**	**2.030**	**6.9E-3**	**0.019**

PRI00000694

REC 2034

TABLE B-H1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to		LL	LL	0.010	1.2E-4	2.0E-3
	OC2	Grizzly to Apron Feeder		LL	LL	0.010	1.2E-4	2.0E-3
	OC3	Apron Feeder to Dribble Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC4	Apron Feeder to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC5	Dribble Conveyor to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor		LL	LL	0.089	1.0E-3	0.018
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile		LL	LL	0.010	1.2E-4	2.0E-3
	OC9	Stockpile Transfers to Reclaim Conveyors		LL	LL	0.049	5.5E-4	9.7E-3
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor		LL	LL	0.049	5.5E-4	9.7E-3
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	LL	LL	0.049	5.5E-4	9.7E-3
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	LL	LL	0.098	1.1E-3	0.019
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	LL	LL	0.011	1.3E-4	2.3E-3
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0.221	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	7E	7E	2.3E-5	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MR	Mercury Retort	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	2.6E-7	0	0	3.1E-6	0
	CKB	Carbon Regeneration Kiln (Burners)	0	8.4E-7	0	0	9.7E-6	0
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	3.7E-8	0	0	4.3E-7	0
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	1.9E-6	0	0	2.2E-5	0
	LKC	PFR Shaft Lime Kiln Combustion	0	5A	5A	0	9.5E-5	0
	LS1	Limestone transfer to Primary Crusher Hopper	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS2	Primary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS3	Primary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323
	LS4	Secondary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS5	Secondary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323

PRI00000695

REC 2035

TABLE B-H1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS8	Ball Mill Feed transfer to Ball	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LSBM	Limestone Ball Mill	0	OOO	OOO	0.043	2.8E-4	0.522
	LS9	Limestone transfer to Kiln Feed Bin	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS11	Fines Screening and Associated Transfers In and Out	0	OOO	OOO	6.3E-3	4.0E-5	0.076
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	5A	5A	7.5E-4	4.8E-6	9.2E-3
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	5A	5A	0.021	1.3E-4	0.251
	LCR	Lime Mill Crushing and associated transfers In and Out	0	5A	5A	6.4E-3	4.1E-5	0
	LSL	Pebble Lime Silo Loading via Bucket Elevator	0	5A	5A	1.4E-4	9.0E-7	0
	LSU	Pebble Lime Silo discharge to Lime Slaker	0	5A	5A	1.4E-5	9.0E-8	0
	LS1L	Mill Lime Silo #1 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	MillS2L	Mill Lime Silo #2 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	ACS1L	AC Lime Silo #1 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS2L	AC Lime Silo #2 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS3L	AC Lime Silo #3 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS4L	AC Lime Silo #4 Loading	0	4.9E-6	2.7E-6	4.7E-4	3.0E-6	0
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
Concrete Production	CM	Central Mixer Loading	0	2.6E-5	8.2E-6	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	8.0E-7	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	8.0E-7	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	8.0E-7	0	0	0	0

PRI00000696

TABLE B-H1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	8.0E-7	0	0	0	0
	CAL	Aggregate Bin Loading	0	OOO	OOO	0.016	1.0E-4	0
	CAU	Aggregate Bin Unloading	0	OOO	OOO	0.016	1.0E-4	0
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	1.9E-7	0	0	2.2E-6	0
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	7.5E-7	0	0	8.6E-6	0
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	1.1E-6	0	0	1.3E-5	0
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	4Z	4Z	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	6C	6C	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	6C	6C	0	0	0
Mining - Modeling Scenario: H1	YPP	Yellow Pine Pit	0	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0.024	0.051	5.585	0.063	1.101
	WEP	West End Pit	0	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	8.0E-3	0.017	1.902	0.021	0.375
	WEPBL	West End Pit Blasting	0	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0	0
	STKP	PC Stockpile	0	4.5E-3	9.7E-3	1.063	0.012	0.210
	FDRSF	Fiddle DRSF	0	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0	0
	HR000	Haul Roads	0	0.105	0.228	24.940	0.281	4.918
	TSF	Tailing Storage Facility	0.232	0	0	0	0	0
	ACCRD	Access Roads	0	4.7E-4	1.0E-3	0.113	1.3E-3	0.022
	UGEXP	Scout Portal	0	1.0E-7	2.3E-7	2.5E-5	2.8E-7	4.9E-6
		Total	**0.453**	**0.142**	**0.308**	**34.252**	**0.385**	**8.870**

PRI00000697

REC 2037

TABLE B-H1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	2.9E-3	0	1.6E-6	4.5E-6
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	0	0	0	0	5.0E-5
	LS1	Limestone transfer to Primary Crusher Hopper	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5

PRI00000698

REC 2038

TABLE B-H1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	0	0	0	0

PRI00000699

REC 2039

TABLE B-H1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	0	0	0	0
	CAL	Aggregate Bin Loading	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	0	0	0	6.8E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	0	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	0	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	0	0	0	0
Mining - Modeling Scenario: H1	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	1.432	0	7.9E-4	2.2E-3
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0.488	0	2.7E-4	7.5E-4
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0.272	0	1.5E-4	4.2E-4
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0	6.393	0	3.5E-3	9.8E-3
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**0.696**	**8.827**	**2.030**	**5.2E-3**	**0.014**

PRI00000700

REC 2040

TABLE B-H2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to		LL	LL	0.010	1.2E-4	2.0E-3
	OC2	Grizzly to Apron Feeder		LL	LL	0.010	1.2E-4	2.0E-3
	OC3	Apron Feeder to Dribble Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC4	Apron Feeder to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC5	Dribble Conveyor to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor		LL	LL	0.089	1.0E-3	0.018
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile		LL	LL	0.010	1.2E-4	2.0E-3
	OC9	Stockpile Transfers to Reclaim Conveyors		LL	LL	0.049	5.5E-4	9.7E-3
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor		LL	LL	0.049	5.5E-4	9.7E-3
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	LL	LL	0.049	5.5E-4	9.7E-3
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	LL	LL	0.098	1.1E-3	0.019
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	LL	LL	0.011	1.3E-4	2.3E-3
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0.221	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	7E	7E	2.3E-5	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MR	Mercury Retort	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	2.6E-7	0	0	3.1E-6	0
	CKB	Carbon Regeneration Kiln (Burners)	0	8.4E-7	0	0	9.7E-6	0
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	3.7E-8	0	0	4.3E-7	0
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	1.9E-6	0	0	2.2E-5	0
	LKC	PFR Shaft Lime Kiln Combustion	0	5A	5A	0	9.5E-5	0
	LS1	Limestone transfer to Primary Crusher Hopper	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS2	Primary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS3	Primary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323
	LS4	Secondary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS5	Secondary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323

PRI00000701

REC 2041

TABLE B-H2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS8	Ball Mill Feed transfer to Ball	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LSBM	Limestone Ball Mill	0	OOO	OOO	0.043	2.8E-4	0.522
	LS9	Limestone transfer to Kiln Feed Bin	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS11	Fines Screening and Associated Transfers In and Out	0	OOO	OOO	6.3E-3	4.0E-5	0.076
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	5A	5A	7.5E-4	4.8E-6	9.2E-3
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	5A	5A	0.021	1.3E-4	0.251
	LCR	Lime Mill Crushing and associated transfers In and Out	0	5A	5A	6.4E-3	4.1E-5	0
	LSL	Pebble Lime Silo Loading via Bucket Elevator	0	5A	5A	1.4E-4	9.0E-7	0
	LSU	Pebble Lime Silo discharge to Lime Slaker	0	5A	5A	1.4E-5	9.0E-8	0
	LS1L	Mill Lime Silo #1 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	MillS2L	Mill Lime Silo #2 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	ACS1L	AC Lime Silo #1 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS2L	AC Lime Silo #2 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS3L	AC Lime Silo #3 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS4L	AC Lime Silo #4 Loading	0	4.9E-6	2.7E-6	4.7E-4	3.0E-6	0
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
Concrete Production	CM	Central Mixer Loading	0	2.6E-5	8.2E-6	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	8.0E-7	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	8.0E-7	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	8.0E-7	0	0	0	0

PRI00000702

REC 2042

TABLE B-H2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	8.0E-7	0	0	0	0
	CAL	Aggregate Bin Loading	0	OOO	OOO	0.016	1.0E-4	0
	CAU	Aggregate Bin Unloading	0	OOO	OOO	0.016	1.0E-4	0
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	1.9E-7	0	0	2.2E-6	0
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	7.5E-7	0	0	8.6E-6	0
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	1.1E-6	0	0	1.3E-5	0
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	4Z	4Z	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	6C	6C	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	6C	6C	0	0	0
Mining - Modeling Scenario: H2	YPP	Yellow Pine Pit	0	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0.024	0.051	5.585	0.063	1.101
	WEP	West End Pit	0	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	8.0E-3	0.017	1.902	0.021	0.375
	WEPBL	West End Pit Blasting	0	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	3.6E-3	7.9E-3	0.858	9.7E-3	0.169
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0	0
	HR000	Haul Roads	0	0.157	0.342	37.334	0.421	7.362
	TSF	Tailing Storage Facility	0.232	0	0	0	0	0
	ACCRD	Access Roads	0	4.7E-4	1.0E-3	0.113	1.3E-3	0.022
	UGEXP	Scout Portal	0	1.0E-7	2.3E-7	2.5E-5	2.8E-7	4.9E-6
		Total	**0.453**	**0.193**	**0.419**	**46.440**	**0.523**	**11.273**

PRI00000703

REC 2043

TABLE B-H2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	2.9E-3	0	1.6E-6	4.5E-6
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	0	0	0	0	5.0E-5
	LS1	Limestone transfer to Primary Crusher Hopper	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5

TABLE B-H2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	0	0	0	0

PRI00000705

TABLE B-H2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	0	0	0	0
	CAL	Aggregate Bin Loading	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	0	0	0	6.8E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	0	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	0	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	0	0	0	0
Mining - Modeling Scenario: H2	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	1.432	0	7.9E-4	2.2E-3
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0.488	0	2.7E-4	7.5E-4
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0.220	0	1.2E-4	3.4E-4
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0	9.570	0	5.3E-3	0.015
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**0.696**	**11.951**	**2.030**	**7.0E-3**	**0.019**

PRI00000706

REC 2046

TABLE B-H3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to		LL	LL	0.010	1.2E-4	2.0E-3
	OC2	Grizzly to Apron Feeder		LL	LL	0.010	1.2E-4	2.0E-3
	OC3	Apron Feeder to Dribble Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC4	Apron Feeder to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC5	Dribble Conveyor to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor		LL	LL	0.089	1.0E-3	0.018
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile		LL	LL	0.010	1.2E-4	2.0E-3
	OC9	Stockpile Transfers to Reclaim Conveyors		LL	LL	0.049	5.5E-4	9.7E-3
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor		LL	LL	0.049	5.5E-4	9.7E-3
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	LL	LL	0.049	5.5E-4	9.7E-3
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	LL	LL	0.098	1.1E-3	0.019
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	LL	LL	0.011	1.3E-4	2.3E-3
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0.221	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	7E	7E	2.3E-5	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MR	Mercury Retort	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	2.6E-7	0	0	3.1E-6	0
	CKB	Carbon Regeneration Kiln (Burners)	0	8.4E-7	0	0	9.7E-6	0
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	3.7E-8	0	0	4.3E-7	0
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	1.9E-6	0	0	2.2E-5	0
	LKC	PFR Shaft Lime Kiln Combustion	0	5A	5A	0	9.5E-5	0
	LS1	Limestone transfer to Primary Crusher Hopper	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS2	Primary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS3	Primary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323
	LS4	Secondary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS5	Secondary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323

PRI00000707

REC 2047

TABLE B-H3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS8	Ball Mill Feed transfer to Ball	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LSBM	Limestone Ball Mill	0	OOO	OOO	0.043	2.8E-4	0.522
	LS9	Limestone transfer to Kiln Feed Bin	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS11	Fines Screening and Associated Transfers In and Out	0	OOO	OOO	6.3E-3	4.0E-5	0.076
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	5A	5A	7.5E-4	4.8E-6	9.2E-3
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	5A	5A	0.021	1.3E-4	0.251
	LCR	Lime Mill Crushing and associated transfers In and Out	0	5A	5A	6.4E-3	4.1E-5	0
	LSL	Pebble Lime Silo Loading via Bucket Elevator	0	5A	5A	1.4E-4	9.0E-7	0
	LSU	Pebble Lime Silo discharge to Lime Slaker	0	5A	5A	1.4E-5	9.0E-8	0
	LS1L	Mill Lime Silo #1 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	MillS2L	Mill Lime Silo #2 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	ACS1L	AC Lime Silo #1 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS2L	AC Lime Silo #2 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS3L	AC Lime Silo #3 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS4L	AC Lime Silo #4 Loading	0	4.9E-6	2.7E-6	4.7E-4	3.0E-6	0
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
Concrete Production	CM	Central Mixer Loading	0	2.6E-5	8.2E-6	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	8.0E-7	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	8.0E-7	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	8.0E-7	0	0	0	0

PRI00000708

TABLE B-H3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	8.0E-7	0	0	0	0
	CAL	Aggregate Bin Loading	0	OOO	OOO	0.016	1.0E-4	0
	CAU	Aggregate Bin Unloading	0	OOO	OOO	0.016	1.0E-4	0
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	1.9E-7	0	0	2.2E-6	0
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	7.5E-7	0	0	8.6E-6	0
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	1.1E-6	0	0	1.3E-5	0
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	4Z	4Z	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	6C	6C	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	6C	6C	0	0	0
Mining - Modeling Scenario: H3	YPP	Yellow Pine Pit	0	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0.024	0.051	5.585	0.063	1.101
	WEP	West End Pit	0	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	8.0E-3	0.017	1.902	0.021	0.375
	WEPBL	West End Pit Blasting	0	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	3.6E-3	7.9E-3	0.858	9.7E-3	0.169
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0	0
	HR000	Haul Roads	0	0.096	0.209	22.854	0.258	4.506
	TSF	Tailing Storage Facility	0.232	0	0	0	0	0
	ACCRD	Access Roads	0	4.7E-4	1.0E-3	0.113	1.3E-3	0.022
	UGEXP	Scout Portal	0	1.0E-7	2.3E-7	2.5E-5	2.8E-7	4.9E-6
		Total	**0.453**	**0.132**	**0.287**	**31.960**	**0.360**	**8.418**

PRI00000709

REC 2049

TABLE B-H3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	2.9E-3	0	1.6E-6	4.5E-6
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	0	0	0	0	5.0E-5
	LS1	Limestone transfer to Primary Crusher Hopper	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5

TABLE B-H3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	0	0	0	0

PRI00000711

REC 2051

TABLE B-H3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	0	0	0	0
	CAL	Aggregate Bin Loading	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	0	0	0	6.8E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	0	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	0	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	0	0	0	0
Mining - Modeling Scenario: H3	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	1.432	0	7.9E-4	2.2E-3
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0.488	0	2.7E-4	7.5E-4
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0.220	0	1.2E-4	3.4E-4
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0	5.858	0	3.2E-3	9.0E-3
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**0.696**	**8.239**	**2.030**	**4.9E-3**	**0.013**

PRI00000712

REC 2052

TABLE B-H4. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to		LL	LL	0.010	1.2E-4	2.0E-3
	OC2	Grizzly to Apron Feeder		LL	LL	0.010	1.2E-4	2.0E-3
	OC3	Apron Feeder to Dribble Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC4	Apron Feeder to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC5	Dribble Conveyor to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor		LL	LL	0.089	1.0E-3	0.018
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile		LL	LL	0.010	1.2E-4	2.0E-3
	OC9	Stockpile Transfers to Reclaim Conveyors		LL	LL	0.049	5.5E-4	9.7E-3
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor		LL	LL	0.049	5.5E-4	9.7E-3
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	LL	LL	0.049	5.5E-4	9.7E-3
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	LL	LL	0.098	1.1E-3	0.019
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	LL	LL	0.011	1.3E-4	2.3E-3
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0.221	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	7E	7E	2.3E-5	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MR	Mercury Retort	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	2.6E-7	0	0	3.1E-6	0
	CKB	Carbon Regeneration Kiln (Burners)	0	8.4E-7	0	0	9.7E-6	0
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	3.7E-8	0	0	4.3E-7	0
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	1.9E-6	0	0	2.2E-5	0
	LKC	PFR Shaft Lime Kiln Combustion	0	5A	5A	0	9.5E-5	0
	LS1	Limestone transfer to Primary Crusher Hopper	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS2	Primary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS3	Primary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323
	LS4	Secondary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS5	Secondary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323

PRI00000713

REC 2053

TABLE B-H4. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS8	Ball Mill Feed transfer to Ball	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LSBM	Limestone Ball Mill	0	OOO	OOO	0.043	2.8E-4	0.522
	LS9	Limestone transfer to Kiln Feed Bin	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS11	Fines Screening and Associated Transfers In and Out	0	OOO	OOO	6.3E-3	4.0E-5	0.076
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	5A	5A	7.5E-4	4.8E-6	9.2E-3
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	5A	5A	0.021	1.3E-4	0.251
	LCR	Lime Mill Crushing and associated transfers In and Out	0	5A	5A	6.4E-3	4.1E-5	0
	LSL	Pebble Lime Silo Loading via Bucket Elevator	0	5A	5A	1.4E-4	9.0E-7	0
	LSU	Pebble Lime Silo discharge to Lime Slaker	0	5A	5A	1.4E-5	9.0E-8	0
	LS1L	Mill Lime Silo #1 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	MillS2L	Mill Lime Silo #2 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	ACS1L	AC Lime Silo #1 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS2L	AC Lime Silo #2 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS3L	AC Lime Silo #3 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS4L	AC Lime Silo #4 Loading	0	4.9E-6	2.7E-6	4.7E-4	3.0E-6	0
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
Concrete Production	CM	Central Mixer Loading	0	2.6E-5	8.2E-6	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	8.0E-7	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	8.0E-7	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	8.0E-7	0	0	0	0

PRI00000714

REC 2054

TABLE B-H4. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	8.0E-7	0	0	0	0
	CAL	Aggregate Bin Loading	0	OOO	OOO	0.016	1.0E-4	0
	CAU	Aggregate Bin Unloading	0	OOO	OOO	0.016	1.0E-4	0
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	1.9E-7	0	0	2.2E-6	0
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	7.5E-7	0	0	8.6E-6	0
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	1.1E-6	0	0	1.3E-5	0
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	4Z	4Z	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	6C	6C	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	6C	6C	0	0	0
Mining - Modeling Scenario: H4	YPP	Yellow Pine Pit	0	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0.024	0.051	5.585	0.063	1.101
	WEP	West End Pit	0	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	8.0E-3	0.017	1.902	0.021	0.375
	WEPBL	West End Pit Blasting	0	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	3.6E-3	7.9E-3	0.858	9.7E-3	0.169
	WEDRSF	West End DRSF	0	0	0	0	0	0
	HR000	Haul Roads	0	0.123	0.268	29.277	0.330	5.773
	TSF	Tailing Storage Facility	0.232	0	0	0	0	0
	ACCRD	Access Roads	0	4.7E-4	1.0E-3	0.113	1.3E-3	0.022
	UGEXP	Scout Portal	0	1.0E-7	2.3E-7	2.5E-5	2.8E-7	4.9E-6
		Total	**0.453**	**0.159**	**0.346**	**38.383**	**0.432**	**9.685**

PRI00000715

REC 2055

TABLE B-H4. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	2.9E-3	0	1.6E-6	4.5E-6
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	0	0	0	0	5.0E-5
	LS1	Limestone transfer to Primary Crusher Hopper	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5

TABLE B-H4. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	0	0	0	0

PRI00000717

REC 2057

TABLE B-H4. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	0	0	0	0
	CAL	Aggregate Bin Loading	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	0	0	0	6.8E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	0	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	0	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	0	0	0	0
Mining - Modeling Scenario: H4	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	1.432	0	7.9E-4	2.2E-3
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0.488	0	2.7E-4	7.5E-4
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0.220	0	1.2E-4	3.4E-4
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0	7.505	0	4.1E-3	0.012
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**0.696**	**9.886**	**2.030**	**5.8E-3**	**0.016**

TABLE B-W1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to		LL	LL	0.010	1.2E-4	2.0E-3
	OC2	Grizzly to Apron Feeder		LL	LL	0.010	1.2E-4	2.0E-3
	OC3	Apron Feeder to Dribble Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC4	Apron Feeder to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC5	Dribble Conveyor to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor		LL	LL	0.089	1.0E-3	0.018
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile		LL	LL	0.010	1.2E-4	2.0E-3
	OC9	Stockpile Transfers to Reclaim Conveyors		LL	LL	0.049	5.5E-4	9.7E-3
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor		LL	LL	0.049	5.5E-4	9.7E-3
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	LL	LL	0.049	5.5E-4	9.7E-3
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	LL	LL	0.098	1.1E-3	0.019
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	LL	LL	0.011	1.3E-4	2.3E-3
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0.221	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	7E	7E	2.3E-5	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MR	Mercury Retort	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	2.6E-7	0	0	3.1E-6	0
	CKB	Carbon Regeneration Kiln (Burners)	0	8.4E-7	0	0	9.7E-6	0
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	3.7E-8	0	0	4.3E-7	0
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	1.9E-6	0	0	2.2E-5	0
	LKC	PFR Shaft Lime Kiln Combustion	0	5A	5A	0	9.5E-5	0
	LS1	Limestone transfer to Primary Crusher Hopper	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS2	Primary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS3	Primary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323
	LS4	Secondary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS5	Secondary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323

PRI00000719

REC 2059

TABLE B-W1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS8	Ball Mill Feed transfer to Ball	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LSBM	Limestone Ball Mill	0	OOO	OOO	0.043	2.8E-4	0.522
	LS9	Limestone transfer to Kiln Feed Bin	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS11	Fines Screening and Associated Transfers In and Out	0	OOO	OOO	6.3E-3	4.0E-5	0.076
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	5A	5A	7.5E-4	4.8E-6	9.2E-3
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	5A	5A	0.021	1.3E-4	0.251
	LCR	Lime Mill Crushing and associated transfers In and Out	0	5A	5A	6.4E-3	4.1E-5	0
	LSL	Pebble Lime Silo Loading via Bucket Elevator	0	5A	5A	1.4E-4	9.0E-7	0
	LSU	Pebble Lime Silo discharge to Lime Slaker	0	5A	5A	1.4E-5	9.0E-8	0
	LS1L	Mill Lime Silo #1 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	MillS2L	Mill Lime Silo #2 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	ACS1L	AC Lime Silo #1 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS2L	AC Lime Silo #2 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS3L	AC Lime Silo #3 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS4L	AC Lime Silo #4 Loading	0	4.9E-6	2.7E-6	4.7E-4	3.0E-6	0
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
Concrete Production	CM	Central Mixer Loading	0	2.6E-5	8.2E-6	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	8.0E-7	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	8.0E-7	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	8.0E-7	0	0	0	0

PRI00000720

REC 2060

TABLE B-W1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	8.0E-7	0	0	0	0
	CAL	Aggregate Bin Loading	0	OOO	OOO	0.016	1.0E-4	0
	CAU	Aggregate Bin Unloading	0	OOO	OOO	0.016	1.0E-4	0
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	1.9E-7	0	0	2.2E-6	0
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	7.5E-7	0	0	8.6E-6	0
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	1.1E-6	0	0	1.3E-5	0
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	4Z	4Z	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	6C	6C	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	6C	6C	0	0	0
Mining - Modeling Scenario: W1	YPP	Yellow Pine Pit	0	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0	0
	WEP	West End Pit	0	0.024	0.051	5.585	0.063	1.101
	BT	Bradley Tailings	0	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	8.0E-3	0.017	1.902	0.021	0.375
	BTBL	Bradley Tailings Blasting	0	0	0	0	0	0
	STKP	PC Stockpile	0	4.5E-3	9.7E-3	1.063	0.012	0.210
	FDRSF	Fiddle DRSF	0	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0	0
	HR000	Haul Roads	0	0.090	0.196	21.435	0.242	4.227
	TSF	Tailing Storage Facility	0.232	0	0	0	0	0
	ACCRD	Access Roads	0	4.7E-4	1.0E-3	0.113	1.3E-3	0.022
	UGEXP	Scout Portal	0	1.0E-7	2.3E-7	2.5E-5	2.8E-7	4.9E-6
		Total	**0.453**	**0.127**	**0.276**	**30.746**	**0.346**	**8.179**

PRI00000721

REC 2061

TABLE B-W1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8 (24-hr) lb/hr	Iron 7439-89-6 (24-hr) lb/hr	Sulfuric Acid 7664-93-9 (24-hr) lb/hr	Thallium 7440-28-0 (24-hr) lb/hr	Vanadium 7440-62-2 (24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	2.9E-3	0	1.6E-6	4.5E-6
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	0	0	0	0	5.0E-5
	LS1	Limestone transfer to Primary Crusher Hopper	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5

PRI00000722

REC 2062

TABLE B-W1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	0	0	0	0

PRI00000723

REC 2063

TABLE B-W1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	0	0	0	0
	CAL	Aggregate Bin Loading	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	0	0	0	6.8E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	0	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	0	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	0	0	0	0
Mining - Modeling Scenario: W1	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	0	1.432	0	7.9E-4	2.2E-3
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0.488	0	2.7E-4	7.5E-4
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0.272	0	1.5E-4	4.2E-4
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0	5.495	0	3.0E-3	8.5E-3
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**0.696**	**7.928**	**2.030**	**4.8E-3**	**0.013**

PRI00000724

REC 2064

TABLE B-W2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to		LL	LL	0.010	1.2E-4	2.0E-3
	OC2	Grizzly to Apron Feeder		LL	LL	0.010	1.2E-4	2.0E-3
	OC3	Apron Feeder to Dribble Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC4	Apron Feeder to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC5	Dribble Conveyor to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor		LL	LL	0.089	1.0E-3	0.018
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile		LL	LL	0.010	1.2E-4	2.0E-3
	OC9	Stockpile Transfers to Reclaim Conveyors		LL	LL	0.049	5.5E-4	9.7E-3
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor		LL	LL	0.049	5.5E-4	9.7E-3
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	LL	LL	0.049	5.5E-4	9.7E-3
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	LL	LL	0.098	1.1E-3	0.019
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	LL	LL	0.011	1.3E-4	2.3E-3
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0.221	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	7E	7E	2.3E-5	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MR	Mercury Retort	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	2.6E-7	0	0	3.1E-6	0
	CKB	Carbon Regeneration Kiln (Burners)	0	8.4E-7	0	0	9.7E-6	0
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	3.7E-8	0	0	4.3E-7	0
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	1.9E-6	0	0	2.2E-5	0
	LKC	PFR Shaft Lime Kiln Combustion	0	5A	5A	0	9.5E-5	0
	LS1	Limestone transfer to Primary Crusher Hopper	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS2	Primary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS3	Primary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323
	LS4	Secondary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS5	Secondary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323

PRI00000725

REC 2065

TABLE B-W2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS8	Ball Mill Feed transfer to Ball	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LSBM	Limestone Ball Mill	0	OOO	OOO	0.043	2.8E-4	0.522
	LS9	Limestone transfer to Kiln Feed Bin	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS11	Fines Screening and Associated Transfers In and Out	0	OOO	OOO	6.3E-3	4.0E-5	0.076
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	5A	5A	7.5E-4	4.8E-6	9.2E-3
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	5A	5A	0.021	1.3E-4	0.251
	LCR	Lime Mill Crushing and associated transfers In and Out	0	5A	5A	6.4E-3	4.1E-5	0
	LSL	Pebble Lime Silo Loading via Bucket Elevator	0	5A	5A	1.4E-4	9.0E-7	0
	LSU	Pebble Lime Silo discharge to Lime Slaker	0	5A	5A	1.4E-5	9.0E-8	0
	LS1L	Mill Lime Silo #1 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	MillS2L	Mill Lime Silo #2 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	ACS1L	AC Lime Silo #1 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS2L	AC Lime Silo #2 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS3L	AC Lime Silo #3 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS4L	AC Lime Silo #4 Loading	0	4.9E-6	2.7E-6	4.7E-4	3.0E-6	0
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
Concrete Production	CM	Central Mixer Loading	0	2.6E-5	8.2E-6	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	8.0E-7	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	8.0E-7	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	8.0E-7	0	0	0	0

PRI00000726

TABLE B-W2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	8.0E-7	0	0	0	0
	CAL	Aggregate Bin Loading	0	OOO	OOO	0.016	1.0E-4	0
	CAU	Aggregate Bin Unloading	0	OOO	OOO	0.016	1.0E-4	0
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	1.9E-7	0	0	2.2E-6	0
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	7.5E-7	0	0	8.6E-6	0
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	1.1E-6	0	0	1.3E-5	0
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	4Z	4Z	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	6C	6C	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	6C	6C	0	0	0
Mining - Modeling Scenario: W2	YPP	Yellow Pine Pit	0	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0	0
	WEP	West End Pit	0	0.024	0.051	5.585	0.063	1.101
	BT	Bradley Tailings	0	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	8.0E-3	0.017	1.902	0.021	0.375
	BTBL	Bradley Tailings Blasting	0	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	3.6E-3	7.9E-3	0.858	9.7E-3	0.169
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0	0
	HR000	Haul Roads	0	0.145	0.316	34.484	0.389	6.800
	TSF	Tailing Storage Facility	0.232	0	0	0	0	0
	ACCRD	Access Roads	0	4.7E-4	1.0E-3	0.113	1.3E-3	0.022
	UGEXP	Scout Portal	0	1.0E-7	2.3E-7	2.5E-5	2.8E-7	4.9E-6
		Total	**0.453**	**0.181**	**0.393**	**43.590**	**0.491**	**10.711**

PRI00000727

REC 2067

TABLE B-W2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	2.9E-3	0	1.6E-6	4.5E-6
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	0	0	0	0	5.0E-5
	LS1	Limestone transfer to Primary Crusher Hopper	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5

PRI00000728

REC 2068

TABLE B-W2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	0	0	0	0

PRI00000729

REC 2069

TABLE B-W2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	0	0	0	0
	CAL	Aggregate Bin Loading	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	0	0	0	6.8E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	0	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	0	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	0	0	0	0
Mining - Modeling Scenario: W2	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	0	1.432	0	7.9E-4	2.2E-3
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0.488	0	2.7E-4	7.5E-4
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0.220	0	1.2E-4	3.4E-4
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0	8.840	0	4.9E-3	0.014
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**0.696**	**11.221**	**2.030**	**6.6E-3**	**0.018**

PRI00000730

REC 2070

TABLE B-W3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to		LL	LL	0.010	1.2E-4	2.0E-3
	OC2	Grizzly to Apron Feeder		LL	LL	0.010	1.2E-4	2.0E-3
	OC3	Apron Feeder to Dribble Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC4	Apron Feeder to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC5	Dribble Conveyor to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor		LL	LL	0.089	1.0E-3	0.018
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile		LL	LL	0.010	1.2E-4	2.0E-3
	OC9	Stockpile Transfers to Reclaim Conveyors		LL	LL	0.049	5.5E-4	9.7E-3
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor		LL	LL	0.049	5.5E-4	9.7E-3
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	LL	LL	0.049	5.5E-4	9.7E-3
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	LL	LL	0.098	1.1E-3	0.019
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	LL	LL	0.011	1.3E-4	2.3E-3
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0.221	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	7E	7E	2.3E-5	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MR	Mercury Retort	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	2.6E-7	0	0	3.1E-6	0
	CKB	Carbon Regeneration Kiln (Burners)	0	8.4E-7	0	0	9.7E-6	0
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	3.7E-8	0	0	4.3E-7	0
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	1.9E-6	0	0	2.2E-5	0
	LKC	PFR Shaft Lime Kiln Combustion	0	5A	5A	0	9.5E-5	0
	LS1	Limestone transfer to Primary Crusher Hopper	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS2	Primary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS3	Primary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323
	LS4	Secondary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS5	Secondary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323

PRI00000731

REC 2071

TABLE B-W3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS8	Ball Mill Feed transfer to Ball	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LSBM	Limestone Ball Mill	0	OOO	OOO	0.043	2.8E-4	0.522
	LS9	Limestone transfer to Kiln Feed Bin	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS11	Fines Screening and Associated Transfers In and Out	0	OOO	OOO	6.3E-3	4.0E-5	0.076
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	5A	5A	7.5E-4	4.8E-6	9.2E-3
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	5A	5A	0.021	1.3E-4	0.251
	LCR	Lime Mill Crushing and associated transfers In and Out	0	5A	5A	6.4E-3	4.1E-5	0
	LSL	Pebble Lime Silo Loading via Bucket Elevator	0	5A	5A	1.4E-4	9.0E-7	0
	LSU	Pebble Lime Silo discharge to Lime Slaker	0	5A	5A	1.4E-5	9.0E-8	0
	LS1L	Mill Lime Silo #1 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	MillS2L	Mill Lime Silo #2 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	ACS1L	AC Lime Silo #1 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS2L	AC Lime Silo #2 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS3L	AC Lime Silo #3 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS4L	AC Lime Silo #4 Loading	0	4.9E-6	2.7E-6	4.7E-4	3.0E-6	0
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
Concrete Production	CM	Central Mixer Loading	0	2.6E-5	8.2E-6	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	8.0E-7	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	8.0E-7	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	8.0E-7	0	0	0	0

PRI00000732

REC 2072

TABLE B-W3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	8.0E-7	0	0	0	0
	CAL	Aggregate Bin Loading	0	OOO	OOO	0.016	1.0E-4	0
	CAU	Aggregate Bin Unloading	0	OOO	OOO	0.016	1.0E-4	0
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	1.9E-7	0	0	2.2E-6	0
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	7.5E-7	0	0	8.6E-6	0
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	1.1E-6	0	0	1.3E-5	0
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	4Z	4Z	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	6C	6C	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	6C	6C	0	0	0
Mining - Modeling Scenario: W3	YPP	Yellow Pine Pit	0	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0	0
	WEP	West End Pit	0	0.024	0.051	5.585	0.063	1.101
	BT	Bradley Tailings	0	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	8.0E-3	0.017	1.902	0.021	0.375
	BTBL	Bradley Tailings Blasting	0	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	3.6E-3	7.9E-3	0.858	9.7E-3	0.169
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0	0
	HR000	Haul Roads	0	0.208	0.452	49.397	0.557	9.740
	TSF	Tailing Storage Facility	0.232	0	0	0	0	0
	ACCRD	Access Roads	0	4.7E-4	1.0E-3	0.113	1.3E-3	0.022
	UGEXP	Scout Portal	0	1.0E-7	2.3E-7	2.5E-5	2.8E-7	4.9E-6
		Total	**0.453**	**0.244**	**0.530**	**58.504**	**0.659**	**13.652**

PRI00000733

REC 2073

TABLE B-W3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8 (24-hr) lb/hr	Iron 7439-89-6 (24-hr) lb/hr	Sulfuric Acid 7664-93-9 (24-hr) lb/hr	Thallium 7440-28-0 (24-hr) lb/hr	Vanadium 7440-62-2 (24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	2.9E-3	0	1.6E-6	4.5E-6
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	0	0	0	0	5.0E-5
	LS1	Limestone transfer to Primary Crusher Hopper	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5

PRI00000734

REC 2074

TABLE B-W3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	0	0	0	0

PRI00000735

REC 2075

TABLE B-W3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	0	0	0	0
	CAL	Aggregate Bin Loading	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	0	0	0	6.8E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	0	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	0	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	0	0	0	0
Mining - Modeling Scenario: W3	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	0	1.432	0	7.9E-4	2.2E-3
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0.488	0	2.7E-4	7.5E-4
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0.220	0	1.2E-4	3.4E-4
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0	12.662	0	7.0E-3	0.019
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**0.696**	**15.043**	**2.030**	**8.7E-3**	**0.024**

PRI00000736

REC 2076

TABLE B-W4. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to		LL	LL	0.010	1.2E-4	2.0E-3
	OC2	Grizzly to Apron Feeder		LL	LL	0.010	1.2E-4	2.0E-3
	OC3	Apron Feeder to Dribble Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC4	Apron Feeder to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC5	Dribble Conveyor to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor		LL	LL	0.089	1.0E-3	0.018
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile		LL	LL	0.010	1.2E-4	2.0E-3
	OC9	Stockpile Transfers to Reclaim Conveyors		LL	LL	0.049	5.5E-4	9.7E-3
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor		LL	LL	0.049	5.5E-4	9.7E-3
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	LL	LL	0.049	5.5E-4	9.7E-3
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	LL	LL	0.098	1.1E-3	0.019
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	LL	LL	0.011	1.3E-4	2.3E-3
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0.221	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	7E	7E	2.3E-5	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MR	Mercury Retort	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	2.6E-7	0	0	3.1E-6	0
	CKB	Carbon Regeneration Kiln (Burners)	0	8.4E-7	0	0	9.7E-6	0
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	3.7E-8	0	0	4.3E-7	0
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	1.9E-6	0	0	2.2E-5	0
	LKC	PFR Shaft Lime Kiln Combustion	0	5A	5A	0	9.5E-5	0
	LS1	Limestone transfer to Primary Crusher Hopper	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS2	Primary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS3	Primary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323
	LS4	Secondary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS5	Secondary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323

PRI00000737

REC 2077

TABLE B-W4. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS8	Ball Mill Feed transfer to Ball	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LSBM	Limestone Ball Mill	0	OOO	OOO	0.043	2.8E-4	0.522
	LS9	Limestone transfer to Kiln Feed Bin	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS11	Fines Screening and Associated Transfers In and Out	0	OOO	OOO	6.3E-3	4.0E-5	0.076
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	5A	5A	7.5E-4	4.8E-6	9.2E-3
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	5A	5A	0.021	1.3E-4	0.251
	LCR	Lime Mill Crushing and associated transfers In and Out	0	5A	5A	6.4E-3	4.1E-5	0
	LSL	Pebble Lime Silo Loading via Bucket Elevator	0	5A	5A	1.4E-4	9.0E-7	0
	LSU	Pebble Lime Silo discharge to Lime Slaker	0	5A	5A	1.4E-5	9.0E-8	0
	LS1L	Mill Lime Silo #1 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	MillS2L	Mill Lime Silo #2 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	ACS1L	AC Lime Silo #1 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS2L	AC Lime Silo #2 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS3L	AC Lime Silo #3 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS4L	AC Lime Silo #4 Loading	0	4.9E-6	2.7E-6	4.7E-4	3.0E-6	0
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
Concrete Production	CM	Central Mixer Loading	0	2.6E-5	8.2E-6	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	8.0E-7	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	8.0E-7	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	8.0E-7	0	0	0	0

PRI00000738

REC 2078

TABLE B-W4. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	8.0E-7	0	0	0	0
	CAL	Aggregate Bin Loading	0	OOO	OOO	0.016	1.0E-4	0
	CAU	Aggregate Bin Unloading	0	OOO	OOO	0.016	1.0E-4	0
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	1.9E-7	0	0	2.2E-6	0
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	7.5E-7	0	0	8.6E-6	0
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	1.1E-6	0	0	1.3E-5	0
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	4Z	4Z	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	6C	6C	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	6C	6C	0	0	0
Mining - Modeling Scenario: W4	YPP	Yellow Pine Pit	0	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0	0
	WEP	West End Pit	0	0.024	0.051	5.585	0.063	1.101
	BT	Bradley Tailings	0	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	8.0E-3	0.017	1.902	0.021	0.375
	BTBL	Bradley Tailings Blasting	0	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	3.6E-3	7.9E-3	0.858	9.7E-3	0.169
	WEDRSF	West End DRSF	0	0	0	0	0	0
	HR000	Haul Roads	0	0.094	0.204	22.281	0.251	4.393
	TSF	Tailing Storage Facility	0.232	0	0	0	0	0
	ACCRD	Access Roads	0	4.7E-4	1.0E-3	0.113	1.3E-3	0.022
	UGEXP	Scout Portal	0	1.0E-7	2.3E-7	2.5E-5	2.8E-7	4.9E-6
		Total	**0.453**	**0.130**	**0.282**	**31.387**	**0.353**	**8.305**

PRI00000739

REC 2079

TABLE B-W4. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	2.9E-3	0	1.6E-6	4.5E-6
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	0	0	0	0	5.0E-5
	LS1	Limestone transfer to Primary Crusher Hopper	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5

PRI00000740

REC 2080

TABLE B-W4. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	0	0	0	0

PRI00000741

TABLE B-W4. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	0	0	0	0
	CAL	Aggregate Bin Loading	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	0	0	0	6.8E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	0	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	0	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	0	0	0	0
Mining - Modeling Scenario: W4	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	0	1.432	0	7.9E-4	2.2E-3
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0.488	0	2.7E-4	7.5E-4
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0.220	0	1.2E-4	3.4E-4
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0	5.711	0	3.1E-3	8.8E-3
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**0.696**	**8.092**	**2.030**	**4.8E-3**	**0.013**

PRI00000742

REC 2082

TABLE B-W5. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to		LL	LL	0.010	1.2E-4	2.0E-3
	OC2	Grizzly to Apron Feeder		LL	LL	0.010	1.2E-4	2.0E-3
	OC3	Apron Feeder to Dribble Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC4	Apron Feeder to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC5	Dribble Conveyor to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor		LL	LL	0.089	1.0E-3	0.018
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile		LL	LL	0.010	1.2E-4	2.0E-3
	OC9	Stockpile Transfers to Reclaim Conveyors		LL	LL	0.049	5.5E-4	9.7E-3
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor		LL	LL	0.049	5.5E-4	9.7E-3
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	LL	LL	0.049	5.5E-4	9.7E-3
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	LL	LL	0.098	1.1E-3	0.019
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	LL	LL	0.011	1.3E-4	2.3E-3
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0.221	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	7E	7E	2.3E-5	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MR	Mercury Retort	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	2.6E-7	0	0	3.1E-6	0
	CKB	Carbon Regeneration Kiln (Burners)	0	8.4E-7	0	0	9.7E-6	0
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	3.7E-8	0	0	4.3E-7	0
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	1.9E-6	0	0	2.2E-5	0
	LKC	PFR Shaft Lime Kiln Combustion	0	5A	5A	0	9.5E-5	0
	LS1	Limestone transfer to Primary Crusher Hopper	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS2	Primary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS3	Primary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323
	LS4	Secondary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS5	Secondary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323

PRI00000743

REC 2083

TABLE B-W5. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS8	Ball Mill Feed transfer to Ball	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LSBM	Limestone Ball Mill	0	OOO	OOO	0.043	2.8E-4	0.522
	LS9	Limestone transfer to Kiln Feed Bin	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS11	Fines Screening and Associated Transfers In and Out	0	OOO	OOO	6.3E-3	4.0E-5	0.076
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	5A	5A	7.5E-4	4.8E-6	9.2E-3
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	5A	5A	0.021	1.3E-4	0.251
	LCR	Lime Mill Crushing and associated transfers In and Out	0	5A	5A	6.4E-3	4.1E-5	0
	LSL	Pebble Lime Silo Loading via Bucket Elevator	0	5A	5A	1.4E-4	9.0E-7	0
	LSU	Pebble Lime Silo discharge to Lime Slaker	0	5A	5A	1.4E-5	9.0E-8	0
	LS1L	Mill Lime Silo #1 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	MillS2L	Mill Lime Silo #2 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	ACS1L	AC Lime Silo #1 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS2L	AC Lime Silo #2 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS3L	AC Lime Silo #3 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS4L	AC Lime Silo #4 Loading	0	4.9E-6	2.7E-6	4.7E-4	3.0E-6	0
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
Concrete Production	CM	Central Mixer Loading	0	2.6E-5	8.2E-6	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	8.0E-7	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	8.0E-7	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	8.0E-7	0	0	0	0

PRI00000744

REC 2084

TABLE B-W5. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	8.0E-7	0	0	0	0
	CAL	Aggregate Bin Loading	0	OOO	OOO	0.016	1.0E-4	0
	CAU	Aggregate Bin Unloading	0	OOO	OOO	0.016	1.0E-4	0
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	1.9E-7	0	0	2.2E-6	0
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	7.5E-7	0	0	8.6E-6	0
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	1.1E-6	0	0	1.3E-5	0
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	4Z	4Z	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	6C	6C	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	6C	6C	0	0	0
Mining - Modeling Scenario: W5	YPP	Yellow Pine Pit	0	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0	0
	WEP	West End Pit	0	0.024	0.051	5.585	0.063	1.101
	BT	Bradley Tailings	0	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	8.0E-3	0.017	1.902	0.021	0.375
	BTBL	Bradley Tailings Blasting	0	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0	0
	WEDRSF	West End DRSF	0	3.6E-3	7.9E-3	0.858	9.7E-3	0.169
	HR000	Haul Roads	0	0.104	0.225	24.595	0.277	4.850
	TSF	Tailing Storage Facility	0.232	0	0	0	0	0
	ACCRD	Access Roads	0	4.7E-4	1.0E-3	0.113	1.3E-3	0.022
	UGEXP	Scout Portal	0	1.0E-7	2.3E-7	2.5E-5	2.8E-7	4.9E-6
		Total	**0.453**	**0.139**	**0.303**	**33.702**	**0.379**	**8.761**

PRI00000745

TABLE B-W5. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	2.9E-3	0	1.6E-6	4.5E-6
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	0	0	0	0	5.0E-5
	LS1	Limestone transfer to Primary Crusher Hopper	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5

PRI00000746

REC 2086

TABLE B-W5. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	0	0	0	0

PRI00000747

REC 2087

TABLE B-W5. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	0	0	0	0
	CAL	Aggregate Bin Loading	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	0	0	0	6.8E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	0	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	0	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	0	0	0	0
Mining - Modeling Scenario: W5	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	0	1.432	0	7.9E-4	2.2E-3
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0.488	0	2.7E-4	7.5E-4
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0.220	0	1.2E-4	3.4E-4
	HR000	Haul Roads	0	6.305	0	3.5E-3	9.7E-3
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**0.696**	**8.686**	**2.030**	**5.2E-3**	**0.014**

PRI00000748

REC 2088

TABLE B-B1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to		LL	LL	0.010	1.2E-4	2.0E-3
	OC2	Grizzly to Apron Feeder		LL	LL	0.010	1.2E-4	2.0E-3
	OC3	Apron Feeder to Dribble Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC4	Apron Feeder to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC5	Dribble Conveyor to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor		LL	LL	0.089	1.0E-3	0.018
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile		LL	LL	0.010	1.2E-4	2.0E-3
	OC9	Stockpile Transfers to Reclaim Conveyors		LL	LL	0.049	5.5E-4	9.7E-3
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor		LL	LL	0.049	5.5E-4	9.7E-3
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	LL	LL	0.049	5.5E-4	9.7E-3
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	LL	LL	0.098	1.1E-3	0.019
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	LL	LL	0.011	1.3E-4	2.3E-3
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0.221	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	7E	7E	2.3E-5	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MR	Mercury Retort	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	2.6E-7	0	0	3.1E-6	0
	CKB	Carbon Regeneration Kiln (Burners)	0	8.4E-7	0	0	9.7E-6	0
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	3.7E-8	0	0	4.3E-7	0
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	1.9E-6	0	0	2.2E-5	0
	LKC	PFR Shaft Lime Kiln Combustion	0	5A	5A	0	9.5E-5	0
	LS1	Limestone transfer to Primary Crusher Hopper	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS2	Primary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS3	Primary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323
	LS4	Secondary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS5	Secondary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323

PRI00000749

REC 2089

TABLE B-B1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS8	Ball Mill Feed transfer to Ball	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LSBM	Limestone Ball Mill	0	OOO	OOO	0.043	2.8E-4	0.522
	LS9	Limestone transfer to Kiln Feed Bin	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS11	Fines Screening and Associated Transfers In and Out	0	OOO	OOO	6.3E-3	4.0E-5	0.076
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	5A	5A	7.5E-4	4.8E-6	9.2E-3
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	5A	5A	0.021	1.3E-4	0.251
	LCR	Lime Mill Crushing and associated transfers In and Out	0	5A	5A	6.4E-3	4.1E-5	0
	LSL	Pebble Lime Silo Loading via Bucket Elevator	0	5A	5A	1.4E-4	9.0E-7	0
	LSU	Pebble Lime Silo discharge to Lime Slaker	0	5A	5A	1.4E-5	9.0E-8	0
	LS1L	Mill Lime Silo #1 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	MillS2L	Mill Lime Silo #2 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	ACS1L	AC Lime Silo #1 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS2L	AC Lime Silo #2 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS3L	AC Lime Silo #3 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS4L	AC Lime Silo #4 Loading	0	4.9E-6	2.7E-6	4.7E-4	3.0E-6	0
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
Concrete Production	CM	Central Mixer Loading	0	2.6E-5	8.2E-6	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	8.0E-7	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	8.0E-7	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	8.0E-7	0	0	0	0

PRI00000750

REC 2090

TABLE B-B1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	8.0E-7	0	0	0	0
	CAL	Aggregate Bin Loading	0	OOO	OOO	0.016	1.0E-4	0
	CAU	Aggregate Bin Unloading	0	OOO	OOO	0.016	1.0E-4	0
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	1.9E-7	0	0	2.2E-6	0
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	7.5E-7	0	0	8.6E-6	0
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	1.1E-6	0	0	1.3E-5	0
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	4Z	4Z	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	6C	6C	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	6C	6C	0	0	0
Mining - Modeling Scenario: B1	YPP	Yellow Pine Pit	0	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0	0
	WEP	West End Pit	0	0	0	0	0	0
	BT	Bradley Tailings	0	0.023	0.051	5.567	0.063	1.098
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	8.0E-3	0.017	1.902	0.021	0.375
	STKP	PC Stockpile	0	4.5E-3	9.7E-3	1.063	0.012	0.210
	FDRSF	Fiddle DRSF	0	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0	0
	HR000	Haul Roads	0	0.120	0.260	28.394	0.320	5.599
	TSF	Tailing Storage Facility	0.232	0	0	0	0	0
	ACCRD	Access Roads	0	4.7E-4	1.0E-3	0.113	1.3E-3	0.022
	UGEXP	Scout Portal	0	1.0E-7	2.3E-7	2.5E-5	2.8E-7	4.9E-6
		Total	**0.453**	**0.156**	**0.339**	**37.687**	**0.424**	**9.547**

PRI00000751

REC 2091

TABLE B-B1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	2.9E-3	0	1.6E-6	4.5E-6
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	0	0	0	0	5.0E-5
	LS1	Limestone transfer to Primary Crusher Hopper	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5

TABLE B-B1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	0	0	0	0

PRI00000753

REC 2093

TABLE B-B1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	0	0	0	0
	CAL	Aggregate Bin Loading	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	0	0	0	6.8E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	0	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	0	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	0	0	0	0
Mining - Modeling Scenario: B1	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	0	1.427	0	7.8E-4	2.2E-3
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0.488	0	2.7E-4	7.5E-4
	STKP	PC Stockpile	0	0.272	0	1.5E-4	4.2E-4
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0	7.278	0	4.0E-3	0.011
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**0.696**	**9.707**	**2.030**	**5.7E-3**	**0.015**

PRI00000754

REC 2094

TABLE B-B2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to		LL	LL	0.010	1.2E-4	2.0E-3
	OC2	Grizzly to Apron Feeder		LL	LL	0.010	1.2E-4	2.0E-3
	OC3	Apron Feeder to Dribble Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC4	Apron Feeder to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC5	Dribble Conveyor to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor		LL	LL	0.089	1.0E-3	0.018
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile		LL	LL	0.010	1.2E-4	2.0E-3
	OC9	Stockpile Transfers to Reclaim Conveyors		LL	LL	0.049	5.5E-4	9.7E-3
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor		LL	LL	0.049	5.5E-4	9.7E-3
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	LL	LL	0.049	5.5E-4	9.7E-3
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	LL	LL	0.098	1.1E-3	0.019
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	LL	LL	0.011	1.3E-4	2.3E-3
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0.221	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	7E	7E	2.3E-5	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MR	Mercury Retort	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	2.6E-7	0	0	3.1E-6	0
	CKB	Carbon Regeneration Kiln (Burners)	0	8.4E-7	0	0	9.7E-6	0
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	3.7E-8	0	0	4.3E-7	0
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	1.9E-6	0	0	2.2E-5	0
	LKC	PFR Shaft Lime Kiln Combustion	0	5A	5A	0	9.5E-5	0
	LS1	Limestone transfer to Primary Crusher Hopper	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS2	Primary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS3	Primary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323
	LS4	Secondary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS5	Secondary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323

PRI00000755

REC 2095

TABLE B-B2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS8	Ball Mill Feed transfer to Ball	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LSBM	Limestone Ball Mill	0	OOO	OOO	0.043	2.8E-4	0.522
	LS9	Limestone transfer to Kiln Feed Bin	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS11	Fines Screening and Associated Transfers In and Out	0	OOO	OOO	6.3E-3	4.0E-5	0.076
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	5A	5A	7.5E-4	4.8E-6	9.2E-3
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	5A	5A	0.021	1.3E-4	0.251
	LCR	Lime Mill Crushing and associated transfers In and Out	0	5A	5A	6.4E-3	4.1E-5	0
	LSL	Pebble Lime Silo Loading via Bucket Elevator	0	5A	5A	1.4E-4	9.0E-7	0
	LSU	Pebble Lime Silo discharge to Lime Slaker	0	5A	5A	1.4E-5	9.0E-8	0
	LS1L	Mill Lime Silo #1 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	MillS2L	Mill Lime Silo #2 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	ACS1L	AC Lime Silo #1 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS2L	AC Lime Silo #2 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS3L	AC Lime Silo #3 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS4L	AC Lime Silo #4 Loading	0	4.9E-6	2.7E-6	4.7E-4	3.0E-6	0
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
Concrete Production	CM	Central Mixer Loading	0	2.6E-5	8.2E-6	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	8.0E-7	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	8.0E-7	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	8.0E-7	0	0	0	0

PRI00000756

REC 2096

TABLE B-B2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	8.0E-7	0	0	0	0
	CAL	Aggregate Bin Loading	0	OOO	OOO	0.016	1.0E-4	0
	CAU	Aggregate Bin Unloading	0	OOO	OOO	0.016	1.0E-4	0
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	1.9E-7	0	0	2.2E-6	0
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	7.5E-7	0	0	8.6E-6	0
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	1.1E-6	0	0	1.3E-5	0
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	4Z	4Z	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	6C	6C	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	6C	6C	0	0	0
Mining - Modeling Scenario: B2	YPP	Yellow Pine Pit	0	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0	0
	WEP	West End Pit	0	0	0	0	0	0
	BT	Bradley Tailings	0	0.023	0.051	5.567	0.063	1.098
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	8.0E-3	0.017	1.902	0.021	0.375
	STKP	PC Stockpile	0	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	3.6E-3	7.9E-3	0.858	9.7E-3	0.169
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0	0
	HR000	Haul Roads	0	0.028	0.061	6.713	0.076	1.324
	TSF	Tailing Storage Facility	0.232	0	0	0	0	0
	ACCRD	Access Roads	0	4.7E-4	1.0E-3	0.113	1.3E-3	0.022
	UGEXP	Scout Portal	0	1.0E-7	2.3E-7	2.5E-5	2.8E-7	4.9E-6
		Total	**0.453**	**0.064**	**0.139**	**15.801**	**0.178**	**5.232**

PRI00000757

REC 2097

TABLE B-B2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	2.9E-3	0	1.6E-6	4.5E-6
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	0	0	0	0	5.0E-5
	LS1	Limestone transfer to Primary Crusher Hopper	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5

PRI00000758

TABLE B-B2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	0	0	0	0

PRI00000759

TABLE B-B2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	0	0	0	0
	CAL	Aggregate Bin Loading	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	0	0	0	6.8E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	0	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	0	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	0	0	0	0
Mining - Modeling Scenario: B2	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	0	1.427	0	7.8E-4	2.2E-3
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0.488	0	2.7E-4	7.5E-4
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0.220	0	1.2E-4	3.4E-4
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0	1.721	0	9.5E-4	2.6E-3
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**0.696**	**4.097**	**2.030**	**2.7E-3**	**6.8E-3**

PRI00000760

REC 2100

TABLE B-Y1. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	LL	LL	LL	LL	LL
	OC2	Grizzly to Apron Feeder	LL	LL	LL	LL	LL
	OC3	Apron Feeder to Dribble Conveyor	LL	LL	LL	LL	LL
	OC4	Apron Feeder to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC5	Dribble Conveyor to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	LL	LL	LL	LL	LL
	OC9	Stockpile Transfers to Reclaim Conveyors	LL	LL	LL	LL	LL
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	LL	LL	LL	LL	LL
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	LL	LL	LL	LL	LL
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	7E
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	7E
	MR	Mercury Retort	7E	7E	7E	7E	7E
	MF	Induction Melting Furnace	7E	7E	7E	7E	7E
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	7E
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	1.3E-7	7.7E-9	7.0E-7	4.8E-5	1.3E-6
	CKB	Carbon Regeneration Kiln (Burners)	4.1E-7	2.4E-8	2.2E-6	1.5E-4	4.3E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	1.8E-8	1.1E-9	9.9E-8	6.8E-6	1.9E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	9.0E-7	5.4E-8	5.0E-6	3.4E-4	9.5E-6
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	5A
	LS1	Limestone transfer to Primary Crusher Hopper	OOO	OOO	OOO	OOO	OOO
	LS2	Primary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS3	Primary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS4	Secondary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS5	Secondary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO

TABLE B-Y1. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS7	Limestone transfer to Ball Mill Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS8	Ball Mill Feed transfer to Ball	OOO	OOO	OOO	OOO	OOO
	LSBM	Limestone Ball Mill	OOO	OOO	OOO	OOO	OOO
	LS9	Limestone transfer to Kiln Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS11	Fines Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	5A
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	5A
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	5A
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	5A
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	5A
	LS1L	Mill Lime Silo #1 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	MillS2L	Mill Lime Silo #2 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	ACS1L	AC Lime Silo #1 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS2L	AC Lime Silo #2 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS3L	AC Lime Silo #3 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS4L	AC Lime Silo #4 Loading	2.3E-8	7.9E-10	2.5E-10	0	4.9E-9
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	1.1E-7	3.8E-9	1.2E-9	0	2.4E-8
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
Concrete Production	CM	Central Mixer Loading	2.0E-6	0	4.9E-9	0	1.7E-6
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	3.3E-9	0	0	2.9E-7

PRI00000762

TABLE B-Y1. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	OOO
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	OOO
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.9E-9	5.4E-7	3.7E-5	1.0E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.4E-8	2.2E-6	1.5E-4	4.1E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.5E-8	3.2E-6	2.2E-4	6.2E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	4Z	4Z	4Z	4Z	4Z
Fuel Storage	TG1	Mine Site Gasoline Tank #1	6C	6C	6C	6C	6C
	TG2	Mine Site Gasoline Tank #2	6C	6C	6C	6C	6C
Mining - Modeling Scenario: Y1	YPP	Yellow Pine Pit	9.4E-3	4.5E-5	7.0E-6	0	2.8E-5
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0.018	8.6E-5	1.3E-5	0	5.4E-5
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	5.7E-3	2.7E-5	4.3E-6	0	1.7E-5
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0.065	5.5E-4	8.5E-5	0	3.4E-4
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	4.0E-6	5.1E-6	7.9E-7	0	3.2E-6
	UGEXP	Scout Portal	2.3E-7	1.1E-9	1.7E-10	0	7.0E-10
		Total	**0.098**	**7.1E-4**	**1.4E-4**	**1.9E-3**	**5.0E-4**

PRI00000763

REC 2103

TABLE B-Y2. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	LL	LL	LL	LL	LL
	OC2	Grizzly to Apron Feeder	LL	LL	LL	LL	LL
	OC3	Apron Feeder to Dribble Conveyor	LL	LL	LL	LL	LL
	OC4	Apron Feeder to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC5	Dribble Conveyor to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	LL	LL	LL	LL	LL
	OC9	Stockpile Transfers to Reclaim Conveyors	LL	LL	LL	LL	LL
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	LL	LL	LL	LL	LL
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	LL	LL	LL	LL	LL
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	7E
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	7E
	MR	Mercury Retort	7E	7E	7E	7E	7E
	MF	Induction Melting Furnace	7E	7E	7E	7E	7E
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	7E
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	1.3E-7	7.7E-9	7.0E-7	4.8E-5	1.3E-6
	CKB	Carbon Regeneration Kiln (Burners)	4.1E-7	2.4E-8	2.2E-6	1.5E-4	4.3E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	1.8E-8	1.1E-9	9.9E-8	6.8E-6	1.9E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	9.0E-7	5.4E-8	5.0E-6	3.4E-4	9.5E-6
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	5A
	LS1	Limestone transfer to Primary Crusher Hopper	OOO	OOO	OOO	OOO	OOO
	LS2	Primary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS3	Primary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS4	Secondary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS5	Secondary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO

TABLE B-Y2. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS7	Limestone transfer to Ball Mill Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS8	Ball Mill Feed transfer to Ball	OOO	OOO	OOO	OOO	OOO
	LSBM	Limestone Ball Mill	OOO	OOO	OOO	OOO	OOO
	LS9	Limestone transfer to Kiln Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS11	Fines Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	5A
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	5A
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	5A
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	5A
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	5A
	LS1L	Mill Lime Silo #1 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	MillS2L	Mill Lime Silo #2 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	ACS1L	AC Lime Silo #1 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS2L	AC Lime Silo #2 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS3L	AC Lime Silo #3 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS4L	AC Lime Silo #4 Loading	2.3E-8	7.9E-10	2.5E-10	0	4.9E-9
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	1.1E-7	3.8E-9	1.2E-9	0	2.4E-8
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
Concrete Production	CM	Central Mixer Loading	2.0E-6	0	4.9E-9	0	1.7E-6
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	3.3E-9	0	0	2.9E-7

PRI00000765

REC 2105

TABLE B-Y2. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	OOO
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	OOO
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.9E-9	5.4E-7	3.7E-5	1.0E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.4E-8	2.2E-6	1.5E-4	4.1E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.5E-8	3.2E-6	2.2E-4	6.2E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	4Z	4Z	4Z	4Z	4Z
Fuel Storage	TG1	Mine Site Gasoline Tank #1	6C	6C	6C	6C	6C
	TG2	Mine Site Gasoline Tank #2	6C	6C	6C	6C	6C
Mining - Modeling Scenario: Y2	YPP	Yellow Pine Pit	9.4E-3	4.5E-5	7.0E-6	0	2.8E-5
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0.018	8.6E-5	1.3E-5	0	5.4E-5
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	4.2E-3	2.0E-5	3.2E-6	0	1.3E-5
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0.094	7.9E-4	1.2E-4	0	5.0E-4
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	4.0E-6	5.1E-6	7.9E-7	0	3.2E-6
	UGEXP	Scout Portal	2.3E-7	1.1E-9	1.7E-10	0	7.0E-10
		Total	**0.125**	**9.5E-4**	**1.8E-4**	**1.9E-3**	**6.5E-4**

PRI00000766

REC 2106

TABLE B-Y3. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	LL	LL	LL	LL	LL
	OC2	Grizzly to Apron Feeder	LL	LL	LL	LL	LL
	OC3	Apron Feeder to Dribble Conveyor	LL	LL	LL	LL	LL
	OC4	Apron Feeder to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC5	Dribble Conveyor to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	LL	LL	LL	LL	LL
	OC9	Stockpile Transfers to Reclaim Conveyors	LL	LL	LL	LL	LL
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	LL	LL	LL	LL	LL
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	LL	LL	LL	LL	LL
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	7E
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	7E
	MR	Mercury Retort	7E	7E	7E	7E	7E
	MF	Induction Melting Furnace	7E	7E	7E	7E	7E
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	7E
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	1.3E-7	7.7E-9	7.0E-7	4.8E-5	1.3E-6
	CKB	Carbon Regeneration Kiln (Burners)	4.1E-7	2.4E-8	2.2E-6	1.5E-4	4.3E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	1.8E-8	1.1E-9	9.9E-8	6.8E-6	1.9E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	9.0E-7	5.4E-8	5.0E-6	3.4E-4	9.5E-6
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	5A
	LS1	Limestone transfer to Primary Crusher Hopper	OOO	OOO	OOO	OOO	OOO
	LS2	Primary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS3	Primary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS4	Secondary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS5	Secondary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO

TABLE B-Y3. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS7	Limestone transfer to Ball Mill Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS8	Ball Mill Feed transfer to Ball	OOO	OOO	OOO	OOO	OOO
	LSBM	Limestone Ball Mill	OOO	OOO	OOO	OOO	OOO
	LS9	Limestone transfer to Kiln Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS11	Fines Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	5A
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	5A
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	5A
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	5A
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	5A
	LS1L	Mill Lime Silo #1 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	MillS2L	Mill Lime Silo #2 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	ACS1L	AC Lime Silo #1 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS2L	AC Lime Silo #2 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS3L	AC Lime Silo #3 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS4L	AC Lime Silo #4 Loading	2.3E-8	7.9E-10	2.5E-10	0	4.9E-9
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	1.1E-7	3.8E-9	1.2E-9	0	2.4E-8
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
Concrete Production	CM	Central Mixer Loading	2.0E-6	0	4.9E-9	0	1.7E-6
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	3.3E-9	0	0	2.9E-7

PRI00000768

TABLE B-Y3. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	OOO
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	OOO
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.9E-9	5.4E-7	3.7E-5	1.0E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.4E-8	2.2E-6	1.5E-4	4.1E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.5E-8	3.2E-6	2.2E-4	6.2E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	4Z	4Z	4Z	4Z	4Z
Fuel Storage	TG1	Mine Site Gasoline Tank #1	6C	6C	6C	6C	6C
	TG2	Mine Site Gasoline Tank #2	6C	6C	6C	6C	6C
Mining - Modeling Scenario: Y3	YPP	Yellow Pine Pit	9.4E-3	4.5E-5	7.0E-6	0	2.8E-5
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0.018	8.6E-5	1.3E-5	0	5.4E-5
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	4.2E-3	2.0E-5	3.2E-6	0	1.3E-5
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0.150	1.3E-3	2.0E-4	0	7.9E-4
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	4.0E-6	5.1E-6	7.9E-7	0	3.2E-6
	UGEXP	Scout Portal	2.3E-7	1.1E-9	1.7E-10	0	7.0E-10
		Total	**0.182**	**1.4E-3**	**2.5E-4**	**1.9E-3**	**9.5E-4**

TABLE B-H1. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	LL	LL	LL	LL	LL
	OC2	Grizzly to Apron Feeder	LL	LL	LL	LL	LL
	OC3	Apron Feeder to Dribble Conveyor	LL	LL	LL	LL	LL
	OC4	Apron Feeder to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC5	Dribble Conveyor to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	LL	LL	LL	LL	LL
	OC9	Stockpile Transfers to Reclaim Conveyors	LL	LL	LL	LL	LL
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	LL	LL	LL	LL	LL
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	LL	LL	LL	LL	LL
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	7E
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	7E
	MR	Mercury Retort	7E	7E	7E	7E	7E
	MF	Induction Melting Furnace	7E	7E	7E	7E	7E
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	7E
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	1.3E-7	7.7E-9	7.0E-7	4.8E-5	1.3E-6
	CKB	Carbon Regeneration Kiln (Burners)	4.1E-7	2.4E-8	2.2E-6	1.5E-4	4.3E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	1.8E-8	1.1E-9	9.9E-8	6.8E-6	1.9E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	9.0E-7	5.4E-8	5.0E-6	3.4E-4	9.5E-6
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	5A
	LS1	Limestone transfer to Primary Crusher Hopper	OOO	OOO	OOO	OOO	OOO
	LS2	Primary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS3	Primary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS4	Secondary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS5	Secondary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO

TABLE B-H1. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS7	Limestone transfer to Ball Mill Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS8	Ball Mill Feed transfer to Ball	OOO	OOO	OOO	OOO	OOO
	LSBM	Limestone Ball Mill	OOO	OOO	OOO	OOO	OOO
	LS9	Limestone transfer to Kiln Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS11	Fines Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	5A
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	5A
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	5A
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	5A
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	5A
	LS1L	Mill Lime Silo #1 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	MillS2L	Mill Lime Silo #2 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	ACS1L	AC Lime Silo #1 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS2L	AC Lime Silo #2 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS3L	AC Lime Silo #3 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS4L	AC Lime Silo #4 Loading	2.3E-8	7.9E-10	2.5E-10	0	4.9E-9
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	1.1E-7	3.8E-9	1.2E-9	0	2.4E-8
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
Concrete Production	CM	Central Mixer Loading	2.0E-6	0	4.9E-9	0	1.7E-6
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	3.3E-9	0	0	2.9E-7

PRI00000771

REC 2111

TABLE B-H1. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	OOO
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	OOO
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.9E-9	5.4E-7	3.7E-5	1.0E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.4E-8	2.2E-6	1.5E-4	4.1E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.5E-8	3.2E-6	2.2E-4	6.2E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	4Z	4Z	4Z	4Z	4Z
Fuel Storage	TG1	Mine Site Gasoline Tank #1	6C	6C	6C	6C	6C
	TG2	Mine Site Gasoline Tank #2	6C	6C	6C	6C	6C
Mining - Modeling Scenario: H1	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	9.4E-3	4.5E-5	7.0E-6	0	2.8E-5
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0.018	8.6E-5	1.3E-5	0	5.4E-5
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	5.7E-3	2.7E-5	4.3E-6	0	1.7E-5
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0.103	8.7E-4	1.4E-4	0	5.4E-4
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	4.0E-6	5.1E-6	7.9E-7	0	3.2E-6
	UGEXP	Scout Portal	2.3E-7	1.1E-9	1.7E-10	0	7.0E-10
		Total	**0.136**	**1.0E-3**	**1.9E-4**	**1.9E-3**	**7.0E-4**

PRI00000772

REC 2112

TABLE B-H2. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	LL	LL	LL	LL	LL
	OC2	Grizzly to Apron Feeder	LL	LL	LL	LL	LL
	OC3	Apron Feeder to Dribble Conveyor	LL	LL	LL	LL	LL
	OC4	Apron Feeder to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC5	Dribble Conveyor to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	LL	LL	LL	LL	LL
	OC9	Stockpile Transfers to Reclaim Conveyors	LL	LL	LL	LL	LL
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	LL	LL	LL	LL	LL
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	LL	LL	LL	LL	LL
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	7E
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	7E
	MR	Mercury Retort	7E	7E	7E	7E	7E
	MF	Induction Melting Furnace	7E	7E	7E	7E	7E
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	7E
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	1.3E-7	7.7E-9	7.0E-7	4.8E-5	1.3E-6
	CKB	Carbon Regeneration Kiln (Burners)	4.1E-7	2.4E-8	2.2E-6	1.5E-4	4.3E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	1.8E-8	1.1E-9	9.9E-8	6.8E-6	1.9E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	9.0E-7	5.4E-8	5.0E-6	3.4E-4	9.5E-6
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	5A
	LS1	Limestone transfer to Primary Crusher Hopper	OOO	OOO	OOO	OOO	OOO
	LS2	Primary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS3	Primary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS4	Secondary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS5	Secondary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO

TABLE B-H2. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS7	Limestone transfer to Ball Mill Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS8	Ball Mill Feed transfer to Ball	OOO	OOO	OOO	OOO	OOO
	LSBM	Limestone Ball Mill	OOO	OOO	OOO	OOO	OOO
	LS9	Limestone transfer to Kiln Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS11	Fines Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	5A
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	5A
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	5A
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	5A
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	5A
	LS1L	Mill Lime Silo #1 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	MillS2L	Mill Lime Silo #2 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	ACS1L	AC Lime Silo #1 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS2L	AC Lime Silo #2 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS3L	AC Lime Silo #3 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS4L	AC Lime Silo #4 Loading	2.3E-8	7.9E-10	2.5E-10	0	4.9E-9
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	1.1E-7	3.8E-9	1.2E-9	0	2.4E-8
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
Concrete Production	CM	Central Mixer Loading	2.0E-6	0	4.9E-9	0	1.7E-6
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	3.3E-9	0	0	2.9E-7

PRI00000774

REC 2114

TABLE B-H2. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	OOO
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	OOO
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.9E-9	5.4E-7	3.7E-5	1.0E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.4E-8	2.2E-6	1.5E-4	4.1E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.5E-8	3.2E-6	2.2E-4	6.2E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	4Z	4Z	4Z	4Z	4Z
Fuel Storage	TG1	Mine Site Gasoline Tank #1	6C	6C	6C	6C	6C
	TG2	Mine Site Gasoline Tank #2	6C	6C	6C	6C	6C
Mining - Modeling Scenario: H2	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	9.4E-3	4.5E-5	7.0E-6	0	2.8E-5
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0.018	8.6E-5	1.3E-5	0	5.4E-5
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	4.2E-3	2.0E-5	3.2E-6	0	1.3E-5
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0.152	1.3E-3	2.0E-4	0	8.1E-4
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	4.0E-6	5.1E-6	7.9E-7	0	3.2E-6
	UGEXP	Scout Portal	2.3E-7	1.1E-9	1.7E-10	0	7.0E-10
		Total	**0.184**	**1.4E-3**	**2.5E-4**	**1.9E-3**	**9.6E-4**

PRI00000775

REC 2115

TABLE B-H3. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	LL	LL	LL	LL	LL
	OC2	Grizzly to Apron Feeder	LL	LL	LL	LL	LL
	OC3	Apron Feeder to Dribble Conveyor	LL	LL	LL	LL	LL
	OC4	Apron Feeder to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC5	Dribble Conveyor to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	LL	LL	LL	LL	LL
	OC9	Stockpile Transfers to Reclaim Conveyors	LL	LL	LL	LL	LL
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	LL	LL	LL	LL	LL
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	LL	LL	LL	LL	LL
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	7E
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	7E
	MR	Mercury Retort	7E	7E	7E	7E	7E
	MF	Induction Melting Furnace	7E	7E	7E	7E	7E
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	7E
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	1.3E-7	7.7E-9	7.0E-7	4.8E-5	1.3E-6
	CKB	Carbon Regeneration Kiln (Burners)	4.1E-7	2.4E-8	2.2E-6	1.5E-4	4.3E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	1.8E-8	1.1E-9	9.9E-8	6.8E-6	1.9E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	9.0E-7	5.4E-8	5.0E-6	3.4E-4	9.5E-6
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	5A
	LS1	Limestone transfer to Primary Crusher Hopper	OOO	OOO	OOO	OOO	OOO
	LS2	Primary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS3	Primary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS4	Secondary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS5	Secondary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO

TABLE B-H3. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS7	Limestone transfer to Ball Mill Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS8	Ball Mill Feed transfer to Ball	OOO	OOO	OOO	OOO	OOO
	LSBM	Limestone Ball Mill	OOO	OOO	OOO	OOO	OOO
	LS9	Limestone transfer to Kiln Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS11	Fines Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	5A
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	5A
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	5A
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	5A
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	5A
	LS1L	Mill Lime Silo #1 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	MillS2L	Mill Lime Silo #2 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	ACS1L	AC Lime Silo #1 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS2L	AC Lime Silo #2 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS3L	AC Lime Silo #3 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS4L	AC Lime Silo #4 Loading	2.3E-8	7.9E-10	2.5E-10	0	4.9E-9
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	1.1E-7	3.8E-9	1.2E-9	0	2.4E-8
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
Concrete Production	CM	Central Mixer Loading	2.0E-6	0	4.9E-9	0	1.7E-6
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	3.3E-9	0	0	2.9E-7

TABLE B-H3. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	OOO
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	OOO
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.9E-9	5.4E-7	3.7E-5	1.0E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.4E-8	2.2E-6	1.5E-4	4.1E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.5E-8	3.2E-6	2.2E-4	6.2E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	4Z	4Z	4Z	4Z	4Z
Fuel Storage	TG1	Mine Site Gasoline Tank #1	6C	6C	6C	6C	6C
	TG2	Mine Site Gasoline Tank #2	6C	6C	6C	6C	6C
Mining - Modeling Scenario: H3	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	9.4E-3	4.5E-5	7.0E-6	0	2.8E-5
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0.018	8.6E-5	1.3E-5	0	5.4E-5
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	4.2E-3	2.0E-5	3.2E-6	0	1.3E-5
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0.095	8.0E-4	1.2E-4	0	5.0E-4
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	4.0E-6	5.1E-6	7.9E-7	0	3.2E-6
	UGEXP	Scout Portal	2.3E-7	1.1E-9	1.7E-10	0	7.0E-10
		Total	**0.126**	**9.6E-4**	**1.8E-4**	**1.9E-3**	**6.5E-4**

PRI00000778

REC 2118

TABLE B-H4. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	LL	LL	LL	LL	LL
	OC2	Grizzly to Apron Feeder	LL	LL	LL	LL	LL
	OC3	Apron Feeder to Dribble Conveyor	LL	LL	LL	LL	LL
	OC4	Apron Feeder to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC5	Dribble Conveyor to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	LL	LL	LL	LL	LL
	OC9	Stockpile Transfers to Reclaim Conveyors	LL	LL	LL	LL	LL
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	LL	LL	LL	LL	LL
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	LL	LL	LL	LL	LL
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	7E
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	7E
	MR	Mercury Retort	7E	7E	7E	7E	7E
	MF	Induction Melting Furnace	7E	7E	7E	7E	7E
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	7E
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	1.3E-7	7.7E-9	7.0E-7	4.8E-5	1.3E-6
	CKB	Carbon Regeneration Kiln (Burners)	4.1E-7	2.4E-8	2.2E-6	1.5E-4	4.3E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	1.8E-8	1.1E-9	9.9E-8	6.8E-6	1.9E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	9.0E-7	5.4E-8	5.0E-6	3.4E-4	9.5E-6
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	5A
	LS1	Limestone transfer to Primary Crusher Hopper	OOO	OOO	OOO	OOO	OOO
	LS2	Primary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS3	Primary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS4	Secondary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS5	Secondary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO

PRI00000779

REC 2119

TABLE B-H4. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS7	Limestone transfer to Ball Mill Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS8	Ball Mill Feed transfer to Ball	OOO	OOO	OOO	OOO	OOO
	LSBM	Limestone Ball Mill	OOO	OOO	OOO	OOO	OOO
	LS9	Limestone transfer to Kiln Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS11	Fines Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	5A
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	5A
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	5A
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	5A
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	5A
	LS1L	Mill Lime Silo #1 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	MillS2L	Mill Lime Silo #2 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	ACS1L	AC Lime Silo #1 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS2L	AC Lime Silo #2 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS3L	AC Lime Silo #3 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS4L	AC Lime Silo #4 Loading	2.3E-8	7.9E-10	2.5E-10	0	4.9E-9
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	1.1E-7	3.8E-9	1.2E-9	0	2.4E-8
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
Concrete Production	CM	Central Mixer Loading	2.0E-6	0	4.9E-9	0	1.7E-6
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	3.3E-9	0	0	2.9E-7

PRI00000780

TABLE B-H4. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	OOO
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	OOO
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.9E-9	5.4E-7	3.7E-5	1.0E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.4E-8	2.2E-6	1.5E-4	4.1E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.5E-8	3.2E-6	2.2E-4	6.2E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	4Z	4Z	4Z	4Z	4Z
Fuel Storage	TG1	Mine Site Gasoline Tank #1	6C	6C	6C	6C	6C
	TG2	Mine Site Gasoline Tank #2	6C	6C	6C	6C	6C
Mining - Modeling Scenario: H4	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	9.4E-3	4.5E-5	7.0E-6	0	2.8E-5
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0.018	8.6E-5	1.3E-5	0	5.4E-5
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	4.2E-3	2.0E-5	3.2E-6	0	1.3E-5
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0.120	1.0E-3	1.6E-4	0	6.4E-4
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	4.0E-6	5.1E-6	7.9E-7	0	3.2E-6
	UGEXP	Scout Portal	2.3E-7	1.1E-9	1.7E-10	0	7.0E-10
		Total	**0.152**	**1.2E-3**	**2.1E-4**	**1.9E-3**	**7.9E-4**

PRI00000781

REC 2121

TABLE B-W1. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	LL	LL	LL	LL	LL
	OC2	Grizzly to Apron Feeder	LL	LL	LL	LL	LL
	OC3	Apron Feeder to Dribble Conveyor	LL	LL	LL	LL	LL
	OC4	Apron Feeder to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC5	Dribble Conveyor to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	LL	LL	LL	LL	LL
	OC9	Stockpile Transfers to Reclaim Conveyors	LL	LL	LL	LL	LL
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	LL	LL	LL	LL	LL
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	LL	LL	LL	LL	LL
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	7E
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	7E
	MR	Mercury Retort	7E	7E	7E	7E	7E
	MF	Induction Melting Furnace	7E	7E	7E	7E	7E
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	7E
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	1.3E-7	7.7E-9	7.0E-7	4.8E-5	1.3E-6
	CKB	Carbon Regeneration Kiln (Burners)	4.1E-7	2.4E-8	2.2E-6	1.5E-4	4.3E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	1.8E-8	1.1E-9	9.9E-8	6.8E-6	1.9E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	9.0E-7	5.4E-8	5.0E-6	3.4E-4	9.5E-6
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	5A
	LS1	Limestone transfer to Primary Crusher Hopper	OOO	OOO	OOO	OOO	OOO
	LS2	Primary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS3	Primary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS4	Secondary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS5	Secondary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO

TABLE B-W1. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS7	Limestone transfer to Ball Mill Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS8	Ball Mill Feed transfer to Ball	OOO	OOO	OOO	OOO	OOO
	LSBM	Limestone Ball Mill	OOO	OOO	OOO	OOO	OOO
	LS9	Limestone transfer to Kiln Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS11	Fines Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	5A
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	5A
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	5A
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	5A
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	5A
	LS1L	Mill Lime Silo #1 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	MillS2L	Mill Lime Silo #2 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	ACS1L	AC Lime Silo #1 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS2L	AC Lime Silo #2 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS3L	AC Lime Silo #3 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS4L	AC Lime Silo #4 Loading	2.3E-8	7.9E-10	2.5E-10	0	4.9E-9
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	1.1E-7	3.8E-9	1.2E-9	0	2.4E-8
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
Concrete Production	CM	Central Mixer Loading	2.0E-6	0	4.9E-9	0	1.7E-6
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	3.3E-9	0	0	2.9E-7

PRI00000783

TABLE B-W1. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	OOO
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	OOO
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.9E-9	5.4E-7	3.7E-5	1.0E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.4E-8	2.2E-6	1.5E-4	4.1E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.5E-8	3.2E-6	2.2E-4	6.2E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	4Z	4Z	4Z	4Z	4Z
Fuel Storage	TG1	Mine Site Gasoline Tank #1	6C	6C	6C	6C	6C
	TG2	Mine Site Gasoline Tank #2	6C	6C	6C	6C	6C
Mining - Modeling Scenario: W1	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	9.4E-3	4.5E-5	7.0E-6	0	2.8E-5
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0.018	8.6E-5	1.3E-5	0	5.4E-5
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	5.7E-3	2.7E-5	4.3E-6	0	1.7E-5
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0.089	7.5E-4	1.2E-4	0	4.7E-4
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	4.0E-6	5.1E-6	7.9E-7	0	3.2E-6
	UGEXP	Scout Portal	2.3E-7	1.1E-9	1.7E-10	0	7.0E-10
		Total	**0.122**	**9.1E-4**	**1.7E-4**	**1.9E-3**	**6.3E-4**

PRI00000784

REC 2124

TABLE B-W2. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	LL	LL	LL	LL	LL
	OC2	Grizzly to Apron Feeder	LL	LL	LL	LL	LL
	OC3	Apron Feeder to Dribble Conveyor	LL	LL	LL	LL	LL
	OC4	Apron Feeder to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC5	Dribble Conveyor to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	LL	LL	LL	LL	LL
	OC9	Stockpile Transfers to Reclaim Conveyors	LL	LL	LL	LL	LL
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	LL	LL	LL	LL	LL
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	LL	LL	LL	LL	LL
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	7E
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	7E
	MR	Mercury Retort	7E	7E	7E	7E	7E
	MF	Induction Melting Furnace	7E	7E	7E	7E	7E
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	7E
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	1.3E-7	7.7E-9	7.0E-7	4.8E-5	1.3E-6
	CKB	Carbon Regeneration Kiln (Burners)	4.1E-7	2.4E-8	2.2E-6	1.5E-4	4.3E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	1.8E-8	1.1E-9	9.9E-8	6.8E-6	1.9E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	9.0E-7	5.4E-8	5.0E-6	3.4E-4	9.5E-6
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	5A
	LS1	Limestone transfer to Primary Crusher Hopper	OOO	OOO	OOO	OOO	OOO
	LS2	Primary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS3	Primary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS4	Secondary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS5	Secondary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO

TABLE B-W2. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS7	Limestone transfer to Ball Mill Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS8	Ball Mill Feed transfer to Ball	OOO	OOO	OOO	OOO	OOO
	LSBM	Limestone Ball Mill	OOO	OOO	OOO	OOO	OOO
	LS9	Limestone transfer to Kiln Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS11	Fines Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	5A
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	5A
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	5A
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	5A
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	5A
	LS1L	Mill Lime Silo #1 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	MillS2L	Mill Lime Silo #2 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	ACS1L	AC Lime Silo #1 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS2L	AC Lime Silo #2 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS3L	AC Lime Silo #3 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS4L	AC Lime Silo #4 Loading	2.3E-8	7.9E-10	2.5E-10	0	4.9E-9
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	1.1E-7	3.8E-9	1.2E-9	0	2.4E-8
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
Concrete Production	CM	Central Mixer Loading	2.0E-6	0	4.9E-9	0	1.7E-6
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	3.3E-9	0	0	2.9E-7

PRI00000786

TABLE B-W2. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	OOO
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	OOO
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.9E-9	5.4E-7	3.7E-5	1.0E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.4E-8	2.2E-6	1.5E-4	4.1E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.5E-8	3.2E-6	2.2E-4	6.2E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	4Z	4Z	4Z	4Z	4Z
Fuel Storage	TG1	Mine Site Gasoline Tank #1	6C	6C	6C	6C	6C
	TG2	Mine Site Gasoline Tank #2	6C	6C	6C	6C	6C
Mining - Modeling Scenario: W2	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	9.4E-3	4.5E-5	7.0E-6	0	2.8E-5
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0.018	8.6E-5	1.3E-5	0	5.4E-5
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	4.2E-3	2.0E-5	3.2E-6	0	1.3E-5
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0.141	1.2E-3	1.9E-4	0	7.5E-4
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	4.0E-6	5.1E-6	7.9E-7	0	3.2E-6
	UGEXP	Scout Portal	2.3E-7	1.1E-9	1.7E-10	0	7.0E-10
		Total	**0.173**	**1.3E-3**	**2.4E-4**	**1.9E-3**	**9.0E-4**

PRI00000787

TABLE B-W3. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	LL	LL	LL	LL	LL
	OC2	Grizzly to Apron Feeder	LL	LL	LL	LL	LL
	OC3	Apron Feeder to Dribble Conveyor	LL	LL	LL	LL	LL
	OC4	Apron Feeder to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC5	Dribble Conveyor to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	LL	LL	LL	LL	LL
	OC9	Stockpile Transfers to Reclaim Conveyors	LL	LL	LL	LL	LL
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	LL	LL	LL	LL	LL
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	LL	LL	LL	LL	LL
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	7E
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	7E
	MR	Mercury Retort	7E	7E	7E	7E	7E
	MF	Induction Melting Furnace	7E	7E	7E	7E	7E
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	7E
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	1.3E-7	7.7E-9	7.0E-7	4.8E-5	1.3E-6
	CKB	Carbon Regeneration Kiln (Burners)	4.1E-7	2.4E-8	2.2E-6	1.5E-4	4.3E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	1.8E-8	1.1E-9	9.9E-8	6.8E-6	1.9E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	9.0E-7	5.4E-8	5.0E-6	3.4E-4	9.5E-6
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	5A
	LS1	Limestone transfer to Primary Crusher Hopper	OOO	OOO	OOO	OOO	OOO
	LS2	Primary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS3	Primary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS4	Secondary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS5	Secondary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO

TABLE B-W3. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS7	Limestone transfer to Ball Mill Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS8	Ball Mill Feed transfer to Ball	OOO	OOO	OOO	OOO	OOO
	LSBM	Limestone Ball Mill	OOO	OOO	OOO	OOO	OOO
	LS9	Limestone transfer to Kiln Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS11	Fines Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	5A
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	5A
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	5A
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	5A
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	5A
	LS1L	Mill Lime Silo #1 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	MillS2L	Mill Lime Silo #2 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	ACS1L	AC Lime Silo #1 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS2L	AC Lime Silo #2 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS3L	AC Lime Silo #3 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS4L	AC Lime Silo #4 Loading	2.3E-8	7.9E-10	2.5E-10	0	4.9E-9
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	1.1E-7	3.8E-9	1.2E-9	0	2.4E-8
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
Concrete Production	CM	Central Mixer Loading	2.0E-6	0	4.9E-9	0	1.7E-6
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	3.3E-9	0	0	2.9E-7

PRI00000789

REC 2129

TABLE B-W3. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	OOO
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	OOO
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.9E-9	5.4E-7	3.7E-5	1.0E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.4E-8	2.2E-6	1.5E-4	4.1E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.5E-8	3.2E-6	2.2E-4	6.2E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	4Z	4Z	4Z	4Z	4Z
Fuel Storage	TG1	Mine Site Gasoline Tank #1	6C	6C	6C	6C	6C
	TG2	Mine Site Gasoline Tank #2	6C	6C	6C	6C	6C
Mining - Modeling Scenario: W3	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	9.4E-3	4.5E-5	7.0E-6	0	2.8E-5
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0.018	8.6E-5	1.3E-5	0	5.4E-5
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	4.2E-3	2.0E-5	3.2E-6	0	1.3E-5
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0.201	1.7E-3	2.7E-4	0	1.1E-3
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	4.0E-6	5.1E-6	7.9E-7	0	3.2E-6
	UGEXP	Scout Portal	2.3E-7	1.1E-9	1.7E-10	0	7.0E-10
		Total	**0.232**	**1.9E-3**	**3.2E-4**	**1.9E-3**	**1.2E-3**

PRI00000790

REC 2130

TABLE B-W4. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	LL	LL	LL	LL	LL
	OC2	Grizzly to Apron Feeder	LL	LL	LL	LL	LL
	OC3	Apron Feeder to Dribble Conveyor	LL	LL	LL	LL	LL
	OC4	Apron Feeder to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC5	Dribble Conveyor to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	LL	LL	LL	LL	LL
	OC9	Stockpile Transfers to Reclaim Conveyors	LL	LL	LL	LL	LL
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	LL	LL	LL	LL	LL
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	LL	LL	LL	LL	LL
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	7E
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	7E
	MR	Mercury Retort	7E	7E	7E	7E	7E
	MF	Induction Melting Furnace	7E	7E	7E	7E	7E
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	7E
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	1.3E-7	7.7E-9	7.0E-7	4.8E-5	1.3E-6
	CKB	Carbon Regeneration Kiln (Burners)	4.1E-7	2.4E-8	2.2E-6	1.5E-4	4.3E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	1.8E-8	1.1E-9	9.9E-8	6.8E-6	1.9E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	9.0E-7	5.4E-8	5.0E-6	3.4E-4	9.5E-6
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	5A
	LS1	Limestone transfer to Primary Crusher Hopper	OOO	OOO	OOO	OOO	OOO
	LS2	Primary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS3	Primary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS4	Secondary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS5	Secondary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO

TABLE B-W4. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS7	Limestone transfer to Ball Mill Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS8	Ball Mill Feed transfer to Ball	OOO	OOO	OOO	OOO	OOO
	LSBM	Limestone Ball Mill	OOO	OOO	OOO	OOO	OOO
	LS9	Limestone transfer to Kiln Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS11	Fines Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	5A
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	5A
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	5A
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	5A
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	5A
	LS1L	Mill Lime Silo #1 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	MillS2L	Mill Lime Silo #2 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	ACS1L	AC Lime Silo #1 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS2L	AC Lime Silo #2 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS3L	AC Lime Silo #3 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS4L	AC Lime Silo #4 Loading	2.3E-8	7.9E-10	2.5E-10	0	4.9E-9
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	1.1E-7	3.8E-9	1.2E-9	0	2.4E-8
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
Concrete Production	CM	Central Mixer Loading	2.0E-6	0	4.9E-9	0	1.7E-6
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	3.3E-9	0	0	2.9E-7

PRI00000792

REC 2132

TABLE B-W4. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	OOO
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	OOO
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.9E-9	5.4E-7	3.7E-5	1.0E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.4E-8	2.2E-6	1.5E-4	4.1E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.5E-8	3.2E-6	2.2E-4	6.2E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	4Z	4Z	4Z	4Z	4Z
Fuel Storage	TG1	Mine Site Gasoline Tank #1	6C	6C	6C	6C	6C
	TG2	Mine Site Gasoline Tank #2	6C	6C	6C	6C	6C
Mining - Modeling Scenario: W4	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	9.4E-3	4.5E-5	7.0E-6	0	2.8E-5
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0.018	8.6E-5	1.3E-5	0	5.4E-5
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	4.2E-3	2.0E-5	3.2E-6	0	1.3E-5
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0.092	7.8E-4	1.2E-4	0	4.9E-4
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	4.0E-6	5.1E-6	7.9E-7	0	3.2E-6
	UGEXP	Scout Portal	2.3E-7	1.1E-9	1.7E-10	0	7.0E-10
		Total	**0.124**	**9.4E-4**	**1.7E-4**	**1.9E-3**	**6.4E-4**

PRI00000793

REC 2133

TABLE B-W5. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	LL	LL	LL	LL	LL
	OC2	Grizzly to Apron Feeder	LL	LL	LL	LL	LL
	OC3	Apron Feeder to Dribble Conveyor	LL	LL	LL	LL	LL
	OC4	Apron Feeder to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC5	Dribble Conveyor to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	LL	LL	LL	LL	LL
	OC9	Stockpile Transfers to Reclaim Conveyors	LL	LL	LL	LL	LL
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	LL	LL	LL	LL	LL
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	LL	LL	LL	LL	LL
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	7E
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	7E
	MR	Mercury Retort	7E	7E	7E	7E	7E
	MF	Induction Melting Furnace	7E	7E	7E	7E	7E
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	7E
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	1.3E-7	7.7E-9	7.0E-7	4.8E-5	1.3E-6
	CKB	Carbon Regeneration Kiln (Burners)	4.1E-7	2.4E-8	2.2E-6	1.5E-4	4.3E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	1.8E-8	1.1E-9	9.9E-8	6.8E-6	1.9E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	9.0E-7	5.4E-8	5.0E-6	3.4E-4	9.5E-6
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	5A
	LS1	Limestone transfer to Primary Crusher Hopper	OOO	OOO	OOO	OOO	OOO
	LS2	Primary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS3	Primary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS4	Secondary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS5	Secondary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO

PRI00000794

TABLE B-W5. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS7	Limestone transfer to Ball Mill Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS8	Ball Mill Feed transfer to Ball	OOO	OOO	OOO	OOO	OOO
	LSBM	Limestone Ball Mill	OOO	OOO	OOO	OOO	OOO
	LS9	Limestone transfer to Kiln Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS11	Fines Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	5A
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	5A
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	5A
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	5A
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	5A
	LS1L	Mill Lime Silo #1 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	MillS2L	Mill Lime Silo #2 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	ACS1L	AC Lime Silo #1 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS2L	AC Lime Silo #2 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS3L	AC Lime Silo #3 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS4L	AC Lime Silo #4 Loading	2.3E-8	7.9E-10	2.5E-10	0	4.9E-9
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	1.1E-7	3.8E-9	1.2E-9	0	2.4E-8
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
Concrete Production	CM	Central Mixer Loading	2.0E-6	0	4.9E-9	0	1.7E-6
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	3.3E-9	0	0	2.9E-7

PRI00000795

TABLE B-W5. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	OOO
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	OOO
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.9E-9	5.4E-7	3.7E-5	1.0E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.4E-8	2.2E-6	1.5E-4	4.1E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.5E-8	3.2E-6	2.2E-4	6.2E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	4Z	4Z	4Z	4Z	4Z
Fuel Storage	TG1	Mine Site Gasoline Tank #1	6C	6C	6C	6C	6C
	TG2	Mine Site Gasoline Tank #2	6C	6C	6C	6C	6C
Mining - Modeling Scenario: W5	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	9.4E-3	4.5E-5	7.0E-6	0	2.8E-5
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0.018	8.6E-5	1.3E-5	0	5.4E-5
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	4.2E-3	2.0E-5	3.2E-6	0	1.3E-5
	HR000	Haul Roads	0.101	8.6E-4	1.3E-4	0	5.4E-4
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	4.0E-6	5.1E-6	7.9E-7	0	3.2E-6
	UGEXP	Scout Portal	2.3E-7	1.1E-9	1.7E-10	0	7.0E-10
		Total	**0.133**	**1.0E-3**	**1.9E-4**	**1.9E-3**	**6.9E-4**

PRI00000796

REC 2136

TABLE B-B1. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	LL	LL	LL	LL	LL
	OC2	Grizzly to Apron Feeder	LL	LL	LL	LL	LL
	OC3	Apron Feeder to Dribble Conveyor	LL	LL	LL	LL	LL
	OC4	Apron Feeder to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC5	Dribble Conveyor to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	LL	LL	LL	LL	LL
	OC9	Stockpile Transfers to Reclaim Conveyors	LL	LL	LL	LL	LL
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	LL	LL	LL	LL	LL
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	LL	LL	LL	LL	LL
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	7E
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	7E
	MR	Mercury Retort	7E	7E	7E	7E	7E
	MF	Induction Melting Furnace	7E	7E	7E	7E	7E
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	7E
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	1.3E-7	7.7E-9	7.0E-7	4.8E-5	1.3E-6
	CKB	Carbon Regeneration Kiln (Burners)	4.1E-7	2.4E-8	2.2E-6	1.5E-4	4.3E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	1.8E-8	1.1E-9	9.9E-8	6.8E-6	1.9E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	9.0E-7	5.4E-8	5.0E-6	3.4E-4	9.5E-6
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	5A
	LS1	Limestone transfer to Primary Crusher Hopper	OOO	OOO	OOO	OOO	OOO
	LS2	Primary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS3	Primary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS4	Secondary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS5	Secondary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO

PRI00000797

TABLE B-B1. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS7	Limestone transfer to Ball Mill Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS8	Ball Mill Feed transfer to Ball	OOO	OOO	OOO	OOO	OOO
	LSBM	Limestone Ball Mill	OOO	OOO	OOO	OOO	OOO
	LS9	Limestone transfer to Kiln Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS11	Fines Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	5A
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	5A
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	5A
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	5A
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	5A
	LS1L	Mill Lime Silo #1 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	MillS2L	Mill Lime Silo #2 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	ACS1L	AC Lime Silo #1 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS2L	AC Lime Silo #2 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS3L	AC Lime Silo #3 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS4L	AC Lime Silo #4 Loading	2.3E-8	7.9E-10	2.5E-10	0	4.9E-9
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	1.1E-7	3.8E-9	1.2E-9	0	2.4E-8
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
Concrete Production	CM	Central Mixer Loading	2.0E-6	0	4.9E-9	0	1.7E-6
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	3.3E-9	0	0	2.9E-7

PRI00000798

REC 2138

TABLE B-B1. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	OOO
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	OOO
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.9E-9	5.4E-7	3.7E-5	1.0E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.4E-8	2.2E-6	1.5E-4	4.1E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.5E-8	3.2E-6	2.2E-4	6.2E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	4Z	4Z	4Z	4Z	4Z
Fuel Storage	TG1	Mine Site Gasoline Tank #1	6C	6C	6C	6C	6C
	TG2	Mine Site Gasoline Tank #2	6C	6C	6C	6C	6C
Mining - Modeling Scenario: B1	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	9.2E-3	4.4E-5	6.9E-6	0	2.8E-5
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0.018	8.6E-5	1.3E-5	0	5.4E-5
	STKP	PC Stockpile	5.7E-3	2.7E-5	4.3E-6	0	1.7E-5
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0.117	9.9E-4	1.5E-4	0	6.2E-4
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	4.0E-6	5.1E-6	7.9E-7	0	3.2E-6
	UGEXP	Scout Portal	2.3E-7	1.1E-9	1.7E-10	0	7.0E-10
		Total	**0.149**	**1.1E-3**	**2.1E-4**	**1.9E-3**	**7.7E-4**

PRI00000799

REC 2139

TABLE B-B2. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	LL	LL	LL	LL	LL
	OC2	Grizzly to Apron Feeder	LL	LL	LL	LL	LL
	OC3	Apron Feeder to Dribble Conveyor	LL	LL	LL	LL	LL
	OC4	Apron Feeder to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC5	Dribble Conveyor to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	LL	LL	LL	LL	LL
	OC9	Stockpile Transfers to Reclaim Conveyors	LL	LL	LL	LL	LL
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	LL	LL	LL	LL	LL
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	LL	LL	LL	LL	LL
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	7E
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	7E
	MR	Mercury Retort	7E	7E	7E	7E	7E
	MF	Induction Melting Furnace	7E	7E	7E	7E	7E
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	7E
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	1.3E-7	7.7E-9	7.0E-7	4.8E-5	1.3E-6
	CKB	Carbon Regeneration Kiln (Burners)	4.1E-7	2.4E-8	2.2E-6	1.5E-4	4.3E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	1.8E-8	1.1E-9	9.9E-8	6.8E-6	1.9E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	9.0E-7	5.4E-8	5.0E-6	3.4E-4	9.5E-6
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	5A
	LS1	Limestone transfer to Primary Crusher Hopper	OOO	OOO	OOO	OOO	OOO
	LS2	Primary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS3	Primary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS4	Secondary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS5	Secondary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO

TABLE B-B2. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS7	Limestone transfer to Ball Mill Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS8	Ball Mill Feed transfer to Ball	OOO	OOO	OOO	OOO	OOO
	LSBM	Limestone Ball Mill	OOO	OOO	OOO	OOO	OOO
	LS9	Limestone transfer to Kiln Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS11	Fines Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	5A
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	5A
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	5A
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	5A
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	5A
	LS1L	Mill Lime Silo #1 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	MillS2L	Mill Lime Silo #2 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	ACS1L	AC Lime Silo #1 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS2L	AC Lime Silo #2 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS3L	AC Lime Silo #3 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS4L	AC Lime Silo #4 Loading	2.3E-8	7.9E-10	2.5E-10	0	4.9E-9
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	1.1E-7	3.8E-9	1.2E-9	0	2.4E-8
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
Concrete Production	CM	Central Mixer Loading	2.0E-6	0	4.9E-9	0	1.7E-6
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	3.3E-9	0	0	2.9E-7

PRI00000801

REC 2141

TABLE B-B2. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	OOO
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	OOO
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.9E-9	5.4E-7	3.7E-5	1.0E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.4E-8	2.2E-6	1.5E-4	4.1E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.5E-8	3.2E-6	2.2E-4	6.2E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	4Z	4Z	4Z	4Z	4Z
Fuel Storage	TG1	Mine Site Gasoline Tank #1	6C	6C	6C	6C	6C
	TG2	Mine Site Gasoline Tank #2	6C	6C	6C	6C	6C
Mining - Modeling Scenario: B2	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	9.2E-3	4.4E-5	6.9E-6	0	2.8E-5
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0.018	8.6E-5	1.3E-5	0	5.4E-5
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	4.2E-3	2.0E-5	3.2E-6	0	1.3E-5
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0.030	2.5E-4	4.0E-5	0	1.6E-4
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	4.0E-6	5.1E-6	7.9E-7	0	3.2E-6
	UGEXP	Scout Portal	2.3E-7	1.1E-9	1.7E-10	0	7.0E-10
		Total	**0.061**	**4.1E-4**	**9.2E-5**	**1.9E-3**	**3.1E-4**

PRI00000802

REC 2142

Appendix C – TAP Modeling Results

TABLE C. TAP Maximum Modeled Concentrations and AACs

	TAP Maximum Modeled Concentrations by Model Scenario																	
	Y1	Y2	Y3	H1	H2	H3	H4	W1 [2]	W2 [2]	W3 [2]	W4 [2]	W5 [3]	B1	B2	Max Scenario			Compl-
Pollutant	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	ID	AAC [4]	iance
Aluminum	1.13561	1.41646	1.13855	1.19028	1.28403	1.09010	1.17371	6.01079	5.27252	6.00999	4.97175	6.17075	1.17437	0.97352	6.17075	W5	500	Yes
Arsenic [1]	0.00030	0.00049	0.00029	0.00023	0.00053	0.00020	0.00021	0.00091	0.00095	0.00090	0.00087	N/A	0.00024	0.00012	0.00095	W2	0.0023	Yes
Barium	0.01279	0.01595	0.01282	0.01341	0.01446	0.01228	0.01322	0.06773	0.05941	0.06772	0.05602	0.06953	0.01323	0.01097	0.06953	W5	25	Yes
Beryllium [1]	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00001	0.00001	0.00001	0.00001	N/A	0.00000	0.00000	0.00001	W1	0.042	Yes
Cadmium [1]	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000002	0.000002	0.000002	0.000002	N/A	0.000000	0.000000	0.000002	W1	0.0056	Yes
Calcium Carbonate	0.34375	0.33431	0.37347	0.39124	0.38168	0.37132	0.38141	1.18652	1.04095	1.18637	0.98165	1.21807	0.39107	0.34851	1.21807	W5	500	Yes
Calcium Oxide	0.14837	0.14837	0.14837	0.14837	0.14837	0.14837	0.14837	0.14837	0.14837	0.14837	0.14837	0.14837	0.14837	0.14837	0.14837	ALL	100	Yes
Cyanide	0.19651	0.19651	0.19651	0.19651	0.19651	0.19651	0.19651	0.19651	0.19651	0.19651	0.19651	0.19651	0.19651	0.19651	0.19651	ALL	250	Yes
Formaldehyde [1]	0.00007	0.00007	0.00007	0.00007	0.00007	0.00007	0.00007	0.00007	0.00007	0.00007	0.00007	N/A	0.00007	0.00007	0.00007	ALL	0.77	Yes
Iron	0.29143	0.36343	0.29219	0.30525	0.32952	0.27957	0.30100	1.54079	1.35154	1.54058	1.27445	1.58179	0.30110	0.24962	1.58179	W5	50	Yes
Manganese	0.00477	0.00595	0.00478	0.00500	0.00538	0.00458	0.00493	0.02531	0.02220	0.02531	0.02094	0.02599	0.00494	0.00410	0.02599	W5	250	Yes
Nickel [1]	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00001	0.00001	0.00001	0.00001	N/A	0.00000	0.00000	0.00001	W1	0.42	Yes
Phosphorus	0.01036	0.01293	0.01039	0.01088	0.01169	0.00996	0.01073	0.05502	0.04827	0.05502	0.04551	0.05649	0.01074	0.00891	0.05649	W5	5	Yes
Sulfuric Acid	0.41149	0.41149	0.41149	0.41149	0.41149	0.41149	0.41149	0.41149	0.41149	0.41149	0.41149	0.41149	0.41149	0.41149	0.41149	ALL	50	Yes
Thallium	0.00016	0.00020	0.00016	0.00017	0.00018	0.00016	0.00017	0.00085	0.00074	0.00085	0.00070	0.00087	0.00017	0.00014	0.00087	W5	5	Yes
Vanadium	0.00045	0.00056	0.00045	0.00047	0.00051	0.00043	0.00046	0.00237	0.00208	0.00237	0.00196	0.00243	0.00046	0.00039	0.00243	W5	2.5	Yes

[1] Carcinogenic TAP concentrations adjusted for 70-year exposure, as discussed in Section 3.4.4.
[2] Carcinogenic TAP concentrations adjusted for the West End pit LOM production limit, as discussed in Section 3.4.5.
[3] Modeling Scenario W5 is eliminated for carcinogenic TAP compliance, as discussed in Section 3.4.5.
[4] The AACs for carcinogenic pollutants are increased by a factor of ten per IDAPA 58.01.01.210.12(b);T-RACT adjustment.

PRI00000804

REC 2144

Appendix D – Electronic Files

The electronic modeling files, emission inventory file, and Addendum references can be accessed via the following link:

https://drive.google.com/drive/folders/1o0-uNIu5DRds8hLShaD_0nPEBnlEJFCQ?usp=sharing

PRI00000806

REC 2146

To: Ian[ian@terrafound.org]; Kelli Wetzel[Kelli.Wetzel@deq.idaho.gov]; Preserve Protect[savethesouthforksalmon@gmail.com]; Josh Johnson[jjohnson@idahoconservation.org]; Julie Simpson[julies@nezperce.org]; Mary Fauci[maryf@nezperce.org]; Darrin Pampaian[Darrin.Pampaian@deq.idaho.gov]
Cc: Pao Baylon[Pao.Baylon@deq.idaho.gov]
From: Kevin Schilling[/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=1E66EDFE8D22405890A87EFEA72C3893-KEVIN SCHIL]
Sent: Tue 2/22/2022 2:06:22 PM (UTC-07:00)
Subject: Re: DEQ contacts

Ian,

Pao Baylon, DEQ's air modeler for the project, drafted the response to your questions as shown below. Pao is currently out of the office, so if you have additional questions on how modeling was performed and evaluated, please contact me at your convenience.

Regards,

Kevin Schilling

Kevin Schilling | Air Quality Dispersion Modeling Supervisor
Idaho Department of Environmental Quality
1410 N Hilton, Boise, ID 83706
Office phone: (208) 373-0112
Personal cell phone: (208) 921-3336
https://www.deq.idaho.gov/

Our mission: To protect public health and the quality of Idaho's air, land, and water.

*****

I am unable to confirm the calculation of the maximum annual arsenic concentration proposed for comparison to the AAC. The value appears in cell M8 of Table C in Tab C of the IDEQ spreadsheet provided and also in the Midas Gold spreadsheet referenced in the T-RACT analysis attached to the Statement of Basis. The values on Line 8 are copied as values and apparently are derived through weighting calculations from Line 29. The maximum value in Line 29 is .00698 ug/m3, and is apparently adjusted to reflect mine operation life and other averaging manipulations to reach the .00095 ug/m3 on line 8, although the adjustment does not appear to be consistent for the various scenarios.

First, the value in cell M8 was compared to the T-RACT AACC, ***not the AAC***. AACC stands for Acceptable Ambient Concentration of a Carcinogen and pertains to carcinogens; AAC stands for Acceptable Ambient Concentration of a Non-Carcinogen and pertains to non-carcinogens. Arsenic is a carcinogen. T-RACT stands for Toxic Air Pollutant Reasonably Available Control Technology and allows the AACCs to be increased by a factor of ten per *Idaho Air Rules* Section 210.12(b).

Second, the value in cell M29 (0.00698 $\mu g/m^3$) is a model output (meaning, a concentration derived from running the model); no adjustments were applied to this value. The value in cell M8 (0.00095 $\mu g/m^3$) is an adjusted value that was calculated based on the value in cell M29 and the highest-impact non-W Scenario. Please refer to Section 5.8 of DEQ's *TAPs Addendum Modeling Review Attachment* for an explanation of the calculation adjustment method (or see discussion below). It is important to note that each adjustment was performed *at each receptor*.

The complexity and extensiveness of the dispersion modeling impact analyses necessitated using two groups of modeling runs: 1) West End Pit Scenarios (4 separate scenarios); 2) non-West End Pit Scenarios (9 separate scenarios). At each receptor, the maximum impact was determined from results of the West End Pit scenarios and results from the non-West End Pit scenarios. The results for all scenarios were modeled using a continual mine production level of 135,000 tons/day for a total life-of-mine production of 788.4 million tons. It was assumed that the worst-case West End Pit scenario could only be associated with 50% of the life-of-mine production and the other 50% would be associated with the worst-case of non-West End Pit scenarios. This is a very conservative approach because the maximum actual production from any of the scenarios is well below 50%. This merging of worst-case West End Pit scenarios and worst-case non-West End Pit scenarios (including the 50% adjustment to maintain a total life-of-mine production of 788.4 million tons) was performed in a post-modeling spreadsheet analysis.

As a reminder, the highest modeled arsenic concentration is predicted to occur for Modeling Scenario W2. When running Modeling

Scenario W2 *only*, the highest-impact concentration is 0.00700 µg/m^3, which is predicted to occur at four distinct receptors:

Easting (meters)	Northing (meters)	Max. Modeled Arsenic Concentration for Scenario W2 (in µg/m^3)
635,099.5	4,977,858.8	0.00700
635,124.5	4,977,858.8	0.00700
635,124.5	4,977,883.8	0.00700
635,099.5	4,977,883.8	0.00700

Note that the four West End Pit modeling scenarios (W1–W4) were evaluated using the 70-year lifetime exposure equation and adjusting for the proposed West End Pit life-of-mine production limit of 50% of the total production. The equation provided in Section 5.8 of DEQ's *TAPs Addendum Modeling Review Attachment* was used to calculate the lifetime arsenic exposure from the West End Pit scenarios (W1–W4) on *a receptor-by-receptor basis*. Combining the concentrations from Modeling Scenarios W1–W4 with the highest concentration from the remaining non-West End Pit scenarios (B1, B2, H1, H2, H3, H4, Y1, Y2, or Y3) conservatively ensures that the maximum potential impacts from applicable sources are evaluated and remain below T-RACT AACCs.

After adjusting for lifetime exposure and for the proposed West End Pit life-of-mine production limit of 50% of the total production of the mine (50% of 788.4 million tons), the maximum lifetime arsenic exposure (cell M8) is 0.00095 µg/m^3, which is predicted to occur at the one receptor listed below. The arsenic impact when running only Modeling Scenario W2 at this receptor is 0.00698 µg/m^3 (cell M29).

Easting (meters)	Northing (meters)	Modeled Arsenic Concentration for Scenario W2 (in µg/m^3)	Max. Modeled Arsenic Concentration for non-W Scenarios (in µg/m^3)	Max. Lifetime Arsenic Exposure for Comparison with T-RACT AACC (in µg/m^3)
635,124.5	4,977,833.8	0.00698	0.00129	0.00095

To summarize, the maximum lifetime arsenic exposure was calculated using this equation:

where *n* represents the receptor with Easting = 635,124.5 meters and Northing = 4,977,833.8 meters.

Finally, DEQ disagrees with the statement that "the adjustment does not appear to be consistent for the various scenarios." DEQ's Modeling Team performed additional analyses to verify the applicant's results and we can confirm that the adjustment was performed for ***ALL*** modeling scenarios. Therefore, the arsenic impact adjustment is consistent for all modeling scenarios.

The values in line 29 are also copied as values and I have been unable to find the original formulae for deriving these values or making the modification to the line 8 compliance assertion values. There are several confusing averaging modifications regarding mine life, 5 year running averages, potential versus LOM considerations, etc.

You can't find any formulae for deriving the values in Line 29 because these are the raw model outputs (although technically speaking, the equations governing dispersion, energy balance, and stable and convective boundary layer mixing are "formulae" that were employed to derive the Line 29 values, but these are formulae and equations already embedded in the air dispersion

model and are neither applicant-generated nor DEQ-generated). Again, no post-processing calculations were performed to derive the Line 29 values; these are values that were derived from the modeling output files. The modeling output files are available from DEQ's Content Manager (Record Number: 2021AAG1772); you may request these files through the public records request process. On the other hand, the value in Line 8 is an adjusted value that was calculated based on the value in Line 29 and the highest-impact non-W Scenario *at each receptor*. An explanation for the calculation method is provided in Section 5.8 of DEQ's *TAPs Addendum Modeling Review Attachment*.

There also seems to be confusing information regarding the genesis of the .00698 ug/m3 As value in cell M29. Is this the modeled variable or is it an adjusted post- AQ-modeling value derived from other As or particulate AQ model results?

The 0.00698 µg/m^3 value listed in cell M29 is a model output that was derived from running Modeling Scenario W2 alone. It is ***not*** a "modeled variable." It is ***not*** an "adjusted post-AQ-modeling value derived from other As or particulate AQ model results." It is a value that can be extracted from the modeling output files. You may request these files through the public records request process (DEQ Content Manager Record Number: 2021AAG1772).

In either case, what are the As emission rate inputs used in the model to generate these values?

This information is already provided in DEQ's *TAPs Addendum Modeling Review Attachment* and was highlighted by DEQ during the virtual meeting held on February 2, 2022. Please refer to column 3 of Table 3 of DEQ's *TAPs Addendum Modeling Review Attachment* for a complete list of modeled arsenic source-specific emission rates. Note that these modeled emission rates pertain only to Modeling Scenario W2, which is the highest-impact modeling scenario for arsenic. Modeled arsenic emission rates for all other modeling scenarios are provided by the applicant in Appendix B of the *Stibnite Gold Project (SGP) Permit to Construct Application TAP Addendum*. Modeled emission rates can also be extracted from the submitted modeling input files as described above (DEQ Content Manager Record Number: 2021AAG1772).

How are these values modified within the model and post model to generate these annual concentrations?

The modeled arsenic emission rates (in lb/hr) provided in column 3 of Table 3 of DEQ's *TAPs Addendum Modeling Review Attachment* were never "modified within the model and post model" because these are the actual emission rates that were used as inputs in the model. You are invited to review the modeling input files (DEQ Content Manager Record Number: 2021AAG1772). The modeled concentrations (meaning the model outputs in µg/m^3) for carcinogenic TAPs were adjusted to account for the life-of-mine production limits. You are invited to review the modeling output files (DEQ Content Manager Record Number: 2021AAG1772). Again, the modeled emission rates in lb/hr were not adjusted; the modeled output concentrations in µg/m^3 were adjusted according to the equation listed above to select worst-case scenarios, combine West End Pit scenario impacts with non-West End Pit scenario impacts, and adjust the combination for a total life-of-mine production of 788.4 million tons.

Details concerning calculation adjustments are provided in Sections 5.7 and 5.8 of DEQ's *TAPs Addendum Modeling Review Attachment*. The applicant has determined that the West End Development Rock Storage Facility (DRSF) will not be constructed. This change eliminated Modeling Scenario W5 from the arsenic modeling evaluation. The remaining four West End Pit modeling scenarios (W1–W4) were evaluated using the 70-year lifetime exposure equation and adjusting for the proposed West End Pit life-of-mine production limit of 50% of the total production. The equation provided in Section 5.8 of DEQ's *TAPs Addendum Modeling Review Attachment* was used to calculate the lifetime arsenic exposure from the West End Pit scenarios (W1–W4) on *a receptor-by-receptor basis*. Combining the concentrations from Modeling Scenarios W1–W4 with the highest concentration from the remaining non-West End Pit scenarios (B1, B2, H1, H2, H3, H4, Y1, Y2, or Y3) conservatively ensures that the maximum potential impacts from applicable sources are evaluated and remain below T-RACT AACCs.

The adjusted arsenic concentrations for Modeling Scenarios W1-W4 resulting from DEQ's verification analyses (0.000910 µg/m^3, 0.000945 µg/m^3, 0.000898 µg/m^3, and 0.000874 µg/m^3, respectively) match the values provided by Air Sciences in cells L8 (0.00091 µg/m^3), M8 (0.00095 µg/m^3), N8 (0.00090 µg/m^3), and O8 (0.00087 µg/m^3) of the worksheet that you referenced. The result for the highest-impact modeling scenario (Modeling Scenario W2 for arsenic) is reported in Table 6 of DEQ's *TAPs Addendum Modeling Review Attachment* and is compared with the T-RACT AACC.

From: Ian <ian@terrafound.org>
Sent: Wednesday, February 16, 2022 4:54 PM
To: Kelli Wetzel <Kelli.Wetzel@deq.idaho.gov>; Preserve Protect <savethesouthforksalmon@gmail.com>; Josh Johnson <jjohnson@idahoconservation.org>; Julie Simpson <julies@nezperce.org>; Mary Fauci <maryf@nezperce.org>; Darrin Pampaian

<Darrin.Pampaian@deq.idaho.gov>
Cc: Kevin Schilling <Kevin.Schilling@deq.idaho.gov>; Pao Baylon <Pao.Baylon@deq.idaho.gov>; Darrin Pampaian <Darrin.Pampaian@deq.idaho.gov>
Subject: RE: DEQ contacts

Thanks to DEQ for the opportunity to seek clarification on the approach and calculations in the Permit application and associated documents. As I am sure all of you are aware how complex and confounding these many calculations are, and it is not our intent for DEQ to do our homework for us. I have done my best to untangle the material, but have reached a stumbling point.

I am unable to confirm the calculation of the maximum annual arsenic concentration proposed for comparison to the AAC. The value appears in cell M8 of Table C in Tab C of the IDEQ spreadsheet provided and also in the Midas Gold spreadsheet referenced in the T-RACT analysis attached to the Statement of Basis. The values on Line 8 are copied as values and apparently are derived through weighting calculations from Line 29. The maximum value in Line 29 is .00698 ug/m3, and is apparently adjusted to reflect mine operation life and other averaging manipulations to reach the .00095 ug/m3 on line 8, although the adjustment does not appear to be consistent for the various scenarios. The values in line 29 are also copied as values and I have been unable to find the original formulae for deriving these values or making the modification to the line 8 compliance assertion values. There are several confusing averaging modifications regarding mine life, 5 year running averages, potential versus LOM considerations, etc.

There also seems to be confusing information regarding the genesis of the .00698 ug/m3 As value in cell M29. Is this the modeled variable or is it an adjusted post- AQ-modeling value derived from other As or particulate AQ model results? In either case, what are the As emission rate inputs used in the model to generate these values? How are these values modified within the model and post model to generate these annual concentrations?

Is it possible to confer with the appropriate staff member(s) to confirm this calculation, beginning with the emission inputs and associated assumptions used develop the annual average As concentration used to reach the conclusion that appropriate risk levels are met.

Thank you for your consideration. You can reach me via this email, or at 208 596 8577

Sincerely
Ian von Lindern

From: Kelli Wetzel [mailto:Kelli.Wetzel@deq.idaho.gov]
Sent: Thursday, February 3, 2022 1:30 PM
To: Preserve Protect <savethesouthforksalmon@gmail.com>; Josh Johnson <jjohnson@idahoconservation.org>; Julie Simpson <julies@nezperce.org>; Mary Fauci <maryf@nezperce.org>; Ian <ian@terrafound.org>
Subject: DEQ contacts

Hi everyone,

As promised during the meeting yesterday, below is a list of contacts to reach out to should any questions arise.

Mike Simon, Stationary Source Bureau Chief, Michael.Simon@deq.idaho.gov, 208-373-0212

Permitting Team – Darrin Pampaian, Air Quality Permit Supervisor, Darrin.Pampaian@deq.idaho.gov, 208-373-0587
Kelli Wetzel, Air Quality Permit Writer, Kelli.Wetzel@deq.idaho.gov, 208-373-0575

Modeling Team – Kevin Schilling, Air Quality Dispersion Modeling Supervisor, Kevin.Schilling@deq.idaho.gov, 208-373-0112
Pao Baylon, Air Quality Dispersion Modeling Analyst, Pao.Baylon@deq.idaho.gov, 208-373-0437

Thanks,

Kelli Wetzel | Air Quality Permit Writer
Idaho Department of Environmental Quality
1410 N Hilton, Boise, ID 83706
Office phone: (208) 373-0575
https://www.deq.idaho.gov/

Our mission: To protect public health and the quality of Idaho's air, land, and water.

To: Kevin Schilling[Kevin.Schilling@deq.idaho.gov]
From: Ian[ian@terrafound.org]
Sent: Wed 2/23/2022 9:47:52 AM (UTC-07:00)
Subject: RE: DEQ contacts

Thanks Kevin;
This is helpful. I have a few more questions that I'd like to discuss. Please let me know a convenient time to call.
Ian

From: Kevin Schilling [mailto:Kevin.Schilling@deq.idaho.gov]
Sent: Tuesday, February 22, 2022 1:06 PM
To: Ian <ian@terrafound.org>; Kelli Wetzel <Kelli.Wetzel@deq.idaho.gov>; Preserve Protect <savethesouthforksalmon@gmail.com>; Josh Johnson <jjohnson@idahoconservation.org>; Julie Simpson <julies@nezperce.org>; Mary Fauci <maryf@nezperce.org>; Darrin Pampaian <Darrin.Pampaian@deq.idaho.gov>
Cc: Pao Baylon <Pao.Baylon@deq.idaho.gov>
Subject: Re: DEQ contacts

Ian,

Pao Baylon, DEQ's air modeler for the project, drafted the response to your questions as shown below. Pao is currently out of the office, so if you have additional questions on how modeling was performed and evaluated, please contact me at your convenience.

Regards,

Kevin Schilling

Kevin Schilling | Air Quality Dispersion Modeling Supervisor
Idaho Department of Environmental Quality
1410 N Hilton, Boise, ID 83706
Office phone: (208) 373-0112
Personal cell phone: (208) 921-3336
https://www.deq.idaho.gov/

Our mission: To protect public health and the quality of Idaho's air, land, and water.

*****

I am unable to confirm the calculation of the maximum annual arsenic concentration proposed for comparison to the AAC. The value appears in cell M8 of Table C in Tab C of the IDEQ spreadsheet provided and also in the Midas Gold spreadsheet referenced in the T-RACT analysis attached to the Statement of Basis. The values on Line 8 are copied as values and apparently are derived through weighting calculations from Line 29. The maximum value in Line 29 is .00698 ug/m3, and is apparently adjusted to reflect mine operation life and other averaging manipulations to reach the .00095 ug/m3 on line 8, although the adjustment does not appear to be consistent for the various scenarios.

First, the value in cell M8 was compared to the T-RACT AACC, ***not the AAC***. AACC stands for Acceptable Ambient Concentration of a Carcinogen and pertains to carcinogens; AAC stands for Acceptable Ambient Concentration of a Non-Carcinogen and pertains to non-carcinogens. Arsenic is a carcinogen. T-RACT stands for Toxic Air Pollutant Reasonably Available Control Technology and allows the AACCs to be increased by a factor of ten per *Idaho Air Rules* Section 210.12(b).

Second, the value in cell M29 (0.00698 µg/m^3) is a model output (meaning, a concentration derived from running the model); no adjustments were applied to this value. The value in cell M8 (0.00095 µg/m^3) is an adjusted value that was calculated based on the value in cell M29 and the highest-impact non-W Scenario. Please refer to Section 5.8 of DEQ's *TAPs Addendum Modeling Review Attachment* for an explanation of the calculation adjustment method (or see discussion below). It is important to note that each adjustment was performed *at each receptor*.

The complexity and extensiveness of the dispersion modeling impact analyses necessitated using two groups of modeling runs: 1) West End Pit Scenarios (4 separate scenarios); 2) non-West End Pit Scenarios (9 separate scenarios). At each receptor, the

maximum impact was determined from results of the West End Pit scenarios and results from the non-West End Pit scenarios. The results for all scenarios were modeled using a continual mine production level of 135,000 tons/day for a total life-of-mine production of 788.4 million tons. It was assumed that the worst-case West End Pit scenario could only be associated with 50% of the life-of-mine production and the other 50% would be associated with the worst-case of non-West End Pit scenarios. This is a very conservative approach because the maximum actual production from any of the scenarios is well below 50%. This merging of worst-case West End Pit scenarios and worst-case non-West End Pit scenarios (including the 50% adjustment to maintain a total life-of-mine production of 788.4 million tons) was performed in a post-modeling spreadsheet analysis.

As a reminder, the highest modeled arsenic concentration is predicted to occur for Modeling Scenario W2. When running Modeling Scenario W2 *only*, the highest-impact concentration is 0.00700 µg/m^3, which is predicted to occur at four distinct receptors:

Easting (meters)	Northing (meters)	Max. Modeled Arsenic Concentration for Scenario W2 (in µg/m^3)
635,099.5	4,977,858.8	0.00700
635,124.5	4,977,858.8	0.00700
635,124.5	4,977,883.8	0.00700
635,099.5	4,977,883.8	0.00700

Note that the four West End Pit modeling scenarios (W1–W4) were evaluated using the 70-year lifetime exposure equation and adjusting for the proposed West End Pit life-of-mine production limit of 50% of the total production. The equation provided in Section 5.8 of DEQ's *TAPs Addendum Modeling Review Attachment* was used to calculate the lifetime arsenic exposure from the West End Pit scenarios (W1–W4) on *a receptor-by-receptor basis*. Combining the concentrations from Modeling Scenarios W1–W4 with the highest concentration from the remaining non-West End Pit scenarios (B1, B2, H1, H2, H3, H4, Y1, Y2, or Y3) conservatively ensures that the maximum potential impacts from applicable sources are evaluated and remain below T-RACT AACCs.

After adjusting for lifetime exposure and for the proposed West End Pit life-of-mine production limit of 50% of the total production of the mine (50% of 788.4 million tons), the maximum lifetime arsenic exposure (cell M8) is 0.00095 µg/m^3, which is predicted to occur at the one receptor listed below. The arsenic impact when running only Modeling Scenario W2 at this receptor is 0.00698 µg/m^3 (cell M29).

Easting (meters)	Northing (meters)	Modeled Arsenic Concentration for Scenario W2 (in µg/m^3)	Max. Modeled Arsenic Concentration for non-W Scenarios (in µg/m^3)	Max. Lifetime Arsenic Exposure for Comparison with T-RACT AACC (in µg/m^3)
635,124.5	4,977,833.8	0.00698	0.00129	0.00095

To summarize, the maximum lifetime arsenic exposure was calculated using this equation:

where *n* represents the receptor with Easting = 635,124.5 meters and Northing = 4,977,833.8 meters.

Finally, DEQ disagrees with the statement that "the adjustment does not appear to be consistent for the various scenarios." DEQ's Modeling Team performed additional analyses to verify the applicant's results and we can confirm that the adjustment was

performed for ***ALL*** modeling scenarios. Therefore, the arsenic impact adjustment is consistent for all modeling scenarios.

The values in line 29 are also copied as values and I have been unable to find the original formulae for deriving these values or making the modification to the line 8 compliance assertion values. There are several confusing averaging modifications regarding mine life, 5 year running averages, potential versus LOM considerations, etc.

You can't find any formulae for deriving the values in Line 29 because these are the raw model outputs (although technically speaking, the equations governing dispersion, energy balance, and stable and convective boundary layer mixing are "formulae" that were employed to derive the Line 29 values, but these are formulae and equations already embedded in the air dispersion model and are neither applicant-generated nor DEQ-generated). Again, no post-processing calculations were performed to derive the Line 29 values; these are values that were derived from the modeling output files. The modeling output files are available from DEQ's Content Manager (Record Number: 2021AAG1772); you may request these files through the public records request process. On the other hand, the value in Line 8 is an adjusted value that was calculated based on the value in Line 29 and the highest-impact non-W Scenario *at each receptor*. An explanation for the calculation method is provided in Section 5.8 of DEQ's *TAPs Addendum Modeling Review Attachment*.

There also seems to be confusing information regarding the genesis of the .00698 ug/m3 As value in cell M29. Is this the modeled variable or is it an adjusted post- AQ-modeling value derived from other As or particulate AQ model results?

The 0.00698 µg/m^3 value listed in cell M29 is a model output that was derived from running Modeling Scenario W2 alone. It is ***not*** a "modeled variable." It is ***not*** an "adjusted post-AQ-modeling value derived from other As or particulate AQ model results." It is a value that can be extracted from the modeling output files. You may request these files through the public records request process (DEQ Content Manager Record Number: 2021AAG1772).

In either case, what are the As emission rate inputs used in the model to generate these values?

This information is already provided in DEQ's *TAPs Addendum Modeling Review Attachment* and was highlighted by DEQ during the virtual meeting held on February 2, 2022. Please refer to column 3 of Table 3 of DEQ's *TAPs Addendum Modeling Review Attachment* for a complete list of modeled arsenic source-specific emission rates. Note that these modeled emission rates pertain only to Modeling Scenario W2, which is the highest-impact modeling scenario for arsenic. Modeled arsenic emission rates for all other modeling scenarios are provided by the applicant in Appendix B of the *Stibnite Gold Project (SGP) Permit to Construct Application TAP Addendum*. Modeled emission rates can also be extracted from the submitted modeling input files as described above (DEQ Content Manager Record Number: 2021AAG1772).

How are these values modified within the model and post model to generate these annual concentrations?

The modeled arsenic emission rates (in lb/hr) provided in column 3 of Table 3 of DEQ's *TAPs Addendum Modeling Review Attachment* were never "modified within the model and post model" because these are the actual emission rates that were used as inputs in the model. You are invited to review the modeling input files (DEQ Content Manager Record Number: 2021AAG1772). The modeled concentrations (meaning the model outputs in µg/m^3) for carcinogenic TAPs were adjusted to account for the life-of-mine production limits. You are invited to review the modeling output files (DEQ Content Manager Record Number: 2021AAG1772). Again, the modeled emission rates in lb/hr were not adjusted; the modeled output concentrations in µg/m^3 were adjusted according to the equation listed above to select worst-case scenarios, combine West End Pit scenario impacts with non-West End Pit scenario impacts, and adjust the combination for a total life-of-mine production of 788.4 million tons.

Details concerning calculation adjustments are provided in Sections 5.7 and 5.8 of DEQ's *TAPs Addendum Modeling Review Attachment*. The applicant has determined that the West End Development Rock Storage Facility (DRSF) will not be constructed. This change eliminated Modeling Scenario W5 from the arsenic modeling evaluation. The remaining four West End Pit modeling scenarios (W1–W4) were evaluated using the 70-year lifetime exposure equation and adjusting for the proposed West End Pit life-of-mine production limit of 50% of the total production. The equation provided in Section 5.8 of DEQ's *TAPs Addendum Modeling Review Attachment* was used to calculate the lifetime arsenic exposure from the West End Pit scenarios (W1–W4) on *a receptor-by-receptor basis*. Combining the concentrations from Modeling Scenarios W1–W4 with the highest concentration from the remaining non-West End Pit scenarios (B1, B2, H1, H2, H3, H4, Y1, Y2, or Y3) conservatively ensures that the maximum potential impacts from applicable sources are evaluated and remain below T-RACT AACCs.

The adjusted arsenic concentrations for Modeling Scenarios W1-W4 resulting from DEQ's verification analyses (0.000910 µg/m^3, 0.000945 µg/m^3, 0.000898 µg/m^3, and 0.000874 µg/m^3, respectively) match the values provided by Air Sciences in cells L8 (0.00091 µg/m^3), M8 (0.00095 µg/m^3), N8 (0.00090 µg/m^3), and O8 (0.00087 µg/m^3) of the worksheet that you referenced. The result for the

highest-impact modeling scenario (Modeling Scenario W2 for arsenic) is reported in Table 6 of DEQ's *TAPs Addendum Modeling Review Attachment* and is compared with the T-RACT AACC.

From: Ian <ian@terrafound.org>
Sent: Wednesday, February 16, 2022 4:54 PM
To: Kelli Wetzel <Kelli.Wetzel@deq.idaho.gov>; Preserve Protect <savethesouthforksalmon@gmail.com>; Josh Johnson <jjohnson@idahoconservation.org>; Julie Simpson <julies@nezperce.org>; Mary Fauci <maryf@nezperce.org>; Darrin Pampaian <Darrin.Pampaian@deq.idaho.gov>
Cc: Kevin Schilling <Kevin.Schilling@deq.idaho.gov>; Pao Baylon <Pao.Baylon@deq.idaho.gov>; Darrin Pampaian <Darrin.Pampaian@deq.idaho.gov>
Subject: RE: DEQ contacts

Thanks to DEQ for the opportunity to seek clarification on the approach and calculations in the Permit application and associated documents. As I am sure all of you are aware how complex and confounding these many calculations are, and it is not our intent for DEQ to do our homework for us. I have done my best to untangle the material, but have reached a stumbling point.

I am unable to confirm the calculation of the maximum annual arsenic concentration proposed for comparison to the AAC. The value appears in cell M8 of Table C in Tab C of the IDEQ spreadsheet provided and also in the Midas Gold spreadsheet referenced in the T-RACT analysis attached to the Statement of Basis. The values on Line 8 are copied as values and apparently are derived through weighting calculations from Line 29. The maximum value in Line 29 is .00698 ug/m3, and is apparently adjusted to reflect mine operation life and other averaging manipulations to reach the .00095 ug/m3 on line 8, although the adjustment does not appear to be consistent for the various scenarios. The values in line 29 are also copied as values and I have been unable to find the original formulae for deriving these values or making the modification to the line 8 compliance assertion values. There are several confusing averaging modifications regarding mine life, 5 year running averages, potential versus LOM considerations, etc.

There also seems to be confusing information regarding the genesis of the .00698 ug/m3 As value in cell M29. Is this the modeled variable or is it an adjusted post- AQ-modeling value derived from other As or particulate AQ model results? In either case, what are the As emission rate inputs used in the model to generate these values? How are these values modified within the model and post model to generate these annual concentrations?

Is it possible to confer with the appropriate staff member(s) to confirm this calculation, beginning with the emission inputs and associated assumptions used develop the annual average As concentration used to reach the conclusion that appropriate risk levels are met.

Thank you for your consideration. You can reach me via this email, or at 208 596 8577

Sincerely
Ian von Lindern

From: Kelli Wetzel [mailto:Kelli.Wetzel@deq.idaho.gov]
Sent: Thursday, February 3, 2022 1:30 PM
To: Preserve Protect <savethesouthforksalmon@gmail.com>; Josh Johnson <jjohnson@idahoconservation.org>; Julie Simpson <julies@nezperce.org>; Mary Fauci <maryf@nezperce.org>; Ian <ian@terrafound.org>
Subject: DEQ contacts

Hi everyone,

As promised during the meeting yesterday, below is a list of contacts to reach out to should any questions arise.

Mike Simon, Stationary Source Bureau Chief, Michael.Simon@deq.idaho.gov, 208-373-0212

Permitting Team – Darrin Pampaian, Air Quality Permit Supervisor, Darrin.Pampaian@deq.idaho.gov, 208-373-0587
Kelli Wetzel, Air Quality Permit Writer, Kelli.Wetzel@deq.idaho.gov, 208-373-0575

Modeling Team – Kevin Schilling, Air Quality Dispersion Modeling Supervisor, Kevin.Schilling@deq.idaho.gov, 208-373-0112
Pao Baylon, Air Quality Dispersion Modeling Analyst, Pao.Baylon@deq.idaho.gov, 208-373-0437

Thanks,

Kelli Wetzel | Air Quality Permit Writer
Idaho Department of Environmental Quality
1410 N Hilton, Boise, ID 83706
Office phone: (208) 373-0575
https://www.deq.idaho.gov/

Our mission: To protect public health and the quality of Idaho's air, land, and water.

To: Kevin Schilling[Kevin.Schilling@deq.idaho.gov]; Pao Baylon[Pao.Baylon@deq.idaho.gov]
From: Morrie Lewis[/O=DEQ/OU=FIRST ADMINISTRATIVE GROUP/CN=RECIPIENTS/CN=MLEWIS]
Sent: Fri 9/11/2020 6:23:34 PM (UTC-06:00)
Subject: NPT and Midas

Hi Pao,

I spoke with Julie Simpson and Mary Fauci in air quality with the Nez Perce Tribe (NPT) today regarding questions on the public comment period for Midas Gold Idaho, Inc. They may also contact you with follow-up questions on the modeling analyses.

Beyond focusing on the fugitive dust section of the permit, a few of the other topics discussed:

- NPT expressed an interest in using deposition modeling to evaluate water quality impacts from air emissions. I indicated that Midas had performed deposition modeling, but that it may take work for them to adapt toward this purpose.
- NPT was interested in impacts on public roadways, including outside the facility boundary. I explained that Midas had used McCall background concentrations to account for an increase in traffic from current pristine conditions to try to address this concern.
- NPT was interested in the treatment of the public roadway inside the facility boundary. I explained that Midas stated that they would have authority to control access along this roadway, and that the public would either be escorted or monitored to allow for passage but to discourage extended stays.

Thanks,

Morrie Lewis | Air Quality Permit Analyst
Idaho Department of Environmental Quality
1410 North Hilton
Boise, Idaho 83706
Phone: (208) 373-0495
Fax: (208) 373-0340
http://www.deq.idaho.gov/

Our mission is to protect human health and the quality of Idaho's air, land, and water.

AIR SCIENCES INC.

DENVER • PORTLAND • LOS ANGELES

Stibnite Gold Project

Air Quality Analysis Addendum

ModPRO2

PREPARED FOR:
PERPETUA RESOURCES

PROJECT NO. 335-21-402
JULY 13, 2021

TABLE OF CONTENTS

List of Abbreviations iv
1.0 Introduction 1
2.0 ModPRO2 Background and Summary 2
3.0 Air Emissions Inventory 4
3.1 Pollutant Emissions 4
4.0 Near-Field Air Quality Analyses 8
4.1 O_3 and Secondary $PM_{2.5}$ Analyses 13
4.2 Screening Visibility Analysis 14
4.3 Screening Mercury Deposition Analysis 14
4.4 Screening Acid Deposition Analysis 15
4.5 Stibnite Public Access Route 15
5.0 Far-Field Air Quality Analyses 17
6.0 RFAI 118 Questionnaire And Responses 19
7.0 References 23

Tables

Table 1. ModPRO2 Summary of Changes 2
Table 2. LOM Years for Pollutant-Specific Maximum Annual Emissions 6
Table 3. Maximum Annual Emissions Summary – ModPRO LOM Year 7 6
Table 4. Maximum Annual Emissions Summary – ModPRO2 LOM Years 6, 10, or 3 (see Table 2) 6
Table 5. IDEQ-Recommended Gaseous Pollutant Background Concentrations for SGP 8
Table 6. ModPRO2 Near-Field Class II PSD Increment Compliance Demonstration 9
Table 7. ModPRO2 Near-Field NAAQS Compliance Demonstration 9
Table 8. ModPRO2 O_3 Analysis 13
Table 9. ModPRO2 Primary and Secondary $PM_{2.5}$ Model Results 13
Table 10. Frequency of Modeled Visible Plumes – Screening Results for FCRNRW: Percent of Time when Perceptibility Threshold is Exceeded (2020 ModPRO VISCREEN Analysis) 14
Table 11. Magnitude of Modeled Visible Plumes – Screening Results for FCRNRW: Ratio of Maximum Impact to Perceptibility Threshold (2020 ModPRO VISCREEN Analysis) 14
Table 12. REMSAD and ModPRO AERMOD Screen Model Mercury Deposition Results 15

PRI00000819

REC 2159

Table 13. ModPRO Screening Nitrogen and Sulfur Boundary Deposition Results..... 15
Table 14. ModPRO2 SPAR Receptor Results and NAAQS Compliance Demonstration 16
Table 15. 50-km Ring AERMOD Results for ModPRO and ModPRO2 17
Table 16. ModPRO Far-Field Impacts Summary 18
Table 17. Class I and Class II Area SIL 18
Table 18. RFAI 118 Questions and Responses 19

Figures

Figure 1. ModPRO2 Site Layout 3
Figure 2. Comparison of ModPRO and ModPRO2 Maximum Daily Combined NO_X, PM_{10}, SO_2, and H_2SO_4 Emissions by LOM Year (lb/day) 5
Figure 3. ModPRO2 Class II Air Quality PSD Increment Modeling Results 11
Figure 4. ModPRO2 Class II Air Quality NAAQS Modeling Results 12

Appendix A – ModPRO2: Emissions Inventory and Modeling Parameters
Appendix B – Electronic Files
Appendix C – 2020 ModPRO VISCREEN Analysis

PRI00000820

REC 2160

LIST OF ABBREVIATIONS

$\mu g/m^3$	Micrograms per Cubic Meter
AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
AQRV	Air Quality-Related Values
CFR	Code of Federal Regulations
CO	Carbon Monoxide
DEIS	Draft Environmental Impact Statement
DRSF	Development Rock Storage Facility
EPA	United States Environmental Protection Agency
FEIS	Final Environmental Impact Statement
H_2SO_4	Sulfuric Acid Gas
HAP	Hazardous Air Pollutants
Hg	Mercury
IDEQ	Idaho Department of Environmental Quality
km	Kilometer
lb/day	Pounds per Day
lb/yr	Pounds per Year
LOM	Life of Mine
Mercury	Hg
MERPs	Modeled Emission Rates for Precursors
ModPRO	Modified Plan of Restoration and Operations
ModPRO2	Second Modification of Plan of Restoration and Operations
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NO_2	Nitrogen Dioxide

PRI00000821

REC 2161

NO_X	Oxides of Nitrogen
O_3	Ozone
Pb	Lead
Perpetua	Perpetua Resources
PM	Particulate Matter
PM_{10}	Particulate Matter less than 10 Microns in Aerodynamic Diameter
$PM_{2.5}$	Particulate Matter less than 2.5 Microns in Aerodynamic Diameter
ppb	Parts per Billion
PRO	Plan of Restoration and Operations
PSD	Prevention of Significant Deterioration
Q&V	Qian and Venkatram
SGP	Stibnite Gold Project
SO_2	Sulfur Dioxide
SPAR	Stibnite Public Access Route
ton/day	Tons per Day
ton/yr	Tons per Year
USDA-FS	United States Department of Agriculture, Forest Service
VOC	Volatile Organic Compounds

PRI00000822

REC 2162

1.0 INTRODUCTION

This addendum provides the Stibnite Gold Project (SGP) air quality analyses for the SGP Refined Proposed Action - ModPRO2 (Midas Gold 2020), a proposed refinement of Alternative 2 included in the SGP Draft Environmental Impact Statement (DEIS) (USDA-FS 2020). In addition, this addendum clarifies the differences between the ModPRO2 and the previously submitted emission inventories. This information was specifically requested in the Request for Additional Information (RFAI) 118 (Stantec 2021). The RFAI 118 questionnaire and responses are provided in Section 6.0.

Perpetua Resources (Perpetua), formerly Midas Gold Idaho, Inc., proposes to construct and operate the SGP in Valley County, Idaho. The SGP will consist of conventional open-pit mining operations and onsite ore preparation and gold extraction processes along with offsite infrastructure that includes a power transmission line and a site access road.

The SGP is a minor stationary source that is not subject to the Title V program or the Prevention of Significant Deterioration (PSD) regulations.

Perpetua conducted air quality analyses to evaluate SGP emissions to demonstrate compliance with the applicable ambient air quality standards and thresholds, and Air Quality Related Values (AQRV) required by coordinating agencies to satisfy the requirements of the National Environmental Policy Act (NEPA). The details and results of these air quality analyses (2018 AQ Report) were submitted to the United States Department of Agriculture, Forest Service (USDA-FS) in October 2018 (Air Sciences 2018). These analyses were based on the SGP plan of operations provided in Perpetua's Plan of Restoration and Operations (PRO) (Midas Gold 2016) and a modification of the PRO, referred to as the ModPRO (Brown and Caldwell 2019).

In December 2020, Perpetua proposed a refined SGP plan of operations, termed ModPRO2 (Midas Gold 2020). ModPRO2 presents a refined and improved project with a smaller footprint and reduced environmental impacts compared with PRO and ModPRO. No significant changes are made to the mining methods, ore processing, exploration activities, water management, and supporting features, including structures, access and haul roads, and infrastructure.

A revised AERMOD modeling was completed using ModPRO2 activities and emissions. The revised modeling analyses provided in this addendum demonstrate compliance with applicable ambient air quality standards and thresholds. Additional analysis was performed to demonstrate that the ModPRO2 changes are not expected to change the far-field analysis results significantly, and therefore, the far-field analysis provided in the 2018 AQ Report is considered representative of ModPRO2 and is not revised in this addendum.

PRI00000823

REC 2163

2.0 MODPRO2 BACKGROUND AND SUMMARY

Before receiving this ModPRO2 analysis, USDA-FS received and reviewed air quality analyses for the proposed action and the lime kiln alternative (and alternative component of the ModPRO). These air quality analyses provided in the 2018 AQ Report (Air Sciences 2018) were evaluated and presented in the DEIS published by the USDA-FS in August 2020 (USDA-FS 2020), as Alternatives 1 (PRO) and 2 (ModPRO).

Perpetua continued to improve the mining and environmental performance of the SGP by evaluating additional data and conducting further analyses to identify "*project refinements that could reduce the overall project footprint, reduce associated wetland impacts, improve surface water and groundwater quality, reduce temperature impacts to surface water, reduce air emissions, improve fisheries and wildlife habitat, and improve upon reclamation and restoration design*" (Midas Gold 2020). The ModPRO2 reflects these refinements and was developed with updated data and analyses to further reduce the potential environmental impacts of the SGP by addressing agency and public comments received during the NEPA scoping and DEIS review processes.

Several aspects of the ModPRO2 refinements could potentially affect the SGP air quality impacts reviewed in the DEIS. Most refinements result in decreases in air quality effects. See parameters summarized in Table 1 with their resultant effect on air quality.

Table 1. ModPRO2 Summary of Changes

Parameters	Air Quality Effect
Reduced Production	Decrease
Reduced Surface Disturbance	Decrease
Reduced Haul Road Surface	Decrease
Smaller Trucks (more truck miles)	Increase
Fiddle DRSF Eliminated (more truck miles)	Increase
Reduced Fuel Use	Decrease
Reduced Blasting	Decrease
Reduced Blasted Area	Decrease
Reduced Drill Holes	Decrease
Reduced Blasting Agent Use	Decrease

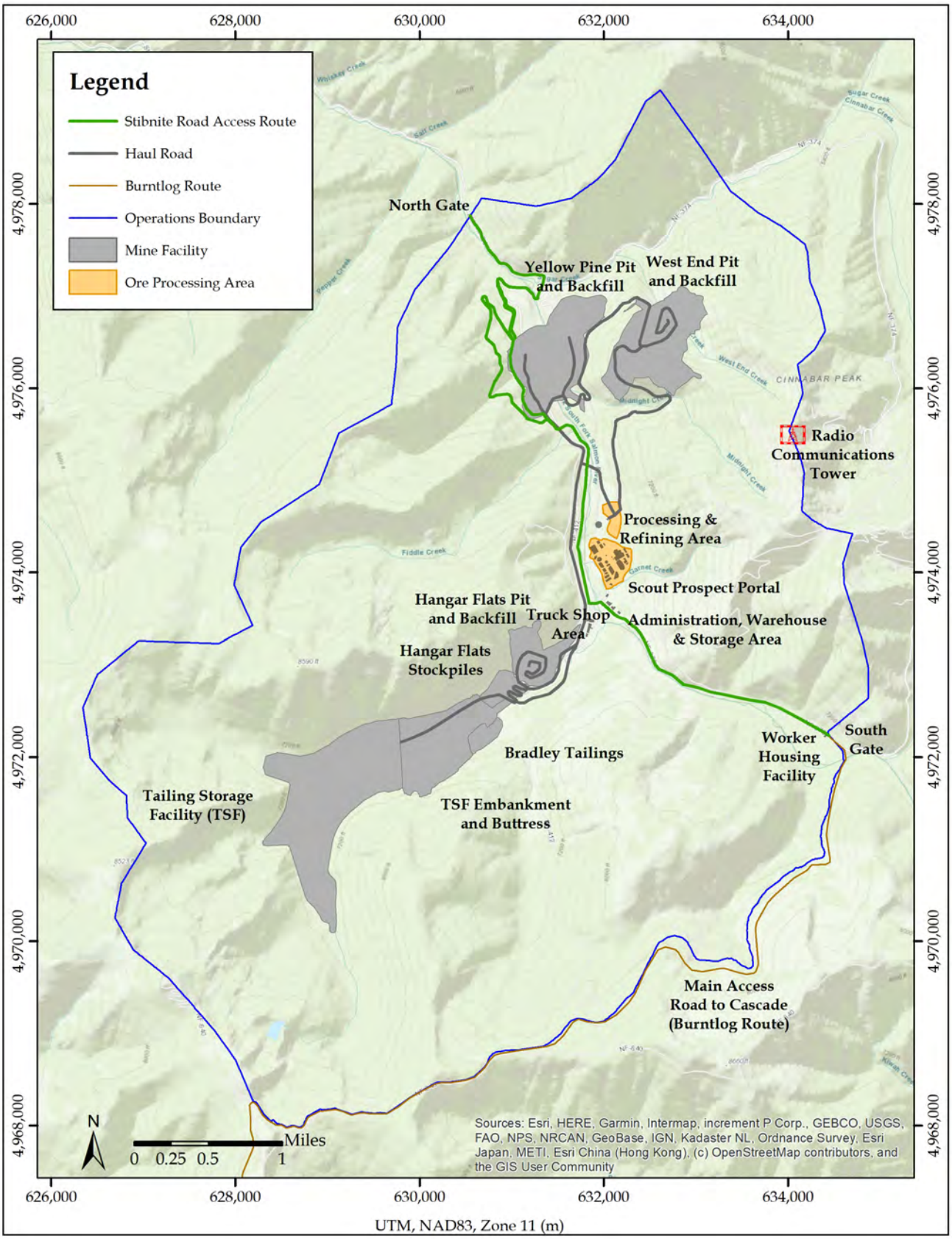
This addendum provides the ModPRO2 air quality impact analysis for the USDA-FS to include and evaluate in the Final Environmental Impact Statement (FEIS). Perpetua requests that ModPRO2 be included in the FEIS as a refined Alternative 2, replacing the Alternative 2 in the DEIS.

The SGP site layout with the ModPRO2 refinements is presented in Figure 1.

PRI00000824

REC 2164

Figure 1. ModPRO2 Site Layout



PRI00000825

REC 2165

3.0 AIR EMISSIONS INVENTORY

An air emissions inventory for ModPRO2 was calculated for each life of mine (LOM) year following the methodology, emission factors, and controls described in the 2018 AQ Report. The ModPRO2 detailed emissions calculations are provided in Appendix A. As shown below in Figure 2, and Tables 3 and 4 the overall ModPRO2 emissions are lower than the ModPRO emissions, except for volatile organic compounds (VOC), which are slightly higher for ModPRO2.

3.1 Pollutant Emissions

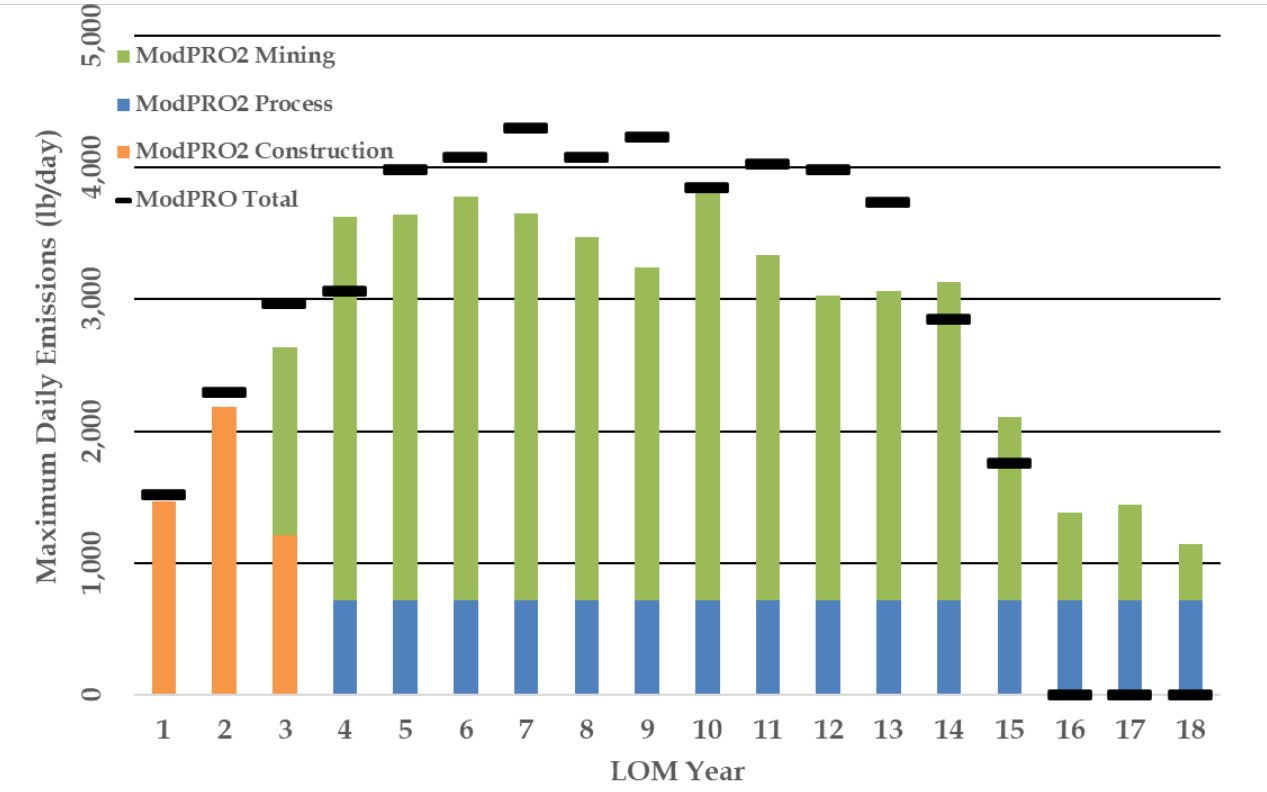
Figure 2 presents a comparison of the maximum daily combined emissions of nitrogen oxides (NO_X), particulate matter less than 10 microns (PM_{10}), sulfur dioxide (SO_2), and sulfuric acid (H_2SO_4) (pollutants considered for the Air Quality Related Values [AQRV] analyses) for each construction and operation year in pounds per day (lb/day) for ModPRO and ModPRO2. The black markers represent the total ModPRO AQRV emissions for each LOM year. The top of each bar represents the total ModPRO2 AQRV emissions for each LOM year.

The construction emissions occur in LOM Years 1, 2, and 3; the mining emissions occur during LOM Years 3 through 15; and the ore processing emissions occur in LOM Years 4 through 15 for ModPRO and Years 4 through 18 for ModPRO2. Emissions from certain mine construction components that continue during the mine operation years are included with the applicable LOM year mining emissions.

PRI00000826

REC 2166

Figure 2. Comparison of ModPRO and ModPRO2 Maximum Daily Combined NO_X, PM_{10}, SO_2, and H_2SO_4 Emissions by LOM Year (lb/day)



For ModPRO, the highest potential maximum daily combined emissions of the AQRV pollutants are approximately 4,300 lb/day, occurring during LOM Year 7 (black marker). For ModPRO2, the highest AQRV pollutant emissions are during LOM Year 10 at approximately 3,870 lb/day; 430 lb/day less than the highest ModPRO emissions.

This figure also shows that the ModPRO2 emissions are higher than ModPRO emissions for LOM Years 4, 14, and 15, but those emissions are still less than the highest ModPRO emissions occurring in LOM Year 7 that were evaluated in the 2018 AQ Report and demonstrated compliance with the applicable AQRV thresholds and standards.

Potential ore processing emissions (blue bars in Figure 2) do not vary over the life of the mine. This is because the ore processing emissions are calculated conservatively based on the maximum daily ore production rate of 25,000 ton/day, although LOM actual annual production rates will be less than the maximum rates. Specifically, the PRO, ModPRO, and ModPRO2 cite average daily production rates of 20,000 to 25,000 ton/day. The highest annual production (ore and waste) for ModPRO is 42.7 million tons, whereas for ModPRO2 the highest annual production is 36.3 million tons.

For air quality impact analyses (modeling) Perpetua identified the highest facility-wide emissions of each pollutant occurring during any LOM year, summarized in Table 2.

Table 2. LOM Years for Pollutant-Specific Maximum Annual Emissions

Pollutant	ModPRO LOM Year	ModPRO2 LOM Year
Carbon monoxide (CO)	7	6
NO_X	7	6
PM_{10}	7	10
Particulate matter less than 2.5 microns ($PM_{2.5}$)	7	10
SO_2	7	6
VOC	7	3
Hazardous air pollutants (HAP), total	7	10
Mercury (Hg)	7	10

As shown in Table 2, the maximum emissions for all pollutants coincidentally occur during the same year (LOM Year 7) for ModPRO. For ModPRO2, the highest PM, PM_{10}, $PM_{2.5}$, total HAP, and Hg emissions occur during LOM Year 10. The highest CO, NO_X, and SO_2 emissions occur during LOM Year 6, and the highest VOC emissions occur during LOM Year 3. The highest annual emissions from these LOM years (Table 2) are summarized in Tables 3 and 4 for ModPRO and ModPRO2, respectively. Hg emissions are provided in units of pounds per year (lb/yr); all other emissions are provided in units of ton/yr in Tables 3 and 4.

Table 3. Maximum Annual Emissions Summary – ModPRO LOM Year 7

Source Category	CO	NO_X	PM	PM_{10}	$PM_{2.5}$	SO_2	VOC	H_2SO_4	HAP	Hg
	(ton/yr)									(lb/yr)
Process and Auxiliary	31.1	38.9	71.1	46.9	32.1	6.6	5.4	8.9	0.43	24.81
Mining and Mobile	519.0	322.7	1,021.6	288.3	35.8	0.9	18.3		4.98	8.46
Burntlog Route	5.3	4.9	113.2	29.0	3.1	0.01	0.6			
SGP Total	555.4	366.5	1,205.9	364.2	71.0	7.5	24.3	8.9	5.41	33.27

Table 4. Maximum Annual Emissions Summary – ModPRO2 LOM Years 6, 10, or 3 (see Table 2)

Source Category	CO	NO_X	PM	PM_{10}	$PM_{2.5}$	SO_2	VOC	H_2SO_4	HAP	Hg
	(ton/yr)									(lb/yr)
Process and Auxiliary	30.6	38.0	86.7	55.8	35.9	6.5	5.3	8.9	4.65	5.81
Mining and Mobile	499.6	292.3	930.7	235.3	30.2	0.8	22.1		4.02	7.79
Burntlog Route	5.3	4.9	113.2	29.0	3.1	0.01	0.0			
SGP Total	535.5	335.2	1,130.6	320.1	69.2	7.3	27.4	8.9	8.67	13.6

PRI00000828

REC 2168

Tables 3 and 4 show that the overall ModPRO2 emissions are lower than the ModPRO emissions, except for VOC, which are slightly higher for ModPRO2. The ModPRO2 process source Hg emissions are significantly lower than the ModPRO emissions. This is a result of Perpetua's commitment to install additional Hg controls for the autoclave. This commitment was made after the 2018 AQ Report was submitted for DEIS.

The ModPRO2 maximum annual greenhouse gas emissions are 190,300 ton/yr as carbon dioxide equivalent (CO2e) compared to the ModPRO maximum CO2e emissions of 200,900 ton/yr. These CO2e emissions are calculated based on the 100-year global warming potential consistent with reporting under the United Nations Framework Convention on Climate Change (IPCC 2007) and Intergovernmental Panel on Climate Change (UNCC n.d.). Detailed greenhouse gas emission calculations are provided in Appendix A.

PRI00000829

REC 2169

4.0 NEAR-FIELD AIR QUALITY ANALYSES

This section provides the near-field (up to 50 kilometers [km] from the project) air quality analyses updated for ModPRO2.

The National Ambient Air Quality Standards (NAAQS) compliance demonstration for this analysis was completed using the revised CO, nitrogen dioxide (NO_2), ozone (O_3), and SO_2 background concentrations recommended by the Idaho Department of Environmental Quality (IDEQ 2019). The revised background concentrations in units of parts per billion (ppb) and micrograms per cubic meter ($\mu g/m^3$) are provided in Table 5.

Table 5. IDEQ-Recommended Gaseous Pollutant Background Concentrations for SGP

Pollutant	Averaging Time	Background Concentration		Reference
		(ppb)	($\mu g/m^3$)	
CO	8 hours	970	1,110	NW AIRQUEST, 2014-2017 design value
	1 hour	1,520	1,740	
NO_2	1 year	0.5	0.9	
	1 hour	2.3	4.3	
O_3	8 hours	60	117.7	
(for NO_2 modeling)	8 hours	55	107.9	
SO_2	3 hours	6.4	16.8	
	1 hour	4.7	12.3	

For NAAQS modeling inputs, Perpetua identified the highest emissions of each pollutant during any LOM year, provided in Table 2. For ModPRO the highest emissions for all criteria pollutants occur during LOM Year 7. For ModPRO2 the highest criteria pollutant emissions occur during two different years, LOM Year 6 (CO, NO_X, and SO_2) and LOM Year 10 ($PM_{2.5}$ and PM_{10}). Therefore, to capture the highest modeled concentration for each pollutant in the ModPRO2 scenario, separate modeling was performed for LOM Years 6 and 10 (i.e., two models).

The AERMOD dispersion modeling results for the ModPRO2 emissions and comparison with the applicable PSD increments and NAAQS are provided in Tables 6 and 7, respectively.

PRI00000830

REC 2170

Table 6. ModPRO2 Near-Field Class II PSD Increment Compliance Demonstration

Pollutant	Averaging Time	Maximum Modeled Concentration (µg/m³)	Maximum Allowable Increase (µg/m³)	PSD Increment Compliance
NO_2	1 year	19.8	25	Yes
$PM_{2.5}$[1]	1 year	1.1	4	Yes
	24 hours	3.3	9	Yes
PM_{10}	1 year	6.5	17	Yes
	24 hours	14.9	30	Yes
SO_2	1 year	0.2	20	Yes
	24 hours	0.7	91	Yes
	3 hours	1.8	512	Yes

[1] Includes secondary impacts provided in Section 4.1.

This table shows that the ModPRO2 maximum modeled concentrations comply with the Class II PSD increments. The results reflect the highest of the two modeled scenarios (LOM Years 6 and 10) and include the hotspot analysis for each pollutant-averaging time combination.

Table 7. ModPRO2 Near-Field NAAQS Compliance Demonstration

Pollutant	Averaging Time	Maximum Modeled Concentration (µg/m³)	Background Concentration (µg/m³)	Total Concentration (µg/m³)	NAAQS (µg/m³)	NAAQS Compliance
CO	8 hours	404.6	1,110	1,515	10,000	Yes
	1 hour	495.5	1,740	2,236	40,000	Yes
Lead (Pb)	Rolling 3 months	Not required[1]				
NO_2	1 year	19.8	0.9	20.7	100	Yes
	1 hour	129.8	4.3	134.1	188	Yes
O_3[2]	8 hours	3.0	117.7	120.7	137	Yes
$PM_{2.5}$[3]	1 year	1.1	3.5	4.6	12	Yes
	24 hours	2.7	15	17.7	35	Yes
PM_{10}	24 hours	15	37	51.9	150	Yes
SO_2	3 hours	1.8	16.8	18.6	1,300	Yes
	1 hour	3.0	12.3	15.3	196	Yes

[1] The SGP facility-wide potential Pb emissions are less than 10% of the Pb significant emission rate of 0.6 ton/yr (40 CFR 52.21(b)(23)) and thus less than the applicable "Below Regulatory Concern" defined in the Idaho rules.

[2] See Section 4.1 for O_3 analysis.

[3] Includes the secondary impacts provided in Section 4.1.

PRI00000831

REC 2171

This table shows that the ModPRO2 maximum modeled total concentrations (SGP impact plus background) comply with the NAAQS. The results reflect the highest of the two modeled scenarios (LOM Years 6 and 10) and include the hotspot analysis for each pollutant-averaging time combination.

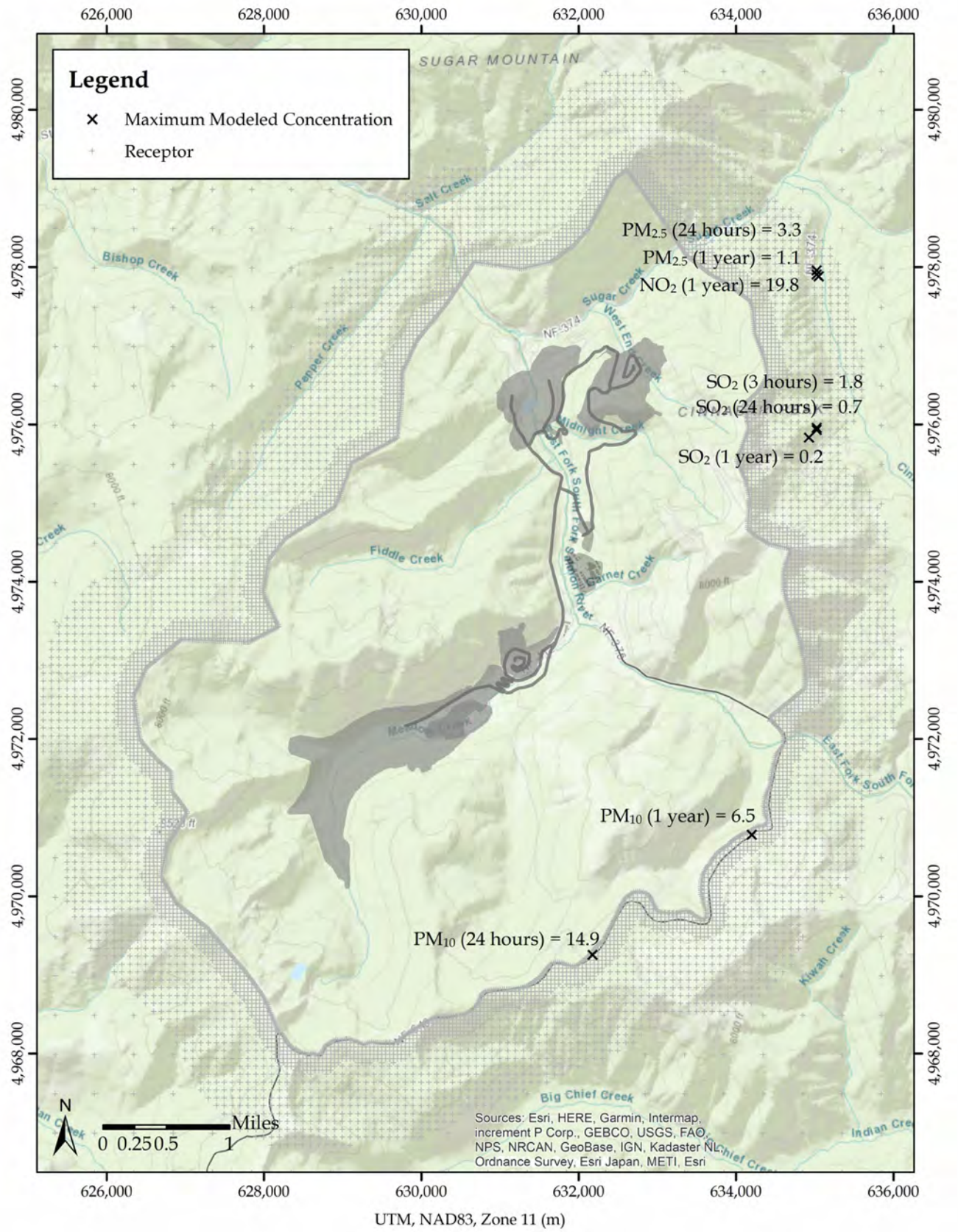
The locations of the maximum impacts for each pollutant and averaging time are shown in Figures 3 and 4 for Class II PSD increment and NAAQS compliance, respectively.

Electronic copies of the modeling files are provided in Appendix B.

PRI00000832

REC 2172

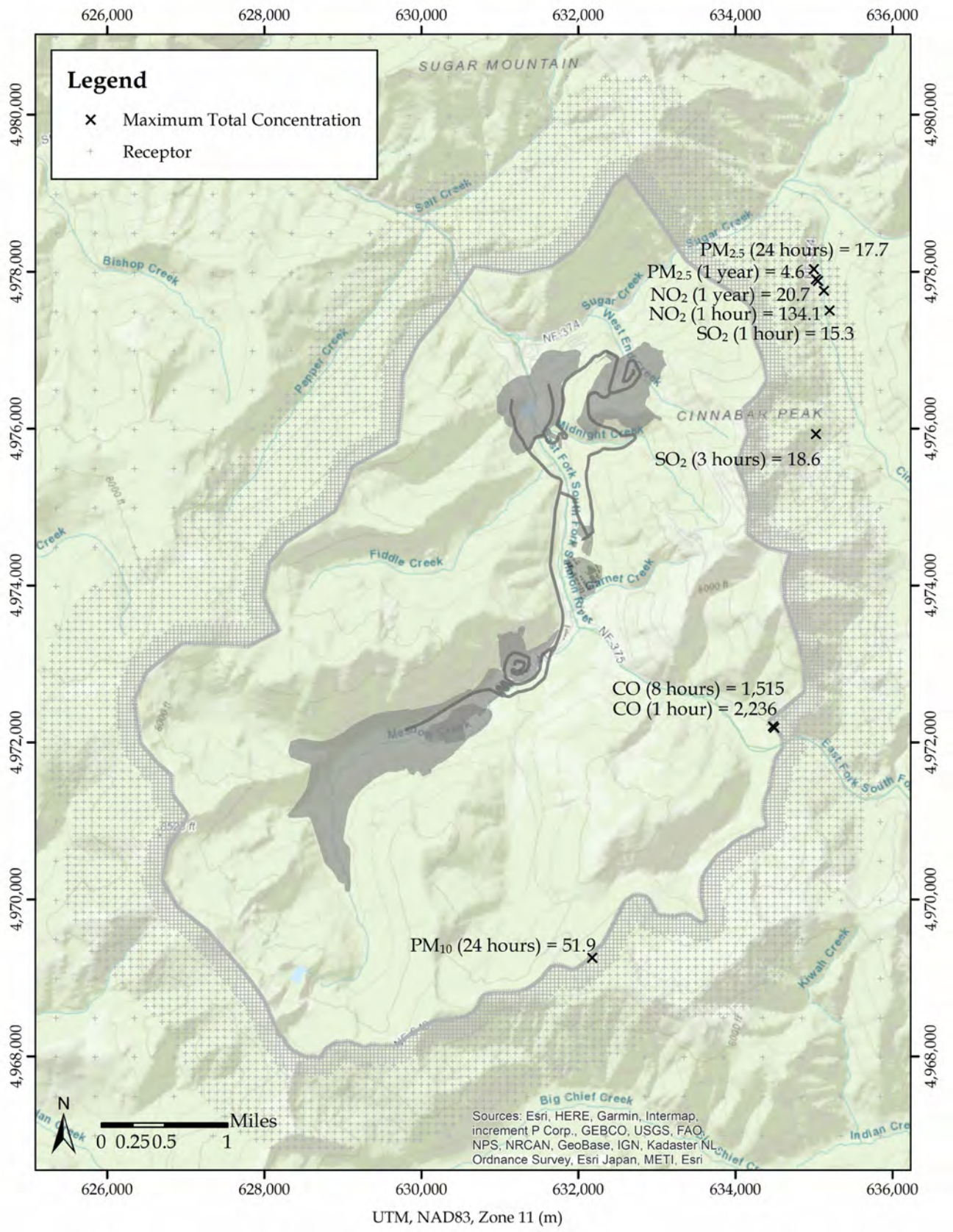
Figure 3. ModPRO2 Class II Air Quality PSD Increment Modeling Results



PRI00000833

REC 2173

Figure 4. ModPRO2 Class II Air Quality NAAQS Modeling Results



PRI00000834

REC 2174

4.1 O_3 and Secondary $PM_{2.5}$ Analyses

This section provides a revised ModPRO2 quantitative evaluation of the O_3 and secondary $PM_{2.5}$ impacts. These analyses were performed using the 2017 Guideline on Air Quality Models Tier 1 assessment methodology and the United States Environmental Protection Agency's modeled emission rates for precursors (MERPs) guidance (EPA 2016a) discussed in the 2018 AQ Report.

The estimated ModPRO2 O_3 impact is provided in Table 8. This table also shows the background and estimated total concentration compared to the 8-hour O_3 NAAQS.

Table 8. ModPRO2 O_3 Analysis

Pollutant	Averaging Time	Maximum Concentration (ppb)	Background Concentration (ppb)	Total Concentration (ppb)	NAAQS (ppb)	NAAQS Compliance
O_3	8 hours	1.4	60.0	61.4	70	Yes

As shown in Table 8, ModPRO2 shows compliance with the O_3 NAAQS.

The estimated ModPRO2 secondary $PM_{2.5}$ impacts are provided in Table 9. This table also shows the $PM_{2.5}$ annual and 24 hours background, primary, and estimated total concentrations compared with the NAAQS.

Table 9. ModPRO2 Primary and Secondary $PM_{2.5}$ Model Results

Pollutant	Averaging Time	Primary Conc. ($\mu g/m^3$)	Secondary Conc. ($\mu g/m^3$)	Background Conc. ($\mu g/m^3$)	Total Conc. ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	NAAQS Compliance
$PM_{2.5}$	1 year	1.1	0.01	3.5	4.6	12	Yes
	24 hours	2.6	0.15	15	17.7	35	Yes

As shown in Table 9, ModPRO2 shows compliance with the $PM_{2.5}$ NAAQS, even when conservatively adding maximum secondary $PM_{2.5}$ concentrations to its modeled direct $PM_{2.5}$ concentrations and ambient background concentrations.

PRI00000835

REC 2175

4.2 Screening Visibility Analysis

Perpetua submitted a revised ModPRO VISCREEN Analysis to the USDA-FS in October 2020 (2020 ModPRO VISCREEN Analysis) based on combined NO_X, PM, and soot emissions of 8,953 lb/day. The combined NO_X, PM, and soot emissions for ModPRO2 are 8,204 lb/day, approximately 8% less than those used in the 2020 ModPRO VISCREEN Analysis. Therefore, the 2020 ModPRO VISCREEN Analysis is conservatively representative of ModPRO2. Thus, the VISCREEN analysis is not revised.

The 2020 ModPRO VISCREEN Analysis is provided in Appendix C. Results of this analysis are summarized in Tables 10 and 11. Note that there are no regulatory standards or regulatory thresholds to compare to the results provided in these tables.

Table 10. Frequency of Modeled Visible Plumes – Screening Results for FCRNRW: Percent of Time when Perceptibility Threshold is Exceeded (2020 ModPRO VISCREEN Analysis)

Plume Parameter	Background	% Day Hours: 10°	% Night Hours: 10°	% Day Hours: 140°	% Night Hours: 140°
Plume Contrast (C)	Terrain	0	0	0	0
Color Contrast (ΔE)	Terrain	0.02	2.9	0	0
Plume Contrast (C)	Sky	0	0	0	0.38
Color Contrast (ΔE)	Sky	0	2.3	0	0

Table 11. Magnitude of Modeled Visible Plumes – Screening Results for FCRNRW: Ratio of Maximum Impact to Perceptibility Threshold (2020 ModPRO VISCREEN Analysis)

Plume Parameter	Background	Day (10°)	Night (10°)	Day (140°)	Night (140°)
Plume Contrast (C)	Terrain	--	--	--	--
Color Contrast (ΔE)	Terrain	1.0	2.2	--	--
Plume Contrast (C)	Sky	--	--	--	1.3
Color Contrast (ΔE)	Sky	--	1.9	--	--

4.3 Screening Mercury Deposition Analysis

As shown in Tables 3 and 4, ModPRO Hg emissions are 33.3 lb/yr, and ModPRO2 Hg emissions are 13.6 lb/yr. ModPRO2 Hg emissions are less than half of the ModPRO Hg

PRI00000836

REC 2176

emissions. Therefore, the ModPRO Hg deposition analysis is conservatively representative of ModPRO2 and thus not revised.

The ModPRO Hg deposition results from the 2018 AQ Report are provided in Table 12. Note that there are no regulatory standards or regulatory thresholds to compare to the results provided in this table.

Table 12. REMSAD and ModPRO AERMOD Screen Model Mercury Deposition Results

Hydrographic Subbasin	REMSAD Background (g/km^2-yr)	AERMOD Screen SGP Results (g/km^2-yr)	SGP Contribution to Existing Background
Subbasin west of SGP	13.9	0.056	0.40%
Subbasin northeast of SGP	13.6	0	0.00%
Subbasin southeast of SGP	12.7	0	0.00%

4.4 Screening Acid Deposition Analysis

The NO_X emissions for ModPRO are 366.5 tons/yr and for ModPRO2 are 335.2 ton/yr. The SO_2 emissions for ModPRO are 7.5 ton/yr and for ModPRO2 are 7.3 ton/yr. Emissions of both NO_X and SO_2 are lower for ModPRO2. These ModPRO2 emission reductions mean that the screening acid deposition analysis remains representative, and thus, it is not revised.

The ModPRO screening nitrogen and sulfur boundary deposition results from the 2018 AQ Report are provided in Table 13. Note that there are no regulatory standards or regulatory thresholds to compare to the results provided in this table.

Table 13. ModPRO Screening Nitrogen and Sulfur Boundary Deposition Results

Pollutant	Deposition (g/m^2-yr)
Nitrogen	0.00081 - 0.0039
Sulfur	0.00001 - 0.0043

4.5 Stibnite Public Access Route

The ModPRO2 NAAQS compliance demonstration for the 25-meter spacing receptors along the Stibnite Public Access Route (SPAR) is presented in Table 14.

PRI00000837

REC 2177

Table 14. ModPRO2 SPAR Receptor Results and NAAQS Compliance Demonstration

Pollutant	Averaging Time	Maximum Modeled Concentration (µg/m³)	Background Concentration (µg/m³)	Total Concentration (µg/m³)	NAAQS (µg/m³)	NAAQS Compliance
CO	8 hours	201.9	1,110	1,312	10,000	Yes
	1 hour	486.8	1,740	2,227	40,000	Yes
NO_2	1 year	39.0	0.9	39.9	100	Yes
	1 hour	124.4	4.3	128.7	188	Yes
$PM_{2.5}$[(1)]	1 year	5.3	3.5	8.8	12	Yes
	24 hours	12.2	15	27.2	35	Yes
PM_{10}	24 hours	65.3	37	102.3	150	Yes
SO_2	3 hours	6.0	16.8	22.8	1,300	Yes
	1 hour	13.6	12	25.9	196	Yes

(1) Includes secondary impacts provided in Section 4.1.

The results provided in Table 14 show compliance with NAAQS. The ModPRO2 SPAR results provided in Table 14 are the highest for the two modeled scenarios (LOM Years 6 and 10). The ModPRO2 SPAR modeling used the United States Environmental Protection Agency (EPA) default Qian and Venkatram (Q&V) method discussed in the 2018 AQ Report. This modeling method, which does not use the BULKRN option, is approved by EPA as one of the default modeling methodologies.

PRI00000838

REC 2178

5.0 FAR-FIELD AIR QUALITY ANALYSES

As shown in Section 3.1, the AQRV pollutant emissions for ModPRO2 are less than those for ModPRO. Therefore, ModPRO2 refinements are not expected to make any significant changes to the far-field analyses—50 km to 300 km from the project site provided in the 2018 AQ Report. To affirm this, additional AERMOD modeling was completed to estimate concentrations at receptors located on a 50-km radius ring around the project; the maximum approved range of AERMOD. The 50-km ring modeling was performed for the applicable AQRV pollutant-averaging time combinations. The 50-km ring modeling result comparison for ModPRO and ModPRO2 is provided in Table 15.

Table 15. 50-km Ring AERMOD Results for ModPRO and ModPRO2

Pollutant	Averaging Time	ModPRO Maximum Result ($\mu g/m^3$)	ModPRO2 Maximum Result ($\mu g/m^3$)
NO_2	1 year	0.53	0.50
$PM_{2.5}$	1 year	0.09	0.09
	24 hours	0.40	0.38
PM_{10}	1 year	0.14	0.11
	24 hours	0.51	0.57
SO_2	1 year	0.01	0.01
	24 hours	0.07	0.06
	3 hours	0.23	0.20

(1) Result includes background concentration.

Table 15 shows that the 50-km ring results are nearly identical for ModPRO and ModPRO2. The ModPRO2 results shown in Table 15 represent the highest concentrations for the two modeled scenarios (LOM Years 6 and 10).

The 50-km ring AERMOD analysis demonstrates that the ModPRO2 changes are not expected to affect the far-field analysis results, and therefore, the ModPRO far-field analyses are representative of ModPRO2 and not revised herein.

The ModPRO far-field impacts from the 2018 AQ Report are summarized in Table 16.

PRI00000839

REC 2179

Table 16. ModPRO Far-Field Impacts Summary

Pollutant/ AQRV	Averaging Time	Class I Impact ($\mu g/m^3$) [1]	Class II Impact ($\mu g/m^3$) [1]	Class I Visibility (98th Percentile Extinction)[1]	Class II Visibility (98th Percentile Extinction)[1]	Class I N, S Deposition (g/ha-yr)[1]	Class II N, S Deposition (g/ha-yr)[1]
NO_2	1 year	0.0101	0.0392	--	--	--	--
$PM_{2.5}$	1 year	0.0021	0.0082	--	--	--	--
	24 hours	0.0370	0.1272	--	--	--	--
PM_{10}	1 year	0.0101	0.0394	--	--	--	--
	24 hours	0.1622	0.5628	--	--	--	--
SO_2	1 year	0.0002	0.0009	--	--	--	--
	24 hours	0.0057	0.0179	--	--	--	--
	3 hours	0.0118	0.0529	--	--	--	--
Nitrogen	1 year	--	--	--	--	1.1832	4.6284
Sulfur	1 year	--	--	--	--	0.1581	0.7551
Visibility	1 year	--	--	1.47%	4.84%	--	--
Threshold		Variable[2]	Variable[2]	5%	N/A[3]	5	N/A[3]

[1] Maximum results are shown. g/ha-yr = grams per hectare-year.
[2] See Table 17.
[3] There are no regulatory standards or regulatory thresholds to compare to the results provided in these columns.

Table 17 shows the Class I and Class II Area Significant Impact Levels (SIL) for comparison to the results provided in Table 16. As shown by these two tables, the far-field impacts of criteria pollutants on Class I and II areas are below the SIL. Table 16 also shows that the Class I visibility and deposition impacts are below the regulatory thresholds.

Table 17. Class I and Class II Area SIL

Pollutant	Averaging Time	Class I Area SIL ($\mu g/m^3$)	Class II Area SIL ($\mu g/m^3$)
NO_2	1 year	0.1	1
$PM_{2.5}$	1 year	0.05	0.3
	24 hours	0.27	1.2
PM_{10}	1 year	0.2	0.2
	24 hours	0.3	1
SO_2	1 year	0.1	1
	24 hours	0.2	5
	3 hours	1	25

PRI00000840

REC 2180

6.0 RFAI 118 QUESTIONNAIRE AND RESPONSES

In February 2021, Perpetua received RFAI 118 related to the SGP emissions inventory and air quality analyses (Stantec 2021). RFAI 118 questions and Perpetua's responses are provided in Table 18.

Table 18. RFAI 118 Questions and Responses

Question	Response
Emissions Inventory	
Provide the updated emissions inventory for ModPRO2 (and any changes to other alternatives) for the EIS and IDEQ permitting submittals (in MS Excel format).	ModPRO2 detailed emissions inventory (EI) is provided in Appendix A to this addendum. An electronic copy of this EI in MS Excel format is provided in Appendix B. The IDEQ EI is also provided in Appendix B. Please note that the IDEQ EI required for New Source Review (NSR) permitting estimates SGP's potential to emit, a hypothetical emissions estimate based on continuous operations at maximum potential daily emission rates. Therefore, the IDEQ EI is not representative of the SGP actual operations covered by the NEPA effects analysis. For the NEPA effects analysis the ModPRO2 EI is the appropriate dataset to evaluate.
Modeling Inquiries	
Confirm that LOM year 7 represents the greatest air quality impact.	The LOM year 7 (production year 4) represents the greatest air quality impacts for ModPRO, described in the 2018 AQ Report, Section 4.2. Table 2 of this addendum provides the highest emission LOM years for ModPRO and ModPRO2.
Confirm when and where fugitive dust emissions from roads are included in the air quality model.	The road fugitive dust emissions were included in the 2018 AQ Report. The emission factors associated with the road fugitive dust (material hauling, water trucking, and grading) are provided in the 2018 AQ Report Table 6. The detailed road fugitive dust emission calculations for the lime kiln alternative are provided in the 2018 AQ Report Appendix B, pages 42-44, 54-56, and 59-60. The ModPRO2 road fugitive dust emissions are provided on pages 45-47, 57-59, and 62-63 in Appendix A to this addendum.
Confirm that EIS analyze throughputs are greater than IDEQ potentials/limits.	The mining activity rates used for the EIS analysis are not greater than those used for the IDEQ analysis. The EIS analysis uses the actual throughputs (maximum year) based on the SGP

PRI00000841

REC 2181

Question	Response
	plan of operations. The IDEQ analysis was performed using potential, maximum capacity throughput rates to present conservative assumptions for the NSR permit review process. Those rates are higher than the SGP plan of operations activity rates.
Provide locations of modelled PM10 exceedances with primary contributing sources.	The air dispersion modeling analysis provided in the 2018 AQ Report did not show any NAAQS exceedance, except for the Stibnite Access Road BULKRN results. This road is determined to be "not ambient air," and thus not subject to NAAQS. In addition, the IDEQ analysis also determined NAAQS compliance. The ModPRO2 NAAQS compliance demonstration is provided in Section 4.0 of this addendum.
Control Measures	
Provide a dust control plan with specific measures that are shown to achieve 90+% dust control efficiency.	A fugitive dust control plan (FDCP) will be developed in accordance with the IDEQ permit. The FDCP will address the following: • Procedures followed by Perpetua employees to control and minimize fugitive dust emissions • Trigger levels requiring corrective actions • Actions to bring fugitive dust emissions within acceptable ranges • Steps to demonstrate that appropriate corrective procedures are followed • Procedures to verify that Perpetua is controlling avoidable fugitive dust emissions
Provide any control measures included in the IDEQ permit application for HAP and mercury emissions.	The HAP and mercury control measures addressed in the IDEQ permit application are as follows: • Mining, general – reasonable controls, FDCP • Drilling – dust collection system • Haul roads – chemical dust suppressant/water application, clean rock capping • Burntlog access road – clean borrow material • Rock dumps and storage piles - reasonable controls, FDCP • Tailings and maintenance pond activities – chemical treatment, reasonable control, FDCP

PRI00000842

REC 2182

Question	Response
	• Ore processing – water sprays, moisture carryover, enclosures, reasonable controls, FDCP • Ore concentration and refining tanks – chemical treatment • Autoclave – venturi scrubber, vent gas cleaning tower, carbon filter • Electrowinning cells and pregnant solution tank – carbon filter • Mercury retort – carbon filter • Melting furnace – baghouse, carbon filter • Carbon kiln – wet scrubber, carbon filter • Limestone ball mill – baghouse • Parallel flow regenerative shaft lime kiln – baghouse • Lime mill crusher – baghouse • Lime slaker – wet scrubber • Storage silos – bin vents • Aggregate and concrete production – water sprays, moisture carryover, reasonable controls, FDCP • Fuel combustion – clean fuel • Emergency engines – EPA standard compliant • Gasoline storage – lids or gasketed seal, submerged filling • Diesel storage - lids
Provide any control measures included in the IDEQ permit application for fugitive mercury emissions.	The fugitive mercury control measures addressed in the IDEQ permit application are as follows: • Mining, general – reasonable controls, FDCP • Drilling – dust collection system • Haul roads – chemical dust suppressant/water application, clean rock capping • Burntlog access road – clean borrow material • Rock dumps and storage piles - reasonable controls, FDCP • Ore processing – water sprays, moisture carryover, enclosures, reasonable controls, FDCP • Aggregate and concrete production – water sprays, moisture carryover, reasonable controls, FDCP

Question	Response
Describe worker health & safety measures for winter-time air quality exposure.	This is not an ambient air quality issue and is not subject to NAAQS.
Assessment Inclusion Details	
Confirm that HAP and mercury emissions are complete (i.e., lime kiln).	The HAP and Hg emission calculations are complete and provided in the 2018 AQ Report Appendix B, pages 22-28 and 69-72 for ModPRO. The ModPRO2 HAP and Hg calculations are provided on pages 21-31 and 72-76 in Appendix A to this addendum.
Confirm that all arsenic and antimony sources have been included in HAP analysis.	The arsenic and antimony emissions are included in the HAP emission calculations provided in the 2018 AQ Report Appendix B, pages 22-28 and 69-72 for ModPRO. The ModPRO2 arsenic and antimony calculations are provided on pages 21-31 and 72-76 in Appendix A to this addendum.
Confirm that fugitive dust emissions (including lime kiln) are complete.	The fugitive dust emissions (including the lime processing) are complete and provided in the 2018 AQ Report Appendix B for ModPRO. The ModPRO2 fugitive dust emissions are provided in Appendix A to this addendum.
Confirm that fugitive dust and VOC emissions from landfarm are complete.	The potential for onsite landfarming to remediate petroleum-contaminated soils (PCS) encountered during construction and operation of the SGP is mentioned in Section 8.7.4 of Perpetua's PRO. Currently, Perpetua does not intend to conduct landfarming onsite; therefore, emissions from this activity were not included in the EIS analysis. If PCS are encountered during SGP operations and landfarming is determined to be an appropriate remedial strategy, it would be conducted in accordance with IDEQ's petroleum release response and corrective action policy (IDAPA 58.01.02.852) and following IDEQ's standard operating procedures for landfarming PCS (SOP WST-2017-02).
Confirm that the inclusion of metals in the fugitive dust under the ModPRO2 modification is complete.	Metal fugitive dust emissions are included in the ModPRO2 emissions inventory provided in Appendix A to this addendum.

PRI00000844

REC 2184

7.0 REFERENCES

Air Sciences. 2018. "Stibnite Gold Project Air Quality Analysis." Prepared for: Midas Gold Idaho, Inc. Project No. 335-1-2. Air Sciences Inc., October 10.

Brown and Caldwell. 2019. "Midas Gold ModPRO Technical Memorandum." Prepared for Midas Gold. Brown and Caldwell.

EPA. 2016a. "Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and PM2.5 under the PSD Permitting Program." Memorandum from Richard A. Wayland, EPA Air Quality Assessment Division Director, to EPA Regional Air Division Directors, Regions 1-10, December 2.

IDEQ. 2019. "Modeling Protocol for Midas." Idaho Department of Environmental Quality, June 27.

IPCC. 2007. "Climate Change 2007 Synthesis Report." Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, 104 pp.

Midas Gold. 2016. "Stibnite Gold Project Valley County, Idaho Plan of Restoration and Operations." Midas Gold Idaho, Inc., September.

—. 2020. "Stibnite Gold Project Valley County, Idaho. Refined Proposed Action ModPRO2." Midas Gold Idaho, Inc., December.

Stantec. 2021. "Request for Additional Information (RFAI)." RFAI # 118. Recipient: Midas Gold. RFAI Subject: Air Quality, February 12.

UNCC. n.d. "Globar Warming Potentials (IPCC Fourth Assessment Report)." United Nations Climate Change. Accessed April 29, 2021. https://unfccc.int/process-and-meetings/transparency-and-reporting/greenhouse-gas-data/frequently-asked-questions#eq-10.

USDA-FS. 2020. "Stibnite Gold Project Draft Environmental Impact Statement." United States Department of Agriculture Forest Service, Region 4, Payette and Boise National Forests, Valley County, Idaho, August.

Appendix A – ModPRO2: Emissions Inventory and Modeling Parameters

EI TABLE OF CONTENTS

Emissions Summary 2
Ore Processing Sources - Criteria Pollutant Emissions 5
Ore Processing Sources - HAP and GHG Emissions 21
Fuel Storage Tank Emissions 32
Mining Fugitive and Mobile, and Burntlog Route - Criteria Pollutant Emissions 41
Mining Fugitive and Mobile, and Burntlog Route - HAP and GHG Emissions 72
Mine Site Construction - Criteria Pollutant, HAP, and GHG Emissions 77
Power Line Construction - Criteria Pollutant, HAP, and GHG Emissions 86
Hg Emission Speciation 95
Hg Deposition Parameters 96
Conversions and Constants 97

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-1-1	PAGE: 1 OF: 3 SHEET: EmSum
AIR EMISSION CALCULATIONS	SUBJECT: Emissions Summary	DATE: June 30, 2021

Emissions Summary

Maximum Annual Emissions

Total Emissions by LOM Year

	LOM	PM ton/yr	PM10 ton/yr	PM2.5 ton/yr	CO ton/yr	NOX ton/yr	SO2 ton/yr	VOC ton/yr
	1	208.0	61.7	14.7	461.7	156.2	0.8	52.3
	2	302.3	92.2	24.3	531.3	220.8	0.9	**56.8**
	3	544.0	145.6	28.5	**641.2**	272.1	1.1	50.9
4-18	4	923.1	268.8	63.9	495.6	323.7	7.3	26.5
4-18	5	922.8	270.4	64.7	491.3	323.0	7.3	26.3
4-18	6	995.3	289.7	65.9	535.4	**335.3**	**7.3**	26.1
4-18	7	904.7	267.7	63.3	506.3	326.1	7.3	26.0
4-18	8	834.7	249.9	62.1	480.1	301.9	7.2	26.0
4-18	9	871.5	255.3	62.6	459.2	268.7	7.2	25.0
4-18	10	**1,130.6**	**320.1**	**69.1**	478.6	304.6	7.2	24.9
4-18	11	848.3	250.9	61.5	473.2	282.7	7.2	24.2
4-18	12	744.7	224.3	58.2	460.1	258.3	7.1	23.1
4-18	13	749.9	225.8	59.1	471.0	262.5	7.1	23.4
4-18	14	796.7	237.3	60.4	392.8	245.3	7.1	20.8
4-18	15	491.4	159.1	51.0	239.0	139.2	6.9	15.2
4-18	16	346.8	119.9	46.5	122.6	88.0	6.7	12.2
4-18	17	370.7	126.3	46.4	107.5	91.4	6.7	11.3
4-18	18	271.0	101.5	43.2	83.7	63.7	6.6	9.9
		PM_tpy	PM10_tpy	PM2.5_tpy	CO_tpy	NOx_tpy	SO2_tpy	VOC_tpy

Maximum Daily Emissions of AQRV Pollutants

Total Emissions by LOM Year

	LOM	Q/D Threshold	PM10 lb/day	PM2.5 lb/day	NOX lb/day	SO2 lb/day	H2SO4 lb/day	AQRV Pollutants (lb/day) Process	Mining	Construction	Total	
	1	775	454.7	101.8	1,013.2	4.5	0.0	0	0	1,472	1,472	chk
	2	775	684.4	173.9	1,498.4	5.6	0.0	0	0	2,188	2,188	chk
	3	775	934.2	180.8	1,695.3	8.5	0.0	0	1,428	1,210	2,638	chk
4-18	4	775	1,612.2	398.0	1,922.5	43.9	48.7	719	2,908	0	3,627	chk
4-18	5	775	1,631.3	405.9	1,914.4	43.9	48.7	719	2,919	0	3,638	chk
4-18	6	775	1,720.4	410.2	**1,969.0**	**44.0**	48.7	719	3,063	0	3,782	chk
4-18	7	775	1,628.1	396.2	1,928.8	43.9	**48.7**	719	2,931	0	3,650	chk
4-18	8	775	1,570.9	393.2	1,812.0	43.7	48.7	719	2,756	0	3,475	chk
4-18	9	775	1,535.5	390.8	1,611.7	43.2	48.7	719	2,520	0	3,239	chk
4-18	10	775	**1,937.0**	**429.7**	1,837.3	43.5	48.7	719	3,148	0	**3,867**	chk
4-18	11	775	1,534.3	386.0	1,705.8	43.2	48.7	719	2,613	0	3,332	chk
4-18	12	775	1,363.4	366.3	1,572.4	42.8	48.7	719	2,308	0	3,027	chk
4-18	13	775	1,386.4	372.5	1,587.3	42.9	48.7	719	2,346	0	3,065	chk
4-18	14	775	1,538.8	384.3	1,500.9	42.8	48.7	719	2,412	0	3,131	chk
4-18	15	775	1,122.1	333.2	898.9	41.4	48.7	719	1,392	0	2,111	chk
4-18	16	775	734.3	297.8	561.7	40.6	48.7	719	666	0	1,385	chk
4-18	17	775	770.3	297.5	580.4	40.5	48.7	719	721	0	1,440	chk
4-18	18	775	630.5	279.5	424.4	40.0	48.7	719	425	0	1,144	chk
			PM10_ppd	PM2.5_ppd	NOx_ppd	SO2_ppd	VOC_ppd	Sul_ppd				

Conversions

365 day/yr

2,000 lb/ton

PRI00000848

REC 2188

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-1-1	PAGE: 2 OF: 3 SHEET: EmSum
AIR EMISSION CALCULATIONS	SUBJECT: Emissions Summary	DATE: June 30, 2021

Emissions Summary

Ore Processing and Refining

	PM_tpy	PM10_tpy	PM2.5_tpy	CO_tpy	NOx_tpy	SO2_tpy	VOC_tpy
LOM	PM	PM10	PM2.5	CO	NOX	SO2	VOC
	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr
4-18	86.7	55.8	35.9	30.6	38.0	6.5	5.3

Mining

	chk	chk	chk	chk	chk	chk	chk
LOM	PM	PM10	PM2.5	CO	NOX	SO2	VOC
	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr
3	341.7	87.3	16.3	370.8	158.5	0.6	22.1
4	836.3	213.0	28.0	465.0	285.7	0.8	21.2
5	836.1	214.7	28.8	460.8	285.0	0.8	21.0
6	908.6	233.9	30.0	504.9	297.2	0.8	20.8
7	817.9	211.9	27.4	475.7	288.0	0.8	20.7
8	748.0	194.2	26.3	449.5	263.9	0.8	20.7
9	784.8	199.5	26.7	428.6	230.7	0.7	19.7
10	1,043.9	264.3	33.3	448.1	266.6	0.7	19.6
11	761.6	195.1	25.6	442.7	244.7	0.7	18.9
12	657.9	168.6	22.4	429.6	220.2	0.6	17.7
13	663.1	170.0	23.3	440.4	224.5	0.6	18.1
14	710.0	181.5	24.5	362.3	207.2	0.6	15.5
15	404.7	103.4	15.2	208.5	101.2	0.4	9.9
16	260.1	64.1	10.6	92.1	50.0	0.2	6.8
17	283.9	70.5	10.6	77.0	53.3	0.2	6.0
18	184.3	45.7	7.3	53.1	25.7	0.1	4.6

Mine Infrastructure Construction[1]

	chk	chk	chk	chk	chk	chk	chk
	189.1	54.2	11.8	392.1	91.6	0.6	47.8
LOM	PM	PM10	PM2.5	CO	NOX	SO2	VOC
	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr
1	189.1	54.2	11.8	392.1	91.6	0.6	47.8
2	264.5	77.3	18.5	392.1	91.6	0.6	47.8
3	183.4	50.9	9.3	200.7	49.0	0.3	24.3

[1] *Construction emissions during mine operation are accounted for in the mining emissions*

Power Line Construction

	chk	chk	chk	chk	chk	chk	chk
	18.9	7.5	2.9	69.6	64.6	0.1	4.5
LOM	PM	PM10	PM2.5	CO	NOX	SO2	VOC
	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr
1	18.9	7.5	2.9	69.6	64.6	0.1	4.5
2	37.8	15.0	5.7	139.3	129.2	0.3	9.0
3	18.9	7.5	2.9	69.6	64.6	0.1	4.5

PRI00000849

REC 2189

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-1-1	PAGE: 3 OF: 3 SHEET: EmSum
AIR EMISSION CALCULATIONS	SUBJECT: Emissions Summary	DATE: June 30, 2021

Emissions Summary

Ore Processing and Refining

	PM_ppd	PM10_ppd	PM2.5_ppd	CO_ppd	NOx_ppd	SO2_ppd	VOC_ppd	Sul_ppd
LOM	PM	PM10	PM2.5	CO	NOX	SO2	VOC	H2SO4
	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day
4-18	n/a	373.0	237.9	204.6	260.0	37.3	n/a	48.7

Mining

		chk	chk	chk	chk	chk	
LOM	PM	PM10	PM2.5	CO	NOX	SO2	VOC
	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day
3	n/a	500.0	93.8	2,462.0	922.1	5.6	n/a
4	n/a	1,239.2	160.1	3,886.0	1,662.5	6.6	n/a
5	n/a	1,258.4	168.0	3,704.0	1,654.3	6.5	n/a
6	n/a	1,347.4	172.3	3,409.5	1,709.0	6.6	n/a
7	n/a	1,255.2	158.3	3,677.9	1,668.8	6.6	n/a
8	n/a	1,197.9	155.3	4,248.4	1,552.0	6.3	n/a
9	n/a	1,162.6	152.9	3,644.7	1,351.7	5.9	n/a
10	n/a	1,564.0	191.8	4,621.9	1,577.3	6.2	n/a
11	n/a	1,161.4	148.1	4,282.5	1,445.7	5.9	n/a
12	n/a	990.5	128.4	4,369.4	1,312.4	5.5	n/a
13	n/a	1,013.4	134.6	4,103.0	1,327.3	5.6	n/a
14	n/a	1,165.8	146.4	4,054.6	1,240.9	5.5	n/a
15	n/a	749.1	95.3	3,018.6	638.8	4.1	n/a
16	n/a	361.3	59.9	543.3	301.6	3.3	n/a
17	n/a	397.3	59.6	458.4	320.3	3.1	n/a
18	n/a	257.6	41.6	324.1	164.4	2.7	n/a

Infrastructure Construction[1][2]

		chk	chk	chk	chk	chk	
		398.5	80.3	2226.5	527.9	3.5	
LOM	PM	PM10	PM2.5	CO	NOX	SO2	VOC
	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day
1	n/a	398.5	80.3	2226.5	527.9	3.5	n/a
2	n/a	572.0	130.9	2226.5	527.9	3.5	n/a
3	n/a	378.0	65.4	1148.4	288.0	1.8	n/a

[1] *Maximum daily emissions based on: 1000 person crew during peak construction, scaled with an average annual crew of 750 and an annual operating schedule of 355 day/yr*

[2] *Construction daily emissions based on: 1000 construction crew during peak construction, scaled with average annual crew of 750 and an annual operating schedule of 355 day/yr. Daily power generation emissions are not scaled by peak crew.*

Power Line Construction[1]

		chk	chk	chk-13	chk	chk	
		56.2	21.5	523.0	485.2	1.1	
LOM	PM	PM10	PM2.5	CO	NOX	SO2	VOC
	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day
1	n/a	56.2	21.5	523.0	485.2	1.1	n/a
2	n/a	112.4	43.0	1046.1	970.5	2.1	n/a
3	n/a	56.2	21.5	523.0	485.2	1.1	n/a

Construction daily emissions based on: 1000 construction crew during peak construction, scaled with average annual crew of 750 and an annual operating schedule of 355 day/yr.

Conversions

2,000	lb/ton	1,000	person construction crew during peak construction
24	hr/day	750	person average construction crew during the year
355	day/yr Annual operations schedule		

SOURCE DESCRIPTION		OPERATING LIMITS							EMISSION FACTORS									
Model	Source Description	Design Throughput						reference	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	H2S	unit	reference
ID		unit/hr	unit/day	unit/yr	units	Material	hr/yr											
OC1	Loader Transfer of Ore to Grizzly Screen	1,042	25,000	9,125,000	ton	Ore	8,760	(Midas Gold 2016), Sec. 10.1	0.00014	4.6E-05	1.3E-05						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.
OC2	Grizzly Screen to Apron Feeder	1,042	25,000	9,125,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.
OC3	Apron Feeder to Dribble Conveyor	1,042	25,000	9,125,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.
OC4	Apron Feeder to Vibrating Grizzly	1,042	25,000	9,125,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.
OC5	Dribble Conveyor to Vibrating Grizzly	1,042	25,000	9,125,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	1,042	25,000	9,125,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	1,042	25,000	9,125,000	ton	Ore	8,760		0.0012	0.00054	0.0001						lb/ton	AP-42, Table 11.19.2-2 (08/04) Tert. Crushing - ctrl.
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	1,042	25,000	9,125,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.
OC9	Stockpile Transfers to Reclaim Conveyors	1,150	27,600	10,074,000	ton	Ore	8,760	(M3 2017b)	0.003	0.0011	0.00017						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - unctrl.; PM2.5 Ch. 13.2.4
OC10	Reclaim Conveyers to SAG Mill Feed Conveyor	1,150	27,600	10,074,000	ton	Ore	8,760		0.003	0.0011	0.00017						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - unctrl.; PM2.5 Ch. 13.2.4
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	1,150	27,600	10,074,000	ton	Ore	8,760		0.003	0.0011	0.00017						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - unctrl.; PM2.5 Ch. 13.2.4
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	1150.0	27,600	10,074,000	ton	Ore	8,760		0.0012	0.00054	0.0001						lb/ton	AP-42, Table 11.19.2-2 (08/04) Tert. Crushing - ctrl.
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	1150.0	27,600	10,074,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.
LS1L	Mill Lime Silo#1 Loading	60	250	4,375	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.00099	0.00034	0.00005						lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	20	250	4,375	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.00042						lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4
MillS2L	Mill Lime Silo #2 Loading	60	250	4,375	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.00099	0.00034	0.00005						lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	20	250	4,375	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.00042						lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4
Sb1	Sb Drying (2.72 MMBtu/hr Propane-Fired)	0		0	MMBtu	Propane	8,760	Removed from PTC, 01/28/21	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874		lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
Sb2	Sb Bagging	4.5		39,420	ton	Stib. Conc.	8,760	(M3 2017d)	0	0	0						lb/hr	Wet bagging, 01/28/21
AC	Autoclave	290	6,960	2,540,400	ton	Float Conc.	8,760	(M3 2017b)	5.075	5.075	5.075			0.6525		0.9	lb/hr	Based on NDEP-BAPC Permits/test data for Autoclaves: PM & SO2 - [Goldstrike (NDEP 2012)], H2S - (APT 2013). Negligible CO due to no organic carbon in the feed (M3 2017a)
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	17	17	510	MMBtu	Propane	30	(M3 2017b)	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874		lb/MMBtu	AP-42, Table 1.5-1 (07/08) Ind. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
ACS1L	AC Lime Silo #1 Loading	120	1,000	17,500	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.00099	0.00034	0.00005						lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	20	480	17,500	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.0004						lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4
ACS2L	AC Lime Silo #2 Loading	120	1,000	17,500	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.00099	0.00034	0.00005						lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	20	480	17,500	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.0004						lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4

SOURCE DESCRIPTION		EMISSION CONTROLS			HOURLY EMISSIONS								DAILY EMISSIONS							
Model ID	Source Description	control system	efficiency	reference	PM lb/hr	PM_{10} lb/hr	$PM_{2.5}$ lb/hr	CO lb/hr	NOx lb/hr	SO_2 lb/hr	VOC lb/hr	H2S lb/hr	PM lb/day	PM_{10} lb/day	$PM_{2.5}$ lb/day	CO lb/day	NOx lb/day	SO_2 lb/day	VOC lb/day	H2S lb/day
OC1	Loader Transfer of Ore to Grizzly Screen	Water Sprays		Control efficiency included in emission factor	0.146	0.0479	0.0135						3.50	1.15	0.325					
OC2	Grizzly Screen to Apron Feeder	Moisture Carry-Over		Control efficiency included in emission factor	0.146	0.0479	0.0135						3.50	1.15	0.325					
OC3	Apron Feeder to Dribble Conveyor	Moisture Carry-Over		Control efficiency included in emission factor	0.146	0.0479	0.0135						3.50	1.15	0.325					
OC4	Apron Feeder to Vibrating Grizzly	Moisture Carry-Over		Control efficiency included in emission factor	0.146	0.0479	0.0135						3.50	1.15	0.325					
OC5	Dribble Conveyor to Vibrating Grizzly	Moisture Carry-Over		Control efficiency included in emission factor	0.146	0.0479	0.0135						3.50	1.15	0.325					
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	Moisture Carry-Over		Control efficiency included in emission factor	0.146	0.0479	0.0135						3.50	1.15	0.325					
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	Water Sprays		Control efficiency included in emission factor	1.25	0.563	0.104						30.0	13.5	2.50					
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	Moisture Carry-Over		Control efficiency included in emission factor	0.146	0.0479	0.0135						3.50	1.15	0.325					
OC9	Stockpile Transfers to Reclaim Conveyors	Undergrnd	80%	Based on AP-42, Chapter 13.2.4, reduction in EF due to wind speed reduction	0.690	0.253	0.0391						16.6	6.07	0.938					
OC10	Reclaim Conveyers to SAG Mill Feed Conveyor	Undergrnd	80%	Based on AP-42, Chapter 13.2.4, reduction in EF due to wind speed reduction	0.690	0.253	0.0391						16.6	6.07	0.938					
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	Enclosure	80%	Based on AP-42, Chapter 13.2.4, reduction in EF due to wind speed reduction	0.690	0.253	0.0391						16.6	6.07	0.94					
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	Water Sprays		Control efficiency included in emission factor	1.380	0.621	0.1150						33.12	14.90	2.760					
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	Moisture Carry-Over		Control efficiency included in emission factor	0.1610	0.0529	0.01495						3.864	1.270	0.3588					
LS1L	Mill Lime Silo#1 Loading	Bin Vent Filter		Control efficiency included in emission factor	0.0594	0.0204	0.00300						0.248	0.0850	0.0125					
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	None	0%		0.0960	0.0560	0.00840						1.20	0.700	0.105					
MillS2L	Mill Lime Silo #2 Loading	Bin Vent Filter		Control efficiency included in emission factor	0.0594	0.0204	0.00300						0.248	0.0850	0.0125					
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	None	0%		0.0960	0.0560	0.00840						1.20	0.700	0.105					
Sb1	Sb Drying (2.72 MMBtu/hr Propane-Fired)	None	NA		0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000		0.000	0.000	0.000	0.00	0.00	0.00	0.000	
Sb2	Sb Bagging	None	NA	Wet process	0.000	0.000	0.000						0.00	0.00	0.00					
AC	Autoclave	Wet Scrubber	NA	PM control efficiency included in emission factor	5.08	5.08	5.08			0.653		0.900	122	122	122			15.7		21.6
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	None	NA	NOX control efficiency included in emission factor	0.130	0.130	0.130	1.39	2.42	0.295	0.149		0.130	0.130	0.130	1.39	2.42	0.295	0.149	
ACS1L	AC Lime Silo #1 Loading	Bin Vent Filter		Control efficiency included in emission factor	0.119	0.0408	0.00600						0.990	0.340	0.0500					
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	None	0%		0.0960	0.0560	0.00800						2.30	1.34	0.192					
ACS2L	AC Lime Silo #2 Loading	Bin Vent Filter		Control efficiency included in emission factor	0.119	0.0408	0.00600						0.990	0.340	0.0500					
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	None	0%		0.0960	0.0560	0.00800						2.30	1.34	0.192					

SOURCE DESCRIPTION		ANNUAL EMISSIONS									NAD 83 LOCATION				
Model ID	Source Description	PM ton/yr	PM_{10} ton/yr	$PM_{2.5}$ ton/yr	CO ton/yr	NOx ton/yr	SO_2 ton/yr	VOC ton/yr	H2S ton/yr	Hg2+P ton/yr	UTM E m	UTM N m	reference	elev m	reference
OC1	Loader Transfer of Ore to Grizzly Screen	0.639	0.210	0.0593						6.13E-7	632,045	4,974,583	PC building center	1,968.5	PC building base
OC2	Grizzly Screen to Apron Feeder	0.639	0.210	0.0593						6.13E-7	632,045	4,974,583	PC building center	1,968.5	PC building base
OC3	Apron Feeder to Dribble Conveyor	0.639	0.210	0.0593						6.13E-7	632,045	4,974,583	PC building center	1,968.5	PC building base
OC4	Apron Feeder to Vibrating Grizzly	0.639	0.210	0.0593						6.13E-7	632,045	4,974,583	PC building center	1,968.5	PC building base
OC5	Dribble Conveyor to Vibrating Grizzly	0.639	0.210	0.0593						6.13E-7	632,045	4,974,583	PC building center	1,968.5	PC building base
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	0.639	0.210	0.0593						6.13E-7	632,045	4,974,583	PC building center	1,968.5	PC building base
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	5.48	2.46	0.456						5.26E-6	632,045	4,974,583	PC building center	1,968.5	PC building base
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	0.639	0.210	0.0593						6.13E-7	631,947	4,974,520	Stockpile center	1,957.0	Stockpile base
OC9	Stockpile Transfers to Reclaim Conveyors	3.02	1.11	0.171						2.90E-6	631,947	4,974,520	Stockpile center	1,957.0	Stockpile base
OC10	Reclaim Conveyers to SAG Mill Feed Conveyor	3.02	1.11	0.171						2.90E-6	631,947	4,974,520	Stockpile center	1,957.0	Stockpile base
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	3.02	1.11	0.171						2.90E-6	632,113	4,974,243	Mill building wall opening	2,000.6	Mill building base
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	6.04	2.720	0.504						5.80E-6	632,028	4,974,187	Pebble crusher building center	1,973.3	Pebble crusher building base
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0.705	0.2317	0.0655						6.77E-7	632,028	4,974,187	Pebble crusher building center	1,973.3	Pebble crusher building base
LS1L	Mill Lime Silo#1 Loading	0.00217	7.44E-4	1.09E-4						4.33125E-11	632,095	4,974,272	Mill Silo #1 center	1,992.0	Mill Silo #1 base
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0.0105	0.00613	9.19E-4						2.1E-10	632,095	4,974,272	Mill Silo #1 center	1,992.0	Mill Silo #1 base
MillS2L	Mill Lime Silo #2 Loading	0.00217	7.44E-4	1.09E-4						4.33125E-11	632,090	4,974,282	Mill Silo #2 center	1,990.0	Mill Silo #2 base
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0.0105	0.00613	9.19E-4						2.1E-10	632,090	4,974,282	Mill Silo #2 center	1,990.0	Mill Silo #2 base
Sb1	Sb Drying (2.72 MMBtu/hr Propane-Fired)	0.0000	0.0000	0.0000	0.000	0.00	0.000	0.000		0.00E+0	632,231	4,974,183	Mill building corner	2,000.6	Mill building base
Sb2	Sb Bagging	0.000	0.000	0.000							632,208	4,974,221	Mill building corner	2,000.6	Mill building base
AC	Autoclave	22.2	22.2	22.2			2.86		3.94	2.10E-6	632,229	4,974,096	POX building corner	2,007.2	POX building base
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0.00195	0.00195	0.00195	0.0209	0.0362	0.00443	0.00223		6.00E-9	632,261	4,974,116	POX building corner	2,007.2	POX building base
ACS1L	AC Lime Silo #1 Loading	0.00866	0.00298	4.38E-4						1.7325E-10	632,267	4,974,124	AC Silo #1 center	2,007.2	AC Silo #1 base
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0.0420	0.0245	0.00350						8.4E-10	632,267	4,974,124	AC Silo #1 center	2,007.2	AC Silo #1 base
ACS2L	AC Lime Silo #2 Loading	0.00866	0.00298	4.38E-4						1.7325E-10	632,257	4,974,140	AC Silo #2 center	2,007.2	AC Silo #2 base
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0.0420	0.0245	0.00350						8.4E-10	632,257	4,974,140	AC Silo #2 center	2,007.2	AC Silo #2 base

SOURCE DESCRIPTION		RELEASE PARAMETERS INPUT						MODEL EMISSION RATES / RELEASE PARAMETERS													
Model	Source Description	POINT	rel ht (ft)	temp (F)	flow (dscfm)	flow (acfm)	dia (ft)	PM_{10}-24	$PM_{2.5}$-24	CO-ALL	NO_2-1	SO_2-1	SO_2-3	PM_{10}-AN	$PM_{2.5}$-AN	NO_2-AN	SO_2-AN	ht (m)	temp (K)	vel (m/s)	dia (m)
ID		VOLUME	rel ht (ft)	width (ft)	vert. ln (ft)	grnd ht (ft)	oz type	gps	gps	gps	gps	gps	gps	gps	gps	gps	gps	ht (m)	oy (m)	oz (m)	
OC1	Loader Transfer of Ore to Grizzly Screen	VOLUME	64	52.9	128	128	srf src	6.04E-3	1.71E-3					6.04E-3	1.71E-3			19.51	3.75	18.15	
OC2	Grizzly Screen to Apron Feeder	VOLUME	64	52.9	128	128	srf src	6.04E-3	1.71E-3					6.04E-3	1.71E-3			19.51	3.75	18.15	
OC3	Apron Feeder to Dribble Conveyor	VOLUME	64	52.9	128	128	srf src	6.04E-3	1.71E-3					6.04E-3	1.71E-3			19.51	3.75	18.15	
OC4	Apron Feeder to Vibrating Grizzly	VOLUME	64	52.9	128	128	srf src	6.04E-3	1.71E-3					6.04E-3	1.71E-3			19.51	3.75	18.15	
OC5	Dribble Conveyor to Vibrating Grizzly	VOLUME	64	52.9	128	128	srf src	6.04E-3	1.71E-3					6.04E-3	1.71E-3			19.51	3.75	18.15	
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	VOLUME	64	52.9	128	128	srf src	6.04E-3	1.71E-3					6.04E-3	1.71E-3			19.51	3.75	18.15	
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	VOLUME	64	52.9	128	128	srf src	7.09E-2	1.31E-2					7.09E-2	1.31E-2			19.51	3.75	18.15	
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	VOLUME	35.8	3	71.6	71.6	srf src	6.04E-3	1.71E-3					6.04E-3	1.71E-3			10.91	0.21	10.15	
OC9	Stockpile Transfers to Reclaim Conveyors	VOLUME	4	8	8	8	srf src	3.19E-2	4.93E-3					3.19E-2	4.93E-3			1.22	0.57	1.13	
OC10	Reclaim Conveyers to SAG Mill Feed Conveyor	VOLUME	4	8	8	8	srf src	3.19E-2	4.93E-3					3.19E-2	4.93E-3			1.22	0.57	1.13	
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	VOLUME	68	4	4	70	elev src w/ bldg	3.19E-2	4.93E-3					3.19E-2	4.93E-3			20.73	0.28	0.57	
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	VOLUME	10	32.7	20	20	srf src	7.82E-2	1.45E-2					7.82E-2	1.45E-2			3.05	2.32	2.84	
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	VOLUME	10	32.7	20	20	srf src	6.67E-3	1.88E-3					6.67E-3	1.88E-3			3.05	2.32	2.84	
LS1L	Mill Lime Silo#1 Loading	POINT	43.7	Ambient	700	700	0.5	4.46E-4	6.56E-5					2.14E-5	3.15E-6			13.32	0.00	18.11	0.15
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	VOLUME	4.5	1	1	5	elev src w/ bldg	3.67E-3	5.51E-4					1.76E-4	2.64E-5			1.37	0.07	0.14	
MillS2L	Mill Lime Silo #2 Loading	POINT	43.7	Ambient	700	700	0.5	4.46E-4	6.56E-5					2.14E-5	3.15E-6			13.32	0.00	18.11	0.15
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	VOLUME	4.5	1	1	5	elev src w/ bldg	3.67E-3	5.51E-4					1.76E-4	2.64E-5			1.37	0.07	0.14	
Sb1	Sb Drying (2.72 MMBtu/hr Propane-Fired)	POINT	150	360	0	0	1.0	--	--	--	--	--	--	--	--	--	--	45.72	455.37	0.00	0.30
Sb2	Sb Bagging	POINT	150	Ambient	800	1,000	1.0	--	--					--	--			45.72	0.00	6.47	0.30
AC	Autoclave	POINT	77	196	3,101	28,680	5.0	6.39E-1	6.39E-1			8.22E-2	8.22E-2	6.39E-1	6.39E-1		8.22E-2	23.47	364.26	7.42	1.52
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	POINT	77	360	2,881	6,703	2.0	6.83E-4	6.83E-4	1.76E-1	3.04E-1	3.72E-2	3.72E-2	5.61E-5	5.61E-5	1.04E-3	1.27E-4	23.47	455.37	10.84	0.61
ACS1L	AC Lime Silo #1 Loading	POINT	57.2	Ambient	1,400	1,400	0.8	1.78E-3	2.62E-4					8.56E-5	1.26E-5			17.44	0.00	16.10	0.23
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	VOLUME	4.5	1	1	5	elev src w/ bldg	7.06E-3	1.01E-3					7.05E-4	1.01E-4			1.37	0.07	0.14	
ACS2L	AC Lime Silo #2 Loading	POINT	57.2	Ambient	1,400	1,400	0.8	1.78E-3	2.62E-4					8.56E-5	1.26E-5			17.44	0.00	16.10	0.23
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	VOLUME	4.5	1	1	5	elev src w/ bldg	7.06E-3	1.01E-3					7.05E-4	1.01E-4			1.37	0.07	0.14	

SOURCE DESCRIPTION		OPERATING LIMITS							EMISSION FACTORS									
Model	Source Description	Design Throughput						reference	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	H2S	unit	reference
ID		unit/hr	unit/day	unit/yr	units	Material	hr/yr											
ACS3L	AC Lime Silo #3 Loading	120	1,000	17,500	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.00099	0.00034	0.00005						lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	20	480	17,500	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.0004						lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4
ACS4L	AC Lime Silo #4 Loading	120	500	8,750	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.00099	0.00034	0.00005						lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	20	480	8,750	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.0004						lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4
CKD	Carbon Regeneration Kiln (Drum)	0.3		2,628	ton	Carbon	8,760	(M3 2017b)	0.42	0.42	0.42	0.12	0.012		0.11		lb/hr	Based on NDEP-BAPC Permit for Carbon Regeneration Kiln [Goldstrike (NDEP 2012)]
CKB	Carbon Regeneration Kiln (Burners)	2.255	54.12	19,754	MMBtu	Propane	8,760	(M3 2017b)	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874		lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
EW	Electrowinning Cells & Pregnant Solution Tank	100 gpm	24 hr		gpm	Au Sol.	8,760	Typical Ind. Oper.	0.07	0.07	0.07						lb/hr	Based on similar source stack test data and 5× safety factor (APT 2016)
MR	Mercury Retort	0.5/batch	24 hr	21	ton	Au Conc.	1,248	(M3 2017b) & (M3 2017a)	0.01	0.01	0.01						lb/hr	Based on similar source stack test data and 5× safety factor (APT 2017)
MF	Induction Melting Furnace	0.5/batch	12 hr	21	ton	Au Conc.	624	(M3 2017b) & (M3 2017a)	2.84	2.84	2.84						lb/hr	Based on IDAPA 58.01.01.701 PM Weight Limit
EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	1000	1 hr	100,000	bkW	Diesel	100	(M3 2017a)	0.2	0.2	0.2	3.5	6.4	0.00657	1.3		g/kW-hr	40 CFR Subpart 60.4202(a)(2); SO2 - mass balance (15ppm ULSD) (CFR 2018b)
EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	1000	1 hr	100,000	bkW	Diesel	100	(M3 2017a)	0.2	0.2	0.2	3.5	6.4	0.00657	1.3		g/kW-hr	40 CFR Subpart 60.4202(a)(2); SO2 - mass balance (15ppm ULSD) (CFR 2018b)
EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	1000	1 hr	100,000	bkW	Diesel	100	(M3 2017a)	0.2	0.2	0.2	3.5	6.4	0.00657	1.3		g/kW-hr	40 CFR Subpart 60.4202(a)(2); SO2 - mass balance (15ppm ULSD) (CFR 2018b)
EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	200	1 hr	20,000	bkW	Diesel	100	Typical Ind. Oper.	0.2	0.2	0.2	3.5	4	0.00657	4		g/kW-hr	Table 4 to Subpart IIII of Part 60 – 130≤KW<225 (175≤HP<300); SO2 - mass balance (15ppm ULSD) (CFR 2018b)
PV	Propane Vaporizer (0.4 MMBtu/hr Propane-Fired)	0.10	2.40	876	MMBtu	Propane	8,760	(M3 2017a)	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874		lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	5.00	120.00	43,800	MMBtu	Propane	8,760	(M3 2017b)	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874		lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	4.00	96.00	35,040	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874		lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	4.00	96.00	35,040	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874		lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	4.00	96.00	35,040	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874		lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
HAC	Autoclave HVAC Heater (1 x 0.25 MMBtu Propane-Fired)	0.25	6.00	2,190	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874		lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
HR	Refinery HVAC Heaters (1 x 0.25 MMBtu Propane-Fired)	0.25	6.00	2,190	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874		lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
HA	Admin HVAC Heaters (1 x 0.25 MMBtu Propane-Fired)	0.25	6.00	2,190	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874		lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0.50	12.00	4,380	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874		lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	2.00	48.00	17,520	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874		lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal

SOURCE DESCRIPTION		EMISSION CONTROLS			HOURLY EMISSIONS								DAILY EMISSIONS							
Model ID	Source Description	control system	efficiency	reference	PM lb/hr	PM_{10} lb/hr	$PM_{2.5}$ lb/hr	CO lb/hr	NOx lb/hr	SO_2 lb/hr	VOC lb/hr	H2S lb/hr	PM lb/day	PM_{10} lb/day	$PM_{2.5}$ lb/day	CO lb/day	NOx lb/day	SO_2 lb/day	VOC lb/day	H2S lb/day
ACS3L	AC Lime Silo #3 Loading	Bin Vent Filter		Control efficiency included in emission factor	0.119	0.0408	0.00600						0.990	0.340	0.0500					
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	None	0%		0.0960	0.0560	0.00800						2.30	1.34	0.192					
ACS4L	AC Lime Silo #4 Loading	Bin Vent Filter		Control efficiency included in emission factor	0.119	0.0408	0.00600						0.495	0.170	0.0250					
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	None	0%		0.0960	0.0560	0.00800						2.30	1.34	0.192					
CKD	Carbon Regeneration Kiln (Drum)	Wet Scrubber / Carbon Filter	NA	PM control efficiency included in emission factor	0.420	0.420	0.420	0.120	0.0120		0.110		10.1	10.1	10.1	2.88	0.288	0	2.64	
CKB	Carbon Regeneration Kiln (Burners)	None	NA		0.0173	0.0173	0.0173	0.185	0.320	0.0392	0.0197		0.414	0.414	0.414	4.44	7.69	0.940	0.473	
EW	Electrowinning Cells & Pregnant Solution Tank	Shared Carbon Filter			0.07	0.07	0.07						1.68	1.68	1.68					
MR	Mercury Retort	Condenser / Carbon Filter			0.01	0.01	0.01						0.24	0.24	0.24					
MF	Induction Melting Furnace	Baghouse / Carbon Filter	NA	Control efficiency included in emission factor	2.84	2.84	2.84						34.1	34.1	34.1					
EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	None	NA		0.441	0.441	0.441	7.72	14.1	0.0145	2.87		0.441	0.441	0.441	7.72	14.11	0.01448	2.866	
EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	None	NA		0.441	0.441	0.441	7.72	14.1	0.0145	2.87		0.441	0.441	0.441	7.72	14.11	0.01448	2.866	
EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	None	NA		0.441	0.441	0.441	7.72	14.1	0.0145	2.87		0.441	0.441	0.441	7.72	14.11	0.01448	2.866	
EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	None	NA		0.0882	0.0882	0.0882	1.54	1.76	0.00290	1.76		0.0882	0.0882	0.0882	1.543	1.764	2.90E-3	1.764	
PV	Propane Vaporizer (0.4 MMBtu/hr Propane-Fired)	None	NA		7.65E-4	7.65E-4	7.65E-4	0.00820	0.0142	0.00174	8.74E-4		0.0184	0.0184	0.0184	0.197	0.341	0.0417	0.0210	
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	None	NA		0.0383	0.0383	0.0383	0.410	0.710	0.0869	0.0437		0.918	0.918	0.918	9.84	17.0	2.09	1.05	
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	None	NA		0.0306	0.0306	0.0306	0.328	0.568	0.0695	0.0350		0.734	0.734	0.734	7.87	13.6	1.67	0.839	
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	None	NA		0.0306	0.0306	0.0306	0.328	0.568	0.0695	0.0350		0.734	0.734	0.734	7.87	13.6	1.67	0.839	
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	None	NA		0.0306	0.0306	0.0306	0.328	0.568	0.0695	0.0350		0.734	0.734	0.734	7.87	13.6	1.67	0.839	
HAC	Autoclave HVAC Heater (1 x 0.25 MMBtu Propane-Fired)	None	NA		0.00191	0.00191	0.00191	0.0205	0.0355	0.00434	0.00219		0.0459	0.0459	0.0459	0.492	0.852	0.104	0.0525	
HR	Refinery HVAC Heaters (1 x 0.25 MMBtu Propane-Fired)	None	NA		0.00191	0.00191	0.00191	0.0205	0.0355	0.00434	0.00219		0.0459	0.0459	0.0459	0.492	0.852	0.104	0.0525	
HA	Admin HVAC Heaters (1 x 0.25 MMBtu Propane-Fired)	None	NA		0.00191	0.00191	0.00191	0.0205	0.0355	0.00434	0.00219		0.0459	0.0459	0.0459	0.492	0.852	0.104	0.0525	
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	None	NA		0.00383	0.00383	0.00383	0.0410	0.0710	0.00869	0.00437		0.0918	0.0918	0.0918	0.984	1.70	0.209	0.105	
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	None	NA		0.0153	0.0153	0.0153	0.164	0.284	0.0348	0.0175		0.367	0.367	0.367	3.93	6.82	0.834	0.420	

SOURCE DESCRIPTION		ANNUAL EMISSIONS									NAD 83 LOCATION				
Model ID	Source Description	PM ton/yr	PM_{10} ton/yr	$PM_{2.5}$ ton/yr	CO ton/yr	NOx ton/yr	SO_2 ton/yr	VOC ton/yr	H2S ton/yr	Hg2+P ton/yr	UTM E m	UTM N m	reference	elev m	reference
ACS3L	AC Lime Silo #3 Loading	0.00866	0.00298	4.38E-4						1.7325E-10	632,248	4,974,156	AC Silo #3 center	2,007.2	AC Silo #3 base
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0.0420	0.0245	0.00350						8.4E-10	632,248	4,974,156	AC Silo #3 center	2,007.2	AC Silo #3 base
ACS4L	AC Lime Silo #4 Loading	0.00433	0.00149	2.19E-4						8.6625E-11	632,238	4,974,171	AC Silo #4 center	2,007.2	AC Silo #4 base
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0.0210	0.0123	0.00175						4.2E-10	632,238	4,974,171	AC Silo #4 center	2,007.2	AC Silo #4 base
CKD	Carbon Regeneration Kiln (Drum)	1.84	1.84	1.84	0.526	0.0526		0.482		6.51E-6	632,013	4,974,051	Refinery building corner	1,970.3	Refinery building base
CKB	Carbon Regeneration Kiln (Burners)	0.0756	0.0756	0.0756	0.810	1.40	0.172	0.0864		2.32E-7	631,998	4,974,042	Along Refinery building wall	1,970.3	Refinery building base
EW	Electrowinning Cells & Pregnant Solution Tank	0.31	0.31	0.31						6.51E-6	631,983	4,974,033	Refinery building corner	1,970.3	Refinery building base
MR	Mercury Retort	0.01	0.01	0.01						6.51E-6	632,003	4,974,001	Refinery building corner	1,970.3	Refinery building base
MF	Induction Melting Furnace	0.89	0.89	0.89						6.51E-6	632,032	4,974,019	Refinery building corner	1,970.3	Refinery building base
EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0.0220	0.0220	0.0220	0.386	0.705	7.24E-4	0.143			634,274	4,972,050	Outside Recreation building	2,114.0	Recreation building base
EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0.0220	0.0220	0.0220	0.386	0.705	7.24E-4	0.143			632,105	4,974,154	Outside Mill building	2,001.0	Mill building base
EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0.0220	0.0220	0.0220	0.386	0.705	7.24E-4	0.143			632,109	4,974,148	Outside Mill building	2,002.0	Mill building base
EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0.00441	0.00441	0.00441	0.0772	0.0882	1.45E-4	0.0882			632,113	4,974,141	Outside Mill building	2,003.0	Mill building base
PV	Propane Vaporizer (0.4 MMBtu/hr Propane-Fired)	0.00335	0.00335	0.00335	0.0359	0.0622	0.00761	0.00383		1.03E-8	632,216	4,974,118	POX building corner	2,007.2	POX building base
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0.168	0.168	0.168	1.80	3.11	0.381	0.191		5.15E-7	632,017	4,974,010	Along Refinery building wall	1,970.3	Refinery building base
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0.134	0.134	0.134	1.44	2.49	0.304	0.153		4.12E-7	632,287	4,974,227	Near underground mine shaft	2,000.0	Mine shaft base
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0.134	0.134	0.134	1.44	2.49	0.304	0.153		4.12E-7	632,288	4,974,228	Near underground mine shaft	2,000.0	Mine shaft base
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0.134	0.134	0.134	1.44	2.49	0.304	0.153		4.12E-7	632,168	4,974,191	Mill building center	2,000.6	Mill building base
HAC	Autoclave HVAC Heater (1 x 0.25 MMBtu Propane-Fired)	0.00838	0.00838	0.00838	0.0898	0.156	0.0190	0.00957		2.58E-8	632,238	4,974,130	POX building center	2,007.2	POX building base
HR	Refinery HVAC Heaters (1 x 0.25 MMBtu Propane-Fired)	0.00838	0.00838	0.00838	0.0898	0.156	0.0190	0.00957		2.58E-8	632,008	4,974,026	Refinery building center	1,970.3	Refinery building base
HA	Admin HVAC Heaters (1 x 0.25 MMBtu Propane-Fired)	0.00838	0.00838	0.00838	0.0898	0.156	0.0190	0.00957		2.58E-8	632,038	4,973,751	Admin building center	1,979.0	Admin building base
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0.0168	0.0168	0.0168	0.180	0.311	0.0381	0.0191		5.15E-8	631,889	4,973,472	Mine Ops building center	1,988.5	Mine Ops building base
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0.0670	0.0670	0.0670	0.718	1.24	0.152	0.0766		2.06E-7	631,848	4,973,398	Truck Shop building center	1,991.8	Truck Shop building base

SOURCE DESCRIPTION		RELEASE PARAMETERS INPUT						MODEL EMISSION RATES / RELEASE PARAMETERS													
Model ID	Source Description	POINT VOLUME	rel ht (ft) rel ht (ft)	temp (F) width (ft)	flow (dscfm) vert. ln (ft)	flow (acfm) grnd ht (ft)	dia (ft) oz type	PM_{10}-24 gps	$PM_{2.5}$-24 gps	CO-ALL gps	NO_2-1 gps	SO_2-1 gps	SO_2-3 gps	PM_{10}-AN gps	$PM_{2.5}$-AN gps	NO_2-AN gps	SO_2-AN gps	ht (m) ht (m)	temp (K) oy (m)	vel (m/s) oz (m)	dia (m)
ACS3L	AC Lime Silo #3 Loading	POINT	57.2	Ambient	1,400	1,400	0.8	1.78E-3	2.62E-4					8.56E-5	1.26E-5			17.44	0.00	16.10	0.23
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	VOLUME	4.5	1	1	5	elev src w/ bldg	7.06E-3	1.01E-3					7.05E-4	1.01E-4			1.37	0.07	0.14	
ACS4L	AC Lime Silo #4 Loading	POINT	47.5	Ambient	1,400	1,400	0.8	8.92E-4	1.31E-4					4.28E-5	6.29E-6			14.49	0.00	16.10	0.23
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	VOLUME	4.5	1	1	5	elev src w/ bldg	7.06E-3	1.01E-3					3.52E-4	5.03E-5			1.37	0.07	0.14	
CKD	Carbon Regeneration Kiln (Drum)	POINT	55	150	120	180	0.5	5.29E-2	5.29E-2	1.51E-2	1.51E-3			5.29E-2	5.29E-2	1.51E-3		16.76	338.71	5.05	0.15
CKB	Carbon Regeneration Kiln (Burners)	POINT	46	360	382	889	1.0	2.17E-3	2.17E-3	2.33E-2	4.04E-2	4.94E-3	4.94E-3	2.17E-3	2.17E-3	4.04E-2	4.94E-3	14.02	455.37	5.75	0.30
EW	Electrowinning Cells & Pregnant Solution Tank	POINT	55	100	2,660	3,740	1.0	8.82E-3	8.82E-3					8.82E-3	8.82E-3			16.76	310.93	24.19	0.30
MR	Mercury Retort	POINT	55	150	16	20	0.3	1.26E-3	1.26E-3					1.80E-4	1.80E-4			16.76	338.71	1.54	0.09
MF	Induction Melting Furnace	POINT	55	150	3,500	5,200	1.3	1.79E-1	1.79E-1					2.55E-2	2.55E-2			16.76	338.71	21.53	0.38
EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	POINT	7	1,100	1,894	10,328	1.5	2.31E-3	2.31E-3	9.72E-1	2.03E-2	2.08E-5	1.82E-3	6.34E-4	6.34E-4	2.03E-2	2.08E-5	2.13	866.48	29.69	0.46
EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	POINT	7	1,100	1,894	10,328	1.5	2.31E-3	2.31E-3	9.72E-1	2.03E-2	2.08E-5	1.82E-3	6.34E-4	6.34E-4	2.03E-2	2.08E-5	2.13	866.48	29.69	0.46
EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	POINT	7	1,100	1,894	10,328	1.5	2.31E-3	2.31E-3	9.72E-1	2.03E-2	2.08E-5	1.82E-3	6.34E-4	6.34E-4	2.03E-2	2.08E-5	2.13	866.48	29.69	0.46
EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	POINT	7	1,100	379	2,066	0.8	4.63E-4	4.63E-4	1.94E-1	2.54E-3	4.16E-6	3.65E-4	1.27E-4	1.27E-4	2.54E-3	4.16E-6	2.13	866.48	23.76	0.23
PV	Propane Vaporizer (0.4 MMBtu/hr Propane-Fired)	POINT	68	360	17	39	0.4	9.64E-5	9.64E-5	1.03E-3	1.79E-3	2.19E-4	2.19E-4	9.64E-5	9.64E-5	1.79E-3	2.19E-4	20.73	455.37	1.58	0.12
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	POINT	46	360	847	1,972	1.3	4.82E-3	4.82E-3	5.16E-2	8.95E-2	1.09E-2	1.09E-2	4.82E-3	4.82E-3	8.95E-2	1.09E-2	14.02	455.37	7.55	0.40
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	POINT	7	360	678	1,577	1.3	3.86E-3	3.86E-3	4.13E-2	7.16E-2	8.76E-3	8.76E-3	3.86E-3	3.86E-3	7.16E-2	8.76E-3	2.13	455.37	6.04	0.40
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	POINT	7	360	678	1,577	0.7	3.86E-3	3.86E-3	4.13E-2	7.16E-2	8.76E-3	8.76E-3	3.86E-3	3.86E-3	7.16E-2	8.76E-3	2.13	455.37	20.82	0.21
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	POINT	141	360	678	394	0.3	3.86E-3	3.86E-3	4.13E-2	7.16E-2	8.76E-3	8.76E-3	3.86E-3	3.86E-3	7.16E-2	8.76E-3	42.98	455.37	28.32	0.09
HAC	Autoclave HVAC Heater (1 x 0.25 MMBtu Propane-Fired)	POINT	68	360	42	99	0.3	2.41E-4	2.41E-4	2.58E-3	4.48E-3	5.47E-4	5.47E-4	2.41E-4	2.41E-4	4.48E-3	5.47E-4	20.73	455.37	7.11	0.09
HR	Refinery HVAC Heaters (1 x 0.25 MMBtu Propane-Fired)	POINT	46	360	42	99	0.3	2.41E-4	2.41E-4	2.58E-3	4.48E-3	5.47E-4	5.47E-4	2.41E-4	2.41E-4	4.48E-3	5.47E-4	14.02	455.37	7.11	0.09
HA	Admin HVAC Heaters (1 x 0.25 MMBtu Propane-Fired)	POINT	21	360	42	99	0.3	2.41E-4	2.41E-4	2.58E-3	4.48E-3	5.47E-4	5.47E-4	2.41E-4	2.41E-4	4.48E-3	5.47E-4	6.40	455.37	7.11	0.09
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	POINT	41	360	85	99	0.7	4.82E-4	4.82E-4	5.16E-3	8.95E-3	1.09E-3	1.09E-3	4.82E-4	4.82E-4	8.95E-3	1.09E-3	12.50	455.37	1.31	0.21
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	POINT	41	360	339	394	0.7	1.93E-3	1.93E-3	2.07E-2	3.58E-2	4.38E-3	4.38E-3	1.93E-3	1.93E-3	3.58E-2	4.38E-3	12.50	455.37	5.20	0.21

SOURCE DESCRIPTION		OPERATING LIMITS							EMISSION FACTORS									
Model	Source Description	Design Throughput						reference	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	H2S	unit	reference
ID		unit/hr	unit/day	unit/yr	units	Material	hr/yr											
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	3.00	72.00	26,280	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874		lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
PSL	Prill Silos Loading (2 x 100 ton)	200	200	7,300	ton	Prill	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.02	0.007	0.00106						lb/ton	AP-42, Table 8.3-2 (7/93), Bulk Loading - unctrl; PM10/PM2.5 Ch. 13.2.4
PSU	Prill Silos Unloading (2 x 100 ton)	200	200	7,300	ton	Prill	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.02	0.007	0.00106						lb/ton	AP-42, Table 8.3-2 (7/93), Bulk Loading - unctrl; PM10/PM2.5 Ch. 13.2.4
CS1L	Cement/Shotcrete Silo#1 Loading	80	80	60,000	ton	Cement	8,760	Typical Ind. Oper.	0.00099	0.00034	0.00005						lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4.
CS1U	Cement/Shotcrete Silo#1 Unloading	20	80	60,000	ton	Cement	8,760	Typical Ind. Oper.	0.0048	0.0028	0.0004						lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4.
CS2L	Cement/Shotcrete Silo#2 Loading	80	80	60,000	ton	Cement	8,760	Typical Ind. Oper.	0.00099	0.00034	0.00005						lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4.
CS2U	Cement/Shotcrete Silo#2 Unloading	20	80	60,000	ton	Cement	8,760	Typical Ind. Oper.	0.0048	0.0028	0.0004						lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4.
CAL	Aggregate Bin Loading	100	2,400	500,000	ton	Aggregate	8,760	Typical Ind. Oper.	0.0069	0.0033	0.0005						lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4.
CAU	Aggregate Bin Unloading	100	2,400	500,000	ton	Aggregate	8,760	Typical Ind. Oper.	0.0069	0.0033	0.0005						lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4.
CM	Central Mixer Loading	20 (120)	80 (2,480)	60,000 (560K)	ton-cement (tot.)	Cement (mix)	8,760	Typical Ind. Oper.	0.0184	0.0055	0.0008						lb/ton	AP-42, Table 11.12-2 (6/06), central mixer-ctrl.; PM2.5 Ch. 13.2.4.
HL	Landmark/Stibnite Heaters (3 x 1.0 MMBtu Propane-Fired)	3.00		26,280	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874		lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
TG1	Mine Site Gasoline Tank #1			250,000	gal	Gasoline	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide tank capacity)							0.219		lb/hr	EPA Tanks 4.0.9d
TG2	Mine Site Gasoline Tank #2			250,000	gal	Gasoline	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide tank capacity)							0.219		lb/hr	EPA Tanks 4.0.9d
TD3	Mine Site Diesel Tank #3			725,000	gal	Diesel	8,760	(Midas Gold 2016), (Midas Gold 2018g)							0.002		lb/hr	EPA Tanks 4.0.9d
TD4	Mine Site Diesel Tank #4			725,000	gal	Diesel	8,760	(Midas Gold 2016), (Midas Gold 2018g)							0.002		lb/hr	EPA Tanks 4.0.9d
TD5	Mine Site Diesel Tank #5			725,000	gal	Diesel	8,760	(Midas Gold 2016), (Midas Gold 2018g)							0.002		lb/hr	EPA Tanks 4.0.9d
TD6	Mine Site Diesel Tank #6			725,000	gal	Diesel	8,760	(Midas Gold 2016), (Midas Gold 2018g)							0.002		lb/hr	EPA Tanks 4.0.9d
TD7	Mine Site Diesel Tank #7			725,000	gal	Diesel	8,760	(Midas Gold 2016), (Midas Gold 2018g)							0.002		lb/hr	EPA Tanks 4.0.9d
TD8	Mine Site Diesel Tank #8			725,000	gal	Diesel	8,760	(Midas Gold 2016), (Midas Gold 2018g)							0.002		lb/hr	EPA Tanks 4.0.9d
TD9	Mine Site Diesel Tank #9			725,000	gal	Diesel	8,760	(Midas Gold 2016), (Midas Gold 2018g)							0.002		lb/hr	EPA Tanks 4.0.9d
TD10	Mine Site Diesel Tank #10			725,000	gal	Diesel	8,760	(Midas Gold 2016), (Midas Gold 2018g)							0.002		lb/hr	EPA Tanks 4.0.9d
TDL1	Landmark Diesel Tank #1			130,000	gal	Diesel	8,760	(Midas Gold 2018d), (Midas Gold 2018g)							0.000		lb/hr	EPA Tanks 4.0.9d
TDL2	Landmark Diesel Tank #2			130,000	gal	Diesel	8,760	(Midas Gold 2018d), (Midas Gold 2018g)							0.000		lb/hr	EPA Tanks 4.0.9d
TGL3	Landmark Gasoline Tank #3			130,000	gal	Gasoline	8,760	(Midas Gold 2018d), (Midas Gold 2018g)							0.118		lb/hr	EPA Tanks 4.0.9d
PCSP1	Portable Crushing and Screening Plant 1 (2 crushers, 2 screens, and 5 transfers)	83	2,000	730,000	ton	Aggregate	8,760	(Midas Gold 2019)	0.0075	0.00279	0.00037						lb/ton	AP-42, Table 11.19.2-2 (08/04): Tert. Crushing - ctrl. × 2 + Screening - ctrl. × 2 + Conv. Transfer - ctrl. × 5

SOURCE DESCRIPTION		EMISSION CONTROLS			HOURLY EMISSIONS								DAILY EMISSIONS							
Model ID	Source Description	control system	efficiency	reference	PM lb/hr	PM_{10} lb/hr	$PM_{2.5}$ lb/hr	CO lb/hr	NOx lb/hr	SO_2 lb/hr	VOC lb/hr	H2S lb/hr	PM lb/day	PM_{10} lb/day	$PM_{2.5}$ lb/day	CO lb/day	NOx lb/day	SO_2 lb/day	VOC lb/day	H2S lb/day
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	None	NA		0.0230	0.0230	0.0230	0.246	0.426	0.0521	0.0262		0.551	0.551	0.551	5.90	10.2	1.25	0.630	
PSL	Prill Silos Loading (2 x 100 ton)	None	0%		4.00	1.40	0.212						4.00	1.40	0.212					
PSU	Prill Silos Unloading (2 x 100 ton)	None	0%		4.00	1.40	0.212						4.00	1.40	0.212					
CS1L	Cement/Shotcrete Silo#1 Loading	Bin Vent Filter		Control efficiency included in emission factor	0.0792	0.0272	0.00400						0.0792	0.0272	0.0040					
CS1U	Cement/Shotcrete Silo#1 Unloading	None	0%		0.0960	0.0560	0.00800						0.384	0.224	0.0320					
CS2L	Cement/Shotcrete Silo#2 Loading	Bin Vent Filter		Control efficiency included in emission factor	0.0792	0.0272	0.00400						0.0792	0.0272	0.0040					
CS2U	Cement/Shotcrete Silo#2 Unloading	None	0%		0.0960	0.0560	0.00800						0.384	0.224	0.0320					
CAL	Aggregate Bin Loading	None	0%		0.690	0.330	0.0500						16.6	7.92	1.20					
CAU	Aggregate Bin Unloading	None	0%		0.690	0.330	0.0500						16.6	7.92	1.20					
CM	Central Mixer Loading	Types of controls used may include water sprays, enclosures, hoods, curtains, shrouds, movable and telescoping chutes, central duct collection systems, and the like.		Control efficiency included in emission factor	0.368	0.110	0.0160						1.47	0.440	0.0640					
HL	Landmark/Stibnite Heaters (3 x 1.0 MMBtu Propane-Fired)	None	NA		0.0230	0.0230	0.0230	0.246	0.426	0.0521	0.0262		0.551	0.551	0.551	5.90	10.2	1.25	0.630	
TG1	Mine Site Gasoline Tank #1	None	NA								0.219								5.25	
TG2	Mine Site Gasoline Tank #2	None	NA								0.219								5.25	
TD3	Mine Site Diesel Tank #3	None	NA								0.00167								0.0400	
TD4	Mine Site Diesel Tank #4	None	NA								0.00167								0.0400	
TD5	Mine Site Diesel Tank #5	None	NA								0.00167								0.0400	
TD6	Mine Site Diesel Tank #6	None	NA								0.00167								0.0400	
TD7	Mine Site Diesel Tank #7	None	NA								0.00167								0.0400	
TD8	Mine Site Diesel Tank #8	None	NA								0.00167								0.0400	
TD9	Mine Site Diesel Tank #9	None	NA								0.00167								0.0400	
TD10	Mine Site Diesel Tank #10	None	NA								0.00167								0.0400	
TDL1	Landmark Diesel Tank #1	None	NA								2.29E-4								0.00551	
TDL2	Landmark Diesel Tank #2	None	NA								2.29E-4								0.00551	
TGL3	Landmark Gasoline Tank #3	None	NA								0.118								2.84	
PCSP1	Portable Crushing and Screening Plant 1 (2 crushers, 2 screens, and 5 transfers)	Water Sprays/Moisture Carry-Over		Control efficiency included in emission factor	0.625	0.233	0.0304						15.0	5.58	0.73					

SOURCE DESCRIPTION		ANNUAL EMISSIONS									NAD 83 LOCATION				
Model ID	Source Description	PM ton/yr	PM_{10} ton/yr	$PM_{2.5}$ ton/yr	CO ton/yr	NOx ton/yr	SO_2 ton/yr	VOC ton/yr	H2S ton/yr	Hg2+P ton/yr	UTM E m	UTM N m	reference	elev m	reference
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0.101	0.101	0.101	1.08	1.87	0.228	0.115		3.09E-7	632,060	4,973,664	Warehouse building center	1,983.9	Warehouse building base
PSL	Prill Silos Loading (2 x 100 ton)	0.0730	0.0256	0.00387							632,346	4,973,500	Prill Silo #1 center	2,010.0	Prill Silo #1 base
PSU	Prill Silos Unloading (2 x 100 ton)	0.0730	0.0256	0.00387							632,346	4,973,500	Prill Silo #1 center	2,010.0	Prill Silo #1 base
CS1L	Cement/Shotcrete Silo#1 Loading	0.0297	0.0102	0.00150							632,095	4,974,272	Aggregate stockpile center	1,992.0	Aggregate stockpile base
CS1U	Cement/Shotcrete Silo#1 Unloading	0.144	0.0840	0.0120							632,095	4,974,272	Aggregate stockpile center	1,992.0	Aggregate stockpile base
CS2L	Cement/Shotcrete Silo#2 Loading	0.0297	0.0102	0.00150							632,095	4,974,272	Aggregate stockpile center	1,992.0	Aggregate stockpile base
CS2U	Cement/Shotcrete Silo#2 Unloading	0.144	0.0840	0.0120							632,095	4,974,272	Aggregate stockpile center	1,992.0	Aggregate stockpile base
CAL	Aggregate Bin Loading	1.73	0.825	0.125						3.45E-08	632,095	4,974,272	Aggregate stockpile center	1,992.0	Aggregate stockpile base
CAU	Aggregate Bin Unloading	1.73	0.825	0.125						3.45E-08	632,095	4,974,272	Aggregate stockpile center	1,992.0	Aggregate stockpile base
CM	Central Mixer Loading	0.552	0.165	0.0240							632,095	4,974,272	Aggregate stockpile center	1,992.0	Aggregate stockpile base
HL	Landmark/Stibnite Heaters (3 x 1.0 MMBtu Propane-Fired)	0.101	0.101	0.101	1.08	1.87	0.228	0.115		3.09E-7	615,386	4,945,451	Googl Earth, PRO Figure 7-8; intersection of NF-579 and NF-447	2,020.0	Google Earth
TG1	Mine Site Gasoline Tank #1							0.957							
TG2	Mine Site Gasoline Tank #2							0.957							
TD3	Mine Site Diesel Tank #3							0.00730							
TD4	Mine Site Diesel Tank #4							0.00730							
TD5	Mine Site Diesel Tank #5							0.00730							
TD6	Mine Site Diesel Tank #6							0.00730							
TD7	Mine Site Diesel Tank #7							0.00730							
TD8	Mine Site Diesel Tank #8							0.00730							
TD9	Mine Site Diesel Tank #9							0.00730							
TD10	Mine Site Diesel Tank #10							0.00730							
TDL1	Landmark Diesel Tank #1							0.00101							
TDL2	Landmark Diesel Tank #2							0.00101							
TGL3	Landmark Gasoline Tank #3							0.518							
PCSP1	Portable Crushing and Screening Plant 1 (2 crushers, 2 screens, and 5 transfers)	2.74	1.018	0.133						5.475E-08	632,348	4,973,429	30 m north of access road start point	2,009.0	Google Earth

SOURCE DESCRIPTION		RELEASE PARAMETERS INPUT						MODEL EMISSION RATES / RELEASE PARAMETERS													
Model ID	Source Description	POINT VOLUME	rel ht (ft) rel ht (ft)	temp (F) width (ft)	flow (dscfm) vert. ln (ft)	flow (acfm) grnd ht (ft)	dia (ft) σz type	PM_{10}-24 gps	$PM_{2.5}$-24 gps	CO-ALL gps	NO_2-1 gps	SO_2-1 gps	SO_2-3 gps	PM_{10}-AN gps	$PM_{2.5}$-AN gps	NO_2-AN gps	SO_2-AN gps	ht (m) ht (m)	temp (K) σy (m)	vel (m/s) σz (m)	dia (m)
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	POINT	41	360	508	394	0.7	2.89E-3	2.89E-3	3.10E-2	5.37E-2	6.57E-3	6.57E-3	2.89E-3	2.89E-3	5.37E-2	6.57E-3	12.50	455.37	5.20	0.21
PSL	Prill Silos Loading (2 x 100 ton)	POINT	25.5	Ambient		700	0.5	7.35E-3	1.11E-3					7.35E-4	1.11E-4			7.77	0.00	18.11	0.15
PSU	Prill Silos Unloading (2 x 100 ton)	VOLUME	4.5	1	1	5	elev src w/ bldg	7.35E-3	1.11E-3					7.35E-4	1.11E-4			1.37	0.07	0.14	
CS1L	Cement/Shotcrete Silo#1 Loading	POINT	43.7	Ambient	930	930	0.5	1.43E-4	2.10E-5					2.93E-4	4.32E-5			13.32	0.00	24.06	0.15
CS1U	Cement/Shotcrete Silo#1 Unloading	VOLUME	5	72.2	10	10	srf src	1.18E-3	1.68E-4					2.42E-3	3.45E-4			1.52	5.12	1.42	
CS2L	Cement/Shotcrete Silo#2 Loading	POINT	43.7	Ambient	930	930	0.5	1.43E-4	2.10E-5					2.93E-4	4.32E-5			13.32	0.00	24.06	0.15
CS2U	Cement/Shotcrete Silo#2 Unloading	VOLUME	5	72.2	10	10	srf src	1.18E-3	1.68E-4					2.42E-3	3.45E-4			1.52	5.12	1.42	
CAL	Aggregate Bin Loading	VOLUME	5	72.2	10	10	srf src	4.16E-2	6.30E-3					2.37E-2	3.60E-3			1.52	5.12	1.42	
CAU	Aggregate Bin Unloading	VOLUME	5	72.2	10	10	srf src	4.16E-2	6.30E-3					2.37E-2	3.60E-3			1.52	5.12	1.42	
CM	Central Mixer Loading	VOLUME	5	72.2	10	10	srf src	2.31E-3	3.36E-4					4.75E-3	6.90E-4			1.52	5.12	1.42	
HL	Landmark/Stibnite Heaters (3 x 1.0 MMBtu Propane-Fired)	POINT	20	360		394	0.7	2.89E-3	2.89E-3	3.10E-2	5.37E-2	6.57E-3	6.57E-3	2.89E-3	2.89E-3	5.37E-2	6.57E-3	6.10	455.37	5.20	0.21
TG1	Mine Site Gasoline Tank #1																				
TG2	Mine Site Gasoline Tank #2																				
TD3	Mine Site Diesel Tank #3																				
TD4	Mine Site Diesel Tank #4																				
TD5	Mine Site Diesel Tank #5																				
TD6	Mine Site Diesel Tank #6																				
TD7	Mine Site Diesel Tank #7																				
TD8	Mine Site Diesel Tank #8																				
TD9	Mine Site Diesel Tank #9																				
TD10	Mine Site Diesel Tank #10																				
TDL1	Landmark Diesel Tank #1																				
TDL2	Landmark Diesel Tank #2																				
TGL3	Landmark Gasoline Tank #3																				
PCSP1	Portable Crushing and Screening Plant 1 (2 crushers, 2 screens, and 5 transfers)	VOLUME	7	185.2	14	14	srf src	2.93E-2	3.83E-3					2.93E-2	3.83E-3			2.13	13.13	1.98	

SOURCE DESCRIPTION		OPERATING LIMITS							EMISSION FACTORS									
Model	Source Description	Design Throughput						reference	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	H2S	unit	reference
ID		unit/hr	unit/day	unit/yr	units	Material	hr/yr											
PCSP2	Portable Crushing and Screening Plant 1 (2 crushers, 2 screens, and 5 transfers)	83	2,000	730,000	ton	Aggregate	8,760	(Midas Gold 2019)	0.0075	0.00279	0.00037						lb/ton	AP-42, Table 11.19.2-2 (08/04): Tert. Crushing - ctrl. × 2 + Screening - ctrl. × 2 + Conv. Transfer - ctrl. × 5
TRUE	LIME PRODUCTION																	
LS1	Limestone transfer to Primary Crusher Hopper	47.08	1,130	317,907	ton	Limestone	8,760	(Midas Gold 2018m)	0.003	0.0011	0.00017						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
LS2	Primary Crushing and Associated Transfers In and Out	47.08	1,130	317,907	ton	Limestone	8,760		0.0054	0.0024	0.00036						lb/ton	AP-42, Table 11.19.2-2 (08/04) Tert. Crush - unctrl.; PM2.5 Ch. 13.2.4
LS3	Primary Screening and Associated Transfers In and Out	47.08	1,130	317,907	ton	Limestone	8,760		0.025	0.0087	0.00132						lb/ton	AP-42, Table 11.19.2-2 (08/04) Screening - unctrl.; PM2.5 Ch. 13.2.4
LS4	Secondary Crushing and Associated Transfers In and Out	47.08	1,130	317,907	ton	Limestone	8,760		0.0054	0.0024	0.00036						lb/ton	AP-42, Table 11.19.2-2 (08/04) Tert. Crush - unctrl.; PM2.5 Ch. 13.2.4
LS5	Secondary Screening and Associated Transfers In and Out	47.08	1,130	317,907	ton	Limestone	8,760		0.025	0.0087	0.00132						lb/ton	AP-42, Table 11.19.2-2 (08/04) Screening - unctrl.; PM2.5 Ch. 13.2.4
LS6	Limestone transfer to Ball Mill Feed Bin	47.08	1,130	317,907	ton	Limestone	8,760		0.003	0.0011	0.00017						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
LS7	Limestone transfer to Ball Mill Feed Conveyor	47.08	1,130	317,907	ton	Limestone	8,760		0.003	0.0011	0.00017						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
LS8	Ball Mill Feed transfer to Ball Mill	47.08	1,130	317,907	ton	Limestone	8,760		0.003	0.0011	0.00017						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
LSBM	Limestone Ball Mill	47.08	1,130	317,907	ton	Limestone	8,760		0.0404	0.0339	0.0121						lb/ton	AP-42, Table 11.19.2-4 (08/04) Dry Grind. with Fabric Filter
LS9	Limestone transfer to Kiln Feed Bin	11.13	267	82,688	ton	Limestone	8,760		0.003	0.0011	0.00017						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
LS10	Limestone transfer to Lime Kiln Feed Conveyor	11.13	267	82,688	ton	Limestone	8,760		0.003	0.0011	0.00017						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
LS11	Fines Screening and Associated Transfers In and Out	11.13	267	82,688	ton	Limestone	8,760		0.025	0.0087	0.00132						lb/ton	AP-42, Table 11.19.2-2 (08/04) Screening - unctrl.; PM2.5 Ch. 13.2.4
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	11.13	267	82,688	ton	Limestone	8,760	(Midas Gold 2018m)	0.003	0.0011	0.00017						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	7.04	169	52,377	ton	Lime	8,760	(Midas Gold 2018m)	0.13	0.13	0.13	0.45	0.24	0.0012			lb/ton	AP-42 Tables 11.17-2, 6 : Gas-Fired Parallel Flow Regenetive Kiln with Fabric Filter (PM = 5x EF)
LKC	PFR Shaft Lime Kiln Combustion	22.04	529	163,935	MMBtu	Propane	8,760	Based on 810 kcal/kg (Maerz 2018)	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874		lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
LCR	Lime Mill Crushing and associated transfers In and Out	7.04	169	52,377	ton	Lime	8,760		0.0404	0.0339	0.0121						lb/ton	AP-42, Table 11.19.2-4 (08/04) Dry Grind. with Fabric Filter
LSL	Pebble Lime Silo Loading via Bucket Elevator	7.04	169	52,377	ton	Lime	8,760		0.00088	0.00088	0.00088						lb/ton	AP-42 Table 11.17-4: Crushed Material Conveyor Transfer with Fabric Filter (PM = 10 x EF)
LSU	Pebble Lime Silo discharge to Lime Slaker	7.04	169	52,377	ton	Lime	8,760		8.8E-05	8.8E-05	8.8E-05						lb/ton	AP-42 Table 11.17-4: Crushed Material Conveyor Transfer with Fabric Filter
Total																		

SOURCE DESCRIPTION		EMISSION CONTROLS			HOURLY EMISSIONS								DAILY EMISSIONS							
Model ID	Source Description	control system	efficiency	reference	PM lb/hr	PM_{10} lb/hr	$PM_{2.5}$ lb/hr	CO lb/hr	NOx lb/hr	SO_2 lb/hr	VOC lb/hr	H2S lb/hr	PM lb/day	PM_{10} lb/day	$PM_{2.5}$ lb/day	CO lb/day	NOx lb/day	SO_2 lb/day	VOC lb/day	H2S lb/day
~~PCSP2~~	Portable Crushing and Screening Plant 1 (2 crushers, 2 screens, and 5 transfers)	Water Sprays/Moisture Carry-Over		Control efficiency included in emission factor	0.625	0.233	0.0304						15.0	5.58	0.73					
TRUE	LIME PRODUCTION																			
LS1	Limestone transfer to Primary Crusher Hopper	None	0		0.141	0.0518	0.0080						3.39	1.24	0.192	0	0	0	0	0
LS2	Primary Crushing and Associated Transfers In and Out	None	0		0.254	0.113	0.0169						6.10	2.71	0.407	0	0	0	0	0
LS3	Primary Screening and Associated Transfers In and Out	None	0		1.18	0.410	0.0621						28.2	9.8	1.49	0	0	0	0	0
LS4	Secondary Crushing and Associated Transfers In and Out	None	0		0.254	0.113	0.0169						6.10	2.71	0.407	0	0	0	0	0
LS5	Secondary Screening and Associated Transfers In and Out	None	0		1.18	0.410	0.0621						28.2	9.8	1.49	0	0	0	0	0
LS6	Limestone transfer to Ball Mill Feed Bin	None	0		0.141	0.0518	0.0080						3.39	1.24	0.192	0	0	0	0	0
LS7	Limestone transfer to Ball Mill Feed Conveyor	None	0		0.141	0.0518	0.00800						3.39	1.243	0.192	0	0	0	0	0
LS8	Ball Mill Feed transfer to Ball Mill	None	0		0.141	0.0518	0.00800						3.39	1.243	0.192	0	0	0	0	0
LSBM	Limestone Ball Mill	Fabric Filter	NA	Control efficiency included in emission factor	1.902	1.5959	0.56964						45.65	38.303	13.671	0	0	0	0	0
LS9	Limestone transfer to Kiln Feed Bin	None	0		0.033	0.0122	0.0019						0.80	0.29	0.045	0	0	0	0	0
LS10	Limestone transfer to Lime Kiln Feed Conveyor	None	0		0.033	0.0122	0.00189						0.80	0.294	0.045	0	0	0	0	0
LS11	Fines Screening and Associated Transfers In and Out	None	0		0.28	0.097	0.0147						6.7	2.3	0.35	0	0	0	0	0
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	None	0		0.033	0.0122	0.00189						0.80	0.294	0.045	0	0	0	0	0
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	Fabric Filter	NA	Control efficiency included in emission factor	0.915	0.915	0.915	3.17	1.69	0.0085	0		21.97	21.97	21.97	76.05	40.6	0.203	0.00	0
LKC	PFR Shaft Lime Kiln Combustion	None	0		0.169	0.169	0.169	1.81	3.13	0.383	0.193		4.05	4.05	4.05	43.4	75.2	9.2	4.62	0
LCR	Lime Mill Crushing and associated transfers In and Out	Fabric Filter	NA	Control efficiency included in emission factor	0.28448	0.23871	0.08520						6.828	5.729	2.045	0	0	0	0	0
LSL	Pebble Lime Silo Loading via Bucket Elevator	Fabric Filter	NA	Control efficiency included in emission factor	6.20E-3	6.20E-3	6.20E-3						0.1487	0.1487	0.1487	0	0	0	0	0
LSU	Pebble Lime Silo discharge to Lime Slaker	Wet Scrubber	NA	Control efficiency included in emission factor	6.20E-4	6.20E-4	6.20E-4						0.0149	0.0149	0.0149	0	0	0	0	0
Total					**35.7**	**21.6**	**13.3**	**33.5**	**55.4**	**1.88**	**11.6**	**0.900**	**575**	**373**	**238**	**205**	**260**	**37.3**	**37.4**	**21.6**

SOURCE DESCRIPTION		ANNUAL EMISSIONS									NAD 83 LOCATION				
Model ID	Source Description	PM ton/yr	PM_{10} ton/yr	$PM_{2.5}$ ton/yr	CO ton/yr	NOx ton/yr	SO_2 ton/yr	VOC ton/yr	H2S ton/yr	Hg2+P ton/yr	UTM E m	UTM N m	reference	elev m	reference
~~PCSP2~~	Portable Crushing and Screening Plant 1 (2 crushers, 2 screens, and 5 transfers)	2.74	1.018	0.133						5.475E-08	632,348	4,973,369	30 m south of access road start point	2,007.0	Google Earth
TRUE	LIME PRODUCTION														
LS1	Limestone transfer to Primary Crusher Hopper	0.477	0.175	0.0270						9.54E-09	632,239	4,974,256	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS2	Primary Crushing and Associated Transfers In and Out	0.86	0.381	0.057						1.72E-08	632,239	4,974,256	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS3	Primary Screening and Associated Transfers In and Out	3.97	1.38	0.210						7.95E-08	632,239	4,974,256	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS4	Secondary Crushing and Associated Transfers In and Out	0.86	0.381	0.057						1.72E-08	632,227	4,974,268	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS5	Secondary Screening and Associated Transfers In and Out	3.97	1.38	0.210						7.95E-08	632,227	4,974,268	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS6	Limestone transfer to Ball Mill Feed Bin	0.477	0.175	0.0270						9.54E-09	632,181	4,974,307	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS7	Limestone transfer to Ball Mill Feed Conveyor	0.477	0.175	0.0270						9.54E-09	632,181	4,974,307	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS8	Ball Mill Feed transfer to Ball Mill	0.477	0.175	0.0270						9.54E-09	632,200	4,974,273	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LSBM	Limestone Ball Mill	6.422	5.389	1.9233						1.28E-07	632,215	4,974,248	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS9	Limestone transfer to Kiln Feed Bin	0.124	0.045	0.0070						2.48E-09	632,169	4,974,325	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS10	Limestone transfer to Lime Kiln Feed Conveyor	0.124	0.045	0.0070						2.48E-09	632,169	4,974,325	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS11	Fines Screening and Associated Transfers In and Out	1.03	0.36	0.055						2.07E-08	632,151	4,974,314	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0.124	0.045	0.0070						2.48E-09	632,056	4,974,285	Drawing SK-OPTION 3b, 06/06/2018	1,984.0	Google Earth
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	3.40	3.40	3.40	11.8	6.29	0.0314			1.05E-03	632,057	4,974,265	Drawing SK-OPTION 3b, 06/06/2018	1,984.0	Google Earth
LKC	PFR Shaft Lime Kiln Combustion	0.627	0.627	0.627	6.72	11.6	1.42	0.72		1.93E-6	632,057	4,974,265	Drawing SK-OPTION 3b, 06/06/2018	1,984.0	Google Earth
LCR	Lime Mill Crushing and associated transfers In and Out	1.0580	0.8878	0.3169						2.11603E-08	632,073	4,974,233	Drawing SK-OPTION 3b, 06/06/2018	1,990.0	Google Earth
LSL	Pebble Lime Silo Loading via Bucket Elevator	0.02305	0.02305	0.02305						4.60918E-10	632,069	4,974,206	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LSU	Pebble Lime Silo discharge to Lime Slaker	0.00230	0.00230	0.00230						4.60918E-11	632,069	4,974,206	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
Total		**86.7**	**55.8**	**35.9**	**30.6**	**38.0**	**6.50**	**5.31**	**3.94**	**1.11E-3**					

SOURCE DESCRIPTION		RELEASE PARAMETERS INPUT						MODEL EMISSION RATES / RELEASE PARAMETERS													
Model	Source Description	POINT	rel ht (ft)	temp (F)	flow (dscfm)	flow (acfm)	dia (ft)	PM_{10}-24	$PM_{2.5}$-24	CO-ALL	NO_2-1	SO_2-1	SO_2-3	PM_{10}-AN	$PM_{2.5}$-AN	NO_2-AN	SO_2-AN	ht (m)	temp (K)	vel (m/s)	dia (m)
ID		VOLUME	rel ht (ft)	width (ft)	vert. ln (ft)	grnd ht (ft)	oz type	gps	gps	gps	gps	gps	gps	gps	gps	gps	gps	ht (m)	oy (m)	oz (m)	
~~PCSP2~~	Portable Crushing and Screening Plant 1 (2 crushers, 2 screens, and 5 transfers)	VOLUME	7	185.2	14	14	srf src	2.93E-2	3.83E-3					2.93E-2	3.83E-3			2.13	13.13	1.98	
TRUE	LIME PRODUCTION																				
LS1	Limestone transfer to Primary Crusher Hopper	VOLUME	11.3	22.6	22.6	22.6	srf src	6.52E-3	1.01E-3					5.03E-3	7.77E-4			3.44	1.60	3.20	
LS2	Primary Crushing and Associated Transfers In and Out	VOLUME	11.3	22.6	22.6	22.6	srf src	1.42E-2	2.14E-3					1.10E-2	1.65E-3			3.44	1.60	3.20	
LS3	Primary Screening and Associated Transfers In and Out	VOLUME	11.3	22.6	22.6	22.6	srf src	5.16E-2	7.83E-3					3.98E-2	6.04E-3			3.44	1.60	3.20	
LS4	Secondary Crushing and Associated Transfers In and Out	VOLUME	11.3	22.6	22.6	22.6	srf src	1.42E-2	2.14E-3					1.10E-2	1.65E-3			3.44	1.60	3.20	
LS5	Secondary Screening and Associated Transfers In and Out	VOLUME	11.3	22.6	22.6	22.6	srf src	5.16E-2	7.83E-3					3.98E-2	6.04E-3			3.44	1.60	3.20	
LS6	Limestone transfer to Ball Mill Feed Bin	POINT	29.0	Ambient		0.155	1.0	6.52E-3	1.01E-3					5.03E-3	7.77E-4			8.84	0.00	0.00	0.30
LS7	Limestone transfer to Ball Mill Feed Conveyor	VOLUME	3.5	1	3	5	elev src w/ bldg	6.52E-3	1.01E-3					5.03E-3	7.77E-4			1.07	0.07	0.43	
LS8	Ball Mill Feed transfer to Ball Mill	VOLUME	28	4	4	30	elev src w/ bldg	6.52E-3	1.01E-3					5.03E-3	7.77E-4			8.53	0.28	0.57	
LSBM	Limestone Ball Mill	POINT	70.0	Ambient	13,000	16,500	2.0	2.01E-1	7.18E-2					1.55E-1	5.53E-2			21.34	0.00	26.68	0.61
LS9	Limestone transfer to Kiln Feed Bin	POINT	29.0	Ambient		0.155	1.0	1.54E-3	2.38E-4					1.31E-3	2.02E-4			8.84	0.00	0.00	0.30
LS10	Limestone transfer to Lime Kiln Feed Conveyor	VOLUME	3.5	1	3	5	elev src w/ bldg	1.54E-3	2.38E-4					1.31E-3	2.02E-4			1.07	0.07	0.43	
LS11	Fines Screening and Associated Transfers In and Out	VOLUME	2.5	8	5	5	srf src	1.22E-2	1.85E-3					1.03E-2	1.57E-3			0.76	0.57	0.71	
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	VOLUME	68	4	4	70	elev src w/ bldg	1.54E-3	2.38E-4					1.31E-3	2.02E-4			20.73	0.28	0.57	
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	POINT	150	350	8000	16,300	2.0	1.15E-1	1.15E-1	3.99E-1	2.13E-1	1.06E-3	1.06E-3	9.79E-2	9.79E-2	1.81E-1	9.04E-4	45.72	449.82	26.36	0.61
LKC	PFR Shaft Lime Kiln Combustion	POINT	150	350	8,000	16,300	2.0	2.12E-2	2.12E-2	2.28E-1	3.95E-1	4.83E-2	4.83E-2	1.80E-2	1.80E-2	3.35E-1	4.10E-2	45.72	449.82	26.36	0.61
LCR	Lime Mill Crushing and associated transfers In and Out	POINT	50	Ambient	2000	2,500	0.8	3.01E-2	1.07E-2					2.55E-2	9.12E-3			15.24	0.00	28.75	0.23
LSL	Pebble Lime Silo Loading via Bucket Elevator	POINT	29.0	Ambient	70	70.000	0.3	7.81E-4	7.81E-4					6.63E-4	6.63E-4			8.84	0.00	4.07	0.10
LSU	Pebble Lime Silo discharge to Lime Slaker	VOLUME	3.5	1	3	5	elev src w/ bldg	7.81E-5	7.81E-5					6.63E-5	6.63E-5			1.07	0.07	0.43	
Total								1.96	1.25	4.22	1.4888	0.231	0.237	1.60	1.032	1.09	0.187				

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-21-402/404	PAGE: 1 OF: 11 SHEET: ProcHAP
AIR EMISSION CALCULATIONS	SUBJECT: Process HAP and GHG Emissions	DATE: June 30, 2021

Hazardous Air Pollutants and Greenhouse Gas Emissions

HAP Emissions Summary

	Emissions	
Pollutant	lb/yr	ton/yr
1,3-Butadiene	7.3E-3	3.7E-6
7-PAH	0.018	9.0E-6
Acetaldehyde	0.215	1.1E-4
Acrolein	0.040	2.0E-5
Antimony	4.913	2.5E-3
Arsenic	39.548	0.020
Benzene	64.793	0.032
Beryllium	3.785	1.9E-3
Biphenyl	0.383	1.9E-4
Cadmium	4.052	2.0E-3
Carbon Disulfide	127	0.063
Chromium	5.601	2.8E-3
Cobalt	4.067	2.0E-3
Cr (VI)	3.0E-3	1.5E-6
Cyanide	10.512	5.3E-3
Dichlorobenzene	0.488	2.4E-4
Formaldehyde	30.960	0.015
Hexane	1,006	0.503
Hydrogen Chloride	7,333	3.666
Lead	4.178	2.1E-3
Manganese	34.994	0.017
Mercury	5.814	2.9E-3
Naphthalene	17.003	8.5E-3
Nickel	4.875	2.4E-3
Phenol	2.106	1.1E-3
Phosphorus	45.709	0.023
POM	0.911	4.6E-4
Selenium	3.593	1.8E-3
Toluene	278	0.139
Xylene	275	0.138
Total HAP	9,307	4.654
		4.654
		chk

GHG Emissions Summary

Source Category	CO_2e[(1)] *(ton/yr)*
Propane Combustion	28,878
Diesel Combustion	246
Autoclaving	47,316
Lime Kiln	30,311
[(1)] Total GHGs	106,751

Annex I Parties, 100-year time horizon (UNCC n.d.); (IPCC 2007)

Conversions

2,000 lb/ton	1.341 hp/kW
907.18582 kg/ton	1E+6 Btu/MMBtu

PRI00000867

REC 2207

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-21-402/404	PAGE: 2 OF: 11 SHEET: ProcHAP
AIR EMISSION CALCULATIONS	SUBJECT: Process HAP and GHG Emissions	DATE: June 30, 2021

PROPANE COMBUSTION

Source Data

Source ID	Description	MMBtu/yr	TAP Rule MMBtu/yr	210.2 Exclusion
Sb1	Sb Drying (2.72 MMBtu/hr Propane-Fired)	0	0	No
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	510	510	No
CKB	Carbon Regeneration Kiln (Burners)	19,754	19,754	No
PV	Propane Vaporizer (0.4 MMBtu/hr Propane-Fired)	876	876	No
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	43,800	43,800	No
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	35,040	35,040	No
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	35,040	35,040	No
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	35,040	35,040	No
HAC	Autoclave HVAC Heater (1 x 0.25 MMBtu Propane-Fired)	2,190	2,190	No
HR	Refinery HVAC Heaters (1 x 0.25 MMBtu Propane-Fired)	2,190	2,190	No
HA	Admin HVAC Heaters (1 x 0.25 MMBtu Propane-Fired)	2,190	2,190	No
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	4,380	4,380	No
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	17,520	17,520	No
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	26,280	26,280	No
HL	Landmark/Stibnite Heaters (3 x 1.0 MMBtu Propane-Fired)	26,280	26,280	No
LKC	PFR Shaft Lime Kiln Combustion	163,935	163,935	No
Total		415,025	415,025	

HAP Emissions - Propane Combustion

Pollutant	Emission Factor[1] lb/MMScf	lb/MMBtu[2]	Emissions ton/yr
Arsenic	2.0E-04	1.96E-7	4.1E-5
Benzene	2.1E-03	2.06E-6	4.3E-4
Beryllium	< 1.2E-05	1.18E-8	2.4E-6
Cadmium	1.1E-03	1.08E-6	2.2E-4
Chromium	1.4E-03	1.37E-6	2.8E-4
Cobalt	8.4E-05	8.24E-8	1.7E-5
Dichlorobenzene	1.2E-03	1.18E-6	2.4E-4
Formaldehyde	7.5E-02	7.35E-5	0.015
Hexane	1.8E+00	1.76E-3	0.366
Manganese	3.8E-04	3.73E-7	7.7E-5
Mercury	2.6E-04	2.55E-7	5.3E-5
Nickel	2.1E-03	2.06E-6	4.3E-4
Selenium	< 2.4E-05	2.35E-8	4.9E-6
Toluene	3.4E-03	3.33E-6	6.9E-4
POM	< 7E-04	6.85E-7	1.4E-4
7-PAH	< 1E-05	1.12E-8	2.3E-6
Total HAP			0.384

(1) *AP-42, Table 1.4-3 & 1.4-4 (7/98) Natural Gas Combustion*

(2) *Based on natural gas higher heating value of:* 1,020 *MMBtu/MMScf*

PRI00000868

REC 2208

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-21-402/404	PAGE: 3 OF: 11 SHEET: ProcHAP
AIR EMISSION CALCULATIONS	SUBJECT: Process HAP and GHG Emissions	DATE: June 30, 2021

PROPANE COMBUSTION - CONTINUED

Propane CO2e Emission Factors:	62.87	kg CO2/MMBtu	*40 CFR Part 98, Table C-1 to Subpart C (11/2013) Propane (CFR 2018d)*
	3.0E-03	kg CH4/MMBtu	*40 CFR Part 98, Table C-2 to Subpart C (11/2013) Petroleum (CFR 2018d)*
	6.0E-04	kg N2O/MMBtu	*40 CFR Part 98, Table C-2 to Subpart C (11/2013) Petroleum (CFR 2018d)*

Total Propane Combustion 415,025 *MMBtu/yr*

Propane CO2e Emissions - Process Sources:

	Emissions	GWP[(1)]	GWP[(2)]	CO2e (ton/yr)	
Greenhouse Gas	ton/yr	100-yr	20-yr	100-yr	20-yr
CO2	28,762	1	1	28,762	28,762
CH4	1.37	25	62	34.311	85.092
N2O	0.27	298	275	81.799	75.485
Total GHG				28,878	28,923

(1) *40 CFR 98, Table A-1 (12/2014) (CFR 2018d)*

(2) *(IPCC 1995)*

PRI00000869

REC 2209

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis	
	PROJECT NO: 335-21-402/404	PAGE: 4	OF: 11 SHEET: ProcHAP
AIR EMISSION CALCULATIONS	SUBJECT: Process HAP and GHG Emissions	DATE: June 30, 2021	

DIESEL COMBUSTION

Source Data

Source ID	Description	Power Rating kW	Power Rating hp	Operation hr/yr	Fuel Consumption MMBtu/hr[1]	Fuel Consumption MMBtu/yr	TAP Rule 210.2 MMBtu/yr	TAP Rule 210.2 Exclusion
EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	1,000	1,341	100	9.39	938.7	938.7	No
EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	1,000	1,341	100	9.39	938.7	938.7	No
EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	1,000	1,341	100	9.39	938.7	938.7	No
EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	200	268	100	1.88	187.7	187.7	No
Total						3,003.8	3,003.8	

(1) *Based on diesel engines brake-specific fuel consumption of:* 7,000 *Btu/hp-hr* *AP-42 Tbl 3.3-1*

HAP Emissions - Diesel Combustion, Small Engines

Pollutant	Emission Factor[1] lb/MMBtu	Emissions ton/yr
1,3-Butadiene	< 3.9E-05	3.7E-6
Acetaldehyde	7.7E-04	7.2E-5
Acrolein	< 9.3E-05	8.7E-6
Benzene	9.3E-04	8.8E-5
Formaldehyde	1.2E-03	1.1E-4
Toluene	4.1E-04	3.8E-5
Xylene	2.9E-04	2.7E-5
POM	1.68E-04	1.6E-5
7-PAH	3.43E-06	3.2E-7
Total HAPs		3.6E-4

(1) *AP-42, Tab. 3.3-2, 10/96, diesel engines (≤600 hp)*

HAP Emissions - Diesel Combustion, Large Engines

Pollutant	Emission Factor[1] lb/MMBtu	Emissions ton/yr
1,3-Butadiene	0	0
Acetaldehyde	2.5E-05	3.5E-5
Acrolein	7.9E-06	1.1E-5
Benzene	7.8E-04	1.1E-3
Formaldehyde	7.9E-05	1.1E-4
Toluene	2.8E-04	4.0E-4
Xylene	1.9E-04	2.7E-4
POM	2.12E-04	3.0E-4
7-PAH	4.50E-06	6.3E-6
Total HAPs		2.2E-3

(1) *AP-42, Tabs. 3.4-3 & 3.4-4, 10/96, large diesel engines (>600 hp)*

Diesel CO2e Emission Factors:

73.96	kg CO_2/MMBtu	*40 CFR Part 98, Table C-1 to Subpart C (11/2013) No.2*
3.0E-03	kg CH_4/MMBtu	*40 CFR Part 98, Table C-2 to Subpart C (11/2013) Petroleum*
6.0E-04	kg N_2O/MMBtu	*40 CFR Part 98, Table C-2 to Subpart C (11/2013) Petroleum*

Total Diesel Combustion 3,003.8 MMBtu/yr

Diesel CO2e Emissions - Process Sources:

Greenhouse Gas	Emissions ton/yr	GWP[1] 100-yr	GWP[2] 20-yr	CO2e (ton/yr) 100-yr	CO2e (ton/yr) 20-yr
CO2	244.89	1	1	245	245
CH4	9.93E-03	25	62	0.248	0.616
N2O	1.99E-03	298	275	0.592	0.546
Total GHG				246	246

(1) *40 CFR 98, Table A-1 (CFR 2018d)*

(2) *(IPCC 1995)*

PRI00000870

REC 2210

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis	
	PROJECT NO: 335-21-402/404	PAGE: 5	OF: 11 SHEET: ProcHAP
AIR EMISSION CALCULATIONS	SUBJECT: Process HAP and GHG Emissions	DATE: June 30, 2021	

ORE PROCESSING

Source Data

Source ID	Description	PM_tpy PM ton/yr	TAP Rule ton/yr	210.2 Exclusion
OC1	Loader Transfer of Ore to Grizzly Screen	0.639	0.639	No
OC2	Grizzly Screen to Apron Feeder	0.639	0.639	No
OC3	Apron Feeder to Dribble Conveyor	0.639	0.639	No
OC4	Apron Feeder to Vibrating Grizzly	0.639	0.639	No
OC5	Dribble Conveyor to Vibrating Grizzly	0.639	0.639	No
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	0.639	0.639	No
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	5.475	5.475	No
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	0.639	0.639	No
OC9	Stockpile Transfers to Reclaim Conveyors	3.022	3.022	No
OC10	Reclaim Conveyers to SAG Mill Feed Conveyor	3.022	3.022	No
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	3.022	3.022	No
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	6.044	6.044	No
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0.705	0.705	No
Total		25.762	25.762	

HAP Emission Factors and Emissions

Pollutant	Concentration ppm[1]	Emissions ton/yr
		ton/yr
Arsenic	667	0.017
Beryllium	3.2	8.2E-5
Cadmium	0.5	1.3E-5
Cobalt	4	1.0E-4
Chromium	9	2.3E-4
Mercury [2]	0.96	2.5E-5
Manganese	299	7.7E-3
Nickel	2	5.2E-5
Lead	8	2.1E-4
Antimony	23	5.9E-4
Phosphorus	650	0.017
Selenium [3]	0.4	1.0E-5
Total		0.043

(1) *(Midas Gold 2017c)* *Median concentration of 55,000 SGP samples.*

(2) *(Midas Gold 2018i)* *Median ore concentration of 151,000 SGP samples; resource block model.*

(3) *(Midas Gold 2020)* *Median concentration of 1,500 SGP samples for Se.*

PRI00000871

REC 2211

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis	
	PROJECT NO: 335-21-402/404	PAGE: 6	OF: 11 SHEET: ProcHAP
AIR EMISSION CALCULATIONS	SUBJECT: Process HAP and GHG Emissions	DATE: June 30, 2021	

ORE CONCETRATION AND REFINING

Source Data and Mercury Emissions

Source ID	Description	Subpart 7E Hg Emissions ton/yr[1]	% of Subpart 7E for Controlled Systems %		Controlled Hg Emissions lb/yr	Controlled Hg Emissions ton/yr	TAP Rule ton/yr	210.2 Exclusion
AC	Autoclave	0.107	[2]		0.20	0.00010	0.0001	No
CKD	Refinery Sources (Kiln, EW, Retort, Furnac	0.008	20.0%	[3]	3.36	0.00168	0.0017	No
Total		0.115			3.56	0.00178		

[1] *Subpart 7E Limit - Ore Pretreatment Processes (CFR 2018c)*

84 lb / ~~MMton~~ × 2,540,400 ~~ton~~ / yr × ~~MMton~~ / 1.0E+6 ~~ton~~ = 213.39 lb / yr × ton / 2,000 lb = 0.107 ton / yr

[1] *Subpart 7E Limit - Carbon Processes with Mercury Retorts*

0.8 lb / ~~ton~~ × 21 ~~ton~~ / yr = 16.8 lb / yr × ton / 2,000 lb = 0.008 ton / yr

[2] *Controlled SysCAD modeled emissions from Autoclave:* 0.01048 g/hr | 2.3E-05 lb/hr | 8,760 hr/yr | 0.20 lb/yr (M3 2019)

[3] *Based on similar source (but with much higher ore Hg content) Hg reporting levels provided below:*

Goldstrike Refinery (2015 & 2016 Hg Reports) (NDEP 2015a) (NDEP 2016)

28.79 lb / yr × yr / 251.00 ton = 0.11 lb / MMton × ton / 0.8 lb = 14.3%

Twin Creeks Refinery (2015 & 2016 Hg Reports) (NDEP 2015a) (NDEP 2016)

31.27 lb / yr × yr / 142.77 ton = 0.22 lb / MMton × ton / 0.8 lb = 27.4%

HAP Emission Factors and Emissions

ton/yr

Pollutant	Emission Factor[1]	Emissions Autoclave ton/yr	Refinery ton/yr	Total ton/yr
Arsenic	same as Hg	1.0E-4	1.7E-3	1.8E-3
Beryllium	same as Hg	1.0E-4	1.7E-3	1.8E-3
Cadmium	same as Hg	1.0E-4	1.7E-3	1.8E-3
Cobalt	same as Hg	1.0E-4	1.7E-3	1.8E-3
Chromium	same as Hg	1.0E-4	1.7E-3	1.8E-3
Mercury	see above	1.0E-4	1.7E-3	1.8E-3
Manganese	same as Hg	1.0E-4	1.7E-3	1.8E-3
Nickel	same as Hg	1.0E-4	1.7E-3	1.8E-3
Lead	same as Hg	1.0E-4	1.7E-3	1.8E-3
Antimony	same as Hg	1.0E-4	1.7E-3	1.8E-3
Phosphorus	same as Hg	1.0E-4	1.7E-3	1.8E-3
Selenium	same as Hg	1.0E-4	1.7E-3	1.8E-3
Total				0.021

[1] *Hg is the most difficult metal to control due to it existing in both particulate and gaseous form. Therefore, all other metals are conservatively estimated to be equal to or less than the Hg emissions.*

AUTOCLAVE CO2 AND H2SO4 EMISSIONS

Description	Operation hr/yr	Throughput ton/hr	CO2 Emissions ton/hr[1]	CO2 Emissions ton/yr	H2SO4 lb/ton[2]	H2SO4 lb/hr	H2SO4 ton/yr
Autoclave	8,760	290	5.40	47,316	0.007	2.03	8.89

[1] *Per M3 Engineering, 10/11/2017; based on ore feed carbonate values and conservatively assuming limestone for neutralization.* (M3 2017c)

[2] *Based on Acidic Autoclave test data (APT 2010)*

PRI00000872

REC 2212

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-21-402/404	PAGE: 7 OF: 11 SHEET: ProcHAP
AIR EMISSION CALCULATIONS	SUBJECT: Process HAP and GHG Emissions	DATE: June 30, 2021

REFINERY CYANIDE EMISSIONS

ton/yr

Pollutant	Emission Factor[1] lb/hr	Emissions[2] EW Cells ton/yr	Tanks[3] ton/yr	Total ton/yr	TAP Rule ton/yr	210.2 Exclusion	TAP Rule Category
Cyanide	0.0006	0.0026	0.0026	5.3E-3	0.0053	No	EW

[1] *(APT 2009)*

[2] *Based continuous operation of: 8,760 hr/yr*

[3] *Pregnant and barren solution tanks*

PAX TANKS

Carbon Disulfide Emissions from Xanthate Decomposition

ton/yr

Pollutant	Xanthate[1] ton/yr	Molar Decomp.[2]	CS_2 MW Ratio	Temperature Adj. Factor[3]	Total ton/yr	TAP Rule ton/yr	210.2 Exclusion	TAP Rule Category
Carbon Disulfide	1,700	0.99%	0.376	1%	0.063	0.0633	No	PAX

[1] *(Midas Gold 2016) p. 12-11*

[2] *(Air Sciences 2020) molar decomposition of xanthate in solution to CS2 gas*

[3] *(Air Sciences 2020) based on the comparison of CS2 generation at 25C and 70C*

	MW	
Xanthate (PAX)	*202.37*	$C6H11KOS_2$
Carbon disulfide	*76.139*	CS_2

PRI00000873

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis	
	PROJECT NO: 335-21-402/404	PAGE: 8	OF: 11 SHEET: ProcHAP
AIR EMISSION CALCULATIONS	SUBJECT: Process HAP and GHG Emissions	DATE: June 30, 2021	

LIMESTONE/LIME/AGGREGATE PRODUCTION AND HANDLING

Source Data

Source ID	Description	PM_tpy PM ton/yr	TAP Rule ton/yr	210.2 Exclusion
LS1	Limestone transfer to Primary Crusher Hopper	0.477	0.477	No
LS2	Primary Crushing and Associated Transfers In and Out	0.858	0.858	No
LS3	Primary Screening and Associated Transfers In and Out	3.974	3.974	No
LS4	Secondary Crushing and Associated Transfers In and Out	0.858	0.858	No
LS5	Secondary Screening and Associated Transfers In and Out	3.974	3.974	No
LS6	Limestone transfer to Ball Mill Feed Bin	0.477	0.477	No
LS7	Limestone transfer to Ball Mill Feed Conveyor	0.477	0.477	No
LS8	Ball Mill Feed transfer to Ball Mill	0.477	0.477	No
LSBM	Limestone Ball Mill	6.422	6.422	No
LS9	Limestone transfer to Kiln Feed Bin	0.124	0.124	No
LS10	Limestone transfer to Lime Kiln Feed Conveyor	0.124	0.124	No
LS11	Fines Screening and Associated Transfers In and Out	1.034	1.034	No
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0.124	0.124	No
LCR	Lime Mill Crushing and associated transfers In and Out	1.058	1.058	No
LSL	Pebble Lime Silo Loading via Bucket Elevator	0.023	0.023	No
LSU	Pebble Lime Silo discharge to Lime Slaker	0.002	0.002	No
LS1L	Mill Lime Silo#1 Loading	0.002	0.002	No
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0.011	0.011	No
MillS2L	Mill Lime Silo #2 Loading	0.002	0.002	No
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0.011	0.011	No
ACS1L	AC Lime Silo #1 Loading	0.009	0.009	No
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0.042	0.042	No
ACS2L	AC Lime Silo #2 Loading	0.009	0.009	No
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0.042	0.042	No
ACS3L	AC Lime Silo #3 Loading	0.009	0.009	No
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0.042	0.042	No
ACS4L	AC Lime Silo #4 Loading	0.004	0.004	No
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0.021	0.021	No
CAL	Aggregate Bin Loading	1.725	1.725	No
CAU	Aggregate Bin Unloading	1.725	1.725	No
PCSP1	Portable Crushing and Screening Plant 1 (2 crushers, 2 screens, and 5 transfers)	2.738	2.738	No
PCSP2	Portable Crushing and Screening Plant 1 (2 crushers, 2 screens, and 5 transfers)	2.738	2.738	No
Total		29.610	29.610	

HAP Emission Factors and Emissions

Pollutant	Concentration ppm(1)	ton/yr Emissions ton/yr
Arsenic	23	6.8E-4
Beryllium	0.8	2.4E-5
Cadmium	0.25	7.4E-6
Cobalt	4	1.2E-4
Chromium	15	4.4E-4
Mercury	0.02	5.9E-7
Manganese	236.5	7.0E-3
Nickel	5	1.5E-4
Lead	3	8.9E-5
Antimony	2.5	7.4E-5
Phosphorus	130	3.8E-3
Total		0.012

(1) *(M3 2018) Median concentrations of SGP limestone material. Metals with medians below the detection limit (DL) are set to 1/2DL.*

PRI00000874

REC 2214

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis	
	PROJECT NO: 335-21-402/404	PAGE: 9	OF: 11 SHEET: ProcHAP
AIR EMISSION CALCULATIONS	SUBJECT: Process HAP and GHG Emissions	DATE: June 30, 2021	

LIME KILN

Source Data

Source ID	Description	Throughput ton/yr	PM ton/yr	TAP Rule ton/yr	TAP Rule ton/yr	210.2 Exclusion
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	52,377	3.405	52,377	3.404505	No

HAP Emission Factors and Emissions

Pollutant	Concentration ppm	Emissions ton/yr	TAP Rule ton/yr	210.2 Exclusion
Arsenic	23	7.8E-5		
Beryllium	0.8	2.7E-6		
Cadmium	0.25	8.5E-7		
Cobalt	4	1.4E-5		
Chromium	15	5.1E-5		
Mercury [1]	0.02	1.0E-3		
Manganese	236.5	8.1E-4		
Nickel	5	1.7E-5		
Lead	3	1.0E-5		
Antimony	2.5	8.5E-6		
Phosphorus	130	4.4E-4	TAP Rule	210.2
Subtotal		2.5E-3	ton/yr	Exclusion
Hydrogen Chloride	0.14 lb/ton product[2]	3.666	3.666	No

[1] *Hg emissions from the Lime Kiln are conservatively estimated assuming 100% volatilization of all Hg in the limestone*

[2] *(EPA 1999)b*

LIME KILN CO2 EMISSIONS

Description	Operation hr/yr	Feed ton/yr	Product ton/yr	Mass Loss ton/yr	CO2 ton/yr
Parallel Flow Regenerative (PFR) Shaft Lime Kiln	8,760	82,688	52,377	30,311	30,311

2,000 lb/ton

PRI00000875

REC 2215

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-21-402/404	PAGE: 10 OF: 11 SHEET: ProcHAP
AIR EMISSION CALCULATIONS	SUBJECT: Process HAP and GHG Emissions	DATE: June 30, 2021

CONCRETE PRODUCTION

Source Data

Thpt_tpy

Source ID	Description	Throughput ton/yr	TAP Rule ton/yr	210.2 Exclusion
CS1L	Cement/Shotcrete Silo#1 Loading	60,000	60,000	No
CS1U	Cement/Shotcrete Silo#1 Unloading	60,000	60,000	No
CS2L	Cement/Shotcrete Silo#2 Loading	60,000	60,000	No
CS2U	Cement/Shotcrete Silo#2 Unloading	60,000	60,000	No
CM	Central Mixer Loading	60,000	60,000	No
	Subtotal Cement Silo Filling	240,000	240,000	
	Subtotal Central Mix Batching	60,000	60,000	

HAP Emission Factors and Emissions

ton/yr

HAP/TAP	Silo Fill lb/ton[1]	Central Mixer lb/ton[2]	Cement Silo L/U ton/yr	Central Mix Batching ton/yr	Total Emissions[3] ton/yr
Arsenic	4.24E-09	2.96E-07	5.1E-7	8.9E-6	9.4E-6
Beryllium	4.86E-10		5.8E-8	0	5.8E-8
Cadmium		7.10E-10	0	2.1E-8	2.1E-8
Chromium	2.90E-08	1.27E-07	3.5E-6	3.8E-6	7.3E-6
Cr (VI)	5.80E-09	2.70E-08	7.0E-7	8.1E-7	1.5E-6
Lead	1.09E-08	3.66E-08	1.3E-6	1.1E-6	2.4E-6
Manganese	1.17E-07	3.78E-06	1.4E-5	1.1E-4	1.3E-4
Nickel	4.18E-08	2.48E-07	5.0E-6	7.4E-6	1.2E-5
Phosphorus		1.20E-06	0	3.6E-5	3.6E-5
Total			2.5E-5	1.7E-4	2.0E-4

(1) *AP-42, Table 11.12-8, (06/06) Cement Silo Filing, Controlled* 20% *Cr (VI), IDEQ email on 11/23/2020*

(2) *AP-42, Table 11.12-8, (06/06) Central Mix Batching, Controlled* 21.29% *Cr (VI), IDEQ email on 11/23/2020*

PRI00000876

REC 2216

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-21-402/404	PAGE: 11 OF: 11 SHEET: ProcHAP
AIR EMISSION CALCULATIONS	SUBJECT: Process HAP and GHG Emissions	DATE: June 30, 2021

FUEL STORAGE - GASOLINE

Source Data

		VOC_tpy		
		VOC	TAP Rule	210.2
Source ID	Description	ton/yr	ton/yr	Exclusion
TG1	Mine Site Gasoline Tank #1	0.96	0.96	No
TG2	Mine Site Gasoline Tank #2	0.96	0.96	No
Total		1.91	1.91	

HAP Emission Factors and Emissions

ton/yr

	Concentration	Emissions
Pollutant	wt. %[(1)]	ton/yr
Benzene	1.608%	0.031
Biphenyl	0.010%	1.9E-4
Hexane	7.138%	0.137
Naphthalene	0.444%	8.5E-3
Phenol	0.055%	1.1E-3
Toluene	7.212%	0.138
Xylene	7.170%	0.137
Total		0.453

(1) *(EPA 1999)a*

PRI00000877

REC 2217

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: E. Huelson/E. Memon
	PROJECT NO: 335-1-1	PAGE: 1 OF: 9 SHEET: Tanks
AIR EMISSION CALCULATIONS	SUBJECT: Fuel Storage Tanks	DATE: June 30, 2021

Fuel Storage Tanks

	Dimensions				VOC	
	Capacity	Diameter	Length	Throughput	Emissions[1]	Reference
Storage Tank	gal	ft	ft	gal/yr	lb/yr ton/yr	
Mine Site Gasoline Tank #1	5,000	8.5	14.33	250,000	1,914.73 0.96	*(Midas Gold 2016)*
Mine Site Gasoline Tank #2	5,000	8.5	14.33	250,000	1,914.73 0.96	*(Midas Gold 2016)*
Mine Site Diesel Tank #3	25,000	12	29.70	725,000	14.60 0.007	*(Midas Gold 2016), (Midas Gold 2018g)*
Mine Site Diesel Tank #4	25,000	12	29.70	725,000	14.60 0.007	*(Midas Gold 2016), (Midas Gold 2018g)*
Mine Site Diesel Tank #5	25,000	12	29.70	725,000	14.60 0.007	*(Midas Gold 2016), (Midas Gold 2018g)*
Mine Site Diesel Tank #6	25,000	12	29.70	725,000	14.60 0.007	*(Midas Gold 2016), (Midas Gold 2018g)*
Mine Site Diesel Tank #7	25,000	12	29.70	725,000	14.60 0.007	*(Midas Gold 2016), (Midas Gold 2018g)*
Mine Site Diesel Tank #8	25,000	12	29.70	725,000	14.60 0.007	*(Midas Gold 2016), (Midas Gold 2018g)*
Mine Site Diesel Tank #9	25,000	12	29.70	725,000	14.60 0.007	*(Midas Gold 2016), (Midas Gold 2018g)*
Mine Site Diesel Tank #10	25,000	12	29.70	725,000	14.60 0.007	*(Midas Gold 2016), (Midas Gold 2018g)*
Landmark Diesel Tank #1	2,500	6	15.00	130,000	2.01 0.001	*(Midas Gold 2018d), (Midas Gold 2018g)*
Landmark Diesel Tank #2	2,500	6	15.00	130,000	2.01 0.001	*(Midas Gold 2018d), (Midas Gold 2018g)*
Landmark Gasoline Tank #3	2,500	6	15.00	130,000	1,036.15 0.518	*(Midas Gold 2018d), (Midas Gold 2018g)*

[1] *Emissions calculated using EPA Tanks 4.0.9d (EPA 1999)*

Conversions

2,000 lb/ton

PRI00000878

REC 2218

Mine Site Gasoline Tanks #1, #2

TANKS 4.0 Report

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	Midas Gasoline Tank - 5,000 gal
City:	
State:	Idaho
Company:	Midas Gold
Type of Tank:	Horizontal Tank
Description:	

Tank Dimensions

Shell Length (ft):	14.33
Diameter (ft):	8.50
Volume (gallons):	5,000.00
Turnovers:	50.00
Net Throughput(gal/yr):	250,000.00
Is Tank Heated (y/n):	N
Is Tank Underground (y/n):	N

Paint Characteristics

Shell Color/Shade:	White/White
Shell Condition	Good

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Boise, Idaho (Avg Atmospheric Pressure = 13.28 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

Midas Gasoline Tank - 5,000 gal - Horizontal Tank

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Gasoline (RVP 9)	All	52.81	46.88	58.74	50.94	3.9950	3.5384	4.4980	67.0000			92.00	Option 4: RVP=9, ASTM Slope=3

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

Midas Gasoline Tank - 5,000 gal - Horizontal Tank

Annual Emission Calcaulations	
Standing Losses (lb):	693.2361
Vapor Space Volume (cu ft):	517.9338
Vapor Density (lb/cu ft):	0.0487
Vapor Space Expansion Factor:	0.1431
Vented Vapor Saturation Factor:	0.5264
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	517.9338
Tank Diameter (ft):	8.5000
Effective Diameter (ft):	12.4565
Vapor Space Outage (ft):	4.2500
Tank Shell Length (ft):	14.3300
Vapor Density	
Vapor Density (lb/cu ft):	0.0487
Vapor Molecular Weight (lb/lb-mole):	67.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	3.9950
Daily Avg. Liquid Surface Temp. (deg. R):	512.4830
Daily Average Ambient Temp. (deg. F):	50.9208
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	510.6108
Tank Paint Solar Absorptance (Shell):	0.1700
Daily Total Solar Insulation Factor (Btu/sqft day):	1,400.5855

file:///C|/Program Files (x86)/Tanks409d/summarydisplay.htm[10/5/2017 9:35:37 AM]

Mine Site Gasoline Tanks #1, #2 - continued

TANKS 4.0 Report

Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.1431
Daily Vapor Temperature Range (deg. R):	23.7125
Daily Vapor Pressure Range (psia):	0.9596
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	3.9950
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	3.5384
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	4.4980
Daily Avg. Liquid Surface Temp. (deg R):	512.4880
Daily Min. Liquid Surface Temp. (deg R):	506.6548
Daily Max. Liquid Surface Temp. (deg R):	518.4111
Daily Ambient Temp. Range (deg. R):	23.6750
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.5264
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	3.9950
Vapor Space Outage (ft):	4.2500
Working Losses (lb):	1,221.4895
Vapor Molecular Weight (lb/lb-mole):	67.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	3.9950
Annual Net Throughput (gal/yr.):	250,000.0000
Annual Turnovers:	50.0000
Turnover Factor:	0.7667
Tank Diameter (ft):	8.5000
Working Loss Product Factor:	1.0000
Total Losses (lb):	1,914.7256

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

Midas Gasoline Tank - 5,000 gal - Horizontal Tank

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Gasoline (RVP 9)	1,221.49	693.24	1,914.73

file:///C|/Program Files (x86)/Tanks409d/summarydisplay.htm[10/5/2017 9:35:37 AM]

Mine Site Diesel Tanks #3 - #10

TANKS 4.0 Report

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	25,000 gallon diesel storage tank
City:	Boise
State:	Idaho
Company:	Midas Gold
Type of Tank:	Vertical Fixed Roof Tank
Description:	Midas Gold Mine Site offroad diesel storage tanks

Tank Dimensions

Shell Height (ft):	29.70
Diameter (ft):	12.00
Liquid Height (ft) :	29.00
Avg. Liquid Height (ft):	14.50
Volume (gallons):	25,000.00
Turnovers:	29.00
Net Throughput(gal/yr):	725,000.00
Is Tank Heated (y/n):	N

Paint Characteristics

Shell Color/Shade:	White/White
Shell Condition	Good
Roof Color/Shade:	White/White
Roof Condition:	Good

Roof Characteristics

Type:	Dome
Height (ft)	1.00
Radius (ft) (Dome Roof)	12.00

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Boise, Idaho (Avg Atmospheric Pressure = 13.28 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

25,000 gallon diesel storage tank - Vertical Fixed Roof Tank
Boise, Idaho

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Distillate fuel oil no. 2	All	52.81	46.88	58.74	50.94	0.0051	0.0041	0.0062	130.0000			188.00	Option 1: VP50 = .0046 VP60 = .0065

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

25,000 gallon diesel storage tank - Vertical Fixed Roof Tank
Boise, Idaho

Annual Emission Calcaulations	
Standing Losses (lb):	3.2383
Vapor Space Volume (cu ft):	1,776.1518
Vapor Density (lb/cu ft):	0.0001
Vapor Space Expansion Factor	0.0419
Vented Vapor Saturation Factor	0.9958
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,776.1518
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	15.7046
Tank Shell Height (ft):	29.7000
Average Liquid Height (ft):	14.5000

file:///C|/Program Files (x86)/Tanks409d/summarydisplay.htm[4/18/2018 11:40:56 AM]

Mine Site Diesel Tanks #3 - #10 - continued

TANKS 4.0 Report

Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0001
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0051
Daily Avg. Liquid Surface Temp. (deg. R):	512.4830
Daily Average Ambient Temp. (deg. F):	50.9208
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	510.6108
Tank Paint Solar Absorptance (Shell):	0.1700
Tank Paint Solar Absorptance (Roof):	0.1700
Daily Total Solar Insulation Factor (Btu/sqft day):	1,400.5355
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.0419
Daily Vapor Temperature Range (deg. R):	23.7129
Daily Vapor Pressure Range (psia):	0.0022
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0051
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	0.0041
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	0.0062
Daily Avg. Liquid Surface Temp. (deg R):	512.4830
Daily Min. Liquid Surface Temp. (deg R):	506.5548
Daily Max. Liquid Surface Temp. (deg R):	518.4111
Daily Ambient Temp. Range (deg. R):	23.6750
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.9958
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	0.0051
Vapor Space Outage (ft):	15.7046
Working Losses (lb):	11.3607
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0051
Annual Net Throughput (gal/yr.):	725,000.0000
Annual Turnovers:	29.0000
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	26,000.0000
Maximum Liquid Height (ft):	29.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	1.0000
Total Losses (lb):	14.5990

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

25,000 gallon diesel storage tank - Vertical Fixed Roof Tank
Boise, Idaho

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Distillate fuel oil no. 2	11.36	3.24	14.60

file:///C|/Program Files (x86)/Tanks409d/summarydisplay.htm[4/18/2018 11:40:56 AM]

Landmark Diesel Tanks #1, #2

TANKS 4.0 Report

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	2,500 gallon diesel storage tank
City:	Boise
State:	Idaho
Company:	Midas Gold
Type of Tank:	Horizontal Tank
Description:	Midas Gold Landmark facility diesel tanks

Tank Dimensions

Shell Length (ft):	15.00
Diameter (ft):	6.00
Volume (gallons):	2,500.00
Turnovers:	52.00
Net Throughput(gal/yr):	130,000.00
Is Tank Heated (y/n):	N
Is Tank Underground (y/n):	N

Paint Characteristics

Shell Color/Shade:	White/White
Shell Condition	Good

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Boise, Idaho (Avg Atmospheric Pressure = 13.28 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

2,500 gallon diesel storage tank - Horizontal Tank
Boise, Idaho

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol Weight	Basis for Vapor Pressure Calculations
Distillate fuel oil no. 2	All	52.81	46.88	58.74	50.94	0.0051	0.0041	0.0062	130.0000			188.00	Option 1: VP50 = .0045 VP60 = .0065

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

2,500 gallon diesel storage tank - Horizontal Tank
Boise, Idaho

Annual Emission Calcaulations	
Standing Losses (lb):	0.4942
Vapor Space Volume (cu ft):	270.1369
Vapor Density (lb/cu ft):	0.0001
Vapor Space Expansion Factor:	0.0419
Vented Vapor Saturation Factor:	0.9992
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	270.1369
Tank Diameter (ft):	6.0000
Effective Diameter (ft):	10.7075
Vapor Space Outage (ft):	3.0000
Tank Shell Length (ft):	15.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0001
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0051
Daily Avg. Liquid Surface Temp. (deg. R)	512.4830
Daily Average Ambient Temp. (deg. F):	50.9208
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	510.6108

file:///C|/Program Files (x86)/Tanks409d/summarydisplay.htm[4/18/2018 11:35:48 AM]

Landmark Diesel Tanks #1, #2 - continued

TANKS 4.0 Report

Tank Paint Solar Absorptance (Shell):	0.1700
Daily Total Solar Insulation Factor (Btu/sqft day):	1,400.5355
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.0419
Daily Vapor Temperature Range (deg. R):	23.7125
Daily Vapor Pressure Range (psia):	0.0022
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0051
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	0.0041
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	0.0062
Daily Avg. Liquid Surface Temp. (deg R):	512.4830
Daily Min. Liquid Surface Temp. (deg R):	506.5548
Daily Max. Liquid Surface Temp. (deg R):	518.4111
Daily Ambient Temp. Range (deg. R):	23.6750
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.9992
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0051
Vapor Space Outage (ft):	3.0000
Working Losses (lb):	1.5148
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0051
Annual Net Throughput (gal/yr.):	130,000.0000
Annual Turnovers:	52.0000
Turnover Factor:	0.7436
Tank Diameter (ft):	6.0000
Working Loss Product Factor:	1.0000
Total Losses (lb):	2.0090

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

2,500 gallon diesel storage tank - Horizontal Tank
Boise, Idaho

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Distillate fuel oil no. 2	1.51	0.49	2.01

file:///C|/Program Files (x86)/Tanks409d/summarydisplay.htm[4/18/2018 11:35:48 AM]

Landmark Gasoline Tanks #3

TANKS 4.0 Report

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	2,500 gallon gasoline tank
City:	Boise
State:	Idaho
Company:	Midas Gold
Type of Tank:	Horizontal Tank
Description:	Midas Gold Landmark facility gasoline tank

Tank Dimensions

Shell Length (ft):	15.00
Diameter (ft):	6.00
Volume (gallons):	2,500.00
Turnovers:	52.00
Net Throughput(gal/yr):	130,000.00
Is Tank Heated (y/n):	N
Is Tank Underground (y/n):	N

Paint Characteristics

Shell Color/Shade:	White/White
Shell Condition	Good

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Boise, Idaho (Avg Atmospheric Pressure = 13.28 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

2,500 gallon gasoline tank - Horizontal Tank
Boise, Idaho

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight	Liquid Mass Fract	Vapor Mass Fract	Mol. Weight	Basis for Vapor Pressure Calculations
Gasoline (RVP 9)	All	52.81	46.88	58.74	50.94	3.9950	3.5384	4.4980	67.0000			92.00	Option 4: RVP=9, ASTM Slope=3

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

2,500 gallon gasoline tank - Horizontal Tank
Boise, Idaho

Annual Emission Calcaulations	
Standing Losses (lb):	420.0911
Vapor Space Volume (cu ft):	270.1369
Vapor Density (lb/cu ft):	0.0487
Vapor Space Expansion Factor:	0.1431
Vented Vapor Saturation Factor:	0.6115
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	270.1369
Tank Diameter (ft):	6.0000
Effective Diameter (ft):	10.7075
Vapor Space Outage (ft):	3.0000
Tank Shell Length (ft):	15.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0487
Vapor Molecular Weight (lb/lb-mole):	67.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	3.9950
Daily Avg. Liquid Surface Temp. (deg. R)	512.4830
Daily Average Ambient Temp. (deg. F):	50.9208
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	510.6108

file:///C|/Program Files (x86)/Tanks409d/summarydisplay.htm[4/18/2018 11:37:57 AM]

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: E. Huelson/E. Memon
	PROJECT NO: 335-1-1	PAGE: 9 OF: 9 SHEET: Tanks
AIR EMISSION CALCULATIONS	SUBJECT: Fuel Storage Tanks	DATE: June 30, 2021

Landmark Gasoline Tanks #3 - continued

TANKS 4.0 Report

Tank Paint Solar Absorptance (Shell):	0.1700
Daily Total Solar Insulation Factor (Btu/sqft day):	1,400.5366
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.1431
Daily Vapor Temperature Range (deg. R):	23.7125
Daily Vapor Pressure Range (psia):	0.9596
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	3.9950
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	3.5384
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	4.4980
Daily Avg. Liquid Surface Temp. (deg R):	512.4830
Daily Min. Liquid Surface Temp. (deg R):	506.5548
Daily Max. Liquid Surface Temp. (deg R):	518.4111
Daily Ambient Temp. Range (deg. R):	23.6750
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.6115
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	3.9950
Vapor Space Outage (ft):	3.0000
Working Losses (lb):	616.0556
Vapor Molecular Weight (lb/lb-mole):	67.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	3.9950
Annual Net Throughput (gal/yr.):	130,000.0000
Annual Turnovers:	52.0000
Turnover Factor:	0.7436
Tank Diameter (ft):	6.0000
Working Loss Product Factor:	1.0000
Total Losses (lb):	1,036.1467

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

2,500 gallon gasoline tank - Horizontal Tank
Boise, Idaho

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Gasoline (RVP 9)	616.06	420.09	1,036.15

file:///C|/Program Files (x86)/Tanks409d/summarydisplay.htm[4/18/2018 11:37:57 AM]

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 1 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10 TAP Analysis FALSE chk chk chk

Mining Activity and Emissions Emissions Summary

By Area/Model ID

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	CO_PPH	CO_TPY	NOX_PPH	NOX_TPY	SO2_PPH	SO2_TPY	VOC_TPY	Hg2+P_TPY
Area/	Location of	PM	PM10		PM2.5		CO		NOX		SO2		VOC	Hg2+P
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr	ton/yr
YPP	Yellow Pine Pit	0.58	1.47	0.26	0.65	0.12	1.84	7.84	1.75	7.43	0.00	0.01	0.44	2.9E-07
HFP	Hangar Flats Pit	0.33	0.82	0.15	0.36	0.06	0.99	4.22	0.99	4.22	0.00	0.01	0.23	1.7E-07
WEP	West End Pit	7.03	18.33	3.25	8.52	1.51	24.14	102.84	21.57	91.87	0.05	0.20	5.86	3.4E-06
BT	Bradley Tailings	--	--	--	--	--	--	--	--	--	--	--	--	--
YPPBL	Yellow Pine Pit Blasting	0.56	4.60	0.29	0.27	0.02	5.19	7.86	0.14	0.21	0.00	0.00	--	3.4E-07
HFPBL	Hangar Flats Pit Blasting	--	--	--	--	--	--	--	--	--	--	--	--	--
WEPBL	West End Pit Blasting	13.52	111.43	7.03	6.43	0.41	128.80	195.00	3.46	5.24	0.01	0.01	--	8.1E-06
BTBL	Bradley Tailings Blasting	--	--	--	--	--	--	--	--	--	--	--	--	--
PC	Process PC	--	--	--	--	--	--	--	--	--	--	--	--	--
HFSTKP	Hangar Flats Stockpiles	1.50	4.13	0.73	0.62	0.11	--	--	--	--	--	--	--	9.0E-07
LSTKP	Limestone Stockpile	0.03	0.08	0.01	0.01	0.00	--	--	--	--	--	--	--	1.8E-08
HFBF	Hangar Flats Backfill	24.56	25.50	4.53	14.87	2.64	4.66	19.85	0.53	2.27	0.01	0.04	1.08	1.5E-05
TSFEB	Tailings Storage Facility I	--	--	--	--	--	--	--	--	--	--	--	--	--
YPBF	Yellow Pine Backfill	17.89	18.57	3.30	10.83	1.92	3.39	14.46	0.39	1.65	0.01	0.03	0.78	1.1E-05
WEBF	West End Backfill	--	--	--	--	--	--	--	--	--	--	--	--	--
PROC	Process Area	0.33	0.86	0.15	0.39	0.07	1.34	5.69	1.02	4.34	0.00	0.01	0.29	1.7E-07
HR	Onsite Hauling	864.36	1,214.45	215.57	131.32	23.31	19.95	85.00	33.90	144.39	0.09	0.40	10.26	2.9E-04
ACCRD	Access Roads	113.18	163.62	29.04	17.36	3.08	1.24	5.28	1.15	4.91	0.00	0.01	0.61	1.0E-06
TSF	Tailings Storage Facility	--	--	--	--	--	--	--	--	--	--	--	--	--
HELI	Heliport	0.00	0.17	0.00	0.17	0.00	1.04	0.02	0.83	0.02	0.08	0.00	0.03	--
Total		1,043.87	1,564.04	264.31	191.79	33.25	192.58	448.06	65.72	266.56	0.26	0.72	19.56	3.3E-04

See worksheet ROADS for haul road (HR) emissions by Model ID.

By Activity

chk chk chk chk chk chk chk chk chk chk chk chk chk

	PM	PM10		PM2.5		CO		NOX		SO2		VOC	Hg2+P
Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr	ton/yr
Open Pit Drilling	1.97	0.58	0.10	0.03	0.01								1.2E-06
Open Pit Blasting	14.08	116.04	7.32	6.69	0.42	133.99	202.86	3.60	5.45	0.01	0.01		8.4E-06
Onsite Hauling	819.13	1,134.04	201.29	113.40	20.13								2.8E-04
Material Load / Unload	4.62	12.31	2.19	1.86	0.33								2.8E-06
Mobile Tailpipes	4.30	24.21	4.30	19.40	3.44	52.35	223.00	56.17	239.29	0.16	0.66	18.01	
Dozing	39.92	36.48	6.47	23.61	4.19								2.4E-05
Grading	21.33	36.07	6.40	3.73	0.66								7.3E-06
Water Truck Travel	21.24	29.41	5.22	2.94	0.52								7.2E-06
Access Roads	113.18	163.62	29.04	17.36	3.08	1.24	5.28	1.15	4.91	0.00	0.01	0.61	1.0E-06
Wind Erosion	2.78	7.83	1.39	1.17	0.21								1.7E-06
Surface Exploration	1.31	3.29	0.58	1.42	0.25	3.97	16.89	3.97	16.89	0.01	0.03	0.92	6.7E-07
Helicopter	0.00	0.17	0.00	0.17	0.00	1.04	0.02	0.83	0.02	0.08	0.00	0.03	
TSF Construction	--	--	--	--	--								--
Total	1,043.87	1,564.04	264.31	191.79	33.25	192.58	448.06	65.72	266.56	0.26	0.72	19.56	3.3E-04

0.00033

chk

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 2 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Mining Activity and Emissions Source Parameters Summary

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	SIG_Y_M	SIG_Z_M	PITVOL_M3	SXINIT_M	SYINIT_M	ANGL_DEG
	Location of	Source	UTM NAD 83		Elev.	Rel. Ht.	S-y	S-z	Pit Vol.	Len X	Len Y	Angle
Model ID	Activity	Type	E m	N m	m	m	m	m	m^3	m	m	deg
YPP	Yellow Pine Pit	AREA	631,024	4,975,923	1,832	4.6		4.3		900	900	-
HFP	Hangar Flats Pit	AREA	630,997	4,972,835	1,993	4.6		4.3		543.0	550.0	-
WEP	West End Pit	AREA	632,123	4,976,032	2,030	4.6		4.3		895.0	895.0	-
BT	Bradley Tailings	AREA	630,087	4,972,258	2,015	4.6		4.3		364	729	68
YPPBL	Yellow Pine Pit Blasting	VOLUME	631,475	4,976,374	1,798	75.0	20.9	34.9				
HFPBL	Hangar Flats Pit Blasting	VOLUME	631,273	4,973,106	1,847	75.0	20.9	34.9				
WEPBL	West End Pit Blasting	VOLUME	632,572	4,976,480	2,170	75.0	20.9	34.9				
HFSTKP	Hangar Flats Stockpiles	VOLUME	630,894	4,972,749	2,009	4.6	75.1	4.3				
LSTKP	Limestone Stockpile	VOLUME	632,286	4,974,288	2,000	4.6	23.3	4.3				
HFBF	Hangar Flats Backfill	VOLUME	631,273	4,973,106	1,998	4.6	78.4	4.3				
TSFEB	Tailings Storage Facility Embank	VOLUME	630,249	4,972,167	2,155	4.6	193.7	4.3				
YPBF	Yellow Pine Backfill	VOLUME	631,475	4,976,374	1,806	4.6	106.3	4.3				
WEBF	West End Backfill	VOLUME	632,572	4,976,480	2,170	4.6	-	4.3				
PROC	Process Area	AREA	631,880	4,973,910	1,970	2.2		2.1		400	400	0
HR	Onsite Hauling	VOLUME	See worksheet: ROADS			4.6	15.1	4.3	-	-	-	-
ACCRD	Access Roads	VOLUME	See worksheet: HR Grid			3.0	5.6	2.8	-	-	-	-
TSF	Tailings Storage Facility	AREA	628,496	4,971,000	2,117	-	-	-	-	1,157	1,157	0
HELI	Heliport	VOLUME	632,222	4,973,588	1,996	3.4	9.1	3.2				

Updat

Emissions by LOM (ton/yr) Calculated on: 07/08/21

PM10+SO2+NOX	LOM	PM	PM10		PM2.5		CO		NOX		SO2		VOC
ton/yr	Year	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr
246	3	341.7	500.0	87.3	93.8	16.3	102.6	370.8	38.4	158.5	0.2	0.6	**22.1**
499	4	836.3	1,239.2	213.0	160.1	28.0	161.9	465.0	69.3	285.7	0.3	0.8	21.2
500	5	836.1	1,258.4	214.7	168.0	28.8	154.3	460.8	68.9	285.0	0.3	0.8	21.0
532	6	908.6	1,347.4	233.9	172.3	30.0	142.1	**504.9**	**71.2**	**297.2**	**0.3**	**0.8**	20.8
501	7	817.9	1,255.2	211.9	158.3	27.4	153.2	475.7	69.5	288.0	0.3	0.8	20.7
459	8	748.0	1,197.9	194.2	155.3	26.3	177.0	449.5	64.7	263.9	0.3	0.8	20.7
431	9	784.8	1,162.6	199.5	152.9	26.7	151.9	428.6	56.3	230.7	0.2	0.7	19.7
532	**10**	**1,043.9**	**1,564.0**	**264.3**	**191.8**	**33.3**	**192.6**	448.1	65.7	266.6	0.3	0.7	19.6
440	11	761.6	1,161.4	195.1	148.1	25.6	178.4	442.7	60.2	244.7	0.2	0.7	18.9
389	12	657.9	990.5	168.6	128.4	22.4	182.1	429.6	54.7	220.2	0.2	0.6	17.7
395	13	663.1	1,013.4	170.0	134.6	23.3	171.0	440.4	55.3	224.5	0.2	0.6	18.1
389	14	710.0	1,165.8	181.5	146.4	24.5	168.9	362.3	51.7	207.2	0.2	0.6	15.5
205	15	404.7	749.1	103.4	95.3	15.2	125.8	208.5	26.6	101.2	0.2	0.4	9.9
114	16	260.1	361.3	64.1	59.9	10.6	22.6	92.1	12.6	50.0	0.1	0.2	6.8
124	17	283.9	397.3	70.5	59.6	10.6	19.1	77.0	13.3	53.3	0.1	0.2	6.0
71	18	184.3	257.6	45.7	41.6	7.3	13.5	53.1	6.8	25.7	0.1	0.1	4.6
		chk	chk	chk	chk	chk	chk	chk	chk	chk	chk	chk	chk

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 3 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Open Pit Drilling

Activity Information

Operating schedule	355 day/yr	*(M3 2014)*	
Total drill holes per year	30,313 hole/yr	*(Perpetua 2021a)*	

Annual LOM-10 rates		Material blasted			Drilling[1]	
YPI	Yellow Pine Pit	1,147,269	ton/yr	*(Perpetua 2021a)*	1,175	hole/yr
HFI	Hangar Flats Pit	0	ton/yr	*(Perpetua 2021a)*		hole/yr
WE	West End Pit	28,466,535	ton/yr	*(Perpetua 2021a)*	29,139	hole/yr
BT_	Bradley Tailings	0	ton/yr	*(Perpetua 2021a)*	0	hole/yr
	Total	29,613,804	ton/yr		30,314	hole/yr

(1) *Total drill holes per year scaled based on material blasted; rounded up to the nearest whole number*

Emission Factors

TSP (PM)	1.3 lb/hole	*AP-42, Tab. 11.9-4, 7/98 (overburden)*

PM Scaling Factors

PM	1	
PM10	0.52	*AP-42, Tab. 11.9-1, 7/98 (blasting, overburden)*
PM2.5	0.03	*AP-42, Tab. 11.9-1, 7/98 (blasting, overburden)*

Emission Controls

Dust collector

Control efficiency: 90% *(CDC 2012), up to 99% control*

Emissions by Model ID

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	Hg2+P_TPY
	Location of	PM	PM10		PM2.5		Hg2+P
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	ton/yr
YPP	Yellow Pine Pit	0.08	0.02	0.00	0.00	0.00	4.6E-08
HFP	Hangar Flats Pit	--	--	--	--	--	--
WEP	West End Pit	1.89	0.55	0.10	0.03	0.01	1.1E-06
BT	Bradley Tailings	--	--	--	--	--	--
Total	Open Pit Drilling	1.97	0.58	0.10	0.03	0.01	1.2E-06

Source Parameters (1)

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	PITVOL_M3	SXINIT_M	SYINIT_M	SIG_Z_M	ANGL_DEG	Area
		Source	UTM NAD 83		Elev.	Rel. Ht.	Pit Vol.	Len X	Len Y	S-z	Angle	
Model ID	Activity	Type	E m	N m	m	m	m^3	m	m	m	deg	
YPP	Yellow Pine Pit	AREA	631,024	4,975,923	1,832	4.57		900.0	900.0	4.26	0.0	810000
HFP	Hangar Flats Pit	AREA	630,997	4,972,835	1,993	4.57		543.0	550.0	4.26	0.0	298650
WEP	West End Pit	AREA	632,123	4,976,032	2,030	4.57		895.0	895.0	4.26	0.0	801025

(1) *UTM - (Midas Gold 2017e); Rel. Ht. - (EPA 2012); Len X, Len Y, Angle - best-fit equal area rectangle; Elev. - (Midas Gold 2018n)*

Source Parameters (1)

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M		SXINIT_M	SYINIT_M	SIG_Z_M	ANGL_DEG	
		Source	UTM NAD 83		Elev.	Rel. Ht.	Pit Vol.	Len X	Len Y	S-z	Angle	
Model ID	Activity	Type	E m	N m	m	m	m^3	m	m	m	deg	
BT	Bradley Tailings	AREA	630,087	4,972,258	2,015	4.57		364	729	4.26	68.0	265356

(1) *UTM, Elev. - (Midas Gold 2017e); Rel. Ht. - (EPA 2012); Len X, Len Y - best-fit equal area rectangle*

Conversions

2,000 lb/ton

PRI00000889

REC 2229

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 4 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Open Pit Blasting

Activity Information

	Operating schedule	126 day/yr	24 hr/day	
BLS	Blast area	63,390 ft^2/blast	*(Perpetua 2021a)*	
TOT	Maximum blasts per year	126 blast/yr	*(Perpetua 2021a)*	

	Annual LOM-10 rates	Material blasted	Blasting[1]	ANFO use	
YPI	Yellow Pine Pit	1,147,269 ton/yr	5 blast/yr	235 ton ANFO/yr	*(Perpetua 2021a)*
HFI	Hangar Flats Pit	0 ton/yr	0 blast/yr	0 ton ANFO/yr	*(Perpetua 2021a)*
WE	West End Pit	28,466,535 ton/yr	121 blast/yr	5,821 ton ANFO/yr	*(Perpetua 2021a)*
BT_	Bradley Tailings	0 ton/yr	0 blast/yr	0 ton ANFO/yr	*(Perpetua 2021a)*
	Total	29,613,804 ton/yr	126 blast/yr	6,055 ton ANFO/yr	

[1] *Maximum blasts per year scaled based on material blasted; rounded up to the nearest whole number*

Emission Factors

Emission factor equation	TSP (lb/blast) = 0.000014 x $A^{1.5}$	*AP-42, Tab. 11.9-1, 7/98 (blasting, overburden)*	
A = Area per blast	63,390 ft^2		
TSP (PM)	223.44 lb/blast		
CO	67.0 lb/ton-ANFO	*AP-42, Tab. 13.3-1, 2/80 (ANFO)*	
NOX	0.9 kg/t-ANFO	*(CSIRO 2008)*	
	1.8 lb/ton-ANFO		
SO2	3.6E-03 lb/ton-ANFO	*Based on:* 6% *diesel content in ANFO*	*(Midas Gold 2017d)*

$$\frac{1.5E\text{-}05\ \text{lb S}}{\text{lb FO}} \times \frac{2\ \text{lb SO2}}{\text{lb S}} \times \frac{6\%\ \text{lb FO}}{\text{lb ANFO}} \times \frac{2{,}000\ \text{lb ANF}}{\text{ton ANFO}} = \frac{3.6E\text{-}03\ \text{lb SO2}}{\text{ton ANFO}}$$

PM Scaling Factors

PM10	0.52	*AP-42, Tab. 11.9-1, 7/98 (blasting, overburden)*
PM2.5	0.03	*AP-42, Tab. 11.9-1, 7/98 (blasting, overburden)*

Emissions by Model ID

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	CO_PPH	CO_TPY	NOX_PPH	NOX_TPY	SO2_PPH	SO2_TPY	Hg2+P_TPY
		PM	PM10		PM2.5		CO		NOX[1]		SO2		Hg2+P
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr
YPPBL	Yellow Pine Pit Blasting	0.56	4.60	0.29	0.27	0.02	5.19	7.86	0.14	0.21	0.0003	0.0004	3.4E-07
HFPBL	Hangar Flats Pit Blasting	--	--	--	--	--	--	--	--	--	--	--	0
WEPBL	West End Pit Blasting	13.52	111.43	7.03	6.43	0.41	128.80	195.00	3.46	5.24	0.0069	0.0105	8.1E-06
BTBL	Bradley Tailings Blasting	--	--	--	--	--	--	--	--	--	--	--	0
Total	Open Pit Blasting	14.08	116.04	7.32	6.69	0.42	133.99	202.86	3.60	5.45	0.0072	0.0109	8.4E-06

[1] *NO2/NOX:* 0.0357 *(CSIRO 2008)*

Source Parameters [1]

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	SIG_Y_M	SIG_Z_M
		Source	UTM NAD 83		Elev.	Rel. Ht.	S-y	S-z
Model ID	Activity	Type	E m	N m	m	m	m	m
YPPBL	Yellow Pine Pit Blasting	VOLUME	631,475	4,976,374	1,798	75	20.93	34.88
HFPBL	Hangar Flats Pit Blasting	VOLUME	631,273	4,973,106	1,847	75	20.93	34.88
WEPBL	West End Pit Blasting	VOLUME	632,572	4,976,480	2,170	75	20.93	34.88

[1] *UTM, Elev. - (Midas Gold 2017e); Rel. Ht. - (CSIRO 2008); S-y, S-z factors - (EPA 2016a)*

Conversions								
2,000 lb/ton	Blast height (BH)	150 m	*(CSIRO 2008)*	Sigma divider			
2.205 lb/kg	Blast width	90 m	*(CSIRO 2008)*	Rel. Ht.	2	of BH	*(EPA 2016a)*
1.102 ton/t	Blast depth	90 m	*(CSIRO 2008)*	S-y	4.3	of SL	*(EPA 2016a)*
	Equal area side length (SL)	90 m		S-z	4.3	of BH	*(EPA 2016a)*

PRI00000890

REC 2230

Mining Year 10
Onsite Hauling

Ore_Waste
Equipment
MachineSpecs

Activity Information

Operating schedule 355 day/yr
Total vehicle miles travelled 1,702,607 VMT/yr (round-trip) *(Perpetua 2021a)* TRUE Total-VMT

Hauling Routes, Production Rates and Distances

Route Origin		Destination		Material Material Type	Hauled [1] Rate ton/yr	One-Way Hauling [2] mi	Truck Loads [3] load/yr	Theorical VMT [4]	Total Travel [5] VMT/yr
Unpaved Roads									
YPI Yellow Pine Pit	YPP	Process PC	PC	Ore	602,078	1.84	4,592	16,934	11,062
YPI Yellow Pine Pit	YPP	Hangar Flats Stockpile	HFSTKP	Ore	189,994	3.48	1,450	10,085	6,588
YPI Yellow Pine Pit	YPP	Hangar Flats Backfill	HFBF	Rock	391,537	4.01	2,987	23,984	15,668
YPI Yellow Pine Pit	YPP	Tailings Storage Facili	TSFEB	Rock	--	4.10	--	--	--
YPI Yellow Pine Pit	YPP	Yellow Pine Backfill	YPBF	Rock	--	1.80	--	--	--
YPI Yellow Pine Pit	YPP	West End Backfill	WEBF	Rock	--	n/a	--	--	--
HFI Hangar Flats Pit	HFP	Process PC	PC	Ore	--	3.16	--	--	--
HFI Hangar Flats Pit	HFP	Hangar Flats Stockpile	HFSTKP	Ore	--	1.30	--	--	--
HFI Hangar Flats Pit	HFP	Hangar Flats Backfill	HFBF	Rock	--	n/a	--	--	--
HFI Hangar Flats Pit	HFP	Tailings Storage Facili	TSFEB	Rock	--	2.17	--	--	--
HFI Hangar Flats Pit	HFP	Yellow Pine Backfill	YPBF	Rock	--	4.31	--	--	--
HFI Hangar Flats Pit	HFP	West End Backfill	WEBF	Rock	--	n/a	--	--	--
WE West End Pit	WEP	Process PC	PC	Ore	2,151,139	2.68	16,407	87,875	57,405
WE West End Pit	WEP	Hangar Flats Stockpile	HFSTKP	Ore	5,492,925	5.10	41,893	427,558	279,304
WE West End Pit	WEP	Hangar Flats Backfill	HFBF	Rock	13,922,251	5.75	106,181	1,220,925	797,574
WE West End Pit	WEP	Tailings Storage Facili	TSFEB	Rock	--	5.83	--	--	--
WE West End Pit	WEP	Yellow Pine Backfill	YPBF	Rock	10,426,067	3.73	79,517	592,729	387,202
WE West End Pit	WEP	West End Backfill	WEBF	Rock	--	0.75	--	--	--
WE West End Pit	WEP	Limestone Stockpile	LSTKP	Rock	318,000	2.92	2,426	14,192	9,271
BT- Bradley Tailings	BT	Process PC	PC	Ore	--	3.02	--	--	--
BT- Bradley Tailings	BT	Hangar Flats Stockpile	HFSTKP	Ore	--	n/a	--	--	--
BT- Bradley Tailings	BT	Hangar Flats Backfill	HFBF	Rock	--	n/a	--	--	--
BT- Bradley Tailings	BT	Tailings Storage Facili	TSFEB	Rock	--	0.87	--	--	--
HFS Hangar Flats Stock	HFSTKP	Process PC	PC	Ore	5,296,781	2.62	40,397	212,067	138,533
BT- Bradley Tailings	BT	West End Backfill	WEBF	Rock	--	n/a	--	--	--
Total					38,790,773	*59.47*	295,850	2,606,347	1,702,607

(1) *(Perpetua 2021a)*
(2) *(Midas Gold 2017e)*
(3) *See truck fleet information below.*
(4) *Truck loads* × *One-way hauling* × 2 *(round-trip) Used for actual VMT appropriation*
(5) *(Perpetua 2021b)*

Truck Fleet

Truck	Payload Capacity [1] ton	Empty Weight [1] ton	Operation [2] hr/yr	Average Weight ton
Ha CAT 785D	146.6	128.4	97,578	201.7
Ar CAT 745C	45.2	36.8	17,582	59.4
Weighted Average	131.1			180.0

(1) *(Caterpillar 2018b); (Caterpillar 2018b)*
(2) *(Perpetua 2021a)*

Conversions
2,000 lb/ton

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 6 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10
Onsite Hauling - continued

Hauling Emissions by Route

Route Origin		Destination		Material Hauled Material Type	PM_TPY PM ton/yr	PM10_PPD PM10 lb/day	PM10_TPY PM10 ton/yr	PM2.5_PPD PM2.5 lb/day	PM2.5_TPY PM2.5 ton/yr	Hg2+P_TPY Hg2+P ton/yr
Unpaved Roads										
YPI Yellow Pine Pit	YPP	Process PC	PC	Ore	5.32	7.37	1.31	0.74	0.13	1.8E-06
YPI Yellow Pine Pit	YPP	Hangar Flats Stockp	HFSTKP	Ore	3.17	4.39	0.78	0.44	0.08	1.1E-06
YPI Yellow Pine Pit	YPP	Hangar Flats Backfi	HFBF	Rock	7.54	10.44	1.85	1.04	0.19	2.6E-06
YPI Yellow Pine Pit	YPP	Tailings Storage Fac	TSFEB	Rock	--	--	--	--	--	--
YPI Yellow Pine Pit	YPP	Yellow Pine Backfill	YPBF	Rock	--	--	--	--	--	--
YPI Yellow Pine Pit	YPP	West End Backfill	WEBF	Rock	--	--	--	--	--	--
HFI Hangar Flats Pit	HFP	Process PC	PC	Ore	--	--	--	--	--	--
HFI Hangar Flats Pit	HFP	Hangar Flats Stockp	HFSTKP	Ore	--	--	--	--	--	--
HFI Hangar Flats Pit	HFP	Hangar Flats Backfi	HFBF	Rock	--	--	--	--	--	--
HFI Hangar Flats Pit	HFP	Tailings Storage Fac	TSFEB	Rock	--	--	--	--	--	--
HFI Hangar Flats Pit	HFP	Yellow Pine Backfill	YPBF	Rock	--	--	--	--	--	--
HFI Hangar Flats Pit	HFP	West End Backfill	WEBF	Rock	--	--	--	--	--	--
WE West End Pit	WEP	Process PC	PC	Ore	27.62	38.23	6.79	3.82	0.68	9.4E-06
WE West End Pit	WEP	Hangar Flats Stockp	HFSTKP	Ore	134.37	186.03	33.02	18.60	3.30	4.6E-05
WE West End Pit	WEP	Hangar Flats Backfi	HFBF	Rock	383.72	531.23	94.29	53.12	9.43	1.3E-04
WE West End Pit	WEP	Tailings Storage Fac	TSFEB	Rock	--	--	--	--	--	--
WE West End Pit	WEP	Yellow Pine Backfill	YPBF	Rock	186.29	257.90	45.78	25.79	4.58	6.3E-05
WE West End Pit	WEP	West End Backfill	WEBF	Rock	--	--	--	--	--	--
WE West End Pit	WEP	Limestone Stockpile	LSTKP	Rock	4.46	6.17	1.10	0.62	0.11	1.5E-06
BT- Bradley Tailings	BT	Process PC	PC	Ore	--	--	--	--	--	--
BT- Bradley Tailings	BT	Hangar Flats Stockp	HFSTKP	Ore	--	--	--	--	--	--
BT- Bradley Tailings	BT	Hangar Flats Backfi	HFBF	Rock	--	--	--	--	--	--
BT- Bradley Tailings	BT	Tailings Storage Fac	TSFEB	Rock	--	--	--	--	--	--
HFS Hangar Flats Stocl	HFSTKF	Process PC	PC	Ore	66.65	92.27	16.38	9.23	1.64	2.3E-05
BT- Bradley Tailings	BT	West End Backfill	WEBF	Rock	--	--	--	--	--	--
Pit Subtotal					819.13	1,134.04	201.29	113.40	20.13	2.8E-04

Emission Factors

Unpaved roads

Emission factor equation	$E = k(s/12)^a (W/3)^b [(365-P)/365]$				*AP-42, Sec. 13.2.2, Eq. 1a, 11/06*
s = Surface material silt content	4	%			*(Midas Gold 2015)*
W = Mean vehicle weight	180.0	ton			
P = Days/year with ≥0.01 in precip	120	day/yr			*AP-42 Fig. 13.2.2-1, 11/06*
	PM	PM10	PM2.5		
k = Size-specific empirical constant	4.9	1.5	0.15		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
a = Size-specific empirical constant	0.7	0.9	0.9		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
b = Size-specific empirical constant	0.45	0.45	0.45		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
E = Size-specific emission factor	9.62	2.36	0.24	lb/VMT	

Emission Controls

Unpaved roads - periodic application of water and chemical dust suppressant
Control efficiency: 90% *(Air Sciences 2018)*

PRI00000892

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 7 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10
Onsite Hauling - continued

Emissions by Area

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	Hg2+P_TPY
		PM	PM10		PM2.5		Hg2+P
Area ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	ton/yr
HR	Onsite Hauling	819.13	1,134.04	201.29	113.40	20.13	2.8E-04

See worksheet ROADS for haul road (HR) emissions by Model ID.

Source Parameters [1]

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	SIG_Y_M	SIG_Z_M
		Source	UTM NAD 83		Elev.	Rel. Ht.	S-y	S-z
Model ID	Activity	Type	E m	N m	m	m	m	m
HR	Onsite Hauling	VOLUME	*See worksheet: ROADS*			4.57	15.14	4.26

[1] *UTM, Elev. - (Midas Gold 2017e); Rel. Ht., Sy, Sz - (EPA 2012)*

Truck	Height		Reference
CAT 785D	5.7	m	*(Caterpillar 2018b)*
CAT 745C	3.7	m	*(Caterpillar 2018b)*
Weighted	5.38	m	
Road width (RW)	26.5	m	*(Midas Gold 2016), Fig. 9-1*

Plume Parameter	Calculation	Value (m)	Const.
Plume top (PT) - unpaved	1.7 x VH	9.15	1.7
Release height - unpaved	0.5 x PT	4.57	0.5
Plume width (PW)	RW + 6 m	32.55	6
Sigma-z - unpaved	PT / 2.15	4.26	2.15
Sigma-y	PW / 2.15	15.14	2.15

(EPA 2012)

Conversions

2,000	lb/ton
3.28	ft/m
12	in/ft

PRI00000893

REC 2233

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 8 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Material Load / Unload

Activity Information

Operating schedule 355 day/yr

Throughput Rates chk

Model ID	Location of Activity	No. of Xfers	Rate ton/yr	Total Rate ton/yr	Xfer Description	
YPP	Yellow Pine Pit	1	1,183,610	1,183,610	Load	
HFP	Hangar Flats Pit	1	0	0	Load	
WEP	West End Pit	1	32,310,382	32,310,382	Load	
BT	Bradley Tailings	1	0	0	Load	
HFSTKP	Hangar Flats Stockpiles	1	5,296,781	5,296,781	Load	(Reload)
PC	Process PC [(1)]	0	8,049,998	0	Unload	
HFSTKP	Hangar Flats Stockpiles	1	5,682,919	5,682,919	Unload	
LSTKP	Limestone Stockpile	1	318,000	318,000	Unload	
HFBF	Hangar Flats Backfill	1	14,313,788	14,313,788	Unload	
TSFEB	Tailings Storage Facility Emb	1	0	0	Unload	
YPBF	Yellow Pine Backfill	1	10,426,067	10,426,067	Unload	
WEBF	West End Backfill	1	0	0	Unload	

(1) *Ore unloading at primary crusher is accounted for in process sources*

Emission Factors

	PM	PM10	PM2.5		
k = Particle size multiplier	0.74	0.35	0.053		*AP-42, Sec. 13.2.4, Pg. 4, 11/06*
E = Emission factor Load	0.00021	0.0001	0.000015	lb/ton	*AP-42, Tab. 11.19.2-2, 8/04 (truck loading - crshed stone)*
Unload	0.00003	0.000016	0.0000024	lb/ton	*AP-42, Tab. 11.19.2-2, 8/04 (truck unloading - fragmented stone)*
Unload	0.00012	0.00006	0.00001	lb/ton	*Average of load and unload*

Emissions by Model ID chk PM_TPY PM10_PPD PM10_TPY PM2.5_PPD PM2.5_TPY Hg2+P_TPY

Model ID	Location of Activity	Total Rate ton/yr	PM ton/yr	PM10 lb/day	PM10 ton/yr	PM2.5 lb/day	PM2.5 ton/yr	Hg2+P ton/yr
YPP	Yellow Pine Pit	1,183,610	0.13	0.33	0.06	0.05	0.01	7.5E-08
HFP	Hangar Flats Pit	--	--	--	--	--	--	--
WEP	West End Pit	32,310,382	3.42	9.10	1.62	1.38	0.24	2.0E-06
BT	Bradley Tailings	--	--	--	--	--	--	--
HFSTKP	Hangar Flats Stockpiles	5,296,781	0.56	1.49	0.26	0.23	0.04	3.4E-07
PC	Process PC	--	--	--	--	--	--	--
HFSTKP	Hangar Flats Stockpiles	5,682,919	0.10	0.26	0.05	0.04	0.01	5.8E-08
LSTKP	Limestone Stockpile	318,000	0.01	0.01	0.00	0.00	0.00	3.2E-09
HFBF	Hangar Flats Backfill	14,313,788	0.24	0.65	0.11	0.10	0.02	1.5E-07
TSFEB	Tailings Storage Facility Emb	--	--	--	--	--	--	--
YPBF	Yellow Pine Backfill	10,426,067	0.18	0.47	0.08	0.07	0.01	1.1E-07
WEBF	West End Backfill	--	--	--	--	--	--	--
Total	Material Load / Unload	69,531,547	4.62	12.31	2.19	1.86	0.33	2.8E-06

Conversions

2.237 mi/hr per m/s
2,000 lb/ton

PRI00000894

REC 2234

Mining Year 10

Material Load / Unload - continued

Source Parameters		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	PITVOL_M3	SXINIT_M	SYINIT_M	SIG_Z_M	ANGL_DEG	
	Location of	Source	UTM NAD 83		Elev.	Rel. Ht.	Pit Vol.	Len X	Len Y	S-z	Angle	
Model ID	Activity	Type	E m	N m	m	m	m^3	m	m	m	deg	
YPP	Yellow Pine Pit	AREA	631,024	4,975,923	1,832	4.57		900	900	4.26	0	Pits
HFP	Hangar Flats Pit	AREA	630,997	4,972,835	1,993	4.57		543	550	4.26	0	Pits
WEP	West End Pit	AREA	632,123	4,976,032	2,030	4.57		895	895	4.26	0	Pits
BT	Bradley Tailings	AREA	630,087	4,972,258	2,015	4.57		364	729	4.26	68	

Source Parameters [(1)]		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	SIG_Y_M	SIG_Z_M	Surface		
	Location of	Source	UTM NAD 83		Elev.	Rel. Ht.	S-y	S-z	Area	Length	
Model ID	Activity	Type	E m	N m	m	m	m	m	m^2	m	
HFSTKP	Hangar Flats Stockpiles	VOLUME	630,894	4,972,749	2,009	4.57	75.11	4.26	1.04E+05	323.0	Stockpile
LSTKP	Limestone Stockpile	VOLUME	632,286	4,974,288	2,000	4.57	23.26	4.26	1.00E+04	100.0	Stockpile
HFBF	Hangar Flats Backfill	VOLUME	631,273	4,973,106	1,998	4.57	78.37	4.26	1.14E+05	337.0	DRSF
TSFEB	Tailings Storage Facility Eml	VOLUME	630,249	4,972,167	2,155	4.57	193.72	4.26	6.94E+05	833.0	DRSF
YPBF	Yellow Pine Backfill	VOLUME	631,475	4,976,374	1,806	4.57	106.28	4.26	2.09E+05	457.0	DRSF
(1) *WEBF*	West End Backfill	VOLUME	632,572	4,976,480	2,170	4.57	0.00	4.26	0.00E+00	0.0	DRSF

UTM, Elev., Area - (Midas Gold 2017e); Rel. Ht. - (EPA 2012); S-y, S-z factors - (EPA 2016a)

Vehicle height (VH):
Weighted Average 5.38 m

Plume Parameter	Calculation	Value (m)	Const.
Plume top (PT)	1.7 x VH	9.15	1.7
Release height	0.5 x PT	4.57	0.5
Sigma-z	PT / 2.15	4.26	2.15

(EPA 2012)

Sample calculation for Hangar Flats Stockpiles

Plume Parameter	Calculation	Value (m)	Const.
Surface area (SA)	Map	104,320	
Side length (SL)	SA^0.5	323.0	0.5
Sigma-y	SL / 4.3	75.11	4.3

(EPA 2016a)

PRI00000895

REC 2235

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 10 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Mobile Equipment (Tailpipes)

Equipment
MachineSpecs

Mobile Equipment Specifications and Activity

Equipment	Equipment Model[1]	ID	Rating hp[2]	Rating kW	Oper. hr/yr[1]	Equip. Count[1]	Diesel gal/yr[1]	Output kW-hr/yr[3]	Travel VMT/yr[4]	Equipment Category	On-road Class[5]	gal/hp-hr
dri Production Drill	CAT MD 6250	EQP1	872	650	31,933	5	798,317	11,651,153		Non-road		0.03
loa Wheel Loader	CAT 994K	EQP2	1,847	1,377	3,147	0	147,915	2,158,765		Non-road		0.03
loa Shovel	CAT 6040	EQP3	2,032	1,515	8,836	2	591,980	8,639,735		Non-road		0.03
tru Haul Truck	CAT 785D	EQP4	1,450	1,081	97,578	14	2,829,767	41,299,459		Non-road		0.02
do: Large Dozer	CAT D10T	EQP5	600	447	23,476	4	493,002	7,195,197		Non-road		0.04
do: Small Dozer	CAT D6T	EQP6	200	149	15,498	3	116,235	1,696,408		Non-road		0.04
gra Grader	CAT 18M	EQP7	357	266	15,236	3	114,268	1,667,707		Non-road		0.02
tru Water Truck	GF WT745C	EQP8	511	381	4,847	1	72,702	1,061,056		Non-road		0.03
loa Loader	CAT 988K	EQP9	580	433	7,995	2	95,944	1,400,266		Non-road		0.02
tru Articulated Truck	CAT 745C	EQP10	511	381	17,582	2	364,008	5,312,563		Non-road		0.04
dri PreSplit Drill	FlexiRoc D60	EQP11	475	354	2,450	0	48,990	714,995		Non-road		0.04
exc Excavator	CAT 390F	EQP12	524	391	7,970	1	115,570	1,686,702		Non-road		0.03
f-6 Stemming Truck	F-650	EQP13	330	246	1,633	0	8,165	119,171	40,827	On-road	MHD	0.02
f-6 Mechanics Truck	F-650	EQP14	330	246	11,394	2	56,972	831,482	284,858	On-road	MHD	0.02
ct-(ANFO Truck	CAT CT660	EQP15	476	355	3,266	1	16,331	238,342	65,323	On-road	HHD	0.01
tru Fuel Lube Truck	CAT 745C	EQP16	511	381	12,730	2	127,298	1,857,867		Non-road		0.02
f-3 Flatbed Truck	F-350	EQP17	440	328	3,919	1	7,839	114,404	97,985	On-road	LHD45	0.00
tru Tire Service Truck	CAT 745C	EQP18	511	381	1,960	0	9,798	143,005		Non-road		0.01
tru LowBoy	CAT 777G	EQP19	1,025	764	644	0	9,667	141,088		Non-road		0.01
for Forklift	CAT DP160N	EQP20	124	92	5,226	1	10,452	152,539		Non-road		0.02
tel(Telehandler	CAT TH514D	EQP21	100	75	2,613	0	7,839	114,404		Non-road		0.03
va Man Van 4x4	Sprinter 4x4	EQP22	188	140	9,798	2	9,798	143,005	244,962	On-road	LHD<=10K	0.01
pic Pickup Truck (4x4)	F250 XL	EQP23	475	354	72,819	11	43,691	637,661	1,820,476	On-road	LHD45	0.00
lig Light Plant	Allmand Maxi	EQP24	14	10	39,279	6	31,423	458,608		Non-road		0.06
tru Rock Spreader	CAT 777G	EQP25	1,025	764	1,956	0	29,342	428,232		Non-road		0.01

[1] *(Perpetua 2021a)* 6,157,311

[2] *(Caterpillar 2016c)/Manufacturer specifications*

[3] *Based on:* 137,000 *BTU/gal* *AP-42, App. A (Diesel)* 7,000 *BTU/hp-hr* *AP-42, Sec. 3.3, (Diesel)*

[4] *Based on the following average speeds (mph):* *(Midas Gold 2018e)*

Stemming Truck	*F-650*	*25*
Mechanics Truck	*F-650*	*25*
ANFO Truck	*CAT CT660*	*20*
Tire Service Truck	*CAT 745C*	*20*
LowBoy	*CAT 777G*	*15*
Man Van 4x4	*Sprinter 4x4*	*25*
Pickup Truck (4x4)	*F250 XL*	*25*
Flatbed Truck	*F-350*	*25*

[5] *On-road vehicle codes and descriptions provided in MOVES2014a emission factors table (EPA 2015)*

Conversions

1.341 hp/kW

PRI00000896

REC 2236

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon	
	PROJECT NO: 335-21-402/404	PAGE: 11	OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021	

Mining Year 10

Mobile Equipment (Tailpipes)

Operating schedule 355 day/yr 24 hr/day

Equipment MachineSpecs

EPA Non-Road Standards

ID	Equipment Type	Model[1] Year	Power Category	EPA Tier	MOVES Lookup ID	MOVES Class ID	EPA Non-Road Standards (g/kW-hr)[2] PM	CO	NOX	VOC
EQP1	Drill	>2015	kW>560	4	T4-kW>560 2015		0.04	3.5	3.5	0.19
EQP2	Loader	≥2018	kW>560	4	T4-kW>560 2015		0.04	3.5	3.5	0.19
EQP3	Shovel	≥2018	kW>560	4	T4-kW>560 2015		0.04	3.5	3.5	0.19
EQP4	Haul Truck	≥2018	kW>560	4	T4-kW>560 2015		0.04	3.5	3.5	0.19
EQP5	Dozer	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015		0.02	3.5	0.4	0.19
EQP6	Dozer	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015		0.02	3.5	0.4	0.19
EQP7	Grader	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015		0.02	3.5	0.4	0.19
EQP8	Water Truck	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015		0.02	3.5	0.4	0.19
EQP9	Loader	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015		0.02	3.5	0.4	0.19
EQP10	Haul Truck	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015		0.02	3.5	0.4	0.19
EQP11	Drill	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015		0.02	3.5	0.4	0.19
EQP12	Excavator	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015		0.02	3.5	0.4	0.19
EQP13	Blaster Truck	>2015			No Standard	MHD				
EQP14	Support Truck	>2015			No Standard	MHD				
EQP15	ANFO Truck	>2015			No Standard	HHD				
EQP16	Support Truck	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015		0.02	3.5	0.4	0.19
EQP17	Support Truck	>2015			No Standard	LHD45				
EQP18	Support Truck	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015		0.02	3.5	0.4	0.19
EQP19	LowBoy	>2015	kW>560	4	T4-kW>560 2015		0.04	3.5	3.5	0.19
EQP20	Forklift	>2015	75≤kW<130, Ph-in	4	T4-56≤kW<130 2015		0.02	5	0.4	0.19
EQP21	Telehandler	>2015	75≤kW<130, Ph-in	4	T4-56≤kW<130 2015		0.02	5	0.4	0.19
EQP22	Support Truck	>2015			No Standard	LHD<=1(				
EQP23	Support Truck	>2015			No Standard	LHD45				
EQP24	Light Plant	>2015	8≤kW<19	4	T4-8≤kW<19 2015		0.4	6.6	7.5	7.5
EQP25	Rock Spreader	>2015	kW>560	4	T4-kW>560 2015		0.04	3.5	3.5	0.19

(1) *(Midas Gold 2017h)*

(2) *(CFR 2018a)*

PRI00000897

REC 2237

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 12 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Mobile Equipment (Tailpipes) - continued
Fuel Sulfur-Content Based SO2 Emission Factor

Fuel Sulfur-Content	0.0015%		*Non-road diesel specification per 40 CFR 80.510*
Diesel Density	7.05	lb/gal	*AP-42, App. A*
Molecular Wt. of SO2	64.064	lb/lb-mol	
Molecular Wt. of S	32.065	lb/lb-mol	
Diesel Heat Content	137,000	BTU/gal	*AP-42, App. A (Diesel)*
Brake-Specific Fuel Use	7,000	BTU/hp-hr	*AP-42, Sec. 3.3, (Diesel)*

SO2 emission factor:

$$0.000011 \frac{\text{lb/hp-hr}}{} = \frac{0.0015\ \%\ \frac{\text{lb S}}{\text{lb Fuel}}}{} \times \frac{7.05\ \frac{\text{lb Fuel}}{\text{gal Fuel}}}{} \times \frac{64.064\ \text{lb SO2}}{32.065\ \text{lb S}} \times \frac{\text{gal Fuel}}{137{,}000\ \text{BTU}} \times \frac{7{,}000\ \text{BTU}}{\text{hp-hr}}$$

$$0.006567 \frac{\text{g/kW-hr}}{} = \frac{0.000011\ \frac{\text{lb}}{\text{hp-hr}}}{} \times \frac{1.341\ \frac{\text{hp}}{\text{kW}}}{} \times \frac{453.593\ \text{g}}{\text{lb}}$$

EPA MOVES 2014a Emission Factors[1]

		Emission Factor (g/VMT)[2]						
Vehicle Class	Description	PM	PM10	PM2.5	CO	NOX	VOC	SO2
LHD<=10K	Passenger Truck 8.5k-10k lb, Diesel	0.178	0.178	0.086	1.322	2.281	0.241	0.006
LHD45	Single Unit Truck 14k-19.5k lb, Diesel	0.589	0.589	0.291	1.867	4.940	0.685	0.011
MHD	Single Unit Truck 19.5k-33k lb, Diesel	0.797	0.797	0.381	2.170	5.684	0.841	0.011
HHD	Single Unit Truck >33k lb, Diesel	1.169	1.169	0.461	2.313	7.324	0.510	0.011

[1] *MOVES 2014a run dated 2017-09-25*
[2] *PM = PM10*

EPA Engine Certification Data

					Emission Factor (g/kW-hr)					
ID	Lookup ID	Engine Description			PM	PM10	PM2.5	CO	NOX	VOC
EQP4	EPA_Cert4	CAT 785D	1,450	hp [1]	0.02	0.02	0.02	0.8	2.7	0.06

[1] *(CARB 2020), Engine family No. MCPXL78.1NVF*

Conversions

1.341	hp/kW
453.593	g/lb

PRI00000898

REC 2238

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 13 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Mobile Equipment (Tailpipes) - continued

Final Emission Factors

ID	Lookup	PM	PM10	PM2.5	CO	NOX	VOC	SO2	EF Unit	Final EF	Activity
EQP1	T4-kW>560 2015	0.04	0.04	0.04	3.50	3.50	0.19	0.007	g/kW-hr	*EPA_NRS*	11,651,153 kW-hr/yr
EQP2	T4-kW>560 2015	0.04	0.04	0.04	3.50	3.50	0.19	0.007	g/kW-hr	*EPA_NRS*	2,158,765 kW-hr/yr
EQP3	T4-kW>560 2015	0.04	0.04	0.04	3.50	3.50	0.19	0.007	g/kW-hr	*EPA_NRS*	8,639,735 kW-hr/yr
EQP4	EPA_Cert4	0.02	0.02	0.02	0.80	2.70	0.06	0.007	g/kW-hr	*EPA_CERT*	41,299,459 kW-hr/yr
EQP5	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	7,195,197 kW-hr/yr
EQP6	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	1,696,408 kW-hr/yr
EQP7	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	1,667,707 kW-hr/yr
EQP8	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	1,061,056 kW-hr/yr
EQP9	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	1,400,266 kW-hr/yr
EQP10	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	5,312,563 kW-hr/yr
EQP11	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	714,995 kW-hr/yr
EQP12	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	1,686,702 kW-hr/yr
EQP13	MHD	0.80	0.80	0.38	2.17	5.68	0.84	0.011	g/VMT	*EPA_MOVES2014a*	40,827 VMT/yr
EQP14	MHD	0.80	0.80	0.38	2.17	5.68	0.84	0.011	g/VMT	*EPA_MOVES2014a*	284,858 VMT/yr
EQP15	HHD	1.17	1.17	0.46	2.31	7.32	0.51	0.011	g/VMT	*EPA_MOVES2014a*	65,323 VMT/yr
EQP16	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	1,857,867 kW-hr/yr
EQP17	LHD45	0.59	0.59	0.29	1.87	4.94	0.68	0.011	g/VMT	*EPA_MOVES2014a*	97,985 VMT/yr
EQP18	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	143,005 kW-hr/yr
EQP19	T4-kW>560 2015	0.04	0.04	0.04	3.50	3.50	0.19	0.007	g/kW-hr	*EPA_NRS*	141,088 kW-hr/yr
EQP20	T4-56≤kW<130 2015	0.02	0.02	0.02	5.00	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	152,539 kW-hr/yr
EQP21	T4-56≤kW<130 2015	0.02	0.02	0.02	5.00	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	114,404 kW-hr/yr
EQP22	LHD<=10K	0.18	0.18	0.09	1.32	2.28	0.24	0.006	g/VMT	*EPA_MOVES2014a*	244,962 VMT/yr
EQP23	LHD45	0.59	0.59	0.29	1.87	4.94	0.68	0.011	g/VMT	*EPA_MOVES2014a*	1,820,476 VMT/yr
EQP24	T4-8≤kW<19 2015	0.40	0.40	0.40	6.60	7.50	7.50	0.007	g/kW-hr	*EPA_NRS*	458,608 kW-hr/yr
EQP25	T4-kW>560 2015	0.04	0.04	0.04	3.50	3.50	0.19	0.007	g/kW-hr	*EPA_NRS*	428,232 kW-hr/yr

Final emission factor options:

Category	EF Unit	Activity Unit	Emission Unit	Multiplier
EPA_CERT	g/kW-hr	kW-hr/yr	ton/yr	1.1E-6
EPA_NRS	g/kW-hr	kW-hr/yr	ton/yr	1.1E-6
EPA_MOVES2014a	g/VMT	VMT/yr	ton/yr	1.1E-6

Conversions

453.593	g/lb	2,000	lb/ton
1.341	hp/kW		

PRI00000899

REC 2239

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 14 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Mobile Equipment (Tailpipes) - continued

Emissions by Area

chk chk chk chk chk chk chk chk-14 chk chk chk chk

Area ID	Equipment	Equipment Type	PM ton/yr	PM10 lb/day	PM10 ton/yr	PM2.5 lb/day	PM2.5 ton/yr	CO lb/hr	CO ton/yr	NOX lb/hr	NOX ton/yr	SO2 lb/hr	SO2 ton/yr	VOC ton/yr
PITS	EQP1	Drill	0.51	2.89	0.51	2.89	0.51	10.55	44.95	10.55	44.95	0.02	0.08	2.44
PITS	EQP2	Loader	0.10	0.54	0.10	0.54	0.10	1.96	8.33	1.96	8.33	3.7E-3	0.02	0.45
PITS	EQP3	Shovel	0.38	2.15	0.38	2.15	0.38	7.82	33.33	7.82	33.33	0.01	0.06	1.81
HR	EQP4	Haul Truck	0.91	5.13	0.91	5.13	0.91	8.55	36.42	28.85	122.9	0.07	0.30	2.73
ALL	EQP5	Dozer	0.16	0.89	0.16	0.89	0.16	6.52	27.76	0.74	3.17	0.01	0.05	1.51
ALL	EQP6	Dozer	0.04	0.21	0.04	0.21	0.04	1.54	6.54	0.18	0.75	2.9E-3	0.01	0.36
HR	EQP7	Grader	0.04	0.21	0.04	0.21	0.04	1.51	6.43	0.17	0.74	2.8E-3	0.01	0.35
HR	EQP8	Water Truck	0.02	0.13	0.02	0.13	0.02	0.96	4.09	0.11	0.47	1.8E-3	7.7E-3	0.22
PITS	EQP9	Loader	0.03	0.17	0.03	0.17	0.03	1.27	5.40	0.14	0.62	2.4E-3	0.01	0.29
HR	EQP10	Haul Truck	0.12	0.66	0.12	0.66	0.12	4.81	20.50	0.55	2.34	9.0E-3	0.04	1.11
PITS	EQP11	Drill	0.02	0.09	0.02	0.09	0.02	0.65	2.76	0.07	0.32	1.2E-3	5.2E-3	0.15
PITS	EQP12	Excavator	0.04	0.21	0.04	0.21	0.04	1.53	6.51	0.17	0.74	2.9E-3	0.01	0.35
PITS	EQP13	Blaster Truck	0.04	0.20	0.04	0.10	0.02	0.02	0.10	0.06	0.26	1.1E-4	4.7E-4	0.04
PITS	EQP14	Support Truck	0.25	1.41	0.25	0.67	0.12	0.16	0.68	0.42	1.78	7.8E-4	3.3E-3	0.26
PITS	EQP15	ANFO Truck	0.08	0.47	0.08	0.19	0.03	0.04	0.17	0.12	0.53	1.8E-4	7.7E-4	0.04
HR	EQP16	Support Truck	0.04	0.23	0.04	0.23	0.04	1.68	7.17	0.19	0.82	3.2E-3	0.01	0.39
HR	EQP17	Support Truck	0.06	0.36	0.06	0.18	0.03	0.05	0.20	0.13	0.53	2.7E-4	1.1E-3	0.07
HR	EQP18	Support Truck	3.2E-3	0.02	3.2E-3	0.02	3.2E-3	0.13	0.55	0.01	0.06	2.4E-4	1.0E-3	0.03
HR	EQP19	LowBoy	6.2E-3	0.04	6.2E-3	0.04	6.2E-3	0.13	0.54	0.13	0.54	2.4E-4	1.0E-3	0.03
PROC	EQP20	Forklift	3.4E-3	0.02	3.4E-3	0.02	3.4E-3	0.20	0.84	0.02	0.07	2.6E-4	1.1E-3	0.03
PROC	EQP21	Telehandler	2.5E-3	0.01	2.5E-3	0.01	2.5E-3	0.15	0.63	0.01	0.05	1.9E-4	8.3E-4	0.02
HR	EQP22	Support Truck	0.05	0.27	0.05	0.13	0.02	0.08	0.36	0.14	0.62	3.9E-4	1.7E-3	0.07
HR	EQP23	Support Truck	1.18	6.66	1.18	3.29	0.58	0.88	3.75	2.33	9.91	5.0E-3	0.02	1.37
HR	EQP24	Light Plant	0.20	1.14	0.20	1.14	0.20	0.78	3.34	0.89	3.79	7.8E-4	3.3E-3	3.79
HR	EQP25	Rock Spreader	0.02	0.11	0.02	0.11	0.02	0.39	1.65	0.39	1.65	7.3E-4	3.1E-3	0.09
Total			4.30	24.21	4.30	19.40	3.44	52.35	223.00	56.17	239.29	0.16	0.66	18.01

Subtotals	Equipment	PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	CO_PPH	CO_TPY	NOX_PPH	NOX_TPY	SO2_PPH	SO2_TPY	VOC_TPY
HR	Haul Roads	2.7	14.9	2.7	11.3	2.0	20.0	85.0	33.9	144.4	0.1	0.4	10.3
PITS	Pits	1.4	8.1	1.4	7.0	1.2	24.0	102.2	21.3	90.9	0.0	0.2	5.8
ALL	All	0.2	1.1	0.2	1.1	0.2	8.1	34.3	0.9	3.9	0.0	0.1	1.9
PROC	Process Area	0.0	0.0	0.0	0.0	0.0	0.3	1.5	0.0	0.1	0.0	0.0	0.1
STKP	PC Stockpile	--	--	--	--	--	--	--	--	--	--	--	--
PC	Process PC	--	--	--	--	--	--	--	--	--	--	--	--
Total	Mobile Tailpipes	4.30	24.21	4.30	19.40	3.44	52.35	223.00	56.17	239.29	0.16	0.66	18.01

ALL - All locations except haul roads

Short-term emissions are based on annual emissions divided by 355 day/yr and 24 hr/day.

LT Unit	ST Unit	Multiplier
ton/yr	lb/day	5.634
ton/yr	lb/hr	0.235

Conversions

2,000 lb/ton
453.59 g/lb

PRI00000900

REC 2240

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 15 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Mobile Equipment (Tailpipes) - continued

Emission Allocation by Model ID

		Area ID				Location of	Total Rate	chk	chk	chk	chk	chk	chk
Model ID	*PITS*	*ALL*	*PROC*	*STKP*	*PC*	Activity	ton/yr	PITS	ALL	PROC	STKP	PC	
YPP	*PITS*					Yellow Pine Pit	1,183,610	3.5%	-	-	-	-	
HFP	*PITS*					Hangar Flats Pit	0	-	-	-	-	-	
WEP	*PITS*					West End Pit	32,310,382	96.5%	-	-	-	-	
BT	*PITS*					Bradley Tailings	0	-	-	-	-	-	
PC					*PC*	Process PC	0	-	-	-	-	-	
HFSTKP				*STKP*		Hangar Flats Stockpiles	10,979,700	-	-	-	100.0%	-	
LSTKP						Limestone Stockpile	318,000	-	-	-	-	-	
HFBF		*ALL*				Hangar Flats Backfill	14,313,788	-	57.9%	-	-	-	
TSFEB		*ALL*				Tailings Storage Facility	0	-	-	-	-	-	
YPBF		*ALL*				Yellow Pine Backfill	10,426,067	-	42.1%	-	-	-	
WEBF		*ALL*				West End Backfill	0	-	-	-	-	-	
PROC			*PROC*			Process Area				100.0%			

ALL - All locations except haul roads

PRI00000901

REC 2241

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 16 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Mobile Equipment (Tailpipes) - continued

		chk	chk	chk	chk	chk	chk	chk	chk	chk	chk	chk	chk
Emissions by Model ID [1]		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	CO_PPH	CO_TPY	NOX_PPH	NOX_TPY	SO2_PPH	SO2_TPY	VOC_TPY
		PM	PM10		PM2.5		CO		NOX[2]		SO2		VOC
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr
YPP	Mobile Tailpipes	0.05	0.29	0.05	0.25	0.04	0.85	3.61	0.75	3.21	0.00	0.01	0.21
HFP	Mobile Tailpipes	--	--	--	--	--	--	--	--	--	--	--	--
WEP	Mobile Tailpipes	1.39	7.85	1.39	6.76	1.20	23.15	98.61	20.57	87.65	0.04	0.19	5.63
BT	Mobile Tailpipes	--	--	--	--	--	--	--	--	--	--	--	--
PC	Mobile Tailpipes	--	--	--	--	--	--	--	--	--	--	--	--
HFSTKP	Mobile Tailpipes	--	--	--	--	--	--	--	--	--	--	--	--
HFBF	Mobile Tailpipes	0.11	0.64	0.11	0.64	0.11	4.66	19.85	0.53	2.27	0.01	0.04	1.08
TSFEB	Mobile Tailpipes	--	--	--	--	--	--	--	--	--	--	--	--
YPBF	Mobile Tailpipes	0.08	0.47	0.08	0.47	0.08	3.39	14.46	0.39	1.65	0.01	0.03	0.78
WEBF	Mobile Tailpipes	--	--	--	--	--	--	--	--	--	--	--	--
PROC	Mobile Tailpipes	0.01	0.03	0.01	0.03	0.01	0.35	1.47	0.03	0.12	0.00	0.00	0.06
HR	Truck/Grader	2.65	14.94	2.65	11.25	2.00	19.95	85.00	33.90	144.39	0.09	0.40	10.26

(1) *See worksheet ROADS for haul road (HR) emissions by Model ID.*

(2) *NO2 / NOX:* *11%* *(CAPCOA 2011)*

Source Parameters [1]		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	SIG_Z_M	SXINIT_M	SYINIT_M	ANGL_DEG	
		Source	UTM NAD 83		Elev.	Rel. Ht.	S-z	Len X	Len Y	Angle	WCB
Model ID	Activity	Type	E m	N m	m	m	m	m	m	deg	deg
PROC	Process Area	AREA	631,880	4,973,910	1,970	2.22	2.07	400	400	0	

(1) *UTM, Elev. - (Midas Gold 2017e); Rel. Ht., S-z - (EPA 2012); Len X, Len Y, Angle - best-fit equal area rectangle*

Vehicle height (VH):

Average (forklifts) 2.62 m *Model Specs*

Plume Parameter	Calculation	Value (m)	Const.
Plume top (PT)	1.7 x VH	4.45	1.7
Release height	0.5 x PT	2.22	0.5
Sigma-z	PT / 2.15	2.07	2.15

(EPA 2012)

Sample Calculation for Mobile Tailpipes

Plume Parameter	Calculation	Value (m)	Const.
Surface area (SA)	Map	160,000	
Side length (SL)	SA^0.5	400.0	0.5
Sigma-y	SL / 4.3	93.02	4.3

(EPA 2016a)

PRI00000902

REC 2242

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 17 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Dozing and Grading

Activity Information

Operating schedule 355 day/yr

Dozer and Grader Fleet

Equipment Category	Activity	
Dozer	38,974	hr/yr
Grader	15,236	hr/yr
	99,033	VMT/yr

Dozing Emission Factors

Emission Factor Equation	TSP (lb/hr) = 5.7 $(s)^{1.2}/(M)^{1.3}$		*AP-42, Tab. 11.9-1, 07/98, (bulldozing, overburden)*
	PM15 (lb/hr) = 1.0 $(s)^{1.5}/(M)^{1.4}$		*AP-42, Tab. 11.9-1, 07/98, (bulldozing, overburden)*
s = Surface material silt content	4	%	*(Midas Gold 2015)*
M = Material moisture content	7.9	%	*AP-42, Table 11.9-3, 07/98, (bulldozers, overburden)*
TSP(PM)	2.048	lb/hr	
PM15	0.443	lb/hr	

Dozing PM Scaling Factors

PM10	0.75	*AP-42, Tab. 11.9-1, 07/98, (applies to PM15 EF, footnote d)*
PM2.5	0.105	*AP-42, Tab. 11.9-1, 07/98, (applies to TSP EF, footnote e)*

Grading Emission Factors

Emission Factor Equation	TSP (lb/VMT) = 0.04 $(S)^{2.5}$		*AP-42, Tab. 11.9-1, 07/98, (grading)*
	PM15 (lb/VMT) = 0.051 $(S)^{2}$		*AP-42, Tab. 11.9-1, 07/98, (grading)*
S - Grader average speed	6.5	mph	*(Caterpillar 2016c), haul road maintenance*
TSP(PM)	4.309	lb/VMT	
PM15	2.155	lb/VMT	

Grading PM Scaling Factors

PM10	0.6	*AP-42, Tab. 11.9-1, 07/98, (applies to PM15 EF, footnote d)*
PM2.5	0.031	*AP-42, Tab. 11.9-1, 07/98, (applies to TSP EF, footnote e)*

Emission Controls

Grading Periodic application of water and chemical dust suppressant

Control efficiency: 90% *See Onsite Hauling*

Emissions by Area

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	Hg2+P_TPY
		PM	PM10		PM2.5		Hg2+P
Area ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	ton/yr
ALL	Dozing	39.92	36.48	6.47	23.61	4.19	2.4E-05
HR	Grading	21.33	36.07	6.40	3.73	0.66	7.3E-06

Conversions

2,000 lb/ton

PRI00000903

REC 2243

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 18 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Dozing and Grading - continued

		chk	chk	chk	chk	chk	chk
Emissions by Model ID		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	Hg2+P_TPY
		PM	PM10		PM2.5		Hg2+P
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	ton/yr
YPP	Dozing	--	--	--	--	--	--
HFP	Dozing	--	--	--	--	--	--
WEP	Dozing	--	--	--	--	--	--
BT	Dozing	--	--	--	--	--	--
PC	Dozing	--	--	--	--	--	--
HFSTKP	Dozing	--	--	--	--	--	--
HFBF	Dozing	23.10	21.10	3.75	13.66	2.43	1.4E-05
TSFEB	Dozing	--	--	--	--	--	--
YPBF	Dozing	16.82	15.37	2.73	9.95	1.77	1.0E-05
WEBF	Dozing	--	--	--	--	--	--
HR	Grading	21.33	36.07	6.40	3.73	0.66	7.3E-06

See worksheet ROADS for haul road (HR) emissions by Model ID.

Source Parameters

Dozing: See Open Pit Drilling and Material Load / Unload for source parameters.

Grading: See Onsite Hauling for source parameters.

PRI00000904

REC 2244

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 19 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Water Truck Travel

Activity Information

Operating schedule 355 day/yr

Truck Fleet

Water Truck	Payload Capacity ton	Empty Weight ton	Gross Weight ton	Units	Oper. hr/yr	Reference	Average Weight ton
GF WT745C	45	37	82	1	4,847	*(Caterpillar 2018b)*	59

Average truck speed 15 mph *(Midas Gold 2018e)*

Total vehicle miles traveled (VMT) 72,702 VMT/yr

Emission Factors

Emission factor equation $E = k(s/12)^a (W/3)^b [(365-P)/365]$ *AP-42, Sec. 13.2.2, Eq. 1a, 11/06*

s = Surface material silt content 4 % *(Midas Gold 2015)*

W = Mean vehicle weight 59.42 ton

P = Days/year with ≥0.01 in precip. 120 day/yr *AP-42 Fig. 13.2.2-1, 11/06*

	PM	PM10	PM2.5		
k = Size-specific empirical constant	4.9	1.5	0.15		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
a = Size-specific empirical constant	0.7	0.9	0.9		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
b = Size-specific empirical constant	0.45	0.45	0.45		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
E = Size-specific emission factor	5.84	1.44	0.14	lb/VMT	

Emission Controls

Periodic application of water and chemical dust suppressant

Control efficiency: 90% *See Onsite Hauling*

Emissions by Area

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	Hg2+P_TPY
		PM	PM10		PM2.5		Hg2+P
Area ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	ton/yr
HR	Water Truck Travel	21.24	29.41	5.22	2.94	0.52	7.2E-06

Source Parameters

See Onsite Hauling for source parameters.

Conversions

2,000 lb/ton

PRI00000905

REC 2245

Mining Year 10

Access Roads

Operation Schedule 355 day/yr 24 hr/day

Equipment MachineSpecs

Mobile Equipment Specifications and Activity

Equipment[1]	Equipment Model[2]	ID	Rating[3] hp	Rating kW	Oper.[4] hr/yr	Annual[1] trip/yr	Diesel[5] gal/yr	Output[6] kW-hr/yr	Travel[7] VMT/yr	Equipment Category	On-road Class	
Grader	Cat 160H	MNT1	200	149	2,000	92	6,748	98,492	6,903	Non-road		CAT 18M
Plow Truck	Cat CT660	MNT2	476	355	2,000	92	16,000	--	6,903	On-road	HHD	Cat CT660
Snow Blower	TM42R	MNT3	450	336	2,000	92	15,126	--	6,903	On-road	HHD	Cat CT660
Water Truck	Cat 725C	MNT4	320	239	2,000	92	16,000	233,514	6,903	Non-road		GF WT745C
Binding Agent Truck	Cat 725C	MNT5	320	239	2,000	92	16,000	233,514	6,903	Non-road		CAT 745C
Vibratory Compactor	Cat CS76 XT	MNT6	177	132	2,000	92	10,500	153,244	6,903	Non-road		CAT TH514
Fuel Service Truck	CAT 740B	MNT7	484	361	2,000	92	18,000	262,704	6,903	Non-road		CAT 745C
Rock Rakes	Cat CT660	MNT8	476	355	2,000	92	16,000	--	6,903	On-road	HHD	Cat CT660
Light Vehicles	F-350	MNT9	440	328		3,156	16,915	--	236,807	On-road	LHD45	F-350
Heavy Trucks	Cat CT660 (8X6)	LDEL	476	355		4,989	57,591	--	374,344	On-road	HHD	Cat CT660

(1) *(Midas Gold 2016), Tables 7-1, 12-2, and 12-4. Maintenance trips distributed equally amongst maintenace equipment.*
Heavy trucks include buses, supply, product shipment and trash trucks. Light vehicles include visitor and employee vehicles.

(2) *Similar models by equipment type from (Midas Gold 2017b)*

(3) *(Caterpillar 2016c)/Manufacturer specifications*

(4) *Combined hours, (Midas Gold 2017f)*

(5) *Maintenance equipment based on brake-specific fuel use scaled for similar equipment from (Midas Gold 2017b)*
Light vehicles based on Ford F-350 fuel economy of: 14.0 *mpg (fuelly.com)* *Heavy trucks based on fuel economy c* 6.5 *mpg (ATRI 2016)*

(6) *Based on* 137,000 *BTU/gal* AP-42, App. A (Diesel) 7,000 *BTU/hp-hr* AP-42, Sec. 3.3, (Diesel)

(7) *Based on access road length of:* 37.5 X 2 *mi (roundtrip)* *(Midas Gold 2018c)*

EPA Non-Road Standards

ID	Equipment Type	Model[1] Year	Power Category	EPA Tier	Lookup ID	EPA Non-Road Standards (g/kW-hr)[2] PM	CO	NOX	VOC
MNT1	Grader	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015	0.02	3.5	0.4	0.19
MNT2	Truck				No Standard				
MNT3	Truck				No Standard				
MNT4	Truck	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015	0.02	3.5	0.4	0.19
MNT5	Truck	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015	0.02	3.5	0.4	0.19
MNT6	Compactor	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015	0.02	3.5	0.4	0.19
MNT7	Truck	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015	0.02	3.5	0.4	0.19
MNT8	Truck				No Standard				
MNT9	Light Truck				No Standard				
LDEL	Truck				No Standard				

(1) *(Midas Gold 2017h)*

(2) *(CFR 2018a)*

Final Emission Factors

ID	Lookup	PM	PM10	PM2.5	CO	NOX	VOC	SO2	EF Unit	Final EF	Activity	
MNT1	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.01	g/kW-hr	*EPA_NRS*	98,492	kW-hr/yr
MNT2	HHD	1.17	1.17	0.46	2.31	7.32	0.51	0.01	g/VMT	*EPA_MOVES2014a*	6,903	VMT/yr
MNT3	HHD	1.17	1.17	0.46	2.31	7.32	0.51	0.01	g/VMT	*EPA_MOVES2014a*	6,903	VMT/yr
MNT4	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.01	g/kW-hr	*EPA_NRS*	233,514	kW-hr/yr
MNT5	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.01	g/kW-hr	*EPA_NRS*	233,514	kW-hr/yr
MNT6	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.01	g/kW-hr	*EPA_NRS*	153,244	kW-hr/yr
MNT7	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.01	g/kW-hr	*EPA_NRS*	262,704	kW-hr/yr
MNT8	HHD	1.17	1.17	0.46	2.31	7.32	0.51	0.01	g/VMT	*EPA_MOVES2014a*	6,903	VMT/yr
MNT9	LHD45	0.59	0.59	0.29	1.87	4.94	0.68	0.01	g/VMT	*EPA_MOVES2014a*	236,807	VMT/yr
LDEL	HHD	1.17	1.17	0.46	2.31	7.32	0.51	0.01	g/VMT	*EPA_MOVES2014a*	374,344	VMT/yr

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 21 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Access Roads - continued
Mobile Equipment Tailpipe Emissions
Emissions by Area

			chk	chk	chk	chk	chk	chk	chk	chk	chk	chk	chk	chk
		Equipment	PM	PM10		PM2.5		CO		NOX		SO2		VOC
Area ID	Equipment	Type	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr
ACCRD	MNT1	Grader	2.2E-3	0.01	2.2E-3	0.01	2.2E-3	0.09	0.38	0.01	0.04	1.7E-4	7.1E-4	0.02
ACCRD	MNT2	Plow Truck	8.9E-3	0.05	8.9E-3	0.02	3.5E-3	4.1E-3	0.02	0.01	0.06	1.9E-5	8.1E-5	3.9E-3
ACCRD	MNT3	Snow Blower	8.9E-3	0.05	8.9E-3	0.02	3.5E-3	4.1E-3	0.02	0.01	0.06	1.9E-5	8.1E-5	3.9E-3
ACCRD	MNT4	Water Truck	5.1E-3	0.03	5.1E-3	0.03	5.1E-3	0.21	0.90	0.02	0.10	4.0E-4	1.7E-3	0.05
ACCRD	MNT5	Binding Agent Truck	5.1E-3	0.03	5.1E-3	0.03	5.1E-3	0.21	0.90	0.02	0.10	4.0E-4	1.7E-3	0.05
ACCRD	MNT6	Vibratory Compactor	3.4E-3	0.02	3.4E-3	0.02	3.4E-3	0.14	0.59	0.02	0.07	2.6E-4	1.1E-3	0.03
ACCRD	MNT7	Fuel Service Truck	5.8E-3	0.03	5.8E-3	0.03	5.8E-3	0.24	1.01	0.03	0.12	4.5E-4	1.9E-3	0.06
ACCRD	MNT8	Rock Rakes	8.9E-3	0.05	8.9E-3	0.02	3.5E-3	4.1E-3	0.02	0.01	0.06	1.9E-5	8.1E-5	3.9E-3
ACCRD	MNT9	Light Vehicles	0.15	0.87	0.15	0.43	0.08	0.11	0.49	0.30	1.29	6.4E-4	2.7E-3	0.18
ACCRD	LDEL	Heavy Trucks	0.48	2.72	0.48	1.07	0.19	0.22	0.95	0.71	3.02	1.0E-3	4.4E-3	0.21
Total			0.68	3.86	0.68	1.68	0.30	1.24	5.28	1.15	4.91	0.00	0.01	0.61
Subtotals	Equipment		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	CO_PPH	CO_TPY	NOX_PPH	NOX_TPY	SO2_PPH	SO2_TPY	VOC_TPY
ACCRD	Access Roads		0.68	3.86	0.68	1.68	0.30	1.24	5.28	1.15	4.91	0.00	0.01	0.61
Total			0.68	3.86	0.68	1.68	0.30	1.24	5.28	1.15	4.91	0.00	0.01	0.61

LT Unit	ST Unit	Multiplier
ton/yr	lb/day	5.634
ton/yr	lb/hr	0.235

Grading
Operation 2,000 hr/yr
13,000 VMT/yr

Grading Emission Factors

Emission Factor Equation	TSP (lb/VMT) = 0.04 $(S)^{2.5}$	*AP-42, Tab. 11.9-1, 07/98, (grading)*
	PM15 (lb/VMT) = 0.051 $(S)^{2}$	*AP-42, Tab. 11.9-1, 07/98, (grading)*
S - Grader average speed	6.5 mph	*(Caterpillar 2016c), haul road maintenance*
TSP(PM)	4.309 lb/VMT	
PM15	2.155 lb/VMT	

Grading PM Scaling Factors

PM10	0.6	*AP-42, Tab. 11.9-1, 07/98, (applies to PM15 EF, footnote d)*
PM2.5	0.031	*AP-42, Tab. 11.9-1, 07/98, (applies to TSP EF, footnote e)*

Emission Controls Periodic application of water and chemical dust suppressant
Control efficiency: 90% *See Onsite Hauling*

Emissions by Area

		PM	PM10		PM2.5		Hg2+P
Area ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	ton/yr
ACCRD	Grading	2.80	7.89	1.40	0.49	0.09	2.5E-08

Conversions

2,000	lb/ton
453.593	g/lb
1.341	hp/kW

PRI00000907

REC 2247

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 22 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Access Roads - continued

Vehicle Travel Dust

Fleet

Equipment Type	Model	Empty Weight[(1)] ton	Gross Weight[(1)] ton	Average Weight ton	Travel mi/yr	
Grader	Cat 160H	17.2	17.2	17.2	6,903	*Grader emissions calculated separately*
Plow Truck	Cat CT660	8.2	26.6	17.4	6,903	
Snow Blower	TM42R	14.8	18.0	16.4	6,903	
Water Truck	Cat 725C	25.6	51.6	38.6	6,903	
Binding Agent Truck	Cat 725C	25.6	51.6	38.6	6,903	
Vibratory Compactor	Cat CS76 XT	19.2	20.8	20.0	6,903	
Fuel Service Truck	CAT 740B	37.6	81.1	59.4	6,903	
Rock Rakes	Cat CT660	8.2	26.6	17.4	6,903	
Light Vehicles	F-350	4.0	7.9	6.0	236,807	
Heavy Trucks	Cat CT660 (8X6)	10.1	34.5	22.3	374,344	

(1) *(Caterpillar 2016c)/Manufacturer specifications*

Total vehicle miles traveled (VMT)	659,473	VMT/yr	*Excluding grader*

Emission Factors

Emission factor equation	$E = k(s/12)^a (W/3)^b [(365-P)/365]$		*AP-42, Sec. 13.2.2, Eq. 1a, 11/06*
s = Surface material silt content	4	%	*(Midas Gold 2015)*
W = Mean vehicle weight	17	ton	*Weighted average weight, excluding grader*
P = Days/year with ≥0.01 in precip.	120	day/yr	*AP-42 Fig. 13.2.2-1, 11/06*

	PM	PM10	PM2.5		
k = Size-specific empirical constant	4.9	1.5	0.15		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
a = Size-specific empirical constant	0.7	0.9	0.9		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
b = Size-specific empirical constant	0.45	0.45	0.45		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
E = Size-specific emission factor	3.33	0.82	0.08	lb/VMT	

Emission Controls

Periodic application of water and chemical dust suppressant

Control efficiency: 90% *See Onsite Hauling*

Emissions by Area

Area ID	Activity	PM ton/yr	PM10 lb/day	PM10 ton/yr	PM2.5 lb/day	PM2.5 ton/yr	Hg2+P ton/yr
ACCRD	Access Roads	109.70	151.87	26.96	15.19	2.70	9.9E-07

Source Parameters

See Onsite Hauling for source parameters.

Conversions

2,000 lb/ton

PRI00000908

REC 2248

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 23 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Access Roads - continued

Emissions by Area

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	CO_PPH	CO_TPY	NOX_PPH	NOX_TPY	SO2_PPH	SO2_TPY	VOC_TPY	Hg2+P_TPY
		PM	PM10		PM2.5		CO		NOX		SO2		VOC	Hg2+P
Area ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr	ton/yr
ACCRD	Access Roads	113.18	163.62	29.04	17.36	3.08	1.24	5.28	1.15	4.91	0.003	0.01	0.61	1.0E-06

Source Parameters [1]

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	SIG_Y_M	SIG_Z_M
		Source	UTM NAD 83		Elev.	Rel. Ht.	S-y	S-z
Model ID	Activity	Type	E m	N m	m	m	m	m
ACCRD	Access Roads	VOLUME	*See worksheet: HR Grid*			2.98	5.63	2.77

[1] *UTM, Elev. - (Midas Gold 2017e); Rel. Ht., Sy, Sz - (EPA 2012)*

Vehicle	Height	
Average	3.5 m	
Grader	3.7 m	
HD Truck	3.6 m	
LD Truck	3.2 m	
Road width (RW)	6.1 m	*(Midas Gold 2016), Fig. 7-2*
Road length	60377.56 m	*(Midas Gold 2018c)*

Plume Parameter	Calculation	Value (m)	Const.
Plume top (PT) - unpaved	1.7 x VH	5.95	1.7
Release height - unpaved	0.5 x PT	2.98	0.5
Plume width (PW)	RW + 6 m	12.096	6
Sigma-z - unpaved	PT / 2.15	2.77	2.15
Sigma-y	PW / 2.15	5.63	2.15

(EPA 2012)

Conversions

2,000	lb/ton
3.28	ft/m
12	in/ft

PRI00000909

REC 2249

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 24 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Wind Erosion

Activity Information

Operating schedule 355 day/yr

Erodible Area

Model ID	Location of Activity	Surface Type	Total Rate ton/yr	Erodible Area (acre/yr)[3] Flat	Pile	Surface Footprint acre
HFSTKP	Hangar Flats Stockpiles	Pile	10,979,700		1,095	26
LSTKP	Limestone Stockpile	Pile	318,000		32	2
HFBF	Hangar Flats Backfill	Pile	14,313,788		1,427	28
TSFEB	Tailings Storage Facility Emban	Pile	--		--	171
YPBF	Yellow Pine Backfill	Pile	10,426,067		1,039	52
WEBF	West End Backfill	Pile	--		--	--
BT	Bradley Tailings	Flat		66		66
TSF	Tailings Storage Facility	Flat		331		331
HR	Haul Roads [1]	Flat		628		182
ACCRD	Access Roads [2]	Flat		91		91

[1] *Based on total haul road length of* 27,700 *m* *(Midas Gold 2017e)* *and width of* 26.5 *m* *(Midas Gold 2016), Fig. 9-1*

[2] *Based on total access road length of* 60377.56 *m* *(Midas Gold 2017e)* *and width of* 6.1 *m* *(Midas Gold 2016), Fig. 7-2*

[3] *Pile surface area calculations:*

Truck dump (TD) size	131.1	ton	
Material density	187.8	lb/ft^3	*(Midas Gold 2017b), average*
	0.094	ton/ft^3	
Material specific volume	10.7	ft^3/ton	
TD volume (V)	1,397	ft^3	
Conical surface calculations			
Side slope	38	deg	
	0.7	rad	
Conical surface area (SA)	Π × r × (h^2 + r^2)^0.5		
Conical volume (V)	(Π × h × r^2) ÷ 3		
Conical base radius	r =	s × cos(slope)	
Conical height	h =	s × sin(slope)	
Sloped side length	s =	(h^2 + r^2)^0.5	

Solution of conical volume equation

Replacing h and r with s × sin(slope) and s × cos(slope), respectively:

s = [3 × V/(pi × sin(slope) × cos^2(slope)]^(1/3)	15.2	ft
r	12.0	ft
h	9.3	ft
SA	569	ft^2
	0.013	acre
	1.0E-4	acre/ton-TD

Scaling Factors

PM10	0.5	*AP-42, Pg. 13.2.5-3, 11/06*
PM2.5	0.075	*AP-42, Pg. 13.2.5-3, 11/06*

Conversions

4,047	m^2/acre
43,560	ft^2/acre
1609.3	m/mi

PRI00000910

REC 2250

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 25 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Wind Erosion - continued ***Wind erosion potential calculations based on Aug-2014 through Aug-2015 Midas Gold on site meteorological data***

Stockpile Surface Wind Erosion Event Emission Calculations

Based on 1 acre/yr 8,760 hr/yr 0.00011 acre/hr

Threshold Wind Event	Date / Hour	u10 (m/s) (1)	u10+ (m/s) (2)	u* (m/s) ID-A (3)	u* (m/s) ID-B (3)	u* (m/s) ID-C (3)	Hours Elapsed ID-A (4)	Hours Elapsed ID-B (4)	Hours Elapsed ID-C (4)	Erodible Surface Area (acre) ID-A (5)	Erodible Surface Area (acre) ID-B (5)	Erodible Surface Area (acre) ID-C (5)
0	6/12/2014 13:00											
1	9/25/2014 14:00	9.810	11.772	1.059	0.706	0.235	2,521	2,521	2,521	0.03453	0.1381	0.1151
2	11/29/2014 12:00	10.050	12.060	1.085	0.724	0.241	1,558	4,079	4,079	0.02134	0.2235	0.1863
3	12/11/2014 03:00	10.000	12.000	1.080	0.720	0.240	279	4,358	4,358	0.00382	0.2388	0.1990
4	12/11/2014 14:00	9.470	11.364	1.023	0.682	0.227	11	4,369	4,369	0.00015	0.2394	0.1995
5	2/5/2015 14:00	10.400	12.480	1.123	0.749	0.250	1,344	5,713	5,713	0.01841	0.3130	0.2609
6	2/6/2015 07:00	10.270	12.324	1.109	0.739	0.246	17	5,730	5,730	0.00023	0.3140	0.2616
7	8/21/2015 14:00	9.610	11.532	1.038	0.692	0.231	4,711	10,441	10,441	0.06453	0.5721	0.4768
8	8/21/2015 15:00	9.530	11.436	1.029	0.686	0.229	1	10,442	10,442	0.00001	0.5722	0.4768
Flat Surface Wind Erosion Event Emission Calculations												
				Flat			Flat			Flat		
N/A	No wind events above 16.04 m/s											

Stockpile Surface Wind Erosion Event Emission Calculations - continued

Threshold Wind Event	Erosion Potential (lb/acre)[1] ID-A (6)	ID-B (6)	ID-C (6)	PM Emissions (lb) ID-A (7)	ID-B (7)	ID-C (7)	Total (8)	PM10 (lb) Total (9)	PM2.5 (lb) Total (10)
1	9.61	--	--	0.332	--	--	0.332	0.166	0.025
2	16.80	--	--	0.359	--	--	0.359	0.179	0.027
3	15.25	--	--	0.058	--	--	0.058	0.029	0.004
4	0.62	--	--	9.34E-5	--	--	9.34E-5	4.67E-5	7.00E-6
5	28.5	--	--	0.525	--	--	0.525	0.263	0.039
6	24.00	--	--	0.006	--	--	0.006	0.003	0.000
7	4.15	--	--	0.268	--	--	0.268	0.134	0.020
8	2.11	--	--	2.88E-5	--	--	2.88E-5	1.44E-5	2.16E-6
Stockpile Subtotal							1.548	0.774	0.116
Flat Surface Wind Erosion Event Emission Calculations - continued									
N/A	No wind events above 16.04 m/s						--	--	--

Zero denotes winds did not exceed the threshold for a surface regime.

Final Emission Factors (lb/acre-yr)

Surface Type	PM	PM10	PM2.5
Pile	1.55	0.77	0.12
Flat	--	--	--

PRI00000911

REC 2251

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 26 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Wind Erosion - continued

Stockpile Surface Wind Erosion Event Emission Calculations - Notes

(1) u10 = wind speed at 10 meters reference height, m/s

(2) u10+ = fastest-mile wind speed, m/s
Based on hourly to fastest-mile wind speed conversion factor of 1.2 *(EPA 1994)*

(3) Pile: u* = friction velocity, m/s = (us/ur) × 0.1 × u10+ *AP-42, Sec. 13.2.5, Eqs. 6 & 7, 11/06*

Area ID	A	B	C
(us/ur)	0.9	0.6	0.2

AP-42, Page 13.2.5-10, 11/06

Flat surface:
u* = friction velocity, m/s = 0.053 × u10+ *AP-42, Sec. 13.2.5, Eq. 4, 11/06*

(4) Hours elapsed since previous wind erosion event

(5) Erodible surface area = hours elapsed since previous erosion event × hourly erodible surface area (acre) × surface regime area fraction Surface regime area fractions:

Area ID	A	B	C
% Surface	0.12	0.48	0.4

AP-42, Page 13.2.5-10, 11/06

(6) Erosion potential, g/m^2, = P = 58(u* - ut*)^2 + 25(u* - ut*); P = 0 for u* ≤ ut*
where, ut* = threshold friction velocity = 1.02 m/s *AP-42, Page 13.2.5-5 (overburden), 11/06*
P converted to lb/acre by multiplying with: 0.002205 lb/g and 4,046.86 m^2/acre
Solving u* = (us/ur) × 0.1 × u10+ for u10, when u* = ut* = 1.02 m/s and u10+ = u* × 1.2
yields the following minimum wind speeds to disturb the each stockpile surface regime:

ID-A	9.44 m/s
ID-B	14.17 m/s
ID-C	42.50 m/s

The threshold wind speed to disturbe flat surfaces is 1.02/0.053/1.2

Flat surface	16.04 m/s

The maximum hourly wind speed in the onsite data is 10.4 m/s, which is less than the threshold wind speeds to cause a disturbance of stockpile regimes ID-B and ID-C, and flat surfaces.

(7) PM emissions, lb = P (lb/acre) × erodible surface area (acre)

(8) Total PM emissions, lb = PM (ID-A), lb + PM (ID-B), lb + PM(ID-C), lb

(9) Total PM10 emissions, lb = total PM emissions, lb × PM10 scaling factors of 0.5 *AP-42, Page 13.2.5-3, 11/06*

(10) Total PM2.5 emissions, lb = total PM emissions, lb × PM2.5 scaling factors of 0.075 *AP-42, Page 13.2.5-3, 11/06*

PRI00000912

REC 2252

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 27 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Wind Erosion - continued

Emissions by Model ID

				chk PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	Hg2+P_TPY
	Location of	Control[1]		PM	PM10		PM2.5		Hg2+P
Model ID	Activity		Type	ton/yr	lb/day	ton/yr	lb/day	ton/yr	ton/yr
HFSTKP	Hangar Flats Stockp	--	Pile	0.847	2.386	0.424	0.358	0.064	5.1E-07
LSTKP	Limestone Stockpile	--	Pile	0.025	0.069	0.012	0.010	0.002	1.5E-08
HFBF	Hangar Flats Backfil	--	Pile	1.104	3.111	0.552	0.467	0.083	6.6E-07
TSFEB	Tailings Storage Faci	--	Pile	--	--	--	--	--	--
YPBF	Yellow Pine Backfill	--	Pile	0.804	2.266	0.402	0.340	0.060	4.8E-07
WEBF	West End Backfill	--	Pile	--	--	--	--	--	--
BT	Bradley Tailings	--	Flat	--	--	--	--	--	--
TSF	Tailings Storage Faci	67%	Flat	--	--	--	--	--	--
HR	Haul Roads	90%	Flat	--	--	--	--	--	--
ACCRD	Access Roads	90%	Flat	--	--	--	--	--	--
Total	Wind Erosion			2.780	7.832	1.390	1.175	0.209	1.7E-06

[1] *TSF - maximum one-third of the total surface exposed (Midas Gold 2017g)*
Roads - see note on page 6

Source Parameters [1]

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	SIG_Z_M	SXINIT_M	SYINIT_M	ANGL_DEG
		Source	UTM NAD 83		Elev.	Rel. Ht.	S-z	Len X	Len Y	Angle
Model ID	Activity	Type	E m	N m	m	m	m	m	m	deg
TSF	Tailings Storage Facility	AREA	628,496	4,971,000	2,117	0.00	0.00	1157	1157	0

[1] *UTM, Elev. - (Midas Gold 2017e); Rel. Ht., S-z - (EPA 2012); Len X, Len Y, Angle - best-fit equal area rectangle*

Conversions
2,000 lb/ton

PRI00000913

REC 2253

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 28 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Surface Exploration

Activity Information

Operating schedule	355	day/yr	24	hr/day	
Duration	14	yr	168	mo	*(Midas Gold 2018b)*
Construction disturbance	13	acres	0.08	acre/mo	*(Midas Gold 2016), p. 13-1*
Total wet drilling (maximum)	700	holes	50	holes/yr	*(Midas Gold 2016), p. 13-1*
Core diameter	2.5	in			*(Midas Gold 2018j)*
Average core length	800	ft			*(Midas Gold 2016), p. 13-2*
Core volume	27.3	ft^3			
Average material density	158.7	lb/ft^3			*(Midas Gold 2017b)*
Average mass	2.16	ton/hole	108.2	ton/yr	

Construction Emission Calculations

Emission Factors

PM	1.2	ton/acre	per month of activity	*AP-42, Page 13.2.3-1, 1/95*

PM Scaling Factors

PM10	0.35	*AP-42, Sec. 13.2.4, Pg. 4, 11/06*
PM2.5	0.053	*AP-42, Sec. 13.2.4, Pg. 4, 11/06*

Construction Emissions

Activity	PM	PM10		PM2.5		Hg2+P
	ton/yr	lb/day	ton/yr	lb/day	ton/yr	ton/yr
Drill Pad and Temporary Road Construction	1.1	2.2	0.4	0.3	0.1	6.7E-07

Wet Drilling Emission Calculations

Emission Factors

PM10	8.0E-5	lb/ton (material blasted)	*AP-42, Table 11.19.2-2 (wet drilling), Rev. 8/04*

PM Scaling Factors

PM	0.74	*AP-42, Sec. 13.2.4-4, 11/06*
PM10	0.35	*AP-42, Sec. 13.2.4-4, 11/06*
PM2.5	0.053	*AP-42, Sec. 13.2.4-4, 11/06*

Blast-to-Drill Volume Ratio[(1)] 400 blast volume/drilled volume

[(1)] *Dyno Nobel 2010 "Blasting and Explosives Quick Reference Guide" (Ratio of total of blast volume to drilled hole volume)*

Wet Drilling Emissions

Activity	PM	PM10		PM2.5		Hg2+P
	ton/yr	lb/day	ton/yr	lb/day	ton/yr	ton/yr
Wet Drilling	0.004	0.010	0.002	0.001	0.0003	2.2E-09

Conversions

12 in/ft	12 mo/yr
2,000 lb/ton	1.341 hp/kW

PRI00000914

REC 2254

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 29 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Surface Exploration - continued

Drill Rig Tailpipe Emission Calculations

Other mobile equipment emissions are included in the Mobile Equipment (Tailpipes) calculations provided on page 14 of this sheet (Midas Gold 2018j)

Drill Specifications and Emission Factors

Equipment[1] Model	Rating[1] hp	Rating kW	Oper.[2] hr/yr	Diesel[3] gal/yr	Output[4] kW-hr/yr	EPA Non-Road Standards (g/kW-hr)[5] PM	CO	NOX	VOC	SO2[6]
CAT MD 6250	872	650.3	12,000	300,000	4,378,396	0.04	3.5	3.5	0.19	0.0066

[1] *Similar to production drill (Midas Gold 2018j)*

[2] *Based on:* 3.3 *ft/hr* *(Midas Gold 2018j)*

[3] *Scaled from production drill*

[4] *Based on:* 137,000 *BTU/gal* *AP-42, App. A (Diesel* 7,000 *BTU/hp-hr* *AP-42, Sec. 3.3, (Diesel)*

[5] *(CFR 2018a)*

[6] *Fuel Sulfur-Content Based SO2 Emission Factor, see page 12 of this sheet*

Drill Tailpipe Emissions

PM	PM10		PM2.5		CO		NOX		SO2		VOC
ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr
0.19	1.09	0.19	1.09	0.19	3.97	16.89	3.97	16.89	0.01	0.03	0.92

Surface Exploration Total Emissions

Hg2+P_TPY

PM	PM10		PM2.5		CO		NOX		SO2		VOC	Hg2+P
ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr	ton/yr
1.31	3.29	0.58	1.42	0.25	3.97	16.89	3.97	16.89	0.01	0.03	0.92	6.7E-07

Emissions by Model ID [1]

		chk PM_TPY	chk PM10_PPD	chk PM10_TPY	chk PM2.5_PPD	chk PM2.5_TPY	chk CO_PPH	chk CO_TPY	chk NOX_PPH	chk NOX_TPY	chk SO2_PPH	chk SO2_TPY	chk VOC_TPY	chk Hg2+P_TPY
		PM	PM10		PM2.5		CO		NOX[2]		SO2		VOC	Hg2+P
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr	ton/yr
YPP	Surface Exploration	0.33	0.82	0.15	0.36	0.06	0.99	4.22	0.99	4.22	0.00	0.01	0.23	1.7E-07
HFP	Surface Exploration	0.33	0.82	0.15	0.36	0.06	0.99	4.22	0.99	4.22	0.00	0.01	0.23	1.7E-07
WEP	Surface Exploration	0.33	0.82	0.15	0.36	0.06	0.99	4.22	0.99	4.22	0.00	0.01	0.23	1.7E-07
PROC	Surface Exploration	0.33	0.82	0.15	0.36	0.06	0.99	4.22	0.99	4.22	0.00	0.01	0.23	1.7E-07

[1] *Equally distributed amongst* 4 *locations* *(Midas Gold 2018j)*

Conversions

907,186 g/ton

2,000 lb/ton

PRI00000915

REC 2255

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 30 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Helicopter

Activity Information

Operating schedule	355 day/yr	24 hr/day	
Flight frequency	4 flight/mo		*(Midas Gold 2018h)*
	48 flight/yr		
	1 flight/day, daily maximum		
	1 flight/hr, hourly maximum		

Landing and Takeoff (LTO) Component Durations

AP-42, Vol. II, Table II-1-3 (helicopter)
(EPA 1991)

LTO Component	minute	hour
Idle	7.00	0.12
Takeoff	--	--
Climbout	6.50	0.11
Approach	6.50	0.11

LTO Component Emission Factors (lb/hr)

AP-42, Vol. II, Table II-1-7 (TPE 331-3 GA TP)
(EPA 1991)

LTO Component	PM	CO	NOX	SO2	VOC
Idle	0.3	6.89	0.32	0.11	8.86
Takeoff	0.8	0.35	5.66	0.46	0.05
Climbout	0.6	0.4	4.85	0.41	0.06
Approach	0.6	1.74	2.48	0.25	0.16

Total Emissions [1] ***by Model I***

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	CO_PPH	CO_TPY	NOX_PPH	NOX_TPY	SO2_PPH	SO2_TPY	VOC_TPY
		PM	PM10		PM2.5		CO		NOX		SO2		VOC
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr
HELI	Heliport	0.004	0.165	0.004	0.165	0.004	1.036	0.025	0.831	0.020	0.084	0.002	0.025

Source Parameters [1]

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	SIG_Y_M	SIG_Z_M	Surface	
		Source	UTM NAD 83		Elev.	Rel. Ht.	S-y	S-z	Area	Length
Model ID	Activity	Type	E m	N m	m	m	m	m	m^2	m
HELI	Heliport	VOLUME	632,222	4,973,588	1,996	3.43	9.15	3.19	387	19.7

[1] *UTM, Elev. - (Midas Gold 2017e); Rel. Ht., Sy, Sz - (EPA 2012)*

Helicopter	Height	Reference
Bell 429	4.0 m	*(Bell 2018)*

Plume Parameter	Calculation	Value (m	Const.
Plume top (PT)	1.7 x VH	6.87	1.7
Release height	0.5 x PT	3.43	0.5
Helipad width		19.67	
Sigma-z	PT / 2.15	3.19	2.15
Sigma-y	PW / 2.15	9.15	2.15

(EPA 2012)

Conversions

60	min/hr
2,000	lb/ton

PRI00000916

REC 2256

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 31 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

TSF Construction

Activity Information

COI Percent of total activity 0% *(Midas Gold 2018f)*

Operation 355 day/yr

Total Life of Mine Emissions

PM	PM10	PM2.5
ton	ton	ton
91.65	28.08	8.18

Detailed emission calculations provided on sheet: Const, page 2

Construction Emissions by Model ID

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	Hg2+P_TPY
		PM	PM10		PM2.5		Hg2+P
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	ton/yr
TSF	Tailings Storage Facility Construction	--	--	--	--	--	--

Maximum daily emissions based on: *1,000* *person crew during peak construction, scaled with an average annual crew of* *750*

Other construction activity during mine operation is accounted for in the mine equipment usage.

Conversions

2,000 lb/ton

PRI00000917

REC 2257

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon/K. Lewis	
	PROJECT NO: 335-21-402/404	PAGE: 1	OF: 5 SHEET: MineHAP
AIR EMISSION CALCULATIONS	SUBJECT: Mining HAP and GHG Emissions	DATE: June 30, 2021	

Mining Year **10**

Hazardous Air Pollutants and Greenhouse Gas Emissions

HAP Emissions Summary

	Emissions	
Pollutant	lb/yr	ton/yr
1,3-Butadiene	10.079	5.0E-3
7-PAH	3.785	1.9E-3
Acetaldehyde	214	0.107
Acrolein	28.926	0.014
Antimony	29.093	0.015
Arsenic	749	0.374
Benzene	741	0.370
Beryllium	4.143	2.1E-3
Biphenyl	0	0
Cadmium	0.982	4.9E-4
Carbon Disulfide	0	0
Chromium	35.192	0.018
Cobalt	5.664	2.8E-3
Cr (VI)	0	0
Cyanide	3,965	1.983
Dichlorobenzene	0	0
Formaldehyde	355	0.178
Hexane	0	0
Hydrogen Chloride	0	0
Lead	13.015	6.5E-3
Manganese	399	0.199
Mercury	7.792	3.9E-3
Naphthalene	0	0
Nickel	4.267	2.1E-3
Phenol	0	0
Phosphorus	803	0.401
POM	180	0.090
Selenium	0.403	2.0E-4
Toluene	287	0.143
Xylene	198	0.099
Total HAP	8,033	4.017
	8,033	
	chk	

GHG Emissions Summary

	CO_2e[(1)]
Pollutant	ton/yr
Total GHGs	73,842

(1) *Annex I Parties, 100-year time horizon (UNCC n.d.); (IPCC 2007)*

Conversions

2,000	lb/ton
1.10231	ton/t

PRI00000918

REC 2258

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon/K. Lewis
	PROJECT NO: 335-21-402/404	PAGE: 2 OF: 5 SHEET: MineHAP
AIR EMISSION CALCULATIONS	SUBJECT: Mining HAP and GHG Emissions	DATE: June 30, 2021

Mining Year **10**

MINING DUST

Activity Information

Activity	PM ton/yr	TAP Rule ton/yr	210.2 Exclusion	TAP Rule Category
Open Pit Drilling	1.97	1.97	No	Mining
Open Pit Blasting	14.08	14.08	No	Mining
Material Load / Unload	4.62	4.62	No	Mining
Dozing	39.92	39.92	No	Mining
Wind Erosion	2.78	2.78	No	Mining
Surface Exploration	1.12	1.12	No	Mining
TSF Construction	--	0.00	No	Mining
Ore/Development Rock Subtotal	64.49	64.49		
Onsite Hauling	819.13	819.13	No	Mining
Grading	21.33	21.33	No	Mining
Water Truck Travel	21.24	21.24	No	Mining
Haul Road Subtotal	861.71	861.71		
Access Road Grading	2.80	2.80	No	Mining
Access Road Vehicle Travel	109.70	109.70	No	Mining
Access Roads	112.50	112.50		

See Mine Sheet

Haul roads capped with clean rock 49% *(Perpetua 2021h)* %CR

Ore, Watse, and Limestone Dust HAP Concentrations [1] and Emissions

Pollutant	O/DR[1] ppm	AR[2] ppm	CR[3] ppm	O/DR ton/yr	AR ton/yr	HR[4] ton/yr	Emissions lb/yr	Emissions ton/yr
Arsenic	667	2.5	90	0.043	2.8E-4	0.331	749	0.374
Beryllium	3.2	2.2	0.5	2.1E-4	2.5E-4	1.6E-3	4.143	2.1E-3
Cadmium	0.5	0.25	0.5	3.2E-5	2.8E-5	4.3E-4	0.982	4.9E-4
Cobalt	4	3.5	1	2.6E-4	3.9E-4	2.2E-3	5.664	2.8E-3
Chromium	9	11	28	5.8E-4	1.2E-3	0.016	35.192	0.018
Mercury	0.6	0.009	0.07	3.9E-5	1.0E-6	2.9E-4	0.666	3.3E-4
Manganese	299	278.5	41	0.019	0.031	0.149	399	0.199
Nickel	2	2.5	2	1.3E-4	2.8E-4	1.7E-3	4.267	2.1E-3
Lead	8	14.5	2	5.2E-4	1.6E-3	4.4E-3	13.015	6.5E-3
Antimony	23	3.75	6	1.5E-3	4.2E-4	0.013	29.093	0.015
Phosphorus	650	430	60	0.042	0.048	0.311	803	0.401
Selenium	0.4			2.6E-5	0	1.8E-4	0.403	2.0E-4
Dust HAP Total				0.107	0.084	0.830	2,043	1.022

[1] *O/DR: ore and development rock; (Midas Gold 2017c) for all metals but Hg and Se; Hg value from (Midas Gold 2018i); Se value from (Midas Gold 2020)*

[2] *AR: Burntlog access route roadbed materal analyses - 1/2 detection limit used for non-detect analyses (ALS 2018)*

[3] *CR: clean rock - used to cap haul roads outside of the pits and DRSFs - 1/2 detection limit used for non-detect analyses (Perpetua 2021g)*

[4] *HR: haul road - emissions calculated based on 49% of the total VMT occuring on CR for LOM Year 10*

Conversions

2,000 lb/ton

PRI00000919

REC 2259

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: K. Lewis
	PROJECT NO: 335-21-402/404	PAGE: 3 OF: 5 SHEET: MineHAP
AIR EMISSION CALCULATIONS	SUBJECT: Mining HAP and GHG Emissions	DATE: June 30, 2021

Mining Year **10**

EXPOSED MINING SURFACE HG EVAPORATION

Fugitive Mercury Flux and Emissions

CAS No.	Pollutant	Source	Area m^2	Area ha	Hg Flux µg/m^2-yr	Emissions lb/yr	Emissions ton/yr	TAP Rule lb/yr	210.2 Exclusion	TAP Rule Category
		Stockpiles	104,320	10.4	556	0.128	6.4E-5	0.128	No	Mining
		Tailings Embankment	693,889	69.4	76.2	0.116	5.8E-5	0.116	No	Mining
		Tailings	1,338,158	133.8	2,144	6.325	3.2E-3	6.325	No	Mining
		Pits	1,909,675	191.0	132.3	0.557	2.8E-4	0.557	No	Mining
7439976	Mercury					7.126	3.6E-3	7.126		

Fugitive Mercury Emission Factors

Source	Twin Creeks (TC) Hg Flux [1] µg/m^2-yr	Twin Creeks (TC) Hg [2] µg/g	Ore Hg Adjusted µg/m^2/yr TC	Stibnite Hg Flux [3] µg/m^2-yr	Stibnite Hg [4] µg/g
Stockpiles	5,609	33	556	556	0.96
Rock Dumps	768	3.5	76.2	76.2	0.60
Tailings	21,621	33	2,144	2,144	0.96
Pits	1,334	9.5	132	132.3	0.60

[1] *(Eckley 2010)* *Table 1: Hg flux µg/m^2-yr*

[2] *(Eckley 2010)* *Table 1: Average Hg flux mg/g: " Stockpiles - high-grade stockpiles, Rock Dumps - waste rock dumps, Tailings - high-grade stockpilese as a surrogate; Pits - pit"*

[3] *(Eckley 2010)* *Figure 2: log(y) = m*log(x) + b*

y = Hg Flux (ng/m^2-d)

x = material Hg concentration (µg/g)]

Slope =	*Solar*	*TC*
	Low	*0.59*
	Medium	*0.6*
	High	*0.77*
	Average	*0.65*

[4] *(Midas Gold 2018i) Stockpiles - Ore, Rock Dumps - Rock, Tailings - Ore as a surrogate, Pits - Ore and Rock combined average*

Sample Calculation: m = log (y1/y2) / log(x1/x2)

m=	0.65	unit less
y1=	5,609	µg/m^2-yr
x1=	33	µg/m^2-yr
x2=	0.96	µg/m^2-yr
log(x1/x2)=	1.536243	unit less
log(y1/y2)=	1.003679	unit less
y1/y2=	10.08506	unit less
y2=	556.2	µg/m^2-yr

Conversions

2,000	lb/ton
10,000	m2/ha
453.593	g/lb
1,000	ng/µg
365	day/yr
0.365	(µg/m^2-yr) / (ng/m^2-d)

$$\frac{1\ \text{ng}}{\text{m2-d}} \times \frac{\text{µg}}{1{,}000\ \text{ng}} \times \frac{365\ \text{d}}{\text{yr}} = \frac{0.365\ \text{µg/m2-yr}}{\text{µg/g}}$$

PRI00000920

REC 2260

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: K. Lewis
	PROJECT NO: 335-21-402/404	PAGE: 4 OF: 5 SHEET: MineHAP
AIR EMISSION CALCULATIONS	SUBJECT: Mining HAP and GHG Emissions	DATE: June 30, 2021

Mining Year **10**

MINING FUGITIVE HCN EVAPORATION

	Description	Dia. ft[1]	pH[1]	Free CN- g/m3[1]	T C[1]	pKa	a0	H	kG[2] m/s	Fa*Fw	Cyanide Emissions g/s	lb/yr	ton/yr	TAP Rule lb/yr	210.2 Exclusion
	Fugitive Sources														
TS	Tailings Maint. Pon	76	7.75	1	3.74	9.803	0.9912	0.0025	1.89E-05	0.641	1.27E-05	0.885	4.4E-4	0.885	No
CI	CN Detox Tank 1	40	8.5	25	25	9.250	0.8490	0.0055	0.000311	0.688	0.002891	201	0.101	201	No
CI	CN Detox Tank 2	40	8.5	25	25	9.250	0.8490	0.0055	0.000311	0.688	0.002891	201	0.101	201	No
CI	CIP Leach Tank 1	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	99.746	0.050	99.746	No
CI	CIP Leach Tank 2	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	99.746	0.050	99.746	No
CI	CIP Leach Tank 3	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	99.746	0.050	99.746	No
CI	CIP Leach Tank 4	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	99.746	0.050	99.746	No
CI	CIL Tank 1	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	173	0.086	173	No
CI	CIL Tank 2	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	173	0.086	173	No
CI	CIL Tank 3	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	173	0.086	173	No
CI	CIL Tank 4	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	173	0.086	173	No
CI	CIL Tank 5	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	173	0.086	173	No
CI	CIL Tank 6	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	173	0.086	173	No
CI	CIP Tank 1	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	16.391	8.2E-3	16.391	No
CI	CIP Tank 2	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	16.391	8.2E-3	16.391	No
CI	CIP Tank 3	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	16.391	8.2E-3	16.391	No
CI	CIP Tank 4	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	16.391	8.2E-3	16.391	No
CI	CIP Tank 5	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	16.391	8.2E-3	16.391	No
CI	CIP Tank 6	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	16.391	8.2E-3	16.391	No
		Acres[1]													
TS	Tails, Aqueous Surf	110.2	7.75	1	3.74	9.803	0.9912	0.0025	1.89E-05	0.421	0.008845	615	0.307	615	No
TS	Tails, Wet Sediment	110.2							5.31E-08	0.421	0.009961	693	0.346	693	No
TS	Tails, Dry Sediment	110.2							2.33E-08	1	0.010375	721	0.361	721	No
		330.7													
	592018 Cyanide											3,965	1.983	3,965	

(1) *(Midas Gold 2016) (M3 2017c) (M3 2017d)*

(2) *(Card 2009) (EPA 2009) (Schmidt 2010)*

Conversions

8,760	hr/yr	453.59	g/lb	Wind adjustment factor Fw	1
2,000	lb/ton	3.28084	ft/m		
4,046.86	m2/acre	3,600	s/hr		

PRI00000921

REC 2261

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon/K. Lewis
	PROJECT NO: 335-21-402/404	PAGE: 5 OF: 5 SHEET: MineHAP
AIR EMISSION CALCULATIONS	SUBJECT: Mining HAP and GHG Emissions	DATE: June 30, 2021

Mining Year **10**

NONROAD ENGINE TAILPIPE EXHAUST

Activity Information

Mining Mobile Equipment			
Large diesel machinery (> 600 hp)	4,706,986 gal/yr	644,857 MMBtu/yr[1]	*See Mine Sheet*
Small diesel machinery (≤ 600 hp)	1,750,325 gal/yr	239,795 MMBtu/yr[1]	*See Mine Sheet*
Access Road Mobile Equipment			
Large diesel machinery (> 600 hp)	-- gal/yr	-- MMBtu/yr[1]	*See Mine Sheet*
Small diesel machinery (≤ 600 hp)	131,289 gal/yr	17,987 MMBtu/yr[1]	*See Mine Sheet*

[1] Based on diesel heating value of 137,000 Btu/gal *AP-42, Appendix A, p. A-5, 9/85*

Combustion HAP Emission Factors and Emissions

	Small Engines[1]	Large Engines[2]	Emissions	
Pollutant	lb/MMBtu	lb/MMBtu	lb/yr	ton/yr
1,3-Butadiene	< 3.9E-05	0	10.079	5.0E-3
Acetaldehyde	7.7E-04	2.5E-05	214	0.107
Acrolein	< 9.3E-05	7.9E-06	28.926	0.014
Benzene	9.3E-04	7.8E-04	741	0.370
Formaldehyde	1.2E-03	7.9E-05	355	0.178
Toluene	4.1E-04	2.8E-04	287	0.143
Xylene	2.9E-04	1.9E-04	198	0.099
POM	1.68E-04	2.12E-04	180	0.090
7-PAH	3.43E-06	4.50E-06	3.785	1.9E-3
HAP Total			2,017	1.009

[1] *AP-42, Tab. 3.3-2, 10/96, diesel engines (≤ 600 hp)*

[2] *AP-42, Tabs. 3.4-3 & 3.4-4, 10/96, large diesel engines (> 600 hp)*

Greenhouse Gas Emission Factors [1] and Emissions

	Emission Factor[1]	Emissions	GWP[2]	GWP[3]	CO2e (ton/yr)	
Greenhouse Gas	kg/MMBtu	mt/yr	100-yr	20-yr	100-yr	20-yr
CO2	73.96	66,759	1	1	66,759	66,759
CH4	3.0E-3	2.7	25	62	68	168
N2O	6.0E-4	0.5	298	275	161	149
Total GHG					66,988	67,076

[1] *40 CFR 98 Tab. C-1 (Fuel Oil No. 2) and C-2 (Petroleum Products) (CFR 2018d)*

[2] *40 CFR 98, Table A-1 (12/2014) (CFR 2018d)*

[3] *(IPCC 1995)*

Conversions

2,000 lb/ton

1,000 kg/mt

PRI00000922

REC 2262

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 1 OF: 9 SHEET: Const
AIR EMISSION CALCULATIONS	SUBJECT: Construction Activity and Emissions	DATE: June 30, 2021

Mine Construction Emissions Construction Year 1

Annual Emissions Summary

Activity	PM ton/yr	PM10 ton/yr	PM2.5 ton/yr	CO ton/yr	NOX ton/yr	SO2 ton/yr	VOC ton/yr	Total HAP ton/yr	CO2e ton/yr
Facility and Infrastructure Construction	37.1	11.4	3.3					0.00	
Power Generation	4.5	4.5	4.5	382.7	85.2	0.59	46.9	9.2	70,573
Access Road	147.5	38.3	4.0	9.4	6.4	0.02	0.9	0.00	3,571
Construction Total	189.1	54.2	11.8	392.1	91.6	0.61	47.8	9.2	74,143

Maximum Daily Emissions Summary[1]

Activity	PM lb/day	PM10 lb/day	PM2.5 lb/day	CO lb/day	NOX lb/day	SO2 lb/day	VOC lb/day	Total HAP lb/day	CO2e lb/day
Facility and Infrastructure Construction	279	85.4	24.9					0.00	
Power Generation	25.2	25.2	25.2	2,156.1	479.9	3.3	264.0	51.7	397,592
Access Road	1,107.9	287.8	30.2	70.3	48.0	0.2	6.7	0.0	26,823
Construction Total	1,411.9	398.5	80.3	2,226.5	527.9	3.5	270.7	51.7	424,414

[1] *Maximum daily emissions based on:* 1,000 *person crew during peak construction, scaled with an average annual crew of* 750 *and an annual operating schedule of* 355 *day/yr (M3 2014)*

Daily power generation emissions are not scaled by peak crew.

Facility Infrastructure Construction Emissions by LOM Year[1]

LOM	PM ton/yr	PM10 ton/yr	PM2.5 ton/yr	CO ton/yr	NOX ton/yr	SO2 ton/yr	VOC ton/yr	Total HAP ton/yr	CO2e ton/yr
1	37.1	11.4	3.3					0.00	
2	112.5	34.5	10.0					0.00	
3	33.7	10.3	3.0					0.00	
4	4.2	1.3	0.4					0.00	
5	22.6	6.9	2.0					0.00	
6	9.6	2.9	0.9					0.00	
7	4.5	1.4	0.4					0.00	
8	9.6	2.9	0.9					0.00	
9	4.2	1.3	0.4					0.00	
[1] 10	3.8	1.2	0.3					0.00	
(Midas Gold 2018f)	chk	chk	chk						

Power Generation Emissions by LOM Year

	LOM	Capacity[1]	PM ton/yr	PM10 ton/yr	PM2.5 ton/yr	CO ton/yr	NOX ton/yr	SO2 ton/yr	VOC ton/yr	Total HAP ton/yr	CO2e ton/yr
co	1	100%	4.5	4.5	4.5	382.7	85.2	0.59	46.9	9.2	70,573
co	2	100%	4.5	4.5	4.5	382.7	85.2	0.59	46.9	9.2	70,573
co	3	50%	2.2	2.2	2.2	191.4	42.6	0.29	23.4	4.6	35,286
[1] *(Midas Gold 2018f)*			chk	chk	chk	chk	chk	chk	chk		

Access Road Emissions by LOM Year

LOM	PM ton/yr	PM10 ton/yr	PM2.5 ton/yr	CO ton/yr	NOX ton/yr	SO2 ton/yr	VOC ton/yr	Total HAP ton/yr	CO2e ton/yr
1	147.5	38.3	4.0	9.4	6.4	0.023	0.9	0.00	3,571
2	147.5	38.3	4.0	9.4	6.4	0.023	0.9	0.00	3,571
3	147.5	38.3	4.0	9.4	6.4	0.023	0.9	0.00	3,571
	chk	chk	chk	chk	chk	chk	chk		

PRI00000923

REC 2263

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 2 OF: 9 SHEET: Const
AIR EMISSION CALCULATIONS	SUBJECT: Construction Activity and Emissions	DATE: June 30, 2021

Facility and Infrastructure Construction

Activity Information *(Midas Gold 2018d)*

Construction Activity	acre
CON Tailings Storage Facility (including water diversions)	425.3
CON Haul Roads	178.1
CON Burntlog Road (including borrows, cut/fill)	337
CON Exploration Decline and Explosives Area	29.9
CON EFSFSR Tunnel (including water diversions)	5.9
CON Ore Processing Area	70.6
CON Truck Shop Area	5.4
CON Stibnite Lodge	21.8
CON Landmark Maintenance Facility	4
CON Logistics Facility	25
CON Other Disturbance	19.1

Emission Factors (ton/acre)	PM	PM10	PM2.5	
Site Preparation/Construction	0.215	0.066	0.019	ton/acre *See sheet: PwrConst, page 2*

Emissions by Facility ***Total Construction Emissions***

Facility	PM ton	PM10 ton	PM2.5 ton
CON Tailings Storage Facility (including water diversions)	91.6	28.1	8.2
CON Haul Roads	38.4	11.8	3.4
CON Burntlog Road (including borrows, cut/fill)	72.6	22.3	6.5
CON Exploration Decline and Explosives Area	6.4	2.0	0.6
CON EFSFSR Tunnel (including water diversions)	1.3	0.4	0.1
CON Ore Processing Area	15.2	4.7	1.4
CON Truck Shop Area	1.2	0.4	0.1
CON Stibnite Lodge	4.7	1.4	0.4
CON Landmark Maintenance Facility	0.9	0.3	0.1
CON Logistics Facility	5.4	1.7	0.5
CON Other Disturbance	4.1	1.3	0.4
Total	241.8	74.1	21.6
	PM_total	PM10_total	PM2.5_total

Conversions

2,000 lb/ton	43,560 ft2/acre	3.28084 ft/m
1.1 ton/mt	100 cm/m	5280 ft/mi

PRI00000924

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 3 OF: 9 SHEET: Const
AIR EMISSION CALCULATIONS	SUBJECT: Construction Activity and Emissions	DATE: June 30, 2021

Mine Construction Emissions

Power Generation

Activity Information

Total Requirement		10 MW			*(Midas Gold 2016), pg. ES-14*
Diesel Generators[1]	75%	8.5 MW	72,420 MW-hr/yr		*(Midas Gold 2017f)*
Propane Generators	25%	2.5 MW	21,300 MW-hr/yr		*(Midas Gold 2017f)*

[1] *Includes temporary power supply to Warm Lake and Yellow Pine based on:* 317 *MMBtu per capita (EIA 2018) an* 100 *people (Midas Gold 2018k)*

Temporary Power 1 MW $\frac{317\ \text{MMBtu}}{\text{person yr}} \times \frac{0.2933\ \text{MW-hr}}{\text{MMBtu}} \times \frac{100\ \text{person}}{8{,}760\ \text{hr}} \times \frac{\text{yr}}{}$

Emission Factors - Diesel Generators (g/kW-hr)

Pollutant	Standard[1]
CO	3.5
NOX	0.67
VOC	0.19
PM	0.03

[1] *40 CFR: 60.4204(b), 60.4201(a), Table 1 of 1039.101*

Fuel Sulfur-Content-Based SO2 Emission Factor

Fuel Sulfur-Content	0.0015%		*non-road diesel, 40 CFR 80.510*
Diesel Density	7.05	lb/gal	*AP-42, App. A*
Molecular Wt. of SO2	64.0638		
Molecular Wt. of S	32.065		
Diesel Heat Content	137,000	BTU/gal	*AP-42, App. A (Diesel)*
Brake-Specific Fuel Use	7,000	BTU/hp-hr	*AP-42, Sec. 3.3, (Diesel)*

SO2 emission factor:

0.000011 lb/hp-hr $= \frac{0.0015\%\ \text{lb S}}{\text{lb Fuel}} \times \frac{7.05\ \text{lb Fuel}}{\text{gal Fuel}} \times \frac{64.064\ \text{lb SO2}}{32.065\ \text{lb S}} \times \frac{\text{gal Fuel}}{137{,}000\ \text{BTU}} \times \frac{7{,}000\ \text{BTU}}{\text{hp-hr}}$

0.006567 g/kW-hr $= \frac{0.000011\ \text{lb}}{\text{hp-hr}} \times \frac{1.341\ \text{hp}}{\text{kW}} \times \frac{453.593\ \text{g}}{\text{lb}}$

Emission Factors - Propane Generators (g/kW-hr)

Pollutant	Standard[1]
CO	4.4
NOX	1.35
VOC	1.35

[1] *40 CFR: 60.4233(c) (>19 kw), 4231(c), 1048.101(2). ≥2007 model year. NOX + VOC = NOX+HC standard at 50:50 split.*

Other Emission Factors

PM/PM10/PM2.5	0.01941	lb/MMBTU[1,2]	8.89E-02	g/kW-hr[3]
SO2	5.88E-04	lb/MMBTU[1]	2.69E-03	g/kW-hr[3]

[1] *AP-42, Tab. 3.2-3, 07-00 (4-stroke rich-burn engines)*

[2] *Filterable + condensable particulates*

[3] *Based on brake-specific fuel consumption of* 7,527 *BTU/hp-hr (Caterpillar 1997)*

Conversions

355	day/yr
24	hr/day
1.341	hp/kW
453.6	g/lb
1,000,000	BTU/MMBTU

PRI00000925

REC 2265

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 4 OF: 9 SHEET: Const
AIR EMISSION CALCULATIONS	SUBJECT: Construction Activity and Emissions	DATE: June 30, 2021

Mine Construction Emissions

Emissions

Generator Type	PM ton/yr	PM10 ton/yr	PM2.5 ton/yr	CO ton/yr	NOX ton/yr	SO2 ton/yr	VOC ton/yr
Diesel Generators(1)	2.4	2.4	2.4	279.4	53.5	0.5	15.2
Propane Generators	2.1	2.1	2.1	103.3	31.7	0.1	31.7
Total	4.5	4.5	4.5	382.7	85.2	0.6	46.9

Fuel Consumption

Diesel Consumption on Access Roads[1] 43,649 MMBTU/yr *See access road fuel consumption on page 6*
Diesel Generators[2] 679,807 MMBTU/yr
Propane Generators[3] 214,996 MMBTU/yr

[1] *Based on 137,000 BTU/gal AP-42, App. A (Diesel)*
[2] *Based on 7,000 BTU/hp-hr AP-42, Sec. 3.3, (Diesel)*
[3] *Based on 7,527 BTU/hp-hr (Caterpillar 1997)*

Combustion HAP Emission Factors and Emissions

CAS No.	Pollutant/Group	Small Engines[1] lb/MMBtu	Large Engines[2] lb/MMBtu	Propane Engines[3] lb/MMBtu	Emissions[4] lb/yr	Emissions[4] ton/yr
78875	1,2-Dichloropropane			2.69E-5	5.78	2.9E-3
106990	1,3-Butadiene	3.91E-5		2.67E-4	85.7	4.3E-2
542756	1,3-Dichloropropene			2.64E-5	5.68	2.8E-3
540841	2,2,4-Trimethylpentane			2.50E-4	53.7	2.7E-2
75070	Acetaldehyde	7.67E-4	2.52E-5	8.36E-3	2,352	1.18
107028	Acrolein	9.25E-5	7.88E-6	5.14E-3	1,172	0.586
71432	Benzene	9.33E-4	7.76E-4	4.40E-4	770	0.385
56235	Carbon Tetrachloride			3.67E-5	7.89	3.9E-3
108907	Chlorobenzene			3.04E-5	6.54	3.3E-3
	Chloroethanes	0.00E+0	0.00E+0	1.21E-4	26.0	1.3E-2
67663	Chloroform			2.85E-5	6.13	3.1E-3
100414	Ethylbenzene			3.97E-5	8.54	4.3E-3
106934	Ethylene Dibromide			4.43E-5	9.52	4.8E-3
50000	Formaldehyde	1.18E-3	7.89E-5	5.28E-2	12,205	6.10
110543	Hexane			1.11E-3	239	0.119
67561	Methanol			2.50E-3	537	0.269
75092	Methylene Chloride			2.00E-5	4.30	2.1E-3
108952	Phenol			2.40E-5	5.16	2.6E-3
	POM [5]	1.68E-4	2.12E-4	3.47E-4	228	0.114
100425	Styrene			2.36E-5	5.07	2.5E-3
108883	Toluene	4.09E-4	2.81E-4	4.08E-4	384	0.192
75014	Vinyl Chloride			1.49E-5	3.20	1.6E-3
1330207	Xylene	2.85E-4	1.93E-4	1.84E-4	246	0.123
Combustion HAP Total					18,360	9.18

[1] *AP-42, Tab. 3.3-2, 10/96, diesel engines (≤ 600 hp)*
[2] *AP-42, Tabs. 3.4-3 & 3.4-4, 10/96, large diesel engines (> 600 hp)*
[3] *AP-42, Tabs. 1.4-2, 1.4-3 & 1.4-4, 07/98, external natural gas combustion, based on 1,020 Btu/Scf*
[4] *Maximum of the two diesel engine emission factors used*
[5] *POM = Poly Organic Matter, includes:*
2-Methylnaphthalene, 3-Methylchloranthrene, 7,12-Dimethylbenz(a)anthracene, Acenaphthene, Acenaphthylene, Anthracene, Benz(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(g,h,i)perylene, Benzo(k)fluoranthene, Chrysene, Dibenzo(a,h)anthracene, Fluoranthene, Fluorene, Indeno(1,2,3-c,d)pyrene, Naphthalene, Phenanthrene, Pyrene.

Conversions

1,000,000 BTU/MMBTU 1,000 kW/MW 907,186 g/ton
2,000 lb/ton 1.341 hp/kW

PRI00000926

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 5 OF: 9 SHEET: Const
AIR EMISSION CALCULATIONS	SUBJECT: Construction Activity and Emissions	DATE: June 30, 2021

Mine Construction Emissions

Greenhouse Gas Emission Factors[1] and Emissions

Fuel	CO2	CH4	N2O	CO2	CH4	N2O	CO2e
	kg/MMBtu			mt/yr	mt/yr	mt/yr	mt/yr
Gen Diesel	73.96	3.0E-3	6.0E-4	50,278	2.0	0.4	50,451
Gen Propane	62.87	3.0E-3	6.0E-4	13,517	0.6	0.1	13,571
Access Rd Diesel	73.96	3.0E-3	6.0E-4	3,228	0.13	0.03	3,239
Combustion Total GHG				67,024	3	1	67,262

[1] *40 CFR 98 Tab. C-1 and C-2 (CFR 2018d)*

Global Warming Potential [1, 2]

CO2	1
CH4	25
N2O	298

[1] *40 CFR 98 Tab. A-1 (CFR 2018d)*

[2] *Annex I Parties, 100-year time horizon (UNCC n.d.); (IPCC 2007)*

Dust HAP Emission Factors and Emissions

HAP Concentrations[1] and Emissions[2]

Pollutant	ppm	Emissions lb/yr	Emissions ton/yr
Arsenic	2.5	0.9	4.6E-4
Beryllium	2.2	0.8	4.0E-4
Cadmium	0.25	9.2E-2	4.6E-5
Cobalt	3.5	1.3	6.4E-4
Chromium	11	4.0	2.0E-3
Mercury	0.009	3.3E-3	1.7E-6
Manganese	278.5	102.3	5.1E-2
Nickel	2.5	0.9	4.6E-4
Lead	14.5	5.3	2.7E-3
Antimony	3.75	1.4	6.9E-4
Phosphorus	430	158.0	7.9E-2
Dust HAP Total		275.1	0.1

[1] *AR: Burntlog access route roadbed materal analyses - 1/2 detection limit used for non-detect analyses (ALS 2018)*

[2] *Based on total PM emissions of* 183.7 *ton/yr* *See construction PM emissions on page 2, and access road PM emissions (excluding tailpipes) on page 8*

Conversions

1,000 kg/mt
2,000 lb/ton

PRI00000927

REC 2267

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 6 OF: 9 SHEET: Const
AIR EMISSION CALCULATIONS	SUBJECT: Construction Activity and Emissions	DATE: June 30, 2021

Mine Construction Emissions

Access Roads

Equipment

Operation Schedule 355 day/yr 24 hr/day

MachineSpecs

Traffic Specifications and Activity

Equipment[1]	Equipment Model[2]	ID	Rating[3] hp	Rating kW	Oper.[4] hr/yr	Annual[1] trip/yr	Diesel[5] gal/yr	Output[6] kW-hr/yr	Travel[7] VMT/yr	Equipment Category	On-road Class	
Grader	Cat 160H	CT1	200	149	3,978	183	13,424	195,912	13,731	Non-road		Ca
Plow Truck	Cat CT660	CT2	476	355	3,978	183	31,826	--	13,731	On-road	HHD	Ca
Snow Blower	TM42R	CT3	450	336	3,978	183	30,088	--	13,731	On-road	HHD	Ca
Water Truck	Cat 725C	CT4	320	239	3,978	183	31,826	464,491	13,731	Non-road		Ca
Binding Agent Truck	Cat 725C	CT5	320	239	3,978	183	31,826	464,491	13,731	Non-road		Ca
Vibratory Compactor	Cat CS76 XT	CT6	177	132	3,978	183	20,886	304,822	13,731	Non-road		Ca
Fuel Service Truck	CAT 740B	CT7	484	361	3,978	183	35,804	522,552	13,731	Non-road		Ca
Rock Rakes	Cat CT660	CT8	476	355	3,978	183	31,826	--	13,731	On-road	HHD	Ca
Light Vehicles	F-350	CT9	440	328		3,314	17,762	--	248,662	On-road	LHD45	F-
Heavy Trucks	Cat CT660 (8	CT10	476	355		6,353	73,337	--	476,691	On-road	HHD	Ca

(1) *(Midas Gold 2016), Tables 7-1, 12-1. Maintenance trips distributed equally amongst maintenace equipment.*

Heavy trucks include buses, supply and trash trucks. Light vehicles include visitor and employee vehicles.

(2) *Similar models by equipment type from (Midas Gold 2017b)*

(3) *(Caterpillar 2016c)/Manufacturer specifications*

(4) *Combined hours, (Midas Gold 2017f)*

(5) *Maintenance equipment based on brake-specific fuel use scaled for similar equipment from (Midas Gold 2017b)*

Light vehicles based on Ford F-350 fuel economy 14.0 *mpg (fuelly.com)* *Heavy trucks based on fuel economy o* 6.5 *mpg (ATRI 2016)*

(6) *Based o* 137,000 *BTU/gal* AP-42, App. A (Diesel) 7,000 *BTU/hp-hr* AP-42, Sec. 3.3, (Diesel)

(7) *Based on access road length of:* 37.5 X 2 *mi (roundtrip)* *(Midas Gold 2018c)*

EPA Non-Road Standards

ID	Equipment Type	Model[1] Year	Power Category	EPA Tier	Lookup ID	EPA Non-Road Standards (g/kW-hr)[2] PM	CO	NOX	VOC
CT1	Grader	>2015	130≤kW<560, Ph-ii	4	T4-130≤kW≤560 2015	0.02	3.5	0.4	0.19
CT2	Truck				No Standard				
CT3	Truck				No Standard				
CT4	Truck	>2015	130≤kW<560, Ph-ii	4	T4-130≤kW≤560 2015	0.02	3.5	0.4	0.19
CT5	Truck	>2015	130≤kW<560, Ph-ii	4	T4-130≤kW≤560 2015	0.02	3.5	0.4	0.19
CT6	Compactor	>2015	130≤kW<560, Ph-ii	4	T4-130≤kW≤560 2015	0.02	3.5	0.4	0.19
CT7	Truck	>2015	130≤kW<560, Ph-ii	4	T4-130≤kW≤560 2015	0.02	3.5	0.4	0.19
CT8	Truck				No Standard				
CT9	Light Truck				No Standard				
CT10	Truck				No Standard				

(1) *(Midas Gold 2017h)*

(2) *(CFR 2018a)*

Final Emission Factors

ID	Lookup	PM	PM10	PM2.5	CO	NOX	VOC	SO2	EF Unit	Final EF	Activity	
CT1	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.01	g/kW-hr	*EPA_NRS*	195,912	kW-hr/yr
CT2	HHD	1.17	1.17	0.46	2.31	7.32	0.51	0.01	g/VMT	*EPA_MOVES2014*	13,731	VMT/yr
CT3	HHD	1.17	1.17	0.46	2.31	7.32	0.51	0.01	g/VMT	*EPA_MOVES2014*	13,731	VMT/yr
CT4	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.01	g/kW-hr	*EPA_NRS*	464,491	kW-hr/yr
CT5	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.01	g/kW-hr	*EPA_NRS*	464,491	kW-hr/yr
CT6	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.01	g/kW-hr	*EPA_NRS*	304,822	kW-hr/yr
CT7	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.01	g/kW-hr	*EPA_NRS*	522,552	kW-hr/yr
CT8	HHD	1.17	1.17	0.46	2.31	7.32	0.51	0.01	g/VMT	*EPA_MOVES2014*	13,731	VMT/yr
CT9	LHD45	0.59	0.59	0.29	1.87	4.94	0.68	0.01	g/VMT	*EPA_MOVES2014*	248,662	VMT/yr
CT10	HHD	1.17	1.17	0.46	2.31	7.32	0.51	0.01	g/VMT	*EPA_MOVES2014*	476,691	VMT/yr

Mine Construction Emissions

Access Roads - continued

Final Emission Factor Options:

Category	EF Unit	Activity Unit	Emission Unit	Multiplier
EPA_CERT	g/kW-hr	kW-hr/yr	ton/yr	1.1E-6
EPA_NRS	g/kW-hr	kW-hr/yr	ton/yr	1.1E-6
EPA_MOVES2014a	g/VMT	VMT/yr	ton/yr	1.1E-6

Traffic Tailpipe Emissions

ID	Equipment Type	PM ton/yr	PM10 lb/day	PM10 ton/yr	PM2.5 lb/day	PM2.5 ton/yr	CO lb/day	CO ton/yr	NOX lb/day	NOX ton/yr	SO2 lb/day	SO2 ton/yr	VOC ton/yr
CT1	Grader	4.3E-3	0.02	4.3E-3	0.02	4.3E-3	4.26	0.76	0.49	0.09	8.0E-3	1.4E-3	0.04
CT2	Plow Truck	0.02	0.10	0.02	0.04	7.0E-3	0.20	0.04	0.62	0.11	9.1E-4	1.6E-4	7.7E-3
CT3	Snow Blower	0.02	0.10	0.02	0.04	7.0E-3	0.20	0.04	0.62	0.11	9.1E-4	1.6E-4	7.7E-3
CT4	Water Truck	0.01	0.06	0.01	0.06	0.01	10.10	1.79	1.15	0.20	0.02	3.4E-3	0.10
CT5	Binding Agent Truc	0.01	0.06	0.01	0.06	0.01	10.10	1.79	1.15	0.20	0.02	3.4E-3	0.10
CT6	Vibratory Compacto	6.7E-3	0.04	6.7E-3	0.04	6.7E-3	6.63	1.18	0.76	0.13	0.01	2.2E-3	0.06
CT7	Fuel Service Truck	0.01	0.06	0.01	0.06	0.01	11.36	2.02	1.30	0.23	0.02	3.8E-3	0.11
CT8	Rock Rakes	0.02	0.10	0.02	0.04	7.0E-3	0.20	0.04	0.62	0.11	9.1E-4	1.6E-4	7.7E-3
CT9	Light Vehicles	0.16	0.91	0.16	0.45	0.08	2.88	0.51	7.63	1.35	0.02	2.9E-3	0.19
CT10	Heavy Trucks	0.61	3.46	0.61	1.36	0.24	6.85	1.22	21.68	3.85	0.03	5.6E-3	0.27
		0.87	4.91	0.87	2.17	0.39	52.76	9.36	36.03	6.40	0.13	0.02	0.89

LT Unit	ST Unit	Multiplier
ton/yr	lb/day	5.634
ton/yr	lb/hr	0.235

Access Road Grading

Operation 3,978 hr/yr
25,859 VMT/yr

Grading Emission Factors

Emission Factor Equation	TSP (lb/VMT) = 0.04 $(S)^{2.5}$	*AP-42, Tab. 11.9-1, 07/98, (grading)*
	PM15 (lb/VMT) = 0.051 $(S)^{2}$	*AP-42, Tab. 11.9-1, 07/98, (grading)*
S - Grader average speed	6.5 mph	*(Caterpillar 2016c), haul road maintenance*
TSP(PM)	4.309 lb/VMT	
PM15	2.155 lb/VMT	

Grading PM Scaling Factors

PM10	0.6	*AP-42, Tab. 11.9-1, 07/98, (applies to PM15 EF, footnote d)*
PM2.5	0.031	*AP-42, Tab. 11.9-1, 07/98, (applies to TSP EF, footnote e)*

Emission Controls Periodic application of water and chemical dust suppressant

Control efficiency: 90% *See Onsite Hauling*

Grading Emissions

PM ton/yr	PM10 lb/day	PM10 ton/yr	PM2.5 lb/day	PM2.5 ton/yr
5.57	16	2.79	0.97	0.17

Conversions

2,000 lb/ton
453.59 g/lb
1.341 hp/kW

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 8 OF: 9 SHEET: Const
AIR EMISSION CALCULATIONS	SUBJECT: Construction Activity and Emissions	DATE: June 30, 2021

Mine Construction Emissions

Access Roads - continued

Access Road Vehicle Travel Dust

Vehicle Specifications

Vehicle Type	Model	Empty Weight[(1)] ton	Gross Weight[(1)] ton	Average Weight ton	Travel mi/yr	
Grader	Cat 160H	17.2	17.2	17.2	13,731	*Grader emissions calculated separately*
Plow Truck	Cat CT660	8.2	26.6	17.4	13,731	
Snow Blower	TM42R	14.8	18.0	16.4	13,731	
Water Truck	Cat 725C	25.6	51.6	38.6	13,731	
Binding Agent Truck	Cat 725C	25.6	51.6	38.6	13,731	
Vibratory Compactor	Cat CS76 XT	19.2	20.8	20.0	13,731	
Fuel Service Truck	CAT 740B	37.6	81.1	59.4	13,731	
Rock Rakes	Cat CT660	8.2	26.6	17.4	13,731	
Light Vehicles	F-350	4.0	7.9	6.0	248,662	
Heavy Trucks	Cat CT660 (8X6)	10.1	34.5	22.3	476,691	

(1) *(Caterpillar 2016c)/Manufacturer specifications*

Total vehicle miles traveled (VMT) 821,472 VMT/yr *Excluding grader*

Emission Factors

Emission factor equation $E = k(s/12)^a (W/3)^b [(365-P)/365]$

s = Surface material silt content	4	%			*(Midas Gold 2015)*
W = Mean vehicle weight	18	ton			*Weighted average weight, excluding grader*
P = Days/year with ≥0.01 in precip.	120	day/yr			

	PM	PM10	PM2.5		
k = Size-specific empirical constant	4.9	1.5	0.15		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
a = Size-specific empirical constant	0.7	0.9	0.9		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
b = Size-specific empirical constant	0.45	0.45	0.45		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
E = Size-specific emission factor	3.43	0.84	0.08	lb/VMT	

Emission Controls

Periodic application of water and chemical dust suppressant

Control efficiency 90% *See Onsite Hauling*

Vehicle Travel Dust Emissions

PM		PM10		PM2.5	
ton/yr	lb/day	ton/yr	lb/day	ton/yr	
141.05	195.28	34.66	19.53	3.47	

Access Road Total Emissions

PM		PM10		PM2.5		CO		NOX		SO2		VOC
ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/day	ton/yr	ton/yr	
147.49	215.88	38.32	22.67	4.02	52.76	9.36	36.03	6.40	0.13	0.02	0.89	

Conversions

2,000 lb/ton

PRI00000930

REC 2270

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 9 OF: 9 SHEET: Const
AIR EMISSION CALCULATIONS	SUBJECT: Construction Activity and Emissions	DATE: June 30, 2021

Mine Construction Emissions

Access Roads - continued

Fuel Sulfur-Content Based SO2 Emission Factor

Fuel Sulfur-Content	0.0015%		*Non-road diesel specification per 40 CFR 80.510*
Diesel Density	7.05	lb/gal	*AP-42, App. A*
Molecular Wt. of SO2	64.064	lb/lb-mol	
Molecular Wt. of S	32.065	lb/lb-mol	
Diesel Heat Content	137,000	BTU/gal	*AP-42, App. A (Diesel)*
Brake-Specific Fuel Use	7,000	Btu/hp-hr	*AP-42, Sec. 3.3, (Diesel engine)*

SO2 emission factor:

$$0.000011 \frac{\text{lb/hp-hr}}{} = \frac{0.0015\ \%\ \frac{\text{lb S}}{\text{lb Fuel}} \times 7.05\ \frac{\text{lb Fuel}}{\text{gal Fuel}} \times 64.064\ \text{lb SO2} \times 7{,}000\ \frac{\text{BTU}}{\text{gal Fuel}}}{32.065\ \text{lb S} \times 137{,}000\ \frac{\text{BTU}}{\text{hp-hr}}}$$

$$0.0066 \frac{\text{g/kW-hr}}{} = \frac{0.000011\ \frac{\text{lb}}{\text{hp-hr}} \times 1.341\ \frac{\text{hp}}{\text{kW}} \times 453.593\ \frac{\text{g}}{\text{lb}}}{}$$

PRI00000931

REC 2271

Air Sciences Inc.	PROJECT TITLE: Midas Gold	BY: E. Memon
	PROJECT NO: 335-1-1	PAGE: 1 OF: 9 SHEET: PwrConst
AIR EMISSION CALCULATIONS	SUBJECT: Power Line Construction Emissions	DATE: June 30, 2021

Power Line Construction **Construction Year** **1**

Annual Emissions Summary

Activity	PM ton/yr	PM10 ton/yr	PM2.5 ton/yr	CO ton/yr	NOX ton/yr	SO2 ton/yr	VOC ton/yr	Total HAP ton/yr	CO2e ton/yr
Facility and Infrastructure Construction	16.5	5.0	1.5					0.0	
Mobile Equipment Tailpipe	2.4	2.4	1.4	69.6	64.6	0.14	4.5	0.3	18,300
Power Line Construction Total	18.9	7.5	2.9	69.6	64.6	0.14	4.5	0.3	18,300

Maximum Daily Emissions Summary[1]

Activity	PM lb/day	PM10 lb/day	PM2.5 lb/day	CO lb/day	NOX lb/day	SO2 lb/day	VOC lb/day	Total HAP lb/day	CO2e lb/day
Facility and Infrastructure Construction	123.7	37.9	11.0					0.2	
Mobile Equipment Tailpipe	18.3	18.3	10.5	523.0	485.2	1.1	33.9	2.2	137,466
Construction Total	142.0	56.2	21.5	523.0	485.2	1.1	33.9	2.4	137,466

(1) *Maximum daily emissions based on 1,000 person crew during peak construction, scaled with an average annual crew of 750 and an annual operating schedule of 355 day/yr (M3 2014)*

Facility Infrastructure Construction Emissions by LOM Year[1]

	LOM	Capacity[1]	PM ton/yr	PM10 ton/yr	PM2.5 ton/yr	CO ton/yr	NOX ton/yr	SO2 ton/yr	VOC ton/yr	Total HAP ton/yr	CO2e ton/yr
CON	1	25%	16.5	5.0	1.5					0.0	
CON	2	50%	32.9	10.1	2.9					0.1	
CON	3	25%	16.5	5.0	1.5					0.0	
(1) *(Midas Gold 2018f)*			chk	chk	chk	chk	chk	chk	chk	chk	chk

Mobile Equipment Tailpipe Emissions by LOM Year

	LOM	Capacity[1]	PM ton/yr	PM10 ton/yr	PM2.5 ton/yr	CO ton/yr	NOX ton/yr	SO2 ton/yr	VOC ton/yr	Total HAP ton/yr	CO2e ton/yr
CON	1	25%	2.4	2.4	1.4	69.6	64.6	0.14	4.5	0.3	18,300
CON	2	50%	4.9	4.9	2.8	139.3	129.2	0.28	9.0	0.6	36,600
CON	3	25%	2.4	2.4	1.4	69.6	64.6	0.14	4.5	0.3	18,300
(1) *(Midas Gold 2018f)*			chk	chk	chk	chk	chk	chk	chk	chk	chk

Conversions

365	day/yr
2,000	lb/ton
1.10	ton/t

PRI00000932

REC 2272

Air Sciences Inc.	PROJECT TITLE: Midas Gold	BY: E. Memon
	PROJECT NO: 335-1-1	PAGE: 2 OF: 9 SHEET: PwrConst
AIR EMISSION CALCULATIONS	SUBJECT: Power Line Construction Emissions	DATE: June 30, 2021

Power Line Construction

POD_2017

Activity Information

Construction Activity	acre[1]	yr[2]
Power Line	305.6	3

[1] *(Midas Gold 2018a)*

[2] *(Midas Gold 2018d)*

Emission Factors (ton/acre)	PM	PM10	PM2.5		
Site Preparation/Construction	0.215	0.066	0.019	ton/acre	*See calculations below*

Site Preparation Activity [1]	***Emission Factor***				***Emission Factor Reference***	***Scaling Factor***	
	PM	PM10	PM2.5			PM10	PM2.5
Dozing	2.05	0.332	0.215	lb/hr	*AP-42, Tab. 11.9-1, 07/98, (bulldozing, overburden); See sheet: Mine, page 17*		
Scraper unloading	0.04	0.0189	0.0029	lb/ton	*AP-42, Tab. 11.9-4, 07/98, (scraper unload); scaling factors from AP-42, Sec. 13.2.4, 11/06*	0.47	0.072
Scraper in travel	20.2	3.2764	2.121	lb/VMT	*See scraping topsoil removel below*		
Scraping topsoil removal	20.2	3.2764	2.121	lb/VMT	*AP-42, Tab. 13.2.3-1, 1/95; dozer scaling factors*	0.16	0.11
Material loading	2.11E-4	1.00E-4	1.51E-5	lb/ton	*AP-42, Tab. 11.19.2-2, 8/04 (truck loading - crshed stone); See sheet: Mine, page 8*		
Material dumping	3.38E-5	1.60E-5	2.42E-6	lb/ton	*AP-42, Tab. 11.19.2-2, 8/04 (truck unloading - fragmented stone); See sheet: Mine, page 8*		
Compacting	2.05	0.33	0.22	lb/hr	*AP-42, Tab. 11.9-1, 07/98, (bulldozing, overburden); See sheet: Mine, page 17*		
Grading	4.31	1.29	0.134	lb/VMT	*AP-42, Tab. 11.9-1, 07/98, (grading); See sheet: Mine, page 17*		

[1] *AP-42, Tab. 13.2.3-1, 1/95*

Construction Operation	***Estimated Activity Rate***			***Estimated Emission Factor (ton/acre)***		
				PM	PM10	PM2.5
Dozing[1]	49	hr/ac		5.02E-2	8.14E-3	5.27E-3
Scraper unloading[2]	4,945	ton/ac		9.89E-2	4.68E-2	7.08E-3
Scraper in travel	0.7	VMT/ac	*See scraping topsoil removel below*	7.25E-3	1.18E-3	7.61E-4
Scraping topsoil removal[3]	0.7	VMT/ac		7.25E-3	1.18E-3	7.61E-4
Material loading	4,945	ton/ac	*See scraper unloading above*	5.23E-4	2.47E-4	3.74E-5
Material dumping	4,945	ton/ac	*See scraper unloading above*	8.36E-5	3.96E-5	5.99E-6
Compacting	49	hr/ac	*See dozing above*	5.02E-2	8.14E-3	5.27E-3
Grading[4]	0.5	VMT/ac		1.11E-3	3.33E-4	3.44E-5

[1] *Based on:* 14,976 *hr dozer useage and* 305.6 *acre disturbance* *Total (3-yr) power line construction activity*

[2] *Based on:* 45 *cm, scraper cut depth (Caterpillar 631K Scraper) (Caterpillar 2016b) & waste material density of:* 153.8 *lb/ft*^{3} *(Midas Gold 2017b)*

[3] *Based on:* 11.5 *ft blade width (Caterpillar 631K Scraper) (Caterpillar 2016b)*

[4] *Based on:* 16.0 *ft blade width (Caterpillar 16M3 Grader) (Caterpillar 2016a)*

Emissions	***Total Construction Emissions***								
Activity	PM	PM10	PM2.5	CO	NOX	SO2	VOC	Total HAP	CO2e
	ton	ton	ton	ton	ton	ton	ton	ton	ton
Power Line	65.9	20.2	5.9					0.1	
Mobile Equipment Tailpipe	9.7	9.7	5.6	278.5	258.4	0.6	18.1	1.2	73,201
Total	75.6	29.9	11.4	278.5	258.4	0.6	18.1	1.3	73,201

Conversions

2,000	lb/ton	43,560	ft2/acre	3.28084	ft/m
1.1	ton/mt	100	cm/m	5280	ft/mi

PRI00000933

REC 2273

Air Sciences Inc.	PROJECT TITLE: Midas Gold	BY: E. Memon
	PROJECT NO: 335-1-1	PAGE: 3 OF: 9 SHEET: PwrConst
AIR EMISSION CALCULATIONS	SUBJECT: Power Line Construction Emissions	DATE: June 30, 2021

Power Line Construction

Mobile Equipment Tailpipe

MachineSpecs

POD_2017

Activity Information

Mobile Equipment Specifications and Activity

ID	Equipment Type[1]		Equipment Model[2]	Rating hp[2]	Rating kW	Oper. hr/yr[1,3]	Diesel gal/hp-hr[2]	Diesel gal/yr	Output kW-hr/yr[4]	Travel VMT/yr[5]	Equipment Category	On-road Class[6]
	Transmission Line	gal/hr										
TL1	Bulldozer	19	Cat D10T2	600	447	4,992	0.032	94,848	1,384,274		Non-road	
TL2	Motor Grader	5.5	Cat 16M	326	243	4,992	0.017	27,456	400,711		Non-road	
TL3	Auger Truck	8	Cat CT660	476	355	4,992	0.017	39,936	582,852	99,840	On-road	HHD
TL4	Wire Reel Trailer	8	Cat CT660	476	355	7,488	0.017	59,904	874,278	149,760	On-road	HHD
TL5	Truck Mounted Crane	8	Cat CT660	476	355	4,992	0.017	39,936	582,852	99,840	On-road	HHD
TL6	Pickup	1	F-350 (PT)	440	328	12,480	0.002	12,480	182,141	312,000	On-road	LHD45
TL7	Fork Lift	2.5	CAT DP160N	124	92	4,992	0.020	12,480	182,141		Non-road	--
TL8	Diesel Tractor	10	Cat 586C	350	261	7,488	0.029	74,880	1,092,848		Non-road	
TL9	Splicing Truck	8	Cat CT660	476	355	1,248	0.017	9,984	145,713	24,960	On-road	HHD
TL10	Boom Truck	8	Cat CT660	476	355	4,992	0.017	39,936	582,852	99,840	On-road	HHD
TL11	Three Drum Puller	8	Cat CT660	476	355	3,744	0.017	29,952	437,139	74,880	On-road	HHD
TL12	Single Drum Puller	8	Cat CT660	476	355	1,872	0.017	14,976	218,570	37,440	On-road	HHD
TL13	OHGW and Fiber Reel Trailer	8	Cat CT660	476	355	4,992	0.017	39,936	582,852	99,840	On-road	HHD
TL14	Dump Truck	9	Cat 740B	484	361	2,496	0.019	22,464	327,854		Non-road	
TL15	Loader	12	Cat 988K	580	433	2,496	0.020	28,704	418,925		Non-road	
TL16	Water Truck	25	Cat 777D	1,000	746	42,432	0.025	1,060,800	15,482,007		Non-road	
TL17	Hauling Truck	25	Cat 777D	1,000	746	4,992	0.025	124,800	1,821,413		Non-road	
TL18	Tensioner	8	Cat CT660	476	355	1,248	0.017	9,984	145,713	24,960	On-road	HHD
	Substation											
SS1	Backhoe	5	CAT 430E	101	75	4,992	0.050	24,960	364,283		Non-road	
SS2	Auger	8	Cat CT660	476	355	19,968	0.017	159,744	2,331,408	399,360	On-road	HHD
SS3	Concrete Truck	8	Cat CT660	476	355	19,968	0.017	159,744	2,331,408	399,360	On-road	HHD
SS4	Pickup	1	F-350 (PT)	440	328	9,984	0.002	9,984	145,713	249,600	On-road	LHD45
SS5	Field Office/Trailer	7	F-650	330	246	2,496	0.021	17,472	254,998	62,400	On-road	MHD
SS6	Drilling Rig	12	Cat MD6420	800	597	2,496	0.015	29,952	437,139		Non-road	
SS7	Vibratory Roller	5.3	Cat CS76 XT	177	132	2,496	0.030	13,104	191,248		Non-road	
SS8	Fork Lift	2.5	CAT DP160N	124	92	7,488	0.020	18,720	273,212		Non-road	--

[1] *(HDR 2017)*

[2] *Equipment type specific make and model, rating, and brake-specific fuel consumption (LOM year 4) selected from mine operation fleet (Midas Gold 2017b)*

[3] *Weekly hours (HDR 2017) times 52 weeks per year*

[4] *Based c* *137,000 BTU/gal* *AP-42, App. A*

7,000 BTU/hp-hr *AP-42, Sec. 3.3*

[6] *On-road vehicle codes and descriptions provided in MOVES emission factors table*

VMT = Vehicle Miles Travelled

[4] *Based on the following average speeds (mph):* *(Midas Gold 2018e)*

Cat CT660	*20*
F-350 (PT)	*25*
F-650	*25*

Conversions

1.341	hp/kW
453.6	g/lb
1,000,000	BTU/MMBTU

PRI00000934

REC 2274

Air Sciences Inc.	PROJECT TITLE: Midas Gold	BY: E. Memon
	PROJECT NO: 335-1-1	PAGE: 4 OF: 9 SHEET: PwrConst
AIR EMISSION CALCULATIONS	SUBJECT: Power Line Construction Emissions	DATE: June 30, 2021

Power Line Construction

Mobile Equipment Tailpipe

Operation schedule 365 day/yr 12 hr/day

EPA Non-Road Standards

ID	Equipment Type	Model[1] Year	Power Category	EPA Tier	Lookup ID	EPA Non-Road Standards (g/kW-hr)[2] PM	CO	NOX	VOC
Transmission Line									
TL1	Dozer	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015	0.02	3.5	0.4	0.19
TL2	Grader	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015	0.02	3.5	0.4	0.19
TL3	Truck	>2015			No Standard				
TL4	Truck	>2015			No Standard				
TL5	Truck	>2015			No Standard				
TL6	Pickup	>2015			No Standard				
TL7	Fork Lift	>2015	75≤kW<130, Ph-in	4	T4-56≤kW<130 2015	0.02	5	0.4	0.19
TL8	Tractor	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015	0.02	3.5	0.4	0.19
TL9	Truck	>2015			No Standard				
TL10	Truck	>2015			No Standard				
TL11	Truck	>2015			No Standard				
TL12	Truck	>2015			No Standard				
TL13	Truck	>2015			No Standard				
TL14	Truck	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015	0.02	3.5	0.4	0.19
TL15	Truck	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015	0.02	3.5	0.4	0.19
TL16	Truck	>2015	kW>560	4	T4-kW>560 2015	0.04	3.5	3.5	0.19
TL17	Truck	>2015	kW>560	4	T4-kW>560 2015	0.04	3.5	3.5	0.19
TL18	Truck	>2015			No Standard				
Substation									
SS1	Backhoe	>2015	75≤kW<130, Ph-in	4	T4-56≤kW<130 2015	0.02	5	0.4	0.19
SS2	Truck	>2015			No Standard				
SS3	Truck	>2015			No Standard				
SS4	Pickup	>2015			No Standard				
SS5	Pickup	>2015			No Standard				
SS6	Drill	>2015	kW>560	4	T4-kW>560 2015	0.04	3.5	3.5	0.19
SS7	Roller	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015	0.02	3.5	0.4	0.19
SS8	Fork Lift	>2015	75≤kW<130, Ph-in	4	T4-56≤kW<130 2015	0.02	5	0.4	0.19

[1] *(Midas Gold 2017h)*

[2] *(CFR 2018a)*

PRI00000935

REC 2275

Air Sciences Inc.	PROJECT TITLE: Midas Gold	BY: E. Memon
	PROJECT NO: 335-1-1	PAGE: 5 OF: 9 SHEET: PwrConst
AIR EMISSION CALCULATIONS	SUBJECT: Power Line Construction Emissions	DATE: June 30, 2021

Power Line Construction

Mobile Equipment Tailpipe

Fuel Sulfur-Content-Based SO2 Emission Factor

Fuel Sulfur-Content	0.0015%		*Non-road diesel, 40 CFR 80.510*
Diesel Density	7.05	lb/gal distillate oil	*AP-42 Appendix A "Weights of Selected Substances" (Distillate oil)*
Molecular Wt. of SO2	64.1	lb/lb-mol	
Molecular Wt. of S	32.1	lb/lb-mol	
Diesel Heat Content	137,000	BTU/gal	*AP-42, App. A*
Brake-Specific Fuel Use	7,000	BTU/hp-hr	*AP-42, Sec. 3.3*

SO2 Emission Factor:

1.08E-5 lb/hp-hr = $\frac{0.0015\%\ \text{~~lb S~~}}{\text{~~lb Fuel~~}} \times \frac{7.05\ \text{~~lb Fuel~~}}{\text{~~gal Fuel~~}} \times \frac{64.064\ \text{lb SO2}}{32.065\ \text{~~lb S~~}} \times \frac{\text{~~gal Fuel~~}}{137{,}000\ \text{~~BTU~~}} \times \frac{7{,}000\ \text{~~BTU~~}}{\text{hp-hr}}$

6.57E-3 g/kW-hr = $\frac{0.000011\ \text{~~lb~~}}{\text{~~hp~~-hr}} \times \frac{1.341\ \text{~~hp~~}}{\text{kW}} \times \frac{453.593\ \text{g}}{\text{~~lb~~}}$

EPA MOVES 2014a Emission Factors[1]

		Emission Factor (g/VMT)[2]						
Vehicle Clas	Description	PM	PM10	PM2.5	CO	NOX	VOC	SO2
LHD<=10K	Passenger Truck 8.5k-10k lb, Diesel	0.178	0.178	0.086	1.322	2.281	0.241	0.006
LHD45	Single Unit Truck 14k-19.5k lb, Diesel	0.589	0.589	0.291	1.867	4.940	0.685	0.011
MHD	Single Unit Truck 19.5k-33k lb, Diesel	0.797	0.797	0.381	2.170	5.684	0.841	0.011
HHD	Single Unit Truck >33k lb, Diesel	1.169	1.169	0.461	2.313	7.324	0.510	0.011

[1] *MOVES 2014a run dated 2017-09-25*

[2] *PM = PM10*

PRI00000936

REC 2276

Air Sciences Inc.	PROJECT TITLE: Midas Gold	BY: E. Memon	
	PROJECT NO: 335-1-1	PAGE: 6	OF: 9 SHEET: PwrConst
AIR EMISSION CALCULATIONS	SUBJECT: Power Line Construction Emissions	DATE: June 30, 2021	

Power Line Construction

Mobile Equipment Tailpipe

Final Emission Factors

ID	Lookup	PM	PM10	PM2.5	CO	NOX	VOC	SO2	EF Unit	Final EF	Activity	
Transmission Line												
TL1	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	6.57E-3	g/kW-hr	*EPA_NRS*	1,384,274	kW-hr/yr
TL2	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	6.57E-3	g/kW-hr	*EPA_NRS*	400,711	kW-hr/yr
TL3	HHD	1.17	1.17	0.46	2.31	7.32	0.51	1.07E-2	g/VMT	*EPA_MOVES2014*	99,840	VMT/yr
TL4	HHD	1.17	1.17	0.46	2.31	7.32	0.51	1.07E-2	g/VMT	*EPA_MOVES2014*	149,760	VMT/yr
TL5	HHD	1.17	1.17	0.46	2.31	7.32	0.51	1.07E-2	g/VMT	*EPA_MOVES2014*	99,840	VMT/yr
TL6	LHD45	0.59	0.59	0.29	1.87	4.94	0.68	1.05E-2	g/VMT	*EPA_MOVES2014*	312,000	VMT/yr
TL7	T4-56≤kW<130 2015	0.02	0.02	0.02	5.00	0.40	0.19	6.57E-3	g/kW-hr	*EPA_NRS*	182,141	kW-hr/yr
TL8	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	6.57E-3	g/kW-hr	*EPA_NRS*	1,092,848	kW-hr/yr
TL9	HHD	1.17	1.17	0.46	2.31	7.32	0.51	1.07E-2	g/VMT	*EPA_MOVES2014*	24,960	VMT/yr
TL10	HHD	1.17	1.17	0.46	2.31	7.32	0.51	1.07E-2	g/VMT	*EPA_MOVES2014*	99,840	VMT/yr
TL11	HHD	1.17	1.17	0.46	2.31	7.32	0.51	1.07E-2	g/VMT	*EPA_MOVES2014*	74,880	VMT/yr
TL12	HHD	1.17	1.17	0.46	2.31	7.32	0.51	1.07E-2	g/VMT	*EPA_MOVES2014*	37,440	VMT/yr
TL13	HHD	1.17	1.17	0.46	2.31	7.32	0.51	1.07E-2	g/VMT	*EPA_MOVES2014*	99,840	VMT/yr
TL14	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	6.57E-3	g/kW-hr	*EPA_NRS*	327,854	kW-hr/yr
TL15	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	6.57E-3	g/kW-hr	*EPA_NRS*	418,925	kW-hr/yr
TL16	T4-kW>560 2015	0.04	0.04	0.04	3.50	3.50	0.19	6.57E-3	g/kW-hr	*EPA_NRS*	15,482,007	kW-hr/yr
TL17	T4-kW>560 2015	0.04	0.04	0.04	3.50	3.50	0.19	6.57E-3	g/kW-hr	*EPA_NRS*	1,821,413	kW-hr/yr
TL18	HHD	1.17	1.17	0.46	2.31	7.32	0.51	1.07E-2	g/VMT	*EPA_MOVES2014*	24,960	VMT/yr
Substation												
SS1	T4-56≤kW<130 2015	0.02	0.02	0.02	5.00	0.40	0.19	6.57E-3	g/kW-hr	*EPA_NRS*	364,283	kW-hr/yr
SS2	HHD	1.17	1.17	0.46	2.31	7.32	0.51	1.07E-2	g/VMT	*EPA_MOVES2014*	399,360	VMT/yr
SS3	HHD	1.17	1.17	0.46	2.31	7.32	0.51	1.07E-2	g/VMT	*EPA_MOVES2014*	399,360	VMT/yr
SS4	LHD45	0.59	0.59	0.29	1.87	4.94	0.68	1.05E-2	g/VMT	*EPA_MOVES2014*	249,600	VMT/yr
SS5	MHD	0.80	0.80	0.38	2.17	5.68	0.84	1.05E-2	g/VMT	*EPA_MOVES2014*	62,400	VMT/yr
SS6	T4-kW>560 2015	0.04	0.04	0.04	3.50	3.50	0.19	6.57E-3	g/kW-hr	*EPA_NRS*	437,139	kW-hr/yr
SS7	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	6.57E-3	g/kW-hr	*EPA_NRS*	191,248	kW-hr/yr
SS8	T4-56≤kW<130 2015	0.02	0.02	0.02	5.00	0.40	0.19	6.57E-3	g/kW-hr	*EPA_NRS*	273,212	kW-hr/yr

Final emission factor options:

Category	EF Unit	Activity Unit	Emission Unit	Multiplier
EPA_CERT	lb/hp-hr	hp-hr/yr	ton/yr	5.0E-4
EPA_NRS	g/kW-hr	kW-hr/yr	ton/yr	1.1E-6
EPA_AP42	lb/hp-hr	hp-hr/yr	ton/yr	5.0E-4
EPA_MOVES2014a	g/VMT	VMT/yr	ton/yr	1.1E-6

Conversions

453.6	g/lb	2,000	lb/ton
1.341	hp/kW		

PRI00000937

REC 2277

Air Sciences Inc.	PROJECT TITLE: Midas Gold	BY: E. Memon	
	PROJECT NO: 335-1-1	PAGE: 7	OF: 9 SHEET: PwrConst
AIR EMISSION CALCULATIONS	SUBJECT: Power Line Construction Emissions	DATE: June 30, 2021	

Power Line Construction

Mobile Equipment Tailpipe

	PM	PM10		PM2.5		CO		NOX		SO2		VOC
ID	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr
Transmission Line												
TL1	0.03	0.17	0.03	0.17	0.03	2.44	5.34	0.28	0.61	4.6E-3	0.01	0.29
TL2	8.8E-3	0.05	8.8E-3	0.05	8.8E-3	0.71	1.55	0.08	0.18	1.3E-3	2.9E-3	0.08
TL3	0.13	0.70	0.13	0.28	0.05	0.12	0.25	0.37	0.81	5.4E-4	1.2E-3	0.06
TL4	0.19	1.06	0.19	0.42	0.08	0.17	0.38	0.55	1.21	8.1E-4	1.8E-3	0.08
TL5	0.13	0.70	0.13	0.28	0.05	0.12	0.25	0.37	0.81	5.4E-4	1.2E-3	0.06
TL6	0.20	1.11	0.20	0.55	0.10	0.29	0.64	0.78	1.70	1.7E-3	3.6E-3	0.24
TL7	4.0E-3	0.02	4.0E-3	0.02	4.0E-3	0.46	1.00	0.04	0.08	6.0E-4	1.3E-3	0.04
TL8	0.02	0.13	0.02	0.13	0.02	1.93	4.22	0.22	0.48	3.6E-3	7.9E-3	0.23
TL9	0.03	0.18	0.03	0.07	0.01	0.03	0.06	0.09	0.20	1.3E-4	2.9E-4	0.01
TL10	0.13	0.70	0.13	0.28	0.05	0.12	0.25	0.37	0.81	5.4E-4	1.2E-3	0.06
TL11	0.10	0.53	0.10	0.21	0.04	0.09	0.19	0.28	0.60	4.0E-4	8.8E-4	0.04
TL12	0.05	0.26	0.05	0.10	0.02	0.04	0.10	0.14	0.30	2.0E-4	4.4E-4	0.02
TL13	0.13	0.70	0.13	0.28	0.05	0.12	0.25	0.37	0.81	5.4E-4	1.2E-3	0.06
TL14	7.2E-3	0.04	7.2E-3	0.04	7.2E-3	0.58	1.26	0.07	0.14	1.1E-3	2.4E-3	0.07
TL15	9.2E-3	0.05	9.2E-3	0.05	9.2E-3	0.74	1.62	0.08	0.18	1.4E-3	3.0E-3	0.09
TL16	0.68	3.74	0.68	3.74	0.68	27.27	59.73	27.27	59.73	0.05	0.11	3.24
TL17	0.08	0.44	0.08	0.44	0.08	3.21	7.03	3.21	7.03	6.0E-3	0.01	0.38
TL18	0.03	0.18	0.03	0.07	0.01	0.03	0.06	0.09	0.20	1.3E-4	2.9E-4	0.01
Substation												
SS1	8.0E-3	0.04	8.0E-3	0.04	8.0E-3	0.92	2.01	0.07	0.16	1.2E-3	2.6E-3	0.08
SS2	0.51	2.82	0.51	1.11	0.20	0.46	1.02	1.47	3.22	2.2E-3	4.7E-3	0.22
SS3	0.51	2.82	0.51	1.11	0.20	0.46	1.02	1.47	3.22	2.2E-3	4.7E-3	0.22
SS4	0.16	0.89	0.16	0.44	0.08	0.23	0.51	0.62	1.36	1.3E-3	2.9E-3	0.19
SS5	0.05	0.30	0.05	0.14	0.03	0.07	0.15	0.18	0.39	3.3E-4	7.3E-4	0.06
SS6	0.02	0.11	0.02	0.11	0.02	0.77	1.69	0.77	1.69	1.4E-3	3.2E-3	0.09
SS7	4.2E-3	0.02	4.2E-3	0.02	4.2E-3	0.34	0.74	0.04	0.08	6.3E-4	1.4E-3	0.04
SS8	6.0E-3	0.03	6.0E-3	0.03	6.0E-3	0.69	1.51	0.06	0.12	9.0E-4	2.0E-3	0.06
Total	3.25	17.81	3.25	10.18	1.86	42.39	92.84	39.33	86.13	0.09	0.19	6.02

LT Unit	ST Unit	Multiplier
ton/yr	lb/day	5.479
ton/yr	lb/hr	0.457

Conversions
2,000 lb/ton
453.59 g/lb

PRI00000938

REC 2278

Air Sciences Inc.	PROJECT TITLE: Midas Gold	BY: E. Memon
	PROJECT NO: 335-1-1	PAGE: 8 OF: 9 SHEET: PwrConst
AIR EMISSION CALCULATIONS	SUBJECT: Power Line Construction Emissions	DATE: June 30, 2021

Power Line Construction

Hazardous Air Pollutants (HAP) and Greenhouse Gases (GHG)

Fuel Consumption TRUE

Small Engines	961,584	gal/yr	131,737 MMBTU/yr[1]
Large Engines	1,215,552	gal/yr	166,531 MMBTU/yr[1]

[1] *Based on 137,000 BTU/gal AP-42, Sec. 3.3*

Combustion HAP Emission Factors and Emissions

CAS No.	Pollutant/Group	Small Engines[1] lb/MMBtu	Large Engines[2] lb/MMBtu	Emissions[4] lb/yr	Emissions[4] ton/yr
106990	1,3-Butadiene	3.91E-5		5.2	2.6E-3
75070	Acetaldehyde	7.67E-4	2.52E-5	105.2	5.3E-2
107028	Acrolein	9.25E-5	7.88E-6	13.5	6.7E-3
71432	Benzene	9.33E-4	7.76E-4	252.1	0.1
50000	Formaldehyde	1.18E-3	7.89E-5	168.6	8.4E-2
	POM [3]	1.68E-4	2.12E-4	57.4	2.9E-2
108883	Toluene	4.09E-4	2.81E-4	100.7	5.0E-2
1330207	Xylene	2.85E-4	1.93E-4	69.7	3.5E-2
Combustion HAP Total				772.3	0.39

[1] *AP-42, Tab. 3.3-2, 10/96, diesel engines (≤ 600 hp)*

[2] *AP-42, Tabs. 3.4-3 & 3.4-4, 10/96, large diesel engines (> 600 hp)*

[3] *POM = Polyoxymethylene, includes:*
2-Methylnaphthalene, 3-Methylchloranthrene, 7,12-Dimethylbenz(a)anthracene, Acenaphthene, Acenaphthylene, Anthracene, Benz(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(g,h,i)perylene, Benzo(k)fluoranthene, Chrysene, Dibenzo(a,h)anthracene, Fluoranthene, Fluorene, Indeno(1,2,3-c,d)pyrene, Naphthalene, Phenanthrene, Pyrene.

Dust HAP Emission Factors and Emissions

HAP Concentrations[1] and Emissions

CAS No.	Pollutant	ppm	Emissions lb/yr	Emissions ton/yr
7440382	Arsenic	667	29.3	1.5E-2
7440417	Beryllium	3.2	0.1	7.0E-5
7440439	Cadmium	0.5	2.2E-2	1.1E-5
7440484	Cobalt	4.0	0.2	8.8E-5
7440473	Chromium	9.0	0.4	2.0E-4
7439976	Mercury	0.6	2.6E-2	1.3E-5
7439965	Manganese	299	13.1	6.6E-3
7440020	Nickel	2.0	8.8E-2	4.4E-5
7439921	Lead	8.0	0.4	1.8E-4
7440360	Antimony	23	1.0	5.0E-4
7723140	Phosphoru	650	28.5	1.4E-2
Dust HAP Total			73.2	3.7E-2

Applicable Dust Emissions

Activity	PM ton/yr
Facility and Infrastructure Construction	22.0

[1] *O/DR: ore and development rock; (Midas Gold 2017c) for all metals but Hg and Se; Hg value from (Midas Gold 2018i); Se value from (Midas Gold 2020)*

Conversions

907,186	g/ton
1,000	kW/MW
1.341	hp/kW
1,000,000	BTU/MMBTU
2,000	lb/ton

PRI00000939

REC 2279

Air Sciences Inc.	PROJECT TITLE: Midas Gold	BY: E. Memon
	PROJECT NO: 335-1-1	PAGE: 9 OF: 9 SHEET: PwrConst
AIR EMISSION CALCULATIONS	SUBJECT: Power Line Construction Emissions	DATE: June 30, 2021

Power Line Construction

GHG Emission Factors [1] ***and Emissions***

Fuel	CO2	CH4	N2O	CO2	CH4	N2O	CO2e
	kg/MMBtu			mt/yr	mt/yr	mt/yr	mt/yr
Diesel	73.96	3.0E-3	6.0E-4	22,060	0.9	0.2	22,136
Combustion Total GHG				22,060	0.9	0.2	22,136

[1] *40 CFR 98 Tab. C-1 and C-2 (CFR. 2018d)*

Global Warming Potential [1, 2]

CO2	1
CH4	25
N2O	298

[1] *40 CFR 98 Tab. A-1 (CFR. 2018d)*

[2] *Annex I Parties, 100-year time horizon (UNCC n.d.); (IPCC 2007)*

Conversions

1,000 kg/mt
2,000 lb/ton

PRI00000940

REC 2280

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: K. Lewis
	PROJECT NO: 335-21-402/404	PAGE: 1 OF: 1 SHEET: HgSpec
AIR EMISSION CALCULATIONS	SUBJECT: Hg Emission Speciation	DATE: June 30, 2021

Mining Year 10

Facility-Wide Hg Emission and Speciation

Emissions

	Total Hg		Speciation*				Hg0	Hg2	HgP	Hg2+P
Activity	ton/yr	lb/yr	Hg0	Hg2	HgP	Total	ton/yr	ton/yr	ton/yr	ton/yr
Process Propane Combustion	0.00005	0.11		100%		100%	--	5.3E-05	--	5.3E-05
Autoclave	0.00010	0.20	97.9%	1.6%	0.5%	100%	9.9E-05	1.6E-06	4.9E-07	2.1E-06
Refinery Sources (Kiln, EW, Retort, Furnace)	0.00168	3.36	98.4%	1.4%	0.1%	100%	1.7E-03	2.4E-05	2.5E-06	2.6E-05
Process Dust	0.00107	2.15			100%	100%	--	--	1.1E-03	1.1E-03
Mine Fugitive Dust	0.00033	0.67			100%	100%	--	--	3.3E-04	3.3E-04
Mine Fugitive Mercury Flux	0.00356	7.13	100%			100%	3.6E-03	--	--	--
Total	0.00680	13.61					5.3E-03	7.8E-05	1.4E-03	1.5E-03
*See tables below:							78%	1.1%	20.7%	21.9%
Process Subtotal	0.0029	0.0029	chk					chk	1.15E-3	1.15E-3
Mine Subtotal	0.0039	0.0039	chk					chk	3.33E-4	3.33E-4

Autoclave Test Data

Source	Date	Method	Hg0 lb/hr	Hg2 lb/hr	HgP lb/hr	HgTotal lb/hr	Hg0 %	Hg2 %	HgP %
Autoclave Phase 1	10/5/20005	FAMS	0.0426	0.000689	0.00021	0.0435	97.93%	1.58%	0.49%

(NDEP 2006)

Refinery Test Data

Source	Date	Method	Hg0 lb/hr	Hg2 lb/hr	HgP lb/hr	HgTotal lb/hr	Hg0 %	Hg2 %	HgP %
Refinery Retort	10/17/2006	OHM	0.00343	0.000055	9E-06	0.0035	98.17%	1.57%	0.26%
AARL Kiln Scrubber	10/14/2006	OHM	0.02799	0.000268	2.3E-05	0.02828	98.97%	0.95%	0.08%
Melt/Pour Furnace	10/12/2006	OHM	0.01041	0.000273	3.1E-05	0.01072	97.16%	2.55%	0.29%
(WES&T 2006)						Wt. Avg.	98.45%	1.40%	0.15%

Estimated Hg emissions split between Refinery Sources for modeling purposes only:

Source	Split
Kiln	25%
EW	25%
Retort	25%
Furnace	25%
	100%

Conversions

2,000 lb/ton

PRI00000941

REC 2281

Air Sciences Inc.	PROJECT TITLE: Midas Gold	BY: K. Lewis	
	PROJECT NO: 335-1-2.4	PAGE: 1	OF: 1 SHEET: HgStoke's
AIR EMISSION CALCULATIONS	SUBJECT: Hg Deposition Parameters	DATE: June 30, 2021	

Stoke's Law

Vts = $gd^2(p - pa) / 18n$ *Engineering Tool Box*

Vts	terminal settling velocity				
g	gravitational acceleration	9.81E+02	cm/s^2		*Engineering Tool Box*
d	diameter of particle (cm)				
pa	density of air	1.212E-03	g/cm^3	18C	*Engineering Tool Box*
p	density of particle (g/cm^3)				
n	coefficient of viscosity of air	1.80E-04	g/cm-s	18C	*Engineering Tool Box*
µ	micron				

Literature values for deposition velocity of Hg2 and HgP

Hg2	0.5-6 cm/s	*(L. Zhang 2009)*	Range Average	3.25 cm/s
HgP	0.02-2 cm/s	*(L. Zhang 2009)*	Range Average	1.01 cm/s
			Average	2.13 cm/s

d	7 µ		*Aerodynamic diameter to achieve a Vts of ~2 cm/s*
p	13.545 g/cm^3	20C	*Engineering Tool Box (liquid Hg)*
Vts	2.01 cm/s		

$$\frac{0.04362\ \text{lb/ft-h} \times \frac{453.592\ \text{g}}{\text{lb}}}{\frac{\text{ft}}{30.48\ \text{cm}} \times \frac{\text{hr}}{3600\ \text{s}}} = 1.80\text{E-}04\ \text{g/cm-s} = 1.80\text{E-}02\ \text{g/m-s}$$

$$\frac{9.81\text{E+}02\ \text{cm}}{\text{s}^2} \times \frac{4.9\text{E-}07\ \text{cm}^2}{} \times \frac{13.545\ \text{g}}{\text{cm}^3} - \frac{1.21\text{E-}03\ \text{g}}{\text{cm}^3} \times \frac{}{18} \times \frac{\text{cm-s}}{1.80\text{E-}04\ \text{g}} = \frac{2.006\ \text{cm}}{\text{s}}$$

Conversions

10,000 cm/µ

Engineering Tool Box URLs

https://www.engineeringtoolbox.com/mercury-d_1002.html
https://www.engineeringtoolbox.com/air-density-specific-weight-d_600.html
https://www.engineeringtoolbox.com/air-absolute-kinematic-viscosity-d_601.html
https://www.engineeringtoolbox.com/accelaration-gravity-d_340.html
https://www.ajdesigner.com/phpstokeslaw/stokes_law_terminal_velocity.php

PRI00000942

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 1 OF: 3 SHEET: Conv
AIR EMISSION CALCULATIONS	SUBJECT: Conversions and Constants	DATE: June 30, 2021

Conversions

60	sec/min			
60	min/hr			
24	hr/day			
365	day/yr			
8,760	hr/yr			
3,600	s/hr			
2,000	lb/ton			
453.593	g/lb			
3.28084	ft/m			
35.3147	ft^3/m^3			
7,000	gr/lb			
1.341	hp/kW			
7.05	lb/gal distillate oil	*AP-42 Appendix A "Weights of Selected Substances" (Distillate oil)*		
907.1858	kg/ton			
459.67	°R at 0°F			
68	°F, standard			
7,000	BTU/hp-hr	*AP-42, Sec. 3.3, (Diesel)*	6893.04	
2.2369	mi/hr per m/s			
7.48052	gal/ft^3			
1.10231	ton/t			
2.20462	lb/kg			
1609.34	m/mi			
137,000	BTU/gal	*AP-42, App. A (Diesel)*		
4046.9	m^2/acre			
43,560	ft^2/acre			
12	in/ft			
1.10231	ton/mt			
1.0E+6	g/mt			
3	ft/yd			
1.0E+6	scf/MMscf			
10,000	m^2/ha			
1,000	kg/mt			
273.15	°K at 0°C			
32	°F at 0°C			
1.8	°F/°C			
1,000	ng/µg			
0.293297	MW-hr/MMBtu			
12	mo/yr			

Fuel Specifications

15 ppm S content		*40 CFR 80.510 (Non-road diesel)*
7.05 lb/gal-fuel		*AP-42, App. A*
32.065 lb/lb-mol S, and		
64.06 lb/lb-mol SO2		
7,000 Btu/hp-hr		*AP-42, Sec. 3.3, (Diesel engine)*
0.00939 MMBtu/kW-hr		*Diesel*
0.137 MMBtu/gal		*AP-42, App. A (Diesel)*
0.0915 MMBtu/gal Propane		

Constants

M.W. SO2	64.0638
M.W. S	32.065
M.W. O	15.9994

Diesel SO2

15 parts S	7.05 lb	64.06 SO2	gal	0.00939 MMBtu	453.593 g	=	6.57E-03	g SO2
1.0E+06	gal diese	32.065 S	0.137 MMBtu	kW-hr	lb			kW-hr

Calculation

185	lb S	44.08	lb C3H8		lb mol	7,000	gr	100	SCF	=	15.90	gr S
1.00E+06	lb C3H8		lb mol	359.05	SCF (0C)		lb		100SCF			100 SCF

Propane heating value 91,500 *Btu/gal* *AP-42, Table 1.5-1 (07/08) Footnote a*

AP-42, Chapter 13.2.4 Particle Size Fractions

0.35	PM10
0.053	PM2.5

PRI00000943

REC 2283

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 2 OF: 3 SHEET: Conv
AIR EMISSION CALCULATIONS	SUBJECT: Conversions and Constants	DATE: June 30, 2021

Fuel Combustion Exhaust Flow (EPA Method 19, Ffactor)

Propane Heater

F-factor	8,710	dscf/MMBtu	Propane, dry
O2%dry	3	%	
Heat input	1	MMBtu/hr	
Standard exhaust flow	10,170	dscf/hr	
	169	dscfm	
Vol % moisture	15.0%	standard for propane boilers	
Temperature	360	°F, Engineering Toolbox* (LPG heating appliances)	
Pressure, site	0.79	atm	
Actual exhaust flow	394	acfm (wet)/MMBtu	

Diesel Engine

F-factor	9,190	dscf/MMBtu	Oil, dry	
O2%dry	9	%		
Heat input	0.007	MMBtu/hp-hr	AP-42, Sec. 3.3, (Diesel engine)	
Standard exhaust flow	113	dscf/hp-hr		
	1.9	dscfm/hp	2.5	dscfm/kW
Vol % moisture	8.0%	standard for diesel engines		
Temperature	1,100	°F, Engineering Toolbox* (diesel exhaust)		
Pressure, site	0.79	atm		
Actual exhaust flow	7.7	acfm (wet)/hp	10.3	acfm (wet)/kW

* *http://www.engineeringtoolbox.com/fuels-exhaust-temperatures-d_168.html*

Refinery and Autoclave Exhaust Flow

dscfm acfm temp_F dia_ft

	Hourly	Exhaust Parameters					
			Flow		Temp	Velocity	Dia
Source	Design Rate	Water	dscfm	acfm	F	ft/s	ft
Carbon Regeneration Kiln (Drum)	0.3 ton	1%	120	180	150	17	0.48
Electrowinning Cells & Pregnant Solution Tan	100 gpm	4%	2,660	3,740	100	79	1
Mercury Retort	0.5/batch ton	1%	16	20	150	5	0.29
Induction Melting Furnace	0.5/batch ton	1%	3,500	5,200	150	71	1.25
Autoclave	290 ton	83%	3,101	28,680	196	24	5
Sb Bagging		0%	800	1,000	68	21	1
Limestone Ball Mill		0%	13,000	16,500	68	88	2
Parallel Flow Regenerative (PFR) Shaft Lime Kiln		4%	8,000	16,300	350	86	2
Lime Mill Crushing and associated transfers In and Out		0%	2,000	2,500	68	119	0.667

Site Pressure Calculation

http://www.sensorsone.com/altitude-pressure-units-conversion/

6000	23.978	6531.9	
7000	23.088	23.505	
0		29.921	0.78556

PRI00000944

REC 2284

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 3 OF: 3 SHEET: Conv
AIR EMISSION CALCULATIONS	SUBJECT: Conversions and Constants	DATE: June 30, 2021

Lime Kiln Specifications

810 *kcal/kg*	100 ton/day	*(Maerz 2018)*	3.96567 *btu/kcal*
870 *kcal/kg*	400 ton/day	*(Maerz 2018)*	
870 *kcal/kg*	169 ton/day	*Midas Gold Kiln Throughput, maximum-case fuel assumption*	

Lime kiln heat requirements

870 kcal / kg	907.186 kg / ton	3.96567 Btu / kcal	MMBtu / 1.E+06 Btu	=	3.130 MMBtu / ton

Dyno Nobel 2010 "Blasting and Explosives Quick Reference Guide"

(B*S*BH*N)/(PI()*D^2/4000*L)

BH	10	m
N	100	
D	0.15	m
B	4.9	m
S	5.6	m
L	10	m
V	27,330	
Vb	70.7	
V/Vb	386.6	400

B - Drilled Burden (m) =(25 to 40) x D
S - Drilled Spacing (m) =1.15 x B
BH - Bench Height (m) ≥D/15
N - Number of Holes in a Blast
D - Hole Diameter (mm)
L - Hole Length

Enclosure Control Efficiency Calculation

Emission factor equation	$E = 0.0032k(U/5)^{1.3}/(M/2)^{1.4}$				*AP-42, Sec. 13.2.4, Eq. 1, 11/06*	
U = Mean wind speed	5.167 mph		2.31 m/s		*(Midas Gold 2017f), Fig. 4-3 (2014 onsite meteorological data)*	
U = Mean wind speed	1.3 mph				*Lowest wind speed for Eq. 1, AP-42, Sec. 13.2.4, Eq. 1, 11/06*	
M = Moisture content	2.5 %					
	PM	PM10	PM2.5			
k = Particle size multiplier	0.74	0.35	0.053		*AP-42, Sec. 13.2.4, Pg. 4, 11/06*	
E = Emission factor	0.00181	0.00086	0.00013	lb/ton	U =	5.167
E = Emission factor	0.00030	0.00014	0.00002	lb/ton	U =	1.300
Control Efficiency	83.4%	83.4%	83.4%			

PRI00000945

REC 2285

Appendix B – Electronic Files

Appendix C – 2020 ModPRO VISCREEN Analysis

SGP VISCREEN ANALYSES AND REVISED 2020 MODELING

PREPARED FOR:	Midas Gold Idaho, Inc.
PREPARED BY:	Air Sciences Inc.
PROJECT NO.:	335-20-2
DATE:	September 1, 2020

Introduction

Air Sciences Inc. (Air Sciences) has conducted several VISCREEN modeling analyses in support of the National Environmental Policy Act (NEPA) process for the Midas Gold Idaho, Inc. (Midas Gold) Stibnite Gold Project (SGP). The original modeling was provided to the U.S. Forest Service (USFS) for review in July of 2018. The final modeling was submitted in March of 2019. This modeling was incorporated into the Draft Environmental Impact Statement (DEIS) dated August 2020.

Between the July 2018 and March 2019 VISCREEN modeling, the USFS requested several input changes to the model to increase its conservatism, and Midas Gold agreed to incorporate these changes. These changes are as follows:

1. Adding non-point source emissions
2. Adding mobile equipment emissions
3. Increasing the background visual range to 270 kilometers (km)
4. Adding large-diameter particulate matter emissions
5. Adding nighttime hours

As stated in the DEIS, VISCREEN is viewed as an inherently conservative model, and the use of the abovementioned inputs has further increased its conservativism. As a result, the March 2019 VISCREEN plume blight predictions may be overly conservative and misleading. These results have led to a conclusion in the DEIS that plume visibility impacts are "likely" in the Frank Church–River of No Return Wilderness (FCRNRW). The original July 2018 VISCREEN modeling predicted that the plumes resulting from the SGP in the FCRNRW are not likely to be visible to a casual observer.

The purpose of this memorandum is to:

1) provide a technical discussion of the conservatism added to the model by the abovementioned model input changes, and

2) provide a revised 2020 modeling analysis that incorporates most of the USFS changes while revising two of these inputs to increase the representativeness of the model.

Conservatism of Model Input Changes

As previously discussed, the use of the abovementioned model inputs may have resulted in overly conservative and misleading plume blight predictions. This conclusion is based on a comparison of the VISCREEN and CALPUFF model results. VISCREEN was rerun for the area within the FCRNRW that is 50 km from the SGP (the nearest distance modeled by CALPUFF). These results were then compared to the CALPUFF model visible impact results for the same location (the FCRNRW area 50 km from the SGP). This comparison shows that VISCREEN significantly overpredicts visibility impacts. At the 50-km common distance, CALPUFF predicted insignificant visibility impacts (less than the 5% extinction threshold), while VISCREEN predicted a visible plume 38% of the time, even though both models used the same Alternate 1 EIS inventory.

A technical discussion of the model input changes incorporated into the March 2019 VISCREEN modeling is provided in the following subsections.

Adding Non-Point Source and Mobile Equipment Emissions

In the July 2018 VISCREEN modeling, the maximum daily emissions from all process and auxiliary point sources (crushers, conveyors, generators, stacks, and other stationary point sources) were included in the model. These sources are located within the process area of the mine site and were conservatively assumed to form a single overlapping, coherent plume. (VISCREEN can only model a single plume.)

In the March 2019 VISCREEN modeling, the maximum daily emissions from non-point fugitive sources (drilling, blasting, material handling, dozing, grading, wind erosion, and transportation), mobile tailpipes, and the Burntlog Route were added to the model. The non-point fugitive and mobile tailpipe sources are spread out over several miles within the mine site and the Burntlog Route extends 38 miles from the mine site. The treatment of these dispersed sources as a single point source emitting a single coherent plume is not representative of realistic conditions, is highly conservative, and creates uncertainty in the modeling prediction.

A theoretical single-point plume origin correction distance of 17.8 km was introduced into the model to help account for the dispersed nature of the fugitive, mobile tailpipe, and Burntlog

Route sources added by request of the USFS. This model adjustment is not discussed in the *Workbook for Plume Visual Impact Screening and Analysis* (VISCREEN User's Guide).[1] Additionally, the VISCREEN and CALPUFF results comparison demonstrates that the theoretical correction did not provide an adequate model adjustment.

Increasing the Background Visual Range to 270 km

In the July 2018 VISCREEN modeling, a background visual range of 60 km was used. This range was obtained from the regional visual range map provided in the VISCREEN User's Guide for the SGP location. In the March 2019 VISCREEN modeling, the background visual range was increased to 270 km. This visual range represents a high estimate of the theoretical visual range for the four nearest Class I areas under natural conditions (conditions estimated to have occurred before human-caused pollution). The median visual ranges (natural conditions) for these Class I areas are between 248 to 266 km.

The FCRNRW is a Class II area. Using a visual range of 270 km for the FCRNRW area is highly conservative because a higher background visual range increases VISCREEN predictions of plume blight. The actual median background visual range is expected to be significantly lower.

Adding Large-Diameter Particulate Matter Emissions

In the July 2018 VISCREEN modeling only PM_{10} (particulate matter less than 10 microns) emissions were included, as these particulates are the major contributor to light scattering and plume blight. The VISCREEN default median particle diameter of 2 microns was used. This is a conservative assumption for PM_{10} emissions because smaller diameter particles result in higher plume blight predictions.

In the March 2019 VISCREEN modeling, large-diameter particulate matter (>10 microns) emissions were added to the model, but the median diameter was left at 2 microns. With the inclusion of the large-diameter particulate matter, 70% of the total particulate modeled was larger than 10 microns. Therefore, modeling the total particulate at 2 microns significantly increased the conservatism of the model.

Adding Nighttime Hours

In the July 2018 VISCREEN modeling, only daytime hours were evaluated for the Level 2 analysis because any plume that occurs at night would not have sunlight to illuminate it. In the March 2019 VISCREEN modeling, nighttime hours were added, which significantly increased

[1] EPA 1992. Workbook for Plume Visual Impact Screening and Analysis (Revised). United States Environmental Protection Agency. Office of Air Quality Planning and Standards. EPA-454/R-92-023. October 1992.

plume blight predictions because nighttime hours typically have lower wind speeds and higher stability classes.

Revised 2020 Model Inputs and Results

As stated in the Introduction, the use of the conservative inputs into an already inherently conservative model results in overly conservative plume blight predictions that are unrepresentative of expected conditions. Revising only two of these inputs increases the representativeness of the model while maintaining a reasonable level of conservatism:

1) Revising the background visual range to 60 km per Figure 9 of the VISCREEN User's Guide.

2) Revising the median particulate diameter to 10 microns. The VISCREEN model limits the maximum particulate diameter input to 10 microns. Therefore, modeling at 10 microns is conservative because more than half of the total particulate modeled (70%) is greater than 10 microns.

The results from the revised 2020 VISCREEN model inputs are provided in the tables below:

Table 1. Frequency of Modeled Visible Plumes – Screening Results for FCRNRW: Percent of Time when Perceptibility Threshold is Exceeded

Plume Parameter	Background	% Day Hours: 10 Degrees	% Night Hours: 10 Degrees	% Day Hours: 140 Degrees	% Night Hours: 140 Degrees
Plume Contrast (C)	Terrain	0	0	0	0
Color Contrast (ΔE)	Terrain	0.02	2.9	0	0
Plume Contrast (C)	Sky	0	0	0	0.38
Color Contrast (ΔE)	Sky	0	2.3	0	0

Table 2. Magnitude of Modeled Visible Plumes – Screening Results for FCRNRW: Ratio of Maximum Impact to Perceptibility Threshold

Plume Parameter	Background	Day (10 Degrees)	Night (10 Degrees)	Day (140 Degrees)	Night (140 Degrees)
Plume Contrast (C)	Terrain	--	--	--	--
Color Contrast (ΔE)	Terrain	1.0	2.2	--	--
Plume Contrast (C)	Sky	--	--	--	1.3
Color Contrast (ΔE)	Sky	--	1.9	--	--

Table 1 shows that the revised 2020 VISCREEN model predicts that 0.02% (1 hour) of the annual daytime hours and 2.9% (107 hours) of the annual nighttime hours may experience a visible plume within the FCRNRW area. Table 2 provides the highest magnitude of the predicted visible plumes.

2020 VISCREEN Results by Viewing Condition

Each VISCREEN run evaluates potential plume blight for a variety of viewing conditions. The two plume blight parameters estimated by VISCREEN are color contrast (ΔE) and contrast (C). VISCREEN calculates these values at two different solar angles: 10 degrees and 140 degrees. Each of these estimates is performed for two different viewing backgrounds: terrain and sky. The SGP VISCREEN results are summarized for the following eight viewing conditions:

1. Color contrast: terrain as background and 10 degrees solar angle (ΔE-Terrain-10)
2. Color contrast: sky as background and 10 degrees solar angle (ΔE-Sky-10)
3. Color contrast: terrain as background and 140 degrees solar angle (ΔE-Terrain-140)
4. Color contrast: sky as background and 140 degrees solar angle (ΔE-Sky-140)
5. Contrast: terrain as background and 10 degrees solar angle (C-Terrain-10)
6. Contrast: sky as background and 10 degrees solar angle (C-Sky-10)
7. Contrast: terrain as background and 140 degrees solar angle (C-Terrain-140)
8. Contrast: sky as background and 140 degrees solar angle (C-Sky-140)

The following sections provide four tables for each of the eight viewing conditions:

1. Number of visible plume hours during daytime
2. Number of visible plume hours during nighttime
3. Maximum VISCREEN results during daytime hours
4. Maximum VISCREEN results during nighttime hours

PRI00000953

REC 2293

Results Summary for ΔE-Terrain-10 Viewing Conditions

The number of potential visible plume daytime and nighttime hours for the ΔE-Terrain-10 combination, for the applicable wind speeds and stability classes, are provided in Table 3 and Table 4, respectively.

Table 3. ΔE-Terrain-10: Number of Visible Plume Hours for Daytime Meteorological Data

Wind Speed (m/s)	Pasquill Stability Class					
	A	B	C	D	E	F
1	-	-	-	-	1	-
2	-	-	-	-	-	-
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-

The stability classes in this table are not adjusted for elevation differences.

Table 4. ΔE-Terrain-10: Number of Visible Plume Hours for Nighttime Meteorological Data

Wind Speed (m/s)	Pasquill Stability Class					
	A	B	C	D	E	F
1	-	-	-	-	1	106
2	-	-	-	-	-	-
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-

The stability classes in this table are not adjusted for elevation differences.

The maximum predicted ΔE for daytime and nighttime hours for the ΔE-Terrain-10 combination, for the applicable wind speed and stability class combinations, are provided in Table 5 and Table 6, respectively.

VISCREEN determines the appropriate screening threshold for each model run. The range of thresholds determined by VISCREEN are listed in the bottom rows of these tables.

Table 5. ΔE-Terrain-10: Maximum VISCREEN ΔE Results for Daytime Hours

Wind Speed (m/s)	Pasquill Stability Class					
	A	B	C	D	E	F
1	-	0.10	0.27	1.47	2.07	-
2	-	0.03	0.10	0.51	0.85	-
3	-	0.02	0.06	0.30	0.28	-
4	-	0.01	0.04	0.22	-	-
5	-	0.01	0.03	0.17	-	-
6	-	-	0.03	0.14	0.14	-
7	-	-	0.02	0.12	-	-
8	-	-	0.01	0.10	-	-
9	-	-	-	0.09	-	-
10	-	-	0.01	0.08	-	-
Minimum ΔE Threshold		8.22	1.92	1.82	2.00	N/A
Maximum ΔE Threshold		8.57	8.60	6.61	2.00	N/A

The stability classes in this table are not adjusted for elevation differences.

Table 6. ΔE-Terrain-10: Maximum VISCREEN ΔE Results for Nighttime Hours

Wind Speed (m/s)	Pasquill Stability Class					
	A	B	C	D	E	F
1	-	-	-	1.42	2.12	4.32
2	-	-	-	0.50	0.93	1.70
3	-	-	-	0.29	0.56	0.98
4	-	-	-	0.21	0.36	0.42
5	-	-	-	0.17	0.32	-
6	-	-	-	0.14	0.13	-
7	-	-	-	0.12	-	-
8	-	-	-	0.09	-	-
9	-	-	-	0.08	-	-
10	-	-	-	0.02	-	-
Minimum ΔE Threshold		N/A	N/A	1.82	2.00	2.00
Maximum ΔE Threshold		N/A	N/A	6.60	2.00	2.00

The stability classes in this table are not adjusted for elevation differences.

Results Summary for ΔE-Sky-10 Viewing Conditions

The number of potential visible plume daytime and nighttime hours for the ΔE-Sky-10 combination, for the applicable wind speeds and stability classes, are provided in Table 7 and Table 8, respectively.

Table 7. ΔE-Sky-10: Number of Visible Plume Hours for Daytime Meteorological Data

Wind Speed (m/s)	Pasquill Stability Class					
	A	B	C	D	E	F
1	-	-	-	-	-	-
2	-	-	-	-	-	-
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-

The stability classes in this table are not adjusted for elevation differences.

Table 8. ΔE-Sky-10: Number of Visible Plume Hours for Nighttime Meteorological Data

Wind Speed (m/s)	Pasquill Stability Class					
	A	B	C	D	E	F
1	-	-	-	-	-	85
2	-	-	-	-	-	-
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-

The stability classes in this table are not adjusted for elevation differences.

The maximum predicted ΔE for daytime and nighttime hours for the ΔE-Sky-10 combination, for the applicable wind speed and stability class combinations, are provided in Table 9 and Table 10, respectively.

Table 9. ΔE-Sky-10: Maximum VISCREEN ΔE Results for Daytime Hours

Wind Speed (m/s)	Pasquill Stability Class					
	A	B	C	D	E	F
1	-	0.08	0.21	1.25	1.97	-
2	-	0.03	0.07	0.44	0.83	-
3	-	0.02	0.05	0.26	0.24	-
4	-	0.01	0.03	0.19	-	-
5	-	0.01	0.03	0.15	-	-
6	-	-	0.02	0.12	0.12	-
7	-	-	0.02	0.10	-	-
8	-	-	0.01	0.09	-	-
9	-	-	-	0.08	-	-
10	-	-	0.00	0.07	-	-
Minimum ΔE Threshold		1.62	0.21	0.21	2.00	N/A
Maximum ΔE Threshold		1.63	9.12	9.17	2.00	N/A

The stability classes in this table are not adjusted for elevation differences.

Table 10. ΔE-Sky-10: Maximum VISCREEN ΔE Results for Nighttime Hours

Wind Speed (m/s)	Pasquill Stability Class					
	A	B	C	D	E	F
1	-	-	-	1.21	2.00	3.85
2	-	-	-	0.44	0.90	1.65
3	-	-	-	0.25	0.54	0.97
4	-	-	-	0.18	0.36	0.41
5	-	-	-	0.15	0.31	-
6	-	-	-	0.12	0.11	-
7	-	-	-	0.10	-	-
8	-	-	-	0.08	-	-
9	-	-	-	0.07	-	-
10	-	-	-	0.01	-	-
Minimum ΔE Threshold		N/A	N/A	0.21	2.00	2.00
Maximum ΔE Threshold		N/A	N/A	9.16	2.00	2.01

The stability classes in this table are not adjusted for elevation differences.

Results Summary for ΔE-Terrain-140 Viewing Conditions

The number of potential visible plume daytime and nighttime hours for the ΔE-Terrain-140 combination, for the applicable wind speeds and stability classes, are provided in Table 11 and Table 12, respectively.

Table 11. ΔE-Terrain-140: Number of Visible Plume Hours for Daytime Meteorological Data

Wind Speed (m/s)	Pasquill Stability Class					
	A	B	C	D	E	F
1	-	-	-	-	-	-
2	-	-	-	-	-	-
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-

The stability classes in this table are not adjusted for elevation differences.

Table 12. ΔE-Terrain-140: Number of Visible Plume Hours for Nighttime Meteorological Data

Wind Speed (m/s)	Pasquill Stability Class					
	A	B	C	D	E	F
1	-	-	-	-	-	-
2	-	-	-	-	-	-
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-

The stability classes in this table are not adjusted for elevation differences.

PRI00000958

REC 2298

The maximum predicted ΔE for daytime and nighttime hours for the ΔE-Terrain-140 combination, for the applicable wind speed and stability class combinations, are provided in Table 13 and Table 14, respectively.

Table 13. ΔE-Terrain-140: Maximum VISCREEN ΔE Results for Daytime Hours

Wind Speed (m/s)	Pasquill Stability Class					
	A	B	C	D	E	F
1	-	0.02	0.05	0.25	0.35	-
2	-	0.01	0.02	0.08	0.14	-
3	-	0.00	0.01	0.05	0.05	-
4	-	0.00	0.01	0.04	-	-
5	-	0.00	0.01	0.03	-	-
6	-	-	0.01	0.02	0.02	-
7	-	-	0.00	0.02	-	-
8	-	-	0.00	0.02	-	-
9	-	-	-	0.01	-	-
10	-	-	0.00	0.01	-	-
Minimum ΔE Threshold		6.70	2.31	2.00	2.00	N/A
Maximum ΔE Threshold		6.82	6.83	4.46	2.00	N/A

The stability classes in this table are not adjusted for elevation differences.

Table 14. ΔE-Terrain-140: Maximum VISCREEN ΔE Results for Nighttime Hours

Wind Speed (m/s)	Pasquill Stability Class					
	A	B	C	D	E	F
1	-	-	-	0.24	0.36	0.76
2	-	-	-	0.08	0.15	0.29
3	-	-	-	0.05	0.11	0.16
4	-	-	-	0.03	0.06	0.07
5	-	-	-	0.03	0.05	-
6	-	-	-	0.02	0.02	-
7	-	-	-	0.02	-	-
8	-	-	-	0.02	-	-
9	-	-	-	0.01	-	-
10	-	-	-	0.00	-	-
Minimum ΔE Threshold		N/A	N/A	2.00	2.00	2.00
Maximum ΔE Threshold		N/A	N/A	4.46	2.00	2.00

The stability classes in this table are not adjusted for elevation differences.

Results Summary for ΔE-Sky-140 Viewing Conditions

PRI00000959

REC 2299

The number of potential visible plume daytime and nighttime hours for the ΔE-Sky-140 combination, for the applicable wind speeds and stability classes, are provided in Table 15 and Table 16, respectively.

Table 15. ΔE-Sky-140: Number of Visible Plume Hours for Daytime Meteorological Data

Wind Speed (m/s)	Pasquill Stability Class					
	A	B	C	D	E	F
1	-	-	-	-	-	-
2	-	-	-	-	-	-
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-

The stability classes in this table are not adjusted for elevation differences.

Table 16. ΔE-Sky-140: Number of Visible Plume Hours for Nighttime Meteorological Data

Wind Speed (m/s)	Pasquill Stability Class					
	A	B	C	D	E	F
1	-	-	-	-	-	-
2	-	-	-	-	-	-
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-

The stability classes in this table are not adjusted for elevation differences.

PRI00000960

REC 2300

The maximum predicted ΔE for daytime and nighttime hours for the ΔE-Sky-140 combination, for the applicable wind speed and stability class combinations, are provided in Table 17 and Table 18, respectively.

Table 17. ΔE-Sky-140: Maximum VISCREEN ΔE Results for Daytime Hours

Wind Speed (m/s)	Pasquill Stability Class					
	A	B	C	D	E	F
1	-	0.04	0.11	0.67	1.00	-
2	-	0.01	0.04	0.23	0.42	-
3	-	0.01	0.02	0.14	0.13	-
4	-	0.01	0.02	0.10	-	-
5	-	0.00	0.01	0.08	-	-
6	-	-	0.01	0.06	0.06	-
7	-	-	0.01	0.05	-	-
8	-	-	0.00	0.05	-	-
9	-	-	-	0.04	-	-
10	-	-	0.00	0.04	-	-
Minimum ΔE Threshold		7.71	3.25	2.00	2.00	N/A
Maximum ΔE Threshold		7.72	7.89	3.91	2.00	N/A

The stability classes in this table are not adjusted for elevation differences.

Table 18. ΔE-Sky-140: Maximum VISCREEN ΔE Results for Nighttime Hours

Wind Speed (m/s)	Pasquill Stability Class					
	A	B	C	D	E	F
1	-	-	-	0.64	1.01	1.95
2	-	-	-	0.23	0.46	0.84
3	-	-	-	0.13	0.28	0.50
4	-	-	-	0.10	0.18	0.21
5	-	-	-	0.08	0.16	-
6	-	-	-	0.06	0.06	-
7	-	-	-	0.05	-	-
8	-	-	-	0.04	-	-
9	-	-	-	0.04	-	-
10	-	-	-	0.01	-	-
Minimum ΔE Threshold		N/A	N/A	2.00	2.00	2.00
Maximum ΔE Threshold		N/A	N/A	3.91	2.00	2.00

The stability classes in this table are not adjusted for elevation differences.

Results Summary for C-Terrain-10 Viewing Conditions

The number of potential visible plume daytime and nighttime hours for the C-Terrain-10 combination, for the applicable wind speeds and stability classes, are provided in Table 19 and Table 20, respectively.

Table 19. C-Terrain-10: Number of Visible Plume Hours for Daytime Meteorological Data

Wind Speed (m/s)	Pasquill Stability Class					
	A	B	C	D	E	F
1	-	-	-	-	-	-
2	-	-	-	-	-	-
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-

The stability classes in this table are not adjusted for elevation differences.

Table 20. C-Terrain-10: Number of Visible Plume Hours for Nighttime Meteorological Data

Wind Speed (m/s)	Pasquill Stability Class					
	A	B	C	D	E	F
1	-	-	-	-	-	-
2	-	-	-	-	-	-
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-

The stability classes in this table are not adjusted for elevation differences.

The maximum predicted C for daytime and nighttime hours for the C-Terrain-10 combination, for the applicable wind speed and stability class combinations, are provided in Table 21 and Table 22, respectively.

Table 21. C-Terrain-10: Maximum VISCREEN C Results for Daytime Hours

Wind Speed (m/s)	Pasquill Stability Class					
	A	B	C	D	E	F
1	-	0.00	0.00	0.01	0.02	-
2	-	-	0.00	0.01	0.01	-
3	-	-	0.00	0.00	0.00	-
4	-	-	-	0.00	-	-
5	-	-	-	0.00	-	-
6	-	-	-	0.00	0.00	-
7	-	-	-	0.00	-	-
8	-	-	-	0.00	-	-
9	-	-	-	0.00	-	-
10	-	-	-	0.00	-	-
Minimum C Threshold		0.43	0.11	0.05	0.05	N/A
Maximum C Threshold		0.44	0.44	0.27	0.05	N/A

The stability classes in this table are not adjusted for elevation differences.

Table 22. C-Terrain-10: Maximum VISCREEN C Results for Nighttime Hours

Wind Speed (m/s)	Pasquill Stability Class					
	A	B	C	D	E	F
1	-	-	-	0.01	0.02	0.04
2	-	-	-	0.01	0.01	0.02
3	-	-	-	0.00	0.01	0.01
4	-	-	-	0.00	0.00	0.00
5	-	-	-	0.00	0.00	-
6	-	-	-	0.00	0.00	-
7	-	-	-	0.00	-	-
8	-	-	-	0.00	-	-
9	-	-	-	0.00	-	-
10	-	-	-	-	-	-
Minimum C Threshold		N/A	N/A	0.05	0.05	0.05
Maximum C Threshold		N/A	N/A	0.27	0.05	0.05

The stability classes in this table are not adjusted for elevation differences.

Results Summary for C-Sky-10 Viewing Conditions

The number of potential visible plume daytime and nighttime hours for the C-Sky-10 combination, for the applicable wind speeds and stability classes, are provided in Table 23 and Table 24, respectively.

Table 23. C-Sky-10: Number of Visible Plume Hours for Daytime Meteorological Data

Wind Speed (m/s)	Pasquill Stability Class					
	A	B	C	D	E	F
1	-	-	-	-	-	-
2	-	-	-	-	-	-
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-

The stability classes in this table are not adjusted for elevation differences.

Table 24. C-Sky-10: Number of Visible Plume Hours for Nighttime Meteorological Data

Wind Speed (m/s)	Pasquill Stability Class					
	A	B	C	D	E	F
1	-	-	-	-	-	-
2	-	-	-	-	-	-
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-

The stability classes in this table are not adjusted for elevation differences.

The maximum predicted C for daytime and nighttime hours for the C-Sky-10 combination, for the applicable wind speed and stability class combinations, are provided in Table 25 and Table 26, respectively.

Table 25. C-Sky-10: Maximum VISCREEN C Results for Daytime Hours

Wind Speed (m/s)	Pasquill Stability Class					
	A	B	C	D	E	F
1	-	-	0.00	0.01	0.01	-
2	-	-	-	0.00	0.01	-
3	-	-	-	0.00	0.00	-
4	-	-	-	0.00	-	-
5	-	-	-	0.00	-	-
6	-	-	-	0.00	0.00	-
7	-	-	-	0.00	-	-
8	-	-	-	0.00	-	-
9	-	-	-	0.00	-	-
10	-	-	-	-	-	-
Minimum C Threshold		0.40	0.16	0.05	0.05	N/A
Maximum C Threshold		0.40	0.41	0.19	0.05	N/A

The stability classes in this table are not adjusted for elevation differences.

Table 26. C-Sky-10: Maximum VISCREEN C Results for Nighttime Hours

Wind Speed (m/s)	Pasquill Stability Class					
	A	B	C	D	E	F
1	-	-	-	0.01	0.01	0.02
2	-	-	-	0.00	0.01	0.01
3	-	-	-	0.00	0.00	0.01
4	-	-	-	0.00	0.00	0.00
5	-	-	-	0.00	0.00	-
6	-	-	-	0.00	0.00	-
7	-	-	-	0.00	-	-
8	-	-	-	0.00	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-
Minimum C Threshold		N/A	N/A	0.05	0.05	0.05
Maximum C Threshold		N/A	N/A	0.19	0.05	0.05

The stability classes in this table are not adjusted for elevation differences.

Results Summary for C-Terrain-140 Viewing Conditions

PRI00000965

REC 2305

The number of potential visible plume daytime and nighttime hours for the C-Terrain-140 combination, for the applicable wind speeds and stability classes, are provided in Table 27 and Table 28, respectively.

Table 27. C-Terrain-140: Number of Visible Plume Hours for Daytime Meteorological Data

Wind Speed (m/s)	Pasquill Stability Class					
	A	B	C	D	E	F
1	-	-	-	-	-	-
2	-	-	-	-	-	-
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-

The stability classes in this table are not adjusted for elevation differences.

Table 28. C-Terrain-140: Number of Visible Plume Hours for Nighttime Meteorological Data

Wind Speed (m/s)	Pasquill Stability Class					
	A	B	C	D	E	F
1	-	-	-	-	-	-
2	-	-	-	-	-	-
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-

The stability classes in this table are not adjusted for elevation differences.

The maximum predicted C for daytime and nighttime hours for the C-Terrain-140 combination, for the applicable wind speed and stability class combinations, are provided in Table 29 and Table 30, respectively.

Table 29. C-Terrain-140: Maximum VISCREEN C Results for Daytime Hours

Wind Speed (m/s)	Pasquill Stability Class					
	A	B	C	D	E	F
1	-	-	0.00	0.00	0.01	-
2	-	-	-	0.00	0.01	-
3	-	-	-	0.00	0.00	-
4	-	-	-	0.00	-	-
5	-	-	-	0.00	-	-
6	-	-	-	0.00	0.00	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-
Minimum C Threshold		0.43	0.11	0.05	0.05	N/A
Maximum C Threshold		0.44	0.44	0.27	0.07	N/A

The stability classes in this table are not adjusted for elevation differences.

Table 30. C-Terrain-140: Maximum VISCREEN C Results for Nighttime Hours

Wind Speed (m/s)	Pasquill Stability Class					
	A	B	C	D	E	F
1	-	-	-	0.01	0.01	0.02
2	-	-	-	0.00	0.00	0.01
3	-	-	-	0.00	0.00	0.00
4	-	-	-	0.00	0.00	0.00
5	-	-	-	0.00	0.00	-
6	-	-	-	0.00	0.00	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-
Minimum C Threshold		N/A	N/A	0.05	0.05	0.05
Maximum C Threshold		N/A	N/A	0.27	0.07	0.05

The stability classes in this table are not adjusted for elevation differences.

Results Summary for C-Sky-140 Viewing Conditions

The number of potential visible plume daytime and nighttime hours for the C-Sky-140 combination, for the applicable wind speeds and stability classes, are provided in Table 31 and Table 32, respectively.

Table 31. C-Sky-140: Number of Visible Plume Hours for Daytime Meteorological Data

Wind Speed (m/s)	Pasquill Stability Class					
	A	B	C	D	E	F
1	-	-	-	-	-	-
2	-	-	-	-	-	-
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-

The stability classes in this table are not adjusted for elevation differences.

Table 32. C-Sky-140: Number of Visible Plume Hours for Nighttime Meteorological Data

Wind Speed (m/s)	Pasquill Stability Class					
	A	B	C	D	E	F
1	-	-	-	-	-	14
2	-	-	-	-	-	-
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-

The stability classes in this table are not adjusted for elevation differences.

PRI00000968

REC 2308

The maximum predicted C for daytime and nighttime hours for the C-Sky-140 combination, for the applicable wind speed and stability class combinations, are provided in Table 33 and Table 34, respectively.

Table 33. C-Sky-140: Maximum VISCREEN C Results for Daytime Hours

Wind Speed (m/s)	Pasquill Stability Class					
	A	B	C	D	E	F
1	-	0.00	0.00	0.03	0.04	-
2	-	-	0.00	0.01	0.02	-
3	-	-	0.00	0.01	0.01	-
4	-	-	0.00	0.00	-	-
5	-	-	0.00	0.00	-	-
6	-	-	-	0.00	0.00	-
7	-	-	-	0.00	-	-
8	-	-	-	0.00	-	-
9	-	-	-	0.00	-	-
10	-	-	-	0.00	-	-
Minimum C Threshold		0.40	0.16	0.05	0.05	N/A
Maximum C Threshold		0.40	0.41	0.19	0.05	N/A

The stability classes in this table are not adjusted for elevation differences.

Table 34. C-Sky-140: Maximum VISCREEN C Results for Nighttime Hours

Wind Speed (m/s)	Pasquill Stability Class					
	A	B	C	D	E	F
1	-	-	-	0.03	0.03	0.06
2	-	-	-	0.01	0.02	0.03
3	-	-	-	0.01	0.01	0.02
4	-	-	-	0.00	0.01	0.01
5	-	-	-	0.00	0.01	-
6	-	-	-	0.00	0.00	-
7	-	-	-	0.00	-	-
8	-	-	-	0.00	-	-
9	-	-	-	0.00	-	-
10	-	-	-	-	-	-
Minimum C Threshold		N/A	N/A	0.05	0.05	0.05
Maximum C Threshold		N/A	N/A	0.19	0.05	0.05

The stability classes in this table are not adjusted for elevation differences.

PRI00000969

REC 2309

To: Hannah Young[Hannah.Young@deq.idaho.gov]; 'Will Tiedemann'[wtiedemann@idahoconservation.org]
From: Whitney Rowley[/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=2903C420ED0840079391679367E89120-WHITNEY ROW]
Sent: Tue 7/12/2022 1:41:17 PM (UTC-06:00)
Subject: RE: Public Records Request #221273—ambient air quality monitoring and air permitting documents

Will,

I spoke with Air Quality and at this time there are no other records that are responsive to this request.

Whitney Rowley | Technical Services Admin Assistant 2, Public Record Request Coordinator
Idaho Department of Environmental Quality
1410 N Hilton, Boise, ID 83706
Office: (208) 373-0193
www.deq.idaho.gov

Our mission: To protect public health and the quality of Idaho's air, land, and water.

From: Hannah Young <Hannah.Young@deq.idaho.gov>
Sent: Tuesday, July 12, 2022 1:37 PM
To: 'Will Tiedemann' <wtiedemann@idahoconservation.org>
Cc: Whitney Rowley <Whitney.Rowley@deq.idaho.gov>
Subject: RE: Public Records Request #221273—ambient air quality monitoring and air permitting documents

Will – I only review records that could potentially be withheld. I don't review every record and therefore do not know what records exist that are responsive. It is certainly possible that there wasn't a written response to the email you received – I can only guess. But the email you did receive was not subject to the attorney client privilege – or any other exemption – which is why you received it.

If you seek additional information, you may of course submit a PRR.

Hannah

From: Will Tiedemann <wtiedemann@idahoconservation.org>
Sent: Tuesday, July 12, 2022 11:44 AM
To: Hannah Young <Hannah.Young@deq.idaho.gov>
Cc: Whitney Rowley <Whitney.Rowley@deq.idaho.gov>
Subject: Re: Public Records Request #221273—ambient air quality monitoring and air permitting documents

Hannah,

Thank you for your response. It has provided the clarity I was seeking. ICL will be evaluating the stated exemption and reserves the right to appeal.

In the meantime, the one email provided to me included correspondence between 3 IDEQ staffers, none of whom are attorneys. Assuming a written response to Mr. Simon was given, I would like to inquire why it was not also provided? Is this because the attorney client privilege exemption cited extends to any written response given to Mr. Simon? If not, I would like to be provided with any and all responses given to Mr. Simon (or others in regard to the same email). If necessary I will submit a formal PRR.

Thank you.

On Tue, Jul 12, 2022 at 11:19 AM Hannah Young <Hannah.Young@deq.idaho.gov> wrote:
Will –

One document was withheld pursuant to Idaho Code 74-104(1), which allows DEQ to withhold documents if they are otherwise exempt from disclosure pursuant to state law. As Whitney indicated, state law protects records that are subject to the attorney

client privilege. In the recent Ada County District Court case *Idaho Press Club v. McGeachin*, the Judge explained how the attorney client privilege was protected under state law and therefore documents subject to the privilege can be withheld from disclosure in a public records request. I'm copying the relevant portions of his decision in that case here, as he explains it well:

> The attorney-client privilege in Idaho is codified at I.C. 9-203, which provides that because "[t]here are particular relations in which it is the policy of the law to encourage confidence [a]n attorney cannot, without the consent of his client, be examined as to any communication made by the client to him, or his advice given thereon in the course of professional employment." LC. 9-203(2). "Communications between attorney and client made in the course of professional employment are protected by the attorney-client privilege." State v. Iwakiri, 106 Idaho 618, 621, 682 P.2d 571, 574 (1984) (citing LC. 9-203). Idaho Rule of Evidence 502 further specifies the contours of the attorney-client privilege in Idaho. For the attorney-client privilege to apply, the communication must be (1) confidential within the meaning of the rule, (2) made between persons described in the rule, and (3) for the purpose of facilitating the rendition of professional legal services to the client. IRE 502(b). "A communication is 'confidential' if not intended to be disclosed to third persons other than those to whom disclosure is made in furtherance of the rendition of professional legal services to the client or those reasonably necessary for the transmission of the communication." IRE 502(a)(5).

In regards to your request below, the Idaho Public Records Act states that when an agency denies part of a request, it must notify the requester of the denial. Section 103(5) then states:

> (5) The notice of denial or partial denial shall state that the attorney for the public agency has reviewed the request or shall state that the public agency has had an opportunity to consult with an attorney regarding the request for examination or copying of a record and has chosen not to do so. The notice of denial or partial denial also shall indicate the statutory authority for the denial and indicate clearly the person's right to appeal the denial or partial denial and the time periods for doing so.

The notice of denial you received (1) notified you that the Attorney General's Office reviewed the request, (2) provided the statutory authority for the denial (Idaho Code 74-104(1), and then the attorney client privilege), and (3) you had the right to appeal and the time period for doing so.

I'm not sure how to answer your question of "how it specifically provides a PRR exemption in regards to the documents I have requested," except to say that the document was exempted pursuant to Idaho Code 74-104(1) as it was protected by the attorney client privilege.

Hannah

From: Will Tiedemann <wtiedemann@idahoconservation.org>
Sent: Tuesday, July 12, 2022 10:53 AM
To: Hannah Young <Hannah.Young@deq.idaho.gov>; Whitney Rowley <Whitney.Rowley@deq.idaho.gov>
Subject: Fwd: Public Records Request #221273—ambient air quality monitoring and air permitting documents

Deputy Attorney General Young,

As per the below emails, it is your assertion that my PRR be partially denied as per Idaho Code 74-104(1):

"(1)Any public record exempt from disclosure by federal or state law or federal regulations to the extent specifically provided for by such law or regulation."

However, neither the partial denial letter nor your follow up response cite the specific federal or state law/regulation and how it specifically provides a PRR exemption in regards to the documents I have requested. I respectfully request that you please do so.

Thank you

---------- Forwarded message ---------
From: **Whitney Rowley** <Whitney.Rowley@deq.idaho.gov>
Date: Tue, Jul 12, 2022 at 10:15 AM
Subject: RE: Public Records Request #221273—ambient air quality monitoring and air permitting documents
To: Will Tiedemann <wtiedemann@idahoconservation.org>

Hi Will,

Hannah Young said the citation in the partial denial letter was for records withheld that were subject to attorney-client privilege.

I attached the email we had where all your three requests were combined into the initial request.

Thanks,
Whitney

Whitney Rowley | Technical Services Admin Assistant 2, Public Record Request Coordinator
Idaho Department of Environmental Quality
1410 N Hilton, Boise, ID 83706
Office: (208) 373-0193
www.deq.idaho.gov

Our mission: To protect public health and the quality of Idaho's air, land, and water.

From: Whitney Rowley
Sent: Tuesday, July 12, 2022 9:07 AM
To: 'Will Tiedemann' <wtiedemann@idahoconservation.org>
Subject: RE: Public Records Request #221273—ambient air quality monitoring and air permitting documents

Sorry, it sent before I finished typing.

I will ask her about your citation question. I also have an email to her in case she can get back to me sooner.

Thank you,
Whitney

Whitney Rowley | Technical Services Admin Assistant 2, Public Record Request Coordinator
Idaho Department of Environmental Quality
1410 N Hilton, Boise, ID 83706
Office: (208) 373-0193
www.deq.idaho.gov

Our mission: To protect public health and the quality of Idaho's air, land, and water.

From: Whitney Rowley
Sent: Tuesday, July 12, 2022 9:06 AM
To: 'Will Tiedemann' <wtiedemann@idahoconservation.org>
Subject: RE: Public Records Request #221273—ambient air quality monitoring and air permitting documents

Hi Will,

Your request for 221273, 221274, and 221275 were all combined into one request (See the attached email). Dianne Hobbs replied to these requests yesterday all under PRR 221273. The attorney who submitted the partial denial is out of the office. When she returns I will ask her about your

Whitney Rowley | Technical Services Admin Assistant 2, Public Record Request Coordinator
Idaho Department of Environmental Quality
1410 N Hilton, Boise, ID 83706
Office: (208) 373-0193
www.deq.idaho.gov

Our mission: To protect public health and the quality of Idaho's air, land, and water.

From: Will Tiedemann <wtiedemann@idahoconservation.org>
Sent: Monday, July 11, 2022 7:37 PM
To: Whitney Rowley <Whitney.Rowley@deq.idaho.gov>
Subject: Fwd: Public Records Request #221273—ambient air quality monitoring and air permitting documents

Hi Whitney,

In the attached partial denial, Idaho Code 74-104(1) is cited,

" (1) Any public record exempt from disclosure by federal or state law or federal regulations to the extent specifically provided for by such law or regulation."

Could you please specifically provide or cite the federal or state law/regulation that specially provided for this partial denial?

Also, does this response from Ms. Hobbs cover records request #221274, or will a separate response be coming?

-Will

---------- Forwarded message ---------
From: **Dianne Hobbs** <Dianne.Hobbs@deq.idaho.gov>
Date: Mon, Jul 11, 2022 at 4:43 PM
Subject: Public Records Request #221273—ambient air quality monitoring and air permitting documents
To: wtiedemann@idahoconservation.org <wtiedemann@idahoconservation.org>

Dear Mr. Tiedemann:
On June 27, 2022, the Idaho Department of Environmental Quality (DEQ) received a public records request from you regarding files we maintain. Attached are copies of the records that fall within the scope of your request.
If the processing of your request incurred any fees, DEQ will send an invoice in a separate mailing.
Sincerely,

Dianne Hobbs - Administrative Assistant
Idaho Department of Environmental Quality
1410 N Hilton St, Boise, ID 83706
208-373-0440

Our mission: To protect public health and the quality of Idaho's air, land, and water.

---------- Forwarded message ----------
From: Michael Simon <Michael.Simon@deq.idaho.gov>
To: Steve Miller <Steve.Miller@deq.idaho.gov>
Cc: Kevin Schilling <Kevin.Schilling@deq.idaho.gov>
Bcc:
Date: Thu, 21 Apr 2022 19:33:14 +0000
Subject: Perpetua Ambient Monitor
Steve:

In reading the public comments received on the proposed Perpetua PTC, including EPA10, we are in fact talking about a request for a post construction ambient air PM10 monitor. In talking with you earlier today, that sounded like a BAM.

Could you help us in providing a list of requirements (high level) that DEQ would need to consider/evaluate if we were to require a post construction ambient air monitor for this facility. Also, what would be the resource impact to DEQ if we had this monitor in the permit ?

Given the comments are asking for an ambient air monitor for PM-10 , I don't think we are going to consider an on-site monitor (within fence-line) given the complexities and time it would present to derive permit conditions that wouldn't address public concerns anyway.

Thx, Mike

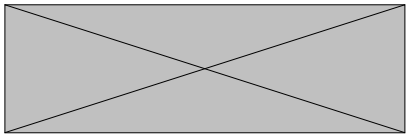
Mike Simon | Stationary Source Bureau Chief
Idaho Department of Environmental Quality
1410 N. Hilton St. Boise, ID 83706
Direct: 208.373.0212
Office: 208.373.0440
https://www.deq.idaho.gov/

Our mission: To protect human health and the quality of Idaho's air, land, and water.

--

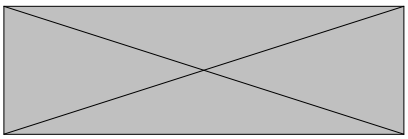
Will Tiedemann (he/his)
Conservation Associate
Idaho Conservation League
office: 208.286.4445

--



Will Tiedemann (he/his)
Conservation Associate
Idaho Conservation League
office: 208.286.4445

--



Will Tiedemann (he/his)
Conservation Associate
Idaho Conservation League
office: 208.286.4445

To: Michael Simon[Michael.Simon@deq.idaho.gov]; Darrin Pampaian[Darrin.Pampaian@deq.idaho.gov]
From: Kevin Schilling[/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=1e66edfe8d22405890a87efea72c3893-Kevin Schil]
Sent: Sun 9/11/2022 5:27:58 PM (UTC-06:00)
Subject: Re: IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 - Motion to Dismiss [SR-ACTIVE.FID4433167]

Mike,

On Page 13 under the paragraph titled "The use of representative precipitation data" it says that Petitioners "speculate that the precipitation data used to model fugitive PM emissions from the ore haul roads is not representative of actual precipitation at the SGP." The Petitioners' support is listed as the Guideline for Performing Air Quality Impact Analysis. There seems to be a misunderstanding by the Petitioners (and it was not caught by this motion) in that the precip data is not used in the dispersion modeling of fugitive dust. It is only used in the calculation of emission quantities. Therefore, the modeling guideline does not directly affect emission calculation beyond statements that emissions should represent potential/allowable rates. It may be beneficial to chat with Kelli and Pao how the precip was used in the emission calculation that went into the model for the 24-hour impact analysis.

From: Michael Simon <Michael.Simon@deq.idaho.gov>
Sent: Friday, September 9, 2022 8:57 AM
To: Kevin Schilling <Kevin.Schilling@deq.idaho.gov>; Darrin Pampaian <Darrin.Pampaian@deq.idaho.gov>
Subject: RE: IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 - Motion to Dismiss [SR-ACTIVE.FID4433167]

Thanks guys.

A write up on how petitioners didn't demonstrate claim of relief nor how DEQ failed to comply with federal and state laws.

From: Kevin Schilling <Kevin.Schilling@deq.idaho.gov>
Sent: Friday, September 09, 2022 7:39 AM
To: Darrin Pampaian <Darrin.Pampaian@deq.idaho.gov>; Michael Simon <Michael.Simon@deq.idaho.gov>
Subject: RE: IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 - Motion to Dismiss [SR-ACTIVE.FID4433167]

I'm still looking it over some, but from a "non-lawyer" standpoint, I don't see anything I have issues with.

From: Darrin Pampaian <Darrin.Pampaian@deq.idaho.gov>
Sent: Friday, September 9, 2022 7:34 AM
To: Michael Simon <Michael.Simon@deq.idaho.gov>; Kevin Schilling <Kevin.Schilling@deq.idaho.gov>
Subject: RE: IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 - Motion to Dismiss [SR-ACTIVE.FID4433167]

Looks fine to me.

Darrin

From: Michael Simon <Michael.Simon@deq.idaho.gov>
Sent: Thursday, September 08, 2022 5:14 PM
To: Darrin Pampaian <Darrin.Pampaian@deq.idaho.gov>; Kevin Schilling <Kevin.Schilling@deq.idaho.gov>
Subject: FW: IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 - Motion to Dismiss [SR-ACTIVE.FID4433167]

For your consumption. Let me know if you find anything in Perpetua's motion that you do not agree with.

Mike

From: Tiffany Floyd <Tiffany.Floyd@deq.idaho.gov>
Sent: Thursday, September 08, 2022 12:59 PM
To: Michael Simon <Michael.Simon@deq.idaho.gov>
Subject: FW: IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 - Motion to Dismiss [SR-ACTIVE.FID4433167]

From: John Shackelford <John.Shackelford@deq.idaho.gov>
Sent: Wednesday, September 7, 2022 6:34 AM
To: Tiffany Floyd <Tiffany.Floyd@deq.idaho.gov>
Subject: FW: IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 - Motion to Dismiss [SR-ACTIVE.FID4433167]

Good morning Tiffany. Here is Perpetua's motion to dismiss. Please review and let me know what you think, when you get a chance.

From: Foster, Wade C. <wade.foster@stoel.com>
Sent: Tuesday, September 6, 2022 5:11 PM
To: dylan@varinthomas.com; Paula Wilson <Paula.Wilson@deq.idaho.gov>; bhurlbutt@advocateswest.org; llucas@advocateswest.org; John Shackelford <John.Shackelford@deq.idaho.gov>; jthrower@mtntoplaw.com
Cc: McIntyre, Krista K. <krista.mcintyre@stoel.com>; Pooser, W. Christopher <christopher.pooser@stoel.com>; Sattler, Carla M. <carla.sattler@stoel.com>
Subject: IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 - Motion to Dismiss [SR-ACTIVE.FID4433167]

CAUTION: This email originated outside the State of Idaho network. Verify links and attachments BEFORE you click or open, even if you recognize and/or trust the sender. Contact your agency service desk with any concerns.

Please find attached Perpetua Resources Idaho's Motion to Dismiss the Petition to Initiate Contested Case.

Wade Foster | Attorney
STOEL RIVES LLP | 101 S. Capitol Boulevard, Suite 1900 | Boise, ID 83702
Direct: (208) 387-4265
wade.foster@stoel.com | Bio | vCard | www.stoel.com

This email may contain material that is confidential, privileged, and/or attorney work product for the sole use of the intended recipient. Any unauthorized review, use, or distribution is prohibited and may be unlawful.

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	
	)	Agency Case No. 0101-22-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON	)	OAH Case No. 23-245-01
Petitioners,	)	**PETITIONERS' RESPONSE TO RESPONDENT DEQ'S CROSS-MOTION FOR SUMMARY JUDGMENT and INTERVENOR PERPETUA'S MOTION FOR SUMMARY JUDGMENT and PETITIONERS' REPLY IN SUPPORT OF PETITIONERS' MOTION FOR SUMMARY JUDGMENT**
v.	)	
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC.	)	
Intervenor.	)	

TABLE OF CONTENTS

INTRODUCTION 1

ARGUMENT 2

I. PETITIONERS HAVE STANDING. 2

A. Petitioners' Standing Declarations. 2

B. Petitioners Will Suffer Injury in Fact From Increases in Air Pollution. 5

C. Petitioners' Injuries Are Fairly Traceable to DEQ's Issuance of the Permit, and a Favorable Decision Will Redress These Injuries. 9

II. EXCLUDING THE STIBNITE ROAD ACCESS ROUTE FROM AMBIENT AIR PROTECTIONS IS UNLAWFUL. 13

III. DEQ'(S) DETERMINATION THAT THE PROJECT WILL COMPLY WITH PM_{10} AND ARSENIC LIMITS IS ARBITRARY AND VIOLATES THE RULES 17

A. DEQ's Assumption that Perpetua Will Prevent 93.3% of Fugitive Dust Emissions Is Unreasonable and Violates the Air Rules Because the Permit Fails to Include Conditions Needed to Achieve This. 17

1. DEQ's determination that a combination of chemical dust suppressants and water would achieve the required dust control efficiency was arbitrary and capricious, and not supported by the permit record. 19

2. The permit lacks enforceable limits on how the dust control efficiency will be achieved to ensure compliance with PM_{10} NAAQS and arsenic AACC. 21

B. DEQ's Use of a "Surrogate Production Limits" in the Permit is Unreasonable and Does Not Ensure Compliance with PM_{10} NAAQS and Arsenic AACC. 24

C. DEQ Failed to Use Representative Precipitation Data. 27

IV. DEQ'S RELIANCE ON FUTURE PLANS TO BE PREPARED BY PERPETUA OUTSIDE OF THE PTC PROCESS VIOLATES THE AIR RULES AND THE CLEAN AIR ACT 27

V. DEQ MUST REQUIRE AMBIENT AIR MONITORING 34

VI. DEQ FAILED TO ANALYZE ECONOMIC INFORMATION AND ENVIRONMENTAL IMPACTS IN THE ARSENIC T-TRACT 36

VII. DEQ'S DETERMINATION THAT THE PROJECT WILL EMIT LESS THAT THE ARSENIC AACC HAS NO RATIONAL BASIS..... 40

CONCLUSION..... 46

TABLE OF AUTHORITIES

CASES

Ass'n of Irritated Residents v. EPA,
10 F.4th 937 (9th Cir. 2021) 7

Barnum Timber Co. v. EPA,
633 F.3d 894 (9th Cir. 2011) 10

Bennett v. Spear,
520 U.S. 154 (1997) 9

Beno v. Shalala,
30 F.3d 1057 (9th Cir. 1994) 11

Bonnichsen v. United States,
367 F.3d 864 (9th Cir. 2004) 11

Cal. Cmtys. Against Toxics v. EPA,
928 F.3d 1041 (D.C. Cir. 2019) 7

Carpenters Indus. Council v. Zinke,
854 F.3d 1 (D.C. Cir. 2017) 11

Citizens Against Linscott/Interstate Asphalt Plant v. Bonner Cnty. Bd. Of Comm'rs,
168 Idaho 705 (2021) 13

Covington v. Jefferson Cnty.,
358 F.3d 6256 (9th Cir. 2014) 7

Ctr. for Biological Diversity v. EPA,
861 F.3d 174 (D.C. Cir. 2017) 11

Env't Def. Ctr., Inc. v. U.S. EPA,
344 F.3d 832 (9th Cir. 2003) 32

Friends of the Earth v. Laidlaw Env't Servs. (TOC),
528 U.S. 167 (2000) 2

Hall v. Norton,
266 F.3d 969 (9th Cir. 2001) 9

Idaho Conservation League v. Atlanta Gold Corp.,
844 F. Supp. 2d 1116 (D. Idaho 2012) 9

In re Zappos.com, Inc.,
888 F.3d 1020 (9th Cir. 2018)..... 6

Koch v. Canyon Cnty.,
145 Idaho 158 (2008) 2

Massachusetts v. EPA,
549 U.S. 497 (2007) 11

Nobel v. Kootenai Cnty. Ex rel. Kootenai Cnty. Bd. Of Comm'rs,
148 Idaho 937 (2010) 13

NRDC v. EPA,
489 F.3d 1364 (D.C. Cir. 2007) 7

NRDC v. Sw. Marine, Inc.,
236 F.3d 985 (9th Cir. 2000) 9

Ocean Advocs. V. U.S. Army Corps of Eng'rs,
402 F.3d 846 (9th Cir. 2005) 5, 10

Powder River Basin Res. Council v. Wyo. DEQ,
226 P.3d 809 (Wyo. 2010)..... 28

Radford v. Van Orden,
168 Idaho 287 (2021) 2

Resisting Env't Destruction on Indigenous Lands, REDOIL v. EPA,
716 F.3d 1155 (9th Cir. 2013)..... 14

Sierra Club v. EPA,
755 F.3d 968 (D.C. Cir. 2014) 7

Sierra Club v. EPA,
762 F.3d 977 (9th Cir. 2014) 7

Sierra Club v. EPA,
972 F.3d 290 (3rd Cir. 2020) 7

Sierra Club v. Morton,
405 U.S. 727 (1972) 6

Summers v. Earth Island Inst.,
555 U.S. 488 (2009) 6-7

Tozzi v. U.S. Dep't of Health & Hum. Servs.,

271 F.3d 301 (D.C. Cir. 2001) 12

United States v. Students Challenging Regul. Agency Procs.,
412 U.S. 669 (1973) 6

Waste Action Proj. v. Draper Valley Holdings, LLC,
49 F. Supp. 3d 799 (W.D. Wash. 2014) 5

Waterkeeper All., Inc. v. EPA,
399 F.3d 486 (2d Cir. 2005).....32, 33, 34

WildEarth Guardians v. BLM,
8 F. Supp. 3d 17 (D.D.C. 2014) 7

REGULATIONS

40 C.F.R. 52.21(b) 22

OTHER AUTHORITIES

Idaho Code § 67-6521(1))(1)..... 13

AIR RULES

IDAPA 58.01.01.006.36..... 22

IDAPA 58.01.01.202 28

IDAPA 58.01.01.202.01.a.i.....28, 31

IDAPA 58.01.01.209.01.c..... 28

IDAPA 58.01.01.209.01.c.i.....28, 31

IDAPA 58.01.01.210.12.....42. 45

IDAPA 58.01.01.210.12.b.....43, 45

IDAPA 58.01.01.210.12.c..... 44

IDAPA 58.01.01.210.14..... 36-40

IDAPA 58.01.01.210.14.a.....37, 38
IDAPA 58.01.01.210.14.b..... 38

IDAPA 58.01.01.210.14.c.....38, 39

IDAPA 58.01.01.210.14.c.i 40

IDAPA 58.01.01.210.14.c.ii 39

IDAPA 58.01.01.210.14.d 38

IDAPA 58.01.01.210.14.d.iii 40

IDAPA 58.01.01.210.15 ..... 41, 42

IDAPA 58.01.01.586 ..... 42, 45

INTRODUCTION

In their Cross Motions for Summary Judgment, the Idaho Department of Environmental Quality ("DEQ") and Perpetua Resources Idaho, Inc. ("Perpetua") (collectively, "Respondents") first assert that Petitioners lack standing to challenge DEQ's issuance of the permit to construct ("Permit"). The Permit authorizes the construction and operation of a mine which will emit coarse particulate matter ("PM_{10}") and arsenic for 16 years: pollutants known to adversely affect human health and the environment. Yet, Respondents argue that neither the Nez Perce Tribe (whose exclusive aboriginal home and treaty rights area includes the Stibnite Gold Project site and its surrounds), the Idaho Conservation League (the state's largest conservation organization), nor Save the South Fork Salmon (a group formed by locals specifically around concerns about the Project's impacts on the South Fork Salmon River watershed) have standing. Petitioners are submitting several declarations herewith attesting to the many ways that they are injured by DEQ's errors in issuing the defective Permit, confirming their standing. Moreover, Respondents' standing arguments would conflict with precedent, and create insurmountable hurdles to bringing contested cases. The Hearing Officer must reject these arguments.

Turning to the merits, Respondents' briefs repeatedly point to DEQ's "discretion" and "expertise" to excuse the errors DEQ made when it issued the Permit. However, in many of these instances DEQ neither has discretion nor the expertise implicated, as discussed below. Even in those instances where DEQ has discretion or relevant expertise, these are not valid excuses for making arbitrary or capricious decisions, nor do they allow DEQ to deviate from the Air Rules (IDAPA 58.01.01), and other governing authorities, as it did here. The Hearing Officer should grant summary judgment for Petitioners, set aside the Permit, and remand to DEQ to correct these errors.

ARGUMENT

I. PETITIONERS HAVE STANDING.

A. Petitioners' Standing Declarations.

"Th[e Idaho Supreme] Court has adopted the federal justiciability standard. 'When deciding whether a party has standing, [the Idaho Supreme Court has] looked to decisions of the United States Supreme Court for guidance.'" *Radford v. Van Orden*, 168 Idaho 287, 299 (2021) (quoting *Koch v. Canyon Cnty.*, 145 Idaho 158, 161 (2008) (internal citations omitted)). An organization has "standing to bring suit on behalf of its members when its members would otherwise have standing to sue in their own right, the interests at stake are germane to the organization's purpose, and neither the claim asserted, nor the relief requested requires the participation of individual members in the lawsuit." *Friends of the Earth v. Laidlaw Env't Servs. (TOC)*, 528 U.S. 167, 169 (2000). For a member to have standing in their own right: (1) the member must suffer an "injury in fact" that is "(a) concrete and particularized and (b) actual or imminent, not conjectural or hypothetical;" (2) the injury must be "fairly traceable to the challenged action;" and (3) it must be "likely, as opposed to merely speculative, that the injury will be redressed by a favorable decision." *Friends of the Earth*, 528 U.S. at 180–81.

Petitioners Nez Perce Tribe (the "Tribe"), Idaho Conservation League ("ICL"), and Save the South Fork Salmon ("SSFS") each have standing to challenge DEQ's issuance of the Permit to Perpetua. The Permit authorizes 16 years of air pollution from the Stibnite Gold Project ("Project"), including coarse particulate matter ("PM_{10}") pollution and arsenic pollution. Eliminating or minimizing air pollution is germane to each Petitioners' purpose and directly harms their members' health, cultural, recreational, aesthetic, and other interests, as was alleged

in the Petition for Contested Case and is confirmed by the declarations from members of each Petitioner organization submitted herewith.

ICL submits standing declarations from its members Jonathan Oppenheimer, Allison Fowle, and Asa Menlove. Mr. Oppenheimer has worked at ICL since 2002, and has been an ICL member for even longer. Oppenheimer Decl. ¶ 2. Founded in 1973, ICL is Idaho's largest state-based conservation organization. *Id.* ¶ 3. Advocating for responsible mining practices, including by engaging in agency permitting processes, is central to ICL's mission to protect the air Idahoan's breathe, the water they drink, and the land and wildlife they love. *Id.* ¶¶ 3–4.

As Exhibit A to Mr. Oppenheimer's declaration shows, EPA has found that there is a no-threshold relationship between PM exposure and several adverse health effects, meaning any increase in PM can have negative health effects. *See id.* ¶ 15 & Ex. A. Exhibit B to Mr. Oppenheimer's declaration is a study titled, "Health Effects Associated with Inhalation of Airborne Arsenic Arising from Mining Operations," which links the inhalation of arsenic-bearing dusts to increased arsenic uptake and adverse carcinogenic and non-carcinogenic health outcomes. *See id.* ¶ 16 & Ex. B.

ICL's declarants have each regularly visited the South Fork Salmon River ("SFSR") watershed, including in the East Fork SFSR drainage, and intend to continue doing so, including specific plans to visit this year and/or next. Oppenheimer Decl. ¶¶ 9–13; Fowle Decl. ¶¶ 3–6, 9–10; Menlove Decl. ¶¶ 7, 9–10. Because of the Project's dust and arsenic emissions, ICL's declarants will suffer health risks when they visit these areas; will suffer degradation of their recreational, environmental, and aesthetic interests; and/or will no longer visit these areas. Oppenheimer Decl. ¶¶ 15–18; Fowle Decl. ¶¶ 7–8, 11; Menlove Decl. ¶¶ 7–11.

SSFS submits standing declarations from its members Zak Sears and Drew Hollenback. SSFS's mission is to protect and preserve the biological resources of the SFSR watershed, including from the threats posed by the Project. Sears Decl. ¶ 2; Hollenback Decl. ¶ 2. SSFS's declarants have each regularly visited the SFSR watershed, including in the East Fork SFSR drainage, and intend to continue doing so, including specific plans to visit this year and beyond. Sears Decl. ¶¶ 5–12; Hollenback Decl. ¶¶ 4–9. Because of the Project's dust and arsenic emissions, SSFS's declarants will suffer health risks when they visit these areas; will suffer degradation of their recreational, environmental, and aesthetic interests; and/or will no longer visit these areas. Sears Decl. ¶¶ 12–21; Hollenback Decl. ¶¶ 10–14.

The Tribe submits the declarations of Joseph Oatman and Emmit Taylor Jr. Mr. Taylor is an enrolled member of the Tribe and is Director of the Tribe's Department of Fisheries and Resources Management ("DFRM"), Watershed Division. Taylor Decl. ¶ 2. Mr. Oatman is an enrolled member of the Tribe and is DFRM's Deputy Program Manager. Oatman Decl. ¶ 2. As Mr. Oatman states:

> Since time immemorial, the Nez Perce people, the Nimiipuu, exclusively occupied over 13 million acres encompassing a large part of what is today Idaho, Washington, and Oregon—stretching from the Bitterroot Mountains to the Blue Mountains. Nez Perce also traveled far beyond this homeland to fish, hunt, gather and pasture—frequently going east to buffalo country, in what is today Montana, and west along the Snake and Columbia Rivers. In 1855, to preserve its way of life and the foods we depend upon, the Tribe entered into a treaty with the United States reserving to itself, among other guarantees, "the right of taking fish at all usual and accustomed places in common with the citizens of the Territory." Treaty with the Nez Perces, June 11, 1855 (12 Stat. 957). Since that time, the Tribe has continued to exercise its treaty-reserved fishing, hunting, gathering, and pasturing rights. It is essential for tribal members to maintain connection with the rivers, lands, and fish that are critical to supporting our culture and livelihoods. Nez Perce Tribal members, pursuant to the Tribe's Treaty-reserved rights, continue to fish, hunt, gather and pasture across the Tribe's vast aboriginal homeland at traditional places, including areas within and surrounding the proposed Stibnite Gold Project ("SGP") area and in waters directly downstream.

Id. ¶ 4. The Tribe has one of the largest fisheries programs in the United States, and DFRM's goal is to recover and restore all populations and species of anadromous and resident fish that are important to exercising the Tribe's treaty-reserved rights and way of life. *Id.* ¶ 8. To that end, DFRM works extensively throughout the SFSR watershed, including moving some Chinook salmon above the "Glory Hole" legacy mine pit at the Project site that blocks salmon from migrating to their spawning grounds farther upstream in the East Fork SFSR. *Id.* ¶ 9.

Mr. Taylor and Mr. Oatman have engaged in treaty fishing within the Project's boundaries and intend to do so in the future. Mr. Taylor and Mr. Oatman and their families also regularly visit the SFSR watershed, including Johnson Creek and the East Fork SFSR drainage, as their families have for generations, and as they plan to continue doing, to gather, hunt, fish, express their culture and identity, and connect to their history, their ancestors, and the land and rivers. Taylor Decl. ¶¶ 5–9; Oatman Decl. ¶¶ 5–7. Because of the Project's dust and arsenic emissions, the Tribe's declarants will suffer health risks when they visit these areas, and will suffer degradation of their subsistence, cultural, spiritual, and economic interests. Taylor Decl. ¶ 9; Oatman Decl. ¶ 7.

B. Petitioners Will Suffer Injury in Fact from Increases in Air Pollution.

"The alleged injury need not be large: an actual and genuine loss, even if a trifle, will suffice for standing purposes." *Waste Action Proj. v. Draper Valley Holdings LLC*, 49 F. Supp. 3d 799, 802 (W.D. Wash. 2014). "[N]othing necessitates a showing of existing environmental harm." *Ocean Advocs. v. U.S. Army Corps of Eng'rs*, 402 F.3d 846, 860 (9th Cir. 2005). Rather, "an increased risk of harm can itself be injury in fact for standing." *Id.*; *see also In re*

Zappos.com, Inc., 888 F.3d 1020, 1026–29 (9th Cir. 2018) (finding sufficient risk of future harm).

DEQ argues that Petitioners have not shown injury in fact because they cannot distinguish themselves from the general public. *See* DEQ Resp. at 8–9.[1] This is wrong. As shown in the declarations described above, Petitioners—unlike the general public—regularly visit the area in and around the Project site on the East Fork SFSR, and will be directly harmed by breathing air with increased concentrations of PM_{10} and arsenic when they visit the area in the future if the Permit remains in effect as approved by DEQ.

Moreover, the U.S. Supreme Court rejected the same argument fifty years ago, stating:

> Aesthetic and environmental well-being, like economic well-being, are important ingredients of the quality of life in our society, and the fact that particular environmental interests are shared by the many rather than the few does not make them less deserving of legal protection through the judicial process.

United States v. Students Challenging Regul. Agency Procs., 412 U.S. 669, 687 (1973) (quoting *Sierra Club v. Morton*, 405 U.S. 727, 734 (1972)). "Consequently, neither the fact that the appellees here claimed only a harm to their use and enjoyment of the natural resources of the Washington area, nor the fact that all those who use those resources suffered the same harm, deprives them of standing." *Id.* at 686–87. "To deny standing to persons who are in fact injured simply because many others are also injured, would mean that the most injurious and widespread Government actions could be questioned by nobody." *Id.* at 688; *see also Summers v. Earth*

[1] DEQ's Response to Petitioners' Motion for Summary Judgment and Brief in Support of Cross Motion for Summary Judgment is abbreviated as "DEQ Resp" followed by the page number. Perpetua's Memorandum in Support of Intervenor-Respondent's Motion for Summary Judgment and in Opposition to Petitioners' Motion for Summary Judgment is abbreviated as "Perpetua Opp'n" followed by the page number. Petitioners' Opening Summary Judgment Brief is abbreviated as "Pet'rs' Mot. Summ. J." followed by the page number.

Island Inst., 555 U.S. 488, 494 (2009) ("While generalized harm to the forest or the environment will not alone support standing, if that harm in fact affects the recreational or even the mere esthetic interest of the plaintiff, that will suffice.").

Federal courts consistently find health, aesthetic, and recreational risks from pollution sufficient to confer standing. *See Friends of the Earth*, 528 U.S. at 183–84 (injury from observing pollutants discharged into water and from alterations of behavior as a result of pollution risk); *Sierra Club v. EPA*, 972 F.3d 290, 299 (3d Cir. 2020) (injury to members whose health, recreational, aesthetic, and economic interests were affected by ozone pollution); *Covington v. Jefferson Cnty.*, 358 F.3d 626, 641 (9th Cir. 2004) (injury to plaintiff's property from RCRA-covered leaking substances caused by a failure to follow Clean Air Act procedures); *Sierra Club v. EPA*, 762 F.3d 971, 977 (9th Cir. 2014) (injury to members with existing respiratory problems and other members who fear the pollution caused by a permit issued to a power company would impact their health); *Ass'n of Irritated Residents v. EPA*, 10 F.4th 937, 943 (9th Cir. 2021) (injury where members' recreational, aesthetic, and health interests were affected by the approval of an inadequate state implementation plan); *Nat. Res. Def. Council v. EPA*, 489 F.3d 1364, 1370–71 (D.C. Cir. 2007) (injury where members "use[d] or live[d] in areas affected by the [pollutant] sources"); *Cal. Cmtys. Against Toxics v. EPA*, 928 F.3d 1041, 1049 (D.C. Cir. 2019) (injury where members lived, commuted, worked, and recreated near a pollution source and would "spend less time outdoors," or have diminished ability to enjoy the outdoors because of fear of health and environmental harms); *Sierra Club v. EPA*, 755 F.3d 968, 974 (D.C. Cir. 2014) (injury resulting in "behavioral changes" from fear of hazardous waste exposure); *WildEarth Guardians v. BLM*, 8 F. Supp. 3d 17, 28 (D.D.C. 2014) (injury from "increase in pollution" that would diminish member's aesthetic, recreational enjoyment).

DEQ's reliance on *Selkirk-Priest Basin Ass'n v. State ex rel. Batt*, 128 Idaho 831 (1996) ("*SPBA*"), and the Board of Environmental Quality order in *In re Simmons Sanitation*, Docket No. 0106-05-01 (Sept. 26, 2005), is misplaced. *See* DEQ Resp. at 6–7. In both matters, the organizations failed to provide the types of detailed, specific information Petitioners provide here in their member declarations attesting to their regular use and enjoyment of specific places that will have increased air pollution, their specific plans to return to these areas, the specific ways in which their experiences will be degraded, and (for some) their concern that they might have to alter their behavior and avoid these places. And in neither case did members show direct health risks to themselves from exposure to increased pollution, like every one of Petitioners' members has attested to here.

In *In re Section 401 Water Quality Certification for Relicensing of the C.J. Strike Hydroelectric Facility*, Docket No. 0102-01-06, at 14 (2002), the Board found Idaho Rivers United established representational standing based on members affidavits stating that they hiked, camped, boated, bird watched, and mountain biked in the area but avoided fishing and swimming in the water because of water quality concerns. Similarly here, Petitioners' members have documented their recreational, aesthetic, and environmental interests in the Project site and nearby areas in the East Fork SFSR drainage, the injuries they will suffer as the members might avoid these activities due to air quality concerns, or if they do still engage in these activities, their experiences will be degraded. Additionally, by continuing to engage in activities in these areas, their health will suffer from increased PM_{10} and arsenic inhalation, further conferring standing beyond what sufficed in *C.J. Strike*.

C. Petitioners' Injuries Are Fairly Traceable to DEQ's Issuance of the Permit, and a Favorable Decision Will Redress These Injuries.

In addition to suffering injury in fact, Petitioners satisfy the remaining elements of standing, because each of their injuries are "fairly traceable" to DEQ's issuance of the Permit, and a favorable decision setting aside and/or remanding the Permit to DEQ to correct errors identified by Petitioners would redress these injuries.

To be "fairly traceable," the causal connection between the injury and the challenged action cannot be too speculative or the result of the independent action of some third party not before the court. *Bennett v. Spear*, 520 U.S. 154, 167 (1997). There is nothing speculative about Petitioners' injuries, which are obviously caused by DEQ's issuance of the Permit, which is required for Perpetua to construct and operate the Project. But for DEQ's issuance of the Permit, Perpetua cannot construct and operate the Project. And there is no dispute that constructing and operating the Project will generate air pollutants—as DEQ's own modeling confirms. This increase in air pollutants will cause the injuries asserted in the declarations submitted by Petitioners' members.

Traceability does not require an absolute certainty, *see Ass'n of Irritated Residents*, 10 F.4th at 944, or a "scientific certainty" that the defendant's actions caused the petitioner's harm. *See Idaho Conservation League v. Atlanta Gold Corp.*, 844 F. Supp. 2d 1116, 1130 (D. Idaho 2012) (quoting *Nat. Res. Def. Council v. Sw. Marine, Inc.*, 236 F.3d 985, 995 (9th Cir. 2000)). Rather, petitioners need only establish that the challenged action has a reasonable probability of threatening a member's concrete interest. *Hall v. Norton*, 266 F.3d 969, 977 (9th Cir. 2001). Petitioners also do not need to show that DEQ's approval of the Permit is the "sole source" of its members' injuries and "need not eliminate any other contributing causes to

establish its standing." *Barnum Timber Co. v. EPA*, 633 F.3d 894, 901 (9th Cir. 2011). *See also Ocean Advocs.*, 402 F.3d at 860 (finding causation even though other factors also caused plaintiffs' injury). Members of Petitioners organizations assert that they will be harmed when they encounter increased air pollution.

DEQ's reliance on *Rebound v. Idaho Dept. of Health & Welfare*, Docket No. 0101-99-07 (Jan. 19, 2002) is misplaced. *See* DEQ Resp. at 9-10. There, the Board held that Rebound (a trade union group) failed to establish standing to challenge a permit modification to add additional equipment to a power plant. *Rebound* at 2. To try to establish organizational standing, Rebound relied on another trade union group and fellow petitioner, IBEW Local, as an organizational member, and relied on affidavits from IBEW local members and other area residents. *Id.* at 3–4. The Board held that Rebound failed to establish standing for many reasons, including because: IBEW Local's mission did not have anything to do with environmental advocacy; Rebound failed to show how IBEW Local members gave it standing; it was unclear whether the area residents who submitted affidavits were actual Rebound members; and the affidavits failed to identify any specific injury, so it was not possible to establish a direct link between increased emissions from the modification and the asserted general injuries. *Id.* Petitioners' declarations here are far more specific, direct, and factual in establishing each Petitioner's interests and injuries caused by the Permit.

DEQ also relies on *Solomon v. IDEQ*, Docket No. 0101-03-01 (2003), DEQ Resp. at 10, where, similar to *Rebound*, petitioners failed to provide sufficient evidence in their affidavits establishing an injury in fact that was caused by DEQ's issuance of two permits instead of one for a facility. *See Solomon* at 6. And DEQ relies on *Rickards v. Idaho Dept. of Health & Welfare*, Docket No. 0101-92-12 (Dec. 18, 1992), *see* DEQ Resp. at 10, where the Board found that the

pro se petitioner failed to establish standing because his injury—driving past the proposed emitting source—was too speculative and failed to make a connection to the challenged action due to his failure in providing affidavits or other certified documentation supporting his contentions. *See Rickards* at 2–4, 11.

By contrast, here (as already discussed), environmental advocacy—including specifically in the SFSR watershed—are central to the missions of Petitioners' organizations; every declarant is a member of one of the organizations; and the declarants point to specific, direct injuries they will suffer from the increased air pollution—including the health risks of breathing in PM_{10} and arsenic—that will occur from the construction and operation of mine, as approved by DEQ. This satisfies causation.

To satisfy redressability, Petitioners must allege that "it is likely, as opposed to merely speculative," that their injuries "will be redressed by a favorable decision." *Friends of the Earth*, 528 U.S. at 181. A plaintiff meets the redressability requirement if it is likely, even if not necessarily certain or inevitable, that the injury can be redressed by a favorable decision. *See Bonnichsen v. United States*, 367 F.3d 864, 873 (9th Cir. 2004); *Beno v. Shalala*, 30 F.3d 1057, 1065 (9th Cir. 1994). It is sufficient to show that the requested remedy would "slow or reduce" the harm. *Massachusetts v. EPA*, 549 U.S. 497, 525 (2007). For procedural injuries, Petitioners need only show that the agency "could reach a different conclusion" if required to reconsider their decisions. *Ctr. for Biological Diversity v. EPA*, 861 F.3d 174, 185 (D.C. Cir. 2017). "Causation and redressability typically 'overlap as two sides of a causation coin'" because "if a government action causes an injury, enjoining the action usually will redress that injury." *Carpenters Indus. Council v. Zinke*, 854 F.3d 1, 6 n.1 (D.C. Cir. 2017).

If the Hearing Officer sets aside the Permit (as Petitioners have requested), this will unquestionably redress Petitioners' injuries because the Project (and the air pollution it will cause) cannot commence without a permit to construct ("PTC"). Additionally, remanding the Permit to DEQ to reconsider and correct any of the errors Petitioners have alleged (as Petitioners have requested) will also redress Petitioners' injuries. Correcting the ambient air boundary so that the Stibnite Road Access Route ("Route") is no longer considered part of the mine site will require Perpetua to further reduce its emissions in order to meet air quality standards, thereby lowering the air pollution Petitioners members will experience when they use the Route. *See infra* Part II. Developing and including in the Permit more robust and specific conditions and limits to ensure Perpetua achieves PM_{10} and arsenic emissions control levels will slow or reduce air pollution emissions, and will better ensure projected emissions levels are indeed met throughout the life of the Project and, if not, that any violations can be more readily enforced. *See infra* Parts III, V–VI. Removing the 16/70 allowance in arsenic concentrations DEQ approved in the Permit will require Perpetua to reduce its arsenic emissions. *See infra* Part VII. Finally, requiring Perpetua to submit to DEQ its "work plans" as part of the public permitting process, instead of letting Perpetua submit them later, will allow for public comments and more robust review by DEQ, which could result in a different decision. *See infra* Part IV. Petitioners, thus, satisfy redressability for both their substantive and procedural claims because they adequately alleged their members could get "at least some" relief. *Tozzi v. U.S. Dep't of Health & Hum. Servs.*, 271 F.3d 301, 310 (D.C. Cir. 2001).

In sum, Petitioners have adequately alleged—and documented through their member declarations—all elements of standing based on the harm the Project's air emissions will cause to

their members' health, aesthetic, recreational, environmental, and other interests within and surrounding the Project area.[2]

II. EXCLUDING THE STIBNITE ROAD ACCESS ROUTE FROM AMBIENT AIR PROTECTIONS IS UNLAWFUL.

Under the current Permit, the Route will be open to the Tribe and general public and the air above it will be excluded from ambient air protections. *See* PET 310.[3] In other words, it will be polluted with undisclosed and unregulated amounts of PM_{10} and arsenic, and other criteria, toxic, or hazardous air pollutants as the health-based limits established under the Clean Air Act ("CAA") and the Idaho Air Rules will not apply.[4] As stated in Perpetua's brief, "the boundary of the project's 'ambient air' is important," and the Route is particularly important to local residents who have used the existing road through the mine site to access high-value recreational and

[2] Respondents also argue Petitioners have failed to show DEQ's issuance of the Permit prejudices their substantial rights under I.C. § 67-5279(4). *See* DEQ Resp. at 13–14, 17; Perpetua Opp'n at 10, 27. First, this requirement only applies to the relief courts can grant when reviewing agency decisions, and does not apply to this contested case. Second, for the same reasons Petitioners have standing, they also show DEQ's decision prejudices their substantial rights, including by jeopardizing their health and well-being, as well as their recreational, cultural, aesthetic, and environmental interests, and by depriving Petitioners of the ability to meaningfully participate in DEQ's permitting process. *See Citizens Against Linscott/Interstate Asphalt Plant v. Bonner Cnty. Bd. of Comm'rs*, 168 Idaho 705, 716 (2021) ("A right is substantial if it could impact the outcome of the litigation."). Finally, the cases cited by DEQ involve land use decisions governed by the Idaho Local Land Use and Planning Act, Idaho Code § 67-6501 *et. seq.*, that has specific provisions defining who is an "affected person," *id.* § 67-6521(1), under which the substantial right inquiry is reviewed. *See* DEQ Resp. at 14, 17 (citing *Noble v. Kootenai Cnty. ex rel. Kootenai Cnty. Bd. of Comm'rs*, 148 Idaho 937 (2010)).

[3] "PET" followed by a Bates number corresponds to Petitioners' exhibits; "PRI" followed by a Bates number corresponds to Perpetua's exhibits.

[4] DEQ states that "[i]t is unclear from the Petitioners' argument exactly how far from the Route the 'ambient air' boundary should extend from either side of the road." DEQ Resp. at 22. However, that determination is not Petitioners' responsibility, but DEQ's responsibility as the permitting agency.

cultural sites on public lands, and who intend to continue to do so. Perpetua's Opp'n at 6; *see supra* Part I.

DEQ's arbitrary and unsupported determination that Perpetua has the ability to *preclude* tribal and public access and then to label the general public traveling on the Route as "guests of the mine," *see* PET 570, to avoid either of two undesirable outcomes—prohibiting tribal and public access to the Route or ensuring the air above the Route complies with air quality standards—is not within the agency's technical expertise, is not entitled to deference, and is wrong.[5] *See* DEQ Resp. at 22; Perpetua Opp'n at 16. The Hearing Officer should vacate the Permit and remand it to DEQ to fix this error.

First, DEQ's assertion that Perpetua has the "legal authority to prohibit access by the 'general public'" is incorrect. DEQ Resp. at 23. According to EPA's Revised Policy on Exclusions from "Ambient Air," there are two policy conditions that determine whether the general public has access: "whether the general public has access in a *legal* sense" and "whether the general public has access in a *practical or physical* sense."[6] PET 774, 776. In this case,

[5] Perpetua mistakenly relies on *Resisting Environmental Destruction on Indigenous Lands, REDOIL v. EPA*, 716 F.3d 1155 (9th Cir. 2013). Perpetua Opp'n at 18–19. The issue there was whether it was reasonable for EPA to apply the ambient air exclusion policy to the area over water versus land. *REDOIL*, 716 F.3d at 1165. Contrary to Perpetua's assertion, the *REDOIL* case did not involve an "air boundary exemption" that allowed the public to access non-ambient air such as what Perpetua is trying to do here. *See* Perpetua Opp'n at 21; *REDOIL*, 716 F.3d at 1159 (stating that in addition to the U.S. Coast Guard's "establishment of an effective safety zone that *prohibits* members of the public from entering the area[,] Shell must also develop and implement a public access control program to [ ] notify the general public of the *prohibition* on entering the safety zone . . . .") (emphasis added).

[6] DEQ argues that in the application of its definition of ambient air, it does not need to be consistent with EPA's policy, DEQ Resp. at 22; Perpetua, however, argues that DEQ "followed EPA guidance," Perpetua Opp'n at 16. Regardless, under the CAA and its regulations which are incorporated into IDAPA 58.01.01 ("Idaho Air Rules") Section 107.03.c, "the air agency must still determine, based on the administrative record for the permit, that the *general public does not*

although Respondents argue that Perpetua can preclude public access in the practical or physical sense by using "security escort vehicles, manned guardhouses, locked gates, barriers, warning signs, and registration of" those accessing the Route, DEQ Resp. at 23, it cannot reasonably determine that the Tribe and public do not have access in a legal sense.

Indeed, the mine plan that is in front of the U.S. Forest Service for review and approval requires that "public access through the site would be provided by" the new Route. PET 957. *See also* PET 905 (indicating that during operations "public access" will be provided "through the Operations Area Boundary [ ] by constructing new road through Yellow Pine pit and below mine haul road to link Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375)"); PET 964 ("The 2021 [Modified Mine Plan] would include a 12-foot-wide gravel road to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375) through the SGP."); PET 838 (same). Additionally, the Route will be open seasonally to the public, as it is now, and Perpetua can only temporarily prohibit public access when there are "concerns related to public or employee health and safety, such as during blasting, mining in the immediate area of the road and other similar operations." PET 838. *See also id.* ("During operations, the public access road would be used to travel through the mine site and would provide seasonal use, open to all vehicles."); PET 1240 ("The public access road would not be plowed in the winter (current county maintenance standards) and signs would inform the public of seasonal and *temporary* closures.") (emphasis added); *id.* ("The through-site public access would be seasonal, similar to current conditions."). Thus, although Perpetua may have the ability to exclude the public "in a

have access to the property in order to exclude an area from ambient air." PET 773 (emphasis added) (footnote omitted).

practical or physical sense" (though this is questionable),[7] it does not, under the mining plan submitted to the U.S. Forest Service, have "the right to preclude the general public's access." PET 776.

Second, it was unreasonable to label the Tribe or public traveling on the Route as "guests of the mine." *See* PET 839 (stating that DEQ's approach to excluding the Route from ambient air protections was that "people traveling on the road would be considered 'guests of the mine.'"). Nothing in the Idaho Air Rules, DEQ's guidance, or EPA policy suggests that, because "access for all guests will be carefully managed," the Tribe or the public are not afforded the protections of ambient air under the CAA. *See* DEQ Resp. at 23; *see also* Perpetua Opp'n at 21 ("Those that seek access must be required to register at the access gate and will be informed that they are proceeding as guests of Perpetua rather than members of the public."). Notably, Respondents do not point to a single case where DEQ has allowed the general public to travel through a facility where the route is exempt from ambient air protections.

DEQ's reference to "business invitees" in EPA's Revised Policy only hurts its case. *See* DEQ Resp. at 23. There, EPA made the distinction between the general public and true "guests of the mine"—others who may have legal and practical access to a site but who would not be afforded air quality protections, such as "employees of the owner or operator who work at the site, or 'business invitees,' such as contractors or delivery persons." PET 776. Respondents cannot reasonably argue that the Tribe or its members traveling to or through the mine site to

[7] It is also questionable whether Perpetua can exclude the public, consistent with EPA's policy, in a practical sense. Although the public traveling to access the road might have to comply with stated safety procedures by stopping at the gate, registering, and following a pilot car, there is no apparent ability for Perpetua to physically exclude the public from accessing the Route if they comply with these procedures.

exercise Treaty-reserved rights, or for the general public to travel through the site to access public lands, who have not been invited by Perpetua, who are not doing business with Perpetua, and who will not be allowed to deviate off of the Route are nonetheless "guests of the mine."

The record thus does not, and cannot, demonstrate that Perpetua may legally or practically preclude Tribal or public access to the Route, and DEQ's determination to the contrary was unreasonable, as was its decision to label the public as "guests of the mine." DEQ's determination was not well-reasoned, and is inconsistent with the Idaho Air Rules, the CAA, and EPA policy. The Hearing Officer should vacate the permit and remand it back to DEQ for further review.

III. DEQ'S DETERMINATION THAT THE PROJECT WILL COMPLY WITH PM_{10} AND ARSENIC LIMITS IS ARBITRARY AND VIOLATES THE AIR RULES.

Even using DEQ's ambient air boundary, DEQ's determination that the Project's potential to emit will not cause or contribute to an exceedance of the PM_{10} National Ambient Air Quality Standards ("NAAQS") and the arsenic acceptable ambient concentrations for carcinogens ("AACC")—as required under Section 203 of the Air Rules prior to issuing a PTC—are arbitrary and capricious, violate the Air Rules, and must be set aside and remanded. *See* Pet'rs' Mot. Summ. J. at 19–28.

A. DEQ's Assumption that Perpetua Will Prevent 93.3% of Fugitive Dust Emissions Is Unreasonable and Violates the Air Rules Because the Permit Fails to Include Conditions Needed to Achieve This.

There is no dispute that a critical factor affecting fugitive dust emissions, and therefore whether the Project will comply with the PM_{10} NAAQS and arsenic AACC limits, is the degree to which Perpetua can effectively control dust from haul roads. It is evident from the permit record that in order for this mine to extract, haul, and process the 180,000 tons of ore per day

needed to meet Perpetua's desired production capacity—a capacity allowed under the Permit conditions—and still comply with PM_{10} NAAQS and arsenic AACC, Perpetua must control the dust to a 93.3% efficiency. *See* Pet'rs' Mot. Summ. J. 19–23. Nothing less will suffice. *See* PET 275 ("[I]t is critical for NAAQS compliance that this high level of control be achieved."); *see also* PET 325 (same), PET 328 (same); PET 325–26 (finding that cutting operations with only 90% dust control would still cause exceedances of the PM_{10} 24-hour NAAQS).

As explained in Petitioners' Opening Brief, the record shows that 93.3% is a very high and aggressive level of control; EPA and other commenters questioned whether this was even achievable by applying chemicals and water as Perpetua plans to do. Pet'rs' Mot. Summ. J. at 19–20. DEQ itself recognized that it will be "challenging to consistently and continuously achieve the targeted level of fugitive dust control." PET 065. Later in the Statement of Basis ("SOB"), DEQ admitted that meeting 93.3% was based on an "assumption" that Perpetua would appropriately apply water and magnesium chloride, "vigilant inspection and monitoring" would be required, and additional measures—not in the Permit—would be necessary in the Fugitive Dust Control Plan ("FDCP") Perpetua will develop later. PET 090. Accordingly, DEQ failed to reasonably determine that 93.3% dust control efficiency was achievable either by the chemical/water method, or by the particular means of application.

Respondents first argue that the record shows 93.3% is achievable. *See* Perpetua Opp'n at 22–23. It does not. Moreover, and addressed more below, Petitioners emphasized that this largely misses the point. Again, DEQ admits that 93.3% is a high, aggressive, and a "challenging" level to achieve. PET 065, 263, 325. Instead of resting on an "assumption" that Perpetua will be "vigilant" and implement the necessary control procedures (procedures that remain unspecified and for future development in various "plans"), DEQ should have developed

and included in the Permit the limits and conditions necessary to ensure 93.3% will be achieved. DEQ modeling staff "recommend[ed] that the permit require an aggressive implementation of measures to achieve above 93% control efficiency for fugitive particulate emissions from roadways." PET 328. Because DEQ did not include such limits and conditions in the Permit, it was arbitrary and capricious to assume this high 93.3% would be achieved, and that the Project would comply with the PM_{10} NAAQS and arsenic AACC, as discussed in more detail below.

1. DEQ's determination that a combination of chemical dust suppressants and water would achieve the required dust control efficiency was arbitrary and capricious, and not supported by the permit record.

Perpetua argues that its technical memorandum demonstrates that chemical dust suppressants applied to unpaved industrial roads can have a dust control efficiency of 90-99% for PM_{10}. Perpetua Opp'n at 22–23 (citing PET 546). It also points out that watering alone, according to AP-42, can reach a control efficiency of 95%. *Id.* at 22 n.9 (citing PET 808). Perpetua, however, misses the mark, and fails to address Petitioners' argument that there is no evidence for, and no rationale provided, that supports a finding that Perpetua will be able to achieve 93.3% dust control efficiency by using a *combination* of chemical dust suppressants and water.

Notably, the evidence that Perpetua points to in its brief contradicts that such a high control efficiency can be achieved with a combination of chemicals and water. *See id.* at 23. The EPA RACT/BACT/LAER Clearinghouse database (reproduced in DEQ's SOB) shows that out of seven sites reviewed that used a combination of chemicals and water to control dust, *none* of them were able to achieve higher than 90% control efficiency. PET 547. Moreover, the permit record demonstrates that, for the studies that it does cite, DEQ never compared the site-specific

conditions of those mines to determine whether the studies were applicable to Perpetua's site; what application methods were used to achieve the stated dust control efficiencies; and come to a conclusion whether the methods and application of dust control was reasonably achievable in this case. *See generally* PET 044–548.

Furthermore, the lack of record support is confirmed by EPA's comment on the final draft permit, stating that "the permit record does not demonstrate that [93.3%] efficienc[y is] achievable based on the site-specific conditions at the Perpetua mine." PET 669. EPA pointed out that "IDEQ's permitting record does not appear to provide support for a 93.3% control efficiency applicable to fugitive dust emissions resulting from mining excavation operations and haul roads[ ]" and that "IDEQ's permitting record does not provide any technical studies showing that the supplementing of magnesium chloride with watering will improve the control efficiency of magnesium chloride." PET 670. Yet, DEQ's response to these comments was a blanket statement that it "has confirmed based on a review of test studies that [93.3% dust control efficiency] can be achieved using water and magnesium chloride dust suppressants," and points to a yet to be seen FDCP to specify the "minimum and substantive requirements" that will not be subject to public review. *See* PET 551, 555, 557.

The questionable capability of achieving 93.3% dust control efficiency is perhaps why DEQ's modeling team recommended "aggressive implementation of measures to achieve above 93% control efficiency." PET 328. Yet the Permit, as discussed below, does nothing to dictate the enforceable limits that would indicate what the aggressive measures will be, or ensure that they are "aggressive[ly] implement[ed]." *Id.*

DEQ's determination that Perpetua would be able to achieve sufficient dust control efficiency such that it would comply with PM_{10} NAAQS and arsenic AACC was thus arbitrary and capricious.

2. The permit lacks enforceable limits on how the dust control efficiency will be achieved to ensure compliance with PM_{10} NAAQS and arsenic AACC.

Respondents argue that because the permit requires Perpetua to generally control dust by using chemical dust suppressants and water, it is legally and practically enforceable. *See* Perpetua Opp'n at 23–26; DEQ at 15–16; PET 008–10 (Permit Conditions 2.1–2.6). It is notable that Perpetua argues that the permit cannot contain details of how dust will be controlled because it is "impractical" to "establish specific numeric limits to control efficiency variables." Perpetua Opp'n at 26. Yet, DEQ relies on a yet-to-be drafted FDCP, which will not be subject to public review, to establish those detailed conditions and limits—unknown measures that will "require an aggressive implementation . . . to achieve above 93.3% control efficiency." PET 328; *see also* PET 009 (Permit Condition 2.5 stating that dust control measures must be applied "on a frequency" to ensure emissions do not exceed a certain threshold); PET 010 (Permit Condition 2.6 requiring the FDCP to "[d]evelop specific criteria to determine what frequency and type (water and/or chemical) of dust suppressant must be applied, and appropriate suppressant application rates."). At bottom, without any actual, meaningful, and enforceable limits in the Permit, DEQ cannot ensure that the Project will be in compliance with PM_{10} NAAQS and arsenic AACC.

Perpetua argues that there is "no legal authority" that requires DEQ to include legally and practically enforceable permit conditions. Perpetua Opp'n at 23–24. However, the Air Rules Section 107.03.c incorporates 40 C.F.R. Part 52 of the CAA regulations that define the "potential

to emit," and state that physical or operational limitations are part of the facility's design "if the limitation or the effect it would have on emissions *is state or federally enforceable*." Air Rules Section 006.36 (emphasis added); *see also* 40 C.F.R. 52.21(b) (definition of potential to emit).

"EPA's longstanding position is that a permit limitation can legally restrict a source's [potential to emit] if it" is practically enforceable—meaning that the limitation is technically accurate; there is a time period specified for the limitation; and there is a method to determine compliance. PET 664 (footnote omitted). Perpetua argues that the Permit Conditions establish that the 93.3% control efficiency meets the criteria to be practically enforceable. Perpetua Opp'n at 24. It is wrong for multiple reasons.

First, there is no technically accurate limitation for achieving the required 93.3% dust control efficiency. For instance, DEQ states that the 93.3% control efficiency is "supported by assuming appropriate application of water and magnesium chloride," PET 090, but neither the permit record, nor the Permit itself, specifies the limitations on how much chemical dust suppressant and/or water should be applied, under what operational or atmospheric conditions, and at what frequency. *See* PET 008–10 (Permit Conditions 2.1–2.6); *see also* PET 670 (EPA stating that "[t]o make the [potential to emit] limitations enforceable as a practical matter, the permit should include the parameters and assumptions used to develop the fugitive dust emission factors estimates for the haul roads and access roads."). Second, there is no time period specified for the limitation. Finally, the monitoring requirements that Perpetua highlights hardly can be considered a method that will determine compliance. For example, Permit Condition 2.2 requires Perpetua to record the frequency and methods used to control fugitive dust, but does not require any actual monitoring or record keeping to demonstrate that those methods are effective. PET 008. Permit Condition 2.4 requires facility-wide inspections of potential sources of fugitive

emissions, but there is no actual requirement to monitor whether the potential source is complying with the limitations or whether, if fugitive emissions were observed, those emissions exceed the PM_{10} NAAQS or arsenic AACC. *Id.* Finally, Permit Condition 2.5 requires that the "visible emissions from vehicle traffic on a haul road do not exceed 10% opacity," but there is no actual requirement to monitor opacity at certain time intervals and under what operational or site-specific conditions, or keep records documenting when opacity requirements were not being met. PET 009. Moreover, nothing in the permit record establishes that a 10% opacity correlates with a 93.3% dust control efficiency, and therefore ensures compliance with the PM_{10} NAAQS or arsenic AACC.

Third, Perpetua asserts that the "FDCP itself ensures compliance with fugitive dust requirements," and since it will contain substantive requirements and is incorporated into the Permit, this demonstrates that the Permit Conditions will "achieve the expected control efficiency." Perpetua Opp'n at 25–26. But Perpetua cannot make that claim when the provisions of the FDCP are unknown as the document does not exist. Moreover, as discussed below, the FDCP which purportedly will contain enforceable permit conditions, will not be available for review and public comment.

Finally, Perpetua complains that the Permit is already more stringent than other permits, and "requires a more comprehensive and detailed FDCP than in any other minor source permit DEQ has issued." *Id.* But here, DEQ's past practice highlights a pervasive approach to air quality permitting that is less vigorous in protecting public health than it should be. *See, e.g.*, PET 842 (stating that a review of synthetic minor source permits "found that many of the permit limitations did not adhere to EPA's guidance" and that many "permit limits did not have sufficient information within the permit or the permit's supporting documentation to determine

whether the limits were technically accurate."). Respondents make no claim that prior, more lenient permits were similar to the present one that requires "aggressive level[s] of control" and "aggressive implementation" that, if not met, would exceed the PM_{10} NAAQS or arsenic AACCs and threaten public health. PET 325, 328.

In summary, DEQ failed to include in the Permit enforceable limitations, as required under the Idaho Air Rules, that it admitted are necessary to ensure Perpetua achieves the "aggressive" 93.3% level of dust control. The Permit should therefore be vacated and remanded to DEQ to fix these deficiencies.

B. DEQ's Use of a "Surrogate Production Limits" in the Permit is Unreasonable, Does Not Ensure Compliance with PM_{10} NAAQS and Arsenic AACC, and the Permit Limit is Not Enforceable.

Variables, such as daily vehicle miles traveled, truck weight, and speed limit are important parameters that are used in developing fugitive dust emission factors for haul roads of any mine, including this one. *See, e.g.*, PET 798, 800; *see also* PET 062. Although there is no specific authority *requiring* DEQ to include those parameters as specific, enforceable permit limitations, *see* Perpetua Opp'n at 27, it was unreasonable in this case for DEQ not to consider these variables given that they were "critical" in calculating fugitive dust emissions and ensuring that PM_{10} NAAQS and arsenic AACC are met. *See, e.g.*, PET 062 ("[I]t was recognized that accurate determination of site-specific parameters characterizing road conditions and vehicle traffic was critical to estimating particulate matter emissions and ambient air impacts."); *see also* PET 275 ("However, it is critical for NAAQS compliance that this high level of [dust] control be achieved."). DEQ's decision to use a production limit as a "surrogate" for these critical variables

to ensure compliance with the PM_{10} NAAQS and arsenic AACC is not supported by the permit record, and is arbitrary and capricious.[8]

Perpetua asserts that a surrogate "production limit" of 180,000 tons of ore hauled per day is sufficient to ensure compliance with PM_{10} NAAQS and arsenic AACC. Perpetua Opp'n at 28. Yet nothing in the permit record demonstrates that a daily production limit is equivalent to providing enforceable limits on the variables that were so critical to demonstrating compliance with air quality standards. For example, Perpetua's citation to DEQ's response to comments only discuss how daily production limits are sufficient in wintertime conditions to ensure compliance, but does not discuss whether production limits alone are sufficient for drier seasons when fugitive dust will be more problematic. *Id.* at 26 (citing PET 629–630).

Simply put, daily production limits do not constrain all the variables that went into the calculation of fugitive dust emissions, and nothing in the permit record indicates that DEQ understood or demonstrated that a daily production limit would be equivalent to more specific permit limits addressing these critical variables. *See generally* PET 044-548. For example, Perpetua can haul the same amount of ore by using all larger trucks driving less miles, or using all smaller trucks driving more miles. But by using only a production limit in the Permit, there exists a legal and plausible operating scenario where more fugitive dust is generated such that it would exceed PM_{10} NAAQS and arsenic AACC. *See* PET 670 (EPA stating that "[t]o make the [potential to emit] limitations enforceable as a practical matter, the permit should include the parameters and assumptions used to develop the fugitive dust emissions factors estimates for the

[8] Silt content is just one variable that is taken into account when calculating fugitive dust emissions. The fact that there may be permit limits on silt content does not fix the lack of permit limits concerning the other critical variables used to calculate fugitive dust emissions. *See* Perpetua Opp'n at 28–29.

haul roads and access roads."). But it is unknown to DEQ and from the permit record whether that is the case, rendering arbitrary and capricious the use of its surrogate limit to ensure compliance. Thus, this is not a "technically accurate" limitation and inconsistent with EPA's guidance on practically enforceable permit limitations. *See* PET 791; Perpetua Opp'n at 32–34.

Relying on past permits that do not include such permit limits does not help DEQ's case as there is no indication that, first, the variables such as truck weight and vehicle miles were "critical" to compliance, and second, if they were, that a surrogate production limit was shown to ensure compliance with air quality standards. *See* Perpetua Opp'n at 28.

What is more, the actual permit limitation found in Permit condition 3.5 does not have any associated monitoring or recordkeeping requirements to ensure compliance, and defers to a yet-to-be created Operation and Maintenance Manual ("O&M Manual") plan that will not be available for review by the public. PET 019; *see* Perpetua Opp'n at 29, 32–34. And Perpetua's contention that the peak production rate modeled will actually be lower, and thus emissions will be lower, is beside the point because the Permit gives Perpetua the legal authority to produce up to the production limit even if it would exceed air quality standards.

DEQ did not demonstrate that a surrogate production limit would ensure compliance with air quality standards. Its decision to substitute this for limits to the critical variables it actually used to calculate fugitive dust emissions is not supported by the record and is arbitrary and capricious. Even more, the surrogate limit it did include in the Permit is not an enforceable limit. The Hearing Officer must vacate the Permit and remand it back to DEQ for further consideration.

C. DEQ Failed to Use Representative Precipitation Data.

Perpetua's argument that Petitioners are wrong to assume "that the use of local precipitation data would have resulted in higher fugitive dust emissions" not only misses the point, but it still uses the wrong precipitation data to try and make its point. Perpetua Opp'n at 31. Petitioners' point is that, as is pervasive throughout the Permit, DEQ did not use available local data that are more accurate and consistent with its own guidance, but opted to use a default, generalized data to perform its calculations. Pet'rs' Open. Mot. Summ. J. at 25-26. Here, Perpetua argues that local data indicates that the conditions are wetter than EPA's default data. But it only looks at a single year. *Id.* Underestimation of the true site conditions when the data is available calls the emissions calculations and results into question. The Hearing Officer should vacate the Permit and remand it back to DEQ for further review.

IV. DEQ'S RELIANCE ON FUTURE PLANS TO BE PREPARED BY PERPETUA OUTSIDE OF THE PERMIT PROCESS VIOLATES THE AIR RULES AND THE CLEAN AIR ACT.

There is no dispute that the Permit calls for four "work plans"—Access Management Plan ("AMP"), FDCP, Haul Road Capping Plan ("HRCP"), and O&M Manual—to be developed by Perpetua later and submitted to DEQ. Petitioners' Opening Brief showed that, by relying on these future plans, DEQ bypassed the requirements of the PTC permitting process, including public comment, and issued what is essentially a partial, incomplete PTC, in violation of the Air Rules and CAA. Pet'rs' Mot. Summ. J. at 28–31. Only later will DEQ issue a complete, final PTC, after Perpetua develops and submits to DEQ additional plans, information, and conditions through the AMP, FDCP, HRCP, and O&M Manual, shielded from public review and outside the normal PTC process required by the Air Rules.

In its Response, Perpetua asserts that "work plans" are "not required by any express provision of Idaho Air Rules (nor the CAA) to be included in the application, the Final Permit, or any part of the public comment process." Perpetua Opp'n at 38. Perpetua is wrong.[9]

Under the Air Rules, DEQ must provide an opportunity for public comment. Air Rules Section 209.01.c. During public comment, the "Department's proposed action, together with the information submitted by the applicant and the Department's analysis of the information, *will* be made available to the public . . . ." Air Rules Section 209.01.c.i. (emphasis added). A PTC application "must . . . be accompanied by all information necessary to perform any analysis or make any determination required under Sections 200 through 227," which includes the requirement to determine whether the facility will cause or contribute to a violation of the NAAQS. Air Rules Section 202. "Required Information" that the applicant must provide includes: "Site information, *plans*, descriptions, specifications, and drawings showing the design of the . . . facility, . . . the nature and amount of emissions . . . , and the manner in which it will be operated and controlled." Air Rules Section 202.01.a.i (emphasis added).

Through the "work plans," DEQ is allowing Perpetua to submit Section 202.01.a.i information later, and allowing itself to review that information later. But Air Rules Section 209.01.c.i requires the "information submitted by the applicant" and DEQ's "analysis of the

[9] Perpetua also argues that Petitioners cannot rely on DEQ violations of the CAA or the CAA regulations at 40 C.F.R. Part 51 to challenge the Permit here. Perpetua Opp'n at 14. But Idaho's Air Rules are EPA-approved CAA rules, which EPA found to satisfy the minimum requirements of the CAA and the CAA Part 51 regulations; therefore, the content of the CAA, the Part 51 regulations, and the federal precedent and guidance under them are persuasive authority in considering DEQ's compliance with the Air Rules and whether DEQ was arbitrary and capricious in approving the Permit under them. *See*, *e.g.*, *Powder River Basin Res. Council v. Wyo. Dep't of Env't Quality*, 226 P.3d 809, 813 (Wyo. 2010) ("[B]ecause the state program is intended to be compatible with, and at least as stringent as, the federal Clean Air Act, federal precedent and regulatory guidance is persuasive authority in Wyoming air quality cases.").

information, will be made available to the public" for comment. DEQ's use of these future work plans, thus, violates the Air Rules.

In its Response, DEQ does not even argue that the work plans comply with the Air Rules; rather, DEQ asserts that relying on work plans is a common DEQ practice and that this practice makes things easier for the permittee and for DEQ. DEQ Resp. at 24. But these points have no bearing on whether DEQ complied with the Air Rules, which it did not. No provisions in the Air Rules authorize DEQ to save pieces of a PTC to be developed later, outside the normal PTC permitting process and without public comment.

DEQ rationalizes its use of post-permit work plans as allowing "the permittee to prepare a specific plan or manual based on the actual equipment purchased and installed, the manufacturer's instructions and recommendations, as well as the operational characteristics of the facility after construction is completed." *Id.* at 24 (quoting Simon Decl. ¶ 10). But the work plans for this Project go way beyond waiting for these types of final and relatively insignificant details.

For example, Permit Condition 3.13 requires that the HRCP include a sampling plan for analyzing arsenic concentrations of materials Perpetua uses, a silt content sampling plan, and information about the frequency with which Perpetua will inspect haul roads, among other similar requirements. PET 019–20. It is entirely feasible for Perpetua to provide, and DEQ to review, these types of sampling plans and road inspection details during the public PTC permitting process. These plans do not depend on final details of actual equipment Perpetua purchases or the characteristics of the facility after it is complete. Many, if not all, of these details can and should have been developed during the PTC process and submitted to the public for comment.

Likewise, Permit Condition 2.6 requires the FDCP to include "specific criteria to determine what frequency and type (water and/or chemical) of dust suppressant must be applied, and appropriate suppressant application rates." PET 010. Why couldn't Perpetua provide details on the "specific criteria" it will use "to determine" the frequency, type, and application rates of suppressants to DEQ for review during the public PTC process? Petitioners and the EPA raised serious concerns about Perpetua's ability to achieve 93.3% dust control; DEQ itself admitted this was an "aggressive" level of control that would require vigilant monitoring and aggressive requirements in the permit, and admitted that achieving 93.3% control is critical to ensuring the NAAQS are met. *See supra* Part III.A. Yet, the Permit does not require 93.3% dust control, and details about how Perpetua will control dust are to be developed later in the FDCP, without public comment.

Similarly, Permit Condition 2.7 requires the AMP to specify the "measures to be used to discourage public access to the facility." PET 010. Again, what does this have to do with the equipment Perpetua actually purchases, and why could these measures not be submitted by Perpetua and reviewed by DEQ during the public PTC process? Access management is a critical issue that generated controversy during public comment. EPA warned in its comments: "Given the unique situation with a public access road traversing the mine site, the key assumptions, parameters, and methodologies used to preclude public access from the mine site must be fully disclosed in the permit record and the necessary requirements be included in the permit and available for public review and comment." PET 569. But DEQ is letting Perpetua decide important details about access management later, outside of public review.

Thus, DEQ is not relying on the work plans to merely account for small, final details related to equipment actually purchased or final characteristics of the facility, which might be

reasonable or practically necessary for some information. Here, the work plans will include all manner of important details bearing on disputed issues about whether the Project will comply with air quality standards and whether DEQ set the right ambient air boundary. These types of information, plans, and details bearing on whether the Project will comply with standards have to be submitted by the applicant under Air Rules Section 202.01.a.i, and that information, along with DEQ's review of the information, are required to be made available to the public under Air Rules Section 209.01.c.i. DEQ does not have a good excuse, or practical necessity, to deviate from these requirements.

DEQ also congratulates itself for what it describes as "the extraordinary and unprecedented three-year collaboration that proceeded" issuing the Permit. DEQ Resp. at 24. In truth, DEQ tried to issue the Permit much faster, but twice after the public alerted DEQ to errors, DEQ had to gather additional information, perform more analysis, take additional comment, and ultimately correct numerous errors. *See* PET 052–54. DEQ's errors and the important role the public played over the three-year permitting process thus confirm the critical role of public comment on all important aspects of the Permit, including on the work plans DEQ is shielding from public review.

Moreover, the Project is a large, complex mine, and permitting it is complicated and time-consuming. To this day, the Permit issued by DEQ is the first and only major permit Perpetua has secured for the Project. Perpetua has yet to receive required authorizations from the Forest Service, U.S. Army Corps of Engineers, NOAA Fisheries, U.S. Fish and Wildlife Service, and other agencies. Perpetua also has yet to receive several other major DEQ permits, including an ore processing by cyanidation permit, an Idaho Pollutant Discharge Elimination System ("IPDES") permit, a point of compliance permit, and a 401 water quality certification. The only

thing "extraordinary" about DEQ's issuance of the Permit in three years, is that it issued this Permit to Perpetua before any other DEQ permit and earlier than any other agency did, while the proposed Project was still in its infancy and before many important details of the Project had even been decided.

Perpetua also criticizes Petitioners for relying on two Clean Water Act ("CWA") cases, instead of any Air Rule or CAA cases, for the proposition that agencies cannot hide important permit-related information from required public review. Perpetua Opp'n at 37. But Perpetua does not point to any Air Rule or CAA cases holding that it is okay to exclude important information from the public during CAA permitting processes. And these CWA cases are relevant.

As Perpetua explained: "in *Environmental Defense Center v. EPA*, the Ninth Circuit held that Notices of Intent ("NOI") are functional equivalents to permits under the Clean Water Act's general permit option, and EPA's failure to require review of NOIs available to the public contravened the express requirements of the Clean Water Act." Perpetua Opp'n at 37 (citing *Env't Def. Ctr., Inc. v. EPA*, 344 F.3d 832, 858 (9th Cir. 2003)). Indeed, the Ninth Circuit found that the NOI at issue "establishes what the discharger will do to reduce discharges to the 'maximum extent practicable,' the [] NOI crosses the threshold from being an item of procedural correspondence to being a substantive component of a regulatory regime." *Env't Def. Ctr.*, 344 F.3d at 853. Similarly here, the "work plans" are not mere procedural correspondence; as already discussed, each plan will establish what Perpetua will do to reduce emissions, to set enforceable permit limits, and to otherwise comply with "substantive components" of the Air Rules.

The work plans are also similar to the Nutrient Management Plans ("NMP") at issue in *Waterkeeper Alliance, Inc. v. EPA*, 399 F.3d 486, 503 (2d Cir. 2005), where the Second Circuit held that EPA "deprive[d] the public of the opportunity for the sort of regulatory participation

that the [CWA] guarantees because the Rule [at issue] effectively shields the nutrient management plans from public scrutiny and comment." Perpetua tries to downplay this case, asserting that the Second Circuit reached this conclusion because the NMPs were "effluent limitations," and the CWA specifically requires public participation in developing effluent limitations. Perpetua Opp'n at 37. Perpetua misleadingly fails to mention that the Second Circuit's decision did not end there, but went farther:

> *And even assuming, arguendo, that the nutrient management plans did not themselves constitute effluent limitations, we would still hold that the CAFO Rule violates the Act's public participation requirements*. Nutrient management plans are . . . a critical indispensable feature of the "plan, or program established by the Administrator or any State" in order to regulate Large CAFO land application discharges. 33 U.S.C. § 1251(e). The EPA itself has stated in the Preamble to the Rule that "the only way to ensure that non-permitted point source discharges of manure, litter, or process wastewaters from CAFOs do not occur is to require ... [land application] in accordance with site specific nutrient management practices."

399 F.3d at 504 (emphasis added).

Like the NMPs in *Waterkeeper*, the work plans here are critical, indispensable features of the Permit. And like the EPA in *Waterkeeper*, DEQ here has acknowledged that details in these work plans are critical to ensuring the Project meets air quality standards. For example, DEQ modeling staff stating "it is *critical* for NAAQS compliance that this high level of control [(93.3% dust control)] be achieved." PET 275 (emphasis added); *see also* PET 325 (same). DEQ staff thus "recommend[ed] that the permit require an aggressive implementation of measures to achieve above 93% control efficiency for fugitive particulate emissions from roadways." PET 328. But the Permit does not include these implementation measures; instead, specific measures for achieving 93.3% dust control will be developed in the FDCP, shielded from public view. Similarly, DEQ admitted in the Statement of Basis "accurate determination of site-specific parameters characterizing road conditions and vehicle traffic was *critical* to estimating

particulate matter emissions and ambient air impacts," PET 062 (emphasis added), but the Permit does not include these site-specific parameters, which will be developed later (if at all) by Perpetua in the HRCP and FDCP without public comment. Likewise, DEQ asserted "[c]ompliance is assured by complying with the [O&M Manual] monitoring and recordkeeping requirements," but again, the Permit does not include monitoring and recordkeeping requirements; Perpetua will develop those later, without public involvement.

Finally, Perpetua cites *Train v. NRDC*, 421 U.S. 60, 79 (1975) for the proposition that "CAA jurisprudence affords broad discretion to states to develop permit conditions." Perpetua Opp'n at 37. Petitioners do not dispute that states have broad discretion to develop permit conditions. The problem here is that DEQ has *not* developed a number of important permit conditions and is letting Perpetua develop them later, outside of the Air Rules PTC process, and without public review. Thus, *Train*, *Environmental Defense Center*, and *Waterkeeper* all underscore that DEQ's use of work plans here to leave numerous details and conditions to be decided later, outside the PTC permitting and public comment processes, violates the Air Rules Section 209.01 public participating requirements.

The Hearing Officer must set aside and remand the Permit to correct these errors.

V. DEQ MUST REQUIRE AMBIENT AIR MONITORING.

As shown in the Opening Brief: DEQ has authority under the Air Rules Section 211.01.d to require Perpetua to monitor ambient air quality while the Project is underway; ICL, SSFS, and the EPA all urged DEQ to require such monitoring to verify whether Perpetua does actually comply with the PM_{10} NAAQS in light of the assumptions and uncertainties surrounding the Project's emissions; but DEQ declined. Pet'rs' Mot. Summ. J. at 31–32. DEQ failed to even respond to this issue. *See generally* DEQ Resp. Perpetua admits that DEQ has authority to

require ambient air monitoring, but after pointing to DEQ's responses to comments argues that in "DEQ's analysis and judgment, there was no reason to impose ambient air monitoring." Perpetua Opp'n at 41. DEQ's reasons for refusing to require ambient air monitoring, however, were arbitrary and capricious.

In response to comments, DEQ suggested that there is no need for ambient air monitoring since the Project area is remote. PET 559. But, as shown in Petitioners' standing declarations, members of the Tribe, ICL, and SSFS visit locations near the ambient air boundary set by DEQ, including staying overnight and engaging in strenuous activities.

DEQ also asserted in response to comments that ambient air monitoring "is not considered unless DEQ lacks a satisfactory confidence of NAAQS or toxic air pollutant ("TAP") increment compliance . . . without such monitoring," PET 562, and that here, DEQ is "reasonably confident" that impacts to ambient air will be below applicable standards, PET 559. To support this, DEQ points out that the Permit includes "extensive fugitive dust control measures," PET 560, "includes limits on operational levels and key parameters" and "includes monitoring and recordkeeping requirements to ensure compliance," PET 561. But the Permit does not include such measures, as discussed in the preceding section, and DEQ, thus, does not have a reasonable basis for being confident the Project will comply with the NAAQS and AACCs. *See supra* Part IV.

Again, as EPA commented: "Given the high level of uncertainty in the assumptions and requirements to ensure compliance with the PM_{10} 24-hr NAAQS, the addition of post-construction ambient monitoring requirements is highly prudent." PET 561. Again, Perpetua aims to achieve what DEQ admitted elsewhere is a "high" and "aggressive" level of dust control, which DEQ modelers recommended requiring aggressive implementation conditions in the

Permit. PET 275, 325, 328. And again, the Permit does not include such measures, leaving it highly uncertain whether the PM_{10} NAAQS will be met.

VI. DEQ FAILED TO ANALYZE ECONOMIC INFORMATION AND ENVIRONMENTAL IMPACTS IN THE ARSENIC T-RACT.

As set forth in the Opening Brief, DEQ granted Perpetua's arsenic "T-RACT demonstration," granting Perpetua a 10-times increase in allowable concentrations of TAP AACCs during operations. *See* Pet'rs' Mot. Summ. J. at 32–34. Air Rules Section 210.14 dictates a specific process with specific requirements for DEQ's review and approval of an applicant's T-RACT, including consideration of technical and economic feasibility and environmental impacts—factors DEQ failed to consider. *Id.* In response, neither DEQ nor Perpetua disputes Petitioners' showing that DEQ failed to consider these factors when it approved Perpetua's T-RACT. Rather, they argue that DEQ did not need to consider these factors. They are wrong.

In response, DEQ makes the absurd argument that it has discretion to do whatever it reasonably wants—whether or not doing so actually complies with the Air Rules. DEQ points to the first sentence in Section 210, which states that a permit applicant shall "demonstrate preconstruction compliance with Section 161[(toxics standards)] *to the satisfaction of the Department*" and argues "[w]hether DEQ is satisfied is a matter of discretion." DEQ Resp. at 18 (emphasis by DEQ). The "to the satisfaction of the Department" language is superfluous and meaningless. How would the provision be any different if it omitted the "to the satisfaction of Department" phrase and instead said the applicant must "demonstrate preconstruction compliance with Section 161"? Even without the "to the satisfaction of the Department" phrase, this provision of the Air Rules would require DEQ to make a determination (to its satisfaction—

not to someone else's satisfaction) that the applicant demonstrated preconstruction compliance. Anytime DEQ is required to make any determination under the Air Rules, it must make that determination to its "satisfaction." And when it does so, DEQ's determination cannot be arbitrary, capricious, an abuse of discretion, unsupported by substantial evidence, contrary to law, or in excess of authority.

DEQ also argues that, because Section 210.14 of the Air Rules states that DEQ is to determine T-RACT on a "case-by-case basis," this somehow gives it free reign to ignore the specific requirements set forth in Section 210.14. DEQ Resp. at 19. Again, DEQ does not have discretion to ignore applicable provisions of the Air Rules. Moreover, what the Air Rules actually say (which DEQ misleadingly omitted from its "case-by-case basis" quote) is: "T-RACT shall be determined on a case-by-case basis by the Department as follows:". Air Rules Section 210.14 (emphasis added). After "as follows", the Air Rules list specific requirements in Sections 210.14.a through 210.14.f for how DEQ is to make this case-by-case determination, including among other requirements:

> **c.** The technological feasibility of a control technology or other requirements for a particular source *will* be determined considering several factors including, but not limited to:
>
> i. Process and operating procedures, raw materials and physical plant layout.
>
> ii. The environmental impacts caused by the control technology that cannot be mitigated, including, but not limited to, water pollution and the production of solid wastes.
>
> . . .
>
> **d.** The economic feasibility of a control technology or other requirement, including the costs of necessary mitigation measures, for a particular source *will* be determined considering several factors including, but not limited to:
>
> i. Capital costs.
>
> ii. Cost effectiveness, which is the annualized cost of the control technology divided by the amount of emission reductions.

iii. The difference in costs between the particular source and other similar sources, if any, that have implemented emissions reductions.

Air Rules Section 210.14 (emphases added). Thus, the Air Rules explicitly require that DEQ "will" consider "technological feasibility," including "environmental impacts," and "will" consider "economic feasibility." *Id.* DEQ cannot simply ignore these explicit requirements for its review of T-RACT.

Perpetua argues that these requirements in 210.14 to consider technological and economic feasibility and environmental impacts apply only when DEQ is considering a new RACT, and argues that "[n]othing in Section 210.1[4] [*sic*] requires DEQ to reevaluate the technological and economic feasibility of established control measures." Perpetua Opp'n at 44. This is wrong. Again, Section 210.14 requires DEQ to determine T-RACT "on a *case-by-case basis*" and prescribes specifically how DEQ is to do this. First, Air Rules Section 210.14.a requires: "[T]he applicant must submit information to the Department identifying and documenting which control technologies or other requirements the applicant believes to be T-RACT." Perpetua did that here. *See* PET 543–48 (SOB, App'x G, "T-RACT Analysis"). Next, Air Rules Section 210.14.b requires: "The Department will review the information submitted by the applicant and determine whether the applicant has proposed T-RACT." DEQ did that here. *See* PET 070 (SOB). Next, when making that determination, Air Rules Sections 210.14.c and d requires that DEQ "will" consider technological feasibility, including environmental impacts, and economic feasibility. Furthermore, parts c and d require DEQ to consider factors that are specific to a particular facility (not factors that are general to the control technology itself), such as "[p]rocess and operating procedures, raw materials and physical plant layout" and the "difference in cost between the particular source and other similar sources."

Nowhere in the Air Rules does it say that these requirements are limited to new control technologies. And nowhere does it say that when DEQ conducts its case-by-case review under Section 210.14 of an applicant's submission of a T-RACT proposal (as occurred here), DEQ can skip the mandatory requirements of 210.14.c and d if the control technology has been used or evaluated in the past, as Perpetua argues it has. Rather, as set forth above, the Air Rules requires DEQ to consider these factors in every case. But, again, DEQ did not do so here.

Perpetua's argument that applying chemical dust suppressant and watering have been used and approved before for other projects ignores the important and unique considerations at issue here. As Petitioners warned in their comments, applying large amounts of magnesium chloride to roads to control dust can cause the accumulation of toxic concentrations of these substances in trees and soils and can degrade water quality and harm aquatic life. PET 596, 612. Additionally, "frequent watering" may cause environmental harm because the water that will be used to supplement dust control measures will be from sources that already have elevated arsenic levels. PET 612. These concerns are especially important here since the mine site is made up of narrow mountain valleys where haul roads are located primarily right next to rivers and streams. *See* Pet'rs' Open. Mot. Summ. J. at 15 (map). These concerns are especially important here also because Perpetua will have to use "aggressive" measures—presumably meaning more chemical suppressants and more water than is typical—to achieve the high 93.3% control level on the haul roads. Just because DEQ has approved other projects to use similar dust control measures does not relieve the agency of its responsibility under Section 210.14.c.ii that it "will" consider water pollution and other environmental impacts caused by Perpetua's "aggressive" dust control efforts in this unique Project site and for this particular case.

Similarly, DEQ must consider technological feasibility by considering the "[p]rocess and operating procedures, raw materials and physical plant layout" for this Project. Air Rules Section 210.14.c.i. The fact that DEQ has in the past considered chemical dust suppressants at other facilities, which employ different processes and operating procedures, which use different materials, and which have different layouts, does not satisfy this requirement.

And DEQ must consider economic feasibility by considering the "difference in cost between the particular source and other similar sources." Air Rules Section 210.14.d.iii. The fact that DEQ has approved chemical dust suppressants for past projects from similar sources does not satisfy this requirement to compare the difference in cost between this "particular source" and other similar sources.

The Hearing Officer should set aside and remand the Permit, and order DEQ to follow the requirements of Section 210.14 to review Perpetua's T-RACT application.

VII. DEQ'S DETERMINATION THAT THE PROJECT WILL EMIT LESS THAN THE ARSENIC AACC HAS NO RATIONAL BASIS.

As shown in Petitioners' Opening Brief, DEQ not only granted Perpetua's T-RACT demonstration (giving Perpetua a 10-times increase in allowable arsenic concentrations), but it went further and effectively diluted the apparent concentration of arsenic the Project will emit by spreading it out over a human lifetime. *See* Pet'rs' Mot. Summ. J. at 34–37. Instead of using the average annual concentration of arsenic emitted for the Project to determine compliance with the AACC under the Idaho Air Rules, DEQ diluted the Project's arsenic concentration by spreading the Project's 16 years of emissions over a 70-year human lifetime. *See id.* Thus, instead of comparing the actual annual arsenic concentration that will be emitted and present in the air while the Project is operating and that people recreating at the point of compliance (the ambient

air boundary) will breathe, DEQ created a fiction by finding that only a fraction (16/70)—a mere 23 percent of the true concentration—will be present in any given year. *Id.*

DEQ does not argue that the 16/70 averaging is allowed under any provision of the Idaho Air Rules (which it is not). Instead, DEQ appears to assert a rationale of why it allowed a 10-fold increase in the arsenic AACC:

> [This] approach to modeling TAP compliance employed the Short-Term Source Factor rule (Section 210.15) by analogue. This section allows an impact of 10 times the AACC for projects having an operational lifetime of no greater than five years. DEQ simply used this general approach to develop a project-specific adjustment factor for the [Stibnite Gold Project], using the 16-year maximum life of the project.

DEQ Resp. at 21 (quoting Schilling Decl. 11–12) (internal citations omitted). DEQ, thus, admits that it applied the "general approach" of a specific Air Rules provision—a provision which purposefully and narrowly addresses "short-term" sources—to a long-term project to fabricate and grant to Perpetua a new AACC adjustment. An adjustment found nowhere in the Air Rules. DEQ never presented this rationale in its response to draft Permit public comments; it is simply post-hoc rationalization. Furthermore, although requested as part of the Petitioners' Discovery, DEQ was unable to produce any previously established guidance, procedural memorandum, or permitting example which rationalizes or justifies the use of this 16/70 averaging tactic. Regardless, its new rationale does not provide any basis for inventing a permitting tactic completely outside the bounds of the Air Rules and arbitrarily and capriciously diluted annual arsenic concentrations beyond the life of a project.

DEQ goes on to assert that "Petitioners . . . offer absolutely no evidence that multi-year averaging presents a public health risk." DEQ Resp. at 21. But that is not Petitioners' responsibility, it is DEQ's. Whether or not DEQ had a reason to use its 16/70 tactic, it cannot ignore the Air Rules, and it needs to provide a rational basis for why its approach does not create

a public health risk. The Air Rules use a one-year average concentration for the arsenic AACC (not a life of the project over an entire lifetime average, as DEQ did). Air Rules Section 586. The Air Rules include explicit exceptions to meeting the normal AACCs, allowing less stringent AACCs either where: a project is five years or less; or where a T-RACT demonstration is done. Air Rules Sections 210.12, 210.15. There are no other exceptions in the Air Rules.

Here, Perpetua's T-RACT demonstration was granted (using Section 210.12), already giving it significant leniency (a 10 times increase in allowable arsenic concentrations). But DEQ chose to give Perpetua even more leniency by creating a new exception—again, not found in the Air Rules—by using the 16/70 approach. DEQ does not have discretion to deviate from the Air Rules and make up new exceptions to the meeting the AACCs. The Hearing Officer must, therefore, set aside and remand the Permit to comply with the Air Rules.

Perpetua's arguments fare no better.[10]

First, as stated above, there is nothing in the Idaho Air rules or the permit record that supports the "normaliz[ation]" of emissions by spreading them out over a time period longer than the project lifetime to assess cancer risk. *See* Perpetua Opp'n at 48. What this "normaliz[ation]" does is unreasonably assume that higher concentrations of arsenic for shorter periods of time (16 years) is equivalent in terms of cancer risk to lower concentrations of arsenic over longer periods of time (70 years). *See id.* ("[DEQ] evaluated the maximum modeled arsenic emissions

[10] To start, Perpetua mischaracterizes Petitioners' arguments, claiming that Petitioners ignore Section 210 methods of compliance and only focus on the Section 586 standards. Perpetua Opp'n at 45–46, 48. Petitioners do not challenge DEQ's use of Section 210.12 as a method for demonstrating compliance with the arsenic AACC; they challenge the way that DEQ determined the amount of arsenic emitted—using unsupported and unvalidated assumptions that have no basis in the Air Rules—to ensure that the emissions would be less than the T-RACT adjusted AACC and thus allow DEQ to claim that emissions would not create a health risk under Section 161. *See* Pet'rs' Mot. Summ. J. at 36–37.

from the Project during the operational period and then evaluated whether that would exceed the AACC over 70 years, demonstrating that the cancer risk was less than one in one hundred thousand."). But there is no support in the permit record nor in the Air Rules for this "normaliz[ation]." Granted, the Air Rules allow an assumption of a linear relationship *between cancer risk and pollutant concentration*—a 10-fold increase in the AACC is equivalent to a 10-fold increase in cancer risk probability. Air Rules Section 210.12.b. There is no comparable equivalency in the Air Rules, however, to allow for the dilution of emissions over a much longer period of time.[11]

In its response to comments, DEQ states:

> The acceptability criteria is that a facility not pose a cancer risk greater than 1-in-1,000,000 or 1-in-100,000 if T-RACT is used. The annual value of the AACC is provided under the assumption that a facility will emit *at such a level* on a permanent basis. Since the criteria of Idaho's TAP rules is the risk associated with the project, *the time over which that risk is spread is immaterial*.

PET 597 (emphasis added). DEQ's assertion means that it can apparently choose any time frame to "spread" out the risk of exposure to arsenic (or any other carcinogenic pollutant) so that it falls below the T-RACT adjusted AACC and thus it is not a cancer risk anymore. Moreover, if the "criteria of the TAP rules is the risk associated with the project," *id.*, the Project's emissions will occur only for 16 years; there is no risk from the Project for the subsequent 54 years. Although

[11] Perpetua argues that Section 125 of the Air Rules provide the rationale for diluting 16 years of arsenic emissions over 70 years. Perpetua Opp'n at 47. First, Perpetua is referring to the definition of "Toxic Air Pollutant Carcinogenic Increments" which is found in the 2020 version of the Air Rules, but has been removed from the current version. Second, the definition refers to 70 years as the timeframe that cancer risk probability is assessed, but it in no way indicates that a facility's emissions can be diluted by a timeframe less than that during which pollutants will be emitted.

this "refined" approach makes it easier to permit a polluting facility, it makes absolutely no sense in terms of assessing cancer risk, as required under Section 161 of the Air Rules.

Case in point, the time over which the risk is spread from 16 to 70 years is very material; one time (16 years) demonstrates that the emissions from the Project are greater than the T-RACT adjusted AACC, while the other (70 years) falsely concludes that the emissions are much lower than the T-RACT adjusted AACC. DEQ's dilution method to assess cancer risk does not account for the fact that for 16 years during the life of the mine, Tribal members such as Emmit Taylor and Joe Oatman, who exercise Treaty rights in and around the ambient air boundary and intend to do so in the future, and Zak Sears, who recreates in and around the ambient air boundary several times a year, will be exposed to close to three times above the level of the T-RACT adjusted AACC for the next 16 years. *See* Taylor Decl. ¶ 9; Oatman Decl. ¶ 7; Sears Decl. ¶ 6. Young children more susceptible to air pollutants, like those of Drew Hollenback, will be breathing in 16 years of arsenic that will be well-above the 1-in-100,000 cancer risk, as provided by the T-RACT adjusted AACC. *See* Hollenback Decl. ¶¶ 4, 6–7. To be sure, Air Rules Section 210.12.c does provide for the potential for "further procedures" to demonstrate that the cancer risk is acceptable under Section 161 when the emissions exceed the T-RACT adjusted AACC. Nevertheless, DEQ did not conduct any further procedures, but instead and without any reasoned or scientific basis, assumed the cancer risk probability from high dose/short-term exposure was equivalent to low dose/long term exposure. *See* Perpetua Opp'n at 48.

EPA noted similar concerns:

> The EPA continues to have concern that the arsenic screening analysis underestimates cumulative impacts of airborne arsenic to the environment in the vicinity of the project. The results presented on page 4-46 of the [draft supplemental environmental impact statement], and Table 4.3-13 are compared to an annual acceptable ambient concentration for a carcinogen (AACC), the Idaho toxics

> screening threshold. However, this screening threshold is not necessarily intended to be compared against a 70-year lifetime scenario where 57 years of the period assumes zero exposure. The threshold is an annual average used for screening, prescribed as a de-minimus value based on lifetime risk. Under IDEQ's hazardous air pollutant program, in practice, project impacts from the maximum year of emissions would typically be compared to the annual average AACC for arsenic.

PET 667.

Next, Perpetua contends that "set[ting] the life-of-mine hauling and excavating limit" is what is important because it is the total arsenic emissions that matter, not the concentration of arsenic and not how long the mine will operate. Perpetua Opp'n at 49 n.19. Yet, neither Perpetua nor DEQ cite any provision in the Air Rules that allows or even supports using "total" emissions to assess cancer risk probability. *See* Air Rules Section 586 (discussing annual averages for AACC); *id.* at Section 210.12.b (allowing a 10-fold increase in the *annual* AACC).

Third, Perpetua argues that the "arsenic emissions produced from the actual operating analysis are only 19% of the worst-case scenario." Perpetua Opp'n at 49. This fact, if it be true, is inconsequential because the permit allows Perpetua to operate at a higher level, and there are no enforceable permit conditions to ensure that the mine operates at a level of reduced emissions and thus actually emits less than the T-RACT adjusted AACC.

Finally, though Respondents were quick to point to prior (undisclosed) permits that had less stringent approaches than what is the case here, by contrast, they cannot point to a single permit where TAPs concentrations were spread out over the human lifetime or any other time, rather than the life of the facility. DEQ's determination that the Project's arsenic emissions demonstrates preconstruction compliance with the Air Rules Section 210.12 requirements is unreasonable, arbitrary and capricious, and unsupported by the record. The Hearing Officer must vacate the permit and remand it back to DEQ to fix these errors.

CONCLUSION

A permit issued by DEQ under the auspices of the Clean Air Act signals to the Tribe and public that this Project is emitting air pollutants, but doing so in a legal way to protect the ambient air—"that portion of the atmosphere . . .to which the general public has access"—and thus public health. PET 772. DEQ's failure, then, to lawfully and reasonably address the fugitive dust emissions is particularly troubling given that these legal and logical failures (esoteric to the general public) now presented to this reviewing body solely on paper will result in real world impacts to public health.

Yet, throughout their briefs, Respondents largely attempt to hide behind the cloak of agency discretion and deference to agency technical expertise. But that discretion is not unreviewable; that deference is not absolute. *See Laurino v. Bd. of Pro. Discipline of Idaho State Bd. of Med.*, 137 Idaho 596, 602 (2002) ("The Board, however, may not use its expertise as a substitute for evidence in the record, since the requirement for administrative decisions based on substantial evidence and reasoned findings—which provide the basis for effective judicial review—would become meaningless if material facts known to or relied upon by the agency did not appear in the record.") (footnote omitted).

As discussed above, there are many instances in this Permit where DEQ made decisions that are unexplained, unreasonable, and unsupported by the permit record. The aggressive and unsupported dust control efficiency. The mathematical distortion of arsenic concentrations. The leniency or lack of enforceable limits and monitoring. And each unexplained, unreasonable, and unsupported decision involves fugitive dust emissions from haul roads, therefore compounding the potential that arsenic and PM_{10} pollution outside of the ambient air boundary where Tribal

members use and the public recreates will exceed levels permitted by the law. This Permit, thus, cannot stand. Hence, the Hearing Officer should vacate the Permit and remand to DEQ for further review.

DATED: June 9, 2023

Respectfully submitted,

/s/ Julia Thrower
Julia S. Thrower
Attorney for Petitioner Save the South Fork Salmon

/s/ Bryan Hurlbutt
Bryan Hurlbutt
Attorney for Petitioners Nez Perce Tribe and Idaho Conservation League

CERTIFICATE OF SERVICE

I hereby certify that on June 9, 2023, a true and correct copy of the Petitioners' Response to Respondent DEQ's Cross-Motion for Summary Judgment and Intervenor Perpetua's Motion for Summary Judgment and Petitioners' Reply in Support of Petitioners' Motion for Summary Judgment was served on the following:

Dylan B. Lawrence Varin Thomas, LLC 242 N. 8th St., Suite 220 Boise, ID 83702 (208) 345-6021 dylan@varinthomas.com *Hearing Officer*	Via:	Email: Fax: CM/ECF: Hand Delivery: U.S. Mail:	[x] [ ] [ ] [ ] [x]
Paula Wilson paula.wilson@deq.idaho.gov *Hearing Coordinator*	Via:	Email:	[x]
Office of Administrative Hearings P.O. Box 83720 Boise, ID 83720-0104 filings@oah.idaho.gov	Via:	Email: U.S. Mail:	[x] [x]
John Shackelford Office of the Attorney General 1410 N. Hilton, 2nd Floor Boise, ID 83706 (208) 373-0453 john.shackelford@deq.idaho.gov *Attorney for Respondent Idaho Department of Environmental Quality*	Via:	Email: Fax: CM/ECF: Hand Delivery: U.S. Mail:	[x] [ ] [ ] [ ] [ ]
Krista McIntyre W. Christopher Pooser Wade Foster Stoel Rives, LLP 101 S. Capital Blvd., Suite 1900 Boise, ID 83702 (208) 389-9000 krista.mcintyre@stoel.com christopher.pooser@stoel.com wade.foster@stoel.com *Attorneys for Intervenor Perpetua Resources of Idaho, Inc.*	Via:	Email: Fax: CM/ECF: Hand Delivery: U.S. Mail:	[x] [ ] [ ] [ ] [ ]

Bryan Hurlbutt (ISB No. 8501)
Laurence J. Lucas (ISB No. 4733)
ADVOCATES FOR THE WEST
P.O. Box 1612
Boise, ID 83701
(208) 342-7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	Agency Case No. 0101-2201
	)	OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,	)	**DECLARATION OF ALLISON FOWLE**
Petitioners,	)	
v.	)	
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC.	)	
Intervenor.	)	

I, ALLISON FOWLE, state and declare as follows:

1. My name is Allison Fowle. I live in Boise, Idaho, and am over 18 years of age. The following statements are based on my personal knowledge, and if called as a witness, I would and could testify thereto.

2. I am a member of the Idaho Conservation League ("ICL"). I have been an ICL member for about five years. One reason I am a member of ICL is because of ICL's advocacy around the Stibnite Gold Project ("SGP").

3. I visit the SGP area several times each year to hike, backpack, and flyfish. While there's no shortage of recreation options that are closer to home, there is something quite special about the South Fork Salmon River ("SFSR") watershed, and the Stibnite area in particular contains a unique combination of cultural history, rugged terrain, and solitude**.**

4. One of my favorite access points for the Frank Church–River of No Return Wilderness is the trailhead at Monumental Creek, which is only accessible by traveling directly through the SGP site. When I'm on Monumental Creek, I feel as though I've traveled back in time—the night sky is dark and alive with visible stars, the creek crossings are impossibly cold, and the air is fresh and clear. During my visits, I also enjoy pulling my truck over on the Stibnite Road and trekking down to the East Fork of the SFSR, which offers this same experience of solitude; though the road is close, its sound is easily drowned by the river's whitewater.

5. I first visited the SGP area in 2018 when I backpacked from the Monumental Creek Trailhead to Big Creek**.** Since then, I have returned to the area at least ten times, including in August 2019, as shown in Figure 1 below. Among recent visits, in September of 2022 I visited the area to hike Parks Peak and Williams Peak, both of which offered expansive views of the area as well as a reprieve from wildfire smoke back home in Boise.



Fig 1. *My dog and I entering the Frank Church–River of No Return Wilderness at Monumental Creek to fly fish in August 2019.*

6. I plan to continue visiting the area each year to hike, backpack, and flyfish. This month (June 2023), I plan to backpack Rainbow Ridge with friends. I have also always wanted to backpack a long loop through the Frank Church starting and ending at the Lookout Mountain Trailhead near Thunder Mountain. I hope to do this in August or September this year.

7. I am concerned about the way these special places would change if the SGP moves forward. My understanding, based on ICL's filings and comments, is that mine construction and operation would generate dust, including dust with arsenic. Dust will obscure the clear night skies and mountain views I so enjoy when I visit the area. Dust and arsenic are also unhealthy to breathe, and I worry about the effects of passing through and spending time

outside in the area while the mine is operating. I am also concerned that dust and arsenic can settle in lakes and streams and harm fish and other life.

8. It makes me sad to think about these ways that my visits would be diminished if the SGP proceeds, as approved in the Idaho Department of Environmental Quality ("DEQ") air permit. It makes me even more sad to consider that I might not visit these special places as frequently as I would like because of air pollution from the mine. My understanding is that the Stibnite Road through the SGP area—which I have used many times—is considered by DEQ to be within the SGP boundary and will not meet air quality standards that apply outside the project boundary if the mine proceeds, even though Perpetua has indicated that the Stibnite Road will still be useable to people like me. It is also my understanding that many details about how the SGP will be conducted have not yet been decided, or are not specified in DEQ's air permit, and will be decided later. I also understand that DEQ is not requiring monitoring at the SGP boundaries to verify the actual levels of air pollution once the SGP is underway.

9. In addition to my regular personal visits, I have visited the area as a high school teacher. I have brought two groups of high school students to Yellow Pine and Stibnite in the past five years. The area is a perfect classroom in which to study ecology, geology, hydrology, and environmental policy, and I intend to continue bringing students to the area for years to come. In the fall of 2023 or 2024, I intend to bring students to the area for a course on land management.

10. On these trips, we spent up to four days camping in the area and often engaged in fairly vigorous exercise, taking full-day hikes close off of the East Fork road, Profile Road, and Stibnite Road. Figures 2, 3, and 4 below show students on the trip I led in September 2019. These trips have been rich and productive learning opportunities and, for some students, have

been life-changing. Alumni of these trips have gone on to study biology, geology, and science education in college, as well as to work as wildland firefighters, river guides, and seasonal staff for agencies like the Forest Service.



Fig. 2. *High school students studying geology at the confluence of Johnson Creek and the East Fork of the SFSR in September 2019.*



Fig. 3. *High school students observing spawning Bull Trout in Sugar Creek in September 2019.*



Fig. 4. *September 2019. High school students engaged in field journaling on the banks of the SFSR.*

11. As a sensitive population for whom I am responsible, I am concerned about risks to the health of my students from air pollution if mining begins, and I worry that I will no longer be able to take students on these trips. Because air quality standards would not be met on the Stibnite Road through the SGP site, I would no longer feel comfortable taking students to visit Sugar Creek. Because of the uncertainties surrounding air pollution from the SGP and the lack of monitoring at the SGP boundary, I am concerned that I should not take students to other locations we have visited in the past outside of, but near, the mine area.

I declare under of penalty of perjury that the foregoing is true and correct.

Dated this 4th day of June 2023, at Boise, Idaho.

/s/ *Allison Fowle*
Allison Fowle

Julia Thrower (ISB No. 10251)
MOUNTAIN TOP LAW PLLC
614 Thompson Avenue
McCall, ID 83638
T: 208.271.6503
E: jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	Agency Case No. 0101-2201 OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, *Petitioners*, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, *Respondent*, and PERPETUA RESOURCES IDAHO, INC., *Intervenor*.	**DECLARATION OF DREW HOLLENBACK**

I, DREW HOLLENBACK, state and declare as follows:

1. My name is Drew Hollenback, and I am a resident of Valley County Idaho.

2. I have been a supporter of Save the South Fork Salmon ("SSFS") since 2016. I became interested in SSFS because of its work to protect the South Fork Salmon River watershed from the impacts of the Stibnite Gold Project proposed by Perpetua Resources Idaho, Inc. I continue to support SSFS's work because I support its mission to protect and preserve the South Fork Salmon River watershed and its natural resources. I have met with Board members of SSFS a few times to discuss the potential impacts of the proposed Stibnite Gold Project. I have donated a substantial amount of money to SSFS through my business, Tenkara Rod Company.

3. I started my company, Tenkara Rod Company, with my business partner in 2010. Tenkara Rod Company sells high quality fishing rods designed with simplicity for the new fly fisher, as well as quality for the seasoned fisherman. I started the company because I believe that fishing gives people a chance to get out and appreciate the beauty of nature and become stewards of our rivers. I talk with customers about places to go fishing, and have discussed the East Fork of the South Fork Salmon River ("East Fork") and the proposed Stibnite Gold Project to try to educate my customers about what is being planned in the area. In 2013, I created a YouTube video to raise awareness of the area as a spectacular place to fish.

4. I have significant interest and a deep personal connection to the South Fork Salmon River watershed, and the rivers in the area, including those around the proposed Stibnite Gold Project area. I personally recreate in the South Fork Salmon River watershed, including in and around the site of the proposed gold mine. I have fished in the Yellow Pine pit where bull trout pool up as they attempt to migrate up the East Fork, and on Salt Creek, Sugar Creek, Profile Creek and many of the other creeks and rivers in the area. I take my family, including my two

daughters (8 and 10 years old) camping off of Sugar Creek. I also occasionally do backcountry motorcycle trips in the area.

5. I have reviewed Perpetua's map that depicts the proposed mine site and the ambient air boundary. A true and correct copy is attached as Exhibit 1. I have recreated and fished in the rivers and creeks both within the blue line that depicts the ambient air boundary, and just outside of that boundary. I have also traveled on the existing road through the proposed mine site to access recreational sites, which corresponds roughly to the green line on the map.

6. I first visited the South Fork Salmon River watershed areas about 10 years ago when I went for a fishing trip. I did a loop trip that took me to Lick Creek, the Secesh River, and to the East Fork. I fell in love with the area's beauty. I was amazed by the changing fall colors and the presence of wildlife. There was an abundance of fish to catch. On this trip alone, I saw a mountain line, a bald eagle, and a black bear. This area felt very wild and very natural, and there was little human traffic. I believe that this area continues to have the best bull trout fisheries in the United States in both quantity of fish and size. This area continues to be a part of my life since my first visit.

7. I spend about 2 to 3 weeks every year fishing, camping with my family, and taking motorcycle trips with friends in and around the Stibnite area. I have taken my two daughters (8 and 10 years old) out to this area since they were babies. We often camp around Sugar Creek, upstream of the East Fork, where daughters swim and snorkel in the rivers, including the East Fork. We were there last year, in 2022, and I intend to return with my daughters this summer and into the future as long as we are able.

8. I have traveled on the road through the mine site to access public lands for recreation. I've driven to the overlook in the mine area so that I can view the salmon in the

Yellow Pine pit. My motorcycle trips also take me into the area. I have ridden the Idaho backcountry discovery route, which goes through Yellow Pine, to Profile Summit, and then drops down to Elk City.

9. I intend to continue to visit these areas yearly in the South Fork Salmon River watershed, including in and around the proposed Stibnite Gold Project, to camp, fish, ride, and enjoy the wildlife, scenery, and beauty of the area, and give these same experiences to my family.

10. I understand that in June 2022, the Idaho Department of Environmental Quality ("DEQ") issued Perpetua Resources an air permit for the proposed Stibnite Gold Project, called a Permit to Construct, under the authority of the Clean Air Act. I understand that the proposed mining operations will emit significant amounts of air pollutants, such as particulate matter, and cancer-causing air pollutants, such as arsenic. I also understand that inside the ambient air boundary line and including over the public road going through the mine site, the impacts to air quality from the emission of air pollutants is not analyzed or regulated. I also understand that outside of the ambient air boundary, the air quality is supposed to meet certain standards, and that these are health-based standards set to protect the public health.

11. I am concerned that the air permit that DEQ issued to Perpetua for the proposed mine will not protect the air quality as is required under the Clean Air Act and under the Idaho rules and regulations. I am concerned that the air permit does not ensure that the air quality outside the ambient air boundary where I recreate will meet the criteria necessary to comply with the laws and regulations.

12. I am greatly concerned about the air quality both on the road that goes through the mine site, and about the air quality outside of the ambient air boundary where I have recreated and plan to recreate in the future. I am concerned in particular about excess arsenic in the air,

which is a carcinogen that can have a negative impact on my health. I am also concerned that the road will not have any air quality protections, and will be unregulated. I am particularly concerned about potentially exposing my daughters to both particulate matter and arsenic in the air at such a young age.

13. I am also concerned that if the arsenic emitted in the air falls to the ground and further pollutes the water it may impact the fisheries over time. I am concerned that the amount of fish would decrease, and fishing would be less enjoyable for both me and my family.

14. I would like to continue to recreate in the South Fork Salmon River watershed, and in the Stibnite area, but if the air quality is degraded by air pollutants emitted from the mine, my recreational activities will be harmed and will be greatly impacted. I will be very concerned about how the air will impact my health and the health of my family. As a result, I personally will think twice about fishing in the areas even outside of the ambient air boundary. I probably would no longer camp, and if I did fish, I would significantly reduce the amount of time I spend there. I would not take my daughters to camp, swim, and snorkel there anymore. We would lose the ability to enjoy the area's natural abundance, and would not be able to continue our family tradition of experiencing the area's natural beauty, amazing rivers, and abundant wildlife.

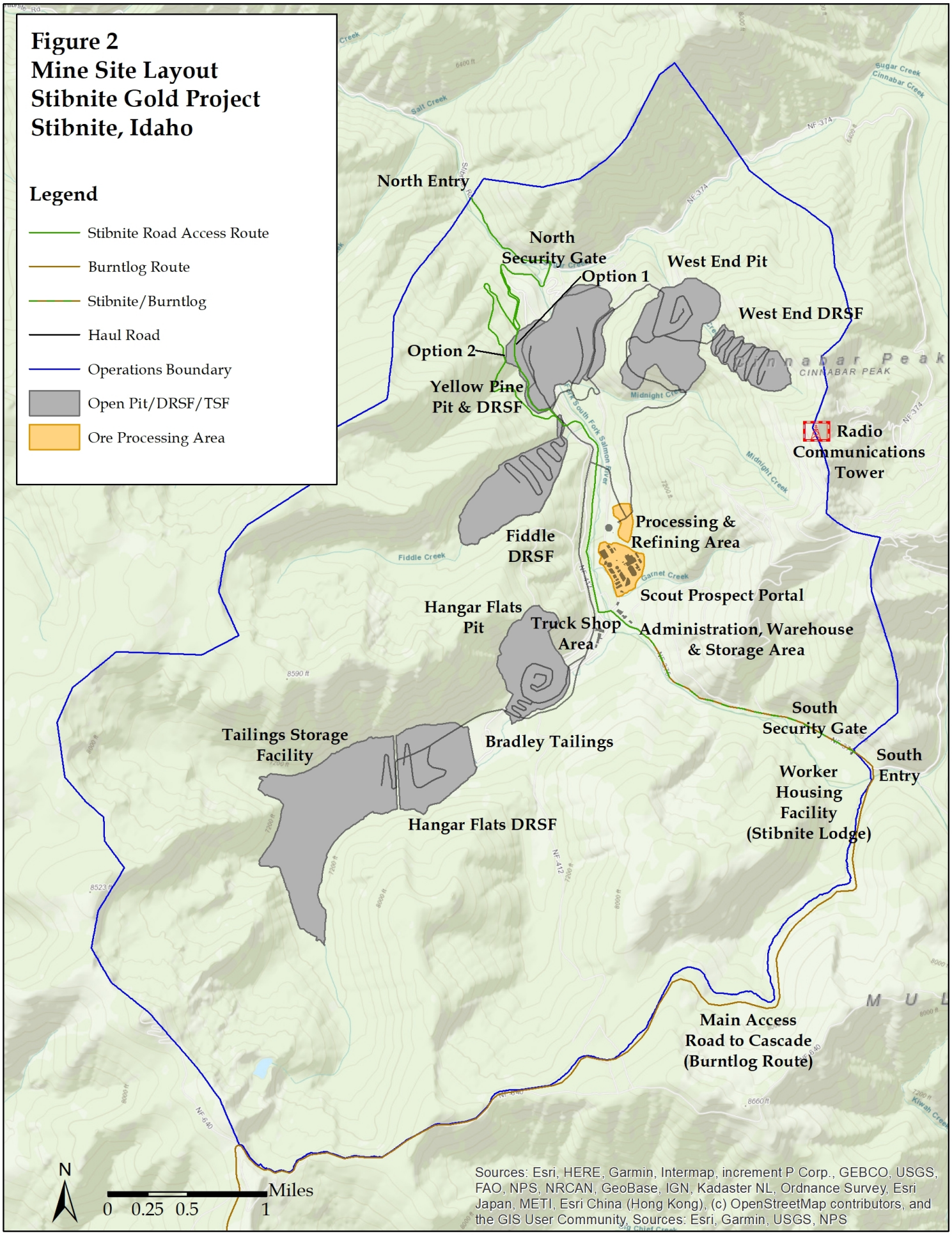
15. It is my understanding that the Clean Air Act and the rules or regulations that DEQ follow in issuing an air permit are designed to protect air quality by imposing pollution limits, best management practices, and restrictions on how the mine can operate, and that DEQ may impose monitoring and reporting requirements to ensure that ambient air quality is maintained. Therefore, a decision from the Office of Administrative Hearings and/or the Board of Environmental Quality that finds that the air permit is in compliance with all laws and regulations will help redress these harms. I would feel better recreating in the area and taking my

family to the area if the air permit could ensure that the amount of air pollutants emitted from the mine do not exceed air quality standards at the ambient air boundary.

Pursuant to Idaho Code 18-5409, I declare under penalty of perjury that the foregoing is true and correct.

Executed this 9th day of June 2023, at Valley County, Idaho.

s/ Drew Hollenback
Drew Hollenback


Figure 2
Mine Site Layout
Stibnite Gold Project
Stibnite, Idaho
Legend
Stibnite Road Access Route
Burntlog Route
Stibnite/Burntlog
Haul Road
Operations Boundary
Open Pit/DRSF/TSF
Ore Processing Area
North Entry
North Security Gate
Option 1
Option 2
West End Pit
West End DRSF
Yellow Pine Pit & DRSF
Radio Communications Tower
Processing & Refining Area
Fiddle DRSF
Scout Prospect Portal
Hangar Flats Pit
Truck Shop Area
Administration, Warehouse & Storage Area
South Security Gate
South Entry
Worker Housing Facility (Stibnite Lodge)
Tailings Storage Facility
Bradley Tailings
Hangar Flats DRSF
Main Access Road to Cascade (Burntlog Route)
N
0 0.25 0.5 1 Miles
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community, Sources: Esri, Garmin, USGS, NPS

Bryan Hurlbutt (ISB No. 8501)
Laurence J. Lucas (ISB No. 4733)
ADVOCATES FOR THE WEST
P.O. Box 1612
Boise, ID 83701
(208) 342-7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	Agency Case No. 0101-2201 OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, *Petitioners,* *v.* IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, *Respondent,* and PERPETUA RESOURCES IDAHO, INC. *Intervenor*.	**DECLARATION OF ASA MENLOVE**

I, ASA MENLOVE, state and declare as follows:

1. My name is Asa Menlove. I live in Stanley, Idaho and am over 18 years of age. The following statements are based on my personal knowledge, and if called as a witness, I would and could testify thereto.

2. I have been an Idaho Conservation League (ICL) member and supporter since about 2019. I worked to found ICL's Youth Salmon Protectors, which is a coalition of young people in the Pacific Northwest dedicated to saving wild Snake River salmon and steelhead. In this role, I have organized rallies, led comment writing workshops, and helped inform thousands on the issues facing these wild fish like the Stibnite Gold Project (SGP). As part of my work with the ICL Youth Salmon Protectors, I have organized multiple comment writing workshops in defense of these salmon and steelhead and in opposition to the SGP's permitting.

3. I support and volunteer with ICL and the Youth Salmon Protectors because I care for the land, water, and air that exists in Idaho, and I have a vested interest in its protection. ICL has been able to take action on my behalf and in defense of the land, water, and air here.

4. ICL's work on the SGP is very dear to me. I am a fly fisherman, river guide, kayaker, backpacker, and lover of the area affected by the SGP. Over the last few years, I have made multiple trips to the SGP site and surrounding areas each season to recreate in and connect with the magnificent ecology and landscapes that exist here.

5. During the summers, I live in Stanley, Idaho, where I work as a full time river guide on the Middle Fork of the Salmon River. Though I spend most of my time in the summers on the Middle Fork, when I have time off from working I find myself making the drive to its sister river, the South Fork of the Salmon. The South Fork and its tributaries are every bit as remote, ecologically complex, beautiful, and mystifying as the Middle Fork, though they have

not been afforded the same level of protection and developmental regulation. This is evident by the obvious effects of historical mining in the Yellow Pine pit, as well as the much higher content level of in-stream contaminants like cyanide and arsenic, much of which has found its way into the streams via dust particulate collected during runoff.

6. The first time I visited the SGP area and its surrounding landscapes was in the fall of 2019, during my senior year of high school. I was there with a dozen or so classmates and a few teachers to study the place and the effects of historical mining practices on the ecological and cultural history. We spent time at the Yellow Pine pit on a tour led by then Midas Gold employees, as well as exploring the surrounding area on our own. The most impactful experience of the trip, and the one that has inspired me to return year after year, was watching critically endangered Bull Trout spawn in the highest reaches of Sugar Creek, a tributary of the East Fork of the South Fork that converges just below the Yellow Pine pit. My classmates and I gathered on the river bank and sat in silence, watching these fish perform a dance and tradition which has been repeated in these streams for thousands upon thousands of years. I had never been able to observe fish as wild, as large, and as beautiful as these ones at such close distance, and they were seemingly unbothered by our presence. Being an angler and lover of wild fish at heart, I knew that I wanted to come back in the summer when they weren't spawning and try to connect with one of these residents.

7. And so, each summer since, I have been back to fish, to pick morel mushrooms, to camp, to explore, and to connect with the greater South Fork Salmon ecosystem. My ability to do all of these things in healthy and enjoyable ways will be negatively affected if the air quality is made worse by the proposed Stibnite Gold Project.

8. On a physical level, I rely on clean and fresh air in my lungs when I am exerting myself in hiking around in exploration of a place. Should the air around the SGP be allowed to be dirtied, I worry that breathing increased dust, and arsenic particulates, will adversely affect my health. On an emotional level, I rely on the health of the landscapes which I love so dearly. The time I spend with this ecology is fundamentally connected to my mental health, and I value this connection in ways that are difficult to articulate. Should the dust levels in the air be increased, so too will the level of contaminants in the waterways, in the soil, in the trees, in every aspect of the ecology of this place. This is an unacceptable risk for myself and thousands of other people who share my connections with this place, and it is a damning risk for the many species who call this place home, including bull trout, Chinook salmon, and steelhead, which are all listed as "threatened" under the federal Endangered Species Act.

9. I am concerned that when it issued the Permit to Construct, the Idaho Department of Environmental Quality (DEQ) did not include the Stibnite Road through the SGP area as part of the "ambient air" that is required to meet air quality standards. I have been on the Stibnite Road to access Sugar Creek, and I would like to return. However, because of the levels of particulate and arsenic pollution allowed under the Permit, I will either be putting my health at risk or will have to make the decision not to go to Sugar Creek.

10. I am also concerned that when it issued the Permit, DEQ made a number of assumptions about how the SGP will operate and reduce its emissions, but that the Permit does not require all such operations and reductions to occur. I am also concerned that DEQ did not require any air quality monitoring surrounding the SGP area boundary. Without all necessary Permit requirements and without monitoring while the mine is built and operated, I am concerned about unknown and potentially higher than expected air pollution levels outside of the

SGP area, which also threaten my health and the health of the environment in the South Fork. Because of these risks, I might avoid visiting places I would like to visit near the mine site.

11. With these points made, I have a very strong interest in ensuring that the air pollution as a result of mining operations be limited to the smallest amounts possible. The South Fork of the Salmon River ecosystem is invaluable to my physical, mental, and emotional well-being, and I sincerely hope that the quality of the air, waterways, and soil here will remain unburdened by deadly air pollution in perpetuity.

I declare under of penalty of perjury that the foregoing is true and correct.

Dated this 7th day of June 2023, at Stanley, Idaho.

/s/ *Asa Menlove*
Asa Menlove

Bryan Hurlbutt (ISB No. 8501)
Laurence J. Lucas (ISB No. 4733)
ADVOCATES FOR THE WEST
P.O. Box 1612
Boise, ID 83701
(208) 342-7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	Agency Case No. 0101-2201
	)	OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,	)	**DECLARATION OF JOSEPH OATMAN**
Petitioners,	)	
v.	)	
IDAHO DEPARTMENT OF ENVIORNMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC.	)	
Intervenor.	)	

I, JOSEPH OATMAN state and declare as follows:

1. My name is Joseph Oatman. I am a resident of Pendleton, Oregon, and am over 18 years of age. The following statements are based on my personal knowledge, and if called as a witness, I would and could testify thereto.

2. I am an enrolled member of the Nez Perce Tribe ("Tribe"), a federally recognized tribe. I am a descendent of Chief Looking Glass, a principal chief who signed the Treaty of 1855 with the United States. I have a Bachelor of Science in Fishery Resources from the University of Idaho and a Masters of Natural Resources from the University of Idaho. From 2001 to 2004 I worked for the Nez Perce Tribe's Department of Fisheries Resource Management ("DFRM") as a harvest biologist. Since 2007, I have served as DFRM's Deputy Program Manager. My responsibilities include overseeing the Harvest Division and assisting the program manager in administering DFRM's many anadromous and resident fish restoration projects and activities.

3. I grew up on the Nez Perce Reservation in north-central Idaho.

4. Since time immemorial, the Nez Perce people, the Nimiipuu, exclusively occupied over 13 million acres encompassing a large part of what is today Idaho, Washington, and Oregon—stretching from the Bitterroot Mountains to the Blue Mountains. Nez Perce also traveled far beyond this homeland to fish, hunt, gather and pasture—frequently going east to buffalo country, in what is today Montana, and west along the Snake and Columbia Rivers. In 1855, to preserve its way of life and the foods we depend upon, the Tribe entered into a treaty with the United States reserving to itself, among other guarantees, "the right of taking fish at all usual and accustomed places in common with the citizens of the Territory." Treaty with the Nez Perces, June 11, 1855 (12 Stat. 957). Since that time, the Tribe has continued to exercise its treaty-reserved fishing, hunting, gathering, and pasturing rights. It is essential for tribal members to maintain connection with the rivers, lands, and fish that are critical to supporting

our culture and livelihoods. Nez Perce Tribal members, pursuant to the Tribe's Treaty-reserved rights, continue to fish, hunt, gather and pasture across the Tribe's vast aboriginal homeland at traditional places, including areas within and surrounding the proposed Stibnite Gold Project ("SGP") area and in waters directly downstream.

5. My family has strong ties to and has used the resources in the Snake River basin, including the South Fork Salmon River ("SFSR") for hundreds of years. I, like my family, have maintained those same strong ties to that area and the culturally-significant resources within it my whole life. Since childhood, I have fished with my family for salmon, steelhead, and bull trout in the SFSR watershed. We go to these same locations when fish are available to harvest them for subsistence, cultural, and other needs. In addition to engaging in treaty fishing, my family and I also engage in other cultural activities in the SFSR. This place is so important to us that when we lose loved ones, we leave rocks with their names inscribed on them to remember the camping, fishing, and enjoyment this area brought to us and those who have passed on. As we carry on our activities and use of this area, we can look up on the hillside where those rocks are placed to remember those who are no longer with us.

6. The South Fork Salmon River watershed is one part of the four major areas of the Snake Basin where we catch most of our spring/summer Chinook on an annual basis. As such, this is a critical area where tribal members can catch fish to meet their ceremonial, subsistence, and commercial needs. Tribal members and their families who use this area, such as my family, often do so as a multi-generational family unit. It is common to see two to four generations within a family traveling, camping, fishing, and using the area. There can be infants/toddlers up to the eldest member of a family that are present and involved in the daily life and activities in the SFSR. The ability to maintain our connection and relationship to each other and to the land, rivers, and fish, can be impacted by conditions or activities occurring in the area that could lead to unsafe or dangerous conditions that could limit, impede

or interfere with our ability to exercise our treaty-rights and gather our foods. Our responsibility is to ensure that all members of our family—from our youngest to our oldest—are safe and protected from anything or activity that could possibly bring harm to them.

7. I have personally engaged in treaty fishing for steelhead and bull trout within the boundaries of the proposed Stibnite Gold Project ("SGP"). My family and I plan to engage in treaty fishing and gathering within and adjacent to the proposed SGP area in the future. I am deeply concerned, however, that Idaho Department of Environmental Quality's ("DEQ") issuance of the air permit for the proposed SGP will injure my family and me by adversely affecting our ability safely exercise our treaty rights in and use and enjoy the area. My understanding from written comments provided by the Tribe to DEQ is that the SGP would create air pollutants, including dust with arsenic, in and adjacent to the SGP area. This air pollution is unhealthy to breathe and could impact our ability to fish which is a physically-demanding and strenuous activity. Air pollution also diminishes visibility that can affect our ability to see fish in the waterways, and may harm waterways, fish, wildlife, and flora, in the area. Injury to our health or to any of these resources caused by DEQ's air permit would adversely affect my ability to safely exercise our treaty rights and to use and enjoy the area within and adjacent to the SGP for subsistence, cultural, spiritual, and economic purposes.

8. In addition to my personal and familial connections to and use of the area, I also have the honor and privilege of serving my Tribe and the Nez Perce people through my professional work as the Tribe's DFRM Deputy Program Manager. The Tribe has one of the largest fisheries program of any tribe in the United States. The goal of DFRM is to recover and restore all populations and all species of anadromous and resident fish that are important to the exercise of the Tribe's treaty-reserved rights and way of life. DFRM headquarters is in Lapwai on the Nez Perce Reservation in Idaho, and DFRM has offices in Powell, Red River, Grangeville, Orofino, McCall, and Sweetwater, Idaho, and Joseph,

Oregon. The program has over 180 employees and operates on a budget of $24 million annually. DFRM has six divisions, which collectively provide administrative, technical, research, and enforcement services related to native resident and anadromous fish management activities in the Columbia and Snake River basins.

9. DFRM works extensively throughout the SFSR watershed, expending approximately $2.79 million annually on fisheries supplementation, harvest management, research, and watershed restoration work, as part of the broader Columbia River Basin salmon restoration efforts. This work includes moving some Chinook salmon above the "Glory Hole"—a legacy mine pit at the proposed SGP that blocks salmon from migrating up to the East Fork SFSR to their spawning grounds.

10. Due to the Tribe's Treaty-reserved rights and resources within and around the proposed SGP, and the Tribe's substantial fishery restoration work in the SFSR watershed, the Tribe has invested substantial time and resources in reviewing the proposed SGP. The Tribe has submitted numerous written comments, including comments to DEQ on the air permit. The Tribe has also participated in staff-to-staff meetings with federal and state permitting agencies, and government-to-government consultations with federal permitting agencies.

I declare under penalty of perjury that the foregoing is true and correct.

Executed this 6th day of June 2023, at Lapwai, Idaho.

/s/ Joseph Oatman
Joseph Oatman

Bryan Hurlbutt (ISB No. 8501)
Laurence J. Lucas (ISB No. 4733)
ADVOCATES FOR THE WEST
P.O. Box 1612
Boise, ID 83701
(208) 342-7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	Agency Case No. 0101-2201 OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, *Petitioners,* *v.* IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, *Respondent,* and PERPETUA RESOURCES IDAHO, INC. *Intervenor*.	**DECLARATION OF JONATHAN OPPENHEIMER**

I, JONATHAN OPPENHEIMER, state and declare as follows:

1. My name is Jonathan Oppenheimer. I live in Boise, Idaho and am over 18 years of age. The following statements are based on my personal knowledge, and if called as a witness, I would and could testify thereto.

2. I have worked at Idaho Conservation League (ICL) since April 2002. I currently work as External Relations Director at ICL. I have also been a member of ICL, since at least 2001, before joining the staff of the organization.

3. Since 1973, ICL has worked to protect Idaho's environment. ICL is Idaho's largest state-based conservation organization with over 25,000 supporters. ICL's mission is to create a conservation community and pragmatic, enduring solutions that protect and restore the air you breathe, the water you drink, and the land and wildlife you love. ICL's main office is in Boise. ICL has field offices in Sandpoint, McCall, and Ketchum.

4. Since ICL's founding, advocating for responsible mining practices has been central to ICL's mission. As part of our work at ICL, my colleagues and I regularly review and evaluate mining proposals and permits for consistency with federal, state, and local regulations and laws. We submit comments on state and federal mining proposals, reclamation plans, administrative rules, and during associated public input opportunities. We have been involved in efforts to promote restoration of abandoned mines, have developed cooperative restoration and mitigation proposals with mining companies, and have engaged in litigation to ensure compliance with existing laws and regulations in order to minimize the negative impacts associated with mining.

5. Of all the things I work on, I feel that mining is one of the most important because of the large-scale, lasting impact it can have on the landscape, water quality, air quality, fish,

wildlife, and communities. One of the primary ways we work to achieve our mission is through participating in the public review and comment process for mining and mineral exploration projects on National Forest lands and other public lands, such as the Stibnite Gold Project.

6. ICL has been engaged in the Stibnite Gold Project for over a decade, since Perpetua's predecessor Midas Gold was conducting exploration at the site. ICL has remained engaged in the Stibnite Gold Project, which has become an organizational priority and is of great concern to our members. Among other activities, ICL has regularly met with Midas Gold and Perpetua staff, contractors, and investors, as well as with state and federal agency officials, tribal members, and journalists concerning the Project. ICL has engaged in public processes for the Project's permitting, including by submitting comments to the Forest Service.

7. ICL has also been engaged in Idaho DEQ's air permitting process for the Stibnite Gold Project. Among other activities, ICL submitted comments to DEQ in October and November of 2020, March of 2021, and March of 2022. These comments have been instrumental in correcting permitting errors within draft permits.

8. Not only is the Stibnite Gold Project important to me professionally; it also important to me personally.

9. My family and I regularly visit the South Fork Salmon River (SFSR) drainage, including the East Fork of the SFSR. I have visited and recreated in and near the East Fork SFSR drainage every summer for more than a decade. My daughters love and appreciate the East Fork SFSR so much that they developed a song about the river. I have explored the surrounding areas, including Riordan Lake, which we visited as a family. I have also camped at Riordan Lake on my own in the past and look forward to returning. We have also rented and stayed at the Johnson Creek Guard Station, where we have adventured into the surrounding mountains.

10. Among other visits to the area, in 2021, I hiked up Sugar Creek with my dogs, off Forest Road #374. I parked near the junction of Sugar Creek and the main Stibnite Road, and I enjoyed visiting the site, picnicking along the creek, walking with my dogs, and birdwatching.

11. During the summer of 2022 my wife, one of my daughters, and I camped in the Old East Fork Road campground, just downstream of Yellow Pine. On that trip, we visited the East Fork SFSR area and enjoyed swimming, hiking, huckleberry picking, and watching wildlife.

12. The East Fork SFSR drainage is special to me and my family, and we look forward to returning every year and enjoying the fresh air, public lands, clean waters, and environment of the area.

13. This summer, we plan to visit the East Fork SFSR drainage. Once again, we plan to camp at the Old East Fork Road Campground and stay at the Johnson Creek Guard Station. I look forward to exploring the area with my family, fishing in Johnson Creek and the East Fork SFSR, and visiting the Stibnite area.

14. I have reviewed the Permit to Construct DEQ issued to Perpetua for the Stibnite Gold Project as well as DEQ's Statement of Basis, ICL's public comments, and Petitioners' filings in this contested case.

15. I am concerned about the air pollution the proposed gold mine would emit and the adverse health effects to my family and me. I have suffered from allergy and exercise induced asthma since I was a child. I regularly use an albuterol inhaler to manage my asthma. Any amount of additional particulate matter (PM) makes air less healthy to breathe. Recent studies on the nature of PM concentrations and their health effects back up previous studies and provide support for a no-threshold relationship between PM exposure and several respiratory and

cardiovascular effects, and mortality, meaning any concentration of PM can have negative health effects.[1] These health risks from increased particulates are even more significant for people like me, with asthma or other respiratory ailments.[2]

16. I am also concerned about arsenic air pollution from the Project. Inhalation of arsenic-bearing dusts have been definitively linked to increased systemic uptake, as well as carcinogenic and non-carcinogenic health outcomes.[3]

17. I am also concerned about particulate and arsenic pollution settling out from the air and into water. The East Fork SFSR is inhabited by native and threatened species, including Chinook salmon, steelhead trout, and bull trout. Atmospheric deposition from elevated heavy metal concentrations has been well studied to increase concentrations in nearby water-ways.

18. The Stibnite Gold Project will degrade the clean air we breathe, the fish and bird life we enjoy, and the public lands we love when my family and I (and other ICL members) visit the SFSR watershed, especially in the East Fork. If the Stibnite Gold Project is approved, traveling through and recreating in the area will harm me and my family by exposing us to increased levels of PM and arsenic in the air, putting our health at risk. I am concerned that we will not enjoy the area as we have in the past, including because I will have to restrict my activities due to the heightened health risks I face with exercise-induced asthma. I also worry that the environment will be degraded by this increased air pollution. And I worry that we may not be able to visit the area at all in order to protect our health.

---

[1] *See* Exhibit A (attached and excerpted), U.S. EPA. Integrated Science Assessment (ISA) for Particulate Matter (Final Report, Dec 2019). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-19/188, 2019 (available at https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=347534).

[2] *See id.*, p. 1-1.

[3] *See* Exhibit B (attached), Martin, R.; Dowling, K.; Pearce, D.; Sillitoe, J.; Florentine, S. Health Effects Associated with Inhalation of Airborne Arsenic Arising from Mining Operations. Geosciences 2014, 4, 128-175 (available at https://doi.org/10.3390/geosciences4030128).

I declare under of penalty of perjury that the foregoing is true and correct.

Dated this 6th day of June 2023, at Boise, Idaho.

/s/ *Jonathan Oppenheimer*
Jonathan Oppenheimer

Exhibit A to Oppenheimer Decl.

EXCERPTED: U.S. EPA. Integrated Science Assessment (ISA) for Particulate Matter (Final Report, Dec 2019). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-19/188, 2019 (available at https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=347534)

EPA/600/R-19/188 | December 2019 | www.epa.gov/isa

EPA
United States
Environmental Protection
Agency

Integrated Science Assessment for Particulate Matter



Office of Research and Development
Center for Public Health & Environmental Assessment, Research Triangle Park, NC

REC 2402

EPA/600/R-19/188
December 2019
www.epa.gov/isa

Integrated Science Assessment for Particulate Matter

December 2019

Contains Errata Sheet created September 2021

Center for Public Health and Environmental Assessment
Office of Research and Development
U.S. Environmental Protection Agency
Research Triangle Park, NC

DISCLAIMER

This document has been reviewed in accordance with the U.S. Environmental Protection Agency policy and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

CONTENTS

INTEGRATED SCIENCE ASSESSMENT TEAM FOR PARTICULATE MATTER ___ LXVI

AUTHORS, CONTRIBUTORS, AND REVIEWERS ___ LXX

ACRONYMNS AND ABBREVIATIONS ___ LXXVII

PREFACE ___ P-1

P.1. Legislative Requirements for the Review of the National Ambient Air Quality Standards ___ P-1
P.1.1. Overview and History of the Reviews of the Primary and Secondary National Ambient Air Quality Standard for Particulate Matter ___ P-3
P.2. Purpose and Overview of the Integrated Science Assessment ___ P-9
P.3. Process for Developing Integrated Science Assessments ___ P-11
P.3.1. Scope of the ISA ___ P-14
P.3.2. Evaluation of the Evidence ___ P-17
P.3.2.1. Biological Plausibility ___ P-17
P.3.2.2. Comparing Epidemiologic Study Results ___ P-19
P.3.2.3. Assessing Causality ___ P-20
P.4. References ___ P-21

EXECUTIVE SUMMARY ___ ES-1

Purpose and Scope of the Integrated Science Assessment ___ ES-1
Sources and Exposure to PM ___ ES-5
Dosimetry of Inhaled PM ___ ES-7
Health and Welfare Effects of PM Exposure ___ ES-8
Health Effects of $PM_{2.5}$ Exposure ___ ES-12
Respiratory Effects ___ ES-12
Cardiovascular Effects ___ ES-13
Nervous System Effects ___ ES-15
Cancer ___ ES-15
Mortality ___ ES-16
Policy-Relevant Considerations for Health Effects Associated with Particulate Matter Exposure ___ ES-17
PM Exposure and Welfare Effects ___ ES-20
Scientific Considerations and Key Findings of the Health and Welfare Effects Evidence ___ ES-21
Health Effects Evidence: Key Findings ___ ES-22
Welfare Effects Evidence: Key Findings ___ ES-24
References ___ ES-25

CHAPTER 1 INTEGRATED SYNTHESIS ___ 1-1

1.1 Introduction ___ 1-1
1.1.1 Purpose ___ 1-1
1.1.2 Organization of the ISA ___ 1-2
1.2 From Emissions Sources to Exposure to PM ___ 1-3
1.2.1 Emission Sources and Distribution of Ambient Concentrations ___ 1-4
1.2.1.1 Sources and Emissions of PM ___ 1-5
1.2.1.2 Atmospheric Processes and PM Formation ___ 1-7
1.2.1.3 Monitoring and Modeling of PM ___ 1-8
1.2.1.4 National PM Concentrations ___ 1-9

1.2.1.5 Spatial and Temporal Variability in PM Concentrations 1-10
1.2.1.6 Summary 1-12
1.2.2 Assessment of Human Exposure 1-13
1.3 Dosimetry of PM 1-17
1.4 Evaluation of the Health Effects of PM 1-19
1.4.1 Health Effects of $PM_{2.5}$ 1-21
1.4.1.1 Respiratory Effects 1-21
1.4.1.1.1 Respiratory Effects Associated with Short-Term $PM_{2.5}$ Exposure 1-21
1.4.1.1.2 Respiratory Effects Associated with Long-Term $PM_{2.5}$ Exposure 1-22
1.4.1.2 Cardiovascular Effects 1-24
1.4.1.2.1 Cardiovascular Effects Associated with Short-Term $PM_{2.5}$ Exposure 1-24
1.4.1.2.2 Cardiovascular Effects Associated with Long-Term $PM_{2.5}$ Exposure 1-25
1.4.1.3 Nervous System Effects 1-27
1.4.1.3.1 Nervous System Effects Associated with Long-Term $PM_{2.5}$ Exposure 1-27
1.4.1.4 Cancer 1-29
1.4.1.4.1 Cancer Associated with Long-Term $PM_{2.5}$ Exposure 1-29
1.4.1.5 Mortality 1-30
1.4.1.5.1 Mortality Associated with Short-Term $PM_{2.5}$ Exposure 1-30
1.4.1.5.2 Mortality Associated with Long-Term $PM_{2.5}$ Exposure 1-31
1.4.2 Health Effects of $PM_{10-2.5}$ 1-41
1.4.3 Health Effects of UFPs 1-41
1.5 Policy-Relevant Considerations 1-42
1.5.1 Potential Copollutant Confounding 1-43
1.5.1.1 Short-Term $PM_{2.5}$ Exposure 1-43
1.5.1.2 Long-Term $PM_{2.5}$ Exposure 1-45
1.5.2 Timing of Effects 1-46
1.5.2.1 Averaging Time 1-46
1.5.2.2 Lag Structure of Associations 1-47
1.5.3 Concentration-Response Relationship 1-48
1.5.3.1 Short-Term Exposure 1-48
1.5.3.2 Long-Term Exposure 1-49
1.5.4 PM Components and Sources 1-50
1.5.4.1 Respiratory Effects 1-51
1.5.4.2 Cardiovascular Effects 1-51
1.5.4.3 Mortality 1-52
1.5.5 Populations and Lifestages at Potentially Increased Risk of a PM-Related Health Effect 1-53
1.6 Welfare Effects of PM 1-56
1.6.1 Visibility Impairment 1-56
1.6.2 Climate Effects 1-57
1.6.3 Materials Effects 1-57
1.7 Summary of Causality Determinations for Health and Welfare Effects 1-59
1.7.1 Health Effects Evidence: Key Findings 1-61
1.7.1.1 *Causal* and *Likely to be Causal Relationship* 1-61
1.7.1.1.1 Epidemiologic Evidence 1-61
1.7.1.1.2 Experimental Evidence 1-62
1.7.1.1.3 Policy-Relevant Considerations 1-62
1.7.1.2 *Suggestive of, but not Sufficient to Infer, a Causal Relationship* 1-63
1.7.1.2.1 Epidemiologic Evidence 1-63

1.7.1.2.2 Experimental Evidence 1-64
1.7.1.3 *Inadequate to Infer the Presence or Absence of a Causal Relationship* 1-64
1.7.1.3.1 Epidemiologic Evidence 1-64
1.7.1.3.2 Experimental Evidence 1-65
1.7.2 Welfare Effects Evidence: Key Findings 1-65
1.7.3 Comparison of Causality Determinations from 2009 PM ISA and Current PM ISA 1-66
1.8 References 1-70

CHAPTER 2 SOURCES, ATMOSPHERIC CHEMISTRY, AND AMBIENT CONCENTRATIONS 2-1

2.1 Summary Overview 2-1
2.2 Atmospheric Size Distributions 2-2
2.3 Primary Sources and Atmospheric Formation 2-5
2.3.1 Primary $PM_{2.5}$ Emissions 2-7
2.3.1.1 National-Scale Emissions 2-7
2.3.1.2 Urban-Scale Emissions 2-9
2.3.2 Secondary $PM_{2.5}$ Formation 2-12
2.3.2.1 Precursor Emissions 2-13
2.3.2.2 Secondary Inorganic Aerosols 2-15
2.3.2.3 Secondary Organic Aerosols 2-17
2.3.3 Primary $PM_{10-2.5}$ Emissions 2-19
2.3.4 Ultrafine Particles 2-20
2.3.4.1 Primary Sources 2-24
2.3.4.2 New Particle Formation 2-25
2.4 Measurement, Monitoring, and Modeling 2-26
2.4.1 $PM_{2.5}$ and PM_{10} 2-26
2.4.2 $PM_{10-2.5}$ 2-27
2.4.3 Ultrafine Particles: Number, Surface Area, Mass 2-29
2.4.3.1 Particle Number and Number Distribution 2-29
2.4.3.2 Surface Area 2-32
2.4.3.3 Mass 2-33
2.4.4 Chemical Components 2-35
2.4.5 Satellite Remote Sensing 2-35
2.4.6 Monitoring Networks 2-38
2.4.7 Chemical Transport Models 2-41
2.5 Ambient Concentrations 2-44
2.5.1 Spatial Distribution 2-44
2.5.1.1 Variability Across the U.S. 2-44
2.5.1.1.1 $PM_{2.5}$ 2-44
2.5.1.1.2 PM_{10} 2-48
2.5.1.1.3 $PM_{10-2.5}$ 2-51
2.5.1.1.4 $PM_{2.5}$:PM_{10} 2-54
2.5.1.1.5 Ultrafine Particles 2-56
2.5.1.1.6 $PM_{2.5}$ Components 2-59
2.5.1.1.7 $PM_{10-2.5}$ Components 2-62
2.5.1.1.8 Ultrafine Particle Components 2-63
2.5.1.1.9 Reactive Oxygen Species 2-64
2.5.1.2 Urban and Neighborhood-Scale Variability 2-65
2.5.1.2.1 $PM_{2.5}$ 2-65

2.5.1.2.2 PM_{10} 2-66
2.5.1.2.3 $PM_{10-2.5}$ 2-66
2.5.1.2.4 Ultrafine Particles 2-67
2.5.1.2.5 Chemical Components 2-68
2.5.2 Temporal Variability 2-69
2.5.2.1 Regional Trends 2-69
2.5.2.1.1 $PM_{2.5}$ 2-69
2.5.2.1.2 PM_{10} 2-72
2.5.2.1.3 $PM_{10-2.5}$ 2-74
2.5.2.1.4 Ultrafine Particles 2-75
2.5.2.1.5 Chemical Components 2-75
2.5.2.2 Seasonal Variations 2-79
2.5.2.2.1 $PM_{2.5}$ 2-79
2.5.2.2.2 $PM_{10-2.5}$ 2-80
2.5.2.2.3 Ultrafine Particles 2-83
2.5.2.2.4 Particulate Matter (PM) Components 2-83
2.5.2.3 Hourly and Weekday-Weekend Variability 2-85
2.5.3 Common Patterns of Particulate Matter Characteristics in the U.S. 2-86
2.5.4 Background Particulate Matter 2-90
2.5.4.1 Natural Background 2-91
2.5.4.2 Intercontinental Transport 2-92
2.6 Summary 2-94
2.7 References 2-97

CHAPTER 3 EXPOSURE TO AMBIENT PARTICULATE MATTER 3-1

3.1 Introduction 3-1
3.2 Conceptual Overview of Human Exposure 3-2
3.2.1 Exposure Terminology 3-2
3.2.2 Conceptual Model of Total Personal Exposure 3-5
3.2.3 Exposure Considerations Specific to Particulate Matter 3-7
3.3 Methodological Considerations for Use of Exposure Data and Models 3-8
3.3.1 Surface Measurement 3-10
3.3.1.1 Ambient Monitoring 3-11
3.3.1.2 Personal Monitoring 3-11
3.3.2 Modeling 3-15
3.3.2.1 Data Averaging 3-17
3.3.2.2 Spatial Interpolation Methods 3-19
3.3.2.3 Land Use Regression and Spatiotemporal Modeling 3-20
3.3.2.3.1 Land Use Regression 3-21
3.3.2.3.2 Spatiotemporal Modeling 3-24
3.3.2.4 Mechanistic Models 3-25
3.3.2.4.1 Chemical Transport Model Applications for Exposure Estimation 3-25
3.3.2.4.2 Dispersion Modeling Applications for Exposure Estimation 3-28
3.3.2.4.3 Hybrid Approaches 3-31
3.3.3 Satellite-Based Methods for Exposure Estimation 3-35
3.3.4 Microenvironmental Exposure Modeling 3-40
3.3.5 Exposure Assignment Methods in Epidemiologic Studies 3-42

3.4 Exposure Assessment and Interpretation of Epidemiologic Study Results 3-53
3.4.1 Relationships Influencing Exposure 3-53
3.4.1.1 Air Exchange Rate and Infiltration 3-53
3.4.1.2 Indoor-Outdoor Concentration Relationships 3-57
3.4.1.3 Personal-Ambient Concentration Relationships 3-61
3.4.2 Factors Contributing to Error in Estimating Exposure to Particulate Matter 3-65
3.4.2.1 Time-Activity Patterns 3-66
3.4.2.2 Spatial Variability in Concentrations 3-71
3.4.2.3 Instrument Accuracy and Precision 3-74
3.4.2.4 Model Accuracy and Precision 3-75
3.4.3 Costressor Relationships 3-77
3.4.3.1 Temporal Relationships among Ambient Particulate Matter and Copollutant Exposures 3-78
3.4.3.2 Spatial Relationships among Ambient Particulate Matter and Copollutant Exposures 3-88
3.4.3.3 Personal and Indoor Relationships between Particular Matter and Copollutant Exposures 3-88
3.4.3.4 Traffic-Related Noise 3-93
3.4.4 Particulate Matter Composition and Exposure Assessment 3-94
3.4.4.1 Composition 3-95
3.4.4.2 Reactive Oxygen Species 3-103
3.4.5 Influence of Exposure Errors on Results from Epidemiologic Studies of Different Designs 3-106
3.4.5.1 Short-Term Exposure Studies 3-107
3.4.5.1.1 Time-Series Studies 3-107
3.4.5.1.2 Panel Studies 3-111
3.4.5.2 Long-Term Exposure Cohort Studies 3-112
3.5 Summary 3-118
3.6 References 3-122

CHAPTER 4 DOSIMETRY OF PARTICULATE MATTER 4-1

4.1 Introduction 4-1
4.1.1 Size Characterization of Inhaled Particles 4-3
4.1.2 Structure and Function of the Respiratory Tract 4-4
4.1.2.1 Anatomy 4-4
4.1.2.2 Breathing Rates 4-6
4.1.2.3 Epithelial Lining Fluid 4-8
4.1.3 Route of Breathing 4-10
4.1.4 Ventilation Distribution 4-12
4.1.5 Particle Inhalability 4-13
4.1.6 Thoracic and Respirable Particles 4-14
4.1.7 Dose and Dose Metrics 4-19
4.2 Particle Deposition 4-21
4.2.1 Mechanisms of Deposition 4-22
4.2.2 Deposition Patterns 4-24
4.2.2.1 Total Respiratory Tract Deposition 4-26
4.2.2.2 Extrathoracic Region 4-27
4.2.2.3 Tracheobronchial and Alveolar Region 4-33
4.2.2.4 Sites of Localized Deposition 4-33
4.2.3 Interspecies Patterns of Deposition 4-34
4.2.4 Factors Modulating Deposition 4-36
4.2.4.1 Physical Activity 4-36

4.2.4.2 Age 4-39
4.2.4.3 Sex 4-41
4.2.4.4 Body Mass Index 4-41
4.2.4.5 Anatomical Variability 4-42
4.2.4.6 Ventilation Distribution 4-43
4.2.4.7 Respiratory Tract Disease 4-44
4.2.4.8 Particle Hygroscopicity 4-46
4.2.5 Summary 4-48
4.3 Particle Clearance 4-49
4.3.1 Clearance Mechanisms 4-50
4.3.1.1 Extrathoracic Region 4-50
4.3.1.2 Tracheobronchial Region 4-50
4.3.1.3 Alveolar Region 4-52
4.3.2 Interspecies Clearance and Retention 4-54
4.3.3 Particle Translocation 4-55
4.3.3.1 Olfactory Delivery 4-56
4.3.3.2 Pulmonary Delivery 4-60
4.3.3.2.1 Membrane Translocation 4-60
4.3.3.2.2 Extrapulmonary Distribution 4-61
4.3.3.3 Transplacental Barrier Transport 4-66
4.3.4 Factors Modulating Particle Clearance 4-67
4.3.4.1 Age 4-67
4.3.4.2 Sex 4-68
4.3.4.3 Respiratory Tract Disease 4-68
4.3.4.4 Particle Overload 4-70
4.3.5 Summary 4-70
4.4 References 4-72

CHAPTER 5 RESPIRATORY EFFECTS 5-1

5.1 Short-Term $PM_{2.5}$ Exposure and Respiratory Effects 5-1
5.1.1 Biological Plausibility 5-3
5.1.1.1 Injury, Inflammation, and Oxidative Stress 5-4
5.1.1.2 Activation of Sensory Nerves 5-6
5.1.1.3 Summary 5-7
5.1.2 Asthma Exacerbation 5-7
5.1.2.1 Hospital Admissions and Emergency Department (ED) Visits 5-8
5.1.2.1.1 Hospital Admissions 5-19
5.1.2.1.2 Emergency Department (ED) Visits 5-20
5.1.2.1.3 Summary of Asthma Hospital Admissions and Emergency Department (ED) Visits 5-21
5.1.2.2 Respiratory Symptoms and Asthma Medication Use in Populations with Asthma 5-22
5.1.2.2.1 Children 5-22
5.1.2.2.2 Adults 5-27
5.1.2.3 Lung Function Changes in Populations with Asthma 5-28
5.1.2.3.1 Children 5-28
5.1.2.3.2 Adults 5-33
5.1.2.3.3 Controlled Human Exposure Studies 5-34
5.1.2.3.4 Animal Toxicological Studies 5-35

5.1.2.3.5 Summary of Lung Function in Populations with Asthma 5-35
5.1.2.4 Subclinical Effects Underlying Asthma Exacerbation 5-35
5.1.2.4.1 Children 5-35
5.1.2.4.2 Adults 5-42
5.1.2.4.3 Controlled Human Exposure Studies 5-43
5.1.2.4.4 Animal Toxicological Studies 5-43
5.1.2.4.5 Summary of Subclinical Effects Underlying Asthma Exacerbation 5-46
5.1.2.5 Summary of Asthma Exacerbations 5-46
5.1.3 Allergy Exacerbation 5-47
5.1.4 Chronic Obstructive Pulmonary Disease (COPD) Exacerbation 5-48
5.1.4.1 Hospital Admissions and Emergency Department (ED) Visits 5-49
5.1.4.1.1 Hospital Admissions 5-55
5.1.4.1.2 Emergency Department (ED) Visits 5-56
5.1.4.1.3 Summary of Chronic Obstructive Pulmonary Disease (COPD) Hospital Admissions and Emergency Department (ED) Visits 5-56
5.1.4.2 Respiratory Symptoms and Medication Use 5-57
5.1.4.3 Lung Function Changes in Adults with Chronic Obstructive Pulmonary Disease (COPD) 5-61
5.1.4.3.1 Epidemiologic Studies 5-61
5.1.4.3.2 Controlled Human Exposure Studies 5-61
5.1.4.4 Subclinical Effects Underlying Exacerbation of Chronic Obstructive Pulmonary Disease (COPD) 5-61
5.1.4.4.1 Epidemiologic Studies 5-61
5.1.4.4.2 Controlled Human Exposure Studies 5-62
5.1.4.4.3 Animal Toxicological Studies 5-62
5.1.4.5 Summary of Exacerbation of Chronic Obstructive Pulmonary Disease (COPD) 5-63
5.1.5 Respiratory Infection 5-63
5.1.5.1 Hospital Admissions and Emergency Department (ED) Visits 5-64
5.1.5.1.1 Hospital Admissions 5-71
5.1.5.1.2 Emergency Department (ED) Visits 5-72
5.1.5.2 Outpatient and Physician Visit Studies 5-73
5.1.5.3 Subclinical Effects Underlying Respiratory Infection 5-73
5.1.5.4 Summary of Respiratory Infection 5-73
5.1.6 Combinations of Respiratory-Related Hospital Admissions and Emergency Department (ED) Visits 5-74
5.1.6.1 Hospital Admissions 5-83
5.1.6.2 Emergency Department (ED) Visits 5-84
5.1.6.3 Summary of Respiratory-Related Hospital Admissions and Emergency Department (ED) Visits 5-85
5.1.7 Respiratory Effects in Healthy Populations 5-86
5.1.7.1 Epidemiologic Studies 5-86
5.1.7.1.1 Respiratory Symptoms 5-87
5.1.7.1.2 Lung Function Changes 5-87
5.1.7.1.3 Subclinical Effects 5-88
5.1.7.2 Controlled Human Exposure Studies 5-93
5.1.7.3 Animal Toxicological Studies 5-94
5.1.7.3.1 Lung Function 5-94
5.1.7.3.2 Respiratory Tract Injury 5-99

5.1.7.3.3 Respiratory Tract Oxidative Stress 5-99
5.1.7.3.4 Respiratory Tract Inflammation 5-100
5.1.7.3.5 Morphology 5-102
5.1.7.3.6 Allergic Sensitization 5-102
5.1.7.3.7 Pathways Related to Otitis Media 5-103
5.1.7.4 Summary of Respiratory Effects in Healthy Populations 5-103
5.1.8 Respiratory Effects in Populations with Cardiovascular Disease 5-104
5.1.9 Respiratory Mortality 5-106
5.1.10 Policy-Relevant Considerations 5-107
5.1.10.1 Examination of Potential Copollutant Confounding 5-108
5.1.10.1.1 $PM_{2.5}$ within the Multipollutant Mixture 5-113
5.1.10.2 Model Specification 5-116
5.1.10.3 Lag Structure 5-118
5.1.10.4 The Role of Season and Temperature on $PM_{2.5}$ Associations 5-123
5.1.10.4.1 Season 5-123
5.1.10.4.2 Temperature 5-127
5.1.10.5 Averaging Time of $PM_{2.5}$ Concentrations 5-128
5.1.10.6 Concentration-Response Relationship and Threshold Analyses 5-130
5.1.11 Short-term exposure to $PM_{2.5}$ Components and Sources and Respiratory Effects 5-137
5.1.11.1 Elemental and Black Carbon 5-139
5.1.11.2 Organic Carbon 5-142
5.1.11.3 Secondary $PM_{2.5}$—Sulfate, Nitrate, Ammonium 5-143
5.1.11.4 Metals 5-144
5.1.11.5 Other $PM_{2.5}$ components 5-146
5.1.11.6 Sources of $PM_{2.5}$ 5-146
5.1.11.7 Summary 5-148
5.1.12 Summary and Causality Determination 5-148
5.2 Long-Term $PM_{2.5}$ Exposure and Respiratory Effects 5-155
5.2.1 Biological Plausibility 5-156
5.2.2 Lung Function and Development 5-159
5.2.2.1 Lung Development 5-160
5.2.2.1.1 Epidemiologic Studies 5-160
5.2.2.1.2 Animal Toxicological Studies 5-166
5.2.2.2 Lung Function 5-167
5.2.2.2.1 Children 5-167
5.2.2.2.2 Adults 5-174
5.2.2.3 Summary of Lung Function and Development 5-176
5.2.3 Development of Asthma 5-176
5.2.3.1 Asthma in Children 5-177
5.2.3.1.1 Copollutant Confounding 5-182
5.2.3.1.2 Concentration-Response Relationship 5-183
5.2.3.2 Asthma in Adults 5-184
5.2.3.3 Subclinical Effects Underlying Development of Asthma 5-188
5.2.3.3.1 Epidemiologic Studies 5-188
5.2.3.3.2 Animal Toxicological Study 5-188
5.2.4 Development of Allergic Disease 5-189
5.2.5 Development of Chronic Obstructive Pulmonary Disease (COPD) 5-191
5.2.6 Respiratory Infection 5-193

5.2.7 Severity of Respiratory Disease 5-195
5.2.7.1 Epidemiologic Studies 5-196
5.2.7.2 Animal Toxicological Study 5-196
5.2.8 Subclinical Effects in Healthy Populations 5-197
5.2.8.1 Respiratory Tract Oxidative Stress 5-199
5.2.8.2 Respiratory Tract Inflammation 5-200
5.2.8.3 Morphological Effects 5-201
5.2.8.4 Summary of Subclinical Effects in Healthy Populations 5-201
5.2.9 Subclinical Effects in Populations with Cardiovascular Disease 5-202
5.2.10 Respiratory Mortality 5-204
5.2.10.1 Potential Copollutant Confounding of the $PM_{2.5}$-Mortality Relationship 5-206
5.2.11 Respiratory Effects and Declining $PM_{2.5}$ Concentrations 5-208
5.2.11.1 Bronchitis 5-208
5.2.11.2 Pulmonary Function 5-209
5.2.11.3 Summary 5-210
5.2.12 Associations between Long-Term Exposure to $PM_{2.5}$ Components and Sources and Respiratory Effects 5-211
5.2.12.1 Elemental Carbon, Black Carbon, and Organic Carbon 5-213
5.2.12.2 Metals 5-214
5.2.12.3 Oxidative Potential 5-214
5.2.12.4 Summary 5-215
5.2.13 Summary and Causality Determination 5-215
5.3 Short-Term $PM_{10-2.5}$ Exposure and Respiratory Effects 5-220
5.3.1 Biological Plausibility 5-221
5.3.1.1 Injury, Inflammation, and Oxidative Stress 5-222
5.3.1.2 Activation of Sensory Nerves 5-223
5.3.1.3 Summary 5-224
5.3.2 Asthma Exacerbation 5-224
5.3.2.1 Hospital Admissions and Emergency Department (ED) Visits 5-225
5.3.2.1.1 Concentration-Response Relationship 5-231
5.3.2.2 Respiratory Symptoms and Medication Use 5-232
5.3.2.3 Lung Function 5-233
5.3.2.4 Subclinical Effects Underlying Asthma Exacerbation 5-234
5.3.2.4.1 Epidemiologic Studies 5-234
5.3.2.4.2 Controlled Human Exposure Studies 5-235
5.3.2.4.3 Animal Toxicological Studies 5-236
5.3.2.5 Summary of Asthma Exacerbation 5-236
5.3.3 Chronic Obstructive Pulmonary Disease (COPD) Exacerbation 5-237
5.3.3.1 Hospital Admissions and Emergency Department (ED) Visits 5-242
5.3.3.1.1 Hospital Admissions 5-242
5.3.3.1.2 Emergency Department (ED) Visits 5-242
5.3.3.2 Other Epidemiologic Studies 5-243
5.3.3.3 Summary of Exacerbation of Chronic Obstructive Pulmonary Disease (COPD) 5-243
5.3.4 Respiratory Infection 5-243
5.3.4.1 Hospital Admissions and Emergency Department (ED) Visits 5-244
5.3.4.2 Outpatient and Physician Visit Studies 5-248
5.3.4.3 Summary of Respiratory Infection 5-248
5.3.5 Combinations of Respiratory-Related Hospital Admissions and Emergency Department (ED) Visits 5-249
5.3.6 Respiratory Effects in Healthy Populations 5-257
5.3.6.1 Epidemiologic Studies 5-258

5.3.6.2 Controlled Human Exposure 5-259
5.3.6.3 Animal Toxicological Studies 5-259
5.3.6.4 Summary of Respiratory Effects in Healthy Populations 5-260
5.3.7 Respiratory Mortality 5-261
5.3.7.1 Characterizing the $PM_{10-2.5}$-Respiratory Mortality Relationship 5-261
5.3.7.1.1 Copollutant Confounding 5-262
5.3.7.1.2 Lag Structure of Associations 5-264
5.3.7.1.3 Effect Modification 5-265
5.3.8 Summary and Causality Determination 5-266
5.4 Long-Term $PM_{10-2.5}$ Exposure and Respiratory Effects 5-270
5.4.1 Biological Plausibility 5-270
5.4.2 Lung Function and Development 5-272
5.4.3 Development of Asthma 5-273
5.4.4 Development of Allergic Disease 5-274
5.4.5 Respiratory Infection 5-274
5.4.6 Severity of Asthma 5-275
5.4.7 Subclinical Effects in Healthy Populations 5-275
5.4.8 Respiratory Mortality 5-276
5.4.9 Summary and Causality Determination 5-276
5.5 Short-Term UFP Exposure and Respiratory Effects 5-279
5.5.1 Biological Plausibility 5-279
5.5.1.1 Injury, Inflammation, and Oxidative Stress 5-281
5.5.1.2 Activation of Sensory Nerves 5-282
5.5.1.3 Summary 5-282
5.5.2 Asthma Exacerbation 5-283
5.5.2.1 Epidemiologic Studies 5-283
5.5.2.2 Controlled Human Exposure 5-287
5.5.2.3 Animal Toxicological Studies 5-287
5.5.3 Chronic Obstructive Pulmonary Disease (COPD) Exacerbation 5-288
5.5.4 Respiratory Infection 5-291
5.5.5 Combinations of Respiratory-Related Hospital Admissions and Emergency Department (ED) Visits 5-294
5.5.6 Respiratory Effects in Healthy Populations 5-297
5.5.6.1 Lung Function 5-297
5.5.6.1.1 Epidemiologic Studies 5-297
5.5.6.1.2 Controlled Human Exposure Studies 5-299
5.5.6.1.3 Animal Toxicological Studies 5-299
5.5.6.2 Summary of Respiratory Effects in Healthy Populations 5-301
5.5.7 Respiratory Effects in Populations with Cardiovascular Disease 5-301
5.5.8 Respiratory Mortality 5-302
5.5.9 Summary and Causality Determination 5-302
5.6 Long-Term UFP Exposure and Respiratory Effects 5-305
5.6.1 Biological Plausibility 5-305
5.6.2 Development of Asthma 5-308
5.6.3 Subclinical Effects in Healthy Populations and Populations with Cardiovascular Disease 5-309
5.6.4 Respiratory Mortality 5-311
5.6.5 Summary and Causality Determination 5-311
5.7 References 5-313

CHAPTER 6 CARDIOVASCULAR EFFECTS 6-1

6.1 Short-Term $PM_{2.5}$ Exposure and Cardiovascular Effects 6-1
6.1.1 Biological Plausibility 6-3
6.1.2 Ischemic Heart Disease and Myocardial Infarction 6-7
6.1.2.1 Emergency Department (ED) Visits and Hospital Admissions 6-7
6.1.2.1.1 Acute Myocardial Infarction (MI) and Angina Pectoris 6-12
6.1.2.2 Epidemiologic Studies of ST Segment Depression 6-14
6.1.3 Heart Failure and Impaired Heart Function 6-16
6.1.3.1 Emergency Department (ED) Visits and Hospital Admissions 6-16
6.1.3.2 Controlled Human Exposure Studies of Impaired Heart Function 6-21
6.1.3.3 Toxicological Studies of Impaired Heart Function 6-21
6.1.4 Ventricular Depolarization, Repolarization, and Arrhythmia 6-22
6.1.4.1 Emergency Department (ED) Visits and Hospital Admissions for Arrhythmia and Out-of-Hospital Cardiac Arrest 6-23
6.1.4.1.1 Arrhythmias 6-23
6.1.4.1.2 Out-of-Hospital Cardiac Arrest 6-27
6.1.4.2 Epidemiologic Studies of Arrhythmia and Conduction Abnormalities 6-30
6.1.4.2.1 Conduction Abnormalities 6-36
6.1.4.3 Controlled Human Exposure Studies for Arrhythmia and Conduction Abnormalities 6-38
6.1.4.4 Toxicological Studies for Arrhythmia and Conduction Abnormalities 6-40
6.1.5 Cerebrovascular Disease and Stroke 6-41
6.1.5.1 Emergency Department (ED) Visits and Hospital Admissions 6-42
6.1.5.1.1 Emergency Department (ED) Visits and Hospital Admissions Visits for Stroke Subtypes 6-46
6.1.6 Blood Pressure and Hypertension 6-47
6.1.6.1 Emergency Department (ED) Visits and Hospital Admissions 6-48
6.1.6.2 Epidemiologic Studies of Changes in Blood Pressure (BP) 6-51
6.1.6.3 Controlled Human Exposure Studies of Changes in Blood Pressure (BP) 6-57
6.1.6.4 Toxicological Studies of Changes in Blood Pressure (BP) 6-59
6.1.6.4.1 Renin-Angiotensin System 6-60
6.1.7 Venous Thromboembolism Disease and Pulmonary Embolism 6-61
6.1.7.1 Emergency Department (ED) Visits and Hospital Admissions 6-62
6.1.8 Combinations of Cardiovascular-Related Emergency Department (ED) Visits and Hospital Admissions 6-66
6.1.9 Cardiovascular Mortality 6-72
6.1.10 Heart Rate (HR) and Heart Rate Variability (HRV) 6-73
6.1.10.1 Epidemiologic Studies of Heart Rate (HR) and Heart Rate Variability (HRV) 6-74
6.1.10.2 Controlled Human Exposure Studies of Heart Rate (HR) and Heart Rate Variability (HRV) 6-80
6.1.10.3 Toxicological Studies of Heart Rate (HR) and Heart Rate Variability (HRV) 6-83
6.1.10.3.1 Heart Rate Variability (HRV) 6-83
6.1.11 Systemic Inflammation, Oxidative Stress, and Blood Lipids 6-85
6.1.11.1 Epidemiologic Studies of Systemic Inflammation and Oxidative Stress 6-85
6.1.11.2 Controlled Human Exposure Studies of Short-Term $PM_{2.5}$ Exposure and Systemic Inflammation, Oxidative Stress, and Blood Lipids 6-89
6.1.11.2.1 Systemic Inflammation 6-89
6.1.11.2.2 Oxidative Stress 6-90
6.1.11.2.3 Blood Lipids 6-90

6.1.11.3 Toxicological Studies of Systemic Inflammation, Oxidative Stress, and Blood Lipids 6-92
6.1.11.3.1 Systemic Inflammation 6-92
6.1.11.3.1 Oxidative Stress 6-94
6.1.11.3.2 Blood Lipids 6-94
6.1.12 Coagulation 6-94
6.1.12.1 Epidemiologic Studies of Coagulation 6-95
6.1.12.2 Controlled Human Exposure Studies of Coagulation 6-97
6.1.12.3 Toxicological Studies of Coagulation and Thrombosis 6-99
6.1.13 Endothelial Dysfunction and Arterial Stiffness 6-100
6.1.13.1 Epidemiologic Studies of Impaired Vascular Function 6-101
6.1.13.1.1 Digital Vascular Function 6-101
6.1.13.1.2 Arterial Stiffness 6-102
6.1.13.1.3 Biomarkers of Endothelial Injury 6-102
6.1.13.2 Controlled Human Exposure Studies of Short-Term $PM_{2.5}$ Exposure and Impaired Vascular Function 6-106
6.1.13.2.1 Arterial Stiffness 6-108
6.1.13.3 Toxicological Studies of Impaired Vascular Function 6-110
6.1.14 Policy-Relevant Considerations 6-111
6.1.14.1 Examination of Potential Copollutant Confounding 6-111
6.1.14.1.1 $PM_{2.5}$ within the Multipollutant Mixture 6-117
6.1.14.2 The Role of Season and Temperature on $PM_{2.5}$ Associations 6-117
6.1.14.3 Lag Structure 6-119
6.1.15 Associations between $PM_{2.5}$ Components and Sources and Cardiovascular Effects 6-122
6.1.15.1 Elemental and Black Carbon 6-124
6.1.15.2 Organic Carbon 6-126
6.1.15.3 Secondary $PM_{2.5}$—Sulfate, Nitrate, Ammonium 6-127
6.1.15.4 Metals 6-127
6.1.15.5 Other $PM_{2.5}$ components 6-128
6.1.15.6 Sources of $PM_{2.5}$ 6-128
6.1.15.7 Associations between $PM_{2.5}$ Components and Sources and Effects in People with Diabetes 6-130
6.1.15.8 Toxicological Studies of Individual Components and Sources as Part of the Particulate Matter (PM) Mixture 6-131
6.1.16 Summary and Causality Determination 6-136
6.2 Long-Term $PM_{2.5}$ Exposure and Cardiovascular Effects 6-140
6.2.1 Biological Plausibility 6-142
6.2.2 Ischemic Heart Disease and Myocardial Infarction 6-145
6.2.2.1 Epidemiologic Studies 6-146
6.2.3 Cerebrovascular Disease and Stroke 6-152
6.2.3.1 Epidemiologic Studies 6-152
6.2.3.1.1 Subclinical Cerebrovascular Disease 6-158
6.2.4 Atherosclerosis 6-159
6.2.4.1 Epidemiologic Studies 6-160
6.2.4.2 Toxicological Studies of Atherosclerosis 6-164
6.2.5 Heart Failure and Impaired Heart Function 6-166
6.2.5.1 Epidemiologic Studies 6-166
6.2.5.2 Toxicological Studies of Impaired Heart Function 6-170
6.2.6 Ventricular Depolarization, Repolarization, and Arrhythmia 6-172
6.2.6.1 Epidemiologic Studies 6-172
6.2.7 Blood Pressure and Hypertension 6-174

6.2.7.1 Epidemiologic Studies 6-174
6.2.7.1.1 Blood Pressure 6-174
6.2.7.1.2 Hypertension 6-180
6.2.7.1.3 Gestational Hypertension and Pre-eclampsia 6-182
6.2.7.1.4 Renal Function 6-182
6.2.7.2 Toxicological Studies of Changes in Blood Pressure (BP) 6-182
6.2.7.2.1 Renin-Angiotensin System 6-183
6.2.8 Venous Thromboembolism Disease and Pulmonary Embolism 6-184
6.2.8.1 Epidemiologic Studies 6-185
6.2.9 Combinations of Cardiovascular-Related Outcomes 6-187
6.2.10 Long-Term $PM_{2.5}$ Exposure and Cardiovascular Mortality 6-189
6.2.11 Heart Rate (HR) and Heart Rate Variability (HRV) 6-192
6.2.11.1 Epidemiologic Studies of Heart Rate Variability (HRV) 6-192
6.2.11.2 Toxicological Studies of Heart Rate (HR) and Heart Rate Variability (HRV) 6-193
6.2.12 Systemic Inflammation, Oxidative Stress, and Blood Lipids 6-194
6.2.12.1 Epidemiologic Studies 6-194
6.2.12.1.1 Systemic Inflammation 6-194
6.2.12.1.2 Blood Lipids 6-195
6.2.12.2 Toxicological Studies 6-195
6.2.12.2.1 Systemic Inflammation 6-196
6.2.12.2.2 Oxidative Stress 6-196
6.2.12.2.3 Blood Lipids 6-197
6.2.13 Coagulation 6-198
6.2.13.1 Epidemiologic Studies 6-198
6.2.14 Impaired Vascular Function and Arterial Stiffness 6-199
6.2.14.1 Epidemiologic Studies 6-199
6.2.14.2 Toxicological Studies 6-200
6.2.15 Copollutant Confounding 6-201
6.2.16 Concentration-Response Relationship 6-206
6.2.17 Associations between $PM_{2.5}$ Components and Sources and Cardiovascular Effects 6-214
6.2.17.1 Toxicological Studies of Individual Components and Sources as Part of a Particulate Matter Mixture 6-217
6.2.18 Summary and Causality Determination 6-219
6.3 Short-Term $PM_{10-2.5}$ Exposure and Cardiovascular Effects 6-224
6.3.1 Biological Plausibility 6-225
6.3.2 Ischemic Heart Disease and Myocardial Infarction 6-227
6.3.2.1 Emergency Department (ED) Visits and Hospital Admissions 6-228
6.3.3 Heart Failure and Impaired Heart Function 6-229
6.3.3.1 Emergency Department (ED) Visits and Hospital Admissions 6-229
6.3.3.2 Toxicological Studies of Impaired Heart Function 6-230
6.3.4 Ventricular Depolarization, Repolarization, and Arrhythmia 6-230
6.3.4.1 Emergency Department (ED) Visits and Hospital Admissions for Arrhythmia and Out-of-Hospital Cardiac Arrest 6-231
6.3.4.1.1 Out-of-Hospital Cardiac Arrest 6-231
6.3.4.2 Epidemiologic Studies for Arrhythmia and Conduction Abnormalities 6-232
6.3.5 Cerebrovascular Disease and Stroke 6-232
6.3.5.1 Emergency Department (ED) Visits and Hospital Admissions 6-232
6.3.6 Blood Pressure and Hypertension 6-233
6.3.6.1 Epidemiologic Studies of Changes in Blood Pressure (BP) 6-234
6.3.6.2 Controlled Human Exposure Studies of Changes in Blood Pressure (BP) 6-234

6.3.6.3 Toxicological Studies of Changes in Blood Pressure (BP) 6-235
6.3.7 Combinations of Cardiovascular-Related Emergency Department (ED) Visits and Hospital Admissions 6-236
6.3.8 Cardiovascular Mortality 6-239
6.3.8.1 Characterizing the $PM_{10-2.5}$ Cardiovascular Mortality Relationship 6-240
6.3.8.2 Copollutant Confounding 6-240
6.3.8.3 Lag Structure of Associations 6-243
6.3.8.4 Effect Modification 6-244
6.3.8.4.1 Season 6-244
6.3.8.4.2 Temperature 6-245
6.3.9 Heart Rate (HR) and Heart Rate Variability (HRV) 6-245
6.3.9.1 Epidemiologic Studies of Heart Rate (HR) and Heart Rate Variability (HRV) 6-245
6.3.9.2 Controlled Human Exposure Studies of Heart Rate (HR) and Heart Rate Variability (HRV) 6-245
6.3.10 Systemic Inflammation and Oxidative Stress 6-246
6.3.10.1 Epidemiologic Studies of Systemic Inflammation and Oxidative Stress 6-247
6.3.10.2 Controlled Human Exposure Studies of Systemic Inflammation and Oxidative Stress 6-247
6.3.11 Coagulation 6-249
6.3.11.1 Epidemiologic Studies of Coagulation 6-250
6.3.11.2 Controlled Human Exposure Studies of Coagulation and Thrombosis 6-250
6.3.12 Endothelial Dysfunction and Arterial Stiffness 6-250
6.3.12.1 Controlled Human Exposure Studies of Impaired Vascular Function 6-251
6.3.13 Summary and Causality Determination 6-252
6.4 Long-Term $PM_{10-2.5}$ Exposure and Cardiovascular Effects 6-256
6.4.1 Biological Plausibility 6-256
6.4.2 Ischemic Heart Disease and Myocardial Infarction 6-258
6.4.3 Heart Failure and Impaired Heart Function 6-262
6.4.3.1 Epidemiologic Studies 6-263
6.4.3.2 Toxicological Studies of Impaired Heart Function 6-264
6.4.4 Cerebrovascular Disease and Stroke 6-265
6.4.5 Atherosclerosis 6-269
6.4.6 Blood Pressure and Hypertension 6-271
6.4.6.1 Epidemiologic Studies 6-271
6.4.6.2 Toxicological Studies of Changes in Blood Pressure (BP) 6-271
6.4.7 Peripheral Vascular Disease (PVD), Venous Thromboembolism, Pulmonary Embolism 6-272
6.4.8 Cardiovascular Mortality 6-273
6.4.9 Systemic Inflammation and Oxidative Stress 6-275
6.4.9.1 Epidemiologic Studies 6-275
6.4.9.2 Toxicological Studies 6-275
6.4.10 Summary and Causality Determination 6-276
6.5 Short-Term UFP Exposure and Cardiovascular Effects 6-278
6.5.1 Biological Plausibility 6-279
6.5.2 Ischemic Heart Disease and Myocardial infarction 6-282
6.5.2.1 Emergency Department (ED) Visits and Hospital Admissions 6-282
6.5.2.2 Epidemiologic Studies of ST Segment Depression 6-283
6.5.3 Heart Failure and Impaired Heart Function 6-283
6.5.3.1 Emergency Department (ED) Visits and Hospital Admissions 6-283
6.5.3.2 Toxicological Studies of Impaired Heart Function 6-283
6.5.4 Ventricular Depolarization, Repolarization, and Arrhythmia 6-284

6.5.4.1 Emergency Department (ED) Visits and Hospital Admissions for Arrhythmia and Out-of-Hospital Cardiac Arrest 6-284
6.5.4.2 Epidemiologic Studies for Arrhythmia and Conduction Abnormalities 6-285
6.5.4.3 Controlled Human Exposure Studies for Arrhythmia and Conduction Abnormalities 6-286
6.5.4.4 Toxicological Studies for Arrhythmia and Conduction Abnormalities 6-286
6.5.5 Cerebrovascular Disease and Stroke 6-287
6.5.5.1 Emergency Department (ED) Visits and Hospital Admissions 6-287
6.5.6 Blood Pressure and Hypertension 6-288
6.5.6.1 Emergency Department (ED) Visits and Hospital Admissions 6-288
6.5.6.2 Epidemiologic Studies of Changes in Blood Pressure (BP) 6-288
6.5.6.3 Controlled Human Exposure Toxicology Studies of Changes in Blood Pressure (BP) 6-289
6.5.6.4 Toxicological Studies of Changes in Blood Pressure (BP) 6-290
6.5.7 Combinations of Cardiovascular-Related Emergency Department (ED) Visits and Hospital Admissions 6-291
6.5.8 Cardiovascular Mortality 6-292
6.5.9 Heart Rate (HR) and Heart Rate Variability (HRV) 6-293
6.5.9.1 Epidemiologic Studies of Heart Rate (HR) and Heart Rate Variability (HRV) 6-293
6.5.9.2 Controlled Human Exposure Studies of Heart Rate (HR) and Heart Rate Variability (HRV) 6-294
6.5.9.3 Toxicological Studies of Heart Rate (HR) and Heart Rate Variability (HRV) 6-295
6.5.10 Systemic Inflammation and Oxidative Stress 6-296
6.5.10.1 Epidemiologic Studies of Systemic Inflammation and Oxidative Stress 6-296
6.5.10.2 Controlled Human Exposure Studies Examining Short-Term UFP Exposure and Systemic Inflammation and Oxidative Stress 6-297
6.5.10.3 Toxicological Studies of Short-Term Ultrafine Particle (UFP) Exposure and Systemic Inflammation and Oxidative Stress 6-298
6.5.11 Coagulation 6-299
6.5.11.1 Epidemiologic Studies 6-299
6.5.11.2 Controlled Human Exposure Studies 6-300
6.5.12 Endothelial Dysfunction and Arterial Stiffness 6-301
6.5.12.1 Epidemiologic Studies 6-301
6.5.12.2 Controlled Human Exposure Studies 6-302
6.5.13 Summary and Causality Determination 6-303
6.6 Long-Term UFP Exposure and Cardiovascular Effects 6-306
6.6.1 Biological Plausibility 6-306
6.6.2 Atherosclerosis 6-306
6.6.3 Heart Failure and Impaired Heart Function 6-307
6.6.4 Blood Pressure and Hypertension 6-308
6.6.5 Systemic Inflammation and Oxidative Stress 6-308
6.6.5.1 Epidemiologic Studies 6-308
6.6.5.2 Toxicological Studies 6-309
6.6.6 Summary and Causality Determination 6-309
6.7 References 6-311

CHAPTER 7 METABOLIC EFFECTS 7-1

7.1 Short-Term $PM_{2.5}$ Exposure and Metabolic Effects 7-1
7.1.1 Biological Plausibility 7-2
7.1.2 Glucose and Insulin Homeostasis 7-4
7.1.2.1 Epidemiologic Studies 7-5
7.1.2.2 Toxicological Studies 7-7
7.1.2.3 Summary 7-9

7.1.3 Other Indicators of Metabolic Function 7-9
7.1.3.1 Inflammation 7-9
7.1.3.2 Liver Function 7-10
7.1.4 Summary and Causality Determination 7-11
7.2 Long-Term $PM_{2.5}$ Exposure and Metabolic Effects 7-12
7.2.1 Biological Plausibility 7-13
7.2.2 Metabolic Syndrome 7-16
7.2.3 Glucose and Insulin Homeostasis 7-18
7.2.3.1 Epidemiologic Studies 7-18
7.2.3.2 Toxicological Studies 7-24
7.2.3.3 Summary 7-27
7.2.4 Type 2 Diabetes Mellitus 7-28
7.2.4.1 Epidemiologic Studies of Type 2 Diabetes Mellitus 7-28
7.2.4.2 Summary 7-33
7.2.5 Other Indicators of Metabolic Function 7-34
7.2.5.1 Inflammation 7-34
7.2.5.2 Liver Function 7-39
7.2.5.2.1 Epidemiologic Studies 7-39
7.2.5.2.2 Toxicological Studies 7-40
7.2.5.3 Endocrine Hormones 7-41
7.2.5.4 Adiposity and Weight Gain 7-41
7.2.5.4.1 Epidemiologic Studies 7-41
7.2.5.4.2 Toxicological Studies 7-42
7.2.5.5 Gestational Diabetes 7-43
7.2.6 Age of Onset of Type 1 Diabetes 7-43
7.2.6.1 Epidemiologic Studies 7-43
7.2.6.2 Toxicological Studies 7-44
7.2.6.3 Summary 7-44
7.2.7 Associations between $PM_{2.5}$ Components and Sources and Metabolic Effects 7-44
7.2.8 Copollutant Confounding 7-45
7.2.9 Metabolic Disease Mortality 7-46
7.2.10 Summary and Causality Determination 7-48
7.3 Short-Term $PM_{10-2.5}$ Exposure and Metabolic Effects 7-52
7.4 Long-Term $PM_{10-2.5}$ Exposure and Metabolic Effects 7-53
7.4.1 Biological Plausibility 7-53
7.4.2 Type 2 Diabetes Mellitus 7-54
7.4.3 Summary and Causal Determination 7-56
7.5 Short-Term UFP Exposure and Metabolic Effects 7-58
7.6 Long-Term UFP Exposure and Metabolic Effects 7-58
7.7 References 7-60

CHAPTER 8 NERVOUS SYSTEM EFFECTS 8-1

8.1 Short-Term $PM_{2.5}$ Exposure and Nervous System Effects 8-1
8.1.1 Biological Plausibility 8-2
8.1.1.1 Activation of Sensory Nerves and Modulation of the Autonomic Nervous System (ANS) 8-4
8.1.1.2 Inflammation 8-5
8.1.1.3 Summary of Biological Plausibility 8-6
8.1.2 Activation of the Sympathetic Nervous System and the Hypothalamic-Pituitary-Adrenal (HPA) Stress Axis 8-6
8.1.2.1 Controlled Human Exposure Study 8-6

8.1.2.2 Animal Toxicological Studies 8-7
8.1.3 Brain Inflammation and Oxidative Stress 8-9
8.1.3.1 Controlled Human Exposure Study 8-9
8.1.3.2 Animal Toxicological Studies 8-10
8.1.4 Diseases of the Nervous System and Depression 8-12
8.1.5 Components and Sources of $PM_{2.5}$ 8-14
8.1.6 Summary and Causality Determination 8-15
8.2 Long-Term $PM_{2.5}$ Exposure and Nervous System Effects 8-17
8.2.1 Biological Plausibility 8-18
8.2.1.1 Upregulation of the Renin-Angiotensin (RAS) and Activation of the Sympathetic Nervous System (SNS) 8-20
8.2.1.2 Inflammation 8-20
8.2.1.3 Summary of Biological Plausibility 8-21
8.2.2 Activation of the Sympathetic Nervous System and the Hypothalamic-Pituitary-Adrenal (HPA) Stress Axis 8-22
8.2.3 Brain Inflammation and Oxidative Stress 8-23
8.2.4 Morphologic Changes in the Brain 8-27
8.2.4.1 Epidemiologic Studies 8-28
8.2.4.2 Animal Toxicological Studies 8-29
8.2.5 Cognitive and Behavioral Effects 8-30
8.2.5.1 Animal Toxicological Studies 8-31
8.2.5.2 Epidemiologic Studies 8-32
8.2.5.2.1 Anxiety and Depression 8-39
8.2.6 Neurodegenerative Diseases 8-41
8.2.7 Neurodevelopmental Effects 8-45
8.2.7.1 Cognitive and Behavioral Effects 8-49
8.2.7.2 Autism 8-49
8.2.7.2.1 Epidemiologic Studies 8-49
8.2.7.2.2 Animal Toxicological Studies 8-53
8.2.8 Components and Sources of $PM_{2.5}$ 8-54
8.2.9 Summary and Causality Determination 8-57
8.3 Short-Term $PM_{10-2.5}$ Exposure and Nervous System Effects 8-61
8.3.1 Biological Plausibility 8-62
8.3.1.1 Summary of Biological Plausibility 8-64
8.3.2 Activation of the Sympathetic Nervous System and the Hypothalamic-Pituitary-Adrenal (HPA) Stress Axis 8-64
8.3.3 Brain Inflammation and Oxidative Stress 8-65
8.3.4 Summary and Causality Determination 8-66
8.4 Long-Term $PM_{10-2.5}$ Exposure and Nervous System Effects 8-67
8.4.1 Biological Plausibility 8-68
8.4.2 Brain Inflammation and Oxidative Stress 8-69
8.4.3 Cognitive and Behavioral Effects in Adults 8-70
8.4.4 Neurodevelopmental Effects 8-73
8.4.5 Summary and Causality Determination 8-73
8.5 Short-Term UFP Exposure and Nervous System Effects 8-75
8.5.1 Biological Plausibility 8-75
8.5.1.1 Activation of Sensory Nerves and Modulation of the Autonomic Nervous System (ANS) 8-77
8.5.1.2 Inflammation 8-78
8.5.1.3 Summary of Biological Plausibility 8-78
8.5.2 Activation of the Sympathetic Nervous System and the Hypothalamic-Pituitary-Adrenal (HPA) Stress Axis 8-79

8.5.2.1 Controlled Human Exposure Study 8-79
8.5.2.2 Animal Toxicological Study 8-80
8.5.3 Brain Inflammation and Oxidative Stress 8-80
8.5.4 Cognitive and Behavioral Effects 8-83
8.5.4.1 Epidemiologic Studies 8-83
8.5.4.2 Animal Toxicological Studies 8-83
8.5.5 Summary and Causality Determination 8-84
8.6 Long-Term UFP Exposure and Nervous System Effects 8-86
8.6.1 Biological Plausibility 8-86
8.6.1.1 Inflammation 8-88
8.6.1.2 Summary of Biological Plausibility 8-89
8.6.2 Activation of the Sympathetic Nervous System and the Hypothalamic-Pituitary-Adrenal (HPA) Stress Axis 8-89
8.6.3 Brain Inflammation and Oxidative Stress 8-90
8.6.4 Morphologic Changes 8-93
8.6.5 Cognitive and Behavioral Effects 8-94
8.6.6 Neurodevelopmental Effects 8-95
8.6.6.1 Epidemiologic Studies 8-95
8.6.6.2 Animal Toxicological Studies 8-96
8.6.7 Summary and Causality Determination 8-100
8.7 References 8-103

CHAPTER 9 REPRODUCTIVE AND DEVELOPMENTAL EFFECTS 9-1

9.1 $PM_{2.5}$ Exposure and Reproductive and Developmental Effects 9-2
9.1.1 Male and Female Reproduction and Fertility 9-3
9.1.1.1 Biological Plausibility 9-3
9.1.1.2 Male Reproduction 9-6
9.1.1.2.1 Epidemiologic Studies 9-6
9.1.1.2.2 Animal Toxicological Studies 9-6
9.1.1.3 Female Reproduction 9-8
9.1.1.3.1 Epidemiologic Studies 9-8
9.1.1.3.2 Animal Toxicological Studies 9-9
9.1.2 Pregnancy and Birth Outcomes 9-10
9.1.2.1 Biological Plausibility 9-10
9.1.2.2 Maternal Health during Pregnancy 9-13
9.1.2.2.1 Epidemiologic Studies 9-13
9.1.2.2.2 Animal Toxicological Studies 9-14
9.1.2.3 Fetal Growth, Birth Weight, and Body Length at Birth 9-16
9.1.2.3.1 Epidemiologic Studies 9-18
9.1.2.3.2 Animal Toxicological Studies 9-22
9.1.2.3.3 Animal Toxicological Studies for Changes in Anogenital Distance 9-24
9.1.2.3.4 Animal Toxicological Studies for Altered Sex Ratio in Litters at Birth 9-24
9.1.2.4 Preterm Birth 9-24
9.1.2.4.1 Epidemiologic Studies 9-25
9.1.2.4.2 Animal Toxicological Studies 9-32
9.1.2.5 Birth Defects 9-32
9.1.2.5.1 Epidemiologic Studies 9-33
9.1.2.5.2 Animal Toxicological Studies 9-33
9.1.2.6 Fetal and Infant Mortality 9-34

9.1.3 Developmental Effects 9-35
9.1.3.1 Respiratory Developmental Effects 9-36
9.1.3.1.1 Epidemiologic Studies 9-36
9.1.3.1.2 Animal Toxicological Studies 9-37
9.1.3.2 Neurodevelopmental Effects 9-37
9.1.3.2.1 Epidemiologic Studies 9-37
9.1.3.2.2 Animal Toxicological Studies 9-38
9.1.3.3 Cardiovascular Developmental Effects 9-38
9.1.3.3.1 Animal Toxicological Studies 9-38
9.1.3.4 Postnatal Growth and Development 9-39
9.1.4 Associations between $PM_{2.5}$ Components and Sources and Reproductive and Developmental Effects 9-39
9.1.5 Summary and Causality Determination 9-41
9.1.5.1 Male and Female Fertility and Reproduction 9-41
9.1.5.2 Pregnancy and Birth Outcomes 9-43
9.1.5.3 Developmental Outcomes 9-46
9.2 $PM_{10-2.5}$ Exposure and Reproductive and Developmental Effects 9-46
9.2.1 Male and Female Reproduction and Fertility 9-46
9.2.1.1 Biological Plausibility 9-46
9.2.1.2 Male and Female Reproduction and Fertility 9-47
9.2.2 Pregnancy and Birth Outcomes 9-47
9.2.2.1 Biological Plausibility 9-47
9.2.2.2 Pregnancy and Birth Outcomes 9-47
9.2.3 Developmental Effects 9-51
9.2.4 Summary and Causality Determination 9-51
9.2.4.1 Male and Female Fertility and Reproduction 9-51
9.2.4.2 Pregnancy and Birth Outcomes 9-54
9.3 UFP Exposure and Reproductive and Developmental Effects 9-56
9.3.1 Male and Female Reproduction and Fertility 9-56
9.3.1.1 Biological Plausibility 9-56
9.3.1.2 Male Reproductive Function 9-58
9.3.1.3 Female Reproduction and Fertility 9-59
9.3.2 Pregnancy and Birth Outcomes 9-60
9.3.2.1 Biological Plausibility 9-60
9.3.2.2 Pregnancy and Birth Outcomes 9-60
9.3.3 Developmental Effects 9-61
9.3.3.1 Neurodevelopmental Effects 9-62
9.3.3.1.1 Neurobehavioral Effects 9-62
9.3.3.1.2 Changes in Brain Structure 9-62
9.3.4 Summary and Causality Determination 9-63
9.3.4.1 Male and Female Fertility and Reproduction 9-63
9.3.4.2 Pregnancy and Birth Outcomes 9-65
9.4 References 9-67

CHAPTER 10 CANCER 10-1

10.1 Introduction 10-1
10.1.1 Evaluation of the Relationship between Long-Term PM Exposure and Cancer 10-1
10.1.2 Carcinogens and the Development of Cancer 10-2
10.2 $PM_{2.5}$ Exposure and Cancer 10-3
10.2.1 Biological Plausibility 10-4

10.2.1.1 Genotoxicity 10-6
10.2.1.2 Epigenetic Effects 10-8
10.2.1.3 Carcinogenic Potential 10-8
10.2.1.4 Characteristics of Carcinogens and Hallmarks of Cancer 10-9
10.2.1.5 Summary of Biological Plausibility 10-9
10.2.2 Genotoxicity 10-9
10.2.2.1 Mutagenicity 10-10
10.2.2.2 DNA Damage 10-14
10.2.2.2.1 Toxicological Studies 10-14
10.2.2.2.2 Controlled Human Exposure Studies 10-18
10.2.2.2.3 Epidemiologic Studies 10-19
10.2.2.2.4 Summary 10-21
10.2.2.3 Cytogenetic Endpoints 10-21
10.2.2.3.1 Toxicological Studies 10-21
10.2.2.3.2 Epidemiologic Studies 10-21
10.2.2.3.3 Summary 10-24
10.2.2.4 Other Markers 10-24
10.2.2.4.1 Toxicological Studies 10-24
10.2.2.4.2 Controlled Human Exposure Studies 10-25
10.2.2.4.3 Epidemiologic Studies 10-26
10.2.2.4.4 Summary 10-26
10.2.2.5 Summary of Genotoxicity 10-26
10.2.3 Epigenetic Effects 10-27
10.2.3.1 Methylation of Promoters of Tumor Suppressor Genes 10-28
10.2.3.2 Methylation of Repetitive Line Elements 10-29
10.2.3.2.1 Toxicological Studies 10-29
10.2.3.2.2 Epidemiologic Studies 10-31
10.2.3.3 Noncoding Microribonucleic Acids (miRNAs) 10-33
10.2.3.4 Summary of Epigenetic Effects 10-34
10.2.4 Carcinogenic Potential 10-34
10.2.5 Cancer Incidence, Mortality, and Survival 10-36
10.2.5.1 Lung Cancer 10-36
10.2.5.1.1 Lung Cancer Mortality 10-45
10.2.5.1.2 Lung Cancer Incidence 10-50
10.2.5.1.3 Copollutant Models 10-54
10.2.5.1.4 Concentration-Response Relationship 10-55
10.2.5.1.5 Summary 10-60
10.2.5.2 Other Cancers 10-61
10.2.5.2.1 Breast Cancer 10-64
10.2.5.2.2 Brain Cancer 10-65
10.2.5.2.3 Liver Cancer 10-65
10.2.5.2.4 Leukemia 10-66
10.2.5.2.5 Multiple Cancers 10-66
10.2.5.2.6 Summary 10-67
10.2.5.3 Cancer Survival 10-67
10.2.6 Associations between $PM_{2.5}$ Sources and Components and Cancer 10-72

10.2.7 Summary and Causality Determination 10-73
10.3 $PM_{10-2.5}$ Exposure and Cancer 10-77
10.3.1 Biological Plausibility 10-78
10.3.1.1 Genotoxicity 10-79
10.3.1.2 Summary of Biological Plausibility 10-80
10.3.2 Genotoxicity 10-81
10.3.2.1 Toxicological Studies 10-81
10.3.2.2 Controlled Human Exposure Studies 10-83
10.3.2.3 Epidemiologic Studies 10-83
10.3.2.4 Summary of Genotoxicity 10-84
10.3.3 Cancer Incidence and Mortality 10-84
10.3.3.1 Lung Cancer 10-84
10.3.3.2 Other Cancers 10-86
10.3.3.3 Summary 10-86
10.3.4 Summary and Causality Determination 10-86
10.4 UFP Exposure and Cancer 10-88
10.4.1 Biological Plausibility 10-89
10.4.1.1 Genotoxicity 10-90
10.4.1.2 Summary of Biological Plausibility 10-91
10.4.2 Genotoxicity 10-92
10.4.2.1 Toxicological Studies 10-92
10.4.2.2 Controlled Human Exposure Studies 10-93
10.4.2.3 Summary of Genotoxicity 10-94
10.4.3 Cancer Incidence and Mortality 10-94
10.4.4 Summary and Causality Determination 10-94
10.5 References 10-96

CHAPTER 11 MORTALITY 11-1

11.1 Short-Term $PM_{2.5}$ Exposure and Total Mortality 11-1
11.1.1 Biological Plausibility for Short-Term $PM_{2.5}$ Exposure and Total (Nonaccidental) Mortality 11-8
11.1.2 Associations between Short-Term $PM_{2.5}$ Exposure and Total (Nonaccidental) Mortality in All-Year Analyses 11-9
11.1.2.1 Examination of $PM_{2.5}$-Mortality Relationship through Causal Modeling Methods 11-10
11.1.3 Associations between Short-Term $PM_{2.5}$ and Cause-Specific Mortality in All-Year Analyses 11-13
11.1.4 Potential Copollutant Confounding of the $PM_{2.5}$-Mortality Relationship 11-14
11.1.5 Other Potential Confounders of the $PM_{2.5}$-Mortality Relationship 11-16
11.1.5.1 Long-Term Temporal Trends and Weather 11-16
11.1.5.2 Influence of Long-Term $PM_{2.5}$ Concentrations on Short-Term $PM_{2.5}$ Associations 11-19
11.1.6 Effect Modification of the $PM_{2.5}$-Mortality Relationship 11-19
11.1.6.1 Season 11-20
11.1.6.2 Temperature 11-21
11.1.6.3 City and Regional Characteristics 11-24
11.1.6.3.1 Composition/Mixtures 11-24
11.1.6.3.2 Exposure Factors 11-28
11.1.7 Evaluation of Exposure Assessment Techniques 11-31
11.1.7.1 Monitor Representativeness 11-31
11.1.7.2 Urban versus Rural Locations 11-33
11.1.8 Timing of Effects and Exposure Metrics 11-34
11.1.8.1 Lag Structure of Associations 11-34

11.1.8.2 24-Hour Average versus Subdaily (Peak) Exposures 11-36
11.1.9 Alternative PM Size Fractions and Exposure Metrics 11-37
11.1.10 Concentration-Response Relationship and Threshold Analyses 11-37
11.1.11 Associations between $PM_{2.5}$ Sources and Components and Mortality 11-41
11.1.11.1 $PM_{2.5}$ Components 11-42
11.1.11.1.1 Single Component Models 11-46
11.1.11.1.2 Additional $PM_{2.5}$ Component Analyses 11-50
11.1.11.1.3 Summary 11-51
11.1.11.2 Sources 11-51
11.1.12 Summary and Causality Determination 11-53
11.2 Long-Term $PM_{2.5}$ Exposure and Total Mortality 11-58
11.2.1 Biological Plausibility for Long-Term $PM_{2.5}$ Exposure and Total Mortality 11-66
11.2.2 Associations between Long-Term $PM_{2.5}$ Exposure and Mortality 11-66
11.2.2.1 Results of American Cancer Society and Harvard Six Cities Cohort Studies 11-66
11.2.2.1 Results of Other North American Cohort Studies 11-69
11.2.2.2 Cardiovascular Mortality 11-77
11.2.2.3 Respiratory Mortality 11-78
11.2.2.4 Studies with Analyses that Inform Causal Inference 11-78
11.2.2.5 Studies of Temporal Trends and Life Expectancy 11-80
11.2.3 Potential Copollutant Confounding of the $PM_{2.5}$-Mortality Relationship 11-81
11.2.4 Concentration-Response Relationship 11-84
11.2.5 Evaluation of Factors That May Influence $PM_{2.5}$ Associations 11-90
11.2.5.1 Comparison of Exposure Assessment Techniques 11-90
11.2.5.2 Comparison of Statistical Techniques 11-91
11.2.5.3 Effects of Different Long-Term Exposure Windows 11-92
11.2.6 Associations between $PM_{2.5}$ Sources and Components and Mortality 11-93
11.2.7 Summary and Causality Determination 11-96
11.3 Short-Term $PM_{10-2.5}$ Exposure and Total Mortality 11-102
11.3.1 Biological Plausibility for Short-Term $PM_{10-2.5}$ Exposure and Total Mortality 11-105
11.3.2 Associations between Short-Term $PM_{10-2.5}$ Exposure and Total (Nonaccidental) Mortality in All-Year Analyses 11-106
11.3.3 Associations between Short-Term $PM_{10-2.5}$ Exposure and Cause-Specific Mortality in All-Year Analyses 11-107
11.3.4 Potential Confounding of the $PM_{10-2.5}$-Mortality Relationship 11-109
11.3.4.1 Copollutants 11-109
11.3.4.2 Long-Term Temporal Trends and Weather 11-111
11.3.5 Effect Modification of the $PM_{10-2.5}$-Mortality Relationship 11-112
11.3.5.1 Season and Temperature 11-113
11.3.5.2 Role of Exposure Assignment and Exposure Misclassification 11-113
11.3.6 Concentration-Response Relationship and Related Issues 11-114
11.3.6.1 Lag Structure of Associations 11-114
11.3.6.2 Concentration-Response Relationship and Threshold Analyses 11-115
11.3.6.2.1 Summary 11-115
11.3.7 Summary and Causality Determination 11-116
11.4 Long-Term $PM_{10-2.5}$ Exposure and Total Mortality 11-120
11.4.1 Biological Plausibility for Long-Term $PM_{10-2.5}$ Exposure and Total Mortality 11-120
11.4.2 Associations between Long-Term $PM_{10-2.5}$ Exposure and Mortality 11-121
11.4.3 Summary and Causality Determination 11-124
11.5 Short-Term UFP Exposure and Total Mortality 11-127
11.5.1 Biological Plausibility for Short-Term UFP Exposure and Total Mortality 11-133
11.5.2 Associations between Short-Term UFP Exposure and Total Mortality in Multicity Studies 11-133

11.5.3 Associations between Short-Term UFP Exposure and Total Mortality in Single-City Studies 11-135
11.5.4 Summary and Causality Determination 11-138
11.6 Long-Term UFP Exposure and Total Mortality 11-141
11.6.1 Biological Plausibility for Long-Term UFP Exposure and Total Mortality 11-141
11.6.2 Associations between Long-Term UFP Exposure and Total Mortality 11-142
11.6.3 Summary and Causality Determination 11-142
11.7 References 11-144

CHAPTER 12 POPULATIONS AND LIFESTAGES POTENTIALLY AT INCREASED RISK OF A PARTICULATE MATTER-RELATED HEALTH EFFECT 12-1

12.1 Introduction 12-1
12.2 Approach to Evaluating and Characterizing the Evidence for Populations or Lifestages Potentially at Increased Risk 12-2
12.3 Pre-existing Diseases/Conditions 12-5
12.3.1 Cardiovascular Disease 12-7
12.3.2 Pre-existing Diabetes and Metabolic Syndrome 12-10
12.3.3 Obesity 12-13
12.3.4 Elevated Cholesterol 12-16
12.3.5 Pre-existing Respiratory Disease 12-18
12.3.5.1 Asthma 12-18
12.3.5.2 Chronic Obstructive Pulmonary Disease (COPD) 12-19
12.4 Genetic Factors 12-20
12.5 Sociodemographic Factors 12-22
12.5.1 Lifestage 12-22
12.5.1.1 Children 12-23
12.5.1.2 Older Adults 12-25
12.5.2 Sex 12-29
12.5.3 Socioeconomic Status 12-31
12.5.4 Race 12-34
12.5.5 Residential Location 12-39
12.5.5.1 Urban/Rural Residential Locations 12-39
12.5.5.2 Residential Proximity to Traffic 12-41
12.6 Behavioral and Other Factors 12-43
12.6.1 Smoking 12-43
12.6.2 Diet 12-44
12.7 Conclusions 12-47
12.8 References 12-52

CHAPTER 13 WELFARE EFFECTS 13-1

13.1 Introduction 13-1
13.2 Effects on Visibility 13-2
13.2.1 Introduction 13-2
13.2.2 Visibility Impairment 13-4
13.2.2.1 Visibility Metrics 13-4
13.2.2.2 Monitoring of Visibility Impairment 13-6
13.2.3 Relationship between Particulate Matter and Visibility Impairment 13-10
13.2.3.1 Estimated Mass Extinction 13-12
13.2.3.2 Hygroscopic Growth 13-15
13.2.3.3 Reconstructing b_{ext} from Particulate Matter Speciation Data 13-16
13.2.4 Seasonal and Spatial Patterns of Visibility Impairment 13-17
13.2.4.1 Seasonal and Spatial Light Extinction $PM_{2.5}$ Species Contributions 13-20

13.2.4.2 Long-Term Trends 13-37
13.2.4.3 Characteristic Fine Particulate Mass Light Scattering Efficiencies 13-41
13.2.5 Human Perception of Haze and Landscape Features 13-42
13.2.6 Summary and Causality Determination 13-44
13.3 Effects on Climate 13-45
13.3.1 Introduction 13-45
13.3.2 Overview of the Physics of Climate Change and Radiative Forcing 13-46
13.3.2.1 Observed Recent Climate Change: Detection and Attribution 13-47
13.3.2.2 Metrics of Climate Change, Including Radiative Forcing 13-48
13.3.3 Effects of Particulate Matter on Radiative Forcing: Mechanisms 13-52
13.3.3.1 Interactions of Particulate Matter with Radiation 13-52
13.3.3.2 Interactions of Particulate Matter with Clouds 13-53
13.3.3.3 Effects of Absorbing Particulate Matter on Snow and Ice Albedo 13-54
13.3.3.4 Effect of Particle Size on the Interactions of Particulate Matter with Climate 13-54
13.3.4 Estimates of Radiative Forcing from Total Particulate Matter 13-55
13.3.4.1 Forcing Due to Interactions of Particulate Matter with Radiation 13-57
13.3.4.2 Forcing Due to Interactions of Particulate Matter with Clouds 13-60
13.3.4.3 Total Radiative Forcing Due to Interactions of Particulate Matter with Clouds and Radiation 13-60
13.3.4.4 Forcing Due to the Effects of Absorbing Particulate Matter on Albedo 13-60
13.3.4.5 Recent Trends in Particulate Matter Forcing 13-61
13.3.5 Effects of Particulate Matter on Climate by Species 13-64
13.3.5.1 Sulfate 13-65
13.3.5.2 Nitrate 13-66
13.3.5.3 Organic Carbon, Including Brown Carbon 13-66
13.3.5.4 Black Carbon 13-67
13.3.5.5 Dust 13-68
13.3.6 Climate Response to Changing Particulate Matter, Including Feedbacks 13-68
13.3.7 Effect of Particulate Matter on U.S. Regional Climate 13-70
13.3.8 Uncertainties in Estimates of Particulate Matter Effects on Radiative Forcing and Climate: Summary 13-74
13.3.9 Summary and Causality Determination 13-76
13.4 Effects on Materials 13-77
13.4.1 Introduction 13-77
13.4.2 Soiling and Corrosion 13-78
13.4.3 Dose-Response Relationships 13-81
13.4.4 Damage Functions 13-85
13.4.5 Summary and Causality Determination 13-87
13.5 References 13-88

APPENDIX DEVELOPMENT OF THE INTEGRATED SCIENCE ASSESSMENT A-1

A.1 Introduction A-1
A.2 Literature Search and Initial Screen A-3
A.2.1 Literature Search Techniques A-3
A.2.2 Initial Screening of Studies from Literature Search A-4
A.2.3 Documentation A-5
A.3 Full Evaluation of Studies A-6
A.3.1 Scope A-6
A.3.2 Individual Study Quality A-9
A.3.2.1 Health Approach A-9
A.3.2.2 Nonecological Welfare Effects Approach A-17
A.3.2.3 Other Approaches A-17

A.4 Peer Review and Public Participation A-18
A.4.1 Call for Information A-18
A.4.2 Integrated Review Plan A-19
A.4.3 Peer Input A-19
A.4.4 Internal Technical Review A-20
A.4.5 Clean Air Scientific Advisory Committee (CASAC) Peer Review A-20
A.5 Quality Assurance A-22
A.6 Conclusion A-23
A.7 References A-24

ACRONYMNS AND ABBREVIATIONS

Acronym/Abbreviation	Meaning
3B-HSD	3-beta-hydroxysteroid dehydrogenase
5hmC	5-hydroxymethylcytosine
5mC	5-methylcytosine
5mdC	5-methyl-2′-deoxycytidine
8-OHdG	8-hydroxy-2′-deoxyguanosine
99mTc	technicium-99m
AARP	American Association of Retired Persons
ABI	ankle-brachial index
AC	air conditioning
ACCMIP	Atmospheric Chemistry and Climate Model Intercomparison Project
ACE	angiotensin-converting enzyme
ACGIH	American Conference of Governmental Industrial Hygienists
aci	aerosol cloud interactions
ACL	Americans Changing Lives
ACS	American Cancer Society
Acta1	alpha skeletal actin
ADHD	attention deficit, hyperreactive disorder
ADI	Autism Diagnostic Interview
ADMS	Atmospheric Dispersion Modelling System
ADOS	Autism Diagnostic Observation Schedule
Adrb2	adrenergic beta 2
AER	air exchange rate
AERMOD	American Meteorological Society/U.S. EPA Regulatory Model
AeroCom	Aerosol Comparisons between Observations and Models
AERONET	Aerosol Robotic Network
AF	atrial fibrillation
AGD	anogenital distance
AhR	aryl hydrocarbon receptor

Acronym/Abbreviation	Meaning
AHR	airway hyperresponsiveness
AHS	Agricultural Health Study
AHSMOG	Adventist Health and Smog
AI	augmentation index
AIC	Akaike's information criterion
ALT	alanine transaminase
Ang	angiotensin
ANS	autonomic nervous system
AOD	aerosol optical depth
APC	antigen presenting cell(s)
APEX	Air Pollutants Exposure model
ApoE	apolipoprotein E
AQCD	Air Quality Criteria Document
AQHI	Air Quality Health Index
AQI	Air Quality Index
AQS	Air Quality System
AR4	Fourth Assessment Report from the IPCC
AR5	Fifth Assessment Report from the IPCC
ari/ARI	aerosol radiation interactions; acute respiratory infection
ARIES	Aerosol Research and Inhalation Epidemiology Study
ASD	autism spectrum disorder
AST	aspartate aminotransferase
At1r	angiotensin 1 receptor
ATPase	adenosine triphosphatase
ATSDR	Agency for Toxic Substances and Disease Registry
avg	average
B1r	bradykinin type 1 receptor
BACE	beta-site APP-cleaving enzyme
BAD	bronchial artery diameter
BAL	bronchoalveolar lavage
BALB	albino inbred mouse strain
BALF	bronchoalveolar lavage fluid

Acronym/Abbreviation	Meaning
BAMSE	Children, Allergy, Milieu, Stockholm, Epidemiological Survey
bap	absorption by particles coefficient
BC	black carbon
bext	light extinction coefficient
BG	background
bhp	brake horsepower
BIC	Bayesian information criterion
BMC	Boston Medical Center
BME	Bayesian maximum entropy
BMI	body mass index
BNP	B-type natriuretic peptide
BP	blood pressure
BPDE	benzo[a]pyrene 7,8-diol-9,10-epoxide
BrC	brown carbon
bsg	scattering by gases coefficient
BSID	Bayley Scale of Infant Development
bsp	sum of light scattering by (aerosol) particles coefficient
BTEX	benzene, toluene, ethylbenzene, xylene
BVAIT	B-Vitamin Atherosclerosis Intervention Trial
BW	bronchial wash
BWGA	birth weight for gestational age
BWHS	Black Women's Health Study
C57BL	wild type c57 black mouse
C_6H_6	benzene
CA	California
CA SEER	California Surveillance Epidemiology and End Results cancer registry
Ca^{2+}	calcium
CAA	Clean Air Act
CAAA	1977 Clean Air Act Amendments
CAC	coronary artery calcification
$CaCO_3$	calcium carbonate

Acronym/Abbreviation	Meaning
CAD	coronary artery disease
CALINE	California LINE (source dispersion model)
CALINE4	California Line Source Dispersion Model 4
CALIPSO	Cloud Aerosol Lidar and Infrared Pathfinder Satellite Observation
CalNex	California Nexus Study
CAMx	Comprehensive Air Quality Model with Extensions
CanCHEC	Canadian Census Health and Environment Cohort
CAPES	China Air Pollution and Health Effects Study
CAPPS	Canadian Asthma Primary Preventions Study
CAPs	concentrated ambient particles
CASAC	Clean Air Scientific Advisory Committee
CBSA	core-based statistical area
CBVD	cerebrovascular disease
CC	corpus callosum
CC16	club cell secretory protein
CCHS	Canadian Community Health Survey
CCR	California Cancer Registry
CDC	Centers for Disease Control and Prevention
CEN	European Committee for Standardization
CERAD	Consortium to Establish a Registry for Alzheimer's Disease
CESD	Center for Epidemiological Studies Depression Scale
CESD-R	Center for Epidemiological Studies Depression Scale Revised
CF	cystic fibrosis
CFD	computational fluid dynamics
CFR	Code of Federal Regulations
CHAD	Consolidated Human Activity Database

Acronym/Abbreviation	Meaning
CHARGE	Childhood Autism Risks from Genetics and the Environment
CHD	coronary heart disease
CHE	controlled human exposure
CHF	congestive heart failure
CHIMERE	multiscale chemical transport model for atmospheric composition analysis and forecast
CHS	Children's Health Study
CI	confidence interval
cIMT	carotid intimal-medial thickness
cm	centimeter(s)
cm^2	square centimeters
cm^3	cubic centimeter(s)
CMAQ	Community Multiscale Air Quality (model)
CNBSS	Canadian National Breast Screening Study
CNS	central nervous system
CO	carbon monoxide
CO^2	carbon dioxide
COD	coefficient of divergence
COGNAC	Cognition and Air Pollution in Children
Col3a1	collagen type 3 alpha
COM	combustion
COPD	chronic obstructive pulmonary disease
COX	cyclooxygenase
COX-1	cyclooxygenase-1
COX-2	cyclooxygenase-2
CPC	condensation particle counter
CPS	Cancer Prevention Study
Cr	Koschmieder relationship
C-R	concentration-response (relationship)
CRH	corticotropin-releasing hormone
CRP	C-reactive protein
CSF	cerebrospinal fluid
CSN	Chemical Speciation Network
CTM	chemical transport model
CTS	California Teachers Study
CuZn	copper zinc
CV	coefficient of variation; cardiovascular
C-V	cross-validation
CVD	cardiovascular disease(s)
CXCR3	chemokine receptor 3
DA	diacetate
d_{ae}	aerodynamic diameter of a particle
DASH	Denver Aerosol Sources and Health
DBA	dibenz[a,h]anthracene
DBP	diastolic blood pressure
DCFH	2′,7′-dicholorfluorescein
DCH	Diet, Cancer, and Health Study
DDST	Denver Developmental Screening Test
DE	diesel exhaust
DEARS	Detroit Exposure and Aerosol Research Study
Dec	December
DEE	diesel engine exhaust
DEP	diesel exhaust particle
df	degrees of freedom
DF	deposition fraction
dg	decigram(s)
DG	dentate gyrus
dL	deciliter(s)
DL	distributed lag
DLCO	diffusing capacity of the lung for carbon monoxide
DM	diabetes mellitus
DMSO	dimethylsulfoxide
DNA	deoxyribonucleic acid
DNC	Danish Nurse Cohort
Dp	physical diameter of a particle
DTPA	diethylenetriaminepentaacetate

Acronym/Abbreviation	Meaning
DTT	dithiothreitol
dv	deciview(s)
DVT	deep vein thromboses
EC	elemental carbon
ECG	electrocardiogram
ECRHS	European Community Respiratory Health Survey
ED	emergency department
EF	ejection fraction
EFAD	early onset familial Alzheimer disease
EFFECT	Enhanced Feedback for Effective Cardiac Treatment
EGU	electricity-generating unit
ELF	epithelial lining fluid
ELITE	Early Versus Late Intervention Trial with Estradiol
eNO	exhaled nitric oxide
ENVIRONAGE	ENVIRonmental influence ON early AGEing
EOM	extracted organic material
EP	entire pregnancy
EPCs	endothelial progenitor cells
ER	endoplasmic reticulum
ERF	effective radiative forcing
ERFaci	effective radiative forcing due to aerosol-cloud interactions
ERFari	effective radiative forcing due to aerosol-radiation interactions
ERK	extracellular signal-regulated kinase
ESCAPE	European Study of Cohorts for Air Pollution Effects
ET	extrathoracic
ET-1	endothelin-1
ETA	endothelin A
EU	European Union
EURAD	European Air Pollution Dispersion
f	breathing frequency
F344	Fischer 344 rat strain
FA	filtered air; fatty acid
FBG	fasting blood glucose
Fe_2O_3	iron (III) oxide
$FEF_{25–75}$	forced expiratory flow between 25 and 75% of forced vital capacity
FEM	Federal Equivalent Method
FeNO	fractional exhaled nitric oxide
FeO	iron (II) oxide
FEV_1	forced expiratory volume in 1 second
F_{inf}	infiltration factors
FINRISK	Finland Risk
FMD	flow-mediated dilation
fmsYFP	yellow fluorescent protein
FO	fish oil
FOXp3	forkhead box P3
FPG	formamidopyrimidine DNA glycosylase
FR	*Federal Register*
FRC	functional residual capacity
FRM	Federal Reference Method
FSH	follicle stimulating hormone
FSIGT	frequently sampled intravenous glucose tolerance (test)
FSIQ	Full Scale Intelligence Quotient
FVB	Friend leukemia virus B
FVC	forced vital capacity
FXII	coagulation factor XII
g	gram(s)
GABA	gamma-aminobutryic acid
GALA	Genes-Environments and Admixture in Latino Americans
GAM	generalized additive model
GASP	Genetics and Environment: Prospective Study on Infancy in Italy
GC	gas chromatograph
GCLC	glutamate cysteine ligase catalytic subunit
GCLM	glutamate cysteine ligase modifier subunit

Acronym/Abbreviation	Meaning
GD	gestation day
GDI	gasoline direct injection
GDM	gestational diabetes mellitus
GE	gasoline exhaust
GEE	gasoline engine exhaust
GEM	gaseous elemental mercury
GEOS	Goddard Earth Observing System
GEOS-Chem	Goddard Earth Observing System with global chemical transport model
GFAP	glial fibrillary acidic protein
GGT	gamma glutamyltransferase
GI	gastrointestinal
GINI	German Infant Nutrition Intervention
GINIplus	German Infant Nutrition Intervention plus environmental and genetic influences
GIS	geographic information system
GISS	Goddard Institute for Space Studies
GLM	generalize linear model
GLuA1	glutamatergic receptor protein subunit A1
GLuA2	glutamatergic receptor protein subunit A2
GPS	global positioning system
GSD	geometric standard deviation
GSHPx	glutathione peroxidase
GSS	glutathione synthetase gene
GST	glutathione S-transferase
GSTM1	glutathione S-transferase mu 1
GSTP1	glutathion S-transferase pi 1
GTP	global temperature potential
GTT	glucose tolerance test
GWP	global warming potential
GWR	geographically weighted regression
h	hour(s)
H^+	hydrogen ion
H_2O_2	hydrogen peroxide
H_2SO_4	sulfuric acid
HA	hospital admission
HAED	hospital admission or emergency department
HAPEM	Hazardous Air Pollutant Exposure Model
HbA1c	glycated hemoglobin
HBM	Hierarchical Bayesian Model
HD-DE	high-dose diesel exhaust
HDL	high-density lipoprotein
HEI	Health Effects Institute
HEPA	high-efficiency particulate air (filter)
HERO	Health and Environmental Research Online database
HF	heart failure; high frequency domain of HRV
HFD	high fat diet
HNE	hydroxynonenal
HNO_3	nitric acid
HNR	Heinz Nixdorf Recall (study)
HO-1	heme oxidase 1
HOMA	Homeostatic Model Assessment
HOMA-IR	Homeostatic Model Assessment of Insulin Resistance
HPA	hypothalamic-pituitary-adrenal
HPFU	Health Professionals Follow-Up
HPLC	high-performance liquid chromatography
HPMEC	human pulmonary microvasculature endothelial
HR	heart rate; hazard ratio
HRS	Health and Retirement Survey
HRV	heart rate variability
HS	hemorrhagic stroke
HSC	Harvard Six Cities (study)
hs-CRP	high sensitivity C-reactive protein

Acronym/Abbreviation	Meaning
IARC	International Agency for Research on Cancer
IBA-1	ionized calcium binding adaptor molecule
IBG	impaired blood glucose
ICAM-1	intercellular adhesion molecule 1
ICD	International Classification of Disease
ICD10	International Classification of Disease version 10
ICD9	International Classification of Disease version 9
ICR	Institute of Cancer Research
ICRP	International Commission on Radiological Protection
ICS	inhaled corticosteroid
ICU	intensive care unit
IDW	inverse-distance weighting
IFN	interferon
IgE	immunoglobulin E
IgG1	immunoglobulin G1
IGM	impaired glucose metabolism
IGT	impaired glucose tolerance
IHD	ischemic heart disease
IKK	inhibitor of nuclear factor-κB kinase
IL	interleukin
IL1β	interleukin-1 beta
IL-4	interleukin-4
IL-6	interleukin-6
IMPROVE	Interagency Monitoring of Protected Visual Environments
INMA	*INfancia y Medio Ambiente*—(Environment and Childhood)
iNOS	inducible nitric oxide synthase
IO	iodine monoxide
IOM	institutes of medicine
IPCC	Intergovernmental Panel on Climate Change
IQ	intelligence quotient
IQR	interquartile range
IR	insulin resistance
IRP	Integrated Review Plan
ISA	Integrated Science Assessment
ISO	International Organization for Standardization
ITT	insulin tolerance test
IUGR	Intra-uterine growth restriction
IVF	in vitro fertilization
K	potassium
KC	keratinocyte-derived chemokine
kg	kilogram(s)
km	kilometer(s)
km^2	square kilometer(s)
KORA	*Kooperative Gesundheitsforschung in der Region Augsburg* (Cooperative Health Research in the Region of Augsburg)
LAC	light-absorbing carbon
LAVI	left atrial volume index
LBL	Lawrence Berkeley Laboratory
LBW	low birth weight
LDH	lactate dehydrogenase
LDL	low-density lipoprotein
$Ldlr^{-/-}$	low-density lipoprotein receptor null
LDSA	lung deposited surface area
LF	low frequency
LH	luteinizing hormone
LHID2000	Longitudinal Health Insurance Database for 2000
LINE-1	long interspersed nucleotide element-1
LISA	Lifestyle Factors on the Development of the Immune System and Asthma
LISAplus	Lifestyle Factors on the Development of the Immune System and Asthma plus Air Pollution and Genetics on Allergy Development

Acronym/Abbreviation	Meaning
lnSDNN	natural log of the standard deviation of all normal-to-normal intervals
LOOCV	leave-one-out cross validation
LOX	lysyl oxidase
LPR	liver-to-phantom ratio
LRI	lower respiratory infection
LRTI	lower respiratory tract infection
LTE4	leukotriene E4
LUR	land use regression
LUR-BME	land use regression—Bayesian maximum entropy
LV	left ventricular
LVDP	left ventricular developed pressure
LVMI	left ventricular mass index
m	meter(s)
m^2	square meters
m^3	cubic meters
MAAS	Manchester Asthma and Allergy Study
MAP	mean arterial pressure
max	maximum
MC	mass concentration
MCAPS	Medicare Air Pollution Study
MCDI	McArthur Communicative Development Inventory
MCI	mild cognitive impairment
MCP	monocyte chemoattractant protein
MCP-1	monocyte chemoattractant protein-1
MCT	mucoid connective tissue
MDA	malondialdehyde
MDL	method detection limit
MED-PARTICLES	particles size and composition in Mediterranean countries: geographical variability and short-term health effects
MEF	midexpiratory flow
MESA	Multi-Ethnic Study of Atherosclerosis
mg	milligram(s)
MI	myocardial infarction
MIDI	Minnesota Infant Development Inventory
min	minute(s)
MINAP	Myocardial Ischaemia National Audit Project
MIP	macrophage inflammatory protein
MISR	Multiangle Imaging Spectroradiometer
mL	milliliter(s)
MMAD	mass median aerodynamic diameter
MMD	mass median diameter
MMEF	maximum midexpiratory flow
mm Hg	millimeters of mercury
MMP	mitochondria membrane potential
MMP-9	matrix metallopeptidase 9
MMT	million metric tons
MnSOD	manganese superoxide dismutase
mo	month(s)
Mo	molybdenum
MOBILIZE	Maintenance of Balance, Independent Living, Intellect, and Zest in the Elderly
MODIS	MODerate Resolution Imaging Spectroradiometer
MOUDI	micro-orifice uniform deposit impactor
MPPD	Multi-Path Particle Dosimetry (model)
MRI	magnetic resonance imaging
mRNA	messenger ribonucleic acid
MSA	metropolitan statistical area
MSE	mean-squared error
Muc5AC	mucin 5AC, oligomeric mucus/gel-forming
MV	minute volume
MVE	motor vehicle exhaust
Na^+	sodium ion
Na_2O	sodium oxide

Acronym/Abbreviation	Meaning
NAAQS	National Ambient Air Quality Standards
NADPH	nicotinamide adenine dinucleotide phosphate hydrogen
NAEPP	National Asthma Education and Prevention Program
NAFLD	nonalcoholic fatty liver disease
NALF	nasal airway lavage fluid
NAPCA	National Air Pollution Control Administration
NAS	Normative Aging Study
NASA	National Aeronautics and Space Administration
NC	number concentration
NCLS-Air	Netherlands Cohort Study on Diet and Cancer
NCore	National Core (multipollutant monitoring network)
NC_{total}	total number concentration
ND	not detected
NECSS	National Enhanced Cancer Surveillance System
NEI	National Emissions Inventory
NFkB	nuclear factor kappa B
ng	nanogram(s)
NH_3	ammonia
NH_4	ammonium
NH_4^+	ammonium ion
NH_4NO_3	ammonium nitrate
NHANES	National Health and Nutrition Examination Survey
NHID	National Health Insurance Database
NHIS	National Health Interview Survey
NHLBI	National Heart, Lung, and Blood Institute
NHS	Nurses' Health Study
NIH	National Institutes of Health
NIH-AARP	National Institutes of Health—American Association of Retired Persons (diet and health cohort)
NIST	National Institute of Standards and Technology
NLCS	Netherlands Cohort Study on Diet and Cancer
nm	nanometer(s)
NMBF	normalized mean bias factor
NME	normalized mean error
NMMAPS	National Morbidity, Mortality, and Air Pollution Study
NMSE	normalized mean squared error
NO	nitric oxide
NO_2	nitrogen dioxide
NO_3^-	nitrate
NO_X	oxides of nitrogen ($NO + NO_2$)
$NOX2^{-/-}$	NADPH oxidase 2 null
NPACT	National Particle Component Toxicity Initiative
NPF	new particle formation
NQO1	NADPH-quinone oxidoreductase 1
NR	not reported
NR-DE	nanoparticle rich diesel exhaust
Nrf2	nuclear factor erythroid 2-related factor
NRPB	National Radiological Protection Board
NTP	nitroprusside
O_2	oxygen gas
O_3	ozone
OAQPS	Office of Air Quality Planning and Standards
OC	organic carbon
OCM	organic carbon matter
oGTT	oral glucose tolerance test
OH	hydroxide
OHCA	out-of-hospital cardiac arrest
OM	organic matter
OO	olive oil
OP	oxidative potential
OR	odds ratio
OTH	other primary sources

Acronym/Abbreviation	Meaning
OVA	ovalbumin
oxoG	oxoguanine
p	probability value
PACF	partial autocorrelation function
PAGE	Parkinson's Genes and Environment (study)
PAH	polycyclic aromatic hydrocarbon(s)
PAI-1	plasminogen activator inhibitor 1
PAPC	1-palmitoyl-2-arachidonoyl-sn-phosphatidylcholine
PARP1	poly (ADP-ribose) polymerase-1
Pb	lead
PBAP	primary biological aerosol particle
PBR	peripheral-type benzodiazepine receptor
PD	Parkinson's disease
PE	phenylephrine; postexposure; pulmonary embolism
PEF	peak expiratory flow
PEFR	peak expiratory flow rate
Penh	enhanced pause
PFI	port fuel injection
PI	posterior interval
PI3K	phosphoinositide 3-kinases
PIAMA	Prevention and Incidence of Asthma and Mite Allergy
PM	particulate matter
PM_{10}	particulate matter with a nominal mean aerodynamic diameter less than or equal to 10 μm.[1]
$PM_{10-2.5}$	particulate matter with a nominal mean aerodynamic diameter greater than 2.5 μm and less than or equal to 10 μm.[2]
$PM_{2.5}$	particulate matter with a nominal mean aerodynamic diameter less than or equal to 2.5 μm.[3]
PM25abs	$PM_{2.5}$ light absorption coefficient
PMF	positive matrix factorization
PMN	polymorphonuclear leukocyte
PN	particle number
PNC	particle number count
PND	postnatal day
pNN50	mean number of times per hour in which change in consecutive normal sinus (NN) intervals exceeds 50 milliseconds
POA	primary organic aerosol (PM from fossil fuel and biofuel)
POC	primary organic carbon
POM	particulate organic matter
PP	pulse pressure

[1] A measurement of thoracic particles (i.e., that subset of inhalable particles thought small enough to penetrate beyond the larynx into the thoracic region of the respiratory tract). In regulatory terms, particles with an upper 50% cut-point of 10 ± 0.5 μm aerodynamic diameter (the 50% cut point diameter is the diameter at which the sampler collects 50% of the particles and rejects 50% of the particles) and a penetration curve as measured by a reference method based on Appendix J of 40 CFR Part 50 and designated in accordance with 40 CFR Part 53 or by an equivalent method designated in accordance with 40 CFR Part 53.

[2] A measurement of thoracic coarse particulate matter or the coarse fraction of PM_{10}. In regulatory terms, particles with an upper 50% cut-point of 10 μm aerodynamic diameter and a lower 50% cut-point of 2.5 μm aerodynamic diameter (the 50% cut point diameter is the diameter at which the sampler collects 50% of the particles and rejects 50% of the particles) as measured by a reference method based on Appendix O of 40 CFR Part 50 and designated in accordance with 40 CFR Part 53 or by an equivalent method designated in accordance with 40 CFR Part 53.

[3] A measurement of fine particles. In regulatory terms, particles with an upper 50% cut-point of 2.5 μm aerodynamic diameter (the 50% cut point diameter is the diameter at which the sampler collects 50% of the particles and rejects 50% of the particles) and a penetration curve as measured by a reference method based on Appendix L of 40 CFR Part 50 and designated in accordance with 40 CFR Part 53, by an equivalent method designated in accordance with 40 CFR Part 53, or by an approved regional method designated in accordance with Appendix C of 40 CFR Part 58.

Acronym/Abbreviation	Meaning
ppb	parts per billion
ppm	parts per million
PR	time interval between the beginning of the P wave to the peak of the R wave
PROM	premature rupture of membranes
PSD	postsynaptic density protein
PSD-95	postsynaptic density protein 95
PTB	preterm birth
PU	pulmonary
PVD	peripheral vascular disease
PWV	pulse wave velocity
Q	flow
QRS	time interval between the beginning of the Q wave and the peak of the S wave
QT	time interval between from beginning of the Q wave to end of the T wave
QTc	corrected QT interval
r	correlation coefficient
R^2	coefficient of determination
RAS	renin-angiotensin system
RCT	randomized control trial
redox	reduction-oxidation
REGARDS	REasons for Geographic and Racial Differences in Stroke
REGICOR	*Registre Gironí del Cor* (Girona Heart Registry)
REM-Calgrid	Regional Eulerian Model—California Grid Model
RESPIRA	Italian acronym for *Rischio ESPosizione Inquinamento aRia Atmosferica* study
REVEAL-HBV	Risk Evaluation of Viral Load Elevation and Associated Liver Disease/Cancer-Hepatitis B Virus
RF	radiative forcing
RFaci	radiative forcing due to aerosol-cloud interactions
RFari	radiative forcing due to aerosol-radiation interactions
RH	relative humidity
RHI	Reactive Hyperemia Index
RIOPA	Relationship among Indoor, Outdoor, and Personal Air
RMSE	root-mean-squared error
RNA	ribonucleic acid
RoLS	Rome Longitudinal Study
ROS	reactive oxygen species
RR	relative risk; rate ratio; risk ratio
RS	remote sensing
RSV	respiratory syncytial virus
RTp	time interval between the beginning of R wave and peak of the T wave
RTP	Research Triangle Park
RVM	Right Ventricular Mass
s	second(s)
SAGE	Study of Asthma, Genes, and the Environment
SALIA	Study on the influence of Air pollution on Lung function, Inflammation, and Aging; Study on the Influence of Air Pollution on the Lung
SAPALDIA	Swiss study on Air Pollution and Lung Diseases in Adults
SBP	systolic blood pressure
SC	surface area concentration
SCQ	social communication questionnaire
SD	standard deviation
S-D	Sprague-Dawley
SDNN	standard deviation of normal-to-normal intervals
SE	standard error
SEARCH	Southeastern Aerosol Research and Characterization
SEM	standard error of the mean
SES	socioeconononomic status; sample equilibration system
SETIL	population-based CC study of childhood cancer in Italy
SGA	small for gestational age

Acronym/Abbreviation	Meaning
SH	spontaneously hypertensive
SHEDS	Stochastic Human Exposure and Dose Simulation (model)
SHR	spontaneously hypertensive rats
SHS	second-hand smoke
sICAM	soluble intercellular adhesion molecule 1
SIDS	sudden infant death syndrome
SiO_2	silica
SIS	six item screener
SLAMS	State and Local Air Monitoring Stations
SMPS	scanning mobility particle sizer
SNP	sodium nitroprusside
SNPs	single nucleotide polymorphisms
SNS	sympathetic nervous system
SO_2	sulfur dioxide
SO_4	sulfate
SO_4^{2-}	sulfate
SOA	secondary organic aerosol
SOC	secondary organic carbon
SOD	superoxide dismutase
SOPHIA	Study of Particles and Health in Atlanta
SO_X	sulfur oxides
SPMSQ	Short Portable Mental Status Questionnaire
SR-B1	scavenger receptor-B1
SRM	standard reference material
SRS	Social Responsiveness Scale
StAR	steroidogenic acute regulatory
STEMI	ST segment elevation myocardial infarction
sTNF	soluble tumor necrosis factor
sVCAM-1	soluble vascular cell adhesion molecule-1
SVE	supraventricular ectopy
T1D	type 1 diabetes
T2D	type 2 diabetes
TAG	Traffic, Asthma, and Genetics (study)
TAPES	Taipei Air Pollution Exposure System for Health Effects
TB	tracheobronchial
TBARS	thiobarbituric acid reactive substances
TC	total carbon
TCHS	Taiwan Children's Health Study
TEOM	tapered element oscillating microbalance
TF	tissue factor
Tg	teragram(s)
TG	triglyceride
TGF	transforming growth factor
Th1	T helper type 1
Th17	T helper type 17
Th2	T helper type 2
Ti	titanium
TIA	transient ischemic attack
TICS	Telephone Interview of Cognitive Status
TiO_2	titanium dioxide
TLR	toll-like receptor
TLR4	toll-like receptor 4
TNF	tumor necrosis factor
TOA	top of the atmosphere
tPA	tissue plasminogen activator
TRANSPHORM	European Study of Transport-Related Air Pollution and Health Impacts-Integrated Methodologies for Assessing Particulate Matter
TRAP	traffic-related ambient particles
TrIPS	Trucking Industry Particle Study
TROY	Testing Responses on Youth
TRP	transient receptor potential
TSP	total suspended particulates
U.K.	United Kingdom
U.S.	United States of America

Acronym/Abbreviation	Meaning
U.S.C.	U.S. Code
U.S. EPA	U.S. Environmental Protection Agency
UF	ultrafine
UFIREG	Ultrafine Particles—An Evidence-Based Contribution to the Development of Regional and European Environmental and Health Policy
UFP	ultrafine particle
URI	upper respiratory infection
V	vanadium
VACES	Versatile Aerosol Concentration Enrichment System
VCAM-1	vascular cell adhesion molecule-1
V_d	deposition velocity
VEGF	vascular endothelial growth factor
VHM and PP	Vorarlberg Health Monitoring and Promotion Program
VOC	volatile organic compound
VPTB	very preterm birth
V_T	tidal volume
VTE	venous thromboembolism
vWF	Von Willebrand factor
W	west
WBC	white blood cell
WCC	white cell count
WHI	Women's Health Initiative
WHIMS	Women's Health Initiative Memory Study
WISC	Wechsler Intelligence Scale for Children
WISH	Women's Isoflavone Soy Health
WKY	Wistar Kyoto
WM	white matter
Wm^{-2}	watts per square meter
w/m^2	watts per square meter
WRF	Weather Research and Forecasting (model)
WT	wild type
wt	weight
yr	year(s)

PREFACE

The Preface to the Integrated Science Assessment for Particulate Matter (PM ISA) outlines the legislative requirements of a National Ambient Air Quality Standard (NAAQS) review and the history of the PM NAAQS. This information provides an understanding of the function of the ISA, and in terms of providing a starting point for this PM ISA, presents the basis for the decisions that supported the previous PM NAAQS review. In addition, the Preface details the purpose of the ISA as well as specific issues pertinent to evaluating the scientific evidence within this ISA, including the scope of the ISA and discipline-specific decisions that governed parts of the review.

P.1. Legislative Requirements for the Review of the National Ambient Air Quality Standards

Two sections of the Clean Air Act (CAA) govern the establishment, review, and revision of the National Ambient Air Quality Standards (NAAQS). Section 108 [42 U.S. Code (U.S.C.) 7408] directs the Administrator to identify and list certain air pollutants and then to issue air quality criteria for those pollutants. The Administrator is to list those air pollutants that in their "judgment, cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare," "the presence of which in the ambient air results from numerous or diverse mobile or stationary sources," and "for which …[the Administrator] plans to issue air quality criteria…" [42 U.S.C. 7408(a)(1) (CAA, 1990a)]. Air quality criteria are intended to "accurately reflect the latest scientific knowledge useful in indicating the kind and extent of all identifiable effects on public health or welfare, which may be expected from the presence of [a] pollutant in the ambient air…" [42 U.S.C. 7408(b)]. Section 109 [42 U.S.C. 7409 (CAA, 1990b)] directs the Administrator to propose and promulgate "primary" and "secondary" NAAQS for pollutants for which air quality criteria are issued. Section 109(b)(1) defines a primary standard as one "the attainment and maintenance of which in the judgment of the Administrator, based on such criteria and allowing an adequate margin of safety, are requisite to protect the public health."[4] A secondary standard, as defined in Section 109(b)(2), must "specify a level of air quality the attainment and maintenance of which, in the judgment of the Administrator, based on such criteria, is requisite to protect

[4] The legislative history of Section 109 indicates that a primary standard is to be set at "…the maximum permissible ambient air level…which will protect the health of any [sensitive] group of the population," and that for this purpose "reference should be made to a representative sample of persons comprising the sensitive group rather than to a single person in such a group" S. Rep. No. 91:1196, 91st Cong., 2d Sess. 10 (1970).

the public welfare from any known or anticipated adverse effects associated with the presence of [the] air pollutant in the ambient air."[5]

The requirement that primary standards provide an adequate margin of safety was intended to address uncertainties associated with inconclusive scientific and technical information available at the time of standard setting. It was also intended to provide a reasonable degree of protection against hazards that research has not yet identified.[6] Both kinds of uncertainty are components of the risk associated with pollution at levels below those at which human health effects can be said to occur with reasonable scientific certainty. Thus, in selecting primary standards that provide an adequate margin of safety, the Administrator is seeking not only to prevent pollution levels that have been demonstrated to be harmful but also to prevent lower pollutant levels that may pose an unacceptable risk of harm, even if the risk is not precisely identified as to nature or degree. The CAA does not require the Administrator to establish a primary NAAQS at a zero-risk level or at background concentration levels, but rather at a level that reduces risk sufficiently so as to protect public health with an adequate margin of safety.[7] In so doing, protection is provided for both the population as a whole and those groups and lifestages potentially at increased risk for health effects from exposure to the air pollutant for which each NAAQS is set.

In addressing the requirement for an adequate margin of safety, the U.S. Environmental Protection Agency (U.S. EPA) considers such factors as the nature and severity of the health effects involved, the size of the sensitive group(s), and the kind and degree of the uncertainties. The selection of any particular approach to providing an adequate margin of safety is a policy choice left specifically to the Administrator's judgment.[8]

In setting standards that are "requisite" to protect public health and welfare as provided in Section 109(b), the U.S. EPA's task is to establish standards that are neither more nor less stringent than necessary for these purposes. In so doing, the U.S. EPA may not consider the costs of implementing the standards.[9] Likewise, "[a]ttainability and technological feasibility are not relevant considerations in the promulgation of national ambient air quality standards."[10]

Section 109(d)(1) requires that "not later than December 31, 1980, and at 5-year intervals thereafter, the Administrator shall complete a thorough review of the criteria published under Section 108

---

[5] Section 302(h) of the Act [42 U.S.C. 7602(h)] provides that all language referring to effects on welfare includes, but is not limited to, "effects on soils, water, crops, vegetation, man-made materials, animals, wildlife, weather, visibility and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being…" (CAA, 2005).

[6] See *Lead Industries Association v. EPA*, 647 F.2d 1130, 1154 [District of Columbia Circuit (D.C. Cir.) 1980]; *American Petroleum Institute v. Costle*, 665 F.2d 1176, 1186 (D.C. Cir. 1981); *American Farm Bureau Federation v. EPA*, 559 F. 3d 512, 533 (D.C. Cir. 2009); *Association of Battery Recyclers v. EPA*, 604 F. 3d 613, 617−18 (D.C. Cir. 2010).

[7] See *Lead Industries v. EPA*, 647 F.2d at 1156 n.51; *Mississippi v. EPA*, 744 F. 3d 1334, 1339, 1351, 1353 (D.C. Cir. 2013).

[8] See *Lead Industries Association v. EPA,* 647 F.2d at 1161−62; *Mississippi v. EPA,* 744 F. 3d at 1353.

[9] See generally, *Whitman v. American Trucking Associations*, 531 U.S. 457, 465−472, 475−476 (2001).

[10] See *American Petroleum Institute v. Costle,* 665 F. 2d at 1185.

and the national ambient air quality standards…and shall make such revisions in such criteria and standards and promulgate such new standards as may be appropriate….” Section 109(d)(2) requires that an independent scientific review committee “shall complete a review of the criteria…and the national primary and secondary ambient air quality standards…and shall recommend to the Administrator any new…standards and revisions of existing criteria and standards as may be appropriate….” Since the early 1980s, this independent review function has been performed by the Clean Air Scientific Advisory Committee (CASAC).[11]

P.1.1. Overview and History of the Reviews of the Primary and Secondary National Ambient Air Quality Standard for Particulate Matter

NAAQS are defined by four basic elements: indicator, averaging time, level, and form. The indicator defines the pollutant to be measured in the ambient air for the purpose of determining compliance with the standard. The averaging time defines the time period over which air quality measurements are to be obtained and averaged or cumulated, considering evidence of effects associated with various time periods of exposure. The level of a standard defines the air quality concentration used (i.e., an ambient concentration of the indicator pollutant) in determining whether the standard is achieved. The form of the standard defines the air quality statistic that is compared with the level of the standard in determining whether an area attains the standard. For example, the form of the current primary annual fine particulate matter ($PM_{2.5}$) standard is the annual mean averaged over 3 years. The Administrator considers these four elements collectively in evaluating the protection to public health provided by the primary NAAQS.

Particulate matter (PM) is the generic term for a broad class of chemically and physically diverse substances that exist as discrete particles (liquid droplets or solids) over a wide range of sizes. Particles originate from a variety of anthropogenic stationary and mobile sources, as well as from natural sources. Particles may be emitted directly or formed in the atmosphere by transformations of gaseous emissions such as sulfur oxides (SO_X), oxides of nitrogen (NO_X), ammonia (NH_3) and volatile organic compounds (VOCs). Examples of secondary particle formation include: (1) the conversion of SO_2 to sulfuric acid (H_2SO_4) vapor that nucleates new particles or condenses on existing particles and further reacts with NH_3 to form various inorganic salts (e.g., ammonium sulfate, $[NH_4]_2SO_4$, or ammonium bisulfate, NH_4HSO_4); (2) the conversion of nitrogen dioxide (NO_2) to nitric acid (HNO_3) vapor that condenses onto existing particles and reacts further with ammonia to form ammonium nitrate (NH_4NO_3); and (3) reactions involving gaseous VOCs yielding organic compounds with low vapor pressures that nucleate or condense on existing particles to form secondary organic particulate matter [SOPM; U.S. EPA (2004)]. The chemical and physical properties of PM vary greatly with time, region, meteorology, and source category,

[11] Additional information on CASAC is available at: https://yosemite.epa.gov/sab/sabpeople.nsf/WebCommittees/CASAC.

thus complicating the assessment of health and welfare effects. These reviews are briefly described below, and further details are provided in the Integrated Review Plan (U.S. EPA, 2016).

The U.S. EPA first established NAAQS for PM in 1971 (36 FR 8186, April 30, 1971), based on the original criteria document (NAPCA, 1969).[12] The Federal Reference Method (FRM) specified for determining attainment of the original standards was the high-volume sampler, which collects PM up to a nominal size of 25 to 45 micrometers (μm; referred to as total suspended particulates or TSP). The primary standards were at 260 μg/m^3, 24-hour avg, not to be exceeded more than once per year, and 75 μg/m^3, annual geometric mean. The secondary standards were 150 μg/m^3, 24-hour avg, not to be exceeded more than once per year, and 60 μg/m^3, annual geometric mean. Since then, the Agency has completed multiple reviews of the air quality criteria and standards, as summarized in Table P-1.

Table P-1 History of the National Ambient Air Quality Standards (NAAQS) for particulate matter, 1971−2012.

Final Rule/Decision	Indicator	Averaging Time	Level (μg/m^3)	Form
1971 36 FR 8186 April 30, 1971	TSP	24 h	260 (primary) 150 (secondary)	Not to be exceeded more than once per year
		Annual	75 (primary) 60 (secondary)	Annual geometric mean
1987 52 FR 24634 July 1, 1987	PM_{10}	24 h	150	Not to be exceeded more than once per year on average over a 3-yr period
		Annual	50	Annual arithmetic mean, averaged over 3 yr
1997 62 FR 38652 July 18, 1997	$PM_{2.5}$	24 h	65	98th percentile, averaged over 3 yr
		Annual	15	Annual arithmetic mean, averaged over 3 yr[a]
	PM_{10}	24 h	150	Initially promulgated 99th percentile, averaged over 3 yr; when 1997 standards were vacated in 1999, the form of 1987 standards remained in place (not to be exceeded more than once per yr on average over a 3-yr period)
		Annual	50	Annual arithmetic mean, averaged over 3 yr

[12] Prior to the review initiated in 2007 (see below), the AQCD provided the scientific basis for the NAAQS.

Table P-1 (Continued): History of the National Ambient Air Quality Standards (NAAQS) for particulate matter, 1971−2012.

Final Rule/Decision	Indicator	Averaging Time	Level (μg/m^3)	Form
2006 71 FR 61144 October 17, 2006	$PM_{2.5}$	24 h	35	98th percentile, averaged over 3 yr
		Annual	15	Annual arithmetic mean, averaged over 3 yr[a]
	PM_{10}	24 h	150	Not to be exceeded more than once per year on average over a 3-yr period
2012 78 FR 3085 January 15, 2013	$PM_{2.5}$	24 h	35	98th percentile, averaged over 3-yr[b]
		Annual	12 (primary) 15 (secondary)	Annual arithmetic mean, averaged over 3-yr[c]
	PM_{10}[d]	24 h	150	Not to be exceeded more than once per year on average over 3-yr

FR = *Federal Register*; h = hour; μg/m^3 = micrograms per cubic meter; PM = particulate matter; $PM_{2.5}$ = particulate matter with a nominal mean aerodynamic diameter less than or equal to 2.5 μm; PM_{10} = particulate matter with a nominal mean aerodynamic diameter less than or equal to 10 μm; TSP = total suspended particles; yr = year.

Note: When not specified, primary and secondary standards are identical.

[a]The level of the 1997 annual $PM_{2.5}$ standard was to be compared with measurements made at the community-oriented monitoring site recording the highest level, or, if specific constraints were met, measurements from multiple community-oriented monitoring sites could be averaged ("spatial averaging"). This approach was judged to be consistent with the short-term exposure epidemiologic studies on which the annual $PM_{2.5}$ standard was primarily based, in which air quality data were generally averaged across multiple monitors in an area or were taken from a single monitor that was selected to represent community-wide exposures, not localized "hot spots" (62 FR 38672). These criteria and constraints were intended to ensure that spatial averaging would not result in inequities in the level of protection afforded by the $PM_{2.5}$ standards. Community-oriented monitoring sites were specified to be consistent with the intent that a spatially averaged annual standard provide protection for persons living in smaller communities, as well as those in larger population centers.

[b]The level of the 24-h standard is defined as an integer (zero decimal places) as determined by rounding. For example, a 3-yr avg 98th percentile concentration of 35.49 μg/m^3 would round to 35 μg/m^3 and thus meet the 24-h standard and a 3-yr avg of 35.50 μg/m^3 would round to 36 and, hence, violate the 24-h standard (40 Code of Federal Regulations Part 50 Appendix N).

[c]In the revisions to the PM NAAQS finalized in 2006, U.S. EPA tightened the constraints on the spatial averaging criteria by further limiting the conditions under which some areas may average measurements from multiple community-oriented monitors to determine compliance (71 FR 61165-61167, October 17, 2006).

[d]The U.S. EPA revoked the annual PM_{10} NAAQS in 2006.

In October 1979 (44 FR 56730, October 2, 1979), the U.S. EPA announced the first periodic review of the air quality criteria and NAAQS for PM. Revised primary and secondary standards were promulgated in 1987 (52 FR 24634, July 1, 1987). In the 1987 decision, the U.S. EPA changed the indicator for particles from TSP to PM_{10}, in order to focus on the subset of inhalable particles small enough to penetrate to the thoracic region of the respiratory tract (including the tracheobronchial and alveolar regions), referred to as thoracic particles.[13] The level of the 24-hour standards (primary and secondary) was set at 150 μg/m^3, and the form was one expected exceedance per year, on average over

[13] PM_{10} refers to particles with a nominal mean aerodynamic diameter less than or equal to 10 μm. More specifically, 10 μm is the aerodynamic diameter for which the efficiency of particle collection is 50%. Larger particles are not excluded altogether but are collected with substantially decreasing efficiency while smaller particles are collected with increasing efficiency.

3 years. The level of the annual standards (primary and secondary) was set at 50 μg/m^3, and the form was annual arithmetic mean, averaged over 3 years.

In April 1994, the U.S. EPA announced its plans for the second periodic review of the air quality criteria and NAAQS for PM, and in 1997 the U.S. EPA promulgated revisions to the NAAQS (62 FR 38652, July 18, 1997). In the 1997 decision, the U.S. EPA determined that the fine and coarse fractions of PM_{10} should be considered separately. This determination was based on evidence that serious health effects were associated with short- and long-term exposures to fine particles in areas that met the existing PM_{10} standards. The U.S. EPA added new standards, using $PM_{2.5}$ as the indicator for fine particles (with $PM_{2.5}$ referring to particles with a nominal mean aerodynamic diameter less than or equal to 2.5 μm). These new standards were as follows: (1) an annual standard with a level of 15.0 μg/m^3, based on the 3-year avg of annual arithmetic mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors[14] and (2) a 24-hour standard with a level of 65 μg/m^3, based on the 3-year avg of the 98th percentile of 24-hour $PM_{2.5}$ concentrations at each monitor within an area. Also, the U.S. EPA established a new reference method for measuring $PM_{2.5}$ in the ambient air and adopted rules for determining attainment of the new standards. To continue to address the coarse fraction of PM_{10} (referred to as thoracic coarse particles or $PM_{10–2.5}$; generally including particles with a nominal mean aerodynamic diameter greater than 2.5 μm and less than or equal to 10 μm), the U.S. EPA retained the annual PM_{10} standard and revised the form of the 24-hour PM_{10} standard to be based on the 99th percentile of 24-hour PM_{10} concentrations at each monitor in an area. The U.S. EPA revised the secondary standards by setting them equal in all respects to the primary standards.

Following promulgation of the 1997 PM NAAQS, petitions for review were filed by a large number of parties, addressing a broad range of issues. In May 1999, the U.S. Court of Appeals for the District of Columbia Circuit (D.C. Circuit) upheld the U.S. EPA's decision to establish fine particle standards, holding that "the growing empirical evidence demonstrating a relationship between fine particle pollution and adverse health effects amply justifies establishment of new fine particle standards.[15]" The D.C. Circuit also found "ample support" for the U.S. EPA's decision to regulate coarse particle pollution, but vacated the 1997 PM_{10} standards, concluding that the U.S. EPA had not provided a reasonable explanation justifying use of PM_{10} as an indicator for coarse particles. Pursuant to the D.C. Circuit's decision, the U.S. EPA removed the vacated 1997 PM_{10} standards, and the pre-existing 1987 PM_{10} standards remained in place (65 FR 80776, December 22, 2000). The D.C. Circuit also upheld the

[14] The level of the 1997 annual $PM_{2.5}$ standard was to be compared with measurements made at the community-oriented monitoring site recording the highest concentration or, if specific constraints were met, measurements from multiple community-oriented monitoring sites could be averaged (i.e., "spatial averaging"). In the last review (completed in 2012) the U.S. EPA replaced the term "community-oriented" monitor with the term "area-wide" monitor. Area-wide monitors are those sited at the neighborhood scale or larger, as well as those monitors sited at micro- or middle scales that are representative of many such locations in the same CBSA (78 FR 3236, January 15, 2013).

[15] *American Trucking Associations v. U.S. EPA*, 175 F. 3d 1027, 1055−56 (D.C. Cir. 1999).

U.S. EPA's determination not to establish more stringent secondary standards for fine particles to address effects on visibility.

The D.C. Circuit also addressed more general issues related to the NAAQS, including issues related to the consideration of costs in setting NAAQS and the U.S. EPA's approach to establishing the levels of NAAQS. Regarding the cost issue, the court reaffirmed prior rulings holding that in setting NAAQS the U.S. EPA is "not permitted to consider the cost of implementing those standards." Regarding the levels of NAAQS, the court held that the U.S. EPA's approach to establishing the level of the standards in 1997 (i.e., both for PM and for the ozone NAAQS promulgated on the same day) effected "an unconstitutional delegation of legislative authority." Although the court stated that "the factors U.S. EPA uses in determining the degree of public health concern associated with different levels of ozone and PM are reasonable," it remanded the rule to the U.S. EPA, stating that when the U.S. EPA considers these factors for potential non-threshold pollutants "what U.S. EPA lacks is any determinate criterion for drawing lines" to determine where the standards should be set.

The D.C. Circuit's holding on the cost and constitutional issues were appealed to the U.S. Supreme Court. In February 2001, the Supreme Court issued a unanimous decision upholding the U.S. EPA's position on both the cost and constitutional issues.[16] On the constitutional issue, the Court held that the statutory requirement that NAAQS be "requisite" to protect public health with an adequate margin of safety sufficiently guided the U.S. EPA's discretion, affirming the U.S. EPA's approach of setting standards that are neither more nor less stringent than necessary.[17]

In October 1997, the U.S. EPA published its plans for the third periodic review of the air quality criteria and NAAQS for PM (62 FR 55201, October 23, 1997). After the CASAC and public review of several drafts, the U.S. EPA's NCEA finalized the Air Quality Criteria Document (AQCD) in October 2004 (U.S. EPA, 2004). The U.S. EPA's OAQPS finalized a Risk Assessment and Staff Paper in December of 2005 (Abt, 2005; U.S. EPA, 2005).[18] On December 20, 2005, the U.S. EPA announced its proposed decision to revise the NAAQS for PM, and solicited comment on a broad range of options (71 FR 2620, January 17, 2006). On September 21, 2006, the U.S. EPA announced its final decisions to revise the primary and secondary NAAQS for PM to provide increased protection of public health and welfare, respectively (71 FR 61144, October 17, 2006). With regard to the primary and secondary standards for fine particles, the U.S. EPA revised the level of the 24-hour $PM_{2.5}$ standards to 35 $\mu g/m^3$, retained the level of the annual $PM_{2.5}$ standards at 15.0 $\mu g/m^3$, and revised the form of the annual $PM_{2.5}$

[16] *Whitman v. American Trucking Associations*, 531 U.S. 457, 464, 475−76.

[17] The Supreme Court remanded the case to the Court of Appeals for resolution of any remaining issues that had not been addressed in that court's earlier rulings. Id. at 475−76. In a March 2002 decision, the Court of Appeals rejected all remaining challenges to the standards, holding that the U.S. EPA's $PM_{2.5}$ standards were reasonably supported by the administrative record and were not "arbitrary and capricious" *American Trucking Associations v. EPA*, 283 F. 3d 355, 369-72 (D.C. Cir. 2002).

[18] Prior to the review initiated in 2007, the Staff Paper, rather than the PA, presented the U.S. EPA staff's considerations and conclusions regarding the adequacy of existing NAAQS and, when appropriate, the potential alternative standards that could be supported by the evidence and information.

standards by narrowing the constraints on the optional use of spatial averaging. For the primary and secondary standards for PM_{10}, the U.S. EPA retained the 24-hour standards, with levels at 150 $\mu g/m^3$, and revoked the annual standards.[19] The Administrator judged that the available evidence generally did not suggest a link between long-term exposure to existing ambient levels of coarse particles and health or welfare effects. In addition, a new reference method was added for measuring $PM_{10-2.5}$ in the ambient air to provide a basis for approving Federal Equivalent Methods (FEMs) and to promote the gathering of scientific data to support future reviews of the PM NAAQS.

Several parties filed petitions for review following promulgation of the revised PM NAAQS in 2006. These petitions addressed the following issues: (1) selecting the level of the primary annual $PM_{2.5}$ standard; (2) retaining PM_{10} as the indicator of a standard for thoracic coarse particles, retaining the level and form of the 24-hour PM_{10} standard, and revoking the PM_{10} annual standard; and (3) setting the secondary $PM_{2.5}$ standards identical to the primary standards. On February 24, 2009, the U.S. Court of Appeals for the District of Columbia Circuit issued its opinion in the case American Farm Bureau Federation v. U.S. EPA. The court remanded the primary annual $PM_{2.5}$ NAAQS to U.S. EPA because U.S. EPA failed to adequately explain why the standards provided the requisite protection from both short- and long-term exposures to fine particles, including protection for at-risk populations.[20] Regarding the standards for PM_{10}, the court upheld U.S. EPA's decisions to retain the 24-hour PM_{10} standard to provide protection from thoracic coarse particle exposures and to revoke the annual PM_{10} standard. For the secondary $PM_{2.5}$ standards, the court remanded the standards to U.S. EPA because the Agency failed to adequately explain why setting the secondary PM standards identical to the primary standards provided the required protection for public welfare, including protection from visibility impairment. The U.S. EPA responded to the court's remands as part of the next review of the PM NAAQS, which was initiated in 2007 (discussed below).

In June 2007, the U.S. EPA initiated the fourth periodic review of the air quality criteria and the PM NAAQS by issuing a call for information in the *Federal Register* (72 FR 35462, June 28, 2007). Based on the NAAQS review process, as revised in 2008 and again in 2009,[21] the U.S. EPA held science/policy issue workshops on the primary and secondary PM NAAQS (72 FR 34003, June 20, 2007; 72 FR 34005, June 20, 2007), and prepared and released the planning and assessment documents that comprise the review process [i.e., IRP (U.S. EPA, 2008), ISA (U.S. EPA, 2009a)], REA planning

[19] In the 2006 proposal, the U.S. EPA proposed to revise the 24-hour PM_{10} standard in part by establishing a new $PM_{10-2.5}$ indicator for thoracic coarse particles (i.e., particles generally between 2.5 and 10 μm in diameter). The U.S. EPA proposed to include any ambient mix of $PM_{10-2.5}$ that was dominated by resuspended dust from high-density traffic on paved roads and by PM from industrial sources and construction sources. The U.S. EPA proposed to exclude any ambient mix of $PM_{10-2.5}$ that was dominated by rural windblown dust and soils and by PM generated from agricultural and mining sources. In the final decision, the existing PM_{10} standard was retained, in part due to an "inability…to effectively and precisely identify which ambient mixes are included in the [$PM_{10-2.5}$] indicator and which are not" (71 FR 61197, October 17, 2006).

[20] *American Farm Bureau Federation v. U.S. EPA*, 559 F. 3d 512, 520−27 (D.C. Cir. 2009).

[21] The history of the NAAQS review process, including revisions to the process, is discussed at https://www.epa.gov/naaqs.

documents for health and welfare (Office of Air and Radiation, 2009; U.S. EPA, 2009b), a quantitative health risk assessment (U.S. EPA, 2010b)[22] and an urban-focused visibility assessment (U.S. EPA, 2010a),[23] and PA (U.S. EPA, 2011)]. In June 2012, the U.S. EPA announced its proposed decision to revise the NAAQS for PM (77 FR 38890, June 29, 2012).

In December 2012, the U.S. EPA announced its final decisions to revise the primary NAAQS for PM to provide increased protection of public health (78 FR 3086, January 15, 2013). Regarding primary standards for $PM_{2.5}$, the U.S. EPA revised the level of the annual $PM_{2.5}$ standard[24] to 12.0 $\mu g/m^3$ and retained the 24-hour $PM_{2.5}$ standard, with its level of 35 $\mu g/m^3$. For the primary PM_{10} standard, the U.S. EPA retained the 24-hour standard, with its level of 150 $\mu g/m^3$, to continue to provide protection against effects associated with short-term exposure to thoracic coarse particles (i.e., $PM_{10-2.5}$). Regarding the secondary PM standards, the U.S. EPA generally retained the 24-hour and annual $PM_{2.5}$ standards[25] and the 24-hour PM_{10} standard to address visibility and nonvisibility welfare effects. On judicial review, the revised standards were upheld in all respects.[26]

P.2. Purpose and Overview of the Integrated Science Assessment

The Integrated Science Assessment (ISA) is a comprehensive evaluation and synthesis of the policy-relevant science "useful in indicating the kind and extent of identifiable effects on public health or welfare which may be expected from the presence of [a] pollutant in ambient air," as described in Section 108 of the Clean Air Act (CAA, 1990a). This ISA communicates critical science judgments of the health and welfare criteria for particulate matter (PM), and serves as the scientific foundation for the review of the current primary (health-based) and secondary (welfare-based) National Ambient Air Quality Standards (NAAQS) for PM. For evaluating the welfare-based evidence, the PM ISA focuses specifically on the nonecological effects of PM (i.e., visibility, materials effects, and climate) because the ecological effects are assessed in the ISA for Oxides of Nitrogen, Oxides of Sulfur, and Particulate Matter—Ecological Criteria as a result of these criteria pollutants being interrelated through complex

[22] The quantitative assessment of health risks conducted in the last review was presented in the Quantitative Health Risk Assessment for Particulate Matter (U.S. EPA, 2010b). In the current review, quantitative assessments for health-related exposures and risks, if warranted, would be presented in the Health Risk and Exposure Assessment (HREA). For consistency with the documents developed under the current NAAQS process, the Quantitative Health Risk Assessment for Particulate Matter (U.S. EPA, 2010b) from the last review will be referenced in this document as the 2010 HREA.

[23] The quantitative assessment of welfare effects conducted in the last review was presented, in part, in the Urban-Focused Visibility Assessment (U.S. EPA, 2010a). In the current review, quantitative assessments for welfare effects, if warranted, would be presented in the Welfare Risk and Exposure Assessment (WREA). The Urban-Focused Visibility Assessment (U.S. EPA, 2010a) from the last review will be referenced in this document as the 2010 UFVA.

[24] The U.S. EPA also eliminated the option for spatial averaging.

[25] Consistent with the primary standard, the U.S. EPA eliminated the option for spatial averaging with the annual standard.

[26] *NAM v U.S. EPA*, 750 F.3d 921 (D.C. Cir. 2014).

chemical and physical atmospheric processes and all contributing to nitrogen (N) and sulfur (S) deposition (U.S. EPA, 2016). While the focus of the evaluation of the visibility and climate evidence is on PM, for materials effects, as detailed in the Integrated Review Plan (IRP), the PM ISA summarizes soiling and deterioration of materials attributable to PM and related N and S components because of the difficulty associated with isolating the effects of gaseous and particulate N and S dry and wet deposition and because the ISA for Oxides of Nitrogen, Oxides of Sulfur, and Particulate Matter—Ecological Criteria focuses only on ecological effects (U.S. EPA, 2016).

This ISA evaluates relevant scientific literature published since the 2009 PM ISA (U.S. EPA, 2009a), integrating key information and judgments contained in the 2009 PM ISA and previous assessments of PM, i.e., 2004 AQCD for PM (U.S. EPA, 2004), 1996 AQCD for PM (U.S. EPA, 1996), 1982 AQCD for PM and Sulfur Oxides (U.S. EPA, 1982) and its Addendum (U.S. EPA, 1986), and the 1969 AQCD for PM (NAPCA, 1969). Thus, this ISA updates the state of the science that was available for the 2009 PM ISA, which informed decisions on the primary and secondary PM NAAQS in the review completed in 2012. In 2012, the U.S. EPA lowered the annual $PM_{2.5}$ standard to a mean of 12 $\mu g/m^3$, which is based on the annual mean averaged over 3 years, while retaining the 24-hour $PM_{2.5}$ standard of 35 $\mu g/m^3$, which is based on the 98th percentile averaged over 3 years (78 FR 3086). As part of the primary annual $PM_{2.5}$ standard, the U.S. EPA eliminated the spatial averaging provision to avoid disproportionate impacts on susceptible populations (i.e., populations potentially at increased risk of a PM-related health effect). The $PM_{2.5}$ standards are meant to provide increased protection for children, older adults, and people with pre-existing heart and lung disease as well as other potentially susceptible populations against an array of $PM_{2.5}$-related health effects, including premature mortality, increased hospital admissions and emergency department (ED) visits, and the development of chronic respiratory disease. Additionally, the U.S. EPA retained the current primary 24-hour PM_{10} standard at a level of 150 $\mu g/m^3$, which is not to be exceeded more than once per year over 3 years, to protect against health effects due to short-term exposure to thoracic coarse particles ($PM_{10–2.5}$) including premature mortality and increased hospital admissions and ED visits (78 FR 3086).

For the secondary PM standards, the U.S. EPA retained the annual $PM_{2.5}$ standard at 15 $\mu g/m^3$ as well as the 24-hour $PM_{2.5}$ standard of 35 $\mu g/m^3$ and the 24-hour PM_{10} standard of 150 $\mu g/m^3$ (78 FR 3086). However, the form of the annual secondary $PM_{2.5}$ standard was changed to remove the option of spatial averaging. These secondary standards protect against nonvisibility welfare effects including ecological effects, effects on materials, and climate effects. To protect against PM-related visibility impairment, the U.S. EPA identified a target degree of protection defined as a $PM_{2.5}$ visibility index of 30 deciviews (dv), which is based on the 90th percentile of 24-hour avg $PM_{2.5}$ concentrations over 3 years (78 FR 3086). However, a U.S. EPA analysis determined that the current secondary 24-hour $PM_{2.5}$ standard would provide sufficient protection, and in some cases greater protection, therefore a distinct secondary standard was not needed to provide requisite protection for both visibility and nonvisibility related welfare effects.

This new review of the primary and secondary PM NAAQS is guided by several policy-relevant questions that are identified in The Integrated Review Plan for the National Ambient Air Quality Standards for Particulate Matter (U.S. EPA, 2016). To address these questions and update the scientific judgments in the 2009 PM ISA (U.S. EPA, 2009a), this ISA aims to:

- Assess whether new information (since the last PM NAAQS review) further informs the relationship between exposure to PM and specific health and nonecological welfare effects.
- Inform whether the current indicators (i.e., $PM_{2.5}$ for fine particles and PM_{10} for thoracic coarse particles), averaging times (e.g., 24-hour avg, annual average), and levels of the PM NAAQS are appropriate.

In addressing policy-relevant questions, this ISA aims to characterize the independent health and welfare effects of PM, specifically $PM_{2.5}$ (fine PM; particulate matter with a nominal mean aerodynamic diameter less than or equal to 2.5 μm) and $PM_{10–2.5}$ (thoracic coarse or coarse PM; particulate matter with a nominal mean aerodynamic diameter greater than 2.5 μm and less than or equal to 10 μm) and whether there is evidence of an independent health effect for other size fractions [e.g., ultrafine particles (UFP), generally considered as particulates with a diameter less than or equal to 0.1 μm (typically based on physical size, thermal diffusivity or electrical mobility); U.S. EPA (2009a)] or specific PM components (e.g., metals). In characterizing whether there is evidence of an independent health and welfare effect due to PM, the ISA considers possible influences of other atmospheric pollutants, including both gaseous (i.e., O_3, NO_2, SO_2, and CO) and other PM size fractions. The information summarized in this ISA will serve as the scientific foundation for reviewing the current primary and secondary PM NAAQS.

P.3. Process for Developing Integrated Science Assessments

The U.S. EPA uses a structured and transparent process for evaluating scientific information and determining the causal nature of relationships between air pollution exposures and health effects [details provided in the Preamble to the Integrated Science Assessments (U.S. EPA, 2015)] and the Appendix. The ISA development process describes approaches for literature searches, criteria for selecting and evaluating relevant studies, and a framework for evaluating the weight of evidence and forming causality determinations. Table P-2 provides a description of each of the five causality determinations and the types of scientific evidence that is considered for each category for both health and welfare effects.

Table P-2 Weight-of-evidence for causality determinations.

	Health Effects	Ecological and Other Welfare Effects
Causal relationship	Evidence is sufficient to conclude that there is a causal relationship with relevant pollutant exposures (e.g., doses or exposures generally within one to two orders of magnitude of recent concentrations). That is, the pollutant has been shown to result in health effects in studies in which chance, confounding, and other biases could be ruled out with reasonable confidence. For example: (1) controlled human exposure studies that demonstrate consistent effects, or (2) observational studies that cannot be explained by plausible alternatives or that are supported by other lines of evidence (e.g., animal studies or mode-of-action information). Generally, the determination is based on multiple high-quality studies conducted by multiple research groups.	Evidence is sufficient to conclude that there is a causal relationship with relevant pollutant exposures. That is, the pollutant has been shown to result in effects in studies in which chance, confounding, and other biases could be ruled out with reasonable confidence. Controlled exposure studies (laboratory or small- to medium-scale field studies) provide the strongest evidence for causality, but the scope of inference may be limited. Generally, the determination is based on multiple studies conducted by multiple research groups, and evidence that is considered sufficient to infer a causal relationship is usually obtained from the joint consideration of many lines of evidence that reinforce each other.
Likely to be causal relationship	Evidence is sufficient to conclude that a causal relationship is likely to exist with relevant pollutant exposures. That is, the pollutant has been shown to result in health effects in studies where results are not explained by chance, confounding, and other biases, but uncertainties remain in the evidence overall. For example: (1) observational studies show an association, but copollutant exposures are difficult to address and/or other lines of evidence (controlled human exposure, animal, or mode of action information) are limited or inconsistent or (2) animal toxicological evidence from multiple studies from different laboratories demonstrate effects but limited or no human data are available. Generally, the determination is based on multiple high-quality studies.	Evidence is sufficient to conclude that there is a likely causal association with relevant pollutant exposures. That is, an association has been observed between the pollutant and the outcome in studies in which chance, confounding, and other biases are minimized but uncertainties remain. For example, field studies show a relationship, but suspected interacting factors cannot be controlled, and other lines of evidence are limited or inconsistent. Generally, the determination is based on multiple studies by multiple research groups.
Suggestive of, but not sufficient to infer, a causal relationship	Evidence is suggestive of a causal relationship with relevant pollutant exposures but is limited, and chance, confounding, and other biases cannot be ruled out. For example: (1) when the body of evidence is relatively small, at least one high-quality epidemiologic study shows an association with a given health outcome and/or at least one high-quality toxicological study shows effects relevant to humans in animal species or (2) when the body of evidence is relatively large, evidence from studies of varying quality is generally supportive but not entirely consistent, and there may be coherence across lines of evidence (e.g., animal studies or mode of action information) to support the determination.	Evidence is suggestive of a causal relationship with relevant pollutant exposures, but chance, confounding, and other biases cannot be ruled out. For example, at least one high-quality study shows an effect, but the results of other studies are inconsistent.

Table P-2 (Continued): Weight of evidence for causality determinations.

	Health Effects	Ecological and Other Welfare Effects
Inadequate to infer the presence or absence of a causal relationship	Evidence is inadequate to determine that a causal relationship exists with relevant pollutant exposures. The available studies are of insufficient quantity, quality, consistency, or statistical power to permit a conclusion regarding the presence or absence of an effect.	Evidence is inadequate to determine that a causal relationship exists with relevant pollutant exposures. The available studies are of insufficient quality, consistency, or statistical power to permit a conclusion regarding the presence or absence of an effect.
Not likely to be a causal relationship	Evidence indicates there is no causal relationship with relevant pollutant exposures. Several adequate studies, covering the full range of levels of exposure that human beings are known to encounter and considering at-risk populations and lifestages, are mutually consistent in not showing an effect at any level of exposure.	Evidence indicates there is no causal relationship with relevant pollutant exposures. Several adequate studies examining relationships with relevant exposures are consistent in failing to show an effect at any level of exposure.

Source: U.S. EPA (2015).

As part of this process, a draft of the ISA is reviewed by the Clean Air Scientific Advisory Committee (CASAC), which is a formal independent panel of scientific experts, and by the public. As this ISA informs the review of the primary and secondary PM NAAQS, it integrates and synthesizes information characterizing exposure to PM and potential relationships with health and welfare effects. Relevant studies include those examining atmospheric chemistry, spatial and temporal trends, and exposure assessment, as well as U.S. EPA analyses of air quality and emissions data. Relevant health research includes epidemiologic, controlled human exposure, and toxicological studies on health effects, as well as studies on dosimetry and biological plausibility. Additionally, relevant welfare research includes studies examining visibility impairment, effects on materials, and climate impacts.

The U.S. EPA initiated the current review of the primary and secondary PM NAAQS in December 2014 with a call for information from the public (U.S. EPA, 2014). Subject-area experts and the public were also able to recommend studies and reports to consider for the ISA during a science/policy issue "kick-off" workshop held at the U.S. EPA in February 2015. Thereafter, the U.S. EPA routinely conducted literature searches to identify relevant peer-reviewed studies published since the previous ISA (i.e., since May 2009). Multiple search methods were used [Preamble to the ISAs (U.S. EPA, 2015), and further detailed in the Appendix], including searches in the PubMed and Web of Science databases. These searches were meant to broadly capture all potentially relevant PM literature. To ensure the most policy-relevant evaluation of the current state of the science, the scope of this PM ISA reflects not only the evolving PM literature base but also the ability of the studies evaluated to directly inform the policy-relevant questions that form the basis of this review. Using both the scope of this ISA, detailed below, as well as the policy-relevant questions outlined in the PM IRP, studies that were uninformative based on title screening were excluded. Studies that were judged to be potentially relevant based on review of the abstract or full text and "considered" for inclusion in the ISA are documented in the Health and Environmental Research Online (HERO) website. The HERO project page for this ISA

(https://hero.epa.gov/hero/particulate-matter) contains the references that are cited in the ISA, the references that were considered for inclusion but not cited, and electronic links to bibliographic information and abstracts.

P.3.1. Scope of the ISA

As initially detailed in the PM IRP (U.S. EPA, 2016) and further expanded upon here, when evaluating the broad body of literature across scientific disciplines, the U.S. EPA considers whether the studies fall within the scope of the PM ISA (i.e., provide information which can address key policy-relevant questions). Thus, the focus of the PM ISA with respect to the health effects evidence is on studies of short-term (i.e., hours up to 1 month) and long-term (i.e., 1 month to years) exposures conducted at concentrations of PM that are relevant to the range of human exposures across ambient microenvironments (up to 2 mg/m^3, which is one to two orders of magnitude above ambient concentrations), and (1) include a composite measure of PM[27] or (2) characterize PM and apply some approach to assess the direct effect of PM when the exposure of interest is a source-based mixture (e.g., diesel exhaust, gasoline exhaust, wood smoke). For epidemiologic studies, the scope is further refined when evaluating the evidence for those health outcomes that the 2009 PM ISA concluded a *causal relationship* (i.e., short- and long-term $PM_{2.5}$ exposure and mortality and cardiovascular effects) to ensure the evaluation of the evidence focuses on the studies that are the most policy-relevant. Therefore, the focus is on those studies conducted in areas where mean $PM_{2.5}$ concentrations are <20 $\mu g/m^3$ or, in the case of a multicity study, where more than half of the cities have concentrations <20 $\mu g/m^3$. However, studies with mean $PM_{2.5}$ concentrations exceeding 20 $\mu g/m^3$ are included if they address specific areas of uncertainty or where limitations remain in the evidence base, as identified in the 2009 PM ISA, such as copollutant confounding. The scope is broader for experimental studies when examining biological plausibility for PM health effects, and in some cases, includes in vitro studies, studies that use intratracheal (IT) installation, studies examining relative toxicity, and studies conducted at concentrations >2 mg/m^3.

In the first case, studies that focus on a single component, group of components, or source, must also examine a composite measure of PM (e.g., mass of $PM_{2.5}$ and/or $PM_{10–2.5}$, or in the case of ultrafine particles [UFP] mass, particle number, etc.). This requirement helps in comparing effects or associations observed for individual components or alternative metrics to the current mass-based PM indicators. To assess the relationship between $PM_{2.5}$ components and specific health effects in experimental studies, this ISA relies on the approach initially outlined in the 2009 PM ISA and further refined in Stanek et al. (2011). This approach is consistent with the Health Effects Institute (HEI) review panel of the National Particle Component Toxicity (NPACT) initiative that states both source categories and component concentrations should be used directly in the health analyses with a focus on examining consistencies and

[27] Composite measures of PM may include mass, volume, surface area, or number concentration.

differences between the two approaches (Lippmann et al., 2013). Thus, experimental studies included within this ISA fulfill the following four criteria: (1) the studies examined exposures consisting of $PM_{2.5}$ from U.S. airsheds or those representative of the U.S. (e.g., Europe, Canada); (2) the studies examined at least five PM components; (3) the studies grouped PM components using statistical methods, for which the groups were not predefined based on common physical or chemical properties (e.g., water soluble vs. nonsoluble); and (4) the studies applied a formal statistical analysis to investigate the relationship between groups of PM components or PM sources and health effects. The criteria applied to both experimental and epidemiologic studies in evaluating PM components ensures that a systematic approach is used in both identifying and evaluating those studies that examine PM components.

The second case primarily applies to experimental studies that attempt to disentangle the effect of PM on health from a complex air pollution mixture of particles, gases, and components distributed between the gas and particle phases. Studies that assess the PM effect from a source-based mixture (e.g., wood smoke, diesel exhaust, gasoline exhaust, etc.) are only included if they use filtration (e.g., a particle trap) or another approach to differentiate between effects due to the mixture and effects due to the particles alone.

Whereas the preceding paragraphs focused broadly on the scope of the entire PM ISA, there are additional nuances that further frame the scope of the ISA, specifically with respect to UFPs. UFPs have often been defined as particles <0.1 μm (U.S. EPA, 2009a), but depending on the scientific discipline, the methods used and the particle sizes examined to assess the UFP-health effects relationship varies. UFP exposures in animal toxicological and controlled human exposure studies typically use a particle concentrator, which can result in exposures to particles <0.30 μm (Section 2.4.3.1). Whereas toxicological studies typically rely on examining UFP mass, epidemiologic studies examine multiple UFP metrics, including particle number concentration (NC), mass concentration (MC), and surface area concentration (SC). However, depending on the monitor used and the metric, the UFP size distribution included within each of these ranges can vary. Some studies that examine NC use no additional size classification and instead measure NC over the entire size range of the particle counter. If the entire size range is measured, limited available measurement data in the U.S. and Europe indicates that approximately 67 to 90% of NC consists of particles <0.1 μm (Section 2.4.3.1). Studies that examine MC or SC often include a range of particle sizes up to 0.3 μm. Currently, there is no consensus within the scientific community on the metric that best represents exposure to UFPs (Baldauf et al., 2016). Consequently, this ISA focuses on evaluating the UFP-health effects relationship of particles <0.3 μm for MC and SC metrics included in experimental studies, and any size range that includes particles <0.1 μm for NC. Focusing on these criteria will provide the most comprehensive assessment of UFPs and ensure that the metric examined represents primarily the UFP size range.

Across disciplines, studies defined as examining UFPs, but focusing on the sources, transport, and fate of fibers and unique nano-objects (namely, dots, hollow spheres, plates, rods, fibers, tubes) are not reviewed because substantial exposures to fibers and unique nano-objects generally occur in the

occupational settings rather than the ambient environment. Furthermore, the in vivo disposition of unique nano-objects is not likely relevant to the behavior of ultrafine (UF) aerosols found in ambient air, which are created by combustion sources and photochemical formation of secondary organic aerosols. However, some studies focusing on engineered nano- or ultrafine particles (e.g., carbon black, titanium dioxide) are included if they contribute to an understanding of the dosimetry or biological plausibility of PM.

In addition to the specific parameters that broadly form the overall scope of the review of PM and health effects, additional criteria were applied in evaluating the evidence for cancer. As detailed in the PM IRP, the PM ISA focuses on whether PM can directly cause cancer through only inhalation exposures at ambient and near-ambient concentrations (i.e., up to 2 mg/m^3). When evaluating the epidemiologic evidence for cancer, consistent with the overall scope of the ISA, the focus is on those studies with composite measures of PM. Whereas the ISA tends not to focus on the health effects evidence from in vitro studies, such studies are discussed regarding the mutagenicity of PM because they provide information on the biological pathways underlying cancer. While some components of PM are known carcinogens (e.g., hexavalent chromium), the focus of this ISA is on composite measures of PM (e.g., $PM_{2.5}$). When applicable, comparisons are made with the effects or associations observed for individual PM components to help inform the adequacy of current mass-based PM indicators. As such, the relationship between PM exposure and cancer is evaluated similarly to that of other health effects, resulting in the exclusion of studies that examine individual PM components without a composite PM measure. The evaluation of cancer includes studies that use PM filter extracts with the understanding that bioavailability of PM components in vivo is a complex issue not easily mimicked by extraction of PM collected on filters. Overall, the evaluation of cancer in the ISA will primarily focus on studies of inhaled PM because these studies are more relevant to ambient exposure conditions, with the recognition of the extensive historical evaluations on the mutagenicity, genotoxicity, and carcinogenicity of whole PM exposures (i.e., not defined by size fraction).

For nonecological welfare effects (i.e., visibility, climate, and materials effects), this ISA will build on information from the last review by discussing PM's role in impairing visibility, in radiative forcing, which can cause global and regional climate change, and in damaging and soiling materials. For visibility effects, studies are included that advance our understanding of visual impairment of airborne PM, such as studies of atmospheric chemistry, visibility preference, or other measures of adversity to public welfare, in urban and rural settings. This ISA focuses on climate as the welfare effect as listed in the Clean Air Act Amendments of 1970 with a focus on radiative forcing, surface meteorological trends, and climate feedbacks, and not on downstream ecosystem effects, human health effects, or future air quality projections resulting from changes in climate (CAA, 1970). The primary literature base for the evaluation of the effects of airborne and deposited PM on climate comes from recent national and international climate assessments such as the National Climate Assessment (Melillo et al., 2014) and the Intergovernmental Panel on Climate Change (IPCC, 2014), as well as other recent and more focused reports relevant to PM climate forcing [e.g., U.S. EPA (2012)]. The focus is on studies that inform the independent role of PM in climate forcing as well as effects on U.S. national and regional climate. For

effects on materials, studies included in the PM ISA examine the role of PM and relevant precursor gases on materials damage and soiling. Specifically, studies that examine both particulate and gaseous contributions from oxides of nitrogen and oxides of sulfur along with other PM components are included here due to the difficulty associated with isolating the effects of gaseous and particulate N and S wet deposition.

P.3.2. Evaluation of the Evidence

The Preamble to the ISAs (U.S. EPA, 2015) describes the general framework for evaluating scientific information, including criteria for assessing study quality and developing scientific conclusions. Aspects specific to evaluating studies of PM are described in the Appendix, which were applied to studies that fit the overall scope of the PM ISA. Categories of health and welfare effects were considered for evaluation in this ISA if they were examined in previous U.S. EPA assessments for PM or in multiple recent studies. Therefore, in this ISA, the broad health effects categories evaluated include those considered in the 2009 PM ISA (i.e., respiratory effects, cardiovascular effects, central nervous system effects, cancer, and mortality) along with the addition of metabolic effects. New research indicates it is more appropriate to further refine the category of reproductive and developmental effects to instead focus overall conclusions specifically on fertility and pregnancy effects, and birth outcomes separately. The welfare effects categories evaluated include visibility impairment, effects on materials, and climate.

P.3.2.1. Biological Plausibility

In forming the key science judgments for each of the health effects categories evaluated, the PM ISA draws conclusions about relationships between PM exposure and health effects by integrating information across scientific disciplines and related health outcomes and synthesizing evidence from previous and recent studies. A new advancement in this ISA is the inclusion of biological plausibility sections that are specific for each PM size fraction, exposure duration, and broad health outcome category for which causality determinations are formed within each of the health effects chapters (Chapter 5, Chapter 6, Chapter 7, Chapter 8, Chapter 9, Chapter 10, and Chapter 11). These sections outline potential pathways along the exposure to outcome continuum and provide plausible links between inhalation of PM (i.e., $PM_{2.5}$, $PM_{10–2.5}$, or UFPs) and health outcomes at the population level. Biological plausibility can strengthen the basis for causal inference (U.S. EPA, 2015). In this ISA, biological plausibility is part of the weight-of-evidence analysis that considers the totality of the health effects evidence, including consistency and coherence of effects described in experimental and observational studies. Although there is some overlap in the potential pathways between the health effects chapters, each biological plausibility section is tailored to the specific broad health outcome category, PM size fraction, and exposure duration being evaluated within the respective section of each health effects chapter.

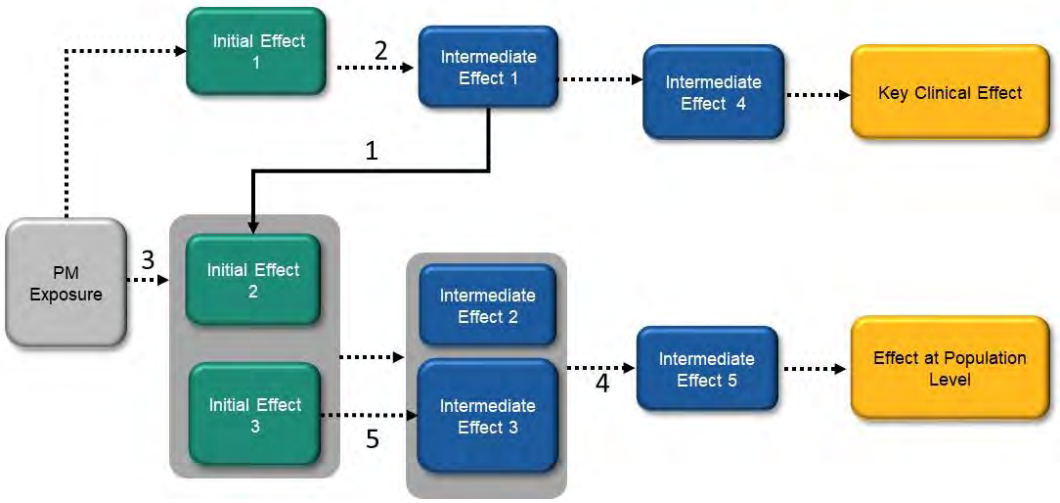
Each of the biological plausibility sections includes a figure depicting potential biological pathways that is accompanied by text. The figures illustrate possible pathways related to PM exposure that are based upon evidence evaluated in previous assessments, both AQCDs and ISAs, as well as evidence from more recent studies. The text characterizes the evidence upon which the figures are based, including results of studies demonstrating specific effects related to PM exposure and considerations of physiology and pathophysiology. Together, the figure and text portray the available evidence that supports the biological plausibility of PM exposures leading to specific health outcomes. Gaps and limitations in the evidence base correspond to gaps in the figure and accompanying text. In addition to portraying the plausible pathways leading to health outcomes, these figures provide insights on future research that may address knowledge gaps.

A model figure is presented below to illustrate its features (Figure P-1). Each box represents evidence that has been demonstrated in a study or group of studies for a particular effect related to exposure to a specific size fraction of PM. While most of the studies used to develop the figures are experimental studies (i.e., animal toxicological and controlled human exposure studies), some observational epidemiologic studies also contribute to the pathways. These epidemiologic studies are generally: (1) panel studies that measure the same or similar effects as the experimental studies (and thus provide supportive evidence) or (2) emergency department and hospital admission studies or studies of mortality, which are effects observed at the population level. The boxes are arranged horizontally, with boxes on the left side representing initial effects that reflect early biological responses and boxes to the right representing intermediate (i.e., subclinical or clinical) effects and effects at the population level. The boxes are color coded according to their position in the exposure to outcome continuum.

The arrows that connect the boxes indicate a progression of effects resulting from PM exposure. In most cases, arrows are dotted (Arrow 1), denoting a possible relationship between the effects. While most arrows point from left to right, some arrows point from right to left, reflecting progression of effects in the opposite direction or a feedback loop (Arrow 2). In a few cases, the arrows are solid (Arrow 2), indicating that progression from the upstream to downstream effect occurs as a direct result of PM exposure. This relationship between the boxes, where the upstream effect is necessary for progression to the downstream effect, is termed "essentiality" (OECD, 2016). Evidence supporting essentiality is generally provided by experimental studies using pharmacologic agents (i.e., inhibitors) or animal models that are genetic knockouts. The use of solid lines, as opposed to dotted lines, reflects the availability of specific experimental evidence that PM exposure results in an upstream effect which is necessary for progression to a downstream effect.

In the figures, upstream effects are sometimes linked to multiple downstream effects. To illustrate this proposed relationship using a minimum number of arrows, downstream boxes are grouped together within a larger shaded box and a single arrow (Arrow 3) connects the upstream single box to the outside of the downstream shaded box containing the multiple boxes. Multiple upstream effects may similarly be linked to a single downstream effect using an arrow (Arrow 4) that connects the outside of a shaded box,

which contains multiple boxes, to an individual box. In addition, arrows sometimes connect one individual box to another individual box that is contained within a larger shaded box (Arrow 2) or two individual boxes both contained within larger shaded boxes (Arrow 5). Thus, arrows may connect individual boxes, groupings of boxes, and individual boxes within groupings of boxes depending on the proposed relationships between effects represented by the boxes.



PM = particulate matter.

Note: The boxes above represent the effects for which there is experimental or epidemiologic evidence related to PM exposure, and the arrows indicate a proposed relationship between those effects. Solid arrows denote evidence of essentiality as provided, for example, by an inhibitor of the pathway or a genetic knockout model used in an experimental study involving PM exposure. Shading around multiple boxes is used to denote a grouping of these effects. Arrows may connect individual boxes, groupings of boxes, and individual boxes within groupings of boxes. Progression of effects is generally depicted from left to right and color coded (gray = exposure; green = initial effect; blue = intermediate effect; orange = effect at the population level or a key clinical effect). Here, population-level effects generally reflect results of epidemiologic studies. When there are gaps or limitations in the evidence, there are complementary gaps in the figure and the accompanying text below.

Figure P-1 Illustrative figure for potential biological pathways for health effects following PM exposure.

P.3.2.2. Comparing Epidemiologic Study Results

For consistency in evaluating health effects evidence for epidemiologic studies, additional parameters to those outlined in the scope (Section P.3.1) were developed. To help compare results across epidemiologic studies, risk estimates were standardized to a defined increment for both short- and long-term exposure to $PM_{2.5}$ and $PM_{10–2.5}$, unless otherwise noted in the text. To determine the appropriate increment, the distribution of $PM_{2.5}$ and $PM_{10–2.5}$ concentrations were examined across the three most recent years of air quality data (2012−2014) within the U.S. For both $PM_{2.5}$ and $PM_{10–2.5}$, an increment of

10 µg/m^3 was defined for short-term exposure studies; this value approximates the 50th−95th percentile of concentrations and accounts for the variability observed in daily $PM_{2.5}$ concentrations. An increment of 5 µg/m^3 was defined for long-term exposure studies; this value approximates the 25th−75th percentile of concentrations and represents the variation observed in long-term mean concentrations. Because there is no extensive monitoring network for UFPs within the U.S., results from UFP studies are not standardized and reflect the increment of exposure defined in each study evaluated. Additionally, in assessing correlations, either with other copollutants or variables, in epidemiologic studies high, moderate, or low correlations are explicitly defined as: low correlation, $r < 0.40$; moderate correlation, $r \geq 0.40$ and $r < 0.70$; and high correlation, $r \geq 0.70$. Consistency interpreting the epidemiologic evidence through approaches such as the standardization of risk estimates and the evaluation of correlations, in combination with the integration of evidence across scientific disciplines, supports a thorough evaluation of the current state of the science for PM.

P.3.2.3. Assessing Causality

In the evaluation of the evidence, determinations are made about causation, not just association, and are based on judgments about the consistency of evidence within a discipline, the coherence of effects across disciplines, and the biological plausibility of observed effects, as well as related uncertainties. The ISA uses a formal causal framework [Table II of the Preamble to the ISAs (U.S. EPA, 2015)] to classify the weight of evidence for both health and welfare effects according to the five-level hierarchy summarized below.

- *Causal relationship*: the pollutant has been shown to result in health or welfare effects at relevant exposures based on studies encompassing multiple lines of evidence and chance, confounding; and other biases can be ruled out with reasonable confidence.
- *Likely to be causal relationship*: there are studies in which results are not explained by chance, confounding, or other biases, but uncertainties remain in the health or welfare effects evidence overall. For example, the influence of co-occurring pollutants is difficult to address, or evidence across scientific disciplines may be limited or inconsistent.
- *Suggestive of, but not sufficient to infer, a causal relationship*: health or welfare effects evidence is generally supportive but not entirely consistent or is limited overall. Chance, confounding, and other biases cannot be ruled out.
- *Inadequate to infer the presence or absence of a causal relationship*: there is insufficient quantity, quality, consistency, or statistical power of results from studies of health or welfare effects.
- *Not likely to be a causal relationship*: several adequate health or welfare effects studies, examining the full range of anticipated exposure concentrations and for health effects, potential at-risk populations, and lifestages, consistently show no effect.

P.4. References

Abt (Abt Associates Inc). (2005). Particulate matter health risk assessment for selected urban areas: Draft report (pp. 164). (EPA Contract No. 68-D-03-002). Research Triangle Park, NC: U.S. Environmental Protection Agency.

Baldauf, RW; Devlin, RB; Gehr, P; Giannelli, R; Hassett-Sipple, B; Jung, H; Martini, G; McDonald, J; Sacks, JD; Walker, K. (2016). Ultrafine particle metrics and research considerations: Review of the 2015 UFP Workshop. Int J Environ Res Public Health 13. http://dx.doi.org/10.3390/ijerph13111054.

CAA (Clean Air Act). (1970). Clean Air Act Amendments of 1970, Pub. L. No. 91-604 (pp. 1676-1713).

CAA (Clean Air Act). (1990a). Clean Air Act, as amended by Pub. L. No. 101-549, section 108: Air quality criteria and control techniques, 42 USC 7408. http://www.law.cornell.edu/uscode/text/42/7408.

CAA (Clean Air Act). (1990b). Clean Air Act, as amended by Pub. L. No. 101-549, section 109: National primary and secondary ambient air quality standards, 42 USC 7409. https://www.law.cornell.edu/uscode/text/42/7409.

CAA (Clean Air Act). (2005). Clean Air Act, section 302: Definitions, 42 USC 7602. http://www.gpo.gov/fdsys/pkg/USCODE-2005-title42/pdf/USCODE-2005-title42-chap85-subchapIII-sec7602.pdf.

IPCC (Intergovernmental Panel on Climate Change). (2014). Climate change 2014: Synthesis report. In RK Pachauri; L Meyer (Eds.), Climate change 2014: Synthesis report Contribution of working groups I, II and III to the fifth assessment report of the Intergovernmental Panel on Climate Change. Geneva, Switzerland.

Lippmann, M; Chen, LC; Gordon, T; Ito, K; Thurston, GD. (2013). National Particle Component Toxicity (NPACT) Initiative: Integrated epidemiologic and toxicologic studies of the health effects of particulate matter components: Investigators' Report [HEI] (pp. 5-13). (177). Boston, MA: Health Effects Institute.

Melillo, JM; Richmond, T; Yohe, GW. (2014). Climate change impacts in the United States: The third National Climate Assessment. In JM Melillo; T Richmond; GW Yohe (Eds.), Climate change impacts in the United States: The third National Climate Assessment. Washington, D.C.: U.S. Government Printing Office. http://nca2014.globalchange.gov/report.

NAPCA (National Air Pollution Control Administration). (1969). Air quality criteria for particulate matter. Washington, DC.

OECD (Organisation for Economic Co-operation and Development). (2016). Users handbook supplement to the guidance document for developing and assessing AOPs. (ENV/JM/MONO(2016)12). http://dx.doi.org/10.1787/5jlv1m9d1g32-en.

Office of Air and Radiation (EPA Office of Air and Radiation). (2009). Particulate matter national ambient air quality standards: Scope and methods plan for urban visibility impact assessment. (EPA-452/P-09-001). Research Triangle Park, NC: U.S. Environmental Protection Agency.

Stanek, LW; Sacks, JD; Dutton, SJ; Dubois, JJB. (2011). Attributing health effects to apportioned components and sources of particulate matter: An evaluation of collective results [Review]. Atmos Environ 45: 5655-5663. http://dx.doi.org/10.1016/j.atmosenv.2011.07.023.

U.S. EPA (U.S. Environmental Protection Agency). (1982). Air quality criteria for particulate matter and sulfur oxides (final, 1982) [EPA Report]. (EPA 600/8-82/029a). Washington, DC: Environmental Criteria and Assessment Office. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=46205.

U.S. EPA (U.S. Environmental Protection Agency). (1986). Second addendum to air quality criteria for particulate matter and sulfur oxides (1982): Assessment of newly available health effects information [EPA Report]. (EPA/600/8-86/020F). Research Triangle Park, NC: Environmental Criteria and Assessment Office.

U.S. EPA (U.S. Environmental Protection Agency). (1996). Air quality criteria for particulate matter [EPA Report]. (EPA/600/P-95/001aF-cF. 3v). Research Triangle Park, National Center for Environmental Assessment-RTP Office NC.

U.S. EPA (U.S. Environmental Protection Agency). (2004). Air quality criteria for particulate matter [EPA Report]. (EPA/600/P-99/002aF-bF). Research Triangle Park, NC: U.S. Environmental Protection Agency, Office of Research and Development, National Center for Environemntal Assessment- RTP Office. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=87903.

U.S. EPA (U.S. Environmental Protection Agency). (2005). Review of the national ambient air quality standards for particulate matter: policy assessment of scientific and technical information. oaqps staff paper [EPA Report]. (EPA/452/R-05/005). Research Triangle Park, NC.

U.S. EPA (U.S. Environmental Protection Agency). (2008). Integrated review plan for the national ambient air quality standards for particulate matter [EPA Report]. Research Triangle Park, NC.

U.S. EPA (U.S. Environmental Protection Agency). (2009a). Integrated science assessment for particulate matter [EPA Report]. (EPA/600/R-08/139F). Research Triangle Park, NC: U.S. Environmental Protection Agency, Office of Research and Development, National Center for Environmental Assessment- RTP Division. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=216546.

U.S. EPA (U.S. Environmental Protection Agency). (2009b). Particulate matter national ambient air quality standards: Scope and methods plan for health risk and exposure assessment. (EPA-452/P-09-002). Research Triangle Park, NC: Office of Air Quality Planning and Standards.

U.S. EPA (U.S. Environmental Protection Agency). (2010a). Particulate matter urban-focused visibility assessment. Final document. (EPA-452/R-10-004). Research Triangle Park, NC: Office of Air and Radiation.

U.S. EPA (U.S. Environmental Protection Agency). (2010b). Quantitative Health Risk Assessment for Particulate Matter. Research Triangle Park, NC: US Environmental Protection Agency.

U.S. EPA (U.S. Environmental Protection Agency). (2011). Policy assessment for the review of the particulate matter national ambient air quality standards [EPA Report]. (EPA 452/R-11-003). Research Triangle Park, NC.

U.S. EPA (U.S. Environmental Protection Agency). (2012). Report to Congress on black carbon [EPA Report]. (EPA-450/R-12-001). http://www.epa.gov/blackcarbon/2012report/fullreport.pdf.

U.S. EPA (U.S. Environmental Protection Agency). (2014). Notice of workshop and call for information on integrated science assessment for particulate matter. Fed Reg 79: 71764-71766.

U.S. EPA (U.S. Environmental Protection Agency). (2015). Preamble to the integrated science assessments [EPA Report]. (EPA/600/R-15/067). Research Triangle Park, NC: U.S. Environmental Protection Agency, Office of Research and Development, National Center for Environmental Assessment, RTP Division. https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=310244.

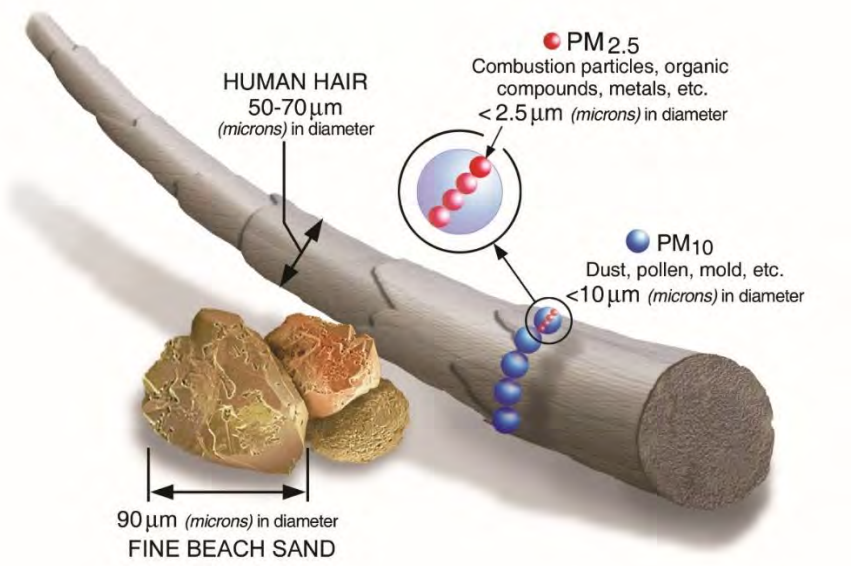
U.S. EPA (U.S. Environmental Protection Agency). (2016). Integrated review plan for the national ambient air quality standards for particulate matter [EPA Report]. (EPA-452/R-16-005). Research Triangle Park, NC. https://yosemite.epa.gov/sab/sabproduct.nsf/0/eb862b233fbd0cde85257dda004fcb8c!OpenDocument&TableRow=2.0.

EXECUTIVE SUMMARY

Purpose and Scope of the Integrated Science Assessment

This Integrated Science Assessment (ISA) is a comprehensive evaluation and synthesis of policy-relevant science aimed at characterizing exposures to ambient particulate matter (PM), and health and welfare effects associated with these exposures.[28] PM is a mixture of solid particles and liquid droplets found in the ambient air,[29] which encompasses multiple size fractions (e.g., fine PM [$PM_{2.5}$, particulate matter with a nominal mean aerodynamic diameter less than or equal to 2.5 μm]; thoracic coarse or coarse PM [$PM_{10–2.5}$, particulate matter with a nominal mean aerodynamic diameter greater than 2.5 μm and less than or equal to 10 μm]; and ultrafine particles [UFPs, generally considered as particulates with a diameter less than or equal to 0.1 μm, typically based on physical size, thermal diffusivity, or electrical mobility]) and is comprised of various components (e.g., metals, black carbon, etc.; Figure ES-1). The evaluation of the science and the overarching conclusions of the ISA serves as the scientific foundation for the review of the primary (health-based) and secondary (welfare-based) National Ambient Air Quality Standard (NAAQS) for PM. This ISA focuses on nonecological welfare effects[30] because ecological effects resulting from deposition of PM and PM components are being considered in a separate assessment as part of the review of the secondary (welfare-based) NAAQS for oxides of nitrogen and sulfur, and PM (U.S. EPA, 2018).

[28] The general process for developing an ISA, including the framework for evaluating weight of evidence and drawing scientific conclusions and causal judgments, is described in a companion document, *Preamble to the Integrated Science Assessments* (U.S. EPA, 2015), https://www.epa.gov/isa.
[29] As defined by U.S. EPA, https://www.epa.gov/pm-pollution/particulate-matter-pm-basics.
[30] From this point forward referred to as welfare effects.



µm = micrometer; PM = particulate matter; $PM_{2.5}$ = particulate matter with a nominal mean aerodynamic diameter less than or equal to 2.5 µm; PM_{10} = particulate matter with a nominal aerodynamic diameter less than or equal to 10 µm.

Source: U.S. EPA (https://www.epa.gov/pm-pollution/particulate-matter-pm-basics).

Figure ES-1 Comparison of PM size fractions.

In 2012, the U.S. Environmental Protection Agency (U.S. EPA) established a new annual $PM_{2.5}$ primary standard of 12 µg/m^3 (the annual mean averaged over 3 years) and retained the 24-hour $PM_{2.5}$ standard of 35 µg/m^3 (the 98th percentile averaged over 3 years; 75 FR 3086).[31] For the primary PM_{10} standard, the U.S. EPA retained the 24-hour standard of 150 µg/m^3 (not to be exceeded more than once per year on average over 3 years) to continue to provide protection against effects associated with short-term exposure to thoracic coarse particles (i.e., $PM_{10-2.5}$). Regarding the secondary PM standards, the U.S. EPA retained the 24-hour (i.e., 35 µg/m^3) and annual (i.e., 15 µg/m^3) $PM_{2.5}$ standards[32] and the 24-hour PM_{10} standard (i.e., 150 µg/m^3) to address visibility and nonvisibility welfare effects. On judicial review, the revised and retained standards were upheld in all respects. NAM v EPA, 750 F.3d 921 (D.C. Cir. 2014).

This ISA updates the 2009 ISA for Particulate Matter [U.S. EPA (2009); hereafter referred to as the 2009 PM ISA] with studies and reports published from January 2009 through approximately January 2018. The U.S. EPA conducted in-depth literature searches using well-defined methods to identify peer-reviewed studies on relevant topics such as health and welfare effects, atmospheric chemistry, ambient concentrations, and exposure. In addition, input on recent studies that the U.S. EPA should

[31] The legislative requirements and history of the PM NAAQS are described in detail in the Preface to this ISA.
[32] Consistent with the primary standard, the U.S. EPA eliminated the option for spatial averaging with the annual standard.

consider in the process of developing the ISA was also solicited from subject-matter experts and the public during a kick-off workshop held at the U.S. EPA in February 2015 (U.S. EPA, 2014). After the broad literature search was conducted and additional studies were identified during the kick-off workshop, the U.S. EPA used various systematic review techniques to identify the most policy-relevant studies and evaluate overall study quality (see the Appendix). To fully describe the state of available science, the U.S. EPA also included in this ISA the most relevant studies from previous assessments.

Section 109(d)(2) of the Clean Air Act, describes the appointment of an independent scientific review committee and their role in reviewing the documents developed by U.S. EPA that provide the air quality criteria defined in Section 108(a)(2), herein the draft PM ISA. This independent review function has been performed by the Clean Air Scientific Advisory Committee (CASAC) of the U.S. EPA's Science Advisory Board. The U.S. EPA released the External Review Draft of the PM ISA on October 23, 2018 (83 FR 53471), which was reviewed in a public meeting of the CASAC to discuss the ISA and provide an independent scientific peer review of the document (83 FR 55529). The CASAC review of the External Review Draft of the PM ISA resulted in a final letter to the Administrator detailing their review, which was released on April 11, 2019.[33]

The Administrator responded to the CASAC's letter on the External Review Draft of the PM ISA on July 25, 2019,[34] and indicated the Agency will "incorporate the CASAC's comments and recommendations, to the extent possible, and create a final PM ISA so that it may be available to inform a proposed decision on any necessary revisions of the NAAQS in early 2020." The U.S. EPA focused on addressing comments presented in the main body of the CASAC letter (i.e., the cover letter and consensus responses to charge questions), and to the extent possible, addressed individual CASAC member comments as well as public comments on the draft PM ISA. The consensus CASAC comments on the draft PM Policy Assessment (December 16, 2019) stated "…the Draft PM ISA, does not provide a … comprehensive, systematic review of relevant scientific literature; inadequate evidence and rationale for altered causal determinations; and a need for clearer discussion of causality and causal biological mechanisms and pathways." To address these comments in the Final PM ISA, the EPA: (1) added text to the Preface and developed a new Appendix to more clearly articulate the process of ISA development; (2) revised the causality determination for long-term UFP exposure and nervous system effects to *suggestive of, but not sufficient to infer, a causal relationship*; and (3) added additional text to the Preface (Section P.3.2.1) as well as text in the health effects chapters to clarify the discussion of biological plausibility and its role in forming causality determinations. Additionally, the U.S. EPA focused on addressing those comments that contributed to improving clarity, could be addressed in the near-term, and identified errors in the draft PM ISA. Lastly, Administrator Wheeler noted, "for those comments and

[33] Available at: https://yosemite.epa.gov/sab/sabproduct.nsf/264cb1227d55e02c85257402007446a4/6CBCBBC3025E13B4852583D90047B352/$File/EPA-CASAC-19-002+.pdf.
[34] Available at: https://yosemite.epa.gov/sab/sabproduct.nsf/264cb1227d55e02c85257402007446a4/6CBCBBC3025E13B4852583D90047B352/$File/EPA-CASAC-19-002_Response.pdf.

recommendations that are more significant or cross-cutting and which were not fully addressed, the Agency will develop a plan to incorporate these changes into future PM ISAs as well as ISAs for other criteria pollutant reviews."

As in the 2009 PM ISA, this ISA determines the causal nature of relationships between health effects and exposure to $PM_{2.5}$, $PM_{10–2.5}$, and UFPs (Chapter 5, Chapter 6, Chapter 7, Chapter 8, Chapter 9, Chapter 10, and Chapter 11). To accomplish this task, a defined scope was developed to narrow the focus to studies that address the question of whether PM exposure directly causes health effects (see Preface). Health effects are considered in relation to exposures at concentrations of PM that are relevant to the range of human exposures across ambient microenvironments, generally within one to two orders of magnitude of current conditions (i.e., up to 2 mg/m^3; Preface, Section P.3.1). The ISA also evaluates: the relationship between PM components and sources to assess whether there is evidence that a component, group of components, or source is more closely related to health effects than PM mass (see Preface); whether specific populations or lifestages are at increased risk of PM-related health effects; and the causal nature of relationships between PM and welfare effects. In the evaluation of the welfare-based evidence (Chapter 13), the PM ISA focuses specifically on the nonecological welfare effects of PM (i.e., visibility, materials effects, and climate). The ecological effects of PM are assessed in the ISA for Oxides of Nitrogen, Oxides of Sulfur, and Particulate Matter—Ecological Criteria because these criteria pollutants are interrelated through complex chemical and physical atmospheric processes and all contribute to nitrogen (N) and sulfur (S) deposition (U.S. EPA, 2018). However, in its assessment of effects on materials, the PM ISA summarizes soiling and deterioration of materials attributable to PM and related N and S components because of the difficulty associated with isolating the effects of gaseous and particulate N and S dry and wet deposition, and because the ISA for Oxides of Nitrogen, Oxides of Sulfur, and Particulate Matter—Ecological Criteria focuses only on ecological effects (U.S. EPA, 2018).

Key to interpreting the health and welfare effects evidence is understanding the sources, chemistry, and distribution of PM in the ambient air (Chapter 2). It is these atmospheric relationships and processes that influence human exposure (Chapter 3) and the uptake of inhaled PM in the respiratory tract (Chapter 4). The uptake of PM and its deposition in the body directly influences the biological mechanisms by which PM could result in a health effect (Chapter 5, Chapter 6, Chapter 7, Chapter 8, Chapter 9, Chapter 10, and Chapter 11). Further, the ISA aims to characterize the effect of PM (i.e., $PM_{2.5}$, $PM_{10–2.5}$, and UFP) on health by evaluating whether there is evidence of an independent effect in epidemiologic studies, often assessed through copollutant models, or a direct effect (i.e., exposure to only PM elicits a health effect) in experimental studies. The ISA also informs policy-relevant issues (Section 1.5), such as (1) potential copollutant confounding (Section 1.5.1); (2) timing of effects (i.e., averaging time of exposure metric and lag at which associations are observed in epidemiologic studies; Section 1.5.2); (3) PM concentration-response relationship(s), and evaluation of potential thresholds below which effects do not occur (Section 1.5.3); (4) PM components and sources and relationships with health effects (Section 1.5.4); and (5) populations or lifestages at increased risk for health effects related to PM exposure (Section 1.5.5 and Chapter 12).

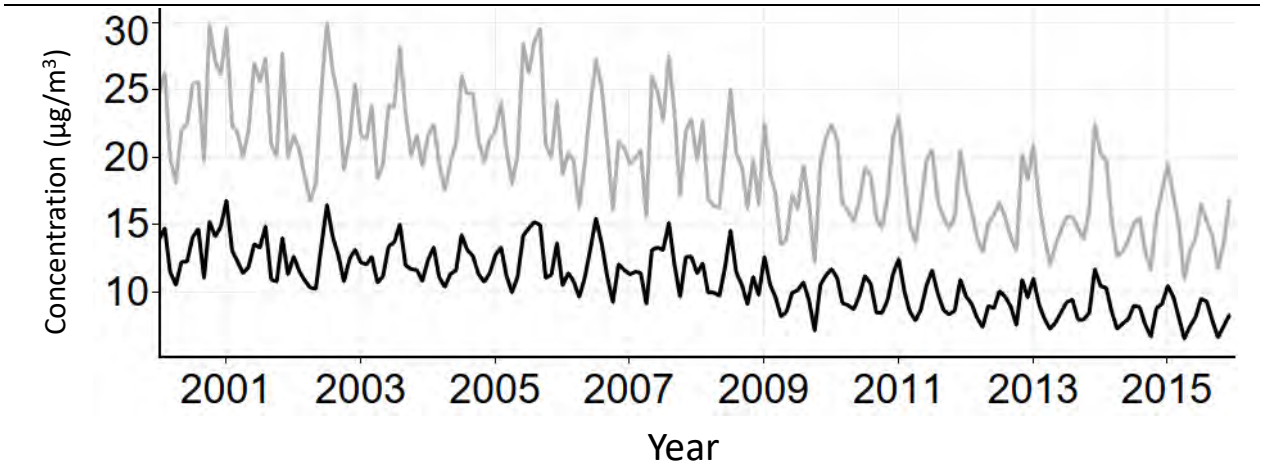
Sources and Exposure to PM

The main objective of the ISA is to characterize health and welfare effects related to ambient PM exposure. This requires understanding PM sources, atmospheric formation, measurement methods, and concentrations. Additionally, characterizing the health effects of PM requires an understanding of the factors that affect both exposure to ambient PM and the uncertainty in estimating exposure. These factors include unmeasured variability in $PM_{2.5}$, $PM_{10–2.5}$, and UFP concentrations and size distributions, exposure to copollutants, and uncharacterized PM composition.

Particulate matter is comprised of components that are directly emitted (primary PM) as well as formed through atmospheric chemical reactions involving gaseous precursors (secondary PM; Section 2.3). Both primary and secondary PM contribute substantially to overall PM mass in ambient air. Within an urban environment, most primary $PM_{2.5}$ emissions are from anthropogenic sources and include some combination of industrial activities, motor vehicles, cooking, and fuel combustion, including biomass burning. However, in many locations, secondary PM formed from the precursors sulfur dioxide (SO_2), oxides of nitrogen (NO_X), ammonia (NH_3), and volatile organic compounds (VOCs), accounts for the majority of $PM_{2.5}$ mass. Direct emissions of primary $PM_{2.5}$ have decreased slightly (~9% since 2002), along with a substantial decrease in emissions since 2006 of the major $PM_{2.5}$ precursors SO_2 and NO_X, 65 and 30%, respectively. $PM_{10–2.5}$ is almost entirely primary in origin, composed largely of crustal material, sea salt, and biological material. Ambient UFPs originate from two distinct processes, primary particles directly emitted from specific sources like motor vehicles and new particle formation by photochemical processes under favorable atmospheric conditions.

There are well-established Federal Reference Methods (FRM) and national monitoring networks for $PM_{2.5}$, PM_{10}, and $PM_{10–2.5}$, but not for UFPs (Section 2.4). Recent monitoring initiatives include the implementation of the National Core multipollutant monitoring network, which includes measurements of $PM_{2.5}$ and $PM_{10–2.5}$, along with a suite of other pollutants, a new near-road monitoring network that includes $PM_{2.5}$ monitors at 36 sites, and the first routine monitoring of UFPs by measuring particle number count (NC) at 24 sites. Satellite-based measurements in conjunction with chemical transport models have also become increasingly used for estimating $PM_{2.5}$ concentrations. In general, the fraction of PM_{10} accounted for by $PM_{2.5}$ is higher in the eastern U.S. than in the western U.S. $PM_{10–2.5}$ concentrations are more spatially variable than $PM_{2.5}$ concentrations. The limited amount of available UFP measurements data indicates that the highest UFP concentrations occur in the winter and near roads with heavy traffic, often over short time periods. Overall, UFP concentrations are more spatially variable than $PM_{2.5}$. As Figure ES-2 shows, the long-term trend in monthly average $PM_{2.5}$ concentrations decreased by about 5 $\mu g/m^3$ from 2000 to 2015. Much of this decrease can be attributed to a corresponding decrease in sulfate concentrations, especially in the eastern U.S., attributed to reduced SO_2 emissions. Sulfate concentrations are mainly associated with $PM_{2.5}$ and have historically been highest in summer. The reduction in $PM_{2.5}$ and sulfate concentrations has coincided with a shift in the season with the highest national average concentration, from summer to a more even distribution of $PM_{2.5}$

concentrations between summer and winter. Additionally, the reduction in $PM_{2.5}$ concentrations has resulted in an increase in the contribution of $PM_{10-2.5}$ to PM_{10} concentrations.



µg/m³ = micrograms per cubic meter; $PM_{2.5}$ = particulate matter with a nominal mean aerodynamic diameter less than or equal to 2.5 µm.

Note: Black = mean, gray = 90th percentile.

Source: Chan et al. (2018).

Figure ES-2 Long-term trend in national monthly average $PM_{2.5}$ concentrations (µg/m³) from 2000−2015.

Fixed-site monitoring is frequently used for obtaining $PM_{2.5}$ exposure surrogates in epidemiologic studies of both short-term and long-term exposure (Section 3.3), given that spatial variability in $PM_{2.5}$ concentrations tends to be lower than that observed for other size fractions. Fixed-site monitoring for $PM_{10-2.5}$ has been performed using several different methods. Thus, because $PM_{10-2.5}$ is typically more spatially variable than $PM_{2.5}$ it is important to consider the method used to measure $PM_{10-2.5}$ to characterize errors and uncertainties in the data that are related both to the monitoring method and the proximity of the individual receptor to the monitor. UFPs also tend to be more spatially variable than $PM_{2.5}$, contributing to uncertainties in exposure assignments. The condensation particle counter (CPC) is most commonly used to measure UFPs. However, some portion of the UFP size distribution may be omitted using CPC because these counters do not typically measure particles smaller than 10 nm.

Modeling approaches, such as spatial interpolation methods, land use regression, dispersion models, and chemical transport models (CTMs), have for years provided estimates of exposure where no measurements are available. More recently, hybrid models have become available that draw on input from CTMs, satellite observations of aerosol optical density, surface measurements of PM concentration, and land use variables. Most studies using hybrid methods are applied to model $PM_{2.5}$ and have out-of-sample

cross-validations with $R^2 > 0.8$. Models are employed less frequently to estimate $PM_{10–2.5}$ and UFP exposures, despite $PM_{10–2.5}$ and UFP typically being more spatially variable than $PM_{2.5}$. This is related in part to less availability of input data.

When particles enter a building envelope, they may be lost during the process of infiltration indoors, producing an infiltration factor (F_{inf}) < 1 (Section 3.4). F_{inf} varies with season, window opening, building age, wind speed, and particle size distribution (with F_{inf} lower for $PM_{10–2.5}$ and UFP compared with $PM_{2.5}$). When examining the influence of estimated exposures on health effect estimates in a time-series study of short-term $PM_{2.5}$ exposure, use of a fixed-site monitor in lieu of a microenvironmental model that accounted for infiltration produced considerably attenuated health effect estimates, which resulted in an underestimation of the health effect association. Infiltration of $PM_{2.5}$ through a building envelope may change the temporal variability of the indoor $PM_{2.5}$ concentration time series, resulting in reduced correlation between the health effect of interest and the estimated exposure. In an epidemiologic study of long-term $PM_{2.5}$ exposure, simulating indoor concentrations produced unbiased health effect estimates.

In summary, exposure error tends to underestimate health effects associations in epidemiologic studies of PM exposure, although bias in either direction can occur. Recent improvements in estimating spatial resolution of the $PM_{2.5}$ concentration surface have reduced bias and uncertainty in health effect estimates. $PM_{10–2.5}$ and UFP concentrations tend to be more spatially variable than $PM_{2.5}$ concentrations, but data are either unavailable or less often available to fit or validate hybrid models for those size fractions. Consequently, there is typically less uncertainty in health effect estimates derived from both monitored and modeled exposure estimates for $PM_{2.5}$ compared with either $PM_{10–2.5}$ or UFP.

Dosimetry of Inhaled PM

Particle dosimetry characterizes the intake, deposition, and retention of PM in the respiratory tract (Chapter 4). The basic understanding of particle dosimetry has not changed since the last review. Quantification of the fraction of inhaled particles reaching the lung and the small fraction of deposited particles that enter the blood, distribute around the body, and accumulate in organs and tissues has improved. Understanding the dosimetry of particles is crucial to providing evidence for biologically plausible pathways that support the link between PM exposure and a range of health effects spanning multiple organ systems.

A variety of factors influence the amount of inhaled particles deposited and retained in the respiratory tract. These factors include exposure concentration and duration, activity level, and breathing conditions (e.g., nasal vs. oronasal route and minute ventilation), and particle properties (e.g., particle size, hygroscopicity, and solubility in airway fluids and cellular components). The inhalability of a particle is particularly important when extrapolating between species because it decreases more rapidly as particle size increases in rodents (commonly used in laboratory studies) than in humans. In people, the fraction of oral versus nasal breathing is influenced by age, activity level, sex, disease status

(e.g., allergies, upper respiratory infections), and perhaps body mass index, which ultimately contributes to the fraction of particles inhaled and reaching the lower respiratory tract.

Recent evidence demonstrates the translocation of poorly soluble particles (generally less than 200 nm) from the respiratory tract into circulation with transport to other organs. For example, in both humans and rodents, a small fraction of gold nanoparticles depositing in the peripheral lung may move into circulation. The fraction of deposited particles that move into circulation is dependent on particle size and is in the range of 0.2% or less for particles between 5 and 200 nm but may reach a few percent for smaller particles. The translocated particles are distributed around the body and may be retained in other organs or eliminated via urine. Some more limited data show that particles may also reach the fetus in a size-dependent manner. Although translocation in humans has only been demonstrated for gold nanoparticles and, to some degree, for titanium dioxide, the translocation of several types of nanoparticles has been demonstrated in rodents. The importance of elemental composition on particle translocation has not yet been ascertained. These studies suggest that, following deposition in the lung, a small fraction of ambient particles under 200 nm may translocate into circulation.

Health and Welfare Effects of PM Exposure

This ISA integrates information on PM exposure and health effects from epidemiologic, controlled human exposure, and toxicological studies to determine the causal nature of relationships between exposure to PM of various size fractions (i.e., $PM_{2.5}$, $PM_{10–2.5}$, and UFPs) and broad health effect categories. For most health effect categories, effects are evaluated separately for short-term exposures (i.e., hours up to approximately 1 month) and long-term exposures (i.e., 1 month to years), except for reproductive and developmental effects where exposures are considered to be long term. For welfare effects, the ISA evaluates evidence as it pertains to visibility impairment, climate effects, and effects on materials. A consistent and transparent framework [Preamble to the ISA (U.S. EPA, 2015), Table II] is applied to classify the health and welfare effects evidence according to a five-level hierarchy:

1. *Causal relationship*
2. *Likely to be causal relationship*
3. *Suggestive of, but not sufficient to infer, a causal relationship*
4. *Inadequate to infer the presence or absence of a causal relationship*
5. *Not likely to be a causal relationship*

The causality determinations presented in Table ES-1, reflect the PM size fraction, exposure duration, and health effect category combinations evaluated in this ISA. The conclusions presented are informed by recent findings in combination with the evidence detailed in the 2009 PM ISA. Important considerations include: (1) determining whether laboratory studies of humans and animals, in combination with epidemiologic studies, inform the biological mechanisms by which PM can impart health effects and provide evidence demonstrating that PM exposure can independently cause a health effect; (2) determining whether there is consistency in epidemiologic evidence across various geographic

locations, populations, and methods used to estimate PM exposure; (3) evaluating epidemiologic studies that examine the potential influence of factors (i.e., confounders) that could bias associations observed with PM exposure; (4) determining the coherence of findings integrated across controlled human exposure, epidemiologic, and toxicological studies; and (5) making judgments regarding the influence of error and uncertainty on the relationship between PM exposure and health effects in the collective body of available studies. Table ES-2 details the causality determinations for the welfare effects.

Table ES-1 Summary of causality determinations for PM exposure and health effects from the 2009 and current Integrated Science Assessment for Particulate Matter.

Summary of Causality Determinations		
Size Fraction	**2009 PM ISA**	**Current PM ISA**
Chapter 5. Respiratory Effects		
Short-Term Exposure		
$PM_{2.5}$	Likely to be causal	Likely to be causal
$PM_{10-2.5}$	Suggestive of, but not sufficient to infer	Suggestive of, but not sufficient to infer
UFP	Suggestive of, but not sufficient to infer	Suggestive of, but not sufficient to infer
Long-Term Exposure		
$PM_{2.5}$	Likely to be causal	Likely to be causal
$PM_{10-2.5}$	Inadequate	Inadequate
UFP	Inadequate	Inadequate
Chapter 6. Cardiovascular Effects		
Short-Term Exposure		
$PM_{2.5}$	Causal	Causal
$PM_{10-2.5}$	Suggestive of, but not sufficient to infer	Suggestive of, but not sufficient to infer
UFP	Suggestive of, but not sufficient to infer	Suggestive of, but not sufficient to infer
Long-Term Exposure		
$PM_{2.5}$	Causal	Causal
$PM_{10-2.5}$	Inadequate	Suggestive of, but not sufficient to infer

Table ES-1 (Continued): Summary of causality determinations for PM exposure and health effects from the 2009 and current Integrated Science Assessment for Particulate Matter.

Summary of Causality Determinations		
Size Fraction	**2009 PM ISA**	**Current PM ISA**
UFP	Inadequate	Inadequate
Chapter 7. Metabolic Effects		
Short-Term Exposure		
$PM_{2.5}$	---	Suggestive of, but not sufficient to infer
$PM_{10-2.5}$	---	Inadequate
UFP	---	Inadequate
Long-Term Exposure		
$PM_{2.5}$	---	Suggestive of, but not sufficient to infer
$PM_{10-2.5}$	---	Suggestive of, but not sufficient to infer
UFP	---	Inadequate
Chapter 8. Nervous System Effects		
Short-Term Exposure		
$PM_{2.5}$	Inadequate	Suggestive of, but not sufficient to infer
$PM_{10-2.5}$	Inadequate	Inadequate
UFP	Inadequate	Suggestive of, but not sufficient to infer
Long-Term Exposure		
$PM_{2.5}$	---	Likely to be causal
$PM_{10-2.5}$	---	Suggestive of, but not sufficient to infer
UFP	---	Suggestive of, but not sufficient to infer
Chapter 9. Reproductive and Developmental Effects		
Male and Female Reproduction and Fertility		
$PM_{2.5}$	Suggestive of, but not sufficient to infer	Suggestive of, but not sufficient to infer
$PM_{10-2.5}$	Inadequate	Inadequate
UFP	Inadequate	Inadequate

Table ES-1 (Continued): Summary of causality determinations for PM exposure and health effects from the 2009 and current Integrated Science Assessment for Particulate Matter.

Summary of Causality Determinations		
Size Fraction	**2009 PM ISA**	**Current PM ISA**
Pregnancy and Birth Outcomes		
$PM_{2.5}$	Suggestive of, but not sufficient to infer	Suggestive of, but not sufficient to infer
$PM_{10-2.5}$	Inadequate	Inadequate
UFP	Inadequate	Inadequate
Chapter 10. Cancer		
$PM_{2.5}$	Suggestive of, but not sufficient to infer	Likely to be causal
$PM_{10-2.5}$	Inadequate	Suggestive of, but not sufficient to infer
UFP	Inadequate	Inadequate
Chapter 11. Mortality		
Short-Term Exposure		
$PM_{2.5}$	Causal	Causal
$PM_{10-2.5}$	Suggestive of, but not sufficient to infer	Suggestive of, but not sufficient to infer
UFP	Inadequate	Inadequate
Long-Term Exposure		
$PM_{2.5}$	Causal	Causal
$PM_{10-2.5}$	Inadequate	Suggestive of, but not sufficient to infer
UFP	Inadequate	Inadequate

$PM_{2.5}$ = particulate matter with a nominal mean aerodynamic diameter less than or equal to 2.5 μm; $PM_{10-2.5}$ = particulate matter with a nominal mean aerodynamic diameter greater than 2.5 μm and less than or equal to 10 μm; UFP = ultrafine particles.

[a]An array of outcomes are evaluated as part of a broad health effect category: physiological measures (e.g., airway responsiveness), clinical outcomes (e.g., hospital admissions), and cause-specific mortality. Total mortality includes all nonaccidental causes of mortality and is informed by findings for the spectrum of morbidity effects (e.g., respiratory, cardiovascular) that can lead to mortality.

Note: The 2009 PM ISA made causality determinations for the broad category of "Reproductive and Developmental Effects." Causality determinations for 2009 represent this broad category and not specifically for "Male and Female Reproduction and Fertility" and "Pregnancy and Birth Outcomes." Table P-2 provides a description of each of the five causality determinations and the types of scientific evidence that is considered for each category. Previous causality determinations taken from the 2009 PM ISA (U.S. EPA, 2009).

Health Effects of $PM_{2.5}$ Exposure

Across the PM size fractions evaluated within this ISA, the most substantial scientific evidence supporting relationships between short- and long-term PM exposure is for $PM_{2.5}$. The causality determinations for $PM_{2.5}$ reflect the total body of scientific evidence, building on the conclusions presented in the 2009 PM ISA. The following sections detail those exposure duration and broad health effect categories for which this ISA concluded a *causal* or *likely to be causal* determination, reflecting the highest degree to which the evidence reduces chance, confounding, and other biases in the exposure–health effect relationship. The causality determinations for health effect categories for which there is a larger degree of uncertainty or limited examination of the relationship between $PM_{2.5}$ exposure and health effects are *suggestive of, but not sufficient to infer, a causal relationship* and *inadequate to determine the presence or absence of a causal relationship.* These causality determinations are summarized in Table ES-1.

Respiratory Effects

As in the 2009 PM ISA, the current ISA concludes there is a *likely to be causal relationship* between short-term $PM_{2.5}$ exposure and respiratory effects (Section 5.1). Recent epidemiologic studies continue to provide strong evidence for a relationship between short-term $PM_{2.5}$ exposure and several respiratory-related endpoints, including asthma exacerbation, chronic obstructive pulmonary disease (COPD) exacerbation, and combined respiratory-related diseases, particularly from studies examining emergency department (ED) visits and hospital admissions. The consistent, positive associations observed for asthma and COPD ED visits and hospital admissions across studies that used different approaches to control for the potential confounding effects of weather (e.g., temperature) are further supported by evidence of increased symptoms and medication use in response to short-term $PM_{2.5}$ exposure, which are indicative of asthma and COPD exacerbations. Animal toxicological studies of short-term $PM_{2.5}$ exposure provide coherence and biological plausibility for asthma and COPD exacerbations by demonstrating asthma-related responses in an animal model of allergic airways disease and enhanced lung injury and inflammation in an animal model of COPD. Animal toxicological evidence in healthy animals demonstrates altered host defense, greater susceptibility to bacterial infection, airway irritant effects, as well as other effects. While there is animal toxicological evidence supporting asthma and COPD exacerbations, the broader body of experimental studies conducted in healthy animals generally provides biological plausibility for respiratory effects in association with short-term $PM_{2.5}$ exposure, not specifically for asthma or COPD exacerbation. Controlled human exposure studies provide minimal evidence of effects due to short-term $PM_{2.5}$ exposure, such as decrements in lung function and pulmonary inflammation, though these studies are limited in terms of endpoints evaluated and the size and health status of study subjects. Recent epidemiologic studies build upon the limited number of studies that previously examined potential copollutant confounding and indicate that $PM_{2.5}$ associations with asthma

exacerbation, combined respiratory-related diseases, and respiratory mortality remain relatively unchanged in copollutant models with gaseous pollutants (i.e., O_3, NO_2, SO_2, with more limited evidence for CO) and other particle sizes (i.e., $PM_{10–2.5}$). The copollutant results in combination with animal toxicological evidence further support an independent effect of $PM_{2.5}$ on respiratory health. Evidence of consistent, positive associations between $PM_{2.5}$ and respiratory mortality supports a continuum of respiratory-related effects.

Both the 2009 PM ISA, and the current ISA concluded there is a *likely to be causal relationship* between long-term $PM_{2.5}$ exposure and respiratory effects (Section 5.2). There is strong evidence from multiple cohorts that varied in study location, exposure assessment methods, and time periods examined that reported an association between long-term $PM_{2.5}$ exposure and lung development (i.e., lung function growth). Additional, although more limited, evidence from epidemiologic studies indicates associations between long-term $PM_{2.5}$ exposure and asthma development in children, asthma prevalence in children, childhood wheeze, and pulmonary inflammation. Animal toxicological studies demonstrating impaired lung development resulting from pre- and postnatal $PM_{2.5}$ exposure and the development of an allergic phenotype along with an increase in airway responsiveness following long-term $PM_{2.5}$ exposure provide biological plausibility for these findings. There is limited assessment of potential copollutant confounding of respiratory morbidity outcomes, but recent animal toxicological studies partially address the independence of $PM_{2.5}$ effects by demonstrating $PM_{2.5}$-induced oxidative stress, inflammation, and morphological changes in both upper and lower airways. This broad body of experimental evidence indicating $PM_{2.5}$-related respiratory effects in healthy populations generally provides biological plausibility for respiratory effects in association with long-term $PM_{2.5}$ exposure. Additional epidemiologic evidence indicates an acceleration of lung function decline in adults, as well as consistent evidence for respiratory mortality and cause-specific respiratory mortality, thereby providing evidence of a continuum of effects in response to long-term $PM_{2.5}$ exposure. The relationship between long-term $PM_{2.5}$ exposure and respiratory effects is further supported by epidemiologic studies demonstrating improvements in lung function growth and bronchitic symptoms in children and improvement in lung function in adults in association with declining $PM_{2.5}$ concentrations.

Cardiovascular Effects

Consistent with the 2009 PM ISA, this ISA concludes there is a *causal relationship* between short-term $PM_{2.5}$ exposure and cardiovascular effects (Section 6.1). The strongest evidence comes from epidemiologic studies that reported consistent, positive associations between short-term $PM_{2.5}$ exposure and cardiovascular-related ED visits and hospital admissions across studies that used different approaches to control for the potential confounding effects of weather (e.g., temperature), particularly for ischemic heart disease (IHD) and heart failure (HF), as well as cardiovascular-related mortality. Recent examinations of potential copollutant confounding generally indicate that the associations observed between $PM_{2.5}$ exposure and cardiovascular effects in single-pollutant models remain relatively

unchanged in copollutant models, providing evidence that the observed associations with $PM_{2.5}$ are not artifacts due to confounding by another air pollutant. The independence of a $PM_{2.5}$ cardiovascular effect is further supported by recent experimental studies. Controlled human exposure studies expand upon previous findings and demonstrate $PM_{2.5}$-induced changes in endothelial function, which is coherent with animal toxicological studies demonstrating the same effect. Moreover, experimental evidence demonstrating decreased cardiac contractility and altered left ventricular pressure is coherent with epidemiologic studies observing positive associations between ambient $PM_{2.5}$ and ED visits and hospital admissions for HF. Thus, the collective body of experimental evidence supports and provides biological plausibility for epidemiologic studies reporting associations, particularly between short-term $PM_{2.5}$ exposure and IHD and HF outcomes, as well as a range of other cardiovascular-related effects (e.g., arrhythmia, thrombosis) that can result in more severe outcomes, possibly including death.

The 2009 PM ISA, as well as the current PM ISA, concluded there is a *causal relationship* between long-term $PM_{2.5}$ exposure and cardiovascular effects (Section 6.2). Epidemiologic studies of multiple recent U.S.-based cohorts along with reanalyses of these cohorts provide strong evidence of consistent, positive associations between long-term $PM_{2.5}$ exposure and cardiovascular mortality. These studies used a variety of exposure assessment and statistical techniques and examined various spatial domains (e.g., 1 × 1-km grid cells, census tract, etc.) in many locations where mean annual average $PM_{2.5}$ concentrations are ≤12 μg/m^3. Recent epidemiologic studies of cardiovascular morbidity have greatly expanded upon the body of evidence available at the completion of the 2009 PM ISA by focusing on populations with distinct demographic characteristics (e.g., postmenopausal woman, male doctors, etc.) and extensively considering potential confounders (e.g., socioeconomic status [SES]). Although an extended analysis of the Women's Health Initiative (WHI) cohort strengthened the initial observation of a relationship between long-term $PM_{2.5}$ exposure and coronary events among postmenopausal women, additional cohorts of women similar to the WHI cohort did not report consistent, positive associations with coronary heart disease (CHD), myocardial infarction, or stroke. Longitudinal studies examining the progression of atherosclerosis in relation to long-term exposure to $PM_{2.5}$ reported inconsistent results that were dependent upon the vascular bed examined, but there was evidence of $PM_{2.5}$-associated coronary artery calcification, a strong predictor of CHD, within a study focusing on the progression of atherosclerosis in a healthy population (i.e., Multi-Ethnic Study of Atherosclerosis and Air Pollution [MESA–Air]). A limited number of epidemiologic studies examining other cardiovascular effects provide some evidence of associations with HF, blood pressure, and hypertension, as well as subclinical cardiovascular biomarkers. Recent studies also reduce the uncertainty associated with potential copollutant confounding by reporting that associations between long-term $PM_{2.5}$ exposure and cardiovascular mortality remained relatively unchanged or increased in copollutant models adjusted for O_3, NO_2, SO_2, and $PM_{10–2.5}$. Evidence from animal toxicological studies further supports a direct $PM_{2.5}$ effect on the cardiovascular system and provides coherence with effects observed in epidemiologic studies. For example, animal toxicological studies demonstrating atherosclerotic plaque progression in mice is coherent with epidemiologic studies of atherosclerosis, and animal toxicological studies reporting increased coronary artery wall thickness, decreased cardiac contractility and output, and changes in blood

pressure are coherent with epidemiologic studies of HF. Furthermore, when considering the collective body of evidence, there are biologically plausible pathways by which long-term exposure to $PM_{2.5}$ could lead to a continuum of effects potentially resulting in death.

Nervous System Effects

The 2009 PM ISA did not make a causality determination for long-term $PM_{2.5}$ exposure and nervous system effects because of the paucity of available data. Since the 2009 PM ISA, the literature base has greatly expanded, and the combination of animal toxicological and epidemiologic evidence supports a *likely to be causal relationship* between long-term $PM_{2.5}$ exposure and nervous system effects (Section 8.2). Animal toxicological studies provide evidence for a range of nervous system effects including neuroinflammation and oxidative stress, neurodegeneration, cognitive effects, and effects on neurodevelopment. Epidemiologic studies, although fewer in number, generally support associations between long-term $PM_{2.5}$ exposure and changes in brain morphology, cognitive decrements, and dementia. Both experimental and epidemiologic evidence are well substantiated and coherent, supporting a pathway involving neuroinflammation in specific regions of the brain (i.e., the hippocampus, cerebral cortex and hypothalamus) and morphologic changes in the brain indicative of neurodegeneration. Overall, the limited assessment of copollutant confounding introduces some uncertainty in interpreting the epidemiologic studies, but this uncertainty is addressed, in part, by the direct evidence of effects provided by experimental animal studies. In addition to the nervous system effects primarily observed in adults, there is preliminary but limited epidemiologic evidence of neurodevelopmental effects, specifically autism spectrum disorder (ASD). Evidence for this outcome is supported by an animal toxicological study demonstrating $PM_{2.5}$-induced inflammatory and morphologic changes in regions of the brain consistent with ASD.

Cancer

The 2009 PM ISA concluded that evidence was *suggestive of a causal relationship*[35] between long-term $PM_{2.5}$ exposure and cancer (Section 10.2). Building upon the decades of research on whole PM exposures and evidence presented in the 2009 PM ISA, recent experimental and epidemiologic evidence indicating genotoxicity, epigenetic effects (i.e., hypo- and hypermethylation of DNA), and carcinogenic potential due to $PM_{2.5}$ exposure, along with strong epidemiologic evidence for increases in the risk of lung cancer incidence and mortality, supports a *likely to be causal relationship* between long-term $PM_{2.5}$ exposure and cancer. $PM_{2.5}$ exhibits various characteristics of carcinogens, as shown in studies demonstrating genotoxic effects (e.g., DNA damage), epigenetic alterations, oxidative stress, and

[35] Since the 2009 PM ISA, the causality determination language has been updated and this category is now stated as *suggestive of, but not sufficient to infer, a causal relationship*.

electrophilicity. Studies of cancer development have often focused on whole PM exposures,[36] not individual PM size fractions, or individual components often found to comprise $PM_{2.5}$ (e.g., hexavalent chromium, arsenic). Ames *Salmonella*/mammalian-microsome mutagenicity assays of $PM_{2.5}$ and $PM_{2.5}$ extracts demonstrate that PM contains mutagenic agents. In vitro and in vivo toxicological studies demonstrate the potential for $PM_{2.5}$ exposure to result in DNA damage, which is supported by limited human evidence. Cytogenic effects (e.g., chromosomal aberrations), and differential expression of genes potentially relevant to genotoxicity or cancer pathogenesis have also been demonstrated. There is also limited evidence for cellular and molecular changes that could lead to genomic instability as well as for the carcinogenic potential of $PM_{2.5}$, which is demonstrated by enhanced tumor formation in animals treated with urethane. The experimental and epidemiologic evidence of genotoxicity, epigenetic effects, and carcinogenic potential provides biological plausibility for the results from multiple epidemiologic studies conducted in diverse cohorts in terms of geographic coverage and population demographics reporting primarily consistent, positive associations between long-term $PM_{2.5}$ exposure and lung cancer incidence and mortality, particularly in never smokers. In the limited assessment of potential copollutant confounding, $PM_{2.5}$-lung cancer incidence and mortality associations were found to be relatively unchanged in models with O_3.

Mortality

As in the 2009 PM ISA, the current ISA concludes there is a *causal relationship* between short-term $PM_{2.5}$ exposure and total (nonaccidental) mortality (Section 11.1). Recent multicity studies conducted in the U.S., Canada, Europe, and Asia in combination with the single- and multicity studies evaluated in the 2009 PM ISA continue to provide evidence of consistent, positive associations between short-term $PM_{2.5}$ exposure and total mortality. The positive associations reported across studies reflect both traditional analyses using ambient monitors as well as analyses conducted in both urban and rural locations that use new exposure assignment techniques and rely on multiple sources of $PM_{2.5}$ data (e.g., ambient monitors, statistical models, and satellite images). Recent studies also expand upon the assessment of potential confounding by copollutants as well as other factors (e.g., temporal trends, weather, long-term PM concentrations). These analyses indicate that $PM_{2.5}$-mortality associations are relatively unchanged in copollutant models with gaseous pollutants and $PM_{10–2.5}$, and when instituting different approaches to control for other confounders, both in terms of covariates included in statistical models and degrees of freedom employed. The positive associations reported for total mortality are supported by positive associations for cause-specific mortality (i.e., cardiovascular- and respiratory-related mortality). The consistent and coherent evidence across scientific disciplines for cardiovascular morbidity, particularly ischemic events and HF (Chapter 6), and to a lesser degree for respiratory morbidity, with the strongest evidence for exacerbations of COPD and asthma (Chapter 5), provide biological plausibility for cause-specific mortality and ultimately total mortality. Recent studies

[36] Whole PM exposures represent exposures that contain both PM and gaseous pollutants.

also further reduce chance, confounding, and other biases in the relationship between short-term $PM_{2.5}$ exposure and total mortality.

Both the 2009 PM ISA and the current ISA concludes there is a *causal relationship* between long-term $PM_{2.5}$ exposure and total (nonaccidental) mortality (Section 11.2). Additional reanalyses and extensions of the American Cancer Society and Harvard Six Cities cohorts, as well as new cohorts consisting of Medicare participants, people that live in Canada, or people employed in a specific job (e.g., teacher, nurse, etc.) further support a positive association between long-term $PM_{2.5}$ exposure and total mortality, particularly in areas with annual mean concentrations <20 $\mu g/m^3$, and in some cases below 12 $\mu g/m^3$. Positive associations persist regardless of the exposure assignment approach used (i.e., ambient monitors or the combination of monitoring, modeling, and satellite data); in copollutant models, particularly with O_3 and more limited evidence for NO_2 and $PM_{10-2.5}$; and across studies that control for a range of individual- and ecological covariates, such as smoking status and SES. The evidence for total mortality is supported by positive associations for cause-specific mortality, including cardiovascular, respiratory, and lung cancer mortality. The coherence of effects across scientific disciplines for cardiovascular morbidity, particularly for CHD, stroke and atherosclerosis, and respiratory morbidity for the development of COPD, contribute to the biological plausibility for mortality due to long-term $PM_{2.5}$ exposure. Additionally, recent studies demonstrating increases in life expectancy due to decreases in long-term $PM_{2.5}$ concentrations further support a relationship between long-term $PM_{2.5}$ exposure and total mortality.

Policy-Relevant Considerations for Health Effects Associated with Particulate Matter Exposure

This section describes issues relevant for considering the potential significance of impacts of ambient PM, particularly $PM_{2.5}$, exposure on public health (Section 1.5),[37] including potential copollutant confounding of $PM_{2.5}$-health effects associations, the relationship between $PM_{2.5}$ exposure and the timing of health effects, the shape of the concentration-response (C-R) relationship, whether $PM_{2.5}$ components and sources are more closely associated with health effects than $PM_{2.5}$ mass, and the identification of populations and lifestages potentially at increased risk of a $PM_{2.5}$-related health effect.

Recent epidemiologic studies greatly expand upon the evidence informing whether associations observed between short- and long-term $PM_{2.5}$ exposure and health are confounded by other pollutants observed in the air pollution mixture. The examination of potential copollutant confounding in studies of respiratory and cardiovascular effects are primarily limited to studies of ED visits and hospital admissions. Across studies of short-term $PM_{2.5}$ exposure and respiratory and cardiovascular effects and mortality, correlations between $PM_{2.5}$ and gaseous (i.e., SO_2, NO_2, CO, and O_3) and particulate pollutants (i.e., $PM_{10-2.5}$) varied across studies, with low to moderate correlations (i.e., <0.7). Collectively, studies of

[37] Section 1.5 in Chapter 1 integrates the evidence across all health chapters, but each health chapter has individual discussions on the topics discussed within this section.

short-term $PM_{2.5}$ exposure that examined potential copollutant confounding indicated that associations remained relatively unchanged in copollutant models, and in instances where associations were attenuated, they remained positive. Far fewer studies examined potential copollutant confounding and long-term $PM_{2.5}$ exposure, but there has been an expansion of studies focusing on mortality. Studies focusing on respiratory (i.e., lung function and asthma development) and cardiovascular effects (i.e., cardiovascular mortality), along with lung cancer incidence and mortality, provide initial evidence that associations with $PM_{2.5}$ are relatively unchanged in copollutant models with primarily traffic-related pollutants (i.e., NO_2, NO_X, and CO) and O_3. For mortality, the most extensive analyses were conducted for O_3, with more limited assessments of other pollutants, but overall associations remained unchanged in copollutant models for total (nonaccidental) mortality and cardiovascular and respiratory mortality.

An important question that informs different aspects of the PM NAAQS is the timing of observed effects due to short-term $PM_{2.5}$ exposure, specifically the averaging time of the exposure metric in epidemiologic studies and the lag days over which health effects are observed. Some recent epidemiologic studies focusing on respiratory- and cardiovascular-related ED visits and hospital admissions, cardiovascular effects (e.g., ST elevation, myocardial infarction, and out-of-hospital cardiac arrest), and mortality examined associations between subdaily exposure metrics and the widely used 24-hour avg exposure metric. Across the studies evaluated, the available evidence does not indicate that subdaily averaging periods for $PM_{2.5}$ are more closely associated with health effects than the 24-hour avg exposure metric. In addition to examining potential differences in associations by averaging time of the exposure metric, recent epidemiologic studies evaluated the timing of effects by systematically examining whether there is evidence of an immediate (e.g., lag 0−1 days), delayed (e.g., lag 2−5 days), or prolonged (e.g., lag 0−5 days) effect of PM on health. Epidemiologic studies examining potential differences in associations in relation to short-term $PM_{2.5}$ exposure focused on respiratory- and cardiovascular-related ED visits and hospital admissions as well as mortality. While recent studies provided evidence of associations in the range of 0−5 days for respiratory effects, there was evidence of an immediate effect for cardiovascular effects and mortality (i.e., 0−1 days) with some initial evidence of associations occurring over longer exposure durations (e.g., 0−4 days).

An examination of the C-R relationship between $PM_{2.5}$ exposure and health effects can help determine both the shape of the C-R curve and address the question of whether a threshold exists (i.e., concentration) below which there is no evidence of an effect of $PM_{2.5}$ on health. Studies of short-term $PM_{2.5}$ exposure and health are limited to studies of respiratory-related ED visits, hospital admissions, and mortality. Epidemiologic studies of respiratory disease and asthma ED visits and hospital admissions focusing on the shape of the C-R curve provide initial evidence of a linear relationship with less certainty at concentrations below 10 $\mu g/m^3$. However, studies focusing on whether the $PM_{2.5}$ association changes at different concentration ranges (i.e., cutpoint analyses) provide some evidence of potential nonlinearities in the C-R relationship. Epidemiologic studies of mortality greatly expand upon the evidence evaluated in the 2009 PM ISA where C-R analyses were limited to studies of PM_{10}. Evidence from U.S. studies examining short-term $PM_{2.5}$ exposure and mortality indicate a linear

relationship at concentrations as low as 5 μg/m^3 with cutpoint analyses providing no evidence of a threshold.

For long-term $PM_{2.5}$ exposure, most of the evidence on the shape of the C-R curve comes from studies of mortality with some initial recent evidence from studies of respiratory and cardiovascular effects, as well as lung cancer mortality and incidence. Epidemiologic studies of long-term $PM_{2.5}$ exposure and mortality used a variety of statistical approaches and cutpoint analyses, which support a linear, no-threshold relationship for total (nonaccidental) mortality, especially at lower ambient $PM_{2.5}$ concentrations, with confidence in some studies in the range of 5−8 μg/m^3. Additionally, there is initial evidence indicating that the slope of the C-R curve may be steeper (supralinear) at lower concentrations for cardiovascular mortality. Evaluation of the C-R relationship is more limited for respiratory and cardiovascular effects, but overall initial assessments support a linear relationship, specifically at long-term $PM_{2.5}$ concentrations ranging from 10−12 and 5−10 μg/m^3, respectively.

Recent epidemiologic and experimental studies extensively build on those studies evaluated in the 2009 PM ISA that examined relationships between exposure to $PM_{2.5}$ components and sources and health effects. As detailed in the Preface, this ISA focuses on specific study criteria to thoroughly evaluate whether there is evidence that an individual component(s) and/or source(s) is more closely related to health effects than PM mass. Across the health effects categories evaluated in this ISA, most studies that examine PM sources and components focused on $PM_{2.5}$. In studies examining both short- and long-term exposure, a variety of health effects were examined ranging from subclinical (e.g., changes in lung function, respiratory symptoms) to more overt (e.g., ED visits, hospital admissions, and mortality). Across exposure durations and health effects categories, it was concluded that many $PM_{2.5}$ components and sources are associated with many health effects, and the evidence does not indicate that any one source or component is consistently more strongly related to health effects than $PM_{2.5}$ mass.

Lastly, an important consideration in evaluating whether the NAAQS provides public health protection is assessing whether there are specific populations or lifestages at increased risk of a PM-related health effect. Whereas the ISA provides substantial evidence of health effects due to short- and long-term exposure to $PM_{2.5}$ across populations with diverse characteristics (e.g., children, older adults, people with pre-existing cardiovascular diseases, etc.), an evaluation of whether any of these populations are at increased risk of a PM-related health effect relies on evidence from specific types of studies that can directly inform this question as detailed in Section 1.5.5 and Chapter 12. Based on the framework for characterizing the evidence for populations potentially at increased risk of an air pollutant-related health effect detailed in the 2013 O_3 ISA (U.S. EPA, 2013), this ISA concludes there is adequate evidence that children are at increased risk of a $PM_{2.5}$-related health effect based on strong evidence of impaired lung function growth and additional evidence of decrements in lung function and asthma development. Additionally, there is adequate evidence that nonwhite people are at increased risk of $PM_{2.5}$-related health effects based on studies of long-term $PM_{2.5}$ exposure and mortality and studies demonstrating differential exposure by race. There was also suggestive evidence that populations with

pre-existing cardiovascular and respiratory disease, that are overweight or obese, with genetic variants in genes in the glutathione transferase pathway and genes related to oxidant metabolism, that are of low SES, or are current or former smokers are at increased risk for $PM_{2.5}$-related health effects. Inadequate evidence exists to determine whether having diabetes, being in an older lifestage (i.e., older adults), residential location (including proximity to source and urban residence), sex, or diet increase the risk of $PM_{2.5}$-related health effects.

PM Exposure and Welfare Effects

Compared with the evaluation of the health effects evidence, the evaluation of the welfare effects evidence focuses broadly on PM and not individual size fractions or exposure durations. Additionally, the evaluation, as noted previously, focuses on the welfare effects of visibility impairment, climate effects, and effects on materials due to the ecological effects of PM being evaluated in the ISA for Oxides of Nitrogen, Oxides of Sulfur and Particulate Matter—Ecological Criteria (U.S. EPA, 2018).

As noted in Table ES-2, this ISA concludes a *causal relationship* between PM visibility impairment, climate effects, and effects on materials which is consistent with the 2009 PM ISA. For visibility impairment (Section 13.2), the relationship between PM and light extinction has been well characterized. The rapid decline in $PM_{2.5}$ sulfate that has occurred from 2002−2012 (i.e., −4.6% per year in rural areas and −6.2% per year in urban areas) has contributed to improvements in visibility in many areas. However, an increasing amount of light extinction is now due to nitrate and organic matter. There have been no recent visibility preference studies; however, a recent meta-analysis demonstrates that scene-dependent haze metrics better account for preference than does using the deciview scale as a metric. For climate (Section 13.3), there is substantial evidence indicating that PM affects the radiative forcing of the climate system, both through direct scattering and absorption of radiation, and indirectly, by altering cloud properties. However, there are still substantial uncertainties with respect to key processes linking PM and climate, particularly those involving aerosol-cloud interactions, because of the scale difference between PM-relevant cloud processes and the resolution of state-of-the-art models, and the indirect impacts and feedbacks in the climate system resulting from an initial radiative perturbation due to PM. Lastly, for effects on materials (Section 13.4), most of the evidence has focused on examining PM effects on stone used for historic monuments and buildings. Recent evidence further expands the understanding of soiling and corrosion process for glass and metals and demonstrates that atmospheric soiling can affect energy efficiency of photovoltaic systems and of some buildings.

Table ES-2 Summary of causality determinations for relationships between PM exposure and welfare effects from the 2009 and current Integrated Science Assessment for Particulate Matter.

Welfare Effect Category	Causality Determination	
	2009 PM ISA	Current PM ISA
Visibility impairment Section 13.2.6	Causal relationship	Causal relationship
Climate effects Section 13.3.9	Causal relationship	Causal relationship
Effects on materials Section 13.4.5	Causal relationship	Causal relationship

PM = particulate matter.

Previous causality determinations taken from the 2009 PM ISA (U.S. EPA, 2009). Table P-2 provides a description of each of the five causality determinations and the types of scientific evidence that is considered for each category.

Scientific Considerations and Key Findings of the Health and Welfare Effects Evidence

As summarized in the Preface (Section P.3), the Preamble to the ISAs (U.S. EPA, 2015) describes the process by which the U.S. EPA evaluates the strengths and limitations in the scientific evidence using a weight-of-evidence framework to form causality determinations within the ISAs. There are five different causality determinations, which may be used to characterize evidence with each determination delineated by the degree to which chance, confounding, and other biases affect interpretation of the scientific evidence (Table P-2). As documented by the extensive evaluation of evidence throughout the subsequent chapters of this ISA, the U.S. EPA carefully considers uncertainties in the evidence, and the extent to which recent studies have addressed or reduced uncertainties from previous assessments, as well as the strengths of the evidence. Uncertainties considered in the epidemiologic evidence, for example, include the potential for confounding by copollutants or covarying factors (e.g., temporal trends and weather in short-term exposure studies, and individual-level and ecological factors in long-term exposure studies) and exposure error. The U.S. EPA evaluates many other important considerations (not uncertainties) such as coherence of evidence from animal and human studies, evaluation of different PM components, heterogeneity of risk estimates, and the shape of concentration-response relationships. All aspects are evaluated in drawing scientific conclusions and making causality determinations. Where there is clear evidence linking PM to effects and minimal remaining uncertainties, the U.S. EPA concludes a *causal* or *likely to be causal* relationship.

Key findings of the health effects evidence spanning each of the PM size fractions and welfare effects evaluated in this ISA are summarized below and in Chapter 1 (Section 1.6). These highlights

encapsulate the strengths and limitations in the evidence base that ultimately lead to the formation of causality determinations. For the health (i.e., respiratory and cardiovascular effects, and mortality due to short- and long-term $PM_{2.5}$ exposure) or welfare effects categories for which *causal* or *likely to be causal* determinations were made, recent findings were found to reduce or fully address previous uncertainties in the evidence and increase the strength of U.S. EPA's scientific conclusions. For other PM-effect relationships, the key findings highlighted below indicate where there is strength in the evidence, but uncertainties remain, resulting in causality determinations of *suggestive of, but not sufficient to infer, a causal relationship* or in some cases *inadequate to infer the presence or absence of a causal relationship*, both of which reflect that there is limited evidence to evaluate both strengths and weaknesses.

Health Effects Evidence: Key Findings

A large body of scientific evidence spanning many decades clearly demonstrates there are health effects attributed to both short- and long-term PM exposure, with the strongest evidence for a relationship between some health effects and $PM_{2.5}$. Generally, for most health effects and exposures to $PM_{10–2.5}$ and UFPs, there are more limitations and uncertainties across scientific disciplines (i.e., atmospheric chemistry, exposure science, and both epidemiology and experimental sciences), complicating the interpretation of the evidence. The collective body of evidence for each of the PM size fraction, exposure, and health effect category combinations evaluated in this ISA was carefully considered and assessed, including the inherent strengths, limitations, and uncertainties in the overall body of evidence such as the available methods, models and data used within and across studies. This full assessment of the current state of the science for $PM_{2.5}$, $PM_{10–2.5}$, and UFPs resulted in the causality determinations detailed in Table 1-4. Through identification of the strengths and limitations in the evidence, this ISA may help in prioritizing research efforts to support future PM NAAQS reviews. Examples of the key findings in the health effects evidence considered in this PM ISA include:

$PM_{2.5}$

- There are many recent epidemiologic studies conducted in diverse geographic locations, that include different population demographics, use a variety of exposure assignment techniques, and include different approaches and covariates to control for potential confounders that continue to report consistent positive associations between short- and long-term $PM_{2.5}$ exposure and respiratory and cardiovascular effects and mortality. This evidence is consistent with the large body of previously published epidemiologic studies reporting positive associations between $PM_{2.5}$ exposure and respiratory and cardiovascular effects and mortality and in some cases strengthens and extends the evidence base for other health effects.
- New $PM_{2.5}$ exposure assignment methods that use several sources of available data (i.e., satellite observations, model predictions, and ambient monitors) in epidemiologic studies better allow for the inclusion of less urban areas. These methods are well validated by $PM_{2.5}$ monitors in areas with moderate-to-high population density. Although fewer monitors are available for model validation in sparsely populated rural areas compared with urban areas, $PM_{2.5}$ concentrations are

typically lower and more spatially homogeneous in rural areas, resulting in the need for fewer validation sites.

- The large number of animal toxicological and controlled human exposure studies provide coherence and biological plausibility for effects observed in epidemiologic studies of short- and long-term $PM_{2.5}$ exposure, particularly respiratory and cardiovascular effects, and mortality.
- Both animal toxicological and controlled human exposure studies, using concentrated ambient particle (CAP) exposures, provide evidence of a direct effect of PM exposure on various health effects.
- Epidemiologic studies that conducted copollutant analyses show that associations remain relatively unchanged when adjusting for gaseous pollutants and other particle size fractions (e.g., $PM_{10–2.5}$), addressing a key uncertainty identified in the 2009 PM ISA.
- Recent epidemiologic studies indicate that the observed heterogeneity in risk estimates is not attributed solely to differences in the composition of $PM_{2.5}$, but also reflects city-specific exposure conditions (e.g., housing and commuting characteristics).
- Evidence continues to support a linear, no-threshold concentration—response relationship, but with less certainty in the shape of the curve at lower concentrations (i.e., below about 8 $\mu g/m^3$).
- For health effects where it was concluded that the evidence is *suggestive of, but not sufficient to infer, a causal relationship* (i.e., short- and long-term $PM_{2.5}$ exposure and metabolic effects, male and female reproduction and fertility, pregnancy and birth outcomes, and short-term exposures and nervous system effects), epidemiologic and experimental studies report inconsistent evidence of an association/effect or there are relatively few studies focusing on the health effect of interest.

$PM_{10–2.5}$

- Routine national monitoring of $PM_{10–2.5}$ was initiated in 2011. $PM_{10–2.5}$ concentrations are more spatially variable than $PM_{2.5}$. Although some $PM_{10–2.5}$ data are available across the nation, micro- to neighborhood-scale data are not widely available, adding uncertainty to the interpretation of results from epidemiologic studies, especially for long-term exposure studies that rely on spatial contrasts to examine associations with health effects.
- Epidemiologic studies that examined associations between short- and long-term $PM_{10–2.5}$ exposure and various health effects use multiple methods to estimate concentrations, complicating the comparison of results across studies.
- For some health effects, few or no experimental studies examined the relationship with short- and long-term exposure to $PM_{10–2.5}$. The few studies conducted provide inconsistent evidence of effects due to $PM_{10–2.5}$ exposures contributing to limited coherence and biological plausibility.
- The causality determinations for all health outcome categories for short- and long-term $PM_{10–2.5}$ exposure was concluded as either *suggestive of, but not sufficient to infer, a causal relationship* or *inadequate to infer the presence or absence of a causal relationship*, indicating limitations and uncertainties in the evidence base.

UFPs

- There is no national ambient monitoring network in place to measure UFP concentrations; thus, there is limited information on UFP exposures within the U.S.

- There are a limited number of epidemiologic studies that examined short- or long-term UFP exposure and various health effects.
- It is difficult to assess the results across epidemiologic studies because of the different size ranges of UFPs examined, the exposure metrics used, and spatial and temporal variability of UFP concentrations.
- While there is strong and consistent animal toxicological evidence linking long-term UFP exposure to nervous system effects, there is limited human data, represented by a single epidemiologic study, to support these effects.
- For all other health effect categories, animal toxicological studies and controlled human exposure studies provide limited, and in some instances inconsistent, evidence of effects due to short- or long-term UFP exposure contributing to limited coherence and biological plausibility.
- There is evidence of translocation of UFPs outside of the respiratory tract to the circulation and to the brain via the olfactory nerve. With respect to the brain, it is unclear whether this translocation occurs in humans as well as in animals. There is also uncertainty surrounding the mechanisms and degree to which particles translocate from the respiratory tract to the brain; however, translocation of particles to the brain may not be required for UFP-related nervous system effects.
- For health effects where it was concluded that the evidence is *suggestive of, but not sufficient to infer, a causal relationship* limitations and uncertainties in the evidence base remain, while for health effects where it was concluded *inadequate to infer the presence or absence of a causal relationship*, few or no epidemiologic and experimental studies examined the relationship between short- or long-term UFP exposures.

Welfare Effects Evidence: Key Findings

A large body of scientific evidence spanning many decades also demonstrates there are welfare effects attributed to PM. This collective body of evidence contributed to the causality determinations detailed in Chapter 13 of this ISA for each of the nonecological welfare effects evaluated (see Table 1-4). Examples of the key findings in the welfare effects evidence considered in this PM ISA include:

- Recent studies further confirm evidence from previous assessments supporting the strong relationship between PM and the nonecological welfare effects of visibility impairment, effects on climate, and materials damage.
- For visibility impairment and materials damage there is extensive evidence demonstrating the relationship between PM and light extinction and PM effects on stone, respectively.
- While there is substantial evidence indicating that PM affects the climate system, specifically through radiative forcing, there are still substantial uncertainties in key processes, such as interactions between clouds and aerosols and the indirect impacts and feedbacks in the climate system due to the radiative effect of PM.

References

Chan, EAW; Gantt, B; McDow, S. (2018). The reduction of summer sulfate and switch from summertime to wintertime PM2.5 concentration maxima in the United States. Atmos Environ 175: 25-32. http://dx.doi.org/10.1016/j.atmosenv.2017.11.055.

U.S. EPA (U.S. Environmental Protection Agency). (2009). Integrated science assessment for particulate matter [EPA Report]. (EPA/600/R-08/139F). Research Triangle Park, NC: U.S. Environmental Protection Agency, Office of Research and Development, National Center for Environmental Assessment- RTP Division. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=216546.

U.S. EPA (U.S. Environmental Protection Agency). (2013). Integrated science assessment for ozone and related photochemical oxidants [EPA Report]. (EPA/600/R-10/076F). Research Triangle Park, NC: U.S. Environmental Protection Agency, Office of Research and Development, National Center for Environmental Assessment-RTP Division. http://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=247492.

U.S. EPA (U.S. Environmental Protection Agency). (2014). Notice of workshop and call for information on integrated science assessment for particulate matter. Fed Reg 79: 71764-71766.

U.S. EPA (U.S. Environmental Protection Agency). (2015). Preamble to the integrated science assessments [EPA Report]. (EPA/600/R-15/067). Research Triangle Park, NC: U.S. Environmental Protection Agency, Office of Research and Development, National Center for Environmental Assessment, RTP Division. https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=310244.

U.S. EPA (U.S. Environmental Protection Agency). (2018). Integrated science assessment for oxides of nitrogen, oxides of sulfur and particulate matterecological criteria (2nd external review draft). (EPA/600/R-18/097). Research Triangle Park, NC: U.S. Environmental Protection Agency, Office of Research and Development, National Center for Environmental Assessment. http://cfint.rtpnc.epa.gov/ncea/prod/recordisplay.cfm?deid=340671.

CHAPTER 1 INTEGRATED SYNTHESIS

Overall Conclusions of the Particulate Matter (PM) Integrated Science Assessment (ISA)

- Recent evidence spanning scientific disciplines (i.e., atmospheric chemistry, exposure science, dosimetry, epidemiology, controlled human exposure, and animal toxicology) builds upon evidence detailed in the 2009 PM ISA and reaffirms a *causal relationship* between short- and long-term $PM_{2.5}$ exposure and cardiovascular effects and total (nonaccidental) mortality, and a *likely to be causal relationship* for respiratory effects.
- Recent experimental and epidemiologic evidence supports a *likely to be causal relationship* between long-term $PM_{2.5}$ exposure and nervous system effects.
- Recent evidence, primarily from studies of lung cancer incidence and mortality, in combination with the decades of research on the mutagenicity and carcinogenicity of PM supports a *likely to be causal relationship* between long-term $PM_{2.5}$ exposure and cancer.
- Remaining uncertainties and limitations in the scientific evidence contribute to a *suggestive of, but not sufficient to infer, a causal relationship* and *inadequate to infer the presence or absence of a causal relationship* for all other exposure, size fraction, and health effects category combinations.
- Recent evidence builds upon and reaffirms that there is a *causal relationship* between PM and the nonecological welfare effects: visibility impairment, climate effects, and materials effects.
- The assessment of PM sources and components confirms and continues to support the conclusion from the 2009 PM ISA: *Many $PM_{2.5}$ components and sources are associated with many health effects, and the evidence does not indicate that any one source or component is more strongly related with health effects than $PM_{2.5}$ mass*.
- Many populations (e.g., healthy, diseased, etc.) and lifestages (e.g., children, older adults, etc.) have been shown to be at risk of a health effect in response to short- or long-term PM exposure, particularly $PM_{2.5}$. However, of the populations and lifestages examined, current scientific evidence indicates that only some populations may be at *disproportionately increased risk* of a $PM_{2.5}$-related health effect, including nonwhite populations, children, people with specific genetic variants in genes in the glutathione transferase pathway, people who are overweight or obese, people with pre-existing cardiovascular and respiratory diseases, people of low socioeconomic status (SES), and people who smoke or were former smokers. Inadequate evidence exists to determine whether having diabetes, being in an older lifestage (i.e., older adults), residential location (including proximity to source and urban residence), sex, or diet increase the risk of $PM_{2.5}$-related health effects.

1.1 Introduction

1.1.1 Purpose

The subsequent chapters of this ISA evaluate and characterize in detail the current state of the science with respect to the health and nonecological welfare effects[38] from exposure to particulate matter (PM). The overall scope of the ISA, which governs the types of studies considered in evaluating the scientific evidence, is detailed in the Preface. Aspects specific to identifying, through literature searches,

[38] Hereafter welfare effects refers to nonecological welfare effects, unless otherwise noted. The ecological effects resulting from the deposition of PM and PM components are being considered in a separate assessment as part of the review of the secondary (welfare-based) NAAQS for oxides of nitrogen, oxides of sulfur, and PM (U.S. EPA, 2018).

Exhibit B to Oppenheimer Decl.

Martin, R.; Dowling, K.; Pearce, D.; Sillitoe, J.; Florentine, S. Health Effects Associated with Inhalation of Airborne Arsenic Arising from Mining Operations. Geosciences 2014, 4, 128-175 (available at https://doi.org/10.3390/geosciences4030128).

Geosciences **2014**, *4*, 128-175; doi:10.3390/geosciences4030128

OPEN ACCESS

geosciences

ISSN 2076-3263

www.mdpi.com/journal/geosciences

Review

Health Effects Associated with Inhalation of Airborne Arsenic Arising from Mining Operations

Rachael Martin [1,*], Kim Dowling [1], Dora Pearce [1,2], James Sillitoe [3] and Singarayer Florentine [1]

[1] Faculty of Science, Federation University Australia, University Drive, Mt Helen, VIC 3350, Australia; E-Mails: k.dowling@federation.edu.au (K.D.); dpearce@unimelb.edu.au (D.P.); s.florentine@federation.edu.au (S.F.)

[2] Centre for Epidemiology and Biostatistics, Melbourne School of Population and Global Health, Faculty of Medicine, Dentistry and Health Sciences, The University of Melbourne, Level 3, 207 Bouverie Street, Melbourne, VIC 3010, Australia

[3] Research and Innovation, Federation University Australia, University Drive, Mt Helen, VIC 3350, Australia; E-Mail: j.sillitoe@federation.edu.au

* Author to whom correspondence should be addressed; E-Mail: r.martin@federation.edu.au; Tel.: +61-353-276-402; Fax: +61-353-279-017.

Received: 30 June 2014; in revised form: 25 July 2014 / Accepted: 29 July 2014 / Published: 13 August 2014

Abstract: Arsenic in dust and aerosol generated by mining, mineral processing and metallurgical extraction industries, is a serious threat to human populations throughout the world. Major sources of contamination include smelting operations, coal combustion, hard rock mining, as well as their associated waste products, including fly ash, mine wastes and tailings. The number of uncontained arsenic-rich mine waste sites throughout the world is of growing concern, as is the number of people at risk of exposure. Inhalation exposures to arsenic-bearing dusts and aerosol, in both occupational and environmental settings, have been definitively linked to increased systemic uptake, as well as carcinogenic and non-carcinogenic health outcomes. It is therefore becoming increasingly important to identify human populations and sensitive sub-populations at risk of exposure, and to better understand the modes of action for pulmonary arsenic toxicity and carcinogenesis. In this paper we explore the contribution of smelting, coal combustion, hard rock mining and their associated waste products to atmospheric arsenic. We also report on the current understanding of the health effects of inhaled arsenic, citing results from various toxicological, biomedical and epidemiological studies. This review is particularly aimed at

those researchers engaged in the distinct, but complementary areas of arsenic research within the multidisciplinary field of medical geology.

Keywords: aerosol; arsenic; coal; dust; epidemiology; cancer; mining; smelting; tailings

1. Introduction

Arsenic is the 20th most abundant element in the earth's crust and may be released into the atmosphere as a result of natural processes and anthropogenic activities [1]. Environmental arsenic is released via chemical and physical weathering processes, biological activity and volcanic emissions, while anthropogenic sources include mining, metal smelting and burning of coal. Annual global arsenic emissions are estimated to be 24,000 t [2], with around 60% originating from copper smelting and coal combustion alone [3]. In some urban and highly industrialized areas, less than 2% of the atmospheric arsenic inputs originate from natural sources [3].

Emissions of arsenic-bearing particulate matter (PM) are of particular concern for human populations living in proximity to an emission source. Arsenic and inorganic arsenic compounds are classified as Group 1 carcinogens and are associated with cancers of the lung, bladder, kidney, skin, liver and prostate [2]. It should be noted that within the general population, inhalation is only considered a minor exposure pathway for inorganic arsenic compounds, and ingestion is considered the primary exposure pathway [2]. However, populations living in the vicinity of an arsenic emission source have an increased risk of additional exposure through inhalation of arsenic-contaminated particulates [4–9].

Despite their substantial contribution to global atmospheric arsenic species, mining operations play an understudied role in the generation of contaminated dust and aerosols [10]. To identify some of the emerging issues associated with arsenic in particulate matter this review presents key findings from a range of distinct but complimentary areas of research within the multidisciplinary field of medical geology, including geochemistry, toxicology, biomedicine and epidemiology. We will discuss two key themes: (i) the origin, occurrence and current monitoring of mining-related arsenic in the atmosphere; and (ii) the current understanding of the health effects of inhaled arsenic, citing results from various toxicological, biomedical and epidemiological studies.

2. Mining Operations as a Source of Airborne Arsenic

For brevity, the term "mining operations" is utilized throughout this paper to include all mining and mining-related activities including extraction, mechanical and high temperature processing, transportation, and storage of mine waste products. To compare or describe the impacts of different types of mining operations, specific mining terms are used.

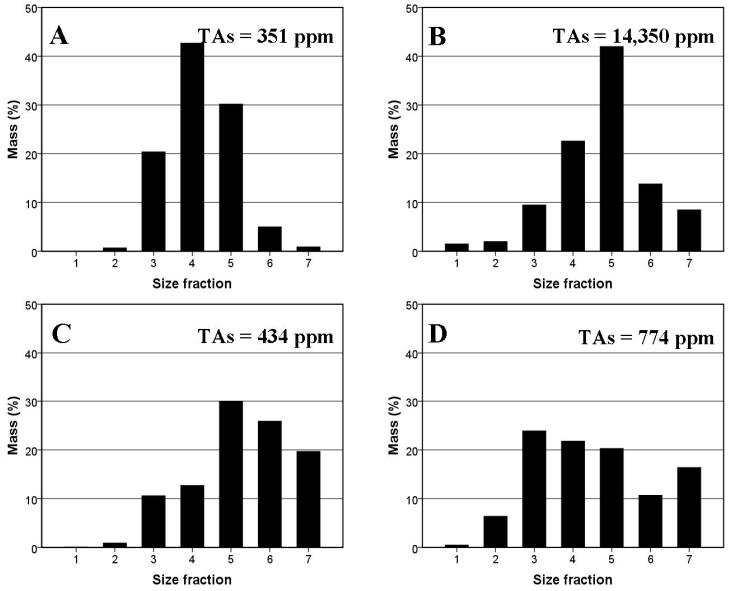
2.1. Generation of Dust and Aerosol: An Overview

Mining operations release arsenic into the atmosphere via wind-borne dispersal of arsenic-laden particulates [11], with dust being the dominant transport medium for these emissions [3]. Active mining operations produce and/or mobilize dust to varying degrees in all stages of the mining process:

during the removal of overburden; in all aspects of the handling of ore, including its extraction, transportation and further processing; as part of waste disposal operations; and as a result of wind erosion of exposed areas [12–15]. Mining operations associated with an opencut coal mining operation in India, for example, generate 9.4 t of dust per day [16]. Active and abandoned mine tailings, mine sites and processing facilities also represent important sources of dust [17–22].

To demonstrate the potential for mine tailings to generate dust emissions, Figure 1 compares the total mass distribution (%) by particle size fraction of four different types of arsenic-bearing gold mine tailings in an historical mining region in regional Victoria, Australia. Comparable with the findings of a Californian-based study [21], our data suggest that mine tailings in this locality may contain up to 45% dust (particles ≤ 100 μm), as recorded in the fine-grained battery sand (Figure 1C). Future analysis may reveal the relationship between total arsenic concentration and particle size in these mine tailings samples.

Figure 1. Percentage mass distribution by particle size fraction for historical mine tailings including: (**A**) coarse battery sand; (**B**) red calcine sand; (**C**) fine battery sand; (**D**) composite coarse/fine battery sand. Size fractions Size fractions 1: >2000 μm; 2: 1000–2000 μm; 3: 500–1000 μm; 4: 250–500 μm; 5: 100–250 μm; 6: 53–100 μm; 7: ≤53 μm. Total arsenic (TAs) concentration (ppm) of each mine waste sample is also shown. (Our results obtained using a modified sieving method protocol described by Kim *et al.* [21]).



While most mining operations generate coarse dust, high temperature processes, such as smelting and coal combustion, are typically associated with fine particulates, accumulation-mode particulates, and vapors [10]. Coarse particles (≥2.5 μm diameter) are produced by mechanical processes such as the crushing and grinding of ore, and may be resuspended via wind erosion and mechanical disturbance [10,23]. Fine (≤2.5 μm) and accumulation mode particles (0.1–2.5 μm) are produced during smelting and combustion through the condensation of high temperature vapors, diffusion and coagulation [10,23].

Coarse and fine particulates have widely varying atmospheric residence times, and as a result, widely varying distributions. Arsenic associated with the fine fraction may remain in the atmosphere between seven [24] and up to 10 days (reviewed in Matschullat [3]), and can travel long distances [25].

Coarse particulates have a much shorter atmospheric residence time, typically minutes to hours due to a larger settling velocity [10]. Particle segregation of mine waste can occur during airborne transport, thereby reducing the size of the individual particles deposited [17]. In addition to mining operation type, atmospheric contaminant concentrations are also influenced by the distance and position of a sampling site in relation to the source, the height of the source (e.g., chimney or tailings pile), the type of dust suppression or flue gas cleaning, the exit velocity of the flue gas, and the prevailing wind speed [26] as well as changes in industrial technologies [27].

2.2. Origin, Production and Release of Particulate Arsenic

It is widely accepted that global atmospheric arsenic fluxes are dominated by mining-related industries involving high temperature processing [3]. An estimated 60% of global anthropogenically-generated atmospheric arsenic is attributed to copper smelting and coal combustion, with annual outputs of 12,080 and 6240 t respectively [3]. While it is well-documented that mine tailings represent major sources of arsenic-contaminated dust throughout the world [10,19,28,29], the contribution by these sources to total global atmospheric arsenic fluxes is yet to be assessed [3]. The occurrence of arsenic-bearing phases in unprocessed ore and the generation of particulate arsenic by different types of mining processes will be reviewed in the following sub-sections.

2.2.1. Smelting Operations

Gold, copper, lead and zinc ores typically contain arsenic-bearing minerals such as pyrite (FeS_2), galena (PbS), chalcopyrite ($CuFeS_2$) and the dominant arsenic-bearing mineral, arsenopyrite (FeAsS), which contains approximately 46% arsenic by weight [2]. The high temperature purification of arsenic-bearing ores during smelting and roasting volatilizes arsenic [30,31], and the resultant vapors may contain up to 95% arsenic [32]. Arsenic in close proximity to smelters and roasters is typically arsenic trioxide in particulate form [33,34], and depending on the feed material and extraction process, flue dusts can contain up to 30% arsenic trioxide [35,36]. Fugitive emissions of particulate arsenic may occur at various stages of high temperature processing, as well as during the transport and storage of ores, concentrates and waste heaps [37].

Although high efficiency control devices are often employed in smelters to reduce emissions, the quantity of total arsenic emitted from a single smelting operation can be substantially high. For example, around 300 t of arsenic are emitted annually from the Copper Smelter Complex Bor, in eastern Serbia [38]. Furthermore, uncontained smelter flue dusts represent an important potential source of airborne arsenic, compared with other secondary smelter by-products [39]. Over a period of 20 years, a copper smelter in Japan produced an estimated 9000 t of arsenic-rich flue dust (19.5 wt % of As) which is currently stockpiled at an undisclosed location in Japan [32]. Stockpiled by-products of the smelting process with high arsenic content present ongoing sources for redistribution.

2.2.2. Coal Combustion

Coal is a complex mixture of organic and inorganic compounds formed over millions of years from successive layers of fallen vegetation. Coal contains detectable levels of the vast majority of elements in the periodic table, including arsenic and other potentially toxic and environmentally sensitive

elements [40,41]. Although much of the arsenic in coal is associated with the inorganic or mineral fraction (such as pyrite and other sulphide minerals), a significant portion is associated with organic matter [42,43]. Arsenic concentrations in coal typically range between 1–10 and 1500 $mg \cdot kg^{-1}$, but concentrations as high as 32,000 $mg \cdot kg^{-1}$ have been reported in some super-enriched coal samples (reviewed in Kang *et al.* [42]). Arsenic in coal occurs in three non-exclusive distinct forms: arsenical pyrite, arsenopyrite and arsenate species [44,45].

During coal combustion, arsenic readily oxidizes to form arsenic oxide vapor [44] which combines with calcium oxide and condenses on the surface of fly ash particles in the form of calcium arsenate [46–48]. The inverse correlation between arsenic concentration and particle size which has been observed demonstrates that volatilized arsenic preferentially adsorbs or condenses on the finer particles [31]. Furthermore, higher combustion temperatures result in higher concentrations of particulate arsenic. For example, an increase in total arsenic concentration in PM_1 (particulate matter <1 μm) from 0.07 to 0.25 $mg \cdot m^{-3}$ at respective temperatures of 1100 and 1400 °C was reported in one study [48].

Solid by-products of the combustion process, including fly ash and bottom ash, are major sinks for arsenic. An estimated 90% to 100% of arsenic is captured in coal combustion by-products [49], with a preferential enrichment (up to 80%) for the fly ash component (reviewed in Yudovich and Ketris [50]). Removal efficiencies of arsenic by particulate control systems such as cyclones, electrostatic precipitators, wet scrubbers and fabric filters range between 43% and 99%, depending on the control device used [51]. An early study by Ondov *et al.* [52] reported that arsenic penetration through electrostatic precipitators (ESP) and wet scrubbers may be as high as 8.8% and 7.5%, respectively. Despite the widespread use of ESPs in Europe, a reported 575 t of arsenic were emitted from the combustion of coal during 1990 [35]. Similarly, in China around 550 t of arsenic were emitted from coal-fired power plants during 2007 [51]. Arsenic emissions arising from coal burning industries are an ongoing issue of global significance.

2.2.3. Mine Tailings

Fugitive dust emissions from mine wastes and mechanical processes associated with the hard rock mining industry such as crushing of sulphide ore and concentrates, and mechanical disturbance and wind erosion of uncontained mine tailings [10,53] are also associated with elevated levels of arsenic [17–19,54]. This is not surprising given that mine wastes and tailings are often characterized by extremely high arsenic concentrations. Concentrations in tailings ranging between 2250 and 21,400 $mg \cdot kg^{-1}$ have been detected in the Zimapan mining district in Mexico [55], and in some historical gold mine waste disposal areas in Victoria, Australia, concentrations of up to 15,000 $mg \cdot kg^{-1}$ have been recorded [56]. The preferential enrichment of arsenic in the finer size fraction in mine tailings [21,57] suggests that re-suspended dusts are characterized by higher arsenic content than the material from which it is suspended.

2.3. A Global Issue

The magnitude of the problems associated with arsenic contamination from mining operations is a serious ongoing issue in many localities throughout the world, and there are no indications of abatement. If the projected increase in global copper production over the next 20 years is correct [58], it could be reasonably expected that smelter emissions, and the generation of flue dust and other

associated waste products, will also increase [39]. Furthermore, despite an overall increase in the number of coal plant retirements in some localities [59], the global demand for coal is predicted to rise at a rate of 1.3% per year, from 147 quadrillion Btu in 2010 to 180 quadrillion Btu in 2020 and 220 quadrillion Btu in 2040 [60]. Expansion of coal consumption reflects substantial increases in China and India [60]. In India, arsenic-contaminated fly ash from coal combustion processes occupies more than 65,000 acres, rendering the surrounding land unsuitable for agriculture [61].

Although not increasing substantially, the number of abandoned mines worldwide runs into millions [62], and their impact is likely to increase due to population growth and urban expansion. In the United States of America, 80% of an estimated 46,000 known abandoned mine sites require further investigation and/or remediation [63]. In Australia, there are more than 50,000 registered abandoned mines ranging from isolated minor surface works to more extensive and complex sites [64,65] In Mexico, the area affected by mining activities is estimated to be over 21.7 million hectares [66]. Each year in China the mining industry produces wastes that occupy an additional 2000 ha [67], and around 4000 Mt of tailings are stockpiled on land that is urgently needed for other purposes [68].

Given the widespread geographical distribution of arsenic-rich mine wastes and the global reliance on smelting and coal combustion for various products and services, the systematic characterization and ongoing monitoring of particulate arsenic generated by mining operations are becoming increasingly important for reliably determining the impacts on human health and the environment [45].

3. Monitoring and Assessment

A number of monitoring and assessment studies have been undertaken for different purposes: (i) to identify the dominant emissions sources of arsenic; (ii) to predict the potential contribution of an identified arsenic emission source to the atmosphere; and (iii) to identify the airborne arsenic species (Table 1). For monitoring and reporting purposes, atmospheric total arsenic concentrations are often compared with the annual mean target value of 6 $ng \cdot m^{-3}$, as set by current European Union air quality standards [69]. According to the World Health Organization (WHO) [70], the excess lifetime risk of contracting lung cancer if continuously exposed to 6.6 $ng \cdot m^{-3}$ is 1:100,000.

The different methodologies used to collect PM from mining operations are reflected in the contrasting size fractions and reporting units listed in Table 1. Air monitoring programs use various types of sampling equipment to collect PM, and the arsenic content of the PM is typically reported in terms of $ng \cdot m^{-3}$. Measurement of total suspended particulates (TSP) was the United States of America standard for atmospheric aerosol until the discovery of the relationship between particle size and lung deposition of inhaled particles [71].

The smaller the particle, the deeper it will travel into the respiratory tract (RT) and PM_{10} (particulate matter $\leq$10 μm) represents the upper limit for tracheobronchial and alveolar deposition in the human lung [72]. To meet the new PM_{10} health-based standard (adopted by the USA, Europe and elsewhere during the mid to late 1980s), collection devices such as the cascade impactor and multiple orifice uniform deposit impactor (MOUDI) have been used in various atmospheric monitoring studies [10,18,54]. These sampling systems are designed to collect a pre-selected suite of aerodynamically-fractionated samples which enables a systematic investigation into the arsenic content of particulates of interest to health. The relationship between particle size and human exposure will be reviewed in detail in Section 4.

Particulate arsenic may also be measured in size-fractionated mine waste samples generated through dry sieving bulk samples [21,57]. Similar to the cascade impactor mentioned above, this method facilitates a systematic characterization of collected mine waste samples but reports the concentrations in terms of $\mu g \cdot g^{-1}$. While this technique cannot provide a quantitative assessment of atmospheric arsenic at a particular location, the data may be useful for predicting potential particulate arsenic emissions from the source.

Atmospheric arsenic concentrations vary between localities and the type of emission source (Table 1). The following sub-sections examine the contribution of each emission source to atmospheric arsenic levels in various localities throughout the world.

3.1. Smelting

Much of the atmospheric arsenic research and monitoring published to date has focused on emissions from smelting operations. This reflects the dominant contribution by smelter emissions to global anthropogenic atmospheric arsenic inputs. As reviewed in Matschulatt [3], copper and zinc smelting activities contribute of 12,800 and 2210 t of arsenic respectively into the atmosphere per year, whereas steel production contributes a comparatively lower annual quantity of 60 t per annum. It should also be noted that in some industrial localities, smelting and other processes associated with the manufacturing of ceramic materials represent important sources of arsenic in the atmosphere [27]. Smelting operations produce the greatest localized air and soil arsenic concentrations while coal combustion distributes arsenic to the air in substantially lower concentrations over a wider area [73].

In the vast majority of case studies summarized in Table 1, concentrations exceeded, and in some cases, greatly exceeded, the annual WHO-prescribed target value [70]. In one extreme case, an average concentration of 330 $ng \cdot m^{-3}$ was reported in TSP collected approximately 1 km from a complex lead-copper smelter in Belgium [4]. Similarly, a maximum arsenic concentration of 572.3 $ng \cdot m^{-3}$ (mean, 93.9 $ng \cdot m^{-3}$) was recorded in TSP collected in the vicinity of a smelter in Walsall, UK, during an air monitoring program conducted between 1972 and 1989 [26]. Interestingly, a declining trend in atmospheric arsenic levels was reported at all of the UK monitoring locations, except the Walsall smelter site [26]. The authors postulated that widespread industrial switching from coal combustion to oil and gas as a domestic energy source for space heating was the probable cause for the overall decline in atmospheric arsenic in the UK [26]. Similar results were recorded in an industrial area in Spain, whereby reductions in atmospheric arsenic concentrations were significantly associated with decreases in industrial activities, specifically the production of ceramic materials [27].

Although the quantification of arsenic in TSP provides one measurement of arsenic contamination in the atmosphere, this measurement may underestimate the respiratory health risks to nearby communities due to the inverse relationship between particle size and arsenic content. After the introduction of particle size-selective criteria, various studies have measured and compared arsenic content in the PM_{10} and $PM_{2.5}$ fractions collected in the vicinity of smelting operations (Table 1). Data from these studies suggest a general trend for preferential enrichment in $PM_{2.5}$ [74–76]. For example, an air monitoring study conducted approximately 3.5 km from the Huelva copper smelter in southwestern Spain found that 85% of the total arsenic concentration in the PM_{10} size fraction was concentrated in $PM_{2.5}$ [77]. Similar studies conducted in the same locality yielded comparable results [74,75]. In contrast to these findings, one study reported that $PM_{2.5}$ collected in the vicinity of a

copper smelter in Tacoma, WA, USA, contained only 37% of the total arsenic in the PM_{10} fraction (calculated from Polissar *et al.* [78]). These results highlight the importance of site-specific investigations during health-based risk assessments.

The greatest atmospheric arsenic levels generated by smelting operations occur in close proximity to the smelter, and decrease with increasing distance from the source [4,76,77]. Multiple reports suggest that the maximum concentrations are typically found within 1 km of the smelter site [4,78–81]. Furthermore, declines in concentrations have been observed over a relatively short distances. For example, atmospheric arsenic levels at a distance of 1 and 2.5 km from a complex copper-lead smelter in Belgium were 330 and 75 $ng \cdot m^{-3}$, respectively [4]. These results were supported by a complementary soil-based study that documented an exponential decline in soil arsenic and heavy metal concentrations within 1 km of a lead smelter in the Czech Republic, followed by a less-steep decrease between 1 and 6 km [37].

Meteorological variables, particularly surface wind circulation, play a critical role in determining the transport and spatial distribution of the pollution plume from smelting operations [82]. Contrary to the general trend between concentration and distance from the emission source, Serbula *et al.* [81] reported average arsenic levels of 131.4, 51.3 and 93.7 $ng \cdot m^{-3}$ at respective increasing distances of 0.8 (town park), 1.9 (institute) and 2.5 km (Jugopetrol) from a copper smelter in Bor, eastern Serbia. Compared with the mid-distance sampling location (institute), the farthest sampling location (Jugopetrol, which is downwind from the pollution source) experienced high-frequency exposure to the emissions as a result of dominant WNW and NW winds. To further highlight the impact of prevailing wind direction, the maximum concentration reported at Jugopetrol was equal to the maximum recorded at the sampling location closest to the smelter (Table 1). Similar relationships between atmospheric arsenic (and other metals), and surface wind characteristics in the vicinity of copper smelters have been documented [74,83]. In addition to wind direction, wind speed plays an important role in determining particulate arsenic distribution from smelting operations. The greatest concentrations of arsenic (and other metallic elements) emitted from the copper smelter in Bor occurred during calm conditions (wind speed less than 0.5 m/s) [38]. Low wind speeds inhibit the dispersal of local pollution away from the emission source and can therefore lead to very high localized concentrations of atmospheric pollutants [38].

3.2. Coal Combustion

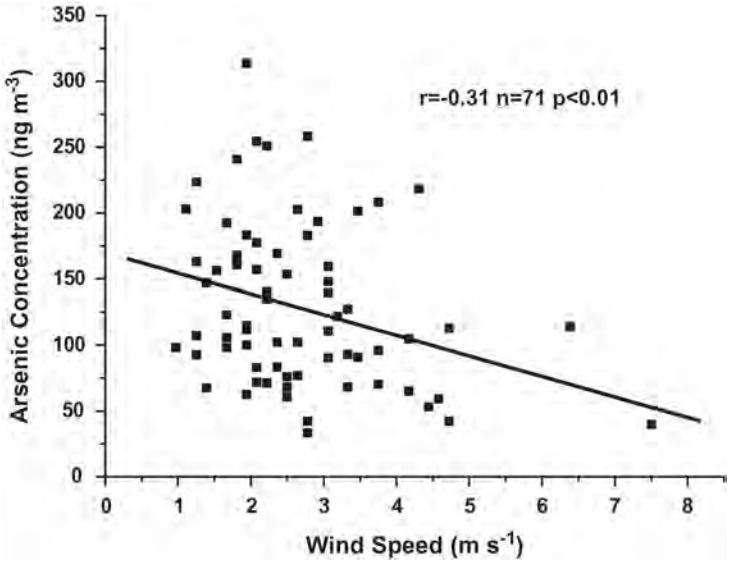
Global coal combustion contributes an estimated 6240 t of arsenic to the atmosphere each year, equating to approximately half the contribution from copper smelting [3]. Atmospheric arsenic concentrations in coal combustion emissions are generally lower and typically distributed over a wider area. As a possible result of these two factors, coal combustion as a source of atmospheric arsenic has received less attention in the literature compared with copper/zinc/lead smelting.

Much of the research into coal combustion as a source of atmospheric arsenic has been undertaken in China (Table 1), and a recent review article listed this source as one of the key contributors to atmospheric arsenic in this country [84]. The mean atmospheric arsenic concentration for 32 localities across China was 51 ± 67 $ng \cdot m^{-3}$ (range, 0.03–200 $ng \cdot m^{-3}$). However, in heavily industrialized areas such as around Beijing, concentrations may be substantially greater [9].

Given that high temperature processes are typically associated with fine and accumulation-mode particles, arsenic levels in PM_{10} and $PM_{2.5}$ are frequently reported [85–88]. Comparable average PM_{10} arsenic concentrations were recorded in Beijing (58.3 $ng \cdot m^{-3}$) and nearby Taiyuan (43.36 $ng \cdot m^{-3}$) whereas the average $PM_{2.5}$ concentration in Ji'nan (40 $ng \cdot m^{-3}$) was almost double that of Beijing (23.08 $ng \cdot m^{-3}$ Table 1). These values greatly exceed the recommended target value of 6 $ng \cdot m^{-3}$.

Wind conditions appear to play an important role in the dispersal of atmospheric arsenic emitted by coal combustion sources [9]. Consistent with the trend found in the vicinity of smelting operations, one study [9] reported a statistically significant negative correlation between atmospheric arsenic concentration and wind speed in Beijing, China ($R = -0.31$, $p < 0.01$; Figure 2).

Figure 2. Relationship between total atmospheric arsenic concentration and wind speed in Beijing, China, for the period February 2009 to March 2011. Reprinted from Yang *et al.* [9] with permission from Elsevier.



3.3. Mine Tailings

Research into mine tailings as a source of atmospheric arsenic has gained momentum in the last decade. Mine tailings have the potential to generate high levels of dust with extremely high atmospheric arsenic concentrations, particularly in arid and semi-arid environments [10]. The Rosh Pinah lead and zinc mine and ore processing plant in Namibia reported a maximum arsenic concentration of 9140 $ng \cdot m^{-3}$ (median, 4970 $ng \cdot m^{-3}$) in wind-blown dust from tailings that cover more than 60 ha and are more than 20 m high [89]. Comparable with the trend observed around smelting operations, the impact of mine tailings on atmospheric arsenic levels are typically greatest at the source [11,17,18,54]. At the Rosh Pinah mine and ore processing plant atmospheric arsenic levels decreased from 4970 $ng \cdot m^{-3}$ at the tailings dam to 60 $ng \cdot m^{-3}$ at a distance of 2.5 km from the mine [89]. This relationship is most likely a result of the short atmospheric residence time of coarse particles (≥2.5 μm) typically found in mine tailings [10].

Arsenic enrichment in the finer fractions of size-fractionated mine tailings has been reported [19,21,57]. Although these findings are not reflective of actual atmospheric arsenic emissions from a particular source, the finer size fractions are more susceptible to wind-borne transport and are most likely to be re-suspended by wind or mechanical disturbance. Kim *et al.* [21] examined the distribution of arsenic

concentration as a function of particle size in mine tailings samples collected from two different localities in the Randsburg historic mining district in south-central California, USA. Although there were distinct differences in the arsenic distributions amongst the wastes, there were obvious inverse relationships between grain size and arsenic concentration. The high arsenic content recorded in the dust size fraction of each sample (range, 356–8210 ppm) illustrates the potential of their corresponding sources to generate potentially hazardous emissions [21].

The effects of seasonality on particulate arsenic emissions from mine tailings have also been investigated. Meteorological factors associated with different seasons, especially rainfall and temperature, have been shown to have a dramatic impact on arsenic mobility through the air [54,90]. During the dry summer months in the City of Lavrion, Greece, concentrations of arsenic in PM_{10} increased dramatically (more than 6 times) compared with concentrations during late winter [54,90]. Similarly, a study in Aznalcazar, southwest Spain, found that sporadic rainfall and low convective atmospheric dynamics during the late winter were associated with relatively low re-suspension of PM from heavy metal mining wastes [54]. During summer, the combination of intensive convective circulation and low rainfall facilitates surface drying leading to enhanced re-suspension of PM. Low rainfall and decreased humidity lead to increased atmospheric particulates, and therefore, increased atmospheric arsenic concentration [90].

3.4. Arsenic Speciation in Particulate Matter

Environmental arsenic exists in four oxidation states including As(V), As(III), As(0) and As(-III) [91,92]. The most common forms of arsenic in the environment include the trivalent (arsenite) and pentavalent (arsenate) species [93], and they are often found occurring together [94,95]. Under oxidizing conditions, such as in surface soils and water, arsenic typically occurs in the pentavalent form [92], whereas in sufficiently reducing environments, or in the presence of a reducing agent, arsenite is the dominant form [94,96]. It is widely recognized that arsenite species have greater mobility in the environment [97] and are reported to be 25 to 60 times more toxic than the corresponding pentavalent forms [98]. Since the oxidation state of arsenic in soil, water, and other environmental matrices is one of the key factors governing toxicity, speciation analysis is of interest in human exposure studies.

Speciation analysis has been used widely for the identification and quantification of arsenic species in bulk samples of surface soils and mine wastes [94,95,99,100]. However, comparatively less work has been conducted in relation to arsenic speciation in atmospheric PM generated by mining operations [9,18,44,74–76,83]. Research conducted to date indicates that both arsenate and arsenite may co-exist in smelter, coal combustion and gold roaster emissions [9,44,45,74–76,83,94] although reported levels for the trivalent species are generally much lower than those for the arsenates (Table 1). For example, arsenate and arsenite concentrations in coal combustion emissions in China were 67 and 4.7 $ng \cdot m^{-3}$, respectively [9]. Similarly, Oliveira *et al.* [83] reported respective arsenate and arsenite concentrations of 10.4 and 1.2 $ng \cdot m^{-3}$ in copper smelter emissions in Spain. The presence of arsenite in smelter emissions may result from the reduction of arsenate by aerosol sulphur dioxide S(IV) complexes during transport of the emission plume [101].

Airborne monitoring programs combined with speciation analysis demonstrate clearly that airborne arsenic is a serious and ongoing issue in mining communities and heavily industrialized areas throughout the world.

Table 1. Summary of the average, minimum and maximum total arsenic (TAs) concentrations recorded in particulate matter (PM) from various mining operations, including smelting, coal combustion and mine waste. Values for TAs are expressed as nanogram per cubic meter ($ng \cdot m^{-3}$) unless otherwise specified. Where applicable, all units of distance measurement have been converted to metric system.

Source	Location	Size Fraction (Time Period)	Distance (km)	TAs (Min–Max)	As(III) (Min–Max)	As(V) (Min–Max)	Ref.
Pb-Cu smelter	Belgium	TSP (May–September 1978)	<1	330			[4]
			2.5	75			
Cu smelter	Tacoma, WA, USA	$PM_{2.5–10}$ (January 1985–Febrary 1986)	0.8	153.9 ± 269.4			[78]
		$PM_{2.5}$ (January 1985–Febrary 1986)		90.2 ± 170.7			
		$PM_{2.5–10}$ (January 1985–Febrary 1986)	10	3.7 ± 9.6			
		$PM_{2.5}$ (January 1985–Febrary 1986)		4.4 ± 3.6			
Cu smelter	Walsall, UK	TSP	<1	93.9 ± 89.7 (10.6–572.3)			[26]
Cu smelter	Quillota, Central Chile	PM_{10} (December 1999–November 2000)	≤40	32.5 ± 33.7 (1.7–196)			[102]
Cu smelter	Huelva, southwest Spain	TSP (January–December 2000)	2	12.3 ± 1.6 (3.0–33.8)	1.2 ± 0.3 (0.3–1.8)	10.4 ± 1.8 (2.1–30.6)	[83]
Cu smelter	Huelva, southwest Spain	PM_{10} (2001)	2	7.7 (1.6–29.4)	1.2 (0.6–2.2)	6.5 (0.01–25.7)	[75]
		PM_{10} (2002)		9.9 (1.3–79.8)	2.1 (0.4–3.4)	7.8 (0.01–56.2)	
Cu smelter	Huelva, southwest Spain	$PM_{2.5}$ (2001)	2	6.4 (0.8–30.2)	0.9 (0.01–1.6)	5.0 (0.01–25.3)	[74]
		$PM_{2.5}$ (2002)		7.9 (1.0–56.6)	1.4 (0.1–2.7)	6.6 (0.01–56.2)	
Cu smelter	Huelva, southwest Spain	PM_{10} (2004)	3.5	4.67 (max: 22.4)			[77]
		$PM_{2.5}$ (2004)	3.5	3.04 (max: 19.0)			
		PM_{10} (2005)	3.5	10.6 (max: 62.1)			
		$PM_{2.5}$ (2005)	3.5	9.18 (max: 60.3)			
Cu mining and smelter complex	Bor, eastern Serbia	PM_{10} (15–year average; 1994–2008)	0.8	131.4 (<2–669)			[81]
			1.9	51.3 (<2–356)			
			2.5	93.7 (<2–670)			
Cu mining and smelter complex	Bor, eastern Serbia	PM_{10} (24 March–1 April 2009)	0.65	32.97 ± 53.63 (2.4–149)			[38]
Ferromanganese plant	Dunkirk, France	PM_{10} (January 2003–March 2005)	2	5.1 ± 5.4 (0.5–35.1)			[103]
Cu smelter	Huelva, southwest Spain	$PM_{2.5}$ (16–22 October 2009)	5	2.1 ± 4.2 (0–20)			[82]

Table 1. *Cont.*

Source	Location	Size Fraction (Time Period)	Distance (km)	TAs (Min–Max)	As(III) (Min–Max)	As(V) (Min–Max)	Ref.
Complex Cu smelter	Tsumeb, Namibia	PM_{10} (2010–2011)	Smelter boundary	310			[80]
			Low exposure site	190			
Coal combustion	Beijing, China	PM_{10} (2001 and 2006)	12 sites across city	58.3 ± 60			[86]
Coal combustion	Beijing, China	TSP (February 2009–March 2011)	n.a.	130 ± 60 (30–310)	4.7 ± 3.6 (0.73–20)	67 ± 35 (14–250)	[9]
Coal combustion	Beijing, China	$PM_{2.5}$ (December 2012–January 2013)	n.a.	23.08			[85]
Coal combustion	Taiyuan, China	PM_{10} (2–16 March 2004)	n.a.	43.36 ± 27.61 (11.98–82.55)			[87]
Coal combustion	Ji'nan, eastern China	$PM_{2.5}$ (17–28 September 2010)	5	40 ± 40			[88]
Coal mine (raw coal)	Southwest Virginia, USA	PM_{10} (7 August 2008)	0.3	0.958			[12]
			1.6	0.735			
Gold mine tailings	Rodalquilar, southeastern Spain	PM_{10}	n.a.	1581 ppm			[19]
		Mechanically re-suspended in lab, n=2		1368 ppm			
Pb-Zn mine	Rosh Pinah, Namibia	TSP	0	4970 (2800–9140)			[89]
		Tailings dam	0	280 (130–920)			
		Ore treatment plant	1.5	30 (30–70)			
			2.5	60 (20–80)			
Cu-Pb-Zn mine tailings	Aznalcazar, South Spain	TSP (20 May–27 December 1998)	0	221 (4.9–2681)			[54]
			0.5	69 (2–921)			
Historical Ag-Pb mine tailings	City of Lavrion, Greece	PM_{10} Overall average	1	520 (1–3031)			[90]
		Winter		115 (1–791)			
		Summer		909 (121–3031)			
Abandoned Au mine tailings	Nova Scotia, Canada	>16 µm (2004)	0	8200		Present but not quantified	[18]
		16–8 µm (2004)		2020			
		8–4 µm (2004)		631			
		4–2 µm (2004)		337			
		2–1 µm (2004)		58.3			
		1–0.5 µm (2004)		13.3			

Table 1. *Cont.*

Source	Location	Size Fraction (Time Period)	Distance (km)	TAs (Min–Max)	As(III) (Min–Max)	As(V) (Min–Max)	Ref.
Former Au mine tailings	Yellowknife, Canada	TSP (July–September 2004)	<1	19 (1–76)			[104]
		PM_{10} (July–September 2004)		6 (1–15)			
Different mine waste types	Butte, Montana, USA	PM_{10} Mine waste type 1	n.a.	406 ppm			[57]
		PM_{10} Mine waste type 2		467 ppm			
		PM_{10} Mine waste type 3		469 ppm			
		PM_{10} Mine waste type 4		769 ppm			
Ag-Au mine tailings	Descarga mine tailings site, USA	>2830 µm	n.a.	203 ppm			[21]
		2830–1700 µm		452 ppm			
		1700–1000 µm		976 ppm			
		1000–500 µm		1870 ppm			
		500–250 µm		2650 ppm			
		250–125 µm		3790 ppm			
		125–75 µm		3650 ppm			
		75–45 µm		4720 ppm			
		45–32 µm		7060 ppm			
		32–20 µm		8210 ppm			
Pb-Zn mine waste	Oklahoma, USA	PM2.5 (July–September 2005)	<1	0.64 ± 0.48			[11]
			5	0.62 ± 0.32			
			18	0.56 ± 0.33			
Cu-Au-Ag mine waste	Rio Tinto mines, Spain	Total bulk deposition (March 2009–February 2010/March 2010–February 2011)	0	4.4/2.1 $mg \cdot m^{-2}$			[17]
			0.5	0.7/0.5 $mg \cdot m^{-2}$			
			1.5	0.7/1.0 $mg \cdot m^{-2}$			
Smelter & coal combustion	China (various localities)	Average of PM10, PM2.5 TSP and dust		51.0 ± 67			[84]
Smelter & other industries	Aspropyrgyros Greece	TSP (December 2004–June 2006)	n.a.	3.4 ± 0.3	<0.2	3.2 ± 0.4	[76]
		PM_{10}–$PM_{2.5}$ (December 2004–June 2006)		1.9 ± 0.3	<0.2	1.7 ± 0.4	
		$PM_{2.5}$ (December 2004–June 2006)		1.1 ± 0.3	<0.2	1.0 ± 0.4	

4. Human Exposure

Communities living in the vicinity of mining operations may be exposed to airborne arsenic-contaminated particulates and be at risk of health deterioration though absorption after dermal and eye contact, or by ingestion after inhalation [28]. However, arsenic absorption through the skin following dermal and eye contact is a minor contributor compared with ingestion and inhalation exposures [25] and will not be further discussed here. Furthermore, incidental ingestion of arsenic-contaminated particulates, usually as a result of contaminated food or water supplies, has been the most thoroughly investigated pathway, and its significant range of adverse effects have been well documented following acute, intermediate and chronic exposures [25], negating the need for further detailed review here.

For the general population, ingestion is typically considered the primary exposure pathway to arsenic, and inhalation of arsenic bearing PM has been considered to be a minor exposure route [2]. The relatively neglected topic of inhalation exposure with consequent issues linked to airborne PM containing arsenic species from proximate mining industries needs to be addressed. For example, exposure assessments of communities living in the vicinity of smelting and coal combustion operations suggest that inhalation may play a similar, if not more important role than ingestion, in the overall exposure to airborne particulate arsenic [4,105–107]. In addition, it has been shown that children are particularly susceptible to inhalation exposure due to: (i) their increased likelihood of coming into contact with dust [78]; and (ii) children inhale a greater volume of air than adults relative to their size [108].

Therefore, in the following sections we will consider some of the ways in which inhaled arsenic-contaminated particulates generated by mining operations may lead to systemic absorption, toxicity, and arsenic-related disease endpoints. In order to understand how arsenic becomes mobile (or bioavailable) and exerts its toxic effects in the human body, we will begin with a discussion on the fate of inhaled particles in the RT with particular emphasis on the role that particle size plays in determining the ultimate absorption or defense mechanisms.

4.1. Deposition Location and Particle Clearance from the Respiratory Tract (RT)

The location and manner in which PM is deposited in the RT are critical for understanding how the arsenic-bearing particles might react with different lung constituents. When PM is inhaled, a proportion of the particles are retained while the remainder are expelled via exhalation. Retained particles are deposited in different regions of the RT according to their size [109–111] and as a general rule, the smaller the particle the deeper it will penetrate into the RT and the longer it will be retained (Table 2; [72,112]). To protect the body against foreign materials, the human respiratory system has developed a range of physiological lines of defense [113,114]. We will review the deposition location of inhaled particles as a function of particle size, the methods of clearance from each location, and pathways for absorption. When referring to the different "deposition regions", we use the morphometric model described by the International Commission on Radiological Protection [115]. This model divides the human RT into three major anatomical regions: (i) the extra-thoracic; (ii) the tracheobronchial, and; (iii) the alveolar, which are modeled deposition locations for the inhalable, thoracic and respirable particulate size fractions, respectively [116].

Table 2. Deposition of PM_{10} in different regions of the human respiratory tract [115,116] as a function of particle size (data from Newman [72]), including the estimated retention time of the particle size in each deposition location (data from Bailey [112]).

Anatomical Region (Corresponding Particulate Size Fraction)	PM Size (μm)	Deposition Location	Retention Time
Extra-thoracic (Inhalable)	7–10	Nasal passage	1 day; small fraction may be retained for longer
	5–7	Pharynx	Few minutes
Tracheobronchial (Thoracic)	3–5	Trachea	Few minutes
	2–3	Bronchi	Hours to weeks
	1.0–2.5	Terminal bronchioles	Hours to weeks
Alveolar (Respirable)	0.5–1.0	Alveoli	50 to 7000 days

4.1.1. Extra-Thoracic Region (Inhalable Particulate Fraction)

The inhalable particulate fraction (particles up to 10 μm in size) consists of particles that can be deposited into the extra-thoracic region and become trapped in the nasal cavity [109], mouth [116] and pharynx [117]. The vast majority of particles deposited in the extra-thoracic region are removed via a combination of nose-blowing, sneezing and mucociliary transport to the gastrointestinal (GI) tract [117]. Nose-blowing clears from 0.5% to 50% of particles from the front of the nose, while the remainder is slowly cleared into the GI tract [117]. Particles in the pharynx may reach the GI tract within one hour following deposition [117], and a very small proportion (around 0.05%) may be absorbed directly via the pharynx epithelium and cleared into the blood or lymphatic system [117]. Ingestion is therefore the dominant exposure pathway to particles deposited in the extra-thoracic region.

4.1.2. Tracheobronchial Region (Thoracic Particulate Fraction)

The thoracic particulate fraction is comprised of particles (1–5 μm in size) that penetrate the extra-thoracic region [116] and deposit in the tracheobronchial region. This region consists of the trachea, bronchi and terminal bronchioles [115]. Particles deposited here are of particular importance because lung carcinomas occur preferentially in the bronchial airways [110]. Particles trapped in the mucous produced by the bronchial epithelial cells are typically cleared by mucociliary transport into the throat, and then expectorated or swallowed [28,114,118]. While it is generally accepted that mucociliary transport is the principal clearance mechanism in the first 24 h [118], the rate of clearance depends upon on the clearance velocity of the mucous, particle shape, charge and surface geochemistry [119]. Furthermore, the ciliary movement is ineffective if the mucous is not of the correct viscosity due to illness or pharmacological action [109]. Other clearance mechanisms from the tracheobronchial region include coughing, absorption through airway epithelium into the blood or lymphatic system, and phagocytosis [113,118], and depending on the method of clearance, particles can be retained in the RT for weeks (Table 2; [112]). As described in sub-Section 4.2, the solubility of the particle plays an important role in determining which clearance mechanism is employed and the duration of the retention.

4.1.3. Alveolar Region (Respirable Particulate Fraction)

Airborne particles ≤1 μm can be deeply inhaled into the unciliated airways of the lung (the alveolar region) and absorbed directly into the pulmonary circulation system [113]. Alternatively, these particles may be phagocytosed and cleared by alveolar macrophages, and then either absorbed into regional lymph nodes via lymphatic vessels [120] or transported into the ciliated airways and cleared via mucociliary transport [121]. This latter process may take weeks to months to complete [122]. Alveolar macrophages are important cells of the immune system, exhibiting major phagocytic abilities and in response to inflammatory reactions, release reactive oxygen species (ROS). Under normal exposure conditions, the components of the inflammatory reaction interact synergistically with ROS to eliminate foreign material from the respiratory system [123].

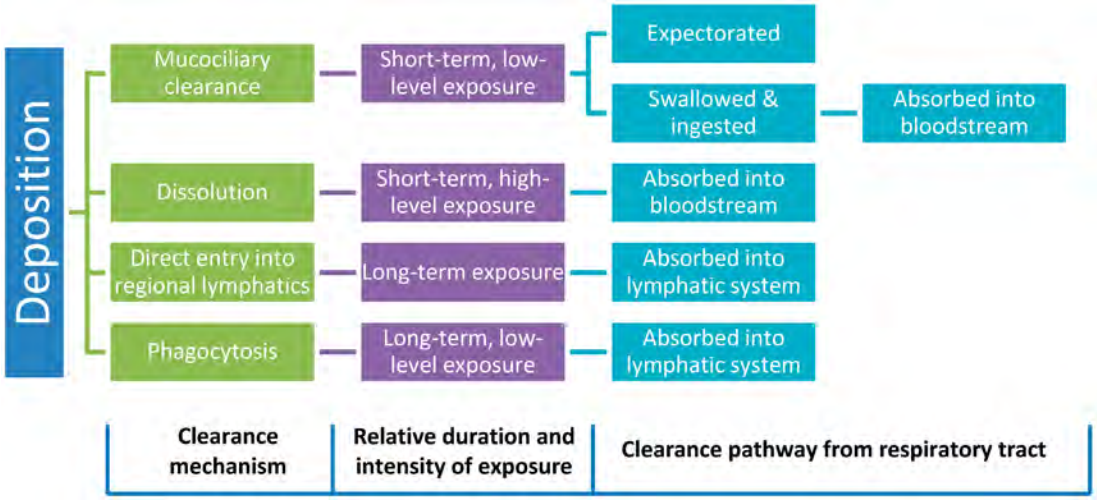
4.2. Effects of Exposure Duration and Solubility

Variation in the solubility of different arsenic compounds is important for exposure and risk assessment studies [57]. In the case of short-term inhalation exposure (minutes to hours), the number of particles in the RT decreases over time until all particles have been cleared via phagocytosis and/or mucociliary transport [124]. Deposited particles containing soluble arsenic compounds may expose nearby cells to a high concentration of arsenic [125], which rapidly declines as the dissolved arsenic is removed from the lungs [126] via absorptive mechanisms through the airway epithelium [127]. Lantz *et al.* [128] proposed that this exposure regime would reduce the time for interaction with pulmonary cells and tissue. Less soluble particles on the other hand that are retained in the lung expose the target tissue to arsenic for a longer period of time (up to weeks), as observed in rodents after intratracheal instillation of inorganic arsenic compounds of varying solubility [125,126,129,130].

In the case of long-term exposure (days to years), a steady state between deposition and clearance will be reached and the retained fraction will remain in the lungs for most of the exposure period [110]. Consequently, retention of particles containing soluble and slightly soluble arsenic compounds, especially those particles deposited in the alveolar region and sequestered in the lymph nodes, may expose cells to low doses of arsenic for a prolonged period of time. It is frequently reported that long-term, low-level exposures to arsenic may be predictive of toxic effects [126,131,132] and the pathogenesis of lung diseases, such as lung carcinoma [130].

Figure 3 illustrates that following inhalation, arsenic can follow different pathways leading to systemic absorption, and each pathway is highly dependent upon particle solubility and method of clearance. Systemic exposure to arsenic may occur as a result of ingestion following mucociliary clearance, by dissolution in the lung fluid, direct entry into lymph nodes, or by phagocytosis. Systemic exposure to arsenic following inhalation of arsenic-bearing particulates could therefore be considered as a multi-pathway process with differing durations and intensities of exposure.

Figure 3. Potential pathways leading to systemic absorption of inhaled arsenic, including clearance mechanisms and their associated durations and intensities of exposure. Adapted from Wang [120].



4.3. Pulmonary Bioavailability of Inhaled Arsenic

The bioavailable fraction of arsenic is considered to be an important determinant of toxicity and the associated disease response [133]. The term bioavailability may be interpreted in a number of different ways [134], however and for the purposes of this review paper, the terms bioavailability and bioaccessibility will be used in accordance with the definitions prescribed by Ng *et al.* [135]. Briefly, the portion of a contaminant that is absorbed into the body following exposure is referred to as the bioavailable fraction and is typically measured *in vivo* [135]. Bioaccessibility on the other hand refers to the soluble fraction of a compound following *in vitro* gastrointestinal or pulmonary extraction, and may be used as a surrogate for estimating the bioavailability of a contaminant [135].

In order to assess the relative risk of inhalation exposure to metal-laden particles of various origins, simulated lung fluids (SLF) such as Gamble's solution and artificial lysosomal fluids (ALF) have been used in various studies [136–139]. Gamble's solution is an electrolyte fluid similar in composition to that of interstitial fluid with a pH near 7.4, and aims to mimic the aqueous component of the lung [140]. ALF is analogous to the fluid produced by macrophages during phagocytosis [141] and has a pH of around 4.5 [137]. Biological fluid pH is an important parameter governing the solubility of arsenic and other metals. For example, arsenic solubility measured as a percentage of the total arsenic concentration of mine waste, was reported as 36.6% in simulated stomach fluid (pH 1.2) and 0.4% in SLF (pH 7.5) [57], suggesting that an acid medium is required for arsenic dissolution. When determining pulmonary arsenic bioaccessibility, it may therefore be prudent to also investigate the behavior of arsenic in the more acidic ALF solution.

A limited number of studies aimed at comparing the bioaccessibility of other metallic compounds in SLF and ALF solutions reported significantly higher dissolution rates of potentially toxic metals in ALF [137,139]. Conversely, Plumlee *et al.* [142] found that SLF (near-neutral pH) was effective in leaching arsenic from dust samples collected from a dry lake, and the oral and inhalation bioaccessible arsenic fractions found in these particular dust samples were comparable. While it is important to note

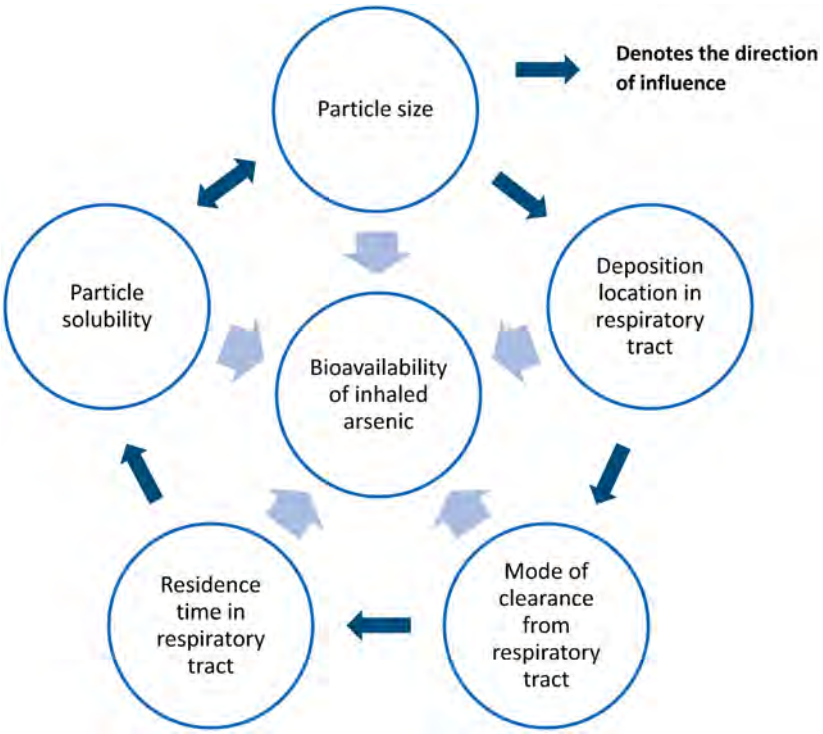
that the contrasting results between these studies highlight the importance of site-specific bioaccessibility assessments, they also indicate that certain arsenic species are relatively mobile at near-neutral conditions. Furthermore, the differences may also be attributed to the contrasting dissolution times used in each study: the mine waste and the dry lake dust samples underwent dissolution times of around 2 h [57] and 24 h [142], respectively. Given that fine particles may be retained in the RT for prolonged periods of time (Table 2), incubation duration is a particularly important parameter in bioaccessibility studies.

Pulmonary bioaccessibility tests may be more reliable predictors of bioavailability than the widely-used aqueous solubility tests, since Rhoads and Sanders [125] reported that arsenic, and other metals with low aqueous solubility, were highly soluble in the lungs of rats. A more recent study observed that SLF was more effective than deionized water at leaching arsenic in the ≤20 μm size fraction of soil impacted by fire, with leachate concentrations of 19 and 2 μg/L, respectively [143].

4.4. Summary

A summary of some of the key factors governing bioavailability of inhaled arsenic-bearing particles is proposed (Figure 4). Particle size governs the deposition location of inhaled particulates in the RT. Knowledge of the location and solubility of deposited particles is important for predicting the methods of clearance from and retention time in the RT, and therefore the types of lung fluids with which the particles may interact. Contact with pulmonary fluids can then release arsenic from inhalable arsenic-bearing particulates. Since the retention of arsenic in the body is predictive of toxicity and the pathogenesis of disease [126,131,132], the long-term pulmonary bioavailability of arsenic represents important consideration in the health risk assessment of populations living in mining-affected regions.

Figure 4. Diagrammatic representation of the interactions between key factors governing the pulmonary bioavailability of arsenic.



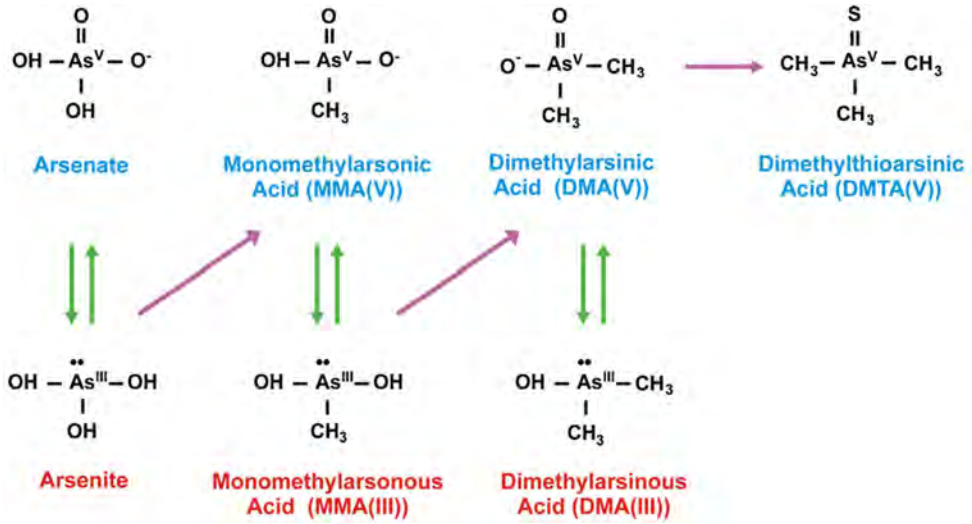
5. Importance of Metabolic Transformation in Arsenic Toxicity

5.1. Arsenic Biomethylation

The role of metabolism in arsenic toxicity has been the subject of several detailed reviews [144–149] therefore the following discussion will provide an overview of the key concepts only. Methylation is the major metabolic pathway for ingested inorganic arsenic in most mammals, and occurs via alternating reduction of pentavalent arsenic to the trivalent state, followed by oxidative addition of a methyl group [146,150–153]. Biotransformation of inorganic arsenicals occurs primarily in the liver with an estimated 70% [154] of metabolites readily excreted in urine [147,155–157]. The remaining portion deposits differentially in other target organs and tissues including the kidneys and the lungs, as well as keratinized tissues such as skin, nails, and hair [158–161].

In terms of clearly understanding arsenic biochemistry and toxicology, arsenic methylation presents a complex problem because the metabolic sequence (Figure 5) yields at least six distinct products, each with its own unique toxicology: arsenite, monomethylarsonic acid (MMA^V), monomethylarsonous acid (MMA^{III}), dimethylarsinic acid (DMA^V), dimethylarsinous acid (DMA^{III}) and dimethylthiolarsinic acid ($DMTA^V$) [146,162,163]. Various studies have demonstrated that the unstable trivalent intermediary products, MMA^{III} and DMA^{III}, are highly reactive and substantially more toxic than the inorganic and pentavalent compounds [149,152,162,164,165]. Arsenic methylation is therefore widely considered to be a bioactivation pathway rather than a detoxification process [144], with the resulting toxicity closely linked to the methylation status and valence state of the metabolites [166]. Therefore, understanding the arsenic biomethylation pathway is critical to elucidating its subsequent action as a toxin and carcinogen [167].

Figure 5. Metabolic pathway of inorganic arsenic. Reprinted from Chilakpati [168] with permission from Elsevier.



5.2. Oxidative Stress as a Mode of Action for Arsenic Carcinogenesis

Although several modes of action for arsenic carcinogenesis have been presented in the literature including oxidative stress, suppressed DNA repair, altered methylation patterns, genotoxicity and cell

proliferation [144], the oxidative stress theory has been intensively investigated and is supported by a substantial mass evidence [168–171]. Oxidative stress refers to an imbalance between the production of reactive oxygen species (ROS), or free radicals, and antioxidant defense mechanisms [172]. Free radicals are characterized by the presence of unpaired electrons and the associated reactivity can lead to tissue injury [173].

The first oxidative stress theory for arsenic proposed that a minor metabolite of DMA^V, dimethylarsine (a trivalent arsenic compound), is produced via a process of reduction *in vivo* [170], possibly following a reaction between DMA^{III} and specific coenzymes important for cellular respiration [174]. Dimethylarsine is estimated to be around 100 times more toxic than DMA^{III} which is a potent genotoxin in its own right [174]. Dimethylarsine can react with molecular oxygen forming the dimethylarsenic ($(CH_3)_2As$) radical, and the superoxide anion O_2^- [175]. Through the addition of another molecule of oxygen, the dimethylarsenic radical forms the dimethylarsenic peroxyl ($(CH_3)_2AsOO$) radical. Finally, the hydroxyl radical ($HO^{\cdot}$) can be produced via reaction with cellular iron and other transition metals [170,175].

Although an excessive production of ROS, such as superoxide anion and hydroxyl radical, is commonly associated with impaired cellular functions, DNA damage and carcinogenesis [144,175,176], the dimethylarsenic and/or dimethylarsenic peroxyl radicals were found to play a crucial role in lung-specific DNA damage, tumorigenesis [169–171,174,177] and general arsenic-induced toxicity [178]. The generation of oxidative stress as a potential mode of action of arsenic for its disease endpoints is an ongoing area of research and the associated complexities have been comprehensively reviewed [145,158,175,179].

5.3. The Human Lung as a Target Organ for Arsenic Toxicity

Remarkably, arsenic is the only reported human lung carcinogen for which there is sufficient evidence of pulmonary carcinogenicity as a result of both inhalation and ingestion exposures [25,180]. Smith *et al.* [181] reported that the relative risk of lung cancer following inhalation and ingestion of arsenic was independent of the exposure pathway. Distinguishing between the different routes of exposure is complicated not only by the arsenic transformations that take place in the body, but also the common target organs following the different exposure pathways [163]. The high variability in pulmonary solubility observed for different arsenic compounds [126,129,130] also represents a confounding factor.

For systemically absorbed arsenic, via inhalation or ingestion, research suggests that the pulmonary system may function as a target tissue for toxicity based on the observation that dimethylarsine is excreted as a gas from the circulation via the lungs [170,177]. High partial pressures of molecular oxygen in the lungs may promote dimethylarsenic and dimethylarsenic peroxyl radical formation as dimethylarsine is excreted and passed through to the respiratory system [144,158,175].

Less soluble arsenic compounds can be retained in the lung as observed in humans [182] and rodents [126,129,130]. According to Styblo *et al.* [152], human lung epithelial cells have very low arsenic methylation capacity *in vitro*, which may translate to a lower capacity to convert inorganic arsenic methylate arsenicals *in vivo*. A reduced capacity to methylate arsenicals could be associated with an increased risk of toxicity due to prolonged retention of inorganic arsenic in the lung [183]. In

support of these observations, various *in vivo* studies have reported that arsenic toxicity is closely linked with a prolonged retention of inorganic arsenic in the lungs of rodents [129,130]. Further studies to examine the direct effects of inorganic arsenic compounds on pulmonary cells in order to elucidate the carcinogenic mode of action of retained arsenic-bearing particulates are suggested.

5.4. Direct Effects of Arsenic on Pulmonary Cells

Some of the key effects of arsenic exposure on a range of different pulmonary cell lines are summarized in Table 3. Since the dose response of arsenic can be substantially different in animal models compared with *in vivo* human exposure [184], this section will primarily focus on studies involving pulmonary cell lines, specifically human bronchial epithelial (HBE) cells derived from human lung epithelium [168], alveolar macrophage (AM) cells, which are typically harvested from animals [185], and human pulmonary fibroblast (HPF) cells. HBE and AM cells represent the first lines of defense against foreign particles [185], while HPF cells are important for regeneration and repair of chemically or mechanically damaged tissues [186]. As discussed by Dodmane *et al.* [165], although the effects of *in vitro* arsenic exposure are likely to reflect the *in vivo* effects, a cautionary approach should be adopted when interpreting the data due to the variability of effects observed amongst experimental systems.

5.4.1. Pulmonary Cytotoxicity of Arsenic

Cytotoxicity assays, and the measurement of representative parameters associated with cell pathology, are widely used to quantitatively assess the *in vitro* potency of a toxicant in the whole animal. Clear dose-response relationships between arsenic concentration and cytoxicity have been established in HBE cells [165,168,187–189], HPF cells [189–191] and AM cells [185]. Figure 6 shows a notable decrease in HPF and HBE cell survival, in a time- and concentration-dependent manner, following 24 and 120 h treatments with sodium arsenite [189]. Relative cell survival rates indicate that sodium arsenite is more cytotoxic to HPF than HBE cells (Figure 6; [189]). A similar study found that arsenic trioxide was also toxic to HPF cells, however greater concentrations were required to produce similar effects [190]. The differential cytotoxicities observed between these two trivalent arsenic compounds can be attributed to the fact that arsenic trioxide has a lower solubility in the lung than sodium arsenite [126].

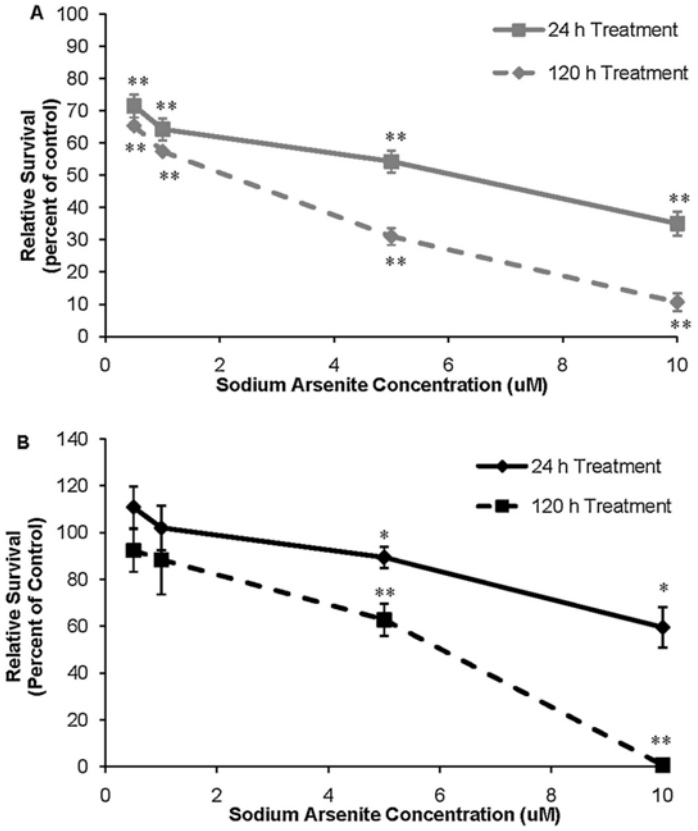
Consistent with other lines of evidence presented in previous sections, recent studies confirm that methylated arsenicals are more cytotoxic to pulmonary cells than the inorganic trivalent forms [165,168,188]. For example, the respective median lethal concentrations (LC50) of As^{III}, DMA^{III} and MMA^{III} in HBE cells were reported as 5.8, 1.4 and 1.0 μM, after a 72 h exposure period [165]. $DMTA^{V}$, exhibited a similar cytotoxicity potency to DMA^{III} [168]. While little is known about the pulmonary toxic effects of $DMTA^{V}$, gene expression analysis has shown that cells exposed to $DMTA^{V}$ and DMA^{III} share a relatively high number of differentially expressed genes (DEGs) following exposure to minimally cytotoxic arsenic concentrations, indicating the existence of associated similarities in the cellular mechanism of cytotoxicity of these two arsenicals at lower concentrations [168].

A systematic assessment of the cytotoxic effects and cellular uptake of As^{III}, MMA^{III}, DMA^{III}, MMA^{V}, DMA^{V} and thiodimethylarsinic acid (thio-DMA^{V}, $[(CH_3)_2As(S)OH]$) on human alveolar

epithelial cells has been undertaken in complementary studies [187,188]. Thio-DMA^V is a human arsenic metabolite of inorganic arsenic and is formed immediately when $DMTA^V$ is added to aqueous solution [187]. Cytotoxicity was quantified by measuring reductions in cell number, cell volume and colony formation following a 24 h exposure period [187,188]. In terms of these cytotoxicity endpoints, the cytotoxic order of extracellular arsenic concentrations was reported as DMA^{III} > MMA^{III} > thio-DMA^V ≥ As^{III} ≥ MMA^V ~ DMA^V [187]. Taking into consideration the bioavailability of each arsenic species, as measured by cellular uptake, the cytotoxic order was reported to change to thio-DMA^V ~ As^{III} ~ MMA^{III} > DMA^{III} ≥ MMA^V ~ DMA^V [187]. Cellular uptake of thio-DMA^V was strongly correlated with cytotoxicity endpoints, including cell number (correlation coefficient, −0.986) and colony forming ability (correlation coefficient, −0.998) [187].

Differences in arsenic-induced cytotoxicity endpoints reported in the literature may be attributed to variability in a number of experimental parameters: (i) the arsenic species or compound; (ii) the cell exposure duration; (ii) the cell systems used in each study; and (iii) the methods for assessing cytotoxicity endpoints.

Figure 6. Cytotoxicity of sodium arsenite in: (**A**) human lung fibroblast cells, and (**B**) human lung epithelial cells, following 24 and 12 h treatments. Reprinted from Xie *et al.* [189] with permission from Elsevier.



5.4.2. Effects of Arsenic-Induced Reactive Oxygen Species (ROS) Production on Human Bronchial Epithelial (HBE) Cells and Human Fibroblast (HF) Cells

Although ROS are widely recognized for their beneficial and growth-promoting effects on cells, overproduction can lead to toxic effects [192] including damage to cellular DNA and protein [144].

Studies show that HBE and HPF cells generate elevated ROS levels in a dose-dependent manner in the presence of arsenic [191,193]. Moreover, chronically exposed arsenic-transformed HBE cells constitutively generate cellular ROS (probably hydrogen peroxide) in the absence of further arsenic exposure [193]. Constitutive generation of ROS was found to be necessary for activating certain signaling pathways that regulate cell survival and cell proliferation [193].

Enhanced arsenic-induced ROS generation and accumulation have been associated with dose-dependent responses in rates of cell proliferation and colony formation in HBE cells [193–196] as well as anti-apoptotic signaling [195]. Increased cell proliferation is a distinguishing characteristic of cancer cells and is crucial for tumor formation, while apoptosis plays an important role in killing abnormal cells so that they cannot form tumors [193]. One study reported that increased cell proliferation of arsenic-exposed cells was mediated by anti-apoptotic-signaling induced by cyclooxygenase, COX-2 [197], an enzyme associated with inflammation and other pathogenesis [198]. Enhanced ROS levels play an important role in mediating COX-2 production in airway epithelial cells [199].

ROS production has also been linked with gene expression changes in HBE cells consistent with several of the proposed mechanisms for arsenic carcinogenesis [144] including oxidative stress, DNA damage and a weakened tumor-suppression response [165,168,195]. Suckle *et al.* [195] assessed the malignant potential of *in vitro* arsenic-transformed cells by injecting them into mice. The *in vivo* study identified phenotypic characteristics consistent with malignant lung epithelial cells [195], and whole genome expression profiling identified potential mitochondrial oxidative stress and increased metabolic energy output, which is indicative of increased mitochondrial energy production [195]. Importantly, chronic arsenic exposure may therefore target mitochondrial function leading to enhanced ROS generation and cancer-related gene signaling [195]. Antioxidants that target mitochondrial function could play a role in ameliorating some of the effects of arsenic in chronically-exposed populations [200].

Zhao *et al.* [201] recently discovered that long-term exposure to arsenic altered cellular energy metabolism through the induction of aerobic glycolysis (the Warburg effect), as observed in arsenite-treated HBE and other human cell lines cells. The Warburg effect is a metabolically supportive phenotype for the increased energy demands associated with the growth, proliferation and invasion of cancer cells (see the review by Vander Heiden *et al.* [202]). Unlike normal cells which produce lactate under anaerobic conditions only, the Warburg effect states that cancer cells generate large quantities of lactate regardless of oxygen availability [202]. This study was potentially the first to link an environmental toxicant with the induction of the Warburg effect, and thus this discovery may assist in identifying the role of arsenic toxicity in other diseases associated with disrupted energy metabolism, such as diabetes and atherosclerosis [201].

5.4.3. Arsenic-Induced Suppression of Alveolar Macrophage (AM) Function

Alveolar macrophages (AM) serve as the front line of cellular defence against foreign material by clearing the air spaces of any infectious, toxic or allergenic particles that have penetrated mechanical defences, such as the nasal passages and mucociliary transport system [203]. Under normal conditions, ROS are secreted by alveolar macrophages in response to phagocytosis or stimulation with specific agents, and play a key role in efficiently killing invading pathogens [204]. Various detrimental

effects of arsenic on these important cell functions have been observed (Table 3). For example, Palmieri *et al.* [185] noted concentration-dependent reductions in AM viability and size following exposure to sodium arsenite concentrations of 2 and 2.5 μM, respectively, and a notable increase in apoptosis after 5 μM. In the presence of the lower sodium arsenite concentrations (<2 μM), AM cells maintained the ability to regulate cell homeostasis whereas higher doses (≥5 μM), reduced cell viability to 50% [185]. Increasing cell culture time generally played a key role in amplifying the observed adverse effects, particularly during exposure to the higher (5 and 10 μM) sodium arsenite concentrations [185].

Contrary to the commonly-observed response by arsenic-exposed HBE and HPF cells, AM cells typically exhibit a dose-dependent reduction in ROS production in the presence of arsenic [128,185,205–208]. Soluble trivalent arsenic was notably more potent at inhibiting ROS production than the corresponding pentavalent form, with superoxide inhibition occurring at respective concentrations of 0.1 and 1 μg/mL [208]. In contrast, the slightly soluble trivalent and pentavalent forms showed similar patterns in ROS production with inhibition occurring at a concentration of 10 μg/mL arsenic [128,207]. Gercken *et al.* [205] postulated that the depression of O_2^- (superoxide anion) production by arsenic-exposed AM may be linked with high concentrations of arsenic on the particle surface. Both the studies by Lantz *et al.* [128,208] observed that a 24 h period of arsenic exposure was required to suppress ROS production.

Suppression of ROS production, or a reduction in AM function as demonstrated by others [128,185,205,207,208], may therefore inhibit phagocytosis: an important clearance mechanism of foreign particles, such as dust and bacteria, from the lung. Suboptimal phagocytosis by AM cells has been associated with a decreased ability to clear dead or dying cells from the respiratory system thereby leading to pathological inflammation [209] as well as an increased susceptibility to pulmonary infection such as pneumonia, in respiratory health-compromised individuals [210].

5.4.4. Arsenic-Induced Inhibition of the Wound Healing Response in Human Bronchial Epithelial (HBE) Cells

As the respiratory epithelium is frequently injured by inhaled pollutants or micro-organisms, the epithelial wound repair response plays a critical role in the maintenance of epithelial barrier integrity [211]. Concentration-dependent arsenic-induced inhibition of wound healing in mechanically-wounded HBE cells has been demonstrated (Table 3). In the absence of arsenic, the wounded area of an epithelial monolayer of HBE cells was largely repaired (approximately 80%) by migrating cells after a period of 4 h [212]. In the presence of 30 and 60 ppb arsenic however, the amounts of wound closure were 48% and 24%, respectively [212]. The highest concentration (290 ppb) resulted in the expansion of the wound area in the first hour, followed by 16.5% healing at 4 h [212]. Further analyses indicated that overexpression of matrix metalloproteinase (MMP-9), an enzyme important for human respiratory healing and wound closure [213], leads to dysregulated wound repair in the presence of arsenic and reductions in cellular migration [212].

Regulation of MMP-9 and migration of airway epithelial cells are linked with ATP-dependent Ca^{2+} signalling [213]. Tightly coordinated Ca^{2+} transport and activity are vital during early wound healing processes; therefore Ca^{2+} is commonly used as an immediate damage indicator [214]. Furthermore,

general interference with airway ATP signalling has been linked with chronic lung diseases, such as chronic obstructive pulmonary disease (COPD) [215]. To investigate whether arsenic disrupts Ca^{2+} signalling in mechanically-wounded HBE cells, Ca^{2+} concentrations were monitored following acute (24 h) and chronic (4–5 weeks) exposure with micromolar and nanomolar concentrations of sodium arsenite [216,217]. Significant and dose-dependent reductions in Ca^{2+} propagation in wounded cells compared to controls were observed (Figure 7; [216,217]). Arsenic-induced suppression of the wound healing response as a result of both acute and chronic exposures (well below levels typically associated with inhalation where arsenic has been linked with disease presentation) may ultimately result in a reduced ability of the lung epithelium to effectively and sufficiently close a barrier breach [212,216,217].

Figure 7. Wound healing assay of 16HBE14o- cells exposed chronically (4–5 weeks) to 0, 130, or 335 nM sodium-arsenite: (**A**) Representative images of initial wounding (left column), 30 min post-wounding (middle column), and 1 h post-wounding (right column). White scale bar represents 50 μM; (**B**) Quantification of percent wound closure over time at 30 and 60 min post-wounding. "*" indicates significant difference from untreated controls by a one-way ANOVA ($p < 0.05$). Reprinted with permission from Sherwood *et al.* [217].

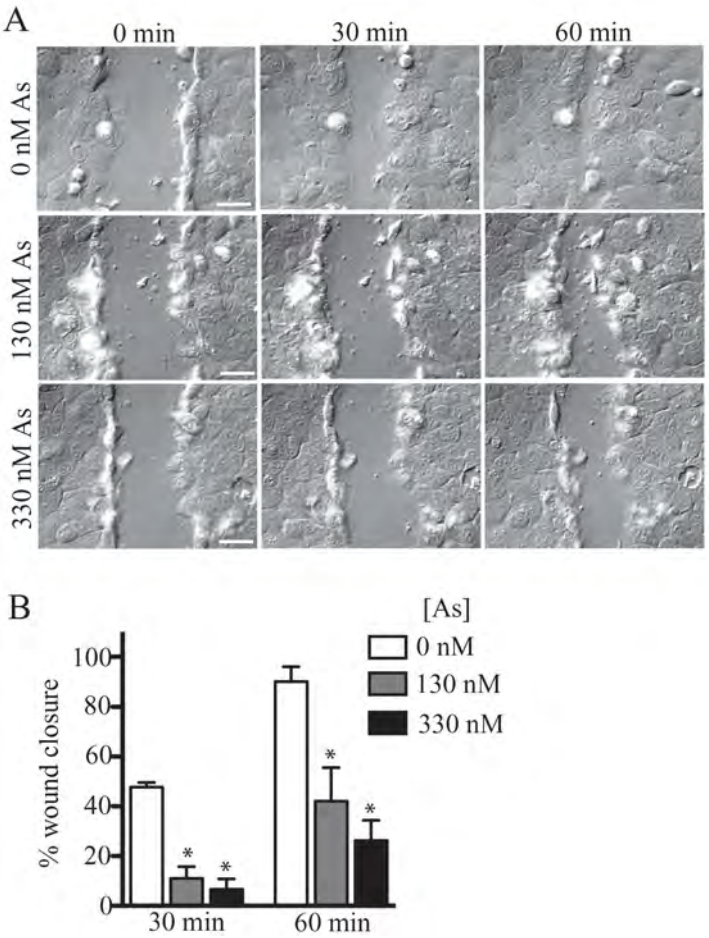


Table 3. Direct effects of arsenic exposure on human bronchial epithelial (HBE) cells, human pulmonary fibroblast (HPF) cells, and pulmonary alveolar macrophage (AM) cells. All experiments were conducted *in vitro*, unless otherwise specified. Specific cell lines are listed in accordance with the abbreviations used in each study.

As Compound	Dose	Cell Line	Pathological Effects	Potential Human Effects	Ref.
Human bronchial (or alveolar epithelial) cells					
Na-arsenite	0.5–10 μM for 24 and 120 h	NHBE	Dose-dependent reduction in cell survival; chromosomal aberrations suggestive of DNA double strand breaks	Lung cancer	[189]
Na-arsenite, MMA^{III}, DMA^{III}	Variable for 3 days	HBE	MMA^{III} & DMA^{III} were more cytotoxic; dose-dependent alteration of inflammatory response at low concentrations; alterations in oxidative stress and DNA damage repair at increasing concentrations	Pulmonary diseases linked with inflammation and increased bronchial cell proliferation	[165]
Na-arsenite	0–4 μM for 2 weeks	HBEp	Concentration-dependent increase in cellular lactate production; lactate produced via aerobic glycolysis (the Warburg effect)	Growth, proliferation and invasion of cancer cells	[201]
As-trioxide	2.5 μM for 6 months	BEAS-2B *In vivo* (Nu/nu mice) *In silico* Signalling pathway analysis	Time-dependent cell proliferation; cells exhibited a cancer-like phenotype Tumour formation; time-dependent increase in tumour volume; cells exhibited a malignant and metastatic phenotype ROS generation; DNA damage; chronic inflammation; dysregulation of pro- and anti-cancer gene signalling, anti-apoptosis and invasive signalling	Lung cancer	[195]
Na-arsenite	130 and 330 nM for 4–5 weeks and 0.8 and 3.9 for 24 h	16HBE14o-cells (wounded)	Dose-dependent reduction in the wound healing response (Ca^{2+} signalling), leading to inhibition of wound repair	Chronic lung disease, e.g., bronchiectasis	[216,217]
Na-arsenite MMA^{III}, DMA^{III}, MMA^{V}, DMA^{V}, $DMTA^{V}$	Various (μM) for 24 h	A549	DMA^{III} and MMA^{III} showed pronounced cellular uptake; differential cellular endpoints related to DNA repair	Arsenic-induced diseases	[187,188]
Na-arsenite	0.25–5 μM for 26 weeks	BEAS-2B	ROS-induced cell proliferation and colony formation; constitutive generation of ROS (probably H_2O_2); degree of effects were concentration-dependent	Primary lung tumour formation	[193]
Na-arsenite	20 nM, 200 nM, 2 μM and 20 μM for 12, 24 and 48 h	BEAS-2B	Enhanced cell growth and proliferation; up-regulation of protein, Cyclin D1, is commonly over-expressed in cancer cells	Development/progression of lung carcinogenesis	[196]
Arsenite, MMA^{III}, DMA^{III}, $DMTA^{V}$	Variable concentrations for 24 h	BEAS-2B	Arsenite was least cytotoxic; methylated forms shared similar cytotoxicities; dose-dependent increase in number of differentially expressed genes linked to carcinogenicity; minimally cytotoxic arsenic levels induced oxidative stress	Lung cancer	[168]

Table 3. *Cont.*

As Compound	Dose	Cell Line	Pathological Effects	Potential Human Effects	Ref.
Na-arsenite	30, 60, 290 ppb for 24 h	16HBE14o- (wounded)	Dose-dependent inhibition of the wound healing response	Compromised lung function	[212]
Na-arsenite	5–40 μM for 6–48 h	BEAS-2B	Overexpression of COX-2; apoptotic disruption; cell proliferation	Accumulation of genetically damaged cells leading to malignancy	[197]
Human pulmonary fibroblast cells					
Na-arsenite	0.5–10 μM for 24 and 120 h	HPF	Dose-dependent reduction in cell survival; concentration-dependent increase in chromosome damage such as DNA double strand breaks.	Lung cancer	[189]
As-trioxide	1–50 μM for 24 h	HPF	Dose-dependent reduction in cell survival between 10 and 50 μM As-trioxide		[190]
As-trioxide	1–50 μM for 0–180 h	NHBF	Dose-dependent increase in ROS (O_2^-) levels; cell growth inhibition and cell death		[191]
Alveolar macrophage cells (harvested from animals)					
Na-arsenite	1.25–10 μM for 24–96 h	Mouse AM	Dose-dependent reduction in macrophage viability and volume; time-dependent increase in apoptotic cell at higher arsenic concentrations; decrease in ROS (O_2^-) generation at low concentrations	Immunological disorders; decreased capacity to respond to toxicants	[185]
As-trioxide & Ca-arsenate (slightly soluble)	0.1–300 μg/mL for 24 h	Rat AM	Dose-dependent reduction of ROS (O_2^-) after 24 h; similar pattern for both arsenicals (around 10 μg/mL)	Alteration in AM function; compromised host defence	[128]
Na-arsenite & Na-arsenate (soluble forms)	0.1–300 μg/mL for 24 h	Rat AM	Dose-dependent reduction of ROS (O_2^-) after 24 h; As^{III} more potent than As^{V}; differential immune response between the two species	Compromised defence against infection and altered immune surveillance	[208]
Arsenic (fly ash)	50–230 ppm for 24 h	Rabbit AM	Concentration-dependent inhibition of ROS (H_2O_2 and O_2^-) production	Suppression of AM function	[206]
As-trioxide	0.1–1000 μM for 24 h	Rabbit AM	Concentration-dependent inhibition of ROS (H_2O_2 and O_2^-) production	Increased susceptibility to bacterial infections	[207]
As-trioxide (fly ash)	Industrially-relevant levels for 24 h	Rabbit AM	Suppressed ROS (O_2^-) production	Suppression of AM function	[205]

6. Epidemiological and Exposure Monitoring

Epidemiological studies provide an important link between health effects and air pollution exposure, because they provide an accurate representation of the health records and environmental conditions pertaining to a well-defined population [218]. In this regard epidemiological studies of industrially-exposed cohorts conducted during the mid-1900s have provided strong evidence of a causative role for airborne arsenic in respiratory cancer mortality. This has resulted in a diverse but important body of historical epidemiological evidence accrued on the health risks and disease outcomes associated with known, high level occupational inhalation exposures [219–221].

However, with increasing concerns regarding the effects of peripheral exposure to potential carcinogens, there is increasing attention directed at the health of communities living in the vicinity of smelting and mining operations and uncontained mine wastes and tailings. Notwithstanding the common source of the concerns, it has been observed that there are important differences between the situations of occupationally- and environmentally-exposed cohorts. Occupational studies usually differ methodologically from the environmental investigations in that there is a contained area of contamination and a restricted population who are exposed to high levels of airborne material. Whereas studies of environmental exposure in communities living in arsenic-affected areas usually start at birth, and the exposure itself may not be recognized for many years and may be intermittent, thereby rendering epidemiological studies more difficult to design and interpret, particularly since they are observational only. For these reasons, we report separately on the findings for each exposure type, since they will address different aspects of the effects of airborne particulate matter on health.

6.1. Known Occupational Exposures

An industrial hygiene study conducted between 1943 and 1965 at the Anaconda copper smelter in Montana, USA, recorded extremely high levels of airborne arsenic (≥5000 $\mu g \cdot m^{-3}$), particularly in and around the ore roasting furnace, materials crushing plant and the arsenic refinery departments [222]. Similar conditions were reported at the Ronnskar smelter in Sweden [220]. Airborne arsenic concentrations in excess of 20,000 $\mu g \cdot m^{-3}$ were not uncommon at these two smelting operations [220,222]. Lower values for airborne arsenic were typically found in areas such as the administration departments, electrical and machine workshops, outdoor environment, building department and general office area [220,222]. Significantly, airborne arsenic concentrations reported at the latter two locations are 8- and 2000-fold greater than the current target value of 6 $ng \cdot m^{-3}$ proposed by EU regulations.

Symptoms of severe arsenic exposure among smelter workers observed during the 1920s included a notable rise in the rate of sick days due to various acute and chronic respiratory disorders [223]. Arsenic trioxide-laden dust (generated as a by-product of the copper smelting process) deposited in the nose and respiratory airways forms arsenous acid on contact with moisture, resulting in necrosis of the mucous membranes [223]. Diseases reported among smelter workers during the early 1930s were bronchitis, tracheitis, ulcers, laryngitis, rhinitis, perforation of the nasal septum, atrophy of the mucus membranes in the respiratory passages and occupational arsenical dermatitis (unpublished works by Inghe and Bursell [224], translated in Gerhardsson *et al.* [225]). Emphysema and ischemic heart disease were also noted [219]. Despite the prevalence of these non-malignant respiratory disorders,

meta-analysis of the available epidemiological data did not detect any statistically significant excesses in mortality among smelter workers compared to the control cases [219,221].

The first cases of lung cancer that were traced to the work environment occurred at a Swedish smelter in the 1960s whereby a five-fold increase in lung cancer mortality compared with controls was observed [226]. Occupational health investigations at other smelting operations, as well as comprehensive reassessments and meta-analyses of previously reported data, demonstrated strong links between airborne arsenic exposure and respiratory cancer [220–222,227,228]. Lubin *et al.* [221] reported a statistically significant trend between the excess relative risk of respiratory cancer and cumulative exposure to airborne arsenic amongst a cohort of 8014 copper smelter workers in Montana, United States. Over a 50 year period, 446 deaths due to respiratory cancers were observed, comprising 428 lung cancers and 14 cancers of the larynx. No other cause of death was found to be associated with arsenic exposure, with the possible exception of COPD [221].

In addition to smelting, other studies have demonstrated a link between lung cancer and arsenic exposure at hard rock mining operations [228]. One of the most comprehensively investigated cases relates to four tin mines and three associated smelting operations in southern China, where underground miners were exposed to respirable concentrations of arsenic ranging between 0.1 and 38.3 $\mu g \cdot m^{-3}$ [229]. Chen and Chen [229] reported that the rates of lung cancer were strongly associated with cumulative dust exposure, arsenic exposure and duration of exposure. While the magnitude of risk from mining (odds ratio (OR), 8.8) was only slightly less than for smelting (OR, 12.3), exposure to both mining and smelting increased the risk to 22.0 [228]. The potential additive carcinogenic effects of inhaled crystalline silica, cigarette smoking and exposure to radon could not be ruled out [228].

To examine the distribution of arsenic in the body following long-term exposure, researchers collected and analysed tissues from deceased workers from the Ronnskar smelter in Sweden, and from various controls, and correlated these with the cause of death [225]. Post-mortem investigations discovered elevated levels of arsenic and seven other metals of concern in the lung, liver and kidneys of the deceased workers [182,225]. Median arsenic concentrations of 35 and 50 $\mu g \cdot kg^{-1}$ reported in lung tissue of the deceased smelter workers were six to seven times greater than the control cases [182,225], providing some evidence of a causative role for arsenic in respiratory cancer mortality among the exposed population [182]. Although the arsenic content diminished in liver tissue, a longer biological half-life of arsenic was observed in the lung [182]. Similar findings have been reported in animal studies [126]. An extended biological half-life and retention of arsenic in lung tissue may have implications for the development of respiratory disease. Lung cancer risk in a cohort of 107 Chinese tin miners was more dependent on the duration of arsenic exposure than then intensity [228]. Conversely, exposure intensity was more important in determining the lung cancer risk than duration in smelter workers [220,222], indicating a need for comparative studies with consistent exposure and outcome criteria.

Due to the use of exposure reduction measures by mining and mining-related industries, the number of published studies relating to rates of lung cancer and mortality in mining and mining-related industries has declined in recent years. However, occupational inhalation exposure to airborne arsenic remains a serious health issue in some localities. A recent study reported that copper smelter workers in northeastern China were exposed to airborne arsenic values that were up to 57% above the short-term exposure threshold limit value of 20 $\mu g \cdot m^{-3}$ [230]. Seven of the 38 copper smelter workers

selected for investigation had arsenic-related skin disorders including hyperkeratosis and/or hyper-pigmentation, as well as elevated urinary arsenic levels [230]. Urinary arsenic speciation analysis revealed that higher occupational exposures and skin damage cases were associated with a decreased capacity for arsenic methylation [230]. Similar results have been reported elsewhere [231]. These findings support the premise that suppressed methylation capacity results in an increased risk of arsenic toxicity due to the retention of arsenic in the body [183].

6.2. Inadvertent Environmental Exposures

It has been found that a number of populations around the world live in the vicinity of active or abandoned mining operations [28], and there exists overwhelming epidemiological evidence suggesting that there is an increased risk of arsenic exposure for these communities [4–9,78,107,232]. These studies show that children are particularly susceptible to inhalation exposure since they respire a greater relative volume of air with respect to their size, and may therefore be exposed to correspondingly higher levels of airborne contaminants than adults. Children also have an increased likelihood of coming into contact with soil and dust through playing in dirt contaminated with arsenic residues [78,233,234]. As a consequence, many human exposure monitoring studies have focussed on measuring arsenic exposure in child populations [4,7,107,233,235,236].

Measurement of arsenic in human nails, hair, urine and blood concentrations are commonly used for determining arsenic uptake in humans [78,105,232,235,236]. Blood and urine arsenic levels provide a reliable short-term measure of arsenic exposure because arsenic is readily excreted from the bloodstream via the kidneys [25]. Analysis of arsenic deposited in the toenails and hair provides useful indicators when the measurement of long-term, low-level arsenic exposure is required [234–238]. It has also been shown that analysis of the arsenic content of particles that have adhered to the hands of children can also be used as an indicator of potential exposure [4].

It is important to note that although such biological markers of arsenic exposure as those reported above are useful for predicting the degree of risk, elucidating the exact pathway to environmental uptake of arsenic in localities where multiple exposure pathways exist is not straightforward [233]. As previously mentioned in this review, airborne arsenic-contaminated particulates generated by mining operations often may be small enough to be inhaled, and have the potential to directly reach the tracheobronchial and/or alveolar regions of the RT of populations living within the reach of the industrial plume or raised dust material [19,54]. However, particles that have been deposited on the ground or other surfaces may be either ingested due to physical contact, or resuspended as dust, and then inhaled [19,105]. Many studies therefore report the existence of multiple possible pathways for human exposure to arsenic-bearing particulates in the vicinity of mining operations which contributes to the complexity of epidemiological studies of this issue [4,7,105,233,238] A recent study reported that the ingestion and inhalation exposure pathways contributed equally to the arsenic-associated carcinogenic and non-carcinogenic risks in such populations [105].

From the work reported in the above investigations, it is clear that human arsenic exposure is governed by a number of variables. There are important inverse relationships which have been frequently reported between the concentration of airborne arsenic levels and the distance from the source, and between biological arsenic levels and the distance of the home, playground or school

environment from metal smelters and other mining operations [4,7,107,233]. Buchet *et al.* [4] reported airborne arsenic concentrations of 330 and 75 $ng \cdot m^{-3}$, and dust concentrations of 1710 and 66 $\mu g \cdot g^{-1}$ at distances of 1 and 2.5 km from a lead smelter in Belgium, which are consistent with this inverse relationship. Correspondingly, the average arsenic concentration on the hands of children living within the 1 km zone was ten times greater than those children living further away [4]. Similarly, Hwang *et al.* [233] found that the urine arsenic content of children living near an extensively contaminated former copper smelter in Montana were significantly inversely correlated with distance from the smelter site.

As cautioned by Frost *et al.* [6], the assumption of a simple inverse relationship between arsenic uptake and distance from the emission source may oversimplify this phenomenon, since seasonality and wind direction are also important variables influencing exposure [9,107,231]. Milham and Strong [107] demonstrated that fluctuations in urine arsenic levels among children living near a copper smelter were closely associated with changes in prevailing wind direction. In this study, the urine arsenic concentrations of children living downwind of the smelter decreased simultaneously with shifts in wind direction [107]. Another study of children living near a former copper smelter site reported elevated biological arsenic levels during the summer, a time when seasonal factors enhance the mobilisation of dust from uncontained mine wastes, such as tailings and flue dust [233].

Carcinogenic and non-carcinogenic risks associated with inhalation exposure to atmospheric arsenic emitted by coal combustion have recently been estimated in exposed Chinese populations [9,105]. Because it has been observed that the average effective diameter of arsenic-containing aerosols from combustion processes is 1 μm [3], there exists a high potential for deposition in the terminal bronchioles and alveoli of exposed populations. Consequently, it has been estimated that more than two million residents in Beijing have an increased risk of developing cancer as a result of probable exposure to atmospheric arsenic, generated principally from coal combustion [9]. Recent measures of daily total inorganic arsenic inhalation exposure values for Beijing residents (0.3–0.8 $\mu g \cdot day^{-1}$) showed that they were 10 times greater than those in the United States (40–90 $ng \cdot day^{-1}$). These studies indicated that daily intakes of arsenite and arsenate in Beijing were 0.01–0.03 and 0.16–0.44 $\mu g \cdot day^{-1}$ by inhalation, respectively. Based on these exposures and the known effects of both arsenite and arsenate as carcinogens, an estimated excess cancer risk of $(4.2 \pm 2.0) \times 10^{-4}$ was predicted for the city's population [9]. In a similar study, Cao *et al.* [105] reported a median carcinogenic risk posed by arsenic inhalation of 2.91×10^{-3} in a community living near the largest coal refinery plant in a town of Shanxi Province, China.

6.3. Impacts of Climate Change

The effects of climate change are predicted to have an impact on mine waste chemistry and mobility. The predicted rise in global temperature is expected to increase the rate of mine waste weathering by a factor of approximately 1.3 by the year 2100 [239]. Prolonged weathering of mine waste materials will lead to the formation of a greater abundance of soluble salts [67]. Moreover, the anticipated increase in extreme weather conditions are likely to lead to a greater frequency and intensity of dust storms, as already observed in localities such as Asia, Africa, and Australia [240,241]

which in combination with the weathering, is likely to result in an increase in the occurrence and bioavailability of airborne arsenic.

7. Conclusions and Research Priorities

The potential health effects of exposure to airborne arsenic-bearing particulates generated by current and/or past mining operations are widely recognized as a growing issue of significant global importance. Investigations surveyed in this review, taken from disparate but complimentary lines of inquiry, strongly support a causative role for inhalation exposure of inorganic arsenic species in the aetiology of lung cancer and other respiratory health disorders, suggesting that a strong focus on this exposure modality is crucial for the long-term health of affected populations.

This review has highlighted the need to conclusively elucidate the exact mechanisms of arsenic-induced toxicity from exposure to PM in order to facilitate the prediction and diagnosis of adverse health consequences, and thereby enable adequate risk assessments to be undertaken.

Recent developments in various complimentary areas of research within the overarching field of medical geology including geochemistry, biomedicine, toxicology and epidemiology, have identified a number of factors that play a key role in understanding these varied phenomena. These include: (i) the effects of differing environmental variables leading to exposure; (ii) the influence of particulate characteristics on the initial deposition location in the RT; (iii) the differing toxicity levels of particulate-borne arsenicals, their species and their metabolites, and (iv) the complex pathogenesis of arsenic-induced lung disease.

While it is clear that absorbed arsenic exerts cytotoxic and genotoxic effects on pulmonary cells following both acute and chronic exposures, important species- and dose-dependent differences in toxicities between the two exposure regimes have been observed. It is also clear that particle size plays a major role in governing the deposition location, solubility, methods of clearance and retention time of arsenic-bearing species in the RT, and hence has a direct effect on the range of arsenic metabolites released to the body. Current research indicates that the exposure to arsenic and of these metabolites is predictive of the pathogenesis of lung disease, which leads to the conclusion that the long-term pulmonary bioavailability of arsenic in PM requires serious consideration in health risk assessments. Development of a series of standardized lung bioavailability assays that assess both short- and long-term exposures would be beneficial, particularly when drawing comparisons between studies.

The potential for human exposure to airborne arsenic will inevitably increase in the future due to several key factors. Increases in global copper production and coal use, with which arsenic species are intimately related, are indicators of increasing global wealth and population. With increasing wealth and population, consequent increases in urbanization will inevitably lead to encroachment on and disturbance of existing contaminated sites. In addition, it is predicted that climate change will have a considerable impact on mine waste chemistry and mobility, effectively amplifying every other risk factor, and increasing the urgency in gaining a greater understanding of all aspects of arsenic in our environment.

It is strongly recommended that future research prioritizes identifying human populations and sensitive sub-populations at risk of exposure, as well as developing long-term, cost-effective methods to adequately contain or reduce airborne emissions from known sources.

Acknowledgments

Rachael Martin is supported by an Australian Postgraduate Award Scholarship. Open access publication of this article was funded by the Collaborative Research Network (CRN), Federation University Australia. The views of the authors do not necessarily represent those of the CRN. The authors would like to thank AINSE Ltd for providing financial assistance (Award-PGRA) to enable work on the original research component of this paper.

Author Contributions

All authors contributed substantially to the work presented in this manuscript. As principal researcher, Rachael Martin made a substantial contribution to this work which was undertaken in association with her PhD program. Kim Dowling provided critical analyses and commentary during the development of this manuscript, ensuring that the reviewed literature was accurately interpreted. Dora Pearce provided extensive commentary on the epidemiology and other health-related sections of this manuscript, ensuring that all findings related to health outcomes were accurately represented. With an extensive background in the field of chemistry, James Sillitoe has made substantial contributions to this paper, particularly regarding the technical aspects. Singarayer Florentine assisted with the development of the underpinning theory and conceptual framework for this manuscript, as well as assisting with major re-drafting and editing.

Conflicts of Interest

The authors declare no conflict of interest.

References

1. Mandal, B.K.; Suzuki, K.T. Arsenic round the world: A review. *Talanta* **2002**, *58*, 201–235.
2. International Agency for Research on Cancer (IARC). *IARC Monographs on the Evaluation of the Carcinogenic Risks to Humans, Vol 100 C, Arsenic, Metals, Fibers and Dusts*; IARC: Lyon, France, 2012.
3. Matschullat, J. Arsenic in the geosphere—A review. *Sci. Total Environ.* **2000**, *249*, 297–312.
4. Buchet, J.P.; Roels, H.; Lauwerys, R.; Braux, P.; Claeys-Thoreau, F.; Lafontaine, A.; Verduyn, G. Repeated surveillance of exposure to cadmium, manganese, and arsenic in school-age children living in rural, urban, and nonferrous smelter areas in Belgium. *Environ. Res.* **1980**, *22*, 95–108.
5. Carrizales, L.; Razo, I.; Tellez-Hernandez, J.I.; Torres-Nerio, R.; Torres, A.; Batres, L.E.; Cubillas, A.; Diaz-Barriga, F. Exposure to arsenic and lead of children living near a copper-smelter in San Luis Potosi, Mexico: Importance of soil contamination for exposure of children. *Environ. Res.* **2006**, *101*, 1–10.
6. Frost, F.; Harter, L.; Milham, S.; Royce, R.; Smith, A.H.; Hartley, J.; Enterline, P. Lung cancer among women residing close to an arsenic emitting copper smelter. *Arch. Environ. Health* **1987**, *42*, 148–153.
7. Landrigan, P.J.; Baker, E.L. Exposure of children to heavy metals from smelters: Epidemiology and toxic consequences. *Environ. Res.* **1981**, *25*, 204–224.

8. Newhook, R.; Hirtle, H.; Byrne, K.; Meek, M.E. Releases from copper smelters and refineries and zinc plants in Canada: Human health exposure and risk characterization. *Sci. Total Environ.* **2003**, *301*, 23–41.
9. Yang, G.; Ma, L.; Xu, D.; Li, J.; He, T.; Liu, L.; Jia, H.; Zhang, Y.; Chen, Y.; Chai, Z. Levels and speciation of arsenic in the atmosphere in Beijing, China. *Chemosphere* **2012**, *87*, 845–850.
10. Csavina, J.; Field, J.; Taylor, M.P.; Gao, S.; Landazuri, A.; Betterton, E.A.; Saez, A.E. A review on the importance of metals and metalloids in atmospheric dust and aerosol from mining operations. *Sci. Total Environ.* **2012**, *433*, 58–73.
11. Zota, A.R.; Willis, R.; Jim, R.; Norris, G.A.; Shine, J.P.; Duvall, R.M.; Schaider, L.A.; Spengler, J.D. Impact of mine waste on airborne respirable particulates in northeastern Oklahoma, United States. *J. Air Waste Manag. Assoc.* **2009**, *59*, 1347–1357.
12. Aneja, V.P.; Isherwood, A.; Morgan, P. Characterisation of particulate matter (PM_{10}) related to surface coal mining operations in Appalachia. *Atmos. Environ.* **2012**, *54*, 496–501.
13. Ghose, M.K.; Majee, S.R. Characteristics of hazardous airborne dust around an Indian surface coal mining area. *Environ. Monit. Assess.* **2007**, *130*, 17–25.
14. Soukup, J.M.; Becker, S. Human alveolar macrophage responses to air pollution particulates are associated with insoluble components of coarse material, including particulate endotoxin. *Toxicol. Appl. Pharmacol.* **2001**, *171*, 20–26.
15. Thompson, R.J.; Visser, A.T. Mine Haul Fugitive Dust Emission and Exposure Characterisation. In Proceedings of the 2nd International Conference on the Impact of Environmental Factors on Health, Catania, Sicily, Italy, 17–19 September 2003; pp. 117–141.
16. Ghose, M.K.; Majee, S.R. Assessment of dust generation due to opencast coal mining—An Indian case study. *Environ. Monit. Assess.* **2000**, *61*, 255–263.
17. Castillo, S.; de la Rosa, J.D.; de la Campa, A.M.S.; Gonzalez-Castanedo, Y.; Fernandez-Caliani, J.C.; Gonzalez, I.; Romero, A. Contribution of mine wastes to atmospheric metal deposition in the surrounding area of an abandoned heavily polluted mining district (Rio Tinto mines, Spain). *Sci. Total Environ.* **2013**, *449*, 363–372.
18. Corriveau, M.C.; Jamieson, H.E.; Parsons, M.B.; Campbell, J.L.; Lanzirotti, A. Direct characterization of airborne particles associated with arsenic-rich mine tailings: Particle size, mineralogy and texture. *Appl. Geochem.* **2011**, *26*, 1639–1648.
19. Moreno, T.; Oldroyd, A.; McDonald, I.; Gibbons, W. Preferential fractionation of trace metals-metalloids into PM_{10} resuspended from contaminated gold mine tailings at Rodalquilar, Spain. *Water Air Soil Pollut.* **2007**, *179*, 93–105.
20. Meza-Figueroa, D.; Maier, R.M.; de la O-Villanueva, M.; Gomez-Alvarez, A.; Moreno-Zazueta, A.; Rivera, J.; Campillo, A.; Grandlic, C.J.; Anaya, R.; Palafox-Reyes, J. The impact of unconfined mine tailings in residential areas from a mining town in a semi-arid environment: Nacozari, Sonora, Mexico. *Chemosphere* **2009**, *77*, 140–147.
21. Kim, C.S.; Wilson, K.M.; Rytuba, J.J. Particle-size dependence on metal(loid) distributions in mine wastes: Implications for water contamination and human exposure. *Appl. Geochem.* **2011**, *26*, 484–495.
22. Ragaini, R.C.; Ralston, H.R.; Roberts, N. Environmental trace metal contamination in Kellogg, Idaho, near a lead smelting complex. *Environ. Sci. Technol.* **1977**, *11*, 773–781.

23. Seinfeld, J.H.; Pandis, S.N. *Atmospheric Chemistry and Physics: From Air Pollution to Climate Change*; Wiley: New York, NY, USA, 2006.
24. Rahn, K.A. *The Chemical Composition of the Atmospheric Aerosol*; Technical Report; University of Rhode Island: Kingston, RI, USA, 1976.
25. Agency for Toxic Substances and Disease Registry (ATSDR). Toxicological Profile for Arsenic. Available online: http://www.atsdr.cdc.gov/ToxProfiles/tp.asp?id=22&tid=3 (accessed on 5 July 2013).
26. Lee, D.S.; Garland, J.A.; Fox, A.A. Atmospheric concentrations of trace elements in urban areas of the United Kingdom. *Atmos. Environ.* **1994**, *28*, 2691–2713.
27. Garcia-Aleix, J.R.; Delgado-Saborit, J.M.; Verdu-Martin, G.; Amigo-Descarrega, J.M.; Esteve-Cano, V. Trends in arsenic levels in PM_{10} and $PM_{2.5}$ aerosol fractions in an industrialized area. *Environ. Sci. Pollut. Res.* **2014**, *21*, 695–703.
28. Plumlee, G.S.; Morman, S.A. Mine wastes and human health. *Elements* **2011**, *7*, 399–404.
29. Schaider, L.A.; Senn, D.B.; Brabander, D.J.; McCarthy, K.D.; Shine, J.P. Characterization of zinc, lead, and cadmium in mine waste: Implications for transport, exposure, and bioavailability. *Environ. Sci. Technol.* **2007**, *41*, 4164–4171.
30. Andrade, C.F.; Jamieson, H.E.; Kyser, T.K.; Praharaj, T.; Fortin, D. Biogeochemical redox cycling of arsenic in mine-impacted lake sediments and co-existing pore waters near Giant Mine, Yellowknife Bay, Canada. *Appl. Geochem.* **2010**, *25*, 199–211.
31. Helsen, L. Sampling technologies and air pollution control devices for gaseous and particulate arsenic: A review. *Environ. Pollut.* **2005**, *137*, 305–315.
32. Shibayama, A.; Takasaki, Y.; William, T.; Yamatodani, A.; Higuchi, Y.; Sunagawa, S.; Ono, E. Treatment of smelting residue for arsenic removal and recovery of copper using pyro-hydrometallurgical process. *J. Hazard. Mater.* **2010**, *181*, 1016–1023.
33. Cullen, W.R.; Reimer, K.J. Arsenic speciation in the environment. *Chem. Rev.* **1989**, *89*, 713–764.
34. Wang, S.; Mulligan, C.N. Occurrence of arsenic contamination in Canada: Sources, behavior and distribution. *Sci. Total Environ.* **2006**, *366*, 701–721.
35. Maggs, R. A Review of Arsenic in Ambient Air in the UK. Available online: http://uk-air.defra.gov.uk/reports/empire/arsenic00/arsenic_97v.pdf (accessed on 12 November 2013).
36. Twidwell, L.G.; Mehta, A.K. Disposal of arsenic bearing copper smelter flue dust. *Nucl. Chem. Waste Manag.* **1985**, *5*, 297–303.
37. Rieuwerts, J.; Farago, M. Heavy metal pollution in the vicinity of a secondary lead smelter in the Czech Republic. *Appl. Geochem.* **1996**, *11*, 17–23.
38. Kovacevic, R.; Jovasevic-Stojanovic, M.; Tasic, V.; Milosevic, N.; Petrovic, N.; Stankovic, S.; Matic-Besarabic, S. Preliminary analysis of levels of arsenic and other metallic elements in PM_{10} sampled near copper smelter Bor, (Serbia). *Chem. Ind. Chem. Eng. Q.* **2010**, *16*, 269–279.
39. Montenegro, V.; Sano, H.; Fujisawa, T. Recirculation of high arsenic content copper smelting dust to smelting and converting processes. *Miner. Eng.* **2013**, *49*, 184–189.
40. Finkelman, R.B. Trace elements in coal: Environmental and health significance. *Biol. Trace Elem. Res.* **1999**, *67*, 197–204.
41. Finkelman, R.B.; Gross, P.M.K. The types of data needed for assessing the environmental and human health impacts of coal. *Int. J. Coal Geol.* **1999**, *40*, 91–101.

42. Kang, Y.; Liu, G.; Chou, C.; Wong, M.H.; Zheng, L.; Ding, R. Arsenic in Chinese coals: Distribution, modes of occurrence, and environmental effects. *Sci. Total Environ.* **2011**, *412–413*, 1–13.
43. Sia, S.; Abdullah, W.H. Enrichment of arsenic, lead, and antimony in Balingian coal from Sarawak, Malaysia: Modes of occurrence, origin, and partitioning behaviour during coal combustion. *Int. J. Coal Geol.* **2012**, *101*, 1–14.
44. Huggins, F.E.; Helble, J.J.; Shah, N.; Zhao, J.; Srinivasachar, S.; Morency, J.R.; Lu, F.; Huffman, G.P. Forms of occurrence of arsenic in coal and their behavior during coal combustion. *Abstr. Pap. Am. Chem. Soc.* **1993**, *38*, 265–271.
45. Nelson, P.F.; Shah, P.; Strezov, V.; Halliburton, B.; Carras, J.N. Environmental impacts of coal combustion: A risk approach to assessment of emissions. *Fuel* **2010**, *89*, 810–816.
46. Bolanz, R.M.; Majzlan, J.; Jurkovic, L.; Gottlicher, J. Mineralogy, geochemistry, and arsenic speciation in coal combustion waste from Novaky, Slovakia. *Fuel* **2012**, *94*, 125–136.
47. Furimsky, E. Characterization of trace element emissions from coal combustion by equilibrium calculations. *Fuel Process. Technol.* **2000**, *63*, 29–44.
48. Zhao, Y.; Zhang, J.; Huang, W.; Wang, Z.; Li, Y.; Song, D.; Zhao, F.; Zheng, C. Arsenic emission during combustion of high arsenic coals from Southwestern Guizhou, China. *Energy Convers. Manag.* **2008**, *49*, 615–624.
49. Brownfield, M.E.; Affolter, R.H.; Cathcart, J.D.; O'Connor, J.T.; Brownfield, I.K. Characterization of feed coal and coal combustion products from power plants in Indiana and Kentucky. In Proceedings of the 24th International Technical Conference on Coal Utilization and Fuel Systems, Clearwater, Florida, FL, USA, 8–11 March 1999; pp. 989–1000.
50. Yudovich, Y.E.; Ketris, M.P. Arsenic in coal: A review. *Int. J. Coal Geol.* **2005**, *61*, 141–196.
51. Tian, H.; Wang, Y.; Xue, Z.; Qu, Y.; Chai, F.; Hao, J. Atmospheric emissions estimation of Hg, As, and Se from coal-fired power plants in China, 2007. *Sci. Total Environ.* **2011**, *409*, 3078–3081.
52. Ondov, J.M.; Ragaini, R.C.; Bierman, A.H. Elemental emissions from a coal-fired power plant. Comparison of a venturi wet scrubber system with a cold-side electrostatic precipitator. *Environ. Sci. Technol.* **1979**, *13*, 588–601.
53. Hamilton, E.I. Environmental variables in a holistic evaluation of land contaminated by historic mine wastes: A study of multi-element mine wastes in West Devon, England using arsenic as an element of potential concern to human health. *Sci. Total Environ.* **2000**, *249*, 171–221.
54. Querol, X.; Alastuey, A.; Lopez-Soler, A.; Plana, F. Levels and chemistry of atmospheric particulates induced by a spill of heavy metal mining wastes in the Donana area, Southwest Spain. *Atmos. Environ.* **2000**, *34*, 239–253.
55. Mendez, M.; Armienta, M.A. Arsenic phase distribution in Zimapan mine tailings, Mexico. *Geofis. Int.* **2003**, *42*, 131–140.
56. Smith, E.; Smith, J.; Smith, L.; Biswas, T.; Correll, R.; Naidu, R. Arsenic in Australian environment: An overview. *J. Environ. Sci. Health Part. A* **2003**, *A38*, 223–239.
57. Mullins, M.J.P.; Norman, J.B. Solubility of metals in windblown dust from mine waste dump sites. *Appl. Occup. Environ. Hyg.* **1994**, *9*, 218–223.

58. Northey, S.; Mohr, S.; Mudd, G.M.; Weng, Z.; Giurco, D. Modelling future copper ore grade decline based on a detailed assessment of copper resources and mining. *Resour. Conserv. Recycl.* **2014**, *83*, 190–201.
59. U.S. Energy Information Administration (EIA). *Annual Energy Outlook 2014 with Projections to 2040*; U.S. EIA: Washington, DC, USA, 2014.
60. U.S. Energy Information Administration (EIA). International Energy Outlook 2013. Available online: http://www.eia.gov/forecasts/ieo/more_highlights.cfm (accessed on 18 August 2013)
61. Pandey, V.C.; Singh, J.S.; Singh, R.P.; Singh, N.; Yunus, M. Arsenic hazards in coal fly ash and its fate in Indian scenario. *Resour. Conserv. Recycl.* **2011**, *55*, 819–835.
62. European Commission. Abandoned Mines Can Be Used as Geothermal Energy Source. Available online: http://ec.europa.eu/environment/integration/research/newsalert/pdf/230na6.pdf (accessed on 18 December 2013).
63. Bureau of Land Management, U.S. Department of the Interior. Abandoned Mine Lands. Available online: http://www.blm.gov/wo/st/en/prog/more/Abandoned_Mine_Lands.html (accessed on 17 May 2013).
64. Ministerial Council on Mineral and Petroleum Resources/Minerals Council of Australia. Strategic Framework for Managing Abandoned Mines in the Minerals Industry. Available online: http://www.industry.gov.au/resource/Mining/Documents/StrategicFrameworkforManagingAbandonedMines.pdf (accessed on 2 February 2014).
65. Unger, C.; Lechner, A.; Glenn, V.; Edraki, M.; Mulligan, D.R. Mapping and prioritising rehabilitation of abandoned mines in Australia. In Proceedings of the 2012 Life-of-Mine Conference, Brisbane, Australia, 10–12 July 2012.
66. Gonzalez, R.C.; Gonzalez-Chavez, M.C.A. Metal accumulation in wild plants surrounding mining wastes. *Environ. Pollut.* **2006**, *144*, 84–92.
67. Lottermoser, B.G. *Mine Wastes: Characterisation, Treatment and Environmental Impacts*; Springer: New York, NY, USA, 2010.
68. Liao, B.; Huang, L.N.; Ye, Z.H.; Lan, C.Y.; Shu, W.S. Cut-off net acid generation pH in predicting acid-forming potential in mine spoils. *J. Environ. Qual.* **2007**, *36*, 887–891.
69. European Commission. Air Quality Standards. Available online: http://ec.europa.eu/environment/air/quality/ standards.htm (accessed on 3 June 2014).
70. World Health Organisation. *Air Quality Guidelines for Europe*, 2nd ed.; WHO Regional Publications: Geneva, Switzerland, 2000.
71. Vincent, J.H. *Aerosol Sampling: Science, Standards, Instrumentations and Applications*; Wiley: Chichester, UK, 2007.
72. Newman, L.S. Clinical pulmonary toxicology. In *Clinical Environmental Health and Exposures*, 2nd ed.; Sullivan, J.B., Krieger, G., Eds.; Lippincott Wiliams and Wilkins: Philadelphia, PA, USA, 2001; pp. 206–233.
73. United States Environmental Protection Agency. Locating and Estimating Air (L&E) Documents, EPA Document Number 454/r-98–013. Available online: http://www.epa.gov/ttnchie1/le/ (accessed on 10 November 2013).

74. De la Campa, A.M.S.; de la Rosa, J.D.; Sanchez-Rodas, D.; Oliveira, V.; Alastuey, A.; Querol, X.; Gomez-Ariza, J.L. Arsenic speciation study of PM2.5 in an urban area near a copper smelter. *Atmos. Environ.* **2008**, *42*, 6487–6495.
75. Sanchez-Rodas, D.; Sanchez de la Campa, A.M.; de la Rosa, J.D.; Oliveira, V.; Gomez-Ariza, J.L.; Querol, X.; Alastuey, A. Arsenic speciation of atmospheric particulate matter (PM10) in an industrialised urban site in southwestern Spain. *Chemosphere* **2007**, *66*, 1485–1493.
76. Tsopelas, F.; Tsakanika, L.; Ochsenkuhn-Petropoulou, M. Extraction of arsenic species from airborne particulate filters-application to an industrial area of Greece. *Microchem. J.* **2008**, *89*, 165–170.
77. Fernandez-Camacho, R.; de la Rosa, J.; de la Campa, A.M.S.; Gonzalez-Castanedo, Y.; Alastuey, A.; Querol, X.; Rodriguez, S. Geochemical characterization of Cu-smelter emission plumes with impact in an urban area of SW Spain. *Atmos. Res.* **2010**, *96*, 590–601.
78. Polissar, L.; Lowry-Coble, K.; Kalman, D.A.; Hughes, J.P.; van Belle, G.; Covert, D.S.; Burbacher, T.M.; Bolgiano, D.; Mottet, N.K. Pathways of human exposure to arsenic in a community surrounding a copper smelter. *Environ. Res.* **1990**, *53*, 29–47.
79. European Commission (EC). Ambient Air Pollution by As, Cd and Ni Compounds. Position Paper. Available online: http://www.itm.su.se/reflabmatningar/dokument/as_cd_ni_position_paper.pdf (accessed on 10 July 2013).
80. Johnson, B.D.; Myers, J.E. Preliminary validation of modelled environmental PM_{10} Arsenic Trioxide (As2O3) dust fallout from a copper smelter in Namibia. In Proceedings of the 4th International Congress on Arsenic in the Environment, Cairns, Australia, 22–27 July 2012; pp. 431–432.
81. Serbula, S.M.; Antonijevic, M.M.; Milosevic, N.M.; Milic, S.M.; Ilic, A.A. Concentrations of particulate matter and arsenic in Bor (Serbia). *J. Hazard. Mater.* **2010**, *181*, 43–51.
82. Chen, B.; Stein, A.F.; Castell, N.; de la Rosa, J.D.; de la Campa, A.M.S.; Gonzalez-Castanedo, Y.; Draxler, R.R. Modeling and surface observations of arsenic dispersion from a large Cu-smelter in southwestern Europe. *Atmos. Environ.* **2012**, *49*, 114–122.
83. Oliveira, V.; Gomez-Ariza, J.L.; Sanchez-Rodas, D. Extraction procedures for chemical speciation of arsenic in atmospheric total suspended particles. *Anal. Bioanal. Chem.* **2005**, *382*, 335–340.
84. Duan, J.; Tan, J. Atmospheric heavy metals and arsenic in China: Situation, sources and control policies. *Atmos. Environ.* **2013**, *74*, 93–101.
85. Greenpeace. Detecting the Heavy Metal Concentration of PM2.5 in Beijing. Available online: http://www.greenpeace.org/eastasia/Global/eastasia/publications (accessed on 3 March 2014).
86. Okuda, T.; Katsuno, M.; Naoi, D.; Nakao, S.; Shigeru, T.; He, K.; Ma, Y.; Lei, Y.; Jia, Y. Trends in hazardous trace metal concentrations in aerosols collected in Beijing, China from 2001 to 2006. *Chemosphere* **2008**, *72*, 917–924.
87. Xie, R.; Seip, H.M.; Wibetoe, G.; Nori, S.; McLeod, C.W. Heavy coal combustion as the dominant source of particulate pollution in Taiyuan, China, corroborated by high concentrations of arsenic and selenium in PM10. *Sci. Total Environ.* **2006**, *370*, 409–415.

88. Zhou, S.; Yuan, Q.; Li, W.; Lu, Y.; Zhang, Y.; Wang, W. Trace metals in atmospheric fine particles in one industrial urban city: Spatial variations, sources, and health implications. *J. Environ. Sci.* **2014**, *26*, 205–213.
89. Kribek, B.; Majer, V.; Pasava, J.; Kamona, F.; Mapani, B.; Keder, J.; Ettler, V. Contamination of soils with dust fallout from the tailings dam at the Rosh Pinah area, Namibia: Regional assessment, dust dispersion modeling and environmental consequences. *J. Geochem. Explor.* **2014**, doi:10.1016/j.gexplo.2014.01.010.
90. Protonotarios, V.; Petsas, N.; Moutsatsou, A. Levels and composition of atmospheric particulates (PM10) in a mining-industrial site in the city of Lavrion, Greece. *J. Air Waste Manag. Assoc.* **2002**, *52*, 1263–1273.
91. Jain, C.K.; Ali, I. Arsenic: Occurrence, toxicity and speciation techniques. *Water Res.* **2000**, *34*, 4304–4312.
92. Ferguson, J.F.; Gavis, J. A review of the arsenic cycle in natural waters. *Water Res.* **1972**, *6*, 1259–1274.
93. Akter, K.; Naidu, R. Arsenic speciation in the environment. In *Managing Arsenic in the Environment: From Soil to Human Health*; Naidu, R., Smith, E., Owens, G., Bhattacharya, P., Nadebaum, P., Eds.; CSIRO Publishing: Collingwood, VT, Australia, 2006; pp. 61–74.
94. Jamieson, H.E.; Walker, S.R.; Andrade, C.F.; Wrye, L.A.; Rasmussen, P.E.; Lanzirotti, A.; Parsons, M.B. Identification and characterization of arsenic and metal compounds in contaminated soil, mine tailings, and house dust using synchrotron-based microanalysis. *Hum. Ecol. Risk Assess.* **2011**, *17*, 1292–1309.
95. Walker, S.R.; Jamieson, H.E. The speciation of arsenic in iron oxides in mine wastes from the giant gold mine, N.W.T. Applications of synchrotron micro-XRD and micro-XANES at the grain scale. *Can. Mineral.* **2005**, *43*, 1205–1224.
96. Cherry, J.A.; Shaikh, A.U.; Tallman, D.E.; Nicholson, R.V. Arsenic species as an indicator of redox conditions in groundwater. *J. Hydrol.* **1979**, *43*, 373–392.
97. Meharg, A. Arsenic in rice—Understanding a new disaster for southeast Asia. *Trends Plant Sci.* **2004**, *9*, 415–417.
98. Korte, N.E.; Fernando, Q. A review of arsenic (III) in groundwater. *Crit. Rev. Environ. Control* **1991**, *21*, 1–39.
99. Garcia-Manyes, S.; Jimenez, G.; Padro, A.; Rubio, R.; Rauret, G. Arsenic speciation in contaminated soils. *Talanta* **2002**, *58*, 97–109.
100. Shuvaeva, O.V.; Bortnikova, S.B.; Korda, T.M.; Lazareva, E.V. Arsenic speciation in a contaminated gold processing tailings dam. *Geostand. Newsl.* **2000**, *24*, 247–252.
101. Eatough, D.J.; Christensen, J.J.; Eatough, N.L.; Hill, M.W.; Major, T.D.; Mangelson, N.F.; Post, M.E.; Ryder, J.F.; Hansen, L.D.; Meisenheimer, R.G.; *et al.* Sulfur chemistry in a copper smelter plume. *Atmos. Environ.* **1982**, *16*, 1001–1015.
102. Hedberg, E.; Gidhagen, L.; Johansson, C. Source contributions to PM10 and arsenic concentrations in Central Chile using positive matrix factorization. *Atmos. Environ.* **2005**, *39*, 549–561.

103. Alleman, L.Y.; Lamaison, L.; Perdrix, E.; Robache, A.; Galloo, J. PM10 metal concentrations and source identification using positive matrix factorization and wind sectoring in a French industrial zone. *Atmos. Res.* **2010**, *96*, 612–625.
104. Hrebenyk, B.W.; Iravani, A. *Air Quality Monitoring at Giant Mine Site—Yellowknife, A Baseline Study*; Report for the Indian and Northern Affairs Canada, Giant Mine Remediation Project; SENES Consultants Ltd: Ontario, USA, 2007.
105. Cao, S.; Duan, X.; Zhao, X.; Ma, J.; Dong, T.; Huang, N.; Sun, C.; He, B.; Wei, F. Health risks from the exposure of children to As, Se, Pb and other heavy metals near the largest coking plant in China. *Sci. Total Environ.* **2014**, *472*, 1001–1009.
106. Huang, M.; Chen, X.; Shao, D.; Zhao, Y.; Wang, W.; Wong, M.H. Risk assessment of arsenic and other metals via atmospheric particles, and effects of atmospheric exposure and other demographic factors on their accumulations in human scalp hair in urban area of Guangzhou, China. *Ecotoxicol. Environ. Saf.* **2014**, *102*, 84–92.
107. Milham, S.; Strong, T. Human arsenic exposure in relation to a copper smelter. *Environ. Res.* **1974**, *7*, 176–182.
108. United States Environmental Protection Agency. Questions About Your Community: Indoor Air. Available online: http://www.epa.gov/region1/communities/indoorair.html (accessed on 5 January 2014).
109. Davies, C.N. Inhalation risk and particle size in dust and mist. *Brit. J. Ind. Med.* **1949**, *6*, 245–253.
110. Hofmann, W. Modelling inhaled particle deposition in the human lung-A review. *J. Aerosol Sci.* **2011**, *42*, 693–724.
111. Lippman, M.; Yeates, D.B.; Albert, R.E. Deposition, retention, and clearance of inhaled particles. *Br. J. Ind. Med.* **1980**, *37*, 337–362.
112. Bailey, M.R. The new ICRP model for the respiratory tract. *Radiat. Prot. Dosim.* **1994**, *53*, 107–114.
113. Labiris, N.R.; Dolovich, M.B. Pulmonary drug delivery. Part I: Physiological factors affecting therapeutic effectiveness of aerosolized medications. *J. Clin. Pharmacol.* **2003**, *56*, 588–599.
114. Nicod, L.P. Lung defences: An overview. *Eur. Respir. J.* **2005**, *14*, 45–50.
115. Taylor, D.M. Human respiratory tract model for radiological protection. *J. Radiol. Prot.* **1996**, *16*, doi:10.1088/0952-4746/16/1/013.
116. World Health Organization (WHO). *Hazard Prevention and Control in the Work Environment: Airborne Dust*; Occupatonal and Environmental Health Department of Protection of the Human Environment, WHO: Geneva, Switzerland, 1999.
117. Smith, J.R.H.; Etherington, G.; Shutt, A.L.; Youngman, M.J. A study of aerosol deposition and clearance from the human nasal passage. *Ann. Occup. Hyg.* **2002**, *46*, 309–313.
118. Asgharian, B.; Hofmann, W.; Miller, F.J. Mucociliary clearance of insoluble particles from the tracheobronchial airways of the human lung. *Aerosol Sci.* **2001**, *32*, 817–832.
119. Kirch, J.; Guenther, M.; Doshi, N.; Schaefer, U.F.; Schneider, M.; Mitragotri, S.; Lehr, C.M. Mucociliary clearance of micro- and nanoparticles is independent of size, shape and charge—An *ex vivo* and in silico approach. *J. Controll. Release* **2012**, *159*, 128–134.
120. Wang, C. *Inhaled particles*; Elsevier Academic Press: New York, NY, USA, 2005.
121. Folkesson, H.G.; Matthay, M.A.; Westrom, B.R.; Kim, K.J.; Karlsson, B.W.; Hastings, R.H. Alveolar epithelial clearance of protein. *J. Appl. Physiol.* **1996**, *80*, 1431–1445.

122. Martonen, T.B. Mathematical model for the selective deposition of inhaled pharmaceuticals. *J. Pharm. Sci.* **1993**, *82*, 1191–1199.
123. Hakim, J. Reactive oxygen species and inflammation. *C R Seances Soc. Biol. Fil* **1993**, *187*, 286–295.
124. Hofmann, W.; Asgharian, B. The effect of lung structure on mucociliary clearance and particle retention in human and rat lungs. *Toxicol. Sci.* **2003**, *73*, 448–456.
125. Rhoads, K.; Sanders, C.L. Lung clearance, translocation, and acute toxicity of arsenic, beryllium, cadmium, cobalt, lead, selenium, vanadium, and ytterbium oxides following deposition in rat lung. *Environ. Res.* **1985**, *36*, 359–378.
126. Marafante, E.; Vahter, M. Solubility, retention, and metabolism of intratracheally and orally administered inorganic arsenic compounds in the hamster. *Environ. Res.* **1987**, *42*, 72–82.
127. Edsbacker, S.; Wollmer, P.; Selroos, O.; Borgstrom, L.; Olsson, B.; Ingelf, J. Do airway clearance mechanisms influence the local and systemic effects of inhaled corticosteroids? *Pulm. Pharmacol. Ther.* **2008**, *21*, 247–258.
128. Lantz, R.C.; Parliman, G.; Chen, G.J.; Barber, B.; Winski, S.; Carter, D.E. Effect of arsenic exposure on alveolar macrophage function. II. Effect of slightly soluble forms of As(III) and As(V). *Environ. Res.* **1995**, *68*, 59–67.
129. Pershagen, G.; Lind, B.; Bjorklund, N. Lung retention and toxicity of some inorganic arsenic compounds. *Environ. Res.* **1982**, *29*, 425–434.
130. Takeo, I.; Akira, H.; Noburu, I. Comparison of arsenic trioxide and calcium arsenate retention in the rat lung after intratracheal instillation. *Toxicol. Lett.* **1982**, *12*, 1–5.
131. O'Bryant, S.E.; Edwards, M.; Menon, C.V.; Gong, G.; Barber, R. Long-term low-level arsenic exposure is associated with poorer neuropsychological functioning: A project FRONTIER study. *Int. J. Environ. Res. Public Health* **2011**, *8*, 861–874.
132. Zhang, C.; Mao, G.; He, S.; Yang, Z.; Yang, W.; Zhang, X.; Qiu, W.; Ta, N.; Cao, L.; Yang, H.; *et al.* Relationship between long-term exposure to low-level arsenic in drinking water and the prevalence of abnormal blood pressure. *J. Hazard. Mater.* **2013**, *262*, 1154–1158.
133. Caussy, D. Case studies of the impact of understanding bioavailability: Arsenic. *Ecotoxicol. Environ. Saf.* **2003**, *56*, 164–173.
134. Naidu, R.; Bolan, N.S.; Megharaj, M.; Juhasz, A.L.; Gupta, S.; Clothier, B.; Schulin, R. Bioavailability, definition, assessment and implications for risk assessment. In *Chemical Bioavailability in Terrestrial Environment*; Elsevier: Amsterdam, The Netherland, 2008; pp. 1–8.
135. Ng, J.C.; Juhasz, A.L.; Smith, E.; Naidu, R. *Contaminant Bioavailability and Bioaccessibility. Part. 2: Guidance for Industry*; Report for the Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE), Technical Report series no. 14; CRC CARE: Salisbury South, Australia, 2009.
136. Broadway, A.; Cave, M.R.; Wragg, J.; Fordyce, F.M.; Bewley, R.J.F.; Graham, M.C.; Ngwenya, B.T.; Farmer, J.G. Determination of the bioaccessibility of chromium in Glasgow soil and the implications for human health risk assessment. *Sci. Total Environ.* **2010**, *409*, 267–277.
137. Colombo, C.; Monhemius, A.J.; Plant, J.A. Platinum, palladium and rhodium release from vehicle exhaust catalysts and road dust exposed to simulated lung fluids. *Ecotoxicol. Environ. Saf.* **2008**, *71*, 722–730.

138. Hedberg, Y.; Gustafsson, J.; Karlsson, H.L.; Moller, L.; Wallinder, I.O. Bioaccessibility, bioavailability and toxicity of commercially relevant iron- and chromium-based particles: *In vitro* studies with an inhalation perspective. *Part. Fibre Toxicol.* **2010**, *7*, 1–14.
139. Herting, G.; Wallinder, I.O.; Leygraf, C. Metal release from various grades of stainless steel exposed to synthetic body fluids. *Corros. Sci.* **2007**, *49*, 103–111.
140. Plumlee, G.S.; Ziegler, T.L. The medical geochemistry of dusts, soils and other earth materials. In *Environmental Geochemistry: Treatise of Geochemistry*; Lollar, B.S., Holland, H.D., Turekian, K.K., Eds.; Elsevier Ltd: Oxford, UK, 2003; Volume 9, pp. 263–310.
141. Marques, M.R.C.; Loebenberg, R.; Almukainzi, M. Simulated biological fluids with possible application in dissolution testing. *Dissolution Technol.* **2011**, *18*, 15–28.
142. Plumlee, G.S.; Morman, S.A.; Ziegler, T.L. The toxocological geochemistry of earth materials: An overview of processes and the interdisciplinary methods used to understsand them. *Rev. Mineral. Geochem.* **2006**, *64*, 5–57.
143. Wolf, R.E.; Morman, S.A.; Hageman, P.L.; Hoefen, T.M.; Plumlee, G.S. Simultaneous speciation of arsenic, selenium, and chromium: Species stability, sample preservation, and analysis of ash and soil leachates. *Anal. Bioanal. Chem.* **2011**, *401*, 2733–2745.
144. Kitchin, K.T. Recent advances in arsenic carcinogenesis: Modes of action, animal model systems, and methylated arsenic metabolites. *Toxicol. Appl. Pharmacol.* **2001**, *172*, 249–261.
145. Vahter, M.; Concha, G. Role of metabolism in arsenic toxicity. *Pharmacol. Toxicol.* **2001**, *89*, 1–5.
146. Vahter, M. Mechanisms of arsenic biotransformation. *Toxicology* **2002**, *181–182*, 211–217.
147. Roy, P.; Saha, A. Metabolism and toxicity of arsenic: A human carcinogen. *Curr. Sci.* **2002**, *82*, 38–45.
148. Thomas, D.J. Molecular processes in cellular arsenic metabolism. *Toxicol. Appl. Pharmacol.* **2007**, *222*, 365–373.
149. Styblo, M.; Drobna, Z.; Jaspers, I.L.S.; Thomas, D.J. The role of biomethylation in toxicity and carcinogenicity of arsenic: A research update. *Environ. Health Perspect.* **2002**, *110*, 767–771.
150. Brima, E.I.; Haris, P.I.; Jenkins, R.O.; Polya, D.A.; Gault, A.G.; Harrington, C.F. Understanding arsenic metabolism through a comparative study of arsenic levels in the urine, hair and fingernails of healthy volunteers from three unexposed ethnic groups in the United Kingdom. *Toxicol. Appl. Pharmacol.* **2006**, *216*, 122–130.
151. Gebel, T.W. Arsenic methylation is a process of detoxification through accelerated excretion. *Int. J. Hyg. Environ. Health* **2002**, *205*, 505–508.
152. Styblo, M.; Del Razo, L.M.; Vega, L.; Germolec, D.R.; LeCluyse, E.L.; Hamilton, G.A.; Reed, W.; Wang, C.; Cullen, W.R.; Thomas, D.J. Comparative toxicity of trivalent and pentavalent inorganic and methylated arsenicals in rat and human cells. *Arch. Toxicol.* **2000**, *74*, 289–299.
153. Thomas, D.J.; Waters, S.B.; Styblo, M. Elucidating the pathway for arsenic methylation. *Toxicol. Appl. Pharmacol.* **2004**, *198*, 319–326.
154. Rossman, T. Arsenic. In *Environmental and Occupational Medicine*; Rom, W., Markowitz, S., Eds.; Lippincott Williams and Wilkins: Hagerstown, MD, USA, 2007; pp. 1006–1017.

155. Aposhian, H.V.; Zheng, B.; Aposhian, M.M.; Le, X.C.; Cebrian, M.E.; Cullen, W.; Zakharyan, R.A.; Ma, M.; Dart, R.C.; Cheng, Z.; *et al.* DMPS-Arsenic challenge test. II. Modulation of arsenic species, including monomethylarsonous acid (MMAIII), excreted in human urine. *Toxicol. Appl. Pharmacol.* **2000**, *165*, 74–83.
156. Buchet, J.P.; Lauwerys, R.; Roels, H. Comparison of the urinary excretion of arsenic metabolites after a single oral dose of sodium arsenite, monomethylarsonate, or dimethylarsinate in man. *Int. Arch. Occup. Environ. Health* **1981**, *48*, 71–79.
157. Raml, R.; Rumpler, A.; Goessler, W.; Vahter, M.; Li, L.; Ochi, T.; Francesconi, K.A. Thio-dimethylarsinate is a common metabolite in urine samples from arsenic-exposed women in Bangladesh. *Toxicol. Appl. Pharmacol.* **2007**, *222*, 374–380.
158. Flora, S.J.S. Arsenic-induced oxidative stress and its reversibility. *Free Radic. Biol. Med.* **2011**, *51*, 257–281.
159. Kenyon, E.M.; Del Razo, L.M.; Hughes, M.F. Tissue distribution and urinary excretion of inorganic arsenic and its methylated metabolites in mice following acute oral administration of arsenate. *Toxicol. Sci.* **2005**, *85*, 468–475.
160. Naranmandura, H.; Bu, N.; Suzuki, K.T.; Lou, Y.; Ogra, Y. Distribution and speciation of arsenic after intravenous administration of monomethylmonothioarsonic acid in rats. *Chemosphere* **2010**, *81*, 206–213.
161. Ratnaike, R.N. Acute and chronic arsenic toxicity. *Postgrad. Med. J.* **2003**, *79*, 391–396.
162. Aposhian, H.V.; Zakharyan, R.A.; Avram, M.D.; Sampayo-Reyes, A.; Wollenberg, M.L. A review of the enzymology of arsenic metabolism and a new potential role of hydrogen peroxide in the detoxication of the trivalent arsenic species. *Toxicol. Appl. Pharmacol.* **2004**, *198*, 327–335.
163. Carter, D.E.; Peraza, M.A.; Ayala-Fierro, F.; Casarez, E.; Barber, D.S.; Winski, S.L. Arsenic metabolism after pulmonary exposure. In Proceedings of the Third International Conference on Arsenic Exposure and Health Effects, San Diego, CA, USA, 12–15 July 1998; pp. 299–309.
164. Cohen, S.M.; Arnold, L.L.; Eldan, M.; Lewis, A.S.; Beck, B.D. Methylated arsenicals: The implications of metabolism and carcinogenicity studies in rodents to human risk assessment. *Crit. Rev. Toxicol.* **2006**, *36*, 99–133.
165. Dodmane, P.R.; Arnold, L.L.; Kakiuchi-Kiyota, S.; Qiu, F.; Liu, X.; Rennard, S.I.; Cohen, S.M. Cytotoxicity and gene expression changes induced by inorganic and organic trivalent arsenicals in human cells. *Toxicology* **2013**, *312*, 18–29.
166. Tseng, C. A review on environmental factors regulating arsenic methylation in humans. *Toxicol. Appl. Pharmacol.* **2009**, *235*, 338–350.
167. Abernathy, C.O.; Thomas, D.J.; Calderon, R.L. Health effects and risk assessment of arsenic. *J. Nutr.* **2003**, 1536–1538.
168. Chilakapati, J.; Wallace, K.; Ren, H.; Fricke, M.; Bailey, K.; Ward, W.; Creed, J.; Kitchin, K. Genome-wide analysis of BEAS-2B cells exposed to trivalent arsenicals and dimethylthioarsinic acid. *Toxicology* **2010**, *268*, 31–39.
169. An, Y.; Kato, K.; Nakano, M.; Otsu, H.; Okada, S.; Yamanaka, K. Specific induction of oxidative stress in terminal bronchiolar Clara cells during dimethylarsenic-induced lung tumor promoting process in mice. *Cancer Lett.* **2005**, *230*, 57–64.

170. Yamanaka, K.; Okada, S. Induction of lung-specific DNA damage by metabolically methylated arsenics via the production of free radicals. *Environ. Health Perspect.* **1994**, *102*, 37–40.
171. Yamanaka, K.; Kato, K.; Mizoi, M.; An, Y.; Nakanao, M.; Hoshino, M.; Okada, S. Dimethylarsine likely acts as a mouse-pulmonary tumor initiator via the production of dimethylarsine radical and/or its peroxy radical. *Life Sci.* **2009**, *84*, 627–633.
172. Halliwell, B. Biochemistry of oxidative stress. *Biochem. Soc. Trans.* **2007**, *35*, 1147–1150.
173. Betteridge, D.J. What is oxidative stress. *Metabolism* **2000**, *49*, 3–8.
174. Andrewes, P.; Kitchin, K.T.; Wallace, K. Dimethylarsine and trimethylarsine are potent genotoxins *in vitro*. *Chem. Res. Toxicol.* **2003**, *16*, 994–1003.
175. Kitchin, K.T.; Ahmad, S. Oxidative stress as a possible mode of action for arsenic carcinogenesis. *Toxicol. Lett.* **2003**, *137*, 3–13.
176. Burdon, R.H. Superoxide and hydrogen peroxide in relation to mammalian cell proliferation. *Free Radic. Biol. Med.* **1995**, *18*, 775–794.
177. Yamanaka, K.; Kato, K.; Mizoi, M.; An, Y.; Takabayashi, F.; Nakano, M.; Hoshino, M.; Okada, S. The role of active arsenic species produced by metabolic reduction of dimethylarsinic acid in genotoxicity and tumorigenesis. *Toxicol. Appl. Pharmacol.* **2004**, *198*, 385–393.
178. Dopp, E.; von Recklinghausen, U.; Diaz-Bone, R.; Hirner, A.V.; Rettenmeier, A.W. Cellular uptake, subcellular distribution and toxicity of arsenic compounds in methylating and non-methylating cells. *Environ. Res.* **2010**, *110*, 435–442.
179. Flora, S.J.S. Arsenic induced oxidative stress and the role of antioxidant supplementation during chelation: A review. *J. Environ. Biol.* **2007**, *28*, 333–347.
180. Tchounwou, P.B.; Centeno, J.A.; Patlolla, A.K. Arsenic toxicity, mutagenesis, and carcinogenesis—A health risk assessment and management approach. *Mol. Cell Biochem.* **2004**, *255*, 47–55.
181. Smith, A.H.; Ercumen, A.; Yuan, Y.; Steinmaus, C.M. Increased lung cancer risks are similar whether arsenic is ingested or inhaled. *J. Exposure Sci. Environ. Epidemiol.* **2009**, *19*, 343–348.
182. Wester, P.O.; Brune, D.; Nordberg, G. Arsenic and selenium in lung, liver, and kidney tissue from dead smelter workers. *Br. J. Ind. Med.* **1981**, *38*, 179–184.
183. Hall, M.N.; Gamble, M.V. Nutritional manipulation of one-carbon metabolisms: Effects on arsenic methylation and toxicity. *J. Toxicol.* **2012**, *2012*, 1–11.
184. Bhattacharjee, P.; Chatterjee, D.; Singh, K.K.; Giri, A. Systems biology approaches to evaluate arsenic toxicity and carcinogenicity: An overview. *Int. J. Hyg. Environ. Health* **2013**, *216*, 574–586.
185. Palmieri, M.A.; Tasat, D.R.; Molinari, B.L. Oxidative metabolism of lung macrophages exposed to sodium arsenite. *Toxicol. In Vitro* **2007**, *21*, 1603–1609.
186. Sappino, A.P.; Schurch, W.; Gabbiani, G. Differentiation repertoire of fibroblastic cells: Expression of cytoskeletal proteins as marker of phenotypic modulations. *Lab. Invest.* **1990**, *63*, 144–161.
187. Bartel, M.; Ebert, F.; Leffers, L.; Karst, U.; Schwerdtle, T. Toxicological characterization of the inorganic and organic arsenic metabolite thio-DMAV in cultured human lung cells. *J. Toxicol.* **2011**, *2011*, 1–9.

188. Ebert, F.; Weiss, A.; Bultemeyer, M.; Hamann, I.; Hartwig, A.; Schwerdtle, T. Arsenicals affect base excision repair by several mechanisms. *Mutat. Res. Fundam. Mol. Mech. Mutagen.* **2011**, *715*, 32–41.
189. Xie, H.; Huang, S.; Martin, S.; Wise, J.P., Sr. Arsenic is cytotoxic and genotoxic to primary human lung cells. *Mutat. Res. Genet. Toxicol. Environ. Mutagen.* **2014**, *760*, 33–41.
190. Park, W.H.; Kim, S.H. Arsenic trioxide induces human pulmonary fibroblast cell death via the regulation of Bcl-2 family and caspase-8. *Mol. Biol. Rep.* **2012**, *39*, 4311–4318.
191. You, B.R.; Park, W.H. Arsenic trioxide induces human pulmonary fibroblast cell death via increasing ROS levels and GSH depletion. *Oncol. Rep.* **2012**, *28*, 749–757.
192. Acharya, A.; Das, I.; Chandhok, D.; Saha, T. Redox regulation in cancer: A double-edged sword with therapeutic potential. *Oxid. Med. Cell Longev.* **2010**, *3*, 23–34.
193. Carpenter, R.L.; Jiang, Y.; Jing, Y.; He, J.; Rojanasakul, Y.; Liu, L.; Jiang, B. Arsenite induces cell transformation by reactive oxygen species, AKT, ERK1/2, and P70s6K1. *Biochem. Biophys. Res. Commun.* **2011**, *414*, 533–538.
194. Chowdhury, R.; Chatterjee, R.; Giri, M.C.; Chaudhuri, K. Arsenic-induced cell proliferation is associated with enhanced ROS generation, Erk signaling and CyclinA expression. *Toxicol. Lett.* **2010**, *198*, 263–271.
195. Stueckle, T.A.; Lu, Y.; Davis, M.E.; Wang, L.; Jiang, B.; Holaskova, I.; Schafer, R.; Barnett, J.B.; Rojanasakul, Y. Chronic occupational exposure to arsenic induces carcinogenic gene signaling networks and neoplastic transformation in human lung epithelial cells. *Toxicol. Appl. Pharmacol.* **2012**, *261*, 204–216.
196. Wang, F.; Shi, Y.; Yadav, S.; Wang, H. p52–Bcl3 complex promotes cyclin D1 expression in BEAS-2B cells in response to low concentration arsenite. *Toxicology* **2010**, *273*, 12–18.
197. Ding, J.; Li, J.; Xue, C.; Wu, K.; Ouyang, W.; Zhang, D.; Yan, Y.; Huang, C. Cyclooxygenase-2 induction by arsenite is through a nuclear factor of activated T-cell-dependent pathway and plays an antiapoptotic role in Beas-2B cells. *J. Biol. Chem.* **2006**, *281*, 24405–24413.
198. Kuwano, T.; Nakao, S.; Yamamoto, H.; Tsuneyoshi, M.; Yamamoto, T.; Kuwano, M.; Ono, M. Cyclooxygenase 2 is a key enzyme for inflammatory cytokine-induced angiogenesis. *FASEB J.* **2004**, *18*, 300–310.
199. Zhao, Y.; Usatyuk, P.V.; Gorshkova, I.A.; He, D.; Wang, T.; Moreno-Vinasco, L.; Geyh, A.S.; Breysse, P.N.; Samet, J.M.; Spannhake, E.W.; *et al.* Regulation of COX-2 expression and IL-6 release by particulate matter in airway epithelial cells. *Am. J. Respir. Cell Mol. Biol.* **2009**, *40*, 19–30.
200. Frantz, M.; Wipf, P. Mitochondria as a target in treatment. *Environ. Mol. Mutagen.* **2010**, *51*, 462–475.
201. Zhao, F.; Severson, P.; Pacheco, S.; Futscher, B.W.; Klimecki, W.T. Arsenic exposure induces the Warburg effect in cultured human cells. *Toxicol. Appl. Pharmacol.* **2013**, *271*, 72–77.
202. Vander Heiden, M.G.; Cantley, L.C.; Thompson, C.B. Understanding the Warburg effect: The metabolic requirements of cell proliferation. *Science* **2009**, *324*, 1029–1033.
203. Rubins, J.B. Alveolar macrophages: Wielding the double-edged sword of inflammation. *Am. J. Respir. Crit. Care Med.* **2003**, *167*, 103–104.

204. Slauch, J.M. How does the oxidative burst of macrophages kill bacteria? Still an open question. *Mol. Microbiol.* **2011**, *80*, 580–583.
205. Gercken, G.; Labedzka, M.; Geertz, R.; Gulyas, H. Influence of heavy metals and mineral dusts on superoxide anion release by alveolar macrophages. *J. Aerosol Sci.* **1988**, *19*, 1133–1136.
206. Gulyas, H.; Labedzka, M.; Gercken, G. Depression of alveolar macrophage hydrogen peroxide and superoxide anion release by mineral dusts: Correlation with antimony, lead, and arsenic contents. *Environ. Res.* **1990**, *51*, 218–229.
207. Labedzka, M.; Gulyas, H.; Schmidt, N.; Gercken, G. Toxicity of metallic ions and oxides to rabbit alveolar macrophages. *Environ. Res.* **1989**, *48*, 255–274.
208. Lantz, R.C.; Parliman, G.; Chen, G.J.; Carter, D.E. Effect of arsenic exposure on alveolar macrophage function. *Environ. Res.* **1994**, *67*, 183–195.
209. Liang, Y.; Harris, F.L.; Brown, L.A.S. Alcohol induced mitochondrial oxidative stress and alveolar macrophage dysfunction. *BioMed Res. Int.* **2013**, *2014*, 1–13.
210. Cohen, A.B.; Cline, M.J. The human alveolar macrophage: Isolation, cultivation *in vitro*, and studies of morphologic and functional characteristics. *J. Clin. Invest.* **1971**, *50*, 1390–1398.
211. Zahm, J.; Kaplan, H.; Herard, A.; Doriot, F.; Pierrot, D.; Somelette, P.; Puchelle, E. Cell migration and proliferation during the *in vitro* wound repir of the respiratory epithelium. *Cell Motil. Cytoskeleton* **1997**, *37*, 33–43.
212. Olsen, C.E.; Liguori, A.E.; Zong, Y.; Lantz, R.C.; Burgess, J.L.; Boitano, S. Arsenic upregulates MMP-9 and inhibits wound repair in human airway epithelial cells. *Am. J. Physiol.* **2008**, *295*, 293–302.
213. Wesley, U.V.; Bove, P.F.; Hristova, M.; McCarthy, S.; van der Vllet, A. Airway epithelial cell migration and wound repair by ATP-mediated activation of dual oxidase 1. *J. Biol. Chem.* **2007**, *282*, 3213–3220.
214. Cordeiro, J.V.; Jacinto, A. The role of transcription-independent damage signals in the initiation of epithelial wound healing. *Nat. Rev. Mol. Cell Biol.* **2013**, *14*, 249–262.
215. Lommatzsch, M.; Cicko, S.; Muller, T.; Lucattelli, M.; Bratke, K.; Stoll, P.; Grimm, M.; Curk, T.; Zissel, G.; Ferrari, D.X. Extracellular adenosine triphosphate and chronic obstructive pulmonary disease. *Am. J. Respir. Crit. Care Med.* **2010**, *181*, 928–934.
216. Sherwood, C.L.; Lantz, R.C.; Burgess, J.L.; Boitano, S. Arsenic alters ATP-dependent Ca^{2+} signaling in human airway epithelial cell wound response. *Toxicol. Sci.* **2011**, *121*, 191–206.
217. Sherwood, C.L.; Lantz, R.C.; Boitano, S. Chronic arsenic exposure in nanomolar concentrations compromises wound response and intercellular signaling in airway epithelial cells. *Toxicol. Sci.* **2012**, *132*, 222–234.
218. Kelly, F.J.; Fussell, J.C. Size, source and chemical composition as determinants of toxicity attributable to ambient particulate matter. *Atmos. Environ.* **2012**, *60*, 504–526.
219. Enterline, P.E.; Day, R.; Marsh, G.M. Cancers related to exposure to arsenic at a copper smelter. *Occup. Envirn. Med.* **1995**, *52*, 28–32.
220. Jarup, L.; Pershagen, G.; Wall, S. Cumulative arsenic exposure and lung cancer in smelter workers: A dose-response study. *Am. J. Ind. Med.* **1989**, *15*, 31–41.

221. Lubin, J.H.; Pottern, L.M.; Stone, B.J.; Fraumeni, J.F. Respiratory cancer in a cohort of copper smelter workers: Results from more than 50 years of follow-up. *Am. J. Epidemiol.* **2000**, *151*, 554–565.
222. Welch, K.; Higgins, I.; Oh, M.; Burchfiel, C. Arsenic exposure, smoking, and respiratory cancer in copper smelter workers. *Arch. Environ. Health* **1982**, *37*, 325–335.
223. Dunlap, L.G. Perforatons of the nasal septum due to inhalation of arsenous oxid. *J. Am. Med. Assoc.* **1921**, *76*, 568–569.
224. Inghe, G.; Bursell, A. The Ronnskar study. Report of investigation. Stockholm, Sweden. Unpublished works, 1937.
225. Gerhardsson, L.; Brune, D.; Nordberg, G.F.; Wester, P.O. Multielemental assay of tissues of deceased smelter workers and controls. *Sci. Total Environ.* **1988**, *74*, 97–110.
226. Axelson, O.; Dahlgren, E.; Jansson, C.D.; Rehnlund, S.O. Arsenic exposure and mortality: A case-referent study from a Swedish copper smelter. *Br. J. Ind. Med.* **1978**, *35*, 8–15.
227. Englyst, V.; Lundstrom, N.; Gerhardsson, L.; Rylander, L.; Nordberg, G. Lung cancer risks among lead smelter workers also exposed to arsenic. *Sci. Total Environ.* **2011**, *273*, 77–82.
228. Taylor, P.R.; Qiao, Y.; Schatzkin, A.; Yao, S.; Lubin, J.; Mao, B.; Rao, J.; McAdams, M.; Xuan, X.; Li, J. Relations of arsenic exposure to lung cancer among tin miners in Yunnan Province, China. *Br. J. Ind. Med.* **1989**, *46*, 881–886.
229. Chen, W.; Chen, J. Nested case-control study of lung cancer in four Chinese tin mines. *Occup. Environ. Med.* **2002**, *59*, 113–118.
230. Xi, S.; Zheng, Q.; Zhang, Q.; Sun, G. Metabolic profile and assessment of occupational arsenic exposure in copper- and steel-smelting workers in China. *Int. Arch. Occup. Environ. Health* **2011**, *84*, 347–353.
231. Wen, J.; Wen, W.; Li, L.; Liu, H. Methylation capacity of arsenic and skin lesions in smelter plant workers. *Environ. Toxicol. Pharmacol.* **2012**, *34*, 624–630.
232. Wu, B.; Chen, T. Changes in hair arsenic concentration in a population exposed to heavy pollution: Follow-up investigation in Chenzhou city, Hunan province, southern China. *J. Environ. Sci.* **2010**, *22*, 283–289.
233. Hwang, Y.H.; Bornschein, R.L.; Grote, J.; Menrath, W.; Roda, S. Environmental arsenic exposure of children around a former copper smelter site. *Environ. Res.* **1997**, *72*, 72–81.
234. Wickre, J.B.; Folt, C.L.; Sturup, S.; Karagas, M.R. Environmental exposure and fingernail analysis of arsenic and mercury in children and adults in a Nicaraguan gold mining community. *Arch. Environ. Health* **2004**, *59*, 400–409.
235. Martin, R.; Dowling, K.; Pearce, D.; Bennett, J.; Stopic, A. Ongoing soil arsenic exposure of children living in an historical gold mining area in regional Victoria: Identifying risk factors associated with uptake. *J. Asian Earth Sci.* **2013**, *77*, 256–261.
236. Pearce, D.C.; Dowling, K.; Gerson, A.R.; Sim, M.R.; Sutton, S.R.; Newville, M.; Russell, R.; McOrist, G. Arsenic microdistribution and speciation in toenail clippings of children living in a historic gold mining area. *Sci. Total Environ.* **2010**, *408*, 2590–2599.
237. Button, M.; Jenkin, G.R.T.; Harrington, C.F.; Watts, M.J. Human toenails as a biomarker of exposure to elevated environmental arsenic. *J. Environ. Monit*. **2009**, *11*, 610–617.

238. Hinwood, A.L.; Sim, M.R.; Jolley, D.; de Klerk, N.; Bastone, E.B.; Gerostamoulos, J.; Drummer, O.H. Hair and toenail arsenic concentrations of residents living in areas with high environmental arsenic concentrations. *Environ. Health Perspect.* **2003**, *111*, 187–193.
239. Nordstrom, D.K. Acid rock drainage and climate change. *J. Geochem. Explor.* **2009**, *100*, 97–104.
240. Middleton, N.J. A geography of dust storms in south-west Asia. *J. Climatol.* **1986**, *6*, 183–196.
241. Zhang, X.Y.; Gong, S.L.; Zhao, T.L.; Arimoto, R.; Wang, Y.Q.; Zhou, Z.J. Sources of Asian dust and role of climate change *versus* desertification in Asian dust emission. *Geophys. Res. Lett.* **2003**, *30*, doi:10.1029/2003GL018206.

© 2014 by the authors; licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution license (http://creativecommons.org/licenses/by/3.0/).

Julia Thrower (ISB No. 10251)
MOUNTAIN TOP LAW PLLC
614 Thompson Avenue
McCall, ID 83638
T: 208.271.6503
E: jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	Agency Case No. 0101-2201 OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, *Petitioners*, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, *Respondent*, and PERPETUA RESOURCES IDAHO, INC., *Intervenor*.	**DECLARATION OF ZAK SEARS**

I, ZAK SEARS, state and declare as follows:

1. My name is Zak Sears, and I am a resident of Idaho County, Idaho.

2. I have been a supporter and member of Save the South Fork Salmon ("SSFS") since 2016. I became interested in SSFS based on its work to protect the South Fork Salmon River watershed from the impacts of the Stibnite Gold Project proposed by Perpetua Resources Idaho, Inc. I continue to support SSFS's work because I support its mission to protect and preserve the ecological resources of the South Fork Salmon River watershed. In 2020, I started a fundraiser where I donated large canvas framed photographs of the South Fork Salmon River watershed to SSFS for use at its events and to auction off to raise funds to support its work. I took some of the photographs; the rights to use other images were donated by other photographers. The fundraiser raised several thousand dollars. I am currently working on a map project of the lower South Fork Salmon River that I will donate to SSFS for its use to raise funds to support its work. The map is intended to be a navigational and informational tool that could be used by a wide variety of recreationists interested in recreating in the South Fork Salmon River watershed. I am also a member of SSFS.

3. I have also supported work that protects the South Fork Salmon River watershed by participating as an informal liaison for recreational non-motorized boaters during the Payette National Forest's development of a river recreational management plan for the lower South Fork Salmon River corridor. As a result of that involvement, two action plans were implemented (Waste Alleviation and Gelling, or WAG, bags and a self-issued permit box), and I continue to engage with the Payette National forest on how to best manage use in that river corridor.

4. I have a deep personal and professional connection to the South Fork Salmon River watershed, including many of the rivers in the area. The area's landscape is remarkable and some stretches of river boast the largest bull trout I have ever seen. It provides a diverse recreational experience during both summer and winter. It is one of the most spectacular places to visit in Idaho.

5. I currently work as a river and steelhead fishing guide, primarily on the Middle Fork Salmon River ("Middle Fork"), which is located in the South Fork Salmon River watershed and downwind of the proposed mine. As part of my guided trips, I fly my clients into the Middle Fork area, and we use areas adjacent to Indian and Little Indian Creeks for camping and for accessing drinking water from the creeks. I spend up to 90 days a year on the Middle Fork as a river and fishing guide.

6. I personally recreate in the South Fork Salmon River watershed, including areas in and around the site of the proposed Stibnite Gold mine. I spend a significant time in the area hiking, photographing, mushroom hunting, fishing, backcountry skiing, birding, and kayaking and snorkeling in the rivers. I have visited the South Fork Salmon River ("South Fork") and the East Fork of the South Fork Salmon River ("East Fork") area at a minimum annually since 2006. For about three years, I made approximately 10 trips each year to the area to kayak, snorkel, fish, and visit Yellow Pine. My most recent visit to the area was in May 2023, where I visited the East Fork near the mouth of Johnson Creek and the lower South Fork canyon. My next planned visit is in June 2023, where I plan to go to the East Fork near Yellow Pine and the lower South Fork canyon.

7. I have reviewed Perpetua's map that depicts the proposed mine site and the ambient air boundary. A true and correct copy is attached as Exhibit 1. I have recreated both within the blue line that depicts the ambient air boundary, and just outside of that boundary. I have also traveled on the existing road through the proposed mine site to access recreational sites, which corresponds roughly to the green line on the map.

8. I have snorkeled in the East Fork below the confluence of Johnson Creek to view the fish and observe their behaviors in their natural habitat. When snorkeling in the lower river, I can get very close to the largest bull trout I've ever seen.

9. In June 2021, I traveled to the proposed mine to access the East Fork downstream of the Yellow Pine Pit with the intent of snorkeling in the deep pools to view the fish. As I drove up the East Fork into the proposed mine area, the river area feels like it is an intact ecosystem. There is large woody debris that creates good fish habitat. Even from the road, you can see deep pools in the river holding large fish. I am drawn to the area to explore these pools and snorkel with the fish. The East Fork downstream of the Yellow Pine Pit is the most incredible stretch of river that I have ever seen in Idaho or anywhere in the world. On this particular trip, I forgot my snorkeling gear. However, I intend to go back to snorkel in the pools south of the Yellow Pine Pit in the future.

10. In March 2020, I did a backcountry ski trip that started in the area on the map that is labeled "Hanger Flat Pit." I toured across the area that is labeled "Hanger Flat TSF" on the map. I intended to continue my ski trip by climbing out of Meadow Creek to reach Pistol Ridge, which would have taken me outside of the ambient air boundary depicted on the map, and return to Warm Lake where I had parked my car. However, I had to turn around because of significant

downed trees and I did not have enough of a window of good weather to take the time I would have needed to complete the loop. I intend to ski that same route in the near future.

11. In June 2021, I drove through the proposed mine site by entering the road from the north (labeled "North Entry" on the map). I exited at the South Gate of the road, and continued to Monumental Summit. Once at Monumental Summit, I hiked from there to the area under the label "South Entry" on the map, which is just outside of the blue ambient air boundary line. From there, I could see several peaks in the distance: the Sawtooths, Mount Borah, the Beaverheads. The view was incredible. I could visually and mentally connect the topographical features on my map to the real landscape to understand where I was situated in this vast ecosystem. I intend to return to this area in the future.

12. As stated above, since 2006, I have visited the South Fork Salmon River watershed area, including the area around the proposed Stibnite Gold Project on a yearly basis, at a minimum. I intend to continue to visit and recreate in this area in the future as long as I am able to do so. I also anticipate that my future trips will require me to travel on the road through the proposed Stibnite Gold Project, and I intend to travel on that road in the future.

13. I understand that in June 2022, the Idaho Department of Environmental Quality ("DEQ") issued Perpetua Resources an air permit for the proposed Stibnite Gold Project, called a Permit to Construct, under the authority of the Clean Air Act. I understand that the proposed mining operations will emit significant amounts of air pollutants, such as particulate matter, and cancer-causing air pollutants, such as arsenic. I also understand that inside the ambient air boundary line and including over the public road going through the mine site, the impacts to air quality from the emission of air pollutants is not analyzed or regulated. I also understand that

outside of the ambient air boundary, the air quality is supposed to meet certain standards, and that these are health-based standards set to protect the public health.

14. I am concerned that the air permit that DEQ issued to Perpetua for the proposed mine will not sufficiently protect air quality as is required under the Clean Air Act and under Idaho's rules and regulations. I am concerned that the air permit does not ensure that the air quality outside the ambient air boundary where I recreate will meet the criteria necessary to comply with the laws and regulations and ensure that it protects my health or does not injure me or negatively impact my health.

15. I am greatly concerned that the air quality outside of the ambient air boundary in areas where I have recreated and plan to recreate in the future will contain air pollutants that exceed the health-based standards. I am greatly concerned about using the road going through the mine site that I have used and plan to use to access public lands to recreate. I am concerned that the pollutants emitted into the air, and the air quality above the road are not regulated at all.

16. I am concerned that if the air pollutants exceed these health-based standards, that it can have a negative impact on my health. I have a family history of esophageal cancer. My father lived downwind of the hanford nuclear waste repository, and died from cancer.I believe that the poor air quality and pollution from the nuclear waste site may have been a factor in my father getting cancer.

17. Many of the areas that I recreate in and take clients to on guided fishing trips, including the Middle Fork, are outside of but close to the ambient air boundary and are downwind of the proposed mine. The area downwind of the proposed mine site is naturally an extremely windy area. I am concerned that the prevailing wind pattern will carry air pollutants,

including particulate matter and arsenic, out of the ambient air boundary and into the areas that I personally recreate in, as well as areas that I take clients to on guided fishing trips.

18. Most of my personal recreational activities are very strenuous aerobic activities. I breathe hard when engaging in these activities. I am concerned that if this air permit does not sufficiently protect the air quality outside of the ambient air boundary where I recreate, that through my strenuous activities, I will be breathing in more air pollutants than I would if the air permit ensured that the air quality outside of the ambient air boundary complied with health-based standards.

19. I would like to continue recreating in the South Fork Salmon River watershed, and in the areas within and outside of the ambient air boundary, but if the air quality is degraded by air pollutants emitted from the mine, then my experiences will be harmed by operation of this mine. I am extremely concerned about how reduced air quality may impact my health. Because the mine will operate year round, degraded air quality will impact both my summer and winter recreational activities in the area. As a result, places I currently enjoy kayaking, hiking, birding, photographing, snorkeling, and skiing, I will no longer feel comfortable enjoying them knowing that I am breathing in carcinogenic air pollutants. I will stop recreating in certain areas that are close to or downwind of the ambient air boundary. I will stop recommending this area as a place for friends to visit. I will be extremely uncomfortable bringing clients to the area to fish, and this would have a significant impact on my business.

20. I am also concerned that air pollutants emitted from the mine, including arsenic, will fall onto the ground and will leach into the rivers, or fall directly onto the water, and increase the arsenic concentration in the rivers where I kayak, fish, snorkel in, and drink water

from. I am concerned that if I continue to recreate in these areas once mine operations start, that I will be exposed to these pollutants. I understand that arsenic is a carcinogen, and if the rivers were more polluted with arsenic, I am concerned how that could impact my health. I would be less likely to kayak in these rivers, and would no longer snorkel. I would lose the ability to see the bull trout and this amazing aquatic habitat up close and personal.

21. I am also concerned how arsenic in the air, and arsenic falling on the ground and polluting the water will impact the bull trout and other aquatic species, terrestrial wildlife, migratory birds, and vegetation.

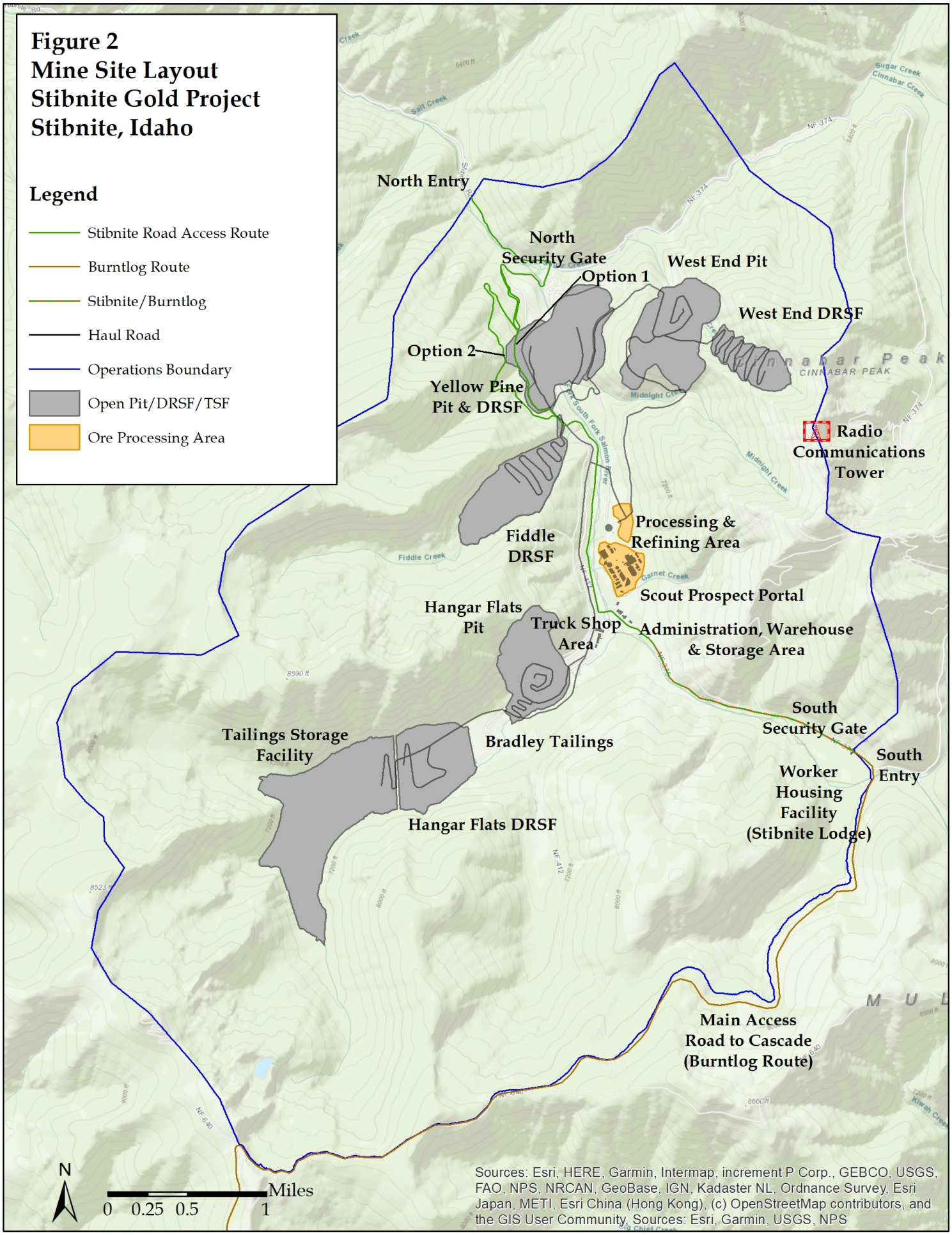
22. It is my understanding that the Clean Air Act and the rules or regulations that DEQ follow in issuing an air permit are designed to protect air quality by imposing pollution limits, best management practices, and restrictions on how the mine can operate, and that DEQ may impose monitoring and reporting requirements to ensure that ambient air quality is maintained. Therefore, a decision from the Office of Administrative Hearings and/or the Board of Environmental Quality that finds that the air permit is in compliance with all laws and regulations will help redress these harms. I would feel better recreating in the area and taking clients to the area if the air permit could ensure that the amount of air pollutants emitted from the mine do not exceed air quality standards at the ambient air boundary.

Pursuant to Idaho Code 18-5409, I declare under penalty of perjury that the foregoing is true and correct.

Executed this 6th day of June 2023, at Idaho County, Idaho.



Zak Sears


Figure 2
Mine Site Layout
Stibnite Gold Project
Stibnite, Idaho
Legend
Stibnite Road Access Route
Burntlog Route
Stibnite/Burntlog
Haul Road
Operations Boundary
Open Pit/DRSF/TSF
Ore Processing Area
North Entry
North Security Gate
Option 1
Option 2
West End Pit
West End DRSF
Yellow Pine Pit & DRSF
Radio Communications Tower
Processing & Refining Area
Fiddle DRSF
Scout Prospect Portal
Hangar Flats Pit
Truck Shop Area
Administration, Warehouse & Storage Area
South Security Gate
South Entry
Worker Housing Facility (Stibnite Lodge)
Tailings Storage Facility
Bradley Tailings
Hangar Flats DRSF
Main Access Road to Cascade (Burntlog Route)
N
0 0.25 0.5 1 Miles
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community, Sources: Esri, Garmin, USGS, NPS

Bryan Hurlbutt (ISB No. 8501)
Laurence J. Lucas (ISB No. 4733)
ADVOCATES FOR THE WEST
P.O. Box 1612
Boise, ID 83701
(208) 342-7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	Agency Case No. 0101-2201
	)	
	)	OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,	)	**DECLARATION OF EMMIT TAYLOR JR.**
Petitioners,	)	
v.	)	
IDAHO DEPARTMENT OF ENVIORNMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC.	)	
Intervenor.	)	

I, EMMIT TAYLOR, JR., state and declare as follows:

1. My name is Emmit Taylor, Jr. I am a resident of Lapwai, Idaho, and am over 18 years of age. The following statements are based on my personal knowledge, and if called as a witness, I would and could testify thereto.

2. I am an enrolled member of the Nez Perce Tribe ("Tribe"), a federally recognized tribe, and am the Director of the Tribe's Department of Fisheries Resources Management ("DFRM"), Watershed Division. I hold a Bachelor of Science Degree in Civil Engineering from Colorado State University and a Master of Natural Resources Degree from the University of Idaho.

3. I grew up on my family's land on the Nez Perce Reservation in north-central Idaho.

4. Since time immemorial, members of the Nez Perce Tribe have used and enjoyed their aboriginal lands, which include portions of the present-day states of Idaho, Oregon, Washington, and Montana and the Columbia and Snake River basins.

5. My family continuously engaged in Nez Perce culture and the exercise of Nez Perce treaty-reserved hunting, gathering, and fishing rights throughout our aboriginal homeland, including in the South Fork Salmon River ("SFSR") watershed.

6. I have direct oral knowledge of my family's history in the SFSR watershed—a history that traces back to time immemorial. My family has countless stories, passed down through enumerable generations, of using the SFSR watershed to gather, hunt, and, mostly, fish. My late uncle, Elmer Crow, described to me how our family annually traveled throughout our aboriginal territory for a three- to five-month fishing and gathering journey. Each year's journey

ended on the SFSR. My grandpa, Ron Oatman, taught me the Nez Perce names for rivers and locations in the SFSR watershed and their place and use in traditional Nez Perce culture. My dad, Emmit Taylor, Sr., and my uncle, Dave Penney, have also shared with me countless stories of my family fishing in the SFSR watersheds streams, including the East Fork SFSR (among others), as well as fishing in Big Creek, which is accessed via the East Fork SFSR.

7. This heritage is who I am and its importance to me and my family cannot be overstated. I continue to take my family to the SFSR area on an annual basis. We hunt, gather, and, most importantly, fish in order to express our culture and identity and connect to our history, ancestors, and the land and rivers themselves. These practices are the heart of who we are as Nez Perce people and are vital to our health and well-being.

8. Today, my family and other Nez Perce Tribal members typically fish in the SFSR and its tributaries from mid-June through August. The SFSR tributaries my family and other Nez Perce Tribal members seasonally fish include the Secesh River, Lick Creek, Johnson Creek, and East Fork SFSR. While there, we also gather our traditional food and medicine.

9. I have personally engaged in treaty fishing within the boundaries of the proposed Stibnite Gold Project ("SGP"). I have fished for steelhead and bull trout which are culturally significant species to the Tribe. My family and I also plan to engage in treaty fishing, hunting, and gathering within and adjacent to the proposed SGP area in the future. I am very concerned about the adverse effects resulting from Idaho Department of Environmental Quality's issuance of the air permit for the proposed SGP on my family's ability to safely exercise our treaty rights in, and use and enjoy, the area. My understanding is that the SGP would generate air pollutants, including dust with arsenic, that are unhealthy to breathe. This air pollution also reduces

visibility which impairs my cultural and ceremonial practices and reduced my enjoyment of these special places. I am also deeply concerned that the arsenic can enter waterways and soil in the area and adversely affect culturally-significant fish and wildlife and the habitat on which those treaty resources depend. Dust with arsenic can also collect on, and can adversely affect, culturally-significant plants and medicines that my family and I gather in the area and use for cultural, subsistence, ceremonial, and spiritual purposes.

10. In addition to personally exercising treaty rights and using and enjoying the area, I also honor my heritage through my professional work as Director of the Tribe's Fisheries Department, Watershed Division.

11. The Tribe established DFRM in the early 1980s after the federal courts acknowledged the Tribe's role a co-manager of its fisheries. Since then, DFRM has devoted substantial time, effort, and resources to recovering and sustaining the Tribe's fishery. Today, the Tribe's Fisheries Department is one of the largest and most successful tribal fisheries programs in the United States with six divisions (Administration, Conservation Enforcement, Harvest, Production, Research, and Watershed), 180 employees, and an annual budget in excess of $24 million. The Fisheries Department works throughout north-central Idaho, northeastern Oregon, and southeastern Washington, with funding primarily provided by the Bonneville Power Administration, to mitigate for the harm caused to anadromous fish by the Columbia River Basin hydropower system.

12. DFRM established an office in McCall, Idaho, in the mid-1990s to maintain the Nez Perce Tribal fishery in the SFSR watershed due to its cultural and biological significance to the Tribe and to Chinook salmon recovery in Idaho. DFRM currently expends $2.79 million

annually in the SFSR watershed on hatchery supplementation, fishery research, and habitat restoration.

13. Among other production and research projects, DFRM biologists in McCall have conducted a unique, long-running study that provides information on the effects of using a hatchery supplementation program to increase a naturally spawning population of fish listed under the ESA. DFRM staff trap and spawn natural/wild-returning salmon in Johnson Creek, a tributary of the East Fork SFSR, to provide the eggs, which are reared to smolts at the McCall Fish Hatchery. DFRM biologists then release approximately 130,000 smolts back into Johnson Creek each year. DFRM monitors these juvenile releases to determine their survival through various stages of their journey out to the ocean and back to spawn. Returns are compared with non-supplemented fish to determine genetic, behavior, and morphological differences in an effort to evaluate how the use of a hatchery affects, and whether a hatchery can be a benefit to, a natural spawning population.

14. Each year, DFRM staff also collect Pacific lamprey from downriver dams, hold them at the Tribe's hatchery on the Clearwater River until the spring, and then release them to spawn in various tributaries within the Tribe's aboriginal territory, including the SFSR, to ensure their continuing presence in these streams. DFRM also moves some Chinook salmon above the fish passage blockage created by the legacy mine pit, known as the Glory Hole, at the historical Stibnite mine site to spawn. The resulting juvenile production from above the Glory Hole helps boost overall returns to the SFSR.

15. I have worked for DFRM, Watershed Division since 1996 and have been the Director for the last twelve years. As Director, I am responsible for developing and

implementing a regional aquatic ecosystem restoration and protection program for anadromous and resident fish habitat. As part of this work, I direct the Tribe's efforts to protect and restore aquatic ecosystems within the SFSR watershed.

16. DFRM Watershed Division first began working out of the McCall Fisheries Department office in 2007, when it applied for, and received, a grant for the specific purpose of reestablishing fish passage in the East Fork SFSR above the Glory Hole and of rehabilitating one mile of spawning habitat above the Glory Hole, in the headwaters of the East Fork SFSR.

17. Unfortunately, the McCall Fisheries Watershed Division was unable to complete this work. Before the Tribe could begin restoring fish passage, the private land owner of the Glory Hole reach of the East Fork SFSR entered into a lease-to-purchase option with Perpetua Resources' predecessor corporations. The Tribe was then told that it could not move forward with the project because of the possibility of re-opening a mine. Consequently, the McCall Fisheries Watershed Division moved its restoration efforts to other parts of the SFSR watershed.

18. Since 2007, DFRM Watershed Division has been able to complete numerous aquatic ecosystem restoration and protection projects in conjunction with the U.S. Forest Service, Idaho Department of Fish and Game, and private landowners. The Watershed Division has planted over 8,000 plants, removed nine fish passage barriers (opening 46 miles of blocked salmon habitat), decommissioned 214 miles of road, and improved 26.7 miles of road to reduce sediment in the SFSR that is detrimental to fish species listed under the federal Endangered Species Act.

19. In addition to this on-the-ground restoration and protection work, DFRM Watershed Division also critically evaluates and comments on other activities proposed within

the Tribe's aboriginal territory that may negatively affect the health of the aquatic ecosystem, undermine DFRM's work in the SFSR watershed, and/or harm the Tribe's treaty-reserved rights and resources and its members.

20. The proposed SGP is currently the biggest ecological threat to the SFSR watershed. The proposed mining activities under the SGP could undermine the Tribe's fisheries and fishery restoration work by degrading or polluting the East Fork SFSR and SFSR, as well as upland terrestrial habitat. Consequently, DFRM Watershed Division, along with Tribe's Cultural Resources Program, Wildlife Department, Water Resources Department, and Air Quality Program have been deeply engaged in review of the SGP. Throughout the process, the Tribe has submitted numerous written comments to federal and state permitting agencies, including written comments to Idaho Department of Environmental Quality on October 12 and November 10, 2020, March 8, 2021, and March 14, 2022. The Tribe has also engaged extensively in staff-to-staff meetings, many of which I participated in personally, and convened government-to-government consultations with federal permitting agencies.

I declare under penalty of perjury that the foregoing is true and correct.

Executed this 6th day of June 2023, at Lapwai, Idaho.

/s/ Emmit Taylor, Jr.
Emmit Taylor, Jr.

Julia Thrower (ISB No. 10251)
MOUNTAIN TOP LAW PLLC
614 Thompson Avenue
McCall, ID 83638
T: 208.271.6503
E: jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	Agency Case No. 0101-2201 OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, *Petitioners*, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, *Respondent*, and PERPETUA RESOURCES IDAHO, INC., *Intervenor*.	**DECLARATION OF JULIA THROWER**

DECLARATION OF JULIA THROWER

I, JULIA THROWER, hereby declare as follows:

1. The following facts are personally known to me, and if called as a witness, I could and would competently testify thereto. I am over eighteen years of age.

2. I am counsel of record representing Save the South Fork Salmon in this matter.

3. The attached Exhibits 15-17 are true and correct copies of the following documents, which were produced during discovery in this matter:

Doc. No.	Bates No.	Document Description
15	PET 838-839	Stantec Memo to Ramanathan (May, 12, 2021)
16	PET 840-885	U.S. EPA Office of Inspector General Report (July 8, 2021)
17	PET 885-1265	Stibnite Gold Project Air Quality Specialist Report (Aug. 2022)

4. The attached declarations are true and correct copies of the following documents, which are filed with Petitioners' Response to DEQ's and Perpetuta's Motions for Summary Judgment and Reply in Support of Petitioners' Motion for Summary Judgment:

- Declaration of Allison Fowle
- Declaration of Drew Hollenback
- Declaration of Asa Menlove
- Declaration of Joseph Oatman
- Declaration of Jonathan Oppenheimer
- Declaration of Zak Sears
- Declaration of Emmit Taylor Jr.

I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge, information, and belief, and based on my personal experiences.

Signed this 9th day of June 2023, in McCall, Idaho.

s/ Julia Thrower
Julia S. Thrower

Stantec

Memo

To:	Brinda Ramanathan USFS Bridger-Teton NF	From:	Eric Clark, PE Boise, Idaho Office
File:	203721981	Date:	May 12, 2021

Reference: Access Road and Ambient Air Boundary Applicability – Stibnite Gold Project EIS

Ms. Ramanathan:

Stantec Consulting Services, Inc. (Stantec) and the United States Forest Service (USFS) held a conference call on March 26th, 2021 to discuss air quality elements of the Stibnite Gold Project (SGP) draft EIS and appropriate updates or changes to be completed for the final EIS. Several questions arose from that meeting, which prompted Stantec to develop a "path forward" document to address specific points of concern. These included potential differences in modeling techniques/requirements between the Idaho Department of Environmental Quality (DEQ) state-regulated air permit and the modeling approach applied for the EIS, whether the proposed dust control efficiencies (93.3%) are attainable and will be monitored appropriately and to explore the applicability of the proposed public access road through SGP being excluded from ambient air. The following discussion focuses on the access road and the rationale for exclusion from ambient air.

Public Road Description and Restricted Access Approach

The road is described, and access control measures outlined by Midas Gold Idaho, now Perpetua Resources, in the December 18th, 2020, Refined Proposed Action – ModPro2 document as follows:

A new 12-foot-wide gravel road would be constructed to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375) through the mine site (Figure 3-2). The road would be constructed on a widened bench within the Yellow Pine pit. South of the Yellow Pine pit, this road would parallel a mine haul road and use a partially revegetated portion of the former Bradley mine haul road. This road would be approximately 4 miles in length. The public access road would be constructed concurrent with the removal of development rock from Yellow Pine pit.

During operations, the public access road would be used to travel through the mine site and would provide seasonal use, open to all vehicles. Vehicles passing through the mine site would be required to check-in with mine personnel at the North or South mine site entry points and would receive a safety briefing. For safety purposes, vehicles on the public access road would be required to pass through the mine site without stopping or deviating from the public access road and would be required to check-out with mine site personnel upon exiting the mine site. Midas Gold would restrict mine site access to any vehicles due to concerns related to public or employee health and safety, such as during blasting, mining in the immediate area of the road and other similar operations.

Berms, security fencing, and an underpass to allow the public road to pass beneath the mine haul road, would separate the public access road from other mine site roads; the underpass would be located north of Fiddle Creek. The public access road would be temporarily closed during construction and maintenance of the public access road, and other mining activities that would be considered public safety hazards (e.g., high wall scaling, blasting). The public access road would be maintained to the current standards (i.e., not plowed in the winter) and signs would be placed to inform the public of seasonal and temporary closure.

During the operations phase (and during closure and reclamation) public access by foot or on roads would be restricted from entering the operations boundary shown in the SGP DEIS on Figure 2.3-2. Security personnel,

Reference: **Access Road and Ambient Air Boundary Applicability – Stibnite Gold Project EIS**

fencing (including wildlife exclusion fencing), and signs would restrict public access to the designated public access roadway within the operations boundary.

Idaho DEQ Approach to Access Road

Prior to completion of the EIS, Perpetua also applied for a Permit to Construct with Idaho DEQ. This application proposed to exclude the public road on the basis of restricted access and that people traveling on the road would be considered "guests of the mine" and maintain full control. The current draft permit and associated statement of basis (as of February 18th, 2021) states that "receptors on the Stibnite Road access road were not included in the SGP air quality analysis as this road is not considered ambient air". Response to comments on February 18th, 2021 also states that the roadway between Stibnite Road at Sugar Creek and Thunder Mountain Road at Meadow Creek was appropriately excluded from ambient air. Lastly, direct communication with DEQ permitting staff has also confirmed this determination.

EPA Approach to Access Road

The Environmental Protection Agency (EPA) to Stantec's knowledge has never explicitly stated that the public access road is excluded from ambient air, but they have insinuated as such on numerous occasions by referring their 2019 guidance memorandum or deferring to DEQ on the matter. For example, on a November 18th, 2020 response to comments of the DEIS, Region X acknowledges, and it is accepting of DEQ's findings and states on page 25 of the response letter they are "recognizing that this control access road would not be ambient air". Additionally, on an April 15th, 2021 conference call with Stantec and the USFS, EPA representatives affirmed that controlled public access road is consistent with the December 2nd, 2019 Revised Policy on Exclusions From "Ambient Air" memorandum.

The memo states "*the atmosphere over land owned or controlled by the stationary source may be excluded from ambient air where the source employs measures. which may include physical barriers. that are effective in precluding access to the land by the general public".* The measures to-be employed by Perpetua, as discussed above, would qualify under the revised broader definition.

Conclusion

After review of all pertinent information associated with other cooperating agencies, it is Stantec's understanding that the public access road can be justifiably excluded from ambient air consideration. The State agency responsible for issued air permits has excluded the road because of restriction measures put in place consistent with their rules and requirements in the permit. Also, EPA Region X has accepted DEQ's conclusions. Dispersion modeling conducted by DEQ has demonstrated compliance with applicable National Ambient Air Quality Standards given higher production rates than will be allowed in the EIS and Record of Decision.

Stantec Consulting Services Inc.

Eric C. Clark

Eric Clark P.E.
Project Engineer
Phone: 208 388 4324
eric.clark@stantec.com

c. george.fennemore@stantec.com; brian.buck@stantec.com; sitka.pence@usds.gov

U.S. ENVIRONMENTAL PROTECTION AGENCY

OFFICE OF INSPECTOR GENERAL

Improving air quality

EPA Should Conduct More Oversight of Synthetic-Minor-Source Permitting to Assure Permits Adhere to EPA Guidance

Report No. 21-P-0175 **July 8, 2021**





PET-840

REC 2559

Report Contributors:

Seth Gerhart
Erica Hauck
Richard Jones
Renee McGhee-Lenart

Abbreviations

CAA	Clean Air Act
CAA CMS	Clean Air Act Stationary Source Compliance Monitoring Strategy
CDPHE	Colorado Department of Public Health and Environment
C.F.R.	Code of Federal Regulations
ECD	Enclosed Combustion Device
EPA	U.S. Environmental Protection Agency
ICIS	Integrated Compliance Information System
NSPS	New Source Performance Standards
OAQPS	Office of Air Quality, Planning, and Standards
OAR	Office of Air and Radiation
ODEQ	Oklahoma Department of Environmental Quality
OIG	Office of Inspector General
TPY	Tons Per Year
VOC	Volatile Organic Compounds

Cover Photos: Enclosed combustion devices, a type of pollution control equipment often covered by synthetic-minor-source permitting limitations, at natural gas extraction facilities. (EPA photos)

Are you aware of fraud, waste, or abuse in an EPA program?

EPA Inspector General Hotline
1200 Pennsylvania Avenue, NW (2431T)
Washington, D.C. 20460
(888) 546-8740
(202) 566-2599 (fax)
OIG_Hotline@epa.gov

Learn more about our OIG Hotline.

EPA Office of Inspector General
1200 Pennsylvania Avenue, NW (2410T)
Washington, D.C. 20460
(202) 566-2391
www.epa.gov/oig

Subscribe to our Email Updates
Follow us on Twitter @EPAoig
Send us your Project Suggestions

U.S. Environmental Protection Agency
Office of Inspector General

21-P-0175
July 8, 2021

At a Glance

EPA Should Conduct More Oversight of Synthetic-Minor-Source Permitting to Assure Permits Adhere to EPA Guidance

Why We Did This Audit

We conducted this audit to determine whether the U.S. Environmental Protection Agency and state and local agencies provide sufficient oversight to assure that synthetic-minor sources of air emissions comply with the limits in their air permits.

Synthetic-minor sources are facilities that agree to restrictions in their permits to reduce their actual emissions below major-source thresholds to avoid being major sources of air pollution under Clean Air Act permitting programs. Major sources are the largest emitters of air pollution and are subject to stringent permitting and compliance requirements.

This audit addresses the following:

- *Improving air quality.*

This audit addresses a top EPA management challenge:

- *Overseeing states implementing EPA programs.*

Address inquiries to our public affairs office at (202) 566-2391 or OIG_WEBCOMMENTS@epa.gov.

List of OIG reports.

What We Found

While the EPA oversees state and local compliance monitoring for synthetic-minor-source permits, the EPA conducts only limited oversight of the permits themselves. The EPA has issued guidance to state and local agencies to develop enforceable permit limitations in synthetic-minor-source permits, but the Agency does not review permits to assure the agencies meet this guidance.

Without clear and enforceable limitations in synthetic-minor-source permits, facilities may emit excess pollution that would otherwise subject them to the more stringent requirements of the Clean Air Act major-source permitting programs.

We reviewed 16 natural gas extraction industry synthetic-minor-source permits from Colorado and Oklahoma and found that many of the permit limitations did not adhere to the EPA's guidance. For example, in those permits, we found that 102 of 529 permit limits did not have sufficient information within the permit or the permit's supporting documentation to determine whether the limits were technically accurate. We also found that 26 limits did not specify the method for assessing compliance. In addition, 55 limits did not have sufficient monitoring requirements to determine whether the facility's assumed pollution reduction from pollution control devices was being achieved. This could result in a synthetic-minor facility emitting pollutants at or above major-source levels without being detected.

In addition, we found that the EPA had not communicated several key expectations for synthetic-minor-source permitting to state and local agencies via guidance. Further, Oklahoma does not allow the public to participate in its permitting process for certain synthetic-minor-source permits, as required by EPA regulations. EPA staff said this may be the case in other states as well.

Recommendations and Planned Agency Corrective Actions

We recommend that the EPA (1) develop and implement an oversight plan for synthetic-minor-source permitting; (2) update its practical enforceability guidance; (3) assess EPA studies and other relevant information on enclosed combustion devices during its next review of applicable regulations to determine whether revisions to monitoring, record-keeping, and reporting requirements are needed; (4) develop and issue new guidance that includes key EPA expectations for synthetic-minor-source permitting; and (5) take steps to assure that all states adhere to public participation requirements for synthetic-minor permits. All recommendations are resolved with corrective actions pending.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

THE INSPECTOR GENERAL

July 8, 2021

MEMORANDUM

SUBJECT: EPA Should Conduct More Oversight of Synthetic-Minor-Source Permitting to Assure Permits Adhere to EPA Guidance
Report No. 21-P-0175

FROM: Sean W. O'Donnell

TO: Joseph Goffman, Acting Assistant Administrator
Office of Air and Radiation

This is our report on the subject audit conducted by the Office of Inspector General of the U.S. Environmental Protection Agency. The project number for this audit was OA&E-FY19-0093. This report contains findings that describe the problems the OIG has identified and corrective actions the OIG recommends. Final determinations on matters in this report will be made by EPA managers in accordance with established audit resolution procedures.

The Office of Air and Radiation is responsible for the recommendations presented in this report.

In accordance with EPA Manual 2750, your office provided acceptable planned corrective actions in response to all five OIG recommendations. All recommendations are resolved, and no final response to this report is required. If you submit a response, however, it will be posted on the OIG's website, along with our memorandum commenting on your response. Your response should be provided as an Adobe PDF file that complies with the accessibility requirements of Section 508 of the Rehabilitation Act of 1973, as amended. The final response should not contain data that you do not want to be released to the public; if your response contains such data, you should identify the data for redaction or removal along with corresponding justification.

We will post this report to our website at www.epa.gov/oig.

Table of Contents

Chapters

1 **Introduction** 1

Purpose 1
Background 1
Responsible Offices 4
Scope and Methodology 4

2 **EPA Should Conduct Additional Oversight to Assure That Synthetic-Minor-Source Permits Meet Guidance** 6

EPA Policy Requires Oversight of Permitting Programs 6
EPA Conducts Oversight of Compliance Monitoring Activities at Synthetic-Minor Sources to Assure Facilities Comply with Permits 7
EPA Conducts Limited Oversight of Synthetic-Minor-Source Permits 7
Many Permits Reviewed Did Not Adhere to EPA Guidance on Practical Enforceability 8
Conclusions 17
Recommendations 17
Agency Response and OIG Assessment 18

3 **EPA Has Not Clearly Communicated Key Synthetic-Minor-Source Permitting Expectations in Official Guidance** 20

Key Expectations Have Not Been Clearly Communicated in Official Guidance 20
Without Clear Guidance, States May Adopt Their Own Practices 21
Conclusions 21
Recommendation 22
Agency Response and OIG Assessment 22

4 **ODEQ Does Not Currently Include Synthetic-Minor-Source Permits in Its Public Participation Process** 23

EPA Regulations Require Opportunity for Public Review and Comment on Synthetic-Minor-Source Permits 23
ODEQ Does Not Currently Provide Opportunity for Public Review and Comment on Individual Synthetic-Minor-Source Permits 23
Lack of Public Participation Precludes Citizen Input on Facility Permits 24
Conclusions 24
Recommendation 24
Agency Response and OIG Assessment 25

--continued--

Status of Recommendations and Potential Monetary Benefits 26

Appendices

A CAA Major-Source-Permitting Programs 27

B Internal Control Assessment 28

C Details on Scope and Methodology 29

D Background on Natural Gas Extraction Industry 32

E Case Study: Synthetic-Minor-Source Permitting in Wood Biomass Industry 34

F Agency Response to Draft Report 35

G Agency Response to Revised Recommendation 3 39

H Distribution 40

Chapter 1
Introduction

Purpose

The Office of Inspector General for the U.S. Environmental Protection Agency conducted this audit to determine whether the EPA and state and local agencies provide sufficient oversight to assure that synthetic-minor sources of air emissions comply with the limits in their air permits. Specifically, we focused on emission, operational, and production limits in the permits.

Top Management Challenge

This audit addresses the following top management challenge for the Agency, as identified in OIG Report No. 20-N-0231, *EPA's FYs 2020–2021 Top Management Challenges*, issued July 21, 2020:

- Overseeing states implementing EPA programs.

Background

The Clean Air Act, or CAA, permitting programs cover three types of facilities:

- **Major sources**, which are facilities that emit regulated pollutants over certain levels measured by tons per year or TPY, referred to as major-source thresholds. Major-source thresholds differ by permitting program and type of pollutant.
- **True-minor sources**, which are facilities that have the potential to emit regulated pollutants below major-source thresholds.
- **Synthetic-minor sources**, which are facilities that have the potential to emit regulated pollutants at or above major-source thresholds but that agree to enforceable restrictions to limit their emissions below these thresholds to avoid being subject to more stringent major-source requirements.[1] Such enforceable restrictions, also called limitations, are included in a facility's air permit.

Enforceable restrictions or limitations are conditions in air permits. If a facility does not adhere to its limitations, the state, local, or tribal permitting agency or the EPA may take administrative, civil, or criminal enforcement actions. This includes issuing a notice of violation, an order for the facility to come into compliance, or a fine. Citizens may also file a civil action suit against a facility for permit limitations violations.

[1] Synthetic-minor sources are referred to as "synthetic" because they would be major sources if not for their enforceable permit restrictions. Thus, they have "synthetically" become a minor source by accepting those restrictions.

Examples of enforceable restrictions are limiting a facility's operating hours or operating pollution control equipment to reduce emissions to a specified level. Figure 1 illustrates how a potential major source may choose to accept enforceable permit restrictions to avoid major-source permitting requirements.

Figure 1: New facility chooses to accept enforceable restrictions to avoid major-source-permitting requirements



Source: EPA OIG analysis of enforceable permit restrictions. (EPA OIG image)

By implementing enforceable permit restrictions on their potential to emit regulated pollutants, synthetic-minor sources can avoid certain costly requirements of CAA permitting programs that apply to major sources. These programs include Title V, Nonattainment New Source Review, and Prevention of Significant Deterioration. Appendix A summarizes these permitting programs and the corresponding levels of emissions that make a facility a major source under each program.

Based on data in the EPA's Integrated Compliance Information System for Air, known as ICIS-Air, there were 27,498 synthetic-minor sources and 12,282 major sources operating in the United States in 2019. The ratio of synthetic-minor sources to major sources has changed slightly over the last decade, with the proportion of synthetic-minor sources being 2 percent higher in 2019 than in 2011 and major sources being 2 percent lower.

State and local agencies conduct most permitting and oversight activities of synthetic-minor sources through permitting programs that have been approved by the EPA. This includes developing or writing facilities' specific permit limitations, as well conducting activities such as inspections to assure that facilities are in compliance with their permit limitations. The EPA is responsible for overseeing state and local agencies' permitting programs through support and evaluation activities by clearly describing objectives and expectations, such as

PET-847
REC 2566

through guidance documents, to increase state and local agencies' ability to successfully implement program requirements.

Some synthetic-minor sources operate under a general permit rather than an individual, facility-specific permit. A general permit is a single permit that establishes terms and conditions that all facilities subject to that permit must comply with. The establishment of a general permit provides for emission limitations in a one-time permitting process and thus avoids the need to issue separate permits for each facility operating under the general permit. A state or local agency may develop general permits for a specific industry when there are a large number of facilities within that industry that need to be permitted.

Types of Synthetic-Minor-Permit Limitations

There are several types of limitations that can be used in a permit to restrict a synthetic minor's potential to emit below major-source thresholds. These include:

- **Emission limits**, which are restrictions over a given period of time on the amount of a pollutant that may be emitted from a source into the outside air.

- **Production limits**, which are restrictions on the amount of final product that can be manufactured or otherwise produced at a source.

- **Operational limits**, which include all other restrictions on the manner in which a source is run, including hours of operation, amount of raw material consumed, fuel combusted, or conditions that specify that the source must install and maintain add-on controls that operate at a specified emission rate or efficiency.

It is important to assure that the limitations in synthetic-minor-source permits are clear and enforceable and that synthetic-minor sources comply with these limitations. If a synthetic-minor-source permit did not have permit limitations, the facility would be considered a major source and subject to the more stringent requirements of the major-source permitting programs. Although these facilities are not major sources, they may still be significant emitters of regulated pollutants. This is particularly the case for synthetic minors considered to be SM-80 sources, which are a subset of synthetic-minor facilities that emit or have the potential to emit pollutants at 80 percent or more of major-source thresholds.

EPA Guidance on Synthetic-Minor Sources

The EPA has issued guidance for state agencies to use in developing synthetic-minor-source permits. Of particular importance in the guidance are two related concepts:

- **Federal enforceability** refers to whether the limitations placed on a source's potential to emit are enforceable by the EPA and private citizens as a legal and practical matter, thereby providing the public with credible assurances that otherwise major sources are not avoiding applicable CAA requirements.

- **Practical enforceability** refers to whether the permit provisions readily allow regulators to assess a facility's compliance with its permit limitations.

The EPA has also issued guidance for conducting compliance monitoring activities at synthetic minors considered to be SM-80 sources. The EPA's 2016 *Clean Air Act Stationary Source Compliance Monitoring Strategy*, known as the *CAA CMS*, describes the recommended frequency of full compliance evaluations at SM-80 sources, as well as the activities that inspectors should complete to assess compliance during full compliance evaluations.

Responsible Offices

Within the Office of Air and Radiation, or the OAR, the Office of Air Quality, Planning, and Standards, known as the OAQPS, is responsible for developing regulations and guidance related to air permitting, as well as providing high-level oversight of state and local air permitting programs. The Office of Enforcement and Compliance Assurance is responsible for developing guidance for state and local agencies to use in conducting compliance monitoring at permitted sources of air pollution and for overseeing state and local compliance monitoring programs. The EPA regions are also responsible for overseeing state and local air permitting and compliance monitoring programs.

Scope and Methodology

We conducted this performance audit from November 2019 to April 2021 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objective. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objective.

As detailed in Appendix B, we assessed the internal controls necessary to satisfy our audit objective.[2] In particular, we assessed the internal control components and underlying principles—as outlined in the U.S. Government Accountability

[2] An entity designs, implements, and operates internal controls to achieve its objectives related to operations, reporting, and compliance. The U.S. Government Accountability Office sets internal control standards for federal entities in GAO-14-704G, *Standards for Internal Control in the Federal Government* (also known as the Green Book), issued September 10, 2014.

Office's Green Book—significant to our audit objective. Any internal control deficiencies we found are discussed in this report. Because our audit was limited to the internal control components and underlying principles deemed significant to our audit objective, our audit may not have disclosed all internal control deficiencies that may have existed at the time of the audit.

To address our objective, we reviewed EPA policies and guidance related to synthetic-minor-source permitting and compliance monitoring. We also interviewed staff and managers in the OAQPS and the Office of Enforcement and Compliance Assurance.

We also reviewed synthetic-minor facilities in the natural gas extraction sector to assess whether synthetic-minor-source permit limitations and provisions adhered to EPA guidance and whether the facilities' inspections were consistent with EPA guidance. Specifically, we reviewed eight facilities in Oklahoma in Region 6 and eight facilities in Colorado in Region 8. We selected these states because they have among the highest number of synthetic-minor facilities in the natural gas extraction industry, according to the 2017 National Emissions Inventory. For each of the 16 facilities, we reviewed each active permit and the associated technical support documentation, referred to as the permit record, to assess whether permit limitations and associated provisions adhered to EPA guidance on synthetic-minor-source permitting. This included a total of 30 permits covering the 16 facilities. In total, we reviewed 523 limits, including:

- 310 unit-specific emission limits.
- 42 facilitywide emission limits.
- 171 production and operation limits.

For each of the 16 facilities, we also reviewed documentation related to full compliance evaluations conducted at the facilities to determine whether the facilities were inspected in accordance with EPA guidance on compliance monitoring activities.

We interviewed staff and managers from the OAQPS; the Office of Enforcement and Compliance Assurance; Regions 6 and 8; the Colorado Department of Public Health and Environment, known as CDPHE; and the Oklahoma Department of Environmental Quality, known as ODEQ.

Appendix C provides more details on our scope and methodology. Appendix D provides background information on the natural gas extraction industry.

PET-850
REC 2569

Chapter 2
EPA Should Conduct Additional Oversight to Assure That Synthetic-Minor-Source Permits Meet Guidance

While the EPA oversees compliance monitoring activities at synthetic-minor facilities to assure that facilities comply with their permits, the EPA conducts minimal oversight of the permits themselves. The EPA has issued guidance for state and local agencies to use in developing synthetic-minor-source permit limitations to assure that the limits are enforceable as a practical matter, but the EPA does not assess whether state and local agencies have developed permit limits in accordance with this guidance. We found that 23 of the 30 synthetic-minor-source permits we reviewed in the natural gas extraction industry did not adhere to all elements of the EPA's guidance on practical enforceability. In cases where practical enforceability guidance was not met due to insufficient monitoring requirements, it could be more difficult to detect when a synthetic-minor source has violated its permit limitations or is actually emitting pollutants at a major-source level. The EPA should increase its oversight of synthetic-minor-source permits to better assure that limits adhere to EPA guidance and are practically enforceable.

EPA Policy Requires Oversight of Permitting Programs

Under the 1984 *EPA Policy on Oversight of Delegated Environmental Programs*, the Agency is responsible for overseeing state and local programs. The policy states that EPA oversight of delegated state programs should, among other things, enhance state capabilities to administer sound environmental protection programs through increased communication and a combination of support and evaluation activities. In addition, the policy calls for the EPA to clearly describe objectives and expectations for state environmental programs to increase the ability of state agencies to successfully implement program requirements and to increase the EPA's ability to provide appropriate assistance and evaluation. Examples of tools provided in the EPA's policy include detailed, up-front guidance on how program work should be performed.

In December 2020, the EPA issued its *National Permitting Oversight Policy*. The policy states that the EPA is responsible for ensuring permits and permitting programs conform with applicable laws and regulations. Additionally, the policy states that the EPA's regular oversight of permits and permitting programs is designed to identify and resolve emerging issues collaboratively with the permitting authority, such as a state or local agency, long before the issues pose a significant risk to the effectiveness of the program. This way, the EPA can avoid invoking procedures to withdraw program delegation, authorization, or approval.

EPA Conducts Oversight of Compliance Monitoring Activities at Synthetic-Minor Sources to Assure Facilities Comply with Permits

The Office of Enforcement and Compliance Assurance oversees state and local compliance monitoring activities including at SM-80s. According to the *CAA CMS*, states should conduct a full compliance evaluation of each SM-80 source once every five fiscal years and report the data to the ICIS-Air database.

Office of Enforcement and Compliance Assurance staff said that the EPA regional offices meet regularly with state and local agencies, and one of the issues they discuss is whether state and local agencies are having any problems meeting the requirements of the *CAA CMS*. Further, Office of Enforcement and Compliance Assurance staff receive a monthly *CAA CMS* report that identifies sources that are overdue for a compliance evaluation and contact the responsible EPA regional office for resolution.

The EPA regional offices audit state performance against *CAA CMS* goals through the State Review Framework reviews, which are completed every five years for each state. The following State Review Framework metrics are relevant to overseeing synthetic-minor sources: full compliance evaluation coverage of SM-80s, documentation of full compliance evaluation elements, and timeliness of high-priority violation determination and identification.

We found that Colorado and Oklahoma conducted compliance monitoring activities at the synthetic-minor natural gas production facilities we reviewed in accordance with the *CAA CMS*. All the facilities we reviewed had at least one full compliance evaluation conducted by the state between fiscal years 2015 and 2020, in accordance with the *CAA CMS*. In addition, reports from states' full compliance evaluations show that the CDPHE and the ODEQ generally included all activities that are supposed to be conducted during such evaluations. Further, compliance monitoring reports contained all the elements required by the *CAA CMS*.

EPA Conducts Limited Oversight of Synthetic-Minor-Source Permits

The EPA developed numerous guidance documents in the late 1980s and throughout the 1990s for state and local agencies to use in developing synthetic-minor-source permit limits so that the limits are practically enforceable. The guidance, however, has not been consolidated and lacks clarity on how to effectively limit facilities' potential to emit air pollution. In fiscal year 2020, the OAQPS issued training slides, titled "Setting Enforceable Potential to Emit Limits in Permits," that present important criteria from various EPA guidance documents. These slides were intended to promote consistency in how state and local agencies develop synthetic-minor-source permit limits, but they are not considered to be official guidance.

Neither EPA headquarters nor regional offices conduct regular or routine evaluations or review synthetic-minor-source permits and the limitations adopted by facilities to avoid major source status. The OAQPS only reviews synthetic-minor-source-permit limitations in cases where a Title V permit under review contains such limitations. This may occur when the Agency receives a petition to review a specific Title V permit. Title V permits are issued for major sources and some minor sources of air pollution and impose certain record-keeping and reporting requirements on facilities. Synthetic-minor limitations may be included in some Title V permits if the facility is a major source for some pollutants and a synthetic-minor source for other pollutants. Beyond Title V permits, OAQPS staff stated that they do not review synthetic-minor limitations, and the office does not receive synthetic-minor-source permits from the state and local agencies.

Region 8 staff told us that they do not oversee minor sources, synthetic or otherwise, because that is not considered to be one of their responsibilities. According to Region 8 staff, EPA headquarters has directed regions to focus their oversight activities on major sources. The only Region 8 responsibilities that relate to synthetic-minor oversight are (1) reviewing State Implementation Plans to modify state permitting programs and (2) assisting states with problems or issues, such as ones brought up during a permit's public comment period or in the media.

A State Implementation Plan is an EPA-approved plan that is made up of various air pollution control measures and activities that a state will implement to meet certain air quality standards.

Region 6 staff told us that the region does not routinely review synthetic-minor-source permits but that states notify the region when a synthetic-minor-source permit is released for public comment. Region 6 does not focus on synthetic-minor permits but may review a permit if the media reports a problem with the permit, the state received a significant comment on the permit, or a citizen complains about the permit.

Many Permits Reviewed Did Not Adhere to EPA Guidance on Practical Enforceability

EPA guidance on practical enforceability states that a permit's provisions should specify:

- A technically accurate limitation and the portions of the source subject to the limitation.
- The time period for the limitation, such as hourly, daily, monthly, or annually. A rolling annual limit, for example, is based on 12 consecutive months rather than a calendar year. When the month changes, the most recent prior 12 months, regardless of the calendar year, are used to determine compliance.

- The method to determine compliance, including appropriate monitoring, record-keeping, and reporting. Examples of this include monitoring and maintaining records on a facility's hours of operation and the amount of product produced.

We identified instances for each of these three elements where permits did not adhere to the EPA's guidance. Practical enforceability is key to permitting because it helps assure that a permit's provisions are written in such a way that regulators and citizens can assess a facility's compliance with its permit limitations. This helps assure that synthetic-minor-source facilities are not actually emitting pollution at major-source levels.

Many Synthetic-Minor-Source Permits or Permit Records Reviewed Did Not Include Sufficient Documentation to Verify Technical Accuracy of Limitations

To assure a synthetic-minor-source permit is practically enforceable, the state or local agency must establish technically accurate permit limitations that include the portions of the facility subject to the limitation. A technically accurate permit limitation is one that is "sound," "appropriate," and based on the most representative data available. We have concluded, based on EPA guidance and interviews with EPA staff, that in order for a reviewer to determine whether a limit is technically accurate, the permit or permit record should include information that supports the different elements that are relied upon to determine the limitation.

The technical accuracy of emission limits that rely on pollution control equipment, such as an enclosed combustion device—known as an ECD—or an engine catalyst system, is verifiable when the permit or permit record includes supporting information about the specific control equipment used. ECDs are intended to reduce volatile organic compounds, known as VOC, and hazardous air pollutant emissions that are known or suspected to cause cancer and other serious health problems. Engine catalyst systems are intended to reduce nitrogen oxides and carbon monoxide emissions.

These pollution control devices are included in air permits with an associated control efficiency, which can vary depending on the specific equipment and pollution control device used. The control efficiency is the percent of pollution emission reduction obtained from pollution control equipment. For example, the CDPHE generally assumes that ECDs reduce VOC and hazardous air pollutant emissions with a 95 percent control efficiency. For the technical accuracy of emission limits that rely on ECDs and engine catalysts to be verifiable, the assumption that the device obtains a specific control efficiency should be supported in the permit or permit record. Based on EPA guidance and interviews, such support could include emissions data from compliance tests, other source tests, or equipment vendor emissions data and guarantees.

PET-854
REC 2573

Limits Reviewed Lacked Sufficient Supporting Documentation

In the permits we reviewed, 96 of the 523 limits were not adequately supported by documentation, such as underlying information about pollution control equipment with an assumed control efficiency, in the permit or permit record. This lack of critical supporting information prevented us from determining whether the limits contained errors and properly prevented the synthetic-minor source from operating at major-source levels.

Of the 96 limits that lacked adequate support, 35 relied on assumed control efficiencies from pollution control equipment designed to restrict emissions, such as ECDs and engine catalysts. In 20 of these 35 cases, the assumed control efficiency was 95 percent or greater, but neither the permit nor permit record provided documentation to support this assumption. Specifically, the permit and permit record did not include a manufacturer's guarantee of control efficiency, testing data, model inputs, or other information that could be used to validate this control efficiency assumption. Staff and managers from the CDPHE told us that the 95 percent control assumption efficiency for ECDs is based on the manufacturer's guaranteed control efficiency and anecdotal field testing in Colorado, but we found no support in the permit or permit record for that assumption in these cases.

We found that 41 of the 96 limits could not be verified because there was insufficient underlying support for the basis of the emission factor used. An emission factor is a representative value designed to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. Such factors facilitate the estimation of emissions from various sources of air pollution. For example, one permit simply cited "Conservative [Texas Commission on Environmental Quality] … emission factors" as the source of the emission factor, but there was no other citation in the permit or permit record that would allow a third party to identify what the emission factor is based on or where to find that information.

Information on which permit limits are based needs to be as complete and transparent as possible so that permit writers, the public, and the EPA can assess whether pollution reductions are likely to occur as intended. Not providing sufficient underlying support for what permit limits are based upon undermines the ability to conduct such an assessment.

Instruction on Documentation Has Not Been Clearly Communicated in EPA Guidance

EPA guidance from the 1980s and 1990s does not provide permitting authorities with instruction on what supporting information should be included in the permit or permit record. The guidance is decades old, not specific to any particular industry or synthetic-minor-source permitting,

PET-855
REC 2574

contained within multiple discrete documents, and, in one case, only available in draft form. The training slides that the EPA developed in fiscal year 2020 present criteria from various guidance documents. It also provides information and examples of technically accurate limitations that are not included in prior guidance. The EPA, however, has not updated its guidance documents to include, or expand upon, the information in the training.

In addition, we found that OAQPS permitting staff and managers have expectations for assuring limits are practically enforceable, but those expectations have not been clearly communicated to state agencies. For example, during one interview, OAQPS staff and managers told us that supporting documentation, such as a manufacturer specification sheet for an ECD, should be contained within the permit record. This expectation is not stated in any formal guidance document.

Some Synthetic-Minor-Source Permit Limits Did Not Include Time Period That Was Consistent with EPA Guidance

To assure a synthetic-minor-source permit is practically enforceable, the permit must specify a time period for the limitation—generally, hourly, daily, or monthly—but not exceed an annual limit on a 12-month rolling basis. The time periods for all limits should readily allow for demonstration of compliance.

The time periods associated with 25 of the 523 permit limits we reviewed did not adhere to EPA guidance. Of the 25 permit limits, 11 were for facilities in Colorado. We found nine emission limits in one permit that were annual limits with no rolling monthly averages. The CDPHE told us that this was a permit-writer error rather than a systemic issue in Colorado permitting. We agree with that assessment, given that we did not find any evidence to contradict this explanation. Separate from this permit-writer error, two Colorado permits contained an operational limit for which the time period did not adhere to EPA guidance.

We found that 14 of the annual emission limits in the Oklahoma permits we reviewed did not adhere to EPA guidance on time periods. In these cases, the permits did not clearly state that the emission limits were to be based on a 12-month rolling total or provide corresponding short-term limits, such as pounds per hour, that would make the limit easier to enforce. The permit writers used a template that labeled annual emission limits as TPY rather than on a rolling annual basis.

It is more difficult for inspectors to determine compliance with limits that have longer time periods. For example, EPA guidance explains that an inspector could not verify compliance for an emissions unit with only monthly and annual production, operational, or emission limits if the inspection occurred at any time except at the end of a month. Further, if there is a compliance problem, such as

excess emissions from a particular piece of equipment, longer time periods could mean that the issue is not detected by the facility or an inspector until months after the problem began. The sooner a violation is identified, the less likely excess emissions will occur.

Some Synthetic-Minor-Source Permits Did Not Specify Method to Determine Compliance with Certain Limitations or Lacked Sufficient Monitoring Requirements

The final component of establishing a practically enforceable limit requires the permit writer to specify the method to determine compliance, including appropriate monitoring, record-keeping, and reporting requirements, for each limit in the permit. Based on 1990 draft EPA guidance, limitations must be easily measurable and allow no subjectivity in their compliance determinations. In particular, when permits include a requirement to operate a control device at a particular control efficiency level, the permits should also contain monitoring requirements for the specific parameters cited in the permit or those which ensure the efficiency of the unit as required in the permit. A parameter, such as temperature, is a key indicator of system performance that is correlated with the control efficiency obtained by the pollution control device. Such requirements allow a permitting agency to instantaneously verify a source's compliance with its limits.

In Oklahoma, 26 Permit Limits Lacked Specified Method to Determine Compliance

For 26 of the 230 limits we reviewed in Oklahoma permits, the permits did not specify a method for determining compliance. The majority of these 26 limits are VOC emission limits associated with engines in a permit that does not require VOC emissions testing. Other limits are based, in part, on production limits, such as limits on throughput. The production limits are required to be tracked and monitored monthly, but the permits did not clearly explain how monthly tracking of production limits demonstrates compliance with emission limits. In these instances, the connection between the production limits and the emission limits were not described.

Vague permitting conditions, such as unclear or missing statements on the method for determining compliance, can allow facilities unintended flexibility. For example, a facility may discover that its typical method for determining compliance with an emission limit generates emissions estimates in excess of the emission limit during a compliance period. If the method of compliance is not stated, the facility has the option to use a more favorable estimation technique that may not show the facility has exceeded its permit limit.

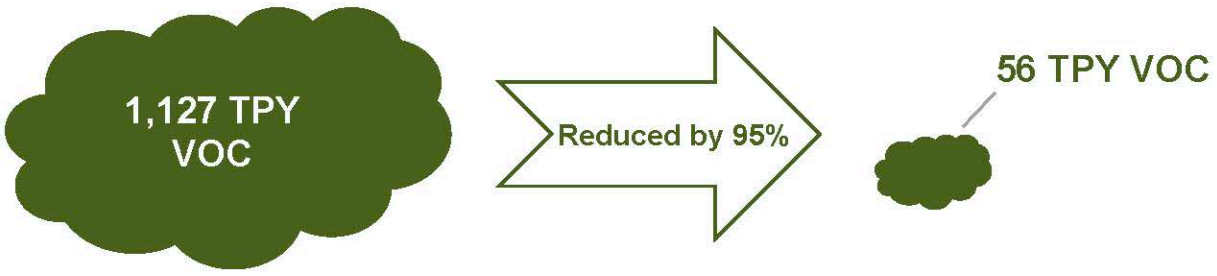
Fifty-Five Limits Did Not Contain Sufficient Monitoring Requirements to Assure That Assumed Control Efficiency Was Being Met

Based on the permits we reviewed, synthetic-minor-source permits often rely on the assumed control efficiencies of add-on control devices, such as an ECD or engine catalyst system, to achieve emission reductions below major-source thresholds. For 55 of the 523 permit limits we reviewed, we found that the permit lacked sufficient direct testing or parametric monitoring to assure that the assumed control efficiency of control devices was being met.

Parametric monitoring measures key indicators of system performance that are correlated with the control efficiency obtained by the pollution control device. These parameters are generally operational or design parameters of the process or the air pollution control device that are known to affect the emissions levels from the process or the control. An example of a potential way to conduct parametric monitoring for ECDs is measuring combustion chamber temperature, as this is considered to be a design parameter that impacts ECD combustion efficiency. Examples of parametric monitoring for engine catalysts include measuring temperature, changes in pressure, and the presence of oxygen.

Figure 2 shows how the assumed control efficiency of a control device, such as an ECD, reduces a facility's potential to emit below major-source thresholds, based on one of the permits we reviewed. In this example, a facility emits 1,127 tons of VOC if it operates for an entire year, which would subject the facility to major-source requirements. Facility management may choose to install an add-on control with an assumed 95 percent VOC control efficiency, which would theoretically reduce the facility's emissions to 56 tons of VOC per year. If the facility emits less than 100 tons of VOC per year, it would be considered a synthetic-minor-source and would not have to follow major-source requirements. If the ECD did not achieve 95 percent VOC control efficiency, the facility could be emitting at major-source levels without having to follow major-source requirements.

Figure 2: How permitting authorities may use a 95 percent control efficiency assumption for an emissions control device to reduce potential emissions



Source: OIG analysis of potential VOC emission reduction from a pollution control device. (EPA OIG image)

Fifty emission limits we reviewed were established based on an ECD operating at a 95 percent or greater control efficiency. Most of the applicable permits included requirements to periodically verify that a pilot light was operating and to check for visible emissions. The pilot light is necessary to combust waste gas flowing to the combustion device and is the difference between achieving a 0 percent (no pilot) and potential 95 percent control. Visible emissions indicate incomplete combustion and demonstrate that the device is not operating correctly. Verifying that the pilot light is operating and checking for visible emissions may indicate whether an ECD is operating properly, but we conclude that these are not parametric measures that accurately show what control efficiency the device is actually achieving. Thus, these measures do not assure that the device is continuously meeting its assumed control efficiency of 95 percent.

In addition, many emission limits we reviewed were established based on an engine catalyst operating at a specific control efficiency. While reviewing Colorado permits containing engine catalysts, we found that facilities were required to conduct daily, weekly, or monthly parametric monitoring, depending on the parameter being monitored and the facilities' permitted emissions. This was in addition to quarterly or semiannual engine emissions testing. Therefore, these facilities were subject to emissions testing and frequent parametric monitoring to help assure the assumed control efficiency of the catalyst was being met.

Facilities operating under Oklahoma's general permit, on the other hand, were required to conduct quarterly testing and to install parametric monitoring equipment, but the general permit did not require frequent parametric monitoring. The Oklahoma individual permits we reviewed did not contain monitoring or record-keeping requirements beyond quarterly testing. While quarterly testing assures that catalyst systems are operating as intended four times per year, the lack of frequent parametric monitoring means that short-term excess emissions from engines may go undetected.

Challenges Exist to Parametric Monitoring

Significant challenges exist to direct testing and parametric monitoring of ECDs. Natural gas extraction facilities tend to be in remote, unmanned locations and may be far from an adequate power source necessary to run monitoring equipment. Further, testing and monitoring can be expensive, difficult, and unsafe given the design of ECDs and their placement at natural gas extraction facilities. The EPA is aware of these challenges and is studying alternatives to existing compliance methods in EPA Region 8.[3] In the meantime, the EPA has pointed to the New Source Performance Standards,

[3] The study Region 8 is conducting is called *Measuring Enclosed Combustion Device Emissions Using Portable Analyzers - Phase 1: Test Summaries*. The EPA is conducting this research in conjunction with the Wyoming Department of Environmental Quality.

known as the NSPS, that cover sources in the natural gas extraction industry as containing visible emissions and pilot light monitoring as the existing requirements for assuring compliance with the assumed control efficiency.[4] EPA staff stated that they would not expect states to have more stringent requirements than what is in EPA regulations.

The standards reflect the "best system of emission reduction" which the EPA determines has been adequately demonstrated. They are subject to revisions given the potential for process improvements and technology advances that would alter the best system of emission reduction. CAA Section 111(b)(1)(B) requires the EPA to review and, if appropriate, revise the NSPS at least every eight years unless the EPA administrator determines that the review is not appropriate in light of readily available information on the efficacy of the standard.

The NSPS in 40 C.F.R. Part 60 Subpart OOOO were due for review under CAA section 111(b)(1)(B) in 2020. The Agency has not reviewed the standards because it has been engaged in reconsideration and revisions of Subparts OOOO and OOOOa standards. EPA staff also told us that the EPA has until 2024 to review the standards in Subpart OOOOa and that, since the types of sources regulated by Subparts OOOO and OOOOa are within the same industry sector, a review of Subpart OOOOa could be planned and executed to also include review of Subpart OOOO.

Lack of Parametric Monitoring Could Result in Unidentified Violations of Permit Limitations

Ultimately, when there is no monitoring associated with a limitation or when the monitoring is insufficient to describe the actual control efficiency of a control device, the state may not be able to obtain sufficient evidence to determine whether a limitation is being violated. In addition, depending on the severity of a violation, the facility could unknowingly be operating as a major source.

Region 8, in conjunction with the Wyoming Department of Environmental Quality, is conducting a study to better understand ECDs and develop an alternative method for demonstrating compliance with permitted control efficiency requirements. Preliminary results from this ongoing study, along with results from a 2014 EPA study, indicate that the control efficiency of these devices can vary and that the devices may fall far below their assumed 95 percent efficiency for unknown periods of time.[5] In the 2014 study, EPA

[4] 40 C.F.R. Part 60 Subparts OOOO and OOOOa. The title of 40 C.F.R. Part 60 Subpart OOOO is "Standards of Performance for Crude Oil and Natural Gas Production, Transmission and Distribution for which Construction, Modification or Reconstruction Commenced After August 23, 2011, and on or before September 18, 2015." The title of 40 C.F.R. Part 60 Subpart OOOOa is "Standards of Performance for Crude Oil and Natural Gas Facilities for which Construction, Modification or Reconstruction Commenced After September 18, 2015."

[5] The title of the 2014 study is *Advancing Understanding of Emissions from Oil and Natural Gas Production Operations to Support EPA's Air Quality Modeling of Ozone Non-Attainment Areas.*

PET-860

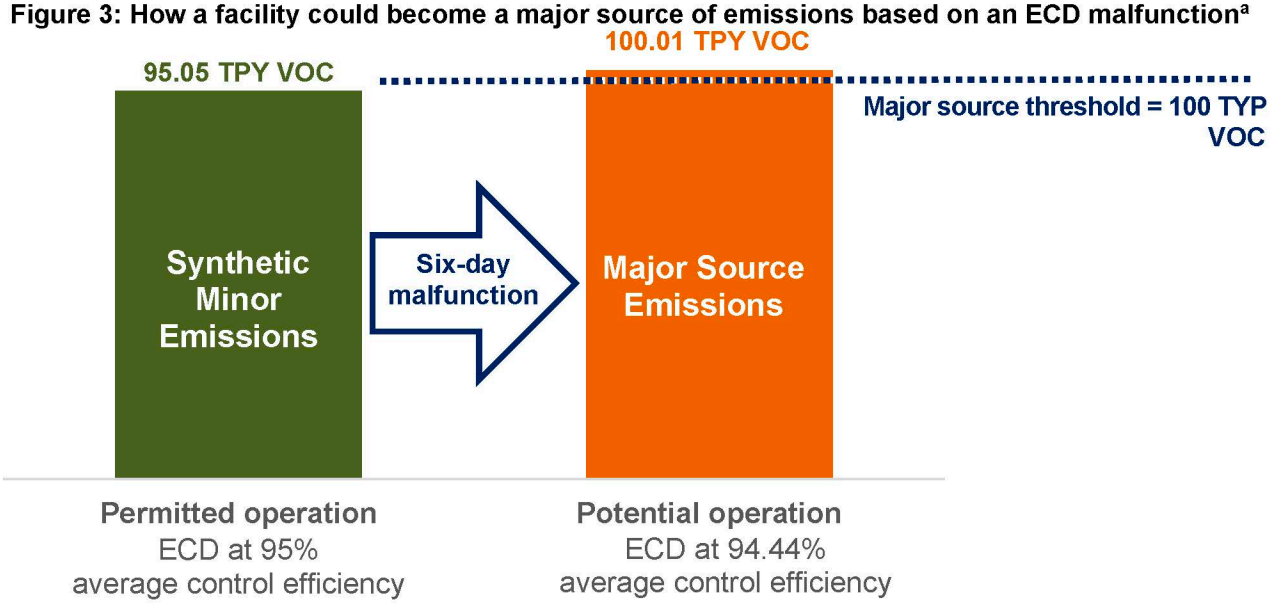
REC 2579

researchers found that an ECD at one of the eight sites they studied was operating at a 60 percent control efficiency.

If a facility's actual control efficiency falls below the assumed control efficiency, it could cause the facility to unknowingly exceed its permit limits and become a major source of emissions. As an example, for one facility we reviewed, if only one of the four permitted ECDs malfunctioned and achieved a maximum 60 percent control efficiency for approximately six days, the facility would violate its permit limits and become a major source of emissions. The violation may not be detected without sufficient monitoring. This is depicted in Figure 3.

If the facility experiences a small malfunction, such as a 94 versus a 95 percent control efficiency over the majority of the compliance period, the facility could become a major source of emissions, perhaps without being detected. The CDPHE told us that facility-conducted field testing in Colorado shows ECDs meet a 95 percent control efficiency most of the time.

Figure 3: How a facility could become a major source of emissions based on an ECD malfunction[a]



Source: OIG analysis of potential VOC emission increases due to a short-term ECD malfunction. (EPA OIG image)

[a] Example is based on a hypothetical situation where a short-term malfunction at one of the facilities we reviewed could result in an ECD control efficiency of 60 percent and cause the facility to release major-source levels of emissions. Values are rounded. Emissions presented in the above columns are based on multiple pieces of permitted equipment, with a malfunction at only one piece of permitted equipment.

Appendix E provides a case study of the wood biomass industry, in which synthetic-minor facilities without sufficient monitoring requirements were found to be emitting pollution over major source thresholds.

Conclusions

The EPA is responsible for overseeing state and local permitting and compliance monitoring activities. The EPA oversees state and local compliance monitoring activities for synthetic-minor sources through the *CAA CMS* and State Review Framework reviews, but it conducts limited oversight of state and local synthetic-minor-source permitting. Neither EPA headquarters nor EPA regional offices regularly review synthetic-minor-source permitting. Existing guidance for establishing synthetic-minor-source permits is dated, scattered across numerous documents, and lacks clarity on how to effectively limit the potential to emit.

In our reviews of Colorado and Oklahoma synthetic-minor-source permits, we found that state and local agencies are largely meeting EPA expectations for compliance monitoring, but many synthetic-minor-source permit limits do not adhere to EPA guidance on practical enforceability. In particular, the Agency should provide better guidance on how state and local agencies can establish limits that are technically accurate. For synthetic-minor-source permits in the natural gas extraction sector, the Agency should place additional emphasis on how state and local agencies can assure that assumed control efficiencies from pollution control devices are being achieved.

Recommendations

We recommend that the assistant administrator for Air and Radiation:

1. Update Agency guidance on practical enforceability to more clearly describe how the technical accuracy of a permit limit should be supported and documented. In updating such guidance, the Office of Air and Radiation should consult and collaborate with the Office of Enforcement and Compliance Assurance, the Office of General Counsel, and the EPA regions.

2. In consultation with the EPA regions, develop and implement an oversight plan to include:

    a. An initial review of a sample of synthetic-minor-source permits in different industries that are issued by state, local, and tribal agencies to assess whether the permits adhere to EPA guidance on practical enforceability, including limits that are technically accurate; have appropriate time periods; and include sufficient monitoring, record-keeping, and reporting requirements.

    b. A periodic review of a sample of synthetic-minor-source permits to occur, at a minimum, once every five years.

PET-862
REC 2581

c. Procedures to resolve any permitting deficiencies identified during the initial and periodic reviews.

3. Assess recent EPA studies of enclosed combustion device performance and compliance monitoring and other relevant information during the next statutorily required review of 40 C.F.R Part 60 Subparts OOOO and OOOOa to determine whether revisions are needed to monitoring, record-keeping, and reporting requirements for enclosed combustion devices to assure continuous compliance with associated limits, and revise the regulatory requirements as appropriate.

Agency Response and OIG Assessment

The Agency agreed with all three recommendations and provided acceptable corrective actions and completion dates. The recommendations are resolved with corrective actions pending. The Agency's full response is in Appendix F.

For Recommendation 1, the OAR will update Agency guidance on the practical enforceability of permit limitations, including, but not limited to, the EPA's June 13, 1989 *Guidance on Limiting Potential to Emit in New Source Permitting*, to describe how the technical accuracy of a permit limit should be supported and documented. In updating its guidance, the OAR will consult and collaborate with the Office of Enforcement and Compliance Assurance, the Office of General Counsel, and the EPA regions. We agree that these planned actions address our recommendation. Recommendation 1 is resolved with corrective actions pending.

For Recommendation 2, the OAR, in consultation with EPA regional offices, will develop and implement an oversight plan for synthetic-minor-source permits in accordance with statutory and EPA regulatory requirements. The OAR's plan will include the specific elements identified in Recommendation 2. We agree that these planned actions address our recommendation. Recommendation 2 is resolved with corrective actions pending.

For Recommendation 3, we initially recommended that the OAR develop technical support information for natural gas production facilities that includes defining the parameters upon which the control efficiency for ECDs is based and methods for measuring those specific parameters so that permitting authorities can verify compliance with permit limits. The OAR agreed that monitoring, record-keeping, and reporting requirements associated with synthetic-minor permit emission limitations serve to ensure that the established enforceable limits are being met and are important to meet the ongoing compliance requirement in EPA regulations. The OAR also agreed that facilities under synthetic-minor status should generate records to demonstrate continuous compliance with permit emission limits.

The OAR disagreed with the OIG's implication in the original recommendation that inadequate technical information regarding monitoring, record-keeping, and

reporting for ECDs was an impediment to verifying emission limits associated with the oil and gas industry. The OAR pointed to federal regulations in 40 C.F.R Part 60 Subparts OOOO and OOOOa and 40 C.F.R Part 63 Subpart HH as evidence that properties related to effective combustion are well-understood and depend on gas composition, gas flow, residence time in the combustion zone, and the continuous presence of a pilot light to ensure ignition. The OAR further pointed to Subpart OOOOa requirements for initial testing of ECDs by the owner or operator—or a certification test by the manufacturer—for continuously monitoring for a pilot flame, for monthly visible emissions testing, and for continuously monitoring gas flow to the unit for certain ECDs.

The OAR was amenable to revising the existing monitoring, record-keeping, and reporting requirements for pollution control equipment at oil and gas facilities if new data and information warrant changes. The OAR cited the statutorily mandated technology review for the NSPS under Subpart OOOOa, to occur by 2024, as an appropriate time to determine whether additional or different monitoring requirements for ECDs are necessary, practicable, and cost-effective.

After reviewing the cited regulations, we still believe that the EPA has not presented adequate technical information to assure that permitting authorities can continuously verify compliance with ECD-related emission limitations. As noted in our report, verifying that the pilot light is operating and checking ECDs periodically for visible emissions are not compliance actions that accurately demonstrate the assumed control efficiency is being met on a continuous basis. In addition, monitoring the flow rate does not guarantee the assumed control efficiency is being met.

We acknowledge that there may be cost and logistical constraints, such as a lack of electricity at some oil and gas production facilities, which make continuous compliance monitoring difficult. Further, the Region 8 study is ongoing, and it may be inappropriate for the EPA to issue supplemental technical information or guidance prior to obtaining complete data or when the applicable NSPS is not under review. Therefore, we agree with the EPA that the upcoming review of standards under Subparts OOOO or OOOOa is an appropriate time to reconsider the monitoring, record-keeping, and reporting requirements for ECDs. As such, we have revised Recommendation 3 to focus on the EPA's review of EPA studies and other relevant information during the statutorily mandated review in 2024.

The Agency concurred with our revised recommendation and provided an acceptable proposed corrective action plan and planned completion date. The planned completion date is the date by which the Agency plans to initiate its statutorily required review of 40 C.F.R Part 60 Subparts OOOO and OOOOa. The Agency's full response to the revised recommendation is in Appendix G. Recommendation 3 is considered resolved with corrective actions pending.

Chapter 3
EPA Has Not Clearly Communicated Key Synthetic-Minor-Source Permitting Expectations in Official Guidance

We found that the EPA has several key expectations for synthetic-minor-source permitting that are not clearly communicated in official guidance. EPA policy requires the Agency to clearly describe objectives and expectations for state environmental programs, such as permitting. Without clear guidance, states may develop their own practices that do not align with EPA expectations.

Key Expectations Have Not Been Clearly Communicated in Official Guidance

The *EPA Policy on Oversight of Delegated Environmental Programs* states that the EPA must clearly describe objectives and expectations for state environmental programs to increase the ability of state agencies to successfully implement program requirements and to increase the ability of the EPA to provide appropriate assistance and evaluation. One way this can be accomplished is by providing detailed, up-front guidance on how program work should be performed. We found through discussions with OAQPS staff and managers that the EPA has key expectations for synthetic-minor-source permitting that it has not clearly communicated to state and local agencies in official guidance, such as:

- The terms of a synthetic-minor limitation, such as the limit itself and the methods for demonstrating compliance with the limit, should be in the permit itself. These terms, along with calculations necessary to demonstrate compliance with synthetic-minor limits, need to be included in the permit or incorporated by reference from another source. It would also be appropriate to include calculations and model inputs used to estimate the potential to emit or to set an emission limit in the permit record, such as the permit's technical support documentation.

- Regarding the technical accuracy of limits that depend on pollution control equipment, the vendor or manufacturer information and specifications for the control equipment should be part of the permit record. One way to better assure that a pollution control device obtains its intended pollution reductions over time is to require a source to follow the manufacturer specifications.

- Synthetic-minor-source permits for facilities with emergency generators, which are devices that are intended to serve solely as backup sources of power in the event of a loss of the normal power source, should include a

limitation for the emergency generator as part of the permit. OAQPS staff stated that an emergency generator would be expected to operate approximately 500 hours under worst-case conditions. Permitting authorities should include this figure when assessing the facility's potential to emit calculations. For a synthetic-minor source permit that contains emission sources other than the emergency generator, the permitting authority should include the emergency generator in the permit itself and establish corresponding limits, such as an emission limit and an operational limitation. For example, the facility may not operate the emergency generator for more than 500 hours per year.

These expectations have not been clearly communicated in official guidance, in part because the EPA has not prioritized revising guidance documents to include the Agency's expectations. The 2020 training slides discussed in Chapter 2 include most aspects of the first two expectations, but they are not official guidance.

Without Clear Guidance, States May Adopt Their Own Practices

In the absence of clear, national guidance, state and local permitting programs may develop their own practices for addressing these issues, which do not align with EPA expectations. For example, based on the permits we reviewed and discussions with CDPHE staff, Colorado does not include emergency generators in the permits themselves or establish corresponding emission or operational limits unless the generator's potential emissions put the facility over the major source threshold.

Conclusions

As part of its oversight of state and local environmental programs, the EPA should clearly describe objectives and expectations so that state and local agencies can successfully implement program requirements. During our audit, EPA staff and managers described to us expectations regarding three important aspects of synthetic-minor-source permitting that are not currently reflected in EPA guidance documents. Rather than updating guidance from the 1980s and 1990s to formalize these expectations, the EPA has developed training materials for state and local agencies. Given the importance of establishing effective limits on the potential to emit—that is, limits that are both federally and practically enforceable—the EPA should communicate all key expectations through formal guidance. Without clear guidance, states may adopt their own practices that do not adhere to EPA expectations or assure synthetic-minor-source permit enforceability.

PET-866
REC 2585

Recommendation

We recommend that the assistant administrator for Air and Radiation:

4. Revise the Agency's guidance to communicate its key expectations for synthetic-minor-source permitting to state and local agencies.

Agency Response and OIG Assessment

The Agency agreed with Recommendation 4 and provided an acceptable corrective action and completion date. The OAR will revise the Agency's guidance to include the key expectations above and may, at least in part, integrate this work with the updates to guidance on practical enforceability in response to Recommendation 1. The recommendation is resolved with corrective actions pending. The Agency's full response is in Appendix F.

PET-867

REC 2586

Chapter 4
ODEQ Does Not Currently Include Synthetic-Minor-Source Permits in Its Public Participation Process

The ODEQ does not currently issue its individual synthetic-minor-source permits for public comment before they are finalized, as required by EPA regulations. Staff in the EPA's OAQPS told us that this may be the case for other state and local agencies as well. ODEQ staff told us that Oklahoma's legislature passed new state rules that will require public comment on synthetic-minor-source permits and that these rules will go into effect in September 2021. Although this deficiency is being addressed in Oklahoma, the EPA has not ensured that all states include public participation in their synthetic-minor-source permitting process.

Without the opportunity to review permit materials and provide comments on proposed synthetic-minor-source permits, citizens are deprived of the ability to assess information and provide input on facilities that may impact air quality where they live. The EPA should regularly confirm that states adhere to requirements on public participation for synthetic-minor-source permits.

EPA Regulations Require Opportunity for Public Review and Comment on Synthetic-Minor-Source Permits

EPA regulations require certain permitting information to be available to the public for review and comment, generally for 30 days. Per 40 C.F.R. § 51.161, permitting authorities must make the following information public:

- Information submitted by owners and operators.
- An analysis of the effect of the construction or modification of the facility on ambient air quality.
- The permitting authority's proposed approval or disapproval of the permit.

Staff from both Region 6 and the OAQPS told us that these requirements apply to synthetic-minor-source permits, and EPA guidance states that public participation is a central tenet of federal enforceability.

ODEQ Does Not Currently Provide Opportunity for Public Review and Comment on Individual Synthetic-Minor-Source Permits

The ODEQ does not currently issue its individual, facility-specific synthetic-minor-source permits for public comment before they are finalized because Oklahoma's current regulations lack such a requirement. Region 6 staff told us that the region is aware of this issue and has communicated with the ODEQ about the need to revise this in Oklahoma's state permitting rules. In November 2020,

ODEQ staff told us that the state's air advisory council had approved new state rules to require an opportunity for public comment. In June 2021, ODEQ staff told us that the rules had been passed by the state legislature and will be going into effect on September 15, 2021. OAQPS staff told us that they are aware that lack of public participation for synthetic-minor sources may be a problem in other states as well.

Lack of Public Participation Precludes Citizen Input on Facility Permits

Synthetic-minor permit limitations are intended to limit emissions from facilities and, as such, have an impact on local air quality. Public participation requirements are intended to assure that citizens have the ability to provide input on the permit limitations, the pollutants that are emitted, and the quantity of emissions that will affect their communities. Not providing the opportunity to review permit materials and provide comments on proposed synthetic-minor-source permits hinders citizens' ability to weigh in on facilities that may impact air quality where they live.

Conclusions

The ODEQ is not currently adhering to EPA regulations that require state and local environmental programs to allow public review of and comment on proposed synthetic-minor-source permits, and this may be the case in other states as well. These requirements were established by the EPA to allow citizens the opportunity to analyze and understand environmental impacts in their communities. Individual synthetic-minor-source permits were approved by the ODEQ without any forewarning or input from the citizens who may be impacted by the permitted emissions. This lack of public participation can undermine permit quality and limits the opportunity for citizens to weigh in on facilities that may be located in their communities. The EPA should work with all state, local, and tribal agencies that do not provide the opportunity for public comment on synthetic-minor-source permits to assure opportunities for public participation, as required by law.

Recommendation

We recommend that the assistant administrator for Air and Radiation:

5. Identify all state, local, and tribal agencies in which Clean Air Act permit program implementation fails to adhere to the public participation requirements for synthetic-minor-source permit issuance and take appropriate steps to assure the identified states adhere to the public participation requirements.

Agency Response and OIG Assessment

The Agency agreed with Recommendation 5 and provided acceptable corrective actions and completion dates. The OAR, with EPA regional office support, will identify state, local, and tribal agencies whose program regulations do not meet the public participation requirements contained in the applicable EPA regulations and guidance with respect to synthetic-minor-source permitting. For the identified agencies, the OAR will take appropriate corrective steps, potentially to include informal engagement. The recommendation is resolved with corrective actions pending. The Agency's full response is in Appendix F.

Status of Recommendations and Potential Monetary Benefits

RECOMMENDATIONS

Rec. No.	Page No.	Subject	Status[1]	Action Official	Planned Completion Date	Potential Monetary Benefits (in $000s)
1	17	Update Agency guidance on practical enforceability to more clearly describe how the technical accuracy of a permit limit should be supported and documented. In updating such guidance, the Office of Air and Radiation should consult and collaborate with the Office of Enforcement and Compliance Assurance, the Office of General Counsel, and the EPA regions.	R	Assistant Administrator for Air and Radiation	10/31/23	
2	17	In consultation with the EPA regions, develop and implement an oversight plan to include: a. An initial review of a sample of synthetic-minor-source permits in different industries that are issued by state, local, and tribal agencies to assess whether the permits adhere to EPA guidance on practical enforceability, including limits that are technically accurate; have appropriate time periods; and include sufficient monitoring, record-keeping, and reporting requirements. b. A periodic review of a sample of synthetic-minor-source permits to occur, at a minimum, once every five years. c. Procedures to resolve any permitting deficiencies identified during the initial and periodic reviews.	R	Assistant Administrator for Air and Radiation	10/31/24	
3	18	Assess recent EPA studies of enclosed combustion device performance and compliance monitoring and other relevant information during the next statutorily required review of 40 C.F.R Part 60 Subparts OOOO and OOOOa to determine whether revisions are needed to monitoring, record-keeping, and reporting requirements for enclosed combustion devices to assure continuous compliance with associated limits, and revise the regulatory requirements as appropriate.	R	Assistant Administrator for Air and Radiation	12/31/24	
4	22	Revise the Agency's guidance to communicate its key expectations for synthetic-minor-source permitting to state and local agencies.	R	Assistant Administrator for Air and Radiation	10/31/24	
5	24	Identify all state, local, and tribal agencies in which Clean Air Act permit program implementation fails to adhere to the public participation requirements for synthetic-minor-source permit issuance and take appropriate steps to assure the identified states adhere to the public participation requirements.	R	Assistant Administrator for Air and Radiation	12/31/23	

[1] C = Corrective action completed.
R = Recommendation resolved with corrective action pending.
U = Recommendation unresolved with resolution efforts in progress.

CAA Major-Source-Permitting Programs

The CAA major-source-permitting programs are Title V, Nonattainment New Source Review, and Prevention of Significant Deterioration. The requirements and major-source thresholds vary by program, and Nonattainment New Source Review and Prevention of Significant Deterioration permitting depend upon whether the area in which the source is located complies with National Ambient Air Quality Standards. These health-based standards are set by the EPA for certain pollutants so that the level of the pollutant in the air is protective of human health and the environment. Areas that comply with these standards are known as attainment areas, while areas that do not comply are known as nonattainment areas. The table below summarizes these permitting programs and the corresponding levels of emissions that make a facility a major source under each program.

Table A-1: CAA programs and their corresponding major-source thresholds of air emissions

	Title V permitting	NNSR permitting	PSD permitting
Summary of program and requirements*	Permitting program for all operating major sources of air pollution. Title V permits contain all CAA requirements to which a facility is subject and impose certain monitoring, reporting, and record-keeping requirements.	Permitting program for new or modified major sources in areas that are in nonattainment with the NAAQS. NNSR permits require sources to install control equipment that obtains the lowest achievable emission rate to reduce emissions.	Permitting program for new or modified major sources in areas that are in attainment with the NAAQS. PSD permits require sources to use the best available control technology to limit emissions.
Major-source threshold	100 TPY of a regulated pollutant, but can be lower in nonattainment areas for the pollutant for which the area is in nonattainment; 25 TPY of total hazardous air pollutants; and 10 TPY of a single hazardous air pollutant.	100 TPY of a regulated pollutant, but can be lower depending on the severity of the air quality problem in the nonattainment area.	250 TPY of a regulated pollutant, except for facilities within 28 specific industries for which the threshold is 100 TPY.
Pollutants covered	VOC, NO_x, CO, SO_2, NO_2, $PM_{2.5}$, and PM_{10}, lead, and hazardous air pollutants, such as benzene, formaldehyde, and n-hexane.	Ozone (including VOC and NO_x, which react in the atmosphere to form ozone), CO, SO_2, NO_2, $PM_{2.5}$, PM_{10}, and lead.	Ozone (including VOC and NO_x, which react in the atmosphere to form ozone), CO, SO_2, NO_2, $PM_{2.5}$, PM_{10}, lead, hydrogen sulfide, and sulfuric acid.

Source: OIG summary of EPA information. (EPA OIG table)

* This table is intended for summary purposes and does not include all requirements of the permitting programs.

Note: CO is carbon monoxide, NAAQS is National Ambient Air Quality Standards, NNSR is Nonattainment New Source Review, NO_2 is nitrogen dioxide, NOx is nitrogen oxides, PM is particulate matter, PSD is Prevention of Significant Deterioration, and SO_2 is sulfur dioxide.

Internal Control Assessment

This table identifies which internal control components and underlying principles are significant to our audit objective.

Which internal control components are significant to the audit objective?		Which internal control principles are significant to the audit objective?	
X	**Control Environment** The foundation for an internal control system. It provides the discipline and structure to help an entity achieve its objectives.		1. The oversight body and management should demonstrate a commitment to integrity and ethical values.
		X	2. The oversight body should oversee the entity's internal control system.
			3. Management should establish an organizational structure, assign responsibilities, and delegate authority to achieve the entity's objectives.
			4. Management should demonstrate a commitment to recruit, develop, and retain competent individuals.
			5. Management should evaluate performance and hold individuals accountable for their internal control responsibilities.
X	**Risk Assessment** Management assesses the risks facing the entity as it seeks to achieve its objectives. This assessment provides the basis for developing appropriate risk responses.	X	6. Management should define objectives clearly to enable the identification of risks and define risk tolerances.
		X	7. Management should identify, analyze, and respond to risks related to achieving the defined objectives.
			8. Management should consider the potential for fraud when identifying, analyzing, and responding to risks.
		X	9. Management should identify, analyze, and respond to significant changes that could impact the internal control system.
X	**Control Activities** The actions management establishes through policies and procedures to achieve objectives and respond to risks in the internal control system, which includes the entity's information system.	X	10. Management should design control activities to achieve objectives and respond to risks.
			11. Management should design the entity's information system and related control activities to achieve objectives and respond to risks.
		X	12. Management should implement control activities through policies.
X	**Information and Communication** The quality information management and personnel communicate and use to support the internal control system.		13. Management should use quality information to achieve the entity's objectives.
			14. Management should internally communicate the necessary quality information to achieve the entity's objectives.
		X	15. Management should externally communicate the necessary quality information to achieve the entity's objectives.
X	**Monitoring** Activities management establishes and operates to assess the quality of performance over time and promptly resolve the findings of audits and other reviews.	X	16. Management should establish and operate monitoring activities to monitor the internal control system and evaluate the results.
		X	17. Management should remediate identified internal control deficiencies on a timely basis.

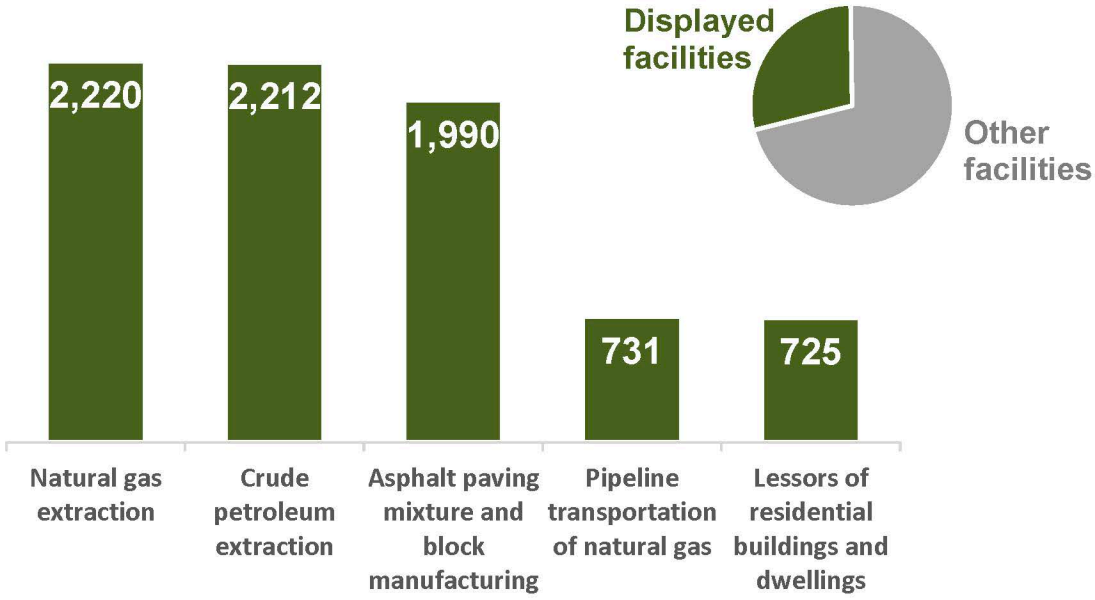
Source: Based on internal control components and principles outlined in GAO-14-704G, *Standards for Internal Control in the Federal Government* (also known as the "Green Book"), issued September 10, 2014.

Details on Scope and Methodology

To address our objective, we reviewed EPA policies and guidance related to synthetic-minor-source permitting and compliance monitoring. We also interviewed staff and managers in the OAQPS and the Office of Enforcement and Compliance Assurance.

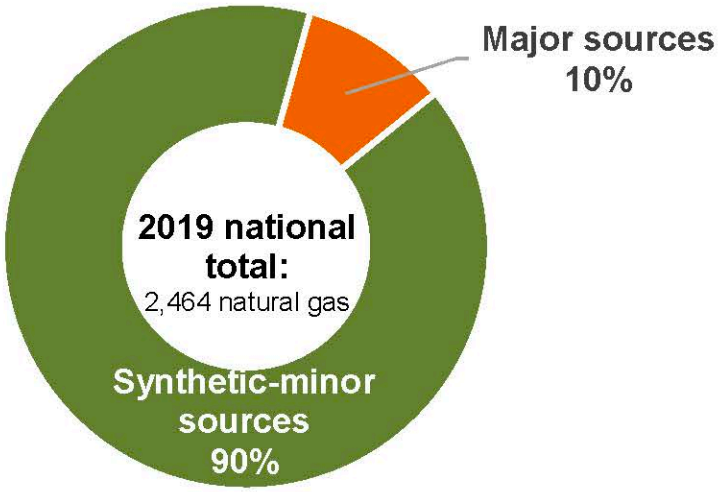
We reviewed synthetic-minor facilities in the natural gas extraction sector to assess whether synthetic-minor-source permit limitations and provisions adhered to EPA guidance and whether the facilities' inspections were consistent with EPA guidance. The natural gas extraction sector is covered by the North American Industry Classification System Code 211130 and involves activities related to the production of natural gas. To select this industry, we used data from the EPA's ICIS-Air database and the National Emissions Inventory. This selection was based on the natural gas extraction sector's disproportionally high (1) cumulative emissions from synthetic-minor sources, (2) number of synthetic-minor facilities within the industry, and (3) prevalence of synthetic minor emissions in areas with relatively poor air quality. Anecdotal statements from permitting and compliance subject matter experts also supported the selection of this industry. Background information on the natural gas extraction industry is included in Appendix D. Figures C-1 and C-2 provide more information about the selection of the natural gas extraction sector for review.

Figure C-1: Top five industries with the most permitted synthetic-minor sources in 2019



Source: OIG analysis of data from ICIS-Air and the EPA's Enforcement and Compliance History Online database. (EPA OIG image)

Figure C-2: Percentage of synthetic-minor sources compared to major sources in natural gas extraction industry[a]

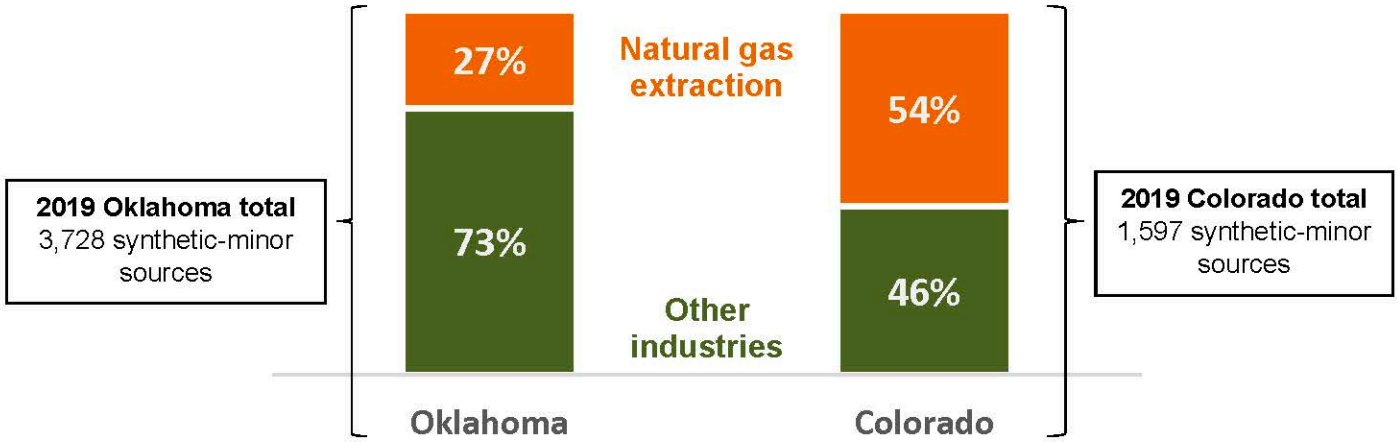


Source: OIG analysis of data from ICIS-Air and the EPA's Enforcement and Compliance History Online database. (EPA OIG image)

[a] Analysis does not include true-minor sources because those data are not required to be submitted to the EPA.

We selected a judgmental sample of two states from which to review natural gas extraction permits. Specifically, we selected to review permits in Colorado and Oklahoma because these states have among the highest number of synthetic-minor facilities in the natural gas extraction industry, according to the 2017 National Emissions Inventory. These states also contain among the most synthetic-minor facilities with actual emissions that potentially exceed major-source thresholds, according to the 2017 National Emissions Inventory. According to ICIS-Air and the EPA's Enforcement and Compliance History Online database, Colorado had 859 facilities identified as synthetic-minor sources in the natural gas extraction industry in 2019, and Oklahoma had 999. Figure C-3 shows the percentage of synthetic-minor sources in Oklahoma and Colorado that are in the natural gas extraction industry compared to other industries.

Figure C-3: Percentage of Oklahoma and Colorado synthetic-minor sources in natural gas extraction industry compared to other industries



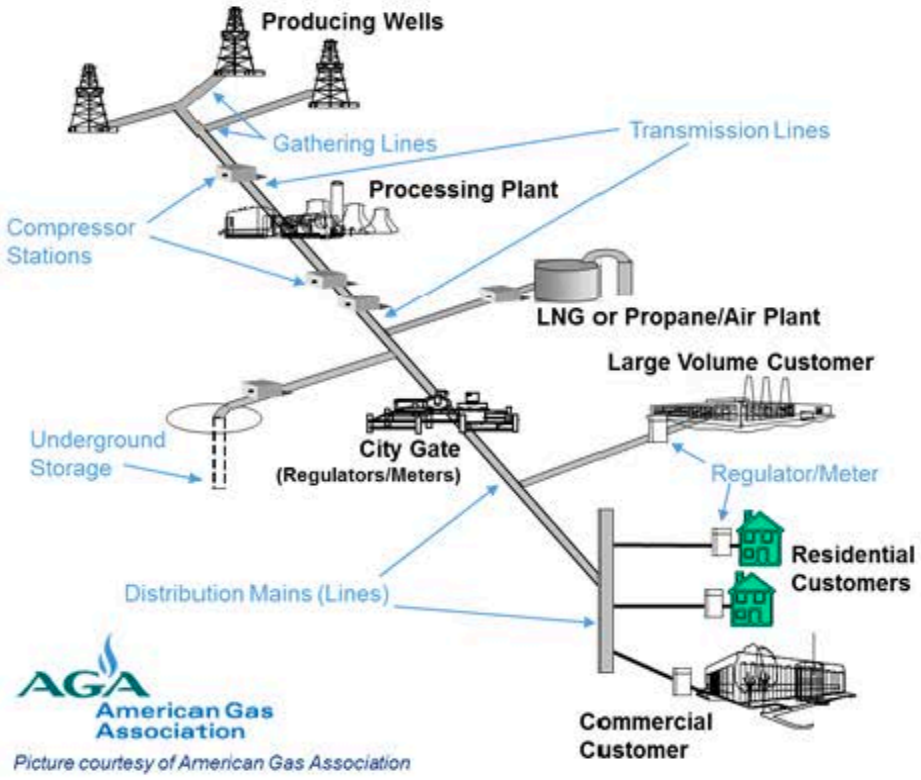
Source: OIG analysis of data from ICIS-Air and the EPA's Enforcement and Compliance History Online database. Data are based on state-submitted information. (EPA OIG image)

In each of these states, we randomly selected eight natural gas extraction facilities that are characterized as SM-80s in ICIS-Air for in-depth review. In Colorado, we selected facilities operating in the Denver and Northern Front Range—located north of Denver and east of the Rocky Mountains—metropolitan areas where the air does not meet EPA air quality standards for ozone. Natural gas extraction facilities contribute to ground-level ozone formation by emitting VOC and nitrogen oxides, which react in sunlight to form ozone. Breathing elevated concentrations of ozone can trigger a variety of health problems, including chest pain, coughing, throat irritation, and airway inflammation. It also can reduce lung function and harm lung tissue. Ozone can worsen bronchitis, emphysema, and asthma, leading to the need for increased medical care. Oklahoma does not have any areas where the air does not meet the EPA's standards for ozone.

Background on Natural Gas Extraction Industry

The natural gas extraction industry includes the production of natural gas. This includes well-production sites, where natural gas is extracted from the ground. It also includes compressor stations, which help maintain the pressure of the gas and move the gas from the individual well-production sites to natural gas processing plants and ultimately the end user. The facilities we reviewed include both well-production sites and compressor stations. Figure D-1 shows where well-production sites and compressor stations are located within the overall natural gas lifecycle—from extraction to distribution to the end user.

Figure D-1: Natural gas industry from production to distribution



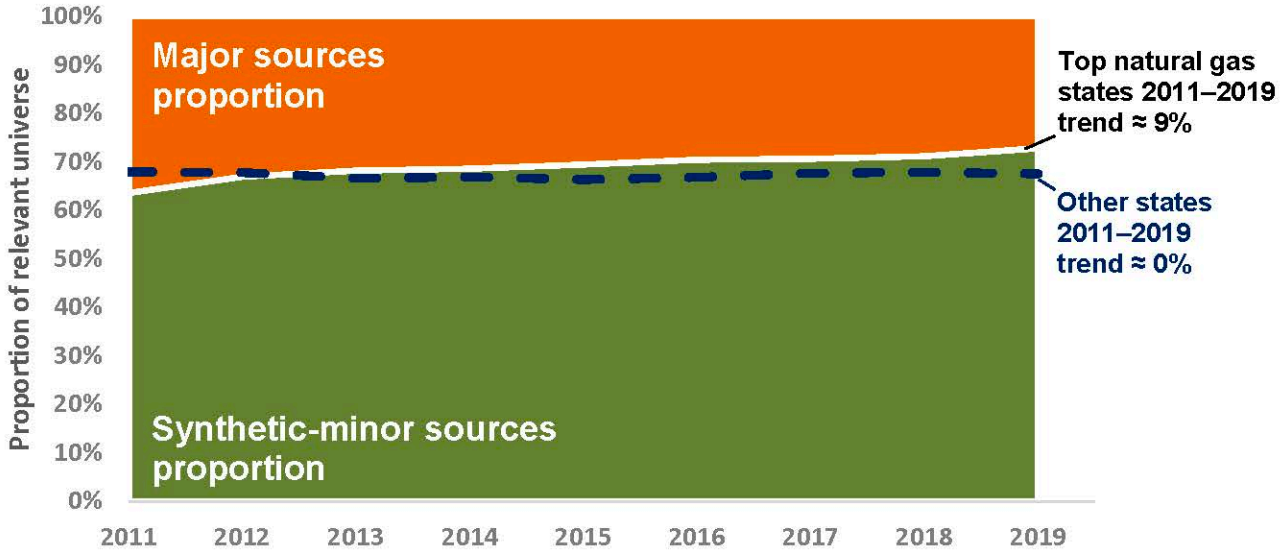
Source: American Gas Association. (American Gas Association image)

Natural gas production facilities emit several types of pollutants, including VOC, nitrogen oxides, carbon monoxide, and hazardous air pollutants. VOC and nitrogen oxides interact in sunlight to form ground-level ozone. Breathing elevated concentrations of ozone can trigger a variety of health problems, including chest pain, coughing, throat irritation, and airway inflammation. It also can reduce lung function and harm lung tissue. Ozone can worsen bronchitis, emphysema, and asthma, leading to a need for increased medical care. Hazardous air pollutants are toxic pollutants known or suspected to cause cancer or other serious health problems.

Colorado and Oklahoma are both among the ten states with the highest amount of natural gas extraction and production. In 2019, Colorado produced 1,988,714 cubic feet of natural gas, while Oklahoma produced 3,175,008 cubic feet.

Based on EPA data, the proportion of synthetic-minor sources compared to major sources in top natural gas producing states was 9 percent higher in 2019 than in 2011, while it remained relatively constant in states that are not top producers of natural gas. This is shown in Figure D-2. This shift could be an indication that more facilities in the natural gas production industry are choosing to implement synthetic-minor limits to avoid major-source permitting requirements than in other industrial sectors.

Figure D-2: Proportion of synthetic-minors and major-sources in top natural gas producing states versus all other states between 2011 and 2019[a]



Source: OIG analysis of data from ICIS-Air and the U.S. Energy Information Agency. (EPA OIG image)

[a] The top ten natural gas producing states, based on our analysis of data from the U.S. Energy Information Administration, include Alaska, Arkansas, Colorado, Louisiana, New Mexico, Ohio, Oklahoma, Pennsylvania, West Virginia, and Wyoming. The analysis does not cover states or U.S. territories that have no synthetic-minor sources identified in ICIS-Air. Although Texas is a top natural gas producing state, it was not included in the analysis for this reason.

PET-878
REC 2597

Case Study: Synthetic-Minor-Source Permitting in Wood Biomass Industry

As detailed in its 2018 report, *Dirty Deception: How the Wood Biomass Industry Skirts the Clean Air Act*, the nonprofit organization Environmental Integrity Project examined air permits and emission information in federal and state records for 21 wood pellet plants in the United States. Wood pellet facilities convert trees into pellets to be burned for electricity. The Environmental Integrity Project found that seven out of 21 facilities violated their permit limits by releasing too much pollution, while another four plants had state-issued permits that failed to require necessary pollution-control equipment. The report explains that most wood pellet facilities are permitted as synthetic-minor sources under the EPA's Prevention of Significant Deterioration permitting program, but they only have a blanket emission limit in their permits, such as "the facility shall emit less than 249 TPY of VOCs," rather than an actual production limit that is directly associated with emissions. An EPA guidance document from 1989 cites a 1988 court decision, *United States vs. Louisiana-Pacific Corporation,* which found that blanket limits are not enforceable as a practical matter. The Environmental Integrity Project concluded that many large wood pellet plants were in fact exceeding their 249 TPY limits because many units emitted much more VOC than states and the industry anticipated.



Source: Biomass manufacturing in the United States as of August 2020, including facilities operating (green), under construction or planned (yellow), and temporarily not in operation (red). (U.S. Energy Information Administration image)

OAQPS and EPA regional staff confirmed to us that there are potential problems with permitting wood biomass sources and that the industry is under increased scrutiny on a national level. OAQPS staff explained that the wood pellet industry is an emerging industry, so the emissions and emissions sources are not well understood. For example, a Region 6 branch chief explained that an issue with these facilities has been the use of unproven emission factors to characterize emissions from pellet coolers. The branch chief said that Louisiana's Department of Environmental Quality reprocessed two permits after further testing and is requiring the facilities to obtain major-source permits. One OAQPS staff person suggested that states could make synthetic-minor permits, including those for wood pellet facilities, more enforceable by requiring source-specific stack testing to confirm expected emissions. In order for a reviewer to know whether the permitted emission limit is enforceable, the staff person said, the permit must include a way to measure emissions.



Wood pellets. (U.S. General Services Administration photo)

Agency Response to Draft Report



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

May 28, 2021

OFFICE OF
AIR AND RADIATION

MEMORANDUM

SUBJECT: EPA Response to OIG Draft Report titled: "EPA Should Conduct More Oversight of Synthetic-Minor-Source Permitting to Assure Permits Adhere to EPA Guidance" - Project No. OA&E-FY19-0093, April 29, 2021

FROM: Joseph Goffman
Acting Assistant Administrator
Office of Air and Radiation

TO: Renee McGhee-Lenart
Acting Air Director
Office of the Inspector General

The Office of Air and Radiation (OAR) welcomes the opportunity to provide comment on the draft report titled: "*EPA Should Conduct More Oversight of Synthetic-Minor-Source Permitting to Assure Permits Adhere to EPA Guidance*" and its recommendations. Based on our review, we find the draft report to be factually accurate overall. Our responses to the draft report recommendations are provided below.

OIG Recommendation 1: Update Agency guidance on practical enforceability to more clearlydescribe how the technical accuracy of a permit limit should be supported and documented. In updating such guidance, the Office of Air and Radiation should consult and collaborate with theOffice of Enforcement and Compliance Assurance, the Office of General Counsel, and the EPA regions.

Response 1: OAR concurs with this recommendation. OAR will update Agency guidance on the practical enforceability of limitations, including but not limited to EPA's June 13, 1989 *Guidance on Limiting Potential to Emit in New Source Permitting*, to describe how the technicalaccuracy of a permit limit should be supported and documented. Specifically, the updated guidance will address the practical enforceability of limitations on potential to emit. In updating our guidance, we will consult and collaborate with the Office of Enforcement and Compliance Assurance, the Office of General Counsel, and the EPA regions.

PET-880
REC 2599

Planned Completion Date: October 2023

OIG Recommendation 2: In consultation with the EPA regions, develop and implement an oversight plan to include:

- An initial review of a sample of synthetic-minor-source permits in different industries that are issued by state, local, and tribal agencies to assess whether the permits adhere toEPA guidance on practical enforceability, including limits that are technically accurate; have appropriate time periods; and include sufficient monitoring, recordkeeping, and reporting requirements.
- A periodic review of a sample of synthetic-minor-source permits to occur, at a minimum,once every five years.
- Procedures to resolve any permitting deficiencies identified during the initial and periodicreviews.

Response 2: OAR concurs with this recommendation. In consultation with EPA Regional offices, OAR will develop and implement an oversight plan in accordance with current statutoryand EPA regulatory requirements and, as appropriate, including the specific elements identified.

Planned Completion Dates:

1. Develop plan: April 2024
2. Complete initial review: October 2024

OIG Recommendation 3: Develop technical support information for natural gas production facilities that includes defining the parameters upon which the control efficiency for enclosedcombustion devices is based and methods for measuring those specific parameters so that permitting authorities can verify compliance with permit limits.

Response 3: We agree with the OIG that monitoring, recordkeeping and reporting requirements(MRR) associated with synthetic minor permit emission limitations serve to ensure that the established enforceable limits are being met and are important to meet the ongoing compliance requirement in the CAA. We also agree with the OIG that facilities under synthetic minor statusshould generate records to demonstrate continuous compliance with permit emission limits.

However, the OIG's recommendation implies that the impediment to verifying compliance with emission limits associated with the oil and gas industry is inadequate technical information regarding MRR permit conditions for pollution control equipment for use by permitting authorities. We disagree that permit authorities do not have the technical tools to effectively establish appropriate MRR in synthetic minor permits. As described below, the technical supportinformation in existing air rules fully addresses the need identified by the OIG.

Federal regulations covering air emissions from oil and gas facilities (40 CFR part 60 subparts OOOO and OOOOa (NSPS OOOO and OOOOa) and 40 CFR part 63 subpart HH (NESHAP HH)) contain provisions requiring control of VOC and HAP at these facilities.

PET-881
REC 2600

Combustion, including enclosed combustors for the natural gas production segment, is a common control option to meet these provisions. As we discussed with the OIG during interviews and reiterated in our written response to the initial draft report, the properties related to effective combustion are well-understood and depend on gas composition, gas flow, residence time in the combustionzone, and the continuous presence of a pilot light to ensure ignition. These parameters are not unique to the natural gas production sector and are standard across multiple rules in a number ofindustries. To ensure proper use and efficacy of combustion control devices by oil and gas facilities, each subpart covering the industry contains targeted MRR requirements. For example,to ensure high combustion efficiency, NSPS OOOOa requires initial testing of enclosed combustion devices by the owner or operator or a certification test by the manufacturer; periodically, the combustor must be retested by the owner, or the owner may continuously monitor the gas flow to the unit. Additionally, owners and operators must continuously monitorfor the presence of a pilot flame and ensure residence time in the combustion zone through design analysis. On a monthly basis, the operator must perform a visible emissions test with Method 22 of appendix A-7 to part 60 to detect smoke, which would indicate less than 95 percent control efficiency.

Continuous Monitoring Systems (CMS), consisting of both continuous emissions monitoring systems and continuous parameter monitoring systems, create continuous electronic data recordsthat can be used to verify continuous compliance. These systems rely on site infrastructure such as shelters, electricity on site, and data acquisition systems. In the oil and gas industry, not all production sites are electrified for support equipment. Well pads and related sites are often powered by the gas itself, through pneumatic pumps and pneumatic controllers. This lack of electrification of all sites limits the blanket use of CMS for continuous compliance.

Looking ahead, OAR is open to revising the existing MRR requirements and adding others if future data demonstrate a need for further action. EPA is currently reviewing NSPS OOOOa under Executive Order 13990. The scope of the action and the timeline for compliance with this EO foreclose EPA's ability to consider additional monitoring provisions in this NSPS to address enclosed combustor compliance assurance issues beyond existing MRR requirements. However, as more data and information become available, and the required technology reviews for both NSPS OOOOa and NESHAP HH approach, EPA may receive data and information that can be analyzed to determine whether additional or different monitoring requirements for these devices are necessary, practicable, and cost effective. In the meantime, by maintaining enforcement of existing MRR requirements and addressing other recommendations stated in the draft report, EPA will be assisting permitting authorities to establish permit parameters that meet the practicalenforceability requirements for synthetic permit limitations.

OIG Recommendation 4: Revise the Agency's guidance to communicate its key expectationsfor synthetic-minor-source permitting to state and local agencies.

Response 4: OAR concurs with this recommendation. OAR will revise the Agency's guidance tocommunicate its key expectations for synthetic-minor-source permitting to state and local agencies. This will include an expectation that synthetic minor permit terms and conditions

ensure that the potential to emit of the source is less than the applicable major source threshold by meeting legal and practical enforceability criteria. Our work related to this recommendation may, at least in part, be integrated with the updated guidance on practical enforceability in response to OIG Recommendation 1.

Planned Completion Date: October 2024

OIG Recommendation 5: Identify all state, local and tribal agencies in which state Clean Air Act permit program implementation fails to adhere to the public participation requirements for synthetic-minor-source permit issuance and take appropriate steps to assure the identified states adhere to the public participation requirements.

Response 5: OAR concurs with this recommendation. With EPA Regional office support, OAR will identify state, local and tribal agencies whose program regulations, including but not limited to minor new source review and federally enforceable state operating permit program regulations and corresponding practices, do not meet the public participation requirements contained in the applicable EPA regulations, e.g., 40 CFR 51.161, and guidance with respect to synthetic minor source permitting. For the identified agencies, OAR will take appropriate corrective steps, which may include constructive, informal engagement.

Planned Completion Dates:
1. Identify target agencies and program regulations with public participation requirement deficiencies: July 2022
2. Take appropriate steps to resolve identified deficiencies: December 2023

If you have any questions regarding this response, please contact JoLynn Collins, OAQPS Audit Coordinator, at (919) 541-5671.

cc: James Hatfield
Betsy Shaw
Peter Tsirigotis
Mike Koerber
Grant Peacock
Scott Mathias
Penny Lassiter
Raj Rao
Cheryl Vetter
Peter Keller
Jodi Howard
Elineth Torres
Matt Witosky
Gerri Garwood
JoLynn Collins

Agency Response to Revised Recommendation 3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

June 21, 2021

OFFICE OF
AIR AND RADIATION

MEMORANDUM

SUBJECT: EPA Revised Response to OIG Draft Report titled: "EPA Should Conduct More Oversight of Synthetic-Minor-Source Permitting to Assure Permits Adhere to EPA Guidance" - Project No. OA&E-FY19-0093, April 29, 2021

FROM: Joseph Goffman
Acting Assistant Administrator

TO: Renee McGhee-Lenart
Acting Air Director
Office of the Inspector General

The Office of Air and Radiation (OAR) welcomes the opportunity to provide comment on the revised recommendation 3 found in the draft report titled: "*EPA Should Conduct More Oversight of Synthetic-Minor-Source Permitting to Assure Permits Adhere to EPA Guidance*". Based on our review, we find the revisions to the draft report to be factually accurate overall. Our response to the revised recommendation 3 is provided below.

OIG Revised Recommendation 3: Assess recent EPA studies of enclosed combustion device performance and compliance monitoring and other relevant information during the next statutorily-required review of 40 C.F.R part 60 subparts OOOO and OOOOa to determine whether revisions are needed to monitoring, record-keeping and reporting requirements for enclosed combustion devices to assure continuous compliance with associated limits, and revise the regulatory requirements as appropriate.

OAR Revised Response: OAR concurs with this revised recommendation. OAR will assess EPA studies of enclosed combustion device performance and compliance monitoring and other relevant information during the next statutorily-required review of 40 C.F.R part 60 subparts OOOO and OOOOa and determine whether revisions are needed to monitoring, record-keeping and reporting requirements for enclosed combustion devices to assure continuous compliance with associated limits, and revise the regulatory requirements as appropriate.

Planned Completion Date: EPA intends to initiate review of subparts OOOO and OOOOa, in accordance with our statutory obligations under CAA section 111(b)(1)(B), by no later than 2024.

Distribution

The Administrator
Deputy Administrator
Chief of Staff, Office of the Administrator
Deputy Chief of Staff, Office of the Administrator
Assistant Administrator for Air and Radiation
Assistant Administrator for Enforcement and Compliance Assurance
Regional Administrators, Regions 1–10
Agency Follow-Up Official (the CFO)
Agency Follow-Up Coordinator
General Counsel
Associate Administrator for Congressional and Intergovernmental Relations
Associate Administrator for Public Affairs
Principal Deputy Assistant Administrator for Air and Radiation
Principal Deputy Assistant Administrator for Enforcement and Compliance Assurance
Deputy Assistant Administrator for Stationary Sources, Office of Air and Radiation
Deputy Assistant Administrator for Mobile Sources, Office of Air and Radiation
Deputy Assistant Administrator for Air and Radiation
Deputy Regional Administrators, Regions 1–10
Director, Office of Air Quality Planning and Standards, Office of Air and Radiation
Director, Office of Compliance, Office of Enforcement and Compliance Assurance
Director, Office of Regional Operations
Director, Office of Continuous Improvement, Office of the Chief Financial Officer
Audit Follow-Up Coordinator, Office of the Administrator
Audit Follow-Up Coordinators, Office of Air and Radiation
Audit Follow-Up Coordinator, Office of Enforcement and Compliance Assurance
Audit Liaison, Office of Air Quality Planning and Standards, Office of Air and Radiation
Audit Follow-Up Coordinator, Office of General Counsel
Audit Follow-Up Coordinators, Regions 1–10

Stibnite Gold Project

Air Quality Specialist Report

Prepared by:
USDA Forest Service
Payette National Forest

for:
Payette and Boise National Forests

August 2022

We make every effort to create documents that are accessible to individuals of all abilities; however, limitations with our word processing programs may prevent some parts of this document from being readable by computer-assisted reading devices. If you need assistance with any part of this document, please contact the Payette National Forest at (208) 634-0700.

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at http://www.ascr.usda.gov/complaint_filing_cust.html and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by: (1) mail: U.S. Department of Agriculture, Office of the Assistant Secretary for Civil Rights, 1400 Independence Avenue, SW, Washington, D.C. 20250-9410; (2) fax: (202) 690-7442; or (3) email: program.intake@usda.gov.

USDA is an equal opportunity provider, employer, and lender.

Table of Contents

1.0 Introduction 1
2.0 Alternatives, Including the Proposed Action 6
2.1 No Action Alternative 6
2.2 2021 MMP 6
2.3 Johnson Creek Route Alternative 8
2.4 Applicable Environmental Design Features 11
3.0 Relevant Laws, Regulations, and Policy 13
3.1 Land and Resource Management Plan 14
3.2 Federal Laws, Regulations, and Policy 14
3.2.1 National Ambient Air Quality Standards 14
3.2.2 Federal Air Permitting 16
3.2.3 Federal New Source Performance Standards 17
3.2.4 National Emission Standards for Hazardous Air Pollutants 17
3.2.5 Wilderness Act 18
3.2.6 Greenhouse Gas Reporting Rule 18
3.2.7 Mobile Source Federal Regulations 19
3.3 State and Local Policy 19
3.3.1 Idaho Minor Source Air Permitting 19
3.3.2 Idaho Visibility Protection Requirements and Regional Haze Rule 19
3.3.3 Idaho Toxic Air Pollutant Program 20
4.0 Issues and Resource Indicators 20
4.1 Significant Issues 20
4.2 Resource Issues and Indicators 21
5.0 Methodology 21
5.1 Analysis Area 22
5.1.1 Direct/Indirect Effects Boundaries 22
5.1.2 Cumulative Effects Boundaries 23
5.2 Analysis Area Methodology 23
5.3 Air Emissions Inventory Methodology 23
5.3.1 Criteria Pollutant Inventory Methods 24
5.3.2 Non-Criteria and HAP Inventory Methods 25
5.3.3 Comparison of 2021 MMP and NSR Inventories 26
5.4 Near Field Air Quality Analyses 27
5.4.1 Ambient Air Quality Refined Modeling 28
5.4.2 Ozone and Secondary $PM_{2.5}$ Analyses 31
5.4.3 Plume Visibility Screening Analysis 32
5.4.4 Mercury Deposition Analysis 33
5.4.5 Nitrogen and Sulfur Deposition Screening Analysis 33
5.5 Far-Field Air Quality Analyses 34
5.5.1 Modeling Methodology for Far-Field Analyses 35
5.5.2 Far-Field Regional Haze Assessment Procedures 36
5.5.3 Far-Field Comparisons with Class I and Class II Increments 36
5.5.4 Far-Field Deposition Assessments 36
6.0 Affected Environment 37
6.1 Existing Conditions 37
6.1.1 Criteria Air Pollutants 37
6.1.2 Hazardous Air Pollutants 38
6.1.3 Ozone 38

PET-0887

REC 2607

6.1.4 Air Quality Related Values 39
6.1.5 Climate and Meteorology 55
7.0 Environmental Consequences 60
7.1 Impact Definitions 60
7.2 Direct and Indirect Effects 61
7.2.1 No Action Alternative 61
7.2.2 2021 MMP 61
7.2.3 Johnson Creek Route Alternative 86
7.3 Mitigation and Monitoring 87
7.4 Cumulative Effects 89
7.4.1 Past, Present, and Reasonably Foreseeable Activities Relevant to Cumulative Effects Analysis 89
7.4.2 No Action Alternative 89
7.4.3 2021 MMP 90
7.4.4 Johnson Creek Route Alternative 92
7.5 Short-term Uses and Long-term Productivity 93
7.5.1 No Action Alternative 93
7.5.2 2021 MMP 93
7.5.3 Johnson Creek Route Alternative 93
7.6 Irreversible and Irretrievable Commitments of Resources 93
7.6.1 No Action Alternative 93
7.6.2 2021 MMP 93
7.6.3 Johnson Creek Route Alternative 94
7.7 Summary 94
7.7.1 Extent of Pollutant Concentrations and Deposition 94
7.7.2 Type and Volume of Air Pollutants Emitted 94
7.7.3 Criteria Air Pollutant Ambient Concentrations Outside the Operations Area Boundary 94
7.7.4 Comparison of Modeled Concentrations to Class I and Class II Increments 95
7.7.5 HAP Emissions and Hg Deposition 95
7.7.6 Deposition Impacts for Nitrogen and Sulfur Compounds at Class I areas and Specified Class II Wilderness Areas 95
7.7.7 Near-field Plume Blight and Far-Field Regional Haze Impacts 95
8.0 References 98

List of Tables

Table 2-1 Action Alternatives Summary 8
Table 2-2 Prominent Regulatory and Forest Plan Requirements for Air Quality 12
Table 2-3 Proponent Proposed Environmental Design Features for Air Quality 13
Table 3-1 National Ambient Air Quality Standards 15
Table 5-1 Comparison of 2021 MMP and PTC NSR Inventories 27
Table 5-2 Background Pollutant Concentrations for IDEQ PTC Air Quality Analysis 29
Table 5-3 Class I Areas in the Far-Field Analysis Area 34
Table 6-1 Ambient Air Data – Perpetua and NW Airquest Consortium Background Values 37
Table 6-2 Annual Ozone Concentrations for Comparison to 8-Hour NAAQS Criteria Values – Craters of the Moon National Monument, 2012-2020 38
Table 6-3 Visibility Impairment and Deposition-Related Monitoring Sites 42

Table 6-4	Historic Visibility Impairment Parameters – Four Class I Area IMPROVE Sites	43
Table 6-5	NTN Speciated Wet Deposition, Annual Average – Craters of the Moon National Monument (Site ID03)	47
Table 6-6	NTN Speciated Wet Deposition, Annual Average – Reynolds Creek (Site ID11)	49
Table 6-7	NTN Speciated Wet Deposition, Annual Average – Lost Trail Pass (Site MT97)	51
Table 6-8	CASTNET Dry Deposition Rates, Annual Average – Two Idaho Sites	53
Table 6-9	Historical Annual Average Concentration and Mercury Deposition Rates – Three Idaho MDN Sites	55
Table 6-10	Annual Average Mercury Concentration – Salt Lake City AMNet Site	55
Table 6-11	Average Temperature Data from McCall National Weather Service Site	56
Table 6-12	Average Precipitation Data from Big Creek Summit SNOTEL Site	57
Table 7-1	Impact Definitions	60
Table 7-2	Maximum Controlled Criteria Pollutant Emissions Summary by LOM Year	66
Table 7-3	Maximum Annual Criteria Pollutant Emissions Summary – LOM 6	67
Table 7-4	Maximum Annual HAP and Air Toxics Emissions Summary	68
Table 7-5	LOM Years for Pollutant-Specific Maximum Annual Emissions	69
Table 7-6	Near-Field NAAQS Compliance Demonstration	70
Table 7-7	Near-Field NAAQS Maximum Geographic Locations	70
Table 7-8	Near-Field Class II PSD Increment Comparison	71
Table 7-9	Highest HAP Annual Emissions LOM Year 10	73
Table 7-10	Idaho AAC/AACC for HAPs	74
Table 7-11	Acute AAC Comparison	75
Table 7-12	Chronic AACC Comparison	75
Table 7-13	Maximum 8-hour Ozone Impact	76
Table 7-14	Primary and Secondary $PM_{2.5}$ Impact	77
Table 7-15	Frequency of Modeled Visible Plumes – Screening Results for FCRNRW: Percent of Time when Perceptibility Threshold is Exceeded	78
Table 7-16	Magnitude of Modeled Visible Plumes – Screening Results for FCRNRW: Ratio of Maximum Impact when Perceptibility Threshold is Exceeded	78
Table 7-17	SGP Contribution Above Estimated Hg Background	79
Table 7-18	Summary of Predicted Near-Field Nitrogen and Sulfur Deposition Rates	80
Table 7-19	SGP Public Access Route Receptor Results and NAAQS Compliance Demonstration	80
Table 7-20	50-km Ring AERMOD Results for 2018 Modeling and 2021 MMP	81
Table 7-21	Far-Field Impacts Summary	82
Table 7-22	Class I and Class II Area SIL	82
Table 7-23	Predicted Regional Haze Contributions in Class I Areas Due to SGP Sources	83
Table 7-24	Predicted Regional Haze Contributions in Class II Area Due to SGP Sources	84
Table 7-25	Summary of Predicted Nitrogen Deposition Rates in Class I Areas Due to SGP Sources	84
Table 7-26	Summary of Predicted Sulfur Deposition Rates in Class I Areas Due to SGP Sources	85
Table 7-27	Summary of Predicted Nitrogen Deposition Rates in Class II Wilderness Areas and Nez Perce Requested Analysis Area	85

PET-0889

REC 2609

Table 7-28 Summary of Predicted Sulfur Deposition Rates in Class II Wilderness Areas and Nez Perce Requested Analysis Area 86
Table 7-29 Reasonably Foreseeable Activities Considered Regarding Cumulative Air Quality Effects for Specific Planning Projects....91
Table 7-30 Reasonably Foreseeable Activities Considered Regarding Cumulative Air Quality Effects for Ongoing Projects and Foreseeable Emissions Sources 91
Table 7-31 Comparison of Air Quality Impacts by Alternative 96

List of Figures

Figure 1-1 SGP Location and Class I Areas, Wilderness Areas and Tribal Lands....3
Figure 1-2 SGP Operations Areas Boundary and Class II Modeling Receptor Grid Based on 2021 MMP....4
Figure 1-3 Far-field Modeling Domain and Class I and Class II Areas....5
Figure 2-1 SGP Layout 7
Figure 6-1 Visibility Impairment and Deposition-Related Monitoring Sites....40
Figure 6-2 Trends in Wet Deposition Rates – Craters of the Moon National Monument, 2006-2020 48
Figure 6-3 Trends in Wet Deposition Rates – Reynolds Creek, 2006-2020....50
Figure 6-4 Trends in Wet Deposition Rates – Lost Trail Pass, 2006-2020 52
Figure 6-5 Trends in Dry Nitrogen and Sulfur Deposition Rates, 2006-2016 54
Figure 6-6 Temperature Range Data for McCall, Idaho, and Monthly Precipitation for Big Creek Summit SNOTEL Site....57
Figure 6-7 Wind Distribution – Stibnite SGP, 2014 59
Figure 7-1 Timeline of Maximum Annual Emissions by Life-of-Mine Year....65

List of Appendices

Appendix A ModPRO2 Emissions Inventory and Modeling Parameters

Appendix B Permit to Construct Application Emissions Inventory

Appendix C Review and Rationale for Selected Air Emission Factors

Appendix D Transportation Management Plan

Acronyms

°C	degrees Celsius
°F	degrees Fahrenheit
µg/m2-yr	micrograms per square meter per year
µg/m3	micrograms per cubic meter
ΔE	color contrast
AAC	acceptable ambient non-carcinogenic concentration
AACC	acceptable ambient carcinogenic concentration
AADT	Annual average daily trip
AERMAP	American Meteorological Society/Environmental Protection Agency Regulatory Model Pre-processor
AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
AMNet	Atmospheric Mercury Network
ASAOC	Administrative Settlement Agreement and Order on Consent
AQRV	Air Quality Related Value
Avg.	average
BULKRN	Bulk Richardson Number
C	contrast
Ca	calcium
CAA	Clean Air Act
CASTNET	Clean Air Status and Trends Network
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
Cl	chloride
CO	carbon monoxide
CR	County Road
CRMO	Craters of the Moon National Monument
DAT	Deposition Analysis Threshold
dm	decimeter

PET-0891

REC 2611

EIS	Environmental Impact Statement
East Fork SFSR	East Fork South Fork Salmon River
EO	Executive Order
EPA	Environmental Protection Agency
Forest Service	United States Forest Service
FCRNRW	Frank Church River of No Return Wilderness
FLAG	Federal Land Managers' Air Quality Related Value Work Group
FR	Forest Road
FSH	Forest Service NEPA Handbook
g/km2-yr	grams per square km per year
GEM	Gaseous Elemental Mercury
GHG	Greenhouse gas
GOM	Gaseous Oxidated Mercury
GOSPEL	Gospel-Hump
H+	free acidity
H_2SO_4	sulfuric acid mist
HAP	Hazardous Air Pollutants
HCN	hydrogen cyanide
HECA	Hells Canyon Wilderness
HEMBLD	Hemingway-Boulders
Hg	mercury
Hg^{2+}	gaseous Hg
HgO	gaseous elemental Hg
HgP	particulate-borne
HMC	highest modeled concentration
IDAPA	Idaho Administration Procedures Act
IDEQ	Idaho Department of Environmental Quality
IMPROVE	Interagency Monitoring of Protected Visual Environments
in.	inch
IPCo	Idaho Power Company

PET-0892

REC 2612

IRA	Inventoried Roadless Area
K	potassium
kg/ha-yr	kilograms per hectare per year
km	kilometer
kV	kilovolt
LOM	Life of Mine
m	meter
m^3	cubic meter
MDN	Mercury Deposition Network
MERP	Modeled Emission Rates for Precursors
Mg	magnesium
MMIF	Mesoscale Model Interface
MMIFStat	MMIF statistics program
MMP	Modified Mine Plan
MOVES	Motor Vehicle Emission Simulator
MT	metric tons
MMBtu	Million British Thermal Units
MMT	million metric ton
MRR	Mandatory Reporting of Greenhouse Gas Rule
MW	megawatt
MWh	megawatt hour
N	nitrogen
N_2O	nitrous oxide
n/a	not applicable
Na	sodium
NAAQS	National Ambient Air Quality Standard
NADP	National Atmospheric Deposition Program
NDEP	Nevada Department of Environmental Protection
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants

PET-0893

REC 2613

NF	National Forest
ng/l	nanograms per liter
NH_4	ammonium
NO_2	nitrogen dioxide
NO_3	nitrate
NO_x	nitrogen oxide
NPS	National Park Service
NRCS	National Resources Conservation Service
NSPS	New Source Performance Standard
NSR	New Source Review
NTN	National Trends Network
NW AIRQUEST	Northwest International Air Quality Environmental Science and Technology Consortium
NWPS	National Wilderness Preservation System
O_3	ozone
OHV	Off-highway Vehicle
OPENPIT	AERMOD Open Pit Source Type
OSV	over-snow vehicle
Pb	lead
PBM2.5	Particle Bound Mercury
PGM	photochemical grid model
Perpetua	Perpetua Resources Idaho Inc.
PM	Particulate matter
$PM_{2.5}$	Particulate matter less than 2.5 microns in diameter
PM_{10}	Particulate matter less than 10 microns in diameter
POM	polycyclic organic matter
POSTUTIL	Calpuff Post Utility Pre-processor
ppb	parts per billion
ppm	part per million
PSD	Prevention of Significant Deterioration

PET-0894

REC 2614

PTC	Permit to Construct
REMSAD	Regional Modeling System for Aerosols and Deposition
S	sulfur
SAWT	Sawtooth Wilderness
SELW	Selway-Bitterroot Wilderness
SGP	Stibnite Gold Project
SILs	Significant Impact Level
SNOTEL	Snow Telemetry
SO_2	sulfur dioxide
SO_4	sulfate
SOB	Statement of Basis
TANKS	United States Environmental Protection Agency TANKs Emission Estimation Software
tpd	tons per day
tpy	tons per year
TSF	Tailings storage facility
TSP	total suspended particulate
U.S.	United States
VISCREEN	visibility impairment screening
VOC	volatile organic compounds
WHTCLD	Cecil D. Andrus - White Cloud
WRCC	Western Regional Climate Center

PET-0895

REC 2615

1.0 Introduction

The United States (U.S.) Department of Agriculture Forest Service (Forest Service) received the Stibnite Gold Project (SGP) Plan of Restoration and Operations, (Midas Gold Idaho, Inc. 2016) for review and approval in accordance with regulations at 36 Code of Federal Regulations (CFR) 228 Subpart A for the proposed SGP in central Idaho. A revised Plan, also known as ModPRO[1], was submitted to the Forest Service in 2019 (Brown and Caldwell 2019). A further modified Plan, also known as ModPRO2[2], was then submitted in October of 2021 (Perpetua 2021a). Midas Gold changed their name to Perpetua Resources Idaho Inc. (Perpetua[3]) in February 2021.

The SGP would consist of mine operations, including an open pit hard rock mine and associated processing facilities, located within Valley County in central Idaho on federal, state, and private lands (**Figure 1-1**). The SGP would produce gold and silver doré, and antimony concentrate, for commercial sale by Perpetua. The SGP would have a life (construction, operation, closure, and reclamation), not including post-reclamation monitoring, of approximately 20 years, with active mining and ore processing occurring over approximately 15 years.

Air quality is the degree to which the ambient air is pollution-free and protective of public health and is assessed by measuring a number of indicators of pollution. Air quality conditions are important from a human health and aesthetic (i.e., visual) perspective, and they also are subject to specific regulations, which are enforced to protect human health. Local and regional air quality may be affected by the SGP.

The affected environment area for the SGP for the air quality analysis is defined by two regions or "fields" for which different assessment tools are applicable. These regions are defined by the requirements of an air quality analysis, and the capabilities of the regulatory models provided for the assessments. The air quality impact analyses presented for the SGP adopt the U.S. Environmental Protection Agency (EPA) recommendations contained in 40 CFR Part 61, Appendix W for the analysis approach as defined for the two fields.

The first region is the "near field," which is defined as a 50-kilometer (km)[4] radius from the proposed SGP, as shown on **Figure 1-1**. Dispersion modeling (i.e., modeling that simulates how air pollutants disperse in the atmosphere) to identify air quality impacts in the near-field region utilize Gaussian plume dispersion models. The near-field analysis focused on comparison of predicted concentrations of air pollutants with federal standards, and screening assessments of air pollutant deposition.

The second region is the much larger "far field," which is defined as a 300-km radius from the SGP that encompasses more distant Class I and Class II areas as described in **Section 3.0**, Relevant Laws, Regulations, Policies, and Plans, and shown on **Figure 1-1**. Mandatory federal Class I areas are national parks and wilderness areas afforded special air quality and visibility protections under the Clean Air Act. To meet the requirements of the far-field analysis for these protected areas, specialized air quality modeling was conducted to support the analysis. The far-field analysis for selected Class I and selected

[1] Associated project documents may reference the Revised Plan as the ModPRO.

[2] Associated project documents may reference the Modified Plan as the ModPRO2.

[3] Documents provided by Perpetua prior to the February 2021 name change will still be cited and referenced as Midas Gold.

[4] Metric units, including kilometers (km), are used predominantly in this section because of permit and modeling standards. 1 km=0.6mi; 1mi=1.6km.

Class II areas assessed the SGP's contribution to regional haze and screened for air pollutant deposition impacts. Dispersion modeling is discussed in **Sections 5.4** and **5.5**.

Modeling within the near-field region included an analysis of potential impacts to "ambient air" as defined for the SGP. The term "ambient air," for modeling purposes, refers to a defined area where the public has access that is subject to the National Ambient Air Quality Standards (NAAQS). The NAAQS are promulgated to protect public health and welfare. Long-standing EPA policy has defined "ambient air" as "that portion of the atmosphere, external to buildings, to which the general public has access," and further that "the exemption from ambient air is available only for the atmosphere over land owned or controlled by the source and to which public access is precluded by a fence or other physical barriers" (EPA 2018c). More recent EPA policy expanded the range of measures that could be implemented to exclude the public from access, such as signage, monitoring of access, security surveillance, and similar effect measures (EPA 2019a). In this case, the SGP public exclusion area is understood to be defined as the limits of the SGP Operations Area Boundary. The Operations Area Boundary establishes the inner boundary of the surrounding "ambient air" that represents the modeling domain for quantifying air quality effects in **Section 7.2**, Direct and Indirect Effects. As part of the air modeling analysis supporting the Stibnite Gold Environmental Impact Statement, and the air permit application to the Idaho Department of Environmental Quality (IDEQ), the Operations Area Boundary was set by the Perpetua air modeling contractor, and subsequently reviewed and approved by the Forest Service and IDEQ (Air Sciences 2018a).

A refined dispersion modeling analysis was conducted within a 10-km radius of the Operations Area Boundary (OAB), as shown on **Figure 1-2**. It was confirmed through preliminary modeling that the 10 km domain size was sufficient to characterize worst-case near-field air quality impacts for the SGP. Air quality effects would decrease at distances beyond the modeled 10 km range. The refined model used a "grid" of defined receptor points at which air pollutant concentrations are predicted by the model calculations. Receptor grids of 25-meter (m)[2], 50-m, 100-m, 500[5]-m, and 1-km spacing beyond the Operations Area Boundary out to the 10-km extent of the modeled domain followed accepted standard U.S. Environmental Protection Agency's (EPA) regulatory modeling protocol. Tighter spaced receptors closer to the OAB allowed the model to map the predicted highest predicted concentrations in more detail.

To develop the far-field air quality analysis area, several agencies were consulted and included: National Park Service (NPS), U.S. Fish and Wildlife Service, EPA, IDEQ, Nez Perce Tribe air quality staff and the Pacific Northwest and Northern regions of the Forest Service. Based upon this group's initial review of the plan, the four Class I areas (as shown in **Figure 1-3**) that far-field modeling results were reported for are: Sawtooth Wilderness [SAWT], Selway-Bitterroot Wilderness (SELW), Hells Canyon Wilderness [HECA]), and Craters of the Moon National Monument (CRMO). Table 1-1 illustrates the distance from the SGP boundary to the various Class I areas. There are additional Class I areas within the 300-km radius; however, these are farther from the proposed SGP and in the same general cardinal directions as the four closer Class I areas. A tiered approach was adopted to initially analyze the closer Class I areas that would likely have greater potential for air quality or visibility impacts. If the impacts predicted at the four closer Class I areas indicated potential for impacts at greater distances, then additional analyses would have been conducted for the more distant Class I areas.

[5] 1 meter (m)=3.3 feet; 1 foot=0.3 meter.

PET-0897

REC 2617

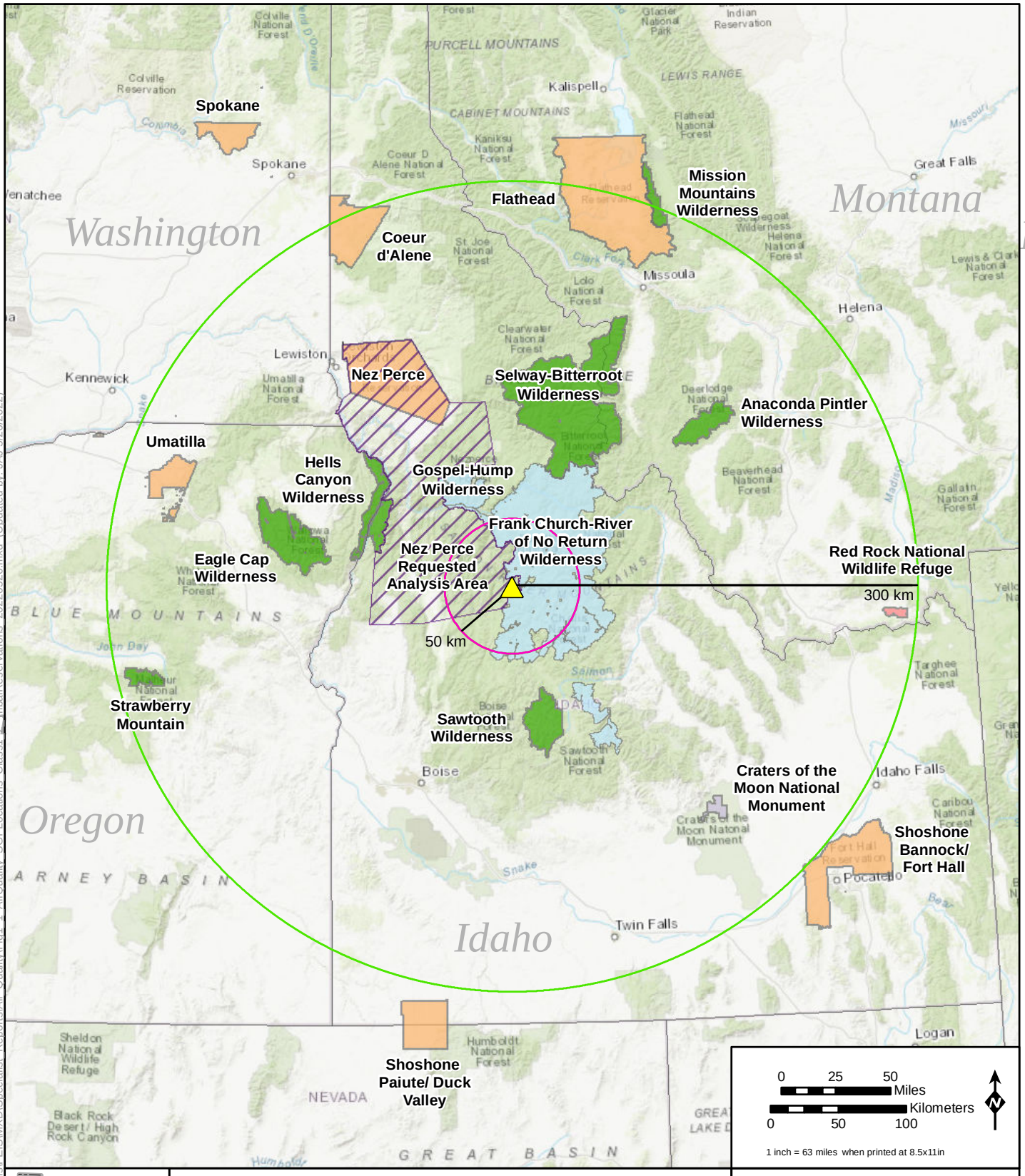
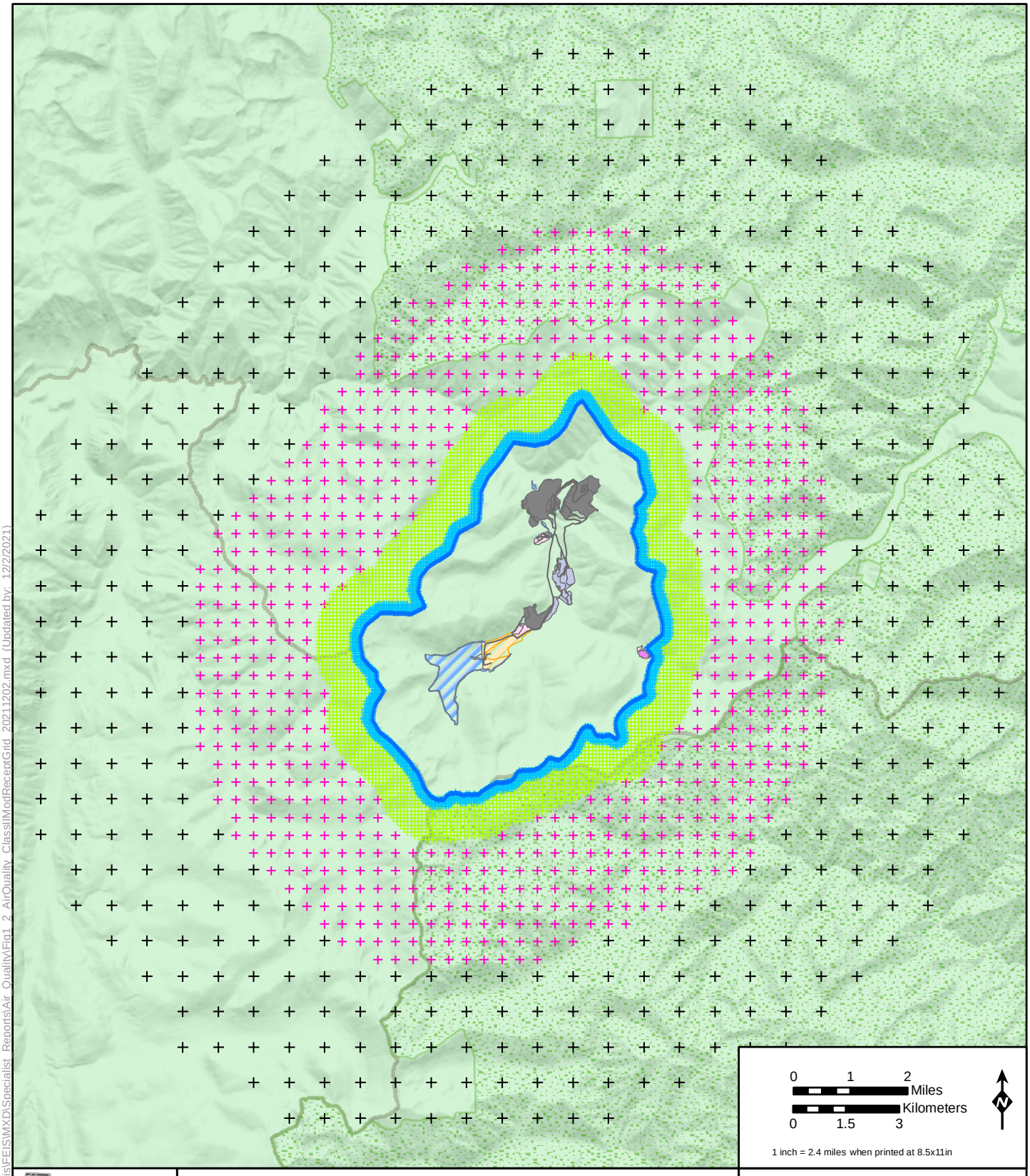
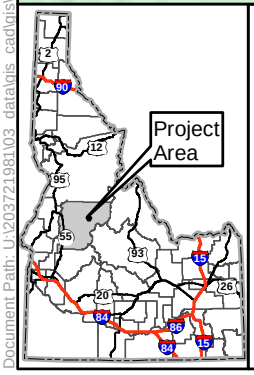


Figure 1-1
SGP Location and Class I & II Areas, Wilderness Areas, Tribal Reservations, and Areas Requested by Tribe for Analysis
Stibnite Gold Project Stibnite, ID

Base Layer: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
Other Data Sources: Perpetua; Air Sciences Inc.; United States Census Bureau

Document Path: U:\2023\21981\03_data\gis_cad\gis\FEIS\WXD\Specialist_Reports\Air_Quality\SGP\Locations_Class1_2_TribalReservations_20220526.mxd (Updated by: JAJ 5/26/2022)





LEGEND

Receptors

- 25-m-spaced receptors along the OAB
- 50-m-spaced receptors extending 250 m beyond the OAB
- 100-m-spaced receptors extending 1 km beyond the 50-m-spaced receptors
- 500-m-spaced receptors out to 5 km beyond the OAB
- 1-km-spaced receptors out to 10 km beyond the OAB

Project Components *

Mine Site

- Tailings Storage Facility
- Growth Media Stockpile
- Open Pit
- Ore Processing Facilities / Mine Support Infrastructure
- Development Rock Storage Facility
- Workers Housing Facility

- Haul Road

Other Features

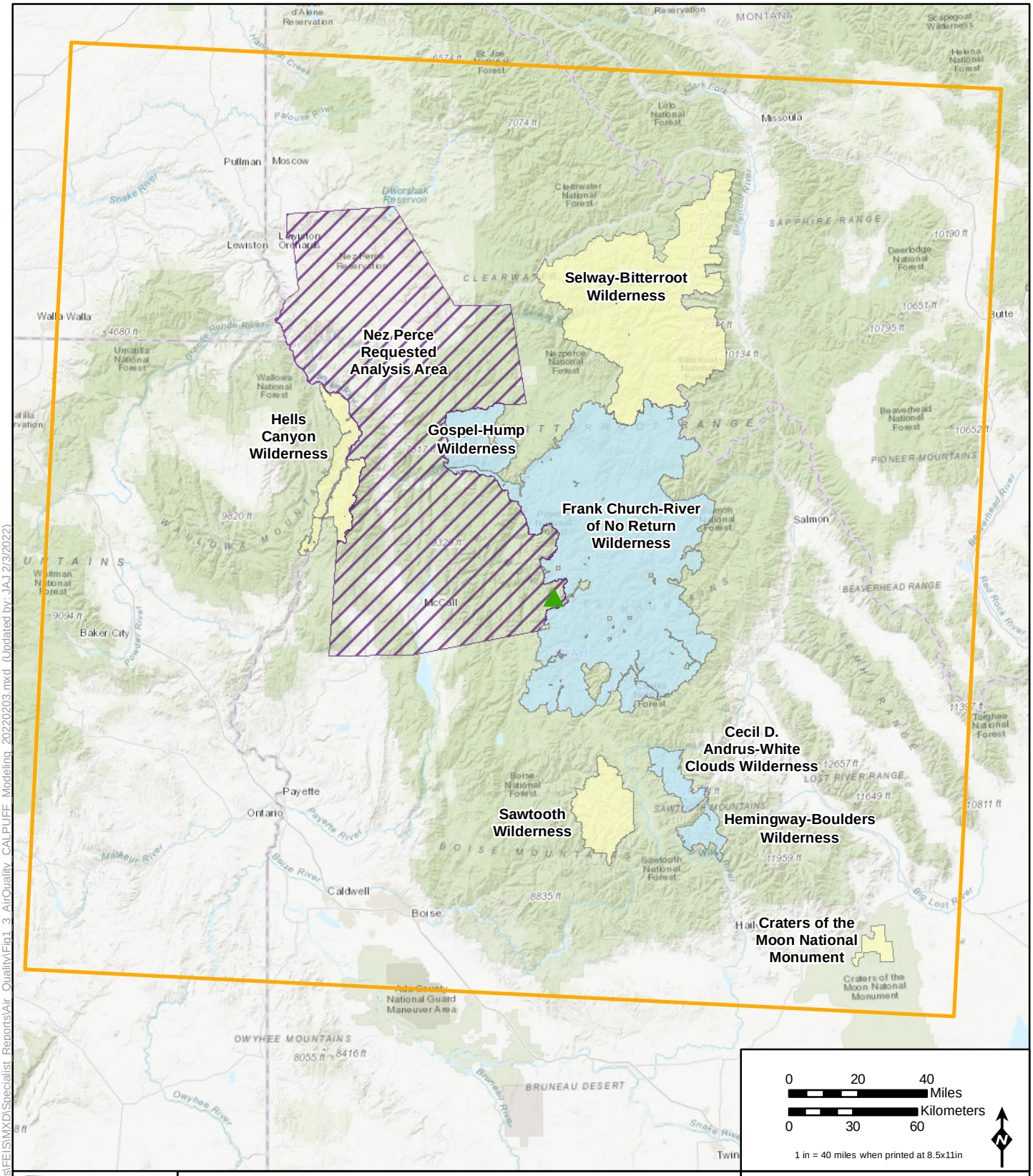
- U.S. Forest Service
- Wilderness

*Project Components are associated with all Alternatives

Figure 1-2
SGP Operations Area Boundary and Class II Modeling Receptor Grid
Stibnite Gold Project
Stibnite, ID

Base Layer: USGS The National Map: 3D Elevation Program. USGS Earth Resources Observation & Science (EROS) Center: GMTED2010. Data refreshed March, 2021.
Other Data Sources: Perpetua; Air Sciences Inc.; Boise National Forest; Payette National Forest

Document Path: U:\2023\21981\03_data\gis_cad\gis\FEIS\WXD\Specialist_Reports\Air_Quality\Fig1_2_AirQuality_ClassIIModReceptGrid_20211202.mxd (Updated by: 12/2/2021)



Document Path: U:\20372\1981\03_data\gis_cad\gis\FEIS\MXD\Specialist Reports\Air Quality\AirQuality_CALPUFF_Modeling_20220203.mxd (Updated by: JAJ 2/3/2022)

Class II wilderness areas are public lands outside of Class I protection that are maintained in its natural state protected against the introduction of intrusive artifacts such as buildings. Four of which are shown in **Figure 1-3** and were selected by the Forest Service for far-field evaluation: Frank Church River of No Return Wilderness (FCRNRW), Gospel Hump, Hemingway-Boulders, and Cecil D. Andrus—White Clouds. The FCRNRW area is a large wilderness adjacent to the Operations Area Boundary and extends more than 50 km from the boundary. For purposes of far-field analysis, only the portion of the FCRNRW that is located more than 50 km from the Operations Area Boundary was considered. Also, at the request of the Nez Perce Tribe, a fifth far-field region was included. This area is identified on **Figure 1-3** as "Nez Perce Requested Analysis Area."

2.0 Alternatives, Including the Proposed Action

The SGP 2021 Modified Mine Plan (MMP) Alternatives Report (Forest Service 2022a) contains the details of the alternatives that are being considered and fully analyzed in this report. For reader convenience, the alternatives are briefly summarized here.

2.1 No Action Alternative

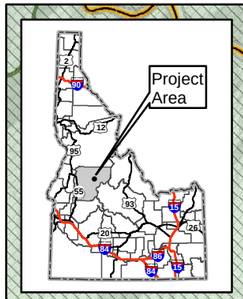
The No Action Alternative provides an environmental baseline for comparison of the action alternatives. Under the No Action Alternative, the mining, ore processing, and related activities under the 2021 MMP or the Johnson Creek Route Alternative would not take place. In addition, certain legacy and existing mining impacts would be addressed as directed in the 2021 Administrative Settlement Agreement and Order on Consent (ASAOC), including installation of stream diversion ditches designed to avoid contact of water with sources of contamination and removal of development rock and tailings currently impacting water quality. However, existing and approved activities (i.e., approved exploration activities and associated reclamation obligations) would continue and Perpetua would not be precluded from subsequently submitting another plan of operations pursuant to the General Mining Law of 1872 (U.S. Congress 1872).

2.2 2021 MMP

The 2021 MMP is based upon Perpetua's Revised Plan (ModPRO2) and is considered the Proposed Action. The description of this alternative has been updated per the Revised Plan submitted in 2021 (Perpetua 2021a). The proposed SGP operations footprint has been modified but would still be within the previously identified Operations Area Boundary (Midas Gold 2016) (**Figure 2-1**).

The following mine components would be common to the action alternatives:

- Mine pit locations, areal extents, and mining and backfilling methods
- Transportation management on existing and proposed roads
- Pit dewatering, surface water management, and water treatment
- Ore processing
- Lime generation
- Tailing storage facility (TSF) construction and operation methods
- TSF Buttress construction methods
- Water supply needs and uses



Surface Land Management
- Private
- U.S. Forest Service

North Security Gate
Stibnite Lake
West End Pit
Yellow Pine Pit & Backfill
Midnight Backfill
Midnight Pond
Growth Media Stockpile
Crusher ROM Stockpile Area
Scout ROM Stockpile Area
Process Plant Area
Substation
Explosives Facility
Cell Tower
Water Treatment Plant
Laydown
Transmission Line
Hangar Flats Pit Backfill, & Stockpiles
Truck Shop Area
TSF Embankment
TSF Buttress
TSF Impoundment
SODA Pond
Radio Communications Tower
Main Gate
Growth Media Stockpile
Worker Housing Facility
Radio Communications Tower

East Fork South Fork Salmon River
Sugar Creek
West End Creek
Stibnite Rd
Hennessy Creek
Midnight Creek
Fiddle Creek
Garnet Creek
Robbin Creek
Blowout Creek
Meadow Creek

T19NR09E
T18NR09E
T19NR10E
T18NR10E

Frank Church-River of No Return Wilderness
Boise National Forest
Payette National Forest
Payette National Forest
Salmon-Challis National Forest

LEGEND

Project Components *

SGP Features
- Pit Backfill
- Growth Media Stockpile
- Mining Pit
- Laydown
- Plant Site
- TSF Buttress
- TSF Liner
- Alluvial Stockpile
- Workers Housing
- Stockpile
- Explosive Facility
- Operations Area Boundary
- Patented Claim Boundary
- Tailings Pipeline
- Clean Water Diversion **
- Clean Water Diversion - Piped **
- East Fork South Fork Salmon River Tunnel ***
- Stream ****
- Pond
- Stibnite Lake
- Light Vehicle Road
- Haul Road
- Helicopter Pad

Access Roads
- Burntlog Route
- Johnson Creek Route
- Cell Tower Access Road
- Public Access Road *****

Utilities
- Transmission Line
- Substation ******
- New Cell Tower
- Existing Communication Tower

Other Features
- U.S. Forest Service
- Wilderness
- IRA and Forest Plan Special Areas
- Monumental Summit
- Road

* Project Components are associated with all Alternatives
** Some surface clean water diversions are not discernible at this figure scale (e.g., the diversions associated with the TSF/buttress north, Fiddle culvert, Midnight Outfall, Scout ROM). Please refer to Figures 2.4-14 and 2.4-15 which provide greater detail regarding the Water Management Plan and its facility/diversion locations.
*** The East Fork South Fork Salmon River Tunnel would only be utilized as a contingency to manage high flows upon completion of the restoration of the East Fork SFSR across the backfill in the Yellow Pine Pit.
**** Perennial streams are not depicted for the entire map area. Only perennial streams within the Operations Area Boundary are depicted.
***** Public Access Road associated with 2021 MMP
****** Substation locations are approximate.

0 0.35 0.7 Miles
1 inch = 0.7 miles when printed at 11x17

Figure 2-1
Mine Site Layout
Stibnite Gold Project
Stibnite, ID

Base Layer: Hillshade derived from LiDAR supplied by Midas Gold
Other Data Sources: Perpetua; State of Idaho Geospatial Gateway (INSIDE Idaho); Boise National Forest; Payette National Forest

Document Path: U:\2037\216\N03_data\gis_cad\gis\FEIS\MXD\Specialist Reports\General\Fig2_4-2_SGP_MineSite_Layout_20220407.mxd (Updated by JAJ 4/6/2022)

- Management of mine impacted water and stormwater runoff
- Stibnite Gold Logistics Facility (SGLF)
- A road maintenance facility
- Surface and underground exploration
- Stibnite Gold Project worker housing facility

For access, the 2021 MMP would utilize Warm Lake Road, Johnson Creek Road, and Stibnite Road during construction of the proposed Burntlog Route; then once constructed, the Burntlog Route would be utilized during operations and reclamation. The actions proposed under the 2021 MMP would take place over a period of approximately 20 to 25 years, not including the long-term, post-closure environmental monitoring or potential long-term water treatment.

2.3 Johnson Creek Route Alternative

The Johnson Creek Route Alternative was developed to evaluate potential reductions in impacts to various resources. The mining portion of this alternative would be the same as under the 2021 MMP. Therefore, the primary focus of the Johnson Creek Route Alternative would be using an existing road for mine access through operations and reclamation instead of the Burntlog Route that would require new road construction in Inventoried Roadless Areas. The Johnson Creek Route Alternative would require upgrades to both Johnson Creek Road and Stibnite Road. Construction schedule for upgrading the roads and construction of the SGP would increase from 3 years to 5 years under this alternative.

The action alternatives are summarized in **Table 2-1**.

Table 2-1 Action Alternatives Summary

SGP Phase	Component/ Subcomponent	2021 MMP	Johnson Creek Route Alternative
All Phases	SGP timeline	• Construction: Approximately3 years. • Operations: Approximately 15 years. • Exploration: Approximately 17 years (during construction and operations). • Reclamation: Approximately 5 years (except for the TSF which would require an additional 9 years for tailings dewatering and consolidation). • Closure/Post-Closure Water Treatment: Approximately through Mine Year 40. • Environmental Monitoring: As long as needed.	Same as 2021 MMP except: • Construction: Approximately 5 years (upgrading the existing Johnson Creek and Stibnite Roads to provide permanent mine access).

SGP Phase	Component/ Subcomponent	2021 MMP	Johnson Creek Route Alternative
All Phases	Access Roads	Construction/Operations: • Warm lake road from State Highway (SH) 55 to Johnson Creek Route intersection (34 miles). • Johnson Creek Route for SGP access during early construction with minor improvements within the road prism. • Burntlog Route (38 miles) for SGP access during last year of construction, mining and ore processing operations, and closure and reclamation. Includes improvements of existing segments (23 miles) and road construction for new segments (15 miles). • Up to eight borrow areas developed along Burntlog Route for materials needed for road improvements and maintenance. • Access route around the Yellow Pine pit for public access. Closure and Reclamation: • New sections of Burntlog Route to be reclaimed after the closure and reclamation period.	• Warm lake road from SH 55 to Johnson Creek Route intersection (34 miles). • Johnson Creek Route (39 miles: Johnson Creek Road 25 miles, Stibnite Road 14 miles) upgraded and used for access throughout life of mine (LOM) instead of the Burntlog Route. • Access route around the Yellow Pine pit for public access, employee access, and deliveries of supplies and equipment to the processing, warehouse, worker housing facility, and administration areas. • No improvements or construction of new segments for Burntlog Route. • Up to seven borrow sources developed along the Johnson Creek Route for materials needed for road improvements and maintenance. Closure and Reclamation: • Improved Johnson Creek and Stibnite roads would not be reclaimed to pre-existing conditions.
All Phases	Public Access	Construction: • Temporary groomed over-snow vehicle (OSV) trail on the west side of Johnson Creek from Trout Creek to Landmark while Burntlog Route is constructed (8 miles). • OSV trail on west side of Johnson Creek from Wapiti Meadows to Trout Creek campground closed during construction (9 miles). • OSV trail from Warm Lake to Landmark closed during construction through operations (8.5 miles). • Cabin Creek Road Groomed OSV trail (11 miles).	Construction and Operations: Same as 2021 MMP except: • OSV trail on the west side of Johnson Creek from Wapiti Meadows to Trout Creek campground would be closed from construction through mine closure (9 miles). • Groomed OSV trail on the west side of Johnson Creek from Trout Creek to Landmark lasting from construction through mine closure. Closure and Reclamation: Same as 2021 MMP.

PET-0904

REC 2624

SGP Phase	Component/ Subcomponent	2021 MMP	Johnson Creek Route Alternative
		• Public roads remain open through the SGP with temporary closures as needed to accommodate construction. Operations: • Groomed OSV trail moves from west side of Johnson Creek Road to Johnson Creek Road from Landmark to Wapiti Meadows (16.7 miles). • Stibnite Road (County Road [CR] 50-412) / Thunder Mountain Road (FR 50375) closed through the SGP. • Seasonal public access through the Operations Area Boundary provided by constructing new road through Yellow Pine pit and below mine haul road to link Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375). • Public access allowed on Burntlog Route to Thunder Mountain Road (FR 50375). Closure and Reclamation: • New road constructed over the Yellow Pine Backfill (backfilled Yellow Pine pit) connecting Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375).	
Operations	Utilities – Transmission Lines	• Upgrade approximately63 miles of the existing 12.5 kilovolt (kV) and 69 kV transmission lines. • New approximate 9-mile, 138 kV line would be constructed from the Johnson Creek substation to a new substation at the mine site. • Upgrade the substations located at Oxbow Dam, Horse Flat, McCall, Lake Fork, and Warm Lake. • Reroute approximately 5.4 miles of transmission line to avoid the Thunder Mountain Estates subdivision.	Same as 2021 MMP.

PET-0905

REC 2625

SGP Phase	Component/ Subcomponent	2021 MMP	Johnson Creek Route Alternative
		• Reroute approximately 0.9 miles of transmission line between Cascade and Donnelly to use an old railroad grade on private property. • Installation of approximately 3 miles of new underground distribution line along Johnson Creek Road from the Johnson Creek substation south to Wapiti Meadows.	
Operations	Utilities - Communication Towers and Repeater Sites	• One cell tower located north of the Hangar Flats pit. • Locations along Burntlog Route for very high frequency (VHF) repeater sites. • Use existing access roads to repeater site locations along Burntlog Route. • Communication site at the SGLF. • Upgrades to existing communication site.	Same as 2021 MMP except: • Cell tower sites constructed and maintained using helicopter (instead of constructing access roads) for sites within IRAs managed for Backcountry/Restoration. • Locations along Johnson Creek route for repeater sites.
Operations	Off-site Maintenance Facility	• SGLF located along Warm Lake Road. • Burntlog Maintenance Facility located at one of the borrow source locations 4.4 miles east of the junction of Johnson Creek Road and Warm Lake Road along the proposed Burntlog Route.	• SGLF same as 2021 MMP • Landmark Maintenance Facility located at junction of Warm Lake Road at Johnson Creek Road.
Closure and Reclamation	Access road segments	• Removal and reclamation of new road segments constructed for Burntlog Route. • Return of previously existing road segments to pre-construction width and condition.	• No removal or reclamation of pre-existing access routes.

Source: Perpetua 2021a

2.4 Applicable Environmental Design Features

The SGP must comply with all laws and regulations that apply to the proposed activities (Forest Service 2021a). Standards and guidelines in the Payette and Boise National Forest Land and Resource Management Plans (Forest Service 2003, 2010) that are designed to reduce or prevent undesirable impacts resulting from proposed management activities are incorporated into all the action alternatives by reference. In addition, best management practices outlined in the Best Management Practices for Mining

in Idaho (Idaho Department of Lands 1992) would be implemented where appropriate and applicable for operations to minimize site disturbance from mining and drilling activities.

In the design of the 2021 MMP, Perpetua has already considered many of the potential environmental impacts that might be caused by the SGP. This has led to an internal evaluation of project design features and operational characteristics that may have the effect of reducing and/or eliminating potential environmental impacts of the SGP. Such project-specific measures intended by a proponent to inherently reduce and/or avoid potential environmental impacts of a proposed action are referred to as environmental "design features."

Based on the application of permits and regulatory compliance requirements (Forest Service 2022a) to the project, regulatory requirements, standards and guidelines, best management practices, and likely permit conditions are listed in **Table 2-2**. The environmental design features that have been proposed and committed to by Perpetua are listed in **Table 2-3**. All of these environmental design measures have been assumed to be effective in conducting the environmental analysis presented in **Section 7.0**.

Table 2-2 Prominent Regulatory and Forest Plan Requirements for Air Quality

Description	Type	Reference
Deploy a satellite or network connected visibility web camera as part of the FS visibility network aimed from the boundary of FCRNRW south of mine across to FCRNRW boundary north of mine and/or from north to south on the FCRNRW boundary looking to the opposite boundary to document frequency of plume blight and visibility impacts to the wilderness area. Work with Perpetua to employ additional controls (likely dust mitigation and speed limits) if Forest Supervisor deems visibility impact magnitude or frequency unacceptable.	Design Feature	
Dust abatement chemicals would be used in accordance with the applicable road maintenance Biological Assessment. Apply dust- abatement additives and stabilization chemicals (typically MgCl2, CaCl2, or lignin sulphonates) to avoid run-off of applied dust abatement solutions to streams. Spill containment equipment would be available during chemical dust abatement application. Where the road surface is within 25 feet (slope distance) of surface water, dust abatement would only be applied to a 10-foot swath down the centerline of the road. The rate and quantity of application would be regulated to insure all of the chemical is absorbed before leaving the road surface.	Design Feature	
Perpetua will prepare a dust mitigation plan with appropriate schedule or triggers for control deemed adequate by IDEQ to achieve the level of control of 93 percent of dust (as submitted in Perpetua's application for Permit to Construct from IDEQ). Alternatively, Perpetua could employ particulate matter or opacity monitors deemed adequate by IDEQ and the Forest Service and immediately apply water or chemical dust control when PM or opacity monitors reach levels within 10 percent of the threshold determined by IDEQ.	IDEQ Permit	IDEQ Permit to Construct
To further ensure the intended high level of control, the FS requires an adaptive management plan as dust is a major component of emissions and air quality impacts affecting the near-field area. See also IDEQ dust control plan outline and EPA AP42 Chapter 13: Miscellaneous Sources, Section 2.2: Unpaved Roads pp. 13.2.2-12 – 13.2.2-17.	Design Feature	

Table 2-3 Proponent Proposed Environmental Design Features for Air Quality

Description
Following crushing, the crushed ore would be transported via conveyor to a dome-shaped, covered stockpile.
All off-highway diesel engines would conform to EPA Tier IV standards for off-highway diesel engines or better.
Perpetua would encourage employees to use company provided shuttle buses as transport to the SGLF from towns along SH 55.
Busing and/or vanpooling would be provided for Perpetua and contractor employees. The associated parking area would accommodate approximately 300 vehicles. To the degree practicable, Perpetua would mandate the use of busing and vans for employee and contractor transportation to the SGP and the worker housing facility.

In addition to the environmental design features listed in **Table 2-3** that are specific to air quality, Perpetua has proposed additional environmental measures for the SGP as described in the following documents:

- Stibnite Gold Mitigation Plan (Perpetua 2021b)
- Fugitive Dust Control Plan (Perpetua 2021c)
- State of Idaho Permit to Construct (IDEQ 2022)

3.0 Relevant Laws, Regulations, and Policy

The Clean Air Act (CAA) of 1970 (42 United States Code 7401 et seq.), as amended in 1977 and 1990, regulates air emissions and protects air quality and air quality related values across the U.S. Provisions of the CAA that are relevant to the analysis of SGP air quality effects are listed below:

- NAAQS
- Attainment and Non-Attainment Area Designations
- New Source Review Permitting
- New Source Performance Standards (NSPS)
- Mobile Source Regulations
- Visibility and Regional Haze
- Greenhouse Gas (GHG) Reporting Rule

Certain areas also may be designated for special protection of air quality. All U.S. lands are categorized as either “Class I” or “Class II,” under the CAA, which determines the level of protection from air pollution impacts provided by regulations. Mandatory federal Class I areas include international parks, wilderness areas, and national memorial parks that exceed 5,000 acres, as well as national parks that exceed 6,000 acres, which were in existence prior to August 7, 1977. All other areas were initially classified as Class II. The CAA also gives states and Tribes the ability to request re-designation from Class II to Class I status.

3.1 Land and Resource Management Plan

Physical, social, and biological resources on National Forest System lands are managed to achieve a desired condition that supports a broad range of biodiversity and social and economic opportunity. National Forest Land and Resource Management Plans embody the provisions of the National Forest Management Act and guide natural resource management activities on National Forest System land.

In the SGP area, the Payette National Forest Land and Resource Management Plan (Payette Forest Plan; Forest Service 2003), and the Boise National Forest Land and Resource Management Plan (Boise Forest Plan; Forest Service 2010) provide management prescriptions designed to realize goals for achieving desired condition for air quality and include various objectives, guidelines, and standards for this purpose.

3.2 Federal Laws, Regulations, and Policy

3.2.1 National Ambient Air Quality Standards

The EPA, in Title 40 CFR 50, established NAAQS for six criteria pollutants: carbon monoxide (CO), lead, nitrogen dioxide (NO_2), ozone (O_3), particulate matter (PM) including PM less than 10 microns in diameter (PM_{10}) and PM less than 2.5 microns in diameter ($PM_{2.5}$), and sulfur dioxide (SO_2). The NAAQS set two levels of standards for each criteria pollutant: primary standards are health- based atmospheric concentration levels, across specific averaging times, and are protective of public health; secondary standards are in comparable form, and are established to protect commercial and natural resources, and public welfare.

The following regulated air pollutants comprise the criteria pollutants covered by NAAQS:

- Ozone: Ground-level O_3 is a secondary pollutant formed in the atmosphere by a series of complex chemical reactions involving precursor pollutants nitrogen oxides (NO_X) and volatile organic compounds in the presence of sunlight. In relatively high concentrations, O_3 is a powerful oxidant capable of destroying organic matter, including human lung and airway tissue.

- Nitrogen dioxide: NO_2 can be emitted directly from combustion sources, such as fuel-fired stationary sources and vehicle exhaust. These are generally the largest source categories for nitric oxide and NO_2, collectively termed NO_X. Nitrogen dioxide is also formed in the atmosphere primarily by the rapid reaction of the colorless gas, nitric oxide, with atmospheric oxygen. Over longer-term exposures, NO_2 can irritate and damage the lungs, cause bronchitis and pneumonia, and lower resistance to respiratory infections such as influenza.

- Carbon monoxide: CO is a colorless, odorless, and potentially toxic gas. It is produced by natural and anthropogenic (caused by human activity) pathways such as combustion processes. The major source of CO is incomplete combustion of carbon-containing fuels (primarily gasoline, diesel, natural gas, and coal). However, it also results from combustion of vegetation such as forest fires and agricultural burning. The potential health impact from CO is that at relatively high concentrations it diminishes the ability of blood to carry oxygen to the brain, heart, and other vital organs, which especially affects sensitive populations and those with respiratory or heart disease.

- Sulfur dioxide: SO_2 is a colorless gas with a sharp, irritating odor. It reacts with moisture in the atmosphere to produce sulfuric acid and sulfates, which contribute to acid deposition and atmospheric visibility impairment. At longer exposures to low concentrations, SO_2 causes

constriction of the airways and poses a respiratory tract infection hazard to sensitive individuals, such as asthmatics and children.

- Respirable PM: PM_{10} consists of airborne PM, fine dusts, and aerosols that are 10 microns or smaller in diameter. The primary sources of PM_{10} include combustion processes, dust from paved and unpaved roads, and earthmoving construction operations. As a regulated pollutant, PM_{10} encompasses different constituents and, therefore, varying effects on health. PM_{10} particles can accumulate in the upper portion of the respiratory system, affecting the bronchial tubes, nose, and throat.

- Fine PM: $PM_{2.5}$ is a mixture of very fine particulate dusts and condensed aerosols that are 2.5 microns or smaller in aerodynamic diameter. $PM_{2.5}$ particles are emitted directly from activities such as industrial and residential combustion processes, wood burning, and from diesel- and gasoline-powered vehicles. They also are formed in the atmosphere by reactions of "precursor" gases, such as SO_2, NO_X, ammonia, and volatile organic compounds that create discrete secondary particulate. $PM_{2.5}$ can enter the deepest portions of the lungs where gas exchange occurs between the air and the blood stream, and where the lungs have no efficient mechanism for removing them. These fine particles can be retained in the lungs permanently, which increases the risks of long-term respiratory disease, cancer, and premature death.

- While the EPA sets the NAAQS, most states, including Idaho, are responsible for implementing, attaining and maintaining the standards and this process is done through the State Implementation Plans (SIPs). The IDEQ is the regulatory agency for air pollution control for the State of Idaho. The CAA allows states to adopt their own standards if they are at least as stringent as the NAAQS. The State of Idaho has adopted the NAAQS by reference in Idaho Administration Procedures Act (IDAPA) 58.01.01(107) in lieu of setting its own standards. In addition, Idaho has adopted an ambient air quality standard for fluorides in IDAPA 58.01.01(577). Literature surveys and published air pollutant emissions inventories for gold mining do not list fluoride as a potential emissions concern, and therefore SGP fluoride emissions are considered to be negligible. **Table 3-1** lists the primary and secondary NAAQS that would apply to the SGP.

Table 3-1 National Ambient Air Quality Standards

Pollutant and Averaging Time	Primary NAAQS	Secondary NAAQS	Exceedance Criteria
CO, 8-Hour	9 ppm	N/A	Not to be exceeded more than once per year
CO, 1-Hour	35 ppm	N/A	Not to be exceeded more than once per year
Lead, 3-month	0.15 $\mu g/m^3$	0.15 $\mu g/m^3$	Not to be exceeded by the rolling 3-month average
NO2, Annual	53 ppb	53 ppb	Not to be exceeded by the average of the 1-hour concentration in a calendar year
NO2, 1-Hour	100 ppb	N/A	98th percentile of 1-hour daily maximum concentration, averaged over 3 years
O3	0.070 ppm	0.070 ppm	Annual 4th highest daily maximum 8-hour concentration, averaged over 3 years
PM2.5, Annual	12 $\mu g/m^3$	15 $\mu g/m^3$	Annual mean, averaged over 3 years
PM2.5, 24-Hour	35 $\mu g/m^3$	35 $\mu g/m^3$	98th percentile, averaged over 3 years

Pollutant and Averaging Time	Primary NAAQS	Secondary NAAQS	Exceedance Criteria
PM10, 24-Hour	150 µg/m3	150 µg/m^3	Not to be exceeded more than once per year on average over 3 years
SO2, 3-Hour	NA	0.5 ppm	Not to be exceeded more than once per year
SO2, 1-Hour	75 ppb	N/A	99th percentile of 1-hour daily maximum concentration, averaged over 3 years

Source: EPA 2018a
µg/m^3 = micrograms per cubic meter
CO = carbon monoxide
m^3 = cubic meters
N/A = not applicable
NAAQS = National Ambient Air Quality Standards
NO_2 = nitrogen dioxide
O_3 = ozone
PM = particulate matter
ppb = parts per billion
ppm = parts per million
SO_2 = sulfur dioxide

The EPA determines and publishes air quality attainment status in the EPA Green Book (USEPA based on whether the air quality in the area consistently meets the NAAQS. Areas that persistently do not meet this standard are designated as nonattainment areas. The geographic areas considered in the air quality analysis area are in attainment of the NAAQS for all pollutants and averaging times (IDEQ 2019).

3.2.2 Federal Air Permitting

The New Source Review process requires facilities to undergo an EPA pre-construction review if they propose building new facilities or modifying existing facilities that would result in a "significant increase" of criteria pollutants per 40 CFR § 52.2376. The New Source Review is further broken down into Major Source Permits for stationary sources that emit criteria pollutants at levels that exceed the defined thresholds for the source type and Minor Source Permits for sources that have emissions below those thresholds. In Idaho, New Source Review air permitting is administered by IDEQ through an EPA approved State Implementation Plan.

Prevention of Significant Deterioration (PSD) permitting applies to new major sources or major modifications at existing sources for specific pollutants in cases where location of the source is in an attainment or maintenance area. For these sources, the PSD program requires an assessment of best available control technology and expanded analysis of air quality impacts in Class I areas in 40 CFR 52.21. Areas surrounding the SGP are in attainment with the NAAQS. Applicability of the PSD program depends on the magnitude of annual emissions for criteria pollutants.

For new or modified major sources subject to the PSD program, ambient concentrations in Class I and Class II areas also are compared to criteria air pollutant concentration increments that specify the maximum increase of ambient air concentrations of pollutants, or the "consumption of increment," over the legally established baseline for an area per 40 CFR § 52.2376. The analysis of increment consumption was promulgated under the CAA, and the available increment levels are specific to a given location. The allowable increment levels are more stringent in Class I areas, compared to Class II areas. It is the responsibility of the individual states, through their permitting programs, to ensure that the increments are not exceeded due to the development of new or modified facilities. While an increment analysis is required for new or modified major sources, it is recognized that new or modified minor sources also may

consume increment. Because the assessment of increment consumption is part of state new source review programs, such an analysis is normally not included in air quality reviews under federal National Environmental Policy Act. However, a simple comparison of modeled pollutant concentrations to the increments for Class I and Class II areas was conducted as part of the SGP air quality analysis. Disclosure of the SGP impacts in comparison to PSD increments helps to inform decision makes and the public regarding the significance of impacts to local air quality.

A Title V operating permit is required for major stationary sources under the Federal Operating Permits Program provided in CAA implementing regulations at 40 CFR 70. Whether a source meets the definition of "major," depends on the type and amount of air pollutants the source could potentially emit on an annual basis.

A determination would be made by the IDEQ whether the SGP would require a Title V permit, due to potential emissions. This will be based on the complete air emissions inventory for stationary sources that would be submitted by Perpetua as part of its application for an air quality permit. On June 17, 2022 IDEQ issued a final Permit to Construct (PTC) and Statement of Basis (SOB) stating that the SGP will not require a Title V permit.

3.2.3 Federal New Source Performance Standards

The NSPS are codified at 40 CFR 60 and are incorporated in Idaho air regulations by reference. These rules establish requirements for new, modified, or reconstructed emission units in specific source categories. NSPS requirements include emission limits, monitoring, reporting, and record keeping. Applicable NSPS for the SGP emission sources are:

- 40 CFR 60 Subpart A – General Provisions. Subpart A contains the general requirements applicable to all emission units subject to 40 CFR 60.
- 40 CFR 60 Subpart LL – Standards of performance for metallic mineral processing facilities. All facilities located in underground mines are exempted from the provisions of this subpart. All surface facilities at which construction or modification commenced after August 24, 1982, are subject to this subpart.
- 40 CFR 60 Subpart IIII – Standards of Performance for Stationary Compression Ignition Internal Combustion Engines. This subpart applies to diesel-fueled reciprocating engines, which would include the compressor and generator engines included in the SGP sources.
- 40 CFR 60 Subpart OOO – Standards of Performance for Nonmetallic Mineral Processing Plants. This subpart applies to the proposed limestone processing plant in Alternative 2.

3.2.4 National Emission Standards for Hazardous Air Pollutants

The federal National Emission Standards for Hazardous Air Pollutants (NESHAP) rules are codified at 40 CFR 61 and 63 and are incorporated in Idaho air regulations by reference. As part of the NESHAPs program, federal maximum achievable control standards are enacted to reduce the emissions of Hazardous Air Pollutants (HAPs) from both major source and area source categories.

Consideration of NESHAP Subparts in 40 CFR 63 indicates that there are three regulations and general provisions applicable to the SGP's air emission sources:

- 40 CFR 63 Subpart A – General Provisions. Subpart A contains the general requirements applicable to all emission units subject to 40 CFR 63.

- 40 CFR 63 Subpart EEEEEEE (7E) - NESHAPs for Gold Mine Ore Processing and Production Area Source Category. The rule was promulgated in February 2011, and this NESHAP applies generally to gold ore processing and production of gold-bearing products. This NESHAP is applicable to minor or "area sources" of HAP, and so would apply to the SGP emission sources. Specifically, this NESHAP applies to gold recovery and refining that use carbon processes, non-carbon processes, and mercury retorts. Therefore, the "carbon-in-pulp" process included in the SGP process sequence that adsorbs dissolved gold into the carbon particles is subject to this subpart. The regulation establishes mercury emissions limitations and work practice standards to control mercury emissions from gold production processes.

- 40 CFR 63 Subpart ZZZZ – National Emissions Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines. This subpart applies to the proposed diesel combustion engines at the SGP.

- 40 CFR 63 Subpart CCCCCC – National Emission Standards for Hazardous Air Pollutants for Source Category: Gasoline Dispensing Facilities. This subpart applies to the proposed gasoline storage tanks at the SGP.

3.2.5 Wilderness Act

The Wilderness Act of 1964 requires that wilderness areas be administered to preserve their wilderness character. The agencies managing wilderness further defined wilderness character in Keeping It Wild 2 (Forest Service 2015a): "Wilderness character is a holistic concept based on the interaction of (1) biophysical environments primarily free from modern human manipulation and impact, (2) personal experiences in natural environments generally free from the encumbrances and signs of modern society, and (3) symbolic meanings of humility, restraint, and interdependence that inspire human connection with nature." The Wilderness Act also created the National Wilderness Preservation System (NWPS) to identify and preserve designated wilderness areas (NWPS 2019a). Further, the Wilderness Act contains specific provisions for managing and protecting these pristine areas (NWPS 2019b). The Forest Service included additional wilderness areas in the air quality screening and modeling for the SGP to evaluate potential impacts on the areas' natural quality of wilderness character.

3.2.6 Greenhouse Gas Reporting Rule

GHGs are natural or anthropogenic gases that trap heat in the atmosphere and contribute to the greenhouse effect. In October 2009, the EPA issued the Mandatory Reporting of Greenhouse Gas Rule (MRR) in 40 CFR 98, which required reporting of GHG data and other relevant information from large sources and suppliers in the U.S. The gases covered by 40 CFR 98 are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, and other fluorinated gases. Implementation of the MRR includes the greenhouse gas reporting program applicable to facilities for which actual emissions of GHG are greater than 25,000 metric tons per year. Facilities subject to the MRR are required to submit annual reports to the EPA (CFR 2016). The Climate Change Specialist Report (Forest Service 2022b) addresses climate change and applicability of the MRR in further detail, but SGP GHG emission estimates would require MRR.

3.2.7 Mobile Source Federal Regulations

Mobile source air pollution control requirements for gasoline and diesel on-road engines are codified in 40 CFR 80, 40 CFR 85, and 40 CFR 86. These standards are designed to reduce emissions from passenger cars, light trucks, and large passenger vehicles (including sport utility vehicles, minivans, vans, and pickup trucks) and to reduce the sulfur content of diesel and gasoline fuels. Under these provisions, the EPA initially established Tier 1 and Tier 2 emissions standards for the purpose of minimizing emissions from these sources. For the on-road vehicles that would be owned and operated by Perpetua, the regulatory criteria indicate that EPA's Tier 2 emission standards program would apply.

Provisions for non-road diesel engines are codified in 40 CFR 89, 40 CFR 90, and 40 CFR 1039. Starting in 1996, manufacturers of non-road engines became subject to the EPA's increasingly stringent Tier 1 through Tier 4 emissions standards, depending on model year and engine size (CFR 2011). All new diesel engines have been required to meet Tier 4 standards since 2015.

EPA's mobile source regulations in 40 CFR 80 Subpart I - Motor Vehicle Diesel Fuel; Non-Road, Locomotive, and Marine Diesel Fuel; and U.S. Emissions Control Area Marine Fuel contains provisions restricting diesel fuel sulfur content for fuel used in mobile sources, in order to prevent damage to the emission control systems. These restrictions would apply to the fuels that would be used by the SGP, as they were phased in for highway diesel fuel starting in 2006 and for non-road diesel fuel in 2007.

3.3 State and Local Policy

3.3.1 Idaho Minor Source Air Permitting

The State of Idaho has enacted air quality regulations that are administered by the IDEQ. With respect to new source review permitting, IDEQ uses a PTC program (codified in IDAPA 58.01.01.200-228) that applies to new and modified sources. In this manner, the PTC program serves to protect ambient air quality from impacts due to major and more-numerous non-major stationary emission sources.

The IDEQ requires minor source permits for new facilities that are subject to federal NSPS and/or NESHAP regulations. A determination would be made by the State of Idaho whether the SGP satisfies the requirements of the PTC program, based on demonstration of the SGP's potential emissions and controls. This would be based on the complete air emissions inventory of stationary sources that would be submitted by Perpetua as part of its application for an air quality permit. Perpetua applied to IDEQ for an air permit under the PTC program. IDEQ issued a final PTC and SOB were issued on June 17, 2022 for the SGP.

3.3.2 Idaho Visibility Protection Requirements and Regional Haze Rule

Atmospheric visibility is defined as the ability of the human eye to distinguish an object from the surrounding background. In 1980, the EPA adopted regulations requiring states to update their State Implementation Plans for protection of visibility in Class I areas in 40 CFR 51 Subpart P (40 CFR 51.300 through 40 CFR 51.307). As a federal land manager of Class I areas, the Forest Service also has affirmative responsibilities to protect air quality and air quality-related values, such as visibility, in the Class I areas.

The federal Regional Haze Rule, adopted by the State of Idaho in IDAPA 58.01.01.665-668, requires states to develop long-term, regional haze, State Implementation Plans for reducing human-caused pollutant emissions that contribute to visibility degradation and to establish goals aimed at improving visibility in Class I areas. Sources of haze-causing pollutants include emissions from industrial sources,

tailpipes, agricultural equipment, and practices; and from natural sources such as volcanic emissions, windblown dust, and smoke from wildfires.

According to IDEQ, regional haze in Idaho's natural parks and scenic areas is attributable to a variety of natural and human source of air pollution and is greatly impacted by the effects of climate, such as drought, increased wildfires, and reduced precipitation (IDEQ 2017).

3.3.3 Idaho Toxic Air Pollutant Program

The State of Idaho's Toxic Air Pollutant Program is a stand-alone risk-based program that regulates approximately 350 pollutants determined by their nature to be toxic to human or animal life or vegetation. The program prohibits emissions of these pollutants in amounts that would injure or unreasonably affect human or animal life or vegetation. Toxic Air Pollutant emissions from industrial sources are compared to screening levels and limited by acceptable ambient concentrations for carcinogenic (i.e., having the potential to cause cancer) and non-carcinogenic pollutants. An air impact modeling analysis is required for projects having Toxic Air Pollutant emissions that exceed screening emission levels provided in IDAPA 58.01.01.585 for non-carcinogens, and IDAPA 58.01.01.586 for carcinogens. The modeling analysis must show that the acceptable ambient concentrations for non-carcinogens are not exceeded on a 24-hour average basis, and on a longer-term average for carcinogens.

IDAPA 58.01.210.14(a) requires control technologies for toxic pollutants as required to demonstrate compliance with appropriate AAC/AACC values. This is known as T-RACT or Toxic Reasonably Available Control Technology. During the development of the IDEQ permit, specific controls were evaluated and determined to be acceptable and compliant with the standards. As a result, IDEQ is requiring the use of "low-arsenic" quartzite (90 ppm arsenic or less) development rock to be applied for capping haul roads excluding those with the various pits and rock storage facilities. In addition, the drill rigs will include a dust control system with a minimum efficiency of 90 percent. Perpetua's PTC application included emissions subject to the Toxic Air Pollutant Program. IDEQ issued a final PTC and SOB for the SGP demonstrating compliance based on the air emissions inventory submitted in the application. The T-RACT analysis requirements outlined above were incorporated into the final PTC.

4.0 Issues and Resource Indicators

4.1 Significant Issues

Significant issues are those which are used to formulate alternatives to the Proposed Action and to develop mitigation measures. The SGP may affect air quality characteristics and resources that are affected by air pollutants. Arsenic emissions are of concern for air quality. For information pertaining to the potential impacts refer to **Section 7.2.2.3** Hazardous Air Pollutant Modeling. Note that Hazardous Air Pollutants (HAPs) are a federally regulated subset of the Idaho state regulated TAPs discussed above. HAPs are identified under the CAA Section 112. Idaho regulates all HAPs and an extended number of toxic pollutants under their TAPs program. HAPs modeling was conducted for this analysis because of this being a federal NEPA action. All other TAPs were analyzed during the PTC permitting process with IDEQ.

4.2 Resource Issues and Indicators

The indicators for the air quality resource reflect four components of air quality impact: magnitude or intensity, duration, geographic extent, and context. The issue and indicators analyzed for air quality are as follows:

Issue: The SGP may affect air quality characteristics and resources that are affected by air pollutants.

Indicators:

- Geographical extent of pollutant concentrations and deposition.
- Type and volume of air pollutants emitted, including haze precursors, airborne dust, and HAPs.
- Criteria air pollutant ambient air concentrations outside the Operations Area Boundary anywhere the public is allowed unrestricted access.
- Comparison of predicted ambient concentrations to Class I and Class II PSD increments and Significant Impact Levels.
- HAPs (including mercury [Hg]) emissions and Hg deposition.
- Deposition of nitrogen and sulfur compounds in Class I and specified Class II areas.
- Near-field plume blight and far-field regional haze in protected areas.

5.0 Methodology

Environmental consequences related to air quality are evaluated by comparing to objective, usually numerical, standards. In this case, the assessment of potential air quality impacts relies on a quantification of the emissions from the construction and operations phase of the action alternatives. It is typical practice for analysis of air quality effects to evaluate the period during which emissions are predicted to be highest. If the resulting indicators for that period are below the appropriate standards, then impacts for other periods can be reasonably concluded to be of lower magnitude and extent. Estimated construction, mining, and processing emissions for the 2021 MMP are presented in **Appendix A**, reproduced from the report entitled Air Quality Analysis, prepared for Perpetua (Air Sciences 2021a) and from an updated modeling analysis submitted to support the air quality permitting process (Air Sciences 2020).

The assessment of potential effects regarding the air quality issue and indicators is analyzed for each action alternative in its entirety (i.e., the combined emissions of the SGP construction/operation, transmission line construction/operation, and access road activities). The methodology for analysis of air quality-related effects is detailed in the following sections. **Section 7.2** presents the results of the quantitative assessment of the impacts of emissions from the action alternatives, including fugitive emissions from surface mining activities, roadway dust, and tailpipe exhaust. For the air quality impacts analysis, the basis for emissions of pollutants, including criteria air pollutants, HAPs, sulfuric acid mist, Hg, and hydrogen cyanide, was the year of mine operations with the highest level of overall emissions.

5.1 Analysis Area

An air quality analysis usually relies on defined geographic regions that represent the areas for which different types of modeling would be conducted. First, a "near field" was examined using appropriate models to quantify the effects of action alternative sources. The near-field modeling domain for the ambient air quality analysis, which extends 10 kilometers (km)[6] from the SGP, is depicted in **Figure 1-2**. Other aspects of the near-field modeling such as nitrogen and sulfur deposition used a domain of 50 km from the SGP. Federal modeling rules (40 CFR 51, Appendix W) stipulate that near-field models may be applied for distances of 50 km or less from the emission sources. For the SGP, preliminary modeling confirmed that the 10-km domain size was adequate to characterize worst-case near-field air quality impacts. Air quality effects would typically decrease at distances beyond the modeled 10 km range. For further detail pertaining to near-field modeling refer to **Section 5.4**.

The refined model uses a "grid" of defined receptor points at which air pollutant concentrations are predicted by the model calculations. Receptor tiers were used starting at 25 m[7] along the Operations Area Boundary (OAB) and transitioning to 1 km spacing out to the 10-km extent of the modeled domain to follow accepted regulatory modeling practice. Tighter spaced receptors were used closer to the OAB to allow the model to map in more detail the predicted close-in concentrations that are generally the highest.

Second, a much larger "far-field" region was defined within an area up to 300 km-radius from the SGP that encompassed more-distant Class I areas, wilderness areas, Tribal reservation and other areas requested by Tribes that were considered in the analysis as shown in **Figure 1-1**, with the Class I areas identified. As described in the following sections, specifically **Section 5.5**, specialized air quality modeling in the far-field region examined SGP source contributions to regional haze, nitrogen deposition, and sulfur deposition.

5.1.1 Direct/Indirect Effects Boundaries

A key concept in air quality analysis is the definition of "ambient air" as a defined area in which air pollutant effects to ambient air are to be compared to the national and state ambient air quality standards because that area is accessible to the general public (U.S. EPA 2019a). For the SGP, the area outside the area of Operations Boundary is defined as ambient air for modeling analyses is the OAB. This area is illustrated in **Figure 1-2** and the limit of the area that is closed to unrestricted public access. In this area, public access would be prohibited, or restricted through such measures that are accepted as means to control public access (EPA 2019a) as Perpetua security checkpoints, physical barriers at points of potential access road and trail entry, and security surveillance patrols.

A May 12, 2021, memorandum developed for the USFS by Stantec Consulting Services, Inc. outlines the rationale to exclude a portion of the proposed seasonal through-site controlled public access road through the mine operations from the public as approved by the Idaho DEQ and accepted by the EPA from ambient air for dispersion modeling purposes (Stantec 2021). This stretch of road is from Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375). The EPA Region X has indicated that the access road could possibly be excluded from ambient air if sufficient enforceable measures are taken to comply with the 2019 revised policy (EPA 2019a). To comply with this measure, Perpetua has developed a Transportation Management Plan that is included as **Appendix D**. The memorandum provides details that Idaho DEQ, who is responsible for issuing air permits in the state have excluded the road because of

[6] Metric units, including kilometers (km), are used predominantly in this section because of permit and measuring requirements. 1 km = 0.6mi; 1 mi =1.6 km

[7] 1 meter (m) = 3.3 feet; 1 foot = 0.3 meter.

PET-0917

REC 2637

restriction measures put in place consistent with their rules and requirements in the permit Lastly, DEQ issued a final PTC on June 17, 2022, that requires an Access Management Plan to be developed outing specific requirements relating to access control. Further information regarding IDEQ's ambient air interpretation is available in the PTC, condition 2.7 and the Response to Comments document, Comment 16.

5.1.2 Cumulative Effects Boundaries

For the far-field air quality impact analysis, a suitable far-field modeling domain was defined as an area 420 km by 420 km in extent, centered on the SGP, as shown in **Figure 1-3**. This area encompasses the closest Class I areas and Class II wilderness areas that are most likely to have impacts. The four Class I areas for which far-field modeling results were reported are SAWT, SELW, HECA, and CRMO.

5.2 Analysis Area Methodology

There are several Class I areas within a 300-km radius of the SGP Operations Area Boundary; however, many of these are farther from the SGP, and in the same general cardinal directions as the four closer Class I areas. A tiered approach was adopted to analyze the closer Class I areas that would have greater potential for air quality or visibility impacts. If the impacts predicted at the four closer Class I areas indicated potential for impacts at greater distances, then additional analyses would have been conducted for the more-distant Class I areas.

Four Class II wilderness areas, also shown in **Figure 1-3**, were selected by the Forest Service for far-field evaluation: FCRNRW, Gospel-Hump (GOSPEL), Hemingway-Boulders (HEMBLD), and Cecil D. Andrus - White Clouds (WHTCLD). Also, at the request of the Nez Perce Tribe, a fifth far-field region was included: the Nez Perce Requested Analysis Area.

The FCRNRW area is a large wilderness adjacent to the SGP Operations Area Boundary and extends more than 50 km from that boundary. For purposes of far-field analysis, only the portion of the FCRNRW that lies beyond 50 km from the Operations Area Boundary was considered. The regions of the FCRNRW that are within 50 km of the SGP were included in the near-field analysis area, which allows the impacts to be evaluated using dispersion models that are suitable for such distances.

5.3 Air Emissions Inventory Methodology

Direct effects are defined as those which are caused by the action and occur at the same time and place. Indirect effects are those that are caused by the action and occur later in time or are farther removed in distance but are still reasonably foreseeable. Because the direct and indirect air quality effects related to concurrent construction and operations are not distinguishable, a complete air emission inventory is to consider mine operations, ore processing (including refining), ongoing development of the SGP, support facilities, access roads, utilities (transmission line construction), and off-site facilities. For purposes of these analyses and IDEQ permitting, separate air pollutant emission inventories have been assembled for:

- Criteria air pollutants addressed by NAAQS: CO, NO_2, $PM_{2.5}$, PM_{10}, SO_2, O_3, and ozone precursors (e.g., NO_X and volatile organic compounds [VOCs]);
- HAPs, including Hg, As, Sb and hydrogen cyanide (HCN);
- Non-criteria pollutants: total PM, sulfuric acid mist (H_2SO_4), hydrogen sulfide; and
- Greenhouse gases.

The detailed emission inventories in **Appendices A** and **B** provide the source and selection rationale for the various factors that were used. Additional evaluation regarding the selection of emission factors for the specific sources included in the SGP is provided in **Appendix C**. This methodology applies to criteria, non-criteria, and HAP emissions estimates. The emission factors and estimation techniques are provided in regulatory and industry technical documents, including, but not limited to:

- EPA Document AP-42: "Compilation of Air Pollutant Emission Factors" and associated background documents (EPA 1995);
- Published emission estimation reports, including reports from the EPA and other environmental experts (EPA 1994; Schmidt and Card 2010; Eckley et al. 2010);
- EPA emission estimation models, such as MOVES (Motor Vehicle Emission Simulator) (EPA 2015a), and TANKS for hydrocarbon storage tanks (EPA 1999);
- Applicable regulatory emission requirements from Title 40 of the CFR (CFR 2011a, 2011b, 2016a, 2016b);
- EPA reference method performance test data or permit limits from similar gold ore processing operations (Nevada Division of Environmental Protection 2006, 2015, 2016; Schmidt and Card 2010);
- Manufacturer emissions certification data (Caterpillar 2019); and
- Other technical documents (Air Sciences 2018a, 2021a, 2021b; EPA 2003, 2012; Nevada Division of Environmental Protection 2017).

The air emissions inventory for the 2021 MMP is based on calculations for each emission source, for each life-of-mine (LOM) year. Perpetua timelines in the Plan of Restoration and Operations (Midas Gold 2016) and supporting documents, including the Air Quality Analysis (Air Sciences 2018a, 2021a), are based on a timeline that starts with construction years listed as negative years to Year 1 which is the first mine operational year. This specialist report assumes Year 1 is the first year of any type of disturbance associated with the SGP, including construction and does not use negative years in discussing mine timelines[8]. Timelines in the air quality discussion are based on the EIS timelines but some figures may be taken from reports using the Perpetua timelines; in these cases, explanatory notes are added.

5.3.1 Criteria Pollutant Inventory Methods

Mine operations involve numerous emission source categories characterized by the type of process, material processed, and equipment used. Most of the methods used to estimate emissions follow the accepted techniques that are described in EPA Document AP-42, Compilation of Air Pollutant Emission Factors (EPA 1995). This compilation is the largest single reference used to develop air emission estimations and is maintained as an EPA website resource. It provides methodologies, emission model equations, and emission factors for a broad range of process equipment and industrial sources. An emission factor is usually a well-supported, representative value that reasonably relates the quantity of a pollutant released from some activity or process to a quantitative measure of the intensity or rate of the

[8] Note that Perpetua's Plan of Restoration and Operations (Midas Gold 2016) includes a schedule that reports SGP construction as negative years (-3, -2, and -1) counting down to when operations begin at the SGP in year 1. This differs from the timeline presented in this report which begins at year 1 aligning with the first year of SGP construction-related activity.

activity. Examples of the measure of activity rate are acres disturbed, tons processed, gallons of fuel combusted, or thermal content of fuel used. An evaluation of the selected emission factors for the SGP sources is provided in **Appendix C**.

In general, Document AP-42 emission factors represent a broad average of emissions data available for a specific source type. A single tabulated emission factor usually encompasses data from several actual operations and a relatively large range of actual emission rates per unit of activity. Therefore, the Document AP-42 emission factors should be considered as representing an average of the range of measured or calculated emission rates. When the individual factors are applied to a specific operating unit, the resulting emissions estimate is therefore subject to some level of uncertainty. In EPA Document AP-42, the level of uncertainty in each factor is indicated by an "emission factor rating" with values ranging from "A" for best accuracy, and "E" for greater uncertainty.

To illustrate the level of confidence in judging emission estimates, it can be noted that nearly all the emission factor values in Section 11.19.2 of Document AP-42, which is relied on for many Perpetua sources, have emission factor ratings of "D" or "E." To compensate for this uncertainty, the accepted practice applied in this analysis is to over-estimate the activity rates for a given operation. This tends to avoid under-reporting the final estimates used for air quality analyses (Air Sciences 2018a).

As described in **Section 5.3.3**, inventories were developed for two different mine operating scenarios. One inventory was applied to support the range of non-regulatory analyses prepared for the 2021 MMP, and a second inventory applied to the NAAQS analysis by IDEQ that supported the PTC for the SGP (**Appendix B**). For each inventory, activity-specific (e.g., drilling, blasting, material crushing and conveying, refining, and other ancillary sources and activities) emissions were estimated based on the maximum activity rates for mining and production sources, coupled with applicable emission estimation techniques. Emissions were calculated on a short-term (hourly) and a long-term (annual) basis for ore processing, mine operations, and construction activities.

During full production, the daily ore-milling and processing rate would range from 20,000 to 25,000 tons per day (tpd). To ensure a conservative analysis, maximum daily ore processing emissions for the two inventories were based on the maximum design rate of 25,000 tpd, and this rate was assumed to be maintained for each annual operating scenario. Maximum annual emissions for the processing sources were based on the maximum daily emissions and multiplied by 365 days per year. Both the 2021 MMP and New Source Review (NSR) inventories from a processing perspective are essentially identical. Slight variations are due to differences of requirements between the EIS and the PTC process. These are discussed in further detail in **Section 5.3.3**.

5.3.2 Non-Criteria and HAP Inventory Methods

Most of the non-criteria and HAP emissions from operations come from the combustion of fossil fuels, processing of gold-bearing ore, and fugitive dust containing trace metals. For the SGP, emission estimates from these sources include:

- Organic and inorganic HAP from combustion of propane and diesel fuel in stationary sources, non-road engines, and vehicles
- Hg from gold ore refining sources (e.g., autoclave, carbon kiln, retort, and induction furnaces);
- Hg from exposed surfaces (stockpiles, development rock, tailings, and pits);
- Fugitive dust containing Hg released from mining and ore processing activities;

- HCN volatilization from the dilute cyanide solution in leach tanks, carbon-in-pulp tanks, and HCN detoxification tanks; and
- Release of trace amounts of residual HCN contained in tailings storage facility (TSF) impoundment of process tailings.
- As emissions from mining dust derived from development rock and ore concentrations

Combustion of propane and diesel fuels in stationary and mobile sources comprise a substantial source of HAP emissions for the SGP. For each category of fuel combustion equipment, published emission factors were used to relate the short term and annual emission rates of HAPs to the rate of fuel consumption. As discussed in **Section 5.3.3**, different categories of fuel combustion sources were included in the two inventories compiled for air quality assessments. Most notably, in line with permitting procedures, the mobile engine tailpipe emissions were not considered in the IDEQ new source review regulatory inventory. The non-regulatory inventory for EIS analyses did include these mobile source tailpipe criteria and HAP emissions.

Emissions of Hg result from mine operations due to the natural Hg content in mined materials and from several thermal steps in the refining of extracted gold (e.g., retort, carbon regeneration kiln, induction furnaces). Estimates of these emissions were based on regulatory compliance emission test results available for several gold mines in Nevada that use the same type of extraction process (Nevada Division of Environmental Protection 2006, 2015, 2016).

Evaluation of potential Hg emission impacts was conducted, in part, to verify that emissions would comply with the EPA Hg emission standards provided in 40 CFR 63, Subpart EEEEEEE, for gold ore processing and production facilities. The SGP would be subject to these federal standards because of the use of a carbon-in-pulp process for capturing gold that has been extracted from the ore using dilute HCN solutions and the use of a retort for purifying the gold-laden precipitate from electrowinning.

Sources of HCN emissions include volatilized HCN from several types of tanks used to extract gold from crushed ore (leach tanks, carbon-in-pulp tanks, HCN detoxification tanks). Process tailings that contain trace amounts of residual HCN impounded in the TSF are the largest source of volatized HCN. These emissions were estimated using published EPA field test data derived from HCN flux measurements at active gold processing facilities in Nevada and estimated physical properties specific to the SGP gold-refining processes (i.e., area, temperature, pH, HCN concentration) (Schmidt and Card 2010).

5.3.3 Comparison of 2021 MMP and NSR Inventories

As described in **Section 7.2**, different mine operational scenarios were used to develop separate emission inventories for the 2021 MMP, and for the modeling that supported the PTC application to IDEQ.

The 2021 MMP inventory examined projected levels of mine development and operation for each LOM year. Emissions from mine operations (drilling, blasting, material extraction and movement, mobile machinery use, lime kiln and other ancillary sources) vary significantly year to year. Therefore, annual emissions were calculated based on the maximum annual activity/production rates for each LOM year. The year with the highest level of overall criteria pollutant emissions, LOM Year 6, has been used for the non-regulatory analyses presented in this specialist report, namely, near-field plume blight (visibility), increment comparison and deposition analyses, and for the far-field air analyses, as discussed in **Section 7.2.2**.

IDEQ, as the regulatory authority for the NAAQS compliance analysis, has approved an alternative emissions inventory to support the NSR process. This inventory, referred to here as the PTC NSR inventory, included the same emissions sources (both fugitive and stationary), but excludes mobile source tailpipe emissions. Additionally, the PTC NSR inventory is the basis for a multitude of hypothetical operating scenarios for NAAQS modeling.

The full inventories of emissions for the 2021 MMP and for the operating scenario comprising the approved PTC NSR inventory are provided in **Appendices A** and **B**, respectively. There are a number of differences to note between the emissions inventories. The inventories used for the 2021 MMP include fugitive dust emissions from the Burntlog Route, as well as mobile tailpipe emissions from on-site mobile equipment. These sources were not included in the PTC NSR inventory because state regulations do not require mobile sources to be covered by the PTC. Other emission levels have been revised in the PTC NSR emissions inventory in accordance with IDEQ's engineering review specific operating condition assumptions. Further, the PTC NSR inventory assumed a specific hypothetical operating scenario that assumed the highest maximum daily mine activity would occur in just a single pit, and that all development rock disposal would use a single development rock storage facility. This resulted in an inventory with generally larger emission rates for the SGP for the PTC NSR inventory than those reflected in the 2021 MMP inventory, which provided a more conservative regulatory assessment of NAAQS compliance (Air Sciences 2020). For further detail refer to **Section 5.4**. **Table 5-1** summarizes the different source categories and action alternatives that were considered in each of the emission inventories.

Table 5-1 Comparison of 2021 MMP and PTC NSR Inventories

Emission Inventory	Used for 2021 MMP Analyses	Used for IDEQ NAAQS Analysis	Action Alternative Basis	Mobile Source Tailpipe Emissions	Burntlog Route Fugitive Dust
2021 MMP [2]	Yes	No	2021 MMP	Included	Included
PTC NSR [1]	No	Yes	2021 MMP	Not Required	Not Required

Sources:
[1] From Perpetua PTC application (Air Sciences 2020)
[2] Air Sciences 2021a

The 2021 MMP inventory includes both dust and tailpipe emissions from vehicle travel for mine construction and operation periods. The traffic emissions included projected workforce, supply, and haulage vehicles (buses, light and heavy trucks) and road maintenance equipment (graders and dozers). Emissions from construction activities during LOM years 1 to 3 (site preparation, temporary power generation to support construction, mobile machinery use, transportation, etc.) vary within each year of the construction period. The maximum overall operations phase criteria pollutant emissions from this source would occur during the peak in mine throughput in LOM Year 6.

5.4 Near Field Air Quality Analyses

This section provides an overview of the air dispersion modeling methods, procedures, and datasets used for the near-field assessment. Additional details are provided in the Air Quality Analysis (Air Sciences 2018a, 2021a). **Figure 1-2** illustrates the extent of the near-field modeling domain. The near-field air quality analyses were conducted in accordance with EPA Guidelines for regulatory air modeling (40 CFR 51, Appendix W) and included the following:

- Ambient air quality analyses to evaluate compliance with NAAQS and compare to Class II increments and Significant Impact Levels (SILs);
- Ozone and secondary fine particulate formation analysis;
- Screening visibility and plume blight analysis;
- Screening Hg deposition analysis; and
- Screening nitrogen and sulfur species deposition analysis.

The PTC NSR inventory prepared for the state of Idaho permit application indicates that the SGP would qualify as a minor source for NSR applicability (based on IDEQ review and approval). In this case, the state air permit application for a minor source is not required to provide a full analysis to show compliance with the Prevention of Significant Deterioration (PSD) criteria in Class I areas within the near-field analysis area. However, an analysis was required to ensure that the new emission sources do not cause or contribute to an exceedance of ambient air standards provided in the NAAQS. The PTC emissions are based on a hypothetical maximum possible production mining rate of 180,000 tons/day of ore and development rock. This is higher than the 2021 MMP emissions inventory that proposes a highest realistic annual production of 36.3 million ton or approximately 99,500 tons per day (Air Sciences 2021a). Additionally, the PTC evaluated numerous scenarios where all 180,000 daily tons were allocated to specific locations throughout the mine. This approach was performed to ensure ease of permitting and are not representative of real-world operations.

SILs are defined concentrations of criteria pollutants in the ambient air that are considered inconsequential in comparison to the NAAQS. Each SIL varies by pollutant and averaging period. In the case of the SGP, an assessment of project impacts in comparison to Class II area PSD increments and SILs for informational purposes provides an additional gauge of the air quality impacts. In addition, comparison of maximum modeled impacts to the SILs for Class II areas can be used, as provided in EPA Guidance, as a measure of the significance of impacts from major or minor sources. A project impact shown to be below a SIL can be presumed to not cause or contribute to the violation of a NAAQS.

5.4.1 Ambient Air Quality Refined Modeling

Refined modeling techniques using the air quality model were used to estimate pollutant concentrations using the 2021 MMP air emissions inventory (except for lead and ozone) at receptor locations. The current version at the time of analysis (19191) of the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) dispersion analysis modeling system was used for this air quality analysis. The AERMOD modeling system is listed as the recommended model for short-range analysis (up to 50 km) in federal regulations (40 CFR 51, Appendix W).

Modeling of background sources was not warranted for this near-field analysis, because the region is generally rural, and large sources of air emissions are absent. A review of state air quality permits showed that there are no permitted facilities located within a 50 km area (extent of near-field analysis area), of the OAB. The contribution to air quality conditions from background sources is accounted for in the selected baseline concentrations for the NAAQS analysis. These baseline concentrations were added to the highest modeled off-site concentrations due to the SGP sources, as represented in the PTC NSR inventory.

Monitored background or baseline concentrations should reflect the existing air pollutant concentrations in the modeling domain. The total ambient concentrations were estimated by aggregating existing baseline concentrations to the modeled future ambient concentrations resulting from the SGP. In

accordance with IDEQ recommendations, the CO, NO_X, and SO_2 baseline concentrations were derived from the Northwest International Air Quality Environmental Science and Technology Consortium online tool (NW AIRQUEST), for monitored years 2014 to 2017, as provided through Washington State University (2018). These baseline concentrations were derived by photochemical modeling methods, which are allowed under EPA Guidelines (40 CFR 51, Appendix W). The O_3 concentration used as the baseline level was provided by IDEQ as representative backgrounds. The baseline concentrations for particulate species were derived from on-site monitoring data provided by Perpetua, obtained by operation of an IDEQ-approved monitoring program (IDEQ 2015). The pollutant baseline concentrations accepted by IDEQ for the NAAQS air quality demonstration, in units of micrograms per cubic meter ($\mu g/m^3$), are listed in **Table 5-2**.

AERMOD requires an input of hourly meteorological data to estimate pollutant concentrations in ambient air resulting from modeled source emissions. For this analysis, one year (January 1, 2014 to December 31, 2014) of site-specific hourly surface meteorological data collected at the Stibnite monitoring station was used. When site-specific data are available, as in this case, use of a single year of meteorological data can be deemed sufficient for the analysis. A full 12 months of data are the minimum required for air quality assessments under EPA Guidelines (40 CFR 51, Appendix W) to account for seasonal effects. The methods and procedures used to collect this dataset were reviewed by IDEQ and approved in December 2013 (IDEQ 2013) based on the PSD meteorological data quality requirements specified in the EPA Appendix W Guidelines. The EPA-recommended preprocessor, AERSURFACE, was used to estimate surface parameters for use in AERMOD that are dependent on the land use and vegetative cover of the area being evaluated.

Table 5-2 Background Pollutant Concentrations for IDEQ PTC Air Quality Analysis

Pollutant	Averaging Time	Background Conc. ($\mu g/m^3$)	Primary NAAQS[1]
CO	8 hours	1110	10,000 $\mu g/m^3$
	1 hour	1740	40,000 $\mu g/m^3$
NO_2	Annual	0.9	100 $\mu g/m^3$
	1 hour	4.3	188 $\mu g/m^3$
O3	8 hours	117.7	137 $\mu g/m^3$
PM10	24 hours	37.0	150 $\mu g/m^3$
PM2.5	Annual	3.5	12 $\mu g/m^3$
	24 hours	15.0	35 $\mu g/m^3$
SO_2	1 hour	12.3	196 $\mu g/m^3$
	3 hours	16.8	1300 $\mu g/m^3$

Source: Air Sciences 2021a, WSU 2018

[1] The NAAQS units are shown to agree with the modeling analysis approved by IDEQ. Gaseous pollutant $\mu g/m^3$ to ppb conversion 1 ppb equals: NO_2: 1.88 $\mu g/m^3$; SO_2: 2.62 $\mu g/m^3$; CO: 1.145 $\mu g/m^3$; O_3: 2.0 $\mu g/m^3$.

$\mu g/m^3$ = micrograms per cubic meter;
CO = carbon monoxide
NO_2 = nitrogen dioxide
O_3 = ozone
PM_{10} = particulate matter 10 microns in diameter and smaller
$PM_{2.5}$ = particulate matter 2.5 microns in diameter and smaller.
SO_2 = sulfur dioxide

Several source categories are defined in AERMOD to reflect different release characteristics. Processing, refining, and ancillary sources with exhaust stacks, such as baghouse-equipped sources, fuel-burning equipment, and the refinery autoclave, retort, smelting furnace, carbon kiln, etc., were modeled as "point" sources. In general, the sources without exhaust stacks, but where emissions have some inherent velocity on release (such as blasting, haul road dust, mechanical transfer of material, and ore screening and crushing) were modeled as "volume" sources. Unlike point sources, emissions from the numerous fugitive sources in the mining pits and process area (e.g., drilling, blasting, material loading, unloading, hauling, and wind erosion of exposed surfaces) were not modeled individually; rather, they were grouped together as combined "area" sources for these activity locations. The haul road network was divided into 22 sections, and these were sub-divided into 65-meter-long segments. Each segment was represented as an individual "volume" source in AERMOD.

Default particulate modeling methods, including deposition were used for estimating $PM_{2.5}$ and PM_{10} impacts. To account for particulate settling, published references were relied on for the particle properties and size distribution for combustion sources (Khalizov et al. 2012; University of Minnesota 2002). The ore and waste material particle densities were provided by Midas Gold (Air Sciences 2018a).

Pollutant emissions from combustion sources are partially composed of nitric oxide (NO) and NO_2. Once in the atmosphere, the NO can be converted to NO_2 through chemical reactions with ambient ozone. An approved conversion method (ozone limiting method) to mathematically estimate the ambient NO_2 concentrations from EPA Guidelines (40 CFR 51, Appendix W), was used to estimate the 1-hour and annual NO_2 impacts for this analysis (EPA 2015b).

The 2021 MMP was characterized in AERMOD by a series of "line" sources laid along the actual route. These sources were assigned a release height of 3 m, and an initial vertical dispersion of 2.8 m. These release parameters were based on an assumed 3.5 m vehicle height, which is representative of an overall approximation of anticipated vehicle heights (grader – 3.7 m, heavy- duty truck – 3.6 m, and pickup truck – 3.2 m [Caterpillar 2019]), and the area source parameter recommendations provided in the EPA Haul Road Workgroup Report (EPA 2012). The Burntlog Route emissions were evenly distributed along the full route by dividing the total road emissions by the total road total area (i.e., the complete Burntlog Route length (60,378 m = 37.5 miles) multiplied by the road width (6.1 m) (as described in Air Sciences [2018b]).

As the SGP is considered a minor source for NSR, it is not required to show compliance with the PSD increments as part of its minor NSR air permit application unless requested by IDEQ to do so. However, due to its proximity to the FCRNRW area and the Nez Perce Requested Analysis Area, the Class II air quality analysis performed for the 2021 MMP analysis did include an assessment of the significance of SGP air quality impacts by comparison to the Class II PSD increments (Air Sciences 2018b). The near-field modeling performed using the 2021 MMP inventory was used to compare predicted ambient concentrations to the Class II increments at the areas of interest. This assessment does not represent a PSD increment compliance demonstration, which is a more detailed evaluation.

PET-0925

REC 2645

5.4.2 Ozone and Secondary $PM_{2.5}$ Analyses

A quantitative evaluation of the impacts of ozone and secondary $PM_{2.5}$ resulting from action alternative sources was performed, applying recent guidance issued by the EPA (Air Sciences 2018b). These two criteria air pollutants are formed through chemical reactions in the atmosphere, so they are referred to as "secondary pollutants." Ozone is not emitted directly from mining activities or processes, but rather is formed by reactions involving NO_X and VOCs in the atmosphere. Therefore, ozone direct effects cannot be evaluated by air dispersion modeling of emissions from a single source or facility. Warm temperatures, clear skies (abundant levels of solar radiation), and stagnant air masses (low wind speeds) increase the potential for ozone formation (EPA 2016).

In January 2017, the EPA promulgated an update to its Guideline on Air Quality Models (EPA 2017) in 40 CFR 51, Appendix W (1978), to incorporate a tiered demonstration approach to address the secondary chemical formation of ozone and $PM_{2.5}$ associated with precursor emissions from single sources. The 2017 Guideline on Air Quality Models outlined a two-tiered approach for addressing single-source ozone and secondary $PM_{2.5}$ impacts:

- Tier 1: The first tier of assessment involves those situations where existing technical information is available, such as the results from existing photochemical grid modeling, published empirical estimates of source-specific impacts, or reduced-form models. In combination with other supportive information and analyses for the purposes of estimating secondary impacts from a particular source. According to the EPA, the existing technical information should provide a credible and representative estimate of the secondary impacts.

- Tier 2: If appropriate information for a Tier 1 analysis is not available, then a Tier 2 analysis would be conducted involving the application of a case-specific air quality modeling analysis using chemical transport models.

5.4.2.1 Tier 1 Assessment Approach – Ozone

According to the EPA guidance, air quality modeling of hypothetical industrial sources that have similar source characteristics and emission rates of ozone precursors, and which are in similar atmospheric environments, are generally suitable for comparative Tier 1 assessments. To evaluate ozone impacts for the SGP analysis, a Tier 1 assessment was performed based on review of the EPA's Modeled Emission Rates for Precursors (MERPs) guidance document, which includes the EPA's hypothetical source photochemical grid model (PGM) results (EPA 2019b). The PGM is a regional-scale atmospheric model that accounts for ozone-forming reactions and assigns the predicted ozone results as background to hypothetical sources of ozone precursors. This selected PGM source used in this case (number 18 in the PGM source roster) is the geographically closest to the SGP—210 miles (336 km) west-northwest of the SGP—in northeastern Oregon. Ozone impacts reported for the selected hypothetical source at a specified emission level were scaled to reflect the action alternative emission levels to estimate ozone impacts. The PGM-based estimates for ozone concentration changes were added to the baseline ozone concentrations to determine total estimated SGP ozone impacts for comparison to the NAAQS (Air Sciences 2018b).

5.4.2.2 Tier 1 Assessment Approach Secondary $PM_{2.5}$

Particulates smaller than 2.5 microns in diameter present in the atmosphere due to combustion or process sources consist of primary particulates, condensable particulates, and secondary particles. Primary particulates are the fraction of emissions that originates as solid particles (e.g., soot). Condensable particulates originate as gaseous chemical emissions and condense to form particles after exposure to the

cooler temperatures of the atmosphere. Secondary particulates can be formed when exhaust gases, the most notable example being NO_x and SO_2 emissions from a process stack, interact with other chemical species in the downwind atmosphere to form fine particles (e.g., nitrates and sulfates).

To evaluate SGP secondary $PM_{2.5}$ impacts, a Tier 1 assessment was performed based on the EPA MERPs guidance document (EPA 2019b). The same modeled hypothetical source in northeastern Oregon that was selected for the ozone assessment based on similarity in source characteristics, emission rates of precursors, and similar atmospheric environment, was selected to evaluate secondary $PM_{2.5}$ impacts. The PGM-based estimates for $PM_{2.5}$ concentration changes were added to the baseline $PM_{2.5}$ concentrations to determine total estimated SGP $PM_{2.5}$ impacts for comparison to the NAAQS (Air Sciences 2018b).

The Tier 1 assessment approach was accepted by both EPA and Idaho DEQ reviewers.

5.4.3 Plume Visibility Screening Analysis

Plume visibility analysis is a means of quantifying the ability of a viewer to discern a visible plume released from a source and is usually evaluated for an observer at the closest point on the boundary of a Class I or Class II wilderness area of concern. For the SGP plume visibility analysis, the most recent version of the EPA visibility impairment screening model (VISCREEN, version 13190) (EPA 1992) was used to determine if a plume released from the 2021 MMP sources could potentially be visible by a human observer. Plume blight occurs when a coherent plume from a source is perceptible to a casual observer against either a terrain or sky background. The VISCREEN model considers the absolute plume contrast and the difference in color contrast, which together provide a measure of the visible difference between a plume and background as perceived by humans.

The VISCREEN model was run using site-specific wind data to estimate the worst-case visibility impacts for worst-case meteorological conditions (wind speed and stability) (EPA 1992). The annual background visual range of 270 km for the SGP location was provided by the Forest Service and is representative of IMPROVE visual range data in the region. Additional details of the VISCREEN analysis procedures are provided in Air Sciences (2018a).

To operate VISCREEN, the aggregated emissions from the action alternative sources were arranged to be released from a single point. This creates some uncertainty, because the emissions from the SGP and process operations area would spread out over several miles. To account for dispersed emission sources, accepted modeling practice is to determine a theoretical single-point plume origin correction distance. The calculated distance in this case was 17.8 km. Subsequently, this distance was added to the hypothetical observer distance at the FCRNRW area boundary, and the combined observer distance was used in the VISCREEN inputs.

VISCREEN results provide a comparison of the two calculated plume contrast parameters with criteria thresholds to determine the plume perceptibility by an observer. Contrast that the is a measure of the difference in the transmitted light intensity without regard for color. Color contrast (ΔE) measures the difference in wavelength of perceived light rather than intensity. For this plume visibility assessment, VISCREEN results for both C and ΔE were evaluated for a plume against a backdrop of sky or terrain, and at solar angles of 10 degrees and 140 degrees. A result that exceeds the criteria thresholds for either C or ΔE indicates that a plume would be visible. Both daytime and nighttime hours were included in this analysis, although it should be recognized that any plume that occurs at night would not have sunlight to illuminate it.

Following the DEIS release it was requested that the VISCREEN modeling be updated with two distinct changes. First, the portion (1.8 percent) of PM emissions from combustion are now categorized as soot in the model rather than PM_{10}. Second, PM emissions larger than PM_{10} have been added to the model. For details refer to Appendix C of the Air Quality Analysis Addendum ModPro2 memorandum (Air Sciences 2021a) and **Section 7.2.2.3**.

5.4.4 Mercury Deposition Analysis

In the atmosphere, the forms of Hg that contribute to the deposition to land and surface waters are gaseous Hg (Hg^{2+}), particulate-borne Hg (HgP), and gaseous elemental Hg (Hg0). Further speciation of the particulate forms of Hg is possible such as fine HgP, which is analogous to filterable and condensable PM_{10}. Essentially, the PM_{10} associated with HgP is the mercury bound within the particles of the particulate smaller than 10 microns. Appropriate particle distribution of mercury can be established using proper test methods and techniques, but the overall percentage of HgP compared to total Hg is small, with HgP PM_{10} being even less (~14.1 percent vs 2.4 percent from a coal boiler as an example) (Peng 2021). However, as discussed below, and in further detail in **Section 7.2.2.3** the approach applied for this analysis did not speciate HgP. The assessment of Hg deposition for the locale of the SGP was conducted using two different tools. EPA computer simulation results based on the Regional Modeling System for Aerosols and Deposition (REMSAD) are available to quantify Hg deposition in each of the lower 48 states (EPA 2008).

This modeling was based on Hg emission inventory data obtained from 2000 through 2006, so would be expected to be higher than more-recent Hg emission levels that reflect regulatory limitations. The REMSAD results were used to estimate background deposition in the locale of the SGP area. Sources of Hg deposition included in the EPA REMSAD modeling analysis were:

- Point- and area-source emission sources in the lower 48 U.S.;
- Emissions from sources in Canada and Mexico; and
- Global background deposition from the Chemical Transport Model, the Global/Regional Atmospheric Heavy Metals model, and the GEOS-Chem model (EPA 2008).

The second analysis tool to assess the contribution to Hg deposition due to the 2021 MMP sources was screening-level dispersion simulation using AERMOD. It is recognized that AERMOD does not simulate the key physical processes affecting Hg in the environment (e.g., chemical transformation, re-emission, wet deposition, etc.) that are included in other models of Hg deposition. However, AERMOD was used in this case as a screening tool, to quantify the potential for increases in deposition of Hg species that could lead to impacts to biota. Complete discussion of the AERMOD method details and calculations are provided in the Air Quality Analysis report (Air Sciences 2018b).

5.4.5 Nitrogen and Sulfur Deposition Screening Analysis

To evaluate near-field deposition due to action alternative sources of NO_x and SO_2, screening-level modeling was conducted using AERMOD for nitrogen and sulfur species. As in the case of Hg deposition, it is recognized that AERMOD does not include several physical processes involved in chemical deposition (e.g., atmosphere chemical transformation of NO_2 and SO_2) found in traditional acid deposition models. However, for purposes of this assessment, it served as a screening tool to conservatively identify potential for adverse deposition effects.

This screening analysis was conducted using the Level 2 procedures prescribed in the draft interagency near-field deposition modeling guidance (U.S. National Park Service [NPS] 2011). The Level 2 analysis assumes that 100 percent of the NO/NO_2 emissions are promptly transformed into soluble nitric acid on release to the atmosphere. This assumption results in a significant overestimation of potential nitrogen species deposition close to the facility and is viewed as conservative.

5.5 Far-Field Air Quality Analyses

Another area of air quality impacts was analysis of potential effects in Class I and Class II areas surrounding the SGP area. The Class I areas within 300 km of the Operations Area Boundary are shown in **Figure 1-3**. The distances and direction between the proposed SGP and the closest boundary of these Class I areas are listed in **Table 5-3**. As described below, a less extensive area was defined as the far-field modeling domain, and several Class II wilderness areas were considered along with the selected Class I areas.

The far-field analysis focused on four Class I areas that were among the closest to the SGP, and in different cardinal directions relative to the SGP area: SAWT, SELW, HECA, and CRMO. The adopted approach was to discern if potential impacts above thresholds were predicted in these areas. Assessment of impacts in these closer Class I areas are conservatively representative of impacts in the areas not included in the model. **Table 5-3** identifies the Class I areas that were not included in far-field modeling; however, if significant impacts had been identified in the closer Class I areas, then additional analysis would be warranted to determine if there were potential impacts also could affect the more distant Class I areas (Air Sciences 2018a).

Table 5-3 Class I Areas in the Far-Field Analysis Area

Class I Area	Included in Far-Field Modeling	Distance, miles (km) and Direction
SAWT	Yes	48.1 (77.5), South
SELW	Yes	53.6 (86.5), North
HECA	Yes	62.0 (100.0), Northwest
Eagle Cap Wilderness	No	84.1 (135.6), West
Anaconda-Pintler Wilderness	No	98.6 (159.0), Northeast
CRMO	Yes	132.8 (214.2), Southeast
Flathead Reservation	No	156.7 (252.7), North-Northeast
Strawberry Mountain Wilderness	No	165.0 (266.1), West-Southwest
Red Rock Lakes National Wildlife Refuge	No	169.6 (273.5), East
Mission Mountains Wilderness	No	177.7 (286.7), North-Northeast

Source: Air Sciences 2018b

Four Class II wilderness areas also were included in the far-field analysis: FCRNRW, GOSPEL, HEMBLD, and WHTCLD. The FCRNRW area is a large wilderness adjacent to the Operations Area Boundary that extends well beyond 50 km from this boundary. For purposes of the far-field analysis, only the portion of the FCRNRW that lies beyond 50 km was considered in far- field modeling. The Nez Perce Requested Analysis Area also was included in the far-field analysis of visibility effects and chemical deposition impacts. The locations of these Class II areas of concern within the modeling domain are illustrated in **Figure 1.3**.

5.5.1 Modeling Methodology for Far-Field Analyses

For the far-field analyses, the CALPUFF dispersion model was selected. The CALPUFF model is a non-steady state, Lagrangian "puff" model that simulates the transport and chemical transformation of discrete puffs of pollutants released into the atmosphere. As wind flow changes geographically from hour to hour after the release, the path of each puff is altered by the model to follow the changing wind direction.

The CALMET processor, which simulates a three-dimensional wind field required by CALPUFF, was not used in this case. Rather, this analysis used a location-specific, 3-year wind field dataset generated by the Weather Research and Forecasting Model (WRF) in accordance with the federal Guideline on Air Quality Models (40 CFR 51, Appendix W). The WRF data was processed with the Mesoscale Model Interface (MMIF) program to prepare the meteorological fields for use in CALPUFF. This wind field spanned the entire modeling domain (420 km by 420 km, at a 4 km resolution [105 by 105 grid cells]) and was based on 3 years of regional data (2015 to 2017) (Air Sciences 2018b).

To assess data quality, the CALPUFF-ready wind field was evaluated against observational data from 15 established monitoring stations distributed throughout the CALPUFF modeling domain using the MMIF statistics program (MMIFStat). From the WRF meteorological data set, the MMIFStat package derives a few data quality metrics for air temperature, relative humidity, and winds. These computed metrics were compared to data quality benchmarks that have been commonly reported for mesoscale model evaluation. These benchmarks are available for both simple and complex terrain and are viewed as indicators of data adequacy and quality but are not used alone to accept or reject datasets.

In this case, the applicable complex terrain benchmarks for temperature and humidity data were generally met by the WRF dataset. However, some divergences from benchmarks were noted for wind speed and direction data. This was attributed to the elevated and complex terrain surrounding the various data monitoring sites, which can cause errors in wind direction simulation. Additional details of the meteorological data assessment procedures for operation of CALPUFF are presented in the Air Quality Analysis report (Air Sciences 2018b).

Sources from the near-field AERMOD modeling files were used to build the CALPUFF inputs, with some significant differences. For point sources having exhaust at ambient air temperature (e.g., dust control baghouses), the CALPUFF model differs from AERMOD, because it sets a constant release temperature approximating ambient air temperature (293.15 degrees Kelvin). In AERMOD, the mine pit sources were modeled as rectangular volume sources (OPENPIT routine), with individual lateral dimensions and release heights for each pit used to calculate initial vertical dispersion parameters. In CALPUFF, the pit sources were modeled as square area sources located with a release height at the top of the pit opening, with the pit located from the AERMOD lateral dimensions. The primary SGP plant access road (Burntlog) was modeled in AERMOD using several defined "line" sources. In CALPUFF, this access road was modeled as a set of widely spaced "volume" sources (Air Sciences 2018a).

Receptors for each Class I area were downloaded from the NPS Class I Area Receptors website (NPS 2018). For the Class II wilderness areas, receptor elevations were determined using the AERMAP program. Receptors were placed in the interior of each wilderness area at a 2-km grid spacing starting at 50 km from the SGP.

5.5.2 Far-Field Regional Haze Assessment Procedures

For the far-field assessments of regional haze impacts, the MESOPUFF II five-pollutant (nitric acid [HNO_3], NO_x, nitrate species, SO_2, and sulfate species [SO_4]) conversion algorithm was applied in CALPUFF to simulate atmospheric chemistry effects and contribution to regional haze. Action alternative source emissions were set at the LOM Year 7 of the DEIS Alternative 2 maximum daily 24-hour emissions of NO_X, SO_2, SO_4, and fine and coarse PM. Additional details of the CALPUFF processing and post-processing methods are presented in the far-field modeling protocol and the Air Quality Analysis report (Air Sciences 2018a, 2018b). Note that Far-Field modeling was not completed a second time, rather a validation comparison was performed to demonstrate that no significant changes to impact concentrations resulted between the DEIS and the 2021 MMP. For further details refer to **Section 7.2.2.4 Direct and Indirect Effects - Fair Field Analysis**.

Use of the annual average natural visual range conditions and visibility background values are usually recommended by federal land manager guidance for Class I areas. The average natural conditions for the four Class I areas in this analysis were obtained from the IMPROVE sites representing those areas (Copeland 2018). For the Class II wilderness areas, Forest Service- recommended HECA background values were used for the Nez Perce Requested Analysis Area, and median background values from the four nearest Class I IMPROVE sites were used for the remaining Class II wilderness areas (Copeland 2018).

5.5.3 Far-Field Comparisons with Class I and Class II Increments

As the SGP is considered a minor source for NSR, it is not required to show compliance with the PSD increments in either Class II or Class I areas. In view of proximity of the SGP to the FCRNRW area and the Nez Perce Requested Analysis Area within a 50 km distance, a comparison of SGP air quality impacts with the Class II PSD increments was conducted as part of the near-field analysis (refer to **Section 5.4**). Similarly, the far-field CALPUFF modeling was used to perform a comparison between maximum ambient concentrations with Class I and Class II increments for the areas of interest in the far-field domain beyond 50 km.

It should be noted that this modeling was based on the 2020 DEIS Alternative 2 inventory. This inventory was shown to have somewhat higher overall criteria pollutant emissions, generally due to the added combustion emissions of the lime kiln. Therefore, it was considered more conservative to perform this increment comparison for the action alternative with the higher quantified emissions. Alternative 2 inventory includes fugitive tailpipe emissions from vehicles operating at the SGP, in common with other non-regulatory modeling analyses such as the regional haze contributions and deposition screening modeling.

5.5.4 Far-Field Deposition Assessments

Total potential annual nitrogen (N) and sulfur (S) deposition from action alternative sources was determined as part of the air quality far-field analyses. The POSTUTIL routines in the CALPUFF model predict the deposition fluxes for both these chemical species at the receptors placed in the areas of concern. These post-processing routines were used to calculate the nitric acid/nitrite concentrations levels at each receptor, accounting for the hourly-occurring humidity and temperature conditions. Similarly, POSTUTIL routines in CALPUFF were applied to predict sulfuric acid/sulfate concentrations at each receptor. The modeling results for total potential N and S deposition are expressed in terms of the quantity of those two elements. Both dry and wet deposition were considered. Deposition impacts were compared to the Deposition Analysis Thresholds (DAT) as outlined in federal land manager guidance on N and S

deposition (NPS 2011). In this guidance, the significance level for N and S deposition rates in Class I areas is listed as 0.005 kilogram per hectare-year.

6.0 Affected Environment

6.1 Existing Conditions

The air quality in a given location is characterized by a number of properties that can be physically monitored and evaluated. The existing conditions that may be affected by the SGP include ambient air quality in comparison to the NAAQS, visibility as impacted by regional haze and visible plumes emitted from mine activities, and current rates of atmospheric deposition of mercury, nitrogen, and sulfur compounds. The description of the affected environment addresses these issues and several other parameters that pertain to regional air quality.

6.1.1 Criteria Air Pollutants

For SGP-specific baseline concentrations, Perpetua (then Midas Gold) collected 20 months (November 2013 to June 2015) of PM_{10} and $PM_{2.5}$ air concentration data at the approved Stibnite monitoring station (IDEQ 2013). The Stibnite monitor is in the same airshed as the SGP; characterized as mountain valley terrain with little or no industry. Additionally, this SGP particulate monitor is located within the near-field analysis area and was deemed by IDEQ to be representative of background conditions in the locale. The IDEQ formally approved the Monitoring Protocol and Quality Assurance Project Plan in December 2013 (IDEQ 2013). Both the meteorological and air quality monitoring began in November 2013 (Trinity Consultants 2017). After reviewing the data and associated quality control procedures, IDEQ concluded that the calendar year 2014 data for PM_{10} and $PM_{2.5}$ data collected at the Stibnite monitoring station satisfied the applicable regulatory requirements and approved the data as representative for analysis (IDEQ 2015).

For the ambient air NAAQS demonstration, IDEQ identified the source for gaseous pollutant background data as the NW AIRQUEST database for years 2014-2017 (Washington State University 2018) to be used in conjunction with particulate matter data collected at the Stibnite monitoring station. **Table 6-1** displays these data along with the applicable NAAQS. The areas considered in the analysis of air quality impacts are in attainment of the NAAQS for all pollutants and averaging times (IDEQ 2019).

Table 6-1 Ambient Air Data – Perpetua and NW Airquest Consortium Background Values

Pollutant and Averaging Time	Monitored Value and Units	NAAQS	Source and Period
PM_{10}, 24-Hour	37 µg/m^3 [1]	150 µg/m^3	Onsite monitor 1/1/14-12/31/14
$PM_{2.5}$, Annual	3.5 µg/m^3 [6]	12 µg/m^3	J Onsite monitor 1/1/14-12/31/14
$PM_{2.5}$, 24-Hour	15 µg/m^3 [3]	35 µg/m^3	Onsite monitor 1/1/14-12/31/14
SO_2, 3-Hour (Secondary)	6.4 ppb [1]	500 ppb	NW Airquest Consortium 7/1/14-6/30/17
SO_2, 1-Hour	4.7 ppb [4]	75 ppb	NW Airquest Consortium 7/1/14-6/30/17
CO, 8-Hour	0.97 ppm [1]	9 ppm	NW Airquest Consortium 7/1/14-6/30/17
CO, 1-Hour	1.52 ppm [1]	35 ppm	NW Airquest Consortium 7/1/14-6/30/17

Pollutant and Averaging Time	Monitored Value and Units	NAAQS	Source and Period
NO_2, Annual	0.5 ppb [2]	53 ppb	NW Airquest Consortium 7/1/14-6/30/17
NO_2, 1-Hour	2.3 ppb [5]	100 ppb	NW Airquest Consortium 7/1/14-6/30/17
Ozone (O_3), 8-Hour	60 ppb [4]	70 ppb	NW Airquest Consortium 7/1/14-6/30/17

Source: Air Sciences 2018a, 2021a; EPA 2018d; NW AIRQUEST 2018
[1] Maximum 2nd-high value for the data collection period.
[2] Annual mean value for the data collection period.
[3] 98th-percentile for the data collection period.
[4] Average of the 99th-percentile daily maximum 1-hour values for the data collection period.
[5] Average of the 98th-percentile daily maximum 1-hour values for the data collection period.
[6] Weighted average of quarterly means for the data collection period.

6.1.2 Hazardous Air Pollutants

There are no permitted sources of HAP emissions in the vicinity of the SGP area. One source, the Tamarack Mill, LLC is 75 km away, and reported minor source level emissions of 5.9 tons per year of HAPs in 2014 (Trinity Consultants 2017). Due to absence of permitted HAP emission sources in the air quality analysis area, it can be assumed that baseline ambient concentrations of HAPs are low and less than more industrialized or heavily populated areas.

6.1.3 Ozone

For purposes of identifying a baseline value for NAAQS assessment of O_3 impacts due to SGP sources, the IDEQ selected the baseline value from the NW AIRQUEST database for years 2014 through 2017 (Washington State University 2018).

The National Park Service has been operating a continuous O_3 monitor at CRMO from 1992 to present. This monitor is the only O_3 data source in the region that is not located in an urban area, therefore, it is likely representative of conditions near the SGP and surrounding rural area. The highest 1-hour maximum O_3 concentration recorded at the monitor was 91 ppb recorded in July 1996 and again in August 2008. However, there is no 1-hr NAAQS for O_3. The highest O_3 concentration measured at CRMO that is comparable to the 8-hour average NAAQS, (i.e., annual fourth-highest daily maximum 8-hour average) was 69 ppb which occurred in 2018. The annual trend of the fourth-highest 8-hour average for recent years is shown in **Table 6-2**.

Table 6-2 Annual Ozone Concentrations for Comparison to 8-Hour NAAQS Criteria Values – Craters of the Moon National Monument, 2012-2020

Annual O_3 Conc. for NAAQS Comparison [1]	NAAQS 8-hr Standard	2012	2013	2014	2015	2016	2017	2018	2019	2020
8-hour O_3 Conc.(ppb)[2]	70	65	60	62	61	58	63	69	58	66

Source: EPA 2021b
[1] The annual 4th highest 8-hour average averaged over a 3-year period is the NAAQS averaging criteria; these data are annual values, without rolling 3-year averaging.
[2] These values can be compared to the 2015 8-hour average O_3 NAAQS of 70 ppb.

PET-0933

REC 2653

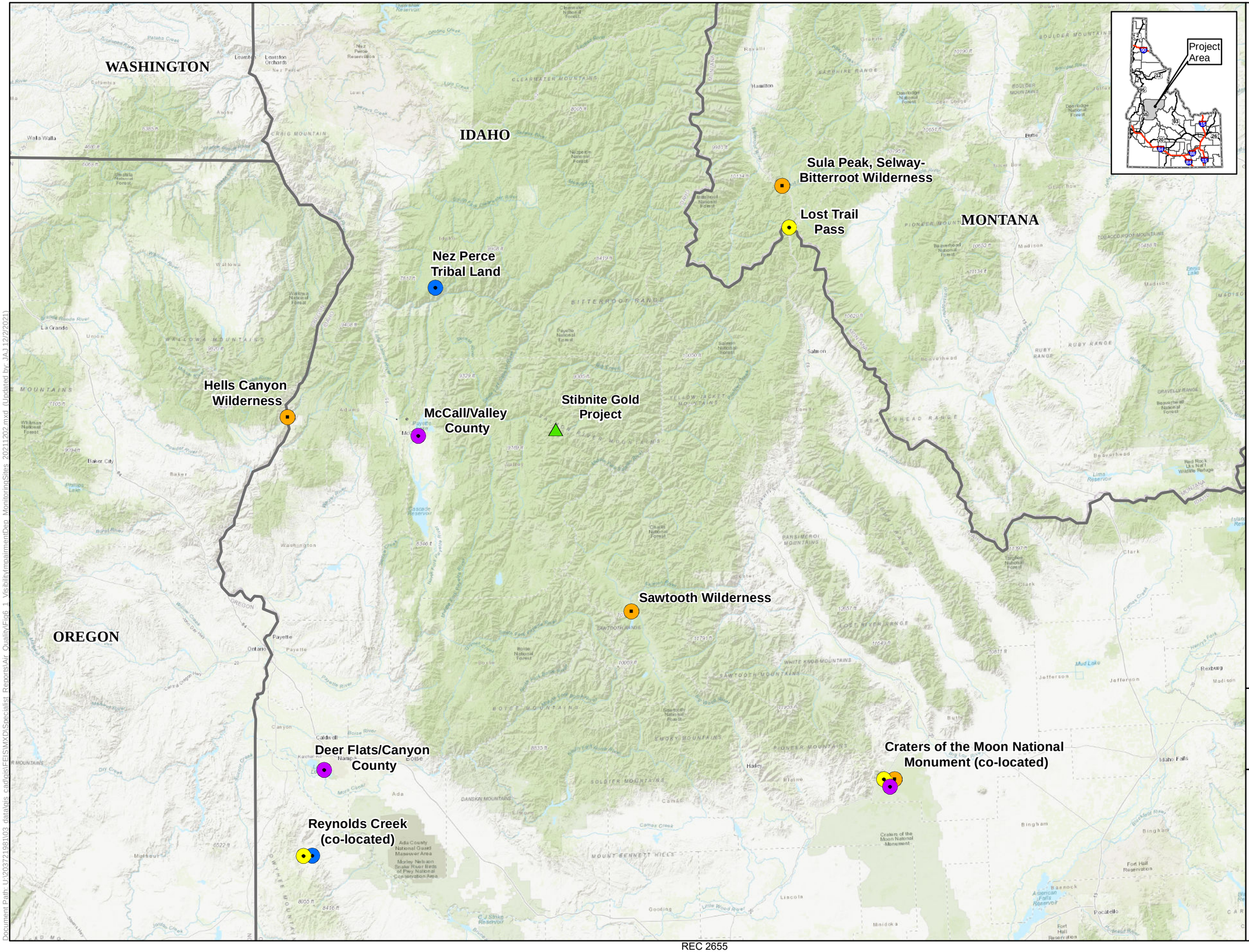
6.1.4 Air Quality Related Values

Air Quality Related Values (AQRVs) are resources sensitive to air quality and include a wide array of resources including, but not limited to, vegetation, soils, water, fish, wildlife, and visibility. Visibility may be affected by impairment due to plume blight or increase in regional haze levels. Plant growth and survival may be adversely affected due to increased ozone concentrations. Deposition of acidic air pollutants may cause episodic or chronic acidification of surface waters and may alter soil chemistry. Elevated deposition of nitrogen or phosphorus can drive species composition changes in both aquatic and terrestrial environments and can change growth and survival rates of plants. Mercury deposition can impact aquatic and riparian dependent species and can bioaccumulate causing health risks to humans and other species.

The CAA gives federal land managers the affirmative responsibility to protect against degradation of air quality and AQRVs in Class I areas. There are several Class I areas within a 300-km radius of the SGP which were considered for AQRV impact assessments. The nearest Class I areas are SAWT (approximately 80 km south-southeast of the SGP Operations Area Boundary) and Selway-Bitterroot

Wilderness (approximately 90 km northeast of the SGP Operations Area Boundary). The Class I areas within a 300-km radius of the SGP Operations Area Boundary are shown in **Figure 1-1**.

The monitoring stations in the far-field analysis area that provide representative background data are listed in **Table 6-3**, and the station locations are mapped in **Figure 6-1**. The Interagency Monitoring of Protected Visual Environments (IMPROVE) monitoring network stations measure chemical constituents that contribute to regional haze and visibility impairment. The National Trends Network (NTN), operated by the National Atmospheric Deposition Program (NADP) provides data on wet atmospheric deposition. The Clean Air Status and Trends Network (CASTNET), provides information on dry atmospheric deposition, including sulfur and nitrogen compounds, as well as ozone. The Mercury Deposition Network (MDN), also operated by NADP, monitors the atmospheric mercury concentration in wet deposition.



LEGEND

- Stibnite Gold Project

Visibility Impairment Deposition Monitoring Sites

- Interagency Monitoring of Protected Visual Environments
- Clean Air Status and Trends Network
- Mercury Deposition Network
- National Trends Network/National Atmospheric Deposition Program

0 10 20 Miles

0 20 40 Kilometers

1 inch = 25 miles when printed at 11x17

Figure 6-1
Visibility Impairment and Deposition-Related Monitoring Sites
Stibnite Gold Project
Stibnite, ID

Base Layer: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
Other Data Sources: Perpetua

Document Path: U:\2023\21990103 data\gis cad\gis\FEIS\MXD\Specialist Reports\Air Quality\Fig6_1_VisibilityImpairmentDep_MonitoringSites_20211202.mxd (Updated by JA) 12/2/2021)

6.1.4.1 Visibility

The CAA sets specific goals for protecting Class I areas from human-caused visibility impacts. Scattering of light by aerosols is the main process that limits visibility in the troposphere (ground level to approximately 10 km) degrading the clarity and color of what can be seen. Some airborne particles are naturally occurring (biogenic) and include seeds, pollen, spores, fragments of plants and animals, sea salt, dust, and smoke. They also are generated from anthropogenic sources, which include dust from roads, wind erosion of tilled land, biomass burning, fuel combustion, and industrial processes. In addition, emissions of sulfur, nitrogen, and carbon compounds, which are emitted from industrial sources burning fossil fuels, or from natural sources (e.g., wildfire or dust storms), can be precursors of condensed aerosol particles. In Class I wilderness areas and parks, the Regional Haze Rule requires states to address human-caused sources of air pollution degrading visibility on a regional scale. States use the "impairment" metric to factor out natural sources, such as wildfire smoke, and international contributions outside their control, in tracking their progress in improving visibility in the Class I areas.

One unit used to quantify visibility deterioration is the "visual range," which is a measurable parameter of atmospheric clarity at a specific monitoring location. A shorter visual range corresponds to more impaired long-range visibility through the atmosphere. Visibility has generally improved in Class I areas across the country, in part due to mandated sulfur restrictions on fuels, and controls on industrial sources of air pollution. Average monthly visual range values in the four Class I areas included in the far-field analysis area are between 223 and 278 km, with significant seasonal fluctuation (Air Sciences 2018a; Federal Land Managers' Air Quality Related Values Work Group 2010).

IMPROVE is a cooperative visibility monitoring effort managed by the EPA, with assistance from multiple U.S. agencies, state agencies, Indian tribes, and associated members in Canada and South Korea. The IMPROVE program measures current and long-term trends in visibility by monitoring, on 3-day intervals, the pollutants that contribute to reduction in visual range. Historic visibility parameters are presented in **Table 6-4** for the four IMPROVE stations in Class I areas in the SGP far-field analysis area. The IMPROVE network is designed so that some monitoring sites are used to represent multiple Class I areas in a region.

The visibility data in **Table 6-4** illustrate how observed impairment can vary seasonally and with local conditions in a given locale. Two different measures of impairment are listed. The "most impaired days" represent the portion of days that exhibit the highest 20 percent of observed visibility impairment and reflects only anthropogenic contributions to haze. Another visibility metric, the "monthly average visual range" includes effects of anthropogenic and natural (e.g., wildfire) contributions to haze, and a higher visual range reflects better clarity. The distribution of most impaired days at the Sawtooth (SAWT1) and Selway-Bitterroot (SULA1) wilderness areas tend to have a greater portion of the most impaired days during the warmer summer months. In contrast, the most impaired days occur more frequently during the winter months at Craters of the Moon National Monument (CRMO1) and Hells Canyon Wilderness (HECA1).

Table 6-3 Visibility Impairment and Deposition-Related Monitoring Sites

Site ID Code	Network	State	Location/ Site Name	Monitored Parameters	Distance and Direction from SGP to Monitor (mi)	Monitor Elevation (feet)	North Latitude (Decimal Deg.)	West Longitude (Decimal Deg.)	Monitoring Period
CRMO1	IMPROVE	Idaho	Craters of the Moon National Monument	Haze/Visibility Impairment	132, southeast	5,964	43.4605	-113.5550	5/1992 to present
HECA1	IMPROVE	Idaho/ Oregon	Hells Canyon Wilderness	Haze/Visibility Impairment	75, west	2,149	44.9702	-116.8437	8/2000 to present
SAWT1	IMPROVE	Idaho	Sawtooth Wilderness	Haze/Visibility Impairment	52, south-southeast	6,530	44.1705	-114.9271	1/1994 to present
SULA1	IMPROVE	Montana	Sula Peak, Selway-Bitterroot Wilderness	Haze/Visibility Impairment	90, northeast	6,220	45.8598	-114.0000	8/1994 to present
RCK263	CASTNET	Idaho	Reynolds Creek	Dry Deposition	165, south-southwest	3,930	43.2105	-116.7510	9/1990 to 12/2016
NPT006	CASTNET	Idaho	Nez Perce Tribal Land	Dry Deposition	51 north-northwest	3,100	46.2758	-116.0216	12/2002 to present
ID03	NTN	Idaho	Craters of the Moon National Monument	Wet Deposition	132, southeast	5,929	43.4605	-113.5551	8/1980 to present
ID11	NTN	Idaho	Reynolds Creek	Wet Deposition	165, south-southwest	3,937	43.2049	-116.7500	11/1983 to present
MT97	NTN	Montana	Lost Trail Pass	Wet Deposition	88, northeast	7,877	45.6920	-113.9680	9/1990 to present
ID03	MDN	Idaho	Craters of the Moon National Monument	Mercury Deposition	132, southeast	5,928	43.4605	-113.5551	10/2006 to 12/2010
ID98	MDN	Idaho	Deer Flats/ Canyon County	Mercury Deposition	182, southwest	2,539	43.5528	-116.6436	3/2008 to 6/2010
ID99	MDN	Idaho	McCall / Valley County	Mercury Deposition	61, west	5,013	44.8913	-116.1047	11/2007 to 6/2010

Source: EPA 2018b; IRMA 2018; NADP 2018

PET-0937

REC 2657

Table 6-4 Historic Visibility Impairment Parameters – Four Class I Area IMPROVE Sites

Month	CRMO1 Percent of Observed Most Impaired Days	CRMO1 Monthly Avg. Visual Range (km)	HECA1 Percent of Observed Most Impaired Days	HECA1 Monthly Avg. Visual Range (km)	SAWT1 Percent of Observed Most Impaired Days	SAWT1 Monthly Avg. Visual Range (km)	SULA1 Percent of Observed Most Impaired Days	SULA1 Monthly Avg. Visual Range (km)
Jan	22.05	245	26.36	224	6.93	259	2.79	251
Feb	16.01	248	14.33	229	2.13	263	2.79	256
Mar	8.14	252	3.72	234	2.93	269	6.69	261
Apr	6.30	255	5.73	237	8.53	272	14.21	264
May	4.72	255	3.15	238	11.47	272	13.09	265
June	0.79	257	0.29	239	10.40	274	10.86	266
July	0.00	261	1.72	242	12.27	278	9.75	270
Aug	0.26	261	1.43	243	8.27	278	3.62	271
Sept	0.26	259	1.43	241	8.00	277	8.91	268
Oct	2.89	255	6.88	235	12.00	273	13.09	262
Nov	17.32	248	15.47	226	10.93	263	10.58	253
Dec	21.26	246	19.48	223	6.13	259	3.62	251

Source: Air Sciences 2018b; Federal Land Manager 2018; IRMA 2018
CRMO1 = Craters of the Moon National Monument, Monitored Years 2002 -17
HECA1 = Hells Canyon Wilderness, Monitored Years 2000 – 17
IMPROVE = Interagency Monitoring of Protected Visual Environments
SAWT1 = Sawtooth Wilderness, Monitored Years 1994 – 2017
SULA1 = Sula Peak, Selway-Bitterroot Wilderness, Monitored Years 1994 – 2017

PET-0938

REC 2658

Plume visibility is a condition that is caused by a source or combination of sources and is the presence of a plume that is visible to an observer some distance from the source.

Assessment of plume visibility is a means to quantify the ability of a viewer to discern a visible plume and is usually evaluated for an observer at the closest point on the boundary of a Class I area of concern. Plume blight occurs when a coherent plume from a source is perceptible against a viewing background (e.g., the sky, or a terrain feature such as a mountain) to a casual observer. The primary parameters of plume blight are the change in visible contrast and color contrast between a plume and background.

6.1.4.2 Atmospheric Deposition

There are two types of deposition that can affect AQRVs: 1) wet deposition, which involves the scavenging of particles and gases in the air by clouds and precipitation; and 2) dry deposition, which involves the direct collection of gases and particles in the air by vegetation and solids and liquid surfaces (Wallace and Hobbs 2006). Atmospheric deposition may be due to distant sources or local sources of pollution.

As described in this section, data for the existing conditions at the monitoring stations nearest the SGP area indicate that both wet and dry nitrogen deposition either show no clear trend or are trending higher. Nationwide, it has been reported that deposition of oxidized nitrogen species has declined between 2006 and 2016, which may reflect improved NO_x emission control technologies for vehicles and power plants. However, over the same period, deposition rates of reduced forms of nitrogen, such as ammonia, have increased or remained unchanged (NADP 2019). The data presented in this section show that no clear trend is evident in wet or dry sulfur species deposition between 2005 and 2015 at the monitoring sites closest to the SGP area. However, nationwide SO_2 emissions have decreased by 76 percent between 2010-2020 (EPA 2022).

Two complementary monitoring networks that collect deposition data are CASTNET and NTN, which collect data related to dry and wet deposition, respectively. Total deposition estimates are provided nationwide by NADP's Total Deposition Science Committee. They use a hybrid approach combining ambient measurements from CASTNET, NTN, and other air concentration monitoring data with model output to provide gridded estimates of total deposition (NADP 2022; Schwede and Lear 2014). Nearly all CASTNET sites are co-located or are near a corresponding NTN site, which together provide the data needed to track temporal and spatial trends in total deposition.

Deposition of nitrogen and sulfur compounds impact the environment through several pathways. In the atmosphere, NO_x reacts with moisture and oxygen to form nitric acid, nitrates, and nitrous oxide, while SO_2 reacts to form sulfuric acid, sulfates, and sulfites, which can be transported to the surface by wet deposition. Nitrogen and sulfur compounds formed in the atmosphere are conveyed by dry and wet deposition and can affect soils, water, and biota far from the origination of the precursor emissions. Excessive nitrogen deposition can cause reduction in plant biodiversity and eutrophication (excessive plant and algae growth) in surface waters. This has the effect of reducing the oxygen content of the water, and therefore reduces the population of animal life the water can sustain.

Of somewhat less concern in the Pacific Northwest is acid deposition, which occurs when SO_2, NO_X, and ammonia in the atmosphere react to form sulfuric acid, nitric acid, and ammonium. These compounds can enter surface waters, primarily through wet deposition. These pollutants originate from anthropogenic sources (e.g., burning of fossil fuels in power plants and motor vehicles, and agricultural practices), and to a lesser degree from natural sources (e.g., forest fires and volcanoes).

National Trends Network

The NTN provides a nationwide historic record of precipitation chemistry that is reflected in wet deposition rates to soil and surface water. The NTN is part of the NADP that operates several atmospheric monitoring programs. NTN sites are typically located away from urban areas and large point sources of pollution, and many stations are in Class I areas. While stations cannot be established and operated in protected wilderness areas, NTN sites are in many cases located near, or are considered representative of, nearby wilderness area deposition conditions at similar elevations. Each monitoring site measures the quantity of precipitation, and automatically captures samples only during precipitation events. Samples are retrieved from the field on a weekly interval, and analyzed for calcium, magnesium, potassium, sodium, ammonium, nitrate, total nitrogen species, chloride, sulfate, and free acidity (as H^+) (NADP 2022). Wet deposition data is expressed in units of kilograms per hectare per year (kg/ha-yr)[9].

Annual data for three NTN sites closest to the SGP is presented in **Tables 6-5** through **Table 6-7**. These three sites are located at the CRMO (213 km distant, southeast) Reynolds Creek (264 km distant, south-southwest), and Lost Trail Pass (142 km distant, northeast). Trends in the wet deposition rates of the primary nitrogen and sulfur species (nitrate [NO_3], ammonium [NH_4], and sulfate [SO_4]) are plotted in **Figures 6-2** through **6-4** for the three NTN sites. These trends show the wide variability in annual wet deposition rates in the region, with no clear long-term trend.

Clean Air Status and Trends Network Data

CASTNET is a long-term, dry deposition national monitoring network managed by EPA. The CASTNET sites measure nitrogen and sulfur species, chloride, and base cations (i.e., a positively charged ion) that are used to calculate dry deposition rates. The network was established under the 1990 CAA Amendments to provide accountability for emission reduction programs by reporting trends in pollutant concentrations and acidic deposition (EPA 2018b). **Table 6-8** shows dry nitrogen compound and dry sulfur compound deposition rates at the two CASTNET monitoring sites closest to the SGP and located in Idaho. These are stations on Nez Perce Tribal Reservation land (82 km distant, north-northwest, and at Reynolds Creek (264 km distant, south-southwest). Like wet deposition, dry deposition is typically expressed in units of kg/ha-yr. **Figure 6-5** illustrates the trends in annual dry deposition rates at these sites, with dry deposition of sulfur species generally higher than nitrogen species.

Mercury Deposition Network

Inorganic Hg in gaseous and particle-bound forms and mercury oxide are emitted from many mine operations and fossil fuel combustion sources, most notably coal-fired electrical-generating units. Each form has specific physical and chemical properties that determine how far it travels in the atmosphere before depositing to the landscape.

Atmospheric deposition of mercury is of particular concern where the potential exists for transfer to riparian areas and/or surface waters through precipitation and runoff. Although gaseous oxidized Hg and particle-bound Hg deposition are prevalent, all forms of Hg may deposit to local or regional watersheds (Zhang 2009). National Hg emissions from domestic anthropogenic sources declined from about 63 tons in 2008 to about 55 tons in 2014, the latest data year available in the EPA National Emissions Inventory (EPA 2017). More than 75 percent of this decline (5.9 tons per year) can be attributed to reductions in Hg emissions from fossil-fueled electric generation plants (EPA 2017). Once deposited in a body of water, inorganic forms of mercury are converted to a chemical form (methyl mercury) that can become concentrated in fish and can harm the health of individuals who consume these fish, particularly children.

[9] 1 kilogram = 2.2lbs; 1 hectare = 2.5 acres.

In relatively arid regions, such as Idaho, dry Hg deposition may be a larger contributor to atmospheric deposition of mercury compared to wet deposition.

Annual averages of sampling data are available from the MDN in the region corresponding to the SGP far field analysis area. Three MDN sites have been located at CRMO, Deer Flats (294 km distant, south-southwest), and McCall, Idaho (59.5 km distant, west). The most recent measurements were between 2007 and 2010 and are provided in **Table 6-9** to serve as an estimate of historical Hg deposition in the region surrounding the SGP area. Total Hg deposition in precipitation (organic + inorganic) is calculated for the MDN in units of micrograms per square meter per year ($\mu g/m^2$-yr) based on measured mass of Hg deposited over a known sample area (NADP 2018).

Mercury Ambient Concentrations

In addition to deposition data, ambient mercury concentrations are measured via the NADP, specifically the Atmospheric Mercury Network (AMNet). AMNet has captured concentration data throughout North America beginning in 2006. AMNet has been in 39 sites throughout the years and 12 currently active locations. Each site measures hourly gaseous elemental mercury (GEM) and also measures 2-hour gaseous oxidized mercury (GOM) and particulate bound mercury ($PBM_{2.5}$). The nearest geographic site to the SGP area is no longer active but was active from December 2008 to August 14, 2017. **Table 6-10** illustrates the annual average concentrations of each component from December 2008 through November 2015. Only a very limit percentage of data was available from December 2015 through August 2017. For further information and concentrations for other locations please refer to http://nadp.slh.wisc.edu.

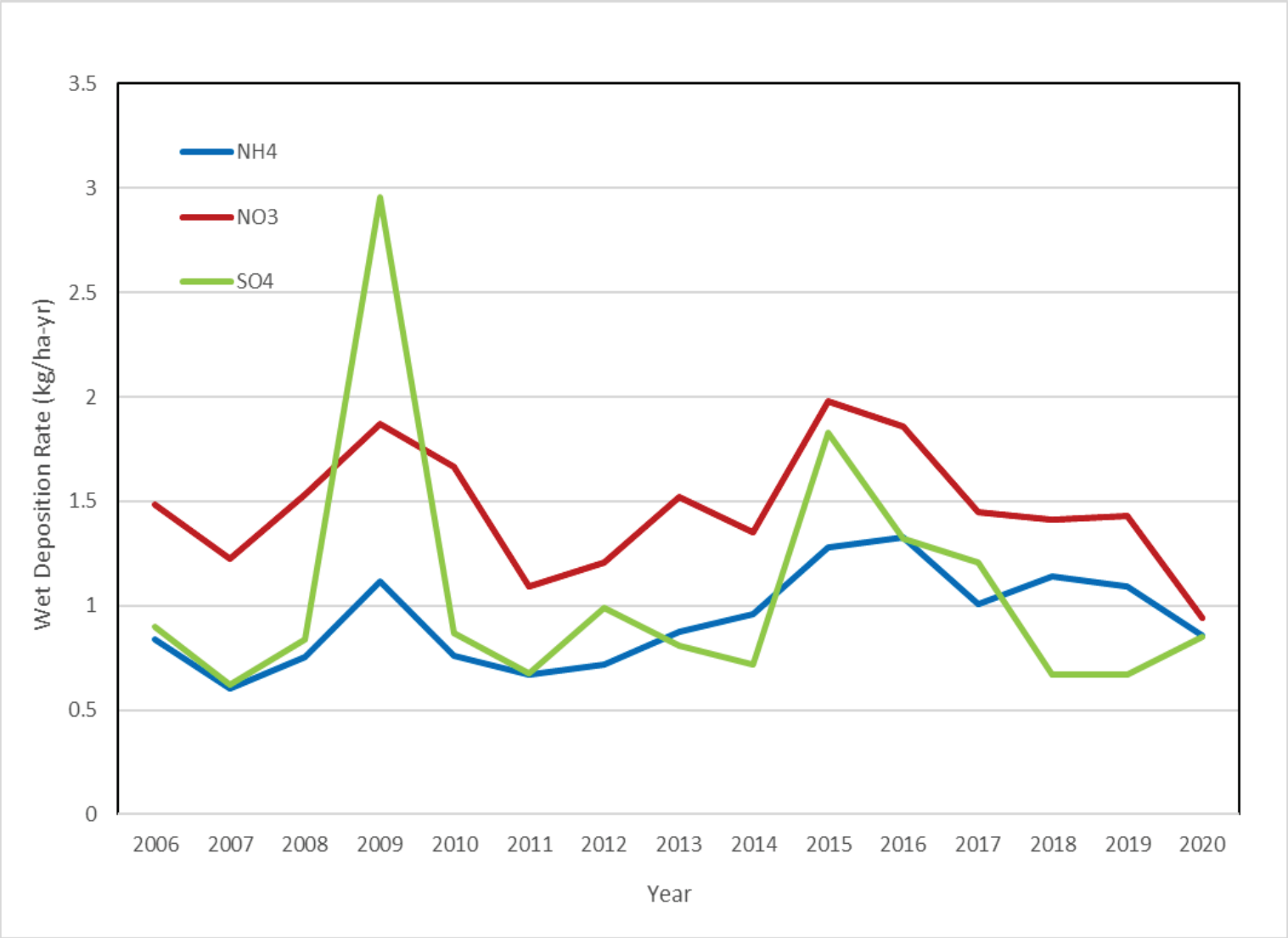
PET-0941

REC 2661

Table 6-5 NTN Speciated Wet Deposition, Annual Average – Craters of the Moon National Monument (Site ID03)

Year	Ca (kg/ha-yr)	Mg (kg/ha-yr)	K (kg/ha-yr)	Na (kg/ha-yr)	NH4 (kg/ha-yr)	NO3 (kg/ha-yr)	Total N (kg/ha-yr)	Cl- (kg/ha-yr)	SO4 (kg/ha-yr)	H+ (kg/ha-yr)
2006	0.336	0.034	0.054	0.092	0.839	1.485	0.987	0.149	0.899	0.005
2007	0.266	0.027	0.035	0.087	0.605	1.223	0.746	0.112	0.618	0.004
2008	0.348	0.038	0.038	0.086	0.752	1.534	0.931	0.167	0.838	0.011
2009	1.81	0.141	0.18	2.768	1.114	1.872	1.289	2.271	2.955	0.007
2010	0.506	0.047	0.04	0.209	0.759	1.664	0.966	0.253	0.87	0.012
2011	0.298	0.035	0.038	0.092	0.667	1.089	0.764	0.148	0.676	0.004
2012	2.084	0.175	0.14	0.608	0.72	1.204	0.831	0.806	0.986	0.003
2013	0.596	0.063	0.072	0.181	0.872	1.517	1.02	0.256	0.809	0.002
2014	0.413	0.048	0.075	0.13	0.959	1.348	1.049	0.214	0.715	0.006
2015	1.022	0.09	0.157	0.913	1.279	1.979	1.441	0.72	1.825	0.006
2016	2.141	0.171	0.265	1.454	1.324	1.858	1.449	1.531	1.32	0.010
2017	0.743	0.111	0.084	0.68	1.005	1.45	1.109	0.618	1.205	0.013
2018	0.58	0.067	0.064	0.253	1.142	1.409	1.207	0.536	0.671	0.005
2019	0.279	0.025	0.046	0.076	1.089	1.427	1.169	0.186	0.671	0.012
2020	1.27	0.139	0.106	0.7	0.856	0.94	0.878	0.66	0.85	0.004
Mean	0.85	0.081	0.093	0.56	0.93	1.47	1.06	0.58	1.06	0.01
Median	0.58	0.063	0.072	0.21	0.87	1.45	1.02	0.26	0.85	0.01

Table Source: NADP 2022
kg/ha-yr = kilograms per hectare per year
(1 kg = 2.2 lbs.; 1 hectare = 2.5 acres)
Ca = calcium N = nitrogen
Cl- = chloride Na = sodium
H+ = free acidity NH_4 = ammonium
K = potassium NO_3 = nitrate
Mg = magnesium SO_4 = sulfate



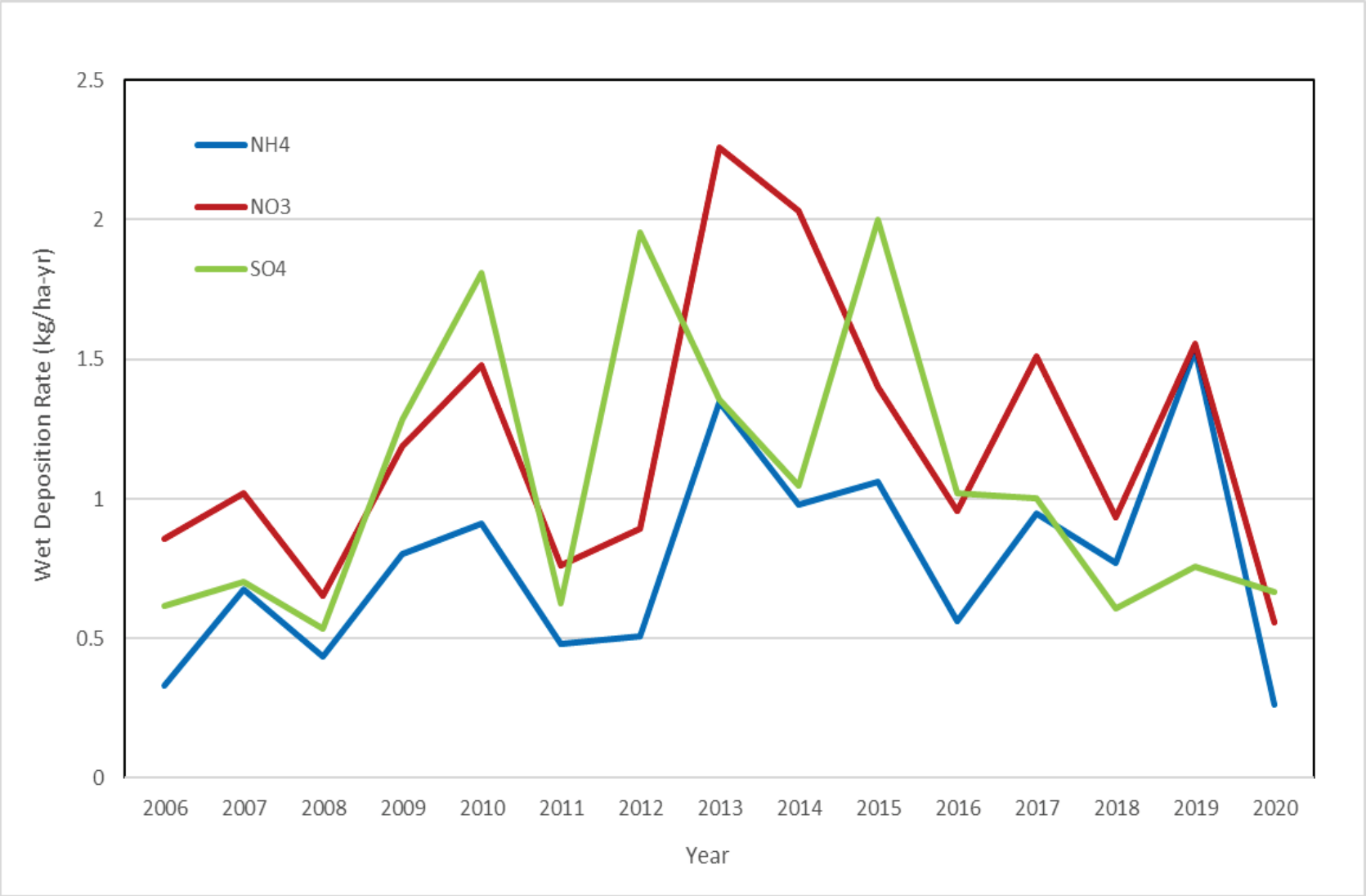
Source: NADP 2022
kg/ha-yr = kilograms per hectare per year; NH4 = ammonium; NO3 = nitrate; SO4 = sulfate

Figure 6-2 Trends in Wet Deposition Rates – Craters of the Moon National Monument, 2006-2020

Table 6-6 NTN Speciated Wet Deposition, Annual Average – Reynolds Creek (Site ID11)

Year	Ca (kg/ha-yr)	Mg (kg/ha-yr)	K (kg/ha-yr)	Na (kg/ha-yr)	NH_4 (kg/ha-yr)	NO_3 (kg/ha-yr)	Total N (kg/ha-yr)	Cl^- (kg/ha-yr)	SO_4 (kg/ha-yr)	H+ (kg/ha-yr)
2006	0.323	0.033	0.042	0.207	0.332	0.855	0.451	0.148	0.615	0.005
2007	0.315	0.033	0.05	0.214	0.674	1.021	0.754	0.157	0.704	0.005
2008	0.145	0.017	0.041	0.197	0.434	0.653	0.485	0.087	0.534	0.004
2009	0.51	0.063	0.118	0.584	0.802	1.188	0.891	0.237	1.284	0.004
2010	0.591	0.066	0.09	0.878	0.912	1.476	1.042	0.391	1.811	0.007
2011	0.297	0.035	0.056	0.402	0.481	0.762	0.546	0.3	0.627	0.006
2012	0.87	0.084	0.119	1.756	0.507	0.895	0.596	0.482	1.953	0.005
2013	0.6	0.072	0.118	0.321	1.347	2.257	1.556	0.244	1.357	0.006
2014	0.466	0.07	0.15	0.32	0.979	2.031	1.22	0.29	1.049	0.005
2015	0.809	0.078	0.13	1.519	1.061	1.399	1.141	0.515	1.998	0.003
2016	0.487	0.047	0.086	0.704	0.562	0.956	0.653	0.297	1.019	0.003
2017	0.785	0.076	0.116	0.535	0.948	1.512	1.078	0.354	1.002	0.009
2018	0.293	0.032	0.056	0.275	0.771	0.933	0.81	0.153	0.608	0.003
2019	0.243	0.028	0.076	0.149	1.533	1.554	1.543	0.163	0.758	0.006
2020	0.331	0.029	0.085	0.498	0.264	0.557	0.331	0.252	0.667	0.008
Mean	0.47	0.051	0.089	0.57	0.77	1.20	0.87	0.27	1.07	0.005
Median	0.47	0.047	0.086	0.40	0.77	1.02	0.81	0.25	1.00	0.005

Table Source: NADP 2022
kg/ha-yr = kilograms per hectare per year
(1 kg = 2.2 lbs.; 1 hectare = 2.5 acres)
Ca = calcium N = nitrogen
Cl- = chloride Na = sodium
H+ = free acidity NH_4 = ammonium
K = potassium NO_3 = nitrate
Mg = magnesium SO_4 = sulfate



Source: NADP 2022
kg/ha-yr = kilograms per hectare per year; NH4 = ammonium; NO3 = nitrate; SO4 = sulfate

Figure 6-3 Trends in Wet Deposition Rates – Reynolds Creek, 2006-2020

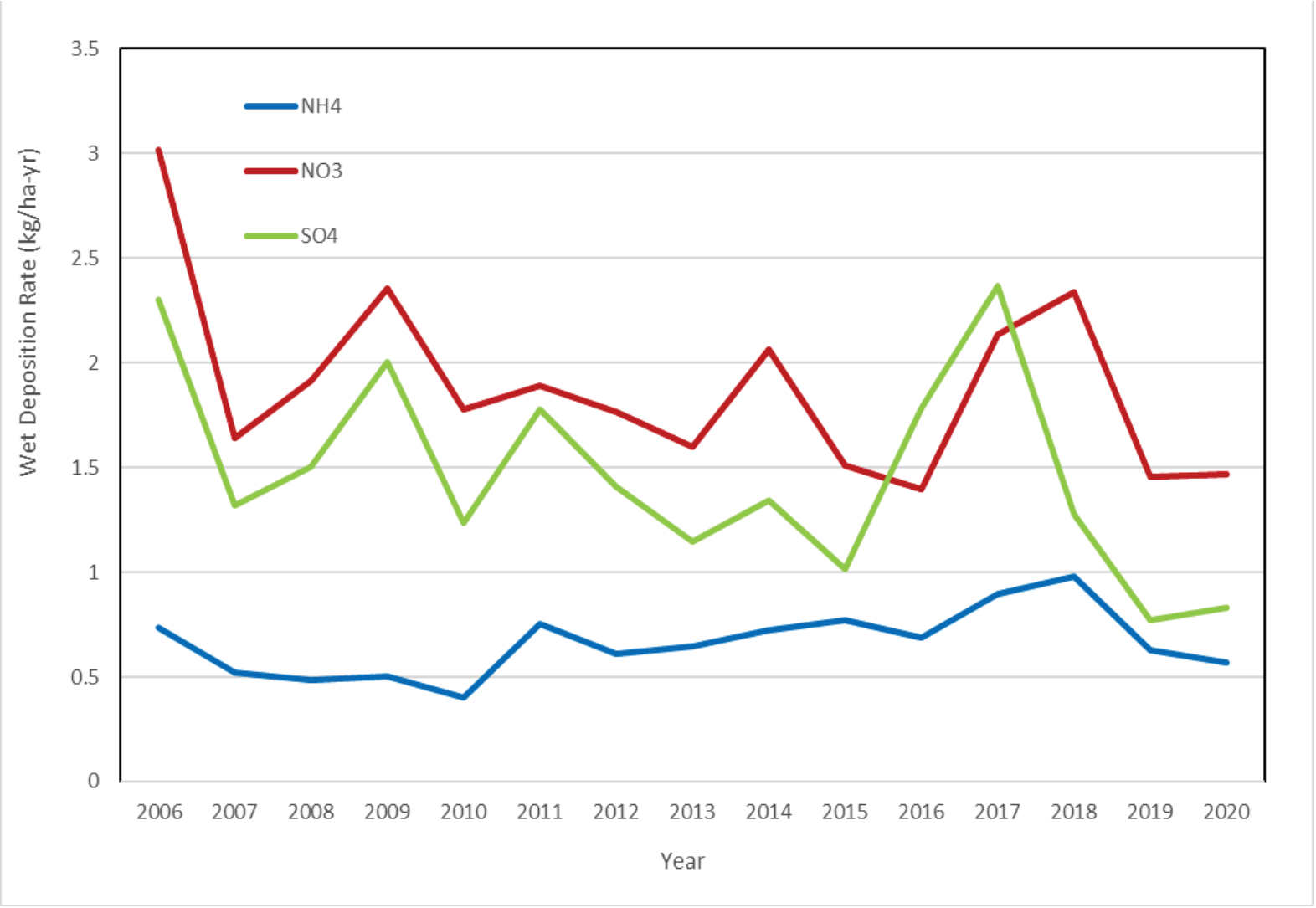
Table 6-7 NTN Speciated Wet Deposition, Annual Average – Lost Trail Pass (Site MT97)

Year	Ca (kg/ha-yr)	Mg (kg/ha-yr)	K (kg/ha-yr)	Na (kg/ha-yr)	NH_4 (kg/ha-yr)	NO_3 (kg/ha-yr)	Total N (kg/ha-yr)	Cl^- (kg/ha-yr)	SO_4 (kg/ha-yr)	H+ (kg/ha-yr)
2006	0.628	0.080	0.329	0.309	0.737	3.018	1.255	0.528	2.301	0.050
2007	0.378	0.048	0.078	0.174	0.523	1.638	0.777	0.252	1.318	0.035
2008	0.422	0.051	0.103	0.144	0.484	1.914	0.808	0.247	1.503	0.039
2009	0.481	0.059	0.226	0.383	0.501	2.356	0.921	0.52	2.003	0.051
2010	0.382	0.048	0.096	0.22	0.402	1.778	0.714	0.258	1.233	0.041
2011	1.15	0.114	0.125	0.41	0.751	1.89	1.011	0.569	1.776	0.042
2012	0.806	0.086	0.108	0.441	0.613	1.763	0.874	0.441	1.408	0.034
2013	0.338	0.047	0.15	0.197	0.648	1.597	0.864	0.357	1.146	0.033
2014	0.452	0.068	0.164	0.233	0.725	2.066	1.03	0.315	1.341	0.056
2015	0.37	0.047	0.133	0.645	0.768	1.508	0.938	0.313	1.015	0.038
2016	4.02	1.306	0.354	1.679	0.69	1.399	0.852	0.802	1.781	0.034
2017	5.468	1.562	0.373	1.761	0.898	2.134	1.18	1.119	2.367	0.047
2018	0.632	0.072	0.155	0.262	0.978	2.337	1.288	0.37	1.276	0.046
2019	0.278	0.037	0.093	0.121	0.63	1.455	0.819	0.213	0.769	0.038
2020	0.405	0.058	0.104	0.173	0.567	1.469	0.772	0.243	0.833	0.04
Mean	1.08	0.25	0.17	0.48	0.66	1.89	0.94	0.44	1.47	0.042
Median	0.45	0.06	0.13	0.26	0.65	1.78	0.87	0.36	1.34	0.040

Table Source: NADP 2022
kg/ha-yr = kilograms per hectare per year
(1 kg = 2.2 lbs.; 1 hectare = 2.5 acres)
Ca = calcium N = nitrogen
Cl- = chloride Na = sodium
H+ = free acidity NH_4 = ammonium
K = potassium NO_3 = nitrate
Mg = magnesium SO_4 = sulfate

PET-0946

REC 2666



Source: NADP 2022
kg/ha-yr = kilograms per hectare per year; NH_4 = ammonium; NO_3 = nitrate; SO_4 = sulfate

Figure 6-4 Trends in Wet Deposition Rates – Lost Trail Pass, 2006-2020

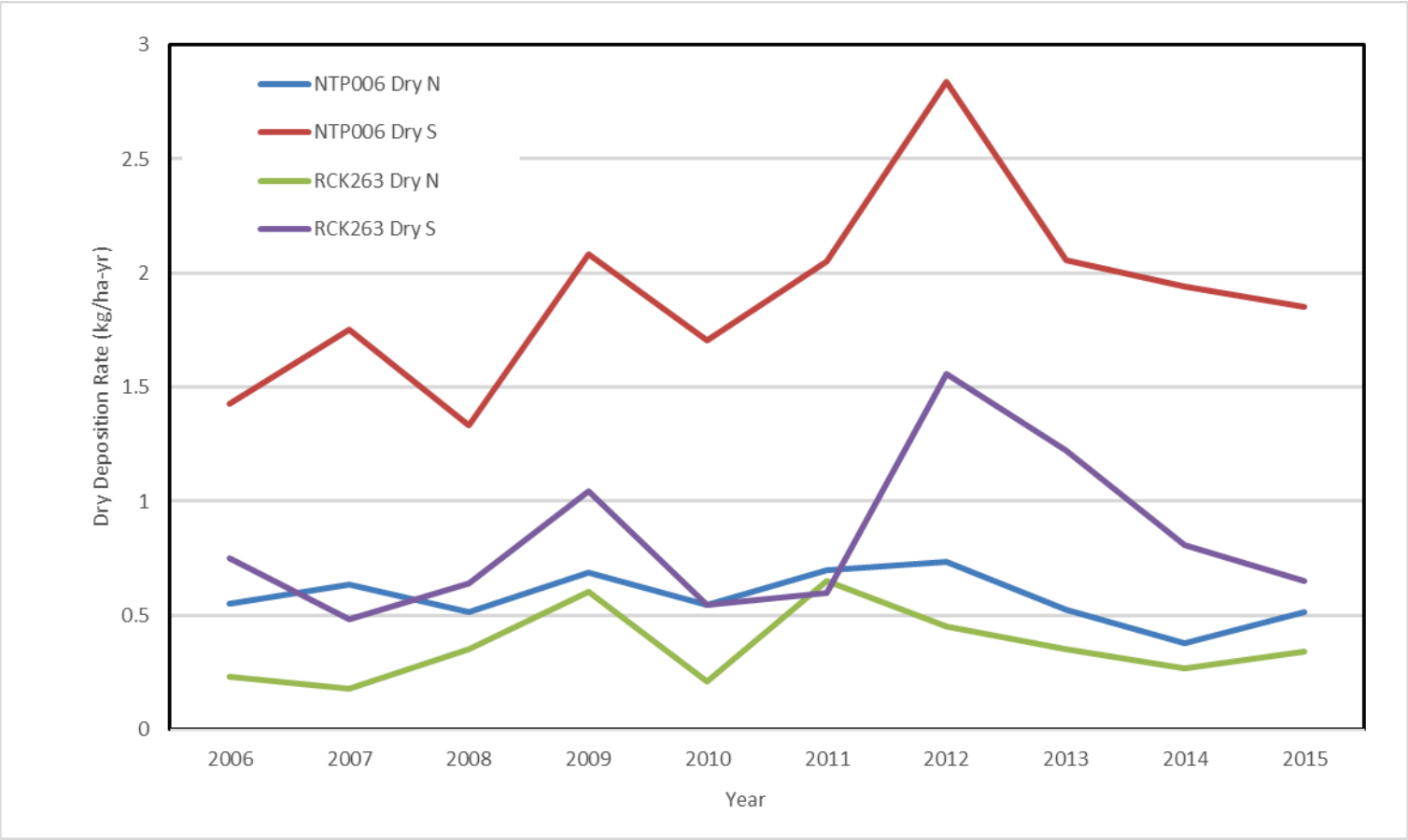
Table 6-8 CASTNET Dry Deposition Rates, Annual Average – Two Idaho Sites

Year	Site NTP006 Dry Nitrogen Deposition Rate (kg/ha-yr)	Site NTP006 Dry Sulfur Deposition Rate (kg/ha-yr)	Site RCK263 Dry Nitrogen Deposition Rate (kg/ha-yr)	Site RCK263 Dry Sulfur Deposition Rate (kg/ha-yr)
2007	0.553	1.425	0.233	0.751
2008	0.633	1.752	0.177	0.481
2009	0.513	1.334	0.350	0.643
2010	0.69	2.081	0.603	1.042
2011	0.547	1.704	0.210	0.545
2012	0.697	2.053	0.650	0.598
2013	0.733	2.837	0.453	1.560
2014	0.527	2.056	0.350	1.221
2015	0.377	1.941	0.267	0.806
2016	0.513	1.853	0.340	0.652
Mean	0.578	1.904	0.363	0.830
Median	0.550	1.897	0.345	0.702

Source: EPA 2018b
kg/ha-yr = kilograms per hectare per year
(1 kg = 2.2 lbs.; 1 hectare = 2.5 acres)
Site NTP0–6 - Nez Perce Tribal Land
Site RCK2–3 - Reynolds Creek

PET-0948

REC 2668



Source: EPA 2018b
kg/ha-yr = kilograms per hectare per year
Site NTP0–6 - Nez Perce Tribal Land; Site RCK2–3 - Reynolds Creek

Figure 6-5 Trends in Dry Nitrogen and Sulfur Deposition Rates, 2006-2016

PET-0949

REC 2669

Table 6-9 Historical Annual Average Concentration and Mercury Deposition Rates – Three Idaho MDN Sites

Year	Station Name (MDN ID) [1,2]	Precipitation Collected (dm/yr)	Average Precipitation Mercury Concentration (ng/L)	Mercury Deposition Rate (µg/m2-yr)
2007	Craters of the Moon NM (ID03)	2.01	14.10	2.83
2008	Craters of the Moon NM (ID03)	5.51	6.45	3.36
2009	Craters of the Moon NM (ID03)	3.91	16.71	6.53
2009	Deer Flats, ID (ID98)	2.15	10.56	2.27
2009	McCall, ID (ID99)	6.52	8.09	5.27
2010	Craters of the Moon NM (ID03)	3.91	14.03	5.48
Mean	All Stations	3.95	11.65	4.29

Table Source: NADP 2018
[1] Individual annual measurements for precipitation and mercury deposition data available for three sites: ID03 Craters of the Moon National Monument; ID98 Deer Flats, Idaho; ID99 McCall Idaho.
[2] The three MDN sites within the far field analysis area ceased operation by 2010.
µg/m^2-yr = deposition rate as micrograms mercury per square meter per year.
dm = decimeter (1 decimeter = 3.94 inches).
ng/L = nanograms per liter precipitation.

Table 6-10 Annual Average Mercury Concentration – Salt Lake City AMNet Site

Year	GEM Hourly Average Concentration (ng/m^3)	GOM Average Concentration (pg/m^3)	PBM2.5 Average Concentration (pg/m^3)
Dec 2008 – Nov 2009	2.15	20.14	15.22
Dec 2009 – Nov 2010	2.07	26.63	6.35
Dec 2010 – Nov 2011	1.83	17.06	8.44
Dec 2011 – Nov 2012	1.80	18.68	16.45
Dec 2012 – Nov 2013	1.87	16.80	22.22
Dec 2013 – Nov 2014	1.73	14.52	12.82
Dec 2014 – Nov 2015	1.74	15.17	8.87
Overall Mean	12.91	18.43	1.88

Table Source: NADP 2022
ng/m^3 = nanograms per cubic meter.
pg/m^3 = picograms per cubic meter
GEM = Gaseous elemental mercury
GOM = Gaseous oxidized mercury
PBM2.5 = particle bound mercury

6.1.5 Climate and Meteorology

The SGP is located in the central portion of the Salmon River Mountain Range, in central Idaho, approximately 10 air miles east of the village of Yellow Pine. The SGP Operations Area Boundary and the broader analysis area are classified as a Warm-Summer Continental Climate (Weatherbase.com). In this region, the climate typically ranges from warm, dry summers to cold, wet winters. However, the locale of the SGP is semi-arid as a result of the Cascade and Sierra Nevada mountains to the west and the Bitterroot and Rocky Mountains to the north, which effectively prevents large scale intrusion of Pacific moisture.

As described by the Western Regional Climate Center (WRCC), organized storm fronts frequently move through the region during winter, resulting in cold outbreaks, and can produce snowfall over 2 feet or more. Cloudy and unsettled weather is common during the winter with measurable precipitation occurring roughly a third of the days. The summer months are typically dominated by high pressure over the Great Basin resulting in warm days with very little precipitation. In general, temperatures in the cooler months average below 30 degrees Fahrenheit (°F) and average above 50°F during the warmer months (WRCC 2018a, 2018b).

Spring months are normally wet and windy with periods of high winds that may persist for days at a time. Weather conditions fluctuate quickly during the spring. Afternoon temperatures in the range of 30 to 50°F with precipitation in the form of rain or snow may occur interspersed with periods of sunny skies and afternoon temperatures between 50 to 70°F. Thunderstorms are not uncommon and are usually accompanied by rain showers and occasional snow. Low elevation snowpack usually melts quickly during the spring, but high elevation snowpack can persist into June or later in the year (WRCC 2018a, 2018b).

The nearest location with a long-term climatological data record is the McCall, Idaho, municipal airport station, which is located approximately 37 air miles west and 1,575 vertical feet below the SGP. The McCall National Weather Service station also monitors surface temperature, dew point and wind speed, direction, and highest gust speed (National Oceanic and Atmospheric Administration 2018). While regionally representative, it can be assumed that the McCall airport data will be slightly warmer with lower amounts of precipitation due to its lower elevation compared to the SGP. The average maximum annual temperature is 54ºF and during the warmest month (July) the average maximum monthly temperature is 81ºF. The average minimum annual temperature is 27ºF and during the coldest month (January) the average minimum monthly temperature is 11ºF (National Oceanic and Atmospheric Administration 2018). **Table 6-11** provides the daily average temperature range parameters for the McCall station for the years 1997 to 2008 (WRCC 2018b). The daily average minimum and maximum temperatures for each month recorded in for McCall also are plotted in **Figure 6-6.**

Table 6-11 Average Temperature Data from McCall National Weather Service Site

Data	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg.
Avg. Max Temp (F)[1]	28.6	32.5	39.3	47.8	58.8	67.6	80.4	78.1	67.9	54.5	39.5	28.2	51.9
Avg. Min Temp (F)[1]	10.4	9.9	16.6	24.5	32.6	37.6	44.1	41.2	33.5	25.6	19.4	11.0	25.5

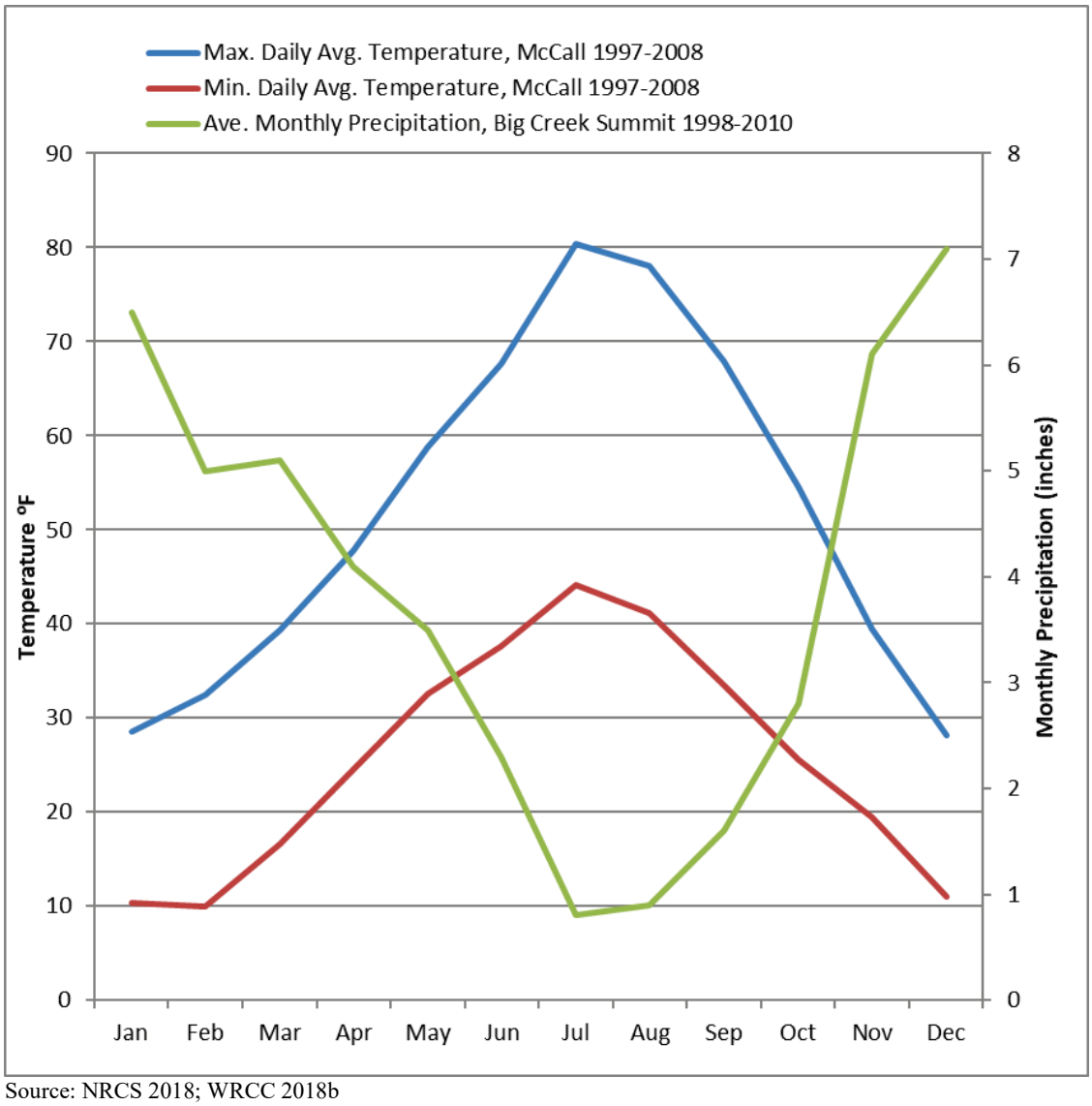
Source: McCall Municipal Airport (WRCC 2018b)
[1] Data from the McCall Municipal Airport, National Weather Service Station averaged from 1997 to 2008.
°F = degrees Fahrenheit; Avg. = average

The Big Creek Summit Site is operated by the National Water and Climate Center's Snow Telemetry (SNOTEL) network. The site is located 28 miles southwest of the SGP at approximately the same elevation and latitude. The site provides data for surface temperature, precipitation, snow water equivalent, and snow depth. The monthly average precipitation and snowfall information for the Big Creek Summit Site can be considered representative of the SGP and is shown in **Table 6-12** (National Resources Conservation Service [NRCS] 2018). Although the climatological data is quoted for different spans of years, this available data provides covers sufficiently long periods to provide representative average values for historical climate description.

Table 6-12 Average Precipitation Data from Big Creek Summit SNOTEL Site

Data	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg.
Avg. Precipitation Increment(in)[1]	6.9	5.1	5.7	4.4	3.4	2.6	0.7	0.8	1.4	3.1	5.5	7.8	4.0
Snow Water Equivalent (avg, in)[1]	13.0	20.0	25.3	30.4	27.9	10.0	0.0	0.0	0.0	0.0	1.0	7.8	11.3
Snow Depth (avg, in)[2]	49.4	66.7	77.3	82.3	63.2	18.1	0.0	0.0	0.0	0.0	2.6	19.3	31.6

Source: Big Creek Summit Site (NRCS 2021)
[1] Data from the Big Creek Summit SNOTEL Station averaged from 1991 to 2020.
[2] Data from the Big Creek Summit SNOTEL Station averaged from July 2000 to January 2020.
avg. = average; in = inch



Source: NRCS 2018; WRCC 2018b

Figure 6-6 Temperature Range Data for McCall, Idaho, and Monthly Precipitation for Big Creek Summit SNOTEL Site

6.1.5.1 Temperature

Between 2010 and 2014, the maximum hourly temperature recorded at the McCall site was 95°F during 2013. Typically, the maximum hourly temperature occurred during July or August. The minimum hourly temperature recorded at the McCall site was -18°F during 2010. In winter, the minimum hourly temperature occurred on numerous days between December and February. Diurnal temperature ranges were the largest in the warmer months (April to September) and decreased during the cooler months (WRCC 2018b). The maximum and minimum daily average temperatures between 1997 and 2008 are shown on **Figure 6-6**.

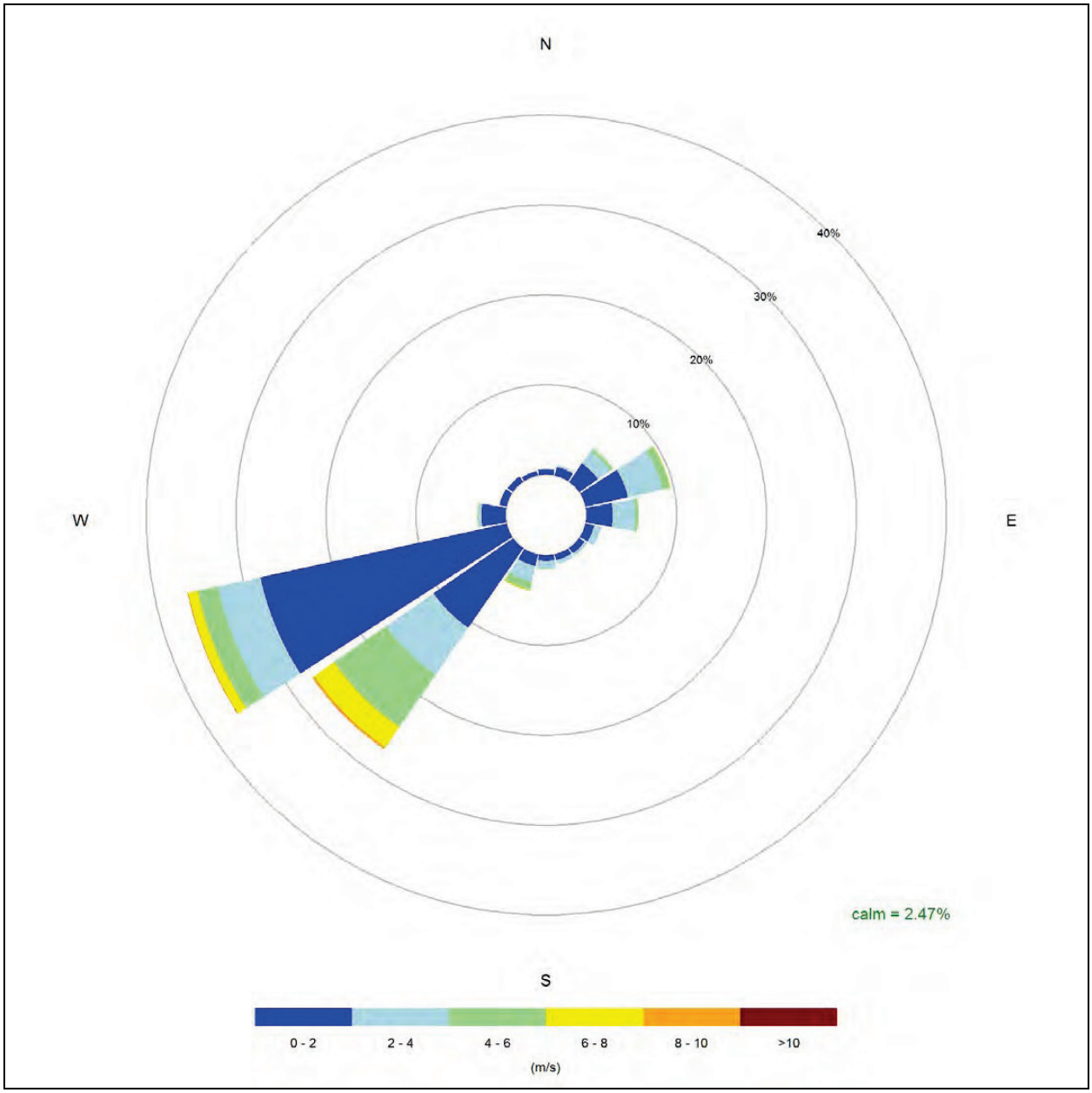
The hourly temperatures recorded at the Big Creek Summit site would be comparable to the SGP, as this station is at the same elevation. Between 2010 and 2014 highest hourly temperature was 90°F, recorded during 2013. Typically, the maximum hourly temperature occurred during July or August. The minimum hourly temperature recorded at the Big Creek Summit site was -13°F during 2010. Typically, the minimum hourly temperature occurred on numerous days between December and February. Diurnal temperature ranges were the largest in the warmer months (April to September) and decreased during the cooler months (National Oceanic and Atmospheric Administration 2018).

6.1.5.2 Precipitation

Precipitation data for the Big Creek Summit SNOTEL site over the period 1991 to 2020 show that monthly average totals range from 5 to 8 inches per month during the cool months (November - March) primarily in the form of snow. The summer is dry, with monthly average precipitation typically less than 2 inches per month from June through September. Annual precipitation accumulation recorded at the Big Creek Summit site was approximately 51.4 inches in 2010, 47.1 inches in 2011, 54.9 inches in 2012, 35.6 inches in 2013, and 52.8 inches in 2014.

6.1.5.3 Wind

Baseline wind speed and direction data at the Stibnite monitoring station were collected from November 2013 to June 2015. During this period, the strongest winds were from the southwest and from the west-southwest. The mean wind speed was 2.3 meters per second (5.2 miles per hour). Wind directions had a strong tendency from the southwest. Speeds varied widely but tended to be strongest from the southwest. The Stibnite wind distribution data collected at the on-site meteorological station from January 2014 to December 2014 are shown in **Figure 6-7** (Air Sciences 2018a).



Source: Air Sciences 2018a

Figure 6-7 Wind Distribution – Stibnite SGP, 2014

7.0 Environmental Consequences

7.1 Impact Definitions

The impacts definitions for intensity, duration (FSH 1909.15, 152b), and context are provided in **Table 7-1** (Forest Service 2012).

Table 7-1 Impact Definitions

Attribute	Term	Description
Intensity	Negligible	Impacts would result in a change in current conditions that would be too small to be physically measured using normal methods or would not be perceptible. There is no noticeable effect on the natural or baseline setting. There are no required changes in management or utilization of the resource.
Intensity	Minor	Impacts would result in a change in current conditions that would be just measurable with normal methods or barely perceptible. The change may affect individuals of a population or a small portion of a resource, but it would not result in a modification in the overall population, or the value or productivity of the resource. There are no required changes in management or utilization of the resource.
Intensity	Moderate	Impacts would result in an easily measurable change in current conditions that is readily noticeable. The change affects a large percentage of a population, or portion of a resource which may lead to modification or loss in viability, value, or productivity in the overall population or resource. There are some required changes in management or utilization of the resource.
Intensity	Major	Impacts are considered significant. Impacts would result in a large, measurable change in current conditions that is easily recognized. The change affects a majority of a resource or individuals of a population, which leads to significant modification in the overall population, or the value or productivity of the resource. This impact may not be in compliance with applicable regulatory standards or impact thresholds, requiring large changes in management or utilization of the resource.
Duration	Temporary	Impacts that are anticipated to last no longer than 1 year.
Duration	Short-Term	Impacts that are anticipated to begin and end within the first 3 years during the construction phase.
Duration	Long-Term	Impacts lasting beyond 3 years to the end of mine operations and through reclamation, approximately 20 years.
Duration	Permanent	Impacts that would remain after reclamation is completed.
Context	Localized	Impacts would occur within the analysis area or the general vicinity of the Operations Area Boundary.
Context	Regional	Impacts would extend beyond the Operations Area Boundary and local area boundaries.

Intensity is the severity or levels of magnitude of an impact.
Duration is the length of time an effect would occur.
Context is the effect(s) of an action that must be analyzed within a framework, or within physical or conceptual limits).

7.2 Direct and Indirect Effects

7.2.1 No Action Alternative

In the No Action Alternative, there would be no surface (open-pit) mining or ore processing to extract gold, silver, and antimony, as described for the action alternatives. Therefore, the air emissions described in **Section 7.2.2** for the 2021 MMP or similar emissions for other action alternatives, would not occur. Perpetua may continue to implement surface exploration and associated activities that have been previously approved on NFS lands as stated in the Golden Meadows Environmental Assessment (Forest Service 2015b). Air emissions and related minor impacts for these activities, which are much lower than emissions under the action alternatives, would continue. These approved activities include construction of several temporary roads (approximately 0.32 mile of temporary roads) to access drill sites (total of 28 drill sites), drill pad construction (total of 182 drill pads) and drilling on both NFS and private lands at and in the vicinity of the SGP. Construction of these facilities in the future would result in temporary air quality effects due to earthmoving and equipment tailpipe emissions, which are described in the Golden Meadows Exploration Project Environmental Assessment (Golden Meadows EA) (Forest Service 2015b).

Perpetua would be required to continue to comply with reclamation and monitoring commitments included in the Golden Meadows EA, which include reclamation of the drill pads and temporary roads by backfilling, re-contouring, and seeding using standard reclamation practices, and monitoring to ensure that sediment and stormwater best management practices are in place. These construction and reclamation activities would result in temporary and intermittent air quality effects due to earthmoving and equipment tailpipe emissions.

In January 2021 Midas Gold (now Perpetua) entered into an ASAOC with the Forest Service and USEPA for removal actions at the Stibnite legacy mining site. Phase 1 of this agreement includes removal of tailings and other mining wastes from the stream channels of lower Meadow Creek and East Fork SFSR and placing the excavated wastes in selected, on-site locations where they would no longer impact water quality in these streams. It also includes construction of three stream diversions to avoid contact of runoff with legacy mining wastes. There would be temporary air quality effects related to the earthmoving and tailpipe emissions from the construction equipment and vehicles used to access the site. This work is planned to occur between 2022 and 2024.

If none of the action alternatives proceed, the current uses by Perpetua and other users on patented mine/mill site claims and on the Payette National Forest and Boise National Forest would continue to follow all existing applicable air quality regulations. Uses of NFS lands that may result in air pollutant emissions include mineral exploration, dispersed off-highway-vehicle use, snowmobiling, and other forms of recreation.

7.2.2 2021 MMP

7.2.2.1 Construction and Operations Description

The construction of the 2021 MMP includes building power transmission, access roads, and mining/processing facilities. These operations are to be performed during LOM 1 through LOM 3. Mine operations would begin in LOM 4 through LOM 18. Access road construction would consist of development of the Burntlog Route for mine access and minor improvements for the Johnson Creek route. Also, while the Burntlog Route is being developed, a temporary groomed OSV trail would be constructed on the west side of Johnson Creek from Trout Creek to Landmark for public access. Other public access

construction would be a Cabin Creek Road groomed OSV trail. Eight borrow sources along the Burntlog Route would also be constructed.

During operations, public access through the site would be provided by constructing a new road around the Yellow Pine pit and below the mine haul road to link Stibnite Road to Thunder Mountain Road. Public access would also be allowed on the Burntlog Route.

Lastly, operations would include communication towers and an offsite logistics and road maintenance facility. A cell tower would be located north of the Hangar Flats pit with very high frequency repeater sites. There would also be a communication site at the SGLF with upgrades to the existing site. The Burntlog maintenance facility would be located approximately 4.4 miles east of the junction of Johnson Creek Road and Warm Lake Road along the proposed Burntlog Route.

7.2.2.2 Construction and Operations Air Emissions Inventory

Air pollutant emissions were initially estimated for activities and process sources included in the 2021 MMP for each LOM year. The LOM years presented in this discussion are based on years starting with LOM 1 as the first year of construction. As discussed in **Section 5.3.3**, LOM 6 is expected to produce the highest overall annual total of criteria pollutant emissions.

Air pollutant emission point sources for the construction phase would include engine-driven generators, portable conical crusher and screens, diesel-fired heaters, and engine-driven air compressors. The fugitive sources related to mine construction and operations would be haul, access, and construction road dust from vehicle travel during the pre-production years, as well as earth-moving equipment, material transfers, storage in several construction stockpiles and waste rock piles, tailpipe emissions and exploratory activities. The use of ammonium nitrate/fuel oil explosives also would be considered a mine construction phase source, as well as an ongoing operations phase source.

In the air emissions inventory, mining and ore processing operations are assumed to be capable of continually operating 365 days per year, so annual emissions, and ambient air and visibility impacts, were derived for that schedule. Most of the construction activities also are assumed to occur at a consistent rate for 355 days per year. Consideration of these schedules allowed emissions to be estimated on a daily-average and hourly bases for modeling purposes. This assumed schedule may produce an overprediction as weather conditions would affect the construction schedule and would suggest higher daily activity during the months of May through November, and higher short-term emission rates at these times. Details regarding the emission source roster, operating assumptions, and resulting emissions estimates are provided in **Appendix A**.

Starting in LOM 4 (after up to 3 years of construction and pre-production activities), construction and mining activity emission sources would consist of conventional open-pit methods to extract ore and waste rock, including drilling, blasting, excavating, limestone production and hauling. The point sources for the operations phase, generally beginning in LOM 4, include many of the same sources that would be used during mine construction. Added emission sources beyond the construction phase would consist of portable and stationary engine-driven generators, two propane-fired heaters for intake vent air, the primary jaw crusher system, and the mill building sources (Midas Gold 2016).

Control measures for air pollutant emissions are incorporated at each step of the mining and processing operations. Air pollution control measures that were proposed by Perpetua are common to both action alternatives. For the 2021 MMP, emission control devices and designs would be put in place to abate emissions of particulate matter, Hg, and criteria pollutant emissions from internal combustion engines.

Assessments of near-field and far-field impacts take these measures into consideration by applying emission factors based on data that include emission controls in compiling the SGP inventory. For off-highway truck travel, the efficiency of dust suppressants was based on vendor information (Air Sciences 2018c).

Tailpipe emissions for off-highway diesel engines included in the SGP are controlled by use of engines that meet Tier IV or better EPA performance standards (e.g., stationary internal combustion new source performance standards, 40 CFR 60, Subparts IIII and JJJJ). Roadway dust and tailpipe emissions from vehicle travel on Burntlog Route from the SGP to Landmark also were calculated for both construction and operation periods. The traffic emissions included projected workforce, supply, and haulage vehicles (buses, light, and heavy trucks) and road maintenance equipment (graders and dozers).

Perpetua would design, construct, and operate SGP facilities with air pollution controls stipulated in applicable regulations and the air quality permit issued by IDEQ. The Idaho PTC issued June 17, 2022, includes stipulations that are based on applicable state and federal regulations, and that are consistent with best available control technology for new surface mining and processing operations. Details on the control measures and estimated control effectiveness for the action alternatives, including additional measures that would be stipulated by the Forest Service, are provided in **Section 2.4**. Specific examples include:

- Adherence to a robust fugitive dust control plan, containing standard operating procedures for dust control, surveillance, record-keeping, and reporting as may be required under best operating practices and/or conditions of air permits under IDEQ.
- The main ore processing facility building, and coarse ore stockpile would be enclosed.
- Water sprays and dust collection systems for ore processing facility material handling activities would be installed.
- Water sprays and/or bag house dust collectors would be installed at the ore-crushing system and at ore reclaim feeders that deliver ore to the grinding circuit.
- Hg emission controls, including particulate filters and carbon adsorption filters, would treat exhaust from the precipitate retort, autoclaves, carbon regeneration kiln, and induction furnaces.
- Internal combustion engines used for the construction and operational phases (diesel- or gasoline-powered) would be maintained in a manner that would promote fuel-efficient operation, and thereby reduce tailpipe emissions.
- Off-highway diesel engines would be rated for EPA Tier IV or better emission performance; operated in compliance with federal air quality applicable to internal combustion engines (e.g.,40 CFR 60, Subparts IIII and JJJJ); and would observe limitations required by IDEQ air quality rules.
- Ultra-low sulfur diesel fuel would be used for mobile sources and stationary diesel engines, to comply with state regulations.

Figure 7-1 presents the annual emissions inventory used in the 2021 MMP air analyses for the criteria pollutants for each LOM construction and operation year as derived from the maximum operating schedule for each type of operation. The construction emissions occur primarily in the pre-production year years (LOM 1 through LOM 3), the mining emissions and ore processing emissions occur from

LOM 4 through LOM18. Emissions from certain mine construction components that continue during the mine operation years are included with the applicable LOM year mining emissions. Note that the maximum potential ore processing emissions would not vary over the life of the mine. This is because ore processing emissions were calculated conservatively based on constant operation at the maximum daily ore production rate of 25,000 tpd, regardless of actual yearly ore production rates each day of the year. The maximum emission rate LOM 6 shown in **Figure 7-1** was selected as the emission inventory basis for detailed 2021 MMP assessment. Note that NAAQS compliance dispersion was conducted for all criteria pollutant for both LOM 6 and LOM10. A separate full regulatory assessment was completed for the IDEQ PTC process and will not be discussed in this report (refer to the State of Idaho SOB on the IDEQ website for details).

The maximum annual pollutant emissions for the 2021 MMP analyses for each LOM year are further detailed in **Table 7-2**. The highest aggregated controlled criteria pollutant annual emissions (including fugitives) would be approximately 1,260 tons per year (tpy) and are predicted to occur in LOM 6, which would be the highest ore production year (289.7 PM_{10}, 65.9 $PM_{2.5}$, 535.4 CO, 335.3 NO_x, 7.3 SO_2 and 26.1 VOC). The corresponding individual source emissions were taken as the basis for the air dispersion modeling analyses described in **Sections 5.4** and **7.2.2.2**. The variation in annual emissions reflects the progression in levels of mining activity in different open pits, and differing levels of haul road transport for the pits during their development (Air Sciences 2018a).

The predicted annual emissions summaries by source category for each criteria pollutant are provided in **Table 7-3**. It should be recognized that the stationary sources represented by the process and auxiliary category are the sources used to determine the applicability of Title V and PSD major source permitting status (mobile sources are excluded from the applicability analysis). As shown in **Table 7-3**, these emissions are less than the annual threshold of 100 tpy that would trigger Title V or 250 tpy for PSD permitting status. Emissions of particulate matter (total suspended particulate [TSP], PM_{10}, and $PM_{2.5}$) from fugitive sources represent the largest contributor to overall emissions. The operation of off-highway trucks and fuel-combusting equipment would constitute the largest sources of CO and NO_x. Due to the low sulfur content of liquid fuels that would be used for the equipment at the SGP, and the more stringent federal emission standards for the recent model-year diesel engines, the emissions of SO_2 and VOC are relatively low.

Dust and tailpipe emissions due to the travel of off-highway trucks and other vehicles were accounted for in the dispersion modeling within the SGP Operations Area Boundary, in the mined pits, and along the Burntlog Route from the SGP. As listed in **Table 7-3**, these emissions were based on the access road and mine road configuration proposed in the 2021 MMP. The estimated operations phase emissions for SGP vehicle travel alongWarm Lake Road (CR 10-579) from Landmark to Cascade also are estimated (**Appendix A**).

The level of traffic and related vehicle emissions impacts beyond the town of Cascade, such as the transportation of supplies and personnel to the SGP or the shipping of antimony concentrate from the SGP, are not sufficiently predictable to be quantified. Nor is that potential unique to the SGP. The vehicles involved in this off-site transportation activity have separate utility only related to the SGP and are operating in relatively large areas where any potential emissions are relatively small compared to the baseline conditions. Based on current estimates, transport of concentrate would require two truck trips per day, so the contribution to SGP emissions would be minimal (~2.9 percent or 2 of 68 AADT during mine operation traffic). However, for informational purposes, emission factors per mile of travel for fully-loaded heavy transport trucks are provided in the Air Quality Analysis report for the 2021 MMP emission inventory (Air Sciences 2021a).

PET-0959

REC 2679

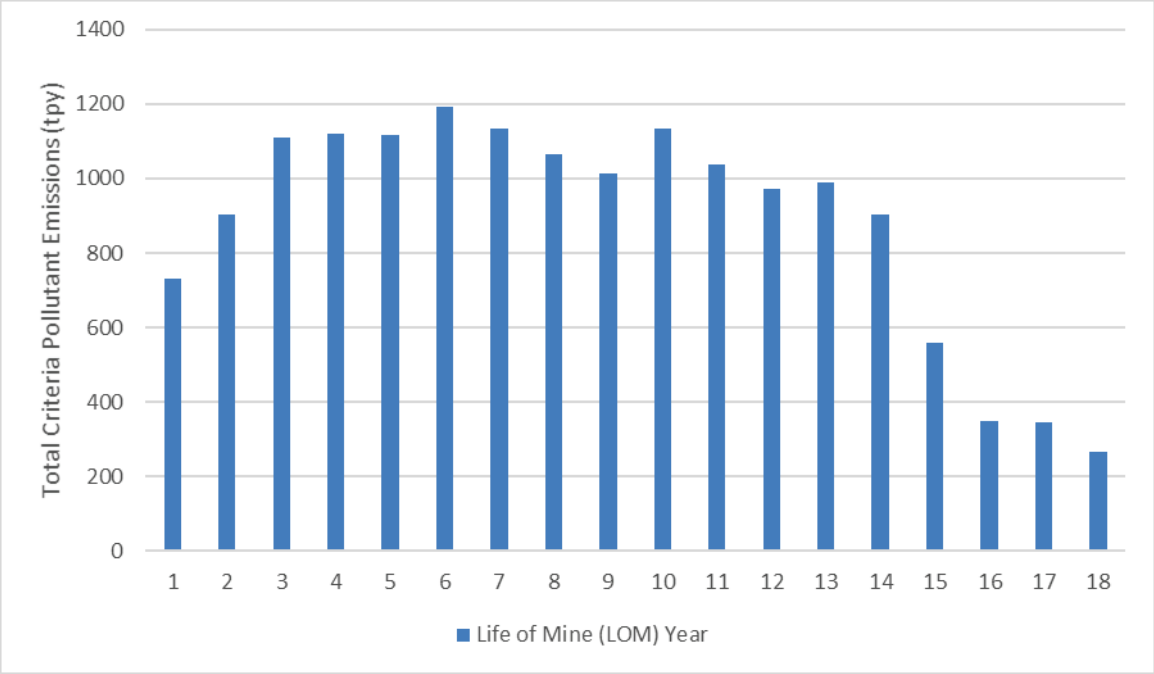


Figure Source: Total Controlled Emissions Data from Air Sciences 2021a. See **Table 7-2** for individual pollutant components.
Note: Life-of-Mine Years shown on the figure use the timeline proposed for the SGP. Perpetua timelines presented in the 2021 MMP (Perpetua 2021a) start with years -3 through -1 being construction phase, which and equate to Years 1 through 3 in this timeline.

Figure 7-1 Timeline of Maximum Annual Emissions by Life-of-Mine Year

Table 7-2 Maximum Controlled Criteria Pollutant Emissions Summary by LOM Year

LOM Year [1, 2]	TSP (tpy)	PM_{10} (tpy)	$PM_{2.5}$ (tpy)	CO (tpy)	NO_X (tpy)	SO_2 (tpy)	VOC (tpy)	Total Criteria Emissions[3] (tpy)
1	208.0	61.7	14.7	461.7	156.2	0.8	52.3	732.5
2	302.3	92.2	24.3	531.3	220.8	0.9	56.8	902.0
3	544.0	145.6	28.5	641.2	272.1	1.1	50.9	1,110.9
4	923.1	268.8	63.9	495.6	323.7	7.3	26.5	1,121.8
5	922.8	270.4	64.7	491.3	323.0	7.3	26.3	1,118.3
6 [4]	995.3	289.7	65.9	535.4	335.3	7.3	26.1	1,193.8
7	904.7	267.7	63.3	506.3	326.1	7.3	26.0	1,133.4
8	834.7	249.9	62.1	480.1	301.9	7.2	26.0	1,065.1
9	871.5	255.3	62.6	459.2	268.7	7.2	25.0	1,015.3
10	1,130.6	320.1	69.1	478.6	304.6	7.2	24.9	1,135.4
11	848.3	250.9	61.5	473.2	282.7	7.2	24.2	1,038.1
12	744.7	224.3	58.2	460.1	258.3	7.1	23.1	972.9
13	749.9	225.8	59.1	471.0	262.5	7.1	23.4	989.8
14	796.7	237.3	60.4	392.8	245.3	7.1	20.8	903.3
15	491.4	159.1	51.0	239.0	139.2	6.9	15.2	559.4
16	346.8	119.9	46.5	122.6	88.0	6.7	12.2	349.4
17	370.7	126.3	46.4	107.5	91.4	6.7	11.3	343.2
18	271.0	101.5	43.2	83.7	63.7	6.6	9.9	265.4

Source: Air Sciences 2021a

[1] The LOM Years presented on the table represent LOM Years as numbered in this report. Perpetua Resource's Refined Proposed Action ModPro2 (Perpetua 2021) portrays the pre-operation years as negative numbers, so LOM years are numbered as -3, -2, -1, 1 through 15.

[2] LOM 1 through LOM3 represent construction and pre-production period. Mining and processing operations are fully active in LOM 4.

[3] Total 2021 MMP emissions are the sum of PM_{10}, CO, NO_X, SO_2, and VOC emission rates. $PM_{2.5}$ is a portion or subset of PM_{10}. TSP is not a criteria pollutant per the EPA and is more of a nuisance pollutant.

[4] The highest overall annual emissions would occur in LOM 6, which corresponds to the year of highest predicted annual mine output.

Table 7-3 Maximum Annual Criteria Pollutant Emissions Summary – LOM 6

Source Category	CO (tpy)	NO_X (tpy)	TSP (tpy)	PM_{10} (tpy)	$PM_{2.5}$ (tpy)	SO_2 (tpy)	VOC (tpy)
Processing & Refining	30.6	38.0	86.7	55.8	35.9	6.5	5.3
Mining Pit/Tailings Activity[1]	157.0	107.7	51.9	13.0	6.2	0.3	8.8
Blasting[2]	240.1	6.5	20.6	10.7	0.6	0.01	--
Stockpiles[3]	--	--	0.6	0.3	0.04	--	--
Process Area	5.7	4.3	0.3	0.2	0.1	0.01	0.3
Hauling	96.7	173.8	721.9	180.7	20.0	0.5	11.1
Access Roads/Heliport	5.3	4.9	113.2	29.1	3.1	0.02	0.6
Mining Activity Total (does not include Processing/Refining)	504.9	297.2	908.6	233.9	30.0	0.8	20.8
Total (Mining, Processing and Refining)[4]	535.4	335.3	995.3	289.7	65.9	7.3	26.1

Source: Air Sciences 2021a

[1] Mining pits include: the Yellow Pine, Hangar Flats and the West End pits. The Tailings include Bradley Tailings and the tailings storage facility.

[2] Blasting emissions are the aggregate total from the three pits mentioned above.

[3] Emissions are the aggregate total from the Hangar Flats and Limestone stockpiles.

[4] Mobile sources and fugitive sources are included in the total emissions. Mobile sources are not included in the permit applicability and fugitive emissions are not considered unless the project is one of 27 PSD list Source Categories. SGP is not a PSD listed source category.

Most of the HAP emissions from operations come from the combustion of fossil fuels and fugitive dust containing trace metals. Other HAP emissions include:

- Hg from gold ore refining sources (e.g., autoclave, carbon kiln, retort, and induction furnaces);
- Hg from exposed surfaces (stockpiles, development rock, tailings, and pits);
- Fugitive dust containing Hg released from mining and ore processing activities;
- HCN volatilization from the dilute cyanide solution in leach tanks, carbon-in-pulp tanks, and HCN detoxification tanks; and
- TSF impoundment of process tailings that would contain trace amounts of residual HCN.

The annual HAP and toxic pollutant emissions for LOM 6 are listed in **Table 7-4**, with Hg reported in pounds per year, and the other toxics in tpy. Details regarding the HAP and air toxics operating assumptions, and resulting emissions estimates for the 2021 MMP, are provided in **Appendix A**. Additionally, facility-wide dispersion modeling was conducted for all HAPs and compared to the IDEQ acceptable ambient non-carcinogenic and carcinogenic concentrations (AAC/AACC) as defined in IDAPA 58.01.01.585/586. Please refer to **Section 7.2.2.2** for further details.

Regarding HCN emissions from gold mines, the EPA has examined U.S. gold ore processing and production facilities and concluded that measurements of HCN concentrations at these gold facilities "showed ambient concentrations below levels of public health and environmental concerns" (EPA 2010a). The latter determination was based on several fence-line monitoring studies directed by EPA to measure HCN concentrations downwind of the gold facilities, and comparison with the applicable HCN reference

concentration. The estimated SGP HCN emissions (1.9 tpy), which is based the area and type (tailings, tanks), the appropriate mass transfer coefficient, snow cover adjustments and solution characteristics. The appropriate emissions factors were derived from the final report from a 2009 fugitive HCN report from three Nevada gold mines (Cortez, Gold Quarry and Rocky Mountain). For further detail, see **Appendix A** and EPA 2010b. This group of existing facilities reported HCN emission rates ranging from 0.2 to 8.8 tpy, with an average of 3.8 tpy (EPA 2010a). Therefore, the SGP estimates are approximately one half the average rate as determined by the study.

Hg is introduced to the ore processing system through the Hg content of the ore itself. Evaluation of potential Hg emission impacts was conducted, in part, to verify that emissions would comply with the EPA Hg emission standards provided in 40 CFR 63, Subpart EEEEEEE, for gold ore processing and production facilities. The SGP would be subject to these federal standards using a carbon-in-pulp process for capturing gold that has been extracted from the crushed ore using dilute NaCN solutions and use of a retort for purifying the gold-laden precipitate from electrowinning. The projected Hg emissions from the gold ore processing sources would be controlled to 20 percent of the Subpart EEEEEEE federal standards for Carbon Processes with Mercury Retorts and less than 1 percent of the pretreatment standard of 84 lb/MMton (autoclave control). Control of the autoclave and its corresponding emissions are derived from SysCad Mercury modeling performed by M3 Engineering that includes the uses of a venturi scrubber, vent gas cleaning tower, vent gas stream condensing tower and at least one sulfur-impregnated activated carbon filter. These controls are also included in the IDEQ PTC. The retort emissions are based on an average of two Refinery reports in 2015/2016 (NDEP 2015, 2016). The corresponding calculations are 20 percent of the retort standard of 0.8 lb/ton. The emissions released from gold-refining processes are controlled as listed below to mitigate particulate and gaseous Hg emissions. These process exhaust control technologies are accounted for in the maximum emissions estimates in **Table 7-4**:

- Activated carbon regeneration kiln – wet scrubber and activated carbon filter;
- Retort – activated carbon canisters and filter pack; and
- Induction furnaces – baghouse filter and activated carbon filter pack.

Table 7-4 Maximum Annual HAP and Air Toxics Emissions Summary

Source Category	HCN (tpy)	H_2SO_4 (tpy)	As[1] (tpy)	HAP (tpy)	Hg (lbs/yr)
Process and Auxiliary	1.9	8.9	0.02	4.7	5.8
Mining fugitive	0.0	0.0	0.374	4.0	7.8
Total[2]	1.9	8.9	0.394	8.7	13.6

[1] Arsenic is also included in the total HAPs calculation. For more information specific to arsenic emissions and the corresponding modeling conducted, refer to **Section 7.2.2.3**.
[2] All emission calculations are derived from methods provided in **Appendix A**.

7.2.2.3 2021 MMP Near-Field Analysis NAAQS

Assessment of conformance to the NAAQS is based on the highest receptor concentration in the modeling domain for the pollutants and averaging times corresponding to the standards. The modeled maximum concentration at each receptor is added to the selected background concentrations that represent current existing conditions (**Table 5-2**). If the results from this computation are below the NAAQS, then impacts at other locations in the domain would be below the NAAQS as well.

For NAAQS modeling inputs, the highest emissions of each pollutant during any LOM year were determined and provided in **Table 7-5**. For the 2021 MMP, the highest criteria pollutant emissions occur during two different years, LOM Year 6 (CO, NO_X, and SO_2) and LOM Year 10 ($PM_{2.5}$ and PM_{10}). Therefore, to capture the highest modeled concentration for each pollutant, separate modeling was performed for LOM Years 6 and 10 (i.e., two models). Note that VOC emission maximums from LOM 3 were not modeled because there is no specific NAAQS for these emissions, however VOCs are addressed as part of the secondary $PM_{2.5}$ analysis discussed in **Section 5.4.2**.

Table 7-5 LOM Years for Pollutant-Specific Maximum Annual Emissions

Pollutant	LOM Year	SGP Total Annual Emissions (tpy)
CO	6	535.5
NO_2	6	335.2
PM_{10}	10	320.1
$PM_{2.5}$	10	69.2
SO_2	6	7.3
VOC	3	27.4
HAPs	10	8.5
Hg	10	13.3 (lb/yr)

The 2021 MMP would include a 12-foot-wide gravel road to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375) through the SGP. Perpetua received a final PTC from IDEQ on June 17, 2022. This application proposed to exclude the public road on the basis of restricted access and maintaining full control, and that people traveling on the road would be considered "guests of the mine". IDEQ accepted the private road concept proposed by Perpetua (see PTC Condition 2.7, Response to Comments #16 and Statement of Basis on the IDEQ website) and in response to comments on February 18, 2021, also states that the roadway between Stibnite Road at Sugar Creek and Thunder Mountain Road at Meadow Creek was appropriately excluded from ambient air. Additionally, the EPA Region X has indicated that the access road could possibly be excluded from ambient air if sufficient enforceable measures are taken to comply with the 2019 revised policy (EPA 2019a). To comply with this measure, Perpetua has developed a Transportation Management Plan that is included as **Appendix D**.

A November 18, 2020 response to comments letter authored by the EPA states that Region X acknowledges and is accepting of DEQ's findings. On page 25 of the EPA response letter, it states they are "recognizing that this control access road would not be ambient air" (Stantec 2021). This is also consistent with the December 2, 2019, Revised Policy on Exclusions From "Ambient Air" memorandum (EPA 2019a). The memo states "*the atmosphere over land owned or controlled by the stationary source may be excluded from ambient air where the source employs measures. which may include physical barriers. that are effective in precluding access to the land by the general public."* The measures to be employed by Perpetua, as discussed in the 2021 MMP (Perpetua 2021a) would qualify under the revised broader definition of ambient air. As a result, because of IDEQ's decision and the EPA general acceptance given an acceptable Transportation Management Plan (**Appendix D**), the public access road was excluded for the NAAQS analysis.

The AERMOD dispersion modeling results for the 2021 MMP emissions and comparison with the applicable NAAQS are provided in **Table 7-6**. The geographic location of the maximum impacts amongst the criteria pollutants and averaging periods between LOM 6 and LOM 10 are provided in Figure 4 of the

Air Quality Analysis Addendum ModPro2 (Air Sciences 2021a). The results demonstrate compliance with all NAAQS and would be considered to have a moderate impact locally and minor impact regionally. Additionally, **Table 7-7** provides geographic locations of the NAAQS maximums.

Table 7-6 Near-Field NAAQS Compliance Demonstration

Pollutant	Averaging Time	Maximum Modeled Conc. (µg/m³)	Background Conc.[3] (µg/m³)	Total Impact Conc. (µg/m³)	NAAQS (µg/m³)	NAAQS Compliance
CO	8 hours	404.6	1,110	1,515	10,000	Yes
	1 hour	495.5	1,740	2,236	40,000	Yes
Lead	3-month rolling	Not Required[1]				
NO_2	Annual	19.8	0.9	20.7	100	Yes
	1 hour	129.8	4.3	134.1	188	Yes
O_3	8 hours	3.0	117.7	120.7	137	Yes
PM_{10}	24 hours	15	37.0	51.9	150	Yes
$PM_{2.5}$ [2]	Annual	1.1	3.5	4.6	12	Yes
	24 hours	2.7	15.0	17.7	35	Yes
SO_2	1 hour	3.0	12.3	15.3	196	Yes
	3 hours	1.8	16.8	18.6	1,300	Yes

1 Lead modeling is not required per IDEQ as the facility-wide emissions are less than 10 percent of the lead significant emission rate of 0.6 tpy and considered "Below Regulatory Concern".
2 Includes the secondary impacts.
3 All background concentrations are derived from the NW Airquest data (WSU 2018).

Table 7-7 Near-Field NAAQS Maximum Geographic Locations

Pollutant	Averaging Time	Easting (m)	Northing (m)	Distance to Boundary (mi)	Nearest Boundary Direction
CO	8 hours	634,478.09	4,972,209.38	0	East Boundary
	1 hour	634,493.79	4,972,189.94	0	East Boundary
NO_2	Annual	635,049.52	4,977,883.80	0.62	Northeast
	1 hour	635,124.52	4,977,758.80	0.59	Northeast
PM10	24 hours	632,174.39	4,969,258.68	0	South Boundary
PM2.5	Annual	634,999.52	4,978,033.81	0.60	Northeast
	24 hours	634,999.52	4,978,033.81	0.60	Northeast
SO_2	1 hour	635,199.52	4,977,533.80	0.56	East
	3 hours	634,999.52	4,975,933.79	0.56	East

Comparison of Maximum Pollutant Impacts with PSD Class II Increments

Comparison of the maximum modeled impacts to PSD Class II increments and SILs is typically required as part of the PSD evaluation for major source ambient air quality assessments. However, for informational purposes relative to the SGP such comparisons provide an additional indicator of the relative significance of air quality impacts. The results in **Table 7-8** based on the 2021 MMP maximum annual inventory show the near-field maximum modeled ambient concentrations derived from the 2021 MMP, near-field analysis. For all pollutants, the modeled concentrations are less than the Class II increments. For pollutants other than SO_2, the maximum modeled concentrations are above the SILs. In the case of a major source, this outcome would indicate that more detailed analysis is warranted to confirm compliance with the NAAQS, and other criteria. For any new source, a project impact shown to be below a SIL is recognized as not causing or contributing to the violation of a NAAQS or PSD increment. The geographic location of the maximum impacts amongst the criteria pollutants and averaging periods between LOM 6 and LOM 10 are provided in Figure 3 of the Air Quality Analysis Addendum ModPro2 (Air Sciences 2021a).

In general, instances of modeled project impacts that exceed a SIL may warrant a refined analysis to investigate whether a project will cause or contribute to a PSD increment violation. Given there are no substantial existing minor or major sources in the immediate vicinity of the SGP, it is viewed as unlikely that significant consumption of the PSD increment occurs in this area. Due to the relatively low maximum concentrations from near-field modeling for SGP, which are well below the PSD increment for all pollutants, it also is unlikely the SGP would cause or contribute to a violation of a PSD increment. If the IDEQ were to have sufficient concern that a PSD increment violation could occur, a full regulatory PSD increment compliance demonstration could be warranted even for a minor source under the state's NSR air permitting process. The impact would be considered minor to Class II PSD areas as the SGP is well below the significance levels for all pollutants and averaging periods.

Table 7-8 Near-Field Class II PSD Increment Comparison

Pollutant	Averaging Time[1]	Maximum Conc. (µg/m^3)	Class II Significant Impact Level[3] (µg/m^3)	Maximum Allowable Increase (µg/m^3)	PSD Increment Compliance
NO_2	Annual	19.8	1.0	25	Yes
PM10	Annual	6.5	0.2	17	Yes
	24 hours	14.9	1.0	30	Yes
PM2.5[2]	Annual	1.1	0.2	4	Yes
	24 hours	3.3	1.0	9	Yes
SO_2	Annual	0.2	1.0	20	Yes
	3 hours	1.8	25	512	Yes
	24 hours	0.7	5.0	91	Yes

Source: Air Sciences 2021a; EPA 2018

[1] Design Value Rank For any period other than an annual period, the applicable maximum allowable increase may be exceeded during one such period per year at any one location.

[2] Includes secondary, condensable $PM_{2.5}$ impacts. The annual SIL was revised as described in EPA Guidance issued in April 2018 (EPA 2018).

[3] These results show that, except for SO_2, the near-field modeled maximum concentrations are above the Significant Impact Levels, which would be relevant if SGP were a major source.

PET-0966

REC 2686

Hazardous Air Pollutant Modeling

A supplemental air quality dispersion modeling analysis was conducted based on federally regulated HAP emissions associated with the 2021 MMP. The analysis consisted of several metal HAPs which were: antimony, arsenic, beryllium, cadmium, chromium, cobalt, manganese, nickel, and selenium from all potential emitting sources at SGP. The main source of metals emissions was from dust produced in mining and hauling/handling ore and development rock. The metals were present in this dust in natural mineral forms. Note that lead and mercury were not assessed in this modeling exercise because lead emissions are considered less than significant (see **Table 7-6**). Mercury is discussed in the Deposition Screening section below and other resource reports (Air Sciences 2018a and 2021a).

The highest LOM emissions in terms of tons/yr were evaluated to establish the status of SGP from a HAP perspective, which was determined to be LOM Year 10. **Table 7-9** illustrates all HAP emissions from LOM Year 10. The only federal requirement pertaining to HAPs is to determine whether the facility would be categorized as a Major or Area source facility for HAPs. If a source is less than 10 tpy of any single HAP and less than 25 tpy of all HAPs in aggregate, the facility is considered to be an Area Source. Based on the information provided in **Table 7-9**, SGP is an Area Source or a minor source for HAPs. For further details regarding the methodology for determining the emissions associated with each applicable emission source, please refer to the Supplemental HAP Air Quality Analysis Addendum – ModPro2 (Air Sciences 2021a).

IDEQ developed a toxics air pollutant program in the early 1990's. The program is based upon health and risk standards that would apply to potential new sources and implemented with appropriate ambient levels. In addition to ambient levels, it was decided to incorporate a stack-based emission levels at or below which it could be reasonably expected that the ambient standard would not be exceeded. The reason the stack-based levels were incorporated was that often stack emissions are easier to calculate than it is to model for ambient concentrations (IDEQ 2001).

The AAC values were based on the American Conference of Government Industrial Hygienists (ACGIH) threshold limit values (TLV). IDEQ equates the ACC to the Occupational Exposure Limit (OEL) divided by 20. For carcinogens (AACC) the unit Risk Factors (URF) from EPA (IRIS) was used and set them equal to a risk level of a one in a million (IDEQ 2001).

Note that only those pollutants mentioned above were modeled because they were the only pollutants that exceeded the State of Idaho screening Emissions Levels as defined by IDAPA 58.01.01.585/586. All other HAPs did not exceed the screening level and were therefore deemed to meet state permitting requirements without further evaluation. It should be noted that the state regulations were applied as a surrogate for the analysis because no federal standards applied. **Table 7-10** identifies the State of Idaho AAC/AACC as defined by the IDAPA rules referenced above. All mining years from LOM Year 3 through LOM Year 18 were modeled as discussed below.

Table 7-9 Highest HAP Annual Emissions LOM Year 10

Pollutant	Emissions (tons/yr)
1,3-Butadiene	0.005
Acetaldehyde	0.107
Acrolein	0.014
Antimony	0.017
Arsenic	0.394
Benzene	0.403
Beryllium	0.004
Biphenyl	0.0002
Cadmium	0.003
Carbon Disulfide	0.063
Chromium	0.020
Cobalt	0.005
Cyanide	1.988
Dichlorobenzene	0.000
Formaldehyde	0.193
Hexane	0.503
Hydrogen Chloride	3.666
Lead	0.009
Manganese	0.217
Mercury	0.007
Naphthalene	0.009
Nickel	0.005
Phenol	0.001
Phosphorus	0.424
POM[1]	0.090
Selenium	0.002
Toluene	0.283
Xylene	0.237
Total	8.668

Source: Air Sciences 2021b
POM = polycyclic organic matter; emissions include polycyclic aromatic hydrocarbons

PET-0968

REC 2688

Table 7-10 Idaho AAC/AACC for HAPs

CAS #	Pollutant	Carcinogenic[1]	Averaging Time	AACC (µg/m³)
7440-36-0	Antimony	No	24 hours	25
7440-38-2	Arsenic	Yes	Annual	0.00023
7440-41-7	Beryllium	Yes	Annual	0.0042
7440-43-9	Cadmium	Yes	Annual	0.00056
7440-47-3	Chromium	No	24 hours	25
7440-48-4	Cobalt	No	24 hours	2.5
7439-96-5	Manganese	No	24 hours	250
7440-02-0	Nickel	Yes	Annual	0.042
7782-49-2	Selenium	No	24 hours	10

Source: Air Sciences 2021b
Carcinogenic pollutants are averaged annually; non-carcinogenic pollutants are averaged daily (24-hrs). Both emissions rates applied to the model are lb/hr or g/s averages based on the applicable timeframe 24-hr or annually.

AERMOD Modeling was conducted for the HAPs in identical fashion to the 2021 MMP NAAQS modeling (Air Sciences 2021a and 2021b). A unit g/s emission rate approach was applied for each modeled source group. All the haul road segments were modeled as a single source group — with unit emission rate proportioned among the individual haul road segments relative to associated particulate emissions within the source group. The access road segments were also modeled as a single source group, like the haul road segments. AERMOD generated modeled concentration tables (plot file) for each source group and all source groups combined. The other input parameters for AERMOD, including source characterization, building downwash, receptor locations, and meteorological data, were consistent with the July 2021 NAAQS analysis (Air Sciences 2021b). A HAP-specific modeled concentration at each receptor was estimated by adding the products (sum-product) of a source group-specific unit concentration and a potential emission rate in g/s for each HAP. Lastly, default particulate deposition method was applied based on the mass fraction, mass mean diameter and density by various source category. For further detail refer to the Supplemental HAP Air Quality Analysis Addendum – ModPro2 (Air Sciences 2021b).

The potential ambient concentration was calculated at each receptor for LOM 3–18. The estimated total concentrations were then compared with the Idaho AACs. For each acute HAP with a 24-hour averaging time AAC, the highest estimated ambient concentration across all modeled receptors and modeling scenarios was compared with the applicable AAC, provided in **Table 7-11**.

PET-0969

REC 2689

Table 7-11 Acute AAC Comparison

CAS #	Pollutant	Averaging Time	AAC (µg/m³)	HMC[1] (µg/m³)	HMC < AAC
7440-36-0	Antimony	24 hours	25	0.0002	Yes
7440-47-3	Chromium	24 hours	25	0.0004	Yes
7440-48-4	Cobalt	24 hours	2.5	0.0001	Yes
7439-96-5	Manganese	24 hours	250	0.0103	Yes
7782-49-2	Selenium	24 hours	10	0.00004	Yes

Source: Air Sciences 2021b
[1] HMC = highest modeled concentration amongst all mining years

Table 7-11 shows that the highest modeled 24-hour concentrations are less than the applicable acute AACs. The location of the maximum 24-hour modeled concentration for each acute HAP is shown in Figure 2 of the Supplemental HAP Air Quality Analysis Addendum – ModPro2 (Air Sciences 2021b).

The annual AACC values are based on IDAPA 58.01.01.586 and were developed "*based on the probability of developing excess cancers over a seventy (70) year lifetime exposure to one (1) microgram per cubic meter (1 µg/m³) of a given carcinogen and expressed in terms of a screening level or an acceptable ambient concentration for a carcinogenic toxic air pollutant.*"

Each HAP with an annual averaging period AACC was evaluated for a 70-yr lifetime exposure, calculated as follows, on a receptor-by-receptor basis:

$$70\ yr\ exposure\ \frac{\mu g}{m^3} = \frac{\sum LOM\ Yrs\ 3\ to\ 16\ annual\ conc\ \frac{\mu g}{m^3}}{70(yrs, exposure)}$$

The highest estimated 70-year lifetime exposure across all receptors was compared with the chronic AAC for each HAP modeled for the annual averaging time, as shown in **Table 7-12**.

Table 7-12 Chronic AACC Comparison

CAS #	Pollutant	Averaging Time	AACC (µg/m³)	HMC[1] (µg/m³)	HMC < AACC
7440-38-2	Arsenic	Annual	0.00023	0.00015	Yes
7440-41-7	Beryllium	Annual	0.0042	0.00001	Yes
7440-43-9	Cadmium	Annual	0.00056	0.000003	Yes
7440-02-0	Nickel	Annual	0.042	0.00001	Yes

Source: Air Sciences 2021b
[1] HMC = highest 70-yr exposure concentration amongst all mining years

Table 7-12 shows that the estimated highest 70-year lifetime exposure concentrations are less than chronic AACCs. The location of the 70-year lifetime exposure concentration for each chronic HAP is shown in Figure 3 of the Supplemental HAP Air Quality Analysis Addendum – ModPro2 (Air Sciences 2021b). The results illustrate that the overall impact from the associated HAPs would be moderate, but well below the IDEQ permitting thresholds.

Ozone and Secondary $PM_{2.5}$ Impact Assessment

To evaluate ozone impacts from VOC and NO_X precursor emissions, a Tier 1 assessment as described in **Section 5.4.2** was performed based on the SGP emissions inventory for LOM year 6, the year of highest projected mine production. For that inventory, the facility-wide potential ozone precursor emissions were estimated in that inventory to be 335 tpy of NO_X and 26.1 tpy of VOCs. This assessment used the 2021 MMP emissions inventory, therefore, SGP mobile source tailpipe emissions were included. Additional discussion regarding the ozone and secondary $PM_{2.5}$ analysis is provided in the Air Quality Analysis report (Air Sciences 2021a).

Following Tier 1 procedures, a representative industrial source as modeled by EPA was selected from the PGM roster to assess ozone impacts. This modeled source (number 18 in the PGM source roster) is geographically the closest to the SGP; 210 miles (336 km) west-northwest of the SGP, in northeastern Oregon. Given the location of number 18 downwind from the coal-fired (550 megawatts) Boardman Power Plant (17 miles (27 km) to the west-southwest), it can be expected that this PGM source would experience higher ozone concentrations than would be expected at the undeveloped SGP area. For hypothetical source 18, ozone contributions from precursor pollutant emissions of NO_X and VOCs (500 tpy each) were predicted to be 1.94 ppb and 0.46 ppb for NO_X and VOCs, respectively (Air Sciences 2018a; EPA 2019b).

On this basis, the corresponding ozone impact due to the 2021 MMP sources was estimated by linearly scaling the source number 18 ozone impact by the relative precursor emission rates of the PGM source and the 2021 MMP. The result is provided in **Table 7-13**. This table also shows the baseline ozone concentration and the estimated total concentration for the highest modeled receptor. This analysis shows that the maximum modeled contribution to ozone levels is a small fraction of the existing baseline conditions. The overall project ozone impact is considered negligible relative to the baseline.

Table 7-13 Maximum 8-hour Ozone Impact

Pollutant	Averaging Time	Maximum Concentration	Baseline Concentration	Total Concentration
Ozone	8 hours	1.4 ppb	60.0 ppb	61.4 ppb
Ozone	8 hours	0.003 µg/m³	0.129 µg/m³	0.131 µg/m³

Source: Air Sciences 2021a
µg/m³ = micrograms per cubic meter
ppb = parts per billion air concentration

To evaluate secondary $PM_{2.5}$ impacts resulting from emissions of secondary $PM_{2.5}$ precursor emissions, a Tier 1 assessment was performed based on the 2021 MMP emissions inventory. For this inventory, the maximum facility-wide potential emissions of secondary $PM_{2.5}$ precursor emissions would be 335 tpy of NO_X and 7.3 tpy of SO_2. This assessment used the same EPA- modeled hypothetical industrial source (number 18 in northern Oregon) for $PM_{2.5}$ precursor emissions and corresponding $PM_{2.5}$ maximum impacts.

Results of the analysis of primary and secondary $PM_{2.5}$ impacts are shown in **Table 7-14**. The PGM industrial source results provided both the primary (as emitted) $PM_{2.5}$ impacts and secondary $PM_{2.5}$ impacts that were scaled to represent the 2021 MMP sources. For this analysis, the concentrations of both forms of $PM_{2.5}$ were added together and combined with the baseline $PM_{2.5}$ concentration. This comparison indicates that predicted primary and secondary $PM_{2.5}$ impacts from the 2021 MMP would be about one-third or less of existing background conditions. The overall secondary $PM_{2.5}$ project impact is considered negligible relative to the baseline.

Table 7-14 Primary and Secondary $PM_{2.5}$ Impact

Pollutant	Averaging Time	Max. Primary $PM_{2.5}$ Concentration ($\mu g/m^3$)	Max. Secondarily- Formed $PM_{2.5}$ Concentration ($\mu g/m^3$)	Baseline Concentration ($\mu g/m^3$)	Total $PM_{2.5}$ Impact ($\mu g/m^3$)
Total $PM_{2.5}$	Annual	1.1	0.01	3.5	4.7
Total $PM_{2.5}$	24 hours	2.6	0.15	15.0	17.7

Source: Air Sciences 2021a
$\mu g/m^3$ = micrograms per cubic meter
$PM_{2.5}$ = Particulate matter less than 2.5-micron diameter

Class II Wilderness Area Plume Visibility Screening Results

Plume visibility modeling is a means of quantifying the ability of a viewer to discern a visible plume from a source and is usually evaluated for an observer at the closest point on the boundary of an area of concern. The model used in this case, VISCREEN, outputs a comparison of two calculated plume parameters to determine the possibility of plume perceptibility by an observer using thresholds based on human visual perception (EPA 1992). The two parameters are C and ΔE. Contrast is a measure of the difference in the light intensity without regard for color. Color contrast measures the difference in wavelength of light rather than intensity.

Applying the Level 2 screening approach as described in **Section 5.4.3**, VISCREEN results for both C and ΔE wereevaluated for a modeled plume against a backdrop of sky or terrain, and at two solar angles (θ) of 10 degrees and 140 degrees. These solar angles generally correspond to a low angle at dawn and dusk, and a high angle that represents mid-day. A result that exceeds the threshold for either C or ΔE indicates that a plume would be visible.

EPA's guidance for using the VISCREEN model for PSD Class I analyses is intended to provide a conservative, worst-case screening model for plume visibility impacts (EPA 1992). Following EPA's VISCREEN guidance, both daytime (6 a.m. to 6 p.m.) and nighttime (6 p.m. to 6 a.m.) are included in this analysis. Therefore, during the summer, the nighttime hours would include some hours when sunlight illuminates any plume and, conversely, during the shorter wintertime daylight hours, some hours analyzed as daytime would occur after the sun has set.

Perpetua performed a revised VISCREEN analysis in October 2020 which is based on combined NOx, PM, and soot emissions of 8,953 lbs/day. Updates included the addition of non-point and mobile equipment emissions; the background visual range was increased to 270 km and large-diameter particle matter emissions were incorporated. However, there was a slight variation in total emissions from the analysis and those emissions produced by the 2021 MMP. The 2021 MMP is expected to produce a combined emissions of 8,204 lbs/day, approximately an 8 percent reduction. The October 2020 analysis was not redone and is considered conservative.

A summary of the VISCREEN results is provided in **Table 7-15** for daytime and nighttime hours, and for combinations of terrain or sky background and two solar angles (Forest Service 2019). These results show the frequency of visible plumes expressed as the highest percentage of time a plume could be visible for a given combination of viewing background and solar angle. The potential for a plume being visible to an observer at the FCRNRW is determined by comparing the modeled result for either C or ΔE to the appropriate perception screening threshold calculated by VISCREEN for each modeled hour during a year. A plume is deemed to be visible during each hour when modeled values of either C or ΔE would exceed the perception thresholds. **Table 7-16** provides the magnitude of the visible plumes.

Table 7-15 Frequency of Modeled Visible Plumes – Screening Results for FCRNRW: Percent of Time when Perceptibility Threshold is Exceeded

Plume Parameter	Background	% Day Hours: 10 Degrees[1]	% Night Hours: 10 Degrees	% Day Hours: 140 Degrees[2]	% Night Hours: 140 Degrees
Plume Contrast (C)	Terrain	0	0	0	0
Color Contrast (ΔE)	Terrain	0.02	2.9	0	0
Plume Contrast (C)	Sky	0	0	0	0.38
Color Contrast (ΔE)	Sky	0	2.3	0	0

Source: (Forest Service 2019) based on Level 2 VISCREEN modeling (Appendix C of Air Sciences 2021a)
[1] The 10-degree solar angle reflects conditions after sunrise (day), and before sunset (night).
[2] The 140-degree solar angle reflects mid-day conditions.
C = modeled plume parameter that quantifies overall contrast or light impeded by a plume.
ΔE = modeled plume parameter that reflects the color difference or contrast with viewing background.
Results tabulated combine the stability classes and wind speed conditions that exhibit plume parameters above perception thresholds. Stability classes are not adjusted for elevation difference.

Table 7-16 Magnitude of Modeled Visible Plumes – Screening Results for FCRNRW: Ratio of Maximum Impact when Perceptibility Threshold is Exceeded

Plume Parameter	Background	Day: 10 Degrees[1]	Night: 10 Degrees	Day: 140 Degrees [2]	Night: 140 Degrees
Plume Contrast (C)	Terrain	--	--	--	--
Color Contrast (ΔE)	Terrain	1.0	2.2	--	--
Plume Contrast (C)	Sky	--	--	--	1.3
Color Contrast (ΔE)	Sky	--	1.9	--	--

Source: (Forest Service 2019) based on Level 2 VISCREEN modeling (Appendix C of Air Sciences 2021a)
[1] The 10-degree solar angle reflects conditions after sunrise (day), and before sunset (night).
[2] The 140-degree solar angle reflects mid-day conditions.
C = modeled plume parameter that quantifies overall contrast or light impeded by a plume.
ΔE = modeled plume parameter that reflects the color difference or contrast with viewing background.
Results tabulated combine the stability classes and wind speed conditions that exhibit plume parameters above perception thresholds. Stability classes are not adjusted for elevation difference.

Mercury Deposition Screening Results

Hg emissions can occur from both mine operations and ore processing, as a consequence of the processing methods used, and the naturally occurring Hg content of the ore and overburden material. This section describes the predicted Hg deposition flux rates in the near-field modeled area surrounding the SGP. The analysis combines the impacts of both existing background sources and the SGP sources.

As described in **Section 5.4.4**, one tool that describes the background effects for Hg deposition is the REMSAD. This model has been implemented by the EPA across the continental 48 states to quantify Hg deposition on a regional basis. The inventory information for this model was gathered between the years 2000 and 2006; therefore, it is likely higher than current emissions levels due to regulatory controls on Hg emissions (e.g., on coal-fired power plants) implemented since 2006, and the trend to replace coal-fired

generation with gas-fired units. The sources of Hg deposition used in the EPA REMSAD modeling analysis included sources in the U.S., Mexico, and Canada; and contributions from global background deposition from Chemical Transport Model, the Global/Regional Atmospheric Heavy Metals model, and the GEOS-Chem model (EPA 2008).

The EPA REMSAD model was used to estimate the background Hg deposition in the SGP area, and three immediately surrounding hydrographic "sub-basins" that extend approximately 20 to 50 miles (32 to 80 km) from the SGP. Results of the REMSAD include both wet and dry deposition mechanisms. As listed in **Table 7-17**, total annual Hg deposition flux rate in the three hydrographic sub-basins ranges from 12.7 to 13.9 grams per square km per year (g/km^2-yr).

An AERMOD screening assessment included the point and fugitive Hg emissions from the SGP that are in the form of elemental, Hg^{2+}, and HgP. Gaseous elemental Hg0 emission sources are controlled by activated carbon absorbers. A source of bias in the analysis is the use of this screening level modeling approach that does not account for recent findings showing the importance of Hg0 deposition to plants, and this flux being the largest point of entry for atmospheric Hg into terrestrial environments. Taking these factors into account suggests that total Hg deposition predicted by the model is likely biased low.

The results of the AERMOD screen modeling of Hg deposition based on the 2021 MMP inventory are listed in **Table 7-17**. This analysis indicates a maximum estimated increase in Hg deposition rate of 0.4 percent or less of the existing background rate. However, it should be recognized that this rate underestimates the total Hg deposition, as the mechanism of Hg0 flux is not included in the screening model.

The range of increased deposition is less than 5 miles (8 km) from the SGP, covering the area generally east of the SGP Operations Area Boundary. Outside of this area, Hg deposition contribution due to 2021 MMP sources is estimated to be less than the minimum value that can be quantified by AERMOD. Additional details and mapping of the Hg deposition rates from REMSAD and the AERMOD analysis are provided in the Air Quality Analysis report (Air Sciences 2021a). The mercury impact associated with the project is negligible compared to the RESMAD past modeling.

Table 7-17 SGP Contribution Above Estimated Hg Background

Hydrographic Sub-basin	REMSAD Background (g/km^2-yr)	AERMOD Screen Results[1] (g/km^2-yr)	2021 MMP Contribution to Existing Background
Within SGP area and the sub-basin east of the SGP	13.9	0.056	0.40%
Sub-basin northeast of the SGP	13.6	0	0.00%
Sub-basin southeast of the SGP	12.7	0	0.00%

Source: Air Sciences 2021a; EPA 2008

[1] Modeled maximum result is at the SGP Operations Area Boundary; screening results show close to zero deposition at any location beyond 5 miles from the SGP.

g/km^2-yr = grams per square kilometer per year

Nitrogen/Sulfur Screening Acid Deposition Analysis

A screening analysis using the AERMOD dispersion model was performed following the approach described in **Section 5.4.5** to predict the near-field deposition of nitrogen and sulfur species from NOX and SO_2 precursor emissions as estimated in the 2021 MMP inventory. Although AERMOD is not designed to simulate several natural processes that affect chemical deposition (e.g., atmospheric chemical

transformations to acid compounds), it was used in this case as a conservative screening tool. As described in **Section 5.4.5**, this screening analysis was conducted using the Level 2 procedures prescribed in the draft interagency near-field deposition modeling guidance (NPS 2011). The Level 2 analysis assumes that 100 percent of the NO_X emissions would be completely transformed into NO_2, and then HNO_3 on release to the atmosphere. This assumed extent of conversion is expected to result in a conservative over-estimation of nitrogen deposition.

The NO_2 dry deposition flux estimated by AERMOD was converted to the potentially absorbed nitrogen at the surface by multiplying the predicted NO_2 flux by the ratio of nitrogen to NO_2 molecular weights (equals 0.304). Similarly, the SO_2 dry deposition flux estimated by AERMOD was converted to sulfur by multiplying with the ratio of sulfur to SO_2 molecular weights (equals 0.5). For purposes of this analysis, deposition of SO_2 was converted to the equivalent amount of SO_4.

The resulting range of predicted screening-level nitrogen and sulfur deposition rates at the SGP Operations Area Boundary and at receptors approximately 10 km beyond that boundary are listed in **Table 7-18** in units of grams per square meter per year.

Table 7-18 Summary of Predicted Near-Field Nitrogen and Sulfur Deposition Rates

Chemical Element	Receptor Locations	Deposition Flux Rate (g/m^2-yr)
Nitrogen (N)	OAB	0.00081 – 0.0039
Nitrogen (N)	10 km from OAB	0.00011 – 0.0098
Sulfur (S)	OAB	0.00001 – 0.0043
Sulfur (S)	10 km from OAB	0 – 0.0002

Source: Air Sciences 2018b, 2021a
g/m^2-yr = grams per square meter per year

Stibnite Public Access Route

As discussed in **Section 7.2.2.2**, the SGP public access route (Figure 1 of Air Sciences 2021a) was excluded from the ambient boundary. However, Perpetua did conduct a NAAQS compliance demonstration by applying 25-m spacing receptors along the public access route which was completed as part of a feasibility assessment. The 2021 MMP analysis was completed using the Bulk Richardson Number method (BULKRN) to preprocess the meteorological data (Air Sciences 2018a). This is consistent with the IDEQ recommendations and to ensure maximum conservative. The public access route analysis was evaluated for LOM Year 6 and Year 10. The difference between the NAAQS outlined in **Section 7.2.2.2** and the public access route was that the BULKRN method was not used, but rather the EPA default approach of Qian and Venkatram method (Air Sciences 2018a). **Table 7-19** illustrates the NAAQS impact results at the public access route through the SGP.

Table 7-19 SGP Public Access Route Receptor Results and NAAQS Compliance Demonstration

Pollutant	Averaging Time	Maximum Modeled Conc. ($\mu g/m^3$)	Baseline Conc. ($\mu g/m^3$)	Total Impact Conc. ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	NAAQS Compliance
CO	8 hours	201.9	1,110	1,312	10,000	Yes
	1 hour	486.8	1,740	2,227	40,000	Yes
NO_2	Annual	39.0	0.9	39.9	100	Yes

PET-0975

REC 2695

Pollutant	Averaging Time	Maximum Modeled Conc. (µg/m³)	Baseline Conc. (µg/m³)	Total Impact Conc. (µg/m³)	NAAQS (µg/m³)	NAAQS Compliance
	1 hour	124.4	4.3	128.7	188	Yes
PM10	24 hours	65.3	37.0	102.3	150	Yes
PM2.5 [2]	Annual	5.3	3.5	8.8	12	Yes
	24 hours	12.2	15.0	27.2	35	Yes
SO_2	1 hour	13.6	12.3	25.9	196	Yes
	3 hours	6.0	16.8	22.8	1,300	Yes

7.2.2.4 Direct and Indirect Effects – Far-Field Analysis

The far-field analysis for regional haze contributions, increment, and chemical deposition was performed for four selected Class I areas: SAWT, SELW, HECA, and CRMO. In addition, four Class II wilderness areas were evaluated in the same manner: FCRNRW (beyond 50 km), GOSPEL, HEMBLD, and the WHTCLD. The nearby Nez Perce Requested Analysis Area also was included in this analysis. The far-field analyses described in this section are based on the 2021 MMP inventory for criteria pollutant emissions.

Additionally, the 2018 modeling report (Air Resources 2018b) conducted far-field NAAQS analysis from 50 km to 300 km. Due to slight differences between the 2018 modeling report and the 2021 MMP a verification analysis was conducted to ensure no significant far-field impact changes.

50-km Ring NAAQS Verification

Additional AERMOD modeling was completed to estimate concentrations at receptors located on a 50-km radius ring around the SGP; the maximum approved range of AERMOD. The 50-km ring modeling was performed for the applicable AQRV pollutant averaging time combinations. The 50-km ring modeling result comparison for 2018 modeling and the 2021 MMP modeling is provided in **Table 7-20**.

Table 7-20 50-km Ring AERMOD Results for 2018 Modeling and 2021 MMP

Pollutant	Averaging Time	2018 Modeling (µg/m³)	2021 MMP (µg/m³)
NO_2	Annual	0.53	0.50
$PM_{2.5}$	Annual	0.09	0.09
	24 hours	0.40	0.38
PM_{10}	Annual	0.14	0.11
	24 hours	0.51	0.57
SO_2	Annual	0.01	0.01
	24 hours	0.07	0.06
	3 hours	0.23	0.20

Source: Air Sciences 2021a

Table 7-20 shows that the 50-km ring results are nearly identical for the 2018 modeling and the 2021 MMP modeling.

The 50-km ring AERMOD analysis demonstrates that the 2021 MMP changes are not expected to affect the far-field analysis results, and therefore, the 2018 far-field analyses are representative of the 2021 MMP. **Table 7-21** illustrates a summary of the far-field impacts.

Table 7-21 Far-Field Impacts Summary

Pollutant / AQRV	Averaging Time	Class I Impacts (µg/m³)	Class II Impacts (µg/m³)	Class I Visibility	Class II Visibility	Class I N, S Deposition	Class II N, S Deposition
				98th Percentile Extinction[1]		g/ha-yr[1]	
NO_2	Annual	0.0101	0.0392	--	--	--	--
$PM_{2.5}$	Annual	0.0021	0.0082	--	--	--	--
	24 hours	0.0370	0.1272	--	--	--	--
PM_{10}	Annual	0.0101	0.0394	--	--	--	--
	24 hours	0.1622	0.5628	--	--	--	--
SO_2	Annual	0.0002	0.0009	--	--	--	--
	24 hours	0.0057	0.0179	--	--	--	--
	3 hours	0.0118	0.0529	--	--	--	--
Nitrogen	Annual	--	--	--	--	1.1832	4.6284
Sulfur	Annual	--	--	--	--	0.1581	0.7551
Visibility	Annual	--	--	1.47%	4.84%	--	--
Threshold		Variable[2]	Variable[2]	5%	N/A[3]	5	N/A[3]

Source: Air Sciences 2021a
[1] Maximum results are shown, g/ha-yr = grams per hectare-year
[2] See Table 7-22
[3] There are no regulatory standards or thresholds to compare to the results provided in these columns.

SILs are defined concentrations of criteria pollutants in the ambient air that are considered inconsequential in comparison to the NAAQS. A project impact shown to be below a SIL can be presumed to not cause or contribute to the violation of a NAAQS. **Table 7-22** shows the Class I and Class II Area SILs for comparison to the results provided in **Table 7-21**. As shown by these two tables, the far-field impacts of criteria pollutants on Class I and II areas are below the SIL. **Table 7-20** also shows that the Class I visibility and deposition impacts are below the regulatory thresholds (Air Sciences 2021a).

Table 7-22 Class I and Class II Area SIL

Pollutant / AQRV	Averaging Time	Class I SIL (µg/m³)	Class II SIL (µg/m³)
NO_2	Annual	0.1	1
$PM_{2.5}$	Annual	0.05	0.3
	24 hours	0.27	1.2
PM_{10}	Annual	0.2	0.2
	24 hours	0.3	1
SO_2	Annual	0.1	1
	24 hours	0.2	5
	3 hours	1	25

Far-Field Evaluation of Regional Haze Impacts

The methodology for the analysis of the impairment of atmospheric clarity, or regional haze,is described in **Section 5.5.2**. For this analysis, maximum 24-hour the 2021 MMP source emissions of SO_2, NO_X, SO_4, and fine and coarse PM were modeled using CALPUFF for the roster of Class I and Class II wilderness areas of interest. To account for atmospheric chemistry, the MESOPUFF II five-pollutant (SO_2, SO_4, NO_X, HNO_3, nitrate) conversion scheme was used. The POSTUTIL routine in CALPUFF was used to calculate concentrations of these chemical species that can act as haze precursors (Federal Land Managers' Air Quality Related Value Work Group [FLAG] 2010).

As described in **Section 5.5**, the CALPUFF-ready wind field was evaluated against 15 regional station observational data benchmarks for a span of 3 calendar years (2015 to 2017) using the MMIFStat statistics program. MMIFStat compiles statistics for air temperature, relative humidity, wind speed, and direction. Because much of the modeling domain is in mountainous terrain the "complex conditions" benchmarks were applied to evaluate whether the CALPUFF datasets were acceptable. These evaluations demonstrated that the meteorological data sets generally met acceptance benchmarks that have been commonly reported for mesoscale model evaluation for air quality modeling (Air Sciences 2018b).

The Class I and Class II wilderness area visibility analysis results are presented in **Tables 7-23** and **7-24**, respectively. These results show the modeled 98th percentile highest daily change in extinction parameters in each analyzed area. The net predicted reduction in atmospheric visibility is less than the 5 percent change in extinction threshold that is considered the significance criteria for Class I areas (FLAG 2010). Using the same stringent Class I criteria for the Class II wilderness areas included in this analysis demonstrates that the level of regional haze impact in these areas is predicted to be minor.

Table 7-23 Predicted Regional Haze Contributions in Class I Areas Due to SGP Sources

Class I Areas	98th Percentile 2015	98th Percentile 2016	98th Percentile 2017	Maximum 98th Percentile	Class I Extinction Threshold	Below Threshold (Yes/No)
CRMO	0.15%	0.07%	0.09%	0.15%	5%	Yes
HECA	0.33%	0.24%	0.61%	0.61%		Yes
SAWT	0.54%	0.36%	0.46%	0.54%		Yes
SELW	1.29%	1.12%	1.47%	1.47%		Yes

Source: Air Sciences 2021a; FLAG 2010
CRMO – Craters of the Moon National Monument
HECA – Hells Canyon Wilderness
SAWT – Sawtooth Wilderness
SELW – Selway-Bitterroot Wilderness

PET-0978

REC 2698

Table 7-24 Predicted Regional Haze Contributions in Class II Area Due to SGP Sources

Class I Areas	98th Percentile 2015	98th Percentile 2016	98th Percentile 2017	Maximum 98th Percentile
HEMBLD	0.27%	0.17%	0.22%	0.27%
GOSPEL	0.77%	0.95%	2.08%	2.08%
NPRAA	1.87%	1.50%	2.63%	2.63%
FCRNRW	3.54%	4.84%	4.70%	4.84%
WHTCLD	0.39%	0.26%	0.34%	0.39%

Source: Air Sciences 2021a; FLAG 2010
FCRNRW = Frank Church-River of No Return Wilderness, area beyond 50 km from SGP Operations Area Boundary
GOSPEL = Gospel-Hump Wilderness
HEMBLD = Hemingway-Boulders Wilderness
NPRAA = Nez Perce Requested Analysis Area
WHTCLD = Cecil D. Andrus-White Cloud Wilderness

Far-Field Nitrogen and Sulfur Deposition

Total potential annual N and S deposition from SGP sources was determined through the same model, CALPUFF, used to assess regional haze effects. The total potential N and S deposition were assumed to be composed only of the N or S component of the different compounds included in the model. Both dry and wet deposition modes were considered. The maximum pollutant emission rates for the ModPro inventory were applied to modeling for three meteorological data years, 2015 through 2017.

Predicted deposition impacts, in grams of pollutant per hectare per year, were compared to the DAT as outlined in the 2011 interagency guidance on N and S deposition as an indicator of significance (NPS 2011). The DAT for N and S in the Class I area are listed as 5 g/ha-yr.

For the three modeled years of 2015 through 2017, the maximum predicted annual deposition rates were below the DAT in each Class I and Class II area evaluated. The estimated maximum N and S deposition in g/ha-yr for the Class I areas evaluated for this analysis are provided in **Tables 7-25** and **7-26**. Predicted deposition rate in SELW is the highest, with N deposition rate of 1.13 g/ha-yr at the highest receptor location. This is well below the DAT of 5 g/ha-yr and indicates that deposition impacts from the SGP in Class I areas would likely be undetectable.

Table 7-25 Summary of Predicted Nitrogen Deposition Rates in Class I Areas Due to SGP Sources

Class I Area	Max. Receptor N Deposition Rate 2015 (g/ha-yr)	Max. Receptor N Deposition Rate 2016 (g/ha-/yr)	Max. Receptor N Deposition Rate 2017 (g/ha-yr)	3-Year Maximum N Deposition Rate (g/ha-yr)	Class I DAT (g/ha-yr)	Below Threshold (Yes/No)
CRMO	0.06	0.11	0.11	0.11	5	Yes
HECA	0.21	0.13	0.09	0.21	5	Yes
SAWT	0.44	0.44	0.48	0.48	5	Yes
SELW	1.00	0.99	1.18	1.18	5	Yes

Source: Air Sciences 2021a; NPS 2011
g/ha-yr = grams per hectare per year
DAT = Deposition Analysis Threshold

Table 7-26 Summary of Predicted Sulfur Deposition Rates in Class I Areas Due to SGP Sources

Class I Area	Max. Receptor N Deposition Rate 2015 (g/ha-yr)	Max. Receptor N Deposition Rate 2016 (g/ha-/yr)	Max. Receptor N Deposition Rate 2017 (g/ha-yr)	3-Year Maximum N Deposition Rate (g/ha-yr)	Class I DAT (g/ha-yr)	Below Threshold (Yes/No)
CRMO	0.01	0.01	0.01	0.01	5	Yes
HECA	0.03	0.01	0.01	0.03	5	Yes
SAWT	0.05	0.05	0.05	0.05	5	Yes
SELW	0.12	0.11	0.16	0.16	5	Yes

Source: Air Sciences 2021a; NPS 2011
g/ha-yr = grams per hectare per year
DAT = Deposition Analysis Threshold

Similarly, the estimated maximum N and S deposition in g/ha-yr for the four Class II areas and closest Tribal lands evaluated for this analysis are provided in **Tables 7-27** and **7-28**.

Predicted deposition rate in FCRNRW is the highest, with N deposition rate of 4.63 g/ha-yr at the highest receptor location. This reflects the position of the FCRNRW as the closest area of concern, essentially adjacent to the SGP area. Despite the proximity to the SGP, the highest deposition rate contribution is still predicted to be below the protective Class I DAT of 5 g/ha-yr.

Table 7-27 Summary of Predicted Nitrogen Deposition Rates in Class II Wilderness Areas and Nez Perce Requested Analysis Area

Class II Wilderness Area	Max. Receptor N Deposition Rate 2015 (g/ha-yr)	Max. Receptor N Deposition Rate 2016 (g/ha-yr)	Max. Receptor N Deposition Rate 2017 (g/ha-yr)	3-Year Maximum N Deposition Rate (g/ha-yr)	Class I DAT (g/ha-yr)	Below Threshold (Yes/No)
HEMBLD	0.25	0.19	0.18	0.25	5	Yes
GOSPEL	0.98	0.90	0.81	0.98	5	Yes
NPRAA	1.35	1.07	1.00	1.35	5	Yes
FCRNRW	3.20	3.20	4.63	4.63	5	Yes
WHTCLD	0.40	0.53	0.33	0.53	5	Yes

Source: Air Sciences 2021a; NPS 2011
g/ha-yr = grams per hectare per year
DAT = Deposition Analysis Threshold

Table 7-28 Summary of Predicted Sulfur Deposition Rates in Class II Wilderness Areas and Nez Perce Requested Analysis Area

Class II Wilderness Area	Max. Receptor S Deposition Rate 2015 (g/ha-yr)	Max. Receptor S Deposition Rate 2016 (g/ha-yr)	Max. Receptor S Deposition Rate 2017 (g/ha-yr)	3-Year Maximum S Deposition Rate (g/ha-yr)	Class I DAT (g/ha-yr)	Below Threshold (Yes/No)
HEMBLD	0.03	0.02	0.02	0.03	5	Yes
GOSPEL	0.10	0.08	0.07	0.10	5	Yes
NPRAA	0.14	0.09	0.07	0.14	5	Yes
FCRNRW	0.40	0.39	0.76	0.76	5	Yes
WHTCLD	0.04	0.06	0.04	0.06	5	Yes

Source: Air Sciences 2021a; NPS 2011
g/ha-yr = grams per hectare per year
DAT = Deposition Analysis Threshold

7.2.3 Johnson Creek Route Alternative

The Johnson Creek Route Alternative would be used for access during mine construction, operations, and closure and reclamation (the Burntlog Route would not be constructed). The approximately 36-mile Route consists of Johnson Creek Road (CR 10-413) and McCall-Stibnite Road (CR 50-412) from the village of Yellow Pine to the SGP. The road design and maintenance for the Johnson Creek Route would be similar to the road design and maintenance described for the 2021 MMP. Construction material borrow sources would be developed along the Johnson Creek Route ROW. Several changes to water and wildlife habitat management also would be included, but these would only affect air quality impacts during the construction phase.

Controlled public access through the SGP during mine operations would be provided by an access road connecting McCall-Stibnite Road (CR 50-412) to Thunder Mountain Road (FR 50375) through the mine area. Similar to this same feature described under the 2021 MMP, this public access road would be constructed during the first year of mine operation and public access to this road would be carefully controlled; fences would prohibit public visitors on this road from having access to the SGP mining or support activities.

7.2.3.1 Construction

The Burntlog Route would not be constructed. Using the Johnson Creek Route for mine access would avoid disturbance-related air quality impacts from construction of approximately 20 miles of new road for the Burntlog Route. This would have the effect of decreasing overall roadway construction phase vehicle tailpipe and airborne dust emissions. The topographic features of the route (e.g., a portion of the route is along a river through a canyon) do not affect the nature of the air emissions during construction. However, the location of air pollutant concentrations may differ because construction activities would take place along a different ROW compared to other action alternatives.

No road widening or straightening of curves would be required for the Johnson Creek Road (CR 10-413) portion of the alternative. The Stibnite Road (CR 50-412) portion would be improved by widening curves to accommodate 55-foot semi-truck trailers. Approximately one mile of road past the village of Yellow Pine would be paved. Based on relative roadway length affected, these changes in roadway construction to improve the Johnson Creek Route would represent a decrease of overall construction phase emissions. However, the magnitude of the emissions difference would be small compared to total construction

emissions during the first three LOM years. Also, the construction phase emissions for these upgrades to the Johnson Creek Route would be less than the emissions for construction of approximately 20 miles of new road to develop the Burntlog Route under other action alternatives.

This alternative would require an extra two years (three vs five) for construction of the upgrades to the Johnson Creek Route and the SGP. As a result, operations would start in year 6 instead of year 4 and the highest impact years for emissions would be LOM Years 8 and 12 (as compared to 6 and 10 for the 2021 MMP).

7.2.3.2 Operations

The Johnson Creek Route would be used to access the SGP. The length of this route is approximately 1.5 miles shorter than the Burntlog Route, so that the overall tailpipe emissions for vehicles accessing the SGP would be slightly less for this alternative. The location of ambient air pollutant concentrations due to vehicle traffic would differ, with such effects being located along the Johnson Creek Route.

Providing public access through the SGP reduces the miles of new motorized trails open to all vehicles in the Meadow Creek IRA, and this is expected to reduce net air quality effects due to vehicles traversing the SGP area.

Several air pollution design features proposed by Perpetua are common to both action alternatives and are described in **Section 2.4** and **7.3**. Emission control devices and designs would be put in place to abate emissions of particulate matter, Hg, and criteria pollutant emissions from internal-combustion engines the same as the 2021 MMP. Operational and reclamation air emission impacts for this alternative would therefore be the same as the 2021 MMP.

The facilities would be designed, constructed, and operated with appropriate air pollution controls to comply with applicable regulations and any air quality permits issued by IDEQ. The PTC would include stipulations for control of airborne dust from vehicle traffic along the Johnson Creek Route that are based on applicable state and federal regulations, and that are consistent with best available control technology for new surface mining and processing operations. Key examples of these controls are described for the emission inventory under the 2021 MMP, in **Section 7.2.2.1**.

7.3 Mitigation and Monitoring

A number of emission controls and monitoring actions have been proposed by Perpetua in compliance with government requirements. These are described below:

Perpetua would develop a fugitive dust control plan (FDCP) in accordance with IDEQ permit requirements. The FDCP will address the following:

- Procedures followed by Perpetua employees to control and minimize fugitive dust emissions.
- Trigger levels will be set that require corrective action.
- Actions to bring fugitive dust emissions within acceptable ranges.
- Steps to demonstrate that appropriate corrective procedures are followed.
- Procedures to verify that Perpetua is controlling avoidable fugitive dust emissions.

PET-0982

REC 2702

Additionally, the IDEQ permit would include the following control measures proposed by Perpetua for HAP and mercury emissions:

- Mining – chemical dust suppressant/water application on haul roads, reasonable controls, FDCP
- Rock dumps and storage piles - reasonable controls, FDCP
- Tailings and maintenance pond activities – chemical suppressant, reasonable control, FDCP
- Ore processing – water sprays, moisture carryover, enclosures, reasonable controls, FDCP
- Ore concentration and refining tanks – chemical suppressant
- Autoclave – venturi scrubber, vent gas cleaning tower, carbon filter
- Electrowinning cells and pregnant solution tank – carbon fiber
- Mercury retort – carbon filter
- Melting furnace – baghouse, carbon filter
- Carbon kiln – wet scrubber, carbon filter
- Limestone ball mill – baghouse
- Parallel flow regenerative shaft lime kiln – baghouse
- Lime mill crusher – baghouse
- Lime shaker – wet scrubber
- Storage silos – bin vents
- Aggregate and concrete production – water sprays, moisture carryover, reasonable controls, FDCP
- Fuel Combustion – clean fuel (ultra-low sulfur diesel)
- Emergency engines – EPA Tier IV standard compliant
- Gasoline storage – lids or gasketed seal, submerged filling
- Diesel storage – lids

Fugitive mercury emissions would be reduced with the following measures:

- Mining – Chemical dust suppressant/water application on haul roads, reasonable controls, FDCP.
- Rock dumps and storage piles - reasonable controls, FDCP.
- Tailings and maintenance pond activities – chemical treatment, reasonable control, FDCP
- Ore processing – water sprays, moisture carryover, enclosures, reasonable controls, FDCP

- Aggregate and concrete production – water sprays, moisture carryover, reasonable controls, FDCP

IDEQ permitting is limiting emissions in the following manner:

- "Low-arsenic" quartzite (90 ppm arsenic or less) development rock to be applied for capping haul roads excluding those with the various pits and rock storage facilities.
- Drill rigs would include a dust control system with a minimum efficiency of 90 percent.

In addition to the government requirements for emission controls and monitoring, Perpetua has also proposed additional environmental design measures that would reduce air emissions; these are:

- All off-highway diesel engines would be EPA Tier IV or better.
- Perpetua would encourage employees to use company provided shuttle buses as transport to the SGLF from towns along SH 55.
- Busing and/or vanpooling would be provided for Perpetua and contractor employees. The associated parking area would accommodate approximately 300 vehicles. To the degree practicable, Perpetua would mandate the use of busing and vans for employee and contractor transportation to the SGP and the worker housing facility.

Mitigation measures required by the Forest Service would represent reasonable and effective means to reduce the impacts identified in the previous section or to reduce uncertainty regarding the forecasting of impacts into the future. These mitigation measures are in addition to the prominent regulatory and Forest Plan requirements and project design features (**Section 2.4**) accounted for in the preceding impact analysis.

Mitigation measures may be added, revised, or refined based on public comment, agency comment, or continued discussions with Perpetua regarding this specialist report or subsequent analysis under NEPA. The adopted mitigation measures will be finalized in the Final EIS.

7.4 Cumulative Effects

7.4.1 Past, Present, and Reasonably Foreseeable Activities Relevant to Cumulative Effects Analysis

Past, present, and reasonably foreseeable future actions include activities, developments, or events that have the potential to change the physical, social, economic, and/or biological nature of a specified area. With respect to air quality, activities directly associated with the SGP and other reasonably foreseeable future actions having air pollutant emissions at a level that cause overlap with SGP-related effects in time and location, would result in cumulative impacts. The air quality cumulative effects analysis considers the potential contributions of actions that could occur in the relatively large analysis area. The cumulative effects study area for air quality is generally the same as the larger far-field region.

7.4.2 No Action Alternative

For the No Action Alternative, the nature and extent of cumulative effects is represented by the current air quality conditions in the analysis area. Ambient air data for CO, NO_2, SO_2, and on-site data for PM_{10} and $PM_{2.5}$ are available to serve as quantitative indicators for the impacts from current non-SGP sources on air

quality (refer to **Section 6.1**, Existing Conditions). These background ambient air measurements offer the best indication of cumulative effects due to current emissions sources, absent the SGP. The monitored baseline values used for the air quality impact assessment were obtained at locations that are more developed than the SGP area. By comparison, the cumulative effects in the analysis area due to the current activities and air emission sources would be minor.

The federal agencies entered into an ASAOC with Midas Gold (now Perpetua) in January 2021 for the cleanup of certain legacy mining wastes in the SGP area. The work would involve excavating the wastes out of certain portions of Meadow Creek and East Fork South Fork Salmon River and then relocating those wastes to more suitable locations on site. This work is scheduled for the construction seasons of 2022 through 2024 and would involve excavation and hauling equipment as well as other vehicles for personnel and fuel/supplies transportation on the current access roads to the area. This would produce dust and tailpipe emissions that would likely precede the major construction activities of the action alternatives and so would not be cumulative to the air emissions from those activities.

7.4.3 2021 MMP

For the far-field air quality impact analysis, a suitable far-field modeling domain was defined as an area 420 km by 420 km in extent, centered on the SGP, as shown in **Figure 1-3**. This area encompasses the closest Class I areas and Class II wilderness areas that are most likely to have impacts. The four Class I areas for which far-field modeling results were reported are SAWT, SELW, HECA, and CRMO.

Cumulative effects analysis for air quality considers the geographic range and timeframe of impacts from past, current, and foreseeable activities. In general, the air quality effects from past projects do not generate cumulative effects due to the transient nature of air quality conditions. The release of pollutants in the past in a region, would not contribute to measured conditions in that region afterward. Transport from far more distant urban regions, even overseas, may contribute to local air conditions (e.g., ozone) but are not in the scope of a cumulative effects analysis. Therefore, past operations by Perpetua in the SGP area, such as exploratory drilling, monitoring wells, and roadway construction and maintenance, are not contributors to air quality cumulative effects. Similarly, past activities in the cumulative analysis area, such as prior roadway and infrastructure construction projects, and timber and underbrush harvesting, would not have effects that overlap in time with the SGP emissions, and therefore would not contribute to air quality cumulative effects.

The ambient air data for CO, NO_2, SO_2, and on-site data for PM_{10} and $PM_{2.5}$ indicate the existing impacts from off-site sources on air quality near the SGP area was reviewed for this analysis (refer to **Section 3.3.4**). These background ambient air measurements offer the best indication of cumulative effects due to current emissions sources. Although some background measurements of ozone in the Boise urban area are above the NAAQS, the ozone baseline value for this assessment recommended by the IDEQ is compliant with the NAAQS. The monitored baseline values used for the SGP air quality impact assessment were obtained at locations that are more developed than the SGP area. By comparison, the cumulative effects in the analysis area due to current activities and air emission sources would be minor.

There are no other permitted sources of HAP emissions in the vicinity of the SGP area. One source, the Tamarack Mill, LLC is 75 miles from the SGP, and has reported minor source level emissions to IDEQ. The HAP emission inventory in the vicinity of the SGP area is unknown; however, given the absence of large HAP emission sources near the SGP area, it can be assumed that the baseline HAP cumulative effects are low.

Several reasonably foreseeable activities in the cumulative effects analysis region that were considered regarding cumulative air quality effects are listed in **Tables 7-29** and **7-30**. The nature of the air emissions and contributions to potential cumulative effects are described for each project. Activities that are anticipated to have overlapping impacts with the SGP related to air quality include wildfires and Big Creek fuels reduction.

Table 7-29 Reasonably Foreseeable Activities Considered Regarding Cumulative Air Quality Effects for Specific Planning Projects

Project Type	Project Names/Description	Nature of Air Emissions and Contribution to Cumulative Effects
Roadway Development and Maintenance	Big Creek Road Plan of Operations Project EA Morgan Ridge Exploration Project – Access Road Plan Such projects authorize the use of and/or improvement of roads to conduct exploration and development of locatable mineral claims.	Dispersed short-term local emissions of road dust and vehicle tailpipe emissions. Negligible long-term cumulative air quality effects in combination with the SGP.
Exploratory Drilling for Mineral Resources	Morgan Ridge Exploratory Drilling Plan of Operations EA Project involves exploratory drilling for locatable minerals from remote drill pads approximately 10 miles north of the SGP. Project is reportedly on hold.	Local emissions from drilling equipment (e.g., compressor engines), road dust, and tailpipe emissions. The magnitude of emissions is not expected to be of sufficient magnitude to have overlapping pollutant concentration effects at this distance from the SGP.
Forest Maintenance and Fire Risk Reduction	Big Creek fuels reduction project approx. 10 miles north of SGP South Fork Restoration and Access Management Plan EA, 25 miles southwest of SGP Projects to reduce wildfire risk and fire severity/intensity on NFS lands and private property using commercial timber harvest, understory treatment, and prescribed burning.	Local emissions from portable generator equipment (e.g., compressor engines, road dust, and tailpipe emissions. Particulate emissions from lumbering activities and hauling. The Big Creek project may be of sufficient magnitude to have overlapping PM concentration effects at this distance from the SGP. The South Fork project is of sufficient distance that it would have negligible cumulative air quality effects.

Table 7-30 Reasonably Foreseeable Activities Considered Regarding Cumulative Air Quality Effects for Ongoing Projects and Foreseeable Emissions Sources

Project Type	Project Names/Description	Nature of Air Emissions and Contribution to Cumulative Effects
Construction Projects	Creek remediation/restoration (ASAOC) Trail construction and maintenance Bridge and culvert replacement projects, generally located more than 10 miles north of the SGP area Hydroelectric projects: small residential projects for power	Short-term emissions during construction with no long- term emission impacts that would likely overlap with impacts related to the SGP.

Project Type	Project Names/Description	Nature of Air Emissions and Contribution to Cumulative Effects
	generation Road maintenance	
Natural Emission Events	Wildland fires Past fires with the headwaters of the East Fork SFSR and Sugar Creek include Indian Creek Point (12,204 acres); Tamarack (2,348 acres); Bishop Creek (2,610 acres); Cascade Complex (299,930 acres); Thunder City (13,263 acres), and Buck Fire (19,474 acres). In the fall of 2021, the Krassel Ranger District conducted prescribed burns to areas east of Yellow Pine (Bald Hill project area) and along the SFSR (Four Mile project areas).	Areas devoid of trees and vegetation may have potentially large, short-term air quality effects, due to increased windblown dust.
Mining Activities	Ongoing mining activities on patented land. Mineral exploration and mining have occurred in several locations around the SGP area. Exploration activities area ongoing for potential future mining development.	Local emissions from drilling equipment (e.g., compressor engines), road dust, and tailpipe emissions. Known mine operations are small in size (50 tpd or less) or are inactive. Locations of foreseeable projects with low emissions are at sufficient distances from the SGP to not contribute overlapping effects.
Recreation and tourism	Recreation and Tourist activities: • Sport hunting, fishing, trapping • Snowmobile trails • Fugitive dust and tailpipe emissions from traffic on unpaved roads • Boating and river recreation • Camping, hiking, backpacking • Outfitter/Guide Operations • Tourist Services – Big Creek Lodge • Off-highway vehicle use • Tourist Services – e.g., Big Creek Lodge	Collectively air emissions from vehicles on unpaved roads and trails, boats, and stationary fuel combustion sources. Depending on the proximity of these activities to the SGP area, transient cumulative effects may occur.

7.4.4 Johnson Creek Route Alternative

Although the magnitude and location of SGP air emission sources are different for the action alternatives, the differences are not large enough to significantly change off-site air quality impacts. Consequently, the potential for cumulative air quality effects described above for the 2021 MMP would also apply to the Johnson Creek Route Alternative. The extent and magnitude of potential cumulative air quality effects due to foreseeable projects in the analysis area would be the same.

7.5 Short-term Uses and Long-term Productivity

The CEQ guidelines require an evaluation of environmental sustainability considering the relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity (40 CFR 1502.16). This section provides a brief overview of the short-term effects of the SGP versus the maintenance and enhancement of potential long-term productivity of the environmental resources in the SGP area. Short-term refers to the analysis period for the SGP (the 20-year life of the mine). Long-term refers to an indefinite period after mine closure.

7.5.1 No Action Alternative

For the No Action Alternative, the impacts to the air quality resource would be roughly the same as current conditions. There would not affect short-term use or long-term productivity of the location with respect to air quality.

7.5.2 2021 MMP

For the 2021 MMP, operation of the mining and production facilities and associated use of transport vehicles would have continual short-term emissions of air pollutants for the duration of the SGP. These short-term emissions and related air quality impacts have been described in **Section 7.2.2**.

There are no anticipated long-term effects related to air quality in the SGP area, after the reclamation of the site. Once the SGP activities cease, air emissions and related effects would no longer occur.

7.5.3 Johnson Creek Route Alternative

The short-term uses of the air resource and effects on long-term productivity for the Johnson Creek Alternative would essentially be the same as the 2021 MMP.

7.6 Irreversible and Irretrievable Commitments of Resources

The CEQ guidelines require an evaluation of "any irreversible or irretrievable commitments of resources which would be involved in the proposal should it be implemented" (40 CFR 1502.16).

7.6.1 No Action Alternative

Under the No Action Alternative, the SGP would not be undertaken. Consequently, there would be no change in the current status of air resources in the SGP area, except for the temporary effects of implementing the ASAOC, and irretrievable or irreversible commitments of public resources with respect to air quality would not occur.

7.6.2 2021 MMP

There are no irreversible commitments for air quality resources under the 2021 MMP. The pollution resulting from 2021 MMP air emissions would occur over the construction through reclamation phases and then stop. Concentrations of pollutants in the analysis area would rapidly decrease to the ambient conditions then existing in the area. This short-term impact to the air resource would constitute an irretrievable commitment of that resource.

7.6.3 Johnson Creek Route Alternative

The irreversible and irretrievable commitment of the air resources under the Johnson Creek Route Alternative would essentially be the same as the 2021 MMP.

7.7 Summary

The air quality analysis conducted for the SGP examined impacts on defined geographic regions that relate to different types of modeling processes. First, a "near field" region surrounding the SGP was examined using air dispersion models to quantify pollutant concentrations and related impacts. For the SGP, preliminary modeling confirmed that a 10-km domain size was adequate to characterize worst-case near-field air quality impacts. Air quality effects would decrease at distances beyond the modeled 10-km range.

Second, a much larger "far-field" region was defined that encompassed more-distant Class I areas, wilderness areas, and tribal lands. In these areas, specialized air quality modeling tools were applied to evaluate the combined effects of dispersion, deposition, and chemical transformations in the atmosphere. The models assessed SGP source contributions to regional haze, nitrogen deposition, and sulfur deposition.

Table 7-30 provides a summary comparison of air quality impacts for each alternative, based on the issue and indicators defined for the air quality resource.

7.7.1 Extent of Pollutant Concentrations and Deposition

Dispersion modeling based on a representative mine operating scenario and the year with highest estimated aggregated air emissions, demonstrated that pollutant concentrations at the Operations Area Boundary would not exceed the NAAQS. This conclusion applies for both action alternatives. Deposition of Hg, and nitrogen and sulfur species were predicted to be less than SILs. A supplemental HAPs modeling analysis was also completed for all sources and compliance with the state AAC/AACCs was maintained.

The differences in SGP emission sources for the Johnson Creek Route Alternative are essentially the same as the 2021 MMP. Under the No Action Alternative, the SGP would not be constructed, so the air quality in the area would essentially remain the same as the existing baseline conditions with the exception of temporary emissions from implementing the ASAOC.

7.7.2 Type and Volume of Air Pollutants Emitted

To characterize the highest anticipated annual emission levels for purposes of conservative air quality impact analysis, a complete emission inventory was compiled for each year from construction through LOM Year 18. The year of peak mine throughput, LOM Year 6, was found to have the highest aggregate pollutant emissions, including haze precursors, airborne dust, and HAPs.

7.7.3 Criteria Air Pollutant Ambient Concentrations Outside the Operations Area Boundary

Dispersion modeling based on the 2021 MMP inventory demonstrated that impacts would not exceed NAAQS outside the operations area boundary. A supplemental HAPs analysis for all potential emission sources and each mine year was analyzed and demonstrated compliance with both the carcinogenic and non-carcinogenic acceptable concentrations. The Johnson Creek Route Alternative do not entail emission source differences of a permanent nature (e.g., roadway construction emissions) to result in long-term

criteria pollutant impacts that differ from the 2021 MMP findings, respectively. Close-in concentrations of pollutants from vehicle exhaust and airborne dust would be distributed differently for other action alternative since some sources and roadways would be in different locations. Under the No Action Alternative, the off-site concentrations of criteria pollutants would remain unchanged from the existing baseline conditions.

7.7.4 Comparison of Modeled Concentrations to Class I and Class II Increments

Both near-field and far-field modeling demonstrated that the Class I and Class II increments would not be exceeded outside the Operations Area Boundary. Although evaluation of incremental air quality impacts is not applicable to minor sources, such as the SGP, this provided an indicator of relative SGP impacts under the 2021 MMP. The far-field air quality impacts resulting from the Johnson Creek Route Alternative would not differ from the findings for the 2021 MMP. For the No Action Alternative, the off-site concentrations of criteria pollutants would remain unchanged from the existing baseline conditions.

7.7.5 HAP Emissions and Hg Deposition

Emissions of HAPs, including mercury, were quantified for the worst case LOM Year as outlined in the Supplemental HAP Air Quality Analysis Addendum – ModPro2 (Air Sciences 2021b). Additionally, HCN, sulfuric acid, Hg, and organic HAPs from fuel combustion, were found to be well below federal major source thresholds. Near-field deposition analysis for Hg indicated that even the maximum predicted deposition rates would be less than significance thresholds.

7.7.6 Deposition Impacts for Nitrogen and Sulfur Compounds at Class I areas and Specified Class II Wilderness Areas

Predicted deposition impacts, in grams pollutant per hectare per year, were obtained from far-field modeling for the 2021 MMP peak year emissions. The modeled results were compared to the DAT an indicator of significance (NPS 2011). The DAT for N and S in the Class I area are listed as 5 g/ha-yr. For the three modeled years of 2015 through 2017, the maximum predicted annual deposition rates were below the DAT in each Class I and Class II area evaluated.

7.7.7 Near-field Plume Blight and Far-Field Regional Haze Impacts

The Level 2 screening analysis addressed an observer at the FCRNRW and demonstrated that the aggregated emissions from the 2021 MMP would have the potential to cause visible plumes at that wilderness area. The VISCREEN updates included adding non-point sources and mobile equipment, increased background visual range to 270 kilometers, adding large-diameter PM emissions and nighttime hours (Appendix C of Air Sciences 2021a). The revised 2020 VISCREEN model predicts that 0.02 percent (1 hour) of the annual daytime hours and 2.9 percent (107 hours) of the annual nighttime hours may experience a visible plume within the FCRNRW area.

For analysis of regional haze impacts, maximum 24-hour SGP source emissions of SO_2, NO_X, SO_4, and fine and coarse PM were modeled. The Class I and Class II wilderness area visibility analysis results show the modeled 98th percentile highest daily change in light extinction parameters, and therefore the change in atmospheric visibility, would be less than the 5 percent change in light extinction that is considered the significance criteria for Class I areas (FLAG 2010). Consequently, the level of regional haze impact in the Class I and Class II areas evaluated was predicted to be minor.

PET-0990

REC 2710

Table 7-31 Comparison of Air Quality Impacts by Alternative

Issue	Indicator	Baseline Conditions	No Action Alternative	2021 MMP	Johnson Creek Alternative
The SGP may affect air quality characteristics and resources	Geographical extent of pollutant concentrations and deposition.	No SGP air emissions to affect existing conditions.	Same as Baseline Conditions.	SGP air quality impacts would be less than NAAQS because emissions and under deposition significance levels. This would be considered minor to moderate and localized/regional.	Same as 2021 MMP.
The SGP may affect air quality characteristics and resources	Type and volume of air pollutants emitted, including haze precursors, airborne dust, and HAPs.	No SGP air emissions to affect existing conditions.	Same as Baseline Conditions.	Emission inventories for construction through LOM Year 18 indicated that the peak year for aggregated pollutant emissions would be LOM Year 10, also the peak year for mine throughput. The overall impact is minor to moderate and localized.	Same as 2021 MMP, except those changes in emissions location due to use of Johnson Creek Route (i.e., different haul routes)
The SGP may affect air quality characteristics and resources	Criteria air pollutant ambient concentrations outside the Operations Area Boundary anywhere the public is allowed unrestricted access.	Current air quality in the SGP area is good, and in attainment with air quality standards.	Same as Baseline Conditions.	SGP air quality impacts would be less than NAAQS because and under deposition significance levels. Expected impacts are minor to moderate, but mostly localized as the highest concentrations are very near the boundary of SGP.	Same as 2021 MMP, except that the locations of off- site concentrations may differ due use of Johnson Creek Route rather than Burntlog Route.
The SGP may affect air quality characteristics and resources	Comparison of modeled concentrations to Class I and Class II increments.	Current air quality in the SGP area is good, and in attainment with air quality standards.	Same as Baseline Conditions.	SGP air quality impacts would be less than the Class I and Class II increments. The overall impacts are minor to Class I and Class II areas and regional in nature.	Same as 2021 MMP, except that the magnitude and locations of off-site concentrations may differ due use of Johnson Creek Route rather than Burntlog route.

Issue	Indicator	Baseline Conditions	No Action Alternative	2021 MMP	Johnson Creek Alternative
The SGP may affect air quality characteristics and resources	HAPs (including Hg emissions and Hg deposition.	Background concentrations and deposition occurs due to transport from distant industrial and urban sources.	Same as Baseline Conditions.	Emissions HAPs, HCN, and Hg estimated for peak mine production year. Deposition of Hg limited in extent and well below health-based thresholds. HAP emission impacts are less than state AAC/AACCs	Same as 2021 MMP.
The SGP may affect air quality characteristics and resources	Deposition impacts from nitrogen and sulfur compounds at Class I areas and specified Class II wilderness areas.	Existing deposition rates occur due to transport from distant industrial and urban sources.	Same as Baseline Conditions.	Modeling of N and S deposition in areas of concern show that deposition rates are below acceptable levels for Class I areas. The overall deposition impacts are minor to Class I and Class II areas and regional in nature.	Same as 2021 MMP.
The SGP may affect air quality characteristics and resources	Near-field plume blight and far- field regional haze impacts in protected areas.	No SGP sources to create visible near-field plumes. Existing regional haze occurs due to transport from distant industrial and urban sources.	Same as Baseline Conditions.	SGP sources may cause visible plumes at the closest Class II wilderness area (FCRNRW) for a small fraction of daylight hours. Far-field modeling of regional haze shows contribution from SGP sources would be below federal significance level. The impacts to visibility is negligible as illustrated by the VISCREEN modeling.	Same as 2021 MMP.

PET-0992

REC 2712

8.0 References

Air Sciences, Inc. (Air Sciences). 2018a. Stibnite Gold Project. Air Quality Analysis. Prepared for Midas Gold Idaho, Inc., Air Sciences, Inc. Project No. 335-1-2, October 10, 2018.

Air Sciences, Inc. (Air Sciences). 2018b. Stibnite Gold Project. Far Field Air Quality Impact Analysis. Prepared for Midas Gold Idaho, Inc., Air Sciences, Inc. Project No. 335-1-2, May 16, 2018.

Air Sciences, Inc. (Air Sciences). 2018c. Stibnite Gold Project. Unpaved Road Dust Control Efficiency from Chemical Suppressants. Prepared for Midas Gold Idaho, Inc., Air Sciences, Inc. Project No. 335-1-2, January 12, 2018.

Air Sciences, Inc. (Air Sciences). 2020. Stibnite Gold Project. State of Idaho Permit to Construct Application. Prepared for Midas Gold Idaho, Inc., Air Sciences, Inc. Project No. 335-1, June 23, 2020.

Air Sciences, Inc. (Air Sciences). 2021a. Stibnite Gold Project. Air Quality Analysis Addendum ModPro2. Prepared for Perpetua Resources, Air Sciences, Inc. Project No 335-21-402, July 13, 2021.

Air Sciences, Inc. (Air Sciences). 2021b. Stibnite Gold Project. Supplemental HAP Air Quality Analysis Addendum ModPro2. Prepared for Perpetua Resources, Air Sciences, Inc. Project No 335-21-402, October 5, 2021.

Code of Federal Regulations (CFR). 2011. Title 40: Protection of Environment. Part 1039 - Control of Emissions from New and In-Use Nonroad Compression-Ignition Engines. Office of the Federal Register and the Government Publishing Office. As amended June 2011. Available at: https://www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title40/40tab_02.tpl. Accessed May 2018.

Code of Federal Regulations (CFR). 2016. Title 40: Protection of Environment. Part 98 - Mandatory Greenhouse Gas Reporting. Subpart A – General Provisions. Office of the Federal Register and the Government Publishing Office. Final Rule Oct. 2009, as amended Dec. 2016. Available at: https://www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title40/40tab_02.tpl. Accessed May 2018.

Federal Land Managers (FLM). 2018. Federal Land Manager Environmental Database (FED). IMPROVE Haze Budgets, Most Impaired Days – Draft. Cooperative Institute for Research in the Atmosphere/Colorado State University. Accessed here: https://views.cira.colostate.edu/fed/SiteBrowser/Default.aspx?appkey=SBCF_Vi.

Federal Land Managers' Air Quality Related Values Work Group (FLAG). 2010. Federal Land Managers' Air Quality Related Values Work Group (FLAG): Phase I Report-Revised (2010). Natural Resource Report/NRPC/NRR-2010/232. Prepared for: U.S. Forest Service, National Park Service, and U.S. Fish and Wildlife Service. National Park Service, August 2010.

Idaho Department of Environmental Quality (IDEQ). 2001. Background and General Guidance for Permitting New and Modified Sources of Toxic Pollution in Idaho: TAP Rule History. Idaho Department of Environmental Quality.

Idaho Department of Environmental Quality (IDEQ). 2013. Approval: Midas Gold, Inc. Monitoring Protocol and Quality Assurance Project Plan for Conducting Ambient Air Quality and Meteorological Monitoring for the Proposed Golden Meadows Mine Project. Correspondence to Midas Gold Inc., December 10.

Idaho Department of Environmental Quality (IDEQ). 2015. Approval: Meteorological and Air Quality Data Summary - Stibnite Gold Project Monitoring Network. Correspondence to Midas Gold Inc., October 2015. (Based on 2013 Air Quality Monitoring Data Summary. Accessed at https://www.deq.idaho.gov/air-quality/monitoring/monitoring-network/.).

Idaho Department of Environmental Quality (IDEQ). 2017. Haze/Regional Haze. Idaho Department of Environmental Quality. Accessed at: http://www.deq.idaho.gov/air-quality/air-pollutants/haze/. Accessed October 2018.

Idaho Department of Environmental Quality (IDEQ). 2019. Idaho Air Quality Planning Areas Map. Attainment versus Nonattainment. Idaho Department of Environmental Quality. Accessed at: https://www.deq.idaho.gov/air-quality/monitoring/attainment-versus-nonattainment/. Accessed May 2019.

Idaho Department of Environmental Quality (IDEQ). 2022. Permit to Construct for Perpetua Resources. Idaho Department of Environmental Quality.

Idaho Department of Lands. 1992. Best Management Practices for Mining in Idaho.

Initiative for Responsible Mining Assurance (IRMA). 2018. IRMA Standard for Responsible Mining IRMA-STD-001. June 2018.Interagency Monitoring of Protected Visual Environments (IMPROVE). 2018. IMPROVE Data. Monitoring Site Browser. Available at: http://vista.cira.colostate.edu/Improve/improve-data/ Accessed October 2018.

Midas Gold Idaho, Inc. (Midas Gold). 2016. Stibnite Gold Project, Valley County, Idaho. Plan of Restoration and Operations. September 2016.

National Atmospheric Deposition Program (NADP). 2018. Mercury Deposition Network/Maps & Data/MDN Data. Available at: http://nadp.sws.uiuc.edu/mdn/MDN Site. Accessed October 2018.

National Atmospheric Deposition Program (NADP). 2019. Total Deposition 2016 Annual Map Summary. Wisconsin State Laboratory of Hygiene, University of Wisconsin, WI.

National Atmospheric Deposition Program (NADP). 2022. National Trends Network. Wet deposition chemistry data. Available at: http://nadp.slh.wisc.edu/NTN/. Accessed May 2022.

National Oceanic and Atmospheric Administration (NOAA). 2018. National Climatic Data Center (NCDC) Data. Available at: http://www.ncdc.noaa.gov/data-access. Accessed October 2018.

National Resources Conservation Service (NRCS). 2021. Snow Telemetry (SNOTEL) Data, Available at: http://www.wcc.nrcs.usda.gov/snow/snotel-wedata.html. Accessed November 2021.

National Wilderness Preservation System (NWPS). 2019a. Designation. Wilderness Connect/NWPS. Available at: https://wilderness.net/learn-about-wilderness/designation.php. Accessed May 2019.

National Wilderness Preservation System (NWPS). 2019b. The Wilderness Act of 1964. Wilderness Connect/NWPS. Available at: https://www.wilderness.net/NWPS/legisact. Accessed May 2019.

Nevada Department of Environmental Protection (NDEP). 2015. "Calendar Year 2015 Actual Production/Emission Reporting Spreadsheet for Mercury Emissions from the Precious Metals Mining Industry." Nevada Mercury Control Program (NMCP) - Annual Emissions Reporting. Nevada Division of Environmental Protection (NDEP). Accessed June 6, 2018. https://ndep.nv.gov/air/nevada-mercury-control-program-nmcp/reporting.

Nevada Department of Environmental Protection (NDEP). 2016. "Calendar Year 2016 Actual Production/Emission Reporting Spreadsheet for Mercury Emissions from the Precious Metals Mining Industry." Nevada Mercury Control Program (NMCP) - Annual Emissions Reporting. Nevada Division of Environmental Protection (NDEP). Accessed June 6, 2018. https://ndep.nv.gov/air/nevada-mercury-control-program-nmcp/reporting.

Peng, Y., Shi, N., Wang, J., Wang, T., and Pan, W. 2021. Mercury Speciation and Size-Specific Distribution in Filterable and Condensable Particulate Matter from Coal Combustion. Science of the Total Environment (Vol. 787).

Perpetua Resources Idaho Inc. (Perpetua). 2021a. Stibnite Gold Project: Refined Proposed Action ModPRO2. October.

Perpetua Resources Idaho Inc. (Perpetua). 2021b. Stibnite Gold Mitigation Plan

Perpetua Resources Idaho Inc. (Perpetua). 2021c. Fugitive Dust Control Plan.

Schwede, D. B., and G. G. Lear. 2014. A Novel hybrid Approach for Estimating Total Deposition in the United State. J. Geophys. Res. 103(D17):22.645-22.661.

Stantec Consulting Services (Stantec). 2021. Access Road and Ambient Air Boundary Applicability – Stibnite Gold Project EIS. Memo dated May 12, 2021. Written to Brinda Ramanathan from Eric Clark.

Trinity Consultants. 2017. Air Quality Baseline Study Stibnite Gold Project. Prepared for Midas Gold, Inc. Trinity Consultants with Stantec Consulting Services. December 2015, Revised April 2017.

U.S. Congress. 1872. 42nd Congress. The Mining Law of 1872, Pub.L. No. Session 2, Chap 152, 17 Stat. 91-96 (1872). Available at: https://govtrackus.s3.amazonaws.com/legislink/pdf/stat/17/STATUTE-17-Pg91.pdf

U.S. Environmental Protection Agency (EPA). 2010a. Meeting with Industry Representatives: Nevada Division of Environmental Protection (NDEP), and EPA. Docket ID: EPA-HQ-OAR-2010-0239-0146. February 17, 2010. Available at: https://www.regulations.gov/docket/EPA-HQ-OAR-2010-0239/

U.S. Environmental Protection Agency (EPA). 2010b. Evaluation of Air Emissions of Hydrogen Cyanide from Fugitive Sources at Nevada Gold Mines Using the USEPA Surface Isolation Flux Chamber Technology. Docket ID: EPA-HQ-OAR-2010-0239-0163. April 2010. Available at: https://www.regulations.gov/docket/EPA-HQ-OAR-2010-0239/

U.S. Environmental Protection Agency (EPA). 2017. Air Pollutant Emissions Trends Data and 2014 National Emissions Inventory (NEI) Data. Available at: https://www.epa.gov/air-emissions-inventories/air-pollutant-emissions-trends-data. Accessed September 2018.

U.S. Environmental Protection Agency (EPA). 2018a. National Ambient Air Quality Standards (NAAQS) Table. Accessed at: https://www.epa.gov/criteria-air-pollutants/naaqs-table QS. Accessed October 2018.

U.S. Environmental Protection Agency (EPA). 2018b. Clean Air Status and Trends Network (CASTNET) Data. Accessed at: http://epa.gov/castnet/javaweb/index.html. Accessed October 2018.

U.S. Environmental Protection Agency (EPA). 2018c. Revised Policy on Exclusions from "Ambient Air". Accessed at: https://www.epa.gov/sites/production/files/2018-11/documents/draft_ambient_air_guidance_110818.pdf, November 2018.

U.S. Environmental Protection Agency (EPA). 2018d. AirData Air Quality Monitors. Accessed at: https://epa.maps.arcgis.com/apps/webappviewer/index.html?id=5f239fd3e72f424f98ef3d5def547eb5&extent=-146.2334,13.1913,-46.3896,56.5319. October 2018.

U.S. Environmental Protection Agency (EPA). 2019a. Revised Policy on Exclusions from "Ambient Air". Memorandum A.R. Wheeler to Regional Administrators. Available at: https://www.epa.gov/sites/default/files/2019-12/documents/revised_policy_on_exclusions_from_ambient_air.pdf. Accessed December.

U.S. Environmental Protection Agency (EPA). 2019b. Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and PM2.5 under the PSD Permitting Program. Available at: https://www.epa.gov/sites/default/files/2019-05/documents/merps2019.pdf

U.S. Environmental Protection Agency (EPA). 2021a, Nonattainment for Criteria Pollutants (Green Book). Available at: https://www.epa.gov/green-book

U.S. Environmental Protection Agency (EPA). 2021b. Interactive Map of Air Quality Monitors: September 2021. Available at: https://www.epa.gov/outdoor-air-quality-data/interactive-map-air-quality-monitors

U.S. Environmental Protection Agency (EPA). 2022, Air Quality – National Summary Emission Trends. Available at: https://www.epa.gov/air-trends/air-quality-national-summary

U.S. Forest Service (Forest Service). 2003. Record of Decision for the Final Environmental Impact Statement and Revised Payette National Forest Land and Resource Management Plan. Revised July 2003.

U.S. Forest Service (Forest Service). 2010. Boise National Forest Land and Resource Management Plan. 2003-2010 Integration.

U.S. Forest Service (Forest Service). 2012. FSH 1909.15 – National Environmental Protection Act Handbook. Amendment No. 1905.15-2012-3. Washington, D.C.: U.S. Forest Service National Headquarters.

U.S. Forest Service (Forest Service). 2015a. Keeping it Wild 2 – An Updated Agency Strategy to Monitor Trends in Wilderness Character Across the National Wilderness Preservation System. U.S. Forest Service, General Technical Report RMRS-GTR-340. October 2015.

U.S. Forest Service (Forest Service). 2015b. Final Environmental Assessment, Golden Meadows Exploration Project. Krassel Ranger Station District, Payette National Forest, Valley County, Idaho. September 2015.U.S. Forest Service (Forest Service). 2021a. Stibnite Gold Project 2021 MMP Alternatives Report. Payette National Forest. November.

U.S. Forest Service (Forest Service). 2022a. Stibnite Gold Project 2021 MMP Alternatives Report. Payette National Forest.

U.S. Forest Service (Forest Service). 2022b. Stibnite Gold Project Climate Change Specialist Report. Payette National Forest.

U.S. National Park Service (NPS). 2018. Air Quality Conditions & Trends. Craters of the Moon National Monument & Preserve. Accessed December 20, 2019.

Wallace, J. M., and P. V. Hobbs. 2006. Atmospheric Chemistry. In Atmospheric Science, 2nd Edition, Chapter 5. Academic Press, Elsevier Inc. ISBN 978-0-12-732951-2.

Washington State University (WSU). 2018. NW AIRQUEST model: Lookup Design Values of Criteria Pollutants. Available at: http://lar.wsu.edu/nw-airquest/lookup.html, accessed September 2018.

Western Regional Climate Center (WRCC). 2018a. Boise Idaho Climate Data Summary 2017. Available at: https://wrcc.dri.edu/summary/Climsmsid.html. Accessed September 2018.

Western Regional Climate Center (WRCC). 2018b. McCall Local Climate Data Summary 2017. Available at: https://wrcc.dri.edu/summary/Climsmsid.html. Accessed September 2018.

Zhang, L. 2009. A Review of Current Knowledge Concerning Dry Deposition of Atmospheric Mercury. Atmospheric Environment 43 (2009) 5853–5864. Leiming Zhang, Paige, Wright, Pierrette Blanchard. Available at: http://www.evergladeshub.com/lit/pdf09/Zhang09AtmEnv139-HgAtmDeposit.pdf. Accessed June 13, 2018.

APPENDIX A MODPRO2 EMISSIONS INVENTORY AND MODELING PARAMETERS

EI TABLE OF CONTENTS

Emissions Summary 2
Ore Processing Sources - Criteria Pollutant Emissions 5
Ore Processing Sources - HAP and GHG Emissions 21
Fuel Storage Tank Emissions 32
Mining Fugitive and Mobile, and Burntlog Route - Criteria Pollutant Emissions 41
Mining Fugitive and Mobile, and Burntlog Route - HAP and GHG Emissions 72
Mine Site Construction - Criteria Pollutant, HAP, and GHG Emissions 77
Power Line Construction - Criteria Pollutant, HAP, and GHG Emissions 86
Hg Emission Speciation 95
Hg Deposition Parameters 96
Conversions and Constants 97

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-1-1	PAGE: 1 OF: 3 SHEET: EmSum
AIR EMISSION CALCULATIONS	SUBJECT: Emissions Summary	DATE: June 30, 2021

Emissions Summary

Maximum Annual Emissions

Total Emissions by LOM Year

	LOM	PM ton/yr	PM10 ton/yr	PM2.5 ton/yr	CO ton/yr	NOX ton/yr	SO2 ton/yr	VOC ton/yr
	1	208.0	61.7	14.7	461.7	156.2	0.8	52.3
	2	302.3	92.2	24.3	531.3	220.8	0.9	**56.8**
	3	544.0	145.6	28.5	**641.2**	272.1	1.1	50.9
4-18	4	923.1	268.8	63.9	495.6	323.7	7.3	26.5
4-18	5	922.8	270.4	64.7	491.3	323.0	7.3	26.3
4-18	6	995.3	289.7	65.9	535.4	**335.3**	**7.3**	26.1
4-18	7	904.7	267.7	63.3	506.3	326.1	7.3	26.0
4-18	8	834.7	249.9	62.1	480.1	301.9	7.2	26.0
4-18	9	871.5	255.3	62.6	459.2	268.7	7.2	25.0
4-18	10	**1,130.6**	**320.1**	**69.1**	478.6	304.6	7.2	24.9
4-18	11	848.3	250.9	61.5	473.2	282.7	7.2	24.2
4-18	12	744.7	224.3	58.2	460.1	258.3	7.1	23.1
4-18	13	749.9	225.8	59.1	471.0	262.5	7.1	23.4
4-18	14	796.7	237.3	60.4	392.8	245.3	7.1	20.8
4-18	15	491.4	159.1	51.0	239.0	139.2	6.9	15.2
4-18	16	346.8	119.9	46.5	122.6	88.0	6.7	12.2
4-18	17	370.7	126.3	46.4	107.5	91.4	6.7	11.3
4-18	18	271.0	101.5	43.2	83.7	63.7	6.6	9.9
		PM_tpy	PM10_tpy	PM2.5_tpy	CO_tpy	NOx_tpy	SO2_tpy	VOC_tpy

Maximum Daily Emissions of AQRV Pollutants

Total Emissions by LOM Year

	LOM	Q/D Threshold	PM10 lb/day	PM2.5 lb/day	NOX lb/day	SO2 lb/day	H2SO4 lb/day	AQRV Pollutants (lb/day) Process	Mining	Construction	Total	
	1	775	454.7	101.8	1,013.2	4.5	0.0	0	0	1,472	1,472	chk
	2	775	684.4	173.9	1,498.4	5.6	0.0	0	0	2,188	2,188	chk
	3	775	934.2	180.8	1,695.3	8.5	0.0	0	1,428	1,210	2,638	chk
4-18	4	775	1,612.2	398.0	1,922.5	43.9	48.7	719	2,908	0	3,627	chk
4-18	5	775	1,631.3	405.9	1,914.4	43.9	48.7	719	2,919	0	3,638	chk
4-18	6	775	1,720.4	410.2	**1,969.0**	**44.0**	48.7	719	3,063	0	3,782	chk
4-18	7	775	1,628.1	396.2	1,928.8	43.9	**48.7**	719	2,931	0	3,650	chk
4-18	8	775	1,570.9	393.2	1,812.0	43.7	48.7	719	2,756	0	3,475	chk
4-18	9	775	1,535.5	390.8	1,611.7	43.2	48.7	719	2,520	0	3,239	chk
4-18	10	775	**1,937.0**	**429.7**	1,837.3	43.5	48.7	719	3,148	0	**3,867**	chk
4-18	11	775	1,534.3	386.0	1,705.8	43.2	48.7	719	2,613	0	3,332	chk
4-18	12	775	1,363.4	366.3	1,572.4	42.8	48.7	719	2,308	0	3,027	chk
4-18	13	775	1,386.4	372.5	1,587.3	42.9	48.7	719	2,346	0	3,065	chk
4-18	14	775	1,538.8	384.3	1,500.9	42.8	48.7	719	2,412	0	3,131	chk
4-18	15	775	1,122.1	333.2	898.9	41.4	48.7	719	1,392	0	2,111	chk
4-18	16	775	734.3	297.8	561.7	40.6	48.7	719	666	0	1,385	chk
4-18	17	775	770.3	297.5	580.4	40.5	48.7	719	721	0	1,440	chk
4-18	18	775	630.5	279.5	424.4	40.0	48.7	719	425	0	1,144	chk
			PM10_ppd	PM2.5_ppd	NOx_ppd	SO2_ppd	VOC_ppd	Sul_ppd				

Conversions

365 day/yr

2,000 lb/ton

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-1-1	PAGE: 2 OF: 3 SHEET: EmSum
AIR EMISSION CALCULATIONS	SUBJECT: Emissions Summary	DATE: June 30, 2021

Emissions Summary

Ore Processing and Refining

	PM_tpy	PM10_tpy	PM2.5_tpy	CO_tpy	NOx_tpy	SO2_tpy	VOC_tpy
LOM	PM	PM10	PM2.5	CO	NOX	SO2	VOC
	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr
4-18	86.7	55.8	35.9	30.6	38.0	6.5	5.3

Mining

	chk	chk	chk	chk	chk	chk	chk
LOM	PM	PM10	PM2.5	CO	NOX	SO2	VOC
	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr
3	341.7	87.3	16.3	370.8	158.5	0.6	22.1
4	836.3	213.0	28.0	465.0	285.7	0.8	21.2
5	836.1	214.7	28.8	460.8	285.0	0.8	21.0
6	908.6	233.9	30.0	504.9	297.2	0.8	20.8
7	817.9	211.9	27.4	475.7	288.0	0.8	20.7
8	748.0	194.2	26.3	449.5	263.9	0.8	20.7
9	784.8	199.5	26.7	428.6	230.7	0.7	19.7
10	1,043.9	264.3	33.3	448.1	266.6	0.7	19.6
11	761.6	195.1	25.6	442.7	244.7	0.7	18.9
12	657.9	168.6	22.4	429.6	220.2	0.6	17.7
13	663.1	170.0	23.3	440.4	224.5	0.6	18.1
14	710.0	181.5	24.5	362.3	207.2	0.6	15.5
15	404.7	103.4	15.2	208.5	101.2	0.4	9.9
16	260.1	64.1	10.6	92.1	50.0	0.2	6.8
17	283.9	70.5	10.6	77.0	53.3	0.2	6.0
18	184.3	45.7	7.3	53.1	25.7	0.1	4.6

Mine Infrastructure Construction[1]

	chk	chk	chk	chk	chk	chk	chk
	189.1	54.2	11.8	392.1	91.6	0.6	47.8
LOM	PM	PM10	PM2.5	CO	NOX	SO2	VOC
	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr
1	189.1	54.2	11.8	392.1	91.6	0.6	47.8
2	264.5	77.3	18.5	392.1	91.6	0.6	47.8
3	183.4	50.9	9.3	200.7	49.0	0.3	24.3

[1] *Construction emissions during mine operation are accounted for in the mining emissions*

Power Line Construction

	chk	chk	chk	chk	chk	chk	chk
	18.9	7.5	2.9	69.6	64.6	0.1	4.5
LOM	PM	PM10	PM2.5	CO	NOX	SO2	VOC
	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr
1	18.9	7.5	2.9	69.6	64.6	0.1	4.5
2	37.8	15.0	5.7	139.3	129.2	0.3	9.0
3	18.9	7.5	2.9	69.6	64.6	0.1	4.5

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-1-1	PAGE: 3 OF: 3 SHEET: EmSum
AIR EMISSION CALCULATIONS	SUBJECT: Emissions Summary	DATE: June 30, 2021

Emissions Summary

Ore Processing and Refining

	PM_ppd	PM10_ppd	PM2.5_ppd	CO_ppd	NOx_ppd	SO2_ppd	VOC_ppd	Sul_ppd
LOM	PM	PM10	PM2.5	CO	NOX	SO2	VOC	H2SO4
	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day
4-18	n/a	373.0	237.9	204.6	260.0	37.3	n/a	48.7

Mining

		chk	chk	chk	chk	chk	
LOM	PM	PM10	PM2.5	CO	NOX	SO2	VOC
	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day
3	n/a	500.0	93.8	2,462.0	922.1	5.6	n/a
4	n/a	1,239.2	160.1	3,886.0	1,662.5	6.6	n/a
5	n/a	1,258.4	168.0	3,704.0	1,654.3	6.5	n/a
6	n/a	1,347.4	172.3	3,409.5	1,709.0	6.6	n/a
7	n/a	1,255.2	158.3	3,677.9	1,668.8	6.6	n/a
8	n/a	1,197.9	155.3	4,248.4	1,552.0	6.3	n/a
9	n/a	1,162.6	152.9	3,644.7	1,351.7	5.9	n/a
10	n/a	1,564.0	191.8	4,621.9	1,577.3	6.2	n/a
11	n/a	1,161.4	148.1	4,282.5	1,445.7	5.9	n/a
12	n/a	990.5	128.4	4,369.4	1,312.4	5.5	n/a
13	n/a	1,013.4	134.6	4,103.0	1,327.3	5.6	n/a
14	n/a	1,165.8	146.4	4,054.6	1,240.9	5.5	n/a
15	n/a	749.1	95.3	3,018.6	638.8	4.1	n/a
16	n/a	361.3	59.9	543.3	301.6	3.3	n/a
17	n/a	397.3	59.6	458.4	320.3	3.1	n/a
18	n/a	257.6	41.6	324.1	164.4	2.7	n/a

Infrastructure Construction[1][2]

		chk	chk	chk	chk	chk	
		398.5	80.3	2226.5	527.9	3.5	
LOM	PM	PM10	PM2.5	CO	NOX	SO2	VOC
	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day
1	n/a	398.5	80.3	2226.5	527.9	3.5	n/a
2	n/a	572.0	130.9	2226.5	527.9	3.5	n/a
3	n/a	378.0	65.4	1148.4	288.0	1.8	n/a

[1] *Maximum daily emissions based on: 1000 person crew during peak construction, scaled with an average annual crew of 750 and an annual operating schedule of 355 day/yr*

[2] *Construction daily emissions based on: 1000 construction crew during peak construction, scaled with average annual crew of 750 and an annual operating schedule of 355 day/yr. Daily power generation emissions are not scaled by peak crew.*

Power Line Construction[1]

		chk	chk	chk-13	chk	chk	
		56.2	21.5	523.0	485.2	1.1	
LOM	PM	PM10	PM2.5	CO	NOX	SO2	VOC
	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day
1	n/a	56.2	21.5	523.0	485.2	1.1	n/a
2	n/a	112.4	43.0	1046.1	970.5	2.1	n/a
3	n/a	56.2	21.5	523.0	485.2	1.1	n/a

Construction daily emissions based on: 1000 construction crew during peak construction, scaled with average annual crew of 750 and an annual operating schedule of 355 day/yr.

Conversions

2,000	lb/ton	1,000	person construction crew during peak construction
24	hr/day	750	person average construction crew during the year
355	day/yr Annual operations schedule		

SOURCE DESCRIPTION		OPERATING LIMITS							EMISSION FACTORS									
Model	Source Description	Design Throughput						reference	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	H2S	unit	reference
ID		unit/hr	unit/day	unit/yr	units	Material	hr/yr											
OC1	Loader Transfer of Ore to Grizzly Screen	1,042	25,000	9,125,000	ton	Ore	8,760	(Midas Gold 2016), Sec. 10.1	0.00014	4.6E-05	1.3E-05						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.
OC2	Grizzly Screen to Apron Feeder	1,042	25,000	9,125,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.
OC3	Apron Feeder to Dribble Conveyor	1,042	25,000	9,125,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.
OC4	Apron Feeder to Vibrating Grizzly	1,042	25,000	9,125,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.
OC5	Dribble Conveyor to Vibrating Grizzly	1,042	25,000	9,125,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	1,042	25,000	9,125,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	1,042	25,000	9,125,000	ton	Ore	8,760		0.0012	0.00054	0.0001						lb/ton	AP-42, Table 11.19.2-2 (08/04) Tert. Crushing - ctrl.
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	1,042	25,000	9,125,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.
OC9	Stockpile Transfers to Reclaim Conveyors	1,150	27,600	10,074,000	ton	Ore	8,760	(M3 2017b)	0.003	0.0011	0.00017						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - unctrl.; PM2.5 Ch. 13.2.4
OC10	Reclaim Conveyers to SAG Mill Feed Conveyor	1,150	27,600	10,074,000	ton	Ore	8,760		0.003	0.0011	0.00017						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - unctrl.; PM2.5 Ch. 13.2.4
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	1,150	27,600	10,074,000	ton	Ore	8,760		0.003	0.0011	0.00017						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - unctrl.; PM2.5 Ch. 13.2.4
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	1150.0	27,600	10,074,000	ton	Ore	8,760		0.0012	0.00054	0.0001						lb/ton	AP-42, Table 11.19.2-2 (08/04) Tert. Crushing - ctrl.
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	1150.0	27,600	10,074,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.
LS1L	Mill Lime Silo#1 Loading	60	250	4,375	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.00099	0.00034	0.00005						lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	20	250	4,375	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.00042						lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4
MillS2L	Mill Lime Silo #2 Loading	60	250	4,375	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.00099	0.00034	0.00005						lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	20	250	4,375	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.00042						lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4
Sb1	Sb Drying (2.72 MMBtu/hr Propane-Fired)	0		0	MMBtu	Propane	8,760	Removed from PTC, 01/28/21	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874		lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
Sb2	Sb Bagging	4.5		39,420	ton	Stib. Conc.	8,760	(M3 2017d)	0	0	0						lb/hr	Wet bagging, 01/28/21
AC	Autoclave	290	6,960	2,540,400	ton	Float Conc.	8,760	(M3 2017b)	5.075	5.075	5.075			0.6525		0.9	lb/hr	Based on NDEP-BAPC Permits/test data for Autoclaves: PM & SO2 - [Goldstrike (NDEP 2012)], H2S - (APT 2013). Negligible CO due to no organic carbon in the feed (M3 2017a)
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	17	17	510	MMBtu	Propane	30	(M3 2017b)	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874		lb/MMBtu	AP-42, Table 1.5-1 (07/08) Ind. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
ACS1L	AC Lime Silo #1 Loading	120	1,000	17,500	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.00099	0.00034	0.00005						lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	20	480	17,500	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.0004						lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4
ACS2L	AC Lime Silo #2 Loading	120	1,000	17,500	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.00099	0.00034	0.00005						lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	20	480	17,500	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.0004						lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4

SOURCE DESCRIPTION		EMISSION CONTROLS			HOURLY EMISSIONS								DAILY EMISSIONS							
Model ID	Source Description	control system	efficiency	reference	PM lb/hr	PM_{10} lb/hr	$PM_{2.5}$ lb/hr	CO lb/hr	NOx lb/hr	SO_2 lb/hr	VOC lb/hr	H2S lb/hr	PM lb/day	PM_{10} lb/day	$PM_{2.5}$ lb/day	CO lb/day	NOx lb/day	SO_2 lb/day	VOC lb/day	H2S lb/day
OC1	Loader Transfer of Ore to Grizzly Screen	Water Sprays		Control efficiency included in emission factor	0.146	0.0479	0.0135						3.50	1.15	0.325					
OC2	Grizzly Screen to Apron Feeder	Moisture Carry-Over		Control efficiency included in emission factor	0.146	0.0479	0.0135						3.50	1.15	0.325					
OC3	Apron Feeder to Dribble Conveyor	Moisture Carry-Over		Control efficiency included in emission factor	0.146	0.0479	0.0135						3.50	1.15	0.325					
OC4	Apron Feeder to Vibrating Grizzly	Moisture Carry-Over		Control efficiency included in emission factor	0.146	0.0479	0.0135						3.50	1.15	0.325					
OC5	Dribble Conveyor to Vibrating Grizzly	Moisture Carry-Over		Control efficiency included in emission factor	0.146	0.0479	0.0135						3.50	1.15	0.325					
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	Moisture Carry-Over		Control efficiency included in emission factor	0.146	0.0479	0.0135						3.50	1.15	0.325					
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	Water Sprays		Control efficiency included in emission factor	1.25	0.563	0.104						30.0	13.5	2.50					
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	Moisture Carry-Over		Control efficiency included in emission factor	0.146	0.0479	0.0135						3.50	1.15	0.325					
OC9	Stockpile Transfers to Reclaim Conveyors	Undergrnd	80%	Based on AP-42, Chapter 13.2.4, reduction in EF due to wind speed reduction	0.690	0.253	0.0391						16.6	6.07	0.938					
OC10	Reclaim Conveyers to SAG Mill Feed Conveyor	Undergrnd	80%	Based on AP-42, Chapter 13.2.4, reduction in EF due to wind speed reduction	0.690	0.253	0.0391						16.6	6.07	0.938					
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	Enclosure	80%	Based on AP-42, Chapter 13.2.4, reduction in EF due to wind speed reduction	0.690	0.253	0.0391						16.6	6.07	0.94					
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	Water Sprays		Control efficiency included in emission factor	1.380	0.621	0.1150						33.12	14.90	2.760					
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	Moisture Carry-Over		Control efficiency included in emission factor	0.1610	0.0529	0.01495						3.864	1.270	0.3588					
LS1L	Mill Lime Silo#1 Loading	Bin Vent Filter		Control efficiency included in emission factor	0.0594	0.0204	0.00300						0.248	0.0850	0.0125					
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	None	0%		0.0960	0.0560	0.00840						1.20	0.700	0.105					
MillS2L	Mill Lime Silo #2 Loading	Bin Vent Filter		Control efficiency included in emission factor	0.0594	0.0204	0.00300						0.248	0.0850	0.0125					
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	None	0%		0.0960	0.0560	0.00840						1.20	0.700	0.105					
Sb1	Sb Drying (2.72 MMBtu/hr Propane-Fired)	None	NA		0.0000	0.0000	0.0000	0.000	0.000	0.0000	0.0000		0.000	0.000	0.000	0.00	0.00	0.00	0.000	
Sb2	Sb Bagging	None	NA	Wet process	0.000	0.000	0.000						0.00	0.00	0.00					
AC	Autoclave	Wet Scrubber	NA	PM control efficiency included in emission factor	5.08	5.08	5.08			0.653		0.900	122	122	122			15.7		21.6
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	None	NA	NOX control efficiency included in emission factor	0.130	0.130	0.130	1.39	2.42	0.295	0.149		0.130	0.130	0.130	1.39	2.42	0.295	0.149	
ACS1L	AC Lime Silo #1 Loading	Bin Vent Filter		Control efficiency included in emission factor	0.119	0.0408	0.00600						0.990	0.340	0.0500					
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	None	0%		0.0960	0.0560	0.00800						2.30	1.34	0.192					
ACS2L	AC Lime Silo #2 Loading	Bin Vent Filter		Control efficiency included in emission factor	0.119	0.0408	0.00600						0.990	0.340	0.0500					
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	None	0%		0.0960	0.0560	0.00800						2.30	1.34	0.192					

SOURCE DESCRIPTION		ANNUAL EMISSIONS									NAD 83 LOCATION				
Model ID	Source Description	PM ton/yr	PM_{10} ton/yr	$PM_{2.5}$ ton/yr	CO ton/yr	NOx ton/yr	SO_2 ton/yr	VOC ton/yr	H2S ton/yr	Hg2+P ton/yr	UTM E m	UTM N m	reference	elev m	reference
OC1	Loader Transfer of Ore to Grizzly Screen	0.639	0.210	0.0593						6.13E-7	632,045	4,974,583	PC building center	1,968.5	PC building base
OC2	Grizzly Screen to Apron Feeder	0.639	0.210	0.0593						6.13E-7	632,045	4,974,583	PC building center	1,968.5	PC building base
OC3	Apron Feeder to Dribble Conveyor	0.639	0.210	0.0593						6.13E-7	632,045	4,974,583	PC building center	1,968.5	PC building base
OC4	Apron Feeder to Vibrating Grizzly	0.639	0.210	0.0593						6.13E-7	632,045	4,974,583	PC building center	1,968.5	PC building base
OC5	Dribble Conveyor to Vibrating Grizzly	0.639	0.210	0.0593						6.13E-7	632,045	4,974,583	PC building center	1,968.5	PC building base
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	0.639	0.210	0.0593						6.13E-7	632,045	4,974,583	PC building center	1,968.5	PC building base
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	5.48	2.46	0.456						5.26E-6	632,045	4,974,583	PC building center	1,968.5	PC building base
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	0.639	0.210	0.0593						6.13E-7	631,947	4,974,520	Stockpile center	1,957.0	Stockpile base
OC9	Stockpile Transfers to Reclaim Conveyors	3.02	1.11	0.171						2.90E-6	631,947	4,974,520	Stockpile center	1,957.0	Stockpile base
OC10	Reclaim Conveyers to SAG Mill Feed Conveyor	3.02	1.11	0.171						2.90E-6	631,947	4,974,520	Stockpile center	1,957.0	Stockpile base
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	3.02	1.11	0.171						2.90E-6	632,113	4,974,243	Mill building wall opening	2,000.6	Mill building base
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	6.04	2.720	0.504						5.80E-6	632,028	4,974,187	Pebble crusher building center	1,973.3	Pebble crusher building base
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0.705	0.2317	0.0655						6.77E-7	632,028	4,974,187	Pebble crusher building center	1,973.3	Pebble crusher building base
LS1L	Mill Lime Silo#1 Loading	0.00217	7.44E-4	1.09E-4						4.33125E-11	632,095	4,974,272	Mill Silo #1 center	1,992.0	Mill Silo #1 base
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0.0105	0.00613	9.19E-4						2.1E-10	632,095	4,974,272	Mill Silo #1 center	1,992.0	Mill Silo #1 base
MillS2L	Mill Lime Silo #2 Loading	0.00217	7.44E-4	1.09E-4						4.33125E-11	632,090	4,974,282	Mill Silo #2 center	1,990.0	Mill Silo #2 base
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0.0105	0.00613	9.19E-4						2.1E-10	632,090	4,974,282	Mill Silo #2 center	1,990.0	Mill Silo #2 base
Sb1	Sb Drying (2.72 MMBtu/hr Propane-Fired)	0.0000	0.0000	0.0000	0.000	0.00	0.000	0.000		0.00E+0	632,231	4,974,183	Mill building corner	2,000.6	Mill building base
Sb2	Sb Bagging	0.000	0.000	0.000							632,208	4,974,221	Mill building corner	2,000.6	Mill building base
AC	Autoclave	22.2	22.2	22.2			2.86		3.94	2.10E-6	632,229	4,974,096	POX building corner	2,007.2	POX building base
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0.00195	0.00195	0.00195	0.0209	0.0362	0.00443	0.00223		6.00E-9	632,261	4,974,116	POX building corner	2,007.2	POX building base
ACS1L	AC Lime Silo #1 Loading	0.00866	0.00298	4.38E-4						1.7325E-10	632,267	4,974,124	AC Silo #1 center	2,007.2	AC Silo #1 base
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0.0420	0.0245	0.00350						8.4E-10	632,267	4,974,124	AC Silo #1 center	2,007.2	AC Silo #1 base
ACS2L	AC Lime Silo #2 Loading	0.00866	0.00298	4.38E-4						1.7325E-10	632,257	4,974,140	AC Silo #2 center	2,007.2	AC Silo #2 base
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0.0420	0.0245	0.00350						8.4E-10	632,257	4,974,140	AC Silo #2 center	2,007.2	AC Silo #2 base

SOURCE DESCRIPTION		RELEASE PARAMETERS INPUT						MODEL EMISSION RATES / RELEASE PARAMETERS													
Model	Source Description	POINT	rel ht (ft)	temp (F)	flow (dscfm)	flow (acfm)	dia (ft)	PM_{10}-24	$PM_{2.5}$-24	CO-ALL	NO_2-1	SO_2-1	SO_2-3	PM_{10}-AN	$PM_{2.5}$-AN	NO_2-AN	SO_2-AN	ht (m)	temp (K)	vel (m/s)	dia (m)
ID		VOLUME	rel ht (ft)	width (ft)	vert. ln (ft)	grnd ht (ft)	σz type	gps	gps	gps	gps	gps	gps	gps	gps	gps	gps	ht (m)	σy (m)	σz (m)	
OC1	Loader Transfer of Ore to Grizzly Screen	VOLUME	64	52.9	128	128	srf src	6.04E-3	1.71E-3					6.04E-3	1.71E-3			19.51	3.75	18.15	
OC2	Grizzly Screen to Apron Feeder	VOLUME	64	52.9	128	128	srf src	6.04E-3	1.71E-3					6.04E-3	1.71E-3			19.51	3.75	18.15	
OC3	Apron Feeder to Dribble Conveyor	VOLUME	64	52.9	128	128	srf src	6.04E-3	1.71E-3					6.04E-3	1.71E-3			19.51	3.75	18.15	
OC4	Apron Feeder to Vibrating Grizzly	VOLUME	64	52.9	128	128	srf src	6.04E-3	1.71E-3					6.04E-3	1.71E-3			19.51	3.75	18.15	
OC5	Dribble Conveyor to Vibrating Grizzly	VOLUME	64	52.9	128	128	srf src	6.04E-3	1.71E-3					6.04E-3	1.71E-3			19.51	3.75	18.15	
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	VOLUME	64	52.9	128	128	srf src	6.04E-3	1.71E-3					6.04E-3	1.71E-3			19.51	3.75	18.15	
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	VOLUME	64	52.9	128	128	srf src	7.09E-2	1.31E-2					7.09E-2	1.31E-2			19.51	3.75	18.15	
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	VOLUME	35.8	3	71.6	71.6	srf src	6.04E-3	1.71E-3					6.04E-3	1.71E-3			10.91	0.21	10.15	
OC9	Stockpile Transfers to Reclaim Conveyors	VOLUME	4	8	8	8	srf src	3.19E-2	4.93E-3					3.19E-2	4.93E-3			1.22	0.57	1.13	
OC10	Reclaim Conveyers to SAG Mill Feed Conveyor	VOLUME	4	8	8	8	srf src	3.19E-2	4.93E-3					3.19E-2	4.93E-3			1.22	0.57	1.13	
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	VOLUME	68	4	4	70	elev src w/ bldg	3.19E-2	4.93E-3					3.19E-2	4.93E-3			20.73	0.28	0.57	
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	VOLUME	10	32.7	20	20	srf src	7.82E-2	1.45E-2					7.82E-2	1.45E-2			3.05	2.32	2.84	
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	VOLUME	10	32.7	20	20	srf src	6.67E-3	1.88E-3					6.67E-3	1.88E-3			3.05	2.32	2.84	
LS1L	Mill Lime Silo#1 Loading	POINT	43.7	Ambient	700	700	0.5	4.46E-4	6.56E-5					2.14E-5	3.15E-6			13.32	0.00	18.11	0.15
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	VOLUME	4.5	1	1	5	elev src w/ bldg	3.67E-3	5.51E-4					1.76E-4	2.64E-5			1.37	0.07	0.14	
MillS2L	Mill Lime Silo #2 Loading	POINT	43.7	Ambient	700	700	0.5	4.46E-4	6.56E-5					2.14E-5	3.15E-6			13.32	0.00	18.11	0.15
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	VOLUME	4.5	1	1	5	elev src w/ bldg	3.67E-3	5.51E-4					1.76E-4	2.64E-5			1.37	0.07	0.14	
Sb1	Sb Drying (2.72 MMBtu/hr Propane-Fired)	POINT	150	360	0	0	1.0	--	--	--	--	--	--	--	--	--	--	45.72	455.37	0.00	0.30
Sb2	Sb Bagging	POINT	150	Ambient	800	1,000	1.0	--	--					--	--			45.72	0.00	6.47	0.30
AC	Autoclave	POINT	77	196	3,101	28,680	5.0	6.39E-1	6.39E-1			8.22E-2	8.22E-2	6.39E-1	6.39E-1		8.22E-2	23.47	364.26	7.42	1.52
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	POINT	77	360	2,881	6,703	2.0	6.83E-4	6.83E-4	1.76E-1	3.04E-1	3.72E-2	3.72E-2	5.61E-5	5.61E-5	1.04E-3	1.27E-4	23.47	455.37	10.84	0.61
ACS1L	AC Lime Silo #1 Loading	POINT	57.2	Ambient	1,400	1,400	0.8	1.78E-3	2.62E-4					8.56E-5	1.26E-5			17.44	0.00	16.10	0.23
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	VOLUME	4.5	1	1	5	elev src w/ bldg	7.06E-3	1.01E-3					7.05E-4	1.01E-4			1.37	0.07	0.14	
ACS2L	AC Lime Silo #2 Loading	POINT	57.2	Ambient	1,400	1,400	0.8	1.78E-3	2.62E-4					8.56E-5	1.26E-5			17.44	0.00	16.10	0.23
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	VOLUME	4.5	1	1	5	elev src w/ bldg	7.06E-3	1.01E-3					7.05E-4	1.01E-4			1.37	0.07	0.14	

SOURCE DESCRIPTION		OPERATING LIMITS							EMISSION FACTORS									
Model	Source Description	Design Throughput						reference	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	H2S	unit	reference
ID		unit/hr	unit/day	unit/yr	units	Material	hr/yr											
ACS3L	AC Lime Silo #3 Loading	120	1,000	17,500	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.00099	0.00034	0.00005						lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	20	480	17,500	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.0004						lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4
ACS4L	AC Lime Silo #4 Loading	120	500	8,750	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.00099	0.00034	0.00005						lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	20	480	8,750	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.0004						lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4
CKD	Carbon Regeneration Kiln (Drum)	0.3		2,628	ton	Carbon	8,760	(M3 2017b)	0.42	0.42	0.42	0.12	0.012		0.11		lb/hr	Based on NDEP-BAPC Permit for Carbon Regeneration Kiln [Goldstrike (NDEP 2012)]
CKB	Carbon Regeneration Kiln (Burners)	2.255	54.12	19,754	MMBtu	Propane	8,760	(M3 2017b)	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874		lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
EW	Electrowinning Cells & Pregnant Solution Tank	100 gpm	24 hr		gpm	Au Sol.	8,760	Typical Ind. Oper.	0.07	0.07	0.07						lb/hr	Based on similar source stack test data and 5× safety factor (APT 2016)
MR	Mercury Retort	0.5/batch	24 hr	21	ton	Au Conc.	1,248	(M3 2017b) & (M3 2017a)	0.01	0.01	0.01						lb/hr	Based on similar source stack test data and 5× safety factor (APT 2017)
MF	Induction Melting Furnace	0.5/batch	12 hr	21	ton	Au Conc.	624	(M3 2017b) & (M3 2017a)	2.84	2.84	2.84						lb/hr	Based on IDAPA 58.01.01.701 PM Weight Limit
EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	1000	1 hr	100,000	bkW	Diesel	100	(M3 2017a)	0.2	0.2	0.2	3.5	6.4	0.00657	1.3		g/kW-hr	40 CFR Subpart 60.4202(a)(2); SO2 - mass balance (15ppm ULSD) (CFR 2018b)
EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	1000	1 hr	100,000	bkW	Diesel	100	(M3 2017a)	0.2	0.2	0.2	3.5	6.4	0.00657	1.3		g/kW-hr	40 CFR Subpart 60.4202(a)(2); SO2 - mass balance (15ppm ULSD) (CFR 2018b)
EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	1000	1 hr	100,000	bkW	Diesel	100	(M3 2017a)	0.2	0.2	0.2	3.5	6.4	0.00657	1.3		g/kW-hr	40 CFR Subpart 60.4202(a)(2); SO2 - mass balance (15ppm ULSD) (CFR 2018b)
EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	200	1 hr	20,000	bkW	Diesel	100	Typical Ind. Oper.	0.2	0.2	0.2	3.5	4	0.00657	4		g/kW-hr	Table 4 to Subpart IIII of Part 60 – 130≤KW<225 (175≤HP<300); SO2 - mass balance (15ppm ULSD) (CFR 2018b)
PV	Propane Vaporizer (0.4 MMBtu/hr Propane-Fired)	0.10	2.40	876	MMBtu	Propane	8,760	(M3 2017a)	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874		lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	5.00	120.00	43,800	MMBtu	Propane	8,760	(M3 2017b)	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874		lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	4.00	96.00	35,040	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874		lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	4.00	96.00	35,040	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874		lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	4.00	96.00	35,040	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874		lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
HAC	Autoclave HVAC Heater (1 x 0.25 MMBtu Propane-Fired)	0.25	6.00	2,190	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874		lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
HR	Refinery HVAC Heaters (1 x 0.25 MMBtu Propane-Fired)	0.25	6.00	2,190	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874		lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
HA	Admin HVAC Heaters (1 x 0.25 MMBtu Propane-Fired)	0.25	6.00	2,190	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874		lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0.50	12.00	4,380	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874		lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	2.00	48.00	17,520	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874		lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal

SOURCE DESCRIPTION		EMISSION CONTROLS			HOURLY EMISSIONS								DAILY EMISSIONS							
Model ID	Source Description	control system	efficiency	reference	PM lb/hr	PM_{10} lb/hr	$PM_{2.5}$ lb/hr	CO lb/hr	NOx lb/hr	SO_2 lb/hr	VOC lb/hr	H2S lb/hr	PM lb/day	PM_{10} lb/day	$PM_{2.5}$ lb/day	CO lb/day	NOx lb/day	SO_2 lb/day	VOC lb/day	H2S lb/day
ACS3L	AC Lime Silo #3 Loading	Bin Vent Filter		Control efficiency included in emission factor	0.119	0.0408	0.00600						0.990	0.340	0.0500					
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	None	0%		0.0960	0.0560	0.00800						2.30	1.34	0.192					
ACS4L	AC Lime Silo #4 Loading	Bin Vent Filter		Control efficiency included in emission factor	0.119	0.0408	0.00600						0.495	0.170	0.0250					
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	None	0%		0.0960	0.0560	0.00800						2.30	1.34	0.192					
CKD	Carbon Regeneration Kiln (Drum)	Wet Scrubber / Carbon Filter	NA	PM control efficiency included in emission factor	0.420	0.420	0.420	0.120	0.0120		0.110		10.1	10.1	10.1	2.88	0.288	0	2.64	
CKB	Carbon Regeneration Kiln (Burners)	None	NA		0.0173	0.0173	0.0173	0.185	0.320	0.0392	0.0197		0.414	0.414	0.414	4.44	7.69	0.940	0.473	
EW	Electrowinning Cells & Pregnant Solution Tank	Shared Carbon Filter			0.07	0.07	0.07						1.68	1.68	1.68					
MR	Mercury Retort	Condenser / Carbon Filter			0.01	0.01	0.01						0.24	0.24	0.24					
MF	Induction Melting Furnace	Baghouse / Carbon Filter	NA	Control efficiency included in emission factor	2.84	2.84	2.84						34.1	34.1	34.1					
EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	None	NA		0.441	0.441	0.441	7.72	14.1	0.0145	2.87		0.441	0.441	0.441	7.72	14.11	0.01448	2.866	
EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	None	NA		0.441	0.441	0.441	7.72	14.1	0.0145	2.87		0.441	0.441	0.441	7.72	14.11	0.01448	2.866	
EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	None	NA		0.441	0.441	0.441	7.72	14.1	0.0145	2.87		0.441	0.441	0.441	7.72	14.11	0.01448	2.866	
EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	None	NA		0.0882	0.0882	0.0882	1.54	1.76	0.00290	1.76		0.0882	0.0882	0.0882	1.543	1.764	2.90E-3	1.764	
PV	Propane Vaporizer (0.4 MMBtu/hr Propane-Fired)	None	NA		7.65E-4	7.65E-4	7.65E-4	0.00820	0.0142	0.00174	8.74E-4		0.0184	0.0184	0.0184	0.197	0.341	0.0417	0.0210	
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	None	NA		0.0383	0.0383	0.0383	0.410	0.710	0.0869	0.0437		0.918	0.918	0.918	9.84	17.0	2.09	1.05	
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	None	NA		0.0306	0.0306	0.0306	0.328	0.568	0.0695	0.0350		0.734	0.734	0.734	7.87	13.6	1.67	0.839	
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	None	NA		0.0306	0.0306	0.0306	0.328	0.568	0.0695	0.0350		0.734	0.734	0.734	7.87	13.6	1.67	0.839	
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	None	NA		0.0306	0.0306	0.0306	0.328	0.568	0.0695	0.0350		0.734	0.734	0.734	7.87	13.6	1.67	0.839	
HAC	Autoclave HVAC Heater (1 x 0.25 MMBtu Propane-Fired)	None	NA		0.00191	0.00191	0.00191	0.0205	0.0355	0.00434	0.00219		0.0459	0.0459	0.0459	0.492	0.852	0.104	0.0525	
HR	Refinery HVAC Heaters (1 x 0.25 MMBtu Propane-Fired)	None	NA		0.00191	0.00191	0.00191	0.0205	0.0355	0.00434	0.00219		0.0459	0.0459	0.0459	0.492	0.852	0.104	0.0525	
HA	Admin HVAC Heaters (1 x 0.25 MMBtu Propane-Fired)	None	NA		0.00191	0.00191	0.00191	0.0205	0.0355	0.00434	0.00219		0.0459	0.0459	0.0459	0.492	0.852	0.104	0.0525	
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	None	NA		0.00383	0.00383	0.00383	0.0410	0.0710	0.00869	0.00437		0.0918	0.0918	0.0918	0.984	1.70	0.209	0.105	
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	None	NA		0.0153	0.0153	0.0153	0.164	0.284	0.0348	0.0175		0.367	0.367	0.367	3.93	6.82	0.834	0.420	

SOURCE DESCRIPTION		ANNUAL EMISSIONS									NAD 83 LOCATION				
Model ID	Source Description	PM ton/yr	PM_{10} ton/yr	$PM_{2.5}$ ton/yr	CO ton/yr	NOx ton/yr	SO_2 ton/yr	VOC ton/yr	H2S ton/yr	Hg2+P ton/yr	UTM E m	UTM N m	reference	elev m	reference
ACS3L	AC Lime Silo #3 Loading	0.00866	0.00298	4.38E-4						1.7325E-10	632,248	4,974,156	AC Silo #3 center	2,007.2	AC Silo #3 base
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0.0420	0.0245	0.00350						8.4E-10	632,248	4,974,156	AC Silo #3 center	2,007.2	AC Silo #3 base
ACS4L	AC Lime Silo #4 Loading	0.00433	0.00149	2.19E-4						8.6625E-11	632,238	4,974,171	AC Silo #4 center	2,007.2	AC Silo #4 base
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0.0210	0.0123	0.00175						4.2E-10	632,238	4,974,171	AC Silo #4 center	2,007.2	AC Silo #4 base
CKD	Carbon Regeneration Kiln (Drum)	1.84	1.84	1.84	0.526	0.0526		0.482		6.51E-6	632,013	4,974,051	Refinery building corner	1,970.3	Refinery building base
CKB	Carbon Regeneration Kiln (Burners)	0.0756	0.0756	0.0756	0.810	1.40	0.172	0.0864		2.32E-7	631,998	4,974,042	Along Refinery building wall	1,970.3	Refinery building base
EW	Electrowinning Cells & Pregnant Solution Tank	0.31	0.31	0.31						6.51E-6	631,983	4,974,033	Refinery building corner	1,970.3	Refinery building base
MR	Mercury Retort	0.01	0.01	0.01						6.51E-6	632,003	4,974,001	Refinery building corner	1,970.3	Refinery building base
MF	Induction Melting Furnace	0.89	0.89	0.89						6.51E-6	632,032	4,974,019	Refinery building corner	1,970.3	Refinery building base
EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0.0220	0.0220	0.0220	0.386	0.705	7.24E-4	0.143			634,274	4,972,050	Outside Recreation building	2,114.0	Recreation building base
EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0.0220	0.0220	0.0220	0.386	0.705	7.24E-4	0.143			632,105	4,974,154	Outside Mill building	2,001.0	Mill building base
EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0.0220	0.0220	0.0220	0.386	0.705	7.24E-4	0.143			632,109	4,974,148	Outside Mill building	2,002.0	Mill building base
EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0.00441	0.00441	0.00441	0.0772	0.0882	1.45E-4	0.0882			632,113	4,974,141	Outside Mill building	2,003.0	Mill building base
PV	Propane Vaporizer (0.4 MMBtu/hr Propane-Fired)	0.00335	0.00335	0.00335	0.0359	0.0622	0.00761	0.00383		1.03E-8	632,216	4,974,118	POX building corner	2,007.2	POX building base
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0.168	0.168	0.168	1.80	3.11	0.381	0.191		5.15E-7	632,017	4,974,010	Along Refinery building wall	1,970.3	Refinery building base
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0.134	0.134	0.134	1.44	2.49	0.304	0.153		4.12E-7	632,287	4,974,227	Near underground mine shaft	2,000.0	Mine shaft base
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0.134	0.134	0.134	1.44	2.49	0.304	0.153		4.12E-7	632,288	4,974,228	Near underground mine shaft	2,000.0	Mine shaft base
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0.134	0.134	0.134	1.44	2.49	0.304	0.153		4.12E-7	632,168	4,974,191	Mill building center	2,000.6	Mill building base
HAC	Autoclave HVAC Heater (1 x 0.25 MMBtu Propane-Fired)	0.00838	0.00838	0.00838	0.0898	0.156	0.0190	0.00957		2.58E-8	632,238	4,974,130	POX building center	2,007.2	POX building base
HR	Refinery HVAC Heaters (1 x 0.25 MMBtu Propane-Fired)	0.00838	0.00838	0.00838	0.0898	0.156	0.0190	0.00957		2.58E-8	632,008	4,974,026	Refinery building center	1,970.3	Refinery building base
HA	Admin HVAC Heaters (1 x 0.25 MMBtu Propane-Fired)	0.00838	0.00838	0.00838	0.0898	0.156	0.0190	0.00957		2.58E-8	632,038	4,973,751	Admin building center	1,979.0	Admin building base
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0.0168	0.0168	0.0168	0.180	0.311	0.0381	0.0191		5.15E-8	631,889	4,973,472	Mine Ops building center	1,988.5	Mine Ops building base
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0.0670	0.0670	0.0670	0.718	1.24	0.152	0.0766		2.06E-7	631,848	4,973,398	Truck Shop building center	1,991.8	Truck Shop building base

SOURCE DESCRIPTION		RELEASE PARAMETERS INPUT						MODEL EMISSION RATES / RELEASE PARAMETERS													
Model	Source Description	POINT	rel ht (ft)	temp (F)	flow (dscfm)	flow (acfm)	dia (ft)	PM_{10}-24	$PM_{2.5}$-24	CO-ALL	NO_2-1	SO_2-1	SO_2-3	PM_{10}-AN	$PM_{2.5}$-AN	NO_2-AN	SO_2-AN	ht (m)	temp (K)	vel (m/s)	dia (m)
ID		VOLUME	rel ht (ft)	width (ft)	vert. ln (ft)	grnd ht (ft)	σz type	gps	gps	gps	gps	gps	gps	gps	gps	gps	gps	ht (m)	σy (m)	σz (m)	
ACS3L	AC Lime Silo #3 Loading	POINT	57.2	Ambient	1,400	1,400	0.8	1.78E-3	2.62E-4					8.56E-5	1.26E-5			17.44	0.00	16.10	0.23
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	VOLUME	4.5	1	1	5	elev src w/ bldg	7.06E-3	1.01E-3					7.05E-4	1.01E-4			1.37	0.07	0.14	
ACS4L	AC Lime Silo #4 Loading	POINT	47.5	Ambient	1,400	1,400	0.8	8.92E-4	1.31E-4					4.28E-5	6.29E-6			14.49	0.00	16.10	0.23
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	VOLUME	4.5	1	1	5	elev src w/ bldg	7.06E-3	1.01E-3					3.52E-4	5.03E-5			1.37	0.07	0.14	
CKD	Carbon Regeneration Kiln (Drum)	POINT	55	150	120	180	0.5	5.29E-2	5.29E-2	1.51E-2	1.51E-3			5.29E-2	5.29E-2	1.51E-3		16.76	338.71	5.05	0.15
CKB	Carbon Regeneration Kiln (Burners)	POINT	46	360	382	889	1.0	2.17E-3	2.17E-3	2.33E-2	4.04E-2	4.94E-3	4.94E-3	2.17E-3	2.17E-3	4.04E-2	4.94E-3	14.02	455.37	5.75	0.30
EW	Electrowinning Cells & Pregnant Solution Tank	POINT	55	100	2,660	3,740	1.0	8.82E-3	8.82E-3					8.82E-3	8.82E-3			16.76	310.93	24.19	0.30
MR	Mercury Retort	POINT	55	150	16	20	0.3	1.26E-3	1.26E-3					1.80E-4	1.80E-4			16.76	338.71	1.54	0.09
MF	Induction Melting Furnace	POINT	55	150	3,500	5,200	1.3	1.79E-1	1.79E-1					2.55E-2	2.55E-2			16.76	338.71	21.53	0.38
EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	POINT	7	1,100	1,894	10,328	1.5	2.31E-3	2.31E-3	9.72E-1	2.03E-2	2.08E-5	1.82E-3	6.34E-4	6.34E-4	2.03E-2	2.08E-5	2.13	866.48	29.69	0.46
EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	POINT	7	1,100	1,894	10,328	1.5	2.31E-3	2.31E-3	9.72E-1	2.03E-2	2.08E-5	1.82E-3	6.34E-4	6.34E-4	2.03E-2	2.08E-5	2.13	866.48	29.69	0.46
EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	POINT	7	1,100	1,894	10,328	1.5	2.31E-3	2.31E-3	9.72E-1	2.03E-2	2.08E-5	1.82E-3	6.34E-4	6.34E-4	2.03E-2	2.08E-5	2.13	866.48	29.69	0.46
EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	POINT	7	1,100	379	2,066	0.8	4.63E-4	4.63E-4	1.94E-1	2.54E-3	4.16E-6	3.65E-4	1.27E-4	1.27E-4	2.54E-3	4.16E-6	2.13	866.48	23.76	0.23
PV	Propane Vaporizer (0.4 MMBtu/hr Propane-Fired)	POINT	68	360	17	39	0.4	9.64E-5	9.64E-5	1.03E-3	1.79E-3	2.19E-4	2.19E-4	9.64E-5	9.64E-5	1.79E-3	2.19E-4	20.73	455.37	1.58	0.12
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	POINT	46	360	847	1,972	1.3	4.82E-3	4.82E-3	5.16E-2	8.95E-2	1.09E-2	1.09E-2	4.82E-3	4.82E-3	8.95E-2	1.09E-2	14.02	455.37	7.55	0.40
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	POINT	7	360	678	1,577	1.3	3.86E-3	3.86E-3	4.13E-2	7.16E-2	8.76E-3	8.76E-3	3.86E-3	3.86E-3	7.16E-2	8.76E-3	2.13	455.37	6.04	0.40
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	POINT	7	360	678	1,577	0.7	3.86E-3	3.86E-3	4.13E-2	7.16E-2	8.76E-3	8.76E-3	3.86E-3	3.86E-3	7.16E-2	8.76E-3	2.13	455.37	20.82	0.21
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	POINT	141	360	678	394	0.3	3.86E-3	3.86E-3	4.13E-2	7.16E-2	8.76E-3	8.76E-3	3.86E-3	3.86E-3	7.16E-2	8.76E-3	42.98	455.37	28.32	0.09
HAC	Autoclave HVAC Heater (1 x 0.25 MMBtu Propane-Fired)	POINT	68	360	42	99	0.3	2.41E-4	2.41E-4	2.58E-3	4.48E-3	5.47E-4	5.47E-4	2.41E-4	2.41E-4	4.48E-3	5.47E-4	20.73	455.37	7.11	0.09
HR	Refinery HVAC Heaters (1 x 0.25 MMBtu Propane-Fired)	POINT	46	360	42	99	0.3	2.41E-4	2.41E-4	2.58E-3	4.48E-3	5.47E-4	5.47E-4	2.41E-4	2.41E-4	4.48E-3	5.47E-4	14.02	455.37	7.11	0.09
HA	Admin HVAC Heaters (1 x 0.25 MMBtu Propane-Fired)	POINT	21	360	42	99	0.3	2.41E-4	2.41E-4	2.58E-3	4.48E-3	5.47E-4	5.47E-4	2.41E-4	2.41E-4	4.48E-3	5.47E-4	6.40	455.37	7.11	0.09
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	POINT	41	360	85	99	0.7	4.82E-4	4.82E-4	5.16E-3	8.95E-3	1.09E-3	1.09E-3	4.82E-4	4.82E-4	8.95E-3	1.09E-3	12.50	455.37	1.31	0.21
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	POINT	41	360	339	394	0.7	1.93E-3	1.93E-3	2.07E-2	3.58E-2	4.38E-3	4.38E-3	1.93E-3	1.93E-3	3.58E-2	4.38E-3	12.50	455.37	5.20	0.21

SOURCE DESCRIPTION		OPERATING LIMITS							EMISSION FACTORS									
Model	Source Description	Design Throughput						reference	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	H2S	unit	reference
ID		unit/hr	unit/day	unit/yr	units	Material	hr/yr											
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	3.00	72.00	26,280	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874		lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
PSL	Prill Silos Loading (2 x 100 ton)	200	200	7,300	ton	Prill	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.02	0.007	0.00106						lb/ton	AP-42, Table 8.3-2 (7/93), Bulk Loading - unctrl; PM10/PM2.5 Ch. 13.2.4
PSU	Prill Silos Unloading (2 x 100 ton)	200	200	7,300	ton	Prill	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.02	0.007	0.00106						lb/ton	AP-42, Table 8.3-2 (7/93), Bulk Loading - unctrl; PM10/PM2.5 Ch. 13.2.4
CS1L	Cement/Shotcrete Silo#1 Loading	80	80	60,000	ton	Cement	8,760	Typical Ind. Oper.	0.00099	0.00034	0.00005						lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4.
CS1U	Cement/Shotcrete Silo#1 Unloading	20	80	60,000	ton	Cement	8,760	Typical Ind. Oper.	0.0048	0.0028	0.0004						lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4.
CS2L	Cement/Shotcrete Silo#2 Loading	80	80	60,000	ton	Cement	8,760	Typical Ind. Oper.	0.00099	0.00034	0.00005						lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4.
CS2U	Cement/Shotcrete Silo#2 Unloading	20	80	60,000	ton	Cement	8,760	Typical Ind. Oper.	0.0048	0.0028	0.0004						lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4.
CAL	Aggregate Bin Loading	100	2,400	500,000	ton	Aggregate	8,760	Typical Ind. Oper.	0.0069	0.0033	0.0005						lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4.
CAU	Aggregate Bin Unloading	100	2,400	500,000	ton	Aggregate	8,760	Typical Ind. Oper.	0.0069	0.0033	0.0005						lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4.
CM	Central Mixer Loading	20 (120)	80 (2,480)	60,000 (560K)	ton-cement (tot.)	Cement (mix)	8,760	Typical Ind. Oper.	0.0184	0.0055	0.0008						lb/ton	AP-42, Table 11.12-2 (6/06), central mixer-ctrl.; PM2.5 Ch. 13.2.4.
HL	Landmark/Stibnite Heaters (3 x 1.0 MMBtu Propane-Fired)	3.00		26,280	MMBtu	Propane	8,760	Typical Ind. Oper.	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874		lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
TG1	Mine Site Gasoline Tank #1			250,000	gal	Gasoline	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide tank capacity)							0.219		lb/hr	EPA Tanks 4.0.9d
TG2	Mine Site Gasoline Tank #2			250,000	gal	Gasoline	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide tank capacity)							0.219		lb/hr	EPA Tanks 4.0.9d
TD3	Mine Site Diesel Tank #3			725,000	gal	Diesel	8,760	(Midas Gold 2016), (Midas Gold 2018g)							0.002		lb/hr	EPA Tanks 4.0.9d
TD4	Mine Site Diesel Tank #4			725,000	gal	Diesel	8,760	(Midas Gold 2016), (Midas Gold 2018g)							0.002		lb/hr	EPA Tanks 4.0.9d
TD5	Mine Site Diesel Tank #5			725,000	gal	Diesel	8,760	(Midas Gold 2016), (Midas Gold 2018g)							0.002		lb/hr	EPA Tanks 4.0.9d
TD6	Mine Site Diesel Tank #6			725,000	gal	Diesel	8,760	(Midas Gold 2016), (Midas Gold 2018g)							0.002		lb/hr	EPA Tanks 4.0.9d
TD7	Mine Site Diesel Tank #7			725,000	gal	Diesel	8,760	(Midas Gold 2016), (Midas Gold 2018g)							0.002		lb/hr	EPA Tanks 4.0.9d
TD8	Mine Site Diesel Tank #8			725,000	gal	Diesel	8,760	(Midas Gold 2016), (Midas Gold 2018g)							0.002		lb/hr	EPA Tanks 4.0.9d
TD9	Mine Site Diesel Tank #9			725,000	gal	Diesel	8,760	(Midas Gold 2016), (Midas Gold 2018g)							0.002		lb/hr	EPA Tanks 4.0.9d
TD10	Mine Site Diesel Tank #10			725,000	gal	Diesel	8,760	(Midas Gold 2016), (Midas Gold 2018g)							0.002		lb/hr	EPA Tanks 4.0.9d
TDL1	Landmark Diesel Tank #1			130,000	gal	Diesel	8,760	(Midas Gold 2018d), (Midas Gold 2018g)							0.000		lb/hr	EPA Tanks 4.0.9d
TDL2	Landmark Diesel Tank #2			130,000	gal	Diesel	8,760	(Midas Gold 2018d), (Midas Gold 2018g)							0.000		lb/hr	EPA Tanks 4.0.9d
TGL3	Landmark Gasoline Tank #3			130,000	gal	Gasoline	8,760	(Midas Gold 2018d), (Midas Gold 2018g)							0.118		lb/hr	EPA Tanks 4.0.9d
PCSP1	Portable Crushing and Screening Plant 1 (2 crushers, 2 screens, and 5 transfers)	83	2,000	730,000	ton	Aggregate	8,760	(Midas Gold 2019)	0.0075	0.00279	0.00037						lb/ton	AP-42, Table 11.19.2-2 (08/04): Tert. Crushing - ctrl. × 2 + Screening - ctrl. × 2 + Conv. Transfer - ctrl. × 5

SOURCE DESCRIPTION		EMISSION CONTROLS			HOURLY EMISSIONS								DAILY EMISSIONS							
Model ID	Source Description	control system	efficiency	reference	PM lb/hr	PM_{10} lb/hr	$PM_{2.5}$ lb/hr	CO lb/hr	NOx lb/hr	SO_2 lb/hr	VOC lb/hr	H2S lb/hr	PM lb/day	PM_{10} lb/day	$PM_{2.5}$ lb/day	CO lb/day	NOx lb/day	SO_2 lb/day	VOC lb/day	H2S lb/day
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	None	NA		0.0230	0.0230	0.0230	0.246	0.426	0.0521	0.0262		0.551	0.551	0.551	5.90	10.2	1.25	0.630	
PSL	Prill Silos Loading (2 x 100 ton)	None	0%		4.00	1.40	0.212						4.00	1.40	0.212					
PSU	Prill Silos Unloading (2 x 100 ton)	None	0%		4.00	1.40	0.212						4.00	1.40	0.212					
CS1L	Cement/Shotcrete Silo#1 Loading	Bin Vent Filter		Control efficiency included in emission factor	0.0792	0.0272	0.00400						0.0792	0.0272	0.0040					
CS1U	Cement/Shotcrete Silo#1 Unloading	None	0%		0.0960	0.0560	0.00800						0.384	0.224	0.0320					
CS2L	Cement/Shotcrete Silo#2 Loading	Bin Vent Filter		Control efficiency included in emission factor	0.0792	0.0272	0.00400						0.0792	0.0272	0.0040					
CS2U	Cement/Shotcrete Silo#2 Unloading	None	0%		0.0960	0.0560	0.00800						0.384	0.224	0.0320					
CAL	Aggregate Bin Loading	None	0%		0.690	0.330	0.0500						16.6	7.92	1.20					
CAU	Aggregate Bin Unloading	None	0%		0.690	0.330	0.0500						16.6	7.92	1.20					
CM	Central Mixer Loading	Types of controls used may include water sprays, enclosures, hoods, curtains, shrouds, movable and telescoping chutes, central duct collection systems, and the like.		Control efficiency included in emission factor	0.368	0.110	0.0160						1.47	0.440	0.0640					
HL	Landmark/Stibnite Heaters (3 x 1.0 MMBtu Propane-Fired)	None	NA		0.0230	0.0230	0.0230	0.246	0.426	0.0521	0.0262		0.551	0.551	0.551	5.90	10.2	1.25	0.630	
TG1	Mine Site Gasoline Tank #1	None	NA								0.219								5.25	
TG2	Mine Site Gasoline Tank #2	None	NA								0.219								5.25	
TD3	Mine Site Diesel Tank #3	None	NA								0.00167								0.0400	
TD4	Mine Site Diesel Tank #4	None	NA								0.00167								0.0400	
TD5	Mine Site Diesel Tank #5	None	NA								0.00167								0.0400	
TD6	Mine Site Diesel Tank #6	None	NA								0.00167								0.0400	
TD7	Mine Site Diesel Tank #7	None	NA								0.00167								0.0400	
TD8	Mine Site Diesel Tank #8	None	NA								0.00167								0.0400	
TD9	Mine Site Diesel Tank #9	None	NA								0.00167								0.0400	
TD10	Mine Site Diesel Tank #10	None	NA								0.00167								0.0400	
TDL1	Landmark Diesel Tank #1	None	NA								2.29E-4								0.00551	
TDL2	Landmark Diesel Tank #2	None	NA								2.29E-4								0.00551	
TGL3	Landmark Gasoline Tank #3	None	NA								0.118								2.84	
PCSP1	Portable Crushing and Screening Plant 1 (2 crushers, 2 screens, and 5 transfers)	Water Sprays/Moisture Carry-Over		Control efficiency included in emission factor	0.625	0.233	0.0304						15.0	5.58	0.73					

SOURCE DESCRIPTION		ANNUAL EMISSIONS									NAD 83 LOCATION				
Model ID	Source Description	PM ton/yr	PM_{10} ton/yr	$PM_{2.5}$ ton/yr	CO ton/yr	NOx ton/yr	SO_2 ton/yr	VOC ton/yr	H2S ton/yr	Hg2+P ton/yr	UTM E m	UTM N m	reference	elev m	reference
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0.101	0.101	0.101	1.08	1.87	0.228	0.115		3.09E-7	632,060	4,973,664	Warehouse building center	1,983.9	Warehouse building base
PSL	Prill Silos Loading (2 x 100 ton)	0.0730	0.0256	0.00387							632,346	4,973,500	Prill Silo #1 center	2,010.0	Prill Silo #1 base
PSU	Prill Silos Unloading (2 x 100 ton)	0.0730	0.0256	0.00387							632,346	4,973,500	Prill Silo #1 center	2,010.0	Prill Silo #1 base
CS1L	Cement/Shotcrete Silo#1 Loading	0.0297	0.0102	0.00150							632,095	4,974,272	Aggregate stockpile center	1,992.0	Aggregate stockpile base
CS1U	Cement/Shotcrete Silo#1 Unloading	0.144	0.0840	0.0120							632,095	4,974,272	Aggregate stockpile center	1,992.0	Aggregate stockpile base
CS2L	Cement/Shotcrete Silo#2 Loading	0.0297	0.0102	0.00150							632,095	4,974,272	Aggregate stockpile center	1,992.0	Aggregate stockpile base
CS2U	Cement/Shotcrete Silo#2 Unloading	0.144	0.0840	0.0120							632,095	4,974,272	Aggregate stockpile center	1,992.0	Aggregate stockpile base
CAL	Aggregate Bin Loading	1.73	0.825	0.125						3.45E-08	632,095	4,974,272	Aggregate stockpile center	1,992.0	Aggregate stockpile base
CAU	Aggregate Bin Unloading	1.73	0.825	0.125						3.45E-08	632,095	4,974,272	Aggregate stockpile center	1,992.0	Aggregate stockpile base
CM	Central Mixer Loading	0.552	0.165	0.0240							632,095	4,974,272	Aggregate stockpile center	1,992.0	Aggregate stockpile base
HL	Landmark/Stibnite Heaters (3 x 1.0 MMBtu Propane-Fired)	0.101	0.101	0.101	1.08	1.87	0.228	0.115		3.09E-7	615,386	4,945,451	Googl Earth, PRO Figure 7-8; intersection of NF-579 and NF-447	2,020.0	Google Earth
TG1	Mine Site Gasoline Tank #1							0.957							
TG2	Mine Site Gasoline Tank #2							0.957							
TD3	Mine Site Diesel Tank #3							0.00730							
TD4	Mine Site Diesel Tank #4							0.00730							
TD5	Mine Site Diesel Tank #5							0.00730							
TD6	Mine Site Diesel Tank #6							0.00730							
TD7	Mine Site Diesel Tank #7							0.00730							
TD8	Mine Site Diesel Tank #8							0.00730							
TD9	Mine Site Diesel Tank #9							0.00730							
TD10	Mine Site Diesel Tank #10							0.00730							
TDL1	Landmark Diesel Tank #1							0.00101							
TDL2	Landmark Diesel Tank #2							0.00101							
TGL3	Landmark Gasoline Tank #3							0.518							
PCSP1	Portable Crushing and Screening Plant 1 (2 crushers, 2 screens, and 5 transfers)	2.74	1.018	0.133						5.475E-08	632,348	4,973,429	30 m north of access road start point	2,009.0	Google Earth

SOURCE DESCRIPTION		RELEASE PARAMETERS INPUT						MODEL EMISSION RATES / RELEASE PARAMETERS													
Model	Source Description	POINT	rel ht (ft)	temp (F)	flow (dscfm)	flow (acfm)	dia (ft)	PM_{10}-24	$PM_{2.5}$-24	CO-ALL	NO_2-1	SO_2-1	SO_2-3	PM_{10}-AN	$PM_{2.5}$-AN	NO_2-AN	SO_2-AN	ht (m)	temp (K)	vel (m/s)	dia (m)
ID		VOLUME	rel ht (ft)	width (ft)	vert. ln (ft)	grnd ht (ft)	σz type	gps	gps	gps	gps	gps	gps	gps	gps	gps	gps	ht (m)	σy (m)	σz (m)	
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	POINT	41	360	508	394	0.7	2.89E-3	2.89E-3	3.10E-2	5.37E-2	6.57E-3	6.57E-3	2.89E-3	2.89E-3	5.37E-2	6.57E-3	12.50	455.37	5.20	0.21
PSL	Prill Silos Loading (2 x 100 ton)	POINT	25.5	Ambient		700	0.5	7.35E-3	1.11E-3					7.35E-4	1.11E-4			7.77	0.00	18.11	0.15
PSU	Prill Silos Unloading (2 x 100 ton)	VOLUME	4.5	1	1	5	elev src w/ bldg	7.35E-3	1.11E-3					7.35E-4	1.11E-4			1.37	0.07	0.14	
CS1L	Cement/Shotcrete Silo#1 Loading	POINT	43.7	Ambient	930	930	0.5	1.43E-4	2.10E-5					2.93E-4	4.32E-5			13.32	0.00	24.06	0.15
CS1U	Cement/Shotcrete Silo#1 Unloading	VOLUME	5	72.2	10	10	srf src	1.18E-3	1.68E-4					2.42E-3	3.45E-4			1.52	5.12	1.42	
CS2L	Cement/Shotcrete Silo#2 Loading	POINT	43.7	Ambient	930	930	0.5	1.43E-4	2.10E-5					2.93E-4	4.32E-5			13.32	0.00	24.06	0.15
CS2U	Cement/Shotcrete Silo#2 Unloading	VOLUME	5	72.2	10	10	srf src	1.18E-3	1.68E-4					2.42E-3	3.45E-4			1.52	5.12	1.42	
CAL	Aggregate Bin Loading	VOLUME	5	72.2	10	10	srf src	4.16E-2	6.30E-3					2.37E-2	3.60E-3			1.52	5.12	1.42	
CAU	Aggregate Bin Unloading	VOLUME	5	72.2	10	10	srf src	4.16E-2	6.30E-3					2.37E-2	3.60E-3			1.52	5.12	1.42	
CM	Central Mixer Loading	VOLUME	5	72.2	10	10	srf src	2.31E-3	3.36E-4					4.75E-3	6.90E-4			1.52	5.12	1.42	
HL	Landmark/Stibnite Heaters (3 x 1.0 MMBtu Propane-Fired)	POINT	20	360		394	0.7	2.89E-3	2.89E-3	3.10E-2	5.37E-2	6.57E-3	6.57E-3	2.89E-3	2.89E-3	5.37E-2	6.57E-3	6.10	455.37	5.20	0.21
TG1	Mine Site Gasoline Tank #1																				
TG2	Mine Site Gasoline Tank #2																				
TD3	Mine Site Diesel Tank #3																				
TD4	Mine Site Diesel Tank #4																				
TD5	Mine Site Diesel Tank #5																				
TD6	Mine Site Diesel Tank #6																				
TD7	Mine Site Diesel Tank #7																				
TD8	Mine Site Diesel Tank #8																				
TD9	Mine Site Diesel Tank #9																				
TD10	Mine Site Diesel Tank #10																				
TDL1	Landmark Diesel Tank #1																				
TDL2	Landmark Diesel Tank #2																				
TGL3	Landmark Gasoline Tank #3																				
PCSP1	Portable Crushing and Screening Plant 1 (2 crushers, 2 screens, and 5 transfers)	VOLUME	7	185.2	14	14	srf src	2.93E-2	3.83E-3					2.93E-2	3.83E-3			2.13	13.13	1.98	

SOURCE DESCRIPTION		OPERATING LIMITS							EMISSION FACTORS									
Model	Source Description	Design Throughput						reference	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	H2S	unit	reference
ID		unit/hr	unit/day	unit/yr	units	Material	hr/yr											
PCSP2	Portable Crushing and Screening Plant 1 (2 crushers, 2 screens, and 5 transfers)	83	2,000	730,000	ton	Aggregate	8,760	(Midas Gold 2019)	0.0075	0.00279	0.00037						lb/ton	AP-42, Table 11.19.2-2 (08/04): Tert. Crushing - ctrl. × 2 + Screening - ctrl. × 2 + Conv. Transfer - ctrl. × 5
TRUE	LIME PRODUCTION																	
LS1	Limestone transfer to Primary Crusher Hopper	47.08	1,130	317,907	ton	Limestone	8,760	(Midas Gold 2018m)	0.003	0.0011	0.00017						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
LS2	Primary Crushing and Associated Transfers In and Out	47.08	1,130	317,907	ton	Limestone	8,760		0.0054	0.0024	0.00036						lb/ton	AP-42, Table 11.19.2-2 (08/04) Tert. Crush - unctrl.; PM2.5 Ch. 13.2.4
LS3	Primary Screening and Associated Transfers In and Out	47.08	1,130	317,907	ton	Limestone	8,760		0.025	0.0087	0.00132						lb/ton	AP-42, Table 11.19.2-2 (08/04) Screening - unctrl.; PM2.5 Ch. 13.2.4
LS4	Secondary Crushing and Associated Transfers In and Out	47.08	1,130	317,907	ton	Limestone	8,760		0.0054	0.0024	0.00036						lb/ton	AP-42, Table 11.19.2-2 (08/04) Tert. Crush - unctrl.; PM2.5 Ch. 13.2.4
LS5	Secondary Screening and Associated Transfers In and Out	47.08	1,130	317,907	ton	Limestone	8,760		0.025	0.0087	0.00132						lb/ton	AP-42, Table 11.19.2-2 (08/04) Screening - unctrl.; PM2.5 Ch. 13.2.4
LS6	Limestone transfer to Ball Mill Feed Bin	47.08	1,130	317,907	ton	Limestone	8,760		0.003	0.0011	0.00017						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
LS7	Limestone transfer to Ball Mill Feed Conveyor	47.08	1,130	317,907	ton	Limestone	8,760		0.003	0.0011	0.00017						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
LS8	Ball Mill Feed transfer to Ball Mill	47.08	1,130	317,907	ton	Limestone	8,760		0.003	0.0011	0.00017						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
LSBM	Limestone Ball Mill	47.08	1,130	317,907	ton	Limestone	8,760		0.0404	0.0339	0.0121						lb/ton	AP-42, Table 11.19.2-4 (08/04) Dry Grind. with Fabric Filter
LS9	Limestone transfer to Kiln Feed Bin	11.13	267	82,688	ton	Limestone	8,760		0.003	0.0011	0.00017						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
LS10	Limestone transfer to Lime Kiln Feed Conveyor	11.13	267	82,688	ton	Limestone	8,760		0.003	0.0011	0.00017						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
LS11	Fines Screening and Associated Transfers In and Out	11.13	267	82,688	ton	Limestone	8,760		0.025	0.0087	0.00132						lb/ton	AP-42, Table 11.19.2-2 (08/04) Screening - unctrl.; PM2.5 Ch. 13.2.4
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	11.13	267	82,688	ton	Limestone	8,760	(Midas Gold 2018m)	0.003	0.0011	0.00017						lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. Xfer - unctrl.; PM2.5 Ch. 13.2.4
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	7.04	169	52,377	ton	Lime	8,760	(Midas Gold 2018m)	0.13	0.13	0.13	0.45	0.24	0.0012			lb/ton	AP-42 Tables 11.17-2, 6 : Gas-Fired Parallel Flow Regenetive Kiln with Fabric Filter (PM = 5x EF)
LKC	PFR Shaft Lime Kiln Combustion	22.04	529	163,935	MMBtu	Propane	8,760	Based on 810 kcal/kg (Maerz 2018)	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874		lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal
LCR	Lime Mill Crushing and associated transfers In and Out	7.04	169	52,377	ton	Lime	8,760		0.0404	0.0339	0.0121						lb/ton	AP-42, Table 11.19.2-4 (08/04) Dry Grind. with Fabric Filter
LSL	Pebble Lime Silo Loading via Bucket Elevator	7.04	169	52,377	ton	Lime	8,760		0.00088	0.00088	0.00088						lb/ton	AP-42 Table 11.17-4: Crushed Material Conveyor Transfer with Fabric Filter (PM = 10 x EF)
LSU	Pebble Lime Silo discharge to Lime Slaker	7.04	169	52,377	ton	Lime	8,760		8.8E-05	8.8E-05	8.8E-05						lb/ton	AP-42 Table 11.17-4: Crushed Material Conveyor Transfer with Fabric Filter
Total																		

SOURCE DESCRIPTION		EMISSION CONTROLS			HOURLY EMISSIONS								DAILY EMISSIONS							
Model ID	Source Description	control system	efficiency	reference	PM lb/hr	PM_{10} lb/hr	$PM_{2.5}$ lb/hr	CO lb/hr	NOx lb/hr	SO_2 lb/hr	VOC lb/hr	H2S lb/hr	PM lb/day	PM_{10} lb/day	$PM_{2.5}$ lb/day	CO lb/day	NOx lb/day	SO_2 lb/day	VOC lb/day	H2S lb/day
~~PCSP2~~	Portable Crushing and Screening Plant 1 (2 crushers, 2 screens, and 5 transfers)	Water Sprays/Moisture Carry-Over		Control efficiency included in emission factor	0.625	0.233	0.0304						15.0	5.58	0.73					
TRUE	LIME PRODUCTION																			
LS1	Limestone transfer to Primary Crusher Hopper	None	0		0.141	0.0518	0.0080						3.39	1.24	0.192	0	0	0	0	0
LS2	Primary Crushing and Associated Transfers In and Out	None	0		0.254	0.113	0.0169						6.10	2.71	0.407	0	0	0	0	0
LS3	Primary Screening and Associated Transfers In and Out	None	0		1.18	0.410	0.0621						28.2	9.8	1.49	0	0	0	0	0
LS4	Secondary Crushing and Associated Transfers In and Out	None	0		0.254	0.113	0.0169						6.10	2.71	0.407	0	0	0	0	0
LS5	Secondary Screening and Associated Transfers In and Out	None	0		1.18	0.410	0.0621						28.2	9.8	1.49	0	0	0	0	0
LS6	Limestone transfer to Ball Mill Feed Bin	None	0		0.141	0.0518	0.0080						3.39	1.24	0.192	0	0	0	0	0
LS7	Limestone transfer to Ball Mill Feed Conveyor	None	0		0.141	0.0518	0.00800						3.39	1.243	0.192	0	0	0	0	0
LS8	Ball Mill Feed transfer to Ball Mill	None	0		0.141	0.0518	0.00800						3.39	1.243	0.192	0	0	0	0	0
LSBM	Limestone Ball Mill	Fabric Filter	NA	Control efficiency included in emission factor	1.902	1.5959	0.56964						45.65	38.303	13.671	0	0	0	0	0
LS9	Limestone transfer to Kiln Feed Bin	None	0		0.033	0.0122	0.0019						0.80	0.29	0.045	0	0	0	0	0
LS10	Limestone transfer to Lime Kiln Feed Conveyor	None	0		0.033	0.0122	0.00189						0.80	0.294	0.045	0	0	0	0	0
LS11	Fines Screening and Associated Transfers In and Out	None	0		0.28	0.097	0.0147						6.7	2.3	0.35	0	0	0	0	0
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	None	0		0.033	0.0122	0.00189						0.80	0.294	0.045	0	0	0	0	0
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	Fabric Filter	NA	Control efficiency included in emission factor	0.915	0.915	0.915	3.17	1.69	0.0085	0		21.97	21.97	21.97	76.05	40.6	0.203	0.00	0
LKC	PFR Shaft Lime Kiln Combustion	None	0		0.169	0.169	0.169	1.81	3.13	0.383	0.193		4.05	4.05	4.05	43.4	75.2	9.2	4.62	0
LCR	Lime Mill Crushing and associated transfers In and Out	Fabric Filter	NA	Control efficiency included in emission factor	0.28448	0.23871	0.08520						6.828	5.729	2.045	0	0	0	0	0
LSL	Pebble Lime Silo Loading via Bucket Elevator	Fabric Filter	NA	Control efficiency included in emission factor	6.20E-3	6.20E-3	6.20E-3						0.1487	0.1487	0.1487	0	0	0	0	0
LSU	Pebble Lime Silo discharge to Lime Slaker	Wet Scrubber	NA	Control efficiency included in emission factor	6.20E-4	6.20E-4	6.20E-4						0.0149	0.0149	0.0149	0	0	0	0	0
Total					**35.7**	**21.6**	**13.3**	**33.5**	**55.4**	**1.88**	**11.6**	**0.900**	**575**	**373**	**238**	**205**	**260**	**37.3**	**37.4**	**21.6**

SOURCE DESCRIPTION		ANNUAL EMISSIONS									NAD 83 LOCATION				
Model ID	Source Description	PM ton/yr	PM_{10} ton/yr	$PM_{2.5}$ ton/yr	CO ton/yr	NOx ton/yr	SO_2 ton/yr	VOC ton/yr	H2S ton/yr	Hg2+P ton/yr	UTM E m	UTM N m	reference	elev m	reference
~~PCSP2~~	Portable Crushing and Screening Plant 1 (2 crushers, 2 screens, and 5 transfers)	2.74	1.018	0.133						5.475E-08	632,348	4,973,369	30 m south of access road start point	2,007.0	Google Earth
TRUE	LIME PRODUCTION														
LS1	Limestone transfer to Primary Crusher Hopper	0.477	0.175	0.0270						9.54E-09	632,239	4,974,256	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS2	Primary Crushing and Associated Transfers In and Out	0.86	0.381	0.057						1.72E-08	632,239	4,974,256	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS3	Primary Screening and Associated Transfers In and Out	3.97	1.38	0.210						7.95E-08	632,239	4,974,256	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS4	Secondary Crushing and Associated Transfers In and Out	0.86	0.381	0.057						1.72E-08	632,227	4,974,268	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS5	Secondary Screening and Associated Transfers In and Out	3.97	1.38	0.210						7.95E-08	632,227	4,974,268	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS6	Limestone transfer to Ball Mill Feed Bin	0.477	0.175	0.0270						9.54E-09	632,181	4,974,307	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS7	Limestone transfer to Ball Mill Feed Conveyor	0.477	0.175	0.0270						9.54E-09	632,181	4,974,307	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS8	Ball Mill Feed transfer to Ball Mill	0.477	0.175	0.0270						9.54E-09	632,200	4,974,273	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LSBM	Limestone Ball Mill	6.422	5.389	1.9233						1.28E-07	632,215	4,974,248	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS9	Limestone transfer to Kiln Feed Bin	0.124	0.045	0.0070						2.48E-09	632,169	4,974,325	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS10	Limestone transfer to Lime Kiln Feed Conveyor	0.124	0.045	0.0070						2.48E-09	632,169	4,974,325	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS11	Fines Screening and Associated Transfers In and Out	1.03	0.36	0.055						2.07E-08	632,151	4,974,314	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0.124	0.045	0.0070						2.48E-09	632,056	4,974,285	Drawing SK-OPTION 3b, 06/06/2018	1,984.0	Google Earth
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	3.40	3.40	3.40	11.8	6.29	0.0314			1.05E-03	632,057	4,974,265	Drawing SK-OPTION 3b, 06/06/2018	1,984.0	Google Earth
LKC	PFR Shaft Lime Kiln Combustion	0.627	0.627	0.627	6.72	11.6	1.42	0.72		1.93E-6	632,057	4,974,265	Drawing SK-OPTION 3b, 06/06/2018	1,984.0	Google Earth
LCR	Lime Mill Crushing and associated transfers In and Out	1.0580	0.8878	0.3169						2.11603E-08	632,073	4,974,233	Drawing SK-OPTION 3b, 06/06/2018	1,990.0	Google Earth
LSL	Pebble Lime Silo Loading via Bucket Elevator	0.02305	0.02305	0.02305						4.60918E-10	632,069	4,974,206	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
LSU	Pebble Lime Silo discharge to Lime Slaker	0.00230	0.00230	0.00230						4.60918E-11	632,069	4,974,206	Drawing SK-OPTION 3b, 06/06/2018	1,996.0	Google Earth
Total		**86.7**	**55.8**	**35.9**	**30.6**	**38.0**	**6.50**	**5.31**	**3.94**	**1.11E-3**					

SOURCE DESCRIPTION		RELEASE PARAMETERS INPUT						MODEL EMISSION RATES / RELEASE PARAMETERS													
Model	Source Description	POINT	rel ht (ft)	temp (F)	flow (dscfm)	flow (acfm)	dia (ft)	PM_{10}-24	$PM_{2.5}$-24	CO-ALL	NO_2-1	SO_2-1	SO_2-3	PM_{10}-AN	$PM_{2.5}$-AN	NO_2-AN	SO_2-AN	ht (m)	temp (K)	vel (m/s)	dia (m)
ID		VOLUME	rel ht (ft)	width (ft)	vert. ln (ft)	grnd ht (ft)	σz type	gps	gps	gps	gps	gps	gps	gps	gps	gps	gps	ht (m)	σy (m)	σz (m)	
~~PCSP2~~	Portable Crushing and Screening Plant 1 (2 crushers, 2 screens, and 5 transfers)	VOLUME	7	185.2	14	14	srf src	2.93E-2	3.83E-3					2.93E-2	3.83E-3			2.13	13.13	1.98	
TRUE	LIME PRODUCTION																				
LS1	Limestone transfer to Primary Crusher Hopper	VOLUME	11.3	22.6	22.6	22.6	srf src	6.52E-3	1.01E-3					5.03E-3	7.77E-4			3.44	1.60	3.20	
LS2	Primary Crushing and Associated Transfers In and Out	VOLUME	11.3	22.6	22.6	22.6	srf src	1.42E-2	2.14E-3					1.10E-2	1.65E-3			3.44	1.60	3.20	
LS3	Primary Screening and Associated Transfers In and Out	VOLUME	11.3	22.6	22.6	22.6	srf src	5.16E-2	7.83E-3					3.98E-2	6.04E-3			3.44	1.60	3.20	
LS4	Secondary Crushing and Associated Transfers In and Out	VOLUME	11.3	22.6	22.6	22.6	srf src	1.42E-2	2.14E-3					1.10E-2	1.65E-3			3.44	1.60	3.20	
LS5	Secondary Screening and Associated Transfers In and Out	VOLUME	11.3	22.6	22.6	22.6	srf src	5.16E-2	7.83E-3					3.98E-2	6.04E-3			3.44	1.60	3.20	
LS6	Limestone transfer to Ball Mill Feed Bin	POINT	29.0	Ambient		0.155	1.0	6.52E-3	1.01E-3					5.03E-3	7.77E-4			8.84	0.00	0.00	0.30
LS7	Limestone transfer to Ball Mill Feed Conveyor	VOLUME	3.5	1	3	5	elev src w/ bldg	6.52E-3	1.01E-3					5.03E-3	7.77E-4			1.07	0.07	0.43	
LS8	Ball Mill Feed transfer to Ball Mill	VOLUME	28	4	4	30	elev src w/ bldg	6.52E-3	1.01E-3					5.03E-3	7.77E-4			8.53	0.28	0.57	
LSBM	Limestone Ball Mill	POINT	70.0	Ambient	13,000	16,500	2.0	2.01E-1	7.18E-2					1.55E-1	5.53E-2			21.34	0.00	26.68	0.61
LS9	Limestone transfer to Kiln Feed Bin	POINT	29.0	Ambient		0.155	1.0	1.54E-3	2.38E-4					1.31E-3	2.02E-4			8.84	0.00	0.00	0.30
LS10	Limestone transfer to Lime Kiln Feed Conveyor	VOLUME	3.5	1	3	5	elev src w/ bldg	1.54E-3	2.38E-4					1.31E-3	2.02E-4			1.07	0.07	0.43	
LS11	Fines Screening and Associated Transfers In and Out	VOLUME	2.5	8	5	5	srf src	1.22E-2	1.85E-3					1.03E-2	1.57E-3			0.76	0.57	0.71	
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	VOLUME	68	4	4	70	elev src w/ bldg	1.54E-3	2.38E-4					1.31E-3	2.02E-4			20.73	0.28	0.57	
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	POINT	150	350	8000	16,300	2.0	1.15E-1	1.15E-1	3.99E-1	2.13E-1	1.06E-3	1.06E-3	9.79E-2	9.79E-2	1.81E-1	9.04E-4	45.72	449.82	26.36	0.61
LKC	PFR Shaft Lime Kiln Combustion	POINT	150	350	8,000	16,300	2.0	2.12E-2	2.12E-2	2.28E-1	3.95E-1	4.83E-2	4.83E-2	1.80E-2	1.80E-2	3.35E-1	4.10E-2	45.72	449.82	26.36	0.61
LCR	Lime Mill Crushing and associated transfers In and Out	POINT	50	Ambient	2000	2,500	0.8	3.01E-2	1.07E-2					2.55E-2	9.12E-3			15.24	0.00	28.75	0.23
LSL	Pebble Lime Silo Loading via Bucket Elevator	POINT	29.0	Ambient	70	70.000	0.3	7.81E-4	7.81E-4					6.63E-4	6.63E-4			8.84	0.00	4.07	0.10
LSU	Pebble Lime Silo discharge to Lime Slaker	VOLUME	3.5	1	3	5	elev src w/ bldg	7.81E-5	7.81E-5					6.63E-5	6.63E-5			1.07	0.07	0.43	
Total								1.96	1.25	4.22	1.4888	0.231	0.237	1.60	1.032	1.09	0.187				

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-21-402/404	PAGE: 1 OF: 11 SHEET: ProcHAP
AIR EMISSION CALCULATIONS	SUBJECT: Process HAP and GHG Emissions	DATE: June 30, 2021

Hazardous Air Pollutants and Greenhouse Gas Emissions

HAP Emissions Summary

	Emissions	
Pollutant	lb/yr	ton/yr
1,3-Butadiene	7.3E-3	3.7E-6
7-PAH	0.018	9.0E-6
Acetaldehyde	0.215	1.1E-4
Acrolein	0.040	2.0E-5
Antimony	4.913	2.5E-3
Arsenic	39.548	0.020
Benzene	64.793	0.032
Beryllium	3.785	1.9E-3
Biphenyl	0.383	1.9E-4
Cadmium	4.052	2.0E-3
Carbon Disulfide	127	0.063
Chromium	5.601	2.8E-3
Cobalt	4.067	2.0E-3
Cr (VI)	3.0E-3	1.5E-6
Cyanide	10.512	5.3E-3
Dichlorobenzene	0.488	2.4E-4
Formaldehyde	30.960	0.015
Hexane	1,006	0.503
Hydrogen Chloride	7,333	3.666
Lead	4.178	2.1E-3
Manganese	34.994	0.017
Mercury	5.814	2.9E-3
Naphthalene	17.003	8.5E-3
Nickel	4.875	2.4E-3
Phenol	2.106	1.1E-3
Phosphorus	45.709	0.023
POM	0.911	4.6E-4
Selenium	3.593	1.8E-3
Toluene	278	0.139
Xylene	275	0.138
Total HAP	9,307	4.654
		4.654
		chk

GHG Emissions Summary

Source Category	CO_2e[1] *(ton/yr)*
Propane Combustion	28,878
Diesel Combustion	246
Autoclaving	47,316
Lime Kiln	30,311
[1] Total GHGs	106,751

Annex I Parties, 100-year time horizon (UNCC n.d.); (IPCC 2007)

Conversions

2,000 lb/ton	1.341 hp/kW
907.18582 kg/ton	1E+6 Btu/MMBtu

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-21-402/404	PAGE: 2 OF: 11 SHEET: ProcHAP
AIR EMISSION CALCULATIONS	SUBJECT: Process HAP and GHG Emissions	DATE: June 30, 2021

PROPANE COMBUSTION

Source Data

Source ID	Description	MMBtu/yr	TAP Rule 210.2 MMBtu/yr	TAP Rule 210.2 Exclusion
Sb1	Sb Drying (2.72 MMBtu/hr Propane-Fired)	0	0	No
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	510	510	No
CKB	Carbon Regeneration Kiln (Burners)	19,754	19,754	No
PV	Propane Vaporizer (0.4 MMBtu/hr Propane-Fired)	876	876	No
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	43,800	43,800	No
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	35,040	35,040	No
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	35,040	35,040	No
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	35,040	35,040	No
HAC	Autoclave HVAC Heater (1 x 0.25 MMBtu Propane-Fired)	2,190	2,190	No
HR	Refinery HVAC Heaters (1 x 0.25 MMBtu Propane-Fired)	2,190	2,190	No
HA	Admin HVAC Heaters (1 x 0.25 MMBtu Propane-Fired)	2,190	2,190	No
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	4,380	4,380	No
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	17,520	17,520	No
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	26,280	26,280	No
HL	Landmark/Stibnite Heaters (3 x 1.0 MMBtu Propane-Fired)	26,280	26,280	No
LKC	PFR Shaft Lime Kiln Combustion	163,935	163,935	No
Total		415,025	415,025	

HAP Emissions - Propane Combustion

Pollutant	Emission Factor[1] lb/MMScf	lb/MMBtu[2]	Emissions ton/yr
Arsenic	2.0E-04	1.96E-7	4.1E-5
Benzene	2.1E-03	2.06E-6	4.3E-4
Beryllium	< 1.2E-05	1.18E-8	2.4E-6
Cadmium	1.1E-03	1.08E-6	2.2E-4
Chromium	1.4E-03	1.37E-6	2.8E-4
Cobalt	8.4E-05	8.24E-8	1.7E-5
Dichlorobenzene	1.2E-03	1.18E-6	2.4E-4
Formaldehyde	7.5E-02	7.35E-5	0.015
Hexane	1.8E+00	1.76E-3	0.366
Manganese	3.8E-04	3.73E-7	7.7E-5
Mercury	2.6E-04	2.55E-7	5.3E-5
Nickel	2.1E-03	2.06E-6	4.3E-4
Selenium	< 2.4E-05	2.35E-8	4.9E-6
Toluene	3.4E-03	3.33E-6	6.9E-4
POM	< 7E-04	6.85E-7	1.4E-4
7-PAH	< 1E-05	1.12E-8	2.3E-6
Total HAP			0.384

(1) *AP-42, Table 1.4-3 & 1.4-4 (7/98) Natural Gas Combustion*

(2) *Based on natural gas higher heating value of:* 1,020 *MMBtu/MMScf*

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-21-402/404	PAGE: 3 OF: 11 SHEET: ProcHAP
AIR EMISSION CALCULATIONS	SUBJECT: Process HAP and GHG Emissions	DATE: June 30, 2021

PROPANE COMBUSTION - CONTINUED

Propane CO2e Emission Factors:	62.87	kg CO2/MMBtu	*40 CFR Part 98, Table C-1 to Subpart C (11/2013) Propane (CFR 2018d)*
	3.0E-03	kg CH4/MMBtu	*40 CFR Part 98, Table C-2 to Subpart C (11/2013) Petroleum (CFR 2018d)*
	6.0E-04	kg N2O/MMBtu	*40 CFR Part 98, Table C-2 to Subpart C (11/2013) Petroleum (CFR 2018d)*

Total Propane Combustion 415,025 *MMBtu/yr*

Propane CO2e Emissions - Process Sources:

	Emissions	GWP[(1)]	GWP[(2)]	CO2e (ton/yr)	
Greenhouse Gas	ton/yr	100-yr	20-yr	100-yr	20-yr
CO2	28,762	1	1	28,762	28,762
CH4	1.37	25	62	34.311	85.092
N2O	0.27	298	275	81.799	75.485
Total GHG				28,878	28,923

(1) *40 CFR 98, Table A-1 (12/2014) (CFR 2018d)*

(2) *(IPCC 1995)*

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis	
	PROJECT NO: 335-21-402/404	PAGE: 4	OF: 11 SHEET: ProcHAP
AIR EMISSION CALCULATIONS	SUBJECT: Process HAP and GHG Emissions	DATE: June 30, 2021	

DIESEL COMBUSTION

Source Data

Source ID	Description	Power Rating kW	Power Rating hp	Operation hr/yr	Fuel Consumption MMBtu/hr[1]	Fuel Consumption MMBtu/yr	TAP Rule MMBtu/yr	210.2 Exclusion
EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	1,000	1,341	100	9.39	938.7	938.7	No
EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	1,000	1,341	100	9.39	938.7	938.7	No
EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	1,000	1,341	100	9.39	938.7	938.7	No
EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	200	268	100	1.88	187.7	187.7	No
Total						3,003.8	3,003.8	

(1) *Based on diesel engines brake-specific fuel consumption of:* 7,000 *Btu/hp-hr* *AP-42 Tbl 3.3-1*

HAP Emissions - Diesel Combustion, Small Engines

Pollutant	Emission Factor[1] lb/MMBtu	Emissions ton/yr
1,3-Butadiene	< 3.9E-05	3.7E-6
Acetaldehyde	7.7E-04	7.2E-5
Acrolein	< 9.3E-05	8.7E-6
Benzene	9.3E-04	8.8E-5
Formaldehyde	1.2E-03	1.1E-4
Toluene	4.1E-04	3.8E-5
Xylene	2.9E-04	2.7E-5
POM	1.68E-04	1.6E-5
7-PAH	3.43E-06	3.2E-7
Total HAPs		3.6E-4

(1) *AP-42, Tab. 3.3-2, 10/96, diesel engines (≤600 hp)*

HAP Emissions - Diesel Combustion, Large Engines

Pollutant	Emission Factor[1] lb/MMBtu	Emissions ton/yr
1,3-Butadiene	0	0
Acetaldehyde	2.5E-05	3.5E-5
Acrolein	7.9E-06	1.1E-5
Benzene	7.8E-04	1.1E-3
Formaldehyde	7.9E-05	1.1E-4
Toluene	2.8E-04	4.0E-4
Xylene	1.9E-04	2.7E-4
POM	2.12E-04	3.0E-4
7-PAH	4.50E-06	6.3E-6
Total HAPs		2.2E-3

(1) *AP-42, Tabs. 3.4-3 & 3.4-4, 10/96, large diesel engines (>600 hp)*

Diesel CO2e Emission Factors:

73.96	kg CO_2/MMBtu	*40 CFR Part 98, Table C-1 to Subpart C (11/2013) No.2*
3.0E-03	kg CH_4/MMBtu	*40 CFR Part 98, Table C-2 to Subpart C (11/2013) Petroleum*
6.0E-04	kg N_2O/MMBtu	*40 CFR Part 98, Table C-2 to Subpart C (11/2013) Petroleum*

Total Diesel Combustion 3,003.8 MMBtu/yr

Diesel CO2e Emissions - Process Sources:

Greenhouse Gas	Emissions ton/yr	GWP[1] 100-yr	GWP[2] 20-yr	CO2e (ton/yr) 100-yr	CO2e (ton/yr) 20-yr
CO2	244.89	1	1	245	245
CH4	9.93E-03	25	62	0.248	0.616
N2O	1.99E-03	298	275	0.592	0.546
Total GHG				246	246

(1) *40 CFR 98, Table A-1 (CFR 2018d)*

(2) *(IPCC 1995)*

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis	
	PROJECT NO: 335-21-402/404	PAGE: 5	OF: 11 SHEET: ProcHAP
AIR EMISSION CALCULATIONS	SUBJECT: Process HAP and GHG Emissions	DATE: June 30, 2021	

ORE PROCESSING

Source Data

Source ID	Description	PM_tpy PM ton/yr	TAP Rule ton/yr	210.2 Exclusion
OC1	Loader Transfer of Ore to Grizzly Screen	0.639	0.639	No
OC2	Grizzly Screen to Apron Feeder	0.639	0.639	No
OC3	Apron Feeder to Dribble Conveyor	0.639	0.639	No
OC4	Apron Feeder to Vibrating Grizzly	0.639	0.639	No
OC5	Dribble Conveyor to Vibrating Grizzly	0.639	0.639	No
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	0.639	0.639	No
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	5.475	5.475	No
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	0.639	0.639	No
OC9	Stockpile Transfers to Reclaim Conveyors	3.022	3.022	No
OC10	Reclaim Conveyers to SAG Mill Feed Conveyor	3.022	3.022	No
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	3.022	3.022	No
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	6.044	6.044	No
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0.705	0.705	No
Total		25.762	25.762	

HAP Emission Factors and Emissions

Pollutant	Concentration ppm[(1)]	Emissions ton/yr (ton/yr)
Arsenic	667	0.017
Beryllium	3.2	8.2E-5
Cadmium	0.5	1.3E-5
Cobalt	4	1.0E-4
Chromium	9	2.3E-4
Mercury [(2)]	0.96	2.5E-5
Manganese	299	7.7E-3
Nickel	2	5.2E-5
Lead	8	2.1E-4
Antimony	23	5.9E-4
Phosphorus	650	0.017
Selenium [(3)]	0.4	1.0E-5
Total		0.043

(1) *(Midas Gold 2017c)* *Median concentration of 55,000 SGP samples.*

(2) *(Midas Gold 2018i)* *Median ore concentration of 151,000 SGP samples; resource block model.*

(3) *(Midas Gold 2020)* *Median concentration of 1,500 SGP samples for Se.*

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-21-402/404	PAGE: 6 OF: 11 SHEET: ProcHAP
AIR EMISSION CALCULATIONS	SUBJECT: Process HAP and GHG Emissions	DATE: June 30, 2021

ORE CONCETRATION AND REFINING

Source Data and Mercury Emissions

Source ID	Description	Subpart 7E Hg Emissions ton/yr[1]	% of Subpart 7E for Controlled Systems %		Controlled Hg Emissions lb/yr	Controlled Hg Emissions ton/yr	TAP Rule ton/yr	210.2 Exclusion
AC	Autoclave	0.107	[2]		0.20	0.00010	0.0001	No
CKD	Refinery Sources (Kiln, EW, Retort, Furnac	0.008	20.0%	[3]	3.36	0.00168	0.0017	No
Total		0.115			3.56	0.00178		

[1] *Subpart 7E Limit - Ore Pretreatment Processes (CFR 2018c)*

$$\frac{84\ lb}{\sout{MMton}} \times \frac{2{,}540{,}400\ \sout{ton}}{yr} \times \frac{\sout{MMton}}{1.0E{+}6\ \sout{ton}} = \frac{213.39\ lb}{yr} \times \frac{ton}{2{,}000\ lb} = \frac{0.107\ ton}{yr}$$

[1] *Subpart 7E Limit - Carbon Processes with Mercury Retorts*

$$\frac{0.8\ lb}{\sout{ton}} \times \frac{21\ \sout{ton}}{yr} = \frac{16.8\ lb}{yr} \times \frac{ton}{2{,}000\ lb} = \frac{0.008\ ton}{yr}$$

[2] *Controlled SysCAD modeled emissions from Autoclave: 0.01048 g/hr 2.3E-05 lb/hr 8,760 hr/yr 0.20 lb/yr (M3 2019)*

[3] *Based on similar source (but with much higher ore Hg content) Hg reporting levels provided below:*

Goldstrike Refinery (2015 & 2016 Hg Reports) (NDEP 2015a) (NDEP 2016)

$$\frac{28.79\ lb}{yr} \times \frac{yr}{251.00\ ton} = \frac{0.11\ lb}{MMton} \times \frac{ton}{0.8\ lb} = 14.3\%$$

Twin Creeks Refinery (2015 & 2016 Hg Reports) (NDEP 2015a) (NDEP 2016)

$$\frac{31.27\ lb}{yr} \times \frac{yr}{142.77\ ton} = \frac{0.22\ lb}{MMton} \times \frac{ton}{0.8\ lb} = 27.4\%$$

HAP Emission Factors and Emissions

Pollutant	Emission Factor[1]	Emissions ton/yr Autoclave	Refinery	Total
Arsenic	same as Hg	1.0E-4	1.7E-3	1.8E-3
Beryllium	same as Hg	1.0E-4	1.7E-3	1.8E-3
Cadmium	same as Hg	1.0E-4	1.7E-3	1.8E-3
Cobalt	same as Hg	1.0E-4	1.7E-3	1.8E-3
Chromium	same as Hg	1.0E-4	1.7E-3	1.8E-3
Mercury	see above	1.0E-4	1.7E-3	1.8E-3
Manganese	same as Hg	1.0E-4	1.7E-3	1.8E-3
Nickel	same as Hg	1.0E-4	1.7E-3	1.8E-3
Lead	same as Hg	1.0E-4	1.7E-3	1.8E-3
Antimony	same as Hg	1.0E-4	1.7E-3	1.8E-3
Phosphorus	same as Hg	1.0E-4	1.7E-3	1.8E-3
Selenium	same as Hg	1.0E-4	1.7E-3	1.8E-3
Total				0.021

[1] *Hg is the most difficult metal to control due to it existing in both particulate and gaseous form. Therefore, all other metals are conservatively estimated to be equal to or less than the Hg emissions.*

AUTOCLAVE CO2 AND H2SO4 EMISSIONS

Description	Operation hr/yr	Throughput ton/hr	CO2 Emissions ton/hr[1]	ton/yr	H2SO4 lb/ton[2]	lb/hr	ton/yr
Autoclave	8,760	290	5.40	47,316	0.007	2.03	8.89

[1] *Per M3 Engineering, 10/11/2017; based on ore feed carbonate values and conservatively assuming limestone for neutralization. (M3 2017c)*

[2] *Based on Acidic Autoclave test data (APT 2010)*

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-21-402/404	PAGE: 7 OF: 11 SHEET: ProcHAP
AIR EMISSION CALCULATIONS	SUBJECT: Process HAP and GHG Emissions	DATE: June 30, 2021

REFINERY CYANIDE EMISSIONS

ton/yr

Pollutant	Emission Factor[1] lb/hr	Emissions[2] EW Cells ton/yr	Tanks[3] ton/yr	Total ton/yr	TAP Rule ton/yr	210.2 Exclusion	TAP Rule Category
Cyanide	0.0006	0.0026	0.0026	5.3E-3	0.0053	No	EW

(1) *(APT 2009)*

(2) *Based continuous operation of: 8,760 hr/yr*

(3) *Pregnant and barren solution tanks*

PAX TANKS

Carbon Disulfide Emissions from Xanthate Decomposition

ton/yr

Pollutant	Xanthate[1] ton/yr	Molar Decomp.[2]	CS_2 MW Ratio	Temperature Adj. Factor[3]	Total ton/yr	TAP Rule ton/yr	210.2 Exclusion	TAP Rule Category
Carbon Disulfide	1,700	0.99%	0.376	1%	0.063	0.0633	No	PAX

(1) *(Midas Gold 2016) p. 12-11*

(2) *(Air Sciences 2020) molar decomposition of xanthate in solution to CS2 gas*

(3) *(Air Sciences 2020) based on the comparison of CS2 generation at 25C and 70C*

	MW	
Xanthate (PAX)	*202.37*	$C6H11KOS_2$
Carbon disulfide	*76.139*	CS_2

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis	
	PROJECT NO: 335-21-402/404	PAGE: 8	OF: 11 SHEET: ProcHAP
AIR EMISSION CALCULATIONS	SUBJECT: Process HAP and GHG Emissions	DATE: June 30, 2021	

LIMESTONE/LIME/AGGREGATE PRODUCTION AND HANDLING

Source Data

Source ID	Description	PM_tpy PM ton/yr	TAP Rule ton/yr	210.2 Exclusion
LS1	Limestone transfer to Primary Crusher Hopper	0.477	0.477	No
LS2	Primary Crushing and Associated Transfers In and Out	0.858	0.858	No
LS3	Primary Screening and Associated Transfers In and Out	3.974	3.974	No
LS4	Secondary Crushing and Associated Transfers In and Out	0.858	0.858	No
LS5	Secondary Screening and Associated Transfers In and Out	3.974	3.974	No
LS6	Limestone transfer to Ball Mill Feed Bin	0.477	0.477	No
LS7	Limestone transfer to Ball Mill Feed Conveyor	0.477	0.477	No
LS8	Ball Mill Feed transfer to Ball Mill	0.477	0.477	No
LSBM	Limestone Ball Mill	6.422	6.422	No
LS9	Limestone transfer to Kiln Feed Bin	0.124	0.124	No
LS10	Limestone transfer to Lime Kiln Feed Conveyor	0.124	0.124	No
LS11	Fines Screening and Associated Transfers In and Out	1.034	1.034	No
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0.124	0.124	No
LCR	Lime Mill Crushing and associated transfers In and Out	1.058	1.058	No
LSL	Pebble Lime Silo Loading via Bucket Elevator	0.023	0.023	No
LSU	Pebble Lime Silo discharge to Lime Slaker	0.002	0.002	No
LS1L	Mill Lime Silo#1 Loading	0.002	0.002	No
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0.011	0.011	No
MillS2L	Mill Lime Silo #2 Loading	0.002	0.002	No
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0.011	0.011	No
ACS1L	AC Lime Silo #1 Loading	0.009	0.009	No
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0.042	0.042	No
ACS2L	AC Lime Silo #2 Loading	0.009	0.009	No
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0.042	0.042	No
ACS3L	AC Lime Silo #3 Loading	0.009	0.009	No
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0.042	0.042	No
ACS4L	AC Lime Silo #4 Loading	0.004	0.004	No
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0.021	0.021	No
CAL	Aggregate Bin Loading	1.725	1.725	No
CAU	Aggregate Bin Unloading	1.725	1.725	No
PCSP1	Portable Crushing and Screening Plant 1 (2 crushers, 2 screens, and 5 transfers)	2.738	2.738	No
PCSP2	Portable Crushing and Screening Plant 1 (2 crushers, 2 screens, and 5 transfers)	2.738	2.738	No
Total		29.610	29.610	

HAP Emission Factors and Emissions

Pollutant	Concentration ppm[(1)]	Emissions ton/yr (ton/yr)
Arsenic	23	6.8E-4
Beryllium	0.8	2.4E-5
Cadmium	0.25	7.4E-6
Cobalt	4	1.2E-4
Chromium	15	4.4E-4
Mercury	0.02	5.9E-7
Manganese	236.5	7.0E-3
Nickel	5	1.5E-4
Lead	3	8.9E-5
Antimony	2.5	7.4E-5
Phosphorus	130	3.8E-3
Total		0.012

(1) *(M3 2018) Median concentrations of SGP limestone material. Metals with medians below the detection limit (DL) are set to 1/2DL.*

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-21-402/404	PAGE: 9 OF: 11 SHEET: ProcHAP
AIR EMISSION CALCULATIONS	SUBJECT: Process HAP and GHG Emissions	DATE: June 30, 2021

LIME KILN

Source Data

Source ID	Description	Thpt_tpy Throughput ton/yr	PM_tpy PM ton/yr	TAP Rule ton/yr	TAP Rule ton/yr	210.2 Exclusion
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	52,377	3.405	52,377	3.404505	No

HAP Emission Factors and Emissions

Pollutant	Concentration ppm	Emissions ton/yr			
		ton/yr			
Arsenic	23	7.8E-5			
Beryllium	0.8	2.7E-6			
Cadmium	0.25	8.5E-7			
Cobalt	4	1.4E-5			
Chromium	15	5.1E-5			
Mercury [1]	0.02	1.0E-3			
Manganese	236.5	8.1E-4			
Nickel	5	1.7E-5			
Lead	3	1.0E-5			
Antimony	2.5	8.5E-6			
Phosphorus	130	4.4E-4	TAP Rule	210.2	
Subtotal		2.5E-3	ton/yr	Exclusion	
Hydrogen Chloride	0.14 lb/ton product[2]	3.666	3.666	No	

[1] *Hg emissions from the Lime Kiln are conservatively estimated assuming 100% volatilization of all Hg in the limestone*

[2] *(EPA 1999)b*

LIME KILN CO2 EMISSIONS

Description	Operation hr/yr	Feed ton/yr	Product ton/yr	Mass Loss ton/yr	CO2 ton/yr
Parallel Flow Regenerative (PFR) Shaft Lime Kiln	8,760	82,688	52,377	30,311	30,311

2,000 lb/ton

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-21-402/404	PAGE: 10 OF: 11 SHEET: ProcHAP
AIR EMISSION CALCULATIONS	SUBJECT: Process HAP and GHG Emissions	DATE: June 30, 2021

CONCRETE PRODUCTION

Source Data

Source ID	Description	Throughput ton/yr	TAP Rule ton/yr	210.2 Exclusion
CS1L	Cement/Shotcrete Silo#1 Loading	60,000	60,000	No
CS1U	Cement/Shotcrete Silo#1 Unloading	60,000	60,000	No
CS2L	Cement/Shotcrete Silo#2 Loading	60,000	60,000	No
CS2U	Cement/Shotcrete Silo#2 Unloading	60,000	60,000	No
CM	Central Mixer Loading	60,000	60,000	No
	Subtotal Cement Silo Filling	240,000	240,000	
	Subtotal Central Mix Batching	60,000	60,000	

HAP Emission Factors and Emissions

HAP/TAP	Silo Fill lb/ton[1]	Central Mixer lb/ton[2]	Cement Silo L/U ton/yr	Central Mix Batching ton/yr	Total Emissions[3] ton/yr
Arsenic	4.24E-09	2.96E-07	5.1E-7	8.9E-6	9.4E-6
Beryllium	4.86E-10		5.8E-8	0	5.8E-8
Cadmium		7.10E-10	0	2.1E-8	2.1E-8
Chromium	2.90E-08	1.27E-07	3.5E-6	3.8E-6	7.3E-6
Cr (VI)	5.80E-09	2.70E-08	7.0E-7	8.1E-7	1.5E-6
Lead	1.09E-08	3.66E-08	1.3E-6	1.1E-6	2.4E-6
Manganese	1.17E-07	3.78E-06	1.4E-5	1.1E-4	1.3E-4
Nickel	4.18E-08	2.48E-07	5.0E-6	7.4E-6	1.2E-5
Phosphorus		1.20E-06	0	3.6E-5	3.6E-5
Total			2.5E-5	1.7E-4	2.0E-4

(1) *AP-42, Table 11.12-8, (06/06) Cement Silo Filing, Controlled* 20% *Cr (VI), IDEQ email on 11/23/2020*

(2) *AP-42, Table 11.12-8, (06/06) Central Mix Batching, Controlled* 21.29% *Cr (VI), IDEQ email on 11/23/2020*

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-21-402/404	PAGE: 11 OF: 11 SHEET: ProcHAP
AIR EMISSION CALCULATIONS	SUBJECT: Process HAP and GHG Emissions	DATE: June 30, 2021

FUEL STORAGE - GASOLINE

Source Data

		VOC_tpy		
		VOC	TAP Rule	210.2
Source ID	Description	ton/yr	ton/yr	Exclusion
TG1	Mine Site Gasoline Tank #1	0.96	0.96	No
TG2	Mine Site Gasoline Tank #2	0.96	0.96	No
Total		1.91	1.91	

HAP Emission Factors and Emissions

		ton/yr
	Concentration	Emissions
Pollutant	wt. %[(1)]	ton/yr
Benzene	1.608%	0.031
Biphenyl	0.010%	1.9E-4
Hexane	7.138%	0.137
Naphthalene	0.444%	8.5E-3
Phenol	0.055%	1.1E-3
Toluene	7.212%	0.138
Xylene	7.170%	0.137
Total		0.453

(1) *(EPA 1999)a*

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: E. Huelson/E. Memon
	PROJECT NO: 335-1-1	PAGE: 1 OF: 9 SHEET: Tanks
AIR EMISSION CALCULATIONS	SUBJECT: Fuel Storage Tanks	DATE: June 30, 2021

Fuel Storage Tanks

	Dimensions				VOC		
	Capacity	Diameter	Length	Throughput	Emissions[1]		Reference
Storage Tank	gal	ft	ft	gal/yr	lb/yr	ton/yr	
Mine Site Gasoline Tank #1	5,000	8.5	14.33	250,000	1,914.73	0.96	*(Midas Gold 2016)*
Mine Site Gasoline Tank #2	5,000	8.5	14.33	250,000	1,914.73	0.96	*(Midas Gold 2016)*
Mine Site Diesel Tank #3	25,000	12	29.70	725,000	14.60	0.007	*(Midas Gold 2016), (Midas Gold 2018g)*
Mine Site Diesel Tank #4	25,000	12	29.70	725,000	14.60	0.007	*(Midas Gold 2016), (Midas Gold 2018g)*
Mine Site Diesel Tank #5	25,000	12	29.70	725,000	14.60	0.007	*(Midas Gold 2016), (Midas Gold 2018g)*
Mine Site Diesel Tank #6	25,000	12	29.70	725,000	14.60	0.007	*(Midas Gold 2016), (Midas Gold 2018g)*
Mine Site Diesel Tank #7	25,000	12	29.70	725,000	14.60	0.007	*(Midas Gold 2016), (Midas Gold 2018g)*
Mine Site Diesel Tank #8	25,000	12	29.70	725,000	14.60	0.007	*(Midas Gold 2016), (Midas Gold 2018g)*
Mine Site Diesel Tank #9	25,000	12	29.70	725,000	14.60	0.007	*(Midas Gold 2016), (Midas Gold 2018g)*
Mine Site Diesel Tank #10	25,000	12	29.70	725,000	14.60	0.007	*(Midas Gold 2016), (Midas Gold 2018g)*
Landmark Diesel Tank #1	2,500	6	15.00	130,000	2.01	0.001	*(Midas Gold 2018d), (Midas Gold 2018g)*
Landmark Diesel Tank #2	2,500	6	15.00	130,000	2.01	0.001	*(Midas Gold 2018d), (Midas Gold 2018g)*
Landmark Gasoline Tank #3	2,500	6	15.00	130,000	1,036.15	0.518	*(Midas Gold 2018d), (Midas Gold 2018g)*

[1] *Emissions calculated using EPA Tanks 4.0.9d (EPA 1999)*

Conversions

2,000 lb/ton

Mine Site Gasoline Tanks #1, #2

TANKS 4.0 Report

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	Midas Gasoline Tank - 5,000 gal
City:	
State:	Idaho
Company:	Midas Gold
Type of Tank:	Horizontal Tank
Description:	

Tank Dimensions

Shell Length (ft):	14.33
Diameter (ft):	8.50
Volume (gallons):	5,000.00
Turnovers:	50.00
Net Throughput(gal/yr):	250,000.00
Is Tank Heated (y/n):	N
Is Tank Underground (y/n):	N

Paint Characteristics

Shell Color/Shade:	White/White
Shell Condition	Good

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Boise, Idaho (Avg Atmospheric Pressure = 13.28 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

Midas Gasoline Tank - 5,000 gal - Horizontal Tank

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Gasoline (RVP 9)	All	52.81	46.88	58.74	50.94	3.9950	3.5384	4.4980	67.0000			92.00	Option 4: RVP=9, ASTM Slope=3

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

Midas Gasoline Tank - 5,000 gal - Horizontal Tank

Annual Emission Calcaulations	
Standing Losses (lb):	693.2361
Vapor Space Volume (cu ft):	517.9338
Vapor Density (lb/cu ft):	0.0487
Vapor Space Expansion Factor:	0.1431
Vented Vapor Saturation Factor:	0.5264
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	517.9338
Tank Diameter (ft):	8.5000
Effective Diameter (ft):	12.4565
Vapor Space Outage (ft):	4.2500
Tank Shell Length (ft):	14.3300
Vapor Density	
Vapor Density (lb/cu ft):	0.0487
Vapor Molecular Weight (lb/lb-mole):	67.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	3.9950
Daily Avg. Liquid Surface Temp. (deg. R):	512.4830
Daily Average Ambient Temp. (deg. F):	50.9208
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	510.6108
Tank Paint Solar Absorptance (Shell):	0.1700
Daily Total Solar Insulation Factor (Btu/sqft day):	1,400.5355

Mine Site Gasoline Tanks #1, #2 - continued

TANKS 4.0 Report

Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.1431
Daily Vapor Temperature Range (deg. R):	23.7125
Daily Vapor Pressure Range (psia):	0.9596
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	3.9950
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	3.5384
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	4.4980
Daily Avg. Liquid Surface Temp. (deg R):	512.4830
Daily Min. Liquid Surface Temp. (deg R):	506.5548
Daily Max. Liquid Surface Temp. (deg R):	518.4111
Daily Ambient Temp. Range (deg. R):	23.6750
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.5264
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	3.9950
Vapor Space Outage (ft):	4.2500
Working Losses (lb):	1,221.4895
Vapor Molecular Weight (lb/lb-mole):	67.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	3.9950
Annual Net Throughput (gal/yr.):	250,000.0000
Annual Turnovers:	50.0000
Turnover Factor:	0.7667
Tank Diameter (ft):	8.5000
Working Loss Product Factor:	1.0000
Total Losses (lb):	1,914.7256

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

Midas Gasoline Tank - 5,000 gal - Horizontal Tank

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Gasoline (RVP 9)	1,221.49	693.24	1,914.73

file:///C|/Program Files (x86)/Tanks409d/summarydisplay.htm[10/5/2017 9:35:37 AM]

Mine Site Diesel Tanks #3 - #10

TANKS 4.0 Report

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	25,000 gallon diesel storage tank
City:	Boise
State:	Idaho
Company:	Midas Gold
Type of Tank:	Vertical Fixed Roof Tank
Description:	Midas Gold Mine Site offroad diesel storage tanks

Tank Dimensions

Shell Height (ft):	29.70
Diameter (ft):	12.00
Liquid Height (ft) :	29.00
Avg. Liquid Height (ft):	14.50
Volume (gallons):	25,000.00
Turnovers:	29.00
Net Throughput(gal/yr):	725,000.00
Is Tank Heated (y/n):	N

Paint Characteristics

Shell Color/Shade:	White/White
Shell Condition	Good
Roof Color/Shade:	White/White
Roof Condition:	Good

Roof Characteristics

Type:	Dome
Height (ft)	1.00
Radius (ft) (Dome Roof)	12.00

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Boise, Idaho (Avg Atmospheric Pressure = 13.28 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

25,000 gallon diesel storage tank - Vertical Fixed Roof Tank
Boise, Idaho

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Distillate fuel oil no. 2	All	52.81	46.88	58.74	50.94	0.0051	0.0041	0.0062	130.0000			188.00	Option 1: VP50 = .0045 VP60 = .0065

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

25,000 gallon diesel storage tank - Vertical Fixed Roof Tank
Boise, Idaho

Annual Emission Calcaulations	
Standing Losses (lb):	3.2383
Vapor Space Volume (cu ft):	1,776.1518
Vapor Density (lb/cu ft):	0.0001
Vapor Space Expansion Factor:	0.0419
Vented Vapor Saturation Factor:	0.9958
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,776.1518
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	15.7046
Tank Shell Height (ft):	29.7000
Average Liquid Height (ft):	14.5000

Mine Site Diesel Tanks #3 - #10 - continued

TANKS 4.0 Report

Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0001
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0051
Daily Avg. Liquid Surface Temp. (deg. R):	512.4830
Daily Average Ambient Temp. (deg. F):	50.9208
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	510.6108
Tank Paint Solar Absorptance (Shell):	0.1700
Tank Paint Solar Absorptance (Roof):	0.1700
Daily Total Solar Insulation Factor (Btu/sqft day):	1,400.5355
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.0419
Daily Vapor Temperature Range (deg. R):	23.7125
Daily Vapor Pressure Range (psia):	0.0022
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0051
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	0.0041
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	0.0062
Daily Avg. Liquid Surface Temp. (deg R):	512.4830
Daily Min. Liquid Surface Temp. (deg R):	506.5548
Daily Max. Liquid Surface Temp. (deg R):	518.4111
Daily Ambient Temp. Range (deg. R):	23.6750
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.9958
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	0.0051
Vapor Space Outage (ft):	15.7046
Working Losses (lb):	11.3607
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0051
Annual Net Throughput (gal/yr.):	725,000.0000
Annual Turnovers:	29.0000
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	25,000.0000
Maximum Liquid Height (ft):	29.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	1.0000
Total Losses (lb):	14.5990

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

25,000 gallon diesel storage tank - Vertical Fixed Roof Tank
Boise, Idaho

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Distillate fuel oil no. 2	11.36	3.24	14.60

file:///C|/Program Files (x86)/Tanks409d/summarydisplay.htm[4/18/2018 11:40:56 AM]

Landmark Diesel Tanks #1, #2

TANKS 4.0 Report

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	2,500 gallon diesel storage tank
City:	Boise
State:	Idaho
Company:	Midas Gold
Type of Tank:	Horizontal Tank
Description:	Midas Gold Landmark facility diesel tanks

Tank Dimensions

Shell Length (ft):	15.00
Diameter (ft):	6.00
Volume (gallons):	2,500.00
Turnovers:	52.00
Net Throughput(gal/yr):	130,000.00
Is Tank Heated (y/n):	N
Is Tank Underground (y/n):	N

Paint Characteristics

Shell Color/Shade:	White/White
Shell Condition	Good

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Boise, Idaho (Avg Atmospheric Pressure = 13.28 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

2,500 gallon diesel storage tank - Horizontal Tank
Boise, Idaho

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Distillate fuel oil no. 2	All	52.81	46.88	58.74	50.94	0.0051	0.0041	0.0062	130.0000			188.00	Option 1: VP50 = .0045 VP60 = .0065

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

2,500 gallon diesel storage tank - Horizontal Tank
Boise, Idaho

Annual Emission Calcaulations	
Standing Losses (lb):	0.4942
Vapor Space Volume (cu ft):	270.1369
Vapor Density (lb/cu ft):	0.0001
Vapor Space Expansion Factor:	0.0419
Vented Vapor Saturation Factor:	0.9992
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	270.1369
Tank Diameter (ft):	6.0000
Effective Diameter (ft):	10.7075
Vapor Space Outage (ft):	3.0000
Tank Shell Length (ft):	15.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0001
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0051
Daily Avg. Liquid Surface Temp. (deg. R):	512.4830
Daily Average Ambient Temp. (deg. F):	50.9208
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	510.6108

Landmark Diesel Tanks #1, #2 - continued

TANKS 4.0 Report

Tank Paint Solar Absorptance (Shell):	0.1700
Daily Total Solar Insulation Factor (Btu/sqft day):	1,400.5355
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.0419
Daily Vapor Temperature Range (deg. R):	23.7125
Daily Vapor Pressure Range (psia):	0.0022
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0051
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	0.0041
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	0.0062
Daily Avg. Liquid Surface Temp. (deg R):	512.4830
Daily Min. Liquid Surface Temp. (deg R):	506.5548
Daily Max. Liquid Surface Temp. (deg R):	518.4111
Daily Ambient Temp. Range (deg. R):	23.6750
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.9992
Vapor Pressure at Daily Average Liquid:	
Surface Temperature (psia):	0.0051
Vapor Space Outage (ft):	3.0000
Working Losses (lb):	1.5148
Vapor Molecular Weight (lb/lb-mole):	130.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0051
Annual Net Throughput (gal/yr.):	130,000.0000
Annual Turnovers:	52.0000
Turnover Factor:	0.7436
Tank Diameter (ft):	6.0000
Working Loss Product Factor:	1.0000
Total Losses (lb):	2.0090

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

2,500 gallon diesel storage tank - Horizontal Tank
Boise, Idaho

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Distillate fuel oil no. 2	1.51	0.49	2.01

file:///C|/Program Files (x86)/Tanks409d/summarydisplay.htm[4/18/2018 11:35:48 AM]

Landmark Gasoline Tanks #3

TANKS 4.0 Report

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	2,500 gallon gasoline tank
City:	Boise
State:	Idaho
Company:	Midas Gold
Type of Tank:	Horizontal Tank
Description:	Midas Gold Landmark facility gasoline tank

Tank Dimensions

Shell Length (ft):	15.00
Diameter (ft):	6.00
Volume (gallons):	2,500.00
Turnovers:	52.00
Net Throughput(gal/yr):	130,000.00
Is Tank Heated (y/n):	N
Is Tank Underground (y/n):	N

Paint Characteristics

Shell Color/Shade:	White/White
Shell Condition	Good

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Boise, Idaho (Avg Atmospheric Pressure = 13.28 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

2,500 gallon gasoline tank - Horizontal Tank
Boise, Idaho

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Gasoline (RVP 9)	All	52.81	46.88	58.74	50.94	3.9950	3.5384	4.4980	67.0000			92.00	Option 4: RVP=9, ASTM Slope=3

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

2,500 gallon gasoline tank - Horizontal Tank
Boise, Idaho

Annual Emission Calcaulations	
Standing Losses (lb):	420.0911
Vapor Space Volume (cu ft):	270.1369
Vapor Density (lb/cu ft):	0.0487
Vapor Space Expansion Factor:	0.1431
Vented Vapor Saturation Factor:	0.6115
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	270.1369
Tank Diameter (ft):	6.0000
Effective Diameter (ft):	10.7075
Vapor Space Outage (ft):	3.0000
Tank Shell Length (ft):	15.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0487
Vapor Molecular Weight (lb/lb-mole):	67.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	3.9950
Daily Avg. Liquid Surface Temp. (deg. R):	512.4830
Daily Average Ambient Temp. (deg. F):	50.9208
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	510.6108

file:///C|/Program Files (x86)/Tanks409d/summarydisplay.htm[4/18/2018 11:37:57 AM]

Landmark Gasoline Tanks #3 - continued

TANKS 4.0 Report

Tank Paint Solar Absorptance (Shell):	0.1700
Daily Total Solar Insulation Factor (Btu/sqft day):	1,400.5355
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.1431
Daily Vapor Temperature Range (deg. R):	23.7125
Daily Vapor Pressure Range (psia):	0.9596
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	3.9950
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	3.5384
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	4.4980
Daily Avg. Liquid Surface Temp. (deg R):	512.4830
Daily Min. Liquid Surface Temp. (deg R):	506.5548
Daily Max. Liquid Surface Temp. (deg R):	518.4111
Daily Ambient Temp. Range (deg. R):	23.6750
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.6115
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	3.9950
Vapor Space Outage (ft):	3.0000
Working Losses (lb):	616.0556
Vapor Molecular Weight (lb/lb-mole):	67.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	3.9950
Annual Net Throughput (gal/yr.):	130,000.0000
Annual Turnovers:	52.0000
Turnover Factor:	0.7436
Tank Diameter (ft):	6.0000
Working Loss Product Factor:	1.0000
Total Losses (lb):	1,036.1467

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

2,500 gallon gasoline tank - Horizontal Tank
Boise, Idaho

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Gasoline (RVP 9)	616.06	420.09	1,036.15

file:///C|/Program Files (x86)/Tanks409d/summarydisplay.htm[4/18/2018 11:37:57 AM]

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 1 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10 TAP Analysis FALSE chk chk chk

Mining Activity and Emissions Emissions Summary

By Area/Model ID

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	CO_PPH	CO_TPY	NOX_PPH	NOX_TPY	SO2_PPH	SO2_TPY	VOC_TPY	Hg2+P_TPY
Area/	Location of	PM	PM10		PM2.5		CO		NOX		SO2		VOC	Hg2+P
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr	ton/yr
YPP	Yellow Pine Pit	0.58	1.47	0.26	0.65	0.12	1.84	7.84	1.75	7.43	0.00	0.01	0.44	2.9E-07
HFP	Hangar Flats Pit	0.33	0.82	0.15	0.36	0.06	0.99	4.22	0.99	4.22	0.00	0.01	0.23	1.7E-07
WEP	West End Pit	7.03	18.33	3.25	8.52	1.51	24.14	102.84	21.57	91.87	0.05	0.20	5.86	3.4E-06
BT	Bradley Tailings	--	--	--	--	--	--	--	--	--	--	--	--	--
YPPBL	Yellow Pine Pit Blasting	0.56	4.60	0.29	0.27	0.02	5.19	7.86	0.14	0.21	0.00	0.00	--	3.4E-07
HFPBL	Hangar Flats Pit Blasting	--	--	--	--	--	--	--	--	--	--	--	--	--
WEPBL	West End Pit Blasting	13.52	111.43	7.03	6.43	0.41	128.80	195.00	3.46	5.24	0.01	0.01	--	8.1E-06
BTBL	Bradley Tailings Blasting	--	--	--	--	--	--	--	--	--	--	--	--	--
PC	Process PC	--	--	--	--	--	--	--	--	--	--	--	--	--
HFSTKP	Hangar Flats Stockpiles	1.50	4.13	0.73	0.62	0.11	--	--	--	--	--	--	--	9.0E-07
LSTKP	Limestone Stockpile	0.03	0.08	0.01	0.01	0.00	--	--	--	--	--	--	--	1.8E-08
HFBF	Hangar Flats Backfill	24.56	25.50	4.53	14.87	2.64	4.66	19.85	0.53	2.27	0.01	0.04	1.08	1.5E-05
TSFEB	Tailings Storage Facility I	--	--	--	--	--	--	--	--	--	--	--	--	--
YPBF	Yellow Pine Backfill	17.89	18.57	3.30	10.83	1.92	3.39	14.46	0.39	1.65	0.01	0.03	0.78	1.1E-05
WEBF	West End Backfill	--	--	--	--	--	--	--	--	--	--	--	--	--
PROC	Process Area	0.33	0.86	0.15	0.39	0.07	1.34	5.69	1.02	4.34	0.00	0.01	0.29	1.7E-07
HR	Onsite Hauling	864.36	1,214.45	215.57	131.32	23.31	19.95	85.00	33.90	144.39	0.09	0.40	10.26	2.9E-04
ACCRD	Access Roads	113.18	163.62	29.04	17.36	3.08	1.24	5.28	1.15	4.91	0.00	0.01	0.61	1.0E-06
TSF	Tailings Storage Facility	--	--	--	--	--	--	--	--	--	--	--	--	--
HELI	Heliport	0.00	0.17	0.00	0.17	0.00	1.04	0.02	0.83	0.02	0.08	0.00	0.03	--
Total		1,043.87	1,564.04	264.31	191.79	33.25	192.58	448.06	65.72	266.56	0.26	0.72	19.56	3.3E-04

See worksheet ROADS for haul road (HR) emissions by Model ID.

By Activity

	chk	chk	chk	chk	chk	chk	chk	chk	chk	chk	chk	chk	chk
	PM	PM10		PM2.5		CO		NOX		SO2		VOC	Hg2+P
Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr	ton/yr
Open Pit Drilling	1.97	0.58	0.10	0.03	0.01								1.2E-06
Open Pit Blasting	14.08	116.04	7.32	6.69	0.42	133.99	202.86	3.60	5.45	0.01	0.01		8.4E-06
Onsite Hauling	819.13	1,134.04	201.29	113.40	20.13								2.8E-04
Material Load / Unload	4.62	12.31	2.19	1.86	0.33								2.8E-06
Mobile Tailpipes	4.30	24.21	4.30	19.40	3.44	52.35	223.00	56.17	239.29	0.16	0.66	18.01	
Dozing	39.92	36.48	6.47	23.61	4.19								2.4E-05
Grading	21.33	36.07	6.40	3.73	0.66								7.3E-06
Water Truck Travel	21.24	29.41	5.22	2.94	0.52								7.2E-06
Access Roads	113.18	163.62	29.04	17.36	3.08	1.24	5.28	1.15	4.91	0.00	0.01	0.61	1.0E-06
Wind Erosion	2.78	7.83	1.39	1.17	0.21								1.7E-06
Surface Exploration	1.31	3.29	0.58	1.42	0.25	3.97	16.89	3.97	16.89	0.01	0.03	0.92	6.7E-07
Helicopter	0.00	0.17	0.00	0.17	0.00	1.04	0.02	0.83	0.02	0.08	0.00	0.03	
TSF Construction	--	--	--	--	--								--
Total	1,043.87	1,564.04	264.31	191.79	33.25	192.58	448.06	65.72	266.56	0.26	0.72	19.56	3.3E-04
													0.00033
													chk

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 2 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Mining Activity and Emissions Source Parameters Summary

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	SIG_Y_M	SIG_Z_M	PITVOL_M3	SXINIT_M	SYINIT_M	ANGL_DEG
	Location of	Source	UTM NAD 83		Elev.	Rel. Ht.	S-y	S-z	Pit Vol.	Len X	Len Y	Angle
Model ID	Activity	Type	E m	N m	m	m	m	m	m^3	m	m	deg
YPP	Yellow Pine Pit	AREA	631,024	4,975,923	1,832	4.6		4.3		900	900	-
HFP	Hangar Flats Pit	AREA	630,997	4,972,835	1,993	4.6		4.3		543.0	550.0	-
WEP	West End Pit	AREA	632,123	4,976,032	2,030	4.6		4.3		895.0	895.0	-
BT	Bradley Tailings	AREA	630,087	4,972,258	2,015	4.6		4.3		364	729	68
YPPBL	Yellow Pine Pit Blasting	VOLUME	631,475	4,976,374	1,798	75.0	20.9	34.9				
HFPBL	Hangar Flats Pit Blasting	VOLUME	631,273	4,973,106	1,847	75.0	20.9	34.9				
WEPBL	West End Pit Blasting	VOLUME	632,572	4,976,480	2,170	75.0	20.9	34.9				
HFSTKP	Hangar Flats Stockpiles	VOLUME	630,894	4,972,749	2,009	4.6	75.1	4.3				
LSTKP	Limestone Stockpile	VOLUME	632,286	4,974,288	2,000	4.6	23.3	4.3				
HFBF	Hangar Flats Backfill	VOLUME	631,273	4,973,106	1,998	4.6	78.4	4.3				
TSFEB	Tailings Storage Facility Embank	VOLUME	630,249	4,972,167	2,155	4.6	193.7	4.3				
YPBF	Yellow Pine Backfill	VOLUME	631,475	4,976,374	1,806	4.6	106.3	4.3				
WEBF	West End Backfill	VOLUME	632,572	4,976,480	2,170	4.6	-	4.3				
PROC	Process Area	AREA	631,880	4,973,910	1,970	2.2		2.1		400	400	0
HR	Onsite Hauling	VOLUME	See worksheet: ROADS			4.6	15.1	4.3	-	-	-	-
ACCRD	Access Roads	VOLUME	See worksheet: HR Grid			3.0	5.6	2.8	-	-	-	-
TSF	Tailings Storage Facility	AREA	628,496	4,971,000	2,117	-	-	-	-	1,157	1,157	0
HELI	Heliport	VOLUME	632,222	4,973,588	1,996	3.4	9.1	3.2				

Updat

Emissions by LOM (ton/yr) Calculated on: 07/08/21

PM10+SO2+NOX	LOM	PM	PM10		PM2.5		CO		NOX		SO2		VOC
ton/yr	Year	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr
246	3	341.7	500.0	87.3	93.8	16.3	102.6	370.8	38.4	158.5	0.2	0.6	**22.1**
499	4	836.3	1,239.2	213.0	160.1	28.0	161.9	465.0	69.3	285.7	0.3	0.8	21.2
500	5	836.1	1,258.4	214.7	168.0	28.8	154.3	460.8	68.9	285.0	0.3	0.8	21.0
532	6	908.6	1,347.4	233.9	172.3	30.0	142.1	**504.9**	**71.2**	**297.2**	**0.3**	**0.8**	20.8
501	7	817.9	1,255.2	211.9	158.3	27.4	153.2	475.7	69.5	288.0	0.3	0.8	20.7
459	8	748.0	1,197.9	194.2	155.3	26.3	177.0	449.5	64.7	263.9	0.3	0.8	20.7
431	9	784.8	1,162.6	199.5	152.9	26.7	151.9	428.6	56.3	230.7	0.2	0.7	19.7
532	**10**	**1,043.9**	**1,564.0**	**264.3**	**191.8**	**33.3**	**192.6**	448.1	65.7	266.6	0.3	0.7	19.6
440	11	761.6	1,161.4	195.1	148.1	25.6	178.4	442.7	60.2	244.7	0.2	0.7	18.9
389	12	657.9	990.5	168.6	128.4	22.4	182.1	429.6	54.7	220.2	0.2	0.6	17.7
395	13	663.1	1,013.4	170.0	134.6	23.3	171.0	440.4	55.3	224.5	0.2	0.6	18.1
389	14	710.0	1,165.8	181.5	146.4	24.5	168.9	362.3	51.7	207.2	0.2	0.6	15.5
205	15	404.7	749.1	103.4	95.3	15.2	125.8	208.5	26.6	101.2	0.2	0.4	9.9
114	16	260.1	361.3	64.1	59.9	10.6	22.6	92.1	12.6	50.0	0.1	0.2	6.8
124	17	283.9	397.3	70.5	59.6	10.6	19.1	77.0	13.3	53.3	0.1	0.2	6.0
71	18	184.3	257.6	45.7	41.6	7.3	13.5	53.1	6.8	25.7	0.1	0.1	4.6
		chk	chk	chk	chk	chk	chk	chk	chk	chk	chk	chk	chk

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 3 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Open Pit Drilling

Activity Information

Operating schedule	355 day/yr	*(M3 2014)*	
Total drill holes per year	30,313 hole/yr	*(Perpetua 2021a)*	

Annual LOM-10 rates		Material blasted			Drilling[1]	
YPI	Yellow Pine Pit	1,147,269	ton/yr	*(Perpetua 2021a)*	1,175	hole/yr
HFI	Hangar Flats Pit	0	ton/yr	*(Perpetua 2021a)*		hole/yr
WE	West End Pit	28,466,535	ton/yr	*(Perpetua 2021a)*	29,139	hole/yr
BT_	Bradley Tailings	0	ton/yr	*(Perpetua 2021a)*	0	hole/yr
	Total	29,613,804	ton/yr		30,314	hole/yr

(1) *Total drill holes per year scaled based on material blasted; rounded up to the nearest whole number*

Emission Factors

TSP (PM)	1.3 lb/hole	*AP-42, Tab. 11.9-4, 7/98 (overburden)*

PM Scaling Factors

PM	1	
PM10	0.52	*AP-42, Tab. 11.9-1, 7/98 (blasting, overburden)*
PM2.5	0.03	*AP-42, Tab. 11.9-1, 7/98 (blasting, overburden)*

Emission Controls

Dust collector

Control efficiency: 90% *(CDC 2012), up to 99% control*

Emissions by Model ID

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	Hg2+P_TPY
	Location of	PM	PM10		PM2.5		Hg2+P
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	ton/yr
YPP	Yellow Pine Pit	0.08	0.02	0.00	0.00	0.00	4.6E-08
HFP	Hangar Flats Pit	--	--	--	--	--	--
WEP	West End Pit	1.89	0.55	0.10	0.03	0.01	1.1E-06
BT	Bradley Tailings	--	--	--	--	--	--
Total	Open Pit Drilling	1.97	0.58	0.10	0.03	0.01	1.2E-06

Source Parameters (1)

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	PITVOL_M3	SXINIT_M	SYINIT_M	SIG_Z_M	ANGL_DEG	Area
		Source	UTM NAD 83		Elev.	Rel. Ht.	Pit Vol.	Len X	Len Y	S-z	Angle	
Model ID	Activity	Type	E m	N m	m	m	m^3	m	m	m	deg	
YPP	Yellow Pine Pit	AREA	631,024	4,975,923	1,832	4.57		900.0	900.0	4.26	0.0	810000
HFP	Hangar Flats Pit	AREA	630,997	4,972,835	1,993	4.57		543.0	550.0	4.26	0.0	298650
WEP	West End Pit	AREA	632,123	4,976,032	2,030	4.57		895.0	895.0	4.26	0.0	801025

(1) *UTM - (Midas Gold 2017e); Rel. Ht. - (EPA 2012); Len X, Len Y, Angle - best-fit equal area rectangle; Elev. - (Midas Gold 2018n)*

Source Parameters (1)

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M		SXINIT_M	SYINIT_M	SIG_Z_M	ANGL_DEG	
		Source	UTM NAD 83		Elev.	Rel. Ht.	Pit Vol.	Len X	Len Y	S-z	Angle	
Model ID	Activity	Type	E m	N m	m	m	m^3	m	m	m	deg	
BT	Bradley Tailings	AREA	630,087	4,972,258	2,015	4.57		364	729	4.26	68.0	265356

(1) *UTM, Elev. - (Midas Gold 2017e); Rel. Ht. - (EPA 2012); Len X, Len Y - best-fit equal area rectangle*

Conversions

2,000 lb/ton

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 4 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Open Pit Blasting

Activity Information

Operating schedule	126	day/yr	24	hr/day
BLS Blast area	63,390	ft^2/blast	*(Perpetua 2021a)*	
TOT Maximum blasts per year	126	blast/yr	*(Perpetua 2021a)*	

Annual LOM-10 rates		Material blasted		Blasting(1)		ANFO use		
YPI	Yellow Pine Pit	1,147,269	ton/yr	5	blast/yr	235	ton ANFO/yr	*(Perpetua 2021a)*
HFI	Hangar Flats Pit	0	ton/yr	0	blast/yr	0	ton ANFO/yr	*(Perpetua 2021a)*
WE	West End Pit	28,466,535	ton/yr	121	blast/yr	5,821	ton ANFO/yr	*(Perpetua 2021a)*
BT_	Bradley Tailings	0	ton/yr	0	blast/yr	0	ton ANFO/yr	*(Perpetua 2021a)*
	Total	29,613,804	ton/yr	126	blast/yr	6,055	ton ANFO/yr	

(1) *Maximum blasts per year scaled based on material blasted; rounded up to the nearest whole number*

Emission Factors

Emission factor equation	TSP (lb/blast) = 0.000014 x $A^{1.5}$	*AP-42, Tab. 11.9-1, 7/98 (blasting, overburden)*	
A = Area per blast	63,390 ft^2		
TSP (PM)	223.44 lb/blast		
CO	67.0 lb/ton-ANFO	*AP-42, Tab. 13.3-1, 2/80 (ANFO)*	
NOX	0.9 kg/t-ANFO	*(CSIRO 2008)*	
	1.8 lb/ton-ANFO		
SO2	3.6E-03 lb/ton-ANFO	*Based on:* 6% *diesel content in ANFO*	*(Midas Gold 2017d)*

$$\frac{1.5\text{E-}05\ \cancel{\text{lb S}}}{\cancel{\text{lb FO}}} \times \frac{2\ \text{lb SO2}}{\cancel{\text{lb S}}} \times \frac{6\%\ \cancel{\text{lb FO}}}{\cancel{\text{lb ANFO}}} \times \frac{2{,}000\ \cancel{\text{lb ANF}}}{\text{ton ANFO}} = \frac{3.6\text{E-}03\ \text{lb SO2}}{\text{ton ANFO}}$$

PM Scaling Factors

PM10	0.52	*AP-42, Tab. 11.9-1, 7/98 (blasting, overburden)*
PM2.5	0.03	*AP-42, Tab. 11.9-1, 7/98 (blasting, overburden)*

Emissions by Model ID

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	CO_PPH	CO_TPY	NOX_PPH	NOX_TPY	SO2_PPH	SO2_TPY	Hg2+P_TPY
		PM	PM10		PM2.5		CO		NOX(1)		SO2		Hg2+P
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr
YPPBL	Yellow Pine Pit Blasting	0.56	4.60	0.29	0.27	0.02	5.19	7.86	0.14	0.21	0.0003	0.0004	3.4E-07
HFPBL	Hangar Flats Pit Blasting	--	--	--	--	--	--	--	--	--	--	--	0
WEPBL	West End Pit Blasting	13.52	111.43	7.03	6.43	0.41	128.80	195.00	3.46	5.24	0.0069	0.0105	8.1E-06
BTBL	Bradley Tailings Blasting	--	--	--	--	--	--	--	--	--	--	--	0
Total	Open Pit Blasting	14.08	116.04	7.32	6.69	0.42	133.99	202.86	3.60	5.45	0.0072	0.0109	8.4E-06

(1) *NO2 / NOX:* 0.0357 *(CSIRO 2008)*

Source Parameters (1)

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	SIG_Y_M	SIG_Z_M
		Source	UTM NAD 83		Elev.	Rel. Ht.	S-y	S-z
Model ID	Activity	Type	E m	N m	m	m	m	m
YPPBL	Yellow Pine Pit Blasting	VOLUME	631,475	4,976,374	1,798	75	20.93	34.88
HFPBL	Hangar Flats Pit Blasting	VOLUME	631,273	4,973,106	1,847	75	20.93	34.88
WEPBL	West End Pit Blasting	VOLUME	632,572	4,976,480	2,170	75	20.93	34.88

(1) *UTM, Elev. - (Midas Gold 2017e); Rel. Ht. - (CSIRO 2008); S-y, S-z factors - (EPA 2016a)*

Conversions								
2,000 lb/ton	Blast height (BH)	150	m	*(CSIRO 2008)*	Sigma divider			
2.205 lb/kg	Blast width	90	m	*(CSIRO 2008)*	Rel. Ht.	2	of BH	*(EPA 2016a)*
1.102 ton/t	Blast depth	90	m	*(CSIRO 2008)*	S-y	4.3	of SL	*(EPA 2016a)*
	Equal area side length (SL)	90	m		S-z	4.3	of BH	*(EPA 2016a)*

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 5 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10
Onsite Hauling

Ore_Waste
Equipment
MachineSpecs

Activity Information

Operating schedule 355 day/yr
Total vehicle miles travelled 1,702,607 VMT/yr (round-trip) *(Perpetua 2021a)* TRUE Total-VMT

Hauling Routes, Production Rates and Distances

	Route Origin		Destination		Material Type	Material Hauled [1] Rate ton/yr	One-Way Hauling [2] mi	Truck Loads [3] load/yr	Theorical VMT [4]	Total Travel [5] VMT/yr
Unpaved Roads										
YPI	Yellow Pine Pit	YPP	Process PC	PC	Ore	602,078	1.84	4,592	16,934	11,062
YPI	Yellow Pine Pit	YPP	Hangar Flats Stockpile	HFSTKP	Ore	189,994	3.48	1,450	10,085	6,588
YPI	Yellow Pine Pit	YPP	Hangar Flats Backfill	HFBF	Rock	391,537	4.01	2,987	23,984	15,668
YPI	Yellow Pine Pit	YPP	Tailings Storage Facili	TSFEB	Rock	--	4.10	--	--	--
YPI	Yellow Pine Pit	YPP	Yellow Pine Backfill	YPBF	Rock	--	1.80	--	--	--
YPI	Yellow Pine Pit	YPP	West End Backfill	WEBF	Rock	--	n/a	--	--	--
HFI	Hangar Flats Pit	HFP	Process PC	PC	Ore	--	3.16	--	--	--
HFI	Hangar Flats Pit	HFP	Hangar Flats Stockpile	HFSTKP	Ore	--	1.30	--	--	--
HFI	Hangar Flats Pit	HFP	Hangar Flats Backfill	HFBF	Rock	--	n/a	--	--	--
HFI	Hangar Flats Pit	HFP	Tailings Storage Facili	TSFEB	Rock	--	2.17	--	--	--
HFI	Hangar Flats Pit	HFP	Yellow Pine Backfill	YPBF	Rock	--	4.31	--	--	--
HFI	Hangar Flats Pit	HFP	West End Backfill	WEBF	Rock	--	n/a	--	--	--
WE	West End Pit	WEP	Process PC	PC	Ore	2,151,139	2.68	16,407	87,875	57,405
WE	West End Pit	WEP	Hangar Flats Stockpile	HFSTKP	Ore	5,492,925	5.10	41,893	427,558	279,304
WE	West End Pit	WEP	Hangar Flats Backfill	HFBF	Rock	13,922,251	5.75	106,181	1,220,925	797,574
WE	West End Pit	WEP	Tailings Storage Facili	TSFEB	Rock	--	5.83	--	--	--
WE	West End Pit	WEP	Yellow Pine Backfill	YPBF	Rock	10,426,067	3.73	79,517	592,729	387,202
WE	West End Pit	WEP	West End Backfill	WEBF	Rock	--	0.75	--	--	--
WE	West End Pit	WEP	Limestone Stockpile	LSTKP	Rock	318,000	2.92	2,426	14,192	9,271
BT-	Bradley Tailings	BT	Process PC	PC	Ore	--	3.02	--	--	--
BT-	Bradley Tailings	BT	Hangar Flats Stockpile	HFSTKP	Ore	--	n/a	--	--	--
BT-	Bradley Tailings	BT	Hangar Flats Backfill	HFBF	Rock	--	n/a	--	--	--
BT-	Bradley Tailings	BT	Tailings Storage Facili	TSFEB	Rock	--	0.87	--	--	--
HFS	Hangar Flats Stock	HFSTKP	Process PC	PC	Ore	5,296,781	2.62	40,397	212,067	138,533
BT-	Bradley Tailings	BT	West End Backfill	WEBF	Rock	--	n/a	--	--	--
	Total					38,790,773	*59.47*	295,850	2,606,347	1,702,607

(1) *(Perpetua 2021a)*
(2) *(Midas Gold 2017e)*
(3) *See truck fleet information below.*
(4) *Truck loads* × *One-way hauling* × 2 *(round-trip) Used for actual VMT appropriation*
(5) *(Perpetua 2021b)*

Truck Fleet

Truck		Payload Capacity [1] ton	Empty Weight [1] ton	Operation [2] hr/yr	Average Weight ton
Ha	CAT 785D	146.6	128.4	97,578	201.7
Ar	CAT 745C	45.2	36.8	17,582	59.4
	Weighted Average	131.1			180.0

(1) *(Caterpillar 2018b); (Caterpillar 2018b)*
(2) *(Perpetua 2021a)*

Conversions

2,000 lb/ton

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 6 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10
Onsite Hauling - continued

Hauling Emissions by Route

Route Origin		Destination		Material Hauled Material Type	PM_TPY PM ton/yr	PM10_PPD PM10 lb/day	PM10_TPY PM10 ton/yr	PM2.5_PPD PM2.5 lb/day	PM2.5_TPY PM2.5 ton/yr	Hg2+P_TPY Hg2+P ton/yr
Unpaved Roads										
YPI Yellow Pine Pit	YPP	Process PC	PC	Ore	5.32	7.37	1.31	0.74	0.13	1.8E-06
YPI Yellow Pine Pit	YPP	Hangar Flats Stockp	HFSTKP	Ore	3.17	4.39	0.78	0.44	0.08	1.1E-06
YPI Yellow Pine Pit	YPP	Hangar Flats Backfi	HFBF	Rock	7.54	10.44	1.85	1.04	0.19	2.6E-06
YPI Yellow Pine Pit	YPP	Tailings Storage Fac	TSFEB	Rock	--	--	--	--	--	--
YPI Yellow Pine Pit	YPP	Yellow Pine Backfill	YPBF	Rock	--	--	--	--	--	--
YPI Yellow Pine Pit	YPP	West End Backfill	WEBF	Rock	--	--	--	--	--	--
HFI Hangar Flats Pit	HFP	Process PC	PC	Ore	--	--	--	--	--	--
HFI Hangar Flats Pit	HFP	Hangar Flats Stockp	HFSTKP	Ore	--	--	--	--	--	--
HFI Hangar Flats Pit	HFP	Hangar Flats Backfi	HFBF	Rock	--	--	--	--	--	--
HFI Hangar Flats Pit	HFP	Tailings Storage Fac	TSFEB	Rock	--	--	--	--	--	--
HFI Hangar Flats Pit	HFP	Yellow Pine Backfill	YPBF	Rock	--	--	--	--	--	--
HFI Hangar Flats Pit	HFP	West End Backfill	WEBF	Rock	--	--	--	--	--	--
WE West End Pit	WEP	Process PC	PC	Ore	27.62	38.23	6.79	3.82	0.68	9.4E-06
WE West End Pit	WEP	Hangar Flats Stockp	HFSTKP	Ore	134.37	186.03	33.02	18.60	3.30	4.6E-05
WE West End Pit	WEP	Hangar Flats Backfi	HFBF	Rock	383.72	531.23	94.29	53.12	9.43	1.3E-04
WE West End Pit	WEP	Tailings Storage Fac	TSFEB	Rock	--	--	--	--	--	--
WE West End Pit	WEP	Yellow Pine Backfill	YPBF	Rock	186.29	257.90	45.78	25.79	4.58	6.3E-05
WE West End Pit	WEP	West End Backfill	WEBF	Rock	--	--	--	--	--	--
WE West End Pit	WEP	Limestone Stockpile	LSTKP	Rock	4.46	6.17	1.10	0.62	0.11	1.5E-06
BT- Bradley Tailings	BT	Process PC	PC	Ore	--	--	--	--	--	--
BT- Bradley Tailings	BT	Hangar Flats Stockp	HFSTKP	Ore	--	--	--	--	--	--
BT- Bradley Tailings	BT	Hangar Flats Backfi	HFBF	Rock	--	--	--	--	--	--
BT- Bradley Tailings	BT	Tailings Storage Fac	TSFEB	Rock	--	--	--	--	--	--
HFS Hangar Flats Stock	HFSTKF	Process PC	PC	Ore	66.65	92.27	16.38	9.23	1.64	2.3E-05
BT- Bradley Tailings	BT	West End Backfill	WEBF	Rock	--	--	--	--	--	--
Pit Subtotal					819.13	1,134.04	201.29	113.40	20.13	2.8E-04

Emission Factors
Unpaved roads

Emission factor equation	$E = k(s/12)^a (W/3)^b [(365-P)/365]$		*AP-42, Sec. 13.2.2, Eq. 1a, 11/06*
s = Surface material silt content	4	%	*(Midas Gold 2015)*
W = Mean vehicle weight	180.0	ton	
P = Days/year with ≥0.01 in precip	120	day/yr	*AP-42 Fig. 13.2.2-1, 11/06*

	PM	PM10	PM2.5		
k = Size-specific empirical constant	4.9	1.5	0.15		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
a = Size-specific empirical constant	0.7	0.9	0.9		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
b = Size-specific empirical constant	0.45	0.45	0.45		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
E = Size-specific emission factor	9.62	2.36	0.24	lb/VMT	

Emission Controls
Unpaved roads - periodic application of water and chemical dust suppressant
Control efficiency: 90% *(Air Sciences 2018)*

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 7 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10
Onsite Hauling - continued

Emissions by Area

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	Hg2+P_TPY
		PM	PM10		PM2.5		Hg2+P
Area ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	ton/yr
HR	Onsite Hauling	819.13	1,134.04	201.29	113.40	20.13	2.8E-04

See worksheet ROADS for haul road (HR) emissions by Model ID.

Source Parameters [1]

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	SIG_Y_M	SIG_Z_M
		Source	UTM NAD 83		Elev.	Rel. Ht.	S-y	S-z
Model ID	Activity	Type	E m	N m	m	m	m	m
HR	Onsite Hauling	VOLUME	*See worksheet: ROADS*			4.57	15.14	4.26

[1] *UTM, Elev. - (Midas Gold 2017e); Rel. Ht., Sy, Sz - (EPA 2012)*

Truck	Height		Reference
CAT 785D	5.7	m	*(Caterpillar 2018b)*
CAT 745C	3.7	m	*(Caterpillar 2018b)*
Weighted	5.38	m	
Road width (RW)	26.5	m	*(Midas Gold 2016), Fig. 9-1*

Plume Parameter	Calculation	Value (m)	Const.
Plume top (PT) - unpaved	1.7 x VH	9.15	1.7
Release height - unpaved	0.5 x PT	4.57	0.5
Plume width (PW)	RW + 6 m	32.55	6
Sigma-z - unpaved	PT / 2.15	4.26	2.15
Sigma-y	PW / 2.15	15.14	2.15

(EPA 2012)

Conversions

2,000	lb/ton
3.28	ft/m
12	in/ft

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 8 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Material Load / Unload

Activity Information

Operating schedule 355 day/yr

Throughput Rates chk

Model ID	Location of Activity	No. of Xfers	Rate ton/yr	Total Rate ton/yr	Xfer Description	
YPP	Yellow Pine Pit	1	1,183,610	1,183,610	Load	
HFP	Hangar Flats Pit	1	0	0	Load	
WEP	West End Pit	1	32,310,382	32,310,382	Load	
BT	Bradley Tailings	1	0	0	Load	
HFSTKP	Hangar Flats Stockpiles	1	5,296,781	5,296,781	Load	(Reload)
PC	Process PC (1)	0	8,049,998	0	Unload	
HFSTKP	Hangar Flats Stockpiles	1	5,682,919	5,682,919	Unload	
LSTKP	Limestone Stockpile	1	318,000	318,000	Unload	
HFBF	Hangar Flats Backfill	1	14,313,788	14,313,788	Unload	
TSFEB	Tailings Storage Facility Emb	1	0	0	Unload	
YPBF	Yellow Pine Backfill	1	10,426,067	10,426,067	Unload	
WEBF	West End Backfill	1	0	0	Unload	

(1) *Ore unloading at primary crusher is accounted for in process sources*

Emission Factors

	PM	PM10	PM2.5		
k = Particle size multiplier	0.74	0.35	0.053		*AP-42, Sec. 13.2.4, Pg. 4, 11/06*
E = Emission factor Load	0.00021	0.0001	0.000015	lb/ton	*AP-42, Tab. 11.19.2-2, 8/04 (truck loading - crshed stone)*
Unload	0.00003	0.000016	0.0000024	lb/ton	*AP-42, Tab. 11.19.2-2, 8/04 (truck unloading - fragmented stone)*
Unload	0.00012	0.00006	0.00001	lb/ton	*Average of load and unload*

Emissions by Model ID chk PM_TPY PM10_PPD PM10_TPY PM2.5_PPD PM2.5_TPY Hg2+P_TPY

Model ID	Location of Activity	Total Rate ton/yr	PM ton/yr	PM10 lb/day	PM10 ton/yr	PM2.5 lb/day	PM2.5 ton/yr	Hg2+P ton/yr
YPP	Yellow Pine Pit	1,183,610	0.13	0.33	0.06	0.05	0.01	7.5E-08
HFP	Hangar Flats Pit	--	--	--	--	--	--	--
WEP	West End Pit	32,310,382	3.42	9.10	1.62	1.38	0.24	2.0E-06
BT	Bradley Tailings	--	--	--	--	--	--	--
HFSTKP	Hangar Flats Stockpiles	5,296,781	0.56	1.49	0.26	0.23	0.04	3.4E-07
PC	Process PC	--	--	--	--	--	--	--
HFSTKP	Hangar Flats Stockpiles	5,682,919	0.10	0.26	0.05	0.04	0.01	5.8E-08
LSTKP	Limestone Stockpile	318,000	0.01	0.01	0.00	0.00	0.00	3.2E-09
HFBF	Hangar Flats Backfill	14,313,788	0.24	0.65	0.11	0.10	0.02	1.5E-07
TSFEB	Tailings Storage Facility Emb	--	--	--	--	--	--	--
YPBF	Yellow Pine Backfill	10,426,067	0.18	0.47	0.08	0.07	0.01	1.1E-07
WEBF	West End Backfill	--	--	--	--	--	--	--
Total	Material Load / Unload	69,531,547	4.62	12.31	2.19	1.86	0.33	2.8E-06

Conversions

2.237 mi/hr per m/s
2,000 lb/ton

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 9 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Material Load / Unload - continued

Source Parameters	TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	PITVOL_M3	SXINIT_M	SYINIT_M	SIG_Z_M	ANGL_DEG	
	Location of	Source	UTM NAD 83		Elev.	Rel. Ht.	Pit Vol.	Len X	Len Y	S-z	Angle	
Model ID	Activity	Type	E m	N m	m	m	m^3	m	m	m	deg	
YPP	Yellow Pine Pit	AREA	631,024	4,975,923	1,832	4.57		900	900	4.26	0	Pits
HFP	Hangar Flats Pit	AREA	630,997	4,972,835	1,993	4.57		543	550	4.26	0	Pits
WEP	West End Pit	AREA	632,123	4,976,032	2,030	4.57		895	895	4.26	0	Pits
BT	Bradley Tailings	AREA	630,087	4,972,258	2,015	4.57		364	729	4.26	68	

Source Parameters [1]	TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	SIG_Y_M	SIG_Z_M	Surface		
	Location of	Source	UTM NAD 83		Elev.	Rel. Ht.	S-y	S-z	Area	Length	
Model ID	Activity	Type	E m	N m	m	m	m	m	m^2	m	
HFSTKP	Hangar Flats Stockpiles	VOLUME	630,894	4,972,749	2,009	4.57	75.11	4.26	1.04E+05	323.0	Stockpile
LSTKP	Limestone Stockpile	VOLUME	632,286	4,974,288	2,000	4.57	23.26	4.26	1.00E+04	100.0	Stockpile
HFBF	Hangar Flats Backfill	VOLUME	631,273	4,973,106	1,998	4.57	78.37	4.26	1.14E+05	337.0	DRSF
TSFEB	Tailings Storage Facility Eml	VOLUME	630,249	4,972,167	2,155	4.57	193.72	4.26	6.94E+05	833.0	DRSF
YPBF	Yellow Pine Backfill	VOLUME	631,475	4,976,374	1,806	4.57	106.28	4.26	2.09E+05	457.0	DRSF
[1] *WEBF*	West End Backfill	VOLUME	632,572	4,976,480	2,170	4.57	0.00	4.26	0.00E+00	0.0	DRSF

UTM, Elev., Area - (Midas Gold 2017e); Rel. Ht. - (EPA 2012); S-y, S-z factors - (EPA 2016a)

Vehicle height (VH):

Weighted Average 5.38 m

Plume Parameter	Calculation	Value (m)	Const.
Plume top (PT)	1.7 x VH	9.15	1.7
Release height	0.5 x PT	4.57	0.5
Sigma-z	PT / 2.15	4.26	2.15

(EPA 2012)

Sample calculation for Hangar Flats Stockpiles

Plume Parameter	Calculation	Value (m)	Const.
Surface area (SA)	Map	104,320	
Side length (SL)	SA^0.5	323.0	0.5
Sigma-y	SL / 4.3	75.11	4.3

(EPA 2016a)

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 10 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Mobile Equipment (Tailpipes)

Equipment
MachineSpecs

Mobile Equipment Specifications and Activity

Equipment	Equipment[1] Model	ID	Rating[2] hp	Rating kW	Oper.[1] hr/yr	Equip.[1] Count	Diesel[1] gal/yr	Output[3] kW-hr/yr	Travel[4] VMT/yr	Equipment Category	On-road[5] Class	gal/hp-hr
dri Production Drill	CAT MD 6250	EQP1	872	650	31,933	5	798,317	11,651,153		Non-road		0.03
loa Wheel Loader	CAT 994K	EQP2	1,847	1,377	3,147	0	147,915	2,158,765		Non-road		0.03
loa Shovel	CAT 6040	EQP3	2,032	1,515	8,836	2	591,980	8,639,735		Non-road		0.03
tru Haul Truck	CAT 785D	EQP4	1,450	1,081	97,578	14	2,829,767	41,299,459		Non-road		0.02
do: Large Dozer	CAT D10T	EQP5	600	447	23,476	4	493,002	7,195,197		Non-road		0.04
do: Small Dozer	CAT D6T	EQP6	200	149	15,498	3	116,235	1,696,408		Non-road		0.04
gra Grader	CAT 18M	EQP7	357	266	15,236	3	114,268	1,667,707		Non-road		0.02
tru Water Truck	GF WT745C	EQP8	511	381	4,847	1	72,702	1,061,056		Non-road		0.03
loa Loader	CAT 988K	EQP9	580	433	7,995	2	95,944	1,400,266		Non-road		0.02
tru Articulated Truck	CAT 745C	EQP10	511	381	17,582	2	364,008	5,312,563		Non-road		0.04
dri PreSplit Drill	FlexiRoc D60	EQP11	475	354	2,450	0	48,990	714,995		Non-road		0.04
exc Excavator	CAT 390F	EQP12	524	391	7,970	1	115,570	1,686,702		Non-road		0.03
f-6 Stemming Truck	F-650	EQP13	330	246	1,633	0	8,165	119,171	40,827	On-road	MHD	0.02
f-6 Mechanics Truck	F-650	EQP14	330	246	11,394	2	56,972	831,482	284,858	On-road	MHD	0.02
ct-(ANFO Truck	CAT CT660	EQP15	476	355	3,266	1	16,331	238,342	65,323	On-road	HHD	0.01
tru Fuel Lube Truck	CAT 745C	EQP16	511	381	12,730	2	127,298	1,857,867		Non-road		0.02
f-3 Flatbed Truck	F-350	EQP17	440	328	3,919	1	7,839	114,404	97,985	On-road	LHD45	0.00
tru Tire Service Truck	CAT 745C	EQP18	511	381	1,960	0	9,798	143,005		Non-road		0.01
tru LowBoy	CAT 777G	EQP19	1,025	764	644	0	9,667	141,088		Non-road		0.01
for Forklift	CAT DP160N	EQP20	124	92	5,226	1	10,452	152,539		Non-road		0.02
tel(Telehandler	CAT TH514D	EQP21	100	75	2,613	0	7,839	114,404		Non-road		0.03
va Man Van 4x4	Sprinter 4x4	EQP22	188	140	9,798	2	9,798	143,005	244,962	On-road	LHD<=10K	0.01
pic Pickup Truck (4x4)	F250 XL	EQP23	475	354	72,819	11	43,691	637,661	1,820,476	On-road	LHD45	0.00
lig Light Plant	Allmand Maxi	EQP24	14	10	39,279	6	31,423	458,608		Non-road		0.06
tru Rock Spreader	CAT 777G	EQP25	1,025	764	1,956	0	29,342	428,232		Non-road		0.01

[1] *(Perpetua 2021a)* 6,157,311

[2] *(Caterpillar 2016c)/Manufacturer specifications*

[3] *Based on:* *137,000 BTU/gal* *AP-42, App. A (Diesel)* *7,000 BTU/hp-hr* *AP-42, Sec. 3.3, (Diesel)*

[4] *Based on the following average speeds (mph):* *(Midas Gold 2018e)*

Stemming Truck	*F-650*	*25*	420,355
Mechanics Truck	*F-650*	*25*	146,321
ANFO Truck	*CAT CT660*	*20*	141,211
Tire Service Truck	*CAT 745C*	*20*	
LowBoy	*CAT 777G*	*15*	
Man Van 4x4	*Sprinter 4x4*	*25*	
Pickup Truck (4x4)	*F250 XL*	*25*	
Flatbed Truck	*F-350*	*25*	

[5] *On-road vehicle codes and descriptions provided in MOVES2014a emission factors table (EPA 2015)*

Conversions

1.341 hp/kW

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 11 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Mobile Equipment (Tailpipes)

Operating schedule 355 day/yr 24 hr/day

Equipment MachineSpecs

EPA Non-Road Standards

ID	Equipment Type	Model[1] Year	Power Category	EPA Tier	Lookup ID	MOVES Class ID	EPA Non-Road Standards (g/kW-hr)[2] PM	CO	NOX	VOC
EQP1	Drill	>2015	kW>560	4	T4-kW>560 2015		0.04	3.5	3.5	0.19
EQP2	Loader	≥2018	kW>560	4	T4-kW>560 2015		0.04	3.5	3.5	0.19
EQP3	Shovel	≥2018	kW>560	4	T4-kW>560 2015		0.04	3.5	3.5	0.19
EQP4	Haul Truck	≥2018	kW>560	4	T4-kW>560 2015		0.04	3.5	3.5	0.19
EQP5	Dozer	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015		0.02	3.5	0.4	0.19
EQP6	Dozer	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015		0.02	3.5	0.4	0.19
EQP7	Grader	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015		0.02	3.5	0.4	0.19
EQP8	Water Truck	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015		0.02	3.5	0.4	0.19
EQP9	Loader	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015		0.02	3.5	0.4	0.19
EQP10	Haul Truck	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015		0.02	3.5	0.4	0.19
EQP11	Drill	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015		0.02	3.5	0.4	0.19
EQP12	Excavator	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015		0.02	3.5	0.4	0.19
EQP13	Blaster Truck	>2015			No Standard	MHD				
EQP14	Support Truck	>2015			No Standard	MHD				
EQP15	ANFO Truck	>2015			No Standard	HHD				
EQP16	Support Truck	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015		0.02	3.5	0.4	0.19
EQP17	Support Truck	>2015			No Standard	LHD45				
EQP18	Support Truck	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015		0.02	3.5	0.4	0.19
EQP19	LowBoy	>2015	kW>560	4	T4-kW>560 2015		0.04	3.5	3.5	0.19
EQP20	Forklift	>2015	75≤kW<130, Ph-in	4	T4-56≤kW<130 2015		0.02	5	0.4	0.19
EQP21	Telehandler	>2015	75≤kW<130, Ph-in	4	T4-56≤kW<130 2015		0.02	5	0.4	0.19
EQP22	Support Truck	>2015			No Standard	LHD<=1(				
EQP23	Support Truck	>2015			No Standard	LHD45				
EQP24	Light Plant	>2015	8≤kW<19	4	T4-8≤kW<19 2015		0.4	6.6	7.5	7.5
EQP25	Rock Spreader	>2015	kW>560	4	T4-kW>560 2015		0.04	3.5	3.5	0.19

(1) *(Midas Gold 2017h)*

(2) *(CFR 2018a)*

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 12 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Mobile Equipment (Tailpipes) - continued
Fuel Sulfur-Content Based SO2 Emission Factor

Fuel Sulfur-Content	0.0015%		*Non-road diesel specification per 40 CFR 80.510*
Diesel Density	7.05	lb/gal	*AP-42, App. A*
Molecular Wt. of SO2	64.064	lb/lb-mol	
Molecular Wt. of S	32.065	lb/lb-mol	
Diesel Heat Content	137,000	BTU/gal	*AP-42, App. A (Diesel)*
Brake-Specific Fuel Use	7,000	BTU/hp-hr	*AP-42, Sec. 3.3, (Diesel)*

SO2 emission factor:

$$0.000011 \frac{\text{lb/hp-hr}}{} = \frac{0.0015\ \%\ \text{lb S}}{\text{lb Fuel}} \times \frac{7.05\ \text{lb Fuel}}{\text{gal Fuel}} \times \frac{64.064\ \text{lb SO2}}{32.065\ \text{lb S}} \times \frac{\text{gal Fuel}}{137{,}000\ \text{BTU}} \times \frac{7{,}000\ \text{BTU}}{\text{hp-hr}}$$

$$0.006567 \frac{\text{g/kW-hr}}{} = \frac{0.000011\ \text{lb}}{\text{hp-hr}} \times \frac{1.341\ \text{hp}}{\text{kW}} \times \frac{453.593\ \text{g}}{\text{lb}}$$

EPA MOVES 2014a Emission Factors[1]

		Emission Factor (g/VMT)[2]						
Vehicle Class	Description	PM	PM10	PM2.5	CO	NOX	VOC	SO2
LHD<=10K	Passenger Truck 8.5k-10k lb, Diesel	0.178	0.178	0.086	1.322	2.281	0.241	0.006
LHD45	Single Unit Truck 14k-19.5k lb, Diesel	0.589	0.589	0.291	1.867	4.940	0.685	0.011
MHD	Single Unit Truck 19.5k-33k lb, Diesel	0.797	0.797	0.381	2.170	5.684	0.841	0.011
HHD	Single Unit Truck >33k lb, Diesel	1.169	1.169	0.461	2.313	7.324	0.510	0.011

[1] *MOVES 2014a run dated 2017-09-25*
[2] *PM = PM10*

EPA Engine Certification Data

					Emission Factor (g/kW-hr)					
ID	Lookup ID	Engine Description			PM	PM10	PM2.5	CO	NOX	VOC
EQP4	EPA_Cert4	CAT 785D	1,450	hp [1]	0.02	0.02	0.02	0.8	2.7	0.06

[1] *(CARB 2020), Engine family No. MCPXL78.1NVF*

Conversions

1.341 hp/kW
453.593 g/lb

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 13 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Mobile Equipment (Tailpipes) - continued

Final Emission Factors

ID	Lookup	PM	PM10	PM2.5	CO	NOX	VOC	SO2	EF Unit	Final EF	Activity	
EQP1	T4-kW>560 2015	0.04	0.04	0.04	3.50	3.50	0.19	0.007	g/kW-hr	*EPA_NRS*	11,651,153	kW-hr/yr
EQP2	T4-kW>560 2015	0.04	0.04	0.04	3.50	3.50	0.19	0.007	g/kW-hr	*EPA_NRS*	2,158,765	kW-hr/yr
EQP3	T4-kW>560 2015	0.04	0.04	0.04	3.50	3.50	0.19	0.007	g/kW-hr	*EPA_NRS*	8,639,735	kW-hr/yr
EQP4	EPA_Cert4	0.02	0.02	0.02	0.80	2.70	0.06	0.007	g/kW-hr	*EPA_CERT*	41,299,459	kW-hr/yr
EQP5	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	7,195,197	kW-hr/yr
EQP6	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	1,696,408	kW-hr/yr
EQP7	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	1,667,707	kW-hr/yr
EQP8	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	1,061,056	kW-hr/yr
EQP9	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	1,400,266	kW-hr/yr
EQP10	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	5,312,563	kW-hr/yr
EQP11	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	714,995	kW-hr/yr
EQP12	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	1,686,702	kW-hr/yr
EQP13	MHD	0.80	0.80	0.38	2.17	5.68	0.84	0.011	g/VMT	*EPA_MOVES2014a*	40,827	VMT/yr
EQP14	MHD	0.80	0.80	0.38	2.17	5.68	0.84	0.011	g/VMT	*EPA_MOVES2014a*	284,858	VMT/yr
EQP15	HHD	1.17	1.17	0.46	2.31	7.32	0.51	0.011	g/VMT	*EPA_MOVES2014a*	65,323	VMT/yr
EQP16	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	1,857,867	kW-hr/yr
EQP17	LHD45	0.59	0.59	0.29	1.87	4.94	0.68	0.011	g/VMT	*EPA_MOVES2014a*	97,985	VMT/yr
EQP18	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	143,005	kW-hr/yr
EQP19	T4-kW>560 2015	0.04	0.04	0.04	3.50	3.50	0.19	0.007	g/kW-hr	*EPA_NRS*	141,088	kW-hr/yr
EQP20	T4-56≤kW<130 2015	0.02	0.02	0.02	5.00	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	152,539	kW-hr/yr
EQP21	T4-56≤kW<130 2015	0.02	0.02	0.02	5.00	0.40	0.19	0.007	g/kW-hr	*EPA_NRS*	114,404	kW-hr/yr
EQP22	LHD<=10K	0.18	0.18	0.09	1.32	2.28	0.24	0.006	g/VMT	*EPA_MOVES2014a*	244,962	VMT/yr
EQP23	LHD45	0.59	0.59	0.29	1.87	4.94	0.68	0.011	g/VMT	*EPA_MOVES2014a*	1,820,476	VMT/yr
EQP24	T4-8≤kW<19 2015	0.40	0.40	0.40	6.60	7.50	7.50	0.007	g/kW-hr	*EPA_NRS*	458,608	kW-hr/yr
EQP25	T4-kW>560 2015	0.04	0.04	0.04	3.50	3.50	0.19	0.007	g/kW-hr	*EPA_NRS*	428,232	kW-hr/yr

Final emission factor options:

Category	EF Unit	Activity Unit	Emission Unit	Multiplier
EPA_CERT	g/kW-hr	kW-hr/yr	ton/yr	1.1E-6
EPA_NRS	g/kW-hr	kW-hr/yr	ton/yr	1.1E-6
EPA_MOVES2014a	g/VMT	VMT/yr	ton/yr	1.1E-6

Conversions

453.593	g/lb	2,000	lb/ton
1.341	hp/kW		

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 14 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Mobile Equipment (Tailpipes) - continued

Emissions by Area

			chk	chk	chk	chk	chk	chk	chk	chk-14	chk	chk	chk	chk
		Equipment	PM	PM10		PM2.5		CO		NOX		SO2		VOC
Area ID	Equipment	Type	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr
PITS	EQP1	Drill	0.51	2.89	0.51	2.89	0.51	10.55	44.95	10.55	44.95	0.02	0.08	2.44
PITS	EQP2	Loader	0.10	0.54	0.10	0.54	0.10	1.96	8.33	1.96	8.33	3.7E-3	0.02	0.45
PITS	EQP3	Shovel	0.38	2.15	0.38	2.15	0.38	7.82	33.33	7.82	33.33	0.01	0.06	1.81
HR	EQP4	Haul Truck	0.91	5.13	0.91	5.13	0.91	8.55	36.42	28.85	122.9	0.07	0.30	2.73
ALL	EQP5	Dozer	0.16	0.89	0.16	0.89	0.16	6.52	27.76	0.74	3.17	0.01	0.05	1.51
ALL	EQP6	Dozer	0.04	0.21	0.04	0.21	0.04	1.54	6.54	0.18	0.75	2.9E-3	0.01	0.36
HR	EQP7	Grader	0.04	0.21	0.04	0.21	0.04	1.51	6.43	0.17	0.74	2.8E-3	0.01	0.35
HR	EQP8	Water Truck	0.02	0.13	0.02	0.13	0.02	0.96	4.09	0.11	0.47	1.8E-3	7.7E-3	0.22
PITS	EQP9	Loader	0.03	0.17	0.03	0.17	0.03	1.27	5.40	0.14	0.62	2.4E-3	0.01	0.29
HR	EQP10	Haul Truck	0.12	0.66	0.12	0.66	0.12	4.81	20.50	0.55	2.34	9.0E-3	0.04	1.11
PITS	EQP11	Drill	0.02	0.09	0.02	0.09	0.02	0.65	2.76	0.07	0.32	1.2E-3	5.2E-3	0.15
PITS	EQP12	Excavator	0.04	0.21	0.04	0.21	0.04	1.53	6.51	0.17	0.74	2.9E-3	0.01	0.35
PITS	EQP13	Blaster Truck	0.04	0.20	0.04	0.10	0.02	0.02	0.10	0.06	0.26	1.1E-4	4.7E-4	0.04
PITS	EQP14	Support Truck	0.25	1.41	0.25	0.67	0.12	0.16	0.68	0.42	1.78	7.8E-4	3.3E-3	0.26
PITS	EQP15	ANFO Truck	0.08	0.47	0.08	0.19	0.03	0.04	0.17	0.12	0.53	1.8E-4	7.7E-4	0.04
HR	EQP16	Support Truck	0.04	0.23	0.04	0.23	0.04	1.68	7.17	0.19	0.82	3.2E-3	0.01	0.39
HR	EQP17	Support Truck	0.06	0.36	0.06	0.18	0.03	0.05	0.20	0.13	0.53	2.7E-4	1.1E-3	0.07
HR	EQP18	Support Truck	3.2E-3	0.02	3.2E-3	0.02	3.2E-3	0.13	0.55	0.01	0.06	2.4E-4	1.0E-3	0.03
HR	EQP19	LowBoy	6.2E-3	0.04	6.2E-3	0.04	6.2E-3	0.13	0.54	0.13	0.54	2.4E-4	1.0E-3	0.03
PROC	EQP20	Forklift	3.4E-3	0.02	3.4E-3	0.02	3.4E-3	0.20	0.84	0.02	0.07	2.6E-4	1.1E-3	0.03
PROC	EQP21	Telehandler	2.5E-3	0.01	2.5E-3	0.01	2.5E-3	0.15	0.63	0.01	0.05	1.9E-4	8.3E-4	0.02
HR	EQP22	Support Truck	0.05	0.27	0.05	0.13	0.02	0.08	0.36	0.14	0.62	3.9E-4	1.7E-3	0.07
HR	EQP23	Support Truck	1.18	6.66	1.18	3.29	0.58	0.88	3.75	2.33	9.91	5.0E-3	0.02	1.37
HR	EQP24	Light Plant	0.20	1.14	0.20	1.14	0.20	0.78	3.34	0.89	3.79	7.8E-4	3.3E-3	3.79
HR	EQP25	Rock Spreader	0.02	0.11	0.02	0.11	0.02	0.39	1.65	0.39	1.65	7.3E-4	3.1E-3	0.09
Total			4.30	24.21	4.30	19.40	3.44	52.35	223.00	56.17	239.29	0.16	0.66	18.01

Subtotals	Equipment	PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	CO_PPH	CO_TPY	NOX_PPH	NOX_TPY	SO2_PPH	SO2_TPY	VOC_TPY
HR	Haul Roads	2.7	14.9	2.7	11.3	2.0	20.0	85.0	33.9	144.4	0.1	0.4	10.3
PITS	Pits	1.4	8.1	1.4	7.0	1.2	24.0	102.2	21.3	90.9	0.0	0.2	5.8
ALL	All	0.2	1.1	0.2	1.1	0.2	8.1	34.3	0.9	3.9	0.0	0.1	1.9
PROC	Process Area	0.0	0.0	0.0	0.0	0.0	0.3	1.5	0.0	0.1	0.0	0.0	0.1
STKP	PC Stockpile	--	--	--	--	--	--	--	--	--	--	--	--
PC	Process PC	--	--	--	--	--	--	--	--	--	--	--	--
Total	Mobile Tailpipes	4.30	24.21	4.30	19.40	3.44	52.35	223.00	56.17	239.29	0.16	0.66	18.01

ALL - All locations except haul roads

Short-term emissions are based on annual emissions divided by 355 day/yr and 24 hr/day.

LT Unit	ST Unit	Multiplier
ton/yr	lb/day	5.634
ton/yr	lb/hr	0.235

Conversions

2,000 lb/ton

453.59 g/lb

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 15 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Mobile Equipment (Tailpipes) - continued

Emission Allocation by Model ID

		Area ID						chk	chk	chk	chk	chk	chk
Model ID	*PITS*	*ALL*	*PROC*	*STKP*	*PC*	Location of Activity	Total Rate ton/yr	PITS	ALL	PROC	STKP	PC
YPP	*PITS*					Yellow Pine Pit	1,183,610	3.5%	-	-	-	-
HFP	*PITS*					Hangar Flats Pit	0	-	-	-	-	-
WEP	*PITS*					West End Pit	32,310,382	96.5%	-	-	-	-
BT	*PITS*					Bradley Tailings	0	-	-	-	-	-
PC					*PC*	Process PC	0	-	-	-	-	-
HFSTKP				*STKP*		Hangar Flats Stockpiles	10,979,700	-	-	-	100.0%	-
LSTKP						Limestone Stockpile	318,000	-	-	-	-	-
HFBF		*ALL*				Hangar Flats Backfill	14,313,788	-	57.9%	-	-	-
TSFEB		*ALL*				Tailings Storage Facility	0	-	-	-	-	-
YPBF		*ALL*				Yellow Pine Backfill	10,426,067	-	42.1%	-	-	-
WEBF		*ALL*				West End Backfill	0	-	-	-	-	-
PROC			*PROC*			Process Area				100.0%		

ALL - All locations except haul roads

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 16 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Mobile Equipment (Tailpipes) - continued

		chk	chk	chk	chk	chk	chk	chk	chk	chk	chk	chk	chk
Emissions by Model ID [1]		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	CO_PPH	CO_TPY	NOX_PPH	NOX_TPY	SO2_PPH	SO2_TPY	VOC_TPY
		PM	PM10		PM2.5		CO		NOX[2]		SO2		VOC
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr
YPP	Mobile Tailpipes	0.05	0.29	0.05	0.25	0.04	0.85	3.61	0.75	3.21	0.00	0.01	0.21
HFP	Mobile Tailpipes	--	--	--	--	--	--	--	--	--	--	--	--
WEP	Mobile Tailpipes	1.39	7.85	1.39	6.76	1.20	23.15	98.61	20.57	87.65	0.04	0.19	5.63
BT	Mobile Tailpipes	--	--	--	--	--	--	--	--	--	--	--	--
PC	Mobile Tailpipes	--	--	--	--	--	--	--	--	--	--	--	--
HFSTKP	Mobile Tailpipes	--	--	--	--	--	--	--	--	--	--	--	--
HFBF	Mobile Tailpipes	0.11	0.64	0.11	0.64	0.11	4.66	19.85	0.53	2.27	0.01	0.04	1.08
TSFEB	Mobile Tailpipes	--	--	--	--	--	--	--	--	--	--	--	--
YPBF	Mobile Tailpipes	0.08	0.47	0.08	0.47	0.08	3.39	14.46	0.39	1.65	0.01	0.03	0.78
WEBF	Mobile Tailpipes	--	--	--	--	--	--	--	--	--	--	--	--
PROC	Mobile Tailpipes	0.01	0.03	0.01	0.03	0.01	0.35	1.47	0.03	0.12	0.00	0.00	0.06
HR	Truck/Grader	2.65	14.94	2.65	11.25	2.00	19.95	85.00	33.90	144.39	0.09	0.40	10.26

(1) *See worksheet ROADS for haul road (HR) emissions by Model ID.*

(2) *NO2 / NOX:* *11%* *(CAPCOA 2011)*

Source Parameters [1]		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	SIG_Z_M	SXINIT_M	SYINIT_M	ANGL_DEG	
		Source	UTM NAD 83		Elev.	Rel. Ht.	S-z	Len X	Len Y	Angle	WCB
Model ID	Activity	Type	E m	N m	m	m	m	m	m	deg	deg
PROC	Process Area	AREA	631,880	4,973,910	1,970	2.22	2.07	400	400	0	

(1) *UTM, Elev. - (Midas Gold 2017e); Rel. Ht., S-z - (EPA 2012); Len X, Len Y, Angle - best-fit equal area rectangle*

Vehicle height (VH):

Average (forklifts) 2.62 m *Model Specs*

Plume Parameter	Calculation	Value (m)	Const.
Plume top (PT)	1.7 x VH	4.45	1.7
Release height	0.5 x PT	2.22	0.5
Sigma-z	PT / 2.15	2.07	2.15

(EPA 2012)

Sample Calculation for Mobile Tailpipes

Plume Parameter	Calculation	Value (m)	Const.
Surface area (SA)	Map	160,000	
Side length (SL)	SA^0.5	400.0	0.5
Sigma-y	SL / 4.3	93.02	4.3

(EPA 2016a)

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 17 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Dozing and Grading

Activity Information

Operating schedule 355 day/yr

Dozer and Grader Fleet

Equipment Category	Activity	
Dozer	38,974	hr/yr
Grader	15,236	hr/yr
	99,033	VMT/yr

Dozing Emission Factors

Emission Factor Equation	TSP (lb/hr) = 5.7 $(s)^{1.2}/(M)^{1.3}$		*AP-42, Tab. 11.9-1, 07/98, (bulldozing, overburden)*
	PM15 (lb/hr) = 1.0 $(s)^{1.5}/(M)^{1.4}$		*AP-42, Tab. 11.9-1, 07/98, (bulldozing, overburden)*
s = Surface material silt content	4	%	*(Midas Gold 2015)*
M = Material moisture content	7.9	%	*AP-42, Table 11.9-3, 07/98, (bulldozers, overburden)*
TSP(PM)	2.048	lb/hr	
PM15	0.443	lb/hr	

Dozing PM Scaling Factors

PM10	0.75	*AP-42, Tab. 11.9-1, 07/98, (applies to PM15 EF, footnote d)*
PM2.5	0.105	*AP-42, Tab. 11.9-1, 07/98, (applies to TSP EF, footnote e)*

Grading Emission Factors

Emission Factor Equation	TSP (lb/VMT) = 0.04 $(S)^{2.5}$		*AP-42, Tab. 11.9-1, 07/98, (grading)*
	PM15 (lb/VMT) = 0.051 $(S)^{2}$		*AP-42, Tab. 11.9-1, 07/98, (grading)*
S - Grader average speed	6.5	mph	*(Caterpillar 2016c), haul road maintenance*
TSP(PM)	4.309	lb/VMT	
PM15	2.155	lb/VMT	

Grading PM Scaling Factors

PM10	0.6	*AP-42, Tab. 11.9-1, 07/98, (applies to PM15 EF, footnote d)*
PM2.5	0.031	*AP-42, Tab. 11.9-1, 07/98, (applies to TSP EF, footnote e)*

Emission Controls

Grading Periodic application of water and chemical dust suppressant

Control efficiency: 90% *See Onsite Hauling*

Emissions by Area

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	Hg2+P_TPY
		PM	PM10		PM2.5		Hg2+P
Area ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	ton/yr
ALL	Dozing	39.92	36.48	6.47	23.61	4.19	2.4E-05
HR	Grading	21.33	36.07	6.40	3.73	0.66	7.3E-06

Conversions

2,000 lb/ton

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 18 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Dozing and Grading - continued

		chk	chk	chk	chk	chk	chk
Emissions by Model ID		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	Hg2+P_TPY
		PM	PM10		PM2.5		Hg2+P
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	ton/yr
YPP	Dozing	--	--	--	--	--	--
HFP	Dozing	--	--	--	--	--	--
WEP	Dozing	--	--	--	--	--	--
BT	Dozing	--	--	--	--	--	--
PC	Dozing	--	--	--	--	--	--
HFSTKP	Dozing	--	--	--	--	--	--
HFBF	Dozing	23.10	21.10	3.75	13.66	2.43	1.4E-05
TSFEB	Dozing	--	--	--	--	--	--
YPBF	Dozing	16.82	15.37	2.73	9.95	1.77	1.0E-05
WEBF	Dozing	--	--	--	--	--	--
HR	Grading	21.33	36.07	6.40	3.73	0.66	7.3E-06

See worksheet ROADS for haul road (HR) emissions by Model ID.

Source Parameters

Dozing: See Open Pit Drilling and Material Load / Unload for source parameters.

Grading: See Onsite Hauling for source parameters.

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 19 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Water Truck Travel

Activity Information

Operating schedule 355 day/yr

Truck Fleet

Water Truck	Payload Capacity ton	Empty Weight ton	Gross Weight ton	Units	Oper. hr/yr	Reference	Average Weight ton
GF WT745C	45	37	82	1	4,847	*(Caterpillar 2018b)*	59

Average truck speed 15 mph *(Midas Gold 2018e)*

Total vehicle miles traveled (VMT) 72,702 VMT/yr

Emission Factors

Emission factor equation	$E = k(s/12)^a (W/3)^b [(365-P)/365]$				*AP-42, Sec. 13.2.2, Eq. 1a, 11/06*
s = Surface material silt content	4 %				*(Midas Gold 2015)*
W = Mean vehicle weight	59.42 ton				
P = Days/year with ≥0.01 in precip.	120 day/yr				*AP-42 Fig. 13.2.2-1, 11/06*
	PM	PM10	PM2.5		
k = Size-specific empirical constant	4.9	1.5	0.15		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
a = Size-specific empirical constant	0.7	0.9	0.9		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
b = Size-specific empirical constant	0.45	0.45	0.45		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
E = Size-specific emission factor	5.84	1.44	0.14	lb/VMT	

Emission Controls

Periodic application of water and chemical dust suppressant

Control efficiency: 90% *See Onsite Hauling*

Emissions by Area

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	Hg2+P_TPY
		PM	PM10		PM2.5		Hg2+P
Area ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	ton/yr
HR	Water Truck Travel	21.24	29.41	5.22	2.94	0.52	7.2E-06

Source Parameters

See Onsite Hauling for source parameters.

Conversions

2,000 lb/ton

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 20 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Access Roads

Operation Schedule 355 day/yr 24 hr/day

Mobile Equipment Specifications and Activity

Equipment[1]	Equipment Model[2]	ID	Rating[3] hp	Rating kW	Oper.[4] hr/yr	Annual[1] trip/yr	Diesel[5] gal/yr	Output[6] kW-hr/yr	Travel[7] VMT/yr	Equipment Category	On-road Class	
Grader	Cat 160H	MNT1	200	149	2,000	92	6,748	98,492	6,903	Non-road		CAT 18M
Plow Truck	Cat CT660	MNT2	476	355	2,000	92	16,000	--	6,903	On-road	HHD	Cat CT660
Snow Blower	TM42R	MNT3	450	336	2,000	92	15,126	--	6,903	On-road	HHD	Cat CT660
Water Truck	Cat 725C	MNT4	320	239	2,000	92	16,000	233,514	6,903	Non-road		GF WT745C
Binding Agent Truck	Cat 725C	MNT5	320	239	2,000	92	16,000	233,514	6,903	Non-road		CAT 745C
Vibratory Compactor	Cat CS76 XT	MNT6	177	132	2,000	92	10,500	153,244	6,903	Non-road		CAT TH514
Fuel Service Truck	CAT 740B	MNT7	484	361	2,000	92	18,000	262,704	6,903	Non-road		CAT 745C
Rock Rakes	Cat CT660	MNT8	476	355	2,000	92	16,000	--	6,903	On-road	HHD	Cat CT660
Light Vehicles	F-350	MNT9	440	328		3,156	16,915	--	236,807	On-road	LHD45	F-350
Heavy Trucks	Cat CT660 (8X6)	LDEL	476	355		4,989	57,591	--	374,344	On-road	HHD	Cat CT660

Equipment MachineSpecs

(1) *(Midas Gold 2016), Tables 7-1, 12-2, and 12-4. Maintenance trips distributed equally amongst maintenace equipment.*
Heavy trucks include buses, supply, product shipment and trash trucks. Light vehicles include visitor and employee vehicles.

(2) *Similar models by equipment type from (Midas Gold 2017b)*

(3) *(Caterpillar 2016c)/Manufacturer specifications*

(4) *Combined hours, (Midas Gold 2017f)*

(5) *Maintenance equipment based on brake-specific fuel use scaled for similar equipment from (Midas Gold 2017b)*
Light vehicles based on Ford F-350 fuel economy of: 14.0 *mpg (fuelly.com)* *Heavy trucks based on fuel economy c* 6.5 *mpg (ATRI 2016)*

(6) *Based on* 137,000 *BTU/gal* AP-42, App. A (Diesel) 7,000 *BTU/hp-hr* AP-42, Sec. 3.3, (Diesel)

(7) *Based on access road length of:* 37.5 X 2 *mi (roundtrip)* *(Midas Gold 2018c)*

EPA Non-Road Standards

ID	Equipment Type	Model[1] Year	Power Category	EPA Tier	Lookup ID	EPA Non-Road Standards (g/kW-hr)[2] PM	CO	NOX	VOC
MNT1	Grader	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015	0.02	3.5	0.4	0.19
MNT2	Truck				No Standard				
MNT3	Truck				No Standard				
MNT4	Truck	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015	0.02	3.5	0.4	0.19
MNT5	Truck	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015	0.02	3.5	0.4	0.19
MNT6	Compactor	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015	0.02	3.5	0.4	0.19
MNT7	Truck	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015	0.02	3.5	0.4	0.19
MNT8	Truck				No Standard				
MNT9	Light Truck				No Standard				
LDEL	Truck				No Standard				

(1) *(Midas Gold 2017h)*

(2) *(CFR 2018a)*

Final Emission Factors

ID	Lookup	PM	PM10	PM2.5	CO	NOX	VOC	SO2	EF Unit	Final EF	Activity	
MNT1	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.01	g/kW-hr	*EPA_NRS*	98,492	kW-hr/yr
MNT2	HHD	1.17	1.17	0.46	2.31	7.32	0.51	0.01	g/VMT	*EPA_MOVES2014a*	6,903	VMT/yr
MNT3	HHD	1.17	1.17	0.46	2.31	7.32	0.51	0.01	g/VMT	*EPA_MOVES2014a*	6,903	VMT/yr
MNT4	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.01	g/kW-hr	*EPA_NRS*	233,514	kW-hr/yr
MNT5	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.01	g/kW-hr	*EPA_NRS*	233,514	kW-hr/yr
MNT6	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.01	g/kW-hr	*EPA_NRS*	153,244	kW-hr/yr
MNT7	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.01	g/kW-hr	*EPA_NRS*	262,704	kW-hr/yr
MNT8	HHD	1.17	1.17	0.46	2.31	7.32	0.51	0.01	g/VMT	*EPA_MOVES2014a*	6,903	VMT/yr
MNT9	LHD45	0.59	0.59	0.29	1.87	4.94	0.68	0.01	g/VMT	*EPA_MOVES2014a*	236,807	VMT/yr
LDEL	HHD	1.17	1.17	0.46	2.31	7.32	0.51	0.01	g/VMT	*EPA_MOVES2014a*	374,344	VMT/yr

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 21 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Access Roads - continued
Mobile Equipment Tailpipe Emissions
Emissions by Area

			chk	chk	chk	chk	chk	chk	chk	chk	chk	chk	chk	chk
		Equipment	PM	PM10		PM2.5		CO		NOX		SO2		VOC
Area ID	Equipment	Type	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr
ACCRD	MNT1	Grader	2.2E-3	0.01	2.2E-3	0.01	2.2E-3	0.09	0.38	0.01	0.04	1.7E-4	7.1E-4	0.02
ACCRD	MNT2	Plow Truck	8.9E-3	0.05	8.9E-3	0.02	3.5E-3	4.1E-3	0.02	0.01	0.06	1.9E-5	8.1E-5	3.9E-3
ACCRD	MNT3	Snow Blower	8.9E-3	0.05	8.9E-3	0.02	3.5E-3	4.1E-3	0.02	0.01	0.06	1.9E-5	8.1E-5	3.9E-3
ACCRD	MNT4	Water Truck	5.1E-3	0.03	5.1E-3	0.03	5.1E-3	0.21	0.90	0.02	0.10	4.0E-4	1.7E-3	0.05
ACCRD	MNT5	Binding Agent Truck	5.1E-3	0.03	5.1E-3	0.03	5.1E-3	0.21	0.90	0.02	0.10	4.0E-4	1.7E-3	0.05
ACCRD	MNT6	Vibratory Compactor	3.4E-3	0.02	3.4E-3	0.02	3.4E-3	0.14	0.59	0.02	0.07	2.6E-4	1.1E-3	0.03
ACCRD	MNT7	Fuel Service Truck	5.8E-3	0.03	5.8E-3	0.03	5.8E-3	0.24	1.01	0.03	0.12	4.5E-4	1.9E-3	0.06
ACCRD	MNT8	Rock Rakes	8.9E-3	0.05	8.9E-3	0.02	3.5E-3	4.1E-3	0.02	0.01	0.06	1.9E-5	8.1E-5	3.9E-3
ACCRD	MNT9	Light Vehicles	0.15	0.87	0.15	0.43	0.08	0.11	0.49	0.30	1.29	6.4E-4	2.7E-3	0.18
ACCRD	LDEL	Heavy Trucks	0.48	2.72	0.48	1.07	0.19	0.22	0.95	0.71	3.02	1.0E-3	4.4E-3	0.21
Total			0.68	3.86	0.68	1.68	0.30	1.24	5.28	1.15	4.91	0.00	0.01	0.61
Subtotals	Equipment		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	CO_PPH	CO_TPY	NOX_PPH	NOX_TPY	SO2_PPH	SO2_TPY	VOC_TPY
ACCRD	Access Roads		0.68	3.86	0.68	1.68	0.30	1.24	5.28	1.15	4.91	0.00	0.01	0.61
Total			0.68	3.86	0.68	1.68	0.30	1.24	5.28	1.15	4.91	0.00	0.01	0.61

LT Unit	ST Unit	Multiplier
ton/yr	lb/day	5.634
ton/yr	lb/hr	0.235

Grading
Operation 2,000 hr/yr
13,000 VMT/yr

Grading Emission Factors

Emission Factor Equation	TSP (lb/VMT) = 0.04 $(S)^{2.5}$	*AP-42, Tab. 11.9-1, 07/98, (grading)*
	PM15 (lb/VMT) = 0.051 $(S)^{2}$	*AP-42, Tab. 11.9-1, 07/98, (grading)*
S - Grader average speed	6.5 mph	*(Caterpillar 2016c), haul road maintenance*
TSP(PM)	4.309 lb/VMT	
PM15	2.155 lb/VMT	

Grading PM Scaling Factors

PM10	0.6	*AP-42, Tab. 11.9-1, 07/98, (applies to PM15 EF, footnote d)*
PM2.5	0.031	*AP-42, Tab. 11.9-1, 07/98, (applies to TSP EF, footnote e)*

Emission Controls Periodic application of water and chemical dust suppressant
Control efficiency: 90% *See Onsite Hauling*

Emissions by Area

		PM	PM10		PM2.5		Hg2+P
Area ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	ton/yr
ACCRD	Grading	2.80	7.89	1.40	0.49	0.09	2.5E-08

Conversions

2,000	lb/ton
453.593	g/lb
1.341	hp/kW

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 22 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Access Roads - continued

Vehicle Travel Dust

Fleet

Equipment Type	Model	Empty Weight[(1)] ton	Gross Weight[(1)] ton	Average Weight ton	Travel mi/yr	
Grader	Cat 160H	17.2	17.2	17.2	6,903	*Grader emissions calculated separately*
Plow Truck	Cat CT660	8.2	26.6	17.4	6,903	
Snow Blower	TM42R	14.8	18.0	16.4	6,903	
Water Truck	Cat 725C	25.6	51.6	38.6	6,903	
Binding Agent Truck	Cat 725C	25.6	51.6	38.6	6,903	
Vibratory Compactor	Cat CS76 XT	19.2	20.8	20.0	6,903	
Fuel Service Truck	CAT 740B	37.6	81.1	59.4	6,903	
Rock Rakes	Cat CT660	8.2	26.6	17.4	6,903	
Light Vehicles	F-350	4.0	7.9	6.0	236,807	
Heavy Trucks	Cat CT660 (8X6)	10.1	34.5	22.3	374,344	

(1) *(Caterpillar 2016c)/Manufacturer specifications*

Total vehicle miles traveled (VMT) 659,473 VMT/yr *Excluding grader*

Emission Factors

Emission factor equation	$E = k(s/12)^a (W/3)^b [(365-P)/365]$	*AP-42, Sec. 13.2.2, Eq. 1a, 11/06*
s = Surface material silt content	4 %	*(Midas Gold 2015)*
W = Mean vehicle weight	17 ton	*Weighted average weight, excluding grader*
P = Days/year with ≥0.01 in precip.	120 day/yr	*AP-42 Fig. 13.2.2-1, 11/06*

	PM	PM10	PM2.5		
k = Size-specific empirical constant	4.9	1.5	0.15		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
a = Size-specific empirical constant	0.7	0.9	0.9		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
b = Size-specific empirical constant	0.45	0.45	0.45		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
E = Size-specific emission factor	3.33	0.82	0.08	lb/VMT	

Emission Controls

Periodic application of water and chemical dust suppressant

Control efficiency: 90% *See Onsite Hauling*

Emissions by Area

Area ID	Activity	PM ton/yr	PM10 lb/day	PM10 ton/yr	PM2.5 lb/day	PM2.5 ton/yr	Hg2+P ton/yr
ACCRD	Access Roads	109.70	151.87	26.96	15.19	2.70	9.9E-07

Source Parameters

See Onsite Hauling for source parameters.

Conversions

2,000 lb/ton

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 23 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Access Roads - continued

Emissions by Area

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	CO_PPH	CO_TPY	NOX_PPH	NOX_TPY	SO2_PPH	SO2_TPY	VOC_TPY	Hg2+P_TPY
		PM	PM10		PM2.5		CO		NOX		SO2		VOC	Hg2+P
Area ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr	ton/yr
ACCRD	Access Roads	113.18	163.62	29.04	17.36	3.08	1.24	5.28	1.15	4.91	0.003	0.01	0.61	1.0E-06

Source Parameters [1]

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	SIG_Y_M	SIG_Z_M
		Source	UTM NAD 83		Elev.	Rel. Ht.	S-y	S-z
Model ID	Activity	Type	E m	N m	m	m	m	m
ACCRD	Access Roads	VOLUME	*See worksheet: HR Grid*			2.98	5.63	2.77

[1] *UTM, Elev. - (Midas Gold 2017e); Rel. Ht., Sy, Sz - (EPA 2012)*

Vehicle	Height		
Average	3.5	m	
Grader	3.7	m	
HD Truck	3.6	m	
LD Truck	3.2	m	
Road width (RW)	6.1	m	*(Midas Gold 2016), Fig. 7-2*
Road length	60377.56	m	*(Midas Gold 2018c)*

Plume Parameter	Calculation	Value (m)	Const.
Plume top (PT) - unpaved	1.7 x VH	5.95	1.7
Release height - unpaved	0.5 x PT	2.98	0.5
Plume width (PW)	RW + 6 m	12.096	6
Sigma-z - unpaved	PT / 2.15	2.77	2.15
Sigma-y	PW / 2.15	5.63	2.15

(EPA 2012)

Conversions

2,000	lb/ton
3.28	ft/m
12	in/ft

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 24 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Wind Erosion

Activity Information

Operating schedule 355 day/yr

Erodible Area

Model ID	Location of Activity	Surface Type	Total Rate ton/yr	Erodible Area (acre/yr)[3] Flat	Pile	Surface Footprint acre
HFSTKP	Hangar Flats Stockpiles	Pile	10,979,700		1,095	26
LSTKP	Limestone Stockpile	Pile	318,000		32	2
HFBF	Hangar Flats Backfill	Pile	14,313,788		1,427	28
TSFEB	Tailings Storage Facility Emban	Pile	--		--	171
YPBF	Yellow Pine Backfill	Pile	10,426,067		1,039	52
WEBF	West End Backfill	Pile	--		--	--
BT	Bradley Tailings	Flat		66		66
TSF	Tailings Storage Facility	Flat		331		331
HR	Haul Roads [1]	Flat		628		182
ACCRD	Access Roads [2]	Flat		91		91

[1] *Based on total haul road length of* 27,700 *m* *(Midas Gold 2017e)* *and width of* 26.5 *m* *(Midas Gold 2016), Fig. 9-1*

[2] *Based on total access road length of* 60377.56 *m* *(Midas Gold 2017e)* *and width of* 6.1 *m* *(Midas Gold 2016), Fig. 7-2*

[3] *Pile surface area calculations:*

Truck dump (TD) size	131.1	ton	
Material density	187.8	lb/ft^3	*(Midas Gold 2017b), average*
	0.094	ton/ft^3	
Material specific volume	10.7	ft^3/ton	
TD volume (V)	1,397	ft^3	
Conical surface calculations			
Side slope	38	deg	
	0.7	rad	
Conical surface area (SA)	Π × r × (h^2 + r^2)^0.5		
Conical volume (V)	(Π × h × r^2) ÷ 3		
Conical base radius	r =	s × cos(slope)	
Conical height	h =	s × sin(slope)	
Sloped side length	s =	(h^2 + r^2)^0.5	
Solution of conical volume equation			
Replacing h and r with s × sin(slope) and s × cos(slope), respectively:			
s = [3 × V/(pi × sin(slope) × cos^2(slope)]^(1/3)	15.2	ft	
r	12.0	ft	
h	9.3	ft	
SA	569	ft^2	
	0.013	acre	
	1.0E-4	acre/ton-TD	

Scaling Factors

PM10	0.5	*AP-42, Pg. 13.2.5-3, 11/06*
PM2.5	0.075	*AP-42, Pg. 13.2.5-3, 11/06*

Conversions

4,047	m^2/acre
43,560	ft^2/acre
1609.3	m/mi

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 25 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Wind Erosion - continued ***Wind erosion potential calculations based on Aug-2014 through Aug-2015 Midas Gold on site meteorological data***

Stockpile Surface Wind Erosion Event Emission Calculations

Based on 1 acre/yr 8,760 hr/yr 0.00011 acre/hr

Threshold Wind Event	Date / Hour	u10 (m/s) (1)	u10+ (m/s) (2)	u* (m/s) ID-A (3)	u* (m/s) ID-B (3)	u* (m/s) ID-C (3)	Hours Elapsed ID-A (4)	Hours Elapsed ID-B (4)	Hours Elapsed ID-C (4)	Erodible Surface Area (acre) ID-A (5)	Erodible Surface Area (acre) ID-B (5)	Erodible Surface Area (acre) ID-C (5)
0	6/12/2014 13:00											
1	9/25/2014 14:00	9.810	11.772	1.059	0.706	0.235	2,521	2,521	2,521	0.03453	0.1381	0.1151
2	11/29/2014 12:00	10.050	12.060	1.085	0.724	0.241	1,558	4,079	4,079	0.02134	0.2235	0.1863
3	12/11/2014 03:00	10.000	12.000	1.080	0.720	0.240	279	4,358	4,358	0.00382	0.2388	0.1990
4	12/11/2014 14:00	9.470	11.364	1.023	0.682	0.227	11	4,369	4,369	0.00015	0.2394	0.1995
5	2/5/2015 14:00	10.400	12.480	1.123	0.749	0.250	1,344	5,713	5,713	0.01841	0.3130	0.2609
6	2/6/2015 07:00	10.270	12.324	1.109	0.739	0.246	17	5,730	5,730	0.00023	0.3140	0.2616
7	8/21/2015 14:00	9.610	11.532	1.038	0.692	0.231	4,711	10,441	10,441	0.06453	0.5721	0.4768
8	8/21/2015 15:00	9.530	11.436	1.029	0.686	0.229	1	10,442	10,442	0.00001	0.5722	0.4768
Flat Surface Wind Erosion Event Emission Calculations				Flat			Flat			Flat		
N/A	No wind events above 16.04 m/s											

Stockpile Surface Wind Erosion Event Emission Calculations - continued

Threshold Wind Event	Erosion Potential (lb/acre)[1] ID-A (6)	ID-B (6)	ID-C (6)	PM Emissions (lb) ID-A (7)	ID-B (7)	ID-C (7)	Total (8)	PM10 (lb) Total (9)	PM2.5 (lb) Total (10)
1	9.61	--	--	0.332	--	--	0.332	0.166	0.025
2	16.80	--	--	0.359	--	--	0.359	0.179	0.027
3	15.25	--	--	0.058	--	--	0.058	0.029	0.004
4	0.62	--	--	9.34E-5	--	--	9.34E-5	4.67E-5	7.00E-6
5	28.5	--	--	0.525	--	--	0.525	0.263	0.039
6	24.00	--	--	0.006	--	--	0.006	0.003	0.000
7	4.15	--	--	0.268	--	--	0.268	0.134	0.020
8	2.11	--	--	2.88E-5	--	--	2.88E-5	1.44E-5	2.16E-6
Stockpile Subtotal							1.548	0.774	0.116
Flat Surface Wind Erosion Event Emission Calculations - continued									
N/A	No wind events above 16.04 m/s						--	--	--

Zero denotes winds did not exceed the threshold for a surface regime.

Final Emission Factors (lb/acre-yr)

Surface Type	PM	PM10	PM2.5
Pile	1.55	0.77	0.12
Flat	--	--	--

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 26 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Wind Erosion - continued

Stockpile Surface Wind Erosion Event Emission Calculations - Notes

(1) u10 = wind speed at 10 meters reference height, m/s

(2) u10+ = fastest-mile wind speed, m/s
Based on hourly to fastest-mile wind speed conversion factor of 1.2 *(EPA 1994)*

(3) Pile: u* = friction velocity, m/s = (us/ur) × 0.1 × u10+ *AP-42, Sec. 13.2.5, Eqs. 6 & 7, 11/06*

Area ID	A	B	C
(us/ur)	0.9	0.6	0.2

AP-42, Page 13.2.5-10, 11/06

Flat surface:
u* = friction velocity, m/s = 0.053 × u10+ *AP-42, Sec. 13.2.5, Eq. 4, 11/06*

(4) Hours elapsed since previous wind erosion event

(5) Erodible surface area = hours elapsed since previous erosion event × hourly erodible surface area (acre) × surface regime area fraction Surface regime area fractions:

Area ID	A	B	C
% Surface	0.12	0.48	0.4

AP-42, Page 13.2.5-10, 11/06

(6) Erosion potential, g/m^2, = P = 58(u* - ut*)^2 + 25(u* - ut*); P = 0 for u* ≤ ut*
where, ut* = threshold friction velocity = 1.02 m/s *AP-42, Page 13.2.5-5 (overburden), 11/06*
P converted to lb/acre by multiplying with: 0.002205 lb/g and 4,046.86 m^2/acre
Solving u* = (us/ur) × 0.1 × u10+ for u10, when u* = ut* = 1.02 m/s and u10+ = u* × 1.2
yields the following minimum wind speeds to disturb the each stockpile surface regime:

ID-A	9.44 m/s
ID-B	14.17 m/s
ID-C	42.50 m/s

The threshold wind speed to disturbe flat surfaces is 1.02/0.053/1.2
Flat surface 16.04 m/s
The maximum hourly wind speed in the onsite data is 10.4 m/s, which is less than the threshold wind speeds to cause a disturbance of stockpile regimes ID-B and ID-C, and flat surfaces.

(7) PM emissions, lb = P (lb/acre) × erodible surface area (acre)

(8) Total PM emissions, lb = PM (ID-A), lb + PM (ID-B), lb + PM(ID-C), lb

(9) Total PM10 emissions, lb = total PM emissions, lb × PM10 scaling factors of 0.5 *AP-42, Page 13.2.5-3, 11/06*

(10) Total PM2.5 emissions, lb = total PM emissions, lb × PM2.5 scaling factors of 0.075 *AP-42, Page 13.2.5-3, 11/06*

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 27 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Wind Erosion - continued

Emissions by Model ID

				chk PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	Hg2+P_TPY
	Location of	Control[1]		PM	PM10		PM2.5		Hg2+P
Model ID	Activity		Type	ton/yr	lb/day	ton/yr	lb/day	ton/yr	ton/yr
HFSTKP	Hangar Flats Stockp	--	Pile	0.847	2.386	0.424	0.358	0.064	5.1E-07
LSTKP	Limestone Stockpile	--	Pile	0.025	0.069	0.012	0.010	0.002	1.5E-08
HFBF	Hangar Flats Backfil	--	Pile	1.104	3.111	0.552	0.467	0.083	6.6E-07
TSFEB	Tailings Storage Faci	--	Pile	--	--	--	--	--	--
YPBF	Yellow Pine Backfill	--	Pile	0.804	2.266	0.402	0.340	0.060	4.8E-07
WEBF	West End Backfill	--	Pile	--	--	--	--	--	--
BT	Bradley Tailings	--	Flat	--	--	--	--	--	--
TSF	Tailings Storage Faci	67%	Flat	--	--	--	--	--	--
HR	Haul Roads	90%	Flat	--	--	--	--	--	--
ACCRD	Access Roads	90%	Flat	--	--	--	--	--	--
Total	Wind Erosion			2.780	7.832	1.390	1.175	0.209	1.7E-06

[1] *TSF - maximum one-third of the total surface exposed (Midas Gold 2017g)*
Roads - see note on page 6

Source Parameters [1]

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	SIG_Z_M	SXINIT_M	SYINIT_M	ANGL_DEG
		Source	UTM NAD 83		Elev.	Rel. Ht.	S-z	Len X	Len Y	Angle
Model ID	Activity	Type	E m	N m	m	m	m	m	m	deg
TSF	Tailings Storage Facility	AREA	628,496	4,971,000	2,117	0.00	0.00	1157	1157	0

[1] *UTM, Elev. - (Midas Gold 2017e); Rel. Ht., S-z - (EPA 2012); Len X, Len Y, Angle - best-fit equal area rectangle*

Conversions
2,000 lb/ton

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 28 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Surface Exploration

Activity Information

Operating schedule	355	day/yr	24	hr/day	
Duration	14	yr	168	mo	*(Midas Gold 2018b)*
Construction disturbance	13	acres	0.08	acre/mo	*(Midas Gold 2016), p. 13-1*
Total wet drilling (maximum)	700	holes	50	holes/yr	*(Midas Gold 2016), p. 13-1*
Core diameter	2.5	in			*(Midas Gold 2018j)*
Average core length	800	ft			*(Midas Gold 2016), p. 13-2*
Core volume	27.3	ft^3			
Average material density	158.7	lb/ft^3			*(Midas Gold 2017b)*
Average mass	2.16	ton/hole	108.2	ton/yr	

Construction Emission Calculations

Emission Factors

PM	1.2	ton/acre	per month of activity	*AP-42, Page 13.2.3-1, 1/95*

PM Scaling Factors

PM10	0.35	*AP-42, Sec. 13.2.4, Pg. 4, 11/06*
PM2.5	0.053	*AP-42, Sec. 13.2.4, Pg. 4, 11/06*

Construction Emissions

Activity	PM	PM10		PM2.5		Hg2+P
	ton/yr	lb/day	ton/yr	lb/day	ton/yr	ton/yr
Drill Pad and Temporary Road Construction	1.1	2.2	0.4	0.3	0.1	6.7E-07

Wet Drilling Emission Calculations

Emission Factors

PM10	8.0E-5	lb/ton (material blasted)	*AP-42, Table 11.19.2-2 (wet drilling), Rev. 8/04*

PM Scaling Factors

PM	0.74	*AP-42, Sec. 13.2.4-4, 11/06*
PM10	0.35	*AP-42, Sec. 13.2.4-4, 11/06*
PM2.5	0.053	*AP-42, Sec. 13.2.4-4, 11/06*

Blast-to-Drill Volume Ratio[(1)] 400 blast volume/drilled volume

[(1)] *Dyno Nobel 2010 "Blasting and Explosives Quick Reference Guide" (Ratio of total of blast volume to drilled hole volume)*

Wet Drilling Emissions

Activity	PM	PM10		PM2.5		Hg2+P
	ton/yr	lb/day	ton/yr	lb/day	ton/yr	ton/yr
Wet Drilling	0.004	0.010	0.002	0.001	0.0003	2.2E-09

Conversions

12 in/ft	12 mo/yr
2,000 lb/ton	1.341 hp/kW

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 29 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Surface Exploration - continued

Drill Rig Tailpipe Emission Calculations

Other mobile equipment emissions are included in the Mobile Equipment (Tailpipes) calculations provided on page 14 of this sheet (Midas Gold 2018j)

Drill Specifications and Emission Factors

Equipment[1] Model	Rating[1] hp	Rating kW	Oper.[2] hr/yr	Diesel[3] gal/yr	Output[4] kW-hr/yr	EPA Non-Road Standards (g/kW-hr)[5] PM	CO	NOX	VOC	SO2[6]
CAT MD 6250	872	650.3	12,000	300,000	4,378,396	0.04	3.5	3.5	0.19	0.0066

[1] *Similar to production drill (Midas Gold 2018j)*

[2] *Based on:* 3.3 *ft/hr* *(Midas Gold 2018j)*

[3] *Scaled from production drill*

[4] *Based on:* 137,000 *BTU/gal* *AP-42, App. A (Diesel* 7,000 *BTU/hp-hr* *AP-42, Sec. 3.3, (Diesel)*

[5] *(CFR 2018a)*

[6] *Fuel Sulfur-Content Based SO2 Emission Factor, see page 12 of this sheet*

Drill Tailpipe Emissions

PM	PM10		PM2.5		CO		NOX		SO2		VOC
ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr
0.19	1.09	0.19	1.09	0.19	3.97	16.89	3.97	16.89	0.01	0.03	0.92

Surface Exploration Total Emissions

PM	PM10		PM2.5		CO		NOX		SO2		VOC	Hg2+P_TPY Hg2+P
ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr	ton/yr
1.31	3.29	0.58	1.42	0.25	3.97	16.89	3.97	16.89	0.01	0.03	0.92	6.7E-07

Emissions by Model ID [1]

		chk PM_TPY	chk PM10_PPD	chk PM10_TPY	chk PM2.5_PPD	chk PM2.5_TPY	chk CO_PPH	chk CO_TPY	chk NOX_PPH	chk NOX_TPY	chk SO2_PPH	chk SO2_TPY	chk VOC_TPY	chk Hg2+P_TPY
		PM	PM10		PM2.5		CO		NOX[2]		SO2		VOC	Hg2+P
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr	ton/yr
YPP	Surface Exploration	0.33	0.82	0.15	0.36	0.06	0.99	4.22	0.99	4.22	0.00	0.01	0.23	1.7E-07
HFP	Surface Exploration	0.33	0.82	0.15	0.36	0.06	0.99	4.22	0.99	4.22	0.00	0.01	0.23	1.7E-07
WEP	Surface Exploration	0.33	0.82	0.15	0.36	0.06	0.99	4.22	0.99	4.22	0.00	0.01	0.23	1.7E-07
PROC	Surface Exploration	0.33	0.82	0.15	0.36	0.06	0.99	4.22	0.99	4.22	0.00	0.01	0.23	1.7E-07

[1] *Equally distributed amongst* 4 *locations* *(Midas Gold 2018j)*

Conversions

907,186 g/ton

2,000 lb/ton

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 30 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

Helicopter

Activity Information

Operating schedule	355	day/yr	24 hr/day	
Flight frequency	4	flight/mo		*(Midas Gold 2018h)*
	48	flight/yr		
	1	flight/day, daily maximum		
	1	flight/hr, hourly maximum		

Landing and Takeoff (LTO) Component Durations *AP-42, Vol. II, Table II-1-3 (helicopter) (EPA 1991)*

LTO Component	minute	hour
Idle	7.00	0.12
Takeoff	--	--
Climbout	6.50	0.11
Approach	6.50	0.11

LTO Component Emission Factors (lb/hr) *AP-42, Vol. II, Table II-1-7 (TPE 331-3 GA TP) (EPA 1991)*

LTO Component	PM	CO	NOX	SO2	VOC
Idle	0.3	6.89	0.32	0.11	8.86
Takeoff	0.8	0.35	5.66	0.46	0.05
Climbout	0.6	0.4	4.85	0.41	0.06
Approach	0.6	1.74	2.48	0.25	0.16

Total Emissions [1] ***by Model I***

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	CO_PPH	CO_TPY	NOX_PPH	NOX_TPY	SO2_PPH	SO2_TPY	VOC_TPY
		PM	PM10		PM2.5		CO		NOX		SO2		VOC
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr
HELI	Heliport	0.004	0.165	0.004	0.165	0.004	1.036	0.025	0.831	0.020	0.084	0.002	0.025

Source Parameters [1]

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	SIG_Y_M	SIG_Z_M	Surface	
		Source	UTM NAD 83		Elev.	Rel. Ht.	S-y	S-z	Area	Length
Model ID	Activity	Type	E m	N m	m	m	m	m	m^2	m
HELI	Heliport	VOLUME	632,222	4,973,588	1,996	3.43	9.15	3.19	387	19.7

[1] *UTM, Elev. - (Midas Gold 2017e); Rel. Ht., Sy, Sz - (EPA 2012)*

Helicopter	Height	Reference
Bell 429	4.0 m	*(Bell 2018)*

Plume Parameter	Calculation	Value (m	Const.
Plume top (PT)	1.7 x VH	6.87	1.7
Release height	0.5 x PT	3.43	0.5
Helipad width		19.67	
Sigma-z	PT / 2.15	3.19	2.15
Sigma-y	PW / 2.15	9.15	2.15

(EPA 2012)

Conversions

60	min/hr
2,000	lb/ton

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 31 OF: 31 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 30, 2021

Mining Year 10

TSF Construction

Activity Information

Percent of total activity 0% *(Midas Gold 2018f)*

Operation 355 day/yr

Total Life of Mine Emissions

PM	PM10	PM2.5
ton	ton	ton
91.65	28.08	8.18

Detailed emission calculations provided on sheet: Const, page 2

Construction Emissions by Model ID		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	Hg2+P_TPY
		PM	PM10		PM2.5		Hg2+P
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	ton/yr
TSF	Tailings Storage Facility Construction	--	--	--	--	--	--

Maximum daily emissions based on: 1,000 person crew during peak construction, scaled with an average annual crew of 750

Other construction activity during mine operation is accounted for in the mine equipment usage.

Conversions

2,000 lb/ton

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon/K. Lewis	
	PROJECT NO: 335-21-402/404	PAGE: 1	OF: 5 SHEET: MineHAP
AIR EMISSION CALCULATIONS	SUBJECT: Mining HAP and GHG Emissions	DATE: June 30, 2021	

Mining Year **10**

Hazardous Air Pollutants and Greenhouse Gas Emissions

HAP Emissions Summary

	Emissions	
Pollutant	lb/yr	ton/yr
1,3-Butadiene	10.079	5.0E-3
7-PAH	3.785	1.9E-3
Acetaldehyde	214	0.107
Acrolein	28.926	0.014
Antimony	29.093	0.015
Arsenic	749	0.374
Benzene	741	0.370
Beryllium	4.143	2.1E-3
Biphenyl	0	0
Cadmium	0.982	4.9E-4
Carbon Disulfide	0	0
Chromium	35.192	0.018
Cobalt	5.664	2.8E-3
Cr (VI)	0	0
Cyanide	3,965	1.983
Dichlorobenzene	0	0
Formaldehyde	355	0.178
Hexane	0	0
Hydrogen Chloride	0	0
Lead	13.015	6.5E-3
Manganese	399	0.199
Mercury	7.792	3.9E-3
Naphthalene	0	0
Nickel	4.267	2.1E-3
Phenol	0	0
Phosphorus	803	0.401
POM	180	0.090
Selenium	0.403	2.0E-4
Toluene	287	0.143
Xylene	198	0.099
Total HAP	8,033	4.017
	8,033	
	chk	

GHG Emissions Summary

	$CO2e^{(1)}$
Pollutant	ton/yr
Total GHGs	73,842

(1) *Annex I Parties, 100-year time horizon (UNCC n.d.); (IPCC 2007)*

Conversions

2,000 lb/ton

1.10231 ton/t

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon/K. Lewis
	PROJECT NO: 335-21-402/404	PAGE: 2 OF: 5 SHEET: MineHAP
AIR EMISSION CALCULATIONS	SUBJECT: Mining HAP and GHG Emissions	DATE: June 30, 2021

Mining Year **10**

MINING DUST

Activity Information

Activity	PM ton/yr	TAP Rule ton/yr	210.2 Exclusion	TAP Rule Category
Open Pit Drilling	1.97	1.97	No	Mining
Open Pit Blasting	14.08	14.08	No	Mining
Material Load / Unload	4.62	4.62	No	Mining
Dozing	39.92	39.92	No	Mining
Wind Erosion	2.78	2.78	No	Mining
Surface Exploration	1.12	1.12	No	Mining
TSF Construction	--	0.00	No	Mining
Ore/Development Rock Subtotal	64.49	64.49		
Onsite Hauling	819.13	819.13	No	Mining
Grading	21.33	21.33	No	Mining
Water Truck Travel	21.24	21.24	No	Mining
Haul Road Subtotal	861.71	861.71		
Access Road Grading	2.80	2.80	No	Mining
Access Road Vehicle Travel	109.70	109.70	No	Mining
Access Roads	112.50	112.50		

See Mine Sheet

Haul roads capped with clean rock 49% *(Perpetua 2021h)* %CR

Ore, Watse, and Limestone Dust HAP Concentrations [1] and Emissions

Pollutant	O/DR[1] ppm	AR[2] ppm	CR[3] ppm	O/DR ton/yr	AR ton/yr	HR[4] ton/yr	Emissions lb/yr	Emissions ton/yr
Arsenic	667	2.5	90	0.043	2.8E-4	0.331	749	0.374
Beryllium	3.2	2.2	0.5	2.1E-4	2.5E-4	1.6E-3	4.143	2.1E-3
Cadmium	0.5	0.25	0.5	3.2E-5	2.8E-5	4.3E-4	0.982	4.9E-4
Cobalt	4	3.5	1	2.6E-4	3.9E-4	2.2E-3	5.664	2.8E-3
Chromium	9	11	28	5.8E-4	1.2E-3	0.016	35.192	0.018
Mercury	0.6	0.009	0.07	3.9E-5	1.0E-6	2.9E-4	0.666	3.3E-4
Manganese	299	278.5	41	0.019	0.031	0.149	399	0.199
Nickel	2	2.5	2	1.3E-4	2.8E-4	1.7E-3	4.267	2.1E-3
Lead	8	14.5	2	5.2E-4	1.6E-3	4.4E-3	13.015	6.5E-3
Antimony	23	3.75	6	1.5E-3	4.2E-4	0.013	29.093	0.015
Phosphorus	650	430	60	0.042	0.048	0.311	803	0.401
Selenium	0.4			2.6E-5	0	1.8E-4	0.403	2.0E-4
Dust HAP Total				0.107	0.084	0.830	2,043	1.022

[1] *O/DR: ore and development rock; (Midas Gold 2017c) for all metals but Hg and Se; Hg value from (Midas Gold 2018i); Se value from (Midas Gold 2020)*

[2] *AR: Burntlog access route roadbed materal analyses - 1/2 detection limit used for non-detect analyses (ALS 2018)*

[3] *CR: clean rock - used to cap haul roads outside of the pits and DRSFs - 1/2 detection limit used for non-detect analyses (Perpetua 2021g)*

[4] *HR: haul road - emissions calculated based on 49% of the total VMT occuring on CR for LOM Year 10*

Conversions

2,000 lb/ton

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: K. Lewis
	PROJECT NO: 335-21-402/404	PAGE: 3 OF: 5 SHEET: MineHAP
AIR EMISSION CALCULATIONS	SUBJECT: Mining HAP and GHG Emissions	DATE: June 30, 2021

Mining Year **10**

EXPOSED MINING SURFACE HG EVAPORATION

Fugitive Mercury Flux and Emissions

CAS No.	Pollutant	Source	Area m²	Area ha	Hg Flux µg/m²-yr	Emissions lb/yr	Emissions ton/yr	TAP Rule lb/yr	210.2 Exclusion	TAP Rule Category
		Stockpiles	104,320	10.4	556	0.128	6.4E-5	0.128	No	Mining
		Tailings Embankment	693,889	69.4	76.2	0.116	5.8E-5	0.116	No	Mining
		Tailings	1,338,158	133.8	2,144	6.325	3.2E-3	6.325	No	Mining
		Pits	1,909,675	191.0	132.3	0.557	2.8E-4	0.557	No	Mining
7439976	Mercury					7.126	3.6E-3	7.126		

Fugitive Mercury Emission Factors

Source	Twin Creeks (TC) Hg Flux [1] µg/m²-yr	Twin Creeks (TC) Hg [2] µg/g	Ore Hg Adjusted µg/m²/yr TC	Stibnite Hg Flux [3] µg/m²-yr	Stibnite Hg [4] µg/g
Stockpiles	5,609	33	556	556	0.96
Rock Dumps	768	3.5	76.2	76.2	0.60
Tailings	21,621	33	2,144	2,144	0.96
Pits	1,334	9.5	132	132.3	0.60

[1] *(Eckley 2010)* *Table 1: Hg flux µg/m² -yr*

[2] *(Eckley 2010)* *Table 1: Average Hg flux mg/g: " Stockpiles - high-grade stockpiles, Rock Dumps - waste rock dumps, Tailings - high-grade stockpilese as a surrogate; Pits - pit"*

[3] *(Eckley 2010)* *Figure 2: log(y) = m*log(x) + b*

y = Hg Flux (ng/m² -d)

x = material Hg concentration (µg/g)]

Slope =	*Solar*	*TC*
	Low	*0.59*
	Medium	*0.6*
	High	*0.77*
	Average	*0.65*

[4] *(Midas Gold 2018i) Stockpiles - Ore, Rock Dumps - Rock, Tailings - Ore as a surrogate, Pits - Ore and Rock combined average*

Sample Calculation: m = log (y1/y2) / log(x1/x2)

m=	0.65	unit less
y1=	5,609	µg/m²-yr
x1=	33	µg/m²-yr
x2=	0.96	µg/m²-yr
log(x1/x2)=	1.536243	unit less
log(y1/y2)=	1.003679	unit less
y1/y2=	10.08506	unit less
y2=	556.2	µg/m²-yr

Conversions

2,000	lb/ton					
10,000	m2/ha					
453.593	g/lb					
1,000	ng/µg					
365	day/yr					
0.365	(µg/m²-yr) / (ng/m²-d)	1 ng / m2-d	µg / 1,000 ng	365 d / yr	=	0.365 µg/m2-yr / µg/g

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: K. Lewis
	PROJECT NO: 335-21-402/404	PAGE: 4 OF: 5 SHEET: MineHAP
AIR EMISSION CALCULATIONS	SUBJECT: Mining HAP and GHG Emissions	DATE: June 30, 2021

Mining Year 10

MINING FUGITIVE HCN EVAPORATION

	Description	Dia. ft[1]	pH[1]	Free CN- g/m3[1]	T C[1]	pKa	a0	H	kG[2] m/s	Fa*Fw	Cyanide Emissions g/s	lb/yr	ton/yr	TAP Rule lb/yr	210.2 Exclusion
	Fugitive Sources														
TS	Tailings Maint. Pon	76	7.75	1	3.74	9.803	0.9912	0.0025	1.89E-05	0.641	1.27E-05	0.885	4.4E-4	0.885	No
CI	CN Detox Tank 1	40	8.5	25	25	9.250	0.8490	0.0055	0.000311	0.688	0.002891	201	0.101	201	No
CI	CN Detox Tank 2	40	8.5	25	25	9.250	0.8490	0.0055	0.000311	0.688	0.002891	201	0.101	201	No
CI	CIP Leach Tank 1	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	99.746	0.050	99.746	No
CI	CIP Leach Tank 2	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	99.746	0.050	99.746	No
CI	CIP Leach Tank 3	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	99.746	0.050	99.746	No
CI	CIP Leach Tank 4	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	99.746	0.050	99.746	No
CI	CIL Tank 1	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	173	0.086	173	No
CI	CIL Tank 2	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	173	0.086	173	No
CI	CIL Tank 3	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	173	0.086	173	No
CI	CIL Tank 4	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	173	0.086	173	No
CI	CIL Tank 5	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	173	0.086	173	No
CI	CIL Tank 6	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	173	0.086	173	No
CI	CIP Tank 1	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	16.391	8.2E-3	16.391	No
CI	CIP Tank 2	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	16.391	8.2E-3	16.391	No
CI	CIP Tank 3	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	16.391	8.2E-3	16.391	No
CI	CIP Tank 4	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	16.391	8.2E-3	16.391	No
CI	CIP Tank 5	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	16.391	8.2E-3	16.391	No
CI	CIP Tank 6	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	16.391	8.2E-3	16.391	No
		Acres[1]													
TS	Tails, Aqueous Surfa	110.2	7.75	1	3.74	9.803	0.9912	0.0025	1.89E-05	0.421	0.008845	615	0.307	615	No
TS	Tails, Wet Sediment	110.2							5.31E-08	0.421	0.009961	693	0.346	693	No
TS	Tails, Dry Sediment	110.2							2.33E-08	1	0.010375	721	0.361	721	No
		330.7													
	592018 Cyanide											3,965	1.983	3,965	

(1) *(Midas Gold 2016) (M3 2017c) (M3 2017d)*

(2) *(Card 2009) (EPA 2009) (Schmidt 2010)*

Conversions

8,760	hr/yr	453.59 g/lb	Wind adjustment factor	Fw	1
2,000	lb/ton	3.28084 ft/m			
4,046.86	m2/acre	3,600 s/hr			

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon/K. Lewis
	PROJECT NO: 335-21-402/404	PAGE: 5 OF: 5 SHEET: MineHAP
AIR EMISSION CALCULATIONS	SUBJECT: Mining HAP and GHG Emissions	DATE: June 30, 2021

Mining Year **10**

NONROAD ENGINE TAILPIPE EXHAUST

Activity Information

Mining Mobile Equipment				
Large diesel machinery (> 600 hp)	4,706,986 gal/yr	644,857 MMBtu/yr[1]	*See Mine Sheet*	
Small diesel machinery (≤ 600 hp)	1,750,325 gal/yr	239,795 MMBtu/yr[1]	*See Mine Sheet*	
Access Road Mobile Equipment				
Large diesel machinery (> 600 hp)	-- gal/yr	-- MMBtu/yr[1]	*See Mine Sheet*	
Small diesel machinery (≤ 600 hp)	131,289 gal/yr	17,987 MMBtu/yr[1]	*See Mine Sheet*	

[1] Based on diesel heating value of 137,000 Btu/gal *AP-42, Appendix A, p. A-5, 9/85*

Combustion HAP Emission Factors and Emissions

	Small Engines[1]	Large Engines[2]	Emissions	
Pollutant	lb/MMBtu	lb/MMBtu	lb/yr	ton/yr
1,3-Butadiene	< 3.9E-05	0	10.079	5.0E-3
Acetaldehyde	7.7E-04	2.5E-05	214	0.107
Acrolein	< 9.3E-05	7.9E-06	28.926	0.014
Benzene	9.3E-04	7.8E-04	741	0.370
Formaldehyde	1.2E-03	7.9E-05	355	0.178
Toluene	4.1E-04	2.8E-04	287	0.143
Xylene	2.9E-04	1.9E-04	198	0.099
POM	1.68E-04	2.12E-04	180	0.090
7-PAH	3.43E-06	4.50E-06	3.785	1.9E-3
HAP Total			2,017	1.009

[1] *AP-42, Tab. 3.3-2, 10/96, diesel engines (≤ 600 hp)*

[2] *AP-42, Tabs. 3.4-3 & 3.4-4, 10/96, large diesel engines (> 600 hp)*

Greenhouse Gas Emission Factors [1] and Emissions

	Emission Factor[1]	Emissions	GWP[2]	GWP[3]	CO2e (ton/yr)	
Greenhouse Gas	kg/MMBtu	mt/yr	100-yr	20-yr	100-yr	20-yr
CO2	73.96	66,759	1	1	66,759	66,759
CH4	3.0E-3	2.7	25	62	68	168
N2O	6.0E-4	0.5	298	275	161	149
Total GHG					66,988	67,076

[1] *40 CFR 98 Tab. C-1 (Fuel Oil No. 2) and C-2 (Petroleum Products) (CFR 2018d)*

[2] *40 CFR 98, Table A-1 (12/2014) (CFR 2018d)*

[3] *(IPCC 1995)*

Conversions

2,000 lb/ton

1,000 kg/mt

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 1 OF: 9 SHEET: Const
AIR EMISSION CALCULATIONS	SUBJECT: Construction Activity and Emissions	DATE: June 30, 2021

Mine Construction EmissionsConstruction Year 1

Annual Emissions Summary

Activity	PM ton/yr	PM10 ton/yr	PM2.5 ton/yr	CO ton/yr	NOX ton/yr	SO2 ton/yr	VOC ton/yr	Total HAP ton/yr	CO2e ton/yr
Facility and Infrastructure Construction	37.1	11.4	3.3					0.00	
Power Generation	4.5	4.5	4.5	382.7	85.2	0.59	46.9	9.2	70,573
Access Road	147.5	38.3	4.0	9.4	6.4	0.02	0.9	0.00	3,571
Construction Total	189.1	54.2	11.8	392.1	91.6	0.61	47.8	9.2	74,143

Maximum Daily Emissions Summary[1]

Activity	PM lb/day	PM10 lb/day	PM2.5 lb/day	CO lb/day	NOX lb/day	SO2 lb/day	VOC lb/day	Total HAP lb/day	CO2e lb/day
Facility and Infrastructure Construction	279	85.4	24.9					0.00	
Power Generation	25.2	25.2	25.2	2,156.1	479.9	3.3	264.0	51.7	397,592
Access Road	1,107.9	287.8	30.2	70.3	48.0	0.2	6.7	0.0	26,823
Construction Total	1,411.9	398.5	80.3	2,226.5	527.9	3.5	270.7	51.7	424,414

[1] *Maximum daily emissions based on:* 1,000 *person crew during peak construction, scaled with an average annual crew of* 750 *and an annual operating schedule of* 355 *day/yr (M3 2014)*

Daily power generation emissions are not scaled by peak crew.

Facility Infrastructure Construction Emissions by LOM Year[1]

LOM	PM ton/yr	PM10 ton/yr	PM2.5 ton/yr	CO ton/yr	NOX ton/yr	SO2 ton/yr	VOC ton/yr	Total HAP ton/yr	CO2e ton/yr
1	37.1	11.4	3.3					0.00	
2	112.5	34.5	10.0					0.00	
3	33.7	10.3	3.0					0.00	
4	4.2	1.3	0.4					0.00	
5	22.6	6.9	2.0					0.00	
6	9.6	2.9	0.9					0.00	
7	4.5	1.4	0.4					0.00	
8	9.6	2.9	0.9					0.00	
9	4.2	1.3	0.4					0.00	
[1] 10	3.8	1.2	0.3					0.00	
(Midas Gold 2018f)	chk	chk	chk						

Power Generation Emissions by LOM Year

LOM	Capacity[1]	PM ton/yr	PM10 ton/yr	PM2.5 ton/yr	CO ton/yr	NOX ton/yr	SO2 ton/yr	VOC ton/yr	Total HAP ton/yr	CO2e ton/yr
CO 1	100%	4.5	4.5	4.5	382.7	85.2	0.59	46.9	9.2	70,573
CO 2	100%	4.5	4.5	4.5	382.7	85.2	0.59	46.9	9.2	70,573
CO 3	50%	2.2	2.2	2.2	191.4	42.6	0.29	23.4	4.6	35,286
[1] *(Midas Gold 2018f)*		chk	chk	chk	chk	chk	chk	chk		

Access Road Emissions by LOM Year

LOM	PM ton/yr	PM10 ton/yr	PM2.5 ton/yr	CO ton/yr	NOX ton/yr	SO2 ton/yr	VOC ton/yr	Total HAP ton/yr	CO2e ton/yr
1	147.5	38.3	4.0	9.4	6.4	0.023	0.9	0.00	3,571
2	147.5	38.3	4.0	9.4	6.4	0.023	0.9	0.00	3,571
3	147.5	38.3	4.0	9.4	6.4	0.023	0.9	0.00	3,571
	chk	chk	chk	chk	chk	chk	chk		

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 2 OF: 9 SHEET: Const
AIR EMISSION CALCULATIONS	SUBJECT: Construction Activity and Emissions	DATE: June 30, 2021

Facility and Infrastructure Construction

Activity Information *(Midas Gold 2018d)*

Construction Activity	acre
CON Tailings Storage Facility (including water diversions)	425.3
CON Haul Roads	178.1
CON Burntlog Road (including borrows, cut/fill)	337
CON Exploration Decline and Explosives Area	29.9
CON EFSFSR Tunnel (including water diversions)	5.9
CON Ore Processing Area	70.6
CON Truck Shop Area	5.4
CON Stibnite Lodge	21.8
CON Landmark Maintenance Facility	4
CON Logistics Facility	25
CON Other Disturbance	19.1

Emission Factors (ton/acre)	PM	PM10	PM2.5	
Site Preparation/Construction	0.215	0.066	0.019	ton/acre *See sheet: PwrConst, page 2*

Emissions by Facility ***Total Construction Emissions***

Facility	PM ton	PM10 ton	PM2.5 ton
CON Tailings Storage Facility (including water diversions)	91.6	28.1	8.2
CON Haul Roads	38.4	11.8	3.4
CON Burntlog Road (including borrows, cut/fill)	72.6	22.3	6.5
CON Exploration Decline and Explosives Area	6.4	2.0	0.6
CON EFSFSR Tunnel (including water diversions)	1.3	0.4	0.1
CON Ore Processing Area	15.2	4.7	1.4
CON Truck Shop Area	1.2	0.4	0.1
CON Stibnite Lodge	4.7	1.4	0.4
CON Landmark Maintenance Facility	0.9	0.3	0.1
CON Logistics Facility	5.4	1.7	0.5
CON Other Disturbance	4.1	1.3	0.4
Total	241.8	74.1	21.6
	PM_total	PM10_total	PM2.5_total

Conversions

2,000 lb/ton	43,560 ft2/acre	3.28084 ft/m
1.1 ton/mt	100 cm/m	5280 ft/mi

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 3 OF: 9 SHEET: Const
AIR EMISSION CALCULATIONS	SUBJECT: Construction Activity and Emissions	DATE: June 30, 2021

Mine Construction Emissions

Power Generation

Activity Information

Total Requirement		10 MW			*(Midas Gold 2016), pg. ES-14*
Diesel Generators[1]	75%	8.5 MW	72,420 MW-hr/yr		*(Midas Gold 2017f)*
Propane Generators	25%	2.5 MW	21,300 MW-hr/yr		*(Midas Gold 2017f)*

[1] *Includes temporary power supply to Warm Lake and Yellow Pine based on:* 317 *MMBtu per capita (EIA 2018) an* 100 *people (Midas Gold 2018k)*

$$\text{Temporary Power} \quad 1\ \text{MW} \times \frac{317\ \cancel{\text{MMBtu}}}{\cancel{\text{person-yr}}} \times \frac{0.2933\ \text{MW-}\cancel{\text{hr}}}{\cancel{\text{MMBtu}}} \times \frac{100\ \cancel{\text{person}}}{8{,}760\ \cancel{\text{hr}}} \times \cancel{\text{yr}}$$

Emission Factors - Diesel Generators (g/kW-hr)

Pollutant	Standard[1]
CO	3.5
NOX	0.67
VOC	0.19
PM	0.03

[1] *40 CFR: 60.4204(b), 60.4201(a), Table 1 of 1039.101*

Fuel Sulfur-Content-Based SO2 Emission Factor

Fuel Sulfur-Content	0.0015%		*non-road diesel, 40 CFR 80.510*
Diesel Density	7.05	lb/gal	*AP-42, App. A*
Molecular Wt. of SO2	64.0638		
Molecular Wt. of S	32.065		
Diesel Heat Content	137,000	BTU/gal	*AP-42, App. A (Diesel)*
Brake-Specific Fuel Use	7,000	BTU/hp-hr	*AP-42, Sec. 3.3, (Diesel)*

SO2 emission factor:

$$0.000011\ \text{lb/hp-hr} \quad 0.0015\%\ \frac{\cancel{\text{lb S}}}{\cancel{\text{lb Fuel}}} \times \frac{7.05\ \cancel{\text{lb Fuel}}}{\cancel{\text{gal Fuel}}} \times \frac{64.064\ \text{lb SO2}}{32.065\ \cancel{\text{lb S}}} \times \frac{\cancel{\text{gal Fuel}}}{137{,}000\ \cancel{\text{BTU}}} \times \frac{7{,}000\ \cancel{\text{BTU}}}{\text{hp-hr}}$$

$$0.006567\ \text{g/kW-hr} \quad \frac{0.000011\ \cancel{\text{lb}}}{\cancel{\text{hp}}\text{-hr}} \times \frac{1.341\ \cancel{\text{hp}}}{\text{kW}} \times \frac{453.593\ \text{g}}{\cancel{\text{lb}}}$$

Emission Factors - Propane Generators (g/kW-hr)

Pollutant	Standard[1]
CO	4.4
NOX	1.35
VOC	1.35

[1] *40 CFR: 60.4233(c) (>19 kw), 4231(c), 1048.101(2). ≥2007 model year. NOX + VOC = NOX+HC standard at 50:50 split.*

Other Emission Factors

PM/PM10/PM2.5	0.01941	lb/MMBTU[1,2]	8.89E-02	g/kW-hr[3]
SO2	5.88E-04	lb/MMBTU[1]	2.69E-03	g/kW-hr[3]

[1] *AP-42, Tab. 3.2-3, 07-00 (4-stroke rich-burn engines)*

[2] *Filterable + condensable particulates*

[3] *Based on brake-specific fuel consumption of* 7,527 *BTU/hp-hr (Caterpillar 1997)*

Conversions

355	day/yr
24	hr/day
1.341	hp/kW
453.6	g/lb
1,000,000	BTU/MMBTU

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 4 OF: 9 SHEET: Const
AIR EMISSION CALCULATIONS	SUBJECT: Construction Activity and Emissions	DATE: June 30, 2021

Mine Construction Emissions

Emissions

Generator Type	PM ton/yr	PM10 ton/yr	PM2.5 ton/yr	CO ton/yr	NOX ton/yr	SO2 ton/yr	VOC ton/yr
Diesel Generators(1)	2.4	2.4	2.4	279.4	53.5	0.5	15.2
Propane Generators	2.1	2.1	2.1	103.3	31.7	0.1	31.7
Total	4.5	4.5	4.5	382.7	85.2	0.6	46.9

Fuel Consumption

Diesel Consumption on Access Roads[1] 43,649 MMBTU/yr *See access road fuel consumption on page 6*
Diesel Generators[2] 679,807 MMBTU/yr
Propane Generators[3] 214,996 MMBTU/yr

[1] *Based on 137,000 BTU/gal AP-42, App. A (Diesel)*
[2] *Based on 7,000 BTU/hp-hr AP-42, Sec. 3.3, (Diesel)*
[3] *Based on 7,527 BTU/hp-hr (Caterpillar 1997)*

Combustion HAP Emission Factors and Emissions

CAS No.	Pollutant/Group	Small Engines[1] lb/MMBtu	Large Engines[2] lb/MMBtu	Propane Engines[3] lb/MMBtu	Emissions[4] lb/yr	Emissions[4] ton/yr
78875	1,2-Dichloropropane			2.69E-5	5.78	2.9E-3
106990	1,3-Butadiene	3.91E-5		2.67E-4	85.7	4.3E-2
542756	1,3-Dichloropropene			2.64E-5	5.68	2.8E-3
540841	2,2,4-Trimethylpentane			2.50E-4	53.7	2.7E-2
75070	Acetaldehyde	7.67E-4	2.52E-5	8.36E-3	2,352	1.18
107028	Acrolein	9.25E-5	7.88E-6	5.14E-3	1,172	0.586
71432	Benzene	9.33E-4	7.76E-4	4.40E-4	770	0.385
56235	Carbon Tetrachloride			3.67E-5	7.89	3.9E-3
108907	Chlorobenzene			3.04E-5	6.54	3.3E-3
	Chloroethanes	0.00E+0	0.00E+0	1.21E-4	26.0	1.3E-2
67663	Chloroform			2.85E-5	6.13	3.1E-3
100414	Ethylbenzene			3.97E-5	8.54	4.3E-3
106934	Ethylene Dibromide			4.43E-5	9.52	4.8E-3
50000	Formaldehyde	1.18E-3	7.89E-5	5.28E-2	12,205	6.10
110543	Hexane			1.11E-3	239	0.119
67561	Methanol			2.50E-3	537	0.269
75092	Methylene Chloride			2.00E-5	4.30	2.1E-3
108952	Phenol			2.40E-5	5.16	2.6E-3
	POM [5]	1.68E-4	2.12E-4	3.47E-4	228	0.114
100425	Styrene			2.36E-5	5.07	2.5E-3
108883	Toluene	4.09E-4	2.81E-4	4.08E-4	384	0.192
75014	Vinyl Chloride			1.49E-5	3.20	1.6E-3
1330207	Xylene	2.85E-4	1.93E-4	1.84E-4	246	0.123
Combustion HAP Total					18,360	9.18

[1] *AP-42, Tab. 3.3-2, 10/96, diesel engines (≤ 600 hp)*
[2] *AP-42, Tabs. 3.4-3 & 3.4-4, 10/96, large diesel engines (> 600 hp)*
[3] *AP-42, Tabs. 1.4-2, 1.4-3 & 1.4-4, 07/98, external natural gas combustion, based on 1,020 Btu/Scf*
[4] *Maximum of the two diesel engine emission factors used*
[5] *POM = Poly Organic Matter, includes:*

2-Methylnaphthalene, 3-Methylchloranthrene, 7,12-Dimethylbenz(a)anthracene, Acenaphthene, Acenaphthylene, Anthracene, Benz(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(g,h,i)perylene, Benzo(k)fluoranthene, Chrysene, Dibenzo(a,h)anthracene, Fluoranthene, Fluorene, Indeno(1,2,3-c,d)pyrene, Naphthalene, Phenanthrene, Pyrene.

Conversions

1,000,000 BTU/MMBTU 1,000 kW/MW 907,186 g/ton
2,000 lb/ton 1.341 hp/kW

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 5 OF: 9 SHEET: Const
AIR EMISSION CALCULATIONS	SUBJECT: Construction Activity and Emissions	DATE: June 30, 2021

Mine Construction Emissions

Greenhouse Gas Emission Factors[1] and Emissions

Fuel	CO2	CH4	N2O	CO2	CH4	N2O	CO2e
	kg/MMBtu			mt/yr	mt/yr	mt/yr	mt/yr
Gen Diesel	73.96	3.0E-3	6.0E-4	50,278	2.0	0.4	50,451
Gen Propane	62.87	3.0E-3	6.0E-4	13,517	0.6	0.1	13,571
Access Rd Diesel	73.96	3.0E-3	6.0E-4	3,228	0.13	0.03	3,239
Combustion Total GHG				67,024	3	1	67,262

[1] *40 CFR 98 Tab. C-1 and C-2 (CFR 2018d)*

Global Warming Potential [1, 2]

CO2	1
CH4	25
N2O	298

[1] *40 CFR 98 Tab. A-1 (CFR 2018d)*

[2] *Annex I Parties, 100-year time horizon (UNCC n.d.); (IPCC 2007)*

Dust HAP Emission Factors and Emissions

HAP Concentrations[1] and Emissions[2]

Pollutant	ppm	Emissions lb/yr	Emissions ton/yr
Arsenic	2.5	0.9	4.6E-4
Beryllium	2.2	0.8	4.0E-4
Cadmium	0.25	9.2E-2	4.6E-5
Cobalt	3.5	1.3	6.4E-4
Chromium	11	4.0	2.0E-3
Mercury	0.009	3.3E-3	1.7E-6
Manganese	278.5	102.3	5.1E-2
Nickel	2.5	0.9	4.6E-4
Lead	14.5	5.3	2.7E-3
Antimony	3.75	1.4	6.9E-4
Phosphorus	430	158.0	7.9E-2
Dust HAP Total		275.1	0.1

[1] *AR: Burntlog access route roadbed materal analyses - 1/2 detection limit used for non-detect analyses (ALS 2018)*

[2] *Based on total PM emissions of* 183.7 *ton/yr See construction PM emissions on page 2, and access road PM emissions (excluding tailpipes) on page 8*

Conversions

1,000 kg/mt
2,000 lb/ton

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 6 OF: 9 SHEET: Const
AIR EMISSION CALCULATIONS	SUBJECT: Construction Activity and Emissions	DATE: June 30, 2021

Mine Construction Emissions

Access Roads

Operation Schedule 355 day/yr 24 hr/day

Equipment
MachineSpecs

Traffic Specifications and Activity

Equipment[1]	Equipment Model[2]	ID	Rating[3] hp	Rating kW	Oper.[4] hr/yr	Annual[1] trip/yr	Diesel[5] gal/yr	Output[6] kW-hr/yr	Travel[7] VMT/yr	Equipment Category	On-road Class	
Grader	Cat 160H	CT1	200	149	3,978	183	13,424	195,912	13,731	Non-road		Ca
Plow Truck	Cat CT660	CT2	476	355	3,978	183	31,826	--	13,731	On-road	HHD	Ca
Snow Blower	TM42R	CT3	450	336	3,978	183	30,088	--	13,731	On-road	HHD	Ca
Water Truck	Cat 725C	CT4	320	239	3,978	183	31,826	464,491	13,731	Non-road		Ca
Binding Agent Truck	Cat 725C	CT5	320	239	3,978	183	31,826	464,491	13,731	Non-road		Ca
Vibratory Compactor	Cat CS76 XI	CT6	177	132	3,978	183	20,886	304,822	13,731	Non-road		Ca
Fuel Service Truck	CAT 740B	CT7	484	361	3,978	183	35,804	522,552	13,731	Non-road		C/
Rock Rakes	Cat CT660	CT8	476	355	3,978	183	31,826	--	13,731	On-road	HHD	Ca
Light Vehicles	F-350	CT9	440	328		3,314	17,762	--	248,662	On-road	LHD45	F-3
Heavy Trucks	Cat CT660 (3	CT10	476	355		6,353	73,337	--	476,691	On-road	HHD	Ca

(1) *(Midas Gold 2016), Tables 7-1, 12-1. Maintenance trips distributed equally amongst maintenace equipment.*
Heavy trucks include buses, supply and trash trucks. Light vehicles include visitor and employee vehicles.

(2) *Similar models by equipment type from (Midas Gold 2017b)*

(3) *(Caterpillar 2016c)/Manufacturer specifications*

(4) *Combined hours, (Midas Gold 2017f)*

(5) *Maintenance equipment based on brake-specific fuel use scaled for similar equipment from (Midas Gold 2017b)*
Light vehicles based on Ford F-350 fuel economy 14.0 *mpg (fuelly.com)* *Heavy trucks based on fuel economy o* 6.5 *mpg (ATRI 2016)*

(6) *Based* 137,000 *BTU/gal* AP-42, App. A (Diesel) 7,000 *BTU/hp-hr* AP-42, Sec. 3.3, (Diesel)

(7) *Based on access road length of:* 37.5 X 2 *mi (roundtrip)* *(Midas Gold 2018c)*

EPA Non-Road Standards

ID	Equipment Type	Model[1] Year	Power Category	EPA Tier	Lookup ID	EPA Non-Road Standards (g/kW-hr)[2] PM	CO	NOX	VOC
CT1	Grader	>2015	130≤kW<560, Ph-ii	4	T4-130≤kW≤560 2015	0.02	3.5	0.4	0.19
CT2	Truck				No Standard				
CT3	Truck				No Standard				
CT4	Truck	>2015	130≤kW<560, Ph-ii	4	T4-130≤kW≤560 2015	0.02	3.5	0.4	0.19
CT5	Truck	>2015	130≤kW<560, Ph-ii	4	T4-130≤kW≤560 2015	0.02	3.5	0.4	0.19
CT6	Compactor	>2015	130≤kW<560, Ph-ii	4	T4-130≤kW≤560 2015	0.02	3.5	0.4	0.19
CT7	Truck	>2015	130≤kW<560, Ph-ii	4	T4-130≤kW≤560 2015	0.02	3.5	0.4	0.19
CT8	Truck				No Standard				
CT9	Light Truck				No Standard				
CT10	Truck				No Standard				

(1) *(Midas Gold 2017h)*

(2) *(CFR 2018a)*

Final Emission Factors

ID	Lookup	PM	PM10	PM2.5	CO	NOX	VOC	SO2	EF Unit	Final EF	Activity	
CT1	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.01	g/kW-hr	*EPA_NRS*	195,912	kW-hr/yr
CT2	HHD	1.17	1.17	0.46	2.31	7.32	0.51	0.01	g/VMT	*EPA_MOVES2014*	13,731	VMT/yr
CT3	HHD	1.17	1.17	0.46	2.31	7.32	0.51	0.01	g/VMT	*EPA_MOVES2014*	13,731	VMT/yr
CT4	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.01	g/kW-hr	*EPA_NRS*	464,491	kW-hr/yr
CT5	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.01	g/kW-hr	*EPA_NRS*	464,491	kW-hr/yr
CT6	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.01	g/kW-hr	*EPA_NRS*	304,822	kW-hr/yr
CT7	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	0.01	g/kW-hr	*EPA_NRS*	522,552	kW-hr/yr
CT8	HHD	1.17	1.17	0.46	2.31	7.32	0.51	0.01	g/VMT	*EPA_MOVES2014*	13,731	VMT/yr
CT9	LHD45	0.59	0.59	0.29	1.87	4.94	0.68	0.01	g/VMT	*EPA_MOVES2014*	248,662	VMT/yr
CT10	HHD	1.17	1.17	0.46	2.31	7.32	0.51	0.01	g/VMT	*EPA_MOVES2014*	476,691	VMT/yr

Mine Construction Emissions

Access Roads - continued

Final Emission Factor Options:

Category	EF Unit	Activity Unit	Emission Unit	Multiplier
EPA_CERT	g/kW-hr	kW-hr/yr	ton/yr	1.1E-6
EPA_NRS	g/kW-hr	kW-hr/yr	ton/yr	1.1E-6
EPA_MOVES2014a	g/VMT	VMT/yr	ton/yr	1.1E-6

Traffic Tailpipe Emissions

	Equipment	PM	PM10		PM2.5		CO		NOX		SO2		VOC
ID	Type	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/day	ton/yr	ton/yr
CT1	Grader	4.3E-3	0.02	4.3E-3	0.02	4.3E-3	4.26	0.76	0.49	0.09	8.0E-3	1.4E-3	0.04
CT2	Plow Truck	0.02	0.10	0.02	0.04	7.0E-3	0.20	0.04	0.62	0.11	9.1E-4	1.6E-4	7.7E-3
CT3	Snow Blower	0.02	0.10	0.02	0.04	7.0E-3	0.20	0.04	0.62	0.11	9.1E-4	1.6E-4	7.7E-3
CT4	Water Truck	0.01	0.06	0.01	0.06	0.01	10.10	1.79	1.15	0.20	0.02	3.4E-3	0.10
CT5	Binding Agent Truc	0.01	0.06	0.01	0.06	0.01	10.10	1.79	1.15	0.20	0.02	3.4E-3	0.10
CT6	Vibratory Compacto	6.7E-3	0.04	6.7E-3	0.04	6.7E-3	6.63	1.18	0.76	0.13	0.01	2.2E-3	0.06
CT7	Fuel Service Truck	0.01	0.06	0.01	0.06	0.01	11.36	2.02	1.30	0.23	0.02	3.8E-3	0.11
CT8	Rock Rakes	0.02	0.10	0.02	0.04	7.0E-3	0.20	0.04	0.62	0.11	9.1E-4	1.6E-4	7.7E-3
CT9	Light Vehicles	0.16	0.91	0.16	0.45	0.08	2.88	0.51	7.63	1.35	0.02	2.9E-3	0.19
CT10	Heavy Trucks	0.61	3.46	0.61	1.36	0.24	6.85	1.22	21.68	3.85	0.03	5.6E-3	0.27
		0.87	4.91	0.87	2.17	0.39	52.76	9.36	36.03	6.40	0.13	0.02	0.89

LT Unit	ST Unit	Multiplier
ton/yr	lb/day	5.634
ton/yr	lb/hr	0.235

Access Road Grading

Operation 3,978 hr/yr
25,859 VMT/yr

Grading Emission Factors

Emission Factor Equation
TSP (lb/VMT) = 0.04 $(S)^{2.5}$ *AP-42, Tab. 11.9-1, 07/98, (grading)*
PM15 (lb/VMT) = 0.051 $(S)^{2}$ *AP-42, Tab. 11.9-1, 07/98, (grading)*

S - Grader average speed 6.5 mph *(Caterpillar 2016c), haul road maintenance*
TSP(PM) 4.309 lb/VMT
PM15 2.155 lb/VMT

Grading PM Scaling Factors

PM10 0.6 *AP-42, Tab. 11.9-1, 07/98, (applies to PM15 EF, footnote d)*
PM2.5 0.031 *AP-42, Tab. 11.9-1, 07/98, (applies to TSP EF, footnote e)*

Emission Controls Periodic application of water and chemical dust suppressant
Control efficiency: 90% *See Onsite Hauling*

Grading Emissions

PM	PM10		PM2.5	
ton/yr	lb/day	ton/yr	lb/day	ton/yr
5.57	16	2.79	0.97	0.17

Conversions
2,000 lb/ton
453.59 g/lb
1.341 hp/kW

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 8 OF: 9 SHEET: Const
AIR EMISSION CALCULATIONS	SUBJECT: Construction Activity and Emissions	DATE: June 30, 2021

Mine Construction Emissions

Access Roads - continued

Access Road Vehicle Travel Dust

Vehicle Specifications

Vehicle Type	Model	Empty Weight[1] ton	Gross Weight[1] ton	Average Weight ton	Travel mi/yr	
Grader	Cat 160H	17.2	17.2	17.2	13,731	*Grader emissions calculated separately*
Plow Truck	Cat CT660	8.2	26.6	17.4	13,731	
Snow Blower	TM42R	14.8	18.0	16.4	13,731	
Water Truck	Cat 725C	25.6	51.6	38.6	13,731	
Binding Agent Truck	Cat 725C	25.6	51.6	38.6	13,731	
Vibratory Compactor	Cat CS76 XT	19.2	20.8	20.0	13,731	
Fuel Service Truck	CAT 740B	37.6	81.1	59.4	13,731	
Rock Rakes	Cat CT660	8.2	26.6	17.4	13,731	
Light Vehicles	F-350	4.0	7.9	6.0	248,662	
Heavy Trucks	Cat CT660 (8X6)	10.1	34.5	22.3	476,691	

[1] *(Caterpillar 2016c)/Manufacturer specifications*

Total vehicle miles traveled (VMT) 821,472 VMT/yr *Excluding grader*

Emission Factors

Emission factor equation $E = k(s/12)^a (W/3)^b [(365-P)/365]$

s = Surface material silt content	4	%			*(Midas Gold 2015)*
W = Mean vehicle weight	18	ton			*Weighted average weight, excluding grader*
P = Days/year with ≥0.01 in precip.	120	day/yr			
	PM	PM10	PM2.5		
k = Size-specific empirical constant	4.9	1.5	0.15		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
a = Size-specific empirical constant	0.7	0.9	0.9		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
b = Size-specific empirical constant	0.45	0.45	0.45		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
E = Size-specific emission factor	3.43	0.84	0.08	lb/VMT	

Emission Controls

Periodic application of water and chemical dust suppressant

Control efficiency 90% *See Onsite Hauling*

Vehicle Travel Dust Emissions

PM	PM10		PM2.5	
ton/yr	lb/day	ton/yr	lb/day	ton/yr
141.05	195.28	34.66	19.53	3.47

Access Road Total Emissions

PM	PM10		PM2.5		CO		NOX		SO2		VOC
ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/day	ton/yr	ton/yr
147.49	215.88	38.32	22.67	4.02	52.76	9.36	36.03	6.40	0.13	0.02	0.89

Conversions

2,000 lb/ton

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 9 OF: 9 SHEET: Const
AIR EMISSION CALCULATIONS	SUBJECT: Construction Activity and Emissions	DATE: June 30, 2021

Mine Construction Emissions

Access Roads - continued

Fuel Sulfur-Content Based SO2 Emission Factor

Fuel Sulfur-Content	0.0015%		*Non-road diesel specification per 40 CFR 80.510*
Diesel Density	7.05	lb/gal	*AP-42, App. A*
Molecular Wt. of SO2	64.064	lb/lb-mol	
Molecular Wt. of S	32.065	lb/lb-mol	
Diesel Heat Content	137,000	BTU/gal	*AP-42, App. A (Diesel)*
Brake-Specific Fuel Use	7,000	Btu/hp-hr	*AP-42, Sec. 3.3, (Diesel engine)*

SO2 emission factor:

$$0.000011 \frac{\text{lb}}{\text{hp-hr}} = 0.0015\% \frac{\text{lb S}}{\text{lb Fuel}} \times 7.05 \frac{\text{lb Fuel}}{\text{gal Fuel}} \times 64.064 \frac{\text{lb SO2}}{\text{lb S}} \times \frac{\text{gal Fuel}}{137{,}000 \text{ BTU}} \times 7{,}000 \frac{\text{BTU}}{\text{hp-hr}}$$

$$0.0066 \frac{\text{g}}{\text{kW-hr}} = 0.000011 \frac{\text{lb}}{\text{hp-hr}} \times 1.341 \frac{\text{hp}}{\text{kW}} \times 453.593 \frac{\text{g}}{\text{lb}}$$

Air Sciences Inc.	PROJECT TITLE: Midas Gold	BY: E. Memon	
	PROJECT NO: 335-1-1	PAGE: 1	OF: 9 SHEET: PwrConst
AIR EMISSION CALCULATIONS	SUBJECT: Power Line Construction Emissions	DATE: June 30, 2021	

Power Line Construction **Construction Year** **1**

Annual Emissions Summary

Activity	PM ton/yr	PM10 ton/yr	PM2.5 ton/yr	CO ton/yr	NOX ton/yr	SO2 ton/yr	VOC ton/yr	Total HAP ton/yr	CO2e ton/yr
Facility and Infrastructure Construction	16.5	5.0	1.5					0.0	
Mobile Equipment Tailpipe	2.4	2.4	1.4	69.6	64.6	0.14	4.5	0.3	18,300
Power Line Construction Total	18.9	7.5	2.9	69.6	64.6	0.14	4.5	0.3	18,300

Maximum Daily Emissions Summary[1]

Activity	PM lb/day	PM10 lb/day	PM2.5 lb/day	CO lb/day	NOX lb/day	SO2 lb/day	VOC lb/day	Total HAP lb/day	CO2e lb/day
Facility and Infrastructure Construction	123.7	37.9	11.0					0.2	
Mobile Equipment Tailpipe	18.3	18.3	10.5	523.0	485.2	1.1	33.9	2.2	137,466
Construction Total	142.0	56.2	21.5	523.0	485.2	1.1	33.9	2.4	137,466

[1] *Maximum daily emissions based on 1,000 person crew during peak construction, scaled with an average annual crew of 750 and an annual operating schedule of 355 day/yr (M3 2014)*

Facility Infrastructure Construction Emissions by LOM Year[1]

	LOM	Capacity[1]	PM ton/yr	PM10 ton/yr	PM2.5 ton/yr	CO ton/yr	NOX ton/yr	SO2 ton/yr	VOC ton/yr	Total HAP ton/yr	CO2e ton/yr
CON	1	25%	16.5	5.0	1.5					0.0	
CON	2	50%	32.9	10.1	2.9					0.1	
CON	3	25%	16.5	5.0	1.5					0.0	
[1] *(Midas Gold 2018f)*			chk	chk	chk	chk	chk	chk	chk	chk	chk

Mobile Equipment Tailpipe Emissions by LOM Year

	LOM	Capacity[1]	PM ton/yr	PM10 ton/yr	PM2.5 ton/yr	CO ton/yr	NOX ton/yr	SO2 ton/yr	VOC ton/yr	Total HAP ton/yr	CO2e ton/yr
CON	1	25%	2.4	2.4	1.4	69.6	64.6	0.14	4.5	0.3	18,300
CON	2	50%	4.9	4.9	2.8	139.3	129.2	0.28	9.0	0.6	36,600
CON	3	25%	2.4	2.4	1.4	69.6	64.6	0.14	4.5	0.3	18,300
[1] *(Midas Gold 2018f)*			chk	chk	chk	chk	chk	chk	chk	chk	chk

Conversions

365	day/yr
2,000	lb/ton
1.10	ton/t

Air Sciences Inc.	PROJECT TITLE: Midas Gold	BY: E. Memon	
	PROJECT NO: 335-1-1	PAGE: 2	OF: 9	SHEET: PwrConst
AIR EMISSION CALCULATIONS	SUBJECT: Power Line Construction Emissions	DATE: June 30, 2021	

Power Line Construction

POD_2017

Activity Information

Construction Activity	acre[1]	yr[2]
Power Line	305.6	3

[1] *(Midas Gold 2018a)*

[2] *(Midas Gold 2018d)*

Emission Factors (ton/acre)	PM	PM10	PM2.5		
Site Preparation/Construction	0.215	0.066	0.019	ton/acre	*See calculations below*

Site Preparation Activity [1]	***Emission Factor***				***Emission Factor Reference***	***Scaling Factor***	
	PM	PM10	PM2.5			PM10	PM2.5
Dozing	2.05	0.332	0.215	lb/hr	*AP-42, Tab. 11.9-1, 07/98, (bulldozing, overburden); See sheet: Mine, page 17*		
Scraper unloading	0.04	0.0189	0.0029	lb/ton	*AP-42, Tab. 11.9-4, 07/98, (scraper unload); scaling factors from AP-42, Sec. 13.2.4, 11/06*	0.47	0.072
Scraper in travel	20.2	3.2764	2.121	lb/VMT	*See scraping topsoil removel below*		
Scraping topsoil removal	20.2	3.2764	2.121	lb/VMT	*AP-42, Tab. 13.2.3-1, 1/95; dozer scaling factors*	0.16	0.11
Material loading	2.11E-4	1.00E-4	1.51E-5	lb/ton	*AP-42, Tab. 11.19.2-2, 8/04 (truck loading - crshed stone); See sheet: Mine, page 8*		
Material dumping	3.38E-5	1.60E-5	2.42E-6	lb/ton	*AP-42, Tab. 11.19.2-2, 8/04 (truck unloading - fragmented stone); See sheet: Mine, page 8*		
Compacting	2.05	0.33	0.22	lb/hr	*AP-42, Tab. 11.9-1, 07/98, (bulldozing, overburden); See sheet: Mine, page 17*		
Grading	4.31	1.29	0.134	lb/VMT	*AP-42, Tab. 11.9-1, 07/98, (grading); See sheet: Mine, page 17*		

[1] *AP-42, Tab. 13.2.3-1, 1/95*

Construction Operation	***Estimated Activity Rate***			***Estimated Emission Factor (ton/acre)***		
				PM	PM10	PM2.5
Dozing[1]	49	hr/ac		5.02E-2	8.14E-3	5.27E-3
Scraper unloading[2]	4,945	ton/ac		9.89E-2	4.68E-2	7.08E-3
Scraper in travel	0.7	VMT/ac	*See scraping topsoil removel below*	7.25E-3	1.18E-3	7.61E-4
Scraping topsoil removal[3]	0.7	VMT/ac		7.25E-3	1.18E-3	7.61E-4
Material loading	4,945	ton/ac	*See scraper unloading above*	5.23E-4	2.47E-4	3.74E-5
Material dumping	4,945	ton/ac	*See scraper unloading above*	8.36E-5	3.96E-5	5.99E-6
Compacting	49	hr/ac	*See dozing above*	5.02E-2	8.14E-3	5.27E-3
Grading[4]	0.5	VMT/ac		1.11E-3	3.33E-4	3.44E-5

[1] *Based on:* 14,976 *hr dozer useage and* 305.6 *acre disturbance* *Total (3-yr) power line construction activity*

[2] *Based on:* 45 *cm, scraper cut depth (Caterpillar 631K Scraper) (Caterpillar 2016b) & waste material density of:* 153.8 *lb/ft*^{3} *(Midas Gold 2017b)*

[3] *Based on:* 11.5 *ft blade width (Caterpillar 631K Scraper) (Caterpillar 2016b)*

[4] *Based on:* 16.0 *ft blade width (Caterpillar 16M3 Grader) (Caterpillar 2016a)*

Emissions	***Total Construction Emissions***								
Activity	PM	PM10	PM2.5	CO	NOX	SO2	VOC	Total HAP	CO2e
	ton	ton	ton	ton	ton	ton	ton	ton	ton
Power Line	65.9	20.2	5.9					0.1	
Mobile Equipment Tailpipe	9.7	9.7	5.6	278.5	258.4	0.6	18.1	1.2	73,201
Total	75.6	29.9	11.4	278.5	258.4	0.6	18.1	1.3	73,201

Conversions

2,000	lb/ton	43,560	ft2/acre	3.28084	ft/m
1.1	ton/mt	100	cm/m	5280	ft/mi

Air Sciences Inc.	PROJECT TITLE: Midas Gold	BY: E. Memon	
	PROJECT NO: 335-1-1	PAGE: 3	OF: 9 SHEET: PwrConst
AIR EMISSION CALCULATIONS	SUBJECT: Power Line Construction Emissions	DATE: June 30, 2021	

Power Line Construction

Mobile Equipment Tailpipe

MachineSpecs

POD_2017

Activity Information

Mobile Equipment Specifications and Activity

ID	Equipment Type[1]		Equipment Model[2]	Rating hp[2]	Rating kW	Oper. hr/yr[1,3]	Diesel gal/hp-hr[2]	Diesel gal/yr	Output kW-hr/yr[4]	Travel VMT/yr[5]	Equipment Category	On-road Class[6]
	Transmission Line	gal/hr										
TL1	Bulldozer	19	Cat D10T2	600	447	4,992	0.032	94,848	1,384,274		Non-road	
TL2	Motor Grader	5.5	Cat 16M	326	243	4,992	0.017	27,456	400,711		Non-road	
TL3	Auger Truck	8	Cat CT660	476	355	4,992	0.017	39,936	582,852	99,840	On-road	HHD
TL4	Wire Reel Trailer	8	Cat CT660	476	355	7,488	0.017	59,904	874,278	149,760	On-road	HHD
TL5	Truck Mounted Crane	8	Cat CT660	476	355	4,992	0.017	39,936	582,852	99,840	On-road	HHD
TL6	Pickup	1	F-350 (PT)	440	328	12,480	0.002	12,480	182,141	312,000	On-road	LHD45
TL7	Fork Lift	2.5	CAT DP160N	124	92	4,992	0.020	12,480	182,141		Non-road	--
TL8	Diesel Tractor	10	Cat 586C	350	261	7,488	0.029	74,880	1,092,848		Non-road	
TL9	Splicing Truck	8	Cat CT660	476	355	1,248	0.017	9,984	145,713	24,960	On-road	HHD
TL10	Boom Truck	8	Cat CT660	476	355	4,992	0.017	39,936	582,852	99,840	On-road	HHD
TL11	Three Drum Puller	8	Cat CT660	476	355	3,744	0.017	29,952	437,139	74,880	On-road	HHD
TL12	Single Drum Puller	8	Cat CT660	476	355	1,872	0.017	14,976	218,570	37,440	On-road	HHD
TL13	OHGW and Fiber Reel Trailer	8	Cat CT660	476	355	4,992	0.017	39,936	582,852	99,840	On-road	HHD
TL14	Dump Truck	9	Cat 740B	484	361	2,496	0.019	22,464	327,854		Non-road	
TL15	Loader	12	Cat 988K	580	433	2,496	0.020	28,704	418,925		Non-road	
TL16	Water Truck	25	Cat 777D	1,000	746	42,432	0.025	1,060,800	15,482,007		Non-road	
TL17	Hauling Truck	25	Cat 777D	1,000	746	4,992	0.025	124,800	1,821,413		Non-road	
TL18	Tensioner	8	Cat CT660	476	355	1,248	0.017	9,984	145,713	24,960	On-road	HHD
	Substation											
SS1	Backhoe	5	CAT 430E	101	75	4,992	0.050	24,960	364,283		Non-road	
SS2	Auger	8	Cat CT660	476	355	19,968	0.017	159,744	2,331,408	399,360	On-road	HHD
SS3	Concrete Truck	8	Cat CT660	476	355	19,968	0.017	159,744	2,331,408	399,360	On-road	HHD
SS4	Pickup	1	F-350 (PT)	440	328	9,984	0.002	9,984	145,713	249,600	On-road	LHD45
SS5	Field Office/Trailer	7	F-650	330	246	2,496	0.021	17,472	254,998	62,400	On-road	MHD
SS6	Drilling Rig	12	Cat MD6420	800	597	2,496	0.015	29,952	437,139		Non-road	
SS7	Vibratory Roller	5.3	Cat CS76 XT	177	132	2,496	0.030	13,104	191,248		Non-road	
SS8	Fork Lift	2.5	CAT DP160N	124	92	7,488	0.020	18,720	273,212		Non-road	--

[1] *(HDR 2017)*

[2] *Equipment type specific make and model, rating, and brake-specific fuel consumption (LOM year 4) selected from mine operation fleet (Midas Gold 2017b)*

[3] *Weekly hours (HDR 2017) times 52 weeks per year*

[4] *Based c* *137,000* *BTU/gal* *AP-42, App. A*

7,000 *BTU/hp-hr* *AP-42, Sec. 3.3*

[6] *On-road vehicle codes and descriptions provided in MOVES emission factors table*

VMT = Vehicle Miles Travelled

[4] *Based on the following average speeds (mph):* *(Midas Gold 2018e)*

Cat CT660	*20*
F-350 (PT)	*25*
F-650	*25*

Conversions

1.341	hp/kW
453.6	g/lb
1,000,000	BTU/MMBTU

Air Sciences Inc.	PROJECT TITLE: Midas Gold	BY: E. Memon	
	PROJECT NO: 335-1-1	PAGE: 4	OF: 9 SHEET: PwrConst
AIR EMISSION CALCULATIONS	SUBJECT: Power Line Construction Emissions	DATE: June 30, 2021	

Power Line Construction

Mobile Equipment Tailpipe

Operation schedule 365 day/yr 12 hr/day

EPA Non-Road Standards

ID	Equipment Type	Model[1] Year	Power Category	EPA Tier	Lookup ID	EPA Non-Road Standards (g/kW-hr)[2] PM	CO	NOX	VOC
Transmission Line									
TL1	Dozer	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015	0.02	3.5	0.4	0.19
TL2	Grader	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015	0.02	3.5	0.4	0.19
TL3	Truck	>2015			No Standard				
TL4	Truck	>2015			No Standard				
TL5	Truck	>2015			No Standard				
TL6	Pickup	>2015			No Standard				
TL7	Fork Lift	>2015	75≤kW<130, Ph-in	4	T4-56≤kW<130 2015	0.02	5	0.4	0.19
TL8	Tractor	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015	0.02	3.5	0.4	0.19
TL9	Truck	>2015			No Standard				
TL10	Truck	>2015			No Standard				
TL11	Truck	>2015			No Standard				
TL12	Truck	>2015			No Standard				
TL13	Truck	>2015			No Standard				
TL14	Truck	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015	0.02	3.5	0.4	0.19
TL15	Truck	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015	0.02	3.5	0.4	0.19
TL16	Truck	>2015	kW>560	4	T4-kW>560 2015	0.04	3.5	3.5	0.19
TL17	Truck	>2015	kW>560	4	T4-kW>560 2015	0.04	3.5	3.5	0.19
TL18	Truck	>2015			No Standard				
Substation									
SS1	Backhoe	>2015	75≤kW<130, Ph-in	4	T4-56≤kW<130 2015	0.02	5	0.4	0.19
SS2	Truck	>2015			No Standard				
SS3	Truck	>2015			No Standard				
SS4	Pickup	>2015			No Standard				
SS5	Pickup	>2015			No Standard				
SS6	Drill	>2015	kW>560	4	T4-kW>560 2015	0.04	3.5	3.5	0.19
SS7	Roller	>2015	130≤kW<560, Ph-in	4	T4-130≤kW≤560 2015	0.02	3.5	0.4	0.19
SS8	Fork Lift	>2015	75≤kW<130, Ph-in	4	T4-56≤kW<130 2015	0.02	5	0.4	0.19

[1] *(Midas Gold 2017h)*

[2] *(CFR 2018a)*

Air Sciences Inc.	PROJECT TITLE: Midas Gold	BY: E. Memon
	PROJECT NO: 335-1-1	PAGE: 5 OF: 9 SHEET: PwrConst
AIR EMISSION CALCULATIONS	SUBJECT: Power Line Construction Emissions	DATE: June 30, 2021

Power Line Construction

Mobile Equipment Tailpipe

Fuel Sulfur-Content-Based SO2 Emission Factor

Fuel Sulfur-Content	0.0015%		*Non-road diesel, 40 CFR 80.510*
Diesel Density	7.05	lb/gal distillate oil	*AP-42 Appendix A "Weights of Selected Substances" (Distillate oil)*
Molecular Wt. of SO2	64.1	lb/lb-mol	
Molecular Wt. of S	32.1	lb/lb-mol	
Diesel Heat Content	137,000	BTU/gal	*AP-42, App. A*
Brake-Specific Fuel Use	7,000	BTU/hp-hr	*AP-42, Sec. 3.3*

SO2 Emission Factor:

1.08E-5 lb/hp-hr = 0.0015% ~~lb S~~ / ~~lb Fuel~~ × 7.05 ~~lb Fuel~~ / ~~gal Fuel~~ × 64.064 lb SO2 / 32.065 ~~lb S~~ × ~~gal Fuel~~ / 137,000 ~~BTU~~ × 7,000 ~~BTU~~ / hp-hr

6.57E-3 g/kW-hr = 0.000011 ~~lb~~ / ~~hp~~-hr × 1.341 ~~hp~~ / kW × 453.593 g / ~~lb~~

EPA MOVES 2014a Emission Factors[1]

Vehicle Class	Description	Emission Factor (g/VMT)[2] PM	PM10	PM2.5	CO	NOX	VOC	SO2
LHD<=10K	Passenger Truck 8.5k-10k lb, Diesel	0.178	0.178	0.086	1.322	2.281	0.241	0.006
LHD45	Single Unit Truck 14k-19.5k lb, Diesel	0.589	0.589	0.291	1.867	4.940	0.685	0.011
MHD	Single Unit Truck 19.5k-33k lb, Diesel	0.797	0.797	0.381	2.170	5.684	0.841	0.011
HHD	Single Unit Truck >33k lb, Diesel	1.169	1.169	0.461	2.313	7.324	0.510	0.011

(1) *MOVES 2014a run dated 2017-09-25*

(2) *PM = PM10*

Air Sciences Inc.	PROJECT TITLE: Midas Gold	BY: E. Memon	
	PROJECT NO: 335-1-1	PAGE: 6	OF: 9 SHEET: PwrConst
AIR EMISSION CALCULATIONS	SUBJECT: Power Line Construction Emissions	DATE: June 30, 2021	

Power Line Construction

Mobile Equipment Tailpipe

Final Emission Factors

ID	Lookup	PM	PM10	PM2.5	CO	NOX	VOC	SO2	EF Unit	Final EF	Activity	
Transmission Line												
TL1	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	6.57E-3	g/kW-hr	*EPA_NRS*	1,384,274	kW-hr/yr
TL2	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	6.57E-3	g/kW-hr	*EPA_NRS*	400,711	kW-hr/yr
TL3	HHD	1.17	1.17	0.46	2.31	7.32	0.51	1.07E-2	g/VMT	*EPA_MOVES2014a*	99,840	VMT/yr
TL4	HHD	1.17	1.17	0.46	2.31	7.32	0.51	1.07E-2	g/VMT	*EPA_MOVES2014a*	149,760	VMT/yr
TL5	HHD	1.17	1.17	0.46	2.31	7.32	0.51	1.07E-2	g/VMT	*EPA_MOVES2014a*	99,840	VMT/yr
TL6	LHD45	0.59	0.59	0.29	1.87	4.94	0.68	1.05E-2	g/VMT	*EPA_MOVES2014a*	312,000	VMT/yr
TL7	T4-56≤kW<130 2015	0.02	0.02	0.02	5.00	0.40	0.19	6.57E-3	g/kW-hr	*EPA_NRS*	182,141	kW-hr/yr
TL8	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	6.57E-3	g/kW-hr	*EPA_NRS*	1,092,848	kW-hr/yr
TL9	HHD	1.17	1.17	0.46	2.31	7.32	0.51	1.07E-2	g/VMT	*EPA_MOVES2014a*	24,960	VMT/yr
TL10	HHD	1.17	1.17	0.46	2.31	7.32	0.51	1.07E-2	g/VMT	*EPA_MOVES2014a*	99,840	VMT/yr
TL11	HHD	1.17	1.17	0.46	2.31	7.32	0.51	1.07E-2	g/VMT	*EPA_MOVES2014a*	74,880	VMT/yr
TL12	HHD	1.17	1.17	0.46	2.31	7.32	0.51	1.07E-2	g/VMT	*EPA_MOVES2014a*	37,440	VMT/yr
TL13	HHD	1.17	1.17	0.46	2.31	7.32	0.51	1.07E-2	g/VMT	*EPA_MOVES2014a*	99,840	VMT/yr
TL14	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	6.57E-3	g/kW-hr	*EPA_NRS*	327,854	kW-hr/yr
TL15	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	6.57E-3	g/kW-hr	*EPA_NRS*	418,925	kW-hr/yr
TL16	T4-kW>560 2015	0.04	0.04	0.04	3.50	3.50	0.19	6.57E-3	g/kW-hr	*EPA_NRS*	15,482,007	kW-hr/yr
TL17	T4-kW>560 2015	0.04	0.04	0.04	3.50	3.50	0.19	6.57E-3	g/kW-hr	*EPA_NRS*	1,821,413	kW-hr/yr
TL18	HHD	1.17	1.17	0.46	2.31	7.32	0.51	1.07E-2	g/VMT	*EPA_MOVES2014a*	24,960	VMT/yr
Substation												
SS1	T4-56≤kW<130 2015	0.02	0.02	0.02	5.00	0.40	0.19	6.57E-3	g/kW-hr	*EPA_NRS*	364,283	kW-hr/yr
SS2	HHD	1.17	1.17	0.46	2.31	7.32	0.51	1.07E-2	g/VMT	*EPA_MOVES2014a*	399,360	VMT/yr
SS3	HHD	1.17	1.17	0.46	2.31	7.32	0.51	1.07E-2	g/VMT	*EPA_MOVES2014a*	399,360	VMT/yr
SS4	LHD45	0.59	0.59	0.29	1.87	4.94	0.68	1.05E-2	g/VMT	*EPA_MOVES2014a*	249,600	VMT/yr
SS5	MHD	0.80	0.80	0.38	2.17	5.68	0.84	1.05E-2	g/VMT	*EPA_MOVES2014a*	62,400	VMT/yr
SS6	T4-kW>560 2015	0.04	0.04	0.04	3.50	3.50	0.19	6.57E-3	g/kW-hr	*EPA_NRS*	437,139	kW-hr/yr
SS7	T4-130≤kW≤560 2015	0.02	0.02	0.02	3.50	0.40	0.19	6.57E-3	g/kW-hr	*EPA_NRS*	191,248	kW-hr/yr
SS8	T4-56≤kW<130 2015	0.02	0.02	0.02	5.00	0.40	0.19	6.57E-3	g/kW-hr	*EPA_NRS*	273,212	kW-hr/yr

Final emission factor options:

Category	EF Unit	Activity Unit	Emission Unit	Multiplier
EPA_CERT	lb/hp-hr	hp-hr/yr	ton/yr	5.0E-4
EPA_NRS	g/kW-hr	kW-hr/yr	ton/yr	1.1E-6
EPA_AP42	lb/hp-hr	hp-hr/yr	ton/yr	5.0E-4
EPA_MOVES2014a	g/VMT	VMT/yr	ton/yr	1.1E-6

Conversions

453.6	g/lb	2,000	lb/ton
1.341	hp/kW		

Air Sciences Inc.	PROJECT TITLE: Midas Gold	BY: E. Memon
	PROJECT NO: 335-1-1	PAGE: 7 OF: 9 SHEET: PwrConst
AIR EMISSION CALCULATIONS	SUBJECT: Power Line Construction Emissions	DATE: June 30, 2021

Power Line Construction

Mobile Equipment Tailpipe

	PM	PM10		PM2.5		CO		NOX		SO2		VOC
ID	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr
Transmission Line												
TL1	0.03	0.17	0.03	0.17	0.03	2.44	5.34	0.28	0.61	4.6E-3	0.01	0.29
TL2	8.8E-3	0.05	8.8E-3	0.05	8.8E-3	0.71	1.55	0.08	0.18	1.3E-3	2.9E-3	0.08
TL3	0.13	0.70	0.13	0.28	0.05	0.12	0.25	0.37	0.81	5.4E-4	1.2E-3	0.06
TL4	0.19	1.06	0.19	0.42	0.08	0.17	0.38	0.55	1.21	8.1E-4	1.8E-3	0.08
TL5	0.13	0.70	0.13	0.28	0.05	0.12	0.25	0.37	0.81	5.4E-4	1.2E-3	0.06
TL6	0.20	1.11	0.20	0.55	0.10	0.29	0.64	0.78	1.70	1.7E-3	3.6E-3	0.24
TL7	4.0E-3	0.02	4.0E-3	0.02	4.0E-3	0.46	1.00	0.04	0.08	6.0E-4	1.3E-3	0.04
TL8	0.02	0.13	0.02	0.13	0.02	1.93	4.22	0.22	0.48	3.6E-3	7.9E-3	0.23
TL9	0.03	0.18	0.03	0.07	0.01	0.03	0.06	0.09	0.20	1.3E-4	2.9E-4	0.01
TL10	0.13	0.70	0.13	0.28	0.05	0.12	0.25	0.37	0.81	5.4E-4	1.2E-3	0.06
TL11	0.10	0.53	0.10	0.21	0.04	0.09	0.19	0.28	0.60	4.0E-4	8.8E-4	0.04
TL12	0.05	0.26	0.05	0.10	0.02	0.04	0.10	0.14	0.30	2.0E-4	4.4E-4	0.02
TL13	0.13	0.70	0.13	0.28	0.05	0.12	0.25	0.37	0.81	5.4E-4	1.2E-3	0.06
TL14	7.2E-3	0.04	7.2E-3	0.04	7.2E-3	0.58	1.26	0.07	0.14	1.1E-3	2.4E-3	0.07
TL15	9.2E-3	0.05	9.2E-3	0.05	9.2E-3	0.74	1.62	0.08	0.18	1.4E-3	3.0E-3	0.09
TL16	0.68	3.74	0.68	3.74	0.68	27.27	59.73	27.27	59.73	0.05	0.11	3.24
TL17	0.08	0.44	0.08	0.44	0.08	3.21	7.03	3.21	7.03	6.0E-3	0.01	0.38
TL18	0.03	0.18	0.03	0.07	0.01	0.03	0.06	0.09	0.20	1.3E-4	2.9E-4	0.01
Substation												
SS1	8.0E-3	0.04	8.0E-3	0.04	8.0E-3	0.92	2.01	0.07	0.16	1.2E-3	2.6E-3	0.08
SS2	0.51	2.82	0.51	1.11	0.20	0.46	1.02	1.47	3.22	2.2E-3	4.7E-3	0.22
SS3	0.51	2.82	0.51	1.11	0.20	0.46	1.02	1.47	3.22	2.2E-3	4.7E-3	0.22
SS4	0.16	0.89	0.16	0.44	0.08	0.23	0.51	0.62	1.36	1.3E-3	2.9E-3	0.19
SS5	0.05	0.30	0.05	0.14	0.03	0.07	0.15	0.18	0.39	3.3E-4	7.3E-4	0.06
SS6	0.02	0.11	0.02	0.11	0.02	0.77	1.69	0.77	1.69	1.4E-3	3.2E-3	0.09
SS7	4.2E-3	0.02	4.2E-3	0.02	4.2E-3	0.34	0.74	0.04	0.08	6.3E-4	1.4E-3	0.04
SS8	6.0E-3	0.03	6.0E-3	0.03	6.0E-3	0.69	1.51	0.06	0.12	9.0E-4	2.0E-3	0.06
Total	3.25	17.81	3.25	10.18	1.86	42.39	92.84	39.33	86.13	0.09	0.19	6.02

LT Unit	ST Unit	Multiplier
ton/yr	lb/day	5.479
ton/yr	lb/hr	0.457

Conversions
2,000 lb/ton
453.59 g/lb

Air Sciences Inc.	PROJECT TITLE: Midas Gold	BY: E. Memon
	PROJECT NO: 335-1-1	PAGE: 8 OF: 9 SHEET: PwrConst
AIR EMISSION CALCULATIONS	SUBJECT: Power Line Construction Emissions	DATE: June 30, 2021

Power Line Construction

Hazardous Air Pollutants (HAP) and Greenhouse Gases (GHG)

Fuel Consumption TRUE

Small Engines	961,584 gal/yr	131,737 MMBTU/yr[1]	
Large Engines	1,215,552 gal/yr	166,531 MMBTU/yr[1]	

[1] *Based on 137,000 BTU/gal AP-42, Sec. 3.3*

Combustion HAP Emission Factors and Emissions

CAS No.	Pollutant/Group	Small Engines[1] lb/MMBtu	Large Engines[2] lb/MMBtu	Emissions[4] lb/yr	Emissions[4] ton/yr
106990	1,3-Butadiene	3.91E-5		5.2	2.6E-3
75070	Acetaldehyde	7.67E-4	2.52E-5	105.2	5.3E-2
107028	Acrolein	9.25E-5	7.88E-6	13.5	6.7E-3
71432	Benzene	9.33E-4	7.76E-4	252.1	0.1
50000	Formaldehyde	1.18E-3	7.89E-5	168.6	8.4E-2
	POM [3]	1.68E-4	2.12E-4	57.4	2.9E-2
108883	Toluene	4.09E-4	2.81E-4	100.7	5.0E-2
1330207	Xylene	2.85E-4	1.93E-4	69.7	3.5E-2
Combustion HAP Total				772.3	0.39

[1] *AP-42, Tab. 3.3-2, 10/96, diesel engines (≤ 600 hp)*

[2] *AP-42, Tabs. 3.4-3 & 3.4-4, 10/96, large diesel engines (> 600 hp)*

[3] *POM = Polyoxymethylene, includes:*
2-Methylnaphthalene, 3-Methylchloranthrene, 7,12-Dimethylbenz(a)anthracene, Acenaphthene, Acenaphthylene, Anthracene, Benz(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(g,h,i)perylene, Benzo(k)fluoranthene, Chrysene, Dibenzo(a,h)anthracene, Fluoranthene, Fluorene, Indeno(1,2,3-c,d)pyrene, Naphthalene, Phenanthrene, Pyrene.

Dust HAP Emission Factors and Emissions

HAP Concentrations[1] and Emissions

CAS No.	Pollutant	ppm	Emissions lb/yr	Emissions ton/yr
7440382	Arsenic	667	29.3	1.5E-2
7440417	Beryllium	3.2	0.1	7.0E-5
7440439	Cadmium	0.5	2.2E-2	1.1E-5
7440484	Cobalt	4.0	0.2	8.8E-5
7440473	Chromium	9.0	0.4	2.0E-4
7439976	Mercury	0.6	2.6E-2	1.3E-5
7439965	Manganese	299	13.1	6.6E-3
7440020	Nickel	2.0	8.8E-2	4.4E-5
7439921	Lead	8.0	0.4	1.8E-4
7440360	Antimony	23	1.0	5.0E-4
7723140	Phosphoru	650	28.5	1.4E-2
Dust HAP Total			73.2	3.7E-2

Applicable Dust Emissions

Activity	PM ton/yr
Facility and Infrastructure Construction	22.0

[1] *O/DR: ore and development rock; (Midas Gold 2017c) for all metals but Hg and Se; Hg value from (Midas Gold 2018i); Se value from (Midas Gold 2020)*

Conversions

907,186	g/ton
1,000	kW/MW
1.341	hp/kW
1,000,000	BTU/MMBTU
2,000	lb/ton

Air Sciences Inc.	PROJECT TITLE: Midas Gold	BY: E. Memon	
	PROJECT NO: 335-1-1	PAGE: 9	OF: 9 SHEET: PwrConst
AIR EMISSION CALCULATIONS	SUBJECT: Power Line Construction Emissions	DATE: June 30, 2021	

Power Line Construction

GHG Emission Factors [1] ***and Emissions***

Fuel	CO2	CH4	N2O	CO2	CH4	N2O	CO2e
	kg/MMBtu			mt/yr	mt/yr	mt/yr	mt/yr
Diesel	73.96	3.0E-3	6.0E-4	22,060	0.9	0.2	22,136
Combustion Total GHG				22,060	0.9	0.2	22,136

[1] *40 CFR 98 Tab. C-1 and C-2 (CFR. 2018d)*

Global Warming Potential [1, 2]

CO2	1
CH4	25
N2O	298

[1] *40 CFR 98 Tab. A-1 (CFR. 2018d)*

[2] *Annex I Parties, 100-year time horizon (UNCC n.d.); (IPCC 2007)*

Conversions

1,000 kg/mt
2,000 lb/ton

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: K. Lewis
	PROJECT NO: 335-21-402/404	PAGE: 1 OF: 1 SHEET: HgSpec
AIR EMISSION CALCULATIONS	SUBJECT: Hg Emission Speciation	DATE: June 30, 2021

Mining Year **10**

Facility-Wide Hg Emission and Speciation

Emissions

	Total Hg		Speciation*				Hg0	Hg2	HgP	Hg2+P
Activity	ton/yr	lb/yr	Hg0	Hg2	HgP	Total	ton/yr	ton/yr	ton/yr	ton/yr
Process Propane Combustion	0.00005	0.11		100%		100%	--	5.3E-05	--	5.3E-05
Autoclave	0.00010	0.20	97.9%	1.6%	0.5%	100%	9.9E-05	1.6E-06	4.9E-07	2.1E-06
Refinery Sources (Kiln, EW, Retort, Furnace)	0.00168	3.36	98.4%	1.4%	0.1%	100%	1.7E-03	2.4E-05	2.5E-06	2.6E-05
Process Dust	0.00107	2.15			100%	100%	--	--	1.1E-03	1.1E-03
Mine Fugitive Dust	0.00033	0.67			100%	100%	--	--	3.3E-04	3.3E-04
Mine Fugitive Mercury Flux	0.00356	7.13	100%			100%	3.6E-03	--	--	--
Total	0.00680	13.61					5.3E-03	7.8E-05	1.4E-03	1.5E-03
*See tables below:							78%	1.1%	20.7%	21.9%
Process Subtotal	0.0029	0.0029	chk					chk	1.15E-3	1.15E-3
Mine Subtotal	0.0039	0.0039	chk					chk	3.33E-4	3.33E-4

Autoclave Test Data

Source	Date	Method	Hg0 lb/hr	Hg2 lb/hr	HgP lb/hr	HgTotal lb/hr	Hg0 %	Hg2 %	HgP %
Autoclave Phase 1	10/5/20005	FAMS	0.0426	0.000689	0.00021	0.0435	97.93%	1.58%	0.49%

(NDEP 2006)

Refinery Test Data

Source	Date	Method	Hg0 lb/hr	Hg2 lb/hr	HgP lb/hr	HgTotal lb/hr	Hg0 %	Hg2 %	HgP %
Refinery Retort	10/17/2006	OHM	0.00343	0.000055	9E-06	0.0035	98.17%	1.57%	0.26%
AARL Kiln Scrubber	10/14/2006	OHM	0.02799	0.000268	2.3E-05	0.02828	98.97%	0.95%	0.08%
Melt/Pour Furnace	10/12/2006	OHM	0.01041	0.000273	3.1E-05	0.01072	97.16%	2.55%	0.29%
(WES&T 2006)						Wt. Avg.	98.45%	1.40%	0.15%

Estimated Hg emissions split between Refinery Sources for modeling purposes only:

Source	Split
Kiln	25%
EW	25%
Retort	25%
Furnace	25%
	100%

Conversions

2,000 lb/ton

Air Sciences Inc.	PROJECT TITLE: Midas Gold	BY: K. Lewis	
	PROJECT NO: 335-1-2.4	PAGE: 1	OF: 1 SHEET: HgStoke's
AIR EMISSION CALCULATIONS	SUBJECT: Hg Deposition Parameters	DATE: June 30, 2021	

Stoke's Law

Vts = $gd^2(p - pa) / 18n$ *Engineering Tool Box*

Vts	terminal settling velocity				
g	gravitational acceleration	9.81E+02	cm/s^2		*Engineering Tool Box*
d	diameter of particle (cm)				
pa	density of air	1.212E-03	g/cm^3	18C	*Engineering Tool Box*
p	density of particle (g/cm^3)				
n	coefficient of viscosity of air	1.80E-04	g/cm-s	18C	*Engineering Tool Box*
µ	micron				

Literature values for deposition velocity of Hg2 and HgP

Hg2	0.5-6 cm/s	*(L. Zhang 2009)*	Range Average	3.25 cm/s
HgP	0.02-2 cm/s	*(L. Zhang 2009)*	Range Average	1.01 cm/s
			Average	2.13 cm/s

d	7 µ		*Aerodynamic diameter to achieve a Vts of ~2 cm/s*
p	13.545 g/cm^3	20C	*Engineering Tool Box (liquid Hg)*
Vts	2.01 cm/s		

$$\frac{0.04362\ \text{lb/ft-h}}{} \left| \frac{453.592\ \text{g}}{\text{lb}} \right| \frac{\text{ft}}{30.48\ \text{cm}} \left| \frac{\text{hr}}{3600\ \text{s}} \right. = 1.80\text{E-}04\ \text{g/cm-s} = 1.80\text{E-}02\ \text{g/m-s}$$

$$\frac{9.81\text{E+}02\ \text{cm}}{\text{s}^2} \left| \frac{4.9\text{E-}07\ \text{cm}^2}{} \right| \frac{13.545\ \text{g}}{\text{cm}^3} - \frac{1.21\text{E-}03\ \text{g}}{\text{cm}^3} \left| \frac{}{18} \right| \frac{\text{cm-s}}{1.80\text{E-}04\ \text{g}} = \frac{2.006\ \text{cm}}{\text{s}}$$

Conversions

10,000 cm/µ

Engineering Tool Box URLs

https://www.engineeringtoolbox.com/mercury-d_1002.html
https://www.engineeringtoolbox.com/air-density-specific-weight-d_600.html
https://www.engineeringtoolbox.com/air-absolute-kinematic-viscosity-d_601.html
https://www.engineeringtoolbox.com/accelaration-gravity-d_340.html
https://www.ajdesigner.com/phpstokeslaw/stokes_law_terminal_velocity.php

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 1 OF: 3 SHEET: Conv
AIR EMISSION CALCULATIONS	SUBJECT: Conversions and Constants	DATE: June 30, 2021

Conversions

60	sec/min
60	min/hr
24	hr/day
365	day/yr
8,760	hr/yr
3,600	s/hr
2,000	lb/ton
453.593	g/lb
3.28084	ft/m
35.3147	ft^3/m^3
7,000	gr/lb
1.341	hp/kW
7.05	lb/gal distillate oil
907.1858	kg/ton
459.67	°R at 0°F
68	°F, standard
7,000	BTU/hp-hr
2.2369	mi/hr per m/s
7.48052	gal/ft^3
1.10231	ton/t
2.20462	lb/kg
1609.34	m/mi
137,000	BTU/gal
4046.9	m^2/acre
43,560	ft^2/acre
12	in/ft
1.10231	ton/mt
1.0E+6	g/mt
3	ft/yd
1.0E+6	scf/MMscf
10,000	m^2/ha
1,000	kg/mt
273.15	°K at 0°C
32	°F at 0°C
1.8	°F/°C
1,000	ng/µg
0.293297	MW-hr/MMBtu
12	mo/yr

Fuel Specifications

15	ppm S content	*40 CFR 80.510 (Non-road diesel)*
7.05	lb/gal-fuel	*AP-42, App. A*
32.065	lb/lb-mol S, and	
64.06	lb/lb-mol SO2	
7,000	Btu/hp-hr	*AP-42, Sec. 3.3, (Diesel engine)*
0.00939	MMBtu/kW-hr	*Diesel*
0.137	MMBtu/gal	*AP-42, App. A (Diesel)*
0.0915	MMBtu/gal Propane	

AP-42 Appendix A "Weights of Selected Substances" (Distillate oil)

AP-42, Sec. 3.3, (Diesel) 6893.04

AP-42, App. A (Diesel)

Constants

M.W. SO2	64.0638
M.W. S	32.065
M.W. O	15.9994

Diesel SO2

$$\frac{15 \text{ parts S}}{1.0E+06} \times \frac{7.05 \text{ lb}}{\text{gal diese}} \times \frac{64.06 \text{ SO2}}{32.065 \text{ S}} \times \frac{\text{gal}}{0.137 \text{ MMBtu}} \times \frac{0.00939 \text{ MMBtu}}{\text{kW-hr}} \times \frac{453.593 \text{ g}}{\text{lb}} = 6.57E\text{-}03 \frac{\text{g SO2}}{\text{kW-hr}}$$

Calculation

$$\frac{185 \text{ lb S}}{1.00E+06 \text{ lb C3H8}} \times \frac{44.08 \text{ lb C3H8}}{\text{lb mol}} \times \frac{\text{lb mol}}{359.05 \text{ SCF (0C)}} \times \frac{7{,}000 \text{ gr}}{\text{lb}} \times \frac{100 \text{ SCF}}{100\text{SCF}} = 15.90 \frac{\text{gr S}}{100 \text{ SCF}}$$

Propane heating value 91,500 *Btu/gal* *AP-42, Table 1.5-1 (07/08) Footnote a*

AP-42, Chapter 13.2.4 Particle Size Fractions

0.35	PM10
0.053	PM2.5

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 2 OF: 3 SHEET: Conv
AIR EMISSION CALCULATIONS	SUBJECT: Conversions and Constants	DATE: June 30, 2021

Fuel Combustion Exhaust Flow (EPA Method 19, Ffactor)

Propane Heater

F-factor	8,710	dscf/MMBtu	Propane, dry
O2%dry	3	%	
Heat input	1	MMBtu/hr	
Standard exhaust flow	10,170	dscf/hr	
	169	dscfm	
Vol % moisture	15.0%	standard for propane boilers	
Temperature	360	°F, Engineering Toolbox* (LPG heating appliances)	
Pressure, site	0.79	atm	
Actual exhaust flow	394	acfm (wet)/MMBtu	

Diesel Engine

F-factor	9,190	dscf/MMBtu	Oil, dry
O2%dry	9	%	
Heat input	0.007	MMBtu/hp-hr	AP-42, Sec. 3.3, (Diesel engine)
Standard exhaust flow	113	dscf/hp-hr	
	1.9	dscfm/hp	2.5 dscfm/kW
Vol % moisture	8.0%	standard for diesel engines	
Temperature	1,100	°F, Engineering Toolbox* (diesel exhaust)	
Pressure, site	0.79	atm	
Actual exhaust flow	7.7	acfm (wet)/hp	10.3 acfm (wet)/kW

* *http://www.engineeringtoolbox.com/fuels-exhaust-temperatures-d_168.html*

Refinery and Autoclave Exhaust Flow

dscfm acfm temp_F dia_ft

Source	Hourly Design Rate		Exhaust Parameters Water	Flow dscfm	Flow acfm	Temp F	Velocity ft/s	Dia ft
Carbon Regeneration Kiln (Drum)	0.3	ton	1%	120	180	150	17	0.48
Electrowinning Cells & Pregnant Solution Tan	100	gpm	4%	2,660	3,740	100	79	1
Mercury Retort	0.5/batch	ton	1%	16	20	150	5	0.29
Induction Melting Furnace	0.5/batch	ton	1%	3,500	5,200	150	71	1.25
Autoclave	290	ton	83%	3,101	28,680	196	24	5
Sb Bagging			0%	800	1,000	68	21	1
Limestone Ball Mill			0%	13,000	16,500	68	88	2
Parallel Flow Regenerative (PFR) Shaft Lime Kiln			4%	8,000	16,300	350	86	2
Lime Mill Crushing and associated transfers In and Out			0%	2,000	2,500	68	119	0.667

Site Pressure Calculation

http://www.sensorsone.com/altitude-pressure-units-conversion/

6000	23.978	6531.9	
7000	23.088	23.505	
0		29.921	0.78556

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project ModPRO2	BY: E. Memon
	PROJECT NO: 335-21-402/404	PAGE: 3 OF: 3 SHEET: Conv
AIR EMISSION CALCULATIONS	SUBJECT: Conversions and Constants	DATE: June 30, 2021

Lime Kiln Specifications

810 *kcal/kg*	100 ton/day	*(Maerz 2018)*	3.96567 *btu/kcal*
870 *kcal/kg*	400 ton/day	*(Maerz 2018)*	
870 *kcal/kg*	169 ton/day	*Midas Gold Kiln Throughput, maximum-case fuel assumption*	

Lime kiln heat requirements

870 kcal / kg	907.186 kg / ton	3.96567 Btu / kcal	MMBtu / 1.E+06 Btu	=	3.130 MMBtu / ton	

Dyno Nobel 2010 "Blasting and Explosives Quick Reference Guide"

(B*S*BH*N)/(PI()*D^2/4000*L)

BH	10	m	BH - Bench Height (m) ≥D/15
N	100		N - Number of Holes in a Blast
D	0.15	m	D - Hole Diameter (mm)
B	4.9	m	B - Drilled Burden (m) =(25 to 40) x D
S	5.6	m	S - Drilled Spacing (m) =1.15 x B
L	10	m	L - Hole Length
V	27,330		
Vb	70.7		
V/Vb	386.6	400	

Enclosure Control Efficiency Calculation

Emission factor equation	$E = 0.0032k(U/5)^{1.3}/(M/2)^{1.4}$				*AP-42, Sec. 13.2.4, Eq. 1, 11/06*	
U = Mean wind speed	5.167 mph		2.31 m/s		*(Midas Gold 2017f), Fig. 4-3 (2014 onsite meteorological data)*	
U = Mean wind speed	1.3 mph				*Lowest wind speed for Eq. 1, AP-42, Sec. 13.2.4, Eq. 1, 11/06*	
M = Moisture content	2.5 %					
	PM	PM10	PM2.5			
k = Particle size multiplier	0.74	0.35	0.053		*AP-42, Sec. 13.2.4, Pg. 4, 11/06*	
E = Emission factor	0.00181	0.00086	0.00013	lb/ton	U =	5.167
E = Emission factor	0.00030	0.00014	0.00002	lb/ton	U =	1.300
Control Efficiency	83.4%	83.4%	83.4%			

APPENDIX B PERMIT TO CONSTRUCT APPLICATION EMISSIONS INVENTORY

REC 2818

Facility Wide Potential to Emit Emission Inventory

Table 8. POTENTIAL TO EMIT FOR NSR REGULATED POLLUTANTS

Emissions	PM	PM10	PM2.5	CO	Pb	NO2	VOC	SO2	CO2e
Unit	T/yr	T/yr	T/yr	T/yr	T/yr	T/yr	T/yr	T/yr	T/yr
Process & Ancillary Point Sources									
LS1L	2.2E-3	7.4E-4	1.1E-4		--				--
MillS2L	2.2E-3	7.4E-4	1.1E-4		--				--
Sb1	0.09	0.09	0.09	0.98	--	1.69	0.10	0.21	1,658
Sb2	0.52	0.52	0.52		--				--
AC	22.23	22.23	22.23		--			2.86	47,316
ACB	2.0E-3	2.0E-3	2.0E-3	0.02	--	0.04	2.2E-3	4.4E-3	35.49
ACS1L	8.7E-3	3.0E-3	4.4E-4		--				--
ACS2L	8.7E-3	3.0E-3	4.4E-4		--				--
ACS3L	8.7E-3	3.0E-3	4.4E-4		--				--
ACS4L	4.3E-3	1.5E-3	2.2E-4		--				--
CKD	1.84	1.84	1.84	0.53	--	0.05	0.48		--
CKB	0.08	0.08	0.08	0.81	--	1.40	0.09	0.17	1,375
EW	0.31	0.31	0.31		--				--
MR	6.2E-3	6.2E-3	6.2E-3		--				--
MF	0.89	0.89	0.89		--				--
EDG1	0.02	0.02	0.02	0.39	--	0.71	0.14	7.2E-4	76.79
EDG2	0.02	0.02	0.02	0.39	--	0.71	0.14	7.2E-4	76.79
EDG3	0.02	0.02	0.02	0.39	--	0.71	0.14	7.2E-4	76.79
EDFP	4.4E-3	4.4E-3	4.4E-3	0.08	--	0.09	0.09	1.4E-4	15.36
PV	3.4E-3	3.4E-3	3.4E-3	0.04	--	0.06	3.8E-3	7.6E-3	60.95
HS	0.17	0.17	0.17	1.80	--	3.11	0.19	0.38	3,048
H1M	0.13	0.13	0.13	1.44	--	2.49	0.15	0.30	2,438
H2M	0.13	0.13	0.13	1.44	--	2.49	0.15	0.30	2,438
HM	0.13	0.13	0.13	1.44	--	2.49	0.15	0.30	2,438
HAC	8.4E-3	8.4E-3	8.4E-3	0.09	--	0.16	9.6E-3	0.02	152
HR	8.4E-3	8.4E-3	8.4E-3	0.09	--	0.16	9.6E-3	0.02	152
HA	8.4E-3	8.4E-3	8.4E-3	0.09	--	0.16	9.6E-3	0.02	152
HMO	0.02	0.02	0.02	0.18	--	0.31	0.02	0.04	305
HTS	0.07	0.07	0.07	0.72	--	1.24	0.08	0.15	1,219
HW	0.10	0.10	0.10	1.08	--	1.87	0.11	0.23	1,829
PSL	0.07	0.03	3.9E-3		--				--
CS1L	0.03	0.01	1.5E-3		2.2E-5				--
CS2L	0.03	0.01	1.5E-3		2.2E-5				--
TG1					--		0.96		--
TG2					--		0.96		--
TD3					--		7.3E-3		--
TD4					--		7.3E-3		--
TD5					--		7.3E-3		--
TD6					--		7.3E-3		--
TD7					--		7.3E-3		--
TD8					--		7.3E-3		--
TD9					--		7.3E-3		--
TD10					--		7.3E-3		--
LS6	0.48	0.17	0.03		--				--
LSBM	6.42	5.39	1.92		--				--
LS9	0.12	0.05	7.0E-3		--				--
LK	3.40	3.40	3.40	11.78	--	6.29		0.03	30,311
LKC	0.63	0.63	0.63	6.72	--	11.65	0.72	1.42	11,407
LCR	1.06	0.89	0.32		--				--
LSL	0.02	0.02	0.02		--				--

Midas Gold - Stibnite Gold Project
IDEQ - Emission Inventory

Facility Wide Potential to Emit Emission Inventory

Table 8. POTENTIAL TO EMIT FOR NSR REGULATED POLLUTANTS

Emissions	PM	PM10	PM2.5	CO	Pb	NO2	VOC	SO2	CO2e
Unit	T/yr	T/yr	T/yr	T/yr	T/yr	T/yr	T/yr	T/yr	T/yr
Process & Ancillary Fugitive Sources									
OC1	0.64	0.21	0.06		5.1E-6				--
OC2	0.64	0.21	0.06		5.1E-6				--
OC3	0.64	0.21	0.06		5.1E-6				--
OC4	0.64	0.21	0.06		5.1E-6				--
OC5	0.64	0.21	0.06		5.1E-6				--
OC6	0.64	0.21	0.06		5.1E-6				--
OC7	5.48	2.46	0.46		4.4E-5				--
OC8	0.64	0.21	0.06		5.1E-6				--
OC9	3.02	1.11	0.17		2.4E-5				--
OC10	3.02	1.11	0.17		2.4E-5				--
OC11	3.02	1.11	0.17		2.4E-5				--
OC12	6.04	2.72	0.50		4.8E-5				--
OC13	0.71	0.23	0.07		5.6E-6				--
LS1U	0.01	6.1E-3	9.2E-4		--				--
MillS2U	0.01	6.1E-3	9.2E-4		--				--
ACS1U	0.04	0.02	3.5E-3		--				--
ACS2U	0.04	0.02	3.5E-3		--				--
ACS3U	0.04	0.02	3.5E-3		--				--
ACS42U	0.02	0.01	1.8E-3		--				--
PSU	0.07	0.03	3.9E-3		--				--
CS1U	0.14	0.08	0.01		--				--
CS2U	0.14	0.08	0.01		--				--
CAL	1.73	0.83	0.13		--				--
CAU	1.73	0.83	0.13		--				--
CM	0.55	0.17	0.02		1.1E-5				--
PCSP1	2.74	1.02	0.13		--				--
PCSP2	2.74	1.02	0.13		--				--
LS1	0.48	0.17	0.03		--				--
LS2	0.86	0.38	0.06		--				--
LS3	3.97	1.38	0.21		--				--
LS4	0.86	0.38	0.06		--				--
LS5	3.97	1.38	0.21		--				--
LS7	0.48	0.17	0.03		--				--
LS8	0.48	0.17	0.03		--				--
LS10	0.12	0.05	7.0E-3		--				--
LS11	1.03	0.36	0.05		--				--
LS12	0.12	0.05	7.0E-3		--				--
LSU	2.3E-3	2.3E-3	2.3E-3		--				--
Mining Fugitive Sources Model Scenario: W3									
YPP	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
HFP	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
WEP	345	162	14.53	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
BT	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
TSF	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
UGEXP	1.5E-3	7.3E-4	1.1E-4	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
YPPBL	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
HFPBL	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
WEPBL	117	61.02	3.52	636		17.08	0.0E+0	0.03	
BTBL	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
STKP	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
FDRSF	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
HFDRSF	52.91	10.42	5.52	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
YPDRSF	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
WEDRSF	0.0E+0	0.0E+0	0.0E+0	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
HR	3,047	751	75.12	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
ACCRD	6.95	1.72	0.17	0.0E+0		0.0E+0	0.0E+0	0.0E+0	
Totals	**3,656**	**1,042**	**135**	**666**	**2.6E-4**	**54.93**	**4.78**	**6.51**	**106,580**

PET-1100

REC 2820

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 1 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emissions	DATE: December 18, 2020

Model Scenario W3

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	HAP/TAP	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
106-99-0	1,3-Butadiene	8.4E-07	3.7E-06	0	0	0	0	8.4E-07	3.7E-06	Y	Y
91-57-6	2-Methylnaphthalene	1.1E-06	4.6E-06	0	0	0	0	1.1E-06	4.6E-06	Y	N
56-49-5	3-Methylchloranthrene	7.8E-08	3.4E-07	0	0	0	0	7.8E-08	3.4E-07	Y	Y
57-97-6	7,12-Dimethylbenz(a)anthracene	7.6E-07	3.0E-06	0	0	0	0	7.6E-07	3.0E-06	Y	N
83-32-9	Acenaphthene	5.7E-06	7.1E-06	0	0	0	0	5.7E-06	7.1E-06	Y	N
208-96-8	Acenaphthylene	1.1E-05	1.4E-05	0	0	0	0	1.1E-05	1.4E-05	Y	N
75-07-0	Acetaldehyde	2.5E-05	1.1E-04	0	0	0	0	2.5E-05	1.1E-04	Y	Y
107-02-8	Acrolein	1.6E-05	2.0E-05	0	0	0	0	1.6E-05	2.0E-05	Y	Y
120-12-7	Anthracene	1.7E-06	2.4E-06	0	0	0	0	1.7E-06	2.4E-06	Y	N
7440-36-0	Antimony	0	0	5.7E-04	2.5E-03	1.9E-02	8.2E-02	1.9E-02	8.5E-02	Y	Y
7440-38-2	Arsenic	8.7E-06	3.8E-05	4.5E-03	2.0E-02	0.54	2.38	0.55	2.40	Y	Y
56-55-3	Benz(a)anthracene	3.1E-07	1.4E-06	0	0	0	0	3.1E-07	1.4E-06	Y	Y
71-43-2	Benzene	3.6E-04	1.6E-03	7.0E-03	3.1E-02	0	0	7.4E-03	3.2E-02	Y	Y
50-32-8	Benzo(a)pyrene	1.4E-07	6.1E-07	0	0	0	0	1.4E-07	6.1E-07	Y	Y
205-99-2	Benzo(b)fluoranthene	4.4E-07	1.9E-06	0	0	0	0	4.4E-07	1.9E-06	Y	Y
191-24-2	Benzo(g,h,i)perylene	7.5E-07	1.1E-06	0	0	0	0	7.5E-07	1.1E-06	Y	N
207-08-9	Benzo(k)fluoranthene	1.5E-07	6.6E-07	0	0	0	0	1.5E-07	6.6E-07	Y	Y
7440-41-7	Beryllium	5.2E-07	2.3E-06	4.3E-04	1.9E-03	2.6E-03	1.1E-02	3.0E-03	1.3E-02	Y	Y
92-52-4	Biphenyl	0	0	4.4E-05	1.9E-04	0	0	4.4E-05	1.9E-04	Y	Y
7440-43-9	Cadmium	4.8E-05	2.1E-04	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.7E-04	3.8E-03	Y	Y
75-15-0	Carbon Disulfide	0	0	1.4E-02	6.3E-02	0	0	1.4E-02	6.3E-02	Y	Y
7440-47-3	Chromium	6.6E-05	2.7E-04	6.1E-04	2.5E-03	7.3E-03	3.2E-02	8.0E-03	3.5E-02	Y	Y
18540-29-9	Cr (VI)	0	0	3.4E-07	1.5E-06	0	0	3.4E-07	1.5E-06	Y	Y
218-01-9	Chrysene	5.8E-07	2.5E-06	0	0	0	0	5.8E-07	2.5E-06	Y	Y
7440-48-4	Cobalt	4.0E-06	1.6E-05	4.7E-04	2.0E-03	3.3E-03	1.4E-02	3.7E-03	1.6E-02	Y	Y
592-01-8	Cyanide	0	0	0.45	1.99	0	0	0.45	1.99	Y	Y
53-70-3	Dibenzo(a,h)anthracene	1.8E-07	7.7E-07	0	0	0	0	1.8E-07	7.7E-07	Y	Y
106-46-7	Dichlorobenzene	5.7E-05	2.3E-04	0	0	0	0	5.7E-05	2.3E-04	Y	Y
206-44-0	Fluoranthene	5.5E-06	7.0E-06	0	0	0	0	5.5E-06	7.0E-06	Y	N
86-73-7	Fluorene	1.7E-05	2.1E-05	0	0	0	0	1.7E-05	2.1E-05	Y	N
50-00-0	Formaldehyde	3.3E-03	1.5E-02	0	0	0	0	3.3E-03	1.5E-02	Y	Y
110-54-3	Hexane	8.5E-02	0.34	3.1E-02	0.14	0	0	0.12	0.48	Y	Y
7647-01-0	Hydrogen Chloride	0	0	0.99	3.67	0	0	0.99	**3.67**	Y	Y
193-39-5	Indeno(1,2,3-cd)pyrene	2.2E-07	9.6E-07	0	0	0	0	2.2E-07	9.6E-07	Y	Y
7439-92-1	Lead	0	0	4.8E-04	2.1E-03	6.5E-03	2.9E-02	7.0E-03	3.1E-02	Y	N
7439-96-5	Manganese	1.8E-05	7.2E-05	4.6E-03	1.7E-02	0.24	1.07	0.25	1.08	Y	Y
7439-97-6	Mercury	1.2E-05	5.0E-05	6.9E-04	2.9E-03	1.3E-03	5.7E-03	2.0E-03	8.6E-03	Y	N
91-20-3	Naphthalene	1.9E-04	3.1E-04	1.9E-03	8.5E-03	0	0	2.1E-03	8.8E-03	Y	Y
7440-02-0	Nickel	9.1E-05	4.0E-04	4.6E-04	2.0E-03	1.6E-03	7.1E-03	2.2E-03	9.5E-03	Y	Y
85-01-8	Phenanthrene	5.1E-05	6.3E-05	0	0	0	0	5.1E-05	6.3E-05	Y	N
108-95-2	Phenol	0	0	2.4E-04	1.1E-03	0	0	2.4E-04	1.1E-03	Y	Y
7723-14-0	Phosphorus	0	0	5.6E-03	2.3E-02	0.53	2.32	0.54	2.34	Y	Y
129-00-0	Pyrene	5.0E-06	6.6E-06	0	0	0	0	5.0E-06	6.6E-06	Y	N
7782-49-2	Selenium	1.1E-06	4.6E-06	4.1E-04	1.8E-03	3.3E-04	1.4E-03	7.4E-04	3.2E-03	Y	Y
108-88-3	Toluene	5.2E-04	1.1E-03	3.2E-02	0.14	0	0	3.2E-02	0.14	Y	Y
1330-20-7	Xylene	2.5E-04	3.0E-04	3.1E-02	0.14	0	0	3.2E-02	0.14	Y	Y
Total HAP		9.0E-02	0.36	1.58	6.25	1.36	5.95	3.03	12.56		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

		0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
TRUE		0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
		chk	chk	chk	chk	chk	chk	chk	chk

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 2 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emissions	DATE: December 18, 2020

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary - continued

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	Non-HAP TAP	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
7429-90-5	Aluminum	0	0	0.65	2.58	57.86	253.41	58.50	255.98	N	Y
7440-39-3	Barium	2.1E-04	8.4E-04	6.6E-03	2.7E-02	0.65	2.86	0.66	2.88	N	Y
1317-65-3	Calcium Carbonate	0	0	2.24	8.12	11.41	49.97	13.65	58.09	N	Y
1305-78-8	Calcium Oxide	0	0	0.70	0.95	0	0	0.70	0.95	N	Y
7440-50-8	Copper	4.0E-05	1.6E-04	4.9E-04	2.1E-03	4.1E-03	1.8E-02	4.6E-03	2.0E-02	N	Y
110-82-7	Cyclohexane	0	0	1.0E-03	4.6E-03	0	0	1.0E-03	4.6E-03	N	Y
7783-06-4	Hydrogen Sulfide	0	0	0.90	3.94	0	0	0.90	3.94	N	Y
7439-89-6	Iron	0	0	0.21	0.81	14.83	64.96	15.04	65.77	N	Y
7439-98-7	Molybdenum	5.2E-05	2.1E-04	4.2E-04	1.8E-03	8.1E-04	3.6E-03	1.3E-03	5.6E-03	N	Y
109-66-0	Pentane	0.12	0.50	0	0	0	0	0.12	0.50	N	Y
7440-22-4	Silver	0	0	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.2E-04	3.6E-03	N	Y
7664-93-9	Sulfuric Acid	0	0	2.03	8.89	0	0	2.03	8.89	N	Y
7440-28-0	Thallium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-61-1	Uranium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-62-2	Vanadium	1.1E-04	4.4E-04	7.3E-04	3.0E-03	2.3E-02	1.0E-01	2.4E-02	0.10	N	Y
25551-13-7	Trimethyl benzene	0	0	1.1E-02	4.8E-02	0	0	1.1E-02	4.8E-02	N	Y
7440-33-7	Tungsten	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-66-6	Zinc	1.4E-03	5.5E-03	8.0E-04	3.3E-03	2.9E-02	0.12	3.1E-02	0.13	N	Y
Total Non-HAP TAP		0.13	0.50	6.75	25.40	84.83	371.54	91.71	397.44		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

Conversions
2,000 lb/ton
8,760 hr/yr
24 hr/day

TABLE B1-W3. HAP/TAP Emissions and Exemptions

						MINING										LEACHING	
						Mining Model Scenario W3										*CN Leach/PAX*	
						YPP,HFP,WEP,BT		YPPBL,HFPBL,WEP BL,BTBL		HR000		STKP, FDRSF, HFDRSF, YPDRSF, WEDRSF		TSF,ACCRD,UGEXP			
CAS	HAP/TAP	HAP	TAP			Pits		Blasting		Haul Roads		Stockpiles and DRFS		Tails, Access Road, Exploration		CN Leach and PAX	
	NSPS or NESHAP HAP/TAP -->			*Y*		*7E*	*7E*	*7E*	*7E*	*7E*	*7E*	*7E*	*7E*	*7E*	*7E*	*7E*	*7E*
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				**A/C**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
106-99-0	1,3-Butadiene	Y	Y	Y	**C**	0	0	0	0	0	0	0	0	0	0		
91-57-6	2-Methylnaphthalene	Y	**N**	**n/a**		0	0	0	0	0	0	0	0	0	0		
56-49-5	3-Methylchloranthrene	Y	Y	Y	**C**	0	0	0	0	0	0	0	0	0	0		
57-97-6	7,12-Dimethylbenz(a)anthracene	Y	**N**	**n/a**		0	0	0	0	0	0	0	0	0	0		
83-32-9	Acenaphthene	Y	**N**	**n/a**		0	0	0	0	0	0	0	0	0	0		
208-96-8	Acenaphthylene	Y	**N**	**n/a**		0	0	0	0	0	0	0	0	0	0		
75-07-0	Acetaldehyde	Y	Y	Y	**C**	0	0	0	0	0	0	0	0	0	0		
107-02-8	Acrolein	Y	Y	Y	**A**	0	0	0	0	0	0	0	0	0	0		
120-12-7	Anthracene	Y	**N**	**n/a**		0	0	0	0	0	0	0	0	0	0		
7440-36-0	Antimony	Y	Y	Y	**A**	1.8E-3	7.9E-3	6.2E-4	2.7E-3	0.016	0.070	2.8E-4	1.2E-3	3.7E-5	1.6E-4		
7440-38-2	Arsenic	Y	Y	Y	**C**	0.052	0.230	0.018	0.078	0.464	2.033	8.1E-3	0.035	1.1E-3	4.6E-3		
71-43-2	Benzene	Y	Y	Y	**C**	0	0	0	0	0	0	0	0	0	0		
50-32-8	**Benzo(a)pyrene**	Y	Y	Y	**C**	0	0	0	0	0	0	0	0	0	0		
56-55-3	**Benz(a)anthracene**	Y	Y	Y	**C**	0	0	0	0	0	0	0	0	0	0		
205-99-2	**Benzo(b)fluoranthene**	Y	Y	Y	**C**	0	0	0	0	0	0	0	0	0	0		
207-08-9	**Benzo(k)fluoranthene**	Y	Y	Y	**C**	0	0	0	0	0	0	0	0	0	0		
218-01-9	**Chrysene**	Y	Y	Y	**C**	0	0	0	0	0	0	0	0	0	0		
53-70-3	**Dibenzo(a,h)anthracene**	Y	Y	Y	**C**	0	0	0	0	0	0	0	0	0	0		
193-39-5	**Indeno(1,2,3-cd)pyrene**	Y	Y	Y	**C**	0	0	0	0	0	0	0	0	0	0		
191-24-2	Benzo(g,h,i)perylene	Y	**N**	**n/a**		0	0	0	0	0	0	0	0	0	0		
7440-41-7	Beryllium	Y	Y	Y	**C**	2.5E-4	1.1E-3	8.6E-5	3.8E-4	2.2E-3	9.8E-3	3.9E-5	1.7E-4	5.1E-6	2.2E-5		
92-52-4	Biphenyl	Y	Y	Y	**A**	0	0	0	0	0	0	0	0	0	0		
7440-43-9	Cadmium	Y	Y	Y	**C**	3.9E-5	1.7E-4	1.3E-5	5.9E-5	3.5E-4	1.5E-3	6.0E-6	2.6E-5	7.9E-7	3.5E-6		
75-15-0	Carbon Disulfide	Y	Y	Y	**A**	0	0	0	0	0	0	0	0	0	0	0.014	0.063
7440-47-3	Chromium	Y	Y	Y	**A**	7.1E-4	3.1E-3	2.4E-4	1.1E-3	6.3E-3	0.027	1.1E-4	4.8E-4	1.4E-5	6.3E-5		
18540-29-9	Cr (VI)	Y	Y	Y	**C**	0	0	0	0	0	0	0	0	0	0		
7440-48-4	Cobalt	Y	Y	Y	**A**	3.1E-4	1.4E-3	1.1E-4	4.7E-4	2.8E-3	0.012	4.8E-5	2.1E-4	6.4E-6	2.8E-5		
592-01-8	Cyanide	Y	Y	Y	**A**	0	0	0	0	0	0	0	0	0	0	0.453	1.983
106-46-7	Dichlorobenzene	Y	Y	Y	**A**	0	0	0	0	0	0	0	0	0	0		
206-44-0	Fluoranthene	Y	**N**	**n/a**		0	0	0	0	0	0	0	0	0	0		
86-73-7	Fluorene	Y	**N**	**n/a**		0	0	0	0	0	0	0	0	0	0		
50-00-0	Formaldehyde	Y	Y	Y	**C**	0	0	0	0	0	0	0	0	0	0		
110-54-3	Hexane	Y	Y	Y	**A**	0	0	0	0	0	0	0	0	0	0		
7647-01-0	Hydrogen Chloride	Y	Y	Y	**A**	0	0	0	0	0	0	0	0	0	0		
7439-92-1	Lead	Y	**N**	**n/a**		6.3E-4	2.8E-3	2.1E-4	9.4E-4	5.6E-3	0.024	9.7E-5	4.2E-4	1.3E-5	5.6E-5		
7439-96-5	Manganese	Y	Y	Y	**A**	0.024	0.103	8.0E-3	0.035	0.208	0.911	3.6E-3	0.016	4.7E-4	2.1E-3		
7439-97-6	Mercury	Y	**N**	**n/a**		9.7E-5	4.3E-4	1.6E-5	7.0E-5	4.2E-4	1.8E-3	5.4E-5	2.4E-4	7.2E-4	3.2E-3		
91-20-3	Naphthalene	Y	Y	Y	**A**	0	0	0	0	0	0	0	0	0	0		
7440-02-0	Nickel	Y	Y	Y	**C**	1.6E-4	6.9E-4	5.4E-5	2.3E-4	1.4E-3	6.1E-3	2.4E-5	1.1E-4	3.2E-6	1.4E-5		
85-01-8	Phenanthrene	Y	**N**	**n/a**		0	0	0	0	0	0	0	0	0	0		
108-95-2	Phenol	Y	Y	Y	**A**	0	0	0	0	0	0	0	0	0	0		
7723-14-0	Phosphorus	Y	Y	Y	**A**	0.051	0.224	0.017	0.076	0.452	1.981	7.9E-3	0.034	1.0E-3	4.5E-3		
129-00-0	Pyrene	Y	**N**	**n/a**		0	0	0	0	0	0	0	0	0	0		
7782-49-2	Selenium	Y	Y	Y	**A**	3.1E-5	1.4E-4	1.1E-5	4.7E-5	2.8E-4	1.2E-3	4.8E-6	2.1E-5	6.4E-7	2.8E-6		
108-88-3	Toluene	Y	Y	Y	**A**	0	0	0	0	0	0	0	0	0	0		
1330-20-7	Xylene	Y	Y	Y	**A**	0	0	0	0	0	0	0	0	0	0		
7429-90-5	Aluminum	**N**	Y	**N**	**A**	5.585	24.463	1.902	8.332	49.397	216	0.858	3.756	0.113	0.494		
7440-39-3	Barium	**N**	Y	**N**	**A**	0.063	0.276	0.021	0.094	0.557	2.438	9.7E-3	0.042	1.3E-3	5.6E-3		
1317-65-3	Calcium Carbonate	**N**	Y	**N**	**A**	1.101	4.824	0.375	1.643	9.740	42.663	0.169	0.741	0.022	0.097		
1305-78-8	Calcium Oxide	**N**	Y	**N**	**A**	0	0	0	0	0	0	0	0	0	0		
7440-50-8	Copper	**N**	Y	**N**	**A**	3.9E-4	1.7E-3	1.3E-4	5.9E-4	3.5E-3	0.015	6.0E-5	2.6E-4	7.9E-6	3.5E-5		
110-82-7	Cyclohexane	**N**	Y	**N**	**A**	0	0	0	0	0	0	0	0	0	0		
7783-06-4	Hydrogen Sulfide	**N**	Y	**N**	**A**	0	0	0	0	0	0	0	0	0	0		
7439-89-6	Iron	**N**	Y	**N**	**A**	1.432	6.271	0.488	2.136	12.662	55.462	0.220	0.963	0.029	0.127		
7439-98-7	Molybdenum	**N**	Y	**N**	**A**	7.9E-5	3.4E-4	2.7E-5	1.2E-4	7.0E-4	3.0E-3	1.2E-5	5.3E-5	1.6E-6	7.0E-6		
109-66-0	Pentane	**N**	Y	**N**	**A**	0	0	0	0	0	0	0	0	0	0		
7440-22-4	Silver	**N**	Y	**N**	**A**	3.9E-5	1.7E-4	1.3E-5	5.9E-5	3.5E-4	1.5E-3	6.0E-6	2.6E-5	7.9E-7	3.5E-6		
7664-93-9	Sulfuric Acid	**N**	Y	**N**	**A**	0	0	0	0	0	0	0	0	0	0		
7440-28-0	Thallium	**N**	Y	**N**	**A**	7.9E-4	3.4E-3	2.7E-4	1.2E-3	7.0E-3	0.030	1.2E-4	5.3E-4	1.6E-5	7.0E-5		
7440-61-1	Uranium	**N**	Y	**N**	**A**	7.9E-4	3.4E-3	2.7E-4	1.2E-3	7.0E-3	0.030	1.2E-4	5.3E-4	1.6E-5	7.0E-5		
7440-62-2	Vanadium	**N**	Y	**N**	**A**	2.2E-3	9.6E-3	7.5E-4	3.3E-3	0.019	0.085	3.4E-4	1.5E-3	4.4E-5	1.9E-4		
25551-13-7	Trimethyl benzene	**N**	Y	**N**	**A**	0	0	0	0	0	0	0	0	0	0		
7440-33-7	Tungsten	**N**	Y	**N**	**A**	7.9E-4	3.4E-3	2.7E-4	1.2E-3	7.0E-3	0.030	1.2E-4	5.3E-4	1.6E-5	7.0E-5		
7440-66-6	Zinc	**N**	Y	**N**	**A**	2.8E-3	0.012	9.4E-4	4.1E-3	0.024	0.107	4.2E-4	1.9E-3	5.6E-5	2.4E-4		
HAP TOTAL						***0.131***	***0.574***	***0.045***	***0.196***	***1.160***	***5.079***	***0.020***	***0.088***	***3.4E-3***	***0.015***	***0.467***	***2.046***
MERCURY TOTAL (exempt)						***9.7E-5***	***4.3E-4***	***1.6E-5***	***7.0E-5***	***4.2E-4***	***1.8E-3***	***5.4E-5***	***2.4E-4***	***7.2E-4***	***3.2E-3***		
MERCURY TOTAL (non-exempt)						***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***
TAP TOTAL (HAP-TAP addressed by NSPS/NESHAP)						***0.130***	***0.571***	***0.044***	***0.195***	***1.154***	***5.053***	***0.020***	***0.088***	***2.6E-3***	***0.012***	***0.467***	***2.046***
TAP TOTAL (For EL Evaluation)						***8.189***	***35.867***	***2.789***	***12.216***	***72.426***	***317***	***1.257***	***5.508***	***0.165***	***0.724***	***0***	***0***

TABLE B1-W3. HAP/TAP Emissions and Exemptions

CAS	HAP/TAP	HAP	TAP			PROCESSING AND PRODUCTION											
						Ore Processing				*Ore Concentration and Refining*				*Process Heating*			
						OC1-13		PS		AC		EW,MR,MF,CKD		ACB, CKB, PV, HS		LKC	
						Crushers & Xfers		Prill Silos		Autoclave		EW, Preg Tank, Retort, Furnace, Carbon Kiln		POX Boiler, C. Kiln Comb., Prop. Vap., Sol'n Heater		Lime Kiln Combustion	
	NSPS or NESHAP HAP/TAP -->			*Y*		*7E/LL*	*7E/LL*	*7E*	*7E*	*7E*	*7E*	*7E*	*7E*	*7E*	*7E*	*5A*	*5A*
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				**A/C**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
106-99-0	1,3-Butadiene	Y	Y	Y	**C**												
91-57-6	2-Methylnaphthalene	Y	N	n/a										1.9E-7	7.6E-7	5.2E-7	1.9E-6
56-49-5	3-Methylchloranthrene	Y	Y	Y	**C**									1.3E-8	5.7E-8	3.3E-8	1.4E-7
57-97-6	7,12-Dimethylbenz(a)anthracene	Y	N	n/a										1.3E-7	5.1E-7	3.5E-7	1.3E-6
83-32-9	Acenaphthene	Y	N	n/a										1.4E-8	5.7E-8	3.9E-8	1.4E-7
208-96-8	Acenaphthylene	Y	N	n/a										1.4E-8	5.7E-8	3.9E-8	1.4E-7
75-07-0	Acetaldehyde	Y	Y	Y	**C**												
107-02-8	Acrolein	Y	Y	Y	**A**												
120-12-7	Anthracene	Y	N	n/a										1.9E-8	7.6E-8	5.2E-8	1.9E-7
7440-36-0	Antimony	Y	Y	Y	**A**	1.4E-4	5.9E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7440-38-2	Arsenic	Y	Y	Y	**C**	3.9E-3	0.017			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.5E-6	6.4E-6	3.7E-6	1.6E-5
71-43-2	Benzene	Y	Y	Y	**C**									1.5E-5	6.7E-5	3.9E-5	1.7E-4
50-32-8	**Benzo(a)pyrene**	Y	Y	Y	**C**									8.7E-9	3.8E-8	2.2E-8	9.6E-8
56-55-3	**Benz(a)anthracene**	Y	Y	Y	**C**									1.3E-8	5.7E-8	3.3E-8	1.4E-7
205-99-2	**Benzo(b)fluoranthene**	Y	Y	Y	**C**									1.3E-8	5.7E-8	3.3E-8	1.4E-7
207-08-9	**Benzo(k)fluoranthene**	Y	Y	Y	**C**									1.3E-8	5.7E-8	3.3E-8	1.4E-7
218-01-9	**Chrysene**	Y	Y	Y	**C**									1.3E-8	5.7E-8	3.3E-8	1.4E-7
53-70-3	**Dibenzo(a,h)anthracene**	Y	Y	Y	**C**									8.7E-9	3.8E-8	2.2E-8	9.6E-8
193-39-5	**Indeno(1,2,3-cd)pyrene**	Y	Y	Y	**C**									1.3E-8	5.7E-8	3.3E-8	1.4E-7
191-24-2	Benzo(g,h,i)perylene	Y	N	n/a										9.5E-9	3.8E-8	2.6E-8	9.6E-8
7440-41-7	Beryllium	Y	Y	Y	**C**	1.9E-5	8.2E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	8.7E-8	3.8E-7	2.2E-7	9.6E-7
92-52-4	Biphenyl	Y	Y	Y	**A**												
7440-43-9	Cadmium	Y	Y	Y	**C**	2.9E-6	1.3E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	8.0E-6	3.5E-5	2.0E-5	8.8E-5
75-15-0	Carbon Disulfide	Y	Y	Y	**A**												
7440-47-3	Chromium	Y	Y	Y	**A**	5.3E-5	2.3E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.1E-5	4.5E-5	3.0E-5	1.1E-4
18540-29-9	Cr (VI)	Y	Y	Y	**C**												
7440-48-4	Cobalt	Y	Y	Y	**A**	2.4E-5	1.0E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3	6.6E-7	2.7E-6	1.8E-6	6.8E-6
592-01-8	Cyanide	Y	Y	Y	**A**					0	0	1.2E-3	5.3E-3				
106-46-7	Dichlorobenzene	Y	Y	Y	**A**									9.5E-6	3.8E-5	2.6E-5	9.6E-5
206-44-0	Fluoranthene	Y	N	n/a										2.4E-8	9.5E-8	6.5E-8	2.4E-7
86-73-7	Fluorene	Y	N	n/a										2.2E-8	8.9E-8	6.1E-8	2.3E-7
50-00-0	Formaldehyde	Y	Y	Y	**C**									5.5E-4	2.4E-3	1.4E-3	6.0E-3
110-54-3	Hexane	Y	Y	Y	**A**									0.014	0.057	0.039	0.145
7647-01-0	Hydrogen Chloride	Y	Y	Y	**A**												
7439-92-1	Lead	Y	N	n/a		4.7E-5	2.1E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7439-96-5	Manganese	Y	Y	Y	**A**	1.8E-3	7.7E-3			2.3E-5	1.0E-4	3.8E-4	1.7E-3	3.0E-6	1.2E-5	8.2E-6	3.1E-5
7439-97-6	Mercury	Y	N	n/a		5.6E-6	2.5E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	2.1E-6	8.3E-6	5.6E-6	2.1E-5
91-20-3	Naphthalene	Y	Y	Y	**A**									4.8E-6	1.9E-5	1.3E-5	4.9E-5
7440-02-0	Nickel	Y	Y	Y	**C**	1.2E-5	5.2E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.5E-5	6.7E-5	3.9E-5	1.7E-4
85-01-8	Phenanthrene	Y	N	n/a										1.3E-7	5.4E-7	3.7E-7	1.4E-6
108-95-2	Phenol	Y	Y	Y	**A**												
7723-14-0	Phosphorus	Y	Y	Y	**A**	3.8E-3	0.017			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
129-00-0	Pyrene	Y	N	n/a										4.0E-8	1.6E-7	1.1E-7	4.0E-7
7782-49-2	Selenium	Y	Y	Y	**A**	2.4E-6	1.0E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.9E-7	7.6E-7	5.2E-7	1.9E-6
108-88-3	Toluene	Y	Y	Y	**A**									2.7E-5	1.1E-4	7.3E-5	2.7E-4
1330-20-7	Xylene	Y	Y	Y	**A**												
7429-90-5	Aluminum	N	Y	N	**A**	0.418	1.829			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7440-39-3	Barium	N	Y	N	**A**	4.7E-3	0.021			2.3E-5	1.0E-4	3.8E-4	1.7E-3	3.5E-5	1.4E-4	9.5E-5	3.5E-4
1317-65-3	Calcium Carbonate	N	Y	N	**A**	0.082	0.361			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
1305-78-8	Calcium Oxide	N	Y	N	**A**												
7440-50-8	Copper	N	Y	N	**A**	2.9E-5	1.3E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3	6.7E-6	2.7E-5	1.8E-5	6.8E-5
110-82-7	Cyclohexane	N	Y	N	**A**												
7783-06-4	Hydrogen Sulfide	N	Y	N	**A**					0.900	3.942	0	0				
7439-89-6	Iron	N	Y	N	**A**	0.107	0.469			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7439-98-7	Molybdenum	N	Y	N	**A**	5.9E-6	2.6E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	8.7E-6	3.5E-5	2.4E-5	8.8E-5
109-66-0	Pentane	N	Y	N	**A**									0.021	0.083	0.056	0.209
7440-22-4	Silver	N	Y	N	**A**	2.9E-6	1.3E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7664-93-9	Sulfuric Acid	N	Y	N	**A**					2.030	8.891	0	0				
7440-28-0	Thallium	N	Y	N	**A**	5.9E-5	2.6E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7440-61-1	Uranium	N	Y	N	**A**	5.9E-5	2.6E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7440-62-2	Vanadium	N	Y	N	**A**	1.6E-4	7.2E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.8E-5	7.3E-5	5.0E-5	1.8E-4
25551-13-7	Trimethyl benzene	N	Y	N	**A**												
7440-33-7	Tungsten	N	Y	N	**A**	5.9E-5	2.6E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7440-66-6	Zinc	N	Y	N	**A**	2.1E-4	9.0E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3	2.3E-4	9.2E-4	6.3E-4	2.3E-3
HAP TOTAL						***9.8E-3***	***0.043***	***0***	***0***	***2.8E-4***	***1.2E-3***	***5.8E-3***	***0.025***	***0.015***	***0.060***	***0.041***	***0.152***
MERCURY TOTAL (exempt)						***5.6E-6***	***2.5E-5***	***0***	***0***	***2.3E-5***	***1.0E-4***	***3.8E-4***	***1.7E-3***	***2.1E-6***	***8.3E-6***	***5.6E-6***	***2.1E-5***
MERCURY TOTAL (non-exempt)						***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***
TAP TOTAL (HAP-TAP addressed by NSPS/NESHAP)						***9.8E-3***	***0.043***	***0***	***0***	***2.3E-4***	***1.0E-3***	***5.0E-3***	***0.022***	***0.015***	***0.060***	***0.041***	***0.152***
TAP TOTAL (For EL Evaluation)						***0.612***	***2.682***	***0***	***0***	***2.930***	***12.835***	***4.6E-3***	***0.020***	***0.021***	***0.084***	***0.057***	***0.212***

TABLE B1-W3. HAP/TAP Emissions and Exemptions

						1	1	1	1	1	1	0	0	0	0	0	0	0	0
						PROCESSING AND PRODUCTION - Continued													
						Lime Production						***Aggregate Prod.***		***Concrete Production***					
						LS1-12,LSBM		LK		LS-L/U,LCR,LS1-L/U,MillS2-L/U,ACS1-4		PCSP1,PCSP2		CM		CS1L,CS1U,CS2L, CS2U		CA-L/U	
CAS	HAP/TAP	HAP	TAP			Limestone Crushers, Screens, Mill, Xfers		Lime Kiln		Lime Silos and Lime Mill Crushing		Portable Crushers, Screens, Xfers		Central Mixer		Cement Silo #1 and #2 L/U		Aggregate Bin	
	NSPS or NESHAP HAP/TAP -->			***Y***		***5A***	***5A***	***5A***	***5A***	***5A***	***5A***	***OOO***	***OOO***					***OOO***	***OOO***
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				**A/C**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
106-99-0	1,3-Butadiene	Y	Y	Y	C														
91-57-6	2-Methylnaphthalene	Y	N	n/a															
56-49-5	3-Methylchloranthrene	Y	Y	Y	C														
57-97-6	7,12-Dimethylbenz(a)anthracene	Y	N	n/a															
83-32-9	Acenaphthene	Y	N	n/a															
208-96-8	Acenaphthylene	Y	N	n/a															
75-07-0	Acetaldehyde	Y	Y	Y	C														
107-02-8	Acrolein	Y	Y	Y	A														
120-12-7	Anthracene	Y	N	n/a															
7440-36-0	Antimony	Y	Y	Y	A	1.4E-5	4.8E-5	2.3E-6	8.5E-6	2.4E-6	3.2E-6	3.1E-6	1.4E-5					3.5E-6	8.6E-6
7440-38-2	Arsenic	Y	Y	Y	C	1.0E-4	4.5E-4	1.8E-5	7.8E-5	6.8E-6	3.0E-5	2.9E-5	1.3E-4	2.0E-6	8.9E-6	1.2E-7	5.1E-7	1.8E-5	7.9E-5
71-43-2	Benzene	Y	Y	Y	C														
50-32-8	**Benzo(a)pyrene**	Y	Y	Y	C														
56-55-3	**Benz(a)anthracene**	Y	Y	Y	C														
205-99-2	**Benzo(b)fluoranthene**	Y	Y	Y	C														
207-08-9	**Benzo(k)fluoranthene**	Y	Y	Y	C														
218-01-9	**Chrysene**	Y	Y	Y	C														
53-70-3	**Dibenzo(a,h)anthracene**	Y	Y	Y	C														
193-39-5	**Indeno(1,2,3-cd)pyrene**	Y	Y	Y	C														
191-24-2	Benzo(g,h,i)perylene	Y	N	n/a															
7440-41-7	Beryllium	Y	Y	Y	C	3.5E-6	1.6E-5	6.2E-7	2.7E-6	2.3E-7	1.0E-6	1.0E-6	4.4E-6	0	0	1.3E-8	5.8E-8	6.3E-7	2.8E-6
92-52-4	Biphenyl	Y	Y	Y	A														
7440-43-9	Cadmium	Y	Y	Y	C	1.1E-6	4.8E-6	1.9E-7	8.5E-7	7.3E-8	3.2E-7	3.1E-7	1.4E-6	4.9E-9	2.1E-8	0	0	2.0E-7	8.6E-7
75-15-0	Carbon Disulfide	Y	Y	Y	A														
7440-47-3	Chromium	Y	Y	Y	A	8.6E-5	2.9E-4	1.4E-5	5.1E-5	1.4E-5	1.9E-5	1.9E-5	8.2E-5	8.7E-7	3.8E-6	7.9E-7	3.5E-6	2.1E-5	5.2E-5
18540-29-9	Cr (VI)	Y	Y	Y	C									1.9E-7	8.1E-7	1.6E-7	7.0E-7		
7440-48-4	Cobalt	Y	Y	Y	A	2.3E-5	7.8E-5	3.7E-6	1.4E-5	3.8E-6	5.1E-6	5.0E-6	2.2E-5					5.5E-6	1.4E-5
592-01-8	Cyanide	Y	Y	Y	A														
106-46-7	Dichlorobenzene	Y	Y	Y	A														
206-44-0	Fluoranthene	Y	N	n/a															
86-73-7	Fluorene	Y	N	n/a															
50-00-0	Formaldehyde	Y	Y	Y	C														
110-54-3	Hexane	Y	Y	Y	A														
7647-01-0	Hydrogen Chloride	Y	Y	Y	A	0	0	0.986	3.666										
7439-92-1	Lead	Y	N	n/a		1.7E-5	5.8E-5	2.7E-6	1.0E-5	2.8E-6	3.9E-6	3.8E-6	1.6E-5	2.5E-7	1.1E-6	3.0E-7	1.3E-6	4.1E-6	1.0E-5
7439-96-5	Manganese	Y	Y	Y	A	1.3E-3	4.6E-3	2.2E-4	8.1E-4	2.2E-4	3.0E-4	3.0E-4	1.3E-3	2.6E-5	1.1E-4	3.2E-6	1.4E-5	3.3E-4	8.2E-4
7439-97-6	Mercury	Y	N	n/a		1.1E-7	3.9E-7	2.8E-4	1.0E-3	1.9E-8	2.6E-8	2.5E-8	1.1E-7					2.8E-8	6.9E-8
91-20-3	Naphthalene	Y	Y	Y	A														
7440-02-0	Nickel	Y	Y	Y	C	2.2E-5	9.7E-5	3.9E-6	1.7E-5	1.5E-6	6.4E-6	6.3E-6	2.7E-5	1.7E-6	7.4E-6	1.1E-6	5.0E-6	3.9E-6	1.7E-5
85-01-8	Phenanthrene	Y	N	n/a															
108-95-2	Phenol	Y	Y	Y	A														
7723-14-0	Phosphorus	Y	Y	Y	A	7.4E-4	2.5E-3	1.2E-4	4.4E-4	1.2E-4	1.7E-4	1.6E-4	7.1E-4	8.2E-6	3.6E-5	0	0	1.8E-4	4.5E-4
129-00-0	Pyrene	Y	N	n/a															
7782-49-2	Selenium	Y	Y	Y	A														
108-88-3	Toluene	Y	Y	Y	A														
1330-20-7	Xylene	Y	Y	Y	A														
7429-90-5	Aluminum	N	Y	N	A	0.129	0.438	0.021	0.077	0.021	0.029	0.028	0.124					0.031	0.078
7440-39-3	Barium	N	Y	N	A	8.3E-4	2.8E-3	1.3E-4	4.9E-4	1.4E-4	1.9E-4	1.8E-4	7.9E-4					2.0E-4	5.0E-4
1317-65-3	Calcium Carbonate	N	Y	N	A	1.567	5.325	0.251	0.935			0.343	1.503						
1305-78-8	Calcium Oxide	N	Y	N	A					0.696	0.952								
7440-50-8	Copper	N	Y	N	A	2.9E-5	9.7E-5	4.6E-6	1.7E-5	4.7E-6	6.4E-6	6.3E-6	2.7E-5					6.9E-6	1.7E-5
110-82-7	Cyclohexane	N	Y	N	A														
7783-06-4	Hydrogen Sulfide	N	Y	N	A														
7439-89-6	Iron	N	Y	N	A	0.059	0.201	9.5E-3	0.035	9.7E-3	0.013	0.013	0.057					0.014	0.036
7439-98-7	Molybdenum	N	Y	N	A	2.9E-6	9.7E-6	4.6E-7	1.7E-6	4.7E-7	6.4E-7	6.3E-7	2.7E-6					6.9E-7	1.7E-6
109-66-0	Pentane	N	Y	N	A														
7440-22-4	Silver	N	Y	N	A	0	0	0	0	0	0	0	0					0	0
7664-93-9	Sulfuric Acid	N	Y	N	A														
7440-28-0	Thallium	N	Y	N	A	2.9E-5	9.7E-5	4.6E-6	1.7E-5	4.7E-6	6.4E-6	6.3E-6	2.7E-5					6.9E-6	1.7E-5
7440-61-1	Uranium	N	Y	N	A	2.9E-5	9.7E-5	4.6E-6	1.7E-5	4.7E-6	6.4E-6	6.3E-6	2.7E-5					6.9E-6	1.7E-5
7440-62-2	Vanadium	N	Y	N	A	8.8E-5	3.0E-4	1.4E-5	5.3E-5	1.5E-5	2.0E-5	1.9E-5	8.5E-5					2.1E-5	5.3E-5
25551-13-7	Trimethyl benzene	N	Y	N	A														
7440-33-7	Tungsten	N	Y	N	A	2.9E-5	9.7E-5	4.6E-6	1.7E-5	4.7E-6	6.4E-6	6.3E-6	2.7E-5					6.9E-6	1.7E-5
7440-66-6	Zinc	N	Y	N	A	1.0E-4	3.5E-4	1.6E-5	6.1E-5	1.7E-5	2.3E-5	2.3E-5	9.9E-5					2.5E-5	6.2E-5
HAP TOTAL						***2.4E-3***	***8.1E-3***	***0.986***	***3.669***	***3.8E-4***	***5.4E-4***	***5.3E-4***	***2.3E-3***	***3.9E-5***	***1.7E-4***	***5.7E-6***	***2.5E-5***	***5.6E-4***	***1.4E-3***
MERCURY TOTAL (exempt)						***1.1E-7***	***3.9E-7***	***2.8E-4***	***1.0E-3***	***1.9E-8***	***2.6E-8***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***
MERCURY TOTAL (non-exempt)						***0***	***0***	***0***	***0***	***0***	***0***	***2.5E-8***	***1.1E-7***					***2.8E-8***	***6.9E-8***
TAP TOTAL (HAP-TAP addressed by NSPS/NESHAP)						***2.3E-3***	***8.1E-3***	***0.986***	***3.668***	***3.7E-4***	***5.4E-4***	***5.2E-4***	***2.3E-3***	***0***	***0***	***0***	***0***	***5.6E-4***	***1.4E-3***
TAP TOTAL (For EL Evaluation)						***1.756***	***5.968***	***0.282***	***1.047***	***0.727***	***0.994***	***0.385***	***1.684***	***3.9E-5***	***1.7E-4***	***5.4E-6***	***2.4E-5***	***0.046***	***0.114***

TABLE B1-W3. HAP/TAP Emissions and Exemptions

						0	0	1	1	1	1			1	1	0	0				
						PROCESSING AND PRODUCTION - Continued						MINING and LEACHING - Totals									
						HVAC		*Emer. Power/Fire*		*Fuel Storage*		*HAP Total*		*Mercury Total*		*Mercury Total*		*TAP Total*		*TAP Total*	
						H1M,H2M,HM, HAC,HR,HA,H MO,HTS,HW		EDG1,EDG2,ED G3,EDFP		TG1,TG2								*HAP-TAP addressed by NSPS/NESHAP*		*For EL Evaluation*	
CAS	HAP/TAP	HAP	TAP			Heaters		Emergency Generators and Fire Pump		Gasoline Fuel Tanks				*Exempt*		*Non-Exempt*					
	NSPS or NESHAP HAP/TAP -->			*Y*				*4Z*	*4Z*	*6C*	*6C*										
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				*A/C*	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
106-99-0	1,3-Butadiene	Y	Y	Y	C			8.4E-7	3.7E-6			0	0					0	0	0	0
91-57-6	2-Methylnaphthalene	Y	N	n/a		4.3E-7	1.9E-6					0	0					0	0	0	0
56-49-5	3-Methylchloranthrene	Y	Y	Y	C	3.2E-8	1.4E-7					0	0					0	0	0	0
57-97-6	7,12-Dimethylbenz(a)anthracene	Y	N	n/a		2.9E-7	1.3E-6					0	0					0	0	0	0
83-32-9	Acenaphthene	Y	N	n/a		3.2E-8	1.4E-7	5.6E-6	6.7E-6			0	0					0	0	0	0
208-96-8	Acenaphthylene	Y	N	n/a		3.2E-8	1.4E-7	1.1E-5	1.3E-5			0	0					0	0	0	0
75-07-0	Acetaldehyde	Y	Y	Y	C			2.5E-5	1.1E-4			0	0					0	0	0	0
107-02-8	Acrolein	Y	Y	Y	A			1.6E-5	2.0E-5			0	0					0	0	0	0
120-12-7	Anthracene	Y	N	n/a		4.3E-8	1.9E-7	1.6E-6	1.9E-6			0	0					0	0	0	0
7440-36-0	Antimony	Y	Y	Y	A							0.019	0.082					0.019	0.082	0	0
7440-38-2	Arsenic	Y	Y	Y	C	3.6E-6	1.6E-5					0.544	2.381					0.544	2.381	0	0
71-43-2	Benzene	Y	Y	Y	C	3.8E-5	1.6E-4	2.7E-4	1.2E-3	7.0E-3	0.031	0	0					0	0	0	0
50-32-8	**Benzo(a)pyrene**	Y	Y	Y	C	2.1E-8	9.4E-8	8.7E-8	3.8E-7			0	0					0	0	0	0
56-55-3	**Benz(a)anthracene**	Y	Y	Y	C	3.2E-8	1.4E-7	2.4E-7	1.0E-6			0	0					0	0	0	0
205-99-2	**Benzo(b)fluoranthene**	Y	Y	Y	C	3.2E-8	1.4E-7	3.6E-7	1.6E-6			0	0					0	0	0	0
207-08-9	**Benzo(k)fluoranthene**	Y	Y	Y	C	3.2E-8	1.4E-7	7.3E-8	3.2E-7			0	0					0	0	0	0
218-01-9	**Chrysene**	Y	Y	Y	C	3.2E-8	1.4E-7	5.0E-7	2.2E-6			0	0					0	0	0	0
53-70-3	**Dibenzo(a,h)anthracene**	Y	Y	Y	C	2.1E-8	9.4E-8	1.2E-7	5.4E-7			0	0					0	0	0	0
193-39-5	**Indeno(1,2,3-cd)pyrene**	Y	Y	Y	C	3.2E-8	1.4E-7	1.4E-7	6.2E-7			0	0					0	0	0	0
191-24-2	Benzo(g,h,i)perylene	Y	N	n/a		2.1E-8	9.4E-8	6.9E-7	8.3E-7			0	0					0	0	0	0
7440-41-7	Beryllium	Y	Y	Y	C	2.1E-7	9.4E-7					2.6E-3	0.011					2.6E-3	0.011	0	0
92-52-4	Biphenyl	Y	Y	Y	A					4.4E-5	1.9E-4	0	0					0	0	0	0
7440-43-9	Cadmium	Y	Y	Y	C	2.0E-5	8.6E-5					4.1E-4	1.8E-3					4.1E-4	1.8E-3	0	0
75-15-0	Carbon Disulfide	Y	Y	Y	A							0.014	0.063					0.014	0.063	0	0
7440-47-3	Chromium	Y	Y	Y	A	2.5E-5	1.1E-4					7.3E-3	0.032					7.3E-3	0.032	0	0
18540-29-9	Cr (VI)	Y	Y	Y	C							0	0					0	0	0	0
7440-48-4	Cobalt	Y	Y	Y	A	1.5E-6	6.6E-6					3.3E-3	0.014					3.3E-3	0.014	0	0
592-01-8	Cyanide	Y	Y	Y	A							0.453	1.983					0.453	1.983	0	0
106-46-7	Dichlorobenzene	Y	Y	Y	A	2.1E-5	9.4E-5					0	0					0	0	0	0
206-44-0	Fluoranthene	Y	N	n/a		5.4E-8	2.4E-7	5.3E-6	6.4E-6			0	0					0	0	0	0
86-73-7	Fluorene	Y	N	n/a		5.0E-8	2.2E-7	1.7E-5	2.1E-5			0	0					0	0	0	0
50-00-0	Formaldehyde	Y	Y	Y	C	1.3E-3	5.9E-3	5.1E-5	2.2E-4			0	0					0	0	0	0
110-54-3	Hexane	Y	Y	Y	A	0.032	0.141			0.031	0.137	0	0					0	0	0	0
7647-01-0	Hydrogen Chloride	Y	Y	Y	A							0	0					0	0	0	0
7439-92-1	Lead	Y	N	n/a								6.5E-3	0.029					0	0	0	0
7439-96-5	Manganese	Y	Y	Y	A	6.8E-6	3.0E-5					0.244	1.067					0.244	1.067	0	0
7439-97-6	Mercury	Y	N	n/a		4.7E-6	2.0E-5					1.3E-3	5.7E-3	1.3E-3	5.7E-3	0	0	0	0	0	0
91-20-3	Naphthalene	Y	Y	Y	A	1.1E-5	4.8E-5	1.6E-4	1.9E-4	1.9E-3	8.5E-3	0	0					0	0	0	0
7440-02-0	Nickel	Y	Y	Y	C	3.8E-5	1.6E-4					1.6E-3	7.1E-3					1.6E-3	7.1E-3	0	0
85-01-8	Phenanthrene	Y	N	n/a		3.0E-7	1.3E-6	5.0E-5	6.0E-5			0	0					0	0	0	0
108-95-2	Phenol	Y	Y	Y	A					2.4E-4	1.1E-3	0	0					0	0	0	0
7723-14-0	Phosphorus	Y	Y	Y	A							0.530	2.320					0.530	2.320	0	0
129-00-0	Pyrene	Y	N	n/a		8.9E-8	3.9E-7	4.7E-6	5.7E-6			0	0					0	0	0	0
7782-49-2	Selenium	Y	Y	Y	A	4.3E-7	1.9E-6					3.3E-4	1.4E-3					3.3E-4	1.4E-3	0	0
108-88-3	Toluene	Y	Y	Y	A	6.1E-5	2.7E-4	3.6E-4	4.3E-4	0.032	0.138	0	0					0	0	0	0
1330-20-7	Xylene	Y	Y	Y	A			2.5E-4	3.0E-4	0.031	0.137	0	0					0	0	0	0
7429-90-5	Aluminum	N	Y	N	A							0	0					0	0	57.855	253
7440-39-3	Barium	N	Y	N	A	7.9E-5	3.4E-4					0	0					0	0	0.652	2.855
1317-65-3	Calcium Carbonate	N	Y	N	A							0	0					0	0	11.408	49.967
1305-78-8	Calcium Oxide	N	Y	N	A							0	0					0	0	0	0
7440-50-8	Copper	N	Y	N	A	1.5E-5	6.7E-5					0	0					0	0	4.1E-3	0.018
110-82-7	Cyclohexane	N	Y	N	A					1.0E-3	4.6E-3	0	0					0	0	0	0
7783-06-4	Hydrogen Sulfide	N	Y	N	A							0	0					0	0	0	0
7439-89-6	Iron	N	Y	N	A							0	0					0	0	14.831	64.958
7439-98-7	Molybdenum	N	Y	N	A	2.0E-5	8.6E-5					0	0					0	0	8.1E-4	3.6E-3
109-66-0	Pentane	N	Y	N	A	0.047	0.204					0	0					0	0	0	0
7440-22-4	Silver	N	Y	N	A							0	0					0	0	4.1E-4	1.8E-3
7664-93-9	Sulfuric Acid	N	Y	N	A							0	0					0	0	0	0
7440-28-0	Thallium	N	Y	N	A							0	0					0	0	8.1E-3	0.036
7440-61-1	Uranium	N	Y	N	A							0	0					0	0	8.1E-3	0.036
7440-62-2	Vanadium	N	Y	N	A	4.1E-5	1.8E-4					0	0					0	0	0.023	0.100
25551-13-7	Trimethyl benzene	N	Y	N	A					0.011	0.048	0	0					0	0	0	0
7440-33-7	Tungsten	N	Y	N	A							0	0					0	0	8.1E-3	0.036
7440-66-6	Zinc	N	Y	N	A	5.2E-4	2.3E-3					0	0					0	0	0.029	0.125
HAP TOTAL						***0.034***	***0.148***	***1.2E-3***	***2.6E-3***	***0.103***	***0.453***	***1.826***	***7.998***								
MERCURY TOTAL (exempt)						***0***	***0***							***1.3E-3***	***5.7E-3***						
MERCURY TOTAL (non-exempt)						***4.7E-6***	***2.0E-5***	***0***	***0***	***0***	***0***					***0***	***0***				
TAP TOTAL (HAP-TAP addressed by NSPS/NESHAP)						***0***	***0***	***1.1E-3***	***2.5E-3***	***0.103***	***0.453***							***1.818***	***7.964***		
TAP TOTAL (For EL Evaluation)						***0.081***	***0.355***	***0***	***0***	***0.012***	***0.052***									***84.827***	***372***

TABLE B1-W3. HAP/TAP Emissions and Exemptions 1 1 0 0

						PROCESSING AND PRODUCTION - Totals										ALL	ALL	ALL	TAP EL	
						HAP Total		*Mercury Total*		*Mercury Total*		*TAP Total*		*TAP Total*		*HAP*	*Hg*	*TAP*	*TAP*	
								Exempt		*Non-Exempt*		*HAP-TAP addressed by NSPS/NESHAP*		*For EL Evaluation*			*Non-Exempt*	*For EL Evaluation*	*Emission Screening Level (EL)*	
CAS	HAP/TAP	HAP	TAP																Non-car	Carcin
	NSPS or NESHAP HAP/TAP -->			*Y*																
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				**A/C**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr	ton/yr	lb/hr	lb/hr	lb/hr
106-99-0	1,3-Butadiene	Y	Y	Y	C	8.4E-7	3.7E-6					8.4E-7	3.7E-6	0	0	3.7E-6		0	--	2.4E-5
91-57-6	2-Methylnaphthalene	Y	N	n/a		1.1E-6	4.6E-6					0	0	0	0	4.6E-6		0	--	--
56-49-5	3-Methylchloranthrene	Y	Y	Y	C	7.8E-8	3.4E-7					4.6E-8	2.0E-7	3.2E-8	1.4E-7	3.4E-7		3.2E-8	--	2.5E-6
57-97-6	7,12-Dimethylbenz(a)anthracene	Y	N	n/a		7.6E-7	3.0E-6					0	0	0	0	3.0E-6		0	--	--
83-32-9	Acenaphthene	Y	N	n/a		5.7E-6	7.1E-6					0	0	0	0	7.1E-6		0	--	--
208-96-8	Acenaphthylene	Y	N	n/a		1.1E-5	1.4E-5					0	0	0	0	1.4E-5		0	--	--
75-07-0	Acetaldehyde	Y	Y	Y	C	2.5E-5	1.1E-4					2.5E-5	1.1E-4	0	0	1.1E-4		0	--	3.0E-3
107-02-8	Acrolein	Y	Y	Y	A	1.6E-5	2.0E-5					1.6E-5	2.0E-5	0	0	2.0E-5		0	0.017	--
120-12-7	Anthracene	Y	N	n/a		1.7E-6	2.4E-6					0	0	0	0	2.4E-6		0	--	--
7440-36-0	Antimony	Y	Y	Y	A	5.7E-4	2.5E-3					5.7E-4	2.5E-3	0	0	0.085		0	0.033	--
7440-38-2	Arsenic	Y	Y	Y	C	4.5E-3	0.020					4.5E-3	0.020	5.7E-6	2.5E-5	2.400		5.7E-6	--	1.5E-6
71-43-2	Benzene	Y	Y	Y	C	7.4E-3	0.032					7.4E-3	0.032	3.8E-5	1.6E-4	0.032		3.8E-5	--	8.0E-4
50-32-8	**Benzo(a)pyrene**	Y	Y	Y	C	1.4E-7	6.1E-7					1.2E-7	5.1E-7	2.1E-8	9.4E-8	6.1E-7				
56-55-3	**Benz(a)anthracene**	Y	Y	Y	C	3.1E-7	1.4E-6					2.8E-7	1.2E-6	3.2E-8	1.4E-7	1.4E-6				
205-99-2	**Benzo(b)fluoranthene**	Y	Y	Y	C	4.4E-7	1.9E-6					4.1E-7	1.8E-6	3.2E-8	1.4E-7	1.9E-6				
207-08-9	**Benzo(k)fluoranthene**	Y	Y	Y	C	1.5E-7	6.6E-7					1.2E-7	5.2E-7	3.2E-8	1.4E-7	6.6E-7		2.0E-7	--	2.0E-6
218-01-9	**Chrysene**	Y	Y	Y	C	5.8E-7	2.5E-6					5.5E-7	2.4E-6	3.2E-8	1.4E-7	2.5E-6				
53-70-3	**Dibenzo(a,h)anthracene**	Y	Y	Y	C	1.8E-7	7.7E-7					1.5E-7	6.8E-7	2.1E-8	9.4E-8	7.7E-7				
193-39-5	**Indeno(1,2,3-cd)pyrene**	Y	Y	Y	C	2.2E-7	9.6E-7					1.9E-7	8.2E-7	3.2E-8	1.4E-7	9.6E-7				
191-24-2	Benzo(g,h,i)perylene	Y	N	n/a		7.5E-7	1.1E-6					0	0	0	0	1.1E-6		0	--	--
7440-41-7	Beryllium	Y	Y	Y	C	4.3E-4	1.9E-3					4.3E-4	1.9E-3	2.3E-7	1.0E-6	0.013		2.3E-7	--	2.8E-5
92-52-4	Biphenyl	Y	Y	Y	A	4.4E-5	1.9E-4					4.4E-5	1.9E-4	0	0	1.9E-4		0	0.100	--
7440-43-9	Cadmium	Y	Y	Y	C	4.6E-4	2.0E-3					4.4E-4	1.9E-3	2.0E-5	8.6E-5	3.8E-3		2.0E-5	--	3.7E-6
75-15-0	Carbon Disulfide	Y	Y	Y	A	0	0					0	0	0	0	0.063		0	2.000	--
7440-47-3	Chromium	Y	Y	Y	A	6.8E-4	2.8E-3					6.5E-4	2.7E-3	2.7E-5	1.2E-4	0.035		2.7E-5	0.033	--
18540-29-9	Cr (VI)	Y	Y	Y	C	3.4E-7	1.5E-6					0	0	3.4E-7	1.5E-6	1.5E-6		3.4E-7	--	5.6E-7
7440-48-4	Cobalt	Y	Y	Y	A	4.7E-4	2.0E-3					4.7E-4	2.0E-3	1.5E-6	6.6E-6	0.016		1.5E-6	3.3E-3	--
592-01-8	Cyanide	Y	Y	Y	A	1.2E-3	5.3E-3					1.2E-3	5.3E-3	0	0	1.988		0	0.333	--
106-46-7	Dichlorobenzene	Y	Y	Y	A	5.7E-5	2.3E-4					3.5E-5	1.3E-4	2.1E-5	9.4E-5	2.3E-4		2.1E-5	30.000	--
206-44-0	Fluoranthene	Y	N	n/a		5.5E-6	7.0E-6					0	0	0	0	7.0E-6		0	--	--
86-73-7	Fluorene	Y	N	n/a		1.7E-5	2.1E-5					0	0	0	0	2.1E-5		0	--	--
50-00-0	Formaldehyde	Y	Y	Y	C	3.3E-3	0.015					2.0E-3	8.6E-3	1.3E-3	5.9E-3	0.015		1.3E-3	--	5.1E-4
110-54-3	Hexane	Y	Y	Y	A	0.117	0.480					0.084	0.339	0.032	0.141	0.480		0.032	12.000	--
7647-01-0	Hydrogen Chloride	Y	Y	Y	A	0.986	3.666					0.986	3.666	0	0	3.666		0	0.050	--
7439-92-1	Lead	Y	N	n/a		4.8E-4	2.1E-3					0	0	0	0	0.031		0	--	--
7439-96-5	Manganese	Y	Y	Y	A	4.6E-3	0.017					4.6E-3	0.017	3.6E-5	1.6E-4	1.085		3.6E-5	0.067	--
7439-97-6	Mercury	Y	N	n/a		7.1E-4	2.9E-3	7.0E-4	2.9E-3	4.7E-6	2.1E-5	0	0	0	0	8.6E-3	2.1E-5	0	--	--
91-20-3	Naphthalene	Y	Y	Y	A	2.1E-3	8.8E-3					2.1E-3	8.8E-3	1.1E-5	4.8E-5	8.8E-3		1.1E-5	3.330	--
7440-02-0	Nickel	Y	Y	Y	C	5.5E-4	2.4E-3					5.1E-4	2.2E-3	4.0E-5	1.8E-4	9.5E-3		4.0E-5	--	2.7E-5
85-01-8	Phenanthrene	Y	N	n/a		5.1E-5	6.3E-5					0	0	0	0	6.3E-5		0	--	--
108-95-2	Phenol	Y	Y	Y	A	2.4E-4	1.1E-3					2.4E-4	1.1E-3	0	0	1.1E-3		0	1.270	--
7723-14-0	Phosphorus	Y	Y	Y	A	5.6E-3	0.023					5.6E-3	0.023	8.2E-6	3.6E-5	2.343		8.2E-6	7.0E-3	--
129-00-0	Pyrene	Y	N	n/a		5.0E-6	6.6E-6					0	0	0	0	6.6E-6		0	--	--
7782-49-2	Selenium	Y	Y	Y	A	4.1E-4	1.8E-3					4.1E-4	1.8E-3	4.3E-7	1.9E-6	3.2E-3		4.3E-7	0.013	--
108-88-3	Toluene	Y	Y	Y	A	0.032	0.139					0.032	0.139	6.1E-5	2.7E-4	0.139		6.1E-5	25.000	--
1330-20-7	Xylene	Y	Y	Y	A	0.032	0.138					0.032	0.138	0	0	0.138		0	29.000	--
7429-90-5	Aluminum	N	Y	N	A	0	0					0	0	0.648	2.577	0		58.504	0.667	--
7440-39-3	Barium	N	Y	N	A	0	0					0	0	6.8E-3	0.028	0		0.659	0.033	--
1317-65-3	Calcium Carbonate	N	Y	N	A	0	0					0	0	2.244	8.125	0		13.652	0.667	--
1305-78-8	Calcium Oxide	N	Y	N	A	0	0					0	0	0.696	0.952	0		0.696	0.133	--
7440-50-8	Copper	N	Y	N	A	0	0					0	0	5.3E-4	2.2E-3	0		4.6E-3	0.067	--
110-82-7	Cyclohexane	N	Y	N	A	0	0					0	0	1.0E-3	4.6E-3	0		1.0E-3	70.000	--
7783-06-4	Hydrogen Sulfide	N	Y	N	A	0	0					0	0	0.900	3.942	0		0.900	0.933	--
7439-89-6	Iron	N	Y	N	A	0	0					0	0	0.213	0.812	0		15.043	0.067	--
7439-98-7	Molybdenum	N	Y	N	A	0	0					0	0	4.7E-4	2.0E-3	0		1.3E-3	0.333	--
109-66-0	Pentane	N	Y	N	A	0	0					0	0	0.123	0.495	0		0.123	118	--
7440-22-4	Silver	N	Y	N	A	0	0					0	0	4.1E-4	1.8E-3	0		8.2E-4	7.0E-3	--
7664-93-9	Sulfuric Acid	N	Y	N	A	0	0					0	0	2.030	8.891	0		2.030	0.067	--
7440-28-0	Thallium	N	Y	N	A	0	0					0	0	5.2E-4	2.2E-3	0		8.7E-3	7.0E-3	--
7440-61-1	Uranium	N	Y	N	A	0	0					0	0	5.2E-4	2.2E-3	0		8.7E-3	0.013	--
7440-62-2	Vanadium	N	Y	N	A	0	0					0	0	8.4E-4	3.5E-3	0		0.024	3.0E-3	--
25551-13-7	Trimethyl benzene	N	Y	N	A	0	0					0	0	0.011	0.048	0		0.011	8.200	--
7440-33-7	Tungsten	N	Y	N	A	0	0					0	0	5.2E-4	2.2E-3	0		8.7E-3	0.333	--
7440-66-6	Zinc	N	Y	N	A	0	0					0	0	2.2E-3	8.8E-3	0		0.031	0.667	--
HAP TOTAL						***1.200***	***4.566***									***12.564***				
MERCURY TOTAL (exempt)								***7.0E-4***	***2.9E-3***											
MERCURY TOTAL (non-exempt)										***4.7E-6***	***2.1E-5***						***2.1E-5***			
TAP TOTAL (HAP-TAP addressed by NSPS/NESHAP)												***1.165***	***4.413***							
TAP TOTAL (For EL Evaluation)														***6.913***	***26.048***			***91.740***		

TABLE B2-Y1. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.089	1.0E-3	0.018	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	7E/LL	7E/LL	7E/LL	7E/LL	0.098	1.1E-3	0.019	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.011	1.3E-4	2.3E-3	0	2.9E-3	0	1.6E-6	4.5E-6
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	2.3E-5	2.3E-5	2.3E-5	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	3.1E-6	0	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	7E	7E	7E	7E	0	9.7E-6	0	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	4.3E-7	0	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	7E	7E	7E	7E	0	2.2E-5	0	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	0	9.5E-5	0	0	0	0	0	5.0E-5
Lime Production	LS1	Limestone transfer to Primary Crusher Hopper	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS6	Limestone transfer to Ball Mill Feed Bin	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	5A	5A	5A	5A	0.043	2.8E-4	0.522	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	5A	5A	5A	5A	6.3E-3	4.0E-5	0.076	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	0.021	1.3E-4	0.251	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	6.4E-3	4.1E-5	0	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	1.4E-4	9.0E-7	0	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	1.4E-5	9.0E-8	0	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7

TABLE B2-Y1. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	5A	5A	5A	5A	4.7E-4	3.0E-6	0	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	2.0E-6	4.9E-9	0	1.7E-6	0	0	0	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.4E-7	3.7E-5	1.0E-6	0	2.2E-6	0	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.2E-6	1.5E-4	4.1E-6	0	8.6E-6	0	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.2E-6	2.2E-4	6.2E-6	0	1.3E-5	0	0	0	0	0	6.8E-6
Mining - Modeling Scenario: Y1	YPP	Yellow Pine Pit	7E	7E	7E	7E	5.585	0.063	1.101	0	1.432	0	7.9E-4	2.2E-3
	YPPBL	Yellow Pine Pit Blasting	7E	7E	7E	7E	1.902	0.021	0.375	0	0.488	0	2.7E-4	7.5E-4
	STKP	PC Stockpile	7E	7E	7E	7E	1.063	0.012	0.210	0	0.272	0	1.5E-4	4.2E-4
	HR000	Haul Roads	7E	7E	7E	7E	15.394	0.173	3.035	0	3.946	0	2.2E-3	6.1E-3
	ACCRD	Access Roads	7E	7E	7E	7E	0.113	1.3E-3	0.022	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	7E	7E	7E	7E	2.5E-5	2.8E-7	4.9E-6	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**5.7E-6**	**2.0E-5**	**1.3E-3**	**4.0E-5**	**24.705**	**0.278**	**6.987**	**0.696**	**6.380**	**2.030**	**3.9E-3**	**0.010**

TABLE B2-Y2. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.089	1.0E-3	0.018	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	7E/LL	7E/LL	7E/LL	7E/LL	0.098	1.1E-3	0.019	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.011	1.3E-4	2.3E-3	0	2.9E-3	0	1.6E-6	4.5E-6
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	2.3E-5	2.3E-5	2.3E-5	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	3.1E-6	0	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	7E	7E	7E	7E	0	9.7E-6	0	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	4.3E-7	0	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	7E	7E	7E	7E	0	2.2E-5	0	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	0	9.5E-5	0	0	0	0	0	5.0E-5
Lime Production	LS1	Limestone transfer to Primary Crusher Hopper	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS6	Limestone transfer to Ball Mill Feed Bin	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	5A	5A	5A	5A	0.043	2.8E-4	0.522	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	5A	5A	5A	5A	6.3E-3	4.0E-5	0.076	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	0.021	1.3E-4	0.251	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	6.4E-3	4.1E-5	0	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	1.4E-4	9.0E-7	0	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	1.4E-5	9.0E-8	0	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7

TABLE B2-Y2. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	5A	5A	5A	5A	4.7E-4	3.0E-6	0	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	2.0E-6	4.9E-9	0	1.7E-6	0	0	0	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.4E-7	3.7E-5	1.0E-6	0	2.2E-6	0	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.2E-6	1.5E-4	4.1E-6	0	8.6E-6	0	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.2E-6	2.2E-4	6.2E-6	0	1.3E-5	0	0	0	0	0	6.8E-6
Mining - Modeling Scenario: Y2	YPP	Yellow Pine Pit	7E	7E	7E	7E	5.585	0.063	1.101	0	1.432	0	7.9E-4	2.2E-3
	YPPBL	Yellow Pine Pit Blasting	7E	7E	7E	7E	1.902	0.021	0.375	0	0.488	0	2.7E-4	7.5E-4
	FDRSF	Fiddle DRSF	7E	7E	7E	7E	0.858	9.7E-3	0.169	0	0.220	0	1.2E-4	3.4E-4
	HR000	Haul Roads	7E	7E	7E	7E	22.711	0.256	4.478	0	5.822	0	3.2E-3	9.0E-3
	ACCRD	Access Roads	7E	7E	7E	7E	0.113	1.3E-3	0.022	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	7E	7E	7E	7E	2.5E-5	2.8E-7	4.9E-6	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**5.7E-6**	**2.0E-5**	**1.3E-3**	**4.0E-5**	**31.817**	**0.358**	**8.390**	**0.696**	**8.203**	**2.030**	**4.9E-3**	**0.013**

TABLE B2-Y3. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.089	1.0E-3	0.018	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	7E/LL	7E/LL	7E/LL	7E/LL	0.098	1.1E-3	0.019	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.011	1.3E-4	2.3E-3	0	2.9E-3	0	1.6E-6	4.5E-6
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	2.3E-5	2.3E-5	2.3E-5	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	3.1E-6	0	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	7E	7E	7E	7E	0	9.7E-6	0	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	4.3E-7	0	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	7E	7E	7E	7E	0	2.2E-5	0	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	0	9.5E-5	0	0	0	0	0	5.0E-5
Lime Production	LS1	Limestone transfer to Primary Crusher Hopper	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS6	Limestone transfer to Ball Mill Feed Bin	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	5A	5A	5A	5A	0.043	2.8E-4	0.522	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	5A	5A	5A	5A	6.3E-3	4.0E-5	0.076	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	0.021	1.3E-4	0.251	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	6.4E-3	4.1E-5	0	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	1.4E-4	9.0E-7	0	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	1.4E-5	9.0E-8	0	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7

TABLE B2-Y3. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	5A	5A	5A	5A	4.7E-4	3.0E-6	0	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	2.0E-6	4.9E-9	0	1.7E-6	0	0	0	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.4E-7	3.7E-5	1.0E-6	0	2.2E-6	0	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.2E-6	1.5E-4	4.1E-6	0	8.6E-6	0	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.2E-6	2.2E-4	6.2E-6	0	1.3E-5	0	0	0	0	0	6.8E-6
Mining - Modeling Scenario: Y3	YPP	Yellow Pine Pit	7E	7E	7E	7E	5.585	0.063	1.101	0	1.432	0	7.9E-4	2.2E-3
	YPPBL	Yellow Pine Pit Blasting	7E	7E	7E	7E	1.902	0.021	0.375	0	0.488	0	2.7E-4	7.5E-4
	HFDRSF	Hangar Flats DRSF	7E	7E	7E	7E	0.858	9.7E-3	0.169	0	0.220	0	1.2E-4	3.4E-4
	HR000	Haul Roads	7E	7E	7E	7E	36.835	0.415	7.263	0	9.442	0	5.2E-3	0.015
	ACCRD	Access Roads	7E	7E	7E	7E	0.113	1.3E-3	0.022	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	7E	7E	7E	7E	2.5E-5	2.8E-7	4.9E-6	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**5.7E-6**	**2.0E-5**	**1.3E-3**	**4.0E-5**	**45.941**	**0.517**	**11.175**	**0.696**	**11.823**	**2.030**	**6.9E-3**	**0.019**

TABLE B2-H1. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.089	1.0E-3	0.018	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	7E/LL	7E/LL	7E/LL	7E/LL	0.098	1.1E-3	0.019	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.011	1.3E-4	2.3E-3	0	2.9E-3	0	1.6E-6	4.5E-6
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	2.3E-5	2.3E-5	2.3E-5	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	3.1E-6	0	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	7E	7E	7E	7E	0	9.7E-6	0	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	4.3E-7	0	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	7E	7E	7E	7E	0	2.2E-5	0	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	0	9.5E-5	0	0	0	0	0	5.0E-5
Lime Production	LS1	Limestone transfer to Primary Crusher Hopper	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS6	Limestone transfer to Ball Mill Feed Bin	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	5A	5A	5A	5A	0.043	2.8E-4	0.522	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	5A	5A	5A	5A	6.3E-3	4.0E-5	0.076	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	0.021	1.3E-4	0.251	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	6.4E-3	4.1E-5	0	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	1.4E-4	9.0E-7	0	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	1.4E-5	9.0E-8	0	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7

TABLE B2-H1. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	5A	5A	5A	5A	4.7E-4	3.0E-6	0	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	2.0E-6	4.9E-9	0	1.7E-6	0	0	0	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.4E-7	3.7E-5	1.0E-6	0	2.2E-6	0	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.2E-6	1.5E-4	4.1E-6	0	8.6E-6	0	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.2E-6	2.2E-4	6.2E-6	0	1.3E-5	0	0	0	0	0	6.8E-6
Mining - Modeling Scenario: H1	HFP	Hangar Flats Pit	7E	7E	7E	7E	5.585	0.063	1.101	0	1.432	0	7.9E-4	2.2E-3
	HFPBL	Hangar Flats Pit Blasting	7E	7E	7E	7E	1.902	0.021	0.375	0	0.488	0	2.7E-4	7.5E-4
	STKP	PC Stockpile	7E	7E	7E	7E	1.063	0.012	0.210	0	0.272	0	1.5E-4	4.2E-4
	HR000	Haul Roads	7E	7E	7E	7E	24.940	0.281	4.918	0	6.393	0	3.5E-3	9.8E-3
	ACCRD	Access Roads	7E	7E	7E	7E	0.113	1.3E-3	0.022	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	7E	7E	7E	7E	2.5E-5	2.8E-7	4.9E-6	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**5.7E-6**	**2.0E-5**	**1.3E-3**	**4.0E-5**	**34.252**	**0.385**	**8.870**	**0.696**	**8.827**	**2.030**	**5.2E-3**	**0.014**

TABLE B2-H2. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.089	1.0E-3	0.018	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	7E/LL	7E/LL	7E/LL	7E/LL	0.098	1.1E-3	0.019	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.011	1.3E-4	2.3E-3	0	2.9E-3	0	1.6E-6	4.5E-6
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	2.3E-5	2.3E-5	2.3E-5	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	3.1E-6	0	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	7E	7E	7E	7E	0	9.7E-6	0	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	4.3E-7	0	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	7E	7E	7E	7E	0	2.2E-5	0	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	0	9.5E-5	0	0	0	0	0	5.0E-5
Lime Production	LS1	Limestone transfer to Primary Crusher Hopper	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS6	Limestone transfer to Ball Mill Feed Bin	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	5A	5A	5A	5A	0.043	2.8E-4	0.522	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	5A	5A	5A	5A	6.3E-3	4.0E-5	0.076	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	0.021	1.3E-4	0.251	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	6.4E-3	4.1E-5	0	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	1.4E-4	9.0E-7	0	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	1.4E-5	9.0E-8	0	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7

TABLE B2-H2. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	5A	5A	5A	5A	4.7E-4	3.0E-6	0	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	2.0E-6	4.9E-9	0	1.7E-6	0	0	0	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.4E-7	3.7E-5	1.0E-6	0	2.2E-6	0	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.2E-6	1.5E-4	4.1E-6	0	8.6E-6	0	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.2E-6	2.2E-4	6.2E-6	0	1.3E-5	0	0	0	0	0	6.8E-6
Mining - Modeling Scenario: H2	HFP	Hangar Flats Pit	7E	7E	7E	7E	5.585	0.063	1.101	0	1.432	0	7.9E-4	2.2E-3
	HFPBL	Hangar Flats Pit Blasting	7E	7E	7E	7E	1.902	0.021	0.375	0	0.488	0	2.7E-4	7.5E-4
	FDRSF	Fiddle DRSF	7E	7E	7E	7E	0.858	9.7E-3	0.169	0	0.220	0	1.2E-4	3.4E-4
	HR000	Haul Roads	7E	7E	7E	7E	37.334	0.421	7.362	0	9.570	0	5.3E-3	0.015
	ACCRD	Access Roads	7E	7E	7E	7E	0.113	1.3E-3	0.022	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	7E	7E	7E	7E	2.5E-5	2.8E-7	4.9E-6	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**5.7E-6**	**2.0E-5**	**1.3E-3**	**4.0E-5**	**46.440**	**0.523**	**11.273**	**0.696**	**11.951**	**2.030**	**7.0E-3**	**0.019**

TABLE B2-H3. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.089	1.0E-3	0.018	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	7E/LL	7E/LL	7E/LL	7E/LL	0.098	1.1E-3	0.019	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.011	1.3E-4	2.3E-3	0	2.9E-3	0	1.6E-6	4.5E-6
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	2.3E-5	2.3E-5	2.3E-5	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	3.1E-6	0	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	7E	7E	7E	7E	0	9.7E-6	0	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	4.3E-7	0	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	7E	7E	7E	7E	0	2.2E-5	0	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	0	9.5E-5	0	0	0	0	0	5.0E-5
Lime Production	LS1	Limestone transfer to Primary Crusher Hopper	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS6	Limestone transfer to Ball Mill Feed Bin	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	5A	5A	5A	5A	0.043	2.8E-4	0.522	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	5A	5A	5A	5A	6.3E-3	4.0E-5	0.076	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	0.021	1.3E-4	0.251	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	6.4E-3	4.1E-5	0	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	1.4E-4	9.0E-7	0	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	1.4E-5	9.0E-8	0	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7

TABLE B2-H3. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	5A	5A	5A	5A	4.7E-4	3.0E-6	0	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	2.0E-6	4.9E-9	0	1.7E-6	0	0	0	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.4E-7	3.7E-5	1.0E-6	0	2.2E-6	0	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.2E-6	1.5E-4	4.1E-6	0	8.6E-6	0	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.2E-6	2.2E-4	6.2E-6	0	1.3E-5	0	0	0	0	0	6.8E-6
Mining - Modeling Scenario: H3	HFP	Hangar Flats Pit	7E	7E	7E	7E	5.585	0.063	1.101	0	1.432	0	7.9E-4	2.2E-3
	HFPBL	Hangar Flats Pit Blasting	7E	7E	7E	7E	1.902	0.021	0.375	0	0.488	0	2.7E-4	7.5E-4
	HFDRSF	Hangar Flats DRSF	7E	7E	7E	7E	0.858	9.7E-3	0.169	0	0.220	0	1.2E-4	3.4E-4
	HR000	Haul Roads	7E	7E	7E	7E	22.854	0.258	4.506	0	5.858	0	3.2E-3	9.0E-3
	ACCRD	Access Roads	7E	7E	7E	7E	0.113	1.3E-3	0.022	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	7E	7E	7E	7E	2.5E-5	2.8E-7	4.9E-6	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**5.7E-6**	**2.0E-5**	**1.3E-3**	**4.0E-5**	**31.960**	**0.360**	**8.418**	**0.696**	**8.239**	**2.030**	**4.9E-3**	**0.013**

TABLE B2-H4. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.089	1.0E-3	0.018	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	7E/LL	7E/LL	7E/LL	7E/LL	0.098	1.1E-3	0.019	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.011	1.3E-4	2.3E-3	0	2.9E-3	0	1.6E-6	4.5E-6
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	2.3E-5	2.3E-5	2.3E-5	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	3.1E-6	0	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	7E	7E	7E	7E	0	9.7E-6	0	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	4.3E-7	0	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	7E	7E	7E	7E	0	2.2E-5	0	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	0	9.5E-5	0	0	0	0	0	5.0E-5
Lime Production	LS1	Limestone transfer to Primary Crusher Hopper	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS6	Limestone transfer to Ball Mill Feed Bin	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	5A	5A	5A	5A	0.043	2.8E-4	0.522	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	5A	5A	5A	5A	6.3E-3	4.0E-5	0.076	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	0.021	1.3E-4	0.251	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	6.4E-3	4.1E-5	0	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	1.4E-4	9.0E-7	0	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	1.4E-5	9.0E-8	0	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7

TABLE B2-H4. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	5A	5A	5A	5A	4.7E-4	3.0E-6	0	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	2.0E-6	4.9E-9	0	1.7E-6	0	0	0	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.4E-7	3.7E-5	1.0E-6	0	2.2E-6	0	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.2E-6	1.5E-4	4.1E-6	0	8.6E-6	0	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.2E-6	2.2E-4	6.2E-6	0	1.3E-5	0	0	0	0	0	6.8E-6
Mining - Modeling Scenario: H4	HFP	Hangar Flats Pit	7E	7E	7E	7E	5.585	0.063	1.101	0	1.432	0	7.9E-4	2.2E-3
	HFPBL	Hangar Flats Pit Blasting	7E	7E	7E	7E	1.902	0.021	0.375	0	0.488	0	2.7E-4	7.5E-4
	YPDRSF	Yellow Pine DRSF	7E	7E	7E	7E	0.858	9.7E-3	0.169	0	0.220	0	1.2E-4	3.4E-4
	HR000	Haul Roads	7E	7E	7E	7E	29.277	0.330	5.773	0	7.505	0	4.1E-3	0.012
	ACCRD	Access Roads	7E	7E	7E	7E	0.113	1.3E-3	0.022	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	7E	7E	7E	7E	2.5E-5	2.8E-7	4.9E-6	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**5.7E-6**	**2.0E-5**	**1.3E-3**	**4.0E-5**	**38.383**	**0.432**	**9.685**	**0.696**	**9.886**	**2.030**	**5.8E-3**	**0.016**

TABLE B2-W1. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.089	1.0E-3	0.018	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	7E/LL	7E/LL	7E/LL	7E/LL	0.098	1.1E-3	0.019	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.011	1.3E-4	2.3E-3	0	2.9E-3	0	1.6E-6	4.5E-6
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	2.3E-5	2.3E-5	2.3E-5	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	3.1E-6	0	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	7E	7E	7E	7E	0	9.7E-6	0	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	4.3E-7	0	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	7E	7E	7E	7E	0	2.2E-5	0	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	0	9.5E-5	0	0	0	0	0	5.0E-5
Lime Production	LS1	Limestone transfer to Primary Crusher Hopper	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS6	Limestone transfer to Ball Mill Feed Bin	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	5A	5A	5A	5A	0.043	2.8E-4	0.522	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	5A	5A	5A	5A	6.3E-3	4.0E-5	0.076	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	0.021	1.3E-4	0.251	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	6.4E-3	4.1E-5	0	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	1.4E-4	9.0E-7	0	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	1.4E-5	9.0E-8	0	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7

TABLE B2-W1. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	5A	5A	5A	5A	4.7E-4	3.0E-6	0	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	2.0E-6	4.9E-9	0	1.7E-6	0	0	0	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.4E-7	3.7E-5	1.0E-6	0	2.2E-6	0	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.2E-6	1.5E-4	4.1E-6	0	8.6E-6	0	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.2E-6	2.2E-4	6.2E-6	0	1.3E-5	0	0	0	0	0	6.8E-6
Mining - Modeling Scenario: W1	WEP	West End Pit	7E	7E	7E	7E	5.585	0.063	1.101	0	1.432	0	7.9E-4	2.2E-3
	WEPBL	West End Pit Blasting	7E	7E	7E	7E	1.902	0.021	0.375	0	0.488	0	2.7E-4	7.5E-4
	STKP	PC Stockpile	7E	7E	7E	7E	1.063	0.012	0.210	0	0.272	0	1.5E-4	4.2E-4
	HR000	Haul Roads	7E	7E	7E	7E	21.435	0.242	4.227	0	5.495	0	3.0E-3	8.5E-3
	ACCRD	Access Roads	7E	7E	7E	7E	0.113	1.3E-3	0.022	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	7E	7E	7E	7E	2.5E-5	2.8E-7	4.9E-6	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**5.7E-6**	**2.0E-5**	**1.3E-3**	**4.0E-5**	**30.746**	**0.346**	**8.179**	**0.696**	**7.928**	**2.030**	**4.8E-3**	**0.013**

TABLE B2-W2. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.089	1.0E-3	0.018	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	7E/LL	7E/LL	7E/LL	7E/LL	0.098	1.1E-3	0.019	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.011	1.3E-4	2.3E-3	0	2.9E-3	0	1.6E-6	4.5E-6
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	2.3E-5	2.3E-5	2.3E-5	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	3.1E-6	0	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	7E	7E	7E	7E	0	9.7E-6	0	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	4.3E-7	0	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	7E	7E	7E	7E	0	2.2E-5	0	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	0	9.5E-5	0	0	0	0	0	5.0E-5
Lime Production	LS1	Limestone transfer to Primary Crusher Hopper	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS6	Limestone transfer to Ball Mill Feed Bin	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	5A	5A	5A	5A	0.043	2.8E-4	0.522	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	5A	5A	5A	5A	6.3E-3	4.0E-5	0.076	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	0.021	1.3E-4	0.251	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	6.4E-3	4.1E-5	0	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	1.4E-4	9.0E-7	0	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	1.4E-5	9.0E-8	0	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7

TABLE B2-W2. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	5A	5A	5A	5A	4.7E-4	3.0E-6	0	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	2.0E-6	4.9E-9	0	1.7E-6	0	0	0	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.4E-7	3.7E-5	1.0E-6	0	2.2E-6	0	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.2E-6	1.5E-4	4.1E-6	0	8.6E-6	0	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.2E-6	2.2E-4	6.2E-6	0	1.3E-5	0	0	0	0	0	6.8E-6
Mining - Modeling Scenario: W2	WEP	West End Pit	7E	7E	7E	7E	5.585	0.063	1.101	0	1.432	0	7.9E-4	2.2E-3
	WEPBL	West End Pit Blasting	7E	7E	7E	7E	1.902	0.021	0.375	0	0.488	0	2.7E-4	7.5E-4
	FDRSF	Fiddle DRSF	7E	7E	7E	7E	0.858	9.7E-3	0.169	0	0.220	0	1.2E-4	3.4E-4
	HR000	Haul Roads	7E	7E	7E	7E	34.484	0.389	6.800	0	8.840	0	4.9E-3	0.014
	ACCRD	Access Roads	7E	7E	7E	7E	0.113	1.3E-3	0.022	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	7E	7E	7E	7E	2.5E-5	2.8E-7	4.9E-6	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**5.7E-6**	**2.0E-5**	**1.3E-3**	**4.0E-5**	**43.590**	**0.491**	**10.711**	**0.696**	**11.221**	**2.030**	**6.6E-3**	**0.018**

TABLE B2-W3. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.089	1.0E-3	0.018	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	7E/LL	7E/LL	7E/LL	7E/LL	0.098	1.1E-3	0.019	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.011	1.3E-4	2.3E-3	0	2.9E-3	0	1.6E-6	4.5E-6
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	2.3E-5	2.3E-5	2.3E-5	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	3.1E-6	0	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	7E	7E	7E	7E	0	9.7E-6	0	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	4.3E-7	0	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	7E	7E	7E	7E	0	2.2E-5	0	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	0	9.5E-5	0	0	0	0	0	5.0E-5
Lime Production	LS1	Limestone transfer to Primary Crusher Hopper	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS6	Limestone transfer to Ball Mill Feed Bin	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	5A	5A	5A	5A	0.043	2.8E-4	0.522	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	5A	5A	5A	5A	6.3E-3	4.0E-5	0.076	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	0.021	1.3E-4	0.251	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	6.4E-3	4.1E-5	0	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	1.4E-4	9.0E-7	0	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	1.4E-5	9.0E-8	0	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7

TABLE B2-W3. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	5A	5A	5A	5A	4.7E-4	3.0E-6	0	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	2.0E-6	4.9E-9	0	1.7E-6	0	0	0	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.4E-7	3.7E-5	1.0E-6	0	2.2E-6	0	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.2E-6	1.5E-4	4.1E-6	0	8.6E-6	0	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.2E-6	2.2E-4	6.2E-6	0	1.3E-5	0	0	0	0	0	6.8E-6
Mining - Modeling Scenario: W3	WEP	West End Pit	7E	7E	7E	7E	5.585	0.063	1.101	0	1.432	0	7.9E-4	2.2E-3
	WEPBL	West End Pit Blasting	7E	7E	7E	7E	1.902	0.021	0.375	0	0.488	0	2.7E-4	7.5E-4
	HFDRSF	Hangar Flats DRSF	7E	7E	7E	7E	0.858	9.7E-3	0.169	0	0.220	0	1.2E-4	3.4E-4
	HR000	Haul Roads	7E	7E	7E	7E	49.397	0.557	9.740	0	12.662	0	7.0E-3	0.019
	ACCRD	Access Roads	7E	7E	7E	7E	0.113	1.3E-3	0.022	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	7E	7E	7E	7E	2.5E-5	2.8E-7	4.9E-6	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**5.7E-6**	**2.0E-5**	**1.3E-3**	**4.0E-5**	**58.504**	**0.659**	**13.652**	**0.696**	**15.043**	**2.030**	**8.7E-3**	**0.024**

TABLE B2-W4. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.089	1.0E-3	0.018	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	7E/LL	7E/LL	7E/LL	7E/LL	0.098	1.1E-3	0.019	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.011	1.3E-4	2.3E-3	0	2.9E-3	0	1.6E-6	4.5E-6
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	2.3E-5	2.3E-5	2.3E-5	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	3.1E-6	0	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	7E	7E	7E	7E	0	9.7E-6	0	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	4.3E-7	0	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	7E	7E	7E	7E	0	2.2E-5	0	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	0	9.5E-5	0	0	0	0	0	5.0E-5
Lime Production	LS1	Limestone transfer to Primary Crusher Hopper	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS6	Limestone transfer to Ball Mill Feed Bin	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	5A	5A	5A	5A	0.043	2.8E-4	0.522	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	5A	5A	5A	5A	6.3E-3	4.0E-5	0.076	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	0.021	1.3E-4	0.251	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	6.4E-3	4.1E-5	0	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	1.4E-4	9.0E-7	0	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	1.4E-5	9.0E-8	0	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7

TABLE B2-W4. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	5A	5A	5A	5A	4.7E-4	3.0E-6	0	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	2.0E-6	4.9E-9	0	1.7E-6	0	0	0	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.4E-7	3.7E-5	1.0E-6	0	2.2E-6	0	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.2E-6	1.5E-4	4.1E-6	0	8.6E-6	0	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.2E-6	2.2E-4	6.2E-6	0	1.3E-5	0	0	0	0	0	6.8E-6
Mining - Modeling Scenario: W4	WEP	West End Pit	7E	7E	7E	7E	5.585	0.063	1.101	0	1.432	0	7.9E-4	2.2E-3
	WEPBL	West End Pit Blasting	7E	7E	7E	7E	1.902	0.021	0.375	0	0.488	0	2.7E-4	7.5E-4
	YPDRSF	Yellow Pine DRSF	7E	7E	7E	7E	0.858	9.7E-3	0.169	0	0.220	0	1.2E-4	3.4E-4
	HR000	Haul Roads	7E	7E	7E	7E	22.281	0.251	4.393	0	5.711	0	3.1E-3	8.8E-3
	ACCRD	Access Roads	7E	7E	7E	7E	0.113	1.3E-3	0.022	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	7E	7E	7E	7E	2.5E-5	2.8E-7	4.9E-6	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**5.7E-6**	**2.0E-5**	**1.3E-3**	**4.0E-5**	**31.387**	**0.353**	**8.305**	**0.696**	**8.092**	**2.030**	**4.8E-3**	**0.013**

TABLE B2-W5. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.089	1.0E-3	0.018	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	7E/LL	7E/LL	7E/LL	7E/LL	0.098	1.1E-3	0.019	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.011	1.3E-4	2.3E-3	0	2.9E-3	0	1.6E-6	4.5E-6
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	2.3E-5	2.3E-5	2.3E-5	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	3.1E-6	0	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	7E	7E	7E	7E	0	9.7E-6	0	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	4.3E-7	0	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	7E	7E	7E	7E	0	2.2E-5	0	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	0	9.5E-5	0	0	0	0	0	5.0E-5
Lime Production	LS1	Limestone transfer to Primary Crusher Hopper	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS6	Limestone transfer to Ball Mill Feed Bin	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	5A	5A	5A	5A	0.043	2.8E-4	0.522	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	5A	5A	5A	5A	6.3E-3	4.0E-5	0.076	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	0.021	1.3E-4	0.251	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	6.4E-3	4.1E-5	0	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	1.4E-4	9.0E-7	0	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	1.4E-5	9.0E-8	0	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7

TABLE B2-W5. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	5A	5A	5A	5A	4.7E-4	3.0E-6	0	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	2.0E-6	4.9E-9	0	1.7E-6	0	0	0	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.4E-7	3.7E-5	1.0E-6	0	2.2E-6	0	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.2E-6	1.5E-4	4.1E-6	0	8.6E-6	0	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.2E-6	2.2E-4	6.2E-6	0	1.3E-5	0	0	0	0	0	6.8E-6
Mining - Modeling Scenario: W5	WEP	West End Pit	7E	7E	7E	7E	5.585	0.063	1.101	0	1.432	0	7.9E-4	2.2E-3
	WEPBL	West End Pit Blasting	7E	7E	7E	7E	1.902	0.021	0.375	0	0.488	0	2.7E-4	7.5E-4
	WEDRSF	West End DRSF	7E	7E	7E	7E	0.858	9.7E-3	0.169	0	0.220	0	1.2E-4	3.4E-4
	HR000	Haul Roads	7E	7E	7E	7E	24.595	0.277	4.850	0	6.305	0	3.5E-3	9.7E-3
	ACCRD	Access Roads	7E	7E	7E	7E	0.113	1.3E-3	0.022	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	7E	7E	7E	7E	2.5E-5	2.8E-7	4.9E-6	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**5.7E-6**	**2.0E-5**	**1.3E-3**	**4.0E-5**	**33.702**	**0.379**	**8.761**	**0.696**	**8.686**	**2.030**	**5.2E-3**	**0.014**

TABLE B2-B1. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.089	1.0E-3	0.018	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	7E/LL	7E/LL	7E/LL	7E/LL	0.098	1.1E-3	0.019	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.011	1.3E-4	2.3E-3	0	2.9E-3	0	1.6E-6	4.5E-6
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	2.3E-5	2.3E-5	2.3E-5	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	3.1E-6	0	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	7E	7E	7E	7E	0	9.7E-6	0	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	4.3E-7	0	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	7E	7E	7E	7E	0	2.2E-5	0	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	0	9.5E-5	0	0	0	0	0	5.0E-5
Lime Production	LS1	Limestone transfer to Primary Crusher Hopper	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS6	Limestone transfer to Ball Mill Feed Bin	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	5A	5A	5A	5A	0.043	2.8E-4	0.522	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	5A	5A	5A	5A	6.3E-3	4.0E-5	0.076	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	0.021	1.3E-4	0.251	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	6.4E-3	4.1E-5	0	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	1.4E-4	9.0E-7	0	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	1.4E-5	9.0E-8	0	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7

TABLE B2-B1. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	5A	5A	5A	5A	4.7E-4	3.0E-6	0	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	2.0E-6	4.9E-9	0	1.7E-6	0	0	0	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.4E-7	3.7E-5	1.0E-6	0	2.2E-6	0	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.2E-6	1.5E-4	4.1E-6	0	8.6E-6	0	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.2E-6	2.2E-4	6.2E-6	0	1.3E-5	0	0	0	0	0	6.8E-6
Mining - Modeling Scenario: B1	BT	Bradley Tailings	7E	7E	7E	7E	5.567	0.063	1.098	0	1.427	0	7.8E-4	2.2E-3
	BTBL	Bradley Tailings Blasting	7E	7E	7E	7E	1.902	0.021	0.375	0	0.488	0	2.7E-4	7.5E-4
	STKP	PC Stockpile	7E	7E	7E	7E	1.063	0.012	0.210	0	0.272	0	1.5E-4	4.2E-4
	HR000	Haul Roads	7E	7E	7E	7E	28.394	0.320	5.599	0	7.278	0	4.0E-3	0.011
	ACCRD	Access Roads	7E	7E	7E	7E	0.113	1.3E-3	0.022	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	7E	7E	7E	7E	2.5E-5	2.8E-7	4.9E-6	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**5.7E-6**	**2.0E-5**	**1.3E-3**	**4.0E-5**	**37.687**	**0.424**	**9.547**	**0.696**	**9.707**	**2.030**	**5.7E-3**	**0.015**

TABLE B2-B2. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.089	1.0E-3	0.018	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	7E/LL	7E/LL	7E/LL	7E/LL	0.010	1.2E-4	2.0E-3	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	7E/LL	7E/LL	7E/LL	7E/LL	0.049	5.5E-4	9.7E-3	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	7E/LL	7E/LL	7E/LL	7E/LL	0.098	1.1E-3	0.019	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	7E/LL	7E/LL	7E/LL	7E/LL	0.011	1.3E-4	2.3E-3	0	2.9E-3	0	1.6E-6	4.5E-6
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	2.3E-5	2.3E-5	2.3E-5	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	3.1E-6	0	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	7E	7E	7E	7E	0	9.7E-6	0	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7E	7E	7E	7E	0	4.3E-7	0	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	7E	7E	7E	7E	0	2.2E-5	0	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	0	9.5E-5	0	0	0	0	0	5.0E-5
Lime Production	LS1	Limestone transfer to Primary Crusher Hopper	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	5A	5A	5A	5A	5.7E-3	3.7E-5	0.070	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	5A	5A	5A	5A	0.027	1.7E-4	0.323	0	0.012	0	5.9E-6	1.8E-5
	LS6	Limestone transfer to Ball Mill Feed Bin	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	5A	5A	5A	5A	3.2E-3	2.0E-5	0.039	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	5A	5A	5A	5A	0.043	2.8E-4	0.522	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	5A	5A	5A	5A	6.3E-3	4.0E-5	0.076	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	7.5E-4	4.8E-6	9.2E-3	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	0.021	1.3E-4	0.251	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	6.4E-3	4.1E-5	0	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	1.4E-4	9.0E-7	0	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	1.4E-5	9.0E-8	0	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	5A	5A	5A	5A	2.3E-4	1.5E-6	0	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5A	5A	5A	5A	1.1E-3	7.3E-6	0	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7

TABLE B2-B2. TAPs that Exceed the EL by Model Source ID

	Source ID	Source Description	Arsenic 7440-38-2	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	5A	5A	5A	5A	9.3E-4	6.0E-6	0	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	5A	5A	5A	5A	4.7E-4	3.0E-6	0	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	5A	5A	5A	5A	2.2E-3	1.4E-5	0	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	0.014	9.1E-5	0.172	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	2.0E-6	4.9E-9	0	1.7E-6	0	0	0	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	0	0	2.9E-7	0	0	0	0	0	0	0	0
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	0.016	1.0E-4	0	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.3E-6	2.9E-4	8.2E-6	0	1.7E-5	0	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.7E-7	1.8E-5	5.1E-7	0	1.1E-6	0	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.4E-7	3.7E-5	1.0E-6	0	2.2E-6	0	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.2E-6	1.5E-4	4.1E-6	0	8.6E-6	0	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.2E-6	2.2E-4	6.2E-6	0	1.3E-5	0	0	0	0	0	6.8E-6
Mining - Modeling Scenario: B2	BT	Bradley Tailings	7E	7E	7E	7E	5.567	0.063	1.098	0	1.427	0	7.8E-4	2.2E-3
	BTBL	Bradley Tailings Blasting	7E	7E	7E	7E	1.902	0.021	0.375	0	0.488	0	2.7E-4	7.5E-4
	HFDRSF	Hangar Flats DRSF	7E	7E	7E	7E	0.858	9.7E-3	0.169	0	0.220	0	1.2E-4	3.4E-4
	HR000	Haul Roads	7E	7E	7E	7E	6.713	0.076	1.324	0	1.721	0	9.5E-4	2.6E-3
	ACCRD	Access Roads	7E	7E	7E	7E	0.113	1.3E-3	0.022	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	7E	7E	7E	7E	2.5E-5	2.8E-7	4.9E-6	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**5.7E-6**	**2.0E-5**	**1.3E-3**	**4.0E-5**	**15.801**	**0.178**	**5.232**	**0.696**	**4.097**	**2.030**	**2.7E-3**	**6.8E-3**

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis/E. Memon
	PROJECT NO: 335-1-4	PAGE: 1 OF: 4 SHEET: Summary
AIR EMISSION CALCULATIONS	SUBJECT: Emissions Summary	DATE: June 22, 2020

Facility-Wide Criteria Pollutant PTE

Activity	PM ton/yr	PM10 lb/hr	PM10 ton/yr	PM2.5 lb/hr	PM2.5 ton/yr	CO lb/hr	CO ton/yr	NOX lb/hr	NOX ton/yr	SO2 lb/hr	SO2 ton/yr	VOC ton/yr
Process & Ancillary	87.3	21.7	56.3	13.4	36.4	33.5	30.5	55.4	37.9	1.9	6.5	4.8
Mining Fugitive	3,569	225	986	22.5	98.9	1,742	636	46.8	17.1	9.4E-02	3.4E-02	0.0E+00
Total	3,656	246	1,042	35.9	135	1,776	666	102	54.9	2.0	6.5	4.8

Mining fugitive emissions are for model scenario: W3

Permitting Applicability

	PM ton/yr	PM10 ton/yr	PM2.5 ton/yr	CO ton/yr	NOX ton/yr	SO2 ton/yr
Total Process & Ancillary	87.3	56.3	36.4	30.5	37.9	6.5
Significant Threshold [1]	25	15	10	100	40	40
	Above	Above	Above	Minor	Minor	Minor
Regulatory Concern Threshold (10% of Significant) [2]						
	2.5	1.5	1	10	4	4
	Permit	Permit	Permit	Permit	Permit	Permit
Major Source Determination		100	100	100	100	100
		Minor	Minor	Minor	Minor	Minor

[1] *IDAPA 58.01.01.006.108.a.*

[2] *IDAPA 58.01.01.221.01*

Modeling Applicability

	PM10 lb/hr	PM2.5 lb/hr	PM2.5 ton/yr	CO lb/hr	NOX lb/hr	NOX ton/yr	SO2 lb/hr	SO2 ton/yr	Pb lb/month
Process & Ancillary	21.7	13.4	36.4	33.5	55.4	37.9	1.9	6.5	4.4E-02
Mining Fugitive	225	22.5	98.9	1,742	46.8	17.1	9.4E-02	3.4E-02	0.0E+00
Total	246	35.9	135	1,776	102	54.9	2.0	6.5	4.4E-02
Level I Thresholds [1]	0.22	0.054	0.35	15	0.20	1.20	0.21	1.2	14
Modeling Triggered?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

[1] *IDEQ, Guideline for Performing Air Quality Impact Analyses Table 2, September-2013*

Permit to Construct Processing Fee Determination [1]

Regulated Pollutant	ton/yr
PM10	56.3
CO	30.5
NOX	37.9
SO2	6.5
VOC	4.8
Total [2]	136

[1] *Process & Ancillary Sources Only*

[2] *In accordance with 58.01.01.225, the Permit to Construct Processing Fee will be $7,500. This is for a non major new source with an increase of emissions of 100 tpy or more.*

Conversions

2,000 lb/ton

8,760 hr/yr

Autoclave Non-HAP TAP Emissions

CAS No.	Pollutant	Throughpu ton/hr	Operation hr/yr	Emission Factor		Emissions lb/hr	ton/yr
7664-93-9	Sulfuric Acid	290	8,760	0.007	lb/ton[1]	2.03	8.9
7783-06-4	Hydrogen Sulfide		8,760	0.9	lb/hr[2]	0.9	3.9

[1] *H2SO4 is based on Acidic Autoclave test data (APT 2010)*

[2] *H2S is based on Acidic Autoclave test data (APT 2013)*

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: S. Pryor/E. Memon
	PROJECT NO: 335-1-4	PAGE: 8 OF: 10 SHEET: ProcHAP
AIR EMISSION CALCULATIONS	SUBJECT: Process HAP Emissions	DATE: June 22, 2020

MATERIAL PROCESSING HAP/TAP EMISSIONS

Ore Processing PM Emissions 5.9 lb/hr
25.8 ton/yr

Ore Dust HAP Concentrations[1] and Emissions

		Concentration	Emissions	
CAS No.	Pollutant	ppm	lb/hr	ton/yr
7440-38-2	Arsenic	667	0.003923	0.0172
7440-41-7	Beryllium	3.2	0.000019	0.0001
7440-43-9	Cadmium	0.5	0.000003	0.00001
7440-48-4	Cobalt	4	0.000024	0.0001
7440-47-3	Chromium	9	0.000053	0.0002
7439-97-6	Mercury	0.96	0.000006	0.00002
7439-96-5	Manganese	299	0.001759	0.0077
7440-02-0	Nickel	2	0.000012	0.0001
7439-92-1	Lead	8	0.000047	0.0002
7440-36-0	Antimony	23	0.000135	0.0006
7723-14-0	Phosphorus	650	0.003823	0.0167
Dust HAP Total			0.009803	0.0429

[1] *(Midas Gold 2017c)*

Ore Dust Non-HAP TAP Concentrations[1] and Emissions

		Concentration	Emissions	
CAS No.	Pollutant	ppm	lb/hr	ton/yr
7440-22-4	Silver	0.5	0.000003	0.00001
7440-39-3	Barium	800	0.004705	0.0206
7440-50-8	Copper	5	0.000029	0.0001
7439-98-7	Molybdenum	1	0.000006	0.00003
7440-28-0	Thallium	10	0.000059	0.00026
7440-61-1	Uranium	10	0.000059	0.0003
Dust HAP Total			0.004861	0.0213

[1] *(Midas Gold 2017c)*

Sb Concentrate Processing PM Emissions 0.12 lb/hr
0.52 ton/yr

Stib. Conc.

Sb Concentrate Dust Non-HAP TAP Concentrations[1] and Emissions

		Concentration	Emissions	
CAS No.	Pollutant	ppm	lb/hr	ton/yr
7440-36-0	Antimony	580,000	0.0684	0.2998

[1] *(Midas Gold 2019d)*

Carbon Disulfide Emissions from Xanthate Decomposition

		Xanthate[1]	Molar	CS_2 MW	Temperature	Emissions	
CAS No.	Pollutant	ton/yr	Decomp.[2]	Ratio	Adj. Factor[3]	lb/hr	ton/yr
75-15-0	Carbon Disulfide	1,700	0.99%	0.376	0.01	0.0145	0.063

[1] *(Midas Gold 2016) p. 12-11*

[2] *(Air Sciences 2020) molar decomposition of of xanthate in solution to CS2 gas*

[3] *(Air Sciences 2020) based on the comparison of CS2 generation at 50C and 70C*

Conversions			MW	
2,000	lb/ton	Xanthate (PAX)	202.37	$C_6H_{11}KOS_2$
8,760	hr/yr	Carbon difulfide	76.139	CS_2

PET-1138

MATERIAL PROCESSING HAP/TAP EMISSIONS

			TRUE
Lead Emission by Source			Pb_tpy
Source ID	**Description**		Pb ton/yr
CS1L	Cement/Shotcrete Silo #1 Loading		2.21E-5
CS2L	Cement/Shotcrete Silo #2 Loading		2.21E-5
CM	Central Mixer Loading		1.15E-5
[1] OC1	Loader Transfer of Ore to Grizzly		5.11E-6
[1] OC2	Grizzly to Apron Feeder		5.11E-6
[1] OC3	Apron Feeder to Dribble Conveyor		5.11E-6
[1] OC4	Apron Feeder to Vibrating Grizzly		5.11E-6
[1] OC5	Dribble Conveyor to Vibrating Grizzly		5.11E-6
[1] OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor		5.11E-6
[5] OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor		4.38E-5
[1] OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile		5.11E-6
[3] OC9	Stockpile Transfers to Reclaim Conveyors		2.42E-5
[3] OC10	Reclaim Conveyors to SAG Mill Feed Conveyor		2.42E-5
[3] OC11	SAG Mill Feed Conveyor Transfer to SAG Mill		2.42E-5
[6] OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)		4.84E-5
[1] OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor		5.64E-6
Total			2.62E-4

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: S. Pryor/E. Memon
	PROJECT NO: 335-1-4	PAGE: 10 OF: 10 SHEET: ProcHAP
AIR EMISSION CALCULATIONS	SUBJECT: Process HAP Emissions	DATE: June 22, 2020

40 CFR 63 Subpart 7E MERCURY SOURCES

Mercury Emissions

Description	Subpart 7E Hg Emissions ton/yr	Oper. hr/yr	% of Subpart 7E for Controlled Systems* %	Controlled Hg Emissions* lb/hr	lb/yr	ton/yr
Autoclave **	0.107	8,760	10.0%	0.002	21.34	0.011
Refinery Sources (Kiln, EW, Retort, Furnace)	0.008	1,248	20.0%	0.003	3.36	0.002
Total 7439-97-6	0.115			0.005	24.70	0.012

**Based on Similar Source Hg Reporting Levels provided below*

***Expected actual emissions from Autoclave:* 0.0105 g/hr 2.3E-05 lb/hr 0.20 lb/yr *(M3 2019)*

Subpart 7E Limit - Ore Pretreatment Processes *(CFR 2018b)*

$$\frac{84\ \text{lb}}{\sout{\text{MMton}}} \times \frac{2{,}540{,}400\ \sout{\text{ton}}}{\text{yr}} \times \frac{\sout{\text{MMton}}}{1.0\text{E+6}\ \sout{\text{ton}}} = \frac{213.39\ \text{lb}}{\text{yr}}$$

Subpart 7E Limit - Carbon Processes with Mercury Retorts

$$\frac{0.8\ \text{lb}}{\sout{\text{ton}}} \times \frac{21\ \sout{\text{ton}}}{\text{yr}} = \frac{16.8\ \text{lb}}{\text{yr}}$$

Similar Source Hg Reporting Levels

Goldstrike Autoclaves 2 & 3 (2015 & 2016 Hg Reports) *(NDEP 2015a) (NDEP 2016)*

$$\frac{28.79\ \text{lb}}{\text{yr}} \times \frac{\text{yr}}{3.13\ \text{MMton}} = \frac{9.18\ \text{lb}}{\text{MMton}} \times \frac{\text{MMton}}{84\ \text{lb}} = 10.9\%$$

Twin Creeks Autoclaves 1 & 2 (2015 & 2016 Hg Reports) *(NDEP 2015a) (NDEP 2016)*

$$\frac{1.01\ \text{lb}}{\text{yr}} \times \frac{\text{yr}}{7.63\ \text{MMton}} = \frac{0.13\ \text{lb}}{\text{MMton}} \times \frac{\text{MMton}}{84\ \text{lb}} = 0.2\%$$

Goldstrike Refinery (2015 & 2016 Hg Reports) *(NDEP 2015a) (NDEP 2016)*

$$\frac{28.79\ \text{lb}}{\text{yr}} \times \frac{\text{yr}}{251.00\ \text{ton}} = \frac{0.11\ \text{lb}}{\text{MMton}} \times \frac{\text{MMton}}{0.8\ \text{lb}} = 14.3\%$$

Twin Creeks Refinery (2015 & 2016 Hg Reports) *(NDEP 2015a) (NDEP 2016)*

$$\frac{31.27\ \text{lb}}{\text{yr}} \times \frac{\text{yr}}{142.77\ \text{ton}} = \frac{0.22\ \text{lb}}{\text{MMton}} \times \frac{\text{MMton}}{0.8\ \text{lb}} = 27.4\%$$

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: E. Huelson/E. Memon
	PROJECT NO: 335-1-4	PAGE: 1 OF: 5 SHEET: Tanks
AIR EMISSION CALCULATIONS	SUBJECT: Fuel Storage Tanks	DATE: June 22, 2020

Fuel Storage Tanks

	Dimensions				VOC Emissions[1]		
	Capacity	Diameter	Length	Throughput			Reference
Storage Tank	gal	ft	ft	gal/yr	lb/yr	ton/yr	
Mine Site Gasoline Tank #1	5,000	8.5	14.33	250,000	1,914.73	0.96	*(Midas Gold 2016), Table 12-4, annual use*
Mine Site Gasoline Tank #2	5,000	8.5	14.33	250,000	1,914.73	0.96	*(Midas Gold 2016), Table 12-4, annual use*
Mine Site Diesel Tank #3	25,000	12	29.70	725,000	14.60	0.007	*(Midas Gold 2016), (Midas Gold 2018c)*
Mine Site Diesel Tank #4	25,000	12	29.70	725,000	14.60	0.007	*(Midas Gold 2016), (Midas Gold 2018c)*
Mine Site Diesel Tank #5	25,000	12	29.70	725,000	14.60	0.007	*(Midas Gold 2016), (Midas Gold 2018c)*
Mine Site Diesel Tank #6	25,000	12	29.70	725,000	14.60	0.007	*(Midas Gold 2016), (Midas Gold 2018c)*
Mine Site Diesel Tank #7	25,000	12	29.70	725,000	14.60	0.007	*(Midas Gold 2016), (Midas Gold 2018c)*
Mine Site Diesel Tank #8	25,000	12	29.70	725,000	14.60	0.007	*(Midas Gold 2016), (Midas Gold 2018c)*
Mine Site Diesel Tank #9	25,000	12	29.70	725,000	14.60	0.007	*(Midas Gold 2016), (Midas Gold 2018c)*
Mine Site Diesel Tank #10	25,000	12	29.70	725,000	14.60	0.007	*(Midas Gold 2016), (Midas Gold 2018c)*

[1] *Emissions calculated using EPA Tanks 4.0.9d (EPA 1999)*

AIR EMISSION CALCULATIONS	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-1-4	PAGE: 1 OF: 2 SHEET: MineLimits
	SUBJECT: Max Case Operation	DATE: June 22, 2020

Maximum Mining Activity Rate

Maximum Operating Schedule

24 hr/day
365 day/yr

Maximum Production

180,000 ton/day, ore and rock *(Midas Gold 2019b)*
180,000 ton/day, ore *(Midas Gold 2019b)*
180,000 ton/day, rock *(Midas Gold 2019b)*

2 blasts per day *(Midas Gold 2019b)*
600 holes per blast *(Midas Gold 2019a)*

Modeling Scenarios

	Model Scenario	Pit YPP ton/day	HFP ton/day	WEP ton/day	BT ton/day	Ore Destination PC ton/day	STKP ton/day	Development Rock Destination FDRSF ton/day	HFDRSF ton/day	YPDRSF ton/day	WEDRSF ton/day
YP	Y1	180,000	--	--	--	--	180,000	--	--	--	--
YP	Y2	180,000	--	--	--	--	--	180,000	--	--	--
YP	Y3	180,000	--	--	--	--	--	--	180,000	--	--
HF	H1	--	180,000	--	--	--	180,000	--	--	--	--
HF	H2	--	180,000	--	--	--	--	180,000	--	--	--
HF	H3	--	180,000	--	--	--	--	--	180,000	--	--
HF	H4	--	180,000	--	--	--	--	--	--	180,000	--
WE	W1	--	--	180,000	--	--	180,000	--	--	--	--
WE	W2	--	--	180,000	--	--	--	180,000	--	--	--
WE	W3	--	--	180,000	--	--	--	--	180,000	--	--
WE	W4	--	--	180,000	--	--	--	--	--	180,000	--
WE	W5	--	--	180,000	--	--	--	--	--	--	180,000
BT	B1	--	--	--	180,000	--	180,000	--	--	--	--
BT	B2	--	--	--	180,000	--	--	--	180,000	--	--

Daily maximum mining equipment

Equipment		Units	
Truck Fleet	Cat 789D	20	*(Midas Gold 2017b)*
Truck Fleet	Cat 740B	12	*(Midas Gold 2019b)*
Water truck	Cat 777D	2	*(Midas Gold 2017b)*
Dozer		6	*(Midas Gold 2017b)*
Grader		3	*(Midas Gold 2017b)*

Daily maximum access road traffic

	One-Way Trips per Day	
Road maintenance equipment	4	*(Midas Gold 2016); Table 12-2*
Light vehicles	19	*(Midas Gold 2016); Table 12-2*
Heavy vehicles	45	*(Midas Gold 2016); Table 12-2*
Total	68	

Acronyms

YPP	Yellow Pine Pit
HFP	Hangar Flats Pit
WEP	West End Pit
BT	Bradley Tailings
FDRSF	Fiddle DRSF
HFDRSF	Hangar Flats DRSF
YPDRSF	Yellow Pine DRSF
WEDRSF	West End DRSF
PC	Primary Crusher
STKP	Primary Crusher Stockpile

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis/E. Memon
	PROJECT NO: 335-1-4	PAGE: 1 OF: 20 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 22, 2020

Model Scenario W3

Mining Activity and Emissions Emissions Summary

By Area/Model ID

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	CO_PPH	CO_TPY	NOX_PPH	NOX_TPY	SO2_PPH	SO2_TPY	VOC_TPY
Area/	Location of	PM	PM10		PM2.5		CO		NOX		SO2		VOC
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr
YPP	Yellow Pine Pit	--	--	--	--	--	--	--	--	--	--	--	--
HFP	Hangar Flats Pit	--	--	--	--	--	--	--	--	--	--	--	--
WEP	West End Pit	344.54	885.54	161.61	79.64	14.53	--	--	--	--	--	--	--
BT	Bradley Tailings	--	--	--	--	--	--	--	--	--	--	--	--
YPPBL	Yellow Pine Pit Blasting	--	--	--	--	--	--	--	--	--	--	--	--
HFPBL	Hangar Flats Pit Blasting	--	--	--	--	--	--	--	--	--	--	--	--
WEPBL	West End Pit Blasting	117.35	334.38	61.02	19.29	3.52	1,742.00	635.83	46.80	17.08	0.09	0.03	--
BTBL	Bradley Tailings Blasting	--	--	--	--	--	--	--	--	--	--	--	--
STKP	PC Stockpile	--	--	--	--	--	--	--	--	--	--	--	--
FDRSF	Fiddle DRSF	--	--	--	--	--	--	--	--	--	--	--	--
HFDRSF	Hangar Flats DRSF	52.91	57.12	10.42	30.23	5.52	--	--	--	--	--	--	--
YPDRSF	Yellow Pine DRSF	--	--	--	--	--	--	--	--	--	--	--	--
WEDRSF	West End DRSF	--	--	--	--	--	--	--	--	--	--	--	--
TSF	Tailing Storage Facility	--	--	--	--	--	--	--	--	--	--	--	--
HR	Haul Roads	3,047.34	4,106.76	750.84	410.88	75.12	--	--	--	--	--	--	--
ACCRD	Access Roads	6.95	9.38	1.72	0.94	0.17	--	--	--	--	--	--	--
UGEXP	Scout Portal	0.002	0.004	0.001	0.001	0.0001	--	--	--	--	--	--	--
Total		3,569.10	5,393.19	985.62	540.98	98.87	1,742.00	635.83	46.80	17.08	0.09	0.03	--

See worksheet ROADS for haul road (HR) emissions by Model ID.

By Activity

	chk	chk-12	chk	chk	chk	chk	chk	chk	chk	chk	chk	chk
	PM	PM10		PM2.5		CO		NOX		SO2		VOC
Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr
Open Pit Drilling	284.70	811.20	148.04	46.80	8.54							
Open Pit Blasting	117.35	334.38	61.02	19.29	3.52	1,742.00	635.83	46.80	17.08	0.09	0.03	
Onsite Hauling	2,901.27	3,899.39	712.95	389.94	71.29							
Material Load / Unload	8.06	20.88	3.81	3.16	0.58							
Dozing	103.56	108.40	19.78	59.58	10.87							
Grading	36.80	60.51	11.04	6.25	1.14							
Water Truck Travel	109.27	146.86	26.85	14.69	2.69							
Access Road	6.95	9.38	1.72	0.94	0.17							
Wind Erosion	0.02	0.04	0.01	0.01	0.00							
Surface Exploration	1.12	2.14	0.39	0.32	0.06							
Underground Exploration	0.002	0.004	0.0007	0.0006	0.0001							
Total	3,569.10	5,393.19	985.62	540.98	98.87	1,742.00	635.83	46.80	17.08	0.09	0.03	--

W3 Model Input Emission Rates (g/s)

By Area/Model ID

		CO_PPH	NOX_TPY	NOX_PPH	PM2.5_TPY	PM2.5_PPD	PM10_PPD	SO2_PPH
Area/	Location of	CO	NO_X		$PM_{2.5}$		PM_{10}	SO_2
Model ID	Activity	8, 1-hr	Annual	1-hr	Annual	24-hr	24-hr	3, 1-hr
YPP	Yellow Pine Pit	--	--	--	--	--	--	--
HFP	Hangar Flats Pit	--	--	--	--	--	--	--
WEP	West End Pit	--	--	--	0.42	0.42	4.65	--
BT	Bradley Tailings	--	--	--	--	--	--	--
YPPBL	Yellow Pine Pit Blasting	--	--	--	--	--	--	--
HFPBL	Hangar Flats Pit Blasting	--	--	--	--	--	--	--
WEPBL	West End Pit Blasting	219.49	0.49	5.90	0.10	0.10	1.76	0.01
BTBL	Bradley Tailings Blasting	--	--	--	--	--	--	--
STKP	PC Stockpile	--	--	--	--	--	--	--
FDRSF	Fiddle DRSF	--	--	--	--	--	--	--
HFDRSF	Hangar Flats DRSF	--	--	--	0.16	0.16	0.30	--
YPDRSF	Yellow Pine DRSF	--	--	--	--	--	--	--
WEDRSF	West End DRSF	--	--	--	--	--	--	--
TSF	Tailing Storage Facility	--	--	--	--	--	--	--
HR	Haul Roads	--	--	--	2.16	2.16	21.56	--
ACCRD	Access Roads	--	--	--	0.00	0.00	0.05	--
UGEXP	Scout Portal	--	--	--	0.000003	0.000003	0.000021	--
Total		219.49	0.49	5.90	2.844043237	2.84	28.31	0.01
		TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE

Model Scenario W3

Open Pit Drilling

Activity Information

Operating schedule 365 day/yr

Total drill holes per year 1,200 hole/day 2 blast/day 600 hole/blast

Annual LOM-W3 rates		Material blasted	Drilling
YPP	Yellow Pine Pit	0 ton/day	0 hole/day
HFP	Hangar Flats Pit	0 ton/day	0 hole/day
WEP	West End Pit	180,000 ton/day	1,200 hole/day
BT	Bradley Tailings	0 ton/day	0 hole/day
	Total	180,000 ton/day	1,200 hole/day

Emission Factors

TSP (PM) 1.3 lb/hole *AP-42, Tab. 11.9-4, 7/98 (overburden)*

PM Scaling Factors

PM 1

PM10 0.52 *AP-42, Tab. 11.9-1, 7/98 (blasting, overburden)*

PM2.5 0.03 *AP-42, Tab. 11.9-1, 7/98 (blasting, overburden)*

Emissions by Model ID

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY
	Location of	PM	PM10		PM2.5	
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr
YPP	Yellow Pine Pit	--	--	--	--	--
HFP	Hangar Flats Pit	--	--	--	--	--
WEP	West End Pit	284.70	811.20	148.04	46.80	8.54
BT	Bradley Tailings	--	--	--	--	--
Total	Open Pit Drilling	284.70	811.20	148.04	46.80	8.54

Source Parameters [1]

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	PITVOL_M3	SXINIT_M	SYINIT_M	SIG_Z_M	ANGL_DEG	Area
		Source	UTM NAD 83		Elev.	Rel. Ht.	Pit Vol.	Len X	Len Y	S-z	Angle	
Model ID	Activity	Type	E m	N m	m	m	m^3	m	m	m	deg	m2
YPP	Yellow Pine Pit	AREA	631,160	4,975,865	1,832	4.75		882.0	882.0	4.42	-8.0	777906
HFP	Hangar Flats Pit	AREA	630,925	4,972,884	1,993	4.75		491.0	491.0	4.42	0.0	241069
WEP	West End Pit	AREA	632,398	4,976,290	2,192	4.75		376.2	376.2	4.42	0.0	141544

[1] *UTM - (Midas Gold 2017d); Rel. Ht. - (EPA 2012); Len X, Len Y, Angle - best-fit equal area rectangle; Elev. - (Midas Gold 2018g)*

Source Parameters [1]

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M		SXINIT_M	SYINIT_M	SIG_Z_M	ANGL_DEG	
		Source	UTM NAD 83		Elev.	Rel. Ht.	Pit Vol.	Len X	Len Y	S-z	Angle	
Model ID	Activity	Type	E m	N m	m	m	m^3	m	m	m	deg	
BT	Bradley Tailings	AREA	630,110	4,972,105	2,012	4.75		820	420	4.42	0.0	344400

[1] *UTM, Elev. - (Midas Gold 2017d); Rel. Ht. - (EPA 2012); Len X, Len Y - best-fit equal area rectangle*

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis/E. Memon
	PROJECT NO: 335-1-4	PAGE: 4 OF: 20 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 22, 2020

Model Scenario W3

Open Pit Blasting

Activity Information

Operating schedule	365	day/yr	24	hr/day	
Blast area	80,795	ft^2/blast	*(Midas Gold 2017b)*		
Blast frequency	1	blast/hr	2	blast/day	730 blast/yr
ANFO use	26	ton/blast	*(Midas Gold 2017b)*		18,980 ton/yr

Annual LOM-W3 rates	Material blasted		Blasting		ANFO use		
Yellow Pine Pit	0	ton/day	0	blast/day	0	ton ANFO/hr	*(Midas Gold 2017b)*
Hangar Flats Pit	0	ton/day	0	blast/day	0	ton ANFO/hr	*(Midas Gold 2017b)*
West End Pit	180,000	ton/day	2	blast/day	26	ton ANFO/hr	*(Midas Gold 2017b)*
Bradley Tailings	0	ton/day	0	blast/day	0	ton ANFO/hr	
Total	180,000	ton/day	2	blast/day	26	ton ANFO/hr	

Emission Factors

Emission factor equation	TSP (lb/blast) = 0.000014 x $A^{1.5}$	*AP-42, Tab. 11.9-1, 7/98 (blasting, overburden)*	
A = Area per blast	80,795 ft^2		
TSP (PM)	321.52 lb/blast		
CO	67 lb/ton-ANFO	*AP-42, Tab. 13.3-1, 2/80 (ANFO)*	
NOX	0.9 kg/t-ANFO	*(CSIRO 2008)*	
	1.8 lb/ton-ANFO		
SO2	3.6E-03 lb/ton-ANFO	*Based on:* 6% *diesel content in ANFO*	*(Midas Gold 2017e)*

$$\frac{1.5E\text{-}05\ \text{lb S}}{\text{lb FO}} \times \frac{2\ \text{lb SO2}}{\text{lb S}} \times \frac{6\%\ \text{lb FO}}{\text{lb ANFO}} \times \frac{2{,}000\ \text{lb ANFO}}{\text{ton ANFO}} = \frac{3.6E\text{-}03\ \text{lb SO2}}{\text{ton ANFO}}$$

PM Scaling Factors

PM10	0.52	*AP-42, Tab. 11.9-1, 7/98 (blasting, overburden)*
PM2.5	0.03	*AP-42, Tab. 11.9-1, 7/98 (blasting, overburden)*

Emissions by Model ID

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY	CO_PPH	CO_TPY	NOX_PPH	NOX_TPY	SO2_PPH	SO2_TPY
		PM	PM10		PM2.5		CO		NOX[1]		SO2	
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
YPPBL	Yellow Pine Pit Blasting	--	--	--	--	--	--	--	--	--	--	--
HFPBL	Hangar Flats Pit Blasting	--	--	--	--	--	--	--	--	--	--	--
WEPBL	West End Pit Blasting	117.35	334.38	61.02	19.29	3.52	1,742.00	635.83	46.80	17.08	0.0936	0.0342
BTBL	Bradley Tailings Blasting	--	--	--	--	--	--	--	--	--	--	--
Total	Open Pit Blasting	117.35	334.38	61.02	19.29	3.52	1,742	635.83	46.80	17.08	0.0936	0.0342

(1) *NO2 / NOX:* 0.0357 *(CSIRO 2008)*

Source Parameters (1)

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	SIG_Y_M	SIG_Z_M
		Source	UTM NAD 83		Elev.	Rel. Ht.	S-y	S-z
Model ID	Activity	Type	E m	N m	m	m	m	m
YPPBL	Yellow Pine Pit Blasting	VOLUME	631,471	4,976,374	1,717	15	20.23	6.98
HFPBL	Hangar Flats Pit Blasting	VOLUME	631,171	4,973,129	1,891	15	20.23	6.98
WEPBL	West End Pit Blasting	VOLUME	632,586	4,976,478	1,994	15	20.23	6.98
BTBL	Bradley Tailings Blasting	VOLUME	630,520	4,972,315	2,012	15	20.23	6.98

(1) *UTM, Elev. - (Midas Gold 2017d); Rel. Ht. - (CSIRO 2008); S-y, S-z factors - (EPA 2016)*

Blast height (BH)	30	m	*(CSIRO 2008)/5 for conservatism*	Sigma divider			
Blast width	87	m	*sqrt(blast area)*	Rel. Ht.	2	of BH	*(EPA 2016)*
Blast depth	87	m	*sqrt(blast area)*	S-y	4.3	of SL	*(EPA 2016)*
Equal area side length (SL)	87	m		S-z	4.3	of BH	*(EPA 2016)*

Conversions

2,000	lb/ton
2.205	lb/kg
1.102	ton/t
3.281	ft/m

Model Scenario W3
Onsite Hauling

Activity Information
Operating schedule 365 day/yr 24 hr/day

Hauling Routes, Production Rates and Distances

Route Origin		Destination		Material Hauled [1] Material Type	Rate ton/day	One-Way Hauling [2] mi	Truck Loads [3] load/day	Total Travel [4] VMT/day
Unpaved Roads								
YPP-I Yellow Pine Pit	YPP	Process PC	PC	Ore	--	1.84	--	--
YPP-S Yellow Pine Pit	YPP	PC Stockpile	STKP	Ore	--	1.80	--	--
YPP-I Yellow Pine Pit	YPP	Fiddle DRSF	FDRSF	Rock	--	2.81	--	--
YPP-I Yellow Pine Pit	YPP	Hangar Flats DRSF	HFDRSF	Rock	--	4.76	--	--
YPP-' Yellow Pine Pit	YPP	Yellow Pine DRSF	YPDRSF	Rock	--		--	--
YPP-\ Yellow Pine Pit	YPP	West End DRSF	WEDRSF	Rock	--		--	--
HFP- Hangar Flats Pit	HFP	Process PC	PC	Ore	--	3.16	--	--
HFP- Hangar Flats Pit	HFP	PC Stockpile	STKP	Ore	--	3.12	--	--
HFP- Hangar Flats Pit	HFP	Fiddle DRSF	FDRSF	Rock	--	4.83	--	--
HFP- Hangar Flats Pit	HFP	Hangar Flats DRSF	HFDRSF	Rock	--	2.83	--	--
HFP- Hangar Flats Pit	HFP	Yellow Pine DRSF	YPDRSF	Rock	--	3.72	--	--
HFP- Hangar Flats Pit	HFP	West End DRSF	WEDRSF	Rock	--		--	--
WEP- West End Pit	WEP	Process PC	PC	Ore	--	2.68	--	--
WEP- West End Pit	WEP	PC Stockpile	STKP	Ore	--	2.63	--	--
WEP- West End Pit	WEP	Fiddle DRSF	FDRSF	Rock	--	4.43	--	--
WEP- West End Pit	WEP	Hangar Flats DRSF	HFDRSF	Rock	180,000	6.49	1,264	16,415
WEP- West End Pit	WEP	Yellow Pine DRSF	YPDRSF	Rock	--	2.75	--	--
WEP- West End Pit	WEP	West End DRSF	WEDRSF	Rock	--	3.07	--	--
BT-P\ Bradley Tailings	BT	Process PC	PC	Ore	--		--	--
BT-S1 Bradley Tailings	BT	PC Stockpile	STKP	Ore	--	3.59	--	--
BT-FI Bradley Tailings	BT	Fiddle DRSF	FDRSF	Rock	--		--	--
BT-H Bradley Tailings	BT	Hangar Flats DRSF	HFDRSF	Rock	--	0.60	--	--
BT-YI Bradley Tailings	BT	Yellow Pine DRSF	YPDRSF	Rock	--		--	--
BT-W Bradley Tailings	BT	West End DRSF	WEDRSF	Rock	--		--	--
Total					180,000			16,415

(1) *(Midas Gold 2019b)*
(2) *(Midas Gold 2017d)*
(3) *See truck fleet information below.*
(4) *Truck loads × One-way hauling ×* 2 *(round-trip)*

Truck Fleet

Truck	Payload Capacity [1] ton	Empty Weight [1] ton	Units [2]	Average Weight ton
Cat 789D	201.8	155.7	20	256.6
Cat 740B	43.5	37.6	12	59.4
Weighted Average	142.4		32	182.6

(1) *789D: (Caterpillar 2016), page 10-14*
740B: (Caterpillar 2011), page 13
(2) *(Midas Gold 2017b)* *(Midas Gold 2019b)*

Model Scenario W3
Onsite Hauling - continued

Hauling Emissions by Route

Route Origin		Destination		Material Hauled Material Type	PM_TPY PM ton/yr	PM10_PPD PM10 lb/day	PM10_TPY PM10 ton/yr	PM2.5_PPD PM2.5 lb/day	PM2.5_TPY PM2.5 ton/yr
Unpaved Roads									
YPP- Yellow Pine Pit	YPP	Process PC	PC	Ore	--	--	--	--	--
YPP- Yellow Pine Pit	YPP	PC Stockpile	STKP	Ore	--	--	--	--	--
YPP- Yellow Pine Pit	YPP	Fiddle DRSF	FDRSF	Rock	--	--	--	--	--
YPP- Yellow Pine Pit	YPP	Hangar Flats DRSF	HFDRSF	Rock	--	--	--	--	--
YPP- Yellow Pine Pit	YPP	Yellow Pine DRSF	YPDRSF	Rock	--	--	--	--	--
YPP- Yellow Pine Pit	YPP	West End DRSF	WEDRSF	Rock	--	--	--	--	--
HFP- Hangar Flats Pit	HFP	Process PC	PC	Ore	--	--	--	--	--
HFP- Hangar Flats Pit	HFP	PC Stockpile	STKP	Ore	--	--	--	--	--
HFP- Hangar Flats Pit	HFP	Fiddle DRSF	FDRSF	Rock	--	--	--	--	--
HFP- Hangar Flats Pit	HFP	Hangar Flats DRSF	HFDRSF	Rock	--	--	--	--	--
HFP- Hangar Flats Pit	HFP	Yellow Pine DRSF	YPDRSF	Rock	--	--	--	--	--
HFP- Hangar Flats Pit	HFP	West End DRSF	WEDRSF	Rock	--	--	--	--	--
WEP West End Pit	WEP	Process PC	PC	Ore	--	--	--	--	--
WEP West End Pit	WEP	PC Stockpile	STKP	Ore	--	--	--	--	--
WEP West End Pit	WEP	Fiddle DRSF	FDRSF	Rock	--	--	--	--	--
WEP West End Pit	WEP	Hangar Flats DRSF	HFDRSF	Rock	2,901.27	3,906.57	712.95	390.66	71.29
WEP West End Pit	WEP	Yellow Pine DRSF	YPDRSF	Rock	--	--	--	--	--
WEP West End Pit	WEP	West End DRSF	WEDRSF	Rock	--	--	--	--	--
BT-P Bradley Tailings	BT	Process PC	PC	Ore	--	--	--	--	--
BT-S Bradley Tailings	BT	PC Stockpile	STKP	Ore	--	--	--	--	--
BT-F Bradley Tailings	BT	Fiddle DRSF	FDRSF	Rock	--	--	--	--	--
BT-H Bradley Tailings	BT	Hangar Flats DRSF	HFDRSF	Rock	--	--	--	--	--
BT-Y Bradley Tailings	BT	Yellow Pine DRSF	YPDRSF	Rock	--	--	--	--	--
BT-W Bradley Tailings	BT	West End DRSF	WEDRSF	Rock	--	--	--	--	--
Pit Subtotal					2,901.27	3,906.57	712.95	390.66	71.29

Emission Factors

Unpaved roads

Annual emission factor equation	$E = k(s/12)^a (W/3)^b [(365-P)/365]$		*AP-42, Sec. 13.2.2, Eq. 1a, 11/06*
Daily emission factor equation	$E = k(s/12)^a (W/3)^b$		*AP-42, Sec. 13.2.2, Eq. 1a, 11/06*
s = Surface material silt content	4	%	*(Midas Gold 2015)*
W = Mean vehicle weight	182.6	ton	
P = Days/year with ≥0.01 in precip	120	day/yr	*AP-42 Fig. 13.2.2-1, 11/06*

	PM	PM10	PM2.5		
k = Size-specific empirical constant	4.9	1.5	0.15		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
a = Size-specific empirical constant	0.7	0.9	0.9		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
b = Size-specific empirical constant	0.45	0.45	0.45		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
E = Size-specific emission factor					
Annual	9.68	2.38	0.24	lb/VMT	
Daily	14.43	3.55	0.35	lb/VMT	

Emission Controls

Unpaved roads - periodic application of water and chemical dust suppressant

Control efficiency: 90% *(Air Sciences 2018)* for chemical suppressant; annual and daily
33% *Conservative estimate* for watering; daily only

Model Scenario W3
Onsite Hauling - continued

Emissions by Area

		PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY
		PM	PM10		PM2.5	
Area ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr
HR	Onsite Hauling	2,901.27	3,899.39	712.95	389.94	71.29

See worksheet ROADS for haul road (HR) emissions by Model ID.

Source Parameters [1]

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	SIG_Y_M	SIG_Z_M
		Source	UTM NAD 83		Elev.	Rel. Ht.	S-y	S-z
Model ID	Activity	Type	E m	N m	m	m	m	m
HR	Onsite Hauling	VOLUME	*See worksheet: ROADS*			4.75	15.14	4.42

[1] *UTM, Elev. - (Midas Gold 2017d); Rel. Ht., Sy, Sz - (EPA 2012)*

Truck	Height		Reference
Cat 789D	6.5	m	*(Caterpillar 2016), page 10-14*
Cat 740B	4.1	m	*(Caterpillar 2011), page 14*
Weighted	5.58	m	
Road width (RW)	26.5	m	*(Midas Gold 2016), Fig. 9-1*

Plume Parameter	Calculation	Value (m)	Const.
Plume top (PT) - unpaved	1.7 x VH	9.49	1.7
Release height - unpaved	0.5 x PT	4.75	0.5
Plume width (PW)	RW + 6 m	32.55	6
Sigma-z - unpaved	PT / 2.15	4.42	2.15
Sigma-y	PW / 2.15	15.14	2.15

(EPA 2012)

Model Scenario W3

Material Load / Unload

Activity Information

Operating schedule 365 day/yr

Throughput Rates

Model ID	Location of Activity	No. of Xfers	Rate ton/day	Total Rate ton/day	Xfer Description
YPP	Yellow Pine Pit	1	0	0	Load
HFP	Hangar Flats Pit	1	0	0	Load
WEP	West End Pit	1	180,000	180,000	Load
BT	Bradley Tailings	1	0	0	Load
PC	Process PC (1)	0	0	0	Unload
STKP	PC Stockpile	2	0	0	Unload & Reload
FDRSF	Fiddle DRSF	1	0	0	Unload
HFDRSF	Hangar Flats DRSF	1	180,000	180,000	Unload
YPDRSF	Yellow Pine DRSF	1	0	0	Unload
WEDRSF	West End DRSF	1	0	0	Unload

(1) *Ore unloading at primary crusher is accounted for in process sources*

Emission Factors

		PM	PM10	PM2.5		
k = Particle size multiplier		0.74	0.35	0.053		*AP-42, Sec. 13.2.4, Pg. 4, 11/06*
E = Emission factor	Load	0.00021	0.0001	0.000015	lb/ton	*AP-42, Tab. 11.19.2-2, 8/04 (truck loading - crushed stone)*
	Unload	0.00003	0.000016	0.0000024	lb/ton	*AP-42, Tab. 11.19.2-2, 8/04 (truck unloading - fragmented stone)*
	Unload &	0.00012	0.00006	0.00001	lb/ton	*Average of loading and unloading EF*

Emissions by Model ID

Model ID	Location of Activity	Total Rate ton/day	PM ton/yr	PM10 lb/day	PM10 ton/yr	PM2.5 lb/day	PM2.5 ton/yr
YPP	Yellow Pine Pit	--	--	--	--	--	--
HFP	Hangar Flats Pit	--	--	--	--	--	--
WEP	West End Pit	180,000	6.95	18.00	3.29	2.73	0.50
BT	Bradley Tailings	--	--	--	--	--	--
PC	Process PC	--	--	--	--	--	--
STKP	PC Stockpile	--	--	--	--	--	--
FDRSF	Fiddle DRSF	--	--	--	--	--	--
HFDRSF	Hangar Flats DRSF	180,000	1.11	2.88	0.53	0.44	0.08
YPDRSF	Yellow Pine DRSF	--	--	--	--	--	--
WEDRSF	West End DRSF	--	--	--	--	--	--
Total	Material Load / Unload	360,000	8.06	20.88	3.81	3.16	0.58

Model Scenario W3

Access Road

Activity Information

Operating schedule 365 day/yr 24 hr/day

Maintenance Equipment, Light and Heavy Truck Specifications and Traffic

Equipment	Equipment Model[1]	Notes	AADT[2]	Annual Traffic	Travel[3] VMT/yr	Vehicle Weight[4] Empty ton	Gross ton	Average Weight ton
Maintenance Equipment	Caterpillar 725C		3	1,095	1,772	25.6	51.6	38.6
Light Vehicles	Ford F-350	5	19	6,935	11,223	4.0	7.9	6.0
Heavy Trucks	Caterpillar CT660 (8X6)	6	45	16,425	26,581	10.1	34.5	22.3
Weighted Average Vehicle Weight								18.4

[1] *Appropriate equipment model from (Midas Gold 2017b)*

[2] *AADT = annual average daily traffic (Midas Gold 2016) Tab. 12-2;*
75% of total maintanance AADT (4) assigned to non-grader maintenance equipment and 25% assigned to grader

[3] *Based on access road length of:* 1.6 *mi (within project boundary)* *(Midas Gold 2017d)*

[4] *(Caterpillar 2016)/manufacturer specifications*

[5] *Light vehicles include visitor and employee vehicles.*

[6] *Heavy trucks include buses, supply, product shipment and trash trucks . 2917 lime delivery trips ((Midas Gold 2017a) Tab. 12-4) are excluded.*

Emission Factors

Annual emission factor equation	$E = k(s/12)^a (W/3)^b [(365-P)/365]$	*AP-42, Sec. 13.2.2, Eq. 1a, 11/06*
Daily emission factor equation	$E = k(s/12)^a (W/3)^b$	*AP-42, Sec. 13.2.2, Eq. 1a, 11/06*
s = Surface material silt content	4 %	*(Midas Gold 2015)*
W = Mean vehicle weight	18.42 ton	
P = Days/year with ≥0.01 in precip.	120 day/yr	*AP-42 Fig. 13.2.2-1, 11/06*

	PM	PM10	PM2.5		
k = Size-specific empirical constant	4.9	1.5	0.15		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
a = Size-specific empirical constant	0.7	0.9	0.9		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
b = Size-specific empirical constant	0.45	0.45	0.45		*AP-42, Tab. 13.2.2-2, Eqs. 1a and 2, 11/06*
E = Size-specific emission factor					
Annual	3.45	0.85	0.08	lb/VMT	
Daily	5.14	1.26	0.13	lb/VMT	

Emission Controls

Periodic application of water and chemical dust suppressant

Control efficiency: 90% *for chemical suppressant; annual and daily* *See Onsite Hauling*
33% *for watering; daily only*

Emissions by Area

				PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY
				PM	PM10		PM2.5	
Area ID	Activity	VMT/day	VMT/yr	ton/yr	lb/day	ton/yr	lb/day	ton/yr
ACCRD	Vehicle Travel	108.4	39,576	6.83	9.17	1.68	0.92	0.17

Model Scenario W3

Access Road

Grading Traffic

Equipment	AADT	Annual Traffic	VMT/day	VMT/yr
Grader	1	365	1.6	591

Emission Factors *Detailed emission factor calculations are provided on page 10*

PM	4.3	lb/VMT
PM10	1.3	lb/VMT
PM2.5	0.1	lb/VMT

Emission Controls

Periodic application of water and chemical dust suppressant

Control efficiency: 90% *See Onsite Hauling*

Emissions by Area

				PM_TPY	PM10_PPD	PM10_TPY	PM2.5_PPD	PM2.5_TPY
				PM	PM10		PM2.5	
Area ID	Activity	VMT/day	VMT/yr	ton/yr	lb/day	ton/yr	lb/day	ton/yr
ACCRD	Grading	1.6	591	0.13	0.21	0.04	0.02	0.004

Source Parameters [1]

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	SIG_Y_M	SIG_Z_M
		Source	UTM NAD 83		Elev.	Rel. Ht.	Width	S-z
Model ID	Activity	Type	E m	N m	m	m	m	m
ACCRD	*Access Roads*	LINE		*Variable*		2.98	6.10	2.77

[1] *UTM, Elev. - (Midas Gold 2017d); Rel. Ht., Sz - (EPA 2012)*

Vehicle	Height		
Average	3.5	m	
Grader	3.7	m	
HD Truck	3.6	m	
LD Truck	3.2	m	
Road width (RW)	6.1	m	*(Midas Gold 2016), Fig. 7-2*
Road length	2,590	m	

Plume Parameter	Calculation	Value (m)	Const.
Plume top (PT) - unpaved	1.7 x VH	5.95	1.7
Release height - unpaved	0.5 x PT	2.98	0.5
Plume width (PW)	RW + 6 m	12.096	6
Sigma-z - unpaved	PT / 2.15	2.77	2.15

(EPA 2012)

Source Parameters

See Onsite Hauling for source parameters.

Model Scenario W3

Wind Erosion

Activity Information

Operating schedule 365 day/yr

Erodible Area

Model ID	Location of Activity	Surface Type	Total Rate ton/yr	Erodible Area [3] Flat acre/yr	Erodible Area [3] Pile acre/yr	Surface Footprint
STKP	PC Stockpile	Pile	--		--	13
FDRSF	Fiddle DRSF	Pile	--		--	148
HFDRSF	Hangar Flats DRSF	Pile	180,000		20	140
YPDRSF	Yellow Pine DRSF	Pile	--		--	152
WEDRSF	West End DRSF	Pile	--		--	70
BT	Bradley Tailings	Flat		85		85
TSF	Tailing Storage Facility	Flat		331		331
HR	Haul Roads [1]	Flat		582		582
ACCRD	Access Roads [2]	Flat		4		4

[1] *Based on scenario haul road length of* 55 *mi* *and width of* 26.5 *m* *(Midas Gold 2016), Fig. 9-1*

[2] *Based on access road (within boundary) length of* 1.6 *mi* *and width of* 6.1 *m* *(Midas Gold 2016), Fig. 7-2*

[3] *Pile surface area calculations:*

Truck dump (TD) size	142.4	ton	
Material density	150.2	lb/ft^3	*(Midas Gold 2017b), Average Ore & Waste (YP, HF, WE, BT)*
	0.075	ton/ft^3	
Material specific volume	13.3	ft^3/ton	
TD volume (V)	1,896	ft^3	
Conical surface calculations			
Side slope	38	deg	*Typical*
	0.7	rad	
Conical surface area (SA)	Π × r × (h^2 + r^2)^0.5		
Conical volume (V)	(Π × h × r^2) ÷ 3		
Conical base radius	r = s × cos(slope)		
Conical height	h = s × sin(slope)		
Sloped side length	s = (h^2 + r^2)^0.5		
Solution of conical volume equation			
Replacing h and r with s × sin(slope) and s × cos(slope), respectively:			
s = [3 × V/(pi × sin(slope) × cos^2(slope)]^(1/3)	16.8	ft	
r	13.2	ft	
h	10.3	ft	
SA	698	ft^2	
	0.016	acre	
	1.1E-4	acre/ton-TD	

Scaling Factors

PM10	0.5	*AP-42, Pg. 13.2.5-3, 11/06*
PM2.5	0.075	*AP-42, Pg. 13.2.5-3, 11/06*

Model Scenario W3

Surface Exploration

Activity Information

Operating schedule	365	day/yr	24 hr/day	
Duration	14	yr	168 mo	*(Midas Gold 2018a)*
Construction disturbance	13	acres	0.08 acre/mo	*(Midas Gold 2016), p. 13-1*
Total wet drilling (maximum)	700	holes	50 holes/yr	*(Midas Gold 2016), p. 13-1*
Material blasted	724.9	ton/hole		

Construction Emission Calculations

Emission Factors

PM	1.2	ton/acre per month of activity	*AP-42, Page 13.2.3-1, 1/95*

PM Scaling Factors

PM10	0.35	*AP-42, Sec. 13.2.4, Pg. 4, 11/06*
PM2.5	0.053	*AP-42, Sec. 13.2.4, Pg. 4, 11/06*

Construction Emissions

Activity	PM	PM10		PM2.5	
	ton/yr	lb/day	ton/yr	lb/day	ton/yr
Drill Pad and Temporary Road Construction	1.1	2.1	0.4	0.3	0.1

Wet Drilling Emission Calculations

Emission Factors

PM10	8.0E-5	lb/ton (material blasted)	*AP-42, Table 11.19.2-2 (wet drilling), Rev. 8/04*
	0.058	lb/hole	

PM Scaling Factors

PM	0.74	*AP-42, Sec. 13.2.4-4, 11/06*
PM10	0.35	*AP-42, Sec. 13.2.4-4, 11/06*
PM2.5	0.053	*AP-42, Sec. 13.2.4-4, 11/06*

Wet Drilling Emissions

Activity	PM	PM10		PM2.5	
	ton/yr	lb/day	ton/yr	lb/day	ton/yr
Wet Drilling	0.0031	0.0079	0.0015	0.0012	0.00022

Surface Exploration Total Emissions

PM	PM10		PM2.5	
ton/yr	lb/day	ton/yr	lb/day	ton/yr
1.12	2.14	0.39	0.32	0.06

Emissions by Model ID [1]

		chk PM_TPY	chk PM10_PPD	chk PM10_TPY	chk PM2.5_PPD	chk PM2.5_TPY
		PM	PM10		PM2.5	
Model ID	Activity	ton/yr	lb/day	ton/yr	lb/day	ton/yr
WEP	Surface Exploration	1.12	2.14	0.39	0.32	0.06

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis/E. Memon
	PROJECT NO: 335-1-4	PAGE: 20 OF: 20 SHEET: Mine
AIR EMISSION CALCULATIONS	SUBJECT: Mining Activity and Emissions	DATE: June 22, 2020

Model Scenario W3

Underground Exploration

Activity Information

Operating schedule	365	day/yr	
Wet drilling	25	holes/yr	*(Midas Gold 2020)*

Wet Drilling Emission Calculations

Emission Factors

PM10	8.0E-5	lb/ton (material blasted)	*AP-42, Table 11.19.2-2 (wet drilling), Rev. 8/04*
	0.058	lb/hole	

PM Scaling Factors

PM	0.74	*AP-42, Sec. 13.2.4-4, 11/06*
PM10	0.35	*AP-42, Sec. 13.2.4-4, 11/06*
PM2.5	0.053	*AP-42, Sec. 13.2.4-4, 11/06*

Wet Drilling Emissions

Activity	PM	PM10		PM2.5	
	ton/yr	lb/day	ton/yr	lb/day	ton/yr
Wet Drilling	0.0015	0.0040	0.0007	0.0006	0.00011

Source Parameters [1]

		TYPE	UTM_E_M	UTM_N_M	ELEV_M	RELHT_M	SIG_Y_M	SIG_Z_M	SXINIT_M	SYINIT_M
		Source	UTM NAD 83		Elev.	Rel. Ht.	S-y	S-z	Length	Width
Model ID	Activity	Type	E m	N m	m	m	m	m	m	m
UGEXP	*Scout Portal*	AREA	632,362	4,973,690	2018	0	0	0	4.88	4.88

UTM, Elev. - (Midas Gold 2017d)

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis/E. Memon		
	PROJECT NO: 335-1-4	PAGE: 4	OF: 4	SHEET: Conv
AIR EMISSION CALCULATIONS	SUBJECT: Conversions and Constants	DATE: June 22, 2020		

Fuel Burning Equipment Emissions

	Source	MMBtu/hr	dscfm Flow Rate dscfm	PM_pph PM lb/hr	PM gr/dscf	PM Limit [1] gr/dscf	
Sb1	Sb Dryer (2.72 MMBtu/hr Propane-Fired)	2.72	461	0.021	0.005	0.015	In Compliance
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	17	2,881	0.130	0.005	0.015	In Compliance
CKB	Carbon Regeneration Kiln (Burners)	2.255	382	0.017	0.005	0.015	In Compliance
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0.1	17	0.001	0.005	0.015	In Compliance
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	5	847	0.038	0.005	0.015	In Compliance
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	4	678	0.031	0.005	0.015	In Compliance
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	4	678	0.031	0.005	0.015	In Compliance
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	4	678	0.031	0.005	0.015	In Compliance
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0.25	42	0.002	0.005	0.015	In Compliance
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0.25	42	0.002	0.005	0.015	In Compliance
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0.25	42	0.002	0.005	0.015	In Compliance
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0.5	85	0.004	0.005	0.015	In Compliance
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	2	339	0.015	0.005	0.015	In Compliance
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	3	508	0.023	0.005	0.015	In Compliance
LKC	PFR Shaft Lime Kiln Combustion	22.0	8,000	0.169	0.002	0.015	In Compliance
EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	9.39	1,259	0.441	0.041	0.05	In Compliance
EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	9.39	1,259	0.441	0.041	0.05	In Compliance
EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	9.39	1,259	0.441	0.041	0.05	In Compliance
EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	1.88	252	0.088	0.041	0.05	In Compliance

[1] *58.01.01.676, Fuel Type: Gas, Emission Oxygen 3%*

Baghouse/Bin Vent Filter PM Emission Concentration

	Source	control Control	dscfm Flow Rate dscfm	PM_pph PM lb/hr	PM gr/dscf	PM10_pph PM10 lb/hr	PM10 gr/dscf
Sb2	Sb Bagging	Baghouse (BH1)	800	0.118	0.017	0.118	0.017
MF	Induction Melting Furnace	Baghouse (BH2)	3,500	2.839	0.095	2.839	0.095
LSBM	Limestone Ball Mill	Baghouse (BH3)	13,000	1.902	0.017	1.596	0.014
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	Baghouse (BH4)	8,000	0.915	0.013	0.915	0.013
LCR	Lime Mill Crushing and associated transfers In and Out	Baghouse (BH5)	2,000	0.284	0.017	0.239	0.014
LS1L	Mill Lime Silo #1 Loading	Bin Vent Filter	700	0.059	0.010	0.020	0.003
MillS2L	Mill Lime Silo #2 Loading	Bin Vent Filter	700	0.059	0.010	0.020	0.003
ACS1L	AC Lime Silo #1 Loading	Bin Vent Filter	1,400	0.119	0.010	0.041	0.003
ACS2L	AC Lime Silo #2 Loading	Bin Vent Filter	1,400	0.119	0.010	0.041	0.003
ACS3L	AC Lime Silo #3 Loading	Bin Vent Filter	1,400	0.119	0.010	0.041	0.003
ACS4L	AC Lime Silo #4 Loading	Bin Vent Filter	1,400	0.119	0.010	0.041	0.003
CS1L	Cement/Shotcrete Silo #1 Loading	Bin Vent Filter	930	0.079	0.010	0.027	0.003
CS2L	Cement/Shotcrete Silo #2 Loading	Bin Vent Filter	930	0.079	0.010	0.027	0.003
LSL	Pebble Lime Silo Loading via Bucket Elevator	Bin Vent Filter	70	0.006	0.010	0.006	0.010

PROJECT TITLE: Stibnite Gold Project
PROJECT NO.: 335-1-4
SUBJECT: **Process Activity Uncontrolled Emissions**

SOURCE DESCRIPTION		HOURLY EMISSIONS							DAILY EMISSIONS							ANNUAL EMISSIONS						
Model	Source Description	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC
ID		lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr
OC1	Loader Transfer of Ore to Grizzly	3.13	1.15	0.18					75.00	27.50	4.25					13.69	5.02	0.78				
OC2	Grizzly to Apron Feeder	3.13	1.15	0.18					75.00	27.50	4.25					13.69	5.02	0.78				
OC3	Apron Feeder to Dribble Conveyor	3.13	1.15	0.18					75.00	27.50	4.25					13.69	5.02	0.78				
OC4	Apron Feeder to Vibrating Grizzly	3.13	1.15	0.18					75.00	27.50	4.25					13.69	5.02	0.78				
OC5	Dribble Conveyor to Vibrating Grizzly	3.13	1.15	0.18					75.00	27.50	4.25					13.69	5.02	0.78				
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	3.13	1.15	0.18					75.00	27.50	4.25					13.69	5.02	0.78				
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	5.63	2.50	0.38					135	60.00	9.00					24.64	10.95	1.64				
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	3.13	1.15	0.18					75.00	27.50	4.25					13.69	5.02	0.78				
OC9	Stockpile Transfers to Reclaim Conveyors	3.45	1.27	0.20					82.80	30.36	4.69					15.11	5.54	0.86				
OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	3.45	1.27	0.20					82.80	30.36	4.69					15.11	5.54	0.86				
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	3.45	1.27	0.20					82.80	30.36	4.69					15.11	5.54	0.86				
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	6.21	2.76	0.41					149	66.24	9.94					27.20	12.09	1.81				
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	3.45	1.27	0.20					82.80	30.36	4.69					15.11	5.54	0.86				
LS1L	Mill Lime Silo #1 Loading	43.80	28.20	4.27					183	118	17.79					1.60	1.03	0.16				
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	9.60E-2	5.60E-2	8.40E-3					1.20	0.70	0.11					1.05E-2	6.13E-3	9.19E-4				
MillS2L	Mill Lime Silo #2 Loading	43.80	28.20	4.27					183	118	17.79					1.60	1.03	0.16				
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	9.60E-2	5.60E-2	8.40E-3					1.20	0.70	0.11					1.05E-2	6.13E-3	9.19E-4				
Sb1	Sb Dryer (2.72 MMBtu/hr Propane-Fired)	2.08E-2	2.08E-2	2.08E-2	0.22	0.39	4.73E-2	2.38E-2	0.50	0.50	0.50	5.35	9.27	1.13	0.57	9.11E-2	9.11E-2	9.11E-2	0.98	1.69	0.21	0.10
Sb2	Sb Bagging	1.18	1.18	1.18					28.27	28.27	28.27					5.16	5.16	5.16				
AC	Autoclave	16.92	16.92	16.92			0.65		406	406	406			15.66		74.10	74.10	74.10			2.86	
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0.13	0.13	0.13	1.39	2.42	0.30	0.15	0.13	0.13	0.13	1.39	2.42	0.30	0.15	1.95E-3	1.95E-3	1.95E-3	2.09E-2	3.62E-2	4.43E-3	2.23E-3
ACS1L	AC Lime Silo #1 Loading	87.60	56.40	8.54					730	470	71.17					6.39	4.11	0.62				
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	9.60E-2	5.60E-2	8.00E-3					2.30	1.34	0.19					4.20E-2	2.45E-2	3.50E-3				
ACS2L	AC Lime Silo #2 Loading	87.60	56.40	8.54					730	470	71.17					6.39	4.11	0.62				
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	9.60E-2	5.60E-2	8.00E-3					2.30	1.34	0.19					4.20E-2	2.45E-2	3.50E-3				
ACS3L	AC Lime Silo #3 Loading	87.60	56.40	8.54					730	470	71.17					6.39	4.11	0.62				

PROJECT TITLE: Stibnite Gold Project
PROJECT NO.: 335-1-4
SUBJECT: **Process Activity Uncontrolled Emissions**

SOURCE DESCRIPTION		HOURLY EMISSIONS							DAILY EMISSIONS							ANNUAL EMISSIONS						
Model ID	Source Description	PM lb/hr	PM_{10} lb/hr	$PM_{2.5}$ lb/hr	CO lb/hr	NOx lb/hr	SO_2 lb/hr	VOC lb/hr	PM lb/day	PM_{10} lb/day	$PM_{2.5}$ lb/day	CO lb/day	NOx lb/day	SO_2 lb/day	VOC lb/day	PM ton/yr	PM_{10} ton/yr	$PM_{2.5}$ ton/yr	CO ton/yr	NOx ton/yr	SO_2 ton/yr	VOC ton/yr
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	9.60E-2	5.60E-2	8.00E-3					2.30	1.34	0.19					4.20E-2	2.45E-2	3.50E-3				
ACS4L	AC Lime Silo #4 Loading	87.60	56.40	8.54					365	235	35.59					3.19	2.06	0.31				
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	9.60E-2	5.60E-2	8.00E-3					2.30	1.34	0.19					2.10E-2	1.23E-2	1.75E-3				
CKD	Carbon Regeneration Kiln (Drum)	1.40	1.40	1.40	0.12	1.20E-2		0.11	33.60	33.60	33.60	2.88	0.29	0.00E+0	2.64	6.13	6.13	6.13	0.53	5.26E-2		0.48
CKB	Carbon Regeneration Kiln (Burners)	1.73E-2	1.73E-2	1.73E-2	0.18	0.32	3.92E-2	1.97E-2	0.41	0.41	0.41	4.44	7.69	0.94	0.47	7.56E-2	7.56E-2	7.56E-2	0.81	1.40	0.17	8.64E-2
EW	Electrowinning Cells and Pregnant Solution Tank																					
MR	Mercury Retort																					
MF	Induction Melting Furnace	5.68	5.68	5.68					68.14	68.14	68.14					1.77	1.77	1.77				
EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0.44	0.44	0.44	7.72	14.11	1.45E-2	2.87	0.44	0.44	0.44	7.72	14.11	1.45E-2	2.87	2.20E-2	2.20E-2	2.20E-2	0.39	0.71	7.24E-4	0.14
EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0.44	0.44	0.44	7.72	14.11	1.45E-2	2.87	0.44	0.44	0.44	7.72	14.11	1.45E-2	2.87	2.20E-2	2.20E-2	2.20E-2	0.39	0.71	7.24E-4	0.14
EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0.44	0.44	0.44	7.72	14.11	1.45E-2	2.87	0.44	0.44	0.44	7.72	14.11	1.45E-2	2.87	2.20E-2	2.20E-2	2.20E-2	0.39	0.71	7.24E-4	0.14
EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	8.82E-2	8.82E-2	8.82E-2	1.54	1.76	2.90E-3	1.76	8.82E-2	8.82E-2	8.82E-2	1.54	1.76	2.90E-3	1.76	4.41E-3	4.41E-3	4.41E-3	7.72E-2	8.82E-2	1.45E-4	8.82E-2
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7.65E-4	7.65E-4	7.65E-4	8.20E-3	1.42E-2	1.74E-3	8.74E-4	1.84E-2	1.84E-2	1.84E-2	0.20	0.34	4.17E-2	2.10E-2	3.35E-3	3.35E-3	3.35E-3	3.59E-2	6.22E-2	7.61E-3	3.83E-3
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	3.83E-2	3.83E-2	3.83E-2	0.41	0.71	8.69E-2	4.37E-2	0.92	0.92	0.92	9.84	17.05	2.09	1.05	0.17	0.17	0.17	1.80	3.11	0.38	0.19
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	3.06E-2	3.06E-2	3.06E-2	0.33	0.57	6.95E-2	3.50E-2	0.73	0.73	0.73	7.87	13.64	1.67	0.84	0.13	0.13	0.13	1.44	2.49	0.30	0.15
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	3.06E-2	3.06E-2	3.06E-2	0.33	0.57	6.95E-2	3.50E-2	0.73	0.73	0.73	7.87	13.64	1.67	0.84	0.13	0.13	0.13	1.44	2.49	0.30	0.15
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	3.06E-2	3.06E-2	3.06E-2	0.33	0.57	6.95E-2	3.50E-2	0.73	0.73	0.73	7.87	13.64	1.67	0.84	0.13	0.13	0.13	1.44	2.49	0.30	0.15
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	1.91E-3	1.91E-3	1.91E-3	2.05E-2	3.55E-2	4.34E-3	2.19E-3	4.59E-2	4.59E-2	4.59E-2	0.49	0.85	0.10	5.25E-2	8.38E-3	8.38E-3	8.38E-3	8.98E-2	0.16	1.90E-2	9.57E-3
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	1.91E-3	1.91E-3	1.91E-3	2.05E-2	3.55E-2	4.34E-3	2.19E-3	4.59E-2	4.59E-2	4.59E-2	0.49	0.85	0.10	5.25E-2	8.38E-3	8.38E-3	8.38E-3	8.98E-2	0.16	1.90E-2	9.57E-3
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	1.91E-3	1.91E-3	1.91E-3	2.05E-2	3.55E-2	4.34E-3	2.19E-3	4.59E-2	4.59E-2	4.59E-2	0.49	0.85	0.10	5.25E-2	8.38E-3	8.38E-3	8.38E-3	8.98E-2	0.16	1.90E-2	9.57E-3
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	3.83E-3	3.83E-3	3.83E-3	4.10E-2	7.10E-2	8.69E-3	4.37E-3	9.18E-2	9.18E-2	9.18E-2	0.98	1.70	0.21	0.10	1.68E-2	1.68E-2	1.68E-2	0.18	0.31	3.81E-2	1.91E-2
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	1.53E-2	1.53E-2	1.53E-2	0.16	0.28	3.48E-2	1.75E-2	0.37	0.37	0.37	3.93	6.82	0.83	0.42	6.70E-2	6.70E-2	6.70E-2	0.72	1.24	0.15	7.66E-2
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	2.30E-2	2.30E-2	2.30E-2	0.25	0.43	5.21E-2	2.62E-2	0.55	0.55	0.55	5.90	10.23	1.25	0.63	0.10	0.10	0.10	1.08	1.87	0.23	0.11
PSL	Prill Silos Loading (2 x 100 ton)	4.00	1.40	0.21					4.00	1.40	0.21					7.30E-2	2.56E-2	3.87E-3				
PSU	Prill Silos Unloading (2 x 100 ton)	4.00	1.40	0.21					4.00	1.40	0.21					7.30E-2	2.56E-2	3.87E-3				
CS1L	Cement/Shotcrete Silo #1 Loading	58.40	37.60	5.69					58.40	37.60	5.69					21.90	14.10	2.14				
CS1U	Cement/Shotcrete Silo #1 Unloading	9.60E-2	5.60E-2	8.00E-3					0.38	0.22	3.20E-2					0.14	8.40E-2	1.20E-2				
CS2L	Cement/Shotcrete Silo #2 Loading	58.40	37.60	5.69					58.40	37.60	5.69					21.90	14.10	2.14				
CS2U	Cement/Shotcrete Silo #2 Unloading	9.60E-2	5.60E-2	8.00E-3					0.38	0.22	3.20E-2					0.14	8.40E-2	1.20E-2				
CAL	Aggregate Bin Loading	0.69	0.33	5.00E-2					16.56	7.92	1.20					1.73	0.83	0.13				
CAU	Aggregate Bin Unloading	0.69	0.33	5.00E-2					16.56	7.92	1.20					1.73	0.83	0.13				
CM	Central Mixer Loading	11.44	3.12	0.47					45.76	12.48	1.89					17.16	4.68	0.71				

PROJECT TITLE: Stibnite Gold Project
PROJECT NO.: 335-1-4
SUBJECT: **Process Activity Uncontrolled Emissions**

SOURCE DESCRIPTION		HOURLY EMISSIONS							DAILY EMISSIONS							ANNUAL EMISSIONS						
Model ID	Source Description	PM lb/hr	PM_{10} lb/hr	$PM_{2.5}$ lb/hr	CO lb/hr	NOx lb/hr	SO_2 lb/hr	VOC lb/hr	PM lb/day	PM_{10} lb/day	$PM_{2.5}$ lb/day	CO lb/day	NOx lb/day	SO_2 lb/day	VOC lb/day	PM ton/yr	PM_{10} ton/yr	$PM_{2.5}$ ton/yr	CO ton/yr	NOx ton/yr	SO_2 ton/yr	VOC ton/yr
TG1	Mine Site Gasoline Tank #1							0.22							5.25							0.96
TG2	Mine Site Gasoline Tank #2							0.22							5.25							0.96
TD3	Mine Site Diesel Tank #3							1.67E-3							4.00E-2							7.30E-3
TD4	Mine Site Diesel Tank #4							1.67E-3							4.00E-2							7.30E-3
TD5	Mine Site Diesel Tank #5							1.67E-3							4.00E-2							7.30E-3
TD6	Mine Site Diesel Tank #6							1.67E-3							4.00E-2							7.30E-3
TD7	Mine Site Diesel Tank #7							1.67E-3							4.00E-2							7.30E-3
TD8	Mine Site Diesel Tank #8							1.67E-3							4.00E-2							7.30E-3
TD9	Mine Site Diesel Tank #9							1.67E-3							4.00E-2							7.30E-3
TD10	Mine Site Diesel Tank #10							1.67E-3							4.00E-2							7.30E-3
PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	6.32	2.31	0.35					152	55.40	8.42					27.67	10.11	1.54				
PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	6.32	2.31	0.35					152	55.40	8.42					27.67	10.11	1.54				
TRUE	LIME PRODUCTION																					
LS1	Limestone transfer to Primary Crusher Hopper	0.14	5.18E-2	8.00E-3					3.39	1.24	0.19					0.48	0.17	2.70E-2				
LS2	Primary Crushing and Associated Transfers In and Out	0.25	0.11	1.69E-2					6.10	2.71	0.41					0.86	0.38	5.72E-2				
LS3	Primary Screening and Associated Transfers In and Out	1.18	0.41	6.21E-2					28.25	9.83	1.49					3.97	1.38	0.21				
LS4	Secondary Crushing and Associated Transfers In and Out	0.25	0.11	1.69E-2					6.10	2.71	0.41					0.86	0.38	5.72E-2				
LS5	Secondary Screening and Associated Transfers In and Out	1.18	0.41	6.21E-2					28.25	9.83	1.49					3.97	1.38	0.21				
LS6	Limestone transfer to Ball Mill Feed Bin	0.14	5.18E-2	8.00E-3					3.39	1.24	0.19					0.48	0.17	2.70E-2				
LS7	Limestone transfer to Ball Mill Feed Conveyor	0.14	5.18E-2	8.00E-3					3.39	1.24	0.19					0.48	0.17	2.70E-2				
LS8	Ball Mill Feed transfer to Ball Mill	0.14	5.18E-2	8.00E-3					3.39	1.24	0.19					0.48	0.17	2.70E-2				
LSBM	Limestone Ball Mill	19.02	15.96	5.70					456	383	137					64.22	53.89	19.23				
LS9	Limestone transfer to Kiln Feed Bin	3.34E-2	1.22E-2	1.89E-3					0.80	0.29	4.54E-2					0.12	4.55E-2	7.03E-3				
LS10	Limestone transfer to Lime Kiln Feed Conveyor	3.34E-2	1.22E-2	1.89E-3					0.80	0.29	4.54E-2					0.12	4.55E-2	7.03E-3				
LS11	Fines Screening and Associated Transfers In and Out	0.28	9.68E-2	1.47E-2					6.68	2.32	0.35					1.03	0.36	5.46E-2				
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	3.34E-2	1.22E-2	1.89E-3					0.80	0.29	4.54E-2					0.12	4.55E-2	7.03E-3				
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	9.15	9.15	9.15	3.17	1.69	8.45E-3		220	220	220	76.05	40.56	0.20		34.05	34.05	34.05	11.78	6.29	3.14E-2	
LKC	PFR Shaft Lime Kiln Combustion	0.17	0.17	0.17	1.81	3.13	0.38	0.19	4.05	4.05	4.05	43.36	75.15	9.19	4.62	0.63	0.63	0.63	6.72	11.65	1.42	0.72
LCR	Lime Mill Crushing and associated transfers In and Out	2.84	2.39	0.85					68.28	57.29	20.45					10.58	8.88	3.17				
LSL	Pebble Lime Silo Loading via Bucket Elevator	6.20E-2	6.20E-2	6.20E-2					1.49	1.49	1.49					0.23	0.23	0.23				
LSU	Pebble Lime Silo discharge to Lime Slaker	6.20E-3	6.20E-3	6.20E-3					0.15	0.15	0.15					2.30E-2	2.30E-2	2.30E-2				
Total		**699**	**443**	**102**	**33.50**	**55.37**	**1.88**	**11.51**	**5,964**	**3,786**	**1,316**	**204**	**259**	**37.21**	**34.53**	**565**	**342**	**169**	**30.45**	**37.85**	**6.48**	**4.78**

SOURCE DESCRIPTION		OPERATING LIMITS							EMISSION FACTORS									EMISSION CON	
Model	Source Description	Design Throughput						Throughput reference	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	unit	reference	control	efficiency
ID		unit/hr	unit/day	unit/yr	units	Material	hr/yr											system	
OC1	Loader Transfer of Ore to Grizzly	1,042	25,000	9,125,000	ton	Ore	8,760	(Midas Gold 2016), Sec. 10.1	0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.	Water Sprays	
OC2	Grizzly to Apron Feeder	1,042	25,000	9,125,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.	Moisture Carry-Over	
OC3	Apron Feeder to Dribble Conveyor	1,042	25,000	9,125,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.	Moisture Carry-Over	
OC4	Apron Feeder to Vibrating Grizzly	1,042	25,000	9,125,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.	Moisture Carry-Over	
OC5	Dribble Conveyor to Vibrating Grizzly	1,042	25,000	9,125,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.	Moisture Carry-Over	
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	1,042	25,000	9,125,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.	Moisture Carry-Over	
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	1,042	25,000	9,125,000	ton	Ore	8,760		0.0012	0.00054	0.0001					lb/ton	AP-42, Table 11.19.2-2 (08/04) Tert. Crushing - ctrl.	Water Sprays	
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	1,042	25,000	9,125,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.	Moisture Carry-Over	
OC9	Stockpile Transfers to Reclaim Conveyors	1,150	27,600	10,074,000	ton	Ore	8,760	(M3 2017b)	0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - unctrl.; PM2.5 Ch. 13.2.4	Undergrnd	80%
OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	1,150	27,600	10,074,000	ton	Ore	8,760		0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - unctrl.; PM2.5 Ch. 13.2.4	Undergrnd	80%
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	1,150	27,600	10,074,000	ton	Ore	8,760		0.003	0.0011	0.00017					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - unctrl.; PM2.5 Ch. 13.2.4	Enclosure	80%
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	1,150	27,600	10,074,000	ton	Ore	8,760		0.0012	0.00054	0.0001					lb/ton	AP-42, Table 11.19.2-2 (08/04) Tert. Crushing - ctrl.	Water Sprays	
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	1,150	27,600	10,074,000	ton	Ore	8,760		0.00014	4.6E-05	1.3E-05					lb/ton	AP-42, Table 11.19.2-2 (08/04) Conv. transfer - ctrl.	Moisture Carry-Over	
LS1L	Mill Lime Silo #1 Loading	60	250	4,375	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.00099	0.00034	0.00005					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4	Bin Vent Filter	
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	20	250	4,375	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.00042					lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4	None	0%
MillS2L	Mill Lime Silo #2 Loading	60	250	4,375	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.00099	0.00034	0.00005					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4	Bin Vent Filter	
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	20	250	4,375	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.00042					lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4	None	0%
Sb1	Sb Dryer (2.72 MMBtu/hr Propane-Fired)	2.72	65.28	23,827	MMBtu	Propane	8,760	(M3 2017d)	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal	None	NA
Sb2	Sb Bagging	4.5	108	39,420	ton	Stib. Conc.	8,760	(M3 2017d)	0.118	0.118	0.118					lb/hr	Based on NDEP-BAPC Permit for Clay Bagging Operation (Hectatone) (NDEP 2015b)	Baghouse (BH1)	NA
AC	Autoclave	290	6,960	2,540,400	ton	Float Conc.	8,760	(M3 2017b)	5.075	5.075	5.075			0.6525		lb/hr	Based on NDEP-BAPC Permits/test data for Autoclaves: PM & SO2 - [Goldstrike (NDEP 2012)]. Negligible CO due to no organic carbon in the feed (M3 2017a)	Wet Scrubber (WS1)	NA
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	17	17	510	MMBtu	Propane	30	(M3 2017b)	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Ind. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal	None	NA
ACS1L	AC Lime Silo #1 Loading	120	1,000	17,500	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.00099	0.00034	0.00005					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4	Bin Vent Filter	
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	20	480	17,500	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.0004					lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4	None	0%
ACS2L	AC Lime Silo #2 Loading	120	1,000	17,500	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.00099	0.00034	0.00005					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4	Bin Vent Filter	
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	20	480	17,500	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.0004					lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4	None	0%
ACS3L	AC Lime Silo #3 Loading	120	1,000	17,500	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.00099	0.00034	0.00005					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4	Bin Vent Filter	
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	20	480	17,500	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.0004					lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4	None	0%
ACS4L	AC Lime Silo #4 Loading	120	500	8,750	ton	Lime	8,760	(Midas Gold 2016), Sec. 12.3 (facility-wide silo capacity)	0.00099	0.00034	0.00005					lb/ton	AP-42, Table 11.12-2 (6/06), pneumatic loading-ctrl.; PM2.5 Ch. 13.2.4	Bin Vent Filter	
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	20	480	8,750	ton	Lime	8,760	Typical Ind. Oper.	0.0048	0.0028	0.0004					lb/ton	AP-42, Table 11.12-2 (6/06), weigh hopper loading-unctrl.; PM2.5 Ch. 13.2.4	None	0%
CKD	Carbon Regeneration Kiln (Drum)	0.3	7.2	2,628	ton	Carbon	8,760	(M3 2017b)	0.42	0.42	0.42	0.12	0.012		0.11	lb/hr	Based on NDEP-BAPC Permit for Carbon Regeneration Kiln [Goldstrike (NDEP 2012)]	Wet Scrubber (WS2) / Carbon Filter (CA1)	NA
CKB	Carbon Regeneration Kiln (Burners)	2.255	54.12	19,754	MMBtu	Propane	8,760	(M3 2017b)	0.00765	0.00765	0.00765	0.0820	0.142	0.01738	0.00874	lb/MMBtu	AP-42, Table 1.5-1 (07/08) Com. Boilers; SO2 - 15.9 gr/100ft^3 & 91,500 Btu/gal	None	NA
EW	Electrowinning Cells and Pregnant Solution Tank	100	24 hr		gpm	Au Sol.	8,760	Typical Ind. Oper.	0.07	0.07	0.07					lb/hr	Based on similar source stack test data and 5× safety factor (APT 2016)	Shared Carbon Filter (CA2)	
MR	Mercury Retort	0.5/batch	24 hr	21	ton	Au Conc.	1,248	(M3 2017b) & (M3 2017a)	0.01	0.01	0.01					lb/hr	Based on similar source stack test data and 5× safety factor (APT 2017)	Condenser / Carbon Filter (CA3)	
MF	Induction Melting Furnace	0.5/batch	12 hr	21	ton	Au Conc.	624	(M3 2017b) & (M3 2017a)	2.84	2.84	2.84					lb/hr	Based on IDAPA 58.01.01.701 PM Weight Limit	Baghouse (BH2) / Carbon Filter (CA4)	NA

SOURCE DESCRIPTION		TROLS	HOURLY EMISSIONS							DAILY EMISSIONS							ANNUAL EMISSIONS								
Model	Source Description	reference	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	UTM E	UTM N
ID			lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	m	m
OC1	Loader Transfer of Ore to Grizzly	Control efficiency included in emission factor	0.146	0.0479	0.0135					3.50	1.15	0.325					0.639	0.210	0.0593					632,045	4,974,583
OC2	Grizzly to Apron Feeder	Control efficiency included in emission factor	0.146	0.0479	0.0135					3.50	1.15	0.325					0.639	0.210	0.0593					632,045	4,974,583
OC3	Apron Feeder to Dribble Conveyor	Control efficiency included in emission factor	0.146	0.0479	0.0135					3.50	1.15	0.325					0.639	0.210	0.0593					632,045	4,974,583
OC4	Apron Feeder to Vibrating Grizzly	Control efficiency included in emission factor	0.146	0.0479	0.0135					3.50	1.15	0.325					0.639	0.210	0.0593					632,045	4,974,583
OC5	Dribble Conveyor to Vibrating Grizzly	Control efficiency included in emission factor	0.146	0.0479	0.0135					3.50	1.15	0.325					0.639	0.210	0.0593					632,045	4,974,583
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	Control efficiency included in emission factor	0.146	0.0479	0.0135					3.50	1.15	0.325					0.639	0.210	0.0593					632,045	4,974,583
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	Control efficiency included in emission factor	1.25	0.563	0.104					30.0	13.5	2.50					5.48	2.46	0.456					632,045	4,974,583
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	Control efficiency included in emission factor	0.146	0.0479	0.0135					3.50	1.15	0.325					0.639	0.210	0.0593					631,947	4,974,520
OC9	Stockpile Transfers to Reclaim Conveyors	Based on AP-42, Chapter 13.2.4, reduction in EF due to wind speed reduction	0.690	0.253	0.0391					16.6	6.07	0.938					3.02	1.11	0.171					631,947	4,974,520
OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	Based on AP-42, Chapter 13.2.4, reduction in EF due to wind speed reduction	0.690	0.253	0.0391					16.6	6.07	0.938					3.02	1.11	0.171					631,947	4,974,520
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	Based on AP-42, Chapter 13.2.4, reduction in EF due to wind speed reduction	0.690	0.253	0.0391					16.6	6.07	0.94					3.02	1.11	0.171					632,113	4,974,243
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	Control efficiency included in emission factor	1.380	0.621	0.1150					33.12	14.90	2.760					6.04	2.720	0.504					632,028	4,974,187
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	Control efficiency included in emission factor	0.1610	0.0529	0.01495					3.864	1.270	0.3588					0.705	0.2317	0.0655					632,028	4,974,187
LS1L	Mill Lime Silo #1 Loading	Control efficiency included in emission factor	0.0594	0.0204	0.00300					0.248	0.0850	0.0125					0.00217	7.44E-4	1.09E-4					632,095	4,974,272
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor		0.0960	0.0560	0.00840					1.20	0.700	0.105					0.0105	0.00613	9.19E-4					632,095	4,974,272
Mill S2L	Mill Lime Silo #2 Loading	Control efficiency included in emission factor	0.0594	0.0204	0.00300					0.248	0.0850	0.0125					0.00217	7.44E-4	1.09E-4					632,090	4,974,282
Mill S2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor		0.0960	0.0560	0.00840					1.20	0.700	0.105					0.0105	0.00613	9.19E-4					632,090	4,974,282
Sb1	Sb Dryer (2.72 MMBtu/hr Propane-Fired)		0.0208	0.0208	0.0208	0.223	0.386	0.0473	0.0238	0.499	0.499	0.499	5.35	9.27	1.13	0.571	0.0911	0.0911	0.0911	0.977	1.69	0.207	0.104	632,231	4,974,183
Sb2	Sb Bagging	Control efficiency included in emission factor	0.118	0.118	0.118					2.83	2.83	2.83					0.517	0.517	0.517					632,208	4,974,221
AC	Autoclave	PM control efficiency included in emission factor	5.08	5.08	5.08			0.653		122	122	122			15.7		22.2	22.2	22.2			2.86		632,229	4,974,096
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)		0.130	0.130	0.130	1.39	2.42	0.295	0.149	0.130	0.130	0.130	1.39	2.42	0.295	0.149	0.00195	0.00195	0.00195	0.0209	0.0362	0.00443	0.00223	632,261	4,974,116
ACS1L	AC Lime Silo #1 Loading	Control efficiency included in emission factor	0.119	0.0408	0.00600					0.990	0.340	0.0500					0.00866	0.00298	4.38E-4					632,267	4,974,124
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker		0.0960	0.0560	0.00800					2.30	1.34	0.192					0.0420	0.0245	0.00350					632,267	4,974,124
ACS2L	AC Lime Silo #2 Loading	Control efficiency included in emission factor	0.119	0.0408	0.00600					0.990	0.340	0.0500					0.00866	0.00298	4.38E-4					632,257	4,974,140
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker		0.0960	0.0560	0.00800					2.30	1.34	0.192					0.0420	0.0245	0.00350					632,257	4,974,140
ACS3L	AC Lime Silo #3 Loading	Control efficiency included in emission factor	0.119	0.0408	0.00600					0.990	0.340	0.0500					0.00866	0.00298	4.38E-4					632,248	4,974,156
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker		0.0960	0.0560	0.00800					2.30	1.34	0.192					0.0420	0.0245	0.00350					632,248	4,974,156
ACS4L	AC Lime Silo #4 Loading	Control efficiency included in emission factor	0.119	0.0408	0.00600					0.495	0.170	0.0250					0.00433	0.00149	2.19E-4					632,238	4,974,171
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker		0.0960	0.0560	0.00800					2.30	1.34	0.192					0.0210	0.0123	0.00175					632,238	4,974,171
CKD	Carbon Regeneration Kiln (Drum)	PM control efficiency included in emission factor	0.420	0.420	0.420	0.120	0.0120		0.110	10.1	10.1	10.1	2.88	0.288	0	2.64	1.84	1.84	1.84	0.526	0.0526		0.482	632,013	4,974,051
CKB	Carbon Regeneration Kiln (Burners)		0.0173	0.0173	0.0173	0.185	0.320	0.0392	0.0197	0.414	0.414	0.414	4.44	7.69	0.940	0.473	0.0756	0.0756	0.0756	0.810	1.40	0.172	0.0864	631,998	4,974,042
EW	Electrowinning Cells and Pregnant Solution Tank		0.07	0.07	0.07					1.68	1.68	1.68					0.31	0.31	0.31					631,983	4,974,033
MR	Mercury Retort		0.01	0.01	0.01					0.24	0.24	0.24					0.006	0.006	0.006					632,003	4,974,001
MF	Induction Melting Furnace	Control efficiency included in emission factor	2.84	2.84	2.84					34.1	34.1	34.1					0.89	0.89	0.89					632,032	4,974,019

SOURCE DESCRIPTION		TROLS	HOURLY EMISSIONS							DAILY EMISSIONS							ANNUAL EMISSIONS								
Model	Source Description	reference	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	UTM E	UTM N
ID			lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	m	m
EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)		0.441	0.441	0.441	7.72	14.1	0.0145	2.87	0.441	0.441	0.441	7.72	14.11	0.01448	2.866	0.0220	0.0220	0.0220	0.386	0.705	7.24E-4	0.143	634,274	4,972,050
EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)		0.441	0.441	0.441	7.72	14.1	0.0145	2.87	0.441	0.441	0.441	7.72	14.11	0.01448	2.866	0.0220	0.0220	0.0220	0.386	0.705	7.24E-4	0.143	632,105	4,974,154
EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)		0.441	0.441	0.441	7.72	14.1	0.0145	2.87	0.441	0.441	0.441	7.72	14.11	0.01448	2.866	0.0220	0.0220	0.0220	0.386	0.705	7.24E-4	0.143	632,109	4,974,148
EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)		0.0882	0.0882	0.0882	1.54	1.76	0.00290	1.76	0.0882	0.0882	0.0882	1.543	1.764	2.90E-3	1.764	0.00441	0.00441	0.00441	0.0772	0.0882	1.45E-4	0.0882	632,113	4,974,141
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)		7.65E-4	7.65E-4	7.65E-4	0.00820	0.0142	0.00174	8.74E-4	0.0184	0.0184	0.0184	0.197	0.341	0.0417	0.0210	0.00335	0.00335	0.00335	0.0359	0.0622	0.00761	0.00383	632,216	4,974,118
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)		0.0383	0.0383	0.0383	0.410	0.710	0.0869	0.0437	0.918	0.918	0.918	9.84	17.0	2.09	1.05	0.168	0.168	0.168	1.80	3.11	0.381	0.191	632,017	4,974,010
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)		0.0306	0.0306	0.0306	0.328	0.568	0.0695	0.0350	0.734	0.734	0.734	7.87	13.6	1.67	0.839	0.134	0.134	0.134	1.44	2.49	0.304	0.153	632,287	4,974,227
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)		0.0306	0.0306	0.0306	0.328	0.568	0.0695	0.0350	0.734	0.734	0.734	7.87	13.6	1.67	0.839	0.134	0.134	0.134	1.44	2.49	0.304	0.153	632,288	4,974,228
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)		0.0306	0.0306	0.0306	0.328	0.568	0.0695	0.0350	0.734	0.734	0.734	7.87	13.6	1.67	0.839	0.134	0.134	0.134	1.44	2.49	0.304	0.153	632,168	4,974,191
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)		0.00191	0.00191	0.00191	0.0205	0.0355	0.00434	0.00219	0.0459	0.0459	0.0459	0.492	0.852	0.104	0.0525	0.00838	0.00838	0.00838	0.0898	0.156	0.0190	0.00957	632,238	4,974,130
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)		0.00191	0.00191	0.00191	0.0205	0.0355	0.00434	0.00219	0.0459	0.0459	0.0459	0.492	0.852	0.104	0.0525	0.00838	0.00838	0.00838	0.0898	0.156	0.0190	0.00957	632,008	4,974,026
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)		0.00191	0.00191	0.00191	0.0205	0.0355	0.00434	0.00219	0.0459	0.0459	0.0459	0.492	0.852	0.104	0.0525	0.00838	0.00838	0.00838	0.0898	0.156	0.0190	0.00957	632,038	4,973,751
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)		0.00383	0.00383	0.00383	0.0410	0.0710	0.00869	0.00437	0.0918	0.0918	0.0918	0.984	1.70	0.209	0.105	0.0168	0.0168	0.0168	0.180	0.311	0.0381	0.0191	631,889	4,973,472
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)		0.0153	0.0153	0.0153	0.164	0.284	0.0348	0.0175	0.367	0.367	0.367	3.93	6.82	0.834	0.420	0.0670	0.0670	0.0670	0.718	1.24	0.152	0.0766	631,848	4,973,398
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)		0.0230	0.0230	0.0230	0.246	0.426	0.0521	0.0262	0.551	0.551	0.551	5.90	10.2	1.25	0.630	0.101	0.101	0.101	1.08	1.87	0.228	0.115	632,060	4,973,664
PSL	Prill Silos Loading (2 x 100 ton)		4.00	1.40	0.212					4.00	1.40	0.212					0.0730	0.0256	0.00387					632,346	4,973,500
PSU	Prill Silos Unloading (2 x 100 ton)		4.00	1.40	0.212					4.00	1.40	0.212					0.0730	0.0256	0.00387					632,346	4,973,500
CS1L	Cement/Shotcrete Silo #1 Loading	Control efficiency included in emission factor	0.0792	0.0272	0.00400					0.0792	0.0272	0.00400					0.0297	0.0102	0.00150					632,095	4,974,272
CS1U	Cement/Shotcrete Silo #1 Unloading		0.0960	0.0560	0.00800					0.384	0.224	0.0320					0.144	0.0840	0.0120					632,095	4,974,272
CS2L	Cement/Shotcrete Silo #2 Loading	Control efficiency included in emission factor	0.0792	0.0272	0.00400					0.0792	0.0272	0.00400					0.0297	0.0102	0.00150					632,095	4,974,272
CS2U	Cement/Shotcrete Silo #2 Unloading		0.0960	0.0560	0.00800					0.384	0.224	0.0320					0.144	0.0840	0.0120					632,095	4,974,272
CAL	Aggregate Bin Loading		0.690	0.330	0.0500					16.6	7.92	1.20					1.73	0.825	0.125					632,095	4,974,272
CAU	Aggregate Bin Unloading		0.690	0.330	0.0500					16.6	7.92	1.20					1.73	0.825	0.125					632,095	4,974,272
CM	Central Mixer Loading	Control efficiency included in emission factor	0.368	0.110	0.0160					1.47	0.440	0.0640					0.552	0.165	0.0240					632,095	4,974,272
TG1	Mine Site Gasoline Tank #1								0.219							5.25							0.957		
TG2	Mine Site Gasoline Tank #2								0.219							5.25							0.957		
TD3	Mine Site Diesel Tank #3								0.00167							0.0400							0.00730		
TD4	Mine Site Diesel Tank #4								0.00167							0.0400							0.00730		
TD5	Mine Site Diesel Tank #5								0.00167							0.0400							0.00730		
TD6	Mine Site Diesel Tank #6								0.00167							0.0400							0.00730		
TD7	Mine Site Diesel Tank #7								0.00167							0.0400							0.00730		
TD8	Mine Site Diesel Tank #8								0.00167							0.0400							0.00730		

SOURCE DESCRIPTION		TROLS	HOURLY EMISSIONS							DAILY EMISSIONS							ANNUAL EMISSIONS								
Model	Source Description	reference	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	PM	PM_{10}	$PM_{2.5}$	CO	NOx	SO_2	VOC	UTM E	UTM N
ID			lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	m	m
TD9	Mine Site Diesel Tank #9								0.00167							0.0400							0.00730		
TD10	Mine Site Diesel Tank #10								0.00167							0.0400							0.00730		
PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	Control efficiency included in emission factor	0.63	0.233	0.030					15.0	5.6	0.73					2.74	1.02	0.133					632,348	4,973,429
PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	Control efficiency included in emission factor	0.625	0.2325	0.0304					15.00	5.58	0.730					2.738	1.018	0.1332					632,348	4,973,369
TRUE	LIME PRODUCTION																								
LS1	Limestone transfer to Primary Crusher Hopper		0.141	0.0518	0.0080					3.39	1.24	0.192	0	0	0	0	0.477	0.175	0.0270					632,239	4,974,256
LS2	Primary Crushing and Associated Transfers In and Out		0.254	0.113	0.0169					6.10	2.71	0.407	0	0	0	0	0.86	0.381	0.057					632,239	4,974,256
LS3	Primary Screening and Associated Transfers In and Out		1.18	0.410	0.0621					28.2	9.8	1.49	0	0	0	0	3.97	1.38	0.210					632,239	4,974,256
LS4	Secondary Crushing and Associated Transfers In and Out		0.254	0.113	0.0169					6.10	2.71	0.407	0	0	0	0	0.86	0.381	0.057					632,227	4,974,268
LS5	Secondary Screening and Associated Transfers In and Out		1.18	0.410	0.0621					28.2	9.8	1.49	0	0	0	0	3.97	1.38	0.210					632,227	4,974,268
LS6	Limestone transfer to Ball Mill Feed Bin		0.141	0.0518	0.0080					3.39	1.24	0.192	0	0	0	0	0.477	0.175	0.0270					632,181	4,974,307
LS7	Limestone transfer to Ball Mill Feed Conveyor		0.141	0.0518	0.00800					3.39	1.243	0.192	0	0	0	0	0.477	0.175	0.0270					632,181	4,974,307
LS8	Ball Mill Feed transfer to Ball Mill		0.141	0.0518	0.00800					3.39	1.243	0.192	0	0	0	0	0.477	0.175	0.0270					632,200	4,974,273
LSBM	Limestone Ball Mill	Control efficiency included in emission factor	1.902	1.5959	0.56964					45.65	38.303	13.671	0	0	0	0	6.422	5.389	1.9233					632,215	4,974,248
LS9	Limestone transfer to Kiln Feed Bin		0.033	0.0122	0.0019					0.80	0.29	0.045	0	0	0	0	0.124	0.045	0.0070					632,169	4,974,325
LS10	Limestone transfer to Lime Kiln Feed Conveyor		0.033	0.0122	0.00189					0.80	0.294	0.045	0	0	0	0	0.124	0.045	0.0070					632,169	4,974,325
LS11	Fines Screening and Associated Transfers In and Out		0.28	0.097	0.0147					6.7	2.3	0.35	0	0	0	0	1.03	0.36	0.055					632,151	4,974,314
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln		0.033	0.0122	0.00189					0.80	0.294	0.045	0	0	0	0	0.124	0.045	0.0070					632,056	4,974,285
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	Control efficiency included in emission factor	0.915	0.915	0.915	3.17	1.69	0.0085		21.97	21.97	21.97	76.05	40.6	0.203	0.00	3.40	3.40	3.40	11.8	6.29	0.0314		632,057	4,974,265
LKC	PFR Shaft Lime Kiln Combustion		0.169	0.169	0.169	1.81	3.13	0.383	0.193	4.05	4.05	4.05	43.4	75.2	9.2	4.62	0.627	0.627	0.627	6.72	11.6	1.42	0.72	632,057	4,974,265
LCR	Lime Mill Crushing and associated transfers In and Out	Control efficiency included in emission factor	0.28448	0.23871	0.08520					6.828	5.729	2.045	0	0	0	0	1.0580	0.8878	0.3169					632,073	4,974,233
LSL	Pebble Lime Silo Loading via Bucket Elevator	Control efficiency included in emission factor	6.20E-3	6.20E-3	6.20E-3					0.1487	0.1487	0.1487	0	0	0	0	0.02305	0.02305	0.02305					632,069	4,974,206
LSU	Pebble Lime Silo discharge to Lime Slaker	Control efficiency included in emission factor	6.20E-4	6.20E-4	6.20E-4					0.0149	0.0149	0.0149	0	0	0	0	0.00230	0.00230	0.00230					632,069	4,974,206
Total			**35.8**	**21.7**	**13.4**	**33.5**	**55.4**	**1.88**	**11.5**	**578**	**376**	**241**	**204**	**259**	**37.2**	**34.5**	**87.3**	**56.3**	**36.4**	**30.5**	**37.9**	**6.48**	**4.78**		

UPDATED EMISSIONS INVENTORIES AS SUBMITTED ON 10/8/2021

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 1 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021

Model Scenario W3 180,000 T/day Emissions

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**HAP/TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
106-99-0	1,3-Butadiene	8.4E-07	3.7E-06	0	0	0	0	8.4E-07	3.7E-06	Y	Y
91-57-6	2-Methylnaphthalene	1.1E-06	4.6E-06	0	0	0	0	1.1E-06	4.6E-06	Y	N
56-49-5	3-Methylchloranthrene	7.8E-08	3.4E-07	0	0	0	0	7.8E-08	3.4E-07	Y	Y
57-97-6	7,12-Dimethylbenz(a)anthracene	7.6E-07	3.0E-06	0	0	0	0	7.6E-07	3.0E-06	Y	N
83-32-9	Acenaphthene	5.7E-06	7.1E-06	0	0	0	0	5.7E-06	7.1E-06	Y	N
208-96-8	Acenaphthylene	1.1E-05	1.4E-05	0	0	0	0	1.1E-05	1.4E-05	Y	N
75-07-0	Acetaldehyde	2.5E-05	1.1E-04	0	0	0	0	2.5E-05	1.1E-04	Y	Y
107-02-8	Acrolein	1.6E-05	2.0E-05	0	0	0	0	1.6E-05	2.0E-05	Y	Y
120-12-7	Anthracene	1.7E-06	2.4E-06	0	0	0	0	1.7E-06	2.4E-06	Y	N
7440-36-0	Antimony	0	0	5.7E-04	2.5E-03	1.9E-02	8.2E-02	1.9E-02	8.5E-02	Y	Y
7440-38-2	Arsenic	8.7E-06	3.8E-05	4.5E-03	2.0E-02	0.54	2.38	0.55	2.40	Y	Y
56-55-3	Benz(a)anthracene	3.1E-07	1.4E-06	0	0	0	0	3.1E-07	1.4E-06	Y	Y
71-43-2	Benzene	3.6E-04	1.6E-03	7.0E-03	3.1E-02	0	0	7.4E-03	3.2E-02	Y	Y
50-32-8	Benzo(a)pyrene	1.4E-07	6.1E-07	0	0	0	0	1.4E-07	6.1E-07	Y	Y
205-99-2	Benzo(b)fluoranthene	4.4E-07	1.9E-06	0	0	0	0	4.4E-07	1.9E-06	Y	Y
191-24-2	Benzo(g,h,i)perylene	7.5E-07	1.1E-06	0	0	0	0	7.5E-07	1.1E-06	Y	N
207-08-9	Benzo(k)fluoranthene	1.5E-07	6.6E-07	0	0	0	0	1.5E-07	6.6E-07	Y	Y
7440-41-7	Beryllium	5.2E-07	2.3E-06	4.3E-04	1.9E-03	2.6E-03	1.1E-02	3.0E-03	1.3E-02	Y	Y
92-52-4	Biphenyl	0	0	4.4E-05	1.9E-04	0	0	4.4E-05	1.9E-04	Y	Y
7440-43-9	Cadmium	4.8E-05	2.1E-04	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.7E-04	3.8E-03	Y	Y
75-15-0	Carbon Disulfide	0	0	1.4E-02	6.3E-02	0	0	1.4E-02	6.3E-02	Y	Y
7440-47-3	Chromium	6.6E-05	2.7E-04	6.1E-04	2.5E-03	7.3E-03	3.2E-02	8.0E-03	3.5E-02	Y	Y
18540-29-9	Cr (VI)	0	0	3.4E-07	1.5E-06	0	0	3.4E-07	1.5E-06	Y	Y
218-01-9	Chrysene	5.8E-07	2.5E-06	0	0	0	0	5.8E-07	2.5E-06	Y	Y
7440-48-4	Cobalt	4.0E-06	1.6E-05	4.7E-04	2.0E-03	3.3E-03	1.4E-02	3.7E-03	1.6E-02	Y	Y
592-01-8	Cyanide	0	0	0.45	1.99	0	0	0.45	1.99	Y	Y
53-70-3	Dibenzo(a,h)anthracene	1.8E-07	7.7E-07	0	0	0	0	1.8E-07	7.7E-07	Y	Y
106-46-7	Dichlorobenzene	5.7E-05	2.3E-04	0	0	0	0	5.7E-05	2.3E-04	Y	Y
206-44-0	Fluoranthene	5.5E-06	7.0E-06	0	0	0	0	5.5E-06	7.0E-06	Y	N
86-73-7	Fluorene	1.7E-05	2.1E-05	0	0	0	0	1.7E-05	2.1E-05	Y	N
50-00-0	Formaldehyde	3.3E-03	1.5E-02	0	0	0	0	3.3E-03	1.5E-02	Y	Y
110-54-3	Hexane	8.5E-02	0.34	3.1E-02	0.14	0	0	0.12	0.48	Y	Y
7647-01-0	Hydrogen Chloride	0	0	0.99	3.67	0	0	0.99	**3.67**	Y	Y
193-39-5	Indeno(1,2,3-cd)pyrene	2.2E-07	9.6E-07	0	0	0	0	2.2E-07	9.6E-07	Y	Y
7439-92-1	Lead	0	0	4.8E-04	2.1E-03	6.5E-03	2.9E-02	7.0E-03	3.1E-02	Y	N
7439-96-5	Manganese	1.8E-05	7.2E-05	4.6E-03	1.7E-02	0.24	1.07	0.25	1.08	Y	Y
7439-97-6	Mercury	1.2E-05	5.0E-05	6.9E-04	2.9E-03	1.3E-03	5.7E-03	2.0E-03	8.6E-03	Y	N
91-20-3	Naphthalene	1.9E-04	3.1E-04	1.9E-03	8.5E-03	0	0	2.1E-03	8.8E-03	Y	Y
7440-02-0	Nickel	9.1E-05	4.0E-04	4.6E-04	2.0E-03	1.6E-03	7.1E-03	2.2E-03	9.5E-03	Y	Y
85-01-8	Phenanthrene	5.1E-05	6.3E-05	0	0	0	0	5.1E-05	6.3E-05	Y	N
108-95-2	Phenol	0	0	2.4E-04	1.1E-03	0	0	2.4E-04	1.1E-03	Y	Y
7723-14-0	Phosphorus	0	0	5.6E-03	2.3E-02	0.53	2.32	0.54	2.34	Y	Y
129-00-0	Pyrene	5.0E-06	6.6E-06	0	0	0	0	5.0E-06	6.6E-06	Y	N
7782-49-2	Selenium	1.1E-06	4.6E-06	4.1E-04	1.8E-03	3.3E-04	1.4E-03	7.4E-04	3.2E-03	Y	Y
108-88-3	Toluene	5.2E-04	1.1E-03	3.2E-02	0.14	0	0	3.2E-02	0.14	Y	Y
1330-20-7	Xylene	2.5E-04	3.0E-04	3.1E-02	0.14	0	0	3.2E-02	0.14	Y	Y
Total HAP		9.0E-02	0.36	1.58	6.25	1.36	5.95	3.03	12.56		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
TRUE	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
	chk	chk	chk-15	chk	chk	chk	chk	chk

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary - continued

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**Non-HAP TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
7429-90-5	Aluminum	0	0	0.65	2.58	57.86	253.41	58.50	255.98	N	Y
7440-39-3	Barium	2.1E-04	8.4E-04	6.6E-03	2.7E-02	0.65	2.86	0.66	2.88	N	Y
1317-65-3	Calcium Carbonate	0	0	2.24	8.12	11.41	49.97	13.65	58.09	N	Y
1305-78-8	Calcium Oxide	0	0	0.70	0.95	0	0	0.70	0.95	N	Y
7440-50-8	Copper	4.0E-05	1.6E-04	4.9E-04	2.1E-03	4.1E-03	1.8E-02	4.6E-03	2.0E-02	N	Y
110-82-7	Cyclohexane	0	0	1.0E-03	4.6E-03	0	0	1.0E-03	4.6E-03	N	Y
7783-06-4	Hydrogen Sulfide	0	0	0.90	3.94	0	0	0.90	3.94	N	Y
7439-89-6	Iron	0	0	0.21	0.81	14.83	64.96	15.04	65.77	N	Y
7439-98-7	Molybdenum	5.2E-05	2.1E-04	4.2E-04	1.8E-03	8.1E-04	3.6E-03	1.3E-03	5.6E-03	N	Y
109-66-0	Pentane	0.12	0.50	0	0	0	0	0.12	0.50	N	Y
7440-22-4	Silver	0	0	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.2E-04	3.6E-03	N	Y
7664-93-9	Sulfuric Acid	0	0	2.03	8.89	0	0	2.03	8.89	N	Y
7440-28-0	Thallium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-61-1	Uranium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-62-2	Vanadium	1.1E-04	4.4E-04	7.3E-04	3.0E-03	2.3E-02	1.0E-01	2.4E-02	0.10	N	Y
25551-13-7	Trimethyl benzene	0	0	1.1E-02	4.8E-02	0	0	1.1E-02	4.8E-02	N	Y
7440-33-7	Tungsten	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-66-6	Zinc	1.4E-03	5.5E-03	8.0E-04	3.3E-03	2.9E-02	0.12	3.1E-02	0.13	N	Y
Total Non-HAP TAP		0.13	0.50	6.75	25.40	84.83	371.54	91.71	397.44		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

Conversions

2,000 lb/ton
8,760 hr/yr
24 hr/day

PROPANE COMBUSTION

Source Data

Source ID	Description	MMBtu/day	MMBtu/yr
Lime Process Heating			
LKC	PFR Shaft Lime Kiln Combustion	529.0	163,935
Ore Process Heating			
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	17.0	510
CKB	Carbon Regeneration Kiln (Burners)	54.1	19,754
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	2.4	876
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	120.0	43,800
Subtotal		193.5	64,940
HVAC			
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	96.0	35,040
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	96.0	35,040
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	96.0	35,040
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	12.0	4,380
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	48.0	17,520
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	72.0	26,280
Subtotal		438.0	159,870

PROPANE COMBUSTION - CONTINUED

HAP/TAP Emission Factors and Emissions

O.Heat_pph O.Heat_tpy L.Heat_pph L.Heat_tpy HVAC_pph HVAC_tpy lb/hr ton/yr

		Emission Factor[2]		Emissions[1] Ore Proc Heat		Lime Proc Heat		HVAC		Total			
CAS	Pollutant	lb/MMscf	lb/MMBtu[3]	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	TAP	A/C
91-57-6	2-Methylnaphthalene	2.4E-05	2.35E-8	1.9E-07	7.6E-07	5.2E-07	1.9E-06	4.3E-07	1.9E-06	1.1E-06	4.6E-06	N	
56-49-5	3-Methylchloranthrene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
57-97-6	7,12-Dimethylbenz(a)anth	< 1.6E-05	1.57E-8	1.3E-07	5.1E-07	3.5E-07	1.3E-06	2.9E-07	1.3E-06	7.6E-07	3.0E-06	N	
83-32-9	Acenaphthene	< 1.8E-06	1.76E-9	1.4E-08	5.7E-08	3.9E-08	1.4E-07	3.2E-08	1.4E-07	8.5E-08	3.4E-07	N	
208-96-8	Acenaphthylene	< 1.8E-06	1.76E-9	1.4E-08	5.7E-08	3.9E-08	1.4E-07	3.2E-08	1.4E-07	8.5E-08	3.4E-07	N	
120-12-7	Anthracene	< 2.4E-06	2.35E-9	1.9E-08	7.6E-08	5.2E-08	1.9E-07	4.3E-08	1.9E-07	1.1E-07	4.6E-07	N	
7440-38-2	Arsenic	2.0E-04	1.96E-7	1.5E-06	6.4E-06	3.7E-06	1.6E-05	3.6E-06	1.6E-05	8.7E-06	3.8E-05	Y	C
56-55-3	Benz(a)anthracene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
71-43-2	Benzene	2.1E-03	2.06E-6	1.5E-05	6.7E-05	3.9E-05	1.7E-04	3.8E-05	1.6E-04	9.1E-05	4.0E-04	Y	C
50-32-8	Benzo(a)pyrene	< 1.2E-06	1.18E-9	8.7E-09	3.8E-08	2.2E-08	9.6E-08	2.1E-08	9.4E-08	5.2E-08	2.3E-07	Y	C
205-99-2	Benzo(b)fluoranthene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
191-24-2	Benzo(g,h,i)perylene	< 1.2E-06	1.18E-9	9.5E-09	3.8E-08	2.6E-08	9.6E-08	2.1E-08	9.4E-08	5.7E-08	2.3E-07	N	
207-08-9	Benzo(k)fluoranthene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
7440-41-7	Beryllium	< 1.2E-05	1.18E-8	8.7E-08	3.8E-07	2.2E-07	9.6E-07	2.1E-07	9.4E-07	5.2E-07	2.3E-06	Y	C
7440-43-9	Cadmium	1.1E-03	1.08E-6	8.0E-06	3.5E-05	2.0E-05	8.8E-05	2.0E-05	8.6E-05	4.8E-05	2.1E-04	Y	C
7440-47-3	Chromium	1.4E-03	1.37E-6	1.1E-05	4.5E-05	3.0E-05	1.1E-04	2.5E-05	1.1E-04	6.6E-05	2.7E-04	Y	A
218-01-9	Chrysene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
7440-48-4	Cobalt	8.4E-05	8.24E-8	6.6E-07	2.7E-06	1.8E-06	6.8E-06	1.5E-06	6.6E-06	4.0E-06	1.6E-05	Y	A
53-70-3	Dibenzo(a,h)anthracene	< 1.2E-06	1.18E-9	8.7E-09	3.8E-08	2.2E-08	9.6E-08	2.1E-08	9.4E-08	5.2E-08	2.3E-07	Y	C
106-46-7	Dichlorobenzene	1.2E-03	1.18E-6	9.5E-06	3.8E-05	2.6E-05	9.6E-05	2.1E-05	9.4E-05	5.7E-05	2.3E-04	Y	A
206-44-0	Fluoranthene	3.0E-06	2.94E-9	2.4E-08	9.5E-08	6.5E-08	2.4E-07	5.4E-08	2.4E-07	1.4E-07	5.7E-07	N	
86-73-7	Fluorene	2.8E-06	2.75E-9	2.2E-08	8.9E-08	6.1E-08	2.3E-07	5.0E-08	2.2E-07	1.3E-07	5.3E-07	N	
50-00-0	Formaldehyde	7.5E-02	7.35E-5	5.5E-04	2.4E-03	1.4E-03	6.0E-03	1.3E-03	5.9E-03	3.3E-03	1.4E-02	Y	C
110-54-3	Hexane	1.8E+00	1.76E-3	1.4E-02	5.7E-02	3.9E-02	1.4E-01	3.2E-02	1.4E-01	8.5E-02	3.4E-01	Y	A
193-39-5	Indeno(1,2,3-cd)pyrene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
7439-96-5	Manganese	3.8E-04	3.73E-7	3.0E-06	1.2E-05	8.2E-06	3.1E-05	6.8E-06	3.0E-05	1.8E-05	7.2E-05	Y	A
7439-97-6	Mercury	2.6E-04	2.55E-7	2.1E-06	8.3E-06	5.6E-06	2.1E-05	4.7E-06	2.0E-05	1.2E-05	5.0E-05	N	
91-20-3	Naphthalene	6.1E-04	5.98E-7	4.8E-06	1.9E-05	1.3E-05	4.9E-05	1.1E-05	4.8E-05	2.9E-05	1.2E-04	Y	A
7440-02-0	Nickel	2.1E-03	2.06E-6	1.5E-05	6.7E-05	3.9E-05	1.7E-04	3.8E-05	1.6E-04	9.1E-05	4.0E-04	Y	C
85-01-8	Phenanthrene	1.7E-05	1.67E-8	1.3E-07	5.4E-07	3.7E-07	1.4E-06	3.0E-07	1.3E-06	8.1E-07	3.2E-06	N	
129-00-0	Pyrene	5.0E-06	4.90E-9	4.0E-08	1.6E-07	1.1E-07	4.0E-07	8.9E-08	3.9E-07	2.4E-07	9.5E-07	N	
7782-49-2	Selenium	< 2.4E-05	2.35E-8	1.9E-07	7.6E-07	5.2E-07	1.9E-06	4.3E-07	1.9E-06	1.1E-06	4.6E-06	Y	A
108-88-3	Toluene	3.4E-03	3.33E-6	2.7E-05	1.1E-04	7.3E-05	2.7E-04	6.1E-05	2.7E-04	1.6E-04	6.5E-04	Y	A
109-66-0	Pentane	2.6E+00	2.55E-3	2.1E-02	8.3E-02	5.6E-02	2.1E-01	4.7E-02	2.0E-01	1.2E-01	5.0E-01	Y	A
7440-39-3	Barium	4.4E-03	4.31E-6	3.5E-05	1.4E-04	9.5E-05	3.5E-04	7.9E-05	3.4E-04	2.1E-04	8.4E-04	Y	A
7440-50-8	Copper	8.5E-04	8.33E-7	6.7E-06	2.7E-05	1.8E-05	6.8E-05	1.5E-05	6.7E-05	4.0E-05	1.6E-04	Y	A
7439-98-7	Molybdenum	1.1E-03	1.08E-6	8.7E-06	3.5E-05	2.4E-05	8.8E-05	2.0E-05	8.6E-05	5.2E-05	2.1E-04	Y	A
7440-62-2	Vanadium	2.3E-03	2.25E-6	1.8E-05	7.3E-05	5.0E-05	1.8E-04	4.1E-05	1.8E-04	1.1E-04	4.4E-04	Y	A
7440-66-6	Zinc	2.9E-02	2.84E-5	2.3E-04	9.2E-04	6.3E-04	2.3E-03	5.2E-04	2.3E-03	1.4E-03	5.5E-03	Y	A
Total				3.6E-02	1.4E-01	9.8E-02	3.6E-01	8.1E-02	3.5E-01	2.1E-01	8.6E-01		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *AP-42, Table 1.4-3 & 1.4-4 (7/98) Natural Gas Combustion* 1.0766 1.0766

(3) *Natural Gas Higher Heating Value* 1,020 *MMBtu/MMscf* chk

DIESEL COMBUSTION

Source Data

Source ID	Description	Power Rating kW	Power Rating hp	Operation hr/day	Operation hr/yr	Fuel Consumption[1] & [2] MMBtu/day	Fuel Consumption[1] & [2] MMBtu/yr
EDG1	Camp Emergency Generator	1,000	1,341	1	100	9.39	938.70
EDG2	Plant Emergency Generator #1	1,000	1,341	1	100	9.39	938.7
EDG3	Plant Emergency Generator #2	1,000	1,341	1	100	9.39	938.7
EDFP	Mill Fire Pump	200	268	1	100	1.88	187.7
Total						30.0	3,003.8

(1) *Based on brake specific fuel consumption for diesel generators* 7,000 *Btu/hp-hr* *AP-42 Tbl 3.3-1*

(2) *Heat Content of* 0.137 *MMBtu/gal* 1E+6 *Btu/MMBtu* 1.341 *hp/kW*

HAP/TAP Emission Factors and Emissions

lb/hr ton/yr

	Pollutant	Factor (lb/MMBtu) ≤600 hp[2]	Factor (lb/MMBtu) >600hp[3]	Emissions (≤600 hp) lb/hr	Emissions (≤600 hp) ton/yr	Emissions (>600 hp) lb/hr	Emissions (>600 hp) ton/yr	Total Emissions[1] lb/hr	Total Emissions[1] ton/yr	TAP	A/C
106-99-0	1,3-Butadiene	< 3.9E-05		8.4E-07	3.7E-06	0.0E+00	0.0E+00	8.4E-07	3.7E-06	Y	C
83-32-9	Acenaphthene	< 1.4E-06	4.7E-06	1.1E-07	1.3E-07	5.5E-06	6.6E-06	5.6E-06	6.7E-06	N	
208-96-8	Acenaphthylene	< 5.1E-06	9.2E-06	4.0E-07	4.7E-07	1.1E-05	1.3E-05	1.1E-05	1.3E-05	N	
75-07-0	Acetaldehyde	7.7E-04	2.5E-05	1.6E-05	7.2E-05	8.1E-06	3.5E-05	2.5E-05	1.1E-04	Y	C
107-02-8	Acrolein	< 9.3E-05	7.9E-06	7.2E-06	8.7E-06	9.2E-06	1.1E-05	1.6E-05	2.0E-05	Y	A
120-12-7	Anthracene	1.9E-06	1.2E-06	1.5E-07	1.8E-07	1.4E-06	1.7E-06	1.6E-06	1.9E-06	N	
56-55-3	Benz(a)anthracene	1.7E-06	6.2E-07	3.6E-08	1.6E-07	2.0E-07	8.8E-07	2.4E-07	1.0E-06	Y	C
71-43-2	Benzene	9.3E-04	7.8E-04	2.0E-05	8.8E-05	2.5E-04	1.1E-03	2.7E-04	1.2E-03	Y	C
50-32-8	Benzo(a)pyrene	< 1.9E-07	< 2.6E-07	4.0E-09	1.8E-08	8.3E-08	3.6E-07	8.7E-08	3.8E-07	Y	C
205-99-2	Benzo(b)fluoranthene	< 9.9E-08	< 1.1E-06	2.1E-09	9.3E-09	3.6E-07	1.6E-06	3.6E-07	1.6E-06	Y	C
191-24-2	Benzo(g,h,i)perylene	< 4.9E-07	< 5.6E-07	3.8E-08	4.6E-08	6.5E-07	7.8E-07	6.9E-07	8.3E-07	N	
207-08-9	Benzo(k)fluoranthene	< 1.6E-07	< 2.2E-07	3.3E-09	1.5E-08	7.0E-08	3.1E-07	7.3E-08	3.2E-07	Y	C
218-01-9	Chrysene	3.5E-07	1.5E-06	7.6E-09	3.3E-08	4.9E-07	2.2E-06	5.0E-07	2.2E-06	Y	C
53-70-3	Dibenzo(a,h)anthracene	< 5.8E-07	< 3.5E-07	1.2E-08	5.5E-08	1.1E-07	4.9E-07	1.2E-07	5.4E-07	Y	C
206-44-0	Fluoranthene	7.6E-06	4.0E-06	6.0E-07	7.1E-07	4.7E-06	5.7E-06	5.3E-06	6.4E-06	N	
86-73-7	Fluorene	2.9E-05	1.3E-05	2.3E-06	2.7E-06	1.5E-05	1.8E-05	1.7E-05	2.1E-05	N	
50-00-0	Formaldehyde	1.2E-03	7.9E-05	2.5E-05	1.1E-04	2.5E-05	1.1E-04	5.1E-05	2.2E-04	Y	C
193-39-5	Indeno(1,2,3-cd)pyrene	< 3.8E-07	< 4.1E-07	8.0E-09	3.5E-08	1.3E-07	5.8E-07	1.4E-07	6.2E-07	Y	C
91-20-3	Naphthalene	8.5E-05	1.3E-04	6.6E-06	8.0E-06	1.5E-04	1.8E-04	1.6E-04	1.9E-04	Y	A
85-01-8	Phenanthrene	2.9E-05	4.1E-05	2.3E-06	2.8E-06	4.8E-05	5.7E-05	5.0E-05	6.0E-05	N	
129-00-0	Pyrene	4.8E-06	3.7E-06	3.7E-07	4.5E-07	4.4E-06	5.2E-06	4.7E-06	5.7E-06	N	
108-88-3	Toluene	4.1E-04	2.8E-04	3.2E-05	3.8E-05	3.3E-04	4.0E-04	3.6E-04	4.3E-04	Y	A
1330-20-7	Xylene	2.9E-04	1.9E-04	2.2E-05	2.7E-05	2.3E-04	2.7E-04	2.5E-04	3.0E-04	Y	A
Total				1.4E-04	3.6E-04	1.1E-03	2.2E-03	1.2E-03	2.6E-03		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *AP-42, Tab. 3.3-2, 10/96, diesel engines (≤ 600 hp)* chk chk

(3) *AP-42, Tabs. 3.4-3 & 3.4-4, 10/96, large diesel engines (> 600 hp)*

ORE PROCESSING

Source Data

Source ID	Description	PM Emissions lb/day	PM Emissions ton/yr
OC1	Loader Transfer of Ore to Grizzly	3.500	0.639
OC2	Grizzly to Apron Feeder	3.500	0.639
OC3	Apron Feeder to Dribble Conveyor	3.500	0.639
OC4	Apron Feeder to Vibrating Grizzly	3.500	0.639
OC5	Dribble Conveyor to Vibrating Grizzly	3.500	0.639
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	3.500	0.639
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	30.000	5.475
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	3.500	0.639
OC9	Stockpile Transfers to Reclaim Conveyors	16.560	3.022
OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	16.560	3.022
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	16.560	3.022
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge C	33.120	6.044
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	3.864	0.705
Total		141.164	25.762

HAP/TAP Emission Factors and Emissions

CAS No.	Pollutant	Concentration ppm[2]	Emissions[1] lb/hr	Emissions[1] ton/yr	TAP	A/C
7440-38-2	Arsenic	667	3.9E-03	1.7E-02	Y	C
7440-41-7	Beryllium	3.2	1.9E-05	8.2E-05	Y	C
7440-43-9	Cadmium	0.50	2.9E-06	1.3E-05	Y	C
7440-48-4	Cobalt	4	2.4E-05	1.0E-04	Y	A
7440-47-3	Chromium	9	5.3E-05	2.3E-04	Y	A
7439-97-6	Mercury [3]	0.96	5.6E-06	2.5E-05	N	
7439-96-5	Manganese	299	1.8E-03	7.7E-03	Y	A
7440-02-0	Nickel	2	1.2E-05	5.2E-05	Y	C
7439-92-1	Lead	8	4.7E-05	2.1E-04	N	
7440-36-0	Antimony	23	1.4E-04	5.9E-04	Y	A
7723-14-0	Phosphorus	650	3.8E-03	1.7E-02	Y	A
7782-49-2	Selenium [4]	0.40	2.4E-06	1.0E-05	Y	A
7440-22-4	Silver	0.50	2.9E-06	1.3E-05	Y	A
7429-90-5	Aluminum	71,000	4.2E-01	1.8E+00	Y	A
7440-39-3	Barium	800	4.7E-03	2.1E-02	Y	A
1317-65-3	Calcium Carbonate	14,000	8.2E-02	3.6E-01	Y	A
7440-50-8	Copper	5	2.9E-05	1.3E-04	Y	A
7439-89-6	Iron [4]	18,200	1.1E-01	4.7E-01	Y	A
7439-98-7	Molybdenum	1	5.9E-06	2.6E-05	Y	A
7440-28-0	Thallium	10	5.9E-05	2.6E-04	Y	A
7440-61-1	Uranium	10	5.9E-05	2.6E-04	Y	A
7440-62-2	Vanadium	28	1.6E-04	7.2E-04	Y	A
7440-33-7	Tungsten	10	5.9E-05	2.6E-04	Y	A
7440-66-6	Zinc	35	2.1E-04	9.0E-04	Y	A
Total			6.2E-01	2.7E+00		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *(Midas Gold 2017c) Median concentration of 55,000 SGP samples.*

[3] *(Midas Gold 2018e) Median ore concentration of 151,000 SGP samples; resource block model.*

[4] *(Midas Gold 2020) Median concentration of 56,000 SGP samples for Fe and 1,500 SGP samples for Se.*

1E+6 parts/ppm

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 7 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021

ORE CONCETRATION AND REFINING

Source Data

Source ID	Description	Subpart 7E Allowable Limit lb/yr[1]	Oper. hr/yr	% of Subpart 7E for Controlled Systems %		Controlled Hg Emissions lb/hr	ton/yr	lb/yr
AC	Autoclave	213.4	8,760	[2]		0.000023	0.00010	0.20
EW,MR,MF,CKD	Refinery Sources (C. Kiln, EW, Retort, Furn	16.8		20%	[3]	0.000384	0.00168	3.36
7439-97-6 Mercury	Total	230.2				0.000407	0.00178	3.56

[1] *Subpart 7E Limit - Ore Pretreatment Processes (CFR 2018b)*

$$\frac{84\ lb}{MMton} \times \frac{2{,}540{,}400\ ton}{yr} \times \frac{MMton}{1.0E+6\ ton} = \frac{213.4\ lb}{yr}$$

[1] *Subpart 7E Limit - Carbon Processes with Mercury Retorts*

$$\frac{0.8\ lb}{ton} \times \frac{21\ ton}{yr} = \frac{16.8\ lb}{yr}$$

[2] *Controlled SysCAD modeled emissions from Autoclave:* 0.0105 g/hr 2.3E-05 lb/hr 0.20 lb/yr (M3 2019)

[3] *Based on similar source (but with much higher ore Hg content) Hg reporting levels provided below:*

Goldstrike Refinery (2015 & 2016 Hg Reports) *(NDEP 2015a) (NDEP 2016)*

$$\frac{28.79\ lb}{yr} \times \frac{yr}{251.00\ ton} = \frac{0.11\ lb}{MMton} \times \frac{ton}{0.8\ lb} = 14.3\%$$

Twin Creeks Refinery (2015 & 2016 Hg Reports) *(NDEP 2015a) (NDEP 2016)*

$$\frac{31.27\ lb}{yr} \times \frac{yr}{142.77\ ton} = \frac{0.22\ lb}{MMton} \times \frac{ton}{0.8\ lb} = 27.4\%$$

HAP/TAP Emission Factors and Emission

AC_pph AC_tpy Refin_pph Refin_tpy lb/hr ton/yr

CAS No.	Pollutant	Emission Factor[1]	Autoclave lb/hr	Autoclave ton/yr	Refinery lb/hr	Refinery ton/yr	Total Emissions lb/hr	Total Emissions ton/yr	TAP	A/C
7440-38-2	Arsenic	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	C
7440-41-7	Beryllium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	C
7440-43-9	Cadmium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	C
7440-48-4	Cobalt	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-47-3	Chromium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7439-97-6	Mercury	see above	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	N	
7439-96-5	Manganese	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-02-0	Nickel	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	C
7439-92-1	Lead	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	N	
7440-36-0	Antimony	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7723-14-0	Phosphorus	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7782-49-2	Selenium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-22-4	Silver	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7429-90-5	Aluminum	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-39-3	Barium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
1317-65-3	Calcium Carbonate	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-50-8	Copper	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7439-89-6	Iron	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7439-98-7	Molybdenum	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-28-0	Thallium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-61-1	Uranium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-62-2	Vanadium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-33-7	Tungsten	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-66-6	Zinc	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
Total			5.5E-04	2.4E-03	9.2E-03	4.0E-02	9.8E-03	4.3E-02		

[1] *Hg is the most difficult metal to control due to it existing in both particulate and gaseous form. Therefore, all other metals are conservatively estimated to be equal to or less than the Hg emissions.*

0.0525 0.0525 chk

7664-93-9	Sulfuric Acid	Autoclave	2.03	8.89			2.03	8.89
7783-06-4	Hydrogen Sulfid	Autoclave	0.90	3.94			0.90	3.94
592-01-8	Cyanide	Point Sources - 5 EW Cells			0.0012	0.0053	0.00	0.01
Total			2.93	12.84	0.01	0.05	2.94	12.88

ORE CONCETRATION AND REFINING - CONTINUED

Source Data

Source ID	Description	Throughput ton/day	Throughput ton/yr	Operation hr/day	Operation hr/yr
AC	Autoclave	6,960	2,540,400	24	8,760

Autoclave HAP/TAP Emission Factors and Emission lb/hr ton/yr

CAS No.	Pollutant	Emission Factor		Emissions[1] lb/hr	Emissions[1] ton/yr
7664-93-9	Sulfuric Acid	0.007	lb/ton[2]	2.03	8.89
7783-06-4	Hydrogen Sulfide	0.9	lb/hr[3]	0.90	3.94

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *H2SO4 is based on Acidic Autoclave test data (APT 2010)*

[3] *H2S is based on Acidic Autoclave test data (APT 2013)*

LEACHING OPERATION

Cyanide (HCN) Source Data, Emission Factors, and Emissions

Source II	Description	Dia. ft[1]	pH[1]	Free CN- g/m3[1]	T C[1]	pKa	a0	H	kG[2] m/s	Fa*Fw	g/s	lb/hr	ton/yr
												lb/hr	ton/yr
TSF	***Fugitive Sources***												
TSF	Tailings Maint. Pond	76	7.75	1	3.74	9.803	0.9912	0.0025	1.89E-05	0.641	1.27E-05	0.0001	0.0004
MILLTA	CN Detox Tank 1	40	8.5	25	25	9.250	0.8490	0.0055	0.000311	0.688	0.002891	0.0229	0.101
MILLTA	CN Detox Tank 2	40	8.5	25	25	9.250	0.8490	0.0055	0.000311	0.688	0.002891	0.0229	0.101
MILLTA	CIP Leach Tank 1	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	0.0114	0.050
MILLTA	CIP Leach Tank 2	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	0.0114	0.050
MILLTA	CIP Leach Tank 3	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	0.0114	0.050
MILLTA	CIP Leach Tank 4	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	0.0114	0.050
MILLTA	CIL Tank 1	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIL Tank 2	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIL Tank 3	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIL Tank 4	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIL Tank 5	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIL Tank 6	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIP Tank 1	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA	CIP Tank 2	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA	CIP Tank 3	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA	CIP Tank 4	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA	CIP Tank 5	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA	CIP Tank 6	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
		Acres[1]											
TSF	Tails, Aqueous Surface	110.222	7.75	1	3.74	9.803	0.9912	0.0025	1.89E-05	0.421	0.008845	0.0702	0.307
TSF	Tails, Wet Sediment	110.222							5.31E-08	0.421	0.009961	0.0791	0.346
TSF	Tails, Dry Sediment	110.222							2.33E-08	1	0.010375	0.0823	0.361
		330.666											
592-01-8	Cyanide Fugitive Sources - Subtotal											0.4527	1.983
75-15-0	Carbon Disulfide											0.01446	0.06332
	Point Sources												
EW	EW Cells	[3]										0.0006	0.003
EW	Preg/Barren Tanks	[3]										0.0006	0.003
592-01-8	Cyanide Point Sources - Subtotal											0.0012	0.0053
	Total											0.454	1.988

[1] *(Midas Gold 2016)(M3 2017c)(M3 2017d)*

[2] *The emission factors and caculation methodology are from the EPA directed HCN study: (Card, T. 2009)(EPA 2009)(Schmidt 2010)*

[3] *(APT 2009)*

Carbon Disulfide Emissions from Xanthate Decomposition

CAS No.	Pollutant	Xanthate[1] ton/yr	Molar Decomp.[2]	CS_2 MW Ratio	Temperature Adj. Factor[3]	Emissions lb/hr	Emissions ton/yr
						lb/hr	ton/yr
75-15-0	Carbon Disulfide	1,700	0.99%	0.376	1%	0.0145	0.063

	MW	
Xanthate (PAX)	202.37	$C6H11KOS_2$
Carbon disulfide	76.139	CS_2

[1] *(Midas Gold 2016) p. 12-11*

[2] *(Air Sciences 2020) molar decomposition of xanthate in solution to CS2 gas*

[3] *(Air Sciences 2020) based on the comparison of CS2 generation at 25C and 70C*

Conversions

8,760	hr/yr	453.5929	g/lb
2,000	lb/ton	3.28084	ft/m
4,046.86	m2/acre	3,600	s/hr

Wind adjustment factor Fw 1

LIME PRODUCTION

Source Data

Source ID	Description	Throughput ton/day	Throughput ton/yr	PM Emissions lb/day	PM Emissions ton/yr
LS1	Limestone transfer to Primary Crusher Hopper			3.39	0.48
LS2	Primary Crushing and Associated Transfers In and Out			6.10	0.86
LS3	Primary Screening and Associated Transfers In and Out			28.25	3.97
LS4	Secondary Crushing and Associated Transfers In and Out			6.10	0.86
LS5	Secondary Screening and Associated Transfers In and Out			28.25	3.97
LS6	Limestone transfer to Ball Mill Feed Bin			3.39	0.48
LS7	Limestone transfer to Ball Mill Feed Conveyor			3.39	0.48
LS8	Ball Mill Feed transfer to Ball Mill			3.39	0.48
LSBM	Limestone Ball Mill			45.65	6.42
LS9	Limestone transfer to Kiln Feed Bin			0.80	0.12
LS10	Limestone transfer to Lime Kiln Feed Conveyor			0.80	0.12
LS11	Fines Screening and Associated Transfers In and Out			6.68	1.03
Subtotal LS1-11				136.18	19.28
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln			0.80	0.12
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	169	52,377	21.97	3.40
Subtotal LS12,LK				22.77	3.53
Total				158.95	22.80

HAP/TAP Emission Factors and Emissions

LS_pph LS_tpy LS12_pph LS12_tpy LK_pph LK_tpy lb/hr ton/yr

CAS No.	Pollutant	Concentration ppm[2]	LS1-11,LSBM lb/hr	LS1-11,LSBM ton/yr	LS12 lb/hr	LS12 ton/yr	Lime Kiln lb/hr	Lime Kiln ton/yr	Emissions[1] lb/hr	Emissions[1] ton/yr	TAP	A/C
7440-38-2	Arsenic	23	1.01E-04	4.43E-04	6.51E-07	2.85E-06	1.79E-05	7.83E-05	1.20E-04	5.24E-04	Y	C
7440-41-7	Beryllium	0.8	3.52E-06	1.54E-05	2.27E-08	9.92E-08	6.22E-07	2.72E-06	4.17E-06	1.82E-05	Y	C
7440-43-9	Cadmium	0.25	1.10E-06	4.82E-06	7.08E-09	3.10E-08	1.94E-07	8.51E-07	1.30E-06	5.70E-06	Y	C
7440-48-4	Cobalt	4	2.27E-05	7.71E-05	1.34E-07	4.96E-07	3.66E-06	1.36E-05	2.65E-05	9.12E-05	Y	A
7440-47-3	Chromium	15	8.51E-05	2.89E-04	5.01E-07	1.86E-06	1.37E-05	5.11E-05	9.93E-05	3.42E-04	Y	A
7439-97-6	Mercury [3]	0.02	1.13E-07	3.86E-07	6.68E-10	2.48E-09	2.82E-04	1.05E-03	2.82E-04	1.05E-03	N	
7439-96-5	Manganese	236.5	1.34E-03	4.56E-03	7.89E-06	2.93E-05	2.16E-04	8.05E-04	1.57E-03	5.39E-03	Y	A
7440-02-0	Nickel	5	2.20E-05	9.64E-05	1.42E-07	6.20E-07	3.89E-06	1.70E-05	2.60E-05	1.14E-04	Y	C
7439-92-1	Lead	3	1.70E-05	5.78E-05	1.00E-07	3.72E-07	2.75E-06	1.02E-05	1.99E-05	6.84E-05	N	
7440-36-0	Antimony	2.5	1.42E-05	4.82E-05	8.34E-08	3.10E-07	2.29E-06	8.51E-06	1.66E-05	5.70E-05	Y	A
7723-14-0	Phosphorus	130	7.38E-04	2.51E-03	4.34E-06	1.61E-05	1.19E-04	4.43E-04	8.61E-04	2.96E-03	Y	A
7440-22-4	Silver	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	Y	A
7429-90-5	Aluminum	22600	1.28E-01	4.36E-01	7.54E-04	2.80E-03	2.07E-02	7.69E-02	1.50E-01	5.15E-01	Y	A
7440-39-3	Barium	145	8.23E-04	2.79E-03	4.84E-06	1.80E-05	1.33E-04	4.94E-04	9.60E-04	3.31E-03	Y	A
1317-65-3	Calcium Carbonate	274500	1.56E+00	5.29E+00	9.16E-03	3.40E-02	2.51E-01	9.35E-01	1.82E+00	6.26E+00	Y	A
7440-50-8	Copper	5	2.84E-05	9.64E-05	1.67E-07	6.20E-07	4.58E-06	1.70E-05	3.31E-05	1.14E-04	Y	A
7439-89-6	Iron	10350	5.87E-02	1.99E-01	3.45E-04	1.28E-03	9.47E-03	3.52E-02	6.85E-02	2.36E-01	Y	A
7439-98-7	Molybdenum	0.5	2.84E-06	9.64E-06	1.67E-08	6.20E-08	4.58E-07	1.70E-06	3.31E-06	1.14E-05	Y	A
7440-28-0	Thallium	5	2.84E-05	9.64E-05	1.67E-07	6.20E-07	4.58E-06	1.70E-05	3.31E-05	1.14E-04	Y	A
7440-61-1	Uranium	5	2.84E-05	9.64E-05	1.67E-07	6.20E-07	4.58E-06	1.70E-05	3.31E-05	1.14E-04	Y	A
7440-62-2	Vanadium	15.5	8.79E-05	2.99E-04	5.17E-07	1.92E-06	1.42E-05	5.28E-05	1.03E-04	3.53E-04	Y	A
7440-33-7	Tungsten	5	2.84E-05	9.64E-05	1.67E-07	6.20E-07	4.58E-06	1.70E-05	3.31E-05	1.14E-04	Y	A
7440-66-6	Zinc	18	1.02E-04	3.47E-04	6.01E-07	2.23E-06	1.65E-05	6.13E-05	1.19E-04	4.10E-04	Y	A
Subtotal			1.75E+00	5.94E+00	1.03E-02	3.82E-02	2.82E-01	1.05E+00	2.04E+00	7.03E+00	9.0667	9.0667
7647-01-0	Hydrogen Chloride	0.14 lb/ton product[4]					0.99	3.67	0.99	3.67		chk

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *(M3 2018) Median concentrations of SGP limestone material. Metals with medians below the detection limit (DL) are set to 1/2DL.*

[3] *Hg emissions from the Lime Kiln are conservatively estimated assuming 100% volatilization of all Hg in the limestone*

[4] *(EPA 1999b)*

1E+6 parts/ppm

LIME PRODUCTION - CONTINUED

Source Data

Source ID	description Description	PM_ppd PM Emissions lb/day	PM_tpy PM Emissions ton/yr
LS1L	Mill Lime Silo #1 Loading	0.248	0.002
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	1.200	0.011
MillS2L	Mill Lime Silo #2 Loading	0.248	0.002
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	1.200	0.011
ACS1L	AC Lime Silo #1 Loading	0.990	0.009
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.304	0.042
ACS2L	AC Lime Silo #2 Loading	0.990	0.009
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.304	0.042
ACS3L	AC Lime Silo #3 Loading	0.990	0.009
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.304	0.042
ACS4L	AC Lime Silo #4 Loading	0.495	0.004
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	2.304	0.021
Subtotal - Mill & AC Lime Silos		15.576	0.203
LCR	Lime Mill Crushing and associated transfers In and Out	6.828	1.058
LSL	Pebble Lime Silo Loading via Bucket Elevator	0.149	0.023
LSU	Pebble Lime Silo discharge to Lime Slaker	0.015	0.002
Subtotal - Lime Mfg		6.991	1.083
Total		22.567	1.286

HAP/TAP Emission Factors and Emissions

CAS No.	Pollutant	Concentration ppm[2]	MillAC_pph Mill and AC lb/hr	MillAC_tpy Mill and AC ton/yr	LimeM_pph Lime Mfg lb/hr	LimeM_tpy Lime Mfg ton/yr	lb/hr Emissions[1] lb/hr	ton/yr Emissions[1] ton/yr	TAP	A/C
7440-38-2	Arsenic	23	1.06E-06	4.66E-06	5.69E-06	2.49E-05	6.75E-06	2.96E-05	Y	C
7440-41-7	Beryllium	0.8	3.70E-08	1.62E-07	1.98E-07	8.67E-07	2.35E-07	1.03E-06	Y	C
7440-43-9	Cadmium	0.25	1.16E-08	5.07E-08	6.18E-08	2.71E-07	7.34E-08	3.22E-07	Y	C
7440-48-4	Cobalt	4	2.60E-06	8.11E-07	1.17E-06	4.33E-06	3.76E-06	5.14E-06	Y	A
7440-47-3	Chromium	15	9.74E-06	3.04E-06	4.37E-06	1.63E-05	1.41E-05	1.93E-05	Y	A
7439-97-6	Mercury	0.02	1.30E-08	4.05E-09	5.83E-09	2.17E-08	1.88E-08	2.57E-08	N	
7439-96-5	Manganese	236.5	1.53E-04	4.79E-05	6.89E-05	2.56E-04	2.22E-04	3.04E-04	Y	A
7440-02-0	Nickel	5	2.31E-07	1.01E-06	1.24E-06	5.42E-06	1.47E-06	6.43E-06	Y	C
7439-92-1	Lead	3	1.95E-06	6.08E-07	8.74E-07	3.25E-06	2.82E-06	3.86E-06	N	
7440-36-0	Antimony	2.5	1.62E-06	5.07E-07	7.28E-07	2.71E-06	2.35E-06	3.22E-06	Y	A
7723-14-0	Phosphorus	130	8.44E-05	2.63E-05	3.79E-05	1.41E-04	1.22E-04	1.67E-04	Y	A
7440-22-4	Silver	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	Y	A
7429-90-5	Aluminum	22,600	1.47E-02	4.58E-03	6.58E-03	2.45E-02	2.13E-02	2.91E-02	Y	A
7440-39-3	Barium	145	9.41E-05	2.94E-05	4.22E-05	1.57E-04	1.36E-04	1.86E-04	Y	A
1305-78-8	Calcium Oxide	740,000 [3]	4.80E-01	1.50E-01	2.16E-01	8.02E-01	6.96E-01	9.52E-01	Y	A
7440-50-8	Copper	5	3.25E-06	1.01E-06	1.46E-06	5.42E-06	4.70E-06	6.43E-06	Y	A
7439-89-6	Iron	10350	6.72E-03	2.10E-03	3.01E-03	1.12E-02	9.73E-03	1.33E-02	Y	A
7439-98-7	Molybdenum	0.5	3.25E-07	1.01E-07	1.46E-07	5.42E-07	4.70E-07	6.43E-07	Y	A
7440-28-0	Thallium	5	3.25E-06	1.01E-06	1.46E-06	5.42E-06	4.70E-06	6.43E-06	Y	A
7440-61-1	Uranium	5	3.25E-06	1.01E-06	1.46E-06	5.42E-06	4.70E-06	6.43E-06	Y	A
7440-62-2	Vanadium	15.5	1.01E-05	3.14E-06	4.52E-06	1.68E-05	1.46E-05	1.99E-05	Y	A
7440-33-7	Tungsten	5	3.25E-06	1.01E-06	1.46E-06	5.42E-06	4.70E-06	6.43E-06	Y	A
7440-66-6	Zinc	18	1.17E-05	3.65E-06	5.24E-06	1.95E-05	1.69E-05	2.31E-05	Y	A
Total			5.02E-01	1.57E-01	2.25E-01	8.38E-01	7.27E-01	9.95E-01		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *See LIME PRODUCTION, page 10*

[3] *(NLA 2007) 40% to 74% CaO in lime*

1E+6 parts/ppm

AGGREGATE PRODUCTION

Source Data

Source ID	Description	PM Emissions lb/day	PM Emissions ton/yr
PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conve	15.00	2.74
PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conve	15.00	2.74
Total		30.00	5.48

HAP/TAP Emission Factors and Emissions

CAS No.	Pollutant	Concentration ppm[2]	Emissions[1] lb/hr	Emissions[1] ton/yr	TAP	A/C
7440-38-2	Arsenic	23	2.88E-05	1.26E-04	Y	C
7440-41-7	Beryllium	0.8	1.00E-06	4.38E-06	Y	C
7440-43-9	Cadmium	0.25	3.13E-07	1.37E-06	Y	C
7440-48-4	Cobalt	4	5.00E-06	2.19E-05	Y	A
7440-47-3	Chromium	15	1.88E-05	8.21E-05	Y	A
7439-97-6	Mercury	0.02	2.50E-08	1.10E-07	N	
7439-96-5	Manganese	236.5	2.96E-04	1.29E-03	Y	A
7440-02-0	Nickel	5	6.25E-06	2.74E-05	Y	C
7439-92-1	Lead	3	3.75E-06	1.64E-05	N	
7440-36-0	Antimony	2.5	3.13E-06	1.37E-05	Y	A
7723-14-0	Phosphorus	130	1.63E-04	7.12E-04	Y	A
7440-22-4	Silver	0	0.00E+00	0.00E+00	Y	A
7429-90-5	Aluminum	22600	2.83E-02	1.24E-01	Y	A
7440-39-3	Barium	145	1.81E-04	7.94E-04	Y	A
1317-65-3	Calcium Carbonate	274500	3.43E-01	1.50E+00	Y	A
7440-50-8	Copper	5	6.25E-06	2.74E-05	Y	A
7439-89-6	Iron	10350	1.29E-02	5.67E-02	Y	A
7439-98-7	Molybdenum	0.5	6.25E-07	2.74E-06	Y	A
7440-28-0	Thallium	5	6.25E-06	2.74E-05	Y	A
7440-61-1	Uranium	5	6.25E-06	2.74E-05	Y	A
7440-62-2	Vanadium	15.5	1.94E-05	8.49E-05	Y	A
7440-33-7	Tungsten	5	6.25E-06	2.74E-05	Y	A
7440-66-6	Zinc	18	2.25E-05	9.86E-05	Y	A
Total			3.85E-01	1.69E+00		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *See LIME PRODUCTION, page 10*

1E+6 parts/ppm

CONCRETE PRODUCTION

Source Data

TP_unit/day TP_unit/yr

Source ID	description Description	Throughput ton/day	ton/yr
CS1L	Cement/Shotcrete Silo #1 Loading	164	60,000
CS1U	Cement/Shotcrete Silo #1 Unloading	164	60,000
CS2L	Cement/Shotcrete Silo #2 Loading	164	60,000
CS2U	Cement/Shotcrete Silo #2 Unloading	164	60,000
CM	Central Mixer Loading	164	60,000
	Subtotal Cement Silo Filling	658	240,000
	Subtotal Central Mix Batching	164	60,000

HAP/TAP Emission Factors and Emissions

CF_pph CF_tpy CM_pph CM_tpy lb/hr ton/yr

CAS No.	HAP/TAP	Silo Fill lb/ton[2]	Central Mixer lb/ton[3]	Cement Silo L/U lb/hr	Cement Silo L/U ton/yr	Central Mix Batching lb/hr	Central Mix Batching ton/yr	Total Emissions[3] lb/hr	Total Emissions[3] ton/yr	TAP	A/C
7440-38-2	Arsenic	4.24E-09	2.96E-07	1.16E-7	5.09E-7	2.03E-6	8.88E-6	2.14E-6	9.39E-6	Y	C
7440-41-7	Beryllium	4.86E-10		1.33E-8	5.83E-8	--	--	1.33E-8	5.83E-8	Y	C
7440-43-9	Cadmium		7.10E-10	--	--	4.86E-9	2.13E-8	4.86E-9	2.13E-8	Y	C
7440-47-3	Chromium	2.90E-08	1.27E-07	7.95E-7	3.48E-6	8.70E-7	3.81E-6	1.66E-6	7.29E-6	Y	A
18540-29-9	Cr (VI)	5.80E-09	2.70E-08	1.59E-7	6.96E-7	1.85E-7	8.11E-7	3.44E-7	1.51E-6	Y	C
7439-92-1	Lead	1.09E-08	3.66E-08	2.99E-7	1.31E-6	2.51E-7	1.10E-6	5.49E-7	2.41E-6	N	
7439-96-5	Manganese	1.17E-07	3.78E-06	3.21E-6	1.40E-5	2.59E-5	1.13E-4	2.91E-5	1.27E-4	Y	A
7440-02-0	Nickel	4.18E-08	2.48E-07	1.15E-6	5.02E-6	1.70E-6	7.44E-6	2.84E-6	1.25E-5	Y	C
7723-14-0	Phosphorus		1.20E-06	--	--	8.22E-6	3.60E-5	8.22E-6	3.60E-5	Y	A
Total				5.73E-6	2.51E-5	3.91E-5	1.71E-4	4.49E-5	1.97E-4		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *AP-42, Table 11.12-8, (06/06) Cement Silo Filing, Controlled.* 20% *Cr (VI), IDEQ email on 11/23/2020* 0.0002 0.0002

(3) *AP-42, Table 11.12-8, (06/06) Central Mix Batching, Controlled.* 21.29% *Cr (VI), IDEQ email on 11/23/2020* chk

Conversions

24 hr/day

CONCRETE PRODUCTION - CONTINUED

Source Data

PM_ppd PM_tpy

Source ID	description Description	PM Emissions lb/day	ton/yr
CAL	Aggregate Bin Loading	16.56	1.73
CAU	Aggregate Bin Unloading	16.56	1.73
Total		33.12	3.45

HAP/TAP Emission Factors and Emissions

lb/hr ton/yr

CAS No.	Pollutant	Concentration ppm[2]	Emissions[1] lb/hr	ton/yr	TAP	A/C
7440-38-2	Arsenic	23	1.81E-05	7.94E-05	Y	C
7440-41-7	Beryllium	0.8	6.30E-07	2.76E-06	Y	C
7440-43-9	Cadmium	0.25	1.97E-07	8.63E-07	Y	C
7440-48-4	Cobalt	4	5.52E-06	1.38E-05	Y	A
7440-47-3	Chromium	15	2.07E-05	5.18E-05	Y	A
7439-97-6	Mercury	0.02	2.76E-08	6.90E-08	N	
7439-96-5	Manganese	236.5	3.26E-04	8.16E-04	Y	A
7440-02-0	Nickel	5	3.94E-06	1.73E-05	Y	C
7439-92-1	Lead	3	4.14E-06	1.04E-05	N	
7440-36-0	Antimony	2.5	3.45E-06	8.63E-06	Y	A
7723-14-0	Phosphorus	130	1.79E-04	4.49E-04	Y	A
7440-22-4	Silver	0	0.00E+00	0.00E+00	Y	A
7429-90-5	Aluminum	22600	3.12E-02	7.80E-02	Y	A
7440-39-3	Barium	145	2.00E-04	5.00E-04	Y	A
7440-50-8	Copper	5	6.90E-06	1.73E-05	Y	A
7439-89-6	Iron	10350	1.43E-02	3.57E-02	Y	A
7439-98-7	Molybdenum	0.5	6.90E-07	1.73E-06	Y	A
7440-28-0	Thallium	5	6.90E-06	1.73E-05	Y	A
7440-61-1	Uranium	5	6.90E-06	1.73E-05	Y	A
7440-62-2	Vanadium	15.5	2.14E-05	5.35E-05	Y	A
7440-33-7	Tungsten	5	6.90E-06	1.73E-05	Y	A
7440-66-6	Zinc	18	2.48E-05	6.21E-05	Y	A
Total			4.63E-02	1.16E-01		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *See LIME PRODUCTION, page 10*

1E+6 parts/ppm

FUEL STORAGE - GASOLINE

Source Data

Source ID	Description	VOC Emissions lb/day	VOC Emissions ton/yr
TG1	Mine Site Gasoline Tank #1	5.25	0.96
TG2	Mine Site Gasoline Tank #2	5.25	0.96
Total		10.49	1.91

HAP/TAP Emission Factors and Emissions

CAS No.	Pollutant	Concentration wt. %[2]	Emissions[1] lb/hr	Emissions[1] ton/yr	TAP	A/C
71-43-2	Benzene	1.608%	7.03E-03	3.08E-02	Y	C
92-52-4	Biphenyl	0.010%	4.37E-05	1.91E-04	Y	A
110-82-7	Cyclohexane	0.240%	1.05E-03	4.60E-03	Y	A
110-54-3	Hexane	7.138%	3.12E-02	1.37E-01	Y	A
91-20-3	Naphthalene	0.444%	1.94E-03	8.50E-03	Y	A
108-95-2	Phenol	0.055%	2.40E-04	1.05E-03	Y	A
108-88-3	Toluene	7.212%	3.15E-02	1.38E-01	Y	A
25551-13-7	Trimethyl benzene	2.500%	1.09E-02	4.79E-02	Y	A
1330-20-7	Xylene	7.170%	3.13E-02	1.37E-01	Y	A
Total			1.15E-01	5.05E-01		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *(EPA 1999a)*

MINING FUGITIVE EMISSIONS

Dust Emissions

Source Data **Model Scenario** **W3** **180,000 T/day Emissions**

Operating schedule 365 day/yr

Clean rock cap (CR) >0% [1]

[1] *(Perpetua 2021h) Percent of VMTs on haul roads capped with CR*
Roads outside of the pits and DRSFs are capped with CR

Source ID	Description	PM Emissions lb/day	PM Emissions ton/yr
YPP	Yellow Pine Pit	--	--
HFP	Hangar Flats Pit	--	--
WEP	West End Pit	1,887.91	344.54
BT	Bradley Tailings	--	--
YPPBL	Yellow Pine Pit Blasting	--	--
HFPBL	Hangar Flats Pit Blasting	--	--
WEPBL	West End Pit Blasting	643.03	117.35
BTBL	Bradley Tailings Blasting	--	--
STKP	PC Stockpile	--	--
FDRSF	Fiddle DRSF	--	--
HFDRSF	Hangar Flats DRSF	289.91	52.91
YPDRSF	Yellow Pine DRSF	--	--
WEDRSF	West End DRSF	--	--
HR000	Haul Roads	16,697.74	3,047.34
TSF	Tailing Storage Facility	--	--
ACCRD	Access Roads	38.10	6.95
UGEXP	Scout Portal	0.008	0.002
Total		19,556.71	3,569.10

TSF, ACCRD, UGEXP 38.11 6.95 chk 3569.10

HAP/TAP Emission Factors

CAS No.	Pollutant	ORE Concentration ppm[1]	DR Concentration ppm[1]	CR Concentration ppm[3]	HRD Concentration ppm[4]	Borrow Concentration ppm[5]	AR Concentration ppm
7440-38-2	Arsenic	667	667	90	667	2.5	667
7440-41-7	Beryllium	3.2	3.2		3.2		3.2
7440-43-9	Cadmium	0.5	0.5		0.5		0.5
7440-48-4	Cobalt	4	4		4		4
7440-47-3	Chromium	9	9		9		9
7439-97-6	Mercury [2]	0.96	0.6		0.6		0.6
7439-96-5	Manganese	299	299		299		299
7440-02-0	Nickel	2	2		2		2
7439-92-1	Lead	8	8		8		8
7440-36-0	Antimony	23	23		23		23
7723-14-0	Phosphorus	650	650		650		650
7782-49-2	Selenium	0.4	0.4		0.4		0.4
7440-22-4	Silver	0.5	0.5		0.5		0.5
7429-90-5	Aluminum	71000	71000		71000		71000
7440-39-3	Barium	800	800		800		800
1317-65-3	Calcium Carbonate	14000	14000		14000		14000
7440-50-8	Copper	5	5		5		5
7439-89-6	Iron	18200	18200		18200		18200
7439-98-7	Molybdenum	1	1		1		1
7440-28-0	Thallium	10	10		10		10
7440-61-1	Uranium	10	10		10		10
7440-62-2	Vanadium	28	28		28		28
7440-33-7	Tungsten	10	10		10		10
7440-66-6	Zinc	35	35		35		35

[1] *(Midas Gold 2017c)* *Median concentration of 55,000 SGP samples.* *1E+6 parts/ppm*
[2] *(Midas Gold 2018e)* *Median ore and development rock (DR) concentrations of 151,000 samples; resource block model.*
[3] *(Perpetua 2021g)* *Median concentration of 265 SGP samples.*
[4] *HRD: haul road - emissions calculated based on 0% of the total VMT occuring on CR*
[5] *(ALS 2018)* *Median concentration of 8 SGP samples.*

DR DR DR DR DR DR DR DR ORE DR DR DR DR HRD DR/AR

MINING FUGITIVE EMISSIONS - CONTINUED **Model Scenario W3** DR **180,000 T/day Emissions**

HAP/TAP Emissions

Hourly [1] YPP_pph HFP_pph WEP_pph BT_pph YPPBL_pph HFPBL_pph WEPBL_pph BTBL_pph STKP_pph FDRSF_pph HFDRSF_pph YPDRSF_pph WEDRSF_pph HR000_pph CCRD, UGEX lb/hr

CAS No.	Pollutant	YPP lb/hr	HFP lb/hr	WEP lb/hr	BT lb/hr	YPPBL lb/hr	HFPBL lb/hr	WEPBL lb/hr	BTBL lb/hr	STKP lb/hr	FDRSF lb/hr	HFDRSF lb/hr	YPDRSF lb/hr	WEDRSF lb/hr	HR000 lb/hr	TSF, ACCRD, UGEXP lb/hr	Total lb/hr
7440-38-2	Arsenic	0	0	0.052	0	0	0	0.018	0	0	0	8.1E-3	0	0	0.464	1.1E-3	0.544
7440-41-7	Beryllium	0	0	2.5E-4	0	0	0	8.6E-5	0	0	0	3.9E-5	0	0	2.2E-3	5.1E-6	2.6E-3
7440-43-9	Cadmium	0	0	3.9E-5	0	0	0	1.3E-5	0	0	0	6.0E-6	0	0	3.5E-4	7.9E-7	4.1E-4
7440-48-4	Cobalt	0	0	3.1E-4	0	0	0	1.1E-4	0	0	0	4.8E-5	0	0	2.8E-3	6.4E-6	3.3E-3
7440-47-3	Chromium	0	0	7.1E-4	0	0	0	2.4E-4	0	0	0	1.1E-4	0	0	6.3E-3	1.4E-5	7.3E-3
7439-97-6	Mercury	0	0	4.7E-5	0	0	0	1.6E-5	0	0	0	7.2E-6	0	0	4.2E-4	9.5E-7	4.9E-4
7439-96-5	Manganese	0	0	0.024	0	0	0	8.0E-3	0	0	0	3.6E-3	0	0	0.208	4.7E-4	0.244
7440-02-0	Nickel	0	0	1.6E-4	0	0	0	5.4E-5	0	0	0	2.4E-5	0	0	1.4E-3	3.2E-6	1.6E-3
7439-92-1	Lead	0	0	6.3E-4	0	0	0	2.1E-4	0	0	0	9.7E-5	0	0	5.6E-3	1.3E-5	6.5E-3
7440-36-0	Antimony	0	0	1.8E-3	0	0	0	6.2E-4	0	0	0	2.8E-4	0	0	0.016	3.7E-5	0.019
7723-14-0	Phosphorus	0	0	0.051	0	0	0	0.017	0	0	0	7.9E-3	0	0	0.452	1.0E-3	0.530
7782-49-2	Selenium	0	0	3.1E-5	0	0	0	1.1E-5	0	0	0	4.8E-6	0	0	2.8E-4	6.4E-7	3.3E-4
7440-22-4	Silver	0	0	3.9E-5	0	0	0	1.3E-5	0	0	0	6.0E-6	0	0	3.5E-4	7.9E-7	4.1E-4
7429-90-5	Aluminum	0	0	5.585	0	0	0	1.902	0	0	0	0.858	0	0	49.397	0.113	57.855
7440-39-3	Barium	0	0	0.063	0	0	0	0.021	0	0	0	9.7E-3	0	0	0.557	1.3E-3	0.652
1317-65-3	Calcium Car	0	0	1.101	0	0	0	0.375	0	0	0	0.169	0	0	9.740	0.022	11.408
7440-50-8	Copper	0	0	3.9E-4	0	0	0	1.3E-4	0	0	0	6.0E-5	0	0	3.5E-3	7.9E-6	4.1E-3
7439-89-6	Iron	0	0	1.432	0	0	0	0.488	0	0	0	0.220	0	0	12.662	0.029	14.831
7439-98-7	Molybdenum	0	0	7.9E-5	0	0	0	2.7E-5	0	0	0	1.2E-5	0	0	7.0E-4	1.6E-6	8.1E-4
7440-28-0	Thallium	0	0	7.9E-4	0	0	0	2.7E-4	0	0	0	1.2E-4	0	0	7.0E-3	1.6E-5	8.1E-3
7440-61-1	Uranium	0	0	7.9E-4	0	0	0	2.7E-4	0	0	0	1.2E-4	0	0	7.0E-3	1.6E-5	8.1E-3
7440-62-2	Vanadium	0	0	2.2E-3	0	0	0	7.5E-4	0	0	0	3.4E-4	0	0	0.019	4.4E-5	0.023
7440-33-7	Tungsten	0	0	7.9E-4	0	0	0	2.7E-4	0	0	0	1.2E-4	0	0	7.0E-3	1.6E-5	8.1E-3
7440-66-6	Zinc	0	0	2.8E-3	0	0	0	9.4E-4	0	0	0	4.2E-4	0	0	0.024	5.6E-5	0.029
Total		0	0	8.320	0	0	0	2.834	0	0	0	1.278	0	0	73.586	0.168	86.185

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.* chk 86.1849 86.1849

DR DR DR DR DR DR DR DR ORE DR DR DR DR HRD DR/AR

MINING FUGITIVE EMISSIONS - CONTINUED **Model Scenario W3** DR **180,000 T/day Emissions**

HAP/TAP Emissions

Annual

		YPP_tpy	HFP_tpy	WEP_tpy	BT_tpy	YPPBL_tpy	HFPBL_tpy	WEPBL_tpy	BTBL_tpy	STKP_tpy	FDRSF_tpy	HFDRSF_tpy	YPDRSF_tpy	WEDRSF_tpy	HR000_tpy	CCRD, UGE	ton/yr
		YPP	HFP	WEP	BT	YPPBL	HFPBL	WEPBL	BTBL	STKP	FDRSF	HFDRSF	YPDRSF	WEDRSF	HR000	TSF, ACCRD, UGEXP	Total
CAS No.	Pollutant	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr
7440-38-2	Arsenic	0	0	0.230	0	0	0	0.078	0	0	0	0.035	0	0	2.033	4.6E-3	2.381
7440-41-7	Beryllium	0	0	1.1E-3	0	0	0	3.8E-4	0	0	0	1.7E-4	0	0	9.8E-3	2.2E-5	0.011
7440-43-9	Cadmium	0	0	1.7E-4	0	0	0	5.9E-5	0	0	0	2.6E-5	0	0	1.5E-3	3.5E-6	1.8E-3
7440-48-4	Cobalt	0	0	1.4E-3	0	0	0	4.7E-4	0	0	0	2.1E-4	0	0	0.012	2.8E-5	0.014
7440-47-3	Chromium	0	0	3.1E-3	0	0	0	1.1E-3	0	0	0	4.8E-4	0	0	0.027	6.3E-5	0.032
7439-97-6	Mercury	0	0	2.1E-4	0	0	0	7.0E-5	0	0	0	3.2E-5	0	0	1.8E-3	4.2E-6	2.1E-3
7439-96-5	Manganese	0	0	0.103	0	0	0	0.035	0	0	0	0.016	0	0	0.911	2.1E-3	1.067
7440-02-0	Nickel	0	0	6.9E-4	0	0	0	2.3E-4	0	0	0	1.1E-4	0	0	6.1E-3	1.4E-5	7.1E-3
7439-92-1	Lead	0	0	2.8E-3	0	0	0	9.4E-4	0	0	0	4.2E-4	0	0	0.024	5.6E-5	0.029
7440-36-0	Antimony	0	0	7.9E-3	0	0	0	2.7E-3	0	0	0	1.2E-3	0	0	0.070	1.6E-4	0.082
7723-14-0	Phosphorus	0	0	0.224	0	0	0	0.076	0	0	0	0.034	0	0	1.981	4.5E-3	2.320
7782-49-2	Selenium	0	0	1.4E-4	0	0	0	4.7E-5	0	0	0	2.1E-5	0	0	1.2E-3	2.8E-6	1.4E-3
7440-22-4	Silver	0	0	1.7E-4	0	0	0	5.9E-5	0	0	0	2.6E-5	0	0	1.5E-3	3.5E-6	1.8E-3
7429-90-5	Aluminum	0	0	24.463	0	0	0	8.332	0	0	0	3.756	0	0	216	0.494	253
7440-39-3	Barium	0	0	0.276	0	0	0	0.094	0	0	0	0.042	0	0	2.438	5.6E-3	2.855
1317-65-3	Calcium Ca	0	0	4.824	0	0	0	1.643	0	0	0	0.741	0	0	42.663	0.097	49.967
7440-50-8	Copper	0	0	1.7E-3	0	0	0	5.9E-4	0	0	0	2.6E-4	0	0	0.015	3.5E-5	0.018
7439-89-6	Iron	0	0	6.271	0	0	0	2.136	0	0	0	0.963	0	0	55.462	0.127	64.958
7439-98-7	Molybdenu	0	0	3.4E-4	0	0	0	1.2E-4	0	0	0	5.3E-5	0	0	3.0E-3	7.0E-6	3.6E-3
7440-28-0	Thallium	0	0	3.4E-3	0	0	0	1.2E-3	0	0	0	5.3E-4	0	0	0.030	7.0E-5	0.036
7440-61-1	Uranium	0	0	3.4E-3	0	0	0	1.2E-3	0	0	0	5.3E-4	0	0	0.030	7.0E-5	0.036
7440-62-2	Vanadium	0	0	9.6E-3	0	0	0	3.3E-3	0	0	0	1.5E-3	0	0	0.085	1.9E-4	0.100
7440-33-7	Tungsten	0	0	3.4E-3	0	0	0	1.2E-3	0	0	0	5.3E-4	0	0	0.030	7.0E-5	0.036
7440-66-6	Zinc	0	0	0.012	0	0	0	4.1E-3	0	0	0	1.9E-3	0	0	0.107	2.4E-4	0.125
Total		0	0	36.441	0	0	0	12.412	0	0	0	5.596	0	0	322	0.736	377
															chk	377.4900	377.4900

MINING FUGITIVE EMISSIONS - CONTINUED

Mercury Evaporative Flux Emissions

Fugitive Mercury Flux and Emissions

			Area		Hg Flux	Emissions[1] lb/hr	ton/yr	lb/yr
CAS No.	Pollutant	Source	m^2	ha	µg/m^2-yr	lb/hr	ton/yr	lb/yr
		Stockpiles	52,623	5.3	556	7.37E-6	3.2E-5	6.5E-2
		Rock Dumps	2,063,990	206.4	76.2	3.96E-5	1.7E-4	0.35
		Tailings	1,338,158	133.8	2,144	7.22E-4	3.2E-3	6.32
		Pits	1,504,919	150.5	132.3	5.01E-5	2.2E-4	0.44
7439-97-6	Mercury					8.2E-4	3.6E-3	7.17

(1) *Hourly emissions based on:* 8,760 *hours per year of operation*

Fugitive Mercury Emission Factors

	Twin Creeks (TC)		Ore Hg Adjusted	Stibnite	
	Hg Flux (1)	Hg (2)	µg/m^2/yr	Hg Flux (3)	Hg (4)
Source	µg/m^2-yr	µg/g	TC	µg/m^2-yr	µg/g
Stockpiles	5,609	33	556	556	0.96
Rock Dumps	768	3.5	76.2	76.2	0.60
Tailings	21,621	33	2,144	2,144	0.96
Pits	1,334	9.5	132	132.3	0.60

(1) *(Eckley 2010)* *Table 1: Hg flux µg/m^2-yr*

(2) *(Eckley 2010)* *Table 1: Average Hg flux mg/g: " Stockpiles - high-grade stockpiles, Rock Dumps - waste rock dumps, Tailings - high-grade stockpiles as a surrogate; Pits - pit"*

(3) *(Eckley 2010)* *Figure 2: log(y) = m*log(x) + b*

y = Hg Flux (ng/m^2-d)
x = material Hg concentration (µg/g)]

Slope =	*Solar*	*TC*
	Low	*0.59*
	Medium	*0.6*
	High	*0.77*
	Average	*0.65*

(4) *(Midas Gold 2018e)*

Sample Calculation: m = log (y1/y2) / log(x1/x2)

m=	0.65	unitless
y1=	5,609	µg/m^2-yr
x1=	33	µg/m^2-yr
x2=	0.96	µg/m^2-yr
log(x1/x2)=	1.536243	unitless
log(y1/y2)=	1.003679	unitless
y1/y2=	10.08506	unitless
y2=	556.2	µg/m^2-yr

Conversions

2,000	lb/ton
10,000	m2/ha
453.593	g/lb

TABLE A-W3. HAP/TAP Emissions and Exemptions

180,000 T/day Emissions						MINING										LEACHING	
chk						*Mining*	*Model Scenario*	*W3*								*CN Leach/PAX*	
						YPP,HFP,WEP,BT		YPPBL,HFPBL,WEPBL,BTBL		HR000		STKP, FDRSF, HFDRSF, YPDRSF, WEDRSF		TSF,ACCRD,UGEXP			
CAS	HAP/TAP	HAP	TAP			Pits		Blasting		Haul Roads		Stockpiles and DRFS		Tails, Access Road, Exploration		CN Leach and PAX	
	NSPS or NESHAP HAP/TAP -->			*Y*													
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				*A/C*	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
106-99-0	1,3-Butadiene	Y	Y	Y	C				0	0	0		0				
91-57-6	2-Methylnaphthalene	Y	N	n/a								0					
56-49-5	3-Methylchloranthrene	Y	Y	Y	C												
57-97-6	7,12-Dimethylbenz(a)anthracene	Y	N	n/a													
83-32-9	Acenaphthene	Y	N	n/a													
208-96-8	Acenaphthylene	Y	N	n/a													
75-07-0	Acetaldehyde	Y	Y	Y	C												
107-02-8	Acrolein	Y	Y	Y	A												
120-12-7	Anthracene	Y	N	n/a													
7440-36-0	Antimony	Y	Y	Y	A	1.8E-3	7.9E-3	6.2E-4	2.7E-3	0.016	0.070	2.8E-4	1.2E-3	3.7E-5	1.6E-4		
7440-38-2	Arsenic	Y	Y	Y	C	0.052	0.230	0.018	0.078	0.464	2.033	8.1E-3	0.035	1.1E-3	4.6E-3		
71-43-2	Benzene	Y	Y	Y	C												
50-32-8	Benzo(a)pyrene	Y	Y	Y	C												
56-55-3	Benz(a)anthracene	Y	Y	Y	C												
205-99-2	Benzo(b)fluoranthene	Y	Y	Y	C												
207-08-9	Benzo(k)fluoranthene	Y	Y	Y	C												
218-01-9	Chrysene	Y	Y	Y	C												
53-70-3	Dibenzo(a,h)anthracene	Y	Y	Y	C												
193-39-5	Indeno(1,2,3-cd)pyrene	Y	Y	Y	C												
191-24-2	Benzo(g,h,i)perylene	Y	N	n/a													
7440-41-7	Beryllium	Y	Y	Y	C	2.5E-4	1.1E-3	8.6E-5	3.8E-4	2.2E-3	9.8E-3	3.9E-5	1.7E-4	5.1E-6	2.2E-5		
92-52-4	Biphenyl	Y	Y	Y	A												
7440-43-9	Cadmium	Y	Y	Y	C	3.9E-5	1.7E-4	1.3E-5	5.9E-5	3.5E-4	1.5E-3	6.0E-6	2.6E-5	7.9E-7	3.5E-6		
75-15-0	Carbon Disulfide	Y	Y	Y	A											0.014	0.063
7440-47-3	Chromium	Y	Y	Y	A	7.1E-4	3.1E-3	2.4E-4	1.1E-3	6.3E-3	0.027	1.1E-4	4.8E-4	1.4E-5	6.3E-5		
18540-29-9	Cr (VI)	Y	Y	Y	C												
7440-48-4	Cobalt	Y	Y	Y	A	3.1E-4	1.4E-3	1.1E-4	4.7E-4	2.8E-3	0.012	4.8E-5	2.1E-4	6.4E-6	2.8E-5		
592-01-8	Cyanide	Y	Y	Y	A											0.453	1.983
106-46-7	Dichlorobenzene	Y	Y	Y	A												
206-44-0	Fluoranthene	Y	N	n/a													
86-73-7	Fluorene	Y	N	n/a													
50-00-0	Formaldehyde	Y	Y	Y	C												
110-54-3	Hexane	Y	Y	Y	A												
7647-01-0	Hydrogen Chloride	Y	Y	Y	A												
7439-92-1	Lead	Y	N	n/a		6.3E-4	2.8E-3	2.1E-4	9.4E-4	5.6E-3	0.024	9.7E-5	4.2E-4	1.3E-5	5.6E-5		
7439-96-5	Manganese	Y	Y	Y	A	0.024	0.103	8.0E-3	0.035	0.208	0.911	3.6E-3	0.016	4.7E-4	2.1E-3		
7439-97-6	Mercury	Y	N	n/a		9.7E-5	4.3E-4	1.6E-5	7.0E-5	4.2E-4	1.8E-3	5.4E-5	2.4E-4	7.2E-4	3.2E-3		
91-20-3	Naphthalene	Y	Y	Y	A												
7440-02-0	Nickel	Y	Y	Y	C	1.6E-4	6.9E-4	5.4E-5	2.3E-4	1.4E-3	6.1E-3	2.4E-5	1.1E-4	3.2E-6	1.4E-5		
85-01-8	Phenanthrene	Y	N	n/a													
108-95-2	Phenol	Y	Y	Y	A												
7723-14-0	Phosphorus	Y	Y	Y	A	0.051	0.224	0.017	0.076	0.452	1.981	7.9E-3	0.034	1.0E-3	4.5E-3		
129-00-0	Pyrene	Y	N	n/a													
7782-49-2	Selenium	Y	Y	Y	A	3.1E-5	1.4E-4	1.1E-5	4.7E-5	2.8E-4	1.2E-3	4.8E-6	2.1E-5	6.4E-7	2.8E-6		
108-88-3	Toluene	Y	Y	Y	A												
1330-20-7	Xylene	Y	Y	Y	A												
7429-90-5	Aluminum	N	Y	N	A	5.585	24.463	1.902	8.332	49.397	216	0.858	3.756	0.113	0.494		
7440-39-3	Barium	N	Y	N	A	0.063	0.276	0.021	0.094	0.557	2.438	9.7E-3	0.042	1.3E-3	5.6E-3		
1317-65-3	Calcium Carbonate	N	Y	N	A	1.101	4.824	0.375	1.643	9.740	42.663	0.169	0.741	0.022	0.097		
1305-78-8	Calcium Oxide	N	Y	N	A												
7440-50-8	Copper	N	Y	N	A	3.9E-4	1.7E-3	1.3E-4	5.9E-4	3.5E-3	0.015	6.0E-5	2.6E-4	7.9E-6	3.5E-5		
110-82-7	Cyclohexane	N	Y	N	A												
7783-06-4	Hydrogen Sulfide	N	Y	N	A												
7439-89-6	Iron	N	Y	N	A	1.432	6.271	0.488	2.136	12.662	55.462	0.220	0.963	0.029	0.127		
7439-98-7	Molybdenum	N	Y	N	A	7.9E-5	3.4E-4	2.7E-5	1.2E-4	7.0E-4	3.0E-3	1.2E-5	5.3E-5	1.6E-6	7.0E-6		
109-66-0	Pentane	N	Y	N	A												
7440-22-4	Silver	N	Y	N	A	3.9E-5	1.7E-4	1.3E-5	5.9E-5	3.5E-4	1.5E-3	6.0E-6	2.6E-5	7.9E-7	3.5E-6		
7664-93-9	Sulfuric Acid	N	Y	N	A												
7440-28-0	Thallium	N	Y	N	A	7.9E-4	3.4E-3	2.7E-4	1.2E-3	7.0E-3	0.030	1.2E-4	5.3E-4	1.6E-5	7.0E-5		
7440-61-1	Uranium	N	Y	N	A	7.9E-4	3.4E-3	2.7E-4	1.2E-3	7.0E-3	0.030	1.2E-4	5.3E-4	1.6E-5	7.0E-5		
7440-62-2	Vanadium	N	Y	N	A	2.2E-3	9.6E-3	7.5E-4	3.3E-3	0.019	0.085	3.4E-4	1.5E-3	4.4E-5	1.9E-4		
25551-13-7	Trimethyl benzene	N	Y	N	A												
7440-33-7	Tungsten	N	Y	N	A	7.9E-4	3.4E-3	2.7E-4	1.2E-3	7.0E-3	0.030	1.2E-4	5.3E-4	1.6E-5	7.0E-5		
7440-66-6	Zinc	N	Y	N	A	2.8E-3	0.012	9.4E-4	4.1E-3	0.024	0.107	4.2E-4	1.9E-3	5.6E-5	2.4E-4		
HAP TOTAL						***0.131***	***0.574***	***0.045***	***0.196***	***1.160***	***5.079***	***0.020***	***0.088***	***3.4E-3***	***0.015***	***0.467***	***2.046***
MERCURY TOTAL (exempt)						***9.7E-5***	***4.3E-4***	***1.6E-5***	***7.0E-5***	***4.2E-4***	***1.8E-3***	***5.4E-5***	***2.4E-4***	***7.2E-4***	***3.2E-3***		
MERCURY TOTAL (non-exempt)																	
TAP TOTAL (HAP-TAP addressed by NSPS/NESHAP)																	
TAP TOTAL (For EL Evaluation)						***8.319***	***36.438***	***2.834***	***12.411***	***73.580***	***322***	***1.278***	***5.595***	***0.168***	***0.735***	***0.467***	***2.046***

TABLE A-W3. HAP/TAP Emissions and Exemptions

180,000 T/day Emissions

chk

						0	0	0	0	1	1	1	1	0	0	1	1
						PROCESSING AND PRODUCTION											
						Ore Processing				***Ore Concentration and Refining***				***Process Heating***			
						OC1-13		PS		AC		EW,MR,MF,CKD		ACB, CKB, PV, HS		LKC	
CAS	HAP/TAP	HAP	TAP			Crushers & Xfers		Prill Silos		Autoclave		EW, Preg Tank, Retort, Furnace, Carbon Kiln		POX Boiler, C. Kiln Comb., Prop. Vap., Sol'n Heater		Lime Kiln Combustion	
	NSPS or NESHAP HAP/TAP -->			***Y***		***LL***	***LL***			***7E***	***7E***	***7E***	***7E***			***5A***	***5A***
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				**A/C**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
106-99-0	1,3-Butadiene	Y	Y	Y	C									1.9E-7	7.6E-7	5.2E-7	1.9E-6
91-57-6	2-Methylnaphthalene	Y	N	n/a										1.3E-8	5.7E-8	3.3E-8	1.4E-7
56-49-5	3-Methylchloranthrene	Y	Y	Y	C									1.3E-7	5.1E-7	3.5E-7	1.3E-6
57-97-6	7,12-Dimethylbenz(a)anthracene	Y	N	n/a										1.4E-8	5.7E-8	3.9E-8	1.4E-7
83-32-9	Acenaphthene	Y	N	n/a										1.4E-8	5.7E-8	3.9E-8	1.4E-7
208-96-8	Acenaphthylene	Y	N	n/a										1.9E-8	7.6E-8	5.2E-8	1.9E-7
75-07-0	Acetaldehyde	Y	Y	Y	C												
107-02-8	Acrolein	Y	Y	Y	A												
120-12-7	Anthracene	Y	N	n/a										1.5E-6	6.4E-6	3.7E-6	1.6E-5
7440-36-0	Antimony	Y	Y	Y	A	1.4E-4	5.9E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7440-38-2	Arsenic	Y	Y	Y	C	3.9E-3	0.017			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.5E-6	6.4E-6	3.7E-6	1.6E-5
71-43-2	Benzene	Y	Y	Y	C									1.5E-5	6.7E-5	3.9E-5	1.7E-4
50-32-8	Benzo(a)pyrene	Y	Y	Y	C									8.7E-9	3.8E-8	2.2E-8	9.6E-8
56-55-3	Benz(a)anthracene	Y	Y	Y	C									1.3E-8	5.7E-8	3.3E-8	1.4E-7
205-99-2	Benzo(b)fluoranthene	Y	Y	Y	C									1.3E-8	5.7E-8	3.3E-8	1.4E-7
207-08-9	Benzo(k)fluoranthene	Y	Y	Y	C									1.3E-8	5.7E-8	3.3E-8	1.4E-7
218-01-9	Chrysene	Y	Y	Y	C									1.3E-8	5.7E-8	3.3E-8	1.4E-7
53-70-3	Dibenzo(a,h)anthracene	Y	Y	Y	C									8.7E-9	3.8E-8	2.2E-8	9.6E-8
193-39-5	Indeno(1,2,3-cd)pyrene	Y	Y	Y	C									1.3E-8	5.7E-8	3.3E-8	1.4E-7
191-24-2	Benzo(g,h,i)perylene	Y	N	n/a										9.5E-9	3.8E-8	2.6E-8	9.6E-8
7440-41-7	Beryllium	Y	Y	Y	C	1.9E-5	8.2E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	8.7E-8	3.8E-7	2.2E-7	9.6E-7
92-52-4	Biphenyl	Y	Y	Y	A												
7440-43-9	Cadmium	Y	Y	Y	C	2.9E-6	1.3E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	8.0E-6	3.5E-5	2.0E-5	8.8E-5
75-15-0	Carbon Disulfide	Y	Y	Y	A												
7440-47-3	Chromium	Y	Y	Y	A	5.3E-5	2.3E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.1E-5	4.5E-5	3.0E-5	1.1E-4
18540-29-9	Cr (VI)	Y	Y	Y	C												
7440-48-4	Cobalt	Y	Y	Y	A	2.4E-5	1.0E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3	6.6E-7	2.7E-6	1.8E-6	6.8E-6
592-01-8	Cyanide	Y	Y	Y	A							1.2E-3	5.3E-3				
106-46-7	Dichlorobenzene	Y	Y	Y	A									9.5E-6	3.8E-5	2.6E-5	9.6E-5
206-44-0	Fluoranthene	Y	N	n/a										2.4E-8	9.5E-8	6.5E-8	2.4E-7
86-73-7	Fluorene	Y	N	n/a										2.2E-8	8.9E-8	6.1E-8	2.3E-7
50-00-0	Formaldehyde	Y	Y	Y	C									5.5E-4	2.4E-3	1.4E-3	6.0E-3
110-54-3	Hexane	Y	Y	Y	A									0.014	0.057	0.039	0.145
7647-01-0	Hydrogen Chloride	Y	Y	Y	A												
7439-92-1	Lead	Y	N	n/a		4.7E-5	2.1E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7439-96-5	Manganese	Y	Y	Y	A	1.8E-3	7.7E-3			2.3E-5	1.0E-4	3.8E-4	1.7E-3	3.0E-6	1.2E-5	8.2E-6	3.1E-5
7439-97-6	Mercury	Y	N	n/a		5.6E-6	2.5E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	2.1E-6	8.3E-6	5.6E-6	2.1E-5
91-20-3	Naphthalene	Y	Y	Y	A									4.8E-6	1.9E-5	1.3E-5	4.9E-5
7440-02-0	Nickel	Y	Y	Y	C	1.2E-5	5.2E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.5E-5	6.7E-5	3.9E-5	1.7E-4
85-01-8	Phenanthrene	Y	N	n/a										1.3E-7	5.4E-7	3.7E-7	1.4E-6
108-95-2	Phenol	Y	Y	Y	A												
7723-14-0	Phosphorus	Y	Y	Y	A	3.8E-3	0.017			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
129-00-0	Pyrene	Y	N	n/a										4.0E-8	1.6E-7	1.1E-7	4.0E-7
7782-49-2	Selenium	Y	Y	Y	A	2.4E-6	1.0E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.9E-7	7.6E-7	5.2E-7	1.9E-6
108-88-3	Toluene	Y	Y	Y	A									2.7E-5	1.1E-4	7.3E-5	2.7E-4
1330-20-7	Xylene	Y	Y	Y	A												
7429-90-5	Aluminum	N	Y	N	A	0.418	1.829			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7440-39-3	Barium	N	Y	N	A	4.7E-3	0.021			2.3E-5	1.0E-4	3.8E-4	1.7E-3	3.5E-5	1.4E-4	9.5E-5	3.5E-4
1317-65-3	Calcium Carbonate	N	Y	N	A	0.082	0.361			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
1305-78-8	Calcium Oxide	N	Y	N	A												
7440-50-8	Copper	N	Y	N	A	2.9E-5	1.3E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3	6.7E-6	2.7E-5	1.8E-5	6.8E-5
110-82-7	Cyclohexane	N	Y	N	A												
7783-06-4	Hydrogen Sulfide	N	Y	N	A					0.900	3.942						
7439-89-6	Iron	N	Y	N	A	0.107	0.469			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7439-98-7	Molybdenum	N	Y	N	A	5.9E-6	2.6E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	8.7E-6	3.5E-5	2.4E-5	8.8E-5
109-66-0	Pentane	N	Y	N	A									0.021	0.083	0.056	0.209
7440-22-4	Silver	N	Y	N	A	2.9E-6	1.3E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7664-93-9	Sulfuric Acid	N	Y	N	A					2.030	8.891						
7440-28-0	Thallium	N	Y	N	A	5.9E-5	2.6E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7440-61-1	Uranium	N	Y	N	A	5.9E-5	2.6E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7440-62-2	Vanadium	N	Y	N	A	1.6E-4	7.2E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.8E-5	7.3E-5	5.0E-5	1.8E-4
25551-13-7	Trimethyl benzene	N	Y	N	A												
7440-33-7	Tungsten	N	Y	N	A	5.9E-5	2.6E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7440-66-6	Zinc	N	Y	N	A	2.1E-4	9.0E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3	2.3E-4	9.2E-4	6.3E-4	2.3E-3
HAP TOTAL						***9.8E-3***	***0.043***			***2.8E-4***	***1.2E-3***	***5.8E-3***	***0.025***	***0.015***	***0.060***	***0.041***	***0.152***
MERCURY TOTAL (exempt)										***2.3E-5***	***1.0E-4***	***3.8E-4***	***1.7E-3***			***5.6E-6***	***2.1E-5***
MERCURY TOTAL (non-exempt)						***5.6E-6***	***2.5E-5***							***2.1E-6***	***8.3E-6***		
TAP TOTAL (HAP-TAP addressed by NSPS/NESHAP)						***9.8E-3***	***0.043***			***2.3E-4***	***1.0E-3***	***5.0E-3***	***0.022***			***0.041***	***0.152***
TAP TOTAL (For EL Evaluation)						***0.612***	***2.682***			***2.930***	***12.835***	***4.6E-3***	***0.020***	***0.036***	***0.144***	***0.057***	***0.212***

TABLE A-W3. HAP/TAP Emissions and Exemptions

180,000 T/day Emissions

chk

						0	0	1	1	0	0	0	0	0	0	0	0	0	0
						PROCESSING AND PRODUCTION - Continued													
						Lime Production						***Aggregate Prod.***		***Concrete Production***					
						LS1-11,LSBM		LK,LS12,LCR,LS-L/U		LS1-L/U,MillS2-L/U,ACS1-4		PCSP1,PCSP2		CM		CS1L,CS1U,CS2L, CS2U		CA-L/U	
CAS	HAP/TAP	HAP	TAP			Limestone Crushers, Screens, Mill, Xfers		Lime Kiln, Kiln Feed, Lime Mill, Pebble Lime Silo		Lime Silos and Lime Mill Crushing		Portable Crushers, Screens, Xfers		Central Mixer		Cement Silo #1 and #2 L/U		Aggregate Bin	
	NSPS or NESHAP HAP/TAP -->			***Y***		***OOO***	***OOO***	***5A***	***5A***			***OOO***	***OOO***					***OOO***	***OOO***
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				***A/C***	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
106-99-0	1,3-Butadiene	Y	Y	Y	C														
91-57-6	2-Methylnaphthalene	Y	N	n/a															
56-49-5	3-Methylchloranthrene	Y	Y	Y	C														
57-97-6	7,12-Dimethylbenz(a)anthracene	Y	N	n/a															
83-32-9	Acenaphthene	Y	N	n/a															
208-96-8	Acenaphthylene	Y	N	n/a															
75-07-0	Acetaldehyde	Y	Y	Y	C														
107-02-8	Acrolein	Y	Y	Y	A														
120-12-7	Anthracene	Y	N	n/a															
7440-36-0	Antimony	Y	Y	Y	A	1.4E-5	4.8E-5	3.1E-6	1.2E-5	1.6E-6	5.1E-7	3.1E-6	1.4E-5					3.5E-6	8.6E-6
7440-38-2	Arsenic	Y	Y	Y	C	1.0E-4	4.4E-4	2.4E-5	1.1E-4	1.1E-6	4.7E-6	2.9E-5	1.3E-4	2.0E-6	8.9E-6	1.2E-7	5.1E-7	1.8E-5	7.9E-5
71-43-2	Benzene	Y	Y	Y	C														
50-32-8	Benzo(a)pyrene	Y	Y	Y	C														
56-55-3	Benz(a)anthracene	Y	Y	Y	C														
205-99-2	Benzo(b)fluoranthene	Y	Y	Y	C														
207-08-9	Benzo(k)fluoranthene	Y	Y	Y	C														
218-01-9	Chrysene	Y	Y	Y	C														
53-70-3	Dibenzo(a,h)anthracene	Y	Y	Y	C														
193-39-5	Indeno(1,2,3-cd)pyrene	Y	Y	Y	C														
191-24-2	Benzo(g,h,i)perylene	Y	N	n/a															
7440-41-7	Beryllium	Y	Y	Y	C	3.5E-6	1.5E-5	8.4E-7	3.7E-6	3.7E-8	1.6E-7	1.0E-6	4.4E-6			1.3E-8	5.8E-8	6.3E-7	2.8E-6
92-52-4	Biphenyl	Y	Y	Y	A														
7440-43-9	Cadmium	Y	Y	Y	C	1.1E-6	4.8E-6	2.6E-7	1.2E-6	1.2E-8	5.1E-8	3.1E-7	1.4E-6	4.9E-9	2.1E-8			2.0E-7	8.6E-7
75-15-0	Carbon Disulfide	Y	Y	Y	A														
7440-47-3	Chromium	Y	Y	Y	A	8.5E-5	2.9E-4	1.9E-5	6.9E-5	9.7E-6	3.0E-6	1.9E-5	8.2E-5	8.7E-7	3.8E-6	7.9E-7	3.5E-6	2.1E-5	5.2E-5
18540-29-9	Cr (VI)	Y	Y	Y	C									1.9E-7	8.1E-7	1.6E-7	7.0E-7		
7440-48-4	Cobalt	Y	Y	Y	A	2.3E-5	7.7E-5	5.0E-6	1.8E-5	2.6E-6	8.1E-7	5.0E-6	2.2E-5					5.5E-6	1.4E-5
592-01-8	Cyanide	Y	Y	Y	A														
106-46-7	Dichlorobenzene	Y	Y	Y	A														
206-44-0	Fluoranthene	Y	N	n/a															
86-73-7	Fluorene	Y	N	n/a															
50-00-0	Formaldehyde	Y	Y	Y	C														
110-54-3	Hexane	Y	Y	Y	A														
7647-01-0	Hydrogen Chloride	Y	Y	Y	A	0	0	0.986	3.666										
7439-92-1	Lead	Y	N	n/a		1.7E-5	5.8E-5	3.7E-6	1.4E-5	1.9E-6	6.1E-7	3.8E-6	1.6E-5	2.5E-7	1.1E-6	3.0E-7	1.3E-6	4.1E-6	1.0E-5
7439-96-5	Manganese	Y	Y	Y	A	1.3E-3	4.6E-3	2.9E-4	1.1E-3	1.5E-4	4.8E-5	3.0E-4	1.3E-3	2.6E-5	1.1E-4	3.2E-6	1.4E-5	3.3E-4	8.2E-4
7439-97-6	Mercury	Y	N	n/a		1.1E-7	3.9E-7	2.8E-4	1.0E-3	1.3E-8	4.1E-9	2.5E-8	1.1E-7					2.8E-8	6.9E-8
91-20-3	Naphthalene	Y	Y	Y	A														
7440-02-0	Nickel	Y	Y	Y	C	2.2E-5	9.6E-5	5.3E-6	2.3E-5	2.3E-7	1.0E-6	6.3E-6	2.7E-5	1.7E-6	7.4E-6	1.1E-6	5.0E-6	3.9E-6	1.7E-5
85-01-8	Phenanthrene	Y	N	n/a															
108-95-2	Phenol	Y	Y	Y	A														
7723-14-0	Phosphorus	Y	Y	Y	A	7.4E-4	2.5E-3	1.6E-4	6.0E-4	8.4E-5	2.6E-5	1.6E-4	7.1E-4	8.2E-6	3.6E-5			1.8E-4	4.5E-4
129-00-0	Pyrene	Y	N	n/a															
7782-49-2	Selenium	Y	Y	Y	A														
108-88-3	Toluene	Y	Y	Y	A														
1330-20-7	Xylene	Y	Y	Y	A														
7429-90-5	Aluminum	N	Y	N	A	0.128	0.436	0.028	0.104	0.015	4.6E-3	0.028	0.124					0.031	0.078
7440-39-3	Barium	N	Y	N	A	8.2E-4	2.8E-3	1.8E-4	6.7E-4	9.4E-5	2.9E-5	1.8E-4	7.9E-4					2.0E-4	5.0E-4
1317-65-3	Calcium Carbonate	N	Y	N	A	1.558	5.291	0.260	0.969			0.343	1.503						
1305-78-8	Calcium Oxide	N	Y	N	A			0.216	0.802	0.480	0.150								
7440-50-8	Copper	N	Y	N	A	2.8E-5	9.6E-5	6.2E-6	2.3E-5	3.2E-6	1.0E-6	6.3E-6	2.7E-5					6.9E-6	1.7E-5
110-82-7	Cyclohexane	N	Y	N	A														
7783-06-4	Hydrogen Sulfide	N	Y	N	A														
7439-89-6	Iron	N	Y	N	A	0.059	0.199	0.013	0.048	6.7E-3	2.1E-3	0.013	0.057					0.014	0.036
7439-98-7	Molybdenum	N	Y	N	A	2.8E-6	9.6E-6	6.2E-7	2.3E-6	3.2E-7	1.0E-7	6.3E-7	2.7E-6					6.9E-7	1.7E-6
109-66-0	Pentane	N	Y	N	A														
7440-22-4	Silver	N	Y	N	A	0	0												
7664-93-9	Sulfuric Acid	N	Y	N	A														
7440-28-0	Thallium	N	Y	N	A	2.8E-5	9.6E-5	6.2E-6	2.3E-5	3.2E-6	1.0E-6	6.3E-6	2.7E-5					6.9E-6	1.7E-5
7440-61-1	Uranium	N	Y	N	A	2.8E-5	9.6E-5	6.2E-6	2.3E-5	3.2E-6	1.0E-6	6.3E-6	2.7E-5					6.9E-6	1.7E-5
7440-62-2	Vanadium	N	Y	N	A	8.8E-5	3.0E-4	1.9E-5	7.1E-5	1.0E-5	3.1E-6	1.9E-5	8.5E-5					2.1E-5	5.3E-5
25551-13-7	Trimethyl benzene	N	Y	N	A														
7440-33-7	Tungsten	N	Y	N	A	2.8E-5	9.6E-5	6.2E-6	2.3E-5	3.2E-6	1.0E-6	6.3E-6	2.7E-5					6.9E-6	1.7E-5
7440-66-6	Zinc	N	Y	N	A	1.0E-4	3.5E-4	2.2E-5	8.3E-5	1.2E-5	3.6E-6	2.3E-5	9.9E-5					2.5E-5	6.2E-5
HAP TOTAL						***2.3E-3***	***8.1E-3***	***0.987***	***3.669***	***2.6E-4***	***8.5E-5***	***5.3E-4***	***2.3E-3***	***3.9E-5***	***1.7E-4***	***5.7E-6***	***2.5E-5***	***5.6E-4***	***1.4E-3***
MERCURY TOTAL (exempt)						***0***	***0***	***2.8E-4***	***1.0E-3***										
MERCURY TOTAL (non-exempt)						***1.1E-7***	***3.9E-7***			***1.3E-8***	***4.1E-9***	***2.5E-8***	***1.1E-7***					***2.8E-8***	***6.9E-8***
TAP TOTAL (HAP-TAP addressed by NSPS/NESHAP)						***2.3E-3***	***8.0E-3***	***0.986***	***3.668***			***5.2E-4***	***2.3E-3***					***5.6E-4***	***1.4E-3***
TAP TOTAL (For EL Evaluation)						***1.746***	***5.930***	***0.517***	***1.923***	***0.502***	***0.157***	***0.385***	***1.684***	***3.9E-5***	***1.7E-4***	***5.4E-6***	***2.4E-5***	***0.046***	***0.114***

TABLE A-W3. HAP/TAP Emissions and Exemptions

180,000 T/day Emissions						PROCESSING AND PRODUCTION - Continued						MINING and LEACHING - Totals									
chk						*HVAC*		*Emer. Power/Fire*		*Fuel Storage*		*HAP Total*		*Mercury Total*		*Mercury Total*		*TAP Total*		*TAP Total*	
CAS	HAP/TAP	HAP	TAP			H1M,H2M,HM,HAC,HR,HA,HMO,HTS,HW		EDG1,EDG2,EDG3,EDFP		TG1,TG2				*Exempt*		*Non-Exempt*		*HAP-TAP addressed by NSPS/NESHAP*		*For EL Evaluation*	
						Heaters		Emergency Generators and Fire Pump		Gasoline Fuel Tanks											
	NSPS or NESHAP HAP/TAP -->		*Y*			*4Z*	*4Z*			*6C*	*6C*										
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				*A/C*	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
106-99-0	1,3-Butadiene	Y	Y	Y	C			8.4E-7	3.7E-6			0	0					0	0	0	0
91-57-6	2-Methylnaphthalene	Y	N	n/a		4.3E-7	1.9E-6														
56-49-5	3-Methylchloranthrene	Y	Y	Y	C	3.2E-8	1.4E-7														
57-97-6	7,12-Dimethylbenz(a)anthracene	Y	N	n/a		2.9E-7	1.3E-6														
83-32-9	Acenaphthene	Y	N	n/a		3.2E-8	1.4E-7	5.6E-6	6.7E-6												
208-96-8	Acenaphthylene	Y	N	n/a		3.2E-8	1.4E-7	1.1E-5	1.3E-5												
75-07-0	Acetaldehyde	Y	Y	Y	C			2.5E-5	1.1E-4												
107-02-8	Acrolein	Y	Y	Y	A			1.6E-5	2.0E-5												
120-12-7	Anthracene	Y	N	n/a		4.3E-8	1.9E-7	1.6E-6	1.9E-6												
7440-36-0	Antimony	Y	Y	Y	A							0.019	0.082							0.019	0.082
7440-38-2	Arsenic	Y	Y	Y	C	3.6E-6	1.6E-5					0.544	2.381							0.544	2.381
71-43-2	Benzene	Y	Y	Y	C	3.8E-5	1.6E-4	2.7E-4	1.2E-3	7.0E-3	0.031										
50-32-8	Benzo(a)pyrene	Y	Y	Y	C	2.1E-8	9.4E-8	8.7E-8	3.8E-7												
56-55-3	Benz(a)anthracene	Y	Y	Y	C	3.2E-8	1.4E-7	2.4E-7	1.0E-6												
205-99-2	Benzo(b)fluoranthene	Y	Y	Y	C	3.2E-8	1.4E-7	3.6E-7	1.6E-6												
207-08-9	Benzo(k)fluoranthene	Y	Y	Y	C	3.2E-8	1.4E-7	7.3E-8	3.2E-7												
218-01-9	Chrysene	Y	Y	Y	C	3.2E-8	1.4E-7	5.0E-7	2.2E-6												
53-70-3	Dibenzo(a,h)anthracene	Y	Y	Y	C	2.1E-8	9.4E-8	1.2E-7	5.4E-7												
193-39-5	Indeno(1,2,3-cd)pyrene	Y	Y	Y	C	3.2E-8	1.4E-7	1.4E-7	6.2E-7												
191-24-2	Benzo(g,h,i)perylene	Y	N	n/a		2.1E-8	9.4E-8	6.9E-7	8.3E-7												
7440-41-7	Beryllium	Y	Y	Y	C	2.1E-7	9.4E-7					2.6E-3	0.011							2.6E-3	0.011
92-52-4	Biphenyl	Y	Y	Y	A					4.4E-5	1.9E-4										
7440-43-9	Cadmium	Y	Y	Y	C	2.0E-5	8.6E-5					4.1E-4	1.8E-3							4.1E-4	1.8E-3
75-15-0	Carbon Disulfide	Y	Y	Y	A							0.014	0.063							0.014	0.063
7440-47-3	Chromium	Y	Y	Y	A	2.5E-5	1.1E-4					7.3E-3	0.032							7.3E-3	0.032
18540-29-9	Cr (VI)	Y	Y	Y	C																
7440-48-4	Cobalt	Y	Y	Y	A	1.5E-6	6.6E-6					3.3E-3	0.014							3.3E-3	0.014
592-01-8	Cyanide	Y	Y	Y	A							0.453	1.983							0.453	1.983
106-46-7	Dichlorobenzene	Y	Y	Y	A	2.1E-5	9.4E-5														
206-44-0	Fluoranthene	Y	N	n/a		5.4E-8	2.4E-7	5.3E-6	6.4E-6												
86-73-7	Fluorene	Y	N	n/a		5.0E-8	2.2E-7	1.7E-5	2.1E-5												
50-00-0	Formaldehyde	Y	Y	Y	C	1.3E-3	5.9E-3	5.1E-5	2.2E-4												
110-54-3	Hexane	Y	Y	Y	A	0.032	0.141			0.031	0.137										
7647-01-0	Hydrogen Chloride	Y	Y	Y	A																
7439-92-1	Lead	Y	N	n/a								6.5E-3	0.029								
7439-96-5	Manganese	Y	Y	Y	A	6.8E-6	3.0E-5					0.244	1.067							0.244	1.067
7439-97-6	Mercury	Y	N	n/a		4.7E-6	2.0E-5					1.3E-3	5.7E-3	1.3E-3	5.7E-3	0	0	0	0	0	0
91-20-3	Naphthalene	Y	Y	Y	A	1.1E-5	4.8E-5	1.6E-4	1.9E-4	1.9E-3	8.5E-3	0	0					0	0	0	0
7440-02-0	Nickel	Y	Y	Y	C	3.8E-5	1.6E-4					1.6E-3	7.1E-3					0	0	1.6E-3	7.1E-3
85-01-8	Phenanthrene	Y	N	n/a		3.0E-7	1.3E-6	5.0E-5	6.0E-5			0	0					0	0	0	0
108-95-2	Phenol	Y	Y	Y	A					2.4E-4	1.1E-3	0	0					0	0	0	0
7723-14-0	Phosphorus	Y	Y	Y	A							0.530	2.320					0	0	0.530	2.320
129-00-0	Pyrene	Y	N	n/a		8.9E-8	3.9E-7	4.7E-6	5.7E-6			0	0					0	0	0	0
7782-49-2	Selenium	Y	Y	Y	A	4.3E-7	1.9E-6					3.3E-4	1.4E-3					0	0	3.3E-4	1.4E-3
108-88-3	Toluene	Y	Y	Y	A	6.1E-5	2.7E-4	3.6E-4	4.3E-4	0.032	0.138	0	0					0	0	0	0
1330-20-7	Xylene	Y	Y	Y	A			2.5E-4	3.0E-4	0.031	0.137	0	0					0	0	0	0
7429-90-5	Aluminum	N	Y	N	A							0	0					0	0	57.855	253
7440-39-3	Barium	N	Y	N	A	7.9E-5	3.4E-4					0	0					0	0	0.652	2.855
1317-65-3	Calcium Carbonate	N	Y	N	A							0	0					0	0	11.408	49.967
1305-78-8	Calcium Oxide	N	Y	N	A							0	0					0	0	0	0
7440-50-8	Copper	N	Y	N	A	1.5E-5	6.7E-5					0	0					0	0	4.1E-3	0.018
110-82-7	Cyclohexane	N	Y	N	A					1.0E-3	4.6E-3	0	0					0	0	0	0
7783-06-4	Hydrogen Sulfide	N	Y	N	A							0	0					0	0	0	0
7439-89-6	Iron	N	Y	N	A							0	0					0	0	14.831	64.958
7439-98-7	Molybdenum	N	Y	N	A	2.0E-5	8.6E-5					0	0					0	0	8.1E-4	3.6E-3
109-66-0	Pentane	N	Y	N	A	0.047	0.204					0	0					0	0	0	0
7440-22-4	Silver	N	Y	N	A							0	0					0	0	4.1E-4	1.8E-3
7664-93-9	Sulfuric Acid	N	Y	N	A							0	0					0	0	0	0
7440-28-0	Thallium	N	Y	N	A							0	0					0	0	8.1E-3	0.036
7440-61-1	Uranium	N	Y	N	A							0	0					0	0	8.1E-3	0.036
7440-62-2	Vanadium	N	Y	N	A	4.1E-5	1.8E-4					0	0					0	0	0.023	0.100
25551-13-7	Trimethyl benzene	N	Y	N	A					0.011	0.048	0	0					0	0	0	0
7440-33-7	Tungsten	N	Y	N	A							0	0					0	0	8.1E-3	0.036
7440-66-6	Zinc	N	Y	N	A	5.2E-4	2.3E-3					0	0					0	0	0.029	0.125
HAP TOTAL						***0.034***	***0.148***	***1.2E-3***	***2.6E-3***	***0.103***	***0.453***	***1.826***	***7.998***								
MERCURY TOTAL (exempt)														***1.3E-3***	***5.7E-3***						
MERCURY TOTAL (non-exempt)						***4.7E-6***	***2.0E-5***									***0***	***0***				
TAP TOTAL (HAP-TAP addressed by NSPS/NESHAP)								***1.1E-3***	***2.5E-3***	***0.103***	***0.453***							***0***	***0***		
TAP TOTAL (For EL Evaluation)						***0.081***	***0.355***			***0.012***	***0.052***									***86.645***	***380***

TABLE A-W3. HAP/TAP Emissions and Exemptions

180,000 T/day Emissions						PROCESSING AND PRODUCTION - Totals										ALL	ALL	ALL	TAP EL	
chk						*HAP Total*		*Mercury Total Exempt*		*Mercury Total Non-Exempt*		*TAP Total HAP-TAP addressed by NSPS/NESHAP*		*TAP Total For EL Evaluation*		*HAP*	*Hg Non-Exempt*	*TAP For EL Evaluation*	*TAP Emission Screening Level (EL)*	
CAS	HAP/TAP	HAP	TAP																	
	NSPS or NESHAP HAP/TAP -->			*Y*															Non-car	Carcin
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				*A/C*	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr	ton/yr	lb/hr	lb/hr	lb/hr
106-99-0	1,3-Butadiene	Y	Y	Y	C	8.4E-7	3.7E-6					8.4E-7	3.7E-6			3.7E-6		0	--	2.4E-5
91-57-6	2-Methylnaphthalene	Y	N	n/a		1.1E-6	4.6E-6									4.6E-6			--	--
56-49-5	3-Methylchloranthrene	Y	Y	Y	C	7.8E-8	3.4E-7					3.3E-8	1.4E-7	4.5E-8	2.0E-7	3.4E-7		4.5E-8	--	2.5E-6
57-97-6	7,12-Dimethylbenz(a)anthracene	Y	N	n/a		7.6E-7	3.0E-6									3.0E-6			--	--
83-32-9	Acenaphthene	Y	N	n/a		5.7E-6	7.1E-6									7.1E-6			--	--
208-96-8	Acenaphthylene	Y	N	n/a		1.1E-5	1.4E-5									1.4E-5			--	--
75-07-0	Acetaldehyde	Y	Y	Y	C	2.5E-5	1.1E-4					2.5E-5	1.1E-4			1.1E-4			--	3.0E-3
107-02-8	Acrolein	Y	Y	Y	A	1.6E-5	2.0E-5					1.6E-5	2.0E-5			2.0E-5			0.017	--
120-12-7	Anthracene	Y	N	n/a		1.7E-6	2.4E-6									2.4E-6			--	--
7440-36-0	Antimony	Y	Y	Y	A	5.7E-4	2.5E-3					5.7E-4	2.5E-3	1.6E-6	5.1E-7	0.085		0.019	0.033	--
7440-38-2	Arsenic	Y	Y	Y	C	4.5E-3	0.020					4.5E-3	0.020	8.2E-6	3.6E-5	2.400		0.544	--	1.5E-6
71-43-2	Benzene	Y	Y	Y	C	7.4E-3	0.032					7.3E-3	0.032	5.3E-5	2.3E-4	0.032		5.3E-5	--	8.0E-4
50-32-8	Benzo(a)pyrene	Y	Y	Y	C	1.4E-7	6.1E-7					1.1E-7	4.8E-7	3.0E-8	1.3E-7	6.1E-7				
56-55-3	Benz(a)anthracene	Y	Y	Y	C	3.1E-7	1.4E-6					2.7E-7	1.2E-6	4.5E-8	2.0E-7	1.4E-6				
205-99-2	Benzo(b)fluoranthene	Y	Y	Y	C	4.4E-7	1.9E-6					3.9E-7	1.7E-6	4.5E-8	2.0E-7	1.9E-6				
207-08-9	Benzo(k)fluoranthene	Y	Y	Y	C	1.5E-7	6.6E-7					1.1E-7	4.7E-7	4.5E-8	2.0E-7	6.6E-7		2.9E-7	--	2.0E-6
218-01-9	Chrysene	Y	Y	Y	C	5.8E-7	2.5E-6					5.3E-7	2.3E-6	4.5E-8	2.0E-7	2.5E-6				
53-70-3	Dibenzo(a,h)anthracene	Y	Y	Y	C	1.8E-7	7.7E-7					1.5E-7	6.4E-7	3.0E-8	1.3E-7	7.7E-7				
193-39-5	Indeno(1,2,3-cd)pyrene	Y	Y	Y	C	2.2E-7	9.6E-7					1.7E-7	7.6E-7	4.5E-8	2.0E-7	9.6E-7				
191-24-2	Benzo(g,h,i)perylene	Y	N	n/a		7.5E-7	1.1E-6									1.1E-6			--	--
7440-41-7	Beryllium	Y	Y	Y	C	4.3E-4	1.9E-3					4.3E-4	1.9E-3	3.5E-7	1.5E-6	0.013		2.6E-3	--	2.8E-5
92-52-4	Biphenyl	Y	Y	Y	A	4.4E-5	1.9E-4					4.4E-5	1.9E-4			1.9E-4			0.100	--
7440-43-9	Cadmium	Y	Y	Y	C	4.6E-4	2.0E-3					4.3E-4	1.9E-3	2.8E-5	1.2E-4	3.8E-3		4.4E-4	--	3.7E-6
75-15-0	Carbon Disulfide	Y	Y	Y	A											0.063		0.014	2.000	--
7440-47-3	Chromium	Y	Y	Y	A	6.8E-4	2.8E-3					6.3E-4	2.6E-3	4.8E-5	1.6E-4	0.035		7.4E-3	0.033	--
18540-29-9	Cr (VI)	Y	Y	Y	C	3.4E-7	1.5E-6							3.4E-7	1.5E-6	1.5E-6		3.4E-7	--	5.6E-7
7440-48-4	Cobalt	Y	Y	Y	A	4.7E-4	2.0E-3					4.7E-4	2.0E-3	4.8E-6	1.0E-5	0.016		3.3E-3	3.3E-3	--
592-01-8	Cyanide	Y	Y	Y	A	1.2E-3	5.3E-3					1.2E-3	5.3E-3			1.988		0.453	0.333	--
106-46-7	Dichlorobenzene	Y	Y	Y	A	5.7E-5	2.3E-4					2.6E-5	9.6E-5	3.1E-5	1.3E-4	2.3E-4		3.1E-5	30.000	--
206-44-0	Fluoranthene	Y	N	n/a		5.5E-6	7.0E-6									7.0E-6			--	--
86-73-7	Fluorene	Y	N	n/a		1.7E-5	2.1E-5									2.1E-5			--	--
50-00-0	Formaldehyde	Y	Y	Y	C	3.3E-3	0.015					1.4E-3	6.2E-3	1.9E-3	8.3E-3	0.015		1.9E-3	--	5.1E-4
110-54-3	Hexane	Y	Y	Y	A	0.117	0.480					0.070	0.281	0.046	0.198	0.480		0.046	12.000	--
7647-01-0	Hydrogen Chloride	Y	Y	Y	A	0.986	3.666					0.986	3.666			3.666			0.050	--
7439-92-1	Lead	Y	N	n/a		4.8E-4	2.1E-3									0.031			--	--
7439-96-5	Manganese	Y	Y	Y	A	4.6E-3	0.017					4.4E-3	0.017	1.9E-4	2.2E-4	1.085		0.244	0.067	--
7439-97-6	Mercury	Y	N	n/a		7.1E-4	2.9E-3	6.9E-4	2.8E-3	1.3E-5	5.4E-5					8.6E-3	5.4E-5		--	--
91-20-3	Naphthalene	Y	Y	Y	A	2.1E-3	8.8E-3					2.1E-3	8.7E-3	1.6E-5	6.7E-5	8.8E-3		1.6E-5	3.330	--
7440-02-0	Nickel	Y	Y	Y	C	5.5E-4	2.4E-3					4.9E-4	2.2E-3	5.6E-5	2.4E-4	9.5E-3		1.7E-3	--	2.7E-5
85-01-8	Phenanthrene	Y	N	n/a		5.1E-5	6.3E-5									6.3E-5			--	--
108-95-2	Phenol	Y	Y	Y	A	2.4E-4	1.1E-3					2.4E-4	1.1E-3			1.1E-3			1.270	--
7723-14-0	Phosphorus	Y	Y	Y	A	5.6E-3	0.023					5.5E-3	0.023	9.3E-5	6.2E-5	2.343		0.530	7.0E-3	--
129-00-0	Pyrene	Y	N	n/a		5.0E-6	6.6E-6									6.6E-6			--	--
7782-49-2	Selenium	Y	Y	Y	A	4.1E-4	1.8E-3					4.1E-4	1.8E-3	6.2E-7	2.6E-6	3.2E-3		3.3E-4	0.013	--
108-88-3	Toluene	Y	Y	Y	A	0.032	0.139					0.032	0.139	8.8E-5	3.7E-4	0.139		8.8E-5	25.000	--
1330-20-7	Xylene	Y	Y	Y	A	0.032	0.138					0.032	0.138			0.138			29.000	--
7429-90-5	Aluminum	N	Y	N	A									0.648	2.577			58.504	0.667	--
7440-39-3	Barium	N	Y	N	A									6.8E-3	0.028			0.659	0.033	--
1317-65-3	Calcium Carbonate	N	Y	N	A									2.244	8.125			13.652	0.667	--
1305-78-8	Calcium Oxide	N	Y	N	A									0.696	0.952			0.696	0.133	--
7440-50-8	Copper	N	Y	N	A									5.3E-4	2.2E-3			4.6E-3	0.067	--
110-82-7	Cyclohexane	N	Y	N	A									1.0E-3	4.6E-3			1.0E-3	70.000	--
7783-06-4	Hydrogen Sulfide	N	Y	N	A									0.900	3.942			0.900	0.933	--
7439-89-6	Iron	N	Y	N	A									0.213	0.812			15.043	0.067	--
7439-98-7	Molybdenum	N	Y	N	A									4.7E-4	2.0E-3			1.3E-3	0.333	--
109-66-0	Pentane	N	Y	N	A									0.123	0.495			0.123	118	--
7440-22-4	Silver	N	Y	N	A									4.1E-4	1.8E-3			8.2E-4	7.0E-3	--
7664-93-9	Sulfuric Acid	N	Y	N	A									2.030	8.891			2.030	0.067	--
7440-28-0	Thallium	N	Y	N	A									5.2E-4	2.2E-3			8.7E-3	7.0E-3	--
7440-61-1	Uranium	N	Y	N	A									5.2E-4	2.2E-3			8.7E-3	0.013	--
7440-62-2	Vanadium	N	Y	N	A									8.4E-4	3.5E-3			0.024	3.0E-3	--
25551-13-7	Trimethyl benzene	N	Y	N	A									0.011	0.048			0.011	8.200	--
7440-33-7	Tungsten	N	Y	N	A									5.2E-4	2.2E-3	0		8.7E-3	0.333	--
7440-66-6	Zinc	N	Y	N	A									2.2E-3	8.8E-3	0		0.031	0.667	--
HAP TOTAL						*1.200*	*4.566*									*12.564*				
MERCURY TOTAL (exempt)								*6.9E-4*	*2.8E-3*											
MERCURY TOTAL (non-exempt)										*1.3E-5*	*5.4E-5*						*5.4E-5*			
TAP TOTAL (HAP-TAP addressed by NSPS/NESHAP)												*1.150*	*4.353*							
TAP TOTAL (For EL Evaluation)														*6.928*	*26.109*			*93.573*		

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 1 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021

Model Scenario W3 T-RACT Emissions

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	HAP/TAP	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
106-99-0	1,3-Butadiene	8.4E-07	3.7E-06	0	0	0	0	8.4E-07	3.7E-06	Y	Y
91-57-6	2-Methylnaphthalene	1.1E-06	4.6E-06	0	0	0	0	1.1E-06	4.6E-06	Y	N
56-49-5	3-Methylchloranthrene	7.8E-08	3.4E-07	0	0	0	0	7.8E-08	3.4E-07	Y	Y
57-97-6	7,12-Dimethylbenz(a)anthracene	7.6E-07	3.0E-06	0	0	0	0	7.6E-07	3.0E-06	Y	N
83-32-9	Acenaphthene	5.7E-06	7.1E-06	0	0	0	0	5.7E-06	7.1E-06	Y	N
208-96-8	Acenaphthylene	1.1E-05	1.4E-05	0	0	0	0	1.1E-05	1.4E-05	Y	N
75-07-0	Acetaldehyde	2.5E-05	1.1E-04	0	0	0	0	2.5E-05	1.1E-04	Y	Y
107-02-8	Acrolein	1.6E-05	2.0E-05	0	0	0	0	1.6E-05	2.0E-05	Y	Y
120-12-7	Anthracene	1.7E-06	2.4E-06	0	0	0	0	1.7E-06	2.4E-06	Y	N
7440-36-0	Antimony	0	0	5.7E-04	2.5E-03	1.3E-02	5.8E-02	1.4E-02	6.1E-02	Y	Y
7440-38-2	Arsenic	8.7E-06	3.8E-05	4.5E-03	2.0E-02	0.23	1.02	0.24	1.04	Y	Y
56-55-3	Benz(a)anthracene	3.1E-07	1.4E-06	0	0	0	0	3.1E-07	1.4E-06	Y	Y
71-43-2	Benzene	3.6E-04	1.6E-03	7.0E-03	3.1E-02	0	0	7.4E-03	3.2E-02	Y	Y
50-32-8	Benzo(a)pyrene	1.4E-07	6.1E-07	0	0	0	0	1.4E-07	6.1E-07	Y	Y
205-99-2	Benzo(b)fluoranthene	4.4E-07	1.9E-06	0	0	0	0	4.4E-07	1.9E-06	Y	Y
191-24-2	Benzo(g,h,i)perylene	7.5E-07	1.1E-06	0	0	0	0	7.5E-07	1.1E-06	Y	N
207-08-9	Benzo(k)fluoranthene	1.5E-07	6.6E-07	0	0	0	0	1.5E-07	6.6E-07	Y	Y
7440-41-7	Beryllium	5.2E-07	2.3E-06	4.3E-04	1.9E-03	1.9E-03	8.1E-03	2.3E-03	1.0E-02	Y	Y
92-52-4	Biphenyl	0	0	4.4E-05	1.9E-04	0	0	4.4E-05	1.9E-04	Y	Y
7440-43-9	Cadmium	4.8E-05	2.1E-04	4.1E-04	1.8E-03	2.9E-04	1.3E-03	7.5E-04	3.3E-03	Y	Y
75-15-0	Carbon Disulfide	0	0	1.4E-02	6.3E-02	0	0	1.4E-02	6.3E-02	Y	Y
7440-47-3	Chromium	6.6E-05	2.7E-04	6.1E-04	2.5E-03	5.2E-03	2.3E-02	5.9E-03	2.6E-02	Y	Y
18540-29-9	Cr (VI)	0	0	3.4E-07	1.5E-06	0	0	3.4E-07	1.5E-06	Y	Y
218-01-9	Chrysene	5.8E-07	2.5E-06	0	0	0	0	5.8E-07	2.5E-06	Y	Y
7440-48-4	Cobalt	4.0E-06	1.6E-05	4.7E-04	2.0E-03	2.3E-03	1.0E-02	2.8E-03	1.2E-02	Y	Y
592-01-8	Cyanide	0	0	0.45	1.99	0	0	0.45	1.99	Y	Y
53-70-3	Dibenzo(a,h)anthracene	1.8E-07	7.7E-07	0	0	0	0	1.8E-07	7.7E-07	Y	Y
106-46-7	Dichlorobenzene	5.7E-05	2.3E-04	0	0	0	0	5.7E-05	2.3E-04	Y	Y
206-44-0	Fluoranthene	5.5E-06	7.0E-06	0	0	0	0	5.5E-06	7.0E-06	Y	N
86-73-7	Fluorene	1.7E-05	2.1E-05	0	0	0	0	1.7E-05	2.1E-05	Y	N
50-00-0	Formaldehyde	3.3E-03	1.5E-02	0	0	0	0	3.3E-03	1.5E-02	Y	Y
110-54-3	Hexane	8.5E-02	0.34	3.1E-02	0.14	0	0	0.12	0.48	Y	Y
7647-01-0	Hydrogen Chloride	0	0	0.99	3.67	0	0	0.99	**3.67**	Y	Y
193-39-5	Indeno(1,2,3-cd)pyrene	2.2E-07	9.6E-07	0	0	0	0	2.2E-07	9.6E-07	Y	Y
7439-92-1	Lead	0	0	4.8E-04	2.1E-03	4.6E-03	2.0E-02	5.1E-03	2.2E-02	Y	N
7439-96-5	Manganese	1.8E-05	7.2E-05	4.6E-03	1.7E-02	0.17	0.76	0.18	0.78	Y	Y
7439-97-6	Mercury	1.2E-05	5.0E-05	6.9E-04	2.9E-03	1.2E-03	5.1E-03	1.9E-03	8.0E-03	Y	N
91-20-3	Naphthalene	1.9E-04	3.1E-04	1.9E-03	8.5E-03	0	0	2.1E-03	8.8E-03	Y	Y
7440-02-0	Nickel	9.1E-05	4.0E-04	4.6E-04	2.0E-03	1.2E-03	5.1E-03	1.7E-03	7.5E-03	Y	Y
85-01-8	Phenanthrene	5.1E-05	6.3E-05	0	0	0	0	5.1E-05	6.3E-05	Y	N
108-95-2	Phenol	0	0	2.4E-04	1.1E-03	0	0	2.4E-04	1.1E-03	Y	Y
7723-14-0	Phosphorus	0	0	5.6E-03	2.3E-02	0.38	1.65	0.38	1.67	Y	Y
129-00-0	Pyrene	5.0E-06	6.6E-06	0	0	0	0	5.0E-06	6.6E-06	Y	N
7782-49-2	Selenium	1.1E-06	4.6E-06	4.1E-04	1.8E-03	2.3E-04	1.0E-03	6.4E-04	2.8E-03	Y	Y
108-88-3	Toluene	5.2E-04	1.1E-03	3.2E-02	0.14	0	0	3.2E-02	0.14	Y	Y
1330-20-7	Xylene	2.5E-04	3.0E-04	3.1E-02	0.14	0	0	3.2E-02	0.14	Y	Y
Total HAP		9.0E-02	0.36	1.58	6.25	0.81	3.56	2.48	10.17		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

	0.2155	0.8650	8.3307	31.6474	61.0803	267.5316	69.6264	300.0439
TRUE	0.2155	0.8650	8.3307	31.6474	61.0803	267.5316	69.6264	300.0439
	chk	chk	chk-15	chk	chk	chk	chk-14	chk

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary - continued

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**Non-HAP TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
7429-90-5	Aluminum	0	0	0.65	2.58	41.11	180.04	41.75	182.62	N	Y
7440-39-3	Barium	2.1E-04	8.4E-04	6.6E-03	2.7E-02	0.46	2.03	0.47	2.06	N	Y
1317-65-3	Calcium Carbonate	0	0	2.24	8.12	8.11	35.50	10.35	43.63	N	Y
1305-78-8	Calcium Oxide	0	0	0.70	0.95	0	0	0.70	0.95	N	Y
7440-50-8	Copper	4.0E-05	1.6E-04	4.9E-04	2.1E-03	2.9E-03	1.3E-02	3.4E-03	1.5E-02	N	Y
110-82-7	Cyclohexane	0	0	1.0E-03	4.6E-03	0	0	1.0E-03	4.6E-03	N	Y
7783-06-4	Hydrogen Sulfide	0	0	0.90	3.94	0	0	0.90	3.94	N	Y
7439-89-6	Iron	0	0	0.21	0.81	10.54	46.15	10.75	46.96	N	Y
7439-98-7	Molybdenum	5.2E-05	2.1E-04	4.2E-04	1.8E-03	5.8E-04	2.5E-03	1.0E-03	4.6E-03	N	Y
109-66-0	Pentane	0.12	0.50	0	0	0	0	0.12	0.50	N	Y
7440-22-4	Silver	0	0	4.1E-04	1.8E-03	2.9E-04	1.3E-03	7.0E-04	3.1E-03	N	Y
7664-93-9	Sulfuric Acid	0	0	2.03	8.89	0	0	2.03	8.89	N	Y
7440-28-0	Thallium	0	0	5.2E-04	2.2E-03	5.8E-03	2.5E-02	6.3E-03	2.8E-02	N	Y
7440-61-1	Uranium	0	0	5.2E-04	2.2E-03	5.8E-03	2.5E-02	6.3E-03	2.8E-02	N	Y
7440-62-2	Vanadium	1.1E-04	4.4E-04	7.3E-04	3.0E-03	1.6E-02	7.1E-02	1.7E-02	7.4E-02	N	Y
25551-13-7	Trimethyl benzene	0	0	1.1E-02	4.8E-02	0	0	1.1E-02	4.8E-02	N	Y
7440-33-7	Tungsten	0	0	5.2E-04	2.2E-03	5.8E-03	2.5E-02	6.3E-03	2.8E-02	N	Y
7440-66-6	Zinc	1.4E-03	5.5E-03	8.0E-04	3.3E-03	2.0E-02	8.9E-02	2.2E-02	9.8E-02	N	Y
Total Non-HAP TAP		0.13	0.50	6.75	25.40	60.27	263.98	67.15	289.88		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

Conversions
- 2,000 lb/ton
- 8,760 hr/yr
- 24 hr/day

PROPANE COMBUSTION

Source Data

Source ID	Description	MMBtu/day	MMBtu/yr
Lime Process Heating			
LKC	PFR Shaft Lime Kiln Combustion	529.0	163,935
Ore Process Heating			
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	17.0	510
CKB	Carbon Regeneration Kiln (Burners)	54.1	19,754
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	2.4	876
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	120.0	43,800
Subtotal		193.5	64,940
HVAC			
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	96.0	35,040
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	96.0	35,040
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	96.0	35,040
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	12.0	4,380
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	48.0	17,520
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	72.0	26,280
Subtotal		438.0	159,870

PROPANE COMBUSTION - CONTINUED

HAP/TAP Emission Factors and Emissions

O.Heat_pph O.Heat_tpy L.Heat_pph L.Heat_tpy HVAC_pph HVAC_tpy lb/hr ton/yr

		Emission Factor[2]		Emissions[1] Ore Proc Heat		Lime Proc Heat		HVAC		Total			
CAS	Pollutant	lb/MMscf	lb/MMBtu[3]	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	TAP	A/C
91-57-6	2-Methylnaphthalene	2.4E-05	2.35E-8	1.9E-07	7.6E-07	5.2E-07	1.9E-06	4.3E-07	1.9E-06	1.1E-06	4.6E-06	N	
56-49-5	3-Methylchloranthrene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
57-97-6	7,12-Dimethylbenz(a)anth	< 1.6E-05	1.57E-8	1.3E-07	5.1E-07	3.5E-07	1.3E-06	2.9E-07	1.3E-06	7.6E-07	3.0E-06	N	
83-32-9	Acenaphthene	< 1.8E-06	1.76E-9	1.4E-08	5.7E-08	3.9E-08	1.4E-07	3.2E-08	1.4E-07	8.5E-08	3.4E-07	N	
208-96-8	Acenaphthylene	< 1.8E-06	1.76E-9	1.4E-08	5.7E-08	3.9E-08	1.4E-07	3.2E-08	1.4E-07	8.5E-08	3.4E-07	N	
120-12-7	Anthracene	< 2.4E-06	2.35E-9	1.9E-08	7.6E-08	5.2E-08	1.9E-07	4.3E-08	1.9E-07	1.1E-07	4.6E-07	N	
7440-38-2	Arsenic	2.0E-04	1.96E-7	1.5E-06	6.4E-06	3.7E-06	1.6E-05	3.6E-06	1.6E-05	8.7E-06	3.8E-05	Y	C
56-55-3	Benz(a)anthracene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
71-43-2	Benzene	2.1E-03	2.06E-6	1.5E-05	6.7E-05	3.9E-05	1.7E-04	3.8E-05	1.6E-04	9.1E-05	4.0E-04	Y	C
50-32-8	Benzo(a)pyrene	< 1.2E-06	1.18E-9	8.7E-09	3.8E-08	2.2E-08	9.6E-08	2.1E-08	9.4E-08	5.2E-08	2.3E-07	Y	C
205-99-2	Benzo(b)fluoranthene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
191-24-2	Benzo(g,h,i)perylene	< 1.2E-06	1.18E-9	9.5E-09	3.8E-08	2.6E-08	9.6E-08	2.1E-08	9.4E-08	5.7E-08	2.3E-07	N	
207-08-9	Benzo(k)fluoranthene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
7440-41-7	Beryllium	< 1.2E-05	1.18E-8	8.7E-08	3.8E-07	2.2E-07	9.6E-07	2.1E-07	9.4E-07	5.2E-07	2.3E-06	Y	C
7440-43-9	Cadmium	1.1E-03	1.08E-6	8.0E-06	3.5E-05	2.0E-05	8.8E-05	2.0E-05	8.6E-05	4.8E-05	2.1E-04	Y	C
7440-47-3	Chromium	1.4E-03	1.37E-6	1.1E-05	4.5E-05	3.0E-05	1.1E-04	2.5E-05	1.1E-04	6.6E-05	2.7E-04	Y	A
218-01-9	Chrysene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
7440-48-4	Cobalt	8.4E-05	8.24E-8	6.6E-07	2.7E-06	1.8E-06	6.8E-06	1.5E-06	6.6E-06	4.0E-06	1.6E-05	Y	A
53-70-3	Dibenzo(a,h)anthracene	< 1.2E-06	1.18E-9	8.7E-09	3.8E-08	2.2E-08	9.6E-08	2.1E-08	9.4E-08	5.2E-08	2.3E-07	Y	C
106-46-7	Dichlorobenzene	1.2E-03	1.18E-6	9.5E-06	3.8E-05	2.6E-05	9.6E-05	2.1E-05	9.4E-05	5.7E-05	2.3E-04	Y	A
206-44-0	Fluoranthene	3.0E-06	2.94E-9	2.4E-08	9.5E-08	6.5E-08	2.4E-07	5.4E-08	2.4E-07	1.4E-07	5.7E-07	N	
86-73-7	Fluorene	2.8E-06	2.75E-9	2.2E-08	8.9E-08	6.1E-08	2.3E-07	5.0E-08	2.2E-07	1.3E-07	5.3E-07	N	
50-00-0	Formaldehyde	7.5E-02	7.35E-5	5.5E-04	2.4E-03	1.4E-03	6.0E-03	1.3E-03	5.9E-03	3.3E-03	1.4E-02	Y	C
110-54-3	Hexane	1.8E+00	1.76E-3	1.4E-02	5.7E-02	3.9E-02	1.4E-01	3.2E-02	1.4E-01	8.5E-02	3.4E-01	Y	A
193-39-5	Indeno(1,2,3-cd)pyrene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
7439-96-5	Manganese	3.8E-04	3.73E-7	3.0E-06	1.2E-05	8.2E-06	3.1E-05	6.8E-06	3.0E-05	1.8E-05	7.2E-05	Y	A
7439-97-6	Mercury	2.6E-04	2.55E-7	2.1E-06	8.3E-06	5.6E-06	2.1E-05	4.7E-06	2.0E-05	1.2E-05	5.0E-05	N	
91-20-3	Naphthalene	6.1E-04	5.98E-7	4.8E-06	1.9E-05	1.3E-05	4.9E-05	1.1E-05	4.8E-05	2.9E-05	1.2E-04	Y	A
7440-02-0	Nickel	2.1E-03	2.06E-6	1.5E-05	6.7E-05	3.9E-05	1.7E-04	3.8E-05	1.6E-04	9.1E-05	4.0E-04	Y	C
85-01-8	Phenanthrene	1.7E-05	1.67E-8	1.3E-07	5.4E-07	3.7E-07	1.4E-06	3.0E-07	1.3E-06	8.1E-07	3.2E-06	N	
129-00-0	Pyrene	5.0E-06	4.90E-9	4.0E-08	1.6E-07	1.1E-07	4.0E-07	8.9E-08	3.9E-07	2.4E-07	9.5E-07	N	
7782-49-2	Selenium	< 2.4E-05	2.35E-8	1.9E-07	7.6E-07	5.2E-07	1.9E-06	4.3E-07	1.9E-06	1.1E-06	4.6E-06	Y	A
108-88-3	Toluene	3.4E-03	3.33E-6	2.7E-05	1.1E-04	7.3E-05	2.7E-04	6.1E-05	2.7E-04	1.6E-04	6.5E-04	Y	A
109-66-0	Pentane	2.6E+00	2.55E-3	2.1E-02	8.3E-02	5.6E-02	2.1E-01	4.7E-02	2.0E-01	1.2E-01	5.0E-01	Y	A
7440-39-3	Barium	4.4E-03	4.31E-6	3.5E-05	1.4E-04	9.5E-05	3.5E-04	7.9E-05	3.4E-04	2.1E-04	8.4E-04	Y	A
7440-50-8	Copper	8.5E-04	8.33E-7	6.7E-06	2.7E-05	1.8E-05	6.8E-05	1.5E-05	6.7E-05	4.0E-05	1.6E-04	Y	A
7439-98-7	Molybdenum	1.1E-03	1.08E-6	8.7E-06	3.5E-05	2.4E-05	8.8E-05	2.0E-05	8.6E-05	5.2E-05	2.1E-04	Y	A
7440-62-2	Vanadium	2.3E-03	2.25E-6	1.8E-05	7.3E-05	5.0E-05	1.8E-04	4.1E-05	1.8E-04	1.1E-04	4.4E-04	Y	A
7440-66-6	Zinc	2.9E-02	2.84E-5	2.3E-04	9.2E-04	6.3E-04	2.3E-03	5.2E-04	2.3E-03	1.4E-03	5.5E-03	Y	A
Total				3.6E-02	1.4E-01	9.8E-02	3.6E-01	8.1E-02	3.5E-01	2.1E-01	8.6E-01		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *AP-42, Table 1.4-3 & 1.4-4 (7/98) Natural Gas Combustion* 1.0766 1.0766

(3) *Natural Gas Higher Heating Value* 1,020 *MMBtu/MMscf* chk

DIESEL COMBUSTION

Source Data

Source ID	Description	Power Rating kW	Power Rating hp	Operation hr/day	Operation hr/yr	Fuel Consumption[1] & [2] MMBtu/day	Fuel Consumption[1] & [2] MMBtu/yr
EDG1	Camp Emergency Generator	1,000	1,341	1	100	9.39	938.70
EDG2	Plant Emergency Generator #1	1,000	1,341	1	100	9.39	938.7
EDG3	Plant Emergency Generator #2	1,000	1,341	1	100	9.39	938.7
EDFP	Mill Fire Pump	200	268	1	100	1.88	187.7
Total						30.0	3,003.8

(1) *Based on brake specific fuel consumption for diesel generators* 7,000 *Btu/hp-hr* *AP-42 Tbl 3.3-1*

(2) *Heat Content of* 0.137 *MMBtu/gal* 1E+6 *Btu/MMBtu* 1.341 *hp/kW*

HAP/TAP Emission Factors and Emissions

lb/hr ton/yr

	Pollutant	Factor (lb/MMBtu) ≤600 hp[2]	Factor (lb/MMBtu) >600hp[3]	Emissions (≤600 hp) lb/hr	Emissions (≤600 hp) ton/yr	Emissions (>600 hp) lb/hr	Emissions (>600 hp) ton/yr	Total Emissions[1] lb/hr	Total Emissions[1] ton/yr	TAP	A/C
106-99-0	1,3-Butadiene	< 3.9E-05		8.4E-07	3.7E-06	0.0E+00	0.0E+00	8.4E-07	3.7E-06	Y	C
83-32-9	Acenaphthene	< 1.4E-06	4.7E-06	1.1E-07	1.3E-07	5.5E-06	6.6E-06	5.6E-06	6.7E-06	N	
208-96-8	Acenaphthylene	< 5.1E-06	9.2E-06	4.0E-07	4.7E-07	1.1E-05	1.3E-05	1.1E-05	1.3E-05	N	
75-07-0	Acetaldehyde	7.7E-04	2.5E-05	1.6E-05	7.2E-05	8.1E-06	3.5E-05	2.5E-05	1.1E-04	Y	C
107-02-8	Acrolein	< 9.3E-05	7.9E-06	7.2E-06	8.7E-06	9.2E-06	1.1E-05	1.6E-05	2.0E-05	Y	A
120-12-7	Anthracene	1.9E-06	1.2E-06	1.5E-07	1.8E-07	1.4E-06	1.7E-06	1.6E-06	1.9E-06	N	
56-55-3	Benz(a)anthracene	1.7E-06	6.2E-07	3.6E-08	1.6E-07	2.0E-07	8.8E-07	2.4E-07	1.0E-06	Y	C
71-43-2	Benzene	9.3E-04	7.8E-04	2.0E-05	8.8E-05	2.5E-04	1.1E-03	2.7E-04	1.2E-03	Y	C
50-32-8	Benzo(a)pyrene	< 1.9E-07	< 2.6E-07	4.0E-09	1.8E-08	8.3E-08	3.6E-07	8.7E-08	3.8E-07	Y	C
205-99-2	Benzo(b)fluoranthene	< 9.9E-08	< 1.1E-06	2.1E-09	9.3E-09	3.6E-07	1.6E-06	3.6E-07	1.6E-06	Y	C
191-24-2	Benzo(g,h,i)perylene	< 4.9E-07	< 5.6E-07	3.8E-08	4.6E-08	6.5E-07	7.8E-07	6.9E-07	8.3E-07	N	
207-08-9	Benzo(k)fluoranthene	< 1.6E-07	< 2.2E-07	3.3E-09	1.5E-08	7.0E-08	3.1E-07	7.3E-08	3.2E-07	Y	C
218-01-9	Chrysene	3.5E-07	1.5E-06	7.6E-09	3.3E-08	4.9E-07	2.2E-06	5.0E-07	2.2E-06	Y	C
53-70-3	Dibenzo(a,h)anthracene	< 5.8E-07	< 3.5E-07	1.2E-08	5.5E-08	1.1E-07	4.9E-07	1.2E-07	5.4E-07	Y	C
206-44-0	Fluoranthene	7.6E-06	4.0E-06	6.0E-07	7.1E-07	4.7E-06	5.7E-06	5.3E-06	6.4E-06	N	
86-73-7	Fluorene	2.9E-05	1.3E-05	2.3E-06	2.7E-06	1.5E-05	1.8E-05	1.7E-05	2.1E-05	N	
50-00-0	Formaldehyde	1.2E-03	7.9E-05	2.5E-05	1.1E-04	2.5E-05	1.1E-04	5.1E-05	2.2E-04	Y	C
193-39-5	Indeno(1,2,3-cd)pyrene	< 3.8E-07	< 4.1E-07	8.0E-09	3.5E-08	1.3E-07	5.8E-07	1.4E-07	6.2E-07	Y	C
91-20-3	Naphthalene	8.5E-05	1.3E-04	6.6E-06	8.0E-06	1.5E-04	1.8E-04	1.6E-04	1.9E-04	Y	A
85-01-8	Phenanthrene	2.9E-05	4.1E-05	2.3E-06	2.8E-06	4.8E-05	5.7E-05	5.0E-05	6.0E-05	N	
129-00-0	Pyrene	4.8E-06	3.7E-06	3.7E-07	4.5E-07	4.4E-06	5.2E-06	4.7E-06	5.7E-06	N	
108-88-3	Toluene	4.1E-04	2.8E-04	3.2E-05	3.8E-05	3.3E-04	4.0E-04	3.6E-04	4.3E-04	Y	A
1330-20-7	Xylene	2.9E-04	1.9E-04	2.2E-05	2.7E-05	2.3E-04	2.7E-04	2.5E-04	3.0E-04	Y	A
Total				1.4E-04	3.6E-04	1.1E-03	2.2E-03	1.2E-03	2.6E-03		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *AP-42, Tab. 3.3-2, 10/96, diesel engines (≤ 600 hp)* chk chk

(3) *AP-42, Tabs. 3.4-3 & 3.4-4, 10/96, large diesel engines (> 600 hp)*

ORE PROCESSING

Source Data

Source ID	Description	PM Emissions lb/day	PM Emissions ton/yr
OC1	Loader Transfer of Ore to Grizzly	3.500	0.639
OC2	Grizzly to Apron Feeder	3.500	0.639
OC3	Apron Feeder to Dribble Conveyor	3.500	0.639
OC4	Apron Feeder to Vibrating Grizzly	3.500	0.639
OC5	Dribble Conveyor to Vibrating Grizzly	3.500	0.639
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	3.500	0.639
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	30.000	5.475
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	3.500	0.639
OC9	Stockpile Transfers to Reclaim Conveyors	16.560	3.022
OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	16.560	3.022
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	16.560	3.022
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge C	33.120	6.044
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	3.864	0.705
Total		141.164	25.762

HAP/TAP Emission Factors and Emissions

CAS No.	Pollutant	Concentration ppm[2]	Emissions[1] lb/hr	Emissions[1] ton/yr	TAP	A/C
7440-38-2	Arsenic	667	3.9E-03	1.7E-02	Y	C
7440-41-7	Beryllium	3.2	1.9E-05	8.2E-05	Y	C
7440-43-9	Cadmium	0.50	2.9E-06	1.3E-05	Y	C
7440-48-4	Cobalt	4	2.4E-05	1.0E-04	Y	A
7440-47-3	Chromium	9	5.3E-05	2.3E-04	Y	A
7439-97-6	Mercury [3]	0.96	5.6E-06	2.5E-05	N	
7439-96-5	Manganese	299	1.8E-03	7.7E-03	Y	A
7440-02-0	Nickel	2	1.2E-05	5.2E-05	Y	C
7439-92-1	Lead	8	4.7E-05	2.1E-04	N	
7440-36-0	Antimony	23	1.4E-04	5.9E-04	Y	A
7723-14-0	Phosphorus	650	3.8E-03	1.7E-02	Y	A
7782-49-2	Selenium [4]	0.40	2.4E-06	1.0E-05	Y	A
7440-22-4	Silver	0.50	2.9E-06	1.3E-05	Y	A
7429-90-5	Aluminum	71,000	4.2E-01	1.8E+00	Y	A
7440-39-3	Barium	800	4.7E-03	2.1E-02	Y	A
1317-65-3	Calcium Carbonate	14,000	8.2E-02	3.6E-01	Y	A
7440-50-8	Copper	5	2.9E-05	1.3E-04	Y	A
7439-89-6	Iron [4]	18,200	1.1E-01	4.7E-01	Y	A
7439-98-7	Molybdenum	1	5.9E-06	2.6E-05	Y	A
7440-28-0	Thallium	10	5.9E-05	2.6E-04	Y	A
7440-61-1	Uranium	10	5.9E-05	2.6E-04	Y	A
7440-62-2	Vanadium	28	1.6E-04	7.2E-04	Y	A
7440-33-7	Tungsten	10	5.9E-05	2.6E-04	Y	A
7440-66-6	Zinc	35	2.1E-04	9.0E-04	Y	A
Total			6.2E-01	2.7E+00		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *(Midas Gold 2017c)* *Median concentration of 55,000 SGP samples.*

[3] *(Midas Gold 2018e)* *Median ore concentration of 151,000 SGP samples; resource block model.*

[4] *(Midas Gold 2020)* *Median concentration of 56,000 SGP samples for Fe and 1,500 SGP samples for Se.*

1E+6 parts/ppm

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis	
	PROJECT NO: 335-20-3	PAGE: 7	OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021	

ORE CONCETRATION AND REFINING

Source Data

Source ID	Description	Subpart 7E Allowable Limit lb/yr[1]	Oper. hr/yr	% of Subpart 7E for Controlled Systems %		Controlled Hg Emissions lb/hr	ton/yr	lb/yr
AC	Autoclave	213.4	8,760	[2]		0.000023	0.00010	0.20
EW,MR,MF,CKD	Refinery Sources (C. Kiln, EW, Retort, Furn	16.8		20%	[3]	0.000384	0.00168	3.36
7439-97-6 Mercury	Total	230.2				0.000407	0.00178	3.56

[1] *Subpart 7E Limit - Ore Pretreatment Processes (CFR 2018b)*

$$\frac{84\ lb}{MMton} \times \frac{2{,}540{,}400\ ton}{yr} \times \frac{MMton}{1.0E{+}6\ ton} = \frac{213.4\ lb}{yr}$$

[1] *Subpart 7E Limit - Carbon Processes with Mercury Retorts*

$$\frac{0.8\ lb}{ton} \times \frac{21\ ton}{yr} = \frac{16.8\ lb}{yr}$$

[2] *Controlled SysCAD modeled emissions from Autoclave:* 0.0105 g/hr 2.3E-05 lb/hr 0.20 lb/yr (M3 2019)

[3] *Based on similar source (but with much higher ore Hg content) Hg reporting levels provided below:*

Goldstrike Refinery (2015 & 2016 Hg Reports) (NDEP 2015a) (NDEP 2016)

$$\frac{28.79\ lb}{yr} \times \frac{yr}{251.00\ ton} = \frac{0.11\ lb}{MMton} \times \frac{ton}{0.8\ lb} = 14.3\%$$

Twin Creeks Refinery (2015 & 2016 Hg Reports) (NDEP 2015a) (NDEP 2016)

$$\frac{31.27\ lb}{yr} \times \frac{yr}{142.77\ ton} = \frac{0.22\ lb}{MMton} \times \frac{ton}{0.8\ lb} = 27.4\%$$

HAP/TAP Emission Factors and Emissions

AC_pph AC_tpy Refin_pph Refin_tpy lb/hr ton/yr

CAS No.	Pollutant	Emission Factor[1]	Autoclave lb/hr	Autoclave ton/yr	Refinery lb/hr	Refinery ton/yr	Total Emissions lb/hr	Total Emissions ton/yr	TAP	A/C
7440-38-2	Arsenic	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	C
7440-41-7	Beryllium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	C
7440-43-9	Cadmium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	C
7440-48-4	Cobalt	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-47-3	Chromium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7439-97-6	Mercury	see above	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	N	
7439-96-5	Manganese	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-02-0	Nickel	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	C
7439-92-1	Lead	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	N	
7440-36-0	Antimony	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7723-14-0	Phosphorus	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7782-49-2	Selenium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-22-4	Silver	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7429-90-5	Aluminum	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-39-3	Barium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
1317-65-3	Calcium Carbonate	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-50-8	Copper	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7439-89-6	Iron	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7439-98-7	Molybdenum	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-28-0	Thallium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-61-1	Uranium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-62-2	Vanadium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-33-7	Tungsten	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-66-6	Zinc	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
Total			5.5E-04	2.4E-03	9.2E-03	4.0E-02	9.8E-03	4.3E-02		

[1] *Hg is the most difficult metal to control due to it existing in both particulate and gaseous form. Therefore, all other metals are conservatively estimated to be equal to or less than the Hg emissions.*

0.0525 0.0525 chk

7664-93-9	Sulfuric Acid	Autoclave	2.03	8.89			2.03	8.89
7783-06-4	Hydrogen Sulfid	Autoclave	0.90	3.94			0.90	3.94
592-01-8	Cyanide	Point Sources - SEW Cells			0.0012	0.0053	0.00	0.01
Total			2.93	12.84	0.01	0.05	2.94	12.88

ORE CONCETRATION AND REFINING - CONTINUED

Source Data

Source ID	Description	Throughput ton/day	Throughput ton/yr	Operation hr/day	Operation hr/yr
AC	Autoclave	6,960	2,540,400	24	8,760

Autoclave HAP/TAP Emission Factors and Emission lb/hr ton/yr

CAS No.	Pollutant	Emission Factor		Emissions[1] lb/hr	Emissions[1] ton/yr
7664-93-9	Sulfuric Acid	0.007	lb/ton[2]	2.03	8.89
7783-06-4	Hydrogen Sulfide	0.9	lb/hr[3]	0.90	3.94

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *H2SO4 is based on Acidic Autoclave test data (APT 2010)*

[3] *H2S is based on Acidic Autoclave test data (APT 2013)*

LEACHING OPERATION

Cyanide (HCN) Source Data, Emission Factors, and Emissions

Source ID	Description	Dia. ft[1]	pH[1]	Free CN- g/m3[1]	T C[1]	pKa	a0	H	kG[2] m/s	Fa*Fw	g/s	lb/hr	ton/yr
												lb/hr	ton/yr
TSF	***Fugitive Sources***												
TSF	Tailings Maint. Pond	76	7.75	1	3.74	9.803	0.9912	0.0025	1.89E-05	0.641	1.27E-05	0.0001	0.0004
MILLTA	CN Detox Tank 1	40	8.5	25	25	9.250	0.8490	0.0055	0.000311	0.688	0.002891	0.0229	0.101
MILLTA	CN Detox Tank 2	40	8.5	25	25	9.250	0.8490	0.0055	0.000311	0.688	0.002891	0.0229	0.101
MILLTA	CIP Leach Tank 1	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	0.0114	0.050
MILLTA	CIP Leach Tank 2	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	0.0114	0.050
MILLTA	CIP Leach Tank 3	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	0.0114	0.050
MILLTA	CIP Leach Tank 4	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	0.0114	0.050
MILLTA	CIL Tank 1	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIL Tank 2	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIL Tank 3	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIL Tank 4	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIL Tank 5	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIL Tank 6	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIP Tank 1	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA	CIP Tank 2	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA	CIP Tank 3	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA	CIP Tank 4	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA	CIP Tank 5	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA	CIP Tank 6	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
		Acres[1]											
TSF	Tails, Aqueous Surface	110.222	7.75	1	3.74	9.803	0.9912	0.0025	1.89E-05	0.421	0.008845	0.0702	0.307
TSF	Tails, Wet Sediment	110.222							5.31E-08	0.421	0.009961	0.0791	0.346
TSF	Tails, Dry Sediment	110.222							2.33E-08	1	0.010375	0.0823	0.361
		330.666											
592-01-8	Cyanide Fugitive Sources - Subtotal											0.4527	1.983
75-15-0	Carbon Disulfide											0.01446	0.06332
	Point Sources												
EW	EW Cells	[3]										0.0006	0.003
EW	Preg/Barren Tanks	[3]										0.0006	0.003
592-01-8	Cyanide Point Sources - Subtotal											0.0012	0.0053
	Total											0.454	1.988

[1] *(Midas Gold 2016)(M3 2017c)(M3 2017d)*

[2] *The emission factors and caculation methodology are from the EPA directed HCN study: (Card, T. 2009)(EPA 2009)(Schmidt 2010)*

[3] *(APT 2009)*

Carbon Disulfide Emissions from Xanthate Decomposition

CAS No.	Pollutant	Xanthate[1] ton/yr	Molar Decomp.[2]	CS_2 MW Ratio	Temperature Adj. Factor[3]	Emissions lb/hr	Emissions ton/yr
						lb/hr	ton/yr
75-15-0	Carbon Disulfide	1,700	0.99%	0.376	1%	0.0145	0.063

	MW	
Xanthate (PAX)	202.37	$C6H11KOS_2$
Carbon disulfide	76.139	CS_2

[1] *(Midas Gold 2016) p. 12-11*

[2] *(Air Sciences 2020) molar decomposition of xanthate in solution to CS2 gas*

[3] *(Air Sciences 2020) based on the comparison of CS2 generation at 25C and 70C*

Conversions

8,760	hr/yr	453.5929	g/lb
2,000	lb/ton	3.28084	ft/m
4,046.86	m2/acre	3,600	s/hr

Wind adjustment factor Fw 1

LIME PRODUCTION

Source Data

Source ID	Description	Throughput ton/day	Throughput ton/yr	PM Emissions lb/day	PM Emissions ton/yr
LS1	Limestone transfer to Primary Crusher Hopper			3.39	0.48
LS2	Primary Crushing and Associated Transfers In and Out			6.10	0.86
LS3	Primary Screening and Associated Transfers In and Out			28.25	3.97
LS4	Secondary Crushing and Associated Transfers In and Out			6.10	0.86
LS5	Secondary Screening and Associated Transfers In and Out			28.25	3.97
LS6	Limestone transfer to Ball Mill Feed Bin			3.39	0.48
LS7	Limestone transfer to Ball Mill Feed Conveyor			3.39	0.48
LS8	Ball Mill Feed transfer to Ball Mill			3.39	0.48
LSBM	Limestone Ball Mill			45.65	6.42
LS9	Limestone transfer to Kiln Feed Bin			0.80	0.12
LS10	Limestone transfer to Lime Kiln Feed Conveyor			0.80	0.12
LS11	Fines Screening and Associated Transfers In and Out			6.68	1.03
Subtotal LS1-11				136.18	19.28
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln			0.80	0.12
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	169	52,377	21.97	3.40
Subtotal LS12,LK				22.77	3.53
Total				158.95	22.80

HAP/TAP Emission Factors and Emissions

			LS_pph	LS_tpy	LS12_pph	LS12_tpy	LK_pph	LK_tpy	lb/hr	ton/yr		
		Concentration	LS1-11,LSBM		LS12		Lime Kiln		Emissions[1]			
CAS No.	Pollutant	ppm[2]	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	TAP	A/C
7440-38-2	Arsenic	23	1.01E-04	4.43E-04	6.51E-07	2.85E-06	1.79E-05	7.83E-05	1.20E-04	5.24E-04	Y	C
7440-41-7	Beryllium	0.8	3.52E-06	1.54E-05	2.27E-08	9.92E-08	6.22E-07	2.72E-06	4.17E-06	1.82E-05	Y	C
7440-43-9	Cadmium	0.25	1.10E-06	4.82E-06	7.08E-09	3.10E-08	1.94E-07	8.51E-07	1.30E-06	5.70E-06	Y	C
7440-48-4	Cobalt	4	2.27E-05	7.71E-05	1.34E-07	4.96E-07	3.66E-06	1.36E-05	2.65E-05	9.12E-05	Y	A
7440-47-3	Chromium	15	8.51E-05	2.89E-04	5.01E-07	1.86E-06	1.37E-05	5.11E-05	9.93E-05	3.42E-04	Y	A
7439-97-6	Mercury [3]	0.02	1.13E-07	3.86E-07	6.68E-10	2.48E-09	2.82E-04	1.05E-03	2.82E-04	1.05E-03	N	
7439-96-5	Manganese	236.5	1.34E-03	4.56E-03	7.89E-06	2.93E-05	2.16E-04	8.05E-04	1.57E-03	5.39E-03	Y	A
7440-02-0	Nickel	5	2.20E-05	9.64E-05	1.42E-07	6.20E-07	3.89E-06	1.70E-05	2.60E-05	1.14E-04	Y	C
7439-92-1	Lead	3	1.70E-05	5.78E-05	1.00E-07	3.72E-07	2.75E-06	1.02E-05	1.99E-05	6.84E-05	N	
7440-36-0	Antimony	2.5	1.42E-05	4.82E-05	8.34E-08	3.10E-07	2.29E-06	8.51E-06	1.66E-05	5.70E-05	Y	A
7723-14-0	Phosphorus	130	7.38E-04	2.51E-03	4.34E-06	1.61E-05	1.19E-04	4.43E-04	8.61E-04	2.96E-03	Y	A
7440-22-4	Silver	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	Y	A
7429-90-5	Aluminum	22600	1.28E-01	4.36E-01	7.54E-04	2.80E-03	2.07E-02	7.69E-02	1.50E-01	5.15E-01	Y	A
7440-39-3	Barium	145	8.23E-04	2.79E-03	4.84E-06	1.80E-05	1.33E-04	4.94E-04	9.60E-04	3.31E-03	Y	A
1317-65-3	Calcium Carbonate	274500	1.56E+00	5.29E+00	9.16E-03	3.40E-02	2.51E-01	9.35E-01	1.82E+00	6.26E+00	Y	A
7440-50-8	Copper	5	2.84E-05	9.64E-05	1.67E-07	6.20E-07	4.58E-06	1.70E-05	3.31E-05	1.14E-04	Y	A
7439-89-6	Iron	10350	5.87E-02	1.99E-01	3.45E-04	1.28E-03	9.47E-03	3.52E-02	6.85E-02	2.36E-01	Y	A
7439-98-7	Molybdenum	0.5	2.84E-06	9.64E-06	1.67E-08	6.20E-08	4.58E-07	1.70E-06	3.31E-06	1.14E-05	Y	A
7440-28-0	Thallium	5	2.84E-05	9.64E-05	1.67E-07	6.20E-07	4.58E-06	1.70E-05	3.31E-05	1.14E-04	Y	A
7440-61-1	Uranium	5	2.84E-05	9.64E-05	1.67E-07	6.20E-07	4.58E-06	1.70E-05	3.31E-05	1.14E-04	Y	A
7440-62-2	Vanadium	15.5	8.79E-05	2.99E-04	5.17E-07	1.92E-06	1.42E-05	5.28E-05	1.03E-04	3.53E-04	Y	A
7440-33-7	Tungsten	5	2.84E-05	9.64E-05	1.67E-07	6.20E-07	4.58E-06	1.70E-05	3.31E-05	1.14E-04	Y	A
7440-66-6	Zinc	18	1.02E-04	3.47E-04	6.01E-07	2.23E-06	1.65E-05	6.13E-05	1.19E-04	4.10E-04	Y	A
Subtotal			1.75E+00	5.94E+00	1.03E-02	3.82E-02	2.82E-01	1.05E+00	2.04E+00	7.03E+00	9.0667	9.0667
7647-01-0	Hydrogen Chloride	0.14 lb/ton product[4]					0.99	3.67	0.99	3.67		chk

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *(M3 2018) Median concentrations of SGP limestone material. Metals with medians below the detection limit (DL) are set to 1/2DL.*

[3] *Hg emissions from the Lime Kiln are conservatively estimated assuming 100% volatilization of all Hg in the limestone*

[4] *(EPA 1999b)*

1E+6 parts/ppm

LIME PRODUCTION - CONTINUED

Source Data

Source ID	Description	PM Emissions lb/day	PM Emissions ton/yr
LS1L	Mill Lime Silo #1 Loading	0.248	0.002
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	1.200	0.011
MillS2L	Mill Lime Silo #2 Loading	0.248	0.002
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	1.200	0.011
ACS1L	AC Lime Silo #1 Loading	0.990	0.009
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.304	0.042
ACS2L	AC Lime Silo #2 Loading	0.990	0.009
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.304	0.042
ACS3L	AC Lime Silo #3 Loading	0.990	0.009
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.304	0.042
ACS4L	AC Lime Silo #4 Loading	0.495	0.004
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	2.304	0.021
Subtotal - Mill & AC Lime Silos		15.576	0.203
LCR	Lime Mill Crushing and associated transfers In and Out	6.828	1.058
LSL	Pebble Lime Silo Loading via Bucket Elevator	0.149	0.023
LSU	Pebble Lime Silo discharge to Lime Slaker	0.015	0.002
Subtotal - Lime Mfg		6.991	1.083
Total		22.567	1.286

HAP/TAP Emission Factors and Emissions

CAS No.	Pollutant	Concentration ppm[2]	Mill and AC lb/hr	Mill and AC ton/yr	Lime Mfg lb/hr	Lime Mfg ton/yr	Emissions[1] lb/hr	Emissions[1] ton/yr	TAP	A/C
7440-38-2	Arsenic	23	1.06E-06	4.66E-06	5.69E-06	2.49E-05	6.75E-06	2.96E-05	Y	C
7440-41-7	Beryllium	0.8	3.70E-08	1.62E-07	1.98E-07	8.67E-07	2.35E-07	1.03E-06	Y	C
7440-43-9	Cadmium	0.25	1.16E-08	5.07E-08	6.18E-08	2.71E-07	7.34E-08	3.22E-07	Y	C
7440-48-4	Cobalt	4	2.60E-06	8.11E-07	1.17E-06	4.33E-06	3.76E-06	5.14E-06	Y	A
7440-47-3	Chromium	15	9.74E-06	3.04E-06	4.37E-06	1.63E-05	1.41E-05	1.93E-05	Y	A
7439-97-6	Mercury	0.02	1.30E-08	4.05E-09	5.83E-09	2.17E-08	1.88E-08	2.57E-08	N	
7439-96-5	Manganese	236.5	1.53E-04	4.79E-05	6.89E-05	2.56E-04	2.22E-04	3.04E-04	Y	A
7440-02-0	Nickel	5	2.31E-07	1.01E-06	1.24E-06	5.42E-06	1.47E-06	6.43E-06	Y	C
7439-92-1	Lead	3	1.95E-06	6.08E-07	8.74E-07	3.25E-06	2.82E-06	3.86E-06	N	
7440-36-0	Antimony	2.5	1.62E-06	5.07E-07	7.28E-07	2.71E-06	2.35E-06	3.22E-06	Y	A
7723-14-0	Phosphorus	130	8.44E-05	2.63E-05	3.79E-05	1.41E-04	1.22E-04	1.67E-04	Y	A
7440-22-4	Silver	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	Y	A
7429-90-5	Aluminum	22,600	1.47E-02	4.58E-03	6.58E-03	2.45E-02	2.13E-02	2.91E-02	Y	A
7440-39-3	Barium	145	9.41E-05	2.94E-05	4.22E-05	1.57E-04	1.36E-04	1.86E-04	Y	A
1305-78-8	Calcium Oxide	740,000 [3]	4.80E-01	1.50E-01	2.16E-01	8.02E-01	6.96E-01	9.52E-01	Y	A
7440-50-8	Copper	5	3.25E-06	1.01E-06	1.46E-06	5.42E-06	4.70E-06	6.43E-06	Y	A
7439-89-6	Iron	10350	6.72E-03	2.10E-03	3.01E-03	1.12E-02	9.73E-03	1.33E-02	Y	A
7439-98-7	Molybdenum	0.5	3.25E-07	1.01E-07	1.46E-07	5.42E-07	4.70E-07	6.43E-07	Y	A
7440-28-0	Thallium	5	3.25E-06	1.01E-06	1.46E-06	5.42E-06	4.70E-06	6.43E-06	Y	A
7440-61-1	Uranium	5	3.25E-06	1.01E-06	1.46E-06	5.42E-06	4.70E-06	6.43E-06	Y	A
7440-62-2	Vanadium	15.5	1.01E-05	3.14E-06	4.52E-06	1.68E-05	1.46E-05	1.99E-05	Y	A
7440-33-7	Tungsten	5	3.25E-06	1.01E-06	1.46E-06	5.42E-06	4.70E-06	6.43E-06	Y	A
7440-66-6	Zinc	18	1.17E-05	3.65E-06	5.24E-06	1.95E-05	1.69E-05	2.31E-05	Y	A
Total			5.02E-01	1.57E-01	2.25E-01	8.38E-01	7.27E-01	9.95E-01		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *See LIME PRODUCTION, page 10*

[3] *(NLA 2007) 40% to 74% CaO in lime*

1E+6 parts/ppm

AGGREGATE PRODUCTION

Source Data

Source ID	Description (description)	PM Emissions lb/day (PM_ppd)	PM Emissions ton/yr (PM_tpy)
PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyo	15.00	2.74
PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyo	15.00	2.74
Total		30.00	5.48

HAP/TAP Emission Factors and Emissions (lb/hr, ton/yr)

CAS No.	Pollutant	Concentration ppm[2]	Emissions[1] lb/hr	Emissions[1] ton/yr	TAP	A/C
7440-38-2	Arsenic	23	2.88E-05	1.26E-04	Y	C
7440-41-7	Beryllium	0.8	1.00E-06	4.38E-06	Y	C
7440-43-9	Cadmium	0.25	3.13E-07	1.37E-06	Y	C
7440-48-4	Cobalt	4	5.00E-06	2.19E-05	Y	A
7440-47-3	Chromium	15	1.88E-05	8.21E-05	Y	A
7439-97-6	Mercury	0.02	2.50E-08	1.10E-07	N	
7439-96-5	Manganese	236.5	2.96E-04	1.29E-03	Y	A
7440-02-0	Nickel	5	6.25E-06	2.74E-05	Y	C
7439-92-1	Lead	3	3.75E-06	1.64E-05	N	
7440-36-0	Antimony	2.5	3.13E-06	1.37E-05	Y	A
7723-14-0	Phosphorus	130	1.63E-04	7.12E-04	Y	A
7440-22-4	Silver	0	0.00E+00	0.00E+00	Y	A
7429-90-5	Aluminum	22600	2.83E-02	1.24E-01	Y	A
7440-39-3	Barium	145	1.81E-04	7.94E-04	Y	A
1317-65-3	Calcium Carbonate	274500	3.43E-01	1.50E+00	Y	A
7440-50-8	Copper	5	6.25E-06	2.74E-05	Y	A
7439-89-6	Iron	10350	1.29E-02	5.67E-02	Y	A
7439-98-7	Molybdenum	0.5	6.25E-07	2.74E-06	Y	A
7440-28-0	Thallium	5	6.25E-06	2.74E-05	Y	A
7440-61-1	Uranium	5	6.25E-06	2.74E-05	Y	A
7440-62-2	Vanadium	15.5	1.94E-05	8.49E-05	Y	A
7440-33-7	Tungsten	5	6.25E-06	2.74E-05	Y	A
7440-66-6	Zinc	18	2.25E-05	9.86E-05	Y	A
Total			3.85E-01	1.69E+00		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *See LIME PRODUCTION, page 10*

1E+6 parts/ppm

CONCRETE PRODUCTION

Source Data

Source ID	Description	Throughput ton/day	Throughput ton/yr
	description	TP_unit/day	TP_unit/yr
CS1L	Cement/Shotcrete Silo #1 Loading	164	60,000
CS1U	Cement/Shotcrete Silo #1 Unloading	164	60,000
CS2L	Cement/Shotcrete Silo #2 Loading	164	60,000
CS2U	Cement/Shotcrete Silo #2 Unloading	164	60,000
CM	Central Mixer Loading	164	60,000
	Subtotal Cement Silo Filling	658	240,000
	Subtotal Central Mix Batching	164	60,000

HAP/TAP Emission Factors and Emissions

CAS No.	HAP/TAP	Silo Fill lb/ton[2]	Central Mixer lb/ton[3]	Cement Silo L/U lb/hr	Cement Silo L/U ton/yr	Central Mix Batching lb/hr	Central Mix Batching ton/yr	Total Emissions[3] lb/hr	Total Emissions[3] ton/yr	TAP	A/C
				CF_pph	CF_tpy	CM_pph	CM_tpy	lb/hr	ton/yr		
7440-38-2	Arsenic	4.24E-09	2.96E-07	1.16E-7	5.09E-7	2.03E-6	8.88E-6	2.14E-6	9.39E-6	Y	C
7440-41-7	Beryllium	4.86E-10		1.33E-8	5.83E-8	--	--	1.33E-8	5.83E-8	Y	C
7440-43-9	Cadmium		7.10E-10	--	--	4.86E-9	2.13E-8	4.86E-9	2.13E-8	Y	C
7440-47-3	Chromium	2.90E-08	1.27E-07	7.95E-7	3.48E-6	8.70E-7	3.81E-6	1.66E-6	7.29E-6	Y	A
18540-29-9	Cr (VI)	5.80E-09	2.70E-08	1.59E-7	6.96E-7	1.85E-7	8.11E-7	3.44E-7	1.51E-6	Y	C
7439-92-1	Lead	1.09E-08	3.66E-08	2.99E-7	1.31E-6	2.51E-7	1.10E-6	5.49E-7	2.41E-6	N	
7439-96-5	Manganese	1.17E-07	3.78E-06	3.21E-6	1.40E-5	2.59E-5	1.13E-4	2.91E-5	1.27E-4	Y	A
7440-02-0	Nickel	4.18E-08	2.48E-07	1.15E-6	5.02E-6	1.70E-6	7.44E-6	2.84E-6	1.25E-5	Y	C
7723-14-0	Phosphorus		1.20E-06	--	--	8.22E-6	3.60E-5	8.22E-6	3.60E-5	Y	A
Total				5.73E-6	2.51E-5	3.91E-5	1.71E-4	4.49E-5	1.97E-4		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *AP-42, Table 11.12-8, (06/06) Cement Silo Filing, Controlled.* 20% *Cr (VI), IDEQ email on 11/23/2020* 0.0002 0.0002

(3) *AP-42, Table 11.12-8, (06/06) Central Mix Batching, Controlled.* 21.29% *Cr (VI), IDEQ email on 11/23/2020* chk

Conversions

24 hr/day

CONCRETE PRODUCTION - CONTINUED

Source Data

Source ID	Description	PM Emissions lb/day	PM Emissions ton/yr
CAL	Aggregate Bin Loading	16.56	1.73
CAU	Aggregate Bin Unloading	16.56	1.73
Total		33.12	3.45

HAP/TAP Emission Factors and Emissions

CAS No.	Pollutant	Concentration ppm[2]	Emissions[1] lb/hr	Emissions[1] ton/yr	TAP	A/C
7440-38-2	Arsenic	23	1.81E-05	7.94E-05	Y	C
7440-41-7	Beryllium	0.8	6.30E-07	2.76E-06	Y	C
7440-43-9	Cadmium	0.25	1.97E-07	8.63E-07	Y	C
7440-48-4	Cobalt	4	5.52E-06	1.38E-05	Y	A
7440-47-3	Chromium	15	2.07E-05	5.18E-05	Y	A
7439-97-6	Mercury	0.02	2.76E-08	6.90E-08	N	
7439-96-5	Manganese	236.5	3.26E-04	8.16E-04	Y	A
7440-02-0	Nickel	5	3.94E-06	1.73E-05	Y	C
7439-92-1	Lead	3	4.14E-06	1.04E-05	N	
7440-36-0	Antimony	2.5	3.45E-06	8.63E-06	Y	A
7723-14-0	Phosphorus	130	1.79E-04	4.49E-04	Y	A
7440-22-4	Silver	0	0.00E+00	0.00E+00	Y	A
7429-90-5	Aluminum	22600	3.12E-02	7.80E-02	Y	A
7440-39-3	Barium	145	2.00E-04	5.00E-04	Y	A
7440-50-8	Copper	5	6.90E-06	1.73E-05	Y	A
7439-89-6	Iron	10350	1.43E-02	3.57E-02	Y	A
7439-98-7	Molybdenum	0.5	6.90E-07	1.73E-06	Y	A
7440-28-0	Thallium	5	6.90E-06	1.73E-05	Y	A
7440-61-1	Uranium	5	6.90E-06	1.73E-05	Y	A
7440-62-2	Vanadium	15.5	2.14E-05	5.35E-05	Y	A
7440-33-7	Tungsten	5	6.90E-06	1.73E-05	Y	A
7440-66-6	Zinc	18	2.48E-05	6.21E-05	Y	A
Total			4.63E-02	1.16E-01		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *See LIME PRODUCTION, page 10*

1E+6 parts/ppm

FUEL STORAGE - GASOLINE

Source Data

Source ID	Description	VOC Emissions lb/day	VOC Emissions ton/yr
	description	VOC_ppd	VOC_tpy
TG1	Mine Site Gasoline Tank #1	5.25	0.96
TG2	Mine Site Gasoline Tank #2	5.25	0.96
Total		10.49	1.91

HAP/TAP Emission Factors and Emissions

CAS No.	Pollutant	Concentration wt. %[2]	Emissions[1] lb/hr	Emissions[1] ton/yr	TAP	A/C
			lb/hr	ton/yr		
71-43-2	Benzene	1.608%	7.03E-03	3.08E-02	Y	C
92-52-4	Biphenyl	0.010%	4.37E-05	1.91E-04	Y	A
110-82-7	Cyclohexane	0.240%	1.05E-03	4.60E-03	Y	A
110-54-3	Hexane	7.138%	3.12E-02	1.37E-01	Y	A
91-20-3	Naphthalene	0.444%	1.94E-03	8.50E-03	Y	A
108-95-2	Phenol	0.055%	2.40E-04	1.05E-03	Y	A
108-88-3	Toluene	7.212%	3.15E-02	1.38E-01	Y	A
25551-13-7	Trimethyl benzene	2.500%	1.09E-02	4.79E-02	Y	A
1330-20-7	Xylene	7.170%	3.13E-02	1.37E-01	Y	A
Total			1.15E-01	5.05E-01		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *(EPA 1999a)*

MINING FUGITIVE EMISSIONS

Dust Emissions

Source Data **Model Scenario** **W3** **T-RACT Emissions**

Operating schedule 365 day/yr

Clean rock cap (CR) >50% [1]

[1] *(Perpetua 2021h) Percent of VMTs on haul roads capped with CR*

Roads outside of the pits and DRSFs are capped with CR

Source ID	Description	PM Emissions lb/day	PM Emissions ton/yr
YPP	Yellow Pine Pit	--	--
HFP	Hangar Flats Pit	--	--
WEP	West End Pit	338.16	61.71
BT	Bradley Tailings	--	--
YPPBL	Yellow Pine Pit Blasting	--	--
HFPBL	Hangar Flats Pit Blasting	--	--
WEPBL	West End Pit Blasting	643.03	117.35
BTBL	Bradley Tailings Blasting	--	--
STKP	PC Stockpile	--	--
FDRSF	Fiddle DRSF	--	--
HFDRSF	Hangar Flats DRSF	152.12	27.76
YPDRSF	Yellow Pine DRSF	--	--
WEDRSF	West End DRSF	--	--
HR000	Haul Roads	12,723.41	2,322.02
TSF	Tailing Storage Facility	--	--
ACCRD	Access Roads	38.10	6.95
UGEXP	Scout Portal	0.008	0.002
Total		13,894.82	2,535.81

TSF, ACCRD, UGEXP 38.11 6.95 chk 2535.81

HAP/TAP Emission Factors

CAS No.	Pollutant	ORE Concentration ppm[1]	DR Concentration ppm[1]	CR Concentration ppm[3]	HRD Concentration ppm[4]	Borrow Concentration ppm[5]	AR Concentration ppm
7440-38-2	Arsenic	667	667	90	378.5	2.5	2.5
7440-41-7	Beryllium	3.2	3.2		3.2		3.2
7440-43-9	Cadmium	0.5	0.5		0.5		0.5
7440-48-4	Cobalt	4	4		4		4
7440-47-3	Chromium	9	9		9		9
7439-97-6	Mercury [2]	0.96	0.6		0.6		0.6
7439-96-5	Manganese	299	299		299		299
7440-02-0	Nickel	2	2		2		2
7439-92-1	Lead	8	8		8		8
7440-36-0	Antimony	23	23		23		23
7723-14-0	Phosphorus	650	650		650		650
7782-49-2	Selenium	0.4	0.4		0.4		0.4
7440-22-4	Silver	0.5	0.5		0.5		0.5
7429-90-5	Aluminum	71000	71000		71000		71000
7440-39-3	Barium	800	800		800		800
1317-65-3	Calcium Carbonate	14000	14000		14000		14000
7440-50-8	Copper	5	5		5		5
7439-89-6	Iron	18200	18200		18200		18200
7439-98-7	Molybdenum	1	1		1		1
7440-28-0	Thallium	10	10		10		10
7440-61-1	Uranium	10	10		10		10
7440-62-2	Vanadium	28	28		28		28
7440-33-7	Tungsten	10	10		10		10
7440-66-6	Zinc	35	35		35		35

[1] *(Midas Gold 2017c)* *Median concentration of 55,000 SGP samples.* *1E+6 parts/ppm*

[2] *(Midas Gold 2018e)* *Median ore and development rock (DR) concentrations of 151,000 samples; resource block model.*

[3] *(Perpetua 2021g)* *Median concentration of 265 SGP samples.*

[4] *HRD: haul road - emissions calculated based on 50% of the total VMT occuring on CR*

[5] *(ALS 2018)* *Median concentration of 8 SGP samples.*

DR DR DR DR DR DR DR DR ORE DR DR DR DR HRD DR/AR

MINING FUGITIVE EMISSIONS - CONTINUED **Model Scenario W3** DR **T-RACT Emissions**

HAP/TAP Emissions

Hourly [1] YPP_pph HFP_pph WEP_pph BT_pph YPPBL_pph HFPBL_pph WEPBL_pph BTBL_pph STKP_pph FDRSF_pph HFDRSF_pph YPDRSF_pph WEDRSF_pph HR000_pph CCRD, UGEX lb/hr

CAS No.	Pollutant	YPP lb/hr	HFP lb/hr	WEP lb/hr	BT lb/hr	YPPBL lb/hr	HFPBL lb/hr	WEPBL lb/hr	BTBL lb/hr	STKP lb/hr	FDRSF lb/hr	HFDRSF lb/hr	YPDRSF lb/hr	WEDRSF lb/hr	HR000 lb/hr	TSF, ACCRD, UGEXP lb/hr	Total lb/hr
7440-38-2	Arsenic	0	0	9.4E-3	0	0	0	0.018	0	0	0	4.2E-3	0	0	0.201	4.2E-6	0.232
7440-41-7	Beryllium	0	0	4.5E-5	0	0	0	8.6E-5	0	0	0	2.0E-5	0	0	1.7E-3	5.1E-6	1.9E-3
7440-43-9	Cadmium	0	0	7.0E-6	0	0	0	1.3E-5	0	0	0	3.2E-6	0	0	2.7E-4	7.9E-7	2.9E-4
7440-48-4	Cobalt	0	0	5.6E-5	0	0	0	1.1E-4	0	0	0	2.5E-5	0	0	2.1E-3	6.4E-6	2.3E-3
7440-47-3	Chromium	0	0	1.3E-4	0	0	0	2.4E-4	0	0	0	5.7E-5	0	0	4.8E-3	1.4E-5	5.2E-3
7439-97-6	Mercury	0	0	8.5E-6	0	0	0	1.6E-5	0	0	0	3.8E-6	0	0	3.2E-4	9.5E-7	3.5E-4
7439-96-5	Manganese	0	0	4.2E-3	0	0	0	8.0E-3	0	0	0	1.9E-3	0	0	0.159	4.7E-4	0.173
7440-02-0	Nickel	0	0	2.8E-5	0	0	0	5.4E-5	0	0	0	1.3E-5	0	0	1.1E-3	3.2E-6	1.2E-3
7439-92-1	Lead	0	0	1.1E-4	0	0	0	2.1E-4	0	0	0	5.1E-5	0	0	4.2E-3	1.3E-5	4.6E-3
7440-36-0	Antimony	0	0	3.2E-4	0	0	0	6.2E-4	0	0	0	1.5E-4	0	0	0.012	3.7E-5	0.013
7723-14-0	Phosphorus	0	0	9.2E-3	0	0	0	0.017	0	0	0	4.1E-3	0	0	0.345	1.0E-3	0.376
7782-49-2	Selenium	0	0	5.6E-6	0	0	0	1.1E-5	0	0	0	2.5E-6	0	0	2.1E-4	6.4E-7	2.3E-4
7440-22-4	Silver	0	0	7.0E-6	0	0	0	1.3E-5	0	0	0	3.2E-6	0	0	2.7E-4	7.9E-7	2.9E-4
7429-90-5	Aluminum	0	0	1.000	0	0	0	1.902	0	0	0	0.450	0	0	37.640	0.113	41.106
7440-39-3	Barium	0	0	0.011	0	0	0	0.021	0	0	0	5.1E-3	0	0	0.424	1.3E-3	0.463
1317-65-3	Calcium Carb	0	0	0.197	0	0	0	0.375	0	0	0	0.089	0	0	7.422	0.022	8.105
7440-50-8	Copper	0	0	7.0E-5	0	0	0	1.3E-4	0	0	0	3.2E-5	0	0	2.7E-3	7.9E-6	2.9E-3
7439-89-6	Iron	0	0	0.256	0	0	0	0.488	0	0	0	0.115	0	0	9.649	0.029	10.537
7439-98-7	Molybdenum	0	0	1.4E-5	0	0	0	2.7E-5	0	0	0	6.3E-6	0	0	5.3E-4	1.6E-6	5.8E-4
7440-28-0	Thallium	0	0	1.4E-4	0	0	0	2.7E-4	0	0	0	6.3E-5	0	0	5.3E-3	1.6E-5	5.8E-3
7440-61-1	Uranium	0	0	1.4E-4	0	0	0	2.7E-4	0	0	0	6.3E-5	0	0	5.3E-3	1.6E-5	5.8E-3
7440-62-2	Vanadium	0	0	3.9E-4	0	0	0	7.5E-4	0	0	0	1.8E-4	0	0	0.015	4.4E-5	0.016
7440-33-7	Tungsten	0	0	1.4E-4	0	0	0	2.7E-4	0	0	0	6.3E-5	0	0	5.3E-3	1.6E-5	5.8E-3
7440-66-6	Zinc	0	0	4.9E-4	0	0	0	9.4E-4	0	0	0	2.2E-4	0	0	0.019	5.6E-5	0.020
Total		0	0	1.490	0	0	0	2.834	0	0	0	0.670	0	0	55.918	0.167	61.079

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.* chk 61.0794 61.0794

DR DR DR DR DR DR DR DR ORE DR DR DR DR HRD DR/AR

MINING FUGITIVE EMISSIONS - CONTINUED **Model Scenario W3** DR **T-RACT Emissions**

HAP/TAP Emissions

Annual

		YPP_tpy	HFP_tpy	WEP_tpy	BT_tpy	YPPBL_tpy	HFPBL_tpy	WEPBL_tpy	BTBL_tpy	STKP_tpy	FDRSF_tpy	HFDRSF_tpy	YPDRSF_tpy	WEDRSF_tpy	HR000_tpy	CCRD, UGEX	ton/yr
		YPP	HFP	WEP	BT	YPPBL	HFPBL	WEPBL	BTBL	STKP	FDRSF	HFDRSF	YPDRSF	WEDRSF	HR000	TSF, ACCRD, UGEXP	Total
CAS No.	Pollutant	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr
7440-38-2	Arsenic	0	0	0.041	0	0	0	0.078	0	0	0	0.019	0	0	0.879	1.8E-5	1.017
7440-41-7	Beryllium	0	0	2.0E-4	0	0	0	3.8E-4	0	0	0	8.9E-5	0	0	7.4E-3	2.2E-5	8.1E-3
7440-43-9	Cadmium	0	0	3.1E-5	0	0	0	5.9E-5	0	0	0	1.4E-5	0	0	1.2E-3	3.5E-6	1.3E-3
7440-48-4	Cobalt	0	0	2.5E-4	0	0	0	4.7E-4	0	0	0	1.1E-4	0	0	9.3E-3	2.8E-5	0.010
7440-47-3	Chromium	0	0	5.6E-4	0	0	0	1.1E-3	0	0	0	2.5E-4	0	0	0.021	6.3E-5	0.023
7439-97-6	Mercury	0	0	3.7E-5	0	0	0	7.0E-5	0	0	0	1.7E-5	0	0	1.4E-3	4.2E-6	1.5E-3
7439-96-5	Manganese	0	0	0.018	0	0	0	0.035	0	0	0	8.3E-3	0	0	0.694	2.1E-3	0.758
7440-02-0	Nickel	0	0	1.2E-4	0	0	0	2.3E-4	0	0	0	5.6E-5	0	0	4.6E-3	1.4E-5	5.1E-3
7439-92-1	Lead	0	0	4.9E-4	0	0	0	9.4E-4	0	0	0	2.2E-4	0	0	0.019	5.6E-5	0.020
7440-36-0	Antimony	0	0	1.4E-3	0	0	0	2.7E-3	0	0	0	6.4E-4	0	0	0.053	1.6E-4	0.058
7723-14-0	Phosphorus	0	0	0.040	0	0	0	0.076	0	0	0	0.018	0	0	1.509	4.5E-3	1.648
7782-49-2	Selenium	0	0	2.5E-5	0	0	0	4.7E-5	0	0	0	1.1E-5	0	0	9.3E-4	2.8E-6	1.0E-3
7440-22-4	Silver	0	0	3.1E-5	0	0	0	5.9E-5	0	0	0	1.4E-5	0	0	1.2E-3	3.5E-6	1.3E-3
7429-90-5	Aluminum	0	0	4.382	0	0	0	8.332	0	0	0	1.971	0	0	165	0.494	180
7440-39-3	Barium	0	0	0.049	0	0	0	0.094	0	0	0	0.022	0	0	1.858	5.6E-3	2.029
1317-65-3	Calcium Carb	0	0	0.864	0	0	0	1.643	0	0	0	0.389	0	0	32.508	0.097	35.501
7440-50-8	Copper	0	0	3.1E-4	0	0	0	5.9E-4	0	0	0	1.4E-4	0	0	0.012	3.5E-5	0.013
7439-89-6	Iron	0	0	1.123	0	0	0	2.136	0	0	0	0.505	0	0	42.261	0.127	46.152
7439-98-7	Molybdenum	0	0	6.2E-5	0	0	0	1.2E-4	0	0	0	2.8E-5	0	0	2.3E-3	7.0E-6	2.5E-3
7440-28-0	Thallium	0	0	6.2E-4	0	0	0	1.2E-3	0	0	0	2.8E-4	0	0	0.023	7.0E-5	0.025
7440-61-1	Uranium	0	0	6.2E-4	0	0	0	1.2E-3	0	0	0	2.8E-4	0	0	0.023	7.0E-5	0.025
7440-62-2	Vanadium	0	0	1.7E-3	0	0	0	3.3E-3	0	0	0	7.8E-4	0	0	0.065	1.9E-4	0.071
7440-33-7	Tungsten	0	0	6.2E-4	0	0	0	1.2E-3	0	0	0	2.8E-4	0	0	0.023	7.0E-5	0.025
7440-66-6	Zinc	0	0	2.2E-3	0	0	0	4.1E-3	0	0	0	9.7E-4	0	0	0.081	2.4E-4	0.089
Total		0	0	6.527	0	0	0	12.412	0	0	0	2.936	0	0	245	0.731	268
															chk	267.5280	267.5280

MINING FUGITIVE EMISSIONS - CONTINUED

Mercury Evaporative Flux Emissions

Fugitive Mercury Flux and Emissions

			Area		Hg Flux	Emissions[1] lb/hr	Emissions[1] ton/yr	Emissions[1] lb/yr
CAS No.	Pollutant	Source	m^2	ha	µg/m^2-yr			
		Stockpiles	52,623	5.3	556	7.37E-6	3.2E-5	6.5E-2
		Rock Dumps	2,063,990	206.4	76.2	3.96E-5	1.7E-4	0.35
		Tailings	1,338,158	133.8	2,144	7.22E-4	3.2E-3	6.32
		Pits	1,504,919	150.5	132.3	5.01E-5	2.2E-4	0.44
7439-97-6	Mercury					8.2E-4	3.6E-3	7.17

(1) *Hourly emissions based on:* 8,760 *hours per year of operation*

Fugitive Mercury Emission Factors

	Twin Creeks (TC)		Ore Hg Adjusted	Stibnite	
	Hg Flux (1)	Hg (2)	µg/m^2/yr	Hg Flux (3)	Hg (4)
Source	µg/m^2-yr	µg/g	TC	µg/m^2-yr	µg/g
Stockpiles	5,609	33	556	556	0.96
Rock Dumps	768	3.5	76.2	76.2	0.60
Tailings	21,621	33	2,144	2,144	0.96
Pits	1,334	9.5	132	132.3	0.60

(1) *(Eckley 2010)* *Table 1: Hg flux µg/m^2-yr*

(2) *(Eckley 2010)* *Table 1: Average Hg flux mg/g: " Stockpiles - high-grade stockpiles, Rock Dumps - waste rock dumps, Tailings - high-grade stockpiles as a surrogate; Pits - pit"*

(3) *(Eckley 2010)* *Figure 2: log(y) = m*log(x) + b*

y = Hg Flux (ng/m^2-d)
x = material Hg concentration (µg/g)]

Slope =	*Solar*	*TC*
	Low	*0.59*
	Medium	*0.6*
	High	*0.77*
	Average	*0.65*

(4) *(Midas Gold 2018e)*

Sample Calculation: m = log (y1/y2) / log(x1/x2)

m=	0.65	unitless
y1=	5,609	µg/m^2-yr
x1=	33	µg/m^2-yr
x2=	0.96	µg/m^2-yr
log(x1/x2)=	1.536243	unitless
log(y1/y2)=	1.003679	unitless
y1/y2=	10.08506	unitless
y2=	556.2	µg/m^2-yr

Conversions

2,000	lb/ton
10,000	m2/ha
453.593	g/lb

TABLE A-W3. HAP/TAP Emissions and Exemptions

T-RACT Emissions						MINING										LEACHING	
chk						*Mining*	*Model Scenario*	*W3*								*CN Leach/PAX*	
						YPP,HFP,WEP,BT		YPPBL,HFPBL,WEPBL,BTBL		HR000		STKP, FDRSF, HFDRSF, YPDRSF, WEDRSF		TSF,ACCRD,UGEXP			
CAS	HAP/TAP	HAP	TAP			Pits		Blasting		Haul Roads		Stockpiles and DRFS		Tails, Access Road, Exploration		CN Leach and PAX	
	NSPS or NESHAP HAP/TAP -->			*Y*													
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				A/C	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
7440-38-2	Arsenic	Y	Y	Y	C	9.4E-3	0.041	0.018	0.078	0.201	0.879	4.2E-3	0.019	4.2E-6	1.8E-5		
7440-41-7	Beryllium	Y	Y	Y	C	4.5E-5	2.0E-4	8.6E-5	3.8E-4	1.7E-3	7.4E-3	2.0E-5	8.9E-5	5.1E-6	2.2E-5		
7440-43-9	Cadmium	Y	Y	Y	C	7.0E-6	3.1E-5	1.3E-5	5.9E-5	2.7E-4	1.2E-3	3.2E-6	1.4E-5	7.9E-7	3.5E-6		
50-00-0	Formaldehyde	Y	Y	Y	C												
7440-02-0	Nickel	Y	Y	Y	C	2.8E-5	1.2E-4	5.4E-5	2.3E-4	1.1E-3	4.6E-3	1.3E-5	5.6E-5	3.2E-6	1.4E-5		

TABLE A-W3. HAP/TAP Emissions and Exemptions

T-RACT Emissions						PROCESSING AND PRODUCTION											
chk						*Ore Processing*				*Ore Concentration and Refining*				*Process Heating*			
						OC1-13		PS		AC		EW,MR,MF,CKD		ACB, CKB, PV, HS		LKC	
CAS	HAP/TAP	HAP	TAP			Crushers & Xfers		Prill Silos		Autoclave		EW, Preg Tank, Retort, Furnace, Carbon Kiln		POX Boiler, C. Kiln Comb., Prop. Vap., Sol'n Heater		Lime Kiln Combustion	
	NSPS or NESHAP HAP/TAP -->	*Y*				***LL***	***LL***			***7E***	***7E***	***7E***	***7E***			***5A***	***5A***
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				**A/C**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
7440-38-2	Arsenic	Y	Y	Y	C	3.9E-3	0.017			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.5E-6	6.4E-6	3.7E-6	1.6E-5
7440-41-7	Beryllium	Y	Y	Y	C	1.9E-5	8.2E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	8.7E-8	3.8E-7	2.2E-7	9.6E-7
7440-43-9	Cadmium	Y	Y	Y	C	2.9E-6	1.3E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	8.0E-6	3.5E-5	2.0E-5	8.8E-5
50-00-0	Formaldehyde	Y	Y	Y	C									5.5E-4	2.4E-3	1.4E-3	6.0E-3
7440-02-0	Nickel	Y	Y	Y	C	1.2E-5	5.2E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.5E-5	6.7E-5	3.9E-5	1.7E-4

TABLE A-W3. HAP/TAP Emissions and Exemptions

T-RACT Emissions						PROCESSING AND PRODUCTION - Continued													
chk						*Lime Production*						*Aggregate Prod.*		*Concrete Production*					
						LS1-11,LSBM		LK,LS12,LCR,LS-L/U		LS1-L/U,MillS2-L/U,ACS1-4		PCSP1,PCSP2		CM		CS1L,CS1U,CS2L, CS2U		CA-L/U	
CAS	HAP/TAP	HAP	TAP			Limestone Crushers, Screens, Mill, Xfers		Lime Kiln, Kiln Feed, Lime Mill, Pebble Lime Silo		Lime Silos and Lime Mill Crushing		Portable Crushers, Screens, Xfers		Central Mixer		Cement Silo #1 and #2 L/U		Aggregate Bin	
	NSPS or NESHAP HAP/TAP -->			*Y*		*OOO*	*OOO*	*5A*	*5A*			*OOO*	*OOO*					*OOO*	*OOO*
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				*A/C*	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
7440-38-2	Arsenic	Y	Y	Y	C	1.0E-4	4.4E-4	2.4E-5	1.1E-4	1.1E-6	4.7E-6	2.9E-5	1.3E-4	2.0E-6	8.9E-6	1.2E-7	5.1E-7	1.8E-5	7.9E-5
7440-41-7	Beryllium	Y	Y	Y	C	3.5E-6	1.5E-5	8.4E-7	3.7E-6	3.7E-8	1.6E-7	1.0E-6	4.4E-6			1.3E-8	5.8E-8	6.3E-7	2.8E-6
7440-43-9	Cadmium	Y	Y	Y	C	1.1E-6	4.8E-6	2.6E-7	1.2E-6	1.2E-8	5.1E-8	3.1E-7	1.4E-6	4.9E-9	2.1E-8			2.0E-7	8.6E-7
50-00-0	Formaldehyde	Y	Y	Y	C														
7440-02-0	Nickel	Y	Y	Y	C	2.2E-5	9.6E-5	5.3E-6	2.3E-5	2.3E-7	1.0E-6	6.3E-6	2.7E-5	1.7E-6	7.4E-6	1.1E-6	5.0E-6	3.9E-6	1.7E-5

TABLE A-W3. HAP/TAP Emissions and Exemptions

T-RACT Emissions						PROCESSING AND PRODUCTION - Continued						MINING and LEACHING - Totals									
chk						*HVAC*		*Emer. Power/Fire*		*Fuel Storage*		*HAP Total*		*Mercury Total*		*Mercury Total*		*TAP Total*		*TAP Total*	
						H1M,H2M,HM,HAC,HR,HA,HMO,HTS,HW		EDG1,EDG2,EDG3,EDFP		TG1,TG2				*Exempt*		*Non-Exempt*		*HAP-TAP addressed by NSPS/NESHAP*		*For EL Evaluation*	
CAS	HAP/TAP	HAP	TAP			Heaters		Emergency Generators and Fire Pump		Gasoline Fuel Tanks											
	NSPS or NESHAP HAP/TAP -->	*Y*						*4Z*	*4Z*	*6C*	*6C*										
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				*A/C*	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
7440-38-2	Arsenic	Y	Y	Y	C	3.6E-6	1.6E-5					0.232	1.017							0.232	1.017
7440-41-7	Beryllium	Y	Y	Y	C	2.1E-7	9.4E-7					1.9E-3	8.1E-3							1.9E-3	8.1E-3
7440-43-9	Cadmium	Y	Y	Y	C	2.0E-5	8.6E-5					2.9E-4	1.3E-3							2.9E-4	1.3E-3
50-00-0	Formaldehyde	Y	Y	Y	C	1.3E-3	5.9E-3	5.1E-5	2.2E-4												
7440-02-0	Nickel	Y	Y	Y	C	3.8E-5	1.6E-4					1.2E-3	5.1E-3					0	0	1.2E-3	5.1E-3

TABLE A-W3. HAP/TAP Emissions and Exemptions

T-RACT Emissions						PROCESSING AND PRODUCTION - Totals										ALL	ALL	ALL	TAP EL	
chk						*HAP Total*		*Mercury Total*		*Mercury Total*		*TAP Total*		*TAP Total*		*HAP*	*Hg*	*TAP*	*TAP*	
								Exempt		*Non-Exempt*		*HAP-TAP addressed by NSPS/NESHAP*		*For EL Evaluation*			*Non-Exempt*	*For EL Evaluation*	*Emission Screening Level (EL)*	
CAS	HAP/TAP	HAP	TAP																	
	NSPS or NESHAP HAP/TAP -->		*Y*																Non-car	Carcin
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				A/C	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr	ton/yr	lb/hr	lb/hr	lb/hr
7440-38-2	Arsenic	Y	Y	Y	C	4.5E-3	0.020					4.5E-3	0.020	8.2E-6	3.6E-5	1.037		0.232	--	1.5E-6
7440-41-7	Beryllium	Y	Y	Y	C	4.3E-4	1.9E-3					4.3E-4	1.9E-3	3.5E-7	1.5E-6	0.010		1.9E-3	--	2.8E-5
7440-43-9	Cadmium	Y	Y	Y	C	4.6E-4	2.0E-3					4.3E-4	1.9E-3	2.8E-5	1.2E-4	3.3E-3		3.2E-4	--	3.7E-6
50-00-0	Formaldehyde	Y	Y	Y	C	3.3E-3	0.015					1.4E-3	6.2E-3	1.9E-3	8.3E-3	0.015		1.9E-3	--	5.1E-4
7440-02-0	Nickel	Y	Y	Y	C	5.5E-4	2.4E-3					4.9E-4	2.2E-3	5.6E-5	2.4E-4	7.5E-3		1.2E-3	--	2.7E-5

APPENDIX C REVIEW AND RATIONALE FOR SELECTED AIR EMISSION FACTORS

Review and Rationale for Selected Air Emission Factors

Stibnite Gold Project

In the report *Air Quality Analysis*, prepared by Air Sciences Incorporated for Midas Gold Idaho, Inc. (Air Sciences 2018) and in the modeling report provided to support the Permit to Construct application to IDEQ (Air Sciences 2020) a variety of published air emission factors were used to quantify pollutant emissions from the Project sources. This discussion will review the selection of emission factors, as tabulated in Tables 4 through 9 in *Air Quality Analysis*, which are excerpted from that report and provided in **Appendix A**.

The estimation of air pollutant emissions for the action alternatives considered a number of factors to derive an inventory to support the analysis of impacts:

- Construction and operation methods (e.g., earthmoving, material loading, open-pit mining, gold extraction processes);
- Design criteria (e.g., equipment type and size, hauling distances);
- Emission abatement techniques (e.g., watering, baghouse, carbon filter);
- Material characteristics (e.g., moisture content, silt content, density); and
- Site characteristics (e.g., wind, precipitation).

Activity-specific (e.g., drilling, blasting, material crushing and conveying, refining, and other ancillary sources) emissions were estimated based on the maximum activity rates during each life-of-mine year, coupled with applicable emission estimation techniques. Maximum emissions were calculated on a short-term (hourly and daily) and a long-term (annual) basis for ore processing, mining operations, and construction activities. The full inventory of emissions for Alternative 1 and Alternative 2 (lime kiln operation) are provided in Appendices A and B, respectively, in the report Air Quality Analysis prepared for the Project (Air Sciences Inc. 2018), and reproduced in this document as **Appendix A**. The alternative emission inventory used for the IDEQ air permit application (Air Sciences 2020) is provided in **Appendix B**.

Emission Factor Use and Uncertainty

An emission factor is usually a well-supported, representative value that reasonably relates the quantity of a pollutant released from some activity or process to a quantitative measure of the intensity or rate of the activity. Examples of the measure of activity rate are acres disturbed, tons processed, gallons of fuel combusted, or thermal content of fuel utilized. The units of the corresponding emission factor would be the weight of pollutant released per unit of activity (e.g., pounds CO/1000-gallon fuel combusted, pounds PM per acre of soil disturbed). If the activity rate is quantified for a specific period of time, then the emission rate per that unit of time can be calculated:

$$E = A \times EF \times (1 - ER/100)$$

where:

E = emission rate (e.g., weight pollutant emitted per unit of time)

A = activity rate (e.g., a quantity of a particular activity per unit of time)

EF = emission factor (e.g., weight pollutant released per unit of activity)

ER = overall emission reduction efficiency (a percent of emission abated) for a control device or mitigation measure.

The estimation of the activity rates "A" for a future operation is subject to uncertainty for several reasons. It is not possible to predict with certitude the specific level of an activity, e.g., fuel combusted, area disturbed, or tons of material processed, for an operation during the early planning stages. As construction and operational parameters are more closely defined during detail design and actual construction, the activity rate estimates would be more certain. For pre-construction licensing and permitting, the values of "A" are selected to conservatively high-biased, to avoid under-estimating of emissions and impacts.

In general, emission factors are representative of a broad average of emissions data available for a specific source category. So, a single emission factor encompasses data from many actual operations that cover a relatively large range of actual emission rates per unit of activity. One should consider the AP-42 emission factors as representing an average of the range of measured or calculated emission rates. Approximately half of the sources in this population would have emission factors higher than the published average, and the remainder would have lower factors (EPA 2003).

In EPA Document AP-42, the level of uncertainty in a given factor is indicated by an "emission factor rating" with values ranging from "A" for best accuracy, and "E" for greater uncertainty. To illustrate the level of confidence in judging emission estimates, it can be noted that nearly all the emission factor values in Section 11.19.2 in Document AP-42, which is relied upon for many Project sources, have emission factor ratings of "D" or "E" (EPA 2003). To compensate for this uncertainty, the accepted practice is to over-estimate the activity rates for a given operation to avoid under-reporting the final estimates. It is also noteworthy the guidance from the State of Nevada, which is the home of numerous surface gold mines, supports the use of factors from this AP-42 section for surface mining operations (NDEP 2017).

Rationale for Emission Factor Selections Used for the Project

Mining operations, such as those described for the Stibnite Gold Project (the Project) involve a large number of emission source categories characterized by the type of process, material processed, and equipment used. For the Project air pollutant emission sources, activity-specific emission factors and techniques provided in industry-standard technical documents. The remainder of this section provides the rationale for emission factor selection, organized by the tables reproduced in this Appendix. These factors were used for the emission inventory and air impact modeling study prepared for the Project. While alternative emission factor choices are available in the literature, the discussion below describes the

reasoning why the selected factors were used. Most emission factor selections followed guidance from the Nevada Division of Environmental Protection (NDEP 2017).

Table 4. Process Source EF from AP-42.

Material Transfer, Crushing, Screening, AP-42 Table 11.19.2-2: For these operations involving transfer and processing of gold or and waste rock, the emission factors in Table 11.19.2-2 are based on data from processes and materials with close physical similarity to the Project. These factors have ratings of C or D, which indicates moderate uncertainty in using these values for a specific process source. As described in Section 11.19.2:

> Major rock types processed by the crushed stone industry include limestone, granite, dolomite, traprock, sandstone, quartz, and quartzite. Minor types include calcareous marl, marble, shell, and slate. Rock and crushed stone products generally are loosened by drilling and blasting and then are loaded by power shovel or front-end loader into large haul trucks that transport the material to the processing operations. Techniques used for extraction vary with the nature and location of the deposit. Processing operations may include crushing, screening, size classification, material handling and storage operations.

Ball Mill, AP-42 Table 11.19.2-4: The ball mill for the project will be handling minerals of the same nature as that used to derive the emission factors in Table 11.19.2-4. This is a broadly representative value for this type of source. Based on the references cited in AP-42, this factor was derived by the EPA using data obtained from the Pulverized Mineral Division of the National Stone, Sand, and Gravel Association.

Lime Kiln Crushing and Transfer, AP-42 Table 11.17-4: One alternative that will be addressed in the EIS is the implementation of an on-site limestone recovery and lime kiln operation. For this alternative, the emission factors cited in Air Quality Analysis are specifically for the lime production process, using limestone as the raw materials, which would differ from the run of mine ore and waste rock otherwise used in the Project.

Lime/Cement/Shotcrete Silo Storage, Aggregate Bin, Central Mixer, AP-42 Table 11.12-2: The material involved in these steps for the Project most closely resemble the physical materials and processes of the concrete batching industry. The size distribution and moisture content would be comparable to the raw materials used for blending concrete. The silos, transfer equipment, and the cement mixer (stationary or mobile) would be essentially identical to the industry sources in this AP-42 section.

Prill Silo Loading/Unloading, AP-42 Table 8.3-2: This operation refers to the silo loading and unloading of ammonium nitrate "prill", which is a solid form of the chemical produced for blending of ANFO explosive. This matches the actual material and physical handling operations for prill that are describe in this section of AP-42:

> Ammonium nitrate is marketed in several forms, depending upon its use. . . .Solid ammonium nitrate may be produced in the form of prills, grains, granules, or crystals. Prills can be produced in either high or low density form, depending on the concentration of the melt. High density prills, granules,

and crystals are used as fertilizer, grains are used solely in explosives, and low density prills can be used as either.

Propane-fired Heaters and Boilers, AP-42 Table 1.5-1: This table provides the accepted factors for external combustion equipment using liquefied petroleum gas (LPG), which is the commercial form of propane that would be used by the process sources. Although this table and the individual average values are based on a substantial data set, the emission factors have a rating of "E". This is the ranking with most uncertainty, due to the wide variation in the emissions data, fuel characteristics, and combustion conditions for the equipment in this source category.

Table 5. Process Source EF from Similar Source Test Data or Permit Limits

In this table, the selected emission factors are derived from similar gold ore refining and related processes in Nevada. There are numerous gold mines and processing facilities in Nevada, and these are regulated by the Nevada Division of Environmental Protection (NDEP) that demonstrates compliance with permit conditions through reference method testing. The physical similarity of the listed processes at gold mines in Nevada to those planned for the Project, and the level of data quality underlying these emission rates, supports the use of the Nevada mine emission rate data for these sources that are specific to gold ore processing. The processes and materials processed (low-moisture, gold-bearing ores) for the sources described in the NDEP information are closely resemble these same point sources that would be included in the Project. The individual steps in refining are well-established by industrial practice, and do not differ significantly between facilities.

The primary consideration for acceptance of an emission factor or emission rate data for a given source is whether the source characteristics underlying the selected factor are more representative of the activity than for other alternative emission factors that could be adopted. There is limited literature on published emission factors for the gold ore refining and concentrate bagging processes listed in Table 5, and those published factors represent operations that are not specific to gold extraction, or bagging of powdered metal concentrates. In such cases, emission factors or rates can be developed from alternative information, that has been accepted by another state agency, and that more closely aligns with the processes of interest. This can include stack test results and other engineering analyses provided by air quality agencies that support permit compliance, as is the case for the NDEP factors listed in Table 5 (NDEP 2012; NDEP 2015).

The sources listed in Table 5 are process point sources. For these specific sources, the emission characteristics rely on fuel combustion, nature of the material being bagged, and the physical treatment of the material involved (e.g., ore heating in the autoclave, stripping of carbon by heating in a kiln, melting of precipitated gold sludge in a furnace). The processes and materials processed (low-moisture, gold-bearing ores) for the northern Nevada sources described in the NDEP information are comparable to these same point sources included in the Project. Gold mines in Nevada are regulated by NDEP, so the supporting emission information is also viewed as technically credible.

For several processes that are specific to gold ore processing, Midas Gold elected to use NDEP information for gold refining emission rates, rather than EPA Document AP-42. However, at the time of this report it is not confirmed by IDEQ that NDEP emission factors will be acceptable for permitting of

the Project. The IDEQ will review and have final approval of the use of these Nevada gold refining process factors as part of the air permit development for the Project. However, the physical similarity of the listed processes at gold mines in Nevada to those for the Plan supports the use by Midas Gold of the Nevada emission factors for these sources that are specific to gold ore refining.

Table 6. EF Used to Calculate Mining Activity Emissions

Drilling, AP-42, Table 11.9-4, Blasting (PM), Dozing and Grading, AP-42 Table 11.9-1: This section of AP-42 addresses surface coal mining sources. However, in AP-42 this is the sole industry for which emission factors for drilling, blasting, bulldozing and surface grading are provided for a extractive mining facility, versus a more generic construction environment. The Project inventory follows accepted practice in using these mining emission factors for the general operations that involve surface overburden and waste rock, which it has in common with surface coal mining.

Blasting (CO), AP-42 Table 13.3-1: There is limited published information on the nature of pollutant emissions due to the ANFO as a blasting agent. The references for this table in AP-42 are dated 1974, and 1976, when measurement techniques were not as sophisticated or accurate as later analytical instruments. The factor rankings are "D" which infers relatively high uncertainty. Normal practice is to use the values in this AP-42 table as a default, unless more recent and accurate information is available.

Blasting (NO_X) CSIRO 2008, and (SO_2) material balance: More recent data than that in AP-42 was obtained for NO_X emissions due to blasting at surface mines, and was preferred for NO_X for this source (CSIRO 2008). A material balance for SO_2 uses the actual sulfur content of the blasting agent for the Project, which is preferable to an industry-wide average value.

Truck Hauling, Water Trucking, Vehicle Travel on Burntlog Route and Warm Lake Route, EF Equations in AP-42 Section 13.2.2: These equations are the accepted correlations for a wide variety of vehicle travel on unpaved ground, for road travel, construction, and mining operations. The selection of parameters for the correlation 1a (silt, and mean vehicle weight) were vetted by the agencies during initial development of this Project inventory.

Truck Loading, Unloading and Wet Drilling, AP-42 Table 11.19.2-2. See the discussion of the AP-42 table in under Table 4, above. These calculations also use the ratio of $PM_{2.5}$ to PM_{10} that is used to characterize emission from "batch drop" of bulk materials, which are correlated to the prevailing wind speed and material moisture.

Helicopter, AP-42, Volume II, Table II-1-3-7: This is the set of engine tailpipe emission factors that are published by EPA that are specific to this category of aviation engine.

Table 7. MOVES 2014a EF Used to Calculate On-Road Vehicle Tailpipe Emissions

The MOVES program 2014a version is the most recent tool for the estimation of on-road vehicle tailpipe emissions. The key parameter is the selection of vehicle categories and weight classes for use of the model. The categories used in this case match well with the roster of vehicles planned for the Project (EPA 2015).

Table 8. EF Used to Calculate Construction Activity Emissions

Dozing, Compacting, Grading, Table 11.9-1, Scraper Unloading, AP-42 Table 11.9-4: Refer to the discussion of these AP-42 tables under Table 6, above.

Scraper in Travel, Topsoil Removal, Overall General Construction, AP-42 Table 13.2.3-1: For construction operations that are not directly associated with mining, such as scraper travel, topsoil handling, and generic site grading, the emission factors in Section 13.2.3 are normally used. These types of operations are characterized by a need to estimate site-wide construction emissions that encompass the typical range of diverse activities, without regard to the actual plans of any individual construction project. For these reasons, this section offers accepted methods by which site-specific emissions may be estimated.

Material Loading, Material Dumping, AP-42 Section 11.19.2-2: Refer to the discussion of this AP-42 table under Table 4, above. For these construction operations at the Project, the material handled is of the same nature as that involved in crushed stone extraction and handling operations.

Table 9. Control Techniques and Efficiencies in Emission Calculations

For this table, it should be noted that with two exceptions, the emission factors that are identified in the preceeding tables include the effect of controls in the published factors. The categories of unpaved road and underground belt material transfers have control efficiencies that are calculated using correlations in AP-42, Section 13.2. The parameters used in these correlations and the resulting efficiency values have been vetted by the reviewing agencies.

REFERENCES

Air Sciences. 2018. Technical Memorandum: Unpaved Road Dust Control Efficiency from Chemical Suppressants. Kevin Lewis, Program Manager, Air Sciences Inc. to Dale Kerner, Midas Gold Idaho, Inc., January 12, 2018.

CSIRO. 2008. NO_X Emissions from Blasting Operations in Open-Cut Coal Mining. Atmospheric Environment. November, Vol. 42, pgs. 7874-7883. Available at: https://publications.csiro.au/rpr/pub?list=BRO&pid=procite:4b841578-b258-41e0-9ffd-bf03ab38f969

NDEP. 2012. Class I Air Quality Operating Permit No. AP1041-0739.02. Issued to Barrick Goldstrike Mines, Inc. Nevada Department of Conservation and Natural Resources. Division of Environmental Protection. Bureau of Air Pollution Control, March 2, 2012.

NDEP. 2015. Class II Air Quality Operating Permit No. AP3295-3398. Issued to Hectatone, Inc. Nevada Department of Conservation and Natural Resources. Division of Environmental Protection. Bureau of Air Pollution Control, April 6, 2015.

NDEP. 2017. Guidance on Emission Factors for the Mining Industry. Nevada Division of Environmental Protection (NDEP). May 31, 2017. Available at: https://ndep.nv.gov/uploads/air-permitting-docs/ndep-mining-emissions-guidance.pdf. Accessed May 2019.

United States Environmental Protection Agency (EPA). 2003. Background Information for Revised AP-42 Section 11.19-2. Crushed Stone Processing and Pulverized Mineral Processing. Air Control Technologies, Inc. for U.S. Environmental Protection Agency. May 2003.

United States Environmental Protection Agency (EPA). 2015. MOVES2014a User Guide. Assessment and Standards Division Office of Transportation and Air Quality U.S. Environmental Protection Agency. EPA-420-B-15- 095, November 2015. Available at: https://www.epa.gov/moves/moves2014a-latest-version-motor- vehicle-emission-simulator-moves.

APPENDIX D TRANSPORTATION MANAGEMENT PLAN

FINAL

Environmental Monitoring and Management Program
Appendix FM-4
Transportation Management Plan

Prepared by
Perpetua Resources Idaho, Inc.
Valley County, Idaho
July 2022

Table of Contents

List of Figures ii
List of Abbreviations iii
1. Introduction 1-1
1.1 Purpose 1-1
1.2 Background 1-1
1.3 Transportation Plan Components 1-3
1.4 Regulatory and Forest Planning Framework 1-4
1.4.1 Environmental Regulations 1-4
1.4.2 Federal, State, and County Planning Framework 1-5
2. Transportation System 2-1
2.1 Existing Conditions 2-1
2.2 Access Routes 2-3
2.2.1 Warm Lake Road (Cascade to Landmark) 2-3
2.2.2 Burntlog Route (ModPRO2) 2-4
2.2.3 Johnson Creek Route 2-4
2.3 Public Access 2-6
2.3.1 Burntlog Route (ModPRO2) 2-6
2.3.2 OSV Route (Cabin/Trout Creek and Johnson Creek; Both Alternatives) 2-7
2.3.3 Stibnite Road – Through Site Public Access 2-7
2.4 Mine Haul Roads 2-8
3. Design Features, Materials Handling, and Environmental Protection Measures 3-1
3.1 Design Features 3-1
3.1.1 Road Construction Design Standards 3-1
3.1.2 Geologic Hazards 3-2
3.1.3 Road Construction Materials 3-5
3.1.4 Bridge Restrictions 3-5
3.1.5 Long Load/Over-width Load Hauling 3-5
3.1.6 Road Maintenance 3-5
3.2 Hazardous Materials Handling and Spill Management 3-6
3.2.1 Cyanide Transport and Handling 3-6
3.2.2 Mercury Handling 3-7
3.2.3 Antimony Concentrate Transportation and Handling 3-7
3.2.4 Solid Waste Handling 3-8
3.2.5 Material Transportation Safety Measures 3-8
3.2.6 Spill Prevention, Control, and Countermeasures Plan 3-12
3.2.7 Emergency Response Plans and Procedures 3-12

3.3 Environmental Protection Measures 3-13
3.3.1 Public Use Safety 3-13
3.3.2 Avalanche 3-14
3.3.3 Landslides, Debris Flows, and Rock Fall 3-15
3.3.4 Roadway Washouts/Culvert Design 3-16
3.3.5 Safety Measures During Hazardous Road Conditions 3-16
3.3.6 Public Access During Construction 3-17
3.3.7 Wildfire 3-19
3.3.8 Response to Traffic Accidents 3-19
3.3.9 Air Quality 3-20
3.3.10 Water Quality and Aquatic Habitats 3-20
3.3.11 Culvert Design and Fish Passage 3-21
3.3.12 Wildlife 3-22
4. References 4-1

List of Figures

Figure 1-1. Vicinity Map 1-2
Figure 2-1. SGP Transportation System – Current Conditions 2-2
Figure 2-2. SGP Transportation System - Alternative Routes 2-5
Figure 2-3. Mine Haul Roads and Facilities 2-9
Figure 3-1. Geologic Hazards and Avalanche Chutes 3-4
Figure 3-2. Spill Response Kit Locations and Access Route Segments Near Streams 3-11

List of Abbreviations

AADT	average annual daily traffic
AASHTO	American Association of State Highway and Transportation Officials
ADT	average daily traffic
BNF	Boise National Forest
CFR	Code of Federal Regulations
DEIS	Draft Environmental Impact Statement
Dynamic	Dynamic Avalanche Consulting, LTD
EFSFSR	East Fork of the South Fork of the Salmon River
EMMP	Environmental Monitoring and Management Program
EPCRA	Emergency Planning and Community Right-to-Know Act
EPM	Environmental Protection Measure
ESOP	environmental standard operating procedure
FDCP	Fugitive Dust Control Plan
FR	forest road
FSH	forest service handbook
HAZWOPER	Hazardous Waste Operations and Emergency Response
H:V	horizontal to vertical length
ICMC	International Cyanide Management Code
ICMI	International Cyanide Management Institute
IDEQ	Idaho Department of Environmental Quality
IDL	Idaho Department of Lands
ISO	International Organization for Standardization
ITD	Idaho Transportation Department
Midas Gold	Midas Gold Idaho, Inc.
Mine Act	Federal Mine Safety and Health Act of 1977
ModPRO2	Refined Proposed Action
mph	miles per hour
MSHA	Mine Safety and Health Administration
NFS	National Forest System
OSHA	Occupational Safety and Health Administration
OSV	over-snow vehicle
Perpetua Resources	Perpetua Resources Idaho, Inc.
PNF	Payette National Forest
PRO	Plan of Restoration and Operations
PTC	permit to construct
RFAI	Request for additional information
ROD	Record of Decision
SDEIS	Supplemental Draft Environmental Impact Statement
SGLF	Stibnite Gold Logistics Facility

SGP	Stibnite Gold Project
SPCC	Spill Prevention, Control, and Countermeasures
SRK	SRK Consulting, Inc.
SSD	Stopping Sight Distance
SWPPP	Storm Water Pollution Prevention Plan
TMP	Transportation Management Plan
TSF	tailings storage facility
USDOT	United States Department of Transportation
USFS	United States Forest Service

Section 1

Introduction

1.1 Purpose

This Transportation Management Plan (TMP) is a facilities management component plan (Appendix FM-4) of the Stibnite Gold Project (SGP) Environmental Monitoring and Management Program (EMMP; Brown and Caldwell 2021). The purpose of the EMMP is to address environmental monitoring and management requirements in a comprehensive, systematic, planned, and documented manner. This TMP documents the methods (design features, material management, and environmental protection measures [EPMs]) for the SGP to comply with regulatory requirements and manage responsibilities for worker, public, and environmental safety standards of federal and state agencies and Perpetua Resources Idaho, Inc. (Perpetua Resources), formerly Midas Gold Idaho, Inc. (Midas Gold). This Plan will inform standard operating procedures to be incorporated into the design, construction, operation, and maintenance of the SGP transportation system.

Upon United States Forest Service (USFS) signature of the Record of Decision (ROD), Perpetua Resources will review any additional or modified requirements to the TMP and submit a revised TMP to incorporate the modifications and additions.

Additionally, as Perpetua Resources proceeds with the SGP and implements the design features, EPMs, and monitoring, the TMP will be revised if measures are determined to be overly restrictive or not functioning as intended. Similarly, environmental conditions described herein may change to a degree that warrants revising the TMP to address the changes.

1.2 Background

The SGP is a proposed open pit mine in the mountains of central Idaho that needs to provide safe access for the mine site and off-site support facilities. The SGP is located in eastern Valley County, 92 air miles and 144 road miles northeast of Boise, Idaho, 44 air miles northeast of Cascade, Idaho, and 10 air miles east of Yellow Pine, Idaho (Figure 1-1). The construction, operation, reclamation, and closure phases of the SGP would take place over approximately 20 to 25 years, followed by post-closure monitoring and maintenance. Perpetua Resources considers it a critical aspect of the SGP to be able to provide safe, reliable transportation to and from the SGP site for employees, suppliers, and contractors while maintaining safe public access to National Forest System (NFS) lands, area residences, and recreational areas.

Use of access routes are for (1) primary mine access: the transportation of mine employees, equipment, and supplies to and from the mine site during SGP construction through closure; (2) USFS and other agency administrative access for land management and project inspections; and (3) continued public access to NFS land. Most access roads described herein would be used for all three types of access.

The SGP is currently undergoing environmental impact analysis under the National Environmental Policy Act. Following initial analysis in the SGP Draft Environmental Impact Statement (DEIS; USFS 2020), Perpetua Resources submitted improvements to the DEIS Alternative 2 to the USFS in October 2021 (Perpetua Resources' Refined Proposed Action – ModPRO2; Perpetua Resources 2021).

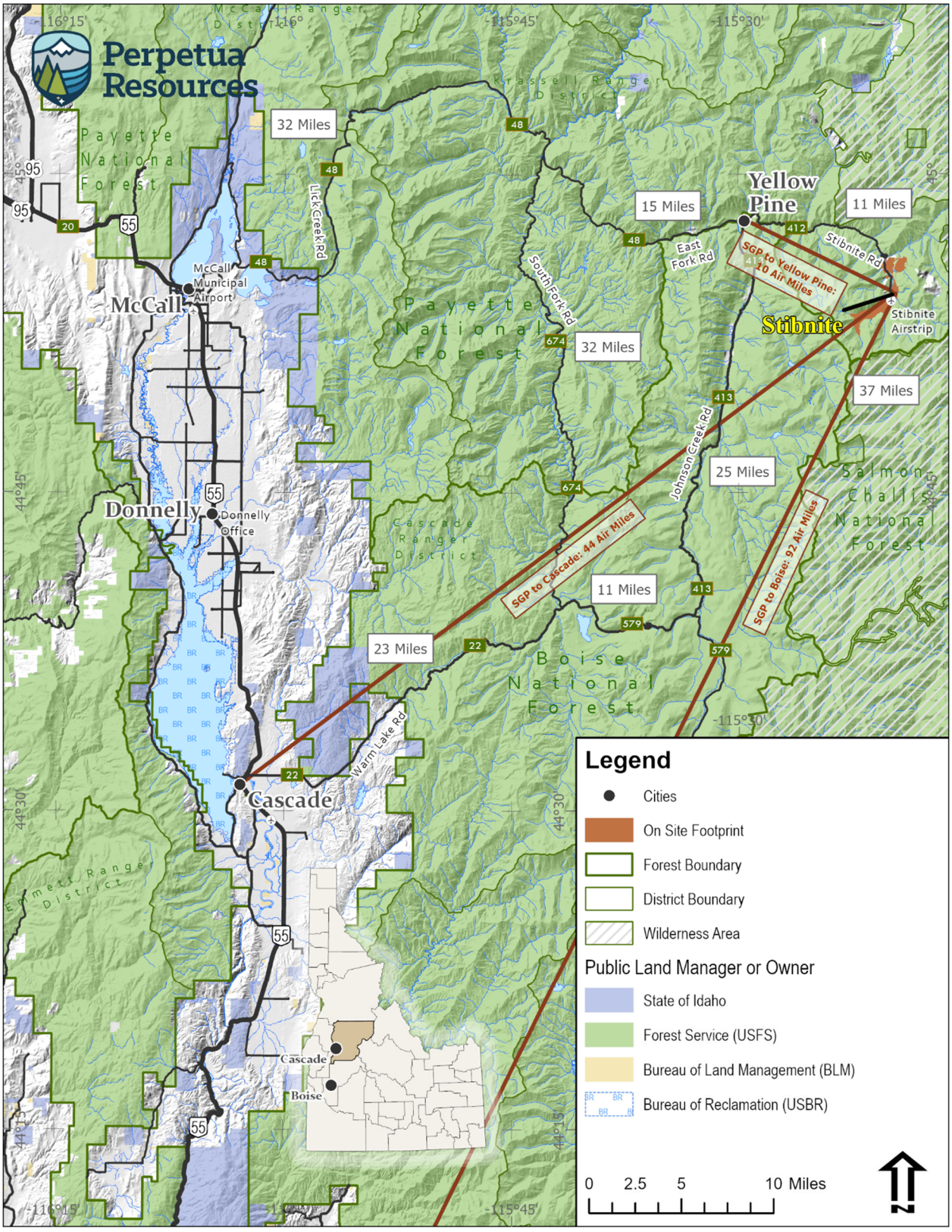


Figure 1-1. Vicinity Map

Primary mine access and public access routes carried forward for further evaluation in the forthcoming Supplemental DEIS (SDEIS) will include the refined version of DEIS Alternative 2 (ModPRO2; Perpetua Resources 2021) and a similarly refined DEIS Alternative 4 (Johnson Creek Route[1] Alternative for ModPRO2). While access differs for each alternative, the ModPRO2 mine plan and all included environmental protection measures and design features are applicable to both alternatives. Specific measures will be confirmed for the selected alternative after a ROD is signed by the USFS. This TMP will be revised to address the alternative selected at that time.

The USFS submitted requests for additional information (RFAI) in February 2021 (RFAI-120) and January 2022 (RFAI-131) to ensure that this TMP provides appropriate information to address public comments on the DEIS. Items requested to be addressed in the TMP are:

- Handling of cyanide
- Handling of antimony concentrate
- Expanding the geographic scope and updated data on spill risk analysis
- Addressing apparent inconsistencies or errors in the relevant sections of the DEIS
- Solid waste handling
- Safety measures to take during hazardous road conditions
- Locations of spill response materials
- Spill response capabilities of local communities
- Providing more information on potential risks related to transportation of hazardous materials
- Providing a description of the proposed cyanide packaging and shipping process
- Describing contingency plans for spills (including diesel spills) in the Project area or along access routes
- Describe contingency plans for wildfire in the Project area and access routes

Information on these topics is included in this Plan.

1.3 Transportation Plan Components

Documents that contain information pertinent to the TMP are listed below and are referenced throughout this TMP. Several of these documents include specific information on transportation system design features or EPMs.

Stibnite Gold Project: Seasonal Public Access – Warm Lake Road and Burntlog Route (Midas Gold 2020a): This document was submitted to the USFS on May 27, 2020. It includes a discussion on expanded public wintertime access on Warm Lake Road east of Warm Lake Lodge due to Perpetua Resources year-round Project access requirements for the life of the mine. Options for appropriate measures to ensure safe public use of the roadway are proposed.

SGP Access Management Plan (Midas Gold 2020b): This document was submitted to the Idaho Department of Environmental Quality (IDEQ) on April 15, 2020, to respond to comments on Perpetua Resources SGP Air Permit to Construct (PTC) Application. Adequate demonstration of appropriate access control for the through-site public access alternative was requested to support ambient air quality modeling parameters included in the permit application.

[1] The Yellow Pine Route is the mine access route assessed in the SGP DEIS (USFS 2020) as Alternative 4. Here, and in forthcoming documents, the Yellow Pine Route is renamed as the Johnson Creek Route. The terms are synonymous and refer to the Project access route that includes Johnson Creek Road (CR-10-413) and Stibnite Road (CR-50-412).

Stibnite Gold Access Roads Snow Avalanche Hazard Assessment for Access Roads (Dynamic Avalanche Consulting, LTD 2021): This document was prepared to support this TMP and is included as Attachment A of this report. It provides additional baseline information regarding identified avalanche slide/chute locations and includes proposed monitoring and mitigation for avalanche occurrences discussed in this TMP.

Perpetua Resources Emergency Response Plans and Emergency Standard Operating Procedures: These documents are referenced in Section 3 of this TMP and include important information regarding best practices and standard procedures to ensure the health and safety of employees, contractors, and the public, and to protect the environment. These are living documents that reflect Perpetua Resources current state of operations and will be updated accordingly as the Project progresses.

1.4 Regulatory and Forest Planning Framework

Perpetua Resources prioritizes the health and safety of people, the protection of the environment, and environmental sustainability. This TMP is prepared in accordance with the Core Values and Guiding Conservation Principles presented in the SGP Plan of Restoration and Operations (PRO; Midas Gold 2016). Transportation routes will be designed to provide safe, reliable roadways that promote health and safety and reduce environmental impacts. Plans for public transportation routes consider that any modifications to access to the National Forest must be offset by options that are likewise (and above all) safe to travel upon, reliable, and reasonably comparable to current levels of access.

As the SGP will be located on federal land and county roads, and is regulated by federal, state, and county regulations, this plan demonstrates how Perpetua Resources will comply with these regulations as they apply to the transportation portion of the SGP. Primary regulations are described below.

1.4.1 Environmental Regulations

Federal and state environmental regulations are applicable to the TMP to address the effects of transporting people, materials, equipment, and waste products to and away from the SGP site. The EMMP notes relevant environmental regulations that apply to transportation management and describes briefly how they are addressed in Section 3 of this Plan:

Endangered Species Act (United States Fish and Wildlife Service and National Oceanic and Atmospheric Administration): Endangered Species Act Section 7 consultation will cover potential impacts of vehicle/wildlife collisions and spills that could impact fisheries and wetlands.

Dredge and Fill in Waters of the United States (United States Army Corps of Engineers and Environmental Protection Agency): Waters of the United States that are subject to regulation under Section 404 of the Clean Water Act could be impacted by transportation during mining operations and post-closure restoration at the SGP.

National Oil and Hazardous Substances Pollution Contingency Plan (United States Environmental Protection Agency): National Oil and Hazardous Substances Pollution Contingency Plan defines the federal agency actions to responding to spills of oil or hazardous substances. This requires notification of any discharge, spill, or release, of a reportable quantity of a hazardous substance to the National Response Center through a toll-free telephone number. The National Response Center acts as the central clearinghouse for all pollution incident reporting.

Emergency Planning and Community Right-to-Know Act (Environmental Protection Agency): Section 312 of the Emergency Planning and Community Right-to-Know Act (EPCRA) contains requirements

for notifying emergency responders and emergency planning committees about the presence and use of hazardous and toxic chemicals at facilities. The EPCRA provisions help increase the public's knowledge and access to information on chemicals at individual facilities, their uses, and releases into the environment.

Hazard Communication (Occupational Safety and Health Administration [OSHA]): This act classifies the potential hazards of chemicals and communicates information concerning hazards and appropriate protective measures to employees. This includes development and implementation of employee training programs regarding hazards of chemicals and protective measures.

Hazardous Waste Operations and Emergency Response (HAZWOPER; OSHA): OSHA's HAZWOPER standards (in general industry, 29 Code of Federal Regulations [CFR] 1910.120; emergency response [§1910.38]; fire prevention plans [§1910.39]; and construction [§1926.65]) established health and safety requirements for employers engaged in these operations, as well as responses to emergencies involving releases of hazardous substances. HAZWOPER requires that employers follow specific work policies, practices, and procedures to protect their workers potentially exposed to hazardous substances.

Federal Mine Safety and Health Act of 1977 (Mine Act) as amended by the MINER Act of 2006. (Mine Safety and Health Administration [MSHA]): MSHA is responsible for enforcing the Mine Act, including the federal mine safety and health regulations outlined in 30 CFR, Subchapter K, Part 56 and 57 - Safety and Health Standards for Surface/Underground Metal and Non-Metal Mines. The purpose of these standards is the protection of life, the promotion of health and safety, and the prevention of accidents. They include requirements for new employee training and providing access to emergency response services.

1.4.2 Federal, State, and County Planning Framework

The SGP and associated transportation infrastructure occur in large part on NFS lands on the Payette National Forest (PNF) and the Boise National Forest (BNF). Therefore, the SGP must meet the requirements for a plan of operations for approval by the USFS for operations under regulations at 36 CFR 228 Subpart A, as well as the requirements for a plan of operations for approval by the Idaho Department of Lands (IDL) under state regulations and Idaho state code. The SGP DEIS (USFS 2020) describes applicable laws, regulations, policies, and plans for providing access across NFS lands for locatable mineral operations. Other applicable transportation management entities include the IDL and Valley County. Federal, state, and county planning documents relevant to this TMP are described below and are addressed by the design features, materials handling, and EPMs provided in Section 3.

United States Department of Agriculture Forest Service: 36 CFR 228.12 – Access:

- …Proposals for construction, improvement, or use of such access as part of a plan of operations shall include…location of the access route, design standards, means of transportation, and other conditions reasonably necessary to protect the environment and forest surface resources, including measures to protect scenic values and to ensure against erosion and water or air pollution.

United States Department of Agriculture Forest Service: 36 CFR 212 – Travel Management: Directives related to travel management on NFS lands include:

- §212.8 Permission to cross lands and easements owned by the United States and administered by the Forest Service.
- §212.9 Principles for sharing use of roads.
- (a) Road improvement. Use of a road for commercial hauling…will be conditioned upon improvement or supplemental construction of the road to safety and economically serve the

contemplated use, unless the Chief determines that the safety and economy of the established and foreseeable use by the United States, its users and cooperators will not be impaired by the use for which application is being made…

Mine Safety and Health Administration Department of Labor: 30 CFR Chapter 1 Subchapter A: MSHA health and safety regulations specific to transportation management are generally restricted to mine site operations. However, best practices included in the MSHA regulations that may be applicable to the transportation system include:

- §56.4330 Firefighting, evacuation, and rescue procedures.
- (a) Mine operators shall establish emergency firefighting, evacuation, and rescue procedures. These procedures shall be coordinated in advance with available firefighting organizations.
- (b) Fire alarm procedures or systems shall be established to promptly warn every person who could be endangered by a fire.
- (c) Fire alarm systems shall be maintained in operable condition.
- §56.9313 Roadway maintenance - Water, debris, or spilled material on roadways which creates hazards to the operation of mobile equipment shall be removed.
- §56.9315 Dust control - Dust shall be controlled at muck piles, material transfer points, crushers, and on haulage roads where hazards to persons would be created as a result of impaired visibility.
- §56.11001 Safe access - Safe means of access shall be provided and maintained to all working places.
- §56.18013 Emergency communications system - A suitable communication system shall be provided at the mine to obtain assistance in the event of an emergency.

Forest Roads and Trails Act:

- 7703.24.4: Intermittent-service roads may provide access for USFS administration of NFS lands or for motor vehicles authorized by contract, permit, or under other written authorization. These roads should continue to be managed, maintained, and operated consistent with the applicable land management plan and applicable road management objectives.

Payette National Forest Land and Resource Management Plan (Payette Forest Plan; USFS 2003) goals and objectives:

- FRG001 - Intermittent-service roads may provide access for USFS administration of NFS lands or for motor vehicles authorized by contract, permit, or under other written authorization. These roads should continue to be managed, maintained, and operated consistent with the applicable land management plan and applicable road management objectives.
- FROB05 – Coordinate transportation systems, management, and decommissioning with other federal, state, and county agencies, tribal governments, permittees, contractors, cost-share cooperators, and the public to develop a shared transportation system serving the needs of all parties to the extent possible.
- FRST02 – To accommodate floods, including associated bedload and debris, new culverts, preplacement culverts, and other stream crossings shall be designed to accommodate a 100-year flood recurrence interval unless site-specific analysis using calculated risk tools, or another method determines a more appropriate recurrence interval.
- FRST04 – Roads shall be constructed to a standard appropriate to their intended use, considering safety and concerns for resource degradation.

- FRST05 – Mitigate handling of road waste material (e.g., slough, rocks) to avoid or minimize delivery of waste material to streams that would result in degradation of soil, water, riparian, and aquatic resources.

Boise National Forest Land and Resource Management Plan (Boise Forest Plan; USFS 2010):

- FRG001 - Provide and maintain a safe, efficient forest transportation system that meets resource management and access needs, while mitigating degrading resource effects.
- FROB05 – Coordinate transportation systems, management, and decommissioning with other federal, state, and county agencies, tribal governments, permittees, contractors, cost-share cooperators, and the public to develop a shared transportation system serving the needs of all parties to the extent possible.
- FRST02 – To accommodate floods, including associated bedload and debris, new culverts, preplacement culverts, and other stream crossings shall be designed to accommodate a 100-year flood recurrence interval unless site-specific analysis using calculated risk tools, or another method determines a more appropriate recurrence interval.
- FRST04 – Road shall be constructed to a standard appropriate to their intended use, considering safety and concerns for resource degradation.
- FRST05 – Mitigate handling of road waste material (e.g., slough, rocks) to avoid or minimize delivery of waste material to streams that would result in degradation of soil, water, riparian, and aquatic resources.

Forest Service Handbook 7709.56 Road Preconstruction Handbook Chapter 40 – Design: This document provides guidance for the selection of design elements and standards required to meet design criteria and resource management prescriptions as set forth in the road management objectives.

United States Department of Transportation – Has jurisdiction over hazardous materials (including explosives) while they are in transit, whether by rail, water, motor carrier, air, or other conventional means. The United States Department of Transportation (USDOT) regulates the transportation of hazardous materials from the Hazardous Materials Transportation Act,49 United States Code 5101 et seq., including shipper and carrier responsibilities, communications training requirements, packaging, and emergency response.

Valley County Master Transportation Plan (Holladay Engineering Company 2008): The Valley County Master Transportation Plan includes recommendations for the maintenance of gravel roads (pp 69, 70).

- The debris and excess vegetation like grass and weeds should be removed from the bottom of ditches and culverts at the beginning of every fall season.
- The ditches should be graded by removing excess silt and sand sediments and reestablishing longitudinal and side slopes at the beginning of every spring and fall seasons.
- Road cross slope and shoulder slopes should be inspected and graded as required and at a minimum of the beginning of spring and fall seasons.
- Repair and/or upgrade culverts depending on storm water demand and existing culvert capacity each fall season.

Section 2

Transportation System

Existing access routes into the Stibnite area, the access route during construction (Johnson Creek Route), and SGP and public access routes proposed during the life of the SGP for the ModPRO2 (modified DEIS Alternative 2; Burntlog Route) and modified DEIS Alternative 4 (Johnson Creek Route) are discussed below.

2.1 Existing Conditions

Existing access to SGP from McCall and Cascade is primarily via paved roads that lead to unpaved county and NFS roads. Three existing primary routes are illustrated in Figure 2-1.

- Lick Creek Route: Stibnite can be accessed from McCall during non-winter conditions by traveling east on the Lick Creek portion of McCall-Stibnite Road (CR 50-412; Lick Creek Road) for approximately 37 miles to the East Fork South Fork portion of McCall-Stibnite Road (CR 50-412; East Fork Road), then approximately 16 miles to the village of Yellow Pine, and approximately 14 miles east on Stibnite Road. Lick Creek Road is closed during the winter because of a high avalanche potential; however, East Fork Road and Stibnite Road are plowed from South Fork Salmon River Road (forest road [FR] 50674) to Yellow Pine by Valley County and from Yellow Pine to the mine site by Perpetua Resources to access their private land inholdings in the area.
- Johnson Creek Route: During non-winter conditions Stibnite can be accessed from Cascade by traveling northeast from State Highway 55 on Warm Lake Road (CR 10-579) for approximately 34 miles to Landmark, then north on Johnson Creek Road (CR 10-413) for approximately 25 miles to the village of Yellow Pine, and approximately 14 miles east on Stibnite Road (CR 50-412). During the winter, Valley County plows approximately 10 miles of Johnson Creek Road from Yellow Pine to Wapiti Meadow Ranch and grooms the remaining 17 miles of Johnson Creek Road from Wapiti Meadow Ranch to Warm Lake Road (CR 10-579) at Landmark for over- snow vehicle (OSV) use. Valley County does not plow Warm Lake Road from Warm Lake to Landmark. This section is a designated groomed OSV route.
- South Fork Salmon River Route: Stibnite may be accessed year-round from Cascade by traveling northeast from State Highway 55 approximately 24 miles northeast on Warm Lake Road (CR 10-579) to the intersection with South Fork Salmon River Road (FR 474), then north on South Fork Salmon River Road (FR 474 to FR 50674) for approximately 30 miles to McCall-Stibnite Road (CR 50-412), and approximately 30 miles east on McCall-Stibnite Road (i.e., East Fork Road and Stibnite Road). Perpetua Resources (under agreement with Valley County) plows along Stibnite Road. This route currently provides the only access to the mine site during winter months.

The Lick Creek Route and South Fork Salmon River Route were evaluated for suitability as part of the mine transportation network and were dismissed from further consideration.

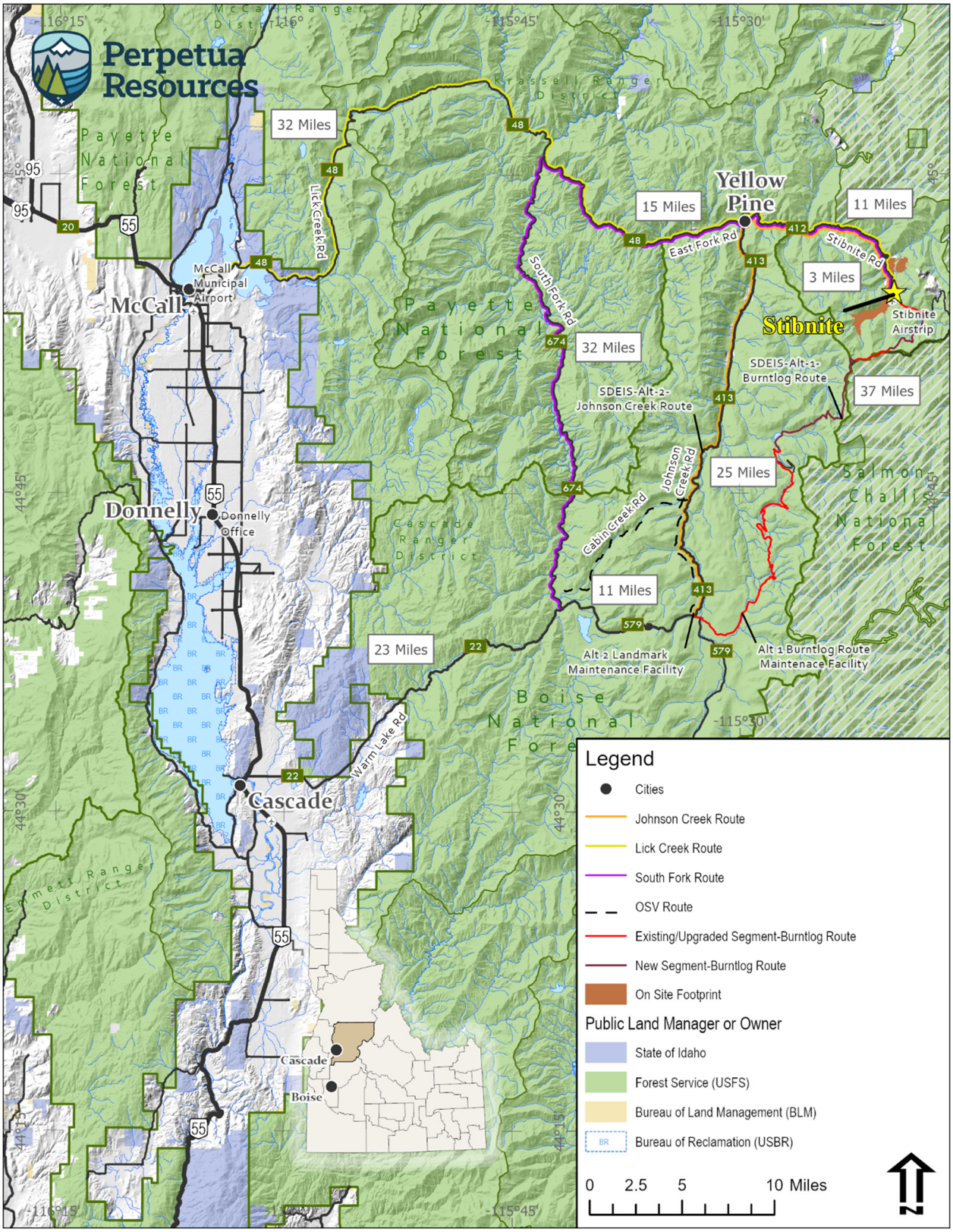


Figure 2-1. SGP Transportation System – Current Conditions

2.2 Access Routes

SGP access routes for the ModPRO2 (Burntlog Route) and modified DEIS Alternative 4 (Johnson Creek Route) will be carried forward for further environmental impact analysis in the SGP SDEIS. Current and proposed conditions for the roads comprising these two alternatives are described in this section. Alternative access routes are illustrated on Figure 2-2.

2.2.1 Warm Lake Road (Cascade to Landmark)

Current Conditions: Warm Lake Road (CR 10-579) is a two-lane (one lane each direction), asphalt-paved roadway with lane markings. The route starts in Cascade, Idaho at an intersection with Idaho State Highway 55 and continues eastward for approximately 34 miles, ending at Johnson Creek Road (CR 10-413) at Landmark. Warm Lake Road is under the jurisdiction of Valley County (USFS 2020; Table 3.16-1). Currently, Valley County does not maintain Warm Lake Road in winter beyond Warm Lake Lodge. With adequate snowpack, an eight-mile segment of the Warm Lake Road east of Warm Lake Lodge is used as an OSV route, allowing access into Landmark and points beyond. Warm Lake Road is used to access recreational sites and residences and has the highest existing use among roads considered in this TMP (1,174 average annual daily traffic [AADT]; USFS 2020: Table 3.16-2).

Proposed Use: SGP will need year-round passenger and delivery truck access from the onset of construction through the life of the mine. Warm Lake Road is suitable for this use in its current condition and would be a necessary road segment for both the ModPRO2 (Burntlog Route) Alternative (DEIS Alternative 2) and the Johnson Creek Route Alternative (DEIS Alternative 4). During SGP construction, operations, and reclamation/closure phases (approximately 23 years), Perpetua Resources will sign a road use agreement with Valley County to conduct wintertime maintenance on the full length of Warm Lake Road from State Highway 55 to Landmark to ensure safe, year-round access to the sole route of ingress/egress to the SGP for all mine support traffic. This would include snow removal and road sanding, as appropriate, to maintain a safe driving surface. Commitments for wintertime maintenance of Warm Lake Road would be documented in a Road Maintenance Agreement with Valley County. Anticipated road use between the Stibnite Gold Logistics Facility (SGLF) and the SGP will be similar to that which is described for SGP DEIS Alternative 2 (USFS 2020); it is expected to peak at 65 AADT during the construction phase of the SGP and reduce to 50 AADT during the operations phase.

Perpetua Resources wintertime maintenance and use of Warm Lake Road would result in two changes to current traffic conditions:

a. Warm Lake Road east of Warm Lake Lodge will not be available as a recreational OSV route from construction through reclamation of the SGP (approximately 20 to 25 years). To replace this recreational use, a dedicated alternative OSV route would be established from the Warm Lake area to Landmark via the Cabin Creek/Trout Creek drainages and adjacent to Johnson Creek Road. Establishing this replacement OSV route would minimize the interactions between SGP traffic and recreational traffic in the winter. The proposed OSV route is illustrated in Figure 2-1.
b. Expanded wintertime public vehicle access on Warm Lake Road east of Warm Lake Lodge would commingle SGP and public travel and thus would be a public health and safety concern. Perpetua Resources proposed several alternatives to address this concern in a memorandum submitted on May 27, 2020 (Midas Gold 2020a). The alternatives include: (1) no seasonal access restriction: broad distribution and availability of public information to deter winter condition travel past the point of current access, (2) administrative seasonal access restriction: static and electronic signage and automated timed stoplights at the point

of public access control, or (3) engineered seasonal access restriction: a physical blockage (lift-gate) near Warm Lake lodge consisting of a manual, electronic or remote-monitored gate. Procedures for managing winter public access on Warm Lake Road east of Warm Lake lodge during the life of the SGP will be determined through consultation with Valley County and the USFS.

2.2.2 Burntlog Route (ModPRO2)

Current Conditions: The Burntlog Route in its entirety does not exist (Figure 2-1); it is proposed as the primary mine access route to the SGP under the ModPRO2 Alternative. The roads that would be connected to create the Burntlog Route (Burntlog Road [FR-447], Meadow Creek Lookout Road [FR 51290], and Thunder Mountain Road [FR 440]) are USFS local roads that connect terminal facilities (e.g., trailheads) with collector roads, arterial roads, or public highways and usually serve a single purpose and receive intermittent use (USFS 2020; Sec. 3.16.3.4). Traffic volume data for Burntlog Road and Thunder Mountain Road indicate AADT of 27 and 11, respectively (USFS 2020; Table 3.16-2).

Proposed Use: Under the ModPRO2, the Burntlog Route would be the designated SGP access route (Figure 2-2). The Burntlog Route would connect the eastern end of Warm Lake Road (at Landmark) to the site (to the northeast) via the existing Burntlog Road (FR 447), Meadow Creek Lookout Road (FR 51290), Thunder Mountain Road (FR 50375) and approximately 15 miles of new road constructed to connect the three. Anticipated road use due to access activities would peak during the SGP construction phase at 65 AADT and would be 50 AADT during the operations phase of the SGP (USFS 2020).

The Burntlog Route would be a two-lane, all-weather, gravel-surfaced road. The full length of the Burntlog Route - including improvements on existing portions would be required to meet all applicable USFS design criteria as well as criteria for semi-trailers (WB-50) and oversize deliveries of large equipment (WB-67) (Parametrix 2018c). Perpetua Resources would conduct all wintertime maintenance of the Burntlog Route for the full duration of its existence (approximately 23 years).

2.2.3 Johnson Creek Route

Current Conditions: The Johnson Creek Route refers to an existing route currently used to access SGP (see Section 2.2). The Johnson Creek Route originates at Landmark at the intersection of Warm Lake Road and Johnson Creek Road and extends north on Johnson Creek Road (CR 10-413) for approximately 25 miles to Yellow Pine. From there, the Stibnite Road (CR 50-412) continues eastward to Stibnite and passes through the site and consists of approximately 14 miles of variable width (one-lane to two-lane), native-surfaced (dirt) roadway (Figure 2-2). Stibnite Road connects to Thunder Mountain Road on the southeastern portion of the Stibnite site and currently provides public access through the site. Johnson Creek Road (CR 10-413), and Stibnite Road (CR 50-412) are considered county collector roads per the Idaho Transportation Department (ITD) functional classification, which generally move traffic from local roads to the arterials or other points of interest. Traffic volume data for Johnson Creek Road and Stibnite Road indicate AADT of 57 and 39, respectively (USFS 2020; Table 3.16-2).

Portions of Johnson Creek Road (from Wapiti Meadows southward) are currently used as a groomed OSV trail during winter and use of the Johnson Creek Route by mine-related construction traffic would conflict with this existing groomed OSV trail. Thus, while the Johnson Creek Route is used as a construction access route, a temporary 15-foot-wide groomed OSV trail adjacent to Johnson Creek Road between the proposed Cabin Creek Groomed OSV Route and Landmark would be constructed (see Public Access below).

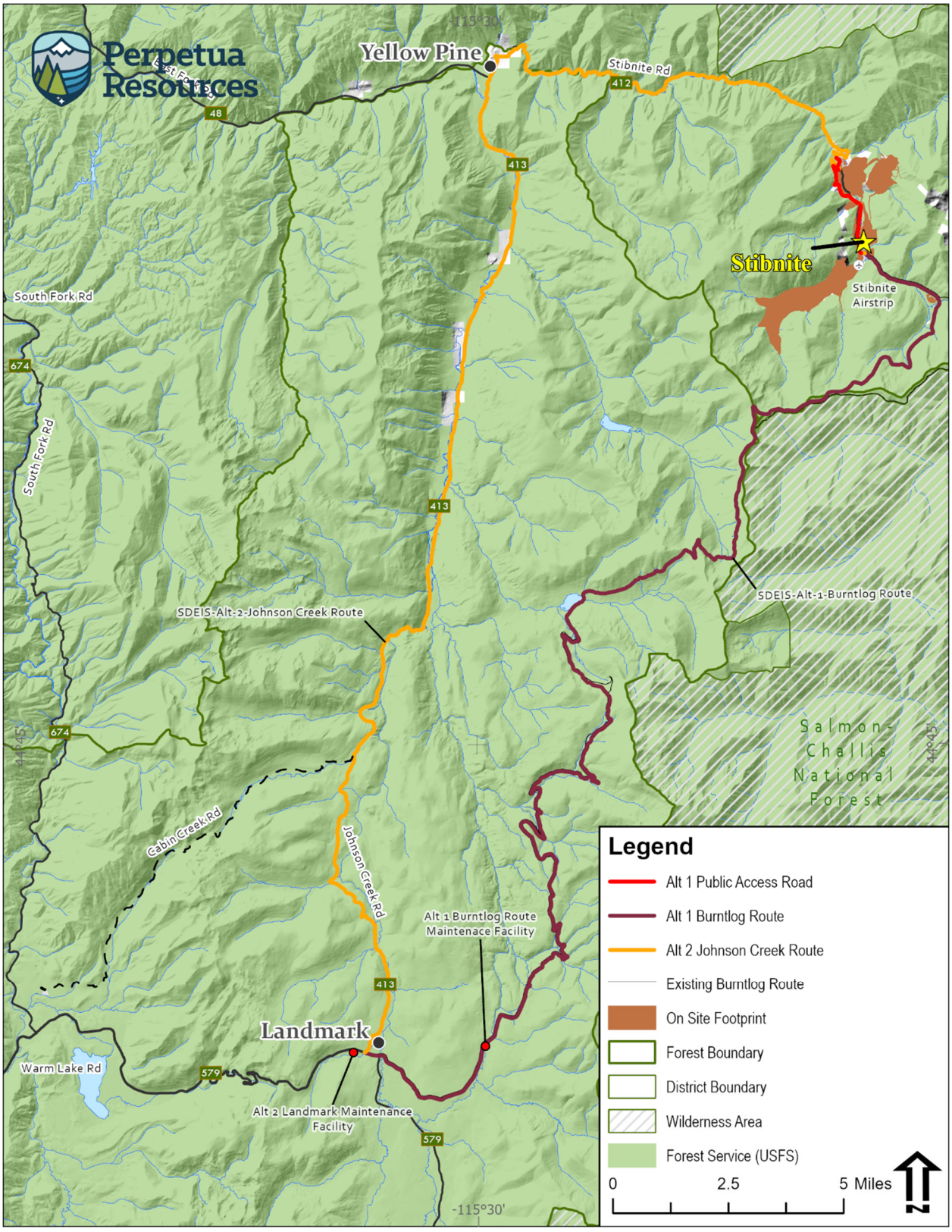


Figure 2-2. SGP Transportation System - Alternative Routes

2.2.3.1 Johnson Creek Route – Construction Phase (ModPRO2)

Proposed Use: During the first two years of the three-year construction phase of the SGP for the ModPRO2, mine-related traffic would access the mine site from State Highway 55, north of the city of Cascade, via Warm Lake Road (CR 10-579), then Johnson Creek Road (CR 10-413) to Yellow Pine, and from Yellow Pine to the mine site via the Stibnite Road segment of the McCall – Stibnite Road (CR 50-412). The USFS submitted RFAI-60 on October 28, 2017, to request additional information on any upgrades to the Johnson Creek Route that would be required for its use during the construction phase of the SGP. The response, submitted on January 4, 2018, notes that minor surface improvements (e.g., ditch and culvert repair, adding gravel, winter snow removal, and summer dust suppression) would occur on the Johnson Creek Route to reduce sediment runoff and dust generation. There would be no road alignment modification or widening of the existing roads for ModPRO2. Traffic volume data for the Johnson Creek Route during the ModPRO2 construction phase would be 65 AADT (USFS 2020).

For the ModPRO2 Alternative, once construction of the Burntlog Route has been completed, the Johnson Creek Route would no longer be used by mine-related traffic. While the Johnson Creek Route is in use, Perpetua Resources would coordinate with Valley County on the use and maintenance of the route for year-round access in accordance with Valley County's public road easement stipulations.

2.2.3.2 Johnson Creek Route – Construction and Operations Phase (Alternative 4)

Proposed Use: The Johnson Creek Route would be mixed SGP access/public access route under DEIS Alternative 4 and would be the only route of ingress/egress into the SGP. The full length of the Johnson Creek Route - particularly the Stibnite Road segment - would require significant improvements to serve as the primary access route and would be required to meet design criteria for WB-50 and WB-67 vehicles (semi-trailers and oversize deliveries of large equipment; Parametrix 2018c). Also, the Johnson Creek Route Alternative (DEIS Alternative 4) would increase the amount of interaction between the public and SGP traffic during construction and throughout the life of the mine. Improvements to Stibnite Road would require drilling and blasting rock overhangs, installing retaining walls, widening and straightening, drainage improvements (e.g., ditching, culvert repair), gravel surfacing and paving approximately one mile of road through Yellow Pine. Anticipated additional traffic on the Johnson Creek Route during SGP construction would be 65 AADT (USFS 2020) and 50 AADT during the operations phase of the SGP (USFS 2020). During the construction, operations, and reclamation/closure phases of the SGP (approximately 23 years), Perpetua Resources would establish a Road Maintenance Agreement with Valley County to conduct all wintertime road maintenance on Johnson Creek Road and Stibnite Road.

2.3 Public Access

Current conditions: Public access to Stibnite and surrounding area is primarily via paved roads that lead to unpaved county and NFS roads. The three existing primary routes to access the Stibnite area are described in the SGP DEIS (USFS 2020) and in Section 2.1 of this document and are illustrated in Figure 2-1. Proposed public access routes described below are included in Figure 2-3.

2.3.1 Burntlog Route (ModPRO2)

The Burntlog Route is the proposed SGP access route for the SGP ModPRO2 Alternative. During the construction of the ModPRO2 through-site public access road (described below), the Burntlog Route would serve as an alternative public access route to Meadow Creek Lookout Road (FR 51290).

2.3.2 OSV Route (Cabin/Trout Creek and Johnson Creek; Both Alternatives)

Due to year-round access to the mine site along Warm Lake Road (for both the ModPRO2 Alternative and DEIS Alternative 4) for the life of the SGP, an existing, approximately 8-mile groomed OSV trail from Warm Lake to Landmark would be closed. To replace this recreational use, a dedicated alternative OSV route would be established from the Warm Lake area to Landmark via the Cabin Creek/Trout Creek drainages. The groomed OSV trail would be approximately 10.4 miles in length on the existing road and would include an approximately 2-acre parking area west of South Fork Road, and a new 1.5-mile groomer access trail from the USFS Warm Lake Project Camp on Paradise Valley Road (FR 488) where the groomer would be stored. From Trout Creek to Landmark, an approximately 7-mile temporary groomed OSV trail would be maintained on NFS lands adjacent to the west side of Johnson Creek Road (CR 10-413). Portions of the temporary groomed OSV trail would be established using a snowplow wing attachment requiring some vegetation and tree removal to allow for safe snowplowing. The precise location of this trail is not yet determined, and in areas where topography and vegetation prevent using the wing attachment to establish the groomed OSV trail, sections would merge with Johnson Creek. Figure 2-1 and Figure 2-2 show the Cabin Creek/Trout Creek/Johnson Creek Road groomed OSV trail from Warm Lake Lodge to Landmark.

2.3.3 Stibnite Road – Through Site Public Access

Current Conditions: Stibnite Road (CR 50-412) extends from Yellow Pine to Stibnite and passes through the site connecting with Thunder Mountain Road on the southeastern portion of the Stibnite site. Stibnite Road provides public access and consists of approximately 14 miles of variable width one-lane to two-lane), native-surfaced (dirt) roadway (Figure 2-1). Stibnite Road is considered a county collector road per ITD functional classification, generally moving traffic from local roads to the arterials or other points of interest. Traffic volume data for Stibnite Road indicates an AADT of 39 (USFS 2020; Table 3.16-2).

Proposed Use (ModPRO2): Public access through the site for both Alternatives would realign Stibnite Road through the site to provide seasonal (non-winter), controlled, through-site access that is safe, provides travel-time comparable to current conditions, and is consistent with the USFS travel management plan.

For the ModPRO2, a through-site public access road would be constructed to replace the current access through the SGP site on Stibnite Road (FR 50375) during mine operations. During construction, public access through the SGP site on Stibnite Road would be restricted for one year or more while a new 4-mile long, 12-foot-wide gravel road is constructed to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375) (Figure 2-3). The public access road would be constructed on a widened bench in the Yellow Pine pit. South of the Yellow Pine pit, this road would pass under the haul road and continue southward, parallel to the mine haul road on a partially revegetated portion of a former haul road.

Southwest of the ore processing area, the public access road would connect with Thunder Mountain Road and continue toward the Worker Housing Facility, exiting the Project site to the southeast. Public access would be separated from other mine site roads by berms, security fencing, and an underpass to allow the public road to pass beneath the mine haul road. The underpass would be in the vicinity of Fiddle Creek. The public access road would not be plowed in the winter (current county maintenance standards) and signs would inform the public of seasonal and temporary closures.

Proposed Use (Johnson Creek Route Alternative): Through-site public access would be provided by shared public use of the primary mine access road for the Johnson Creek Route Alternative (Figure 2-3). Due to the design criteria for the mine access road to accommodate larger vehicles, the orientation of this route would differ from the ModPRO2, the road would be wider, would include

additional switchbacks, and would be constructed so that road gradients do not exceed 10 percent. South of the Yellow Pine pit, this road would diverge from the combined mine access/public access route and follow an alignment similar to the ModPRO2 through-site public access road. It would pass under the haul road and continue southward, and southwest of the ore processing area would connect with Thunder Mountain Road and continue toward the Worker Housing Facility, exiting the Project site to the southeast. This portion of the public access road (south of the Yellow Pine pit) would not be plowed in the winter (current county maintenance standards) and would not be accessible to the public.

Proposed Use (Both Alternatives): The through-site public access would be seasonal, similar to current conditions. During operations, public access through the mine site would be provided during the snow-free season to all vehicle types. Vehicles passing through the mine site would be required to check-in with mine personnel at the north or south mine site entry points to receive a safety briefing and to check-out with mine site personnel upon exiting the mine site. For safety purposes, no stopping or deviating from the public access road would be allowed. Mine site access would be restricted during road construction and maintenance, blasting, high wall scaling, mining in the immediate area of the road, and similar operations. During mine reclamation and closure, the portion of Stibnite Road (FR 50375) passing through the site will be relocated and reestablished east of the East Fork of the South Fork of the Salmon River (EFSFSR) to minimize waterway crossings, but otherwise will be in an alignment similar to its current configuration. The relocated Stibnite Road will provide permanent public access through the reclaimed site and will also provide mine site access for post closure monitoring and maintenance.

2.4 Mine Haul Roads

With the exception of a portion of the mine access/public access road west of the Yellow Pine pit (Johnson Creek Route Alternative) mine haul roads and access roads/trails on the mine site would not be accessible to the public. Haul roads would be used to transport ore, development rock, and reclamation materials from mining or storage areas to the ore processing facility or tailings storage facility (TSF) Buttress, or to transport vehicles to the mobile equipment maintenance shop. Personnel would primarily use haul roads for access to the reclamation and construction areas, pits, TSF, TSF Buttress, ore processing facility, water treatment plant, and maintenance areas. A typical haul road running surface would be approximately 87 feet wide. The haul roads would be built and maintained for year-round access and would be surfaced with gravel aggregate sourced from on-site development rock or aggregate borrow sources. Road maintenance activities would be conducted to manage fugitive dust emissions in accordance with the IDEQ Air PTC, and to maintain stormwater management features per the site multi-sector general permit Stormwater Pollution Prevention Plan (SWPPP; Aquionix, Inc. 2021). Perpetua Resources would maintain internal service and access roads and trail systems designed specifically for smaller vehicles and foot traffic to facilitate access to certain sites and facilities for safety and maintenance. These sites include water quality monitoring sites, well sites, radio communications tower, perimeter of the TSF, and various monitoring sites.

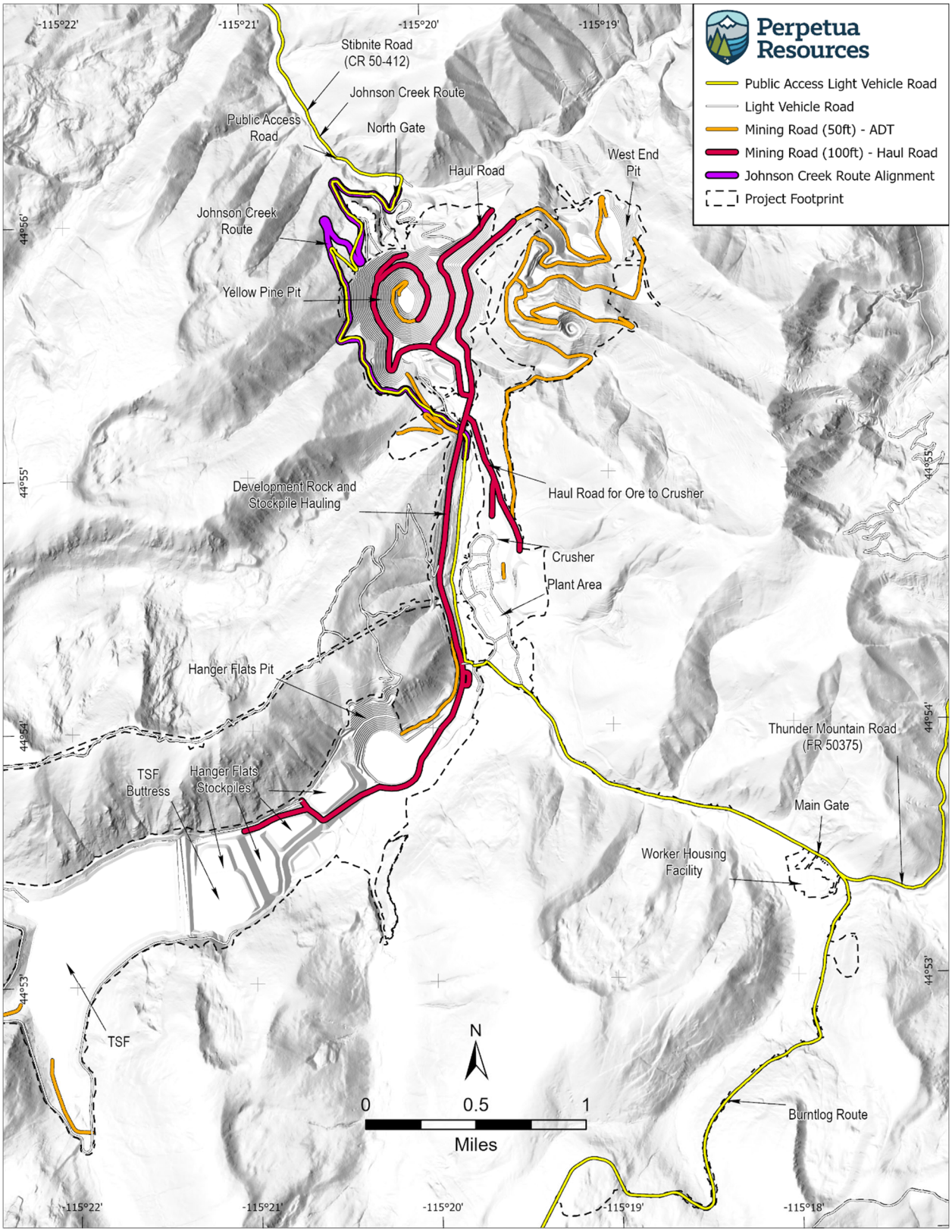


Figure 2-3. Mine Haul Roads and Facilities

Section 3

Design Features, Materials Handling, and Environmental Protection Measures

This section lists transportation design features, hazardous materials handling and spill response procedures, and EPMs to provide for public health and safety and protect environmental quality.

3.1 Design Features

The SGP includes several design features incorporated into the mine plan that are meant to minimize or avoid transportation related risks. These include road construction design standards to reduce sedimentation and dust impacts, road design features and maintenance protocols to address geologic hazards, road construction material choices to avoid surface water impacts, bridge restrictions and load hauling rules to increase safety, and a dedicated facility for road maintenance.

3.1.1 Road Construction Design Standards

Design standards for the access road are addressed in a Feasibility Design Memorandum (Parametrix 2018a) provided in response to RFAI-79 and in a Feasibility Study Access Road Design report (Parametrix 2018c). Applicable excerpts detail appropriate design standards relative to proposed road use and included provisions for oversized equipment that would be delivered to the SGP (e.g., the pressure oxidation autoclave).

- Road design, construction, and operation/maintenance will consider all practicable methods to avoid and minimize potential impacts to waters of the United States (Dredge and Fill in waters of the United States).
- Guidelines and standards for designing NFS Roads as published in the USFS handbook (FSH) 7709.56 (published in 2010 with partial amendments in 2011 and 2014) were used as the primary basis for the design criteria. The FSH incorporates design standards for two lane service roads from American Association of State Highway and Transportation Officials (AASHTO's) Guidelines for Geometric Design of Very Low-Volume Roads (average daily traffic [ADT] less than 400).
- Valley County has adopted the 'Greenbook' AASHTO standards. AASHTO's Guidelines of Very Low-Volume Local Roads (ADT less than 400) provides a functional classification for Rural Resource Recovery Roads specifically for logging and mining operations.
- The debris and excess vegetation like grass and weeds should be removed from the bottom of ditches and culverts at the beginning of every fall season.
- The ditches should be graded by removing excess silt and sand sediments and reestablishing longitudinal and side slopes at the beginning of every spring and fall seasons.
- Road cross slope and shoulder slopes should be inspected and graded as required and at a minimum of the beginning of spring and fall seasons.

- Repair and/or upgrade culverts depending on storm water demand and existing culvert capacity each fall season.
- A summary of key design standards (Parametrix 2018c):
  - ADT: 70 vehicles.
  - Level of Service: Criteria 'I', Rural Resource Recovery Road.
  - Design Speed: 20-miles per hour (mph) posted (designed to 25-mph where possible and reduced to 15-mph where needed).
  - Design Vehicle & Loading: WB-50 (intermediate sized tractor-trailer) with AASHTO HL-93 loading.
  - Critical design vehicle (only occurring in special situations with appropriate traffic control) is a lowboy trailer with mining equipment (similar to WB-67). Additional loading requirements may be placed on structures for the autoclave and other equipment.
  - Number of Lanes & Road Width (including shoulders and recovery zone): 2 lanes (with the ability to reduce to 1 if needed under special circumstances); 21-feet wide (14-feet for single lane).
  - Bridge Width: 24-feet minimum (14-feet for single lane).
  - Bridge Span: Clear span 120 percent of bankfull width; bankfull defined as a peak flow event that occurs on average once every 1.5 years (Q1.5).
  - Surfacing: Gravel, with asphalt 100-feet each side of bridges.
  - Cross-slope & Direction: 3 percent to 5 percent, insloped typical on steep areas (more than 5 percent grade), crowned or outsloped on flatter areas may be considered.
  - Minimum Radii: 50-foot (policy), 85-foot (15 mph), 160-foot (20 mph), 245-foot (25 mph).
  - Curve Widening: 11-foot on 50-foot radius, and 5-foot on 100-foot radius.
  - Stopping Sight Distance (SSD): 157-foot (30 mph), (232-foot worst case, 15 mph downgradient in snow).
  - Sight Distance: Exceed the SSD.
  - Horizontal Clear Zone: 0 to 4-feet.
  - Vertical Grade: 10 percent max, 0.5 percent min, and 5 percent at switch backs (extending 100 feet).
  - Vertical Curves (Sag and Crest), Minimum K and Length: 15 crest, 26 sag (75-foot length).
- Mitigate handling of road waste material (e.g., slough, rocks) to avoid or minimize delivery of waste material to streams that would result in degradation of soil, water, riparian, and aquatic resources.

Additional road design features to reduce environmental impacts from sedimentation, provide appropriate drainage and reduce fugitive dust are included in Section 3.3 – Environmental Protection Measures.

3.1.2 Geologic Hazards

Geologic hazards in the vicinity of the Yellow Pine and Burntlog access routes are discussed in the SGP DEIS (USFS 2020: Section 3.2.3.7.2). Identified geologic hazards on the Burntlog and Johnson Creek Routes are illustrated in Figure 3-1. Although the geologic hazards for the alternative access routes differ based on the location of the roadway, measures were incorporated into preliminary road construction design to address geologic hazards and reduce their potential impacts on roadways:

- Elevation out of the drainages, less avalanche chutes: A memorandum submitted to the USFS in July 2019 (RFAI-83c) documented the destructive nature of avalanches in the Stibnite Road corridor. The location of Stibnite Road - in the bottom of the EFSFSR drainage – places it in the runout zone of avalanches in the area. The design of the Burntlog Route specifically targeted road placement higher up in the drainages to reduce potential damage from intersecting avalanche chutes. This design feature has the important added benefit of reducing the risk to human health and safety of a catastrophic avalanche.
- Retaining walls and layback design; The potential for rockfall and landslides to incur into roadways is addressed by (1) road placement relative to identified areas of potential slope instability and (2) road design, i.e., appropriate cut/fill slope, laybacks, and retention structures to deter mass movement. The response to RFAI-83 and supporting technical memorandum (Parametrix 2018b) note that appropriate design considerations for the Stibnite Road portion of the Johnson Creek Route to mitigate for geotechnical hazards would include drilling and blasting of rock overhangs along 3 miles of roadway to achieve an appropriate layback slope, retaining walls along 7 miles of roadway and concrete barriers along nearly 5 miles of roadway to mitigate for adjacent steep topography. Similar required design features for the Burntlog Route are less robust as it occurs higher in the drainage in alluvium and regolith with virtually no overhanging rock and thus less upslope geotechnical load. Preliminary design for the Burntlog Route includes approximately 5 miles of retaining wall (RFAI-83a). General cut/fill slope recommendations (Parametrix 2018c) for various surface materials include:
  - Cut Slopes - Colluvium/Non-Glacial Soils
  - 1.5 horizontal to 1 vertical (H:V), 10-foot vertical slope preferred (20-foot maximum) with a minimum 3-foot-wide catchment ditch. Utilize mechanically stabilized earth walls downslope of the road if needed
  - 2H:1V is the preferred slope
- Glacial Till
  - 1H:1V, 20-foot vertical maximum slopes with a minimum 5-foot-wide catchment ditch
  - 1.5H:1V preferred slopes with a 3-foot-wide catchment ditch
- Rock
  - 0.5H:1V slope with a minimum 5-foot-wide catchment ditch
- Fill Slopes - All Conditions
  - 1.5H:1V maximum slope
  - 2H:1V preferred if geometry allows. This slope angle is more suitable for applying erosion protection and maintaining vegetation and requires less maintenance
- Maintenance: The Feasibility Study Access Road Design memorandum (Parametrix 2018c) notes that all slide areas adjacent to the roadway will require periodic cleanup of debris, including inspection and cleaning of adjacent culverts.

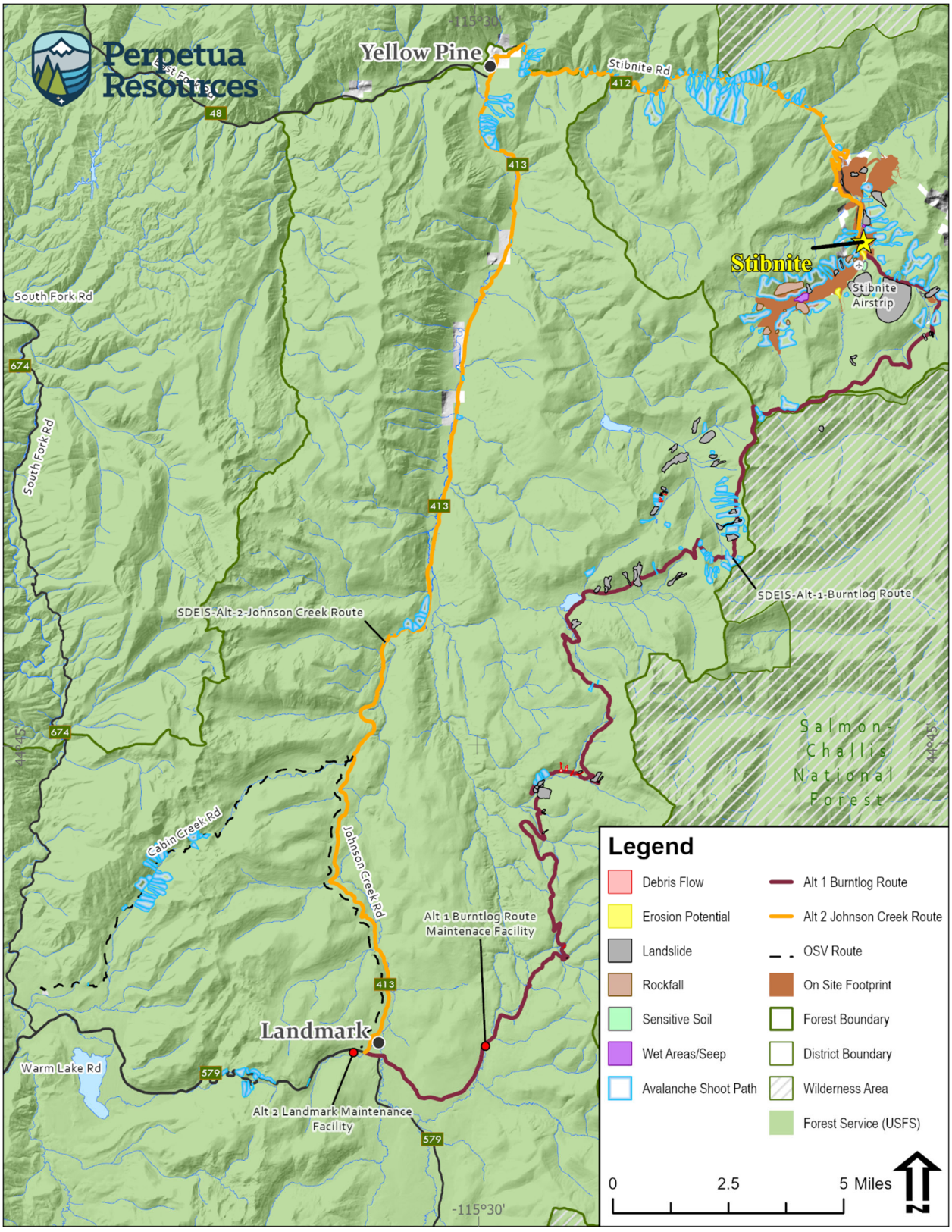


Figure 3-1. Geologic Hazards and Avalanche Chutes

3.1.3 Road Construction Materials

Road construction material for either of the mine access routes will come from borrow sources that are located along the access route. Borrow site material quality assessment and construction material specifications are included in documentation supporting the Feasibility Study Access Road Design memorandum (Parametrix 2018c), which recommends targeting USFS standard specifications for aggregate quality.

Road construction materials for haul roads on the SGP will be sourced from quartzite development rock from the West End mine pit that demonstrates relatively low arsenic concentrations compared to other available development rock. An evaluation of estimated haul road runoff water quality based on the use of this material was prepared in response to RFAI-115 (SRK Consulting, Inc. [SRK] 2021). It concluded that runoff from haul road surfaces would not exceed any of the strictest applicable water quality criteria. Modeling of haul road fugitive dust is addressed in Appendix A of the ModPRO2 Air Quality Analysis Addendum (Air Sciences, 2021).

3.1.4 Bridge Restrictions

Gross vehicle, axle, and wheel loads shall not exceed the following limits on bridges:

a. For typical State of Idaho highway-legal vehicles, maximum gross vehicle, axle, and wheel loads shall not exceed posted load limits or those established by the State of Idaho or the USFS.
b. All vehicles that do not meet the conditions of (a) will be required to obtain written approval (given by the Forest Engineer on a case-by-case basis) prior to crossing the bridge.

Detailed analysis for bridge loading was conducted for the Burntlog Route only; however, a similar approach to bridge loading analysis would be applied to the Johnson Creek Route. Per USFS standards, bridges on NFS roads are to be designed to handle AASHTO HL-93 loading. The SGP Feasibility Study Access Road Design (Parametrix 2018c) notes that there are five existing bridges (four timber and one three-sided concrete box) along Burntlog Road. Due to the anticipated loading that these structures would experience with the mine development and operations, each of the four timber bridges would need to be replaced. A total of six new bridges (four to replace the existing timber bridges) would be needed for the ModPRO2 (Burntlog Route) alignment. There will likely be several special transports to deliver large equipment to the site. To accommodate this additional loading, steel beams would provide temporary support, pending approval by the Forest Engineer.

3.1.5 Long Load/Over-width Load Hauling

All SGP, contractor, and vendor vehicles will be required to comply with the rules for long load/over-width load hauling on the permitted roads. Pilot vehicles would be required for long load/over-width load hauling and for the transport of various materials on permitted roads. Perpetua Resources would include these rules in the safety training for all employees.

3.1.6 Road Maintenance

The Landmark Maintenance Facility proposed in the PRO and included in Alternative 4 would be located near the intersection of the Warm Lake and Johnson Creek Roads (Figure 2-1. The ModPRO2 proposes the Maintenance Facility be located approximately 4 miles northeast of Landmark on the Burntlog Route, within a proposed borrow area. Both alternative locations for the Maintenance Facility are located on federal land administered by the BNF and would include:

- Covered stockpiles of coarse sand and gravel for winter sanding activities
- Housing for road maintenance crews during periods of heavy snow removal needs and other winter maintenance activities

- Communications equipment including a tower
- Equipment such as sanding/snowplowing trucks, snow blowers, road graders, and support equipment
- A fuel storage area with secondary containment for maintenance equipment
- Facilities to support snowmobile trail grooming and grooming equipment storage if needed
- Handling of road waste material (e.g., slough, rocks) to avoid or minimize delivery of waste material to streams that would result in degradation of soil, water, riparian, and aquatic resources

3.2 Hazardous Materials Handling and Spill Management

This section addresses potential risks related to transportation of hazardous materials (including explosives) and emergency spill response (in compliance with Idaho Water Quality Standards, National Oil and Hazardous Substances Pollution Contingency Plan, OSHA Hazardous Communication, HAZWOPER).

- Personnel who transport, handle, or use mine processing reagents, fuel, or other materials that have the potential to be released and impact surface water and groundwater quality will receive appropriate training in best management practices, spill response procedures, and reporting requirements.
- Personnel who transport, handle, or use mine processing reagents, fuel, or other hazardous or toxic materials will receive appropriate training in best management practices, personal protective equipment, emergency response procedures, and reporting requirements.
- Information on hazardous and toxic chemicals transported to the SGP and used in mining operations is included in the PRO (Midas Gold 2016); additional information will be recorded in publicly available documents (EPCRA, HAZWOPER).

3.2.1 Cyanide Transport and Handling

The PRO (Section 12.3.6) indicates that all SGP onsite and offsite facilities, and contractor equipment and materials handling facilities will be designed and operated to meet the International Cyanide Management Institute (ICMI) Cyanide Management Code (ICMC). The Principles and Standards of Practice of the ICMC requires adherence to Principles and Standards of Practice with regard to cyanide production, purchasing, transport, and handling, including:

- Purchase cyanide from certified manufacturers employing appropriate practices and procedures to limit exposure of their workforce to cyanide and to prevent releases of cyanide to the environment.
- Require that cyanide is safely managed through the entire transportation and delivery process from the production facility to the mine by use of certified transport with clear lines of responsibility for safety, security, release prevention, training, and emergency response.
- Design and construct unloading, storage, and mixing facilities consistent with sound, accepted engineering practices and quality control and quality assurance procedures, spill prevention and spill containment measures.
- Operate unloading, storage, and mixing facilities using inspections, preventive maintenance, and contingency plans to prevent or contain releases and control and respond to worker exposures.

In accordance with these ICMC principles, Perpetua Resources will incorporate the following EPMs:

- The anticipated supplier of cyanide for the SGP is Cyanco, a founding member and signatory of the ICMC. All of Cyanco's facilities are ICMC certified.

- Solid form, dry sodium cyanide briquettes would be transported in an International Organization for Standardization (ISO) container, which eliminates the risk of fluid leaks or spills during transportation. Any release of the solid form could be easily recovered. ISO containers are heavy-duty steel containers that are air and water-tight and ruggedly designed to withstand rollovers and other accidents.
- The ISO containers remain sealed at all times because dry solid sodium cyanide is extracted by circulating water through the container to dissolve the briquettes, then directly to the reagent circuit. There is no risk of spills during unloading or transfer steps since there are none.
- Cyanide unloading facility will be constructed and operated consistent with the ICMC standards for primary and secondary containment.
- The ISO containers are returned to the supplier for reuse, so there is no container disposal.
- Cyanide trucks will be escorted by pilot vehicles and be subject to other protocols, as described in the PRO Section 12.2.

3.2.2 Mercury Handling

The capture and handling of mercury in the ore processing circuit is described by SRK (2019); a memorandum provided with RFAI-104.

- Mercury will follow gold and silver through carbon stripping and electrowinning. It will be separated from the precious metals in the retort process, where it is volatilized with heat from the electrowinning sludge. The retort gas will then be passed through a chilled condenser, where mercury will be converted to its liquid metallic state and then securely stored prior to shipment to a Resource Conservation and Recovery Act certified hazardous waste disposal facility.

3.2.3 Antimony Concentrate Transportation and Handling

Additional clarification on antimony concentrate handling was requested in RFAI-131 (January 2022); applicable information from the RFAI-131 response is incorporated here.

The SGP ore processing circuit will produce an antimony concentrate that would contain approximately 55 to 60 percent antimony by weight. The remaining 40 to 45 percent of the concentrate would be predominantly sulfur (as sulfide in the stibnite) and common rock, with trace amounts of gold, silver, and mercury. The concentrate would be filtered then transferred by a screw feeder to a feed hopper on the bagging machine. The feed hopper would load antimony concentrate into 2-ton sealed supersacks constructed of woven polypropylene. Filled supersacks would be sampled, sealed, and placed with a forklift on the concrete floor of the antimony loadout facility prior to being loaded into a steel, wooden-floored shipping container for transport. Shipping containers would be closed and affixed with a numbered metal shipping seal.

The shipping containers would utilize either the Burntlog Route or Johnson Creek Route to Landmark before traveling along Warm Lake Road to the intersection with State Highway 55 (Figure 2-1. From there the concentrate would be trucked via State Highway 55 to a commercial truck, train, barge, or ship loading facility depending upon the final destination.

Approximately one to two shipping containers with a typical payload of 20 to 27 tons would be hauled off site each day. Perpetua Resources would assume ownership of the antimony concentrate until it arrives at its final destination.

Best practices for handing and transporting antimony concentrate would include:

- Shipping containers would be inspected upon arrival at the SGP and prior to loading. Any unsealed, damaged, or punctured containers would be tagged, segregated, and handled in accordance with the nature and degree of the specific situation.

- Shipping container leaks would be investigated to identify the cause of leakage, the location of the damage that caused the leakage, and trigger spill response in accordance with the Spill Prevention, Control, and Countermeasures (SPCC) Plan to address the effects of leakage from the point of damage to the point of discovery.
- Supersacks would be loaded into shipping containers using a forklift with hooked lifting racks. Using the lifting straps keeps the forks or hooks above the bag and reduces the chances of puncture and spillage.
- Filled and unused supersacks would be inspected at the beginning of each shift for tears, punctures, open spouts, or leakage and replaced as necessary.
- Spilled antimony concentrate would be cleaned up in a manner that does not disperse dust and returned to the antimony concentration/filtering process.

3.2.4 Solid Waste Handling

Solid waste handling will be conducted as described in the ModPRO2 Section 3.12 (Perpetua Resources 2021):

- No petroleum-contaminated soil landfarm nor solid waste landfill will be constructed or maintained at the Project site; these waste materials will be transported off-site for disposal.
- Used petroleum products would be stored on site in approved containers then transported off site for recycling or disposal in an approved facility.
- All waste materials will be recycled to the extent practicable or disposed of in accordance with regulations. Wastes anticipated to be generated at the mine site include fluorescent bulbs, batteries, empty aerosol containers, and hazardous wastes, which would be managed in accordance with the regulatory standards.
- Legacy waste materials may be encountered during construction and operations. These materials would be characterized to determine whether to reprocess, reuse, or dispose of off-site.
- Sanitary waste facilities would be present at the mine site and off-site facilities and would be constructed and operated in accordance with Valley County, IDEQ, and Idaho Department of Health and Human Services standards.
- A large-scale on-site composting facility is not anticipated due to the lack of space in the Project area. Small scale composting of organic materials generated at the worker housing facility may be incorporated within the centralized growth media stockpile in the Fiddle Valley. Any larger composting facilities necessary to support growth media quality or quantity improvements would be located off-site.
- Material that meets the classification of a “hazardous waste” will be collected and stored, per the Waste Management Plan at specially designed and operated secured satellite collection sites and a main storage site prior to shipment to a Resource Conservation and Recovery Act certified hazardous waste disposal facility.
- All municipal waste and construction and demolition waste generated at the SGP will be hauled off-site for disposal. Concrete foundations would be broken and buried in the TSF Buttress or pit backfill prior to installation of a geomembrane barrier cover.

3.2.5 Material Transportation Safety Measures

Operation will entail the use of petroleum fuels, chemicals, and hazardous materials in order to mine and process ore and conduct related activities. Anticipated quantities and delivery frequency of materials, supplies, and reagents are summarized in the PRO (Table 12-4). Perpetua Resources’ standard operating procedures for fuel transportation are presented in a Fuel Transportation Plan

(Environmental Standard Operating Procedure [ESOP]-44); a similar hazardous materials transportation plan is in development to address the transport of chemical reagents and supplies that will be required during the operation of the SGP.

Appropriate measures will be taken to protect worker health and safety and protect the environment when transporting chemicals and hazardous materials to prevent spills, fires, or explosions and to protect the existing biological and hydrologic resources of the area during construction, operation, reclamation, and closure.

All transport drivers will be required to have spill response, safety, and resource awareness training. In this program, drivers will be informed of the Idaho State Emergency Medical Service, first hazardous materials responder actions, and the importance of anadromous fisheries that must be protected. In addition, each driver will participate in a SGP safe-driver training course. The course will cover the operating procedures as well as discuss causes of accidents and how to minimize risks. Chemical use volumes would be reported under the United States Environmental Protection Agency Toxic Release Inventory program, as applicable and required by Section 313 of the EPCRA.

Several of the materials that would be transported to SGP require safe handling and transport procedures. Hazardous chemicals will be transported to the mine site in (USDOT)-certified containers and by USDOT-registered transporters, who will comply with applicable USDOT, OSHA, and MSHA regulations. Transportation vehicles will meet the standards of USDOT requirements and carry required markings, labels, and placards.

The following safety measures would be implemented to reduce the risk of accidents:

- Schedules will be developed for planned dates and times for transport of materials. The schedules will be communicated with staff and drivers so that timing of material transport is known, and arrangements can be made to minimize possible hazards.
- Fuel hauling will be done with single chassis units.
- Transportation of fuel and materials will be done during daylight hours.
- Spill response equipment are located along portions of the access route and in in the Perpetua Resources Spill Response trailer (Figure 3-2).
- Prior to material hauls, areas of “flat water” along the route will be communicated to appropriate hazardous materials response personnel to identify areas of potential booming in waterways adjacent to the route. These areas are identified for the Johnson Creek Route (Figure 3-2) and will be established along the Burntlog Route in revised versions of the SPCC Plan.
- Documented annual inspections of commercial transport vehicles are required by 49 CFR 396.17-23. Inspections will be conducted by a qualified USDOT inspector. Commercial transport vehicles will also be inspected by the drivers prior to transport. Transport companies are required to document DOT annual inspections and vehicle inspections. In addition, daily inspection of transport vehicles will occur as required by MSHA requirements.
- Material transporters to the site:
  - Will be required to check in at the SGLF. Safety inspections of all transport vehicles will be conducted by Perpetua Resources personnel prior to transportation of fuel and materials.
  - Will be required to provide documentation of successfully completed training in responding in the event of spills or other releases of transported materials and will have spill cleanup kits on the vehicle at all times.
  - Will be familiarized with the transportation route prior to transportation of fuel, hazardous materials, and operational supplies.

- Pilot vehicles will be used to escort shipments of fuel, chemicals, reagents, or antimony concentrate from the site. The pilot vehicles will have radio contact with the site and the transport vehicle. Pilot and emergency response vehicles would carry appropriate spill containment and first aid equipment.
- The pilot vehicle will advise oncoming traffic to park until the convoy passes and will regulate the speed of the transporting vehicle so that it does not exceed posted speed limits and safety conditions inherent to the road.
- Road signs will be placed at both the start and end of the route while a convoy is operating, indicating to the public that a fuel convoy is in progress and to use caution.
- Communications with Perpetua Resources management by using the SPOT™ GPS Messenger, (or similar GPS vehicle tracking equipment) – signal on the road/still traveling (custom message) at least hourly, and signal checking-in/OK upon reaching the Stibnite camp and upon safely returning to Cascade.

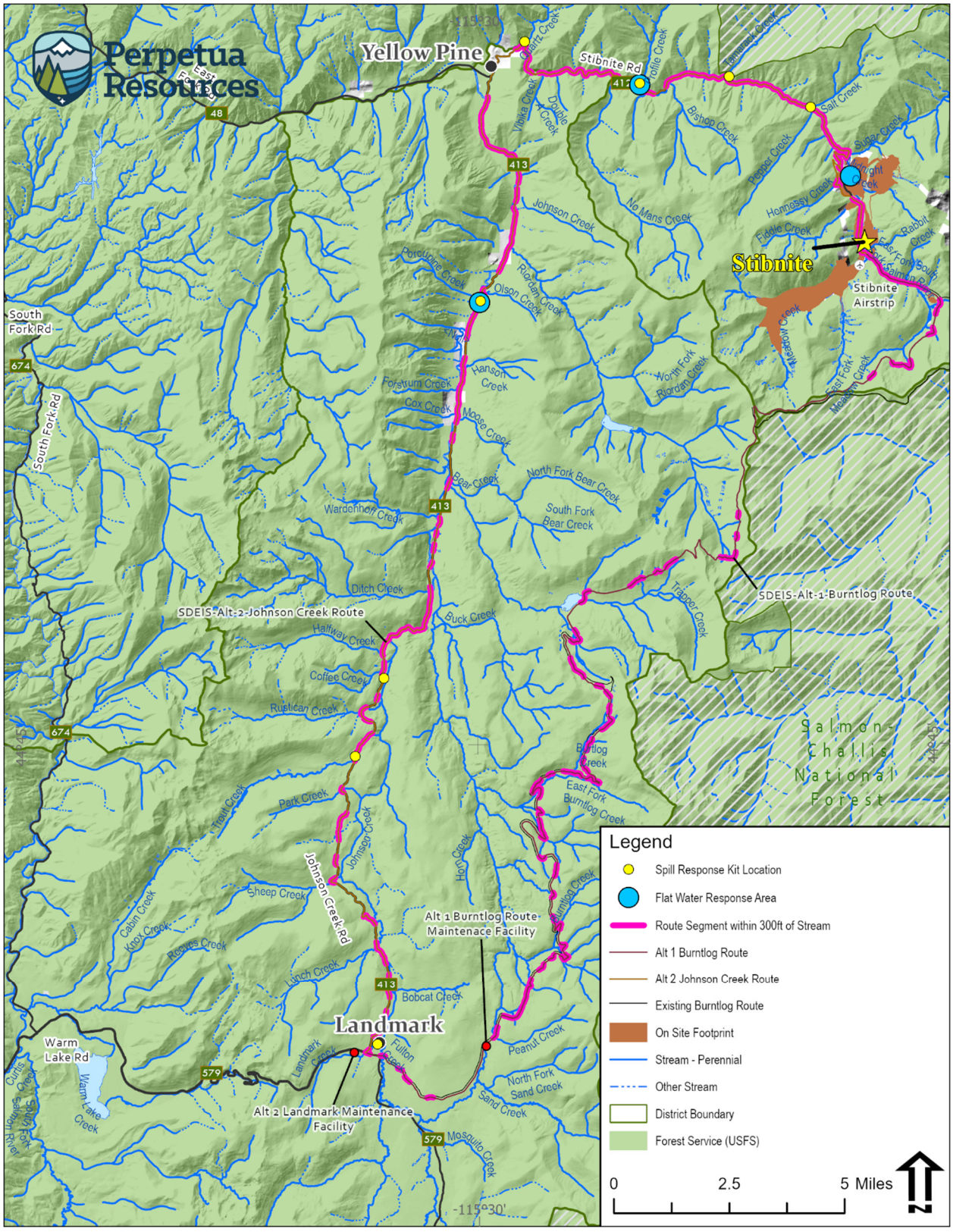


Figure 3-2. Spill Response Kit Locations and Access Route Segments Near Streams

3.2.6 Spill Prevention, Control, and Countermeasures Plan

A SPCC Plan will be maintained for material transportation, transfer, and storage operations as required by 40 CFR 112 regulations. Perpetua Resources maintains an SPCC Plan for current fuel storage at the SGP to support site exploration and current site maintenance activities. Anticipated quantities of materials stored at the SGP are included in the ModPRO2 document (Midas Gold, 2020). The SPCC Plan will be updated to reflect the approved Environmental Impact Statement alternative and will address site-specific spill prevention measures, fuel haul guidelines, fuel unloading procedures, inspections, secondary containment of all onsite fuel storage tanks, and staff training.

- The SGP SPCC Plan (most current revision, February 2019) includes measures to avoid inadvertent release of hazardous materials into the environment, particularly streams and rivers and describes response and remediation measures to minimize effects of an inadvertent release. Spill response kit locations on the Yellow Pine access route are indicated on Figure 3-2; similarly spaced spill response kits would be placed along the Burntlog Route during its construction and when it is in operation.
- Per the requirements of 40 CFR 112, the SPCC plan meets the applicable requirements for drainage, bulk storage tanks, tank car and truck loading and unloading, transfer operations (intra-facility piping), inspections and records, security, and training. Additionally, the facility must fully implement the SPCC Plan and train personnel in the execution of the SPCC Plan.
- The SPCC Plan will be updated and revised to address spill response through all phases of mine life from construction through post-closure (or as required to maintain compliance with 40 CFR 112).
- Secondary containment will be maintained for all chemicals and reagents to be used, including any oil storage areas (unleaded gasoline, diesel fuel), the autoclave facility, and the leaching circuit).

3.2.7 Emergency Response Plans and Procedures

In the event of spills, Perpetua Resources will respond with spill response measures described in the SGP Emergency Response Program (OHS-008) Spill Plan (OHSF-008K). This document includes supporting Emergency Response Plans that provide information specific to incident response actions including:

- Emergency Call List and Contact Matrix (OHSF-008-A): Communication protocols for internal (Perpetua Resources) contacts for emergency notification and call matrices per incident type (e.g., spill, flood, fire, avalanche, etc.) for appropriate federal, state, and county agency reporting.
- Protection Systems and Response Equipment (OHSF-008-D): Identifies the locations of emergency response equipment and includes an inventory of available emergency response equipment at each location.
- Spill Plan (OHS-008 K): Provides emergency response protocols for employees and contractors in the event of spills. Includes directives for minor and major spill response, emergency contacts, reporting requirements for fuel spills/hazardous materials spills, contact numbers for environmental response contractor (Specialty Environmental Services), muster points, and emergency medical services contact information (i.e., LifeFlight and Cascade Ambulance).
- Related plans include:
  - Critical Operations List (OHSR-008-C)
  - Evacuation Plan (OHSF-008-G)
  - HAZWOPER Program (OHSF-008-N)

  - Waste Determinations SOP (ESOP-021)
  - Herbicide Spill Response SOP (ESOP-024)
- For major spills, areas of "flat water" in adjacent waterways will be identified prior to material hauls in the event that booms need to be placed to capture major spills. [These areas are identified for the Johnson Creek Route (Figure 3-1) and will be established along the Burntlog Route in revised versions of the SPCC Plan].

3.3 Environmental Protection Measures

3.3.1 Public Use Safety

Interaction with the public is an important transportation safety consideration. Current operations at the Stibnite site include interaction between the public and Stibnite maintenance staff. Future SGP operations will increase the amount of traffic in the area. Numerous considerations are incorporated into the proposed SGP and subsequent alternatives (including ModPRO2 Alternative and DEIS Alternative 4) to ensure the safety of public users of Forest System roads:

- Employee traffic into and out of the SGP site will be reduced by providing worker housing and mass transit to/from SGP. Perpetua Resources would maintain a parking and assembly area as part at the SGLF. The parking area would accommodate approximately 300 light vehicles and mandatory employee and contractor busing would provide transportation for workers to the site.
- The Burntlog Route was proposed as the primary access route to reduce the interaction of SGP and public traffic. The Johnson Creek Route would require significant measures during construction and operations to ensure continued safe roadway access. In particular, during construction of the Stibnite Road portion of the Johnson Creek Route which requires extensive drilling and blasting to widen the route, provisions for continued public access would increase the overall construction phase by at least two years (four years in total) due to limited daily construction periods that allow for intervals of public access.
- DEIS Alternative 2 and the Modified Alternative 2 (ModPRO2) would include on-site lime production to reduce anticipated operational AADT by more than 25 percent (68 AADT in the PRO to 50 AADT in DEIS Alternative 2 and ModPRO2),
- Public access through the SGP site during operations would be separated from the SGP haul roads and monitored to ensure timely passage of vehicles through the site. Protocols for through-site public access are discussed in Section 2.3 of this document and detailed in the SGP Access Management Plan (Midas Gold 2020b).
- Increased wintertime access on Warm Lake Road east of Warm Lake Lodge would increase the potential for interaction between SGP public traffic. Appropriate alternative measures to promote safe public travel up Warm Lake Road to Warm Lake Summit are discussed in Section 2.2.1 of this document and included in Seasonal Public Access: Warm Lake Road and Burntlog Route (Midas Gold 2020b).
- The SGLF, and a nearby site on private property, would host radio and microwave repeater equipment to provide telephone, internet, and radio communications for the facility and SGP traffic. Additional radio repeater locations will be needed to facilitate full coverage along the Burntlog Route.
- All access routes would have signed speed limits and appropriate traffic control devices. Posted speed limits are those that are sign-posted along the road and are enforceable by law. The posted speed limits will be consistent with County and/or USFS guidelines. Work zone speed limits would be as specified in the traffic control plan, which is used to help facilitate safe and efficient movement of traffic through a work zone. Factors that influence work zone speed limits

can include: the posted speed limit when the work zone is not present, location of the work zone and workers in relation to traffic, type of traffic control (e.g., cones, barrels, concrete barriers), and the complexity of the work zone (e.g., lane shifts, narrowed lanes).

- Traffic controls convey important information about the road conditions, potential hazards, and other obstacles. They are markers, signs, and signal devices used to inform, guide, and control traffic, including pedestrians, motor vehicle drivers, and bicyclists. These devices are usually placed adjacent to, over, or along the roads and other public areas that require traffic control. The Federal Highway Administration Manual on Uniform Traffic Control Devices (Federal Highway Administration, 2009) will be used to determine appropriate traffic controls on the access routes.
- Signs warning motorized and nonmotorized road users of hazardous conditions or the presence of large trucks and equipment would be placed following the recommendations in the Manual on Uniform Traffic Control Devices.
- Planned responses to vehicle collisions are described in the SGP Emergency Response Program Vehicle Incident Plan (OHSF-008-L).

3.3.2 Avalanche

Road design features that address the potential for road damage from avalanches are discussed in Section 3.1 of this document. Avalanches also have important health and safety implications and can impact the environment. This is illustrated in RFAI-83c, which documents avalanche occurrences in 2014 and 2019, along the Stibnite Road portion of the Johnson Creek Route and again most recently in 2021. One avalanche in 2019 obliterated approximately ½ mile of the Stibnite Road delivering the included road material into the stream as well as entrained sediment (and hundreds of trees). Reducing the potential for avalanche/roadway interaction can be accomplished by (1) appropriate design of the access road alignment that avoids placement in the bottom of avalanche chutes, (2) continual monitoring of avalanche occurrences and appropriately updating the avalanche database to inform road users, and (3) mitigating catastrophic avalanches by inducing smaller, less destructive events.

Recent, updated assessments of identified avalanche chutes on the Burntlog and Yellow Pine Project access routes have been prepared (Dynamic 2021) and will be provided in draft form as Attachment A of this TMP submittal. Figure 3-1 illustrates avalanche chutes referenced in the report.

Perpetua Resources used these data to develop EPMs for avalanches. These measures are listed below and may be modified after monitoring and reassessment as described in the Dynamics (2021) report, after consultation with the USFS:

- Map locations where small-sized avalanches frequently occur and include these locations in safety plans to inform drivers of areas of potential risk.
- Periodically update the mapping before the next snow season if wildfire or any other large scale vegetation modification alter the size or frequency following the methods described in the Snow Avalanche Hazard Assessment for Access Roads (Dynamic 2021). Current known locations are shown on Figure 3-1.
- Review all paths with summer and winter imagery, review topographic contours and slope classes.
- Construct catchment areas for smaller avalanche paths on slopes on the west side of the Warm Lake Summit.

- Frequently remove snow from catchment areas/ditches or design ditches to hold most of the snow for the winter with "Jersey" barriers to increase the depth. The appropriate size of the ditch could be evaluated on a site-specific basis, which is a function of the length and incline of the slope above and the depth of the snow in a design (e.g., 10-year) winter.
- Implement an avalanche hazard management program for larger avalanches with return periods of 1 to 10 years. This could include avalanche control and/or road closure.
- Post permanent warning signage in avalanche-prone areas of critical avalanche size[2].
- Monitor avalanche parameters and take appropriate actions:
  - Daily region-scale assessments
  - Daily weather observations, including snowpack and avalanche observations
  - Notify SGP staff when conditions are highly unstable
  - Close roads during periods of elevated hazard or blocked roadways.
  - Control avalanche initiation with explosives using helicopters, case charging, Avalauncher, hand charging, or remote control.

3.3.3 Landslides, Debris Flows, and Rock Fall

Landslides and debris flows are types of mass earth movements and are shown on Figure 3-1. They are initiated by periods of heavy precipitation that saturates slopes, decreasing the internal stability of unconsolidated materials (soil, alluvium) while increasing their mass. Freeze/thaw cycles of the nearby ground and soils may result in materials falling from the roadside onto the access routes, potentially blocking the route and striking vehicles. Road cuts at the base of these features can increase their likelihood by reducing the amount of material effectively buttressing the slope. More volumetric slope failures can result in large slumps that completely obliterate sections of roadway. The Riordan Creek Valley segment of the Burntlog Route crosses areas of active landslides (Figure 3-1). They may also be seismically induced.

Rock fall occurs from rock spalling from steep, rocky overhangs and creates debris on the roadways in steep sections of the access routes. This is particularly notable along sections of Stibnite Road, and there is potential for rockfall on the Black Lake and Riordan Creek Valley segments of the Burntlog Route. Rock falls are caused by diurnal freeze/thaw cycles typical of spring weather conditions. Potential impacts from rock falls include roadway blockage and/or damage, and there is also a significant human health and safety concern due to the potential to strike vehicles. EPMs such as rock bolts, netting, and signage will be installed along segments susceptible to rock falls. Responsibility for removal of rock debris from the roadways will be detailed in the maintenance agreement with Valley County.

As noted in Section 3.1 above, appropriate design features and construction considerations would be made to minimize the exacerbation of geologic hazards.

- Avoid known occurrences of slope failures to the degree practicable,
- Incorporate appropriate cut slopes and stabilizing features (e.g., retaining walls, soil nails) into road design to reduce the potential for slope failure.
- Road layback design to prevent the formation of steep overhangs and prevent spalling.
- Consider rock bolt and netting and catch benches would also be considered in these areas.

[2] At least, could bury and destroy a car, damage a truck, destroy a wood frame house, or break a few trees, typically 10,000 tons or more and 3,000 feet long with 2,000 pounds/square foot of pressure (Dynamic Avalanche Consulting 2021)

- A Road Maintenance Agreement between Perpetua Resources and Valley County would be developed defining the procedure and protocols for removing material debris from the access route.
- Dewatering or other stabilizing structural features as control measures.
- Where necessary, realign the roadway.

3.3.4 Roadway Washouts/Culvert Design

Adequately handling water along the roadway is imperative to maintain the roadway in good condition. Periods of heavy precipitation that saturate the roadway and surrounding roadside increase the risk of the roadway surfaces and base courses to be washed out, making the access routes unpassable. This is best addressed in appropriate road design and associated culvert sizing and maintaining culverts to perform as designed.

- Ditches would be installed on the in-sloped edge of the road, which would collect water from the gravel surfacing as well as the hillside above the road.
- For the proposed Burntlog Route, an 18-inch-deep V-shaped ditch with 1.5H:1V slopes would be used along the roadway, as is typical of most gravel roads in mountainous areas.
- Culverts providing drainage for non-fish bearing streams would take into account the estimated drainage basin area and would be sized to accommodate a recommended peak 25-year design flow at each culvert location (Parametrix 2018c). (Culvert sizing for fish-bearing streams is discussed later in this Section.)
- Additional relief culverts would be placed at intervals depending upon the uphill drainage basin size and road profiles.
- The drainage system (roadside ditches and culverts) would require a reasonable amount of maintenance and inspection to ensure the system is working properly. Debris and sediment would be removed on an annual basis, in addition to any emergency situations that may arise. To maintain culvert efficiency, Perpetua Resources would monitor the roadways and clear debris from culvert inlets and outlets during and after significant storm events.
- The planned Maintenance Agreement with Valley County would include procedures and protocols for rerouting traffic, providing temporary signage for the road closure, and any repairs required for the access roadways to return to functional operation.
- Washouts will be addressed by variable message signage and rerouting traffic until the damaged segment can be repaired.
- New culverts, replacement culverts, and other stream crossings shall be designed to accommodate a 100-year flood recurrence interval unless site-specific analysis using calculated risk tools, or another method determines a more appropriate recurrence interval.

3.3.5 Safety Measures During Hazardous Road Conditions

Consistent with recommendations included in the Feasibility Study Road Design Report (Parametrix 2018c), the following measures will address hazardous road conditions.

- Appropriate signage would be placed along SGP and public access roads to guide travelers along the roadway at night or during inclement weather.
- In areas of steep terrain and side slopes, delineators would be placed at the edge of the road to visually distinguish in shadows and snow cover.
- Delineators would be high enough to remain effective during the winter season due to the snow depth.

- Repairs to roadway signs and delineators each summer to address damage from winter maintenance activities.
- If a major storm event, wildfire, or other condition arises that represents a significant hazard and is determined to represent a health and safety risk to travel on the mine access road, delivery vehicles would be detained at the SGLF, the mine site, or notified at their point of origin to delay their delivery. Once safe travel conditions resume, Perpetua Resources would consolidate and coordinate accumulated vehicles to safely complete their delivery routes. This would temporarily increase daily traffic rates; however, it would not impact overall AADT for construction, operations, or reclamation/closure phases of the SGP.

3.3.6 Public Access During Construction

For the ModPRO2 Alternative, during the Burntlog Route construction phase (2 years), safe public access would be maintained by:

- Mine-related traffic would access the mine site from State Highway 55, north of the city of Cascade, via Warm Lake Road (CR 10-579), then Johnson Creek Road (CR 10-413) to Yellow Pine, and from Yellow Pine to the mine site via the Stibnite Road segment of the McCall – Stibnite Road (CR 50-412) (Figure 2-1).
- During the construction phase, minor surface improvements (e.g., ditch and culvert repair, adding gravel, winter snow removal, and summer dust suppression) would occur on the Johnson Creek Route to reduce sediment runoff and dust generation.
- There would be no road alignment modification or widening of the existing roads. Public access during this construction phase would include periodic lane restrictions and appropriate signage to notify travelers of construction activities.

Estimates of changes in public access are based on a preliminary construction schedule for the Johnson Creek Route as part of a revised (Johnson Creek Route) Access Road Feasibility Design memorandum (Parametrix 2019). Construction of the Johnson Creek Route is estimated to require two more years to complete than the Burntlog Route; a total of four years. Upgrades on the Johnson Creek Road portion of the Johnson Creek Route would require one full year with no public access. During the same season, the road around the mine operations would also be constructed, which starts south of Sugar Creek and ends at the Worker Housing Facility. In this manner, both segments would be closed to public access for one year; however, this approach would facilitate partial public access in subsequent years during the construction of the Stibnite Road segment of the Johnson Creek Route. The remaining three years of the construction period would be used to complete upgrades and widening of Stibnite Road; an effort which would be complicated by providing continued periodic public access through the construction area. Parametrix (2019) notes: “With the tight terrain and amount of rock blasting anticipated, daily full-road closures would be expected. It was assumed that the Stibnite Road would have to re-open for public use each night (after 4 PM), thus reducing production rates and construction efficiencies.”

- In summary, public access under the Johnson Creek Route Alternative during the first year of construction would completely restrict public access on Johnson Creek Road for one year. Public access to Yellow Pine during this time would be on the South Fork Road.
- Public access to points beyond Yellow Pine would be partially restricted for the next three years of construction. Public access to Yellow Pine via Johnson Creek Road would be re-established during this time.

3.3.6.1 Through Site Public Access Road Construction

The ModPRO2 (modified DEIS Alternative 2) and DEIS Alternative 4 each include a through-site public access route that would replace the current access through the SGP site on Stibnite Road (FR 50375) during mine operations. Through-site public access routes for both Alternatives are described in Section 2.3.3.

For the ModPRO2, the through-site public access road would be a designated roadway separate from the mine haul road network and would be constructed on a widened bench within the Yellow Pine pit. South of the Yellow Pine pit, this road would parallel a mine haul road and use a partially revegetated portion of the former Bradley mine haul road. This road would be approximately 4 miles. The public access road would be constructed concurrent with the removal of development rock from Yellow Pine pit.

- During construction, current public access through the SGP site on Stibnite Road would be restricted for one year or more while a new through-site public access road is constructed.
- A new 12-foot-wide gravel road would be constructed to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375) through the mine site Figure 2-2 and Figure 2-3.

For DEIS Alternative 4, the through-site public access road would be a shared roadway with mine access traffic to the area south of the Yellow Pine Pit. The shared access road would have a slightly different alignment to meet the mine access road design criteria (lower maximum grade, wider running width, greater curve radius, etc.). As noted in Section 3.3.6, the through-site public access road would be constructed in the first year of construction. For the next three years, access to the through-site public access road would be subject to daily restrictions (estimated 10 A.M. to 4 P.M. daily) to allow for construction upgrades to Stibnite Road.

3.3.6.2 Recreational Access for OSVs

Due to year-round access to the mine site along Warm Lake Road (for both the ModPRO2 Alternative and DEIS Alternative 4) for the life of the SGP:

- The existing, approximately 8-mile groomed OSV trail from Warm Lake to Landmark would be closed.
- To replace this recreational use, at the onset of the construction phase (including minor upgrades to Johnson Creek Road) a dedicated alternative OSV route would be established from the Warm Lake area to Landmark via the Cabin Creek/Trout Creek drainages.
- The groomed OSV trail would be approximately 10.4 miles in length on the existing road and would include an approximately 2-acre parking area west of South Fork Road, and a new 1.5-mile groomer access trail from the USFS Warm Lake Project Camp on Paradise Valley Road (FR 488) where the groomer would be stored. An approximate 0.1-mile segment would be groomed from the intersection of Paradise Valley Road (FR 488) and FR 488A to Warm Lake Road.
- From Trout Creek to Landmark, an approximately 7-mile temporary groomed OSV trail would be maintained on NFS lands adjacent to the west side of Johnson Creek Road (CR 10-413).
- Portions of the temporary groomed OSV trail would be established using a snowplow wing attachment requiring some vegetation and tree removal to allow for safe snowplowing.
- The precise location of this trail is not yet determined, and in areas where topography and vegetation prevent using the wing attachment to establish the groomed OSV trail, sections would merge with Johnson Creek.
- A 0.3-mile trail would be maintained south of Warm Lake Road and would connect Johnson Creek Road to the Landmark-Stanley Road (FR 579).

Figure 2-2 shows the Cabin Creek/Trout Creek/Johnson Creek Road groomed OSV trail from Warm Lake lodge to Landmark.

3.3.7 Wildfire

- The SGP transportation system would maintain emergency road access as required by the Forest Roads and Trails Act, and the BNF and PNF Land and Resource Management Plans goal FRG001). Perpetua Resources Fire and Explosion Emergency Response Plan (OHSF-008-H) includes Wildfire response measures address employee, contractor, and public health and safety. Additionally, an Emergency Response Plan that incorporates fire/wildfire response will be developed per the requirements of the Cyanidation Permit (Idaho Administrative Procedures Act 58.01.13).
- The Fire and Explosion Emergency Response Plan addresses fire/explosions and spills (including flammable liquids). Plans detail evacuation directives, designated muster points, and shelter-in-place procedures. These existing plans will be incorporated into a comprehensive Emergency Response Plan that will detail best practices for all manner of emergency response through all phases of mine life from construction through post-closure.
- A fire emergency response and evacuation plan will be developed and maintained as part of Perpetua Resources' overall safety aspects to comply with both company and MSHA requirements (Section 1.4.1).
- The potable water tank(s) at the ore processing facility will include a capacity for firefighting needs. In case of a fire, water from these tanks can be gravity fed to a series of fire hydrants at the ore processing facility and truck shop complexes and at the employee housing facility.
- Fire extinguishers and fire hoses will be installed and maintained at strategic locations, such as the ore processing facility, shop, offices, and employee housing facility. Site water trucks, portable tanks, and pumping apparatus may be used by Perpetua Resources for firefighting purposes. The mobile equipment and apparatus would also be available for wildland firefighting, if requested by the appropriate authorities.

3.3.8 Response to Traffic Accidents

Reponses to vehicle accidents are addressed by Perpetua Resources Vehicle Incident Emergency Response Plan (OHSF-008-L). Included are best practices for responding to accidents by or between mine employees and contractors, including situational safety assessment, reporting protocols, information to be collected/shared, and in the case of injuries, notifying emergency health care services as appropriate.

- Perpetua Resources contractors, suppliers, and/or staff: Perpetua Resources Emergency Response staff, as well as local law enforcement would be contacted and dispatched to the accident location to address any blockage to the access route and reopening the route to travel.
- Environmental hazardous materials: For vehicle accidents involving other potential hazardous materials spills (e.g., gasoline, oil, vehicle fluids, etc.), Perpetua Resources Emergency Response staff would be dispatched to the accident location to address any hazardous materials spills and local law enforcement would be contacted to control traffic until the route can reopen to travel.
- Local law enforcement to be contacted and dispatched to the accident location to address any blockage to the access route and reopening the route to travel.

For incidents that involve the public.

- Where possible, Perpetua Resources will assist local people in the event of an incident.
- Perpetua Resources employees may obtain consent (or implicit consent) and render first aid to any person who may be injured, if safe to do so, in accordance with the Personal Injury Emergency Response Plan (OHSF-008-I).

3.3.9 Air Quality

Perpetua Resources provided a response to RFAI-118 on March 31, 2021, providing information on fugitive dust control (environmental protection) measures that would be implemented as part of the Fugitive Dust Control Plan (FDCP); this is a forthcoming document that is an IDEQ requirement for the Air PTC. The EPMs would target maintaining a control efficiency of 90 percent on the on-site haul roads.

The FDCP would address the following:

- Procedures followed by Perpetua Resources employees to control and minimize fugitive dust emissions, including speed limits, application of dust suppressants (e.g., water, chemical dust suppressants).
- Trigger levels (identified by monitoring to be determined in the forthcoming Air PTC) requiring corrective actions.
- Actions to bring fugitive dust emissions within acceptable ranges.
- Visual monitoring and reporting that demonstrates that appropriate corrective procedures are followed.

General EPMs to ensure that fugitive dust generation is minimized would include:

- All suppliers, vendors, and employees maintain posted speed limits on the access routes.
- Application of binding agent (e.g., magnesium chloride, lignin sulfonate, etc.) or road wetting on SGP and public access roads would be applied as needed.

3.3.10 Water Quality and Aquatic Habitats

The SWPPP (Aquionix, Inc. 2021) includes measures (including best management practices) to protect waterways from pollution and sedimentation during construction. In summary (see the SWPPP for details) measures address:

- General best management practices for earth disturbed activities and construction guidelines
- Timing of construction
- Staging area
- Preservation of existing vegetation
- Clearing limits
- Stabilization of construction entrance and exit
- Erosion prevention from temporary roads
- Good Housekeeping
- Dust control
- Cover for materials and equipment
- Stockpile management
- SPCC
- Vehicle and equipment washing and maintenance
- Waste management
- Sanitary and septic waste management
- Slope Protection and Stabilization
- Mulching
- Hydromulching
- Geotextile
- Matting
- Soil binders
- Topsoil seeding
- Planting slope roughening

- Gradient terracing
- Channel Protection
- Temporary channel liners
- Riprap slope and outlet protection
- Inlet protection
- Check dams
- Temporary stream crossings
- Sediment Collection and Runoff Diversion
- Biofilter bags
- Fiber rolls
- Silt fence
- Vegetative buffer strip
- Sediment trap (basin) portable sediment tank
- Temporary swale
- Earth dike
- Perimeter dike/swale
- Temporary berms

All vendor contracts will include requirements for adhering to posted speed limits, drivers trained in spill response, and spill kits on all vehicles transporting hazardous materials. In the event of spills, Perpetua Resources will respond with spill response measures described in the SGP Emergency Response Program Spill Plan (OHS-008-K).

3.3.11 Culvert Design and Fish Passage

Road crossings of fish bearing streams will be designed such that structures allow fish passage. FSH guidelines for fish-bearing streams include structures that span 120 percent of the channel's bankfull width and pass the peak 100-year design storm. The USFS generally considers the bankfull discharge to occur on average every 1 to 3 years (USFS 2014). The bankfull width determination will be completed in the field during final design; however, the 1.5-year design storm or a localized drainage area regression equation was generally used for initial calculations included in the Feasibility Study Road Design Report (Parametrix 2018c).

The existing box culvert on the EFSFSR just downstream of the confluence with Meadow Creek at the Stibnite Road (CR-412) crossing is believed to be a full or partial barrier to upstream movement by salmonids. Improvements to fish passage will be made along the Burntlog Route by replacing collapsed, undersized, or otherwise degraded or poorly designed culverts. Perpetua Resources will complete this work using the USFS Stream Simulation approach (USFS 2008).

- The SWPPP (Aquionix, Inc. 2021) discussed in Section 3.3.10.1, measures in Public Safety Section 3.3.1, road engineering with surface drainage, roadside ditching, road-cut stabilization, and road surface maintenance would be implemented to maintain water quality and aquatic habitats.
- Road surfaces would be stabilized and managed to minimize transport of sediment, dust, and other materials, especially near watercourses. Crushed rock would be placed on access roads as needed to provide a durable surface and limit sediment transport into nearby streams. Erodible (i.e., non-rock cut) slopes along roads would be mulched, hydro-seeded, or covered with rock or coarse gravel to minimize the potential for sediment mobilization.
- During winter road maintenance, snow would be removed from the Burntlog Route, haul roads, and the temporary construction access Johnson Creek Route.
  - Avoiding disposal of snow in riparian areas, wetlands, or areas where snowmelt might cause road damage or erosion during spring melt.
- Care will also be taken to avoid disposing of collected snow, which may contain sand or gravel, into nearby streams and rivers.
- Perpetua Resources would use coarse sand (with less than 20 percent fines) for winter sanding of the main access road and haul roads in combination with a fine to medium gravel as needed, (approximately 1/4 - 5/8-inch sizing).

- New roads constructed for the SGP on NFS lands will be closed and reclaimed once they are no longer needed to support construction, operations, closure, or reclamation activities.

3.3.12 Wildlife

- Measures to reduce the amount of mine traffic listed in Section 3.3.1 would similarly reduce the potential for wildlife/vehicle collisions.
- Appropriate speed limits and other measures will target minimizing vehicle and wildlife interactions. Personnel will be trained in the documentation and reporting of wildlife mortality incidents to reduce future occurrences (see RFAI-29) (Endangered Species Act).
- Signage of known crossing and wildlife usage areas along access and haul road corridors and all active facility areas. Sign locations are to be determined, but signs would include the road name and mile markers where these corridors are known to exist. Known wildlife areas near roads would be referenced in the training materials along with visible signage in these locations.
- Refer to the EMMP Wildlife Monitoring and Management Plan (Appendix RM-3) for the procedure and protocols for removing animals that have been struck. Coordination with Idaho Department of Fish and Game would be made for carcass removal.

Figure 3-2 shows the road segments within 300 feet of streams with anadromous fish. For Alternative 2, the operational traffic would not use Johnson Creek Road or Stibnite Road thus reducing the length of the route within 300 feet to less than 10 percent. Alternative 4 would have over 50 percent of the route within 300 feet of a stream during operations. ESOP-004 includes procedures for spill response to protect water quality.

Section 4

References

Air Sciences, 2021. *Air Quality Analysis Addendum – ModPRO2*. July.

Aquionix, Inc., 2021. *Stormwater Pollution Prevention Plan (SWPPP) ESOP-029*, Prepared for Perpetua Resources, May.

Brown and Caldwell, 2021. *DRAFT Stibnite Gold Project Environmental Monitoring and Management Program*, Prepared for Perpetua Resources, May.

Dynamic Avalanche Consulting, LTD., 2021. *Stibnite Gold Access Roads Snow Avalanche Hazard Assessment for Access Roads DRAFT*.

Federal Highway Administration, 2009. *Manual of Uniform Traffic Control Devices for Streets and Highways*.

Holladay Engineering Company, 2008. *Valley County Master Transportation Plan*, Prepared for Valley County Idaho, March.

Midas Gold Idaho, Inc. (Midas Gold), 2016. *Stibnite Gold Project Plan of Restoration and Operations (PRO)*, September.

Midas Gold, 2020a. *Stibnite Gold Project: Seasonal Public Access –Warm Lake Road and Burntlog Route*.

Midas Gold, 2020b. *Access Management Plan*.

Parametrix, 2018a. *Stibnite Gold-Access Road Feasibility Design*. Memorandum to Gene Bosley, Midas Gold Idaho from Ismael Medina. Revised May.

Parametrix, 2018b. *RFAI-83 Response: SGP Access Road Feasibility Design*. Memorandum to Dale Kerner, Midas Gold from Ismael Medina. May 10, 2018, revised June 11, 2018.

Parametrix, 2018c. *Stibnite Gold Project Feasibility Study Access Road Design Documentation*, Prepared for Midas Gold, December.

Parametrix, 2019. *RFAI-83c Response: Attachment D, Stibnite Gold Project – Access Road Feasibility Design (Revised Version 3)*. Memorandum to Dale Kerner, Midas Gold from Ismael Medina and Dave Meldrum. June 20, 2019.

Perpetua Resources, 2021. *Stibnite Gold Project: Refined Proposed Action – ModPRO2*, October.

SRK Consulting, Inc. (SRK), 2019. *Mercury Emissions Control in the Proposed Stibnite Processing Plan*, Prepared for Midas Gold (submitted with RFAI-104 May 29, 2019).

SRK, 2021. *Stibnite Gold Project – Haul Road Predictive Runoff Water Quality,* Prepared for Midas Gold January.

United States Forest Service (USFS), 2003. *Payette National Forest Land and Resource Management Plan.* Revised. Ogden, UT: USDA Forest Service, Intermountain Region.

USFS, 2008. *Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings*. In partnership with US Department of Transportation, Federal Highway Administration Coordinated Federal Lands Highway Technology Implementation Program, United States Department of Agriculture Forest Service August.

USFS, 2020. *Stibnite Gold Project Draft Environmental Impact Statement.* United States Department of Agriculture Forest Service (USFS, Region 4, Payette and Boise National Forests, Valley County, Idaho, August.

USFS Requests for Additional Information (RFAI):

USFS RFAI-21 *Hazardous Materials*, 2017. Response provided by Midas Gold on July 21, 2017.

USFS RFAI-29 *Wildlife Mitigation*, 2017. Response provided by Midas Gold on August 16, 2017, and revised March 28, 2018.

USFS RFAI-60 *Yellow Pine Road Upgrades*, 2017. Response provided by Midas Gold on January 4, 2018.

USFS RFAI-83 *Johnson Creek/Stibnite Road cut/fill slopes and improvements*, 2018. Response provided by Midas Gold on June 26, 2018, including Parametrix (2018a).

USFS RFAI-104 *Hg (Mercury) Waste Management*, 2019. Response provided by Midas Gold May 29, 2019, including SRK 2019.

USFS RFAI-115 *Road Construction Material Geochemistry*, 2021. Response provided January 28, 2021. Includes SRK 2021. Stibnite Gold Project – Haul Road Predictive Runoff Water Quality.

USFS RFAI-120 *Hazardous Materials*, 2021. Response provided by Perpetua Resources April 9, 2021.

USFS RFAI-131 *Antimony Transport and Storage*, 2022. Response provided by Perpetua Resources February 11, 2022.

RAÚL R. LABRADOR
Attorney General

RAÚL R. LABRADOR
Attorney General

SCOTT L. CAMPBELL
Deputy Attorney General
Chief, Energy and Natural Resources Division

JOHN R. SHACKELFORD, ISB# 8647
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: (208) 373-0453
Facsimile: (208) 373-0481
john.shackelford@deq.idaho.gov

Attorneys for Respondent

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	Agency Case No. 0101-22-01 OAH Case No. 23-245-01 RESPONSENT'S NON-REPLY TO PETITIONERS' RESPONSE

COMES NOW, Respondent, the Idaho Department of Environmental Quality, by and through the Office of the Attorney General, and hereby elects to not reply to Petitioners' Response, which recycles arguments previously refuted by the documents filed in support of Respondent's Cross Motion for Summary Judgment. The Department stands by its three-year analysis of the Stibnite PTC.

Dated: June 23, 2023.

STATE OF IDAHO, DEPARTMENT OF ENVIRONMENTAL QUALITY

By: /s/ *John R. Shackelford*
John R. Shackelford
Attorney for Respondent

CERTIFICATION OF SERVICE

I HEREBY CERTIFY that on this 23rd day of June, 2023, a true and correct copy of the foregoing RESPONDENT'S NON-REPLY TO PETITIONERS' RESPONSE was served on the following via electronic mail to the indicated address:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Dylan Lawrence
Hearing Officer
Varin Thomas, LLC
242 N. 8th St., Suite 220
Boise, ID 83702
dylan@varinthomas.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Resources Division
Office of the Attorney General
1410 N. Hilton St.
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

/s/ Patricia Jordan
Patricia Jordan, Legal Assistant

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047

NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,

Petitioners,

v.

IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,

Respondent,

and

PERPETUA RESOURCES IDAHO, INC.,

Intervenor-Respondent.

Case Docket No. 0101-22-01

REPLY MEMORANDUM IN SUPPORT OF INTERVENOR-RESPONDENT PERPETUA'S MOTION FOR SUMMARY JUDGMENT

TABLE OF CONTENTS

TABLE OF AUTHORITIES III

KEY TO TERMS AND ABBREVIATIONS V

INTRODUCTION 1

DEQ'S PERMIT RECORD AND EVIDENCE RELIED ON 2

STANDARD OF REVIEW 3

I. The Board must decide, as a matter of law, whether Petitioners proved DEQ's action was arbitrary and capricious, an abuse of discretion, or contrary to law. 3

II. The Board may defer to DEQ's technical expertise and special skill 4

REPLY ARGUMENT 5

I. Standing: Petitioners failed to demonstrate, as is their burden, that they are persons "aggrieved" by an action or inaction of DEQ. 5

II. Ambient air boundary (Claims 11 and 12): DEQ followed EPA guidance and exercised discretion to exclude the Stibnite Access Route from the Project's ambient air boundary. 5

III. Fugitive dust emissions (Claims 1, 2, 5, and 8): DEQ did not act arbitrarily and capriciously or violate the Idaho Air Rules in determining that fugitive dust emissions from the Project's roads will comply with the PM_{10} NAAQS and arsenic AACC. 9

A. DEQ reasonably determined that 93.3% control efficiency for fugitive dust from haul roads was attainable and enforceable (Claims 2 and 8). 9

1. Petitioners have not shown that DEQ's use of the 93.3% control efficiency was unsupported or unreasonable. 9

2. Petitioners fail to prove that the Final Permit lacks enforceable conditions to ensure 93.3% control efficiency when DEQ imposed technical limits, daily monitoring, and other substantive conditions. 11

B. Petitioners fail to show that DEQ is required to impose conditions restricting vehicle miles traveled and truck weights when DEQ imposed surrogate production limits and other requirements (Claims 1 and 8). 14

C. Petitioners did not prove that DEQ's use of 120 days of precipitation data to estimate fugitive dust emissions was arbitrary and capricious (Claims 5 and 8) 17

IV. Work Plans (Claim 3): the Final Permit requires Perpetua to develop work plans for DEQ approval and does not violate the CAA or the Idaho Air Rules. 18

V. Ambient air monitoring (Claim 13): DEQ did not violate the law by issuing a preconstruction permit that omitted ambient air monitoring. 21

VI. Arsenic T-RACT (Claims 6 and 7): because chemical dust suppressant and water are already established as reasonably available control technologies, DEQ was not required to conduct a technological or economic feasibility analysis. 22

VII. Arsenic averaging (Claim 9): DEQ reasonably exercised its discretion in evaluating the health risks from arsenic..... 25

CONCLUSION..... 27

TABLE OF AUTHORITIES

Cases

Auer v. Robbins,
519 U.S. 452 (1997).....25

Environmental Defense Center, Inc. v. U.S. EPA,
344 F.3d 832 (9th Cir. 2003).....20

Hoppe v. Nichols,
100 Idaho 133, 594 P.2d 643 (1979).....26

Idaho Power Co. v. Idaho PUC,
155 Idaho 780, 316 P.3d 1278 (2013) (Jones, J. concurring).....25, 27

J.R. Simplot Co. v. Idaho State Tax Comm'n,
120 Idaho 849, 820 P.2d 1206 (1991).....4

Laurino v. Bd. of Pro. Discipline of Idaho State Bd. of Med.,
137 Idaho 596 (2002).....4

REDOIL v. U.S. EPA,
716 F.3d 1155 (9th Cir. 2013).....8

Train v. NRDC,
421 U.S. 60 (1975).....4, 21

Waterkeeper Alliance, Inc. v. U.S. EPA,
399 F.3d 486 (2d Cir. 2005).....20, 21

Statutes

Administrative Procedure Act.....3, 4

Clean Air Act, 42 U.S.C. § 7401, *et seq*. 6, 20

Clean Water Act.....20, 21

Idaho Code § 39-107(5).....5

Idaho Code § 39-115.....4

Idaho Code § 67-5251(5).....4

Idaho Code § 67-5279.....3

Idaho Code § 67-5279(3).....3

Idaho Code § 67-5279(4) 3

Rules for the Control of Air Pollution in Idaho, IDAPA 58.01.01, *et seq*. 9

IDAPA § 202 18

IDAPA § 202.01 18

IDAPA § 202.03 18

IDAPA § 210 27

IDAPA § 210.12 25

IDAPA § 211 12

IDAPA § 210.14.c 24

IDAPA § 210.14.d 24

Other Authorities

John Calcagni, Director, Air Quality Management Division, *Transmittal of Background Statement on "Top-Down" Best Available Control Technology (BACT)*, U.S. Environmental Protection Agency (June 13, 1989), https://www.epa.gov/sites/default/files/2015-07/documents/topdawn.pdf 23

KEY TO TERMS AND ABBREVIATIONS

AACC	Acceptable Ambient Concentration for a Carcinogen
AMP	Access Management Plan
CAA	Clean Air Act, 42 U.S.C. § 7401, *et seq*.
DEQ	Respondent Idaho Department of Environmental Quality
EPA	United States Environmental Protection Agency
HAP	Hazardous air pollutant
FDCP	Fugitive Dust Control Plan
Final Permit	Air Quality Permit to Construct No. P-2019.0047, issued June 17, 2022
HRCP	Haul Road and Capping Plan
Idaho Air Rules	Rules for the Control of Air Pollution in Idaho, IDAPA 58.01.01, *et seq*.
NAAQS	National Ambient Air Quality Standards
O&M Manual	Operations and Maintenance Manual
Perpetua	Intervenor-Respondent Perpetua Resources Idaho, Inc.
Petitioners	Petitioners Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon
PM	Particulate matter
Project	Stibnite Gold Project
RBLC database	RACT/BACT/LAER Clearinghouse Database
TAP	Toxic air pollutant
T-RACT	Toxic air pollutant reasonably available control technology

Intervenor-Respondent Perpetua Resources Idaho, Inc. ("Perpetua") submits this reply brief in support of its motion for summary judgment.

INTRODUCTION

The Stibnite Gold Project (the "Project") is a pioneering approach to mining precious and critical minerals. Not only will it afford Valley County and resident Idahoans with economic benefits, the Project will restore a contaminated mine site that has long since been abandoned by the federal government. In 2021, Perpetua entered into a voluntary administrative settlement agreement with the United States Environmental Protection Agency ("EPA") and the United States Forest Service ("USFS"), committing millions of dollars to pre-permitting cleanup.

The Idaho Department of Environmental Quality's ("DEQ") issuance of Permit to Construct No. 2019.0047 (the "Final Permit") is the first of many permits needed to construct and operate the Project. Perpetua welcomes these regulatory reviews and commits to compliance with the many legal obligations imposed to protect public health and the environment. Following more than three years of scrutiny and review by DEQ and members of the public, including Petitioners Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon ("Petitioners"), Perpetua seeks affirmation of the validity of the Final Permit.

In their response brief, there is much that Petitioners conveniently ignore about the Final Permit and the exhaustive process DEQ and Perpetua navigated to get to this point. Petitioners ignore that DEQ thoroughly assessed future fugitive dust emissions from fourteen maximum emission operating scenarios. They ignore that an effective permit must conservatively address the expected mining activities and afford operational flexibility to the permittee. They ignore that an effective permit must protect the National Ambient Air Quality Standards ("NAAQS") through practically enforceable permit conditions that are consistent with DEQ programs, practices, and policies.

Overall, they ignore the expertise reflected in DEQ's careful, deliberative, thorough, and conservative three-year process to develop the Final Permit, including four requests for supplemental information and air quality analyses from Perpetua, three extended public review and comment opportunities, two public informational meetings, and three draft permits. Petitioners ignore DEQ's discretion to impose "any reasonable conditions upon an approval." IDAPA 58.01.01.211.01. And Petitioners ignore the dense record supporting DEQ's decisions following years of review and analyses, including significant attention to Petitioners' numerous and repetitive critiques.

In the end, Petitioners have not shown, as is their burden, that DEQ's decision making violated the law, was arbitrary and capricious, or was an abuse of discretion. Each of Petitioners' challenges to the Final Permit were considered and rejected (several times over the years) by DEQ based on reasoned, rational, and lawful choices. Perpetua respectfully asks the Board of Environmental Quality ("Board") to grant Perpetua and DEQ's motions for summary judgment and dismiss Petitioners' Amended Petition.

DEQ'S PERMIT RECORD AND EVIDENCE RELIED ON

For this reply brief, Perpetua continues to rely on documents from DEQ's permit file supporting the Final Permit (cited as "PET [bates #]" and "PRI [bates #]"). As part of their response, Petitioners submitted three documents that are not in DEQ's permit file but produced in discovery. Those documents are also cited as "PET [bates #]." Perpetua also relies on the Declaration of Kevin Lewis ("Lewis Decl.") submitted with this brief and the Declarations of Kevin Schilling ("Schilling Decl."), Mike Simon ("Simon Decl."), and Tiffany Floyd ("Floyd Decl.") submitted by DEQ in support of its motion for summary judgment.

STANDARD OF REVIEW

I. The Board must decide, as a matter of law, whether Petitioners proved DEQ's action was arbitrary and capricious, an abuse of discretion, or contrary to law.

It is worth repeating the standards applicable to the Board's review of the Amended Petition. First, Petitioners must prove the allegations of the Amended Petition by a preponderance of the evidence. *See* IDAPA 58.01.23.062. Second, Petitioners must prove that DEQ's issuance of the Final Permit violated the law, was arbitrary and capricious, or was an abuse of discretion. *See* Idaho Code § 67-5279(3). Third, the Board must affirm DEQ's action unless Petitioners show their substantial rights were prejudiced. *See* Idaho Code § 67-5279(4). Fourth, the Board must decide as a matter of law whether Petitioners met their burden of proof and are entitled to the relief they seek when there are no genuine disputes of material fact, as is the case here. *See* IDAPA 58.01.23.162.02, .410; I.R.C.P. 56.

Petitioners do not dispute the legal standards outlined above, except for the requirement to show prejudice to a substantial right. *See* Pet. Response Br. at 13 n.2.[1] They argue this requirement only applies to judicial review, not the Board's contested case review. Petitioners, however, initiated review under the standards of the Administrative Procedures Act and specifically Idaho Code § 67-5279, *see* Amended Petition at ¶¶ 4, 7, 35, 52, 61, 69, 72, and cannot pick and choose which parts of those standards they must satisfy.

[1] We refer to Petitioners' Opening Summary Judgment Brief (submitted Apr. 14, 2023) as "Pet. Opening Br." and Petitioners' Response to DEQ and Perpetua's Motion for Summary Judgment and Reply in Support of Petitioners' Motion for Summary Judgment (submitted June 9, 2023) as "Pet. Response Br." Perpetua's Memorandum in Support of Motion for Summary Judgment and in Opposition to Petitioners' Motion for Summary Judgment (submitted May 12, 2023) is referred to as "Perpetua Opening Br."

II. The Board may defer to DEQ's technical expertise and special skill.

In fulfilling its role as reviewer of the Amended Petition, the Board can defer to DEQ's expertise under both the Administrative Procedure Act and the Board's contested case rules. Applicable law is clear that the Board may defer to DEQ's technical expertise and special skill in evaluating its preconstruction permitting decisions. *See* Idaho Code § 67-5251(5); IDAPA 04.11.01.600; *see also J.R. Simplot Co. v. Idaho State Tax Comm'n*, 120 Idaho 849, 859, 820 P.2d 1206, 1216 (1991) ("[T]he expertise of an agency is often useful in technical areas of the law where the risk of failing to understand all of the implications of a decision are great.").

Deference is particularly appropriate here. DEQ is granted primary authority to determine specific, source-by-source emission limitations in air quality permitting. *See* Idaho Code § 39-115 (granting DEQ the authority to issue pollution source permits); *see also* Floyd Decl. at ¶ 7. As the United States Supreme Court recognized in *Train v. NRDC*, 421 U.S. 60, 79 (1975), "so long as the ultimate effect of a State's choice of emission limitations is compliance with the [NAAQS], the State is at liberty to adopt whatever mix of emission limitations it deems best suited to its particular situation."

In their response brief, Petitioners agree "that states have broad discretion to develop permit conditions." Pet. Response Br. at 34. But while admitting that DEQ has discretion to develop permit conditions, Petitioners ignore the discretion manifest in the many decisions DEQ made as part of the Final Permit. In other words, while Petitioners accept the idea of agency discretion, they then reject DEQ's use of that discretion to choose which conditions to impose or how to implement them in the Final Permit. That is illogical and absurd.

Petitioners also suggest (in their conclusion) that DEQ used its expertise as a substitute for evidence in the record. *See* Pet. Response Br. at 46 (citing *Laurino v. Bd. of Pro. Discipline of Idaho State Bd. of Med.*, 137 Idaho 596, 602 (2002)). Yet other than lobbing a disparaging

grenade at DEQ in their conclusion, Petitioners did not point to any aspect of the Final Permit that proves DEQ relied solely on its expertise. Indeed, as will be explained, DEQ carefully weighed and evaluated Perpetua's application and made professional and technical judgments that are rational, justified by the record, supported by substantial evidence, and entitled to deference.

REPLY ARGUMENT

I. Standing: Petitioners failed to demonstrate, as is their burden, that they are persons "aggrieved" by an action or inaction of DEQ.

In opposition to Petitioners' motion for summary judgment, Perpetua joined in DEQ's argument that none of the Petitioners demonstrated legal standing, as is each Petitioner's burden. *See* Perpetua Opening Br. at 13-14. Petitioners provided absolutely no evidence to show they were aggrieved persons under Idaho Code § 39-107(5) and IDAPA 58.01.23.005.01. *Id*. For the first time, in their response, Petitioners submitted declarations purporting to show that each of them has legal standing. Those evidentiary submissions do not show the Petitioners will suffer an injury that is causally connected to the challenged DEQ action, nor do Petitioners show any real and actual injury. The Board must dismiss the Petition for this reason alone.

II. Ambient air boundary (Claims 11 and 12): DEQ followed EPA guidance and exercised discretion to exclude the Stibnite Access Route from the Project's ambient air boundary.

DEQ conformed to EPA guidance and exercised reasonable discretion in excluding the Stibnite Access Route from the Project's ambient air boundary. While Petitioners raise several questions in their response brief and may have different opinions on how DEQ should have established the ambient air boundary, Petitioners fail to meet their burden to show that DEQ's decision is arbitrary, capricious, or an abuse of discretion. As demonstrated by the underlying

record and EPA guidance, DEQ's decision to exclude the Stibnite Access Route from the ambient air boundary is rational and reasonable and supported by substantial evidence.

Petitioners present two primary misunderstandings in their response brief: (1) Perpetua is unable to control access on the Stibnite Access Route and (2) the individuals traveling on the road cannot be considered "guests of the mine." Pet. Response Br. at 15-16. For the following reasons, both opinions are unavailing and should be rejected.[2]

With respect to control, Perpetua controls access to the Stibnite Access Route consistent with EPA's updated 2019 guidance defining ambient air (the "2019 Guidance"). *See* PET 772. That analysis is thoroughly addressed in earlier submittals by Respondents. *See* Perpetua Opening Br. at 23-28; Schilling Decl. at 7-8. Yet Petitioners challenge Perpetua's control over the route by misrepresenting statements made in an USFS Air Quality Specialist Report (the "USFS Report"), PET 885, and a memorandum developed for USFS by Stantec Consulting Services, PET 838. According to Petitioners, "the mine plan that is in front of the U.S. Forest Service for review and approval *requires* that 'public access through the site would be provided by' the new Route." Pet. Response Br. at 15 (emphasis added). This reading of the USFS Report and Stantec memorandum is fundamentally wrong and misleading.

[2] In addition to their two primary viewpoints, Petitioners inaccurately predict that the Stibnite Access Route "will be polluted with undisclosed and unregulated amounts of PM_{10} and arsenic, and other criteria, toxic, or hazardous air pollutants as the health-based limits established under the CAA and the Idaho Air Rules will not apply." *See* Pet. Response Br. at 13. This statement is misleading and wrong. Activities and emissions throughout the Project, including on the Stibnite Access Route, will be highly regulated by the Final Permit to control the fully disclosed and thoroughly analyzed estimated emissions of regulated air pollutants. Excluding the route from the ambient air boundary means that compliance with the NAAQS and ambient TAPs concentrations is demonstrated at other locations representing the operational perimeter of the Project. For TAPs, this approach is consistent with IDAPA 58.101.210.03. For NAAQS, this approach follows EPA guidance. *See* Schilling Decl. at 7-8.

As the record demonstrates, Perpetua volunteered to construct the Stibnite Access Route for limited connectivity to Thunder Mountain Road and points beyond. PET 529. Perpetua is not legally obligated to construct the Stibnite Access Route and has sole and complete control over construction, operation, and use of the road, including complete closure of the road when necessary for safety or operational reasons. PET 310-311, 570. It follows, and should be clear, that the USFS Report and the Stantec memorandum merely report what Perpetua volunteered to do and will do once the mine plan is approved. *See* PET 838-839, 917-918, 964.

The USFS Report states that access through the Project will be provided by constructing a new route around the Yellow Pine pit and below the mine haul road to link Stibnite Road to Thunder Mountain Road. PET 957. The report does not require the Stibnite Access Route and does not treat the route as an ambient air boundary. *See* PET 917-918. In fact, the Stantec memorandum concludes that the route is exempt from the ambient air boundary:

> After review of all pertinent information associated with other cooperating agencies, it is Stantec's understanding that the public access road can be justifiably excluded from ambient air consideration. The State agency responsible for issued air permits has excluded the road because of restriction measures put in place consistent with their rules and requirements in the permit. Also, EPA Region X has accepted DEQ's conclusions.

PET 839. Thus Petitioners' argument that Perpetua does not have the legal or practical ability to preclude public access is disingenuous, as they ignore the record and fail to cite any authority to support its position. *See* Pet. Response Br. at 15-16.

Conversely, the record and the Final Permit illuminate the many ways the general public is legally and physically precluded from accessing the Stibnite Access Route. *See* Perpetua Opening Br. at 20-21. Under Condition 2.7, only authorized vehicles and individuals can enter the route, and Perpetua must maintain, control, and monitor access points. PET 10. Conforming to these controls allows only "guests" to transgress the Project area. *Id*. Perpetua must develop an

Access Management Plan ("AMP") such that "[o]nly registered guests of the facility will be allowed access to or though the facility." *Id.*; *see also* Schilling Decl. at 8.

Petitioners claim that those accessing the Stibnite Access Route cannot be considered "guests of the mine," Pet. Response Br. at 16-17, but they ignore DEQ's record and reasoned analyses. Petitioners' argument on the semantics of a "guest" is unpersuasive. Based on Condition 2.7 and Perpetua's physical and non-physical barriers to entry, only registered vehicles and their passengers will be permitted entry onto the Stibnite Access Route. PET 10. Vehicles will be supervised, cannot stop, and must check out at the egress point. *See id*. The elaborate measures at both entry and egress locations, plus supervision of vehicles requiring continuous movement without stopping along the route, reinforce Perpetua's control of the route, in contrast to a county road or other thoroughfare that is uninhibitedly open to the general public. The measures required by the Final Permit preclude access by the general public and support DEQ's well-reasoned decision to exclude the Stibnite Access Route from the ambient air boundary.

Petitioners also argue that Perpetua's reliance on *REDOIL v. U.S. EPA*, 716 F.3d 1155, 1165 (9th Cir. 2013), is misplaced since the fact patterns are not identical. Pet. Response Br. at 14 n.5. Perpetua, however, did not and does not contend that the cases are identical. Rather, Perpetua cited *REDOIL* because it is relevant authority on agency discretion to determine the ambient air boundary. Perpetua Opening Br. at 18-19, 21. The case stands for the notions that safety zones and control measures influence ambient air boundary analyses, and deference is allowed for agency decisions. *See id*.

Perpetua demonstrated that it has legal and practical ability to exclude the general public from the Stibnite Access Route consistent with EPA's 2019 Guidance. DEQ concluded after thorough deliberation and consultations with EPA Region 10 that the Stibnite Access Route was

properly excluded from the ambient air boundary. *See* PRI 10, 156; Schilling Decl. at 8 & Ex. A. The Board should uphold DEQ's well-supported and documented determination.

III. Fugitive dust emissions (Claims 1, 2, 5, and 8): DEQ did not act arbitrarily and capriciously or violate the Idaho Air Rules in determining that fugitive dust emissions from the Project's roads will comply with the PM_{10} NAAQS and arsenic AACC.

Petitioners insist that DEQ's conclusions regarding fugitive dust emissions from unpaved roads are arbitrary and capricious and violate the Rules for the Control of Air Pollution in Idaho, IDAPA 58.01.01, *et seq*. (the "Idaho Air Rules"). After exhaustive review (much of it in response to Petitioners' public comments), DEQ concluded that these emissions will neither cause nor contribute to violations of the PM_{10} NAAQS and the acceptable ambient concentration for a carcinogen ("AACC"). DEQ also concluded that a 93.3% control efficiency for fugitive dust from the haul roads was appropriate. Petitioners disagree with DEQ's assessment and prefer that it use a lower control efficiency. DEQ imposed enforceable permit limits and conditions to ensure the 93.3% control efficiency is achieved to reduce emissions. Petitioners disagree with that work too and would add more permit limits and conditions to control operations. Petitioners' objections are simply a difference of opinion. Petitioners have not shown that DEQ's choices were unreasonable, unsupported, irrational or unlawful.

A. DEQ reasonably determined that 93.3% control efficiency for fugitive dust from haul roads was attainable and enforceable (Claims 2 and 8).

1. Petitioners have not shown that DEQ's use of the 93.3% control efficiency was unsupported or unreasonable.

Petitioners fail to meet their burden to prove that DEQ's use of the 93.3% control efficiency to predict emissions from the haul roads was unsupported or unreasonable. DEQ reasonably established the 93.3% control efficiency based on a combination of dust suppressant

chemical application (90% control) and watering (33% control).[3] *See* PET 143, 551. Petitioners do not contest these individual control efficiencies, nor do they contest that chemical suppressant and water are commonly used together to control fugitive dust emissions from unpaved roads. *See* Pet. Response Br. at 17-21; *see also generally* PET 90, 551, 558; Simon Decl. at 13. Petitioners repeat the same refrain "that there is no evidence for, and no rationale provided, that supports a finding that Perpetua will be able to achieve 93.3% dust control efficiency by using a *combination* of chemical dust suppressants and water." Pet. Response Br. at 19 (emphasis in original). Petitioners simply ignore DEQ's robust, reasoned, and rational analysis and decision making reflected in the permit record.

For their response, Petitioners rely on a similar argument they made in public comments: of the seven case-specific projects that DEQ identified from the EPA RACT/BACT/LAER Clearinghouse ("RBLC") database, "*none* of them were able to achieve higher than 90% control efficiency" using a combination of chemicals and water. *Id*. (emphasis in original); *see also* PET 557-558. Petitioners' reading of the RBLC database is wrong. They also rely on EPA's comments that the permitting record "does not appear to provide support for" the 93.3% control efficiency. Pet. Response Br. at 20; *see also* PET 556. This reference highlights that both Petitioners and EPA choose to ignore the dense permit record.

The RBLC database provides the *minimum* control efficiency required for 10 major stationary source projects using chemical dust suppressants or a combination of chemical suppressants and watering. *See* PET 546-547. The database does not report the maximum control

[3] DEQ explained in its response to comments that it could have listed the control efficiencies separately for chemical (90% control) and water (33.3% control), but it chose to combine the control efficiency as 93.3% to emphasize the importance of using chemical and water suppressants in combination. PET 557, 558.

efficiency achieved by the projects. *See id*. As the permitting authority familiar with the RBLC database, DEQ concluded the database identified projects—including gold, cement and concrete, steel, and quarry projects—referencing control efficiency of 90% *or greater* for unpaved roads. *Id*. When using chemical suppressants alone, two of the RBLC projects identified a 90% control efficiency and one of the projects a 98% control efficiency. PET 547. DEQ found those and the other projects representative of circumstances presented by Perpetua. PET 546. Petitioners ignore this work by DEQ.

To bolster its analysis, along with its assessment of the RBLC database, DEQ relied on AP-42 examples, which likewise supported a control efficiency over 90% when chemical and water suppressant is used in combination. *Id*. As DEQ noted, test reports referenced in AP-42 13.2.2 show that a chemical suppressant alone can achieve 90% to 99% control efficiency and 98% for magnesium chloride in particular. PET 546-547. Watering alone achieves 75% to 95% control efficiency. *Id*. DEQ also found that fugitive dust from the haul roads was likely to be controlled at levels greater than 93.3% during wintertime conditions when the site receives an average snow depth of 21-68 inches and 6 inches of average precipitation. PET 558-559.

Ultimately DEQ chose to rely on empirical data gleaned from the RBLC database and AP-42 rather than rely on Petitioners' opinions and unsupported critiques of DEQ's professional analyses. *See* PET 551, 558, 620. Petitioners lack any evidence that DEQ's decisions were arbitrary and capricious or unsupported by the record.

2. Petitioners fail to prove that the Final Permit lacks enforceable conditions to ensure 93.3% control efficiency when DEQ imposed technical limits, daily monitoring, and other substantive conditions.

Petitioners make much of DEQ's recognition that meeting the 93.3% control efficiency for fugitive dust from the haul roads "requires conscientious efforts, vigilant inspection and monitoring, and a comprehensive FDCP." Pet. Response Br. at 18-19 (citing PET 90, 328).

Petitioners contend the Final Permit only "requires Perpetua to generally control dust by using chemical dust suppressants and water" and that the Final Permit lacks legally or practically enforceable permit limits and conditions to ensure the control efficiency is met. *Id*. at 21. But as Perpetua explained in its opening brief, Petitioners simply want different conditions from those imposed by DEQ. *See* Perpetua Opening Br. at 23-30. Petitioners seek to substitute their choices for DEQ's. Yet Petitioners cannot prove that the conditions imposed in the Final Permit are arbitrary and capricious or violate the Idaho Air Rules.

Petitioners blatantly misrepresent Perpetua's argument in support of the adequacy of the Final Permit. As told by Petitioners, "Perpetua argues that there is no 'legal authority' that requires DEQ to include legally and practically enforceable permit conditions." Pet. Response Br. at 21 (citing Perpetua Opening Br. at 23-24). Perpetua said no such thing. Perpetua took issue with Petitioners' unsupported contention that DEQ must include the specific conditions demanded by Petitioners on the type, quantity, application rate, and frequency of using dust suppressants. As Perpetua pointed out, Petitioners "cite to no legal authority that DEQ was required to include those conditions" to satisfy the requirements of Section 211. Perpetua Opening Br. at 23-24. That was true then, and it is true now.

Petitioners maintain the same opinions and preferences for enforceable permit conditions that they expressed throughout the permit process, without citing any requirement under the Idaho Air Rules that DEQ must impose the specific conditions on the specific activities that Petitioners prefer. Moreover, Petitioners ask the Board to view each condition in isolation for adequacy, without considering how the Final Permit's numerous conditions operate together to require and verify compliance with the 93.3% fugitive dust control efficiency. DEQ determined that the totality of conditions imposed in the Final Permit, including monitoring, recordkeeping,

and reporting, are practically enforceable and sufficient to achieve compliance. *See* PET 558-559.

For emphasis consider: Conditions 1.2 establishes the 93.3% fugitive dust control efficiency, PET 3; Condition 3.5 establishes mine production limits through daily and annual hauling and excavating limits, PET 19; and Condition 3.13 establishes maximum silt content of 4% for capping haul roads and the contents for the Haul Road Capping Plan ("HRCP"), PET 19-20. Conditions 2.2, 2.4, 2.5, and 2.6 then provide enforceable conditions for achieving 93.3% haul road dust control by the proper application of dust suppressant chemicals and watering. Condition 2.2 requires monitoring and recordkeeping of fugitive dust control methods twice a day; Condition 2.4 requires daily facility-wide inspections, recordkeeping, and immediate corrective action if fugitive dust is not controlled; Condition 2.5 requires fugitive dust control measures at all times to ensure no more than 10% opacity and immediate corrective action if the limit is not met; and Condition 2.6 requires a Fugitive Dust Control Plan ("FDCP"). PET 8-9. In total, DEQ imposed a robust and extensive set of conditions to control fugitive dust.

Those conditions also refute Petitioners' opinions and complaints that DEQ did not include actual monitoring and recordkeeping requirements to ensure compliance. *See generally* Pet. Response Br. at 22-23. As for monitoring, Condition 2.4 again establishes a daily monitoring time interval. PET 8. As for recordkeeping, chemical suppressant and water applications must be recorded every 12 hours under Condition 2.2, dust complaints must be recorded under Condition 2.3, and all inspections and corrective actions must be recorded under Condition 2.4. PET 9. Condition 3.13 requires haul road inspections and silt content sampling. PET 20. Moreover, Condition 7.10 establishes detailed recordkeeping requirements for

monitoring records, and Condition 7.11 requires documentation and reporting of excess opacity emissions. PET 40-41.

Petitioners' repeated observation that the Fugitive Dust Control Plan ("FDCP") and its contents are "unknown" is also easily refuted. *See generally* Pet. Response Br. at 23. In Condition 2.6, DEQ provides detailed instructions for the contents of the FDCP, including: maximum speed limits for haul trucks; the application of chemical suppressant and water to haul roads; the maintenance of roads; criteria to determine frequency, type, and application rates of dust suppressant consistent with manufacturer's instructions and recommendations; trained and EPA certified inspectors; and yearly evaluation of those requirements and practices. PET 9-10. These elements of the FDCP required by Condition 2.6 provide Petitioners ample knowledge on the contents of the FDCP.

Despite express limits and extensive conditions requiring "conscientious efforts, vigilant inspection and monitoring, and a comprehensive FDCP," Petitioners just disagree with the conditions DEQ chose. Petitioners ask the Board to ignore DEQ's expertise and experience and substitute Petitioners' choices for DEQ's. No matter how many times Petitioners express their opinions, they fail to prove that DEQ acted unlawfully, unreasonably or irrationally in exercising discretion to impose limits and conditions that together ensure the legal and practical enforceability of the 93.3% control efficiency. Claims 2 and 8 must be dismissed.

B. Petitioners fail to show that DEQ is required to impose conditions restricting vehicle miles traveled and truck weights when DEQ imposed surrogate production limits and other requirements (Claims 1 and 8).

Petitioners are also wrong that the Final Permit is unenforceable because it does not include limits on vehicle miles traveled, truck weights, and speed limits. Pet. Response Br. at 24-26. Petitioners finally admit there are no requirements under the Idaho Air Rules to include those parameters as enforceable permit limits, yet they still contend DEQ acted arbitrarily and

capriciously by not considering or including them and by using production limits instead. *Id*. Petitioners ignore the support in the record for the use of production limits to constrain vehicles miles traveled, truck weights, and speed limits. *Id*.

As already explained in Perpetua's opening brief, DEQ disagreed with Petitioners' assessment and exercised discretion to develop the Final Permit as issued. Nothing about DEQ's decision to limit production, as one of many controls on fugitive dust emissions, was unreasonable or irrational. The record reflects that DEQ considered all emissions inputs and variables, both minor and critical, and established enforceable permit conditions to control fugitive dust. *See* Perpetua Opening Br. at 27-30.

Over the three years and in response to repeated comments from Petitioners on this topic, DEQ estimated fugitive dust emissions from the haul roads using 14 maximum emission scenarios, evaluating the silt content of the road, vehicle miles traveled, and the average weight of the haul truck fleet. PET 797-798, 800; Simon Decl. at 9; Lewis Decl. at ¶¶ 4, 8-9. DEQ also modeled numerous mining scenarios, each using a maximum production rate of 180,000 tons per day, which was repeated for 365 days per year, to define conservative, upper-bound emissions cases for the Project. PET 275-276, 551; *see also* Lewis Decl. at ¶¶ 8-10. Actual production will not be 180,000 tons per day, 365 days per year, but approximately 116,964 tons per day. PET 65.

DEQ relied on Perpetua's mining knowledge and business objectives to optimize operations, as reflected in the emissions estimates and project descriptions presented in the application for the Project. For example, Perpetua intends to use the largest trucks possible based on safety, operational, and cost considerations. Using large trucks requires less labor and less fuel and results in less dust emissions. This operational input is utilized to estimate emissions for the application but is not an operational detail that would be within DEQ's scope to dictate in the

Final Permit. DEQ's role is to review the Project as defined by Perpetua, not to direct Perpetua in the design or operating details, like dictating truck size. *See* Lewis Dec. ¶¶ 9-12.

Ultimately, as discussed above, DEQ chose three variables to be the most effective and practically enforceable permit conditions: 93.3% control efficiency, a haul road silt content limit, and daily production limits for hauling and excavation. *See* PET 3, 19-20, 551-552; Lewis Decl. at ¶¶ 11-12. DEQ explained the importance of those variables to emissions estimates and ensuring compliance with the PM_{10} NAAQS. PET 551-552, 557, 567, 572. DEQ also reasoned that enforceable emissions limits are not commonly included for fugitive sources; production rates limits are used for process rate-limiting sources; production rate limits "serve as surrogate emissions limits for PM, PM_{10}, $PM_{2.5}$, HAP and TAP from fugitive sources"; variables for vehicle speed limit, type, and miles traveled are not typically included in a permit, but can be found in Perpetua's application materials; and enhanced monitoring of silt content and production levels would verify estimated vehicle miles traveled. PET 557, 562, 574, 578-579, 611; *see also* Lewis Decl. at ¶ 11.

Finally, Petitioners argue that "the actual permit limitation found in Permit condition 3.5 does not have any associated monitoring or recordkeeping requirements to ensure compliance." Pet. Response Br. at 26. Perpetua has already shown that is not true. *See* Perpetua Opening Br. at 32-34. Condition 3.16 requires daily and monthly monitoring to ensure compliance with the production limits, PET 20, and Condition 7.10 requires those records be retained for at least five years, PET 40. Further, Condition 3.16 requires that the devices and methodologies used to measure production be identified in the Operations and Maintenance Manual ("O&M Manual"). PET 20. And just like the FDCP, the Final Permit mandates detailed requirements for the

contents of the O&M Manual. PET 13 (Condition 2.20 requiring a regular schedule for operation, inspection, maintenance, and repair of devices).

In sum, Petitioners fail to show that the Final Permit lacks practically enforceable monitoring requirements to ensure compliance. The Board must dismiss Claims 1 and 8.

C. Petitioners did not prove that DEQ's use of 120 days of precipitation data to estimate fugitive dust emissions was arbitrary and capricious (Claims 5 and 8).

Petitioners also continue to take issue with DEQ's choice of 120 days of precipitation per year (rain and snow) to estimate fugitive dust emissions from the Project's access road. Recall that this value is provided in AP-42. *See* PET 146. Petitioners contend that DEQ failed to consider "true site conditions when the data is available," yet they fail to cite any legal requirement that the agency do so. *See* Pet. Response Br. at 27. Moreover, they fail to cite what local data DEQ should have used or show how the data used by DEQ underestimated fugitive dust emissions from the access road. *See id*.

Petitioners again ignore DEQ's reasoned decision to use the 120 days per year value. DEQ considered local precipitation data collected by Perpetua in 2014, which showed 155 days of precipitation.[4] Schilling Decl. at 13. DEQ also considered data (showing 113 days of precipitation per year) from a weather station that is over 40 kilometers from the Project. DEQ found neither dataset appropriate and choose the 120 days per year value from AP-42. DEQ also noted that the weather station data nearly matched AP-42, which was far more conservative than the site specific 2014 data. *Id*. Petitioners fail to explain how DEQ's choice was unreasonable or irrational, based on clearly erroneous findings, or prejudices their substantial rights.

[4] Perpetua and DEQ differ on the number of days of precipitation in 2014: Perpetua calculated 168 days, and DEQ calculated 155 days. *See* Perpetua Opening Br. at 31; Schilling Decl. at 13. Regardless, the available local data shows far more days of precipitation than AP-42's default 120 days per year.

Petitioners simply prefer a different precipitation input. Claims 5 and 8 must be dismissed because Petitioners fail to demonstrate, as is their burden, that DEQ's decision making was arbitrary and capricious.

IV. Work Plans (Claim 3): the Final Permit requires Perpetua to develop work plans for DEQ approval and does not violate the CAA or the Idaho Air Rules.

DEQ lawfully required future development of the AMP, FDCP, HRCP, and O&M Manual in the Final Permit. Petitioners' argument that the Final Permit is "incomplete" ignores the evidence in the permit record, ignores DEQ's well established practice, and is legally unfounded. Petitioners cite Section 202.01 of the Idaho Air Rules and argue the work plans at issue were required "plans" to be submitted as part of Perpetua's permit application and to be circulated for public comment. Pet. Response Br. at 28. There is no textual support that the AMP, FDCP, HRCP, and O&M Manual are "plans" as that term is used in Section 202.01. Petitioners fail to present any argument to support their interpretation of the word. DEQ's interpretation of its rules, plus its authority to determine an application complete and to request additional information that DEQ needs to make the determinations required, like whether the Project will cause or contribute to a violation of the NAAQS per Section 202, are entitled to deference. Section 202.03. Notably, none of DEQ's incompleteness letters to Perpetua requested that the work plans be included in the permit application.

Petitioners contend that DEQ failed to develop important permit conditions for work plans, but DEQ included permit conditions prescribing great specificity for Perpetua's work plans. PET 9-10 (Condition 2.6 (FDCP) and Condition 2.7 (AMP)), 12-14 (Condition 2.20 (O&M Manual)), 19-20 (Condition 3.13 (HRCP)). DEQ requires that the work plans "ensure compliance" with pertinent requirements. *See*, *e.g.*, PET 009 (Condition 2.6: "The Permittee shall develop and maintain a FDCP to ensure compliance with fugitive dust requirements (Permit

Conditions 2.1-2.5) and also fugitive dust best management practices…in accordance with IDAPA 58.01.01.799.").

Petitioners ignore the explicit permit conditions prescribing the contents of the work plans. *See*, *e.g.*, PET 012-014 (Condition 2.20 detailing nine specific items to be included in the O&M Manual). The Final Permit requires Perpetua to develop and submit for DEQ approval at least 30 days prior to startup a FDCP, O&M Manual, AMP, and HRCP. PET 9-10 (Condition 2.6 (FDCP) and Condition 2.7 (AMP)), 12-14 (Condition 2.20 (O&M Manual)), 19-20 (Condition 3.13 (HRCP)). The Final Permit details the minimum and substantive requirements that Perpetua must account for in the work plans. *Id*. Once approved, the work plans and manuals are incorporated into the permit and are enforceable. *Id*.

DEQ confirmed that requiring work plans after issuance of the Final Permit and prior to startup for DEQ review and approval complies with the Idaho Air Rules, its discretion therein, and agency practice:

> DEQ contends the requirement to review and approve each Plan and Manual after the permit is issued and prior to facility startup is sufficient, reasonable, and appropriate to ensure compliance with applicable requirements…[;] DEQ uses its authority to require a permittee to develop and submit for DEQ approval Plans and Manuals in accordance with IDAPA 58.01.01.211.01.[5]

Simon Decl. at 9. DEQ explains that this is standard protocol, because more information becomes available after the permit application is approved and prior to startup, such as actual equipment purchased and installed, and the operational activities implemented after construction is completed. *Id*. at 10.

[5] Petitioners state that "DEQ does not even argue that the work plans comply with the Air Rules," but Simon's Declaration speaks directly to this point. *Compare* Pet. Response Br. at 29 *with* Simon Decl. at 9.

Contrary to Petitioners' accusations, DEQ is not "shielding" work plans from public review. DEQ placed the specific requirements for content of the work plans in plain sight within the Final Permit and DEQ intends to publish the approved work plans on the agency website. DEQ is not required to review and approve work plans during the preconstruction permit review process, nor is public review appropriate for the specific operational choices implemented by the permittee in those plans.

Petitioners fail to point to any legal obligation in the Idaho Air Rules, or the Clean Air Act ("CAA") more generally, that requires AMPs, FDCPs, HRCPs, or O&M Manuals be circulated for public comment and review. Petitioners attempt to shift the burden to Perpetua and DEQ when it states "Perpetua does not point to any Air Rule or CAA cases" related to excluding work plans during CAA permitting processes. Pet. Response Br. at 32. This is Petitioners' burden. And there are no Idaho Air Rules or CAA cases for either party to cite because the Idaho Air Rules and CAA do not require these documents in the application nor in the public review process.

Petitioners rely on Clean Water Act ("CWA") cases ignoring the distinct statutory requirements of the CWA. The cases cited are distinguishable and inapposite because they (1) relate to an entirely different federal law and permitting scheme and (2) address information that is expressly required by the CWA to be provided to the public. In *Environmental Defense Center, Inc. v. U.S. EPA*, the Ninth Circuit held Notices of Intent needed to be made available to the public due to the express requirements of the CWA. 344 F.3d 832, 858 (9th Cir. 2003). Similarly, in *Waterkeeper Alliance, Inc. v. U.S. EPA*, the Second Circuit held nutrient management plans are requisite effluent limitations and must be made available to the public by the express terms of the CWA. 399 F.3d 486, 492 (2d Cir. 2005). Petitioners' citation to

Waterkeeper Alliance underscores that the reason the Second Circuit held the nutrient management plans are required to be made publicly available is because these plans constitute effluent limitations and, even if they did not, "'site specific nutrient management practices'" are explicitly listed in EPA's Preamble to the Rule as necessary. *Id*. at 504 (citation omitted).

Petitioners try to extrapolate that because the Ninth Circuit and Second Circuit upheld express requirements of the CWA that address what needs to be made publicly available, the Board here must offer Perpetua's work plans for public comment, too. Pet. Response Br. at 33. This argument has no merit because neither the CAA nor Idaho Air Rules require the Board to do so. Rather, the Idaho Air Rules and relevant CAA jurisprudence provide that DEQ has broad discretion in development of permit conditions. *Train*, 421 U.S. at 79; IDAPA 58.01.01.211.01.

Petitioners agree that "states have broad discretion to develop permit conditions." Pet. Response Br. at 34 but reject DEQ's manifestations of that discretion. That Petitioners would like something different or something more detailed is inapt. DEQ's approach to the work plans complies with the Idaho Air Rules, its discretion, and its practice. The Board should accordingly reject Petitioners' Claim 3.

V. Ambient air monitoring (Claim 13): DEQ did not violate the law by issuing a preconstruction permit that omitted ambient air monitoring.

Petitioners acknowledge that DEQ has discretion to require ambient air monitoring. Pet. Response Br. at 34-35. Petitioners present no new arguments on this point, nor do they explain how DEQ erred in a manner that would be reversible. *See id*. Instead, based on their difference of opinion about the effectiveness of the conditions of the Final Permit, Petitioners argue that DEQ should have required ambient air monitoring. Petitioners point to their standing declarations to suggest that since people will be infrequently accessing areas around the Project, DEQ must protect these individuals by requiring ambient air monitoring. Petitioners fail to differentiate the

Project, the Final Permit, or these infrequent visitors from any other permit issued by DEQ that does not require ambient air monitoring.

As explained by both Kevin Schilling and Mike Simon, requiring an ambient air monitor for a remote facility that is not located near relatively permanent sensitive receptors (like a school) is not consistent with DEQ's practice. Simon Decl. at 10-11; Schilling Decl. at 19. Further, as Kevin Schilling explained, a monitor does not ensure compliance with the NAAQS because it only reflects an isolated location. Schilling Decl. at 19. Here, DEQ followed its practice, applied its expertise and judgment, established enforceable permit conditions to ensure compliance with the Air Rules, and determined that no ambient air monitor was necessary or appropriate in these circumstances. Petitioners have not identified a reversible error or even a legal theory of reversible error, instead, Petitioners just do not like DEQ's decision. Therefore, The Board should accordingly reject Petitioners' Claim 13.

VI. Arsenic T-RACT (Claims 6 and 7): because chemical dust suppressant and water are already established as reasonably available control technologies, DEQ was not required to conduct a technological or economic feasibility analysis.

Petitioners criticize DEQ for failing to analyze the economic feasibility and environmental impacts of Perpetua's use of chemical dust suppressants and frequent watering. Pet. Response Br. at 36-40. Petitioners ignore the totality of the applicable rules and focus narrowly on IDAPA 58.01.01.210.14(c) and (d). Petitioners' argument also ignores DEQ's toxic air pollutant reasonably available control technology ("T-RACT") selection process and the common knowledge of the control technologies that were selected.

As explained in Perpetua's opening brief, the control technologies selected as T-RACT are both well recognized by DEQ and EPA and are even required by the Air Rules. Perpetua Opening Br. at 41-42. Reading the Air Rules as Petitioners do would require DEQ and each applicant to repeatedly evaluate accepted and non-controversial control technologies such as

basic filters, bag houses, and commonly applied dust suppressants. Take watering and chemical dust suppressant, which are required by IDAPA 58.01.01.651.01 and .02 for fugitive dust control – no economic or technological feasibility analysis is required by these rules. But, under Petitioners' reading of the Air Rules, any applicant that designates watering or chemical suppressant as T-RACT must evaluate the economic and technological feasibility of these methods. This is truly an absurd result.

Instead of the absurd result urged by Petitioners, DEQ's approach to implementing T-RACT is efficient and recognizes the effects and impacts of commonly utilized methods of emissions control, especially those methods prescribed by DEQ in its own rules. DEQ identifies the most effective control technology that is feasible and reasonably available—which is what the Idaho Air Rules require. IDAPA 58.01.01.210.14. As explained in Mike Simon's declaration, Idaho's T-RACT rules were developed to follow the same process as the selection of Best Available Control Technology ("BACT") for major new sources. Simon Decl. at 11. The process of selecting control technology under both T-RACT and BACT follows a five-step approach:

1) Identify all available control options;
2) Eliminate technically infeasible options;
3) Rank remaining control technologies;
4) Consider the energy, environmental and economic impacts;
5) Select the most effective control technology not eliminated in Step 4.

Id. at 11-12.[6]

Perpetua followed this process in its T-RACT analyses to confirm selection of the methods required for fugitive dust control. PET 544. First, Perpetua queried EPA's RBLC

[6] *See also* John Calcagni, Director, Air Quality Management Division, *Transmittal of Background Statement on "Top-Down" Best Available Control Technology (BACT)*, U.S. Environmental Protection Agency (June 13, 1989), https://www.epa.gov/sites/default/files/2015-07/documents/topdawn.pdf.

database to identify all possible control technologies and identified those potential control technologies in its T-RACT analyses. PET 546. Perpetua then provided DEQ with information regarding which technologies were not technologically feasible and why. PET 544, 547. After determining certain control technologies were not feasible (wet drilling and paving haul roads), Perpetua then selected *all* of the remaining identified control technologies as T-RACT. Perpetua also included capping the haul roads with low-arsenic development rock as an additional T-RACT work practice. PET 548.

Petitioners' argument that DEQ erred by failing to thoroughly analyze the environmental and economic feasibility of well-recognized control technologies ignores the common knowledge of these methods reflected in DEQ's rules, and ignores the process that DEQ uses to select T-RACT.

Under the process utilized by DEQ, the applicant and DEQ are only required to analyze the technological and economic feasibility of a control technology if the applicant asserts that it is not reasonably available. Perpetua and DEQ agreed that paving haul roads and wet drilling were not technologically feasible based on the process and operating parameters of the Project. PET 70; PET 544, 547. Perpetua then selected all of the remaining control technologies as T-RACT, thus DEQ was never called on to evaluate whether the remaining control technologies were economically or technologically feasible because both DEQ and Perpetua recognized that they were reasonably available.

DEQ's approach in the Final Permit was entirely consistent with the Air Rules. Nowhere do the Air Rules require that DEQ conduct a technological and economic feasibility analysis of each proposed control technology. *See* IDAPA 58.01.01.210.14.b. Instead, and consistent with DEQ's approach, described above, Section 210.14.c and .d set forth factors that DEQ and the

applicant are to consider on a case-by-case basis to determine that an identified control technology is not "reasonably available." This is an entirely reasonable and consistent interpretation of the Air Rules, and as such is entitled to deference. *See Idaho Power Co. v. Idaho PUC*, 155 Idaho 780, 791 n.2, 316 P.3d 1278, 1289 n.2 (2013) (Jones, J. concurring) ("As a general rule, courts defer to an agency's interpretation of its own regulations unless the interpretation is 'plainly erroneous or inconsistent with the regulation.'" (quoting *Auer v. Robbins*, 519 U.S. 452, 461 (1997)). Therefore, the Board should accordingly dismiss Petitioners' Claims 6 and 7.

VII. Arsenic averaging (Claim 9): DEQ reasonably exercised its discretion in evaluating the health risks from arsenic.

Petitioners disagree with DEQ's approach for evaluating whether arsenic emissions will injure or unreasonably affect human or animal life or vegetation, as required by the Idaho Air Rules. But they cannot decide on a legal theory, much less demonstrate how DEQ's decision warrants reversal. In their opening brief, Petitioners argued that DEQ's arsenic analysis "violates the Air Rules" by allowing arsenic emissions to exceed the AACC. Pet. Opening Br. at 36-37. In their response brief, Petitioners abandon this position and argue that "DEQ's determination that the Project's arsenic emissions demonstrates preconstruction compliance with the Air Rules Section 210.12 is unreasonable, arbitrary and capricious, and unsupported by the record." Pet. Response Br. at 45. Both of Petitioners' legal theories ignore the record and reveal Petitioners' lack of understanding of the complex analyses conducted by DEQ.

As documented in the record and described in DEQ's TAPs Modeling Review Attachment, PET 331, DEQ thoroughly evaluated Perpetua's modeling and analyses of arsenic emissions. *See* Perpetua Opening Br. at 48-49. DEQ considered the conservative aspects of the TAPs compliance framework, which likely overstated the estimated TAPs emissions impacts

from the Project. PET 333. Further, DEQ evaluated the potential lifetime exposure of a receptor to carcinogenic TAPs, which was appropriate because carcinogenic impacts are of concern from a long-term exposure basis. PET 332. No other aspect of emissions from the Project received more discussion by both Perpetua and DEQ (or more criticism from Petitioners during the many public comments) than TAPs emissions, and specifically arsenic emissions. *See* PET 331-354; PET 596-609; PRI 581-806; PRI 807-811.

DEQ's exhaustive analyses were entirely reasonable considering the health risks posed by arsenic and the purpose of the TAPs requirements in the Air Rules. As explained in Perpetua's opening brief, arsenic is a carcinogen, and the Air Rules establish limits for arsenic emissions based on a lifetime – 70 year – exposure.[7] Perpetua Opening Br. at 47-48.

Kevin Schilling explains that the air permitting process was established primarily to regulate well-defined sources that have consistent emissions through time. Schilling Decl. at 8. Assessing emissions from fugitive sources at a dynamic mine site is significantly more difficult due to the dynamic nature of the mining activity and emissions generating activities. *Id.* DEQ's approach, of evaluating worst-case emissions over a five-year averaging period and accounting for the lifetime operations of the Project, more accurately reflected the variability inherent in fugitive emissions from the Project and was consistent with the intent of the Air Rules. *Id.* at 12.

DEQ's analyses were also consistent with the text of the Air Rules. Under the Air Rules for sources using T-RACT, DEQ compared the source's approved T-RACT ambient

[7] Petitioners suggest that the definition of Toxic Air Pollutant Carcinogenic Increments which describes the basis for the values established in the AACCs is no longer operative. However, the version of the Air Rules containing the definition was still in effect when DEQ issued the Permit, and is therefore still applicable for purposes of reviewing the Permit. *See Hoppe v. Nichols*, 100 Idaho 133, 137, 594 P.2d 643, 647 (1979). This definition was not removed as a material change in the Air Rules, but was instead part of a regulatory cleanup. Schilling Decl. at 11.

concentration at the point of compliance to the amount of TAP that would contribute to an ambient air cancer risk probability of less than one in one hundred thousand. IDAPA 58.01.01.210.12.c. The "T-RACT ambient concentration of the source . . . is estimated by using refined modeling and the T-RACT emission rate." IDAPA 58.01.01.210.03.g. Notably, nothing in the rules requires emissions to be evaluated on an annual basis. DEQ used refined modeling to account for operational variability of the Project to fully account for arsenic exposure at the point of compliance from emissions from the Project. PET 344-345; Schilling Decl. at 11-12. DEQ then analyzed the cancer risk of the arsenic emissions by comparing the lifetime exposure at the point of compliance on an annual basis against the 1 in 100,000 cancer risk provided in the T-RACT adjusted AACC and found that the arsenic emissions would be below the acceptable risk level and the AACC. PET 348.

DEQ thoroughly analyzed the lifetime cancer risk posed by arsenic emissions from the Project and satisfied itself that Perpetua complied with IDAPA 58.01.01.203.03. DEQ used the methods provided in Section 210. DEQ thoroughly explained and documented its analysis and arrived at its decision with reason supported by the record. This is the work required to lawfully issue the Final Permit. The Air Rules afford DEQ discretion to select an analytical pathway to account for carcinogenic TAPs emissions from highly variable fugitive sources. DEQ used its discretion to interpret its own rules to account for the inherent variability of fugitive emissions and the finite operational life of the Project. DEQ's approach and interpretation of the Air Rules is well reasoned and supported and therefore should be upheld. *Idaho Power Co.*, 155 Idaho at 791 n.2. The Board should accordingly dismiss Petitioners' Claim 9.

CONCLUSION

Petitioners devalue and misrepresent DEQ's three-year review process that included four requests for additional information to supplement the permit application, three extended public

comment opportunities to solicit feedback from the public and other stakeholders, two informational meetings requested by the public, and three iterations of draft permits. This unprecedented review process allowed Petitioners an extensive opportunity to participate in the shaping of the Final Permit. DEQ thoroughly and diligently addressed Petitioners' concerns throughout the prolonged review period. While Petitioners accept of the idea of agency discretion, Petitioners reject DEQ's manifestations of that discretion, and ask the Board to substitute Petitioners' preferences for DEQ's deliberative work in the substantive record for the Final Permit. Evidence in the voluminous record and declarations from DEQ personnel confirm and document that the agency's decision-making and choices complied with applicable law, were not arbitrary and capricious, and were entirely consistent with the discretion afforded DEQ by state and federal law. The Final Permit must be affirmed by the Board.

The Board should deny Petitioners' motion for summary judgment and instead grant Perpetua's motion for summary judgment as a matter of law.

DATED: June 23, 2023.

STOEL RIVES LLP

/s/ *W. Christopher Pooser*
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

CERTIFICATE OF SERVICE

I hereby certify that on this 23rd day of June 2023, a true and correct copy of the foregoing was served on the following:

Dylan B. Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Paula J. Wilson
Hearing Coordinator
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

/s/ *W. Christopher Pooser*
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	Case Docket No. 0101-22-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	**DECLARATION OF KEVIN LEWIS IN SUPPORT OF INTERVENOR-RESPONDENT PERPETUA'S REPLY IN SUPPORT OF MOTION FOR SUMMARY JUDGMENT**

I, KEVIN LEWIS, declare as follows:

1. My name is Kevin Lewis. I am currently a Principal Air Quality Engineer at Air Sciences, Inc. (Air Sciences). I have prepared this declaration in support of Intervenor-

Respondent Perpetua Resources Idaho, Inc.'s ("Perpetua") reply in support of motion for summary judgment in the matter of Air Quality Permit to Construct P-2019.0047.

2. I have been an employee of Air Sciences since 1993, an owner since 1996, and the President of the company from 2011 through 2021. I have over 32 years of air quality experience: 2 years with the Wisconsin Department of Natural Resources writing air quality permits for toxic air pollutants and conducting compliance inspections and 30 years with Air Sciences performing air quality analysis for air permits in over 25 states. My work at Air Sciences has primarily consisted of air permitting for the gold mining industry. I received a Bachelor of Science (BS) degree in Chemical Engineering from the University of Wisconsin, Madison in 1990.

3. During my tenure at Air Sciences, I have developed the air quality analyses for hundreds of air permits, permit renewals, and permit modifications; provided technical support to the state agencies during their technical review, permit drafting, and public comment stages of air permitting; and helped my clients comply with their air permits. In this time, I have never experienced a permit review process that was as long and as thorough as the one conducted by the Air Division of the State of Idaho Department of Environmental Quality (DEQ) for the Perpetua gold mining project (Project).

4. The initial application review process for this project included six meetings and five rounds of application revisions (January 28, 2019, through June 24, 2020). The DEQ air quality review and final permit issuance included the development of two supplemental toxic air pollutant analysis reports, three public comment periods (all extended by an additional 30 days) with responses to public comments, two public meetings, three draft permits and technical review documents, and one final permit and technical review document (June 25, 2020 through

June 17, 2022). This total timeline was over three years, not counting the time for the ongoing contested case appeal.

5. In my 32 years of experience, I have never seen an air permitting process conducted with this level of review and scrutiny. The Perpetua Project is classified as a non-major stationary source. In my 30 years of working on gold mining air permits in multiple states, I have seen these air permits typically issued within three to nine months for non-major sources and a year for major stationary sources.

6. The over three-year timeline for the Perpetua Project is unprecedented and was primarily driven by DEQ going to great lengths to address concerns raised by the public, and to ensure and document that the Perpetua Project would meet all air quality standards. Additional time and consideration were also dedicated by DEQ to craft a set of comprehensive air permit conditions that limited operations and air emissions in a verifiable and enforceable manner.

7. In my experience, the permit conditions for the Perpetua Project are more onerous than those in other gold mining permits I have reviewed for both non-major and major stationary sources.

8. DEQ's analyses and determination of compliance considered 14 maximum-emission operating scenarios and included layers of conservatism to ensure compliance with the NAAQS with a margin of safety. DEQ performed these analyses using conservative inputs for key variables, such as production, haul road miles, and control efficiency.

9. Variables relevant to haul road emissions considered by DEQ included:

   a. Mining Production (180,000 tons per day, resulting in a maximum of 16,415 miles/day of haul truck travel for operating scenario W3);

b. Emissions Factor (3.55 lb/mi) that reflects relevant conditions that can impact haul road emissions, such as surface moisture, precipitation, wind speed, truck weight, silt concentration (4%), other parameters; and

c. Haul Road Control Efficiency (90% for chemical, 33% for water, and 93.3% combined).

10. Estimated emissions using these inputs demonstrated compliance using an inherently conservative ambient air quality model. DEQ's highest modeled impacts for the Project were 82% of the PM_{10} NAAQS.

11. Air quality permits will often include conditions only for the key variables (or key variable surrogates) used in conservative air quality analyses. It is not necessary to establish permit limits for all variables. The Final Permit imposes enforceable limitations on three key variables: Mining Production (180,000 tons/day), Haul Road Control Efficiency (93.3%) and Silt Content (4%).

12. These three key variables in the Final Permit are practically enforceable through monitoring, recordkeeping and required work plans, Fugitive Dust Control Plan and Haul Road Capping Plan. Compliance with these enforceable conditions ensure emissions do not exceed estimated air quality results.

I declare under penalty of perjury pursuant to the laws of the State of Idaho that the foregoing is true and correct.

DATED: June 23, 2023.

/s/ *Kevin Lewis*
Kevin Lewis

CERTIFICATE OF SERVICE

I hereby certify that on this 23rd day of June 2023, a true and correct copy of the foregoing was served on the following:

Dylan B. Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Paula J. Wilson
Hearing Coordinator
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

/s/ *W. Christopher Pooser*
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	Case Docket No. 0101-22-01 **INTERVENOR-RESPONDENT PERPETUA'S MOTION TO STRIKE**

INTRODUCTION AND REQUESTED RELIEF

Intervenor-Respondent Perpetua Resources Idaho, Inc. ("Perpetua"), through undersigned counsel, moves to strike paragraphs 15 and 16 of the Declaration of Jonathan Oppenheimer, and related exhibits attached thereto. Mr. Oppenheimer's Declaration was filed on June 9, 2023, in support of Petitioners' Response to Respondent DEQ's Cross-Motion for Summary Judgment and Intervenor Perpetua's Motion for Summary Judgment and Petitioners' Reply in Support of Petitioners' Motion for Summary Judgment.

Paragraphs 15 and 16 of Mr. Oppenheimer's declaration offer opinion testimony regarding the health effects of particulate matter and arsenic. His opinions are not rationally based on his perception and are improper expert opinion testimony and therefore must be stricken from the record. Further, the studies included as exhibits to Mr. Oppenheimer's declaration were not produced in discovery, are not authenticated, and are the subject of improper expert opinion testimony. The exhibits must also be stricken from the record. Perpetua makes this motion based on the grounds and authority set forth below.

ARGUMENT

I. The Contested Case Rules require declarations to be based on personal knowledge and that expert testimony be disclosed and qualified.

Under the Contested Case Rules, the Board of Environmental Quality's (the "Board") consideration of motions for summary judgment are governed by the Idaho Rules of Civil Procedure ("I.R.C.P."). IDAPA 58.01.23.162.02. I.R.C.P. 56(c)(4) requires that "an affidavit used to support or oppose a motion must be made on personal knowledge, set out facts that would be admissible in evidence, and show that the affiant or declarant is competent testify on the matters stated."

Further, the Contested Case Rules incorporate the Idaho Rules of Administrative Procedure of the Attorney General. *See* IDAPA 58.01.123.03. The Attorney General Rules allow the admission of evidence "if it is of a type commonly relied upon by prudent persons in the conduct of their affairs," IDAPA 04.11.01.600, and also set forth requirements for the disclosure of expert testimony, IDAPA 04.11.01.530, .355. The Board requires that experts be qualified and that their testimony be consistent with their knowledge, skill, and training. *Freeman v. IDEQ*, Docket No. 0101-11-04, at 11 (Apr. 11, 2012); *Ford v. Idaho Department of Health and Welfare*, Docket No. 0102-98-16, at 4 (June 16, 1999) (finding that expert needed to be qualified to render expert opinion). To qualify as an expert witness, there must be "some demonstration that the witness has acquired, through some type of training, education or experience, the necessary expertise and knowledge to render the proffered opinion." *State v. Pearce*, 146 Idaho 241, 246, 192 P.3d 1065, 1070 (2008).

II. Mr. Oppenheimer is not qualified as an expert and the scientific studies on which he bases his testimony were not timely disclosed.

In his declaration, Mr. Oppenheimer makes conclusions about scientific matters and purports to support them by reference to recent scientific studies. With no attempt to qualify his expert testimony or authenticate the evidence provided, Mr. Oppenheimer states:

> 15. …. Any amount of additional particulate matter (PM) makes air less healthy to breathe. Recent studies on the nature of PM concentrations and their health effects back up previous studies and provide support for a no-threshold relationship between PM exposure and several respiratory and cardiovascular effects, and mortality, meaning any concentration of PM can have negative health effects. These health risks from increased particulates are even more significant for people like me, with asthma or other respiratory ailments.
>
> 16. I am also concerned about arsenic air pollution from the Project. Inhalation of arsenic-bearing dusts have been definitively linked to increased systemic uptake, as well as carcinogenic and non-carcinogenic health outcomes.

Oppenheimer Decl., ¶¶ 15, 16 (citations omitted). Both paragraphs are supported by footnotes, which cite to and incorporate the scientific studies.

Mr. Oppenheimer offers no evidence to demonstrate that he has the necessary expertise and knowledge to render the opinions proffered in his declaration. Further, he does not purport that his opinions are rationally based on his perception, and indeed they are not. Again, they are based on the scientific studies. Unauthenticated testimony submitted by a declarant that has failed to qualify as an expert is not of the type "commonly relied upon by prudent persons." IDAPA 04.11.01.600. Accordingly, the Board should strike paragraphs 15 and 16 from Mr. Oppenheimer's declaration and the associated exhibits.

Beyond the failure of Mr. Oppenheimer to qualify as an expert, the studies attached to his declaration must be struck for two independent reasons. First, these studies were not disclosed by Petitioners during the discovery process and must therefore be excluded. *Zylstra v. State*, 157 Idaho 457, 467, 337 P.3d 616, 626 (2014) (holding that expert testimony provided after the deadline for discovery established in the scheduling order should be stricken). The deadline for discovery was February 14, 2023. Scheduling Order at 2 (Jan. 19, 2023). The studies Mr. Oppenheimer refers to were not disclosed until long after this deadline.

Second, Mr. Oppenheimer does not purport to have personal knowledge of the methods used to arrive at the conclusions expressed in these studies, nor of the studies themselves. The opinions offered in the studies are those of experts, which Mr. Oppenheimer is not qualified to rely or testify on. Not only is Mr. Oppenheimer unqualified, but Perpetua is prejudiced by these late disclosed studies as it has not had the ability to counter them with competent evidence without also running afoul of the Scheduling Order entered in this case.

////

////

CONCLUSION

For the foregoing reasons, Perpetua respectfully requests that the Board strike paragraphs 15 and 16 from Mr. Oppenheimer's declaration and the associated exhibits.

DATED: June 23, 2023.

STOEL RIVES LLP

/s/ *W. Christopher Pooser*
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

CERTIFICATE OF SERVICE

I hereby certify that on this 23rd day of June 2023, a true and correct copy of the foregoing was served on the following:

Dylan B. Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Paula J. Wilson
Hearing Coordinator
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

/s/ *W. Christopher Pooser*
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

DYLAN LAWRENCE
VARIN THOMAS LLC
P.O. Box 1676
Boise, ID 83701
(208) 345-6021
dylan@varinthomas.com

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	BEQ Case No. 0101-22-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,	)	OAH Case No. 23-245-01
Petitioners,	)	NOTICE OF STATUS AND SCHEDULING CONFERENCE
v.	)	
DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC.,	)	
Intervenor.	)	

Based upon a stipulation among the Parties, the Scheduling Order of January 19, 2023 states that, "[t]he Parties will coordinate with the hearing officer a date for the hearing on the motion(s) for summary judgment on the next status conference held in this matter." Petitioners filed a Motion for Summary Judgment on April 14, 2023. DEQ and Perpetua Resources filed summary judgment motions on May 12, 2023. Briefing on all of the summary judgment motions concluded on June 23, 2023. On that same day, Perpetua Resources also filed a motion to strike certain portions of the Declaration of Jonathan Oppenheimer.

Based on the foregoing, NOTICE IS HEREBY GIVEN that the hearing officer and Parties

will hold a status and scheduling conference on Tuesday, July 11, 2023, at 2:00 p.m. mountain time, via Zoom, in order to schedule a hearing on the pending motions. The Zoom credentials have been distributed to counsel for the Parties electronically and are attached hereto.

Dated this 7th day of July, 2023.

Dylan Lawrence
Hearing Officer

CERTIFICATE OF SERVICE

I hereby certify that on this 7th day of July, 2023, I caused to be served a true and correct copy of the foregoing by the following method to:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

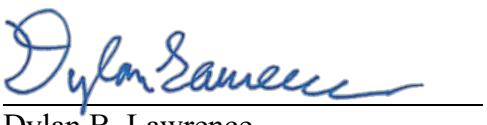
Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Resources Division
Office of the Attorney General
1410 N. Hilton St.
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service



Dylan B. Lawrence
Hearing Officer

Status and Scheduling Conference

Created by: Dylan Lawrence

Time

2pm - 3pm (Mountain Time - Boise)

Date

Tue Jul 11, 2023

Guests

bhurlbutt@advocateswest.org
christopher.pooser@stoel.com
filings@oah.idaho.gov
john.shackelford@deq.idaho.gov
jthrower@mtntoplaw.com
krista.mcintyre@stoel.com
llucas@advocateswest.org
wade.foster@stoel.com

Where

https://us06web.zoom.us/j/86720590897?pwd=NjNiUXBuaUV0enBCTnNCR0dma3lYQT09

Description

Dylan Lawrence is inviting you to a scheduled Zoom meeting.

Join Zoom Meeting
https://us06web.zoom.us/j/86720590897?pwd=NjNiUXBuaUV0enBCTnNCR0dma3lYQT09

Meeting ID: 867 2059 0897
Passcode: 596365

One tap mobile

+16694449171,,86720590897#,,,,*596365# US
+16699006833,,86720590897#,,,,*596365# US (San Jose)

Dial by your location
• +1 669 444 9171 US
• +1 669 900 6833 US (San Jose)
• +1 719 359 4580 US
• +1 253 205 0468 US
• +1 253 215 8782 US (Tacoma)
• +1 346 248 7799 US (Houston)
• +1 408 638 0968 US (San Jose)
• +1 386 347 5053 US
• +1 507 473 4847 US
• +1 564 217 2000 US
• +1 646 876 9923 US (New York)
• +1 646 931 3860 US
• +1 689 278 1000 US
• +1 301 715 8592 US (Washington DC)
• +1 305 224 1968 US
• +1 309 205 3325 US
• +1 312 626 6799 US (Chicago)
• +1 360 209 5623 US

Meeting ID: 867 2059 0897
Passcode: 596365

Find your local number: https://us06web.zoom.us/u/k4jLhGrTR

My Notes

Bryan Hurlbutt (ISB No. 8501)
Laurence J. Lucas (ISB No. 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
(208) 342-7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Julia Thrower (ISB No. 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
(208) 271-6503
jthrower@mtntoplaw.com

Attorneys for Petitioners

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	Agency Case No. 0101-2201 OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, *Petitioners,* *v.* IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, *Respondent,* and PERPETUA RESOURCES IDAHO, INC. *Intervenor-Respondent*.	**OPPOSITION TO PERPETUA'S MOTION TO STRIKE OPPENHEIMER DECLARATION**

INTRODUCTION

Petitioners hereby oppose the Motion to Strike filed by Perpetua on June 26, 2023. Perpetua moved to strike two paragraphs in the Declaration of Jonathan Oppenheimer ("Oppenheimer Declaration") and two studies cited in those paragraphs. The Oppenheimer Declaration was submitted to show Petitioner Idaho Conservation League ("ICL") has standing to bring this contested case in response to DEQ's and Perpetua's arguments that ICL lacked standing. As set forth below, the Hearing Officer can consider the Oppenheimer Declaration in its entirety, including the studies submitted with it, for the purpose of standing and should, thus, deny Perpetua's Motion to Strike.

BACKGROUND

In its response/opening brief on cross motions for summary judgment, DEQ contested Petitioners' standing. *See* DEQ Resp. Br. at 5–12. DEQ argued that Petitioners lack standing because they did not show that they would suffer any personal injuries, that those injuries were causally linked to DEQ's issuance of the permit to construct ("PTC"), and that a favorable decision would redress such injuries. *See id.* In its response/opening brief, Perpetua joined DEQ's standing argument. Perpetua Resp. Br. at 13–14. With their reply/response brief, Petitioners submitted seven standing declarations, including the Oppenheimer Declaration, to establish each Petitioner's organizational standing. *See* Pet'rs' Reply Br. at 2–5.

As stated in his declaration, Mr. Oppenheimer has worked at ICL since 2002, and has been an ICL member for even longer. Oppenheimer Decl. ¶ 2. Every summer, for more than a decade, Mr. Oppenheimer has visited and recreated in and near the East Fork of the South Fork Salmon River ("SFSR"). *Id.* ¶¶ 9–11. The East Fork SFSR is "special" to Mr. Oppenheimer and his family, and they "look forward to returning every year and enjoying the fresh air, public

lands, clean waters, and environment" there. *Id.* ¶ 12. This summer, Mr. Oppenheimer plans to camp at the Old East Fork Campground and to stay at the Johnson Creek Guard Station, about which he says: "I look forward to exploring the area with my family, fishing in Johnson Creek and the East Fork SFSR, and visiting the Stibnite area." *Id.* ¶¶ 12–13.

Expressing his concerns and beliefs about the health risks from breathing increased levels of particulate matter and arsenic, especially for an asthmatic like himself, Oppenheimer states:

> 15. I am concerned about the air pollution the proposed gold mine would emit and the adverse health effects to my family and me. I have suffered from allergy and exercise induced asthma since I was a child. I regularly use an albuterol inhaler to manage my asthma. Any amount of additional particulate matter (PM) makes air less healthy to breathe. Recent studies on the nature of PM concentrations and their health effects back up previous studies and provide support for a no-threshold relationship between PM exposure and several respiratory and cardiovascular health effects.[1] These health risks from increased particulates are even more significant for people like me, with asthma or other respiratory ailments.[2]
>
> 16. I am also concerned about arsenic air pollution from the Project. Inhalation of arsenic-bearing dusts have been definitively linked to increased systemic uptake, as well as carcinogenic and non-carcinogenic health outcomes.[3]

[1] *See* Exhibit A (attached and excerpted), U.S. EPA. Integrated Science Assessment (ISA) for Particulate Matter (Final Report, Dec 2019). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-19/188, 2019 (available at https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=347534).
[2] *See id.*, p. 1-1.
[3] *See* Exhibit B (attached), Martin, R.; Dowling, K.; Pearce, D.; Sillitoe, J.; Florentine, S. Health Effects Associated with Inhalation of Airborne Arsenic Arising from Mining Operations. Geosciences 2014, 4, 128-175 (available at https://doi.org/10.3390/geosciences4030128).

Oppenheimer Decl. ¶¶ 15–16.

In its Motion to Strike, Perpetua asks the Hearing Officer to strike paragraphs 15 and 16, arguing that they are "improper expert opinion testimony." Perpetua Mot. to Strike at 2. Perpetua also asks the Hearing Officer to strike Exhibits A and B, arguing they were not produced during discovery, were not authenticated, and are improper expert opinion testimony. *Id.*

ARGUMENT

The Oppenheimer Declaration was submitted for the purpose of establishing Petitioner ICL's standing in response to DEQ and Perpetua's arguments that ICL lacked standing and was not submitted for the merits. As such, the Hearing Officer can consider the Oppenheimer Declaration in its entirety, including the studies submitted therewith, for the purpose of evaluating ICL's standing.

"Th[e Idaho Supreme] Court has adopted the federal justiciability standard. When deciding whether a party has standing, [the Idaho Supreme Court has] looked to decisions of the United States Supreme Court for guidance." *Radford v. Van Orden*, 168 Idaho 287, 299 (2021) (quotation and citations omitted). For an organization like ICL to have standing, it must show, among other factors, that for one of its members: (1) the member must suffer an "injury in fact" that is "(a) concrete and particularized and (b) actual or imminent, not conjectural or hypothetical;" (2) the injury must be "fairly traceable to the challenged action;" and (3) it must be "likely, as opposed to merely speculative, that the injury will be redressed by a favorable decision." *Friends of the Earth v. Laidlaw Env't Servs. (TOC)*, 528 U.S. 167, 180–81 (2000).

To demonstrate injury in fact, the declarant must demonstrate that they have "reasonable concerns about the effects of" the challenged action on their "interests." *Friends of the Earth*, 528 U.S. at 183–84. At the summary judgment stage, the plaintiff "must set forth by affidavit or other evidence specific facts, which for purposes of the summary judgment motion will be taken to be true." *Lujan v. Defenders of Wildlife*, 504 U.S. 555, 561 (1992). Like the U.S. Supreme Court, the Idaho Supreme Court and the Board of Environmental Quality consider affidavits and other evidence, like the Oppenheimer Declaration for the purpose of evaluating standing. *See*, *e.g.*, *Boundary Backpackers v. Boundary Cnty.*, 128 Idaho 371, 375 (1996) (reviewing

organization member affidavits to evaluate standing); *In re Section 401 Water Quality Certification for Relicensing of the C.J. Strike Hydroelectric Facility*, Docket No. 0102-01-6, at *14 (Nov. 2002) (same).

The Idaho Supreme Court has found that a plaintiff failed to establish standing when she "failed to provide any testimony or other evidence that she suffered an injury in fact." *Haight v. Idaho Dep't of Transp.*, 163 Idaho 383, 392 (2018). Similarly, the Board of Environmental Quality has explained that in response to a motion for summary judgment on the issue of standing: "Petitioners had to submit affidavits or other evidence showing through specific facts that individual or organizational petitioners would be directly affected" by the challenged action. *Solomon v. IDEQ*, Docket No. 0101-03-01, at *5 (Dec. 2003).

"The doctrine of standing focuses on the party seeking relief and not on the issues the party wishes to have adjudicated." *Miles v. Idaho Power Co.*, 116 Idaho 635, 641 (1989). Courts "assume the truth of evidence proffered by plaintiffs" for the purpose of establishing standing. *Bonnichsen v. U.S. Dep't of Army*, 969 F. Supp. 628, 633 (D. Or. 1997). "The issue of standing, [however], should not be confused with the merits of the underlying action." *Id.* at 637, n.5.

Federal courts have denied motions to strike standing declarations, even if they are extra-record evidence or contain opinion statements. For example, in *Center for Biological Diversity v. U.S. EPA*, 90 F. Supp. 3d 1177 (W.D. Wash. 2015) the court denied a motion to strike, even though the declaration was not part of the administrative record before the court and even though it was filed with a summary judgment reply brief. *Id.* at 1192 n.11. The court concluded that the declaration was properly "submitted for the limited purpose of satisfying Article III standing requirements," and found the declaration was timely submitted since it was submitted after standing was contested and when the other side would still have an opportunity to respond. *Id.*

Similarly, in *Oregon Natural Desert Ass'n v. Rasmussen*, 451 F. Supp. 2d 1202 (D. Oregon 2006), the court denied a motion to strike, even though the declarant's stated "concerns regarding specific wilderness issues . . . do not qualify him as an expert." *Id.* at 1209. The court considered the declaration "in its entirety only for the purpose of establishing [plaintiff]'s standing." *Id.*

Here, in response to DEQ's and Perepetua's cross motions for summary judgment, which raised the issue of standing, Petitioners responded by submitting "affidavits," including the Oppenheimer Declaration, and "other evidence," namely the PM and arsenic studies included as exhibits to the Oppenheimer Declaration. The Oppenheimer Declaration and its exhibits set forth specific facts and demonstrate Mr. Oppenheimer's "reasonable concerns," as required to establish standing.

The two paragraphs Perpetua moves to strike include Mr. Oppenheimer's reasonable concerns about the risk he and his family face from breathing air with increased concentrations of PM and arsenic in and near the proposed mine site. Again, in paragraph 15, Oppenheimer states: "I am concerned about the air pollution the proposed gold mine would emit and the adverse health effects to my family and me. I have suffered from allergy and exercise induced asthma since I was a child. . . . Any amount of additional particulate matter (PM) makes air less healthy to breathe. . . ." In paragraph 16, he states: "I am also concerned about arsenic air pollution from the Project. Inhalation of arsenic-bearing dusts have been definitively linked to increased systemic uptake, as well as carcinogenic and non-carcinogenic health outcomes." These paragraphs can be considered by the Hearing Officer for purposes of standing.

Perpetua also seeks to strike the two studies cited by Oppenheimer in paragraphs 15 and 16 and included as exhibits to his declaration. These studies substantiate the concerns and beliefs Mr. Oppenheimer states in his declaration, that any PM or arsenic air pollution caused by DEQ's

approval of the Stibnite Gold Project could harm his physical well being. The 2019 EPA study, "Integrated Science Assessment for Particulate Matter," includes a number of "overall conclusions" that substantiate Oppenheimer's reasonable concerns about the health risks associated with PM exposure (even short-term PM exposure, and especially for someone who suffers from asthma like Mr. Oppenheimer), including the following EPA conclusions:

> Many populations (e.g., healthy, diseased, etc.) and lifestages (e.g., children, older adults, etc.) have been shown to be at risk of a health effect in response to short- or long-term PM exposure, particularly PM2.5. However, of the populations and lifestages examined, current scientific evidence indicates that only some populations may be at *disproportionately increased risk* of a PM2.5-related health effect, including . . . people with pre-existing cardiovascular and respiratory diseases. . . .

Exhibit A to Oppenheimer Decl., at 1-1. The 2014 study in *Goesciences*, "Health Effects Associated with Inhalation of Airborne Arsenic Arising from Mining Operations," substantiates Oppenheimer's reasonable concerns about the health risks associated with inhaling arsenic-laden PM caused by the Stibnite Gold Project. *See* Exhibit B to Oppenheimer Decl.

In summary, in response to DEQ's and Perpetua's summary judgment filings raising the issue of standing, Petitioners were required to and properly did submit declarations and other evidence—including the Oppenheimer Declaration and the two studies included with it—setting forth specific facts showing Mr. Oppenheimer's reasonable concerns about the ways the Stibnite Gold Project (as approved by DEQ) harms his interests. The Hearing Officer can consider this evidence for the purpose of evaluating Petitioners' standing.

CONCLUSION

For the reasons set forth above, Petitioners respectfully request that the Hearing Officer deny Perpetua's Motion to Strike.

Dated this 7th day of July, 2023.

Respectfully submitted,

/s/ Bryan Hurlbutt
Bryan Hurlbutt
ADVOCATES FOR THE WEST
P.O. Box 1612
Boise, ID 83701
(208) 342-7024
bhurlgutt@advocateswest.org
filings@advocateswest.org

Attorney for the Nez Perce Tribe and Idaho Conservation League

/s/ Julia S. Thrower
Julia S. Thrower
MOUNTAIN TOP LAW PLLC
614 Thompson Avenue
McCall, ID 83638
(208) 271-6503
jthrower@mtntoplaw.com

Attorney for Petitioner Save the South Fork Salmon

CERTIFICATE OF SERVICE

I hereby certify that on July 7, 2023, a true and correct copy of the Petitioners' Opposition to Perpetua's Motion to Strike Oppenheimer Declaration was served on the following:

Dylan B. Lawrence Varin Thomas, LLC 242 N. 8th St., Suite 220 Boise, ID 83702 (208) 345-6021 dylan@varinthomas.com *Hearing Officer*	Via:	Email: Fax: CM/ECF: Hand Delivery: U.S. Mail:	[x] [ ] [ ] [ ] [x]
Paula Wilson paula.wilson@deq.idaho.gov *Hearing Coordinator*	Via:	Email: Fax: CM/ECF: Hand Delivery: U.S. Mail:	[x] [ ] [ ] [ ] [ ]
Office of Administrative Hearings P.O. Box 83720 Boise, ID 83720-0104 filings@oah.idaho.gov	Via:	Email: Fax: CM/ECF: Hand Delivery: U.S. Mail:	[x] [ ] [ ] [ ] [x]
John Shackelford Office of the Attorney General 1410 N. Hilton, 2nd Floor Boise, ID 83706 (208) 373-0453 john.shackelford@deq.idaho.gov *Attorney for Respondent Idaho Department of Environmental Quality*	Via:	Email: Fax: CM/ECF: Hand Delivery: U.S. Mail:	[x] [ ] [ ] [ ] [ ]

Krista McIntyre
W. Christopher Pooser
Wade Foster
Stoel Rives, LLP
101 S. Capital Blvd., Suite 1900
Boise, ID 83702
(208) 389-9000
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
Attorneys for Intervenor Perpetua Resources of Idaho, Inc.

Via:

Email:	[x]
Fax:	[ ]
CM/ECF:	[ ]
Hand Delivery:	[ ]
U.S. Mail:	[ ]

/s/ Bryan Hurlbutt
Bryan Hurlbutt
Julia Thrower

Attorneys for Petitioners

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	Agency Case No. 0101-22-01
	OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	**PETITIONERS' MOTION TO STRIKE DECLARATION OF KEVIN LEWIS AND BRIEF IN SUPPORT**

MOTION TO STRIKE LEWIS DECLARATION

Pursuant to IDAPA 58.01.23.162.01 and 4.11.01.260, Petitioners Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon ("Petitioners") move to strike the Declaration of Kevin Lewis ("Lewis Declaration") and all portions of Respondent-Intervenor Perpetua Resources Idaho's ("Perpetua") briefs that rely on the declaration.

Mr. Lewis's declaration was filed on June 23, 2023, in support of the Reply Memorandum in Support of Intervenor-Respondent Perpetua's Motion for Summary Judgment ("Perpetua's Reply"). The Lewis Declaration should be stricken because it was improperly filed well after discovery had closed in the case. In the alternative, if the Lewis Declaration is not stricken from the record, Petitioners request that the Hearing Officer allow Petitioners to file a sur-reply responding specifically to the allegations in the Lewis Declaration and relied on by Perpetua in its Reply.

BRIEF IN SUPPORT

The January 9, 2023 Scheduling Order entered in this case ordered that each party provide "any additional documentary evidence they deem relevant to these proceedings by February 14, 2023." That time passed months ago. Yet Perpetua attempts to introduce further evidence by submitting the Lewis Declaration in support of its cross motion for summary judgment, well beyond the end of the discovery period and after Petitioners filed their final brief on summary judgment.

The Lewis Declaration makes several assertions regarding the air permit review process in this case, but also makes several unsupported assertions comparing this permit to the declarant's other experiences in permitting gold mines. *See* Lewis Decl. ¶¶ 4–7. The Lewis Declaration also makes factual assertions regarding the record that has been submitted in this

case. *See id.* ¶¶ 8–10. Additionally, the Lewis Declaration impermissibly attempts to provide legal conclusions on the legal sufficiency of DEQ's review which extend beyond what is permissible. *See* Lewis Decl. ¶¶ 8–12. Regardless of whether Mr. Lewis's declaration is offered as a fact or expert witness, to the extent that Mr. Lewis reaches specific conclusions that DEQ acted in compliance with applicable legal duties are impermissible.

At this stage of the proceedings, Petitioners do not have the opportunity to depose Mr. Lewis because discovery has closed. Petitioners also do not have the opportunity to respond to the assertions Perpetua has made in its brief in reliance on the Lewis Declaration because no further briefing is authorized under the Scheduling Order. Petitioners are thus prejudiced by Perpetua's late disclosure of this "witness" and by Perpetua's reliance on his declaration in Perpetua's Reply. The Hearing Officer should thus strike from the record the Lewis Declaration and the portions of Perpetua's Reply that rely on it.

CONCLUSION

For the reasons set forth above, Petitioners respectfully request that the Hearing Officer strike the Lewis Declaration and portions of Perpeteua's Reply that rely on the Lewis Declaration for support, or in the alternative allow Petitioners to file a sur-reply limited to responding to the assertions Perpetua relies on in the Lewis Declaration.

//

//

//

Dated this 7th day of July 2023.

Respectfully submitted,

/s/ Julia Thrower
Julia S. Thrower
MOUNTAIN TOP LAW PLLC
614 Thompson Avenue
McCall, ID 83638
(208) 271-6503
jthrower@mtntoplaw.com

Attorney for Petitioner Save the South Fork Salmon

/s/ Bryan Hurlbutt
Bryan Hurlbutt
ADVOCATES FOR THE WEST
P.O. Box 1612
Boise, ID 83701
(208) 342-7024
bhurlgutt@advocateswest.org
filings@advocateswest.org

Attorney for the Nez Perce Tribe and Idaho Conservation League

CERTIFICATE OF SERVICE

I hereby certify that on July 7th, 2023, a true and correct copy of the Petitioners' Motion to Strike Declaration of Kevin Lewis and Brief in Support was served on the following:

Dylan B. Lawrence Varin Thomas, LLC 242 N. 8th St., Suite 220 Boise, ID 83702 (208) 345-6021 dylan@varinthomas.com *Hearing Officer*	Via:	Email: Fax: CM/ECF: Hand Delivery: U.S. Mail:	[x] [ ] [ ] [ ] [x]
Paula Wilson paula.wilson@deq.idaho.gov *Hearing Coordinator*	Via:	Email: Fax: CM/ECF: Hand Delivery: U.S. Mail:	[x] [ ] [ ] [ ] [ ]
Office of Administrative Hearings P.O. Box 83720 Boise, ID 83720-0104 filings@oah.idaho.gov	Via:	Email: Fax: CM/ECF: Hand Delivery: U.S. Mail:	[x] [ ] [ ] [ ] [x]
John Shackelford Office of the Attorney General 1410 N. Hilton, 2nd Floor Boise, ID 83706 (208) 373-0453 john.shackelford@deq.idaho.gov *Attorney for Respondent Idaho Department of Environmental Quality*	Via:	Email: Fax: CM/ECF: Hand Delivery: U.S. Mail:	[x] [ ] [ ] [ ] [ ]

Krista McIntyre
W. Christopher Pooser
Wade Foster
Stoel Rives, LLP
101 S. Capital Blvd., Suite 1900
Boise, ID 83702
(208) 389-9000
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
Attorneys for Intervenor Perpetua Resources of Idaho, Inc.

Via:

Email:	[x]
Fax:	[ ]
CM/ECF:	[ ]
Hand Delivery:	[ ]
U.S. Mail:	[ ]

s/ Bryan Hurlbutt
Bryan Hurlbutt

DYLAN LAWRENCE
VARIN THOMAS LLC
P.O. Box 1676
Boise, ID 83701
(208) 345-6021
dylan@varinthomas.com

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	BEQ Case No. 0101-22-01 OAH Case No. 23-245-01 ORDER AND NOTICE FROM STATUS AND SCHEDULING CONFERENCE

On July 11, 2023, a status and scheduling conference was held virtually via Zoom. Bryan Hurlbutt appeared for Petitioners Nez Perce Tribe and Idaho Conservation League, and Julia Thrower appeared for Petitioner Save the South Fork Salmon. John Shackelford, Deputy Attorney General, appeared for Respondent. W. Christopher Pooser, Krista McIntyre, and Wade Foster appeared for Intervenor.

Based on the discussions and agreements at the conference, it is hereby ordered that:

Pursuant to BEQ Rule of Procedure 162.02, Intervenor may file a reply brief in support of its pending Motion to Strike no later than Friday, July 14, 2023; and

Pursuant to BEQ Rule of Procedure 162.02, Petitioners may file a reply brief in support of their pending Motion to Strike no later than seven (7) days after Intervenor's filing of its response to Petitioners' Motion.

In addition, notice is hereby given that oral argument on the pending motions for summary judgment will take place beginning at 9:30 a.m. on Thursday, September 21, 2023, in the 2nd Floor courtroom of the Borah Building, 304 N. 8th Street, Boise, Idaho 83702.

Dated this 12th day of July, 2023.

Dylan Lawrence
Hearing Officer

CERTIFICATE OF SERVICE

I hereby certify that on this 12th day of July, 2023, I caused to be served a true and correct copy of the foregoing by the following method to:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

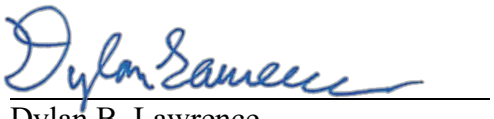
Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Resources Division
Office of the Attorney General
1410 N. Hilton St.
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service



Dylan B. Lawrence
Hearing Officer

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 _____ NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	Case Docket No. 0101-22-01 **INTERVENOR-RESPONDENT'S REPLY IN SUPPORT OF MOTION TO STRIKE OPPENHEIMER DECLARATION**

Perpetua Resources Idaho, Inc. ("Perpetua") submits this reply in support of its motion to strike paragraphs 15 and 16 of the Declaration of Jonathan Oppenheimer, and related exhibits attached thereto. Petitioners essentially argue that because these unauthenticated scientific studies are offered solely for purposes of standing, the rules of evidence do not apply. Not so.

Petitioners cannot evade the requirements of the Contested Case Rules and Idaho Rule of Evidence ("I.R.E.") 702 to backdoor undisclosed scientific studies under the guise of making a limited standing argument. However, if the Board does allow this evidence, it should only be for the very limited purpose of standing.

ARGUMENT

A. Oppenheimer's Declaration includes highly technical scientific studies that require expert testimony to be admitted.

Petitioners essentially argue that, since Mr. Oppenheimer offers expert testimony and undisclosed studies only in support of the Idaho Conservation League's ("ICL") standing, the Board is free to ignore the rules of evidence. Nothing in the Contested Case Rules or the Idaho Rules of Evidence exempt expert testimony offered solely to prove a petitioner's standing from Rule 702. *Boundary Backpackers v. Boundary County*, 128 Idaho 371, 375, 913 P.2d 1141, 1145 (1996) (holding that plaintiff had standing where declarant qualified as expert and expert testimony demonstrated injury was not speculative); *see In re ConAgra Foods, Inc.*, 302 F.R.D. 537, 549 (C.D. Cal. 2014) (granting motion to strike expert declaration offered in part to support plaintiff's standing).

The cases cited by Petitioners do not provide support for admitting unverified scientific studies under the guise of establishing standing.

In *Center for Biological Diversity v. U.S. EPA*, the U.S. Environmental Protection Agency moved to strike a declaration of Dr. Burke Hales, Professor of Oregon Ecology and Biogeochemistry at Oregon State University, which offered expert testimony regarding ocean acidification solely for the purpose of establishing plaintiff's standing. 90 F. Supp. 3d 1177, 1191, 1192 n.11 (W.D. Wash. 2015). In that case, no one objected to admission of the studies cited by Dr. Hales to support plaintiff's standing because they were already in the administrative

record under review.[1] *Id.* at 1191. And no one questioned Dr. Hales' expert qualifications. *Id.* at 1192 n.11. EPA moved to strike the declaration because it was filed with the plaintiff's reply brief. The court denied EPA's motion to strike, finding that consideration of the expert declaration was appropriate solely for establishing standing. Unlike *Center for Biological Diversity*, here, Mr. Oppenheimer is not an expert qualified to testify about the studies cited in his declaration. Further, as discussed below, these studies *are not part of the record* and were not disclosed as documentary evidence in discovery.

In *Oregon Natural Desert Ass'n v. Rasmussen*, the court refused to strike portions of the declaration where the declarant offered his opinion of the adverse impacts of overgrazing on public lands. 451 F. Supp. 2d 1202, 1209 (D. Or. 2006). Mr. Oppenheimer offers an opinion on the adverse impacts to him and his family from the Stibnite Gold Project. Oppenheimer Decl. ¶ 15. Oppenheimer goes well beyond the declaration in *Rasmussen*, however, and attempts to introduce two scientific studies, without establishing his qualifications as an expert witness under I.R.E. 702.

Under I.R.E. 702, Oppenheimer is not qualified to opine on the studies attached to his declaration. Oppenheimer does not suggest that he developed his concerns about arsenic only after reading the studies attached to his declaration, nor does he offer any first-hand personal knowledge related to the effects of arsenic or particulate matter. To the extent Oppenheimer purports to interpret studies that were not previously disclosed nor within the declarant's verified expertise, those portions of his declaration must be struck, along with the attached studies.

[1] Under the Administrative Procedure Act, the Court is to review agency action based on "the whole record [before the agency] or those parts of it cited by a party." 5 U.S.C. § 706. In *Center for Biological Diversity*, none of the parties challenged plaintiff's ability to rely on documents contained in the administrative record to support its standing.

B. The studies cited by Oppenheimer were not disclosed in discovery.

Petitioners do not address their failure to disclose the studies attached to Oppenheimer's declaration as documentary evidence prior to the discovery cutoff in this matter, as required by the Scheduling Order (dated Jan. 19, 2023). The Scheduling Order established a February 14, 2023 discovery deadline for "any additional documentary evidence [the parties] deem relevant to these proceedings." Under Idaho law, a court is well within its discretion to strike documentary evidence attached to a declaration, especially a purported expert declaration, that were not disclosed in discovery. *Hilliard v. Murphy Land Co.*, 158 Idaho 737, 740, 351 P.3d 1195, 1198 (2015). For this reason alone, the studies attached to the Oppenheimer Declaration should be struck.

C. If admitted, the evidence must be limited to the narrow issue of Idaho Conservation League's standing.

As Petitioners explain in their brief, even when declarations are admitted for the purpose of demonstrating standing, "the issue of standing … should not be confused with the merits of the underlying action." Petitioners' Memorandum in Opposition at 4 (citing *Bonnichsen v. U.S. Dep't of Army*, 969 F. Supp. 628, 637 n.5 (D. Or. 1997)). Accordingly, to the extent the Board does not strike paragraphs 15 and 16 of the Oppenheimer Declaration and studies cited therein, Perpetua requests that the Board only consider these statements for the purpose of determining whether Petitioners have standing.

CONCLUSION

For the foregoing reasons, Perpetua respectfully requests that the Board grant the motion to strike paragraphs 15 and 16 from Oppenheimer's declaration and the associated exhibits. Alternatively, if the Board denies the motion to strike, Perpetua respectfully requests that the testimony be admitted for the limited purpose of standing.

DATED: July 14, 2023.

STOEL RIVES LLP

/s/ *W. Christopher Pooser*
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

CERTIFICATE OF SERVICE

I hereby certify that on July 14, 2023, a true and correct copy of the foregoing was served on the following:

Dylan B. Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Paula J. Wilson
Hearing Coordinator
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

/s/ *W. Christopher Pooser*
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 _____ NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	Case Docket No. 0101-22-01 **INTERVENOR-RESPONDENT'S OPPOSITION TO PETITIONERS' MOTION TO STRIKE DECLARATION OF KEVIN LEWIS**

Perpetua Resources Idaho, Inc. ("Perpetua") submits this opposition to Petitioners' Motion to Strike Declaration of Kevin Lewis ("Lewis Decl."). Petitioners seek to strike paragraphs 4 through 12 of Mr. Lewis' declaration on the grounds that (1) it is new evidence improperly filed after the close of discovery, and (2) it includes improper legal conclusions.

Alternatively, Petitioners seek permission to file a surreply to respond to the allegations in Mr. Lewis' declaration and relied on by Perpetua in its Reply Memorandum submitted June 23, 2023. The hearing officer should deny the motion to strike and request to file a surreply. As explained below, Mr. Lewis' declaration simply reiterates what is already in the record and thoroughly addressed by the parties in their briefs and raises no new evidence or argument.[1]

I. ARGUMENT

A. Mr. Lewis' declaration is not subject to the February 14, 2023 deadline for documentary evidence and, in any event, contains no new evidence or argument.

Petitioners contend Mr. Lewis' declaration should be struck because it was submitted after the February 14, 2023 fact discovery deadline established by the Scheduling Order (dated Jan. 19, 2023). That deadline relates solely to "any additional documentary evidence [the parties] deem relevant to these proceedings" and did not require the disclosure of witnesses. Mr. Lewis' declaration is not documentary evidence. Moreover, a party may support its reply in support of a motion for summary judgment with an additional declaration. *See, e.g., Hauser v. Idaho Dep't of Health & Welfare*, No. CV-03-04943, 2004 WL 1854250, at *7 n.8 (Idaho Dist. May 21, 2004) (unpublished). Only when the declaration makes "wholly new arguments in support of [the] motion" does the court have the "discretion to disregard the arguments" and grant a motion to strike. *See Franklin Bldg. Supply Co. v. Hymas*, 157 Idaho 632, 640, 339 P.3d 357, 365 (2014).

Mr. Lewis' declaration does not include any new evidence or new arguments. In fact, it is no different than, and is entirely consistent with, the declarations of Kevin Schilling (the "Schilling Decl."), Mike Simon (the "Simon Decl."), and Tiffany Floyd (the "Floyd Decl.") submitted by the Idaho Department of Environmental Quality ("DEQ") in support of its motion

[1] If the Lewis Declaration is stuck it should be because it is redundant, as it provides no materially new information. However, Petitioners did not move to strike the declaration for that reason.

for summary judgment. DEQ submitted the declarations after the February 14, 2023 deadline, yet Petitioners did not seek to strike them—presumably because they are not "documentary evidence" and simply explain or expand on concepts in the documentary evidence disclosed by DEQ, Perpetua, and Petitioners. Mr. Lewis' declaration is no different.

Consider each of the paragraphs Petitioners seek to strike.

Lewis Decl. ¶ 4 – "The initial application review process for this project included six meetings and five rounds of application revisions (January 28, 2019, through June 24, 2020). The DEQ air quality review and final permit issuance included the development of two supplemental toxic air pollutant analysis reports, three public comment periods (all extended by an additional 30 days) with responses to public comments, two public meetings, three draft permits and technical review documents, and one final permit and technical review document (June 25, 2020 through June 17, 2022). This total timeline was over three years, not counting the time for the ongoing contested case appeal."

This same information is documented in the Statement of Basis, PET 52-54, 93, as well as in the Simon Decl. at 3-4 and Floyd Decl. at ¶¶ 9-16. It was also addressed in Perpetua's Opening Brief (at p. 3), DEQ's Opening Brief (at p. 4), and Petitioners' Response Brief (at pp. 31-32).

Lewis Decl. ¶ 5 – "In my 32 years of experience, I have never seen an air permitting process conducted with this level of review and scrutiny. The Perpetua Project is classified as a non-major stationary source. In my 30 years of working on gold mining air permits in multiple states, I have seen these air permits typically issued within three to nine months for non-major sources and a year for major stationary sources."

This same information is documented in the Statement of Basis, PET 60, 72, Simon Decl. at 3-4, and Floyd Decl. at ¶¶ 9, 18-19. These statements are also addressed in Perpetua's Opening Brief (at pp. 1, 2, 25-26).

Lewis Decl. ¶ 6 – "The over three-year timeline for the Perpetua Project is unprecedented and was primarily driven by DEQ going to great lengths to address concerns raised by the public, and to ensure and document that the Perpetua Project would meet all air quality standards. Additional time and consideration were also dedicated by DEQ to craft a set of comprehensive air permit conditions that limited operations and air emissions in a verifiable and enforceable manner."

This same information is documented in the Simon Decl. at 3-4 and Floyd Decl. at ¶¶ 10-20. And, it was addressed in Perpetua's Opening Brief (at pp. 3, 22-32), and Petitioner's Response Brief (at pp. 17-27).

Lewis Decl. ¶ 7 – "In my experience, the permit conditions for the Perpetua Project are more onerous than those in other gold mining permits I have reviewed for both non-major and major stationary sources."

Perpetua did not rely on this paragraph in its Reply Memorandum and does not object to the Board disregarding it in deciding the motions for summary judgment. Notwithstanding, this is simply a factual observation based on Mr. Lewis' personal experience and does not rely on any documentary evidence that was not disclosed.

Lewis Decl. ¶ 8 – "DEQ's analyses and determination of compliance considered 14 maximum-emission operating scenarios and included layers of conservatism to ensure compliance with the NAAQS with a margin of safety. DEQ performed these analyses using conservative inputs for key variables, such as production, haul road miles, and control efficiency."

This same information is included in the Statement of Basis, PET 64-65, and Appendix B to the Statement of Basis (Ambient Air Quality Impact Analyses Review Memorandum), PET 261-265, 276, 284, 297, 313. DEQ's conservative approach is further documented in the Schilling Decl. at p. 10; the Statement of Basis, PET 62, 65; Response to Comments, PET 551, 555, 557, 561-562, 567-568, 572, 574, 578-579, 585-586, 609, 628, 630; and addressed in both Perpetua's Opening Brief (at pp. 4, 8) and Petitioners' Response Brief (at pp. 23-24).

Lewis Decl. ¶ 9 – "Variables relevant to haul road emissions considered by DEQ included:

a. Mining Production (180,000 tons per day, resulting in a maximum of 16,415 miles/day of haul truck travel for operating scenario W3);
b. Emissions Factor (3.55 lb/mi) that reflects relevant conditions that can impact haul road emissions, such as surface moisture, precipitation, wind speed, truck weight, silt concentration (4%), other parameters; and
c. Haul Road Control Efficiency (90% for chemical, 33% for water, and 93.3% combined)."

This same information is included in the Simon Decl. at 6, 9; Appendix B to the Statement of Basis, PET 320-321; and addressed in Perpetua's Opening Brief (at pp. 22-23, 28-29) and Petitioners' Response Brief (at pp. 17-19, 25, 39). Moreover, this paragraph simply restates facts in the record; it offers no legal conclusion as to the meaning of these facts.

Lewis Decl. ¶ 10 – "Estimated emissions using these inputs demonstrated compliance using an inherently conservative ambient air quality model. DEQ's highest modeled impacts for the Project were 82% of the PM10 NAAQS."

This same information is documented in the Schilling Decl. at 17-18; Appendix B of the Statement of Basis, PET 265; TAP Addendum Modeling Review, PET 351; and addressed in Perpetua's Opening Brief (at pp. 4-5).

Lewis Decl. ¶ 11 – "Air quality permits will often include conditions only for the key variables (or key variable surrogates) used in conservative air quality analyses. It is not necessary to establish permit limits for all variables. The Final Permit imposes enforceable limitations on three key variables: Mining Production (180,000 tons/day), Haul Road Control Efficiency (93.3%) and Silt Content (4%)."

This same information is documented in the Statement of Basis, PET 65; DEQ's Response to Comments, PET 557, 562, 574, 578-579, 611; and addressed in Perpetua's Opening Brief (at pp. 22-23, 28-29); and Petitioner's Response Brief (at pp. 17-19, 25, 39). Additionally, this paragraph offers a factual observation based on Mr. Lewis' considerable experience based on the contents of the Final Permit. It does not contain a a legal conclusion.

Lewis Decl. ¶ 12 – "These three key variables in the Final Permit are practically enforceable through monitoring, recordkeeping and required work plans, Fugitive Dust Control Plan and Haul Road Capping Plan. Compliance with these enforceable conditions ensure emissions do not exceed estimated air quality results."

To the extent Mr. Lewis offers a legal conclusion, this paragraph is consistent with the Simon Decl. at 8-9 and DEQ's Response to Comments, PET 551-552, 557, 567, 572, 578-579, 611. Further, this statement has been thoroughly addressed in Perpetua's Opening Brief (at pp. 22-26, 41-45) and Petitioners' Response Brief (at pp. 18, 23, 27-34).

Thus, as shown above, Mr. Lewis' declaration does not include any "wholly new arguments." His declaration only restates information already in the record and addressed by the parties in their briefing. Moreover, no new facts were alleged in the declaration. Mr. Lewis' statements support arguments that had been made in Perpetua's and DEQ's motions for summary judgment. Petitioners' claim that there was no opportunity to respond to these assertions is entirely without merit. Petitioners have had ample opportunity to respond to all facts reasserted by Mr. Lewis, and in fact did, because this declaration only confirms the arguments made in support of Perpetua's and DEQ's motions for summary judgment.

B. Mr. Lewis' declaration contains factual assertions, not legal conclusions.

An affidavit will be adequately supported if it is based on "personal knowledge . . . [and] set[s] out facts that would be admissible in evidence." I.R.C.P. 56(e). Thus, while an affidavit will not be acceptable if merely conclusory, it must be accepted if it sets forth facts based on personal knowledge. *State v. Shama Res. Ltd. P'ship*, 127 Idaho 267, 271, 899 P.2d 977, 981 (1995).

As shown above, in his declaration, Mr. Lewis makes factual assertions that are based on personal knowledge. Indeed, the foundation for such personal knowledge is outlined in the declaration itself, where he addresses his close involvement with the development of the Final Permit. Lewis Decl. ¶¶ 1-3. Mr. Lewis does not make any legal conclusions in the declaration, but merely recounts facts based on his personal knowledge and the contents of the Final Permit. Petitioners argue that the declaration attempts to provide legal conclusions but offer no explanation or reasoning for this claim. Mr. Lewis' statements are merely assertions of fact based on his personal knowledge. Accordingly, the motion to strike this declaration has no legal basis and should be denied.

C. Petitioners have failed to show that there are new arguments for which a surreply is warranted.

Additionally, Petitioners' request for a surreply is improper and unsupported. The Idaho Rules of Civil Procedure do not allow a surreply as a matter of right. I.R.C.P. 56. The court has discretion to allow supplemental briefing in the form of a surreply. *Oregon Mut. Ins. Co. v. Seattle Collision Ctr. Inc.*, No. 09-36105, 2010 WL 4629066 (9th Cir. Nov. 16, 2010). However, surreplies are "'highly disfavored,'" *Green Technology Lighting Corp. v. Insure Idaho, LLC*, No. 1:17-CV-00432-DCN, 2023 WL 2744121, at *15 (D. Idaho Mar. 31, 2023) (citation omitted), and the court should only grant a request for a surreply in "extraordinary circumstances." *Id*. Raising new issues or evidence in a reply brief may constitute extraordinary circumstances. *Id.* But, as explained above, Mr. Lewis' declaration does not include any new arguments. Therefore, there is no new information to which Petitioners need to reply.

II. CONCLUSION

For the foregoing reasons, the Board should deny Petitioners' motion to strike and alternative request for surreply.

DATED: July 14, 2023.

STOEL RIVES LLP

/s/ *W. Christopher Pooser*
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

CERTIFICATE OF SERVICE

I hereby certify that on July 14, 2023, a true and correct copy of the foregoing was served on the following:

Dylan B. Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Paula J. Wilson
Hearing Coordinator
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

/s/ *W. Christopher Pooser*
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	Agency Case No. 0101-22-01
	OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON *Petitioners*, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, *Respondent*, and PERPETUA RESOURCES IDAHO, INC., *Intervenor-Respondent*.	**PETITIONERS' REPLY IN SUPPORT OF MOTION TO STRIKE DECLARATION OF KEVIN LEWIS**

Petitioners Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon file this Reply in Support of Motion to Strike Declaration of Kevin Lewis. The Lewis Declaration was filed by Intervenor-Respondent Perpetua Resources Idaho, Inc. ("Perpetua") with its reply brief in support of its cross motion for summary judgment, *after* the close of the limited discovery agreed to by all parties, and *after* the deadline by which Petitioners were required to file their final brief on summary judgment. Petitioners, thus, ask the Hearing Officer to strike the Lewis Declaration, or alternatively, allow Petitioners to file a sur-reply to respond to the points for which Perpetua relied on the Lewis Declaration. Each of the points Perpetua makes in its opposition to the Motion to Strike can be rejected.

First, Perpetua argues that the Lewis Declaration did not run afoul of the Scheduling Order's February 14, 2023 deadline for disclosing "documentary" evidence, because the Lewis Declaration is not documentary evidence. Perpetua is correct that the Lewis Declaration is not documentary evidence; it is witness testimony. However, this does not excuse Perpetua from failing to disclose Mr. Lewis as a witness and filing his declaration at the last possible moment. The Scheduling Order does not include any deadline for disclosing witnesses and for discovery of such experts, because the parties agreed there was no need for witnesses, expert or otherwise. Instead of conferring with the parties to discuss Perpetua's change of mind regarding witness testimony, Perpetua simply submitted the Lewis Declaration at the last minute, without agreement from the parties or approval from the Hearing Officer, and without any opportunity for Petitioners to conduct discovery of the witness or to respond.

The Lewis Declaration should thus be stricken as not complying with the Scheduling Order. Alternatively, Petitioners should be allowed to file a sur-reply, which is a modest request, given that Petitioners could seek to conduct discovery related to Mr. Lewis's statements.

Next, Perpetua argues that because Petitioners did not move to strike declarations submitted by DEQ, this somehow gives Perpetua the right to file an improper declaration. Like the Lewis Declaration, the DEQ declarations were also submitted improperly, as they too were submitted beyond the close of discovery and are improper witness testimony that was not authorized under the agreed to discovery plan and schedule. Petitioners, however, made the decision not to move to strike DEQ's declarations, in part because the DEQ declarations were submitted with DEQ's opening summary judgment brief and Petitioners, therefore, had the opportunity to respond in their summary judgment reply brief. By contrast, Perpetua submitted the Lewis Declaration later, after Petitioners filed their summary judgment reply brief and when (absent being granted leave to file a sur-reply) Petitioners would have no opportunity to respond.

Finally, Perpetua makes the curious argument that the Lewis Declaration should not be stricken because it "raises no new evidence or argument." Perpetua Opp., p. 2. Perpetua is wrong. For example, Lewis discusses his history of working on other gold mining air permits in multiple states and makes statements regarding his opinion of what "typical" timeframes are. Lewis. Decl. ¶ 5. Lewis also opines that DEQ went "to great lengths" in issuing the permit. *Id.* ¶ 6. Lewis also asserts that in his "experience," the permit conditions are "more onerous" than for other gold mine permits. *Id.* at 7. He also offers improper legal opinions that the permit limits are "verifiable and enforceable," are "practically enforceable," and complying with them will "ensure emissions do not exceed air quality results." *Id.* at ¶¶ 7 & 12. Mr. Lewis's background, the other gold mining projects he refers to, and his opinions about the permit at issue here are new evidence and argument, which Perpetua introduced after the close of discovery and at the very end of summary judgment briefing, without giving Petitioner any opportunity to take discovery of the witness and to otherwise respond to his declaration.

Moreover, if Perpetua is correct that the Lewis Declaration provides no new evidence or argument (as it repeatedly asserts in its opposition), then this is further grounds for striking the Declaration. "Evidence is relevant if: (a) it has any tendency to make a fact more or less probable than it would be without the evidence; and (b) the fact is of consequence to determining the action." Idaho Rule of Evidence (I.R.E.) 401. "Irrelevant evidence is not admissible." I.R.E. 402. Thus, accepting Perpetua's argument that the Lewis Declaration adds nothing to the facts or arguments in this case, it is irrelevant and inadmissible and should be stricken.

CONCLUSION

For the reasons set forth above, Petitioners respectfully request that the Hearing Officer grant Petitioners Motion to Strike Lewis Declaration or grant leave to file a limited sur-reply.

Dated this 20th day of July, 2023.

Respectfully submitted,

/s/ Bryan Hurlbutt
Bryan Hurlbutt
ADVOCATES FOR THE WEST
P.O. Box 1612
Boise, ID 83701
(208) 342-7024
bhurlbutt@advocateswest.org

Attorney for the Nez Perce Tribe and Idaho Conservation League

/s/ Julia Thrower
Julia S. Thrower
MOUNTAIN TOP LAW PLLC
614 Thompson Avenue
McCall, ID 83638
(208) 271-6503
jthrower@mtntoplaw.com

Attorney for Petitioner Save the South Fork Salmon

CERTIFICATE OF SERVICE

I hereby certify that on July 20th, 2023, a true and correct copy of the Petitioners' Reply in Support of Motion to Strike Declaration of Kevin Lewis was served on the following:

Dylan B. Lawrence Varin Thomas, LLC 242 N. 8th St., Suite 220 Boise, ID 83702 (208) 345-6021 dylan@varinthomas.com *Hearing Officer*	Via:	
	Email:	[x]
	Fax:	[ ]
	CM/ECF:	[ ]
	Hand Delivery:	[ ]
	U.S. Mail:	[x]
Paula Wilson paula.wilson@deq.idaho.gov *Hearing Coordinator*	Via:	
	Email:	[x]
	Fax:	[ ]
	CM/ECF:	[ ]
	Hand Delivery:	[ ]
	U.S. Mail:	[ ]
Office of Administrative Hearings P.O. Box 83720 Boise, ID 83720-0104 filings@oah.idaho.gov	Via:	
	Email:	[x]
	Fax:	[ ]
	CM/ECF:	[ ]
	Hand Delivery:	[ ]
	U.S. Mail:	[x]
John Shackelford Office of the Attorney General 1410 N. Hilton, 2nd Floor Boise, ID 83706 (208) 373-0453 john.shackelford@deq.idaho.gov *Attorney for Respondent Idaho Department of Environmental Quality*	Via:	
	Email:	[x]
	Fax:	[ ]
	CM/ECF:	[ ]
	Hand Delivery:	[ ]
	U.S. Mail:	[ ]

Krista McIntyre
W. Christopher Pooser
Wade Foster
Stoel Rives, LLP
101 S. Capital Blvd., Suite 1900
Boise, ID 83702
(208) 389-9000
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
Attorneys for Intervenor Perpetua Resources of Idaho, Inc.

Via:

Email:	[x]
Fax:	[ ]
CM/ECF:	[ ]
Hand Delivery:	[ ]
U.S. Mail:	[ ]

/s/ Bryan Hurlbutt
Bryan Hurlbutt

DYLAN LAWRENCE
VARIN THOMAS LLC
P.O. Box 1676
Boise, ID 83701
(208) 345-6021
dylan@varinthomas.com

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v.	BEQ Case No. 0101-22-01 OAH Case No. 23-245-01 ORDER ON PEREPETUA'S MOTION TO STRIKE
DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	

I. PROCEDURAL BACKGROUND

Pursuant to the stipulated Scheduling Order of January 19, 2023, all three sets of parties have filed and fully briefed motions for summary judgment. The Petitioners filed their summary judgment motion and supporting materials on April 14; Perpetua Resources and DEQ filed their responses to that motion and their own motions and supporting materials on May 12; the Petitioners filed their response to the Perpetua and DEQ motions and reply in support of their own motion on June 9; and Perpetua filed a reply brief in support of its own motion on June 23. Petitioners' June 9 filing included several declarations from witnesses. There were eight declarations total, seven of

which were geared primarily towards establishing standing. For the Nez Perce Tribe, the declarants were Joseph Oatman and Emmit Taylor, Jr. For the Idaho Conservation League (ICL), the declarants were Allison Fowle, Asa Menlove, and Jonathan Oppenheimer. For Save the South Fork Salmon, the declarants were Drew Hollenback and Zak Sears. The ninth declaration was a declaration of counsel authenticating documents from the record.

Simultaneously with its summary judgment reply brief, Perpetua Resources filed a motion to strike a portion of the Oppenheimer Declaration. In particular, Perpetua requests the striking of Paragraphs 15 and 16 of that declaration and the two related exhibits. Paragraph 15 reads:[1]

> [(a)] I am concerned about the air pollution the proposed gold mine would emit and the adverse health effects to my family and me. [(b)] I have suffered from allergy and exercise induced asthma since I was a child. [(c)] I regularly use an albuterol inhaler to manage my asthma. [(d)] Any amount of additional particulate matter (PM) makes air less healthy to breathe. [(e)] Recent studies on the nature of PM concentrations and their health effects back up previous studies and provide support for a no-threshold relationship between PM exposure and several respiratory and cardiovascular effects, and mortality, meaning any concentration of PM can have negative health effects.[1] [(f)] These health risks from increased particulates are even more significant for people like me, with asthma or other respiratory ailments.[2]

The footnotes at the end of Paragraphs 15(e) and (f) both refer to Exhibit A of the Declaration, an 88-page EPA report titled "Integrated Science Assessment for Particulate Matter" (December 2019). The second footnote refers specifically to page 1-1 of that report. Paragraph 16 then reads:

> [(a)] I am also concerned about arsenic air pollution from the Project. [(b)] Inhalation of arsenic-bearing dusts have been definitively linked to increased systemic uptake, as well as carcinogenic and non-carcinogenic health outcomes.[3]

The footnote at the end of Paragraph 16(b) refers to Exhibit B of the Declaration, a 48-page article from a 2014 issue of the journal *Geosciences*, titled "Health Effects Associated with Inhalation of Airborne Arsenic Arising from Mining Operations." No pinpoint cites were provided.

---

[1] Subparagraph labels have been inserted within Paragraphs 15 and 16 for ease of reference.

II. RELEVANT STANDARDS

There are multiple sets of standards relevant to Perpetua's motion and the Oppenheimer Declaration. First, because the Oppenheimer Declaration was filed in connection with Petitioners' summary judgment response, the standards governing motions for summary judgment are relevant. Motions for summary judgment filed in administrative proceedings before the BEQ are governed by the Idaho Rules of Civil Procedure. *In the Matter of Simmons Sanitation*, Findings of Fact, Conclusions of Law, and Preliminary Order on Motion for Summary Judgment of 9/23/05, at p. 3 (BEQ Dkt. No. 0106-05-01). Those rules provide in relevant part:

> An affidavit used to support or oppose a motion must be made on personal knowledge, set out facts that would be admissible in evidence, and show that the affiant or declarant is competent to testify on the matters stated. Sworn or certified copies of all papers or parts of papers referred to in an affidavit must be attached to or served with the affidavit.

IDA.R.CIV.PROC. 56(c)(4); *see also Freeman v. Idaho Dept. of Env. Quality*, Final Order of 4/11/12 at p. 11 (BEQ Dkt. No. 0101-11-04) (applying Rule 56 standards to conclude an affidavit was admissible as expert testimony).

Second, on matters of admissibility of evidence, BEQ Procedural Rule 003.13 adopts AG Procedural Rule 600, which states:

> Evidence should be taken by the agency to assist the parties' development of the record, not excluded to frustrate that development. The presiding officer at hearing is not bound by the Idaho Rules of Evidence. No informality in any proceeding or in the manner of taking testimony invalidates any order. The presiding officer, with or without objection, may exclude evidence that is irrelevant, unduly repetitious, inadmissible on constitutional or statutory grounds, or on the basis of any evidentiary privilege provided by statute or recognized in the courts of Idaho. All other evidence may be admitted if it is of a type commonly relied upon by prudent persons in the conduct of their affairs. The agency's experience, technical competence and specialized knowledge may be used in evaluation of evidence.

Third, even if the BEQ is not strictly bound by the Idaho Rules of Evidence, those rules do

---

throughout this Order.

provide helpful guidance and standards in evaluating technical evidence that may require expert witness testimony. Idaho Rule of Evidence 702 states:

> A witness who is qualified as an expert by knowledge, skill, experience, training, or education may testify in the form of an opinion or otherwise if the expert's scientific, technical, or other specialized knowledge will help the trier of fact to understand the evidence or to determine a fact in issue.

Finally, the decision on a motion to strike is within the discretion of the court (in judicial proceedings) or agency (in administrative proceedings). *See generally Shea v. Kevic Corp*., 328 P.3d 520, 524, 156 Idaho 540, 544 (Idaho 2014). "A trial court does not abuse its discretion if it (1) correctly perceives the issue as discretionary, (2) acts within the bounds of discretion and applies the correct legal standards, and (3) reaches the decision through an exercise of reason." *Id*.

III. LEGAL ANALYSIS

Perpetua articulates a few different bases to strike Paragraphs 15 and 16 of the Oppenheimer Declaration and the related exhibits. First, Perpetua argues that Mr. Oppenheimer's testimony is not properly qualified as expert witness testimony. Also, as to the two exhibits, Perpetua argues they should be stricken both because they were not disclosed in discovery, and because Mr. Oppenheimer "does not purport to have personal knowledge of the methods used to arrive at the conclusions expressed in these studies, nor of the studies themselves."

The Petitioners respond that Paragraphs 15 and 16 help to establish ICL's standing in this matter. Petitioners describe the Oppenheimer Declaration as one of seven "standing declarations" it filed on June 9. (*See* Petitioners' Resp. Br. of 7/7/23, pp. 1, 4.)

Paragraph 15(a)-(c) and 16(a) simply discuss Mr. Oppenheimer's personal experience, condition, and concerns, which are rationally related to concern over the issuance of an air quality permit. There is no basis to strike these four subparagraphs. As to Paragraph 15(a)-(c) and 16(a), Perpetua's motion is denied.

The remainder of Paragraphs 15 and 16 are affirmative, mostly definitive statements regarding the effects of emissions on human health. These statements are inherently of a technical nature and require the witness to be qualified as an expert. The Oppenheimer Declaration does not purport to establish Mr. Oppenheimer as an expert witness on air emissions or human health. Moreover, these statements do not attempt to explain how they relate to the actual legal and regulatory standards that govern the disposition of this matter. In other words, even if Mr. Oppenheimer were qualified to make these statements, they do not "help the trier of fact to understand the evidence or to determine a fact in issue" under Idaho Rule of Evidence 702.

However, the Petitioners rely on the Oppenheimer Declaration for the limited purpose of helping to establish ICL's standing. When otherwise inadmissible evidence may still be relevant to the standing issue, it is appropriate for the decision-maker to refrain from striking the offending evidence but clarify the scope of its relevance and consideration. *See generally Oregon Natural Desesrt Ass'n v. Rasmussen*, 451 F.Supp.2d 1202, 1208-1209 (D.Ore. 2006).

Overall, Paragraphs 15(d)-(f) and 16(b) and the two related exhibits are rationally related to establishing Mr. Oppenheimer's concern over the air permit issued to Perpetua Resources and, therefore, ICL's standing in this matter. Therefore, Perpetua's motion to strike those subparagraphs is denied. However, because those subparagraphs do not satisfy the requirements of Idaho Rule of Evidence 702, the Hearing Officer will limit consideration of them to the standing issue. The Hearing Officer will not consult the Oppenheimer Declaration or either of the two exhibits in evaluating any alleged errors on the part of DEQ in issuing the permit to Perpetua Resources.

As to Perpetua's argument that the two exhibits should be stricken because they were not disclosed in discovery, DEQ and Perpetua moved for summary judgment on the standing issue on May 12, 2023—well after the February 14, 2023 discovery deadline. While the Petitioners have an

ongoing duty to supplement their discovery responses, *see generally* IDA.R.CIV.PROC. 26(e), the Hearing Officer does not find the length of time from May 12 to June 9 to be inordinately long, particularly given that Petitioners were under a deadline to prepare and file summary judgment response and reply materials during that same timeframe. In any event, because the Hearing Officer will not rely on the exhibits in evaluating whether DEQ has committed any substantive errors in issuing the air permit to Perpetua, there is limited prejudice to Perpetua arising from their late disclosure, which is outweighed by the Petitioners' interests in responding to Perpetua's standing arguments.

IV. CONCLUSION

Based on the foregoing, the Hearing Officer denies Perpetua's motion to strike Paragraphs 15 and 16 of the Oppenheimer Declaration, but will consider the declaration and its exhibits in their entirety only for the limited purpose of evaluating ICL's standing to bring this action.

Dated this 31st day of July, 2023.



Dylan Lawrence
Hearing Officer

CERTIFICATE OF SERVICE

I hereby certify that on this 31st day of July, 2023, I caused to be served a true and correct copy of the foregoing by the following method to:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

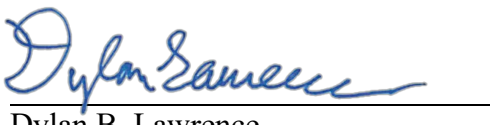
Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Resources Division
Office of the Attorney General
1410 N. Hilton St.
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service



Dylan B. Lawrence
Hearing Officer

DYLAN LAWRENCE
VARIN THOMAS LLC
P.O. Box 1676
Boise, ID 83701
(208) 345-6021
dylan@varinthomas.com

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v.	BEQ Case No. 0101-22-01 OAH Case No. 23-245-01 ORDER ON PETITIONERS' MOTION TO STRIKE
DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	

I. PROCEDURAL BACKGROUND

Pursuant to the stipulated Scheduling Order of January 19, 2023, all three sets of parties have filed and fully briefed motions for summary judgment. The Petitioners filed their summary judgment motion and supporting materials on April 14; Perpetua Resources and DEQ filed their responses to that motion and their own motions and supporting materials on May 12; the Petitioners filed their response to the Perpetua and DEQ motions and reply in support of their own motion on June 9; and Perpetua filed a reply brief in support of its own motion on June 23, along with a declaration of Kevin Lewis, an air quality engineer at Air Sciences, Inc. In general, the Lewis

Declaration discusses DEQ's efforts in evaluating Perpetua's permit application and issuing the permit. According to Lewis, the process was conducted with an unprecedented "level of review and scrutiny" and the permit conditions are "more onerous than those in other gold mining permits" he has reviewed. (Lewis Decl., ¶¶ 5-7.)

The Petitioners filed a motion to strike the Lewis Declaration on July 7, arguing primarily that it should be stricken because discovery has closed. In addition, in the event the Lewis Declaration is not stricken, the Petitioners have requested an opportunity to file a sur-reply brief to respond to it substantively.

II. LEGAL ANALYSIS

The Lewis Declaration should be stricken, though on a somewhat different basis than that articulated by the Petitioners. Motions for summary judgment filed in administrative proceedings before the BEQ are governed by the Idaho Rules of Civil Procedure. *In the Matter of Simmons Sanitation*, Findings of Fact, Conclusions of Law, and Preliminary Order on Motion for Summary Judgment of 9/23/05, at p. 3 (BEQ Dkt. No. 0106-05-01). Those rules provide:

> The motion [for summary judgment], ***supporting documents and brief*** must be served at least 28 days before the date of the hearing. If the adverse party wishes to oppose summary judgment, the party must serve an answering brief. The ***answering brief and any opposing documents*** must be served at least 14 days before the date of the hearing. Any ***reply brief*** of the moving party must be served at least 7 days before the date of the hearing.
>
> ***
>
> The court may alter or shorten the time periods and requirements of this rule for ***good cause shown***….

IDA.R.CIV.PROC. 56(b)(2), (3) (emphasis added).

Similarly, the rule governing motions other than summary judgment motions contemplates the filing of affidavits to support motions and responses, but not reply briefs. *See* IDA.R.CIV.PROC. 7(b)(3)(A)-(C). The text of these rules provides a clear indication that a summary

judgment movant must specifically request leave and establish "good cause shown" to file an affidavit (or declaration) in support of a reply brief. While the Scheduling Order in this matter alters the standard deadlines under Rule 56, it does not otherwise authorize the filing of affidavits or declarations out of sequence with that established by the Rule. (*See* Order of 1/19/23.)

Generally speaking, the decision on a motion to strike is within the discretion of the court (in judicial proceedings) or agency (in administrative proceedings). *See generally Shea v. Kevic Corp*., 328 P.3d 520, 524, 156 Idaho 540, 544 (Idaho 2014). However, the Idaho Supreme Court has held that ***not*** striking the Lewis Declaration under these circumstances would be an abuse of the Board's discretion:

> Before analyzing whether the depositions and affidavits on file in this case present any issues of material fact, we must first address the correctness of the district judge's decision to consider the Jensen affidavit. As mentioned previously, RR & T served Sun Valley with a copy of this affidavit no more than three days before the hearing on the motion and did not actually file the affidavit until the day before the hearing. Nonetheless, the district judge denied Sun Valley's motion to strike the affidavit ruling that I.R.C.P. 56(e) allows a court to permit a party to supplement or oppose an affidavit by further affidavit and that Sun Valley failed to show any resulting prejudice.
>
> Rule 56(c) requires the moving party to serve the motion along with supporting brief and affidavits not less than twenty-eight days before the hearing. I.R.C.P. 56(c). The purpose is to give the opposing party an adequate and fair opportunity to support its case. The rule requires the adverse party, if it chooses, to respond with an opposing brief and affidavits no less than fourteen days prior to the hearing. *Id*. Again, the purpose is to give the moving party an adequate opportunity to respond. Finally, if the moving party chooses to reply, the rule permits the service of a reply brief no fewer than seven days before the hearing. *Id*. While the above language is mandatory, the trial court may shorten the time periods for good cause shown. *Id*.
>
> ***
>
> Rule 56(e) does give the trial court discretion to allow a party to oppose or supplement an affidavit by further affidavits, however, ***the time limitations set forth in Rule 56(c) still apply unless the court shortens the time for good cause shown***.
>
> ***
>
> With the Jensen affidavit in hand, the district judge granted RR & T's motion for

> partial summary judgment noting that Sun Valley failed to contradict assertions made in the affidavit.
>
> ***
>
> Because there was no showing of good cause for failing to comply with the time limits by RR & T, and clearly Sun Valley was at a disadvantage in responding to the summary judgment motion, ***the district judge abused his discretion in considering Jensen's affidavit***. Therefore, we will not consider Jensen's statements in our review of RR & T's motion for partial summary judgment.

Sun Valley Potatoes, Inc. v. Rosholt, Robertson & Tucker, 981 P.2d 236, 240-241, 133 Idaho 1 (Idaho 1999) (emphasis added).

Admittedly, the circumstances in *Sun Valley Potatoes* were much more extreme than they are here. In that case, the offending affidavit was served on the other party three days prior to the summary judgment hearing and was filed with the court the day before the hearing. *Id*. at 240. Here, the summary judgment hearing has been scheduled for September 21, 2023—nearly three months after the Lewis Declaration was filed.

Regardless, the basic mechanics of Rule 56 still apply: In order for a summary judgment movant to file an affidavit or declaration after the deadlines established by rule (or as amended by a scheduling order), it must establish "good cause" for doing so. Neither Perpetua's summary judgment reply brief that accompanied the Lewis Declaration nor its opposition to the Petitioners' motion to strike reference the "good cause" standard or otherwise attempt to explain why it could not have filed the declaration earlier.

This would be difficult in any event. The briefing deadlines established by the Scheduling Order are generous. Moreover, Perpetua itself agreed that the Petitioners would file their summary judgment motion nearly a full month before Perpetua's motion. (Order of 1/19/23, at p. 2.) Effectively, Perpetua had a preview of the Petitioners' arguments that Rule 56 does not normally provide. Why Perpetua would have needed more than two months from the time Petitioners filed

their summary judgment motion on April 14 to file the Lewis Declaration on June 23 is not apparent.

III. CONCLUSION

Based on the foregoing, the Petitioners' motion to strike the June 23 declaration of Kevin Lewis is granted. The Hearing Officer will not consider that declaration in ruling on the pending motions for summary judgment. Petitioners' request for leave to file a sur-reply brief is now moot.

Dated this 31st day of July, 2023.

Dylan Lawrence
Hearing Officer

CERTIFICATE OF SERVICE

I hereby certify that on this 31st day of July, 2023, I caused to be served a true and correct copy of the foregoing by the following method to:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

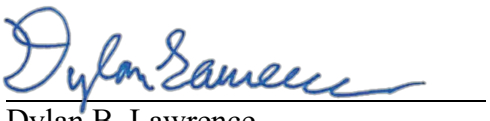
Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Resources Division
Office of the Attorney General
1410 N. Hilton St.
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service



Dylan B. Lawrence
Hearing Officer

DYLAN LAWRENCE
VARIN THOMAS LLC
P.O. Box 1676
Boise, ID 83701
(208) 345-6021
dylan@varinthomas.com

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	BEQ Case No. 0101-22-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,	)	OAH Case No. 23-245-01
Petitioners,	)	NOTICE PURSUANT TO IRAP 412
v.	)	
DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC.,	)	
Intervenor.	)	

Pursuant to BEQ Contested Case Rule 003.12 and the Idaho Attorney General's Rule of Administrative Procedure 412, attached hereto is an updated list of matters in which both the Hearing Officer and the State of Idaho are involved. The redlining indicates updates that have occurred since the disclosure of December 21, 2022. A related waiver request has been approved by the Office of Administrative Hearings.

Dated this 8th day of August, 2023.

Dylan Lawrence
Hearing Officer

CERTIFICATE OF SERVICE

I hereby certify that on this 8th day of August, 2023, I caused to be served a true and correct copy of the foregoing by the following method to:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

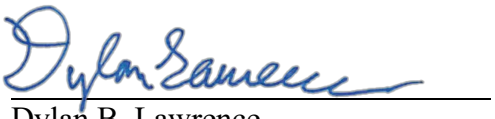
Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Resources Division
Office of the Attorney General
1410 N. Hilton St.
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service



Dylan B. Lawrence
Hearing Officer

CONTRACT HEARING OFFICER'S REQUEST FOR WAIVER

PURSUANT TO IDAHO CODE § 67-5283(1)(d)

I, Dylan Lawrence, hereby request a waiver of prohibited conduct pursuant to Idaho Code §§ 67-5283(1)(d) as follows (***please select each applicable item***):

☑ **Engaging in the practice of law outside of the Hearing Officer's role with the Office of Administrative Hearings**. The following also specifically applies to my practice:

- ☐ I currently or previously have represented the State of Idaho, its agencies, and/or its personnel;
- ☑ I am or have been adverse to the State of Idaho, its agencies, and/or its personnel; or
- ☐ None of the above apply to me.

☐ **Holding, or being a candidate for, any federal state, county, municipal, district, or elective office**. Please identify the office:

_____

☐ **Serving as the agent, representative, officer, political treasurer, or employee, whether for profit or otherwise, of any political party, political committee, or candidate, whether as defined in either Chapter 1, Title 34, or Chapter 66, Title 67, Idaho Code, or otherwise.** Please identify the position:

_____

☐ **Holding any other public or private-sector position, whether for profit or otherwise, except for volunteer positions that are not inconsistent with their duties as a Hearing Officer.** Please insert specifics below:

_____

☐ **Any other provision of the Code of Conduct.** Explain:

_____

Additional information may be requested by the Chief Administrative Hearing Officer or their designee. Following review of all submitted information, you will be informed in writing if your request for waiver is granted or denied.

THIS FORM MUST BE SUBMITTED EACH TIME YOU NEED TO REQUEST NEW/ADDITIONAL GROUNDS FOR WAIVER

Dylan Lawrence
Contract Hearing Officer Signature

July 31, 2023
Date

Current Formal Judicial/Administrative Proceedings Involving State Agencies as Adverse Parties

State of Idaho v. BLH Enterprises, et al. (Bear Lake County; Case No. CV04-22-0168): I am co-counsel of record for defendants in a case filed by IDL for activities at Bear Lake below the ordinary high water mark. The judicial proceedings are currently dormant while the defendants prepare and file a permit application. It is likely that resolution of the permit application will require a hearing under the Lake Protection Act that, as of Jan. 1, 2023, would be conducted by a representative of OAH.

In the Matter of Application for Permit No. 63-34753 in the Name of Idaho Water Resource Board: This involves the water right application filed by IWRB that is associated with the proposed raise of Anderson Ranch Dam. I represent Elmore County, who has filed a protest in opposition to the application.

In the Matter of Applications for Permits for the Diversion and Use of Surface and Ground Water Within the Snake River Basin: This involves a recent moratorium issued by IDWR on water right applications on the Snake River between King Hill and Swan Falls Dam. I represent Elmore County, who has filed a petition opposing the moratorium.

In the Matter of Application for Permit No. 63-35061 in the Name of Heritage Ranch, LLC: I represent the applicant for a new water right in the Parma area that has been protested by IDFG.

In the matter of: United Oil of Magic Valley, Inc., LUST Consent Order 4-160052: I have been asked to review the terms of a proposed Consent Order on behalf of the regulated entity. This would involve direct interaction with one of the DAGs assigned to DEQ.

Other Ongoing, Less Formal Contacts with State Agencies

My client in the BLH Enterprises case described above has communicated with DEQ regarding related boat fueling practices. Thus far, I have not been directly involved in such discussions, but future contacts are reasonably forseeable. I understand BLH Enterprises recently provided a copy of a letter I drafted on this issue to representatives of DEQ, the Idaho Department of Lands, and the Idaho Department of Insurance.

I have clients who have been pursuing funding from DEQ for water projects. I have been involved in some discussions with DEQ staff related to that effort.

My practice focuses on water rights, so I am nearly always involved in multiple matters and communications with IDWR and IWRB. For example, I typically have multiple clients with water right applications or protests pending with IDWR, and am in regular communication with IWRB and IDWR staff on a variety of topics and matters.

Past Matters

DEQ/BEQ: I have been directly adverse to DEQ in two air quality permit matters and in a handful of matters involving releases and management of hazardous waste.

Others: I have been directly adverse to IDWR, IWRB, IDFG, IDL, and ABC in dozens of past matters (mostly IDWR and IWRB).

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 _____ NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	Case Docket No. 0101-22-01 **JOINT MOTION *IN LIMINE* TO EXCLUDE COMMUNICATIONS FROM U.S. EPA SENT AFTER PERMIT WAS ISSUED**

The Idaho Department of Environmental Quality (the "Department") and Perpetua Resources Idaho, Inc. ("Perpetua") respectfully move to exclude recent comments from the U.S. Environmental Protection Agency ("EPA") to the Department that were communicated after the

Final Permit to Construct was issued and briefing on the Parties' motions for summary judgment was concluded.

I. INTRODUCTION

The Regional Administrator of EPA Region 10 corresponded with the Director of the Department in a letter dated August 10, 2023 (the "EPA Letter") regarding the Permit to Construct issued to Perpetua on June 17, 2022 (the "Permit"). The Permit is currently the subject of this contested case proceeding, and scheduled for a summary judgment hearing September 21, 2023.

No party has attempted to introduce the EPA Letter, however it has been shared by an unknown party or parties with the press. An article regarding the letter appeared on August 28, 2023, and included comments from at least one Petitioner in this proceeding. The letter itself, together with Petitioner's comments to the press, are outside the record and do not fairly characterize either the EPA Letter nor the facts at issue in this proceeding. Both the EPA Letter and the press reports occasioned by its release should be ignored and it is for that reason that the Department and Perpetua are filing this motion.

The Department and Perpetua move to exclude the EPA Letter and the press reports regarding the EPA Letter to ensure that this proceeding is not tainted by claims made by non-parties, including EPA, or by parties commenting on this case. Specifically, (1) EPA is not a party to this contested case proceeding; (2) the EPA Letter was sent over a year after the Permit was issued; (3) the EPA Letter was not relied upon by the Department in determining whether to issue the Permit or in determining what conditions to include in the Permit; and (4) the EPA Letter was sent months after briefing concluded on the Parties' cross-motions for summary judgment. The pending administrative review of the Department's action in this contested case

proceeding is subject to Idaho law and the Board of Environmental Quality's (the "Board") contested case rules, and the Board's review of the Permit is not impacted by comments from EPA.

II. LEGAL STANDARD

"A motion in limine is a procedural mechanism to limit in advance testimony or evidence in a particular area." *Hana Fin., Inc. v. Hana Bank*, 735 F.3d 1158, 1162 n. 4 (9th Cir. 2013) (quoting *United States v. Heller*, 551 F.3d 1108, 1111 (9th Cir. 2009)). There is no express authority for motions in limine in either the Idaho Rules of Civil Procedure or the Idaho Rules of Evidence. Nevertheless, these motions are well recognized in practice and by case law. *See, e.g., Noel v. City of Rigby*, 166 Idaho 575, 587 (2020); *Ohler v. United States*, 529 U.S. 753, 758. The purpose of a motion in limine is to "exclude prejudicial evidence before the evidence is actually offered." *Luce v. United States*, 469 U.S. 38, 40 (1984).

III. ARGUMENT

The EPA Letter must be excluded because it is not part of the record before the Board and was not considered by the Department in issuing the Permit. Additionally, the EPA Letter was sent to the Department after briefing on the cross-motions for summary judgment was completed. Finally, the EPA Letter contains impermissible hearsay.

A. The EPA Letter was not considered by the Department in issuing the Permit and is not part of the Record.

Petitioners challenge the Department's Permit under the Idaho Administrative Procedure Act ("APA") standard for judicial review of adjudicative agency actions. *See* First Amended Petition ¶¶ 4, 7, 35, 52, 61, 69, 72.[1] It is well established under the APA, and not disputed here

[1] *See also* Petitioner's Opening Summary Judgment Brief ("Opening Br.") at 13; Perpetua's Memorandum in Support of Motion for Summary Judgment and in Opposition to

by the Parties, that in determining whether the Department erred as a matter of law, the role of the Board is to review the permitting record before the Department at the time it took the action of issuing the Permit. *See* Opening Br. at 13; Perpetua Br. at 10; *Floyd v. Bd. of Ada Cty. Comm'rs*, 164 Idaho 659, 663, 667 (2019).

The EPA Letter was transmitted to the Department over a year after the Permit was issued. EPA previously submitted multiple comments on the Permit that the Department appropriately responded to. The EPA Letter was not before the Department when it issued the Permit and has no bearing on whether the Department's action, based on the permitting record before it, was supported by substantial evidence or was arbitrary, capricious, or an abuse of discretion. *See* Idaho Code § 67-5279(3). The EPA Letter is therefore not part of the record upon which review of the Department's action is based, and accordingly, the EPA Letter should be excluded.

B. The EPA Letter was sent after briefing on the motions for summary judgment was complete and was not addressed by the parties.

Briefing on the pending cross-motions for summary judgment was completed on June 23, 2023. The EPA Letter was dated August 10, 2023. The EPA Letter should be excluded because it was sent after briefing concluded. *See* I.R.C.P. 26(e)(3) ("The court may exclude … evidence not disclosed" as required by the Idaho Rules of Civil Procedure).

C. The EPA Letter contains inadmissible hearsay.

"Hearsay" is a statement that "the declarant does not make while testifying at the current trial or hearing; and a party offers in evidence to prove the truth of the matter asserted in the

---

Petitioner's Motion for Summary Judgment ("Perpetua Mem.") 9-10; DEQ Response to Petitioner's Motion for Summary Judgment and Brief in Support of Cross Motion for Summary Judgment ("DEQ Br.") at 12-13.

statement." I.R.E. 801(c). "Hearsay is not admissible" unless it meets one of the enumerated exceptions in the Idaho Rules of Evidence. I.R.E. 802.

EPA is not a party to this contested case proceeding, nor have any of the Parties offered direct testimony from the EPA Regional Administrator in this contested case proceeding. To the extent that the EPA Letter, or press reports about it, might be offered for the truth of the matters asserted in the EPA Letter, it should be excluded as hearsay. The statements in the EPA Letter offer further critiques of the Permit and do not meet any of the enumerated exceptions on Rule 803 or Rule 804 of the Idaho Rules of Evidence.

Finally, because EPA is not a party to this contested case proceeding, the Department and Perpetua were not able to test the validity of EPA's assertions in their summary judgment briefing, nor will they be able to test these assertions through cross-examination at any eventual hearing. *State v. Harris*, 141 Idaho 721, 726, 117 P.3d 135, 140 (Ct. App. 2005) (explaining that the purpose of the hearsay rule "is to assure that testimony presenting assertions can be tested by cross-examination of the person making the assertion"). Accordingly, the EPA Letter must be excluded.

IV. CONCLUSION

For the foregoing reasons, the Board should exclude the EPA and any press reports about the Letter and not consider either in deciding this contested case proceeding.

DATED: August 28, 2023.

STOEL RIVES LLP

/s/ W. Christopher Pooser
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

DEPARTMENT OF ENVIRONMENTAL QUALITY



John Shackelford
Deputy Attorney General

Attorney for Respondent

CERTIFICATE OF SERVICE

I hereby certify that on August 28, 2023, a true and correct copy of the foregoing was served on the following:

Dylan B. Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Paula J. Wilson
Hearing Coordinator
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

/s/ *W. Christopher Pooser*
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 _____ NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	Case Docket No. 0101-22-01 **JOINT MOTION TO SHORTEN TIME AND FOR EXPEDITED CONSIDERATION**

The Idaho Department of Environmental Quality (the "Department") and Perpetua Resources Idaho, Inc. ("Perpetua") respectfully move to shorten time for Petitioners to respond to the Joint Motion *in Limine*, filed on August 28, 2023, and move for expedited consideration of

the Joint Motion *in Limine* such that it may be decided before the summary judgment hearing scheduled for September 21, 2023.

I. INTRODUCTION

The Parties' cross motions for summary judgment are scheduled to be heard on September 21, 2023.[1] On August 28, 2023, the Department and Perpetua filed a joint motion in limine to exclude correspondence sent to the Department by the U.S. Environmental Protection Agency after the Permit was finalized. Under the Board of Environmental Quality's contested case rules, the Hearing Officer has authority to shorten time for consideration of pre-hearing motions. *See* IDAPA 58.01.23. Due to the rapidly approaching summary judgment hearing, and the need to adequately prepare for the hearing, the Department and Perpetua respectfully request that the Hearing Officer shorten time for Petitioners to respond to the Joint Motion *in Limine* and also to expedite consideration of the motion. The Department and Perpetua also request the opportunity to file a reply in support of the Joint Motion *in Limine*.

II. ARGUMENT

Pursuant to IDAPA 58.01.23.162, the Hearing Officer has authority to manage the process for consideration of a pre-hearing motion, including the time for parties to respond to the motion. Typically, the responding party has 14 days to respond to a pre-hearing motion. *Id.* This would make Petitioners' response due on September 11, which is 10 days from the summary judgment hearing. To allow the Parties adequate time to prepare for the hearing, the Department and Perpetua respectfully request that the Hearing Officer shorten time for Petitioners to file their

[1] During the Status Conference held on July 11, 2023, the Hearing Officer indicated that he would provide a list of questions to focus the issues to be addressed at the hearing. Expedited briefing of and a decision on the Motion *in Limine* and early submission of the Hearing Officer's questions will allow the parties time to prepare for the summary judgment hearing.

response to the Joint Motion *in Limine* such that it is due no later than September 6. The Department and Perpetua also request that the Hearing Officer expedite consideration of the Joint Motion *in Limine* so that the Parties may have a decision on the motion in time to prepare for the summary judgment hearing.

Pursuant to IDAPA 58.01.23.162.02, the Hearing Officer may allow an opportunity for the movant to file a reply brief. The Department and Perpetua respectfully request the opportunity to file a reply brief in support of the Joint Motion *in Limine*. The Department and Perpetua will file its reply brief the day after Petitioners file their response brief.

III. CONCLUSION

For the foregoing reasons, the Department and Perpetua respectfully request that the Hearing Officer shorten time for Petitioners to respond to the Joint Motion *in Limine* and expedite consideration of the motion. The Department and Perpetua also request that the Hearing Officer allow a reply in support of the Joint Motion *in Limine*.

DATED: August 31, 2023.

STOEL RIVES LLP

/s/ W. Christopher Pooser
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

DEPARTMENT OF ENVIRONMENTAL QUALITY

/s/ John Shackelford (with permission)
John Shackelford
Deputy Attorney General

Attorneys for Respondent

CERTIFICATE OF SERVICE

I hereby certify that on August 31, 2023, a true and correct copy of the foregoing document was served on the following:

Dylan B. Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Paula J. Wilson
Hearing Coordinator
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

/s/ *W. Christopher Pooser*
W. Christopher Pooser

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	Agency Case No. 0101-22-01
	OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	**PETITIONERS' MOTION TO STAY THE CASE AND BRIEF IN SUPPORT**

MOTION TO STAY

Petitioners Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon ("Petitioners") hereby move to stay this contested case, including postponing the summary judgment hearing scheduled for September 21, 2023, and setting a status conference in October to discuss the status of the contested case.

Petitioners' stay request is based on the letter dated August 10, 2023, from EPA Regional Administrator Casey Sixkiller to Idaho Department of Environmental Quality ("DEQ") Director Jess Byrne (the "EPA Letter"),[1] raising concerns with the Permit to Construct for the Stibnite Gold Project (the "PTC"), which is the subject of this contested case. The EPA Letter is attached as Exhibit A. The EPA Letter requests an in-person meeting aimed at a timely resolution of EPA's concerns, such as by issuing a revised PTC. Some of the concerns raised in the EPA Letter are substantially similar to the claims that Petitioners' have raised in this case. A stay is necessary to give EPA and DEQ time to meet and potentially resolve EPA's concerns, which could dispose of this contested case and/or narrow the issues, saving the Parties' and the Hearing Officer's time and resources. Petitioners' counsel reached out to counsel for DEQ and Perpetua, and they oppose a stay.

BRIEF IN SUPPORT OF MOTION TO STAY

The Hearing Officer has broad discretion to manage this contested case, including by staying these proceedings. *See* IDAPA 04.11.01.

[1] The EPA Letter is the subject of DEQ's and Perpetua's pending Joint Motion in Limine. Petitioners are filing a Motion to Supplement, and a Response to the Motion in Limine, regarding the propriety of considering the EPA Letter on the merits. Here, the EPA Letter is submitted for the purpose of supporting this Motion to Stay.

I. THE EPA LETTER

In the EPA Letter, Regional Administrator Sixkiller requested a personal and in-person meeting with DEQ Director Byrne, including with appropriate members of the agency's permit and legal teams, within 30 days, "[g]iven the seriousness of the concerns raised by the EPA and the need to reach a timely resolution." EPA Letter at 1. It is Petitioners' understanding that such a meeting has not yet occurred, but that DEQ and EPA do plan to meet, including possibly a site visit, to discuss these matters.

The EPA Letter states that EPA has three primary concerns with the Permit:

> The Agency has three primary concerns with the Department's Permit: (1) the Permit's emission limits are not adequate to limit the Stibnite Gold Project's potential to emit below the Prevention of Significant Deterioration permitting threshold; thus, construction of the Stibnite Gold Project would constitute construction of a major stationary source without a Prevention of Significant Deterioration permit, (2) the Permit's emission limits are not adequate to protect the particulate matter National Ambient Air Quality Standard, and (3) the Department's delineation between the Stibnite Gold Project boundary and the ambient air—where the National Ambient Air Quality Standards apply—is not adequately supported. Details of the Agency's evaluation of the final permit are enclosed for your review.

EPA Letter at 1. The EPA Letter also states that EPA "believes that the deficiencies in the Permit outlined in the enclosure and articulated in prior comments can be rectified through issuance of a revised permit to construct with adequate and enforceable conditions." *Id.*

II. GRANTING A LIMITED STAY WILL SAVE RESOURCES AND WILL NOT PREJUDICE ANY PARTY

By granting the requested stay, DEQ will have time to meet with EPA to try to resolve EPA's concerns with the PTC, which could resolve this contested case or significantly narrow the issues. Two of the three primary concerns EPA has with the PTC (inadequate limits to comply with particulate NAAQS and inadequate support for setting the ambient air boundary) are the same as or substantially overlap with the issues Petitioners' have pursued in this contested case.

See Pet'rs' Br. in Supp. of Mot. Summ. J. Should EPA and DEQ resolve these concerns by going through the process of revising the PTC, as EPA has requested, this could address some or all of the issues Petitioners raised in this contested case.

A stay will not prejudice the other parties. If EPA and DEQ are not able to reach a timely resolution, or if such resolution does not dispose of Petitioners' contested case, the contested case can resume and proceed to a decision on summary judgment.

DEQ will not be prejudiced by a stay. DEQ is a state agency created by the Idaho Environmental Health and Protection Act. Idaho Code § 39-101. DEQ's stated mission is: "To protect human health and the quality of Idaho's air, land, and water." Webpage, About Us, https://www.deq.idaho.gov/about-us/. DEQ works in partnership with the EPA to implement the Clean Air Act, 42 U.S.C. § 7401 *et seq.*, and the Idaho Air Rules, IDAPA 58.01.01, as the "CAA is a joint venture, one that makes the States and the Federal Government partners in the struggle against air pollution." *In re Volkswagen*, 959 F.3d 1201, 1214 (9th Cir. 2020). It is in DEQ's interest to issue a lawful and valid PTC that protects health and the environment and is supported by its federal partner agency EPA. Even if no resolution is reached, it is still in DEQ's interest to at least meet with EPA with time to try to timely address EPA's concerns.

Perpetua will not be prejudiced by a temporary stay either. Because Petitioners have not sought to stay the PTC, the PTC is currently in effect. *See* IDAPA 58.01.23.061. Thus, the pendency of this contested case does not preclude Perpetua from commencing construction. Moreover, before Perpetua can commence construction and operation of the Stibnite Gold Project, it needs numerous additional state and federal approvals. Other than the PTC issued by DEQ, most (if not all) of these other approvals have not yet been granted. Thus, temporarily

staying this matter for a short time will not prejudice Perpetua, but it could save the parties and the Hearing Officer substantial time and resources.

For the foregoing reasons, Petitioners' request that the Hearing Officer grant this motion for stay, vacate the September 21, 2023 hearing date, and set a date for a status conference in October or as allowed by the Hearing Officer's and the parties' schedules.

Dated this 1st day of September 2023.

Respectfully submitted,

s/ Julia Thrower

Julia S. Thrower
MOUNTAIN TOP LAW PLLC
614 Thompson Avenue
McCall, ID 83638
(208) 271-6503
jthrower@mtntoplaw.com

Attorney for Petitioner Save the South Fork Salmon

s/ Byran Hurlbutt

Bryan Hurlbutt
ADVOCATES FOR THE WEST
P.O. Box 1612
Boise, ID 83701
(208) 342-7024
bhurlgutt@advocateswest.org
filings@advocateswest.org

Attorney for the Nez Perce Tribe and Idaho Conservation League

CERTIFICATE OF SERVICE

I hereby certify that on September 1, 2023, a true and correct copy of the Petitioners' Motion to Stay the Case and Brief in Support was served on the following:

Dylan B. Lawrence Varin Thomas, LLC 242 N. 8th St., Suite 220 Boise, ID 83702 (208) 345-6021 dylan@varinthomas.com *Hearing Officer*	Via:	Email: Fax: CM/ECF: Hand Delivery: U.S. Mail:	[x] [ ] [ ] [ ] [x]
Paula Wilson paula.wilson@deq.idaho.gov *Hearing Coordinator*	Via:	Email: Fax: CM/ECF: Hand Delivery: U.S. Mail:	[x] [ ] [ ] [ ] [ ]
Office of Administrative Hearings P.O. Box 83720 Boise, ID 83720-0104 filings@oah.idaho.gov	Via:	Email: Fax: CM/ECF: Hand Delivery: U.S. Mail:	[x] [ ] [ ] [ ] [x]
John Shackelford Office of the Attorney General 1410 N. Hilton, 2nd Floor Boise, ID 83706 (208) 373-0453 john.shackelford@deq.idaho.gov *Attorney for Respondent Idaho Department of Environmental Quality*	Via:	Email: Fax: CM/ECF: Hand Delivery: U.S. Mail:	[x] [ ] [ ] [ ] [ ]

Krista McIntyre
W. Christopher Pooser
Wade Foster
Stoel Rives, LLP
101 S. Capital Blvd., Suite 1900
Boise, ID 83702
(208) 389-9000
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
Attorneys for Intervenor Perpetua Resources of Idaho, Inc.

Via:

Email:	[x]
Fax:	[ ]
CM/ECF:	[ ]
Hand Delivery:	[ ]
U.S. Mail:	[ ]

s/ Julia Thrower
Julia Thrower

Exhibit A

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue, Suite 155
Seattle, WA 98101

OFFICE OF THE REGIONAL ADMINISTRATOR

August 10 2023

Mr. Jess Byrne
Director
Idaho Department of Environmental Quality
1410 North Hilton Street
Boise, Idaho 83706

Dear Mr. Byrne,

The purpose of this letter is to request an in-person meeting, either in Seattle or Boise, to follow-up on our recent discussion regarding concerns with Idaho Department of Environmental Quality's air quality Permit to Construct issued to Perpetua Resources Idaho, Inc. on June 17, 2022. The Permit authorizes Perpetua Resources Idaho, Inc. to construct a gold, silver and antimony mine, referred to as the Stibnite Gold Project. The Agency previously provided comments on draft permits to the Department raising numerous issues. The Agency has reviewed the final Permit, statement of basis and the Department's response to comments and continues to be concerned that construction and operation of the Stibnite Gold Project under the terms set out in the Department's Permit would not comply with the Clean Air Act. As we discussed, the Agency does not oppose the Stibnite Gold Project, generally. The Agency's interest is ensuring that the Stibnite Gold Project is properly permitted and complies with the Clean Air Act to ensure the protection of human health and the environment.

The Agency has three primary concerns with the Department's Permit: (1) the Permit's emission limits are not adequate to limit the Stibnite Gold Project's potential to emit below the Prevention of Significant Deterioration permitting threshold; thus, construction of the Stibnite Gold Project would constitute construction of a major stationary source without a Prevention of Significant Deterioration permit, (2) the Permit's emission limits are not adequate to protect the particulate matter National Ambient Air Quality Standard, and (3) the Department's delineation between the Stibnite Gold Project boundary and the ambient air—where the National Ambient Air Quality Standards apply—is not adequately supported. Details of the Agency's evaluation of the final permit are enclosed for your review.

The Agency believes that the deficiencies in the Permit outlined in the enclosure and articulated in prior comments can be rectified through issuance of a revised permit to construct with adequate and enforceable conditions that limit the Stibnite Gold Project's potential to emit and ensure compliance with the National Ambient Air Quality Standards. I invite the Department to discuss these concerns with the Agency and collaborate with the Agency on an appropriate path forward.

Given the seriousness of the concerns raised by the EPA and the need to reach a timely resolution, I would like to schedule the meeting in the next 30 days, with your and my personal involvement, along with appropriate members of our permit and legal teams.

If you are supportive of such a meeting, please have your scheduler contact my Executive Assistant, Michelle Fraser, at (206) 553-4629 or fraser.michelle@epa.gov. Thank you for your attention to this matter.

Sincerely,

CASEY SIXKILLER

Digitally signed by CASEY SIXKILLER
Date: 2023.08.10 14:46:37 -07'00'

Casey Sixkiller
Regional Administrator

cc: Ms. Tiffany Floyd
Idaho Department of Environmental Quality

Mr. John Shackelford
Idaho Office of the Attorney General

Chairman Shannon F. Wheeler
Nez Perce Tribe

Enclosure

ENVIRONMENTAL PROTECTION AGENCY
EVALUATION OF AIR QUALITY PERMIT TO CONSTRUCT
Perpetua Resources Idaho, Inc.
Permit Number P-2019-0047
Issued: June 17, 2022

PRIOR ENVIRONMENTAL PROTECTION AGENCY (EPA) COMMENTS ON DRAFT PERMITS

Perpetua Resources Idaho, Inc. (PRI) submitted an application for a permit to construct (PTC) the Stibnite Gold Project (SGP) to Idaho Department of Environmental Quality (IDEQ) on August 20, 2019. Prior to issuance of the final PTC, IDEQ developed and offered for public comment three draft PTCs. EPA submitted two formal comment letters dated March 19, 2021, and March 16, 2022, on two of the prior permit drafts dated February 18, 2021, and January 13, 2022, respectively. In these comments, EPA raised numerous concerns with the adequacy of the draft PTCs to limit the SGP's potential to emit (PTE) to below major stationary source levels and to ensure the SGP does not cause or contribute to a violation of the National Ambient Air Quality Standards (NAAQS). IDEQ issued the Final Permit, Statement of Basis (SOB), and Response to Comments (RTC) on June 17, 2022.

STATUTORY AND REGULATORY REQUIREMENTS

Major stationary sources in Idaho are required to obtain a prevention of significant deterioration permit (PSD) prior to commencing construction.[1] Similarly, major stationary sources in Idaho must obtain a Tier I operating permit.[2] For purposes of the PSD permitting requirement, a source meets the definition of major stationary source if it has a PTE of 250 tons per year or more of a regulated NSR pollutant or 100 tons per year or more of a regulated air pollutant if the source is of the type specifically listed in the regulations (e.g., lime plants).[3] For the purposes of the requirement to obtain a Tier I operating permit, a source meets the definition of major stationary source if the source has a PTE of 100 tons per year or more of any regulated air pollutant, 10 tons per year or more of any hazardous air pollutant (HAP), or 25 tons per year of any combination of HAPs.[4] Particulate matter and particulate matter with an aerodynamic diameter of less than or equal to 10 micrometers are regulated air pollutants.[5]

A state-issued permit condition can legally restrict a source's PTE if it meets two criteria: 1) the condition is legally enforceable by the state air pollution control agency; and 2) it is enforceable as a practical matter.[6]

---

[1] IDAPA 58.01.01.205; 40 CFR 52.670(c).
[2] In Idaho, major sources under Title V of the CAA and 40 CFR part 70 are referred to as Tier I Sources. IDAPA 58.01.01.300-397.
[3] IDAPA 58.01.01.201 and 205.01 and 40 CFR 52.21(b); 40 CFR 52.670(c).
[4] IDAPA 58.01.01.006; 58.01.01.008; 58.01.01.107; 40 CFR 70.2.
[5] IDAPA 58.01.01.006; 40 CFR 52.670(c).
[6] Terrell E. Hunt and John S. Seitz, "Limiting Potential to Emit in New Source Permitting" (June 13, 1989) ("Hunt Memo") at 2; John Seitz and Robert Van Heuvelen, "Release of Interim Policy on Federal Enforceability of Limitations on Potential to Emit" (Jan. 22, 1996) at 3.

In general, practical enforceability for a source-specific permit term means that the provision must specify: (1) a technically accurate limitation and the portions of the source subject to the limitation; (2) the time period for the limitation (hourly, daily, monthly, annually); and (3) the method to determine compliance including appropriate monitoring, record keeping and reporting.[7]

Emission factors used to derive a PTE limit must be technically accurate.[8] In general, emissions factors published in EPA's *AP-42 Compilation of Air Pollutant Emission Factors* (AP-42) are based on averages and are not intended for establishing source-specific limits.[9] EPA recommends using emissions factors in AP-42 only when source specific emissions factors are not available and selecting conservatively higher emissions factors.[10] EPA assigns each emissions factor in AP-42 a rating from A to E, with A being the best.[11] According to AP-42, "Factors based on many observations, or on more widely accepted test procedures, are assigned higher rankings. Conversely, a factor based on a single observation of questionable quality, or one extrapolated from another factor from a similar process, would probably be rated much lower."[12]

Emission factors also include numerous operating assumptions and variables regarding the source.[13] Accordingly, the permit should contain conditions to ensure the operating assumptions and variables underlying the emission factor accurately reflect site-specific conditions and are enforceable.[14]

When permits require add-on controls operated at a specified efficiency level, permit writers should include, so that the operating efficiency condition is enforceable as a practical matter, those operating parameters and assumptions which the permitting agency depended upon to determine that the control equipment would have a given efficiency.[15]

---

[7] John S. Seitz, "Options for Limiting the Potential to Emit (PTE) of a Stationary Source Under Section 112 and Title V of the Clean Air Act" (Jan. 25, 1995) ("Seitz Memo") at 5-6; Kathie Stein, "Guidance on Enforceability Requirements for Limiting Potential to Emit through SIP and § 112 Rules and General Permits" (January 25, 1995) ("Stein Memo") at 6; *In re Shell Offshore, Inc.*, 15 E.A.D. 526, 551 (March 30, 2012); Reclassification of Major Sources as Area Sources Under Section 112 of the Clean Air Act, 84 FR 36304, 36318 (July 26, 2019).

[8] Peabody Western Coal, 12 E.A.D. at 39; *see also* In re Shell Offshore, Inc. 15 E.A.D. at 559; In the Matter of Yuhuang Chemical Inc. Methanol Plant St. James Parish, Louisiana, Title V Petition Response Order, No. VI-2015-03 (August 31, 2016) ("Yuhuang Order") at 19, 28.

[9] Peabody Western Coal, 12 E.A.D. at 38 ("Peabody not only proposes to rely on the AP-42 factors to establish both its PTE limit and to demonstrate compliance with that limit, Peabody compounds the potential inaccuracy of this approach by using unverified emission control assumptions in both calculations."); see also John S. Seitz and Eric Schaeffer, "Potential to Emit (PTE) Guidance for Specific Source Categories" (April 14, 1998) at 4 n.4.

[10] In re Shell Offshore, Inc. 15 E.A.D. at 559.

[11] Compilation of Air Pollutant Emission Factors (AP-42) Fifth Edition, January 1995, Introduction at pp. 2; 4; 8.

[12] *Id.* at 8.

[13] Peabody Western Coal, 12 E.A.D. at 39 n.40.

[14] Hunt Memo at 7-8; See also Peabody Western Coal, 12 E.A.D. at 38 n.38; Yuhuang Order at 19, 28.

[15] Hunt Memo at 7, 20-21; see also Cash Creek General LLC, Title V Petition Response Order, No. IV-2010-4 (June 22, 2012) at 17, 26 (granting in part because the permittee's claims of 90% control efficiency of PM emissions from storage piles and associated roadways was unsubstantiated and the permit lacked any requirements governing frequency of wet suppression, atmospheric or operations conditions under which wet suppression should applied the time of day that wet or chemical suppression should be applied, or the amount that should be applied).

When permits contain emissions, production or operational limits, they should also have monitoring, recordkeeping, and reporting (MRR) requirements that allow a permitting agency to verify a source's compliance with its limits.[16] The permit should provide for the collecting, maintaining, and reporting of information necessary to determine emissions of each pollutant as well as compliance with operating parameters.[17] The permit must include conditions that clearly specify the monitoring requirements and how the permittee must demonstrate compliance via the monitoring requirements.[18]

With respect to National Ambient Air Quality Standards (NAAQS) compliance, in accordance with IDAPA 58.01.01.203.02: "No permit to construct shall be granted for a new or modified source unless the application shows to the satisfaction of the Department all of the following: NAAQS. The stationary source or modification would not cause or significantly contribute to a violation of any ambient air quality standard." See also 40 CFR 52.670(c). Similarly, new major stationary sources in attainment or unclassifiable areas are subject to IDAPA 58.01.01.205, which is an approved part of Idaho's State Implementation Plan.[19] In order to satisfy the requirements of CAA Section 110(a)(2)(J), IDAPA 58.01.01.205 incorporates by reference several sections of 40 CFR 52.21, including 40 CFR 52.21(k). The regulation at 40 CFR 52.21(k) and CAA Section 165(a)(3) require that, "The owner or operator of the proposed source or modification shall demonstrate that allowable emission increases from the proposed source or modification, in conjunction with all other applicable emissions increases or reductions (including secondary emissions), would not cause or contribute to air pollution in violation of: Any national ambient air quality standard in any air quality control region; or Any applicable maximum allowable increase over the baseline concentration in any area."

EVALUATION OF FINAL PERMIT

1. The production limits in the PTC do not restrict the SGP's PTE to below major stationary source permitting thresholds under the prevention of significant deterioration (PSD) or Title V programs.

a. Underestimation of Emissions from Ore Processing Emission Units

In its prior comment letters, EPA advised DEQ that the emission factors relied upon in the draft permits were not representative of emissions. For instance, EPA's March 16, 2022 comment letter stated: "Some of the PTE limitations may not be technically accurate because they are not based on emission factors that are representative of the emission sources. For example, AP-42 Section 11.24 Metallic Minerals Processing emission factors applies to the processing of hard ores including gold. However, the application uses AP-42 emissions factors from Section 11.19.2 Crushed Stone Processing that is applicable to non-metallic mineral processing. The permitting record does not provide a reasoned explanation as to why emission factors from Section 11.24 were selected over those from Section 11.19.2."[20]

---

[16] Hunt Memo at 17; In re Shell Offshore, Inc. 15 E.A.D. at 551.
[17] 84 Fed. Reg. 36,304, 36,320.
[18] Yuhuang Order at 21.
[19] 40 CFR 52.670(c).
[20] March 16, 2022, EPA Comment 5

DEQ's Response to Comment did not provide any additional information or rationale for decision making. Instead, DEQ stated, "Representativeness of these parameters was discussed with and reconfirmed by PRI at various points during review and the estimates of emissions and underlying assumptions were supported to the satisfaction of DEQ."[21]

Even if a permitting authority was unable to find more accurate emission factors than AP-42, the introduction to Section 11.19 states, "The construction aggregate industry covers a range of subclassifications of the nonmetallic minerals industry (see Section 11.24, Metallic Minerals Processing, for information on that similar activity)." IDEQ did not follow the listed instructions to see Section 11.24 for Metallic Minerals Processing.

IDEQ did not state that it performed any analysis of other emission information. IDEQ did not state that it sought out emission factor information of higher quality than AP-42, as required by IDEQ Guidance[22] (Guidance) which states, "When estimating emissions, emissions data that *best* reflects emissions from a stationary source must be used" (emphasis added). DEQ did not make a determination that the emission factor chosen meets the Guidance. Similarly, the Guidance states "The rating of the AP-42 factor must be considered…" However, IDEQ did not state how it considered the rating of the factor chosen or if IDEQ considered other factors with higher ratings. For reference, AP-42 Section 11.24 has a rating of "C" for primary crushing emission factor. AP-42 Section 11.19 has no emission factor for primary crushing, but states that tertiary crushing can be used for primary and secondary crushing and the rating for tertiary crushing is "E", the lowest rating assigned by AP-42. Setting aside the choice of using an emission factor for Non-Metallic Minerals instead of the Metallic Minerals, IDEQ has not evaluated the available emission factors based on the rating, as required by its own Guidance.

EPA's document AP-42 Metallic Mineral Processing Plants – Background Information for Proposed Standards Volume 2 Appendices (EPA-450/3-81.009b) lists visits and emission testing at various mineral processing and mining operations. Appendix C – Summary of Test Data includes data on nine plants that processed metallic minerals. Table C-1 specifically includes testing at processing equipment at a gold mine with baghouse control. Thus, the metallic mineral processing plants evaluated and tested to form the basis for the emissions factors in AP-42 Section 11.24 are most similar to the metallic mineral processing emission units at the SGP. These background documents clearly indicate that the emissions factors in Section 11.24 are most appropriate for estimating emissions from the SGP.

Multiplying the emission factor found in AP-42 Section 11.24 by the production limitation on the primary crusher (OC7) results in an emission estimate over 90 tons of PM per year for that unit alone. Similarly, if AP-42 Section 11.24 emission factors are multiplied by the production limits for the remaining emission units OC1 through OC13, potential PM emissions from that collection of units *exceeds 800 tons PM per year*. Given the PSD threshold of 250 tons per year and the fact that even Section 11.24 is an average emission factor (and approximately half of all emission units will emit above an average rate), the PTC fails to restrict emissions below major source thresholds.

---

[21] RTC at pp. 3; 23; 25-26.

[22] Guidance available at https://www2.deq.idaho.gov/admin/LEIA/api/document/download/5521.

Based on the above information, IDEQ did not follow DEQ Guidance, did not support the use of the chosen emission factor, and was arbitrary when choosing emission factors for the ore processing emission units. Accordingly, the PTC does not restrict the Facility's PTE below major source thresholds as a legal and practical matter.

b. Underestimation of Emissions from Lime Plant Emission Units

EPA previously commented that IDEQ's emission estimates for the lime production emission units are not technically accurate because they do not appear to be based on emission factors that are representative of the emission sources. For example, EPA commented that AP-42 Section 11.17 Lime Manufacturing emission factors applies to the processing of lime derived from marble. However, IDEQ used AP-42 emissions factors from Section 11.19.2 Crushed Stone Processing. In addition, the limestone excavating emission estimates (Material Load & Unload) appear to use emission factors from Section 11.19.2 Crushed Stone Processing instead of Section 11.9 Western Surface Coal Mining emission factors that are representative and specific to mining excavation activities. The permitting record does not explain why emission factors from AP-42 Section 11.19.2 were selected over those from Sections 11.17 and 11.9. If IDEQ does not have a good technical reason for their selection of emission factors, the most conservative emission factor should be used for emission units.[23]

IDEQ responded to EPA and other commenters that: "As described previously in the Representativeness and Uncertainty of Emissions section, although some degree of uncertainty is present in all emission factors used in estimating emissions, all emission factors were adequately supported and the approach of estimating potential to emit (PTE) at design capacity was considered a conservative approach. Emission factors with control efficiencies built into them were adequately supported by that corresponding control device listed in the permit. Representative emission factors from EPA's AP-42 Section 11.17, 11.19.2 and 11.9 were used to estimate emissions from the lime plant, lime plant support equipment, and marble overburden mining, respectively. The facility's emission inventory includes crushers, screens, and conveyors controlled by water sprays. EPA's AP-42 11.19.2 (08/2004) provides representative emission factors for these specific processes and controls."[24]

Consistent with the evaluation in Section 1.a., above, DEQ failed to apply appropriate emission factors to the lime plant emission units, did not follow IDEQ guidance specific to emission factor use in permits and failed to create an enforceable restriction on the lime plant's potential to emit below major source thresholds (e.g., 100 tons PM per year).

IDEQ's selection of emissions factors for the lime plant and basis therefor suffer from the same deficiencies as the ore processing units evaluated in Section 1.a., above. IDEQ relied upon sections of AP-42 that are not specific to the process units being permitted. For instance, IDEQ relied upon non-metallic mineral processing emission estimates in EPA's AP-42 Section 11.19 instead of evaluating EPA's emission factors for lime manufacturing, Section 11.17. A single example of how important it is to accurately estimate emissions is illustrated by a process unit in

[23] March 16, 2022, EPA Comment 11.
[24] RTC at pp. 27-28.

the Lime Plant, LS3/LS4 (primary Screen/Secondary Crusher). If the emission factor for secondary crushers (0.62 lb/ton) in Section 11.17 is applied to those production units, potential emissions would exceed 100 tons PM per year from those units alone. The same result applies to emission unit LS5 (secondary screen), resulting in an additional 128 tons PM per year. These two simple examples highlight the importance of accurately estimating future emissions from the proposed SGP.

Based on the above and corresponding issues highlighted in Section 1.a., IDEQ did not follow IDEQ Guidance, did not support the use of the chosen emission factor and was arbitrary when choosing emission factors for the lime processing emission units, and did not restrict the lime plant's PTE below major source thresholds.

c. Lack of Emission Limits

IDEQ's permit imposes only production limits for the ore processing units while relying on the unrepresentative emission factors that significantly underestimate emissions. While use of production limits alone to limit PTE may be acceptable in certain circumstances, such as when the limits are derived from conservative emission factors, this is not the case here.

In addition to inadequate production limits derived from unrepresentative emission factors, the Final Permit lacks emissions limits for several emission units, including the ore crushers, screens, and conveyors. This further undermines the enforceability of the synthetic minor limits. EPA advised IDEQ of this problem in its March 19, 2021, letter (Comments 1-4). Despite these comments, the Final Permit does not contain either source-wide emission limits applicable to all emission units or unit-specific limits on the mining and ore processing emission units.[25] As a result, enforcement of the synthetic minor limits is constrained to the inaccurate production limits with no corresponding limitation on the emissions from those units. As discussed above, IDEQ used emission factors that significantly underestimate the emissions from the ore processing units as well as the lime plant units. Based on the analysis above, DEQ's permit does not restrict the SGP's PM PTE to below PSD or Title V major source thresholds as a legal and practical matter.

d. Lack of Sufficient Monitoring, Recordkeeping and Reporting

EPA previously commented that the Draft Permit lacked sufficient monitoring, recordkeeping and reporting (MRR) to ensure the production and emission limits are enforceable as a practical matter.[26] EPA commented that the Final Permit did not include core monitoring, recordkeeping, and reporting (MRR) requirements directly, but rather allowed the permittee to develop these MRR requirements post permit issuance in an Operations and Maintenance Manual (O&M Manual). EPA, as well as many other commenters, raised procedural and substantive concerns with IDEQ's approach to incorporating MRR requirements into the permit. Procedurally, EPA commented that the O&M Manual ought to be developed and available for public comment prior to permit issuance and that any changes to the O&M Manual ought to be reviewed and approved

[25] Includes Drilling Activities, Blasting Activities, Excavating and hauling activities, Rock dumps and hauling activities, Prill Silos #1-2, OC1 through OC13.
[26] March 16, 2022 EPA Comments 6, 7, 12, 13, 22-25

by IDEQ prior to the change. Substantively, EPA commented that the permit condition specifying the minimum requirements for the O&M Manual lacked the necessary specificity to ensure the permit include adequate MRR.

IDEQ's RTC included some responses to EPA's comments. IDEQ revised PTC Condition 2.20 from draft to final to require that the O&M manual be developed 30 days prior to startup of any process equipment. Condition 2.20 also states: "The requirements in the O&M manual shall be incorporated by reference to this permit and shall be enforceable permit conditions." In addition, PTC Condition 2.21 requires: "The O&M manual shall be submitted for approval to DEQ 30 days prior to startup of any ore processing, ore concentration and refining, lime production, or aggregate production emission source regulated by this permit (as identified in Table 1.1) at the address provided (Permit Condition 2.26), and shall remain onsite at all times. Any changes to the O&M manual shall be submitted to DEQ for review, comment, and approval 30 days prior to the change."[27]

These conditions in the Final PTC and Idaho's RTC do not fully address EPA's concerns regarding the development and approval of the O&M Manual. IDEQ did not require the applicant to develop and submit the O&M Manual as part of its application. Accordingly, the O&M Manual will not be subject to public review and comment, even though the Manual will establish enforceable conditions in the permit. In addition, Conditions 2.20 and 2.21 do not mandate IDEQ *approval* prior to startup or a change to the O&M Manual, only that the Permittee submit the O&M Manual to IDEQ for approval. Finally, Condition 2.20 specifies that the O&M Manual shall be incorporated by reference into the permit. However, this condition does not make clear whether only the approved O&M Manual is incorporated by reference or any version of the O&M Manual submitted by the permittee. Moreover, given that the O&M Manual establishes permit conditions that bear on emission and compliance, revisions to the O&M Manual constitute permit revisions that ought to be subject to public review and comment.[28]

Condition 2.20 contains the minimum content requirements for the O&M Manual. In response to commenters questioning the sufficiency of these minimum requirements, IDEQ reasserted that Condition 2.20 contains the minimum requirements for the O&M Manual and that Condition 2.20 requires the permittee to describe various methods, procedures, and schedules to monitor emission units and control equipment.[29] Neither the Final Permit nor IDEQ's RTC adequately address EPA's concerns.

At the outset, these minimum requirements are vague and may not compel specific, enforceable conditions in the ultimate O&M Manual. For many critical monitoring and operational requirements, Condition 2.20 merely requires the permittee to "describe" the procedures and/or schedule. In addition, the requirement to "Describe the schedule and procedures for routine inspection (Permit Condition 2.10), maintenance, repair, and replacement of control equipment" does not specify any particular method (e.g. EPA Test Methods 9, 22) for visual observation of opacity or fugitive emissions. Accordingly, this vague condition will not lead to sufficient MRR in the O&M Manual.

---

[27] RTC at p. 15.
[28] *See* IDAPA 50.01.01.209.04.
[29] RTC at pp. 13-18; 20 (Comments 6, 7, 8, 11, 12, and 15).

In addition to these overarching concerns with Condition 2.20, numerous permit conditions reference the O&M Manual to satisfy MRR requirements. However, as illustrated in Table 1, below, Condition 2.20 does not mandate specific MRR for all of these corresponding production or emission limits.[30]

Table 1: Evaluation of O&M Manual Requirements

Conditions	O&M Manual Requirements	Evaluation
Conditions 3.11-3.12: • The permittee shall install and operate dust collection systems with a minimum control efficiency of 90% on all drilling rigs in accordance with the O&M manual. • The permittee shall install, operate, and maintain water sprays in accordance with the O&M manual (Permit Condition 2.20) to control PM emissions from each ore processing crusher and conveyor.	Condition 2.20 does not contain any specific minimum requirements for water sprays.	The MRR for drill rigs and rock crushing equipment is inadequate. The O&M manual contains no provisions regarding water sprays. While Condition 2.20 does require incorporation of certain manufacturer's guarantees, this requirement is specific to certain control devices: wet scrubber, vent gas cleaning tower, venturi scrubber, carbon filter, baghouse and bin vent filter cartridge control device.
Conditions 3.16-3.20: • The devices and methodologies used to measure weights shall be identified in the O&M Manual.	Condition 2.20 requires the O&M Manual to "Describe each monitoring device and methodology used to measure weight rates of materials to demonstrate compliance with each material throughput limit (Permit Conditions 3.5–3.9, 4.8–4.11, and 5.4–5.8). Procedures for proper installation, calibration, and maintenance shall be included."	This condition lacks specificity with respect to the scale used to determine the weights of materials, particularly daily ore loading conditions in 3.16-3.20. In order for these daily limits to be practically enforceable, the permit must contain monitoring, recordkeeping and reporting of total daily weights of ore. This necessitates use of an accurate scale. Condition 2.20

[30] Conditions 3.11-3.12; 3.16-3.20; 4.13-4.17; Table 4.2, Footnote C; 4.21-4.23; 4.29-4.32; 5.11-5.16; 5.17-5.26.

		does not mandate the use of any particular scale, or that the permittee maintain the scale within a certain percent accuracy. Without these minimum conditions in Condition 2.20, IDEQ has limited grounds to disapprove an O&M Manual that allows for inappropriate or inaccurate scales. See the regulation at 40 CFR 63.11646(a)(8)-(10) for detailed requirements for the measuring and recording of weights. Neither Condition 2.20 nor Conditions 3.16-3.20 contain required calculations for summing daily weights to demonstrate continuous compliance. In its response to comments, IDEQ stated that the permittee will use a weighometer to measure weights.[31] While this may be true, no condition in the permit requires the use of a weighometer.
Conditions 4.13-4.17 • The permittee shall install, operate, and maintain venturi scrubber (VS1), vent gas cleaning tower (ST1), vent gas steam condensation tower (CT1), and carbon filter (CA5) systems in accordance with the O&M manual (Permit	Describe the schedule and procedures for routine inspection (Permit Condition 2.10), maintenance, repair, and replacement of control equipment. • See-no-see visible emissions inspection of each wet scrubber, carbon filter, baghouse, and bin vent shall be	No conditions specify any specific methods for see-no-see inspections, e.g. Method 22 observations. Without referencing the method, the compliance determination is subjective and likely unenforceable.

[31] RTC at p. 15.

Condition 2.20) and consistent with manufacturer's recommendations. • The permittee shall install, operate, and maintain a carbon filter (CA2) in accordance with the O&M manual (Permit Condition 2.20) and consistent with manufacturer's recommendations.	conducted at least once per day. • Describe the schedule and procedures for corrective action that will be taken if visible emissions are present from wet scrubber (WS2, WS3), carbon filter (CA1, CA2, CA3, CA4, CA5), baghouse (BH2, BH3, BH4, BH5), or bin vent filter (LS, LS1, MillS2, ACS1, ACS2, ACS3, ACS4, CS1, CS2) control equipment at any time. Procedures should include how to determine whether filter cartridges are ruptured or are not appropriately secured in place, and how to determine whether the wet scrubber, condenser, and carbon filters are operating properly.	
Table 4.2 Footnote C Pounds per hour, as determined by a test method prescribed by IDAPA 58.01.01.157, EPA reference test method, continuous emission monitoring system (CEMS) data, or DEQ-approved alternative. Condition 4.8 The permittee shall process ore concentrate as the raw	Describe each monitoring device and methodology used to measure weight rates of materials to demonstrate compliance with each material throughput limit (Permit Conditions 3.5–3.9, 4.8–4.11, and 5.4–5.8). Procedures for proper installation, calibration, and maintenance shall be included. Establish operating ranges for control equipment, based on	Condition 2.20 does not contain MRR requirements specific to Venturi Scrubber (VS1) Vent Gas Cleaning Tower (ST1) or Vent Gas Steam Condensation Tower (CT1) used to control emissions from the Autoclave. Condition 2.20 contains a requirement to describe the schedule for taking corrective action if visible emissions are

material in the autoclave, and the maximum input to the autoclave shall not exceed 6,960 T/day. Condition 4.13 The permittee shall install, operate, and maintain venturi scrubber (VS1), vent gas cleaning tower (ST1), vent gas steam condensation tower (CT1), and carbon filter (CA5) systems in accordance with the O&M manual (Permit Condition 2.20) and consistent with manufacturer's recommendations. Conditions 4.21-4.23 • The devices and methodologies used to measure weights shall be identified in the O&M Manual, and the devices shall be installed in accordance with the requirements of NESHAP Subpart EEEEEEE. • The devices and methodologies used to measure weights shall be identified in the O&M Manual. • At least once per shift, the permittee shall monitor and record the circulation flow rate in the venturi scrubber, the circulation flow rate in the vent gas cleaning tower, the	manufacturer specifications and conditions measured during performance testing. • Minimum pressure drop across each wet scrubber, vent gas cleaning tower, and venturi scrubber; • Minimum circulation flow rate for each wet scrubber, vent gas cleaning tower, venturi scrubber; • Maximum inlet gas stream temperature to each carbon filter; • Maximum pressure drop across each carbon filter; • Minimum pressure drop across each baghouse. Describe the schedule and procedures for corrective action that will be taken if visible emissions are present from wet scrubber (WS2, WS3), carbon filter (CA1, CA2, CA3, CA4, CA5), baghouse (BH2, BH3, BH4, BH5), or bin vent filter (LS, LS1, MillS2, ACS1, ACS2, ACS3, ACS4, CS1, CS2) control equipment at any time. Procedures should include how to determine whether filter cartridges are ruptured or are not appropriately secured in place, and how to determine whether the wet scrubber, condenser, and carbon filters are operating properly.	present, but does not mandate any specific corrective actions. NESHAP Subpart EEEEEE contains detailed MRR requirements at 40 CFR 63.11646(a)(8)-(10), including maintenance and calibration requirements. However, Condition 4.21 does not require maintenance or calibration in accordance with NESHAP Subpart EEEEEEE, only installation in accordance with NESHAP Subpart EEEEEEE.

pressure drop across the venturi scrubber, and the pressure drop across the vent gas cleaning tower to ensure compliance with O&M specifications.		
Conditions 5.11-5.16 • The permittee shall install, operate, and maintain water sprays in accordance with the O&M manual (Permit Condition 2.20) to control PM emissions from each portable crushing and screening plant. Water sprays shall operate at all times, except as specified in the O&M manual during winter conditions, when this equipment is operated to ensure compliance with Fugitive Dust requirements (Permit Conditions 2.1–2.6). • The permittee shall install, operate, and maintain a baghouse system (BH4) in accordance with the O&M manual (Permit Condition 2.20) and consistent with manufacturer's recommendations. All emissions from the parallel flow regenerative kiln shall be ducted to the baghouse at all times	Establish operating ranges for control equipment, based on manufacturer specifications and conditions measured during performance testing. Describe the schedule and procedures for routine inspection (Permit Condition 2.10), maintenance, repair, and replacement of control equipment. The replacement dates for each baghouse and bin vent filter cartridge and for each activated carbon filter medium shall be recorded at the time of each replacement. For cartridges, records shall include the manufacturer and model. For carbon filters, records shall include the manufacturer, type, and form of medium added. Records shall also include any changes in supplier and other relevant information Describe the schedule and procedures for corrective action that will be taken if visible emissions are present from wet scrubber (WS2, WS3), carbon filter (CA1,	Condition 2.20 does not contain any specific minimum requirements for water sprays. Thus, the permit lacks sufficient MRR for these conditions.

to ensure compliance with parallel flow regenerative emission limits.	CA2, CA3, CA4, CA5), baghouse (BH2, BH3, BH4, BH5), or bin vent filter (LS, LS1, MillS2, ACS1, ACS2, ACS3, ACS4, CS1, CS2) control equipment at any time. Procedures should include how to determine whether filter cartridges are ruptured or are not appropriately secured in place, and how to determine whether the wet scrubber, condenser, and carbon filters are operating properly.	
Condition 5.3 Emissions from the lime production plant stacks shall not exceed any emission rate limit in the following table . . .	None	The permit does not contain any requirements to calculate emissions to demonstrate ongoing compliance with these emission limits. The permit does not contain any formulas, data reduction methods, or periodic calculation requirements to demonstrate continuous compliance with these emission limits.
Conditions 5.17-5.26 • The devices and methodologies used to measure weights shall be identified in the O&M Manual.	Describe each monitoring device and methodology used to measure weight rates of materials to demonstrate compliance with each material throughput limit (Permit Conditions 3.5–3.9, 4.8–4.11, and 5.4–5.8). Procedures for proper installation, calibration, and maintenance shall be included.	Same evaluation as Conditions 3.16-3.20.

In addition, the Permit does not require testing for the ore processing or lime production emission units to confirm the accuracy of emission factors. As discussed above, IDEQ used inaccurate emission factors to derive production limits for ore processing and lime production emission units. In its RTC, IDEQ acknowledges the uncertainty present in emission factors. However, IDEQ did not require initial or routine testing to confirm the accuracy of the emissions

factors used to establish production and emission limits. Given the low quality of the emissions factors used, such testing is critical to ensuring the adequacy of the synthetic minor limits. However, the Final Permit does not require any testing.

Given the absence of sufficient MRR requirements for the corresponding production limits, emission limits, and control equipment requirements, many of the synthetic minor emission limits are not enforceable as a practical matter.

2. The SGP, as permitted, will cause or contribute to a violation of the PM_{10} NAAQS.

a. Unsubstantiated estimates of fugitive dust control

EPA, as well as several other commenters, questioned the basis for IDEQ's determination that PRI could achieve a 93.3% control efficiency to control fugitive dust from haul roads at the SGP. Specifically, EPA commented that IDEQ did not provide a reasoned analysis demonstrating that the studies showing that 90% control efficiency is achievable using magnesium chloride reflect conditions at the SGP. EPA also commented that IDEQ did not include specific details necessary to support such a demonstration in the permitting record.[32]

In its RTC, IDEQ responded stating that 93.3% is an aggressive level of control and that PRI has committed to undertaking all measures to achieve this level of control. IDEQ further stated that, based on a review of test studies, the 93.3% level of control can be achieved using water and magnesium chloride dust suppressants (citing PRI's application). IDEQ explained that chemical and water dust suppressants are used in combination for the control of dust from haul roads, and that achieving the target combined control efficiency of 93.3% is ultimately important to ensure compliance with applicable standards. According to IDEQ, it is for this reason that the combined control efficiency was listed in the permit in lieu of separate chemical (90% control) and water (33.3%) dust suppressant control efficiencies.[33]

IDEQ's responses do not adequately address EPA's comments. IDEQ did not proffer further evidence that conditions at the SGP are comparable to areas where studies indicating a 90% control efficiency on fugitive dust is achievable. Even so, these studies do not support IDEQ's contention that a control efficiency of *93.3%* is achievable. Ultimately, IDEQ appears to have back-calculated the control efficiency necessary to demonstrate NAAQS compliance, rather than determine a control efficiency that is achievable in practice.[34]

b. Underestimation of Fugitive Dust Emissions

With respect to demonstrating NAAQS compliance, EPA commented that IDEQ's use of a median silt content of 4.0% underestimates fugitive dust emissions from haul roads. EPA commented that the arithmetic average silt content for haul roads based on Perpetua's site-specific data is 4.3%. Use of the 4.3% average value results in about 7% more fugitive dust emissions from the haul roads than estimated using the median value. IDEQ's modeling

[32] March 16, 2022, EPA Comment 19.
[33] RTC at p. 3.
[34] SOB at p. 59; 65-66 (Table 28).

sensitivity study showed values just below the NAAQS, such that an 7% increase in fugitive dust from haul roads would have resulted in 24-hour PM_{10} NAAQS violations.[35]

In response, IDEQ stated the use of site-specific median values for silt content is commonly accepted by DEQ, and the values used in calculations were supported by PRI.[36] This response does not adequately justify why a median value rather than the arithmetic average is more appropriate taking into consideration the site-specific sampling. Given that a small difference in the silt content will result in an exceedance of the NAAQS, IDEQ's insistence on using a median silt content appears arbitrary and unreasonable and indicates that PRI has not demonstrated that the emissions will not cause or contribute toa NAAQS violation. On the contrary, operation of the SGP will likely cause or contribute to a violation of the PM_{10} NAAQS.

c. Lack of Conditions to Ensure Continuous Compliance with PM_{10} NAAQS

EPA, along with several other commenters, commented that the permit lacks conditions sufficient to ensure continuous compliance with the PM_{10} NAAQS. Specifically, EPA raised concerns with the adequacy and practical enforceability of the Fugitive Dust Control Plan (FDCP). Specifically, EPA raised concerns that the permit did not contain specific conditions necessary to ensure continuous compliance with the 93.3% control efficiency, but rather allowed the permittee to develop these conditions as part of an FDCP after permit issuance and allowed the permittee to change the FDCP without IDEQ approval. EPA also commented that the permit lacks conditions necessary to make the 93.3% control efficiency practically enforceable, such as frequency of dust suppression, requirements for when to use chemical dust suppression, amount of dust suppression that must be applied, vehicle weight, vehicle speed, vehicle daily miles traveled, and road silt content.[37] With respect to Condition 2.5 requiring PRI to apply fugitive dust control measures such that visible emissions are below 10% opacity, EPA also commented that permitting record does not support a correlation of the 10% opacity requirement in Condition 2.5 with a 93.3% control efficiency.[38]

In response to these comments, IDEQ updated permit condition 2.8 to require IDEQ approval of the FDCP 30 days prior to startup and after any subsequent changes. IDEQ also responded that the permit contains activity rate limits that serve as surrogate limits for fugitive sources. IDEQ also stated that it typically does not include vehicle speed, type, and miles traveled in permits. IDEQ also asserted that Conditions 2.1-2.6 contain the minimum requirements for the contents of the fugitive dust plan.[39] Finally, IDEQ responded that "An instantaneous 10% opacity limit for vehicle traffic on haul roads is considered a very conservative control trigger level to ensure that an appropriate control measure is taken to reasonably control emissions of fugitive dust (Permit condition 2.5)."[40]

---

[35] March 16, 2022 EPA Comment 20.
[36] RTC at p. 4.
[37] March 16, 2022, EPA Comments 16 – 19
[38] *Id.* at Comment 19.
[39] RTC at p. 9.
[40] *Id.*

These responses do not fully address EPA's comments with respect to the practical enforceability of emission limits necessary for NAAQS compliance. Condition 2.8 does not require that IDEQ approve the FDCP prior to startup, only that the permittee submit the FDCP 30 days prior to startup. Similarly, Condition 2.8 does not clearly require IDEQ approval of FDCP changes prior to the permittee making the changes.

Conditions 2.1 through 2.6 are insufficient to ensure the permittee achieves 93.3% fugitive dust control efficiency on haul roads. First, the permitting record indicates that application of magnesium chloride is necessary to achieve up to 90% control of fugitive dust. However, Conditions 2.1 through 2.6 do not require the permittee to use magnesium chloride for dust suppression. Rather, Condition 2.6 merely requires that the FDCP contain reasonable precautions including: "apply water or suitable dust suppressant (e.g. magnesium chloride, calcium chloride) to disturbed areas, haul roads, equipment staging areas, parking areas, and storage piles during the dry season and at other times as necessary to control fugitive dust." Moreover, magnesium chloride degrades over time. However, the permit does not require the permittee to reapply magnesium chloride at regular intervals.

Similarly, IDEQ assumed a combined control efficiency of water and chemical dust suppression to achieve 93.3%. However, Conditions 2.1 through 2.6 contain no explicit requirements that the permittee use both water and chemical dust suppression in a manner necessary to achieve the 93.3% control efficiency. Magnesium chloride does not perform as a dust suppressant in dry conditions. Therefore, supplemental watering will be necessary. However, the permit does not require supplemental watering to ensure the magnesium chloride performs as a dust suppressant.

With respect to vehicle weight and vehicle miles traveled, compliance with the NAAQS is dependent on vehicle miles traveled staying at or below 7,758 per day.[41] However, the permit contains no such limit. IDEQ also did not make clear how the activity limits, including Condition 2.4 (Blasting Limits) and Condition 3.5 (Daily Hauling and Excavating Limits), would necessarily restrict vehicle miles traveled to at or below 7,758 per day. There are no requirements or restrictions on the manner the permittee uses the haul roads.

Regarding the silt content, the permit does not contain conditions to ensure the silt content on haul roads remains at or below 4%. Condition 3.13 contains the minimum requirements for the Haul Road Capping Plan (HRCP). According to IDEQ, Condition 3.13 limits maximum silt content to 4.0%. This is not accurate. Condition 3.13 states that "The permittee shall use capping material with a maximum of 4.0% silt content." This condition does not require the permittee to maintain the haul road silt content to at or below 4.0%. Nor does the requirement account for mixing of the capping material with the base or wearing of the cap over time. Condition 3.13 also contain no explicit sampling or compliance demonstration methods. Rather, Condition 3.13 allows the permittee to develop a "silt content sampling plan including standard operational procedure for sampling, frequency of sampling, and ASTM (or equivalent) method of analysis for silt content."

Finally, IDEQ's response to EPA's comment on the basis for the 10% opacity limit in Condition 2.5 does not provide additional basis for a correlation between opacity and the 93.3% control.

[41] SOB at Appendix B, p. 65

The permit contains no testing requirements to establish a correlation between fugitive dust control and opacity. Nor does the permit contain any specific method for determining opacity or the frequency or location of opacity observations.

3. Neither the permit record nor permit conditions demonstrate that the entirety of the SGP ought to be excluded from the scope of "ambient air."

"Ambient air" is defined as that portion of the atmosphere, external to buildings, to which the general public has access."[42] General public includes "any person(s) other than those who are permitted access to the property as employees or business invitees of a specific stationary source (including trespassers)."[43] EPA interprets access to encompass two key concerns: legal access and physical or practical access.[44] Legal access concerns whether the general public has the right or permission to enter a specific property. Physical access addresses whether the general public is able to, under actual circumstances, enter a particular parcel of land. In order to preclude physical access to a parcel of land, the source must employ measures, which may include physical barriers, that are effective in precluding access to the land by the general public.[45] Such measures can include video surveillance, monitoring, clear signage, and routine security patrols.[46] Measures can be effective even if there is not 100 percent certainty that they will prevent public access.[47] Measures must be reasonable taking into consideration the nature of the measure used, source location, type and size of source and property to be excluded, and surrounding area.[48]

a. Legal Right to Exclude General Public

As stated above, legal access concerns whether the general public has the right or permission to enter a specific property. IDEQ asserts in the SOB and RTC that PRI has "complete and sole authority to control access to or through the facility, granting access at their discretion to anyone wishing to visit the site or pass through the site."[49] Neither the SOB nor the RTC, however, evaluate PRI's claims. In light of the fact that the SGP encompasses the East Fork South Fork Salmon River and is located within National Forest lands, the permitting record ought to contain a more thorough evaluation of PRI's legal authority and members of the general public's right of access to the SGP area of operations.

b. Measures to Exclude General Public as a Practical Matter

EPA commented that the permit lacks conditions to ensure PRI employs sufficient measures such that the entirety of the SGP is appropriately excluded from the definition of ambient air. Specifically, EPA raised concerns that the general public may be able to access the SGP,

---

[42] IDAPA 58.01.01.006.10; 40 CFR 50.1(e).
[43] "Revised Policy on Exclusions from 'Ambient Air'" Memorandum from Andrew R. Wheeler to Regional Administrators, December 2, 2019, at p. 6.
[44] *Id.* at 5.
[45] *Id.* at 9.
[46] *Id.* at 7.
[47] *Id.* at 8.
[48] *Id.*
[49] RTC at p. 21.

regardless of their legal right to do so.[50] The basis for EPA's comment was that the permit does not contain specific measures the permittee will take to exclude members of the public from the SGP. Rather, the permit allows the permittee to develop an Access Management Plan ostensibly designed to exclude members of the public. In response, IDEQ asserted that Condition 2.7 contains the requirements for the ACP, including adequately informing anyone approaching an access point that travel beyond the established gate involves entering an active mine site as a guest of the permittee and providing verbal and written requirements that must be followed while on the SGP site.[51] The SOB also states that the primary and secondary access points are controlled by adjacent natural features, such as streams and creeks, steep topography, and areas of thick vegetation and undergrowth.[52] In addition, the SOB states that PRI will place boulders across trails and adjacent to the train to prevent vehicle access.[53] Finally, according to the SOB, PRI security personnel will routinely patrol mine facilities and roadways for unauthorized individuals.[54]

IDEQ's responses and statements in the SOB do not adequately address EPA's concerns. As permitted, the general public will likely have physical or practical access to portions of the SGP. The SGP operations area boundary covers 2,372 acres of land within the Payette and Boise National Forests. The SGP is located in Valley County, Idaho. The nearest settlement is the village of Yellow Pine, Idaho, approximately 14 miles by road.[55] The Payette National Forest includes the Frank Church River of No Return Wilderness. The Salmon River runs through the Payette National Forest. The SGP is surrounded by numerous recreation areas in the Payette and Boise National Forests.[56] National Forest roads 374, 440, and 640 provide vehicle access to the site.[57]

Given the scale of the SGP, proximity to recreation opportunities, and multiple access points, the permittee should employ multiple measures to preclude public access. However, condition 2.7 is vague and leaves the permittee considerable latitude on the methods used to exclude members of the general public. While the SOB indicates that placement of boulders on secondary roadways is necessary to prevent access, Condition 2.7 contains no such requirement. Also, Condition 2.7 does not specify a minimum patrol frequency or minimum signage requirements. Nor does Condition 2.7 require the permittee to post or monitor the vast operations boundary to effectively preclude recreators from entering the site. Condition 2.7 only requires the permittee to employ measures to "discourage" access to secondary roadways and trails. This does not meet the standard to effectively exclude members of the general public. Similarly, EPA questions whether the entire boundary surrounding the operations area incorporates natural features that preclude access. Given the numerous recreational opportunities in the surrounding wilderness areas, access by recreators off trail appears possible. Therefore, the Final PTC does not ensure that the

---

[50] March 16, 2022, EPA Comments 26-27
[51] RTC pp. 20-21; 42
[52] SOB at p. 55.
[53] *Id.*
[54] *Id.*
[55] Stibnite Gold Project Supplemental Draft EIS, Forest Service, p. 1-7.
[56] See Payette National Forest - Thunder Mt./Monumental Area, Krassel RD (usda.gov); Payette National Forest - Monumental Trailhead (usda.gov); Payette National Forest - Lookout Mt Trailhead (usda.gov); Boise National Forest - Meadow Creek / Summit Trailhead (usda.gov).
[57] SOB at p. 6.

entirety of the SGP is appropriately excluded from the definition of ambient air. This implicates IDEQ's determination that the SGP will not cause or contribute to a violation of the PM_{10} NAAQS.

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	Agency Case No. 0101-22-01
	OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	**PETITIONERS' MOTION TO SUPPLEMENT WITH AUGUST 10, 2023 EPA LETTER AND BRIEF IN SUPPORT**

MOTION TO SUPPLEMENT

Petitioners Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon ("Petitioners") hereby move to supplement the evidence in this case with the August 10, 2023 letter from EPA Regional Administrator Casey Sixkiller to Idaho Department of Environmental Quality ("DEQ") Director Jess Byrne (the "EPA Letter"), which as attached as Exhibit A.[1] The EPA Letter raises multiple concerns the EPA has with the Permit to Construct for the Stibnite Gold Project (the "PTC"). EPA's concerns, and the information EPA provides to back up its concerns, support many of Petitioners' claims and should be considered in this contested case.

BRIEF IN SUPPORT

As set forth below, the applicable rules favor admitting relevant evidence to develop the agency record in a contested case like this one; the EPA Letter supports Petitioners' summary judgment arguments and is thus relevant to the pending cross motions for summary judgment; and granting this motion to supplement is not prejudicial.

ARGUMENT

I. The Rules Favor the Inclusion of Relevant Evidence in a Contested Case

Under the Board of Environmental Quality's Contested Case Rules (IDAPA 58.01.23), a contested case like this one allows for factual development, including through discovery and evidentiary hearings.[2] Even after the Hearing Office makes a decision and issues a recommended

[1] The EPA Letter is the subject of DEQ's and Perpetua's pending Joint Motion in Limine, filed on August 28, 2023. The Joint Motion in Limine also requests that press reports regarding the EPA Letter be excluded from the evidence in this case. Petitioners do not seek to supplement the evidence with any press reports.

[2] DEQ and Perpetua's Joint Motion in Limine attempts to exclude the EPA Letter because it "was not part of the record upon which review of the Department's action is based." Mot. in Limine at 4. IDAPA 58.01.23 does not, however, limit contested case records solely to those documents in possession of the agency. Furthermore, the January 19, 2023 Scheduling Order in this case

or preliminary order, the Board of Environmental Quality "may hold additional hearings or may remand the matter for further evidentiary hearings if further factual development is necessary before issuing a final order." IDAPA 58.01.23.720.02.b. & 730.03.

The Board's Contested Case Rules incorporate many provisions of the Idaho Rules of Administrative Procedure of the Attorney General ("AG Rules"). IDAPA 58.01.23.003. This includes the AG Rules on evidence at IDAPA 04.11.01.600-606. The AG Rules strongly favor the inclusion of relevant evidence and discourage its exclusion:

> Evidence should be taken by the agency to assist the parties' development of the record, not excluded to frustrate that development. The presiding officer at hearing is not bound by the Idaho Rules of Evidence. No informality in any proceeding or in the manner of taking testimony invalidates any order. The presiding officer, with or without objection, may exclude evidence that is irrelevant, unduly repetitious, inadmissible on constitutional or statutory grounds, or on the basis of any evidentiary privilege provided by statute or recognized in the courts of Idaho. All other evidence may be admitted if it is of a type commonly relied upon by prudent persons in the conduct of their affairs.

IDAPA 04.11.01.600.

In addition, a party may supplement prior responses to a discovery request with additional information. *See* I.R.C.P. 26.[3] The January 19, 2023 Scheduling Order in this case states that "[e]ach Party shall serve upon the other Parties any additional documentary evidence they deem relevant to these proceedings by February 14, 2023." As discussed below, the EPA Letter is relevant to the proceedings, but it was not available at the time documentary evidence was due. Nothing in the Board's Contested Case Rules, the AG Rules, the Idaho Rules of Civil

---

allowed both Perpetua and Petitioners to submit "any additional documentary evidence they deem relevant," demonstrating that the record in this case was never limited to those documents in DEQ's possession at the time it approved the PTC. Petitioners will file a response to the Motion in Limine further addressing this issue subsequent to this Motion to Supplement.

[3] Although the EPA Letter does not create a duty to supplement prior discovery responses under I.R.C.P 26(e), nothing in the Idaho Rules of Civil Procedure prohibits a party from doing so.

Procedure, or order's entered in this case prohibit augmentation of the record with new information relevant to the claims at issue.

II. The EPA Letter Is Relevant

In the EPA Letter, Regional Administrator Sixkiller requested a personal and in-person meeting with DEQ Director Byrne, including with appropriate members of the agency's permit and legal teams, within 30 days, "[g]iven the seriousness of the concerns raised by the EPA and the need to reach a timely resolution." The EPA Letter states:

> The Agency has three primary concerns with the Department's Permit: (1) the Permit's emission limits are not adequate to limit the Stibnite Gold Project's potential to emit below the Prevention of Significant Deterioration permitting threshold; thus, construction of the Stibnite Gold Project would constitute construction of a major stationary source without a Prevention of Significant Deterioration permit, (2) the Permit's emission limits are not adequate to protect the particulate matter National Ambient Air Quality Standard, and (3) the Department's delineation between the Stibnite Gold Project boundary and the ambient air—where the National Ambient Air Quality Standards apply—is not adequately supported. Details of the Agency's evaluation of the final permit are enclosed for your review.

EPA Letter at 1.

Two of these three primary concerns raised by EPA—inadequate limits to comply with particulate NAAQS and inadequate support for setting the ambient air boundary)—are the same as or substantially overlap with the issues Petitioners have raised in this contested case. *See* Pet'rs' Br. in Supp. of Mot. Summ. J ("Pet'rs. MSJ").

The enclosure to the EPA Letter ("Enclosure") includes more detailed and up-to-date information about these issues, including sections on the following issues which largely match issues Petitioners raised in their summary judgment brief related to particulate emissions: "Lack of Sufficient Monitoring, Recordkeeping and Reporting," *compare* Enclosure at 6-14 *with* Pet'rs' MSJ at 26-31; "Unsubstantiated Estimates of Fugitive Dust Controls," *compare* Enclosure at 14

with Pet'rs' MSJ at 19-23; "Lack of Conditions to Ensure Compliance with PM10 NAAQS," *compare* Enclosure at 15-17 *with* Pet'rs' MSJ at 23-28. The enclosure also includes more detailed and up-to-date information about EPA concerns with the ambient air boundary, including sections on the: "Legal Right to Exclude General Public" and "Measures to Exclude General Public as a Practical Matter." *Compare* Enclosure at 17-18 *with* Pet'rs' MSJ at 14-19.

EPA had already raised similar concerns during public comment on the PTC. *See* EPA Comment Letter (PET 663). The current EPA Letter, however, provides additional information and states EPA's position that DEQ's final PTC and response to comments did not resolve EPA's concerns. The EPA Letter is thus relevant and is the type of information a "prudent" person would consider here.

III. Admitting the EPA Letter Is Not Prejudicial

Petitioners' request to add the EPA Letter to the record is timely and does not prejudice DEQ or Perpetua. The EPA Letter was not available during the discovery period of January 19 to February 14, 2023, established by the January 19, 2023 Scheduling Order. Thus, Petitioners could not have submitted the EPA Letter while discovery was open. Furthermore, allowing the EPA Letter into evidence does not prejudice DEQ or Perpetua even though summary judgment briefing has concluded on the claims presented in Petition for Review. Again, the EPA Letter confirms that the concerns EPA already raised in its public comments on the draft PTC, and which Petitioners have already raised in this matter, remain concerns to EPA in the final PTC. Considering the EPA Letter does not expand the issues already briefed, an the Parties can readily address the EPA Letter at the hearing on the motions for summary judgment.

CONCLUSION

For the foregoing reasons, the Hearing Officer should augment the record to include the EPA Letter for consideration of the merits of the case.

Dated this 1st day of September 2023.

Respectfully submitted,

s/ Julia Thrower
Julia S. Thrower
MOUNTAIN TOP LAW PLLC
614 Thompson Avenue
McCall, ID 83638
(208) 271-6503
jthrower@mtntoplaw.com

Attorney for Petitioner Save the South Fork Salmon

s/ Bryan Hurlbutt
Bryan Hurlbutt
ADVOCATES FOR THE WEST
P.O. Box 1612
Boise, ID 83701
(208) 342-7024
bhurlgutt@advocateswest.org
filings@advocateswest.org

Attorney for the Nez Perce Tribe and Idaho Conservation League

CERTIFICATE OF SERVICE

I hereby certify that on September 1, 2023, a true and correct copy of the Petitioners' Motion to Supplement the Record with August 10, 2023 EPA Letter and Brief in Support was served on the following:

Dylan B. Lawrence Varin Thomas, LLC 242 N. 8th St., Suite 220 Boise, ID 83702 (208) 345-6021 dylan@varinthomas.com *Hearing Officer*	Via:	
	Email:	[x]
	Fax:	[ ]
	CM/ECF:	[ ]
	Hand Delivery:	[ ]
	U.S. Mail:	[x]
Paula Wilson paula.wilson@deq.idaho.gov *Hearing Coordinator*	Via:	
	Email:	[x]
	Fax:	[ ]
	CM/ECF:	[ ]
	Hand Delivery:	[ ]
	U.S. Mail:	[ ]
Office of Administrative Hearings P.O. Box 83720 Boise, ID 83720-0104 filings@oah.idaho.gov	Via:	
	Email:	[x]
	Fax:	[ ]
	CM/ECF:	[ ]
	Hand Delivery:	[ ]
	U.S. Mail:	[x]
John Shackelford Office of the Attorney General 1410 N. Hilton, 2nd Floor Boise, ID 83706 (208) 373-0453 john.shackelford@deq.idaho.gov *Attorney for Respondent Idaho Department of Environmental Quality*	Via:	
	Email:	[x]
	Fax:	[ ]
	CM/ECF:	[ ]
	Hand Delivery:	[ ]
	U.S. Mail:	[ ]

Krista McIntyre
W. Christopher Pooser
Wade Foster
Stoel Rives, LLP
101 S. Capital Blvd., Suite 1900
Boise, ID 83702
(208) 389-9000
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
Attorneys for Intervenor Perpetua Resources of Idaho, Inc.

Via:

Email:	[x]
Fax:	[ ]
CM/ECF:	[ ]
Hand Delivery:	[ ]
U.S. Mail:	[ ]

s/ Julia Thrower
Julia Thrower

Exhibit A

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue, Suite 155
Seattle, WA 98101

OFFICE OF THE
REGIONAL
ADMINISTRATOR

August 10 2023

Mr. Jess Byrne
Director
Idaho Department of Environmental Quality
1410 North Hilton Street
Boise, Idaho 83706

Dear Mr. Byrne,

The purpose of this letter is to request an in-person meeting, either in Seattle or Boise, to follow-up on our recent discussion regarding concerns with Idaho Department of Environmental Quality's air quality Permit to Construct issued to Perpetua Resources Idaho, Inc. on June 17, 2022. The Permit authorizes Perpetua Resources Idaho, Inc. to construct a gold, silver and antimony mine, referred to as the Stibnite Gold Project. The Agency previously provided comments on draft permits to the Department raising numerous issues. The Agency has reviewed the final Permit, statement of basis and the Department's response to comments and continues to be concerned that construction and operation of the Stibnite Gold Project under the terms set out in the Department's Permit would not comply with the Clean Air Act. As we discussed, the Agency does not oppose the Stibnite Gold Project, generally. The Agency's interest is ensuring that the Stibnite Gold Project is properly permitted and complies with the Clean Air Act to ensure the protection of human health and the environment.

The Agency has three primary concerns with the Department's Permit: (1) the Permit's emission limits are not adequate to limit the Stibnite Gold Project's potential to emit below the Prevention of Significant Deterioration permitting threshold; thus, construction of the Stibnite Gold Project would constitute construction of a major stationary source without a Prevention of Significant Deterioration permit, (2) the Permit's emission limits are not adequate to protect the particulate matter National Ambient Air Quality Standard, and (3) the Department's delineation between the Stibnite Gold Project boundary and the ambient air—where the National Ambient Air Quality Standards apply—is not adequately supported. Details of the Agency's evaluation of the final permit are enclosed for your review.

The Agency believes that the deficiencies in the Permit outlined in the enclosure and articulated in prior comments can be rectified through issuance of a revised permit to construct with adequate and enforceable conditions that limit the Stibnite Gold Project's potential to emit and ensure compliance with the National Ambient Air Quality Standards. I invite the Department to discuss these concerns with the Agency and collaborate with the Agency on an appropriate path forward.

Given the seriousness of the concerns raised by the EPA and the need to reach a timely resolution, I would like to schedule the meeting in the next 30 days, with your and my personal involvement, along with appropriate members of our permit and legal teams.

If you are supportive of such a meeting, please have your scheduler contact my Executive Assistant, Michelle Fraser, at (206) 553-4629 or fraser.michelle@epa.gov. Thank you for your attention to this matter.

Sincerely,

CASEY SIXKILLER

Digitally signed by CASEY SIXKILLER
Date: 2023.08.10 14:46:37 -07'00'

Casey Sixkiller
Regional Administrator

cc: Ms. Tiffany Floyd
Idaho Department of Environmental Quality

Mr. John Shackelford
Idaho Office of the Attorney General

Chairman Shannon F. Wheeler
Nez Perce Tribe

Enclosure

ENVIRONMENTAL PROTECTION AGENCY
EVALUATION OF AIR QUALITY PERMIT TO CONSTRUCT

Perpetua Resources Idaho, Inc.
Permit Number P-2019-0047
Issued: June 17, 2022

PRIOR ENVIRONMENTAL PROTECTION AGENCY (EPA) COMMENTS ON DRAFT PERMITS

Perpetua Resources Idaho, Inc. (PRI) submitted an application for a permit to construct (PTC) the Stibnite Gold Project (SGP) to Idaho Department of Environmental Quality (IDEQ) on August 20, 2019. Prior to issuance of the final PTC, IDEQ developed and offered for public comment three draft PTCs. EPA submitted two formal comment letters dated March 19, 2021, and March 16, 2022, on two of the prior permit drafts dated February 18, 2021, and January 13, 2022, respectively. In these comments, EPA raised numerous concerns with the adequacy of the draft PTCs to limit the SGP's potential to emit (PTE) to below major stationary source levels and to ensure the SGP does not cause or contribute to a violation of the National Ambient Air Quality Standards (NAAQS). IDEQ issued the Final Permit, Statement of Basis (SOB), and Response to Comments (RTC) on June 17, 2022.

STATUTORY AND REGULATORY REQUIREMENTS

Major stationary sources in Idaho are required to obtain a prevention of significant deterioration permit (PSD) prior to commencing construction.[1] Similarly, major stationary sources in Idaho must obtain a Tier I operating permit.[2] For purposes of the PSD permitting requirement, a source meets the definition of major stationary source if it has a PTE of 250 tons per year or more of a regulated NSR pollutant or 100 tons per year or more of a regulated air pollutant if the source is of the type specifically listed in the regulations (e.g., lime plants).[3] For the purposes of the requirement to obtain a Tier I operating permit, a source meets the definition of major stationary source if the source has a PTE of 100 tons per year or more of any regulated air pollutant, 10 tons per year or more of any hazardous air pollutant (HAP), or 25 tons per year of any combination of HAPs.[4] Particulate matter and particulate matter with an aerodynamic diameter of less than or equal to 10 micrometers are regulated air pollutants.[5]

A state-issued permit condition can legally restrict a source's PTE if it meets two criteria: 1) the condition is legally enforceable by the state air pollution control agency; and 2) it is enforceable as a practical matter.[6]

---

[1] IDAPA 58.01.01.205; 40 CFR 52.670(c).
[2] In Idaho, major sources under Title V of the CAA and 40 CFR part 70 are referred to as Tier I Sources. IDAPA 58.01.01.300-397.
[3] IDAPA 58.01.01.201 and 205.01 and 40 CFR 52.21(b); 40 CFR 52.670(c).
[4] IDAPA 58.01.01.006; 58.01.01.008; 58.01.01.107; 40 CFR 70.2.
[5] IDAPA 58.01.01.006; 40 CFR 52.670(c).
[6] Terrell E. Hunt and John S. Seitz, "Limiting Potential to Emit in New Source Permitting" (June 13, 1989) ("Hunt Memo") at 2; John Seitz and Robert Van Heuvelen, "Release of Interim Policy on Federal Enforceability of Limitations on Potential to Emit" (Jan. 22, 1996) at 3.

In general, practical enforceability for a source-specific permit term means that the provision must specify: (1) a technically accurate limitation and the portions of the source subject to the limitation; (2) the time period for the limitation (hourly, daily, monthly, annually); and (3) the method to determine compliance including appropriate monitoring, record keeping and reporting.[7]

Emission factors used to derive a PTE limit must be technically accurate.[8] In general, emissions factors published in EPA's *AP-42 Compilation of Air Pollutant Emission Factors* (AP-42) are based on averages and are not intended for establishing source-specific limits.[9] EPA recommends using emissions factors in AP-42 only when source specific emissions factors are not available and selecting conservatively higher emissions factors.[10] EPA assigns each emissions factor in AP-42 a rating from A to E, with A being the best.[11] According to AP-42, "Factors based on many observations, or on more widely accepted test procedures, are assigned higher rankings. Conversely, a factor based on a single observation of questionable quality, or one extrapolated from another factor from a similar process, would probably be rated much lower."[12]

Emission factors also include numerous operating assumptions and variables regarding the source.[13] Accordingly, the permit should contain conditions to ensure the operating assumptions and variables underlying the emission factor accurately reflect site-specific conditions and are enforceable.[14]

When permits require add-on controls operated at a specified efficiency level, permit writers should include, so that the operating efficiency condition is enforceable as a practical matter, those operating parameters and assumptions which the permitting agency depended upon to determine that the control equipment would have a given efficiency.[15]

---

[7] John S. Seitz, "Options for Limiting the Potential to Emit (PTE) of a Stationary Source Under Section 112 and Title V of the Clean Air Act" (Jan. 25, 1995) ("Seitz Memo") at 5-6; Kathie Stein, "Guidance on Enforceability Requirements for Limiting Potential to Emit through SIP and § 112 Rules and General Permits" (January 25, 1995) ("Stein Memo") at 6; *In re Shell Offshore, Inc.*, 15 E.A.D. 526, 551 (March 30, 2012); Reclassification of Major Sources as Area Sources Under Section 112 of the Clean Air Act, 84 FR 36304, 36318 (July 26, 2019).

[8] Peabody Western Coal, 12 E.A.D. at 39; *see also* In re Shell Offshore, Inc. 15 E.A.D. at 559; In the Matter of Yuhuang Chemical Inc. Methanol Plant St. James Parish, Louisiana, Title V Petition Response Order, No. VI-2015-03 (August 31, 2016) ("Yuhuang Order") at 19, 28.

[9] Peabody Western Coal, 12 E.A.D. at 38 ("Peabody not only proposes to rely on the AP-42 factors to establish both its PTE limit and to demonstrate compliance with that limit, Peabody compounds the potential inaccuracy of this approach by using unverified emission control assumptions in both calculations."); see also John S. Seitz and Eric Schaeffer, "Potential to Emit (PTE) Guidance for Specific Source Categories" (April 14, 1998) at 4 n.4.

[10] In re Shell Offshore, Inc. 15 E.A.D. at 559.

[11] Compilation of Air Pollutant Emission Factors (AP-42) Fifth Edition, January 1995, Introduction at pp. 2; 4; 8.

[12] *Id.* at 8.

[13] Peabody Western Coal, 12 E.A.D. at 39 n.40.

[14] Hunt Memo at 7-8; See also Peabody Western Coal, 12 E.A.D. at 38 n.38; Yuhuang Order at 19, 28.

[15] Hunt Memo at 7, 20-21; see also Cash Creek General LLC, Title V Petition Response Order, No. IV-2010-4 (June 22, 2012) at 17, 26 (granting in part because the permittee's claims of 90% control efficiency of PM emissions from storage piles and associated roadways was unsubstantiated and the permit lacked any requirements governing frequency of wet suppression, atmospheric or operations conditions under which wet suppression should applied the time of day that wet or chemical suppression should be applied, or the amount that should be applied).

When permits contain emissions, production or operational limits, they should also have monitoring, recordkeeping, and reporting (MRR) requirements that allow a permitting agency to verify a source's compliance with its limits.[16] The permit should provide for the collecting, maintaining, and reporting of information necessary to determine emissions of each pollutant as well as compliance with operating parameters.[17] The permit must include conditions that clearly specify the monitoring requirements and how the permittee must demonstrate compliance via the monitoring requirements.[18]

With respect to National Ambient Air Quality Standards (NAAQS) compliance, in accordance with IDAPA 58.01.01.203.02: "No permit to construct shall be granted for a new or modified source unless the application shows to the satisfaction of the Department all of the following: NAAQS. The stationary source or modification would not cause or significantly contribute to a violation of any ambient air quality standard." See also 40 CFR 52.670(c). Similarly, new major stationary sources in attainment or unclassifiable areas are subject to IDAPA 58.01.01.205, which is an approved part of Idaho's State Implementation Plan.[19] In order to satisfy the requirements of CAA Section 110(a)(2)(J), IDAPA 58.01.01.205 incorporates by reference several sections of 40 CFR 52.21, including 40 CFR 52.21(k). The regulation at 40 CFR 52.21(k) and CAA Section 165(a)(3) require that, "The owner or operator of the proposed source or modification shall demonstrate that allowable emission increases from the proposed source or modification, in conjunction with all other applicable emissions increases or reductions (including secondary emissions), would not cause or contribute to air pollution in violation of: Any national ambient air quality standard in any air quality control region; or Any applicable maximum allowable increase over the baseline concentration in any area."

EVALUATION OF FINAL PERMIT

1. The production limits in the PTC do not restrict the SGP's PTE to below major stationary source permitting thresholds under the prevention of significant deterioration (PSD) or Title V programs.

a. Underestimation of Emissions from Ore Processing Emission Units

In its prior comment letters, EPA advised DEQ that the emission factors relied upon in the draft permits were not representative of emissions. For instance, EPA's March 16, 2022 comment letter stated: "Some of the PTE limitations may not be technically accurate because they are not based on emission factors that are representative of the emission sources. For example, AP-42 Section 11.24 Metallic Minerals Processing emission factors applies to the processing of hard ores including gold. However, the application uses AP-42 emissions factors from Section 11.19.2 Crushed Stone Processing that is applicable to non-metallic mineral processing. The permitting record does not provide a reasoned explanation as to why emission factors from Section 11.24 were selected over those from Section 11.19.2."[20]

---

[16] Hunt Memo at 17; In re Shell Offshore, Inc. 15 E.A.D. at 551.
[17] 84 Fed. Reg. 36,304, 36,320.
[18] Yuhuang Order at 21.
[19] 40 CFR 52.670(c).
[20] March 16, 2022, EPA Comment 5

DEQ's Response to Comment did not provide any additional information or rationale for decision making. Instead, DEQ stated, "Representativeness of these parameters was discussed with and reconfirmed by PRI at various points during review and the estimates of emissions and underlying assumptions were supported to the satisfaction of DEQ."[21]

Even if a permitting authority was unable to find more accurate emission factors than AP-42, the introduction to Section 11.19 states, "The construction aggregate industry covers a range of subclassifications of the nonmetallic minerals industry (see Section 11.24, Metallic Minerals Processing, for information on that similar activity)." IDEQ did not follow the listed instructions to see Section 11.24 for Metallic Minerals Processing.

IDEQ did not state that it performed any analysis of other emission information. IDEQ did not state that it sought out emission factor information of higher quality than AP-42, as required by IDEQ Guidance[22] (Guidance) which states, "When estimating emissions, emissions data that *best* reflects emissions from a stationary source must be used" (emphasis added). DEQ did not make a determination that the emission factor chosen meets the Guidance. Similarly, the Guidance states "The rating of the AP-42 factor must be considered…" However, IDEQ did not state how it considered the rating of the factor chosen or if IDEQ considered other factors with higher ratings. For reference, AP-42 Section 11.24 has a rating of "C" for primary crushing emission factor. AP-42 Section 11.19 has no emission factor for primary crushing, but states that tertiary crushing can be used for primary and secondary crushing and the rating for tertiary crushing is "E", the lowest rating assigned by AP-42. Setting aside the choice of using an emission factor for Non-Metallic Minerals instead of the Metallic Minerals, IDEQ has not evaluated the available emission factors based on the rating, as required by its own Guidance.

EPA's document AP-42 Metallic Mineral Processing Plants – Background Information for Proposed Standards Volume 2 Appendices (EPA-450/3-81.009b) lists visits and emission testing at various mineral processing and mining operations. Appendix C – Summary of Test Data includes data on nine plants that processed metallic minerals. Table C-1 specifically includes testing at processing equipment at a gold mine with baghouse control. Thus, the metallic mineral processing plants evaluated and tested to form the basis for the emissions factors in AP-42 Section 11.24 are most similar to the metallic mineral processing emission units at the SGP. These background documents clearly indicate that the emissions factors in Section 11.24 are most appropriate for estimating emissions from the SGP.

Multiplying the emission factor found in AP-42 Section 11.24 by the production limitation on the primary crusher (OC7) results in an emission estimate over 90 tons of PM per year for that unit alone. Similarly, if AP-42 Section 11.24 emission factors are multiplied by the production limits for the remaining emission units OC1 through OC13, potential PM emissions from that collection of units *exceeds 800 tons PM per year*. Given the PSD threshold of 250 tons per year and the fact that even Section 11.24 is an average emission factor (and approximately half of all emission units will emit above an average rate), the PTC fails to restrict emissions below major source thresholds.

---

[21] RTC at pp. 3; 23; 25-26.

[22] Guidance available at https://www2.deq.idaho.gov/admin/LEIA/api/document/download/5521.

Based on the above information, IDEQ did not follow DEQ Guidance, did not support the use of the chosen emission factor, and was arbitrary when choosing emission factors for the ore processing emission units. Accordingly, the PTC does not restrict the Facility's PTE below major source thresholds as a legal and practical matter.

b. Underestimation of Emissions from Lime Plant Emission Units

EPA previously commented that IDEQ's emission estimates for the lime production emission units are not technically accurate because they do not appear to be based on emission factors that are representative of the emission sources. For example, EPA commented that AP-42 Section 11.17 Lime Manufacturing emission factors applies to the processing of lime derived from marble. However, IDEQ used AP-42 emissions factors from Section 11.19.2 Crushed Stone Processing. In addition, the limestone excavating emission estimates (Material Load & Unload) appear to use emission factors from Section 11.19.2 Crushed Stone Processing instead of Section 11.9 Western Surface Coal Mining emission factors that are representative and specific to mining excavation activities. The permitting record does not explain why emission factors from AP-42 Section 11.19.2 were selected over those from Sections 11.17 and 11.9. If IDEQ does not have a good technical reason for their selection of emission factors, the most conservative emission factor should be used for emission units.[23]

IDEQ responded to EPA and other commenters that: "As described previously in the Representativeness and Uncertainty of Emissions section, although some degree of uncertainty is present in all emission factors used in estimating emissions, all emission factors were adequately supported and the approach of estimating potential to emit (PTE) at design capacity was considered a conservative approach. Emission factors with control efficiencies built into them were adequately supported by that corresponding control device listed in the permit. Representative emission factors from EPA's AP-42 Section 11.17, 11.19.2 and 11.9 were used to estimate emissions from the lime plant, lime plant support equipment, and marble overburden mining, respectively. The facility's emission inventory includes crushers, screens, and conveyors controlled by water sprays. EPA's AP-42 11.19.2 (08/2004) provides representative emission factors for these specific processes and controls."[24]

Consistent with the evaluation in Section 1.a., above, DEQ failed to apply appropriate emission factors to the lime plant emission units, did not follow IDEQ guidance specific to emission factor use in permits and failed to create an enforceable restriction on the lime plant's potential to emit below major source thresholds (e.g., 100 tons PM per year).

IDEQ's selection of emissions factors for the lime plant and basis therefor suffer from the same deficiencies as the ore processing units evaluated in Section 1.a., above. IDEQ relied upon sections of AP-42 that are not specific to the process units being permitted. For instance, IDEQ relied upon non-metallic mineral processing emission estimates in EPA's AP-42 Section 11.19 instead of evaluating EPA's emission factors for lime manufacturing, Section 11.17. A single example of how important it is to accurately estimate emissions is illustrated by a process unit in

[23] March 16, 2022, EPA Comment 11.
[24] RTC at pp. 27-28.

the Lime Plant, LS3/LS4 (primary Screen/Secondary Crusher). If the emission factor for secondary crushers (0.62 lb/ton) in Section 11.17 is applied to those production units, potential emissions would exceed 100 tons PM per year from those units alone. The same result applies to emission unit LS5 (secondary screen), resulting in an additional 128 tons PM per year. These two simple examples highlight the importance of accurately estimating future emissions from the proposed SGP.

Based on the above and corresponding issues highlighted in Section 1.a., IDEQ did not follow IDEQ Guidance, did not support the use of the chosen emission factor and was arbitrary when choosing emission factors for the lime processing emission units, and did not restrict the lime plant's PTE below major source thresholds.

c. Lack of Emission Limits

IDEQ's permit imposes only production limits for the ore processing units while relying on the unrepresentative emission factors that significantly underestimate emissions. While use of production limits alone to limit PTE may be acceptable in certain circumstances, such as when the limits are derived from conservative emission factors, this is not the case here.

In addition to inadequate production limits derived from unrepresentative emission factors, the Final Permit lacks emissions limits for several emission units, including the ore crushers, screens, and conveyors. This further undermines the enforceability of the synthetic minor limits. EPA advised IDEQ of this problem in its March 19, 2021, letter (Comments 1-4). Despite these comments, the Final Permit does not contain either source-wide emission limits applicable to all emission units or unit-specific limits on the mining and ore processing emission units.[25] As a result, enforcement of the synthetic minor limits is constrained to the inaccurate production limits with no corresponding limitation on the emissions from those units. As discussed above, IDEQ used emission factors that significantly underestimate the emissions from the ore processing units as well as the lime plant units. Based on the analysis above, DEQ's permit does not restrict the SGP's PM PTE to below PSD or Title V major source thresholds as a legal and practical matter.

d. Lack of Sufficient Monitoring, Recordkeeping and Reporting

EPA previously commented that the Draft Permit lacked sufficient monitoring, recordkeeping and reporting (MRR) to ensure the production and emission limits are enforceable as a practical matter.[26] EPA commented that the Final Permit did not include core monitoring, recordkeeping, and reporting (MRR) requirements directly, but rather allowed the permittee to develop these MRR requirements post permit issuance in an Operations and Maintenance Manual (O&M Manual). EPA, as well as many other commenters, raised procedural and substantive concerns with IDEQ's approach to incorporating MRR requirements into the permit. Procedurally, EPA commented that the O&M Manual ought to be developed and available for public comment prior to permit issuance and that any changes to the O&M Manual ought to be reviewed and approved

[25] Includes Drilling Activities, Blasting Activities, Excavating and hauling activities, Rock dumps and hauling activities, Prill Silos #1-2, OC1 through OC13.
[26] March 16, 2022 EPA Comments 6, 7, 12, 13, 22-25

by IDEQ prior to the change. Substantively, EPA commented that the permit condition specifying the minimum requirements for the O&M Manual lacked the necessary specificity to ensure the permit include adequate MRR.

IDEQ's RTC included some responses to EPA's comments. IDEQ revised PTC Condition 2.20 from draft to final to require that the O&M manual be developed 30 days prior to startup of any process equipment. Condition 2.20 also states: "The requirements in the O&M manual shall be incorporated by reference to this permit and shall be enforceable permit conditions." In addition, PTC Condition 2.21 requires: "The O&M manual shall be submitted for approval to DEQ 30 days prior to startup of any ore processing, ore concentration and refining, lime production, or aggregate production emission source regulated by this permit (as identified in Table 1.1) at the address provided (Permit Condition 2.26), and shall remain onsite at all times. Any changes to the O&M manual shall be submitted to DEQ for review, comment, and approval 30 days prior to the change."[27]

These conditions in the Final PTC and Idaho's RTC do not fully address EPA's concerns regarding the development and approval of the O&M Manual. IDEQ did not require the applicant to develop and submit the O&M Manual as part of its application. Accordingly, the O&M Manual will not be subject to public review and comment, even though the Manual will establish enforceable conditions in the permit. In addition, Conditions 2.20 and 2.21 do not mandate IDEQ *approval* prior to startup or a change to the O&M Manual, only that the Permittee submit the O&M Manual to IDEQ for approval. Finally, Condition 2.20 specifies that the O&M Manual shall be incorporated by reference into the permit. However, this condition does not make clear whether only the approved O&M Manual is incorporated by reference or any version of the O&M Manual submitted by the permittee. Moreover, given that the O&M Manual establishes permit conditions that bear on emission and compliance, revisions to the O&M Manual constitute permit revisions that ought to be subject to public review and comment.[28]

Condition 2.20 contains the minimum content requirements for the O&M Manual. In response to commenters questioning the sufficiency of these minimum requirements, IDEQ reasserted that Condition 2.20 contains the minimum requirements for the O&M Manual and that Condition 2.20 requires the permittee to describe various methods, procedures, and schedules to monitor emission units and control equipment.[29] Neither the Final Permit nor IDEQ's RTC adequately address EPA's concerns.

At the outset, these minimum requirements are vague and may not compel specific, enforceable conditions in the ultimate O&M Manual. For many critical monitoring and operational requirements, Condition 2.20 merely requires the permittee to "describe" the procedures and/or schedule. In addition, the requirement to "Describe the schedule and procedures for routine inspection (Permit Condition 2.10), maintenance, repair, and replacement of control equipment" does not specify any particular method (e.g. EPA Test Methods 9, 22) for visual observation of opacity or fugitive emissions. Accordingly, this vague condition will not lead to sufficient MRR in the O&M Manual.

---

[27] RTC at p. 15.
[28] *See* IDAPA 50.01.01.209.04.
[29] RTC at pp. 13-18; 20 (Comments 6, 7, 8, 11, 12, and 15).

In addition to these overarching concerns with Condition 2.20, numerous permit conditions reference the O&M Manual to satisfy MRR requirements. However, as illustrated in Table 1, below, Condition 2.20 does not mandate specific MRR for all of these corresponding production or emission limits.[30]

Table 1: Evaluation of O&M Manual Requirements

Conditions	O&M Manual Requirements	Evaluation
Conditions 3.11-3.12: • The permittee shall install and operate dust collection systems with a minimum control efficiency of 90% on all drilling rigs in accordance with the O&M manual. • The permittee shall install, operate, and maintain water sprays in accordance with the O&M manual (Permit Condition 2.20) to control PM emissions from each ore processing crusher and conveyor.	Condition 2.20 does not contain any specific minimum requirements for water sprays.	The MRR for drill rigs and rock crushing equipment is inadequate. The O&M manual contains no provisions regarding water sprays. While Condition 2.20 does require incorporation of certain manufacturer's guarantees, this requirement is specific to certain control devices: wet scrubber, vent gas cleaning tower, venturi scrubber, carbon filter, baghouse and bin vent filter cartridge control device.
Conditions 3.16-3.20: • The devices and methodologies used to measure weights shall be identified in the O&M Manual.	Condition 2.20 requires the O&M Manual to "Describe each monitoring device and methodology used to measure weight rates of materials to demonstrate compliance with each material throughput limit (Permit Conditions 3.5–3.9, 4.8–4.11, and 5.4–5.8). Procedures for proper installation, calibration, and maintenance shall be included."	This condition lacks specificity with respect to the scale used to determine the weights of materials, particularly daily ore loading conditions in 3.16-3.20. In order for these daily limits to be practically enforceable, the permit must contain monitoring, recordkeeping and reporting of total daily weights of ore. This necessitates use of an accurate scale. Condition 2.20

[30] Conditions 3.11-3.12; 3.16-3.20; 4.13-4.17; Table 4.2, Footnote C; 4.21-4.23; 4.29-4.32; 5.11-5.16; 5.17-5.26.

		does not mandate the use of any particular scale, or that the permittee maintain the scale within a certain percent accuracy. Without these minimum conditions in Condition 2.20, IDEQ has limited grounds to disapprove an O&M Manual that allows for inappropriate or inaccurate scales. See the regulation at 40 CFR 63.11646(a)(8)-(10) for detailed requirements for the measuring and recording of weights. Neither Condition 2.20 nor Conditions 3.16-3.20 contain required calculations for summing daily weights to demonstrate continuous compliance. In its response to comments, IDEQ stated that the permittee will use a weighometer to measure weights.[31] While this may be true, no condition in the permit requires the use of a weighometer.
Conditions 4.13-4.17 • The permittee shall install, operate, and maintain venturi scrubber (VS1), vent gas cleaning tower (ST1), vent gas steam condensation tower (CT1), and carbon filter (CA5) systems in accordance with the O&M manual (Permit	Describe the schedule and procedures for routine inspection (Permit Condition 2.10), maintenance, repair, and replacement of control equipment. • See-no-see visible emissions inspection of each wet scrubber, carbon filter, baghouse, and bin vent shall be	No conditions specify any specific methods for see-no-see inspections, e.g. Method 22 observations. Without referencing the method, the compliance determination is subjective and likely unenforceable.

[31] RTC at p. 15.

Condition 2.20) and consistent with manufacturer's recommendations. • The permittee shall install, operate, and maintain a carbon filter (CA2) in accordance with the O&M manual (Permit Condition 2.20) and consistent with manufacturer's recommendations.	conducted at least once per day. • Describe the schedule and procedures for corrective action that will be taken if visible emissions are present from wet scrubber (WS2, WS3), carbon filter (CA1, CA2, CA3, CA4, CA5), baghouse (BH2, BH3, BH4, BH5), or bin vent filter (LS, LS1, MillS2, ACS1, ACS2, ACS3, ACS4, CS1, CS2) control equipment at any time. Procedures should include how to determine whether filter cartridges are ruptured or are not appropriately secured in place, and how to determine whether the wet scrubber, condenser, and carbon filters are operating properly.	
Table 4.2 Footnote C Pounds per hour, as determined by a test method prescribed by IDAPA 58.01.01.157, EPA reference test method, continuous emission monitoring system (CEMS) data, or DEQ-approved alternative. Condition 4.8 The permittee shall process ore concentrate as the raw	Describe each monitoring device and methodology used to measure weight rates of materials to demonstrate compliance with each material throughput limit (Permit Conditions 3.5–3.9, 4.8–4.11, and 5.4–5.8). Procedures for proper installation, calibration, and maintenance shall be included. Establish operating ranges for control equipment, based on	Condition 2.20 does not contain MRR requirements specific to Venturi Scrubber (VS1) Vent Gas Cleaning Tower (ST1) or Vent Gas Steam Condensation Tower (CT1) used to control emissions from the Autoclave. Condition 2.20 contains a requirement to describe the schedule for taking corrective action if visible emissions are

material in the autoclave, and the maximum input to the autoclave shall not exceed 6,960 T/day. Condition 4.13 The permittee shall install, operate, and maintain venturi scrubber (VS1), vent gas cleaning tower (ST1), vent gas steam condensation tower (CT1), and carbon filter (CA5) systems in accordance with the O&M manual (Permit Condition 2.20) and consistent with manufacturer's recommendations. Conditions 4.21-4.23 • The devices and methodologies used to measure weights shall be identified in the O&M Manual, and the devices shall be installed in accordance with the requirements of NESHAP Subpart EEEEEEE. • The devices and methodologies used to measure weights shall be identified in the O&M Manual. • At least once per shift, the permittee shall monitor and record the circulation flow rate in the venturi scrubber, the circulation flow rate in the vent gas cleaning tower, the	manufacturer specifications and conditions measured during performance testing. • Minimum pressure drop across each wet scrubber, vent gas cleaning tower, and venturi scrubber; • Minimum circulation flow rate for each wet scrubber, vent gas cleaning tower, venturi scrubber; • Maximum inlet gas stream temperature to each carbon filter; • Maximum pressure drop across each carbon filter; • Minimum pressure drop across each baghouse. Describe the schedule and procedures for corrective action that will be taken if visible emissions are present from wet scrubber (WS2, WS3), carbon filter (CA1, CA2, CA3, CA4, CA5), baghouse (BH2, BH3, BH4, BH5), or bin vent filter (LS, LS1, MillS2, ACS1, ACS2, ACS3, ACS4, CS1, CS2) control equipment at any time. Procedures should include how to determine whether filter cartridges are ruptured or are not appropriately secured in place, and how to determine whether the wet scrubber, condenser, and carbon filters are operating properly.	present, but does not mandate any specific corrective actions. NESHAP Subpart EEEEEE contains detailed MRR requirements at 40 CFR 63.11646(a)(8)-(10), including maintenance and calibration requirements. However, Condition 4.21 does not require maintenance or calibration in accordance with NESHAP Subpart EEEEEEE, only installation in accordance with NESHAP Subpart EEEEEEE.

pressure drop across the venturi scrubber, and the pressure drop across the vent gas cleaning tower to ensure compliance with O&M specifications.		
Conditions 5.11-5.16 • The permittee shall install, operate, and maintain water sprays in accordance with the O&M manual (Permit Condition 2.20) to control PM emissions from each portable crushing and screening plant. Water sprays shall operate at all times, except as specified in the O&M manual during winter conditions, when this equipment is operated to ensure compliance with Fugitive Dust requirements (Permit Conditions 2.1–2.6). • The permittee shall install, operate, and maintain a baghouse system (BH4) in accordance with the O&M manual (Permit Condition 2.20) and consistent with manufacturer's recommendations. All emissions from the parallel flow regenerative kiln shall be ducted to the baghouse at all times	Establish operating ranges for control equipment, based on manufacturer specifications and conditions measured during performance testing. Describe the schedule and procedures for routine inspection (Permit Condition 2.10), maintenance, repair, and replacement of control equipment. The replacement dates for each baghouse and bin vent filter cartridge and for each activated carbon filter medium shall be recorded at the time of each replacement. For cartridges, records shall include the manufacturer and model. For carbon filters, records shall include the manufacturer, type, and form of medium added. Records shall also include any changes in supplier and other relevant information Describe the schedule and procedures for corrective action that will be taken if visible emissions are present from wet scrubber (WS2, WS3), carbon filter (CA1,	Condition 2.20 does not contain any specific minimum requirements for water sprays. Thus, the permit lacks sufficient MRR for these conditions.

to ensure compliance with parallel flow regenerative emission limits.	CA2, CA3, CA4, CA5), baghouse (BH2, BH3, BH4, BH5), or bin vent filter (LS, LS1, MillS2, ACS1, ACS2, ACS3, ACS4, CS1, CS2) control equipment at any time. Procedures should include how to determine whether filter cartridges are ruptured or are not appropriately secured in place, and how to determine whether the wet scrubber, condenser, and carbon filters are operating properly.	
Condition 5.3 Emissions from the lime production plant stacks shall not exceed any emission rate limit in the following table . . .	None	The permit does not contain any requirements to calculate emissions to demonstrate ongoing compliance with these emission limits. The permit does not contain any formulas, data reduction methods, or periodic calculation requirements to demonstrate continuous compliance with these emission limits.
Conditions 5.17-5.26 • The devices and methodologies used to measure weights shall be identified in the O&M Manual.	Describe each monitoring device and methodology used to measure weight rates of materials to demonstrate compliance with each material throughput limit (Permit Conditions 3.5–3.9, 4.8–4.11, and 5.4–5.8). Procedures for proper installation, calibration, and maintenance shall be included.	Same evaluation as Conditions 3.16-3.20.

In addition, the Permit does not require testing for the ore processing or lime production emission units to confirm the accuracy of emission factors. As discussed above, IDEQ used inaccurate emission factors to derive production limits for ore processing and lime production emission units. In its RTC, IDEQ acknowledges the uncertainty present in emission factors. However, IDEQ did not require initial or routine testing to confirm the accuracy of the emissions

factors used to establish production and emission limits. Given the low quality of the emissions factors used, such testing is critical to ensuring the adequacy of the synthetic minor limits. However, the Final Permit does not require any testing.

Given the absence of sufficient MRR requirements for the corresponding production limits, emission limits, and control equipment requirements, many of the synthetic minor emission limits are not enforceable as a practical matter.

2. The SGP, as permitted, will cause or contribute to a violation of the PM_{10} NAAQS.

a. Unsubstantiated estimates of fugitive dust control

EPA, as well as several other commenters, questioned the basis for IDEQ's determination that PRI could achieve a 93.3% control efficiency to control fugitive dust from haul roads at the SGP. Specifically, EPA commented that IDEQ did not provide a reasoned analysis demonstrating that the studies showing that 90% control efficiency is achievable using magnesium chloride reflect conditions at the SGP. EPA also commented that IDEQ did not include specific details necessary to support such a demonstration in the permitting record.[32]

In its RTC, IDEQ responded stating that 93.3% is an aggressive level of control and that PRI has committed to undertaking all measures to achieve this level of control. IDEQ further stated that, based on a review of test studies, the 93.3% level of control can be achieved using water and magnesium chloride dust suppressants (citing PRI's application). IDEQ explained that chemical and water dust suppressants are used in combination for the control of dust from haul roads, and that achieving the target combined control efficiency of 93.3% is ultimately important to ensure compliance with applicable standards. According to IDEQ, it is for this reason that the combined control efficiency was listed in the permit in lieu of separate chemical (90% control) and water (33.3%) dust suppressant control efficiencies.[33]

IDEQ's responses do not adequately address EPA's comments. IDEQ did not proffer further evidence that conditions at the SGP are comparable to areas where studies indicating a 90% control efficiency on fugitive dust is achievable. Even so, these studies do not support IDEQ's contention that a control efficiency of *93.3%* is achievable. Ultimately, IDEQ appears to have back-calculated the control efficiency necessary to demonstrate NAAQS compliance, rather than determine a control efficiency that is achievable in practice.[34]

b. Underestimation of Fugitive Dust Emissions

With respect to demonstrating NAAQS compliance, EPA commented that IDEQ's use of a median silt content of 4.0% underestimates fugitive dust emissions from haul roads. EPA commented that the arithmetic average silt content for haul roads based on Perpetua's site-specific data is 4.3%. Use of the 4.3% average value results in about 7% more fugitive dust emissions from the haul roads than estimated using the median value. IDEQ's modeling

[32] March 16, 2022, EPA Comment 19.
[33] RTC at p. 3.
[34] SOB at p. 59; 65-66 (Table 28).

sensitivity study showed values just below the NAAQS, such that an 7% increase in fugitive dust from haul roads would have resulted in 24-hour PM_{10} NAAQS violations.[35]

In response, IDEQ stated the use of site-specific median values for silt content is commonly accepted by DEQ, and the values used in calculations were supported by PRI.[36] This response does not adequately justify why a median value rather than the arithmetic average is more appropriate taking into consideration the site-specific sampling. Given that a small difference in the silt content will result in an exceedance of the NAAQS, IDEQ's insistence on using a median silt content appears arbitrary and unreasonable and indicates that PRI has not demonstrated that the emissions will not cause or contribute toa NAAQS violation. On the contrary, operation of the SGP will likely cause or contribute to a violation of the PM_{10} NAAQS.

c. Lack of Conditions to Ensure Continuous Compliance with PM_{10} NAAQS

EPA, along with several other commenters, commented that the permit lacks conditions sufficient to ensure continuous compliance with the PM_{10} NAAQS. Specifically, EPA raised concerns with the adequacy and practical enforceability of the Fugitive Dust Control Plan (FDCP). Specifically, EPA raised concerns that the permit did not contain specific conditions necessary to ensure continuous compliance with the 93.3% control efficiency, but rather allowed the permittee to develop these conditions as part of an FDCP after permit issuance and allowed the permittee to change the FDCP without IDEQ approval. EPA also commented that the permit lacks conditions necessary to make the 93.3% control efficiency practically enforceable, such as frequency of dust suppression, requirements for when to use chemical dust suppression, amount of dust suppression that must be applied, vehicle weight, vehicle speed, vehicle daily miles traveled, and road silt content.[37] With respect to Condition 2.5 requiring PRI to apply fugitive dust control measures such that visible emissions are below 10% opacity, EPA also commented that permitting record does not support a correlation of the 10% opacity requirement in Condition 2.5 with a 93.3% control efficiency.[38]

In response to these comments, IDEQ updated permit condition 2.8 to require IDEQ approval of the FDCP 30 days prior to startup and after any subsequent changes. IDEQ also responded that the permit contains activity rate limits that serve as surrogate limits for fugitive sources. IDEQ also stated that it typically does not include vehicle speed, type, and miles traveled in permits. IDEQ also asserted that Conditions 2.1-2.6 contain the minimum requirements for the contents of the fugitive dust plan.[39] Finally, IDEQ responded that "An instantaneous 10% opacity limit for vehicle traffic on haul roads is considered a very conservative control trigger level to ensure that an appropriate control measure is taken to reasonably control emissions of fugitive dust (Permit condition 2.5)."[40]

---

[35] March 16, 2022 EPA Comment 20.
[36] RTC at p. 4.
[37] March 16, 2022, EPA Comments 16 – 19
[38] *Id.* at Comment 19.
[39] RTC at p. 9.
[40] *Id.*

These responses do not fully address EPA's comments with respect to the practical enforceability of emission limits necessary for NAAQS compliance. Condition 2.8 does not require that IDEQ approve the FDCP prior to startup, only that the permittee submit the FDCP 30 days prior to startup. Similarly, Condition 2.8 does not clearly require IDEQ approval of FDCP changes prior to the permittee making the changes.

Conditions 2.1 through 2.6 are insufficient to ensure the permittee achieves 93.3% fugitive dust control efficiency on haul roads. First, the permitting record indicates that application of magnesium chloride is necessary to achieve up to 90% control of fugitive dust. However, Conditions 2.1 through 2.6 do not require the permittee to use magnesium chloride for dust suppression. Rather, Condition 2.6 merely requires that the FDCP contain reasonable precautions including: "apply water or suitable dust suppressant (e.g. magnesium chloride, calcium chloride) to disturbed areas, haul roads, equipment staging areas, parking areas, and storage piles during the dry season and at other times as necessary to control fugitive dust." Moreover, magnesium chloride degrades over time. However, the permit does not require the permittee to reapply magnesium chloride at regular intervals.

Similarly, IDEQ assumed a combined control efficiency of water and chemical dust suppression to achieve 93.3%. However, Conditions 2.1 through 2.6 contain no explicit requirements that the permittee use both water and chemical dust suppression in a manner necessary to achieve the 93.3% control efficiency. Magnesium chloride does not perform as a dust suppressant in dry conditions. Therefore, supplemental watering will be necessary. However, the permit does not require supplemental watering to ensure the magnesium chloride performs as a dust suppressant.

With respect to vehicle weight and vehicle miles traveled, compliance with the NAAQS is dependent on vehicle miles traveled staying at or below 7,758 per day.[41] However, the permit contains no such limit. IDEQ also did not make clear how the activity limits, including Condition 2.4 (Blasting Limits) and Condition 3.5 (Daily Hauling and Excavating Limits), would necessarily restrict vehicle miles traveled to at or below 7,758 per day. There are no requirements or restrictions on the manner the permittee uses the haul roads.

Regarding the silt content, the permit does not contain conditions to ensure the silt content on haul roads remains at or below 4%. Condition 3.13 contains the minimum requirements for the Haul Road Capping Plan (HRCP). According to IDEQ, Condition 3.13 limits maximum silt content to 4.0%. This is not accurate. Condition 3.13 states that "The permittee shall use capping material with a maximum of 4.0% silt content." This condition does not require the permittee to maintain the haul road silt content to at or below 4.0%. Nor does the requirement account for mixing of the capping material with the base or wearing of the cap over time. Condition 3.13 also contain no explicit sampling or compliance demonstration methods. Rather, Condition 3.13 allows the permittee to develop a "silt content sampling plan including standard operational procedure for sampling, frequency of sampling, and ASTM (or equivalent) method of analysis for silt content."

Finally, IDEQ's response to EPA's comment on the basis for the 10% opacity limit in Condition 2.5 does not provide additional basis for a correlation between opacity and the 93.3% control.

[41] SOB at Appendix B, p. 65

The permit contains no testing requirements to establish a correlation between fugitive dust control and opacity. Nor does the permit contain any specific method for determining opacity or the frequency or location of opacity observations.

3. Neither the permit record nor permit conditions demonstrate that the entirety of the SGP ought to be excluded from the scope of "ambient air."

"Ambient air" is defined as that portion of the atmosphere, external to buildings, to which the general public has access."[42] General public includes "any person(s) other than those who are permitted access to the property as employees or business invitees of a specific stationary source (including trespassers)."[43] EPA interprets access to encompass two key concerns: legal access and physical or practical access.[44] Legal access concerns whether the general public has the right or permission to enter a specific property. Physical access addresses whether the general public is able to, under actual circumstances, enter a particular parcel of land. In order to preclude physical access to a parcel of land, the source must employ measures, which may include physical barriers, that are effective in precluding access to the land by the general public.[45] Such measures can include video surveillance, monitoring, clear signage, and routine security patrols.[46] Measures can be effective even if there is not 100 percent certainty that they will prevent public access.[47] Measures must be reasonable taking into consideration the nature of the measure used, source location, type and size of source and property to be excluded, and surrounding area.[48]

a. Legal Right to Exclude General Public

As stated above, legal access concerns whether the general public has the right or permission to enter a specific property. IDEQ asserts in the SOB and RTC that PRI has "complete and sole authority to control access to or through the facility, granting access at their discretion to anyone wishing to visit the site or pass through the site."[49] Neither the SOB nor the RTC, however, evaluate PRI's claims. In light of the fact that the SGP encompasses the East Fork South Fork Salmon River and is located within National Forest lands, the permitting record ought to contain a more thorough evaluation of PRI's legal authority and members of the general public's right of access to the SGP area of operations.

b. Measures to Exclude General Public as a Practical Matter

EPA commented that the permit lacks conditions to ensure PRI employs sufficient measures such that the entirety of the SGP is appropriately excluded from the definition of ambient air. Specifically, EPA raised concerns that the general public may be able to access the SGP,

---

[42] IDAPA 58.01.01.006.10; 40 CFR 50.1(e).
[43] "Revised Policy on Exclusions from 'Ambient Air'" Memorandum from Andrew R. Wheeler to Regional Administrators, December 2, 2019, at p. 6.
[44] *Id.* at 5.
[45] *Id.* at 9.
[46] *Id.* at 7.
[47] *Id.* at 8.
[48] *Id.*
[49] RTC at p. 21.

regardless of their legal right to do so.[50] The basis for EPA's comment was that the permit does not contain specific measures the permittee will take to exclude members of the public from the SGP. Rather, the permit allows the permittee to develop an Access Management Plan ostensibly designed to exclude members of the public. In response, IDEQ asserted that Condition 2.7 contains the requirements for the ACP, including adequately informing anyone approaching an access point that travel beyond the established gate involves entering an active mine site as a guest of the permittee and providing verbal and written requirements that must be followed while on the SGP site.[51] The SOB also states that the primary and secondary access points are controlled by adjacent natural features, such as streams and creeks, steep topography, and areas of thick vegetation and undergrowth.[52] In addition, the SOB states that PRI will place boulders across trails and adjacent to the train to prevent vehicle access.[53] Finally, according to the SOB, PRI security personnel will routinely patrol mine facilities and roadways for unauthorized individuals.[54]

IDEQ's responses and statements in the SOB do not adequately address EPA's concerns. As permitted, the general public will likely have physical or practical access to portions of the SGP. The SGP operations area boundary covers 2,372 acres of land within the Payette and Boise National Forests. The SGP is located in Valley County, Idaho. The nearest settlement is the village of Yellow Pine, Idaho, approximately 14 miles by road.[55] The Payette National Forest includes the Frank Church River of No Return Wilderness. The Salmon River runs through the Payette National Forest. The SGP is surrounded by numerous recreation areas in the Payette and Boise National Forests.[56] National Forest roads 374, 440, and 640 provide vehicle access to the site.[57]

Given the scale of the SGP, proximity to recreation opportunities, and multiple access points, the permittee should employ multiple measures to preclude public access. However, condition 2.7 is vague and leaves the permittee considerable latitude on the methods used to exclude members of the general public. While the SOB indicates that placement of boulders on secondary roadways is necessary to prevent access, Condition 2.7 contains no such requirement. Also, Condition 2.7 does not specify a minimum patrol frequency or minimum signage requirements. Nor does Condition 2.7 require the permittee to post or monitor the vast operations boundary to effectively preclude recreators from entering the site. Condition 2.7 only requires the permittee to employ measures to "discourage" access to secondary roadways and trails. This does not meet the standard to effectively exclude members of the general public. Similarly, EPA questions whether the entire boundary surrounding the operations area incorporates natural features that preclude access. Given the numerous recreational opportunities in the surrounding wilderness areas, access by recreators off trail appears possible. Therefore, the Final PTC does not ensure that the

---

[50] March 16, 2022, EPA Comments 26-27
[51] RTC pp. 20-21; 42
[52] SOB at p. 55.
[53] *Id.*
[54] *Id.*
[55] Stibnite Gold Project Supplemental Draft EIS, Forest Service, p. 1-7.
[56] See Payette National Forest - Thunder Mt./Monumental Area, Krassel RD (usda.gov); Payette National Forest - Monumental Trailhead (usda.gov); Payette National Forest - Lookout Mt Trailhead (usda.gov); Boise National Forest - Meadow Creek / Summit Trailhead (usda.gov).
[57] SOB at p. 6.

entirety of the SGP is appropriately excluded from the definition of ambient air. This implicates IDEQ's determination that the SGP will not cause or contribute to a violation of the PM_{10} NAAQS.

DYLAN LAWRENCE
VARIN THOMAS LLC
P.O. Box 1676
Boise, ID 83701
(208) 345-6021
dylan@varinthomas.com

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	BEQ Case No. 0101-22-01 OAH Case No. 23-245-01 SCHEDULING ORDER ON MOTIONS RELATED TO RECENT EPA LETTER

BACKGROUND

On August 10, 2023, EPA sent a letter to Idaho DEQ Director Jess Byrne, expressing three concerns regarding the air permit issued to Perpetua Resources in this matter (the "EPA Letter"). The Letter requests a meeting between EPA and DEQ representatives to discuss those concerns. Ultimately, the Letter suggests that DEQ should issue a revised permit.

On August 28, 2023, Perpetua Resources and DEQ filed a joint motion in limine requesting exclusion of the EPA Letter and any press releases about it from consideration in this proceeding. Under the default rules of procedure, the deadline for Petitioners to respond to this motion would be

September 11. However, on August 31, Perpetua and DEQ filed a motion to establish September 6 as the Petitioners' response deadline and to expedite consideration of the motion in limine. The motion also requests permission to file a reply brief.

On September 1, the Petitioners filed two motions. One motion requests a stay of these proceedings, including postponing the September 21 summary judgment hearing and setting a status conference in October to discuss the status of this matter. The other motion requests the Hearing Officer to augment the record in this matter with the EPA Letter. Under the default rules of procedure, the deadline for responses to these two motions is September 15.

Given the proximity of these motions to the summary judgment hearing scheduled for September 21, the Hearing Officer convened an informal status conference with the parties on September 6 to discuss the pending motions. At that status conference, the Petitioners informed the Hearing Officer and other parties that they intend to file a motion to amend their petition in this matter in the near future based upon one or more of the concerns expressed in the EPA Letter. Counsel for the Petitioners indicated it would be possible to file such a motion by Friday, September 8. In addition, both Perpetua and DEQ expressed a strong preference for keeping the September 21 summary judgment hearing in place.

DISCUSSION

Hearings Officers have broad authority to control the scheduling of cases to which they are assigned. *See* BEQ Rule of Procedure 003.08; AG Rule of Procedure 413. At the September 6 informal status conference, the parties agreed that the scheduling of matters related to these pending motions is within the discretion of the Hearing Officer.

The permit in this matter was issued on June 17, 2022, and these administrative proceedings have been pending since the filing of the initial petition on July 22, 2022. The record in this matter

establishes that EPA was aware of the permit application and was in communication with DEQ representatives during the processing of the application. Yet, EPA did not issue its Letter until August 10, 2023—420 days after the permit was issued.

At the September 6 status conference, Perpetua and DEQ were strongly in favor of keeping the existing summary judgment hearing in place. This is significant to the Hearing Officer. Arguably, these two parties face the most severe consequences if the three concerns expressed in the EPA Letter truly amount to legal "deficiencies," in the words of EPA. For example, if DEQ is not in compliance with EPA requirements, it risks losing authority to administer the Clean Air Act permitting programs within Idaho.

Presumably, this is not a result that Perpetua would desire, because—at least in the Hearing Officer's experience—regulated entities prefer dealing with more local permitting authorities. According to the Idaho Legislature, "the goals to protect human health and the environment can be best achieved by vesting responsibility for environmental protection…in a ***state department*** which has as its sole mission, protection for human health and the environment for the state of Idaho and its residents…." IDAHO CODE § 39-102A(5) (emphasis added); *see also* IDAHO CODE § 39-175A (legislative findings and purposes in obtaining state delegation of Clean Water Act NPDES permitting programs).

This contested case proceeding has been pending for more than one year. The Petitioners have had ample time to more fully explore and develop the errors alleged in their petition. EPA had ample opportunity to participate and comment as the permit was developed. If DEQ and Perpetua desire to keep the September 21 summary judgment hearing on the calendar, the Hearing Officer believes it is appropriate to preserve that hearing date for the time being by truncating the briefing schedule for the pending motions. The Hearing Officer will address the merits of the Petitioners'

motion for stay at the appropriate time, but believes preserving the ability for that hearing to proceed for the time being is the appropriate course of action.

ORDER

Based on the foregoing, the following procedures shall govern the five motions related to the EPA Letter:

1) The Petitioners shall file any written response to the DEQ/Perpetua motion in limine no later than 6:00 p.m. Friday, September 8.

2) The Petitioners shall file any motions to amend their petition in this matter no later than 6:00 p.m. Friday, September 8.

3) DEQ and Perpetua shall have until 6:00 p.m. Monday, September 11 to file written responses to the Petitioners' motion for stay, motion to augment, and anticipated motion to amend.

4) No reply briefs are needed.

5) Brevity is encouraged.

6) Combined briefs and jointly filed briefs are encouraged.

7) The filing of any other motions or briefs not specifically contemplated by this Order shall require leave from the Hearing Officer.

8) The Hearing Officer's goal will be to issue a decision on these motions and provide the parties with a description of issues to discuss at the summary judgment hearing, if it proceeds, by 6:00 p.m. on Friday, September 15.

Dated this 6th day of September, 2023.

Dylan Lawrence
Hearing Officer

CERTIFICATE OF SERVICE

I hereby certify that on this 6th day of September, 2023, I caused to be served a true and correct copy of the foregoing by the following method to:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

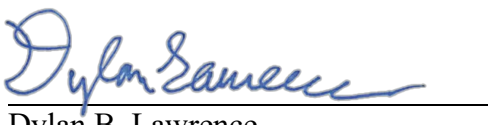
Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Resources Division
Office of the Attorney General
1410 N. Hilton St.
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service



Dylan B. Lawrence
Hearing Officer

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	Agency Case No. 0101-22-01
	OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	**PETITIONERS' RESPONSE IN OPPOSITION TO MOTION IN LIMINE**

INTRODUCTION

Petitioners Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon ("Petitioners") file this response opposing DEQ's and Perpetua's August 28, 2023 Joint Motion in Limine. The motion concerns the August 10, 2023 letter from EPA Regional Administrator Casey Sixkiller to DEQ Director Jess Byrne (the "EPA Letter"), raising concerns with the Permit to Construct for the Stibnite Gold Project (the "PTC") and requesting a personal and in-person meeting with DEQ Director Byrne, including with appropriate members of the agency's permit and legal teams, within 30 days, "[g]iven the seriousness of the concerns raised by the EPA and the need to reach a timely resolution."

As set forth in Petitioners' Motion to Stay and Motion to Supplement (both filed on September 1, 2023, and incorporated herein by reference), the Board of Environmental Quality Contested Case Rules and the Attorney General Rules favor admitting relevant evidence to develop the agency record in a contested case. Furthermore, the EPA Letter is relevant to the pending cross motions for summary judgment, and granting this motion to supplement is not prejudicial. DEQ's and Perpetua's Motion in Limine is unfounded, as the EPA Letter will not improperly influence the Hearing Officer, nor taint the proceedings. It is also not hearsay. The Hearing Officer should thus deny the Motion in Limine and reject DEQ's and EPA's request to ignore relevant information in the EPA Letter.

ARGUMENT

I. The Rules Favor the Inclusion of Relevant Evidence in a Contested Case

DEQ and Perpetua argue that, because Petitioners' challenges to the PTC arise under the Idaho Administrative Procedure Act ("APA), the Hearing Officer's review is limited to "the

permitting record before [DEQ] at the time it took the action of issuing the permit." Mot. in Limine at 3. That depiction is flatly incorrect.

Under Idaho Code Sections 39-107 and 67-5244, the Board of Environmental Quality ("Board") has final authority to determine whether the PTC issued by DEQ is in accordance with all relevant legal requirements and supported by the facts. The Hearing Officer's job is to develop a full factual record and assess the issues presented in a contested case petition, and issue a Recommended Order for the Board's review and ultimate decision. IDAPA 58.01.23.720. Thus, as discussed further in Petitioners' Motion to Supplement, the Board's Contested Case Rules (IDAPA 58.01.01) and the Attorney General's Rules (IDAPA 04.11.01) do not limit documentary evidence to those before the agency at the time of the permit issuance, but favor including all relevant matters that may affect the Board's review.

Reflecting these principles, the January 19, 2023 Scheduling Order ("Order") in this case never limited the documents to those considered by DEQ in making its decision to issue the PTC. The Order states it "governs" the "discovery parameters." Although formal discovery in the form of interrogatories and requests for production were limited to "documents or information in the possession of" DEQ, the Order did not limit documents to only those *considered by DEQ* in reviewing the permit application. In fact, Petitioners' discovery requests went beyond those documents that were considered by DEQ at the time the PTC decision was made. For example, Petitioners requested communications related to several interrogatories, "includ[ing] those generated prior and up to the data of the issuance of the [permit] as well as after the date of the issuance of the [permit] and up to the present day," and "all air permits issued by IDEQ . . . that applied a 70-year 'lifetime' average for any carcinogenic [toxic air pollutant]." Pet'rs' First Discovery Requests and Requests for Production of Documents

(Attachment 1). Because Petitioners' requests for production were consistent with the Order, DEQ provided responses and documents to such requests, and it never argued that requesting such documents was improper because they were not in front of DEQ when it made the decision to issue the permit.

Moreover, the Order also allowed both Perpetua and Petitioners to add "*any additional documentary evidence* they deem relevant to these proceedings" without limiting it to documents that were considered by DEQ during issuance of the PTC. Neither DEQ nor Perpetua attempted to exclude any of the additional documents that Petitioners served on the parties because they were not before DEQ at the time of its decision. To the contrary, both Perpetua and DEQ submitted post-PTC declarations in support of their summary judgment motions, after the discovery period closed. *See, e.g.,* Perpetua's Lewis Declaration (submitted June 23, 2023 in support of Perpetua's summary judgment reply brief); DEQ's Floyd, Simon, Schilling Declarations (submitted May 15, 2023 in support of DEQ's summary judgment motion).

Thus, this contested case has never been strictly limited to documents that were in front of DEQ at the time it issued the permit; and it should not be so construed now to preclude a significant source of information relating to the fundamental flaws in the permit, as identified by the EPA Letter. Accordingly, the fact that the EPA Letter was not before DEQ when it made its decision is not a basis for excluding it from this case, and the Hearing Officer should deny the Motion in Limine.

II. The EPA Letter Will Not "Taint" the Proceedings, and Can Be Addressed at the Hearing on Motions for Summary Judgment.

Perpetua and DEQ further argue that the EPA Letter should be excluded because it may "taint" the current proceedings. Mot. in Limine at 2. That argument, however, appears to be based on the fact that they do not like the information contained in the EPA Letter—not that the

EPA Letter is illegal, without basis, or has in some way been corrupted. The fact that the EPA identifies significant flaws in the permit that reiterate Petitioners' challenges does not constitute some kind of improper "taint."

Additionally, DEQ and Perpetua's argument that the EPA Letter should be excluded because it was sent after briefing and is evidence that was not disclosed under Idaho Rule of Civil Procedure (IRCP) 26(e)(3) should be rejected. Mot. in Limine at 4. IRCP 26(e)(3) governs exclusion of testimony or evidence not disclosed by a supplement required under the rules of discovery. For one, the EPA Letter is clearly being disclosed in this process and in the Petitioners' Motion to Supplement with August 10, 2023 EPA Letter, and it is being disclosed prior to the hearing. Moreover, the EPA Letter is not the type of evidence that requires disclosure by a supplementation of discovery under IRCP 26(e) (duty to supplement incorrect disclosures, or duty to identify persons having knowledge of discoverable matters). The Motion in Limine should therefore again be denied.

III. The Letter Is Not Hearsay

Lastly, Pereptua and DEQ contend that the EPA Letter should be excluded from evidence in this case because it is hearsay based on Rule 802 of the Idaho Rules of Evidence ("IRE"). Mot. in Limine at 4-5. However, the EPA Letter falls into the public records exception of IRE 803(8). IRE 803(3) excludes application of the rule against hearsay for certain evidence "regardless of whether the declarant is available as a witness" and including "[a] record or statement of a public office." IRE 803(8).

The EPA Letter meets all the requirements of IRE 803(8) as a public record. EPA is indisputedly a "public office" created by federal statutes within the executive branch, and EPA is the federal agency with authority and responsibility for enforcing State Implementation Plans

under the Clean Air Act.[1] The EPA Letter was sent by EPA Regional Administrator Sixkiller to DEQ Director Byrne pursuant to EPA's conduct of its Clean Air Act oversight responsibilities over the Idaho SIP, under which EPA "has the authority and responsibility to take direct action" if a "state partner is not taking timely or appropriate action to address threats to public health and the environment," as directed by EPA Administrator Regan in a February 2023 memorandum to all EPA regional administrators.[2] The EPA Letter was thus created as part of "regularly recorded and regularly conducted activities," and neither DEQ nor Perpetua has "show[n] that the source of information or other circumstances indicate a lack of trustworthiness" of the EPA Letter under IRE 803(8)(B). The EPA Letter is thus not improper hearsay under IRE 803 and is properly considered by the Hearing Officer.

CONCLUSION

For the foregoing reasons, the Hearing Officer should deny the Motion in Limine.

Dated this 8th day of September 2023.

Respectfully submitted,

s/ *Julia Thrower*

Julia S. Thrower
MOUNTAIN TOP LAW PLLC
614 Thompson Avenue
McCall, ID 83638
(208) 271-6503
jthrower@mtntoplaw.com

Attorney for Petitioner Save the South Fork Salmon

[1] *See* Basic Information about Air Quality SIPs, available at: https://www.epa.gov/air-quality-implementation-plans/basic-information-about-air-quality-sips#epa-role (last visited Sept. 7, 2023).

[2] *See* Memorandum, "Principles and Best Practices for Oversight of State Implementation and Enforcement of Federal Environmental Laws," dated February 13, 2023 from EPA Administrator Michael S. Regan, available at: https://www.epa.gov/system/files/documents/2023-03/principles-and-best-practices-oversight-federal-environmental-programs-2023.pdf.

s / Laird J. Lucas
Laurence ("Laird") J. Lucas
ADVOCATES FOR THE WEST
P.O. Box 1612
Boise, ID 83701
(208) 342-7024
llucas@advocateswest.org

Attorney for the Nez Perce Tribe and Idaho Conservation League

CERTIFICATE OF SERVICE

I hereby certify that on September 8, 2023, a true and correct copy of the Petitioners' Response in Opposition to Motion in Limine was served on the following:

Dylan B. Lawrence Varin Thomas, LLC 242 N. 8th St., Suite 220 Boise, ID 83702 (208) 345-6021 dylan@varinthomas.com *Hearing Officer*	Via:	
	Email:	[x]
	Fax:	[ ]
	CM/ECF:	[ ]
	Hand Delivery:	[ ]
	U.S. Mail:	[x]

Paula Wilson paula.wilson@deq.idaho.gov *Hearing Coordinator*	Via:	
	Email:	[x]
	Fax:	[ ]
	CM/ECF:	[ ]
	Hand Delivery:	[ ]
	U.S. Mail:	[ ]

Office of Administrative Hearings P.O. Box 83720 Boise, ID 83720-0104 filings@oah.idaho.gov	Via:	
	Email:	[x]
	Fax:	[ ]
	CM/ECF:	[ ]
	Hand Delivery:	[ ]
	U.S. Mail:	[x]

John Shackelford Office of the Attorney General 1410 N. Hilton, 2nd Floor Boise, ID 83706 (208) 373-0453 john.shackelford@deq.idaho.gov *Attorney for Respondent Idaho Department of Environmental Quality*	Via:	
	Email:	[x]
	Fax:	[ ]
	CM/ECF:	[ ]
	Hand Delivery:	[ ]
	U.S. Mail:	[ ]

Krista McIntyre
W. Christopher Pooser
Wade Foster
Stoel Rives, LLP
101 S. Capital Blvd., Suite 1900
Boise, ID 83702
(208) 389-9000
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
Attorneys for Intervenor Perpetua Resources of Idaho, Inc.

Via:

Email:	[x]
Fax:	[ ]
CM/ECF:	[ ]
Hand Delivery:	[ ]
U.S. Mail:	[ ]

s/ Julia Thrower
Julia Thrower

Attachment 1

Pet’rs’ First Discovery Requests and Requests for Production of Documents

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	
	CASE DOCKET NO. 0101-22-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC. Intervenor.	**PETITIONERS' FIRST DISCOVERY REQUESTS AND REQUESTS FOR PRODUCTION TO RESPONDENT IDEQ**

TO: Respondent Idaho Department of Environmental Quality and its attorney of record:

PLEASE TAKE NOTICE that Petitioners Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon hereby submit the the following Interrogatories and Requests of Production of Documents to Respondent Idaho Department of Environmental Quality ("IDEQ" or the "Department"). These Discovery Requests are issued to you pursuant to the Hearing Officer's January 19, 2023 *Scheduling Order* ("Discovery Order"); IDEQ's Contested Case Rules (IDAPA §§ 58.01.23 *et seq.*); the Idaho Rules of Administrative Procedure of the Attorney General (IDAPA §§ 04.11.01 *et seq.*) ("AG Rules") sections 520 through 532, which are incorporated by reference in IDEQ's Rules (IDAPA 58.01.23.003.11); and the Idaho Rules of Civil Procedure (IRCP) sections 26 through 37, which are incorporated in part by reference in the AG Rules (IDAPA § 04.11.01.520.02). Specifically, these Discovery Requests include Interrogatories and Requests for Production pursuant to AG Rule 524 and IRCP 33 and 34.

Pursuant to the *Scheduling Order*, <u>your responses, answered in writing, and production of documents are due on or before February 14, 2023</u>.

INSTRUCTIONS

1. Unless otherwise indicated, these Interrogatories and Requests for Production refer to Air Quality Permit to Construct P-2019-0047.

2. In responding to this Discovery Request, base your responses on all information available to you, not merely information within your own personal knowledge; please include information in the possession of your attorneys, experts, employees, agents, representatives, members, and consultants, whether past or present.

3. If documents supporting a Request for Production have already been provided via the Project File, sent by IDEQ to the parties on or about October 22, 2022, there is no need to

reproduce that information here. Instead, the Respondent may refer to the relevant document in the Project File by file name, including reference to relevant page(s) and/or section(s), if appropriate.

4. Whether for privilege or other reasons, if you do not provide a complete response to any Interrogatory or Request for Production, state with respect to such Interrogatory or Request for Production that a complete response is not provided and state the reason for the incomplete response.

5. If you contend that any information response to any of the following Interrogatories or Requests for Production is privileged, in whole or in part, or should otherwise not be disclosed, or otherwise object to any part of the discovery request, you should identify with particularly each piece of information for which you claim a privilege or to which you object, state the grounds for exclusion or reasons for your objection, and describe the information withheld or objected to in terms of its subject matter, the time at which it was acquired or communicated, the parties who possessed and/or exchanged such information, and other information as may be reasonably needed by Petitioners to understand the basis of your objection to disclosure.

6. These Interrogatories and Requests for Production are deemed continuing in nature, and your answers are to be supplemented as additional information and knowledge become available to you.

7. Produce all documents in searchable PDF format with Bates numbers, with the exception of Microsoft Excel based files. These types of files are requested to be produced in their original Excel format. Provide input and output files for modeling simulations in format that can be opened with standard public-domain software, or provide the necessary software that

allows for proprietary format or other non-standard format files to be opened, viewed, and for the subject data to be comprehended by a human viewer.

DEFINITIONS

1. "AACC" refers to Acceptable Ambient Concentration for a Carcinogen as found in IDAPA 58.01.01.106.02.

2. The terms "and" and "or" are used interchangeably, and shall be construed either disjunctively or conjunctively as necessary to bring within the scope the Discovery Requests and any document that otherwise might be outside the scope of the Discovery Request.

3. "Describe," "identify," or "explain" mean to provide a detailed description of all the facts, relevant actions or inactions, and the identity of all documents that are responsive or utilized in responding to these Discovery Requests.

4. "General public" means a member of the public not associated with the operation of a facility or a business invitee of a facility (including contractors or delivery persons).

5. "Communication(s)" or "Correspondence" shall mean any transmission of words, thoughts, or information between or among two or more persons, and includes, but is not limited to spoken words, conversations, conference, correspondence, discussions, talks, and reports, whether transmitted in person or by any electronic device, such as a temphone, computer, or radio, and/or by Documents as defined below.

6. "IDEQ" means the Idaho Department of Environmental Quality.

7. "Documents" shall mean the original, all copies, and all translations of any writing, drawings, calculations, graphs, sound recordings, images, and other data or data compilations stored in any medium (paper or other tangible format, as well as any electronic format) from which information can be obtained.

8. "EPA" means the U.S. Environmental Protection Agency.

9. "Project File" means the "Perpetua Project File" prepared by IDEQ for the Air Quality Permit to Construct P-2019-0047, and sent on a flash drive to Petitioners by letter dated October 24, 2022.

10. "PTC" means Air Quality Permit to Construct P-2019-0047.

11. "TAP" means Toxic Air Pollutant as defined in IDAPA 58.01.01.124.

12. "T-RACT" means Toxic Air Pollutant Reasonably Available Control Technology as defined in IDAPA 58.01.01.007.12.

RELATED INTERROGATORIES & REQUESTS FOR PRODUCTION

INTERROGATORY NO. 1: Identify and describe all air emissions inventory calculations conducted by IDEQ, or conducted by anyone else and which IDEQ is aware of, related to development of the PTC for which the results were not presented in the Statement of Basis, including by describing the results of the other emissions inventory calculations and by describing the inputs, data set(s), and/or assumptions used in the other emissions inventory calculations which differ from those for which the results are presented in the Statement of Basis.

REQUEST FOR PRODUCTION NO. 1: Provide all Documents that support or relate to your answer to Interrogatory No. 1.

INTERROGATORY NO. 2: Identify and describe all air dispersion modeling simulations conducted by IDEQ, or conducted by anyone else and which IDEQ is aware of, related to development of the PTC for which the results were not presented in the Statement of Basis, including by describing results of the modeling simulations and by describing the inputs, data set(s), and/or assumptions used in the modeling simulations which differ from those for which the results are presented in the Statement of Basis.

REQUEST FOR PRODUCTION NO. 2: Provide all Documents that support or relate to your answer to Interrogatory No. 2.

ADDITIONAL REQUESTS FOR PRODUCTION

INSTRUCTION FOR REQUESTS FOR PRODUCTION NOS. 3–6: "Communications" for Interrogatories Nos. 3 through 6 means all communications, including but not limited to all letters, emails, calls, voicemails, text messages, meetings, meeting notes, reports, status updates, memos to file, and all Documents included with such Communications, and includes those generated prior and up to the date of the issuance of the PTC as well as after the date of the issuance of the PTC and up to the present day.

REQUEST FOR PRODUCTION NO. 3: Provide all internal IDEQ communications related to the development and issuance of the PTC

REQUEST FOR PRODUCTION NO. 4: Provide all Communications, both internal and external, related to or between IDEQ and EPA regarding the development and issuance of the PTC.

REQUEST FOR PRODUCTION NO. 5: Provide all Communications, both internal and external, related to or between IDEQ and Midas Gold, Perpetua Resources, or any of their consultants, experts, or contractors regarding development and issuance of the PTC.

REQUEST FOR PRODUCTION NO. 6: Provide all Communications, both internal and external, related to or between IDEQ and any other person, agency (local, state, or federal), or entity regarding the development and issuance of the PTC.

REQUEST FOR PRODUCTION NO. 7: Provide all guidance, policies, memos to file, or other Documents supporting use of a 70-year "lifetime" average for arsenic emissions in comparison to the AACC for the PTC.

REQUEST FOR PRODUCTION NO. 8: Provide all air permitsissued by IDEQ, other than the PTC, that applied a 70-year "lifetime" average for any carcinogenic TAP in comparison to the associated AACC, including the statements of basis.

REQUEST FOR PRODUCTION NO. 9: Provide all guidance, policies, memos to file, or other Documents related to defining an ambient air boundary.

REQUEST FOR PRODUCTION NO. 10: Provide all air permitsissued by IDEQ, other than the PTC, for which the general public had regular, conditional access to any location within the facility's ambient air boundary, including the statements of basis.

REQUEST FOR PRODUCTION NO. 11: To the extent not previously disclosed in the Project File or in response to any of the above, provide all Documents stored in the project folder in IDEQ's electronic records management system for Project 62288.

REQUEST FOR PRODUCTION NO. 12: To the extent not previously disclosed in the Project File or in response to any of the above, provide all Documents stored under the facility folder for Midas Gold and/or Perpetua Resources (or any similar variation) in IDEQ's electronic records management system.

Dated: January 31, 2023

Respectfully submitted,

/s/ Bryan Hurlbutt
Bryan Hurlbutt
Attorney for the Nez Perce Tribe and the Idaho Conservation League

/s/ Julia S. Thrower
Julia S. Thrower
Attorney for Save the South Fork Salmon

CERTIFICATION OF SERVICE

I hereby certify that on this January 31, 2023, I caused a true and correct copy of the foregoing PETITIONERS' FIRST DISCOVERY REQUESTS AND REQUESTS FOR PRODUCTION TO RESPONDENT IDEQ to be served upon the following persons:

Via Email:

John Shackelford, Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov

Krista McIntyre
W. Christopher Pooser
Wade Foster
Stoel Rives LLP
101 S. Capitol Blvd., Ste. 1900
Boise, ID 83701
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com

/s/ Bryan Hurlbutt
Bryan Hurlbutt

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	
	)	CASE DOCKET NO. 0101-22-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON	)	**PETITIONERS' MOTION TO AMEND CONTESTED CASE PETITION**
Petitioners,	)	
v.	)	
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC.	)	
Intervenor.	)	

Petitioners Nez Perce Tribe (the "Tribe"), Idaho Conservation League ("ICL"), and Save the South Fork Salmon ("SSFS") hereby move to amend their contested case petition in this matter through the [Proposed] Second Amended Petition to Initiate Contested Case, submitted herewith as Attachment 1. Petitioners bring this motion to amend under Idaho Rules of Administrative Procedure of the Attorney General Rule 04.11.01.305 and Idaho Rule of Civil Procedure ("I.R.C.P.") 15(a)(2).

Petitioners propose to amend the existing First Amended Petition by adding an additional claim challenging the Permit to Construct ("PTC") at issue here, regarding the adequacy of the Idaho Department of Environmental Quality's ("DEQ") determination that Perpetua Resources's Stibnite Gold Project will not exceed threshold levels of pollutant emissions such that it could proceed in issuance of a permit to construct as a minor source, rather than a major source permit under the Prevention of Significant Deterioration program of the Clean Air Act.

As Petitioners' counsel explained during the recent informal status conference with the Hearing Officer, this is the first issue raised in the August 10, 2023 letter from EPA Regional Administrator Casey Sixkiller to DEQ Director Jess Byrne (the "EPA Letter"), but is not directly raised in the current First Amended Petition, although the second and third issues in the EPA Letter are presented in the First Amended Petition and addressed in the parties' current summary judgment briefings.

BRIEF IN SUPPORT

I. Leave to Amend Shall Be Freely Given.

DEQ's Contested Case Rule 58.01.23.003.01 adopts the Idaho Rules of Administrative Procedure of the Attorney General Rule 305, which states: "The presiding officer may allow any pleading to be amended or corrected or any omission to be supplied." IDAPA 04.11.01.305.

Similarly, after a responsive pleading has been filed, the Idaho Rules of Civil Procedure allow the pre-trial amendment of a pleading either with the opposing party's written consent or with the court's leave, and states that "[t]he court should freely give leave when justice so requires." I.R.C.P. 15(a)(2).

"The twin purposes behind the rule are to allow claims to be determined on the merits rather than on technicalities, and to make pleadings serve the limited role of providing notice of the nature of the claim and the facts at issue." *Carl H. Christensen Family Trust v. Christensen*, 133 Idaho 866, 871 (1999) (citation omitted). Thus, "motions for leave to amend pleadings are to be liberally granted," *Taylor v. McNichols*, 149 Idaho 826, 847 (2010), and the burden is on the party opposing the amendment "to show why a court should not grant leave to amend a [petition]." *Clark v. Olsen*, 110 Idaho 323, 326 (1986). A district court's refusal to grant leave to amend without any justifying reason is, per se, an abuse of discretion. *Id.* (holding district court abused its discretion by denying a motion to amend without a justifying reason even though seven years separated the original and amended complaints and defendants had moved for summary judgment prior to the motion to amend).

"In considering whether to grant a motion for leave to amend, a trial court may consider whether the amended pleading sets out a valid claim, whether the opposing party would be prejudiced by any undue delay, or whether the opposing party has an available defense to the newly added claim." *Spur Products Corp v. Stoel Rives LLP*, 142 Idaho 41, 44 (2005) (citation omitted). "Timeliness of a motion for leave to amend is not decisive, but it is important in view of factors such as undue delay, bad faith, and prejudice to the opponent." *Id.* (quotation and citation omitted).

II. The Proposed Amendment Sets Forth a Valid Claim.

The proposed amendment sets forth a valid claim under the Idaho Administrative Procedure Act, Idaho Code § 67-5279. Specifically, the amendment alleges that DEQ relied on technically inaccurate emissions factors and unsupported assumptions to approve Perpetua's PTC for the Stibnite Gold Project as a minor source permit without a reasoned explanation of why it used those emission factors; and that DEQ failed to follow agency guidance documents on estimating emission factors from stationary sources, such as from ore crushing and other mineral processing facilities and mining operations, and failed to provide a reasoned explanation for deviation from that guidance. As such, the amendment alleges that DEQ's decision to issue the PTC was arbitrary and capricious.[1] *See* Attach. 1.

As with the other claims already pled, DEQ and Pereptua do not have a valid defense against this amendment. Petitioners have exhausted their administrative remedies for this amendment as the issue was raised in Petitioners' and other commenters' letters on the final draft permit. *See* PET 638 (ICL/SSFS Comment Letter); PET 661 (Tribe Comment Letter); PET 665-66 (EPA Comment Letter). DEQ was thus on notice of the issue, and had the opportunity to respond during the administrative process and prior to issuing the permit.

III. Petitioners' Motion to Amend Is Timely.

Petitioners' Motion is timely under the circumstances. The earliest that the EPA Letter was available to the parties was August 10, 2023, and Petitioners are promptly moving to amend their contested case petition within just a few weeks of that date. Petitioners have not somehow

[1] "The court may not [ ] weigh the sufficiency of the evidence related to the additional claim." *Spur Prods.*, 142 Idaho at 44.

been dilatory in moving to present the EPA Letter and their proposed amendment in light of that timing.

"[T]imliness is important in view of the [other] factors such as undue delay, bad faith, and prejudice to the opponent." *Christensen*, 133 Idaho at 871. As discussed below, combined with the lack of unfair prejudice and undue delay, Petitioners' Motion to Amend is timely, and the motion should be granted.

IV. Amending the Petition Would Not Cause Unfair Prejudice or Undue Delay.

DEQ and Perpetua will not be unfairly prejudiced by granting Petitioners' Motion to Amend. The amendment does not seriously impair DEQ's or Perpetua's ability to adequately present their case; it does not necessitate further expenditure of significant additional resources; and it will not cause undue delay of already scheduled proceedings.

First, the amendment is based on the same set of facts and documentary evidence already in the case record that were served on the parties during discovery, and therefore will not require re-opening of discovery or additional evidence or witness gathering.[2]

Furthermore, the amendment also would not significantly delay the resolution of the case. The amendment is independent of the other claims and can be resolved in its own summary judgment proceeding. The amendment does propose to amend the prior claims by either adding fact or other legal theories to those claims that are subject to the current summary judgment motions, and thus will not impact or require delay of the September 21st hearing on those motions. Thus, the amendment will not cause undue delay of this case.

[2] "The court may not [ ] weigh the sufficiency of the evidence related to the additional claim." *Spur Prods.*, 142 Idaho at 44. Regardless, Petitioners' ability to present their case does not rely on the EPA Letter being admitted into evidence for this case. Furthermore, Petitioners will not seek to reopen discovery if the Motion to Amend is granted.

Moreover, amending the petition would not create undue hardship for Perpetua in the construction or operation of the Project or in its progress for securing other state and federal permits. The proposed Stibnite Gold Project has yet to be approved by the U.S. Forest Service, which has still not issued any Final Environmental Impact Statement under the National Environmental Policy Act; and the Forest Service does not anticipate a decision until March 2024 at the earliest.[3] Moreover, Perpetua has to secure several other major permits and federal agency reviews prior to construction and operation of the mine, including an Army Corps of Engineers' permit under Clean Water Act Section 404, a Clean Water Act Idaho Pollution Discharge Elimination System permit, and completion of Section 7 consultation with U.S. Fish and Wildlife Service and NOAA Fisheries under the Endangered Species Act.[4] Amending the petition will neither delay nor impact any of those needed decisions or permits, nor delay construction or operation of the mine.

Therefore, there is no showing of unfair prejudice or undue delay that would allow denial of the amendment. The Hearing Officer should therefore grant Petitioners' motion to amend the petition.

V. It is in the Public's Interest to Ensure DEQ Issues Permits that are in Compliance with the Clean Air Act.

Granting Petitioners' Motion to Amend is in the public interest. DEQ is charged with the responsibility of protecting the public health and environment by ensuring that facilities that

[3] *See* Payette National Forest Schedule of Proposed Actions (July 2023 through September 2023), available at: https://www.fs.usda.gov/sopa/components/reports/sopa-110412-2023-07.pdf (last visited Sept. 8, 2023).

[4] *See* Perpetua Resources, Permitting, available at: https://perpetuaresources.com/permitting/ (stating that Perpetua "must earn more than 50 permits from federal, state, and local agencies . . . .") (last visited Sept. 8, 2023).

operate in the State of Idaho comply with federal and state environmental laws. The issue of whether the Stibnite Gold Project complies with the Clean Air Act is of significant importance to the quality of Idaho's air, the health of Idaho's public, and to the Nez Perce Tribe who use the area to exercise its treaty reserved rights to hunt, fish, gather, and pasture in the immediate area.

Moreover, the EPA Letter underscores that the federal agency charged with ultimate compliance and enforcement of the federal Clean Air Act—namely, EPA—has identified substantial concerns about DEQ's decision to approve a PTC for the Stibnite Gold Project based on faulty emission factors and estimates, underscoring EPA's concerns about threats to Idaho air quality and public health. Since the Hearing Officer's duty is to ensure a full record is prepared and provide a Recommended Order to the Board of Environmental Quality, which has ultimate responsibility for reviewing the PTC and determining Petitioners' challenges to it, the Hearing Officer should not allow Perpetua and DEQ to prevent developing the full record and arguments at this contested case hearing stage.

In short, the proposed amendment raises a touchstone issue of whether DEQ appropriately and reasonably analyzed the amount of emissions from the facility such that it ensures that the mine would not emit pollutants that would exceed threshold emissions requiring a different permit issued under an entirely different program with consideration of different factors. Ensuring that DEQ had a reasoned basis for the emission factors that it chose to analyze this mine as a minor source of pollutants is critical to protecting Idaho's air quality, the surrounding environment, and the public's health.

CONCLUSION

As discussed above, the amendment is timely, it does not cause prejudice, undue delay, or hardship. Petitioners' Motion to Amend should be granted.

Dated this 8th day of September 2023.

Respectfully submitted,

s/ Julia Thrower

Julia S. Thrower
MOUNTAIN TOP LAW PLLC
614 Thompson Avenue
McCall, ID 83638
(208) 271-6503
jthrower@mtntoplaw.com

Attorney for Petitioner Save the South Fork Salmon

Laird J. Lucas
Laurence ("Laird") J. Lucas
Bryan Hurlbutt
ADVOCATES FOR THE WEST
P.O. Box 1612
Boise, ID 83701
(208) 342-7024
llucas@advocateswest.org
bhurlbutt@advocateswest.org

Attorneys for the Nez Perce Tribe and Idaho Conservation League

CERTIFICATE OF SERVICE

I hereby certify that on September 8, 2023, a true and correct copy of the Petitioners' Motion to Amend Contested Case Petition was served on the following:

	Via:	
Dylan B. Lawrence Varin Thomas, LLC 242 N. 8th St., Suite 220 Boise, ID 83702 (208) 345-6021 dylan@varinthomas.com *Hearing Officer*	[x] [ ] [ ] [ ] [x]	Email Fax CM/ECF Hand Deliver U.S. Mail
Paula Wilson paula.wilson@deq.idaho.gov *Hearing Coordinator*	Via: [x] [ ] [ ] [ ] [ ]	 Email Fax CM/ECF Hand Deliver U.S. Mail
Office of Administrative Hearings P.O. Box 83720 Boise, ID 83720-0104 filings@oah.idaho.gov	Via: [x] [ ] [ ] [ ] [x]	 Email Fax CM/ECF Hand Deliver U.S. Mail
John Shackelford Office of the Attorney General 1410 N. Hilton, 2nd Floor Boise, ID 83706 (208) 373-0453 john.shackelford@deq.idaho.gov *Attorney for Respondent Idaho Department of Environmental Quality*	Via: [x] [ ] [ ] [ ] [ ]	 Email Fax CM/ECF Hand Deliver U.S. Mail

Krista McIntyre
W. Christopher Pooser
Wade Foster
Stoel Rives, LLP
101 S. Capital Blvd., Suite 1900
Boise, ID 83702
(208) 389-9000
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
Attorneys for Intervenor Perpetua Resources of Idaho, Inc.

Via:

[x] Email
[ ] Fax
[ ] CM/ECF
[ ] Hand Deliver
[ ] U.S. Mail

s/ Julia Thrower
Julia Thrower

Attachment 1

[PROPOSED] SECOND ~~FIRST~~ AMENDED PETITION
TO INITIATE CONTESTED CASE: AIR QUALITY
PERMIT TO CONSTRUCT P-2019.0047 (JUN. 17, 2022)*

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	
	)	Agency Case No. 0101-22-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON	)	OAH Case No. 23-245-01
Petitioners,	)	**[PROPOSED] SECOND ~~FIRST~~ AMENDED PETITION TO INITIATE CONTESTED CASE: AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 (JUN. 17, 2022)***
v.	)	
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC.	)	
Intervenor.	)	

** This [Proposed] Second Amended Petition uses underscoring to highlight the additions made to the First Amended Petition, as illustrated here. For clarity, changes to paragraph numbers, however, are not indicated.

INTRODUCTION

1. Petitioners Nez Perce Tribe, Idaho Conservation League ("ICL"), and Save the South Fork Salmon ("SSFS"), by and through their attorneys of record, file this Petition to Initiate Contested Case ("Petition") before the Idaho Board of Environmental Quality ("Board") pursuant to Idaho Code § 39-107(5) and IDAPA 58.01.23. This Petition challenges the Air Quality Permit to Construct P-2019.0047 ("PTC") issued by the Idaho Department of Environmental Quality ("DEQ") on June 17, 2022, to mining company Perpetua Resources Idaho, Inc. ("Perpetua") for its proposed Stibnite Gold Project ("SGP").

2. The SGP is in the headwaters of the East Fork of the South Fork of the Salmon River approximately ten miles east of the town of Yellow Pine, Idaho. The SGP is geographically located within the Nez Perce Tribe's aboriginal homeland and within the area over which the Nez Perce Tribe has Treaty-reserved rights and resources. As proposed, Perpetua would use conventional mining techniques to extract ore from three open pits, process gold, and dispose of mine waste at the SGP site.

3. The PTC being challenged here authorizes emissions of air pollutants from the SGP that will occur over the mine's anticipated 16-year life span. These emissions include massive quantities of dust generated by mining, hauling, and processing. The dust includes particulate matter and arsenic—pollutants which can cause serious harm to human health and the environment.

4. When it issued the PTC, DEQ failed to comply with the federal Clean Air Act and with Idaho rules, regulations, and guidance for Clean Air Act permitting, and DEQ acted arbitrarily and capriciously, acted on unlawful procedure, and abused its discretion, under the Idaho Administrative Procedure Act, Idaho Code § 67-5279, in multiple ways set forth below.

Petitioners respectfully request that the Board reverse and set aside the PTC and remand to DEQ to correct these errors.

LISTING OF REPRESENTATIVES

5. Copies of all pleadings, correspondence, and official documents shall be served on the Petitioners' counsel listed below:

For the Nez Perce Tribe and the Idaho Conservation League:

Bryan Hurlbutt
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org

For Save the South Fork Salmon:

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com

JURISDICTION, STANDARD OF REVIEW, PARTIES, AND STANDING

6. Pursuant to Idaho Code § 39-107(5), IDAPA 58.01.23, and IDAPA 58.01.01 (the "Idaho Air Rules"), the Board has jurisdiction over this contested case challenging DEQ's action issuing PTC P-2019.0047 for the SGP on June 17, 2022. The original Petition was timely filed on July 22, 2022, within thirty-five (35) days of the date of DEQ's June 17, 2022 decision. *See* IDAPA 58.01.23.060. The~~is~~ First Amended Petition was filed on December 6, 2022. This Second Amended Petition is proper under IDAPA 58.01.23.003.01, IDAPA 04.11.01.305, and Idaho Rule of Civil Procedure 15(a)(2).

7. An agency action, such as DEQ's issuance of the PTC being challenged here, may be reversed if it is in violation of constitutional or statutory provisions, is in excess of statutory

authority, is made on unlawful procedure, or is arbitrary, capricious, or an abuse of discretion. Idaho Code ("I.C.") § 67-5279. When an agency action is not affirmed, it shall be set aside, in whole or in part, and remanded for further proceedings as necessary. *Id.*

8. Pursuant to IDAPA 58.01.23.002.02: "Any person aggrieved by an action or inaction of the Department may file a petition to initiate a contested case pursuant to Chapter 52, Title 67, Idaho Code." An aggrieved person is defined as "any person or entity with legal standing to challenge an action or inaction of the Department, including but not limited to permit holders and applicants for permits challenging Department permitting actions." IDAPA 58.01.23.005.01.

9. PETITIONER NEZ PERCE TRIBE is a federally-recognized Indian tribe with headquarters on the Nez Perce Reservation in Lapwai, Idaho; and with offices in Orofino, McCall, and Powell, Idaho, and Joseph, Oregon.

10. The Nez Perce Tribe has standing to bring this contested case. The Nez Perce people, the *Nimiipuu*, exclusively occupied, since time immemorial, over thirteen million acres encompassing a large part of what is today Idaho, Oregon, and Washington—stretching from the Bitterroot Mountains to the Blue Mountains. Nez Perce also traveled far beyond this homeland to fish, hunt, gather, and pasture—frequently going east to buffalo country, in what is today the state of Montana, and west along the Snake and Columbia rivers to the Pacific Ocean. The Nez Perce actively maintain their connection to the land, water, and resources of their vast homeland. The Nez Perce's intimate knowledge and continuous use of their homeland over millennia have created a unique and reverential bond between people and place that defines Nez Perce culture and identity.

11. When the Nez Perce Tribe entered into a treaty with the United States in 1855, it sought to reserve the rights central to maintaining its culture and way of life. The 1855 Treaty reserved to the Tribe, for its "exclusive use and benefit," 7.5 million acres of its more than thirteen-million- acre homeland, including an area spanning present-day north-central Idaho, southeast Washington, and northeast Oregon as well as:

> [T]he right of taking fish at all usual and accustomed places in common with citizens of the Territory; and of erecting temporary buildings for curing, together with the privilege of hunting, gathering roots and berries, and pasturing their horses and cattle upon open and unclaimed land.

Treaty with the Nez Perces, art. 3, June 11, 1855, 12 Stat. 957. Nez Perce Tribal members, pursuant to the Nez Perce Tribe's Treaty-reserved rights, continue to fish, hunt, gather, and pasture across the Nez Perce Tribe's vast aboriginal homeland and at traditional places, including areas within and surrounding the SGP. The Nez Perce Tribe, as a co-manager of its treaty-reserved resources, also plays a leading role in the restoration of the East Fork South Fork Salmon River and South Fork Salmon River fisheries, expending approximately $2.5 million annually to restore Chinook salmon runs in both rivers through hatchery supplementation, fishery research, and watershed restoration.

12. The Nez Perce Tribe will suffer physical, cultural, spiritual, and economic injury caused by excessive air pollutants resulting from DEQ's issuance of the PTC. Clean, clear air is a critical component to ensuring the health and resiliency of the Nez Perce Tribe's Treaty-reserved rights and resources. Air pollution reduces visibility, which impairs cultural and ceremonial practices for Tribal members and reduces enjoyment of these special places. Air pollution causes a host of environmental and human health problems, including damage to culturally important plants, sensitive forests, and fish habitat, acidification of lakes and streams, depletion of soil nutrients, aggravated asthma, heart attacks, and premature death. Impacts can be especially

harmful to at-risk ecosystems and especially harmful for sensitive human populations such as asthmatics, children, the elderly, people with diabetes, and people with heart or lung disease.

13. To safeguard its rights and interests, the Nez Perce Tribe has participated extensively in DEQ's review process, including submitting comments on October 12 and November 10, 2020, March 8, 2021, and March 14, 2022. A favorable decision in the Contested Case will redress these injuries suffered by the Tribe.

14. PETITIONER IDAHO CONSERVATION LEAGUE is an Idaho non-profit conservation organization. Its main office is located in Boise, Idaho, and it has three field offices in Sandpoint, Ketchum, and McCall. ICL represents approximately 50,000 supporters dedicated to protecting and conserving Idaho's clean water, air, public lands, and wildlife.

15. ICL has standing to bring this contested case. ICL supporters, staff, and board members ("ICL members") regularly visit the SGP and/or nearby areas where air quality would be affected by the SGP for professional, recreational, aesthetic, and other purposes. ICL members will suffer health, environmental, and aesthetic injuries from the particulate matter and arsenic air pollution emitted by the SGP and authorized by DEQ's issuance of the PTC. A favorable decision in the Contested Case will redress ICL's injuries. Neither the claim asserted, nor the relief requested, requires participation of these individual ICL members in the lawsuit. The interests ICL seeks to protect are germane to the organization's purpose in protecting Idaho's clean water, clean air, wildlife, and public lands.

16. In furtherance of its mission, ICL participated extensively in the public processes for the PTC, including by submitting formal public comments to DEQ on October 12 and November 11, 2020, March 19, 2021, and March 16, 2022.

17. PETITIONER SAVE THE SOUTH FORK SALMON is a community-based, non-profit conservation organization headquartered in McCall, Idaho. SSFS represents members and supporters dedicated to preserving the South Fork Salmon River watershed and ecosystem.

18. SSFS has standing to bring this contested case. SSFS members, supporters, and members of the Board of Directors ("SSFS members") regularly visit the South Fork Salmon River watershed and the SGP site, where the emission of excessive air pollutants due to DEQ's issuance of the PTC would impact professional, economic, recreational, aesthetic, environmental, and human health interests. SSFS members would suffer injury from DEQ's issuance of the PTC from environmental, health, and aesthetic harms caused by the emission of harmful air pollutants, including particulate matter and arsenic. A favorable decision in the Contested Case will redress these injuries suffered by SSFS members. Neither the claims asserted, nor the relief requested, requires participation of these individual supporters in the lawsuit. The interests SSFS seeks to protect are germane to the organization's mission of protecting and preserving the South Fork Salmon River watershed and ecosystem, and protecting public health, the river, the fish, and recreational opportunities in the area.

19. In furtherance of this mission, SSFS participated extensively in the public process for the PTC, including submitting formal public comments to DEQ on October 12 and November 11, 2020, March 19, 2021, and March 16, 2022.

20. RESPONDENT IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY is an executive department and administrative agency organized under the laws of the State of Idaho, pursuant to the Idaho Constitution (Article IV, Section 20) and Idaho Code section 39-104(1). Its principal offices are located at 1410 N. Hilton, Boise, Idaho 83706. DEQ, through its

Director, and subject to Board oversight, is responsible for issuing air quality PTCs under the Idaho Air Rules, IDAPA 58.01.01.

21. On June 17, 2022, DEQ issued PTC P-2019.0047, which is the subject of this contested case. On July 22, 2022, Petitioners timely filed the original Petition to Initiate Contested Case. On July 28, 2022, the Hearing Officer Dylan Lawrence was assigned to preside over this matter. On August 12, 2022, Perpetua filed a Petition to Intervene. On August 22, 2022, Perpetua's Petition to Intervene was granted. On September 6, 2022, Perpetua filed a Motion to Dismiss. On November 15, 2022, the Hearing Officer issued the Order on Motion to Dismiss, denying the motion with respect to the majority of Petitioners' claims, dismissing or partially dismissing four claims, and declining to allow the pleadings to be amended unless Petitioners file for consideration a formal motion to amend the Petition.

FACTUAL SUPPORT FOR PETITION

I. OVERVIEW OF SGP & CHRONOLOGY OF DEQ'S ISSUING THE PTC

22. Perpetua is currently in the process of seeking multiple permits and other approvals from multiple agencies and other authorities for the proposed SGP. As described by DEQ in the Statement of Basis ("SOB") document prepared with the PTC:

> Perpetua proposes to construct and operate the SGP, consisting of conventional open-pit mining, ore preparation, and gold extraction operations. The SGP is to be located in Valley County at the intersection Forest Service roads NF-374 and NF-412 (Stibnite Road), approximately 10 miles east of Yellow Pine. The project will be located on a combination of public national forest and private lands. The mining operations boundary within which public access will be excluded is defined in Figure 1. This operations boundary also defines the ambient air boundary that was used in all ambient air quality impact analyses as part of the development process of the PTC.
>
> The SGP will require the construction of significant infrastructure, including a power transmission line, a primary mine site access road, onsite haul roads, an ore processing facility, onsite workspaces, employee housing and recreation, water storage and distribution facilities, and sewage disposal facilities.

Conventional open-pit mining methods including drilling, blasting, excavating, and hauling will be used to extract ore and waste rock, termed development rock (DR). Hydraulic shovels and front-end loaders will be used to load ore and DR into haul trucks. DR will be used for construction, restoration, and backfilling, or hauled to the dedicated development rock storage facilities (DRSF). Approximately 340 million tons of DR will be handled over the life of the mine.

The SGP will include three years of pre-mining development and construction activities, followed by an operating mine life of approximately 12 years. Mining will occur in three open pits: Yellow Pine Pit (YPP), Hangar Flats pit (HFP), and West End pit (WEP). Although there will be overlap in mine development, construction and operations, the general sequence of mining will be the YPP deposit, followed by the HFP and WEP deposits. Legacy tailings from the Meadow Creek valley (Bradley Tailings [BT]) will also be reclaimed and reprocessed during the initial project schedule. Surface exploration drilling will occur within the pits and within the Scout Prospect decline (underground exploration) throughout the mine operation period. Restoration and reclamation of other legacy mining features will occur prior to mining, throughout the life of the mine, and as part of the mine closure.

Ore will be hauled to the primary crusher area, where it will be fed directly into the crusher dump pocket or stockpiled. The ore crushing plant will be designed to operate at a maximum rate of 25,000 tons per calendar day (T/day). Approximately 100 million tons of ore will be mined from the three pits over the life of the project. The metal-recovery process from ore will include conventional crushing and grinding, followed by froth-flotation circuits that will generate separate gold-silver and antimony-silver concentrates. The antimony-silver concentrate will be shipped offsite for refining, whereas additional onsite processing of the gold-silver concentrate will include pressure oxidation, carbon-in-leach circuits, and refining processes to recover gold and minor amounts of silver. The finely ground leftover ore material from the mineral recovery process, termed tailings, will be neutralized, thickened, and transported via a pipeline to the tailings storage facility. A diagram of ore processing and ore concentration and refining process flows is provided in Figure 2.

23. Perpetua (previously Midas Gold) submitted a PTC application for the SGP to DEQ on August 20, 2019. As shown in the "Application Chronology" section of the SOB, between that date and March 6, 2020, DEQ determined that the application was incomplete, requested additional information, and received supplementary materials from Perpetua no fewer than four times. On May 15, 2020, DEQ deemed Perpetua's application complete.

24. Between May 15, 2020, and March 16, 2022, DEQ developed three versions of the draft PTC and released them for public comment. As noted in comments submitted by the Nez Perce Tribe, ICL, and SSFS, the first two draft versions of the PTC (herein referred to the September 2020 and February 2021 draft PTCs) contained significant shortcomings. As a result, the September 2020 draft PTC was considered deficient and required updated information from Perpetua, including updated hazardous air pollutants ("HAP") and toxic air pollutants ("TAP") emissions estimates, a HAP/TAP addendum to the application, updated TAP modeling analyses, supporting references, and updated modeling files with corrections for formaldehyde and sulfuric acid.

25. DEQ subsequently updated the draft PTC and in February 2021, provided a revised draft PTC for public comment. Following additional comments, DEQ again determined that the February 2021 draft PTC was deficient and required additional information from Perpetua, including Prevention of Significant Deterioration emissions estimates and regulatory applicability for the lime manufacturing plant, as well as an updated TAP/HAP addendum including an updated emission inventory and modeling files.

26. DEQ revised theFebruary 2021 draft PTC and released it for public comment on January 13, 2022. Comments were submitted by the Nez Perce Tribe, ICL, SSFS, the U.S. Environmental Protection Agency ("EPA") Region 10, and Ian von Lindern of Terragraphics International Foundation. Commenters raised numerous concerns with the draft PTC and urged DEQ to gather additional information, to perform additional modeling and analysis, and to develop additional enforceable permit conditions and limits prior to issuing a final PTC. On June 17, 2022, DEQ issued the final PTC, along with responses to comments and the SOB.

While DEQ made limited updates to the PTC, it rejected most of the issues raised by the commenters.

27. On August 10, 2023, EPA Regional Administrator Casey Sixkiller wrote a letter to Idaho Department of Environmental Quality ("DEQ") Director Jess Byrne (the "EPA Letter"), expressing ongoing concerns with the PTC. The EPA Letter stated:

> The Agency has three primary concerns with the Department's Permit: (1) the Permit's emission limits are not adequate to limit the Stibnite Gold Project's potential to emit below the Prevention of Significant Deterioration permitting threshold; thus, construction of the Stibnite Gold Project would constitute construction of a major stationary source without a Prevention of Significant Deterioration permit, (2) the Permit's emission limits are not adequate to protect the particulate matter National Ambient Air Quality Standard, and (3) the Department's delineation between the Stibnite Gold Project boundary and the ambient air—where the National Ambient Air Quality Standards apply—is not adequately supported. Details of the Agency's evaluation of the final permit are enclosed for your review.

28. In the supporting enclosure to the EPA Letter, EPA provided more detailed information and analysis regarding its concerns with the PTC, including providing detailed information about EPA's concern that DEQ failed to use appropriate emissions factors to estimate emissions from the SGP's ore processing and lime plant units.

29. The EPA Letter also stated that EPA "believes that the deficiencies in the Permit outlined in the enclosure and articulated in prior comments can be rectified through issuance of a revised permit to construct with adequate and enforceable conditions." *Id.* The EPA Letter requested an in-person meeting aimed at a timely resolution of EPA's concerns, such as by issuing a revised PTC.

II. PM_{10} & ARSENIC EMISSIONS FROM THE SGP

30. While the SGP will emit numerous air pollutants, PM_{10} and arsenic are the air pollutants of greatest concern and are the pollutants at issue in this contested case.

A. PM_{10} Pollution and Regulation

31. Particulate matter ("PM") contains microscopic solids or liquid droplets that are so small that they can be inhaled and cause serious health problems. Some particles less than 10 micrometers in diameter can get deep into a person's lungs, and some may even get into the person's bloodstream. Numerous scientific studies have linked particle pollution exposure to a variety of problems, including premature death in people with heart or lung disease; nonfatal heart attacks; irregular heartbeat; aggravated asthma; decreased lung function; and increased respiratory symptoms, such as irritation of the airways, coughing or difficulty breathing. People with heart or lung diseases, children, and older adults are the most likely to be affected by particle pollution exposure.

32. In addition to causing human health problems, PM causes environmental damage. Particles can be carried over long distances by wind and then settle on ground or water. Depending on their chemical composition, the effects of settling may include making lakes and streams acidic; changing the nutrient balance in river basins; depleting nutrients in soil; damaging sensitive forests and crops; affecting diversity of ecosystems; and contributing to acid rain.

33. Under Sections 108 and 109 of the federal Clean Air Act, EPA is required to establish National Ambient Air Quality Standards ("NAAQS") for each "criteria air pollutant" to protect the nation's public health and welfare. "[E]ffects on welfare include[ ], but [are] not limited to, effects on soils, water, crops, vegetation, manmade materials, animals, wildlife,

weather, visibility, and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being, whether caused by transformation, conversion, or combination with other air pollutants." 42 U.S.C. § 7602(h).

34. PM is a criteria air pollutant. EPA has established primary and secondary NAAQS for coarse particulate matter, or "PM_{10}," 40 C.F.R. § 50.6, and for fine particulate matter, or "$PM_{2.5}$," *id.* at § 50.7. PM_{10} consists of inhalable particles with diameters that are generally ten micrometers and smaller. 42. U.S.C. § 7602(t). $PM_{2.5}$ consists of inhalable particles that are 2.5 micrometers and smaller. The NAAQS specify a maximum amount of PM to be present in the outdoor air. *See* 40 C.F.R. §§ 50.6, 50.7.

35. EPA has delegated to DEQ authority to issue air quality permits in Idaho. Under the Clean Air Act, State air rules like DEQ's "shall" include "enforceable emission limitations" and other control measures, means, or techniques as necessary or appropriate to meet Clean Air Act requirements. 42 U.S.C. § 7410(a)(2)(A). State plans "shall" include a "program to provide for the enforcement" of the limitations and measures described in subparagraph (A), and for the "regulation of the modification and construction of any stationary source . . . to assure that [NAAQS] are achieved." *Id.* § 7410(a)(2)(C). EPA's Clean Air Act regulations require each State plan to "set forth legally enforceable procedures" that enable the State to determine whether the construction of a facility will result in a violation of its air pollution control strategies or interfere with attaining or maintaining the NAAQS. 40 C.F.R. § 51.160(a). These legally enforceable procedures: must include means by which the State will prevent construction if the facility will violate air pollution control strategies or will interfere with attaining or maintaining the NAAQS; and must provide for the applicant to submit information on the

"location, design, construction, and operation of such facility . . . as may be necessary" to permit the state to "to make the determination" that the facility will comply with its air pollution control strategies and the NAAQS. *Id.* § 51.160(b)–(c). "The legally enforceable procedures in § 51.160(b) must also require" the State to provide opportunity for public comment on information submitted by the applicant and on the State's analysis of the effects on ambient air quality. *Id.* § 51.161(a). Under the Rules for the Control of Air Pollution in Idaho, DEQ is required to ensure that no PTC shall be granted for a new or modified stationary source unless the applicant shows to the satisfaction of DEQ that the source would not cause or significantly contribute to a violation of any NAAQS. IDAPA 58.01.01.203.02. To satisfy these requirements, DEQ must assess air impacts using maximum potential emissions as limited by either the capacity of the unit/operation or as limited by enforceable permit provisions. *See* IDAPA 58.01.01.006.88. Prior to issuing a permit to contruct, DEQ must provide an opportunity for public comment by making available DEQ's proposed action together with information provided by the applicant and with DEQ's analysis of air quality impacts. IDAPA 58.01.01.209.c.

B. PM_{10} Pollution from the SGP & Flaws in the PTC

36. According to DEQ's Statement of Basis for the SGP, the SGP has the potential to emit 55.7 tons per year of PM_{10} from a variety of sources. The generation of dust from ore haul trucks traveling along haul roads is the most significant source, estimated to be approximately 55% of all modeled PM_{10} emissions. The next most significant source is open pit drilling fugitive emissions, estimated by DEQ to account for approximately 24% of all modeled emissions.

37. DEQ modeled receptors at various locations along the SGP's ambient air boundary and determined that the maximum potential emissions will be below (and thus comply

with) the 24-hour PM_{10} NAAQS. DEQ found the maximum 24-hour PM_{10} pollution from the SGP would be 123.5 ug/m^3, which is 82.3% of the NAAQS.

38. For each of the reasons below, DEQ's determination that the SGP will not cause or contribute to a violation of the PM_{10} NAAQS and its action approving the PTC violates the Clean Air Act, violates EPA's Clean Air Act regulations, violates the Idaho Air Rules, and is otherwise arbitrary, capricious, made on unlawful procedure, and an abuse of discretion and must be set aside under I.C. § 67-5279.

39. First, important variables affecting the quantity of PM_{10} generated by the ore haul trucks are not directly limited and enforceable as PTC permit conditions. Perpetua estimated the quantity of PM_{10} that would be emitted by the ore haul trucks based on EPAs compilation of air emissions factors (AP-42 Chapter 13.2.2) and their subsequent analysis of sources used by the EPA to develop Chapter 13.2.2. Critical variables that Perpetua used as inputs to PM emission calculations include: the average empty weight of ore haul trucks; the average loaded weight of ore haul trucks; the total number of larger versus smaller ore haul trucks (CAT 789D versus CAT 740B); the silt content of the haul road being traveled; the number of days per year with precipitation greater than or equal to 0.01 inches per day; and the total number vehicle miles traveled by ore haul trucks. However, only one of these critical variables is directly limited and enforceable as a condition in the PTC: the silt content of the haul roads. *See* PTC condition 3.13.

40. Instead of developing PTC conditions for these other critical variables, DEQ relied on a surrogate limit in the PTC (total ore haulage per day, *see* PTC conditions 3.5) and on plans that have not yet been developed and have not been subject to public comment,—a Fugitive Dust Control Plan ("FDCP") and a Haul Road Capping Plan ("HRCP")—to claim the PTC ensures enforceable compliance with 24-hour PM_{10} NAAQS. Without developing the

FDCP and HRCP first, without taking public comment on them, and without including important variables as enforceable permit conditions, there is no assurance the SGP will comply with the 24-hour PM_{10} NAAQS, even with the total ore haulage per day limit. Perpetua used a very specific combination of these variables to arrive at a quantity of ore haul truck generated PM_{10} that they contend ensures compliance with the NAAQS. Changing these variables in any number of ways (ways which are not precluded by any conditions in the PTC) can result in higher PM_{10} levels—levels so high that they exceed the NAAQS. As just one example, merely changing the ratio of large to small ore haul trucks used by Perpetua (to include more small trucks) could cause a violation of the NAAQS.

41. Second, DEQ assumed 93.3% of all haul road PM_{10} emissions from the SGP can be controlled by using an unspecified combination, volume, and frequency of water sprays and chemical dust suppressants. This extremely high level of control which DEQ assumed Perpetua can achieve is based on Perpetua's interpretation of AP-42 Chapter 13.2.2. AP-42 Chapter 13.2.2 discusses the critically important variables surrounding control efficiencies (in particular to chemical suppressants, some of which can reasonably be assumed to apply to water too):

> The control effectiveness of chemical dust suppressants appears to depend on (a) the dilution rate used in the mixture; (b) the application rate (volume of solution per unit road surface area); (c) the time between applications; (d) the size, speed and amount of traffic during the period between applications; and (e) meteorological conditions (rainfall, freeze/thaw cycles, etc.) during the period. Other factors that affect the performance of dust suppressants include other traffic characteristics (e. g., cornering, track-on from unpaved areas) and road characteristics (e. g., bearing strength, grade). The variabilities in the above factors and differences between individual dust control products make the control efficiencies of chemical dust suppressants difficult to estimate. Past field testing of emissions from controlled unpaved roads has shown that chemical dust suppressants provide a PM-10 control efficiency of **about 80 percent when applied at regular intervals of 2 weeks to 1 month (**emphasis added**).**

42. None of the above variables, however, have any specific and enforceable permit conditions within the PTC to ensure a 93.3% control efficiency. Instead, the PTC has a permit condition (permit condition 2.6) only requiring the permittee to develop and submit the FCDP and HRCP, which merely describe how these variables will be addressed 30 days before start-up of the SGP. Permit condition 2.6 details what variables contributing to PM_{10} control effectiveness must be detailed in the FCDP, but the specific details that are so important to control efficiency (e.g., the amount of water or chemical suppressants applied and the frequency of application) are undetermined at present, have not been subject to public comment, and are left to Perpetua to decide at a later date. A lesser control efficiency, even just slightly lesser, could result in large enough PM_{10} emissions to violate the NAAQS. In fact, if the SGP were to instead achieve 80% control (as EPA found through past field testing of chemical dust suppressants), then the SGP's PM_{10} emissions could exceed the NAAQS.

43. Third, DEQ relied on monitoring and record keeping (permit condition 3.16) using devices and methodologies in the Operation and Maintenance ("O&M") Manual for the potential to emit limit associated with the 180,000 tons per day hauling in permit condition 3.5. However, the O&M Manual has not yet been developed, submitted to the public for comment, ~~or~~ reviewed and revised by DEQ, or incorporated into and made enforceable under the Permit. The O&M Manual is critical to ensuring the 180,000 tons per day hauling condition is satisfied, and the 180,000 tons per day is critical to DEQ's determination under IDAPA 58.01.01.203.02 that the SGP will not exceed the NAAQS. Additionally, DEQ is authorized to require plans and to impose any reasonable conditions on permits, but instead of doing so here, it is letting Perpetua do this later, outside of the permit process. *See* IDAPA 58.01.01.202.03 (authorizing DEQ to obtain from permit applicant "[a]ny additional information, plans, specifications, evidence or

documents the Department may require to make the determinations required under [the PTC sections of the Air Rules]"); IDAPA 58.01.01.211 (authorizing DEQ to "impose any reasonable conditions upon an approval" of a PTC); IDAPA 58.01.01.121 (authorizing DEQ to require schedules, reports, records, monitoring, and plans to ensure compliance with Air Rules); IDAPA 58.01.01.122.03.g (authorizing DEQ to issue an information order to provide any "information the Department may require").

44. Fourth, DEQ assumed there would be 120 days of recordable precipitation at the SGP (defined as recording precipitation of 0.01 inch or greater) as a variable in its ore haul road fugitive PM emission calculations. This 120 days comes from general geographic guidance from AP-42 Chapter 13.2.2-1. DEQ, however, should have used local meteorological data. Section 6.8 (Meteorological Data) of DEQ's *Guideline for Performing Air Quality Impact Analyses* states: "The meteorological data used in the modeling analysis should be representative of the meteorological conditions at the particular site of the proposed construction or modification." Days of recordable precipitation is an important variable affecting the SGP's emissions of PM_{10} from ore haul roads. DEQ's failure to use the most representative site data is counter to this guidance and increases the risk of miscalculation of ore haul road emissions. As a result, DEQ failed to ensure PM_{10} emissions from the SGP will comply with the NAAQS.

C. Arsenic Pollution & Regulation

45. Arsenic is a naturally occurring element in soils and minerals. When soil or rock containing arsenic is disturbed, arsenic may enter the air, water, and land from wind-blown dust and from run-off and leaching. The EPA classifies inorganic arsenic as a "human carcinogen," based on evidence in human studies of links to lung, bladder, kidney, skin, and liver cancers.

46. Arsenic released from the soil and rock as airborne dust causes environmental damage. Airborne arsenic pollutes soil, plants, and water resources when it is removed from the air by rain, snow, or gradually settling. Studies have shown that there is a strong correlation between arsenic concentrations in water and in the tissues of fish collected from arsenic-polluted waters. Plants may also absorb arsenic in their leaves and root system from arsenic-polluted soil. The health effects of long-term ingestion of arsenic include developmental effects, diabetes, pulmonary disease, cardiovascular disease, and skin, bladder, or lung cancer.

47. Arsenic is a Toxic Air Pollutant regulated by DEQ. DEQ is required to ensure that no permit to construct shall be granted for a new or modified stationary source unless emissions of TAPs from the constructed source would not injure or unreasonably affect human or animal life or vegetation as required by Section 161. IDAPA 58.01.01.203.03. Section 161 states, "any contaminant which is by its nature toxic to human or animal life or vegetation shall not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation." IDAPA 58.01.01.161.

48. To comply with these TAPs regulations, emissions from a facility must not exceed the Acceptable Ambient Concentrations of Carcinogens ("AACC") at the ambient air boundary. For each carcinogenic TAP, IDAPA 58.01.01.586 lists the applicable TAP and its AACC in ug/m^3 as an annual average. The AACC can practically be defined as the concentration of a TAP that, if an individual was exposed to yearly over a 70-year lifetime, would equate to a cancer development probability risk of 1 in 1,000,000. *See* IDAPA 58.01.01.006.125 & 58.01.01.210.12.

49. In order to determine a facility's TAP concentration at their ambient air boundary, and as noted similarly for PM_{10} emissions, DEQ must assess air impacts using maximum potential emissions as limited by either the capacity of the unit/operation or as limited by enforceable permit provisions. *See* IDAPA 58.01.01.006.88.

D. Arsenic Pollution from the SGP & Flaws in the PTC

50. There are numerous arsenic sources at the SGP, including drilling, blasting, excavating, hauling, silos, rock dumps, and storage and tailing piles. Table 3 in the SGP TAPs Addendum indicates that the maximum arsenic Potential Total Emissions ("PTE") is 0.544 lbs/hr at the maximum mine production rate of 180,000 tons/day. The largest source of arsenic emissions are haul roads estimated at 0.464 lbs/yr (Table B1-W3 in SOB). PTE estimates for arsenic are calculated using the same formulas and Emission Factors as total particulate and PM_{10} emission rates. As such, like the PM and PM_{10} emission estimates discussed already, the arsenic emission estimates are similarly underestimated and equally unreliable.

51. During the permitting process, DEQ determined that the SGP's estimated arsenic emissions and concentrations at the ambient air boundary were excessive and would not meet the AACC for arsenic. To get around this problem, Perpetua chose to employ a process known as T-RACT. T-RACT is a demonstration that allows a permittee to analyze and employ reasonably available control technologies ("RACT") that could be applied to a source of TAPs. If RACT does not sufficiently reduce toxic emissions to below the AACC, then the permittee is allowed a 10-fold increase in the AACC and can employ production limitations to ensure compliance with the now 10-times-bigger AACC. These production limitations should then be incorporated as enforceable permit conditions. *See* IDAPA 58.01.01.210.13–14.

52. As part of the T-RACT determination process, the applicant must supply, and DEQ must consider, information on a variety of factors relevant to determining a "reasonable" control technology including, but not limited to, control effectiveness, economic costs, operational feasibility, and associated environmental impact. IDAPA 58.01.01.210.14a–d.

53. Perpetua submitted to DEQ a T-RACT demonstration for arsenic emissions from open-pit drilling and ore haul roads. Perpetua determined that the most effective RACT for open-pit drilling was dry drilling with dust collectors and that the most effective RACT for ore haul roads was water sprays and chemical suppressants. In its T-RACT demonstration, Perpetua included limited qualitative discussion, and no quantitative support, regarding economic considerations. Perpetua failed to provide any discussion of environmental impacts.

54. DEQ approved Perpetua's T-RACT demonstration and granted Perpetua a 10-fold increase in allowable arsenic pollution, subject to operational limitations to reduce PTE. And as modeled by DEQ, arsenic pollution from the SGP would comply with this larger AACC.

55. For each of the reasons below, DEQ's approval of Perpetua's T-RACT demonstration for arsenic, its analysis determining the SGP will not exceed the AACC and thus will not injure or unreasonably affect human or animal life or vegetation, and its action approving the PTC violates the Clean Air Act, violates EPA's Clean Air Act regulations, violates the Idaho Air Rules, and is otherwise arbitrary, capricious, made on unlawful procedure, and an abuse of discretion and must be set aside under I.C. § 67-5279.

56. First, the T-RACT demonstration contained no persuasive economic information and no discussion at all regarding associated environmental impacts, despite the requirements to do so in IDAPA 58.01.01.210.14. There will be water quality and biological impacts associated with Perpetua's use of substantial amounts of chemical dust suppressants and water that have not

been considered in the PTC. For example, the use of chemical dust suppressants like magnesium chloride can cause toxicity in trees and can lead to tree death. Magnesium chloride is also known to adversely affect aquatic ecosystems. Moreover, the proposed water source for dust control is primarily water collected in runoff ponds (captured rain or snowfall that has become contaminated through the contact of mine facilities), groundwater, and surface water from the East Fork of the South Fork of the Salmon River. USGS sampling indicates elevated arsenic in these waters. The environmental impact of using magnesium chloride or arsenic-polluted water as dust suppression methods was never considered as part of the T-RACT demonstration. Likewise, the T-RACT demonstration did not provide sufficient economic support for Perpetua's decision to use water and chemical dust suppressants as compared to paving the haul roads, even though paving was shown to achieve the highest reasonable dust control efficiency.

57. Second, because the underlying particulate and PM_{10} emissions estimates and particulate control assumptions are unreliable in numerous respects, as already discussed above, so too are the estimated arsenic emissions. The SGP's estimated arsenic emissions were based on its PM_{10} emissions. PM_{10} emissions from the SGP may be higher, and their control effectiveness may be lower, than DEQ assumed, in which case arsenic emissions would also be higher and might exceed the AACC.

58. Third, Perpetua's and DEQ's TAPs analyses substantially reduce the SGP's purported arsenic emissions using three improper averaging tactics: (1) averaging emissions over a 5-year period for the T-RACT input to ambient toxics modeling; (2) averaging the estimated annual ambient modeling impacts across two multi-year scenarios; and (3) averaging the resultant 16-year total emissions over the 70-year human lifetime to assert compliance. Nothing in the Idaho Air Rules allows for multi-year emissions averaging and ambient air concentration

adjustments. Rather, the arsenic AACC is an annual average. *See* IDAPA 58.01.01.586). DEQ's T-RACT regulations require comparing the estimated maximum annual ambient air arsenic concentration to 10 times the listed annual AACC. IDAPA 58.01.01.12.b. Therefore, to determine compliance with the AACC requires that DEQ estimate the SGP's maximum 1-year annual arsenic emissions and compare it to the annual arsenic AACC.

59. By relying on these improper averaging tactics, DEQ fails to show the SGP will satisfy the arsenic AACC and the resulting analysis masks potentially severe human health and environmental impacts of SGP's potential arsenic emissions. The underlying analyses supporting the TAPs requirements allows for a 1-in-1,000,000 excess cancer risk factor. The T-RACT approval increases that risk 10-fold to a 1-in-100,000 excess cancer risk factor. IDAPA 58.01.01.12.b. Perpetua's multi-year averaging of emission rates combined with DEQ's decision to allow the full lifetime exposure (70 years) to be imposed on receptors during the 16-year estimated life of mine increases the cancer risk by another order of magnitude to the 1-in-10,000 range or higher. Combined with uncertainties associated with the underlying particulate emissions calculations noted above, the SGP may result in extremely dangerous arsenic exposures.

60. While not the basis for a separate claim for relief, Petitioners note that excacerbating this cancer risk is the fact that under DEQ's incremental TAPs regulations (*see* IDAPA 58.01.01.585), when DEQ considers permitting any additional sources of arsenic in the area over the next 70 years (such as an extension of the life of the SGP, expansion of the facility itself, and/or any adjacent facilities seeking a similar permit, like the potential Horse Heaven project), DEQ will not have to consider the arsenic emissions authorized by this PTC.

E. DEQ's Ambient Air Boundary for the SGP

61. The Clean Air Act and Idaho Air Rules require meeting various air standards, including the NAAQS and TAPs, in ambient air. *See*, *e.g.*, IDAPA 58.01.01.006.11 (NAAQS), 58.01.01.006.125 (TAPs). EPA defines "ambient air" as "that portion of the atmosphere, external to buildings, to which the general public has access." 40 C.F.R. § 50.1(e). In defining an ambient air boundary, the EPA has long followed a policy that exempts "the atmosphere over land owned or controlled by the source and to which public access is precluded . . ." from ambient air. EPA's Revised Policy on Exclusions from "Ambient Air" (Nov. 2018) states that "it is appropriate to exclude the atmosphere over land owned or controlled by the stationary source, where the owner or operator of the source employs measures, which may include physical barriers, that are effective in deterring or precluding access to the land by the general public."

62. The Idaho Air Rules define "ambient air" as "[t]hat portion of the atmosphere, external to building, to which the general public has access." IDAPA 58.01.01.005.09. To exclude areas from consideration as ambient air, the following conditions must be met: (1) the permittee must have the legal authority to exclude the general public from the area; (2) the boundary to ambient air must be clearly discernible to the general public; (3) the general public must be effectively precluded from assessing the facility; and (4) the general public is not considered employees of the facility; those having official business with the facility; guests of the facility, including participants in facility routes and those seeking access for a specific purpose.

63. Perpetua established an operations boundary (the active industrial site where mining activities and heavy equipment operation will occur) for the purposes of excluding this area from ambient air analysis, and for excluding public access. The area includes the current

Stibnite Road point of entry and proposed site access via the Burntlog Route. According to Perpetua, access inside the operations boundary will be restricted for the life of the mine by physical barriers at points of potential access, as well as natural features of the landscape that prevent public access.

64. DEQ's determination to exclude the access route from ambient air protections, and its action approving the PTC violates the Clean Air Act, violates EPA's Clean Air Act regulations, violates the Idaho Air Rules, and is otherwise arbitrary, capricious, made on unlawful procedure, and an abuse of discretion and must be set aside under I.C. § 67-5279.

65. Perpetua has indicated that it intends to allow access to the general public through the mine site between Stibnite Road at Sugar Creek and Thunder Mountain Road at Meadow Creek. Furthermore, this roadway is currently accessible to and has been regularly used by the general public. And while Perpetua claims that it has "legal and practical ability to enforce its control over roadway access," the Forest Service has not yet completed its NEPA analysis and approval of the SGP, which would include a decision on whether it will require or will not permit general public access through the mine site.

66. DEQ states that the route would be managed in accordance with the Stibnite Road Access Management Plan ("AMP"). DEQ, however, relied on an ambiguous description of measures and requirements to preclude public access and ensure that those traveling over the road can be classified as "guests" of the mine.

67. PTC condition 2.7 requires the development of an AMP to address whether the NAAQS apply to the mine's access road through the Perpetua site given the extent of public access allowed. PTC condition 2.8 allows the AMP to be developed later, after the PTC was issued and without public comment, and it does not require the AMP to be enforceable. For the

AMP to preclude the applicability of the NAAQS along the access road, the AMP must be reviewed and approved by DEQ, it must be reviewed through public comment, and it must be enforceable under the PTC.

68. Without full disclosure and knowledge of the exact measures and requirements in the AMP and enforceable permit limits, DEQ cannot make a determination of whether exclusion of the access road from ambient air protections complies with EPA's ambient air policy and the Idaho Air Rules, nor can DEQ determine whether the SGP will comply with the NAAQS and TAPs.

F. DEQ's Failure to Require Ambient Air Monitoring for the SGP

69. DEQ has the authority to require ambient air monitoring to determine the effect emissions from the stationary source or facility may have on the air quality of the area potentially impacted by the source. IDAPA 58.01.01.211.01(d).

70. DEQ received comments from the Nez Perce Tribe, EPA Region 10, ICL, and SSFS urging the PTC to require ambient air monitoring to verify the SGP's compliance with the NAAQS and TAPs increments. But DEQ declined, stating in the Response to Comments (pg. 16): "DEQ disagrees that a PM/PM_{10} ambient monitoring network is necessary to make the PTC practically enforceable." DEQ states in the Response to Comments that any violation of the permit would be processed in accordance with DEQ's enforcement procedures manual.

71. However, without ambient air monitoring, it will be impossible for DEQ to assess whether the SGP's operation is in compliance with NAAQS and TAPs increments at any given time. Ambient air monitoring is necessary because of the large uncertainty surrounding dust control efficiency and emissions factors associated with the SGP for PM_{10} and arsenic, as well as

the lack of enforceable permit conditions for many important variables, as already described in this Petition.

H. DEQ's Improper Use of Emission Factors for Ore Processing

72. To estimate emissions from the SGP's ore processing units, DEQ used AP-42 emission factors from Section 11.19 Crushed Stone Processing, instead of using emission factors from AP-42 Section 11.24 Metallic Minerals Processing. The Crushed Stone Processing emission factors apply to non-metalic mineral processing. The Metallic Mineral Processing emission factors are more representative of the SPG's gold mining. As estimated in the EPA Letter from August 10, 2023, had DEQ instead used the Metallic Minerals Processing emission factors for ore crushers 1 through 13, potential PM emissions from just those units exceeds 800 tons per year, which is multiple times higher than the 250 tons per year threshold for minor source permitting. When it chose to use the Crushed Stone Processing emission factors, DEQ failed to demonstrate the AP-42 Crushed Stone Processing emissions factors are representative and appropriate to use for the SGP and failed to consider or explain this massive difference in emissions had it instead used the Metallic Minerals Processing emission factors.

73. Similarly, to estimate emissions from the SGP's Lime Plant, DEQ again used non-metallic mineral processings emission estimates from AP-42 Section 11.24, instead of using EPA's emission factors for lime manufacturing in Section 11.17. As estimated in the EPA Letter from August 10, 2023, had DEQ used Section 11.17 emission factors for Lime Plant units LS3/LS4 (primary Screen/Secondary Crusher), potential emissions would exceed 100 tons of PM per year for those units alone. Similarly, as estimated int eh EPA Letter, applying Section 11.17 emission factors to Lime Plant unit LS5 (secondary screen), another 128 tons of PM per year could be emitted. But DEQ chose, instead, to use Section 11.24 emission factors without

demonstrating that doing so was accurate, and without acknowledging the large difference in emissions had it used other emission factors for the Lime Plant.

74. The use of the AP-42 must be done with careful consideration, per the fifth (and most recent) edition of AP-42:

> "Use of these (AP-42) factors as source-specific permit limits and/or as emission regulation compliance determinations is not recommended by EPA. Because emission factors essentially represent an average of a range of emission rates, approximately half of the subject sources will have emission rates greater than the emission factor and the other half will have emission rates less than the factor. As such, a permit limit using an AP-42 emission factor would result in half of the sources being in noncompliance."

Furthermore, AP-42 also warns:

> "The extent of between-source variability that exists, even among similar individual sources, can be large depending on process, control system, and pollutant. Although the causes of this variability are considered in emission factor development, this type of information is seldom included in emission test reports used to develop AP-42 factors. As a result, some emission factors are derived from tests that may vary by an order of magnitude or more. Even when the major process variables are accounted for, the emission factors developed may be the result of averaging source tests that differ by factors of five or more."

75. The EPA Letter recommends the use of different AP-42 emission factors than those used by Perpetua. When given multiple opportunities through draft PTC public comment to provide a reasoned basis for the use of Perpetua's preferred AP-42 emission factors, DEQ failed to provide any justification. In choosing to accept the unjustified use of Perpetua's preferred AP-42 emission factors, IDEQ's decision to use Perpetua's preferred AP-42 emission factors was arbitrary and capricious.

76. IDEQ did not consider additional emission quantification techniques including stack/enclosure testing, vendor guarantees and stack/enclosure test data from similar facilities, optical remote sensing, or material balance calculations, all of which are emission quantification techniques recommended by the EPA when AP-42 emission factors may not be appropriate.

77. Higher PM emissions from the ore processing and lime plant units could contribute to a violation of the PM/PM_{10}/$PM_{2.5}$ NAAQS and the arsenic AACCs. These higher emissions could also exceed the thresholds under the Prevention of Significant Deterioration ("PSD") permitting pro.

78. PSD permitting generally applies to new or modified stationary emissions sources that have the potential to emit (generally defined has having the legal, *i.e,* permitted, and practical ability to emit at a certain level) more than 250 tons per year of a criteria pollutants (for a specific list of facilities, including lime processing plants, that threshold is reduced to 100 tons per year). Facilities subject to PSD permitting require: installation of the "Best Available Control Technology" (BACT); an airshed level air quality analysis; an additional impacts analysis; and prescribed public involvement. As per the EPA, "PSD permitting is designed to protect public health and welfare; preserve, protect, and enhance the air quality in national parks, national wilderness areas, national monuments, national seashores and other areas of special national or regional natural, recreational, scenic, or historic value; insure that economic growth will occur in a manner consistent with the preservation of existing clean air resources; and assure that any decision to permit increased air pollution in any area to which this section applies is made only after careful evaluation of all the consequences of such a decision and after adequate procedural opportunities for informed public participation in the decision making process." PSD permitting is generally required for only the most serious sources for air pollution that will have significant impacts on air quality.

79. Based on the flaws in DEQ's issuance of the PTC described above, DEQ's action is in violation of these provisions of the Idaho Air Rules, the Clean Air Act, and EPA's Clean

Air Act regulations, and is otherwise arbitrary, capricious, made on unlawful procedure, and an abuse of discretion and must be reversed.

RELIEF REQUESTED

80. An agency action, like DEQ's issuance of the PTC, may be reversed if it is in violation of constitutional or statutory provisions, is in excess of statutory authority, is made on unlawful procedure, or is arbitrary, capricious or an abuse of discretion. I.C. § 67-5279. When an agency action is not affirmed, it shall be set aside, in whole or in part, and remanded for further proceedings as necessary. *Id.*

81. As stated above, under the Idaho Air Rules, DEQ must not issue a PTC unless it determines: (1) "the stationary source or modification would comply with all applicable local, state or federal emission standards"; (2) "the stationary source would not cause or significantly contribute to a violation of any ambient air quality standard"; and (3) "the emissions of toxic air pollutants from the stationary source or modification would not injure or unreasonably affect human or animal life or vegetation as required by Section 161." IDAPA 58.01.01.203. Prior to issuing a permit to contruct, DEQ must provide an opportunity for public comment by making available DEQ's proposed action together with the information provided by the applicant and with DEQ's analysis. IDAPA 58.01.01.209.c. To ensure compliance with the NAAQS and other air pollution control strategies, the Clean Air Act and EPA's Clean Air Act regulations require state air rules like DEQ's: to include "enforceable emission limitations" and other measures, 42 U.S.C. § 7410(a)(2)(A); to include a "program to provide for the enforcement" of such measures, and to regulate the construction of any stationary source, *id.* § 7410(a)(2)(C); to "set forth legally enforceable procedures" for determining whether the construction of a facility will comply with control strategies and NAAQS, 40 C.F.R. § 51.160(a); to require sufficient information needed

"to make the determination" whether the facility will comply with air pollution control strategies and the NAAQS, i*d.* § 51.160(c); and to provide opportunity for public comment on information submitted by the applicant and on the agency's analysis of the effects to air quality. *Id.* § 51.161(a). Based on the flaws in DEQ's issuance of the PTC described above, DEQ's action is in violation of these provisions of the Idaho Air Rules, the Clean Air Act, and EPA's Clean Air Act regulations, and is otherwise arbitrary, capricious, made on unlawful procedure, and an abuse of discretion and must be reversed.

82. By issuing the PTC in its current form, DEQ failed to adequately protect the public and environment from harmful air pollution causing injury to the Nez Perce Tribe, ICL, SSFS, and their members and supporters. To redress these injuries, Petitioners respectfully request the Board set aside and remand the PTC and direct DEQ to correct the following errors prior to issuing any new or revised PTC:

Ore Haul Road PM_{10} & Arsenic Emissions

A. DEQ must develop and include in the PTC enforceable permit conditions for the maximum average empty weight of ore haul trucks, the maximum average loaded weight of ore haul trucks, the maximum total number vehicle miles traveled annually by ore haul trucks, the silt content of the roadbed, the arsenic content of the silt in the roadbed, and any other important variables affecting the SGP's fugitive emissions of PM_{10} and arsenic from vehicle traffic on mine haul roads. To develop such permit conditions and ensure compliance with the NAAQS and TAP limits, DEQ must reevaluate and recalculate fugitive emissions of PM_{10} and arsenic.

B. Silt and arsenic levels should be included as permit conditions and monitored regularly *in situ,* rather than from stockpiles as applied to the roadbed.

C. Instead of assuming 120 days of recordable precipitation at the SGP as a variable within ore haul road fugitive PM emission calculations, as done by the applicant based off general geographic guidance from AP-42 chapter 13.2.2-1, DEQ must recalculate all fugitive emissions after analyzing local meteorological data sources to determine a more accurate and representative number of days with recordable precipitation.

FDCP, AMP, O&M Manual, & HRCP

D. DEQ must require Perpetua to submit the FDCP, AMP, O&M Manual, and HRCP (collectively, "Plans"), must provide for public comment on the Plans, must review and revise Plans to ensure the SGP's emissions comply with IDAPA 58.01.01.203, and must incorporate the Plans as enforceable PTC conditions.

Arsenic Averaging

E. DEQ must remove the 5-year averaging for arsenic emissions, the averaging of estimated annual ambient modeling impacts across two multi-year scenarios, and the 16/70 life of mine versus lifetime exposure adjustment for the SGP's maximum arsenic ambient concentration it used to assess arsenic TAPs compliance. DEQ must use the SGP's highest 1-year arsenic emission rates for each scenario evaluated and repeat the modeling analyses using these rates. DEQ must use the maximum annual ambient arsenic concentration from the single emission scenario producing the highest annual concentration for any 1-year as the point of compliance. *See* IDAPA 58.01.01.210.03b ("The point of compliance is the receptor site that is estimated to have the highest ambient concentration of the toxic air pollutant of all the receptor sites that are located either at or beyond the facility property boundary or at a point of public access . . . ."). DEQ must assess the impact of the SGP's maximum 1-year annual emissions from the single emission configuration by comparing to the T-RACT AACC for arsenic (10 times the

AACC value published in IDAPA 58.01.01.586), without averaging over multiple years, and without adjusting for the alleged 16-year life of the mine or the 70-year lifetime exposure.

Ambient Air Boundary Monitoring

F. As part of any PTC for the SGP, DEQ must require ambient air boundary monitoring, as provided for by IDAPA 58.01.01.211.01(d), to ensure compliance with the NAAQS and the TAPs increments. DEQ must require Perpetua to submit an ambient air boundary monitoring plan ("AABMP"), must take public comment on the AABMP, must review and revise the AABMP, and must incorporate the AABMP as enforceable PTC conditions. At a minimum, the AABMP must provide a strategy for monitoring the ambient air concentrations of PM_{total}, PM_{10}, $PM_{2.5}$ and arsenic at the SGP's ambient air boundary. The AABMP must be developed according to best industry and regulatory practices, consulting contemporary sources (e.g., DEQ or EPA guidance, similarly established plans for other state permits, etc.). At a minimum, monitoring stations must be required for areas of the ambient air boundary in which DEQ ambient air modeling results (specifically results using operating scenario W3 and BULKRN meteorological data) show receptors with 24-hour PM_{10} or arsenic concentrations within 70% of the applicable NAAQS or AACC (without consideration to multi-year emissions averaging and 16/70 adjustment).

Environmental & Economic Impacts of Arsenic Control Technology

G. DEQ must require Perpetua to update their T-RACT analysis to include analysis of "environmental impacts caused by the control technology that cannot be mitigated, including, but not limited to, water pollution and the production of solid wastes," including the use of magnesium chloride and its aquatic life and tree toxicity effects, as well as using arsenic-contaminated water sources for dust suppression. IDAPA 58.01.01.210.14.c.ii. DEQ must also

require the updated T-RACT to adequately address the "economic feasibility of a control technology or other requirement, including the costs of necessary mitigation measures, for a particular source," including detailed consideration of the economic feasibility of paving haul roads to better control fugitive dust emissions. IDAPA 58.01.01.210.14.d. DEQ must provide the updated T-RACT demonstration for public comment, must review and revise the T-RACT demonstration, and must incorporate enforceable PTC conditions from the T-RACT demonstration in the PTC.

Accurate Emissions Factors

H. DEQ must develop, scientifically support, and use representative emission factors for the SGP's ore processing. DEQ must also develop, scientifically support, and use representative emission factors for the SGP's lime plant. Using these representative emission factors, DEQ must ensure the SGP complies with the applicable NAAQS, AACCs, and PSD requirements, including by requiring additional enforceable emission limits and/or requiring a PSD permit.

CONCLUSION

83. When it issued the PTC for the SGP, DEQ violated the federal Clean Air Act, EPA's Clean Air Act regulations, and the Idaho Air Rules; and it acted arbitrarily, capriciously, and on unlawful procedure and abused its discretion under I.C. § 67-5279. Accordingly, the Board should vacate and withdraw the PTC and remanded to DEQ to correct all errors.

Dated: ~~December 6, 2022~~ September __, 2023

Respectfully submitted,

Julia S. Thrower
MOUNTAIN TOP LAW PLLC
614 Thompson Avenue

McCall, ID 83638
(208) 271-6503
jthrower@mtntoplaw.com

Attorney for Petitioner Save the South Fork Salmon

_____

Bryan Hurlbutt
Laurence ("Laird") J. Lucas
ADVOCATES FOR THE WEST
P.O. Box 1612
Boise, ID 83701
(208) 342-7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for the Nez Perce Tribe and Idaho Conservation League

John R. Shackelford, ISB No. 8647
john.shackelford@deq.idaho.gov
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: 208.373.0453

Attorney for Respondent

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047

NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,

Petitioners,

v.

IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,

Respondent,

and

PERPETUA RESOURCES IDAHO, INC.,

Intervenor-Respondent.

Case Docket No. 0101-22-01

JOINT OPPOSITION TO PETITIONERS' MOTION TO AMEND CONTESTED CASE PETITION

The Idaho Department of Environmental Quality (the "Department") and Perpetua Resources Idaho, Inc. ("Perpetua") respectfully submit this opposition to Petitioners' Motion to Amend Contested Case Petition.

I. INTRODUCTION

Petitioners seek to amend their First Amended Petition to add claims that the Department erred in determining that the Stibnite Gold Project is a minor source instead of a major source under the Prevention of Significant Deterioration program of the Clean Air Act ("CAA"). Petitioners' motion to amend is untimely because this proceeding has now been pending for more than a year and is days away from a hearing on competing summary judgment motions, reflects avoidable delay because the proposed claims are based on evidence that was readily available to Petitioners when they initiated this contested case proceeding, and prejudices the Department and Perpetua because significant work was performed to narrow the claims subject to review and brief those claims for summary judgment. Accordingly, Petitioners motion for leave to amend should be denied.

II. ARGUMENT

The Idaho Rules of Administrative Procedure of the Attorney General and Rule 15(a) of the Idaho Rules of Civil Procedure provide the Hearing Officer discretion to allow pleadings to be amended. *See* IDAPA 04.11.01.305. However, the Hearing Officer need not grant leave to amend when the amendment will cause prejudice to the opposing party, is sought in bad faith, produces an undue delay in litigation, or is futile. *See Zeyen v. Pocatello/Chubbuck Sch. Dist. No. 25*, 165 Idaho 690, 695, 451 P.3d 25, 30 (2019). A Hearing Officer is well within his discretion to deny leave to amend when the party seeking leave to amend could have raised the claims in its original Petition, but failed to do so. *See id.* at 696; *accord Scannell v. Wash. State*

Bar Ass'n, 671 F. App'x 529, 531 (9th Cir. 2016) (upholding denial of leave to amend where amendment was based on previously available evidence).

A. Petitioners' proposed amendment is untimely, prejudicial, and based on previously available evidence.

The Department issued the final air quality Permit to Construct on June 17, 2022. In July 2022, Petitioners filed their Petition to Initiate Contested Case and subsequently filed a First Amended Petition in January 2023. Following the First Amended Petition, the parties meet and conferred and filed a proposed scheduling order, which the Hearing Officer entered on January 19, 2023. The parties did not contemplate any further amendment of pleadings and thus did not include any such deadline. The parties then exchanged discovery requests and eventually filed cross motions for summary judgment on Petitioners' First Amended Petition. Summary judgment briefing began on April 4, 2023, and was completed on June 23, 2023. A hearing on the pending motions for summary judgment is set for September 21, 2023.

Now over a year after the original Petition was filed, seven months after the First Amended Petition was filed, two months after briefing on summary judgment was completed, and less than two weeks before oral argument is scheduled, Petitioners move to amend their contested case petition for the second time. Petitioners move to amend their petition again based on what they view as newly discovered evidence, a letter from the U.S. Environmental Protection Agency ("EPA") to the Department, dated August 10, 2023 (the "EPA Letter"). The EPA Letter, however, does not contain newly discovered evidence, and Petitioners motion to amend is untimely and prejudicial because the substance of the proposed amendment was within the original, existing record.

In the proposed second amended petition, Petitioners allege that the Department erred in determining that the SGP is a synthetic minor stationary source instead of a major stationary

source. *See* Petitioners' Motion to Amend Contested Case Petition ("Pet. Mot.") at 1; *see also id.*, Attach. 1 ("Proposed Petition") ¶¶ 72-79. Petitioners' Proposed Petition alleges that the Department used the wrong emission factors in estimating the SGP's potential to emit. *Id.* Petitioners further allege that the Department failed to consider additional stationary source emission quantification techniques, which may have more accurately determined emissions from the SGP. *Id.* ¶ 76. Petitioners allege that higher emissions may exceed the thresholds under the Prevention of Significant Deterioration program. *Id.* ¶ 77.

Although Petitioners justify the timing of the proposed amendment with the arrival of the EPA Letter, this is disingenuous. Petitioner Nez Perce Tribe presented a similar question to the Department during the public comment period on the draft Permit. *See* PET 555, 566. Additionally, as the EPA Letter recognizes repeatedly, EPA already provided these comments to the Department, and the Department found them meritless. EPA repeatedly noted that the Department chose the wrong emission factors, PET 573, 576-77, and failed to consider additional emission quantification techniques, *id.*; *see also id.* at 574, 575. Petitioners failed to include the proposed claim in the original Petition or First Amended Petition. Now Petitioners seek an opportunity to expand the contested case review.

Petitioners contend that their additional claims do not rely on the EPA Letter being admitted into evidence and will not require more discovery. Pet. Mot. at 4 n.2. If that is true, Petitioners had all the information they needed to assert this claim in 2022 when the original Petition was filed, in 2023 when the First Amended Petition was filed, and certainly since the close of discovery in February 2023. Yet Petitioners failed to assert the claim in original and amended petitions and then waited six months after discovery closed to seek leave to amend. Petitioners were aware of these additional facts since well before they filed their original

Petition. Comments from both the Nez Perce Tribe and the EPA provided Petitioners with ample notice of these claims, yet Petitioners did not act until the EPA Letter. "[P]rejudice may be presumed to flow from unexcused and unreasonably delay." *Roberts v. Verner*, 116 Idaho 575, 578, 777 P.2d 1248, 1251 (Ct. App. 1989).

B. Granting leave to amend will cause undue delay and unfair prejudice to the Department and Perpetua.

Again, Petitioners waited until after briefing on summary judgment was completed and until 10 days before oral argument to file their motion for leave to amend. Petitioners did not present this claim in their summary judgment motions. Allowing this amendment at this late date will result in undue delay in final resolution of the merits of this contested case proceeding.

Petitioners argue that the amendment would not cause significant delay because the new claim is "independent of the other claims and can be resolved in its own summary judgment proceeding." Yet Petitioners also seek to stay the contested case and delay the current summary judgment hearing. Granting leave to amend will unquestionably cause undue delay of the ultimate resolution of this case. This is especially egregious where Petitioners had all the facts they needed to raise this new claim long before Petitioners' filed their original Petition and long before the parties briefed the pending summary judgment motions. *See AmerisourceBergen Corp. v. Dialysist W., Inc.*, 465 F.3d 946, 953 (9th Cir. 2006) ("[I]n evaluating undue delay, we also inquire 'whether the moving party knew or should have known the facts and theories raised by the amendment in the original pleading.'" (*quoting Jackson v. Bank of Hawaii*, 902 F.2d 1385, 1388 (9th Cir. 1990)).

While Petitioners argue there will be no unfair prejudice, they ignore that granting leave to amend will require the Department and Perpetua to expend significant resources in analyzing Petitioners' new claim and briefing additional motions for summary judgment. Petitioners

diminish the impact of prejudice on Perpetua stating that there are many permits yet to be obtained. Pet. Mot. at 5. This indifference ignores that Perpetua will be prejudiced by the ongoing legal uncertainty related to the Permit. *AmerisourceBergen Corp.*, 465 F.3d at 953 (upholding denial of leave to amend where plaintiff sought to add new legal theory to case even though discovery was still open).The merits of Petitioners' motion to amend must be evaluated in the context of these proceedings, not the broader context of the SGP development.

III. CONCLUSION

For the foregoing reasons, the Department and Perpetua respectfully request that the Hearing Officer deny Petitioners' Motion to Amend Contested Case Petition.

DATED: September 11, 2023.

DEPARTMENT OF ENVIRONMENTAL QUALITY

/s/ John Shackelford
John Shackelford
Deputy Attorney General

Attorney for Respondent

STOEL RIVES LLP

/s/ W. Christopher Pooser
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

CERTIFICATE OF SERVICE

I hereby certify that on September 11, 2023, a true and correct copy of the foregoing was served on the following:

Dylan B. Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Paula J. Wilson
Hearing Coordinator
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

/s/ *W. Christopher Pooser*
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

John R. Shackelford, ISB No. 8647
john.shackelford@deq.idaho.gov
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: 208.373.0453

Attorney for Respondent

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047

NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,

Petitioners,

v.

IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,

Respondent,

and

PERPETUA RESOURCES IDAHO, INC.,

Intervenor-Respondent.

Case Docket No. 0101-22-01

JOINT RESPONSE IN OPPOSITION TO PETITIONERS' MOTION TO SUPPLEMENT WITH AUGUST 10, 2023 EPA LETTER

The Idaho Department of Environmental Quality (the "Department") and Perpetua Resources Idaho, Inc. ("Perpetua") respectfully submit this response in opposition to Petitioners' Motion to Supplement with August 10, 2023 EPA Letter. The Department and Perpetua also incorporate by reference the argument contained in their Joint Motion *in Limine* to Exclude Communications from U.S. EPA Sent After Permit was Issued (filed August 28, 2023).

I. INTRODUCTION

On August 10, 2023, the Administrator for Region 10 of the United States Environmental Protection Agency ("EPA") transmitted the letter referred to in Petitioners' Motion to Supplement to the Department (the "EPA Letter"). Petitioners' Motion to Supplement should be denied for the following reasons: First, because the contents of the letter are either entirely irrelevant or, where relevant, repeat EPA's and Petitioners' comments that are already contained in the contested case record. EPA is not a party to the pending contested case proceeding. Second, the EPA Letter was received over one year after the Department issued its Permit to Construct to Perpetua Resources Idaho, Inc. on June 17, 2022 (the "Permit"), over one year after Petitioners filed their contested case petition, and months after briefing on the motions for summary judgment concluded. Finally, the Department did not rely on the contents of the EPA Letter in its deliberations or in the development of the Permit and nothing in the EPA Letter affects the administrative standard of review of the Department's action in this contested case proceeding under the Board of Environmental Quality's contested case rules. Accordingly, Perpetua and the Department respectfully request that the Hearing Officer deny Petitioners' Motion to Supplement the Record.

II. ARGUMENT

The Hearing Officer has discretion to supplement the record with newly discovered evidence, where that evidence was not reasonably available to the moving party prior to the request to supplement, and the newly discovered evidence is relevant and not cumulative. *See Roberts v. Bonneville County*, 125 Idaho 588, 592, 873 P.2d 842, 846 (1994). However, a party cannot supplement the record with legal arguments that could have been made previously or with facts that could have been offered, but were not. *See Zimmerman v. City of Oakland*, 255 F.3d 734, 740 (9th Cir. 2001).

A. The contents of the EPA Letter are not new evidence

Although the EPA Letter itself was sent well after briefing on summary judgment concluded, the contents of the EPA Letter are not new evidence. As EPA repeatedly references in the letter, much of its commentary was previously provided to the Department in the form of comments on the various drafts of the Permit. *See* EPA Letter, Attach. at 3, 5, 6, 7, 14, 15, 16, 17, 18; PET 549-634. The EPA Letter takes issue with some of the Department's responses to its comments, and slightly refines its previous comments, but it does not provide new evidence that was previously unavailable to the Petitioners.[1] Instead, the EPA Letter recycles arguments previously advanced by the EPA and, as to at least one issue, by Petitioners, referring to elements contained in the administrative record.

B. Portions of the EPA Letter are irrelevant and highly prejudicial to this proceeding

In the EPA Letter, EPA suggests that the Department underestimated emissions from stationary sources at the Project for purposes of determining major stationary source permitting

[1] The EPA Letter is akin to an expert report in that it provides no actual evidence, only opinions based on the evidence available to EPA. If the EPA Letter were an expert report, it would clearly be untimely.

thresholds. Namely EPA suggests the Department underestimated emissions from ore processing units and the lime plant based on what, in its view, was consideration of the wrong chapters of AP-42 Compilation of Air Pollutant Emission Factors ("AP-42"). EPA Letter, Attach. at 3-5. AP-42 provides emissions factors to be used in determining the potential for a stationary source to emit regulated pollutants. *See id.* at 2. Although EPA previously presented these concerns in its comments to the Department, *id.* at 3, 5, Petitioners did not raise a claim relating to the Department's choice of emissions factors in their Petition or First Amended Petition. EPA's opinions on the use of emissions factors are irrelevant to this contested case proceeding. *See generally* Petition (filed July 22, 2022); First Amended Petition (filed Jan. 11, 2023).

EPA also previously commented that the Department should impose either source-wide emission limits applicable to all emission units or unit-specific emission limits. EPA Letter, Attach. at 6. Again, although these comments were in the record prior to Petitioners initiating this contested case, Petitioners failed to raise claims relating to source-wide emission limits or unit-specific emission limits in their Petition or First Amended Petition. EPA's opinions on the type of emission limits to include are irrelevant to this proceeding.

Finally, although Petitioners suggest that EPA's comments related to the ambient air boundary are relevant to their claims, Petitioners' Mot. at 3, they are not. The EPA Letter primarily concerns the enforceability of requirements to preclude access at secondary access points, and to preclude public access from the overall ambient air boundary by reliance on natural features. EPA Letter, Attach. at 18. Entirely different is Petitioners' claim that the ambient air boundary should specifically include the proposed through road by which Perpetua will control access by certain individuals who pass through the site. *See* First Amended Petition ¶¶ 58-65. Again, although these facts were in the existing record prior to Petitioners initiating

this contested case, Petitioners did not raise claims relating to overall site access and control of the ambient air boundary in their Petition or First Amended Petition. EPA's opinions on the overall boundary controls are irrelevant to this proceeding.

Even under the permissive rules for the admission of evidence under the Idaho Rules of Administrative Procedure of the Attorney General, evidence must still be relevant. IDAPA 04.11.01.600 ("The presiding officer … may exclude evidence that is irrelevant …."). As described above, the EPA Letter is irrelevant to Petitioners' claims and should be excluded.

Perpetua and the Department will be prejudiced by the admission of this evidence because while Petitioners' review of the existing record could have led to similar claims, no such claims were raised as issues in this case. And no such claims were addressed in the parties' summary judgment briefs. To the extent that Petitioners, at the eleventh hour, now attempt to expand their claims based on the EPA Letter, the substance of which was available to them in 2022 and prior to August 10, 2023, Perpetua and the Department have not had the opportunity to brief these issues.[2]

C. The rest of EPA's comments are unduly repetitious and cumulative and should be excluded

As Petitioners recognize in their motion, to the extent EPA's comments are relevant they "confirm[] the concerns EPA already raised in its public comments on the draft PTC, and which Petitioners have already raised" making EPA's opinions repetitious. Specifically, the EPA Letter addresses the Department's approach to recordkeeping and reporting, EPA Letter, Attach. at 6, and estimation of and control of fugitive dust from haul roads, *id.*, Attach. at 14-16. For example,

[2] The Department and Perpetua address the prejudice inherent from the introduction of the EPA Letter this late into this contested case proceedings in their Joint Response in Opposition to Petitioners' Motion to Stay, filed herewith.

like the Petitioners, EPA repeats previously expressed opinions that the Permit does not contain sufficient conditions to ensure that Perpetua complies with the National Ambient Air Quality Standards ("NAAQS") for PM10. For increased enforceability of conditions that limit emissions, EPA directs the Department to require preparation of the Operations and Maintenance Plan, Haul Road Capping Plan, Fugitive Dust Control Plan, and Access Management Plan during the permit application review period and to publish those plans for public comment prior to issuing the Permit. Consistent with its delegated authority from EPA under the Clean Air Act, the Department thoroughly addressed its approaches to NAAQS compliance, to enforceability of the Permit, and to the plans in the Department's Responses to Comments and extensively in the parties' briefing. *See, e.g.*, DEQ's Response to Petitioners' Motion for Summary Judgment and Brief in Support of Cross Motion at 13-16 (May 12, 2023); Pet. Br. at 19, 26-28; Perpetua Memorandum in Support of Intervenor-Respondent's Motion for Summary Judgment at 22-29, 32-37 (May 12, 2023). The EPA Letter provides no new information on these claims.

To the extent that EPA's comments are relevant to Petitioners' claims, they are cumulative and unduly repetitious of EPA's, and Petitioners', previous comments.

Additionally, EPA takes issue with how the Department responded to EPA's previous comments on the draft Permit. These opinions are best left to interagency communications. The question presented in the parties' cross motions for summary judgment is not whether the Department satisfied EPA in its response to comments, but whether the Department acted arbitrarily and capriciously, abused its discretion, or acted contrary to the Idaho Air Rules. As addressed in Perpetua's Motion for Summary Judgment, EPA does not have authority to "question the wisdom of a State's choices of emission limitations." Memorandum in Support of Perpetua's Motion for Summary Judgment at 15 (May 12, 2023) (*quoting Train v. Nat. Res. Def.*

Council, Inc., 421 U.S. 60, 79 (1975)). Therefore, while EPA's comments may overlap with Petitioners' evidence and arguments, EPA's opinions are best excluded from this contested case proceeding to determine whether the Department erred in issuing the Permit based on the applicable standard of review.

III. CONCLUSION

For the foregoing reasons, Perpetua and the Department respectfully request that the Hearing Officer deny Petitioners' Motion to Supplement with August 10, 2023 EPA Letter.

DATED: September 11, 2023.

DEPARTMENT OF ENVIRONMENTAL QUALITY

/s/ John Shackelford
John Shackelford
Deputy Attorney General

Attorney for Respondent

STOEL RIVES LLP

/s/ W. Christopher Pooser
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

CERTIFICATE OF SERVICE

I hereby certify that on September 11, 2023, a true and correct copy of the foregoing document was served on the following:

Dylan B. Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Paula J. Wilson
Hearing Coordinator
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

/s/ *W. Christopher Pooser*
W. Christopher Pooser

John R. Shackelford, ISB No. 8647
john.shackelford@deq.idaho.gov
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, ID 83706
Telephone: 208.373.0453

Attorney for Respondent

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047

NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,

Petitioners,

v.

IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,

Respondent,

and

PERPETUA RESOURCES IDAHO, INC.,

Intervenor-Respondent.

Case Docket No. 0101-22-01

JOINT RESPONSE IN OPPOSITION TO PETITIONERS' MOTION TO STAY THE CASE

The Idaho Department of Environmental Quality (the "Department") and Perpetua Resources Idaho, Inc. ("Perpetua") respectfully submit this response in opposition to Petitioners' Motion to Stay the Case.

I. INTRODUCTION

The Department and Perpetua oppose Petitioners' request for a stay of this contested case proceeding. The basis for the stay request is purportedly to allow the Department time to meet with the United States Environmental Protection Agency ("EPA") regarding the concerns raised in the Regional Administrator's August 10, 2023 letter (the "EPA Letter"). A stay is not warranted and Petitioners' motion should be denied.

First, EPA is clearly not a party to this legal proceeding, the requested meeting has not been scheduled between the Department and EPA (although the Department has suggested a date that falls in mid-October), and no outcome from a proposed future meeting has any impact on these issues before the Hearing Officer. Moreover, the EPA Letter presents concerns that, while previously raised by EPA and addressed by the Department, are not part of Petitioners' contested case petition. How and when the two agencies communicate about EPA's latest correspondence is not relevant to this ongoing proceeding initiated by Petitioners.

Second, this case has been pending for well over a year. The parties have spent significant time and expense fully briefing the summary judgment motions, which are now pending and set for hearing on September 21. Further delay of this contested case proceeding will prejudice the Department and Perpetua by delaying a final decision on the merits of the Permit. Accordingly, the Department and Perpetua respectfully request that Petitioners' motion to stay be denied.

II. ARGUMENT

The decision whether to grant or deny a stay is a matter vested in the discretion of the Hearing Officer. *See Cont'l Cas. Co. v. Brady*, 127 Idaho 830, 834, 907 P.2d 807, 811 (1995). The party seeking a stay bears the burden of establishing its need. *See Clinton v. Jones*, 520 U.S. 681, 708 (1997).

Petitioners argue that a stay may allow time for the Department and EPA to meet and resolve EPA's concerns, which may address Petitioners' concerns. There are several problems with Petitioners' request. First, the EPA Letter addresses issues that are not raised in Petitioners' contested case petition. The EPA Letter concerns three issues: (1) whether the Stibnite Gold Project is a major stationary source under the Clean Air Act ("CAA"); (2) whether fugitive dust from the Project's haul roads will cause or contribute to a violation of the PM10 NAAQS; and (3) whether the Permit includes sufficient measures to exclude the general public from the entirety of the Project for purposes of the ambient air boundary. Only the second issue is raised and addressed in Petitioners' contested case petition.[1]

Second, Petitioners can only speculate about interagency interactions that may or may not occur in response to the EPA Letter. Unless Petitioners or their clients are directly involved in the discussions between the Department and EPA, then they can only guess how or when the discussions might, at some point in the future, resolve their concerns related to the Permit. Meanwhile, Petitioners' claims are live in this proceeding. Motions for summary judgment are fully briefed (and have been since June 23, 2023) and set for oral argument in 10 days. The most

[1] While Petitioners challenge the ambient air boundary in their contested case, they challenge the boundary based on the Stibnite Access Route. They did not raise the same issue EPA addresses, namely whether the Permit conditions are sufficiently enforceable to preclude physical or practical access by the general public to the entire ambient air boundary for the Project.

just and efficient path forward is to hear the summary judgment oral arguments on September 21, 2023, and decide the merits of Petitioners' claims, applying the legal standard for review of the Department's actions.

As Perpetua explained in its Motion for Summary Judgment, the CAA creates a partnership between the federal government and the states to prevent and control air pollution. *See* Memorandum in Support of Perpetua's Motion for Summary Judgment and in Opposition to Petitioners' Motion for Summary Judgment (May 12, 2023) at 14 (citing *Cal. Dump Truck Owners Ass'n v. Nichols*, 784 F.3d 500, 502 (9th Cir. 2015)). Although EPA is charged with setting the National Ambient Air Quality Standards ("NAAQS") and approving Idaho's State Implementation Plan ("SIP"), EPA has "no authority to question the wisdom of a state's choices of emission limitations." *Id.* at 15 (quoting *Train v. Nat. Res. Def. Council, Inc.*, 421 U.S. 60, 79 (1975)). Thus, while the Department welcomes a constructive conversation with EPA, it is ultimately responsible for developing and enforcing the Permit.

Consistent with the CAA partnership, EPA submitted multiple comments on the Permit during the three-year review process, and the Department responded in the normal course of permit issuance. *See generally* PET 549-634. Then, without any precedent known to the Department and Perpetua, the EPA Letter repeats many of those comments over a year after issuance of the Permit and just before the summary judgment hearing in this live contested case proceeding.

The Department is currently evaluating the legal and technical bases of the feedback in the EPA Letter and intends to schedule a meeting with EPA after a thorough evaluation. Declaration of Tiffany Floyd ("Floyd Decl.") ¶ 4; *id.* Ex. A. The earliest the Department will be able to meet with EPA is October 13; however, no meeting is yet confirmed. *See* Floyd Decl. ¶ 5,

Ex. A. The Department also expects that more time will be needed following a meeting with EPA to determine what, if any, action the Department may take in response. There is only speculation currently about the merits of the comments presented in the EPA Letter, the Department's responses, and the timing of future interagency communications. The outcome of the discussions between EPA and the Department is unknown and far from certain. There is only delay, uncertainty, and inaction if the pending contested case is postponed by a stay of this proceeding.

Third, when determining whether to grant a stay, courts weigh competing interests including (1) the possible damage which may result from the granting of a stay, (2) the hardship or inequity that a party may suffer in being required to go forward, and (3) the orderly course of justice measured in terms of simplifying or complicating issues, proof, and questions of law which could be expected to result from a stay. *See CMAX, Inc. v. Hall*, 300 F.2d 265, 268 (9th Cir. 1962).

Here, granting a stay will further delay resolution of this contested case for issues that are simply not before the Board and will deny Perpetua and the Department certainty regarding the legal sufficiency of the Permit under the Idaho Air Rules. This directly conflicts with Idaho's general policy favoring a decision on the merits. *See Dorion v. Keane*, 153 Idaho 371, 376, 283 P.3d 118, 123 (Ct. App. 2012). Although Petitioners have not moved to stay the effectiveness of the Permit, these proceedings cast a cloud over the sufficiency of the Permit and create significant legal uncertainty that can only be resolved through decisions on the merits.

Petitioners will not face any hardship or inequity from going forward in this contested case. Petitioners filed their contested case petition in July 2022 and an amended petition in January 2023. Discovery and summary judgment briefing was completed months ago; the only

thing that is left is oral argument on September 21, 2023, and decisions on the pending cross motions for summary judgment. With their motion for a stay at this stage of the contested case, Petitioners only seek to delay resolution of their claims and to maintain the cloud of uncertainty around the Permit.

Additionally, Petitioners raised claims that are absent from the EPA Letter, for example the Department's selection of T-RACT and averaging of arsenic emissions that have no analogue in the CAA and are not addressed in the EPA Letter. Therefore, no matter the outcome of any interagency communication, there are live and different issues remaining in this contested case.

A stay at this stage of the live contested case is unnecessary, inefficient, and prejudicial. Instead, the most efficient path forward is for the Hearing Officer to hear from the parties on September 21, 2023, to consider the issues that are directly at issue under the contested case petition, and to decide the merits of the pending cross motions for summary judgment. *See Posey v. Lake Pend Oreille Sch. Dist. No. 84*, No. CV05-272-N-EJL, 2007 U.S. Dist. LEXIS 7829, at *7 (D. Idaho Feb. 2, 2007) (reversed on other grounds) (denying stay where summary judgment fully briefed).

If the Hearing Officer stays this contested case pending resolution of the EPA Letter, the duration of any postponement is likely indefinite and will concern issues not raised in this contested case proceeding, the delay in an already extended legal process drags on, and the parties will still be required to litigate the remaining issues beyond the scope of the EPA Letter. A stay at this stage of a live contested case wastes the resources already devoted to this matter by the parties and exacerbates the uncertainly for Department and Perpetua.

III. CONCLUSION

For the foregoing reasons, Perpetua and the Department respectfully request that the Hearing Officer deny Petitioners' Motion to Stay the Case.

DATED: September 11, 2023.

DEPARTMENT OF ENVIRONMENTAL QUALITY

/s/ John Shackelford
John Shackelford
Deputy Attorney General

Attorney for Respondent

STOEL RIVES LLP

/s/ W. Christopher Pooser
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

CERTIFICATE OF SERVICE

I hereby certify that on September 11, 2023, a true and correct copy of the foregoing document was served on the following:

Dylan B. Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Paula J. Wilson
Hearing Coordinator
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

/s/ *W. Christopher Pooser*
W. Christopher Pooser

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	Agency Case No. 0101-22-01
	OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	DECLARATION OF TIFFANY FLOYD OPPOSING THE MOTION TO STAY

I, Tiffany Floyd, hereby declare under penalty of perjury pursuant to the law of the State of Idaho that the following is true and correct:

1. My name is Tiffany Floyd, and I am employed by the State of Idaho, Department of Environmental Quality ("the Department") as the Air Quality Division Administrator ("Air Administrator").

2. I have been working for the Department as the Air Administrator for 11 years.

3. On August 11, 2023, I received a letter from the EPA ("the EPA letter") regarding the Department's PTC for the Stibnite mine project. In that letter, the EPA requests an in-person meeting with appropriate permitting and legal staff.

4. At this time, the Department does intend to meet with the EPA to discuss its

concerns, which are currently under review by our permitting team and legal counsel.

5. The Department has offered to host a meeting with the EPA on October 13, 2023. That offer was extended by Director Byrne in a letter dated September 8, 2023. I have attached a true and correct copy of that letter to this declaration. At this time, no meeting date has been agreed upon.

6. The Department does not require or request a pause in these administrative proceedings to meet with the EPA and therefore opposes the Petitioners' motion to stay.

Dated: September 11, 2023

STATE OF IDAHO, DEPARTMENT OF ENVIRONMENTAL QUALITY

By: _____
Tiffany Floyd, Air Quality Administrator

CERTIFICATE OF SERVICE

I hereby certify that on September 11, 2023, a true and correct copy of the foregoing document was served on the following:

Dylan B. Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Paula J. Wilson
Hearing Coordinator
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

/s/ *W. Christopher Pooser*
W. Christopher Pooser

Exhibit A

1410 N Hilton Street
Boise, ID 83706 • (208) 373-0502

Brad Little, Governor
Jess Byrne, Director

September 8, 2023

Mr. Casey Sixkiller
Regional Administrator, Region 10
United States Environmental Protection Agency
1200 Sixth Avenue, Suite 155
Seattle, WA 98101

Dear Mr. Sixkiller,

I received your letter dated August 10, 2023, regarding Perpetua Resources Idaho, Inc.'s ("Perpetua") permit to construct. I feel it is important to respond by reiterating that the Idaho Department of Environmental Quality (DEQ) is confident that the permit issued to Perpetua complies with the Clean Air Act and protects air quality. It also incorporates countless hours of staff time that went into gaining an operational understanding of the site while developing the permit. The permit to construct utilizes well-established practices and processes that are consistent with numerous similar permits within Idaho and other states.

DEQ takes our responsibility to protect air quality seriously, as demonstrated by the fact that all airsheds within the state currently meet the national ambient air quality standards. In recent years, airsheds that historically did not meet or attain those standards have been brought into attainment, due in large part to DEQ's efforts. Additionally, various proactive and voluntary measures have been taken in airsheds approaching the health-based standards that have resulted in improved air quality. All of this has been accomplished amid unprecedented population growth, which has resulted in increased emission sources. Our Air Quality Division staff, including our Permitting Bureau, have worked tirelessly to get us to this point and proudly implement a successful federally approved state program.

If the intent of EPA's unprecedented interest in Perpetua's permit to construct is to change decades of commonly accepted approaches, practices, and processes, it should be done at a national level through the development of formal oversight plans, updated guidance, and proactive communication with states that are on the front lines of protecting air quality. It should not be done through a draft permit public comment period, or a letter sent 420 days after the issuance of a permit to construct.

Despite our frustration with the timing of the letter and overall approach, we have considered your request to meet to discuss EPA's concerns and have identified October 13, 2023, as the earliest date that the appropriate staff from my office would be available for a meeting in

Boise. If that date does not work for EPA, we would have to look at additional dates further out. I will have my executive assistant, Elaine Ganino, reach out to Ms. Fraser to follow up.

Sincerely,



Jess Byrne
Director

cc: Tiffany Floyd
Idaho Department of Environmental Quality

John Shackelford
Idaho Office of the Attorney General

DYLAN LAWRENCE
VARIN THOMAS LLC
P.O. Box 1676
Boise, ID 83701
(208) 345-6021
dylan@varinthomas.com

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,	)	BEQ Case No. 0101-22-01
Petitioners,	)	OAH Case No. 23-245-01
v.	)	ORDER ON MOTIONS RELATED TO RECENT EPA LETTER
DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC.,	)	
Intervenor.	)	

I. BACKGROUND

On August 10, 2023, EPA sent a letter to Idaho DEQ Director Jess Byrne, expressing three concerns regarding the air permit issued to Perpetua Resources in this matter (the "EPA Letter"). The Letter requests a meeting between EPA and DEQ representatives to discuss those concerns. Ultimately, the Letter suggests that DEQ should issue a revised permit. (*See* Mot. to Stay of 9/8/23, Ex. A, p. 1.) Issuance of the letter has spawned the following five motions from the parties:

On August 28, 2023, Perpetua Resources and DEQ filed a joint motion in limine requesting exclusion of the EPA Letter and any press releases about it from consideration in this proceeding.

On August 31, Perpetua and DEQ filed a motion to shorten the Petitioners' deadline to respond to the motion in limine and to expedite consideration of the motion in limine.

On September 1, the Petitioners filed two motions. One motion requests a stay of these proceedings, including postponing the September 21 summary judgment hearing and setting a status conference in October to discuss the status of this matter. The other motion requests supplementation of the record in this matter with the EPA Letter.

On September 8, the Petitioners filed a motion to amend their petition based upon one of the concerns expressed in the EPA Letter.

Based upon the August 31 motion, a status conference, and the impending summary judgment hearing, the hearing officer issued a scheduling order on September 6 establishing a truncated briefing schedule for the other four motions. Briefing is now complete and a decision on all four motions is appropriate.

II. LEGAL ANALYSIS

A. Petitioners' Motion to Amend Petition

Petitioners request leave to amend their petition based upon one of the concerns expressed in the EPA Letter. More specifically, according to EPA, "the Permit's emission limits are not adequate to limit the [SGP]'s potential to emit below the Prevention of Significant Deterioration permitting threshold…." (Mot. to Stay of 9/1/23, Ex. A, p. 1.) Based on that assertion, the Petitioners seek to add a new alleged error—that DEQ improperly used emission factors for crushed stone processing instead of those for metallic minerals processing. (*See* Mot. to Amend of 9/8/23, Att. 1, pp. 27-29, 34.)

1. Applicable Standards

The applicable administrative procedural rule states that, "[t]he presiding officer may

allow any pleading to be amended or corrected or any omission to be supplied." BEQ R.PROC. 003.05; AG R.PROC. 305. In the absence of additional standards in the administrative rules, presumably, this decision is within the sound discretion of the hearing officer. Reference to principles under the Idaho Rules of Civil Procedure is not mandated by AG Procedural Rule 052 but is still be helpful.

Were this proceeding governed by the judicial rules, the applicable rule would read: "In all other cases [*i.e.*, before trial and when there is no longer a right to amend], a party may amend its pleading only with the opposing party's written consent or the court's leave. The court should freely give leave ***when justice so requires***." IDA.R.CIV.PROC. 15(a)(2) (emphasis added). Due in part to this "when justice so requires" language, the Idaho Supreme Court has held that "the decision to grant or refuse permission to amend [a pleading] is left to the sound discretion of the trial court." *Jones v. Watson*, 98 Idaho 606, 570 P.2d 284, 288 (1977); *see also Zeyen v. Pocatello/Chubbuck School District No. 25*, 451 P. 3d 25, 29-32, 165 Idaho 690 (2019) (affirming denial of request to amend pleadings).

The courts recognize several situations in which it is appropriate to deny leave to amend pleadings. *See Clark v. Olsen*, 110 Idaho 323, 715 P.2d 993 (Idaho 1986) (*citing Foman v. Davis*, 371 U.S. 178, 182, 83 (1962)). "Undue delay and prejudice are proper standards on which to deny a motion to amend." *Spur Products Corp. v. Stoel Rives LLP*, 142 Idaho 41, 122 P. 3d 300, 304 (2005).

2. Analysis

The hearing officer finds that justice does not require amendment of the petition under these circumstances for two separate reasons. First, waiting this long to assert this new alleged error constitutes undue delay by Petitioners. The permit in this matter was issued on June 17,

2022, and these administrative proceedings have been pending since July 22, 2022. Under the stipulated scheduling order Petitioners agreed to, discovery opened on January 13, 2023, and the Petitioners had until April 14, 2023 to file their motion for summary judgment. (Sched. Order of 1/19/23, p. 2.) From the issuance of the permit to their summary judgment deadline, the Petitioners had 302 days to analyze the permit in detail for potential errors.

While Petitioners argue they "have not somehow been dilatory in moving to present the EPA Letter," in the opinion of the hearing officer, the period of time between the issuance of the EPA Letter and the filing of the motion to amend is not the relevant inquiry. This is because the EPA Letter is not a new event or changed circumstance. The Petitioners filed a very detailed initial petition in this matter which demonstrates a high level of understanding of federal and state air quality regulation and a high degree of scrutiny of the permitting process generally, and the permit issued to Perpetua specifically. (*See* Pet. to Initiate Contested Case of 7/22/22.)

In fact, during summary judgment, the Petitioners filed a declaration of counsel that included DEQ's response to comments as an exhibit. (Hurlbutt Decl. of 4/14/23, Ex. 3.) This includes responses by DEQ to multiple comments by EPA specifically dealing with emission factors and their impacts on the "potential to emit" calculation. (R., pp. PET573-577.) Regardless of whether these precisely mimic the concerns expressed in the EPA Letter, they were sufficient to put the Petitioners on notice of them.

Indeed, in their proposed amended petition, the Petitioners state that, "[w]hen given multiple opportunities through draft PTC public comment to provide a reasoned basis for the use of Perpetua's preferred AP-42 emission factors, DEQ failed to provide any justification." (Mot. to Amend of 9/8/23, Ex. A, p. 28, ¶ 75.) This acknowledgment that the public comment record references similar concerns expressed in the EPA Letter demonstrates there is no reason the

Petitioners could not have identified those concerns earlier in this proceeding.

Second, granting leave to amend the Petition in this matter would constitute undue prejudice to DEQ and Perpetua. On this issue, Petitioners first argue there will be no prejudice because "amendment…would not significantly delay the resolution of the case." (Mot. to Amend of 9/8/23, p. 4.) The hearing officer disagrees. If the pending motion were granted, DEQ and Perpetua would then need to file updated responsive pleadings, after which there would likely be additional discovery needed, another round of summary judgment briefing, additional declarations from DEQ staff members explaining their actions, another summary judgment hearing, and an order. This would likely add at least three months to the proceeding. In addition, this places an undue burden on DEQ and Perpetua to again mobilize resources for further case develop and briefing, after the parties agreed among themselves to an extended summary judgment schedule with generous deadlines. (*See* Stip. of 1/13/23; Sched. Order of 1/19/23.)

The Petitioners next argue that "[a]mending the petition will neither delay nor impact any of those needed decisions or permits [from various other agencies], nor delay construction or operation of the mine." (Mot. to Amend of 9/8/23, pp. 4-5.) The hearing officer understands the term "prejudice" to refer specifically to prejudice within the context of this administrative proceeding, not to the overall project. Moreover, the hearing officer finds the assertions regarding impacts to other permits and the timing of construction and operation of the SGP to be speculative and outside the scope and record of this proceeding.

3. Conclusion

Petitioners' motion for leave to further amend their petition in this matter based upon the EPA Letter is denied.

B. Petitioners' Motion for Stay

Petitioners request the hearing officer to vacate the summary judgment hearing scheduled for September 21, 2023 and stay these proceedings to allow time for DEQ to respond to the EPA Letter. Applicable procedural rules authorize stays of orders generally, either upon petition of a party or by the agency itself upon its own motion. *See* BEQ PROC.R. 003.22; AG PROC.R. 780. The hearing officer and parties agree this decision is within the sound discretion of the hearing officer pursuant to BEQ Procedural Rule 003.08 and AG Procedural Rule 413. (*See* Mot. to Stay of 9/1/23, p. 1; Joint Resp. in Opp. to Mot. to Stay of 9/11/23, p. 3.)

The question, then, is whether it is appropriate to stay the effectiveness of the Scheduling Order of January 19, 2023, which was based upon the January 13, 2023 joint motion and stipulation among the parties. Clearly, had the motion for leave to amend the petition been granted, some relief from the Scheduling Order would be necessary, though that does not necessarily require an outright "stay" of the proceedings. Regardless, having denied the motion to amend motion, the need to vacate the summary judgment hearing and stay the proceeding is much less compelling.

Admittedly, having to address the EPA Letter so close to the summary judgment hearing interferes with preparation for that hearing. However, that is an issue that applies similarly to everyone involved—DEQ, Perpetua, the Petitioners, and the hearing officer. Both Perpetua and DEQ strongly oppose further delay. Where the permit being challenged has been issued to Perpetua and the EPA Letter is addressed to DEQ, the hearing officer would need a more compelling need to delay the summary judgment hearing over their objections than mere interference with hearing preparation that affects all of the parties.

The Petitioners' motion to vacate the summary judgment hearing and stay this proceeding is denied.

C. Perpetua and DEQ's Motion in Limine; Petitioners' Motion to Supplement Record

For the most part, these two motions are two sides of the same coin: The Petitioners want the EPA Letter included in the record, and DEQ and Perpetua want it excluded. Therefore, this order will deal with both motions simultaneously.

Regarding the admissibility of evidence, the applicable procedural rule provides:

> ***Evidence should be taken by the agency to assist the parties' development of the record, not excluded to frustrate that development. The presiding officer at hearing is not bound by the Idaho Rules of Evidence.*** No informality in any proceeding or in the manner of taking testimony invalidates any order. ***The presiding officer, with or without objection, may exclude evidence that is irrelevant***, unduly repetitious, inadmissible on constitutional or statutory grounds, or on the basis of any evidentiary privilege provided by statute or recognized in the courts of Idaho. All other evidence may be admitted if it is of a ***type commonly relied upon by prudent persons*** in the conduct of their affairs. The agency's experience, technical competence and specialized knowledge may be used in evaluation of evidence.

BEQ PROC.R. 003.13; AG PROC.R. 600 (emphasis added).

As an initial matter, the parties disagree as to whether the EPA Letter constitutes inadmissible hearsay. However, the above rule clearly states that this decision is not governed by the Idaho Rules of Evidence and that any evidence "commonly relied upon by prudent persons" is admissible. Therefore, a detailed analysis of the hearsay rule and its exceptions is not necessary. Given EPA's critical role in administering the Clean Air Act, a "prudent person" may indeed rely on EPA's interpretation of its terms. Also, in proceedings that do not involve a jury as the fact-finder, the rules of evidence are generally more liberal. *See generally State v. Powell*, 120 Idaho 707, 819 P. 2d 561, 563-564 (1991). These factors all favor admissibility of the EPA Letter.

On the other hand, DEQ and Perpetua raise a valid concern: For any alleged errors that are not resolved on summary judgment, it is conceivable, perhaps even likely, that depositions

and testimony at a hearing on the merits will be necessary. Because EPA is not a party to these proceedings, DEQ and Perpetua would not have the opportunity to conduct discovery and cross-examination of EPA regarding the contents of the Letter. It would not be fair to allow the Petitioners to use the EPA Letter as a "sword" to establish error while simultaneously depriving DEQ and Perpetua of the "shields" of discovery and cross examination.

To balance these competing standards and interests, the hearing officer believes it is appropriate to supplement the record with the EPA Letter, but limit the purposes for which it may be considered, as follows:

First, the EPA Letter should only be referenced to the extent it is relevant to alleged errors that are already within the scope of this proceeding. Consistent with the above ruling on the motion to amend the petition, the EPA Letter should not be used to add new alleged errors to this proceeding.

Second, to the extent the EPA Letter includes factual information or data that is not already within the existing record, that information should not be considered. The purpose of this proceeding is to determine whether DEQ committed reversible error when it issued the permit on June 17, 2022, based upon the information available to it at that time.

Third, the EPA Letter cannot be used as a proxy for expert testimony from the Petitioners. To the extent any declarations or affidavits adduced by DEQ or Perpetua qualify as expert testimony, the EPA Letter cannot be used to rebut such testimony.

Finally, DEQ and Perpetua's motion in limine requests exclusion of media coverage of the EPA Letter. However, the Petitioners' subsequent motion to supplement the record was limited to the EPA Letter. Unless and until there is a more overt request to supplement the record with any such media materials, it is unnecessary to rule on that aspect of the motion.

III. ORDER

In summary:

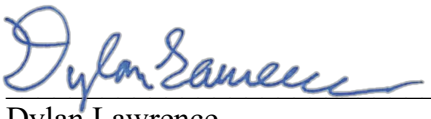
The Petitioners' motion to amend their petition in this matter is denied.

The Petitioners' motion to stay these proceedings is denied.

The Petitioners' motion to supplement the record in this matter with the EPA Letter is granted, subject to the limitations described above.

The motion in limine filed by DEQ and Perpetua is granted in part and denied in part. It is denied in the sense that the EPA Letter is being admitted into the record, but granted to the extent of the limitations described above.

Dated this 15th day of September, 2023.



Dylan Lawrence
Hearing Officer

CERTIFICATE OF SERVICE

I hereby certify that on this 15th day of September, 2023, I caused to be served a true and correct copy of the foregoing by the following method to:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Resources Division
Office of the Attorney General
1410 N. Hilton St.
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Dylan B. Lawrence
Hearing officer

DYLAN LAWRENCE
VARIN THOMAS LLC
P.O. Box 1676
Boise, ID 83701
(208) 345-6021
dylan@varinthomas.com

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v.	BEQ Case No. 0101-22-01 OAH Case No. 23-245-01 NOTICE REGARDING SUMMARY JUDGMENT HEARING
DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	

Pursuant to BEQ Procedural Rule 003.08 and AG Procedural Rule 413.01, the Hearing Officer hereby notifies the parties regarding general procedures for, and questions/issues to address at, the summary judgment hearing scheduled for Thursday, September 21. The goal of this notice is to provide for more efficient hearing preparation for counsel and a more efficient hearing for everyone involved.

Typically, summary judgment hearings proceed party-by-party, in that the moving party begins oral argument, the opposing party goes next, and the moving party then concludes. For a few reasons, this approach does not make sense in this proceeding.

First, all of the parties have pending motions for summary judgment on the same issues. Everyone is a movant, and everyone is an opposing party. Second, there are several complex, highly technical issues involved in this proceeding, such that proceeding issue-by-issue will be more efficient. Third, and perhaps most importantly, the summary judgment briefs and declarations are voluminous, approaching comprehensiveness.

Based on these factors and his review of the summary judgment briefs, the hearing officer would like the summary judgment hearing to focus primarily on the exclusion of the access road from ambient air (Claim Nos. 11 and 12).[1] Attachment A to this notice contains a series of questions related to this issue that will be helpful for the parties to address. Secondarily, it may be helpful for the parties to walk the hearing officer through the language of DEQ's Air Rule 214, as it pertains to the evaluation of economic and environmental factors in DEQ's T-RACT determination (Claim Nos. 6 and 7).

To the extent the parties wish to provide oral argument on other issues, they may do so. However, given the comprehensive nature of the existing summary judgment briefs, the parties should not feel the need to re-explain their arguments orally. The hearing officer's suggested sequence is provided below:

1) Alleged errors relevant to ambient air
   a) Exclusion of access road from ambient air (Claim Nos. 11 and 12)
   b) Lack of required ambient air monitoring (Claim No. 13)
2) Alleged errors relevant to PM_{10} emissions
   a) Reliance on plans to be developed later instead of enforceable limitations on average empty weight of ore haul trucks, average loaded weight of ore haul trucks, and total number of

[1] Claim numbers refer to those assigned in the November 15, 2022 Order on Motion to Dismiss.

vehicle miles traveled by ore haul trucks (Claim No. 1)

b) Assumption of control of 93.3% of PM_{10} emissions without related enforceable conditions (Claim No. 2)

c) Assumption of 120 days of recordable precipitation data instead of use of local weather data (Claim No. 5)

3) Alleged errors relevant to arsenic emissions

a) Whether errors in estimating PM_{10} emissions result in errors as to arsenic emissions (Claim No. 8)

b) Exclusion of economic and environmental evaluations in T-RACT analysis (Claim Nos. 6 and 7)

c) Averaging of projected arsenic emissions (Claim No. 9)

4) Standing, aggrieved party status, and prejudice of substantial rights under Idaho Code Section 67-5279(4)

Dated this 15th day of September, 2023.

Dylan Lawrence
Hearing Officer

Attachment A

(Questions Regarding Exclusion of Access Road From Ambient Air)

1. The Petitioners appear to assert two separate bases of error: (1) Perpetua lacks the legal authority to preclude access (Claim No. 11), and (2) the permit provisions regarding access control are inadequate (Claim No. 12). Is this an accurate characterization?

2. Is there anything in the record regarding the general public's need to utilize the road through the SGP, for example, to access, trails, campgrounds, other communities, *etc.*?

3. Is there anything in the record regarding the nature of Perpetua's property interests in the SGP and its legal ability to control access?

4. To the extent DEQ relies on representations by a permit applicant regarding its ability to control access, are there any legal authorities addressing the extent to which DEQ may so rely and/or the extent to which DEQ is responsible for verifying that information?

5. To what extent are DEQ's enforcement authorities relevant to these issues?

6. Is there anything in the record discussing the difference between guests of the facility and members of the general public, and how Perpetua will determine who is allowed access and who is not?

7. How do the DEQ guidance document in the record at PET743-744 and the EPA email attached to the Schilling Declaration affect the determination of ambient air?

CERTIFICATE OF SERVICE

I hereby certify that on this 15th day of September, 2023, I caused to be served a true and correct copy of the foregoing by the following method to:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

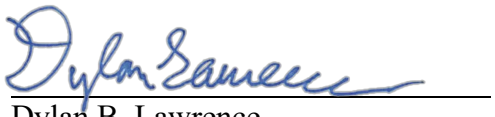
Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Resources Division
Office of the Attorney General
1410 N. Hilton St.
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service



Dylan B. Lawrence
Hearing Officer

DYLAN LAWRENCE
VARIN THOMAS LLC
P.O. Box 1676
Boise, ID 83701
(208) 345-6021
dylan@varinthomas.com

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	
	BEQ Case No. 0101-22-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v.	OAH Case No. 23-245-01 MEMORANDUM DECISION ON MOTIONS FOR SUMMARY JUDGMENT AND PRELIMINARY ORDER
DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	

I. FACTUAL AND PROCEDURAL HISTORY

Perpetua Resources Idaho, Inc. is in the process of applying for a variety of permits for its proposed Stibnite Gold Project ("SGP") in Valley County, Idaho. The SGP would consist of conventional open-pit mining, ore preparation, and gold extraction operations. In August 2019, Perpetua applied to the Idaho Department of Environmental Quality ("DEQ") for an air quality permit for the construction and operation of the SGP, pursuant to the Rules for the Control of Air Pollution in Idaho in IDAPA 58.01.01 (the "Air Rules"). DEQ issued the final version of air quality permit-to-construct P-2019.0047 (the "Permit") on June 17, 2022.

On July 22, 2022, the Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon ("Petitioners") filed a joint petition to initiate a contested case (the "Petition") regarding the Permit. The Petition alleges DEQ committed several errors in its development of the Permit and asks the Board of Environmental Quality ("Board" or "BEQ") to vacate and withdraw the Permit and remand it to DEQ to correct such errors. After some motion practice, the Petitioners filed an amended Petition on January 11, 2023.

DEQ filed its response to the initial Petition on August 12, 2022 and its response to the amended Petition on January 17, 2023. DEQ's response admits many of the Petition's allegations regarding general background information and applicable law, but ultimately denies DEQ committed any errors in issuing the permit, and requests its actions in issuing the Permit be affirmed.

On August 12, 2022, Perpetua filed a petition to intervene in the contested case proceeding pursuant to Rule 353.01 of the Board's Contested Case Rules in IDAPA 58.01.23 (the "BEQ Procedural Rules"), which the hearing officer granted on August 22, 2022. Perpetua filed its response to the amended Petition on December 13, 2022. Similar to DEQ's responsive pleading, Perpetua's response admits many of the Petition's allegations regarding general background information and applicable law, but ultimately denies that DEQ committed any errors in issuing the Permit and requests the Permit be affirmed and the Petition dismissed.

On September 6, 2022, Perpetua filed a motion to dismiss the Petition. The hearing officer ruled on that motion on November 15, 2022. In doing so, the hearing officer identified 13 individual claims of error in the Petition. The order granted the motion to dismiss as to Claim Nos. 3, 4, and 10 and partially granted the motion as to Claim No. 8. As to the remaining claims, the order denied the motion. Therefore, Claim Nos. 1, 2, 5, 6, 7, 9, 11, 12, 13, and a portion of Claim No. 8 survived.[1]

[1] On pages 22, 23, and 24 of the order on the motion to dismiss, there are incorrect references to

Pursuant to a stipulated scheduling order, the Petitioners filed a motion for summary judgment on April 14, 2023, and DEQ and Perpetua filed motions for summary judgment on May 12, 2023. Briefing on those motions and two related motions to strike was complete as of July 20, 2023. The hearing officer ruled on the motions to strike on July 31, 2023, and the parties and hearing officer held a hearing on the summary judgment motions on September 21, 2023.

II. RELEVANT LEGAL STANDARDS

A. Standards on Motions for Summary Judgment

Motions for summary judgment filed in administrative proceedings before the BEQ are governed by the Idaho Rules of Civil Procedure. *In the Matter of Simmons Sanitation*, Findings of Fact, Conclusions of Law, and Preliminary Order on Motion for Summary Judgment of 9/23/05, at p. 3 (BEQ Dkt. No. 0106-05-01). Those rules provide in pertinent part:

> A party may move for summary judgment, identifying each claim or defense, or the part of each claim or defense, on which summary judgment is sought. The court must grant summary judgment if the movant shows that there is no genuine dispute as to any material fact and the movant is entitled to judgment as a matter of law.
>
> ***
>
> A party asserting that a fact cannot be or is genuinely disputed must support the assertion by…citing to particular parts of materials in the record, including depositions, documents, electronically stored information, affidavits or declarations, stipulations (including those made for purposes of the motion only), admissions, interrogatory answers, or other materials; or…showing that the materials cited do not establish the absence or presence of a genuine dispute, or that an adverse party cannot produce admissible evidence to support the fact.
>
> ***
>
> An affidavit used to support or oppose a motion must be made on personal knowledge, set out facts that would be admissible in evidence, and show that the affiant or declarant is competent to testify on the matters stated. Sworn or certified copies of all papers or parts of papers referred to in an affidavit must be attached to

---

Claim Nos. 10, 11, and 12 at the end of the sections discussing Claim Nos. 11, 12, and 13, respectively. The heading of each of those sections is correct.

> or served with the affidavit. The court may permit affidavits to be supplemented or opposed by depositions, answers to interrogatories, or further affidavits.

IDA.R.CIV.PROC. 56(a), (c)(1), (c)(4).

Air permit matters are often technical in nature, requiring the decision-maker to understand the relevant science and to analyze long, detailed regulations. Therefore, discussion of the rules governing expert witness testimony at the summary judgment stage is warranted. In the context of legal malpractice cases, the Idaho Supreme Court has held:

> When a defendant-attorney files a motion for summary judgment, the plaintiff ordinarily has an obligation to provide expert affidavits that explain how the lawyer's conduct fell below the standard of care and how the conduct proximately caused damages. The reason for this rule is that ***laypeople sitting on a jury usually do not have the knowledge or experience necessary*** to determine the standard of care that applies to an attorney or how the attorney's performance of that duty may or may not harm a client. The only recognized exception to this rule is where the attorney's alleged malpractice is so obvious that it is within the ordinary knowledge and experience of laymen, such as when an attorney allows a statute of limitations to run.
>
> When Smith filed his motion for summary judgment, he also filed an affidavit and report from an expert witness stating that 'in [his] opinion, Mr. Smith met and exceeded the applicable standard of care in representing Ms. Greenfield in both the Criminal and Civil Cases.' The report analyzed the various deficiencies alleged by Greenfield and concluded that any alleged deficiency was not the cause of the jury's adverse verdict. ***Greenfield did not file any expert affidavits to refute these opinions*** and never disclosed any expert witnesses during the course of discovery. Instead, she filed her own affidavit setting forth the ways she believed that Smith's performance was deficient.
>
> ***
>
> These alleged deficiencies are not simple matters like an attorney allowing a statute of limitations to run…. ***Without expert testimony, Greenfield could not demonstrate that there were genuine issues of material fact*** as to whether Smith's performance fell below the standard of care or proximately caused her damages. As such, the district court ***properly granted summary judgment*** in favor of Smith.

Greenfield v. Smith, 395 P.3d 1279, 1285-1286, 162 Idaho 246, 252-253 (Idaho 2017) (emphasis added) (citations omitted); *see also Samuel v. Hepworth, Nungester & Lezamiz, Inc*., 996 P.2d 303, 134 Idaho 84 (Idaho 2000); *Rich v. Hepworth Holzer, LLP*, at p. 10-11, Ida. Sup. Ct. Dkt. No. 49300

(Sept. 6, 2023) (reaffirming *Greenfield* principles).

The test for whether a summary judgment respondent is required to adduce an expert affidavit is whether the relevant evidence is "the type that would be within the ordinary knowledge and experience of a layperson." *Ciccarello v. Jeffrey Bo Davies, & Marcus, Christian, Hardee & Davies, LLP*, 166 Idaho 153, 161, 456 P.3d 519, 527 (Idaho 2019). "Judges, after all, are lay persons, no matter how well-read they are in science." *Earl v. Cryovac, A Div. of W.R. Grace Co*., 772 P.2d 725, 728, 115 Idaho 1087, 1090 (App. 1989) (citation omitted).

Many of the errors alleged by Petitioners are not "the type that would be within the ordinary knowledge and experience of a layperson." Therefore, as to each alleged error, it is important to determine if expert witness testimony is necessary to render a decision, and if so, to evaluate the sufficiency of the expert testimony.

B. Idaho APA Judicial Standards of Review

The pleadings, motions, and briefs in this matter frequently invoke Idaho Code Section 67-5279. That statute contains the standards of review applicable when a petition for judicial review of an agency decision has been filed pursuant to the Idaho Administrative Procedure Act, Idaho Code Sections 67-5201 – 67-5292 (the "APA"). After a final order has been issued in this matter, if a party appeals to the judicial system, Section 67-5279 contains the standards governing the court's evaluation of the final order.

Even though APA standards are not directly applicable to the pending motions, it is still important to understand the standards that will ultimately govern judicial review of the Board's decision. As the Board itself has recognized, in a contested case proceeding, "the Board must determine whether DEQ has acted reasonably and in accordance with law." *In the Matter of Sunnyside Park Utilities' Application for Sewage Disposal Permit*, Final Order on Petition for

Review of Preliminary Order, at p. 10 (BEQ Dkt. 0103-07-02, Apr. 7, 2009).[2]

Pursuant to DEQ Procedural Rule 003.18 and AG Procedural Rule 740, the Board will render a decision in this matter by issuing a final order. Therefore, subsection (3) of Section 67-5279 applies to judicial review, and the court would affirm the Board's decision unless it finds:

- DEQ and the Board acted in violation of constitutional or statutory provisions;
- DEQ and the Board acted in excess of their statutory authority;
- DEQ's approval of the Permit and the Board's decision to uphold it were made upon unlawful procedure;
- The Board's decision was not supported by substantial evidence on the record as a whole; or
- DEQ and the Board otherwise acted in a manner that qualifies as arbitrary, capricious, or an abuse of discretion.

IDAHO CODE § 67-5279(3)

C. Deference to DEQ

According to the Idaho Supreme Court, "[t]he actions of an agency…are afforded a ***strong presumption of validity***." *Duncan v. State Bd. of Accountancy*, 232 P. 3d 322, 324, 149 Idaho 1 (Idaho 2010) (emphasis added).

> Where an agency interprets a statute or rule, this Court applies a four-pronged test to determine the appropriate level of deference to the agency interpretation. This Court must determine whether: (1) the agency is responsible for administration of the rule in issue; (2) the agency's construction is reasonable; (3) the language of the rule does not expressly treat the matter at issue; and (4) any of the rationales underlying the rule of agency deference are present. There are five rationales underlying the rule of deference: (1) that a practical interpretation of the rule exists; (2) the presumption of

[2] The hearing officer is aware that Board members have previously expressed concern regarding application of Section 67-5279 standards too early in an administrative hearing process. (*See generally* Order of 9/23/22, *taking administrative notice of* Tr. of 12/4/14, 47:5-9 (BEQ Dkt. No. 0101-14-01)). Because those are the standards that ultimately govern the disposition of this matter, it is still necessary to reference them on summary judgment. As with a cause of action in a civil lawsuit, it is still necessary at the summary judgment stage to reference and understand the legal standards and claim elements that would govern at trial.

> legislative acquiescence; (3) reliance on the agency's expertise in interpretation of the rule; (4) the rationale of repose; and (5) the requirement of contemporaneous agency interpretation.

Id. (citations omitted).

This matter requires a detailed review of the Air Rules. Clearly, DEQ is responsible for administering those Rules. Therefore, unless an issue is squarely addressed by the Air Rules, the hearing officer will defer to "practical" interpretations of the Air Rules by DEQ.

III. ANALYSIS

A. Standing and the Petitioners' Status as "Aggrieved Parties"

Both DEQ and Perpetua moved for summary judgment on the basis that each of the three Petitioners lacks standing. This order will address standing before proceeding to the alleged errors.

1. Discussion of Applicable Standards

BEQ's Rules of Procedure state that "[a]ny person aggrieved by an action or inaction of the Department may file a petition to initiate a contested case pursuant to" the APA. BEQ PROC. RULE 002.02. The rules define "person aggrieved" as "[a]ny person or entity with legal standing to challenge an action or inaction of the Department…." BEQ PROC. RULE 005.01. Regarding legal standing, the BEQ has held:

> The petitioner to a contested case proceeding can be either an individual or an organization. In order to satisfy standing, an individual petitioner must demonstrate: (1) an injury in fact which is real, concrete and particularized, and actual or imminent, and not just speculative or hypothetical; (2) a causal connection between the challenged action and the injury; and (3) the likelihood that the injury will be redressed by a favorable decision.
>
> An organization may obtain associational or representational standing on behalf of its members. To achieve standing on behalf of its members, an organization must show that: (1) its members would otherwise have standing to sue individually; (2) the interests the organization seeks to protect are germane to the organization's purpose; and (3) neither the claim asserted, nor the relief requested, requires participation of individual members in the lawsuit.

Solomon v. Idaho Dept. of Env. Quality, Order of 12/17/03, at p. 4 (BEQ Dkt. No. 0101-03-01) (citations omitted).

2. Idaho Conservation League

The Idaho Conservation League (ICL) filed declarations of Allison Fowle, Asa Menlove, and Jonathan Oppenheimer to establish standing. Ms. Fowle testifies, among other things, that she is a member of ICL; that she has used the Stibnite Road through the SGP many times; that she plans to continue visiting the area to recreate; and that she is concerned about the health effects from dust and arsenic if she continues to recreate in the area while the mine is operating. (Fowle Decl., ¶¶ 2-8.) The Menlove Declaration contains similar assertions. (*See* Menlove Decl., ¶¶ 2, 4, 9, 10.) Mr. Oppenheimer testifies that he is both a member and employee of ICL; that he has recreated in the general area and plans to continue to do so; and that he is concerned about the health effects of particulate matter and arsenic emissions from the SGP. (Oppenheimer Decl., ¶¶ 2, 9-13, 15-16.) All of these factual assertions are uncontradicted.

All three declarants appear to satisfy the standards for individual standing. Their concerns over health effects from particulate and arsenic emissions are sufficiently "concrete and particularized" to satisfy the first prong of the test, particularly given that they have recreated in the area in the past and plan to continue to do so, which distinguishes their concerns from those suffered alike by all citizens and taxpayers of the state. There is a sufficient causal connection between the challenged action (issuance of a permit allowing emissions of air pollutants) and the claimed injury (health effects from breathing emissions authorized by the permit) to satisfy the second prong of the individual standing test. For the third prong, there is a sufficient likelihood that the declarants' health concerns will be addressed by a decision in ICL's favor in this matter.

As to organizational standing, Mr. Oppenheimer testifies extensively regarding ICL's

purpose, history, and advocacy efforts related to the environment generally, and air quality specifically. (Oppenheimer Decl., ¶¶ 3-7.) In a prior case, the Board approved ICL's petition to intervene in a matter involving water quality at mining facilities in north Idaho. The Board found that ICL had established a sufficient "direct and substantial" interest in that matter based upon an affidavit similar to the ICL declarations in this case. S*ee Hecla Mining Co. v. Idaho Dept. of Env. Quality*, Order on Intervention, pp. 3-4 (BEQ Dkt. No. 0102-03-13).

Moreover, there is no reason ICL's claims of error or relief requested in this matter require the participation of Ms. Fowle, Mr. Menlove, or Mr. Oppenheimer individually. If ICL relied on Mr. Oppeheimer's declaration and its exhibits to establish substantive error, the third prong of organizational standing may not have been satisfied as to him. However, because ICL has clarified, and the hearing officer has ruled, that Mr. Oppenheimer's declaration will only be considered to evaluate standing, the third prong is satisfied as to him.

Based on the foregoing, the DEQ and Perpetua motions for summary judgment on the basis that ICL lacks standing are hereby DENIED.

3. Nez Perce Tribe

The Nez Perce Tribe (NPT) filed declarations of Joseph Oatman and Emmit Taylor, Jr. to establish standing. Among other things, Mr. Oatman and Mr. Taylor testify that they have fished within the boundaries of the SGP; that they intend to do so in the future; and that they are concerned about adverse health effects from air pollutants generated by the SGP. (Oatman Decl., ¶ 7; Taylor Decl., ¶ 9.) These assertions are uncontradicted and appear to satisfy the individual standing standards of concrete injury, causal connection, and redressability.

Similarly, the organizational standing standards of individual standing, germane protectable interests, and not needing the individuals' participation are sufficient to shift the burden back to

DEQ and Perpetua for summary judgment purposes. Here, it is worth noting the relatively cursory analysis of the standing issue by DEQ and Perpetua. The only discussion specific to whether the NPT has standing appears in DEQ's May 12 brief, filed ***before*** the Oatman and Taylor Declarations were filed on June 9. DEQ chose not to discuss the NPT declarations in its June 23 "Non-Reply," and Perpetua did not discuss the NPT specifically at all. (*See* Perpetua Mem. in Supp. of 5/12/23, pp. 13-14; Perpetua Reply of 6/23/23, p. 5.) "The burden is upon the party moving for summary judgment…to establish that there is no genuine issue of material fact." *G & M Farms v. Funk Irr. Co*., 808 P.2d 851, 863, 119 Idaho 514 (1991). Without more explanation from DEQ and Perpetua as to why the NPT does not satisfy the relevant standards, they have not carried their burden as summary judgment movants.

Based on the foregoing, the DEQ and Perpetua motions for summary judgment that the NPT lacks standing are hereby DENIED.

4. Save Our South Fork Salmon

Save the South Fork Salmon (SSFS) filed declarations of Drew Hollenback and Zak Sears to establish standing. They both testify, among other things, that they have been financial supporters of SSFS since 2016; that they have recreated in the area and utilized the access road through the SGP in the past and plan to continue to do so in the future; and that they are concerned about air pollution from the SGP if they continue to recreate in the area. (Hollenback Decl. of 6/9/23, ¶¶ 2, 4, 5, 7, 8, 10-12; Sears Decl. of 6/9/23, ¶¶ 2, 5-7, 12, 14, 15, 19.) For summary judgment purposes, this is adequate to shift the burden back to DEQ and Perpetua as to individual and organizational standing. As with the NPT, after SSFS adduced these declarations, neither DEQ nor Perpetua attempted to explain why or how they do not satisfy standing, aside from Perpetua's highly conclusory paragraph on the issue. (*See* Perpetua Reply Mem. of 6/23/23, p. 5.)

Based on the foregoing, the DEQ and Perpetua motions for summary judgment that SSFS lacks standing are hereby DENIED.

B. Evaluation of Declarations as Expert Testimony

Having denied the motions for summary judgment on standing, the remainder of this order addresses the individual alleged errors. Before doing so, it is necessary to determine which declarations, if any, are admissible as expert testimony. *See* IDA.R.CIV.PROC. 56(c)(4) (affidavits must be admissible in evidence and show that the declarant is competent to testify on the matters stated); *Hecla Min. Co. v. Star-Morning Min. Co*., 122 Idaho 778, 784, 839 P.2d 1192, 1198 (Idaho 1992) (recognizing that on a motion for summary judgment, "[t]he question of admissibility is a threshold question to be answered before applying the liberal construction and reasonable inferences rule to the admissible evidence").

> A witness who is qualified as an expert by knowledge, skill, experience, training, or education may testify in the form of an opinion or otherwise if the expert's scientific, technical, or other specialized knowledge will help the trier of fact to understand the evidence or to determine a fact in issue.

IDA.R.EVID. 702.

The Petitioners supported their motion for summary judgment with one declaration, a declaration of counsel that was limited to authentication of documents from the record. (Hurlbutt Decl. of 4/14/23.) When DEQ moved for summary judgment, it adduced declarations of Tiffany Floyd, Kevin Schilling, and Mike Simon. Mr. Schilling testifies, among other things, that he has a B.S. in environmental science with a minor in chemistry; has a M.S. in environmental engineering with an emphasis on atmospheric chemistry, meteorology, air pollution monitoring, and atmospheric pollutant dispersion; has worked for the State of Idaho and within the private sector in some capacity relating to air quality science and engineering since the spring of 1989; and has been a Stationary

Source Air Modeling Supervisor for DEQ since September 2004. (Schilling Decl. of 5/12/23, p. 2.) Mr. Simon testifies, among other things, that he has a B.S. in electrical engineering and has over 30 years of air quality experience that includes conducting air quality analyses, writing air quality permits, processing air quality enforcement cases, managing air quality programs, and installation, operation, calibration, and maintenance of meteorological and navigational equipment. (Simon Decl. of 5/12/23, p. 2.)

On their face, both the Schilling and Simon Declarations appear to satisfy the Rule 702 standards.[3] Both witnesses testify regarding education and experience that qualifies them as experts on the issues involved in this matter, and then they explain the basis for DEQ's actions in issuing the Permit to Perpetua as they pertain to the alleged errors. Moreover, because Schilling and Simon are DEQ employees, their testimony is entitled to deference. *See generally Chisholm v. Idaho Dept. of Water Resources*, 125 P.3d 515, 518, 142 Idaho 159 (Idaho 2005).

The Petitioners do not challenge the admissibility of the DEQ declarations as expert testimony. They also do not rebut the DEQ declarations with their own expert declarations. The declarations filed by Petitioners on June 9, 2023, are primarily dedicated to challenging the contention that they lack standing. Petitioners themselves describe them as "standing declarations." (Petitioners' Resp./Reply Br. of 6/9/23, pp. 2-4, 35; Petitioners' Resp. to Mot. to Strike of 7/7/23, pp. 1, 4.) The Oppenheimer Declaration purports to discuss technical air quality issues, but the hearing officer has ruled that declaration should only be considered for standing purposes. (Order on Perpetua's Mot. to Strike of 7/31/23, p. 6.) Mr. Oatman and Mr. Taylor have impressive education and experience, but their backgrounds are in fisheries. This does not "help the trier of fact to understand the evidence or to determine a fact in issue" in an air permitting matter.

[3] The Idaho Rules of Evidence do not strictly apply. BEQ R.PROC. 003.13; AG R.PROC. 600.

C. Exclusion of Stibnite Access Road From Ambient Air

The Petition alleges multiple errors regarding ambient air boundaries and monitoring. Even though the phrase "ambient air" appears in the Permit one time, (*see* Permit, p. 41, § 7.13), it is an important concept behind many Permit conditions. Therefore, before addressing each individual alleged error, it will be helpful to discuss the concept of ambient air within the Air Rules.

1. Ambient Air Generally

Under the federal Clean Air Act, EPA is required to establish national ambient air quality standards (NAAQS) for a handful of "criteria" air pollutants, including PM_{10}. *See generally* 42 U.S.C. § 7602(t); 40 C.F.R. § 50.6. When DEQ evaluates an application for a permit to construct, it must determine that "[t]he stationary source or modification would not cause or significantly contribute to a violation of any ambient air quality standard." AIR RULES § 203.02. Based on the federal definition, the Air Rules define "ambient air" as "[t]hat portion of the atmosphere, external to buildings, to which the general public has access." AIR RULES § 006.05.

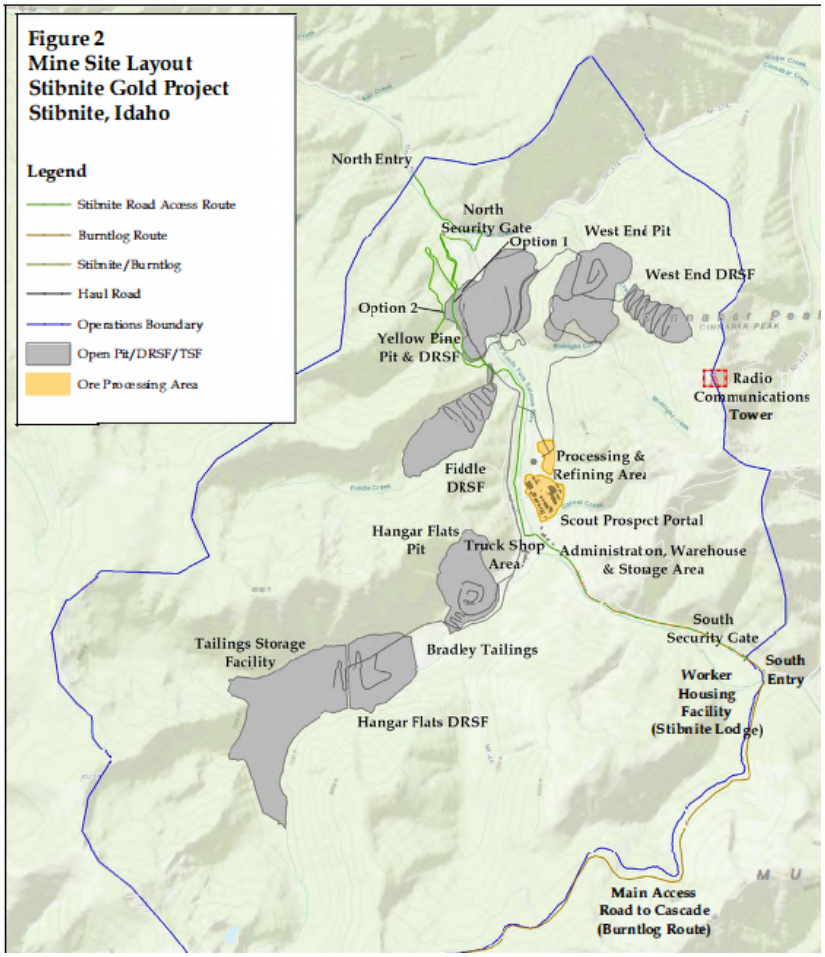
The Petition alleges—and DEQ agrees—that to exclude areas from ambient air, the following must be true: (1) the permittee must have the ***legal authority to exclude the general public*** from the area; (2) the boundary to ambient air must be clearly discernable to the general public; (3) the general public must be ***effectively precluded*** from assessing the facility; and (4) the general public is not considered (a) employees of the facility; (b) those having official business with the facility; or (c) guests of the facility, including participants in facility routes and those seeking access for a specific purpose. (Pet., ¶ 59; DEQ Resp., p. 5 (emphasis added)).

2. The SGP and the Access Road

The SGP is located in a relatively remote location administered by the Payette National Forest. (R., at p. PRI00000418.) Its elevation ranges from approximately 6,421 feet and 6,936 feet

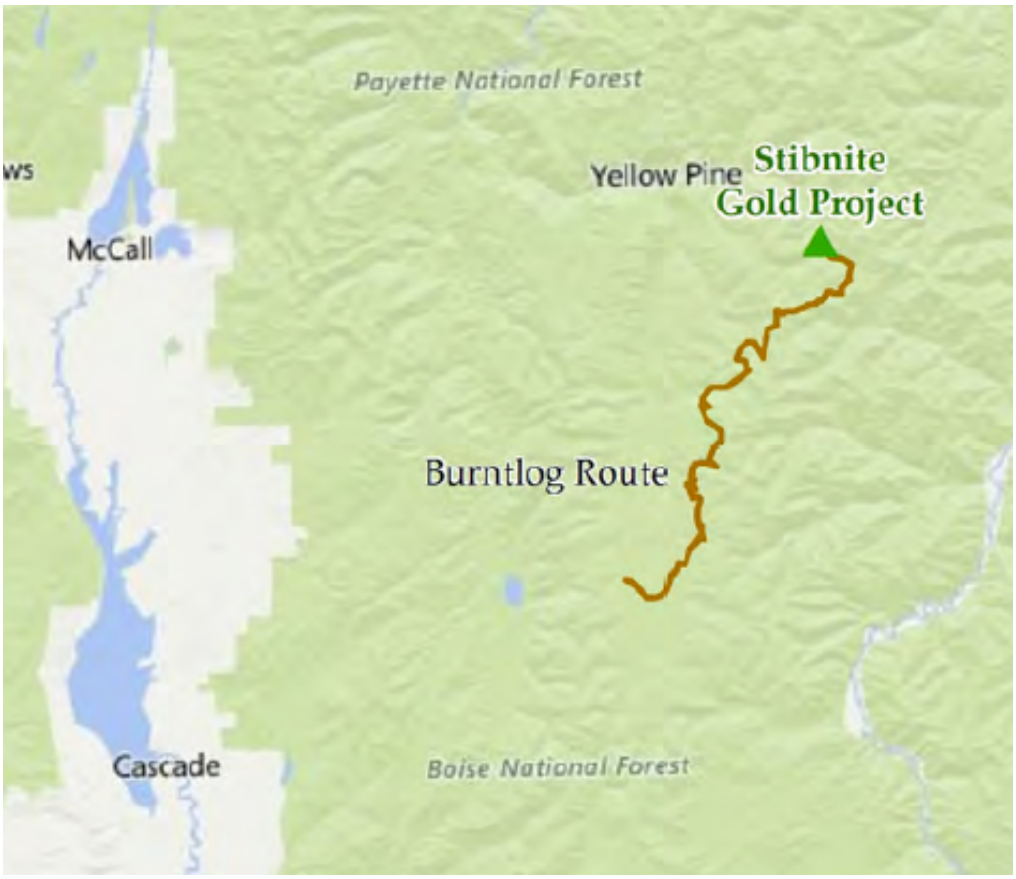
above sea level. (*See generally* R., at pp. PRI00000450-453.) Between December and May, it has an average snow depth between 21 inches and 84 inches. (R., at p. PRI00000419.) It is approximately 37 miles as the crow flies due east of McCall, and approximately 43 miles as the crow files northeast of Cascade.

The SGP is bisected by a U.S. Forest Service ("USFS") road that runs from the northern portion of the SGP to the south-southeast (or conversely, from the southeast portion of the SGP to the north-northwest). Generally speaking, this creates two ways to access the SGP by road. One could drive east from McCall to reach the North Entry of the SGP, passing through the community of Yellow Pine along the way, or one could drive northeast from Cascade to reach the South Entry of the SGP. (*See generally* R., at p. PET 527.)



(R., at p. PET533.)

Perpetua proposed year-round access to the SGP would be accomplished via the "Burntlog Route," which would involve the improvement and extension of the existing Burntlog Road and portions of Thunder Mountain Road. (R., at p. PRI00000418.) The Burntlog Route would provide year-round access to the south side of the SGP.



(R., at p. PRI00000416.)

The community of Yellow Pine is approximately 10 road miles west of the SGP's North Entry, and there are seasonal recreational destinations outside the SGP's South Entry. (*See* R., at p. PRI00000418.) Therefore, if access through the SGP is precluded, those traveling from Yellow Pine to access those recreational areas would have to travel much farther and around the SGP to do so.

Indeed, Perpetua initially proposed public access through the SGP would be prohibited. (R.,

at p. PET 527.) In response to public comments, Perpetua then proposed to allow "restricted seasonal [non-winter] access through the SGP site," which would "allow limited access to the Thunder Mountain recreational area from the town of Yellow Pine similar to the existing seasonal route." (R., at p. PRI00000418; *see also* R., at pp. PET 527, 530.) Alternative 2 under consideration by USFS under the National Environmental Policy Act ("NEPA") would allow continued access through the SGP. (R., at p. PET 527.)

For the purposes of the air modeling, Perpetua proposed to treat the access road within the operational boundary of the SGP as part of the SGP. The access road within the SGP was not treated as "ambient air," the result being that Perpetua was not required to demonstrate NAAQS compliance within that portion of the road. According to the Petition, that access road should have been treated as ambient air, not excluded from it, such that compliance with NAAQS would be required within the road. (*See generally* Pet. ¶¶ 60, 62.)

3. Whether Perpetua Has Adequate Legal Authority to Exclude the General Public (Claim No. 11)

The Petitioners argue there is not sufficient evidence in the record demonstrating Perpetua's legal authority to preclude access by the general public, in part because USFS's evaluation of the SGP under NEPA is not complete. (*See* Pet. ¶ 62; Br. in Supp. of MSJ of 4/14/23, pp. 14-18.) DEQ and Perpetua's primary response is that DEQ reasonably relied upon Perpetua's representation in its permit application that it will have the legal authority to control access.

In advance of the summary judgment hearing, the hearing officer requested the parties identify "any legal authorities addressing the extent to which DEQ may so rely [on representations by a permit applicant] and/or the extent to which DEQ is responsible for verifying that information." (Not. Re SJ Hearing of 9/15/23, Att. A, No. 4.) At the hearing, the only specific legal authority cited by any party was Petitioners' reference to *Ctr. for Biological Diversity v. U.S. Fish & Wildlife*

Serv., 33 F.4th 1202 (9th Cir. 2022), referred to as the "*Rosemont*" case because it involved a project proposed by the Rosemont Copper Company. *Rosemont* involved a determination of the scope of rights provided to claimants of mining claims on federal land under the federal Mining Law of 1872. *Id*. at 1208. At its core, that case involves the ***legal interpretation*** of that particular set of federal statutes; it does not squarely address the issue of the extent to which an agency may rely upon ***factual representations*** by an applicant.

In the absence of a specific legal requirement on this issue, the hearing officer must affirm DEQ's decision unless there is not substantial evidence in the record of Perpetua's legal ability to exclude the public or it was otherwise arbitrary or capricious to so rely. In its permit application materials, Perpetua makes the following representations:

> Midas Gold[4] ***will legally control the SGP***, an active industrial site where mining activities will occur, such as heavy equipment operation. Most areas of the mine will require strict safety protocols and controlled access. Midas Gold has established an operations boundary to identify the area ***where public access will be excluded***. Public access inside the operations boundary ***will be restricted for the life of the mine*** by physical barriers at points of potential access, including the current Stibnite Road point of entry and proposed site access via the Burntlog Route, as well as natural features of the landscape that prevent access.

(R., at p. PRI00000467 (emphasis added).)

The next section of this opinion discusses Section 2.7 of the Permit in detail. For now, it is adequate to note that Section 2.7 requires Perpetua to take actions to both "discourage" and "preclude" public access to the SGP. The Air Rules state:

> All documents, including but not limited to, ***application forms for permits to construct***, application forms for operating permits, progress reports, records, monitoring data, supporting information, requests for confidential treatment, testing reports or compliance certifications submitted to the Department must contain a certification by a responsible official. ***The certification must state that, based on information and belief formed after reasonable inquiry, the statements and information in the document are true, accurate, and complete***.

[4] Midas Gold Corp. formally changed its name to Perpetua Resources Corp. in Februrary 2021.

***

> Persons are prohibited from knowingly making any ***false statement, representation, or certification*** in any form, notice, or report required under any permit, or any applicable rule or order in force pursuant thereto.

AIR RULES 123, 125 (emphasis added).

Perpetua acknowledged the certification requirement in its application materials. (R., p. PRI00000167-168, 381.) It is also worth noting that DEQ has broad enforcement authorities. *See* IDAHO CODE §§ 39-105, 39-108, 39-109. If the representations that Perpetua "will legally control the SGP" in a manner in which "public access will be excluded" and "restricted for the life of the mine" were not true at the time they were made, then Perpetua would be subject to enforcement by DEQ. If Perpetua ultimately lacks the ability to preclude public access as a result of the NEPA process, operating the SGP anyway would be in plain violation of Section 2.7 of the Permit, which requires Perpetua to "preclude" and "discourage" public access.

In the experience of the hearing officer, it is not unusual for an agency to rely on representations made in a permit application, even as to an issue as fundamental as the nature of the applicant's interests in the relevant property. *See* APPLICATION FOR PERMIT TO APPROPRIATE THE PUBLIC WATERS OF THE STATE OF IDAHO, Item No. 11, *available at* https://tinyurl.com/yc5p48ss (last visited Oct. 15, 2023). Under these circumstances, the hearing officer finds DEQ's reliance on Perpetua's representation that it will eventually have the ability to control access reasonable and supported by substantial evidence in the record.

As to Claim No. 11, the Petitioners' motion for summary judgment is hereby DENIED, and the motions for summary judgment filed by DEQ and Perpetua are hereby GRANTED.

4. Whether the Permit Adequately Precludes Access by the General Public (Claim No. 12)

The Petitioners argue the Permit does not adequately preclude access by the general public

through the SGP. Sections 2.6 and 2.7 of the Permit require Perpetua to develop an "Access Management Plan (AMP)" that, among other things, "clearly specifies measures used to discourage public access to the facility," and that "shall be submitted to DEQ for approval 30 days prior to startup…." (R., at p. PET 010.) The Petition alleges that, "[w]ithout full disclosure and knowledge of the exact measures and requirements in the AMP and enforceable permit limits, DEQ cannot make a determination of whether exclusion of the access road from ambient air protections complies with EPA's ambient air policy and the Idaho Air Rules, nor can DEQ determine whether the SGP will comply with the NAAQS and TAPs." (Pet., ¶¶ 58, 59, 62, 65).

In contrast to many of the other errors alleged by Petitioners, the hearing officer finds establishment of ambient air boundaries as a matter that is within the common knowledge or a layperson. Therefore, expert testimony is not necessary. The hearing officer agrees that Perpetua and DEQ cannot demonstrate compliance by reference to a document that is not yet final. Therefore, consideration of this issue is limited to the "four corners" of the Permit, which states:

- Perpetua must "[o]bserve all primary access points to preclude unauthorized public access" and ensure "[o]nsite personnel [are] available for this purpose during active mining and mineral processing operations."
- Perpetua may control access at the North Entry and South Entry either "by the use of locked gates, barriers, or equivalent measures," by "manned guardhouses," or "by the use of security escort vehicles."
- Perpetua is required to "[p]ost warning signs and periodically patrol secondary access points to the facility [*i.e.*, secondary roadways and trails traversing the SGP] to preclude public access" and to make onsite personal available for this purpose.
- Perpetua may only provide "registered guests of the facility" with access to or

through the SGP "for the sole purpose of passing through the facility to another destination," and is required to provide literature that "explains Perpetua's requirements for accessing the site" and that "identifies potential hazards of the site." (R., at p. PET 010.)

Aside from the relatively brief definition of "ambient air," the Air Rules do not articulate legal standards for when the general public has adequate "access" to the atmosphere and when it does not. As a result, the parties refer to guidance documents promulgated by EPA and DEQ.

According to EPA's 2019 ambient air policy: (1) it is appropriate to exclude areas from ambient air where measures are employed that are "effective in precluding access to the land by the general public;" (2) such measures can include physical barriers, but physical barriers are not required; (3) determinations by the agency are discretionary on a case-by-case basis; (4) the permit applicant must have the legal ability to preclude access by the general public and must employ measures that actually preclude the general public as a practical matter; (5) in evaluating the adequacy of the preclusion measures, the agency applies a "rule of reason" as to whether the general public will have access "under reasonably anticipated circumstances." (R., at p. PET772-785.)

DEQ's 2021 guidance document asks a series of questions to determine if access by the general public is sufficiently precluded. If there is a fence or other physical barrier, it is appropriate to establish the ambient air boundary at that location. If access by the general public is discouraged by the nature or remote location of the facility and the facility either posts "no trespassing" signs or has security personnel who will ask trespassers to leave, then it is appropriate to establish the ambient air boundary at the property boundary. If none of the above are true, then the ambient air boundary is determined by a variety of factors. (*See* R., at pp. PET743-744.)

Again, the specific error alleged by Petitioners is that exclusion of the access road from

ambient air was error. This is not an evaluation of the entire ambient air boundary adopted by DEQ. In this regard, the requirements in the Permit enumerated above are consistent with both agency guidance documents and the conclusion that the access road is appropriately excluded from ambient air. At a minimum, the Permit makes it clear that Perpetua is required to preclude unauthorized access by the general public and that members of the public can become guests of the facility only if they are seeking to pass through to access another destination. Even Petitioners acknowledge their understanding that members of the general public who become guests of the SGP for the purpose of passing through will not be able to stop within the SGP. (*See* Tr. of 9/21/23 at 34:7-15.) And, if Perpetua does not take measures to discourage and preclude access by the general public, DEQ states that would be a violation of the Permit—likely a "major" violation. (Tr. of 9/21/23 at 40:8-18.)

While it is always possible to suggest ways in which a particular permit provision could be drafted differently, the hearing officer does not believe his role is to nitpick the language DEQ drafted in the Permit. Even without considering the yet-to-be-developed AMP, the hearing officer finds Section 2.7 of the Permit to adequately require Perpetua to preclude access by the general public for the purpose of excluding the access road from the definition of "ambient air."

Therefore, the Petitioners' motion for summary judgment as to Claim Nos. 11 and 12 is hereby DENIED, and the summary judgment motions filed by DEQ and Perpetua as to Claim Nos. 11 and 12 are hereby GRANTED.

D. Lack of Requirements for Ongoing Ambient Air Monitoring (Claim No. 13)

The Permit contains a variety of provisions requiring Perpetua to take actions to minimize air pollution. Section 1.2 and Table 1.1 identify and categorize the various discrete activities that will take place throughout the SGP and identify the pollution "control equipment" required for each individual activity. (R., at pp. PET 003-007.) The Permit also contains facility-wide requirements to

control fugitive dust, visible emissions, and odors. (R., at pp. PET 008-011.). The Permit also contains several monitoring and recordkeeping requirements. Generally applicable requirements to the SGP appear in Section 7.10, which states:

> The permittee shall maintain sufficient records to ensure compliance with all of the terms and conditions of this permit. Monitoring records shall include, but not be limited to, the following: (a) the date, place, and times of sampling or measurements; (b) the date analyses were performed; (c) the company or entity that performed the analyses; (d) the analytical techniques or methods used; (e) the results of such analyses; and (f) the operating conditions existing at the time of sampling or measurement. All monitoring records and support information shall be retained for a period of at least five years from the date of the monitoring sample, measurement, report, or application. Supporting information includes, but is not limited to, all calibration and maintenance records, all original strip-chart recordings for continuous monitoring instrumentation, and copies of all reports required by this permit. All records required to be maintained by this permit shall be made available in either hard copy or electronic format to DEQ representatives upon request.

(R., at p. PET 040).

The same "General Provisions" portion of the Permit contains multiple reporting requirements. (*See* R., at pp. PET 041-042.) In addition, the portion of the Permit applicable to fugitive dust contains several monitoring and recordkeeping requirements. (*See* R., at pp. 008 (§ 2.2), 011 (§ 2.10), and 012-014 (§ 2.20).) Moreover, the Permit incorporates several portions of the Code of Federal Regulations, including 40 C.F.R. Part 60, Subpart A (General Provisions), which includes requirements related to recordkeeping (40 C.F.R. § 60.7), monitoring (40 C.F.R. § 60.13), and reporting (40 C.F.R. § 60.19.) (*See* R., at p. PET 014 (§ 2.22).)

The Permit does not require ongoing monitoring of the quality of the ambient air while the SGP is operating. The Petition alleges that "without ambient air monitoring, it will be impossible for DEQ to assess whether the SGP's operation is in compliance with NAAQS and TAPs increments at any given time." (Pet., ¶ 68). Air Rule 211.01(d) expressly authorizes—but does not require—DEQ to include reasonable ambient air monitoring requirements in a permit-to-construct. Therefore, the

question is whether it was arbitrary, capricious, or an abuse of discretion for DEQ not to require ongoing ambient air quality monitoring.

Recognizing that ambient air quality monitoring is not legally required in all cases, Mr. Schilling describes the circumstances in which ambient air quality monitoring is typically appropriate. These include situations in which (1) "postconstruction air quality is projected to be so close to the NAAQS that monitoring is needed to certify attainment;" (2) "uncertainties in source or emissions characteristics result in significant uncertainties about the projected impact of the source or modification; and (3) when there are nearby sensitive receptors such as hospitals and schools. (*See* Schilling Decl., pp. 14-19.) According to Mr. Schilling, DEQ normally utilizes very conservative assumptions that overstate emissions in order to ensure NAAQS compliance is achieved. Upon discovery that a non-conservative figure for median silt content was used during the evaluation of Perpetua's Permit application, Mr. Schilling testifies:

> The options at this point were: 1) recalculate PM_{10} emissions from haul roads using a more conservative statistic for road silt than the median value, then revise the air impact modeling analyses; 2) require post construction ambient air monitoring to increase the assurance of NAAQS compliance; 3) use the 4.0 percent silt value as a maximum allowable value in the permit, requiring periodic monitoring of the road silt content during mining operations; and/or 4) develop other means by which lower levels of fugitive emissions from vehicle traffic could be attained and assured through monitoring (monitoring other than ambient air monitoring).
>
> Requiring ambient air monitoring for the SGP was discussed within the Air Division, including stationary source staff, ambient monitoring staff, and State Implementation Plan (SIP) staff. From the perspective of air permit modeling verification, I believe the requirement of PM_{10} ambient air monitoring to assure NAAQS compliance is of limited value for the SGP because of the following:
>
> - Monitored values showing compliance with the NAAQS only demonstrates compliance for that point in space and time. While a monitored exceedance likely indicates a failure to adequately control emissions (unless the exceedance may be caused by elevated background concentrations), compliance doesn't assure compliance at other ambient air locations.
>
> - Selecting a single monitoring location to represent worst-case impacts is

nearly impossible. In general, atmospheric dispersion models perform reasonably well at predicting the magnitude of maximum impacts (provided the inputs of emissions and emission release parameters is reasonably accurate); however, they perform poorly at predicting the location of maximum impacts in most cases. The accuracy of predicted locations of maximum impacts is even worse for analyses involving complex terrain, complex meteorological conditions, and emission sources involving atypical release characteristics (fugitive emissions from vehicle traffic, blasting operations, ore handling, *etc*.). Monitoring results that show compliance with NAAQS may portray a false confidence of NAAQS compliance on a facility-wide scale.

- No sensitive receptors have been identified near the facility. Sensitive receptors are locations where there is likely to be a concentration of the general public present. These include private residences, schools, hospitals, care centers, retail stores, parks, and resorts. DEQ believes the confidence of NAAQS compliance must be higher at these locations than at locations where there is a lower probability of public exposure. Ambient air monitoring at these locations can provide the additional assurance that air pollutant impacts from a neighboring industry will not violate standards and impact the health of the general public at sensitive receptor locations.

After internal discussions, Option 3 was selected, changing the 4.0 percent silt content limit from the median value to a maximum value. If the required sampling and testing of road material indicates a maximum silt content above 4.0 percent, it will be a permit violation. The permittee must then work with DEQ to develop a way to further reduce emissions, adjust operations, and/or revise impact analyses to enable NAAQS compliance to be demonstrated. This would likely require a permit modification.

(Schilling Decl., pp. 18-20.)

In addition, Mr. Simon testifies as follows:

DEQ did consider the option of requiring a PM_{10} ambient air monitor in the PRI PTC. In considering this option, staff reviewed DEQ's history of decisions requiring ambient air monitors in permits. Where DEQ did require an ambient monitor in a permit, the facility had already been in operation for many years and there was a recent modeled NAAQS (National Ambient Air Quality) violation. In these cases, DEQ negotiated with the facility to site and operate an ambient air monitor and develop a corrective action plan for the facility. This allowed the facility to monitor air quality while it made process changes and modified its permit to demonstrate a return to NAAQS compliance. Once the changes were implemented or approved, the facility would then demonstrate NAAQS compliance through modeling analysis. The monitor was eventually removed from their respective permits. In these few situations, DEQ never had an ambient air monitored violation.

> In all cases where DEQ processed a PTC application for a new or modified facility, DEQ required the applicant to demonstrate NAAQS pre-construction compliance using DEQ's approved modeling procedures as outlined in the 'State of Idaho Guideline for Performing Air Quality Impact Analysis.' DEQ will not issue a final PTC if the applicant has not demonstrated pre-construction NAAQS compliance to the satisfaction of the Department.
>
> DEQ also considered the location of the proposed PRI facility, the proximity of nearby residences and the implementation costs of requiring an ambient monitor. Given all of these factors, DEQ ultimately decided not to require an ambient air monitor in the permit. DEQ did reach out to PRI prior to final PTC issuance to see if they would voluntarily install an ambient monitor but declined at that time.

(Simon Decl., pp. 10-11.)

DEQ recognized that whether to require ambient air quality monitoring is within its discretion, and Schilling and Simon describe a reasoned, logical explanation for why DEQ did not require such monitoring in this case. This is unrebutted expert testimony on an issue that is not within the common knowledge of a layperson. The Petitioners identify various ways NAAQS violations could occur hypothetically, but these are arguments in a brief. Without expert testimony explaining why monitoring should have been required in this case, the hearing officer lacks discretion to find that DEQ committed error by not requiring ambient air quality monitoring.

Based on the foregoing, the Petitioners' motion for summary judgment as to Claim No. 13 is hereby DENIED. The motions for summary judgment filed by DEQ and Perpetua as to Claim No. 13 are hereby GRANTED.

E. Reliance on Plans Instead of Enforceable Limitations for Control of PM_{10} Emissions (Claim No. 1)

The Petition asserts error occurred because "important variables affecting the quantity of PM_{10} generated by the ore haul trucks are not directly limited and enforceable as PTC permit conditions." (Pet., ¶ 36). More specifically, even though Perpetua used multiple "[c]ritical variables…as inputs to PM emission calculations," the Petition argues DEQ erred by "rel[ying] on a

surrogate limit in the PTC," "[i]nstead of developing PTC conditions for these other critical variables." (Pet., ¶¶ 36-37). According to the Petition, the three "critical variables" lacking relevant Permit conditions are the average empty weight of ore haul trucks, the average loaded weight of ore haul trucks, and the total number of vehicle miles traveled by ore haul trucks.[5] (*See* Pet. ¶ 36). Without enforceable limitations on those three variables, Petitioners argue "DEQ could not reasonably claim when it issued the Permit that the facility will not cause or contribute" to violations of applicable air quality standards. (Mem. in Supp. of MSJ of 4/14/23, p. 24.)

Petitioners do not point to an Air Rule specifically requiring every modeling input and variable to be the subject of a specific permit condition or limitation. Therefore, this issue is governed by Air Rule 210.01, which provides DEQ with discretion to impose reasonable conditions on a permit to construct. The inquiry here is whether it was arbitrary, capricious, or an abuse of discretion for DEQ not to include Permit conditions specifically regulating the average empty weight of ore haul trucks, the average loaded weight of ore haul trucks, and the total number of vehicle miles traveled by ore haul trucks. On this issue, Mr. Simon testifies:

> In reviewing the mean vehicle weight variable used in calculating haul road emissions, PRI proposed the use of 20 large Cat 789D mining trucks and 12 smaller CAT 740B dump trucks. PRI stated that the ratio of large to small trucks would be 20:12. Mean vehicle weight used in the calculation for haul road emissions include the total mean vehicle weight from fully loaded trucks. ***Rather than developing a methodology in the permit to measure and determine average vehicle weight each day, DEQ developed a haul road usage limit of 180,000 tons of ore and development rock per day (PTC condition 3.5). This limit accounts for the average loaded vehicle weight of all trucks as well as the average round-trip distance traveled as presented in the application***. The monitoring methodology required to measure daily ore and development rock hauling is addressed in the required Operations and Maintenance Manual (PTC condition 2.20).

(Simon Decl., p. 9 (emphasis added).)

[5] The Petition acknowledges that an enforceable Permit condition was included for silt content of haul roads.

This is unrebutted testimony from an expert witness on an issue that is not within the common knowledge of the layperson. On its face, this is a reasonable explanation that is consistent with DEQ's response to comments:

> Enforceable monitoring, recordkeeping, and reporting [MMR] requirements were established in the permit. PM/PM_{10}/$PM_{2.5}$ emissions limits for point sources were established with supporting activity rate limits and MRR requirements. ***While emissions limits and emission factors are not commonly included in the permit for fugitive sources, activity rate limits and MRR requirements were established for those sources that were identified as process rate-limiting (as summarized in Table 1.1 of the permit). These activity rate limits serve as surrogate emissions limits for PM, PM_{10}, $PM_{2.5}$, HAP and TAP from fugitive sources***. And while documented in the Statement of Basis and application materials, underlying parameters associated with calculating emissions such as vehicle speed limit, type, and miles traveled are not typically included in the permit ***but can be found in the application materials*** (Appendix A).

(R., at p. PET 557 (emphasis added).)

In other words, due to the nature of fugitive emissions, DEQ chose to control those emissions by limiting the amount of ore and development rock that can be hauled per day, with both a daily haulage limit and a limit on the five-year rolling average of daily haulage. (*See* R., at p. Pet 019 (Permit § 3.5).) If the representations of vehicle weights and miles traveled in Perpetua's application materials end up being materially different from reality, those discrepancies will be well documented via the various plans, monitoring, and reporting required by the Permit, and DEQ will have enforcement capabilities pursuant to Air Rules 123, 125, and 202 and Idaho Code Sections 39-105, 39-108, and 39-109.

Based on the foregoing, the hearing officer hereby DENIES Petitioners' motion for summary judgment as to Claim No. 1. The motions for summary judgment filed by DEQ and Perpetua as to Claim No. 1 are hereby GRANTED.

F. Assumption of Control of 93.3% of PM10 Emissions Without Related Enforceable Conditions (Claim No. 2)

Section 3.1 and Table 3.2 of the Permit provide in pertinent part:

Table 3.1 contains a description of control equipment used to control emissions from mining and ore processing activities.

Table 3.1 Mining and Ore Processing Control Device Descriptions

Emission Sources	Control Devices
Mining	
Excavating and hauling activities	Reasonable control & FDCP Chemical suppression and water sprays ***Control efficiency: 93.3% for PM/PM10 (haul roads)*** Haul road capping with low-arsenic quartzite

(*See* R., PET018 (emphasis added).)

The Petition asserts error occurred because "DEQ assumed 93.3% of all haul road PM_{10} emissions from the SGP can be controlled by using an unspecified combination, volume, and frequency of water sprays and chemical dust suppressants" without also including "specific and enforceable permit conditions within the PT to ensure a 93.3% control efficiency." (Pet. ¶¶ 38-39). According to the Petition, "[a] lesser control efficiency, even just slightly lesser, could result in large enough PM_{10} emissions to violate the NAAQS." (*Id*. at ¶ 39).

On summary judgment, the Petitioners further elaborate on these three distinct but related points: First, DEQ's assumption that Perpetua can achieve 93.3% control efficiency is without an adequate basis. Second, DEQ's assumption that Perpetua can achieve 93.3% control efficiency is aggressive because "[i]t is challenging to consistently and continuously achieve 93.3 percent control." (Tr. of 9/21/23 at 67:10-14.) According to Petitioners, this provides only a "razor thin" margin of error, such that if the 93.3% figure is not achieved, violations of the NAAQS will

necessarily result. (Tr. of 9/21/23, 66:13.) Third, given the first two points, it was error for DEQ not to include more specific requirements to ensure 93.3% control efficiency is achieved.

1. Without Adequate Basis

As to the first point, it is helpful to note that the 93.3% control efficiency figure is based on two separate assumptions regarding the control efficiency for chemical suppressants and the control efficiency for water. Regarding the control efficiency for chemical suppressants, Simon explains:

> PRI's consultant, Air Sciences, Inc., provided information in their application from their research of AP-42: Compilation of Air Emission Factors, Section 13.2.2, emission factors for unpaved roads (EPA 2006). According to AP-42, test studies on various unpaved industrial roads where chemical dust suppressants were applied documented a range from 90 to 99 percent dust control efficiency for PM_{10}. Based on this data, PRI proposed to use a 90% dust control efficiency for PM_{10} when utilizing chemical dust suppressants on unpaved roads.

(Simon Decl., pp. 5-6.)

Regarding the control efficiency for water, Simon explains:

> In addition to using the chemical dust suppressant, controlled PM_{10} emission calculations for unpaved haul roads also incorporate the control efficiency for water. For annual dust control from water, AP-42 accounts for this in an equation that uses annual precipitation data. When using the 120 days of precipitation obtained from AP-42 section 13.2.2, the precipitation term accounts for natural mitigation in calculating the annual unpaved road emissions. Staff reviewed and approved this methodology. The daily unpaved road emission calculations use an applied water control efficiency of 33%. This value was supported by permit staff based on an evaluation of figure 13.2.2-2 of AP-42 for water control effectiveness on unpaved roads.

(Simon Decl., p. 8.)

Stated in layman's terms, the 93.3% control efficiency is essentially calculated as follows: Chemical dust suppressants will control 90% of the dust emissions from unpaved roads, and water will control 33% of the remaining uncontrolled 10%. (*See generally* R., at pp. PET 551, 557-558.)

DEQ has adduced expert testimony explaining the basis for the 93.3% control efficiency figure, an issue not within the common knowledge of the layperson. The Petitioners have not

offered expert testimony to rebut it. At oral argument, the Petitioners cited to the EPA Letter. However, the hearing officer has ruled the EPA Letter cannot be relied on as a proxy for expert testimony, in part because EPA is not a party and therefore not subject to cross-examination. Without admissible expert testimony, under *Greenfield*, the hearing officer must affirm DEQ's action unless there is some obvious flaw in DEQ's reasoning. Seeing none, the hearing officer finds DEQ's adoption of the 93.3% control efficiency figure adequately supported.

2. Razor Thin Margin

As to Petitioners' second point, again, Mr. Simon has testified that the 90% control efficiency assumption for chemical suppressants is on the low end of the 90-99% range identified in AP-42. Mr. Schilling testifies:

> Late in the review process, PRI determined that the West End Development Rock Storage Facility will not be constructed, thereby eliminating the modeling operational scenario W5. Scenario W5 was the scenario where modeled exceedances of the 24-hour PM_{10} NAAQS were shown when using the BULKRN-processed meteorological data. When Scenario W5 is removed, the highest impacting operational scenario is W3, which represents the transport of development rock from the West End Pit to the Hanger Flats Development Rock Storage Facility. Maximum impacts still slightly exceed the NAAQS when using a single value background concentration value, ***but are well below NAAQS when seasonal backgrounds are used*** (82% of the NAAQS at 123.5 μg/m3).

(Schilling Decl., pp. 17-18 (emphasis added).)

Mr. Schilling further testifies that DEQ's modeling group did not learn until later in the review process that a non-conservative assumption of 4.0% silt content of the road surface was used in the modeling. Because he believed "NAAQS compliance could not be assured at a sufficiently high confidence level…even though there are other areas of the analyses that are very conservative," Mr. Schilling adopted 4.0% as the maximum allowable silt content value. (Schilling Decl., pp. 17, 19.) That limitation is in Section 3.13 of the Permit, (R., p. PET020), and "[i]f the required sampling and testing of road material indicates a maximum silt content above 4.0 percent, it will be a permit

violation." (Schilling Decl., p. 19.)

To support their argument that 93.3% control efficiency provides only a "razor thin" margin of error, the Petitioners rely on assertions by counsel and isolated references in the permitting record and the EPA Letter. By contrast, DEQ has adduced expert testimony describing multiple ways in which conservativism was utilized in the modeling and permit-writing process. In the absence of expert testimony to the contrary, the hearing officer finds DEQ's explanations reasonable.

3. Failure to Include More Specific Requirements to Ensure Compliance

Petitioners argue, "[t]he error is that there is…no 93.3 percent enforceable limitation or there is no other limitations that reasonably assure" 93.3% control is achieved. (Tr. of 9/21/23 at 67:24-68:2.) However, as to the first argument, as previously referenced, the Permit includes a specific requirement that 93.3% control efficiency be achieved. As to the second argument, the Petitioners do not cite to any legal standard requiring additional requirements or otherwise explaining how the existing Permit provision is legally inadequate. Moreover, the Petitioners have not offered expert testimony describing the terms they believe are necessary to ensure compliance. Without these, and given the presumption in favor of agency action on technical issues, the hearing officer finds no basis to conclude DEQ committed error.

4. Summary and Conclusion as to Claim No. 2

For the foregoing reasons, as to Claim No. 2, the hearing officer hereby DENIES the Petitioners' motion for summary judgment and GRANTS the motions filed by DEQ and Perpetua.

G. Assumption of 120 Days of Recordable Precipitation Data Instead of Use of Local Weather Data (Claim No. 5)

The Petition alleges that (1) "[d]ays of recordable precipitation is an important variable affecting the SGP's emissions of PM_{10} from ore haul roads;" (2) "DEQ assumed there would be 120 days of recordable precipitation at the SGP" based on "general geographic guidance" instead of

"local meteorological data;" and (3) "DEQ's failure to use the most representative site data…increases the risk of miscalculation of ore haul road emissions." (Pet., ¶ 41). The Petitioners moved for summary judgment on this issue, arguing:

> Rather than use available site-specific meteorological data to calculate fugitive dust emissions from haul roads, DEQ used a generic value in EPA guidance to assume that there are 120 days of recordable precipitation at the Project site. See PET 146; see also PET 805 (map). This was arbitrary and counter to DEQ guidance.
>
> For modeling ambient air impacts, Section 6.8 of DEQ's Guideline for Performing Air Quality Impact Analyses states: "The meteorological data used in the modeling analysis should be representative of the meteorological conditions at the particular site of the proposed construction or modification."

(Pets.' Br. ISO MSJ of 4/12/23, p. 25.)

That same DEQ guidance document goes on to state that, "[t]here are several sources of meteorological data besides on-site collected data." (R., at p. PET 746.) Ultimately, the relevance of this issue is that "precipitation can reduce fugitive dust emissions." (Pets.' Br. ISO MSJ of 4/12/23, p. 25.) In other words, a higher number of precipitation days per year is generally associated with lower expected fugitive dust emissions from the ore haul roads. In response, Mr. Schilling makes several important clarifications:

First, the 120 annual precipitation days is derived from EPA's AP42 guidance document, which includes a map for the entire United States that is contoured based on climatological data. According to Schilling, "[t]he resolution provided by the AP42 map is adequate to provide reasonably accurate emission estimation, well within the general uncertainty of the factor and other inputs…that can be taken to reduce emissions." (Schilling Decl., p. 13).

Second, the Taylor Ranch station raised by Petitioners "is over 40 kilometers from the SGP site, making it questionably more representative than the AP42 map." (*Id*.)

Third, "the Taylor Ranch data indicated there was an average of 113 [precipitation] days each

year…effectively matching the 120-day value obtained from the AP42 map." (*Id.*)

Fourth, the onsite data from 2014 "indicates there were 155 [precipitation] days…." (*Id.*) In other words, use of the onsite data (which has 35 more precipitation days than the AP42 figure) presumably would have lowered expected emissions substantially more than the heightened expected emissions had the Taylor Ranch data (which has 7 fewer precipitation days) been used. Ultimately, DEQ did not use the 155-day figure because the "onsite data were only collected for one year," making it "questionable whether it can be considered more representative than the AP42 map for typical conditions because of the year-to-year variability…." (Schilling Decl., p. 13.)

With these explanations, DEQ has satisfied its burden as a summary judgment movant and has shifted the burden to Petitioners to explain why the decision to utilize the 120 precipitation days figure from AP42 was arbitrary, capricious, or an abuse of discretion. Because the selection of proper precipitation data is not within the common knowledge of a layperson, expert testimony was required to rebut DEQ's expert testimony. "If an expert is qualified to render an opinion, based on his expertise in the subject, then he must be accorded substantial deference in the selection of data upon which he chooses to base his opinion." *Earl v. Cryovac, A Div. of W.R. Grace Co*., 772 P.2d 725, 728, 115 Idaho 1087, 1090 (App. 1989). In order to create a disputed, triable issue of material fact for a hearing on the merits, the Petitioners were required to adduce expert testimony explaining more specifically how DEQ's use of the AP42 figure could be error. Without such testimony, summary judgment in favor of DEQ and Perpetua is appropriate.

Therefore, as to Claim No. 5, the Petitioners' motion for summary judgment is DENIED, and the motions for summary judgment filed by DEQ and Perpetua are GRANTED.

H. Whether Errors in Estimating PM_{10} Emissions Result in Errors as to As Emissions (Claim No. 8)

Paragraph 54 of the Petition alleges:

> Second, because the underlying particulate and PM_{10} emissions estimates and particulate control assumptions are unreliable in numerous respects, as already discussed above, so too are the estimated arsenic emissions. The SGP's estimated arsenic emissions were based on its PM_{10} emissions. PM_{10} emissions from the SGP may be higher, and their control effectiveness may be lower, than DEQ assumed, in which case arsenic emissions would also be higher and might exceed the AACC [Acceptable Concentrations of Carcinogens].

(Pet. ¶ 54).

Because the hearing officer has granted summary judgment in favor of DEQ and Perpetua as to all of the alleged errors related to PM_{10} emissions as described above, the disposition of this particular claim is automatic. As to Claim No. 8, the motions for summary judgment filed by DEQ and Perpetua are hereby GRANTED, and the motion for summary judgment filed by the Petitioners is hereby DENIED.

I. Exclusion of Economic and Environmental Evaluations in T-RACT Analysis (Claim Nos. 6 and 7)

The Petition alleges DEQ's evaluation of "reasonably available control technologies" ("RACT") for the toxic air pollutant arsenic ("T-RACT") "contained no persuasive economic information and no discussion at all regarding associated environmental impacts" resulting from "Perpetua's decision to use water and chemical dust suppressants as compared to paving the haul roads, even though paving was shown to achieve the highest reasonable dust control efficiency." (Pet. ¶¶ 48, 53). According to the Petition, this violated Air Rule 210.14. T-RACT is defined in the Air Rules as:

> An emission standard based on the lowest emission of toxic air pollutants that a particular source is capable of meeting by the application of control technology that is reasonably available, as determined by the Department, considering ***technological and economic feasibility***. ***If control technology is not feasible, the emission standard may be based on the application of a design, equipment, work practice or operational requirement, or combination thereof.***

AIR RULE 210 (emphasis added).

The first step in the T-RACT process is for the applicant to "submit information to [DEQ] identifying and documenting which control technologies or other requirements the applicant believes to be T-RACT." AIR RULE 210.14(a). DEQ must then review the information submitted by the applicant and determine if it has proposed T-RACT "on a case-by-case basis" considering separate factors for both technological feasibility and economic feasibility. AIR RULE 210.14(b), (c).

Based upon the T-RACT definition above, these feasibility determinations are relevant to whether the control technology is "reasonably available" for use by the applicant. For economic feasibility, DEQ must consider a non-exclusive list of factors, including costs of necessary mitigation measures, capital costs, cost effectiveness, and the difference in costs between the particular source and other sources, if any, that have implemented emissions reductions. AIR RULE 210.14(d). For technological feasibility, the Air Rules specifically require DEQ's evaluation to include consideration of "[t]he environmental impacts caused by the control technology that cannot be mitigated, including, but not limited to, water pollution and the production of solid wastes." AIR RULE 210.14(c)(ii). "If [DEQ] determines that the applicant has proposed T-RACT, [it] shall determine which of the options, or combination of options, will result in the lowest emission of toxic air pollutants, develop the emission standards constituting T-RACT and incorporate the emission standards into the permit to construct." AIR RULE 210.14(e).

The Simon Declaration describes DEQ's five-step process for determining T-RACT:

1. Identify all available control options.

2. Eliminate technically infeasible options.

3. Rank remaining control technologies.

4. Consider the energy, environmental, and economic impacts.

5. Select the most effective control technology not eliminated in Step 4.

(Simon Decl., pp. 11-12.)

While these five steps do not necessarily repeat the language of Air Rule 210.14 verbatim, they are not inconsistent with it either. Given the deference given to an agency in interpreting its rules, the hearing officer has no basis to question this five-step process. According to Simon:

> In reviewing T-RACT analysis for haul roads, PRI identified the following possible control options:
>
> 1. Paving roads
>
> 2. Application of chemical dust suppressants and water
>
> Paving haul roads was determined to be technically infeasible by PRI and permit staff because paving is not feasible for mining roads utilizing very heavy trucks which would exceed the design limitations of paving.

(Simon Decl. of 5/12/23, p. 13.)

More specifically, Perpetua submitted information indicating that paved haul roads would only be capable of supporting vehicles with weights up to 10 tons. (R., at p. PET 547.) However, Perpetua's loaded haul trucks will weigh between 60 tons and 260 tons. (*Id*.) The Petitioners do not rebut Mr. Simon's explanation for elimination of paving as technically infeasible with their own expert testimony that it is feasible. On its face, Mr. Simon's explanation is otherwise reasonable and supported by the record. Therefore, elimination of paving as T-RACT was not error.

The next question is whether it was error for DEQ not to evaluate the environmental impacts of the control technology that was chosen, a combination of chemical dust suppressants and water. This is where a careful reading of the language of Air Rule 210.14 in connection with the definition of T-RACT is important.

According to the language of the rules, evaluation of environmental impacts occurs specifically within the context of evaluating technological feasibility. The purpose of evaluating both economic feasibility and technological feasibility is to determine whether a particular control

technology is "reasonably available." According to Mr. Simon, the combination of chemical dust suppressants and water is already known by DEQ to be "reasonably available" because:

> Application of chemical dust suppressants and water is an effective dust control method which is a common control technology for unpaved haul roads. Magnesium chloride and water combinations are widely used and effective dust suppressant by state, county, and industrial unpaved roadways. DEQ is not aware of any negative environmental impacts as long as the operators apply the dust suppressant according to manufacturer's recommendations.[6]

(Simon Decl., p. 13.)

This issue is not within the common knowledge of the layperson. Mr. Simon's declaration is unrebutted expert testimony that is otherwise reasonable, so there is no basis for the hearing officer to find that DEQ's decision lacked adequate basis. Without the ability to establish factual error, the Petitioners can establish error only by demonstrating that DEQ's T-RACT process violated the plain language of the Air Rules.

In this regard, Petitioners argue DEQ's reliance on its pre-existing knowledge regarding the availability of chemical suppressants and water as dust control technology violated the requirement to determine T-RACT on a "case-by-case basis" under Air Rule 210.14. In effect, Petitioners argue DEQ must ignore what it already knows about the availability of chemical suppressants and water as a control technology and determine anew that it is "reasonably available." It is also notable that, elsewhere in the Air Rules, "suitable chemicals" are specifically recognized as a "reasonable precaution" for controlling dust from dirt roads. *See* AIR RULE 651.02.

In addition to the requirement to defer to DEQ's interpretation of its rules, there is a canon of construction that disfavors absurd results. *See, e.g., Friends of Farm to Market v. Valley County*, 137 Idaho 192, 46 P.3d 9, 14 (Idaho 2002). To the hearing officer, interpreting the "case-by-case"

[6] The Permit, in turn, requires that "[c]hemical dust suppressants shall be applied consistent with manufacturer's instructions and recommendations." (R., at p. PET 010.)

language in Rule 210.14 to require DEQ to ignore Air Rule 651.02, ignore the technical knowledge it possesses as the entity with statutory responsibility to administer Idaho's air permitting programs, and to engage in a brand-new feasibility evaluation every time an applicant proposes a well-established control technology would be an absurd result. It is also notable that Air Rule 210.14 further defines what constitutes a "case-by-case" evaluation by stating "as follows" and then enumerating the T-RACT steps previously described. The Simon Declaration describes DEQ's process for evaluating the T-RACT information submitted by Perpetua pursuant to Air Rule 210.14. The hearing officer finds that explanation adequate to satisfy Rule 210.14.

Finally, it is helpful to recall that the Air Rules are concerned with the control of "air pollution," which is defined by statute as follows:

> The presence in the outdoor atmosphere of any air pollutant or combination thereof in such quantity of such nature and duration and under such conditions as would be injurious to human health or welfare, to animal or plant life, or to property, or to interfere unreasonably with the enjoyment of life or property.

IDAHO CODE § 39-103(2).

While this definition allows for regulation of pollution "injurious…to animal or plant life," it does so specifically within the context of pollutants that are "presen[t] in the outdoor atmosphere." The term "atmosphere" is not defined in the Air Rules, the Clean Air Act, or Black's Law Dictionary. The Clean Air Act does, however, define "air pollutant" as pollutants emitted into the "ambient air," a phrase this opinion has already discussed in detail. *See* 42 U.S.C. § 7602(g). The Petitioners allege:

> There will be water quality and biological impacts associated with Perpetua's use of substantial amounts of chemical dust suppressants and water that have not been considered in the PTC. For example, the use of chemical dust suppressants like magnesium chloride can cause toxicity in trees and can lead to tree death. Magnesium chloride is also known to adversely affect aquatic ecosystems.

> Moreover, the proposed water source for dust control is primarily water collected in runoff ponds (captured rain or snowfall that has become contaminated through the contact of mine facilities), groundwater, and surface water from the East Fork of the South Fork of the Salmon River. USGS sampling indicates elevated arsenic in these waters. The environmental impact of using magnesium chloride or arsenic-polluted water as dust suppression methods was never considered as part of the T-RACT demonstration.

(Pet. ¶ 53.)

The Petitioners may indeed have legitimate concerns regarding the impacts of chemical dust suppressants on trees and aquatic ecosystems, but this air permit proceeding is not the appropriate forum for them. The "air pollutant" at issue in the T-RACT determination is arsenic (not magnesium chloride) that is present in the "outdoor atmosphere" and "ambient air" (not bodies of water). The Petitioners' concerns on these issues are more appropriately raised through authorities such as IDAPA 58.01.02 (Water Quality Standards) and 58.01.05 (Rules & Standards for Hazardous Waste).

In short, the Petitioners have not established that DEQ's reliance upon existing knowledge of chemical suppressants and water as "reasonably available" control technologies was error. Based on the Simon declaration, DEQ has offered expert testimony and a reasonable explanation for its T-RACT analysis. Therefore, the Petitioners' motion for summary judgment as to Claims 6 and 7 is hereby DENIED, and DEQ's and Perpetua's motions for summary judgment as to Claims 6 and 7 are hereby GRANTED.

J. Averaging of Projected As Emissions (Claim No. 9)

The Petition alleges DEQ utilized "three improper averaging tactics: (1) averaging emissions over a 5-year period for the T-RACT input to ambient toxics modeling; (2) averaging the estimated annual ambient modeling impacts across two multi-year scenarios; and (3) averaging the resultant 16-year total emissions over the 70-year human lifetime to assert compliance." (Pet. ¶ 55.) According to the Petitioners, the Air Rules do not allow "multi-year emissions averaging" and

instead require DEQ to "estimate the SGP's maximum 1-year annual arsenic emissions and compare it to the annual arsenic AACC" in Air Rule 586. (*Id*.) In effect, the Petitioners allege DEQ employed a "tactic" that is contrary to the plain language of the Air Rules.

All three sets of parties moved for summary judgment on this issue. Before discussing the motions, it will be helpful to summarize the relevant Air Rules. The starting place is Air Rule 203:

> No permit to construct shall be granted for a new…stationary source unless the applicant shows to the satisfaction of the Department all of the following:
>
> ***
>
> **Toxic Air Pollutants.** ***Using the methods provided in Section 210***, the emissions of toxic air pollutants from the stationary source…would not injure or unreasonably affect human health or animal life or vegetation ***as required by Section 161***. Compliance with all applicable toxic air pollutant carcinogenic increments and toxic air pollutant non-carcinogenic increments ***will also demonstrate preconstruction compliance with Section 161*** with regards to the pollutants listed in Sections 585 and 586.

AIR RULE 203.03 (emphasis added).

Section 161, in turn, provides:

> Any contaminant which is by its nature toxic to human or animal life or vegetation shall not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, ***injure or unreasonably affect human or animal life or vegetation***.

AIR RULE 161 (emphasis added).

The use of the phrase "will also demonstrate preconstruction compliance" in Section 203.03 effectively creates two regulatory paths. First, the applicant and DEQ can use "the methods in Section 210" to show that emissions will not "injure or unreasonably affect human or animal life or vegetation." Section 210, in turn, consists of six-and-a-half pages of detailed, technical, complex regulations, and any attempt by the hearing officer to summarize Section 210 in a manner that is both useful and accurate would be an exercise in futility. Regardless, the relevant legal standard—

"injure or unreasonably affect"—is not further defined within the Air Rules.

Effectively, the second path—compliance with Sections 585 and 586—provides applicants with a safe harbor. If an applicant demonstrates "[c]ompliance with all applicable toxic air pollutant carcinogenic increments and toxic air pollutant non-carcinogenic increments…with regards to the pollutants listed in Sections 585 and 586," then satisfaction of Section 161 is automatic and application of the "injure or unreasonably affect" standard unnecessary. Section 586, in turn, identifies "acceptable ambient concentrations" (AACCs) for a variety of pollutants, including "arsenic compounds." According to the plain language of that Rule, these AACCs are expressed as "annual averages." For arsenic compounds, the applicable AACC is $2.3E^{-04}$ $\mu g/m^3$. So, if an applicant can demonstrate arsenic emissions will not exceed that AACC, then the Section 203.03 analysis for arsenic is over. As a matter of law, the legal standard of Section 161 is satisfied.

While out of sequence with the order of the motions filed, it is helpful to begin with a discussion of the summary judgment motions filed by DEQ and Perpetua. Broadly speaking, DEQ provides the factual background regarding its decision-making process on this issue through the Schilling Declaration, and Perpetua's briefing includes a "deep dive" into the language of the relevant and complex Air Rules.

According to Mr. Schilling, DEQ analyzed Perpetua's application under Air Rule 210.12. (Schilling Decl., p. 10.) That section contains somewhat of a trade-off: If an applicant demonstrates it is utilizing T-RACT as pollution control technology for a particular toxic air pollutant, then it satisfies Section 161 if its modeled emissions for that toxic pollutant is less than 10 times the applicable AACC. *See* AIR RULE 210.12. This effectively creates another "safe harbor" that allows an applicant to demonstrate compliance with Section 161 through the quantitative standards in Section 586 instead of the qualitative toxicity standard. According to that Rule:

> If the source's…approved T-RACT ambient concentration at the point of compliance is less than or equal to the amount of the air pollutant that would contribute an ***ambient air cancer risk probability of less than one to one hundred thousand (1:100,000)***, no further procedures for demonstrating preconstruction compliance will be required for that toxic air pollutant as part of the application process.

AIR RULE 210.12(c) (emphasis added).

The preceding subsection explains that the "ambient air cancer risk probability of less than one to one hundred thousand (1:100,000)" is "equivalent to ten (10) times the applicable [AACC] in Section 586." AIR RULE 210.12(b). So again, if Perpetua's approved T-RACT ambient concentration for arsenic at the point of compliance is less than 10 times the AACC in Section 586, compliance with Section 161 is achieved as a matter of law.

Paraphrasing Mr. Schilling, DEQ determined that Perpetua proposed T-RACT for arsenic emissions and, therefore, evaluated modeled emissions under Air Rule 210.12 as described above. DEQ started with very conservative assumptions that overestimate emissions. Using those conservative assumptions, the modeling showed exceedances of the 10x AACC standard. As a result, he and DEQ then conducted a "refinement of exposure calculations to provide a more representative comparison to the AACC." (Schilling Decl., pp. 9-11.)

The issue here is that the AACCs are based on an assumed lifetime exposure to the relevant carcinogen over a 70-year period because for permitting and conservatism principles, DEQ normally assumes the project life will exceed that 70-year period. Clearly, if a project will only operate for 16 years and AACC compliance is still achieved, that is the end of the inquiry, because exposure to a carcinogen at a certain level for only 16 years cannot result in a higher cancer risk than exposure to the same carcinogen at the same level for 70 years. But, if a project will only operate for 16 years and AACC compliance is not achieved, that does not automatically mean that the cancer risk exceeds the 1 in 1,000,000,000 or 1 in 100,000 standards. This is because comparison of emissions

that will only take place for 16 years to a standard that is based on an assumed 70-year exposure period is an "apples to oranges" comparison. Based upon his knowledge that the AACCs are based on a lifetime cancer risk over a 70-year period, Mr. Schilling and DEQ made a more refined exposure calculation that proceeds as follows:

First, they reviewed the 14 modeling scenarios provided by PRI for the 16-year period of operations. From this set of 224 data points, they chose the highest modeled concentration of arsenic emissions.

Next, they multiplied that highest annual concentration by the 16-year operational period to calculate a conservative figure for total arsenic emission exposure over the life of the mine.

Next, they divided that figure by the 70-year exposure period on which the AACCs are based.

Finally, they compared that figure to the AACC for arsenic. Because it was less than the AACC, DEQ concluded there was not an unreasonable risk or injury posed to human life. (*See* R., at pp. PET 332, 344; Schilling Decl., pp. 8-12).

The Petitioners may indeed be correct that DEQ's approach is not strictly consistent with Section 586. However, that is not the end of the inquiry. As previously described, and as DEQ and Perpetua correctly note, if strict compliance with the quantitative standards in Sections 585 and 586 is not achieved, then the applicable standard to be met is the qualitative one, that the toxic air pollutant "shall not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, ***injure or unreasonably affect human or animal life or vegetation***." AIR RULE 161 (emphasis added). Among other things, Mr. Schilling testifies as follows:

> The typical permitting approach is to use worst-case assumptions and data in a limited number of analyses that will confidently show that allowable operations, as described and limited in the permit and permit-required plans and procedures, cannot result in impacts that exceed applicable standards. When this approach is applied to

mining operations, results of the impact modeling tend to greatly overstate actual impacts that will occur or even could occur.

***

The number of TAP-applicable arsenic emission sources for the SGP was expanded late in the permit application review process, after it was determined that some sources had been incorrectly excluded from analysis as per Idaho Air Rules Section 210. The incorrect exclusion was confirmed by the DEQ Permit Writer, the DEQ Permitting Supervisor, and the DEQ Stationary Source Bureau Chief after considering comments received during a public comment period. Without completely reworking the complex and still very conservative approach used to assess carcinogenic TAP impacts, compliance could not be demonstrated using the typical approach outlined above. I then undertook the task of evaluating whether a more refined approach could be used to demonstrate compliance with TAP rules of Section 210.

A first step in refinement of impacts or adjustment of allowable impacts was to assure that reasonably available control technologies were used for all sources of arsenic. This level of control is referred to as T-RACT and its use in the evaluation of carcinogenic TAPs is described in Idaho Air Rules Section 210.12. If T-RACT is used to control emissions from sources, then the allowable impact is ten times that of the AACCs, corresponding to a lifetime cancer risk of 1 in 100,000. The AACC conservatively represents a long-term exposure (70 years) that would result in a 1 in 1,000,000 cancer risk.

***

A worst-case conservative but simplistic approach used for the SGP did not show compliance with the arsenic AACC, or even the AACC multiplied by a factor of ten to reflect the allowable impact when using T-RACT. ***DEQ then reviewed the basis for the AACCs to further evaluate refinement of exposure calculations to provide a more representative comparison to the AACC***. AACCs were established in Idaho Air Rules to protect against a project-caused lifetime excess cancer risk of more than 1-in-1,000,000, or 1-in-100,000 where T-RACT is used to control emissions from sources.

***

Although a lifetime risk is the benchmark, DEQ listed annual averages for the AACCs in Idaho Air Rules because that timeframe 1) is long enough to establish a good representation of long-term impacts for most sources requiring a permit, 2) is short enough to provide compliance assurance early in the life of the industrial operation, and 3) is convenient for compliance monitoring and reporting, providing a practically enforceable limit on operations. ***Use of an annual limit is not key to attaining a limit on the lifetime cancer risk; and, since a lifetime risk is the***

> ***benchmark, use of annual averaged emissions to show compliance with the AACC on an annual basis could be unnecessarily restrictive where processes vary considerably year-to-year and have a project lifetime substantially shorter than 70 years, such as mining processes.***
>
> PRI indicated that the SGP will have a 16-year maximum project lifetime. To calculate a project-based arsenic concentration representative of the project, appropriate for comparison to the AACC (based on a 70-year exposure), the modeled impact was adjusted by the factor 16/70.

(Schilling Decl., pp. 9-11.)

Even if the 16/70 adjustment is not specifically authorized by Sections 210.12 and 586, the hearing officer finds Mr. Schilling's testimony adequate to support DEQ's decision under the qualitative standard of Section 161. Mr. Schilling recognizes that the over-arching legal standard is the toxicity standard in Section 161 and explains why strict compliance with standards expressed as annual limitations is not always necessary to satisfy that standard, particularly when the exposure period is considerably shorter than the assumed 70-year exposure period on which the AACCs are based. Overall, he provides a thoughtful and conservative approach to ensuring arsenic emissions will not exceed the 1-in-100,000 lifetime cancer risk standard when T-RACT is used.

The Schilling Declaration is unrebutted expert testimony on an issue clearly not within the common knowledge of the layperson. To be clear, the hearing officer understands and appreciates the Petitioners' argument that in applying the 16/70 exposure refinement, DEQ "assumed the cancer risk probability from high dose/short-term exposure was equivalent to low dose/long term exposure." (Pet.'rs' Resp. of 6/9/23, p. 44.) It is unclear to the hearing officer if "normalizing" arsenic exposure for a 16-year project in order to compare it to a health standard based on a 70-year lifetime exposure period is truly as simple as applying the 16/70 adjustment factor.

On the other hand, Petitioners do not question the accuracy of the 16-year operational

period,[7] and it is illogical for this issue to turn solely on satisfaction of a standard that is based on a 70-year exposure period, when the permitted project is expected to operate for less than one-fourth of that time. Given the deference accorded to DEQ in the interpretation of its rules, the presumption DEQ acted reasonably, and the layers of conservatism built into the TAP evaluation process described by Mr. Schilling, without expert testimony from the Petitioners explaining why the 16/70 adjustment could cause injury to human life or is otherwise arbitrary, capricious, or an abuse of discretion, Petitioners have not sufficiently rebutted Mr. Schilling.

Based on the foregoing, the hearing officer hereby DENIES the motion for summary judgment filed by Petitioners as to Claim No. 9. The hearing officer hereby GRANTS the motions for summary judgment filed by DEQ and Perpetua as to Claim No. 9.

IV. SUMMARY, CONCLUSION, AND PRELIMINARY ORDER

The Petition alleges thirteen discrete errors. On November 15, 2022, the hearing officer dismissed Claim Nos. 3, 4, and 10, and partially dismissed Claim No. 8. As to the remaining claims, based on the foregoing, it is hereby ordered that:

The motion for summary judgment filed by Petitioners as to Claim Nos. 1, 2, 5, 6, 7, 9, 11, 12, 13, and the remainder of Claim No. 8 is hereby DENIED.

The motions for summary judgment filed by DEQ and Perpetua as to Claim Nos. 1, 2, 5, 6, 7, 9, 11, 12, 13, and the remainder of Claim No. 8 are hereby GRANTED.

[7] It is worth noting that Air Rule 210.12(d) requires DEQ to "include emission limits and other permit terms for the toxic air pollutant in the permit to construct that assure that the facility will be operated in the manner described in the preconstruction compliance demonstration." To the extent Petitioners are concerned the 16-year mine life was not adopted as a limitation within the Permit, DEQ explains that the hauling limits in Permit Condition 3.6 acts as "a life of mine hauling and excavating limit." (R., at p. PET 597.)

V. RULE 730 NOTICE

Pursuant to Idaho Code Sections 67-5243 and 67-5245, BEQ Rule of Procedure 730, and AG Rule of Procedure 730:

This is a preliminary order of the Hearing Officer and will become final without further action of the Idaho Board of Environmental Quality unless any party appeals to the Board by filing a petition for review of the preliminary order.

Within fourteen (14) days of the service date of this preliminary order, any party may take exceptions to any part of this preliminary order by filing a petition for review of the preliminary order. Otherwise, this preliminary order will become a final order of the Board. The basis for review must be stated in the petition. The Board may review the preliminary order on its own motion.

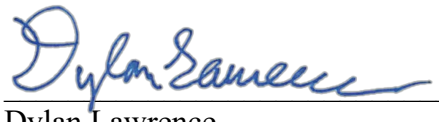
If any party files a petition for review of the preliminary order, the Board will allow all parties an opportunity to file briefs in support of or taking exceptions to the preliminary order and may schedule oral argument in the matter before issuing a final order. The hearing coordinator will issue a notice setting out the briefing schedule and date and time for oral argument. The Board will issue a final order within fifty-six (56) days of receipt of the written briefs or oral argument, whichever is later, unless waived or extended by the parties or for good cause shown. The Board may hold additional hearings or may remand the matter for further evidentiary hearings if further factual development of the record is necessary before issuing a final order.

Pursuant to Idaho Code Sections 67-5270 and 67-5272, if this preliminary order becomes final, any party aggrieved by the final order or orders previously issued in this case may appeal the final order and all previously issued orders in this case to district court by filing a petition in the district court of the county in which: (1) a hearing was held; (2) the final agency action was taken;

(3) the party seeking review of the order resides or operates its principal place of business in Idaho; or (4) the real property or personal property that was the subject of the agency action is located.

This appeal must be filed within twenty-eight (28) days of this preliminary order becoming final. *See* IDAHO CODE § 67-5273. The filing of an appeal to district court does not itself stay the effectiveness or enforcement of the order under appeal.

Dated this 31st day of October 2023.



Dylan Lawrence
Hearing Officer

CERTIFICATE OF SERVICE

I hereby certify that on this 31st day of October 2023, I caused to be served a true and correct copy of the foregoing by the following method to:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Resources Division
Office of the Attorney General
1410 N. Hilton St.
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service



Dylan B. Lawrence
Hearing Officer

RAÚL R. LABRADOR
Attorney General

SCOTT L. CAMPBELL
Deputy Attorney General
Chief, Energy and Natural Resources Division

HANNAH M.C. YOUNG, ISB #9781
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: (208) 373-0422
Facsimile: (208) 373-0481
Email: hannah.young@deq.idaho.gov

Attorneys for Respondent

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 _____ NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	Agency Case No. 0101-22-01 OAH Case No. 23-245-01 NOTICE OF SUBSTITUTION OF COUNSEL

NOTICE IS HEREBY GIVEN, pursuant to IDAPA 58.01.23.003; IDAPA 04.11.01.205, that Hannah M.C. Young of the Office of the Idaho Attorney General has been substituted as counsel of record in place of John R. Shackelford to represent Respondent, Idaho Department of Environmental Quality, in the above-entitled action. It is hereby requested that all pleadings, correspondence, and other matters be served upon said substituted counsel at the address below:

Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Email: hannah.young@deq.idaho.gov

DATED: November 2, 2023.

STATE OF IDAHO
OFFICE OF THE ATTORNEY GENERAL

/s/ Hannah M.C. Young
HANNAH M.C. YOUNG
Deputy Attorney General
Attorneys for the Idaho Department of Environmental Quality

CERTIFICATION OF SERVICE

I HEREBY CERTIFY that on this 2nd day of November, 2023, a true and correct copy of the foregoing NOTICE OF SUBSTITUTION OF COUNSEL was served on the following via electronic mail to the indicated address:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Dylan Lawrence
Hearing Officer
Varin Thomas, LLC
242 N. 8th St., Suite 220
Boise, ID 83702
dylan@varinthomas.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Resources Division
Office of the Attorney General
1410 N. Hilton St.
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

/s/ DeAnne M. Chaffin
DeAnne M. Chaffin
Legal Assistant

RAÚL R. LABRADOR
Attorney General

SCOTT L. CAMPBELL
Deputy Attorney General
Chief, Energy and Natural Resources Division

Hannah M.C. Young, ISB No. 9781
hannah.young@deq.idaho.gov
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: 208.373.0453

Attorneys for Respondent

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047

NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,

Petitioners,

v.

IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,

Respondent,

and

PERPETUA RESOURCES IDAHO, INC.,

Intervenor-Respondent.

Case Docket No. 0101-22-01

JOINT MOTION FOR RECONSIDERATION AND/OR CLARIFICATION

The Idaho Department of Environmental Quality (the "Department") and Perpetua Resources Idaho, Inc. ("Perpetua") respectfully submit this Motion for Reconsideration and/or Clarification of the Memorandum Decision on Motions for Summary Judgment and Preliminary Order issued on October 31, 2023 ("Memorandum Decision"). This motion is brought pursuant to Idaho Code § 67-5243(3), IDAPA 04.11.01.730, IDAPA 04.11.01.770, and IDAPA 58.01.23.73. This motion is supported by the Memorandum in Support filed concurrently herewith and the briefs and pleadings filed in this matter.

The Department and Perpetua respectfully request that the Hearing Officer clarify that "Petition" or "Pet.," as used in the Memorandum Decision, refers to the Amended Petition, that the Memorandum Decision dismissed the Petitioners' Amended Petition in its entirety, and reconsider whether Petitioners' Claim 3 was revived in the Amended Petition and is addressed to resolve this proceeding completely.

DATED: November 10, 2023.

DEPARTMENT OF ENVIRONMENTAL QUALITY

/s/ *Hannah M.C. Young*
Hannah M.C. Young
Deputy Attorney General

Attorney for Respondent

STOEL RIVES LLP

/s/ W. Christopher Pooser
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

CERTIFICATE OF SERVICE

I hereby certify that on November 10, 2023, a true and correct copy of the foregoing document was served on the following:

Dylan B. Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Paula J. Wilson
Hearing Coordinator
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

/s/ *Hannah M.C. Young*
Hannah M.C. Young

RAÚL R. LABRADOR
Attorney General

SCOTT L. CAMPBELL
Deputy Attorney General
Chief, Energy and Natural Resources Division

Hannah M.C. Young, ISB No. 9781
hannah.young@deq.idaho.gov
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: 208.373.0453

Attorneys for Respondent

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,	Case Docket No. 0101-22-01 **MEMORANDUM IN SUPPORT OF JOINT MOTION FOR RECONSIDERATION AND/OR CLARIFICATION**

Respondent,

and

PERPETUA RESOURCES IDAHO, INC.,
Intervenor-Respondent.

The Idaho Department of Environmental Quality (the "Department") and Perpetua Resources Idaho, Inc. ("Perpetua") respectfully submit this memorandum in support of their Joint Motion for Reconsideration and/or Clarification.

I. INTRODUCTION

Pursuant to Idaho Code § 67-5243(3), IDAPA 04.11.01.730, IDAPA 04.11.01.770, and IDAPA 58.01.23.730, the Department and Perpetua jointly request that the Hearing Officer reconsider and/or clarify the Memorandum Decision on Motions for Summary Judgment and Preliminary Order issued October 31, 2023 (the "Memorandum Decision") in the following respects. First, the Department and Perpetua request that the Hearing Officer clarify whether "Petition or Pet." as used in the Memorandum Decision references the Petition to Initiate Contested Case: Air Quality Permit to Construct P-2019.0047 filed on July 22, 2022 (the "Petition") or the Amended Petition to Initiate Contested Case: Air Quality Permit to Construct P-2019.0047 filed on December 6, 2022 and refiled on January 11, 2023 (the "Amended Petition"). Second, the Department and Perpetua request that the Hearing Officer clarify whether the Memorandum Decision dismissed the Amended Petition in its entirety. Third, the Department and Perpetua request that the Hearing Officer reconsider and/or clarify the outcome of Claim 3.

II. BACKGROUND

Petitioners initiated this contested case by filing the Petition on July 22, 2022. On September 6, 2022, Perpetua filed a motion to dismiss the Petition, which the Department joined. *See* Perpetua Resources Idaho's Motion to Dismiss and Supporting Brief (Sept. 6, 2022). After briefing and argument, the Hearing Officer issued an order granting in part and denying in part the motion to dismiss. *See* Order on Motion to Dismiss (Nov. 15, 2022). The Order on Motion to Dismiss categorized Petitioners' allegations into 13 claims. *See* Order at 8-9. That Order dismissed Claims 3, 4, and 10, and dismissed Claim 8 in part. *Id.*

On December 6, 2022, Petitioners filed a motion to amend the Petition, which neither the Department nor Perpetua opposed. *See* Order Granting Motion to File First Amended Petition (Jan. 6, 2023). On January 6, 2023, the Hearing Officer granted Petitioners' motion, and Petitioners filed the Amended Petition on January 11, 2023. *See id.*

The Amended Petition added allegations to Paragraph 40 and Paragraph 70 ostensibly reviving the allegation presented in Claim 3 of the Petition. Amended Petition ¶¶ 40, 70. Thus, on summary judgment, Petitioners, the Department, and Perpetua all moved for summary judgment on the allegations contained in Paragraphs 40 and 70 of the Amended Petition and on Claim 3. *See* Petitioners' Opening Brief in Support of Motion for Summary Judgment at 28-31 (April 14, 2023).[1]

[1] *See also* DEQ's Response to Petitioners' Motion for Summary Judgment and Brief in Support of Cross Motion for Summary Judgment at 23-24 (May 12, 2023); Memorandum in Support of Perpetua's Motion for Summary Judgment and in Opposition to Petitioners' Motion for Summary Judgment at 34-38 (May 12, 2023); Petitioners' Response to Respondent DEQ's Cross-Motion for Summary Judgment and Intervenor Perpetua's Motion for summary Judgment and Petitioners' Reply in Support of Petitioners' Motion for Summary Judgment at 27-34 (June 9, 2023); Reply Memorandum in Support of Intervenor-Respondent Perpetua's Motion for Summary Judgment at 18-21 (June 23, 2023).

III. ARGUMENT

Idaho Code § 67-5243(3) and the Idaho Rules of Administrative Procedure, IDAPA 04.11.01.730, authorize parties to a contested case proceeding to seek reconsideration of a recommended or preliminary order within 14 days of the service date of the order. The Department and Perpetua appreciate the thorough analyses presented in the Memorandum Decision and only seek reconsideration and/or to clarify certain elements of the Memorandum Decision.

A. It is unclear whether the Memorandum Decision cites to and addresses the claims presented in the Petition or the Amended Petition.

In recounting the procedural history of this matter, the Memorandum Decision notes that Petitioners filed the Amended Petition. *See* Mem. Dec. at 2. However, the Memorandum Decision defines "Petition" as the filing on July 22, 2022, not the Amended Petition filed on January 11, 2023. *Id*. From there, when describing Petitioners' claims, the Memorandum Decision cites "Pet." with corresponding paragraph numbers. *See e.g.*, Mem. Dec. at 13, 16. Notably, the paragraph numbers of the Petition and the Amended Petition did not change. Thus, it is not clear whether the Memorandum Decision refers to and addresses the Petition or the Amended Petition.

When Petitioners filed the Amended Petition, it became the operative pleading, and the Petition was superseded. See *Hammer v. Ribi*, 162 Idaho 570, 573, 401 P.3d 148, 151 (2017) ("[T]he amended complaint supersedes the original, the latter being treated thereafter as non-existent."). The Department and Perpetua respectfully request clarification that "Petition" and "Pet." referenced throughout the Memorandum Decision are references to the Amended Petition.

B. It is unclear whether the Memorandum Decision fully resolves all previously undecided claims and necessarily results in dismissal of the Amended Petition.

In their motion for summary judgment, Petitioners requested that the Hearing Officer set aside and remand the Final Permit to the Department. *See* Pet. Mot. Summary Judgment at 2 (April 14, 2023). In their competing motions for summary judgment, the Department and Perpetua requested that the Hearing Officer dismiss Petitioners' Amended Petition. *See* Perpetua's Mot. Summary Judgment at 2 (May 12, 2023); DEQ's Cross-Motion for Summary Judgment at 2 (May 12, 2023). Although the Memorandum Decision is identified as a preliminary order and grants the Department's and Perpetua's respective motions for summary judgment, and denies Petitioners' motion, as to Claims 1, 2, 5, 6, 7, 8, 9, 11, 12, and 13, it does not explicitly dismiss the Amended Petition. *See* Mem. Dec. at 46-47.

The Department and Perpetua respectfully request that the Hearing Officer clarify that the Memorandum Decision resolved all issues in this contested case proceeding and resulted in dismissal of Petitioners' Amended Petition.

C. It is unclear whether Claim 3 was revived in the Amended Petition and should have been decided in the Memorandum of Decision.

The Memorandum Decision correctly stated that Petitioners' Claim 3 was dismissed in the Order on Motion to Dismiss. *See* Mem. Dec. at 2, 46. Subsequently, however, Petitioners amended Paragraphs 40 and 70 to revive Claim 3. Amended Petition ¶¶ 40, 70. Additionally, the Amended Petition requested that the work plans required by the Final Permit be provided for public comment prior to becoming enforceable permit conditions. *Id.* ¶ 71.D. The parties addressed this claim in their summary judgment papers. *See* Petitioners' Opening Brief in Support of Motion for Summary Judgment at 28-31 (April 14, 2023); *see also supra* note 1.

The Department and Perpetua agree that Claim 3 was dismissed in the Order on Motion to Dismiss and surmise that Claim 3 was revived in the Amended Petition. The Department and

Perpetua request that the Hearing Officer reconsider whether Claim 3 was revived by the Amended Petition, and if so, decide the outcome of this claim. The Department and Perpetua note that since this issue was fully briefed by the parties on summary judgment, it does not require additional briefing to address.

IV. CONCLUSION

For the foregoing reasons, the Department and Perpetua respectfully request that the Hearing Officer clarify that "Petition or Pet.," as used in the Memorandum Decision, refers to the Amended Petition, that the Memorandum Decision dismissed the Petitioners' Amended Petition in its entirety, and reconsider whether Petitioners' Claim 3 was revived in the Amended Petition and is addressed to resolve this proceeding completely.

DATED: November 10, 2023.

DEPARTMENT OF ENVIRONMENTAL QUALITY

/s/ *Hannah M.C. Young*
Hannah M.C. Young
Deputy Attorney General

Attorney for Respondent

STOEL RIVES LLP

/s/ *W. Christopher Pooser*
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

CERTIFICATE OF SERVICE

I hereby certify that on November 10, 2023, a true and correct copy of the foregoing document was served on the following:

Dylan B. Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Paula J. Wilson
Hearing Coordinator
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

/s/ *Hannah M.C. Young*
Hannah M.C. Young

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	
	)	CASE DOCKET NO. 0101-22-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON	)	**PETITION FOR REVIEW OF PRELIMINARY ORDER**
Petitioners,	)	
v.	)	
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC.	)	
Intervenor.	)	

Petitioners Nez Perce Tribe, Idaho Conservation League ("ICL"), and Save the South Fork Salmon ("SSFS") hereby petition the Idaho Board of Environmental Quality (the "Board") for review of the October 31, 2023 Preliminary Order issued by the Hearing Officer in this matter. This Petition for Review of Preliminary Order is brought under Idaho Code §§ 67-5243(3), 67-5245(2) and IDAPA 58.01.23.730. The Preliminary Order should be modified, amended, or revoked, and the Permit should be vacated and remanded to DEQ, based on the following errors:

1. The Hearing Office erred, factually and legally, in upholding DEQ's determination that Perpetua has legal control of the Stibnite Road Access Route such that the Route need not comply with ambient air quality standards;

2. In finding that Perpetua will preclude the general public from accessing locations within the ambient air boundary, the Hearing Officer lacked a reasonable factual basis and misapplied applicable regulations, policy, and guidance;

3. The Hearing Officer failed to decide Petitioners' claim that DEQ violated the Clean Air Act and applicable state and federal rules and regulations by allowing Perpetua to submit plans with important project details in the future–after Permit issuance and without public comment; or to the extent that this claim was decided, the Hearing Officer erred;

4. The Hearing Officer erroneously determined that the Permit includes enforceable conditions that will achieve 93.3% dust control.

5. The Hearing Officer misinterpreted and misapplied applicable rules to uphold DEQ's decision to artificially dilute the ambient arsenic concentrations attributable to the SGP by 16/70;

Petitioners request that the Board set out a briefing schedule on this petition as required under IDAPA 58.01.23.730.03.

BACKGROUND

In this contested case, Petitioners challenge the Idaho Department of Environmental Quality's ("DEQ" or "Department") approval of a permit to construct (the "Permit") issued to Perpetua Resources Idaho, Inc. ("Perpetua") for the proposed Stibnite Gold Project ("SPG" or "Project"): a massive open-pit mine in Valley County, Idaho. As proposed, Perpetua would excavate 340 million tons of waste rock to mine and process approximately 100 million tons of ore, using 55 miles of haul truck routes over 16 years. Blasting, excavating, ore hauling, and other Project activities will emit air pollutants, including coarse particulate matter ("PM_{10}") and arsenic. PM_{10} and arsenic are regulated under the federal Clean Air Act and Idaho's air pollution regulations, because they can cause significant and severe health and environmental hazards.

On June 17, 2022, DEQ issued permit to construct ("PTC") P-2019.0047, which is the Permit at issue in this contested case. On July 22, 2022, Petitioners timely filed the original Petition to Initiate Contested Case. On July 28, 2022, the Hearing Officer Dylan Lawrence was assigned to preside over this matter. On August 12, 2022, Perpetua filed a Petition to Intervene. On August 22, 2022, Perpetua's Petition to Intervene was granted. On September 6, 2022, Perpetua filed a Motion to Dismiss. On November 15, 2022, the Hearing Officer issued the Order on Motion to Dismiss, denying the motion with respect to the majority of Petitioners' claims, dismissing or partially dismissing four claims, and declining to allow the pleadings to be amended unless Petitioners file for consideration a formal motion to amend the Petition. On January 11, 2022, Petitioners filed their First Amended Petition to Initiate Contested Case.

After DEQ produced a Project Record and the Parties engaged in limited discovery, Petitioners filed a Motion for Summary Judgment on all claims remaining in the contested case on April 14, 2023. DEQ and Perpetua filed Cross Motions for Summary Judgment.

On August 28, 2023, Perpetua and DEQ filed a joint Motion in Limine to exclude an August 10, 2023 letter from EPA Region 10 Administrator Casey Sixkiller to IDEQ Director Jess Byrne requesting an in-person meeting to discuss EPA's concerns with the Permit. In the letter, EPA raised three primary concerns with the Permit, including concerns that: DEQ used the wrong emission factors, and had it used proper emission factors, the SGP's potential to emit would exceed the major source permitting threshold; DEQ's emission limits were inadequate to demonstrate compliance with NAAQS for particulate matter; and DEQ's delineation of the SGP's ambient air boundary was not supported. Further explanation of the EPA's concerns were detailed in a 19-page enclosure. Three days later, Petitioners filed a Motion to Supplement with EPA's letter and enclosure, and on September 8, 2023, filed a Motion to Amend Contested Case Petition to add a claim regarding the issue EPA raised in its letter about whether DEQ used improper emission factors and was thus wrong when it concluded the SGP's potential to emit will be below major source thresholds. On September 15, 2023, the Hearing Officer denied Perpetua and DEQ's motion in limine, granted Petitioners' motion to supplement with the EPA letter, and denied Petitioners' motion to amend.

On September 21, 2023, the Hearing Officer held a hearing on the cross motions for summary judgment. On October 31, 2023, the Hearing Officer issued a Memorandum Decision on Motions for Summary Judgment and Preliminary Order (the "Preliminary Order").[1]

[1] On November 10, DEQ and Perpetua filed a Joint Motion for Reconsideration and/or Clarification. Petitioners will timely respond to the Joint Motion for Reconsideration and/or Clarification. However, because the DEQ contested case rules at IDAPA 58.01.23.730 differ

In the Preliminary Order, the Hearing Officer rejected DEQ's and Perpetua's arguments that Petitioners lacked standing to pursue this contested case, finding each Petitioner had standing to challenge the Permit. But the Hearing Officer ruled against Petitioners on all claims addressed in the Preliminary Order and granted Summary Judgment to DEQ and Perpetua. The Preliminary Order, however, never addressed one of Petitioners' bases for review: DEQ's allowing Perpetua to defer the submittal of project plans until later, after the Permit is already issued, outside of the normal permitting process, and without public comment.

Petitioners hereby seek review of the October 31, 2023 Preliminary Order, including review of the issue never addressed by the Hearing Officer, as well as review of additional issues set forth below on which the Hearing Officer erred.

BASES FOR PETITION

1. The Hearing Office erred, factually and legally, in upholding DEQ's determination that Perpetua has legal control of the Stibnite Road Access Route such that the Route need not comply with ambient air quality standards.

The Clean Air Act ("CAA") and the Rules for the Control of Air Pollution in Idaho ("Air Rules"), IDAPA 58.01.01 *et seq.*, require Perpetua to meet various air quality standards, including the National Ambient Air Quality Standards ("NAAQS") and acceptable ambient concentrations of carcinogens ("AACCs") for toxic air pollutants ("TAPs"), in ambient air. *See*, *e.g.*, Air Rules Sections 006.11 (NAAQS), 006.125 (TAPs). The U.S. Environmental Protection Agency ("EPA") CAA regulations define "ambient air" as "that portion of the atmosphere, external to buildings, to which the general public has access." 40 C.F.R. § 50.1(e).

---

from the Attorney General rules at IDAPA 04.11.01 and do not explicitly provide for motions for reconsideration or clarification of preliminary orders, Petitioners now file this Petition for Review of Preliminary Order within the deadline set forth in the DEQ rules for seeking the Board's review of a preliminary order. *See* IDAPA 58.01.23.730. Petitioners reserve the right to re-file this, or file a new Petition for Review, upon any resolution of the Joint Motion for Reconsideration and/or Clarification. *See* IDAPA 04.11.01.730.02.b.

The Stibnite Road Access Route ("Route") is a road that passes through what Perpetua and DEQ have defined as the mine's operations boundary and the ambient air boundary, and the inside of that boundary is the active industrial site where Project mining activities and heavy equipment operation will occur. Perpetua has indicated that it will not cut off public access along the Stibnite Road Access Route during mine operations, and as explained by DEQ, Perpetua "will manage an access route to provide the general public with limited access through the [Project] site between Stibnite Road at Sugar Creek and Thunder Mountain Road at Meadow Creek."

Petitioners presented evidence that Perpetua lacks authority to control access along the Stibnite Access Route. This included evidence that there is an ongoing process where the United States Forest Service is reviewing Perpetua's proposed mine, and that Perpetua's authority to control access along the Stibnite Access Route depends on the outcome of that ongoing process. In the Preliminary Order, the Hearing Officer concluded that DEQ could rely on Perpetua's assertions in its submissions to DEQ that it has authority to control access. The Hearing Officer ignored the evidence to the contrary and misapplied the law.

Petitioners seek review of this issue, and ask the Board to vacate and remand the Permit and hold that Perpetua lacks the required authority to control access on the Stibnite Access Route for purposes of determining the Project's ambient air boundary.

2. In finding that Perpetua will preclude the general public from accessing locations within the ambient air boundary, the Hearing Officer lacked a reasonable factual basis and misapplied applicable regulations, policy, and guidance.

Even if Perpetua has authority to control access, Perpetua does not plan to (and the Permit does not require Perpetua to) preclude access. Instead, as the evidence in the record shows, Perpetua plans to allow public access. Petitioners presented evidence showing that Perpetua will allow anyone to use the Stibnite Access Route, so long as they check in and agree

to be "guests of the mine." Petitioners showed that under applicable laws, regulations, guidance, and policy, these people are general public, requiring ambient air quality standards to be met along the Stibnite Access Route.

In ruling against Petitioners, the Hearing Officer stated: "the Permit makes it clear that Perpetua is required to preclude unauthorized access by the general public and that members of the public can become guests of the facility only if they are seeking to pass through to access another destination." Prelim. Order at 21. The Hearing Officer failed to address Petitioners' specific argument that under the CAA, the Air Rules, and EPA's and DEQ's guidance, "guests of the facility" who are passing through to access another destination still count as the general public. Perpetua cannot simply convert the general public to something else by labeling them "guests," and it does not matter whether they are passing through to another destination versus lingering on site. By authorizing people to use the Stibnite Access Road to pass through the site and access other destinations is letting the general public in, and ambient air standards must, therefore, be met along the Stibnite Access Route. The Hearing Officer erred in simply assuming that by labeling them "guests of the facility," people Perpetua will allow on site are not the general public.

Petitioners seek review of this issue, and ask the Board to vacate and remand the Permit and hold that "guests of the facility" traveling the Stibnite Access Route are entitled to ambient air quality protections.

3. The Hearing Officer failed to decide Petitioners' claim that DEQ violated the Clean Air Act and applicable state and federal rules and regulations by allowing Perpetua to submit plans with important project details in the future–after Permit issuance and without public comment; or to the extent that this claim was decided, the Hearing Officer erred.

EPA has delegated to DEQ authority to issue air quality permits in Idaho. Under the Clean Air Act, State air rules like DEQ's "shall" include "enforceable emission limitations" and

other control measures, means, or techniques as necessary or appropriate to meet Clean Air Act requirements. 42 U.S.C. § 7410(a)(2)(A). State plans "shall" include a "program to provide for the enforcement" of the limitations and measures described in subparagraph (A), and for the "regulation of the modification and construction of any stationary source . . . to assure that [NAAQS] are achieved." *Id.* § 7410(a)(2)(C).

EPA's Clean Air Act regulations require each State plan to "set forth legally enforceable procedures" that enable the State to determine whether the construction of a facility will result in a violation of its air pollution control strategies or interfere with attaining or maintaining the NAAQS. 40 C.F.R. § 51.160(a). These legally enforceable procedures: must include means by which the State will prevent construction if the facility will violate air pollution control strategies or will interfere with attaining or maintaining the NAAQS; and must provide for the applicant to submit information on the "location, design, construction, and operation of such facility . . . as may be necessary" to permit the state to "to make the determination" that the facility will comply with its air pollution control strategies and the NAAQS. *Id.* § 51.160(b)–(c). "The legally enforceable procedures in § 51.160(b) must also require" the State to provide opportunity for public comment on information submitted by the applicant and on the State's analysis of the effects on ambient air quality. *Id.* § 51.161(a).

Under the Rules for the Control of Air Pollution in Idaho, DEQ is required to ensure that no PTC shall be granted for a new or modified stationary source unless the applicant shows to the satisfaction of DEQ that the source would not cause or significantly contribute to a violation of any NAAQS. IDAPA 58.01.01.203.02. To satisfy these requirements, DEQ must assess air impacts using maximum potential emissions as limited by either the capacity of the unit/operation or as limited by enforceable permit provisions. *See* IDAPA 58.01.01.006.88. Prior

to issuing a permit to construct, DEQ must provide an opportunity for public comment by making available DEQ's proposed action together with information provided by the applicant and with DEQ's analysis of air quality impacts. IDAPA 58.01.01.209.c.

Under the Permit, Perpetua is required to submit the following plans in the future: the Fugitive Dust Control Plan; the Haul Road Capping Plan; the Operation and Maintenance Manual; and the Stibnite Road Access Management Plan. These plans are not subject to public comment, and while DEQ will review them, it will do so outside of the permitting process set forth in the Air Rules. Despite devoting extensive briefing to this issue, the Hearing Officer did not decide this specific issue in the Preliminary Order. Alternatively, to the extent that the Hearing Officer decided this issue, he erred.

Petitioners seek review of this issue, and ask the Board to vacate and remand the Permit and hold that DEQ must require Perpetua to submit the plans as part of the public permitting process.

4. The Hearing Officer erroneously determined that the Permit includes enforceable conditions to achieve 93.3% dust control.

Under the Air Rules, DEQ cannot issue a PTC unless it determines that the facility: (1) "would comply with all applicable federal emissions standards;" (2) "would not cause or significantly contribute to a violation of any ambient air quality standards" (i.e., the NAAQS); and (3) "emissions of toxic air pollutants . . . would not injure or unreasonably affect human or animal life or vegetation as required by Section 161." Air Rules Section 203.

A critical factor affecting the SGP's fugitive dust emissions, and therefore whether DEQ can make the required determinations under Air Rules Section 203 that the Project will comply with the PM_{10} NAAQS and arsenic AACC limits, is the degree to which Perpetua will effectively control dust from haul roads. When it approved the Permit, DEQ assumed that Perpetua will

achieve a 93.3% control efficiency of all haul road dust by using a combination of water sprays and chemical dust suppressants. However, as EPA and other commenters pointed out, it is highly questionable whether 93.3% fugitive dust control is realistically attainable for this Project, and even if it were technically possible, the Permit lacks conditions necessary to ensure that Perpetua will achieve such a high level of control.

In the Preliminary Order, the Hearing Officer concluded that DEQ properly concluded that the Project will achieve 93.3% control because "the Permit includes a specific requirement that 93.3% control efficiency be achieved." Preliminary Order at 31. This is incorrect. The Permit does not include a specific requirement to achieve 93.3% or any other level of dust control. The Permit does include requirements for Perpetua to develop a Fugitive Dust Control Plan and a Haul Road Capping Plan. And while the Permit requires specific things to be included in those plans, none of them ensure any specific control efficiency be achieved--let alone an aggressive 93.3% control efficiency.

The Hearing Officer also faulted Petitioners for not offering "expert testimony describing the terms they believe are necessary to ensure compliance." Preliminary Order at 31. The Hearing Officer ignored the expert testimony in the form of public comments and other submissions to DEQ made by the EPA, Petitioners, and others with technical expertise on this very issue, including testimony that conditions specifying the combinations, volumes, and frequencies for applying water sprays and chemical dust suppressants are necessary.

Petitioners seek review of this issue, and ask the Board to vacate and remand the Permit and hold that DEQ must include enforceable permit limits on the combinations, volumes, and frequencies for applying water sprays and chemical suppressants sufficient to achieve 93.3% dust control.

5. The Hearing Officer misinterpreted and misapplied applicable rules to uphold DEQ's decision to artificially dilute the ambient arsenic concentrations attributable to the SGP by 16/70.

No PTC can be granted unless DEQ determines the applicant showed: "Using the methods provided in Section 210, the emissions of toxic air pollutants from the . . . source . . . would not injure or unreasonably affect human health or animal life or vegetation as required by Section 161." Air Rules Section 203.03. Section 161 states, "[a]ny contaminant which is by its nature toxic to human or animal life or vegetation shall not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation." Air Rules Section 161.

For each carcinogenic TAP, including arsenic, the Air Rules set Acceptable Ambient Concentrations of Carcinogens ("AACC"), where each AACC is an annual average in ug/m3. Air Rules Section 586. The applicable TAPs "carcinogenic increments" that must be met to satisfy Section 203.03 are the AACCs, which are *annual average* ambient concentrations. *See* Air Rules Section 586.

The "methods provided in Section 210" that must be followed to satisfy Section 203.03 spell out in detail how to estimate TAPs emissions and ambient concentrations. *See* Air Rules Section 210. The Air Rules include explicit exceptions to meeting the normal AACCs, allowing less stringent AACCs either where: (a) a project is five years or less; or (b) a T-RACT demonstration is done. Air Rules Sections 210.12, 210.15. There are no other exceptions in the Air Rules.

Because the Stibnite Gold Project is for 16 years (which is longer than five years or less), it is not eligible for the short-term source exception. DEQ did grant the T-RACT exception to Perpetua. Even with the T-RACT adjusted arsenic AACC—which allows Perpetua 10 times the normal limit—DEQ recognized that the Project would still exceed the arsenic AACC. To avoid

this problem, DEQ contrived a new tactic to artificially reduce the apparent arsenic exposure by spreading out the actual arsenic exposure resulting from the 16-year Project over a longer 70-year human lifetime. This new trick artificially reduces the apparent concentration of arsenic to a mere 23% (16/70 x 100) of what the arsenic concentration will actually be each year during the Project.

In accepting DEQ's approach, the Hearing Officer stated that "unless an issue is squarely addressed by the Air Rules, the hearing officer will defer to 'practical' interpretations of the Air Rules by DEQ." Prelim. Order at 7. Here, the Hearing Officer improperly deferred to DEQ's interpretation of the Air Rules and ignored the fact that the Air Rules squarely address this issue: the Air Rules provide two specific exceptions to meeting the arsenic AACC, and do not allow for other exceptions. The Hearing Officer effectively allowed DEQ to rewrite the Rules without following the rulemaking process and allowed DEQ to create a new exception--found nowhere in the Air Rules --to the requirement to comply with the arsenic AACCs following the methods in Section 210.

Petitioners seek review of this issue, and ask the Board to vacate and remand the Permit and order that DEQ must comply with the methods in Air Rules Section 210 and cannot authorize the Permit unless it will comply with the arsenic AACCs, as adjusted by the T-RACT, without any 16/70 adjustment.

CONCLUSION

Petitioners request that the Board issue an order remanding to DEQ and vacating the Permit, and/or remand to the Hearing Officer for additional proceedings.

Dated: November 14, 2023

Respectfully submitted,

/s/ Bryan Hurlbutt
Bryan Hurlbutt
Attorney for the Nez Perce Tribe and the Idaho Conservation League

/s/ Julie S. Thrower
Julia S. Thrower
Attorney for Save the South Fork Salmon

CERTIFICATE OF SERVICE

I hereby certify that on November 14, 2023, a true and correct copy of the Petition for Review of Preliminary Order was served on the following:

Dylan B. Lawrence Varin Thomas, LLC 242 N. 8th St., Suite 220 Boise, ID 83702 (208) 345-6021 dylan@varinthomas.com *Hearing Officer*	Via: Email: [x] Fax: [ ] CM/ECF: [ ] Hand Delivery: [ ] U.S. Mail: [x]
Paula Wilson paula.wilson@deq.idaho.gov *Hearing Coordinator*	Via: Email: [x] Fax: [ ] CM/ECF: [ ] Hand Delivery: [ ] U.S. Mail: [ ]
Office of Administrative Hearings P.O. Box 83720 Boise, ID 83720-0104 filings@oah.idaho.gov	Via: Email: [x] Fax: [ ] CM/ECF: [ ] Hand Delivery: [ ] U.S. Mail: [x]

Hannah M.C. Young Deputy Attorney General Department of Environmental Quality 1410 N. Hilton, 2nd Floor Boise, ID 83706 (208) 373-0422 hannah.young@deq.idaho.gov *Attorney for Respondent Idaho Department of Environmental Quality*	Via: Email: [x] Fax: [ ] CM/ECF: [ ] Hand Delivery: [ ] U.S. Mail: [ ]
Krista McIntyre W. Christopher Pooser Wade Foster Stoel Rives, LLP 101 S. Capital Blvd., Suite 1900 Boise, ID 83702 (208) 389-9000 krista.mcintyre@stoel.com christopher.pooser@stoel.com wade.foster@stoel.com *Attorneys for Intervenor Perpetua Resources of Idaho, Inc.*	Via: Email: [x] Fax: [ ] CM/ECF: [ ] Hand Delivery: [ ] U.S. Mail: [ ]

DYLAN LAWRENCE
VARIN THOMAS LLC
P.O. Box 1676
Boise, ID 83701
(208) 345-6021
dylan@varinthomas.com

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	BEQ Case No. 0101-22-01 OAH Case No. 23-245-01 ORDER ON POST PRELIMINARY ORDER PROCEDURES

On October 31, 2023, the hearing officer issued a Memorandum Decision on Motions for Summary Judgment and Preliminary Order. Under BEQ's rules of procedure, a preliminary order becomes a final order of the BEQ unless a party files a petition for review of the order within fourteen days. BEQ R.PROC. 730.02(b). When a petition for review is filed, the review process takes place before the BEQ and is coordinated by its hearing coordinator. BEQ R.PROC. 730.03.

In addition to that petition for review process, BEQ has adopted Rule 770 of the rules of procedure adopted by the Idaho Attorney General. BEQ R.PROC. 003.21. That rule allows a party affected by any order (including a preliminary order) to file a "petition" to clarify the order and to

combine that petition with a petition for reconsideration. AG R.PROC. 770. Curiously, Rule 770 does not expressly specify a deadline for filing such petitions. However, because a preliminary order automatically becomes final unless a petition for review is filed within fourteen days, at least as to preliminary orders, there is an effective fourteen-day deadline. Once a Rule 770 petition has been filed, other parties then have 21 days to file an "answer." AG R. PROC. 230.01(b), 270.01.

On November 10, 2023, DEQ and Perpetua filed a Joint Motion for Reconsideration and/or Clarification, requesting the hearing officer to clarify issues related to the fact that the Petitioners amended their initial petition and to "reconsider whether Petitioners' Claim 3 was revived in the Amended Petition and is addressed to resolve this proceeding completely." (Joint Mot. of 11/10/23, p. 2.) On November 14, 2023, the "original" Petitioners (Idaho Conservation League, Nez Perce Tribe, and Save the South Fork Salmon) filed a petition for review of the Preliminary Order by BEQ.

This is perhaps a situation in which the BEQ procedural rules, AG procedural rules, and Idaho Administrative Procedure Act could be integrated a little better. Under Idaho Code Section 67-5243(3), a petition for reconsideration not acted on within 21 days is deemed denied. Therefore, if the original Petitioners took the full 21 days to answer DEQ and Perpetua's Rule 770 petition, by statute, the request for reconsideration would be automatically denied before the hearing officer would have time to act on it.

Thankfully, the original Petitioners have voluntarily agreed to file their answer/response to the Rule 770 petition by Monday, November 20. Therefore, based on the foregoing, it is hereby ordered that the Idaho Conservation League, Nez Perce Tribe, and Save the South Fork Salmon shall file a response/answer to the November 10 Joint Motion on or before Monday, November 20, 2023.

Dated this 17th day of November, 2023.



Dylan Lawrence
Hearing Officer

CERTIFICATE OF SERVICE

I hereby certify that on this 17th day of November, 2023, I caused to be served a true and correct copy of the foregoing by the following method to:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Resources Division
Office of the Attorney General
1410 N. Hilton St.
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
hannah.young@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service



Dylan B. Lawrence
Hearing Officer

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	
	CASE DOCKET NO. 0101-22-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC. Intervenor-Respondent.	**PETITIONERS' RESPONSE TO JOINT MOTION FOR RECONSIDERATION AND/OR CLARIFICATION**

Petitioners Nez Perce Tribe, Idaho Conservation League ("ICL"), and Save the South Fork Salmon ("SSFS") file this Response to the Joint Motion for Reconsideration and/or Clarification filed by Respondent Idaho Department of Environmental Quality ("DEQ") and Intervenor-Respondent Perpetua Resources Idaho, Inc. ("Perpetua"). Petitioners agree with DEQ and Perpetua that what they are calling "Claim 3"—DEQ's reliance of various future plans to be submitted by Perpetua violates procedural requirements of the Air Rules and the Clean Air Act and its regulations—was raised in the Amended Petition, was fully briefed by all parties in the cross motions for summary judgment, but was not addressed by the Hearing Officer in the October 31, 2023 Memorandum Decision and Preliminary Order. Petitioners, thus, do not oppose reconsideration and/or clarification on this issue.[1] However, Petitioners request that upon any reconsideration and/or clarification, the Hearing Officer grant summary judgment in favor of Petitioners on Claim 3 for the reasons set forth in the summary judgment briefing and vacate and remand the Permit.

First, the Amended Petition raised this "Claim 3" issue: that DEQ violated the CAA and the Air Rules by failing to require Perpetua to submit the Fugitive Dust Control Plan ("FDCP"), the Haul Road Capping Plan ("HRCP"), the Operation and Maintenance Manual ("O&M Manual"), and the Access Management Plan ("AMP"). Both the original Petition and the Amended Petition included a Relief Requested section titled "FDCP, AMP, O&M Manual, & HRCP" which states as follows:

[1] Petitioners filed a Petition for Review of Preliminary Order on November 14, 2023, seeking review by the Idaho Board of Environmental Quality (the "Board") of this "Claim 3" issue, and other issues. DEQ's contested case rules explicitly provide for seeking the Board's review of a preliminary order by filing a petition for review within 14 days, as Petitioners have done. IDAPA 58.01.23.730. Petitioners reserve the right to re-file their Petition for Review by the Board as necessary, or to file a new Petition for Review, upon any resolution of the Joint Motion for Reconsideration and/or Clarification.

> DEQ must require Perpetua to submit the FDCP, AMP, O&M Manual, and HRCP (collectively, "Plans"), must provide for public comment on the Plans, must review and revise Plans to ensure the SGP's emissions comply with IDAPA 58.01.01.203, and must incorporate the Plans as enforceable PTC conditions.

Petition at ¶ D; Amended Petition at ¶ D. After the Hearing Officer's decision on the Motion to Dismiss, Petitioners revised Paragraphs 32 and 70 to add CAA regulation and Idaho Air Rule provisions related to the permit review process requirements, including public comment requirements, in the Amended Petition. The FDCP and HRCP were already discussed in the original Petition in Paragraphs 37 and 39, including stating that these plans had not yet been developed but were being relied upon by DEQ. After the decision on the Motion to Dismiss, Paragraph 37 was revised to add references raising the issue that DEQ failed to take public comment on the FDCP and HRCP in the Amended Petition. The O&M Manual was already discussed in the original Petition in Paragraph 40, and after the decision on the Motion to Dismiss, Paragraph 40 was revised to add additional information about the O&M Manual and about Air Rule permit process requirements, including requirement for submitting project plans and for taking public comment. The AMP was already discussed in the original Petition in Paragraphs 63 through 65, including raising the issue that DEQ was relying on the AMP even though it had not yet been written and would not go through public comment.

Second, this "Claim 3" issue was fully briefed on summary judgment. Petitioners' opening brief devoted an entire section to this specific issue: Section III, titled "DEQ's Reliance on Future Plans to be Prepared by Perpetua Outside of the PTC Process Violates the Air Rules and CAA." Pet'rs' Opening Br. at 28–31. In that section of the opening brief, Petitioners argued that DEQ violated the Air Rules and the CAA by relying on the FDCP, HRCP, O&M Manual, and AMP without preparing these plans during the permitting process set forth in the Air Rules and CAA, including without taking public comment on the plans. DEQ and Perpetua responded,

opposing this specific claim on the merits, and without arguing the claim had been dismissed or was not raised in the Amended Petition. DEQ Resp. Br. at 23–24; Perpetua Resp. Br. at 34–38. Petitioners' reply brief again devoted an entire section to this issue: Section IV, titled "DEQ's Reliance on Future Plans to be Prepared by Perpetua Outside of the Permit Process Violates the Air Rules and the Clean Air Act." Pet'rs' Reply Br. at 27–34. In fact, this was the lengthiest argument section of Petitioners' reply brief.

Third, while the Preliminary Order discusses some of the future plans in relation to some of Petitioners' other claims, it never addresses this "Claim 3" issue. To be sure, other claims Petitioners raised do involve some of these same future plans; however, those claims contest the adequacy of the required content of those plans, and the adequacy of Permit provisions related to the plans. *See*, *e.g.*, Pet'rs' Opening Br. at 21–24, 26–27. Whereas Claim 3 is concerned with whether the procedures set forth in the Air Rules and CAA allow relying on future plans in the manner that DEQ did here. *See* Pet'rs'Opening Br. at 28–31; Pet'rs' Reply Br. at 27–34.

For these reasons, Petitioners do not oppose reconsideration and/or clarification regarding "Claim 3", and if any decision is issued on reconsideration or clarification, Petitioners ask that the Hearing Officer grant summary judgment for Petitioners on Claim 3.

Dated: November 20, 2023

Respectfully submitted,

/s/ Bryan Hurlbutt
Bryan Hurlbutt
Attorney for the Nez Perce Tribe and the Idaho Conservation League

/s/ Julie S. Thrower
Julia S. Thrower
Attorney for Save the South Fork Salmon

CERTIFICATE OF SERVICE

I hereby certify that on November 20, 2023, a true and correct copy of the Petitioners' Response to Joint Motion for Reconsideration and/or Clarification was served on the following:

Dylan B. Lawrence Varin Thomas, LLC 242 N. 8th St., Suite 220 Boise, ID 83702 (208) 345-6021 dylan@varinthomas.com *Hearing Officer*	Via: Email: [x] Fax: [ ] CM/ECF: [ ] Hand Delivery: [ ] U.S. Mail: [x]
Paula Wilson paula.wilson@deq.idaho.gov *Hearing Coordinator*	Via: Email: [x] Fax: [ ] CM/ECF: [ ] Hand Delivery: [ ] U.S. Mail: [ ]
Office of Administrative Hearings P.O. Box 83720 Boise, ID 83720-0104 filings@oah.idaho.gov	Via: Email: [x] Fax: [ ] CM/ECF: [ ] Hand Delivery: [ ] U.S. Mail: [x]

Hannah M.C. Young Office of the Attorney General 1410 N. Hilton, 2nd Floor Boise, ID 83706 (208) 373-0453 hannah.young@deq.idaho.gov *Attorney for Respondent Idaho Department of Environmental Quality*	Via: Email: [x] Fax: [ ] CM/ECF: [ ] Hand Delivery: [ ] U.S. Mail: [ ]
Krista McIntyre W. Christopher Pooser Wade Foster Stoel Rives, LLP 101 S. Capital Blvd., Suite 1900 Boise, ID 83702 (208) 389-9000 krista.mcintyre@stoel.com christopher.pooser@stoel.com wade.foster@stoel.com *Attorneys for Intervenor Perpetua Resources of Idaho, Inc.*	Via: Email: [x] Fax: [ ] CM/ECF: [ ] Hand Delivery: [ ] U.S. Mail: [ ]

/s/ Bryan Hurlbutt
Bryan Hurlbutt

DYLAN LAWRENCE
VARIN THOMAS LLC
P.O. Box 1676
Boise, ID 83701
(208) 345-6021
dylan@varinthomas.com

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v.	BEQ Case No. 0101-22-01 OAH Case No. 23-245-01 ORDER ON JOINT MOTION FOR RECONSIDERATION AND/OR CLARIFICATION
DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	

On October 31, 2023, the hearing officer issued a Memorandum Decision on Motions for Summary Judgment and Preliminary Order (the "Preliminary Order"). On November 10, 2023, DEQ and Perpetua filed a joint motion requesting the hearing officer to:

1. Clarify that citations to "Petition" or "Pet." in the Preliminary Order refer to the First Amended Petition to Initiate Contested Case filed by the Petitioners on January 11, 2023, as opposed to the initial Petition to Initiate Contested Case filed by the Petitioners on July 22, 2022;

2. Clarify whether the Preliminary Order dismissed the Amended Petition in its entirety; and

3. Reconsider whether Claim No. 3 was revived in the Amended Petition, and if so, to decide the outcome of that claim.

The Petitioners filed their response to the Motion on November 20, 2023. They do not oppose the Motion and request the hearing officer to grant summary judgment in their favor on Claim No. 3.

Regarding the first issue, unless otherwise stated, any references or citations in the Preliminary Order to "Pet." or to the "Petition" relate to the Amended Petition of January 11, 2023. Contemporaneously with this order, the hearing officer is issuing an Amended Memorandum Decision on Motions for Summary Judgment and Preliminary Order ("Amended Preliminary Order") that includes a new footnote 1 clarifying this point.

Regarding the second issue, Section IV of the Preliminary Order reflects that the Preliminary Order grants summary judgment in favor of DEQ and Perpetua on all claims that had not already been dismissed in the November 15, 2022 Order on Motion to Dismiss. In addition, Section V of the Preliminary Order contains the Rule 730 notice language. This is notable because BEQ Rule of Procedure 003.17 adopts AG Rules of Procedure 710 and 711 governing interlocutory orders. AG Rule of Procedure 710 establishes that (1) interlocutory orders are orders that do not decide all previously undecided issues, and (2) an order accompanied by Rule 730 notice language is not interlocutory. In other words, inclusion of the Rule 730 notice language inherently indicates that all claims for relief have been resolved. With that said, Section IV of the Amended Preliminary Order now includes additional language that is more explicit on this issue.

Regarding the third issue, it is important to recall the sequence of events. The hearing officer issued an order formally dismissing Claim No. 3 on November 15, 2022. The Petitioners filed their Motion to File First Amended Petition on December 6, 2022. The Petitioners describe the intent of

that motion as "merely…to correct deficiencies the Hearing Officer found with respect to some claims and to provide additional detail and clarity regarding each claim being pursued in this contested case…." (Mot. to File Am. Pet. of 12/6/22, p. 3.) That motion did not contain any express references to Claim No. 3. The Petitioners formally filed their Amended Petition on January 11, 2023. The Amended Petition added some additional content to Paragraph 40, the portion of the original Petition most closely associated with Claim No. 13. But, it did not otherwise reference Claim No. 3 or request the hearing officer to take any action regarding Claim No. 3.

Generally speaking, when a judge or hearing officer renders a formal, written decision on an issue, that ruling is then the established "law of the case" for the remainder of the proceeding. The only way to reverse a prior ruling is to formally ask the judge or hearing officer to reconsider that prior ruling. Indeed, even DEQ—one of the movants for clarification/reconsideration—actively decided not to advance further argument regarding Claim No. 3 on summary judgment because it had been dismissed. (*See* DEQ Resp. and Br. in Supp. of MSJ of 5/12/23, p. 16.)

The Petitioners did not accompany either their December 6, 2022 motion to amend or their Amended Petition with any formal request to re-visit the dismissal of Claim No. 3. Neither of those filings specifically reference Claim No. 3. In this regard, it is helpful to recall that the Amended Petition contains 30 pages of lengthy, detailed allegations. It is unrealistic to expect adding a few additional sentences to an allegation within a 30-page pleading to adequately inform the hearing officer and BEQ of a belief that a claim has been automatically revived, in spite of a prior formal ruling dismissing it. In this regard, it is helpful to recall that, even though the standards for amending pleadings are easily met, amending a pleading still requires approval; it is not done "as of right." *See* BEQ R.PROC. 003.05; AG R.PROC. 305.

For the foregoing reasons, the hearing officer finds that Claim No. 3 was not revived simply

by the filing of the Amended Petition. However, the hearing officer understands that, in the event he is reversed on this issue, it will be more efficient to have addressed the substance of the claim too, particularly given that Petitioners and Perpetua have briefed it on summary judgment. Therefore, the Amended Preliminary Order contains a new section addressing Claim No. 3.

Based on the foregoing, the Joint Motion for Reconsideration and/or Clarification is hereby GRANTED by the issuance of the Amended Preliminary Order filed contemporaneously herewith.

Dated this 5th day of December, 2023.



Dylan Lawrence
Hearing Officer

CERTIFICATE OF SERVICE

I hereby certify that on this 5th day of December, 2023, I caused to be served a true and correct copy of the foregoing by the following method to:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Resources Division
Office of the Attorney General
1410 N. Hilton St.
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
hannah.young@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Dylan B. Lawrence
Hearing Officer

DYLAN LAWRENCE
VARIN THOMAS LLC
P.O. Box 1676
Boise, ID 83701
(208) 345-6021
dylan@varinthomas.com

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	
	BEQ Case No. 0101-22-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	OAH Case No. 23-245-01 AMENDED MEMORANDUM DECISION ON MOTIONS FOR SUMMARY JUDGMENT AND PRELIMINARY ORDER

I. FACTUAL AND PROCEDURAL HISTORY

Perpetua Resources Idaho, Inc. is in the process of applying for a variety of permits for its proposed Stibnite Gold Project ("SGP") in Valley County, Idaho. The SGP would consist of conventional open-pit mining, ore preparation, and gold extraction operations. In August 2019, Perpetua applied to the Idaho Department of Environmental Quality ("DEQ") for an air quality permit for the construction and operation of the SGP, pursuant to the Rules for the Control of Air Pollution in Idaho in IDAPA 58.01.01 (the "Air Rules"). DEQ issued the final version of air quality permit-to-construct P-2019.0047 (the "Permit") on June 17, 2022.

On July 22, 2022, the Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon ("Petitioners") filed a joint petition to initiate a contested case (the "Petition") regarding the Permit. The Petition alleges DEQ committed several errors in its development of the Permit and asks the Board of Environmental Quality ("Board" or "BEQ") to vacate and withdraw the Permit and remand it to DEQ to correct such errors. After some motion practice, the Petitioners filed an amended Petition on January 11, 2023.[1]

DEQ filed its response to the initial Petition on August 12, 2022 and its response to the amended Petition on January 17, 2023. DEQ's response admits many of the Petition's allegations regarding general background information and applicable law, but ultimately denies DEQ committed any errors in issuing the permit, and requests its actions in issuing the Permit be affirmed.

On August 12, 2022, Perpetua filed a petition to intervene in the contested case proceeding pursuant to Rule 353.01 of the Board's Contested Case Rules in IDAPA 58.01.23 (the "BEQ Procedural Rules"), which the hearing officer granted on August 22, 2022. Perpetua filed its response to the amended Petition on December 13, 2022. Similar to DEQ's responsive pleading, Perpetua's response admits many of the Petition's allegations regarding general background information and applicable law, but ultimately denies that DEQ committed any errors in issuing the Permit and requests the Permit be affirmed and the Petition dismissed.

On September 6, 2022, Perpetua filed a motion to dismiss the Petition. The hearing officer ruled on that motion on November 15, 2022. In doing so, the hearing officer identified 13 individual claims of error in the Petition. The order granted the motion to dismiss as to Claim Nos. 3, 4, and 10 and partially granted the motion as to Claim No. 8. As to the remaining claims, the order denied the

[1] For ease of reference, unless otherwise stated, references in this Order to "Pet." or the "Petition" are references to the Amended Petition of January 11, 2023.

motion. Therefore, Claim Nos. 1, 2, 5, 6, 7, 9, 11, 12, 13, and a portion of Claim No. 8 survived.[2]

Pursuant to a stipulated scheduling order, the Petitioners filed a motion for summary judgment on April 14, 2023, and DEQ and Perpetua filed motions for summary judgment on May 12, 2023. Briefing on those motions and two related motions to strike was complete as of July 20, 2023. The hearing officer ruled on the motions to strike on July 31, 2023, and the parties and hearing officer held a hearing on the summary judgment motions on September 21, 2023.

The hearing officer issued a Memorandum Decision on Motions for Summary Judgment and Preliminary Order on October 31, 2023. DEQ and Perpetua filed a Joint Motion for Reconsideration and/or Clarification on November 10, 2023, requesting the hearing officer clarify issues related to the Amended Petition and whether Claim No. 3 had been revived by it. The hearing officer issues this Amended Memorandum Decision on Motions for Summary Judgment and Preliminary Order in response to the November 10 joint motion. This will provide the parties and the Board with a single, unified decision document for the purposes of the Petition for Review of Preliminary Order filed by the Petitioners on November 14, 2023.

II. RELEVANT LEGAL STANDARDS

A. Standards on Motions for Summary Judgment

Motions for summary judgment filed in administrative proceedings before the BEQ are governed by the Idaho Rules of Civil Procedure. *In the Matter of Simmons Sanitation*, Findings of Fact, Conclusions of Law, and Preliminary Order on Motion for Summary Judgment of 9/23/05, at p. 3 (BEQ Dkt. No. 0106-05-01). Those rules provide in pertinent part:

A party may move for summary judgment, identifying each claim or defense, or the

[2] On pages 22, 23, and 24 of the order on the motion to dismiss, there are incorrect references to Claim Nos. 10, 11, and 12 at the end of the sections discussing Claim Nos. 11, 12, and 13, respectively. The heading of each of those sections is correct.

> part of each claim or defense, on which summary judgment is sought. The court must grant summary judgment if the movant shows that there is no genuine dispute as to any material fact and the movant is entitled to judgment as a matter of law.
>
> ***
>
> A party asserting that a fact cannot be or is genuinely disputed must support the assertion by…citing to particular parts of materials in the record, including depositions, documents, electronically stored information, affidavits or declarations, stipulations (including those made for purposes of the motion only), admissions, interrogatory answers, or other materials; or…showing that the materials cited do not establish the absence or presence of a genuine dispute, or that an adverse party cannot produce admissible evidence to support the fact.
>
> ***
>
> An affidavit used to support or oppose a motion must be made on personal knowledge, set out facts that would be admissible in evidence, and show that the affiant or declarant is competent to testify on the matters stated. Sworn or certified copies of all papers or parts of papers referred to in an affidavit must be attached to or served with the affidavit. The court may permit affidavits to be supplemented or opposed by depositions, answers to interrogatories, or further affidavits.

IDA.R.CIV.PROC. 56(a), (c)(1), (c)(4).

Air permit matters are often technical in nature, requiring the decision-maker to understand the relevant science and to analyze long, detailed regulations. Therefore, discussion of the rules governing expert witness testimony at the summary judgment stage is warranted. In the context of legal malpractice cases, the Idaho Supreme Court has held:

> When a defendant-attorney files a motion for summary judgment, the plaintiff ordinarily has an obligation to provide expert affidavits that explain how the lawyer's conduct fell below the standard of care and how the conduct proximately caused damages. The reason for this rule is that ***laypeople sitting on a jury usually do not have the knowledge or experience necessary*** to determine the standard of care that applies to an attorney or how the attorney's performance of that duty may or may not harm a client. The only recognized exception to this rule is where the attorney's alleged malpractice is so obvious that it is within the ordinary knowledge and experience of laymen, such as when an attorney allows a statute of limitations to run.
>
> When Smith filed his motion for summary judgment, he also filed an affidavit and report from an expert witness stating that 'in [his] opinion, Mr. Smith met and exceeded the applicable standard of care in representing Ms. Greenfield in both the

> Criminal and Civil Cases.' The report analyzed the various deficiencies alleged by Greenfield and concluded that any alleged deficiency was not the cause of the jury's adverse verdict. ***Greenfield did not file any expert affidavits to refute these opinions*** and never disclosed any expert witnesses during the course of discovery. Instead, she filed her own affidavit setting forth the ways she believed that Smith's performance was deficient.
>
> ***
>
> These alleged deficiencies are not simple matters like an attorney allowing a statute of limitations to run….***Without expert testimony, Greenfield could not demonstrate that there were genuine issues of material fact*** as to whether Smith's performance fell below the standard of care or proximately caused her damages. As such, the district court ***properly granted summary judgment*** in favor of Smith.

Greenfield v. Smith, 395 P.3d 1279, 1285-1286, 162 Idaho 246, 252-253 (Idaho 2017) (emphasis added) (citations omitted); *see also Samuel v. Hepworth, Nungester & Lezamiz, Inc*., 996 P.2d 303, 134 Idaho 84 (Idaho 2000); *Rich v. Hepworth Holzer, LLP*, at p. 10-11, Ida. Sup. Ct. Dkt. No. 49300 (Sept. 6, 2023) (reaffirming *Greenfield* principles).

The test for whether a summary judgment respondent is required to adduce an expert affidavit is whether the relevant evidence is "the type that would be within the ordinary knowledge and experience of a layperson." *Ciccarello v. Jeffrey Bo Davies, & Marcus, Christian, Hardee & Davies, LLP*, 166 Idaho 153, 161, 456 P.3d 519, 527 (Idaho 2019). "Judges, after all, are lay persons, no matter how well-read they are in science." *Earl v. Cryovac, A Div. of W.R. Grace Co*., 772 P.2d 725, 728, 115 Idaho 1087, 1090 (App. 1989) (citation omitted).

Many of the errors alleged by Petitioners are not "the type that would be within the ordinary knowledge and experience of a layperson." Therefore, as to each alleged error, it is important to determine if expert witness testimony is necessary to render a decision, and if so, to evaluate the sufficiency of the expert testimony.

B. Idaho APA Judicial Standards of Review

The pleadings, motions, and briefs in this matter frequently invoke Idaho Code

Section 67-5279. That statute contains the standards of review applicable when a petition for judicial review of an agency decision has been filed pursuant to the Idaho Administrative Procedure Act, Idaho Code Sections 67-5201 – 67-5292 (the "APA"). After a final order has been issued in this matter, if a party appeals to the judicial system, Section 67-5279 contains the standards governing the court's evaluation of the final order.

Even though APA standards are not directly applicable to the pending motions, it is still important to understand the standards that will ultimately govern judicial review of the Board's decision. As the Board itself has recognized, in a contested case proceeding, "the Board must determine whether DEQ has acted reasonably and in accordance with law." *In the Matter of Sunnyside Park Utilities' Application for Sewage Disposal Permit*, Final Order on Petition for Review of Preliminary Order, at p. 10 (BEQ Dkt. 0103-07-02, Apr. 7, 2009).[3]

Pursuant to DEQ Procedural Rule 003.18 and AG Procedural Rule 740, the Board will render a decision in this matter by issuing a final order. Therefore, subsection (3) of Section 67-5279 applies to judicial review, and the court would affirm the Board's decision unless it finds:

- DEQ and the Board acted in violation of constitutional or statutory provisions;
- DEQ and the Board acted in excess of their statutory authority;
- DEQ's approval of the Permit and the Board's decision to uphold it were made upon unlawful procedure;
- The Board's decision was not supported by substantial evidence on the record as a whole; or

[3] The hearing officer is aware that Board members have previously expressed concern regarding application of Section 67-5279 standards too early in an administrative hearing process. (*See generally* Order of 9/23/22, *taking administrative notice of* Tr. of 12/4/14, 47:5-9 (BEQ Dkt. No. 0101-14-01)). Because those are the standards that ultimately govern the disposition of this matter, it is still necessary to reference them on summary judgment. As with a cause of action in a civil lawsuit, it is still necessary at the summary judgment stage to reference and understand the legal standards and claim elements that would govern at trial.

- DEQ and the Board otherwise acted in a manner that qualifies as arbitrary, capricious, or an abuse of discretion.

IDAHO CODE § 67-5279(3)

C. Deference to DEQ

According to the Idaho Supreme Court, "[t]he actions of an agency…are afforded a ***strong presumption of validity***." *Duncan v. State Bd. of Accountancy*, 232 P. 3d 322, 324, 149 Idaho 1 (Idaho 2010) (emphasis added).

> Where an agency interprets a statute or rule, this Court applies a four-pronged test to determine the appropriate level of deference to the agency interpretation. This Court must determine whether: (1) the agency is responsible for administration of the rule in issue; (2) the agency's construction is reasonable; (3) the language of the rule does not expressly treat the matter at issue; and (4) any of the rationales underlying the rule of agency deference are present. There are five rationales underlying the rule of deference: (1) that a practical interpretation of the rule exists; (2) the presumption of legislative acquiescence; (3) reliance on the agency's expertise in interpretation of the rule; (4) the rationale of repose; and (5) the requirement of contemporaneous agency interpretation.

Id. (citations omitted).

This matter requires a detailed review of the Air Rules. Clearly, DEQ is responsible for administering those Rules. Therefore, unless an issue is squarely addressed by the Air Rules, the hearing officer will defer to "practical" interpretations of the Air Rules by DEQ.

III. ANALYSIS

A. Standing and the Petitioners' Status as "Aggrieved Parties"

Both DEQ and Perpetua moved for summary judgment on the basis that each of the three Petitioners lacks standing. This order will address standing before proceeding to the alleged errors.

1. Discussion of Applicable Standards

BEQ's Rules of Procedure state that "[a]ny person aggrieved by an action or inaction of the Department may file a petition to initiate a contested case pursuant to" the APA. BEQ PROC.

RULE 002.02. The rules define "person aggrieved" as "[a]ny person or entity with legal standing to challenge an action or inaction of the Department…." BEQ PROC. RULE 005.01. Regarding legal standing, the BEQ has held:

> The petitioner to a contested case proceeding can be either an individual or an organization. In order to satisfy standing, an individual petitioner must demonstrate: (1) an injury in fact which is real, concrete and particularized, and actual or imminent, and not just speculative or hypothetical; (2) a causal connection between the challenged action and the injury; and (3) the likelihood that the injury will be redressed by a favorable decision.
>
> An organization may obtain associational or representational standing on behalf of its members. To achieve standing on behalf of its members, an organization must show that: (1) its members would otherwise have standing to sue individually; (2) the interests the organization seeks to protect are germane to the organization's purpose; and (3) neither the claim asserted, nor the relief requested, requires participation of individual members in the lawsuit.

Solomon v. Idaho Dept. of Env. Quality, Order of 12/17/03, at p. 4 (BEQ Dkt. No. 0101-03-01) (citations omitted).

2. Idaho Conservation League

The Idaho Conservation League (ICL) filed declarations of Allison Fowle, Asa Menlove, and Jonathan Oppenheimer to establish standing. Ms. Fowle testifies, among other things, that she is a member of ICL; that she has used the Stibnite Road through the SGP many times; that she plans to continue visiting the area to recreate; and that she is concerned about the health effects from dust and arsenic if she continues to recreate in the area while the mine is operating. (Fowle Decl., ¶¶ 2-8.) The Menlove Declaration contains similar assertions. (*See* Menlove Decl., ¶¶ 2, 4, 9, 10.) Mr. Oppenheimer testifies that he is both a member and employee of ICL; that he has recreated in the general area and plans to continue to do so; and that he is concerned about the health effects of particulate matter and arsenic emissions from the SGP. (Oppenheimer Decl., ¶¶ 2, 9-13, 15-16.) All of these factual assertions are uncontradicted.

All three declarants appear to satisfy the standards for individual standing. Their concerns over health effects from particulate and arsenic emissions are sufficiently "concrete and particularized" to satisfy the first prong of the test, particularly given that they have recreated in the area in the past and plan to continue to do so, which distinguishes their concerns from those suffered alike by all citizens and taxpayers of the state. There is a sufficient causal connection between the challenged action (issuance of a permit allowing emissions of air pollutants) and the claimed injury (health effects from breathing emissions authorized by the permit) to satisfy the second prong of the individual standing test. For the third prong, there is a sufficient likelihood that the declarants' health concerns will be addressed by a decision in ICL's favor in this matter.

As to organizational standing, Mr. Oppenheimer testifies extensively regarding ICL's purpose, history, and advocacy efforts related to the environment generally, and air quality specifically. (Oppenheimer Decl., ¶¶ 3-7.) In a prior case, the Board approved ICL's petition to intervene in a matter involving water quality at mining facilities in north Idaho. The Board found that ICL had established a sufficient "direct and substantial" interest in that matter based upon an affidavit similar to the ICL declarations in this case. S*ee Hecla Mining Co. v. Idaho Dept. of Env. Quality*, Order on Intervention, pp. 3-4 (BEQ Dkt. No. 0102-03-13).

Moreover, there is no reason ICL's claims of error or relief requested in this matter require the participation of Ms. Fowle, Mr. Menlove, or Mr. Oppenheimer individually. If ICL relied on Mr. Oppeheimer's declaration and its exhibits to establish substantive error, the third prong of organizational standing may not have been satisfied as to him. However, because ICL has clarified, and the hearing officer has ruled, that Mr. Oppenheimer's declaration will only be considered to evaluate standing, the third prong is satisfied as to him.

Based on the foregoing, the DEQ and Perpetua motions for summary judgment on the basis

that ICL lacks standing are hereby DENIED.

3. Nez Perce Tribe

The Nez Perce Tribe (NPT) filed declarations of Joseph Oatman and Emmit Taylor, Jr. to establish standing. Among other things, Mr. Oatman and Mr. Taylor testify that they have fished within the boundaries of the SGP; that they intend to do so in the future; and that they are concerned about adverse health effects from air pollutants generated by the SGP. (Oatman Decl., ¶ 7; Taylor Decl., ¶ 9.) These assertions are uncontradicted and appear to satisfy the individual standing standards of concrete injury, causal connection, and redressability.

Similarly, the organizational standing standards of individual standing, germane protectable interests, and not needing the individuals' participation are sufficient to shift the burden back to DEQ and Perpetua for summary judgment purposes. Here, it is worth noting the relatively cursory analysis of the standing issue by DEQ and Perpetua. The only discussion specific to whether the NPT has standing appears in DEQ's May 12 brief, filed ***before*** the Oatman and Taylor Declarations were filed on June 9. DEQ chose not to discuss the NPT declarations in its June 23 "Non-Reply," and Perpetua did not discuss the NPT specifically at all. (*See* Perpetua Mem. in Supp. of 5/12/23, pp. 13-14; Perpetua Reply of 6/23/23, p. 5.) "The burden is upon the party moving for summary judgment…to establish that there is no genuine issue of material fact." *G & M Farms v. Funk Irr. Co*., 808 P.2d 851, 863, 119 Idaho 514 (1991). Without more explanation from DEQ and Perpetua as to why the NPT does not satisfy the relevant standards, they have not carried their burden as summary judgment movants.

Based on the foregoing, the DEQ and Perpetua motions for summary judgment that the NPT lacks standing are hereby DENIED.

4. Save Our South Fork Salmon

Save the South Fork Salmon (SSFS) filed declarations of Drew Hollenback and Zak Sears to establish standing. They both testify, among other things, that they have been financial supporters of SSFS since 2016; that they have recreated in the area and utilized the access road through the SGP in the past and plan to continue to do so in the future; and that they are concerned about air pollution from the SGP if they continue to recreate in the area. (Hollenback Decl. of 6/9/23, ¶¶ 2, 4, 5, 7, 8, 10-12; Sears Decl. of 6/9/23, ¶¶ 2, 5-7, 12, 14, 15, 19.) For summary judgment purposes, this is adequate to shift the burden back to DEQ and Perpetua as to individual and organizational standing. As with the NPT, after SSFS adduced these declarations, neither DEQ nor Perpetua attempted to explain why or how they do not satisfy standing, aside from Perpetua's highly conclusory paragraph on the issue. (*See* Perpetua Reply Mem. of 6/23/23, p. 5.)

Based on the foregoing, the DEQ and Perpetua motions for summary judgment that SSFS lacks standing are hereby DENIED.

B. Evaluation of Declarations as Expert Testimony

Having denied the motions for summary judgment on standing, the remainder of this order addresses the individual alleged errors. Before doing so, it is necessary to determine which declarations, if any, are admissible as expert testimony. *See* IDA.R.CIV.PROC. 56(c)(4) (affidavits must be admissible in evidence and show that the declarant is competent to testify on the matters stated); *Hecla Min. Co. v. Star-Morning Min. Co*., 122 Idaho 778, 784, 839 P.2d 1192, 1198 (Idaho 1992) (recognizing that on a motion for summary judgment, "[t]he question of admissibility is a threshold question to be answered before applying the liberal construction and reasonable inferences rule to the admissible evidence").

A witness who is qualified as an expert by knowledge, skill, experience, training, or

> education may testify in the form of an opinion or otherwise if the expert's scientific, technical, or other specialized knowledge will help the trier of fact to understand the evidence or to determine a fact in issue.

IDA.R.EVID. 702.

The Petitioners supported their motion for summary judgment with one declaration, a declaration of counsel that was limited to authentication of documents from the record. (Hurlbutt Decl. of 4/14/23.) When DEQ moved for summary judgment, it adduced declarations of Tiffany Floyd, Kevin Schilling, and Mike Simon. Mr. Schilling testifies, among other things, that he has a B.S. in environmental science with a minor in chemistry; has a M.S. in environmental engineering with an emphasis on atmospheric chemistry, meteorology, air pollution monitoring, and atmospheric pollutant dispersion; has worked for the State of Idaho and within the private sector in some capacity relating to air quality science and engineering since the spring of 1989; and has been a Stationary Source Air Modeling Supervisor for DEQ since September 2004. (Schilling Decl. of 5/12/23, p. 2.) Mr. Simon testifies, among other things, that he has a B.S. in electrical engineering and has over 30 years of air quality experience that includes conducting air quality analyses, writing air quality permits, processing air quality enforcement cases, managing air quality programs, and installation, operation, calibration, and maintenance of meteorological and navigational equipment. (Simon Decl. of 5/12/23, p. 2.)

On their face, both the Schilling and Simon Declarations appear to satisfy the Rule 702 standards.[4] Both witnesses testify regarding education and experience that qualifies them as experts on the issues involved in this matter, and then they explain the basis for DEQ's actions in issuing the Permit to Perpetua as they pertain to the alleged errors. Moreover, because Schilling and Simon are DEQ employees, their testimony is entitled to deference. *See generally Chisholm v. Idaho Dept. of*

[4] The Idaho Rules of Evidence do not strictly apply. BEQ R.PROC. 003.13; AG R.PROC. 600.

Water Resources, 125 P.3d 515, 518, 142 Idaho 159 (Idaho 2005).

The Petitioners do not challenge the admissibility of the DEQ declarations as expert testimony. They also do not rebut the DEQ declarations with their own expert declarations. The declarations filed by Petitioners on June 9, 2023, are primarily dedicated to challenging the contention that they lack standing. Petitioners themselves describe them as "standing declarations." (Petitioners' Resp./Reply Br. of 6/9/23, pp. 2-4, 35; Petitioners' Resp. to Mot. to Strike of 7/7/23, pp. 1, 4.) The Oppenheimer Declaration purports to discuss technical air quality issues, but the hearing officer has ruled that declaration should only be considered for standing purposes. (Order on Perpetua's Mot. to Strike of 7/31/23, p. 6.) Mr. Oatman and Mr. Taylor have impressive education and experience, but their backgrounds are in fisheries. This does not "help the trier of fact to understand the evidence or to determine a fact in issue" in an air permitting matter.

C. Exclusion of Stibnite Access Road From Ambient Air

The Petition alleges multiple errors regarding ambient air boundaries and monitoring. Even though the phrase "ambient air" appears in the Permit one time, (*see* Permit, p. 41, § 7.13), it is an important concept behind many Permit conditions. Therefore, before addressing each individual alleged error, it will be helpful to discuss the concept of ambient air within the Air Rules.

1. Ambient Air Generally

Under the federal Clean Air Act, EPA is required to establish national ambient air quality standards (NAAQS) for a handful of "criteria" air pollutants, including PM_{10}. *See generally* 42 U.S.C. § 7602(t); 40 C.F.R. § 50.6. When DEQ evaluates an application for a permit to construct, it must determine that "[t]he stationary source or modification would not cause or significantly contribute to a violation of any ambient air quality standard." AIR RULES § 203.02. Based on the federal definition, the Air Rules define "ambient air" as "[t]hat portion of the atmosphere, external to

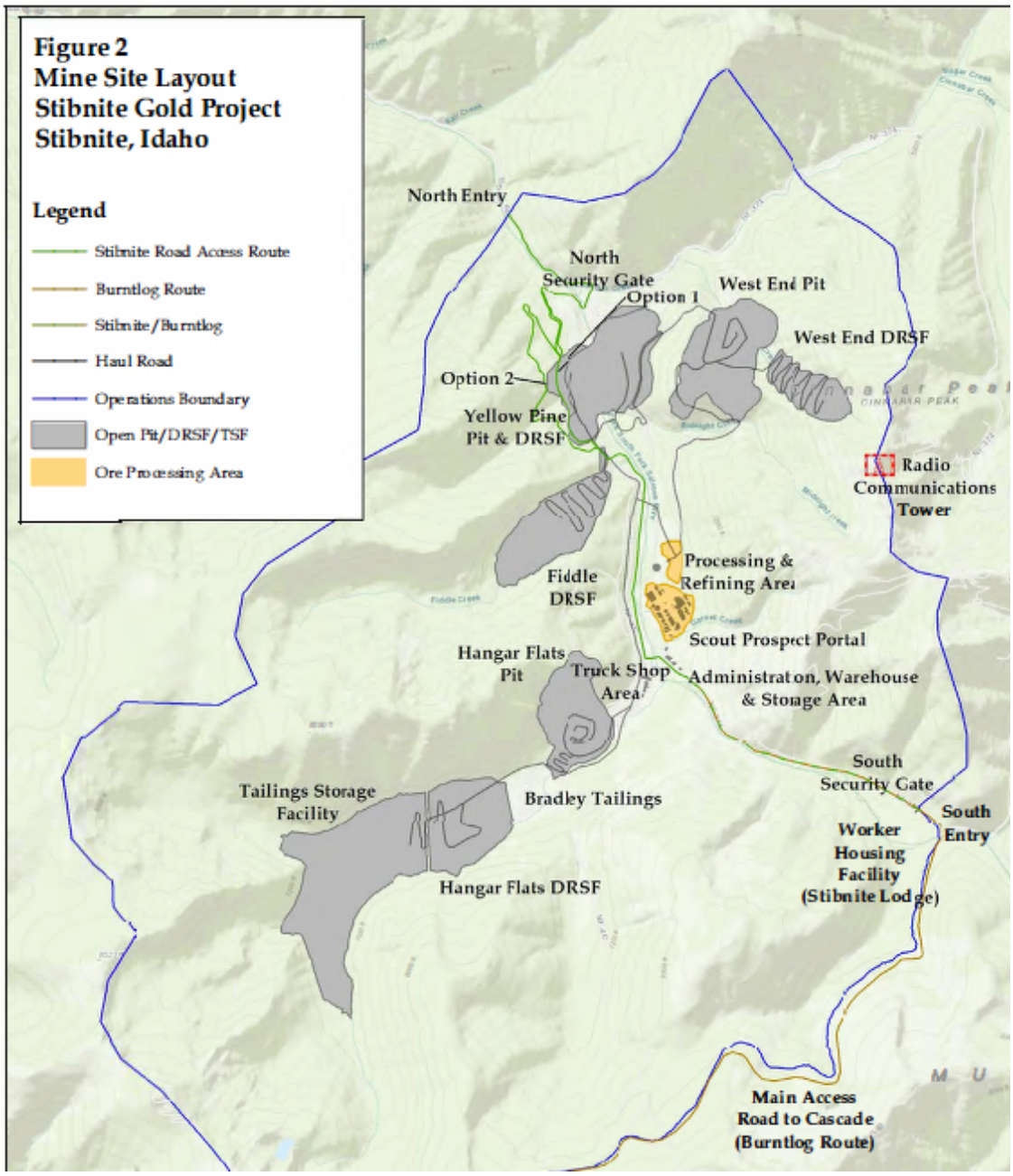
buildings, to which the general public has access." AIR RULES § 006.05.

The Petition alleges—and DEQ agrees—that to exclude areas from ambient air, the following must be true: (1) the permittee must have the ***legal authority to exclude the general public*** from the area; (2) the boundary to ambient air must be clearly discernable to the general public; (3) the general public must be ***effectively precluded*** from assessing the facility; and (4) the general public is not considered (a) employees of the facility; (b) those having official business with the facility; or (c) guests of the facility, including participants in facility routes and those seeking access for a specific purpose. (Pet., ¶ 59; DEQ Resp., p. 5 (emphasis added)).

2. The SGP and the Access Road

The SGP is located in a relatively remote location administered by the Payette National Forest. (R., at p. PRI00000418.) Its elevation ranges from approximately 6,421 feet and 6,936 feet above sea level. (*See generally* R., at pp. PRI00000450-453.) Between December and May, it has an average snow depth between 21 inches and 84 inches. (R., at p. PRI00000419.) It is approximately 37 miles as the crow flies due east of McCall, and approximately 43 miles as the crow files northeast of Cascade.

The SGP is bisected by a U.S. Forest Service ("USFS") road that runs from the northern portion of the SGP to the south-southeast (or conversely, from the southeast portion of the SGP to the north-northwest). Generally speaking, this creates two ways to access the SGP by road. One could drive east from McCall to reach the North Entry of the SGP, passing through the community of Yellow Pine along the way, or one could drive northeast from Cascade to reach the South Entry of the SGP. (*See generally* R., at p. PET 527.)



(R., at p. PET533.)

Perpetua proposed year-round access to the SGP would be accomplished via the "Burntlog Route," which would involve the improvement and extension of the existing Burntlog Road and portions of Thunder Mountain Road. (R., at p. PRI00000418.) The Burntlog Route would provide year-round access to the south side of the SGP.



(R., at p. PRI00000416.)

The community of Yellow Pine is approximately 10 road miles west of the SGP's North Entry, and there are seasonal recreational destinations outside the SGP's South Entry. (*See* R., at p. PRI00000418.) Therefore, if access through the SGP is precluded, those traveling from Yellow Pine to access those recreational areas would have to travel much farther and around the SGP to do so.

Indeed, Perpetua initially proposed public access through the SGP would be prohibited. (R., at p. PET 527.) In response to public comments, Perpetua then proposed to allow "restricted seasonal [non-winter] access through the SGP site," which would "allow limited access to the Thunder Mountain recreational area from the town of Yellow Pine similar to the existing seasonal route." (R., at p. PRI00000418; *see also* R., at pp. PET 527, 530.) Alternative 2 under consideration by USFS under the National Environmental Policy Act ("NEPA") would allow continued access

through the SGP. (R., at p. PET 527.)

For the purposes of the air modeling, Perpetua proposed to treat the access road within the operational boundary of the SGP as part of the SGP. The access road within the SGP was not treated as "ambient air," the result being that Perpetua was not required to demonstrate NAAQS compliance within that portion of the road. According to the Petition, that access road should have been treated as ambient air, not excluded from it, such that compliance with NAAQS would be required within the road. (*See generally* Pet. ¶¶ 60, 62.)

3. Whether Perpetua Has Adequate Legal Authority to Exclude the General Public (Claim No. 11)

The Petitioners argue there is not sufficient evidence in the record demonstrating Perpetua's legal authority to preclude access by the general public, in part because USFS's evaluation of the SGP under NEPA is not complete. (*See* Pet. ¶ 62; Br. in Supp. of MSJ of 4/14/23, pp. 14-18.) DEQ and Perpetua's primary response is that DEQ reasonably relied upon Perpetua's representation in its permit application that it will have the legal authority to control access.

In advance of the summary judgment hearing, the hearing officer requested the parties identify "any legal authorities addressing the extent to which DEQ may so rely [on representations by a permit applicant] and/or the extent to which DEQ is responsible for verifying that information." (Not. Re SJ Hearing of 9/15/23, Att. A, No. 4.) At the hearing, the only specific legal authority cited by any party was Petitioners' reference to *Ctr. for Biological Diversity v. U.S. Fish & Wildlife Serv.*, 33 F.4th 1202 (9th Cir. 2022), referred to as the "*Rosemont*" case because it involved a project proposed by the Rosemont Copper Company. *Rosemont* involved a determination of the scope of rights provided to claimants of mining claims on federal land under the federal Mining Law of 1872. *Id*. at 1208. At its core, that case involves the ***legal interpretation*** of that particular set of federal statutes; it does not squarely address the issue of the extent to which an agency may rely upon

factual representations by an applicant.

In the absence of a specific legal requirement on this issue, the hearing officer must affirm DEQ's decision unless there is not substantial evidence in the record of Perpetua's legal ability to exclude the public or it was otherwise arbitrary or capricious to so rely. In its permit application materials, Perpetua makes the following representations:

> Midas Gold[5] ***will legally control the SGP***, an active industrial site where mining activities will occur, such as heavy equipment operation. Most areas of the mine will require strict safety protocols and controlled access. Midas Gold has established an operations boundary to identify the area ***where public access will be excluded***. Public access inside the operations boundary ***will be restricted for the life of the mine*** by physical barriers at points of potential access, including the current Stibnite Road point of entry and proposed site access via the Burntlog Route, as well as natural features of the landscape that prevent access.

(R., at p. PRI00000467 (emphasis added).)

The next section of this opinion discusses Section 2.7 of the Permit in detail. For now, it is adequate to note that Section 2.7 requires Perpetua to take actions to both "discourage" and "preclude" public access to the SGP. The Air Rules state:

> All documents, including but not limited to, ***application forms for permits to construct***, application forms for operating permits, progress reports, records, monitoring data, supporting information, requests for confidential treatment, testing reports or compliance certifications submitted to the Department must contain a certification by a responsible official. ***The certification must state that, based on information and belief formed after reasonable inquiry, the statements and information in the document are true, accurate, and complete***.
>
> ***
>
> Persons are prohibited from knowingly making any ***false statement, representation, or certification*** in any form, notice, or report required under any permit, or any applicable rule or order in force pursuant thereto.

AIR RULES 123, 125 (emphasis added).

Perpetua acknowledged the certification requirement in its application materials. (R., p.

PRI00000167-168, 381.) It is also worth noting that DEQ has broad enforcement authorities. *See* IDAHO CODE §§ 39-105, 39-108, 39-109. If the representations that Perpetua "will legally control the SGP" in a manner in which "public access will be excluded" and "restricted for the life of the mine" were not true at the time they were made, then Perpetua would be subject to enforcement by DEQ. If Perpetua ultimately lacks the ability to preclude public access as a result of the NEPA process, operating the SGP anyway would be in plain violation of Section 2.7 of the Permit, which requires Perpetua to "preclude" and "discourage" public access.

In the experience of the hearing officer, it is not unusual for an agency to rely on representations made in a permit application, even as to an issue as fundamental as the nature of the applicant's interests in the relevant property. *See* APPLICATION FOR PERMIT TO APPROPRIATE THE PUBLIC WATERS OF THE STATE OF IDAHO, Item No. 11, *available at* https://tinyurl.com/yc5p48ss (last visited Oct. 15, 2023). Under these circumstances, the hearing officer finds DEQ's reliance on Perpetua's representation that it will eventually have the ability to control access reasonable and supported by substantial evidence in the record.

As to Claim No. 11, the Petitioners' motion for summary judgment is hereby DENIED, and the motions for summary judgment filed by DEQ and Perpetua are hereby GRANTED.

4. Whether the Permit Adequately Precludes Access by the General Public (Claim No. 12)

The Petitioners argue the Permit does not adequately preclude access by the general public through the SGP. Sections 2.6 and 2.7 of the Permit require Perpetua to develop an "Access Management Plan (AMP)" that, among other things, "clearly specifies measures used to discourage public access to the facility," and that "shall be submitted to DEQ for approval 30 days prior to startup…." (R., at p. PET 010.) The Petition alleges that, "[w]ithout full disclosure and knowledge

[5] Midas Gold Corp. formally changed its name to Perpetua Resources Corp. in Februrary 2021.

of the exact measures and requirements in the AMP and enforceable permit limits, DEQ cannot make a determination of whether exclusion of the access road from ambient air protections complies with EPA's ambient air policy and the Idaho Air Rules, nor can DEQ determine whether the SGP will comply with the NAAQS and TAPs." (Pet., ¶¶ 58, 59, 62, 65).

In contrast to many of the other errors alleged by Petitioners, the hearing officer finds establishment of ambient air boundaries as a matter that is within the common knowledge or a layperson. Therefore, expert testimony is not necessary. The hearing officer agrees that Perpetua and DEQ cannot demonstrate compliance by reference to a document that is not yet final. Therefore, consideration of this issue is limited to the "four corners" of the Permit, which states:

- Perpetua must "[o]bserve all primary access points to preclude unauthorized public access" and ensure "[o]nsite personnel [are] available for this purpose during active mining and mineral processing operations."
- Perpetua may control access at the North Entry and South Entry either "by the use of locked gates, barriers, or equivalent measures," by "manned guardhouses," or "by the use of security escort vehicles."
- Perpetua is required to "[p]ost warning signs and periodically patrol secondary access points to the facility [*i.e.*, secondary roadways and trails traversing the SGP] to preclude public access" and to make onsite personal available for this purpose.
- Perpetua may only provide "registered guests of the facility" with access to or through the SGP "for the sole purpose of passing through the facility to another destination," and is required to provide literature that "explains Perpetua's requirements for accessing the site" and that "identifies potential hazards of the site."

(R., at p. PET 010.)

Aside from the relatively brief definition of "ambient air," the Air Rules do not articulate legal standards for when the general public has adequate "access" to the atmosphere and when it does not. As a result, the parties refer to guidance documents promulgated by EPA and DEQ.

According to EPA's 2019 ambient air policy: (1) it is appropriate to exclude areas from ambient air where measures are employed that are "effective in precluding access to the land by the general public;" (2) such measures can include physical barriers, but physical barriers are not required; (3) determinations by the agency are discretionary on a case-by-case basis; (4) the permit applicant must have the legal ability to preclude access by the general public and must employ measures that actually preclude the general public as a practical matter; (5) in evaluating the adequacy of the preclusion measures, the agency applies a "rule of reason" as to whether the general public will have access "under reasonably anticipated circumstances." (R., at p. PET772-785.)

DEQ's 2021 guidance document asks a series of questions to determine if access by the general public is sufficiently precluded. If there is a fence or other physical barrier, it is appropriate to establish the ambient air boundary at that location. If access by the general public is discouraged by the nature or remote location of the facility and the facility either posts "no trespassing" signs or has security personnel who will ask trespassers to leave, then it is appropriate to establish the ambient air boundary at the property boundary. If none of the above are true, then the ambient air boundary is determined by a variety of factors. (*See* R., at pp. PET743-744.)

Again, the specific error alleged by Petitioners is that exclusion of the access road from ambient air was error. This is not an evaluation of the entire ambient air boundary adopted by DEQ. In this regard, the requirements in the Permit enumerated above are consistent with both agency guidance documents and the conclusion that the access road is appropriately excluded from ambient air. At a minimum, the Permit makes it clear that Perpetua is required to preclude unauthorized

access by the general public and that members of the public can become guests of the facility only if they are seeking to pass through to access another destination. Even Petitioners acknowledge their understanding that members of the general public who become guests of the SGP for the purpose of passing through will not be able to stop within the SGP. (*See* Tr. of 9/21/23 at 34:7-15.) And, if Perpetua does not take measures to discourage and preclude access by the general public, DEQ states that would be a violation of the Permit—likely a "major" violation. (Tr. of 9/21/23 at 40:8-18.)

While it is always possible to suggest ways in which a particular permit provision could be drafted differently, the hearing officer does not believe his role is to nitpick the language DEQ drafted in the Permit. Even without considering the yet-to-be-developed AMP, the hearing officer finds Section 2.7 of the Permit to adequately require Perpetua to preclude access by the general public for the purpose of excluding the access road from the definition of "ambient air."

Therefore, the Petitioners' motion for summary judgment as to Claim Nos. 11 and 12 is hereby DENIED, and the summary judgment motions filed by DEQ and Perpetua as to Claim Nos. 11 and 12 are hereby GRANTED.

D. Lack of Requirements for Ongoing Ambient Air Monitoring (Claim No. 13)

The Permit contains a variety of provisions requiring Perpetua to take actions to minimize air pollution. Section 1.2 and Table 1.1 identify and categorize the various discrete activities that will take place throughout the SGP and identify the pollution "control equipment" required for each individual activity. (R., at pp. PET 003-007.) The Permit also contains facility-wide requirements to control fugitive dust, visible emissions, and odors. (R., at pp. PET 008-011.). The Permit also contains several monitoring and recordkeeping requirements. Generally applicable requirements to the SGP appear in Section 7.10, which states:

> The permittee shall maintain sufficient records to ensure compliance with all of the terms and conditions of this permit. Monitoring records shall include, but not be

> limited to, the following: (a) the date, place, and times of sampling or measurements; (b) the date analyses were performed; (c) the company or entity that performed the analyses; (d) the analytical techniques or methods used; (e) the results of such analyses; and (f) the operating conditions existing at the time of sampling or measurement. All monitoring records and support information shall be retained for a period of at least five years from the date of the monitoring sample, measurement, report, or application. Supporting information includes, but is not limited to, all calibration and maintenance records, all original strip-chart recordings for continuous monitoring instrumentation, and copies of all reports required by this permit. All records required to be maintained by this permit shall be made available in either hard copy or electronic format to DEQ representatives upon request.

(R., at p. PET 040).

The same "General Provisions" portion of the Permit contains multiple reporting requirements. (*See* R., at pp. PET 041-042.) In addition, the portion of the Permit applicable to fugitive dust contains several monitoring and recordkeeping requirements. (*See* R., at pp. 008 (§ 2.2), 011 (§ 2.10), and 012-014 (§ 2.20).) Moreover, the Permit incorporates several portions of the Code of Federal Regulations, including 40 C.F.R. Part 60, Subpart A (General Provisions), which includes requirements related to recordkeeping (40 C.F.R. § 60.7), monitoring (40 C.F.R. § 60.13), and reporting (40 C.F.R. § 60.19.) (*See* R., at p. PET 014 (§ 2.22).)

The Permit does not require ongoing monitoring of the quality of the ambient air while the SGP is operating. The Petition alleges that "without ambient air monitoring, it will be impossible for DEQ to assess whether the SGP's operation is in compliance with NAAQS and TAPs increments at any given time." (Pet., ¶ 68). Air Rule 211.01(d) expressly authorizes—but does not require—DEQ to include reasonable ambient air monitoring requirements in a permit-to-construct. Therefore, the question is whether it was arbitrary, capricious, or an abuse of discretion for DEQ not to require ongoing ambient air quality monitoring.

Recognizing that ambient air quality monitoring is not legally required in all cases, Mr. Schilling describes the circumstances in which ambient air quality monitoring is typically

appropriate. These include situations in which (1) "postconstruction air quality is projected to be so close to the NAAQS that monitoring is needed to certify attainment;" (2) "uncertainties in source or emissions characteristics result in significant uncertainties about the projected impact of the source or modification; and (3) when there are nearby sensitive receptors such as hospitals and schools. (*See* Schilling Decl., pp. 14-19.) According to Mr. Schilling, DEQ normally utilizes very conservative assumptions that overstate emissions in order to ensure NAAQS compliance is achieved. Upon discovery that a non-conservative figure for median silt content was used during the evaluation of Perpetua's Permit application, Mr. Schilling testifies:

> The options at this point were: 1) recalculate PM_{10} emissions from haul roads using a more conservative statistic for road silt than the median value, then revise the air impact modeling analyses; 2) require post construction ambient air monitoring to increase the assurance of NAAQS compliance; 3) use the 4.0 percent silt value as a maximum allowable value in the permit, requiring periodic monitoring of the road silt content during mining operations; and/or 4) develop other means by which lower levels of fugitive emissions from vehicle traffic could be attained and assured through monitoring (monitoring other than ambient air monitoring).
>
> Requiring ambient air monitoring for the SGP was discussed within the Air Division, including stationary source staff, ambient monitoring staff, and State Implementation Plan (SIP) staff. From the perspective of air permit modeling verification, I believe the requirement of PM_{10} ambient air monitoring to assure NAAQS compliance is of limited value for the SGP because of the following:
>
> - Monitored values showing compliance with the NAAQS only demonstrates compliance for that point in space and time. While a monitored exceedance likely indicates a failure to adequately control emissions (unless the exceedance may be caused by elevated background concentrations), compliance doesn't assure compliance at other ambient air locations.
>
> - Selecting a single monitoring location to represent worst-case impacts is nearly impossible. In general, atmospheric dispersion models perform reasonably well at predicting the magnitude of maximum impacts (provided the inputs of emissions and emission release parameters is reasonably accurate); however, they perform poorly at predicting the location of maximum impacts in most cases. The accuracy of predicted locations of maximum impacts is even worse for analyses involving complex terrain, complex meteorological conditions, and emission sources involving atypical release characteristics (fugitive emissions from vehicle traffic, blasting

operations, ore handling, *etc*.). Monitoring results that show compliance with NAAQS may portray a false confidence of NAAQS compliance on a facility-wide scale.

- No sensitive receptors have been identified near the facility. Sensitive receptors are locations where there is likely to be a concentration of the general public present. These include private residences, schools, hospitals, care centers, retail stores, parks, and resorts. DEQ believes the confidence of NAAQS compliance must be higher at these locations than at locations where there is a lower probability of public exposure. Ambient air monitoring at these locations can provide the additional assurance that air pollutant impacts from a neighboring industry will not violate standards and impact the health of the general public at sensitive receptor locations.

After internal discussions, Option 3 was selected, changing the 4.0 percent silt content limit from the median value to a maximum value. If the required sampling and testing of road material indicates a maximum silt content above 4.0 percent, it will be a permit violation. The permittee must then work with DEQ to develop a way to further reduce emissions, adjust operations, and/or revise impact analyses to enable NAAQS compliance to be demonstrated. This would likely require a permit modification.

(Schilling Decl., pp. 18-20.)

In addition, Mr. Simon testifies as follows:

DEQ did consider the option of requiring a PM_{10} ambient air monitor in the PRI PTC. In considering this option, staff reviewed DEQ's history of decisions requiring ambient air monitors in permits. Where DEQ did require an ambient monitor in a permit, the facility had already been in operation for many years and there was a recent modeled NAAQS (National Ambient Air Quality) violation. In these cases, DEQ negotiated with the facility to site and operate an ambient air monitor and develop a corrective action plan for the facility. This allowed the facility to monitor air quality while it made process changes and modified its permit to demonstrate a return to NAAQS compliance. Once the changes were implemented or approved, the facility would then demonstrate NAAQS compliance through modeling analysis. The monitor was eventually removed from their respective permits. In these few situations, DEQ never had an ambient air monitored violation.

In all cases where DEQ processed a PTC application for a new or modified facility, DEQ required the applicant to demonstrate NAAQS pre-construction compliance using DEQ's approved modeling procedures as outlined in the 'State of Idaho Guideline for Performing Air Quality Impact Analysis.' DEQ will not issue a final PTC if the applicant has not demonstrated pre-construction NAAQS compliance to the satisfaction of the Department.

> DEQ also considered the location of the proposed PRI facility, the proximity of nearby residences and the implementation costs of requiring an ambient monitor. Given all of these factors, DEQ ultimately decided not to require an ambient air monitor in the permit. DEQ did reach out to PRI prior to final PTC issuance to see if they would voluntarily install an ambient monitor but declined at that time.

(Simon Decl., pp. 10-11.)

DEQ recognized that whether to require ambient air quality monitoring is within its discretion, and Schilling and Simon describe a reasoned, logical explanation for why DEQ did not require such monitoring in this case. This is unrebutted expert testimony on an issue that is not within the common knowledge of a layperson. The Petitioners identify various ways NAAQS violations could occur hypothetically, but these are arguments in a brief. Without expert testimony explaining why monitoring should have been required in this case, the hearing officer lacks discretion to find that DEQ committed error by not requiring ambient air quality monitoring.

Based on the foregoing, the Petitioners' motion for summary judgment as to Claim No. 13 is hereby DENIED. The motions for summary judgment filed by DEQ and Perpetua as to Claim No. 13 are hereby GRANTED.

E. Reliance on Plans Instead of Enforceable Limitations on Three Variables Affecting Control of PM_{10} Emissions (Claim No. 1)

The Petition asserts error occurred because "important variables affecting the quantity of PM_{10} generated by the ore haul trucks are not directly limited and enforceable as PTC permit conditions." (Pet., ¶ 36). More specifically, even though Perpetua used multiple "[c]ritical variables…as inputs to PM emission calculations," the Petition argues DEQ erred by "rel[ying] on a surrogate limit in the PTC…and on plans[6] that have not yet been developed," "[i]nstead of developing PTC conditions for these other critical variables." (Pet., ¶¶ 36-37). According to the

[6] These are the Fugitive Dust Control Plan and the Haul Road Capping Plan.

Petition, the three "critical variables" lacking relevant Permit conditions are the average empty weight of ore haul trucks, the average loaded weight of ore haul trucks, and the total number of vehicle miles traveled by ore haul trucks.[7] (*See* Pet. ¶ 36). Without enforceable limitations on those three variables, Petitioners argue "DEQ could not reasonably claim when it issued the Permit that the facility will not cause or contribute" to violations of applicable air quality standards. (Mem. in Supp. of MSJ of 4/14/23, p. 24.)

Petitioners do not point to an Air Rule specifically requiring every modeling input and variable to be the subject of a specific permit condition or limitation. Therefore, this issue is governed by Air Rule 210.01, which provides DEQ with discretion to impose reasonable conditions on a permit to construct. The inquiry here is whether it was arbitrary, capricious, or an abuse of discretion for DEQ not to include Permit conditions specifically regulating the average empty weight of ore haul trucks, the average loaded weight of ore haul trucks, and the total number of vehicle miles traveled by ore haul trucks. On this issue, Mr. Simon testifies:

> In reviewing the mean vehicle weight variable used in calculating haul road emissions, PRI proposed the use of 20 large Cat 789D mining trucks and 12 smaller CAT 740B dump trucks. PRI stated that the ratio of large to small trucks would be 20:12. Mean vehicle weight used in the calculation for haul road emissions include the total mean vehicle weight from fully loaded trucks. ***Rather than developing a methodology in the permit to measure and determine average vehicle weight each day, DEQ developed a haul road usage limit of 180,000 tons of ore and development rock per day (PTC condition 3.5). This limit accounts for the average loaded vehicle weight of all trucks as well as the average round-trip distance traveled as presented in the application***. The monitoring methodology required to measure daily ore and development rock hauling is addressed in the required Operations and Maintenance Manual (PTC condition 2.20).

(Simon Decl., p. 9 (emphasis added).)

This is unrebutted testimony from an expert witness on an issue that is not within the

[7] The Petition acknowledges that an enforceable Permit condition was included for silt content of haul roads.

common knowledge of the layperson. On its face, this is a reasonable explanation that is consistent with DEQ's response to comments:

> Enforceable monitoring, recordkeeping, and reporting [MMR] requirements were established in the permit. $PM/PM_{10}/PM_{2.5}$ emissions limits for point sources were established with supporting activity rate limits and MRR requirements. ***While emissions limits and emission factors are not commonly included in the permit for fugitive sources, activity rate limits and MRR requirements were established for those sources that were identified as process rate-limiting (as summarized in Table 1.1 of the permit). These activity rate limits serve as surrogate emissions limits for PM, PM_{10}, $PM_{2.5}$, HAP and TAP from fugitive sources***. And while documented in the Statement of Basis and application materials, underlying parameters associated with calculating emissions such as vehicle speed limit, type, and miles traveled are not typically included in the permit ***but can be found in the application materials*** (Appendix A).

(R., at p. PET 557 (emphasis added).)

In other words, due to the nature of fugitive emissions, DEQ chose to control those emissions by limiting the amount of ore and development rock that can be hauled per day, with both a daily haulage limit and a limit on the five-year rolling average of daily haulage. (*See* R., at p. Pet 019 (Permit § 3.5).) If the representations of vehicle weights and miles traveled in Perpetua's application materials end up being materially different from reality, those discrepancies will be well documented via the various plans, monitoring, and reporting required by the Permit, and DEQ will have enforcement capabilities pursuant to Air Rules 123, 125, and 202 and Idaho Code Sections 39-105, 39-108, and 39-109.

Based on the foregoing, the hearing officer hereby DENIES Petitioners' motion for summary judgment as to Claim No. 1. The motions for summary judgment filed by DEQ and Perpetua as to Claim No. 1 are hereby GRANTED.

F. Assumption of Control of 93.3% of PM10 Emissions Without Related Enforceable Conditions (Claim No. 2)

Section 3.1 and Table 3.2 of the Permit provide in pertinent part:

Table 3.1 contains a description of control equipment used to control emissions from mining and ore processing activities.

Table 3.1 Mining and Ore Processing Control Device Descriptions

Emission Sources	Control Devices
Mining	
Excavating and hauling activities	Reasonable control & FDCP Chemical suppression and water sprays ***Control efficiency: 93.3% for PM/PM10 (haul roads)*** Haul road capping with low-arsenic quartzite

(*See* R., PET018 (emphasis added).)

The Petition asserts error occurred because "DEQ assumed 93.3% of all haul road PM_{10} emissions from the SGP can be controlled by using an unspecified combination, volume, and frequency of water sprays and chemical dust suppressants" without also including "specific and enforceable permit conditions within the PT to ensure a 93.3% control efficiency." (Pet. ¶¶ 38-39). According to the Petition, "[a] lesser control efficiency, even just slightly lesser, could result in large enough PM_{10} emissions to violate the NAAQS." (*Id*. at ¶ 39).

On summary judgment, the Petitioners further elaborate on these three distinct but related points: First, DEQ's assumption that Perpetua can achieve 93.3% control efficiency is without an adequate basis. Second, DEQ's assumption that Perpetua can achieve 93.3% control efficiency is aggressive because "[i]t is challenging to consistently and continuously achieve 93.3 percent control." (Tr. of 9/21/23 at 67:10-14.) According to Petitioners, this provides only a "razor thin" margin of error, such that if the 93.3% figure is not achieved, violations of the NAAQS will necessarily result. (Tr. of 9/21/23, 66:13.) Third, given the first two points, it was error for DEQ not to include more specific requirements to ensure 93.3% control efficiency is achieved.

1. Without Adequate Basis

As to the first point, it is helpful to note that the 93.3% control efficiency figure is based on two separate assumptions regarding the control efficiency for chemical suppressants and the control efficiency for water. Regarding the control efficiency for chemical suppressants, Simon explains:

> PRI's consultant, Air Sciences, Inc., provided information in their application from their research of AP-42: Compilation of Air Emission Factors, Section 13.2.2, emission factors for unpaved roads (EPA 2006). According to AP-42, test studies on various unpaved industrial roads where chemical dust suppressants were applied documented a range from 90 to 99 percent dust control efficiency for PM_{10}. Based on this data, PRI proposed to use a 90% dust control efficiency for PM_{10} when utilizing chemical dust suppressants on unpaved roads.

(Simon Decl., pp. 5-6.)

Regarding the control efficiency for water, Simon explains:

> In addition to using the chemical dust suppressant, controlled PM_{10} emission calculations for unpaved haul roads also incorporate the control efficiency for water. For annual dust control from water, AP-42 accounts for this in an equation that uses annual precipitation data. When using the 120 days of precipitation obtained from AP-42 section 13.2.2, the precipitation term accounts for natural mitigation in calculating the annual unpaved road emissions. Staff reviewed and approved this methodology. The daily unpaved road emission calculations use an applied water control efficiency of 33%. This value was supported by permit staff based on an evaluation of figure 13.2.2-2 of AP-42 for water control effectiveness on unpaved roads.

(Simon Decl., p. 8.)

Stated in layman's terms, the 93.3% control efficiency is essentially calculated as follows: Chemical dust suppressants will control 90% of the dust emissions from unpaved roads, and water will control 33% of the remaining uncontrolled 10%. (*See generally* R., at pp. PET 551, 557-558.)

DEQ has adduced expert testimony explaining the basis for the 93.3% control efficiency figure, an issue not within the common knowledge of the layperson. The Petitioners have not offered expert testimony to rebut it. At oral argument, the Petitioners cited to the EPA Letter. However, the hearing officer has ruled the EPA Letter cannot be relied on as a proxy for expert

testimony, in part because EPA is not a party and therefore not subject to cross-examination. Without admissible expert testimony, under *Greenfield*, the hearing officer must affirm DEQ's action unless there is some obvious flaw in DEQ's reasoning. Seeing none, the hearing officer finds DEQ's adoption of the 93.3% control efficiency figure adequately supported.

2. Razor Thin Margin

As to Petitioners' second point, again, Mr. Simon has testified that the 90% control efficiency assumption for chemical suppressants is on the low end of the 90-99% range identified in AP-42. Mr. Schilling testifies:

> Late in the review process, PRI determined that the West End Development Rock Storage Facility will not be constructed, thereby eliminating the modeling operational scenario W5. Scenario W5 was the scenario where modeled exceedances of the 24-hour PM_{10} NAAQS were shown when using the BULKRN-processed meteorological data. When Scenario W5 is removed, the highest impacting operational scenario is W3, which represents the transport of development rock from the West End Pit to the Hanger Flats Development Rock Storage Facility. Maximum impacts still slightly exceed the NAAQS when using a single value background concentration value, ***but are well below NAAQS when seasonal backgrounds are used*** (82% of the NAAQS at 123.5 μg/m3).

(Schilling Decl., pp. 17-18 (emphasis added).)

Mr. Schilling further testifies that DEQ's modeling group did not learn until later in the review process that a non-conservative assumption of 4.0% silt content of the road surface was used in the modeling. Because he believed "NAAQS compliance could not be assured at a sufficiently high confidence level…even though there are other areas of the analyses that are very conservative," Mr. Schilling adopted 4.0% as the maximum allowable silt content value. (Schilling Decl., pp. 17, 19.) That limitation is in Section 3.13 of the Permit, (R., p. PET020), and "[i]f the required sampling and testing of road material indicates a maximum silt content above 4.0 percent, it will be a permit violation." (Schilling Decl., p. 19.)

To support their argument that 93.3% control efficiency provides only a "razor thin" margin

of error, the Petitioners rely on assertions by counsel and isolated references in the permitting record and the EPA Letter. By contrast, DEQ has adduced expert testimony describing multiple ways in which conservativism was utilized in the modeling and permit-writing process. In the absence of expert testimony to the contrary, the hearing officer finds DEQ's explanations reasonable.

3. Failure to Include More Specific Requirements to Ensure Compliance

Petitioners argue, "[t]he error is that there is…no 93.3 percent enforceable limitation or there is no other limitations that reasonably assure" 93.3% control is achieved. (Tr. of 9/21/23 at 67:24-68:2.) However, as to the first argument, as previously referenced, the Permit includes a specific requirement that 93.3% control efficiency be achieved. As to the second argument, the Petitioners do not cite to any legal standard requiring additional requirements or otherwise explaining how the existing Permit provision is legally inadequate. Moreover, the Petitioners have not offered expert testimony describing the terms they believe are necessary to ensure compliance. Without these, and given the presumption in favor of agency action on technical issues, the hearing officer finds no basis to conclude DEQ committed error.

4. Summary and Conclusion as to Claim No. 2

For the foregoing reasons, as to Claim No. 2, the hearing officer hereby DENIES the Petitioners' motion for summary judgment and GRANTS the motions filed by DEQ and Perpetua.

G. Reliance on Plans Instead of Enforceable Monitoring and Recordkeeping Requirements (Claim No. 3)

Developing enforceable emissions limitations for a mining operation can be challenging. DEQ's air quality regulations have been developed "to primarily regulate well-defined, consistent pollutant-emitting processes," such as manufacturing operations. (*See* Schilling Decl., p. 8.) Mining operations, by contrast, involve "numerous operational phases, each with different emission generating activities and a different magnitude of emission quantities, occurring at different locations

at the site and at differing times." (*Id*.) Therefore, as previously discussed with respect to Claim No. 1, for mining operations, emissions limitations often take the form of limitations on ***activities*** that generate air emissions, rather than on the concentration of pollutants in those emissions.

One such activity limitation appears in Section 3.5 of the Permit, which states that Perpetua shall not haul more than 180,000 tons per day of ore and development rock. (R., at p. PET 019.) Section 3.16, in turn, states:

> Each day, the permittee shall monitor and record the amount of ore and DR [development rock] transported on haul trucks (T/day). The devices and methodologies used to measure weights shall be identified in the O&M Manual.
>
> Each calendar month, the permittee shall monitor and record the amount of ore and DR transported on haul trucks in tons per month (T/mo) and in tons per year (T/yr). Annual amounts of ore and DR transported shall be determined by summing the monthly amount over the previous consecutive 12-month period. The annual amounts of ore and DR transported shall be used to calculate the 5-year rolling average in T/day.

(R., at PET 020.)

The "O&M Manual" is governed by Sections 2.20 and 2.21 of the Permit. (*See* R., at pp. PET 012-013.) Perpetua is required to submit the O&M Manual to DEQ for review and approval at least 30 days prior to the startup of emissions-generating activities. (*Id*.)

The Petitioners assert that DEQ's reliance on an O&M Plan to be developed in the future constitutes error. According to Petitioners, "[t]he O&M Manual is critical to ensuring the 180,000 tons per day hauling condition is satisfied, and the 180,000 tons per day is critical to DEQ's determination…that the SGP will not exceed the NAAQS." (Am. Pet. of 1/11/23, ¶ 40; *see also* Pets.' Opening SJ Br. of 4/14/23, pp. 28-31.)

1. Claim No. 3 Has Already Been Dismissed

The hearing officer issued an order formally dismissing Claim No. 3 on November 15, 2022. (*See* Order on Mot. to Dismiss of 11/15/22, pp. 11-12.) The Petitioners then filed their Motion to

File First Amended Petition on December 6, 2022, which the hearing officer granted on January 6, 2023. The Petitioners described the intent of that motion as "merely…to correct deficiencies the Hearing Officer found with respect to some claims and to provide additional detail and clarity regarding each claim being pursued in this contested case…." (Mot. to File Am. Pet. of 12/6/22, p. 3.) That motion did not contain any express references to Claim No. 3.

The Petitioners formally filed their Amended Petition on January 11, 2023. The Amended Petition added some additional content to Paragraph 40, the portion of the original Petition most closely associated with Claim No. 13. But, it did not otherwise reference Claim No. 3 or request the hearing officer to take any action regarding Claim No. 3.

Generally speaking, when a judge or hearing officer renders a formal, written decision on an issue, that ruling is then the established "law of the case" for the remainder of the proceeding. The only way to reverse a prior ruling is to formally ask the judge or hearing officer to reconsider that prior ruling. Indeed, DEQ actively decided not to advance further argument regarding Claim No. 3 on summary judgment because it understood the claim had been dismissed. (*See* DEQ Resp. and Br. in Supp. of MSJ of 5/12/23, p. 16.)

The Petitioners did not accompany either their December 6, 2022 motion to amend or their Amended Petition with any formal request to re-visit the dismissal of Claim No. 3. Neither of those filings specifically reference Claim No. 3. In this regard, it is helpful to recall that the Amended Petition contains 30 pages of lengthy, detailed allegations. It is unrealistic to expect adding a few additional sentences to an allegation within a 30-page pleading to adequately inform the hearing officer and BEQ of a belief that a claim has been automatically revived, in spite of a prior formal ruling dismissing it. In this regard, it is helpful to recall that, even though the standards for amending pleadings are easily met, amending a pleading still requires approval; it is not done "as of

right." *See* BEQ R.PROC. 003.05; AG R.PROC. 305.

For the foregoing reasons, the hearing officer finds that Claim No. 3 was not revived simply by the filing of the Amended Petition.

2. Summary Judgment in Favor of DEQ and Perpetua on Claim No. 3 Is Appropriate

If BEQ finds the Petitioners adequately revived Claim No. 3, it will be more efficient for this order to have also addressed the substance of the claim, particularly given that the Petitioners and Perpetua briefed it on summary judgment.

Air Rule 202 identifies the information a permit applicant is required to provide to DEQ. Once DEQ has determined the application is sufficiently complete to be evaluated, Air Rule 209 describes the procedures for evaluating the application and developing the permit. These include a requirement to solicit public comment. When DEQ is preparing the permit, Air Rule 211.01 states that DEQ "may impose any reasonable conditions upon an approval [of a permit to construct]," including conditions related to sampling, monitoring, and recording emissions data.

The Petitioners assert that DEQ's deferring aspects of emissions monitoring and recordkeeping requirements to an O&M Plan that has not yet been developed was error and did not satisfy DEQ's responsibilities under Air Rules 202, 209, and 211.01 and related federal air quality statutes and regulations. The hearing officer is not aware of any outright prohibition of this practice, and the language of Air Rule 211.01 provides DEQ with wide discretion regarding appropriate permit terms. Therefore, stated in terms of applicable standards, the question is whether DEQ's reliance upon plans to be developed in the future was arbitrary, capricious, or an abuse of discretion.

As previously referenced, the Permit already contains requirements to monitor and record the tonnage of ore and development rock transported. What the Permit defers until later in the O&M Manual are "[t]he devices and methodologies used to measure weights…." (R., at PET 020.) On

this issue, Mr. Simon testifies as follows:

> It is common for the permit program to require certain plans, such as an O&M manual or FDCP to be prepared by the permittee post permit issuance. This allows the permittee to prepare a specific plan or manual based on ***the actual equipment purchased and installed, the manufacturer's instructions and recommendations, as well as the operational characteristics of the facility after construction is completed***. DEQ uses its authority to require a permittee to develop and submit for DEQ approval Plans and Manuals in accordance with IDAPA 58.01.01.211.01 as reasonable permit conditions.

(Simon Decl., ¶ 10 (emphasis added).)

This is a logical explanation for deferring identification of the "devices and methodologies" until later. Given that (a) there is a requirement in the Permit to monitor and record the amount of ore and development rock transported, and (b) the Petitioners have not offered expert testimony explaining how deferring identification of the specific "devices and methodologies" until later could be arbitrary, capricious, or an abuse of discretion, the hearing officer lacks discretion to conclude that DEQ committed reversible error.

Based on the foregoing, as to Claim No. 3, the hearing officer hereby DENIES the Petitioners' motion for summary judgment and GRANTS the motions filed by DEQ and Perpetua.

H. Assumption of 120 Days of Recordable Precipitation Data Instead of Use of Local Weather Data (Claim No. 5)

The Petition alleges that (1) "[d]ays of recordable precipitation is an important variable affecting the SGP's emissions of PM_{10} from ore haul roads;" (2) "DEQ assumed there would be 120 days of recordable precipitation at the SGP" based on "general geographic guidance" instead of "local meteorological data;" and (3) "DEQ's failure to use the most representative site data…increases the risk of miscalculation of ore haul road emissions." (Pet., ¶ 41). The Petitioners moved for summary judgment on this issue, arguing:

> Rather than use available site-specific meteorological data to calculate fugitive dust emissions from haul roads, DEQ used a generic value in EPA guidance to assume

> that there are 120 days of recordable precipitation at the Project site. See PET 146; see also PET 805 (map). This was arbitrary and counter to DEQ guidance.
>
> For modeling ambient air impacts, Section 6.8 of DEQ's Guideline for Performing Air Quality Impact Analyses states: "The meteorological data used in the modeling analysis should be representative of the meteorological conditions at the particular site of the proposed construction or modification."

(Pets.' Br. ISO MSJ of 4/12/23, p. 25.)

That same DEQ guidance document goes on to state that, "[t]here are several sources of meteorological data besides on-site collected data." (R., at p. PET 746.) Ultimately, the relevance of this issue is that "precipitation can reduce fugitive dust emissions." (Pets.' Br. ISO MSJ of 4/12/23, p. 25.) In other words, a higher number of precipitation days per year is generally associated with lower expected fugitive dust emissions from the ore haul roads. In response, Mr. Schilling makes several important clarifications:

First, the 120 annual precipitation days is derived from EPA's AP42 guidance document, which includes a map for the entire United States that is contoured based on climatological data. According to Schilling, "[t]he resolution provided by the AP42 map is adequate to provide reasonably accurate emission estimation, well within the general uncertainty of the factor and other inputs…that can be taken to reduce emissions." (Schilling Decl., p. 13).

Second, the Taylor Ranch station raised by Petitioners "is over 40 kilometers from the SGP site, making it questionably more representative than the AP42 map." (*Id*.)

Third, "the Taylor Ranch data indicated there was an average of 113 [precipitation] days each year…effectively matching the 120-day value obtained from the AP42 map." (*Id*.)

Fourth, the onsite data from 2014 "indicates there were 155 [precipitation] days…." (*Id*.) In other words, use of the onsite data (which has 35 more precipitation days than the AP42 figure) presumably would have lowered expected emissions substantially more than the heightened expected

emissions had the Taylor Ranch data (which has 7 fewer precipitation days) been used. Ultimately, DEQ did not use the 155-day figure because the "onsite data were only collected for one year," making it "questionable whether it can be considered more representative than the AP42 map for typical conditions because of the year-to-year variability…." (Schilling Decl., p. 13.)

With these explanations, DEQ has satisfied its burden as a summary judgment movant and has shifted the burden to Petitioners to explain why the decision to utilize the 120 precipitation days figure from AP42 was arbitrary, capricious, or an abuse of discretion. Because the selection of proper precipitation data is not within the common knowledge of a layperson, expert testimony was required to rebut DEQ's expert testimony. "If an expert is qualified to render an opinion, based on his expertise in the subject, then he must be accorded substantial deference in the selection of data upon which he chooses to base his opinion." *Earl v. Cryovac, A Div. of W.R. Grace Co*., 772 P.2d 725, 728, 115 Idaho 1087, 1090 (App. 1989). In order to create a disputed, triable issue of material fact for a hearing on the merits, the Petitioners were required to adduce expert testimony explaining more specifically how DEQ's use of the AP42 figure could be error. Without such testimony, summary judgment in favor of DEQ and Perpetua is appropriate.

Therefore, as to Claim No. 5, the Petitioners' motion for summary judgment is DENIED, and the motions for summary judgment filed by DEQ and Perpetua are GRANTED.

I. Whether Errors in Estimating PM_{10} Emissions Result in Errors as to As Emissions (Claim No. 8)

Paragraph 54 of the Petition alleges:

> Second, because the underlying particulate and PM_{10} emissions estimates and particulate control assumptions are unreliable in numerous respects, as already discussed above, so too are the estimated arsenic emissions. The SGP's estimated arsenic emissions were based on its PM_{10} emissions. PM_{10} emissions from the SGP may be higher, and their control effectiveness may be lower, than DEQ assumed, in which case arsenic emissions would also be higher and might exceed the AACC [Acceptable Concentrations of Carcinogens].

(Pet. ¶ 54).

Because the hearing officer has granted summary judgment in favor of DEQ and Perpetua as to all of the alleged errors related to PM_{10} emissions as described above, the disposition of this particular claim is automatic. As to Claim No. 8, the motions for summary judgment filed by DEQ and Perpetua are hereby GRANTED, and the motion for summary judgment filed by the Petitioners is hereby DENIED.

J. Exclusion of Economic and Environmental Evaluations in T-RACT Analysis (Claim Nos. 6 and 7)

The Petition alleges DEQ's evaluation of "reasonably available control technologies" ("RACT") for the toxic air pollutant arsenic ("T-RACT") "contained no persuasive economic information and no discussion at all regarding associated environmental impacts" resulting from "Perpetua's decision to use water and chemical dust suppressants as compared to paving the haul roads, even though paving was shown to achieve the highest reasonable dust control efficiency." (Pet. ¶¶ 48, 53). According to the Petition, this violated Air Rule 210.14. T-RACT is defined in the Air Rules as:

> An emission standard based on the lowest emission of toxic air pollutants that a particular source is capable of meeting by the application of control technology that is reasonably available, as determined by the Department, considering ***technological and economic feasibility***. ***If control technology is not feasible, the emission standard may be based on the application of a design, equipment, work practice or operational requirement, or combination thereof.***

AIR RULE 210 (emphasis added).

The first step in the T-RACT process is for the applicant to "submit information to [DEQ] identifying and documenting which control technologies or other requirements the applicant believes to be T-RACT." AIR RULE 210.14(a). DEQ must then review the information submitted by the applicant and determine if it has proposed T-RACT "on a case-by-case basis" considering separate

factors for both technological feasibility and economic feasibility. AIR RULE 210.14(b), (c).

Based upon the T-RACT definition above, these feasibility determinations are relevant to whether the control technology is "reasonably available" for use by the applicant. For economic feasibility, DEQ must consider a non-exclusive list of factors, including costs of necessary mitigation measures, capital costs, cost effectiveness, and the difference in costs between the particular source and other sources, if any, that have implemented emissions reductions. AIR RULE 210.14(d). For technological feasibility, the Air Rules specifically require DEQ's evaluation to include consideration of "[t]he environmental impacts caused by the control technology that cannot be mitigated, including, but not limited to, water pollution and the production of solid wastes." AIR RULE 210.14(c)(ii). "If [DEQ] determines that the applicant has proposed T-RACT, [it] shall determine which of the options, or combination of options, will result in the lowest emission of toxic air pollutants, develop the emission standards constituting T-RACT and incorporate the emission standards into the permit to construct." AIR RULE 210.14(e).

The Simon Declaration describes DEQ's five-step process for determining T-RACT:

1. Identify all available control options.

2. Eliminate technically infeasible options.

3. Rank remaining control technologies.

4. Consider the energy, environmental, and economic impacts.

5. Select the most effective control technology not eliminated in Step 4.

(Simon Decl., pp. 11-12.)

While these five steps do not necessarily repeat the language of Air Rule 210.14 verbatim, they are not inconsistent with it either. Given the deference given to an agency in interpreting its rules, the hearing officer has no basis to question this five-step process. According to Simon:

> In reviewing T-RACT analysis for haul roads, PRI identified the following possible control options:
>
> 1. Paving roads
>
> 2. Application of chemical dust suppressants and water
>
> Paving haul roads was determined to be technically infeasible by PRI and permit staff because paving is not feasible for mining roads utilizing very heavy trucks which would exceed the design limitations of paving.

(Simon Decl. of 5/12/23, p. 13.)

More specifically, Perpetua submitted information indicating that paved haul roads would only be capable of supporting vehicles with weights up to 10 tons. (R., at p. PET 547.) However, Perpetua's loaded haul trucks will weigh between 60 tons and 260 tons. (*Id*.) The Petitioners do not rebut Mr. Simon's explanation for elimination of paving as technically infeasible with their own expert testimony that it is feasible. On its face, Mr. Simon's explanation is otherwise reasonable and supported by the record. Therefore, elimination of paving as T-RACT was not error.

The next question is whether it was error for DEQ not to evaluate the environmental impacts of the control technology that was chosen, a combination of chemical dust suppressants and water. This is where a careful reading of the language of Air Rule 210.14 in connection with the definition of T-RACT is important.

According to the language of the rules, evaluation of environmental impacts occurs specifically within the context of evaluating technological feasibility. The purpose of evaluating both economic feasibility and technological feasibility is to determine whether a particular control technology is "reasonably available." According to Mr. Simon, the combination of chemical dust suppressants and water is already known by DEQ to be "reasonably available" because:

> Application of chemical dust suppressants and water is an effective dust control method which is a common control technology for unpaved haul roads. Magnesium chloride and water combinations are widely used and effective dust suppressant by

> state, county, and industrial unpaved roadways. DEQ is not aware of any negative environmental impacts as long as the operators apply the dust suppressant according to manufacturer's recommendations.[8]

(Simon Decl., p. 13.)

This issue is not within the common knowledge of the layperson. Mr. Simon's declaration is unrebutted expert testimony that is otherwise reasonable, so there is no basis for the hearing officer to find that DEQ's decision lacked adequate basis. Without the ability to establish factual error, the Petitioners can establish error only by demonstrating that DEQ's T-RACT process violated the plain language of the Air Rules.

In this regard, Petitioners argue DEQ's reliance on its pre-existing knowledge regarding the availability of chemical suppressants and water as dust control technology violated the requirement to determine T-RACT on a "case-by-case basis" under Air Rule 210.14. In effect, Petitioners argue DEQ must ignore what it already knows about the availability of chemical suppressants and water as a control technology and determine anew that it is "reasonably available." It is also notable that, elsewhere in the Air Rules, "suitable chemicals" are specifically recognized as a "reasonable precaution" for controlling dust from dirt roads. *See* AIR RULE 651.02.

In addition to the requirement to defer to DEQ's interpretation of its rules, there is a canon of construction that disfavors absurd results. *See, e.g., Friends of Farm to Market v. Valley County*, 137 Idaho 192, 46 P.3d 9, 14 (Idaho 2002). To the hearing officer, interpreting the "case-by-case" language in Rule 210.14 to require DEQ to ignore Air Rule 651.02, ignore the technical knowledge it possesses as the entity with statutory responsibility to administer Idaho's air permitting programs, and to engage in a brand-new feasibility evaluation every time an applicant proposes a well-

[8] The Permit, in turn, requires that "[c]hemical dust suppressants shall be applied consistent with manufacturer's instructions and recommendations." (R., at p. PET 010.)

established control technology would be an absurd result. It is also notable that Air Rule 210.14 further defines what constitutes a "case-by-case" evaluation by stating "as follows" and then enumerating the T-RACT steps previously described. The Simon Declaration describes DEQ's process for evaluating the T-RACT information submitted by Perpetua pursuant to Air Rule 210.14. The hearing officer finds that explanation adequate to satisfy Rule 210.14.

Finally, it is helpful to recall that the Air Rules are concerned with the control of "air pollution," which is defined by statute as follows:

> The presence in the outdoor atmosphere of any air pollutant or combination thereof in such quantity of such nature and duration and under such conditions as would be injurious to human health or welfare, to animal or plant life, or to property, or to interfere unreasonably with the enjoyment of life or property.

IDAHO CODE § 39-103(2).

While this definition allows for regulation of pollution "injurious…to animal or plant life," it does so specifically within the context of pollutants that are "presen[t] in the outdoor atmosphere." The term "atmosphere" is not defined in the Air Rules, the Clean Air Act, or Black's Law Dictionary. The Clean Air Act does, however, define "air pollutant" as pollutants emitted into the "ambient air," a phrase this opinion has already discussed in detail. *See* 42 U.S.C. § 7602(g). The Petitioners allege:

> There will be water quality and biological impacts associated with Perpetua's use of substantial amounts of chemical dust suppressants and water that have not been considered in the PTC. For example, the use of chemical dust suppressants like magnesium chloride can cause toxicity in trees and can lead to tree death. Magnesium chloride is also known to adversely affect aquatic ecosystems. Moreover, the proposed water source for dust control is primarily water collected in runoff ponds (captured rain or snowfall that has become contaminated through the contact of mine facilities), groundwater, and surface water from the East Fork of the South Fork of the Salmon River. USGS sampling indicates elevated arsenic in these waters. The environmental impact of using magnesium chloride or arsenic-polluted water as dust suppression methods was never considered as part of the T-RACT demonstration.

(Pet. ¶ 53.)

The Petitioners may indeed have legitimate concerns regarding the impacts of chemical dust suppressants on trees and aquatic ecosystems, but this air permit proceeding is not the appropriate forum for them. The "air pollutant" at issue in the T-RACT determination is arsenic (not magnesium chloride) that is present in the "outdoor atmosphere" and "ambient air" (not bodies of water). The Petitioners' concerns on these issues are more appropriately raised through authorities such as IDAPA 58.01.02 (Water Quality Standards) and 58.01.05 (Rules & Standards for Hazardous Waste).

In short, the Petitioners have not established that DEQ's reliance upon existing knowledge of chemical suppressants and water as "reasonably available" control technologies was error. Based on the Simon declaration, DEQ has offered expert testimony and a reasonable explanation for its T-RACT analysis. Therefore, the Petitioners' motion for summary judgment as to Claims 6 and 7 is hereby DENIED, and DEQ's and Perpetua's motions for summary judgment as to Claims 6 and 7 are hereby GRANTED.

K. Averaging of Projected As Emissions (Claim No. 9)

The Petition alleges DEQ utilized "three improper averaging tactics: (1) averaging emissions over a 5-year period for the T-RACT input to ambient toxics modeling; (2) averaging the estimated annual ambient modeling impacts across two multi-year scenarios; and (3) averaging the resultant 16-year total emissions over the 70-year human lifetime to assert compliance." (Pet. ¶ 55.) According to the Petitioners, the Air Rules do not allow "multi-year emissions averaging" and instead require DEQ to "estimate the SGP's maximum 1-year annual arsenic emissions and compare it to the annual arsenic AACC" in Air Rule 586. (*Id.*) In effect, the Petitioners allege DEQ employed a "tactic" that is contrary to the plain language of the Air Rules.

All three sets of parties moved for summary judgment on this issue. Before discussing the

motions, it will be helpful to summarize the relevant Air Rules. The starting place is Air Rule 203:

> No permit to construct shall be granted for a new…stationary source unless the applicant shows to the satisfaction of the Department all of the following:
>
> ***
>
> **Toxic Air Pollutants.** ***Using the methods provided in Section 210***, the emissions of toxic air pollutants from the stationary source…would not injure or unreasonably affect human health or animal life or vegetation ***as required by Section 161***. Compliance with all applicable toxic air pollutant carcinogenic increments and toxic air pollutant non-carcinogenic increments ***will also demonstrate preconstruction compliance with Section 161*** with regards to the pollutants listed in Sections 585 and 586.

AIR RULE 203.03 (emphasis added).

Section 161, in turn, provides:

> Any contaminant which is by its nature toxic to human or animal life or vegetation shall not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, ***injure or unreasonably affect human or animal life or vegetation***.

AIR RULE 161 (emphasis added).

The use of the phrase "will also demonstrate preconstruction compliance" in Section 203.03 effectively creates two regulatory paths. First, the applicant and DEQ can use "the methods in Section 210" to show that emissions will not "injure or unreasonably affect human or animal life or vegetation." Section 210, in turn, consists of six-and-a-half pages of detailed, technical, complex regulations, and any attempt by the hearing officer to summarize Section 210 in a manner that is both useful and accurate would be an exercise in futility. Regardless, the relevant legal standard—"injure or unreasonably affect"—is not further defined within the Air Rules.

Effectively, the second path—compliance with Sections 585 and 586—provides applicants with a safe harbor. If an applicant demonstrates "[c]ompliance with all applicable toxic air pollutant carcinogenic increments and toxic air pollutant non-carcinogenic increments…with regards to the

pollutants listed in Sections 585 and 586," then satisfaction of Section 161 is automatic and application of the "injure or unreasonably affect" standard unnecessary. Section 586, in turn, identifies "acceptable ambient concentrations" (AACCs) for a variety of pollutants, including "arsenic compounds." According to the plain language of that Rule, these AACCs are expressed as "annual averages." For arsenic compounds, the applicable AACC is $2.3E^{-04}$ $\mu g/m^3$. So, if an applicant can demonstrate arsenic emissions will not exceed that AACC, then the Section 203.03 analysis for arsenic is over. As a matter of law, the legal standard of Section 161 is satisfied.

While out of sequence with the order of the motions filed, it is helpful to begin with a discussion of the summary judgment motions filed by DEQ and Perpetua. Broadly speaking, DEQ provides the factual background regarding its decision-making process on this issue through the Schilling Declaration, and Perpetua's briefing includes a "deep dive" into the language of the relevant and complex Air Rules.

According to Mr. Schilling, DEQ analyzed Perpetua's application under Air Rule 210.12. (Schilling Decl., p. 10.) That section contains somewhat of a trade-off: If an applicant demonstrates it is utilizing T-RACT as pollution control technology for a particular toxic air pollutant, then it satisfies Section 161 if its modeled emissions for that toxic pollutant is less than 10 times the applicable AACC. *See* AIR RULE 210.12. This effectively creates another "safe harbor" that allows an applicant to demonstrate compliance with Section 161 through the quantitative standards in Section 586 instead of the qualitative toxicity standard. According to that Rule:

> If the source's…approved T-RACT ambient concentration at the point of compliance is less than or equal to the amount of the air pollutant that would contribute an ***ambient air cancer risk probability of less than one to one hundred thousand (1:100,000)***, no further procedures for demonstrating preconstruction compliance will be required for that toxic air pollutant as part of the application process.

AIR RULE 210.12(c) (emphasis added).

The preceding subsection explains that the "ambient air cancer risk probability of less than one to one hundred thousand (1:100,000)" is "equivalent to ten (10) times the applicable [AACC] in Section 586." AIR RULE 210.12(b). So again, if Perpetua's approved T-RACT ambient concentration for arsenic at the point of compliance is less than 10 times the AACC in Section 586, compliance with Section 161 is achieved as a matter of law.

Paraphrasing Mr. Schilling, DEQ determined that Perpetua proposed T-RACT for arsenic emissions and, therefore, evaluated modeled emissions under Air Rule 210.12 as described above. DEQ started with very conservative assumptions that overestimate emissions. Using those conservative assumptions, the modeling showed exceedances of the 10x AACC standard. As a result, he and DEQ then conducted a "refinement of exposure calculations to provide a more representative comparison to the AACC." (Schilling Decl., pp. 9-11.)

The issue here is that the AACCs are based on an assumed lifetime exposure to the relevant carcinogen over a 70-year period because for permitting and conservatism principles, DEQ normally assumes the project life will exceed that 70-year period. Clearly, if a project will only operate for 16 years and AACC compliance is still achieved, that is the end of the inquiry, because exposure to a carcinogen at a certain level for only 16 years cannot result in a higher cancer risk than exposure to the same carcinogen at the same level for 70 years. But, if a project will only operate for 16 years and AACC compliance is not achieved, that does not automatically mean that the cancer risk exceeds the 1 in 1,000,000,000 or 1 in 100,000 standards. This is because comparison of emissions that will only take place for 16 years to a standard that is based on an assumed 70-year exposure period is an "apples to oranges" comparison. Based upon his knowledge that the AACCs are based on a lifetime cancer risk over a 70-year period, Mr. Schilling and DEQ made a more refined exposure calculation that proceeds as follows:

First, they reviewed the 14 modeling scenarios provided by PRI for the 16-year period of operations. From this set of 224 data points, they chose the highest modeled concentration of arsenic emissions.

Next, they multiplied that highest annual concentration by the 16-year operational period to calculate a conservative figure for total arsenic emission exposure over the life of the mine.

Next, they divided that figure by the 70-year exposure period on which the AACCs are based.

Finally, they compared that figure to the AACC for arsenic. Because it was less than the AACC, DEQ concluded there was not an unreasonable risk or injury posed to human life. (*See* R., at pp. PET 332, 344; Schilling Decl., pp. 8-12).

The Petitioners may indeed be correct that DEQ's approach is not strictly consistent with Section 586. However, that is not the end of the inquiry. As previously described, and as DEQ and Perpetua correctly note, if strict compliance with the quantitative standards in Sections 585 and 586 is not achieved, then the applicable standard to be met is the qualitative one, that the toxic air pollutant "shall not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, ***injure or unreasonably affect human or animal life or vegetation***." AIR RULE 161 (emphasis added). Among other things, Mr. Schilling testifies as follows:

> The typical permitting approach is to use worst-case assumptions and data in a limited number of analyses that will confidently show that allowable operations, as described and limited in the permit and permit-required plans and procedures, cannot result in impacts that exceed applicable standards. When this approach is applied to mining operations, results of the impact modeling tend to greatly overstate actual impacts that will occur or even could occur.
>
> ***
>
> The number of TAP-applicable arsenic emission sources for the SGP was expanded late in the permit application review process, after it was determined that some sources had been incorrectly excluded from analysis as per Idaho Air Rules Section

210. The incorrect exclusion was confirmed by the DEQ Permit Writer, the DEQ Permitting Supervisor, and the DEQ Stationary Source Bureau Chief after considering comments received during a public comment period. Without completely reworking the complex and still very conservative approach used to assess carcinogenic TAP impacts, compliance could not be demonstrated using the typical approach outlined above. I then undertook the task of evaluating whether a more refined approach could be used to demonstrate compliance with TAP rules of Section 210.

A first step in refinement of impacts or adjustment of allowable impacts was to assure that reasonably available control technologies were used for all sources of arsenic. This level of control is referred to as T-RACT and its use in the evaluation of carcinogenic TAPs is described in Idaho Air Rules Section 210.12. If T-RACT is used to control emissions from sources, then the allowable impact is ten times that of the AACCs, corresponding to a lifetime cancer risk of 1 in 100,000. The AACC conservatively represents a long-term exposure (70 years) that would result in a 1 in 1,000,000 cancer risk.

***

A worst-case conservative but simplistic approach used for the SGP did not show compliance with the arsenic AACC, or even the AACC multiplied by a factor of ten to reflect the allowable impact when using T-RACT. ***DEQ then reviewed the basis for the AACCs to further evaluate refinement of exposure calculations to provide a more representative comparison to the AACC***. AACCs were established in Idaho Air Rules to protect against a project-caused lifetime excess cancer risk of more than 1-in-1,000,000, or 1-in-100,000 where T-RACT is used to control emissions from sources.

***

Although a lifetime risk is the benchmark, DEQ listed annual averages for the AACCs in Idaho Air Rules because that timeframe 1) is long enough to establish a good representation of long-term impacts for most sources requiring a permit, 2) is short enough to provide compliance assurance early in the life of the industrial operation, and 3) is convenient for compliance monitoring and reporting, providing a practically enforceable limit on operations. ***Use of an annual limit is not key to attaining a limit on the lifetime cancer risk; and, since a lifetime risk is the benchmark, use of annual averaged emissions to show compliance with the AACC on an annual basis could be unnecessarily restrictive where processes vary considerably year-to-year and have a project lifetime substantially shorter than 70 years, such as mining processes.***

PRI indicated that the SGP will have a 16-year maximum project lifetime. To calculate a project-based arsenic concentration representative of the project, appropriate for comparison to the AACC (based on a 70-year exposure), the modeled

impact was adjusted by the factor 16/70.

(Schilling Decl., pp. 9-11.)

Even if the 16/70 adjustment is not specifically authorized by Sections 210.12 and 586, the hearing officer finds Mr. Schilling's testimony adequate to support DEQ's decision under the qualitative standard of Section 161. Mr. Schilling recognizes that the over-arching legal standard is the toxicity standard in Section 161 and explains why strict compliance with standards expressed as annual limitations is not always necessary to satisfy that standard, particularly when the exposure period is considerably shorter than the assumed 70-year exposure period on which the AACCs are based. Overall, he provides a thoughtful and conservative approach to ensuring arsenic emissions will not exceed the 1-in-100,000 lifetime cancer risk standard when T-RACT is used.

The Schilling Declaration is unrebutted expert testimony on an issue clearly not within the common knowledge of the layperson. To be clear, the hearing officer understands and appreciates the Petitioners' argument that in applying the 16/70 exposure refinement, DEQ "assumed the cancer risk probability from high dose/short-term exposure was equivalent to low dose/long term exposure." (Pet.'rs' Resp. of 6/9/23, p. 44.) It is unclear to the hearing officer if "normalizing" arsenic exposure for a 16-year project in order to compare it to a health standard based on a 70-year lifetime exposure period is truly as simple as applying the 16/70 adjustment factor.

On the other hand, Petitioners do not question the accuracy of the 16-year operational period,[9] and it is illogical for this issue to turn solely on satisfaction of a standard that is based on a 70-year exposure period, when the permitted project is expected to operate for less than one-fourth

[9] It is worth noting that Air Rule 210.12(d) requires DEQ to "include emission limits and other permit terms for the toxic air pollutant in the permit to construct that assure that the facility will be operated in the manner described in the preconstruction compliance demonstration." To the extent Petitioners are concerned the 16-year mine life was not adopted as a limitation within the Permit, DEQ explains that the hauling limits in Permit Condition 3.6 acts as "a life of mine

of that time. Given the deference accorded to DEQ in the interpretation of its rules, the presumption DEQ acted reasonably, and the layers of conservatism built into the TAP evaluation process described by Mr. Schilling, without expert testimony from the Petitioners explaining why the 16/70 adjustment could cause injury to human life or is otherwise arbitrary, capricious, or an abuse of discretion, Petitioners have not sufficiently rebutted Mr. Schilling.

Based on the foregoing, the hearing officer hereby DENIES the motion for summary judgment filed by Petitioners as to Claim No. 9. The hearing officer hereby GRANTS the motions for summary judgment filed by DEQ and Perpetua as to Claim No. 9.

IV. SUMMARY, CONCLUSION, AND PRELIMINARY ORDER

The Petition alleges thirteen discrete errors. On November 15, 2022, the hearing officer dismissed Claim Nos. 3, 4, and 10, and partially dismissed Claim No. 8. As to the remaining claims, based on the foregoing, it is hereby ordered that:

The motion for summary judgment filed by Petitioners as to Claim Nos. 1, 2, 5, 6, 7, 9, 11, 12, 13, and the remainder of Claim No. 8 is hereby DENIED.

The motions for summary judgment filed by DEQ and Perpetua as to Claim Nos. 1, 2, 5, 6, 7, 9, 11, 12, 13, and the remainder of Claim No. 8 are hereby GRANTED.

To the extent the Amended Petition adequately revived Claim No. 3, the motion for summary judgment filed by Petitioners is hereby DENIED, and the motions for summary judgment filed by DEQ and Perpetua are hereby GRANTED.

All of the claims for relief asserted in the Petitioners' Amended Petition have now been resolved in favor of DEQ and Perpetua and against the Petitioners.

---

hauling and excavating limit." (R., at p. PET 597.)

V. RULE 730 NOTICE

Pursuant to Idaho Code Sections 67-5243 and 67-5245, BEQ Rule of Procedure 730, and AG Rule of Procedure 730:

This is a preliminary order of the Hearing Officer and will become final without further action of the Idaho Board of Environmental Quality unless any party appeals to the Board by filing a petition for review of the preliminary order.

Within fourteen (14) days of the service date of this preliminary order, any party may take exceptions to any part of this preliminary order by filing a petition for review of the preliminary order. Otherwise, this preliminary order will become a final order of the Board. The basis for review must be stated in the petition. The Board may review the preliminary order on its own motion.

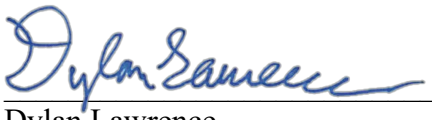
If any party files a petition for review of the preliminary order, the Board will allow all parties an opportunity to file briefs in support of or taking exceptions to the preliminary order and may schedule oral argument in the matter before issuing a final order. The hearing coordinator will issue a notice setting out the briefing schedule and date and time for oral argument. The Board will issue a final order within fifty-six (56) days of receipt of the written briefs or oral argument, whichever is later, unless waived or extended by the parties or for good cause shown. The Board may hold additional hearings or may remand the matter for further evidentiary hearings if further factual development of the record is necessary before issuing a final order.

Pursuant to Idaho Code Sections 67-5270 and 67-5272, if this preliminary order becomes final, any party aggrieved by the final order or orders previously issued in this case may appeal the final order and all previously issued orders in this case to district court by filing a petition in the district court of the county in which: (1) a hearing was held; (2) the final agency action was taken;

(3) the party seeking review of the order resides or operates its principal place of business in Idaho; or (4) the real property or personal property that was the subject of the agency action is located.

This appeal must be filed within twenty-eight (28) days of this preliminary order becoming final. *See* IDAHO CODE § 67-5273. The filing of an appeal to district court does not itself stay the effectiveness or enforcement of the order under appeal.

Dated this 5th day of December 2023.



Dylan Lawrence
Hearing Officer

CERTIFICATE OF SERVICE

I hereby certify that on this 5th day of December 2023, I caused to be served a true and correct copy of the foregoing by the following method to:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

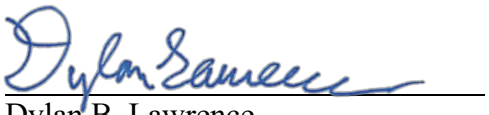
Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Resources Division
Office of the Attorney General
1410 N. Hilton St.
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
hannah.young@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service



Dylan B. Lawrence
Hearing Officer

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	
	)	CASE DOCKET NO. 0101-22-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON	)	**AMENDED PETITION FOR REVIEW OF PRELIMINARY ORDERS**
Petitioners,	)	
v.	)	
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC.	)	
Intervenor.	)	

Petitioners Nez Perce Tribe, Idaho Conservation League ("ICL"), and Save the South Fork Salmon ("SSFS") hereby petition the Idaho Board of Environmental Quality (the "Board") for review of the October 31, 2023 Preliminary Order and the December 5, 2023 Amended Preliminary Order issued by the Hearing Officer in this matter. This Amended Petition for Review of Preliminary Orders is brought under Idaho Code §§ 67-5243(3), 67-5245(2) and IDAPA 58.01.23.730. The Preliminary Orders should be modified, amended, or revoked, and the Permit should be vacated and remanded to DEQ, based on the following errors:

1. The Hearing Office erred, factually and legally, in upholding DEQ's determination that Perpetua has legal control of the Stibnite Road Access Route such that the Route need not comply with ambient air quality standards;

2. In finding that Perpetua will preclude the general public from accessing locations within the ambient air boundary, the Hearing Officer lacked a reasonable factual basis and misapplied applicable regulations, policy, and guidance;

3. In the Preliminary Order, the Hearing Officer failed to decide Petitioners' claim that DEQ violated the Clean Air Act and applicable state and federal rules and regulations by allowing Perpetua to submit plans with important project details in the future—after Permit issuance and without public comment; and in the Amended Preliminary Order, the Hearing Officer erroneously found that this issue was not raised in the First Amended Petition to Initiate Contested Case and erroneously determined that, if this issue was raised, DEQ is allowed to let Perpetua develop the plans later;

4. The Hearing Officer erroneously determined that the Permit includes enforceable conditions that will achieve 93.3% dust control.

5. The Hearing Officer misinterpreted and misapplied applicable rules to uphold DEQ's decision to artificially dilute the ambient arsenic concentrations attributable to the SGP by 16/70;

Petitioners request that the Board set out a briefing schedule on this petition as required under IDAPA 58.01.23.730.03.

BACKGROUND

In this contested case, Petitioners challenge the Idaho Department of Environmental Quality's ("DEQ" or "Department") approval of a permit to construct (the "Permit") issued to Perpetua Resources Idaho, Inc. ("Perpetua") for the proposed Stibnite Gold Project ("SPG" or "Project"): a massive open-pit mine in Valley County, Idaho. As proposed, Perpetua would excavate 340 million tons of waste rock to mine and process approximately 100 million tons of ore, using 55 miles of haul truck routes over 16 years. Blasting, excavating, ore hauling, and other Project activities will emit air pollutants, including coarse particulate matter ("PM_{10}") and arsenic. PM_{10} and arsenic are regulated under the federal Clean Air Act and Idaho's air pollution regulations, because they can cause significant and severe health and environmental hazards.

On June 17, 2022, DEQ issued permit to construct ("PTC") P-2019.0047, which is the Permit at issue in this contested case. On July 22, 2022, Petitioners timely filed the original Petition to Initiate Contested Case. On July 28, 2022, the Hearing Officer Dylan Lawrence was assigned to preside over this matter. On August 12, 2022, Perpetua filed a Petition to Intervene. On August 22, 2022, Perpetua's Petition to Intervene was granted. On September 6, 2022, Perpetua filed a Motion to Dismiss. On November 15, 2022, the Hearing Officer issued the Order on Motion to Dismiss, denying the motion with respect to the majority of Petitioners' claims, dismissing or partially dismissing four claims, and declining to allow the pleadings to be

amended unless Petitioners file for consideration a formal motion to amend the Petition. On January 11, 2022, Petitioners filed their First Amended Petition to Initiate Contested Case.

After DEQ produced a Project Record and the Parties engaged in limited discovery, Petitioners filed a Motion for Summary Judgment on all claims remaining in the contested case on April 14, 2023. DEQ and Perpetua filed Cross Motions for Summary Judgment.

On August 28, 2023, Perpetua and DEQ filed a joint Motion in Limine to exclude an August 10, 2023 letter from EPA Region 10 Administrator Casey Sixkiller to IDEQ Director Jess Byrne requesting an in-person meeting to discuss EPA's concerns with the Permit. In the letter, EPA raised three primary concerns with the Permit, including concerns that: DEQ used the wrong emission factors, and had it used proper emission factors, the SGP's potential to emit would exceed the major source permitting threshold; DEQ's emission limits were inadequate to demonstrate compliance with NAAQS for particulate matter; and DEQ's delineation of the SGP's ambient air boundary was not supported. Further explanation of the EPA's concerns were detailed in a 19-page enclosure. Three days later, Petitioners filed a Motion to Supplement with EPA's letter and enclosure, and on September 8, 2023, filed a Motion to Amend Contested Case Petition to add a claim regarding the issue EPA raised in its letter about whether DEQ used improper emission factors and was thus wrong when it concluded the SGP's potential to emit will be below major source thresholds. On September 15, 2023, the Hearing Officer denied Perpetua and DEQ's motion in limine, granted Petitioners' motion to supplement with the EPA letter, and denied Petitioners' motion to amend.

On September 21, 2023, the Hearing Officer held a hearing on the cross motions for summary judgment. On October 31, 2023, the Hearing Officer issued a Memorandum Decision on Motions for Summary Judgment and Preliminary Order (the "Preliminary Order").

In the Preliminary Order, the Hearing Officer rejected DEQ's and Perpetua's arguments that Petitioners lacked standing to pursue this contested case, finding each Petitioner had standing to challenge the Permit. But the Hearing Officer ruled against Petitioners on all claims addressed in the Preliminary Order and granted Summary Judgment to DEQ and Perpetua. The Preliminary Order, however, never addressed one of Petitioners' bases for review: DEQ's allowing Perpetua to defer the submittal of project plans until later, after the Permit is already issued, outside of the normal permitting process, and without public comment.

On November 14, 2023, Petitioners filed a timely Petition for Review of Preliminary Order, seeking review of the October 31, 2023 Preliminary Order, including review of the issue ("Claim No. 3") never addressed by the Hearing Officer, as well as review of additional issues.

On November 10, 2023, DEQ and Perpetua filed a Joint Motion for Reconsideration and/or Clarification regarding whether Claim No. 3 was addressed. Petitioners responded, and on December 5, 2023, the Hearing Officer issued an Order on Joint Motion for Reconsideration and/or Clarification and also issued an Amended Memorandum Decision on Motions for Summary Judgment and Preliminary Order (the "Amended Preliminary Order"). The Amended Preliminary Order found Claim No. 3 had already been dismissed and, alternatively, granted summary judgment to DEQ and Perpetua on Claim No. 3.

Petitioners hereby file this Amended Petition for Review, seeking review of the issues set forth below on which the Hearing Officer erred. This Amended Petition for Review seeks review of the same five issues as in the original Petition for Review, with minimal changes to reflect that review is now sought of the Preliminary Order and/or the Amended Preliminary Order.

//

//

BASES FOR PETITION

1. The Hearing Office erred, factually and legally, in upholding DEQ's determination that Perpetua has legal control of the Stibnite Road Access Route such that the Route need not comply with ambient air quality standards.

The Clean Air Act ("CAA") and the Rules for the Control of Air Pollution in Idaho ("Air Rules"), IDAPA 58.01.01 *et seq.*, require Perpetua to meet various air quality standards, including the National Ambient Air Quality Standards ("NAAQS") and acceptable ambient concentrations of carcinogens ("AACCs") for toxic air pollutants ("TAPs"), in ambient air. *See*, *e.g.*, Air Rules Sections 006.11 (NAAQS), 006.125 (TAPs). The U.S. Environmental Protection Agency ("EPA") CAA regulations define "ambient air" as "that portion of the atmosphere, external to buildings, to which the general public has access." 40 C.F.R. § 50.1(e).

The Stibnite Road Access Route ("Route") is a road that passes through what Perpetua and DEQ have defined as the mine's operations boundary and the ambient air boundary, and the inside of that boundary is the active industrial site where Project mining activities and heavy equipment operation will occur. Perpetua has indicated that it will not cut off public access along the Stibnite Road Access Route during mine operations, and as explained by DEQ, Perpetua "will manage an access route to provide the general public with limited access through the [Project] site between Stibnite Road at Sugar Creek and Thunder Mountain Road at Meadow Creek."

Petitioners presented evidence that Perpetua lacks authority to control access along the Stibnite Access Route. This included evidence that there is an ongoing process where the United States Forest Service is reviewing Perpetua's proposed mine, and that Perpetua's authority to control access along the Stibnite Access Route depends on the outcome of that ongoing process. In the Preliminary Order and Amended Preliminary Order, the Hearing Officer concluded that

DEQ could rely on Perpetua's assertions in its submissions to DEQ that it has authority to control access. The Hearing Officer ignored the evidence to the contrary and misapplied the law.

Petitioners seek review of this issue, and ask the Board to vacate and remand the Permit and hold that Perpetua lacks the required authority to control access on the Stibnite Access Route for purposes of determining the Project's ambient air boundary.

2. In finding that Perpetua will preclude the general public from accessing locations within the ambient air boundary, the Hearing Officer lacked a reasonable factual basis and misapplied applicable regulations, policy, and guidance.

Even if Perpetua has authority to control access, Perpetua does not plan to (and the Permit does not require Perpetua to) preclude access. Instead, as the evidence in the record shows, Perpetua plans to allow public access. Petitioners presented evidence showing that Perpetua will allow anyone to use the Stibnite Access Route, so long as they check in and agree to be "guests of the mine." Petitioners showed that under applicable laws, regulations, guidance, and policy, these people are general public, requiring ambient air quality standards to be met along the Stibnite Access Route.

In ruling against Petitioners, the Hearing Officer stated: "the Permit makes it clear that Perpetua is required to preclude unauthorized access by the general public and that members of the public can become guests of the facility only if they are seeking to pass through to access another destination." Prelim. Order at 21; Amended Prelim. Order at 21–22. The Hearing Officer failed to address Petitioners' specific argument that under the CAA, the Air Rules, and EPA's and DEQ's guidance, "guests of the facility" who are passing through to access another destination still count as the general public. Perpetua cannot simply convert the general public to something else by labeling them "guests," and it does not matter whether they are passing through to another destination versus lingering on site. By authorizing people to use the Stibnite Access Road to pass through the site and access other destinations is letting the general public in,

and ambient air standards must, therefore, be met along the Stibnite Access Route. The Hearing Officer erred in simply assuming that by labeling them "guests of the facility," people Perpetua will allow on site are not the general public.

Petitioners seek review of this issue, and ask the Board to vacate and remand the Permit and hold that "guests of the facility" traveling the Stibnite Access Route are entitled to ambient air quality protections.

3. The Hearing Officer failed to decide Petitioners' claim that DEQ violated the Clean Air Act and applicable state and federal rules and regulations by allowing Perpetua to submit plans with important project details in the future–after Permit issuance and without public comment; or to the extent that this claim was decided, the Hearing Officer erred.

EPA has delegated to DEQ authority to issue air quality permits in Idaho. Under the Clean Air Act, State air rules like DEQ's "shall" include "enforceable emission limitations" and other control measures, means, or techniques as necessary or appropriate to meet Clean Air Act requirements. 42 U.S.C. § 7410(a)(2)(A). State plans "shall" include a "program to provide for the enforcement" of the limitations and measures described in subparagraph (A), and for the "regulation of the modification and construction of any stationary source . . . to assure that [NAAQS] are achieved." *Id.* § 7410(a)(2)(C).

EPA's Clean Air Act regulations require each State plan to "set forth legally enforceable procedures" that enable the State to determine whether the construction of a facility will result in a violation of its air pollution control strategies or interfere with attaining or maintaining the NAAQS. 40 C.F.R. § 51.160(a). These legally enforceable procedures: must include means by which the State will prevent construction if the facility will violate air pollution control strategies or will interfere with attaining or maintaining the NAAQS; and must provide for the applicant to submit information on the "location, design, construction, and operation of such facility . . . as may be necessary" to permit the state to "to make the determination" that the facility will comply

with its air pollution control strategies and the NAAQS. *Id.* § 51.160(b)–(c). "The legally enforceable procedures in § 51.160(b) must also require" the State to provide opportunity for public comment on information submitted by the applicant and on the State's analysis of the effects on ambient air quality. *Id.* § 51.161(a).

Under the Rules for the Control of Air Pollution in Idaho, DEQ is required to ensure that no PTC shall be granted for a new or modified stationary source unless the applicant shows to the satisfaction of DEQ that the source would not cause or significantly contribute to a violation of any NAAQS. IDAPA 58.01.01.203.02. To satisfy these requirements, DEQ must assess air impacts using maximum potential emissions as limited by either the capacity of the unit/operation or as limited by enforceable permit provisions. *See* IDAPA 58.01.01.006.88. Prior to issuing a permit to construct, DEQ must provide an opportunity for public comment by making available DEQ's proposed action together with information provided by the applicant and with DEQ's analysis of air quality impacts. IDAPA 58.01.01.209.c.

Under the Permit, Perpetua is required to submit the following plans in the future: the Fugitive Dust Control Plan; the Haul Road Capping Plan; the Operation and Maintenance Manual; and the Stibnite Road Access Management Plan. These plans are not subject to public comment, and while DEQ will review them, it will do so outside of the permitting process set forth in the Air Rules. Despite devoting extensive briefing to this issue, the Hearing Officer erred when he did not decide this specific issue in the Preliminary Order.

The Hearing Officer also erred in the Amended Preliminary Order where he determined that this issue was not raised in the Amended Petition for Contested Case and determined, alternatively, that DEQ can issue a permit first and allow these plans to be submitted later under the CAA and the Idaho Air Rules. Amended Prelim. Order at 32–36. Both the original Petition

and the Amended Petition included a Relief Requested section titled "FDCP, AMP, O&M Manual, & HRCP" which states as follows:

> DEQ must require Perpetua to submit the FDCP, AMP, O&M Manual, and HRCP (collectively, "Plans"), must provide for public comment on the Plans, must review and revise Plans to ensure the SGP's emissions comply with IDAPA 58.01.01.203, and must incorporate the Plans as enforceable PTC conditions.

Petition to Initiate Contested Case at ¶ D; First Amended Petition to Initiate Contested Case at ¶ D. After the Hearing Officer's decision on the Motion to Dismiss, Petitioners revised Paragraphs 32 and 70 in the Amended Petition to Initiate Contested Case by adding CAA regulation and Idaho Air Rule provisions related to the permit review process requirements, including public comment requirements. The FDCP and HRCP were already discussed in the original Petition to Initiate Contested Case in Paragraphs 37 and 39, including stating that these plans had not yet been developed but were being relied upon by DEQ. After the decision on the Motion to Dismiss, Paragraph 37 was revised to add references raising the issue that DEQ failed to take public comment on the FDCP and HRCP in the First Amended Peition to Initiate Contested Case. The O&M Manual was already discussed in the original Petition to Initiate Contested Case in Paragraph 40, and after the decision on the Motion to Dismiss, Paragraph 40 was revised to add additional information about the O&M Manual and about Air Rule permit process requirements, including requirement for submitting project plans and for taking public comment. The AMP was already discussed in the original Petition in Paragraphs 63 through 65, including raising the issue that DEQ was relying on the AMP even though it had not yet been written and would not go through public comment.

Petitioners seek review of this issue, and ask the Board to vacate and remand the Permit and hold that DEQ must require Perpetua to submit the plans as part of the public permitting process.

4. The Hearing Officer erroneously determined that the Permit includes enforceable conditions to achieve 93.3% dust control.

Under the Air Rules, DEQ cannot issue a PTC unless it determines that the facility: (1) "would comply with all applicable federal emissions standards;" (2) "would not cause or significantly contribute to a violation of any ambient air quality standards" (i.e., the NAAQS); and (3) "emissions of toxic air pollutants . . . would not injure or unreasonably affect human or animal life or vegetation as required by Section 161." Air Rules Section 203.

A critical factor affecting the SGP's fugitive dust emissions, and therefore whether DEQ can make the required determinations under Air Rules Section 203 that the Project will comply with the PM_{10} NAAQS and arsenic AACC limits, is the degree to which Perpetua will effectively control dust from haul roads. When it approved the Permit, DEQ assumed that Perpetua will achieve a 93.3% control efficiency of all haul road dust by using a combination of water sprays and chemical dust suppressants. However, as EPA and other commenters pointed out, it is highly questionable whether 93.3% fugitive dust control is realistically attainable for this Project, and even if it were technically possible, the Permit lacks conditions necessary to ensure that Perpetua will achieve such a high level of control.

In the Preliminary Orders, the Hearing Officer concluded that DEQ properly concluded that the Project will achieve 93.3% control because "the Permit includes a specific requirement that 93.3% control efficiency be achieved." Prelim. Order at 31; Amended Prelim. Order at 32. This is incorrect. The Permit does not include a specific requirement to achieve 93.3% or any other level of dust control. The Permit does include requirements for Perpetua to develop a Fugitive Dust Control Plan and a Haul Road Capping Plan. And while the Permit requires specific things to be included in those plans, none of them ensure any specific control efficiency be achieved—let alone an aggressive 93.3% control efficiency.

The Hearing Officer also faulted Petitioners for not offering "expert testimony describing the terms they believe are necessary to ensure compliance." Preliminary Order at 31. The Hearing Officer ignored the expert testimony in the form of public comments and other submissions to DEQ made by the EPA, Petitioners, and others with technical expertise on this very issue, including testimony that conditions specifying the combinations, volumes, and frequencies for applying water sprays and chemical dust suppressants are necessary.

Petitioners seek review of this issue, and ask the Board to vacate and remand the Permit and hold that DEQ must include enforceable permit limits on the combinations, volumes, and frequencies for applying water sprays and chemical suppressants sufficient to achieve 93.3% dust control.

5. The Hearing Officer misinterpreted and misapplied applicable rules to uphold DEQ's decision to artificially dilute the ambient arsenic concentrations attributable to the SGP by 16/70.

No PTC can be granted unless DEQ determines the applicant showed: "Using the methods provided in Section 210, the emissions of toxic air pollutants from the . . . source . . . would not injure or unreasonably affect human health or animal life or vegetation as required by Section 161." Air Rules Section 203.03. Section 161 states, "[a]ny contaminant which is by its nature toxic to human or animal life or vegetation shall not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation." Air Rules Section 161.

For each carcinogenic TAP, including arsenic, the Air Rules set Acceptable Ambient Concentrations of Carcinogens ("AACC"), where each AACC is an annual average in ug/m3. Air Rules Section 586. The applicable TAPs "carcinogenic increments" that must be met to satisfy Section 203.03 are the AACCs, which are *annual average* ambient concentrations. *See* Air Rules Section 586.

The "methods provided in Section 210" that must be followed to satisfy Section 203.03 spell out in detail how to estimate TAPs emissions and ambient concentrations. *See* Air Rules Section 210. The Air Rules include explicit exceptions to meeting the normal AACCs, allowing less stringent AACCs either where: (a) a project is five years or less; or (b) a T-RACT demonstration is done. Air Rules Sections 210.12, 210.15. There are no other exceptions in the Air Rules.

Because the Stibnite Gold Project is for 16 years (which is longer than five years or less), it is not eligible for the short-term source exception. DEQ did grant the T-RACT exception to Perpetua. Even with the T-RACT adjusted arsenic AACC—which allows Perpetua 10 times the normal limit—DEQ recognized that the Project would still exceed the arsenic AACC. To avoid this problem, DEQ contrived a new tactic to artificially reduce the apparent arsenic exposure by spreading out the actual arsenic exposure resulting from the 16-year Project over a longer 70-year human lifetime. This new trick artificially reduces the apparent concentration of arsenic to a mere 23% (16/70 x 100) of what the arsenic concentration will actually be each year during the Project.

In accepting DEQ's approach, the Hearing Officer stated that "unless an issue is squarely addressed by the Air Rules, the hearing officer will defer to 'practical' interpretations of the Air Rules by DEQ." Prelim. Order at 7; Amended Prelim. Order at 7. Here, the Hearing Officer improperly deferred to DEQ's interpretation of the Air Rules and ignored the fact that the Air Rules squarely address this issue: the Air Rules provide two specific exceptions to meeting the arsenic AACC, and do not allow for other exceptions. The Hearing Officer effectively allowed DEQ to rewrite the Rules without following the rulemaking process and allowed DEQ to create a

new exception—found nowhere in the Air Rules—to the requirement to comply with the arsenic AACCs following the methods in Section 210.

Petitioners seek review of this issue, and ask the Board to vacate and remand the Permit and order that DEQ must comply with the methods in Air Rules Section 210 and cannot authorize the Permit unless it will comply with the arsenic AACCs, as adjusted by the T-RACT, without any 16/70 adjustment.

CONCLUSION

Petitioners request that the Board issue an order remanding to DEQ and vacating the Permit, and/or remand to the Hearing Officer for additional proceedings.

Dated: December 15, 2023

Respectfully submitted,

/s/ Bryan Hurlbutt
Bryan Hurlbutt
Attorney for the Nez Perce Tribe and the Idaho Conservation League

/s/ Julie S. Thrower
Julia S. Thrower
Attorney for Save the South Fork Salmon

CERTIFICATE OF SERVICE

I hereby certify that on December 15, 2023, a true and correct copy of the Petition for Review of Preliminary Order was served on the following:

Dylan B. Lawrence Varin Thomas, LLC 242 N. 8th St., Suite 220 Boise, ID 83702 (208) 345-6021 dylan@varinthomas.com *Hearing Officer*	Via: Email: [x] Fax: [ ] CM/ECF: [ ] Hand Delivery: [ ] U.S. Mail: [x]
Paula Wilson paula.wilson@deq.idaho.gov *Hearing Coordinator*	Via: Email: [x] Fax: [ ] CM/ECF: [ ] Hand Delivery: [ ] U.S. Mail: [ ]
Office of Administrative Hearings P.O. Box 83720 Boise, ID 83720-0104 filings@oah.idaho.gov	Via: Email: [x] Fax: [ ] CM/ECF: [ ] Hand Delivery: [ ] U.S. Mail: [x]

Hannah M.C. Young Deputy Attorney General Department of Environmental Quality 1410 N. Hilton, 2nd Floor Boise, ID 83706 (208) 373-0422 hannah.young@deq.idaho.gov *Attorney for Respondent Idaho Department of Environmental Quality*	Via: Email: [x] Fax: [ ] CM/ECF: [ ] Hand Delivery: [ ] U.S. Mail: [ ]
Krista McIntyre W. Christopher Pooser Wade Foster Stoel Rives, LLP 101 S. Capital Blvd., Suite 1900 Boise, ID 83702 (208) 389-9000 krista.mcintyre@stoel.com christopher.pooser@stoel.com wade.foster@stoel.com *Attorneys for Intervenor Perpetua Resources of Idaho, Inc.*	Via: Email: [x] Fax: [ ] CM/ECF: [ ] Hand Delivery: [ ] U.S. Mail: [ ]

/s/ Bryan Hurlbutt
Bryan Hurlbutt

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	Agency Case No. 0101-22-01 OAH Case No. 23-245-01 **CERTIFICATION AND TRANSMITTAL OF AGENCY RECORD AND TRANSCRIPT**

I, Paula J. Wilson, certify and state as follows:

1. My name is Paula J. Wilson. I am a paralegal with the Energy and Natural Resources Division of the Idaho Attorney General's Office.

2. My duties as paralegal include assisting the Department of Environmental Quality with contested cases by organizing and managing the documents filed into the agency record.

3. In this capacity and for the purpose of contested cases, I am referred to as hearing coordinator.

4. As hearing coordinator, I am custodian of the record compiled under Idaho Code § 67-5249.

5. A true and correct copy of the *Agency Record and Transcript* is transmitted to the Idaho Board of Environmental Quality via posting at https://www2.deq.idaho.gov/admin/LEIA/api/document/download/21659 and available on the

Department of Environmental Quality's Petitions for Review website. The posted *Agency Record and Transcript* is current as of December 15, 2023, and will be updated as documents are filed with the Board.

6. I will issue a notice of briefing schedule on December 27, 2023. Date for oral argument is pending.

I certify under penalty of perjury pursuant to the law of the State of Idaho that the foregoing is true and correct.

Dated this 15th day of December, 2023.

/s/ Paula J. Wilson
Paula J. Wilson, Paralegal
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, Idaho 83706
paula.wilson@deq.idaho.gov

CERTIFICATE OF SERVICE

I HEREBY CERTIFY that on this 15th day of December, 2023, the foregoing was filed, served, and copied as shown below.

Hannah Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
hannah.young@deq.idaho.gov

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
Counsel for the Idaho
Board of Environmental Quality
ann.yribar@ag.idaho.gov

/s/ Paula J. Wilson
Paula J. Wilson

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	Agency Case No. 0101-22-01 OAH Case No. 23-245-01 **NOTICE OF BRIEFING SCHEDULE**

On October 31, 2023, the Hearing Officer issued the *Memorandum Decision on Motions for Summary Judgment and Preliminary Order*, and on November 14, 2023, Petitioners filed the *Petition for Review of Preliminary Order*.

On December 5, 2023, the Hearing Officer issued the *Amended Memorandum Decision on Motions for Summary Judgment and Preliminary Order*, and on December 15, 2023, Petitioners filed the *Amended Petition for Review of Preliminary Orders*.

Pursuant to Idaho Code § 67-5245 and IDAPA 58.01.23.730, NOTICE IS HEREBY GIVEN that the following schedule has been set for filing briefs in support of or taking exceptions to the *Memorandum Decision on Motions for Summary Judgment and Preliminary Order* and/or the *Amended Memorandum Decision on Motions for Summary Judgment and Preliminary Order*:

1. Petitioners' brief shall be filed by January 17, 2024.

2. Respondent's and Intervenor-Respondent's briefs shall be filed by February 7, 2024.

3. Petitioners' reply brief shall be filed by February 14, 2024.

Notice of Oral Argument is forthcoming.

Dated this 27th day of December, 2023.

/s/ Paula J. Wilson
Paula J. Wilson, Paralegal
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, Idaho 83706
paula.wilson@deq.idaho.gov

CERTIFICATION OF SERVICE

I HEREBY CERTIFY that on this 27th day of December, 2023, the foregoing was filed, served, and copied as shown below.

Hannah Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
hannah.young@deq.idaho.gov

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
Counsel for the Idaho
Board of Environmental Quality
ann.yribar@ag.idaho.gov

Dylan Lawrence
Varin Thomas LLC
P.O. Box 1676
Boise, ID 83701
Hearing Officer
dylan@varinthomas.com

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-004
filings@oah.idaho.gov

/s/ Paula J. Wilson
Paula J. Wilson

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	Agency Case No. 0101-22-01 OAH Case No. 23-245-01 **NOTICE OF ORAL ARGUMENT**

On October 31, 2023, the Hearing Officer issued the *Memorandum Decision on Motions for Summary Judgment and Preliminary Order*, and on November 14, 2023, Petitioners filed the *Petition for Review of Preliminary Order*.

On December 5, 2023, the Hearing Officer issued the *Amended Memorandum Decision on Motions for Summary Judgment and Preliminary Order*, and on December 15, 2023, Petitioners filed the *Amended Petition for Review of Preliminary Orders*.

Pursuant to Idaho Code § 67-5245 and IDAPA 58.01.23.730, NOTICE IS HEREBY GIVEN that oral argument will take place on March 14, 2024, at 9:30 a.m. Mountain Time, or as soon thereafter as the matter may be heard, in conference rooms C and D at the Department of Environmental Quality State Office, 1410 N. Hilton, Boise, Idaho. The parties will each be allowed thirty (30) minutes for argument, including rebuttal.

The oral argument in this matter will be heard by the Idaho Board of Environmental Quality at the Special Board Meeting scheduled to commence at 9:30 a.m. Mountain Time on March 14, 2024. The public may attend the meeting in person or via Microsoft Teams. The meeting location and Teams link will be available in the Meeting Notice posted at https://www.deq.idaho.gov/board-of-environmental-quality/ five (5) or more days prior to the meeting date.

Dated this 9th day of January, 2024.

/s/ Paula J. Wilson
Paula J. Wilson, Paralegal
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, Idaho 83706
paula.wilson@deq.idaho.gov

CERTIFICATION OF SERVICE

I HEREBY CERTIFY that on this 9th day of January, 2024, the foregoing was filed, served, and copied as shown below.

Hannah Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
hannah.young@deq.idaho.gov

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
Counsel for the Idaho
Board of Environmental Quality
ann.yribar@ag.idaho.gov

Dylan Lawrence
Varin Thomas LLC
P.O. Box 1676
Boise, ID 83701
Hearing Officer
dylan@varinthomas.com

ARV, A Veritext Company
Court Reporting Service
calendar-arv@veritex.com

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-004
filings@oah.idaho.gov

/s/ Paula J. Wilson
Paula J. Wilson

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	Agency Case No. 0101-22-01
	)	OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON	)	**PETITIONERS' OPENING BRIEF IN SUPPORT OF AMENDED PETITION FOR REVIEW OF PRELIMINARY ORDERS**
Petitioners,	)	
v.	)	
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC.	)	
Intervenor-Respondent.	)	

TABLE OF CONTENTS

THE CLEAN AIR ACT AND IDAHO AIR RULES 1

STATEMENT OF FACTS 4

I. THE STIBNITE GOLD PROJECT. 4

II. OVERVIEW OF PERPETUA'S APPLICATION AND DEQ'S APPROVAL. 5

III. PM10 EMISSIONS FROM THE PROJECT. 7

IV. ARSENIC EMISSIONS FROM THE PROJECT. 9

V. AMBIENT AIR BOUNDARY AND THE STIBITE ROAD ACCESS ROUTE. 11

CONTESTED CASE BACKGROUND 12

APPLICABLE LEGAL STANDARDS 15

ARGUMENT 16

I. AMBIENT AIR PROTECTIONS MUST BE MET ALONG THE STIBNITE ROAD ACCESS ROUTE. 16

A. DEQ Impermissibly Relied on Perpetua's Assertions That It Has Legal Control of the Route. 17

B. Because Perpetua Will Allow "Guests of the Mine" to Use the Route, the Route Is Ambient Air. 22

II.DEQ VIOLATED THE PROCEDURAL REQUIREMENTS OF THE AIR RULES BY ISSUING A PERMIT FIRST AND ALLOWING PERPETUA TO SUBMIT PROJECT PLANS LATER. 25

A. Petitioners Properly Raised This Issue in Their Petition to Initiate Contested Case and Opening Summary Judgment Brief. 25

B. By Deferring Permit Details to Be Determined Later Outside the PTC Process and Without Public Comment, DEQ Violated the Air Rules. 29

III. DEQ LACKED A REASONABLE BASIS FOR FINDING THE PROJECT WILL ACHIEVE 93.3% DUST CONTROL, AS NEEDED TO COMPLY WITH THE NAAQS AND TAPS. 35

IV. DEQ'S CREATION OF A "PROJECT SPECIFIC ADJUSTMENT FACTOR" TO ARTIFICIALLY DILUTE THE AMBIENT ARSENIC CONCENTRATIONS ATTRIBUTABLE TO THE SGP VIOLATES THE AIR RULES. 40

VI. THE PERMIT MUST BE SET ASIDE AND REMANDED TO DEQ TO CORRECT ALL ERRORS. 47

CONCLUSION 48

Table of Abbreviations & Terms

AACC.....Acceptable Ambient Concentrations of Carcinogens

Air Rules ..... Idaho Rules for the Control of Air Pollution

Amended Preliminary Order & Amended Order.....
..... Amended Memorandum Decision on Motions for Summary Judgment and Preliminary Order

AMP ..... Access Management Plan

CAA .....Clean Air Act

Claim No. 3 .....???

Contested Case Rules.....
..... DEQ's Contested Case Rules and Rules for the Protection and Disclosure of Records

CWA.....Clean Water Act

DEQ ..... Idaho Department of Environmental Quality

EPA ..... Environmental Protection Agency

FDCP..... Fugitive Dust Control Plan

HAP..... Hazardous air pollutants

HRCP ..... Haul Road Capping Plan

I.R.C.P. .....Idaho Rules of Civil Procedure

ICL ..... Idaho Conservation League

Idaho Rules of Administrative Procedure .....
.....Idaho Rules of Administrative Procedures of the Attorney General

NAAQS .....National Ambient Air Quality Standards

NMP(s).....Nutrient management plan(s)

O&M Plan .....Operations and Management Plan

PM.....Particulate matter

Preliminary Order .....

.....Memorandum Decision on Motions for Summary Judgment and Preliminary Order

Project ..... Stibnite Gold Project

PSD .....Prevention of Significant Deterioration

PTC .....Permit to construct

RACT .....Reasonable available control technologies

Route .....Stibnite Road Access Route

RTC .....Response to Comment

SGP ..... Stibnite Gold Project

SOB.....Statement of Basis

SSFS.....Save the South Fork Salmon

TAP .....Toxic air pollutants

Table of Authorities

Cases

917 Lusk v. City of Boise,
158 Idaho 12 (2015) 15

American Lung Association of Idaho/Nevada v. Idaho State Department of Agriculture,
142 Idaho 544 (2006) 15

Asarco Inc. v. State,
138 Idaho 719 (2003) 44

Black & Decker Corp. v. C.I.R.,
986 F.2d 60 (4th Cir. 1993) 44

Brown v. Caldwell School District No. 132,
127 Idaho 112 (1995) 46

Environmental Defense Center v. U.S. Environmental Protection Agency,
344 F.3d 832 (9th Cir. 2003) 34

Herdon v. West,
87 Idaho 335 (1964) 44

Idaho State Insurance Fund v. Hunnicutt,
110 Idaho 257 (1985) 18

In re Variance ZV2011-2,
156 Idaho 491 (2014) 47

Local 1494 of International Association of Firefighters v. City of Coeur d' Alene,
99 Idaho 630 (1978) 18

Mead v. Arnell,
117 Idaho 660 44

Mickelsen v. City of Rexburg,
101 Idaho 305 (1980) 45

Natural Resource Defense Council v. Thomas,
845 F.2d 1088 (D.C. Cir. 1988) 2

Perez-Guzman v. Lynch,
835 F.3d 1066 (9th Cir. 2016) 45

Radzanower v. Tourche Ross & Co.,
426 U.S. 148 (1976) 45

Tomich v. City of Pocatello,
127 Idaho 394 (1995) 44

Waterkeeper Alliance v. U.S. Environmental Protection Agency,
399 F.3d 486 (2d Cir. 2005) 31, 34

Federal Rules, Regulations & Statutes

40 C.F.R. § 50.6 7

40 C.F.R. § 50.7 7

40 C.F.R. § 51.160(a) 2, 29

40 C.F.R. § 51.160(b)–(c) 3, 30

40 C.F.R. § 51.161(a) 3, 30

40 C.F.R. § 52.02(a) 2

40 C.F.R. 50.1(e) 11, 16, 22

42 U.S.C. § 7401 et seq. 1

42 U.S.C. § 7407(d) 2

42 U.S.C. § 7408(a)(1)(A) 2

42 U.S.C. § 7409(a)(1) 2

42 U.S.C. § 7409(d) 2

42 U.S.C. § 7410 2

42 U.S.C. § 7410(a)(2)(A) 2

42 U.S.C. § 7410(a)(2)(C) 2

Idaho Rules, Regulations & Statutes

Idaho Rules of Civil Procedure 56(c) 15

Idaho Code § 67-5279 47

Idaho Code § 67-5279(3) 15

IDAPA 04.11.01.052 26

IDAPA 04.11.01.305 26

IDAPA 58.01.01 ..... 3,16, 27

IDAPA 58.01.01.006.05 ..... 16, 19

IDAPA 58.01.01.006.11 ..... 11, 16

IDAPA 58.01.01.006.125 ..... 11, 16

IDAPA 58.01.01.006.88 4

IDAPA 58.01.01.161 ..... 4, 9, 34, 40, 41, 44, 45, 47

IDAPA 58.01.01.202 ..... 3, 30

IDAPA 58.01.01.202.01.a.i 3, 30, 31

IDAPA 58.01.01.202.03 3

IDAPA 58.01.01.203 ..... 4, 9, 34, 35, 40

IDAPA 58.01.01.203.03 ..... 9, 41, 45-47

IDAPA 58.01.01.209 ..... 4, 29

IDAPA 58.01.01.209.01.b.i 4

IDAPA 58.01.01.209.01.b.ii 4

IDAPA 58.01.01.209.01.c 4, 30

IDAPA 58.01.01.209.01.c.i 30, 31, 34

IDAPA 58.01.01.209.04.b.iii 4

IDAPA 58.01.01.210 40-47

IDAPA 58.01.01.210.12 41

IDAPA 58.01.01.210.12.a 42

IDAPA 58.01.01.210.12.b 10, 42

IDAPA 58.01.01.210.12.c 42

IDAPA 58.01.01.210.14 10

IDAPA 58.01.01.210.15 ..... 41, 43, 45, 47

IDAPA 58.01.01.211 4

IDAPA 58.01.01.586 ..... 9, 41, 42, 45, 46

IDAPA 58.01.23 ..... 15, 25, 26

IDAPA 58.01.23.003.01 25

IDAPA 58.01.23.160.01 26

IDAPA 58.01.23.162.02 15

Other Authorities

Antonin Scalia & Bryan A. Garner,
Reading Law: The Interpretation of Legal Texts 183 (2012) 45

Petitioners Nez Perce Tribe ("NPT"), Idaho Conservation League ("ICL"), and Save the South Fork Salmon ("SSFS") submit this opening in support of their Amended Petition for Review of the Preliminary Orders.

In this contested case, Petitioners challenge the Idaho Department of Environmental Quality's ("DEQ" or "Department") approval of a permit to construct (the "Permit") issued to Perpetua Resources Idaho, Inc. ("Perpetua") for the proposed Stibnite Gold Project ("SPG" or "Project"): a large open-pit mine in Valley County, Idaho. As proposed, Perpetua would excavate 340 million tons of waste rock to mine and process approximately 100 million tons of ore, using 55 miles of haul truck routes over 16 years. Blasting, excavating, ore hauling, and other Project activities will emit air pollutants, including coarse particulate matter ("PM_{10}") and arsenic. PM_{10} and arsenic are regulated under the federal Clean Air Act and Idaho's air pollution regulations, because they can cause significant and severe health and environmental hazards.

The Hearing Officer committed multiple errors in granting summary judgment for DEQ and Perpetua in the October 31, 2023 Preliminary Order and the December 5, 2023 Amended Preliminary Order. The Preliminary Orders should be modified, amended, or revoked, and the Permit should be vacated and remanded to DEQ, based on the errors below.

THE CLEAN AIR ACT AND IDAHO AIR RULES

The federal Clean Air Act ("CAA"), 42 U.S.C. § 7401 *et seq.*, was passed to "protect and enhance the quality of the Nation's air resources" by prescribing national ambient air quality standards ("NAAQS") which state and regional authorities are required to either maintain or make progress toward. To achieve the CAA's goals, Congress directed the Environmental Protection Agency ("EPA") to establish primary and secondary NAAQS for any pollutant "reasonably . . . anticipated to endanger public health or welfare" and to periodically review and

revise those standards. *Id.* §§ 7408(a)(1)(A), 7409(a)(1), (d). The CAA also requires the EPA to divide up the country into areas designated as "nonattainment," "attainment," or "unclassified" based on whether these areas meet the NAAQS. *Id.* § 7407(d).

States have the primary responsibility for assuring that air quality within their borders meets the NAAQS. Each state must establish a state implementation plan (SIP), which is submitted to EPA for review. *Id.* § 7410. To be approved by EPA, each SIP must "include enforceable emission limitations and other control measures, means, or techniques . . . as may be necessary or appropriate to meet the applicable requirements of [the CAA]." *Id.* § 7410(a)(2)(A); 40 C.F.R. § 52.02(a). States can adopt and enforce their own standards regarding emissions "provided such state standard is no less stringent than any applicable federally mandated SIP provision." *Nat. Res. Def. Council v. Thomas*, 845 F.2d 1088, 1090 (D.C. Cir. 1988).

The CAA requires that State air rules "shall" include "enforceable emission limitations" and other control measures, means, or techniques as necessary or appropriate to meet CAA requirements. 42 U.S.C. § 7410(a)(2)(A). SIPs "shall" also include a "program to provide for the enforcement" of the limitations and measures described in subparagraph (A), and for the "regulation of the modification and construction of any stationary source . . . to assure that [NAAQS] are achieved." *Id.* § 7410(a)(2)(C).

EPA's CAA regulations require each SIP to "set forth legally enforceable procedures" that enable the State to determine whether the construction of a facility will result in a violation of its air pollution control strategies or interfere with attaining or maintaining the NAAQS. 40 C.F.R. § 51.160(a). These legally enforceable procedures must include means by which the State will prevent construction if the facility will violate air pollution control strategies or interfere with attaining or maintaining the NAAQS, and they must provide for the applicant to submit

information on the "location, design, construction, and operation of such facility . . . as may be necessary" to permit the State to "to make the determination" that the facility will comply with its air pollution control strategies and the NAAQS. *Id.* § 51.160(b)–(c). "The legally enforceable procedures in § 51.160(b) must also require" the State to provide opportunity for public comment on information submitted by the applicant and on the State's analysis of the effects on ambient air quality. *Id.* § 51.161(a).

EPA has delegated to DEQ authority to issue air quality permits in Idaho pursuant to the Rules for the Control of Air Pollution in Idaho ("Air Rules"), IDAPA 58.01.01. Prior to construction of a facility, the owner or operator must first obtain a permit to construct ("PTC") from DEQ which satisfies the applicable requirements of the Air Rules. Air Rules Section 201.

A PTC application "shall be accompanied by all information necessary to perform any analysis or make any determination required under Sections 200 through 228." Air Rules Section 202. The applicant must provide the following required information: "Site information, plans, descriptions, specifications, and drawings showing the design of the stationary source, facility, or modification, the nature and amount of emissions (including secondary emissions), and the manner in which it will be operated and controlled." Air Rules Section 202.01.a.i. The applicant must also provide: "Any additional information, plans, specifications, evidence or documents that the Department may require to make the determinations required under Sections 200 through 225 shall be furnished upon request." Air Rules Section 202.03.

Among other determinations, DEQ cannot issue a PTC unless it determines that the facility: (1) "would comply with all applicable federal emissions standards;" (2) "would not cause or significantly contribute to a violation of any ambient air quality standards" (i.e., the

NAAQS); and (3) "emissions of toxic air pollutants . . . would not injure or unreasonably affect human or animal life or vegetation as required by Section 161." Air Rules Section 203. When making these determinations, DEQ must consider the source's "potential to emit" ("PTE"), which is defined as:

> The maximum capacity of a facility or stationary source to emit an air pollutant under its physical and operational design. Any physical or operational limitation on the capacity of the facility or source to emit an air pollutant, including air pollution control equipment and restrictions on hours of operation or on the type or amount of material combusted, stored or processed, shall be treated as part of its design if the limitation or the effect it would have on emissions is state or federally enforceable. Secondary emissions do not count in determining the potential to emit from a facility or stationary source.

Air Rules Section 006.88.

For all PTC applications, DEQ must provide an opportunity for public comment. Air Rules Section 209.01.c. The Air Rules also require DEQ to issue either an "approval," a "conditional approval," or a "denial." Air Rules Sections 209.01.b.i & ii, c.iv. DEQ "may impose any reasonable conditions" upon the facility in the PTC. Air Rules Section 211. DEQ can also authorize revisions to permits, but such revisions must go through the Air Rule Section 209 public comment process if the revision results in an increase in emissions or if deemed appropriate by the DEQ director. Air Rules Section 209.04.b.iii.

STATEMENT OF FACTS

I. THE STIBNITE GOLD PROJECT.

Perpetua proposes to construct and operate a conventional open-pit mine with ore preparation and gold extraction facilities approximately 10 miles east of the town of Yellow Pine, in Valley County, Idaho. *See* REC 0415–17 (DEQ Statement of Basis ("SOB"), Facility Information). The Project is located on a combination of public National Forest and private

lands. *Id.* The Project is also geographically located within the Nez Perce Tribe's aboriginal homeland and within the area over which the Nez Perce Tribe has Treaty-reserved rights and resources. *See* REC 2390 (Oatman Decl.), 2548 (Taylor Decl.).

The Project includes 3 years of development and construction activities, followed by approximately 12 years of mining. REC 0415–17. The Project would require "construction of significant infrastructure," including a power transmission line, a primary mine site access road, onsite haul roads, an ore processing facility, onsite workspaces, employee housing and recreation, water storage and distribution facilities, and sewage disposal facilities. *Id.* Conventional open-pit mining methods including drilling, blasting, excavating, and hauling will be used to extract ore and waste rock (termed development rock) from three open pits. *Id*. Over the life of the mine, approximately 340 million tons of waste rock would be handled and 100 million tons of ore will be mined from the three pits. *Id.* A fleet of large trucks will haul ore and waste rock using a network of over 55 miles of unpaved haul roads at the mine site. REC 0431.

The Permit issued by DEQ on June 17, 2022 (REC 0367–409) is the first of over 50 permits required from various local, state, and federal agencies for the proposed mine. Perpetua is currently in the process of seeking these other permits for the proposed Project, including from the U.S. Forest Service, U.S. Army Corps of Engineers, and U.S. Fish and Wildlife Service.

II. OVERVIEW OF PERPETUA'S APPLICATION AND DEQ'S APPROVAL.

Perpetua (previously Midas Gold) submitted a PTC application to DEQ on August 20, 2019. *See* REC 0418–420 (SOB, Application Chronology). Between that date and March 6, 2020, DEQ determined that the application was incomplete, requested additional information, and received supplementary materials from Perpetua no fewer than four times. *Id.* On May 15, 2020, DEQ deemed Perpetua's application complete. *Id.*

Between May 15, 2020, and March 16, 2022, DEQ developed three versions of the draft Permit and released them for public comment. *Id.* As noted in comments submitted by the Nez Perce Tribe, ICL, SSFS, and other members of the public and agencies, the first two draft versions of the Permit (the "September 2020" and "February 2021" Draft Permits) contained significant shortcomings. *See* REC 0983–1000 (DEQ Response to Comments ("RTC")). After taking public comment, DEQ deemed the September 2020 draft Permit deficient and required updated information from Perpetua, including updated hazardous air pollutants ("HAP") and toxic air pollutants ("TAP") emissions estimates. *See* REC 0418–420.

DEQ subsequently updated the draft Permit in February 2021, and took public comment. *Id.* Following additional comments, DEQ determined that the February 2021 draft Permit was deficient and required additional information from Perpetua, including Prevention of Significant Deterioration ("PSD") emissions estimates and regulatory applicability for the lime manufacturing plant. *Id.*

DEQ revised the February 2021 draft PTC and released it for public comment on January 13, 2022. *Id.* Comments were submitted by the Nez Perce Tribe, ICL, SSFS, EPA, and Ian von Lindern of Terragraphics International Foundation. *See* REC 0915–0982. Commenters raised numerous concerns and urged DEQ to gather additional information, to perform additional modeling and analysis, and to develop additional enforceable permit conditions and limits prior to issuing a final Permit. *See id.*

DEQ rejected most of the issues raised by the commenters. *See id.* And on June 17, 2022, DEQ issued the final Permit (REC 0367–409) along with the Statement of Basis ("SOB") (REC 0410–0914) and Response to Comments ("RTC") (REC 0915–1000).

III. PM_{10} EMISSIONS FROM THE PROJECT.

Particulate matter ("PM") is a "criteria air pollutant." Under CAA Sections 108 and 109, EPA is required to establish NAAQS for each criteria pollutant to protect the nation's public health and welfare. The NAAQS specify a maximum amount of PM to be present in the outdoor air. *See* 40 C.F.R. §§ 50.6, 50.7. EPA established primary and secondary NAAQS for coarse particulate matter, or "PM_{10}," and for fine particulate matter, or "$PM_{2.5}$". 40 C.F.R. § 50.6–50.7. PM_{10} consists of inhalable particles with diameters that are generally ten micrometers and smaller; whereas, $PM_{2.5}$ consists of inhalable particles that are 2.5 micrometers and smaller. *Id.*

DEQ found that the Project has the potential to emit 986 tons per year of PM_{10} from a variety of controlled fugitive sources, plus 55.7 additional tons per year of PM_{10} from a variety of controlled point sources. REC 0430 (Table 3). The generation of dust from ore haul trucks traveling along haul roads is the most significant source, representing approximately 72% of all fugitive PM_{10} emissions, and 68% of all modeled PM_{10} emissions. *See id.* The next most significant sources of PM_{10} are from drilling and blasting activities, which together account for an estimated 21% of all fugitive PM_{10} emissions (20% of all emissions). *See id.*

To evaluate whether the Project would comply with the PM_{10} NAAQS, DEQ modeled receptors at various locations along the Project's ambient air boundary and found the Project would exceed the 24-hour PM_{10} NAAQS at one receptor, when using a single-value for PM_{10} background at the site. REC 0717–19 (SOB, App'x B at "TAPs Addendum Modeling Review"). DEQ then used seasonal and monthly background PM_{10} values to find that the maximum 24-hour PM_{10} pollution from the Project would be 123.5 micrograms per meter cubed ("ug/m^3), which is 82.3% of the NAAQS. REC 0717 (Table 7).

Among other factors, these modeled PM_{10} emissions are based on Permit Condition 3.5 limiting Perpetua's production to no more than 180,000 tons per day, and no more than an average of 135,000 tons per day on a rolling five-year basis. *See* REC 0421 (Table 1). They also depend on Perpetua achieving a 93.3% rate of control of fugitive dust. *Id.* Achieving these and other Permit conditions, and assumptions used in the modeling, also depend on future plans called for in the Permit, including a Fugitive Dust Control Plan ("FDCP"), Operations and Maintenance Plan ("O&M Plan"), and Haul Road Capping Plan ("HRCP"). *See* REC 0375, 0378, 0386 (Permit Conditions 2.6, 2.20, 3.13), 0456–57.

During public comment, Petitioners, EPA, and other commenters warned that DEQ unreasonably assumed PM_{10} emissions would be this low. REC 0921–25. Specifically, Petitioners and EPA commented that DEQ unreasonably assumed Perpetua would be able to control 93.3% of dust it would otherwise emit on haul roads, and pointed out that DEQ's assumptions relied on the yet-to-be determined details of numerous future plans that have not yet been developed by Perpetua, submitted to DEQ, or included as conditions of the Permit. *Id.*

In its comments, EPA underscored that achieving 93.3% control for excavation and haul roads, and 90% control for drilling, "are critical to ensuring no violation of the NAAQS and Title V HAP limits." REC 0921. EPA warned that the Permit lacks conditions necessary to assure Perpetua achieves these efficiencies and that record fails to show those efficiencies are achievable based on site-specific conditions. REC 0921–22. EPA also noted that DEQ failed to provide evidence to support its claim that a 90% control using magnesium chloride could be improved by also using water sprays to achieve a 93.3% control. REC 0923.

Similarly, the NPT, ICL, and SSFS commented that DEQ had not demonstrated that 93.3% control was attainable or enforceable under the Permit. REC 0921, 0923–24.

IV. ARSENIC EMISSIONS FROM THE PROJECT.

Arsenic is a Toxic Air Pollutant ("TAP") regulated by DEQ. Air Rules Section 586. DEQ determined arsenic is the largest projected TAP emission from the Project. REC 0435. DEQ found that the Project could emit 0.544 lbs/hr at the maximum mine production rate of 180,000 tons per day. REC 0433. Arsenic is a component of rocks, soils, and dust at the Project site, so arsenic emissions are essentially a percentage of the Project's PM_{10} emissions, and like with PM_{10}, the largest source of Project arsenic emissions are haul roads, estimated at 0.464 lbs/hr. REC 0428.

No PTC can be granted unless DEQ determines the applicant showed "the emissions of toxic air pollutants from the . . . source . . . would not injure or unreasonably affect human health or animal life or vegetation as required by Section 161." Air Rules Section 203.03. Section 161 states, "[a]ny contaminant which is by its nature toxic to human or animal life or vegetation shall not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation." Air Rules Section 161. For each carcinogenic TAP, including arsenic, the Air Rules set Acceptable Ambient Concentrations of Carcinogens ("AACC"), where each AACC is an annual average in ug/m^3. Air Rules Section 586. To demonstrate compliance with these TAPs requirements, ambient impacts must be less than the AACC. Air Rule Section 203; *see also* REC 0836.

Because of the Project's high arsenic emissions, Perpetua used what DEQ described in the SOB as "a highly refined TAPs analysis approach to demonstrate compliance with applicable TAP increments." REC 0698.

As one part of this approach, DEQ approved Perpetua's "T-RACT demonstration" to allow a 10-times increase in the arsenic AACC. *Id.* As the Air Rules provide, a permittee can

analyze reasonable available control technologies ("RACT") that could be applied to a source of TAPs. *See* Air Rules Section 210.14. If using RACT does not sufficiently reduce toxic emissions to below the AACC, then the permittee is allowed a 10-fold increase in the AACC and can employ production limitations to ensure compliance with the now increased AACC. *See* Air Rules Section 210.12.b. Perpetua submitted to DEQ a T-RACT demonstration for arsenic emissions from open-pit drilling and ore haul roads. *See* REC 0909–914 (SOB, App'x G, T-RACT Analysis). For open-pit drilling, Perpetua determined dry drilling with dust collectors was the most effective RACT. REC 0911. For ore haul roads, Perpetua determined that the application of chemical dust suppressant, supplemented with frequent watering, as the RACT. REC 0914.

As another part of this "highly refined" approach, DEQ allowed what it called an "AACC adjustment for the Operational Life of the Mine." REC 0698. Under this approach, instead of comparing the highest annual average ambient arsenic concentration during the Project lifetimes to the T-RACT adjusted AACC (which is also an annual average), DEQ stretched out and diluted the arsenic concentrations from the 16-year Project lifetime over a longer 70-year human life. *See* REC 0710. Multiplying the modeled highest annual arsenic concentration by 16 and dividing by 70, as DEQ did here, dilutes the arsenic concentration to only 23% of its actual value. During permitting, DEQ staff noted that this approach had not been used before, and raised concerns about whether it was permissible under the Air Rule. *See* REC 1183–190; REC 1191–96.

During public comment, Petitioners questioned DEQ's novel tactic for diluting the apparent arsenic exposure by spreading it over 70 years, and warned that without this the Project would exceed the arsenic AACC, even with the T-RACT adjustment. REC 0962, 0971, 0975. Petitioners also warned that DEQ failed to assess the environmental impacts caused by the

control technology, including by applying large amounts of magnesium chloride to roads to control dust, which can accumulate over time to toxic concentrations in trees and soils and can impact water. REC 0962, 0978.

In the end, DEQ approved Perpetua's T-RACT demonstration and, thus, granted a 10-fold increase in allowable arsenic pollution combined with using the creative new "adjustment" to dilute the apparent arsenic exposure to just 16/70 (or 23%) of its modeled value so that DEQ and Perpetua could determined the Project would comply with the AACC. *See* REC 0698.

V. AMBIENT AIR BOUNDARY AND THE STIBITE ROAD ACCESS ROUTE.

The CAA and Idaho Air Rules require Perpetua to meet various air standards, including the NAAQS and TAPs AACCs, in ambient air. *See*, *e.g.*, Air Rules Sections 006.11 (NAAQS), 006.125 (TAPs). EPA's CAA regulations define "ambient air" as "that portion of the atmosphere, external to buildings, to which the general public has access." 40 C.F.R. § 50.1(e).

The Stibnite Road Access Route ("Route") is a road that passes through what Perpetua and DEQ have defined as the mine's operations boundary and the ambient air boundary, and the inside of that boundary is the active industrial site where Project mining activities and heavy equipment operation will occur. REC 0415 (map). Perpetua has indicated that it will not cut off public access along the Stibnite Road Access Route during mine operations, and as explained by DEQ, Perpetua "will manage an access route to provide the general public with limited access through the [Project] site between Stibnite Road at Sugar Creek and Thunder Mountain Road at Meadow Creek." REC 0676.

In public comments, Petitioners urged DEQ to count the Stibnite Road Access Route as ambient air where air quality standards would have to be met, since Perpetua plans to allow public access on the Route. REC 0956–58. But DEQ excluded everything within the mine

operations boundary from ambient air—including the Stibnite Road Access Route. *See id.*; *see also* REC 0415 (map).

In its comments, EPA urged: "Given the unique situation with a public access road traversing the mine site, the key assumptions, parameters, and methodologies used to preclude public access from the mine site must be fully disclosed in the permit record and the necessary requirements be included in the permit and available for public review and comment." REC 0935. But instead of following EPA's advice, DEQ is instead allowing Perpetua to develop an Access Management Plan ("AMP") to address these issues later without public review. REC 0376, 0436.

CONTESTED CASE BACKGROUND

On June 17, 2022, DEQ issued a permit to construct ("PTC") P-2019.0047, which is the Permit at issue in this contested case. *See* REC 0367–0409 (Permit). On July 22, 2022, Petitioners timely filed the original Petition to Initiate Contested Case. REC 0001. On July 28, 2022, the Hearing Officer Dylan Lawrence was assigned to preside over this matter. REC 0031. On August 12, 2022, Perpetua filed a Petition to Intervene. REC 0040. On August 22, 2022, Perpetua's Petition to Intervene was granted. REC 0044. On September 6, 2022, Perpetua filed a Motion to Dismiss. REC 0052. On November 15, 2022, the Hearing Officer issued the Order on Motion to Dismiss, denying the motion with respect to the majority of Petitioners' claims, dismissing or partially dismissing four claims, and declining to allow the pleadings to be amended unless Petitioners file for consideration a formal motion to amend the Petition. REC 0160. On December 6, 2022, Petitioners filed their First Amended Petition to Initiate Contested Case. REC 0292.

After DEQ produced a Project Record and the Parties engaged in limited discovery, Petitioners filed a Motion for Summary Judgment on all claims remaining in the contested case on April 14, 2023. REC 0319 (Petitioners' Motion for Summary Judgment), 0323 (Petitioners' Opening Summary Judgment Brief), REC 0364 (Hurlbutt Declaration, submitting documents cited in brief). DEQ and Perpetua filed Cross Motions for Summary Judgment, along with opening briefs and declarations. *See* REC 1204-2316. On June 9, 2023, Petitioners filed a Response/Reply Summary Judgment Brief (REC 2317), additional documents (REC 2555), and standing declarations (REC 2372-2554). DEQ filed a "non-reply" (REC 2986), and Perpetua filed a reply brief (REC 2989).

On August 28, 2023, Perpetua and DEQ filed a joint Motion in Limine to exclude an August 10, 2023 letter from EPA Region 10 Administrator Casey Sixkiller to IDEQ Director Jess Byrne requesting an in-person meeting to discuss EPA's concerns with the Permit. REC 3097. In the letter, EPA raised three primary concerns with the Permit, including concerns that: DEQ used the wrong emission factors, and had it used proper emission factors, the SGP's potential to emit would exceed the major source permitting threshold; DEQ's emission limits were inadequate to demonstrate compliance with NAAQS for particulate matter; and DEQ's delineation of the SGP's ambient air boundary was not supported. Further explanation of the EPA's concerns were detailed in a 19-page enclosure. REC 3146. Three days later, Petitioners filed a Motion to Supplement with EPA's letter and enclosure, and on September 8, 2023, filed a Motion to Amend Contested Case Petition to add a claim regarding the issue EPA raised in its letter about whether DEQ used improper emission factors and was thus wrong when it concluded the SGP's potential to emit will be below major source thresholds. REC 3137. On September 15, 2023, the Hearing

Officer denied Perpetua and DEQ's motion in limine, granted Petitioners' motion to supplement with the EPA letter, and denied Petitioners' motion to amend. REC 3265.

On September 21, 2023, the Hearing Officer held a hearing on the cross motions for summary judgment. REC 3275 (Notice of Hearing), TR 0001 (Transcript).

On October 31, 2023, the Hearing Officer issued a Memorandum Decision on Motions for Summary Judgment and Preliminary Order (the "Preliminary Order"). REC 3280.

In the Preliminary Order, the Hearing Officer rejected DEQ's and Perpetua's arguments that Petitioners lacked standing to pursue this contested case, finding each Petitioner had standing to challenge the Permit. But the Hearing Officer ruled against Petitioners on all claims addressed in the Preliminary Order and granted Summary Judgment to DEQ and Perpetua. The Preliminary Order, however, never addressed one of Petitioners' bases for review: DEQ's allowing Perpetua to defer the submission of project plans until later, after the Permit is already issued, outside of the normal permitting process, and without public comment.

On November 14, 2023, Petitioners filed a timely Petition for Review of Preliminary Order, seeking review of the October 31, 2023 Preliminary Order, including review of the issue ("Claim No. 3") never addressed by the Hearing Officer, as well as review of additional issues. REC 3342.

On November 10, 2023, DEQ and Perpetua filed a Joint Motion for Reconsideration and/or Clarification regarding whether Claim No. 3 was addressed. REC 3332. Petitioners responded (REC 3361), and on December 5, 2023, the Hearing Officer issued an Order on Joint Motion for Reconsideration and/or Clarification (REC 3367) and also issued an Amended Memorandum Decision on Motions for Summary Judgment and Preliminary Order (the "Amended Preliminary Order") (REC 3372). The Amended Preliminary Order found Claim

No. 3 had already been dismissed and, alternatively, granted summary judgment to DEQ and Perpetua on Claim No. 3.

On December 15, 2023, Petitioners filed the Amended Petition for Review, seeking review of the same five issues as in the original Petition for Review, with minimal changes to reflect that review is now sought of the Preliminary Order and/or the Amended Preliminary Order. REC 3426.

APPLICABLE LEGAL STANDARDS

Petitioners bring this contested case to challenge DEQ's action in issuing the Permit. Under the Idaho APA, an agency action like DEQ issuing the Permit will be overturned where its findings, inferences, conclusions, or decisions are: "(a) in violation of constitutional or statutory provisions; (b) in excess of the statutory authority of the agency; (c) made upon unlawful procedure; (d) not supported by substantial evidence on the record as a whole; or (e) arbitrary, capricious, or an abuse of discretion." Idaho Code ("I.C."). § 67-5279(3). *See 917 Lusk v. City of Boise*, 158 Idaho 12, 14 (2015).

"An action is capricious if it was done without a rational basis. It is arbitrary if it was done in disregard to the facts and circumstances presented or without adequate determining principles." *Am. Lung Ass'n of Idaho/Nev. v. Idaho State Dep't of Agric.*, 142 Idaho 544, 547 (2006) (citations omitted).

Motions for summary judgment before the Board are allowed by IDAPA 58.01.23.162.02 and are governed by the Idaho Rules of Civil Procedure ("I.R.C.P."). Summary judgment is proper here under I.R.C.P. 56(c), because there is no genuine issue as to any material fact and Petitioners are entitled to judgment as a matter of law. I.R.C.P. 56(c).

ARGUMENT

I. AMBIENT AIR PROTECTIONS MUST BE MET ALONG THE STIBNITE ROAD ACCESS ROUTE.

The Clean Air Act and Idaho's Air Rules, IDAPA 58.01.01 *et seq.*, require Perpetua to meet various air quality standards, including the National Ambient Air Quality Standards ("NAAQS") and acceptable ambient concentrations of carcinogens ("AACCs") for toxic air pollutants ("TAPs"), in ambient air. *See*, *e.g.*, Air Rules Sections 006.11 (NAAQS), 006.125 (TAPs). The U.S. Environmental Protection Agency ("EPA") CAA regulations define "ambient air" as "that portion of the atmosphere, external to buildings, to which the general public has access." 40 C.F.R. § 50.1(e). This definition of ambient air is incorporated by reference in Idaho Air Rule 006.05.

The Permit, however, fails to provide any ambient air protections to the general public traveling on the Stibnite Road Access Route thought the SGP to access public lands, exposing the public to concentrations of particulate matter and toxic, carcinogenic air emissions that exceed the NAAQS and health-based standards for carcinogenic pollutants. This includes NPT, ICL, and SSFS members, whose declarations demonstrate that they regularly use the Route and will be injured by the Project. *See* REC 2372–2554 (Petitioners' standing declarations).

The Hearing Officer's determination that DEQ had substantial evidence of Perpetua's legal authority to preclude the public from entering, and reasonably determined that the Perpetua did not need to provide ambient air protections to the public traveling over the Stibnite Road Access Route to access recreational sites on public land was in err. The Board of Environmental Quality should grant this Petition for Review, set aside the Permit, and order DEQ on remand to ensure that the Stibnite Road Access Route maintains air quality consistent with the NAAQS and health-based standards for arsenic.

A. DEQ Impermissibly Relid on Perpetua's Assertions That It Has Legal Control of the Route.

The Stibnite Road Access Route ("Route") is a road that passes through what Perpetua and DEQ have defined as the mine's 14,000+-acre operations boundary and the ambient air boundary. The Amended Memorandum and Decision on Motions for Summary Judgment and Preliminary Order ("Amended Order") make several misstatements and implications regarding the Route, which are corrected here. First, the Amended Order states that "one could drive northeast from Cascade to reach the South Entry of the SGP." REC 3385. Currently, to access the South Entry by driving northeast from Cascade, one would have to pass through Yellow Pine to reach the North Entry and travel through the proposed mine site to reach the South Entry and public sites on National Forest land as the Burntlog Route does not exist.[1] . Second, the Amended Order states that the "Burntlog Route would provide year-round access to the south side of the SGP." REC 3386. This statement is true *only if* the Burntlog Road alternative is approved by the Forest Service after the NEPA process. However, even with the Burntlog Route, if access through the SGP is precluded, residents of Yellow Pine would have to travel west on Lick Creek Road, through McCall, south to Cascade, and northeast on Johnson Creek Road to reach the proposed Burntlog Route and the south side of the SGP to access public sites on National Forest land. REC 340. Finally, the Amended Order states that "if access through the SGP is precluded, those traveling from Yellow Pine to access those recreational areas would have to travel much farther and around the SGP to do so." REC 3387. This is true, however, *only if* the Forest Service approves the alternative that allows for the construction and extension of the

[1] Currently, access from Yellow Pine to public recreational sites is possible by continuing east, past the Stibnite Road turn off, and traveling along Sugar Creek on NF-374. However, this route will presumably be closed at the North Entry point because it is within the ambient air boundary. REC 340.

Burntlog Route, which currently does not exist, and thus far has not been approved.[2] If the Burntlog Route is not approved and travel is precluded through the SGP, the public will *not* have access to important public recreational areas on National Forest land. *Id.*

Second, the Hearing Officer erred in determining that it was reasonable for DEQ to rely on Pereptua's single, factual statement in its application that Perpetua had legal control of the Stibnite Road Access Route without any other documentation to that effect and without consideration of other, conflicting evidence in the record. *See* REC 3389–390. Specifically, the Hearing Officer's erred in three ways.

First, the Hearing Officer erred in determining that it was reasonable for DEQ to rely solely on one single statement made in the application by a permit applicant to determine that Perpetua had legal control over the Stibnite Road Access Route. *See* REC 3388–90. However, an agency's determination can only be upheld where "evidence supporting the agency decision is substantial when viewed in the light of *the entire record, including the body of evidence opposed to the agency's view.*" *State Ins. Fund v. Hunnicutt*, 110 Idaho 257, 261 (1985) (emphasis added); *see also Local 1494 of Intern. Ass'n of Firefighters v. City of Coeur d'Alene*, 99 Idaho 630, 638, (1978) (stating that a court's "task" is to "determine whether, on the whole record, the [agency's] decision was substantially supported by the evidence and by applicable law"). Instead of considering the whole record, the Hearing Officer stated, "in the experience of the Hearing Officer, it is not unusual for an agency to rely on representations made in a permit application." REC 3390. The Hearing Officer's finding that "DEQ's reliance on Perpetua's representation," without further consideration of the record as a whole, was "reasonable and supported by

[2] The other alternative mining route that the Forest Service is considering would follow Johnson Creek Road up to Yellow Pine and travel east along Stibnite Road to the North Entry of the SGP.

substantial evidence in the record" is inconsistent with Idaho Supreme Court precedent, and should be rejected.

Second, the evidence in the record does not support DEQ's finding that Perpetua had legal control over the Stibnite Road Access Route to preclude public access. As discussed above, the ambient air is "that portion of the atmosphere, external to buildings, to which the general public has access." Idaho Air Rules 006.05. The EPA's Revised Policy on Exclusions from "Ambient Air" states that the agency's

> longstanding policy is based on the view that the general public does not have access to land occupied by a stationary source . . . when the land meets both of the following conditions: (1) the land is owned or controlled by the owner or operator of the stationary source: and (2) the land is surrounded by a fence or other physical barriers that preclude general public access.

REC 1141. EPA's policy further explains:

> it uses "controlled" . . . to mean that the owner or operator of the source has the legal right to use the land, and that its land-use rights include "the power to control public access" *and* "the power to exclude the general public."

REC 1143 (emphasis added).

Here, DEQ's determination—based solely on the representation made by Perpetua in the application itself—that Perpetua has legal control to exclude the general public from the Stibnite Road Access Route was erroneous, unreasonable, and not supported by substantial evidence in the record. Perpetua's single statement on the issue provides that:

> [Perpetua] will legally control the SGP, an active industrial site where mining activities will occur, such as heavy equipment operation. Most areas of the mine will require strict safety protocols and controlled access. [Perpetua] has established an operations boundary to identify the area where public access will be excluded. Public access inside the operations boundary will be restricted for the life of the mine by physical barriers at points of potential access, including the current Stibnite Road point of entry and proposed site access via the Burntlog Route, as well as natural features of the landscape that prevent access.

REC 1807. Notably, Perpetua does not state that it *has* legal control over the Stibnite Road Access Route. That is because Perpetua does not have legal control over the Route, which is a public road managed by the Forest Service. To get legal control over the Route, and the power to *exclude* the public from it, requires Forest Service approval—something Perpetua has not received.

Perpetua is in the process of seeking Forest Service approval for the Stibnite Gold Project. However, not only has Perpetua yet to achieve such approval, even if the Forest Service approves the SGP, the SGP will not authorize Perpetua to exclude the public.

Perpetua initially proposed to the Forest Service during the NEPA process to exclude public access through the SGP site, which would limit or preclude all access to Thunder Mountain and other important public recreational sites. REC 0893, 0896. However, due to extensive public comments in opposition, access preclusion was dropped, and the *only* alternative now under consideration for approval by the Forest Service provides the public with continued access through the SGP on the Stibnite Road Access Route. REC 0983; *see also* REC 2677 (stating that "public access would be provided by" the Stibnite Road Access Route); REC 2625 (indicating that during operations "public access" will be provided "through the Operations Area Boundary [ ] by constructing new road through Yellow Pine pit and below mine haul road to link Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375)"); REC 2684 ("The 2021 [Modified Mine Plan] would include a 12-foot-wide gravel road to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375) through the SGP."); REC 2557 ("During operations, the public access road would be used to travel through the mine site and would provide seasonal use, open to all vehicles."). Thus, even if the Forest Service

approves the current mine plan, it would only give Pereptua the legal ability to "control public access;" it will not give Perpetua the legal "power to exclude the general public."

As is evident in the record before DEQ, the Forest Service has not approved the SGP yet, has therefore not given Perpetua legal control over the Stibnite Road Access Route, and based on the current alternative under consideration, will *not* give Perpetua the legal authority to preclude public access such that Perpetua can exclude the Stibnite Road Access Route from meeting ambient air quality standards. *See* REC 1142 (EPA policy stating that to exclude an area from ambient air, an "owner or operator of the source [must] ha[ve] the legal right to use the land, and that its land-use rights include 'the power to control public access' *and* 'the power to exclude the general public'"). DEQ's reliance on a single, unsupported statement from the permit applicant to determine that Perpetua has legal control to exclude the public from Stibnite Road Access Route, and thus exclude it from ambient air protections, is not supported by substantial evidence. In fact, the evidence in the record shows Perpetua does not have and will not have the power to exclude the public. DEQ's determination is thus arbitrary and capricious.

Third, the Hearing Officer's post-hoc rationale that DEQ's "broad enforcement authority" is relevant to the legality of DEQ'S determination on the application at hand cannot be used to justify improper and unreasonable decision-making. *See* REC 3390.

The Board must set aside and remand the Permit to DEQ, hold that Perpetua lacks the required authority to preclude public access on the Stibnite Access Route, and direct DEQ to treat the Route as ambient air entitled to air quality protections.

B. Because Perpetua Will Allow "Guests of the Mine" to Use the Route, the Route Is Ambient Air.

Because Perpetua does not–and will not[3]–have the legal right to preclude the public from using the Stibnite Road Access Route to access important public recreational sites (and thus would have to exclude the Stibnite Road Access Route from the ambient air boundary), it created a new definition for "guests of the mine" which neither has a basis in law nor in EPA policy or DEQ guidance. The Hearing Officer erred in finding that the Permit is consistent with the Idaho Air Rule's definition of ambient air, agency policy, and guidance documents, and that exclusion of the Stibnite Road Access Route from ambient air was appropriate. *See* REC 3392.

First, the Hearing Officer erroneously determined that the Permit conditions sufficiently demonstrate that the Permit complies with EPA's ambient air policy and DEQ guidance. *Id.* Air Rule 006.005 defines "ambient air" as "that portion of the atmosphere, external to buildings, to which the general public has access (incorporating EPA's regulatory definition of ambient air found in 40 C.F.R 50.1(e)). Conversely, if the general public does not have access, the area can be excluded from complying with ambient air quality standards. "EPA has long recognized that certain areas external to buildings may be excluded from the regulatory definition of ambient air because *the general public does not have access to them*." REC 1140 (emphasis added). As discussed above, "the general public does not have access to land occupied by a stationary source . . . when the land meets" two conditions: (1) it "is owned or controlled by the owner or operator . . .; and (2) the land is surrounded by a fence or other physical barriers that preclude general public access." REC 1141; *see also* REC 1109 (DEQ guidance stating the same). "Controlled"

[3] Again, the only alternative under consideration by the Forest Service would leave the Stibnite Road Access Route open for public use to travel through the SGP to public recreational sites, like Thunder Mountain and Monumental Summit.

means the owner or operator has "'the power to control public access' and 'the power to exclude the general public.'" REC 1141.

DEQ's guidance is similar to EPA's policy in that it "assume[s] that the air within the facility boundaries is ambient air unless the facility can demonstrate that public access is *precluded*." REC 1109. "The facility-proposed ambient air boundary must include justification that demonstrates the facility has reasonable control of the area *and effectively precludes public access on a routine basis.*" *Id.*

Point blank, in order to exclude an area from ambient air, both EPA's policy and DEQ's guidance together require that the owner or operator be able to *exclude* the general public from accessing the area on a routine basis. The Permit conditions referenced by the Hearing Officer do not demonstrate that.

The first condition in Permit Section 2.7 requires Perpetua to "[o]bserve all primary access points to preclude *unauthorized* public access." REC 0376 (emphasis added). It is unclear what "unauthorized" public access is. But the condition does not preclude authorized public access—travel over the Stibnite Road Access Route for access to public recreational sites—that would be allowed under the mine plan being considered for approval by the Forest Service. *See* REC 2677; REC 2625; REC 2684; REC 2557. The second condition in Permit Section 2.7 states that Perpetua may control access at the North and South Entry does not speak to precluding authorized public access, but only exerting some control over access. *See* REC 0376. The third condition in Permit Section 2.7 discusses "secondary access points" and is not relevant to access to the Stibnite Road Access Route, which is a primary access point. *See id.*

Finally, the fourth condition in Permit Section 2.7 restricts access to "guests of the facility." *Id.* Allowing the general public to use the Route such as to access public lands (as

Perpetua has committed to doing, and as the Forest Service expects under the Project it is reviewing), but labeling them "guests of the mine," does not count as precluding public access..

The Hearing Officer erred in finding that DEQ and Perpetua's labeling of the public as "guests of the mine" is consistent with EPA policy and DEQ guidance. *See* REC 3392–93. For example, "EPA also recognized that some persons that have both legal and practical access to the source's property" but "are not necessarily considered members of the general public." REC 1142. However, those persons EPA recognized as not necessarily members of the general public are limited to persons with a direct, business connection for accessing the facility, such as "employees of the owner or operator who work at the site, or business invitees; such as contractors or delivery persons." *Id.* These persons recognized by EPA are nothing like any and all people driving the Stibnite Access Route to access public lands.

Similarly, DEQ's guidance states that if the "general public [is] invited as part of the normal business conducted on the facility site" then the area where the "public is invited is determined to be ambient air." REC 1110. Furthermore, if the "general public [is] allowed on site as a part of a right-of-way easement or a common service road," then that road is "determined to be ambient air." *Id.* Here, the Stibnite Access Route is such a road that the general public will be invited and allowed to use. As such, the DEQ guidance (like EPA policy) affords people using the Route ambient air quality protections, whether or not Perpetua labels them "guests of the mine."

The Board should vacate and remand the Permit and hold that "guests of the facility" traveling the Stibnite Access Route are entitled to ambient air quality protections.

II. DEQ VIOLATED THE PROCEDURAL REQUIREMENTS OF THE AIR RULES BY ISSUING A PERMIT FIRST AND ALLOWING PERPETUA TO SUBMIT PROJECT PLANS LATER.

Under the Permit, Perpetua is allowed to submit the following plans in the future: the Fugitive Dust Control Plan ("FDCP"); the Haul Road Capping Plan ("HRCP"); the Operation and Maintenance Manual ("O&M"); and the Stibnite Road Access Management Plan ("AMP"). *See* REC 0375–76, 0378–80, 0385–86 (Permit conditions). These plans will include numerous Project details which significantly affect air emissions and public access. *See id.* Yet, because DEQ already issued the Permit, DEQ will review the plans outside of the PTC permitting process set forth in the Air Rules, including reviewing them without public comment.

Despite devoting extensive briefing to this issue in Petitioners' Opening Summary Judgment Brief (REC 0353–56) and Response/Reply Summary Judgment Brief (REC 2350–57), the Hearing Officer failed to even consider this issue in the Preliminary Order (*see* REC 3280–3328). In the Amended Preliminary Order, the Hearing Officer erred where he first found that Petitioners' failed to raise this issue, and he erred again when he found that DEQ satisfied the Air Rules anyway. REC 3403–7.

A. Petitioners Properly Raised This Issue in The Petition to Initiate Contested Case and Summary Judgment Briefs.

DEQ's Contested Case Rules and Rules for the Protection and Disclosure of Records ("Contested Case Rules"), IDAPA 58.01.23, govern contested cases, such as this one. The Contested Case Rules incorporate Rules 52 and 305 (among others) of the Idaho Rules of Administrative Procedure of the Attorney General ("Idaho Rules of Administrative Procedure"). IDAPA 58.01.23.003.01, .05. Rule 52 states:

> The rules in this chapter will be liberally construed to secure just, speedy and economical determination of all issues presented to the agency. Unless prohibited by statute, the agency may permit deviation from these rules when it finds that compliance with them is impracticable, unnecessary or not in the public interest.

IDAPA 04.11.01.052. Similarly, Rule 305 favors liberal construction of the pleadings and amendment if necessary:

> The presiding officer may allow any pleading to be amended or corrected or any omission to be supplied. Pleadings will be liberally construed, and defects that do not affect substantial rights of the parties will be disregarded. . . .

IDAPA 04.11.01.305 Rule 52 further provides: "Unless required by statute, the Idaho Rules of Civil Procedure and the Idaho Rules of Evidence do not apply to contested case proceedings." *Id*.

Nowhere do the rules require that a petition to initiate a contested case include specific claims for relief. Rather, Rule 160.01 provides that a contested case petition must include the following contents:

> a. Fully state the facts upon which it is based, including the specific alleged action or inaction of the Department;
>
> b. Refer to the particular provisions of statute, rule, order or other controlling law upon which it is based. Legal assertions will be accompanied by citations of cases and statutory provisions;
>
> c. State the relief sought; and
>
> d. State the basis for the petitioner's legal standing to initiate the contested case.

IDAPA 58.01.23.160.01.

The Amended Petition to Initiate Contested Case complied with these rules by including detailed factual and legal background describing DEQ's action in issuing the Permit and citing applicable laws and regulations. REC 0270–80. The Amended Petition also described the errors and omissions DEQ allegedly made when it issued the Permit. REC 0280–87. The Amended Petition also included a section on the requested relief, stating in detail the relief sought by Petitioners. REC 0287–291. The Amended Petition did not, and was not required to by the applicable rules, set forth separate claims for relief.

Later, in the Argument section of its Opening Summary Judgment Brief, Petitioners organized the brief to argue the separate bases upon which DEQ was alleged to have erred. *See* REC 0339–62. Each of these sections in the Opening Summary Judgment Brief addressed alleged errors, omissions, and other flaws which had been identified and discussed in the Amended Petition to Initiate Contested Case.

The Hearing Officer erroneously held that the issue of whether DEQ violated procedural requirements of the Air Rules when it issued the Permit first and allowed Perpetua to submit various plans later, outside the PTC process and without public comment, was not raised in the Amended Petition.

Both the original Petition and the Amended Petition included a Relief Requested section titled "FDCP, AMP, O&M Manual, & HRCP" which states as follows:

> DEQ must require Perpetua to submit the FDCP, AMP, O&M Manual, and HRCP (collectively, "Plans"), must provide for public comment on the Plans, must review and revise Plans to ensure the SGP's emissions comply with IDAPA 58.01.01.203, and must incorporate the Plans as enforceable PTC conditions.

REC 0025 (Petition, ¶ D); REC 0289–90 (Amended Petition, ¶ D). After the Hearing Officer's decision on the Motion to Dismiss, Petitioners revised Paragraphs 32 and 70 in the Amended Petition to Initiate Contested Case by adding CAA regulation and Idaho Air Rule provisions related to the permit review process requirements, including public comment requirements. *See* REC 0274–75, 0288. The FDCP and HRCP were already discussed in the original Petition to Initiate Contested Case in Paragraphs 37 and 39, including stating that these plans had not yet been developed but were being relied upon by DEQ; and after the decision on the Motion to Dismiss, Paragraph 37 was revised to add references raising the issue that DEQ failed to take public comment on the FDCP and HRCP in the First Amended Petition to Initiate Contested Case. *See* REC 0276–78. The O&M Manual was already discussed in the original Petition to

Initiate Contested Case in Paragraph 40; and after the decision on the Motion to Dismiss, Paragraph 40 was revised to add additional information about the O&M Manual and about Air Rule permit process requirements, including requirement for submitting project plans and for taking public comment. *See* REC 0278. The AMP was already discussed in the original Petition in Paragraphs 63 through 65, including raising the issue that DEQ was relying on the AMP even though it had not yet been written and would not go through public comment; and these statements remained in the Amended Petition. *See* REC 0286.

Petitioners also devoted extensive briefing to this issue in their summary judgment briefing. Petitioners' Opening Summary Judgment Brief included an entire section on this specific issue: Section III, titled "DEQ's Reliance on Future Plans to be Prepared by Perpetua Outside of the PTC Process Violates the Air Rules and CAA." REC 0353–56. In that section of the opening brief, Petitioners argued that DEQ violated the Air Rules and the CAA by relying on the FDCP, HRCP, O&M Manual, and AMP without preparing these plans during the permitting process set forth in the Air Rules and CAA, including without taking public comment on the plans. DEQ and Perpetua responded, opposing this specific claim on the merits, and without arguing the claim had been dismissed or was not raised in the Amended Petition. REC 1229–30 (DEQ); REC 1319–23 (Perpetua). Petitioners' Response/Reply Summary Judgment Brief again devoted an entire section to this issue: Section IV, titled "DEQ's Reliance on Future Plans to be Prepared by Perpetua Outside of the Permit Process Violates the Air Rules and the Clean Air Act." REC 2350–57. In fact, this was the lengthiest argument section of Petitioners' reply brief.

The Board should find that Petitioners properly raised this issue.

B. By Deferring Permit Details to Be Determined Later, Outside the PTC Process and Without Public Comment, DEQ Violated the Air Rules and the CAA.

DEQ deferred addressing many issues during the PTC permitting process and will let Perpetua address those issues in the future through various plans. Again, these "plans" include the the Fugitive Dust Control Plan ("FDCP"); the Haul Road Capping Plan ("HRCP"); the Operation and Maintenance Manual ("O&M"); and the Stibnite Road Access Management Plan ("AMP"). *See* REC 0375–76, 0378–80, 0385–86 (Permit conditions). All of the Plans are to be developed by Perpetua later and submitted to DEQ for 30 days prior to starting operation for review and approval without public comment. *See id.* (Permit Conditions 2.8, 2.21, 3.13).

DEQ's reliance on these future Plans violates the Air Rules and CAA, and is otherwise arbitrary and capricious. No provisions in the Air Rules authorize DEQ to save portions of a PTC to be developed later, outside the normal PTC permitting process. Rather, the Air Rules require DEQ to process PTC applications only when they are complete, require DEQ to ensure the applicant has submitted sufficient information so DEQ can make all required determinations for PTCs, and requires DEQ to take public comment. *See* Air Rules Section 209.

EPA's CAA regulations require each SIP to "set forth legally enforceable procedures" that enable the State to determine whether the construction of a facility will result in a violation of its air pollution control strategies or interfere with attaining or maintaining the NAAQS. 40 C.F.R. § 51.160(a). These legally enforceable procedures must include means by which the State will prevent construction if the facility will violate air pollution control strategies or interfere with attaining or maintaining the NAAQS, and they must provide for the applicant to submit information on the "location, design, construction, and operation of such facility . . . as may be necessary" to permit the State to "to make the determination" that the facility will comply with

its air pollution control strategies and the NAAQS. *Id.* § 51.160(b)–(c). "The legally enforceable procedures in § 51.160(b) must also require" the State to provide opportunity for public comment on information submitted by the applicant and on the State's analysis of the effects on ambient air quality. *Id.* § 51.161(a).

Under the Air Rules (which are Idaho's EPA-approved SIP), DEQ must provide an opportunity for public comment. Air Rules Section 209.01.c. During public comment, the "Department's proposed action, together with the information submitted by the applicant and the Department's analysis of the information, *will* be made available to the public . . . ." Air Rules Section 209.01.c.i. (emphasis added). A PTC application "must . . . be accompanied by all information necessary to perform any analysis or make any determination required under Sections 200 through 227," which includes the requirement to determine whether the facility will cause or contribute to a violation of the NAAQS. Air Rules Section 202. "Required Information" that the applicant must provide includes: "Site information, *plans*, descriptions, specifications, and drawings showing the design of the . . . facility, . . . the nature and amount of emissions . . . , and the manner in which it will be operated and controlled." Air Rules Section 202.01.a.i (emphasis added).

Here, instead of following these procedural requirements in Sections 202 and 209, DEQ rushed forward and issued Perpetua what is essentially a *partial, incomplete PTC*, based on incomplete information and analysis, and lacking numerous permit conditions. DEQ will effectively issue a complete PTC later, after Perpetua develops and submits to DEQ additional plans, information, and conditions through the AMP, HRCP, FDCP, and O&M Manual, shielded from public review and outside the normal PTC process required by the Air Rules and the CAA.

Through the future "plans," DEQ is allowing Perpetua to submit Section 202.01.a.i information later, and allowing itself to review that information later. But Air Rules Section 209.01.c.i requires the "information submitted by the applicant" and DEQ's "analysis of the information, will be made available to the public" for comment. DEQ's use of these future work plans, thus, violates the Air Rules and the CAA regulations upon which they are based. No provisions in the Air Rules authorize DEQ to save pieces of a PTC to be developed later, outside the normal PTC permitting process and without public comment as DEQ has done here.

The Board must, therefore, set aside and remand the Permit.

Not only does DEQ's reliance on these Plans fail to comport with the Air Rules and the CAA provisions discussed above, but it also undermines DEQ's determinations that the Project will comply with air quality standards. Because DEQ has deprived the public of meaningful involvement, and has failed to conduct a full and adequate review of the application before it issued the Permit, DEQ cannot reasonably claim that the Project will comply with the PM_{10} NAAQS and arsenic AACC.

Federal courts have rejected similar tactics when it comes to Clean Water Act ("CWA") permitting. In one case, the Second Circuit recognized that CWA permitting schemes that do not allow for public review of best management practices incorporated into permits violate the CWA. *Waterkeeper Alliance v. U.S. EPA*, 399 F.3d 486, 503-504 (2d Cir. 2005). The Second Circuit held that a permit that relies on best management practices but does not specifically list those best management practices in the permit itself "deprives the public of the opportunity for the sort of regulatory participation that the Act guarantees because [such a permit] effectively shields the . . . management plans from public scrutiny and comment." *Id*. at 503. The Ninth Circuit has similarly held that "programs that are designed by regulated parties must, in every instance, be

subject to meaningful review by an appropriate regulating entity to ensure that each such program reduces the discharge of pollutants to the maximum extent practicable [i.e., the relevant statutory standard]." *Envtl. Def. Ctr. v. U.S. EPA*, 344 F.3d 832, 856 (9th Cir. 2003).

By allowing Perpetua to provide plans, descriptions, specifications, and information about the manner in which the facility will be operated and controlled at a later date after the Permit has already been approved, DEQ has similarly circumvented the Air Rules and CAA permitting requirements, shielding the plans from public scrutiny and comment, depriving the public of meaningful review, and undermining DEQ's determinations that the Project will comply with applicable standards.

DEQ tries to rationalize its use of post-permit work plans as allowing "the permittee to prepare a specific plan or manual based on the actual equipment purchased and installed, the manufacturer's instructions and recommendations, as well as the operational characteristics of the facility after construction is completed." REC 1230. But the work plans for this Project go way beyond waiting for these limited types of relatively inconsequential final details.

For example, Permit Condition 3.13 requires that the HRCP include a sampling plan for analyzing arsenic concentrations of materials Perpetua uses, a silt content sampling plan, and information about the frequency with which Perpetua will inspect haul roads, among other similar requirements. REC 0385–86. It is entirely feasible for Perpetua to provide, and DEQ to review, these types of sampling plans and road inspection details during the public PTC permitting process. These plans do not depend on final details of actual equipment Perpetua purchases or the operational characteristics of the facility after it is complete. Many, if not all, of these details can and should have been developed during the PTC process and submitted to the public for comment.

Likewise, Permit Condition 2.6 requires the FDCP to include "specific criteria to determine what frequency and type (water and/or chemical) of dust suppressant must be applied, and appropriate suppressant application rates." REC 0376. Why couldn't Perpetua provide details on the "specific criteria" it will use "to determine" the frequency, type, and application rates of suppressants to DEQ for review during the public PTC process? Petitioners and the EPA raised serious concerns about Perpetua's ability to achieve 93.3% dust control; DEQ itself admitted this was an "aggressive" level of control that would require vigilant monitoring and aggressive requirements in the permit, and admitted that achieving 93.3% control is critical to ensuring the NAAQS are met. *See infra* Part III. Yet, the Permit does not require 93.3% dust control, and details about how Perpetua will control dust are to be developed later in the FDCP, without public comment.

Similarly, Permit Condition 2.7 requires the AMP to specify the "measures to be used to discourage public access to the facility." REC 0376. Again, what does this have to do with the equipment Perpetua actually purchases, and why could these measures not be submitted by Perpetua and reviewed by DEQ during the public PTC process? Access management is a critical issue that generated controversy during public comment. EPA warned in its comments: "Given the unique situation with a public access road traversing the mine site, the key assumptions, parameters, and methodologies used to preclude public access from the mine site must be fully disclosed in the permit record and the necessary requirements be included in the permit and available for public review and comment." REC 0935. But through the AMP DEQ is letting Perpetua decide important details about access management later, outside of public review.

Likewise, the Permit provides that the Operation and Maintenance Manual will "ensure compliance with emission limits (Permit Conditions 2.9, 2.13, 4.3, and 5.3)." REC 0378. But

again, the Permit does not include monitoring and recordkeeping requirements; Perpetua will develop those later, shielded from public scrutiny.

Like the nutrient management plans (NMPs) at issue in *Waterkeeper*, the work plans here are critical, indispensable features of the Permit. And like the EPA in *Waterkeeper*, DEQ here has acknowledged that details in these work plans are critical to ensuring the Project meets air quality standards. Thus, these plans and their details must be submitted by the applicant under Air Rules Section 202.01.a.i, and that information, along with DEQ's review of the information, are required to be made available to the public under Air Rules Section 209.01.c.i.[4]

Again, the Board should set aside and remand the Permit, and should require Perpetua to submit the AMP, FDCP, O&M Manual, and HRCP; to provide for public comment on the Plans; to review and revise Plans to ensure the Project's emissions, as limited by enforceable conditions, comply with Air Rules Section 203; and to complete these steps before issuing a new Permit—not afterward and behind closed doors.

---

[4] Purporting to address the merits of this issue, the Hearing Officer inexplicably considered only whether "deferring aspects of emissions monitoring and recordkeeping requirements to an O&M Plan that has not yet been developed." REC 3406. He never mentions the other three plans at issue (the FDCP, HRCP, and AMP), never mentions the public comment requirement and other permit application requirements of Air Rules Sections 202 and 209, and never mentions the *Waterkeeper* and *Environmental Defense Center* cases. *See* REC 3406–7. Again, these issues were briefed extensively by Petitioners and Perpetua (and to a lesser degree by DEQ).

And when he considered this one limited issue, the Hearing Officer faulted Petitioners for not offering "expert testimony explaining how deferring identification of the specific 'devices and methodologies' until later could be arbitrary, capricious, or an abuse of discretion." REC 3407. The Hearing Officer improperly ignored the fact that Petitioners extensively cited to DEQ's own statements (already discussed above), as well as the expert federal agency EPA and other commenters with expertise. *See also* REC 1036 (EPA stating that "[t]o make the [potential to emit] limitations enforceable as a practical matter, the permit should include the parameters and assumptions used to develop the fugitive dust emission factors estimates for the haul roads and access roads.").

III. DEQ LACKED A REASONABLE BASIS FOR FINDING THE PROJECT WILL ACHIEVE 93.3% DUST CONTROL, AS NEEDED TO COMPLY WITH THE NAAQS AND TAPS.

Under the Air Rules, DEQ cannot issue a PTC unless it determines that the facility: (1) "would comply with all applicable federal emissions standards;" (2) "would not cause or significantly contribute to a violation of any ambient air quality standards" (i.e., the NAAQS); and (3) "emissions of toxic air pollutants . . . would not injure or unreasonably affect human or animal life or vegetation as required by Section 161." Air Rules Section 203.

A critical factor affecting the SGP's fugitive dust emissions, and therefore whether DEQ can make the required determinations under Air Rules Section 203 that the Project will comply with the PM_{10} NAAQS and arsenic AACC limits, is the degree to which Perpetua will effectively control dust from haul roads. When it approved the Permit, DEQ assumed that Perpetua will achieve a 93.3% control efficiency of all haul road dust by using a combination of water sprays and chemical dust suppressants. However, as EPA and other commenters pointed out, it is highly questionable whether 93.3% fugitive dust control is realistically attainable for this Project, and even if it were technically possible, the Permit lacks sufficient conditions for DEQ to reasonably assume Perpetua will achieve such a high level of control.

The Hearing Officer concluded that DEQ reasonably determined that the Project will achieve 93.3% control because "the Permit includes a specific requirement that 93.3% control efficiency be achieved." REC 3402. This is incorrect. The Permit does not include a specific requirement to achieve 93.3% or any other level of dust control. *See* REC 0367–409 (Permit).

The Permit does include requirements for Perpetua to develop a Fugitive Dust Control Plan (Permit Condition 2.6, (REC 0375–76)) and a Haul Road Capping Plan (Permit Condition 3.13 (REC 0385–86)). And while Permit conditions 2.6 and 3.13 require specific things to be

included in those plans, none of the required contents of the plan ensure any specific control efficiency will be achieved—let alone an aggressive 93.3% control efficiency.

As approved, Perpetua can comply with the Permit conditions by submitting its plans to DEQ, even if those plans will not actually achieve 93.3% dust control. All Perpetua must do is describe what it will do to control dust, and then follow through on those plans. For example, if Perpetua's plans would only achieve only, say, 90% dust control in actuality, so long as Perpetua submits those plans to DEQ, DEQ signs off on them, and Perpetua follows through and complies with the deficient plans, then Perpetua will be in compliance with the terms of the Permit--even though it will not achieve 93.3% dust control. And this is significant, because Perpetua's and DEQ's modeling showed that if Perpetua cut its operations by a third (hauling 120,000 tons per day instead of the authorized 180,000 tons per day) and achieved only 90% dust control, this slightly lower dust control—even when combined with a major cut in mining activity—would cause exceedances of the PM_{10} NAAQS. REC 0691–92.

Thus, contrary to the Hearing Officer's finding, the Permit does not explicitly require 93.3% dust control. Moreover, the Permit lacks other conditions necessary to ensure such a high level of control is achieved. It was, therefore, arbitrary and capricious for DEQ to conclude the Project will achieve 93.3% control and thereby comply with the NAAQS.

The Hearing Officer also faulted Petitioners for not offering "expert testimony describing the terms they believe are necessary to ensure compliance." REC 3402. The Hearing Officer ignored the briefing and the expert testimony in the form of public comments and other submissions to DEQ made by the EPA, Petitioners, and others with technical expertise on this very issue, including briefing relying on expert statements.

As Petitioners noted in their summary judgment briefing, information in the record shows that 93.3% is a very high and aggressive level of control; EPA and other commenters questioned whether this was even achievable by applying chemicals and water as Perpetua plans to do; and DEQ itself repeatedly stated it would be critical to meeting the NAAQS, yet challenging to actually achieve, 93.3% control. *See* REC 0344–48. DEQ experts admitted that 93.3% is a high, aggressive, and a "challenging" level to achieve. REC 0431 (DEQ stating it will be "challenging to consistently and continuously achieve the targeted level of fugitive dust control"), 0629, 0691. Elsewhere in the Statement of Basis ("SOB"), DEQ admitted that meeting 93.3% was based on an "assumption" that Perpetua would appropriately apply water and magnesium chloride, "vigilant inspection and monitoring" would be required, and additional measures—not in the Permit—would be necessary in the Fugitive Dust Control Plan ("FDCP") Perpetua will develop later. REC 0456. DEQ modeling staff thus "recommend[ed] that the permit require an aggressive implementation of measures to achieve above 93% control efficiency for fugitive particulate emissions from roadways." REC 0694. Because DEQ did not include such limits, conditions, and aggressive implementation measures in the Permit, it was arbitrary and capricious for DEQ to assume this high 93.3% would be achieved, and that the Project would comply with the PM_{10} NAAQS and arsenic AACC.

In their briefing, Petitioners also pointed to guidance from the expert agency EPA to argue that even if one assumes that the high 93.3 % dust control efficiency could technically be achieved, the Permit fails to include enforceable limits on the spray frequency and rates, and other important factors, affecting whether Perpetua will in fact achieve anywhere near 93.3% dust control. EPA guidance identifies the following factors bearing on the effectiveness of chemical dust suppressants: (a) the dilution rate used in the mixture; (b) the application rate

(volume of solution per unit road surface area); (c) the time between applications; (d) the size, speed, and amount of traffic during the period between applications; and (e) meteorological conditions (rainfall, freeze/thaw cycles, etc.) during the period. REC 1163–82.

To be sure, the Permit includes conditions related to dust control. Permit Conditions 2.1 through 2.5 require Perpetua to take "reasonable precautions" to monitor and maintain records related to dust emissions; but they do not specify the quantity or frequency of spray or other important variables. *See* REC 0374–75. Permit Condition 2.6 requires Perpetua to develop the Fugitive Dust Control Plan ("FDCP"), which will become an enforceable part of the Permit, with a "list of all potential sources of fugitive dust emissions and the following reasonable precautions to minimize fugitive dust emissions." REC 0375. But Permit Condition 2.6 does not set out those "reasonable precautions" such as requirements for the frequency or quantity of sprays and other important variables that EPA (an expert) said is important. Instead, Condition 2.6 directs Perpetua to "[d]evelop specific criteria to determine what frequency and type (water and/or chemical) of dust suppressant must be applied, and appropriate suppressant application rates." REC 0376.

This vague direction for Perpetua to develop "criteria to determine" spray frequency, rates, and types in no way assures that the criteria Perpetua decides on will actually achieve its ambitious 93.3% control efficiency—or anywhere close to it. This is especially so since the FDCP will be developed by Perpetua and submitted to DEQ for approval 30 days prior to startup, without public comment. *See supra* II.B.

Again, DEQ (an expert agency) itself recognized that it will be "challenging to consistently and continuously achieve the targeted level of fugitive dust control for emissions from traffic on unpaved roadways, with over 55 miles of haul truck routes within the operations

boundary a fleet of 32 haul trucks weighting between 37 and 357 tons, and a targeted dust control efficiency of 93.3% accomplished by application of both dust suppressant and water controls." REC 0430. Later in the SOB, DEQ admitted that meeting 93.3% was based on an "assumption" that Perpetua would appropriately apply water and magnesium chloride, that "vigilant inspection and monitoring" would be required, and that additional measures beyond those actually required by the Permit would be necessary in the FDCP:

> Reduction of PM emissions from haul roads by a combined 93.3% was supported by assuming appropriate application of water and magnesium chloride dust suppression; DEQ is cognizant that to consistently achieve this level of control requires conscientious efforts, vigilant inspection and monitoring, and a comprehensive FDCP. Because continuous operation was proposed, suppression measures will need to account for and accommodate all weather conditions including diurnal and seasonal variability, and all traffic loads including mining and public traffic along publicly accessible roads. Conditions outside of what may normally be anticipated may require additional measures such as a reduction in vehicle speeds or selection of a more effective chemical dust suppressant. Although the FDCP specifies a minimum of efforts required, additional operational limits and monitoring are to be considered moving forward and evaluated for incorporation into the FDCP.

REC 0456.

DEQ's modeling staff similarly recognized that "it is critical for NAAQS compliance that this high level of control [(93.3%)] be achieved." REC 0641. The modeling staff called this "an aggressive level of control," adding that this "high level of emission control was needed to demonstrate compliance with NAAQS." REC 0691. Again, DEQ modeled what would happen if Perpetua cut its operations by a third (hauling 120,000 tons per day instead of the authorized 180,000 tons per day) and achieved only 90% dust control; DEQ found that this slightly lower dust control, even when combined with a major cut in mining activity, would cause exceedances of the PM10 24-hour NAAQS. REC 0691–92. Ultimately, DEQ's modeling team

"recommend[ed] that the permit require an aggressive implementation of measures to achieve above 93% control efficiency for fugitive particulate emissions from roadways." REC 0694.

But DEQ failed to require such "aggressive implementation" and "vigilant inspection and monitoring" in the Permit, instead relying on the vague direction for Perpetua to consider some of these issues later in its FDCP. Without determining first what dust suppressant types, frequencies, and rates Perpetua will employ, DEQ had no reasonable basis for assuming the Project will achieve 93.3% dust control as required so as not to cause or contribute to a violation of the NAAQS.

The Board should vacate and remand the Permit and hold that DEQ must include enforceable permit limits on the combinations, volumes, and frequencies for applying water sprays and chemical suppressants, as well as necessary monitoring and inspection, sufficient to achieve 93.3% dust control and meet the NAAQS before it can issue a PTC. Air Rules, Section 203.

IV. DEQ'S CREATION OF A "PROJECT SPECIFIC ADJUSTMENT FACTOR" TO ARTIFICIALLY DILUTE THE AMBIENT ARSENIC CONCENTRATIONS ATTRIBUTABLE TO THE SGP VIOLATES THE AIR RULES.

The Hearing Officer ignored the plain language of the Air Rules when he endorsed DEQ's use of "other methods" and DEQ's creation of a "project specific adjustment factor" to show (fictitiously) that the Project would comply with the arsenic toxic pollutant standards, as required to issue a PTC.

Under the Air Rules, "no permit to construct shall be granted" unless DEQ determines that the applicant has shown: "Using the methods provided in Section 210, the emissions of toxic air pollutants from the . . . source . . . would not injure or unreasonably affect human health or animal life or vegetation as required by Section 161." Air Rules Section 203.03.

Section 161 requires, "[a]ny contaminant which is by its nature toxic to human or animal life or vegetation shall not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation." Air Rules Section 161. For each carcinogenic TAP, including arsenic, the Air Rules set Acceptable Ambient Concentrations of Carcinogens ("AACC"), where each AACC is an annual average in ug/m3. Air Rules Section 586. If an applicant can demonstrate that its annual average emissions meet the specified AACC, then compliance with Section 161 is demonstrated. Air Rules Section 203.03 The AACC for arsenic is 0.00023 μg/m^3. *See id.*

The "methods provided in Section 210" (which must be followed to satisfy Section 203.03) spell out in detail how to estimate TAPs emissions and ambient concentrations. *See* Air Rules Section 210. Section 210 includes two explicit exceptions to meeting the normal AACCs in Sectio 586: (a) a project is short term (five years or less); and/or (b) a T-RACT demonstration is made. Air Rules Sections 210.12, 210.15. A T-RACT demonstration is a specific "emission standard based on the lowest emissions of toxic air pollutants that a particular source is capable of meeting by the application of control technology that is reasonably available." Air Rules Section 210. When either of these exceptions apply, the AACC is adjusted by increasing it tenfold (making it more lenient); but the applicant must still satisfy the adjusted AACC.

There are no other exceptions in the Air Rules.

The Stibnite Gold Project is for 16 years, and thus it is not eligible for the short-term (five-year-or-less) source exception at Section 210.15. DEQ did, however, grant the Section 210.12 T-RACT exception to Perpetua, which allows Perpetua 10 times the normal annual average arsenic limit, or 0.0023 ug/m^3 of arsenic (instead of 0.00023 μg/m^3). Even with this large leniency afforded by the T-RACT adjustment, DEQ found, however, that the Project would still

exceed the adjusted arsenic AACC of 0.0023 µg/m^3. In summary judgment briefing, Petitioners demonstrated based on Perpetua's and DEQ's modeling that annually the Project will result in around 0.0042 µg/m^3 arsenic.[5] This value, which represents the undisputed annual arsenic exposure modeled to occur during the 16 years of the Project, is *181%* of the T-RACT adjusted arsenic AACC and thus would not meet Section 210.12.a requirement that a "source's . . . approved T-RACT ambient concentration at the point of compliance" be "less than or equal to the amount" "which is equivalent to ten (10) times the [AACC] listed in Section 586." Air Rules Sections 210.12.b, c.

DEQ recognized that the Project would exceed the AACC, even with the T-RACT adjustment. To avoid this problem, DEQ created a new tactic not authorized under the Air Rules to artificially reduce the apparent arsenic exposure by spreading out the actual arsenic exposure resulting from the 16-year Project over a longer 70-year human lifetime. *See* REC 0698, 0710 (SOB, App'x B). This never-before-used tactic artificially reduces the apparent concentration of arsenic to a mere 23% (16/70 x 100) of what the arsenic concentration will actually be (based on Perpetua and DEQ's modeling) each year during the Project. This violates the Air Rules.[6]

---

[5] Applying the novel "lifetime exposure adjustment" to dilute the Project's annual arsenic concentration by 16/70, DEQ calculated a Maximum Modeled Lifetime Exposure Concentration of 0.00095 ug/m^3 of arsenic. REC 0714 (Table 6). *See also* REC 0710. This value is less than (about 41% of) the T-RACT adjusted arsenic AACC of 0.0023 ug/m^3 (*see* Air Rules Section 586). DEQ's dilution can be removed by multiplying 0.00095 ug/m^3 by 70 and then dividing by 16, which results in an *annual* arsenic exposure during the Project of 0.0042 ug/m^3.

[6] DEQ permitting staff recognized this problem, and documented their concerns in two memos. *See* REC 1183–90; REC 1191–96. DEQ staff acknowledged that this approach had not been used before, stating that requiring the methods in Section 210 is "certainly how DEQ has used this in the past." REC 1185. DEQ staff questioned whether this novel approach was allowed under the Air Rules. *See*, *e.g.*, REC 1188 ("Can a 70 year average concentration be used for comparison to AACCs rather than a single year average for Section 210 analyses?"). In the end, DEQ broke from its established practice of comparing annual average arsenic exposures from a facility to the annual average AACC and instead spread the arsenic exposures from the 16-year Project over 70 years, reducing the supposed arsenic exposure to a mere 23% of what it is really modeled be during Perpetua's operations. *See* REC 0710.

Again, Section 210 allows applicants to seek a 10-times larger AACC through T-RACT (a large leniency, which DEQ allowed Perpetua) and/or through the five-year-or-less short-term project exception (which everyone agrees does not apply to this 16-year Project). *Id.* But nothing in Section 210 allows DEQ to grant *even greater leniency* or use of a "qualitative" standard when it comes to meeting the AACCs, such as by diluting a project's 16-year TAPs concentrations over 70 years, as it did here.

During these proceedings, DEQ conceded that this 16/70 adjustment is not found in the Air Rules. At the summary judgment hearing, DEQ's counsel explained that the agency "applied the five-year rule [in Section 210.15] by analog and extend[ed] it to a 16-year projected mine site." TR 0021 (Transcript p. 80). Similarly, in its briefing and declarations, DEQ explained:

> [This] approach to modeling TAP compliance employed the Short-Term Source Factor rule (Section 210.15) by analogue. This section allows an impact of 10 times the AACC for projects having an operational lifetime of no greater than five years. DEQ simply used this general approach to develop *a project-specific adjustment factor* for the [Stibnite Gold Project], using the 16-year maximum life of the project.

REC 1227 (quoting Schilling Decl. 11–12) (internal citations omitted) (emphasis added). DEQ, thus, admits that it instead of applying the "methods provided in section 210" (as required by the Air Rules), such as the applying the short-term exception at 210.15 as written, it used the short-term exception as a starting point to then make up an entirely new exception for Perpetua—"a project specific adjustment factor."

Accepting DEQ's approach, the Hearing Officer stated that "unless an issue is squarely addressed by the Air Rules, the hearing officer will defer to 'practical' interpretations of the Air Rules by DEQ." REC 3378. But as already stated above, the Air Rules squarely address this issue: they provide two specific exceptions to meeting the numeric arsenic AACC (the short-term exception at 210.15 and the T-RACT exception at 210.10); and they do not provide

other exceptions. The Hearing Officer erred by deferring to DEQ's "practical" interpretation, an interpretation fabricated a third exception found nowhere in the Rules.

DEQ is not free to disregard the plain language of the Air Rules, even if it has some rationale for doing so. Agency rules (like the Air Rules) have the full force and effect of law. *See Mead v. Arnell*, 117 Idaho 660, 664–65 (1990). As the Idaho Supreme Court has explained: "We must follow the law as written. If it is socially or economically unsound, the power to correct it is legislative, not judicial." *Herndon v. West*, 87 Idaho 335, 339 (1964). Thus, the Air Rules—as written—apply to the Project, whether or not DEQ has some rationale for deviating from the plain language of the rules.

Nor can DEQ simply amend the Air Rules through the process of issuing an individual permit, as it did here when it invented "a project specific adjustment factor" for Perpetua. A rule is void if it was not adopted following the required processes. *See Asarco Inc. v. State*, 138 Idaho 719, 722–25 (2003) (voiding TMDL issued by DEQ because it qualified as a rule and was not promulgated according to the rulemaking requirements of the Idaho Administrative Procedure Act). DEQ can seek to change the Air Rules following the required process under the Idaho APA and other applicable laws. Until then, DEQ must follow the Air Rules "as written," and DEQ is not free to make up project-specific rules for Perpetua, as it did here.

The Hearing Officer also erred by drawing on the general provisions of the Rules at Sections 161 to override the specific provisions in Section 210 and 586. "Regulations, like statutes, are interpreted according to canons of construction." Black & Decker Corp. v. C.I.R., 986 F.2d 60, 65 (4th Cir. 1993). Under the canon of *generalia specialibus non derogant*, when there is a conflict between a general provision and a specific provision, the specific provision prevails. "The canon provides that a 'narrow, precise, and specific' statutory provision is not

overridden by another provision 'covering a more generalized spectrum' of issues." *Perez-Guzman v. Lynch*, 835 F.3d 1066, 1075 (9th Cir. 2016) (quoting *Radzanower v. Tourche Ross & Co.*, 426 U.S. 148, 153–54 (1976)). "[T]he assumption being that the more specific of two conflicting provisions 'comes closer to addressing the very problem posed by the case at hand and is thus more deserving of credence.'" *Perez-Guzman*, 835 F.3d at 1075 (quoting Antonin Scalia & Bryan A. Garner, Reading Law: The Interpretation of Legal Texts 183 (2012)). The Idaho Supreme Court applies this cannon. *See Tomich v. City of Pocatello*, 127 Idaho 394, 400 (1995); *Mickelsen v. City of Rexburg*, 101 Idaho 305, 307 (1980).

Again here, Air Rules Section 203.03 requires "no permit to construct shall be granted" unless DEQ determines that the applicant has shown: "Using the methods provided in Section 210, the emissions of toxic air pollutants from the . . . source . . . would not injure or unreasonably affect human health or animal life or vegetation as required by Section 161." To protect human health, Section 586 specifically sets a numeric arsenic AACC at an annual average of 0.00023 ug/m^3. Section 210 creates two specific exceptions to meeting the AACC (which is an annual emissions factor), allowing a 10x higher AACC where the applicant makes a T-RACT demonstration (Section 210.10) and/or where a project is short-term (5 years or less) (Section 210.15).

Disregarding these specific, numerical provisions in Sections 586 and 210, and disregarding Section 203.03's unequivocal command to "Us[e] the methods provided in section 210," the Hearing Officer accepted DEQ's argument that it could rely on other general and qualitative language in the Air Rules as an excuse for DEQ to invent and grant Perpetua "a project specific adjustment factor." *See* REC 3419–21. Specifically, the Hearing Officer relied on the "qualitative" standard in Air Rule 161, which provides that a toxic air pollutant "shall not be

emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation." REC 3419. The Hearing Officer's interpretation runs afoul of basic rules of regulatory interpretation, because it lets a general and qualitative provision trump the specific numeric provisions that apply.

Another cannon of construction requires interpreting regulations to avoid rendering provisions superfluous. "A statute should be construed so that effect is given to all its provisions, so that no part will be rendered superfluous or insignificant." *Brown v. Caldwell Sch. Dist. No. 132*, 127 Idaho 112, 117 (1995). In order to determine whether a project will meet the Air Rules' general, qualitative directive that it "would not injure or unreasonably affect human health or animal life or vegetation", the Air Rules explicitly require the applicant and DEQ to "Us[e] the methods provided in Section 210" to make such a determination. Air Rules 203.03. To do so, DEQ must find that the applicant has shown it will meet the numerical AACC for arsenic (0.00023 ug/m^3), which is specifically set in the Air Rules at Section 586. And again, Section 210 includes two specific exceptions for when a project need not meet that AACC (projects that have demonstrated T-RACT and short-term five-year-or-less projects), which must meet a more lenient AACC. Under DEQ's interpretation of the rules, where it can simply offer a qualitative explanation for why any project will not injure or unreasonably affect human health, then what is the point of Section 203.03's directive to follow the methods in Section 210? What is the point of the numeric AACC for arsenic and other carcinogens in Section 586? What is the point of the two explicit exceptions to meeting the AACCs in Section 210 (T-RACT, and five-year-or-less short term projects)? DEQ's interpretation renders these provisions superfluous and, thus, cannot stand.

In summary, even with the T-RACT adjustment allowing a 10 times higher limit, Perpetua's and DEQ's modeling shows that the Stibnite Gold Project would exceed the arsenic AACC. DEQ agrees that the Project was not eligible for the short-term five-year-or-less project adjustment set forth in the Rules at Section 210.15. DEQ also agrees that annual arsenic emissions as calculated over the 16-year lifetime of the Project exceeds the T-RACT adjusted AACC. But instead of denying the Permit or requiring Perpetua to reduce arsenic emissions as required by Air Rules Section 203.03, DEQ created "a project specific adjustment factor" of 16/70 to dilute the apparent arsenic to a mere 23 percent of its true, modeled concentration. Accepting this approach, the Hearing Officer allowed DEQ to impermissibly ignore and rewrite the Air Rules.

The Hearing Officer incorrectly interpreted the Air Rules to find a "qualitative standard" for compliance with Section 161 that neither exists in Section 210 nor anywhere else in the Air Rules to justify DEQ's "16/70 adjustment." *See* REC 3421 DEQ does not have discretion to deviate from the plain language of the Air Rules and make up new exceptions to meeting the AACCs. The Board must, therefore, set aside and remand the Permit and order that DEQ not authorize the Permit unless it will comply with the arsenic AACCs using the methods in Air Rules Section 210, without any "project specific adjustment factor" of 16/70.

V. THE PERMIT MUST BE SET ASIDE AND REMANDED TO DEQ TO CORRECT ALL ERRORS.

Under the Idaho APA, when an agency action is not affirmed by a court, it "shall" be set aside, in whole or in part, and remanded for further proceedings as necessary. I.C. § 67-5279. *See also In re Variance ZV2011-2*, 156 Idaho 491, 496 (Idaho 2014) (vacating and remanding arbitrary agency action for further proceedings consistent with the Court's opinion). Upon reversing the Hearing Officer and granting summary judgment for Petitioners on any of their

claims above, the Board of Environmental Quality should set aside the Permit and remand to DEQ to correct the errors it made when it issued the Permit.

CONCLUSION

Petitioners request that the Board of Environmental Quality issue an order remanding to DEQ and vacating the Permit, and/or remand to the Hearing Officer for additional proceedings.

Dated: January 17, 2024

Respectfully submitted,

/s/ Bryan Hurlbutt
Bryan Hurlbutt
Attorney for the Nez Perce Tribe and the Idaho Conservation League

/s/ Julia S. Thrower
Julia S. Thrower
Attorney for Save the South Fork Salmon

CERTIFICATE OF SERVICE

I hereby certify that on January 17, 2024, a true and correct copy of Petitioners' Opening Brief was served on the following:

By email and U.S. Mail:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov

Dylan B. Lawrence
Varin Thomas, LLC
242 N. 8th St., Suite 220
Boise, ID 83702
(208) 345-6021
dylan@varinthomas.com
Hearing Officer

By email only:

Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, ID 83706
(208) 373-0422
hannah.young@deq.idaho.gov
Attorney for Respondent Idaho Department of Environmental Quality

Ann Yribar
Deputy Attorney General
Office of the Attorney General
P.O Box 83720
Boise, ID 83720-0010
ann.yribar@ag.idaho.gov
Attorney for the Idaho Board of Environmental Quality

Krista McIntyre
W. Christopher Pooser
Wade Foster
Stoel Rives, LLP
101 S. Capital Blvd., Suite 1900
Boise, ID 83702
(208) 389-9000
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
Attorneys for Intervenor Perpetua Resources of Idaho, Inc.

/s/ Julia Thrower
Julia Thrower

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	Agency Case No. 0101-22-01 OAH Case No. 23-245-01 **AMENDED NOTICE OF ORAL ARGUMENT**

On October 31, 2023, the Hearing Officer issued the *Memorandum Decision on Motions for Summary Judgment and Preliminary Order*, and on November 14, 2023, Petitioners filed the *Petition for Review of Preliminary Order*.

On December 5, 2023, the Hearing Officer issued the *Amended Memorandum Decision on Motions for Summary Judgment and Preliminary Order*, and on December 15, 2023, Petitioners filed the *Amended Petition for Review of Preliminary Orders*.

Pursuant to Idaho Code § 67-5245 and IDAPA 58.01.23.730, NOTICE IS HEREBY GIVEN that oral argument will take place on March 14, 2024, at 9:00 a.m. Mountain Time, or as soon thereafter as the matter may be heard, in conference rooms C and D at the Department of Environmental Quality State Office, 1410 N. Hilton, Boise, Idaho. The parties will each be allowed thirty (30) minutes for argument, including rebuttal.

The oral argument in this matter will be heard by the Idaho Board of Environmental Quality at the Special Board Meeting scheduled to commence at 9:00 a.m. Mountain Time on March 14, 2024. The public may attend the meeting in person or via Microsoft Teams. The meeting location and Teams link will be available in the Meeting Notice posted at https://www.deq.idaho.gov/board-of-environmental-quality/ five (5) or more days prior to the meeting date.

Dated this 30th day of January, 2024.

/s/ Paula J. Wilson
Paula J. Wilson, Paralegal
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, Idaho 83706
paula.wilson@deq.idaho.gov

CERTIFICATION OF SERVICE

I HEREBY CERTIFY that on this 30th day of January, 2024, the foregoing was filed, served, and copied as shown below.

Hannah Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
hannah.young@deq.idaho.gov

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
Counsel for the Idaho
Board of Environmental Quality
ann.yribar@ag.idaho.gov

Dylan Lawrence
Varin Thomas LLC
P.O. Box 1676
Boise, ID 83701
Hearing Officer
dylan@varinthomas.com

ARV, A Veritext Company
Court Reporting Service
calendar-arv@veritex.com

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-004
filings@oah.idaho.gov

/s/ Paula J. Wilson
Paula J. Wilson

RAÚL R. LABRADOR
Attorney General

SCOTT L. CAMPBELL
Deputy Attorney General
Chief, Energy and Natural Resources Division

HANNAH M.C. YOUNG, ISB #9781
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: (208) 373-0422
Facsimile: (208) 373-0481
Email: hannah.young@deq.idaho.gov

Attorneys for Respondent

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047

NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,

Petitioners,
v.

IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,

Respondent,
and

PERPETUA RESOURCES IDAHO, INC.,

Intervenor – Respondent.

Agency Case No. 0101-22-01

OAH Case No. 23-245-01

RESPONDENT IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY'S BRIEF AND RESPONSE TO PETITIONERS' OPENING BRIEF

TABLE OF CONTENTS

TABLE OF CONTENTS 2
INTRODUCTION 3
PROCEDURAL HISTORY 3
STATEMENT OF FACTS 5
LEGAL STANDARDS 6
I. Standard of Review. 6
II. Agency Deference. 7
ARGUMENT 8
I. DEQ acted reasonably and in accordance with all applicable law in excluding the Stibnite Access Road from the Ambient Air Boundary. 8
A. DEQ reasonably relied on Perpetua's assertions regarding control of the Route, and the record supports DEQ's determination. 8
B. The PTC requires Perpetua to have the ability to restrict the general public from the Route. 10
C. DEQ and EPA guidance support DEQ's determination that the Route is not "ambient air." 11
II. DEQ acted reasonable and did not violate any rule or statute by allowing Perpetua to submit certain plans later. 13
A. Allowing Perpetua to submit the Plans later does not violate the CAA or the Air Rules. 13
B. DEQ's Approach was reasonable and is customary practice. 19
III. DEQ clearly demonstrated a reasonable basis for determining that Perpetua can achieve 93.3% dust control under the terms of the PTC. 20
A. DEQ had a reasonable basis to determine Perpetua could achieve 93.3% dust control. 21
B. The PTC includes enforceable and sufficient conditions to ensure compliance with Idaho's Air Rules. 22
IV. DEQ's "project specific adjustment factor" clearly complied with the Air Rules, and DEQ used proper discretion and expertise to average arsenic emissions over the projected duration of the Mine. 26
A. DEQ's use of the "project specific adjustment factor" is not contrary to the Air Rules. 27
B. DEQ did not rely on a qualitative standard and Petitioners misunderstand DEQ's approach. 31
CONCLUSION 32

Respondent, the Idaho Department of Environmental Quality ("DEQ"), by and through the Office of the Attorney General, hereby submits this Brief and Response to Petitioners' Opening Brief.

INTRODUCTION

On June 17, 2022, DEQ issued a Permit to Construct ("PTC") to Perpetua Resources Idaho, Inc. ("Perpetua") for the Stibnite Gold Project ("SGP"). REC 1274. The PTC, which is the subject of this petition for review, was issued after a nearly three-year permitting effort by DEQ. *Id.* This effort included three extended public comment periods, two public informational meetings, frequent meetings with Perpetua, numerous requests for additional information from Perpetua, and four permit iterations. *Id*. Nez Perce Tribe, Idaho Conservation League ("ICL"), and Save the South Fork Salmon ("SSFS") (collectively, "Petitioners") challenge the permitted dust emissions covered by the PTC in this petition to the Board of Environmental Quality ("the Board").

Although Petitioners make many claims in their Opening Brief, they present no evidence or facts demonstrating that DEQ acted unreasonably or violated any rule or statute in issuing the PTC. Petitioners' arguments can primarily be summarized as a collection of gross oversimplifications and misstatements. The Hearing Officer, who carefully and thoroughly considered this matter for over a year after Petitioners first challenged the PTC issuance, also found Petitioners' claims unpersuasive, granting Summary Judgment in DEQ and Perpetua's favor. DEQ now urges the Board to do the same and find that the PTC meets all applicable legal requirements and to uphold the Hearing Officer's December 5, 2023 decision.

PROCEDURAL HISTORY

On July 22, 2022, Petitioners initiated a contested case, challenging DEQ's issuance of the PTC to Perpetua for the SGP. REC 0001-0028. Soon thereafter, the Board appointed a Hearing

Officer to oversee and decide the contested case. REC 0031-0032. On August 12, 2022, DEQ responded to the Petition, denying it committed any error in issuing the PTC. REC 0033-0039. That same day, Perpetua filed a petition to intervene in the contested case, as the permittee, which the Hearing Officer granted. REC 0040-0045.

On September 6, 2022, Perpetua filed a Motion to Dismiss the Petition, which DEQ joined. REC 0052-0124. The Hearing Officer ruled on the Motion to Dismiss on November 15, 2022, dismissing three of Petitioners' claims and partially dismissing an additional claim. REC 0160-0186. Thereafter, Petitioners were given leave to amend their Petition and an Amended Petition was filed on January 11, 2023. REC 0263-0292.

Petitioners filed a Motion for Summary Judgment on April 14, 2023, and DEQ and Perpetua filed their own Motions for Summary Judgment on May 12, 2023. REC 0319-0363; REC 1204-1232; REC 1276-1336. The Hearing Officer held a hearing on the motions on September 21, 2023. REC 3275-3279. On October 31, 2023, the Hearing Officer issued a *Memorandum Decision on Motions for Summary Judgment and Preliminary Order*, appearing to dismiss all of Petitioners' claims. REC 3280-3328. Because DEQ and Perpetua sought clarity on whether the Hearing Officer did intend to dismiss all of Petitioners' claims, they filed a Joint Motion for Reconsideration and/or Clarification on November 10, 2023. REC 3332-3341. On December 5, 2023, the Hearing Officer issued his *Amended Memorandum Decision on Motions for Summary Judgment and Preliminary Order* ("Preliminary Order"). REC 3372-3425. The Hearing Officer made it clear he dismissed <u>all</u> of Petitioners' claims. *Id*.

On December 15, 2023, Petitioners filed the Amended Petition for Review of Preliminary Orders ("the Petition"), initiating this appeal to the Board. REC 3426-3441.

STATEMENT OF FACTS

The Clean Air Act ("CAA") is the federal law that regulates air emissions from stationery and mobile sources. 42 U.S.C. § 7401, *et seq*. The Environmental Protection Agency ("EPA") has delegated the authority to implement the CAA in Idaho to DEQ. REC 1272. To implement the CAA in Idaho, DEQ promulgated the Rules for the Control of Air Pollution in Idaho, IDAPA 58.01.01 (the "Air Rules"). DEQ has received delegated authority from EPA for decades, and EPA has approved DEQ's CAA program year after year. *Id.* This delegation includes the authority to issue permits to qualifying facilities in Idaho. *Id.* DEQ's air quality permit program issues more than 100 permits a year. REC 1258. In writing these permits, DEQ staff use federal and state regulations as well as the internal guiding practices outlined in standard operating procedures. REC 1273. When DEQ receives a permit application for a "permit to construct," DEQ strives to issue the permit within 150 days, which includes the necessary time for a public comment period. *Id.*

Perpetua submitted an application for a permit to construct for the SGP on August 20, 2019. REC 0418. The SGP will consist of conventional open-pit mining, ore preparation, and gold extraction. REC 0415. DEQ expended extraordinary efforts to evaluate the application, consider public comments, and engage in highly technical decision-making to arrive at a legally and environmentally sound permit. *See* REC 1273-1274. DEQ engaged in three extended public comment periods, two public informational meetings, frequent meetings with Perpetua, and made many requests for additional information from Perpetua. REC 0418. DEQ determined Perpetua's application incomplete on three occasions. *Id.* Petitioners attempt to suggest that DEQ's three incompleteness determinations and multiple requests for supplemental information somehow indicate a failure or dereliction by Perpetua or DEQ. *See* REC 3464. They are wrong. In fact,

DEQ's relentless pursuit for necessary information, and Perpetua's willingness to provide it, demonstrate the parties' desire to prepare only a defensible, environmentally protective permit.

On June 17, 2022, DEQ issued the 43-page PTC and accompanying 505-page Statement of Basis for the SGP. *See* REC 0367-0914. Petitioners then initiated the contested case on July 22, 2022, challenging DEQ's issuance of the PTC. REC 0001-0028.

LEGAL STANDARDS

I. Standard of Review.

In a contested case proceeding, "the Board must determine whether DEQ has acted reasonably and in accordance with law." *In the Matter of Sunnyside Park Utilities' Application for Sewage Disposal Permit*, Final Order on Petition for Review of Preliminary Order, at 10 (BEQ Dkt. 0103-07-02, Apr. 7, 2009).[1] A court will affirm the Board's decision, should it be appealed, unless the court finds that DEQ and the Board's decision is in violation of constitutional or statutory provisions, is in excess of statutory authority, is made on unlawful procedure, or is arbitrary, capricious, or an abuse of discretion. *See* I.C. § 67-5279(3).[2] But, it is the Petitioners who have "the burden of proving by a preponderance of the evidence, the allegations in the petition." IDAPA 58.01.23.062. Thus, the Board must uphold DEQ's decision to issue the PTC unless it determines that Petitioners have in fact proven, by a preponderance of the evidence, that DEQ's decision was (1) unreasonable, (2) not in accordance with law, (3) issued upon unlawful procedure, and (4) was arbitrary, capricious, or an abuse of discretion.

[1] Publicly available at https://www2.deq.idaho.gov/admin/LEIA/api/document/download/5566.

[2] The Hearing Officer recognized the helpfulness of using the judicial standard of review in I.C. § 67-5279, "[b]ecause those are the standards that ultimately govern the disposition of this matter…" REC 3377. Further, and importantly, Petitioners use the judicial standard of review set out in I.C. § 67-5279 in asking for relief. REC 3474.

When reviewing the Hearing Officer's Preliminary Order, the Board has the authority to "exercise all of the decision-making power that [the Board] would have if [the Board] had presided over the hearing." I.C. § 67-5245(7). "This means that, in reviewing the Preliminary Order, the Board may review all of the evidence *de novo*…" *In the Matter of Sunnyside Park Utilities' Application for Sewage Disposal Permit*, at 2. "A de novo standard of review permits an appellate court to review all legal issues raised in the lower court, even if one of the issues was not addressed in the first instance, so long as there is a sufficient factual basis." *State v. Jay*, 167 Idaho 592, 598, 473 P.3d 861, 867 (Ct. App. 2020).

II. Agency Deference.

In a contested case, "[t]he agency's experience, technical competence, and specialized knowledge may be utilized in the evaluation of the evidence." I.C. § 67-5251(5). Because agencies have technical, specialized expertise and knowledge, the Idaho Supreme Court has recognized that "[t]he actions of an agency… are afforded a strong presumption of validity." *Duncan v. State Bd. of Accountancy*, 149 Idaho 1, 3, 232 P.3d 322, 324 (2010). Agencies are "clothed with power to construe [the law] as a necessary precedent to administrative action." *J.R. Simplot Co. v. Idaho State Tax Comm'n*, 120 Idaho 849, 854, 820 P.2d 1206, 1211 (1991). The Idaho Supreme Court has "long followed the rule that the construction given to a statute by the executive and administrative officers of the State is entitled to great weight and will be followed by the courts unless there are cogent reasons for holding otherwise." *Id*. (citations omitted). And an "agency's factual determinations are binding on the reviewing court, even where there is conflicting evidence before the agency, so long as the determinations are supported by substantial and competent evidence in the record." *Peck v. State, Dep't of Transp.*, 153 Idaho 37, 42, 278 P.3d 439, 444 (Ct. App. 2012) (citations omitted).

When an agency is interpreting its own rules, the court "applies a four-pronged test to determine the appropriate level of deference to the agency interpretation." *Duncan*, 149 Idaho at 3, 232 P.3d at 324. Under this test, the court must determine whether:

> (1) the agency is responsible for administration of the rule in issue; (2) the agency's construction is reasonable; (3) the language of the rule does not expressly treat the matter at issue; and (4) any of the rationales underlying the rule of agency deference are present.

Id. Here, DEQ is responsible for administering the CAA and the Air Rules in Idaho. Therefore, when the agency is interpreting the language of the Air Rules, the Board should defer to DEQ's reasonable and practical interpretations.

ARGUMENT

I. DEQ acted reasonably and in accordance with all applicable law in excluding the Stibnite Access Road from the Ambient Air Boundary.

In the PTC, DEQ determined that the Stibnite Access Route ("the Route") was not accessible by the general public and was, therefore, not "ambient air," as that term is defined at 40 CFR § 50.19(c) and IDAPA 58.01.01.006.10. REC 3475. Petitioners claim the Route is in fact ambient air and that the Hearing Officer erred when he determined that DEQ had permissibly excluded the Route from the ambient air boundary. *Id.* The Hearing Officer established that DEQ had substantial evidence to find that Perpetua had the legal authority to preclude the general public from traveling over the Route, and that DEQ and EPA guidance supported DEQ's determination. *Id*. For the reasons discussed below, Petitioners fail to prove these allegations or demonstrate that DEQ acted unreasonably or in violation of any law.

A. DEQ reasonably relied on Perpetua's assertions regarding control of the Route, and the record supports DEQ's determination.

In support of this claim, Petitioners first argue that DEQ impermissibly relied on the assertions provided by Perpetua—primarily, Perpetua's statement in its permit application

regarding its control over the Route.[3] DEQ did exclude the Route from ambient air because, in part, Perpetua represented that it would have legal authority to prohibit access by the "general public" and the practical ability to do so. REC 1260; REC 1236-1240. DEQ's reliance on these assertions is completely reasonable. As the Hearing Officer stated:

> In the experience of the hearing officer, it is not unusual for an agency to rely on representations made in a permit application, even as to an issue as fundamental as the nature of the applicant's interests in the relevant property.

REC 3390. In advance of the hearing on the motions for summary judgment, the Hearing Officer asked the parties to provide any legal authorities addressing DEQ's ability to rely on representations made by a permit applicant and the extent to which DEQ is responsible for verifying that information. REC 3388. None of the parties provided any legal authority demonstrating DEQ was responsible for verifying factual information provided by the permittee. Id. This is both logical and practical, as DEQ cannot be expected to fact check every individual averment made by a permittee. This is also why permit applicants are required to certify that the information and statements provided in a permit application are "true, accurate, and complete." IDAPA 58.01.01.123. Perpetua certified that the information in its application was accurate. REC 3389. And, as the Hearing Officer pointed out, should it later be determined that Perpetua does not have legal control over the Route as it claimed it will, then Perpetua would be in violation of its permit. REC 3390.

[3] Petitioners cite *State Ins. Fund v. Hunnicutt*, 110 Idaho 257, 715 P.2d 927 (1985), in support of the contention that "an agency determination can **only** be upheld where 'evidence supporting the agency decision is substantial when viewed in the light of the entire record, including the body of evidence opposed to the agency's view." REC 3477 (emphasis added). In *Hunnicutt*, the Court actually stated: "Nevertheless, reviewing courts should evaluate whether 'the evidence supporting that decision [under review] is substantial, when viewed in the light that the record in its entirety furnishes, including the body of evidence opposed to the [agency's] view.'" *Hunnicutt*, 110 Idaho at 261, 715 P.2d at 931 (citations omitted).

Petitioners discuss at length Perpetua's current process of seeking Forest Service approval for the SGP. REC 3479-3475. Petitioners contend that because the Forest Service has not yet approved the SGP, Perpetua does not have legal control over the Route. *Id.* Besides being an oversimplification, this discussion is irrelevant to DEQ's review of Perpetua's application and ultimate issuance of the PTC. Many things could change from the time a permittee submits an application. While DEQ may wish it had a crystal ball to see into the future, including what the Forest Service may or may not do regarding the SGP, DEQ can only permit a project based on the facts as they exist at the time the application is submitted. If circumstances do change, the permit may need to be modified, or the permittee could be in violation of the issued permit. The bottom line is that the agency record as it currently exists—namely Perpetua's assertions and the conditions of the PTC, discussed below—support DEQ's determination that Perpetua will have legal authority to exclude the general public from the Route.[4]

B. The PTC requires Perpetua to have the ability to restrict the general public from the Route.

The PTC itself requires that the "general public" be precluded from accessing the Route and requires that access for all guests be carefully managed. REC 0376. The Route will not be, as Petitioners contend, a "public access road." Permit Condition 2.7 requires a combination of security escort vehicles, manned guardhouses, locked gates, barriers, warning signs, and registration of all guests to the mine site. *Id*. Condition 2.7 also requires Perpetua to submit an Access Management Plan, which must include the specific measures Perpetua will use to discourage public access, including those included in Condition 2.7. *Id.* These conditions will be more than sufficient to notify a reasonable person that his or her presence is not permitted and

[4] Petitioners claim that the Hearing Officer ignored other facts in the record. REC 3478. It is unclear what the Petitioners are referring to. The only other information discussed is what the Forest Service may or may not end up approving regarding the project. This is not information that needed to be considered, as discussed above.

therefore punishable under I.C. § 18-7008 for criminal trespass and actionable under I.C. § 6-202 for civil trespass. Looking just at the "four corners" of the PTC, the Hearing Officer also found "Section 2.7 of the Permit to adequately require Perpetua to preclude access by the general public for the purpose of excluding the access road [the Route] from the definition of 'ambient air.'" REC 3393. It is disingenuous of Petitioners to call the Route a "public access road" when the PTC itself requires Perpetua to take all necessary actions to discourage public access.

C. DEQ and EPA guidance support DEQ's determination that the Route is not "ambient air."

Next, Petitioners claim that DEQ acted contrary to EPA and DEQ guidance in finding the Route does not qualify as "ambient air." In this way, the Petitioners are challenging DEQ's interpretation of its own rule, which should be afforded substantial deference. Petitioners also miscite EPA's 2019 "Revised Policy on Exclusions from 'Ambient Air,'" which does not require state agencies to apply the policy because they "retain the discretion to determine whether the steps taken by a source will be adequate to preclude public access." REC 1139.

However, DEQ's determination that the Route is not "ambient air" is supported by both DEQ and EPA guidance. The Hearing Officer summarized EPA's guidance well when he stated:

> According to EPA's 2019 ambient air policy: (1) it is appropriate to exclude areas from ambient air where measures are employed that are "effective in precluding access to the land by the general public;" (2) such measures can include physical barriers, but physical barriers are not required; (3) determinations by the agency are discretionary on a case-by-case basis; (4) the permit applicant must have the legal ability to preclude access by the general public and must employ measures that actually preclude the general public as a practical matter; (5) in evaluating the adequacy of the preclusion measures, the agency applies a "rule of reason" as to whether the general public will have access "under reasonably anticipated circumstances.

REC 3392. DEQ's modeling staff "evaluated EPA guidance on Ambient Air and outlined requirements the permit needed to address to manage access to the facility…" which was

"documented in Section 3.3.10 of the January 6, 2022, Modeling Memorandum from [DEQ staff person] Dr. Pao Baylon." REC 1260. When DEQ staff consulted with EPA on this issue, EPA Region 10 Meteorologist and Regional Modeling Contact, Dr. Jay McAlpine, stated:

> My understanding is the road is likely exempt from ambient air protections because it is fully under the control and surveillance of the source and unsupervised public access is precluded. It seems like a slam dunk, based on my understanding of EPA's revised ambient air policy.

REC 1240. DEQ's decision is in line with EPA's guidance, as the PTC requires Perpetua to take several measures to preclude access, as discussed, and Perpetua must have the legal ability to do so.

Similarly, DEQ's guidance focuses on the ways in which the permittee will discourage public access. REC 3392. The nature or remote location of the facility may discourage public access, or the permittee may take steps to prevent access. *Id.* If the general public is sufficiently precluded, it is reasonable to consider that the facility or specific area would not qualify as ambient air. *Id.* Petitioners rely on DEQ guidance language that states "if the general public [is] invited as part of the normal business conducted on the facility site" the area where the "public is invited is determined to be ambient air," and if the "general public [is] allowed on site as a part of a right-of-way easement or a common service road," then that road is "determined to be ambient air." Again, the general public is not invited, but meant to be precluded. This is not a "right-of-way easement" or "common service road." As one example, PTC condition 2.7 requires registration of all guests of a mine—surely no easement or common service road requires such registration.

DEQ's decision to differentiate between the "general public" and Perpetua's guests was not unreasonable or otherwise not in accordance with any law. DEQ's interpretation of the definition of "ambient air" is due considerable deference because: (1) DEQ is responsible for administration of this rule in issue; (2) its construction is reasonable; and, (3) the language of the rule does not

expressly treat the matter at issue. *See Preston v. Idaho State Tax Comm'n,* 131 Idaho 502, 960 P.2d 185 (1998). Thus, the Hearing Officer's Order should be affirmed, and the PTC should be upheld.

II. DEQ acted reasonable and did not violate any rule or statute by allowing Perpetua to submit certain plans later.

Pursuant to DEQ's discretion, the PTC requires Perpetua to develop plans and manuals and submit them to DEQ for approval at least 30 days prior to startup. REC 1264; REC 0367-0409. These plans and manuals include the Fugitive Dust Control Plan, the Haul Road Capping Plan, the Operation and Maintenance Manual, and the Stibnite Road Access Management Plan (collectively, "the Plans"). Petitioners claim that allowing Perpetua to submit the Plans later violates the Air Rules and CAA, and that "DEQ deferred addressing many issues during the PTC permitting process" by allowing Perpetua to "address those issues in the future through various plans." REC 3488. Petitioners contend that the PTC is partial and incomplete without the Plans themselves. This is a misstatement. DEQ did not defer addressing any issues, and the PTC contains all necessary conditions. As discussed below, DEQ is allowing Perpetua to provide additional detail in the required Plans. Petitioners fail to demonstrate that DEQ violated any rule or statute in using this customary practice of requiring plans be submitted later pursuant to the PTC.

A. Allowing Perpetua to submit the Plans later does not violate the CAA or the Air Rules.

Petitioners assert that "[n]o provision in the Air Rules authorizes DEQ to save portions of a PTC to be developed later, outside the normal PTC permitting process," and that the Air Rules require the Plans to be included in Perpetua's application and subject to public comment. REC 3488. Petitioners' Opening Brief regurgitates CAA regulations requiring legally enforceable procedures to protect air quality and requiring public comment on information submitted by an

applicant, as well as the Air Rules requiring that DEQ provide opportunity for public comment. REC 3488-89. Petitioners, however, do not provide any rule or regulation requiring that every detail and plan be included in the application or available for public comment. Instead, as the Hearing Officer recognized, there is no "outright prohibition of this practice [requiring detailed implementation plans after issuance of the PTC], and the language of Air Rule 211.01 provides DEQ with wide discretion regarding appropriate permit terms." REC 3406.

The PTC itself contains specific requirements that will ensure Perpetua complies with the Air Rules and CAA—that is, the PTC details "what" is required for compliance. The PTC conditions requiring that detailed plans be developed later merely mandates that Perpetua develop the specific details on "how" the PTC requirements will be achieved. Section 202 of the Air Rules specifies the requirements for a permit to construct application and identifies information required to be included in the application. IDAPA 58.01.01.202.01. Requisite information for new sources includes information related to the design of the source, nature and amount of emissions, the manner in which the source will be operated and controlled, and a schedule for construction. *Id.* The PTC does include all necessary information under Section 202. And DEQ may request any additional information necessary to make determinations under the Air Rules, IDAPA 58.01.01.202.03, while Section 211.01 also provides DEQ with flexibility and discretion to "impose any reasonable conditions."

During the public comment period, Petitioners submitted similar comments, raising concerns with the submission and review process of the Plans. PET 0922-0923. DEQ responded and explained that the PTC specifies minimum and substantive requirements for the Plans. *Id.* In addition, DEQ will exercise oversight, review, and approve the Plans, and publish the final plans

on its website. *Id*. Furthermore, all elements of the Plans will be incorporated and enforceable through the Final Permit. REC 0376; REC 0380; REC 0386.

Petitioners also claim that because the Plans have not yet been submitted, then "DEQ cannot reasonably claim that the Project will comply with the PM10 NAAQS and arsenic AACC." REC 3490. Petitioners utterly downplay what the PTC contains and what the Plans will actually entail. Using the Operation and Maintenance Manual ("O&M") as an example, the PTC contains at least ten substantive requirements, most of which contain additional related requirements, that must be in Perpetua's O&M. These requirements include, among other things, the following:

- Identify the manufacturer, model, date of manufacture, and maximum capacity (as-built) for each regulated emission source assigned a source ID, and for each control device in the service of ore concentration and refining, lime production, and concrete production (in Table 1.1).

- Establish operating ranges for control equipment, based on manufacturer specifications and conditions measured during performance testing [with six additional requirements following therein].

- Describe the procedures for proper operation, startup, and shutdown of control equipment, based on manufacturer specifications.

- Describe the schedule and procedures for routine inspection (Permit Condition 2.10), maintenance, repair, and replacement of control equipment.

- Describe the schedule and procedures for corrective action that will be taken if visible emissions are present from wet scrubber…, carbon filter…, baghouse…, or bin vent filter… control equipment at any time. Procedures should include how to determine whether filter cartridges are ruptured or are not appropriately secured in place, and how to determine whether the wet scrubber, condenser, and carbon filters are operating properly.

- Describe each monitoring device and methodology used to measure weight rates of materials to demonstrate compliance with each material throughput limit (Permit Conditions 3.5–3.9, 4.8–4.11, and 5.4–5.8). Procedures for proper installation, calibration, and maintenance shall be included.

- Describe each monitoring device and methodology used to measure the volumetric rates of materials to demonstrate compliance with the electrowinning cells and pregnant solution tank throughput limit (Permit Condition 4.12). Procedures for proper installation, calibration, and maintenance shall be included.

- Describe each monitoring device and methodology used to monitor pH, temperature, and free cyanide in each cyanide leach tank, each cyanide detox tank, and each tailings reclaim stream to comply with Cyanide Emissions Limit Compliance Monitoring (Permit Condition 4.18). Procedures for proper installation, calibration, and maintenance shall be included.

REC. 0378-0379. The PTC also contains the necessary operational conditions—conditions for drilling limits, blasting limits, daily hauling and excavating limits, life of mine hauling and excavating limits, and so on. REC 0386. In short, DEQ is relying on the PTC itself to ensure compliance with the Air Rules and CAA.

Petitioners also claim that allowing Perpetua to submit the Plans later deprives the public of meaningful involvement. REC 3490. Petitioners fail to cite any case law to support their position that public review is required for the Plans under the CAA or Air Rules. The relevant CAA jurisprudence affords broad discretion to states to develop permit conditions. *See Train v. Nat. Res. Def. Council, Inc.*, 421 U.S. 60, 79 (1975). The Air Rules state that DEQ must provide an opportunity for public comment on its "proposed action, together with the information submitted by the applicant and the Department's analysis of the information." IDAPA 58.01.01.209.01.c.i. But, as previously discussed, DEQ underwent three extended public comment periods. REC 1274. DEQ responded to the many public comments received, at times making changes to the PTC based upon comments. *See* REC 1242. And, although not required, DEQ held two informational public meetings. REC 1274. DEQ is not denying the public an opportunity that they would otherwise be provided. The public has had many opportunities to engage with DEQ in the development of this PTC. Allowing Perpetua to submit the Plans later does not change that fact; the public was able to engage with DEQ on the development of the substantive requirements of the PTC, as required by IDAPA 58.01.01.209.01.c.i.

Petitioners cite inapposite cases, none of which support Petitioners' position that use of post-permit plans is prohibited. In *Waterkeeper Alliance v. U.S. EPA*, 399 F.3d 486 (2d Cir. 2005), environmental groups challenged an administrative rule promulgated by the EPA under the Clean Water Act ("CWA") to regulate water pollutants from concentrated animal feeding operations (the "CAFO Rule"). The CAFO Rule established non-numerical effluent limitations in the form of best management practices, rather than numerical effluent limitations. However, the Court determined that the CWA requires that (NPDES) permits include the effluent limitations the CAFO Rule deferred for inclusion in a post-permit nutrient management plan. *Id.* at 502. Additionally, "the CAFO Rule prevents the public from calling for a hearing about—and then meaningfully commenting on—NPDES permits before they issue." *Id.* at 503. For these reasons, "the CAFO Rule violates the plain dictates of 33 U.S.C. § 1251(e)." *Id.*

Waterkeeper is easily distinguished from the present case. For one, *Waterkeeper* challenges EPA's promulgation of an administrative rule and is not concerned with whether any specific permit adequately provides public participation, or whether any specific permit complies with federal emission requirements. Instead, *Waterkeeper* considers whether EPA's administrative rule allowing the inclusion of effluent limits in a post-permit plan violates the CWA. Here again, *Waterkeeper* is inapposite. The Plans Petitioners criticize are not meant to include emissions limitations required under the statute—those are provided in the PTC itself. Unlike the CAFO Rule's nutrient management plan, which deferred specific effluent limitations for formulation after issuance of a permit, the PTC mandates a litany of specific requirements, all meant to safeguard air quality and achieve compliance with the Air Rules. The post-permit plans required by DEQ will not include the conditions and limitations required by the CAA and Air Rules—they are

included in the PTC and were part of the public comment process. *Waterkeeper* simply does not support Petitioners' claim that the Plans deprive the public of meaningful involvement.

In *Env't Def. Ctr., Inc. v. U.S. E.P.A.,* 344 F.3d 832 (9th Cir. 2003), petitioners challenged an EPA rule to control pollutants from storm sewers (the "Phase II Rule"). Under the Phase II Rule, "dischargers may apply for an individualized permit with the relevant permitting authority, or may file a 'Notice of Intent' ('NOI') to seek coverage under a 'general permit.'" *Id.* at 853. "The Phase II Rule requires that each NOI contain information on an individualized pollution control program that addresses each of the six general criteria specified in the Minimum Measures." *Id.* The Court found that this scheme "constitutes compliance with the standard of reducing pollutants to the 'maximum extent practicable.'" *Id.* The Court concluded that EPA is "required to ensure that the individual programs adopted are consistent with the law." *Id.* at 856. Consequently, the aspect of the rule allowing coverage under an NOI was remanded. The Court noted however: "Our holding does not preclude regulated parties from designing aspects of their own stormwater management programs." *Id.*

Env't Def. Ctr. is also distinguishable from the present case, for many of the same reasons as the *Waterkeeper* case. *Env't Def. Ctr.* challenges an administrative rule, not a specific permit. Further, while the Phase II Rule provided an end-run around creating stormwater management programs or issuing permits without public comment, the PTC here did not. Instead, the PTC and its conditions for compliance with the Air Rules went through public comment. Only the details of implementation, not compliance and consistency with law, remain to be developed in the Plans. DEQ has satisfied the Ninth Circuit's admonishment that "programs that are designed by regulated parties must, in every instance, be subject to meaningful review by an appropriate regulating entity." *Id.* at 503.

Both *Waterkeeper* and *Environmental Defense Center* rested their holdings on express requirements under the Clean Water Act for public review of specific materials. The decisions are clearly distinguishable from Perpetua's Plans, which are not required by any express provision of the Air Rules (nor the CAA) to be included in the application, the Final Permit, or any part of the public comment process. The Board should accordingly not give any weight to these cited cases because they are factually and legally distinguishable. Instead, the Air Rules support DEQ's issuance of the permit and conditions for post-permit plans.

B. DEQ's Approach was reasonable and is customary practice.

Allowing Perpetua to submit the Plans later, but prior to startup, is both reasonable and consistent with DEQ's practice. REC 1265. As DEQ's Stationary Source Bureau Chief Mike Simon stated:

> It is common for the permit program to require certain plans, such as an O&M manual or FDCP to be prepared by the permittee post permit issuance. This allows the permittee to prepare a specific plan or manual based on the actual equipment purchased and installed, the manufacturer's instructions and recommendations, as well as the operational characteristics of the facility after construction is completed. DEQ uses its authority to require a permittee to develop and submit for DEQ approval Plans and Manuals in accordance with IDAPA 58.01.01.211.01 as reasonable permit conditions.

REC 1265. As to this explanation from Mr. Simon, the Hearing Officer found: "This is a logical explanation for deferring identification of the 'devices and methodologies' until later." REC 3407. Thus, the Hearing Officer held:

> Given that (a) there is a requirement in the Permit to monitor and record the amount of ore and development rock transported, and (b) the Petitioners have not offered expert testimony explaining how deferring identification of the specific "devices and methodologies" until later could be arbitrary, capricious, or an abuse of discretion, the hearing officer lacks discretion to conclude that DEQ committed reversible error.

Id.

Simply put, DEQ's rationale for deferring submittal of the Plans until later is justified because the PTC contains enforceable conditions and parameters which those Plans must include and achieve. DEQ made no special exceptions in this case, but simply followed its common, reasonable practice. Petitioners certainly disagree with this approach, but dislike is not the legal standard. DEQ exercised reasonable discretion in developing the PTC conditions and requiring the Plans with additional details be submitted later. DEQ did not violate the CAA or the Air Rules. Thus, the Board must affirm the Hearing Officer's Preliminary Order and find that DEQ acted reasonably and in accordance with all applicable law.

III. DEQ clearly demonstrated a reasonable basis for determining that Perpetua can achieve 93.3% dust control under the terms of the PTC.

Petitioners contend DEQ lacked a reasonable basis in determining that the SGP can achieve 93.3% dust control. REC 3494. Specifically, Petitioners argue "it is highly questionable whether 93.3% fugitive dust control is realistically attainable," and that "the Permit lacks sufficient conditions for DEQ to reasonably assume Perpetua will achieve such a high level of control." *Id.* Instead of attacking DEQ's underlying rationale, Petitioners summarily argue that "[b]ecause DEQ did not include such limits, conditions, and aggressive implementation measures in the Permit, it was arbitrary and capricious for DEQ to assume this high 93.3% would be achieved." REC 3496. Petitioners wrongly believe that without including specific limits "on the combinations, volumes, and frequencies for applying water sprays and chemical suppressants, as well as necessary monitoring and inspection" in the PTC itself, DEQ had no reasonable basis for assuming the SGP will achieve 93.3% dust control. REC 3499.

A. DEQ had a reasonable basis to determine Perpetua could achieve 93.3% dust control.

DEQ carefully and conscientiously studied this complex issue to ensure air standards were met. *See* REC 0924-0925; REC 1247-1248; REC 1260-1261. The 93.3%[5] control efficiency is based on a combination of dust suppressant chemical application (90% or higher) and watering (33% and higher) to increase road surface moisture. *See* REC 0509. As the Hearing Officer summarized, "DEQ has adduced expert testimony explaining the basis for the 93.3% control efficiency figure, an issue not within the common knowledge of the layperson." REC 3401. The Hearing Officer found that "Petitioners have not offered expert testimony to rebut" DEQ's efficiency figure. *Id.* Again, Petitioners have offered no evidence to contradict the Hearing Officer's reasoned decision, nor to suggest that DEQ's dust control figure is not adequately supported.[6]

Requiring Perpetua to achieve a 93.3% control efficiency was soundly within DEQ's discretion and supported by objective data that was reasonably relied upon. DEQ's evaluation to satisfy the requirements of Section 203 of the Air Rules included estimates of fugitive dust emissions from the Project's haul roads, including a dust control efficiency of 93.3%. *See* REC 0384. Conditions in the PTC will ensure that the control efficiency will be maintained through a combination of chemical dust suppressants (e.g., magnesium chloride or calcium chloride) and frequent watering, among other permit conditions. *Id.* Petitioners contend it is "highly questionable

[5] 93.3% control = (1-90%) * (1-33%).

[6] Petitioners seem to claim that "expert testimony" was offered "in the form of public comments and other submissions to DEQ made by the EPA." REC 3495. As the Petitioners know, the EPA is not considered an "expert" in the same manner DEQ is. As the Hearing Officer determined, because EPA is not a party to this case, they are not subject to discovery or cross examination, and are therefore not "experts." REC 3272. These vague references to "expert testimony" are disingenuous at best.

whether 93.3% fugitive dust control is realistically attainable." REC 3494. DEQ found otherwise, and Petitioners have not shown that DEQ's conclusion was unreasonable.

Petitioners have failed to show that DEQ's 93.3% control requirement is unachievable, nor have they actually demonstrated that 93.3% control would result in violations of Idaho's Air Rules. It is the burden of the party contesting an administrative agency's decision to show how the agency's decision was unsupportable. *See Grace at Fairview Lakes, LLC v. Idaho Department of Health and Welfare,* 172 Idaho 743, 748, 536 P.3d 382, 387 (2023). Petitioners have failed to meet that burden. DEQ determined that 93.3% dust control was both achievable and would protect air quality; the Board should uphold that determination and adopt the Hearing Officer's determination that "DEQ's adoption of the 93.3% control efficiency figure [was] adequately supported." REC 3402.

B. The PTC includes enforceable and sufficient conditions to ensure compliance with Idaho's Air Rules.

Petitioners' argument that the PTC "does not include a specific requirement to achieve 93.3% or any other level of dust control" fails. REC 3494. Petitioners mislead the Board, but the PTC speaks for itself. The PTC specifically requires that a dust control efficiency of 93.3% be maintained.

> Table 3.1 contains a description of control equipment used to control emissions from mining and ore processing activities.

Table 3.1 Mining and Ore Processing Control Device Descriptions

Emission Sources	Control Devices
Mining	
Excavating and hauling activities	Reasonable control & FDCP Chemical suppression and water sprays **Control efficiency: 93.3% for PM/PM10 (haul roads)** Haul road capping with low-arsenic quartzite

REC 0384 (PTC Table 3.1) (emphasis added). The Hearing Officer recognized this and determined that the PTC itself "includes a specific requirement that 93.3% control efficiency be achieved." REC 3403.

Next, Petitioners contend "the Permit lacks sufficient conditions for DEQ to reasonably assume Perpetua will achieve such a high level of control." REC 3494. But Petitioners recognize "the Permit includes conditions related to dust control" such as: monitoring and maintaining dust emission records (Permit Conditions 2.1-2.5) and development of a Fugitive Dust Control Plan ("FDCP") (Permit Condition 2.6). *See* REC 3497. Petitioners erroneously label these conditions "vague direction" and argue DEQ must include, in the PTC itself, details such as the exact dust suppressant types Perpetua will use and the frequency and rates of their use. REC 3499. Petitioners, however, "do not cite to any legal standard requiring additional requirements or otherwise explaining how the existing Permit provision is legally inadequate." REC 3403. Nonetheless, the PTC does include sufficient conditions for DEQ to believe Perpetua will achieve the required dust control level.

DEQ developed permit conditions to ensure the 93.3% control efficiency is maintained on a daily and annual basis, and Petitioners have not shown those conditions are unreasonable or unenforceable. According to EPA guidance, for source-specific permit provisions to be practically enforceable, they must specify: (1) a technically accurate limitation and the portions of the source subject to the limitation; (2) the time period for the limitation (hourly, daily, monthly, annually); and (3) the method to determine compliance including appropriate monitoring, recordkeeping and reporting. REC 1157. DEQ ensured those enforceability criteria were met with respect to the 93.3% control efficiency. Not only did DEQ include that level of control in the PTC and find it achievable, but the PTC requires proper application of chemical dust suppressant and watering,

verified through daily visible emission monitoring and recordkeeping. *See* REC 0917, 0921, 0923, 0934, 0937.

DEQ's conclusion is well supported and reasonable. Condition 2.2 requires Perpetua to monitor the frequency and methods used to control fugitive dust at least once every 12 hours and maintain those records. REC 0374. Condition 2.4 requires daily facility-wide inspections of hauling activities to ensure the expected control efficiency is achieved. *Id.* Condition 2.5 mandates that fugitive dust control measures be applied to haul roads "on a frequency such that visible emissions from vehicle traffic on a haul road do not exceed 10% opacity." REC 0375. And if emissions exceed that level, Perpetua must take immediate corrective action until fugitive dust control is achieved. *Id.* These daily inspection and haul road opacity requirements are more stringent than in other permits that DEQ has issued. REC 1261.

The FDCP will also ensure compliance with fugitive dust requirements. Condition 2.6 establishes minimum and substantive requirements for the FDCP, including:

- posting and limiting the maximum speed of haul trucks;
- applying water or suitable dust suppressant chemicals to haul roads during the dry season and at other times as necessary to control fugitive dust;
- prior to onset of winter conditions, maintenance of the roads and any preventative dust suppression activities before the roads are frozen;
- developing specific criteria to determine what frequency and type (water and/or chemical) of dust suppressant and appropriate suppressant application rates;
- applying chemical dust suppressants consistent with manufacturer's instructions and recommendations;
- providing training to all relevant employees and conducting visible emissions evaluations by certified employees who are visible emission observers; and,
- at least once each year, evaluating FDCP requirements to identify additional requirements and evaluating the effectiveness of practices.

REC 0375-0376. The PTC "requires a more comprehensive and detailed FDCP than in any other minor source permit DEQ has issued." REC 1263. Thus, DEQ did not give "vague direction" to consider type, quantity, and rates of dust suppressants later in its FDCP; DEQ provided specific dust control conditions and detailed guidance on the requirements that must be contained in the FDCP.[7]

DEQ's imposition of minimum and substantive requirements in the Permit and through the FCDP was reasonable. It understood how uncommon and impractical it would be to establish specific numeric limits to control efficiency variables. *See* REC 1261-1262. Instead, the Permit, among other conditions, requires that chemical suppressants be applied in accordance with the manufacturer's instructions and recommendations and that the control effectiveness of the combination of dust suppressant chemicals and watering be verified daily. *See* REC 0374-0375. Petitioners have not satisfied their burden to show that DEQ unreasonably relies on the many permit conditions to achieve the required control efficiency.

Finally, Petitioners contention that Perpetua need only "describe what it will do to control dust, and then follow through on those plans" in order to comply with the PTC, is wholly without merit. REC 3495. Petitioners' straw man argument claims that if Perpetua "submits [] plans to DEQ, DEQ signs off on them, and Perpetua follows through and complies with the deficient plans, then Perpetua will be in compliance with the terms of the PTC – even though it will not achieve 93.3% dust control."[8] *Id.* This is wrong. As discussed, the PTC explicitly requires a 93.3% dust control efficiency. DEQ could not, and would not, approve a FDCP that falls below the expressly

[7] As discussed above in Section II, DEQ's use of plans to provide additional detail is in line with the Air Rules, and a reasonable, customary practice.

[8] This begs the question: what evidence do Petitioners have that adding more specific provisions to the permit—rather than the FDCP—will ensure that Perpetua controls its dust emissions?

stated Permit limit. Petitioners' contention to the contrary is disingenuous and must be disregarded. If Perpetua fails to achieve a 93.3% dust control level—verified through the visible emission inspections—they will be in noncompliance with the PTC.

In sum, the PTC requires Perpetua to achieve a 93.3% control efficiency. The experts at DEQ determined that 93.3% is both achievable and will comply with Idaho's air quality standards—Petitioners have proffered no evidence showing DEQ's decision is unsupported. The PTC contains express dust control requirements to ensure Perpetua's compliance. Moreover, despite being under no legal obligation to include additional requirements or conditions in the PTC, the PTC provides a plethora of conditions that will also ensure Perpetua complies with the PTC and achieves the target dust control number. Thus, DEQ's determination that the PTC would comply with the NAAQS was rational and supported by substantial evidence and Petitioners have failed to offer competent expert testimony or sound legal argument to the contrary. As such, the Board should affirm DEQ's determinations and adopt the Hearing Officer's well-reasoned opinion.

IV. DEQ's "project specific adjustment factor" clearly complied with the Air Rules, and DEQ used proper discretion and expertise to average arsenic emissions over the projected duration of the Mine.

Finally, Petitioners allege that DEQ created a "project specific adjustment factor" to "artificially dilute the ambient arsenic concentrations attributable to the SGP." REC 3499. According to Petitioners, DEQ violated the Air Rules by "artificially reduc[ing] the apparent arsenic exposure by spreading out the actual arsenic exposure resulting from the 16-year Project over a longer 70-year human lifetime." REC 3501. Accordingly, Petitioners claim the Hearing Officer "incorrectly interpreted the Air Rules" in allowing DEQ to use this "adjustment." REC 3506. Fundamentally, Petitioners misunderstand DEQ's analysis, which was not based on a

"qualitative" standard, as alleged. For the reasons discussed below, Petitioners fail to demonstrate that DEQ acted unreasonably or violated any applicable rule.

A. DEQ's use of the "project specific adjustment factor" is not contrary to the Air Rules.

There are four rule sections applicable to this claim. First, Air Rule Section 203.03 states that DEQ cannot issue a permit to construct for a new stationary source "unless the applicant shows to the satisfaction of the Department" that the following is met:

> Toxic Air Pollutants. Using the methods provided in Section 210, the emissions of toxic air pollutants from the stationary source… would not injure or unreasonably affect human health or animal life or vegetation as required by Section 161. Compliance with all applicable toxic air pollutant carcinogenic increments and toxic air pollutant non-carcinogenic increments will also demonstrate preconstruction compliance with Section 161 with regards to the pollutants listed in Sections 585[9] and 586.

IDAPA 58.01.01.203.03. Section 210 begins as follows: "In accordance with Subsection 203.03, the applicant must demonstrate preconstruction compliance with Section 161 to the satisfaction of the Department." IDAPA 58.01.01.210. Section 210 goes on at length to provide the methods by which DEQ and the permit applicant analyze the toxic air pollution emissions.

Section 161 then states: "Any contaminant that is by its nature toxic to human or animal life or vegetation must not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation. IDAPA 58.01.01.161. Accordingly, the language of Section 161 mirrors Section 203, both of which state that toxic air pollutants must not "injure or unreasonably affect human health or animal life or vegetation." That determination is made using the methods in Section 210.

[9] Section 585, Toxic Air Pollutants Non-Carcinogenic Increments, is not relevant to this case. Section 586 is discussed below.

Finally, Section 586 provides the acceptable ambient concentrations (AACC) for carcinogens, which includes arsenic compounds. Petitioners appear to focus on the AACC in Section 586, while discounting the Departments discretion under the other applicable rules.

The Hearing Officer accurately described the interplay between these rule sections well, stating:

> The use of the phrase "will also demonstrate preconstruction compliance" in Section 203.03 effectively creates two regulatory paths. First, the applicant and DEQ can use "the methods in Section 210" to show that emissions will not "injure or unreasonably affect human or animal life or vegetation." Section 210, in turn, consists of six-and-a-half pages of detailed, technical, complex regulations… Regardless, the relevant legal standard— "injure or unreasonably affect"—is not further defined within the Air Rules.
>
> Effectively, the second path—compliance with Sections 585 and 586—provides applicants with a safe harbor. If an applicant demonstrates "[c]ompliance with all applicable toxic air pollutant carcinogenic increments and toxic air pollutant non-carcinogenic increments…with regards to the pollutants listed in Sections 585 and 586," then satisfaction of Section 161 is automatic and application of the "injure or unreasonably affect" standard unnecessary… For arsenic compounds, the applicable AACC is 2.3E-04 µg/m3. So, if an applicant can demonstrate arsenic emissions will not exceed that AACC, then the Section 203.03 analysis for arsenic is over. As a matter of law, the legal standard of Section 161 is satisfied.

REC 3416-3417.

Regarding Perpetua's PTC, DEQ took the "first path," analyzing Perpetua's application under Section 210.12. REC 1242. Section 210.12 essentially "allows an applicant to demonstrate compliance with Section 161 through the quantitative standards in Section 586 instead of the qualitative toxicity standard." (emphasis added). REC 3417. The rule states:

> If the source's… approved T-RACT [reasonably available control technologies] ambient concentration at the point of compliance is less than or equal to the amount of the toxic air pollutant that would contribute an ambient air cancer risk probability of less than one to one hundred thousand (1:100,000), no further procedures for demonstrating preconstruction compliance will be required for that toxic air pollutant as part of the application process.

IDAPA 58.01.01.210.12.c. And the "ambient air cancer risk probability of less than one to one hundred thousand (1:100,000) (which amount is equivalent to ten (10) times the applicable acceptable ambient concentration listed in Section 586)." IDAPA 58.01.01.210.12.b. As Kevin Schilling, DEQ's Stationary Source Air Modeling Supervisor, explained:

> If T-RACT is used to control emissions from sources, then the allowable impact is ten times that of the AACCs, corresponding to a lifetime cancer risk of 1 in 100,000. The AACC conservatively represents a long-term exposure (70 years) that would result in a 1 in 1,000,000 cancer risk.

REC 1242. Perpetua proposed the T-RACT of using chemical suppressants on the roads to address arsenic emissions. REC 1268.

When DEQ completed the analysis, using very conservative assumptions, the analyses "resulted in modeled arsenic impacts exceeding a value of 10 times the AACC." REC 1242. Mr. Schilling explained DEQ's next steps as follows:

> Before undertaking an extensive revision of the conservative emission calculation approach used in the emission inventory and the air impact model, DEQ evaluated whether certain refinements in exposure calculations would be consistent with requirements of *Idaho Air Rules* and specifically with *Idaho Air Rules* Section 210 for carcinogenic TAPs.

REC 1242. Here, DEQ considered refining the assumed lifetime exposure to the relevant carcinogen, arsenic, from the stated 70-year period. *Id.* Perpetua had indicated that the SGP will only have a 16-year maximum project lifetime.[10] *Id.* Thus, "[t]o calculate a project-based arsenic concentration representative of the project, appropriate for comparison to the AACC (based on a 70-year exposure), the modeled impact was adjusted by the factor 16/70." *Id.*

[10] Perpetua importantly noted the following during its summary judgment briefing: "DEQ set the life-of-mine hauling and excavating limit at 788.4 million tons of ore and development rock. Whether this amount is mined in 16-years, the life of the mine, or 70 years, the lifetime exposure period, the total arsenic emissions will be the same, they would just be spread out over more time. Thus, the total arsenic exposure to public receptors will be the same irrespective of how long the mine is in operation." REC 1334.

"DEQ simply used this general approach to develop a project-specific adjustment factor for the SGP, using the 16-year maximum life of the project." REC 1244. Still, DEQ's calculations were as conservative as reasonably possible: the equation for calculating lifetime exposure risk to arsenic utilized the highest annual concentration from 14 different operational scenarios and repeated it over sixteen years, the lifetime of the mine. REC 0789. The annual arsenic emissions were based on a five-year rolling average of 135,000 tons of per day, for sixteen years. REC 0710. This total ore production is over fifty percent greater than the actual potential mine production. *Id*. Using worst-case scenarios, or overestimating expected emissions, is a common modeling strategy that ensures actual emissions do not exceed applicable air standards. *See* REC 1246.

DEQ's use of this "project specific factor" is supported by the Air Rules. Petitioners make much of the fact that DEQ used a "novel" approach. *See* REC 3501. But DEQ's approach still fits squarely within the confines of the Air Rules. DEQ used the AACC in Section 586. DEQ also used the methods for a T-RACT analysis in 210.12.c. Ultimately, Section 203, as well as Section 161, require DEQ to demonstrate that the SGP's arsenic emissions "would not injure or unreasonably affect human health or animal life or vegetation…" IDAPA 58.01.01.203.03. DEQ was able to demonstrate this using the conservative modeling and data specific to the project itself, all based upon Sections 586 and 210.

The Hearing Officer was persuaded by DEQ's expert testimony, finding:

> Mr. Schilling recognizes that the over-arching legal standard is the toxicity standard in Section 161 and explains why strict compliance with standards expressed as annual limitations is not always necessary to satisfy that standard, particularly when the exposure period is considerably shorter than the assumed 70-year exposure period on which the AACCs are based. Overall, he provides a thoughtful and conservative approach to ensuring arsenic emissions will not exceed the 1-in-100,000 lifetime cancer risk standard when T-RACT is used.

REC 3421.

Further, Section 210.12.d states the following: "The Department will include emission limits and other permit terms for the toxic air pollutant in the permit to construct that assure that the facility will be operated in the manner described in the preconstruction compliance demonstration." The analysis discussed above demonstrates that the PTC does "assure that the facility will be operated in the manner described in the preconstruction compliance demonstration." DEQ developed the PTC to include operational permit limits that were used in the preconstruction compliance demonstration of the Air Rules – conditions such as throughput limits, hours of operation, materials combusted, processed, and stored, etc. REC 0385. DEQ took the parameters in the analysis, including the 16-year life of mine, and set them as operational limits per Section 210.12.d.

B. DEQ did not rely on a qualitative standard and Petitioners misunderstand DEQ's approach.

Petitioners claim that the Hearing Officer's decision was in error "because it lets a general and qualitative provision trump the specific numeric provisions that apply." REC 3505. As discussed above, DEQ did not rely solely on the "qualitative provision" of Section 161. As discussed at length in Mr. Schilling's declaration, REC 1233-1255, DEQ conducted the T-RACT analysis set forth in Section 210 and relied upon the AACC in Section 586 as representative of the cancer risk for a specified exposure period. DEQ is simply arguing that it had discretion to use the data points that made most sense, including the project specific information regarding the life of the mine. And Section 161 supports this decision, as it requires, ultimately, that DEQ find that "the emissions would not injure or unreasonably affect human health or animal life or vegetation." DEQ came to that conclusion – using the AACC and T-RACT analysis.

In a series of what appear to be rhetorical questions (e.g. "what is the point of Section 203.03's directive to follow the methods in Section 210?"), Petitioners allege that DEQ's

interpretation renders Sections 586 and 210 as "superfluous." REC 3505. Petitioner is reaching. Clearly, DEQ relied upon Section 586. As Mr. Schilling states: "To calculate a project-based arsenic concentration representative of the project, appropriate for comparison to the AACC (based on a 70-year exposure), the modeled impact was adjusted by the factor 16/70." REC 1243. A T-RACT analysis was performed, using conservative modeling and data, under Section 210. *Id.* Although Petitioners clearly imply DEQ would do so, it is hard to imagine DEQ finding a permittee in compliance with Section 161 without ample modeling and data to come to such a conclusion. These rhetorical questions miss the point.

DEQ provided unrebutted expert testimony supporting its interpretation and implementation of the Air Rules. While Petitioners take issue with DEQ's interpretation, DEQ should be afforded deference in its interpretation as (1) DEQ is responsible for administration of the rules at issue, (2) its construction is reasonable, and (3) the language of the rules does not expressly treat the matter at issue. *See* Preston, 131 Idaho 502, 960 P.2d 185 (1998). The Board should affirm the Hearing Officer's decision and find that DEQ acted reasonably and in accordance with law.

CONCLUSION

DEQ takes very seriously its mission to protect public health and the environment. After an enormous effort, which included much stakeholder involvement, DEQ issued a permit that is legally and technically defensible. REC 1273. Petitioners have failed to prove that DEQ committed any errors in its thorough and diligent PTC analysis. Petitioners fail to demonstrate that DEQ acted unreasonably, violated any constitutional or statutory provisions, was in excess of statutory authority, issued the PTC on unlawful procedure, or acted in a manner that was arbitrary, capricious, or an abuse of discretion. Thus, the Board must deny Petitioners' appeal, affirm the

Hearing Officer's Preliminary Order, and find that DEQ acted reasonably and in accordance with law in issuing the PTC.

DATED: February 7, 2024.

STATE OF IDAHO
OFFICE OF THE ATTORNEY GENERAL

/s/ Hannah M.C. Young
HANNAH M.C. YOUNG
Deputy Attorney General
Attorneys for the Idaho Department of Environmental Quality

CERTIFICATION OF SERVICE

I HEREBY CERTIFY that on this 7th day of February, 2024, a true and correct copy of the foregoing RESPONDENT IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY'S BRIEF AND RESPONSE TO PETITIONERS' OPENING BRIEF was served on the following via electronic mail to the indicated address:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-004
filings@oah.idaho.gov
via electronic service

Dylan Lawrence
Hearing Officer
Varin Thomas, LLC
242 N. 8th St., Suite 220
Boise, ID 83702
dylan@varinthomas.com
via electronic service

Bryan Hurlbutt
Laurence ("Laird") J. Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
ann.yribar@ag.idaho.gov
via electronic service

Paula Wilson, Hearing Coordinator
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton St.
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

/s/ DeAnne M. Chaffin
DeAnne M. Chaffin
Legal Assistant

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Intervenor-Respondent Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047

NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,

Petitioners,

v.

IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,

Respondent,

and

PERPETUA RESOURCES IDAHO, INC.,

Intervenor-Respondent.

Case Docket No. 0101-22-01
OAH Case No. 23-245-01

INTERVENOR-RESPONDENT'S BRIEF IN OPPOSITION TO PETITIONERS' AMENDED PETITION FOR REVIEW OF PRELIMINARY ORDERS

TABLE OF CONTENTS

TABLE OF AUTHORITIES iii

KEY TO TERMS AND ABBREVIATIONS vi

INTRODUCTION 1

EVIDENCE RELIED ON 3

STATEMENT OF UNDISPUTED FACTS 3

I. The Project and permit history. 3

A. The Project will develop gold and antimony resources and restore a previously mined and contaminated mine site. 3

B. DEQ issued the Final Permit after multiple requests for additional information, multiple public comment periods, and multiple draft permits. 5

II. PM_{10} fugitive emissions from the Project were conservatively estimated by DEQ. 6

III. The Stibnite Access Route. 8

IV. DEQ analyzed arsenic emissions and determined that they would not exceed the lifetime risk limit established by the Idaho Air Rules. 9

CONTESTED CASE BACKGROUND 11

I. Petitioners filed an amended contested case petition after the Hearing Officer partially dismissed the initial petition. 11

II. The Hearing Officer dismissed the amended contested case petition and found DEQ's decision making was reasonable and not in violation of the Idaho Air Rules. 12

III. Petitioners' Amended Petition seeks Board review of Claims 2, 3, 8, 9, 11, and 12. 13

IV. DEQ and Perpetua seek to supplement the record with DEQ's November 2023 response to the EPA letter. 14

STANDARD OF REVIEW 14

I. The Board must decide whether DEQ acted unreasonably or in violation of the law. 14

II. The Board may defer to DEQ's technical expertise and special skill. 16

ARGUMENT 18

I. The Hearing Officer correctly held that DEQ followed EPA guidance and properly exercised its discretion in excluding the Stibnite Access Route from ambient air (Claims 11 and 12). 18

A. EPA guidance on ambient air and agency discretion. 19

B. DEQ acted within its discretion to accept Perpetua's representation that it will have legal authority to preclude access by the general public. 20

C. DEQ acted within its discretion in determining that the Stibnite Access Route is exempt from ambient air. 23

II. The Hearing Officer correctly held that the Idaho Air Rules do not require Perpetua to develop work plans for DEQ approval before issuance of the Final Permit (Claim 3). 26

A. Petitioners cannot challenge DEQ's issuance of a permit to construct for failure to comply with the CAA. 27

B. The Idaho Air Rules do not require work plans to be submitted with applications or circulated for public comment. 28

C. DEQ's decision for Perpetua to develop and submit the work plans for approval before starting construction was not arbitrary or capricious. 30

D. Petitioners' legal authority from the Clean Water Act is distinguishable and inapplicable to DEQ's preconstruction permitting process. 31

III. The Hearing Officer correctly held that DEQ acted reasonably in determining that a 93.3% control efficiency for fugitive dust emissions from the Project's haul roads will meet the PM_{10} NAAQS and arsenic AACC (Claims 2 and 8). 33

A. DEQ acted reasonably and within its discretion in determining that 93.3% control efficiency for fugitive dust from haul roads is attainable. 33

B. DEQ acted within its discretion to impose daily monitoring and other substantive conditions to ensure a 93.3% control efficiency. 36

IV. The Hearing Officer correctly held that DEQ reasonably exercised its discretion in evaluating the health risks from arsenic (Claim 9). 42

CONCLUSION 49

TABLE OF AUTHORITIES

Page(s)

Cases

Duncan v. State Bd. of Accountancy,
149 Idaho 1, 232 P.3d 322 (2010).....17

Env't Def. Ctr., Inc. v. EPA,
344 F.3d 832 (9th Cir. 2003) 32

Floyd v. Bd. of Ada Cnty. Comm'rs,
164 Idaho 659, 434 P.3d 1265 (2019).....16

Grindstone Butte Mut. Canal Co. v. Idaho Pub. Utils. Comm'n,
102 Idaho 175, 627 P.2d 804 (1981).....18

J.R. Simplot Co. v. Idaho State Tax Comm'n,
120 Idaho 849, 820 P.2d 1206 (1991).....17, 18

Mason v. Donnelly Club,
135 Idaho 581, 21 P.3d 903 (2001).....45

Mobil Oil Corp. v. United States of America,
Civil Action No. 99-1467-A (E.D. Virginia).....4

NRDC v. S. Coast Air Quality Mgmt. Dist.,
694 F. Supp. 2d 1092 (C.D. Cal. 2010), *aff'd*, 651 F.3d 1066 (9th Cir. 2011).....27

In re: Permit Applicant Garnet Energy LLC (Permit No. 0027-00081),
Dkt. No. 0101-01-10, Order Granting Motion for Summary Judgment (Feb. 22, 2002) 18

REDOIL v. U.S. EPA,
716 F.3d 1155 (9th Cir. 2013) 26

State v. Besaw,
155 Idaho 134, 306 P.3d 219 (Ct. App. 2013).....47

In the Matter of Sunnyside Park Utilities' Application for Sewage Disposal Permit, Final Order on Petition for Review of Preliminary Order 14, 15

Train v. NRDC,
421 U.S. 60 (1975).....17, 27, 31, 32

United States of America v. Bradley Mining Co.,
Case Nos. 3:08-CV-03968 TEH and 3:08-CV-05501 TEH (N.D. Cal.) 4

United States of America v. Estate of J. J. Oberbillig,
Case No. CV 02-451-S-LMB (D. Idaho) 4

Waterkeeper Alliance, Inc. v. U.S. EPA,
399 F.3d 486 (2d Cir. 2005)....31, 32

Wheeler v. Idaho Dep't of Health & Welfare,
147 Idaho 257, 207 P.3d 988 (2009)....15

Wheeler v. Idaho Transp. Dep't,
148 Idaho 378, 223 P.3d 761 (Ct. App. 2009)....45

Statutes

30 U.S.C. § 612(b)....5

33 U.S.C. § 1251....32

33 U.S.C. § 1251(e)....32

42 U.S.C. § 7401....11, 12

42 U.S.C. § 7410(a)....27

42 U.S.C. § 7410(k)(3)....27

Idaho Code § 39-108....22

Idaho Code § 39-109....22

Idaho Code § 39-115....16, 17

Idaho Code § 67-5201 *et seq*.....15

Idaho Code § 67-5245(7)....14

Idaho Code § 67-5251(4)(b)....16

Idaho Code § 67-5251(5)....16, 18, 28

Idaho Code § 67-5279(3)....15

Regulations

36 C.F.R. pt. 228....4, 5

40 C.F.R. § 50(e)....8

40 C.F.R. § 50.1(e)....19, 20

40 C.F.R. § 51.161 28

Other Authorities

Michael S. Gilmore & Dale D. Goble, *The Idaho Administrative Procedure Act: A Primer for the Practitioner*, 30 Idaho L. Rev. 273 (1994).....16, 17

U.S. EPA, Compilation of Air Pollutant Emissions Factors, Technical Air Pollution Rules, AP-42 ….....passim

KEY TO TERMS AND ABBREVIATIONS

AACC	Acceptable Ambient Concentration for a Carcinogen
AMP	Access Management Plan
CAA	Clean Air Act, 42 U.S.C. § 7401, *et seq*.
DEQ	Respondent Idaho Department of Environmental Quality
EPA	United States Environmental Protection Agency
FDCP	Fugitive Dust Control Plan
Final Permit	Air Quality Permit to Construct No. P-2019.0047, issued June 17, 2022
HAP	Hazardous Air Pollutant
HRCP	Haul Road Capping Plan
Idaho Air Rules	Rules for the Control of Air Pollution in Idaho, IDAPA 58.01.01
Midas Gold	Midas Gold Idaho Inc., Perpetua's predecessor
NAAQS	National Ambient Air Quality Standards
O&M Manual	Operations and Maintenance Manual
Perpetua	Intervenor-Respondent Perpetua Resources Idaho, Inc.
Petitioners	Petitioners Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon
PM	Particulate Matter
Preliminary Order	Amended Memorandum Decision on Motions for Summary Judgment and Preliminary Order, dated Dec. 5, 2023
Project	Stibnite Gold Project
RBLC database	RACT/BACT/LAER Clearinghouse database
SIP	State Implementation Plan
TAP	Toxic Air Pollutant
T-RACT	Toxic Air Pollutant Reasonably Available Control Technology

Intervenor-Respondent Perpetua Resources Idaho, Inc. ("Perpetua") submits this opposition to the Amended Petition for Review of Preliminary Orders (the "Amended Petition") and Opening Brief submitted by Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon ("Petitioners").

INTRODUCTION

The Stibnite Gold Project (the "Project") is a pioneering approach to mining precious and critical minerals. Not only will it afford Valley County and resident Idahoans with economic benefits, the Project will restore a contaminated mine site that was abandoned by the federal government. Through an agreement with the United States Forest Service (the "Forest Service") and the United States Environmental Protection Agency ("EPA"), Perpetua is committing millions of dollars to pre-permitting cleanup of contaminated conditions it did not cause. Perpetua's restoration efforts at the site are ongoing, even while it procures the many permits needed to construct and operate the Project.

The Idaho Department of Environmental Quality's ("DEQ") issuance of Permit to Construct No. 2019.0047 (the "Final Permit") is the first of the many permits needed for the Project. The Final Permit authorizes construction of the Project, which is a minor source in a remote Idaho landscape designated in attainment with National Ambient Air Quality Standards ("NAAQS"). DEQ developed the Final Permit after a three-year process, which included four requests for supplemental information and air quality analyses from Perpetua, three draft permits, three extended public review and comment opportunities, and two public information meetings.

In July 2022, following the extensive scrutiny and review by DEQ and the public, Petitioners filed this contested case challenging the Final Permit. This Board appointed a Hearing Officer to decide Petitioners' challenges. Over the past 18 months, the parties participated in discovery, extensive motion practice, and a summary judgment hearing. In December 2023, the

Hearing Officer issued an Amended Memorandum Decision on Motions for Summary Judgment and Preliminary Order (the "Preliminary Order") granting DEQ and Perpetua's motions for summary judgment and dismissing the contested case. Now Petitioners seek review of the Preliminary Order, presenting the same opinions and critiques that were thoroughly addressed by DEQ during the permitting process and by the Hearing Officer during the contested case process.

Petitioners dislike DEQ's decision making in the Final Permit and ask the Board to substitute Petitioners' opinions and preferences for DEQ's substantive work and discretion. The Idaho Administrative Procedure Act leaves agencies with the ability to judge how to interpret data and deal with scientific uncertainty and to decide which scientific and technical analyses to accept or reject. DEQ is delegated responsibility to make such determinations in air quality preconstruction permitting. After repeated attempts to substitute their preferences for DEQ's, Petitioners now ask the Board to second-guess the experience, expertise, scientific analyses, expert judgments, and reasoned conclusions of DEQ.

To that end, in their Opening Brief, there is much that Petitioners conveniently ignore about the Final Permit and the exhaustive process to get to this point. Petitioners ignore that DEQ followed EPA guidance and acted reasonably to determine the Project's ambient air boundary. They ignore that DEQ thoroughly assessed future fugitive dust emissions and exercised its discretion in establishing protective fugitive dust controls. They ignore that an effective permit must conservatively regulate the expected mining activities while affording operational flexibility to the permittee. They ignore that an effective permit must protect the NAAQS through practically enforceable permit conditions that are consistent with DEQ programs, practices, and policies manifested in the Final Permit.

Overall, Petitioners ignore the expertise reflected in DEQ's careful, deliberative, thorough, and conservative analysis. Petitioners ignore that DEQ is better suited, and legally authorized, to make policy decisions based on scientific uncertainty and has the discretion to impose "any reasonable conditions upon an approval." IDAPA 58.01.01.211.01. And Petitioners ignore the dense record supporting the Hearing Officer's ruling and that they failed to carry their burden to show DEQ's decision making was arbitrary and capricious, was an abuse of discretion, or violated the law. Perpetua respectfully asks the Board to affirm the Hearing Officer's Preliminary Order and dismiss Petitioners' contested case petition.

EVIDENCE RELIED ON

In opposition to Petitioner's Amended Petition, Perpetua[1] relies on the Agency Record (cited as "REC") certified and transmitted to the Board on December 15, 2023. The Agency Record includes DEQ's permit file, the documents submitted during summary judgment proceedings, and the Hearing Officer's Preliminary Order and other orders. In addition, DEQ and Perpetua have submitted a motion to supplement the administrative record to include DEQ's response to an EPA letter referenced in Petitioner's Amended Petition and Opening Brief.

STATEMENT OF UNDISPUTED FACTS

I. The Project and permit history.

A. The Project will develop gold and antimony resources and restore a previously mined and contaminated mine site.

The Project is located in the Stibnite Mining District, a contaminated legacy mining area the federal government abandoned in 2012 after decades of mining.[2] The Project is designed to

[1] In the permit record, Perpetua is referred to as "PRI."

[2] In a series of consent decrees approved by the federal courts, settling federal agencies (including the United States Department of Agriculture, the United States Department of the Interior, the United States Department of Commerce, the United States Department of Defense,

produce precious metals from the previously mined landscape, as well as critical minerals necessary for the country's energy transformation and national security. REC 415, 417, 1758. The Project has a 16 year life span, as there are only 16 years of ore available to be mined and processed. REC 1949. As part of the Project, in 2021, Perpetua committed millions of dollars to pre-permitting cleanup and to remediate and restore the contaminated site under a voluntary administrative settlement agreement with the Forest Service and EPA. The initial phase to improve water quality is nearly complete.

The Project is approximately 10 miles east of the small community of Yellow Pine, Idaho. REC 415, 1758. The Project is remote, bounded by a mountainous landscape with elevations ranging from 6,000 to 8,500 feet above sea level. REC 1758. Between December and February, the area has an average snow depth of between 21 and 68 inches and receives 6 inches in average precipitation. REC 1759. Between March and May, the average snow depth is between 66 and 84 inches, and the area receives another 6.1 inches in average precipitation. *Id*. From June to November, the average precipitation is 7 inches. *Id*.

The Project includes both patented mining claims, which Perpetua owns and controls, and unpatented mining claims located on national forest land. REC 894, 1758. Because portions of the Project are on national forest land, Perpetua submitted a Plan of Restoration and Operations (which we refer to as the "mine plan") to the Forest Service for approval in 2016. *See* 36 C.F.R. pt. 228; REC 894-895. The mine plan has since been refined to reduce the environmental

---

EPA, and the United States General Services Administration) and other parties were released from past and future response costs in the Stibnite Mining District for pennies on the dollar. *See Mobil Oil Corp. v. United States of America*, Civil Action No. 99-1467-A (E.D. Virginia) (consent decree filed June 26, 2000); *United States of America v. Estate of J. J. Oberbillig*, Case No. CV 02-451-S-LMB (D. Idaho) (consent decree filed March 18, 2004); *United States of America v. Bradley Mining Co.*, Case Nos. 3:08-CV-03968 TEH and 3:08-CV-05501 TEH (N.D. Cal.) (consent decree filed April 19, 2012).

impacts and footprint of the Project. *See* REC 2163.

The Forest Service's approval of the mine plan will confirm the Project's operational boundary and authorize Perpetua to exclude the general public from the Project. *See* 30 U.S.C. § 612(b); 36 C.F.R. pt. 228, subpt. A. Perpetua's permit to construct application and the Final Permit are based on the mine plan, and Perpetua cannot begin to construct the Project until it obtains approval of the mine plan and secures other governmental authorizations.

B. DEQ issued the Final Permit after multiple requests for additional information, multiple public comment periods, and multiple draft permits.

In August 2019, Perpetua applied to DEQ for a permit to construct a minor source. REC 418. DEQ's review of Perpetua's application was thorough and comprehensive. A typical permit to construct with a public comment period is processed in 150 days. REC 1259 [Simon Decl. at 4]. DEQ's review of Perpetua's application took much longer.

Over three years, DEQ repeatedly asked Perpetua to supplement the application with additional information before determining the application complete, offered three extended comment opportunities to solicit public feedback, and held two public informational meetings. REC 418-420, 459, 1258 [Simon Decl. at 3]. Petitioners fully participated and repeatedly criticized DEQ's evaluations and proposed controls of particulate matter ("PM") and toxic air pollutant ("TAP") emissions. *See* REC 915-1000. Petitioners also engaged directly with DEQ staff throughout the permitting process requesting information, analysis, and explanations of DEQ's ongoing work. *See*, *e.g.*, REC 2147-51, 2152-56, 2157, 2310-14.

In response to Petitioners' formal comments, DEQ requested, and Perpetua provided, additional information such as updated hazardous air pollutant ("HAP") and TAP emission inventories and modeling analyses. *See* REC 418-420, 631-633, 1258 [Simon Decl. at 3]. With that information, DEQ conducted additional modeling evaluations of PM emissions and

additional analyses of TAP emissions and enhanced the enforceable permit requirements. *See* REC 627-628. All in all, DEQ asked Perpetua to supplement the application with additional information four times, prepared three draft permits (dated July 14, 2020, February 8, 2021, and December 9, 2021), and provided thorough responses to Petitioners' public comments. *See* REC 418-420, 631-633, 915-1000, 1258 [Simon Decl. at 3].

This multi-year, comprehensive process culminated in the issuance of the Final Permit on June 17, 2022. REC 367-409. Petitioners not only participated directly and indirectly in the permit development, their comments informed DEQ's requests and reviews, plus the permit content developed by DEQ over the three-year permitting process.

II. PM_{10} fugitive emissions from the Project were conservatively estimated by DEQ.

DEQ implements air quality permitting through the Idaho Air Rules, IDAPA 58.01.01 *et seq*. The Idaho Air Rules establish requirements for applicants and DEQ that govern the issuance of permits to construct for new and modified air emission sources. IDAPA 58.01.01.200-227. Under Section 203 of the rules, no permit to construct can be issued unless the applicant demonstrates "to the satisfaction of the Department" that the proposed project "would not cause or contribute to a violation of any ambient air quality standard" (or NAAQS) and that emissions of a TAP "would not injure or unreasonably affect human or animal life or vegetation." IDAPA 58.01.01.203.03.

PM_{10} emissions from the Project represent the largest emissions for this minor source. Emissions from stationary sources and fugitive sources of PM_{10} were estimated in the permit application materials. As DEQ recognized, air emission impact analyses for mining operations "typically involve considerable uncertainty and variability" in both emission-affecting parameters and dispersion-affecting parameters. REC 945. DEQ mitigated the uncertainties and variabilities with a conservative approach (i.e., overstating emissions and impacts) and analyzed

the proposed emissions and modeling to fulfill the requirements of Section 203. REC 917-919, 944-945, 927-928; *see generally* REC 1246-1252 [Schilling Decl. at 14-20].

There are four general steps for determinations based on modeling assessments.

Step 1: Calculate estimated air emissions from all appropriate sources of air pollution. This step typically utilizes the maximum capacity of each source of emissions, an emission factor that represents the best available information to estimate emissions, and an emission control efficiency if an emission control device or practice is used to reduce emissions. EPA's AP-42, *Compilation of Air Pollutant Emissions Factors*, is a commonly used reference for emission factor information for air pollution sources, such as unpaved roads.[3] Acceptable emissions estimation methods vary and often require site-specific parameters.

Step 2: Characterize each air pollution source. Each emission source must be characterized by its initial air dispersion type (e.g., point, volume, or area) and initial air dispersion parameters (e.g., initial exhaust temperature and velocity, length, width, and height of the emitting source), and source location.

Step 3: Use the EPA approved air dispersion model to predict the downwind impacts of the emissions from all sources. The model inputs include the emissions from each source estimated in Step 1, the source characterizations from Step 2, the local terrain and meteorological conditions, and other model inputs.

Step 4: Run the model. The final step is running the model for all pollutants and the appropriate averaging periods to inform DEQ's determinations. In the case of Perpetua's permit, DEQ ran the model for many emissions scenarios to reflect the dynamic operational plan

[3] U.S. EPA, Technical Air Pollution Rules, AP-42, https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors-stationary-sources.

involved in mining activity.

DEQ issues a permit to construct when it is satisfied that the proposed emissions will not cause or contribute to a violation of a NAAQS and the TAP emissions would not injure or unreasonably harm human health, animal health, or vegetation. *See* IDAPA 58.01.01.203. The permitting record before DEQ, including the Final Permit, the Statement of Basis, and the Response to Comments, details the agency's analyses and decision making. As explained below, that record shows that DEQ repeatedly executed the steps outlined above to address different scenarios and to complete conservative assessments and satisfied the requirement to produce and issue the Final Permit in conformity with the Idaho Air Rules.

III. The Stibnite Access Route.

Because DEQ must be satisfied that a project's proposed emissions do not adversely impact compliance with the NAAQS, the boundary of the project's "ambient air" is important. Both EPA and the Idaho Air Rules define "ambient air" as "that portion of the atmosphere, external to buildings, to which the general public has access." 40 C.F.R. § 50(e); IDAPA 58.01.01.006.10. EPA's longstanding guidance provides that the ambient air boundary depends on the source's control of the area and the measures it takes to preclude the general public's access to the land. *See* REC 1138, 1341.

The Stibnite Access Route refers to a seasonal (non-winter) road that will pass through the Project. REC 415, 1758. Petitioners suggest—without any factual support—that the Stibnite Access Route is a Forest Service requirement of the Project and that Perpetua will be unable to preclude general public access to the route. *See* Opening Br. at 20-21. Petitioners are incorrect. The record reflects that public comments from local residents revealed a significant interest in access through the Project. *See* REC 676, 893-895, 1758. Individuals in the Johnson Creek and

Yellow Pine areas who use Stibnite Road to access Thunder Mountain Road and points beyond were particularly concerned about changes that would lengthen travel time. *See id*.

In response to those concerns and at the encouragement of the Forest Service, Perpetua's predecessor, Midas Gold Idaho Inc. ("Midas Gold"), evaluated numerous access options through and around the Project. REC 893-895. Perpetua's mine plan identifies the Stibnite Access Route as a route that would safely address local interests. *Id*.; *see also* REC 676. As noted above, once approved, the mine plan will affirm the Project's operational boundary and construction of the Stibnite Access Route, as well as Perpetua's authority to preclude general public access from the Project. Operations of the Project do not rely on the presence of the Stibnite Access Route and the road is not a Forest Service requirement.

Given the importance of establishing the Project's ambient air boundary, early in the permitting process, Midas Gold engaged with DEQ on the Stibnite Access Route to determine if the route could be excluded from ambient air. *See* REC 1237 [Schilling Decl. at 5]. DEQ contacted EPA, which indicated that the road would be exempt from the Project's ambient air because it will be fully under Perpetua's control and surveillance, and general public access would be precluded. REC 1240 [Schilling Dec. at 8], 1254, 1350-1351, 1496-1497. The Forest Service has recognized this conclusion too. *See* REC 2558, 2637.

IV. DEQ analyzed arsenic emissions and determined that they would not exceed the lifetime risk limit established by the Idaho Air Rules.

Under IDAPA 58.01.01.203, no permit to construct can be issued unless the applicant demonstrates "to the satisfaction of the Department" that the proposed emissions of a TAP "would not injure or unreasonably affect human or animal life or vegetation." Following the second public comment period, DEQ and Perpetua reevaluated TAP emissions in response to concerns expressed by Petitioners. REC 697. DEQ determined that a refined analysis of TAP

emissions, particularly arsenic, was needed to demonstrate preconstruction compliance with the Idaho Air Rules. *Id.*

On October 5, 2021, Perpetua submitted the *Stibnite Gold Project (SGP) Permit to Construct Application TAP Addendum* (the "TAP Addendum"). *Id*. The TAP Addendum reassessed conformity with TAP permitting requirements, refined TAPs evaluations to demonstrate compliance with applicable TAP increments, revised and refined operational parameters affecting TAP emissions, and refined TAP air impact analyses. *See id.* Specifically, the TAP Addendum evaluated arsenic emissions after considering reasonably available control technology ("T-RACT") and operational adjustments.[4] REC 699. The refined TAP analysis included many layers of conservative assumptions, including continual operation of the worst-case operational scenario; operation at maximum allowable rates for the entire averaging period; and no reduction in wintertime emissions from fugitive sources, thus discounting the emission suppression effects of increased moisture. *Id.*

Once the modeled carcinogenic TAP concentrations were obtained they were adjusted to account for the finite, 16-year life of the Project and the related finite exposure risks. REC 710, 1947. This was accomplished by multiplying the highest annual concentrations from the modeling scenarios by 16 years and then dividing by 70 years. *Id*. Multiplying the highest annual concentration of arsenic by 16 years allowed DEQ to determine the maximum concentration of arsenic an offsite receptor would be exposed to during the 16-year operational period. Dividing this maximum concentration by 70 years allowed DEQ to evaluate the lifetime health risk from

[4] As part of its reevaluation of TAP emissions, Perpetua proposed, and DEQ approved, T-RACT controls including installing and operating dust collection systems on drilling rigs, capping haul roads with clean development rock, and using chemical dust suppressant with frequent watering on roads. *See* REC 1291-1292.

that maximum exposure. *Id*. Through this process, DEQ determined that the maximum lifetime exposure concentration of carcinogenic TAPs were below regulatory thresholds and complied with the Idaho Air Rules. REC 710-11.

CONTESTED CASE BACKGROUND

I. Petitioners filed an amended contested case petition after the Hearing Officer partially dismissed the initial petition.

In July 2022, Petitioners filed a contested case petition asking the Board to set aside and remand the Final Permit. REC 1-27. In their petition, Petitioners repeat the same critiques made during the multiple public review periods, seeking to substitute their preferences for DEQ's expertise, pressing for more review and work by DEQ, and alleging that the Final Permit violates the federal Clean Air Act ("CAA"), 42 U.S.C. § 7401, *et seq*., and the Idaho Air Rules. *See id*. Petitioners remain dissatisfied with the Final Permit and urge the Board to substitute Petitioners' preferences for DEQ's reasoned decision making. *See id*.

The Board appointed a Hearing Officer to consider and decide Petitioners' contested case petition. REC 31. Perpetua was allowed to intervene, REC 44, and filed a motion to dismiss the petition, which DEQ joined. REC 52-76. The Hearing Officer partially granted the motion to dismiss. REC 160-185. In his order, the Hearing Officer categorized Petitioners' allegations into 13 claims and dismissed Claims 3, 4, and 10 in full and Claim 8 in part. REC 167-168, 184-185. That prompted Petitioners to file a motion to amend their contested case petition, which DEQ and Perpetua did not oppose. REC 190-192, 194-223.

After the Hearing Officer granted the motion to amend, REC 255-256, Petitioners filed an amended contested case petition in January 2023, REC 263-292. The amended contested case petition adds allegations reviving, of the dismissed claims, only Claim 3. *See generally* REC 209-210 (¶ 40), 219-220 (¶ 70).

II. The Hearing Officer dismissed the amended contested case petition and found DEQ's decision making was reasonable and not in violation of the Idaho Air Rules.

After the parties exchanged discovery, Petitioners moved for summary judgment. REC 319-363. DEQ and Perpetua filed cross-motions for summary judgment. REC 1204-1231, 1276-1335. After summary judgment briefing was completed, Petitioners moved to supplement the administrative record with a letter sent by EPA Region 10 to the Director of DEQ on August 10, 2023, regarding the Final Permit. REC 3137-3142. Petitioners also moved to stay the contested case on the grounds that DEQ should be given time to respond to the EPA letter, REC 3108-3112, and that Petitioners should be allowed to amend their contested case petition again, REC 3190-3197. DEQ and Perpetua opposed Petitioners' motions, REC 3236-3257, and sought to exclude the EPA letter, REC 3097-3102.

The Hearing Officer denied Petitioners' motions to stay and to amend their contested case petition. REC 3265-3270. As for the Petitioners' motion to supplement the record with the EPA letter, the Hearing Officer allowed admission of the EPA letter but limited how it could be considered. REC 3271-3273. The EPA letter could not be used to add new allegations of error on the part of DEQ or add factual information that was not already part of the record. REC 3272. Nor could the EPA letter "be used as a proxy for expert testimony from the Petitioners." *Id*. Petitioners have not sought Board review of those rulings, but still reference the EPA letter in their Amended Petition, REC 3429, and their Opening Brief, Opening Br. at 13-14, 36.

The Hearing Officer conducted a summary judgment hearing on the parties' motions in September 2023. *See* TR 1-57. On October 31, 2023, the Hearing Officer issued a Memorandum Decision on Motions for Summary Judgment and Preliminary Order. REC 3280-3327. The Hearing Officer's order denied Petitioners summary judgment and granted DEQ and Perpetua summary judgment on Claims 1, 2, 5, 6, 7, 9, 11, 12, 13 and the remainder of Claim 8. REC

3325. The Hearing Officer did not address Claim 3, believing the claim was dismissed. *See* REC 3281. That prompted DEQ and Perpetua to move for reconsideration and/or clarification requesting the Hearing Officer to reconsider whether Claim 3 was revived in Petitioners' amended contested case petition and should be addressed. *See id*. REC 3332-3333, 3335-3340.

On December 5, 2023, the Hearing Officer granted DEQ and Perpetua's motion for reconsideration and/or clarification and issued the Amended Memorandum Decision on Motions for Summary Judgment and Preliminary Order (which, as noted, is referred to as the "Preliminary Order"). REC 3367-3370, 3372-3424. In the Preliminary Order, the Hearing Officer granted summary judgment to DEQ and Perpetua on Claim 3, thereby dismissing the whole of Petitioners' amended contested case petition. REC 3422. Previously, on November 14, 2023, Petitioners filed a Petition for Review of Preliminary Order. REC 3342-54. December 15, 2023, Petitioners filed the Amended Petition for Review of Preliminary Orders (which is referred to as the "Amended Petition"). REC 3426-3439.

III. Petitioners' Amended Petition seeks Board review of Claims 2, 3, 8, 9, 11, and 12.

Petitioners' Amended Petition seeks Board review of some, not all, of the issues they raised in their amended contested case petition. Petitioners do not seek review of Claim 1 (dismissed on summary judgment, REC 3397-3399), Claim 4 (dismissed on motion to dismiss, REC 172-173), Claim 5 (dismissed on summary judgment, REC 3407-3409), Claims 6 and 7 (dismissed on summary judgment, REC 3410-3415), Claim 10 (dismissed on motion to dismiss, REC 178-179), and Claim 13 (dismissed on summary judgment, REC 3393-3397).

As for the remaining claims (Claims 2, 3, 8, 9, 11, and 12), Petitioners contend the Hearing Officer erred in holding that: (1) DEQ's determinations that Perpetua has legal control to exclude and will adequately preclude the general public from the Project were not arbitrary and capricious, or an abuse of discretion (Claims 11 and 12); (2) DEQ's determination that the

Final Permit's enforceable conditions will achieve 93.3% control of fugitive dust was not arbitrary and capricious or an abuse of discretion (Claims 2 and 8); (3) DEQ's determination that post-construction operational plans must be submitted for approval 30 days before the start of construction was not arbitrary and capricious, an abuse of discretion, or a violation of the Idaho Air Rules (Claim 3); and (4) DEQ's evaluation of the health risks from arsenic was not a violation of the Idaho Air Rules (Claim 9). As discussed below, Petitioners fail to meet the burden of proof required to support their claims of error before the Board.

IV. DEQ and Perpetua seek to supplement the record with DEQ's November 2023 response to the EPA letter.

On November 22, 2023, DEQ's Director responded to the EPA letter, thoroughly addressing each of EPA's issues and defending the Final Permit. DEQ's response, having come after the Hearing Officer's Preliminary Order, is not part of the administrative record. For that reason, DEQ and Perpetua have jointly sought to supplement the record with DEQ's response consistent with the limited purpose for which the Hearing Officer allowed consideration of the EPA letter. Because the EPA letter is part of the record on a limited basis, it is only appropriate that the record include DEQ's response with the same limitations.

STANDARD OF REVIEW

I. The Board must decide whether DEQ acted unreasonably or in violation of the law.

When reviewing a Preliminary Order, "[t]he head of the agency … for the review of preliminary orders shall exercise all of the decision-making power that he would have had if the agency head had presided over the hearing." Idaho Code § 67-5245(7). According to the Board, "[t]his means that, in reviewing the Preliminary Order, the Board may review all of the evidence *de novo*." *See In the Matter of Sunnyside Park Utilities' Application for Sewage Disposal Permit*, Final Order on Petition for Review of Preliminary Order, at 2 (BEQ Dkt. 0103-07-02, Apr. 7,

2009). The Board has also recognized that it "must determine whether DEQ has acted reasonably and in accordance with law." *Id*. at 10.

Under the Board's contested case rules, Petitioners have "the burden of proving by a preponderous of the evidence, the allegations in the petition." IDAPA 58.01.23.062. The rules also authorize the Board to consider motions for summary judgment, governed by the Idaho Rules of Civil Procedure ("I.R.C.P."). IDAPA 58.01.23.162.02, .410. Under I.R.C.P. 56(a), the Board "must grant summary judgment if the movant shows that there is no genuine dispute as to any material fact and the movant is entitled to judgment as a matter of law." A moving party must support its assertion by citing particular materials in the record or by showing the "materials cited do not establish the … presence of a genuine dispute, or that an adverse party cannot produce admissible evidence to support the fact[s]." I.R.C.P. 56(c)(1)(B).

As the Hearing Officer observed, it is also "important to understand the standards that will ultimately govern judicial review of the Board's decision." REC 3377. That is particularly true here because Petitioners challenge the Final Permit based on the standard for judicial review for adjudicative agency actions under the Idaho Administrative Procedure Act, Idaho Code § 67-5201 *et seq*. *See* Opening Br. at 15 (citing Idaho Code § 67-5279(3); REC 263-292 (¶¶ 4, 35, 52, 61, 69, 72), 338. Under that standard, an agency action may only be overturned if it is (a) in violation of constitutional or statutory provisions, (b) in excess of statutory authority, (c) made on unlawful procedure, (d) not supported by substantial evidence, or (e) arbitrary, capricious, or an abuse of discretion. Idaho Code § 67-5279(3).

There are additional principles regarding the Idaho Administrative Procedure Act's standard worth addressing. The party challenging the agency decision must demonstrate that the agency erred in a manner specified in Section 67-5279. *Wheeler v. Idaho Dep't of Health &*

Welfare, 147 Idaho 257, 260, 207 P.3d 988, 991 (2009). Thus, by relying on the judicial review standard, Petitioners have invited a review process. Under Idaho law, it is DEQ's role to resolve factual issues in determining whether and under what conditions to issue a permit to construct, supported by the permitting record before it. *See* Idaho Code § 39-115. It follows that the Board's function is to decide whether DEQ's issuance of the Final Permit violated the law, was arbitrary and capricious, or was an abuse of discretion.

That means Petitioners present no disputes of material fact—indeed their Opening Brief identifies none—and instead only question the legal conclusions made by DEQ based on the facts underlying the Final Permit. The Board's review is limited to determining whether DEQ acted unlawfully as Petitioners allege. A violation of law speaks for itself. An "arbitrary and capricious decision occurs where the decision was reached in an unreasonable manner or based on clearly erroneous findings." *Floyd v. Bd. of Ada Cnty. Comm'rs*, 164 Idaho 659, 668, 434 P.3d 1265, 1274 (2019). "Clearly erroneous applies where factual findings are not supported by substantial and competent evidence." *Id*. "An abuse of discretion standard examines whether the [agency] acted within the boundaries of its discretionary decision and applicable legal standards, and reached a decision by exercising reason." *Id*.

II. The Board may defer to DEQ's technical expertise and special skill.

In addition to the standards above, the Idaho Administrative Procedure Act speaks to the deference the Board may afford DEQ in reaching a decision in a contested case: "[t]he agency's experience, technical competence, and specialized knowledge may be utilized in the evaluation of the evidence." Idaho Code § 67-5251(5); *see also* IDAPA 04.11.01.600. Also the Board may take official notice of "generally recognized technical or scientific facts within the agency's specialized knowledge." Idaho Code § 67-5251(4)(b); *see also* IDAPA 04.11.01.602. Thus Idaho law explicitly recognizes that "the agency's repeated exposure to a specialized subject matter is a

source of specialized knowledge that is useful in evaluating evidence." Michael S. Gilmore & Dale D. Goble, *The Idaho Administrative Procedure Act: A Primer for the Practitioner*, 30 Idaho L. Rev. 273, 319 (1994).

Deference is particularly appropriate here. DEQ is granted primary authority to determine specific, source-by-source emission limitations in air quality permitting. *See* Idaho Code § 39-115 (granting DEQ the authority to issue pollution source permits); *see also* REC 1272 (¶ 7). As the United States Supreme Court recognized in *Train v. NRDC*, 421 U.S. 60, 79 (1975), "so long as the ultimate effect of a State's choice of emission limitations is compliance with the [NAAQS], the State is at liberty to adopt whatever mix of emission limitations it deems best suited to its particular situation." Thus the Board may give due consideration and deference to the technical expertise and special skill of DEQ, as the Hearing Officer did. *See* REC 3378.

The deference the Board may give DEQ is illustrated by the deference courts give agencies, when reviewing an agency action. First, Idaho courts defer to agency interpretations of law. *J.R. Simplot Co. v. Idaho State Tax Comm'n*, 120 Idaho 849, 862-63, 820 P.2d 1206, 1219-20 (1991). When an agency is entrusted with administering a statute, the courts may defer to the agency's interpretation of a statute or rule if the interpretation is reasonable and not contrary to its express language. *See id.* at 862, 820 P.2d at 1219. Generally, the Idaho Supreme Court finds agency interpretations of statutes and rules are "reasonable unless the agency relied on erroneous facts or law in its determination." *Duncan v. State Bd. of Accountancy*, 149 Idaho 1, 4, 232 P.3d 322, 325 (2010) (citing cases). Stated differently, an agency's interpretation of a rule or statute is unreasonable when it "is so obscure and doubtful that it is entitled to no weight or consideration." *Simplot*, 120 Idaho at 862, 820 P.2d at 1219 (citation omitted).

Second, consistent with the Idaho Code § 67-5251(5) and IDAPA 04.11.01.600 noted above, the reviewing courts defer to the agency when reviewing a scientific determination in its particular field of expertise. *See Simplot*, 120 Idaho at 859, 820 P.2d at 1216 ("[T]he expertise of an agency is often useful in technical areas of the law where the risk of failing to understand all of the implications of a decision are great."); *Grindstone Butte Mut. Canal Co. v. Idaho Pub. Utils. Comm'n*, 102 Idaho 175, 182, 627 P.2d 804, 811 (1981) (noting that the Court will temper its review with deference to the expertise of the Idaho Public Utilities Commission when considering testimony that is technical in nature); *see also* Idaho Code § 67-5251(5).

ARGUMENT

Applying those standards to this case, the Hearing Officer correctly granted summary judgment in favor of DEQ and Perpetua and dismissed Petitioners' contested case petition. Petitioners appeal the issuance of the Final Permit based on alleged errors in the preconstruction permitting process. That process requires DEQ to reach decisions through the exercise of discretion and through its scientific and technical expertise. Summary judgment on contested cases has been found appropriate where the action being challenged involved a discretionary decision reached by the exercise of DEQ's special skill and expertise. *See, e.g.*, *In re: Permit Applicant Garnet Energy LLC (Permit No. 0027-00081)*, Dkt. No. 0101-01-10, Order Granting Motion for Summary Judgment (Feb. 22, 2002).

I. The Hearing Officer correctly held that DEQ followed EPA guidance and properly exercised its discretion in excluding the Stibnite Access Route from ambient air (Claims 11 and 12).

Petitioners contend that DEQ's decision to exclude the Stibnite Access Route from ambient air protections was arbitrary and capricious and an abuse of discretion for two reasons. Opening Br. at 16-24. First, they argue that Perpetua does not have legal control to preclude the general public from the Project. *Id*. at 17-21. Second, they argue that the Final Permit does not

adequately preclude the general public. *Id*. at 22-24. The Hearing Officer disagreed and rightly so. REC 3384-3393. Petitioners simply dispute DEQ's exercise of discretion and take a view of ambient air that is far narrower than what EPA and DEQ guidance allows.

A. EPA guidance on ambient air and agency discretion.

The term "ambient air" is not defined in the CAA. EPA filled this gap by defining "ambient air" as "that portion of the atmosphere, external to buildings, *to which the general public has access*." 40 C.F.R. § 50.1(e) (emphasis added). Idaho similarly defines "ambient air" as "that portion of the atmosphere, external to buildings, to which the general public has access." IDAPA 58.01.01.006.05. EPA has long recognized that an applicant need not demonstrate the impact of a source's emissions on air within areas to which general public access is restricted. *See* REC 1138, 1341, 1805.

Thus, EPA has consistently exempted "the atmosphere over land [1] owned or controlled by the source and [2] to which the public access is precluded by a fence or other physical barriers" from "ambient air." REC 1138. In 2019, EPA broadened the "fence or other physical barriers" element and recognized that physical boundaries are not the only way in which to preclude public access. REC 1146. Specifically, EPA recognized that other measures (such as video surveillance, monitoring, clear signage, and routine security patrols) may be effective in deterring or precluding access to the land by the general public. *Id*. EPA gives the example that clearly visible "No Trespassing" signs in conjunction with some degree of fencing or other physical and/or non-physical barriers may be effective to preclude access by the general public in appropriate situations. REC 1147.

Also important, EPA recognizes a source's "ambient air" is reviewed based on an individual, case-by-case basis. REC 1147-1148. As EPA explains in the 2019 guidance:

> The EPA will apply a rule of reason in evaluating the effectiveness of any measure proposed by a source … this evaluation should address relevant factors, such as the nature of the measure used (e.g., physical or non-physical), source location, type and size of source and property to be excluded, surrounding area (including the proximity, nature, and size of the population in the area), and other factors affecting whether members of the general public would readily be able to trespass upon or otherwise have access to the source's properties.

REC 1147. Air agencies "should consider all relevant information provided by the source or other interested parties, or otherwise available regarding the effectiveness of the measures to prevent public access." *Id*. Thus air agencies exercise discretion in determining whether a permit condition is appropriate to ensure that the source administers selected measures in a manner that maintains continued public health protection. *Id*.

B. DEQ acted within its discretion to accept Perpetua's representation that it will have legal authority to preclude access by the general public.

Petitioners contend that the Hearing Officer erred in finding that DEQ could rely on Perpetua's representations that it will legally control the Project and the Project's operational boundary. Opening Br. at 17-21. Petitioners present a primary misunderstanding in their Opening Brief: that Perpetua will not have legal authority to preclude public access from the Stibnite Access Route. *Id*. The record does not support Petitioners, and the Hearing Officer was correct to reject their unsupported assertion for two reasons.

First, DEQ was satisfied with Perpetua's representation that it will have sole and complete control of general public access to the Stibnite Access Route, including complete closure when necessary. REC 676-677, 936. As the Hearing Officer observed, Midas Gold, Perpetua's predecessor, certified the truth of the following representation:

> Midas Gold will legally control the SGP, an active industrial site where mining activities will occur, such as heavy equipment operation. Most areas of the mine will require strict safety protocols and controlled access. Midas Gold has established an operations boundary to identify the area where public access will be excluded. Public access inside the operations boundary will be restricted for

> the life of the mine by physical barriers at points of potential access, including the current Stibnite Road point of entry and proposed site access via the Burntlog Route, as well as natural features of the landscape that prevent access.

REC 1807. Indeed, in the permit to construct application, Perpetua certified that, "based on information and belief formed after reasonable inquiry, the statement and information in this and any attached and/or referenced document(s) are true, accurate, and complete in accordance with IDAPA 58.01.01.123, 124." REC 1508; *see also* REC 1507, 1721. Perpetua also informed DEQ that the Stibnite Access Route was included in the mine plan and was subject to the Forest Service's approval. *See* REC 894-895, 2163.

Unlike DEQ and the Hearing Officer, Petitioners ignore that the Final Permit is a *preconstruction* permit, that construction of the Project has not begun, and that construction cannot begin until Perpetua obtains the Forest Service's approval of the mine plan. Petitioners' argument that Perpetua does not have control of the Project now is nothing more than misdirection. The Project is located on a combination of private land and public national forest land, and Perpetua is required to obtain authorization from the Forest Service. The mine plan establishes the Project's operational boundary and its approval will provide Perpetua with authority to preclude public access for safety and operational reasons.

Perpetua's application for a permit to construct and DEQ's approval of the Final Permit is based on the proposed operational boundary. If the Forest Service does not approve the mine plan, the Project will not proceed. If there is no Project, Perpetua has no need for the Final Permit. These sequential realities do not invalidate Perpetua's representation that it "will legally control" the Project and "has established an operations boundary to identify the area where public access will be excluded." DEQ can, and must, rely on the representations of permit

applicants, and the record supports that its reliance on Perpetua here was reasonable and supported.[5]

Second, Petitioners are wrong that Perpetua will not obtain legal authority to preclude the general public from the Stibnite Access Route once the Forest Service approves the Project's mine plan. On page 20 of their Opening Brief, Petitioners challenge Perpetua's control over the road by misrepresenting statements made in an Air Quality Specialist Report prepared for the Forest Service (the "USFS Report"), REC 2605-2985, and a May 2021 memorandum developed for the Forest Service by Stantec Consulting Services, REC 2557-2558. According to Petitioners, the mine plan *requires* Perpetua to provide public access through the Project and thus Perpetua will not have legal ability to preclude public access. Opening Br. at 20-21. This reading of the USFS Report and Stantec memorandum is fundamentally wrong and misleading.

As the record demonstrates, Perpetua volunteered to construct the Stibnite Access Route for limited connectivity to Thunder Mountain Road and points beyond. REC 985. Perpetua is not legally obligated to construct the Stibnite Access Route and has sole and complete control over construction, operation, and use of the road, including complete closure of the road when necessary for safety or operational reasons. REC 676-677, 936. The USFS Report and the Stantec memorandum merely *report* what Perpetua volunteered to do and will do once the mine plan is approved. *See* REC 2557-2558, 2625, 2637-2638, 2677, 2684.

[5] Petitioners also criticize the Hearing Officer's observations that DEQ has broad enforcement authority and that in his experience, agencies typically rely on representations made in permit applications. *See* Opening Br. at 18, 21 (citing REC 3390). The Hearing Officer simply recognized what is obvious. DEQ must rely on the representations of permit applicants to fulfill its permitting authority. And when there is a violation of the Idaho Air Rules, including IDAPA 58.01.01.123, .124, and .125. DEQ can enforce the violation and bring civil and criminal enforcement actions against violators. *See* Idaho Code §§ 39-108, 39-109.

The USFS Report simply states that public access through the Project will be provided by a new route through the Project. REC 2677. It also observes that in the operational boundary, "public access would be prohibited, or restricted through such measures that are accepted as means to control public access (EPA 2019a) as Perpetua security checkpoints, physical barriers at points of potential access road and trail entry, and security surveillance patrols." REC 2637. The USFS Report does not require the Stibnite Access Route, nor does it treat the road as the ambient air boundary. *See* REC 2637-2638. In fact, the USFS Report references the Stantec memorandum, REC 2737, which concludes that the road is not ambient air:

> After review of all pertinent information associated with other cooperating agencies, *it is Stantec's understanding that the public access road can be justifiably excluded from ambient air consideration*. The State agency responsible for issued air permits has excluded the road because of restriction measures put in place consistent with their rules and requirements in the permit.

REC 2558 (emphasis added). The Stantec memorandum also observed, "*EPA Region X has accepted DEQ's conclusions*." *Id*. (emphasis added).

Thus Petitioners' argument that Perpetua does not have the legal ability to preclude public access is disingenuous, as they ignore and misrepresent the record. *See* Opening Br. at 20-21. Moreover, as explained below, the Final Permit illuminates the many ways the general public will be legally and physically precluded from accessing the Stibnite Access Route.

C. DEQ acted within its discretion in determining that the Stibnite Access Route is exempt from ambient air.

As the Hearing Officer held, DEQ conformed to EPA guidance and exercised reasonable discretion in excluding the Stibnite Access Route from the Project's ambient air. REC 3390-3393. While Petitioners raise several questions in their Opening Brief and may have different opinions on how DEQ should have established the ambient air boundary, they fail to meet their burden to show that DEQ's decision is arbitrary and capricious, or an abuse of discretion. *See*

Opening Br. at 22-24. As evidenced by the record, DEQ conducted a thorough review of this issue. In deciding that the Stibnite Access Route is excluded from ambient air, DEQ reached a reasonable determination consistent with the definition of ambient air and agency guidance.

As noted earlier (at p. 9), DEQ and Perpetua recognized from the beginning the importance of establishing the ambient air boundary to permit the Project. *See* REC 1240 [Schilling Decl. at 8]. In 2018, DEQ contacted EPA Region 10, which gave this guidance regarding the Stibnite Access Route: "If the public access road is only accessible to public traveling in automobiles under the escort, supervision, and monitoring of Midas personnel (they mentioned a pilot car as a possibility), and there are no stopping points with public access along the road, then the road is not ambient air." REC 1350. In 2020, EPA Region 10 reiterated that the road would be exempt "because it is fully under the control and surveillance of the source and unsupervised public access is precluded. It seems like a slam dunk, based on my understanding of EPA's revised ambient air policy." REC 1496, 1240 [Schilling Decl. at 8].

DEQ analyzed the ambient air boundary issue using EPA's guidance. *See* REC 676-677, 935-936, 958. As to the second element (measures precluding public access), DEQ evaluated how Perpetua would restrict access and prohibit the public from freely accessing the Stibnite Access Route. REC 676-677, 936. DEQ considered that Perpetua would preclude general public access to the road by (1) establishing manned access gates at points prior to the ambient air boundary; (2) employing physical barriers at points of potential access; (3) posting signs warning the public against entry into the site; (4) implementing routine patrolling and surveillance for unauthorized individuals; and (5) only allowing registered guests access to or through the facility. *Id*.; *see also* REC 1807-1809.

Nevertheless, Petitioners liken the Stibnite Access Route to a right-of-way easement or common service road and argue that individuals traveling the Route are the general public. Opening Br. at 24. They also contend that the Final Permit does not preclude access to the general public. *Id*. at 23. But unlike a right-of-way or common service road, members of the general public will not be permitted to freely access the Stibnite Access Route. REC 376 (Condition 2.7); *see also* REC 676-677, 935-936. In Condition 2.7, DEQ conditioned the Final Permit on the establishment of an Access Management Plan ("AMP") prohibiting the general public from freely accessing the Stibnite Access Route. REC 376.

Under Condition 2.7, "Only registered guests of the facility will be allowed access to or through the facility. Those seeking to be a guest for the sole purpose of passing through the facility to another destination shall be provided a registration sheet that explains Perpetua's requirements for accessing the site and identified potential hazards of the site." *Id*. Those that seek access must be required to register at the access gate and will be informed that they are proceeding as guests rather than members of the general public. *Id*. Perpetua must also install locked gates and barriers for the two primary access points, plus post warning signs, require registration by users seeking access, and more. *Id*. Also the measures specified in the AMP will be incorporated by reference into the Final Permit and will be enforceable permit conditions. *Id.*

Despite those restrictions, Petitioners persist that those accessing the Stibnite Access Route cannot be considered "guests of the mine," yet they ignore DEQ's record and reasoned analyses and simply argue the semantics of a "guest." *See* Opening Br. at 23-24. But based on Condition 2.7 and Perpetua's barriers to entry, only registered vehicles and their passengers will be permitted entry onto the Stibnite Access Route. REC 376. Vehicles will be supervised, cannot stop, and must check out at the egress point. *See id*. The elaborate measures at both entry and

egress locations, plus supervision of vehicles requiring continuous movement without stopping along the route, reinforce Perpetua's control of the road, in contrast to a county road or other thoroughfare that is uninhibitedly open to the general public.

Thus, the measures required by the Final Permit preclude access by the general public and support DEQ's well-reasoned decision to exclude the Stibnite Access Route from the ambient air boundary. *See REDOIL v. U.S. EPA*, 716 F.3d 1155, 1165 (9th Cir. 2013) (holding that EPA's grant of an ambient air exemption conditioned on a safety zone was a permissible interpretation of the ambient air regulation and EPA's 2019 guidance).

***

In sum, as the Hearing Officer found, Perpetua demonstrated it has the legal and practical ability to preclude the general public from the Stibnite Access Route consistent with EPA's 2019 Guidance. REC 3384-3393. After thorough deliberation and consultations with EPA Region 10, DEQ concluded the Stibnite Access Route was properly excluded from the ambient air boundary based on the Project's individual circumstances. *See* REC 1236-1240 [Schilling Decl. at 4-8], 1254, 1350, 1496, 2558, 2737. Just as the Ninth Circuit upheld EPA's decision in *REDOIL*, the Board should uphold DEQ's determination on the Project's ambient air boundary.

II. The Hearing Officer correctly held that the Idaho Air Rules do not require Perpetua to develop work plans for DEQ approval before issuance of the Final Permit (Claim 3).

DEQ lawfully required future development of the AMP, Fugitive Dust Control Plan ("FDCP"), Haul Road Capping Plan ("HRCP"), and Operations and Maintenance Manual ("O&M Manual"). Petitioners' arguments that the Final Permit is incomplete and the work plans violate the CAA and the Idaho Air Rules ignore the permit record and DEQ's well established practice and are legally unfounded. *See* Opening Br. at 29-34. Pursuant to DEQ's discretion, the Final Permit requires Perpetua to develop the work plans, include specific provisions in the

plans, and submit them to DEQ for approval prior to startup. REC 375-376 (Condition 2.6 (FDCP) and Condition 2.7 (AMP)), 378-380 (Condition 2.20 (O&M Manual)), 385-386 (Condition 3.13 (HRCP)). As the Hearing Officer held, DEQ did not violate the CAA or the Idaho Air Rules or act arbitrarily and capriciously. REC 3406-3407.

A. Petitioners cannot challenge DEQ's issuance of a permit to construct for failure to comply with the CAA.

At the start, the Board must reject Petitioners' allegations that DEQ's issuance of the Final Permit violates the CAA. *See* Opening Br. at 29-32. The CAA and part 51 regulations delineate the required contents of SIPs. *See* 42 U.S.C. § 7410(a). In other words, the federal provisions describe "the general *types* of emissions standards and limitations that a SIP must contain"—they establish "requirements for *SIPs*, not *sources*." *NRDC v. S. Coast Air Quality Mgmt. Dist.*, 694 F. Supp. 2d 1092, 1105, 1111 (C.D. Cal. 2010) (emphases in original), *aff'd*, 651 F.3d 1066 (9th Cir. 2011). EPA must approve a SIP so long as it satisfies those requirements. *See* 42 U.S.C. § 7410(k)(3).

This distinction between SIPs and sources is important here. EPA "is plainly charged by the Act with the responsibility for setting the [NAAQS]. Just as plainly, however, it is relegated by the Act to a secondary role in the process of determining and enforcing the specific, source-by-source emission limitations." *Train*, 421 U.S. at 79. Thus, EPA has "no authority to question the wisdom of a State's choices of emission limitations." *Id*. "[S]o long as the ultimate effect of a State's choice of emission limitations is compliance with the [NAAQS], the State is at liberty to adopt whatever mix of emission limitations it deems best suited to its particular situation." *Id*.

The CAA and part 51 regulations require that SIPs provide for an opportunity for public comment on "information submitted by owners and operators [and] [t]he public information must include the agency's analysis of the effect of construction or modification on ambient air

quality, including the agency's proposed approval or disapproval." 40 C.F.R. § 51.161. EPA approved Idaho's SIP, including DEQ's specific preconstruction rules. IDAPA 58.01.01.200-223. Because the CAA and the part 51 regulations establish requirements for SIPs, not sources, the only relevant question now is whether DEQ complied with the Idaho Air Rules.

B. The Idaho Air Rules do not require work plans to be submitted with permit to construct applications or circulated for public comment.

The Idaho Air Rules do not require that work plans be developed at all, let alone that they be prepared before construction commences or be available for public comment before a preconstruction permit can be issued. *See* IDAPA 58.01.01.211.01. Section 202 of the Idaho Air Rules specifies the requirements for a permit to construct application and identifies information required to be included in the application. IDAPA 58.01.01.202.01. Requisite information for new sources includes "[s]ite information, plans, descriptions, specifications, and drawings showing the design of the stationary source, facility, or modification, the nature and amount of emissions (including secondary emissions), and the manner in which it will be operated and controlled." IDAPA 58.01.01.202.01.a.i. DEQ may request any additional information necessary to make determinations under the Idaho Air Rules. IDAPA 58.01.01.202.03.

Petitioners cite Section 202.01 and argue the work plans at issue were required "plans" to be submitted as part of Perpetua's permit application and to be circulated for public comment. Opening Br. at 30. There is no textual support that the AMP, FDCP, HRCP, and O&M Manual are "plans" as that term is used in Section 202.01. Petitioners fail to present any argument to support their interpretation of the term. Moreover, DEQ's interpretation of its rules, plus its authority to determine an application complete, are entitled to deference. *See* IDAPA 58.01.01.202.03; *see also* Idaho Code § 67-5251(5); IDAPA 04.11.01.600.

DEQ must provide an opportunity for public comment on its "proposed action, together with the information submitted by the applicant and the Department's analysis of the information." IDAPA 58.01.01.209.01.c.i. As such, Petitioners' argument that Perpetua's application is incomplete or that these plans must be made available for public comment is legally incorrect. *See* Opening Br. at 29. Following the Idaho Air Rules, DEQ's review of Perpetua's application was an exemplar of this process: it included four requests for additional information to supplement the application, three extended public comment opportunities, two informational meetings requested by the public, and three iterations of draft permits. REC 418-419, 459. Notably, none of DEQ's incompleteness letters to Perpetua requested that the work plans be included in the permit application.

DEQ confirmed that requiring work plans after issuance of the Final Permit and prior to startup for DEQ review and approval complies with the Idaho Air Rules, its discretion under the rules, and agency practice:

> DEQ contends the requirement to review and approve each Plan and Manual after the permit is issued and prior to facility startup is sufficient, reasonable, and appropriate to ensure compliance with applicable requirements…[;] DEQ uses its authority to require a permittee to develop and submit for DEQ approval Plans and Manuals in accordance with IDAPA 58.01.01.211.01.

REC 1264 [Simon Decl. at 9]. DEQ explains that this is standard protocol, because more information becomes available after the permit application is submitted and approved and prior to startup, such as actual equipment purchased and installed, and the operational activities that are actually implemented after construction is completed. REC 1265 [Simon Decl. at 10].

In the end, Petitioners fail to point to any legal obligation in the Idaho Air Rules that requires AMPs, FDCPs, HRCPs, or O&M Manuals be circulated for public comment and review. In the absence of such rules, Petitioners try to shift the burden to Perpetua and DEQ by

arguing that "[n]o provisions in the Air Rules authorize DEQ to save portions of a PTC to be developed later." Opening Br. at 29. But it is Petitioners' burden to show DEQ's failure to comply with a legal obligation. And there are no such Idaho Air Rules because the rules do not require these documents in the application or in the public review process. The Hearing Officer was correct in finding DEQ did not violate the Idaho Air Rules and that "the language of Air Rule 211.01 provides DEQ with wide discretion regarding appropriate permit terms." REC 3406.

C. DEQ's decision for Perpetua to develop and submit the work plans for approval before starting construction was not arbitrary or capricious.

Contrary to Petitioners' accusations, DEQ is not "shielding" work plans from public review. Opening Br. at 32. Petitioners contend that DEQ failed to develop important permit conditions for work plans. However, DEQ included permit conditions prescribing great specificity for Perpetua's work plans. *See* REC 375-376 (Condition 2.6 detailing specific requirements of the FDCP and Condition 2.7 detailing specific requirements of the AMP), 378-380 (Condition 2.20 detailing specific requirements of the O&M Manual), 385-386 (Condition 3.13 detailing specific requirements of the HRCP), 932-933. DEQ also requires that the work plans "ensure compliance" with pertinent requirements. *See*, *e.g.*, REC 375 (Condition 2.6: "The Permittee shall develop and maintain a FDCP to ensure compliance with fugitive dust requirements (Permit Conditions 2.1-2.5) and also fugitive dust best management practices…in accordance with IDAPA 58.01.01.799.").

In addition, while the work plans are not required by any rule to be submitted at all, DEQ will exercise oversight, review and approve the work plans, and publish the final plans on its website. *Id*. Perpetua shall submit the plans to DEQ for approval at least 30 days prior to startup. REC 375-376 (Condition 2.6 (FDCP) and Condition 2.7 (AMP)), 378-380 (Condition 2.20 (O&M Manual)), 385-386 (Condition 3.13 (HRCP)); *see also* REC 932. Furthermore, elements

of the work plans, including recordkeeping and reporting requirements, will be incorporated and enforceable through the Final Permit. *Id*.

The method by which DEQ addressed the work plans in the Final Permit is consistent with DEQ's practice and is reasonable. *See* REC 1265 [Simon Decl. at 10]. It allows the permittee to prepare a specific plan or manual based on information that is not available at the permit to construct phase, such as the actual equipment purchased and operational characteristics of the facility. *Id*. Petitioners disagree with the approach executed by DEQ, but disagreement is not the legal standard. DEQ exercised reasonable discretion in developing the permit conditions related to the work plans. *See* REC 3406-3407. DEQ's approach did not violate the CAA governing SIPs, nor the Idaho Air Rules governing sources.

D. Petitioners' legal authority from the Clean Water Act is distinguishable and inapplicable to DEQ's preconstruction permitting process.

Petitioners fail to cite any case law to support their position that public review is required for work plans under the CAA or Idaho Air Rules for permits to construct. *See* Opening Br. at 29-34. This is not an oversight. There is no legal authority for Petitioners to reference. The relevant CAA jurisprudence affords broad discretion to states to develop permit conditions. *See Train*, 421 U.S. at 79. As demonstrated above, to issue the Final Permit lawfully, the work plans need not be included with applications or published for public comment and review as part of the preconstruction review process. In the absence of such authority, Petitioners cite two Clean Water Act cases to support their position on the work plans ignoring the distinct statutory requirements of that statute. Opening Br. at 31-32, 34.

In the first case, *Waterkeeper Alliance, Inc. v. U.S. EPA*, the plaintiff sought review of the National Pollution Discharge Elimination System Permit Regulation and Effluent Limitation Guidelines and Standards for Concentrated Animal Feeding Operations (the "CAFO Rule"). 399

F.3d 486, 492 (2d Cir. 2005). The plaintiff argued that the permitting scheme established by the CAFO Rule violated the Clean Water Act's public participation requirements because it did not require nutrient management plans, which constitute effluent limitations, to be made available to the public. *Id.* at 503. Under the Clean Water Act, effluent limitations are specifically identified in the list of items that public participation should be provided for. 33 U.S.C. § 1251. As such, the Second Circuit held the CAFO Rule "violates the plain dictates of 33 U.S.C. § 1251(e)." *Waterkeeper Alliance*, 399 F.3d at 504.

Similarly, in *Environmental Defense Center, Inc. v. EPA,* the Ninth Circuit held that Notices of Intent ("NOI") are functional equivalents to permits under the Clean Water Act's general permit option, and EPA's failure to require review of NOIs available to the public contravened the express requirements of the Clean Water Act. *Env't Def. Ctr., Inc. v. EPA*, 344 F.3d 832, 858 (9th Cir. 2003).

The Board should not give any weight to *Waterkeeper Alliance* and *Environmental Defense Center* because they are factually distinguishable and inapposite. Both relate to an entirely different federal law and permitting scheme and address information that is expressly required by the Clean Water Act to be provided to the public. The facts underlying these decisions are clearly different from Perpetua's work plans, which are not required by any express provision of the Idaho Air Rules (or the CAA) to be included in the application, the Final Permit, or any part of the public comment process. Rather, the Idaho Air Rules and relevant CAA jurisprudence provide that DEQ has broad discretion in development of permit conditions. *Train*, 421 U.S. at 79; IDAPA 58.01.01.211.01.

***

In sum, the Idaho Air Rules do not require DEQ to review and approve work plans during

the preconstruction permit review process, nor is public review appropriate for the specific operational choices implemented by the permittee in those plans. Moreover, DEQ placed the specific requirements for content of the work plans in plain sight within the Final Permit. As the Hearing Officer held, the Idaho Air Rules support DEQ's decision and discretion not to require Perpetua to develop work plans before issuance of the Final Permit. *See* REC 3406-3407.

III. The Hearing Officer correctly held that DEQ acted reasonably in determining that a 93.3% control efficiency for fugitive dust emissions from the Project's haul roads will meet the PM_{10} NAAQS and arsenic AACC (Claims 2 and 8).

To satisfy the requirements of Section 203 of the Idaho Air Rules, DEQ's evaluation included estimates of fugitive dust emissions from the Project's haul roads, including a dust control efficiency of 93.3%. *See* REC 431, 456, 917. Petitioners insist DEQ lacked a reasonable basis to determine that Perpetua will achieve a 93.3% control efficiency.[6] Opening Br. at 35-40. The Hearing Officer disagreed and found DEQ's selected control efficiency was reasonable and that the Final Permit includes enforceable limits and conditions to achieve that level of control. REC 3399-3403. The record fully supports the reasonableness of DEQ's determinations and the Hearing Officer's ruling. Petitioners' objections are simply a difference of opinion and provide no basis to conclude DEQ acted unreasonably.

A. DEQ acted reasonably and within its discretion in determining that 93.3% control efficiency for fugitive dust from haul roads is attainable.

Contrary to Petitioners' contention, the Final Permit includes a specific requirement to achieve 93.3% control of fugitive dust on the Project's haul roads. *See* Opening Br. at 35-36. The requirement is set forth in Conditions 1.2 and 3.2 of the Final Permit. REC 369, 384; *see also* REC 3399-3400. And as the Hearing Officer ruled, DEQ reasonably established the 93.3%

[6] Before the Hearing Officer, Petitioners also argued that DEQ's fugitive dust determinations violated the Idaho Air Rules. *See* REC 344, 2340. Petitioners do not present that argument here.

control efficiency based on a combination of dust suppressant chemical application (90% control) and watering (33% control) to increase road surface moisture.[7] *See* REC 3401-3402 (citing REC 917, 923-924). Petitioners do not offer alternative values; nor do they contest that chemical suppressant and water are commonly used together to control fugitive dust emissions from unpaved roads. *See generally* REC 912, 917, 924, 1245 [Schilling Decl. at 13], 1838.

Rather, Petitioners suggest, without argument or support, that it is "highly questionable whether 93.3% fugitive dust control is realistically attainable." Opening Br. at 35; *see also id*. at 36-37. They also make much of DEQ's recognition that meeting the 93.3% control efficiency for fugitive dust from the haul roads "requires conscientious efforts, vigilant inspection and monitoring, and a comprehensive [Fugitive Dust Control Plan]." *See id*. at 37, 39 (citing REC 456). Petitioners simply ignore DEQ's robust, reasoned, and rational analysis and decision making reflected in the permit record. DEQ relied on two sources to conclude a 93.3% control efficiency was achievable.

The first source was EPA's AP-42 guidance, which is commonly used for emission factor information for air pollution sources. DEQ relied on studies referenced in AP-42 Section 13.2.2, Unpaved Roads (2006), which supports a control efficiency over 90% when chemical and water suppressants are used in combination. *See* REC 917, 912, 1260-1261 [Simon Decl. at 5-6], 1838. As DEQ noted, the referenced test reports show that chemical suppressant alone can achieve 90% to 99% control efficiency and 98% for magnesium chloride in particular. REC 546-547.

[7] 93.3% control = (1-90%) * (1-33%). DEQ explained in its response to comments that it could have listed the control efficiencies separately for chemical (90% control) and water (33.3% control), but it chose to combine the control efficiency as 93.3% to emphasize the importance of using chemical and water suppressants in combination. REC 923-924.

Section 13.2.2 of AP-42 also provides that watering alone can achieve 75% to 95% control efficiency. REC 548, 808 (Figure 13.2.2-2), 1838.

To bolster its analysis, DEQ also reviewed a second source, EPA's RACT/BACT/LAER Clearinghouse ("RBLC") database. REC 924. The RBLC database identifies 10 major stationary source projects using chemical dust suppressants or a combination of chemical suppressants and watering with 90% to 98% control efficiency. REC 912-913. While Petitioners sought to discredit most of the 10 projects as unrepresentative, DEQ found the database provided additional support that a 90% or greater control efficiency is achievable, in various states with similar operations, by treating unpaved roads with chemical suppressants. REC 923-925.

To be sure, the RBLC database reports the *minimum* control efficiency required for the 10 projects, not the projects' achieved maximum control efficiency. REC 912-913. When using chemical suppressants alone, two of the RBLC projects identified a 90% control efficiency and one of the projects a 98% control efficiency. REC 913. As the permitting authority familiar with the database, DEQ concluded the database identified projects—including gold, cement and concrete, steel, and quarry projects—referencing control efficiency of 90% *or greater* for unpaved roads. REC 924, 912-913. DEQ found those and the other projects representative of circumstances presented by Perpetua. REC 924.

DEQ also found that fugitive dust from the haul roads was likely to be controlled at levels greater than 93.3% during wintertime conditions when the site receives an average snow depth of 21-68 inches and 6 inches of average precipitation. REC 924-925. Petitioners ignore all this work by DEQ. Ultimately DEQ chose to rely on empirical data gleaned from AP-42 and the RBLC database rather than Petitioners' unsupported critiques of DEQ's professional analyses. *See* REC 917, 924, 986 (noting that Petitioners did not demonstrate that their assumptions "were more

accurate or appropriate than data provided" and accepted by DEQ). DEQ reasonably supported its finding that the 93.3% control efficiency for chemical dust suppression and watering was both achievable and conservative. As the Hearing Officer correctly ruled, Petitioners have not shown that DEQ's conclusion was unsupported or unreasonable. *See* REC 3401-3402.

B. DEQ acted within its discretion to impose daily monitoring and other substantive conditions to ensure a 93.3% control efficiency.

The Hearing Officer also rejected Petitioners' contention that the Final Permit lacks sufficient and enforceable conditions to ensure a 93.3% level of control of fugitive dust from the haul roads will be met. REC 3402-3403. Petitioners argue that DEQ should have accepted EPA's advice and included conditions on the type, quantity, application rate, and frequency of dust suppressants. Opening Br. at 37-40. But as the Hearing Officer noted, they cite to no legal authority that DEQ was *required* to include those conditions, because there is none. REC 3403. Further, DEQ developed numerous permit conditions to ensure the 93.3% control efficiency is maintained on a daily and annual basis, and as the Hearing Officer held, Petitioners have not shown those conditions are unsupported, unreasonable, or unenforceable. *See id*.

1. DEQ imposed daily monitoring, dust control application, and other conditions to ensure the 93.3% control efficiency will be met.

Under the Idaho Air Rules, DEQ has the discretion to impose "any reasonable conditions upon an approval." IDAPA 58.01.01.211.01; *see also* IDAPA 58.01.01.651 ("All reasonable precautions must be taken to prevent particulate matter from becoming airborne."). Petitioners simply want different conditions to control haul road fugitive dust emissions from those imposed by DEQ and ask the Board to substitute their choices for DEQ's. Yet they cannot prove by a preponderance of the evidence that the conditions imposed in the Final Permit are arbitrary and capricious or unreasonable. Moreover, Petitioners ask the Board to view each condition in isolation for adequacy, without considering how the Final Permit's numerous conditions operate

together to require and verify compliance with the 93.3% fugitive dust control efficiency.

According to EPA guidance, for source-specific permit provisions to be practically enforceable, they must specify: (1) a technically accurate limitation and the portions of the source subject to the limitation; (2) the time period for the limitation (hourly, daily, monthly, annually); and (3) the method to determine compliance including appropriate monitoring, recordkeeping and reporting. REC 1157. DEQ ensured those enforceability criteria were met with respect to the 93.3% control efficiency. Not only did DEQ include that level of control in the Final Permit and find it achievable (as just explained), the Final Permit required, among other things, the proper application of dust suppressant chemicals and watering as verified through daily visible emission monitoring and recordkeeping. REC 917, 921, 923, 934, 937.

DEQ's conclusion is amply supported by the record and reasonable. Conditions 2.2, 2.4, 2.5, 2.6, and 2.8 provide enforceable conditions for achieving 93.3% haul road dust control by the proper application of dust suppressant chemicals and watering. Condition 2.2 requires Perpetua to monitor the frequency and methods used to control fugitive dust at least once every 12 hours and maintain those records. REC 374. Condition 2.4 requires daily facility-wide inspections of hauling activities to ensure the expected control efficiency is achieved. *Id*. Condition 2.5 requires fugitive dust control measures at all times to ensure no more than 10% opacity and immediate corrective action if the limit is not met. REC 375. The daily inspection and haul road opacity requirements are more stringent than in other permits that DEQ has issued. REC 1261 [Simon Decl. at 6].

Those conditions also refute Petitioners' complaints that DEQ did not include "vigilant inspection and monitoring" to ensure compliance. *See* Opening Br. at 37-40. As for monitoring, Condition 2.4 again establishes a daily monitoring time interval. REC 374. As for recordkeeping,

chemical suppressant and water applications must be recorded every 12 hours under Condition 2.2, dust complaints must be recorded under Condition 2.3, and all inspections and corrective actions must be recorded under Condition 2.4. *Id*. In addition, Condition 3.13 requires haul road inspections and silt content sampling. REC 385-386. And Condition 7.10 establishes detailed recordkeeping requirements for monitoring records, and Condition 7.11 requires documentation and reporting of excess opacity emissions. REC 406-407.

Moreover, Conditions 2.6 and 2.8 require a FDCP, which must be submitted to DEQ for approval 30 days prior to startup, and once approved, will be incorporated into the permit and enforceable. REC 375-376. The FDCP itself ensures compliance with the Final Permit's fugitive dust requirements. Condition 2.6 establishes and details minimum and substantive requirements for the FDCP, including:

- posting and limiting the maximum speed of haul trucks;
- applying water or suitable dust suppressant chemicals to haul roads during the dry season and at other times as necessary to control fugitive dust;
- prior to onset of winter conditions, maintenance of the roads and any preventative dust suppression activities before the roads are frozen;
- developing specific criteria to determine what frequency and type (water and/or chemical) of dust suppressant and appropriate suppressant application rates;
- applying chemical dust suppressants consistent with manufacturer's instructions and recommendations;
- providing training to all relevant employees and conducting visible emissions evaluations by certified employees who are visible emission observers; and

- at least once each year, evaluating FDCP requirements to identify additional requirements and evaluating the effectiveness of practices.

REC 375-376 (Condition 2.6). Thus, DEQ did not give "vague direction" to consider type, quantity, and rates of dust suppressants later in its FDCP. *See* Opening Br. at 38. As DEQ explained in response to Petitioners' criticisms, the Final Permit requires Perpetua to apply dust suppressants in proper amounts and proper frequencies as local conditions dictate and also requires daily inspections to ensure the 93.3% control efficiency is met. REC 917, 921, 923, 934, 937. Ultimately, the Final Permit "requires a more comprehensive and detailed FDCP than in any other minor source permit DEQ has issued." REC 1263 [Simon Decl. at 8].

DEQ rightly recognized the challenge of achieving fugitive dust controls at the 93.3% control efficiency. REC 456. As noted, Petitioners attempt to use DEQ's acknowledgment against it, *see* Opening Br. at 37, 39-40, but it illustrates that DEQ's choices in establishing Conditions 2.1 to 2.8 were deliberate, rational, and reasonable. For instance, DEQ reasoned that frequent inspections "once every 12 hours ensures that both daytime and nighttime operations will be observed, to confirm that sufficient fugitive dust control measures are applied as assumed in demonstrations of compliance with NAAQS on a 24-hour basis." REC 724. DEQ also considered the Final Permit's surrogate production limits (discussed below) and that a 93.3% level of control could be met and likely exceeded during wintertime conditions, when modeling showed possible violations of the PM_{10} NAAQS. REC 924-925, 995-996.

Rather than affording passing consideration to achieving 93.3% control levels, DEQ directly confronted the challenge and developed robust permit conditions to assure future permit compliance. DEQ's imposition of minimum and substantive requirements in the Final Permit and through the FDCP was reasonable. DEQ understood how uncommon and impractical it would be

to establish specific numeric limits to control efficiency variables advocated by Petitioners. Instead, the Final Permit requires that chemical suppressants be applied in accordance with the manufacturer's instructions and recommendations and that the control effectiveness of the combination of dust suppressant chemicals and watering be verified daily. As the Hearing Officer concluded, Petitioners have not satisfied their burden to show that the many permit conditions imposed by DEQ will not achieve the expected control efficiency. REC 3403.

2. DEQ also established surrogate production limits and other requirements to ensure the 93.3% control efficiency is achievable.

Petitioners also ignore the other enforceable conditions DEQ imposed to control fugitive dust emissions from the haul roads. As DEQ explained, emissions limits and parameters associated with estimating emissions are not commonly included in permits for fugitive dust sources. REC 923, 939-940. Instead, DEQ uses production limits and monitoring and recordkeeping requirements, which it did here. *Id*. In Condition 3.5, DEQ established daily hauling and excavation limits of 180,000 tons/day and 135,000 tons/day on a five-year rolling basis. REC 385; *see also* REC 917, 939. It did so because daily production limits directly limit "hauling operations and associated emissions" and "serve as surrogate emissions limits for PM, PM_{10}, $PM_{2.5}$, HAP and TAP from fugitive sources." REC 722, 923, 939-940.

DEQ also recognized the importance of the silt content parameter in estimating fugitive dust emissions and ensuring compliance with the PM_{10} NAAQS. REC 918. In response to Petitioners' and EPA's comments, DEQ imposed Condition 3.13, which requires Perpetua to cap haul roads with material having a maximum of 4% silt content and to develop a HRCP to ensure the limit is met. REC 385-386; *see also* REC 918, 938-939. Further, as just discussed, DEQ imposed Conditions 2.1 to 2.8 to require fugitive dust emission limits (to ensure that visible

emissions do not exceed 10% opacity) and control requirements (such as the application of water and chemical dust suppressants to haul roads). REC 374-376, 456.

Equally important are the monitoring and recordkeeping requirements DEQ imposed. As DEQ explained, "[s]uch monitoring includes the monitoring of maximum road silt content [and] monitoring of production levels to verify estimated vehicle miles traveled (VMT) used in fugitive road dust emission calculations." REC 928. Indeed, Condition 3.13 requires sampling and monitoring of the maximum road silt content, and Condition 3.16 requires daily, monthly, and yearly hauling and excavating monitoring. REC 386. And, again, Condition 2.6 requires Perpetua to develop and maintain the FDCP to ensure compliance with Conditions 2.1 to 2.5. REC 375-376. The FDCP must include precautions to minimize fugitive dust emissions, such as maximum speed limits, monitoring and maintenance of haul roads, and frequency of chemical dust suppressant and watering. *Id*.

Finally, Petitioners overlook the conservative assumptions that overestimated fugitive dust emissions from the haul roads and modeled maximum PM_{10} impacts. EPA's method for estimating haul road fugitive dust emissions predicts higher emissions for more miles traveled and a heavier vehicle weight. *See* REC 1163-1164. Thus, DEQ also justified its choice of conditions because the emissions were "[c]alculated at maximum daily processing rates" and "would tend to be conservatively estimated." REC 431. At the 180,000 tons/day production limit (or 65,700,00 tons/year), DEQ modeled all hauling scenarios to capture the maximum case hauling distance of 16,415 miles per day (or approximately 500,000 miles per month). *Id*. But the Project's peak production rate is actually 116,964 tons/day (or 42,692,000 tons/year), *id*., and the peak hauling mileage is approximately 116,700 miles per month, far less than modeled, REC

722. And where the conservatism of some emissions calculated was questioned, "DEQ required enhanced monitoring and record-keeping," such as Conditions 3.13 and 3.16. REC 92.

In sum, the entire premise of Petitioners' challenge is wrong–there is no legal requirement for DEQ to include the type, quantity, application rate, and frequency of dust suppressants to control fugitive dust emissions from the haul roads. Petitioners also ignore the actual conditions DEQ chose to impose and its justification for establishing fugitive dust controls, surrogate production limits, and enhanced monitoring and recordkeeping requirements. Petitioners may disagree with DEQ's choices, but they have not shown that DEQ lacked a reasonable basis for such conditions.

***

After exhaustive review (much of it in response to Petitioners' public comments), DEQ concluded that fugitive dust emissions from the Project's haul roads will neither cause nor contribute to violations of the PM_{10} NAAQS and the arsenic AACC. *See* IDAPA 58.01.01.203. Petitioners disagree with DEQ's assessments and prefer that it use a lower control efficiency and add more permit limits and conditions to control operations. The Hearing Officer was correct in ruling that Petitioners have not shown that DEQ's choices were unreasonable, unsupported, or irrational. REC 3399-3403.

IV. The Hearing Officer correctly held that DEQ reasonably exercised its discretion in evaluating the health risks from arsenic (Claim 9).

Petitioners argue that "[t]he Hearing Officer ignored the plain language of the Air Rules" by holding that DEQ appropriately found that emissions of arsenic would not injure or unreasonably affect human health or the environment. Opening Br. at 40. However, it is Petitioners who ignore the plain language of the Idaho Air Rules. Petitioners fault DEQ for using a "project specific adjustment factor" to account for the actual operational life of the Project, but

ignore that this project specific adjustment is envisioned by the Idaho Air Rules and well within DEQ's discretion. *See id.*

Following the second public comment period and in response to Petitioners' comments, Perpetua modeled carcinogenic TAPs emissions using an emission inventory that included T-RACT controls, as authorized by Section 210 of the Idaho Air Rules. *See* REC 1944. Typically a source will have an indefinite or unknown operational life, so the Idaho Air Rules require that the source's TAP emissions do not exceed the T-RACT adjusted AACC, which is 10x the AACC listed in Section 586 of the Idaho Air Rules.[8] Section 210.12. This ensures that over a 70-year human life, the ambient air cancer risk from the source's emissions over that period do not exceed one in 100,000. REC 1243 [Schilling Decl. at 11].

However, here the Project does not have an indefinite operational life. Instead, the Project will only operate for 16 years. *See* REC 698, 710, 1947. Accordingly, DEQ used a project specific adjustment factor, authorized under the authority granted to it by Section 210.12, to evaluate whether the TAP emissions from the Project, and specifically arsenic emissions, from the Project would be less than the TAP Standards established in Section 210 and Section 586. REC 710-711.

Arsenic is the primary TAP of concern from the SGP. REC 435. Arsenic is a carcinogen, and the concerns for health impacts from arsenic exposure are from a long-term exposure basis. *See* REC 698, 1243 [Schilling Decl. at 11]. Thus, to reflect the long-term health impacts from sources with indefinite operational spans, the carcinogenic increments reflected in Section 586 are based on a 70-year lifetime exposure. REC 963, 1242-1243 [Schilling Decl. at 10-11].

[8] The Idaho Air Rules were established primarily to regulate well-defined, consistent pollutant emitting processes of an indefinite life. REC 1240 [Schilling Decl. at 8], 1243 [Schilling Decl. at 11].

Notably, before the rules were updated in 2022,[9] the Idaho Air Rules defined "Toxic Air Pollutant Carcinogenic Increments (AACCs)" as "[t]hose ambient air quality increments based on the probability of developing excess cancers over a seventy (70) year lifetime exposure to one (1) microgram per cubic meter (1 μg/m3) of a given carcinogen and expressed in terms of a screening emission level or an acceptable ambient concentration for a carcinogenic toxic air pollutant." IDAPA 58.01.01.006.125 (2022); REC 1243. So, while the AACC is stated in annual averages, these values were developed to be protective where a facility emits at the level reflected in the AACC over the entire 70-year exposure period. *See* REC 963, 1242-1243. In other words, when adjusted for T-RACT, the concentration established by the AACC assumes that if 100,000 people spend a lifetime (24 hours per day, every day, for 70 years) at the maximum receptor point, one person "may" develop cancer.

Again, here, the Project will operate, and potentially generate arsenic emissions, for only 16 years. REC 698. Thus, there will be no arsenic generating activity at the Project after year 16. To account for the actual operational period, DEQ evaluated whether arsenic emissions from the Project would, when evaluated over a 70-year period, be less than or equal to the AACC as required by Section 210.12. REC 69, 719. Conservatively, DEQ took the highest annual modeled concentration of arsenic and assumed that that concentration would be repeated for each year of operations, 16 years. REC 710, 1243. DEQ then averaged this exposure across 70 years, which is the lifetime exposure period that forms the basis of the AACCs and which is required to be evaluated by the Idaho Air Rules. REC 710, 963, 1243. DEQ then compared the lifetime arsenic exposure from the Project, on an annual basis, to the AACC for arsenic, as provided in Section

[9] *See* Executive Order No. 2020-01 (requiring State rules to be streamlined).

586, and determined that the maximum lifetime exposure would be approximately 41% of the AACC. REC 714.

When interpreting a rule, such as Section 210.12, "[t]he language of the rule … should be given its plain, obvious and rational meaning." *Wheeler v. Idaho Transp. Dep't*, 148 Idaho 378, 384, 223 P.3d 761, 767 (Ct. App. 2009) (citing *Mason v. Donnelly Club*, 135 Idaho 581, 586, 21 P.3d 903, 908 (2001)). Petitioners fault DEQ for ensuring that its evaluation of arsenic emissions from the Project was equivalent to the AACC. But DEQ's approach is envisioned and permitted by the plain language of Section 210.12, which requires that DEQ must:

> Compare the source's or modification's approved T-RACT ambient concentration at the point of compliance for the toxic air pollutant to the amount of the toxic air pollutant that would contribute an ambient air cancer risk probability of less than one to one hundred thousand (1:100,000) (which amount is equivalent to ten (10) times the applicable acceptable ambient concentration listed in Section 586).

IDAPA 58.01.01.210.12.b. Following this evaluation, then

> [i]f the source's or modification's approved T-RACT ambient concentration at the point of compliance is less than or equal to the amount of the toxic air pollutant that would contribute an ambient air cancer risk probability of less than one to one hundred thousand (1:100,000), no further procedures for demonstrating preconstruction compliance will be required for that toxic air pollutant as part of the application process.

IDAPA 58.01.01.210.12.c. Thus, under Section 210.12.b and c, DEQ must evaluate the arsenic emissions and determine if they are less than or equal to the amount of TAP that would contribute to an ambient air cancer risk probability of less than one to 100,000.

As described by Section 210.12, this air cancer risk probability is equivalent to the AACC listed in Section 586. However, the AACC was based on a 70-year exposure period, while the life of the Project is only 16 years. To determine whether the emissions from the 16-year Project were actually equivalent to the AACC, DEQ applied a project specific adjustment

factor to evaluate the arsenic emissions from the Project on the same basis as the AACC – 70 years. REC 710-11; REC 1243 [Schilling Decl. at 11].

Importantly, unlike the other subsections of Section 210 that require the source to demonstrate that its TAP emissions will be at or below the AACC, Section 210.12 contains no such explicit requirement.[10] For instance, Section 210.06 requires that the source's "uncontrolled ambient at the point of compliance" be "*less than or equal to the applicable acceptable ambient concentration*." IDAPA 58.01.01.210.06.b (emphasis added); *see also* IDAPA 58.01.01.210.08.b, 210.10.b, 210.11.c. Had DEQ intended to require that annual emissions from the Project meet the AACC each and every year, it would have said as much in Section 210.12. It did not.

Instead, Section 210.12 requires that DEQ evaluate the acceptable air cancer risk that is "equivalent to" the value found in the AACC. "Equivalent" does not mean "exactly." It means "equal in value, force, amount, effect, or significance." *Equivalent, Black's Law Dictionary* (11th ed. 2019). So here, DEQ must determine whether the Project's arsenic emissions, released over 16 years, have the same cancer risk value as the value found in the AACC that is based on emissions over 70 years. Petitioners can hardly argue that 16 years is equivalent to 70 years. DEQ appropriately conducted its evaluation of the arsenic emissions from the Project by annualizing the worst-case modeled emissions from the Project for the 16-year operational life over the 70-year period upon which the AACCs are based. When DEQ applied the project

[10] Petitioners conveniently ignore the portions of Section 210.12.b and c that require DEQ to compare arsenic emissions to the amount of emissions that would "contribute an ambient air cancer risk probability of less than one to one hundred thousand." *See* Opening Br. at 42. Instead, Petitioners rewrite Section 210.12 to make it seem like DEQ must determine whether the arsenic emissions are less than or equal to the AACC in every year that the Project operates. *Id.* This is not what Section 210.12 requires.

specific adjustment factor, it complied with the plain language of the Idaho Air Rules to determine that the Project met the requirements of Section 210.12.

Not only did DEQ comply with the plain language of the Idaho Air Rules, it also complied with the intent of the Idaho Air Rules. When interpreting a rule, the Board must construe the rule as a whole to give effect to DEQ's intent in enacting the rule. *See State v. Besaw*, 155 Idaho 134, 142, 306 P.3d 219, 227 (Ct. App. 2013). Section 161 demonstrates DEQ's intent in requiring a preconstruction compliance demonstration for TAPs–that TAP emissions do not "injure or unreasonably affect human or animal life or vegetation." Section 586 establishes acceptable levels of carcinogenic air pollutants: if a receptor were exposed to each year for 70 years, this would not result in an increased cancer risk. These AACCs are designed to be both protective and enforceable for projects that have an indefinite operating life. REC 1243 [Schilling Decl. at 11]. Section 210.12 requires that arsenic emissions from the Project not exceed an ambient concentration that would be greater than one to 100,000.

Clearly then, the intent of the Idaho Air Rules is to ensure that emissions from a source do not create an unacceptable cancer risk and are not otherwise injurious to life and health. However, Petitioners ignore the intent of the Idaho Air Rules and argue that unless the ambient concentration in each year of the Project meets the exact value of the AACC, DEQ erred, irrespective of the relative cancer risk of the arsenic emissions from the Project. Opening Br. at 43.[11]

[11] Petitioners focus on DEQ's explanation at the hearing on summary judgment to argue that DEQ made up a new regulatory exception to evaluate arsenic emissions from the Project. That is not what occurred. As explained by DEQ in the record, REC 710-711, 719, and Kevin Schilling's declaration, REC 1242-1243, DEQ used a project specific adjustment factor to ensure that its comparison of arsenic emissions from the Project was equivalent to the AACC. Part of the confusion regarding this claim is caused by Petitioners' ever-shifting theory of how DEQ

DEQ conducted a thorough review of Perpetua's potential arsenic emissions and determined that the Project would comply with Section 210.12. DEQ made repeated requests for additional information related to TAPs emissions from the Project. *See* REC 419-420, 1926. At DEQ's request, Perpetua prepared a TAP Addendum that analyzed TAP emissions using T-RACT controls, production limits,[12] and emission inventory refinements. REC 1944. Also, at DEQ's request, Perpetua conducted an arsenic modeling analysis comparing the worst-case modeling analysis, used to determine preconstruction compliance, and an assessment of the actual arsenic concentrations expected from the actual mining operations. REC 1949. The arsenic emissions produced from the actual operating analysis are only 19% of the worst-case scenario. REC 1950. This searching evaluation demonstrates that DEQ complied with the intent of the Idaho Air Rules.

Here, DEQ complied with both the plain language of Section 210.12 and the intent of the Idaho Air Rules in finding that the arsenic emissions from the Project would have a lifetime ambient air cancer risk less than or equal to one to 100,000. *See* REC 1244 [Schilling Decl. at 12]. As the Hearing Officer recognized, DEQ provided "a thoughtful and conservative approach

---

erred. In their opening summary judgment brief Petitioners seemed to argue that DEQ violated the Idaho Air Rules, although they never explicitly stated as much. REC 361-362. In their reply brief, Petitioners changed tack and argued that DEQ's arsenic analysis was arbitrary and capricious, apparently abandoning their previous position. REC 2368. Now, they shift again and attempt to make more explicit their theory that DEQ violated the Air Rules. Opening Br. at 40. Perpetua and DEQ have been required to respond to Petitioners' ever evolving argument, which is reflected in the past explanations of why the Final Permit was lawfully issued.

[12] DEQ set the life-of-mine hauling and excavating limit at 788.4 million tons of ore and development rock. Whether this amount is mined in 16 years, the life of the mine, or 70 years, the lifetime exposure period, the total arsenic emissions will be the same, they would just be spread out over more time. Thus, the total arsenic exposure to public receptors will be the same irrespective of how long the mine is in operation.

to ensuring arsenic emissions will not exceed the 1-in-100,000 lifetime cancer risk standard when T-RACT is used." REC 3421. That is all the Idaho Air Rules require, nothing more.

In sum, as the Hearing Officer concluded, DEQ complied with both the letter and the intent of the Idaho Air Rules in evaluating arsenic emissions from the Project. REC 3415-3422. DEQ concluded, after extensive evaluation of the potential arsenic emissions, that the Project would not result in impacts to ambient air that exceed TAP increments of Section 586. *See* REC 719. The Board should uphold DEQ's well-reasoned determination as consistent with the Idaho Air Rules.

CONCLUSION

The Board should deny Petitioners' Amended Petition for Review of Preliminary Orders and affirm the Hearing Officer's Amended Memorandum Decision on Motions for Summary Judgment and Preliminary Order.

DATED: February 7, 2024.

STOEL RIVES LLP

/s/ *W. Christopher Pooser*
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Intervenor-Respondent Perpetua Resources Idaho, Inc.

CERTIFICATE OF SERVICE

I hereby certify that on this 7th day of February 2024, a true and correct copy of the foregoing was served on the following:

Hannah Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
hannah.young@deq.idaho.gov
via electronic service

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
Counsel for the Idaho
Board of Environmental Quality
ann.yribar@ag.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Paula J. Wilson, Paralegal
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, Idaho 83706
paula.wilson@deq.idaho.gov
via electronic service

Dylan B. Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

/s/ *W. Christopher Pooser*
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Intervenor-Respondent Perpetua Resources Idaho, Inc.

RAÚL R. LABRADOR
Attorney General

SCOTT L. CAMPBELL
Deputy Attorney General
Chief, Energy and Natural Resources Division

Hannah M.C. Young, ISB No. 9781
hannah.young@deq.idaho.gov
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: 208.373.0453

Attorney for Respondent

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047

NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,

Petitioners,

v.

IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,

Respondent,

and

PERPETUA RESOURCES IDAHO, INC.,

Intervenor-Respondent.

Case Docket No. 0101-22-01
OAH Case No. 23-245-01

JOINT MOTION TO SUPPLEMENT RECORD WITH DEQ RESPONSE TO EPA LETTER

Respondent Idaho Department of Environmental Quality ("DEQ") and Intervenor-Respondent Perpetua Resources Idaho, Inc. ("Perpetua") jointly move to supplement the administrative record with DEQ's response to a letter the United States Environmental Protection Agency ("EPA") sent to DEQ's Director. Previously, the Hearing Officer granted Petitioners' motion to supplement the record with the EPA letter, subject to certain limitations. Fairness and completeness dictate that the Board of Environmental Quality (the "Board") supplement the record with DEQ's response, subject to the same limitations. This motion is supported by the Declaration of Tiffany Floyd ("Floyd Decl.") and brought pursuant to Idaho Code § 67-5245(7) and IDAPA 04.11.01.600.

BACKGROUND

Petitioners filed a contested case petition challenging DEQ's issuance of Permit to Construct No. 2019.0047 (the "Final Permit"). REC 1-27, 263-292.[1] The Final Permit is a preconstruction permit that authorizes Perpetua to construct the Stibnite Gold Project (the "Project"). After the Board assigned a hearing officer to hear the contested case, the Hearing Officer heard the parties' competing motions for summary judgment and on October 31, 2023, issued a Preliminary Order dismissing the contested case petition. REC 3280-3327. The Hearing Officer later issued an Amended Preliminary Order. REC 3372-3424. On March 14, 2024, the Board is scheduled to hear Petitioners' Amended Petition for Review of Preliminary Orders.

This motion arises because once discovery and summary judgment briefing was completed before the Hearing Officer, Petitioners moved to supplement the administrative record with an August 10, 2023 letter sent by EPA Region 10 to the Director of DEQ, regarding EPA's concerns with the Final Permit. REC 3137-3142. Over DEQ and Perpetua's objections, *see* REC

[1] Citations to "REC" are references to the Agency Record, which was certified and transmitted to the Board on December 15, 2023.

3236-3257, the Hearing Officer partially granted Petitioners' motion to supplement the record, REC 3271-3273. While allowing the admission of the EPA letter, the Hearing Officer limited the purposes for which it could be considered. The EPA letter cannot be used (1) to add new allegations of error, (2) to add factual information that was not already part of the record, or (3) "as a proxy for expert testimony from the Petitioners." REC 3272. Petitioners have not asked the Board to review of the Hearing Officer's rulings. Neither have DEQ and Perpetua.

There is more to the story, however.

On October 13 and 23, 2023, DEQ and EPA staff met to discuss EPA's concerns with the Final Permit. Floyd Decl. at ¶ 4. On November 22, 2023, DEQ's Director formally responded to the EPA letter with a 31 page "Response to the August 10, 2023 EPA Region 10 Letter to Idaho DEQ." *Id*. at ¶ 5, Ex. A. In the transmittal letter, the DEQ Director explained that the supporting materials detailed the information DEQ and EPA staff discussed in the technical meetings and that "[i]t is our understanding that through those meetings and conversations, DEQ addressed all of EPA's concerns that were identified in your August 10, 2023, letter and that the PTC issued by DEQ to Perpetua Resources on June 17, 2022, is protective of the National Ambient Air Quality Standards and meets the requirement of the Clean Air Act." *Id*., Ex. A.

DEQ and Perpetua now move the Board to supplement the administrative record with DEQ's response to ensure DEQ's response to the EPA letter is fairly and completely reflected.

ARGUMENT

When reviewing a Preliminary Order, "[t]he head of the agency … for the review of preliminary orders shall exercise all of the decision-making power that he would have had if the agency head had presided over the hearing." Idaho Code § 67-5245(7). Thus the Board has the authority to take evidence to assist in the development of the administrative record. *See* IDAPA

04.11.01.600; *see also* IDAPA 04.11.01.413 (allowing a hearing officer to accept evidence in the record), 606 (allowing the agency head to rule on objections to the admission of evidence).[2]

Supplementing the record before the Board to include DEQ's response to the EPA letter is necessary to ensure fairness and the completeness of the record. The EPA letter concerned four issues: (1) whether the Project is a major stationary source under the CAA; (2) whether fugitive dust from the Project's haul roads will cause or contribute to a violation of the PM_{10} NAAQS; (3) whether Perpetua has the legal right to exclude the general public for purposes of the ambient air boundary; and (4) whether the Permit includes sufficient measures to exclude the general public from the entirety of the Project for the ambient air boundary.

Only two of those issues—the second and the third issues—are raised in Petitioners' Amended Petition for Review of Preliminary Orders. Petitioners reference the EPA Letter in their Amended Petition, REC 3429, and their opening brief, *see* Opening Br. at 13-14, and contrary to the Hearing Officer's order, rely on EPA's "public comments and other submissions to DEQ" as "expert testimony," *Id*. at 36. *See also Id*. at 8, 33, 35-36, 38. Having come after the Hearing Officer's Preliminary Order, DEQ's response is not part of the administrative record. Thus Petitioners do not acknowledge DEQ's response to the EPA letter, which thoroughly addressed and rejected each of EPA's concerns. *See* Floyd Decl. at ¶ 5, Ex. A.

If the EPA letter is relevant to these proceedings, then DEQ's response is equally relevant. It is only fair and equitable to supplement the administrative record with DEQ's response to ensure the record is complete and accurately reflects the resolution of the EPA letter. For those reasons, the Board should allow the admission of DEQ's response under the same

[2] The Board's contested case rules incorporate Section 413 and Sections 600-606 of IDAPA 04.11.01. *See* IDAPA 58.01.23.003.08., 13.

conditions the Hearing Officer allowed consideration of the EPA Letter. Just as the EPA letter cannot be used to add new allegations of error or factual information that was not already part of the record or "as a proxy for expert testimony from the Petitioners," neither can DEQ's response to the EPA letter. *See* REC 3272.

Thus, DEQ's response should only be considered to the extent it is relevant to alleged errors that are already within the scope of this contested case proceeding and includes factual information or data that is already within the existing the record. Again, that includes only the second and the third issues raised in the EPA letter, which DEQ addressed during the Final Permit's multiple public comment periods and addressed again in the response to the letter. Thus no new factual information or data are raised. To that end, supplementing the record to include DEQ's response to the EPA letter does not require additional hearings, further factual development, or remand to the Hearing Officer. Nor will the admission of DEQ's response prejudice Petitioners.

CONCLUSION

In sum, because Petitioners were allowed to supplement the record with the EPA letter, the Board should be aware of DEQ's thorough response and dismissal of the EPA letter. To ensure fairness and the completeness of the record, the Board should supplement the record with DEQ's response, subject to the same limitations the Hearing Officer admitted the EPA letter.

DATED: February 7, 2024.

DEPARTMENT OF ENVIRONMENTAL QUALITY

/s/ *Hannah M.C. Young*
Hannah M.C. Young
Deputy Attorney General

Attorney for Respondent

DATED: February 7, 2024.

STOEL RIVES LLP

/s/ *W. Christopher Pooser*
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Intervenor-Respondent Perpetua Resources Idaho, Inc.

CERTIFICATE OF SERVICE

I hereby certify that on February 7, 2024, a true and correct copy of the foregoing was served on the following:

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
Counsel for the Idaho
Board of Environmental Quality
ann.yribar@ag.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Paula J. Wilson, Paralegal
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, Idaho 83706
paula.wilson@deq.idaho.gov
via electronic service

Dylan B. Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

/s/ *Hannah M.C. Young*
Hannah M.C. Young

RAÚL R. LABRADOR
Attorney General

SCOTT L. CAMPBELL
Deputy Attorney General
Chief, Energy and Natural Resources Division

Hannah M.C. Young, ISB No. 9781
hannah.young@deq.idaho.gov
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: 208.373.0453

Attorney for Respondent

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047

NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,

Petitioners,

v.

IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,

Respondent,

and

PERPETUA RESOURCES IDAHO, INC.,

Intervenor-Respondent.

Case Docket No. 0101-22-01
OAH Case No. 23-245-01

DECLARATION OF TIFFANY FLOYD IN SUPPORT OF JOINT MOTION TO SUPPLEMENT RECORD WITH DEQ RESPONSE TO EPA LETTER

I, TIFFANY FLOYD, hereby declare under penalty of perjury and pursuant to the law of the State of Idaho that the following is true and correct:

1. My name is Tiffany Floyd, and I am employed by the State of Idaho, Department of Environmental Quality (the "Department") as the Air Quality Division Administrator ("Air Administrator").

2. I have been working for the Department as the Air Administrator for 11 years.

3. On August 10, 2023, DEQ's Director received a letter from the United States Environmental Protection Agency ("EPA") Region 10 regarding Permit to Construct No. 2019.0047, an air quality preconstruction permit DEQ issued to Perpetua Resources Idaho, Inc. on June 17, 2022.

4. On October 13 and 23, 2023, I and other DEQ staff met with EPA staff to discuss concerns raised in the EPA letter.

5. On November 22, 2023, DEQ's Director formally responded to the EPA letter with a transmittal letter and document entitled "Response to the August 10, 2023 EPA Region 10 Letter to Idaho DEQ," a true and correct copy of which is attached hereto as **Exhibit A.**

DATED: February 7, 2024.

Tiffany Floyd

CERTIFICATE OF SERVICE

I hereby certify that on February 7, 2024, a true and correct copy of the foregoing was served on the following:

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
Counsel for the Idaho
Board of Environmental Quality
ann.yribar@ag.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Paula J. Wilson, Paralegal
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, Idaho 83706
paula.wilson@deq.idaho.gov
via electronic service

Dylan B. Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

/s/ Hannah M.C. Young
Hannah M.C. Young

EXHIBIT A

1410 N Hilton Street
Boise, ID 83706 • (208) 373-0502

Brad Little, Governor
Jess Byrne, Director

November 22, 2023

Mr. Casey Sixkiller
Regional Administrator, Region 10
United States Environmental Protection Agency
1200 Sixth Avenue, Suite 155
Seattle, WA 98101

Dear Mr. Sixkiller,

This letter, and its attachment, are a follow-up, and hopefully conclusion, to your letter dated August 10, 2023, regarding Perpetua Resources of Idaho, Inc's ("Perpetua") permit to construct. As my September 8, 2023, letter indicated, the Idaho Department of Environmental Quality (DEQ) takes our responsibility to protect air quality and public health, through implementation of our federally approved state air quality program, very seriously. We are also extremely proud of our history of success in carrying out this responsibility. As such, we do not take the concerns and accusations raised in your letter lightly—which is demonstrated by the thoroughness of the attached information, particularly considering this effort was on top of the multi-year permit development process we undertook when developing the Perpetua permit.

I'd like to take this opportunity to personally recognize and thank the DEQ and Environmental Protection Agency (EPA) staff that participated in the technical meetings held on October 13 & 23, 2023, where EPA's concerns with the Perpetua permit were discussed. I know that DEQ staff went to great lengths to further explain how the Perpetua application was evaluated, and permit conditions developed. The meetings were very productive and collaborative. That said, it is my sincerest hope that we can avoid the need for similar meetings moving forward. I believe there is a mutual recognition of that being possible through better communication during the permit development process.

The attached supporting documentation details the information that staff discussed during the day and a half of meetings. It is our understanding that through those meetings and conversations, DEQ addressed all of EPA's concerns that were identified in your August 10, 2023, letter and that the PTC issued by DEQ to Perpetua Resources on June 17, 2022, is protective of the National Ambient Air Quality Standards and meets the requirement of the Clean Air Act. If you or your staff have any additional questions regarding the materials provided, please reach out to Tiffany Floyd, Air Quality Division Administrator.

I look forward to building upon this experience as both agencies strive to work together to carry out our respective responsibilities.

Sincerely,

Jess Byrne

Jess Byrne

cc: Tiffany Floyd
Idaho Department of Environmental Quality

Response to the August 10, 2023 EPA Region 10 Letter to Idaho DEQ

Perpetua Resources Idaho, Inc.
Stibnite, Idaho

Facility ID No. 085-00011

Permit to Construct No. P-2019.0047

Project No. 62288

Prepared by:
Kelli Wetzel, Permit Writer
AIR QUALITY DIVISION

EPA Allegation 1. The production limits in the PTC do not restrict the SGP's PTE to below major stationary source permitting thresholds under the prevention of significant deterioration (PSD) or Title V programs

EPA Comment 1a. Underestimation of Emissions from Ore Processing Emission Units

In its prior comment letters, EPA advised IDEQ that the emission factors relied upon in the draft permits were not representative of emissions. For instance, EPA's March 16, 2022, comment letter stated: "Some of the PTE limitations may not be technically accurate because they are not based on emission factors that are representative of the emission sources. For example, AP-42 Section 11.24 Metallic Minerals Processing emission factors applies to the processing of hard ores including gold. However, the application uses AP-42 emissions factors from Section 11.19.2 Crushed Stone Processing that is applicable to non-metallic mineral processing. The permitting record does not provide a reasoned explanation as to why emission factors from Section 11.24 were selected over those from Section 11.19.2."[20]

IDEQ's Response to Comment did not provide any additional information or rationale for decision making. Instead, IDEQ stated, "Representativeness of these parameters was discussed with and reconfirmed by PRI at various points during review and the estimates of emissions and underlying assumptions were supported to the satisfaction of IDEQ."[21]

Even if a permitting authority was unable to find more accurate emission factors than AP-42, the introduction to Section 11.19 states, "The construction aggregate industry covers a range of subclassifications of the nonmetallic minerals industry (see Section 11.24, Metallic Minerals Processing, for information on that similar activity)." IDEQ did not follow the listed instructions to see Section 11.24 for Metallic Minerals Processing.

IDEQ did not state that it performed any analysis of other emission information. IDEQ did not state that it sought out emission factor information of higher quality than AP-42, as required by IDEQ Guidance[22] (Guidance) which states, "When estimating emissions, emissions data that *best* reflects emissions from a stationary source must be used" (emphasis added). IDEQ did not make a determination that the emission factor chosen meets the Guidance. Similarly, the Guidance states "The rating of the AP-42 factor must be considered…" However, IDEQ did not state how it considered the rating of the factor chosen or if IDEQ considered other factors with higher ratings. For reference, AP-42 Section 11.24 has a rating of "77C" for primary crushing emission factor. AP-42 Section 11.19 has no emission factor for primary crushing, but states that tertiary crushing can be used for primary and secondary crushing and the rating for tertiary crushing is "E", the lowest rating assigned by AP-42. Setting aside the choice of using an emission factor for Non-Metallic Minerals instead of the Metallic Minerals, IDEQ has not evaluated the available emission factors based on the rating, as required by its own Guidance.

EPA's document AP-42 Metallic Mineral Processing Plants – Background Information for Proposed Standards Volume 2 Appendices (EPA-450/3-81.009b) lists visits and emission testing at various mineral processing and mining operations. Appendix C – Summary of Test Data includes data on nine plants that processed metallic minerals. Table C-1 specifically includes testing at processing equipment at a gold mine with baghouse control. Thus, the metallic mineral processing plants evaluated and tested to form the basis for the emissions factors in AP-42 Section 11.24 are most similar to the metallic mineral processing emission units at the SGP. These background documents clearly indicate that the emissions factors in Section 11.24 are most appropriate for estimating emissions from the SGP.

Multiplying the emission factor found in AP-42 Section 11.24 by the production limitation on the primary crusher (OC7) results in an emission estimate over 90 tons of PM per year for that unit alone. Similarly, if AP-42 Section 11.24 emission factors are multiplied by the production limits for the remaining emission units OC1 through OC13, potential PM emissions from that collection of units *exceeds 800 tons PM per year*. Given the PSD threshold of 250 tons per year and the fact that even Section 11.24 is an average emission factor (and approximately half of all emission units will emit above an average rate), the PTC fails to restrict emissions below major source thresholds.

Based on the above information, IDEQ did not follow IDEQ Guidance, did not support the use of the chosen emission factor, and was arbitrary when choosing emission factors for the ore processing emission units. Accordingly, the PTC does not restrict the Facility's PTE below major source thresholds as a legal and practical matter.

IDEQ Response

EPA contends that IDEQ did not follow its own guidance in the Emissions Data Hierarchy Guidance document when choosing emission factors for the ore processing emission units located at Perpetua Resources Idaho (PRI) Stibnite site, aka Stibnite Gold Project (SGP). A thorough review of the administrative record reveals that IDEQ did follow its own guidance precisely. IDEQ's guidance states that when estimating emissions, emissions data that best reflects emissions from a stationary source must be used in the following hierarchy:

1. Continuous Emissions Monitoring (CEM) data from the stationary source
2. Performance test data from the stationary source
3. Manufacturer emission guarantee
4. CEM data from a similar stationary source or sources
5. Performance test data from a similar stationary source or sources
6. AP-42 or industry-derived emission factors.

In this case, the data described in numbers 1-5 were unavailable. Therefore, IDEQ employed the AP-42 emission factors to estimate emissions.

Introduction of emission factor selection. IDEQ endeavors to issue legally defensible permits that protect Idaho's air quality to the greatest extent possible. In doing so, IDEQ relies upon permit applicants to supply site-specific data that account for real-world parameters and processes. IDEQ therefore seeks to apply emission factors that actually reflect the permit applicant's plans and processes. In comparing Sections 11.19.2 and 11.24 of AP-42, IDEQ found that applying section 11.19.2 would be most applicable to the SGP proposal. Conversely, Section 11.24 is largely inapplicable – despite its misleading title – and applying it to the SGP would likely be considered arbitrary and capricious. A thorough review of the background materials, underlying AP-42 emission factors, along with the administrative record, demonstrates that EPA's concern is unsupportable and lacks a rational basis.

AP-42 emission factors for ore processing reside in Section 11.19.2 for non-metallic mineral processing and Section 11.24 for metallic minerals processing. Section 11.24 emission factors are from 1982 with primary to tertiary crushing ratings ranging from C to E (with E being the lowest rating). Section 11.24 also only lists emission factors for PM and PM_{10} but not $PM_{2.5}$.

Table 11.24-2 (English Units). EMISSION FACTORS FOR METALLIC MINERALS PROCESSING[a,b]

EMISSION FACTOR RATINGS: (A-E) Follow The Emission Factor

Source	Filterable[b,c]			
	PM	RATING	PM-10	RATING
Low-moisture ore[c]				
Primary crushing (SCC 3-03-024-01)[d]	0.5	C	0.05	C
Secondary crushing (SCC 303-024-02)[d]	1.2	D	ND	
Tertiary crushing (SCC 3-03-024-03)[d]	2.7	E	0.16	E
Wet grinding	Neg		Neg	
Dry grinding with air conveying and/or air classification (SCC 3-03-024-09)[e]	28.8	C	26	C
Dry grinding without air conveying and/or air classification (SCC 3-03-024-10)[e]	2.4	D	0.31	D
Drying--all minerals except titanium/zirconium sands (SCC 3-03-024-11)[f]	19.7	C	12	C
Drying--titanium/zirconium with cyclones (SCC 3-03-024-11)[f]	0.5	C	ND	C
Material handling and transfer--all minerals except bauxite (SCC 3-03-024-04)[g]	0.12	C	0.06	C
Material handling and transfer--bauxite/alumina (SCC 3-03-024-04)[g,h]	1.1	C	ND	
High-moisture ore[c]				
Primary crushing (SCC 3-03-024-05)[d]	0.02	C	0.009	C
Secondary crushing (SCC 3-03-024-06)[d]	0.05	D	0.02	D
Tertiary crushing (SCC 3-03-024-07)[d]	0.06	E	0.02	E
Wet grinding	Neg		Neg	
Dry grinding with air conveying and/or air classification (SCC 3-03-024-09)[e]	28.8	C	26	C
Dry grinding without air conveying and/or air classification (SCC 3-03-024-10)[e]	2.4	D	0.31	D
Drying--all minerals except titanium/zirconium sands (SCC 3-03-024-11)[f]	19.7	C	12	C
Drying--titanium/zirconium with cyclones (SCC 3-03-024-11)[f]	0.5	C	ND	
Material handling and transfer--all minerals except bauxite (SCC 3-03-024-08)[g]	0.01	C	0.004	C
Material handling and transfer--bauxite/alumina (SCC 3-03-024-08)[g,h]	ND		ND	

Section 11.19.2 includes major processing for rock types such as limestone, granite, dolomite, traprock (basalt), sandstone, quartz, and quartzite. Section 11.19.2 emission factors are from 2004 which are approximately 20 years newer than those from Section 11.24. The facility's emission inventory includes crushers and conveyors controlled by water sprays. EPA's AP-42 11.19.2 provides representative emission factors for these specific processes and controls for PM, PM_{10}, and $PM_{2.5}$. These emission factors also range from C to E.

Table 11.19.2-2 (English Units). EMISSION FACTORS FOR CRUSHED STONE PROCESSING OPERATIONS (lb/Ton)[a]

Source [b]	Total Particulate Matter [r,s]	EMISSION FACTOR RATING	Total PM-10	EMISSION FACTOR RATING	Total PM-2.5	EMISSION FACTOR RATING
Primary Crushing (SCC 3-05-020-01)	ND		ND[n]		ND[n]	
Primary Crushing (controlled) (SCC 3-05-020-01)	ND		ND[n]		ND[n]	
Secondary Crushing (SCC 3-05-020-02)	ND		ND[n]		ND[n]	
Secondary Crushing (controlled) (SCC 3-05-020-02)	ND		ND[n]		ND[n]	
Tertiary Crushing (SCC 3-050030-03)	0.0054[d]	E	0.0024[o]	C	ND[n]	
Tertiary Crushing (controlled) (SCC 3-05-020-03)	0.0012[d]	E	0.00054[p]	C	0.00010[q]	E
Fines Crushing (SCC 3-05-020-05)	0.0390[e]	E	0.0150[e]	E	ND	
Fines Crushing (controlled) (SCC 3-05-020-05)	0.0030[f]	E	0.0012[f]	E	0.000070[q]	E
Screening (SCC 3-05-020-02, 03)	0.025[c]	E	0.0087[l]	C	ND	
Screening (controlled) (SCC 3-05-020-02, 03)	0.0022[d]	E	0.00074[m]	C	0.000050[q]	E
Fines Screening (SCC 3-05-020-21)	0.30[g]	E	0.072[g]	E	ND	
Fines Screening (controlled) (SCC 3-05-020-21)	0.0036[g]	E	0.0022[g]	E	ND	
Conveyor Transfer Point (SCC 3-05-020-06)	0.0030[h]	E	0.00110[h]	D	ND	
Conveyor Transfer Point (controlled) (SCC 3-05-020-06)	0.00014[i]	E	4.6×10^{-5}[i]	D	1.3×10^{-5}[q]	E
Wet Drilling - Unfragmented Stone (SCC 3-05-020-10)	ND		8.0×10^{-5}[j]	E	ND	
Truck Unloading -Fragmented Stone (SCC 3-05-020-31)	ND		1.6×10^{-5}[j]	E	ND	
Truck Loading - Conveyor, crushed stone (SCC 3-05-020-32)	ND		0.00010[k]	E	ND	

A thorough review of the various AP-42 sections was conducted and the AP-42 emission factors that match the PRI ore crushing process equipment and controls was selected. The emission factors selected and resulting minor source designation are entirely consistent with other gold mining permits issued in Region 10 and Nevada.

For further confirmation that use of the newest emission factors are appropriate for PRI to use, additional resources were consulted. The State of Nevada has approximately 30 gold mines that are currently active and permitted by the Nevada Division of Environmental Protection (NDEP). The NDEP Bureau of Air Pollution Control (BAPC) has published a document entitled *Guidance on Emission Factors for the Mining Industry* dated May of 2017. This guidance document provides a compilation of various particulate matter emission factors for common processes in the mining industry. In Table 2.3 of the document, primary crushing and associated transfers in or out use an emission factor from Section 11.19.2 for tertiary crushing. In the Notes/Comments it states that the BAPC has determined that the use of AP-42 Chapter 11.19.2-2 is appropriate for the gold mining industry given the very low fraction of gold contained in the rock and the tertiary crushing emission factor is utilized as a conservative estimate because there is no primary crushing emission factor.

PRI estimated emissions based on metal concentration profiles from approximately 55,000 onsite core samples of ore taken primarily from the more mineralized zones of the SGP pits (i.e., in and around gold ore deposits).[1] The median metal concentration of gold is 0.1 ppm which is a very small fraction of metal contained in the ore.

[1] "Geochemistry Statistics" email R. McCluskey to E. Memon, Stibnite Gold Project, Air Sciences, September 26, 2017. (ref. PRI 2017c; 2020AAG205)

Below is a list of permitted gold mines in both Region 10 and Nevada with throughputs and permitted status. Of the 33 mines found that use some sort of control on the crushing system, 4 are PSD major and all major facilities have either a power plant or ore roasting at the facility. Stibnite would be the only facility to be a potentially major source without either of those sources if emission factors from 11.24 were used in the analysis. Using the emission factor from 11.24 would make 7 more minor sources potentially major sources that are smaller than Stibnite.

Survey of Gold Mining Minor and Major Permits in Region 10 and Nevada

No. of Permits	Source Status	Ore Crushing	Power Plant or Roaster
28	Minor	Yes	No
2	Major	Yes	Yes
3	Major - PSD	Yes	Yes
33			

Survey of Gold Mining Minor and Major Permits in Region 10 and Nevada with Wateer Sprays

No. of Permits	Source Status	Ore Crushing	Crushing Controls	
19	Minor	Yes	Water Sprays	Baghouse, Water Sprays
0	Major	Yes	Water Sprays	Baghouse, Water Sprays
2	Major - PSD	Yes	Water Sprays	Baghouse, Water Sprays
21				

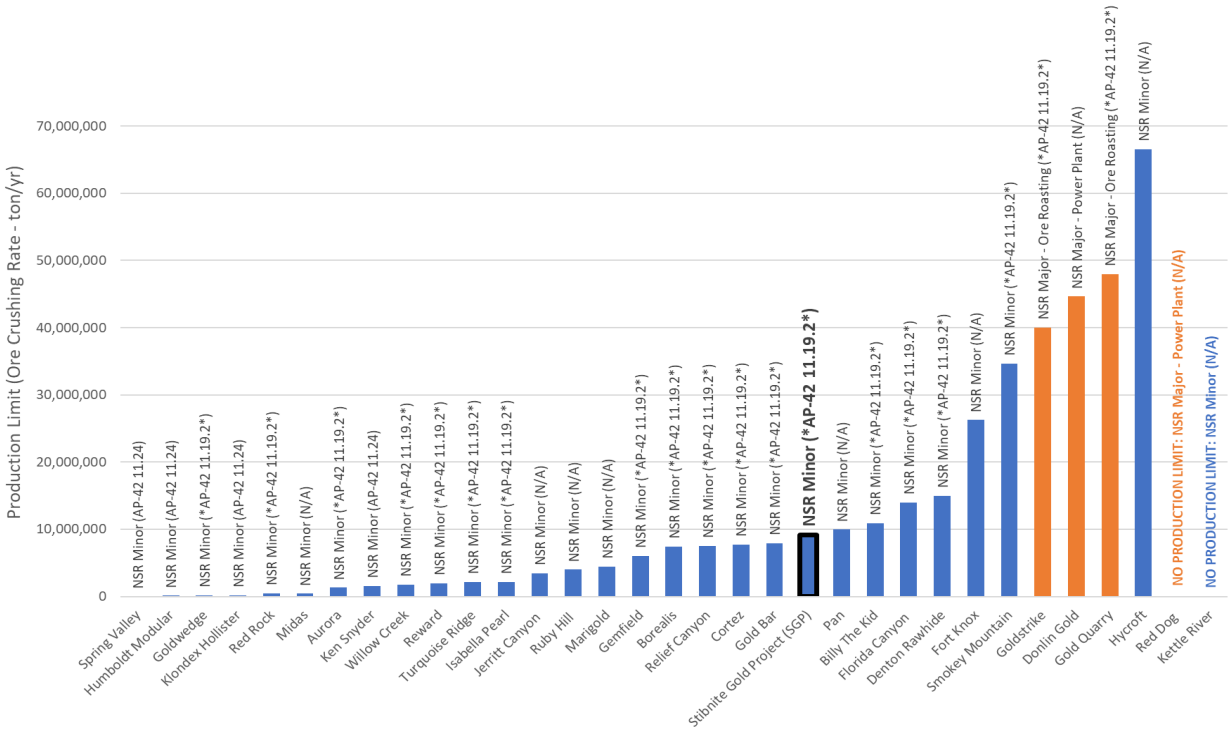
Survey of Gold Mining Permits in Region 10 and Nevada Using Water Sprays

No. of Permits	Ore Crushing	Crushing Controls	AP-42 Section		Min	Max	SGP
17	Yes	Water Sprays	11.19.2	Baghouse, Water Sprays	156,000	48,000,000	9,125,000
4	Yes	Water Sprays	11.24	Baghouse, Water Sprays	26,280	450,000	
21							

State	Company	Facility Name	Facility ID	Industry	Permit No.	Permit Date	Permit Category	Prim Crusher Rate		Control	Sec/Tert Crusher R		Control	Major Comment
AK	Donlin Gold LLC	Donlin Gold Project	-	Gold Ores	AQ0934CPT02	6/1/2023	NSR Major	44,676,000	TPY	Baghouse	5,781,600	TPY	Baghouse	Power Plant
AK	Fairbanks Gold Mining Inc	Fort Knox Mine	-	Gold Ores	AQ0053MSS04	12/17/2012	NSR Minor	26,280,000	TPY	Baghouse	3,504,000	TPY	Baghouse	
AK	Teck-Comico	Red Dog Mine	-	Gold Ores	AQ0290CPT01	12/4/1996	NSR Major	Not listed	-	Baghouse	-	-	-	Power Plant
ID	Perpetua Resources Idaho Inc	Stibnite	085-00011	Gold Ores	P-2019.0047	6/17/2022	NSR Minor	9,125,000	TPY	Water Sprays	10,074,000	TPY	Water Sprays	
NV	Nevada Gold Mines LLC	Cortez District	A0001	Gold Ores	AP1041-4392	8/10/2022	NSR Minor	7,685,000	TPY	Water Sprays	3,500,000	TPY	Water Sprays	
NV	Nevada Gold Mines LLC	Gold Quarry Operations	A0002	Gold Ores	AP1041-0793.02	3/24/20223	NSR Major	48,000,000	TPY	Water Sprays	53,400,000	TPY	Wet Scrubber, Baghouse, Water Sprays	Ore Roasting
NV	Jerritt Canyon Gold LLC	Jerritt Canyon Mine	A0004	Gold Ores	AP1041-3422	3/12/2019	NSR Minor	3,467,500	TPY	Baghouse, Wet Scrubber	2,190,000	TPY	Baghouse	
NV	Barrick Goldstrike Mines Inc	Goldstrike	A0005A	Gold Ores	AP1041-0729.04	5/31/2019	NSR Major	40,011,000	TPY	Baghouse, Water Sprays	23,642,940	TPY	Baghouse, Water Sprays	Ore Roasting
NV	Klondex Hollister Mine	Klondex Hollister Mine	A0006	Gold Ores	AP1041-3127	6/13/2023	NSR Minor	182,500	TPY	Water Sprays	-	TPY	-	
NV	Klondex Mining Operations Inc	Ken Snyder Mine	A0175	Gold Ores	AP1041-0766.02	5/16/2019	NSR Minor	1,545,000	TPY	Baghouse, Water Sprays	450,000	TPY	Baghouse	
NV	Klondex Midas Operations Inc	Midas Mine Site	A0175	Gold Ores	AP1041-3722	2/16/2022	NSR Minor	450,000	TPY	Baghouse	450,000	TPY	Baghouse	
NV	Goldwedge, LLC	Goldwedge Mine	A0373	Gold Ores	AP1041-1457.03	11/4/2019	NSR Minor	156,000	TPY	Water Sprays	156,000	TPY	Water Sprays	
NV	Florida Mining, Inc	Florida Canyon Mine	A0386	Gold Ores	AP1041-0106.05	3/8/2021	NSR Minor	14,000,000	TPY	Water Sprays	28,000,000	TPY	Water Sprays	
NV	Marigold Mining Company	Marigold Mine	A0387	Gold Ores	AP1041-3666	4/21/2020	NSR Minor	4,467,600	TPY	Baghouse	4,467,600	TPY	Baghouse#2	
NV	Nevada Gold Mines LLC	Turquoise Ridge/Getchell Mine	A0389	Gold Ores	AP1041-0292.04	3/14/2022	NSR Minor	2,190,000	TPY	Water Sprays	2,190,000	TPY	Water Sprays	
NV	Hycroft Resources and Development LLC	Hycroft Mine	A0390	Gold Ores	AP1041-0334.05	10/15/2021	NSR Minor	66,576,000	TPY	Baghouse	70,080,000	TPY	Baghouse	
NV	Ruby Hill Mining Company LLC	Ruby Hill Mine	A0399	Gold Ores	AP1041-0713.05	7/3/2023	NSR Minor	4,000,000	TPY	Baghouse	4,000,000	TPY	Baghouse	
NV	Comstock Processing LLC.	Billy The Kid Mine	A0404	Gold Ores	AP1041-4051	2/12/2020	NSR Minor	10,913,500	TPY	Baghouse, Water Sprays	10,971,900	TPY	Baghouse, Water Sprays	
NV	Rawhide Mining LLC	Denton Rawhide Mine	A0406	Gold Ores	AP1041-3977	6/26/2020	NSR Minor	15,000,000	TPY	Water Sprays	5,000,000	TPY	Water Sprays	
NV	Klondex Aurora Mine, Inc.	Aurora Mine	A0408	Gold Ores	AP1041-3858.01	10/19/2022	NSR Minor	1,314,000	TPY	Water Sprays	1,314,000	TPY	Water Sprays	
NV	Borealis Mining Company LLC	Borealis Mining Company LLC	A0675	Gold Ores	AP1041-3901	8/3/2022	NSR Minor	7,446,000	TPY	Water Sprays	7,446,000	TPY	Water Sprays	
NV	Geo-Nevada Inc	Spring Valley Mine	A0715	Gold Ores	AP1041-4391	2/23/2023	NSR Minor	26,280	TPY	Water Sprays	-	TPY	-	
NV	Gold Acquisition Corporation	Relief Canyon Mine	A0904	Gold Ores	AP1041-2441.02	11/16/2022	NSR Minor	7,500,000	TPY	Water Sprays	7,500,000	TPY	Water Sprays	
NV	CR Reward LLC	Reward Mine	A0966	Gold Ores	AP1041-2492.02	2/20/2019	NSR Minor	2,000,000	TPY	None	5,000,000	TPY	Baghouse, none	
NV	Golden Predator Mines US Inc	Humboldt Modular Mill	A1111	Gold Ores	AP1041-2693	7/23/2010	NSR Minor	131,400	TPY	Water Sprays	52,560	TPY	Water Sprays	
NV	GRP Pan LLC	Pan Mine	A1497	Gold Ores	AP1041-3831.01	8/24/2022	NSR Minor	10,000,000	TPY	Baghouse	10,000,000	TPY	Baghouse	
NV	McEwen Mining Inc	Gold Bar Project	A2005	Gold Ores	AP1041-799.01	8/24/2022	NSR Minor	7,884,000	TPY	Water Sprays	-	TPY	-	
NV	Walker Lane Minerals Corporation	Isabella Pearl Mine	A2039	Gold Ores	AP1041-3853	8/30/2017	NSR Minor	2,190,000	TPY	Water Sprays	2,190,000	TPY	Water Sprays	
NV	Gemfield Resources LTD	Gemfield Mine	A2109	Gold Ores	AP1041-3980	7/19/2021	NSR Minor	6,000,000	TPY	Water Sprays	18,000,000	TPY	Baghouse	
NV	Enegix Mining Group LLP	Willow Creek Mine Site	A2287	Gold Ores	AP1041-4309	4/26/2021	NSR Minor	1,752,000	TPY	Water Sprays	-	TPY	-	
NV	Quartz Lake Mining Inc	Red Rock Mill	A2461	Gold Ores	AP1041-4520	7/31/2023	NSR Minor	438,000	TPY	Water Sprays	438,000	TPY	Water Sprays	
NV	Round Mountain Gold Corp	Smokey Mountain Operations	A0394	Gold Ores	AP1041-3955	1/30/2023	NSR Minor	34,669,950	TPY	Baghouse, None	7,033,350	TPY	Baghouse	
OR	No permits found	No permits found	-	-	-	-	-	-	-	-	-	-	-	-
WA	Echo Bay Minerals Company	Kettle River Mill	A0190103	Gold Ores	22AQ-E031	6/28/2022	NSR Minor	Not listed	-	Baghouse	-	-	-	

The below figure shows the AP-42 section used for determining the PM_{10} and PM emissions from each gold mine. The majority of the gold mines used AP-42 Section 11.19.2 (19 of 23). Only 4 gold mines used AP-42 Section 11.24, and in each case, the gold mines had very low primary crushing rates. At these low rates, the use of either AP-42 section characterizes the sources as minor. Note that no AP-42 section is required for baghouse and wet scrubber controlled crushers as these are based on performance data.

Source Designations (NSR Minor or NSR Major) and AP-42 Emission Factors



A comparitive analysis of AP-42 Sections 11.19.2 and 11.24 for emission units OC1 through OC13 is provided below. This analysis compares the key emission parameters of equipment, controls, material, and emission type of the SGP emission units to the emission units in the test programs for the two AP-42 sections.

Analysis of AP-42 Section 11.19.2 vs. 11.24		AP-42 Section 11.19.2		AP-42 Section 11.24		Determination
Source Parameter	SGP	11.19.2 Represetative	11.19.2 Test Program Source Parameter	11.24 Represetative	11.24 Test Program Source Parameter	Emission Factor Detemination
Equipment	Primary Crusher (OC7) and Pebble Crusher (OC12), No Screens	Yes	Tertiary crushing (controlled)	No	Primary crushing operations as a whole: a hopper or ore dump, screen(s), crusher, surge bin, apron feeder, and conveyor belt transfer points	11.19.2, Tertiary Crushing (controlled), is representative. Use of this factor is conservative for primary and secondary crushers 11.24 is determined unrepresentative and does not provide factors for individual units and includes screens
Controls	Water sprays	Yes	Water sprays	No	Baghouse or wet scrubber (measured at inlet)	
Material	Primarily granite, quartzite, and marble, with lesser amounts of quartz, calcareous marl, and slate, containing microscopic gold (0.1 ppm median)	Yes	Limestone, granite, dolomite, traprock, sandstone, quartz, and quartzite. Minor types include calcareous marl, marble, shell, and slate	Yes	Hard (copper, gold, iron, and molybdenum ores) and soft (uranium, bauxite, and titanium/zirconium ores) ores	
Emission Type	Fugitive	Yes	Fugutive	No	Captured, non-fugitive (Method 5 testing conducted at the inlet of the baghouse or wet scrubber)	
If more than one emission factor is representative, then consider the date and rating for each factor						
Published Date		-	8/2004	-	8/1982 (Reformatted 1/1995)	Rating not applicable, only 11.19.2 is representative
Rating			C/E		C/D	

Source Parameter	SGP	11.19.2 Represetative	11.19.2 Test Program Source Parameter	11.24 Represetative	11.24 Test Program Source Parameter	Emission Factor Detemination
Equipment	Conveyor and other transfers (OC1-6, OC8-11, OC13)	Yes	Conveyor transfer point (controlled)	No	Material handling and transfer--all minerals except bauxite The material handling and transfer factors do not apply to small hoppers, surge bins, or transfer points that are integral with crushing, drying, or grinding operations.	11.19.2, Conveyor transfer point (controlled), is representative and provides factors for individual transfers 11.24 is determined unrepresentative, and combined with the 11.24 primary crushing operations emission factors, it would double count emissions
Controls	Water sprays and Moisture carry over, and enclosures for some transfers	Yes	Water sprays and Moisture carry over	No	Baghouse or wet scrubber (measured at inlet)	
Material	Primarily granite, quartzite, and marble, with lesser amounts of quartz, calcareous marl, and slate, containing microscopic gold (0.1 ppm median)	Yes	Limestone, granite, dolomite, traprock, sandstone, quartz, and quartzite. Minor types include calcareous marl, marble, shell, and slate	Yes	Hard (copper, gold, iron, and molybdenum ores) and soft (uranium, bauxite, and titanium/zirconium ores) ores	
Emission Type	Fugitive	Yes	Fugutive	No	Captured, non-fugitive (Method 5 testing conducted at the inlet of the baghouse or wet scrubber)	
If more than one emission factor is representative, then consider the date and rating for each factor						
Published Date		-	8/2004	-	8/1982 (Reformatted 1/1995)	Rating not applicable, only 11.19.2 is representative
Rating			D/E		C	

AP-42 Section 11.19.2 more closely reflects the equipment, controls, material, and emission type of the SGP emission units.

Equipment and Controls

AP-42 Section 11.19.2 provides emission factors for crushers and conveyors, both controlled with water sprays or uncontrolled, which reflect the SGP emission units. In contrast, AP-42 Section 11.24 does not provide emission factors that are similar or representative of SGP equipment and controls. The emission factors in AP-42 Sections 11.24 "are for the process as a whole" which includes screens not utilized by the SGP. Individual emission factors for OC1 through OC13 were necessary for NAAQS compliance modeling because the emission units are spread out over a large area, and each has unique dispersion characteristics. The single "whole process" emission factor in AP-42 Section 11.24 cannot be split between the individual SGP emission units for modeling.

Section 11.24 states that emission factors are provided in Tables 11.24-1 and 11.24-2 for two types of dry grinding operations: those that involve air conveying and/or air classification of material and those that involve screening of material without air conveying. Grinding operations that involve air conveying and air classification usually require dry cyclones for efficient product recovery. The factors in Tables 11.24-1 and 11.24-2 are for emissions after product recovery cyclones. The facility does not have the conditions specified for using the emission factors in Section 11.24.

Material

AP-42 Section 11.19.2 describes the major material types as "limestone, granite, dolomite, traprock, sandstone, quartz, and quartzite" and minor material as "calcareous marl, marble, shell, and slate". The SGP gold deposits are primarily granite, quartzite, and marble, with smaller amounts of calcareous marl, and slate.

At gold mines, microscopic gold is disseminated throughout all the rock types within the pits. The difference between ore (which EPA characterizes as metallic mineral) and development rock (nonmetallic mineral) is simply the value of the microscopic gold contained within the rock. The SGP gold ore concentration is approximately 0.1 ppm. It would be unreasonable, inaccurate, and arbitrary to choose emission factors from AP-42 based simply on the title of the AP-42 section and ignoring other key emission parameters.

Emission Type

The AP-42 Section 11.19.2 test program was specfically designed to accurately measure fugitive emissions "a quasi-stack system" from individual units. This measurement approach reflects the fugitive emissions from the SGP emission units. In contrast, the emission factors in AP-42 Section 11.24 were derived from whole processes ducted and controlled by wet scrubbers or baghouses (non-fugitive emissions). Measurements were taken at the inlet of the control equipment to develop the uncontrolled emission factors published in AP-42 11.24. Because the emissions from these sources are non-fugitive, EPA test Method 5 was used to measure the non-fugitive emissions in the inlet ducting.

EPA contends that applying AP-42 Section 11.24 for the primary and secondary crushing circuit results in over 800 tons per year of PM emissions, and over 90 tons per year from OC7 (the primary crusher). Although EPA did not provide their calculations, it was determined that EPA used AP-42 Section 11.24 emission factors for high moisture ore primary crushing, secondary crushing, and material handling. EPA's application of these factors is incorrect resulting in a significant overestimation of alleged emissions.

Per AP-42 Section 11.24: The emission factors in Tables 11.24-1 and 11.24-2 are for the process operations as a whole. At most metallic mineral processing plants, each process operation requires several types of equipment. A single crushing operation likely includes a hopper or ore dump, screen(s), crusher, surge bin, apron feeder, and conveyor belt transfer points. Emissions from these various pieces of equipment are often ducted to a single control device. The emission factors provided in Tables 11.24-1 and 11.24-2 for primary, secondary, and tertiary crushing operations are for process units that are typical arrangements of the above equipment.

For example, the single primary crushing emission factor estimates emissions from the crusher, screens, and all transfers. EPA applied AP-42 Section 11.24 factors to each piece of equipment resulting in double counting of emissions and also did not backout the emissions predicted by the factor for screens which do not exist at SGP at the primary and secondary crushing circuit. Screens are the largest source of emissions.

Applying AP-42 Section 11.24 emission factors to the equipment at SGP is not representative. If IDEQ tries to apply Section 11.24 emission factors to the process and then uses Section 11.19 for screening emission factors to backout the emissions for screens, total emissions are well below PSD thresholds but not representative of the process at SGP.

Review of Background documents for AP-42 Section 11.24

EPA does not identify a "Background Document" for Section 11.24 on the webpage for AP-42 Chapter 11: Mineral Products Industry, whereas a Background Document is provided for Sections 11.17 Lime Manufacturing, and 11.19.2 Crushed Stone Processing and Pulverized Mineral Processing. EPA's Comment 1 references a document *Metallic Mineral Processing Plants – Background Information for Proposed Standards Volume 2 Appendices* (EPA-450/3-81.009b). IDEQ obtained a copy of this document, dated August 1982, which was prepared to support development of a New Source Performance Standard for the Metallic Mineral Processing Industry. This document may be the final version of reference 9 listed in AP-42 Section 11.24. Reference 9 is *Metallic Mineral Processing Plants –*

Background Information for Proposed Standards (Draft). EPA Contract No. 68-02-3063, TRW, Research Triangle Park, NC, 1981.

Documents EPA-450/3-81.009a, and EPA-450/3-81.009b were reviewed. As discussed in document (a), page 3-2, "As shown in Table 3-1, most metallic ores are composed primarily of nonmetallic constituents. The metals and metallic compounds of economic interest are usually less than 10% of the total mined product….Thus the particulate emissions from most metallic mineral processes are composed primarily of nonmetallic constituents".

Document (a), page 3-49, Section 3.2.13, Emission Factors for Related Industries, states, "Engineering estimates of uncontrolled emissions for crushed stone or rock handling facilities have been made (EPA, 1979). These factors, included in Table 3-14, are suggestive of the range of emissions that might be expected from the metallic minerals processing industries that employ similar processes." The uncontrolled Primary crushing emisson factor in Table 3-14 is 0.5 lb PM/ton material entering the primary crusher, which is the same factor currently in AP-42, Table 11.24-2 that EPA Region 10 proposes should be used by PRI.

Table 3-14. PARTICULATE EMISSION FACTORS FOR ROCK-HANDLING PROCESSES[a]

Type of process	Uncontrolled total[b] lb/ton	Uncontrolled total[b] kg/Mg	Settled out in plant, %	Suspended emission lb/ton	Suspended emission kg/Mg
Dry crushing operations					
Primary crushing	0.5	0.25	80	0.1	0.05
Secondary crushing and screening	1.5	0.75	60	0.6	0.3
Tertiary crushing and screening (if used)	6	3	40	3.6	1.8
Recrushing and screening	5	2.5	50	2.5	1.25
Fines mill	6	3	25	4.5	2.25
Miscellaneous operations					
Screening, conveying, and handling	2	1			
Storage pile losses					

[a] U.S. EPA, 1979.

[b] All values are based on raw material entering primary crusher, except those for recrushing and screening, which are based on throughput for that operation.

Document (a), page 4-3, states, "In order to broaden the range of conditions considered for the performance of the control equipment, test data for non-metallic mineral processing facilities are also included in the data base discussed in this chapter." "Data from the non-metallic mineral industries may be appropriately transferred to the metallic mineral industries for several reasons. As noted in Chapter 3, much of the process equipment of interest in this document is similar in the metallic and non-metallic processing industries. Because the ores from which metallic elements are extracted are primarily non-metallic in character, the emissions from metallic mineral processing operations are primarily non-metallic mineral constituents. Furthermore, the similarity of emissions from metallic and non-metallic processes in

key parameters such as particle size distribution and mass loading provide additional evidence of similarity between the two industries. These measurements were routinely made during the testing of both metallic and non-metallic processing facilities and form the basis for extrapolating control efficiency from one industry, whether metallic or non-metallic, to another."

Document (a), page 4-78, Section 4.10, Conclusions from Test and Modelling Data states, "Several conclusions are justified after a review of the test data in this chapter. A comparison of particle size ranges for the metallic and non-metallic facilities indicates similar distributions."

Document (b), Appendix C, Summary of Test Data – indicates that Emissions data included in Appendix C were gathered from 17 mineral processing plants. Of the 17, nine process metallic minerals and eight process non-metallic minerals. The test summary tables indicate Method 5 particulate sampling was conducted at the inlet and outlet of scrubber and baghouse control equipment. Fugitive emissions were evaluated for opacity using Method 9.

Review of Background documents for AP-42 Section 11.19.2

The background document for Section 11.19.2, available on EPA's AP-42 web page, is dated May 12, 2003, and presents the background information that was used to develop the revised AP-42, Section 11.19.2 on crushed stone processing and pulverized mineral processing. As noted in the document introduction, emission data from nine emission tests conducted at stone (granite and limestone) processing plants were used to develop emission factors for various, crushing, screening, and conveying operations. For several tests, the uncontrolled emission data from crushers, screens and conveyor transfer points was measured by using EPA reference test methods on the exhaust of a track-mounted hood system that was used to capture fugitive emissions, which is described as a "quasi-stack system". The date of the emission tests is not directly provided in the background document, though the references in background document indicate that many of the tests were conducted between 1992 and 2001.

Section III. Results of Data Analysis, states, "Emission factors were developed for conveyer transfer points, screening, tertiary crushing, fines crushing, and fines screening operations. The only data available for secondary crushing were of questionable quality and were not consistent with the emission tests included in this review. Therefore, the revised AP-42 section does not include emission factors for primary and secondary crushing of stone. However, the emission factors for tertiary stone crushing can be used as an upper limit to primary and secondary crushing."

Page 19 states that, "All of the PM emission factors have been rated as E due to the limited test data and the need to estimate emission factors using extrapolations of the $PM_{2.5}$ and PM_{10} data. The $PM_{2.5}$ emission factors for tertiary crushing screening, conveyor transfer, and fines crushing (all controlled using wet suppression) were assigned an E rating because data from a single A-rated test were used for each source."

After a thorough review of the various AP-42 sections, background document, and administrative record, the AP-42 emission factors that match the PRI ore crushing process equipment and controls was selected. The emission factors selected and resulting minor source designation are entirely consistent with other gold mining permits issued in Region 10 and Nevada.

EPA Comment 1b. Underestimation of Emissions from Lime Plant Emission Units

EPA previously commented that IDEQ's emission estimates for the lime production emission units are not technically accurate because they do not appear to be based on emission factors that are representative of the emission sources. For example, EPA commented that AP-42 Section 11.17 Lime Manufacturing

emission factors applies to the processing of lime derived from marble. However, IDEQ used AP-42 emissions factors from Section 11.19.2 Crushed Stone Processing. In addition, the limestone excavating emission estimates (Material Load & Unload) appear to use emission factors from Section 11.19.2 Crushed Stone Processing instead of Section 11.9 Western Surface Coal Mining emission factors that are representative and specific to mining excavation activities. The permitting record does not explain why emission factors from AP-42 Section 11.19.2 were selected over those from Sections 11.17 and 11.9. If IDEQ does not have a good technical reason for their selection of emission factors, the most conservative emission factor should be used for emission units.[23]

IDEQ responded to EPA and other commenters that: "As described previously in the Representativeness and Uncertainty of Emissions section, although some degree of uncertainty is present in all emission factors used in estimating emissions, all emission factors were adequately supported and the approach of estimating potential to emit (PTE) at design capacity was considered a conservative approach. Emission factors with control efficiencies built into them were adequately supported by that corresponding control device listed in the permit. Representative emission factors from EPA's AP-42 Section 11.17, 11.19.2 and 11.9 were used to estimate emissions from the lime plant, lime plant support equipment, and marble overburden mining, respectively. The facility's emission inventory includes crushers, screens, and conveyors controlled by water sprays. EPA's AP-42 11.19.2 (08/2004) provides representative emission factors for these specific processes and controls."[24]

Consistent with the evaluation in Section 1.a., above, IDEQ failed to apply appropriate emission factors to the lime plant emission units, did not follow IDEQ guidance specific to emission factor use in permits and failed to create an enforceable restriction on the lime plant's potential to emit below major source thresholds (e.g., 100 tons PM per year).

IDEQ's selection of emissions factors for the lime plant and basis therefore suffer from the same deficiencies as the ore processing units evaluated in Section 1.a., above. IDEQ relied upon sections of AP-42 that are not specific to the process units being permitted. For instance, IDEQ relied upon non-metallic mineral processing emission estimates in EPA's AP-42 Section 11.19 instead of evaluating EPA's emission factors for lime manufacturing, Section 11.17. A single example of how important it is to accurately estimate emissions is illustrated by a process unit in the Lime Plant, LS3/LS4 (primary Screen/Secondary Crusher). If the emission factor for secondary crushers (0.62 lb/ton) in Section 11.17 is applied to those production units, potential emissions would exceed 100 tons PM per year from those units alone. The same result applies to emission unit LS5 (secondary screen), resulting in an additional 128 tons PM per year. These two simple examples highlight the importance of accurately estimating future emissions from the proposed SGP.

Based on the above and corresponding issues highlighted in Section 1.a., IDEQ did not follow IDEQ Guidance, did not support the use of the chosen emission factor and was arbitrary when choosing emission factors for the lime processing emission units, and did not restrict the lime plant's PTE below major source thresholds.

IDEQ Response

EPA contends that emission factors from AP-42 Section 11.19.2 are not accurate for lime production emission units and that IDEQ should have selected emission factors from AP-42 Section 11.17. PRI used emission factors from Section 11.17 for the lime kiln, lime silo loading, and lime silo discharge. PRI used emission factors from Section 11.19.2 for the crushers, screens, and conveyors used in the lime production process.

IDEQ seeks to apply emission factors that actually reflect the permit applicant's plans and processes. In comparing Sections 11.19.2 and 11.17, IDEQ found that applying 11.19.2 would be most applicable to

the PRI proposal for the limestone crushing process and applying 11.17 would be most applicable for the lime kiln, lime silo loading, and lime silo discharge. A thorough review of the background materials, underlying AP-42 emission factors, along with the administrative record, demonstrates that EPA's concern is unsupportable and lacks a rational basis.

AP-42 emission factors for Section 11.17 are from 1998 with primary crushing ratings listed as E (with E being the lowest rating). Section 11.17 also only lists emission factors for PM with no emission factors listed for PM_{10} or $PM_{2.5}$. Additionally, there are no emission factors listed for secondary or tertiary crushing.

Table 11.17-3 (Metric Units). EMISSION FACTORS FOR LIME MANUFACTURING RAW MATERIAL AND PRODUCT PROCESSING AND HANDLING[a]

Source	Filterable[b]			
	PM	EMISSION FACTOR RATING	PM-10	EMISSION FACTOR RATING
Primary crusher[c] (SCC 3-05-016-01)	0.0083	E	ND	
Scalping screen and hammermill (secondary crusher)[c] (SCC 3-05-016-02)	0.31	E	ND	
Primary crusher with fabric filter[d] (SCC 3-05-016-01)	0.00021	D	ND	
Primary screen with fabric filter[e] (SCC 3-05-016-16)	0.0030	D	ND	
Crushed material conveyor transfer with fabric filter[f] (SCC 3-05-016-24)	4.4×10^{-5}	D	ND	
Secondary and tertiary screen with fabric filter[g] (SCC 3-05-016-25)	6.5×10^{-5}	D	ND	
Product transfer and conveying (SCC 3-05-016-15)[h]	1.1	E	ND	
Product loading, enclosed truck (SCC 3-05-016-26)[h]	0.31	D	ND	
Product loading, open truck (SCC 3-05-016-27)[h]	0.75	D	ND	

In the process description for Section 11.19.2, crushed stone processing includes major processing for rock types such as limestone, granite, dolomite, traprock (basalt), sandstone, quartz, and quartzite.

A thorough review of the various AP-42 sections was conducted and the AP-42 emission factors that match the PRI lime plant equipment was selected. The emission factors selected and resulting minor source designation are entirely consistent with other lime plants issued in Utah and Nevada.

A search was conducted for permitted lime plants in surrounding states. The Nevada Division of Environmental Protection (NDEP) Bureau of Air Pollution Control (BAPC) has permitted Graymont Western US Pilot Peak Plant, a lime manufacturing facility. The facility uses emission factors from AP-42 Section 11.19.2 for most transfers and conveyors that are uncontrolled at the facility but uses the guidance default grain loading emission factors for crushers and screens with baghouse control. No emission factors from AP-42 Section 11.17 were found to be used in the application.

Utah Department of Environmental Quality has permitted Graymont Western US Incorporated – Cricket Mountain Plant, a lime processing plant. This facility also uses emission factors from AP-42 Section 11.19.2 for most transfers and conveyors that are uncontrolled at the facility.

A comparitive analysis of AP-42 Sections 11.19.2 and 11.17 for emission units LS1 through LS12, LSBM, and LCR is provided below. A comparitive analysis of AP-42 Sections 11.19.2 and 11.9 is also provided. This analysis compares the key emission parameters of equipment, controls, material, and

emission type of the PRI emission units to the emission units in the test programs for the two AP-42 sections.

Analysis of AP-42 Section 11.19.2 vs. 11.17		AP-42 Section 11.19.2		AP-42 Section 11.17		Determination
Source Parameter	**SGP**	**11.19.2 Representative**	**11.19.2 Test Program Source Parameter**	**11.17 Representative**	**11.17 Test Program Source Parameter**	**Emission Factor Determination**
Equipment	**Primary Crusher (LS2) and Secondary Crusher (LS4)**	Yes	Tertiary crushing (uncontrolled)	Yes	Primary crusher	11.19.2, tertiary crushing (uncontrolled), is representative. The use of this factor is conservative for primary and secondary crushers.
Controls	Uncontrolled	Yes	Uncontrolled	No	Fabric filter (inlet)	11.17 is determined unrepresentative.
Material	Limestone	Yes	Limestone and other rock types	Yes	Limestone	11.17 recommends the use of 11.19: "Section 11.19, Construction Aggregate Processing, also includes stone processing emission factors that are based on more recent testing, and, therefore, may be more representative of emissions from stone crushing, grinding, and screening." (EPA 1998.02, p. 11.17-4)
Emission Type	Fugitive	Yes	Fugitive	No	Captured non-fugitive (Method 5 testing conducted at the inlet of the fabric filter)	
If more than one emission factor is representative, then consider the date and rating for each factor						
Date Published		8/2004		2/1998		Rating not applicable, only 11.19.2 is representative
Rating		C/E		E		

Source Parameter	**SGP**	**11.19.2 Representative**	**11.19.2 Test Program Source Parameter**	**11.17 Representative**	**11.17 Test Program Source Parameter**	**Emission Factor Determination**
Equipment	**Primary Screen (LS3), Secondary Screen (LS5), and Fines Screening (LS11)**	Yes	Screening (uncontrolled)	No	Scalping screen and hammermill (secondary crusher)	11.19.2, screening (uncontrolled), is representative
Controls	Uncontrolled	Yes	Uncontrolled	No	Fabric filter (inlet)	11.17 is determined unrepresentative and includes a hammermill
Material	Limestone	Yes	Limestone and other rock types	Yes	Limestone	11.17 recommends the use of 11.19: "Section 11.19, Construction Aggregate Processing, also includes stone processing emission factors that are based on more recent testing, and, therefore, may be more representative of emissions from stone crushing, grinding, and screening." (EPA 1998.02, p. 11.17-4)
Emission Type	Fugitive	Yes	Fugitive	No	Captured non-fugitive (Method 5 testing conducted at the inlet of the fabric filter)	
If more than one emission factor is representative, then consider the date and rating for each factor						
Date Published		8/2004		2/1998		Rating not applicable, only 11.19.2 is representative
Rating		C/E		E		

Source Parameter	**SGP**	**11.19.2 Representative**	**11.19.2 Test Program Source Parameter**	**11.17 Representative**	**11.17 Test Program Source Parameter**	**Emission Factor Determination**
Equipment	**Ball Mill (LSBM)**	Yes	Grinding (dry) with fabric filter control	No	Primary crusher with fabric filter	11.19.2, grinding (dry) with fabric filter control, is representative
Controls	Baghouse (BH3)	Yes	Fabric filter	Yes	Fabric filter	11.17 is determined unrepresentative. There are no factors for milling or grinding.
Material	Limestone (crushed)	Yes	Limestone, and other rock types (crushed)	No	Limestone (uncrushed)	11.17 recommends the use of 11.19: "Section 11.19, Construction Aggregate Processing, also includes stone processing emission factors that are based on more recent testing, and, therefore, may be more representative of emissions from stone crushing, grinding, and screening." (EPA 1998.02, p. 11.17-4)
Emission Type	Captured non-fugitive	Yes	Captured non-fugitive	Yes	Captured non-fugitive (Method 5 testing conducted at the inlet of the fabric filter)	
If more than one emission factor is representative, then consider the date and rating for each factor						
Date Published		8/2004		2/1998		Rating not applicable, only 11.19.2 is representative
Rating		B/D		D		

Source Parameter	**SGP**	**11.19.2 Representative**	**11.19.2 Test Program Source Parameter**	**11.17 Representative**	**11.17 Test Program Source Parameter**	**Emission Factor Determination**
Equipment	**Conveyor and other transfers (LS1, LS6-10, LS12)**	Yes	Conveyor transfer point (uncontrolled)	No	Product transfer and conveying "13 product transfer and drop points to a fabric filter" (EPA 1994, p. 35)	11.19.2, conveyor transfer point (uncontrolled), is representative and provides factors for individual transfers
Controls	Uncontrolled	Yes	Uncontrolled	No	Fabric filter (inlet)	11.17 is determined unrepresentative and does not provide factors for individual transfers
Material	Limestone	Yes	Limestone and other rock types	No	Lime product	11.17 recommends the use of 11.19: "Section 11.19, Construction Aggregate Processing, also includes stone processing emission factors that are based on more recent testing, and, therefore, may be more representative of emissions from stone crushing, grinding, and screening." (EPA 1998.02, p. 11.17-4)
Emission Type	Fugitive	Yes	Fugitive	No	Captured non-fugitive (Method 5 testing conducted at the inlet of the fabric filter)	
If more than one emission factor is representative, then consider the date and rating for each factor						
Date Published		8/2004		2/1998		Rating not applicable, only 11.19.2 is representative
Rating		D/E		E		

Source Parameter	SGP	11.19.2 Representative	11.19.2 Test Program Source Parameter	11.17 Representative	11.17 Test Program Source Parameter	Emission Factor Determination
Equipment	Mill Lime Crusher (LCR)	Yes	Grinding (dry) with fabric filter control	Yes	Primary crusher with fabric filter	11.19.2, grinding (dry) with fabric filter control, is representative 11.17 is determined unrepresentative. There are no factors for product (lime) crushing. The closest factors are for limestone primary crusher with fabric filter. However, these factors are less conservative than the 11.19.2 factors (e.g., PM: 0.00043 vs. 0.0404 lb/ton)
Controls	Baghouse (BH5)	Yes	Fabric filter	Yes	Fabric filter	
Material	Lime	Yes	Limestone, and other rock types (crushed)	No	Limestone (uncrushed)	
Emission Type	Captured non-fugitive	Yes	Captured non-fugitive	Yes	Captured non-fugitive (Method 5 testing conducted at the inlet of the fabric filter)	
If more than one emission factor is representative, then consider the date and rating for each factor						
Date Published		8/2004		2/1998		Rating not applicable, only 11.19.2 is representative
Rating		B/D		D		

Analysis of AP-42 Section 11.19.2 vs. 11.9		AP-42 Section 11.19.2		AP-42 Section 11.9		Determination
Source Parameter	SGP	11.19.2 Representative	11.19.2 Test Program Source Parameter	11.9 Representative	11.9 Test Program Source Parameter	Emission Factor Determination
Equipment	Haul Truck Loading and Unloading	Yes	Truck loading - conveyor, crushed Truck unloading - fragmented stone	No	Truck loading by power shovel (batch drop)[c] Bottom dump truck unloading (batch drop)[c] [c]"Predictive emission factor equations, which generally provide more accurate estimates of emissions, are presented in Chapter 13." (EPA 1998.10, p. 11.9-11)	11.19.2, truck loading - conveyor, crushed and truck unloading - fragmented stone are representative 11.9 is determined unrepresentative because it is geographic area specific and does not reflect the material at the SGP. Additionally, 11.9 recommends using Chapter 13 instead of the provided factors. However, Chapter 13 requires material moisture, which is not available for the SGP.
Controls	Uncontrolled	Yes	Uncontrolled	Yes	Uncontrolled	
Material	Limestone	Yes	Limestone and other rock types	No	Overburden - Mine V (N.E. Wyoming), Surface soil type: "Loamy, sandy, clayey, and clay loamy"	
Emission Type	Fugitive	Yes	Fugitive	Yes	Fugitive	
If more than one emission factor is representative, then consider the date and rating for each factor						
Date Published		8/2004		7/1998		Rating not applicable, only 11.19.2 is representative
Rating		E		E		

The use of AP-42 Section 11.19.2 for the PRI limestone processing units (LS1 through LS12) conforms with the guidance provided in both AP-42 sections. AP-42 Section 11.17 specifically recommends the use of Section 11.19.2 for stone crushing, grinding, and screening over Section 11.17: “Section 11.19, Construction Aggregate Processing, also includes stone processing emission factors [11.19.2 Crushed Stone Processing] that are based on more recent testing, and therefore, may be more representative of emissions from stone crushing, grinding, and screening.”

AP-42 Section 11.19.2 was also used for lime product crushing unit (LCR). Use of 11.19.2 factors for the LCR unit is highly conservate compared to Section 11.17 factors.

The use of AP-42 Section 11.19.2 for limestone excavation, specifically haul truck loading and unloading, conforms with the guidance provided in both Sections 11.19.2 and 11.9. The loading and unloading emission factors in AP-42 Section 11.9, Table 11.9-4 were developed for a specific geographical area, and use of these factors is not recommended for other locations unless they have very similar characteristics. These factors were developed from source testing at Mine V in northeast Wyoming, with a surface soil type described as: “Loamy, sandy, clayey, and clay loamy”. This is not similar to the limestone excavated at the SGP for the lime plant.

Review of Background documents for AP-42 Section 11.17

The background document provided on the AP-42 web page for Emission Factor Documentation for Lime Manufacturing is dated April 28, 1994. The document notes, on page 15, that the emission factor quality rating system is somewhat subjective and depends to an extent on the individual reviewer. Table 4.1, Summary of Emission Test Reports used to Develop Emission Factors, identifies one test (reference 2) for “Primary crusher, screens, hammermill, and final sizing screens” conducted in 1974 at J.M. Brenner Company in Lancaster, PA. Of the approximately 30 tests listed in the table, that is the only test that identifies a crusher and screens as being the source tested. The vast majority of the tests were on lime plant rotary kiln emissions. One report (reference 50) also identifies the source as “six raw material processing sources”, conducted in 1993 at Chemstar Lime in Bancroft, Idaho. The document includes analysis of Reference 2, on page 33. The analysis includes, in part, “The sources tested include a primary crusher, final sizing screens, and combination of scalping screens and a hammermill. The tests were

conducted in 1974 and were sponsored by EPA as part of the information gathering effort for an NSPS for stone crushing. Emissions from the primary crusher, scalping screens, and hammermill are controlled with a common fabric filter. Emissions from the final sizing screens are controlled with a separate fabric filter." "Method 5 (front and back halves) was used to measure PM emissions. Although back half PM catches are reported in the results, these processes operate at ambient temperature and should not emit condensable PM. Therefore, it is assumed that the back half catches are the result of an anomaly in the sampling and analytical procedures used. The test report does not include adequate information to determine the origin of this apparent anomaly. Three runs were conducted on the outlets of the two fabric filters, but only two inlet runs were conducted." "Emission factors were developed for filterable PM emissions from all of the sources tested."

"The emission factors for uncontrolled emissions from the primary crusher are rated C because only two test runs were conducted, and the emission factors for uncontrolled emissions from the scalping screens/hammermill are rated D because only two runs were conducted and the filterable PM data varied by more than three orders of magnitude."

Regarding test Reference 50, "This report documents measurements of emissions of filterable PM from six raw material processing sources…" The raw material processing sources tested included: primary crushing, including the scalping screen, scalping screen discharges, primary crusher discharges: primary screening including the screen feed, screen discharge, and surge bin discharge; two conveyor transfer points on the conveyor from the primary crusher to the primary stockpile; secondary and tertiary screening, including the conveyor transfer point for the primary stockpile underflow to the secondary screen, and tertiary screening. "Fabric filters are used to control emissions from each of the sources tested, and only controlled emissions were tested."

The emission factor provided in Table 4-5 for Primary Crushing (uncontrolled) for the Reference 2 test is 0.017 lb/ton of filterable PM. This is the same emission factor provided in AP-42 Table 11.17-4 for Lime Manufacturing primary crusher emissions. Therefore, it appears the current AP-42 emission factor for uncontrolled lime plant primary crusher PM emissions is based on one test (consisting of two runs) conducted in 1974 on the inlet side of a baghouse.

After a thorough review of the various AP-42 sections, background documents, and administrative record, the AP-42 emission factors that match the PRI lime production equipment and controls were selected. The emission factors selected and resulting minor source designation are entirely consistent with other lime plants in EPA Region 9.

EPA Comment 1c. Lack of Emission Limits

IDEQ's permit imposes only production limits for the ore processing units while relying on the unrepresentative emission factors that significantly underestimate emissions. While use of production limits alone to limit PTE may be acceptable in certain circumstances, such as when the limits are derived from conservative emission factors, this is not the case here.

In addition to inadequate production limits derived from unrepresentative emission factors, the Final Permit lacks emissions limits for several emission units, including the ore crushers, screens, and conveyors. This further undermines the enforceability of the synthetic minor limits. EPA advised IDEQ of this problem in its March 19, 2021, letter (Comments 1-4). Despite these comments, the Final Permit does not contain either source-wide emission limits applicable to all emission units or unit-specific limits on the mining and ore processing emission units.[25] As a result, enforcement of the synthetic minor limits is constrained to the inaccurate production limits with no corresponding limitation on the emissions from those units. As discussed above, IDEQ used emission factors that significantly underestimate the emissions from the ore processing units as well as the lime plant units. Based on the analysis above,

IDEQ's permit does not restrict the SGP's PM PTE to below PSD or Title V major source thresholds as a legal and practical matter.

IDEQ Response

IDEQ believes that the appropriate emission factors were used in representing PRI's emissions and that emissions were not underestimated. Likewise, the production limits and emission limits established in the permit were appropriate to limit the facility's PTE to below major source thresholds.

EPA contends that the permit lacks emission limits for several emission units including the ore crushers, screens, and conveyors. Permit condition 3.7 is the primary crusher limit in the Mining and Ore Processing section of the permit. The primary crushing process is limited to 25,000 tons per day. Permit condition 3.8 limits the pebble crusher to 27,600 tons per day. As shown below in the screen capture from the emissions inventory spreadsheet, subsequent equipment from both crushers do not need an individual limit because no new ore is introduced at these points and the same throughput is conservatively used to estimate emissions from the crushers and conveyors. The annual PTE, as shown in the statement of basis, is calculated using the daily throughput limit, emission factor, and 8,760 hours per year.

SOURCE DESCRIPTION		OPERATING LIMITS					
Model	Source Description	Design Throughput					
ID		unit/hr	unit/day	unit/yr	units	Material	hr/yr
OC1	Loader Transfer of Ore to Grizzly	1,042	25,000	9,125,000	ton	Ore	8,760
OC2	Grizzly to Apron Feeder	1,042	25,000	9,125,000	ton	Ore	8,760
OC3	Apron Feeder to Dribble Conveyor	1,042	25,000	9,125,000	ton	Ore	8,760
OC4	Apron Feeder to Vibrating Grizzly	1,042	25,000	9,125,000	ton	Ore	8,760
OC5	Dribble Conveyor to Vibrating Grizzly	1,042	25,000	9,125,000	ton	Ore	8,760
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	1,042	25,000	9,125,000	ton	Ore	8,760
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	1,042	25,000	9,125,000	ton	Ore	8,760
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	1,042	25,000	9,125,000	ton	Ore	8,760
OC9	Stockpile Transfers to Reclaim Conveyors	1,150	27,600	10,074,000	ton	Ore	8,760
OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	1,150	27,600	10,074,000	ton	Ore	8,760
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	1,150	27,600	10,074,000	ton	Ore	8,760
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	1,150	27,600	10,074,000	ton	Ore	8,760
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	1,150	27,600	10,074,000	ton	Ore	8,760

The same is true for the limestone crushing process. The primary crushing process is limited to 1,130 tons per day. No new limestone is introduced in the process at subsequent points and the same throughput is conservatively used to estimate emissions from secondary crushing and conveyors. It should be noted that hourly emission limits exist in the permit for the lime, aggregate, and concrete production plants.

The potential to emit (PTE) for all emission units at the site is calculated using continuous throughput and the design throughput for the equipment with a few exceptions as noted below.

Emission unit ACB, the POX boiler, is limited to autoclave start-up operation only (Permit condition 4.7) and PTE is calculated at 30 hours per year. POX boiler operation monitoring is required in Permit condition 4.20. Emission units MR and MF, the mercury retort and induction melting furnace, use a batch

process and the PTE is calculated for 21 batches per year. The mercury retort and induction melting furnace are limited to 1,000 pounds per batch and 21 tons per year in Permit conditions 4.9 and 4.10. Monitoring and recordkeeping is described in Permit conditions 4.22 and 4.23.

The PTE for the emergency generators and fire pump are calculated at 100 hours per year. Permit condition 6.3 limits these units to 100 hours per year for non-emergency purposes.

The mine site gasoline and diesel tanks (TG1, TG2, TD4 – TD10) PTE is calculated using design throughput and EPA Tanks 4.0.9d.

After a thorough review of the various AP-42 emission factors and the production limits and emission limits established in the permit, it is determined that the production and emission limits established in the permit are appropriate to limit the facility's PTE to below major source thresholds.

EPA Comment 1d. Lack of Sufficient Monitoring, Recordkeeping and Reporting

EPA previously commented that the Draft Permit lacked sufficient monitoring, recordkeeping and reporting (MRR) to ensure the production and emission limits are enforceable as a practical matter.[26] EPA commented that the Final Permit did not include core monitoring, recordkeeping, and reporting (MRR) requirements directly, but rather allowed the permittee to develop these MRR requirements post permit issuance in an Operations and Maintenance Manual (O&M Manual). EPA, as well as many other commenters, raised procedural and substantive concerns with IDEQ's approach to incorporating MRR requirements into the permit. Procedurally, EPA commented that the O&M Manual ought to be developed and available for public comment prior to permit issuance and that any changes to the O&M Manual ought to be reviewed and approved by IDEQ prior to the change. Substantively, EPA commented that the permit condition specifying the minimum requirements for the O&M Manual lacked the necessary specificity to ensure the permit includes adequate MRR.

IDEQ's RTC included some responses to EPA's comments. IDEQ revised PTC Condition 2.20 from draft to final to require that the O&M Manual be developed 30 days prior to startup of any process equipment. Condition 2.20 also states: "The requirements in the O&M Manual shall be incorporated by reference to this permit and shall be enforceable permit conditions." In addition, PTC Condition 2.21 requires: "The O&M manual shall be submitted for approval to DEQ 30 days prior to startup of any ore processing, ore concentration and refining, lime production, or aggregate production emission source regulated by this permit (as identified in Table 1.1) at the address provided (Permit Condition 2.26), and shall remain onsite at all times. Any changes to the O&M manual shall be submitted to DEQ for review, comment, and approval 30 days prior to the change."[27]

These conditions in the Final PTC and Idaho's RTC do not fully address EPA's concerns regarding the development and approval of the O&M Manual. IDEQ did not require the applicant to develop and submit the O&M Manual as part of its application. Accordingly, the O&M Manual will not be subject to public review and comment, even though the Manual will establish enforceable conditions in the permit. In addition, Conditions 2.20 and 2.21 do not mandate IDEQ *approval* prior to startup or a change to the O&M Manual, only that the Permittee submit the O&M Manual to IDEQ for approval. Finally, Condition 2.20 specifies that the O&M Manual shall be incorporated by reference into the permit. However, this condition does not make clear whether only the approved O&M Manual is incorporated by reference or any version of the O&M Manual submitted by the permittee. Moreover, given that the O&M Manual establishes permit conditions that bear on emission and compliance, revisions to the O&M Manual constitute permit revisions that ought to be subject to public review and comment.[28]

Condition 2.20 contains the minimum content requirements for the O&M Manual. In response to commenters questioning the sufficiency of these minimum requirements, IDEQ reasserted that Condition

2.20 contains the minimum requirements for the O&M Manual and that Condition 2.20 requires the permittee to describe various methods, procedures, and schedules to monitor emission units and control equipment.[29] Neither the Final Permit nor IDEQ's RTC adequately address EPA's concerns.

At the outset, these minimum requirements are vague and may not compel specific, enforceable conditions in the ultimate O&M Manual. For many critical monitoring and operational requirements, Condition 2.20 merely requires the permittee to "describe" the procedures and/or schedule. In addition, the requirement to "Describe the schedule and procedures for routine inspection (Permit Condition 2.10), maintenance, repair, and replacement of control equipment" does not specify any particular method (e.g. EPA Test Methods 9, 22) for visual observation of opacity or fugitive emissions. Accordingly, this vague condition will not lead to sufficient MRR in the O&M Manual.

In addition to these overarching concerns with Condition 2.20, numerous permit conditions reference the O&M Manual to satisfy MRR requirements. However, as illustrated in Table 1, below, Condition 2.20 does not mandate specific MRR for all of these corresponding production or emission limits.[30]

In addition, the Permit does not require testing for the ore processing or lime production emission units to confirm the accuracy of emission factors. As discussed above, IDEQ used inaccurate emission factors to derive production limits for ore processing and lime production emission units. In its RTC, IDEQ acknowledges the uncertainty present in emission factors. However, IDEQ did not require initial or routine testing to confirm the accuracy of the emissions factors used to establish production and emission limits. Given the low quality of the emissions factors used, such testing is critical to ensuring the adequacy of the synthetic minor limits. However, the Final Permit does not require any testing.

Given the absence of sufficient MRR requirements for the corresponding production limits, emission limits, and control equipment requirements, many of the synthetic minor emission limits are not enforceable as a practical matter.

IDEQ Response

The permittee is required to develop an O&M manual per permit condition 2.20. The purpose of the O&M manual is to ensure that the permittee has a detailed manual for complying with the PTC conditions for all sources and control devices. The PTC conditions for monitoring, recordkeeping, and reporting makes PTE limitations enforceable as a practical matter. There are numerous recordkeeping and monitoring requirements and the minimum requirements are contained. Specific equipment operations are not known at this time because equipment hasn't been procured by the permittee. There has to be flexibility for brand of equipment, specific operating requirements, etc. according to the manufacturer recommendations. In addition, requiring a source test on ore processing and lime production emission units when they are fugitive in nature is not practical.

EPA Comment on Permit Conditions 2.20, 3.11-3.12 (From Table 1)

The MRR for drill rigs and rock crushing equipment is inadequate. The O&M manual contains no provisions regarding water sprays. While Condition 2.20 does require incorporation of certain manufacturer's guarantees, this requirement is specific to certain control devices: wet scrubber, vent gas cleaning tower, venturi scrubber, carbon filter, baghouse and bin vent filter cartridge control device.

IDEQ Response

The MRR for drill rigs, rock crushing equipment, water sprays, etc. is contained within the O&M manual. Permit condition 2.6 contains the requirements that water sprays must be used for control of fugitive dust. Permit condition 3.12 contains the requirement that the permittee shall install, operate, and maintain water

sprays in accordance with the O&M manual (Permit Condition 2.20) to control PM emissions from each ore processing crusher and conveyor. Water sprays shall operate according to the FDCP (Fugitive Dust Control Plan) when this equipment is operated to ensure compliance with Fugitive Dust requirements (Permit Conditions 2.1–2.6).

In addition, drill rig requirements are contained in Permit Condition 3.11 which states that the permittee shall install and operate dust collection systems with a minimum control efficiency of 90% on all drilling rigs in accordance with the O&M manual (Permit Condition 2.20). The dust collection systems shall be in operation at all times when the drilling rigs are operated.

EPA Comment on Permit Conditions 2.20, 3.16-3.20 (From Table 1)

This condition lacks specificity with respect to the scale used to determine the weights of materials, particularly daily ore loading conditions in 3.16-3.20. In order for these daily limits to be practically enforceable, the permit must contain monitoring, recordkeeping and reporting of total daily weights of ore. This necessitates use of an accurate scale. Condition 2.20 does not mandate the use of any particular scale, or that the permittee maintain the scale within a certain percent accuracy. Without these minimum conditions in Condition 2.20, IDEQ has limited grounds to disapprove an O&M Manual that allows for inappropriate or inaccurate scales. See the regulation at 40 CFR 63.11646(a)(8)-(10) for detailed requirements for the measuring and recording of weights.

Neither Condition 2.20 nor Conditions 3.16-3.20 contain required calculations for summing daily weights to demonstrate continuous compliance.

In its response to comments, IDEQ stated that the permittee will use a weighometer to measure weights.[31] While this may be true, no condition in the permit requires the use of a weighometer.

IDEQ Response

In Permit Condition 2.20, the requirements for the O&M manual, it specifically states to describe each monitoring device and methodology used to measure weight rates of materials to demonstrate compliance with each material throughput limit (Permit Conditions 3.5–3.9, 4.8–4.11, and 5.4–5.8). Procedures for proper installation, calibration, and maintenance shall be included. In Permit Condition 2.21, the O&M manual shall be submitted for approval to IDEQ 30 days prior to startup. Any changes to the O&M manual shall also be submitted for IDEQ review, comment, and approval 30 days prior to the change.

EPA Comment on Permit Conditions 2.20, 4.13-4.17 (From Table 1)

No conditions specify any specific methods for see-no-see inspections, e.g. Method 22 observations. Without referencing the method, the compliance determination is subjective and likely unenforceable.

IDEQ Response

Permit condition 2.10 requires a facility-wide inspection of potential sources of visible emissions. The inspection shall consist of a see/no see evaluation for each potential source of visible emissions. To perform a see/no see evaluation, no specific reference method is required. If any visible emissions are present from any point of emission the permittee is to take appropriate corrective action as expeditiously as possible and/or perform a Method 9 opacity test in accordance with IDAPA 58.01.01.625. Method 9 opacity test does require certification to perform this test.

EPA Comment on Permit Conditions 2.20, 4.8, 4.13, 4.21-4.23 (From Table 1)

Condition 2.20 does not contain MRR requirements specific to Venturi Scrubber (VS1), Vent Gas Cleaning Tower (ST1), or Vent Gas Steam Condensation Tower (CT1) used to control emissions from the Autoclave.

Condition 2.20 contains a requirement to describe the schedule for taking corrective action if visible emissions are present, but does not mandate any specific corrective actions.
NESHAP Subpart EEEEEE contains detailed MRR requirements at 40 CFR 63.11646(a)(8)-(10), including maintenance and calibration requirements. However, Condition 4.21 does not require maintenance or calibration in accordance with NESHAP Subpart EEEEEE, only installation in accordance with NESHAP Subpart EEEEEE.

IDEQ Response

Permit condition 4.13 contains the requirements to install, operate, and maintain venturi scrubber (VS1), vent gas cleaning tower (ST1), vent gas steam condensation tower (CT1), and carbon filter (CA5) systems in accordance with the O&M manual (Permit Condition 2.20) and consistent with manufacturer's recommendations.

As described in the previous response, Permit Condition 2.10 requires a facility-wide inspection of potential sources of visible emissions. The inspection shall consist of a see/no see evaluation for each potential source of visible emissions. If any visible emissions are present from any point of emission the permittee is to take appropriate corrective action as expeditiously as possible and/or perform a Method 9 opacity test in accordance with IDAPA 58.01.01.625.

The detailed MRR requirements contained in NESHAP Subpart EEEEEEE will be included in the required Title V operating permit that the facility will apply for within 12 months of operation. All of the requirements of Subpart EEEEEEE are incorporated into the permit by reference in Permit condition 2.22.

EPA Comment on Permit Conditions 2.20, 5.11-5.16 (From Table 1)

Condition 2.20 does not contain any specific minimum requirements for water sprays. Thus, the permit lacks sufficient MRR for these conditions.

IDEQ Response

As described previously, Permit condition 2.6 contains the requirements that water sprays must be used for control of fugitive dust. Permit condition 3.12 contains the requirement that the permittee shall install, operate, and maintain water sprays in accordance with the O&M manual (Permit Condition 2.20) to control PM emissions from each ore processing crusher and conveyor. Water sprays shall operate according to the FDCP when this equipment is operated to ensure compliance with Fugitive Dust requirements (Permit Conditions 2.1–2.6).

EPA Comment on Permit Condition 5.3 (From Table 1)

The permit does not contain any requirements to calculate emissions to demonstrate ongoing compliance with these emission limits. The permit does not contain any formulas, data reduction methods, or periodic calculation requirements to demonstrate continuous compliance with these emission limits.

IDEQ Response

The monitoring and recordkeeping requirements to demonstrate compliance with the emission limits listed in Permit Condition 5.3 are contained in Permit Conditions 5.17 through 5.26.

EPA Comment on Permit Conditions 5.17-5.26 (From Table 1)

Same evaluation as Conditions 3.16-3.20. (This condition lacks specificity with respect to the scale used to determine the weights of materials, particularly daily ore loading conditions in 3.16-3.20. In order for these daily limits to be practically enforceable, the permit must contain monitoring, recordkeeping and reporting of total daily weights of ore. This necessitates use of an accurate scale. Condition 2.20 does not mandate the use of any particular scale, or that the permittee maintain the scale within a certain percent accuracy. Without these minimum conditions in Condition 2.20, IDEQ has limited grounds to disapprove an O&M Manual that allows for inappropriate or inaccurate scales. See the regulation at 40 CFR 63.11646(a)(8)-(10) for detailed requirements for the measuring and recording of weights.

Neither Condition 2.20 nor Conditions 3.16-3.20 contain required calculations for summing daily weights to demonstrate continuous compliance.)
In its response to comments, IDEQ stated that the permittee will use a weighometer to measure weights. While this may be true, no condition in the permit requires the use of a weighometer.)

IDEQ Response

As stated in a previous response, in Permit Condition 2.20, the requirements for the O&M manual, it specifically states to describe each monitoring device and methodology used to measure weight rates of materials to demonstrate compliance with each material throughput limit (Permit Conditions 3.5–3.9, 4.8–4.11, and 5.4–5.8). Procedures for proper installation, calibration, and maintenance shall be included. In Permit condition 2.21, the O&M manual shall be submitted for approval to DEQ 30 days prior to startup. Any changes to the O&M manual shall also be submitted for DEQ review, comment, and approval 30 days prior to the change. As stated in Permit Condition 2.20, the requirements in the O&M manual are incorporated by reference into the permit and are enforceable.

Permit Conditions 5.17 through 5.22 all include the specific language that the devices and methodologies used to measure weights shall be identified in the O&M Manual.

EPA Comment on Testing Ore Processing and Lime Production

EPA's Evaluation: In addition, the Permit does not require testing for the ore processing or lime production emission units to confirm the accuracy of emission factors. As discussed above, IDEQ used inaccurate emission factors to derive production limits for ore processing and lime production emission units. In its RTC, IDEQ acknowledges the uncertainty present in emission factors. However, IDEQ did not require initial or routine testing to confirm the accuracy of the emission factors used to establish production and emission limits. Given the low quality of the emissions factors used, such testing is critical to ensuring the adequacy of the synthetic minor limits. However, the Final Permit does not require any testing.

Given the absence of sufficient MRR requirements for the corresponding production limits, emission limits, and control equipment requirements, many of the synthetic minor emission limits are not enforceable as a practical matter.

IDEQ Response

The emission factors used in the ore processing and lime production are from AP-42 Sections 11.19.2 and 11.17. These emission factors are for fugitive emissions that are either uncontrolled or incorporate water sprays. Requiring a source test on ore processing and lime production emission units when they are fugitive in nature is not practical or reasonable.

IDEQ contends the permit does require sufficient monitoring, recordkeeping and reporting (MRR) to ensure the production and emission limits are enforceable as a practical matter. The purpose of the O&M manual is to ensure that the permittee has a detailed manual for complying with the PTC conditions for all sources and control devices. The PTC conditions for monitoring, recordkeeping, and reporting makes PTE limitations enforceable as a practical matter. The O&M manual, along with other plans such as the Fugitive Dust Control Plan (FDCP), Haul Road Capping Plan (HRCP), and Access Management Plan (AMP), will be posted to IDEQ's website with the final permit and statement of basis when completed.

EPA Allegation 2. The SGP, as permitted, will cause or contribute to a violation of the PM10 NAAQS

EPA Comment 2a. Unsubstantiated estimates of fugitive dust control

EPA, as well as several other commenters, questioned the basis for IDEQ's determination that PRI could achieve a 93.3% control efficiency to control fugitive dust from haul roads at the SGP. Specifically, EPA commented that IDEQ did not provide a reasoned analysis demonstrating that the studies showing that 90% control efficiency is achievable using magnesium chloride reflect conditions at the SGP. EPA also commented that IDEQ did not include specific details necessary to support such a demonstration in the permitting record.[32]

In its RTC, IDEQ responded stating that 93.3% is an aggressive level of control and that PRI has committed to undertaking all measures to achieve this level of control. IDEQ further stated that, based on a review of test studies, the 93.3% level of control can be achieved using water and magnesium chloride dust suppressants (citing PRI's application). IDEQ explained that chemical and water dust suppressants are used in combination for the control of dust from haul roads, and that achieving the target combined control efficiency of 93.3% is ultimately important to ensure compliance with applicable standards. According to IDEQ, it is for this reason that the combined control efficiency was listed in the permit in lieu of separate chemical (90% control) and water (33.3%) dust suppressant control efficiencies.[33]

IDEQ's responses do not adequately address EPA's comments. IDEQ did not proffer further evidence that conditions at the SGP are comparable to areas where studies indicating a 90% control efficiency on fugitive dust is achievable. Even so, these studies do not support IDEQ's contention that a control efficiency of *93.3%* is achievable. Ultimately, IDEQ appears to have back-calculated the control efficiency necessary to demonstrate NAAQS compliance, rather than determine a control efficiency that is achievable in practice.[34]

IDEQ Response

The EPA allegation that IDEQ has back-calculated the control efficiency necessary to demonstrate NAAQS compliance is simply unfounded and presumptuous. As answered in the Response to Comments, IDEQ relied on chemical (90% control) and water (33.3%) dust suppressant control efficiencies.

The 90% chemical control efficiency is found to be both achievable and conservative based on EPA's AP-42 13.2.2 referenced test reports, which show that a chemical dust suppressant alone can achieve 90 to

99% control efficiency for PM_{10}. The control efficiency of 33% for watering was found to be both achievable and conservative based on EPA's AP-42 Section 13.2.2, which states 95% control for increasing the surface moisture by only 1%. The AP-42 section contains no discussions regarding potential parameters or other aspects of unpaved roads that must be quantified for the purpose of estimating the control efficiency from chemical suppressants.

An exhaustive review was conducted based on the best available information. The references listed in Appendix G, Table 10 from the EPA's own RBLC database were provided as additional supporting information of approved control technologies and control efficiencies. The references illustrate that a control efficiency of 90% is achievable by treating unpaved roads with chemical suppressant in various states.

Listed Facilities in Appendix G, Table 10
AK Donlin Gold Project AK-0084
AR Turk Power Plant AR-0094
CO Rio Grande Portland Cement Corp. CO-0043
IN Nucor Steel IN-0034
LA Nucor Steel Louisiana LA-0239
MO Lafarge Corp. MO-0048
NV Sloan Quarry NV-0045
NV Nellis Air Force Base NV-0047
OH Unlimited Concrete OH-0126
OH Unlimited Concrete OH-0131

A permit issued within EPA Region 10, The Alaska Donlin Gold Project highlighted above, specifically uses a 90% control efficiency for chemical suppressants with additional control for water (precipitation) in the emission factor equation for unpaved roads which similarly reflects a 93.3% control efficiency. In reviewing EPA's comments on the recently issued permit (7/1/2023), EPA did not submit a comment regarding the control efficiency of water and chemical suppression used for the project. EPA did comment that the annual precipitation correction factor is not appropriate for 24-hour PM_{10} assessments. Alaska DEC responded that "Donlin applied corrective factors in estimating their PM-10 impacts to account for the use of both chemical dust suppression and watering of unpaved roads. They indicate that a single corrective factor of 35-percent was observed to address surface watering by both naturally occurring precipitation and direct-mechanical application. The net reduction in estimated short- and long-term PM-10 impacts attributable to assumed chemical and wet suppression together is greater than 90-percent." In addition, Alaska responded with "A review of literature, however, suggests that watering may be assumed to ensure greater than 90-percent control efficiencies, with other conditions remaining the same. Assumed control efficiencies are likely to rise when taken in context along with the contemporaneous use of environmentally persistent chemical dust suppressants. It is worth noting that Table 13.2.2-2 of AP-42 Section 13.2.2 indicates nearly 95-percent of control from watering is realized with a surface moisture content of approximately 2.5-percent."

IDEQ seeks to apply a control efficiency that can actually be achieved, reflects the permit application, and can demonstrate compliance with the PM_{10} NAAQS. After a thorough review of the background materials, RBLC database, and AP-42 guidance, along with the administrative record, IDEQ contends that a 93.3% control efficiency along with a robust FDCP is achievable.

EPA Comment 2b. Underestimation of Fugitive Dust Emissions

With respect to demonstrating NAAQS compliance, EPA commented that IDEQ's use of a median silt content of 4.0% underestimates fugitive dust emissions from haul roads. EPA commented that the arithmetic average silt content for haul roads based on Perpetua's site-specific data is 4.3%. Use of the

4.3% average value results in about 7% more fugitive dust emissions from the haul roads than estimated using the median value. IDEQ's modeling sensitivity study showed values just below the NAAQS, such that an 7% increase in fugitive dust from haul roads would have resulted in 24-hour PM_{10} NAAQS violations.[35]

In response, IDEQ stated the use of site-specific median values for silt content is commonly accepted by IDEQ, and the values used in calculations were supported by PRI.[36] This response does not adequately justify why a median value rather than the arithmetic average is more appropriate taking into consideration the site-specific sampling. Given that a small difference in the silt content will result in an exceedance of the NAAQS, IDEQ's insistence on using a median silt content appears arbitrary and unreasonable and indicates that PRI has not demonstrated that the emissions will not cause or contribute to a NAAQS violation. On the contrary, operation of the SGP will likely cause or contribute to a violation of the PM_{10} NAAQS.

IDEQ Response

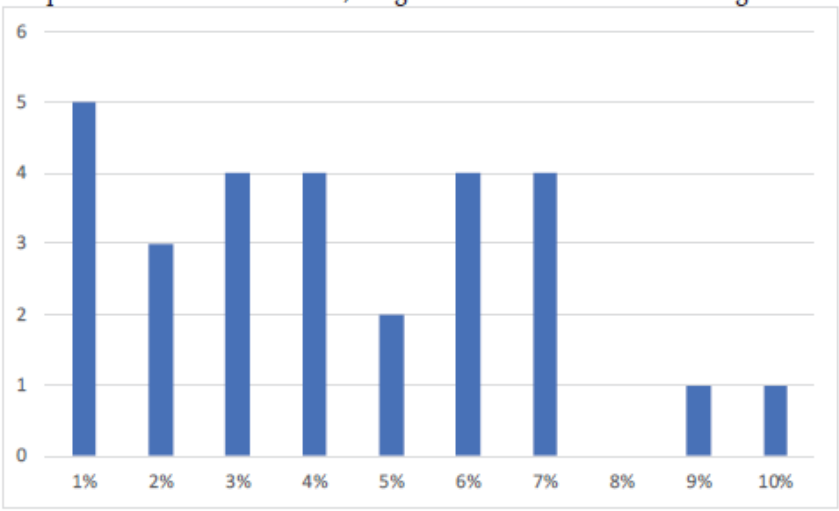
The median value of silt content of 4% was determined to be appropriate and representative for the unpaved road emission factor equation. This value is slightly more conservative than the geometric mean of 3.5% and similar to the arithmetic mean of 4.3%. The geometric mean and arithmetic mean both round to 4%, consistent with the precision of the raw data. In general, the arithmetic mean is used when the data has a normal number of distributions which have a low amount of outliers. The median is used to return the central tendency for skewed number distributions. With the silt data at SGP being skewed, it is appropriate to use the median value. EPA has routinely used median, geomean, and arithmetic mean in analyzing environmental data. For example, EPA's AP-42 Section 11.9, Western Surface Coal Mining, recommends the use of the geometric mean for silt content.

As described in Appendix A (page 336) of PRI's application: The silt value is derived from site-specific soil data: a geomean of 3.5% and a median value of 4.0% (Midas Gold 2015). As noted in the background documentation for EPA AP-42 Section 13.2.2, EPA uses the geomean to average environmental measurements, as these measurements vary widely and do not yield a normal distribution curve (MRI 1998) (MRI 2006); however, this application uses the higher median value for a more conservative estimate. Below is a capture of PRI's silt data.

Soil Resources Baseline Study (Midas Gold 2015)
Stibnite Gold Project
Midas Gold, Inc.
Apr-2015

	<#200	Frequency Distribution	
PT1-1019	2%	1%	5
PT1-1042	7%	2%	3
PT1-1062	10%	3%	4
PT1-1080	3%	4%	4
PT1-1096	3%	5%	2
PT1-1107	7%	6%	4
PT1-1121	4%	7%	4
PT1-1154	7%	8%	0
1174	3%	9%	1
1196	1%	10%	1
1407	2%		
1420	5%		
1676	6%		
1685	7%		
1698	6%		
1433	1%		
1475	6%		
1522	4%		
1530	1%		
1549	1%		
1554	1%		
1577	4%		
1912	9%		
1931	6%		
1948	4%		
1956	2%		
1978	5%		
1992	3%		
Median	4.0%		
Count	28		
Geomean	3.5%		

Graph illustrates skewed dataset; use geomean or median for the average silt.



Applying a median silt content value of 4.0% is neither arbitrary or unreasonable. After a thorough review of the background materials and statistical analysis, along with the administrative record, IDEQ contends that a 4.0% silt content value is reasonable and conservative.

EPA Comment 2c. Lack of Conditions to Ensure Continuous Compliance with PM_{10} NAAQS

EPA, along with several other commenters, commented that the permit lacks conditions sufficient to ensure continuous compliance with the PM_{10} NAAQS. Specifically, EPA raised concerns with the adequacy and practical enforceability of the Fugitive Dust Control Plan (FDCP). Specifically, EPA raised concerns that the permit did not contain specific conditions necessary to ensure continuous compliance with the 93.3% control efficiency, but rather allowed the permittee to develop these conditions as part of an FDCP after permit issuance and allowed the permittee to change the FDCP without IDEQ approval. EPA also commented that the permit lacks conditions necessary to make the 93.3% control efficiency

practically enforceable, such as frequency of dust suppression, requirements for when to use chemical dust suppression, amount of dust suppression that must be applied, vehicle weight, vehicle speed, vehicle daily miles traveled, and road silt content.[37] With respect to Condition 2.5 requiring PRI to apply fugitive dust control measures such that visible emissions are below 10% opacity, EPA also commented that permitting record does not support a correlation of the 10% opacity requirement in Condition 2.5 with a 93.3% control efficiency.[38]

In response to these comments, IDEQ updated permit condition 2.8 to require IDEQ approval of the FDCP 30 days prior to startup and after any subsequent changes. IDEQ also responded that the permit contains activity rate limits that serve as surrogate limits for fugitive sources. IDEQ also stated that it typically does not include vehicle speed, type, and miles traveled in permits. IDEQ also asserted that Conditions 2.1-2.6 contain the minimum requirements for the contents of the fugitive dust plan.[39] Finally, IDEQ responded that "An instantaneous 10% opacity limit for vehicle traffic on haul roads is considered a very conservative control trigger level to ensure that an appropriate control measure is taken to reasonably control emissions of fugitive dust (Permit condition 2.5)."[40]

These responses do not fully address EPA's comments with respect to the practical enforceability of emission limits necessary for NAAQS compliance. Condition 2.8 does not require that IDEQ approve the FDCP prior to startup, only that the permittee submit the FDCP 30 days prior to startup. Similarly, Condition 2.8 does not clearly require IDEQ approval of FDCP changes prior to the permittee making the changes.

Conditions 2.1 through 2.6 are insufficient to ensure the permittee achieves 93.3% fugitive dust control efficiency on haul roads. First, the permitting record indicates that application of magnesium chloride is necessary to achieve up to 90% control of fugitive dust. However, Conditions 2.1 through 2.6 do not require the permittee to use magnesium chloride for dust suppression. Rather, Condition 2.6 merely requires that the FDCP contain reasonable precautions including: "apply water or suitable dust suppressant (e.g. magnesium chloride, calcium chloride) to disturbed areas, haul roads, equipment staging areas, parking areas, and storage piles during the dry season and at other times as necessary to control fugitive dust." Moreover, magnesium chloride degrades over time. However, the permit does not require the permittee to reapply magnesium chloride at regular intervals.

Similarly, IDEQ assumed a combined control efficiency of water and chemical dust suppression to achieve 93.3%. However, Conditions 2.1 through 2.6 contain no explicit requirements that the permittee use both water and chemical dust suppression in a manner necessary to achieve the 93.3% control efficiency. Magnesium chloride does not perform as a dust suppressant in dry conditions. Therefore, supplemental watering will be necessary. However, the permit does not require supplemental watering to ensure the magnesium chloride performs as a dust suppressant.

With respect to vehicle weight and vehicle miles traveled, compliance with the NAAQS is dependent on vehicle miles traveled staying at or below 7,758 per day.[41] However, the permit contains no such limit. IDEQ also did not make clear how the activity limits, including Condition 2.4 (Blasting Limits) and Condition 3.5 (Daily Hauling and Excavating Limits), would necessarily restrict vehicle miles traveled to at or below 7,758 per day. There are no requirements or restrictions on the manner the permittee uses the haul roads.

Regarding the silt content, the permit does not contain conditions to ensure the silt content on haul roads remains at or below 4%. Condition 3.13 contains the minimum requirements for the Haul Road Capping Plan (HRCP). According to IDEQ, Condition 3.13 limits maximum silt content to 4.0%. This is not accurate. Condition 3.13 states that "The permittee shall use capping material with a maximum of 4.0% silt content." This condition does not require the permittee to maintain the haul road silt content to at or below 4.0%. Nor does the requirement account for mixing of the capping material with the base or wearing of the

cap over time. Condition 3.13 also contain no explicit sampling or compliance demonstration methods. Rather, Condition 3.13 allows the permittee to develop a "silt content sampling plan including standard operational procedure for sampling, frequency of sampling, and ASTM (or equivalent) method of analysis for silt content."

Finally, IDEQ's response to EPA's comment on the basis for the 10% opacity limit in Condition 2.5 does not provide additional basis for a correlation between opacity and the 93.3% control.

The permit contains no testing requirements to establish a correlation between fugitive dust control and opacity. Nor does the permit contain any specific method for determining opacity or the frequency or location of opacity observations.

IDEQ Response

The Fugitive Dust Control Plan (FDCP) as required by permit condition 2.6, states that at a minimum, the FDCP shall contain a list of all potential sources of fugitive dust emissions and reasonable precautions to minimize fugitive dust emissions with a bulleted list encompassed in the permit condition. One of the bullets is to develop specific criteria to determine what frequency and type (water and/or chemical) of dust suppressant must be applied, and appropriate suppressant application rates. Chemical dust suppressants shall be applied consistent with manufacturer's instructions and recommendations. Permit condition 2.5 is but one of the monitoring methods required to ensure effective dust control of the unpaved roads. The 10% opacity threshold is an aggressive threshold for prompting corrective action.

Permit condition 2.8 does require approval of the FDCP as stated: Copies of the FDCP and AMP shall be submitted to IDEQ for approval 30 days prior to startup at the address provided (Permit Condition 2.26) and shall remain onsite at all times. Any changes to the FDCP or the AMP shall be submitted to IDEQ for review, comment, and approval 30 days prior to the change.

Similar to the FDCP, the Haul Road Capping Plan (HRCP) is also a permit required plan and incorporated into the permit with some minimum requirements included in the permit as existing permit conditions with IDEQ approval. Permit Condition 3.13 includes the frequency of inspection of the haul roads and maintenance procedures. These maintenance procedures include the wearing of the haul roads over time which will be developed in the HRCP.

With respect to vehicle weight and vehicle miles traveled (VMT), the facility and IDEQ have modeled a very conservative scenario of 20 CAT 789D trucks and 12 CAT 740B trucks with a weighted average of 182.6 tons. The daily hauling limit of 180,000 tons per day inherently limits the amount of truck loads per day and VMT. An analysis was done to ensure that the most conservative approach was taken. VMT was calculated by using the farthest distance that a truck will travel (3.07 miles between the West End Pit and the West End DR Storage Facility), the daily hauling limit of 180,000 tons per day, the payload of both small and large trucks, and the number of large and small trucks throughout the life of mine. Actual VMTs will decrease over time as mining locations change. When increasing the number of large trucks, emissions decrease and when increasing the payload for both large and small trucks, emissions decrease ensuring that the most conservative approach was used in the analysis for SGP. Therefore, specific VMT limits do not need to be placed in the permit nor is this a common practice in IDEQs evaluation of all other gold mine permits in Nevada and Region 10.

IDEQ contends that the permit as issued ensures continuous compliance with the PM_{10} NAAQS with the development of a IDEQ approved FDCP and HRCP. Both the FDCP and the HRCP are practically enforceable and incorporated into the permit as enforceable requirements.

EPA Allegation 3. Neither the permit record nor permit conditions demonstrate that the entirety of the SGP ought to be excluded from the scope of "ambient air."

"Ambient air" is defined as that portion of the atmosphere, external to buildings, to which the general public has access."[42] General public includes "any person(s) other than those who are permitted access to the property as employees or business invitees of a specific stationary source (including trespassers)."[43] EPA interprets access to encompass two key concerns: legal access and physical or practical access.[44] Legal access concerns whether the general public has the right or permission to enter a specific property. Physical access addresses whether the general public is able to, under actual circumstances, enter a particular parcel of land. In order to preclude physical access to a parcel of land, the source must employ measures, which may include physical barriers, that are effective in precluding access to the land by the general public.[45] Such measures can include video surveillance, monitoring, clear signage, and routine security patrols.[46] Measures can be effective even if there is not 100 percent certainty that they will prevent public access.[47] Measures must be reasonable taking into consideration the nature of the measure used, source location, type and size of source and property to be excluded, and surrounding area.[48]

EPA Comment 3a. Legal Right to Exclude General Public

As stated above, legal access concerns whether the general public has the right or permission to enter a specific property. IDEQ asserts in the SOB and RTC that PRI has "complete and sole authority to control access to or through the facility, granting access at their discretion to anyone wishing to visit the site or pass through the site."[49] Neither the SOB nor the RTC, however, evaluate PRI's claims. In light of the fact that the SGP encompasses the East Fork South Fork Salmon River and is located within National Forest lands, the permitting record ought to contain a more thorough evaluation of PRI's legal authority and members of the general public's right of access to the SGP area of operations.

IDEQ Response

IDEQ's standard practice is to review asserted conditions and proposed methods, data, and procedures in the permit application to a degree that ensures that the general public are not exposed to unacceptable levels of air pollution, and then to establish requirements that reasonably assure implementation of those methods. It is not IDEQ's standard practice to verify all details of an applicant's assertion of property rights in a permitting action unless there are questionable claims and those claims are key to ensuring NAAQS compliance. PRI asserted in their permit application that modeling receptors were included in all areas that could be considered as ambient air. Although the application focused on roadway and trail access because of the unique circumstance these represent, IDEQ's upcoming review of the permit-required Access Management Plan (AMP) will provide for a more detailed assessment and ultimate assurance of both the legal and practical ability to preclude public access from all areas excluded from ambient air. Considering the quantity and characteristics of potential emissions, the conservatism of analyses supporting permit issuance, and the probability for public exposure to air pollutant levels in excess of NAAQS for a duration that endangers health and safety, IDEQ strongly disagrees with EPA's criticism that the permitting record ought to contain a more thorough evaluation of PRI's legal authority to preclude public access to the site. Perpetua asserted in their permit application that modeling receptors were included in all areas that could be considered as ambient air. Although the application focused on roadway and trail access, IDEQ's review of the permit-required Access Management Plan (AMP) will provide a more detailed review of both the legal and practical ability to preclude public access from all areas excluded from ambient air.

EPA Comment 3b. Measures to Exclude General Public as a Practical Matter

EPA commented that the permit lacks conditions to ensure PRI employs sufficient measures such that the entirety of the SGP is appropriately excluded from the definition of ambient air. Specifically, EPA raised

concerns that the general public may be able to access the SGP, regardless of their legal right to do so.[50] The basis for EPA's comment was that the permit does not contain specific measures the permittee will take to exclude members of the public from the SGP. Rather, the permit allows the permittee to develop an Access Management Plan ostensibly designed to exclude members of the public. In response, IDEQ asserted that Condition 2.7 contains the requirements for the ACP, including adequately informing anyone approaching an access point that travel beyond the established gate involves entering an active mine site as a guest of the permittee and providing verbal and written requirements that must be followed while on the SGP site.[51] The SOB also states that the primary and secondary access points are controlled by adjacent natural features, such as streams and creeks, steep topography, and areas of thick vegetation and undergrowth.[52] In addition, the SOB states that PRI will place boulders across trails and adjacent to the train to prevent vehicle access.[53] Finally, according to the SOB, PRI security personnel will routinely patrol mine facilities and roadways for unauthorized individuals.[54]

IDEQ's responses and statements in the SOB do not adequately address EPA's concerns. As permitted, the general public will likely have physical or practical access to portions of the SGP. The SGP operations area boundary covers 2,372 acres of land within the Payette and Boise National Forests. The SGP is located in Valley County, Idaho. The nearest settlement is the village of Yellow Pine, Idaho, approximately 14 miles by road.[55] The Payette National Forest includes the Frank Church River of No Return Wilderness. The Salmon River runs through the Payette National Forest. The SGP is surrounded by numerous recreation areas in the Payette and Boise National Forests.[56] National Forest roads 374, 440, and 640 provide vehicle access to the site.[57]

Given the scale of the SGP, proximity to recreation opportunities, and multiple access points, the permittee should employ multiple measures to preclude public access. However, condition 2.7 is vague and leaves the permittee considerable latitude on the methods used to exclude members of the general public. While the SOB indicates that placement of boulders on secondary roadways is necessary to prevent access, Condition 2.7 contains no such requirement. Also, Condition 2.7 does not specify a minimum patrol frequency or minimum signage requirements. Nor does Condition 2.7 require the permittee to post or monitor the vast operations boundary to effectively preclude recreators from entering the site. Condition 2.7 only requires the permittee to employ measures to "discourage" access to secondary roadways and trails. This does not meet the standard to effectively exclude members of the general public. Similarly, EPA questions whether the entire boundary surrounding the operations area incorporates natural features that preclude access. Given the numerous recreational opportunities in the surrounding wilderness areas, access by recreators off trail appears possible. Therefore, the Final PTC does not ensure that the entirety of the SGP is appropriately excluded from the definition of ambient air. This implicates IDEQ's determination that the SGP will not cause or contribute to a violation of the PM_{10} NAAQS.

IDEQ Response

Perpetua has certified in their permit application materials their legal authority to preclude public access to areas excluded from ambient air. This certification by the applicant establishes the air impact analyses supporting issuance of the PTC. To ensure adequate measures are in place to effectively preclude access to areas excluded from ambient air, the PTC requires submission and approval of an Access Management Plan (AMP). Adequacy of measures will depend on the following factors: 1) likelihood of the public to attempt access; 2) physical ease of access; 3) potential for specific area to expose the public to impacts exceeding NAAQS or TAP increments; 4) extent to which the area is obviously not public; 5) effectiveness of access preclusion measures taken.

The IDEQ Ambient Air Quality Impact Analyses Review Memorandum (Modeling Review Memorandum), included as Appendix B of the IDEQ Statement of Basis, provides a description of general measures that will be taken to preclude public access. This description will guide the development of the AMP. The Modeling Review Memorandum lists the following measures:

- Primary Access Points: The Stibnite Road (north) and Burntlog Route (south) access points will include locked gates. Guard shacks will be located at each gate to monitor all vehicle ingress/egress. Each gate also will include appropriate adjacent barriers (i.e., fencing, bollards, boulders, or other barriers) to prevent any vehicle from circumventing the gate and gaining site access. These primary access points are also controlled by adjacent natural features, such as streams and creeks, steep topography, and areas of thick vegetation and undergrowth that serve as natural barriers or impediments to access.

- Secondary Access Points: Other potential access points, such as secondary roadways and trails, will include posted signs warning the public against entry into the site. At these locations, boulders will be placed across the trail and at an appropriate width adjacent to the trail to prevent any vehicle from circumventing the barrier. These secondary access points also incorporate adjacent natural features, such as streams and creeks, steep topography, and areas of thick vegetation and undergrowth that serve as natural barriers or impediments to access. Some mine features, such as the TSF and process plant areas, will include perimeter fencing.

- Surveillance: PRI security personnel will routinely patrol mine facilities and roadways for unauthorized individuals. In addition, all onsite personnel will be trained on the necessity of restricting public access to areas within the operations boundary. Any suspected trespassing by unauthorized individuals will be reported immediately to security, and trespassers will be escorted off the site.

The Modeling Review Memorandum also provides general measures to manage access through the site on the Stibnite Road access route, stating the following:

Persons wishing to traverse the SGP site on the Stibnite Road access route will be required to check in at the security gate to receive a safety briefing and to alert mine staff of their presence. Travelers will be required to check out upon exiting the site to ensure passage through the site in a safe and timely manner. Travelers will not be allowed to stop or loiter while traveling though the operations area. Along its full length, the Stibnite Road access route would have appropriate signage to direct travelers and would be separated from mine haul roads and areas of mine operations by fencing, berms, or gates to prevent travelers from straying from the route. When possible and to the degree practicable, anticipated public access restrictions will be communicated to the public in a timely manner so that they may plan appropriately.

The Access Management Plant will be developed and approved by IDEQ prior to mining operations. It will establish more detailed methods and procedures to manage and monitor access to the site at an appropriate level to preclude public access to areas exclude from consideration as ambient air.

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	Agency Case No. 0101-22-01
	)	OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON	)	**PETITIONERS' REPLY BRIEF IN SUPPORT OF AMENDED PETITION FOR REVIEW OF PRELIMINARY ORDERS**
Petitioners,	)	
v.	)	
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC.	)	
Intervenor-Respondent.	)	

TABLE OF CONTENTS

INTRODUCTION 1

ARGUMENT 1

I. DEQ CANNOT EXCLUDE THE STIBNITE ROAD ACCESS ROUTE FROM AMBIENT AIR PROTECTIONS 1

A. DEQ Unreasonably Relied On Perpetua's Statement That It Has Legal Control To Preclude Public Access Over The Stibnite Road Access Route 2

B. The General Public Are Not "Guest of the Mine" And Must Be Provided Ambient Air Protections 5

II. By Deferring Permit Details To Be Determined Later, Outside The PTC Process And Without Public Comment, DEQ Violated The Air Rules And The CAA 7

A. Violations Of Air Rule Section 202 Requirements For What Must Be Included In An Application 8

B. Violations Of Section 209 Public Comment Requirements 12

III. DEQ Had No Reasonable Basis to Conclude Perpetua Will Achieve 93.3% Dust Control As Opposed to Some Other High But Insufficient Level, Such as 90%. 15

IV. THE "PROJECT SPECIFIC ADJUSTMENT" DEQ GRANTED PERPETUA VIOLATES THE AIR RULES, AND THREATENS PUBLIC HEALTH 19

CONCLUSION 23

INTRODUCTION

Petitioners Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon submit this Reply Brief in support of their Amended Petition for Review of Preliminary Orders. For the reasons set forth in Petitioners' Opening Brief, and as further explained below, the Idaho Department of Environmental Quality ("DEQ") committed multiple errors when it issued the permit to construct ("the Permit") to Perpetua Resources Idaho, Inc. ("Perpetua") for the proposed Stibnite Gold Project ("SGP" or "Project"): a 16-year proposal to construct and operate a large open-pit gold mine in Valley County, Idaho.

These errors threaten to expose the public to unhealthy concentrations of particulate matter ("PM") and arsenic air pollution. These errors also render DEQ's approval of the permit arbitrary, capricious, and not in accordance with the Rules for the Control of Air Pollution in Idaho ("Air Rules"), IDAPA 58.01.01 *et seq.* The Board should set aside the Permit, and remand to DEQ to correct these errors, comply with the Air Rules, and protect the public from the SGP.

ARGUMENT

I. DEQ CANNOT EXCLUDE THE STIBNITE ROAD ACCESS ROUTE FROM AMBIENT AIR PROTECTIONS.

DEQ cannot exclude the Stibnite Road Access Route from ambient air protections because Perpetua does not and will not have the legal authority to preclude the public from traveling on the Route. Its impermissible creation of a "guest of the mine" category to strip away ambient air protections from the public is not supported by EPA policy, DEQ guidance, the Idaho Air Rules, or the Clean Air Act, and should be rejected.

A. DEQ Unreasonably Relied on Perpetua's Statement that It Has Legal Control to Preclude Public Access Over the Stibnite Road Access Route.

It is incredulous that despite the established legal precedent that an agency's decision must be based on the record before it,[1] conflicting evidence in the record, and questions raised by the public during the comment period, DEQ and Perpetua continue to advance the argument that it was reasonable for DEQ to rely on one assertion by Perpetua to determine that Perpetua had legal authority to *preclude* the public from the Stibnite Road Access Route. *See* PRI at 20-21; DEQ at 9-10. But that is their argument, and it is wrong.DEQ argues that it "cannot be expected to fact check every individual averment made by a permittee," DEQ at 9, but that is not what Petitioners are asking here. Petitioners, instead, ask that the Board find that DEQ's determination, that was based on one statement in the record and ignored other evidence in the record, was not reasonable, and should be remanded to DEQ for further consideration.

Given the context of this air permit, DEQ's contention that it was appropriate to rely on one statement in the application flies in the face of reasoned decision-making.

First, the truth and accuracy of Perpetua's statement that it has legal control to preclude public access is central to the determination of whether the Route can be excluded from ambient air protections and consistency with EPA's policy on ambient air that states that an owner or operator must have "the right to preclude the general public's access." REC 1142. This is a threshold question for the ambient air boundary determination, and would not be unreasonable for DEQ to verify the truth of the statement.[2]

[1] *State Ins. Fund v. Hunnicutt*, 110 Idaho 257, 261(1985).
[2] As discussed further below, Perpetua's representation can be read several ways, but what it does not state in no uncertain terms is that Perpetua will have the legal right to "preclude" public access from the Stibnite Road Access Route.

The Ninth Circuit in the "*Rosemont*" case faced a similar situation regarding a mining company's claims of rights to use public land. *Ctr. for Biol. Diversity v. U.S Fish & Wildlife Serv.*, 33 F.4th 1202 (9th Cir. 2022) There, the threshold issue centered around the 1872 mining law allowing a mining company to dump its waste on Forest Service land if it holds a "valid" mining claim on those lands. *Id.* at 1210. The Forest Service relied on Rosemont Copper Company's statements that it had valid mining claims, but failed to verify that assumption. *Id.* at 1221. The Ninth Circuit found the Forest Service "improperly assumed their validity" and reversed the Forest Service's approval of the Rosemont's project. *Id.* at 1222.

Second, has Petitioners brought up during the public comment period and throughout this contested case, there was substantial evidence in the record (and in conflict with Perpetua's representation) to indicate that, although Perpetua may have (once the mine plan is approved) the legal to "control" public access, it will not have the legal right to "preclude" access. Given that Perpetua's legal right to preclude public access was an issue throughout the administrative process, it was unreasonable for DEQ to not question Perpetua's statement "when viewed in the light that the record in its entirety furnishes, including the body of evidence opposed to the [agency's] view." *Hunnicutt*, 110 Idaho at 261.

DEQ makes light of the issue, calling it an "oversimplification" and "irrelevant" to the ultimate issuance of the permit. DEQ at 10. But it is neither. Setting the ambient air boundary is central to the entire permit and establishes the point of compliance for which all modeling of air pollutant emissions is based, and central to the protection of public health by ensuring that the public does not breathe air that does not comply with the NAAQS established by the EPA. *See* PRI at 21 ("Perpetua's application for a permit to construct and DEQ's approval of the Final

Permit is based on the proposed operational [or ambient air] boundary."); *see also* REC 415 ("This operations boundary also defines the ambient air boundary used in all ambient air quality impact analyses.").

As stated above, Perpetua's legal rights over the Route is a central and threshold issue as to whether it can even think about excluding the Route from ambient air protections. In that vein, DEQ still refuses to look at the record before it, arguing "[i]t is unclear what Petitioners are referring to." DEQ at 10. However, Petitioners' briefs have cited many instances in the record that demonstrate that no matter what mine plan alternative the Forest Service approves, the Route will remain open as a public access route to access important recreational and other sites on public lands. *See* REC 895; REC 2624-25; Pet'rs' Opening Br. at 20-21. Having the legal right to preclude public access, as stated above, is central to EPA's determination whether an area external to a source's buildings are afforded ambient air protections or excluded from them. REC 1142.

"Voluneer[ing]" to build the Stibnite Road Access Route around mining features (note that a road through the proposed mine site, Stibnite Road, currently exists) is an inaccurate characterization of the case at hand, and still does not give Perpetua the right to preclude public access. *See* PRI at 22. The record demonstrates that Perpetua attempted to exclude public access in its mine plan, but the Forest Service–after receiving numerous public comments indicating that a change in access "was of significant concern–directed Perpetua to evaluate "access options for the [Stibnite Gold Project] that provided access similar to existing conditions and travel times." REC 895. As a result, the only alternative under consideration that can be approved by

the Forest Service is a mine plan that would "provide access similar to that provided by the existing Stibnite Road." REC 895.

"[D]eterminations concerning the adequacy of measures to preclude public access should be made on a case-by-case basis *after consideration of information in the relevant administrative record*." REC 1148 (emphasis added). DEQ did not do this. As such, this Board should not, and can not, allow DEQ to refuse to provide ambient air protections to the general public, and should reverse the Hearing Officer's order, vacate the permit, and remand it back to DEQ for further consideration.

B. The General Public Are Not "Guests Of The Mine" and Must Be Provided Ambient Air Protections.

If the mine plan is approved by the Forest Service, the only alternative, as demonstrated above, is a mine whereby the Stibnite Road Access Route will remain open to the public for through travel to access public recreation sites on Forest Service land. Without the legal right to preclude public access and the inability to provide ambient air protections over the Route, which traverses right through the center of the mine site, Perpetua and DEQ needed to create a new category of the public that will not longer be the public, but will be "guests of the mine." Calling the public "guests of the mine" in this manner and based on the public's use of the Route, is inconsistent with EPA's ambient air policy and DEQ's guidance, and strips the public of any ambient air protections afforded by the Clean Air Act.

Perpetua's and DEQ's briefs, and the Hearing Officer's order attempt to misdirect the issue by focusing on whether the physical measures that Perpetua proposes to use to control public access, such as a manned access and warning signs, are adequate to control public access

under EPA's policy on ambient air. *See* DEQ at 11-12; PRI at 23-26; REC 3392. To be sure, they could be, if they were used to actually physically "preclude" the public from access.[3]

But what Perpetua's and DEQ's briefs and the Hearing Officer's order fail to address is DEQ and Perpetua's legal sleight of hand which strips the public of its status as the public–and thus ambient air protections–with a single signature on a "waiver" that requires the public to agree to be "guests of the mine" despite the fact that they were never invited to be a guest of the mine, and have no intentions of visiting the mine. *See* PRI at 24; DEQ at 12.

Neither Perpetua nor DEQ claim that the Clean Air Act allows the public to waive its right to ambient air protections in this way. And that would be inconsistent with both EPA's policy on ambient air and DEQ's guidance which distinguish those people that can be excluded from ambient air protections by virtue of their defined activity, but not the effectiveness of physical or non-physical barriers.

For example, EPA's policy states that the EPA

> recognize[s] that some persons that have both legal and practical access to the source's property are not necessarily considered as members of the general public, such as employees or the owner or operator who work at the site, or "business invitees," such as contractors or delivery persons.

REC 1142. These classes of people may not require ambient air protections because they are at the facility for the purpose of the facility–to work at the facility, to provide services to the

[3] *See, e.g.*, PRI at 24 (discussing manned gates, physical barriers, posting signs, etc.). Perpetua relies on an unofficial statement from Jay McAlpine, Regional Modeling Contact at EPA, that provides an opinion as to whether the Route is not ambient air, but clearly qualifies his statement with "we need to confirm th[is] with the policy division." PRI at 24; REC 1350. A year and a half later, McAlpine provided a similar opinion regarding the Route, but still "[could]not provide an approval." REC 1496. And yet, despite these questions from DEQ staff, the EPA, and Petitioners on whether exclusion of the Route from ambient air protections is consistent with EPA's policy, DEQ never submitted the question for EPA's review. REC 1038.

facility; the public traveling over the Route is not there for the purpose of the facility, and so under this policy, should be afforded ambient air protections.

Similarly, DEQ's guidance states,

> The facility-proposed ambient air boundary must include justification that demonstrates the facility has reasonable control of the area and effectively *precludes public access on a routine basis*. * * * *For the purpose of defining ambient air, the "general public" is considered anyone not directly associated with the facility. In general, if someone present at the site would be subject to [the Occupational Safety and Health Administration], then they are considered as the general public.*

REC 743 (emphasis added). DEQ and Perpetua can't credibly claim that persons traveling over the Stibnite Road Access Route–who may not even be aware that they would be passing through an active mine site–to access public lands are "directly associated with the facility" or are subject to the federal Occupational Safety and Health Administration's jurisdiction.

DEQ's and Perpetua's plan to strip the public from ambient air protections by calling them "guests of the mine" is disingenuous at best. It is not consistent with EPA's ambient air policy, DEQ's guidance, or the Idaho Air Rules that adopt the federal regulatory definition of ambient air. The Board should reject DEQ and Perpetua's

II. BY DEFERRING PERMIT DETAILS TO BE DETERMINED LATER, OUTSIDE THE PTC PROCESS AND WITHOUT PUBLIC COMMENT, DEQ VIOLATED THE AIR RULES AND THE CAA.

Under the Permit, Perpetua is allowed to submit the following plans in the future: the Fugitive Dust Control Plan ("FDCP"); the Haul Road Capping Plan ("HRCP"); the Operation and Maintenance Manual ("O&M"); and the Stibnite Road Access Management Plan ("AMP"). *See* REC 0375–76, 0378–80, 0385–86 (Permit conditions). The FDCP, HRCP, and AMP will include numerous Project details, some of which significantly affect PM_{10} and arsenic emissions, as well as the public's access and exposure to emissions. *See id.* Yet, because DEQ already

issued the Permit, DEQ will review the plans behind closed doors and outside of the PTC permitting process set forth in the Air Rules. As explained in Petitioners' Opening Brief (pp. 25-34) and further explained below, this violates the Air Rules Section 202 requirements for what information must be included in a PTC application, and it violates the Section 209 public comment requirements.

A. Violations of Air Rule Section 202 Requirements for What Must Be Included in an Application.

DEQ's deferral of the plans violates Section 202 requirements for what must be included in a PTC application. "Required Information" that the applicant must provide includes: "Site information, plans, descriptions, specifications, and drawings showing the design of the . . . facility, . . . the nature and amount of emissions . . . , and the manner in which it will be operated and controlled." Air Rules Section 202.01.a.i (emphasis added). Additionally, a PTC application "must . . . be accompanied by all information necessary to perform any analysis or make any determination required under Sections 200 through 227," which includes the requirement to determine whether the facility will cause or contribute to a violation of the NAAQS. Air Rules Section 202.

Here, the FDCP, HRCP, O&M Manual, and AMP are themselves and/or will include "plans," "information," "descriptions," and "specifications" required to be in an application under Section 202.01.a.i. They will also include "information necessary" under Section 202 for DEQ to analyze and determine compliance with the PM_{10} NAAQS. DEQ and Perpetua argue that because DEQ has allowed some plans for some other projects to be deferred like this in the past, it was fine to defer all of these plans here. While it may be appropriate under the Air Rules for some project to allow some of plans and project details to be submitted later after the project has

already been approved, it runs afoul of Air Rules Section 202 to defer plans that include "information necessary" for DEQ to analyze and determine compliance with Sections 200 through 227. Here, DEQ has impermissibly allowed important project details including "information necessary" under Section 202 for DEQ to determine compliance with the NAAQS, as explained below.

1. Fugitive Dust Control Plan

Under Permit Condition 2.6, Perpetua is required to prepare a Fugitive Dust Control *Plan*. REC 0375-76. The FDCP is a "plan" under Section 202.01.a.i because it includes details related to the nature and amount of the SGP's fugitive dust emissions, and the manner in which Perpetua will operate the mine and control fugitive dust. Among other Permit requirements of the FDCP, Perpetua is required to develop "specific criteria to determine what frequency and type (water and/or chemical) of dust suppressant must be applied, and appropriate suppressant application rates". REC 0376. The frequency, type, and rate at which Perpetua will apply dust suppressants are "information," "descriptions," and/or "specifications" on the manner in which the facility will be operated and how Perpetua will control fugitive dust under Section 202.01.a.i and, therefore, must be included in the PTC application--not developed after the PTC has already been approved.

The FDCP also includes the type of "information necessary" under Section 202 for DEQ to analyze and determine whether the Project complies with the PM_{10} NAAQS and, therefore, this information must be in the PTC application. Project PM_{10} emissions come mostly from haul roads, and applying dust suppressants is the primary way Perpetua plans to achieve 93.3% dust control on the roads. Achieving only slightly less than the targeted 93.3% dust control will

violate the hourly PM_{10} NAAQS, as was found in the modeling supporting the Permit Statement of Basis. *See* REC 0691–92. The frequency, type, and application rates of dust suppressants Perpetua will use is information which is critical to understanding how and whether the SGP will comply with the PM_{10} NAAQS. Thus, this is the type of "necessary information" under Section 202 which should have been considered as part of the application, when DEQ had to make its determination that the Project would not violate the NAAQS. Deferring these critical project details to later violates the Air Rules.

2. Haul Road Capping Plan

Under Permit Condition 3.13, Perpetua is required to prepare, submit, and follow a Haul Road Control *Plan*. REC 0385-86. The HRCP is a "plan" under Section 202.01.a.i because it is a plan related to the nature and amount of the mine's fugitive dust emissions, and the manner in which Perpetua will operate the mine and prevent dust emissions by capping some Project roads. Among other conditions in the Permit, the HRCP is required to include: a silt content sampling plan (including standard procedures for sampling, sampling frequency, and sampling analysis method); a sampling plan for low-arsenic quartzite rock; and specifications for how frequently haul roads will be inspected and maintained. REC 0386.

These required plans and specifications within the HRCP are "information," "plans," "descriptions," and/or "specifications" on the manner in which the facility will be operated and how Perpetua will prevent fugitive dust required to be in the application under Section 202.01.a.i, not deferred to later. Furthermore, these plans and other information which will be in the HRCP include "information necessary" under Section 202 for DEQ to analyze and determine

whether the Project will achieve the PM_{10} NAAQS. Therefore, these plans and information must be included in the PTC application—not developed after the PTC is already approved.

3. Operation & Maintenance Manual

Petitioners are willing to concede for purposes of this Petition for Review that the O&M Manual required at Permit Condition 2.20 is the type of plan DEQ might reasonably allow Perpetua to submit later. Permit Condition 2.20 provides: "The O&M manual shall be a permittee-developed document based upon, but independent from, manufacturer-supplied operating manuals." REC 0378. The requirements of the O&M Manual relate primarily to the operation, maintenance, and monitoring for specific control equipment, and none of which bear meaningfully on DEQ's determination and analysis that the Project will satisfy ambient PM10 and arsenic limits. *See* REC 0378-79. By contrast, and as already stated above, parts of the FDCP and HRCP will include plans, descriptions, specifications, and other information and details regarding how Perpetua will control fugitive dust emissions, details which are not yet determined, which do not depend on manufacturer specifications, and which are critical to analyzing and determining compliance with the PM_{10} NAAQS.

4. Access Management Plan

Under Permit Condition 2.7, Perpetua is required to prepare, submit, and follow an Access Management *Plan*. REC 0376. In the AMP, Perpetua is required to "identif[y] the facility boundary and all primary and secondary access points, and clearly specif[y] measures used to discourage public access to the facility." *Id.* Moreover: "*Plans* shall be described in the AMP, including identifying the access points monitored, the frequency of patrol, and measures employed to discourage access." *Id.* (emphasis added). The AMP itself is a "plan," and the

contents of the AMP are "information," "plans," "descriptions," and "specifications" of the facility and of the manner in which it will be operated and controlled regarding access, making them "required information" under Section 202.01.a.i. Moreover, these details in the AMP are "information necessary" for DEQ's analysis and determination as to what the proper ambient air boundary is for the SGP, making them required information under Section 202.

In summary, while it might be appropriate for DEQ to allow some types of information to be submitted later (such as things like the specifications related to purchased equipment called for in the O&M Manual), DEQ went too far here when it allowed important project details concerning the nature of the facility, its operations, its dust control measures, its ability comply with the NAAQS, and its ambient air boundary to be developed and submitted by Perpetua later. The Board should remand the Permit, and direct DEQ to require Perpetua to prepare and submit the FDCP, HRCP, and AMP first, and for DEQ to factor each plan into its analyses and determinations as to whether the Project satisfies the requirements of the Air Rules.

B. Violations of Section 209 Public Comment Requirements.

DEQ's deferral of the FDCP, HRCP, and AMP separately but relatedly violates the Air Rules Section 209 public comment requirement. Not only do the Air Rules require public comment, but they require that during public comment, the "Department's proposed action, together with the information submitted by the applicant and the Department's analysis of the information, *will* be made available to the public . . . ." Air Rules Section 209.01.c.i. (emphasis added). The FDCP, HRCP, and AMP will include "information submitted by the applicant" under 209.01.c.i. And when DEQ reviews each plan (as the Permit requires it to do), DEQ will perform an "analysis of that information" under 209.01.c.i. But the public comment periods already occurred, and the information Perpetua will submit in these plans, and DEQ's analysis of that

information, will happen in the future, without public comment. This violates the plain language of the public comment provisions at Section 209.01.c.

The Clean Water Act ("CWA") cases Petitioners presented in their Opening Brief support this. Pet'rs' Opening Br., pp. 31-32. Perpetua and DEQ try to distinguish these cases on the grounds that those cases concerned rulemakings for specific types of CWA permits instead of CAA permits. But neither DEQ nor Perpetua points to any cases or other authorities to offer any principled basis for determining what types of project information need to be subjected to public comment as part of pollution permitting versus which project information can be appropriately withheld from the public. These CWA cases are instructive and highly persuasive on this point.

In *Environmental Defense Center v. U.S. EPA*, 344 F.3d 832, 856 (9th Cir. 2003), the Ninth Circuit considered whether Notices of Intent ("NOI") prepared by applicants seeking coverage under the CWA's general permit option were required to be subject to EPA review and to public comment. The Ninth Circuit held that because the NOI at issue "establishes what the discharger will do to reduce discharges to the 'maximum extent practicable,' the [] NOI crosses the threshold from being an item of procedural correspondence to being a substantive component of a regulatory regime" and require EPA review. *Id.* at 853. The Ninth Circuit also held that because "the NOIs . . . contain the substantive information about how the operator . . . will reduce discharges to the maximum extent practicable", the NOIs are subject to the CWA's public availability and public hearing requirements. *Id.* at 857.

Similarly here, the FDCP, HRCP, and AMP are more than mere procedural correspondence between Perpetua and DEQ. Each plan will include critical details as to how Perpetua will control emissions in order to comply with the "substantive components" of the Air

Rules. Again, the FDCP will set the criteria for determining types, frequencies, and application rates of dust suppressants necessary to achieving 93.3% dust control, as is necessary for the Project to comply with the PM10 NAAQS. Again, the HRCP will include sub-plans with numerous details as to how Perpetua will cap roads to reduce fugitive emissions. And again, the AMP will include details as to how Perpetua will exclude the public and maintain its ambient air boundary. Moreover, the details specified in the FDCP, HRCP, and AMP will "be incorporated by reference" into the Permit and will become"enforceable permit conditions." *See* REC 0375 (FDCP), 0376 (AMP), 0386 (HRCP). These plans include the type of substantive information, plus enforceable permit limits, for how Perpetua will control emissions to required levels that should be subject to the Air Rule Section 209 public comment requirements.

The FDCP, HRCP, and AMP are also similar to the Nutrient Management Plans ("NMP") at issue in *Waterkeeper Alliance, Inc. v. EPA*, 399 F.3d 486 (2d Cir. 2005). There, the Second Circuit recognized that CWA permitting schemes that do not allow for public review of best management practices set forth in NMPs, where those NMPs are then incorporated into permits, violate the CWA. *Id.* at 503-504. The Second Circuit noted that the NMPs are "a critical indispensable feature of" the plan to regulate the pollution discharges from the type of facilities at issue. *Id.* at 504. The Second Circuit explained that a permit that relies on best management practices in an NMP but does not specifically list those best management practices in the permit itself "deprives the public of the opportunity for the sort of regulatory participation that the Act guarantees because [such a permit] effectively shields the . . . management plans from public scrutiny and comment." *Id*. at 503.

Here, like the NMPs in *Waterkeeper*, the FDCP, HRCP, and AMP are critical and indispensable features of the Permit. For example, DEQ modeling staff stating "it is *critical* for NAAQS compliance that this high level of control [(93.3% dust control)] be achieved." REC 0641 (emphasis added); *see also* REC 0691 (same). Yet, the FDCP is where Perpetua will select the types, rates, and frequencies for which it will try to achieve 93.3% dust control. And here, like the EPA in *Waterkeeper*, DEQ has shielded the FDCP, HRCP, and AMP from public scrutiny and comment and has deprived the public of the sort of regulatory participation the Air Rules Section 209 guarantees.

Perpetua cites *Train v. NRDC*, 421 U.S. 60, 79 (1975) for the proposition that "CAA jurisprudence affords broad discretion to states to develop permit conditions." Perpetua Opp'n at 31. Petitioners do not dispute that DEQ has broad discretion to develop permit conditions. The problem here is that DEQ has *not* developed a number of important permit conditions yet and is letting Perpetua develop them later, outside of the Air Rules PTC process, and without public inolvement. Thus, *Train*, *Environmental Defense Center*, and *Waterkeeper* all underscore that DEQ's use of work plans here to leave numerous details and conditions to be decided later, outside the PTC permitting and public comment processes, violates the Air Rules Section 209.01 public participating requirements.

The Board should remand the Permit, and order that the FDCP, HRCP, and AMP must be subject to public comment before DEQ can issue any permit.

III. DEQ HAD NO REASONABLE BASIS TO CONCLUDE PERPETUA WILL ACHIEVE 93.3% DUST CONTROL AS OPPOSED TO SOME OTHER HIGH BUT INSUFFICIENT LEVEL, SUCH AS 90%.

Under the Air Rules, DEQ cannot issue a PTC unless it determines that the facility "would not cause or significantly contribute to a violation of any ambient air quality standards"

(i.e., the NAAQS). Air Rules Section 203. A critical factor affecting the SGP's fugitive dust emissions, and therefore whether DEQ can make the required determinations under Air Rules Section 203 that the Project will comply with the PM_{10} NAAQS, is the degree to which Perpetua will effectively control dust from haul roads.[4]

There is no dispute that 93.3% is a very high and aggressive level of dust control, and no dispute that achieving 93.3% is critical to meeting the PM_{10} NAAQS. Among other examples in the record, DEQ modeling staff stated "it is *critical* for NAAQS compliance that this high level of control [(93.3% dust control)] be achieved." REC 0641 (emphasis added); *see also* REC 0691 (same); REC 0921 (EPA saying the same). Nor is there any dispute that if Perpetua fails to achieve this high level control, even by just a little bit, then it will cause exceedances of the PM_{10} NAAQs. For example, Perpetua's and DEQ's modeling showed that if Perpetua cut its operations by a third (hauling just 120,000 tons per day instead of the authorized 180,000 tons per day) yet achieved only 90% dust control, this slightly lower dust control—even when combined with a major cut in mining activity—would cause exceedances of the PM_{10} NAAQS. REC 0691–92.

At this stage in the proceedings, Petitioners do not challenge DEQ's determination that 93.3% dust control could technically be possible. Rather, Petitioners challenge DEQ's determination that this Project, based on the terms and conditions in the Permit, will actually achieve 93.3% and thus comply with the NAAQS, as opposed to achieving some slightly lesser control, such as 90%, which would violate the NAAQS. Thus, even removing the "conservative" (as DEQ and Perpetua put it) ways the modeling was conducted (by assuming higher activity

[4] There are other sources of fugitive dust emissions at the facility, including "drilling and blasting activities, crushing and ore handling equipment, ore and rock storage piles, and unpaved roadways." REC 0430. However, fugitive dust emission from unpaved roadways represents a majority of the estimated PM10 (and arsenic) emissions from the facility. REC 0427, 0429 (Table 3).

than Perpetua and DEQ says is likely to occur), if Perpetua underperforms just slightly on dust control, it will violate the NAAQS.

First, the Permit does not include an enforceable condition to achieve 93.3% dust control. Perpetua appears to acknowledge this reality in its Brief. But in its Brief, DEQ claims otherwise, pointing to a table in the permit that has "93.3%" in it to argue that this is an enforceable permit limit. In fact, there are two such tables in the Permit. But neither of these tables includes enforceable permit conditions. Table 1.1 merely "lists all sources of regulated emissions in this permit" and describes the "Control Equipment" for each regulated emission source. REC 0369. Similarly, Table 3.1 "contains a description of control equipment used to control emissions from mining and ore processing activities." REC 0384. "Excavating and hauling activities" are listed in both tables as an emission source whose "Control Equipment" includes chemical and water sprays with a control efficiency of "93.3%" for haul roads. *Id.* These tables merely list the 93.3% *target or goal* for haul road fugitive dust control, they do not list enforceable permit conditions.

Even if this 93.3% dust control goal was a permit limit or condition, it is not enforceable. Perpetua is not required to prove, by testing or monitoring, the actual percent dust control it achieves once operations are underway. Perpetua is not required to monitor ambient air to ensure the SGP complies with the NAAQS. Under the terms of the Permit, there is no way DEQ will ever know whether Perpetua actually achieves 93.3% dust control and whether it violates the NAAQS. And there is, thus, no way for DEQ to try to enforce any supposed 93.3% limit (which doesn't exist anyway).

To DEQ's credit, the Permit does include a number of enforceable terms and conditions related to dust control. These include terms and conditions that will be included in the

forthcoming FDCP and HRCP, and other conditions, which generally require Perpetua to develop various plans, require following a variety of best practices, and require corresponding monitoring to ensure that those plans and best practices are indeed followed. These terms and conditions are all well and good, for what they are worth. But none of these terms and conditions have any bearing on whether the Project will achieve 93.3% dust control as opposed to, say, 90% (or even less) dust control.

It might be within DEQ's technical expertise to conclude that the dust control conditions in the Permit are adequate to ensure a high level of dust control for the SGP. But the finding that Perpetua will achieve a whopping 93.3% dust control and not, say, 90% (which is still very high, but is not sufficient to meet the NAAQS) is entirely speculative and untethered from any enforceable conditions in the Permit. Again, the Permit does not require testing or monitoring the actual dust control achieved, nor does it require any ambient air boundary monitoring to ensure the NAAQS are being met. Under the Air Rules, DEQ has authority under Section 211 to require any reasonable conditions in the Permit, and authority under Section 211.01(d) specifically to require ambient air boundary monitoring. Had DEQ exercised either or both of these authorities here to require dust control testing or monitoring, or to require ambient air boundary monitoring, then it could ensure the "high" and "aggressive" 93.3% will be achieved. But DEQ did not.

As a result, Perpetua could submit the plans as called for in the Permit, DEQ could approve those plans, Perpetua could operate and follow the plans and all other permit conditions to a tee, and Perpetua could achieve a high level of dust control; yet, that high level of dust control might be only, say, 90%, meaning the SGP would cause NAAQS violations over the next 16 years. If this happens, neither DEQ, Perpetua, nor the public will ever know. Perpetua will be

in compliance with the Permit. And there will be no way to take any enforcement action against Perpetua to bring its dust control up to the necessary 93.3%.

For these reasons, DEQ lacked a reasonable basis for concluding that the SGP will not cause or contribute to an exceedance of the NAAQS. The Board should, thus, set aside and remand the Permit and order DEQ not to approve the Permit unless DEQ imposes enforceable monitoring and/or testing to ensure 93.3% control is achieved, or otherwise limits or alters Perpetua's mining or emissions controls so that it will comply with the PM_{10} NAAQS.

IV. THE "PROJECT SPECIFIC ADJUSTMENT" DEQ GRANTED PERPETUA VIOLATES THE AIR RULES, AND THREATENS PUBLIC HEALTH.

Deference to agency expertise cannot overcome an attempt at a regulatory overhaul allowing project-specific adjustments, methods never before used for any other permit application in DEQ's history, REC 1201, and not found in the Air Rules. As Petitioners explained in the Opening Brief (pages 40-47), DEQ must follow the Air Rules as written, and cannot deviate from those rules, as it did here when it granted Perpetua a "project specific adjustment factor." Under the Air Rules, "no permit to construct shall be granted" unless DEQ determines that the applicant has shown: "Using the methods provided in Section 210, the emissions of toxic air pollutants from the . . . source . . . would not injure or unreasonably affect human health or animal life or vegetation as required by Section 161." Air Rules Section 203.03 (emphasis added). Section 210 does not allow for project specific adjustment factors like DEQ used here to artificially dilute the amount of arsenic it actually modeled to result from the project annually by spreading it out by 16/70s (the life of the mine, divided by the average human lifetime). Perpetua's and DEQ's opposition briefs provide no convincing evidence or argument that such a project-specific adjustment is "envisioned by the Air Rules," "authorized" under the

Air Rules, or "well within DEQ's discretion" to use, or squared with DEQ's "mission to protect public health and the environment." PRI at 43; DEQ at 32. For that reason, the Board must thus grant Petitioners' Amended Petition, reverse the Hearing Officer's order, vacate the permit, and remand to DEQ for further consideration.

DEQ and Perpetua argue that this project specific adjustment factor is warranted here because the Air Rules, they argue, are designed for facilities that have an "indefinite or unknown operational life" which could emit pollutants over a 70-year human life, and because, they also argue, this a unique situation where the mine's operational life is known and is shorter than 70 years. *See* PRI at 43-44. This is wrong. There is nothing novel about a short-term source, and the Air Rules explicitly address short-term sources in Section 210.

The Air Rules define short-term source as "[a]ny new stationary source . . . with an operational life no greater than five (5) years from the inception of any operations to the cessation of actual operations." Air Rules 007.08. Under Section 210.15, such short-term sources may utilize a short-term adjustment factor of ten times to demonstrate compliance with the acceptable ambient concentrations of arsenic. Thus, the methods in Section 210 specifically address short term sources. DEQ and Perpetua, however, apparently disagree with the way DEQ previously (when it adopted the Air Rules) chose to define short-term sources. But again, DEQ is not free to deviate from the rules or to rewrite them by redefining what qualifies as a short-term source. DEQ must follow the methods in Section 210.

Perpetua also argues that the use of the word "equivalent" in Section 210.12 somehow gives DEQ wiggle room to grant Perpetua a project-specific adjustment factor. But it does not. By way of background, in addition to allowing a 10 times leniency for short-term sources that

are five or less years (Section 210.15), the Air Rules also allow a 10 times leniency for sources that demonstrate "T-RACT" (Section 210.12). The T-RACT rules explain how to determine whether a source like Perpetua's which has been granted T-RACT complies with the TAPs requirements:

> Compare the source's . . . approved T-RACT ambient concentration at the point of compliance for the toxic air pollutant to the amount of the toxic air pollutant that would contribute an ambient air cancer risk probability of less than one to one hundred thousand (1:100,000) (which amount is equivalent to ten (10) times the applicable acceptable ambient concentration listed in Section 586).

Air Rules, 210.12.b (emphases added).

Here, DEQ granted Perpetua's T-RACT, but when it compared the SGP's annual average ambient arsenic concentrations to 10 times the annual acceptable ambient concentration for arsenic listed in Section 586 (as 210.12.b instructs DEQ to do), DEQ and Perpetua determined that the SGP would exceed that value. *See* Pet'rs' Opening Br. pp. 41-42. This is when DEQ made up the "project specific adjustment factor." This never-before-used tactic artificially reduces the apparent concentration of arsenic to a mere 23% (16/70 x 100) of what the arsenic concentration will actually be (based on Perpetua and DEQ's modeling) each year during the Project.

Perpetua argues that where Section 210.12.b directs DEQ to compare the ambient arsenic concentration to the "equivalent" of 10 times the value listed in Section 586, that use of the term "equivalent" instead of "equal" gives DEQ the option to compare the SGP's arsenic concentrations to something else. The plain reading of 201.12.b is clear: compare the ambient arsenic concentrations for Perpetua's project to 10 times the acceptable ambient arsenic concentration in Section 586. The idea that the use of term "equivalent" creates an ambiguity that

allows DEQ to grant even more than a 10 times leniency to Perpetua is absurd. By being granted T-RACT, Perpetua was already given a large leniency: 10 times the arsenic concentrations that would otherwise be allowable. T-RACT does not allow additional leniency beyond that.

Ultimately, DEQ's use of the project specific adjustment factor here was not made "[u]sing the methods provided in Section 210;" yet that it was Section 203.03 requires DEQ to do. Using the methods in Section 210, including granting Perpetua's T-RACT demonstration, the SGP was modeled to cause ambient arsenic concentrations that exceed 10 times the acceptable arsenic value in Section 586. *See* Pet'rs' Opening Br. pp. 41-42. To get around this problem, instead of limiting the SGP's throughput, or imposing other conditions to reduce arsenic emissions, DEQ made up a new approach that deviates from the specific numeric methods set forth in Section 210.

Additionally, DEQ argues that arsenic emissions won't be that high because it used the worst-case scenario: the permit bases emissions on "total ore production" which "is <u>over fifty percent greater</u> than the actual potential mine production." DEQ at 30 (emphasis in original). But DEQ cannot reasonably base its decision that arsenic emissions will not exceed the AAAC (or adjusted AAAC) based on emissions calculations it did not perform and certainly against the mandate that agency's make decisions based on substantial evidence in the record and not in an arbitrary and capricious manner. Furthermore, any limitations to ore production limits that are placed in the permit are based on the modeling. If DEQ is going to rationalize that arsenic emissions won't exceed the adjusted AAAC because production won't be as high as was modeled, it needs to put those production limits as enforceable limitations in the permit. There is no indication that it has done that. *See* DEQ at 30-31.

In summary, DEQ failed to follow its own rules. Agencies are not afforded deference to deviate from the plain language of their rules. What is more concerning is the precedent that will be set for future projects in Idaho if this Board sanctions DEQ's deviation from the Idaho Air Rules by the use of project-specific methods, procedures, and adjustments, shielded from review in the name of agency deference. The Board therefore must set aside the permit, and remand to DEQ to ensure the Project complies with the Air Rules' arsenic protections.

CONCLUSION

For the foregoing reasons, Petitioners request that the Board issue an order reversing the Office of Administrative Hearing's preliminary order, vacating or setting aside the Permit, and remanding it back to DEQ for further consideration.

Dated: February 14, 2024

Respectfully submitted,

/s/ Bryan Hurlbutt
Bryan Hurlbutt
Attorney for the Nez Perce Tribe and the Idaho Conservation League

/s/ Julia Thrower
Julia S. Thrower
Attorney for Save the South Fork Salmon

CERTIFICATE OF SERVICE

I hereby certify that on February 14, 2024, a true and correct copy of Petitioners' Reply Brief in Support of Amended Petition for Review of Preliminary Order was served on the following:

By electronic service:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov

Dylan B. Lawrence
Varin Thomas, LLC
242 N. 8th St., Suite 220
Boise, ID 83702
(208) 345-6021
dylan@varinthomas.com
Hearing Officer

Krista McIntyre
W. Christopher Pooser
Wade Foster
Stoel Rives, LLP
101 S. Capital Blvd., Suite 1900
Boise, ID 83702
(208) 389-9000
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
Attorneys for Intervenor Perpetua Resources of Idaho, Inc.

Paula J. Wilson, Paralegal
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, Idaho 83706
paula.wilson@deq.idaho.gov

Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, ID 83706
(208) 373-0422
hannah.young@deq.idaho.gov
Attorney for Respondent Idaho Department of Environmental Quality

Ann Yribar
Deputy Attorney General
Office of the Attorney General
P.O Box 83720
Boise, ID 83720-0010
ann.yribar@ag.idaho.gov
Attorney for the Idaho Board of Environmental Quality

/s/ Julia Thrower
Julia Thrower

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	Agency Case No. 0101-22-01
	)	OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON	)	**PETITIONERS' OPPOSITION TO DEQ AND PERPETUA'S JOINT MOTION TO SUPPLEMENT RECORD WITH DEQ RESPONSE TO EPA LETTER**
Petitioners,	)	
v.	)	
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC.	)	
Intervenor-Respondent.	)	

Petitioners Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon submit this brief in opposition to Respondent Idaho Department of Environmental Quality ("DEQ") and Respondent-Interventor Perpetua Idaho Resources, Inc. ("Perpetua") Joint Motion to Supplement Record with the DEQ's Response to the August 10, 2023 EPA Region 10 Letter to Idaho DEQ ("Mtn. to Suppl.").

ARGUMENT

Although the Board may take evidence "to assist the parties' development of the record," the Board "may exclude evidence that is irrelevant [or] unduly repetitious." IDAPA 40.11.01.600. Here, neither DEQ nor Perpetua cite the November 22, 2023 DEQ Letter to Mr. Casey Sixkiller, EPA Regional Administrator for Region 10 ("DEQ Response Letter") in their briefs before this Board; DEQ and Perpetua also claim that the DEQ Response Letter only "includes factual information or data that is already within the existing record." Mtn. to Suppl. at 5. The letter, thus, lacks probative value and provides nothing but repetitious information that is already available in the extensive administrative record submitted by Petitioners, DEQ, and Perpetua through the petition process in front of the Office of Administrative Hearings that includes:

- A 505-page Statement of Basis that provides DEQ's rationale for approving the Permit, REC 410-914;
- An 86-page Response to Comments that provides DEQ's response specific to Petitioners' concerns raised in their comment letters, REC 915-1000;
- Over 2,000 pages of documents that were before DEQ in making its decision and are part of the agency record in this case; and
- An additional, post-decisional declaration submitted by DEQ further rationalizing its decision to approve the Permit during briefing in front of the Office of Administrative Hearings. REC 1233-55.

The DEQ Response Letter should thus not be admitted into the record for that reason alone.

What is more, instead of ensuring fairness and completeness, supplementing the record with DEQ's Response Letter risks unfairness, incompleteness, and prejudices Petitioners by introducing the agency's post-hoc justification for approving the Permit, shielded from public scrutiny. *See* Mtn. to Suppl. at 4, 5.

The final Permit was approved on June 17, 2022, and DEQ's decision to approve the Permit based on the information before DEQ from Perpetua, Petitioners, and other commenters during the three-year long public process. REC 367; Pet'rs' Opening Br. at 5-6 (references cited therein). Between that date DEQ issued the Permit and the date of the DEQ Response Letter–about 18 months–the following occurred: DEQ received a letter from EPA regarding its concerns about the Permit approval; DEQ and EPA had two meetings in October 2023, to discuss EPA's concerns; and DEQ wrote a response letter which it submitted to EPA on November 22, 2023, which provides EPA with DEQ's justification for approval of the Permit. Mtn. to Suppl., Decl. of Tiffany Flody ¶ ¶ 3-5. The DEQ Response Letter contains post-hoc rationalizations of DEQ's year-and-a-half old decision.

Moreover, these rationalizations were made behind closed doors and were not part of the public comment periods for the Permit, depriving the public of the opportunity to comment that is granted under the Air Rules.

Finally, admitting the DEQ Response Letter would be unfair and incomplete because this is just a single document post-dating the issuance of the Permit. There may be other new data, communications, meeting notes, and other information that may be probative of the rationale (or lack thereof) for the justifications in the DEQ Response Letter have not been submitted or

offered as part of the agency record in this case.Without opening this contested case up to further discovery on this issue, allowing supplementation of the record with the DEQ Response Letter alone is not fair, creates an incomplete agency record, is prejudicial to Petitioners' case, and undermines the Board's review.

CONCLUSION

Supplementation of the record with the DEQ Response Letter, even with DEQ and Perpetua's suggested limitations on its consideration, does not alleviate either concern that the letter is "unduly repetitive" or risks consideration of evidence without the underlying agency record that purportedly supports the statement in the letter. Hence, the Board should deny DEQ and Perpetua's motion to supplement the record.

Dated: February 21, 2024

Respectfully submitted,

/s/ Julia Thrower
Julia S. Thrower
Attorney for Save the South Fork Salmon

/s/ Bryan Hurlbutt
Bryan Hurlbutt
Attorney for the Nez Perce Tribe and the Idaho Conservation League

CERTIFICATE OF SERVICE

I hereby certify that on February 21, 2024, a true and correct copy of **Petitioners' Opposition to Joint Motion to Supplement Record with DEQ Response to EPA Letter** was served on the following:

By electronic service:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov

Dylan B. Lawrence
Varin Thomas, LLC
242 N. 8th St., Suite 220
Boise, ID 83702
(208) 345-6021
dylan@varinthomas.com
Hearing Officer

Krista McIntyre
W. Christopher Pooser
Wade Foster
Stoel Rives, LLP
101 S. Capital Blvd., Suite 1900
Boise, ID 83702
(208) 389-9000
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
Attorneys for Intervenor Perpetua Resources of Idaho, Inc.

Paula J. Wilson, Paralegal
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, Idaho 83706
paula.wilson@deq.idaho.gov

Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, ID 83706
(208) 373-0422
hannah.young@deq.idaho.gov
Attorney for Respondent Idaho Department of Environmental Quality

Ann Yribar
Deputy Attorney General
Office of the Attorney General
P.O Box 83720
Boise, ID 83720-0010
ann.yribar@ag.idaho.gov
Attorney for the Idaho Board of Environmental Quality

/s/ *Julia Thrower*
Julia S. Thrower

RAÚL R. LABRADOR
Attorney General

SCOTT L. CAMPBELL
Deputy Attorney General
Chief, Energy and Natural Resources Division

Hannah M.C. Young, ISB No. 9781
hannah.young@deq.idaho.gov
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: 208.373.0453

Attorney for Respondent

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047

NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,

Petitioners,

v.

IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,

Respondent,

and

PERPETUA RESOURCES IDAHO, INC.,

Intervenor-Respondent.

Case Docket No. 0101-22-01
OAH Case No. 23-245-01

JOINT MOTION TO SUPPLEMENT RECORD WITH MARCH 12, 2024 EPA LETTER

Respondent Idaho Department of Environmental Quality ("DEQ") and Intervenor-Respondent Perpetua Resources Idaho, Inc. ("Perpetua") jointly move to supplement the administrative record with a letter dated March 12, 2024, from the U.S. Environmental Protection Agency ("EPA") to DEQ's Director. EPA's March 12, 2024 letter responds to DEQ's response to EPA's August 10, 2023 letter to DEQ's Director. The history of EPA's August 10, 2023 letter, DEQ's response thereto, and the genesis of the March 12 EPA letter are described in DEQ and Perpetua's joint motion to supplement the record with DEQ's response. REC 3161. This motion is supported by the Declaration of Tiffany Floyd ("Floyd Decl.") and brought pursuant to Idaho Code § 67-5245(7) and IDAPA 04.11.01.600.

ARGUMENT

When reviewing a Preliminary Order, "[t]he head of the agency … for the review of preliminary orders shall exercise all of the decision-making power that he would have had if the agency head had presided over the hearing." Idaho Code § 67-5245(7). Thus, the Board has the authority to take evidence to assist in the development of the administrative record. *See* IDAPA 04.11.01.600; *see also* IDAPA 04.11.01.413 (allowing a hearing officer to accept evidence in the record), 606 (allowing the agency head to rule on objections to the admission of evidence).[1]

Supplementing the record before the Board to include EPA's March 12, 2024 letter is necessary to ensure fairness and the completeness of the record. DEQ and Perpetua have moved to supplement the record with DEQ's response to the August 10, 2023 EPA letter. REC 3161. The March 12, 2024 EPA letter refers to EPA's concerns raised in the August 10, 2023 EPA letter and acknowledges DEQ's work in support of critical assumptions in the Final Permit, technical justifications, and agency processes for the Final Permit. If the August 10, 2023 EPA

[1] The Board's contested case rules incorporate Section 413 and Sections 600-606 of IDAPA 04.11.01. *See* IDAPA 58.01.23.003.08., 13.

letter is relevant to these proceedings, then DEQ's response, and EPA's subsequent correspondence is equally relevant. It is only fair and equitable to supplement the administrative record with the March 12, 2024 EPA letter to ensure the record is complete and accurately reflects the resolution of the August 10, 2023 EPA letter. For those reasons, the Board should allow the admission of March 12, 2024 EPA letter under the same conditions the Hearing Officer allowed consideration of the August 10, 2023 EPA Letter. Just as the August 10, 2023 EPA letter cannot be used to add new allegations of error or factual information that was not already part of the record or "as a proxy for expert testimony from the Petitioners," neither can EPA's subsequent March 12, 2024 letter. *See* REC 3272.

Supplementing the record to include the March 12, 2024 EPA letter does not require additional hearings, further factual development, or remand to the Hearing Officer. Nor will the admission of March 12 2024 EPA letter prejudice Petitioners.

CONCLUSION

In sum, because Petitioners were allowed to supplement the record with the August 10, 2023 EPA letter, the Board should be aware of DEQ's thorough response, and EPA's subsequent communication concluding EPA's concerns. To ensure fairness and the completeness of the record, the Board should supplement the record with the March 12, 2024 EPA letter, subject to the same limitations the Hearing Officer admitted the August 10, 2023 EPA letter.

DATED: March 13, 2024.

DEPARTMENT OF ENVIRONMENTAL QUALITY

/s/ *Hannah M.C. Young*
Hannah M.C. Young
Deputy Attorney General

Attorney for Respondent

DATED: March 13, 2024.

STOEL RIVES LLP

/s/ *W. Christopher Pooser*
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Intervenor-Respondent Perpetua Resources Idaho, Inc.

CERTIFICATE OF SERVICE

I hereby certify that on March 13, 2024, a true and correct copy of the foregoing was served on the following:

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
Counsel for the Idaho
Board of Environmental Quality
ann.yribar@ag.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Paula J. Wilson, Paralegal
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, Idaho 83706
paula.wilson@deq.idaho.gov
via electronic service

Dylan B. Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

/s/ *DeAnne M. Chaffin*
DeAnne M. Chaffin
Legal Assistant

RAÚL R. LABRADOR
Attorney General

SCOTT L. CAMPBELL
Deputy Attorney General
Chief, Energy and Natural Resources Division

Hannah M.C. Young, ISB No. 9781
hannah.young@deq.idaho.gov
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: 208.373.0453

Attorney for Respondent

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047

NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,

Petitioners,

v.

IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,

Respondent,

and

PERPETUA RESOURCES IDAHO, INC.,

Intervenor-Respondent.

Case Docket No. 0101-22-01
OAH Case No. 23-245-01

DECLARATION OF TIFFANY FLOYD IN SUPPORT OF JOINT MOTION TO SUPPLEMENT RECORD WITH MARCH 12, 2024 EPA LETTER

I, TIFFANY FLOYD, hereby declare under penalty of perjury and pursuant to the law of the State of Idaho that the following is true and correct:

1. My name is Tiffany Floyd, and I am employed by the State of Idaho, Department of Environmental Quality (the "Department") as the Air Quality Division Administrator ("Air Administrator").

2. I have been working for the Department as the Air Administrator for 11 years.

3. On March 12, 2024, DEQ's Director received a letter from the United States Environmental Protection Agency ("EPA") Region 10 regarding Permit to Construct No. 2019.0047, an air quality preconstruction permit DEQ issued to Perpetua Resources Idaho, Inc. on June 17, 2022. A true and correct copy of the March 12, 2024 letter is attached hereto as **Appendix A.**

DATED: March 13, 2024.

Tiffany Floyd

CERTIFICATE OF SERVICE

I hereby certify that on March 13, 2024, a true and correct copy of the foregoing was served on the following:

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
Counsel for the Idaho
Board of Environmental Quality
ann.yribar@ag.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Paula J. Wilson, Paralegal
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, Idaho 83706
paula.wilson@deq.idaho.gov
via electronic service

Dylan B. Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

/s/ DeAnne M. Chaffin
DeAnne M. Chaffin
Legal Assistant

APPENDIX A

REGION 10 ADMINISTRATOR

SEATTLE, WA 98101

March 12, 2024

Mr. Jess Byrne
Director
Idaho Department of Environmental Quality
1410 North Hilton Street
Boise, Idaho 83706

Dear Mr. Byrne:

Thank you for your letter dated November 22, 2023, in response to my letter dated August 10, 2023, regarding the permit to construct issued to Perpetua Resources Idaho, Inc. With your letter, you included (1) a substantial amount of information and references supporting Idaho Department of Environmental Quality's choice of emission factors for the mining operation and lime manufacturing plant, (2) information and documentation supporting the achievable control efficiencies for fugitive dust control measures and (3) additional information about Perpetua's plans to restrict public access to the site. I appreciate the additional information and you and your staff's time in meeting with me last October.

The U.S. Environmental Protection Agency, Region 10's staff have reviewed and assessed the information you provided. Overall, we believe that this information provides a reasonable basis for IDEQ's emissions estimates for ore processing, lime processing and haul road emission units in the Stibnite Gold Project.

IDEQ's permit relies on permittee-developed plans to ensure the practical enforceability of critical emission limits. In this circumstance, it is particularly important to affirm the adequacy and practical enforceability of emission limits in the permit designed to limit the source's potential to emit to ensure that the National Ambient Air Quality Standards are not violated.

For example, the permit requires that the source submit a fugitive dust control plan for approval, and to operate in compliance with that plan. The permit incorporates the plan prospectively into the permit to make the elements of the plan enforceable. Although the permit outlines the types of measures that need to be addressed in the plan, the permit does not include language requiring that the control measures in the plan, along with the associated monitoring, recordkeeping and reporting needed to make them enforceable, achieve the level of control relied upon in the permitting record. While the EPA acknowledges IDEQ's intent to rigorously review each of these plans for adequacy, the permit language does not require that outcome. The EPA understands that not all details of an approvable plan can be known in advance, but without permit conditions requiring the source to demonstrate that the plans will achieve the required level of control, IDEQ may have limited ability to reject, or require improvements to, a plan that falls short.

With respect to the ambient air boundary designation, the EPA continues to have concerns with IDEQ's acceptance of Perpetua's assertion that members of the general public do not have a legal right of access to areas within the operations area boundary. Regarding the practical exclusion of the general public aspect of the ambient air boundary designation, the permit conditions outlining the requirements for the Access Management Plan, as well as the measures enumerated in the Statement of Basis, are generally consistent with the EPA's December 2, 2019, *Revised Policy on Exclusions from "Ambient Air."* However, the permit conditions may not adequately manage public use of the access road (i.e., where Perpetua is allowing access). The approved plan should include measures to maintain continuous monitoring of the public's movements while they are using the road to traverse the mine site.

The information that you submitted on November 22, 2023, along with the subsequent staff level conversations, have improved the EPA's understanding of the Permit. This information is the basis for emission estimation of critical processes at Perpetua Resources Idaho, Inc., and as support for certain critical assumptions underlying the permit, such as the high level of fugitive dust control. We encourage IDEQ to make this information available to the public. We also encourage the permittee-developed plans, as required by the permit for fugitive dust and access control, be made available to the public, after those are approved by IDEQ.

Moving forward, we expect that all information relied upon to issue permits by the State of Idaho's permitting program be made available for public review at the time that draft permits are made available for public comment.

Finally, as we previously discussed, I will continue to work with other federal agencies to determine whether any changes to the permit would be needed to address the Nez Perce Tribe's treaty rights. If you would like additional information, please feel free to contact me or have your staff contact Dr. Karl Pepple, Branch Manager, Air Permits and Toxics Branch, at (206) 553-1778 or pepple.karl@epa.gov.

Sincerely,

CASEY SIXKILLER Digitally signed by CASEY SIXKILLER Date: 2024.03.12 11:47:27 -07'00'

Casey Sixkiller
Regional Administrator

cc: Ms. Tiffany Floyd
Idaho Department of Environmental Quality

Chairman Shannon F. Wheeler
Nez Perce Tribe

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	Agency Case No. 0101-22-01 OAH Case No. 23-245-01 **NOTICE OF SPECIAL MEETING OF THE BOARD OF ENVIRONMENTAL QUALITY | APRIL 8, 2024**

NOTICE IS HEREBY GIVEN that the Board of Environmental Quality has scheduled a special meeting for the purpose of holding an executive session pursuant to Idaho Code § 74-206(1)(f) to communicate with legal counsel to discuss the ramifications of and legal options regarding this pending contested case. Because the Board will not take any action at this meeting, the parties are invited but not required to attend.

The special meeting will be held on April 8, 2024, at 11:00 a.m. Mountain Time in conference rooms A and B at the Department of Environmental Quality State Office, 1410 N. Hilton, Boise, Idaho, with a Microsoft Teams link available for remote attendance. The meeting location and Teams link are available in the Meeting Notice posted at https://www.deq.idaho.gov/board-of-environmental-quality/.

Dated this 22nd day of March, 2024.

/s/ Paula J. Wilson
Paula J. Wilson, Paralegal
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, Idaho 83706
paula.wilson@deq.idaho.gov

CERTIFICATION OF SERVICE

I HEREBY CERTIFY that on this 22nd day of March, 2024, the foregoing was filed, served, and copied as shown below.

Hannah Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
hannah.young@deq.idaho.gov

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
Counsel for the Idaho
Board of Environmental Quality
ann.yribar@ag.idaho.gov

Dylan Lawrence
Varin Thomas LLC
P.O. Box 1676
Boise, ID 83701
Hearing Officer
dylan@varinthomas.com

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-004
filings@oah.idaho.gov

/s/ Paula J. Wilson
Paula J. Wilson

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	Agency Case No. 0101-22-01 OAH Case No. 23-245-01 **NOTICE OF SPECIAL MEETING OF THE BOARD OF ENVIRONMENTAL QUALITY | MAY 1, 2024**

NOTICE IS HEREBY GIVEN that the Board of Environmental Quality has scheduled a special meeting to take action on the Amended Petition for Review of Preliminary Orders. The Board will discuss and adopt a final order prior to service of the written order within 56 days of the March 14, 2024, oral argument. Attendance by the parties is encouraged.

The special meeting will be held on May 1, 2024, at 9:00 a.m. Mountain Time in conference rooms A and B at the Department of Environmental Quality State Office, 1410 N. Hilton, Boise, Idaho, with a Microsoft Teams link available for remote attendance. The meeting location and Teams link are available in the Meeting Notice posted at https://www.deq.idaho.gov/board-of-environmental-quality/.

Dated this 22nd day of March, 2024.

/s/ Paula J. Wilson
Paula J. Wilson, Paralegal
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, Idaho 83706
paula.wilson@deq.idaho.gov

CERTIFICATION OF SERVICE

I HEREBY CERTIFY that on this 22nd day of March, 2024, the foregoing was filed, served, and copied as shown below.

Hannah Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
hannah.young@deq.idaho.gov

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
Counsel for the Idaho
Board of Environmental Quality
ann.yribar@ag.idaho.gov

Dylan Lawrence
Varin Thomas LLC
P.O. Box 1676
Boise, ID 83701
Hearing Officer
dylan@varinthomas.com

ARV, A Veritext Company
Court Reporting Service
calendar-arv@veritex.com

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-004
filings@oah.idaho.gov

/s/ Paula J. Wilson
Paula J. Wilson

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY

STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	Case Docket No. 010-22-01 OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOURTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondents, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	FINAL ORDER

I. INTRODUCTION

On July 22, 2022, the Nez Perce Tribe, the Idaho Conservation League, and Save the South Fork Salmon (collectively "Petitioners"), filed a *Petition to Initiate Contested Case: Air Quality Permit to Construct P-2019.0047 (Jun. 17, 2022)*, seeking review of the Idaho Department of Environmental Quality's ("DEQ") issuance on June 17, 2022 of Air Quality Permit to Construct P-2019.0047 ("PTC"), to mining company Perpetua Resources Idaho, Inc.

("Perpetua") for its proposed Stibnite Gold Project ("SGP"). REC 0001–0028. Perpetua filed a Petition to Intervene in the matter on August 12, 2022. REC 0040–0043. A Hearing Officer was appointed and the parties participated in discovery and ultimately filed cross-motions for summary judgement. REC 319–322, REC 1204–1206, REC 1276–1278. On October 31, 2023, the Hearing Officer issued a *Preliminary Order*. REC 3280–3328. On November 14, 2023, the Petitioners filed a *Petition for Review* of the *Preliminary Order.* REC 3342–3356. On December 5, 2023, the Hearing Officer issued an *Amended Preliminary Order*. REC 3372–3425. In response, the Petitioners filed an *Amended Petition for Review* that requested review by the Board of Environmental Quality of both the October 31, 2023 *Preliminary Order* and the December 5, 2023 *Amended Preliminary Order*. REC 3426–3441.

The *Amended Petition for Review*, claims the following errors with the PTC:

1. That DEQ erred in finding Perpetua has legal control of the Stibnite Road Access Route such that the Route need not comply with ambient air quality standards.

2. That DEQ erred in finding Perpetua will be able to practically and physically preclude the general public from accessing locations within the ambient air boundary.

3. That DEQ violated the Air Rules[1] by allowing Perpetua to submit plans with project details after the PTC was issued and without allowing for public comment on the plans.

4. That the PTC does not include enforceable conditions that will achieve 93.3% dust control.

5. That DEQ violated the Air Rules when calculating the ambient arsenic concentrations attributable to the SGP by diluting them by 16/70.

REC 3427–3428.

[1] The "Air Rules" are found at IDAPA 58.01.01.

The Board of Environmental Quality has the authority to review Preliminary Orders pursuant to I.C. § 67-5245(2) and IDAPA 58.01.23.730. The Parties presented briefs on the issues in this matter and participated in oral argument on March 14, 2024.

II. STANDARD OF REVIEW

In making its decision on the *Amended Petition for Review* the Board of Environmental Quality "shall exercise all the decision-making power that [it] would have had if the agency head had presided over the hearing." I.C. § 67-5245(7). This means that the Board of Environmental Quality can take a "de novo" or completely new look at the facts and issues. The Board of Environmental Quality must determine whether DEQ "has acted reasonably and in accordance with law" when issuing the Permit. *See* I.C. §§ 67-5248(a) and 67-5279; *In the Matter of Sunnyside Park Utilities' Application for Sewage Disposal Permit*, Final Order on Petition for Review of Preliminary Order, at p. 10 (BEQ Dkt. 0103-07-02, April 7, 2009).

The case before the Hearing Officer was decided on summary judgment. A motion for summary judgment must be granted if "the movant shows that there is no genuine dispute as to any material fact and the movant is entitled to judgment as a matter of law." I.R.C.P. 56(a). Facts relied on by the parties must be supported by "citing to particular parts of materials in the record, including depositions, documents, electronically stored information, affidavits or declarations, stipulations . . . admissions, interrogatory answers, or other materials . . .." I.R.C.P. 56(c)(1). If the Board of Environmental Quality determines that a party has failed to "properly support an assertion of fact or fails to properly address another party's assertion of fact as required by Rule 56(c) . . . [it may] (1) give an opportunity to properly support or address the fact; (2) consider the fact undisputed for purposes of the motion; (3) grant summary judgment if the motion and

supporting materials, including the facts considered undisputed, show that the movant is entitled to it; or (4) issue any other appropriate order." I.R.C.P. 56(e).

III. ANALYSIS

1. DEQ Acted Reasonably and in Accordance with Law when it Found Perpetua has Legal and Practical Control of the Stibnite Access Route such that it Could be Excluded from the Ambient Air Boundary.

Petitioners assert that there was insufficient evidence in the record for DEQ to determine that Perpetua has legal and practical control over the Stibnite Access Route such that the Route could be excluded from the ambient air boundary. Under the federal Clear Air Act, EPA is required to establish national ambient air quality standards ("NAAQS") for "criteria" pollutants, which include particulate matter PM_{10}.[2] *See generally* 42 U.S.C. § 7602(t); 40 C.F.R. § 50.6. When DEQ evaluates an application for permit to construct, it must determine that the "stationary source or modification would not cause or significantly contribute to a violation of any ambient air quality standard." IDAPA 58.01.01.203.02. Ambient air is "[t]hat portion of the atmosphere, external to buildings, to which the general public has access." IDAPA 58.01.01.006.05. Any portion of the atmosphere that is not ambient air need not comply with NAAQS.

The EPA has issued guidelines that further elucidate the meaning of "ambient air". REC 1138–1149. The EPA Guidelines provide that the "general public" includes "any person(s) other than those who are permitted access to the property as employees or business invitees of a specific stationary source (including trespassers)." REC 1145 The EPA Guidelines also describe two aspects to consider when determining whether there will be access by the general public. The "first aspect of the access element (i.e. legal access) concerns whether the general public has

[2] PM_{10} is "all particulate matter in the ambient air with an aerodynamic diameter less than or equal to ten (10) micrometers." IDAPA 58.01.01.006.35.

the right or permission to enter a specific property . . . (i.e. the source has legal authority, via ownership or control to preclude access by the public)." REC 1145. The "second aspect of the access element (i.e. physical or practical access) addresses whether the general public is able to, under actual circumstances, enter a particular parcel of land." REC 1145. A "rule of reason" should be used to evaluate whether physical or practical access will be restricted. REC 1147. The evaluation should include consideration of relevant factors:

> [S]uch as the nature of the measure used (e.g. physical or non-physical), source location, type, and size of the source and property to be excluded, surrounding area (including the proximity, nature, and size of the population in the area), and other factors affecting whether the members of the general public would readily be able to trespass upon or otherwise have access to the sources' property.

REC 1147.

a. There is Sufficient Evidence to Demonstrate Perpetua Will have Legal Control Over Access to the Ambient Air Boundary.

The land ownership within the SGP is a patchwork of federal and private ownership. REC 415. The parties do not appear to dispute that Perpetua will have legal control over the lands in private ownership. The federal lands within the project boundary are owned by the United States Forest Service ("USFS"). Perpetua will have to obtain permission from the USFS, to operate the mine. Part of obtaining permission from the USFS will involve an evaluation of the project under the National Environmental Policy Act ("NEPA"). During the NEPA process, the USFS will evaluate continuing access to the SGP by the general public. The record demonstrates that "[o]ne of the alternatives currently being evaluated in the Draft environmental impact statement (EIS), Alternative 2, would provide continuing access through the SGP site on a realigned Stibnite Road during mine operations." REC 893. However, it is noted that the "implementation of this Plan [Alternative 2 with continuing public access through the site] is

contingent upon the selection of the applicable alternative by the USFS as the preferred alternative for the SGP and inclusion of the proposed Stibnite Road access route as a component of the approved SGP." REC 893, *see also* REC 895–896 (describing alternatives for alignment of the access route.).

The NEPA process is not yet complete, and no final EIS has been issued by the USFS. Transcript p. 38, ln. 12. Thus, the record does not contain any evidence that the USFS will require continuing public access through the SGP. DEQ recognized at oral argument that, should the USFS ultimately require public access through the SGP, the ambient air boundary analysis will have to be reevaluated. Transcript p. 88 ln. 19–p.89 ln. 17. The Board of Environmental Quality will not speculate as to the outcome of the USFS NEPA process and finds there is not sufficient evidence to support a conclusion that Perpetua will not have legal authority to control access to the federal lands within the project boundaries.

Petitioners additionally argue that it was impermissible for DEQ to rely on the following statement in Perpetua's application form when it determined Perpetua would have legal control over access to the SGP: "Midas Gold [Perpetua] will legally control the SGP, an active industrial site where mining activities will occur, such as heavy equipment operation. . . . Midas Gold [Perpetua] has established an operations boundary to identify the area where public access will be excluded." REC 1807. The Air Rules require that "all documents, including but not limited to, application forms for permits to construct . . . must contain a certification by a responsible official. The certification must state that, based on information and belief formed after reasonable inquiry, the statements and information in the document are true, accurate, and complete." IDAPA 58.01.01.123. The Air Rules also provide: "Persons are prohibited from

knowingly making any false statement, representation, or certification in any form, notice, or report. . . ." IDAPA 58.01.01.125.

It was reasonable for DEQ to rely on Perpetua's representations in its application form that it would have legal control over access to the Stibnite Road Access Route. Other than the USFS NEPA process addressed above, Petitioners have cited no evidence suggesting that Perpetua will not have legal authority to prevent the general public from accessing the ambient air boundary. Therefore, the Board of Environmental Quality finds DEQ acted reasonably in relying on Perpetua's representations in its PTC application that it would have legal authority over access to the SGP.

b. The PTC Contains Enforceable Conditions that Will Preclude Practical Access to the Ambient Air Boundary by the General Public.

Petitioners also assert that Perpetua will not have physical or practical control over access to the SGP property. However, the Board of Environmental Quality finds that there are substantial conditions in the PTC that require Perpetua to implement practical and physical restrictions on access to the SGP by the general public. Permit Condition 2.7 requires Perpetua to "observe all primary access points to preclude unauthorized public access" including providing "onsite personnel" for that purpose. REC 376. It further requires monitoring of primary public access to the facility "by use of security escort vehicles or manned guardhouses or . . . by the use of locked gates, barriers, or equivalent measures." REC 376. Condition 2.7 also requires monitoring secondary public access to the facility by "post[ing] warning signs and periodically patrol[ling]" the secondary access points and providing "onsite personnel" for that purpose. REC 376. Perpetua is also required to describe its plans for precluding access in an Access Management Plan ("AMP") that includes "identifying the access points monitored, the frequency of patrol, and measures employed to discourage access (e.g., locked gates, barriers,

natural features, etc.)." REC 376. Condition 2.7 also provides: "Only registered guests of the facility will be allowed access to or through the facility. Those seeking to be a guest for the sole purpose of passing through the facility to another destination shall be provided a registration sheet that explains Perpetua's requirements for accessing the site and identifies potential hazards of the site." REC 376. Finally, Condition 2.8 requires that Perpetua file an AMP with DEQ for approval 30 days before startup.

At least one version of an AMP was provided to DEQ in April 2020. REC 893–897. That version provides additional details of the types of access control that Perpetua plans to provide. REC 896–897. That plan specifically addresses measures to be taken with regard to persons wishing to pass through the SGP:

> Signage would be placed at the North Security Gate . . . and the Main (South) Security Gate . . . entry points to provide information to travelers, and guard shacks would be located at each SGP Site entry gate to monitor all vehicle ingress/egress. To ensure passage through the site in a safe and timely manner, persons wishing to traverse the SGP site on the Stibnite Access Road access route would be required to check in at the security gate upon entry to receive a safety briefing and to alert mine staff to their presence. After passing through the SGP site, travelers would also be required to stop at the guard shack upon exiting to check out. Travelers would not be allowed to stop or loiter while traveling through the operations area. Along its full length, the Stibnite Road access route would have appropriate signage to direct travelers and would be separated from mine haul roads and areas of mine operations by fencing, berms, or gates to prevent travelers from straying from the route.

REC 896. This description makes clear that access to the SGP and the Stibnite Access Road Route will only be available under a very limited basis and not to the "general public." Allowing some access by non-employees to facilities, such as the SGP, is common. *See e.g.* Transcript pg. 83 ln. 16–pg. 85 ln. 10. Those persons who are allowed limited access are subject to additional measures that would not apply to the "general public." *See e.g.* REC 896. Therefore, the mere

fact that some limited access through the SGP over the Stibnite Access Road will be allowed does not mean that access will be provided to the "general public" such that the road should be considered ambient air.

Thus, Conditions 2.7 and 2.8 require Perpetua to maintain physical and practical control of access to the SGP. Petitioners have provided no evidence demonstrating that these conditions are unenforceable. Therefore, the Board of Environmental Quality finds that there is sufficient evidence in the record to support DEQ's conclusion that Perpetua has physical and practical control over the Stibnite Road Access Route such that it may be excluded from consideration as ambient air.

2. DEQ Acted Reasonably and in Accordance with Law When it Allowed Perpetua to Submit Some Plans After the PTC was Issued.

Petitioners assert that DEQ violated the Air Rules by allowing Perpetua to submit some plans after the PTC was issued. The Air Rules provide the types of information that must be submitted with an application for PTC:

> Depending upon the proposed size and location of the new or modified stationary source or facility, the application for a permit to construct must include all information required by one or more of the following provisions:
>
> a. For any new or modified stationary source or facility:
>
> i. Site information, plans, descriptions, specifications, and drawings showing the design of the stationary source, facility, or modification, the nature and amount of emissions (including secondary emissions), and the manner in which it will be operated and controlled.

IDAPA 58.01.01.202.01.a.i. The rules require that an "opportunity for public comment will be provided on all applications requiring a permit to construct." IDAPA 58.01.01.209.c. The Air Rules further provide: "Any additional information, plans, specifications, evidence or documents

that the Department may require to make the determinations required under Section 200 through 225 shall be furnished upon request." IDAPA 58.01.01.202.03.

Petitioners focus on the requirement that the application include information about "the manner in which it [the project] will be operated and controlled," arguing that this language means that any plans describing operation and control must be submitted with the application and before the PTC is issued. Petitioners assert that DEQ erred in allowing a Fugitive Dust Plan, Haul Road Capping Plan, Operation and Maintenance Manual, and Access Management Plan to be submitted after the PTC was issued. *Petitioner's Opening Brief* at 29.

Rule 202 requires the applicant provide sufficient information with its application for DEQ to develop the PTC. IDAPA 58.01.01.202.01.a.i. In this case, Perpetua submitted considerable information with its application for PTC. *See* REC 1506–1643. This included information about its emissions units (REC 1512–1592), emissions unit control systems (REC 1593-1620), the nature and amount of emissions (REC 1621–1628), air emission modeling (REC 1634–1643), emission controls (REC 1771–1773), and proposals for T-RACT (REC 1952-1958). This information was subject to scrutiny by the public. Transcript pg. 97, ln. 11–20. After evaluating this information, allowing for public comment, and responding to public comment, DEQ issued the PTC. Transcript pg. 97, ln. 11–20, *see also* REC 921–982 (DEQ's responses to public comments).

It was reasonable for DEQ to allow certain plans and information to be submitted after the PTC is issued. This common DEQ practice is not in violation of Air Rule 202.03 because certain details simply cannot be known at the time an application is filed. For instance, it would be impractical to require an applicant to provide detailed information regarding the application of T-RACT dust control measures before the T-RACT has been evaluated and approved by DEQ.

The applicant must first know that it will be required to use water and chemical suppressants to achieve 93.3% dust control before it is able to submit a detailed plan regarding its methods for applying the water and chemical suppressant to achieve that requirement. Requiring all plans to be submitted up front with the application form is not practical and is not required by the Air Rules. To the contrary, IDAPA 58.01.01.202.03 specifically provides that DEQ has the discretion to require additional information be "furnished upon request." Therefore, the Board of Environmental Quality finds that DEQ did not violate the Air Rules by allowing some information and plans to be submitted after the PTC was issued.

3. The PTC Contains Enforceable Conditions that Will Achieve 93.3% Dust Control.

Petitioner's do not argue that the 93.3% dust control analysis performed by DEQ was inadequate or that it is not possible to achieve 93.3% dust control for the SGP. Transcript pg. 69 ln. 8– ln. 14; *see also* Transcript pg. 99 ln. 18–24, Transcript pg. 137 ln. 1– ln. 8. Rather, Petitioners assert that the PTC does not contain enforceable conditions that will ensure that 93.3% dust control is achieved. Transcript pg. 69 ln. 15–ln. 21.

The PTC, however, contains multiple conditions that require Perpetua to take specific steps to achieve 93.3% dust control. Condition 2.1 provides for specific precautions to be used to control fugitive dust including use of water and chemicals for dust control during demolition of existing buildings and on road surfaces, installation, where practical, of hoods and fans, covering open body trucks, and paving roadways. REC 374. Condition 2.2 provides that, every 12-hours, Perpetua must monitor and record the "frequency and methods used (e.g. water chemical dust suppressants) to reasonably control fugitive dust emissions." REC 374. Condition 2.3 requires Perpetua to "maintain records of all fugitive dust complaints received . . . [and] take appropriate corrective action as expeditiously as practicable after receipt of a valid complaint."

REC 374. Condition 2.4 requires daily inspection of potential sources of fugitive dust emissions, taking action to remedy any dust discovered, and keeping records of each inspection. REC 374. Condition 2.5 requires fugitive dust control measures be applied to haul roads "such that visible emissions from vehicle traffic . . . do not exceed 10% opacity." REC 375. Condition 2.6 requires development of a Fugitive Dust Plan to ensure compliance with fugitive dust requirements and provides an extensive list of measures and precautions that should be implemented. REC 375–376. And finally, a requirement in Table 3.1 specifically states that 93.3% dust control is required: "Control efficiency: 93.3% for PM/PM10 (haul roads)." REC 384.

The conditions in the permit are control efficiencies. As explained at oral argument, the conditions set forth certain steps that must be taken to control fugitive dust emissions. Transcript pg. 103 ln. 20–pg. 105 ln. 21; pg. 136 ln. 6–ln. 19. If the measures listed in Conditions 2.1–2.6 are taken, then the outcome will be 93.3% dust control. If those steps are not taken, Perpetua would be in violation of its PTC. And Table 3.1 makes clear that the control efficiencies must result in 93.3% dust control. REC 384. Therefore, the Board of Environmental Quality finds that the PTC contains numerous enforceable conditions that will result in 93.3% dust control.

4. DEQ Did Not Act Reasonably and in Accordance with Law When it Analyzed the Ambient Arsenic Air Concentrations for the SGP.

Petitioners assert that DEQ acted unreasonably when it diluted the ambient arsenic air concentrations by applying a 16/70 factor in its calculations. The Board of Environmental Quality agrees that there was insufficient evidence to support DEQ's analysis of the ambient arsenic air concentrations.

a. Overview of the Air Rules Requirement for Determining Ambient Arsenic Concentrations.

The Air Rule requirements for toxic pollutants begin with IDAPA 58.01.01.161. Section 161 is the over-arching policy or qualitative standard that should be applied to the emission of toxic contaminants such as arsenic. It provides: "Any contaminant that is by its nature toxic to human or animal life or vegetation ***must not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human life or vegetation.***" (emphasis added). To obtain a permit to construct an applicant must demonstrate, to the satisfaction of the Department:

> ***Using the methods provided in Section 210***, the emissions of toxic air pollutants from the stationary source or modification would not injure or unreasonably affect human or animal life or vegetation ***as required by Section 161***. Compliance with all applicable toxic air pollutant carcinogenic increments and toxic air pollutant non-carcinogenic increments demonstrates preconstruction compliance with Section 161 ***with regard to the pollutants listed in Section 585 and 586.***

IDAPA 58.01.01.203.03 (emphasis added). Thus, if a toxic air pollutant is listed in IDAPA 58.01.01.585 or 586, ("Section 586") it must be evaluated under the methods provided in Section 210.

Arsenic is listed in Section 586 of the Air Rules which consists of a table that lists each carcinogenic[3] toxic air pollutant that is covered by the rules. Section 586 includes "the screening emissions levels (EL) and acceptable ambient concentrations (AACC)" for each toxic carcinogenic pollutant listed. The EL listed for arsenic is "1.5E-06 lb/hr" and the AACC for arsenic is "2.3E-04 µg/m^3." The AACC is the carcinogen concentration in air in which daily exposure would limit the risk of cancer to 1 in 1 million over a lifetime, which is identified as 70

[3] A carcinogen is an agent capable of inducing cancer. Cancer is a disease of heritable, somatic mutations affecting cell growth and differentiation, characterized by an abnormal, uncontrolled growth of cells.

years. The AACCs listed in the table in Section 586 are based on "annual averages." IDAPA 58.01.01.586.

Section 210.01 provides that the applicant must first identify what toxic air pollutants will be emitted by the project. IDAPA 58.01.01.210.01. Then the applicant must use "standard scientific and engineering principles and practices to estimate the emission rate" of the pollutant. IDAPA 58.01.01.210.02.a.[4] If the EL exceeds the levels listed in Section 586, then the applicant must continue with further analysis under Section 210.

The Applicant must then use "the modeling methods provided in Subsection 202.02 to estimate the ambient concentrations at specific receptor sites for any toxic air pollutant emitted from the point(s) of emission." IDAPA 58.01.01.210.03.a.[5] The "point of compliance is the receptor site that is estimated to have the highest ambient concentration of the toxic air pollutant of all the receptor sites . . .." IDAPA 58.01.01.210.03.b. Preconstruction compliance for toxic pollutants can be demonstrated using any of the methods "described in Subsection 210.05

[4] The "uncontrolled emissions rate" is "calculated using the maximum capacity of the source . . . without the effect of any physical or operational limitations." IDAPA 58.01.01.210.02.b.

The "controlled emissions rate" is "calculated using the maximum capacity of the source . . . with the effect of any physical or operational limitations that has been specifically described" by the applicant and submitted to DEQ. IDAPA 58.01.01.210.02.c.

The "T-RACT emissions rate" is "calculated using the maximum capacity of the source . . . with the effect of any physical or operational limitation other than control equipment that has been specifically described" by the applicant" and "an emission standard that is T-RACT." IDAPA 58.01.01.210.02.d.

[5] Section 202.02 provides that modeling "must be based on the applicable air quality models, data bases, and other requirements specified in 40 CFR Part 51, Appendix W (Guideline on Air Quality Models). Where an air quality model specified in the "Guideline on Air Quality Models" is inappropriate, the model may be modified or another model substituted, subject to written approval of the EPA Administrator and public comment pursuant to Subsection 209.01.c; provided that modifications and substitutions or models used for toxic air pollutants will be reviewed by the Department."

through 210.08 and may use any applicable specialized method described in Subsection 210.09 through 210.12." IDAPA 58.01.01.210.04.[6]

Most applicable here are the compliance methods described in Section 210.12, which provides for the use of T-RACT to demonstrate preconstruction compliance for toxic pollutants listed in Section 586. T-RACT stands for "Toxic Air Pollutant Reasonably Available Control Technology" and "is an emission standard based on the lowest emission of toxic air pollutants that a particular source is capable of meeting by the application of control technology that is reasonably available, as determined by the Department, considering technological and economic feasibility." IDAPA 58.01.01.210. The applicant must comply with IDAPA 58.01.01.210.13 and 210.14 to first get the T-RACT approved by DEQ before it can be used in the modeling. If T-RACT is used it allows for a comparison of:

> [T]he source's . . . approved T-RACT ambient concentration at the point of compliance for the toxic air pollutant to the amount of the toxic air pollutant that would contribute an ambient air cancer risk probability of less than one to one hundred thousand (1:100,000) (which amount is equivalent to ten (10) times the applicable acceptable ambient concentration listed in Section 586).

IDAPA 58.01.01.210.12.b. Thus, if the source's approved T-RACT ambient concentration meets the AACC listed in Section 586 times 10, then "no further procedures for demonstrating preconstruction compliance will be required for that toxic air pollutant as part of the application process." IDAPA 58.01.01.210.12.c. DEQ must then include appropriate conditions in the permit to ensure that the T-RACT is implemented so that the 10-times ambient concentrations

[6] Section 210.05 Uncontrolled Emissions; Section 210.06 Uncontrolled Ambient Concentration; Section 210.07 Controlled Emissions, Section 210.08 Controlled Ambient Emissions; Section 210.09 Net Emissions; Section 210.10 Net Ambient Concentration; Section 210.11 Toxic Air Pollutant Offset Ambient Concentration; Section 210.12 T-RACT Ambient Concentration for Carcinogens.

can be met. IDAPA 58.01.01.210.12.d. Thus, the Air Rules establish two acceptable cancer risk levels—1 in 1,000,000 (the AACC level) and 1 in 100,000 (the T-RACT level).

Section 210 provides one further analysis that has bearing in this case. Section 210.15 provides that "short term" projects "may utilize a short-term adjustment factor of ten (10). For a carcinogen, multiply either the applicable acceptable ambient concentration (AACC) or the screening emission rate, but not both, by ten (10), to demonstrate preconstruction compliance." IDAPA 58.01.01.210.15. "Short Term Source" is defined as any new stationary source "with an operational life no greater than five (5) years from the inception of any operations to the cessation of actual operations." IDAPA 58.01.01.007.08. Thus, short term sources are also allowed 10 times the AACC, which would represent a 1 in 100,000 cancer risk, as long as the operational source life is no greater than five (5) years.

b. Overview of the Ambient Air Concentration for Arsenic Analysis Performed by DEQ.

DEQ performed its analysis of ambient arsenic levels by first determining that the levels of arsenic that would be generated by the project exceeded the EL levels found in Section 586. REC 1760. Then DEQ modeled the arsenic levels using the "simple" method described by Kevin Schilling in his declaration. *See* REC 1241. Even after some refinements to this "simple" method, however, DEQ determined that "compliance could not be demonstrated using the typical approach . . .." REC 1241.

DEQ then "undertook the task of evaluating whether a more refined approach could be used to demonstrate compliance with TAP rules of Section 210." REC 1242. The first step in the refinement was to apply the T-RACT analysis under Section 210.12. REC 1242. However, after applying the T-RACT analysis, DEQ determined that: "[c]onsideration of T-RACT in the analyses still resulted in modeled arsenic impacts exceeding a value of 10 times the AACC."

REC 1242, *see also* REC 1242–1243 ("A worst-case conservative but simplistic approach used for the SGP did not show compliance with the arsenic AACC, or even the AACC multiplied by a factor of ten to reflect the allowable impact when using T-RACT.") DEQ went on to explain:

> Faced with this problem, there were effectively two options: 1) revision of the emission calculation and modeling methods, using those that would be less conservative (less of a tendency to overestimate emission quantities that could occur) and perhaps more complicated; or 2) refine the exposure calculation to better account for the dynamic nature of emission-generating activities and the limited project lifetime.

Ultimately, DEQ decided to use the latter method. REC 1243–1244, *see also* REC 698–706.

Rather than returning to the model, DEQ applied an additional analysis that focused on the length of time the project would operate—16 years. DEQ justified this additional analysis using IDAPA 58.01.01.210.15, which allows for an adjustment of the AACC when a project is determined to be "short term" (operating for five years or less). IDAPA 58.01.01.007.08. The applicant stated that the operational lifetime of the mine would be 16 years. REC 1243. However, the AACC levels listed in Section 586 are based on a 70-year lifetime exposure rate. DEQ reasoned, if an adjustment of 10 times is allowed for a short-term (5 year or less) project, then a similar adjustment should be allowed to account for a 16-year project. REC 1243–1244. Using this reasoning DEQ calculated a "project-based arsenic concentration representative of the project, appropriate for comparison to the AACC (based on a 70-year exposure), the modeled impact was adjusted by the factor 16/70." REC 1243.

The mathematical equation used to make this calculation is as follows:

$$LifeExpose_{Wi,j,n} = \left[\left(WEPExpose_{Wi,n}\right)(50\%) + \left(nonWEPExpose_{Sj,n}\right)(50\%)\right]\left[\frac{16\ year\ LOM}{70\ year\ exposure}\right]$$

where:

W*i*	=	West End Pit scenario, where *i* = 1 to 4.
S*j*	=	non West End Pit scenario, where *j* = B1, B2, H1, H2, H3, H4, Y1, Y2, and Y3.
n	=	specific receptor.
$LifeExpose_{Wi,j,n}$	=	lifetime exposure in µg/m^3 for West End Pit scenario *i*, non West End Pit scenario *j*, at receptor *n*.
$WEPExpose_{Wi,n}$	=	annual maximum impact in µg/m^3 for West End Pit scenario *i* at receptor *n*.
$nonWEPExpose_{Sj,n}$	=	annual maximum impact in µg/m^3 for non West End Pit scenario *j* at receptor *n*.
16 year LOM	=	maximum life-of-mine.
70 year exposure	=	Lifetime exposure used for development of AACCs in *Idaho Air Rules*.

REC 710–711.

This equation includes the use of a five-year rolling average and T-RACT adjustments made to the production levels of the West End Pit and the non-West End Pit, as well as the 16/70 adjustment for the life of the mine. These adjustments will be discussed in detail below.

c. DEQ did not Act Reasonably in Using a Five-Year Rolling Average for T-RACT that was not Properly Supported by Permit Conditions.

The AACC's listed in Section 586 are based on annual averages, however, DEQ used a 5-year rolling average when performing its arsenic ambient air concentration calculations. The 135,000 T/day five-year rolling average was added as a T-RACT control. REC 939. As described below, the modeled ambient arsenic concentration calculations were based on the 135,000 T/day, not on 180,000 T/day. REC 710. In the PTC, DEQ limited the daily hauling and excavating limits to "no more than 180,000 tons per day (T/day) of ore and DR" and "not more than 135,000 T/day of ore and DR, based on a 5-year rolling average." REC 385. These conditions, however, would not prevent Perpetua from hauling more than 135,000 T/day, so long

as the overall average is achieved. Perpetua must only achieve the 135,000 T/day over a five-year rolling average period. This means that it could, theoretically, run the mine at 180,000 T/day for a shorter period of time (i.e. one calendar year), but still achieve the overall requirement of 135,000 T/day over the five-year rolling period.[7]

Thus, the five-year rolling average allows for a smoothing out of the peak concentrations of ambient arsenic. For the AACC and T-RACT-AACC to limit cancer risk to 1 in 1 million and 1 in 100,000 respectively, the rule specifies compliance on an annual basis. A five-year rolling average allows considerable daily and annual increases in exposures which are contrary to limits set forth in the Air Rules.

The AACC limits set forth in Section 586 are based on annual averages, and there was no evidence in the record explaining how the five-year rolling average comports with the annual AACC limits. Therefore, the Board of Environmental Quality was unable to determine if a five-year rolling average would be equally protective of ambient air as the AACC limits set forth in Section 586. In addition, use of the five-year rolling average as a T-RACT control was not properly supported by the PTC conditions. As explained above, the PTC conditions were inadequate to ensure that the 135,000 T/day used in the ambient arsenic air concentration analysis would not be exceeded for some portion of the five-year rolling period. Therefore, the Board of Environmental Quality finds that there was insufficient evidence to support use of the five-year rolling average in the ambient arsenic air concentration analysis.

d. There was Insufficient Evidence to Support the T-RACT Analysis Limiting the Non-West End Pit Production Limit.

[7] The PTC also contains a condition limiting the overall lifetime production of the mine to 788.4 million tons. This figure is based on the 135,000 T/day over 16 years. REC 710. Similar to the five-year rolling average, however, the overall limitation to 788.4 million tons would not provide a limitation on the daily amount of hauling that could occur, so long as the total 16-year amount is not exceeded.

As part of the T-RACT analysis, DEQ also limited the West End Pit production as a means of controlling ambient arsenic concentrations. REC 710. As shown in the mathematical equation above, the West End Pit exposure was adjusted by 50%. REC 710. This adjustment is properly reflected in PTC Condition 3.6 which requires that the permittee "shall haul no more than 394.2 MT [million tons] of ore and DR from the West End deposit over the life of the mine." REC 385.

However, the equation listed above shows that the non-West End Pit production was also limited by 50%. REC 710. The Board of Environmental Quality was unable to determine from the record where this 50% reduction came from or whether it was actually applied when doing the calculation. Other than the equation, the Board of Environmental Quality could not identify any evidence discussing a 50% reduction in the non-West End Pit production. In addition, the PTC does not contain any conditions limiting the non-West End Pit production to 50%. PTC Condition 3.6 makes clear that all production (both West End and Non-West End Pit) is limited to 788.4 million tons, which is based on 135,000 T/day over the 16 year life of the mine. REC 710. And, as noted above, Condition 3.6 also makes clear that the West End Pit production is limited to 50%. *See* REC 385 ("The permittee shall haul no more than 788.4 million tons (MT) of ore and DR from all deposits over the life of the mine and no more than 349.2 MT of ore and DR from the West End deposit over the life of the mine."). However, the Board of Environmental Quality could not identify a PTC condition that would limit the non-West End Pit production by 50%. Therefore, there was insufficient evidence in the record to demonstrate exactly how or whether the non-West End Pit production was limited and, if it was, the Board of Environmental Quality could not find any PTC conditions able to enforce that reduction.

e. DEQ Did Not Act Reasonably and in Accordance with Law When it Applied the 16/70 Calculation to the Ambient Arsenic Air Concentration Analysis.

As noted above, the AACC levels found in Section 586 "conservatively represents a long-term exposure (70 years) that would result in a 1 in 1,000,000 cancer risk." REC 1242. These levels could not be met for the SGP, so the T-RACT of reducing the production of the mine to 135,000 T/day on a five-year rolling average and reducing the production of the West End Pit was applied to the analysis. The T-RACT amount allowed for in Section 210.12 represents a 1 in 100,000 lifetime cancer risk. IDAPA 58.01.01.210.12.b. But even using T-RACT, the AACC levels, as adjusted to 10-times higher by IDAPA 58.01.01.210.12.b, still could not be met. REC 1243–1244. It was at that point, that DEQ decided to apply the 16/70 adjustment to the calculation. REC 1243–1244, *see also* REC 698–706.

The Air Rules clearly provide an AACC standard in Section 586. They then clearly provide an adjustment to that AACC standard when T-RACT can be used to control emissions. IDAPA 58.01.01.210.12.b. The Air Rules also clearly allow for a 10-times adjustment to the AACC when a project is going to operate for 5 years or less. IDAPA 58.01.01.210.15. But nowhere in the Air Rules does it provide that a project that will operate more than 5 years but less than 70 years may be adjusted in proportion to the amount of time it will operate.

In addition, the Board of Environmental Quality cannot find sufficient evidence in the record to support the proposition that a higher exposure to arsenic for a shorter period of time is equally or more protective than a lower annual lifetime average exposure. Application of the 16/70 factor artificially results in 41.3% of the T-RACT-modified AACC. REC 714. The equation above demonstrates that DEQ calculated the lifetime exposure ($\mu g/m^3$) by including a variable which multiplied the results by 16/70, which takes a 16-year life of mine dividing by the 70-year exposure

limit used to set the AACC. REC 710–711. The impact of this additional variable in the equation ultimately results in over a 75% reduction in the calculated exposure.

DEQ provided the following explanation of the cancer risk vis-à-vis its 16/70 analysis:

> AACCs were established in Idaho Air Rules to protect against a project-caused lifetime excess cancer risk of more than 1-in-1,000,000, or 1-in-100,000 where T-RACT is used to control emissions from sources. Prior to a regulatory clean up in 2022, Idaho Air Rules Section 006.125 defined Toxic Air Pollutant Carcinogenic Increments (AACCs) as, "Those ambient air quality increments based on the probability of developing excess cancers over a seventy (70) year lifetime exposure to one (1) microgram per cubic meter (1 $\mu g/m^3$) of a given carcinogen and expressed in terms of a screening emission level or an acceptable ambient concentration for a carcinogenic toxic air Pollutant. They are listed in Section 586." Although a lifetime risk is the benchmark, DEQ listed annual averages for the AACCs in Idaho Air Rules because that timeframe 1) is long enough to establish a good representation of long-term impacts for most sources requiring a permit, 2) is short enough to provide compliance assurance early in the life of the industrial operation, and 3) is convenient for compliance monitoring and reporting, providing a practically enforceable limit on operations. Use of an annual limit is not key to attaining a limit on the lifetime cancer risk; and, since a lifetime risk is the benchmark, use of annual averaged emissions to show compliance with the AACC on an annual basis could be unnecessarily restrictive where processes vary considerably year-to-year and have a project lifetime substantially shorter than 70 years, such as mining processes.

REC 1242–1243. DEQ's discussion of the cancer risk is couched in terms of annual averages, but as discussed above, a five-year rolling average was used for the analysis. The Board of Environmental Quality could find no other evidence in the record discussing the 16/70 adjustment in relation to human toxicology and cancer risk. Therefore, DEQ did not provide sufficient evidence in the form of an expert opinion from a toxicologist or other qualified expert regarding the cancer risk associated with the 16/70 adjustment.

The arsenic analysis performed by DEQ must be viewed within the wider lens of IDAPA 58.01.01.161 and 203 which require that toxic pollutants must "not be emitted in such quantities

or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation." *see also* IDAPA 58.01.01.203.03. The Board of Environmental Quality has not found sufficient evidence in the record to convince it that the 16/70 analysis performed by DEQ was equally or more protective of human and animal life and vegetation as what is provided for by the Air Rules. Therefore, the Board of Environmental Quality remands this matter back for the development of further evidence regarding the ambient air concentrations of arsenic that will be produced by the SGP and whether those levels comply with the Air Rules.

IV. CONCLUSION

Based on the foregoing, it is hereby ordered:

1. DEQ Acted Reasonably and in Accordance with Law When it Determined that Perpetua Will have Legal Control of the Stibnite Road Access Route Such that it Could Properly be Excluded from Consideration as Ambient Air.

2. DEQ Acted Reasonably and in Accordance with Law When it Determined that Perpetua Will have Physical and Practical Control of the Stibnite Road Access Route Such that it Could Properly be Excluded from Consideration as Ambient Air.

3. DEQ Acted Reasonably and in Accordance with Law When it Allowed Perpetua to Submit Some Plans After the PTC was Issued.

4. The PTC Includes Enforceable Conditions that Will Achieve 93.3% Dust Control.

5. DEQ Did Not Act Reasonably and in Accordance with Law When it Analyzed the Ambient Arsenic Air Concentrations for the SGP.

The Board of Environmental Quality remands this matter to the Hearing Officer for further factual development in accordance with the terms of this order.

Dated this 9TH day of May, 2024

Mark Bowen
Chairman, Idaho Board of Environmental Quality

CERTIFICATE OF SERVICE

I HEREBY CERTIFY that on this 9th day of May 2024, I caused to be served a true and correct copy of the foregoing FINAL ORDER by transmitting a copy thereof in the manner listed below:

Hannah Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
hannah.young@deq.idaho.gov

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com

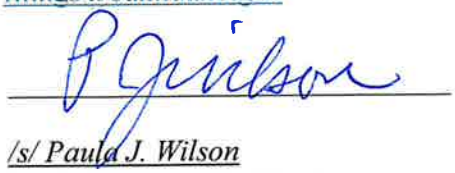
Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
Counsel for the Idaho
Board of Environmental Quality
ann.yribar@ag.idaho.gov

Dylan Lawrence
Varin Thomas LLC
P.O. Box 1676
Boise, ID 83701
Hearing Officer
dylan@varinthomas.com

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-004
filings@oah.idaho.gov



/s/ Paula J. Wilson
Paula J. Wilson, Paralegal
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, Idaho 83706
paula.wilson@deq.idaho.gov

EXPLANATORY INFORMATION TO ACCOMPANY A FINAL ORDER

The accompanying order is a "**Final Order**" issued by the Board of Environmental Quality pursuant to section 67-5246, Idaho Code.

PETITION FOR RECONSIDERAQTION

Any party may file a petition for reconsideration of a final order within fourteen (14) days of the service date of this order as shown on the certificate of service. **Note: The petition must be received by the Board of Environmental Quality within this fourteen (14) day period.** The Board of Environmental Quality will act on a petition for reconsideration within twenty-one (21) days of its receipt, or the petition will be considered denied by operation of law. See Section 67-5246(4), Idaho Code.

APPEAL OF FINAL ORDER TO DISTRICT COURT

Pursuant to Section 67-5270 and 67-5272, Idaho Code, any party aggrieved by a final order or orders previously issued in a matter before the Board of Environmental Quality may appeal the final order and all previously issued orders in the matter to district court by filing a petition in the district court of the county in which:

i. A hearing was held,
ii. The final agency action was taken,
iii. The party seeking review of the orders resides, or
iv. The real property or personal property that was the subject of the agency action is located.

The appeal must be filed within twenty-eight (28) days of: a) the service date of the final order, b) the service date of an order denying a petition for reconsideration, or c) the failure within twenty-one (21) days to grant or deny a petition for reconsideration, whichever is later. See Section 67-5273, Idaho Code. The filing of an appeal to district court does not in itself stay the effectiveness or enforcement of the order under appeal.

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	Agency Case No. 0101-22-01
	)	OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON	)	**PETITIONERS' MOTION FOR CLARIFICATION AND/OR RECONSIDERATION**
Petitioners,	)	
v.	)	
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC.	)	
Intervenor-Respondent.	)	

INTRODUCTION

Petitioners Nez Perce Tribe, Idaho Conservation League ("ICL"), and Save the South Fork Salmon ("SSFS") hereby seek clarification and/or reconsideration from the Idaho Board of Environmental Quality (the "Board") regarding the relief granted in the May 9, 2024 Final Order. In the Order, the Board found three ways DEQ acted unreasonably and violated the Rules for the Control of Air Pollution in Idaho, IDAPA 58.01.01 ("Air Rules"), when it analyzed arsenic ambient air concentrations for the Stibnite Gold Project. First, DEQ unreasonably used a five-year rolling average in its arsenic calculations allowing for "considerable daily and annual increases in exposures which are contrary to the limits set forth in the Air Rules." REC 3713. Second, there was insufficient evidence to support a 50% reduction in emissions from non-West End Pit production and no enforceable permit conditions to support that reduction. REC 3714. Third, DEQ violated the Air Rules by using a project-specific adjustment factor for arsenic emissions and failed to provide sufficient evidence of the cancer risk from using the adjustment factor. REC 3715-17. Based on these errors, the Board "remand[ed] this matter to the Hearing Officer for further factual development in accordance with the terms of this order." REC 3717.

Petitioners respectfully request that the Board clarify, or order on reconsideration, that the Permit to Construct ("PTC") approved by DEQ is set aside or vacated while on remand for DEQ to reevaluate the PTC application, or an amended application, in accordance with the terms of the Order. While the effect of the Order seems to mean that the PTC is not valid unless and until DEQ corrects the deficiencies the Board identified, the Order does not specifically say so. This creates a risk that, without clarification or reconsideration, Perpetua might begin construction and operation of the Stibnite Gold Project before DEQ resolves the Board's concerns on remand or even without DEQ ever resolving those concerns. Surely this cannot be.

BASIS FOR CLARIFICATION AND/OR RECONSIDERATION

Clarification or Reconsideration Is Warranted to Set Aside or Vacate the PTC Approval Until DEQ Issues a New Decision

Throughout the proceedings before the Board, Petitioners requested that if the Board ruled in Petitioners' favor on any issue, including the arsenic issue, then DEQ's approval of the PTC must be set aside or vacated (effectively, the same thing) and remanded. *See* REC 3432, 3433, 3435, 3437, 3439 (Amended Petition); REC 3475, 3480, 3483, 3490, 3493, 3499, 3506-07 (Pet'rs' Opening Br.); C-REC 3649, 3653, 3667, 3668, 3671 (Pet'rs' Reply); Tr. 66:15-17, 74:13-17, 76:17-21 (Mar. 14, 2024 Hearing). Neither DEQ nor Perpetua contested the propriety of this relief, nor did they argue for any alternative relief. *See* C-REC 3512-44 (DEQ Opp. Br.); C-REC 3546-601 (Perpetua Opp. Br.); Tr. (Mar. 14, 2024 Hearing). While the Board ruled in Petitioners' favor on the arsenic issue and remanded for further proceedings, the Order never addressed whether or not DEQ's issuance of the PTC was set aside or vacated.

Setting aside agency action is not just an appropriate remedy, it is required by the Idaho Administrative Procedure Act ("Idaho APA"). Under the Idaho APA, agency action must be affirmed unless the agency's decision was "(a) in violation of constitutional or statutory provisions; (b) in excess of the statutory authority of the agency; (c) made upon unlawful procedure; (d) not supported by substantial evidence on the record as a while; or (e) arbitrary, capricious, or an abuse of discretion." I.C. § 67-5279(3). "If the agency action is not affirmed, it shall be set aside, in whole or in part, and remanded for further proceedings as necessary." *Id.* (emphasis added). Here, the Board did not affirm DEQ's action in issuing the PTC. It found that DEQ "Did Not Act Reasonably and in Accordance with the Law When it Analyzed the Ambient Arsenic Air Concentrations for the [Stibnite Gold Project]." REC 3717. Thus, under the Idaho APA, DEQ's action should be set aside.

Setting aside DEQ's action is in line with the Board's practice.[1] For example, in *Sunnyside Park*, after DEQ denied Sunnyside's permit application to expand its subsurface sewage system, and after a hearing officer issued a preliminary order upholding DEQ's denial, the Board issued a Final Order reversing DEQ for not acting reasonably and in accordance with law under the Idaho APA and setting aside and vacating DEQ's action. *In re Sunnyside Park Utilities' Application For Sewage Disposal Permit*, Docket No. 0103-07-02 (Apr. 7, 2009). The Board explained:

> Setting aside the permit denial will allow DEQ to process the application again, or to process an amended application should Sunnyside decide to submit one, and in so doing, identify the facts and circumstances that should be considered, apply its expertise to the facts and circumstances that should be considered, apply its expertise to the facts and issues, and provide adequate explanation for its decision.

Id. at 12.

Here, setting aside DEQ's issuance of the PTC will allow DEQ to process the application again, or process an amended application should Perpetua decide to submit one. This will allow DEQ to apply its expertise to the facts and circumstances; to determine whether to issue, issue with conditions, or deny the application;[2] and to provide an adequate explanation with supporting information and analysis for its decision consistent with the Board's Order.

---

[1] Vacating and remanding is also consistent with the practice of the Idaho Supreme Court. *See In re Variance ZV2011-2*, 156 Idaho 491, 496 (vacating and remanding arbitrary agency action for further proceedings consistent with the Court's opinion).

[2] Under the Air Rules, DEQ has three options when evaluating a PTC application: approve the application; conditionally approve the application; or deny the application. *See* Air Rules 209.01.b & c.v. Additionally, DEQ "may impose any reasonable conditions" on the facility in the PTC. Air Rules 211.01. On remand, DEQ should have this full suite of options available when it reviews the PTC application (or an amended application) consistent with the Board's Order. Without clarification or reconsideration to explicitly set aside or vacate the PTC, the Order might be interpreted as limiting DEQ's options on remand to just one predetermined outcome: develop additional facts to support the approved PTC as is.

Finally, setting aside or vacating DEQ's approval of the PTC is also required to comply with the Air Rules. Section 203 prohibits DEQ from issuing a PTC unless the applicant shows that the source "would comply with all applicable local, state or federal emissions standards" and using the methods in Section 210 "the emissions of toxic air pollutants . . . would not injure or unreasonably affect human or animal life or vegetation." Air Rules 203.01. The Board held that DEQ unreasonably determined that the Stibnite Gold Project would comply with applicable arsenic standards and would not injure or unreasonably affect health. The Board remanded the permit "for the development of further evidence regarding ambient air concentrations of arsenic" and to consider "whether those levels comply with the Air Rules." REC 3717. If Section 203 prohibits DEQ from issuing a PTC in the first instance when applicable Air Rules requirements are not met, then surely an already-issued PTC cannot remain valid when, like here, the Board finds that those same Air Rules requirements have not been met.

In summary, leaving the PTC in place during remand when the Board found that it fails to comply with arsenic standards is at odds with the Idaho APA, *Sunnyside Park*, and the Air Rules. It also puts public health at risk. Without clarifying or ordering on reconsideration that DEQ's approval of the PTC is set aside or vacated, the Order could be interpreted to allow Perpetua to begin construction and operations during remand before DEQ determines—or without DEQ ever determining—that the Stibnite Gold Project complies with the Air Rules.

CONCLUSION

For the reasons above, Petitioners respectfully request that the Board clarify or reconsider the remedy in its May 9, 2024 Final Order and now order that the PTC, while on remand, is set aside, vacated, or otherwise invalid until DEQ makes a new decision on the PTC application, or an amended application, consistent with the Board's order.

Dated: May 23, 2024

Respectfully submitted,

/s/ Bryan Hurlbutt
Bryan Hurlbutt
Attorney for the Nez Perce Tribe and the Idaho Conservation League

/s/ Julia S. Thrower
Julia S. Thrower
Attorney for Save the South Fork Salmon

CERTIFICATE OF SERVICE

I hereby certify that on May 23, 2024, a true and correct copy of Petitioners' foregoing Motion was served on the following:

By email and U.S. Mail:
Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov

By email only:

Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, ID 83706
(208) 373-0422
hannah.young@deq.idaho.gov
Attorney for Respondent Idaho Department of Environmental Quality

Krista McIntyre
W. Christopher Pooser
Wade Foster
Stoel Rives, LLP
101 S. Capital Blvd., Suite 1900
Boise, ID 83702
(208) 389-9000
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
Attorneys for Intervenor Perpetua Resources of Idaho, Inc.

Ann Yribar
Deputy Attorney General
Office of the Attorney General
P.O Box 83720
Boise, ID 83720-0010
ann.yribar@ag.idaho.gov
Attorney for the Idaho Board of Environmental Quality

Dylan B. Lawrence
Varin Thomas, LLC
242 N. 8th St., Suite 220
Boise, ID 83702
(208) 345-6021
dylan@varinthomas.com
Hearing Officer

Paula Wilson, Paralegal
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
paula.wilson@deq.idaho.gov
Hearing Coordinator

/s/ Bryan Hurlbutt
Bryan Hurlbutt

RAÚL R. LABRADOR
Attorney General

SCOTT L. CAMPBELL
Deputy Attorney General
Chief, Energy and Natural Resources Division

Hannah M.C. Young, ISB No. 9781
hannah.young@deq.idaho.gov
Michael A. Short
michael.short@deq.idaho.gov
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: 208.373.0453

Attorney for Respondent

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047

NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,

Petitioners,

v.

IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,

Respondent,

and

PERPETUA RESOURCES IDAHO, INC.,

Intervenor-Respondent.

Case Docket No. 0101-22-01
OAH Case No. 23-245-01

JOINT MOTION FOR RECONSIDERATION AND/OR CLARIFICATION OF FINAL ORDER

The Idaho Department of Environmental Quality ("DEQ") and Perpetua Resources Idaho, Inc. ("Perpetua") respectfully submit this Joint Motion for Reconsideration and/or Clarification of the Final Order issued by the Board of Environmental Quality (the "Board") on May 9, 2024. This motion is brought pursuant to Idaho Code § 67-5246(4), IDAPA 04.11.01.740.02, and IDAPA 04.11.01.770. This motion is supported by the memorandum in support filed herewith and the administrative record in this matter.

As set forth more fully in the supporting memorandum, DEQ and Perpetua respectfully request that the Board reconsider its decision that DEQ did not act reasonably and in accordance with the law when it analyzed the ambient concentration for arsenic. Alternatively, DEQ and Perpetua request that the Board reconsider and/or clarify the remand instructions to the Hearing Officer for "development of further evidence."

DATED: May 23, 2024.

DEPARTMENT OF ENVIRONMENTAL QUALITY

/s/ Hannah M.C. Young
Hannah M.C. Young
Michael A. Short
Deputy Attorney General

Attorney for Respondent
STOEL RIVES LLP

/s/ W. Christopher Pooser
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Intervenor-Respondent Perpetua Resources Idaho, Inc.

CERTIFICATE OF SERVICE

I hereby certify that on May 23, 2024, a true and correct copy of the foregoing JOINT MOTION FOR RECONSIDERATION AND/OR CLARIFICATION OF FINAL ORDER was served on the following:

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

Dylan B. Lawrence
Hearing Officer
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Bryan Hurlbutt
Laird ("Laird") J. Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
ann.yribar@ag.idaho.gov
via electronic service

Paula Wilson, Hearing Coordinator
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, Idaho 83706
paula.wilson@deq.idaho.gov
via electronic service

/s/ DeAnne M. Chaffin
DeAnne M. Chaffin
Legal Assistant

RAÚL R. LABRADOR
Attorney General

SCOTT L. CAMPBELL
Deputy Attorney General
Chief, Energy and Natural Resources Division

Hannah M.C. Young, ISB No. 9781
hannah.young@deq.idaho.gov
Michael A. Short
michael.short@deq.idaho.gov
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: 208.373.0453

Attorney for Respondent

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047

NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,

Petitioners,

v.

IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,

Respondent,

and

PERPETUA RESOURCES IDAHO, INC.,

Intervenor-Respondent.

Case Docket No. 0101-22-01
OAH Case No. 23-245-01

MEMORANDUM IN SUPPORT OF JOINT MOTION FOR RECONSIDERATION AND/OR CLARIFICATION OF FINAL ORDER

TABLE OF CONTENTS

INTRODUCTION AND BACKGROUND 3

RELIEF REQUESTED 4

STANDARD OF REVIEW 5

ARGUMENT 6

I. The Board must reconsider its holding that DEQ did not act reasonably and in accordance with law when it analyzed arsenic ambient concentrations. 6

A. There is sufficient evidence in the record to support the T-RACT analysis limiting production from the non-West End Pits. 6

1. Relevant background on DEQ's T-RACT ambient concentration analysis. 7

2. A 50% limit for the non-West End Pits is unnecessary because the total production from the SGP cannot exceed 788.4 million tons. 9

B. The record supports that DEQ acted reasonably and in accordance with the law when it adjusted the exposure duration for the arsenic ambient concentration analysis to reflect the 16-year life of the mine 10

1. Compliance with the AACCs is not demonstrated based on an annual average but on EPA's lifetime inhalation unit risk factors. 11

2. Adjusting the T-RACT ambient concentration to reflect exposure duration is consistent with the Air Rules. 13

C. The record supports that DEQ acted reasonably in using a five-year rolling average for T-RACT that was properly supported by permit conditions. 17

II. If the Board remands to the Hearing Officer to conduct additional hearings, DEQ and Perpetua seek reconsideration and/or clarification of the remand instructions. 18

CONCLUSION 19

INTRODUCTION AND BACKGROUND

On May 9, 2024, the Board of Environmental Quality (the "Board") issued a Final Order in this contested case. *See* REC 3695-3720. On four of the five claims presented, the Board found the Idaho Department of Environmental Quality ("DEQ") acted reasonably and in accordance with the law in issuing a Permit to Construct ("PTC") to Perpetua Resources Idaho, Inc. ("Perpetua") for the Stibnite Gold Project ("SGP"). REC 3698-3706. On the fifth issue, the Board held DEQ did not act reasonably and in accordance with the law when it analyzed ambient concentrations of arsenic from the SGP and determined those levels were less than the amount of arsenic that would contribute to an ambient air cancer risk probability of less than one to one hundred thousand (1:100,000). REC 3706-3717.

Specifically, the Board found that (1) there was insufficient evidence to support the T-RACT analysis limiting production from the non-West End Pits; (2) DEQ did not act reasonably and in accordance with the law when it applied an exposure duration of 16/70 to calculate the arsenic ambient concentration; and (3) DEQ did not act reasonably in using a five-year rolling average for T-RACT. *Id*. The Board's findings are factually and legally incorrect and are based on misunderstandings of DEQ's acceptable ambient concentrations for carcinogens ("AACCs") and the lifetime exposure risk represented in Section 586 of the Rules for the Control of Air Pollution in Idaho, IDAPA 58.01.01 (2022) (the "Air Rules").[1]

DEQ and Perpetua move the Board to reconsider and/or clarify its holding that DEQ's analysis of arsenic ambient concentrations was unreasonable and unlawful. The record before the Board confirms that DEQ issued the PTC in accordance with the Air Rules, that arsenic emissions from the SGP do not present an unacceptable risk to human health or the environment,

[1] Because the PTC was issued in June 2022, the 2022 version of the Air Rules applies.

and that the PTC as issued is a valid authorization to construct. If the Final Order stands, the Board will have improperly altered the meaning and interpretation of the Air Rules in a manner that is inconsistent with analytical methods and permitting tools that DEQ has utilized for over 30 years to implement its toxic air pollutant program. To ensure DEQ's toxic air pollutant program is administered consistently, correctly, and in compliance with the Air Rules, the Board must grant DEQ and Perpetua the relief requested.

RELIEF REQUESTED

Before addressing the relief requested, DEQ and Perpetua must first raise a procedural error in the Board's issuance of a "final order" that affords judicial review under I.C. § 67-5270. The Board issued the Final Order under I.C. § 67-5246 and also remanded this matter back to the Hearing Officer "for the development of further evidence" on DEQ's analysis of ambient concentrations of arsenic. REC 3717, 3720. The Board's issuance of a "final order" subject to I.C. § 67-5270 was error for two reasons.

First, a final order in a contested case is one that constitutes a final determination of the parties' rights. *In re Johnson*, 153 Idaho 246, 250 n.5, 280 P.3d 749, 753 n.5 (Ct. App. 2012). "If issues necessary for a final determination of the parties' rights remain unresolved, there is no final order." *Id*. Second, in reviewing a preliminary order, the Board can take one of three actions: "(a) Issue a final order in writing …; (b) Remand the matter for additional hearings; or (c) Hold additional hearings." I.C. § 67-5245(6). The word "or" in the statute is disjunctive, meaning that each item is considered an alternative to the others. *State v. Herren*, 157 Idaho 722, 726, 339 P.3d 1126, 1130 (2014). Having remanded this matter for additional, albeit narrow proceedings before the Hearing Officer, the Board cannot also issue a "final order."

That leads to DEQ and Perpetua's requested relief for reconsideration and/or clarification and the Board's options under I.C. § 67-5245(6):

- DEQ and Perpetua ask the Board to reconsider its decision regarding DEQ's analysis of arsenic ambient concentrations and issue a final order that finds DEQ acted reasonably and in accordance with law. The Board has the authority to do so under I.C. §§ 67-5246(4) and 67-5245(6)(a).
- Alternatively, DEQ and Perpetua ask the Board to reconsider its decision regarding DEQ's analysis of arsenic ambient concentrations and reopen the proceedings before the Board and hold an additional hearing on the analysis before issuing a final order. The Board has the authority to do so under I.C. §§ 67-5246(4) and 67-5245(6)(c).
- If, however, the Board remands for additional hearings before the Hearing Officer under I.C. § 67-5245(6)(b), DEQ and Perpetua ask the Board to reconsider and/or clarify its instructions on remand so that the Hearing Officer and the parties directly address the sufficiency of evidence the Board seeks in order to affirm the PTC.

In the event the Board decides to hold additional hearings or remand for additional hearings before the Hearing Officer, the Board must issue a non-final order finding that DEQ acted reasonably and in accordance with law on the first four issues considered and instructing the parties on the issues to be heard before the Board or on remand.

STANDARD OF REVIEW

Parties to a contested case may seek reconsideration or clarification of a final order within 14 days of the service date of the order. I.C. § 67-5246(4); IDAPA 04.11.01.740.02; IDAPA 04.11.01.770. While the Idaho Administrative Procedure Act and contested case rules do not address the standard for reconsideration, Idaho courts are well versed in such motions. The "purpose of a motion for reconsideration is to reexamine the correctness of an order." *Int'l Real Est. Sols., Inc. v. Arave*, 157 Idaho 816, 819, 340 P.3d 465, 468 (2014). A "'reconsideration in

the trial court usually involves new or additional facts, and a more comprehensive presentation of both law and fact. Indeed, the chief virtue of a reconsideration is to obtain a full and complete presentation of all available facts, so that the truth may be ascertained, and justice done, as nearly as may be.'" *Coeur d'Alene Mining Co. v. First Nat'l Bank of N. Idaho*, 118 Idaho 812, 823, 800 P.2d 1026, 1037 (1990) (citation omitted).

Here DEQ and Perpetua do not introduce new or additional facts but present a more comprehensive presentation of the law and facts in the record before the Board that bear on the incorrectness of the Final Order.

ARGUMENT

I. The Board must reconsider its holding that DEQ did not act reasonably and in accordance with law when it analyzed arsenic ambient concentrations.

For the reasons below, DEQ and Perpetua request that the Board reconsider the Final Order and either issue a final order that is factually and legally correct or hold additional hearings before the Board. *See* I.C. § 67-5246(4); I.C. § 67-5245(6)(a) and (c).

A. There is sufficient evidence in the record to support the T-RACT analysis limiting production from the non-West End Pits.

The Board erred in finding there was insufficient evidence to support the T-RACT analysis limiting production from the non-West End Pits. *See* REC 3713-3714. The Board misunderstood the life-of-mine production limits in PTC Condition 3.6 and the air emissions modeling and calculation supporting the T-RACT ambient concentration analysis for arsenic. As a result, the Board incorrectly concluded that the PTC must limit production from the non-West End Pits by 50% to demonstrate preconstruction compliance with the arsenic AACC.

1. Relevant background on DEQ's T-RACT ambient concentration analysis.

Petitioners did not challenge the absence of a production limit on the non-West End Pits. *See* REC 0263-0292, REC 3451-3507, C-REC 3647-3671. Thus, DEQ and Perpetua did not provide the Hearing Officer or the Board with the relevant background. We do so now.

DEQ initially modeled 14 hypothetical operating scenarios to evaluate the potential maximum hourly, daily, and annual emissions from all feasible origin and destination combinations for mining ore and development rock. REC 0431. As DEQ explained in the Statement of Basis, "Although drilling, blasting, excavating, and hauling activities are not expected to be confined to a single scenario in practice, emissions in each scenario were conservatively estimated at the maximum daily proposed processing rate … to allow for maximum operational flexibility, and to evaluate potential air quality impacts." *Id*. The operating scenarios for the West End Pit are identified as modeling scenarios W1-W5. *See id*. The operating scenarios for the non-West End Pits (Yellow Pine, Hangar Flats, and Bradley) are identified as modeling scenarios Y1, Y2, Y3, H1, H2, H3, H4, B1, and B2. *See id*.

To analyze the risk of carcinogenic toxic air pollutants, including arsenic, DEQ conducted modeling for the same operational scenarios using an emissions inventory that included T-RACT controls and long-term production limits that could be imposed in the PTC. REC 0701, 0714. The operating adjustments DEQ made include:

- The removal of modeling scenario W5 after Perpetua decided not to construct the West End developmental rock storage facility; and
- Limiting the West End Pit's life-of-mine production to 50% of SGP's total life-of-mine production of 788.4 million tons (50% * 788.4 million tons = 394.2 million tons).

REC 0699, 0710. SGP's total life-of-mine production limit is based on DEQ limiting the project's total production to 135,000 tons per day over the 16-year life of the mine. *See id*. To ensure compliance with the Air Rules' toxic air pollutant provisions, DEQ included PTC Condition 3.6, which limits the total life-of-mine production for SGP to 788.4 million tons from all deposits and 394.2 million tons from the West End Pit. REC 0385, 0421.

As a result, the West End Pit is limited to 394.2 million tons of production, the non-West End Pits are each individually limited to 788.4 million tons of production, and total maximum production from the SGP is limited to 788.4 million tons. DEQ's modeling of carcinogenic toxic air pollutants was based on the production limits in Condition 3.6. At those maximum production rates, DEQ modeled the remaining 13 operating scenarios on a receptor-by-receptor basis: the non-West End Pits (modeling scenarios B1, B2, H1, H2, H3, H4, Y1, Y2, and Y3) and the West End Pit (modeling scenarios W1-W4). REC 0710-0711, 0714, 1944-1945, 2144.

The non-West End modeling scenarios were based on 788.4 million tons of production for each operating scenario and showed compliance with the arsenic AACC. *See* REC 0710, 0714, 2144. West End modeling scenarios were based on 394.2 million tons of production for each modeling scenario, with the remaining 50% of production coming from the non-West End Pits. REC 0710-0711. Worst-case impacts for arsenic were associated with the West End modeling scenarios, due to the proximity of the West End Pit to the location of the maximum arsenic impact. REC 0714-0715. The West End modeling was performed on a receptor-by-receptor basis to identify the receptor site with the highest T-RACT ambient concentration of arsenic of all the receptor sites and all the modeling scenarios. REC 0711. That turned out to be West End modeling scenario W2. REC 0714.

2. A 50% limit for the non-West End Pits is unnecessary because the total production from the SGP cannot exceed 788.4 million tons.

The Board was unable to determine why and how the production of the non-West End Pits was adjusted and limited by 50% in the West End modeling scenarios. REC 3714. In particular, the Board cited the equation at REC 0710-0711 and reproduced at page 18 of the Final Order:

$$LifeExpose_{Wi,j,n} = \left[\left(WEPExpose_{Wi,n}\right)(50\%) + \left(nonWEPExpose_{Sj,n}\right)(50\%)\right]\left[\frac{16\ year\ LOM}{70\ year\ exposure}\right]$$

REC 3712. Referring to this equation, the Board asked where the 50% reduction for the non-West End Pits came from and why the PTC did not limit production from the non-West End Pits by 50%. REC 3714. The answers lie in DEQ's worse-case T-RACT modeling analysis, *see* REC 0699-0720 and the fact that the equation was used to calculate the lifetime arsenic exposure from the West End operating scenarios (W1-W4)—not the non-West End operating scenarios—on a receptor-by-receptor and scenario-by-scenario basis, REC 0710-0711.

Again, to ensure compliance with the highest modeled T-RACT ambient concentration (W2), the West End modeling scenarios were based on a maximum of 394.2 million tons (50% of 788.4 MT) of production as set forth in Condition 3.6, with the remaining 50% of production coming from the non-West End Pits. REC 0710-0711. This 50%–50% split is shown in the equation above. That is reasonable and logical: if the West End Pit is mined to its maximum allowed production of 394.2 million tons (which results in maximum modeled concentrations to demonstrate compliance under the W2 operating scenario), then total production from the non-West End Pits is limited to the remaining 50%. Further, if less than 50% production occurs from the West End Pit, then the production from the non-West End Pits will be more than 50%. And as noted, all non-West End operating scenarios demonstrated compliance with the PTC maximum production limit of 788.4 million tons.

In sum, with the West End Pit production limited by 50% in Condition 3.6, a second 50% limit for the non-West End Pits is unnecessary and would be redundant considering the total production from the SGP cannot exceed 100% (788.4 million tons). It follows that there is no need to establish a second 50% limit for the non-West End Pits. Contrary to the Board's decision, there was sufficient evidence in the record to demonstrate how the production of non-West End Pits was limited and why a permit condition limiting production from the non-West End Pits to 394.2 million tons was unnecessary to support the T-RACT ambient concentration analysis. The Board should grant reconsideration.

B. The record supports that DEQ acted reasonably and in accordance with the law when it adjusted the exposure duration for the arsenic ambient concentration analysis to reflect the 16-year life of the mine.

The Board erred in finding that the Air Rules do not allow consideration of an exposure duration of 16 years in determining preconstruction compliance with the AACCs under Sections 210.12 and 586. According to the Board, the Air Rules do not "provide that a project that will operate more than 5 years but less than 70 years may be adjusted in proportion to the amount of time it will operate." REC 3715. The Board could also not find sufficient evidence in the record to support DEQ's analysis and presumed a toxicologist or other qualified expert is needed to cure perceived evidentiary gaps. REC 3715-3717. The Board's conclusions are factually and legally incorrect and jeopardize the lawful, efficient, and effective permitting of toxic air emission sources in Idaho. The Board misinterpreted Rule 210.12 and 586 to require an annual compliance demonstration and ignored that the arsenic AACC is calculated based on 70 years of continuous exposure. The evidence in the record shows DEQ properly adjusted the T-RACT ambient concentration analysis for 16 years of exposure duration.

1. Compliance with the AACCs is not demonstrated based on an annual average but on EPA's lifetime inhalation unit risk factors.

DEQ and Perpetua first address the Board's flawed understanding of the cancer risk associated with carcinogenic exposure and misunderstanding that compliance with the AACCs is "based on annual averages." *See* REC 3708, 3712, 3713. Under its enabling statute, DEQ has the authority to utilize the best available peer reviewed science and supporting studies when adopting the Air Rules. *See* I.C. § 39-107D. DEQ did that here. DEQ adopted the AACCs and Unit Risk Factors ("URFs") in Section 586 based on EPA published toxicity values. As explained below, AACCs are derived from URFs. The Air Rules specifically identify "URF" to mean "Unit Risk Factor from the US Environmental Protection Agency." *See* IDAPA 58.01.01.106.19, .586 (2022).

Thus URFs and AACCs are not developed by DEQ. EPA develops toxicity values resulting from chronic exposure to chemicals and publishes them in the Integrated Risk Information System ("IRIS"), a database maintained by EPA and accessible at https://www.epa.gov/iris.[2] In the IRIS database, EPA refers to URFs as "inhalation unit risks" or "IURs," which it defines as "an estimate of the increased cancer risk from inhalation exposure to a concentration of 1 µg/m^3 for a lifetime. The IUR can be multiplied by an estimate of lifetime exposure (in µg/m^3) to estimate the lifetime cancer risk."[3]

[2] All websites were last visited on May 23, 2024.

[3] U.S. EPA, Basic Information about the Integrated Risk Information System, IRIS Toxicity Values, https://www.epa.gov/iris/basic-information-about-integrated-risk-information-system#process; *see also* U.S. EPA, IRIS Glossary, Inhalation Unit Risk, https://www.epa.gov/iris/iris-glossary (defined as: "The upper-bound excess lifetime cancer risk estimated to result from continuous exposure to an agent at a concentration of 1 µg/m³ in air. The interpretation of inhalation unit risk would be as follows: if unit risk = 2×10^{-6} per µg/m³, 2 excess cancer cases (upper bound estimate) are expected to develop per 1,000,000 people if exposed daily for a lifetime to 1 µg of the chemical per m³ of air.").

EPA uses 70 years to represent a lifetime.[4] Thus, a lifetime cancer risk of 1 in 1,000,000 means that, if 1 million people are continuously exposed to a defined level of a pollutant (the IUR) continuously for 70 years (*i.e.*, 24 hours a day exposure for 365 days a year for 70 years), one person may develop cancer.[5] *See also* REC 1242. For inorganic arsenic, EPA determined the IUR is 4.3E-3 per µg/m^3 (0.0043 / µg/m^3) based on respiratory cancer mortality observed in smelter workers. *See* U.S. EPA, Arsenic, Inorganic; CASRN 7440-38-2 at pp. 16-17.[6] This IUR estimates an increase in cancer risk of 1 in 1,000,000 cases at an arsenic air concentration of 2.3E-4 µg/m^3 (0.00023 µg/m^3) assuming continuous lifetime (70 year) exposure. *See id*. at p. 16. Because both the numerator and denominator of the IUR assume a 24 hour per day exposure for 365 days per year for 70 years, the calculation of EPA's arsenic air concentration is simply the risk divided by the IUR: 0.000001/.0043 per µg/m3 = 0.00023 µg/m3. *See id*.

Having originated from EPA's IRIS database, DEQ's arsenic URF (4.3E-3 per µg/m^3) and expression of the acceptable risk in the AACC (2E-4 µg/m^3) are the same as EPA's IUR and air concentration risk level for arsenic. *See* IDAPA 58.01.01.586 (2022). DEQ's definition of "toxic air pollutant carcinogenic increments" also makes clear that DEQ has adopted EPA's toxicity values and risk assessment methodology:

> Those ambient air quality increments based on the probability of developing excess cancers over a seventy (70) year lifetime exposure to one (1) microgram per cubic meter (1 ug/m3) of a given carcinogen and expressed in terms of a screening emission level or an acceptable ambient concentration for a carcinogenic toxic air pollutant. They are listed in Section 586.

---

[4] U.S. EPA, Background on Risk Characterization, https://archive.epa.gov/airtoxics/nata/web/html/riskbg.html.

[5] U.S. EPA, AirTox Frequent Questions, Q1, https://www.epa.gov/AirToxScreen/airtoxscreen-frequent-questions#risk1.

[6] U.S. EPA, IRIS, Arsenic, Inorganic, https://iris.epa.gov/static/pdfs/0278_summary.pdf; https://iris.epa.gov/ChemicalLanding/&substance_nmbr=278;

IDAPA 58.01.01.006.125 (2022); *see also* REC 1242-1243. Without question, continuous exposure for a 70-year lifetime is accounted for and incorporated in the calculation of the AACCs. The value assumes the exposure duration and the lifetime are equal. The AACCs reflect that a person is exposed 24 hours per day for 365 days a year for 70 years at the AACC level.

Thus, the Board's finding the AACCs "are based on annual averages" is wrong. *See* REC 3708, 3712, 3713. The AACCs are not an annual standard. They are an expression of risk represented in DEQ's modeling analyses as an annual average concentration. As Section 586 states, "The AACC in this section *are* annual averages." IDAPA 58.01.01.586 (2022) (emphasis added). The rule does not specify compliance on an annual basis. Nor does Section 210.12. *See* IDAPA 58.01.01.210.12 (2022). Rather, *the AACCs are modeled as annual averages*, as opposed to daily or hourly averages, *for each year of the exposure duration*. The AACCs, as derived from EPA's published IUR values, do not prompt or require demonstration of compliance on an annual basis. Compliance is measured over the exposure duration.

2. Adjusting the T-RACT ambient concentration to reflect exposure duration is consistent with the Air Rules.

By adopting EPA's URFs, DEQ adopted EPA's implementation and application methods for analyzing toxic air pollutant ambient concentrations. That includes EPA's recognition that exposure duration is not always 70 years. When the exposure duration is less than 70 years, EPA describes how adjustments are made to correctly use the values, just as DEQ did here. EPA's "toolbox for exposure assessors" (called EPA ExpoBox)[7] explains that "[e]stimating exposure from inhalation requires information on the concentrations of contaminants in the air and *the*

[7] *See* U.S. EPA ExpoBox (A Toolbox for Exposure Assessors) (explaining that EPA ExpoBox "is a toolbox created to assist individuals from within government, industry, academia, and the general public with assessing exposure. It is a compendium of exposure assessment tools that links to guidance documents, databases, models, reference materials, and other related resources").

timeframe over which inhalation exposure occurs." Exposure Assessment Tools by Routes – Inhalation (emphasis added).[8] EPA also explains: "Using EPA's current methodology, it is unnecessary to calculate an inhaled dose when using dose-response factors from IRIS in a risk assessment. However, *inhalation risk assessments may require that an adjusted air concentration be used to represent continuous exposure*." *Id*. (emphasis added).

Thus, for AACCs to be applied properly, the ambient concentration being evaluated must be adjusted to reflect the exposure duration (ED). Otherwise, the comparison to the AACC will be incorrect. EPA uses an equation to determine the adjusted air concentration ($C_{air\text{-}adj}$), where for carcinogens the exposure is averaged over the assumed 70-year lifetime:

$$C_{air-adj} = C_{air} \times ET \times \frac{1\ day}{24\ hours} \times EF \times ED/AT$$

Where:
C_{air} = Concentration of contaminant in air (mg/m^3)
ET = Exposure time (hours/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
AT = Averaging time (days)

Id. In the equation, the concentration in air (C_{air}) is either a measured or modeled value. *Id*. The temporal parameters in the equation include:

- Exposure time (ET) and exposure frequency (EF), which "refer to the frequency with which the exposure occurs and might be provided in hours per day and days per year, respectively."

[8] *See* EPA ExpoBox, https://www.epa.gov/expobox/exposure-assessment-tools-routes-inhalation.

- Exposure duration (ED), which "is the amount of time that an individual or population is exposed to the contaminant being evaluated and is typically given in years."
- Averaging time (AT), which is the amount of time over which exposure is averaged for chronic assessments (*e.g.*, cancer).

Id. Since EPA's URF values are adopted at Section 586 as AACCs with an expected 70-year lifetime exposure, DEQ must adjust the arsenic concentration to reflect the exposure duration to ensure the comparison to the AACC is correct.

DEQ's evaluation followed EPA's framework to adjust the air concentration ($C_{air\text{-}adj}$) for an exposure duration known to be less than 70 years. *See* REC 0710. For the exposure duration, DEQ used the 16/70 adjustment following EPA tools established for URF values. *See id*. Specifically, again, the highest modeled T-RACT ambient concentration of arsenic resulted from West End modeling scenario W2. This is the C_{air} in EPA's equation above. That annual average modeled concentration was 0.00414 µg/m^3. *See* REC 2144.[9] Using EPA's equation for proper implementation of the URF to reflect exposure duration, the arsenic T-RACT ambient concentration (or $C_{air\text{-}adj}$) is:

$C_{air\text{-}adj}$ = 0.00414 µg/m^3 x 24 hours/day x 365 days/year x 16 years /
24 hours/day x 365 days/year x 70 years = 0.00095 µg/m^3

This is the correct T-RACT ambient concentration (0.00095 ug/m3) to compare to the T-RACT AACC representing a 1:100,000 risk probability (0.0023 ug/m3). *See* IDAPA 58.01.01.210.12 (2022). Further, using the arsenic URF in accordance with EPA, the risk probability is calculated from the highest modeled T-RACT ambient concentration (C_{air} of 0.00414 µg/m^3) using the exposure duration and averaging time:

[9] REC 2144 shows an adjusted ambient concertation of 0.00095 µg/m3, which is 0.00414 µg/m^3 * 16/70.

Risk = (0.00414 ug/m3 x 24 hours/day x 365 days/year x 16 years /
24 hours/day x 365 days/year x 70 years) x (4.3E-3 per $\mu g/m^3$) = 4.1E-06

A risk of 4.1E-06 is a risk of 4:1,000,000 or 1:246,056. In other words, DEQ's comparison demonstrated a risk probability of less than 1:100,000. REC 0710.

Using the correct T-RACT ambient concentration (or $C_{air\text{-}adj}$) to compare to the T-RACT AACC is required by the Air Rules. Section 210.12.b requires that DEQ *compare* the T-RACT ambient concentration to the T-RACT AACC to show compliance:

> Compare the source's or modification's approved T-RACT ambient concentration at the point of compliance for the toxic air pollutant to the amount of the toxic air pollutant that would contribute an ambient air cancer risk probability of less than one to one hundred thousand (1:100,000) (which amount is equivalent to ten (10) times the applicable acceptable ambient concentration listed in Section 586).

IDAPA 58.01.01.210.12.b (2022). By adopting the URF and EPA's methods for proper toxicity assessment, the T-RACT ambient concentration ($C_{air\text{-}adj}$) must reflect the exposure duration to make a proper comparison to the T-RACT AACC. If not, as the Hearing Officer recognized, the "comparison of emissions that will only take place for 16 years to a standard that is based on an assumed 70-year exposure period is an 'apples to oranges' comparison." REC 3418.

Thus, DEQ acted in accordance with the Air Rules and followed the proper framework for adjusting the exposure concentration for the actual exposure duration when the inhalation exposure is less than 70 years. REC 0710. DEQ demonstrated preconstruction compliance because the SGP's approved T-RACT ambient concentration at the point of compliance is less than or equal to an ambient air cancer risk probability of less than one to one hundred thousand (1:100,000). IDAPA 58.01.01.210.12.b and c (2022). DEQ compared the T-RACT ambient concentration to the T-RACT AACC, considering exposure duration (16 years) consistent with adoption of the URF-based arsenic concentration that defaults to lifetime exposure (70 years).

Contrary to the Board's holding, DEQ complied with the Air Rules by comparing the T-RACT ambient concentration (or $C_{air\text{-}adj}$) to the T-RACT AACC. *See* REC 3715.

For the same reasons, the record before the Board includes sufficient evidence to support how the exposure duration adjustment relates to human toxicology and cancer risk. REC 3715, 3717. No additional evidence from a toxicologist or other qualified expert regarding the protectiveness of the analysis performed by DEQ is necessary. *See* REC 3716. Sufficient evidence resides in the record and is grounded in the URF and AACC values selected by DEQ from EPA published toxicity values. DEQ's determination of acceptable risk is consistent with the adoption of those values and the framework to assess the acceptable risk from ambient air concentrations. All the information needed to perform these calculations is in the record before the Board. DEQ's 16/70 adjustment aligns with EPA's framework to reflect the exposure duration in carcinogenic risk reviews.

For those reasons, the Board should reconsider its decision that DEQ did not act reasonably and in accordance with the law when it applied an exposure duration of 16/70 to calculate the worst-case T-RACT arsenic ambient concentration.

C. The record supports that DEQ acted reasonably in using a five-year rolling average for T-RACT that was properly supported by permit conditions.

The Board also misunderstood the T-RACT production limits imposed in the PTC and how DEQ used those limits in modeling ambient concentrations of arsenic. REC 3712-3713. PTC Condition 3.5 limits the production of the SGP to 135,000 tons per year based on a five-year rolling average. REC 0385. The Board found "no evidence in the record explaining how the five-year rolling average comports with the annual AACC limits," assuming the AACCs "are based on annual averages" and the five-year rolling average "allows for a smoothing out of the peak concentrations of ambient arsenic." REC 3713.

As already explained, the Board erred in finding the arsenic AACC is an annual standard under Section 586 requiring a demonstration of compliance on an annual basis. The AACC is an expression of risk over a lifetime (70 years) of continuous exposure represented as an annual average. After confirming compliance with the 16-year exposure duration, DEQ determined that a five-year rolling average production limit ensured the mine is operated in a manner described in the compliance demonstration under Section 210.12.d. DEQ selected the five-year averaging period to provide Perpetua operational flexibility and ensure compliance with the 16-year exposure duration. Any averaging period on the production limit that is equal to or less than the exposure duration of 16 years is consistent with Sections 210.12 and 586 and will not increase or decrease the cancer risk.

The Board overlooked sufficient evidence in the record to determine that a five-year rolling average would be protective of the arsenic AACC. The Board should also reconsider its finding that DEQ acted unreasonably in using a five-year rolling average for T-RACT.

II. If the Board remands to the Hearing Officer to conduct additional hearings, DEQ and Perpetua seek reconsideration and/or clarification of the remand instructions.

In the event the Board remands for additional hearings before the Hearing Officer, DEQ and Perpetua also seek reconsideration and/or clarification of the Hearing Officer's role to develop and consider further evidence. In remanding this matter "for the development of further evidence," the Board specifically referenced evidence "regarding the ambient air concentrations of arsenic that will be produced by the SGP and whether those levels comply with the Air Rules." REC 3717. Those instructions seeming conflict with the Board's finding that the Air Rules do not allow a project operating more than 5 years but less than 70 years to "be adjusted in proportion to the amount of time it will operate." REC 3715. The Board should reconsider and/or clarify if the Hearing Officer can decide whether DEQ's analysis complies with the Air Rules.

In addition, as discussed above, the Board made multiple findings of insufficient evidence "to support DEQ's analysis of the ambient arsenic air concentrations." REC 3706. The Board found insufficient evidence to support the use of the five-year rolling average, REC 3713, and to demonstrate how or whether the non-West End Pit production was limited, REC 3714. Regarding DEQ's consideration of exposure duration, the Board found insufficient evidence to support DEQ's analysis using the exposure duration of the SGP (which it thought resulted in a higher exposure to arsenic for a shorter period of time) that is equally or more protective of human and animal life and vegetation than what is provided for by the Air Rules. REC 3715, 3717. The Board also found insufficient evidence "in the form of an expert opinion from a toxicologist or other qualified expert regarding the cancer risk associated with the 16/70 adjustment." REC 3716.

DEQ and Perpetua seek clarification and confirmation that the Hearing Officer can hear additional testimony on those issues from DEQ staff, for example Kevin Schilling and Mike Simon, who the Hearing Officer found were qualified to give expert testimony. S*ee* REC 3833-3834, 3918-3922. In addition, DEQ and Perpetua seek to confirm that the parties can retain a toxicologist or other qualified expert regarding the acceptable cancer risk associated with the arsenic URF and AACC. The Board should clarify if the Hearing Officer is empowered to add to the existing record regarding the specific areas of insufficient evidence found by the Board, make findings with respect to the sufficiency of the evidence presented, and determine whether DEQ's arsenic ambient concentration analysis complies with the Idaho Air Rules.

CONCLUSION

This contested case involves a complex and complicated PTC for operations that are varied in activity and location throughout the SGP mine site. It also involves a dense record compiled over years of DEQ review and the need to understand toxic air pollutant carcinogenic

increments and technical analyses using modeling to demonstrate compliance with those increments. The Board's Final Order includes factual and legal mistakes that cannot be left to influence this proceeding or DEQ's future toxic air pollutant permitting. The Board's conclusions are unjustified scientifically and undermine the expertise and experience of DEQ professionals implementing the toxic air pollutant program for over 30 years.

For those reasons, the Board must grant reconsideration and address the mistakes raised here. The Board has the authority to either issue a final order that is factually and legally correct or hold additional hearings before the Board. Should, however, the Board remand for additional hearings before the Hearing Officer, it should clarify the Hearing Officer's role in developing and considering further evidence on remand to ensure the Hearing Officer and the parties directly address the sufficiency of evidence the Board seeks in order to affirm the PTC.

DATED: May 23, 2024.

DEPARTMENT OF ENVIRONMENTAL QUALITY

/s/ Hannah M.C. Young
Hannah M.C. Young
Michael A. Short
Deputy Attorney General

Attorney for Respondent

STOEL RIVES LLP

/s/ W. Christopher Pooser
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Intervenor-Respondent Perpetua Resources Idaho, Inc.

CERTIFICATE OF SERVICE

I hereby certify that on May 23, 2024, a true and correct copy of the foregoing MEMORANDUM IN SUPPORT OF JOINT MOTION FOR RECONSIDERATION AND/OR CLARIFICATION OF FINAL ORDER was served on the following:

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

Dylan B. Lawrence
Hearing Officer
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Bryan Hurlbutt
Laird ("Laird") J. Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
ann.yribar@ag.idaho.gov
via electronic service

Paula Wilson, Hearing Coordinator
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, Idaho 83706
paula.wilson@deq.idaho.gov
via electronic service

/s/ DeAnne M. Chaffin
DeAnne M. Chaffin
Legal Assistant

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	Agency Case No. 0101-22-01 OAH Case No. 23-245-01 **NOTICE OF SPECIAL MEETING OF THE BOARD OF ENVIRONMENTAL QUALITY | MAY 29, 2024**

NOTICE IS HEREBY GIVEN that the Board of Environmental Quality has scheduled a special meeting to review *Petitioners' Motion for Clarification and/or Reconsideration* and *Joint Motion for Reconsideration and/or Clarification of Final Order* filed by Respondent and Intervenor-Respondent.

The special meeting will be held on May 29, 2024, at 9:00 a.m. Mountain Time in conference rooms A and B at the Department of Environmental Quality State Office, 1410 N. Hilton, Boise, Idaho, with a Microsoft Teams link available for remote attendance. The meeting location and Teams link are available in the Meeting Notice posted at https://www.deq.idaho.gov/board-of-environmental-quality/.

Dated this 24th day of May, 2024.

/s/ Paula J. Wilson
Paula J. Wilson, Paralegal
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton, Boise, Idaho 83706
paula.wilson@deq.idaho.gov

CERTIFICATION OF SERVICE

I HEREBY CERTIFY that on this 24th day of May, 2024, the foregoing was filed, served, and copied as shown below.

Hannah Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
hannah.young@deq.idaho.gov

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
Counsel for the Idaho
Board of Environmental Quality
ann.yribar@ag.idaho.gov

Dylan Lawrence
Varin Thomas LLC
P.O. Box 1676
Boise, ID 83701
Hearing Officer
dylan@varinthomas.com

ARV, A Veritext Company
Court Reporting Service
calendar-arv@veritex.com

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-004
filings@oah.idaho.gov

/s/ Paula J. Wilson
Paula J. Wilson

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	Agency Case No. 0101-22-01 OAH Case No. 23-245-01 **NOTICE OF SPECIAL MEETING OF THE BOARD OF ENVIRONMENTAL QUALITY | JUNE 12, 2024**

NOTICE IS HEREBY GIVEN that the Board of Environmental Quality has scheduled a special meeting to take action on *Petitioners' Motion for Clarification and/or Reconsideration* and *Joint Motion for Reconsideration and/or Clarification of Final Order* filed by Respondent and Intervenor-Respondent. The Board will discuss and make a decision prior to service of the written order.

The special meeting will be held on June 12, 2024, at 9:00 a.m. Mountain Time in conference rooms A and B at the Department of Environmental Quality State Office, 1410 N. Hilton, Boise, Idaho, with a Microsoft Teams link available for remote attendance. The meeting location and Teams link are available in the Meeting Notice posted at

https://www.deq.idaho.gov/board-of-environmental-quality/.

Dated this 3rd day of June, 2024.

/s/ Paula J. Wilson
Paula J. Wilson, Paralegal
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, Idaho 83706
paula.wilson@deq.idaho.gov

CERTIFICATION OF SERVICE

I HEREBY CERTIFY that on this 3rd day of June, 2024, the foregoing was filed, served, and copied as shown below.

Hannah Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
hannah.young@deq.idaho.gov

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
Counsel for the Idaho
Board of Environmental Quality
ann.yribar@ag.idaho.gov

Dylan Lawrence
Varin Thomas LLC
P.O. Box 1676
Boise, ID 83701
Hearing Officer
dylan@varinthomas.com

ARV, A Veritext Company
Court Reporting Service
calendar-arv@veritex.com

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-004
filings@oah.idaho.gov

/s/ Paula J. Wilson
Paula J. Wilson

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	Agency Case No. 0101-22-01
	)	OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON	)	**PETITIONERS' RESPONSE OPPOSING DEQ/PERPETUA'S MOTION FOR RECONSIDERATION**
Petitioners,	)	
v.	)	
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC.	)	
Intervenor-Respondent.	)	

Petitioners Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon hereby oppose the Joint Motion for Reconsideration and/or Clarification of Final Order filed by DEQ and Perpetua on May 23, 2024. Petitioners respectfully request that the Board deny DEQ and Perpetau's request to reevaluate the merits, as the merits issues should be fairly and fully considered on remand, not on a one-sided motion for reconsideration.

This matter has been pending since June 17, 2022, when Petitioners filed the Petition to Initiated Contested Case. In that very first filing, Petitioners alleged that DEQ's arsenic averaging tactics violated the Air Rules because the Air Rules require meeting an annual arsenic concentration (the acceptable ambient concentrations of carcinogen or "AACC"). REC 0016, 19, 25–26. Throughout the proceedings before the Hearing Officer, Petitioners repeatedly and consistently argued that the AACC is an annual average that Perpetua must meet. REC 0335-36, 0360-62 (Opening SJ Br.); REC 2363-68 (Reply SJ Br.); TR 0019 (SJ Hearing). Petitioners made the same allegation and argument to the Board. REC 3437 (Am. Pet. for Rev.); REC 3469-506 (Opening Br.); C-REC 3667–71 (Reply Br.); TR 0070–71, 95 (Board Hearing).

On reconsideration, DEQ and Perpetua suggest that the Board made a mistake when it assumed that the arsenic AACC is an annual value, and they submit "new evidence" for the Board to correct this alleged oversight.[1] But DEQ and Perpetua could have presented this "new evidence" in any of their many filings over the last two years.[2] Instead, they try to introduce it now on reconsideration and without a full and fair opportunity for Petitioners to respond.

---

[1] The annual nature of the AACC underlies each of the three ways the Board found DEQ acted unreasonably and failed to follow the Air Rules, as Petitioners intend to show on remand.

[2] Though DEQ and Perpetua now file their motion for reconsideration together, they filed separate responses to the petitions and filed separate briefs on the merits, totaling eight such written filings on the merits before the Hearing Officer and the Board. *See* Corrected Record Docs 021, 028, 038, 043, 054, 055, 096, 097.

DEQ and Perpetua's "new evidence" is that the toxic air pollutants ("TAPs") and AACCs in the Air Rules were based on EPA's Unit Risk Factors ("URFs"), which were based on a 70-year lifetime. While the URFs did inform the TAPs rulemaking, DEQ and Perpetua ignore evidence from the TAPs rulemaking which confirms that the Board rightly concluded: the AACCs are annual averages; and there are specific, limited exceptions to meeting the AACCs, including the short-term source exception for facilities that operate for five years or less.

For example, DEQ explained in a July 13, 1992 meeting package in support of the TAPs rulemaking:

> For short term sources (usually less than five years in duration), such as remediation projects, a probability of greater than one in a million risk (over [ ] 70 years) will generally be acceptable to account for the decreased term of exposure. <u>It is not acceptable however, for exposed individuals to receive a full 70 year exposure during the life of a short term project</u>.

See Exh. 1 to Tiedemann Decl. (filed herewith) at Attach. 7 (emphasis added). Allowing a full 70-year exposure during the life of the 16-year Stibnite Gold Project is exactly what DEQ did here. This is "not acceptable" under the Air Rules, and the Board rightly rejected this in its Final Order.

DEQ and Perpetua's effort to introduce "new evidence" to the Board on a one-sided motion for reconsideration following years of litigation underscores that revisiting the merits without a remand and a full and fair opportunity to respond is prejudicial to Petitioners and undermines the Board's ability to reach the correct result. For these reasons, the Board should deny DEQ and Perpetua's motion for reconsideration and should allow these issues to be developed on remand with equal opportunities for the parties to provide evidence, argument, and response.

Dated: June 3, 2024

Respectfully submitted,

/s/ Bryan Hurlbutt
Bryan Hurlbutt
Attorney for the Nez Perce Tribe and the Idaho Conservation League

/s/ Julia S. Thrower
Julia S. Thrower
Attorney for Save the South Fork Salmon

CERTIFICATE OF SERVICE

I hereby certify that on June 3, 2024, a true and correct copy of Petitioners' foregoing Response, and the Declaration of William Tiedemann (and all exhibits thereto), and was served on the following:

By email and U.S. Mail:
Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov

By email only:

Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, ID 83706
(208) 373-0422
hannah.young@deq.idaho.gov
Attorney for Respondent Idaho Department of Environmental Quality

Krista McIntyre
W. Christopher Pooser
Wade Foster
Stoel Rives, LLP
101 S. Capital Blvd., Suite 1900
Boise, ID 83702
(208) 389-9000
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
Attorneys for Intervenor Perpetua Resources of Idaho, Inc.

Ann Yribar
Deputy Attorney General
Office of the Attorney General
P.O Box 83720
Boise, ID 83720-0010
ann.yribar@ag.idaho.gov
Attorney for the Idaho Board of Environmental Quality

Dylan B. Lawrence
Varin Thomas, LLC
242 N. 8th St., Suite 220
Boise, ID 83702
(208) 345-6021
dylan@varinthomas.com
Hearing Officer

Paula Wilson, Paralegal
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
paula.wilson@deq.idaho.gov
Hearing Coordinator

/s/ Bryan Hurlbutt
Bryan Hurlbutt

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	Agency Case No. 0101-22-01
	)	OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON	)	**DECLARATION OF WILLIAM TIEDEMANN**
Petitioners,	)	
v.	)	
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC.	)	
Intervenor-Respondent.	)	

I, WILLIAM TIEDEMMAN, hereby declare as follows:

1. The following facts are personally known to me, and if called as a witness, I could and would competently testify thereto. I am over eighteen years of age.

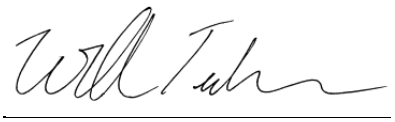
2. I am employed by the Idaho Conservation League (ICL) as a Conservation Associate.

3. The attached Exhibit is a true and correct copy of the following document, which I received from DEQ in respone to a public records request:

Exhibit 1: Meeting Packet, Idaho Division of Environmental Quality (July 13, 1992).

I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge, information, and belief, and based on my personal experiences.

Signed this 3rd day of June, 2024 in Boise, Idaho.



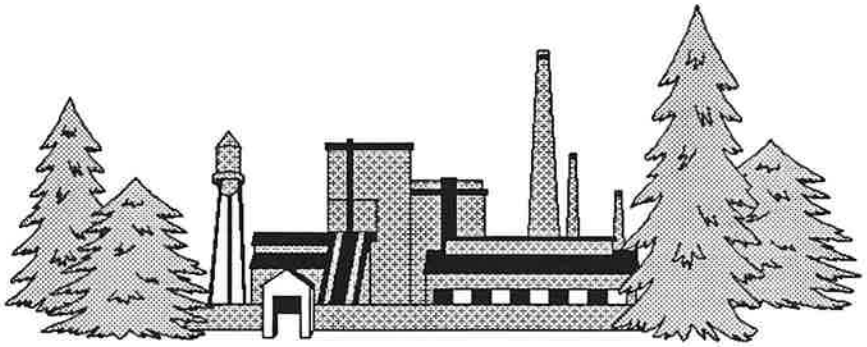
William Tiedemann

Exhibit 1 - Meeting Packet, Idaho Division of Environmental Quality (July 13, 1992)

5318

IDAHO DIVISION of

ENVIRONMENTAL QUALITY



MONDAY, JULY 13, 1992

Our Goal for Air Toxics Policy/Rule Making:

To protect the public health and the environment from the harmful effects of toxic air pollutants (TAP) per our responsibilities set forth in IDAPA 16.01.1011,01 and 1601.1952,02. and provide regulated industries with a reasonable, flexible, minimally burdensome framework with which to work.

Our Goal for this meeting:

To successfully negotiate air quality rules revisions that will satisfy the regulated industries need to have reasonable, flexible regulations that do not place an unwarranted impediment to their ability to do business in Idaho, while at the same time providing adequate protection to the public from the harmful effects of TAP. We hope that these revisions will provide industry with an awareness of what DEQ considers harmful and provide the basis for a straight forward and efficient permitting process.

Brief History of the DEQ TAP List

The DEQ TAP list (hereafter referred to as the list), was conceived as part of the New Source Review Policy, which was a response to the need to control the emissions of airborne toxic chemicals in the absence of effective EPA regulations. NESHAP (National Emmision Standards for Hazardous Air Pollutants, §122 of the 1970 Clean Air Act) had proven to be an ineffective means of of controling TAP as only seven pollutants were ever regulated after 17 years of the NESHAPS program.

It was the position of the DEQ that given the resources that we had available to us, that we would only attempt to hold the line on air quality and try to insure that new sources of air pollution did not "injure or unreasonably affect human or animal life or vegetation." One of the principal ways that we chose to do this was the development of a comprehensive list of TAP and, where possible, health based emissions limits and or acceptable ambient concentrations.

Our list was developed from a combination of sources. We surveyed what other states were doing and found that New Mexico had the most logical, straight approach to air toxics. The New Mexico list was chosen as the basis for our own TAP list. In addition, we looked at the Occupational Health and Safty Administration (OSHA), American Conference of Government and Industrial Hygenests (ACGIH) and National Institute for Occupational Safty and Health (NIOSH) occupational exposure limits (OEL) and threshold limit values (TLV) for non-carcinogens. For carcinogens we looked at the

data from the International Agency for Research on Cancer (IARC) and the Carcinogen Assesment Group of the EPA (CAG). In addition, we reviewed data from the Agency for Toxic Substances and Disease Registry of the Public Health Service. As many who have received periodic updates know, we have tried to continuously refine the list to reflect new data and to correct inaccuracies.

The DEQ list of regulated air toxics is quite large in scope. However, this was not done to burden industry. Quite the contrary. It was done in order, to the maximum extent possible, to provide industry with a ready reference to acceptable screening levels of these various compounds. This enables new sources to review their processes and see if controls, may be needed early on in the planning process, there by maximixing start up budget planning. In addition, it allows existing sources to review their emissions and see how they compare to the screening levels that the DEQ considers reasonably protective of human health and the environment. Please see appendix 6 for the derivation of emissions limits (EL) and acceptable ambient concentrations (AALC).

DEQ Position on the EPA "198" List

The EPA list of 189 compounds to be regulated represents a political process by the congress, rather than being put together by any environmental agency. This list is inadequate in and of it self to protect the air quality of Idaho or other specific location in the nation. This opinion is based on the following:

* The EPA 189 list is not an attempt to protect people or the environment of any specific area but a compromise list to address some of the major nation-wide sources of air pollution. The original proposed list contained 224 compounds, including ammonia and hydrogen sulfide which were later removed. We do not believe that this nation-wide effort can be effectively applied to Idaho and be adequate to address the unique Idaho situation. All along, EPA admitted that their agenda was not to protect all communities completely, rather their intent and design has been to address only pollutants and source catagories that are national in scope.

* The EPA 189 list does not include all the well documented carcinogens that have been assigned unit risk factors[1], let alone most possible and suspected carcinogens as listed in DEQ Appendix A2 of the New Source Review Policy. State and local agencies need to have the flexibility to protect public health by regulating the emission into the air of these very dangerous compounds should they be present locally.

* From only a partial inventory, we have found that there are currently being emitted into the ambient air of Idaho three known or suspected carcinogens which are not addressed by the EPA 189 list. In addition there are about 35 non-carcinogens of varying toxicity levels currently being emitted or being reviewed for new source permits.

* While it is not possible to predict the future, in a fast growing state like Idaho it is very reasonable to assume that new industries will be moving to Idaho as our work force expands with new residents. In addition, as environmental regulations in California and other states become more restrictive, Idaho will look more attractive to many of these regulated industries. This is already occurring in Nevada. While we certainly want the jobs and incomes that these industries may represent, just as certainly, we do not want to become a "toxic magnet" for polluting industries that other states don't want.

---

[1] Unit Risk Factors for a known or suspected carcinogen describes the possibility of developing excess cancers over a 70 year lifetime of exposure to 1 microgram per cubic meter of that substance.

* Title III of the Clean Air Act Amendments of 1990 (CAAA) requires EPA to publish a list of source categories and then promulgate maximum achievable control technology (MACT) for the first 40 categories. MACT standards are then required for the rest of the categories on a phased in schedule. Even if this time schedule was adhered to, the first MACT standards would not be available before November of 1992. Without its own TAP policy or rules and regulations, Idaho is thus without any appropriate air toxics regulation until EPA is finished. EPA is already late in publishing the first source category list.

* If a particular source in Idaho is not addressed in the first 40 source categories, the DEQ could be unable to address toxic emissions from that source no mater how toxic the emissions might be or in what quantity the emissions may be emitted until EPA finally promulgates MACT standards. Given the past history of EPA deadlines, this is a very real concern. Even if EPA adhered to all deadlines, some sources would conceivably still be able to emit unregulated toxics until the year 2000, if that source was in the last group to have standards promulgated. It should also be noted that not all sources are covered by these MACT standards. As a consequence, sources not covered by this MACT standard would be essentially unregulated in Idaho. Further, the majority of covered sources are associated with surface coating and manufacturing of the regulated chemicals, while fore most sources of TAP in Idaho, the TAP in question is used in or produced as a by-product of their processes.

* Finally, Congress itself apparently felt that this list was not final. Congress required the EPA to periodically review the list and add pollutants "...which present or may present ...a threat of adverse human health effects (including but not limited to, substances which are known to be, or may be reasonably be anticipated to be, carcinogenic, mutagenic, teratogenic, neurotoxic, which cause reproductive dysfunction, or which are acuity or chronically toxic) or adverse environmental effects..." The EPA 189 list should be considered to be a starting point for toxics regulations.

* It is not the intent of DEQ to require sources to do an emissions inventory of every compound on the DEQ list. It is quite reasonable to assume that any source, including the small sources, be familiar with their own processes. There are common, readily available sources of information, such as Material Safty Data Sheets (MSDS)[2] that will assist a source

---

[2] MSDS provides data concerning the nature and concentrations of hazardous or toxic components of substances used by a source. These sheets are available from the manufacturers of all compounds with hazardous or toxic components.

to ascertain what compounds can be reasonably assumed to be present in their process. They then need only inventory those compounds that can reasonably assumed to be emitted. In addition, the DEQ will be happy to assist sources in identifying potential TAP.

Some Options for Discussion

Option 1: Maintain current situation.
Pros: Would, of course, make DEQ happy; require no further legislation; all ready in place and functional.
Cons: Could make several in industry unhappy; may be seen as burdensome by industry; a policy is not as clear as a standard.

Option 2: Go with Maximum Achievable Control Technology (MACT) as per the 1990 CAAA or Best Available Control Technology (BACT) or Lowest Achievable Emissions Reduction (LAER) or Adaqualtly Demonstrated Control Technology (ADCT) or some other control technology based standard.
Pros: No EL or AALC; single consistent standard.
Cons: MACT/BACT etc. difficult to define: must be industry and chemical specific; lack flexibility esp. for relatively "clean" industries; no provision for new pollutants; may not adequately protect human health and the environment, esp. in the case where MACT/BACT has not been defined for various toxic chemicals.

Option 3: Regulate EPA "189 List" only
Pros: Would reduce the list in size; could possibly speed up permitting process
Cons: Not protective enough of human health and the environment; lacks flexibility; would not address many pollutants that are commonly emitted by modern industry; no provision for new pollutants; somewhat pointless as the EPA is already doing it; could complicate and slow the permitting process by increasing public comment over pollutants not covered.

Option 4: Regulate EPA "189 list" plus currently known TAP
Pros: list would be somewhat shorter and simpler;
Cons: no provision for adding new pollutants; could require more extensive and costly emissions inventories.

Option 5: Regulate EPA "189 List" plus any thing that has been identified elsewhere as toxic, hazardous or a carcinogen
Pros: Would be comprehensive; would regulate only pollutants that have been demonstrated to be of concern; would be similar to current policy, require little or no new legislation;
Cons: Could be a large list; May be seen as burdensome by some in industry; no provision for adding pollutants.

Option 6: Develop a series of "source specific" TAP lists
Pros: Would be easier for specific industries to know what to report on; A number of useful references available See Appendix 9.
Cons: Could require emissions inventories of some regulated industries; no provision for variation among industries of the same type; MSDS will not reflect bi-product compounds.

Option 7: Options 1 and 3 through 6 with the addtion of a method out side of DEQ to add TAP to lists. (Pros and Cons would, of course depend on the method for adding to the list, but in general, a board or review panel of some sort seems to be a common notion.)
Pros: Would provide DEQ with industry input on additions to lists; would provide DEQ with industry input on standards; would provide DEQ and industry with input by public interest groups;
Cons: Could slow down the process of adding new toxics and there for probably slow down the permitting process because of the public particapation process; could cause a political battle over the structure of the addition process; could convert the health based process for additions to list into a political one; depending on the make up of the committee/board, could be less protective of the public health.

Appendix 1

The following are known or possible carcinogens that have a URF but are not listed by EPA on the list of 189 toxics but are listed on Appendix A2 (carcinogens)

Aldrin* insecticide
Bis(2-chloroethyel)ether solvent
chloromethane methyl chloride
DDT insecticide, most uses banned; used for Tussock moth
1,2-dibromoethane solvent chemical industry
1,1-dichloroethane solvent
1,2-dichloroethane degreaser, ore flotation, solvent, paint, finish removers
1.1-dichloroethylene solvent
Dieldrin* insecticide
diethylstilbestrol synthetic estrogen
dimethylnitrosamine solvent
heptachlor epoxide insecticide
hexachlorodibenzo-p-dioxin (1:2 mixture) Possible. herbicide, a contaminant, poison
hydrazine sulfate mineral analysis, determination of arsenic in metals, fungicide, fumigant
3-methylcholanthrene biochemical research
N-nitroso-n-butylamine**
N-nitrosopyrrolidine**
pronamide herbicide
reserpine antihypertensive [lowers blood pressure], tranquilizer
thiourea photography, analytical reagent chemical intermediate

* part of current permit analysis at INEL Chem. Lab.
** no reference located
Benzo(a)pyrene, dibenz(a,h)anthracene, chrysene and other polynuclear aromatic hydrocarbons can be regulated under polycyclic organic mater (POM) which, as a category, is listed on the EPA list of 189.

Only two of these chemicals are currently under review. However, many of these chemicals are solvents which would seem to have the potential for use in industries common to Idaho (light manufacturing, electronics and so forth).

Appendix 2

The following are carcinogenic substances that are or have been reviewed in conjunction with permit applications in Idaho. These substances are not on the EPA 189 list but are on Appendix A2 (carcinogens):

Aldrin and **Dieldrin** as noted above
dimethyl sulfide from craft pulping black liquor

Appendix 3

The following are non-carcinogenic substances that are or have been reviewed in conjunction with permit applications in Idaho. These substances are not on the EPA 189 list but are on Appendix A1 (non-carcinogens): Note: many of these compounds are on the EPA Extremely Hazardous substances list, and the Community Right to Know list.

hydrogen sulfide: rotten eggs smell, human poison by inhalation, severe irritant, violent reaction with various metals & chemicals
methyl mercaptan: poison by inhalation,
turpentine: toxic by inhalation, irritant, experimental tumorigen
methanol: toxic by inhalation, experimental teratogen, reproductive effects, human mutagenic data.
fluorine: toxic by inhalation, irritant, mutagenic data
aluminum: possible cause of pulmonary fibrosis by inhalation
copper: tumorigen, teratogen, experimental reproductive effects
iron: potentially toxic by inhalation (arc welders lung)
magnesium: toxic by inhalation
zinc: relatively nontoxic
terphenyl: little toxicological data available
nitric acid: poison, corrosive, experimental teratogen and reproductive effects
isophorone diiysocyanate: poison by inhalation,
methyl ethyl ketone peroxide: moderately toxic by inhalation, experimental tumorigen
cyclohexanone: moderately toxic by inhalation, irritant
acetone: moderately toxic by various routes, irritant
hydrogen peroxide, 90%: moderately toxic by inhalation, skin contact, corrosive irritant, experimental tumorigen, suspected carcinogen
dimethyl disulfide: poison by inhalation
dimethyl sulfide: volitile liquid, gas odorant, solvent

Appendix 4

The following are non-carcinogenic substances that are or have been listed on the Toxic Release Inventory (TRI)[3] for Idaho. These substances are not on the EPA 189 list but are on Appendix A1 (non-carcinogens). Note: many of these compounds are on the EPA Extremely Hazardous substances list, and the Community Right to Know list.

sodium hydroxide: corrosive irritant, mutagenic data
methanol: toxic by inhalation, experimental teratogen, reproductive effects, human mutagenic data.
nitric acid: poison, corrosive, experimental teratogen and reproductive effects
hydrofluoric acid: human poison by inhalation, corrosive irritant, experimental teratogenic, reproductive effects, mutagenic data
chlorine: Moderately toxic by inhalation, irritant, human mutagenic data
ammonia: experimental poison by inhalation, irritant, mutagenic data
phosphoric acid: human poison, corrosive irritant
copper: tumorigen, teratogen, experimental reproductive effects
Methylene diphenyl diisocyanate (MDI): poison by inhalation, irritant, mutagenic data
Freon 113: most uses will be fazed out by 1995
ammonium sulfate: moderately toxic by several routes
ammonium nitrate: powerful allergen
zinc compounds: relatively nontoxic
barium compounds: low toxicity
hydrochloric acid: poison by unspecified route, mildly toxic by inhalation, corrosive irritant
manganese compounds: toxic by inhalation

The following substances are non-carcinogenic substances that are being reviewed in conjunction with permit applications or field inspections. These substances are not on the EPA 189 or currently on the DEQ list. ***This points out the need to be able to respond to changing circumstances.***

Acenaphthylene: irritant, mutagenic data
Amino functional Siloxane: organosilicon oxide polymer, mild to severe irritant
Busan 1127D (2-(thiocyanomethylthio)benzothiazole): mist is considered moderatly to highly toxic.
Carbitol Acetate (2-(2-Ethyoxyethoxy) Ethyl Acetate): solvent and placticizer
dimethyl disulfide: poison by inhalation

---

[3] The TRI is a report of all emissions of compounds required to be disclosed under SARA Title III.

Appendix 5

The following are examples of sources now existing in Idaho that have air releases of substances not on the EPA 189 list:

American Micro systems Inc.
Basic American Foods
Blount Industries
Borden Inc. Dairy
Del Monte Foods USA #130
Deming Industries
Fiberglass Systems Inc.
FMC Corp.
Gustafson
Hewlett Packard
IBP Inc.
INEL
J.R. Simplot
J.R. Simplot Food Di.
John E. Quinn
Kerr McGee Vanadium Facility
Kraft Inc.
MIcron Technology
Monsanto
N.A Degerstrom Inc.
Nu-West Industries Inc
Ore-Ida Foods
Peabody Spunstrand
Penford Products Co.
Pondarosa Paint Mfg. Inc.
Post Falls Particalboard
Potlatch
Spears Manufacturing Inc.
Unitech Composites Inc.
Zilog

Appendix 6

In developing emissions limits for new permitted facilities, the Idaho DEQ uses the terms Unit Risk Factors and Threshold Limit Values. The following is an explanation of these terms and how they are used.

UNIT RISK FACTOR

A unit risk factor (URF) is used to describe the possibility of developing excess cancers over an average 70 year lifetime. This is based on being exposed to concentration of one microgram of a carcinogenic (cancer causing) substance in one cubic meter ($1\ ug/m^3$) of air over 70 years. The term excess cancers means cases of cancers in excess of what would be normal for a given population. For example, if there was normally 5 cases of a given type of cancer in Anytown USA before a given exposure to some substance and 7 after the exposure, there would be 2 excess cancers.

Inhalation URFs are developed for carcinogenic substances by the EPA. Each URF represents months of research and often years of policy process. Teams of toxicologists gather toxicological data for each known or suspected carcinogen. The available data are then rated or point factored per the quality of the research involved. A URF is then a probability statement derived from this process. Each URF proposed by EPA is extensively reviewed and debated in public by scientists, health officials and industry representatives. Every URF represents a consensus of the best science and health opinion of the potency of a given carcinogen.

URFs are usually expressed as a number times 10 to some negative power. For example, benzene, an organic hydrocarbon found in various petroleum products and cigarette smoke has a unit risk factor of 8.3×10^{-6}. This means that are 8.3 chances in one million of getting cancer if a person is exposed to $1\ \mu g/m^3$ 24 hours a day for 70 years.

Another example would be asbestos. Asbestos has a URF of 2.3×10^{-1}. That means that if exposed to $1\ ug/m^3$ concentration for 70 years, the chances of getting cancer would be .23 in 10.

Within IAQB New Source Review (NSR) policy, URFs are used to calculate acceptable ambient levels for a given carcinogen. IAQB generally establishes that an ambient concentration which causes no more excess cancers than one in a million (1×10^{-6}) is acceptable. Once an acceptable ambient level is established, IAQB can then back calculate via engineering equations to an acceptable emission rate (in pounds per hour) for a given stack.

THRESHOLD LIMIT VALUE

Threshold Limit Value (TLV) is a time weighted exposure limit developed by the Occupation and Safety Administration or the American Council of Government Industrial Hygienists. This value is used to limit the exposure of informed workers to a given toxic substance in the work place. The value is based on exposure of adult males working an eight hour shift. The DEQ uses TLV information to screen proposed new source emissions levels. The DEQ divides the TLV first by a value of 10 due to the fact that an ambient air exposure of a carcinogen means people are usually living under that exposure longer than eight hours out of 24. This value is then again divided by 10 to compensate for the fact that not everyone who is potentially exposed is an adult male. Other people may be more sensitive. The TLV thus is divided by a total of 100 for use in setting an acceptable ambient level.

For example, the TLV for cyanide is 5 milligrams per cubic meter (mg/m^3). An acceptable ambient level under DEQ policy would be 5 divided by 100 or 0.05 mg/m^3. For another example, the TLV for Lindane (an insecticide) would be 0.5 mg/m^3 concentration. The acceptable ambient level would be 0.5 divided by 100 or 0.005 mg/m^3. As with carcinogens, the TLV derived acceptable ambient levels are used by the DEQ engineers to back calculate an acceptable stack emission rate for any proposed new source.

EL and AAL(C) as listed in the TAP list are *screening levels*, not standards. If a proposed source, at any level of review is shown to be under the screening level for the TAP in question then the source goes forward in the permitting process. If, on the other hand, the source is shown to likely exceed the screening level, then there is a number of options such as further analysis or enhanced controls that can be pursued. See: Idaho DEQ Procedures for Modeling Impacts of Toxic Air Emissions and Assessing Associated Risk Appendix 7, and the General Summary of DEQ's New Source Review Policy for Toxic Air Pollutants, Appendix 8 for a more complete discussion of this topic.

APPENDIX 7

DRAFT

Idaho DEQ Procedures for Modeling Impacts of Toxic Air Emissions and Assessing Associated Risk

Procedures for modeling the dispersion of air emissions are consistent for criteria pollutants and toxics.

Emissions are calculated for the specific operation, with EPA's AP-42 as the standard guidance document. Impacts for any toxic air pollutant (TAP) emitted in potentially significant amounts are estimated through a three tiered evaluation approach, using the Division of Environmental Quality (DEQ) TAP list and models approved by EPA for regulatory use.

The emissions screening levels as listed on the DEQ TAP list are a quick way to determine if modeling is needed. If a toxic air pollutant has the maximum potential to be emitted at levels below the screening emission level, the proposed emission is typically approved by the DEQ.

If the maximum potential emissions are above the screening levels, then modeling is performed. The models most commonly used for the first modeling run are TSCREEN and SCREEN for single emission points, or ISC with worst case meteorological data for multiple emission points. In "screening modeling", quantified emissions and stack (or fugitive) data are required, as well as distance to property boundary or, with DEQ approval, an off site receptor. Estimates of off site concentrations of the pollutant(s) are output by the model, which assumes a variety of worst case dispersion conditions. Model output is typically in one hour averages. Persistence factors are usually used to estimate worst case impacts for other averaging periods. Unit risk factors are then applied to translate the predicted off site concentrations to determine risk to those exposed.

If, after "screening modeling", unacceptable risks still are shown to be possible, refined modeling may be done. Refined modeling replaces many worst case assumptions in screening modeling with actual conditions. In refined modeling, a more realistic three dimensional simulation of emissions, topography, meteorology, and receptors is supplied. Actual on site meteorological data typically helps the applicant, since the alternative is a worst case meteorological data file like that used in screening modeling. The most commonly used models are ISC, COMPLEX1, and FDM. Refined modeling provides the most detailed and accurate assessment of potential air quality impacts.

After ambient concentrations are determined, these ambient levels are, in the case of known or suspected carcinogens (TAP list Appendix A2), converted to annual concentrations using persistence factors as mentioned above. They are then multiplied by the EPA

unit risk factor (URF) to obtain a risk level. A risk level of one in a million is generally considered acceptable for a long term or permanent emissions source. The acceptable ambient levels for a carcinogen (AALC) listed in the TAP list Appendix A2 reflect this one in a million risk level for carcinogens with established URFs.

For short term sources (usually less than five years in duration), such as remediation projects, a probability of greater than one in a million risk (over a 70 years) will generally be acceptable to account for the decreased term of exposure. It is not acceptable however, for exposed individuals to receive a full 70 year exposure during the life of a short term project. In addition, first impacts at receptor sites farther from the source than property boundaries may be considered for short duration projects.

For non-carcinogens (TAP list Appendix A1) the risk assessment procedures are similar. Ambient concentrations are compared with 1/100 of the published American Council of Government and Industrial Hygienists (ACGIH) Occupational Exposure Limits (OEL) or other ambient standard adopted by the DEQ in the absence of a published ACGIH OEL.

The 1/100 factor was derived to accommodate two levels of extrapolation of potential risk to the general public:

1. ACGIH factors assume an eight hour exposure; source exposures are generally continuous (24 hrs.).

2. ACGIH factors are derived from historical data that comes essentially from a work force of healthy adult males.

Thus we have used an uncertainty factor of 100 (10X for each of the above conditions) to accommodate the more sensitive populations.

In the absence of any published URF or OEL. the acceptable ambient concentration will be considered the detection limit unless it can be demonstrated to the satisfaction of the DEQ that an ambient level higher than the detection limit will not have an adverse effect on human health or the environment. In such cases we have allowed the toxicological profiles of like chemicals or compounds to be substituted for the unknowns.

General Summary of Idaho Air Quality Bureau's New Source Review Policy for Toxic Air Pollutants

Regulation Summary

January 1991

Toxic substances within ambient air are regulated in Idaho by IDAPA 16.01.1011,01. Toxic Substances, which states:

> *Any contaminant which is by its nature toxic to human or animal life or vegetation, but is not specifically controlled elsewhere in Idaho Department of Health and Welfare Rules and Regulations, Title 1, Chapter 1, "Rules and Regulations for the Control of Air Pollution in Idaho," shall not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation. As information becomes available, limits will be specified for concentration of toxic materials in the ambient air and emission limits will be set accordingly.*
>
> *(1-24-69)*

Any new source of air pollutants (including toxic pollutants) not specifically covered by the thirteen (13) specific New Source Performance Standards is regulated by IDAPA 16.01.1952,02 Sources Not Specifically Regulated which states:

> *Sources not specifically regulated under Idaho Department of Health and Welfare Rules and Regulations Sections 01.1955 through 01.1999 shall achieve the greatest degree of emission reduction that has been adequately demonstrated.*
>
> *(1-1-75)*

Idaho Air Quality Bureau (IAQB) has developed a method for permitting new sources of toxic air pollutants consistent with our responsibilities and authority under the Rules and Regulations for the Control of Air Pollution in Idaho. For that method, IAQB compiled a list of toxic air pollutants (TAP) and screening level emission limits for those substances.

Permit Decisions

If the Bureau finds that an eight-hour average ambient concentration of a toxic air pollutant will likely not exceed one hundredth (.01) of the OEL for non carcinogens, or is below detection levels for a compound without an OEL or URF, the Bureau shall grant the permit.

Similarly, if the Bureau can substantiate that ambient concentrations due to emissions of known or suspected carcinogens are not likely to cause excess cancers of more than one in a million (10^{-6}) then the bureau shall grant a permit.

If potential new source emissions are shown to likely cause ambient concentrations:

1. in excess of 1/100 of the OEL or
2. which could cause cancers in excess of one in one hundred thousand (10^{-5}) or
3. which exceed minimum detection levels for TAP without an OEL or URF,

the Bureau may grant the permit if the applicant implements the best available control technology (BACT) for that source or pollutant and after considering other factors.

If the TAP screening level is shown to likely be exceeded the Bureau will make a final decision considering the following factors:

(a) the health and environmental assessment prepared by the applicant (if one is required by the Bureau);

(b) the nature of the toxic air pollutant and the susceptibility and proximity of the human population;

(c) other health and environmental impacts associated with the anticipated level of exposure.

The Bureau may grant a permit for a new source to emit carcinogens which are likely to cause excess cancers between 1/100,000 and 1/1,000,000 (between 10^{-5} and 10^{-6}) after the applicant proves that additional controls would be a severe hardship.

Appendix 9

Samples of Industry Specific TAP Emissions Data for an Example Industry; the Asphalt Paving Mixtures and Block Industry, SIC Code 2951

This appendix contains excerpts from:

Toxic Air Pollutant Emission Factors - A Compilation for Selected Air Toxic Compounds and Sources, Second Edition EPA-450/2-90-011

Toxic Air Pollutant/Source Crosswalk - A screening tool For Locating Possible Sources Emitting Toxic Air Pollutants, Second Edition EPA 450/2-89-017

Compilation of Air Pollution Emission Factors, AP-42 Fourth Edition September 1985 Volume I Stationary Point And Area Sources. (While this document is not specifically for TAP, the emission factors for VOC's can be useful for calculations and it is a standard reference.

MSDS for the same industry.

United States
Environmental Protection
Agency

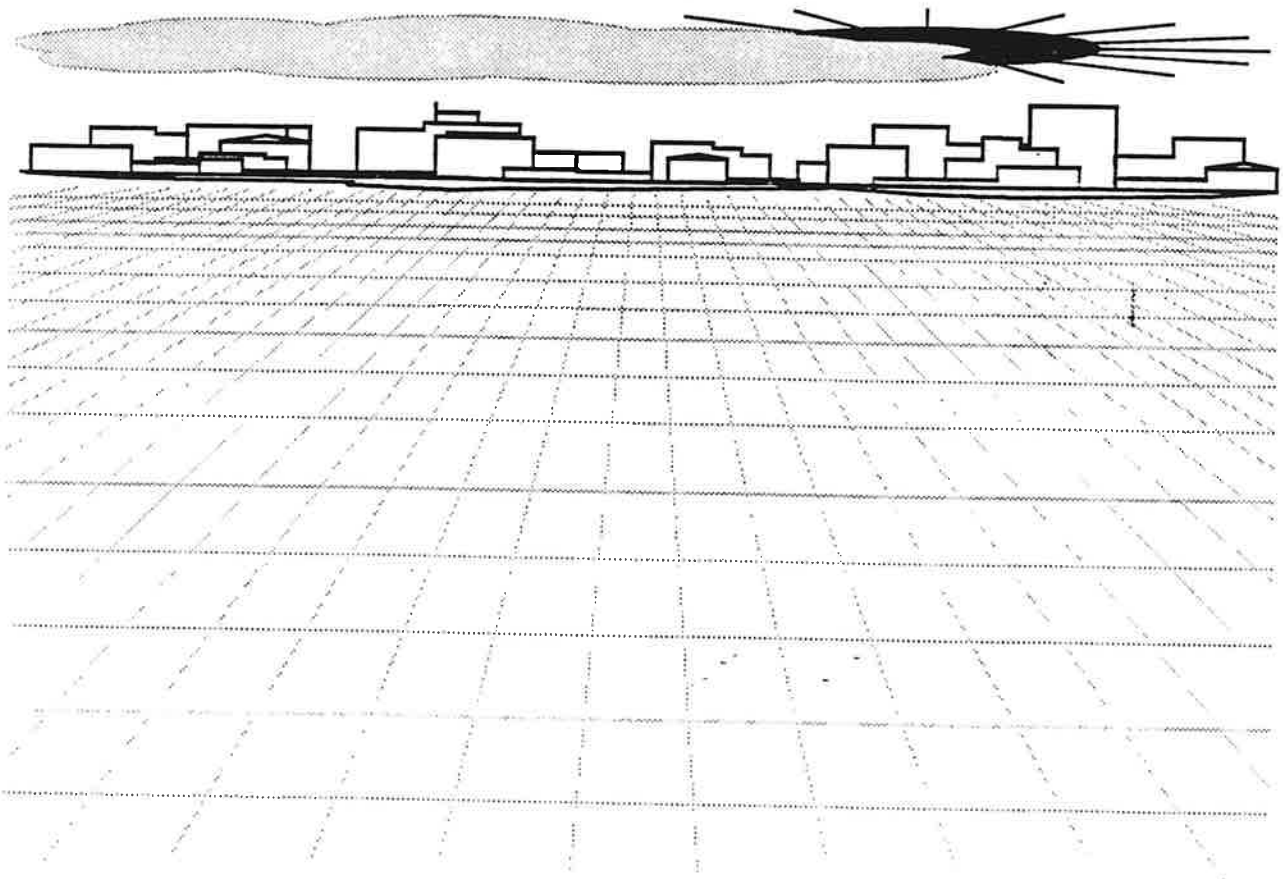
Office of Air Quality
Planning And Standards
Research Triangle Park, NC 27711

EPA-450/2-90-011
October 1990

AIR

EPA

TOXIC AIR POLLUTANT EMISSION FACTORS - A COMPILATION FOR SELECTED AIR TOXIC COMPOUNDS AND SOURCES, SECOND EDITION



REC 3784

SIC	SIC Code Description	SCC Code	Associated Pollutants
2951	Asphalt paving mixtures and blocks		ACETALDEHYDE (27); ACETATE, METHYL (29); ACETONE (27,28); ALUMINUM OXIDE (27); AMMONIA (21,22,23,27,29); ANILINE, 3-NITRO- (28); ANTHRACENE (27); ANTIMONY (27); ASBESTOS (21,22,23,27,28,29); ASPHALT (22); BENZENE (20,21,23,27,28,29); BENZENE, CHLORO- (28); BENZENE, ETHYL- (27,28); BENZENE, HEXACHLORO- (22,28); BENZIDINE (28); BENZO(A)PYRENE (21,23,28); BIPHENYL (27); BUTANETHIOL, N- (28); 1-BUTANOL (27); BUTYRALDEHYDE (26); CHLORINE (27); CHROMIUM (21,23,27,29); CUMENE (27); CYCLOHEXANE (27,28); DIBUTYL PHTHALATE (27); DIOCTYL PHTHALATE (27); EPOXY RESINS (25); ETHANE, CHLORO- (27); ETHANE, 1,2-DICHLORO- (27); ETHANE, 1,1,1-TRICHLORO- (21,22,23,28,29); ETHANOL, 2-ETHOXY-, ACETATE (22); ETHYLENE (27); ETHYLENE GLYCOL (27); ETHYLENE OXIDE (27); FORMALDEHYDE (20,21,22,26,28,29); FORMAMIDE, N,N-DIMETHYL- (28); FURAN, DIBENZO- (27); FURAN, 1,2,3,6,7,8-HEXACHLORODIBENZO- (27); FURAN, 1,2,3,7,8,9-HEXACHLORODIBENZO- (27); HEPTANE (22); HEXANE (22); HYDROGEN CHLORIDE (27,28); ISOPROPANOL (27); KEROSINE (29); LEAD (27); MANGANESE (29); MERCURY (23,29); METHANOL (27); METHYL ETHYL KETONE (21,22,27,28); METHYL ISOBUTYL KETONE (27); METHYLISOCYANATE (21,22,23,29); NAPHTHALENE (21,24,27,28); NICKEL (29); N-OCTYL PHTHALATE (27); 2-PENTANOL, 4-METHYL- (29); PHENOL, 2,4-DICHLORO- (27); POLYCYCLIC ORGANIC MATTER (21,23,26,29); POLYETHYLENE GLYCOL (25); POLYVINYL CHLORIDE LATEX (28); PROPYLENE (27); SODIUM HYDROXIDE (27); SORBITAN, MONO-9-OCTADECENOATE, POLY(OXY-1,2-ETHANDIYL) (2)- (29); STYRENE (28); SULFURIC ACID (21,22,27,28); TETRACHLOROETHYLENE (22,28); THALLIUM COMPOUNDS (28); TOLUENE (20,21,22,23,27,28,29); XYLENE, M- (27); XYLENE, O- (27); XYLENE, P- (27); XYLENES (MIXED ISOMERS) (27,28); ZINC COMPOUNDS (27)
		3-05-002	BUTYRALDEHYDE (26); FORMALDEHYDE (26)
		3-05-002-01	BENZENE (20); FORMALDEHYDE (20); POLYCYCLIC ORGANIC MATTER (26); TOLUENE (20)
		3-05-002-03	NAPHTHALENE (21,24)
		3-05-002-05	POLYCYCLIC ORGANIC MATTER (26)

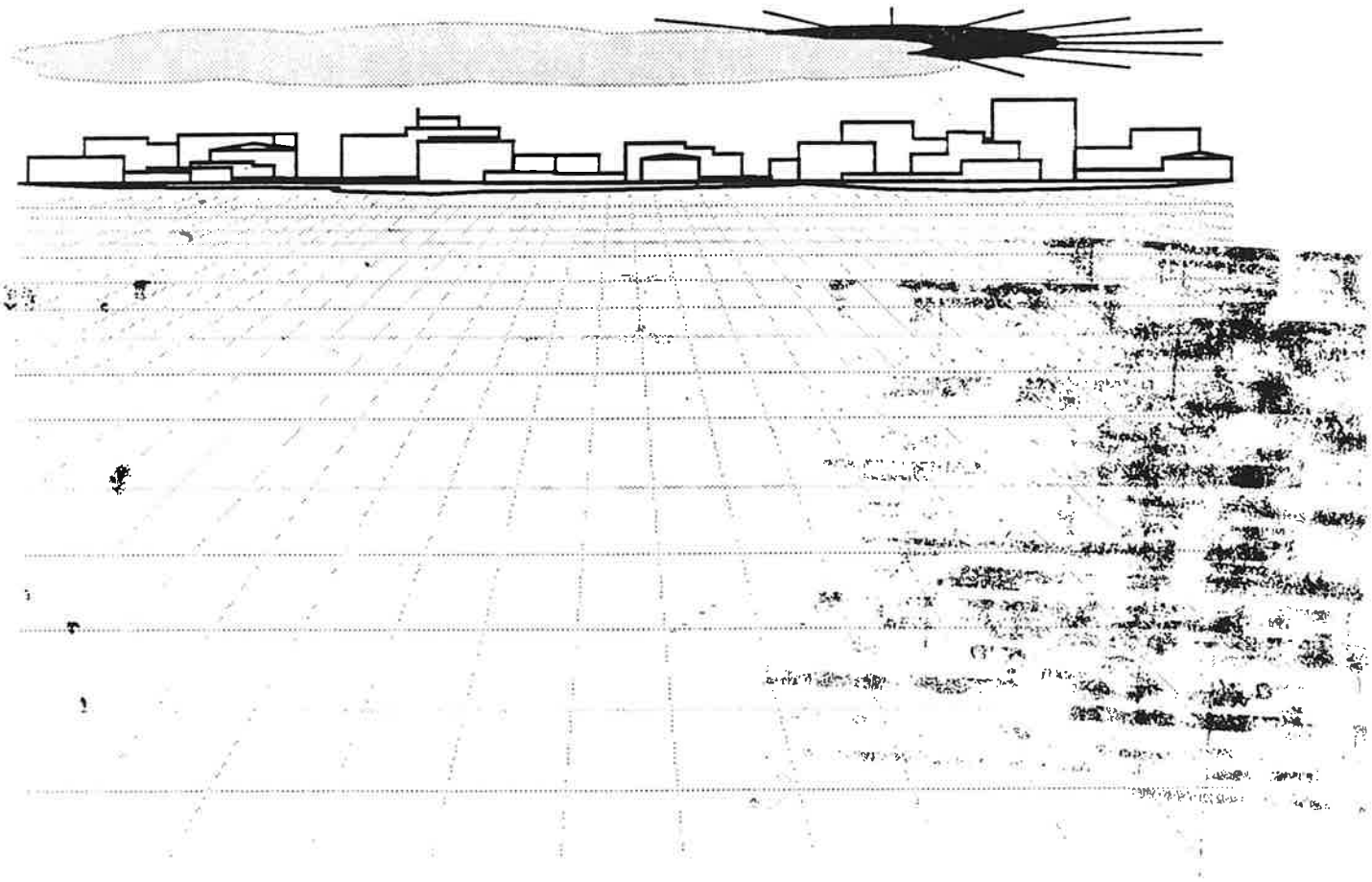
United States
Environmental Protection
Agency

Office of Air Quality
Planning And Standards
Research Triangle Park, NC 27711

EPA-450/2-89-017
December 1989

AIR

TOXIC AIR POLLUTANT/SOURCE CROSSWALK - A SCREENING TOOL FOR LOCATING POSSIBLE SOURCES EMITTING TOXIC AIR POLLUTANTS, SECOND EDITION



REC 3786

INDUSTRIAL PROCESS	SIC CODE	EMISSION SOURCE	SCC CODE	POLLUTANT	CAS NUMBER	EMISSION FACTOR	NOTES	REFERENCE
Asphaltic concrete production	2951	Plant stack	305002	Magnesium	7439954	8.8 x 10E-9 lb/ton concrete	Controlled (unspecified) from a single plant, mean of 2 values, range is 4.4 x 10E-9 - 1.32 x 10E-8 lb ton	170
Asphaltic concrete production	2951	Plant stack	305002	Magnesium	7439954	2.96 x 10E-7 lb/ton concrete	Uncontrolled from a single plant, mean of 2 values, range is 2.05 x 10E-7 - 3.87 x 10E-7 lb/ton	170
Asphaltic concrete production	2951	Plant stack	305002	Manganese	7439965	3.02 x 10E-10 lb/ton concrete	Controlled (unspecified) from a single plant, average of 2 values, range is 1.63 x 10E-10 - 4.4 x 10E-10 lb/ton	170
Asphaltic concrete production	2951	Plant stack	305002	Manganese	7439965	5.72 x 10E-9 lb/ton concrete	Uncontrolled from a single plant, average of 2 values, range is 3.3 x 10E-9 - 8.1 x 10E-9 lb/ton	170
Asphaltic concrete production	2951	Plant stack	305002	Mercury	7439976	<1.1 x 10E-9 lb/ton concrete	Controlled (unspecified) from a single plant, average of 2 values, range is 8.8 x 10E-10 - 1.3 x 10E-9	170
Asphaltic concrete production	2951	Plant stack	305002	Mercury	7439976	<2.07 x 10E-9 lb/ton concrete	Uncontrolled from a single plant, average of 2 values, range is 1.5 x 10E-9 - 2.6 x 10E-9	170
Asphaltic concrete production	2951	Plant stack	305002	Nickel	7440020	1.48 x 10E-10 lb/ton concrete	Controlled (unspecified) from a single plant, avg. of 2 values, range is 1.44 x 10E-10 - 1.51 x 10E-10 lb/ton	170
Asphaltic concrete production	2951	Plant stack	305002	Nickel	7440020	7.7 x 10E-10 lb/ton concrete	Uncontrolled from a single plant, avg. of 2 values, range is 6.6 x 10E-10 - 8.8 x 10E-10 lb/ton	170
Asphaltic concrete production	2951	Plant stack	305002	Vanadium	7440622	1.87 x 10E-9 lb/ton concrete	Controlled (unspecified) from a single plant, avg. of 2 values, range is 1.76 x 10E-9 - 1.98 x 10E-9	170
Asphaltic concrete production	2951	Plant stack	305002	Vanadium	7440622	<3.9 x 10E-9 lb/ton concrete	Uncontrolled from a single plant, avg. of 2 values, range is 1.98 x 10E-9 - 5.7 x 10E-9	170
Asphaltic concrete production	2951	Plant stack	305002	Vanadium	7440622	8.00E-7 g/ton concrete	Controlled (unspecified) from a single plant	170
Asphaltic concrete production	2951	Plant stack	305002	Zinc	7440666	5.5 x 10E-10 lb/ton concrete	Controlled (unspecified) from a single plant, avg. of 2 values, range is 4.4 x 10E-10 - 6.6 x 10E-10 lb/ton	170
Asphaltic concrete production	2951	Plant stack	305002	Zinc	7440666	1.98 x 10E-9 lb/ton concrete	Uncontrolled from a single plant, avg. of 2 values, range is 1.76 x 10E-9 - 2.2 x 10E-9 lb/ton	170
Automobile carburetor manufacture	3592	Manual plating cleaning tanks		Sodium hydroxide	1310732	0.03 lb/hr/ft2 tank	Developed by State agency and plant personnel, assume NaOH is 5.7% soln.	158
Automotive products use		End use		Xylenes (mixed isomers)	1330207	2000 lb/ton xylene consumed	Engineering Judgement	77
Bagasse combustion	0133	Industrial boilers	10201101	Polycyclic organic matter		179.7 lb/10E12 Btu heat input	2 boilers each w/ multicyclone vented to 1 common stack. Represents both gaseous & particulate POM	114
Bagasse combustion	0133	Industrial boilers	10201101	Polycyclic organic matter		99.9 lb/10E12 Btu heat input	Average of 2 (17.2-68.9), multicyclone, represents both gaseous and particulate POM.	114

REC 3787

1/4 PRINT

INDUSTRIAL PROCESS	SIC CODE	EMISSION SOURCE	SCC CODE	POLLUTANT	CAS NUMBER	EMISSION FACTOR	NOTES	REFERENCE
Asphaltic concrete production	2951	Plant stack	305002	Aluminum	7429905	1.2 x 10E-7 - 2.67 x 10E-7 lb/ton concrete	Uncontrolled from a single plant	170
Asphaltic concrete production	2951	Plant stack	305002	Aluminum	7429905	1.76 x 10E-9 - 5.1 x 10E-9 lb/ton concrete	Controlled (unspecified) from a single plant	170
Asphaltic concrete production	2951	Plant stack	305002	Beryllium	7440417	2.50 x 10E-11 lb/ton concrete	Uncontrolled from a single plant, avg. of 2 values, range is 2.1 - 2.9 x 10E-11 lb/ton	170
Asphaltic concrete production	2951	Plant stack	305002	Beryllium	7440417	1.98 x 10E-12 lb/ton concrete	Controlled (unspecified) from a single plant	170
Asphaltic concrete production	2951	Plant stack	305002	Butyraldehyde	123728	0.0024 lb/ton concrete	Based on limited test data, cyclone/wet scrubber control	97
Asphaltic concrete production	2951	Plant stack	305002	Cadmium	7440439	2.46 x 10E-10 lb/ton concrete	Controlled (unspecified) from a single plant, avg. of 2 values, range is 5.24 x 10E-11 - 4.4 x 10E-10 lb/ton	170
Asphaltic concrete production	2951	Plant stack	305002	Cadmium	7440439	1.82 x 10E-10 lb/ton concrete	Uncontrolled from a single plant, avg. of 2 values, range is 1.81 x 10E-10 - 1.83 x 10E-10 lb/ton	170
Asphaltic concrete production	2951	Plant stack	305002	Calcium	7440702	1.73 x 10E-5 lb/ton concrete	Uncontrolled from a single plant, avg. of 2 values, range is 1.03 x 10E-5 - 2.42 x 10E-5 lb/ton	170
Asphaltic concrete production	2951	Plant stack	305002	Calcium	7440702	2.76 x 10E-7 lb/ton concrete	Controlled (unspecified) from a single plant, avg. of 2 values, range is 1.72 x 10E-7 - 3.81 x 10E-7 lb/ton	170
Asphaltic concrete production	2951	Plant stack	305002	Calcium	7440702	3.3 x 10E-11 lb/ton concrete	Controlled (unspecified) from a single plant	170
Asphaltic concrete production	2951	Plant stack	305002	Chromium	7440473	1.24 x 10E-10 lb/ton concrete	Controlled (unspecified) from a single plant. Avg. of 2 values, range is 7.57 x 10E-11 - 1.71 x 10E-10 lb/ton	170
Asphaltic concrete production	2951	Plant stack	305002	Chromium	7440473	1.21 x 10E-9 lb/ton	Uncontrolled from a single plant, avg. of 2 values, range is 1.10 x 10E-9 - 1.32 x 10E-9 lb/ton	170
Asphaltic concrete production	2951	Plant stack	305002	Formaldehyde	50000	0.00015 lb/ton concrete	Based on limited test data, cyclone/wet scrubber control	97
Asphaltic concrete production	2951	Plant stack	305002	Iron	15438310	3.72 x 10E-7 lb/ton concrete	Uncontrolled from a single plant, avg. of 2 values, range is 2.22 x 10E-7 - 5.21 x 10E-7 lb/ton	170
Asphaltic concrete production	2951	Plant stack	305002	Iron	15438310	4.73 x 10E-9 lb/ton concrete	Controlled (unspecified) from a single plant, avg. of 2 values, range is 3.08 x 10E-9 - 6.38 x 10E-9 lb/ton	170
Asphaltic concrete production	2951	Plant stack	305002	Lead	7439921	3.98 x 10E-11 lb/ton	Controlled (unspecified) from a single plant, avg. of 2 values, range is 3.7 x 10E-11 - 4.25 x 10E-11 lb/ton	170
Asphaltic concrete production	2951	Plant stack	305002	Lead	7439921	9.9 x 10E-10 lb/ton concrete	Uncontrolled from a single plant, average of 2 values, range is 8.8 x 10E-10 - 1.1 x 10E-9 lb/ton	170

REC 3788

INDUSTRIAL PROCESS	SIC CODE	EMISSION SOURCE	SCC CODE	POLLUTANT	CAS NUMBER	EMISSION FACTOR	NOTES	REFERENCE
Asphalt (hot mix) production	2951	Drum mix plant	30500205	Polycyclic organic matter		7.18 x 10E-5 lb/ton asphalt produced	Knock out box, using recycled feed	114
Asphalt (hot mix) production	2951	Drum mix plant	30500205	Polycyclic organic matter		3.38 x 10E-5 lb/ton asphalt produced	Knock out box and venturi scrubber, using recycled feed	114
Asphalt (hot mix) production	2951	Drum mix plant	30500205	Polycyclic organic matter		4.42 x 10E-5 lb/ton asphalt produced	Knock out box	114
Asphalt (hot mix) production	2951	Drum mix plant	30500205	Polycyclic organic matter		2.7 x 10E-5 lb/ton asphalt produced	Knock out box and venturi scrubber	114
Asphalt distribution/use	5032	Entire process		Benzene	71432	0.077 lb/ton asphalt applied	Benzene assumed to be 9.6% of THC	92
Asphalt distribution/use	5032	Entire process		Formaldehyde	50000	0.004 lb/ton asphalt applied	Formaldehyde assumed to be 0.5% of THC	92
Asphalt distribution/use	5032	Entire process		Polycyclic organic matter		0.0008 lb/ton asphalt applied	POM assumed to be 0.1% of THC	92
Asphalt production		Entire process		Formaldehyde	50000	0.00015 lb/ton asphalt produced	Control uncertain	94
Asphalt roofing material production	2952	Asphalt blowing still	30500101	Polycyclic organic matter		0.0304 lb/ton asphalt blown	Uncontrolled	114
Asphalt roofing material production	2952	Asphalt blowing still	30500101	Polycyclic organic matter		9.6 x 10E-5 lb/ton asphalt blown	Afterburner	114
Asphalt roofing material production	2952	Asphalt blowing still	30500101	Polycyclic organic matter		4.2 x 10E-6 lb/ton asphalt blown	Fume incinerator	114
Asphalt roofing material production	2952	Asphalt blowing still	30500101	Polycyclic organic matter		1.16 x 10E-5 lb/ton asphalt blown	Process heater furnace	114
Asphalt roofing material production	2952	Asphalt blowing still	30500101	Polycyclic organic matter		0.0096 lb/ton asphalt blown	Stack baffles, represents particulate POM	114
Asphalt roofing material production	2952	Saturator	30500103	Polycyclic organic matter		4.2 x 10E-4 lb/ton produced	Uncontrolled	114
Asphalt roofing material production	2952	Saturator	30500103	Polycyclic organic matter		1.92 x 10E-4 lb/ton produced	ESP controlled	114
Asphalt roofing material production	2952	Saturator	30500103	Polycyclic organic matter		6.6 x 10E-4 lb/ton produced	Uncontrolled	114
Asphalt roofing material production	2952	Saturator and asphalt storage tanks	30500103	Polycyclic organic matter		0.042 lb/ton produced	High velocity air filter	114

REC 3789

1CT 4PRINT

INDUSTRIAL PROCESS	SIC CODE	EMISSION SOURCE	SCC CODE	POLLUTANT	CAS NUMBER	EMISSION FACTOR	NOTES	REFERENCE
Asbestos product fabrication	3292	Floor tile		Asbestos	1332214	1.0 lb/ton asbestos produced	Controlled	33
Asbestos product fabrication	3292	Friction material production		Asbestos	1332214	6 lb/ton asbestos produced	Controlled	33
Asbestos product fabrication	3292	Grinding brake shoes		Asbestos	1332214	465 fibers/cc air/g asbestos machined	Average of test results	22
Asbestos product fabrication	3292	Sawing asbestos cement sheet		Asbestos	1332214	1838 fibers/cc air/g asbestos machined	Average of test results, cut-off wheel saw	22
Asbestos product fabrication	3292	Sawing asbestos cement sheet		Asbestos	1332214	305 fibers/cc air/g asbestos machined	Average of test results, toothed blade saw	22
Asbestos product fabrication	3292	Sawing asbestos millboard		Asbestos	1332214	647 fibers/cc air/g asbestos machined	Average of test results, toothed blade saw	22
Asbestos product fabrication	3292	Textiles		Asbestos	1332214	40 lb/ton asbestos produced	Uncontrolled	33
Asbestos product fabrication	3292	Textiles		Asbestos	1332214	2 lb/ton asbestos produced	Controlled	33
Asbestos product usage		Brake linings		Asbestos	1332214	10 lb/ton asbestos produced	Uncontrolled	33
Asbestos product usage		Construction industry		Asbestos	1332214	26 lb/ton asbestos produced		33
Asbestos product usage		Insulating cement		Asbestos	1332214	26 lb/ton asbestos produced	Controlled	33
Asbestos product usage		Steel fireproofing		Asbestos	1332214	10 lb/ton asbestos produced	Controlled	33
Asbestos textiles manufacturing	3292	Entire process		Asbestos	1332214	63.7 lb/ton asbestos consumed	Calculated average uncontrolled factor, calculated range 26.7-88.8	100
Asbestos textiles manufacturing	3292	Entire process		Asbestos	1332214	3.54 lb/ton asbestos consumed	Calculated average controlled factor, calculated range 0.026-35.5	100
Asbestos-reinforced plastics manufacturing	3292	Entire process		Asbestos	1332214	930.8 lb/ton asbestos consumed	Calculated average uncontrolled factor, calculated range 0.96-2000	100
Asbestos-reinforced plastics manufacturing	3292	Entire process		Asbestos	1332214	5.70 lb/ton asbestos consumed	Calculated average controlled factor, calculated range 9.66 x 10-5 - 200	100
Ascorbic acid production	2833	Plantwide emissions	301060	Chloroform	67663	4.92 x 10E5 lb/yr	Based on one facility (30 million lb/yr production)	160
Asphalt (hot mix) production	2951	Batch mix plant, rotary dryer and mixer	30500201	Polycyclic organic matter		3.94 x 10E-5 lb/ton asphalt produced	Cyclone and wet scrubber, virgin feed material	114

REC 3790

1/7/4PRINT

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

COMPILATION OF AIR POLLUTANT EMISSION FACTORS, AP-42

FOURTH EDITION

September 1985

Volume I: Stationary Point And Area Sources

Stock No. 055-000-00251-7, $20.00

And

Volume II: Mobile Sources

Stock No. 055-000-00252-5, $19.00

SUPPLEMENT A

To

Volume I: Stationary Point And Area Sources

October 1986

Stock No. 055-000-00265-7, $21.00

These volumes should be ordered from:

Superintendent Of Documents
Government Printing Office
Washington, DC 20402-9325

(202) 783-3238

4.5 CUTBACK ASPHALT, EMULSIFIED ASPHALT AND ASPHALT CEMENT

4.5.1 General[1-3]

Asphalt surfaces and pavements are composed of compacted aggregate and an asphalt binder. Aggregate materials are produced from rock quarries as manufactured stone or are obtained from natural gravel or soil deposits. Metal ore refining processes produce artificial aggregates as a byproduct. In asphalt, the aggregate performs three functions. It transmits the load from the surface to the base course, takes the abrasive wear of traffic, and provides a nonskid surface. The asphalt binder holds the aggregate together, preventing displacement and loss of aggregate and providing a waterproof cover for the base.

Asphalt binders take the form of asphalt cement (the residue of the distillation of crude oils) and liquified asphalts. To be used for pavement, asphalt cement, which is semisolid, must be heated prior to mixing with aggregate. The resulting hot mix asphalt concrete is generally applied in thicknesses of from two to six inches. Liquified asphalts are (1) asphalt cutbacks (asphalt cement thinned or "cutback" with volatile petroleum distillates such as naptha, kerosene, etc.) and (2) asphalt emulsions (nonflammable liquids produced by combining asphalt and water with an emulsifying agent, such as soap). Liquified asphalts are used in tack and seal operations, in priming roadbeds for hot mix application, and for paving operations up to several inches thick.

Cutback asphalts fall into three broad categories: rapid cure (RC), medium cure (MC), and slow cure (SC) road oils. SC, MC and RC cutbacks are prepared by blending asphalt cement with heavy residual oils, kerosene-type solvents, or naptha and gasoline solvents, respectively. Depending on the viscosity desired, the proportions of solvent added generally range from 25 to 45 percent by volume.

Emulsified asphalts are of two basic types. One type relies on water evaporation to cure. The other type (cationic emulsions) relies on ionic bonding of the emulsion and the aggregate surface. Emulsified asphalt can substitute for cutback in almost any application. Emulsified asphalts are gaining in popularity, because of the energy and environmental problems associated with the use of cutback asphalts.

4.5.2 Emissions[1,2]

The primary pollutants of concern from asphalts and asphalt paving operations are volatile organic compounds (VOC). Of the three types of asphalts, the major source of VOC is cutback. Only minor amounts of VOC are emitted from emulsified asphalts and asphalt cement.

VOC emissions from cutback asphalts result from the evaporation of the petroleum distillate solvent, or diluent, used to liquify the asphalt cement. Emissions occur at both the job site and the mixing plant. At the job site, VOCs are emitted from the equipment used to apply the asphaltic product and from the road surface. At the mixing plant, VOCs are released during mixing and stockpiling. The largest source of emissions, however, is the road surface itself.

For any given amount of cutback asphalt, total emissions are believed to be the same, regardless of stockpiling, mixing and application times. The two major variables affecting both the quantity of VOC emitted and the time over which emissions occur are the type and the quantity of petroleum distillate used as a diluent. As an approximation, long term emissions from cutback asphalts can be estimated by assuming that 95 percent of the diluent evaporates from rapid cure (RC) cutback asphalts, 70 percent from medium cure (MC) cutbacks, and about 25 percent from slow cure (SC) asphalts, by weight percent. Some of the diluent appears to be retained permanently in the road surface after application. Limited test data suggest that, from rapid cure (RC) asphalt, 75 percent of the total diluent loss occurs on the first day after

REC 3792

application, 90 percent occurs within the first month, and 95 percent in three to four months. Evaporation takes place more slowly from medium cure (MC) asphalts, with roughly 20 percent of the diluent being emitted during the first day, 50 percent during the first week, and 70 percent after three to four months. No measured data are available for slow cure (SC) asphalts, although the quantity emitted is believed to be considerably less than with either rapid or medium cure asphalts, and the time during which emissions take place is expected to be considerably longer (Figure 4.5-1). An example calculation for determining VOC emissions from cutback asphalts is given below:

Example: Local records indicate that 10,000 kg of RC cutback asphalt (containing 45 percent diluent, by volume) was applied in a given area during the year. Calculate the mass of VOC emitted during the year from this application.

To determine VOC emissions, the volume of diluent present in the cutback asphalt must first be determined. Because of density of naptha (0.7 kg/l) differs from that of asphalt cement (1.1 kg/l), the following equations should be solved to determine the volume of diluent (x) and the volume of asphalt cement (y) in the cutback asphalt:

$$10{,}000 \text{ kg cutback asphalt} = (x \text{ liter, diluent}) \cdot \left(\frac{0.7 \text{ kg}}{\text{liter}}\right) + (y \text{ liter, asphalt cement}) \cdot \left(\frac{1.1 \text{ kg}}{\text{liter}}\right)$$

and

$$x \text{ liter, diluent} = 0.45\ (x \text{ liter, diluent} + y \text{ liter, asphalt cement})$$

From these equations, the volume of diluent present in the cutback asphalt is determined to be about 4900 liters, or about 3400 kg. Assuming that 95 percent of this is evaporative VOC, emissions are then: 3400 kg x 0.95 = 3200 kg (i.e., 32% by weight, of the cutback asphalt eventually evaporates).

These equations can be used for medium cure and slow cure asphalts by assuming typical diluent densities of 0.8 and 0.9 kg/liter, respectively. Of course, if actual density values are known from local records, they should be used in the above equations rather than typical values. Also, if different diluent contents are used, they should also be reflected in the above calculations. If actual diluent contents are not known, a typical value of 35 percent may be assumed for inventory purposes.

In lieu of solving the equations in the above example, Table 4.5-1 may be used to estimate long term emissions from cutback asphalts. Table 4.5-1 directly yields long term emissions as a function of the volume of diluent added to the cutback and of the density of the diluents and asphalt cement used in the cutback asphalt. If short term emissions are to be estimated, Figure 4.5-1 should be used in conjunction with Table 4.5-1.

No control devices are employed to reduce evaporative emissions from cutback asphalts. Asphalt emulsions are typically used in place of cutback asphalts to eliminate VOC emissions.

REC 3793

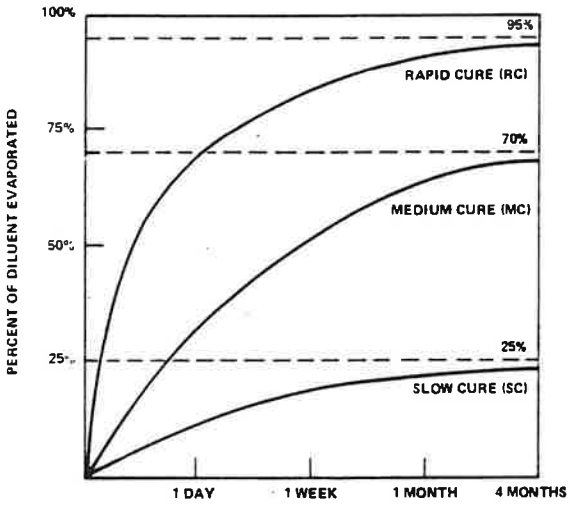


Figure 4.5-1. Percent of diluent evaporated from cutback asphalt over time.

TABLE 4.5-1. EVAPORATIVE VOC EMISSIONS FROM CUTBACK ASPHALTS AS A FUNCTION OF DILUENT CONTENT AND CUTBACK ASPHALT TYPE[a]

EMISSION FACTOR RATING: C

Type of Cutback[b]	Percent, by Volume, of Diluent in Cutback[c]		
	25%	35%	45%
Rapid cure	17	24	32
Medium cure	14	20	26
Slow cure	5	8	10

[a]These numbers represent the percent, by weight, of cutback asphalt evaporated. Factors are based on References 1 and 2.

[b]Typical densities assumed for diluents used in RC, MC and SC cutbacks are 0.7, 0.8 and 0.9 kg/liter, respectively.

[c]Diluent contents typically range between 25-45%, by volume. Emissions may be linearly interpolated for any given type of cutback between these values.

REC 3794

References for Section 4.5

1. R. Keller and R. Bohn, *Nonmethane Volatile Organic Emissions from Asphalt Cement and Liquified Asphalts*, EPA-450/3-78-124, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 1978.

2. F. Kirwan and C. Maday, *Air Quality and Energy Conservation Benefits from Using Emulsions To Replace Asphalt Cutbacks in Certain Paving Operations*, EPA-450/2-78-004. U.S. Environmental Protection Agency, Research Triangle Park. NC, January 1978.

3. David W. Markwordt, *Control of Volatile Organic Compounds from Use of Cutback Asphalt*, EPA-450/2-77-037, U.S. Environmental Protection Agency, Research Triangle Park. NC, December 1977.

REC 3795

M A T E R I A L S A F E T Y D A T A S H E E T

IDAHO ASPHALT SUPPLY INC.
Nampa, Idaho

CRS-1, CRS-2, CRS-2f, CRS-2h

MATERIAL IDENTIFICATION

Chemical Name: Cationic Rapid Set Asphalt Emulsion
Manufacturer: Idaho Asphalt Supply Inc.
Address: P.O. Box 966, Nampa, Id. 83651
Hazard Rating (NFPA)
Health: 1
Fire: 0
Reactivity: 0
Special: None

CAS Registry No. N/A
Date Prepared; 5/19/89

Hazard Rating Scale:
0 - Minimal
1 - Slight
2 - Moderate
3 - Serious
4 - Severe

HAZARDOUS INGREDIENTS

Ingredients	CAS #	Percent	PEL	STEL	TLV
Asphalt cement	8052-42-4	65-70%	N/A	10mg/m	5mg/m
Naptha	8032-32-4	0-3%	100ppm	N/A	400ppm
Emulsifier	TSCA	0.15-0.5%	N/A	N/A	N/A

PHYSICAL DATA

Boiling Point - 212f
Vapor Pressure - <1
Vapor Density - >0.062
Specific Gravity @ 60f - 1.025 to 1.06
Melting Point - N/A
Evaporation Rate - <1
Solubility in water - up to 100%
Appearance and Odor - Viscous brown to black liquid ; odor of amines and hydrocarbons

FIRE AND EXPLOSIVE DATA

Flash Point - N/A
Autoignition Temperature NFPA - N/A
Extinguishing Media - CO2, Class "B" extinguisher, foam and water fog.
Special Fire Fighting Procedures - Avoid breathing vapors, wear self-contained breathing apparatus.
Unusual Fire Explosion Hazards - DO NOT heat material above 212f to avoid generating excessive steam pressure.

REACTIVITY DATA

Stable: X Unstable:

Conditions to Avoid	-	DO NOT HEAT ABOVE 212f, Ignition sources.
Incompatible Materials	-	Avoid strong oxidizing agents
Hazardous Decomposition Products	-	Combustion may form CO2, CO, and sulfur oxide.
Hazardous Polymerization	-	Will not occur.

HEALTH HAZARD DATA

Route of Exposure	Primary Route	Signs and Symptoms
Inhalation	[X]	Use with good ventilation. May cause respiratory tract irritation
Skin Absorption	[ ]	No significant symptoms indicative of skin absorption expected.
Skin Irritation	[X]	Will cause burns when product is hot. May cause dermatitis and acne like lesions on prolonged exposure.
Ingestion	[ ]	May cause nausea and diarrhea.
Eye Contact	[X]	Will burn and irritate.

Listed as Carcinogen? Not listed by NTP, IARC, or OSHA.

EMERGENCY FIRST AID

Inhalation:	Remove to fresh air. Give oxygen or artificial respiration as needed Obtain medical attention promptly.
Eye Contact:	Flush eyes with low pressure water for at least 15 minutes and obtain medical attention immediately.
Skin Contact:	If product is hot, cool with cold water. Otherwise wash thoroughly with soap and water.
Ingestion:	Call physician. Do not induce vomiting.

PROTECTIVE EQUIPMENT / CONTROL MEASURES

Respiratory Protection:	Avoid breathing vapors in confined spaces. NIOSH approved respirators may be required if TLV's are exceeded.
Eye Protection:	Use safety glasses, goggles or face shields.
Skin Protection:	Use rubber gloves, coveralls and impervious footwear.
Engineering controls:	Local exhaust ventilation may be required to meet exposure standards in confined areas.
Handling Precautions:	Avoid heating over 212f.

SPILL AND DISPOSAL

Spill or Release:	Stop release, prevent flow from entering sewers or public waters. Allow to cool. Recover large spill. Let product cure or soak up with sand on smaller spills.
Waste Disposal Method:	Handle in accordance with federal, state and local regulations.

DISCLAIMER

Some of the information presented and conclusions drawn herein are from sources other than direct test data on the product itself. The information in this MSDS was obtained from sources which we believe reliable. However, the information is provided without any warranty, expressed or implied, regarding its correctness.

The condition or methods of handling, storage, use and disposal of the products are beyond our control and may be beyond our knowledge. For this and other reasons, we do not assume responsibility and expressly disclaim liability for loss, damage or expense arising out of or in any way connected with the handling, storage, use or disposal of the product.

This MSDS was prepared and is to be used only for this product. If the product is used as a component in another product, this MSDS information may not be applicable.

This MSDS has been prepared in accordance with the requirements of the OSHA Hazardous Communication Standard (29 CFR 1200)

MATERIAL SAFETY DATA SHEET

IDAHO ASPHALT SUPPLY INC.
(Hauser) Post Falls, ID

RECEIVED
JUN 26 1992
DIV. OF ENVIRONMENTAL QUALITY
PERMITS & ENFORCEMENTS

LMCRS-2, LMCRS-2h, CRS-2R

MATERIAL IDENTIFICATION

Chemical Name: Cationic Rapid Set Asphalt Emulsion
Manufacturer: Idaho Asphalt Supply Inc.
Address: P.O. Box 966, Nampa, Id. 83651
Hazard Rating (NFPA)
Health: 1
Fire: 0
Reactivity: 0
Special: None

CAS Registry No. N/A
Date Prepared: 5/19/89

Hazard Rating Scale:
0 - Minimal 3 - Serious
1 - Slight 4 - Severe
2 - Moderate

HAZARDOUS INGREDIENTS

Ingredients	CAS #	Percent	PEL	STEL	TLV
Asphalt cement	8052-42-4	57-68%	N/A	10mg/m	5 mg/m
Naptha	8032-32-4	0-3%	100ppm	N/A	400ppm
Elastomers	126-99-8	1.5-3%	10ppm	N/A	10ppm
Emulsifier	TSCA	1-3%	N/A	N/A	N/A

PHYSICAL DATA

Boiling Point - 212f
Vapor Pressure - <1
Vapor Density - >0.062
Specific Gravity @ 60f - 1.025 to 1.06
Melting Point - N/A
Evaporation Rate - <1
Solubility in water - up to 100%
Appearance and Odor - Viscous brown to black liquid ; odor of amines and hydrocarbons

FIRE AND EXPLOSIVE DATA

Flash Point - N/A
Autoignition Temperature NFPA - N/A
Extinguishing Media - CO2, Class "B" extinguisher, foam and water fog.
Special Fire Fighting Procedures - Avoid breathing vapors, wear self-contained breathing apparatus.
Unusual Fire Explosion Hazards - DO NOT heat material above 212f to avoid generating excessive steam pressure.

REACTIVITY DATA

Stable: X Unstable:

Conditions to Avoid	-	DO NOT HEAT ABOVE 212f, Ignition sources.
Incompatible Materials	-	Avoid strong oxidizing agents
Hazardous Decomposition Products	-	Combustion may form CO2, CO, and sulfur dioxide.
Hazardous Polymerization	-	Will not occur.

HEALTH HAZARD DATA

Route of Exposure	Primary Route	Signs and Symptoms
Inhalation	[X]	Use with good ventilation. May cause respiratory tract irritation
Skin Absorption	[ ]	No significant symptoms indicative of skin absorption expected.
Skin Irritation	[X]	Will cause burns when product is hot. May cause dermatitis and acne like lesions on prolonged exposure.
Ingestion	[ ]	May cause nausea and diarrhea.
Eye Contact	[X]	Will burn and irritate.

Listed as Carcinogen? Not listed by NTP, IARC, or OSHA.

EMERGENCY FIRST AID

Inhalation:	Remove to fresh air. Give oxygen or artificial respiration as needed Obtain medical attention promptly.
Eye Contact:	Flush eyes with low pressure water for at least 15 minutes and obtain medical attention immediately.
Skin Contact:	If product is hot, cool with cold water. Otherwise wash thoroughly with soap and water.
Ingestion:	Call physician. Do not induce vomiting.

PROTECTIVE EQUIPMENT / CONTROL MEASURES

Respiratory Protection:	Avoid breathing vapors in confined spaces. NIOSH approved respirators may be required if TLV's are exceeded.
Eye Protection:	Use safety glasses, goggles or face shields.
Skin Protection:	Use rubber gloves, coveralls and impervious footwear.
Engineering controls:	Local exhaust ventilation may be required to meet exposure standards in confined areas.
Handling Precautions:	Avoid heating over 212f.

SPILL AND DISPOSAL

Spill or Release:	Stop release, prevent flow from entering sewers or public waters. Allow to cool. Recover large spill. Let product cure or soak up with sand on smaller spills.
Waste Disposal Method:	Handle in accordance with federal, state and local regulations.

DISCLAIMER

Some of the information presented and conclusions drawn herein are from sources other than direct test data on the product itself. The information in this MSDS was obtained from sources which we believe reliable. However, the information is provided without any warranty, expressed or implied, regarding its correctness.

The condition or methods of handling, storage, use and disposal of the products are beyond our control and may be beyond our knowledge. For this and other reasons, we do not assume responsibility and expressly disclaim liability for loss, damage or expense arising out of or in any way connected with the handling, storage, use or disposal of the product.

This MSDS was prepared and is to be used only for this product. If the product is used as a component in another product, this MSDS information may not be applicable.

This MSDS has been prepared in accordance with the requirements of the OSHA Hazardous Communication Standard (29 CFR 1200)

MATERIAL SAFETY DATA SHEET

IDAHO ASPHALT SUPPLY INC.
Nampa, Idaho

MC Cutbacks

MATERIAL IDENTIFICATION

Chemical Name: Medium Cure Cutback Asphalts
Manufacturer: Idaho Asphalt Supply Inc.
Address: P.O. Box 966, Nampa, Id. 83651
Hazard Rating (NFPA)
Health: 2
Fire: 2
Reactivity: 0
Special: None

CAS Registry No. N/A
Date Prepared: 5/19/89

Hazard Rating Scale:
0 - Minimal 3 - Serious
1 - Slight 4 - Severe
2 - Moderate

HAZARDOUS INGREDIENTS

Ingredients	CAS #	Percent	PEL	STEL	TLV
Asphalt cement	8052-42-4	60-90%	N/A	10mg/m	5mg/m
Benzene	100-14-1	>0.1%?	N/A	25 ppm	10ppm
No.1 Fuel	8032-32-4	40-10%	100ppm	N/A	400ppm

PHYSICAL DATA

Boiling Point - > 300f
Vapor Pressure - < 1
Vapor Density - > 1
Solubility in water - No
Specific Gravity @ 60f - 0.90 to 1.10
Melting Point - N/A
Evaporation Rate - <1
Appearance and Odor - Black liquid or solid. Odor of hydrocarbons.

FIRE AND EXPLOSIVE DATA

Flash Point - > 100f TOC
Autoignition Temperature NFPA - N/A
Extinguishing Media - CO2. Class "B" extinguisher. foam or water fog.
Special Fire Fighting Procedures - Avoid breathing vapors. Avoid subsurface penetration with water; may cause foaming or frothing which could spread hazard
Unusual Fire Explosion Hazards - None

REACTIVITY DATA

Stable: X Unstable:

Conditions to Avoid	-	Ignition sources.
Incompatible Materials	-	Avoid strong oxidizing agents
Hazardous Decomposition Products	-	Combustion may form CO2, CO, and sulfur dioxide.
Hazardous Polymerization	-	Will not occur.

HEALTH HAZARD DATA

Route of Exposure	Primary Route	Signs and Symptoms
Inhalation	[X]	Use with good ventilation. May cause respiratory tract irritation
Skin Absorption	[ ]	No significant symptoms indicative of skin absorption expected.
Skin Irritation	[X]	Will cause burns when product is hot. May cause dermatitis and acne like lesions on prolonged exposure.
Ingestion	[ ]	May cause nausea and diarrhea.
Eye Contact	[X]	Will burn and irritate.

Listed as Carcinogen? Not listed by NTP, IARC, or OSHA.

EMERGENCY FIRST AID

Inhalation:	Remove to fresh air. Give oxygen or artificial respiration as needed Obtain medical attention promptly.
Eye Contact:	Flush eyes with low pressure water for at least 15 minutes and obtain medical attention immediately.
Skin Contact:	If product is hot, cool with cold water. Otherwise wash thoroughly with soap and water.
Ingestion:	Call physician. Do not induce vomiting.

PROTECTIVE EQUIPMENT / CONTROL MEASURES

Respiratory Protection:	Avoid breathing vapors in confined spaces. NIOSH approved respirators may be required if TLV's are exceeded.
Eye Protection:	Use safety glasses, goggles or face shields.
Skin Protection:	Use rubber gloves, coveralls and impervious footwear
Engineering controls:	Local exhaust ventilation may be required to meet exposure standards in confined areas.
Handling Precautions:	Storage tanks and trucks must be emptied, cooled, ventilated, and tested for absence of vapors before allowing personel entry.

SPILL AND DISPOSAL

Spill or Release:	Stop release, prevent flow from entering sewers or public waters. Allow to cool. Recover large spill. Let product cure or soak up with sand on smaller spills.
Waste Disposal Method:	Handle in accordance with federal, state and local regulations.

DISCLAIMER

Some of the information presented and conclusions drawn herein are from sources other than direct test data on the product itself. The information in this MSDS was obtained from sources which we believe reliable. However, the information is provided without any warranty, expressed or implied, regarding its correctness.

The condition or methods of handling, storage, use and disposal of the products are beyond our control and may be beyond our knowledge. For this and other reasons, we do not assume responsibility and expressly disclaim liability for loss, damage or expense arising out of or in any way connected with the handling, storage, use or disposal of the product.

This MSDS was prepared and is to be used only for this product. If the product is used as a component in another product, this MSDS information may not be applicable.

This MSDS has been prepared in accordance with the requirements of the OSHA Hazardous Communication Standard (29 CFR 1200)

M A T E R I A L S A F E T Y D A T A S H E E T

IDAHO ASPHALT SUPPLY INC.
Nampa, Idaho

CMS-2, CMS-2h, CMS-2s, CMS-2R

MATERIAL IDENTIFICATION

Chemical Name: Cationic Medium Set Asphalt Emulsion
Manufacturer: Idaho Asphalt Supply Inc.
Address: P.O. Box 966, Nampa, Id. 83651
Hazard Rating (NFPA)

Health: 1
Fire: 1
Reactivity: 0
Special: None

CAS Registry No. N/A
Date Prepared; 5/19/89

Hazard Rating Scale:
0 - Minimal
1 - Slight
2 - Moderate
3 - Serious
4 - Severe

HAZARDOUS INGREDIENTS

Ingredients	CAS #	Percent	PEL	STEL	TLV
Asphalt cement	8052-42-4	60-70%	N/A	10mg/m	5mg/m
Benzene	100-14-1	>0.1%?	N/A	25 ppm	10ppm
Naptha	8032-32-4	5-15%	100ppm	N/A	400ppm
Emulsifier	TSCA	0.15-0.5%	N/A	N/A	N/A

PHYSICAL DATA

Boiling Point - 212f
Vapor Pressure - <1
Vapor Density - >0.062
Specific Gravity @ 60f - 1.025 to 1.06
Melting Point - N/A
Evaporation Rate - <1
Solubility in water - up to 100%
Appearance and Odor - Viscous brown to black liquid ; odor of amines and hydrocarbons

---

FIRE AND EXPLOSIVE DATA

Flash Point - N/A
Autoignition Temperature NFPA - N/A
Extinguishing Media - CO2, Class "B" extinguisher, foam and water fog.
Special Fire Fighting Procedures - Avoid breathing vapors, wear self-contained breathing apparatus.
Unusual Fire Explosion Hazards - DO NOT heat material above 212f to avoid generating excessive steam pressure.

REACTIVITY DATA

Stable: X Unstable:

Conditions to Avoid	-	DO NOT HEAT ABOVE 212f, Ignition sources.
Incompatible Materials	-	Avoid strong oxidizing agents
Hazardous Decomposition Products	-	Combustion may form CO2, CO, and sulfur dioxide.
Hazardous Polymerization	-	Will not occur.

HEALTH HAZARD DATA

Route of Exposure	Primary Route	Signs and Symptoms
Inhalation	[X]	Use with good ventilation. May cause respiratory tract irritation
Skin Absorption	[ ]	No significant symptoms indicative of skin absorption expected.
Skin Irritation	[X]	Will cause burns when product is hot. May cause dermatitis and acne like lesions on prolonged exposure.
Ingestion	[ ]	May cause nausea and diarrhea.
Eye Contact	[X]	Will burn and irritate.

Listed as Carcinogen? Not listed by NTP, IARC, or OSHA

EMERGENCY FIRST AID

Inhalation:	Remove to fresh air. Give oxygen or artificial respiration as needed Obtain medical attention promptly.
Eye Contact:	Flush eyes with low pressure water for at least 15 minutes and obtain medical attention immediately.
Skin Contact:	If product is hot, cool with cold water. Otherwise wash thoroughly with soap and water.
Ingestion:	Call physician. Do not induce vomiting.

PROTECTIVE EQUIPMENT / CONTROL MEASURES

Respiratory Protection:	Avoid breathing vapors in confined spaces. NIOSH approved respirators may be required if TLV's are exceeded.
Eye Protection:	Use safety glasses, goggles or face shields.
Skin Protection:	Use rubber gloves, coveralls and impervious footwear.
Engineering controls:	Local exhaust ventilation may be required to meet exposure standards in confined areas.
Handling Precautions:	Avoid heating over 212f.

SPILL AND DISPOSAL

Spill or Release:	Stop release, prevent flow from entering sewers or public waters. Allow to cool. Recover large spill. Let product cure or soak up with sand on smaller spills.
Waste Disposal Method:	Handle in accordance with federal, state and local regulations.

DISCLAIMER

Some of the information presented and conclusions drawn herein are from sources other than direct test data on the product itself. The information in this MSDS was obtained from sources which we believe reliable. However, the information is provided without any warranty, expressed or implied, regarding its correctness.

The condition or methods of handling, storage, use and disposal of the products are beyond our control and may be beyond our knowledge. For this and other reasons, we do not assume responsibility and expressly disclaim liability for loss, damage or expense arising out of or in any way connected with the handling, storage, use or disposal of the product.

This MSDS was prepared and is to be used only for this product. If the product is used as a component in another product, this MSDS information may not be applicable.

This MSDS has been prepared in accordance with the requirements of the OSHA Hazardous Communication Standard (29 CFR 1200)

M A T E R I A L S A F E T Y D A T A S H E E T

IDAHO ASPHALT SUPPLY INC.
Nampa, Idaho

CSS-1, CSS-1H

MATERIAL IDENTIFICATION

Chemical Name: Cationic Slow Set Asphalt Emulsion
Manufacturer: Idaho Asphalt Supply Inc.
Address: P.O. Box 966, Nampa, Id. 83651
Hazard Rating (NFPA)
Health: 1
Fire: 0
Reactivity: 0
Special: None

CAS Registry No. N/A
Date Prepared: 7/1/89

Hazard Rating Scale:
0 - Minimal
1 - Slight
2 - Moderate
- erious
- Severe

HAZARDOUS INGREDIENTS

Ingredients	CAS #	Percent	PEL	STEL	LV
Asphalt cement	8052-42-4	57-68%	N/A	10mg/m	mg/m
Emulsifier	TSCA	1-3%	N/A	N/A	N/A

PHYSICAL DATA

Boiling Point - 212f
Vapor Pressure - <1
Vapor Density - >0.062
Solubility in water - up to 100%
Specific Gravity @ 60f - 1.025 to 1.06
Melting Point - N/A
Evaporation Rate - <1
Appearance and Odor - Viscous brown to black liquid ; odor of amines and hydrocarbons

FIRE AND EXPLOSIVE DATA

Flash Point - N/A
Autoignition Temperature NFPA - N/A
Extinguishing Media - CO2, Class "B" extinguisher, foam and water fog.
Special Fire Fighting Procedures - Avoid breathing vapors, wear self-contained breathing apparatus.
Unusual Fire Explosion Hazards - DO NOT heat material above 212f to avoid generating excessive steam pressure.

REACTIVITY DATA

Stable: X Unstable:

Conditions to Avoid	-	DO NOT HEAT ABOVE 212f, Ignition sources.
Incompatible Materials	-	Avoid strong oxidizing agents
Hazardous Decomposition Products	-	Combustion may form CO2, CO, and sulfur dioxide.
Hazardous Polymerization	-	Will not occur.

HEALTH HAZARD DATA

Route of Exposure	Primary Route	Signs and Symptoms
Inhalation	[X]	Use with good ventilation. May cause respiratory tract irritation
Skin Absorption	[ ]	No significant symptoms indicative of skin absorption expected.
Skin Irritation	[X]	Will cause burns when product is hot. May cause dermatitis and acne like lesions on prolonged exposure.
Ingestion	[ ]	May cause nausea and diarrhea.
Eye Contact	[X]	Will burn and irritate.

Listed as Carcinogen? Not listed by NTP, IARC, or OSHA.

EMERGENCY FIRST AID

Inhalation:	Remove to fresh air. Give oxygen or artificial respiration as needed Obtain medical attention promptly.
Eye Contact:	Flush eyes with low pressure water for at least 15 minutes and obtain medical attention immediately.
Skin Contact:	If product is hot, cool with cold water. Otherwise wash thoroughly with soap and water.
Ingestion:	Call physician. Do not induce vomiting.

PROTECTIVE EQUIPMENT / CONTROL MEASURES

Respiratory Protection:	Avoid breathing vapors in confined spaces. NIOSH approved respirators may be required if TLV's are exceeded.
Eye Protection:	Use safety glasses, goggles or face shields.
Skin Protection:	Use rubber gloves, coveralls and impervious footwear.
Engineering controls:	Local exhaust ventilation may be required to meet exposure standards in confined areas.
Handling Precautions:	Avoid heating over 212f.

REVISION #1

LABEL INFORMATION

Chemical name: Asphalt Cements
Common name: Penetration Graded Asphalt AASHTO M-20;
Viscosity Graded Asphalt AASHTO M-226.

DANGER! VAPOR HARMFUL
DO NOT INTRODUCE WATER

Keep away from flames and other sources of ignition
Stable unless moisture is introduced
Extinguishing media - CO_2 or Class 'B' extinguisher
DO NOT APPLY WATER
Avoid breathing vapors. May contain low concentrations of hydrogen sulfide. Wear self-contained breathing apparatus when fire fighting. May cause dermatitis and acne lesions on prolonged and repeated exposure. Can cause severe burns when hot material contacts unprotected skin. Wear chemical resistant gloves, goggles or face shield, long sleeve shirt and pants. Use NIOSH approved respirator if TVL's are exceeded.

FIRST AID

Inhalation - Remove victim to fresh air. Start artificial resuscitation if necessary. Call a physician.

Eyes - Flush eyes with water for at least 15 minutes. Call a physician.

Skin- If hot material contacts skin, place affected part in cold water. Have a physician remove material or for small amounts use mineral oil for removal.

Ingestion - If ingested call a physician.

For further information refer to data sheet for Asphalt Cements.

Farmers Union Central Exchange, Inc. (CENEX)
P. O. Box 909
Laurel, Montana 59044
Telephone: (406)628-4311 or (406)628-4518

REVISION #1

FARMERS UNION CENTRAL EXCHANGE, INC.
P.O. Box 909, Laurel, Montana 59044

Asphalt Cements
Quick Identifier

MATERIAL SAFETY DATA SHEET

The information contained herein is based on data considered accurate, however, no warranty is expressed or implied regarding the accuracy of these data or the results to be obtained from the use thereof. Vendor assumes no responsibility for injury to vendee or third person proximately caused by the material if reasonable safety procedures are not adhered to as stipulated in the data sheet. Additionally, vendor assumes no responsibility for injury to vendee or third persons proximately caused by abnormal use of the material even if reasonable safety procedures are followed. Furthermore, vendee assumes the risk in his use of the material.

SECTION 1 GENERAL

Manufacturer's Name: Farmers Union Central Exchange, Inc. (CENEX)

Emergency Telephone No. 406/628-4518 | Information Telephone No. 406/628-4311

Chemical Name: Asphalt Cements | Date Prepared: 9/20/85

Chemical Family: Petroleum Asphalt Cements

Common Name(s): Penetration graded asphalt AASHTO M-20; Viscosity graded asphalt AASHTO M-22(

SECTION 2 HAZARDOUS INGREDIENTS/IDENTITY

This product, when heated above the softening point, may contain low concentrations of hydrogen sulfide. This gas, at low concentrations, may be irritating to eyes, skin and respiratory tract.

OSHA PEL: Petroleum Asphalt Cement Not Available

ACGIH TLV'S: Asphalt Cements - 5mg/m^3 Fumes; STEL - 10mg/m^3

SECTION 3 PHYSICAL/CHEMICAL CHARACTERISTICS

Boiling Point	Above 1050°F	Specific Gravity	1.02-1.06
Vapor Pressure	<1	Melting Point	Unknown
Vapor Density	>1	Evaporation Rate	Unknown

Solubility in Water: No

Appearance and Odor: Black semi-solid thermoplastic material; odor of hydrocarbon.

Becomes liquid above 90-130°F

SECTION 4 FIRE AND EXPLOSION HAZARD DATA

Flash Point in Degrees F (Method Used)	Above 325°F COC (D-92)	Flammable Limits in air % by volume	LEL Unknown	UEL Unknown

Extinguishing Media: CO_2 and Class 'B' extinguisher

Special Fire Fighting Procedures: Avoid breathing vapors, wear self-contained breathing apparatus. DO NOT APPLY WATER.

Unusual Fire and Explosion Hazards: Flammable at temperatures above 500°F.

DO NOT MIX WITH WATER.

SECTION 5 REACTIVITY DATA

Stability	Unstable		Conditions to Avoid	Stable unless moisture is introduced
	Stable	X		Flames and other sources of ignition

Incompatability (Materials to Avoid): Water, hydrocarbon solvents, strong oxidizing agents

Hazardous Decomposition Products: Fumes, smoke, carbon monoxide in the case of incomplete combustion

Hazardous Polymerization	May Occur	REC 3811	Conditions to Avoid	
	Will Not Occur	X		

SECTION 6 HEALTH HAZARDS

Acute Will cause severe burns if hot material contacts unprotected skin.

Chronic Respiratory tract irritation

Signs & Symptoms of Exposure May cause dermatitis and acne like lesions on prolonged and repeated exposure to dust or vapors.

Medical Conditions Generally Aggravated by Exposure Respiratory disease and infection; cardiovascular diseases

Chemical Listed as Carcinogen or Potential Carcinogen	National Toxicology Program	Yes	No	X	IARC	Yes	No	X	OSHA	Yes	No	X

ROUTES OF ENTRY WITH EMERGENCY & FIRST AID PROCEDURES

1. Inhalation Remove victim to fresh air. Start artificial resuscitation if necessary. Call a physician.
2. Eyes Flush eyes with water for at least 15 minutes. Call a physician.
3. Skin If hot material contacts skin, place affected part in cold water. Have a physician remove material or for small amounts use mineral oil for removal.
4. Ingestion If ingested call a physician.

SECTION 7 SPECIAL PRECAUTIONS

Precautions to be Taken in Handling and Storing Never introduce water when hot. Avoid skin exposure to hot material. Avoid breathing vapors in confined spaces. Avoid sources of ignition.

Shipping Information DOT ID #NA1999 - No Placard Required

Steps to be Taken in Case Material is Spilled or Released In case of spillage allow to cool and pick up when solid or semi-solid. Have proper extinguishing media present.

Waste Disposal Methods Handle in accordance with federal, state and local regulations.

SECTION 8 CONTROL MEASURES

Ventilation 1. Local Exhaust 2. Mechanical — If possibility of vapor or fume accumulation exists, utiliz explosion proof ventilating equipment, to avoid toxic or explosive concentrations.

Protective Gloves Chemical Resistant

Eye Protection Goggles or Face Shield

Respiratory Protection (Specify Type) Use appropriate NIOSH approved respirator if TLV's are exceeded.

Other Protective Clothing or Equipment Long sleeve shirt and pants to minimize skin contact.

Work & Hygienic Wash exposed skin with soap and water after work periods and before

DRAFT

Idaho Division of Environmental Quality

Air Permitting Screening Policy for Air Strippers used in the Cleanup of Petroleum Contaminated Groundwater

DRAFT

This policy is designed to quickly identify air stripper cleanups of petroleum contaminated ground water which pose limited risk to the public through the air pathway, and to expedite the approval for such air emissions. This policy is designed to work together with DEQ's Screening Model and Risk Assessment Procedures For Air Quality Permitting of Vapor Extraction Systems and Air Stripping Used for Leaking Underground Storage Tank Cleanup. Version 1.0 of that document is being updated to include this screening policy for air stripping.

The policy is implemented through a simple question and answer form (a copy of which follows), which conservatively estimates the significance of the emissions given the distance to the nearest property boundary or receptor. Sources with relatively insignificant emissions, as determined by answering the questions on the form and documented as required on the form, are offered DEQ review and final action within two weeks of the date of receipt. This significantly accelerates DEQ turnaround time to expedite the cleanup, since the timeline on processing air permit applications is typically 90 days or more.

For the purposes of this policy, a sensitive receptor is defined as any building or location occupied or frequented by persons who, due to age, infirmity or other health based criteria as defined by the Division of Environmental Quality, may be more susceptible to the deleterious effects of a toxic air pollutant(s) than the general population. Examples of sensitive receptors include but are not limited to: elementary and secondary schools, licensed day care centers, playgrounds and parks, hospitals, clinics and nursing homes.

The existence of a sensitive receptor within 500 feet of the proposed action will not necessarily result in a permit denial, but will trigger tighter DEQ scrutiny of risks to the surrounding population.

This screening policy does not supersede any other DEQ policies or requirements, but instead complements existing DEQ policies by identifying low risk sources, removing them from the standard air permit workload, and accelerating their review. Sources not approvable through this screening policy still may be approvable through the DEQ air quality permitting program. In those cases, a more thorough risk assessment will be required and DEQ review will remain on traditional timelines.

DRAFT

AIR PERMIT SCREENING TEST FOR AIR STRIPPING PETROLEUM CONTAMINATED WATER

Company/facility name _____
Facility address _____

A. PRESENCE OF SENSITIVE RECEPTORS

Is the proposed air stripping site located within 500 feet of a sensitive recepto: defined in the attached Air Permitting Screening Policy for Air Strippers used i: Cleanup of Petroleum Contaminated Ground water?

YES _____ NO _____

B. CALCULATE UNCONTROLLED BENZENE LEVELS IN AIR EMISSIONS

1. Flow rate of water into Air Stripper in gallons per minute. The proposed flow must have DEQ approval. The proposed flow rate must be sufficient to adequ: control, contain, and remove the petroleum contamination. Please a: documentation verifying DEQ approval of the proposed flow rate.

_____ gal./min.

2. Convert flow rate to liters per minute.
Multiply line 1 by 3.785. _____ *l*/min.

3. Determine Benzene concentration in ground water.

Is free product present in any ground water well associated with this petroleum release site? YES _____ NO _____

a. If you marked YES, you must conduct a pilot test to determine expected ber concentrations. See the attached "Directions for Conducting a Pilot Tes Determine Benzene Concentrations in Ground Water" for more information. I the benzene concentration here.

Benzene concentration from pilot test = _____ ppb (ug,

b. If you marked NO and free product is <u>not</u> present in any well, determine benzene concentration in the ground water by one of the following two meth

i. Enter the Benzene concentration from a ground water well with the hic benzene concentration. Use only the most recent analysis.

Benzene concentration from single well = _____ ppb (ug,

ii. Conduct a pilot test to determine benzene concentrations following directions of the attached "Directions for Conducting Pilot a Tes Determine Benzene Concentrations in Ground Water."

Benzene concentration from pilot test = _____ ppb (ug,

4. Calculate benzene flow rate to air stripper.
Multiply line 2 by line 3a or 3b, whichever is appropriate. _____ ug/min.

5. Convert uncontrolled benzene air emission rate from ug/min to lbs/day. Multiply line 4 by 3.18E-6. _____ lbs./day

B. CALCULATION OF MAXIMUM ALLOWABLE BENZENE EMISSION RATE

6. a. Distance to nearest property line. _____ ft
b. Distance to nearest offsite structure serving as a workplace or residence _____ ft

DRAFT

7. **Allowable Benzene emission level.**

a. Divide Line 6a by 100. _____
b. Divide line 6b by 200. _____
c. Enter the larger of line 7a or Line 7b _____
d. Enter the value 1.5 or the result from 7c, whichever is smaller. _____ lbs./day

The result in line 7d is the maximum allowable benzene emission rate for the proposed stripping operation at this site. Is the uncontrolled emission rate for benzene in li less than the maximum allowable benzene emission level in line 7d?

Yes ____ Control of benzene air emissions shall not be required. You ay skip Sec C. of this form and proceed directly to Section D. Document all data ent and enclose complete set of most recent water sampling results, a site map c to scale showing monitoring wells, and your monitoring plan. Send them with form to Division of Environmental Quality, Permits and Enforcement Program, N. Hilton, Boise, ID 83706.

No ____ Control of benzene air emissions shall be required. Call (208) 334-5898 review air quality permit requirements or proceed to the following page complete questions on emissions controls.

C. **CALCULATE CONTROLLED BENZENE LEVELS IN AIR EMISSIONS**
(please complete lines 1 to 7 before proceeding with this section)

8. Describe the type of emissions control you propose to use.

_____
_____
_____

9. Control Efficiency (0 < eff. < 1) 0.

10. 1.0 - Control Efficiency 0.

11. Enter uncontrolled benzene air emission rate from line 7 on reverse side. _____ lbs/day

12. Controlled benzene emissions Multiply lines 10 and 11. _____ lbs/day

Is the controlled emission rate for Benzene in line 12 less than the maximum allow Benzene emission rate calculated in line 7d?

Yes ____ Document all data entries and enclose complete set of most recent water samp results, a site map drawn to scale showing monitoring wells, your monito plan, and documentation on the control equipment (manufacturer's specificatio its application at the proposed site, and its efficiency if credit is take emission controls through this process. Send them with this form to Div of Environmental Quality, Permits and Enforcement Program, 1410 N. Hilton, Bo ID 83706.

No ____ Call (208) 334-5898, to review air quality permit requirements with DEQ staff

D. **SIGNATURE AND CONTACT INFORMATION**

Applications approved through this process will be required to document emissions rat DEQ during the initial two months of operation. Emissions rates exceeding those calcu above may result in further emissions limitations. DEQ may, in its sole discretion, rec modification to any project plans in order to protect public health.

_____ _____
Signature of preparer

DRAFT

( ) _____ Phone number REC 3817

DRAFT

Directions for Conducting a Pilot Test to Determine Benzene Concentrations in Ground Water (Air Stripping)

Benzene emission rates in air associated with air stripping operations are estimated using a benzene concentration in ground water. These data are then used to determine whether air emissions from the air stripping equipment require controls. The Division of Environmental Quality (DEQ) has determined that a short-term, full-scale pumping test with ground water sampling is an appropriate method for determining the benzene concentration in ground water in some cases. This procedure is required for determining benzene concentrations in ground water when free product is present in monitoring or recovery wells. It is also an acceptable, but not required, method of determining benzene concentrations when free product is not present.

For purposes of this guidance, the term "pilot test" shall mean the process of pumping ground water from the contaminated subsurface in the area targeted for remediation. Water samples shall be collected for laboratory analysis to determine benzene concentrations prior to treatment by the air stripping equipment. The criteria contained herein are designed specifically as a means of determining the concentration of benzene in pumped ground water. It may be possible to modify an aquifer test (designed to determine subsurface hydraulic parameters) conducted during site investigation work to obtain the same data. Alternatively, it may be appropriate to design or modify the pilot test so that subsurface hydraulic parameters are determined along with the expected benzene concentration.

Note that DEQ does not require air stripping equipment to be installed prior to conducting the pilot test. The pilot test may be conducted at any time within the site investigation as long as the benzene concentration is not likely to increase appreciably over time and site conditions are expected to be comparable between the time of sampling and cleanup. The criteria to be followed in performance of an acceptable pilot test are:

- Pumping shall take place from recovery well(s) expected to be used in the full-scale cleanup.

- The pumping rate shall be the same rate used in the full-scale cleanup. Usually, the pumping rate is approved by DEQ

REC 3818

through submission of a written cleanup plan. The pumping system shall operate continuously at the desired rate for a minimum of two (2) hours and a maximum of twelve (12) hours. Upon completion of pumping, one (1) grab sample shall be collected and analyzed for benzene, toluene, ethylbenzene, and xylenes (BTEX).

- One (1) duplicate sample shall be collected and analyzed for BTEX. Duplicate sample analyses must result in a relative percent difference (RPD) of 25% or less.

- Samples shall be collected from the pumping system at a location representative of inflow to the air stripper but after any preliminary treatment equipment (i.e., oil/water separators, etc.).

- The laboratory analysis method must be an EPA-approved method and must have a lower detection limit of no greater than one (1) ug/l (ppb). Sampling must be conducted in accordance with the RCRA Ground Water Monitoring Technical Enforcement Guidance Document (National Water Well Association, 1986) or equivalent.

- Contaminated water generated during the pilot test must be treated or disposed of in a safe and acceptable manner. On-site storage prior to treatment system completion is acceptable as long as all applicable regulations and ordinances are followed. The treatment and disposal of all generated wastes are the sole responsibility of the person(s) conducting the pilot test.

C. List appropriate soil sample analytical results from excavated contaminated soil. Samples collected shall be representative of the respective stockpiled PCS. If the petroleum is not gasoline or fuel oil, attach separate table.

col.1 Stockpile volume (yd^3)	col.2 Sample I.D.	col.3 Sample type TPH-Gas TPH-Diesel	col.4 Grab or composite sample?	col.5 Sample TPH (ppm)	col.6 Average TPH per stockpile	col.7 Multiply average TPH (col. 6) by stockpile volume (col. 1)

sum of col. 1 _____ sum of col. 7 = _____

Note: Copies of lab results and chain of custody forms must be included.

IV. **Screening test for air emissions.**

A. Calculate average TPH for all PCS to be treated.

1. Enter TOTAL TPH x VOL. (sum of col. 7) here. _____
2. Enter TOTAL VOLUME (sum of col. 1) here. _____
3. Calculate AVERAGE TPH. Divide line 1 (TOTAL TPH x VOL.) by line 2 (TOTAL VOLUME) and enter quotient here. _____

B. Refer to table 2 to determine setback requirement based upon the TOTAL VOLUME and AVERAGE TPH values calculated above. Enter the setback requirement here. _____

Note: If the setback requirement is greater than the distance to the nearest building or residential property line appearing in line II.D, then the land-treatment proposal will not be approved under this expedited format and further review of the land-treatment proposal will be required.

V. **Include the following figures:**

A. Copy of county soil survey map (if the county has been mapped) with copies of the interpretation tables or sheets. CLEARLY MARK location of site on the soil map.

B. Map with exact land treatment site location marked.

VI. **Proposed end use of PCS:** _____

_____

_____

****

_____
Applicant's signature

_____ ( ) _____
Date Telephone

Consultant (or other) preparing this form

Company name_____

Street_____

City, zip_____

Telephone_____

DRAFT

DRAFT

OFFSET DISTANCES FOR LANDFARMING GASOLINE PETROLEUM CONTAMINATED SOIL

(Distances given in feet)

TOTAL PETROLEUM HYDROCARBON CONCENTRATIONS (PPM)

CUBIC YARDS OF MATERIAL

	150	200	250	300	350	400	500	600	700	800	900	1000	1200	1400	1500	1600	1800	2000	2200	2400	2600	2800	3000	3500	4000
50	50	50	50	50	50	50	50	50	50	50	53	60	74	87	94	100	113	125	137	148	160	170	181	206	229
100	50	50	50	50	50	50	50	53	65	76	87	98	119	140	149	159	177	195	212	229	244	260	274	309	343
150	50	50	50	50	50	50	57	72	87	101	116	129	156	181	193	205	227	249	270	290	310	329	355	396	436
200	50	50	50	50	50	52	70	89	106	123	140	156	187	216	230	243	270	295	319	343	367	390	412	462	511
250	50	50	50	50	51	62	83	104	124	143	161	179	214	247	262	278	308	336	364	392	420	445	470	530	588
300	50	50	50	50	59	71	95	117	139	160	181	201	239	275	292	309	343	379	408	437	466	495	523	590	656
350	50	50	50	53	66	79	104	128	150	171	191	210	244	301	320	339	376	412	448	485	522	562	603	719	858
400	50	50	50	59	73	88	115	142	167	192	216	239	284	326	347	367	407	445	482	517	552	587	621	703	781
450	50	50	50	65	80	95	125	153	180	207	232	257	304	350	372	394	437	477	516	555	593	630	667	755	839
500	50	50	54	70	87	103	134	164	193	220	247	273	324	373	397	420	464	508	550	591	632	672	711	804	894
550	50	50	58	76	93	110	142	174	204	234	262	290	343	395	420	444	491	537	582	626	669	712	753	852	947
600	50	50	62	81	99	116	151	184	215	246	276	305	361	417	442	468	517	566	614	660	706	750	794	898	998
650	50	50	66	86	104	123	159	193	226	258	289	320	381	436	464	490	543	594	644	693	741	788	833	943	1047
700	50	50	70	90	110	129	165	202	237	270	303	335	396	453	481	508	562	613	663	711	757	801	843	942	1028
750	50	53	74	95	115	135	174	211	247	282	315	352	414	475	505	534	592	648	703	756	808	859	909	1026	1141
800	50	56	78	99	120	141	181	219	257	293	328	365	430	493	525	555	615	674	731	786	840	893	945	1065	1186
850	50	59	81	104	125	147	188	228	265	304	340	376	446	512	544	576	638	699	758	816	872	927	980	1108	1230
900	50	62	85	108	130	152	195	236	275	314	352	389	461	530	563	596	661	724	785	845	903	959	1015	1147	1273
950	50	64	88	112	135	158	201	244	285	325	364	403	476	547	582	616	683	748	811	873	933	991	1048	1185	1315
1000	50	67	92	116	140	163	209	251	294	335	375	415	491	564	600	635	705	772	837	901	962	1023	1081	1222	1356
1050	50	70	95	120	144	168	214	259	302	345	386	426	506	581	618	655	726	795	862	928	991	1053	1114	1259	1397
1100	50	72	99	124	149	173	220	266	311	355	396	439	520	596	636	673	747	818	887	954	1020	1083	1146	1295	1436
1150	50	75	101	127	153	178	226	274	319	364	409	451	534	614	653	692	767	840	911	980	1048	1113	1177	1330	1476
1200	50	77	104	131	157	183	232	281	328	374	420	463	549	630	670	710	787	862	935	1006	1075	1142	1207	1365	1514
1250	51	80	107	135	161	187	239	286	336	383	430	474	562	646	687	726	807	884	959	1031	1102	1171	1238	1399	1552
1300	53	82	110	138	165	192	244	295	344	393	440	486	575	662	704	745	827	905	982	1056	1128	1199	1267	1432	1589
1350	55	84	113	142	169	197	250	301	352	402	450	497	588	677	720	763	846	926	1005	1081	1154	1226	1297	1465	1626
1400	56	87	116	145	173	201	255	308	360	411	460	508	602	692	736	780	865	947	1027	1105	1180	1254	1325	1496	1662
1450	58	89	119	148	177	206	261	315	368	420	470	519	615	707	752	797	884	968	1049	1129	1206	1281	1354		
1500	60	91	122	152	181	210	266	321	375	428	479	529	627	722	766	813	902	988	1071	1152	1231	1307	1382		

REC 3821

DRAFT

OFFSET DISTANCES FOR LANDFARMING DIESEL CONTAMINATED SOIL

(Distances given in feet)

TOTAL PETROLEUM HYDROCARBON CONCENTRATIONS (PPM)

CUBIC YARDS OF MATERIAL	150	200	250	300	350	400	500	600	700	800	900	1000	1200	1400	1500	1600	1800	2000	2200	2400	2600	2800	3000	3500	4000
50	50	50	50	50	50	50	50	50	50	50	53	60	74	87	94	100	113	125	137	148	160	170	181	206	229
100	50	50	50	50	50	50	50	53	65	76	87	98	119	140	149	159	177	195	212	229	244	260	274	300	300
150	50	50	50	50	50	50	57	72	87	101	116	129	156	181	193	205	227	249	270	290	300	300	300	300	300
200	50	50	50	50	50	52	70	89	106	123	140	156	187	216	230	243	270	295	300	300	300	300	300	300	300
250	50	50	50	50	51	62	83	104	124	143	161	179	214	247	262	278	300	300	300	300	300	300	300	300	300
300	50	50	50	50	59	71	95	117	139	160	181	201	239	275	292	300	300	300	300	300	300	300	300	300	300
350	50	50	50	53	66	79	104	128	150	171	191	210	244	300	300	300	300	300	300	300	300	300	300	300	300
400	50	50	50	59	73	88	115	142	167	192	216	239	284	300	300	300	300	300	300	300	300	300	300	300	300
450	50	50	50	65	80	95	125	153	180	207	232	257	300	300	300	300	300	300	300	300	300	300	300	300	300
500	50	50	54	70	87	103	134	164	193	220	247	273	300	300	300	300	300	300	300	300	300	300	300	300	300
550	50	50	58	76	93	110	142	174	204	234	262	290	300	300	300	300	300	300	300	300	300	300	300	300	300
600	50	50	62	81	99	116	151	184	215	246	276	300	300	300	300	300	300	300	300	300	300	300	300	300	300
650	50	50	66	86	104	123	159	193	226	258	289	300	300	300	300	300	300	300	300	300	300	300	300	300	300
700	50	50	70	90	110	129	166	202	237	270	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
750	50	53	74	95	115	135	174	211	247	282	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
800	50	56	78	99	120	141	181	219	257	293	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
850	50	59	81	104	125	147	188	228	268	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
900	50	62	85	108	130	152	195	236	275	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
950	50	64	88	112	135	158	201	244	285	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
1000	50	67	92	116	140	163	208	251	294	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
1050	50	70	95	120	144	168	214	259	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
1100	50	72	98	124	149	173	220	266	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
1150	50	75	101	127	153	178	226	274	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
1200	50	77	104	131	157	183	232	281	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
1250	51	80	107	135	161	187	238	288	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
1300	53	82	110	138	165	192	244	295	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
1350	55	84	113	142	169	197	250	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
1400	56	87	116	145	173	201	255	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
1450	58	89	119	148	177	206	261	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
1500	60	91	122	152	181	210	266	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300

REC 3822

RAÚL R. LABRADOR
Attorney General

SCOTT L. CAMPBELL
Deputy Attorney General
Chief, Energy and Natural Resources Division

Hannah M.C. Young, ISB No. 9781
hannah.young@deq.idaho.gov
Michael A. Short, ISB No. 10554
michael.short@deq.idaho.gov
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: 208.373.0453

Attorneys for Respondent

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047

NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,

Petitioners,

v.

IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,

Respondent,

and

PERPETUA RESOURCES IDAHO, INC.,

Intervenor-Respondent.

Case Docket No. 0101-22-01
OAH Case No. 23-245-01

JOINT MOTION TO STRIKE PETITIONERS' RESPONSE

The Idaho Department of Environmental Quality ("Department") and Perpetua Resources Idaho, Inc. ("Perpetua"), through undersigned counsel, pursuant to IDAPA 58.01.23.162, respectfully moves to strike Petitioners' Nez Perce Tribe, Save the South Fork Salmon, Inc., and Idaho Conservation Leage (collectively "Petitioners") Response Opposing DEQ/Perpetua's Motion for Reconsideration filed on June 3, 2024 ("Response").

On May 23, 2024, the Department and Perpetua filed a Joint Motion for Reconsideration and/or Clarification of Final Order requesting that the Board of Environmental Quality ("Board") reconsider its holding that the Permit to Construct be remanded to the Hearing Officer. On June 3, 2024, Petitioners filed the Response in opposition to Department and Perpetua's motion for reconsideration. Notably, Petitioners fail to identify any authority authorizing the filing of a response to a motion for reconsideration. Indeed, none exists.

Neither the Idaho Rules of Administrative Procedure of the Attorney General,[1] nor Idaho Code authorize the filing of a response brief to a motion for reconsideration. I.C. § 67-5246(4); IDAPA 04.11.01.740. This is particularly notable, because the Rules *do* specifically authorize and provide for a response brief when a party appeals to the Board. *See* IDAPA 04.11.01.730.02.c. Had the Department intended to authorize responses to motions for reconsideration it would have included a provision in the rules. Therefore, Petitioners' Response should be struck and not considered.

Irrespective of whether Petitioners' Response is struck, the document attached as Exhibit 1 to Mr. Tiedemann's declaration fully supports the Department's and Perpetua's motion for reconsideration. *See* Tiedemann Decl., Ex. 1, App'x 6. This document explains that the TAPs screening levels were just that, screening levels, not standards. *Id.* The Department used unit risk

[1] The relevant Rules of Administrative Procedure, IDAPA 04.11.01, are incorporated by reference in the Department's Contested Case Rules. IDAPA 58.01.23.003.18.

factors ("URF") from the U.S. Environmental Protection Agency to set these screening levels, which it converted to annual concentrations now set forth as acceptable ambient concentrations for carcinogens ("AACCs") in IDAPA 58.01.01.586. *Id.*; see also id., App'x 7. However, as the document explains, the ultimate question is not whether a source meets the screening level on an annual basis, but whether the source is likely to cause an unacceptable cancer risk evaluated based on a lifetime exposure of 70 years. *Id.*, App'x 8. Petitioners' reference to short term sources is consistent with this interpretation. Even though the screening level was increased for short term sources, DEQ still needed to assure itself that the risk from these projects would be less than one in one million, and therefore limited the duration of exposure for screening purposes. As explained in the Department's and Perpetua's Motion for Reconsideration, utilizing the URFs and AACCs, the Stibnite Gold Project does not cause an unacceptable cancer risk.

For the foregoing reasons, Perpetua respectfully requests that the Board strike Petitioners' Response. To the extent that the Board is inclined to consider Petitioners' Response, the Department and Perpetua request that the Board read the entirety of the 1992 meeting packet and not just the isolated excerpt from Petitioners' Response.

DATED: June 4, 2024.

DEPARTMENT OF ENVIRONMENTAL QUALITY

/s/ Hannah M.C. Young
Hannah M.C. Young
Michael A. Short
Deputy Attorney General

Attorney for Respondent

STOEL RIVES LLP

/s/ W. Christopher Pooser
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Intervenor-Respondent Perpetua Resources Idaho, Inc.

CERTIFICATE OF SERVICE

I hereby certify that on June 4, 2024, a true and correct copy of the foregoing JOINT MOTION TO STRIKE PETITIONERS' RESPONSE was served on the following:

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

Dylan B. Lawrence
Hearing Officer
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Bryan Hurlbutt
Laird ("Laird") J. Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
ann.yribar@ag.idaho.gov
via electronic service

Paula Wilson, Hearing Coordinator
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, Idaho 83706
paula.wilson@deq.idaho.gov
via electronic service

/s/ DeAnne M. Chaffin
DeAnne M. Chaffin
Legal Assistant

RAÚL R. LABRADOR
Attorney General

SCOTT L. CAMPBELL
Deputy Attorney General
Chief, Energy and Natural Resources Division

Hannah M.C. Young, ISB No. 9781
hannah.young@deq.idaho.gov
Michael A. Short, ISB No. 10554
michael.short@deq.idaho.gov
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: 208.373.0543

Attorney for Respondent

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047

NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,

Petitioners,

v.

IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,

Respondent,

and

PERPETUA RESOURCES IDAHO, INC.,

Intervenor-Respondent.

Case Docket No. 0101-22-01
OAH Case No. 23-245-01

NOTICE OF APPEARANCE

TO ALL PARTIES AND THEIR COUNSEL OF RECORD:

PLEASE TAKE NOTICE that Michael A. Short, Deputy Attorney General, Idaho Department of Environmental Quality, hereby appears as counsel of record for the Respondent, Idaho Department of Environmental Quality, in the above-entitled matter. All future notices, correspondence, submissions, pleadings, orders or any other communications relating to this matter, should be served on the undersigned counsel as follows:

Michael A. Short
michael.short@deq.idaho.gov
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: 208.373.0543

DATED: June 5, 2024.

IDAHO DEPARTMENT OF
ENVIRONMENTAL QUALITY

/s/ Michael A. Short
Michael A. Short
Deputy Attorney General
Attorney for Respondent

CERTIFICATE OF SERVICE

I hereby certify that on June 5, 2024, a true and correct copy of the foregoing NOTICE OF APPEARANCE was served on the following:

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

Dylan B. Lawrence
Hearing Officer
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Bryan Hurlbutt
Laird ("Laird") J. Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
ann.yribar@ag.idaho.gov
via electronic service

Paula Wilson, Hearing Coordinator
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, Idaho 83706
paula.wilson@deq.idaho.gov
via electronic service

/s/ *DeAnne M. Chaffin*
DeAnne M. Chaffin
Legal Assistant

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	Agency Case No. 0101-22-01
	)	OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON	)	**PETITIONERS' RESPONSE OPPOSING DEQ/PERPETUA'S MOTION TO STRIKE**
Petitioners,	)	
v.	)	
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC.	)	
Intervenor-Respondent.	)	

Petitioners Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon hereby oppose the Joint Motion to Strike filed by the Idaho Department of Environmental Quality ("DEQ") and Perpetua Resources Idaho, Inc. ("Perpetua") on June 4, 2024. The Idaho Rules of Administrative Procedure of the Attorney General neither specifically authorize nor prohibit the filing of a response to a motion for reconsideration. Moreover, those rules provide:

> The rules in this chapter will be liberally construed to secure just, speedy and economical determination of all issues presented to the agency. Unless prohibited by statute, the agency may permit deviation from these rules when it finds that compliance with them is impracticable, unnecessary or not in the public interest.

IDAPA 04.11.01.052. Considering Petitioners' short response to DEQ and Perpetua's Joint Motion for Reconsideration and/or Clarification of Final Order ("Reconsideration Motion") will allow for just, speedy, and economical determination of the issues. The Reconsideration Motion relied on "new" evidence that was in existence both during the three years DEQ was reviewing Perpetua's application for a permit to construct and during the two years of this contested case proceeding, but was never presented to DEQ, the Hearing Officer, or this Board until the eleventh-hour scramble requesting this Board to reconsider its Final Order. As Petitioners' raised in their response to the Reconsideration Motion, it is not in the public interest, nor is it appropriate, for the Board to consider this "new" evidence on a one-sided motion for reconsideration. *See* IDAPA 58.01.23.730.03 (providing the Board with the authority to "remand the matter for further evidentiary hearings if further factual development of the record is necessary . . .") (emphasis added).

//

//

//

The Board should therefore deny DEQ and Perpetua's Joint Motion to Strike,

Dated: June 7, 2024

Respectfully submitted,

/s/ Bryan Hurlbutt
Bryan Hurlbutt
Attorney for the Nez Perce Tribe and the Idaho Conservation League

/s/ Julia S. Thrower
Julia S. Thrower
Attorney for Save the South Fork Salmon

CERTIFICATE OF SERVICE

I hereby certify that on June 7, 2024, a true and correct copy of Petitioners' foregoing Response and was served on the following:

By email and U.S. Mail:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov

By email only:

Hannah M.C. Young
Deputy Attorney General
Michael A. Short
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, ID 83706
(208) 373-0422
hannah.young@deq.idaho.gov
(208) 373-0543
michael.short@deq.idaho.gov
Attorneys for Respondent Idaho Department of Environmental Quality

Krista McIntyre
W. Christopher Pooser
Wade Foster
Stoel Rives, LLP
101 S. Capital Blvd., Suite 1900
Boise, ID 83702
(208) 389-9000
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
Attorneys for Intervenor Perpetua Resources of Idaho, Inc.

Ann Yribar
Deputy Attorney General
Office of the Attorney General
P.O Box 83720
Boise, ID 83720-0010
ann.yribar@ag.idaho.gov
Attorney for the Idaho Board of Environmental Quality

Dylan B. Lawrence
Varin Thomas, LLC
242 N. 8th St., Suite 220
Boise, ID 83702
(208) 345-6021
dylan@varinthomas.com
Hearing Officer

Paula Wilson, Paralegal
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
paula.wilson@deq.idaho.gov
Hearing Coordinator

/s/ Julia Thrower
Julia Thrower

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY

STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	Case Docket No. 0101-22-01 OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOURTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondents, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	ORDER ON PETITIONS FOR RECONSIDERATION AND/OR CLARIFICATION OF FINAL ORDER

I. INTRODUCTION

On July 22, 2022, the Nez Perce Tribe, the Idaho Conservation League, and Save the South Fork Salmon (collectively "Petitioners"), filed a *Petition to Initiate Contested Case: Air Quality Permit to Construct P-2019.0047 (Jun. 17, 2022)*, seeking review of the Idaho Department of Environmental Quality's ("DEQ") issuance on June 17, 2022 of Air Quality Permit to Construct P-2019.0047 ("PTC"), to mining company Perpetua Resources Idaho, Inc.

("Perpetua") for its proposed Stibnite Gold Project ("SGP"). REC 0001–0028. Perpetua filed a Petition to Intervene in the matter on August 12, 2022. REC 0040–0043. A Hearing Officer was appointed and the parties participated in discovery and ultimately filed cross-motions for summary judgement. REC 319–322, REC 1204–1206, REC 1276–1278. On October 31, 2023, the Hearing Officer issued a *Preliminary Order*. REC 3280–3328. On November 14, 2023, the Petitioners filed a *Petition for Review* of the *Preliminary Order.* REC 3342–3356. On December 5, 2023, the Hearing Officer issued an *Amended Preliminary Order*. REC 3372–3425. In response, the Petitioners filed an *Amended Petition for Review* that requested review by the Board of Environmental Quality of both the October 31, 2023 *Preliminary Order* and the December 5, 2023 *Amended Preliminary Order*. REC 3426–3441. On May 9, 2024 the Board issued a *Final Order* in this matter. REC 3695–3720. On May 23, 2024, Petitioners filed their *Petitioners' Motion for Clarification and/or Reconsideration.* REC 3721–3727. On May 23, 2024, DEQ and Perpetua filed a *Joint Motion for Reconsideration and/or Clarification of Final Order* and *Memorandum in Support of Joint Motion for Reconsideration and/or Clarification of Final Order*. REC 3728–3751. On June 3, 2024, Petitioners filed *Petitioners Response Opposing DEQ/Perpetua's Motion for Reconsideration.* On June 4, 2024, DEQ and Perpetua filed a *Joint Motion to Strike Petitioner's Response*.

RELIEF REQUESTED

1. Petitioner's Requests

Petitioners request the Board of Environmental Quality clarify or reconsider its *Final Order* to set aside or vacate the PTC while on remand or to order an amended Application for Permit to Construct be filed with DEQ.

2. DEQ and Perpetua's Requests

DEQ and Perpetua request the Board of Environmental Quality:

1. Reconsider its issuance of a final order in this matter.

2. Reconsider its decision regarding DEQ's analysis of arsenic ambient concentrations and issue a final order that finds DEQ acted reasonably and in accordance with law.

3. Reconsider its decision regarding DEQ's analysis of arsenic ambient concentrations and reopen the proceedings before the Board and hold additional hearings on the analysis before issuing a final order.

4. Reconsider and/or clarify its instructions on remand so that the Hearing Officer and the parties directly address the sufficiency of evidence the Board seeks to affirm the PTC.

ANALYSIS

1. Petitioner's Motion for Reconsideration is Denied

Petitioners assert that the Board of Environmental Quality is required to set aside the PTC under I.C. § 67-5279(3). That provision, however, applies to judicial review by a court of an agency action and is not applicable in this matter.

Petitioners further cite *In the Matter of Sunnyside Park Utilities' Application for Sewage Disposal Permit*, Final Order on Petition for Review of Preliminary Order, at p. 10 (BEQ Dkt. 0103-07-02, April 7, 2009) for the proposition that the PTC must be set aside. In *Sunnyside*, DEQ denied an application for permit but failed to provide sufficient reasoning for the denial. *Id.* at 11. The Board of Environmental Quality found:

> Simply put, we are unable to tell exactly what criteria DEQ chose to apply in determining whether Idaho Falls' central wastewater system was reasonably accessible to the subdivision. Since we cannot determine that DEQ's reasoning and conclusion were rational, the permit denial must be set aside. Setting aside the permit denial will apply DEQ to process the application again, or to process an amended application should Sunnyside decide to submit one, and in so doing identify the facts and circumstances that should be considered, apply its expertise to the facts and issues, and provide an adequate explanation for its decision.

Id. at 11–12. Unlike in *Sunnyside*, DEQ provided, in this matter, extensive reasoning for its issuance of the PTC. The Board of Environmental Quality found that DEQ's decision in four of the five issues brought for review were supported by sufficient evidence and that DEQ acted reasonably in making those decisions. The fifth issue brought for review has been remanded to the Hearing Officer for additional fact finding. But the remand has no effect on the Board of Environmental Quality's decision on the first four issues for which there was sufficient evidence. Because DEQ has been upheld on most of its decisions in the PTC it does not make sense to set aside or vacate the entire PTC or to require the applicant to file a new application for permit. Therefore, the *Petitioners' Motion for Clarification and/or Reconsideration* is denied.

2. DEQ and Perpetua's Motion for Reconsideration and/or Clarification is Denied in Part and Granted in Part.

As outlined below, the Board of Environmental Quality grants DEQ and Perpetua's request to clarify the effective date of the *Final Order*, denies the request to reconsider its decision on the ambient arsenic concentration issue, denies the request to reopen the proceedings before the Board or hold additional hearings before the Board on the arsenic issue, and denies the request to provide additional clarification on the issues for remand.

A. The Board of Environmental Quality Clarifies its Decision as to the Effective Date of the Final Order.

When reviewing a petition for review of a preliminary order, the Board of Environmental Quality must: "(a) Issue a final order in writing, within fifty-six (56) days of the receipt of the final briefs or oral argument, whichever is later, unless the period is waived or extended with the written consent of all parties, or for good cause shown; (b) Remand the matter for additional hearings; or (c) Hold additional hearings." I.C. § 67-5245(6)(a)–(c). DEQ and Perpetua argue that the disjunctive "or" in this section means that the Board may *either* issue a final order or

remand the matter for additional hearings, but not do both. However, I.C. § 67-5246(1) seems to contemplate that the only type of order an agency head may issue is a final order: "If the presiding officer is the agency head, the presiding officer shall issue a final order."

In this matter, the Board of Environmental Quality found that sufficient evidence existed to support DEQ's findings in four of the five issues brought for review and that DEQ acted reasonably in making those decisions. The Board of Environmental Quality's decision on those matters is final. However, the Board also found, with regard to the ambient arsenic air concentration analysis, that there was not sufficient evidence to support DEQ's analysis and that further factual development was needed on that issue. Consequently, the Board remanded that issue to the Hearing Officer. So that issue is not yet final.

This split decision creates some ambiguity as to the nature of the order that the Board of Environmental Quality must issue in this matter. The Board recognizes that if it issues a final order that issuance will trigger certain time frames under I.C. §§ 67-5270 and 67-5273 under which the parties must seek judicial review of that final order. Those time frames would likely overlap with any proceedings being held by the Hearing Officer on remand, creating a situation in which the parties must simultaneously seek judicial review under I.C. § 67-5270, while at the same time engaging in a remand proceeding before the Hearing Officer on the arsenic issue. The Board of Environmental Quality recognizes that this may create confusion in the record and likely does not result in judicial economy.

Idaho Code Section 67-5246(5) provides: "*Unless a different date is stated in a final order*, the order is effective fourteen (14) days after its service date if a party has not filed a petition for reconsideration. . . ." (emphasis added); *see also* IDAPA 58.01.23.730.03. This provision provides the Board of Environmental Quality some discretion to determine a different timeframe

for when its order becomes "effective" for purposes of triggering judicial review deadlines under I.C. §§ 67-5270 and 67-5273. While the Board's decision is final as to the first four issues, it is not final as to the arsenic issue. Therefore, the Board will stay issuance of a final order on all five issues until the remand before the Hearing Officer is complete and all statutory deadlines for review of the Hearing Officer's Orders have run. The order will still be a "Final Order," but it will not be considered "effective" for purposes of I.C. §§ 67-5246(5), 67-5270, and 67-5273 until the Hearing Officer has issued an order on the arsenic issue and all statutorily-allowed administrative review of that issue has been completed. At that point, all five issues will be considered "final" and appealable under I.C. §§ 67-5270 and 67-5273. This will allow a full factual record to be developed for the arsenic issue and will prevent the parties from having to simultaneously file for judicial review and engage in additional fact finding before the Hearing Officer. Therefore, the Board of Environmental Quality grants DEQ and Perpetua's motion for clarification of the effective date of the *Final Order*.

B. The Board of Environmental Quality Denies the Request to Reconsider its Decision on the Ambient Arsenic Concentration Issue.

DEQ and Perpetua argue that the Board of Environmental Quality misunderstood or was mistaken in its decision on the ambient arsenic air concentration analysis. In support of their positions, DEQ and Perpetua present additional evidence that is not a part of the record in this case. DEQ and Perpetua also make new arguments that were not briefed or argued by the parties. When reviewing a preliminary order, the Board of Environmental Quality's findings of fact "must be based exclusively on the evidence in the record of the contested case and on matters officially noticed in that proceeding." I.C. § 67-5248(2). The agency record of a contested case consists of all items enumerated in I.C. § 67-5249(1)(a)–(g) (pleadings, evidence received, matter officially noticed, record prepared by the hearing officer and transcript of the

proceeding, staff memos or data, and orders). Unless an exception exists, "the agency record constitutes the exclusive basis for agency action in contested cases under this chapter or for judicial review thereof." I.C. § 67-5249(3), *see also* IDAPA 04.11.01.650.01, *Masterson v. Idaho Dep't of Transp.*, 150 Idaho 126, 130, 244 P.3d 625, 629 (Ct. App. 2010) (holding a hearing officer in a contested case erred by relying on materials that were not made part of the record.).

The Board of Environmental Quality will not accept new evidence or arguments regarding the ambient arsenic air concentration analysis and will not reconsider its decision on that issue. The parties will have an opportunity to supplement and develop a full factual record on the arsenic issue before the Hearing Officer on remand. Therefore, DEQ and Perpetua's request for the Board to reconsider its decision on the arsenic issue is denied.

C. The Board of Environmental Quality Denies the Request to Reopen the Proceedings or Hold Additional Hearing before the Board.

DEQ and Perpetua request the Board of Environmental Quality reopen the proceedings before the Board or hold additional hearings. The Board will not reopen the proceedings before it or hold additional hearing in this matter. The parties will have an opportunity to develop a full factual record on the arsenic issue before the Hearing Officer on remand. Therefore, DEQ and Perpetua's request to reopen or hold additional proceedings before the Board of Environmental Quality is denied.

D. The Board of Environmental Quality Denies the Request for Additional Clarification or Instructions to the Hearing Officer.

DEQ and Perpetua request the Board of Environmental Quality provide clarification and instructions to the Hearing Officer regarding the proceedings on remand, including determining what evidence may be submitted and how the issue must be framed. The Board will not limit the scope of the proceedings on remand or the types of evidence that may be presented, other than to

restate that they must focus only on the development of additional factual evidence on the ambient arsenic air concentration analysis performed by DEQ for the PTC. As stated above, the other four issues brought before the Board have been finally decided and cannot be reopened on remand. The parties will have a full opportunity before the Hearing Officer on remand to define the scope of those proceedings and evidence that may be presented. Therefore, DEQ and Perpetua's request for additional clarification and instruction for the Hearing Officer on remand is denied.

CONCLUSION

Based on the foregoing, it is hereby ordered:

1. Petitioner's Motion for Clarification and/or Reconsideration is Denied
2. The Joint Motion for Reconsideration and/or Clarification of Final Order is Granted in Part and Denied in Part.
    a. The Board of Environmental Quality Clarifies its Decision as to the Effective Date of the Final Order.
    b. The Board of Environmental Quality Denies the Request to Reconsider its Decision on the Ambient Arsenic Concentration Issue.
    c. The Board of Environmental Quality Denies the Request to Reopen the Proceedings or Hold Additional Hearing before the Board.
    d. The Board of Environmental Quality Denies the Request for Additional Clarification or Instructions to the Hearing Officer.

Dated this 12th day of June, 2024

Mark Bowen
Chairman, Idaho Board of Environmental Quality

CERTIFICATE OF SERVICE

I HEREBY CERTIFY that on this 12th day of June, 2024, a true and correct copy of the foregoing was served on the following:

Hannah Young
Michael Short
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
hannah.young@deq.idaho.gov
michael.short@deq.idaho.gov

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
Counsel for the Idaho
Board of Environmental Quality
ann.yribar@ag.idaho.gov

Dylan Lawrence
Varin Thomas LLC
P.O. Box 1676
Boise, ID 83701
Hearing Officer
dylan@varinthomas.com

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-004
filings@oah.idaho.gov

/s/ Paula J. Wilson
Paula J. Wilson, Paralegal
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, Idaho 83706
paula.wilson@deq.idaho.gov

DYLAN LAWRENCE
VARIN THOMAS LLC
P.O. Box 1676
Boise, ID 83701
(208) 345-6021
dylan@varinthomas.com

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	BEQ Case No. 0101-22-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	)	OAH Case No. 23-245-01 NOTICE OF STATUS AND SCHEDULING CONFERENCE; UPDATED DISCLOSURE

On June 12, 2024, the Board of Environmental Quality issued its Order on Petitions for Reconsideration and/or Clarification of Final Order, returning jurisdiction of this matter to the Office of Administrative Hearings and the hearing officer. On June 17, 2024, counsel for DEQ sent an email to the parties and hearing officer attaching a proposed Scheduling Order and requesting the setting of a scheduling conference. Based on subsequent email exchanges, the parties will meet and confer regarding scheduling matters on June 25, 2024. The parties had also set aside July 2 and 3, 2024 to discuss scheduling issues, though there is disagreement among the parties as to whether the July dates were intended to be counsel-only or with the hearing officer. Regardless of that issue, the

subsequent email exchange also informed the hearing officer that counsel for Save the South Fork Salmon would be unavailable for the majority of July and a few days in early August.

The hearing officer is sympathetic to—and personally identifies with—the challenges of managing summer travel while working at a small law firm. However, the hearing officer is not comfortable deferring the first post-remand conference among the parties and hearing officer until mid-August. Because counsel for the parties had already been setting aside July 2 and/or 3 to discuss scheduling issues, the hearing officer hereby notifies the parties that he will convene a status and scheduling conference via Zoom on 2:30 p.m. on Tuesday, July 2, 2024, and will circulate the associated Zoom credentials separately. To the extent counsel for any of the parties is unavailable at that date and time, he or she should coordinate an alternative, mutually convenient date and time with the other parties and inform the hearing officer so that an amended notice can be issued. The hearing officer can rearrange his calendar to accommodate a conference at any reasonable time on July 2 or July 3.

In light of the proposed hearing dates in DEQ's draft Scheduling Order, the hearing officer hereby notifies the parties, in advance of their June 25 meet-and-confer, that he currently has a contested case hearing scheduled for late September 2024. Therefore, a hearing on the merits in this matter should take place no earlier than October 2024. In addition, the hearing officer invites and encourages the parties to file a short status report regarding their June 25 meet-and-confer on or prior to Friday, June 28, 2024, noting the areas of agreement and disagreement regarding the nature, scope, and conduct of the proceedings on remand.

Finally, in connection with the resumption of these proeedings, the hearing officer hereby attaches an updated disclosure of his other professional matters involving the State of Idaho as a party, and notifies the parties that OAH has approved the associated waiver request.

Dated this 24th day of June, 2024.



Dylan Lawrence
Hearing Officer

CERTIFICATE OF SERVICE

I hereby certify that on this 24th day of July, 2024, I caused to be served a true and correct copy of the foregoing by the following method to:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Resources Division
Office of the Attorney General
1410 N. Hilton St.
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Michael A. Short
Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
michael.short@deq.idaho.gov
hannah.young@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service



Dylan B. Lawrence
Hearing Officer

Current Formal Judicial/Administrative Proceedings Involving State Agencies as Adverse Parties

In the Matter of Application for Permit No. 63-34753 in the Name of Idaho Water Resource Board: This involves the water right application filed by IWRB that is associated with the proposed raise of Anderson Ranch Dam. I represent Elmore County, who has filed a protest in opposition to the application.

In the Matter of Application for Permit No. 2-10556 in the Name of the State of Idaho: This involves the water right application filed by IWRB for a winter water supply for the Snake River pump station and treatment plant project at the Mountain Home Air Force Base. I represent Elmore County, who has filed a protest requesting certain conditions to be placed on any approval.

Hirschi v. Idaho Dept. of Lands, Case No. CV04-24-0096, Sixth District, Bear Lake County: I represent the petitioner in a petition for judicial review of an IDL decision involving encroachment permit applications under the Lake Protection Act.

Hirschi, et al. v. State of Idaho, et al., Case No. CV04-24-0112, Sixth District, Bear Lake County: I represent the plaintiff in a declaratory judgment action against DEQ, IDL, the Dept. of Insurance, and the Bear Lake Fire District regarding regulation of fueling practices.

Other Ongoing, Less Formal Contacts with State Agencies

I have clients who have been pursuing funding from DEQ for water projects. I have been involved in some discussions with DEQ staff related to that effort.

My practice focuses on water rights, so I am nearly always involved in multiple matters and communications with IDWR and IWRB. For example, I typically have multiple clients with water right applications or protests pending with IDWR, and am in regular communication with IWRB and IDWR staff on a variety of topics and matters.

Past Matters

DEQ/BEQ: I have been directly adverse to DEQ in two air quality permit matters and in a handful of matters involving releases and management of hazardous waste.

Others: I have been directly adverse to IDWR, IWRB, IDFG, IDL, and ABC in dozens of past matters (mostly IDWR and IWRB).

DYLAN LAWRENCE
VARIN THOMAS LLC
P.O. Box 1676
Boise, ID 83701
(208) 345-6021
dylan@varinthomas.com

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	Case Docket No. 0101-22-01 OAH Case No. 23-245-01 **IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY'S INITIAL STATUS REPORT**

On May 9, 2024 the Idaho Board of Environmental Quality ("Board") issued the *Final Order* remanding this matter to the Hearing Officer "for the development of further evidence regarding the ambient air concentrations of arsenic that will be produced by the [Stibnite Gold Project ("SGP")] and whether those levels comply with the Air Rules." Final Order at 23.

On June 12, 2024, the Board issued its *Order on Petitions for Reconsideration and/or Clarification of Final Order* ("Reconsideration Order"). The Board explained that "[t]he parties will have a full opportunity before the Hearing Officer on remand to define the scope of those proceedings and evidence that may be presented." *Id.*

The Idaho Department of Environmental Quality ("DEQ") submitted a proposed scheduling order on June 17, 2024. After email discussions among the Hearing Officer and the parties, the Hearing Officer issued his *Notice of Status and Scheduling Conference; Updated*

Disclosure on June 24, 2024 requesting status reports from the parties. On June 25, 2024, the parties met and conferred to discuss the scope of the issues on remand and a scheduling order. While the parties have come to an agreement on the scope of the issues, no agreement was met on the nature and schedule for the proceedings.

A. Issues on Remand

The parties agree that the appropriate scope of issues on remand are:

1) Whether DEQ acted reasonably in its use of the five-year rolling average in the ambient arsenic air concentration analysis. Final Order at 18-19.
2) Whether "non-West End Pit" production was limited, and what effect non-West End Pit production has on arsenic emissions. Final Order at 19-20.
3) Whether the "16/70 analysis performed by DEQ was equally or more protective of human and animal life and vegetation as what is provided for by the Air Rules" and whether the level of arsenic emissions from the SGP comply with the Air Rules. Final Order at 21-23.

Accordingly, these will be the only issues considered by the Hearing Officer on remand.

B. Schedule

DEQ proposes the following scheduling order for these remand proceedings:

July 2, 2024-	Scheduling Conference
August 9, 2024-	DEQ submission addressing remand issues (including declarations and/or exhibits)
August 23, 2024-	Perpetua response to DEQ (including declarations and/or exhibits)
September 6, 2024-	Petitioners response to DEQ and Perpetua (including declarations and/or exhibits)

October 1, 2024- Hearing officer makes determination on the need of a hearing, including identification of the specific issues or sub-issues he wants the parties to present or argue.

October 15, 2024- Hearing officer decision (if no hearing is requested)

October 22, 2024- Hearing (if requested)

November 15, 2024- Post-hearings briefs (simultaneous)

December 15, 2024- Hearing officer decision

C. Proposed Procedures for Brief and at a Potential Hearing

One source of disagreement among the parties, specifically the opinion of Petitioners, concerns the nature and scope of presenting new factual evidence, as requested by the Board. Specifically, Petitioners believe that DEQ's submission must be limited to explaining the record as it currently exists. Despite the clear language of the Board's Reconsideration Order, Petitioners argue that it is inappropriate for DEQ to use later or new evidence to justify the permit.[1]

In the Reconsideration Order, the Board explained that "[t]he Board will not limit the scope of the proceedings on remand or the types of evidence that may be presented, other than to restate that they **must focus only on the development of additional factual evidence** on the ambient arsenic air concentration analysis performed by DEQ for the PTC." Reconsideration Order at 7-8 (emphasis added); *see also* Final Order ("the Board of Environmental Quality remands this matter back for the development of further evidence regarding the ambient air concentrations of arsenic that will be produced by the SGP and whether those levels comply with the Air Rules) (emphasis added). "The parties will have an opportunity to supplement and develop a full factual record on

[1] Petitioners have indicated that if new evidence is presented they will ask for briefing on the acceptability of that evidence, as well as a hearing and decision, all before setting any further scheduling. This unnecessary effort would delay scheduling and briefing on the substantive issues for many months. The Board unequivocally remanded the arsenic issue for the development of new, additional factual evidence. Extensive time dedicated to the non-issue of whether DEQ and Perpetua can develop new evidence undermines the express purpose of the remand, is a delay tactic, and should be disregarded.

the arsenic issue before the Hearing Officer on remand." Reconsideration Order at 7 (emphasis added).

To be clear, it is DEQ's intent to more fully expound on and clarify its rationale for its decision on the arsenic issue. The Board has explicitly requested that DEQ do so through the "development of further evidence," and DEQ will use this opportunity on remand to provide a more full and complete explanation of its decision regarding the arsenic issue. DEQ maintains that its arsenic decision is correct and that additional explanation of evidence in the record, as well as new testimony and evidence explaining and reinforcing DEQ's rationale, will serve to clarify any confusion or uncertainty the Board has. This effort will likely necessitate the presentation of some new evidence and the reframing of existing evidence. But, DEQ is not presenting any new theory for its decision, nor is DEQ submitting data or evidence that was not relied upon by DEQ for its original agency decision. DEQ's submission and supporting declarations will not be voluminous nor will they contain arguments and data that is novel or a surprise to Petitioners. Any new evidence presented will serve the simple purpose of providing additional detail, explanation, and clarification of the evidence, arguments, and rationale already in the record.

The issues on remand are not new to the parties. DEQ stands ready to present its submission in short order, as does Perpetua. Throughout this lengthy contested case, Petitioners, same as DEQ and Perpetua, were afforded considerable time to consult experts and understand the issues. Any suggestion that DEQ's use of new facts or its clarification on the arsenic issue would necessitate significant time for Petitioners to respond is insincere, and such attempts to transform this narrowly tailored remand into a full-blown litigious proceedings should be avoided.

If the Hearing Officer determines that a hearing is necessary, DEQ requests that he identify specifically the issues or sub-issues to be presented. DEQ also requests that the Hearing Officer

indicate which, if any, witness he personally wants to testify and question. At the hearing, each party will have the opportunity to call witnesses. The other parties and the hearing officer will then have the opportunity to examine each witness. The party calling the witness will have the opportunity for redirect examination of their witness. DEQ defers to the Hearing Officer's discretion as to the number of days necessary to hold a potential hearing.

DEQ's suggested scope and course of the proceedings is reasonable, provides a manageable and effective, but efficient, resolution of the remand, and more importantly, it will serve the explicit purposes of the remand—to develop further factual evidence on the arsenic issue.

DATED: July 1, 2024.

DEPARTMENT OF ENVIRONMENTAL QUALITY

/s/ Michael A. Short
Michael A. Short
Deputy Attorney General

Attorneys for Respondent

CERTIFICATE OF SERVICE

I hereby certify that on July 1, 2024, a true and correct copy of the foregoing ***IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY'S INITIAL STATUS REPORT*** was served on the following:

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

Dylan B. Lawrence
Hearing Officer
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Laird ("Laird") J. Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
llucas@advocateswest.org
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Paula Wilson, Hearing Coordinator
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, Idaho 83706
paula.wilson@deq.idaho.gov
via electronic service

/s/ Michael A. Short

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 _____ NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioner, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC. Intervenor-Respondent.	Case Docket No. 0101-22-01 **INTERVENOR-RESPONDENT'S STATUS REPORT**

The Hearing Officer asked the parties to submit a short status report regarding their June 25 meet-and-confer, "noting the areas of agreement and disagreement regarding the nature, scope, and conduct of the proceedings on remand." Intervenor-Respondent Perpetua Resources Idaho, Inc. ("Perpetua") submits the following status report.

The parties met on June 25, 2024, discussed the remand proceedings, and later (by email) exchanged proposed schedules.

Areas of Agreement. The parties are aligned on the scope of issues remanded by the Board of Environmental Quality (the "Board"). The issues are:

(1) Whether the Idaho Department of Environmental Quality ("DEQ") acted reasonably in its use of the five-year rolling average in the ambient arsenic air concentration analysis. Final Order at 18-19 (May 9, 2024).

(2) Whether "non-West End Pit" production was limited, and what effect non-West End Pit production has on arsenic emissions. *Id*. at 19-20.

(3) Whether the "16/70 analysis performed by DEQ was equally or more protective of human and animal life and vegetation as what is provided for by the Air Rules" and whether the level of arsenic emissions from the SGP comply with the Air Rules. *Id*. at 21-23.

Areas of Partial Agreement/Partial Disagreement. With respect to the nature and conduct of the proceedings on remand, the parties are not completely aligned. Perpetua proposes the following schedule (with additional explanation below):

1. August 9 – DEQ submission addressing remand issues (including declarations and/or exhibits)
2. August 23 – Perpetua response to DEQ (including declarations and/or exhibits)
3. September 6 - Petitioners response to DEQ and Perpetua (including declarations and/or exhibits)
4. September 20 – hearing officer identifies specific issues for evidentiary hearing
5. October 4 – (simultaneous filing) pre-hearing briefs
6. October 17 (and October 18 if needed) – evidentiary hearing
7. November 1 – (simultaneous filing) post hearing briefs
8. November 30 – tentative hearing officer decision

First we address Nos. 1 – 3 above. At the June 25 meet and confer, Petitioners suggested that DEQ first address the remand issues, followed by responses by Perpetua and Petitioners. DEQ proposed August 9, 2024, for its deadline to address the remand issues (including declarations and/or exhibits). Perpetua agrees with that approach and deadline. DEQ also

proposed that Perpetua respond to DEQ by August 23, 2024, and that Petitioners respond by September 6, 2024. Perpetua also agrees with this approach and the deadlines. While Petitioners seek September 13, 2024, for their response, four weeks is more than enough time.

Petitioners also propose an entirely different procedure, which is inconsistent with the Board's remand order. Petitioners contend the remand proceedings must be limited to explaining the record before DEQ at the time it approved the PTC and ask for the opportunity to object to "new evidence" or rationale by September 13, followed by additional briefing and oral argument if they do object. Such a process is unnecessary and contrary to the Board's order requiring remand: "the Board of Environmental Quality remands this matter back *for the development of further evidence* regarding the ambient air concentrations of arsenic that will be produced by the SGP and whether those levels comply with the Air Rules."[1] *Id*. at 23 (emphasis added). In particular, the Board observed that DEQ "did not provide sufficient evidence in the form of an expert opinion from a toxicologist or other qualified expert regarding the cancer risk associated with the 16/70 adjustment." *Id*. at 22.

The Board's order on reconsideration reiterates that the case is remanded "for additional fact finding" and the development of a "full factual record." Order on Petitions for Reconsideration and/or Clarification at 4, 6 (June 12, 2024). The Board also stated that it "will not limit the scope of the proceedings on remand or the types of evidence that may be presented, other than to restate that they must focus only on *the development of additional factual evidence* on the ambient arsenic air concentration analysis performed by DEQ for the PTC. … The parties

[1] The Board clearly has the discretion to remand for additional hearings. Idaho Code § 67-5245(6). The Board also has the authority to regulate the course of the proceedings and afford the opportunity to present and respond to evidence. Idaho Code § 67-5242(3). The Board's Contested Case Rules also allow for the development of evidence. *See* IDAPA 58.01.23.003.13 (incorporating IDAPA 04.11.01.600-609). The Board has done that here.

will have a full opportunity before the Hearing Officer on remand to define the scope of those proceedings and evidence that may be presented." *Id*. at 8 (emphasis added).

Perpetua agrees that Petitioners should have the opportunity to consider and respond to DEQ and Perpetua's respective submissions, including additional evidence. The proposed response date of September 6, 2024, provides sufficient time. While Petitioners can object to any additional evidence, there is no need to delay these proceedings by weeks and months as Petitioners propose. Petitioners can make their objections as part of their September 6th submittal. Allowing Petitioners to object to any additional evidence with more briefing and oral argument and then, if they lose, to present competing evidence is unnecessary, and it unreasonably delays the remand hearing and decision by the Hearing Officer. Petitioners' objections and submissions of additional evidence can be considered by the Hearing Officer in deciding the scope of the hearing.

That leads to Nos. 4 – 8 above, and Perpetua's proposal regarding the hearing and briefing. Our understanding is that the parties reached some agreement, but not complete agreement regarding the hearing and briefing. The parties generally agree that the Hearing Officer can preside over a hearing on remand and can determine the scope of the hearing within the confines set in the Board's remand (namely, the three issues referenced above). Perpetua requests that any evidentiary hearing fall within the Board's remand instructions. Perpetua does not oppose a narrow hearing on specific issues identified by the Hearing Officer within the general scope set by the Board to allow testimony and examination of declarants on the evidence presented on remand. Perpetua proposes October 17 (and 18 if necessary) for the hearing date.

As for briefing, unlike DEQ, Perpetua sees value in simultaneous pre-hearing briefs for all concerned, including the Hearing Officer, but we would be amenable to reasonably tight page

limits to ensure the pre-hearing briefs are focused. Perpetua agrees with DEQ's proposal for simultaneous post-hearing briefs.

Perpetua understands the proposed dates for Nos. 4-8 depend on multiple schedules and may need modest revision. During the six weeks between September 6 and hearing on October 17-18, Perpetua proposes that the Hearing Officer prescribe the scope of the evidentiary hearing on or about September 20 and that the parties present pre-hearing briefs by October 4. The hearing would commence two weeks later. Post-hearing briefs would be due October 31, two weeks after the hearing.

After four years in process and following two years of administrative review since issuance of a Final PTC, Perpetua seeks efficiency, economy of resources, and continuity to resolve the pending proceeding as required by the contested case rules. *See* IDAPA 04.11.01.052. We appreciate your attention and commitment to this matter.

DATED: July 1, 2024.

STOEL RIVES LLP

W. Christopher Pooser

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

CERTIFICATE OF SERVICE

I hereby certify that on July 1, 2024, a true and correct copy of the **INTERVENOR-RESPONDENT'S STATUS REPORT** was served on the following:

Dylan B. Lawrence
Hearing Officer
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

John Shackelford
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
john.shackelford@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

W. Christophe Pooser
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	BEQ Case No. 0101-22-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON Petitioners, v. DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	OAH Case No. 23-245-01 **PETITIONERS' STATUS REPORT**

Pursuant to the Hearing Officer's June 24, 2024 Notice of Status and Scheduling Conference; Updated Disclosure ("Notice"), and subsequent emails between the Hearing Officer and counsel for the Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon ("Petitioners"), the Department of Environmental Quality ("DEQ"), and Perpetua Resources Idaho, Inc. ("Perpetua"), Petitioners hereby submit this status report regarding the Petitioners' position on the nature, scope, and conduct of the proceedings on remand.

The Hearing Officer scheduled a status conference in this case for July 2, 2024. Prior to the conference, on June 25, 2024, the parties' counsel met and conferred to discuss the issues on remand, how the remand proceedings may be conducted, and scheduling proceedings on remand. Further discussion was exchanged between the parties by email in the subsequent days. The parties, however, were unable to come to an agreement on many of the items discussed, and therefore determined to file separate status reports.

I. Scope of Issues on Remand

This case was remanded to the Hearing Officer from the May 9, 2024 Board of Environmental Quality's ("Board") Final Order that "DEQ did not act reasonably and in accordance with the law when it analyzed the ambient arsenic air concentrations for the [Stibnite Gold Project]." Final Order at 23. Petitioners generally agree with DEQ's proposed identification of the issues on remand, but add to the issues (in underline) as follows:

1. Whether DEQ acted reasonably in its use of the five-year rolling average in the ambient arsenic air concentrations analysis and whether use of the five-year rolling average complies with the Air Rules. Final Order at 18-19;
2. Whether "non-West End Pit" production was limited, and what effect non-West End Pit production has on arsenic emissions. Final Order at 19-20; and

3. Whether the "16/70 analysis performed by DEQ was equally or more protective of human and animal life and vegetation as what is provided for by the Air Rules" and whether the level of arsenic emissions from the Stibnite Gold Project comply with the Air Rules. Final Order at 21-23.

II. Nature of Proceedings on Remand

The Board's remand to the Hearing Officer to address these three issues does not change the nature of this administrative appeal, which evaluates whether the Stibnite Gold Project permit to construct was properly issued by DEQ in accordance with the Clean Air Act, idaho air rules, the Idaho Administrative Procedure Act, and other legal requirements, as the parties have addressed through their previous cross-motions for summary judgment

The Board's remand for the Hearing Officer to address the above three issues thus does not expand the scope of review, which remains constrained to determine whether or not DEQ erred in issuing the permit in any of these three ways. In other words, the remand is not an opportunity for DEQ to somehow rewrite the permit or use later or new evidence to justify the permit that it approved.

Through discussions among counsel, DEQ has indicated it needs until August 9, 2024, to submit its materials on the issues for remand. Petitioners agree that date is reasonable and should be adopted by the Hearing Officer as the initial deadline on remand.

However, Petitioners reiterate that DEQ's remand submissions should properly be limited to explaining the record before DEQ at the time it approved the air permit, which might include declarations from permit staff, as DEQ provided with its prior summary judgment briefing papers submitted during prior proceedings before this Hearing Officer. But Petitioners intend to object and move to strike if DEQ seeks to submit new evidence (including, e.g., later scientific

reports or expert testimony) which goes beyond the record before the agency when it approved the permit. Indeed, if the permit cannot be supported by the record in place when DEQ approved it, the correct process is for DEQ to reopen the permit and allow further public comment on any new evidence that DEQ wants to consider.

Moreover, Petitioners do not believe that Perpetua should be able to submit any new evidence or rationale on remand. It is DEQ's responsibility to justify the permit on the record existing at the time it was approved to ensure that it is in accordance with the Clean Air Act and Idaho's air rules, not Perpetua's.

To the extent that DEQ or Perpetua submit new evidence or rationales outside of the current record to support an existing permit, again, Petitioners plan to object and move to strike such new evidence. But until DEQ (and Perpetua) provide their submissions on remand, Petitioners cannot determine whether such an objection is needed. Thus, any schedule for this remand needs to have adequate opportunity for Petitioners to evaluate DEQ's and Perpetua's submissions so that Petitioners can determine whether to object, and if so, prepare appropriate motion(s) to strike or other appropriate responses.

Finally, if the Hearing Officer does allow DEQ and Perpetua to submit new evidence, expert testimony, or rationales, then Petitioners will need additional time to determine whether Petitioners need to submit their own evidence and/or expert testimony. But Petitioners submit that such scheduling is unnecessary and premature until the parties and Hearing Officer have resolved the scope of the remand submissions that DEQ and/or Perpetua may properly submit.

//

//

//

III. Initial Schedule for Proceedings on Remand

Petitioners thus propose that the Hearing Officer set August 9, 2024, as the deadline for DEQ to submit its proposed remand submissions, and (assuming Perpetua insists on submissions as well), August 23, 2024, as the deadline for Perpetua's submissions.

Petitioners further propose that the Hearing Officer set September 13, 2024, as the deadline for Petitioners to file any objections and related motions to strike DEQ and/or Perpetua's submissions. If Petitioners do object to submissions filed by DEQ and/or Perpetua, the Hearing Officer should set a reasonable briefing schedule on petitioners' anticipated motion(s) to strike during the remainder of September and early October 2024, and set an oral argument date in mid-October. A further scheduling conference can then be conducted once the Hearing Officer issues a decision on any motion(s).

Dated: July 1, 2024

Respectfully submitted,

/s/ *Laird J. Lucas*
Laurence ("Laird") J. Lucas

Attorney for the Nez Perce Tribe and the Idaho Conservation League

/s/ *Julia Thrower*
Julia S. Thrower

Attorney for Save the South Fork Salmon

CERTIFICATE OF SERVICE

I hereby certify that on July 1, 2024, a true and correct copy of Petitioners' Status Report was served on the following:

By electronic service:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov

Dylan B. Lawrence, Hearing Officer
Varin Thomas, LLC
242 N. 8th St., Suite 220
Boise, ID 83702
(208) 345-6021
dylan@varinthomas.com

Krista McIntyre
W. Christopher Pooser
Wade Foster
Stoel Rives, LLP
101 S. Capital Blvd., Suite 1900
Boise, ID 83702
(208) 389-9000
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com

Attorneys for Intervenor Perpetua Resources of Idaho, Inc.

Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Resources Division
Office of the Attorney General
1410 N. Hilton St.
Boise, ID 83706
paula.wilson@deq.idaho.gov

Michael A. Short
Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
michael.short@deq.idaho.gov
hannah.young@deq.idaho.gov

Attorneys for DEQ

/s/ *Julia Thrower*
Julia S. Thrower

DYLAN LAWRENCE
VARIN THOMAS LLC
P.O. Box 1676
Boise, ID 83701
(208) 345-6021
dylan@varinthomas.com

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	BEQ Case No. 0101-22-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,	)	OAH Case No. 23-245-01
Petitioners,	)	SCHEDULING ORDER
v.	)	
DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC.,	)	
Intervenor.	)	

On May 9, 2024, the Board of Environmental Quality (BEQ) issued a document styled as a Final Order. The Final Order affirmed the hearing officer's dismissal of four claims of error, but concluded that "DEQ did not act reasonably and in accordance with law when it analyzed the ambient arsenic air concentrations for the SGP." (Final Order of 5/9/24, at p. 23.) More specifically, BEQ concluded that (1) "DEQ did not act reasonably in using a five-year rolling average for T-RACT that was not properly supported by permit conditions;" (2) "there was insufficient evidence to support the T-RACT analysis limiting the non-West End Pit production limit;" and (3) "DEQ did not act reasonably and in accordance with law when it applied the 16/70

calculation to the ambient arsenic air concentration analysis" (collectively, the "Remaining Issues").) (*Id*. at pp. 18, 19, 21.)

After some post-Final Order motion practice, on June 12, 2024, BEQ issued its Order on Petitions for Reconsideration and/or Clarification of Final Order. That Order remanded the matter to OAH with instructions to provide the parties with "an opportunity to supplement and develop a full factual record on the arsenic issue…." (Order of 6/12/24, at p. 7.) Otherwise, BEQ declined to provide additional instructions, clarifications, or limitations regarding the conduct of the remaining administrative proceedings.

On July 2, 2024, the parties and hearing officer convened via Zoom for a status and scheduling conference to discuss the nature, scope, and timing of the proceedings on remand. At the conference, the parties and hearing officer generally agreed to the following:

1. The Remaining Issues are highly technical in nature, such that expert testimony is required to assist the hearing officer as the trier of fact.
2. The parties prefer to utilize expert witness declarations to develop their testimony prior to a hearing on the merits instead of written discovery, expert witness disclosures, and depositions pursuant to Idaho Rules of Civil Procedure 26, 30, 33, and 34.
3. Sequentially, DEQ should file the first expert witness declarations. All of the parties' status reports of July 1, 2024 suggested August 9, 2024 as the deadline for DEQ's filings, though at the status conference, DEQ indicated an additional week may be helpful. (In a subsequent email, counsel for DEQ indicated he will be unavailable August 14 to 23, 2024.)
4. Perpetua should have an opportunity to file the second round of declarations, in case

it wishes to supplement or clarify anything in DEQ's declarations. All three status reports suggested August 23, 2024 as the deadline for Perpetua's filings.

5. The Petitioners should then file its own expert witness declarations, responding to the DEQ and Perpetua filings. In their status reports, DEQ and Perpetua suggested September 6, 2024 as Petitioners' deadline. Petitioners' status report suggested September 13, 2024 for their deadline, though the specific context at the time was for objections and motions to strike, as the status report was filed before the discussion of the need for expert witness testimony at the conference.
6. Even though DEQ's expert witness declarations will inform and affect the subsequent filings by Perpetua and the Petitioners to a certain extent, BEQ's orders are sufficiently detailed regarding the nature of the Remaining Issues for those parties to consult with and retain expert witnesses prior to DEQ's filings.
7. The parties and hearing officer set aside October 17, and 18, 2024 as the dates for a hearing on the merits, with the understanding that they will revisit those dates after DEQ has filed its declarations.
8. The parties declined to establish the related dates and deadlines leading up to a hearing on the merits at the conference. Instead, they expressed a preference for the hearing officer to do his best to establish those dates and deadlines in the forthcoming scheduling order.
9. Due to the highly technical nature of the Remaining Issues, it seems unlikely that further dispositive motion practice is warranted.

Based upon the above understandings and related email exchanges, the hearing officer hereby establishes the following dates and deadlines to govern the remainder of these administrative

proceedings:

Tuesday, August 13, 2024: Deadline for DEQ to file expert witness declarations explaining the basis for DEQ's decision-making regarding the Remaining Issues.

Friday, August 30, 2024: Deadline for Perpetua to file expert witness declarations, to the extent necessary to supplement or clarify any aspects of DEQ's expert witness declarations.

Wednesday, September 4, 2024, at 3:30 p.m.: Status and scheduling conference among parties and hearing officer to revisit the remaining deadlines and hearing dates in light of the declarations filed thus far, and whether they should establish deadlines to exchange witness lists and exhibits in advance of the hearing on the merits. (For now, the hearing officer assumes those issues will be relatively clear from the declarations filed.)

Friday, September 20, 2024: Deadline for the Petitioners to file responsive expert witness declarations and any motions in limine, motions to strike, or any other procedural motions related to the conduct of the hearing on the merits (collectively, "Procedural Motions").

Friday, September 27, 2024: Deadline for DEQ and Perpetua responses to Procedural Motions filed by the Petitioners.

Friday, October 4, 2024: Deadline for DEQ and Perpetua to file any Procedural Motions.

Friday, October 11, 2024: Deadline for (1) pre-hearing statements, summarizing the testimony each party will adduce at the hearing on the merits and how it relates to the Remaining Issues; and (2) Petitioners' response to Procedural Motions filed by DEQ or Perpetua.

Tuesday, October 15, 2024, 10:30 a.m.: Pre-hearing conference to discuss the upcoming hearing on the merits and any related procedural matters.

Thursday, October 17, 2024: Day 1 of hearing on the merits (location TBD).

Friday, October 18, 2024: If necessary, Day 2 of hearing on the merits (location TBD).

Friday, October 25, 2024: Deadline for post-hearing statements, identifying key testimony from the hearing on the merits and how it relates to the Remaining Issues.

Tuesday, November 26, 2024: Target date for written decision regarding the Remaining Issues.

In addition to the above dates, the hearing officer provides the following reminders and additional instructions:

There shall be no page limits on the expert witness declarations. Any other filings referenced above (Procedural Motions, responses thereto, pre-hearing statements, post-hearing statements) shall be limited to 10 pages of content, exclusive of the first page and the certificate of service. If a party wishes to exceed these page limits, that party shall email the hearing officer in advance of the filing (copying the other parties), with a request to that effect and a brief explanation.

Expert witness declarations should establish the witness's qualifications to opine on the Remaining Issues and should lay the proper foundation for any opinions offered as to the Remaining Issues.

While the deadlines for Procedural Motions and responses thereto are relatively tight, because the hearing officer (not a jury) is the finder of fact, he assumes any such filings will be relatively limited and targeted.

Parties who wish to reschedule any of the conferences or hearings established herein shall confer with the other parties regarding their availability and provide the hearing officer with three alternative mutually agreeable sets of dates and times from which to choose.

Dated this 8th day of July, 2024.

Dylan Lawrence
Hearing Officer

CERTIFICATE OF SERVICE

I hereby certify that on this 8th day of July, 2024, I caused to be served a true and correct copy of the foregoing by the following method to:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Resources Division
Office of the Attorney General
1410 N. Hilton St.
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Michael A. Short
Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
michael.short@deq.idaho.gov
hannah.young@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service



Dylan B. Lawrence
Hearing Officer

RAÚL R. LABRADOR
Attorney General

SCOTT L. CAMPBELL
Deputy Attorney General
Chief, Energy and Natural Resources Division

Hannah M.C. Young, ISB No. 9781
hannah.young@deq.idaho.gov
Michael A. Short, ISB No. 10554
michael.short@deq.idaho.gov
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: 208.373.0543

Attorneys for Respondent

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047

NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,

Petitioners,

v.

IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,

Respondent,

and

PERPETUA RESOURCES IDAHO, INC.,

Intervenor-Respondent.

Case Docket No. 0101-22-01
OAH Case No. 23-245-01

EXPERT DECLARATION OF NORKA E. PADEN, Ph.D.

I, NORKA E. PADEN, Ph.D., hereby declare under penalty of perjury and pursuant to the law of the State of Idaho that the foregoing is true and correct:

Qualifications

1. My name is Norka E. Paden. I am an Environmental Toxicologist with 16 years of experience and have been with the Idaho Department of Environmental Quality's (DEQ's) Toxicologist/Risk Assessor since 2016. I am responsible for toxicological and risk assessment analyses for contaminated sites and toxic exposures statewide. I provide toxicological expertise for contamination issues related to air, water, and soil. I deliver written comments to policy makers and stakeholders during negotiated rulemaking that involves selenium, copper, and arsenic human health water quality criteria. I mentored a professor from Lewis-Clark State College on the risk assessment of air pollutants in the Lewiston Valley and was acknowledged in the paper, "Observations of volatile organic and sulfur compounds in ambient air and health risk assessment near a paper mill in rural Idaho, U.S.A," published in the 2020 *Atmospheric Pollution Journal*. In 2023, I delivered technical comments for the Idaho Department of Health and Welfare's "Letter Health Consultation for the Lewiston Clark Air Quality Study," and DEQ received commendation from the Nez Perce Tribe for the technical support.

2. I received my Master of Science in Human Ecology at the Free University of Brussels, Belgium, and Ph.D. in Environmental Toxicology from Texas Tech University. Prior to joining DEQ, I worked for the Idaho Department of Health and Welfare from 2011 through 2016 and authored six public health consultations and 12 letter health consultations, which are written responses to a specific request for information about health risks related to a hazardous material, chemical release, or specific site, under the Agency for Toxic Substances and Disease Registry (ATSDR) cooperative agreement. While working at GEI Inc., a Colorado environmental consulting firm from 2008 to 2011, I provided technical expertise in preparing risk investigations for Superfund sites, drafted technical reports on toxicity evaluations, and supported clients by writing technical reports and rebuttals during rulemaking meetings. I served as an adjunct faculty member for the Department of Community and Environmental Health at Boise State University from 2012 to 2015. I currently serve on various advisory committees in Idaho including the Cancer/Cluster Analysis Work Group, Fish Consumption Advisory Project, One Health Consortium, Groundwater Monitoring Technical Group, and Federal-State Toxicology Risk Analysis Committee. I am also a member of the Society of Environmental Toxicology and Chemistry (SETAC) and Editorial Board of the Journal of Integrated Environmental Assessment and Management.

Assignment

3. I have been asked by DEQ's Air Quality Division to review and evaluate the issue: "DEQ did not act reasonably and in accordance with law when it applied the 16/70 calculation to the ambient arsenic air concentration analysis" and provide this declaration to assist the Hearing Officer as the trier of fact. This declaration provides evidence in the form of an expert opinion

as a toxicologist, as the Board of Environmental Quality (DEQ Board) suggested in its *Final Order in the Matter of Air Quality Permit to Construct P-2019.0047* (Final Order).[1]

Summary of Opinions

4. Based on the information provided, cancer risk estimates using 16-years, and 70-years of exposure duration are both within the range of public health guidelines of 1 in 1,000,000 to 1 in 10,000 (i.e., one in a million to one in ten thousand) for protection of human health as suggested by the United States Environmental Protection Agency's (EPA's) target cancer risk range. Based on this assessment, the estimated lifetime cancer risk from exposure to arsenic through inhalation using the exposure duration of 16 years (lifetime of the mine) followed EPA's guidelines that are the framework for DEQ's Rules for the Control of Air Pollution in Idaho and falls within EPA's target cancer risk range of 1 in 1,000,000 to 1 in 10,000 (i.e., one in a million to one in ten thousand) and is not expected to increase cancer risk under current permit operating conditions.

Documents reviewed

5. I reviewed the May 1, 2024, DEQ Board meeting minutes transcript and background of the Perpetua-Stibnite Gold Mine Permit to Construct issued in June 2022 and subsequent documents on the case docket No. 0101-55-01 OAH No 23-245-01: May 23 Memorandum in Support of Joint Motion for Reconsideration and/or Clarification of Final Order, June 12 Order on Petitions for Reconsideration and/or Clarification of Final order, and July 8 Scheduling Order.

Background and Discussion

6. Based on my interpretation, the DEQ Board supported DEQ on four of the five matters. The fifth matter related to Section 586 of the "Rules for Control of Air Pollution in Idaho" (IDAPA 58.01.01) and DEQ's approach to arsenic and cancer risk. The DEQ Board found insufficient evidence to support DEQ's ambient arsenic air concentration analysis and determined that further factual development was needed on this issue. The DEQ Board remanded this issue to the Hearing Officer.

7. Dr. McMillan indicates that DEQ misinterpreted the acceptable ambient concentration (AACC) for carcinogens to comply with the air quality rules. He disagrees with the project-specific adjustment factor (16 years of mining operation), contends that DEQ failed to recognize the AACC functions to limit cancer initiation not only after 70 years but every day

[1] *See* REC 3716, *Final Order in the Matter of Air Quality Permit to Construct P-2019.0047*, *Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon v. Idaho Department of Environmental Quality*, Case Docket No. 0101-22-01, OAH Case No. 23-245-01 (Final Order at 22).

of a person's life starting at birth, and posits that DEQ's analysis underestimates the actual cancer risk (MacMillan 2024).[2]

8. Based on the analyses presented below, the cancer risk estimates were accurately calculated; the methodology for the calculations adheres to toxicological guidance and analytical practices to modify exposure duration and did not underestimate risk.

9. After reviewing the permit's cancer risk calculations and the toxic air pollutant rules, I researched cancer risk from arsenic exposures through inhalation. I calculated exposure concentrations and excess cancer risks for a residential inhalation exposure scenario (for a person living at a residence) using the maximum modeled annual concentration (potential worse-case scenario) of 0.00416 µg/m^3, calculated by analyses of the permit application, for the following exposure duration scenarios of 16 years (lifetime of the mine), and 70 years (EPA's lifetime exposure). The following paragraphs summarize my findings.

10. The permit application and DEQ review documentation states that cancer risk calculations used modeling scenarios, applied to develop AACCs outlined in the rules, and evaluated via the 70-year lifetime exposure. The maximum modeled concentrations for carcinogenic toxic air pollutants were modified to account for the life-of-mine production limits that affect the lifetime exposure using the following formula (DEQ 2022)[3]:

$$Lifetime\ exposure\ \left(\frac{\mu g}{m^3}\right) = \frac{Highest\ annual\ concentration\ \left(\frac{\mu g}{m^3}\right) \times 16\ (mine\ operation\ years)}{70\ (years, lifetime\ exposure)}$$

Cancer Risk Calculation in the Idaho Air Rules mirrors EPA's Guidelines

11. Section 586 in IDAPA 58.01.01, "Rules for the Control of Air Pollution in Idaho" (Idaho Air Rules), provides the following values for carcinogen toxic air pollutants: unit risk factors (URF) from EPA, screening emission levels (EL), and acceptable ambient levels for carcinogens (AACCs) (i.e., determined to cause cancer over lifetime exposure). The acceptable ambient levels for carcinogens are based on the cancer unit risk values from EPA and correspond to a one in one million cancer risk (DEQ 2019)[4]. In other words, the AACC for arsenic compounds presented in Idaho Air Rule Section 586 is calculated using EPA's Excess Cancer Risk Probability formula shown below:

---

[2] *See* Board of Environmental Quality Special Meeting (May 1, 2024) Transcript ("SM Tr.") 10:19-21 ("I believe DEQ has misinterpreted how the acceptable ambient concentration for carcinogens, the AACC, must be applied if it is to comply with our air quality rules"); *see also* SM Tr. 11:2-11.

[3] REC 710, Idaho Department of Environmental Quality. *TAPs Addendum Modeling Review Attachment* to the *PRI SGP Modeling Review Memorandum* (January 6, 2022) ("DEQ's TAPS Modeling Attachment") at 14. For convenience, a true and correct copy of DEQ's TAPS Modeling Attachment is attached hereto as Exhibit A.

[4] Idaho Department of Environmental Quality. *Idaho Administrative Bulletin*. Boise, ID, September 4, 2019–Vol 19-9, page 388 ("The acceptable ambient levels for carcinogens are based on the cancer unit risk values from the Environmental Protection Agency and correspond to a one in a million cancer risk") (citing EPA 2019). A true and correct copy of page 388 is attached hereto as Exhibit B.

Excess Cancer Risk Probability = IUR x EC

Where Excess Cancer risk = 10^{-6} (1 in 1,000,000 one in a million)

IUR for arsenic is = 4 x 10^{-3} (0.0043)

EC = exposure concentration or acceptable ambient concentration (AACC)

AACC= (10^{-6})/ 4.3 x 10^{-3}

AACC= 2.3 x 10^{-4} = 0.00023 µg/m^3

The arsenic lifetime concentration associated with an excess cancer risk of one in one million is 0.00023 µg/m^3.

12. Under EPA's methodology for human health risk assessments, cancer risk calculations are done using a lifetime exposure set at 70 years. The exposure duration is the amount of time an individual is exposed to the contaminant being evaluated and is typically given in years. The exposure duration can be modified based on the site-specific information using the following formula to calculate screening values (EPA 2009)[5].

EC = (CA x ET x EF x ED)/AT

Where: EC (µg/m^3) = exposure concentration;
CA (µg/m^3) = contaminant concentration in air;
ET (hours/day) = exposure time;
EF (days/year) = exposure frequency;
ED (years) = exposure duration; and
AT (lifetime in years 70 x 365 days/year x 24 hours/day) = averaging time

13. **Step 1: Exposure Concentration Calculations**: I calculated exposure concentrations using the maximum modeled arsenic concentration in air (0.00416 µg/m^3), exposure time (24 hours per day), exposure frequency (365 days per year), and averaging time for 70 years of lifetime (EPA's default value) exposed for 365 days and 24 hours per day for a resident scenario with exposure durations of 16-years (life time of the mine), 70- years (EPA's default lifetime exposure) using EPA's approach and the formulas presented above. Table 1 shows the results for the calculations:

Table 1. Values used for the exposure concentration calculation.

Contaminant Concentration in Air (µg/m^3)	Exposure Time (hours/day)	Exposure Frequency (days/year)	Exposure Duration (years)	Averaging Time	Exposure Concentration µg/m^3
0.00416	24	365	16 (lifetime of the mine)	70x365x24	0.00095
0.00416	24	365	70 (EPA's default lifetime exposure)	70x365x24	0.00416

[5] Environmental Protection Agency (EPA). 2009. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment). EPA-540-R-070-002. OSWER 9285.7-82. Available at: https://semspub.epa.gov/work/HQ/140530.pdf. Accessed on July 18, 2024.

14. **Step 2: Cancer Risk Calculations:** To calculate cancer risk, I used the Inhalation Unit Risk (IUR) for arsenic from EPA's Integrated Risk Information System (IRIS) and the exposure concentrations calculated in Table 1 using the following formula (EPA 2009).[6] As previously mentioned, this is the same formula used for the AACC calculation in the Idaho Air Rules. Results of these calculations are presented in Table 2. *See* IDAPA 58.01.01.586.

Excess Cancer Risk Probability = IUR x EC

Where: IUR $(\mu g/m^3)^{-1}$ = Inhalation Unit Risk (for arsenic is 0.0043); and
EC $(\mu g/m^3)$ = exposure concentration

EPA defines excess cancer risk as an additional risk of cancer from exposure to a contaminant beyond an individual's risk of cancer from everyday life. Excess cancer risk is the probability that an exposed individual will develop cancer from exposure over a lifetime (70 years)[7]. The methodology EPA uses for the calculation of the excess cancer risk includes the inhalation unit risk (IUR) value, based on toxicological studies, the value selected for the inhalation unit risk represents a continuous exposure (24 hours/day and 7 days/week) and is supported by years of research from scientists at EPA's Integrated Risk Information System (IRIS) and the Superfund Health Risk Technical Support Center[8].

Table 2. Excess cancer risk calculations and interpretation.

Exposure duration (in years)	Inhalation Unit Risk $(\mu g/m^3)^{-1}$	Exposure Concentration $(\mu g/m^3)$	Excess Cancer Risk Probability	Interpretation	Within EPA's Recommended range > 1 in 1 million to < 1 in 10,000
16 (lifetime of the mine)	0.0043	0.00095	4.09E-06	4 in 1 million	Yes
70 (EPA's default lifetime exposure)	0.0043	0.00416	1.79E-05	2 in 100,000	Yes

15. DEQ used EPA's methodology for adjusting exposure duration given the known exposure duration (lifetime of the mine). The modification of the exposure duration is also consistent with DEQ's screening level risk assessment methodology for any contaminated site in Idaho (i.e., EPA's Regional Screening Levels)[9]. Inputs and outputs of the EPA's Regional Screening Levels online calculator using the parameters outlined in Table 1 (i.e., exposure duration, exposure time, lifetime in years) yield the same cancer risk estimates shown in Table 2 and are

[6] *Id.*

[7] Environmental Protection Agency. 2024. Supplementary Materials: Risk Communication. Attachment 6: Useful Terms and Definitions for Explaining Risk. Available at: https://semspub.epa.gov/work/11/176250.pdf. Accessed on July 19, 2024.

[8] *See* fn. 5.

[9] United States Environmental Protection Agency. Regional Screening Levels for Chemical Contaminants at Superfund Sites. Available at: https://www.epa.gov/risk/regional-screening-levels-rsls. Accessed on June 4, 2024.

presented in Exhibit C.[10] Two parameters that were modified in the EPA's Regional Screening Level Calculator were: exposure frequency from 350 days (EPA assumption is that the receptor takes 2 weeks of vacation every year away from the contamination) to 365 days/year, which is more conservative. The other parameter that was modified was the target hazard quotient (THQ) from 0.1 usually used when screening multiple contaminants to THQ=1.0, commonly used when screening only one contaminant, in this case arsenic.

Cancer Risk Estimates and T-RACT within EPA's acceptable range

16. Toxic Air Pollutant Reasonably Available Control Technology (T-RACT) for carcinogens outlined in the Idaho Air Rules: cancer risk probability of less than one in one hundred thousand (1 in 100,000) (IDAPA 58.01.01.210.12.b) falls within the EPA's recommended range of > 1 in 1 million to < 1 in 10,000 presented in Table 2.

17. The cancer risk estimates from exposure to 0.00416 µg/m^3 arsenic (maximum arsenic concentration calculated from modeling using potential worse-case scenario) through inhalation 24 hours a day, 365 days, and for 16 years (lifetime of the mine) is four additional cancers in a population of one million people exposed. The probability for a resident to develop cancer after exposure to 0.00416 µg/m^3 arsenic through inhalation 24 hours a day, 365 days, and for 70 years (EPA's default lifetime exposure) is two additional cancers in 100,000. These excess cancer risk estimates are within the range EPA considers acceptable (<1 in 10,000 to > 1 in 1,000,000) [7]. EPA considers excess cancer risk < 10^{-6} (1 in 1,000,000) to be negligible, 10^{-4} (>1 in 10,000) and 10^{-6} to 10^{-4} (1 in 1,000,000 to 1 in 10,000) to be acceptable (EPA 1989)[11]. This analysis shows at the maximum arsenic levels modeled (0.00416 µg/m^3) for exposures of 16, or 70 years are within the public health guidelines, and DEQ followed EPA's guidelines when using the 16-year exposure scenario (lifetime of the mine).

Cancer Risk Considerations

18. Other factors may play a role in analyzing cancer risk, such as existing cancers in the population, arsenic background concentrations at the site, sensitive populations living near the site, and uncertainty of maximum arsenic concentration derivation. According to the American Cancer Society, cancer affects 1 in 3 people in the United States, meaning that over a lifetime, an American's probability of getting any cancer is 0.333333 (ACS 2024)[12]. Adding the probability of 2 in 100,000 (excess cancer risk calculated for someone exposed for a lifetime of 70) to 0.333333, the probability of an individual getting cancer increases to 0.333353; this difference is very small.

---

[10] A true and correct copy of EPA's *Regional Screening Levels Calculator Inputs and Outputs for Exposure Durations 16, and 70 years* is attached hereto as Exhibit C.

[11] Environmental Protection Agency (EPA). 1989. Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A). Available at: https://www.epa.gov/sites/default/files/2015-09/documents/rags_a.pdf. Accessed on June 5, 2024.

[12] American Cancer Society. 2024. Understanding Cancer. Available at: https://www.cancer.org/cancer/understanding-cancer/what-is-cancer.html. Accessed on July 22, 2024.

19. From the toxicological point of view, enough evidence exists on the carcinogenic effects (urinary bladder, lung, and skin) of inorganic arsenic (IARC 2012)[13]. People who accidentally eat arsenic for a long time can develop some diseases. Sources of arsenic for ingestion include food (seafood, fish, algae, cereals), air (coal-fired power and smelting), and water (EFSA 2009)[14]. Evidence indicates that long-term exposure to arsenic mainly through drinking water is of great concern to human health due to daily consumption and occurrence in several regions of the world over the past decades (Martinez et al. 2011)[15]. Some occupational studies have documented lung cancer due to inhalation exposures to arsenic, and EPA has used these studies to derive the Inhalation Unit Risk (IUR) (EPA 2024)[16].

20. Cancer risk depends on a wide variety of factors such as alcohol and tobacco use, sun light and radiation exposures, age, diet, hormones, obesity, infectious agents, cancer-causing agents, family history, immunosuppression, and chronic inflammation (NIH 2015)[17]. The literature indicates that inorganic arsenic causes harmful effects mainly through the initiation of oxidative stress (when there are many molecules called free radicals in the body and not enough antioxidants to eliminate them), alterations to DNA (DNA and RNA are both macromolecules essential for life), protein modification, and RNA expression as Dr. McMillan alluded; however, these effects are mainly documented from exposures to elevated levels of arsenic in drinking water (EPA 2024)[18]. The literature also reveals that further cancer studies are needed to understand the mechanisms of arsenic carcinogenesis (Zhou & Xi 2018; Speer et al. 2022)[19,20].

---

[13] International Agency for Research on Cancer (IARC). 2012. Arsenic, Metals and Dusts. Volume 100C. A Review of Human Carcinogens. Lyon, France. Available at: https://publications.iarc.fr/Book-And-Report-Series/Iarc-Monographs-On-The-Identification-Of-Carcinogenic-Hazards-To-Humans/Arsenic-Metals-Fibres-And-Dusts-2012. Accessed on July 22, 2024.

[14] European Food Safety Authority (EFSA). 2009. Scientific opinion on arsenic in food. *EFSA Journal*. 7(10):1351. Available at: https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efsa.2009.1351. Accessed on July 21, 2024.

[15] Martinez V.D., Vucic E.A., Becker-Santos D. D., Gil L., Lam W.L. 2011. Arsenic Exposure and the Induction of Human Cancers. *Journal of Toxicology.* Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3235889/. Accessed on July 19, 2024.

[16] Environmental Protection Agency (EPA) & National Center for Environmental Assessment. 2024. Integrated Risk Information System (IRIS). Chemical Summary for Arsenic, inorganic; CASRN 7440-38-2. Available at: https://iris.epa.gov/static/pdfs/0278_summary.pdf. Accessed on July 19, 2024.

[17] National Institutes of Health (NIH). National Cancer Institute. 2015. Risk Factors for Cancer. Available at: https://www.cancer.gov/about-cancer/causes-prevention/risk. Accessed on July 19, 2024.

[18] *See* fn. 14.

[19] Zhou Q., Xi S. 2018. *A review on arsenic carcinogenesis: Epidemiology, metabolism, genotoxicity and epigenetic changes.* Journal of Regulatory Toxicology and Pharmacology 99: 78-88. https://www.sciencedirect.com/science/article/abs/pii/S0273230018302320?via%3Dihub

[20] Speer R. M., Zhou X., Volk L.B., Liu K.J., Hudson L.G. 2022. Arsenic and cancer: evidence and mechanisms. Journal Adv Pharmacol. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10860672/. Accessed on July 18, 2024.

Cancer Risk Calculations were not underestimated

21. Additional information to support DEQ's calculation did not underestimate cancer risk, including the no significant concentration level of 0.067 μg/m^3 (i.e., air concentration at 1 in 100,000 excess lung cancer mortality) from the Texas Commission on Environmental Quality (Erraguntla et al.2012)[21]. The value is used to evaluate ambient air monitoring data to protect the public against adverse health effects from chronic exposure to arsenic. The maximum modeled air concentration 0.00416 μg/m^3 is below this threshold. The maximum modeled air concentration of 0.00416 μg/m^3 is within World Health Organization's recommendations for concentrations of arsenic range from 1–10 ng/m^3 (0.001–0.01 μg/m^3) in rural areas, 3–30 ng/m^3 (0.003–0.03 μg/m^3) in noncontaminated urban areas (WHO 2000)[22].

Conclusion

22. I conclude that DEQ's analysis followed EPA's guidelines and that results from a shorter duration exposure (i.e., 16 years) is within EPA's target risk range of 1 in 1,000,000 to 1 in 10,000 (i.e., one in one million to one in ten thousand) and is not likely to increase cancer risk by the arsenic air emissions calculated by the analyses of the air permit application (maximum arsenic-modeled concentrations).

DATED: August 13, 2024

/s/ Norka E. Paden, Ph.D.
NORKA E. PADEN, Ph.D.

[21] Erraguntla N.K., Sielken R.L. Valdez-Flores C., Grant R.L. 2012. An updated inhalation unit risk factor for arsenic and inorganic arsenic compounds based on a combined analysis of epidemiology studies. *Journal Regulatory Toxicology and Pharmacology* 64(2):329-41. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0273230012001304. Accessed on July 23, 2024.

[22] World Health Organization (WHO), 2000, Air Quality Guidelines for Europe: Second Edition (WHO Regional Publications, European Series, No 91) Copenhagen, Denmark, World Health Organization, Regional Office for Europe, Available at https://www.who.int/publications/i/item/9789289013581. Accessed on July 22, 2024

CERTIFICATE OF SERVICE

I hereby certify that on August 13, 2024, a true and correct copy of the foregoing ***EXPERT DECLARATION OF NORKA E. PADEN, Ph.D.*** was served on the following:

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

Dylan B. Lawrence
Hearing Officer
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Bryan Hurlbutt
Laird ("Laird") J. Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Paula Wilson, Hearing Coordinator
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, Idaho 83706
paula.wilson@deq.idaho.gov
via electronic service

/s/ DeAnne Chaffin

EXHIBIT A

TAPs Addendum Modeling Review Attachment

1.0 Introduction and Summary

Perpetua Resources Idaho, Inc. (PRI) submitted the *Stibnite Gold Project (SGP) Permit to Construct Application TAP Addendum* (*TAP Addendum*), prepared by Air Sciences Inc. (Air Sciences) and submitted to DEQ on October 5, 2021. The TAP Addendum reassessed source applicability to Toxic Air Pollutant (TAP) permitting requirements, refined TAPs regulatory methods to demonstrate compliance with applicable TAP increments, revised and/or refined operations and operational parameters affecting TAP emissions, and refined TAP air impact analyses. The revisions and refinements made for the TAP Addendum also reduced PM_{10} and $PM_{2.5}$ emissions, and this effect is presented in this *TAPs Addendum Modeling Review Attachment* (*Modeling Review Attachment*).

2.0 Scope of TAPs Addendum

DEQ reevaluated TAPs compliance regulatory interpretations and impact assessment methods following the second public comment period of February 18, 2021, through March 19, 2021. Areas of revision in response to issues identified after the public comment period included:

- Revising source-specific TAP impact assessment applicability, primarily identifying what sources can be excluded because they are "covered" or "addressed" by a National Emissions Standard for Hazardous Air Pollutants (NESHAP) or New Source Performance Standard (NSPS).
- Refining regulatory methods used to demonstrate compliance with TAP increments.
- Refining TAP emission calculation methods and dispersion-affecting parameters.
- Reassessing TAP impacts resulting from revised and/or refined methods and data.
- Providing a best-estimate of actual TAP emissions that will occur from operation of the mine, and then comparing this to maximum permit-allowable emissions.

PRI and Air Sciences, PRI's permitting consultant, submitted the *TAP Addendum* on October 5, 2021.

3.0 Revised NESHAP/NSPS TAP Exclusion

DEQ and PRI reevaluated TAP source applicability after the second public comment period in response to expressed concerns regarding sources excluded as per *Idaho Air Rules* Section 210.20 (excluding sources that are "covered" or "addressed" by a NESHAP). TAP applicability is explained in greater detail in the main body of the DEQ Statement of Basis. As a result of the reevaluation, some additional sources were included in the TAP impact modeling analyses that were not previously. TAP sources from gold mining that were modeled in the final TAP analyses included: drilling, blasting, excavating, hauling, prill silos, rock dumps and storage piles, and tailings.

Air Sciences consulted with DEQ to refine TAP compliance demonstration methods from what was originally submitted in the application. The refinement was primarily needed to show compliance with the

REC 3884
REC 0697
PET 331

arsenic Acceptable Ambient Concentration of a Carcinogen (AACC). The revised methods are described in the submitted *TAP Addendum* and this DEQ *Modeling Review Attachment*.

4.0 TAPs Refined Compliance Demonstration Approach

PRI, in consultation with DEQ, used a highly refined TAPs analysis approach to demonstrate compliance with applicable TAP increments. This approach involved the following:

- AACC Adjustment for Toxic Air Pollutant Reasonably Available Control Technology (T-RACT) Utilization.
- TAP Emission Averaging Period.
- AACC Adjustment for the Operational Life of the Mine.

4.1 AACC Adjustment for T-RACT Utilization

Idaho Air Rules Section 210.12 allows TAP impacts of 10 times the AACC if the application demonstrates that T-RACT is used for the TAP emission sources. This represents a life-time cancer risk of 1-in-100,000. An adjustment cannot be made for non-carcinogenic TAPs listed in *Idaho Air Rules* Section 585.

Review of the T-RACT demonstration is performed by the DEQ permit writer and is described in the main body of the DEQ Statement of Basis.

4.2 TAP Emission Averaging Period

Annual average emissions of carcinogenic TAPs are typically used in the dispersion model to estimate maximum annual impacts. PRI refined the analyses by using source-specific emission rates that are representative of a 5-year averaging period. This approach is appropriate because carcinogenic impacts are of concern from a long-term exposure basis.

4.3 AACC Adjustment for the Operational Life of the Mine

AACCs were established based on a 1-in-1,000,000 cancer risk over a 70-year lifetime, as stated in *Idaho Air Rules* Section 006.125:

> ***Toxic Air Pollutant Carcinogenic Increments****. Those ambient air quality increments based on the probability of developing excess cancers over a seventy (70) year lifetime exposure to one (1) microgram per cubic meter (1 ug/m3) of a given carcinogen and expressed in terms of a screening emission level or an acceptable ambient concentration for a carcinogenic toxic air pollutant. They are listed in Section 586.*

PRI indicated the maximum life-of-mine will be 16 years. Life-time exposures to carcinogenic TAPs were refined by multiplying the maximum modeled annual impact by a ratio of 16/70. Section 5.7 of this *Modeling Review Attachment* provides more details on this adjustment for the project.

5.0 Refined TAP Emission Estimates and Modeling Methods/Parameters

This section describes changes made to TAP emission estimates and to methods/parameters used in the impact modeling analyses.

5.1 Operational Adjustments

PRI and Air Sciences proposed and committed to several operational adjustments to reduce actual and estimated TAP emissions:

- Installing and operating dust collection systems on drilling rigs (determined to be T-RACT).
- Capping the haul roads that are outside of the pits and development rock storage facilities (DRSFs) with clean (lower levels of arsenic) development rock (determined to be T-RACT).
- Eliminating the West End Development Rock Storage Facility, which eliminated the highest-emitting operational scenario W5.
- Limiting long-term mining production to an average of 135,000 tons/day for a 5-year rolling average.
- Constructing the Burntlog access road with offsite materials containing "background" levels of arsenic.
- Updating the bulldozing emission factor using the SGP site-specific silt content.

5.2 General Modeling Methods and Parameters

Modeling methods and parameters used in TAP impact analyses presented in the *TAP Addendum* are largely identical to those used in the previously submitted application. These include the air dispersion model used, meteorological data, terrain, building downwash, ambient air boundary, and receptors. TAP modeling was conducted for the 14 operational modeling scenarios, consistent with the NAAQS analyses. Modeling Scenario W5 was eliminated from the arsenic modeling, as discussed in Section 5.8 of this *Modeling Review Attachment*.

The meteorological dataset processed using McCall, Idaho, cloud cover data was used for analyses in the *TAP Addendum*. Impacts were not assessed using the dataset processed using the Bulk Richardson (BULKRN) method for boundary layer parameter calculations. EPA considers both methods to be acceptable. Although modeled impacts tend to be somewhat larger when using meteorological data processed by the BULKRN method, DEQ contends that the impact analyses are still largely conservative compared to actual impacts anticipated. Conservative aspects include: continual operation of the worst-case operational scenario; operation at maximum allowable rates for the averaging period; no reduction in winter-time emissions from fugitive sources, accounting for emission suppression effects of increased moisture.

5.3 TAP Modeling Applicability

Table 1 provides a comparison between applicable facility-wide maximum potential TAP emissions for the highest-emitting scenario (W3) and TAP screening emission levels (ELs) from *Idaho Air Rules* Sections 585 (for non-carcinogens) and 586 (for carcinogens). Note that TAPs also classified as HAPs

REC 3886
REC 0699
PET 333

emitted from sources "addressed" or "covered" by NSPS or NESHAP were not required to be evaluated for compliance with TAP increments in accordance with *Idaho Air Rules* Section 210.20. Furthermore, PRI has determined that the West End Development Rock Storage Facility will not be constructed. This change eliminated Modeling Scenario W5 (the highest-emitting scenario described in the main body of the DEQ *Modeling Review Memorandum*) as a potential operating scenario. After eliminating Modeling Scenario W5, it was determined that Modeling Scenario W3 is the highest-emitting scenario for all TAPs.

Table 1. TAP MODELING APPLICABILITY DETERMINATION (HIGHEST-EMITTING MODELING SCENARIO: W3).

HAP/TAP	Emissions (lb/hr)			EL (lb/hr)		Determination
	(a)	(b)	Total	(c)	(d)	
1,3-Butadiene	--	--	--	--	2.4E-5	EL not exceeded
3-Methylchloranthrene	--	4.5E-8	4.5E-8	--	2.5E-6	EL not exceeded
Acetaldehyde	--	--	--	--	3.0E-3	EL not exceeded
Acrolein	--	--	--	1.7E-2	--	EL not exceeded
Antimony	1.9E-2	1.6E-6	1.9E-2	3.3E-2	--	EL not exceeded
Arsenic	5.4E-1	8.2E-6	5.4E-1	--	1.5E-6	Carcinogenic EL exceeded
Benzene	--	5.3E-5	5.3E-5	--	8.0E-4	EL not exceeded
Benzo(a)pyrene[e]	--	3.0E-8				
Benz(a)anthracene[e]	--	4.5E-8				
Benzo(b)fluoranthene[e]	--	4.5E-8				
Benzo(k)fluoranthene[e]	--	4.5E-8	2.9E-7	--	2.0E-6	EL not exceeded
Chrysene[e]	--	4.5E-8				
Dibenzo(a,h)anthracene[e]	--	3.0E-8				
Indenol(1,2,3-cd)pyrene[e]	--	4.5E-8				
Beryllium	2.6E-3	3.5E-7	2.6E-3	--	2.8E-5	Carcinogenic EL exceeded
Biphenyl	--	--	--	1.0E-1	--	EL not exceeded
Cadmium	4.1E-4	2.8E-5	4.4E-4	--	3.7E-6	Carcinogenic EL exceeded
Carbon disulfide	1.4E-2	--	1.4E-2	2.0E+0	--	EL not exceeded
Chromium	7.3E-3	4.8E-5	7.4E-3	3.3E-2	--	EL not exceeded
Chromium (VI)	--	3.4E-7	3.4E-7	--	5.6E-7	EL not exceeded
Cobalt	3.3E-3	4.8E-6	3.26E-3	3.3E-3	--	EL not exceeded
Cyanide	4.5E-1	--	4.5E-1	3.3E-1	--	Non-carcinogenic EL exceeded
Dichlorobenzene	--	3.1E-5	3.1E-5	3.0E+1	--	EL not exceeded
Formaldehyde	--	1.9E-3	1.9E-3	--	5.1E-4	Carcinogenic EL exceeded
Hexane	--	4.6E-2	4.6E-2	1.2E+1	--	EL not exceeded
Hydrogen Chloride	--	--	--	5.0E-2	--	EL not exceeded
Manganese	2.4E-1	1.9E-4	2.4E-1	6.7E-2	--	Non-carcinogenic EL exceeded
Naphthalene	--	1.6E-5	1.6E-5	3.3E+0	--	EL not exceeded
Nickel	1.6E-3	5.6E-5	1.7E-3	--	2.7E-5	Carcinogenic EL exceeded
Phenol	--	--	--	1.3E+0	--	EL not exceeded
Phosphorus	5.3E-1	9.3E-5	5.3E-1	7.0E-3	--	Non-carcinogenic EL exceeded
Selenium	3.3E-4	6.2E-7	3.3E-4	1.3E-2	--	EL not exceeded
Toluene	--	8.8E-5	8.8E-5	2.5E+1	--	EL not exceeded
Xylene	--	--	--	2.9E+1	--	EL not exceeded
Aluminum	5.8E+1	6.5E-1	5.9E+1	6.7E-1	--	Non-carcinogenic EL exceeded
Barium	6.5E-1	6.8E-3	6.6E-1	3.3E-2	--	Non-carcinogenic EL exceeded
Calcium Carbonate	1.1E+1	2.2E+0	1.4E+1	6.7E-1	--	Non-carcinogenic EL exceeded
Calcium Oxide	--	7.0E-1	7.0E-1	1.3E-1	--	Non-carcinogenic EL exceeded
Copper	4.1E-3	5.3E-4	4.6E-3	6.7E-2	--	EL not exceeded
Cyclohexane	--	1.0E-3	1.0E-3	7.0E+1	--	EL not exceeded
Hydrogen Sulfide	--	9.0E-1	9.0E-1	9.3E-1	--	EL not exceeded
Iron	1.5E+1	2.1E-1	1.5E+1	6.7E-2	--	Non-carcinogenic EL exceeded
Molybdenum	8.1E-4	4.7E-4	1.3E-3	3.3E-1	--	EL not exceeded
Pentane	--	1.2E-1	1.2E-1	1.2E+2	--	EL not exceeded
Silver	4.1E-4	4.1E-4	8.2E-4	7.0E-3	--	EL not exceeded
Sulfuric Acid	--	2.0E+0	2.0E+0	6.7E-2	--	Non-carcinogenic EL exceeded

REC 3887
REC 0700
PET 334

Table 1. TAP MODELING APPLICABILITY DETERMINATION (HIGHEST-EMITTING MODELING SCENARIO: W3).						
HAP/TAP	Emissions (lb/hr)			EL (lb/hr)		Determination
	(a)	(b)	Total	(c)	(d)	
Thallium	8.1E-3	5.2E-4	8.7E-3	7.0E-3	--	Non-carcinogenic EL exceeded
Uranium	8.1E-3	5.2E-4	8.7E-3	1.3E-2	--	EL not exceeded
Vanadium	2.3E-2	8.4E-4	2.4E-2	3.0E-3	--	Non-carcinogenic EL exceeded
Trimethyl Benzene	--	1.1E-2	1.1E-2	8.2E+0	--	EL not exceeded
Tungsten	8.1E-3	5.2E-4	8.7E-3	3.3E-1	--	EL not exceeded
Zinc	2.9E-2	2.2E-3	3.1E-2	6.7E-1	--	EL not exceeded

a. Total HAP/TAP emissions for EL evaluation from mining (i.e., pits, blasting, haul roads, stockpiles and DRSF, tailings storage facility, access road, and underground exploration) and leaching. Emissions from sources covered/addressed by NSPS/NESHAP are not included in the evaluation for modeling applicability.

b. Total HAP/TAP emissions for EL evaluation from processing and production (i.e., ore processing [crushers and transfer, prill silos], ore concentration and refining [autoclave, electrowinning cells and pregnant solution tank, retort, furnace, carbon kiln], process heating [POX boiler, carbon regeneration kiln, propane vaporizer, solution heater], lime production [limestone crushers, screens, mill, transfers, lime kiln, kiln feed, lime mill, pebble lime silo, lime silos, lime mill crushing], aggregate production [portable crushers, screens, transfers], concrete production [central mixer, cement silos, aggregate bin], HVAC [heaters], emergency power [emergency generators, fire pump], fuel storage [gasoline fuel and tanks]). Emissions from sources covered/addressed by NSPS/NESHAP are not included in the evaluation for modeling applicability.

c. Non-carcinogenic EL from *Idaho Air Rules* Section 585.

d. Carcinogenic EL from *Idaho Air Rules* Section 586.

Table 1 shows that the SGP facility-wide potential TAP emissions exceed the respective EL for arsenic, beryllium, cadmium, cyanide, formaldehyde, manganese, nickel, phosphorus, aluminum, barium, calcium carbonate, calcium oxide, iron, sulfuric acid, thallium, and vanadium. Therefore, modeling was required for these 16 TAPs (11 non-carcinogenic and five carcinogenic TAPs) to demonstrate compliance with Acceptable Ambient Concentrations of Non-Carcinogens (AACs) and AACCs.

5.4 TAP Modeled Emission Rates

Table 2 lists the source-specific modeled emission rates for all 11 non-carcinogenic TAPs that required modeling (worst-case modeling scenario for all non-carcinogenic TAPs: W5). Table 3 lists the source-specific modeled emission rates for all five carcinogenic TAPs that required modeling (worst-case impacts for arsenic are associated with modeling scenario W2; worst-case impacts for all other carcinogenic TAPs are associated with modeling scenario W1). Note that all source-specific emission rates listed in Tables 2 and 3 were extracted by DEQ's modeling staff from the submitted modeling input files.

The total modeled emission rates for all non-carcinogenic TAPs are equal to the total facility-wide HAP/TAP emissions as stated in the permitting emissions inventory (excluding sources addressed by NSPS/NESHAP), evaluated at 180,000 T/day (see last two rows of Table 2). However, for carcinogenic TAPs, modeling was performed using an emission inventory that included T-RACT controls, long-term mining production limits, and other emission inventory refinements, as described in Section 4.0 of this *Modeling Review Attachment* (see last three rows of Table 3).

Table 2. MODELED EMISSION RATES FOR NON-CARCINOGENIC TAPS (WORST-CASE MODELING SCENARIOS).												
Type of Source	**Source ID**	**ALUM[a] (lb/hr)[b]**	**BARI[c] (lb/hr)**	**CACA[d] (lb/hr)**	**CAOX[e] (lb/hr)**	**CYAN[f] (lb/hr)**	**IRON[g] (lb/hr)**	**MANG[h] (lb/hr)**	**PHOS[i] (lb/hr)**	**SULF[j] (lb/hr)**	**THAL[k] (lb/hr)**	**VANA[l] (lb/hr)**
Point Sources	LS1L	2.33E-04	1.50E-06	0	7.63E-03	0	1.07E-04	2.44E-06	1.34E-06	0	5.16E-08	1.60E-07
	MILLS2L	2.33E-04	1.50E-06	0	7.63E-03	0	1.07E-04	2.44E-06	1.34E-06	0	5.16E-08	1.60E-07
	AC	2.31E-05	2.31E-05	2.31E-05	0	0	2.31E-05	0	0	2.03E+00	2.31E-05	2.31E-05
	ACB	0	3.06E-06	0	0	0	0	2.64E-07	0	0	0	1.60E-06
	ACS1L	9.32E-04	5.98E-06	0	3.05E-02	0	4.27E-04	9.76E-06	5.36E-06	0	2.06E-07	6.39E-07
	ACS2L	9.32E-04	5.98E-06	0	3.05E-02	0	4.27E-04	9.76E-06	5.36E-06	0	2.06E-07	6.39E-07
	ACS3L	9.32E-04	5.98E-06	0	3.05E-02	0	4.27E-04	9.76E-06	5.36E-06	0	2.06E-07	6.39E-07
	ACS4L	4.66E-04	2.99E-06	0	1.53E-02	0	2.13E-04	4.88E-06	2.68E-06	0	1.03E-07	3.20E-07
	CKD	9.59E-05	9.59E-05	9.59E-05	0	0	9.59E-05	0	0	0	9.59E-05	9.59E-05
	CKB	0	9.73E-06	0	0	0	0	8.40E-07	0	0	0	5.08E-06
	EW	9.59E-05	9.59E-05	9.59E-05	0	0	9.59E-05	0	0	0	9.59E-05	9.59E-05
	MR	9.59E-05	9.59E-05	9.59E-05	0	0	9.59E-05	0	0	0	9.59E-05	9.59E-05
	MF	9.59E-05	9.59E-05	9.59E-05	0	0	9.59E-05	0	0	0	9.59E-05	9.59E-05
	EDG1	0	0	0	0	0	0	0	0	0	0	0
	EDG2	0	0	0	0	0	0	0	0	0	0	0
	EDG3	0	0	0	0	0	0	0	0	0	0	0
	EDFP	0	0	0	0	0	0	0	0	0	0	0
	PV	0	4.31E-07	0	0	0	0	3.73E-08	0	0	0	2.25E-07
	HS	0	2.16E-05	0	0	0	0	1.86E-06	0	0	0	1.13E-05
	H1M	0	1.73E-05	0	0	0	0	1.49E-06	0	0	0	9.02E-06
	H2M	0	1.73E-05	0	0	0	0	1.49E-06	0	0	0	9.02E-06
	HM	0	1.73E-05	0	0	0	0	1.49E-06	0	0	0	9.02E-06
	HAC	0	1.08E-06	0	0	0	0	9.31E-08	0	0	0	5.64E-07
	HR	0	1.08E-06	0	0	0	0	9.31E-08	0	0	0	5.64E-07
	HA	0	1.08E-06	0	0	0	0	9.31E-08	0	0	0	5.64E-07
	HMO	0	2.16E-06	0	0	0	0	1.86E-07	0	0	0	1.13E-06
	HTS	0	8.63E-06	0	0	0	0	7.45E-07	0	0	0	4.51E-06
	HW	0	1.29E-05	0	0	0	0	1.12E-06	0	0	0	6.76E-06
	PSL	0	0	0	0	0	0	0	0	0	0	0
	CS1L	0	0	0	0	0	0	8.01E-07	0	0	0	0
	CS2L	0	0	0	0	0	0	8.01E-07	0	0	0	0
	LS6	3.19E-03	2.05E-05	3.88E-02	0	0	1.46E-03	0	0	0	7.06E-07	2.19E-06
	LSBM	4.30E-02	2.76E-04	5.22E-01	0	0	1.97E-02	0	0	0	9.51E-06	2.95E-05
	LS9	7.54E-04	4.84E-06	9.16E-03	0	0	3.45E-04	0	0	0	1.67E-07	5.17E-07
	LK	2.07E-02	1.33E-04	2.51E-01	0	0	9.47E-03	0	0	0	4.58E-06	1.42E-05
	LKC	0	9.51E-05	0	0	0	0	0	0	0	0	4.97E-05
	LCR	6.43E-03	4.12E-05	0	2.11E-01	0	2.94E-03	0	0	0	1.42E-06	4.41E-06
	LSL	1.40E-04	8.99E-07	0	4.59E-03	0	6.41E-05	0	0	0	3.10E-08	9.60E-08

REC 3889

REC 0702

PET 336

Table 2. MODELED EMISSION RATES FOR NON-CARCINOGENIC TAPS (WORST-CASE MODELING SCENARIOS).												
Type of Source	**Source ID**	**ALUM[a] (lb/hr)[b]**	**BARI[c] (lb/hr)**	**CACA[d] (lb/hr)**	**CAOX[e] (lb/hr)**	**CYAN[f] (lb/hr)**	**IRON[g] (lb/hr)**	**MANG[h] (lb/hr)**	**PHOS[i] (lb/hr)**	**SULF[j] (lb/hr)**	**THAL[k] (lb/hr)**	**VANA[l] (lb/hr)**
Area Sources	WEP	5.59E+00	6.29E-02	1.10E+00	0	0	1.43E+00	2.35E-02	5.11E-02	0	7.87E-04	2.20E-03
	UGEXP	2.49E-05	2.80E-07	4.91E-06	0	0	6.38E-06	1.05E-07	2.28E-07	0	3.50E-09	9.81E-09
	TSF	0	0	0	0	2.32E-01	0	0	0	0	0	0
Line Sources	AR01	2.02E-02	2.28E-04	3.99E-03	0	0	5.18E-03	8.52E-05	1.85E-04	0	2.85E-06	7.98E-06
	AR02	1.56E-02	1.75E-04	3.07E-03	0	0	3.99E-03	6.55E-05	1.42E-04	0	2.19E-06	6.13E-06
	AR03	3.93E-02	4.43E-04	7.75E-03	0	0	1.01E-02	1.66E-04	3.60E-04	0	5.54E-06	1.55E-05
	AR04	3.77E-02	4.25E-04	7.43E-03	0	0	9.66E-03	1.59E-04	3.45E-04	0	5.31E-06	1.49E-05
Volume Sources	WEPBL	1.90E+00	2.14E-02	3.75E-01	0	0	4.88E-01	8.01E-03	1.74E-02	0	2.68E-04	7.50E-04
	WEDRSF	8.58E-01	9.66E-03	1.69E-01	0	0	2.20E-01	3.61E-03	7.85E-03	0	1.21E-04	3.38E-04
	OC1	1.04E-02	1.17E-04	2.04E-03	0	0	2.65E-03	0	0	0	1.46E-06	4.08E-06
	OC2	1.04E-02	1.17E-04	2.04E-03	0	0	2.65E-03	0	0	0	1.46E-06	4.08E-06
	OC3	1.04E-02	1.17E-04	2.04E-03	0	0	2.65E-03	0	0	0	1.46E-06	4.08E-06
	OC4	1.04E-02	1.17E-04	2.04E-03	0	0	2.65E-03	0	0	0	1.46E-06	4.08E-06
	OC5	1.04E-02	1.17E-04	2.04E-03	0	0	2.65E-03	0	0	0	1.46E-06	4.08E-06
	OC6	1.04E-02	1.17E-04	2.04E-03	0	0	2.65E-03	0	0	0	1.46E-06	4.08E-06
	OC7	8.87E-02	1.00E-03	1.75E-02	0	0	2.28E-02	0	0	0	1.25E-05	3.50E-05
	OC8	1.04E-02	1.17E-04	2.04E-03	0	0	2.65E-03	0	0	0	1.46E-06	4.08E-06
	OC9	4.90E-02	5.52E-04	9.66E-03	0	0	1.26E-02	0	0	0	6.90E-06	1.93E-05
	OC10	4.90E-02	5.52E-04	9.66E-03	0	0	1.26E-02	0	0	0	6.90E-06	1.93E-05
	OC11	4.90E-02	5.52E-04	9.66E-03	0	0	1.26E-02	0	0	0	6.90E-06	1.93E-05
	OC12	9.80E-02	1.10E-03	1.93E-02	0	0	2.51E-02	0	0	0	1.38E-05	3.86E-05
	OC13	1.14E-02	1.29E-04	2.25E-03	0	0	2.93E-03	0	0	0	1.61E-06	4.51E-06
	LS1U	1.13E-03	7.25E-06	0	3.70E-02	0	5.18E-04	1.18E-05	6.50E-06	0	2.50E-07	7.75E-07
	MILLS2U	1.13E-03	7.25E-06	0	3.70E-02	0	5.18E-04	1.18E-05	6.50E-06	0	2.50E-07	7.75E-07
	ACS1U	2.17E-03	1.39E-05	0	7.10E-02	0	9.94E-04	2.27E-05	1.25E-05	0	4.80E-07	1.49E-06
	ACS2U	2.17E-03	1.39E-05	0	7.10E-02	0	9.94E-04	2.27E-05	1.25E-05	0	4.80E-07	1.49E-06
	ACS3U	2.17E-03	1.39E-05	0	7.10E-02	0	9.94E-04	2.27E-05	1.25E-05	0	4.80E-07	1.49E-06
	ACS42U	2.17E-03	1.39E-05	0	7.10E-02	0	9.94E-04	2.27E-05	1.25E-05	0	4.80E-07	1.49E-06
	PSU	0	0	0	0	0	0	0	0	0	0	0
	CS1U	0	0	0	0	0	0	8.01E-07	0	0	0	0
	CS2U	0	0	0	0	0	0	8.01E-07	0	0	0	0
	CAL	1.56E-02	1.00E-04	0	0	0	7.14E-03	0	0	0	3.45E-06	1.07E-05
	CAU	1.56E-02	1.00E-04	0	0	0	7.14E-03	0	0	0	3.45E-06	1.07E-05
	CM	0	0	0	0	0	0	2.59E-05	8.22E-06	0	0	0
	PCSP1	1.41E-02	9.06E-05	1.72E-01	0	0	6.47E-03	0	0	0	3.12E-06	9.69E-06
	PCSP2	1.41E-02	9.06E-05	1.72E-01	0	0	6.47E-03	0	0	0	3.12E-06	9.69E-06
	LS1	3.19E-03	2.05E-05	3.88E-02	0	0	1.46E-03	0	0	0	7.06E-07	2.19E-06
	LS2	5.75E-03	3.69E-05	6.98E-02	0	0	2.63E-03	0	0	0	1.27E-06	3.94E-06
	LS3	2.66E-02	1.71E-04	3.23E-01	0	0	1.22E-02	0	0	0	5.88E-06	1.82E-05

REC 3890

REC 0703

PET 337

Table 2. MODELED EMISSION RATES FOR NON-CARCINOGENIC TAPS (WORST-CASE MODELING SCENARIOS).												
Type of Source	**Source ID**	**ALUM[a] (lb/hr)[b]**	**BARI[c] (lb/hr)**	**CACA[d] (lb/hr)**	**CAOX[e] (lb/hr)**	**CYAN[f] (lb/hr)**	**IRON[g] (lb/hr)**	**MANG[h] (lb/hr)**	**PHOS[i] (lb/hr)**	**SULF[j] (lb/hr)**	**THAL[k] (lb/hr)**	**VANA[l] (lb/hr)**
	LS4	5.75E-03	3.69E-05	6.98E-02	0	0	2.63E-03	0	0	0	1.27E-06	3.94E-06
	LS5	2.66E-02	1.71E-04	3.23E-01	0	0	1.22E-02	0	0	0	5.88E-06	1.82E-05
	LS7	3.19E-03	2.05E-05	3.88E-02	0	0	1.46E-03	0	0	0	7.06E-07	2.19E-06
	LS8	3.19E-03	2.05E-05	3.88E-02	0	0	1.46E-03	0	0	0	7.06E-07	2.19E-06
	LS10	7.54E-04	4.84E-06	9.16E-03	0	0	3.45E-04	0	0	0	1.67E-07	5.17E-07
	LS11	6.29E-03	4.03E-05	7.63E-02	0	0	2.88E-03	0	0	0	1.39E-06	4.31E-06
	LS12	7.54E-04	4.84E-06	9.16E-03	0	0	3.45E-04	0	0	0	1.67E-07	5.17E-07
	LSU	1.40E-05	8.99E-08	0	4.59E-04	0	6.41E-06	0	0	0	3.10E-09	9.60E-09
	MILLTANKS	0	0	0	0	2.21E-01	0	0	0	0	0	0
	HRT001-HRT072[m]	2.62E-01	2.95E-03	5.16E-02	0	0	6.71E-02	1.10E-03	2.40E-03	0	3.69E-05	1.03E-04
	HRN001-HRN022[m]	2.62E-01	2.95E-03	5.16E-02	0	0	6.71E-02	1.10E-03	2.40E-03	0	3.69E-05	1.03E-04
Total Modeled Rates		***3.37E+01***	***3.79E-01***	***8.76E+00***	***6.96E-01***	***4.53E-01***	***8.69E+00***	***1.39E-01***	***3.03E-01***	***2.03E+00***	***5.17E-03***	***1.39E-02***
Total Emission Rates at 180,000 T/day[n]		***3.37E+01***	***3.79E-01***	***8.76E+00***	***6.96E-01***	***4.53E-01***	***8.69E+00***	***1.39E-01***	***3.03E-01***	***2.03E+00***	***5.17E-03***	***1.39E-02***

a. Aluminum (worst-case modeling scenario: W5).
b. Pounds per hour.
c. Barium (worst-case modeling scenario: W5).
d. Calcium carbonate (worst-case modeling scenario: W5).
e. Calcium oxide (worst-case modeling scenario: W5).
f. Cyanide (worst-case modeling scenario: W5).
g. Iron (worst-case modeling scenario: W5).
h. Manganese (worst-case modeling scenario: W5).
i. Phosphorus (worst-case modeling scenario: W5).
j. Sulfuric acid (worst-case modeling scenario: W5).
k. Thallium (worst-case modeling scenario: W5).
l. Vanadium (worst-case modeling scenario: W5).
m. The Haul Road was represented in the model as a series of volume sources. The emission rates listed in this table represent each individual volume source.
n. Total emission rates at 180,000 tons per day were derived from Worksheet "TblA" in the emission inventory dated October 5, 2021. The total emission rates in this row represent all facility-wide HAP/TAP emission sources from mining, leaching, and processing and production (excluding emissions from sources "addressed" or "covered" by NSPS/NESHAP).

REC 3891

Table 3. MODELED EMISSION RATES FOR CARCINOGENIC TAPS (WORST-CASE MODELING SCENARIOS).						
Type of Source	**Source ID**	**ARSE[a] (lb/hr)[b]**	**BERY[c] (lb/hr)**	**CADM[d] (lb/hr)**	**FORM[e] (lb/hr)**	**NICK[f] (lb/hr)**
Point Sources	LS1L	1.14E-08	3.96E-10	1.24E-10	0	2.47E-09
	MILLS2L	1.14E-08	3.96E-10	1.24E-10	0	2.47E-09
	AC	0	0	0	0	0
	ACB	1.28E-07	7.66E-09	7.02E-07	4.79E-05	1.34E-06
	ACS1L	4.55E-08	1.58E-09	4.94E-10	0	9.89E-09
	ACS2L	4.55E-08	1.58E-09	4.94E-10	0	9.89E-09
	ACS3L	4.55E-08	1.58E-09	4.94E-10	0	9.89E-09
	ACS4L	2.27E-08	7.91E-10	2.47E-10	0	4.94E-09
	CKD	0	0	0	0	0
	CKB	4.07E-07	2.44E-08	2.24E-06	1.52E-04	4.27E-06
	EW	0	0	0	0	0
	MR	0	0	0	0	0
	MF	0	0	0	0	0
	EDG1	0	0	0	0	0
	EDG2	0	0	0	0	0
	EDG3	0	0	0	0	0
	EDFP	0	0	0	0	0
	PV	1.80E-08	1.08E-09	9.91E-08	6.76E-06	1.89E-07
	HS	9.01E-07	5.41E-08	4.96E-06	3.38E-04	9.46E-06
	H1M	7.84E-07	4.71E-08	4.31E-06	2.94E-04	8.24E-06
	H2M	7.84E-07	4.71E-08	4.31E-06	2.94E-04	8.24E-06
	HM	7.84E-07	4.71E-08	4.31E-06	2.94E-04	8.24E-06
	HAC	4.90E-08	2.94E-09	2.70E-07	1.84E-05	5.15E-07
	HR	4.90E-08	2.94E-09	2.70E-07	1.84E-05	5.15E-07
	HA	4.90E-08	2.94E-09	2.70E-07	1.84E-05	5.15E-07
	HMO	9.80E-08	5.88E-09	5.39E-07	3.68E-05	1.03E-06
	HTS	3.92E-07	2.35E-08	2.16E-06	1.47E-04	4.12E-06
	HW	5.88E-07	3.53E-08	3.24E-06	2.21E-04	6.18E-06
	PSL	0	0	0	0	0
	CS1L	2.90E-08	3.33E-09	0	0	2.86E-07
	CS2L	2.90E-08	3.33E-09	0	0	2.86E-07
	LS6	0	0	0	0	0
	LSBM	0	0	0	0	0
	LS9	0	0	0	0	0
	LK	0	0	0	0	0
	LKC	0	0	0	0	0
	LCR	0	0	0	0	0
	LSL	0	0	0	0	0
Area Sources	WEP	9.40E-03	4.51E-05	7.04E-06	0	2.82E-05
	UGEXP	2.34E-07	1.12E-09	1.75E-10	0	7.01E-10
	TSF	0	0	0	0	0
Line Sources	AR01	7.12E-07	9.12E-07	1.42E-07	0	5.70E-07
	AR02	5.48E-07	7.01E-07	1.10E-07	0	4.38E-07
	AR03	1.38E-06	1.77E-06	2.77E-07	0	1.11E-06
	AR04	1.33E-06	1.70E-06	2.65E-07	0	1.06E-06

REC 3892
REC 0705

PET 339

Table 3. MODELED EMISSION RATES FOR CARCINOGENIC TAPS (WORST-CASE MODELING SCENARIOS).						
Type of Source	**Source ID**	**ARSE[a] (lb/hr)[b]**	**BERY[c] (lb/hr)**	**CADM[d] (lb/hr)**	**FORM[e] (lb/hr)**	**NICK[f] (lb/hr)**
Volume Sources	WEPBL	1.79E-02	8.57E-05	1.34E-05	0	5.36E-05
	FDRSF	4.23E-03				
	STKP		2.72E-05	4.25E-06	0	1.70E-05
	OC1	0	0	0	0	0
	OC2	0	0	0	0	0
	OC3	0	0	0	0	0
	OC4	0	0	0	0	0
	OC5	0	0	0	0	0
	OC6	0	0	0	0	0
	OC7	0	0	0	0	0
	OC8	0	0	0	0	0
	OC9	0	0	0	0	0
	OC10	0	0	0	0	0
	OC11	0	0	0	0	0
	OC12	0	0	0	0	0
	OC13	0	0	0	0	0
	LS1U	5.51E-08	1.92E-09	5.99E-10	0	1.20E-08
	MILLS2U	5.51E-08	1.92E-09	5.99E-10	0	1.20E-08
	ACS1U	2.21E-07	7.67E-09	2.40E-09	0	4.79E-08
	ACS2U	2.21E-07	7.67E-09	2.40E-09	0	4.79E-08
	ACS3U	2.21E-07	7.67E-09	2.40E-09	0	4.79E-08
	ACS42U	1.10E-07	3.84E-09	1.20E-09	0	2.40E-08
	PSU	0	0	0	0	0
	CS1U	2.90E-08	3.33E-09	0	0	2.86E-07
	CS2U	2.90E-08	3.33E-09	0	0	2.86E-07
	CAL	0	0	0	0	0
	CAU	0	0	0	0	0
	CM	2.03E-06	0	4.86E-09	0	1.70E-06
	PCSP1	0	0	0	0	0
	PCSP2	0	0	0	0	0
	LS1	0	0	0	0	0
	LS2	0	0	0	0	0
	LS3	0	0	0	0	0
	LS4	0	0	0	0	0
	LS5	0	0	0	0	0
	LS7	0	0	0	0	0
	LS8	0	0	0	0	0
	LS10	0	0	0	0	0
	LS11	0	0	0	0	0
	LS12	0	0	0	0	0
	LSU	0	0	0	0	0
	MILLTANKS	0	0	0	0	0

REC 3893
REC 0706

PET 340

Table 3. MODELED EMISSION RATES FOR CARCINOGENIC TAPS (WORST-CASE MODELING SCENARIOS).						
Type of Source	**Source ID**	**ARSE[a] (lb/hr)[b]**	**BERY[c] (lb/hr)**	**CADM[d] (lb/hr)**	**FORM[e] (lb/hr)**	**NICK[f] (lb/hr)**
Volume Sources	HRF001-HRF055[g]	1.03E-03				
	HRQ001-HRQ049[g]	1.03E-03				
	HRR001-HRR006[g]	1.03E-03				
	HRN001-HRN022[g]	1.03E-03	9.27E-06	1.45E-06	0	5.80E-06
	HRB001-HRB003[g]	1.03E-03				
	HRP001-HRP057[g]		9.27E-06	1.45E-06	0	5.80E-06
	HRO001-HRO002[g]	1.03E-03	9.27E-06	1.45E-06	0	5.80E-06
Total Modeled Rates		***1.73E-01***	***9.15E-04***	***1.71E-04***	***1.89E-03***	***6.27E-04***
Total T-RACT Emission Rates[h]		***1.73E-01***	***9.1E-04***	***1.7E-04***	***1.9E-03***	***6.3E-04***
Total Emission Rates at 180,000 T/day[i]		***4.03E-01***	***1.36E-03***	***2.40E-04***	***1.89E-03***	***9.04E-04***

a. Arsenic (worst-case modeling scenario: W2).
b. Pounds per hour.
c. Beryllium (worst-case modeling scenario: W1).
d. Cadmium (worst-case modeling scenario: W1).
e. Formaldehyde (worst-case modeling scenario: W1).
f. Nickel (worst-case modeling scenario: W1).
g. The Haul Road was represented in the model as a series of volume sources. The emission rates listed in this table represent each individual volume source.
h. Total T-RACT emission rates – calculated based on T-RACT controls, long-term mining production limits, and other emission inventory refinements, as described in Section 4.0 of this *Modeling Review Attachment* – are derived from Tables B-W2 (for Arsenic) and B-W1 (for Beryllium, Cadmium, Formaldehyde, and Nickel) in Appendix B of the *TAP Addendum*.
i. Total emission rates at 180,000 tons per day were derived from Worksheet "TblA" in the emission inventory dated October 5, 2021. The total emission rates in this row represent all facility-wide HAP/TAP emission sources from mining, leaching, and processing and production (excluding emissions from sources "addressed" or "covered" by NSPS/NESHAP).

5.5 Cyanide Modeling Emission Source Parameters

Modeling analyses for cyanide introduced two new emission sources that were not previously evaluated by DEQ: tailings storage facility (model ID: TSF) and mill tanks (model ID: MILLTANKS).

1. The tailings storage facility was modeled by Air Sciences as a surface-based (zero release height above ground-level and zero initial vertical dimension) AREA source. The easterly and northerly lengths were calculated as square-root of the TSF area (easterly length = northerly length = $\sqrt{1{,}338{,}158\ square\ meters}$ = 1,157 meters).

2. The mill tanks were grouped and modeled by Air Sciences as a single VOLUME source. The tanks sit on the ground, so the release height was set to the average tank height of 12.2 meters (40 feet). The initial lateral dispersion (σ_y) was calculated as the equivalent diameter of the combined (18) tank area divided by the single VOLUME source coefficient of 4.3:

REC 3894
REC 0707
PET 341

$$\sigma_{y(MILLTANKS)} = \frac{Equivalent\ diameter}{4.3} = \frac{\sqrt{\Sigma(d)^2}}{4.3} = 42.8\ feet$$

The individual tank diameters (d) are: two tanks at 40 feet, four tanks at 52 feet, six tanks at 54 feet, and six tanks at 20 feet.

DEQ typically requires that tailings storage facilities be modeled as an AREAPOLY source with an outline that follows the contour of the emission source, and that mill tanks be represented in the model as individual volume sources; but, given that the maximum modeled concentration for cyanide is safely below the AAC (0.08%), DEQ's modeling team accepted the modeling analysis submitted by Air Sciences and concluded that it confidently demonstrates that the cyanide AAC will not be exceeded.

5.6 Deposition Modeling

Air Sciences applied particle deposition algorithms in the impact modeling for particulate TAPs. The particulate deposition parameters used in the NAAQS compliance analysis were derived for PM_{10} and $PM_{2.5}$ (see Tables 22 and 23 in the main body of the DEQ *Modeling Review Memorandum*). Dust-related metal TAP emissions include total particulates (all size fractions of particulate matter [PM] up to PM_{30}). Therefore, the deposition parameters for PM were calculated using the same methodology and EPA references used for PM_{10} and $PM_{2.5}$ in the NAAQS compliance demonstration analyses. The PM deposition parameters are provided below in Table 4. The same density values were used as in the previous TAPs modeling analysis. However, an additional deposition characterization bin was added to better handle deposition of 10 µm to 30 µm particulates; mass fractions were adjusted accordingly.

Table 4. PARTICULATE MATTER DEPOSITION PARAMETERS BY SOURCE CATEGORY.

Source Category	Parameter	PM				
		Bin 1	**Bin 2**	**Bin 3**	**Bin 4**	**Bin 5**
Haul Roads	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.02	0.23	0.75	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3) (YPP, HFP, WEP DR average)	2.46	2.46	2.46	--	--
Material Handling (Ore, DR, Limestone)	Bin Upper Diameter (µm)	2.50	5.00	10.00	30.00	--
	Mass Fraction	0.07	0.20	0.20	0.53	--
	Mass Mean Diameter (µm)	2.50	5.00	10.00	30.00	--
	Density (g/cm^3) (Ore)	Pit-specific, see Table 23[a].				
	Density (g/cm^3) (Ore and Waste)	Pit-specific, see Table 23.				
	Density (g/cm^3) (Limestone)	1.09	1.09	1.09	1.09	--
Baghouses	Bin Upper Diameter (µm)	2.50	6.00	10.00	30.00	--
	Mass Fraction	0.25	0.45	0.20	0.10	--
	Mass Mean Diameter (µm)	2.50	6.00	10.00	30.00	--
	Density (g/cm^3) (Ore)	Pit-specific, see Table 23.				
Diesel Engines	Bin Upper Diameter (µm)	1.00	2.50	6.00	10.00	30.00
	Mass Fraction	0.82	0.08	0.03	0.03	0.04
	Mass Mean Diameter (µm)	1.00	2.50	6.00	10.00	30.00
	Density (g/cm^3) (Diesel Combustion)	1.00	1.00	1.00	1.00	1.00
Heaters and Boilers	Bin Upper Diameter (µm)	1.00	2.50	6.00	10.00	30.00
	Mass Fraction	0.23	0.22	0.25	0.09	0.21
	Mass Mean Diameter (µm)	1.00	2.50	6.00	10.00	30.00
	Density (g/cm^3) (Propane Combustion)	1.24	1.24	1.24	1.24	1.24

REC 3895
REC 0708
PET 342

Table 4. PARTICULATE MATTER DEPOSITION PARAMETERS BY SOURCE CATEGORY.						
Source Category	**Parameter**	**PM**				
		Bin 1	**Bin 2**	**Bin 3**	**Bin 4**	**Bin 5**
Lime Loading and Unloading (Quick, Pebble)	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.05	0.29	0.66	--	--
	Mass Mean Diameter	2.50	10.00	30.00	--	--
	Density (g/cm^3) (Quick)	0.44	0.44	0.44	--	--
	Density (g/cm^3) (Pebble)	0.96	0.96	0.96	--	--
Lime Unloading (Quick, Pebble)	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.09	0.49	0.42	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3) (Quick)	0.44	0.44	0.44	--	--
	Density (g/cm^3) (Pebble)	0.96	0.96	0.96	--	--
Cement and Aggregate Loading and Unloading	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.05	0.29	0.66	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3) (Cement)	1.44	1.44	1.44	--	--
	Density (g/cm^3) (Aggregate)	1.28	1.28	1.28	--	--
Prill Loading and Unloading	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.05	0.30	0.65	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3) (Prill)	0.84	0.84	0.84	--	--
Refining Processes	Bin Upper Diameter (µm)	1.00	2.50	6.00	10.00	30.00
	Mass Fraction	0.72	0.10	0.07	0.03	0.08
	Mass Mean Diameter (µm)	1.00	2.50	6.00	10.00	30.00
	Density (g/cm^3) (Diesel Combustion)	1.00	1.00	1.00	1.00	1.00
Portable Crushing and Screening Plant	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.05	0.32	0.63	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3) (YPP, HFP, WEP DR average)	2.46	2.46	2.46	--	--
Lime Kiln and Ball Mill	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction (Kiln)	0.27	0.28	0.45	--	--
	Mass Fraction (Ball Mill)	0.30	0.54	0.16	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3)	1.09	1.09	1.09	--	--
Blasting and Drilling	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.03	0.49	0.48	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3) (Ore or DR)	Pit-specific, see Table 23.				
Dozing	Bin Upper Diameter (µm)	2.50	10.00	15.00	30.00	--
	Mass Fraction	0.11	0.08	0.06	0.75	--
	Mass Mean Diameter (µm)	2.50	10.00	15.00	30.00	--
	Density (g/cm^3) (DR)	Pit-specific, see Table 23.				

[a.] See Table 23 in the main body of the DEQ *Modeling Review Memorandum*.

5.7 Carcinogenic TAP Modeling Lifetime Exposure Adjustment

Maximum modeled concentrations for carcinogenic TAPs were adjusted to account for the life-of-mine production limits, which affects the lifetime exposure.

PRI evaluated the highest modeled annual carcinogenic TAP concentration from each of the 14 modeling scenarios for lifetime exposure as follows:

$$Lifetime\ exposure\ \left(\frac{\mu g}{m^3}\right) = \frac{Highest\ annual\ concentration\ \left(\frac{\mu g}{m^3}\right) \times 16\ (mine\ operation\ years)}{70\ (years, lifetime\ exposure)}$$

This equation assumes that the highest annual concentration from the 14 modeling scenarios is repeated for 16 years of mining operation. This was then averaged over 70 years to calculate the 70-year lifetime exposure.

PRI and Air Sciences contend that calculating lifetime exposure based on 16 years of mining operation is conservative. The annual emissions for carcinogenic TAP modeling are based on 135,000 tons/day (see Section 5.1 of this *Modeling Review Attachment*) and 365 days per year. Over 16 years, this equates to a potential mining production of 788.4 million tons:

$$\frac{135{,}000\ \left(\frac{tons}{day}\right) \times 365\ \left(\frac{days}{year}\right) \times 16\ years}{1{,}000{,}000\ \left(\frac{tons}{million\ ton}\right)} = 788.4\ million\ tons$$

The actual life-of-mine total production as described in the SGP *Refined Proposed Action* (*ModPRO2*) mine plan is only 402.86 million tons (Perpetua 2021), which is 51.1% of the potential life-of-mine production represented in the above equation and related emission evaluations.

5.8 Arsenic Compliance Demonstration for Modeling Scenarios W1-W4

To demonstrate compliance with the AACC for arsenic, PRI applied two additional operating limitations:

- The removal of Modeling Scenario W5 as a potential operating scenario
- Limiting the West End Pit's life-of-mine potential mining production to 50% of the total life-of-mine potential mining production of 788.4 million tons: 50% * 788.4 million tons = 394.2 million tons

PRI has determined that the West End Development Rock Storage Facility (DRSF) will not be constructed. This change eliminated Modeling Scenario W5 from the arsenic modeling evaluation. The remaining four West End Pit modeling scenarios (W1–W4) are evaluated using the 70-year lifetime exposure equation from Section 5.7 and adjusting for the proposed West End Pit life-of-mine production limit of 50% of the total production as follows:

$$LifeExpose_{Wi,j,n} = \left[\left(WEPExpose_{Wi,n}\right)(50\%) + \left(nonWEPExpose_{Sj,n}\right)(50\%)\right]\left[\frac{16\ year\ LOM}{70\ year\ exposure}\right]$$

where:

W*i*	=	West End Pit scenario, where *i* = 1 to 4.
S*j*	=	non West End Pit scenario, where *j* = B1, B2, H1, H2, H3, H4, Y1, Y2, and Y3.
n	=	specific receptor.
$LifeExpose_{Wi,j,n}$	=	lifetime exposure in µg/m^3 for West End Pit scenario *i*, non West End Pit scenario *j*, at receptor *n*.
$WEPExpose_{Wi,n}$	=	annual maximum impact in µg/m^3 for West End Pit scenario *i* at receptor *n*.
$nonWEPExpose_{Sj,n}$	=	annual maximum impact in µg/m^3 for non West End Pit scenario *j* at receptor *n*.
16 year LOM	=	maximum life-of-mine.
70 year exposure	=	Lifetime exposure used for development of AACCs in *Idaho Air Rules*.

The above equation was used to calculate the lifetime arsenic exposure from the West End Pit scenarios (W1–W4) on a receptor-by-receptor basis. Combining the concentrations from Modeling Scenarios W1–W4 with the highest concentration from the remaining non-West End Pit scenarios (B1, B2, H1, H2, H3, H4, Y1, Y2, or Y3) conservatively ensures that the maximum potential impacts from applicable sources are evaluated and remain below AACCs.

PRI contends that calculating lifetime arsenic exposure based on the proposed West End Pit life-of-mine production limit of 50% of the total production is conservative. The actual life-of-mine total production from the West End Pit as described in the ModPRO2 mine plan is only 198.26 million tons (Perpetua 2021), which is 50.3% of the proposed West End Pit life-of-mine production limit of 394.2 million tons.

6.0 Impact Results

TAP impact analysis results, as submitted in the *TAP Addendum* and as further assessed by DEQ, are discussed in this section. The effect of various operational refinements also reduced PM_{10} and $PM_{2.5}$ impacts, and this is discussed in Section 6.2.

6.1 TAP Impact Analyses Results

This section describes the revised TAP impact analyses and demonstrates that applicable TAP emissions resulting from operation of the SGP will not result in increased impacts that exceed AACs or AACCs.

6.1.1 Modeling Non-Carcinogenic TAPs

The non-carcinogenic TAPs subject to impact modeling requirements to demonstrate compliance with AACs of *Idaho Air Rules* Section 585 were modeled at the emission levels shown in Table 1 above. The maximum 24-hour modeled concentration for each of the 14 modeling scenarios demonstrates compliance with the applicable AAC, as summarized below in Table 5. PRI elected to include Scenario W5 in the modeling analysis for non-carcinogenic TAPs. Figure 1 illustrates the locations of the maximum impacts for each non-carcinogenic TAP.

REC 3898
REC 0711
PET 345

Table 5. RESULTS FOR TAPS IMPACT ANALYSES FOR NON-CARCINOGENIC TAPS.					
Toxic Air Pollutant	**Averaging Time**	**Maximum Modeled Concentration ($\mu g/m^3$)[a]**	**Model Scenario**	**AAC[b] ($\mu g/m^3$)**	**Percent of AAC**
Aluminum	24-hour	6.17	W5	500	1.23%
Barium	24-hour	0.07	W5	25	0.28%
Calcium carbonate	24-hour	1.22	W5	500	0.24%
Calcium oxide	24-hour	0.15	All	100	0.15%
Cyanide	24-hour	0.20	All	250	0.08%
Iron	24-hour	1.58	W5	50	3.16%
Manganese	24-hour	0.03	W5	250	0.01%
Phosphorus	24-hour	0.06	W5	5	1.20%
Sulfuric acid	24-hour	0.41	All	50	0.82%
Thallium	24-hour	0.001	W5	5	0.02%
Vanadium	24-hour	0.002	W5	2.5	0.08%

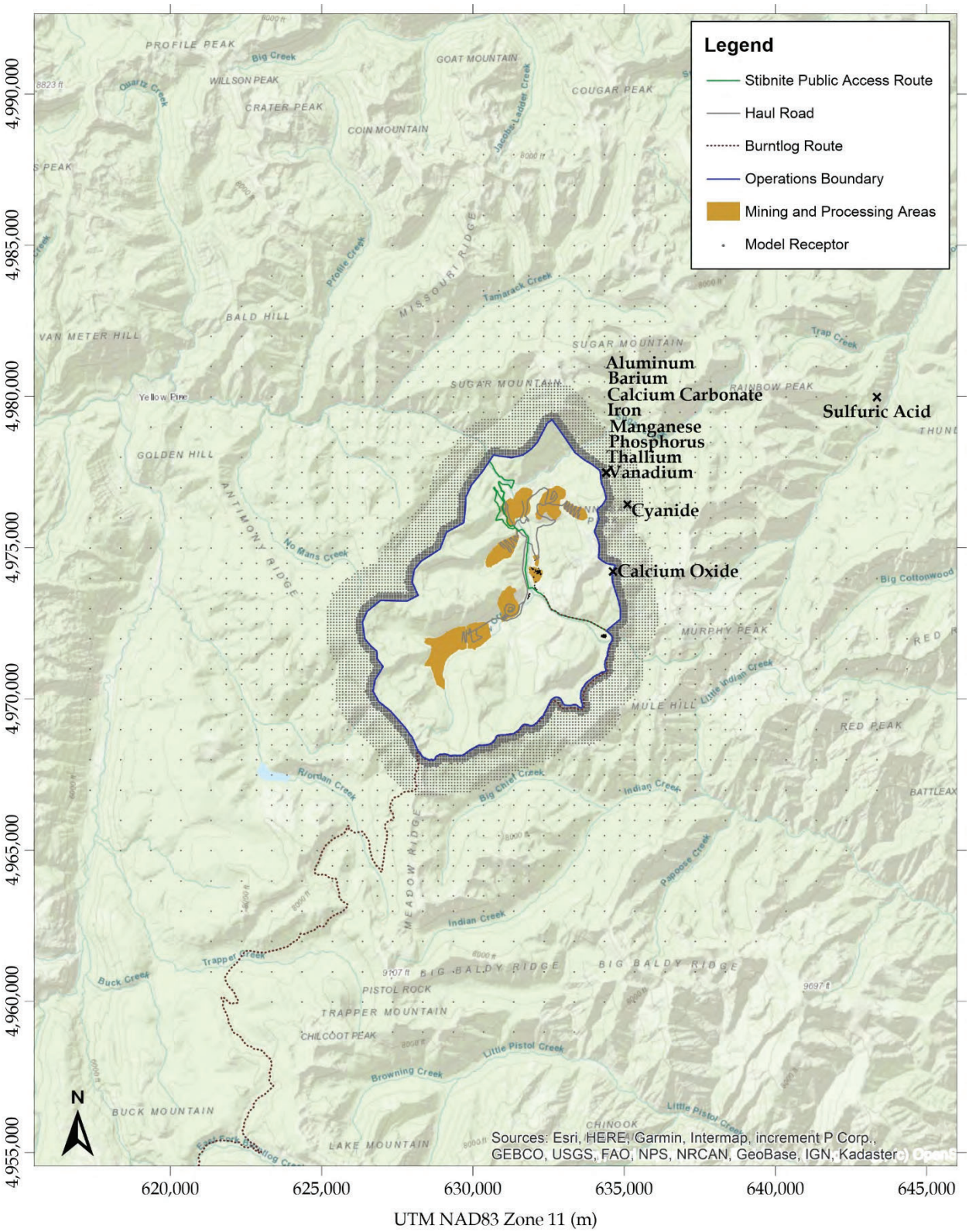
a. Micrograms per cubic meter.

b. Acceptable Ambient Concentration of a Non-carcinogenic TAP.

REC 3899
REC 0712

PET 346

Figure 1. SGP NON-CARCINOGENIC MAXIMUM TAP IMPACT LOCATIONS.



REC 3900
REC 0713

PET 347

6.1.2 Modeling Carcinogenic TAPs

The carcinogenic TAPs subject to impact modeling requirements to demonstrate compliance with AACCs of *Idaho Air Rules* Section 586 were modeled using an emission inventory that includes the T-RACT controls, long-term mining production limits, and other emission inventory refinements, as described in Section 4.0 and 5.0 of this *Modeling Review Attachment*.

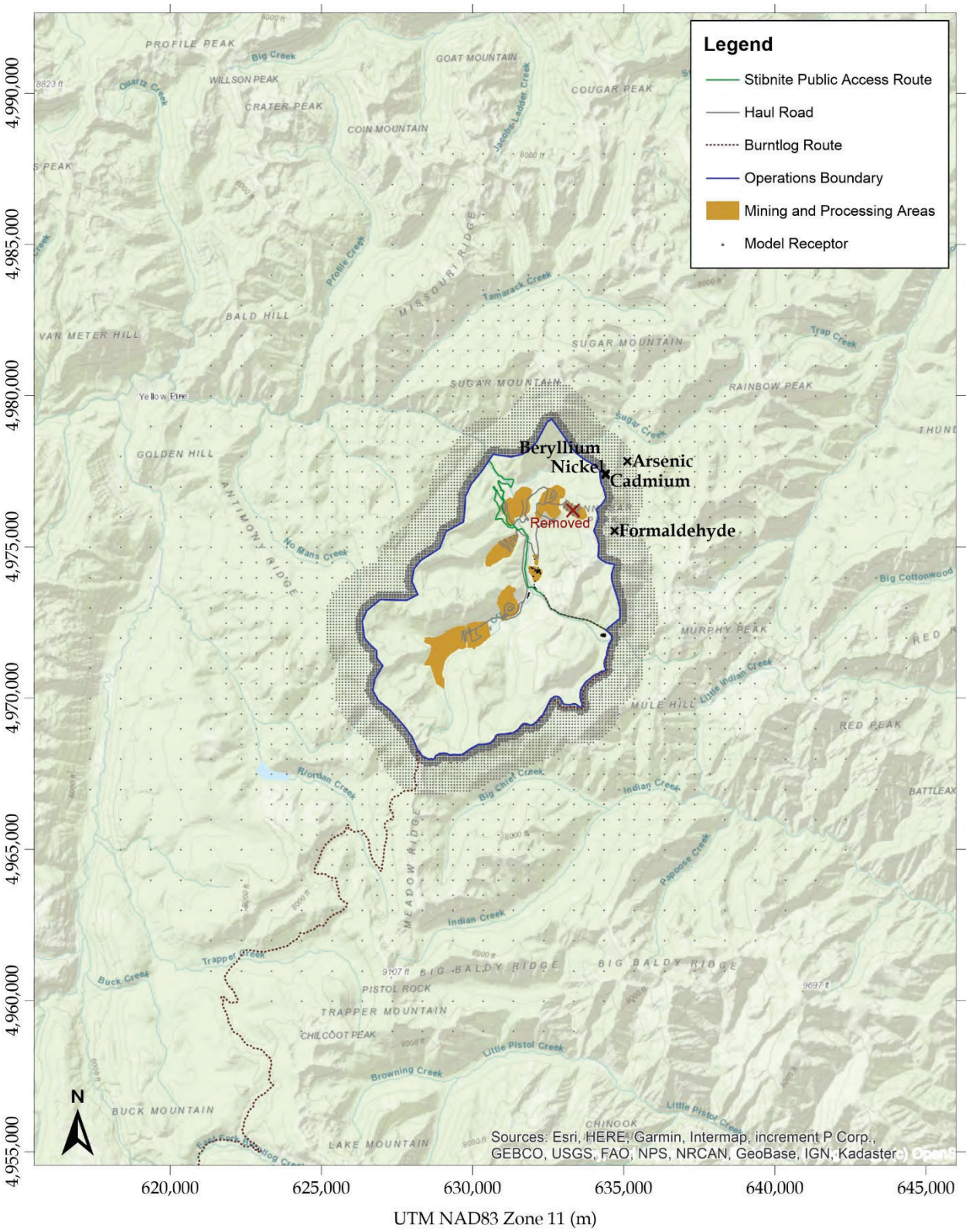
The maximum modeled impact for each of the 14 modeling scenarios demonstrated compliance with the T-RACT AACC, as summarized below in Table 6. The SGP maximum concentrations were adjusted to account for the life-of-mine production limits, which affect the lifetime exposure, and to account for the elimination of Modeling Scenario W5. See Sections 5.7 and 5.8 of this *Modeling Review Attachment* for more detail. The locations of the maximum impacts for each carcinogenic TAP are presented in Figure 2. Arsenic concentrations are considerably lower in areas away from the location of maximum impact as shown in Figure 3.

Table 6. RESULTS FOR TAPS IMPACT ANALYSES FOR CARCINOGENIC TAPS.

Toxic Air Pollutant	Averaging Time	Maximum Modeled Lifetime Exposure Concentration ($\mu g/m^3$)[a,b]	Model Scenario	AACC[c] ($\mu g/m^3$)	T-RACT[d] AACC	Percent of T-RACT AACC
Arsenic	Annual	0.00095	W2	0.00023	0.0023	41.30%
Beryllium	Annual	0.00001	W1	0.0042	0.042	0.02%
Cadmium	Annual	0.000002	W1	0.00056	0.0056	0.04%
Formaldehyde	Annual	0.00007	W1	0.077	0.77	0.01%
Nickel	Annual	0.00001	W1	0.042	0.42	<0.01%

a. Micrograms per cubic meter.
b. The lifetime exposure concentrations are based on the proposed restrictions discussed in Sections 5.7 and 5.8 of this *Modeling Review Attachment*.
c. Acceptable Ambient Concentration of a Carcinogenic TAP.
d. Toxic Air Pollutant Reasonably Available Control Technology allows the AACCs to be increased by a factor of ten per *Idaho Air Rules* Section 210.12(b).

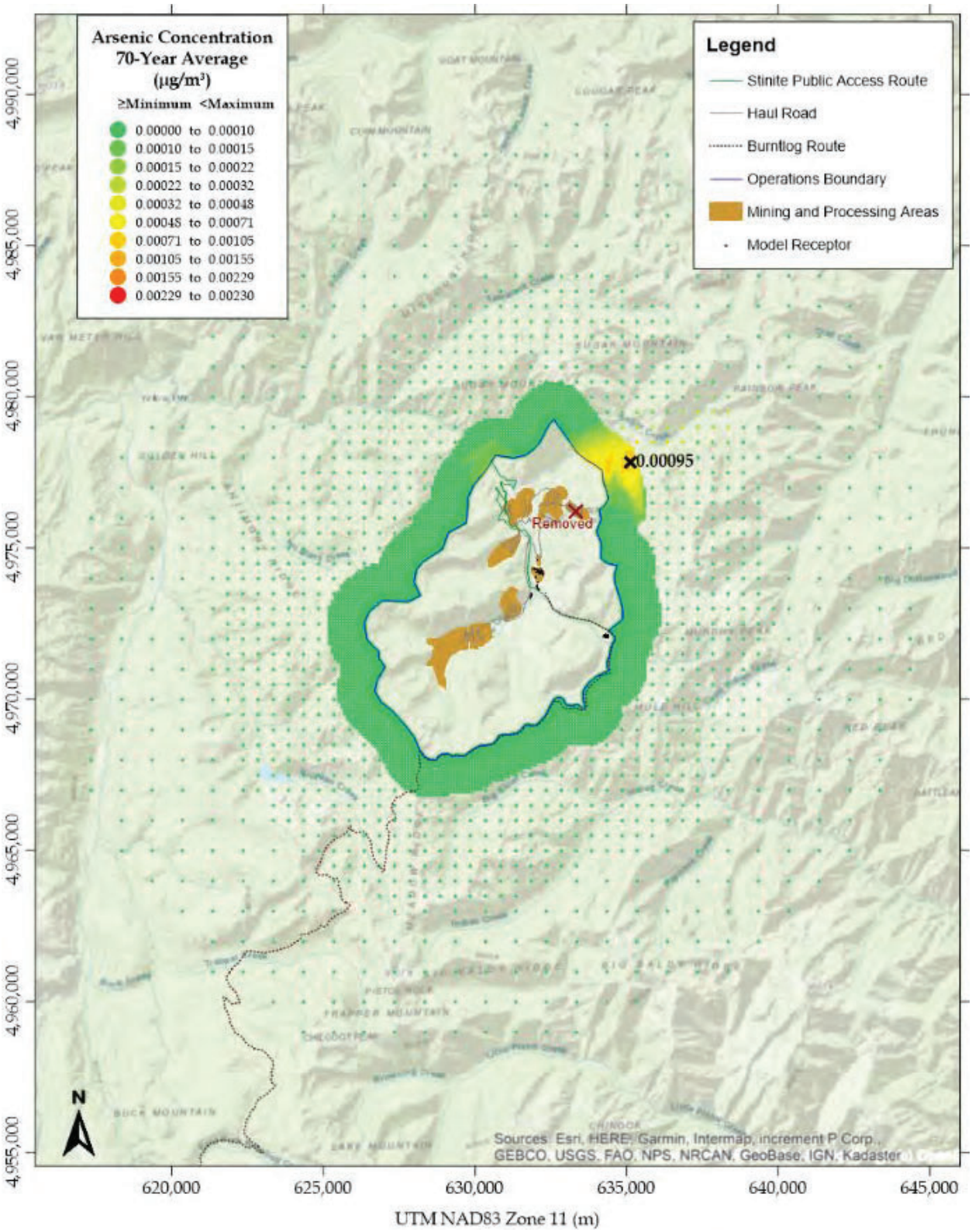
Figure 2. SGP CARCINOGENIC MAXIMUM TAP IMPACT LOCATIONS.



REC 3902
REC 0715

PET 349

Figure 3. SGP CONTOURS OF LIFETIME ARSENIC IMPACTS.



6.2 Effect of Changes to Modeled PM_{10} Results

PRI has determined that the West End Development Rock Storage Facility will not be constructed. This change eliminated Modeling Scenario W5 as a potential operating scenario. In Section 4.1.4 in the main body of the DEQ *Modeling Review Memorandum*, DEQ identified PM_{10} NAAQS exceedances at four hotspot receptors when using the BULKRN meteorological dataset for Modeling Scenario W5 (the highest PM_{10} impact modeling scenario). When Modeling Scenario W5 is removed, the highest modeled impacts are predicted to occur for Modeling Scenario W3, which represents the transport of development rock from the West End Pit to the Hangar Flats Development Rock Storage Facility.

Table 7 presents results for the cumulative NAAQS impact analyses for Scenario W3. Results still exceed the 24-hour PM_{10} NAAQS even when Modeling Scenario W5 is eliminated. However, there is only one hotspot receptor exceeding NAAQS. The modeled violation is also predicted to occur during winter. This is a critical consideration because during winter, not only are fugitive emissions minimized because of the higher moisture content of material handled or driven over, but background concentrations in such remote areas are also generally much lower because of the absence of wildfires and dust-generating sources.

Table 7 also lists the results when using temporally varying backgrounds, instead of a single-value background, in the cumulative NAAQS impact analysis (using the "SEASON" and "MONTH" options in AERMOD). The highest daily average PM_{10} concentrations measured at Stibnite for every season and month in 2014 were used as inputs in the model. Table 7 shows that the SGP facility *safely* demonstrates compliance with the 24-hour PM_{10} NAAQS when temporally varying backgrounds (both seasonal and monthly) are used instead of the single-value background. Summing modeled design values with a single-value background that is on the upper end of the distribution results in a very conservative estimate of total impacts. DEQ strongly believes that using temporally varying backgrounds that respect seasonality is appropriate for the SGP facility, and that using the highest value in the period interval is very conservative.

TABLE 7. RESULTS FOR 24-HOUR PM_{10} CUMULATIVE NAAQS IMPACT ANALYSES FOR MODELING SCENARIO W3.

Backgrounds Scenario	Max. Conc.[a] (µg/m³)[b]	Model Scenario	Back. Conc.[c] (µg/m³)	Total Conc.[d] (µg/m³)	NAAQS (µg/m³)	Percent of NAAQS
Single-Value Background	116.9	W3	34.0	150.9[e]	150	100.6%
Seasonally Varying Backgrounds	123.5[f]	W3	*Seasonal*	123.5[f]		82.3%
Monthly Varying Backgrounds	123.5[f]	W3	*Monthly*	123.5[f]		82.3%

a. Max. Conc. = maximum modeled design concentration.
b. Micrograms per cubic meter.
c. Back. Conc. = background concentration.
d. Total Conc. = total (modeled + background) concentration.
e. One hotspot receptor exceeds NAAQS.
f. The maximum modeled design concentration already incorporates the seasonal and monthly background values.

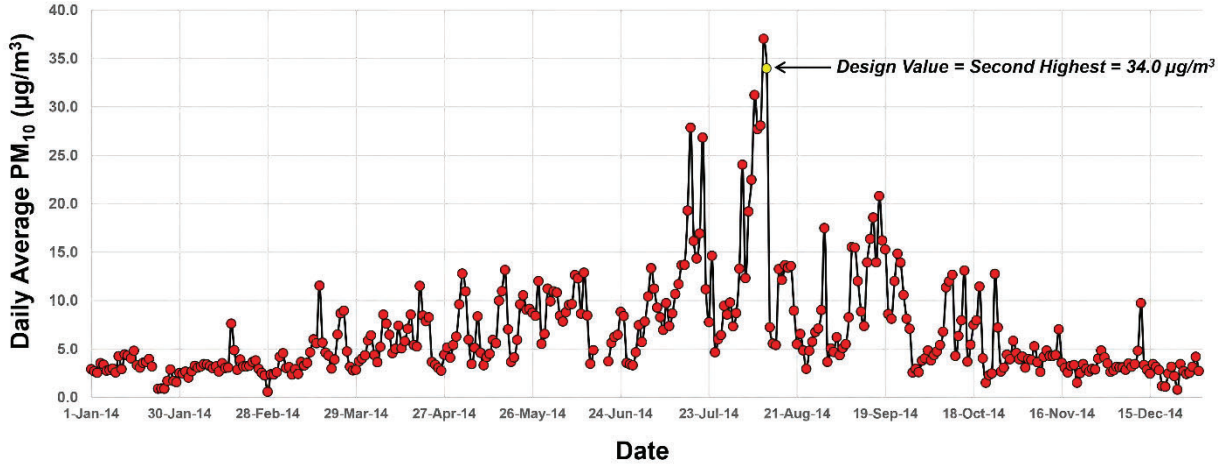
The time series plot in Figure 4 and the box-and-whiskers plot in Figure 5 illustrate the variability in daily average PM_{10} concentrations collected at the Stibnite Site in 2014. Figures 4 and 5 confirm that the highest concentrations from the modeled and monitored datasets do *not* occur simultaneously. Highest modeled impacts are predicted to occur during winter while the highest background concentrations were measured at Stibnite during summer. Therefore, the summation method, where total impacts are

REC 3904
REC 0717
PET 351

calculated by summing modeled design values with a background concentration that is also consistent in form with the regulatory design value, results in a very conservative estimate of the total impact for comparison to NAAQS. DEQ concludes that use of temporally varying (i.e., seasonal and monthly) backgrounds for SGP is justified. DEQ is highly confident that operation of the SGP will not cause or contribute to a violation of NAAQS.

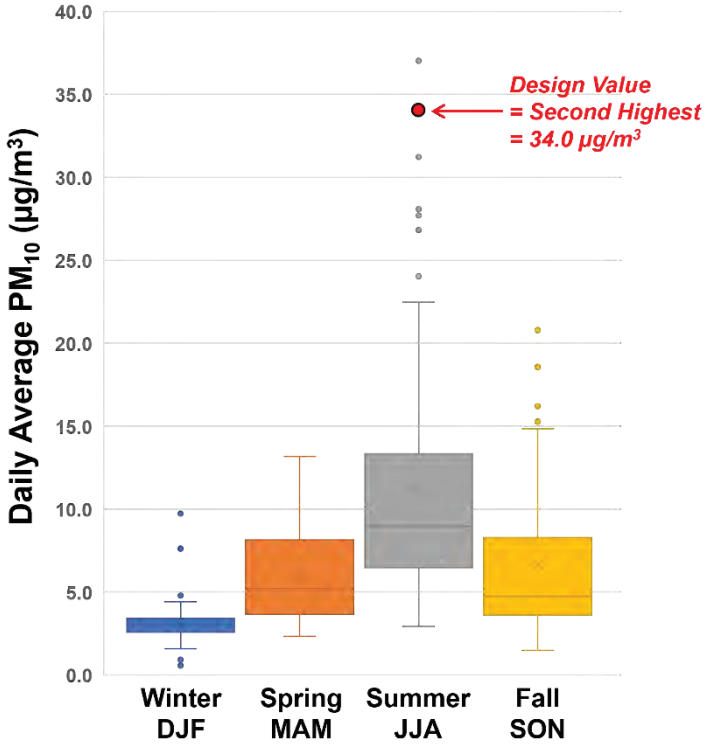
PM_{10} and $PM_{2.5}$ NAAQS compliance was previously demonstrated prior to refinements and adjustments proposed in the submitted *TAP Addendum*. The main body of the DEQ *Modeling Review Memorandum* discussed and considered results from both modeling with meteorological data processed using the BULKRN method and modeling with data processed using cloud cover data, and DEQ concluded that NAAQS compliance was demonstrated with a high degree of confidence. The adjustments and refinements described in the *TAP Addendum* further increase DEQ's confidence in NAAQS compliance.

Figure 4. TIME SERIES OF DAILY AVERAGE PM_{10} CONCENTRATIONS MEASURED AT STIBNITE IN 2014.



REC 3905
REC 0718
PET 352

Figure 5. BOX-AND-WHISKERS PLOT FOR SEASONAL PM_{10} BACKGROUND CONCENTRATIONS MEASURED AT STIBNITE IN 2014.



In Figure 5 the middle line of each box represents the median. The "x" in the box represents the mean. The bottom and the top lines of the box represent the 1st quartile (25th percentile) and the 3rd quartile (75th percentile), respectively. The whiskers extend to the minimum and maximum values not considered outliers. Outliers are plotted individually.

7.0 Conclusions

This section provides conclusions of the *TAP Addendum* and DEQ's review of the *TAP Addendum*.

7.1 Conclusions of Revised TAP Analyses

The revised and refined TAP analyses:

- Revised TAP-applicable sources at the SGP facility.
- Proposed additional emission control measure and adjusted operations to reduce TAP emissions.
- Refined the approach used to demonstrate compliance with TAP regulations.

The submitted application, with the adjustments and refinements to analyses as described in the *TAP Addendum*, demonstrated to DEQ's satisfaction that the emissions of applicable TAPs will not result in impacts to ambient air that exceed TAP increments of *Idaho Air Rules* Section 585 and 586.

7.2 Effects of Adjustments/Revisions on NAAQS Compliance Demonstrations

The submitted application, prior to the *TAP Addendum*, demonstrated compliance with NAAQS to DEQ's satisfaction; and the operational measures proposed in the *TAP Addendum* will only further reduce estimated emissions. Eliminating Modeling Scenario W5 impacts, with the elimination of the West End Development Rock Storage Facility, affects the 24-hour PM_{10} impact modeling analysis for SGP. Modeling Scenario W3 is now the scenario producing the highest modeled impacts, and NAAQS compliance is easily demonstrated when using temporally varying background PM_{10} values, which were obtained from onsite monitoring data.

7.3 Conservatism of Permitting Analyses

Emissions and locations from which emissions occur are highly dynamic at mining facilities. This presents unique challenges for permit development because permits must include limits and operational requirements that ensure air quality standards are not violated. Permitting rules require that air impacts be assessed using maximum potential emissions as limited by either the capacity of the unit/operation or as limited by enforceable permit provisions. A permit where actual emissions are nearly representative of maximum allowable emissions, through imposing permit limits, would be exceedingly complex and require overly burdensome monitoring and record-keeping requirements. To avoid this, applicants typically calculate allowable emissions and perform impact analyses based on simplistic operational scenarios that largely overstate emissions estimated to occur from the facility.

PRI and Air Sciences have asserted that the submitted emission estimates, operational scenarios, and air impact analyses associated with the permit application greatly overstate best-estimated values. This point is evident when comparing the permit application materials and analyses with those presented in ModPRO2, PRI's revised mine plan and associated impacts. ModPRO2 is used in support of the Environmental Impact Statement (EIS).

Reference

Perpetua. 2021. "ModPRO2 Mine Plan." *File: Midas Stibnite Mine Plan and Equipment Schedule (10Feb21).xlsx.* Email from R. McCluskey, Perpetua Resources Inc., to E. Memon, Air Sciences Inc., February 11.

REC 3907
REC 0720
PET 354

EXHIBIT B

order to effectively implement 161, the department developed a policy that set emission limits for certain toxic air pollutants. Idaho industry requested that the policy be implemented in rule (instead of a policy) to provide greater certainty and transparency for industry. Through many discussions with industry and the public, a rule was developed that was responsibly protective of environmental quality while being reasonably permissive of industrial activity. As noted in Section 203.03, by complying with the TAPs rules developed in sections 210, 585 and 586, a facility adequately demonstrated compliance with 161.

Because TAPs are generally known to be hazardous to human health (EPA 1991), the federal government also implemented rules to control emissions of TAPs through National Emission Standards for Hazardous Air Pollutants (NESHAPs). EPA first tried to implement risk based standards according to the Clean Air Act (CAA) amendments of 1970. Between 1970 and 1990, EPA was only able to implement standards for 8 pollutants (asbestos, benzene, beryllium, coke oven emissions, inorganic arsenic, mercury, radionuclides, and vinyl chloride). Because of EPA's inability to address air toxics in a timely and efficient manner, Congress revised the CAA in 1990 to develop a program to control a list of hazardous air pollutants (HAPs) through technology standards for specific industries. Congress itself developed the list of 188 HAPs. They also prescribed maximum achievable control (MACT) standards for large (major) sources of HAPs and generally achievable control technology (GACT) standards for smaller (area) sources. The area source NESHAPs also only focused on a subset of 30 HAPs that were identified as being the most problematic in urban areas. Congress's intent was to address the major risks associated with TAPs by focusing on the most toxic pollutants and most significant source categories. The original list of 188 HAPs was based on the list of pollutants subject to the Emergency Planning and Community Right-to-Know Act (EPCRA). After the HAPs list was created in the early 1990's, the list of pollutants subject to EPCRA has doubled, while the list of HAPs has remained essentially unchanged.

The Idaho TAPs rules were developed to complement the federal NESHAPs, thus the rules are not more stringent than federal law. IDAPA 58.01.01.210.20 specifically states that if a facility is subject to a federal NESHAP, they have met the requirements of our state air toxics rules. These rules do regulate an activity not regulated by the federal government. They are a uniquely Idaho solution of addressing air toxics emissions. An argument could be made that the rules are broader in scope than federal law, as they do regulate an activity not regulated by federal law.

(2) To the degree that a department action is based on science, in proposing any rule or portions of any rule subject to this section, the department shall utilize:

(a) The best available peer reviewed science and supporting studies conducted in accordance with sound and objective scientific practices; and

The Idaho TAPs rules were developed to protect public health by developing risk based standards that would apply to new or modified industrial sources only. There are two lists of pollutants that facilities need to consider, but only if the facility is not subject to a federal air toxics standard.

The first list of pollutants are non-carcinogens (do not cause cancer) in IDAPA 58.01.01.585. They may cause adverse health effects based on short term (24-hour) exposures. Examples include methyl isocyanate, chlorine, cyanide and xylene. The acceptable ambient levels for non-carcinogens are based on occupational exposure levels from the American Conference of Government Industrial Hygienists (ACGIH) threshold limit values (TLV). (ACGIH 2019). The TLV is typically an 8 hour time weighted average concentration and it is the concentration to which workers may be repeatedly exposed during a 40 hour work week without adverse effect. Two safety factors were applied to the TLV value: 1) to extrapolate the 8 hour exposure level to a 24 hour public exposure, and 2) to extrapolate from the relatively healthy mostly male working population to a general population that included women, children and the elderly. Thus the TAP increment values are 1/20th the TLV values.

Because ambient monitoring values can sometimes be difficult to determine, the department also developed stack emission screening levels (ELs) for easier analysis (in pounds/hour). These were based on a conservative stack modeling analysis.

The second list of pollutants are carcinogens (i.e., have been determined to cause cancer over a lifetime of exposure) in IDAPA 58.01.01.586. Examples include formaldehyde, benzene, and polycyclic aromatic hydrocarbons. The acceptable ambient levels for carcinogens are based on the cancer unit risk values from the Environmental Protection Agency and correspond to a one in a million cancer risk. (EPA 2019). An EL was also determined for

Exhibit C:

EPA's Regional Screening Levels Calculator Inputs and Outputs for Exposure Durations: 16, and 70 years

Site-specific
Resident Air Inputs

Variable	Resident Air Default Value	Site-Specific Value
ED_{res} (exposure duration) years	26	16
ED_{0-2} (mutagenic exposure duration first phase) years	2	2
ED_{2-6} (mutagenic exposure duration second phase) years	4	4
ED_{6-16} (mutagenic exposure duration third phase) years	10	10
ED_{16-26} (mutagenic exposure duration fourth phase) years	10	10
EF_{res} (exposure frequency) days/year	350	365
EF_{0-2} (mutagenic exposure frequency first phase) days/year	350	350
EF_{2-6} (mutagenic exposure frequency second phase) days/year	350	350
EF_{6-16} (mutagenic exposure frequency third phase) days/year	350	350
EF_{16-26} (mutagenic exposure frequency fourth phase) days/year	350	350
ET_{res} (exposure time) hours/day	24	24
ET_{0-2} (mutagenic exposure time first phase) hours/day	24	24
ET_{2-6} (mutagenic exposure time second phase) hours/day	24	24
ET_{6-16} (mutagenic exposure time third phase) hours/day	24	24
ET_{16-26} (mutagenic exposure time fourth phase) hours/day	24	24
THQ (target hazard quotient) unitless	0.1	1
LT (lifetime) years	70	70
TR (target risk) unitless	1.0E-06	1.0E-06

Site-specific

Resident Risk-Based Regional Screening Levels (RSL) for Air

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; T = ATSDR DRAFT; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = OW; R = ORD; N = WI; W = TEF applied; E = RPF applied; G = see user guide; U = user provided; ca = cancer; nc = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; max = ceiling limit exceeded; sat = Csat exceeded.

Chemical	CAS Number	Mutagen?	Volatile?	Chemical Type	IUR ($ug/m^3)^{-1}$	IUR Ref	RfC (mg/m^3)	RfC Ref	Carcinogenic SL TR=1E-06 (ug/m^3)	Noncarcinogenic SL THI=1 (ug or $fibers/m^3$)	Screening Level (ug or $fibers/m^3$)
Arsenic, Inorganic	7440-38-2	No	No	Inorganics	4.30E-03	I	1.50E-05	C	1.02E-03	1.50E-02	1.02E-03 ca*

Site-specific
Resident Risk for Air

Chemical	IUR $(ug/m^3)^{-1}$	IUR Ref	RfC (mg/m^3)	RfC Ref	Concentration (ug or fibers/m^3)	Carcinogenic Risk	Noncarcinogenic HI
Arsenic, Inorganic	4.30E-03	I	1.50E-05	C	4.16E-03	4.09E-06	2.77E-01
**Total Risk/HI*	-		-		-	*4.09E-06*	*2.77E-01*

Site-specific
Resident Air Inputs

Variable	Resident Air Default Value	Site-Specific Value
ED_{res} (exposure duration) years	26	70
ED_{0-2} (mutagenic exposure duration first phase) years	2	2
ED_{2-6} (mutagenic exposure duration second phase) years	4	4
ED_{6-16} (mutagenic exposure duration third phase) years	10	10
ED_{16-26} (mutagenic exposure duration fourth phase) years	10	10
EF_{res} (exposure frequency) days/year	350	365
EF_{0-2} (mutagenic exposure frequency first phase) days/year	350	350
EF_{2-6} (mutagenic exposure frequency second phase) days/year	350	350
EF_{6-16} (mutagenic exposure frequency third phase) days/year	350	350
EF_{16-26} (mutagenic exposure frequency fourth phase) days/year	350	350
ET_{res} (exposure time) hours/day	24	24
ET_{0-2} (mutagenic exposure time first phase) hours/day	24	24
ET_{2-6} (mutagenic exposure time second phase) hours/day	24	24
ET_{6-16} (mutagenic exposure time third phase) hours/day	24	24
ET_{16-26} (mutagenic exposure time fourth phase) hours/day	24	24
THQ (target hazard quotient) unitless	0.1	1
LT (lifetime) years	70	70
TR (target risk) unitless	1.0E-06	1.0E-06

Site-specific

Resident Risk-Based Regional Screening Levels (RSL) for Air

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; T = ATSDR DRAFT; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = OW; R = ORD; N = WI; W = TEF applied; E = RPF applied; G = see user guide; U = user provided; ca = cancer; nc = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; max = ceiling limit exceeded; sat = Csat exceeded.

Chemical	CAS Number	Mutagen?	Volatile?	Chemical Type	IUR ($ug/m^3)^{-1}$	IUR Ref	RfC (mg/m^3)	RfC Ref	Carcinogenic SL TR=1E-06 (ug/m^3)	Noncarcinogenic SL THI=1 (ug or $fibers/m^3$)	Screening Level (ug or $fibers/m^3$)
Arsenic, Inorganic	7440-38-2	No	No	Inorganics	4.30E-03	I	1.50E-05	C	2.33E-04	1.50E-02	2.33E-04 ca*

Site-specific
Resident Risk for Air

Chemical	IUR $(ug/m^3)^{-1}$	IUR Ref	RfC (mg/m^3)	RfC Ref	Concentration (ug or fibers/m^3)	Carcinogenic Risk	Noncarcinogenic HI
Arsenic, Inorganic	4.30E-03	I	1.50E-05	C	4.16E-03	1.79E-05	2.77E-01
**Total Risk/HI*	-		-		-	*1.79E-05*	*2.77E-01*

RAÚL R. LABRADOR
Attorney General

SCOTT L. CAMPBELL
Deputy Attorney General
Chief, Energy and Natural Resources Division

Hannah M.C. Young, ISB No. 9781
hannah.young@deq.idaho.gov
Michael A. Short, ISB No. 10554
michael.short@deq.idaho.gov
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: 208.373.0543

Attorneys for Respondent

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047

NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,

Petitioners,

v.

IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,

Respondent,

and

PERPETUA RESOURCES IDAHO, INC.,

Intervenor-Respondent.

Case Docket No. 0101-22-01
OAH Case No. 23-245-01

EXPERT DECLARATION OF KEVIN SCHILLING

I, KEVIN SCHILLING, hereby declare under penalty of perjury and pursuant to the law of the State of Idaho that the foregoing is true and correct:

I. Introduction

1. My name is Kevin Schilling. I am the Stationary Source Air Modeling Supervisor for the Stationary Source Bureau at the State Air Quality Division of the Idaho Department of Environmental Quality (DEQ) in Boise. I have held this position since September of 2004; however, the title of the position and location within the organizational structure of the Air Quality Division has changed over time.

2. Presently, two staff positions, both Air Quality Dispersion Modeling Analysts, report directly to me. Darrin Mehr fills one of those positions and the other is filled by Christina Boulay. Ms. Boulay filled the position vacated by Dr. Pao Baylon, who left DEQ in 2023 for employment with a private environmental consulting company. Dr. Baylon was the lead Air Quality Dispersion Modeling Analyst for review of the Perpetua Resources Idaho, Inc. (PRI) Stibnite Gold Project (SGP) air impact analyses that were submitted with the Permit to Construct (PTC) application.

3. My role in the permitting of the SGP has been both supervisory and technical/policy review and evaluation. As mentioned above, Dr. Baylon was the lead in review and verification of impact analyses submitted with the application, and he also performed supplemental analyses to support DEQ's conclusion that the SGP would not cause or contribute to violation of air quality standards or increments. Where air impact modeling methods used by PRI and presented in the PTC application were atypical or of questionable appropriateness, Dr. Baylon discussed the approach, data, and analyses with me. Prior to permit issuance, Dr. Baylon, DEQ Permit Writer Kelli Wetzel, Permitting Supervisor Darrin Pampaian, Stationary Source Bureau Chief Mike Simon, and I discussed various aspects of the SGP, including proposed operations, emission calculations, permit provisions needed to assure compliance, and monitoring and recordkeeping requirements. This was done to provide a comprehensive assessment of DEQ's confidence of NAAQS and TAP compliance in a weight-of-evidence type approach. At the conclusion, DEQ was highly confident that operation of the SGP, as described in the application and as required by the DEQ PTC, will not cause or contribute to a violation of a National Ambient Air Quality Standard (NAAQS) or exceed an applicable Toxic Air Pollutant (TAP) increment.

A. Assignment

4. The *Final Order in the Matter of Air Quality Permit to Construct P-2019.0045*[1] ("Final Order") indicated there was "insufficient evidence to support DEQ's analysis of the ambient arsenic air concentrations." Three remaining issues were identified by the Board of Environmental Quality (DEQ Board) for resolution. These are:

[1] REC 3706, *Final Order in the Matter of Air Quality Permit to Construct P-2019.0047*, *Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon v. Idaho Department of Environmental Quality*, Case Docket No. 0101-22-01, OAH Case No. 23-245-01 (Final Order at 12).

a. DEQ did not act reasonably in using a five-year rolling average for T-RACT that was not properly supported by permit conditions.

b. There was insufficient evidence to support the T-RACT analysis limiting the non-West End pit production limit.

c. DEQ did not act reasonably and in accordance with law when it applied the 16/70 calculation to the ambient arsenic air concentration analysis.

5. The identified issues pertain to specific requirements for how analyses and developed permit conditions and restrictions must provide for satisfactory assurance that the facility will operate as described in the application and as needed to comply with applicable air quality standards and/or increments. The accuracy, representativeness, and/or conservatism of methods and data used to estimate impacts were described in detail in the PTC application materials submitted by PRI and in DEQ's *Modeling Review Memorandum* and the *TAPs Addendum Modeling Review Attachment* attached thereto.[2] The aspects of methods and data used in the analyses are not in question by any of the three remaining issues, and this report will not revisit or expand on DEQ's confidence in the results of impact analyses. This report will address the above-listed issues by showing how DEQ's regulatory interpretation is appropriate and that the permit conditions adequately assure compliance with the arsenic T-RACT TAP increment.

B. Summary of Opinions

6. This Expert Declaration will show that:

a. Use of a 5-year rolling average production limit for assessing compliance with the T-RACT AACC is appropriate because long-term exposure to a given concentration over the life of the project is the critical parameter for the risk-based AACCs. Short-term fluctuations in impacts do not affect compliance and do not impact long-term exposure concentrations.

b. A specific limit on non-West End Pit production is not necessary to assure compliance with T-RACT AACCs. Since West End Pit production is the risk driver in analyses, the combination of a limit on total production and a limit on the fraction of total production that may occur from West End Pit sources is adequate to assure compliance with the T-RACT AACC.

[2] *See* REC 699, 701-711, 719-720, Idaho Department of Environmental Quality, *TAPs Addendum Modeling Review Attachment* to the PRI SGP *Modeling Review Memorandum* (January 6, 2022) (REC 697-713, Demonstrating Compliance with IDAPA 58.01.01.203.02 (NAAQS) and 203.03 (TAPs) as it relates to air quality impact analyses) ("DEQ's TAPS Modeling Attachment"). For convenience, a true and correct copy of DEQ's TAPS Modeling Attachment is attached hereto as Exhibit A.

c. DEQ acted reasonably and in accordance with law when it applied a 16/70 factor to adjust concentrations for comparison to the T-RACT AACC. The Expert Declaration of DEQ Environmental Toxicologist Dr. Norka Paden [3] shows that the factor is appropriate because cancer risk estimates, as evaluated by the EPA risk model, are conservative and are a function of a combination of concentration, exposure time, exposure frequency, and exposure duration. Dr. Paden's Declaration provides the primary justification for using the 16/70 factor to account for the limited duration SGP, and this Declaration provides a brief description of how that meets the requirements of carcinogenic TAP permitting rules.

C. Qualifications and Experience

7. I received a Bachelor of Science (BS) degree in Environmental Science, with a minor in chemistry, from Washington State University in 1986. After graduation I was employed by Washington State University as a Research Assistant at the Laboratory for Atmospheric Research while attending graduate school. I received a Masters of Science (MS) degree in Environmental Engineering (specializing in atmospheric chemistry, air pollution meteorology, air pollution monitoring, and atmospheric pollutant dispersion) from Washington State University in 1988.

8. I initially began employment with DEQ (at that time the Division of Environmental Quality) in 1989 and then left the agency in 1990 for employment with Morrison Knudsen Company, a large Idaho-based construction company. I worked in Morrison Knudsen's Environmental Group, performing a wide range of air quality related projects where a key focus was air pollutant impact assessment. These projects included permitting, pollutant emissions estimation, atmospheric dispersion modeling, air pollution monitoring, and industrial hygiene functions.

9. In the mid-1990s, I actively participated in the initial development of Idaho's TAP permitting regulations while working at Morrison Knudsen. I provided technical and regulatory assistance to the Idaho Association of Commerce and Industry (IACI). IACI negotiated with DEQ on the development and promulgation of the TAP rules. I held the position of Chair of the Air Toxics Subcommittee during part of the multi-year negotiations. I stepped down from Chair of the subcommittee before final promulgation of the TAP rules because of other project obligations at Morrison Knudsen that required extensive work outside of Idaho. The work on the IACI Air Toxic Subcommittee involved:

a. Evaluation of the basis from which carcinogenic and non-carcinogenic air impact limits would be established.

b. Ensuring that the interests and concerns of the regulated community were considered in the development of regulations.

[3] *Expert Declaration of Dr. Norka Paden* (August 13, 2024) ("Paden Decl."), ¶¶ 11-18.

c. Structuring regulations in a format that is easily used in the context of air permitting for industrial facilities and DEQ.

10. I returned to DEQ in December of 2001, working in the Technical Services Division where I primarily reviewed air impact modeling analyses submitted as part of air permit applications. I transferred to the Air Quality Program Office as the Stationary Source Air Modeling Coordinator in 2004. Later my title was changed from *coordinator* to *supervisor*.

11. My primary responsibilities as Stationary Source Air Modeling Supervisor are both management/administrative and senior level technical and regulatory oversight. A critical component of my position in the Stationary Source Modeling Group is performing, reviewing, and overseeing technical and regulatory aspects of air impact analyses that satisfy regulatory requirements for permit issuance. Where project-specific conditions present unique circumstances, and there is uncertainty in the acceptability of proposed technical and regulatory approaches to address those unique circumstances, DEQ collectively employs its expertise and experience to develop and evaluate the approach.

II. Background Discussion

A. Permitting Requirements for TAPs

12. TAPs were regulated only by *Idaho Air Rules* Section 161[4] prior to the mid-1990s. DEQ developed a permitting TAPs Policy to provide consistency in how TAPs would be addressed in air permitting. The foundation of that policy was to ensure that a proposed project would not cause impacts to ambient air exceeding: 1) non-carcinogenic pollutant concentration levels that are based on occupational exposure limits; and 2) carcinogenic pollutant concentration levels that are based on EPA inhalation Unit Risk Factors (URFs) (as described in more detail in the Expert Declaration of Dr. Norka Paden[5]) and a selected acceptable lifetime cancer risk. The unit risk is lifetime[6] excess cancer risk estimated to result from continuous exposure to a toxic air contaminant at a concentration of 1 microgram/cubic meter of air ($\mu g/m^3$).

13. The regulated community (those applying for and regulated by an air quality permit from DEQ) expressed concerns in the early 1990s regarding DEQ regulation of TAPs by policy. The regulated community, under the representation of IACI, then engaged in regulatory negotiation with DEQ to establish TAP rules for air permitting. The goals of the negotiations were to develop rules that: 1) are reasonably protective of public health, but still afford flexibility to regulated

[4] *Idaho Administrative Procedures Act 58.01.01, Rules for the Control of Air Pollution in Idaho* ("Idaho Air Rules"), Section 161, Toxic Air Pollutants. This Section states: "Any contaminant that is by its nature toxic to human or animal life or vegetation must not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation."

[5] Paden Decl., ¶¶ 12-16.

[6] 70 years was selected as a lifetime.

facilities and projects; 2) are relatively easy to understand and implement; and 3) do not require excessive expenditure of time and resources by DEQ and the permittee during the permitting process.

14. During development of the TAP rules, DEQ's reliance on EPA URFs remained the regulatory approach cornerstone for developing consistent acceptable methods to evaluate impacts to ambient air for carcinogenic TAPs. A DEQ internal memorandum[7] responding to a request for layman's explanation of URF & TLV/100 stated, "Within IAQB (Idaho Air Quality Bureau) New Source Review (NSR) policy, URFs are used to calculate acceptable ambient levels for a given carcinogen. IAQB generally establishes that an ambient concentration which causes no more excess cancers than one in a million (1×10^{-6}) is acceptable." In the early stages of TAP regulation development, DEQ sent IACI a letter that provided a "straw-man" of possible TAP regulatory language.[8] That regulatory straw-man proposal stated the following for procedures to demonstrate compliance for emissions of carcinogenic pollutants:

> "For sources that can demonstrate, using Department-approved methods, that emissions of carcinogens contribute an ambient air cancer risk probability of less than 1:1,000,000 and that emissions of non-carcinogens contribute to an ambient air concentration less than one percent of the Threshold Limit Value, no additional procedures are needed."

15. During development of the TAP rules, DEQ continually asserted that carcinogenic TAPs resulting from a permitting project should be regulated to prevent an unacceptable excess cancer risk based on a 70-year lifetime. Excess inhalation cancer risk probability over a 70-year lifetime is calculated from the EPA Inhalation Unit Risk and the Exposure Concentration, as described in the Expert Declaration of Dr. Norka Paden.[9] The formula is as follows:

Excess Cancer Risk Probability = (IUR)(EC)

Where: IUR = Inhalation Unit Risk per $\mu g/m^3$ of exposure
EC = Exposure Concentration in $\mu g/m^3$

An acceptable arsenic concentration can be calculated by rearranging the formula and solving for EC using an allowable risk of 10^{-6} (1-in-1,000,000) and a IUR of $0.0043/(\mu g/m^3)$ for arsenic. The resulting EC is 2.3 E-4 $\mu g/m^3$, which is the AACC listed in *Idaho Air Rules* Section 586. This clearly shows how the EPA cancer risk model was used to generate AACCs to protect against lifetime cancer risk from long-term exposures.

---

[7] State of Idaho Department of Health and Welfare, Division of Environmental Quality. *Request for layman's explanation of URF& TLV/100*. From Robert Wilkosz and Tim Teater. To Orvil [sic] Green. March 7, 1991. A true and correct copy of this memorandum is attached hereto as Exhibit B.

[8] State of Idaho Department of Health and Welfare, Division of Environmental Quality. Letter from Robert Wilkosz, Bureau Chief, Technical Services Bureau, to Dick Rush, Vice President, IACI. July 29, 1992. A true and correct copy of this letter is attached hereto as Exhibit C.

[9] Paden Decl., ¶ 15.

16. Dr. Paden further explains that the Exposure Concentration can be calculated using the contaminant concentration, exposure time, exposure frequency, exposure duration, and applicable averaging time by the following:

$$EC = (CA \times ET \times EF \times ED)/AT$$

Where: EC = Exposure Concentration ($\mu g/m^3$)
CA = Contaminant Concentration ($\mu g/m^3$)
ET = Exposure Time (hours/day)
EF = Exposure Frequency (day/year)
ED = Exposure Duration (years)
AT = Averaging Time (70 years x 365 days/year x 24 hours/day)

17. The above formula is used to calculate an Exposure Concentration for a specified project duration over a 70-year average lifetime. This Exposure Concentration can then be compared to a concentration limit that is protective for lifetime cancer risk, such as the AACC or the T-RACT AACC. Although the AACC is expressed as an annual average, it represents the concentration averaged over a 70-year lifetime, as defined by how it was generated from URFs and how it is intended to limit long-term exposure concentration and limit the associated excess cancer risk to 1-in-1,000,000. When the Exposure Duration is equal to the 70-year Averaging Time, and the Exposure Frequency and Time are conservatively set to 365 day/year and 24 hours/day, then the Exposure Concentration is simply equal to the Contaminant Concentration, which is the annual impact obtained from the model. Since the vast majority of DEQ permitting projects are of permanent operations (70 years), no adjustment of the Contaminant Concentration is required to obtain the Exposure Concentration.

18. The SGP will have an Exposure Duration of 16 years, the applicable Contaminant Concentration (an annual value obtained from modeling results) is 0.00416 $\mu g/m^3$, the Exposure Frequency is 365 days/year, and the Exposure Time is 24 hours/day. The calculated Exposure Concentration is then:

$$EC = \frac{(0.00416\ \mu g/m^3)(24\ \text{hours/day})(365\ \text{days/year})(16\ \text{years})}{(24\ \text{hours/day})(365\ \text{days/year})(70\ \text{years})} = 0.00095\ \mu g/m^3$$

As observed in the equation, with conservative assumptions for exposure time and frequency, the equation reduces to the 16/70 factor that was used in DEQ's analysis to account for the limited life of the mine. This demonstrates how a 16/70 adjustment factor to annual estimated impacts is appropriate.

19. DEQ air permits are issued to facilities primarily for permanent and consistent operations where resulting emissions vary little through time. Rather than develop a carcinogenic TAP rule that provided for a project-specific lifetime in the calculation of allowable carcinogenic TAP concentrations in ambient air, DEQ provided simpler regulatory language that provides a concentration limit based on a 70-year continual exposure and expressed that exposure as an annual

average exposure concentration. TAP permitting regulations in *Idaho Air Rules* Section 210.15 provide a short-term project adjustment factor of 10 to apply to the allowable AAC when a project will have a duration of less than 5 years. This shows: 1) an adjustment in the exposure concentration is appropriate (in this case, the rules adjust the AACC rather than the exposure concentration); 2) an adjustment greater than 10 cannot be used for projects of duration less than 5 years. In general, DEQ determined it would not be appropriate to subject individuals to a life-time allowable cancer risk within a duration of less than 5 years. Therefore, the adjustment was capped at 10, rather than using a higher value or values calculated from exposure durations of 5 years of less (e.g., 70 years/5 years = 14 or 70 years/2 years = 35). These short-term projects were most commonly remediation and pilot-scale projects having a duration of up to several years.

B. Form of the Arsenic AACC

20. *Idaho Air Rules* Section 586 state that the AACCs "in this section are annual averages." The rules also state that the Toxic Air Pollutant Carcinogenic Increments "are based on . . . a seventy (70) year lifetime exposure." The former is the averaging period of the modeling results (CA), and the latter is the average period of the lifetime exposure concentration (EC) used for determining excess cancer risk. Air impact analyses only demonstrate compliance with standards when the analyses use the same averaging period as the applicable standard. An annual average impact concentration does not demonstrate compliance with a 24-hour standard. In the case of carcinogenic TAPs, the applicable standard is a pollutant-specific inhalation cancer risk posed in ambient air that results from allowable emissions from the proposed project for the life of the project. That acceptable cancer risk is either 10^{-6} (1-in-1,000,000) as expressed in the AACC or 10^{-5} (1-in-100,000) when controls meeting T-RACT are used. The listed annual AACCs are an expression of that standard when applied to a permanent project/facility that has no permit restrictions on operating duration. These AACCs were developed using the EPA inhalation Unit Risk Factors (URFs) that existed at the time *Idaho Air Rules* Section 586 was promulgated. The *Idaho Air Rules* do not preclude use of an exposure concentration adjustment for impacts, and the EPA risk model that was used in the development of the AACCs provides for this adjustment to calculate the exposure concentration.

C. Arsenic Compliance Approach for SGP

21. The arsenic TAP compliance demonstration approach used by PRI for the SGP permitting analyses was thoroughly described in DEQ's *TAPs Addendum Modeling Review Attachment* of the DEQ *Modeling Review Memorandum*[10] for the SGP. This Expert Declaration will summarize the regulatory approach used to demonstrate compliance and provide additional justification for that approach. It will not reiterate the conservatism of the data and methods of the modeling approach used to estimate arsenic impacts to ambient air, as that is not an identified issue.

22. During development of final SGP permitting analyses, PRI expressed concern that compliance with AACCs could not be demonstrated with the conservative assumptions used in

[10] REC 698, 710-711; DEQ's TAPS Modeling Attachment at 2, 14-15.

previous analyses, including the assumption that the SGP was a permanent source rather than one of 16-year duration. Rather than revise the analytical approach to provide a less conservative assessment of impacts, I proposed that compliance with carcinogenic TAP increments could be based on cumulative cancer risk of the limited-duration project rather than the worst-case annual impact for a project of limited duration. Since the AACC annual average is an expression of a 1-in-1,000,000 cancer risk limit for permitting projects, modeled impacts (annual contaminant concentration) must be adjusted to an exposure concentration that is appropriately comparable to the annual average AACC. Therefore, annual impacts for a project with a 16-year duration could be multiplied by a 16/70 factor to more appropriately compare to the AACC, which is based on a 70-year exposure duration. Similarly, year-to-year variability in emissions could be distributed over an alternative averaging period, provided there is still an adequate periodic evaluation that long-term risk limits are not exceeded.

23. My justification for the acceptability of using a 16/70 factor to adjust modeled impacts was based on technical/scientific considerations, my personal working-level knowledge of DEQ's TAP rules, and my limited knowledge of carcinogenic risk assessment and its relation to the TAP rules. Because of the unique 16-year project duration of the SGP and because *Idaho Air Rules* only identify AACC values for 70 years and less than 5 years, I discussed the approach with the DEQ permitting team prior to proposing use of the method. The DEQ permitting team concluded that the exposure duration consideration was an appropriate adjustment to the calculation of an exposure concentration (EC) for comparison to the T-RACT AACC, and it was concluded by the team that this approach was consistent with implementation of the URFs and identified acceptable excess cancer risks (1-in-1,000,000 or 1-in-100,000 when T-RACT is used) adopted by DEQ as AACCs into *Idaho Air Rules* Section 586.

III. Response to Remaining Issues Identified by the Board of Environmental Quality

A. DEQ Acted Reasonably in Using a 5-Year Rolling Average for T-RACT and it was Supported by Permit Conditions

24. *Idaho Air Rules* Section 586 state that AACCs are annual averages. The implication of the stated issue is that when a standard or increment is specified for a certain averaging-period, then any limits imposed on operations should be for the same averaging period or a shorter averaging period. For example, an operational limit designed to limit emissions that is based on a 5-year averaging period would not be adequate for assuring compliance with an annual average standard. This is because variability in operational rates within the 5-year period could result in a violation of the annual standard while still complying with the 5-year operational limit in the permit. For short-term 1-hour standards, DEQ uses 1-hour averaged operational limits and 1-hour averaged monitoring requirements. Permit requirements to assure compliance with a 1-hour limit would not be based on longer averaging periods such as daily rates because the 1-hour limit could be exceeded while still complying with the daily rate.

25. As I have established earlier in this declaration, carcinogenic TAP AACCs were established to ensure that impacts of any carcinogenic TAPs from a project or facility would not cause a lifetime cancer risk over 1-in-1,000,000 or 1-in-100,000 when using T-RACT. Cancer risks used to establish AACCs were based on EPA's cancer risk model (using established EPA URFs), where risk is dependent on an exposure for a certain project duration, and the risk varies linearly with exposure duration. Because limiting total project-caused cancer risk is the underlying criteria for carcinogenic TAP regulation, any permit limits must only assure that concentrations in ambient air over the total duration of the project do not cause a potential exposure concentration associated with a 1-in-1,000,000 or 1-in-100,000 cancer risk. Therefore, compliance with the carcinogenic AACCs would still be demonstrated if processing rates were only limited to the 788.4 million tons over the life of the mine (combined with the restriction on West End Pit production as described in the next section). Use of a 5-year averaging period for limiting processing rates easily accomplishes this requirement for a project with a 16-year duration, and it provides for reasonable periodic assurance of compliance with the long-term limit.

26. The *Final Order* from the DEQ Board[11] asserted that, "A five-year rolling average allows considerable daily and annual increases in exposures which are contrary to limits set forth in the Air Rules." Because pollutant-specific total project cancer risk is the blanketing objective of regulating carcinogenic TAPs, and since risks as assessed by the EPA risk model are a function of exposure concentration (accounting for exposure duration over a lifetime), any daily and annual variability is inconsequential to the exposure concentration and resulting risk. For example, assume a processing rate of 200,000 tons/year results in an annual arsenic impact of 3.0 E-4 $\mu g/m^3$, 153,000 tons/year results in 2.3 E-4 $\mu g/m^3$ (equal to the standard), and processing 100,000 tons/year results in an annual impact of 1.5 E-4 $\mu g/m^3$. Then assume a facility processes 200,000 tons during years one and two, 100,000 tons during years three and five, and 153,000 tons during year four. The total material processed over five years is 753,000 tons, and the mean annual processing rate is 150,600 tons/year. The same mean processing rate would result from processing 150,600 tons for each of the five years, and this would result in the same average annual air impact and the same carcinogenic exposure concentration. Since the exposure concentration (a resulting project caused concentration averaged over a lifetime) is a measure of compliance with AACC, the five-year rolling average is consistent with limits in *Idaho Air Rules* for carcinogenic TAPs.

B. DEQ had sufficient Evidence Supporting Limits on non-West End Pit Production

27. Final maximum potential arsenic exposures resulting from the SGP, as limited by permit conditions, were calculated from maximum modeled annual impacts and post-processing of those impacts by the following equation[12,13]:

[11] REC 3713 (Final Order at 19).

[12] REC 710-711, DEQ's TAPS Modeling Attachment at 14-15.

[13] *See* REC 1947-48, *Stibnite Gold Project Permit to Construct Application TAP Addendum.* Prepared for Perpetua Resources Idaho, Inc., Prepared by Air Sciences Inc., October 5, 2021 (full document at REC 1921-2146).

$$LifeExposure_{Wi,j,n} = \left[\left(WEPExposure_{Wi,n}\right)(50\%) + \left(nonWEPExposure_{Sj,n}\right)(50\%)\right]\left[\frac{16\ year\ LOM}{70\ year\ exposure}\right]$$

Where:

W_i	=	West End Pit scenario, where i = 1 to 4
S_j	=	Non-West End Pit scenario, where j = B1, B2, H1, H2, H3, H4, Y1, Y2, and Y3.
n	=	specific receptor.
$LifeExposure_{Wi,j,n}$	=	lifetime exposure in µg/m^3 for West End Pit scenario i, non-West End Pit scenario j, at receptor n.
$WEPExposure_{Wi,n}$	=	annual maximum modeled impact in µg/m^3 for West End Pit scenario i at receptor n
$nonWEPExposure_{Sj,n}$	=	annual maximum modeled impact in µg/m^3 for non-West End Pit scenario j at receptor n
16 *year LOM*	=	maximum life-of-mine
70 *year exposure*	=	lifetime exposure used for development of AACCs in *Idaho Air Rules*

The issued permit provided a total mine production limit and a production limit for West End Pit operations. The *Final Order* from the DEQ Board[14] stated, "However, the equation listed above shows that the non-West End Pit production was also limited by 50%. The Board of Environmental Quality was unable to determine from the record where this 50% reduction came from or whether it was actually applied when doing the calculation."

28. The DEQ Board, in the *Final Order*, fails to understand how the issued PTC appropriately and effectively limits both West End Pit and non-West End Pit production. The listed equation provides worst-case impacts for the various scenarios, but by itself it does not fully explain how certain sources must be limited by the permit to assure that the SGP operates as described in the application and in compliance with applicable standards and increments. The PTC limits total hauling and excavation from the mine to 788.4 million tons (West End Pit production combined with non-West End Pit production) and limits hauling and excavation from the West End Pit to 394.2 million tons, which is equal to 50% of total allowable production. Impacts to critical receptors (those having impacts that may approach the T-RACT AACC) are far greater for West End Pit sources than for non-West End Pit Sources. Analyses performed by DEQ during review of the application [15] showed that maximum arsenic impacts when 100% of the allowable production is from non-West End Pit sources (0.0023 µg/m^3 before adjusting for the life of the mine and 0.00053 µg/m^3 after adjusting for the life of the mine) are well below the maximum impact when 100% of allowable production is from West End Pit; therefore, with both a limit on total production and West End Pit production, an additional limit on non-West End Pit production is not necessary to assure that the SGP operates as represented in the application and as needed to

[14] REC 3714 (Final Order at 20).

[15] *PERPETUA RESOURCES IDAHO, INC. – P-2019.0047 PROJ 62288 - Lifetime Arsenic Exposure for Scenarios W1-W4 (DEQ's Post Processing Analysis).xlxs*. Excel Workbook. DEQ, 2021. A true and correct copy of this Excel workbook is provided concomitantly with this declaration and identified as Exhibit D.

assure that applicable emissions do not exceed the arsenic T-RACT AACC. Non-West End Pit production is limited to the facility-wide 788.4-million-ton limit for total hauling and excavation at the mine if there were no West End Pit production.

29. Production is effectively limited from non-West End Pit sources because of the following relationship:

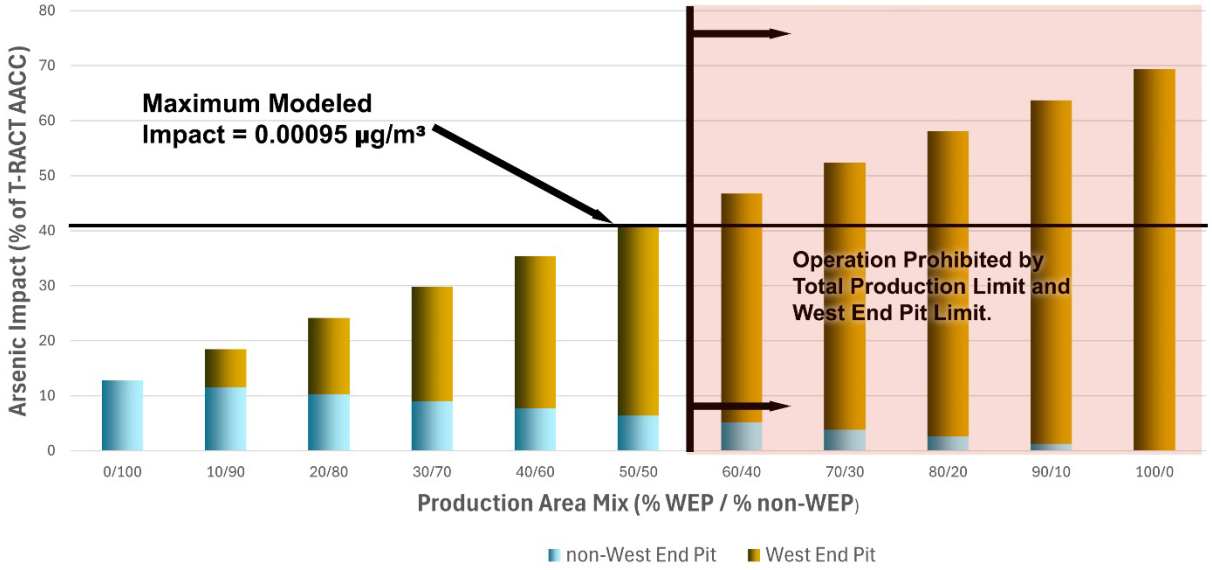
$$Production_{Non\text{-}WEP} = Production_{total} - Production_{WEP}$$

Where:

$Production_{Non\text{-}WEP}$ = production from non-West End Pit Sources
$Production_{total}$ = Total allowable production.
$Production_{WEP}$ = production from West End Pit Sources (not to exceed 50% of $Production_{total}$)

30. The effect of a limit on total production and West End Pit production can be observed by showing how maximum arsenic impacts change with changes in the fraction of total allowable production that occurs from the West End Pit. This was done for the single receptor that had the highest overall exposure concentration. Figure 1 shows how the total adjusted impact is affected by changes in the West End Pit production. The Figure shows how total impacts increase as West End Pit production increases and non-West End Pit production decreases. Figure 1 also shows how impacts would increase above the adjusted combined impact of 0.00095 µg/m^3 for West End Pit allowable production above 50% of the total allowable production from combined West End Pit and non-West End Pit sources.

Figure 1: Maximum Arsenic Impacts as a Function of the Percentage of Total Allowable Production that may Occur from West End Pit Sources



C. DEQ Acted Reasonably and in Accordance with Law when it Applied the 16/70 Calculation to the Ambient Arsenic Air Concentration Analysis

31. The DEQ Board, in the Final Order, misses the point that project-caused pollutant specific cancer risk is the overriding criteria of acceptability and that AACCs, expressed as an annual average, are provided to simplistically apply to permanent sources with emissions of low variability. The Final Order states that "nowhere in the Air Rules does it provide that a project that will operate more than 5 years but less than 70 years may be adjusted in proportion to the amount of time it will operate." Idaho Air Rules do not preclude the use of such a factor within the context of the regulatory intent. *Idaho Air Rules* do not alter EPA's science nor preclude its use, which includes use of a 70-year lifetime exposure duration in calculating AACCs. For projects with an enforceable operational life of less than 70 years, an adjustment for reduced exposure duration is appropriate. Total project-caused carcinogenic risk has been identified as the criteria from which the AACCs were established, as has been described earlier in this Declaration. When specific parameters associated with a project subject to the AACCs are not consistent with the assumptions/conditions that went into development of the AACCs, DEQ staff are compelled to adjust for those in an appropriate and/or conservative manner. DEQ then used its authority to write reasonable permit conditions per IDAPA 58.01.01.211 to limit total production including specific limitations on the West End pit.

32. Additionally, DEQ did not adjust the AACC. DEQ adjusted the applicable modeled impact concentration, which has a duration of 16 years, to an exposure concentration representative of a 70-year lifetime. With this adjustment, the exposure concentration can be compared to the AACC or the T-RACT AACC. The adjustment involved assuming maximum modeled impacts persist for the 16 years of mine life, and then those impacts are evenly distributed over a 70-year period to be consistent with the assumptions of carcinogenic TAP regulations.

33. Apart from the DEQ Board's identified issue with lack of specific allowance in the *Idaho Air Rules* to use an adjustment factor to account for project duration, the *Final Order* also stated that "DEQ did not provide sufficient evidence in the form of an expert opinion from a toxicologist or other qualified expert regarding the cancer risk associated with the 16/70 adjustment." As previously mentioned, outside of DEQ's adjustment factor of 10 specified for short-term sources of less than five years, cancer risk associated with exposures between 5 and 70 years are based on the EPA risk assessment model, using established URFs and exposure concentrations. DEQ's toxicologist, Dr. Norka Paden, demonstrated in her declaration[16] that use of the 16/70 adjustment factor is appropriate to calculate exposure concentration impacts of a 16-year project to be compared to the T-RACT AACC, which is based on a 70-year lifetime.

IV. Conclusions

34. Regarding the three remaining issues identified by the DEQ Board on the arsenic analysis supporting issuance of the DEQ PTC, DEQ concludes:

[16] Paden Decl., ¶ 18.

A. A 5-year rolling average production limit and associated monitoring of production was appropriate and reasonable because the criterion of acceptance is project-caused excess inhalation cancer risk. Short-term variability is inconsequential to the total risk.

B. Limits on total production along with a limit on West End Pit production effectively limits non-West End Pit production. A separate limit on non-West End Pit production is not necessary because compliance with the T-RACT AACC is still demonstrated when 100% of total allowable production is from non-West End Pit sources.

C. DEQ acted reasonably and in accordance with law when applying the 16/70 factor to generate an Exposure Concentration to compare against the T-RACT AACC. As demonstrated, AACCs are an annual representation of the acceptable Exposure Concentration for a permanent project and a 1-in-1,000,000 excess cancer risk. Standard EPA risk assessment methods (the same methods used to develop the AACCs) were used with the modeled annual concentration to calculate an Exposure Concentration representative of the 16-year project duration while conservatively assuming a 24 hour/day Exposure Time and a 365 day/year Exposure Frequency. This reduces to the 16/70 factor applied to the modeled concentration.

DATED August 13, 2024

/s/ Kevin Schilling
KEVIN SCHILLING

CERTIFICATE OF SERVICE

I hereby certify that on August 13, 2024, a true and correct copy of the foregoing ***EXPERT DECLARATION OF KEVIN SCHILLING*** was served on the following:

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

Dylan B. Lawrence
Hearing Officer
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Bryan Hurlbutt
Laird ("Laird") J. Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Paula Wilson, Hearing Coordinator
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, Idaho 83706
paula.wilson@deq.idaho.gov
via electronic service

/s/ DeAnne Chaffin

EXHIBIT A

TAPs Addendum Modeling Review Attachment

1.0 Introduction and Summary

Perpetua Resources Idaho, Inc. (PRI) submitted the *Stibnite Gold Project (SGP) Permit to Construct Application TAP Addendum* (*TAP Addendum*), prepared by Air Sciences Inc. (Air Sciences) and submitted to DEQ on October 5, 2021. The TAP Addendum reassessed source applicability to Toxic Air Pollutant (TAP) permitting requirements, refined TAPs regulatory methods to demonstrate compliance with applicable TAP increments, revised and/or refined operations and operational parameters affecting TAP emissions, and refined TAP air impact analyses. The revisions and refinements made for the TAP Addendum also reduced PM_{10} and $PM_{2.5}$ emissions, and this effect is presented in this *TAPs Addendum Modeling Review Attachment* (*Modeling Review Attachment*).

2.0 Scope of TAPs Addendum

DEQ reevaluated TAPs compliance regulatory interpretations and impact assessment methods following the second public comment period of February 18, 2021, through March 19, 2021. Areas of revision in response to issues identified after the public comment period included:

- Revising source-specific TAP impact assessment applicability, primarily identifying what sources can be excluded because they are "covered" or "addressed" by a National Emissions Standard for Hazardous Air Pollutants (NESHAP) or New Source Performance Standard (NSPS).
- Refining regulatory methods used to demonstrate compliance with TAP increments.
- Refining TAP emission calculation methods and dispersion-affecting parameters.
- Reassessing TAP impacts resulting from revised and/or refined methods and data.
- Providing a best-estimate of actual TAP emissions that will occur from operation of the mine, and then comparing this to maximum permit-allowable emissions.

PRI and Air Sciences, PRI's permitting consultant, submitted the *TAP Addendum* on October 5, 2021.

3.0 Revised NESHAP/NSPS TAP Exclusion

DEQ and PRI reevaluated TAP source applicability after the second public comment period in response to expressed concerns regarding sources excluded as per *Idaho Air Rules* Section 210.20 (excluding sources that are "covered" or "addressed" by a NESHAP). TAP applicability is explained in greater detail in the main body of the DEQ Statement of Basis. As a result of the reevaluation, some additional sources were included in the TAP impact modeling analyses that were not previously. TAP sources from gold mining that were modeled in the final TAP analyses included: drilling, blasting, excavating, hauling, prill silos, rock dumps and storage piles, and tailings.

Air Sciences consulted with DEQ to refine TAP compliance demonstration methods from what was originally submitted in the application. The refinement was primarily needed to show compliance with the

REC 3933
REC 0697
PET 331

arsenic Acceptable Ambient Concentration of a Carcinogen (AACC). The revised methods are described in the submitted *TAP Addendum* and this DEQ *Modeling Review Attachment*.

4.0 TAPs Refined Compliance Demonstration Approach

PRI, in consultation with DEQ, used a highly refined TAPs analysis approach to demonstrate compliance with applicable TAP increments. This approach involved the following:

- AACC Adjustment for Toxic Air Pollutant Reasonably Available Control Technology (T-RACT) Utilization.
- TAP Emission Averaging Period.
- AACC Adjustment for the Operational Life of the Mine.

4.1 AACC Adjustment for T-RACT Utilization

Idaho Air Rules Section 210.12 allows TAP impacts of 10 times the AACC if the application demonstrates that T-RACT is used for the TAP emission sources. This represents a life-time cancer risk of 1-in-100,000. An adjustment cannot be made for non-carcinogenic TAPs listed in *Idaho Air Rules* Section 585.

Review of the T-RACT demonstration is performed by the DEQ permit writer and is described in the main body of the DEQ Statement of Basis.

4.2 TAP Emission Averaging Period

Annual average emissions of carcinogenic TAPs are typically used in the dispersion model to estimate maximum annual impacts. PRI refined the analyses by using source-specific emission rates that are representative of a 5-year averaging period. This approach is appropriate because carcinogenic impacts are of concern from a long-term exposure basis.

4.3 AACC Adjustment for the Operational Life of the Mine

AACCs were established based on a 1-in-1,000,000 cancer risk over a 70-year lifetime, as stated in *Idaho Air Rules* Section 006.125:

> ***Toxic Air Pollutant Carcinogenic Increments****. Those ambient air quality increments based on the probability of developing excess cancers over a seventy (70) year lifetime exposure to one (1) microgram per cubic meter (1 ug/m3) of a given carcinogen and expressed in terms of a screening emission level or an acceptable ambient concentration for a carcinogenic toxic air pollutant. They are listed in Section 586.*

PRI indicated the maximum life-of-mine will be 16 years. Life-time exposures to carcinogenic TAPs were refined by multiplying the maximum modeled annual impact by a ratio of 16/70. Section 5.7 of this *Modeling Review Attachment* provides more details on this adjustment for the project.

5.0 Refined TAP Emission Estimates and Modeling Methods/Parameters

This section describes changes made to TAP emission estimates and to methods/parameters used in the impact modeling analyses.

5.1 Operational Adjustments

PRI and Air Sciences proposed and committed to several operational adjustments to reduce actual and estimated TAP emissions:

- Installing and operating dust collection systems on drilling rigs (determined to be T-RACT).
- Capping the haul roads that are outside of the pits and development rock storage facilities (DRSFs) with clean (lower levels of arsenic) development rock (determined to be T-RACT).
- Eliminating the West End Development Rock Storage Facility, which eliminated the highest-emitting operational scenario W5.
- Limiting long-term mining production to an average of 135,000 tons/day for a 5-year rolling average.
- Constructing the Burntlog access road with offsite materials containing "background" levels of arsenic.
- Updating the bulldozing emission factor using the SGP site-specific silt content.

5.2 General Modeling Methods and Parameters

Modeling methods and parameters used in TAP impact analyses presented in the *TAP Addendum* are largely identical to those used in the previously submitted application. These include the air dispersion model used, meteorological data, terrain, building downwash, ambient air boundary, and receptors. TAP modeling was conducted for the 14 operational modeling scenarios, consistent with the NAAQS analyses. Modeling Scenario W5 was eliminated from the arsenic modeling, as discussed in Section 5.8 of this *Modeling Review Attachment*.

The meteorological dataset processed using McCall, Idaho, cloud cover data was used for analyses in the *TAP Addendum*. Impacts were not assessed using the dataset processed using the Bulk Richardson (BULKRN) method for boundary layer parameter calculations. EPA considers both methods to be acceptable. Although modeled impacts tend to be somewhat larger when using meteorological data processed by the BULKRN method, DEQ contends that the impact analyses are still largely conservative compared to actual impacts anticipated. Conservative aspects include: continual operation of the worst-case operational scenario; operation at maximum allowable rates for the averaging period; no reduction in winter-time emissions from fugitive sources, accounting for emission suppression effects of increased moisture.

5.3 TAP Modeling Applicability

Table 1 provides a comparison between applicable facility-wide maximum potential TAP emissions for the highest-emitting scenario (W3) and TAP screening emission levels (ELs) from *Idaho Air Rules* Sections 585 (for non-carcinogens) and 586 (for carcinogens). Note that TAPs also classified as HAPs

REC 3935
REC 0699
PET 333

emitted from sources "addressed" or "covered" by NSPS or NESHAP were not required to be evaluated for compliance with TAP increments in accordance with *Idaho Air Rules* Section 210.20. Furthermore, PRI has determined that the West End Development Rock Storage Facility will not be constructed. This change eliminated Modeling Scenario W5 (the highest-emitting scenario described in the main body of the DEQ *Modeling Review Memorandum*) as a potential operating scenario. After eliminating Modeling Scenario W5, it was determined that Modeling Scenario W3 is the highest-emitting scenario for all TAPs.

Table 1. TAP MODELING APPLICABILITY DETERMINATION (HIGHEST-EMITTING MODELING SCENARIO: W3).

HAP/TAP	Emissions (lb/hr)			EL (lb/hr)		Determination
	(a)	(b)	Total	(c)	(d)	
1,3-Butadiene	--	--	--	--	2.4E-5	EL not exceeded
3-Methylchloranthrene	--	4.5E-8	4.5E-8	--	2.5E-6	EL not exceeded
Acetaldehyde	--	--	--	--	3.0E-3	EL not exceeded
Acrolein	--	--	--	1.7E-2	--	EL not exceeded
Antimony	1.9E-2	1.6E-6	1.9E-2	3.3E-2	--	EL not exceeded
Arsenic	5.4E-1	8.2E-6	5.4E-1	--	1.5E-6	Carcinogenic EL exceeded
Benzene	--	5.3E-5	5.3E-5	--	8.0E-4	EL not exceeded
Benzo(a)pyrene[e]	--	3.0E-8				
Benz(a)anthracene[e]	--	4.5E-8				
Benzo(b)fluoranthene[e]	--	4.5E-8				
Benzo(k)fluoranthene[e]	--	4.5E-8	2.9E-7	--	2.0E-6	EL not exceeded
Chrysene[e]	--	4.5E-8				
Dibenzo(a,h)anthracene[e]	--	3.0E-8				
Indenol(1,2,3-cd)pyrene[e]	--	4.5E-8				
Beryllium	2.6E-3	3.5E-7	2.6E-3	--	2.8E-5	Carcinogenic EL exceeded
Biphenyl	--	--	--	1.0E-1	--	EL not exceeded
Cadmium	4.1E-4	2.8E-5	4.4E-4	--	3.7E-6	Carcinogenic EL exceeded
Carbon disulfide	1.4E-2	--	1.4E-2	2.0E+0	--	EL not exceeded
Chromium	7.3E-3	4.8E-5	7.4E-3	3.3E-2	--	EL not exceeded
Chromium (VI)	--	3.4E-7	3.4E-7	--	5.6E-7	EL not exceeded
Cobalt	3.3E-3	4.8E-6	3.26E-3	3.3E-3	--	EL not exceeded
Cyanide	4.5E-1	--	4.5E-1	3.3E-1	--	Non-carcinogenic EL exceeded
Dichlorobenzene	--	3.1E-5	3.1E-5	3.0E+1	--	EL not exceeded
Formaldehyde	--	1.9E-3	1.9E-3	--	5.1E-4	Carcinogenic EL exceeded
Hexane	--	4.6E-2	4.6E-2	1.2E+1	--	EL not exceeded
Hydrogen Chloride	--	--	--	5.0E-2	--	EL not exceeded
Manganese	2.4E-1	1.9E-4	2.4E-1	6.7E-2	--	Non-carcinogenic EL exceeded
Naphthalene	--	1.6E-5	1.6E-5	3.3E+0	--	EL not exceeded
Nickel	1.6E-3	5.6E-5	1.7E-3	--	2.7E-5	Carcinogenic EL exceeded
Phenol	--	--	--	1.3E+0	--	EL not exceeded
Phosphorus	5.3E-1	9.3E-5	5.3E-1	7.0E-3	--	Non-carcinogenic EL exceeded
Selenium	3.3E-4	6.2E-7	3.3E-4	1.3E-2	--	EL not exceeded
Toluene	--	8.8E-5	8.8E-5	2.5E+1	--	EL not exceeded
Xylene	--	--	--	2.9E+1	--	EL not exceeded
Aluminum	5.8E+1	6.5E-1	5.9E+1	6.7E-1	--	Non-carcinogenic EL exceeded
Barium	6.5E-1	6.8E-3	6.6E-1	3.3E-2	--	Non-carcinogenic EL exceeded
Calcium Carbonate	1.1E+1	2.2E+0	1.4E+1	6.7E-1	--	Non-carcinogenic EL exceeded
Calcium Oxide	--	7.0E-1	7.0E-1	1.3E-1	--	Non-carcinogenic EL exceeded
Copper	4.1E-3	5.3E-4	4.6E-3	6.7E-2	--	EL not exceeded
Cyclohexane	--	1.0E-3	1.0E-3	7.0E+1	--	EL not exceeded
Hydrogen Sulfide	--	9.0E-1	9.0E-1	9.3E-1	--	EL not exceeded
Iron	1.5E+1	2.1E-1	1.5E+1	6.7E-2	--	Non-carcinogenic EL exceeded
Molybdenum	8.1E-4	4.7E-4	1.3E-3	3.3E-1	--	EL not exceeded
Pentane	--	1.2E-1	1.2E-1	1.2E+2	--	EL not exceeded
Silver	4.1E-4	4.1E-4	8.2E-4	7.0E-3	--	EL not exceeded
Sulfuric Acid	--	2.0E+0	2.0E+0	6.7E-2	--	Non-carcinogenic EL exceeded

REC 3936
REC 0700
PET 334

Table 1. TAP MODELING APPLICABILITY DETERMINATION (HIGHEST-EMITTING MODELING SCENARIO: W3).						
HAP/TAP	Emissions (lb/hr)			EL (lb/hr)		Determination
	(a)	(b)	Total	(c)	(d)	
Thallium	8.1E-3	5.2E-4	8.7E-3	7.0E-3	--	Non-carcinogenic EL exceeded
Uranium	8.1E-3	5.2E-4	8.7E-3	1.3E-2	--	EL not exceeded
Vanadium	2.3E-2	8.4E-4	2.4E-2	3.0E-3	--	Non-carcinogenic EL exceeded
Trimethyl Benzene	--	1.1E-2	1.1E-2	8.2E+0	--	EL not exceeded
Tungsten	8.1E-3	5.2E-4	8.7E-3	3.3E-1	--	EL not exceeded
Zinc	2.9E-2	2.2E-3	3.1E-2	6.7E-1	--	EL not exceeded

a. Total HAP/TAP emissions for EL evaluation from mining (i.e., pits, blasting, haul roads, stockpiles and DRSF, tailings storage facility, access road, and underground exploration) and leaching. Emissions from sources covered/addressed by NSPS/NESHAP are not included in the evaluation for modeling applicability.

b. Total HAP/TAP emissions for EL evaluation from processing and production (i.e., ore processing [crushers and transfer, prill silos], ore concentration and refining [autoclave, electrowinning cells and pregnant solution tank, retort, furnace, carbon kiln], process heating [POX boiler, carbon regeneration kiln, propane vaporizer, solution heater], lime production [limestone crushers, screens, mill, transfers, lime kiln, kiln feed, lime mill, pebble lime silo, lime silos, lime mill crushing], aggregate production [portable crushers, screens, transfers], concrete production [central mixer, cement silos, aggregate bin], HVAC [heaters], emergency power [emergency generators, fire pump], fuel storage [gasoline fuel and tanks]). Emissions from sources covered/addressed by NSPS/NESHAP are not included in the evaluation for modeling applicability.

c. Non-carcinogenic EL from *Idaho Air Rules* Section 585.

d. Carcinogenic EL from *Idaho Air Rules* Section 586.

Table 1 shows that the SGP facility-wide potential TAP emissions exceed the respective EL for arsenic, beryllium, cadmium, cyanide, formaldehyde, manganese, nickel, phosphorus, aluminum, barium, calcium carbonate, calcium oxide, iron, sulfuric acid, thallium, and vanadium. Therefore, modeling was required for these 16 TAPs (11 non-carcinogenic and five carcinogenic TAPs) to demonstrate compliance with Acceptable Ambient Concentrations of Non-Carcinogens (AACs) and AACCs.

5.4 TAP Modeled Emission Rates

Table 2 lists the source-specific modeled emission rates for all 11 non-carcinogenic TAPs that required modeling (worst-case modeling scenario for all non-carcinogenic TAPs: W5). Table 3 lists the source-specific modeled emission rates for all five carcinogenic TAPs that required modeling (worst-case impacts for arsenic are associated with modeling scenario W2; worst-case impacts for all other carcinogenic TAPs are associated with modeling scenario W1). Note that all source-specific emission rates listed in Tables 2 and 3 were extracted by DEQ's modeling staff from the submitted modeling input files.

The total modeled emission rates for all non-carcinogenic TAPs are equal to the total facility-wide HAP/TAP emissions as stated in the permitting emissions inventory (excluding sources addressed by NSPS/NESHAP), evaluated at 180,000 T/day (see last two rows of Table 2). However, for carcinogenic TAPs, modeling was performed using an emission inventory that included T-RACT controls, long-term mining production limits, and other emission inventory refinements, as described in Section 4.0 of this *Modeling Review Attachment* (see last three rows of Table 3).

Table 2. MODELED EMISSION RATES FOR NON-CARCINOGENIC TAPS (WORST-CASE MODELING SCENARIOS).												
Type of Source	**Source ID**	**ALUM[a] (lb/hr)[b]**	**BARI[c] (lb/hr)**	**CACA[d] (lb/hr)**	**CAOX[e] (lb/hr)**	**CYAN[f] (lb/hr)**	**IRON[g] (lb/hr)**	**MANG[h] (lb/hr)**	**PHOS[i] (lb/hr)**	**SULF[j] (lb/hr)**	**THAL[k] (lb/hr)**	**VANA[l] (lb/hr)**
Point Sources	LS1L	2.33E-04	1.50E-06	0	7.63E-03	0	1.07E-04	2.44E-06	1.34E-06	0	5.16E-08	1.60E-07
	MILLS2L	2.33E-04	1.50E-06	0	7.63E-03	0	1.07E-04	2.44E-06	1.34E-06	0	5.16E-08	1.60E-07
	AC	2.31E-05	2.31E-05	2.31E-05	0	0	2.31E-05	0	0	2.03E+00	2.31E-05	2.31E-05
	ACB	0	3.06E-06	0	0	0	0	2.64E-07	0	0	0	1.60E-06
	ACS1L	9.32E-04	5.98E-06	0	3.05E-02	0	4.27E-04	9.76E-06	5.36E-06	0	2.06E-07	6.39E-07
	ACS2L	9.32E-04	5.98E-06	0	3.05E-02	0	4.27E-04	9.76E-06	5.36E-06	0	2.06E-07	6.39E-07
	ACS3L	9.32E-04	5.98E-06	0	3.05E-02	0	4.27E-04	9.76E-06	5.36E-06	0	2.06E-07	6.39E-07
	ACS4L	4.66E-04	2.99E-06	0	1.53E-02	0	2.13E-04	4.88E-06	2.68E-06	0	1.03E-07	3.20E-07
	CKD	9.59E-05	9.59E-05	9.59E-05	0	0	9.59E-05	0	0	0	9.59E-05	9.59E-05
	CKB	0	9.73E-06	0	0	0	0	8.40E-07	0	0	0	5.08E-06
	EW	9.59E-05	9.59E-05	9.59E-05	0	0	9.59E-05	0	0	0	9.59E-05	9.59E-05
	MR	9.59E-05	9.59E-05	9.59E-05	0	0	9.59E-05	0	0	0	9.59E-05	9.59E-05
	MF	9.59E-05	9.59E-05	9.59E-05	0	0	9.59E-05	0	0	0	9.59E-05	9.59E-05
	EDG1	0	0	0	0	0	0	0	0	0	0	0
	EDG2	0	0	0	0	0	0	0	0	0	0	0
	EDG3	0	0	0	0	0	0	0	0	0	0	0
	EDFP	0	0	0	0	0	0	0	0	0	0	0
	PV	0	4.31E-07	0	0	0	0	3.73E-08	0	0	0	2.25E-07
	HS	0	2.16E-05	0	0	0	0	1.86E-06	0	0	0	1.13E-05
	H1M	0	1.73E-05	0	0	0	0	1.49E-06	0	0	0	9.02E-06
	H2M	0	1.73E-05	0	0	0	0	1.49E-06	0	0	0	9.02E-06
	HM	0	1.73E-05	0	0	0	0	1.49E-06	0	0	0	9.02E-06
	HAC	0	1.08E-06	0	0	0	0	9.31E-08	0	0	0	5.64E-07
	HR	0	1.08E-06	0	0	0	0	9.31E-08	0	0	0	5.64E-07
	HA	0	1.08E-06	0	0	0	0	9.31E-08	0	0	0	5.64E-07
	HMO	0	2.16E-06	0	0	0	0	1.86E-07	0	0	0	1.13E-06
	HTS	0	8.63E-06	0	0	0	0	7.45E-07	0	0	0	4.51E-06
	HW	0	1.29E-05	0	0	0	0	1.12E-06	0	0	0	6.76E-06
	PSL	0	0	0	0	0	0	0	0	0	0	0
	CS1L	0	0	0	0	0	0	8.01E-07	0	0	0	0
	CS2L	0	0	0	0	0	0	8.01E-07	0	0	0	0
	LS6	3.19E-03	2.05E-05	3.88E-02	0	0	1.46E-03	0	0	0	7.06E-07	2.19E-06
	LSBM	4.30E-02	2.76E-04	5.22E-01	0	0	1.97E-02	0	0	0	9.51E-06	2.95E-05
	LS9	7.54E-04	4.84E-06	9.16E-03	0	0	3.45E-04	0	0	0	1.67E-07	5.17E-07
	LK	2.07E-02	1.33E-04	2.51E-01	0	0	9.47E-03	0	0	0	4.58E-06	1.42E-05
	LKC	0	9.51E-05	0	0	0	0	0	0	0	0	4.97E-05
	LCR	6.43E-03	4.12E-05	0	2.11E-01	0	2.94E-03	0	0	0	1.42E-06	4.41E-06
	LSL	1.40E-04	8.99E-07	0	4.59E-03	0	6.41E-05	0	0	0	3.10E-08	9.60E-08

REC 3938

REC 0702

PET 336

Table 2. MODELED EMISSION RATES FOR NON-CARCINOGENIC TAPS (WORST-CASE MODELING SCENARIOS).												
Type of Source	**Source ID**	**ALUM[a] (lb/hr)[b]**	**BARI[c] (lb/hr)**	**CACA[d] (lb/hr)**	**CAOX[e] (lb/hr)**	**CYAN[f] (lb/hr)**	**IRON[g] (lb/hr)**	**MANG[h] (lb/hr)**	**PHOS[i] (lb/hr)**	**SULF[j] (lb/hr)**	**THAL[k] (lb/hr)**	**VANA[l] (lb/hr)**
Area Sources	WEP	5.59E+00	6.29E-02	1.10E+00	0	0	1.43E+00	2.35E-02	5.11E-02	0	7.87E-04	2.20E-03
	UGEXP	2.49E-05	2.80E-07	4.91E-06	0	0	6.38E-06	1.05E-07	2.28E-07	0	3.50E-09	9.81E-09
	TSF	0	0	0	0	2.32E-01	0	0	0	0	0	0
Line Sources	AR01	2.02E-02	2.28E-04	3.99E-03	0	0	5.18E-03	8.52E-05	1.85E-04	0	2.85E-06	7.98E-06
	AR02	1.56E-02	1.75E-04	3.07E-03	0	0	3.99E-03	6.55E-05	1.42E-04	0	2.19E-06	6.13E-06
	AR03	3.93E-02	4.43E-04	7.75E-03	0	0	1.01E-02	1.66E-04	3.60E-04	0	5.54E-06	1.55E-05
	AR04	3.77E-02	4.25E-04	7.43E-03	0	0	9.66E-03	1.59E-04	3.45E-04	0	5.31E-06	1.49E-05
Volume Sources	WEPBL	1.90E+00	2.14E-02	3.75E-01	0	0	4.88E-01	8.01E-03	1.74E-02	0	2.68E-04	7.50E-04
	WEDRSF	8.58E-01	9.66E-03	1.69E-01	0	0	2.20E-01	3.61E-03	7.85E-03	0	1.21E-04	3.38E-04
	OC1	1.04E-02	1.17E-04	2.04E-03	0	0	2.65E-03	0	0	0	1.46E-06	4.08E-06
	OC2	1.04E-02	1.17E-04	2.04E-03	0	0	2.65E-03	0	0	0	1.46E-06	4.08E-06
	OC3	1.04E-02	1.17E-04	2.04E-03	0	0	2.65E-03	0	0	0	1.46E-06	4.08E-06
	OC4	1.04E-02	1.17E-04	2.04E-03	0	0	2.65E-03	0	0	0	1.46E-06	4.08E-06
	OC5	1.04E-02	1.17E-04	2.04E-03	0	0	2.65E-03	0	0	0	1.46E-06	4.08E-06
	OC6	1.04E-02	1.17E-04	2.04E-03	0	0	2.65E-03	0	0	0	1.46E-06	4.08E-06
	OC7	8.87E-02	1.00E-03	1.75E-02	0	0	2.28E-02	0	0	0	1.25E-05	3.50E-05
	OC8	1.04E-02	1.17E-04	2.04E-03	0	0	2.65E-03	0	0	0	1.46E-06	4.08E-06
	OC9	4.90E-02	5.52E-04	9.66E-03	0	0	1.26E-02	0	0	0	6.90E-06	1.93E-05
	OC10	4.90E-02	5.52E-04	9.66E-03	0	0	1.26E-02	0	0	0	6.90E-06	1.93E-05
	OC11	4.90E-02	5.52E-04	9.66E-03	0	0	1.26E-02	0	0	0	6.90E-06	1.93E-05
	OC12	9.80E-02	1.10E-03	1.93E-02	0	0	2.51E-02	0	0	0	1.38E-05	3.86E-05
	OC13	1.14E-02	1.29E-04	2.25E-03	0	0	2.93E-03	0	0	0	1.61E-06	4.51E-06
	LS1U	1.13E-03	7.25E-06	0	3.70E-02	0	5.18E-04	1.18E-05	6.50E-06	0	2.50E-07	7.75E-07
	MILLS2U	1.13E-03	7.25E-06	0	3.70E-02	0	5.18E-04	1.18E-05	6.50E-06	0	2.50E-07	7.75E-07
	ACS1U	2.17E-03	1.39E-05	0	7.10E-02	0	9.94E-04	2.27E-05	1.25E-05	0	4.80E-07	1.49E-06
	ACS2U	2.17E-03	1.39E-05	0	7.10E-02	0	9.94E-04	2.27E-05	1.25E-05	0	4.80E-07	1.49E-06
	ACS3U	2.17E-03	1.39E-05	0	7.10E-02	0	9.94E-04	2.27E-05	1.25E-05	0	4.80E-07	1.49E-06
	ACS42U	2.17E-03	1.39E-05	0	7.10E-02	0	9.94E-04	2.27E-05	1.25E-05	0	4.80E-07	1.49E-06
	PSU	0	0	0	0	0	0	0	0	0	0	0
	CS1U	0	0	0	0	0	0	8.01E-07	0	0	0	0
	CS2U	0	0	0	0	0	0	8.01E-07	0	0	0	0
	CAL	1.56E-02	1.00E-04	0	0	0	7.14E-03	0	0	0	3.45E-06	1.07E-05
	CAU	1.56E-02	1.00E-04	0	0	0	7.14E-03	0	0	0	3.45E-06	1.07E-05
	CM	0	0	0	0	0	0	2.59E-05	8.22E-06	0	0	0
	PCSP1	1.41E-02	9.06E-05	1.72E-01	0	0	6.47E-03	0	0	0	3.12E-06	9.69E-06
	PCSP2	1.41E-02	9.06E-05	1.72E-01	0	0	6.47E-03	0	0	0	3.12E-06	9.69E-06
	LS1	3.19E-03	2.05E-05	3.88E-02	0	0	1.46E-03	0	0	0	7.06E-07	2.19E-06
	LS2	5.75E-03	3.69E-05	6.98E-02	0	0	2.63E-03	0	0	0	1.27E-06	3.94E-06
	LS3	2.66E-02	1.71E-04	3.23E-01	0	0	1.22E-02	0	0	0	5.88E-06	1.82E-05

REC 3939

REC 0703

PET 337

Table 2. MODELED EMISSION RATES FOR NON-CARCINOGENIC TAPS (WORST-CASE MODELING SCENARIOS).												
Type of Source	**Source ID**	**ALUM[a] (lb/hr)[b]**	**BARI[c] (lb/hr)**	**CACA[d] (lb/hr)**	**CAOX[e] (lb/hr)**	**CYAN[f] (lb/hr)**	**IRON[g] (lb/hr)**	**MANG[h] (lb/hr)**	**PHOS[i] (lb/hr)**	**SULF[j] (lb/hr)**	**THAL[k] (lb/hr)**	**VANA[l] (lb/hr)**
	LS4	5.75E-03	3.69E-05	6.98E-02	0	0	2.63E-03	0	0	0	1.27E-06	3.94E-06
	LS5	2.66E-02	1.71E-04	3.23E-01	0	0	1.22E-02	0	0	0	5.88E-06	1.82E-05
	LS7	3.19E-03	2.05E-05	3.88E-02	0	0	1.46E-03	0	0	0	7.06E-07	2.19E-06
	LS8	3.19E-03	2.05E-05	3.88E-02	0	0	1.46E-03	0	0	0	7.06E-07	2.19E-06
	LS10	7.54E-04	4.84E-06	9.16E-03	0	0	3.45E-04	0	0	0	1.67E-07	5.17E-07
	LS11	6.29E-03	4.03E-05	7.63E-02	0	0	2.88E-03	0	0	0	1.39E-06	4.31E-06
	LS12	7.54E-04	4.84E-06	9.16E-03	0	0	3.45E-04	0	0	0	1.67E-07	5.17E-07
	LSU	1.40E-05	8.99E-08	0	4.59E-04	0	6.41E-06	0	0	0	3.10E-09	9.60E-09
	MILLTANKS	0	0	0	0	2.21E-01	0	0	0	0	0	0
	HRT001-HRT072[m]	2.62E-01	2.95E-03	5.16E-02	0	0	6.71E-02	1.10E-03	2.40E-03	0	3.69E-05	1.03E-04
	HRN001-HRN022[m]	2.62E-01	2.95E-03	5.16E-02	0	0	6.71E-02	1.10E-03	2.40E-03	0	3.69E-05	1.03E-04
Total Modeled Rates		***3.37E+01***	***3.79E-01***	***8.76E+00***	***6.96E-01***	***4.53E-01***	***8.69E+00***	***1.39E-01***	***3.03E-01***	***2.03E+00***	***5.17E-03***	***1.39E-02***
Total Emission Rates at 180,000 T/day[n]		***3.37E+01***	***3.79E-01***	***8.76E+00***	***6.96E-01***	***4.53E-01***	***8.69E+00***	***1.39E-01***	***3.03E-01***	***2.03E+00***	***5.17E-03***	***1.39E-02***

a. Aluminum (worst-case modeling scenario: W5).
b. Pounds per hour.
c. Barium (worst-case modeling scenario: W5).
d. Calcium carbonate (worst-case modeling scenario: W5).
e. Calcium oxide (worst-case modeling scenario: W5).
f. Cyanide (worst-case modeling scenario: W5).
g. Iron (worst-case modeling scenario: W5).
h. Manganese (worst-case modeling scenario: W5).
i. Phosphorus (worst-case modeling scenario: W5).
j. Sulfuric acid (worst-case modeling scenario: W5).
k. Thallium (worst-case modeling scenario: W5).
l. Vanadium (worst-case modeling scenario: W5).
m. The Haul Road was represented in the model as a series of volume sources. The emission rates listed in this table represent each individual volume source.
n. Total emission rates at 180,000 tons per day were derived from Worksheet "TblA" in the emission inventory dated October 5, 2021. The total emission rates in this row represent all facility-wide HAP/TAP emission sources from mining, leaching, and processing and production (excluding emissions from sources "addressed" or "covered" by NSPS/NESHAP).

REC 3940

Table 3. MODELED EMISSION RATES FOR CARCINOGENIC TAPS (WORST-CASE MODELING SCENARIOS).						
Type of Source	**Source ID**	**ARSE[a] (lb/hr)[b]**	**BERY[c] (lb/hr)**	**CADM[d] (lb/hr)**	**FORM[e] (lb/hr)**	**NICK[f] (lb/hr)**
Point Sources	LS1L	1.14E-08	3.96E-10	1.24E-10	0	2.47E-09
	MILLS2L	1.14E-08	3.96E-10	1.24E-10	0	2.47E-09
	AC	0	0	0	0	0
	ACB	1.28E-07	7.66E-09	7.02E-07	4.79E-05	1.34E-06
	ACS1L	4.55E-08	1.58E-09	4.94E-10	0	9.89E-09
	ACS2L	4.55E-08	1.58E-09	4.94E-10	0	9.89E-09
	ACS3L	4.55E-08	1.58E-09	4.94E-10	0	9.89E-09
	ACS4L	2.27E-08	7.91E-10	2.47E-10	0	4.94E-09
	CKD	0	0	0	0	0
	CKB	4.07E-07	2.44E-08	2.24E-06	1.52E-04	4.27E-06
	EW	0	0	0	0	0
	MR	0	0	0	0	0
	MF	0	0	0	0	0
	EDG1	0	0	0	0	0
	EDG2	0	0	0	0	0
	EDG3	0	0	0	0	0
	EDFP	0	0	0	0	0
	PV	1.80E-08	1.08E-09	9.91E-08	6.76E-06	1.89E-07
	HS	9.01E-07	5.41E-08	4.96E-06	3.38E-04	9.46E-06
	H1M	7.84E-07	4.71E-08	4.31E-06	2.94E-04	8.24E-06
	H2M	7.84E-07	4.71E-08	4.31E-06	2.94E-04	8.24E-06
	HM	7.84E-07	4.71E-08	4.31E-06	2.94E-04	8.24E-06
	HAC	4.90E-08	2.94E-09	2.70E-07	1.84E-05	5.15E-07
	HR	4.90E-08	2.94E-09	2.70E-07	1.84E-05	5.15E-07
	HA	4.90E-08	2.94E-09	2.70E-07	1.84E-05	5.15E-07
	HMO	9.80E-08	5.88E-09	5.39E-07	3.68E-05	1.03E-06
	HTS	3.92E-07	2.35E-08	2.16E-06	1.47E-04	4.12E-06
	HW	5.88E-07	3.53E-08	3.24E-06	2.21E-04	6.18E-06
	PSL	0	0	0	0	0
	CS1L	2.90E-08	3.33E-09	0	0	2.86E-07
	CS2L	2.90E-08	3.33E-09	0	0	2.86E-07
	LS6	0	0	0	0	0
	LSBM	0	0	0	0	0
	LS9	0	0	0	0	0
	LK	0	0	0	0	0
	LKC	0	0	0	0	0
	LCR	0	0	0	0	0
	LSL	0	0	0	0	0
Area Sources	WEP	9.40E-03	4.51E-05	7.04E-06	0	2.82E-05
	UGEXP	2.34E-07	1.12E-09	1.75E-10	0	7.01E-10
	TSF	0	0	0	0	0
Line Sources	AR01	7.12E-07	9.12E-07	1.42E-07	0	5.70E-07
	AR02	5.48E-07	7.01E-07	1.10E-07	0	4.38E-07
	AR03	1.38E-06	1.77E-06	2.77E-07	0	1.11E-06
	AR04	1.33E-06	1.70E-06	2.65E-07	0	1.06E-06

REC 3941
REC 0705

PET 339

Table 3. MODELED EMISSION RATES FOR CARCINOGENIC TAPS (WORST-CASE MODELING SCENARIOS).						
Type of Source	**Source ID**	**ARSE[a] (lb/hr)[b]**	**BERY[c] (lb/hr)**	**CADM[d] (lb/hr)**	**FORM[e] (lb/hr)**	**NICK[f] (lb/hr)**
Volume Sources	WEPBL	1.79E-02	8.57E-05	1.34E-05	0	5.36E-05
	FDRSF	4.23E-03				
	STKP		2.72E-05	4.25E-06	0	1.70E-05
	OC1	0	0	0	0	0
	OC2	0	0	0	0	0
	OC3	0	0	0	0	0
	OC4	0	0	0	0	0
	OC5	0	0	0	0	0
	OC6	0	0	0	0	0
	OC7	0	0	0	0	0
	OC8	0	0	0	0	0
	OC9	0	0	0	0	0
	OC10	0	0	0	0	0
	OC11	0	0	0	0	0
	OC12	0	0	0	0	0
	OC13	0	0	0	0	0
	LS1U	5.51E-08	1.92E-09	5.99E-10	0	1.20E-08
	MILLS2U	5.51E-08	1.92E-09	5.99E-10	0	1.20E-08
	ACS1U	2.21E-07	7.67E-09	2.40E-09	0	4.79E-08
	ACS2U	2.21E-07	7.67E-09	2.40E-09	0	4.79E-08
	ACS3U	2.21E-07	7.67E-09	2.40E-09	0	4.79E-08
	ACS42U	1.10E-07	3.84E-09	1.20E-09	0	2.40E-08
	PSU	0	0	0	0	0
	CS1U	2.90E-08	3.33E-09	0	0	2.86E-07
	CS2U	2.90E-08	3.33E-09	0	0	2.86E-07
	CAL	0	0	0	0	0
	CAU	0	0	0	0	0
	CM	2.03E-06	0	4.86E-09	0	1.70E-06
	PCSP1	0	0	0	0	0
	PCSP2	0	0	0	0	0
	LS1	0	0	0	0	0
	LS2	0	0	0	0	0
	LS3	0	0	0	0	0
	LS4	0	0	0	0	0
	LS5	0	0	0	0	0
	LS7	0	0	0	0	0
	LS8	0	0	0	0	0
	LS10	0	0	0	0	0
	LS11	0	0	0	0	0
	LS12	0	0	0	0	0
	LSU	0	0	0	0	0
	MILLTANKS	0	0	0	0	0

Table 3. MODELED EMISSION RATES FOR CARCINOGENIC TAPS (WORST-CASE MODELING SCENARIOS).						
Type of Source	**Source ID**	**ARSE[a] (lb/hr)[b]**	**BERY[c] (lb/hr)**	**CADM[d] (lb/hr)**	**FORM[e] (lb/hr)**	**NICK[f] (lb/hr)**
Volume Sources	HRF001-HRF055[g]	1.03E-03				
	HRQ001-HRQ049[g]	1.03E-03				
	HRR001-HRR006[g]	1.03E-03				
	HRN001-HRN022[g]	1.03E-03	9.27E-06	1.45E-06	0	5.80E-06
	HRB001-HRB003[g]	1.03E-03				
	HRP001-HRP057[g]		9.27E-06	1.45E-06	0	5.80E-06
	HRO001-HRO002[g]	1.03E-03	9.27E-06	1.45E-06	0	5.80E-06
Total Modeled Rates		***1.73E-01***	***9.15E-04***	***1.71E-04***	***1.89E-03***	***6.27E-04***
Total T-RACT Emission Rates[h]		***1.73E-01***	***9.1E-04***	***1.7E-04***	***1.9E-03***	***6.3E-04***
Total Emission Rates at 180,000 T/day[i]		***4.03E-01***	***1.36E-03***	***2.40E-04***	***1.89E-03***	***9.04E-04***

a. Arsenic (worst-case modeling scenario: W2).
b. Pounds per hour.
c. Beryllium (worst-case modeling scenario: W1).
d. Cadmium (worst-case modeling scenario: W1).
e. Formaldehyde (worst-case modeling scenario: W1).
f. Nickel (worst-case modeling scenario: W1).
g. The Haul Road was represented in the model as a series of volume sources. The emission rates listed in this table represent each individual volume source.
h. Total T-RACT emission rates – calculated based on T-RACT controls, long-term mining production limits, and other emission inventory refinements, as described in Section 4.0 of this *Modeling Review Attachment* – are derived from Tables B-W2 (for Arsenic) and B-W1 (for Beryllium, Cadmium, Formaldehyde, and Nickel) in Appendix B of the *TAP Addendum*.
i. Total emission rates at 180,000 tons per day were derived from Worksheet "TblA" in the emission inventory dated October 5, 2021. The total emission rates in this row represent all facility-wide HAP/TAP emission sources from mining, leaching, and processing and production (excluding emissions from sources "addressed" or "covered" by NSPS/NESHAP).

5.5 Cyanide Modeling Emission Source Parameters

Modeling analyses for cyanide introduced two new emission sources that were not previously evaluated by DEQ: tailings storage facility (model ID: TSF) and mill tanks (model ID: MILLTANKS).

1. The tailings storage facility was modeled by Air Sciences as a surface-based (zero release height above ground-level and zero initial vertical dimension) AREA source. The easterly and northerly lengths were calculated as square-root of the TSF area (easterly length = northerly length = $\sqrt{1{,}338{,}158\ square\ meters}$ = 1,157 meters).

2. The mill tanks were grouped and modeled by Air Sciences as a single VOLUME source. The tanks sit on the ground, so the release height was set to the average tank height of 12.2 meters (40 feet). The initial lateral dispersion (σ_y) was calculated as the equivalent diameter of the combined (18) tank area divided by the single VOLUME source coefficient of 4.3:

REC 3943
REC 0707
PET 341

$$\sigma_{y(MILLTANKS)} = \frac{Equivalent\ diameter}{4.3} = \frac{\sqrt{\Sigma(d)^2}}{4.3} = 42.8\ feet$$

The individual tank diameters (d) are: two tanks at 40 feet, four tanks at 52 feet, six tanks at 54 feet, and six tanks at 20 feet.

DEQ typically requires that tailings storage facilities be modeled as an AREAPOLY source with an outline that follows the contour of the emission source, and that mill tanks be represented in the model as individual volume sources; but, given that the maximum modeled concentration for cyanide is safely below the AAC (0.08%), DEQ's modeling team accepted the modeling analysis submitted by Air Sciences and concluded that it confidently demonstrates that the cyanide AAC will not be exceeded.

5.6 Deposition Modeling

Air Sciences applied particle deposition algorithms in the impact modeling for particulate TAPs. The particulate deposition parameters used in the NAAQS compliance analysis were derived for PM_{10} and $PM_{2.5}$ (see Tables 22 and 23 in the main body of the DEQ *Modeling Review Memorandum*). Dust-related metal TAP emissions include total particulates (all size fractions of particulate matter [PM] up to PM_{30}). Therefore, the deposition parameters for PM were calculated using the same methodology and EPA references used for PM_{10} and $PM_{2.5}$ in the NAAQS compliance demonstration analyses. The PM deposition parameters are provided below in Table 4. The same density values were used as in the previous TAPs modeling analysis. However, an additional deposition characterization bin was added to better handle deposition of 10 µm to 30 µm particulates; mass fractions were adjusted accordingly.

Table 4. PARTICULATE MATTER DEPOSITION PARAMETERS BY SOURCE CATEGORY.

Source Category	Parameter	PM				
		Bin 1	**Bin 2**	**Bin 3**	**Bin 4**	**Bin 5**
Haul Roads	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.02	0.23	0.75	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3) (YPP, HFP, WEP DR average)	2.46	2.46	2.46	--	--
Material Handling (Ore, DR, Limestone)	Bin Upper Diameter (µm)	2.50	5.00	10.00	30.00	--
	Mass Fraction	0.07	0.20	0.20	0.53	--
	Mass Mean Diameter (µm)	2.50	5.00	10.00	30.00	--
	Density (g/cm^3) (Ore)	Pit-specific, see Table 23[a].				
	Density (g/cm^3) (Ore and Waste)	Pit-specific, see Table 23.				
	Density (g/cm^3) (Limestone)	1.09	1.09	1.09	1.09	--
Baghouses	Bin Upper Diameter (µm)	2.50	6.00	10.00	30.00	--
	Mass Fraction	0.25	0.45	0.20	0.10	--
	Mass Mean Diameter (µm)	2.50	6.00	10.00	30.00	--
	Density (g/cm^3) (Ore)	Pit-specific, see Table 23.				
Diesel Engines	Bin Upper Diameter (µm)	1.00	2.50	6.00	10.00	30.00
	Mass Fraction	0.82	0.08	0.03	0.03	0.04
	Mass Mean Diameter (µm)	1.00	2.50	6.00	10.00	30.00
	Density (g/cm^3) (Diesel Combustion)	1.00	1.00	1.00	1.00	1.00
Heaters and Boilers	Bin Upper Diameter (µm)	1.00	2.50	6.00	10.00	30.00
	Mass Fraction	0.23	0.22	0.25	0.09	0.21
	Mass Mean Diameter (µm)	1.00	2.50	6.00	10.00	30.00
	Density (g/cm^3) (Propane Combustion)	1.24	1.24	1.24	1.24	1.24

REC 3944
REC 0708
PET 342

Table 4. PARTICULATE MATTER DEPOSITION PARAMETERS BY SOURCE CATEGORY.						
Source Category	**Parameter**	**PM**				
		Bin 1	**Bin 2**	**Bin 3**	**Bin 4**	**Bin 5**
Lime Loading and Unloading (Quick, Pebble)	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.05	0.29	0.66	--	--
	Mass Mean Diameter	2.50	10.00	30.00	--	--
	Density (g/cm^3) (Quick)	0.44	0.44	0.44	--	--
	Density (g/cm^3) (Pebble)	0.96	0.96	0.96	--	--
Lime Unloading (Quick, Pebble)	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.09	0.49	0.42	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3) (Quick)	0.44	0.44	0.44	--	--
	Density (g/cm^3) (Pebble)	0.96	0.96	0.96	--	--
Cement and Aggregate Loading and Unloading	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.05	0.29	0.66	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3) (Cement)	1.44	1.44	1.44	--	--
	Density (g/cm^3) (Aggregate)	1.28	1.28	1.28	--	--
Prill Loading and Unloading	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.05	0.30	0.65	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3) (Prill)	0.84	0.84	0.84	--	--
Refining Processes	Bin Upper Diameter (µm)	1.00	2.50	6.00	10.00	30.00
	Mass Fraction	0.72	0.10	0.07	0.03	0.08
	Mass Mean Diameter (µm)	1.00	2.50	6.00	10.00	30.00
	Density (g/cm^3) (Diesel Combustion)	1.00	1.00	1.00	1.00	1.00
Portable Crushing and Screening Plant	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.05	0.32	0.63	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3) (YPP, HFP, WEP DR average)	2.46	2.46	2.46	--	--
Lime Kiln and Ball Mill	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction (Kiln)	0.27	0.28	0.45	--	--
	Mass Fraction (Ball Mill)	0.30	0.54	0.16	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3)	1.09	1.09	1.09	--	--
Blasting and Drilling	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.03	0.49	0.48	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3) (Ore or DR)	Pit-specific, see Table 23.				
Dozing	Bin Upper Diameter (µm)	2.50	10.00	15.00	30.00	--
	Mass Fraction	0.11	0.08	0.06	0.75	--
	Mass Mean Diameter (µm)	2.50	10.00	15.00	30.00	--
	Density (g/cm^3) (DR)	Pit-specific, see Table 23.				

[a.] See Table 23 in the main body of the DEQ *Modeling Review Memorandum*.

5.7 Carcinogenic TAP Modeling Lifetime Exposure Adjustment

Maximum modeled concentrations for carcinogenic TAPs were adjusted to account for the life-of-mine production limits, which affects the lifetime exposure.

PRI evaluated the highest modeled annual carcinogenic TAP concentration from each of the 14 modeling scenarios for lifetime exposure as follows:

$$Lifetime\ exposure\ \left(\frac{\mu g}{m^3}\right) = \frac{Highest\ annual\ concentration\ \left(\frac{\mu g}{m^3}\right) \times 16\ (mine\ operation\ years)}{70\ (years, lifetime\ exposure)}$$

This equation assumes that the highest annual concentration from the 14 modeling scenarios is repeated for 16 years of mining operation. This was then averaged over 70 years to calculate the 70-year lifetime exposure.

PRI and Air Sciences contend that calculating lifetime exposure based on 16 years of mining operation is conservative. The annual emissions for carcinogenic TAP modeling are based on 135,000 tons/day (see Section 5.1 of this *Modeling Review Attachment*) and 365 days per year. Over 16 years, this equates to a potential mining production of 788.4 million tons:

$$\frac{135{,}000\ \left(\frac{tons}{day}\right) \times 365\ \left(\frac{days}{year}\right) \times 16\ years}{1{,}000{,}000\ \left(\frac{tons}{million\ ton}\right)} = 788.4\ million\ tons$$

The actual life-of-mine total production as described in the SGP *Refined Proposed Action* (*ModPRO2*) mine plan is only 402.86 million tons (Perpetua 2021), which is 51.1% of the potential life-of-mine production represented in the above equation and related emission evaluations.

5.8 Arsenic Compliance Demonstration for Modeling Scenarios W1-W4

To demonstrate compliance with the AACC for arsenic, PRI applied two additional operating limitations:

- The removal of Modeling Scenario W5 as a potential operating scenario
- Limiting the West End Pit's life-of-mine potential mining production to 50% of the total life-of-mine potential mining production of 788.4 million tons: 50% * 788.4 million tons = 394.2 million tons

PRI has determined that the West End Development Rock Storage Facility (DRSF) will not be constructed. This change eliminated Modeling Scenario W5 from the arsenic modeling evaluation. The remaining four West End Pit modeling scenarios (W1–W4) are evaluated using the 70-year lifetime exposure equation from Section 5.7 and adjusting for the proposed West End Pit life-of-mine production limit of 50% of the total production as follows:

$$LifeExpose_{Wi,j,n} = \left[\left(WEPExpose_{Wi,n}\right)(50\%) + \left(nonWEPExpose_{Sj,n}\right)(50\%)\right]\left[\frac{16\ year\ LOM}{70\ year\ exposure}\right]$$

where:

W*i*	=	West End Pit scenario, where *i* = 1 to 4.
S*j*	=	non West End Pit scenario, where *j* = B1, B2, H1, H2, H3, H4, Y1, Y2, and Y3.
n	=	specific receptor.
$LifeExpose_{Wi,j,n}$	=	lifetime exposure in µg/m^3 for West End Pit scenario *i*, non West End Pit scenario *j*, at receptor *n*.
$WEPExpose_{Wi,n}$	=	annual maximum impact in µg/m^3 for West End Pit scenario *i* at receptor *n*.
$nonWEPExpose_{Sj,n}$	=	annual maximum impact in µg/m^3 for non West End Pit scenario *j* at receptor *n*.
16 year LOM	=	maximum life-of-mine.
70 year exposure	=	Lifetime exposure used for development of AACCs in *Idaho Air Rules*.

The above equation was used to calculate the lifetime arsenic exposure from the West End Pit scenarios (W1–W4) on a receptor-by-receptor basis. Combining the concentrations from Modeling Scenarios W1–W4 with the highest concentration from the remaining non-West End Pit scenarios (B1, B2, H1, H2, H3, H4, Y1, Y2, or Y3) conservatively ensures that the maximum potential impacts from applicable sources are evaluated and remain below AACCs.

PRI contends that calculating lifetime arsenic exposure based on the proposed West End Pit life-of-mine production limit of 50% of the total production is conservative. The actual life-of-mine total production from the West End Pit as described in the ModPRO2 mine plan is only 198.26 million tons (Perpetua 2021), which is 50.3% of the proposed West End Pit life-of-mine production limit of 394.2 million tons.

6.0 Impact Results

TAP impact analysis results, as submitted in the *TAP Addendum* and as further assessed by DEQ, are discussed in this section. The effect of various operational refinements also reduced PM_{10} and $PM_{2.5}$ impacts, and this is discussed in Section 6.2.

6.1 TAP Impact Analyses Results

This section describes the revised TAP impact analyses and demonstrates that applicable TAP emissions resulting from operation of the SGP will not result in increased impacts that exceed AACs or AACCs.

6.1.1 Modeling Non-Carcinogenic TAPs

The non-carcinogenic TAPs subject to impact modeling requirements to demonstrate compliance with AACs of *Idaho Air Rules* Section 585 were modeled at the emission levels shown in Table 1 above. The maximum 24-hour modeled concentration for each of the 14 modeling scenarios demonstrates compliance with the applicable AAC, as summarized below in Table 5. PRI elected to include Scenario W5 in the modeling analysis for non-carcinogenic TAPs. Figure 1 illustrates the locations of the maximum impacts for each non-carcinogenic TAP.

REC 3947
REC 0711
PET 345

Table 5. RESULTS FOR TAPS IMPACT ANALYSES FOR NON-CARCINOGENIC TAPS.					
Toxic Air Pollutant	**Averaging Time**	**Maximum Modeled Concentration ($\mu g/m^3$)[a]**	**Model Scenario**	**AAC[b] ($\mu g/m^3$)**	**Percent of AAC**
Aluminum	24-hour	6.17	W5	500	1.23%
Barium	24-hour	0.07	W5	25	0.28%
Calcium carbonate	24-hour	1.22	W5	500	0.24%
Calcium oxide	24-hour	0.15	All	100	0.15%
Cyanide	24-hour	0.20	All	250	0.08%
Iron	24-hour	1.58	W5	50	3.16%
Manganese	24-hour	0.03	W5	250	0.01%
Phosphorus	24-hour	0.06	W5	5	1.20%
Sulfuric acid	24-hour	0.41	All	50	0.82%
Thallium	24-hour	0.001	W5	5	0.02%
Vanadium	24-hour	0.002	W5	2.5	0.08%

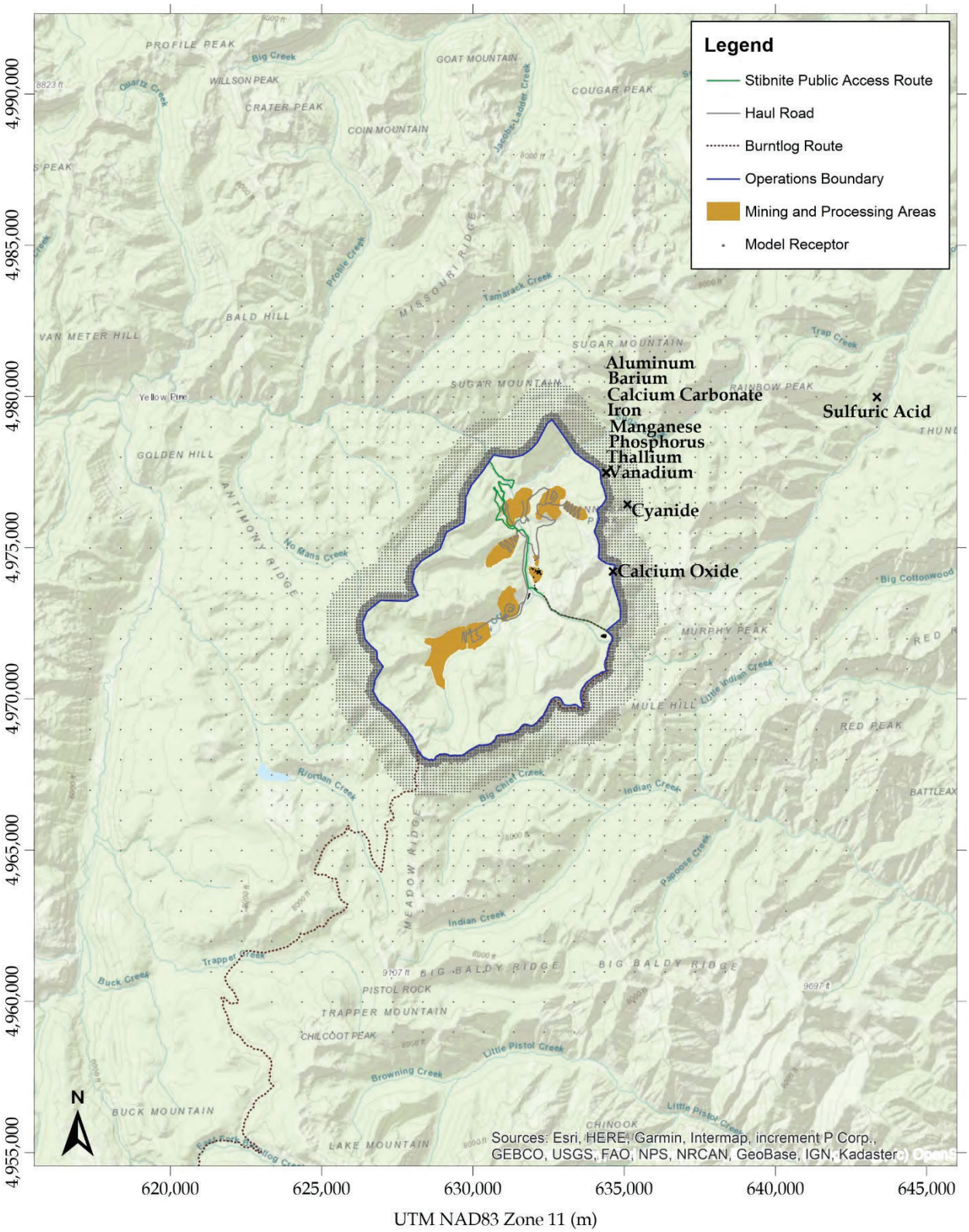
a. Micrograms per cubic meter.

b. Acceptable Ambient Concentration of a Non-carcinogenic TAP.

REC 3948
REC 0712

PET 346

Figure 1. SGP NON-CARCINOGENIC MAXIMUM TAP IMPACT LOCATIONS.



6.1.2 Modeling Carcinogenic TAPs

The carcinogenic TAPs subject to impact modeling requirements to demonstrate compliance with AACCs of *Idaho Air Rules* Section 586 were modeled using an emission inventory that includes the T-RACT controls, long-term mining production limits, and other emission inventory refinements, as described in Section 4.0 and 5.0 of this *Modeling Review Attachment*.

The maximum modeled impact for each of the 14 modeling scenarios demonstrated compliance with the T-RACT AACC, as summarized below in Table 6. The SGP maximum concentrations were adjusted to account for the life-of-mine production limits, which affect the lifetime exposure, and to account for the elimination of Modeling Scenario W5. See Sections 5.7 and 5.8 of this *Modeling Review Attachment* for more detail. The locations of the maximum impacts for each carcinogenic TAP are presented in Figure 2. Arsenic concentrations are considerably lower in areas away from the location of maximum impact as shown in Figure 3.

Table 6. RESULTS FOR TAPS IMPACT ANALYSES FOR CARCINOGENIC TAPS.

Toxic Air Pollutant	Averaging Time	Maximum Modeled Lifetime Exposure Concentration ($\mu g/m^3$)[a,b]	Model Scenario	AACC[c] ($\mu g/m^3$)	T-RACT[d] AACC	Percent of T-RACT AACC
Arsenic	Annual	0.00095	W2	0.00023	0.0023	41.30%
Beryllium	Annual	0.00001	W1	0.0042	0.042	0.02%
Cadmium	Annual	0.000002	W1	0.00056	0.0056	0.04%
Formaldehyde	Annual	0.00007	W1	0.077	0.77	0.01%
Nickel	Annual	0.00001	W1	0.042	0.42	<0.01%

a. Micrograms per cubic meter.
b. The lifetime exposure concentrations are based on the proposed restrictions discussed in Sections 5.7 and 5.8 of this *Modeling Review Attachment*.
c. Acceptable Ambient Concentration of a Carcinogenic TAP.
d. Toxic Air Pollutant Reasonably Available Control Technology allows the AACCs to be increased by a factor of ten per *Idaho Air Rules* Section 210.12(b).

Figure 2. SGP CARCINOGENIC MAXIMUM TAP IMPACT LOCATIONS.

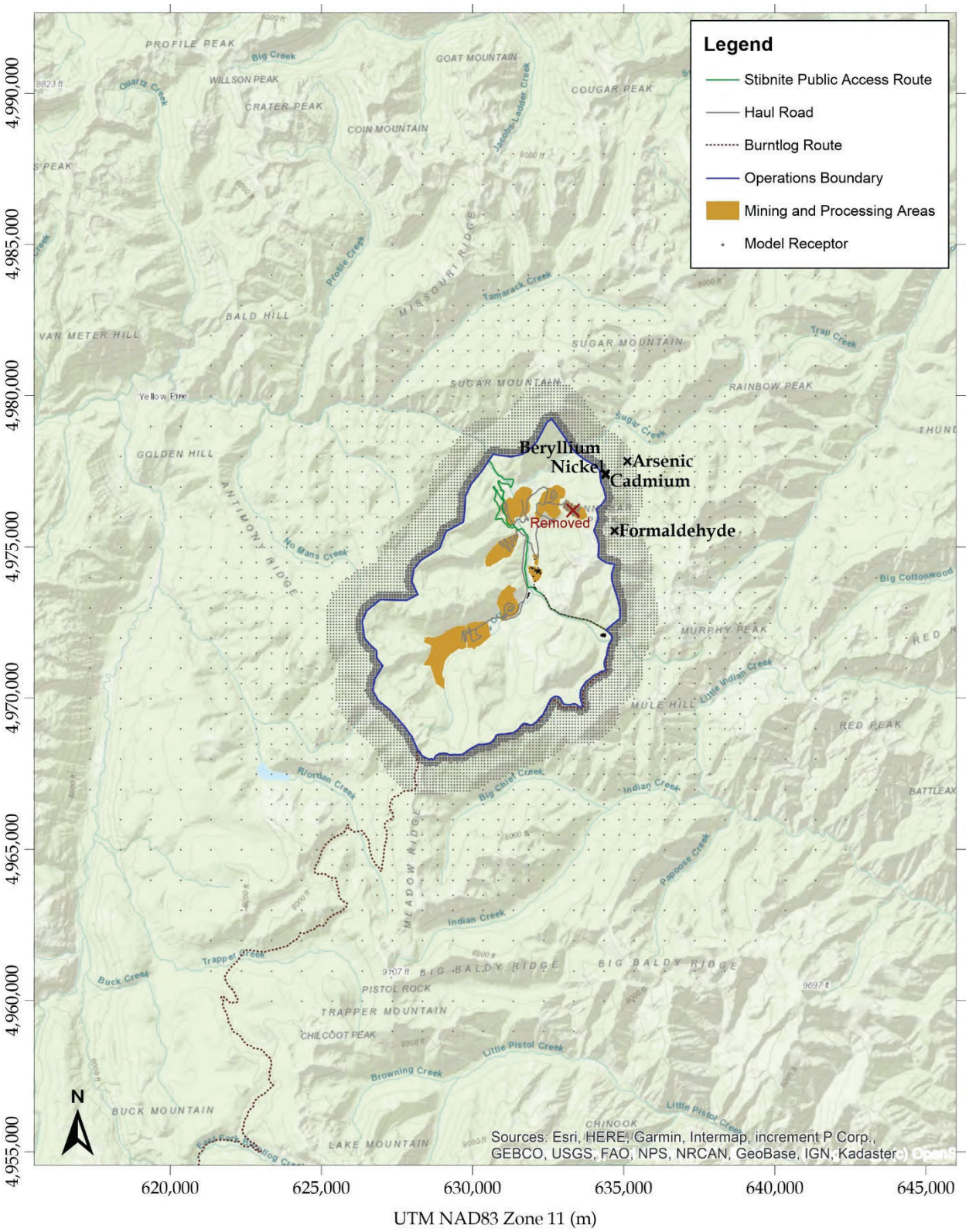
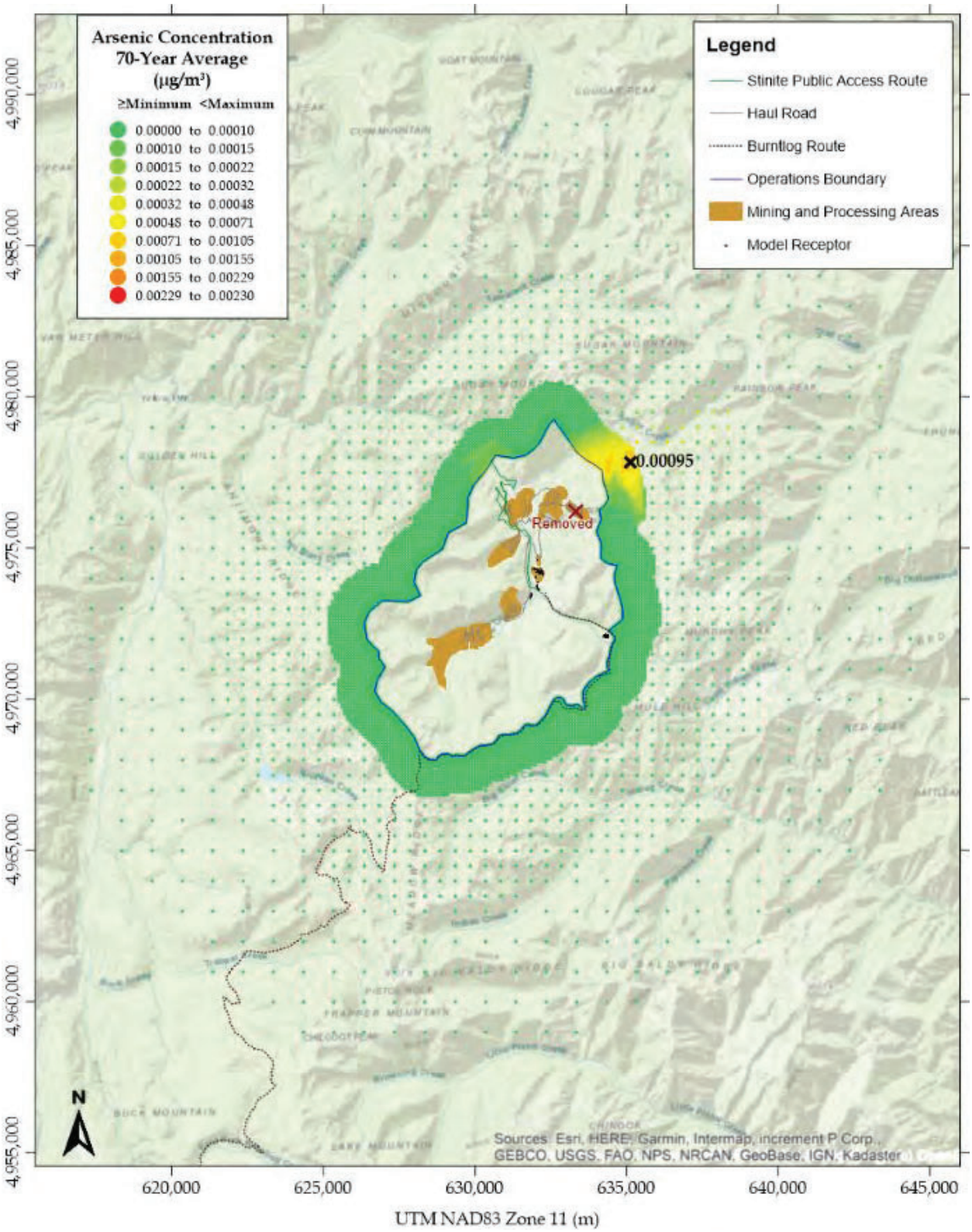


Figure 3. SGP CONTOURS OF LIFETIME ARSENIC IMPACTS.



6.2 Effect of Changes to Modeled PM_{10} Results

PRI has determined that the West End Development Rock Storage Facility will not be constructed. This change eliminated Modeling Scenario W5 as a potential operating scenario. In Section 4.1.4 in the main body of the DEQ *Modeling Review Memorandum*, DEQ identified PM_{10} NAAQS exceedances at four hotspot receptors when using the BULKRN meteorological dataset for Modeling Scenario W5 (the highest PM_{10} impact modeling scenario). When Modeling Scenario W5 is removed, the highest modeled impacts are predicted to occur for Modeling Scenario W3, which represents the transport of development rock from the West End Pit to the Hangar Flats Development Rock Storage Facility.

Table 7 presents results for the cumulative NAAQS impact analyses for Scenario W3. Results still exceed the 24-hour PM_{10} NAAQS even when Modeling Scenario W5 is eliminated. However, there is only one hotspot receptor exceeding NAAQS. The modeled violation is also predicted to occur during winter. This is a critical consideration because during winter, not only are fugitive emissions minimized because of the higher moisture content of material handled or driven over, but background concentrations in such remote areas are also generally much lower because of the absence of wildfires and dust-generating sources.

Table 7 also lists the results when using temporally varying backgrounds, instead of a single-value background, in the cumulative NAAQS impact analysis (using the "SEASON" and "MONTH" options in AERMOD). The highest daily average PM_{10} concentrations measured at Stibnite for every season and month in 2014 were used as inputs in the model. Table 7 shows that the SGP facility ***safely*** demonstrates compliance with the 24-hour PM_{10} NAAQS when temporally varying backgrounds (both seasonal and monthly) are used instead of the single-value background. Summing modeled design values with a single-value background that is on the upper end of the distribution results in a very conservative estimate of total impacts. DEQ strongly believes that using temporally varying backgrounds that respect seasonality is appropriate for the SGP facility, and that using the highest value in the period interval is very conservative.

TABLE 7. RESULTS FOR 24-HOUR PM_{10} CUMULATIVE NAAQS IMPACT ANALYSES FOR MODELING SCENARIO W3.

Backgrounds Scenario	Max. Conc.[a] (µg/m³)[b]	Model Scenario	Back. Conc.[c] (µg/m³)	Total Conc.[d] (µg/m³)	NAAQS (µg/m³)	Percent of NAAQS
Single-Value Background	116.9	W3	34.0	150.9[e]	150	100.6%
Seasonally Varying Backgrounds	123.5[f]	W3	*Seasonal*	123.5[f]		82.3%
Monthly Varying Backgrounds	123.5[f]	W3	*Monthly*	123.5[f]		82.3%

a. Max. Conc. = maximum modeled design concentration.
b. Micrograms per cubic meter.
c. Back. Conc. = background concentration.
d. Total Conc. = total (modeled + background) concentration.
e. One hotspot receptor exceeds NAAQS.
f. The maximum modeled design concentration already incorporates the seasonal and monthly background values.

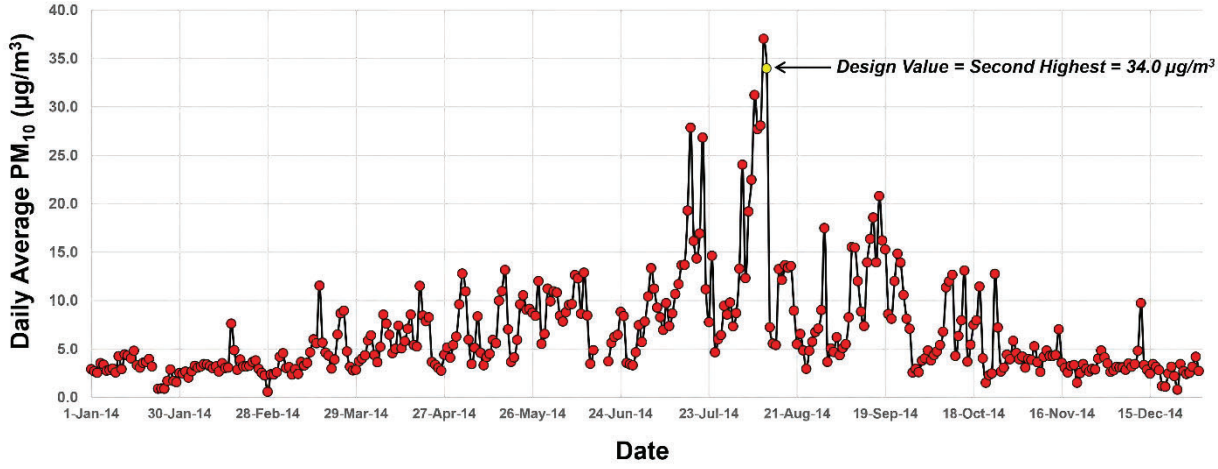
The time series plot in Figure 4 and the box-and-whiskers plot in Figure 5 illustrate the variability in daily average PM_{10} concentrations collected at the Stibnite Site in 2014. Figures 4 and 5 confirm that the highest concentrations from the modeled and monitored datasets do ***not*** occur simultaneously. Highest modeled impacts are predicted to occur during winter while the highest background concentrations were measured at Stibnite during summer. Therefore, the summation method, where total impacts are

REC 3953
REC 0717
PET 351

calculated by summing modeled design values with a background concentration that is also consistent in form with the regulatory design value, results in a very conservative estimate of the total impact for comparison to NAAQS. DEQ concludes that use of temporally varying (i.e., seasonal and monthly) backgrounds for SGP is justified. DEQ is highly confident that operation of the SGP will not cause or contribute to a violation of NAAQS.

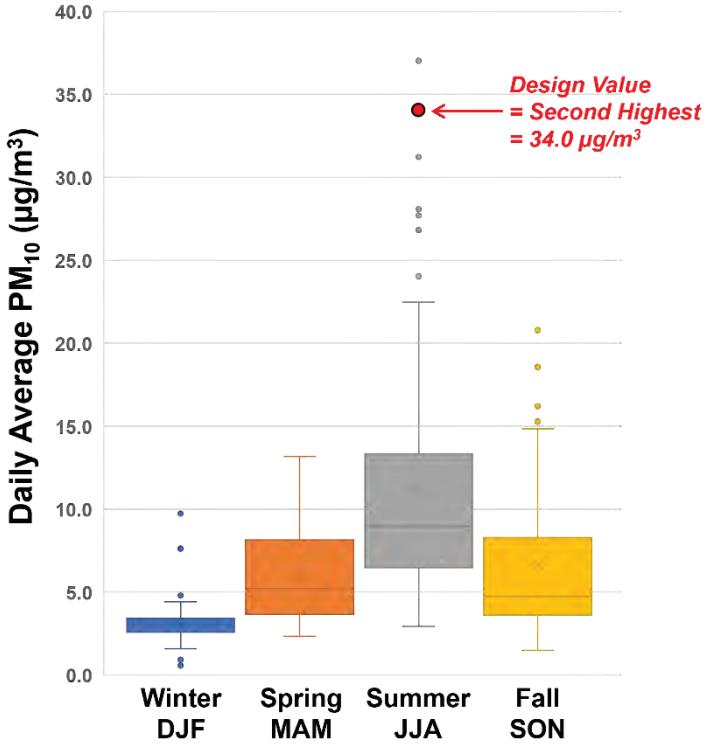
PM_{10} and $PM_{2.5}$ NAAQS compliance was previously demonstrated prior to refinements and adjustments proposed in the submitted *TAP Addendum*. The main body of the DEQ *Modeling Review Memorandum* discussed and considered results from both modeling with meteorological data processed using the BULKRN method and modeling with data processed using cloud cover data, and DEQ concluded that NAAQS compliance was demonstrated with a high degree of confidence. The adjustments and refinements described in the *TAP Addendum* further increase DEQ's confidence in NAAQS compliance.

Figure 4. TIME SERIES OF DAILY AVERAGE PM_{10} CONCENTRATIONS MEASURED AT STIBNITE IN 2014.



REC 3954
REC 0718
PET 352

Figure 5. BOX-AND-WHISKERS PLOT FOR SEASONAL PM_{10} BACKGROUND CONCENTRATIONS MEASURED AT STIBNITE IN 2014.



In Figure 5 the middle line of each box represents the median. The "x" in the box represents the mean. The bottom and the top lines of the box represent the 1st quartile (25th percentile) and the 3rd quartile (75th percentile), respectively. The whiskers extend to the minimum and maximum values not considered outliers. Outliers are plotted individually.

7.0 Conclusions

This section provides conclusions of the *TAP Addendum* and DEQ's review of the *TAP Addendum*.

7.1 Conclusions of Revised TAP Analyses

The revised and refined TAP analyses:

- Revised TAP-applicable sources at the SGP facility.
- Proposed additional emission control measure and adjusted operations to reduce TAP emissions.
- Refined the approach used to demonstrate compliance with TAP regulations.

The submitted application, with the adjustments and refinements to analyses as described in the *TAP Addendum*, demonstrated to DEQ's satisfaction that the emissions of applicable TAPs will not result in impacts to ambient air that exceed TAP increments of *Idaho Air Rules* Section 585 and 586.

7.2 Effects of Adjustments/Revisions on NAAQS Compliance Demonstrations

The submitted application, prior to the *TAP Addendum*, demonstrated compliance with NAAQS to DEQ's satisfaction; and the operational measures proposed in the *TAP Addendum* will only further reduce estimated emissions. Eliminating Modeling Scenario W5 impacts, with the elimination of the West End Development Rock Storage Facility, affects the 24-hour PM_{10} impact modeling analysis for SGP. Modeling Scenario W3 is now the scenario producing the highest modeled impacts, and NAAQS compliance is easily demonstrated when using temporally varying background PM_{10} values, which were obtained from onsite monitoring data.

7.3 Conservatism of Permitting Analyses

Emissions and locations from which emissions occur are highly dynamic at mining facilities. This presents unique challenges for permit development because permits must include limits and operational requirements that ensure air quality standards are not violated. Permitting rules require that air impacts be assessed using maximum potential emissions as limited by either the capacity of the unit/operation or as limited by enforceable permit provisions. A permit where actual emissions are nearly representative of maximum allowable emissions, through imposing permit limits, would be exceedingly complex and require overly burdensome monitoring and record-keeping requirements. To avoid this, applicants typically calculate allowable emissions and perform impact analyses based on simplistic operational scenarios that largely overstate emissions estimated to occur from the facility.

PRI and Air Sciences have asserted that the submitted emission estimates, operational scenarios, and air impact analyses associated with the permit application greatly overstate best-estimated values. This point is evident when comparing the permit application materials and analyses with those presented in ModPRO2, PRI's revised mine plan and associated impacts. ModPRO2 is used in support of the Environmental Impact Statement (EIS).

Reference

Perpetua. 2021. "ModPRO2 Mine Plan." *File: Midas Stibnite Mine Plan and Equipment Schedule (10Feb21).xlsx.* Email from R. McCluskey, Perpetua Resources Inc., to E. Memon, Air Sciences Inc., February 11.

REC 3956
REC 0720
PET 354

EXHIBIT B

State of Idaho
DEPARTMENT OF HEALTH AND WELFARE
Division of Environmental Quality

1410 N. Hilton
Boise, Idaho 83706

CECIL D. ANDRUS
Governor
RICHARD P. DONOVAN
Director

March 7, 1991

M E M O R A N D O M

To: Orvil Green

From: Robert Wilkosz RW
Tim Teater TT

Subject: Request for layman's explanation of URF & TLV

Attached, per your request is a draft explanation of URF and TLV/100 concepts as utilized in TAP NSR. This, of course, represents our tox. based views of what will do the job. We defer this draft to you for final decision as to what a layman might understand.

In developing emissions limits for new permitted facilities, the Idaho Air Quality Bureau (IAQB) uses the terms Unit Risk Factors and Threshold Limit Values. The following is an explanation of these terms and how they are used.

UNIT RISK FACTOR

A unit risk factor (URF) is used to describe the possibility of developing excess cancers over a average 70 year lifetime. This is based on being exposed to concentration of one microgram of a carcinogenic (cancer causing) substance in one cubic meter (1 $ug/m^{3)}$ of air over the 70 years. The term excess cancers means cases of cancers in excess of what would be normal for a given population. For example, if there was normally 5 cases of a given type of cancer in Anytown USA before a given exposure to some substance and 7 after the exposure, there would be 2 excess cancers.

Inhalation URFs are developed by the U.S. Environmental Protection Agency for carcinogenic substances. Each URF represents months of research and often years of policy process. Teams of toxicologists gathered all the toxicological information for each known or suspected carcinogen that could be found around the world. The available data were then rated or point factored per the quality of the research involved. A URF then is a probability statement derived from this process. Each URF was proposed by EPA

Celebrate IDAHO
1890 · CENTENNIAL · 1990™
REC 3958
Printed on Recycled Paper

and extensively reviewed and debated in public by scientists, health officials and industry representatives. Every URF represents a consensus of the best science and health opinion of the potency of a given carcinogen.

URFs are usually expressed as a number times 10 to some negative power. For example, benzine, an organic hydrocarbon found in various petroleum products and cigarette smoke has a unit risk factor of 8.3×10^{-6}. This means that there are 8.3 chances in one million of getting cancer if a person is exposed to 1 ug/m^3 24 hours a day for 70 years.

Another example would be asbestos. Asbestos has a URF of 2.3×10^{-1}. That means that if exposed to 1 ug/m^3 concentration for 70 years, the chances of getting cancer would be 2.3 in 10.

Within IAQB New Source Review (NSR) policy, URFs are used to calculate acceptable ambient levels for a given carcinogen. IAQB generally establishes that an ambient concentration which causes no more excess cancers than one in a million (1×10^{-6}) is acceptable. Once an acceptable ambient level is established, IAQB can then back calculate via engineering equations to an acceptable emission rate (in pounds per hour) for a given stack.

THRESHOLD LIMIT VALUE

Threshold Limit Value (TLV) is a time weighted exposure limit developed by the Occupational and Safety Administration and or the American Council of Government Industrial Hygienists. This value is used to limit the exposure of informed workers to a given toxic substance in the work place. The value is based on exposure of adult males working an eight hour shift. The IAQB uses TLV information to screen proposed new source emissions levels. The IAQB divides the TLV first by a value of 10 due to the fact that an ambient air exposure of a carcinogen means people are usually living under that exposure longer than eight hours out of 24. This value is then again divided by 10 to compensate for the fact that not everyone who is potentially exposed is an adult male. Other people may be more sensitive. The TLV thus is divided by a total of 100 for use in setting an acceptable ambient level.

For example, the TLV for cyanide is 5 milligrams per cubic meter (mg/m^3). An acceptable ambient level under IAQB policy would be 5 divided by 100 or 0.05 mg/m^3. For another example, the TLV for Lindane (an insecticide) would be 0.5 mg/m^3 concentration. The acceptable ambient level would be 0.5 divided by 100 or 0.005 mg/m^3.

As with carcinogens, the TLV derived acceptable ambient levels are used by the IAQB engineers to back calculate an acceptable stack emission rate for any proposed new source. A more pointed treatment these concepts can be found in The Toxic Air Pollutant NSR Policy Summary or the more thorough Draft Guidance Manual for Obtaining a Permit to Construct, Modify or Operate an Air Pollution Source.

REC 3959

EXHIBIT C

R. Wilkosz

IDAHO DEPARTMENT
OF HEALTH AND WELFARE

DIVISION OF
ENVIRONMENTAL QUALITY

1410 North Hilton, Statehouse Mail, Boise, ID 83720-9000, (208) 334-0502 Cecil D. Andrus, Governor Richard P. Donovan, Director

July 29, 1992

Dick Rush, Vice President
IACI
P. O. Box 389
Boise, ID 83701

Dear Mr. Rush:

Attached is the DEQ list of ideas for rules to control new sources of toxic air pollutants in Idaho. This submittal should be considered a "straw-man" in that our deputy attorney general has not had adequate time to review this material. Nor has anyone from the State Bureau of Health had opportunity to comment. I will continue to try to get that input prior to our next meeting. But for now, we must consider this specific submittal for discussion purposes only.

The package is formatted so that comparisons can be made to the existing Air Quality Rules. If you have any questions, please call me.

Sincerely,

Robert Wilkosz
Bureau Chief
Technical Services Bureau
Division of Environmental Quality

RW:br/Rush.ltr

Attachment

cc: COF 1.1

TOXIC AIR POLLUTION
-- RULES CHANGE IDEAS FROM DEQ

IDAPA 16.01.01003 -- DEFINITIONS.

Approved Fuels. Natural gas, propane gas, liquified petroleum gas, distillate fuel oils, residual fuel oils, and diesel fuel; except that waste oil, gasoline, or refined gasoline are not approved fuels.

Environmental Remediation Source. An emission source that functions to remediate or recover any release, spill, leak, discharge or disposal of any petroleum product or substance or any hazardous waste as defined by IDAPA 16.01.01003,44, from any soil or ground or surface waters. Any Environmental Remediation Source shall have an operational life of no greater than five (5) years from the inception of actual operations to the cessation of actual operations.

Pilot or Experimental Plant. An emission source that functions to test processing, mechanical, or pollution control equipment to determine full-scale feasibility.

Occupational Exposure Limit. Refers to airborne concentrations of substances and represents conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effects. Occupational exposure Limits can be found in Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices with Intended Changes for 1991-92 or the current edition, adopted by the American Conference of Governmental Industrial Hygienists, or the National Institute for Occupational Safety and Health (NIOSH) current Relative Exposure Limit (REL), or the Occupational Health and Safety Administration (OSHA) Air Contaminate Standards, current Permissible Exposure Limit (PEL) or current Worker Protection Standards for Agricultural Pesticides promulgated by the Environmental Protection Agency under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). In the case of conflicting values, the most stringent value shall take precedence.

Unit Risk Factor. These factors describe the probability of developing excess cancers over a 70 year lifetime exposure to 1 ug/m^3 of a given carcinogen. Unit Risk Factors Can Be Found in the Federal Register Vol. 56 No. 35 / Thursday February 21, 1991 / Rules and Regulations Appendix V. or listed on the Integrated Risk Information System (IRIS) of the U.S. Environmental Protection Agency or listed in the Health Effects Summary Tables promulgated

by the U.S. Environmental Protection Agency Office of Health Effects Assessment and the Office of Air Quality Planning and Standards. In the absence of U.S. EPA accepted risk factors, risk factors under review by the EPA Carcinogen Risk Assessment Verification Endeavor (CRAVE) shall be used on an interim basis.

IDAPA 16.01.01012, PROCEDURES AND REQUIREMENTS FOR PERMITS TO CONSTRUCT AND OPERATING PERMITS.

IDAPA 16.01.01012,02. *Permit to Construct. No owner or operator may commence construction ..., except that no permit to construct is required for ~~the following classes of equipment which have actual and allowable emissions of less than one hundred (100) tons per year of any air contaminant or and would not significantly increase the emissions of a major facility~~ sources which:*

a. have actual and allowable emissions of less than one hundred (100) tons per year of any air contaminant

and

b. would not significantly increase the emissions of a major facility

and

c. will not have an ambient air concentration of any air contaminant that would, as demonstrated using Department-approved methods:

i. cause or significantly contribute to a violation of an ambient air quality standard,

or

ii. cause an ambient concentration in excess of one percent of the Threshold Limit Value,

or

iii. cause a cancer-risk probability in excess of one in one million:

and

list: including but not limited to.

d. which belong to one of the following classes of equipment:

i. Air conditioning or ventilating equipment not designed to remove air contaminants generated by or released from equipment;

ii. Air contaminant detectors or recorders, combustion controllers, or combustion shutoffs;

iii. Fuel burning equipment for indirect heating and for heating and reheating furnaces using gas exclusively with a capacity of less than fifty (50) million BTU's per hour input;

iv. Other fuel burning equipment for indirect heating with a capacity of less than one million (1,000,000) BTU's per hour input;

v. Mobile internal combustion engines, marine installations and locomotives;

vi. Stationary internal combustion engines in accordance with the following:

100 horsepower or less -- unlimited hours of operation
101 to 200 horsepower -- 450 hours per month
201 to 400 horsepower -- 225 hours per month
401 to 600 horsepower -- 150 hours per month

vii. Stationary internal combustion engines used exclusively for emergency power generation which burn an approved fuel and which operate less than 200 hours per year;

viii. Laboratory equipment used exclusively for chemical and physical analyses, including ventilating and exhaust systems for laboratory hoods;

ix. *Environmental characterization activities including emplacement and operation of field instruments, drilling of sampling and monitoring wells, and any other activities specifically exempted by the Director;*

x. *Pilot or experimental plants located at least 1/4 mile from any recreational area or residence or other structure not occupied or used solely by the owner of the facility or the owner of the property upon which the facility is located; which operate less than one year; and that also meet one of the following conditions:*

1. *use a slip stream from an existing process stream not to exceed ten percent of that existing process stream, or*

2. *have actual uncontrolled emissions which are not significant;*

xi. *Any emission source or sources provided that the actual uncontrolled facility-wide emissions are not significant, and the uncontrolled emissions would not significantly contribute to ambient air quality concentrations;*

xii. *Any other class or size of equipment specifically exempted by the Director. A list of those sources unconditionally exempted by the Director will be maintained by the Department, and made available upon request.*

IDAPA 16.01.01012,13. *Procedure for Issuing Permits*

a. General procedures ...

b. Additional procedures ... attainment or unclassifiable area ...

c. Additional procedures ... federal Class I area ...

d. Procedures for operating permits ...

e. The Department ... fluid model ...

f. Modification of permits ...

g. Additional procedures for demonstrating compliance with the toxic substances provision 01.01011,01.

i. For sources that can demonstrate, using Department-approved methods, that emissions of carcinogens contribute an ambient air cancer risk probability of less than 1:1,000,000 and that emissions of non-carcinogens contribute to an ambient air concentration less than one percent of the Threshold Limit Value, no additional procedures are needed.

ii. For sources not recognized by the Department as environmental remediation sources that cannot demonstrate, using Department-approved methods, that emissions of carcinogens contribute an ambient air cancer risk probability of less than 1:100,000 and that emissions of non-carcinogens contribute to an ambient air concentration of less than one percent of the Threshold Limit Value, a permit cannot be issued unless the source has achieved the greatest degree of emission reduction that has been adequately

demonstrated and declared acceptable by the Department's Division of Health.

iii. For remediation sources that cannot demonstrate, using Department-approved methods, that emissions of carcinogens contribute an ambient air cancer risk probability of less than 1:10,000 and that emissions of non-carcinogens contribute to an ambient air concentration of less than ten percent of the Threshold Limit Value, a permit cannot be issued unless the source has achieved the greatest degree of emission reduction that has been adequately demonstrated and declared acceptable by the Department's Division of Health.

iv. Department-approved methods will consist of the following:

(a) Comparison of maximum potential emissions to the screening emission limits for carcinogens and non-carcinogens as documented in Appendix A1 or A2 of the Toxic Air Pollutant list as promulgated but the Division of Environmental Quality. Maximum potential emissions can be determined by actual emissions testing using U.S. Environmental Protection Agency approved methods subject to review and approval by the Division of Environmental Quality or estimates of the maximum potential emissions using standard scientific and engineering principals and practices subject to review and approval by the Division of Environmental Quality

The State is reviewing and approving EPA policy... this is redundant

We need to open up in that we want to be able to approve more than EPA approved...

(b) *Atmospheric dispersion modeling, using only U.S. Environmental Protection Agency (EPA) currently approved models, applied according to EPA's Guidelines on Air Quality Models, and as approved for the application by the Division of Environmental Quality.*

average in what respect
- emission levels
- met conditions

1. *For carcinogens, multiply the average hourly concentration by a persistence factor of 0.15 to convert the hourly average to an annual average The resulting product is then multiplied by the unit risk factor to obtain a an ambient air cancer risk probability.*

or other long term model procedures allow better factor than 0.15 that

2. *For non-carcinogens, multiply the average hourly concentration by persistence factor of 0.15 to convert the hourly average to an annual average The resulting product is then compared to one one hundredth (1/100 of the appropriate occupational exposure limit.*

(c) *Any other method approved by the Director.*

TOXDEMN2.RUL

This language probably assumes use of T-SCREEN or something. We need to go more general?

We need to get model examples out to rest of group.

REC 3969

EXHIBIT D

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	*	AERMOD	(	19191):	MIDAS	GOLD	STIBNITE	-	MODELING	R27	########			
2	*	AERMET	(	19191):	16:04:03									
3	*	MODELING	OPTIONS	USED:	RegDFAULT	CONC	ELEV	NOWARN	DRYDPLT	WETDPLT	RURAL	ADJ_U*		
4	*	PLOT	FILE	OF	ANNUAL	VALUES	AVERAGED	ACROSS	1	YEARS	FOR	SOURCE	GROUP:	ALL
5	*	FOR	A	TOTAL	OF	720	RECEPTORS.							
6	*	FORMAT:	(3(1X,F13.5),3(1X,F8.2),2X,A6,2X,A8,2X,I8.8,2X,A8)											
7	*	X	Y	AVERAGE	CONC	ZELEV	ZHILL	ZFLAG	AVE	GRP	NUM	YRS	NET	ID
8	*													
9	0.001300	635399.5	4975934	0.00011	2213.4	2844.3	0	ANNUAL	ALL	1				
10	max ↑	635424.5	4975934	0.00011	2212.64	2844.3	0	ANNUAL	ALL	1				
11		635449.5	4975934	0.00011	2211.27	2844.3	0	ANNUAL	ALL	1				
12		635474.5	4975934	0.00011	2212.5	2844.3	0	ANNUAL	ALL	1				
13		635499.5	4975934	0.0001	2215.21	2844.3	0	ANNUAL	ALL	1				
14		635524.5	4975934	0.0001	2215.98	2844.3	0	ANNUAL	ALL	1				
15		635549.5	4975934	0.0001	2215	2844.3	0	ANNUAL	ALL	1				
16		635574.5	4975934	0.0001	2215.74	2844.3	0	ANNUAL	ALL	1				
17		635599.5	4975934	0.0001	2218.34	2844.3	0	ANNUAL	ALL	1				
18		635399.5	4975959	0.00012	2202.75	2844.3	0	ANNUAL	ALL	1				
19		635424.5	4975959	0.00012	2204.36	2844.3	0	ANNUAL	ALL	1				
20		635449.5	4975959	0.00011	2204.87	2844.3	0	ANNUAL	ALL	1				
21		635474.5	4975959	0.00011	2206.39	2844.3	0	ANNUAL	ALL	1				
22		635499.5	4975959	0.00011	2208.99	2844.3	0	ANNUAL	ALL	1				
23		635524.5	4975959	0.0001	2210.99	2844.3	0	ANNUAL	ALL	1				
24		635549.5	4975959	0.0001	2211.29	2844.3	0	ANNUAL	ALL	1				
25		635574.5	4975959	0.0001	2210.92	2844.3	0	ANNUAL	ALL	1				
26		635599.5	4975959	0.0001	2208.83	2844.3	0	ANNUAL	ALL	1				
27		635399.5	4975984	0.00012	2195.09	2844.3	0	ANNUAL	ALL	1				
28		635424.5	4975984	0.00012	2198.19	2844.3	0	ANNUAL	ALL	1				
29		635449.5	4975984	0.00012	2198.7	2844.3	0	ANNUAL	ALL	1				
30		635474.5	4975984	0.00011	2201.57	2844.3	0	ANNUAL	ALL	1				
31		635499.5	4975984	0.00011	2203.99	2844.3	0	ANNUAL	ALL	1				
32		635524.5	4975984	0.00011	2206.27	2844.3	0	ANNUAL	ALL	1				
33		635549.5	4975984	0.00011	2206.83	2844.3	0	ANNUAL	ALL	1				
34		635574.5	4975984	0.00011	2205.61	2844.3	0	ANNUAL	ALL	1				
35		635599.5	4975984	0.0001	2202.99	2844.3	0	ANNUAL	ALL	1				
36		635399.5	4976009	0.00013	2195.69	2844.3	0	ANNUAL	ALL	1				
37		635424.5	4976009	0.00013	2189.65	2844.3	0	ANNUAL	ALL	1				
38		635449.5	4976009	0.00012	2194	2844.3	0	ANNUAL	ALL	1				
39		635474.5	4976009	0.00012	2200.13	2844.3	0	ANNUAL	ALL	1				
40		635499.5	4976009	0.00012	2202.83	2844.3	0	ANNUAL	ALL	1				
41		635524.5	4976009	0.00011	2203.57	2844.3	0	ANNUAL	ALL	1				
42		635549.5	4976009	0.00011	2203.82	2844.3	0	ANNUAL	ALL	1				
43		635574.5	4976009	0.00011	2202.81	2844.3	0	ANNUAL	ALL	1				
44		635599.5	4976009	0.00011	2200.59	2844.3	0	ANNUAL	ALL	1				
45		635399.5	4976034	0.00013	2198.23	2844.3	0	ANNUAL	ALL	1				
46		635424.5	4976034	0.00013	2186.98	2844.3	0	ANNUAL	ALL	1				
47		635449.5	4976034	0.00013	2190.14	2844.3	0	ANNUAL	ALL	1				
48		635474.5	4976034	0.00012	2198.63	2844.3	0	ANNUAL	ALL	1				
49		635499.5	4976034	0.00012	2198.93	2844.3	0	ANNUAL	ALL	1				
50		635524.5	4976034	0.00012	2199.39	2844.3	0	ANNUAL	ALL	1				
51		635549.5	4976034	0.00012	2201.1	2844.3	0	ANNUAL	ALL	1				
52		635574.5	4976034	0.00011	2200.59	2844.3	0	ANNUAL	ALL	1				
53		635599.5	4976034	0.00011	2197.96	2844.3	0	ANNUAL	ALL	1				
54		635399.5	4976059	0.00014	2196.33	2844.3	0	ANNUAL	ALL	1				
55		635424.5	4976059	0.00014	2184.09	2844.3	0	ANNUAL	ALL	1				
56		635449.5	4976059	0.00013	2180.82	2844.3	0	ANNUAL	ALL	1				
57		635474.5	4976059	0.00013	2193.11	2844.3	0	ANNUAL	ALL	1				
58		635499.5	4976059	0.00013	2194.5	2844.3	0	ANNUAL	ALL	1				
59		635524.5	4976059	0.00012	2197.17	2844.3	0	ANNUAL	ALL	1				
60		635549.5	4976059	0.00012	2199.4	2844.3	0	ANNUAL	ALL	1				
61		635574.5	4976059	0.00012	2198.27	2844.3	0	ANNUAL	ALL	1				
62		635599.5	4976059	0.00012	2194.62	2844.3	0	ANNUAL	ALL	1				
63		635399.5	4976084	0.00014	2188.98	2844.3	0	ANNUAL	ALL	1				
64		635424.5	4976084	0.00014	2180.22	2844.3	0	ANNUAL	ALL	1				
65		635449.5	4976084	0.00014	2174.51	2844.3	0	ANNUAL	ALL	1				
66		635474.5	4976084	0.00014	2180.27	2844.3	0	ANNUAL	ALL	1				
67		635499.5	4976084	0.00013	2185.71	2844.3	0	ANNUAL	ALL	1				
68		635524.5	4976084	0.00013	2191.13	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
69		635549.5	4976084	0.00012	2193.95	2844.3	0	ANNUAL	ALL	1				
70		635574.5	4976084	0.00012	2190.58	2844.3	0	ANNUAL	ALL	1				
71		635599.5	4976084	0.00012	2183.01	2844.3	0	ANNUAL	ALL	1				
72		635399.5	4976109	0.00015	2182.28	2844.3	0	ANNUAL	ALL	1				
73		635424.5	4976109	0.00015	2177.24	2844.3	0	ANNUAL	ALL	1				
74		635449.5	4976109	0.00015	2171.45	2844.3	0	ANNUAL	ALL	1				
75		635474.5	4976109	0.00014	2172.26	2844.3	0	ANNUAL	ALL	1				
76		635499.5	4976109	0.00014	2177.58	2844.3	0	ANNUAL	ALL	1				
77		635524.5	4976109	0.00014	2180.23	2844.3	0	ANNUAL	ALL	1				
78		635549.5	4976109	0.00013	2179.81	2844.3	0	ANNUAL	ALL	1				
79		635574.5	4976109	0.00013	2176.94	2844.3	0	ANNUAL	ALL	1				
80		635599.5	4976109	0.00013	2179.4	2844.3	0	ANNUAL	ALL	1				
81		635399.5	4976134	0.00016	2176.77	2844.3	0	ANNUAL	ALL	1				
82		635424.5	4976134	0.00015	2174.27	2844.3	0	ANNUAL	ALL	1				
83		635449.5	4976134	0.00015	2171.04	2844.3	0	ANNUAL	ALL	1				
84		635474.5	4976134	0.00015	2166.4	2844.3	0	ANNUAL	ALL	1				
85		635499.5	4976134	0.00015	2167.48	2844.3	0	ANNUAL	ALL	1				
86		635524.5	4976134	0.00014	2172.09	2844.3	0	ANNUAL	ALL	1				
87		635549.5	4976134	0.00014	2171.44	2844.3	0	ANNUAL	ALL	1				
88		635574.5	4976134	0.00014	2172.93	2844.3	0	ANNUAL	ALL	1				
89		635599.5	4976134	0.00013	2178.31	2844.3	0	ANNUAL	ALL	1				
90		635199.5	4976834	0.00044	2116.83	2844.3	0	ANNUAL	ALL	1				
91		635224.5	4976834	0.00045	2112.53	2844.3	0	ANNUAL	ALL	1				
92		635249.5	4976834	0.00046	2108.39	2844.3	0	ANNUAL	ALL	1				
93		635274.5	4976834	0.00047	2105.23	2844.3	0	ANNUAL	ALL	1				
94		635299.5	4976834	0.00048	2101.6	2844.3	0	ANNUAL	ALL	1				
95		635324.5	4976834	0.00049	2098.74	2844.3	0	ANNUAL	ALL	1				
96		635349.5	4976834	0.00047	2104.26	2844.3	0	ANNUAL	ALL	1				
97		635374.5	4976834	0.00044	2110.4	2844.3	0	ANNUAL	ALL	1				
98		635399.5	4976834	0.00041	2117.98	2844.3	0	ANNUAL	ALL	1				
99		635199.5	4976859	0.00045	2114.34	2844.3	0	ANNUAL	ALL	1				
100		635224.5	4976859	0.00046	2108.68	2844.3	0	ANNUAL	ALL	1				
101		635249.5	4976859	0.00048	2104.42	2844.3	0	ANNUAL	ALL	1				
102		635274.5	4976859	0.00049	2101.28	2844.3	0	ANNUAL	ALL	1				
103		635299.5	4976859	0.0005	2098.83	2844.3	0	ANNUAL	ALL	1				
104		635324.5	4976859	0.0005	2096.89	2844.3	0	ANNUAL	ALL	1				
105		635349.5	4976859	0.00048	2101.21	2844.3	0	ANNUAL	ALL	1				
106		635374.5	4976859	0.00045	2108.71	2844.3	0	ANNUAL	ALL	1				
107		635399.5	4976859	0.00041	2118.31	2844.3	0	ANNUAL	ALL	1				
108		635199.5	4976884	0.00046	2111.17	2844.3	0	ANNUAL	ALL	1				
109		635224.5	4976884	0.00048	2104.78	2844.3	0	ANNUAL	ALL	1				
110		635249.5	4976884	0.0005	2100.14	2844.3	0	ANNUAL	ALL	1				
111		635274.5	4976884	0.00051	2097.48	2844.3	0	ANNUAL	ALL	1				
112		635299.5	4976884	0.00051	2095.42	2844.3	0	ANNUAL	ALL	1				
113		635324.5	4976884	0.00051	2094.96	2844.3	0	ANNUAL	ALL	1				
114		635349.5	4976884	0.0005	2097.83	2844.3	0	ANNUAL	ALL	1				
115		635374.5	4976884	0.00045	2107.96	2844.3	0	ANNUAL	ALL	1				
116		635399.5	4976884	0.00041	2119.17	2844.3	0	ANNUAL	ALL	1				
117		635199.5	4976909	0.00047	2108.51	2844.3	0	ANNUAL	ALL	1				
118		635224.5	4976909	0.00049	2102.17	2844.3	0	ANNUAL	ALL	1				
119		635249.5	4976909	0.00051	2097.31	2844.3	0	ANNUAL	ALL	1				
120		635274.5	4976909	0.00052	2094.85	2844.3	0	ANNUAL	ALL	1				
121		635299.5	4976909	0.00053	2093.19	2844.3	0	ANNUAL	ALL	1				
122		635324.5	4976909	0.00052	2093.48	2844.3	0	ANNUAL	ALL	1				
123		635349.5	4976909	0.0005	2098.12	2844.3	0	ANNUAL	ALL	1				
124		635374.5	4976909	0.00045	2108.79	2844.3	0	ANNUAL	ALL	1				
125		635399.5	4976909	0.0004	2120.74	2844.3	0	ANNUAL	ALL	1				
126		635199.5	4976934	0.00047	2106.38	2844.3	0	ANNUAL	ALL	1				
127		635224.5	4976934	0.0005	2100.81	2844.3	0	ANNUAL	ALL	1				
128		635249.5	4976934	0.00051	2096.21	2844.3	0	ANNUAL	ALL	1				
129		635274.5	4976934	0.00053	2092.89	2844.3	0	ANNUAL	ALL	1				
130		635299.5	4976934	0.00054	2091.1	2844.3	0	ANNUAL	ALL	1				
131		635324.5	4976934	0.00053	2092.46	2844.3	0	ANNUAL	ALL	1				
132		635349.5	4976934	0.00049	2099.48	2844.3	0	ANNUAL	ALL	1				
133		635374.5	4976934	0.00044	2110.37	2844.3	0	ANNUAL	ALL	1				
134		635399.5	4976934	0.0004	2122.91	2844.3	0	ANNUAL	ALL	1				
135		635199.5	4976959	0.00048	2104.62	2844.3	0	ANNUAL	ALL	1				
136		635224.5	4976959	0.0005	2099.28	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
137		635249.5	4976959	0.00052	2094.41	2844.3	0	ANNUAL	ALL	1				
138		635274.5	4976959	0.00054	2090.59	2844.3	0	ANNUAL	ALL	1				
139		635299.5	4976959	0.00055	2088.8	2844.3	0	ANNUAL	ALL	1				
140		635324.5	4976959	0.00053	2092.02	2844.3	0	ANNUAL	ALL	1				
141		635349.5	4976959	0.00049	2100.12	2844.3	0	ANNUAL	ALL	1				
142		635374.5	4976959	0.00044	2112.07	2844.3	0	ANNUAL	ALL	1				
143		635399.5	4976959	0.00039	2125.69	2844.3	0	ANNUAL	ALL	1				
144		635199.5	4976984	0.00049	2102.45	2844.3	0	ANNUAL	ALL	1				
145		635224.5	4976984	0.00051	2097.29	2844.3	0	ANNUAL	ALL	1				
146		635249.5	4976984	0.00054	2091.62	2844.3	0	ANNUAL	ALL	1				
147		635274.5	4976984	0.00055	2087.92	2844.3	0	ANNUAL	ALL	1				
148		635299.5	4976984	0.00056	2086.81	2844.3	0	ANNUAL	ALL	1				
149		635324.5	4976984	0.00052	2092.65	2844.3	0	ANNUAL	ALL	1				
150		635349.5	4976984	0.00048	2101.3	2844.3	0	ANNUAL	ALL	1				
151		635374.5	4976984	0.00043	2114.13	2844.3	0	ANNUAL	ALL	1				
152		635399.5	4976984	0.00039	2128.46	2844.3	0	ANNUAL	ALL	1				
153		635199.5	4977009	0.0005	2099.39	2844.3	0	ANNUAL	ALL	1				
154		635224.5	4977009	0.00052	2093.66	2844.3	0	ANNUAL	ALL	1				
155		635249.5	4977009	0.00055	2087.97	2844.3	0	ANNUAL	ALL	1				
156		635274.5	4977009	0.00057	2084.9	2844.3	0	ANNUAL	ALL	1				
157		635299.5	4977009	0.00055	2087.43	2844.3	0	ANNUAL	ALL	1				
158		635324.5	4977009	0.00051	2094.55	2844.3	0	ANNUAL	ALL	1				
159		635349.5	4977009	0.00047	2103.74	2844.3	0	ANNUAL	ALL	1				
160		635374.5	4977009	0.00042	2116.64	2844.3	0	ANNUAL	ALL	1				
161		635399.5	4977009	0.00038	2131.12	2844.3	0	ANNUAL	ALL	1				
162		635199.5	4977034	0.00052	2094.63	2844.3	0	ANNUAL	ALL	1				
163		635224.5	4977034	0.00055	2088.76	2844.3	0	ANNUAL	ALL	1				
164		635249.5	4977034	0.00057	2084.27	2844.3	0	ANNUAL	ALL	1				
165		635274.5	4977034	0.00058	2082.71	2844.3	0	ANNUAL	ALL	1				
166		635299.5	4977034	0.00054	2089.9	2844.3	0	ANNUAL	ALL	1				
167		635324.5	4977034	0.0005	2098.21	2844.3	0	ANNUAL	ALL	1				
168		635349.5	4977034	0.00046	2107.49	2844.3	0	ANNUAL	ALL	1				
169		635374.5	4977034	0.00042	2119.09	2844.3	0	ANNUAL	ALL	1				
170		635399.5	4977034	0.00038	2133.38	2844.3	0	ANNUAL	ALL	1				
171		634899.5	4977134	0.00032	2221.02	2844.3	0	ANNUAL	ALL	1				
172		634924.5	4977134	0.00033	2207.85	2844.3	0	ANNUAL	ALL	1				
173		634949.5	4977134	0.00034	2190.45	2844.3	0	ANNUAL	ALL	1				
174		634974.5	4977134	0.00036	2169.12	2844.3	0	ANNUAL	ALL	1				
175		634999.5	4977134	0.00038	2150.64	2844.3	0	ANNUAL	ALL	1				
176		635024.5	4977134	0.00041	2135.97	2844.3	0	ANNUAL	ALL	1				
177		635049.5	4977134	0.00043	2122.38	2844.3	0	ANNUAL	ALL	1				
178		635074.5	4977134	0.00045	2113.7	2844.3	0	ANNUAL	ALL	1				
179		635099.5	4977134	0.00048	2105.9	2844.3	0	ANNUAL	ALL	1				
180		634899.5	4977159	0.00033	2213.37	2844.3	0	ANNUAL	ALL	1				
181		634924.5	4977159	0.00033	2201.16	2844.3	0	ANNUAL	ALL	1				
182		634949.5	4977159	0.00035	2181.17	2844.3	0	ANNUAL	ALL	1				
183		634974.5	4977159	0.00037	2161.72	2844.3	0	ANNUAL	ALL	1				
184		634999.5	4977159	0.00039	2145.73	2844.3	0	ANNUAL	ALL	1				
185		635024.5	4977159	0.00041	2132.12	2844.3	0	ANNUAL	ALL	1				
186		635049.5	4977159	0.00044	2119.59	2844.3	0	ANNUAL	ALL	1				
187		635074.5	4977159	0.00047	2109.27	2844.3	0	ANNUAL	ALL	1				
188		635099.5	4977159	0.00049	2101.29	2844.3	0	ANNUAL	ALL	1				
189		634899.5	4977184	0.00033	2206.56	2844.3	0	ANNUAL	ALL	1				
190		634924.5	4977184	0.00034	2193.64	2844.3	0	ANNUAL	ALL	1				
191		634949.5	4977184	0.00036	2172.29	2844.3	0	ANNUAL	ALL	1				
192		634974.5	4977184	0.00038	2154.5	2844.3	0	ANNUAL	ALL	1				
193		634999.5	4977184	0.0004	2141.04	2844.3	0	ANNUAL	ALL	1				
194		635024.5	4977184	0.00042	2128.3	2844.3	0	ANNUAL	ALL	1				
195		635049.5	4977184	0.00045	2114.34	2844.3	0	ANNUAL	ALL	1				
196		635074.5	4977184	0.00049	2102.7	2844.3	0	ANNUAL	ALL	1				
197		635099.5	4977184	0.00051	2096.47	2844.3	0	ANNUAL	ALL	1				
198		634899.5	4977209	0.00034	2199.13	2844.3	0	ANNUAL	ALL	1				
199		634924.5	4977209	0.00035	2184.15	2844.3	0	ANNUAL	ALL	1				
200		634949.5	4977209	0.00037	2163.72	2844.3	0	ANNUAL	ALL	1				
201		634974.5	4977209	0.00039	2146.68	2844.3	0	ANNUAL	ALL	1				
202		634999.5	4977209	0.00041	2136.15	2844.3	0	ANNUAL	ALL	1				
203		635024.5	4977209	0.00043	2124.22	2844.3	0	ANNUAL	ALL	1				
204		635049.5	4977209	0.00048	2105.9	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
205		635074.5	4977209	0.00051	2096.39	2844.3	0	ANNUAL	ALL	1				
206		635099.5	4977209	0.00053	2091.31	2844.3	0	ANNUAL	ALL	1				
207		634899.5	4977234	0.00035	2185.16	2844.3	0	ANNUAL	ALL	1				
208		634924.5	4977234	0.00037	2172.04	2844.3	0	ANNUAL	ALL	1				
209		634949.5	4977234	0.00039	2152.41	2844.3	0	ANNUAL	ALL	1				
210		634974.5	4977234	0.00041	2139.97	2844.3	0	ANNUAL	ALL	1				
211		634999.5	4977234	0.00042	2130.73	2844.3	0	ANNUAL	ALL	1				
212		635024.5	4977234	0.00045	2117.31	2844.3	0	ANNUAL	ALL	1				
213		635049.5	4977234	0.0005	2098.65	2844.3	0	ANNUAL	ALL	1				
214		635074.5	4977234	0.00052	2092.39	2844.3	0	ANNUAL	ALL	1				
215		635099.5	4977234	0.00054	2087.32	2844.3	0	ANNUAL	ALL	1				
216		634899.5	4977259	0.00036	2180.4	2844.3	0	ANNUAL	ALL	1				
217		634924.5	4977259	0.00038	2160.19	2844.3	0	ANNUAL	ALL	1				
218		634949.5	4977259	0.0004	2143.3	2844.3	0	ANNUAL	ALL	1				
219		634974.5	4977259	0.00042	2132.11	2844.3	0	ANNUAL	ALL	1				
220		634999.5	4977259	0.00044	2123.02	2844.3	0	ANNUAL	ALL	1				
221		635024.5	4977259	0.00048	2107.09	2844.3	0	ANNUAL	ALL	1				
222		635049.5	4977259	0.00051	2095.35	2844.3	0	ANNUAL	ALL	1				
223		635074.5	4977259	0.00054	2089.07	2844.3	0	ANNUAL	ALL	1				
224		635099.5	4977259	0.00056	2083.6	2844.3	0	ANNUAL	ALL	1				
225		634899.5	4977284	0.00036	2180.69	2844.3	0	ANNUAL	ALL	1				
226		634924.5	4977284	0.00039	2158.28	2844.3	0	ANNUAL	ALL	1				
227		634949.5	4977284	0.00041	2139.34	2844.3	0	ANNUAL	ALL	1				
228		634974.5	4977284	0.00044	2123.05	2844.3	0	ANNUAL	ALL	1				
229		634999.5	4977284	0.00046	2112.91	2844.3	0	ANNUAL	ALL	1				
230		635024.5	4977284	0.0005	2100.55	2844.3	0	ANNUAL	ALL	1				
231		635049.5	4977284	0.00052	2092.76	2844.3	0	ANNUAL	ALL	1				
232		635074.5	4977284	0.00055	2085.71	2844.3	0	ANNUAL	ALL	1				
233		635099.5	4977284	0.00058	2078.67	2844.3	0	ANNUAL	ALL	1				
234		634899.5	4977309	0.00037	2178.55	2844.3	0	ANNUAL	ALL	1				
235		634924.5	4977309	0.00039	2156.77	2844.3	0	ANNUAL	ALL	1				
236		634949.5	4977309	0.00042	2136.54	2844.3	0	ANNUAL	ALL	1				
237		634974.5	4977309	0.00045	2119.59	2844.3	0	ANNUAL	ALL	1				
238		634999.5	4977309	0.00048	2107.01	2844.3	0	ANNUAL	ALL	1				
239		635024.5	4977309	0.00051	2096.52	2844.3	0	ANNUAL	ALL	1				
240		635049.5	4977309	0.00054	2089.24	2844.3	0	ANNUAL	ALL	1				
241		635074.5	4977309	0.00056	2082.55	2844.3	0	ANNUAL	ALL	1				
242		635099.5	4977309	0.0006	2075.98	2844.3	0	ANNUAL	ALL	1				
243		634899.5	4977334	0.00038	2173.18	2844.3	0	ANNUAL	ALL	1				
244		634924.5	4977334	0.0004	2153.29	2844.3	0	ANNUAL	ALL	1				
245		634949.5	4977334	0.00043	2133.9	2844.3	0	ANNUAL	ALL	1				
246		634974.5	4977334	0.00046	2117.58	2844.3	0	ANNUAL	ALL	1				
247		634999.5	4977334	0.00049	2104.03	2844.3	0	ANNUAL	ALL	1				
248		635024.5	4977334	0.00052	2093.8	2844.3	0	ANNUAL	ALL	1				
249		635049.5	4977334	0.00055	2085.23	2844.3	0	ANNUAL	ALL	1				
250		635074.5	4977334	0.00058	2078.76	2844.3	0	ANNUAL	ALL	1				
251		635099.5	4977334	0.0006	2074.53	2844.3	0	ANNUAL	ALL	1				
252		635399.5	4976159	0.00016	2171.27	2844.3	0	ANNUAL	ALL	1				
253		635424.5	4976159	0.00016	2169.98	2844.3	0	ANNUAL	ALL	1				
254		635449.5	4976159	0.00016	2167.61	2844.3	0	ANNUAL	ALL	1				
255		635474.5	4976159	0.00016	2164.06	2844.3	0	ANNUAL	ALL	1				
256		635499.5	4976159	0.00015	2161.76	2844.3	0	ANNUAL	ALL	1				
257		635524.5	4976159	0.00015	2160.48	2844.3	0	ANNUAL	ALL	1				
258		635549.5	4976159	0.00015	2162.19	2844.3	0	ANNUAL	ALL	1				
259		635574.5	4976159	0.00014	2168.15	2844.3	0	ANNUAL	ALL	1				
260		635599.5	4976159	0.00014	2173.85	2844.3	0	ANNUAL	ALL	1				
261		635399.5	4976184	0.00017	2168.06	2844.3	0	ANNUAL	ALL	1				
262		635424.5	4976184	0.00017	2166.17	2844.3	0	ANNUAL	ALL	1				
263		635449.5	4976184	0.00017	2163.95	2844.3	0	ANNUAL	ALL	1				
264		635474.5	4976184	0.00016	2161.05	2844.3	0	ANNUAL	ALL	1				
265		635499.5	4976184	0.00016	2158.86	2844.3	0	ANNUAL	ALL	1				
266		635524.5	4976184	0.00016	2157.1	2844.3	0	ANNUAL	ALL	1				
267		635549.5	4976184	0.00016	2157.07	2844.3	0	ANNUAL	ALL	1				
268		635574.5	4976184	0.00015	2164.59	2844.3	0	ANNUAL	ALL	1				
269		635599.5	4976184	0.00014	2172.06	2844.3	0	ANNUAL	ALL	1				
270		635399.5	4976209	0.00018	2165.29	2844.3	0	ANNUAL	ALL	1				
271		635424.5	4976209	0.00018	2163.14	2844.3	0	ANNUAL	ALL	1				
272		635449.5	4976209	0.00017	2160.76	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
273		635474.5	4976209	0.00017	2158.05	2844.3	0	ANNUAL	ALL	1				
274		635499.5	4976209	0.00017	2155.43	2844.3	0	ANNUAL	ALL	1				
275		635524.5	4976209	0.00017	2153.57	2844.3	0	ANNUAL	ALL	1				
276		635549.5	4976209	0.00016	2156.02	2844.3	0	ANNUAL	ALL	1				
277		635574.5	4976209	0.00015	2165.26	2844.3	0	ANNUAL	ALL	1				
278		635599.5	4976209	0.00015	2175.01	2844.3	0	ANNUAL	ALL	1				
279		635399.5	4976234	0.00019	2162.56	2844.3	0	ANNUAL	ALL	1				
280		635424.5	4976234	0.00018	2160.46	2844.3	0	ANNUAL	ALL	1				
281		635449.5	4976234	0.00018	2157.93	2844.3	0	ANNUAL	ALL	1				
282		635474.5	4976234	0.00018	2155.5	2844.3	0	ANNUAL	ALL	1				
283		635499.5	4976234	0.00018	2152.67	2844.3	0	ANNUAL	ALL	1				
284		635524.5	4976234	0.00017	2150.12	2844.3	0	ANNUAL	ALL	1				
285		635549.5	4976234	0.00017	2156.6	2844.3	0	ANNUAL	ALL	1				
286		635574.5	4976234	0.00016	2167.62	2844.3	0	ANNUAL	ALL	1				
287		635599.5	4976234	0.00015	2178.35	2844.3	0	ANNUAL	ALL	1				
288		634999.5	4978134	0.00081	2044.53	2844.3	0	ANNUAL	ALL	1				
289		635024.5	4978134	0.0009	2030.56	2844.3	0	ANNUAL	ALL	1				
290		635049.5	4978134	0.00099	2018.07	2844.3	0	ANNUAL	ALL	1				
291		635074.5	4978134	0.00107	2006.69	2844.3	0	ANNUAL	ALL	1				
292		635099.5	4978134	0.00107	2006.39	2844.3	0	ANNUAL	ALL	1				
293		635124.5	4978134	0.00101	2013.34	2844.3	0	ANNUAL	ALL	1				
294		635149.5	4978134	0.00095	2020.75	2844.3	0	ANNUAL	ALL	1				
295		635174.5	4978134	0.00089	2029.05	2844.3	0	ANNUAL	ALL	1				
296		635199.5	4978134	0.00082	2038.91	2844.3	0	ANNUAL	ALL	1				
297		634999.5	4978159	0.00081	2044.5	2844.3	0	ANNUAL	ALL	1				
298		635024.5	4978159	0.0009	2030.78	2844.3	0	ANNUAL	ALL	1				
299		635049.5	4978159	0.001	2017.35	2844.3	0	ANNUAL	ALL	1				
300		635074.5	4978159	0.00109	2004.54	2844.3	0	ANNUAL	ALL	1				
301		635099.5	4978159	0.00108	2003.81	2844.3	0	ANNUAL	ALL	1				
302		635124.5	4978159	0.00103	2010.57	2844.3	0	ANNUAL	ALL	1				
303		635149.5	4978159	0.00098	2017.75	2844.3	0	ANNUAL	ALL	1				
304		635174.5	4978159	0.00092	2025.18	2844.3	0	ANNUAL	ALL	1				
305		635199.5	4978159	0.00084	2035.11	2844.3	0	ANNUAL	ALL	1				
306		634999.5	4978184	0.00081	2044.38	2844.3	0	ANNUAL	ALL	1				
307		635024.5	4978184	0.00091	2028.98	2844.3	0	ANNUAL	ALL	1				
308		635049.5	4978184	0.00101	2015.36	2844.3	0	ANNUAL	ALL	1				
309		635074.5	4978184	0.00109	2002.43	2844.3	0	ANNUAL	ALL	1				
310		635099.5	4978184	0.0011	2000.86	2844.3	0	ANNUAL	ALL	1				
311		635124.5	4978184	0.00105	2007.53	2844.3	0	ANNUAL	ALL	1				
312		635149.5	4978184	0.001	2014.6	2844.3	0	ANNUAL	ALL	1				
313		635174.5	4978184	0.00094	2022.07	2844.3	0	ANNUAL	ALL	1				
314		635199.5	4978184	0.00087	2031.45	2844.3	0	ANNUAL	ALL	1				
315		634999.5	4978209	0.00082	2043.46	2844.3	0	ANNUAL	ALL	1				
316		635024.5	4978209	0.00092	2027.94	2844.3	0	ANNUAL	ALL	1				
317		635049.5	4978209	0.00102	2013.73	2844.3	0	ANNUAL	ALL	1				
318		635074.5	4978209	0.0011	2000.96	2844.3	0	ANNUAL	ALL	1				
319		635099.5	4978209	0.00111	1998.75	2844.3	0	ANNUAL	ALL	1				
320		635124.5	4978209	0.00107	2004.56	2844.3	0	ANNUAL	ALL	1				
321		635149.5	4978209	0.00102	2011.78	2844.3	0	ANNUAL	ALL	1				
322		635174.5	4978209	0.00096	2019.36	2844.3	0	ANNUAL	ALL	1				
323		635199.5	4978209	0.00089	2027.82	2844.3	0	ANNUAL	ALL	1				
324		634999.5	4978234	0.00082	2042.97	2844.3	0	ANNUAL	ALL	1				
325		635024.5	4978234	0.00093	2026.61	2844.3	0	ANNUAL	ALL	1				
326		635049.5	4978234	0.00103	2012.57	2844.3	0	ANNUAL	ALL	1				
327		635074.5	4978234	0.00111	2000.24	2844.3	0	ANNUAL	ALL	1				
328		635099.5	4978234	0.00113	1996.61	2844.3	0	ANNUAL	ALL	1				
329		635124.5	4978234	0.00109	2001.65	2844.3	0	ANNUAL	ALL	1				
330		635149.5	4978234	0.00103	2009.16	2844.3	0	ANNUAL	ALL	1				
331		635174.5	4978234	0.00097	2016.86	2844.3	0	ANNUAL	ALL	1				
332		635199.5	4978234	0.00091	2024.48	2844.3	0	ANNUAL	ALL	1				
333		634999.5	4978259	0.00083	2041.08	2844.3	0	ANNUAL	ALL	1				
334		635024.5	4978259	0.00094	2024.08	2844.3	0	ANNUAL	ALL	1				
335		635049.5	4978259	0.00103	2011.49	2844.3	0	ANNUAL	ALL	1				
336		635074.5	4978259	0.0011	2000.61	2844.3	0	ANNUAL	ALL	1				
337		635099.5	4978259	0.00113	1994.84	2844.3	0	ANNUAL	ALL	1				
338		635124.5	4978259	0.0011	1999.29	2844.3	0	ANNUAL	ALL	1				
339		635149.5	4978259	0.00105	2007.14	2844.3	0	ANNUAL	ALL	1				
340		635174.5	4978259	0.00099	2014.96	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
341		635199.5	4978259	0.00092	2023.44	2844.3	0	ANNUAL	ALL	1				
342		634999.5	4978284	0.00084	2039.02	2844.3	0	ANNUAL	ALL	1				
343		635024.5	4978284	0.00095	2022.69	2844.3	0	ANNUAL	ALL	1				
344		635049.5	4978284	0.00104	2010.11	2844.3	0	ANNUAL	ALL	1				
345		635074.5	4978284	0.00111	1999.28	2844.3	0	ANNUAL	ALL	1				
346		635099.5	4978284	0.00114	1993.94	2844.3	0	ANNUAL	ALL	1				
347		635124.5	4978284	0.00111	1996.86	2844.3	0	ANNUAL	ALL	1				
348		635149.5	4978284	0.00106	2004.78	2844.3	0	ANNUAL	ALL	1				
349		635174.5	4978284	0.001	2012.7	2844.3	0	ANNUAL	ALL	1				
350		635199.5	4978284	0.00093	2021.78	2844.3	0	ANNUAL	ALL	1				
351		634999.5	4978309	0.00085	2036.72	2844.3	0	ANNUAL	ALL	1				
352		635024.5	4978309	0.00094	2023.32	2844.3	0	ANNUAL	ALL	1				
353		635049.5	4978309	0.00103	2010.1	2844.3	0	ANNUAL	ALL	1				
354		635074.5	4978309	0.0011	1999.36	2844.3	0	ANNUAL	ALL	1				
355		635099.5	4978309	0.00114	1992.81	2844.3	0	ANNUAL	ALL	1				
356		635124.5	4978309	0.00113	1994.13	2844.3	0	ANNUAL	ALL	1				
357		635149.5	4978309	0.00107	2001.68	2844.3	0	ANNUAL	ALL	1				
358		635174.5	4978309	0.00102	2009.75	2844.3	0	ANNUAL	ALL	1				
359		635199.5	4978309	0.00095	2018.84	2844.3	0	ANNUAL	ALL	1				
360		634999.5	4978334	0.00087	2033.58	2844.3	0	ANNUAL	ALL	1				
361		635024.5	4978334	0.00095	2021.76	2844.3	0	ANNUAL	ALL	1				
362		635049.5	4978334	0.00103	2009.59	2844.3	0	ANNUAL	ALL	1				
363		635074.5	4978334	0.00109	1999.33	2844.3	0	ANNUAL	ALL	1				
364		635099.5	4978334	0.00114	1991.74	2844.3	0	ANNUAL	ALL	1				
365		635124.5	4978334	0.00114	1991.62	2844.3	0	ANNUAL	ALL	1				
366		635149.5	4978334	0.00109	1998.49	2844.3	0	ANNUAL	ALL	1				
367		635174.5	4978334	0.00104	2006.18	2844.3	0	ANNUAL	ALL	1				
368		635199.5	4978334	0.00097	2015.32	2844.3	0	ANNUAL	ALL	1				
369		634299.5	4978134	0.00078	2065.05	2844.3	0	ANNUAL	ALL	1				
370		634324.5	4978134	0.00085	2052.1	2844.3	0	ANNUAL	ALL	1				
371		634349.5	4978134	0.00089	2045.24	2844.3	0	ANNUAL	ALL	1				
372		634374.5	4978134	0.00096	2034.94	2844.3	0	ANNUAL	ALL	1				
373		634399.5	4978134	0.00107	2020.36	2844.3	0	ANNUAL	ALL	1				
374		634424.5	4978134	0.00118	2003.67	2844.3	0	ANNUAL	ALL	1				
375		634449.5	4978134	0.00125	1995.29	2844.3	0	ANNUAL	ALL	1				
376		634474.5	4978134	0.00116	2007.74	2844.3	0	ANNUAL	ALL	1				
377		634499.5	4978134	0.00101	2026.56	2844.3	0	ANNUAL	ALL	1				
378		634299.5	4978159	0.00082	2056.37	2844.3	0	ANNUAL	ALL	1				
379		634324.5	4978159	0.00089	2043.39	2844.3	0	ANNUAL	ALL	1				
380		634349.5	4978159	0.00097	2031.51	2844.3	0	ANNUAL	ALL	1				
381		634374.5	4978159	0.00103	2023.05	2844.3	0	ANNUAL	ALL	1				
382		634399.5	4978159	0.00113	2009.29	2844.3	0	ANNUAL	ALL	1				
383		634424.5	4978159	0.00123	1995	2844.3	0	ANNUAL	ALL	1				
384		634449.5	4978159	0.00125	1992.7	2844.3	0	ANNUAL	ALL	1				
385		634474.5	4978159	0.00115	2006.88	2844.3	0	ANNUAL	ALL	1				
386		634499.5	4978159	0.00102	2023.97	2844.3	0	ANNUAL	ALL	1				
387		634299.5	4978184	0.00084	2049.3	2844.3	0	ANNUAL	ALL	1				
388		634324.5	4978184	0.00093	2036.32	2844.3	0	ANNUAL	ALL	1				
389		634349.5	4978184	0.00102	2022.34	2844.3	0	ANNUAL	ALL	1				
390		634374.5	4978184	0.00111	2009.09	2844.3	0	ANNUAL	ALL	1				
391		634399.5	4978184	0.00117	1999.89	2844.3	0	ANNUAL	ALL	1				
392		634424.5	4978184	0.00127	1987.52	2844.3	0	ANNUAL	ALL	1				
393		634449.5	4978184	0.00124	1991.46	2844.3	0	ANNUAL	ALL	1				
394		634474.5	4978184	0.00114	2006.06	2844.3	0	ANNUAL	ALL	1				
395		634499.5	4978184	0.00104	2020.38	2844.3	0	ANNUAL	ALL	1				
396		634299.5	4978209	0.00087	2043.21	2844.3	0	ANNUAL	ALL	1				
397		634324.5	4978209	0.00095	2030.6	2844.3	0	ANNUAL	ALL	1				
398		634349.5	4978209	0.00104	2016.03	2844.3	0	ANNUAL	ALL	1				
399		634374.5	4978209	0.00114	2000.87	2844.3	0	ANNUAL	ALL	1				
400		634399.5	4978209	0.00122	1990.53	2844.3	0	ANNUAL	ALL	1				
401		634424.5	4978209	0.00129	1981.32	2844.3	0	ANNUAL	ALL	1				
402		634449.5	4978209	0.00123	1989.45	2844.3	0	ANNUAL	ALL	1				
403		634474.5	4978209	0.00113	2004.01	2844.3	0	ANNUAL	ALL	1				
404		634499.5	4978209	0.00105	2016.91	2844.3	0	ANNUAL	ALL	1				
405		634299.5	4978234	0.00089	2037.27	2844.3	0	ANNUAL	ALL	1				
406		634324.5	4978234	0.00096	2025.09	2844.3	0	ANNUAL	ALL	1				
407		634349.5	4978234	0.00106	2009.81	2844.3	0	ANNUAL	ALL	1				
408		634374.5	4978234	0.00115	1996.13	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
409		634399.5	4978234	0.00124	1984.05	2844.3	0	ANNUAL	ALL	1				
410		634424.5	4978234	0.0013	1975.87	2844.3	0	ANNUAL	ALL	1				
411		634449.5	4978234	0.00124	1984.97	2844.3	0	ANNUAL	ALL	1				
412		634474.5	4978234	0.00114	2000.36	2844.3	0	ANNUAL	ALL	1				
413		634499.5	4978234	0.00107	2011.73	2844.3	0	ANNUAL	ALL	1				
414		634299.5	4978259	0.0009	2030.97	2844.3	0	ANNUAL	ALL	1				
415		634324.5	4978259	0.00098	2018.02	2844.3	0	ANNUAL	ALL	1				
416		634349.5	4978259	0.00107	2002.99	2844.3	0	ANNUAL	ALL	1				
417		634374.5	4978259	0.00116	1990.41	2844.3	0	ANNUAL	ALL	1				
418		634399.5	4978259	0.00124	1978.88	2844.3	0	ANNUAL	ALL	1				
419		634424.5	4978259	0.00129	1972.17	2844.3	0	ANNUAL	ALL	1				
420		634449.5	4978259	0.00126	1977.85	2844.3	0	ANNUAL	ALL	1				
421		634474.5	4978259	0.00117	1992.52	2844.3	0	ANNUAL	ALL	1				
422		634499.5	4978259	0.0011	2003.44	2844.3	0	ANNUAL	ALL	1				
423		634299.5	4978284	0.00093	2023.26	2844.3	0	ANNUAL	ALL	1				
424		634324.5	4978284	0.00101	2008.98	2844.3	0	ANNUAL	ALL	1				
425		634349.5	4978284	0.00108	1996.31	2844.3	0	ANNUAL	ALL	1				
426		634374.5	4978284	0.00117	1984.2	2844.3	0	ANNUAL	ALL	1				
427		634399.5	4978284	0.00124	1973.37	2844.3	0	ANNUAL	ALL	1				
428		634424.5	4978284	0.00128	1969.23	2844.3	0	ANNUAL	ALL	1				
429		634449.5	4978284	0.00125	1975.58	2844.3	0	ANNUAL	ALL	1				
430		634474.5	4978284	0.00117	1989.07	2844.3	0	ANNUAL	ALL	1				
431		634499.5	4978284	0.0011	2000.53	2844.3	0	ANNUAL	ALL	1				
432		634299.5	4978309	0.00096	2012.41	2844.3	0	ANNUAL	ALL	1				
433		634324.5	4978309	0.00103	1999.74	2844.3	0	ANNUAL	ALL	1				
434		634349.5	4978309	0.0011	1988.62	2844.3	0	ANNUAL	ALL	1				
435		634374.5	4978309	0.00118	1977.79	2844.3	0	ANNUAL	ALL	1				
436		634399.5	4978309	0.00123	1967.1	2844.3	0	ANNUAL	ALL	1				
437		634424.5	4978309	0.00125	1968.14	2844.3	0	ANNUAL	ALL	1				
438		634449.5	4978309	0.00121	1977.66	2844.3	0	ANNUAL	ALL	1				
439		634474.5	4978309	0.00112	1992.31	2844.3	0	ANNUAL	ALL	1				
440		634499.5	4978309	0.00105	2006.23	2844.3	0	ANNUAL	ALL	1				
441		634299.5	4978334	0.00099	2000.94	2844.3	0	ANNUAL	ALL	1				
442		634324.5	4978334	0.00105	1991.1	2844.3	0	ANNUAL	ALL	1				
443		634349.5	4978334	0.00112	1980.66	2844.3	0	ANNUAL	ALL	1				
444		634374.5	4978334	0.00119	1970.39	2844.3	0	ANNUAL	ALL	1				
445		634399.5	4978334	0.00123	1961.38	2844.3	0	ANNUAL	ALL	1				
446		634424.5	4978334	0.00122	1968.29	2844.3	0	ANNUAL	ALL	1				
447		634449.5	4978334	0.00116	1980.95	2844.3	0	ANNUAL	ALL	1				
448		634474.5	4978334	0.00106	1997.36	2844.3	0	ANNUAL	ALL	1				
449		634499.5	4978334	0.00099	2012.52	2844.3	0	ANNUAL	ALL	1				
450		634299.5	4978359	0.00101	1991.4	2844.3	0	ANNUAL	ALL	1				
451		634324.5	4978359	0.00107	1982.72	2844.3	0	ANNUAL	ALL	1				
452		634349.5	4978359	0.00113	1972.75	2844.3	0	ANNUAL	ALL	1				
453		634374.5	4978359	0.00118	1962.87	2844.3	0	ANNUAL	ALL	1				
454		634399.5	4978359	0.00122	1958.17	2844.3	0	ANNUAL	ALL	1				
455		634424.5	4978359	0.00118	1968.79	2844.3	0	ANNUAL	ALL	1				
456		634449.5	4978359	0.00111	1984.24	2844.3	0	ANNUAL	ALL	1				
457		634474.5	4978359	0.00101	2002.2	2844.3	0	ANNUAL	ALL	1				
458		634499.5	4978359	0.00095	2016.76	2844.3	0	ANNUAL	ALL	1				
459		634299.5	4978384	0.00102	1982.57	2844.3	0	ANNUAL	ALL	1				
460		634324.5	4978384	0.00107	1975.68	2844.3	0	ANNUAL	ALL	1				
461		634349.5	4978384	0.00112	1964.84	2844.3	0	ANNUAL	ALL	1				
462		634374.5	4978384	0.00119	1956.29	2844.3	0	ANNUAL	ALL	1				
463		634399.5	4978384	0.0012	1955.61	2844.3	0	ANNUAL	ALL	1				
464		634424.5	4978384	0.00115	1968.65	2844.3	0	ANNUAL	ALL	1				
465		634449.5	4978384	0.00107	1986.09	2844.3	0	ANNUAL	ALL	1				
466		634474.5	4978384	0.00098	2004.63	2844.3	0	ANNUAL	ALL	1				
467		634499.5	4978384	0.00091	2018.69	2844.3	0	ANNUAL	ALL	1				
468		634299.5	4978409	0.00103	1975.4	2844.3	0	ANNUAL	ALL	1				
469		634324.5	4978409	0.00106	1967.52	2844.3	0	ANNUAL	ALL	1				
470		634349.5	4978409	0.00113	1957.04	2844.3	0	ANNUAL	ALL	1				
471		634374.5	4978409	0.00119	1949.69	2844.3	0	ANNUAL	ALL	1				
472		634399.5	4978409	0.00119	1951.43	2844.3	0	ANNUAL	ALL	1				
473		634424.5	4978409	0.00111	1967.3	2844.3	0	ANNUAL	ALL	1				
474		634449.5	4978409	0.00103	1986.39	2844.3	0	ANNUAL	ALL	1				
475		634474.5	4978409	0.00095	2005.28	2844.3	0	ANNUAL	ALL	1				
476		634499.5	4978409	0.00089	2019.28	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
477		634299.5	4978434	0.00102	1965.22	2844.3	0	ANNUAL	ALL	1				
478		634324.5	4978434	0.00107	1958.88	2844.3	0	ANNUAL	ALL	1				
479		634349.5	4978434	0.00113	1950.79	2844.3	0	ANNUAL	ALL	1				
480		634374.5	4978434	0.00118	1943.73	2844.3	0	ANNUAL	ALL	1				
481		634399.5	4978434	0.00116	1949.4	2844.3	0	ANNUAL	ALL	1				
482		634424.5	4978434	0.00109	1965.04	2844.3	0	ANNUAL	ALL	1				
483		634449.5	4978434	0.00102	1984.59	2844.3	0	ANNUAL	ALL	1				
484		634474.5	4978434	0.00092	2004.45	2844.3	0	ANNUAL	ALL	1				
485		634499.5	4978434	0.00088	2017.53	2844.3	0	ANNUAL	ALL	1				
486		634249.4	4977384	0.00043	2291.4	2717.08	0	ANNUAL	ALL	1				
487		634274.4	4977384	0.00043	2282.65	2742	0	ANNUAL	ALL	1				
488		634299.4	4977384	0.00043	2273.71	2742	0	ANNUAL	ALL	1				
489		634324.4	4977384	0.00043	2263.84	2742	0	ANNUAL	ALL	1				
490		634349.4	4977384	0.00043	2250.84	2742	0	ANNUAL	ALL	1				
491		634374.4	4977384	0.00043	2238.58	2742.16	0	ANNUAL	ALL	1				
492		634399.4	4977384	0.00043	2232.43	2742.16	0	ANNUAL	ALL	1				
493		634424.4	4977384	0.00041	2242.73	2742.16	0	ANNUAL	ALL	1				
494		634449.4	4977384	0.0004	2255.36	2742	0	ANNUAL	ALL	1				
495		634249.4	4977409	0.00044	2284.43	2742	0	ANNUAL	ALL	1				
496		634274.4	4977409	0.00044	2274.53	2742	0	ANNUAL	ALL	1				
497		634299.4	4977409	0.00044	2264.56	2742	0	ANNUAL	ALL	1				
498		634324.4	4977409	0.00044	2254.44	2742	0	ANNUAL	ALL	1				
499		634349.4	4977409	0.00044	2243.93	2742.16	0	ANNUAL	ALL	1				
500		634374.4	4977409	0.00044	2231.37	2742.16	0	ANNUAL	ALL	1				
501		634399.4	4977409	0.00044	2226.02	2844.3	0	ANNUAL	ALL	1				
502		634424.4	4977409	0.00042	2236.92	2742.16	0	ANNUAL	ALL	1				
503		634449.4	4977409	0.00041	2249.43	2742.16	0	ANNUAL	ALL	1				
504		634249.4	4977434	0.00045	2279.34	2742	0	ANNUAL	ALL	1				
505		634274.4	4977434	0.00045	2267.65	2742	0	ANNUAL	ALL	1				
506		634299.4	4977434	0.00045	2255.85	2742	0	ANNUAL	ALL	1				
507		634324.4	4977434	0.00045	2244.86	2742	0	ANNUAL	ALL	1				
508		634349.4	4977434	0.00045	2234.48	2742.16	0	ANNUAL	ALL	1				
509		634374.4	4977434	0.00045	2223.18	2844.3	0	ANNUAL	ALL	1				
510		634399.4	4977434	0.00045	2218.5	2844.3	0	ANNUAL	ALL	1				
511		634424.4	4977434	0.00043	2230.27	2844.3	0	ANNUAL	ALL	1				
512		634449.4	4977434	0.00042	2243.66	2742.16	0	ANNUAL	ALL	1				
513		634249.4	4977459	0.00046	2275.78	2742	0	ANNUAL	ALL	1				
514		634274.4	4977459	0.00046	2262.83	2742	0	ANNUAL	ALL	1				
515		634299.4	4977459	0.00046	2248.74	2742	0	ANNUAL	ALL	1				
516		634324.4	4977459	0.00046	2237.43	2742.16	0	ANNUAL	ALL	1				
517		634349.4	4977459	0.00046	2226.72	2844.3	0	ANNUAL	ALL	1				
518		634374.4	4977459	0.00046	2214.97	2844.3	0	ANNUAL	ALL	1				
519		634399.4	4977459	0.00046	2211.75	2844.3	0	ANNUAL	ALL	1				
520		634424.4	4977459	0.00044	2223.34	2844.3	0	ANNUAL	ALL	1				
521		634449.4	4977459	0.00043	2237.29	2844.3	0	ANNUAL	ALL	1				
522		634249.4	4977484	0.00046	2272.5	2742	0	ANNUAL	ALL	1				
523		634274.4	4977484	0.00046	2258.48	2742	0	ANNUAL	ALL	1				
524		634299.4	4977484	0.00047	2243.77	2742	0	ANNUAL	ALL	1				
525		634324.4	4977484	0.00047	2231.45	2742.16	0	ANNUAL	ALL	1				
526		634349.4	4977484	0.00047	2219.9	2844.3	0	ANNUAL	ALL	1				
527		634374.4	4977484	0.00047	2207.94	2844.3	0	ANNUAL	ALL	1				
528		634399.4	4977484	0.00047	2204.62	2844.3	0	ANNUAL	ALL	1				
529		634424.4	4977484	0.00045	2216.76	2844.3	0	ANNUAL	ALL	1				
530		634449.4	4977484	0.00044	2230.33	2844.3	0	ANNUAL	ALL	1				
531		634249.4	4977509	0.00047	2269.17	2742	0	ANNUAL	ALL	1				
532		634274.4	4977509	0.00047	2254.88	2742	0	ANNUAL	ALL	1				
533		634299.4	4977509	0.00047	2240.59	2742	0	ANNUAL	ALL	1				
534		634324.4	4977509	0.00048	2227.32	2844.3	0	ANNUAL	ALL	1				
535		634349.4	4977509	0.00048	2213.19	2844.3	0	ANNUAL	ALL	1				
536		634374.4	4977509	0.00048	2200.19	2844.3	0	ANNUAL	ALL	1				
537		634399.4	4977509	0.00048	2197.61	2844.3	0	ANNUAL	ALL	1				
538		634424.4	4977509	0.00046	2211.03	2844.3	0	ANNUAL	ALL	1				
539		634449.4	4977509	0.00045	2223.57	2844.3	0	ANNUAL	ALL	1				
540		634249.4	4977534	0.00048	2266.65	2742	0	ANNUAL	ALL	1				
541		634274.4	4977534	0.00048	2251.58	2742	0	ANNUAL	ALL	1				
542		634299.4	4977534	0.00048	2237.18	2742	0	ANNUAL	ALL	1				
543		634324.4	4977534	0.00049	2223.67	2844.3	0	ANNUAL	ALL	1				
544		634349.4	4977534	0.00049	2207.86	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
545		634374.4	4977534	0.0005	2193.38	2844.3	0	ANNUAL	ALL	1				
546		634399.4	4977534	0.00049	2191.95	2844.3	0	ANNUAL	ALL	1				
547		634424.4	4977534	0.00047	2205.88	2844.3	0	ANNUAL	ALL	1				
548		634449.4	4977534	0.00046	2217.63	2844.3	0	ANNUAL	ALL	1				
549		634249.4	4977559	0.00049	2264.12	2742	0	ANNUAL	ALL	1				
550		634274.4	4977559	0.00049	2247.26	2742	0	ANNUAL	ALL	1				
551		634299.4	4977559	0.00049	2232.74	2742	0	ANNUAL	ALL	1				
552		634324.4	4977559	0.00049	2218.55	2844.3	0	ANNUAL	ALL	1				
553		634349.4	4977559	0.0005	2203.35	2844.3	0	ANNUAL	ALL	1				
554		634374.4	4977559	0.0005	2189.62	2844.3	0	ANNUAL	ALL	1				
555		634399.4	4977559	0.0005	2184.96	2844.3	0	ANNUAL	ALL	1				
556		634424.4	4977559	0.00048	2200.77	2844.3	0	ANNUAL	ALL	1				
557		634449.4	4977559	0.00047	2211.07	2844.3	0	ANNUAL	ALL	1				
558		634249.4	4977584	0.00049	2258.01	2742	0	ANNUAL	ALL	1				
559		634274.4	4977584	0.0005	2242.66	2742	0	ANNUAL	ALL	1				
560		634299.4	4977584	0.0005	2227.67	2844.3	0	ANNUAL	ALL	1				
561		634324.4	4977584	0.0005	2213.51	2844.3	0	ANNUAL	ALL	1				
562		634349.4	4977584	0.00051	2199.5	2844.3	0	ANNUAL	ALL	1				
563		634374.4	4977584	0.00051	2185.33	2844.3	0	ANNUAL	ALL	1				
564		634399.4	4977584	0.00052	2177.11	2844.3	0	ANNUAL	ALL	1				
565		634424.4	4977584	0.00049	2192.43	2844.3	0	ANNUAL	ALL	1				
566		634449.4	4977584	0.00048	2203.16	2844.3	0	ANNUAL	ALL	1				
567		634999.5	4977834	0.00074	2055.79	2844.3	0	ANNUAL	ALL	1				
568		635024.5	4977834	0.00078	2048.42	2844.3	0	ANNUAL	ALL	1				
569		635049.5	4977834	0.00082	2043	2844.3	0	ANNUAL	ALL	1				
570		635074.5	4977834	0.00085	2037.93	2844.3	0	ANNUAL	ALL	1				
571		635099.5	4977834	0.00088	2034.24	2844.3	0	ANNUAL	ALL	1				
572		635124.5	4977834	0.0009	2031.45	2844.3	0	ANNUAL	ALL	1				
573		635149.5	4977834	0.00084	2038.5	2844.3	0	ANNUAL	ALL	1				
574		635174.5	4977834	0.00075	2050.35	2844.3	0	ANNUAL	ALL	1				
575		635199.5	4977834	0.00067	2063.26	2844.3	0	ANNUAL	ALL	1				
576		634999.5	4977859	0.00076	2052.63	2844.3	0	ANNUAL	ALL	1				
577		635024.5	4977859	0.0008	2046.41	2844.3	0	ANNUAL	ALL	1				
578		635049.5	4977859	0.00083	2040.95	2844.3	0	ANNUAL	ALL	1				
579		635074.5	4977859	0.00087	2036.03	2844.3	0	ANNUAL	ALL	1				
580		635099.5	4977859	0.00089	2032.3	2844.3	0	ANNUAL	ALL	1				
581		635124.5	4977859	0.00091	2030.17	2844.3	0	ANNUAL	ALL	1				
582		635149.5	4977859	0.00084	2038.33	2844.3	0	ANNUAL	ALL	1				
583		635174.5	4977859	0.00075	2049.93	2844.3	0	ANNUAL	ALL	1				
584		635199.5	4977859	0.00067	2062.54	2844.3	0	ANNUAL	ALL	1				
585		634999.5	4977884	0.00078	2049.11	2844.3	0	ANNUAL	ALL	1				
586		635024.5	4977884	0.00081	2044.13	2844.3	0	ANNUAL	ALL	1				
587		635049.5	4977884	0.00085	2038.92	2844.3	0	ANNUAL	ALL	1				
588		635074.5	4977884	0.00088	2034.26	2844.3	0	ANNUAL	ALL	1				
589		635099.5	4977884	0.00091	2030.48	2844.3	0	ANNUAL	ALL	1				
590		635124.5	4977884	0.00092	2029.04	2844.3	0	ANNUAL	ALL	1				
591		635149.5	4977884	0.00084	2038.45	2844.3	0	ANNUAL	ALL	1				
592		635174.5	4977884	0.00075	2049.51	2844.3	0	ANNUAL	ALL	1				
593		635199.5	4977884	0.00068	2061.56	2844.3	0	ANNUAL	ALL	1				
594		634999.5	4977909	0.00079	2047.27	2844.3	0	ANNUAL	ALL	1				
595		635024.5	4977909	0.00083	2042.16	2844.3	0	ANNUAL	ALL	1				
596		635049.5	4977909	0.00086	2036.97	2844.3	0	ANNUAL	ALL	1				
597		635074.5	4977909	0.00089	2032.48	2844.3	0	ANNUAL	ALL	1				
598		635099.5	4977909	0.00092	2028.7	2844.3	0	ANNUAL	ALL	1				
599		635124.5	4977909	0.00092	2028.77	2844.3	0	ANNUAL	ALL	1				
600		635149.5	4977909	0.00084	2038.62	2844.3	0	ANNUAL	ALL	1				
601		635174.5	4977909	0.00076	2049.12	2844.3	0	ANNUAL	ALL	1				
602		635199.5	4977909	0.00068	2060.48	2844.3	0	ANNUAL	ALL	1				
603		634999.5	4977934	0.0008	2046.79	2844.3	0	ANNUAL	ALL	1				
604		635024.5	4977934	0.00083	2040.92	2844.3	0	ANNUAL	ALL	1				
605		635049.5	4977934	0.00088	2034.68	2844.3	0	ANNUAL	ALL	1				
606		635074.5	4977934	0.00091	2029.58	2844.3	0	ANNUAL	ALL	1				
607		635099.5	4977934	0.00094	2025.61	2844.3	0	ANNUAL	ALL	1				
608		635124.5	4977934	0.00092	2027.68	2844.3	0	ANNUAL	ALL	1				
609		635149.5	4977934	0.00084	2038.09	2844.3	0	ANNUAL	ALL	1				
610		635174.5	4977934	0.00076	2048.68	2844.3	0	ANNUAL	ALL	1				
611		635199.5	4977934	0.00069	2059.02	2844.3	0	ANNUAL	ALL	1				
612		634999.5	4977959	0.0008	2045.95	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
613		635024.5	4977959	0.00084	2039.51	2844.3	0	ANNUAL	ALL	1				
614		635049.5	4977959	0.00089	2032.45	2844.3	0	ANNUAL	ALL	1				
615		635074.5	4977959	0.00093	2026.52	2844.3	0	ANNUAL	ALL	1				
616		635099.5	4977959	0.00096	2022.6	2844.3	0	ANNUAL	ALL	1				
617		635124.5	4977959	0.00092	2027.13	2844.3	0	ANNUAL	ALL	1				
618		635149.5	4977959	0.00085	2036.89	2844.3	0	ANNUAL	ALL	1				
619		635174.5	4977959	0.00077	2046.85	2844.3	0	ANNUAL	ALL	1				
620		635199.5	4977959	0.00071	2056.78	2844.3	0	ANNUAL	ALL	1				
621		634999.5	4977984	0.00081	2045.34	2844.3	0	ANNUAL	ALL	1				
622		635024.5	4977984	0.00085	2037.82	2844.3	0	ANNUAL	ALL	1				
623		635049.5	4977984	0.00091	2030.43	2844.3	0	ANNUAL	ALL	1				
624		635074.5	4977984	0.00095	2024.12	2844.3	0	ANNUAL	ALL	1				
625		635099.5	4977984	0.00098	2019.96	2844.3	0	ANNUAL	ALL	1				
626		635124.5	4977984	0.00092	2026.73	2844.3	0	ANNUAL	ALL	1				
627		635149.5	4977984	0.00085	2035.4	2844.3	0	ANNUAL	ALL	1				
628		635174.5	4977984	0.00079	2044.46	2844.3	0	ANNUAL	ALL	1				
629		635199.5	4977984	0.00073	2053.52	2844.3	0	ANNUAL	ALL	1				
630		634999.5	4978009	0.00081	2044.81	2844.3	0	ANNUAL	ALL	1				
631		635024.5	4978009	0.00087	2035.59	2844.3	0	ANNUAL	ALL	1				
632		635049.5	4978009	0.00092	2028.05	2844.3	0	ANNUAL	ALL	1				
633		635074.5	4978009	0.00097	2021.18	2844.3	0	ANNUAL	ALL	1				
634		635099.5	4978009	0.001	2017.1	2844.3	0	ANNUAL	ALL	1				
635		635124.5	4978009	0.00093	2025.97	2844.3	0	ANNUAL	ALL	1				
636		635149.5	4978009	0.00086	2034.03	2844.3	0	ANNUAL	ALL	1				
637		635174.5	4978009	0.0008	2041.95	2844.3	0	ANNUAL	ALL	1				
638		635199.5	4978009	0.00075	2050.09	2844.3	0	ANNUAL	ALL	1				
639		634999.5	4978034	0.00082	2043.29	2844.3	0	ANNUAL	ALL	1				
640		635024.5	4978034	0.00089	2032.46	2844.3	0	ANNUAL	ALL	1				
641		635049.5	4978034	0.00095	2024.39	2844.3	0	ANNUAL	ALL	1				
642		635074.5	4978034	0.001	2017.56	2844.3	0	ANNUAL	ALL	1				
643		635099.5	4978034	0.00101	2015.24	2844.3	0	ANNUAL	ALL	1				
644		635124.5	4978034	0.00094	2024.2	2844.3	0	ANNUAL	ALL	1				
645		635149.5	4978034	0.00088	2032.02	2844.3	0	ANNUAL	ALL	1				
646		635174.5	4978034	0.00081	2040.48	2844.3	0	ANNUAL	ALL	1				
647		635199.5	4978034	0.00075	2049.69	2844.3	0	ANNUAL	ALL	1				
648		634599.5	4976834	0.00027	2431.97	2717.08	0	ANNUAL	ALL	1				
649		634624.5	4976834	0.00026	2425.11	2717.08	0	ANNUAL	ALL	1				
650		634649.5	4976834	0.00026	2416.95	2717.08	0	ANNUAL	ALL	1				
651		634674.5	4976834	0.00026	2407.96	2717.08	0	ANNUAL	ALL	1				
652		634699.5	4976834	0.00026	2398.82	2717.08	0	ANNUAL	ALL	1				
653		634724.5	4976834	0.00026	2389.57	2717.08	0	ANNUAL	ALL	1				
654		634749.5	4976834	0.00026	2378.83	2717.08	0	ANNUAL	ALL	1				
655		634774.5	4976834	0.00026	2368.3	2717.08	0	ANNUAL	ALL	1				
656		634799.5	4976834	0.00026	2352.38	2717.08	0	ANNUAL	ALL	1				
657		634599.5	4976859	0.00027	2427	2717.08	0	ANNUAL	ALL	1				
658		634624.5	4976859	0.00027	2421.36	2717.08	0	ANNUAL	ALL	1				
659		634649.5	4976859	0.00027	2412.9	2717.08	0	ANNUAL	ALL	1				
660		634674.5	4976859	0.00027	2401.58	2717.08	0	ANNUAL	ALL	1				
661		634699.5	4976859	0.00026	2391.51	2717.08	0	ANNUAL	ALL	1				
662		634724.5	4976859	0.00026	2381.29	2717.08	0	ANNUAL	ALL	1				
663		634749.5	4976859	0.00026	2371.44	2717.08	0	ANNUAL	ALL	1				
664		634774.5	4976859	0.00026	2358.57	2717.08	0	ANNUAL	ALL	1				
665		634799.5	4976859	0.00026	2341.91	2742	0	ANNUAL	ALL	1				
666		634599.5	4976884	0.00027	2422.69	2717.08	0	ANNUAL	ALL	1				
667		634624.5	4976884	0.00027	2418.17	2717.08	0	ANNUAL	ALL	1				
668		634649.5	4976884	0.00027	2408.98	2717.08	0	ANNUAL	ALL	1				
669		634674.5	4976884	0.00027	2396.57	2717.08	0	ANNUAL	ALL	1				
670		634699.5	4976884	0.00027	2383.76	2717.08	0	ANNUAL	ALL	1				
671		634724.5	4976884	0.00027	2371.27	2717.08	0	ANNUAL	ALL	1				
672		634749.5	4976884	0.00027	2362.03	2717.08	0	ANNUAL	ALL	1				
673		634774.5	4976884	0.00027	2350.11	2717.08	0	ANNUAL	ALL	1				
674		634799.5	4976884	0.00027	2334.35	2742	0	ANNUAL	ALL	1				
675		634599.5	4976909	0.00027	2418.11	2717.08	0	ANNUAL	ALL	1				
676		634624.5	4976909	0.00027	2412.47	2717.08	0	ANNUAL	ALL	1				
677		634649.5	4976909	0.00027	2402.76	2717.08	0	ANNUAL	ALL	1				
678		634674.5	4976909	0.00027	2392.81	2717.08	0	ANNUAL	ALL	1				
679		634699.5	4976909	0.00027	2377.98	2717.08	0	ANNUAL	ALL	1				
680		634724.5	4976909	0.00027	2364.11	2717.08	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
681		634749.5	4976909	0.00027	2354.73	2717.08	0	ANNUAL	ALL	1				
682		634774.5	4976909	0.00027	2345.14	2717.08	0	ANNUAL	ALL	1				
683		634799.5	4976909	0.00027	2331	2742	0	ANNUAL	ALL	1				
684		634599.5	4976934	0.00028	2411.78	2717.08	0	ANNUAL	ALL	1				
685		634624.5	4976934	0.00027	2403.98	2717.08	0	ANNUAL	ALL	1				
686		634649.5	4976934	0.00027	2394.61	2717.08	0	ANNUAL	ALL	1				
687		634674.5	4976934	0.00027	2383.71	2717.08	0	ANNUAL	ALL	1				
688		634699.5	4976934	0.00027	2371.78	2717.08	0	ANNUAL	ALL	1				
689		634724.5	4976934	0.00027	2359.09	2717.08	0	ANNUAL	ALL	1				
690		634749.5	4976934	0.00027	2347.63	2717.08	0	ANNUAL	ALL	1				
691		634774.5	4976934	0.00027	2337.6	2742	0	ANNUAL	ALL	1				
692		634799.5	4976934	0.00027	2326.97	2742	0	ANNUAL	ALL	1				
693		634599.5	4976959	0.00028	2404.1	2717.08	0	ANNUAL	ALL	1				
694		634624.5	4976959	0.00028	2396.65	2717.08	0	ANNUAL	ALL	1				
695		634649.5	4976959	0.00028	2385.41	2717.08	0	ANNUAL	ALL	1				
696		634674.5	4976959	0.00028	2372.07	2717.08	0	ANNUAL	ALL	1				
697		634699.5	4976959	0.00028	2362.55	2717.08	0	ANNUAL	ALL	1				
698		634724.5	4976959	0.00028	2351.59	2717.08	0	ANNUAL	ALL	1				
699		634749.5	4976959	0.00028	2341.2	2717.08	0	ANNUAL	ALL	1				
700		634774.5	4976959	0.00028	2328.55	2742	0	ANNUAL	ALL	1				
701		634799.5	4976959	0.00028	2318.72	2742	0	ANNUAL	ALL	1				
702		634599.5	4976984	0.00028	2396.35	2717.08	0	ANNUAL	ALL	1				
703		634624.5	4976984	0.00028	2389.04	2717.08	0	ANNUAL	ALL	1				
704		634649.5	4976984	0.00028	2377.21	2717.08	0	ANNUAL	ALL	1				
705		634674.5	4976984	0.00028	2363.6	2717.08	0	ANNUAL	ALL	1				
706		634699.5	4976984	0.00028	2350.85	2717.08	0	ANNUAL	ALL	1				
707		634724.5	4976984	0.00028	2340.79	2717.08	0	ANNUAL	ALL	1				
708		634749.5	4976984	0.00028	2331.79	2742	0	ANNUAL	ALL	1				
709		634774.5	4976984	0.00028	2320.7	2742	0	ANNUAL	ALL	1				
710		634799.5	4976984	0.00028	2308.59	2742	0	ANNUAL	ALL	1				
711		634599.5	4977009	0.00028	2388.79	2717.08	0	ANNUAL	ALL	1				
712		634624.5	4977009	0.00028	2379.17	2717.08	0	ANNUAL	ALL	1				
713		634649.5	4977009	0.00028	2368.25	2717.08	0	ANNUAL	ALL	1				
714		634674.5	4977009	0.00028	2355.13	2717.08	0	ANNUAL	ALL	1				
715		634699.5	4977009	0.00028	2341.52	2717.08	0	ANNUAL	ALL	1				
716		634724.5	4977009	0.00029	2328.18	2742	0	ANNUAL	ALL	1				
717		634749.5	4977009	0.00028	2321.24	2742	0	ANNUAL	ALL	1				
718		634774.5	4977009	0.00028	2313.44	2742	0	ANNUAL	ALL	1				
719		634799.5	4977009	0.00029	2301.46	2742.16	0	ANNUAL	ALL	1				
720		634599.5	4977034	0.00029	2379.36	2717.08	0	ANNUAL	ALL	1				
721		634624.5	4977034	0.00029	2369.28	2717.08	0	ANNUAL	ALL	1				
722		634649.5	4977034	0.00029	2356.46	2717.08	0	ANNUAL	ALL	1				
723		634674.5	4977034	0.00029	2343.53	2717.08	0	ANNUAL	ALL	1				
724		634699.5	4977034	0.00029	2329.9	2742	0	ANNUAL	ALL	1				
725		634724.5	4977034	0.00029	2316.92	2742	0	ANNUAL	ALL	1				
726		634749.5	4977034	0.00029	2309.32	2742	0	ANNUAL	ALL	1				
727		634774.5	4977034	0.00029	2302.58	2742	0	ANNUAL	ALL	1				
728		634799.5	4977034	0.00029	2295.21	2742.16	0	ANNUAL	ALL	1				
729	**	CONCUNIT	ug/m^3											
730	**	DEPUNIT	g/m^2											

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	*	AERMOD	(	19191):	MIDAS	GOLD	STIBNITE	-	MODELING	R27	########			
2	*	AERMET	(	19191):	16:55:28									
3	*	MODELING	OPTIONS	USED:	RegDFAULT	CONC	ELEV	NOWARN	DRYDPLT	WETDPLT	RURAL	ADJ_U*		
4	*	PLOT	FILE	OF	ANNUAL	VALUES	AVERAGED	ACROSS	1	YEARS	FOR	SOURCE	GROUP:	ALL
5	*	FOR	A	TOTAL	OF	720	RECEPTORS.							
6	*	FORMAT:	(3(1X,F13.5),3(1X,F8.2),2X,A6,2X,A8,2X,I8.8,2X,A8)											
7	*	X	Y	AVERAGE	CONC	ZELEV	ZHILL	ZFLAG	AVE	GRP	NUM	YRS	NET	ID
8	*													
9	0.002140	635399.5	4975934	0.00015	2213.4	2844.3	0	ANNUAL	ALL	1				
10	max ↑	635424.5	4975934	0.00015	2212.64	2844.3	0	ANNUAL	ALL	1				
11		635449.5	4975934	0.00015	2211.27	2844.3	0	ANNUAL	ALL	1				
12		635474.5	4975934	0.00015	2212.5	2844.3	0	ANNUAL	ALL	1				
13		635499.5	4975934	0.00014	2215.21	2844.3	0	ANNUAL	ALL	1				
14		635524.5	4975934	0.00014	2215.98	2844.3	0	ANNUAL	ALL	1				
15		635549.5	4975934	0.00014	2215	2844.3	0	ANNUAL	ALL	1				
16		635574.5	4975934	0.00014	2215.74	2844.3	0	ANNUAL	ALL	1				
17		635599.5	4975934	0.00013	2218.34	2844.3	0	ANNUAL	ALL	1				
18		635399.5	4975959	0.00017	2202.75	2844.3	0	ANNUAL	ALL	1				
19		635424.5	4975959	0.00017	2204.36	2844.3	0	ANNUAL	ALL	1				
20		635449.5	4975959	0.00016	2204.87	2844.3	0	ANNUAL	ALL	1				
21		635474.5	4975959	0.00016	2206.39	2844.3	0	ANNUAL	ALL	1				
22		635499.5	4975959	0.00015	2208.99	2844.3	0	ANNUAL	ALL	1				
23		635524.5	4975959	0.00015	2210.99	2844.3	0	ANNUAL	ALL	1				
24		635549.5	4975959	0.00015	2211.29	2844.3	0	ANNUAL	ALL	1				
25		635574.5	4975959	0.00015	2210.92	2844.3	0	ANNUAL	ALL	1				
26		635599.5	4975959	0.00015	2208.83	2844.3	0	ANNUAL	ALL	1				
27		635399.5	4975984	0.00019	2195.09	2844.3	0	ANNUAL	ALL	1				
28		635424.5	4975984	0.00018	2198.19	2844.3	0	ANNUAL	ALL	1				
29		635449.5	4975984	0.00018	2198.7	2844.3	0	ANNUAL	ALL	1				
30		635474.5	4975984	0.00017	2201.57	2844.3	0	ANNUAL	ALL	1				
31		635499.5	4975984	0.00016	2203.99	2844.3	0	ANNUAL	ALL	1				
32		635524.5	4975984	0.00016	2206.27	2844.3	0	ANNUAL	ALL	1				
33		635549.5	4975984	0.00016	2206.83	2844.3	0	ANNUAL	ALL	1				
34		635574.5	4975984	0.00016	2205.61	2844.3	0	ANNUAL	ALL	1				
35		635599.5	4975984	0.00016	2202.99	2844.3	0	ANNUAL	ALL	1				
36		635399.5	4976009	0.00019	2195.69	2844.3	0	ANNUAL	ALL	1				
37		635424.5	4976009	0.0002	2189.65	2844.3	0	ANNUAL	ALL	1				
38		635449.5	4976009	0.00019	2194	2844.3	0	ANNUAL	ALL	1				
39		635474.5	4976009	0.00018	2200.13	2844.3	0	ANNUAL	ALL	1				
40		635499.5	4976009	0.00017	2202.83	2844.3	0	ANNUAL	ALL	1				
41		635524.5	4976009	0.00017	2203.57	2844.3	0	ANNUAL	ALL	1				
42		635549.5	4976009	0.00016	2203.82	2844.3	0	ANNUAL	ALL	1				
43		635574.5	4976009	0.00016	2202.81	2844.3	0	ANNUAL	ALL	1				
44		635599.5	4976009	0.00016	2200.59	2844.3	0	ANNUAL	ALL	1				
45		635399.5	4976034	0.00019	2198.23	2844.3	0	ANNUAL	ALL	1				
46		635424.5	4976034	0.00021	2186.98	2844.3	0	ANNUAL	ALL	1				
47		635449.5	4976034	0.0002	2190.14	2844.3	0	ANNUAL	ALL	1				
48		635474.5	4976034	0.00018	2198.63	2844.3	0	ANNUAL	ALL	1				
49		635499.5	4976034	0.00018	2198.93	2844.3	0	ANNUAL	ALL	1				
50		635524.5	4976034	0.00018	2199.39	2844.3	0	ANNUAL	ALL	1				
51		635549.5	4976034	0.00017	2201.1	2844.3	0	ANNUAL	ALL	1				
52		635574.5	4976034	0.00017	2200.59	2844.3	0	ANNUAL	ALL	1				
53		635599.5	4976034	0.00017	2197.96	2844.3	0	ANNUAL	ALL	1				
54		635399.5	4976059	0.0002	2196.33	2844.3	0	ANNUAL	ALL	1				
55		635424.5	4976059	0.00023	2184.09	2844.3	0	ANNUAL	ALL	1				
56		635449.5	4976059	0.00023	2180.82	2844.3	0	ANNUAL	ALL	1				
57		635474.5	4976059	0.0002	2193.11	2844.3	0	ANNUAL	ALL	1				
58		635499.5	4976059	0.00019	2194.5	2844.3	0	ANNUAL	ALL	1				
59		635524.5	4976059	0.00018	2197.17	2844.3	0	ANNUAL	ALL	1				
60		635549.5	4976059	0.00018	2199.4	2844.3	0	ANNUAL	ALL	1				
61		635574.5	4976059	0.00018	2198.27	2844.3	0	ANNUAL	ALL	1				
62		635599.5	4976059	0.00018	2194.62	2844.3	0	ANNUAL	ALL	1				
63		635399.5	4976084	0.00022	2188.98	2844.3	0	ANNUAL	ALL	1				
64		635424.5	4976084	0.00025	2180.22	2844.3	0	ANNUAL	ALL	1				
65		635449.5	4976084	0.00026	2174.51	2844.3	0	ANNUAL	ALL	1				
66		635474.5	4976084	0.00024	2180.27	2844.3	0	ANNUAL	ALL	1				
67		635499.5	4976084	0.00022	2185.71	2844.3	0	ANNUAL	ALL	1				
68		635524.5	4976084	0.0002	2191.13	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
69		635549.5	4976084	0.00019	2193.95	2844.3	0	ANNUAL	ALL	1				
70		635574.5	4976084	0.0002	2190.58	2844.3	0	ANNUAL	ALL	1				
71		635599.5	4976084	0.00022	2183.01	2844.3	0	ANNUAL	ALL	1				
72		635399.5	4976109	0.00025	2182.28	2844.3	0	ANNUAL	ALL	1				
73		635424.5	4976109	0.00026	2177.24	2844.3	0	ANNUAL	ALL	1				
74		635449.5	4976109	0.00028	2171.45	2844.3	0	ANNUAL	ALL	1				
75		635474.5	4976109	0.00028	2172.26	2844.3	0	ANNUAL	ALL	1				
76		635499.5	4976109	0.00025	2177.58	2844.3	0	ANNUAL	ALL	1				
77		635524.5	4976109	0.00024	2180.23	2844.3	0	ANNUAL	ALL	1				
78		635549.5	4976109	0.00024	2179.81	2844.3	0	ANNUAL	ALL	1				
79		635574.5	4976109	0.00024	2176.94	2844.3	0	ANNUAL	ALL	1				
80		635599.5	4976109	0.00023	2179.4	2844.3	0	ANNUAL	ALL	1				
81		635399.5	4976134	0.00027	2176.77	2844.3	0	ANNUAL	ALL	1				
82		635424.5	4976134	0.00028	2174.27	2844.3	0	ANNUAL	ALL	1				
83		635449.5	4976134	0.00029	2171.04	2844.3	0	ANNUAL	ALL	1				
84		635474.5	4976134	0.00031	2166.4	2844.3	0	ANNUAL	ALL	1				
85		635499.5	4976134	0.0003	2167.48	2844.3	0	ANNUAL	ALL	1				
86		635524.5	4976134	0.00028	2172.09	2844.3	0	ANNUAL	ALL	1				
87		635549.5	4976134	0.00027	2171.44	2844.3	0	ANNUAL	ALL	1				
88		635574.5	4976134	0.00027	2172.93	2844.3	0	ANNUAL	ALL	1				
89		635599.5	4976134	0.00024	2178.31	2844.3	0	ANNUAL	ALL	1				
90		635199.5	4976834	0.00119	2116.83	2844.3	0	ANNUAL	ALL	1				
91		635224.5	4976834	0.00102	2112.53	2844.3	0	ANNUAL	ALL	1				
92		635249.5	4976834	0.00101	2108.39	2844.3	0	ANNUAL	ALL	1				
93		635274.5	4976834	0.001	2105.23	2844.3	0	ANNUAL	ALL	1				
94		635299.5	4976834	0.00099	2101.6	2844.3	0	ANNUAL	ALL	1				
95		635324.5	4976834	0.00098	2098.74	2844.3	0	ANNUAL	ALL	1				
96		635349.5	4976834	0.00094	2104.26	2844.3	0	ANNUAL	ALL	1				
97		635374.5	4976834	0.0009	2110.4	2844.3	0	ANNUAL	ALL	1				
98		635399.5	4976834	0.00098	2117.98	2844.3	0	ANNUAL	ALL	1				
99		635199.5	4976859	0.00121	2114.34	2844.3	0	ANNUAL	ALL	1				
100		635224.5	4976859	0.00106	2108.68	2844.3	0	ANNUAL	ALL	1				
101		635249.5	4976859	0.00105	2104.42	2844.3	0	ANNUAL	ALL	1				
102		635274.5	4976859	0.00104	2101.28	2844.3	0	ANNUAL	ALL	1				
103		635299.5	4976859	0.00103	2098.83	2844.3	0	ANNUAL	ALL	1				
104		635324.5	4976859	0.00101	2096.89	2844.3	0	ANNUAL	ALL	1				
105		635349.5	4976859	0.00098	2101.21	2844.3	0	ANNUAL	ALL	1				
106		635374.5	4976859	0.00093	2108.71	2844.3	0	ANNUAL	ALL	1				
107		635399.5	4976859	0.00102	2118.31	2844.3	0	ANNUAL	ALL	1				
108		635199.5	4976884	0.0011	2111.17	2844.3	0	ANNUAL	ALL	1				
109		635224.5	4976884	0.00111	2104.78	2844.3	0	ANNUAL	ALL	1				
110		635249.5	4976884	0.0011	2100.14	2844.3	0	ANNUAL	ALL	1				
111		635274.5	4976884	0.00109	2097.48	2844.3	0	ANNUAL	ALL	1				
112		635299.5	4976884	0.00107	2095.42	2844.3	0	ANNUAL	ALL	1				
113		635324.5	4976884	0.00105	2094.96	2844.3	0	ANNUAL	ALL	1				
114		635349.5	4976884	0.00102	2097.83	2844.3	0	ANNUAL	ALL	1				
115		635374.5	4976884	0.00096	2107.96	2844.3	0	ANNUAL	ALL	1				
116		635399.5	4976884	0.00105	2119.17	2844.3	0	ANNUAL	ALL	1				
117		635199.5	4976909	0.00114	2108.51	2844.3	0	ANNUAL	ALL	1				
118		635224.5	4976909	0.00115	2102.17	2844.3	0	ANNUAL	ALL	1				
119		635249.5	4976909	0.00114	2097.31	2844.3	0	ANNUAL	ALL	1				
120		635274.5	4976909	0.00113	2094.85	2844.3	0	ANNUAL	ALL	1				
121		635299.5	4976909	0.00111	2093.19	2844.3	0	ANNUAL	ALL	1				
122		635324.5	4976909	0.00108	2093.48	2844.3	0	ANNUAL	ALL	1				
123		635349.5	4976909	0.00104	2098.12	2844.3	0	ANNUAL	ALL	1				
124		635374.5	4976909	0.00098	2108.79	2844.3	0	ANNUAL	ALL	1				
125		635399.5	4976909	0.00111	2120.74	2844.3	0	ANNUAL	ALL	1				
126		635199.5	4976934	0.00118	2106.38	2844.3	0	ANNUAL	ALL	1				
127		635224.5	4976934	0.00118	2100.81	2844.3	0	ANNUAL	ALL	1				
128		635249.5	4976934	0.00117	2096.21	2844.3	0	ANNUAL	ALL	1				
129		635274.5	4976934	0.00116	2092.89	2844.3	0	ANNUAL	ALL	1				
130		635299.5	4976934	0.00114	2091.1	2844.3	0	ANNUAL	ALL	1				
131		635324.5	4976934	0.00111	2092.46	2844.3	0	ANNUAL	ALL	1				
132		635349.5	4976934	0.00106	2099.48	2844.3	0	ANNUAL	ALL	1				
133		635374.5	4976934	0.001	2110.37	2844.3	0	ANNUAL	ALL	1				
134		635399.5	4976934	0.00116	2122.91	2844.3	0	ANNUAL	ALL	1				
135		635199.5	4976959	0.00122	2104.62	2844.3	0	ANNUAL	ALL	1				
136		635224.5	4976959	0.00122	2099.28	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
137		635249.5	4976959	0.00121	2094.41	2844.3	0	ANNUAL	ALL	1				
138		635274.5	4976959	0.00119	2090.59	2844.3	0	ANNUAL	ALL	1				
139		635299.5	4976959	0.00117	2088.8	2844.3	0	ANNUAL	ALL	1				
140		635324.5	4976959	0.00114	2092.02	2844.3	0	ANNUAL	ALL	1				
141		635349.5	4976959	0.00109	2100.12	2844.3	0	ANNUAL	ALL	1				
142		635374.5	4976959	0.00102	2112.07	2844.3	0	ANNUAL	ALL	1				
143		635399.5	4976959	0.00121	2125.69	2844.3	0	ANNUAL	ALL	1				
144		635199.5	4976984	0.00126	2102.45	2844.3	0	ANNUAL	ALL	1				
145		635224.5	4976984	0.00125	2097.29	2844.3	0	ANNUAL	ALL	1				
146		635249.5	4976984	0.00125	2091.62	2844.3	0	ANNUAL	ALL	1				
147		635274.5	4976984	0.00122	2087.92	2844.3	0	ANNUAL	ALL	1				
148		635299.5	4976984	0.0012	2086.81	2844.3	0	ANNUAL	ALL	1				
149		635324.5	4976984	0.00117	2092.65	2844.3	0	ANNUAL	ALL	1				
150		635349.5	4976984	0.00111	2101.3	2844.3	0	ANNUAL	ALL	1				
151		635374.5	4976984	0.00104	2114.13	2844.3	0	ANNUAL	ALL	1				
152		635399.5	4976984	0.00126	2128.46	2844.3	0	ANNUAL	ALL	1				
153		635199.5	4977009	0.0013	2099.39	2844.3	0	ANNUAL	ALL	1				
154		635224.5	4977009	0.0013	2093.66	2844.3	0	ANNUAL	ALL	1				
155		635249.5	4977009	0.00128	2087.97	2844.3	0	ANNUAL	ALL	1				
156		635274.5	4977009	0.00125	2084.9	2844.3	0	ANNUAL	ALL	1				
157		635299.5	4977009	0.00123	2087.43	2844.3	0	ANNUAL	ALL	1				
158		635324.5	4977009	0.00119	2094.55	2844.3	0	ANNUAL	ALL	1				
159		635349.5	4977009	0.00113	2103.74	2844.3	0	ANNUAL	ALL	1				
160		635374.5	4977009	0.00124	2116.64	2844.3	0	ANNUAL	ALL	1				
161		635399.5	4977009	0.00131	2131.12	2844.3	0	ANNUAL	ALL	1				
162		635199.5	4977034	0.00135	2094.63	2844.3	0	ANNUAL	ALL	1				
163		635224.5	4977034	0.00133	2088.76	2844.3	0	ANNUAL	ALL	1				
164		635249.5	4977034	0.00131	2084.27	2844.3	0	ANNUAL	ALL	1				
165		635274.5	4977034	0.00128	2082.71	2844.3	0	ANNUAL	ALL	1				
166		635299.5	4977034	0.00125	2089.9	2844.3	0	ANNUAL	ALL	1				
167		635324.5	4977034	0.0012	2098.21	2844.3	0	ANNUAL	ALL	1				
168		635349.5	4977034	0.00114	2107.49	2844.3	0	ANNUAL	ALL	1				
169		635374.5	4977034	0.00129	2119.09	2844.3	0	ANNUAL	ALL	1				
170		635399.5	4977034	0.00136	2133.38	2844.3	0	ANNUAL	ALL	1				
171		634899.5	4977134	0.00095	2221.02	2844.3	0	ANNUAL	ALL	1				
172		634924.5	4977134	0.00108	2207.85	2844.3	0	ANNUAL	ALL	1				
173		634949.5	4977134	0.00132	2190.45	2844.3	0	ANNUAL	ALL	1				
174		634974.5	4977134	0.00173	2169.12	2844.3	0	ANNUAL	ALL	1				
175		634999.5	4977134	0.00204	2150.64	2844.3	0	ANNUAL	ALL	1				
176		635024.5	4977134	0.00207	2135.97	2844.3	0	ANNUAL	ALL	1				
177		635049.5	4977134	0.0019	2122.38	2844.3	0	ANNUAL	ALL	1				
178		635074.5	4977134	0.00147	2113.7	2844.3	0	ANNUAL	ALL	1				
179		635099.5	4977134	0.00149	2105.9	2844.3	0	ANNUAL	ALL	1				
180		634899.5	4977159	0.00106	2213.37	2844.3	0	ANNUAL	ALL	1				
181		634924.5	4977159	0.0012	2201.16	2844.3	0	ANNUAL	ALL	1				
182		634949.5	4977159	0.00153	2181.17	2844.3	0	ANNUAL	ALL	1				
183		634974.5	4977159	0.00191	2161.72	2844.3	0	ANNUAL	ALL	1				
184		634999.5	4977159	0.0021	2145.73	2844.3	0	ANNUAL	ALL	1				
185		635024.5	4977159	0.00205	2132.12	2844.3	0	ANNUAL	ALL	1				
186		635049.5	4977159	0.00184	2119.59	2844.3	0	ANNUAL	ALL	1				
187		635074.5	4977159	0.00151	2109.27	2844.3	0	ANNUAL	ALL	1				
188		635099.5	4977159	0.00152	2101.29	2844.3	0	ANNUAL	ALL	1				
189		634899.5	4977184	0.00117	2206.56	2844.3	0	ANNUAL	ALL	1				
190		634924.5	4977184	0.00134	2193.64	2844.3	0	ANNUAL	ALL	1				
191		634949.5	4977184	0.00173	2172.29	2844.3	0	ANNUAL	ALL	1				
192		634974.5	4977184	0.00205	2154.5	2844.3	0	ANNUAL	ALL	1				
193		634999.5	4977184	0.00213	2141.04	2844.3	0	ANNUAL	ALL	1				
194		635024.5	4977184	0.00202	2128.3	2844.3	0	ANNUAL	ALL	1				
195		635049.5	4977184	0.00176	2114.34	2844.3	0	ANNUAL	ALL	1				
196		635074.5	4977184	0.00154	2102.7	2844.3	0	ANNUAL	ALL	1				
197		635099.5	4977184	0.00155	2096.47	2844.3	0	ANNUAL	ALL	1				
198		634899.5	4977209	0.0013	2199.13	2844.3	0	ANNUAL	ALL	1				
199		634924.5	4977209	0.00154	2184.15	2844.3	0	ANNUAL	ALL	1				
200		634949.5	4977209	0.00192	2163.72	2844.3	0	ANNUAL	ALL	1				
201		634974.5	4977209	0.00213	2146.68	2844.3	0	ANNUAL	ALL	1				
202		634999.5	4977209	0.00211	2136.15	2844.3	0	ANNUAL	ALL	1				
203		635024.5	4977209	0.00197	2124.22	2844.3	0	ANNUAL	ALL	1				
204		635049.5	4977209	0.00155	2105.9	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
205		635074.5	4977209	0.00157	2096.39	2844.3	0	ANNUAL	ALL	1				
206		635099.5	4977209	0.00157	2091.31	2844.3	0	ANNUAL	ALL	1				
207		634899.5	4977234	0.00155	2185.16	2844.3	0	ANNUAL	ALL	1				
208		634924.5	4977234	0.00179	2172.04	2844.3	0	ANNUAL	ALL	1				
209		634949.5	4977234	0.00209	2152.41	2844.3	0	ANNUAL	ALL	1				
210		634974.5	4977234	0.00214	2139.97	2844.3	0	ANNUAL	ALL	1				
211		634999.5	4977234	0.00206	2130.73	2844.3	0	ANNUAL	ALL	1				
212		635024.5	4977234	0.00184	2117.31	2844.3	0	ANNUAL	ALL	1				
213		635049.5	4977234	0.00158	2098.65	2844.3	0	ANNUAL	ALL	1				
214		635074.5	4977234	0.00159	2092.39	2844.3	0	ANNUAL	ALL	1				
215		635099.5	4977234	0.00157	2087.32	2844.3	0	ANNUAL	ALL	1				
216		634899.5	4977259	0.00165	2180.4	2844.3	0	ANNUAL	ALL	1				
217		634924.5	4977259	0.002	2160.19	2844.3	0	ANNUAL	ALL	1				
218		634949.5	4977259	0.00213	2143.3	2844.3	0	ANNUAL	ALL	1				
219		634974.5	4977259	0.00208	2132.11	2844.3	0	ANNUAL	ALL	1				
220		634999.5	4977259	0.00196	2123.02	2844.3	0	ANNUAL	ALL	1				
221		635024.5	4977259	0.00156	2107.09	2844.3	0	ANNUAL	ALL	1				
222		635049.5	4977259	0.00159	2095.35	2844.3	0	ANNUAL	ALL	1				
223		635074.5	4977259	0.00158	2089.07	2844.3	0	ANNUAL	ALL	1				
224		635099.5	4977259	0.00157	2083.6	2844.3	0	ANNUAL	ALL	1				
225		634899.5	4977284	0.00165	2180.69	2844.3	0	ANNUAL	ALL	1				
226		634924.5	4977284	0.00201	2158.28	2844.3	0	ANNUAL	ALL	1				
227		634949.5	4977284	0.00211	2139.34	2844.3	0	ANNUAL	ALL	1				
228		634974.5	4977284	0.00195	2123.05	2844.3	0	ANNUAL	ALL	1				
229		634999.5	4977284	0.00154	2112.91	2844.3	0	ANNUAL	ALL	1				
230		635024.5	4977284	0.00158	2100.55	2844.3	0	ANNUAL	ALL	1				
231		635049.5	4977284	0.00159	2092.76	2844.3	0	ANNUAL	ALL	1				
232		635074.5	4977284	0.00158	2085.71	2844.3	0	ANNUAL	ALL	1				
233		635099.5	4977284	0.00157	2078.67	2844.3	0	ANNUAL	ALL	1				
234		634899.5	4977309	0.00169	2178.55	2844.3	0	ANNUAL	ALL	1				
235		634924.5	4977309	0.00201	2156.77	2844.3	0	ANNUAL	ALL	1				
236		634949.5	4977309	0.00207	2136.54	2844.3	0	ANNUAL	ALL	1				
237		634974.5	4977309	0.00185	2119.59	2844.3	0	ANNUAL	ALL	1				
238		634999.5	4977309	0.00155	2107.01	2844.3	0	ANNUAL	ALL	1				
239		635024.5	4977309	0.00158	2096.52	2844.3	0	ANNUAL	ALL	1				
240		635049.5	4977309	0.00157	2089.24	2844.3	0	ANNUAL	ALL	1				
241		635074.5	4977309	0.00158	2082.55	2844.3	0	ANNUAL	ALL	1				
242		635099.5	4977309	0.00158	2075.98	2844.3	0	ANNUAL	ALL	1				
243		634899.5	4977334	0.00177	2173.18	2844.3	0	ANNUAL	ALL	1				
244		634924.5	4977334	0.00202	2153.29	2844.3	0	ANNUAL	ALL	1				
245		634949.5	4977334	0.00202	2133.9	2844.3	0	ANNUAL	ALL	1				
246		634974.5	4977334	0.0018	2117.58	2844.3	0	ANNUAL	ALL	1				
247		634999.5	4977334	0.00154	2104.03	2844.3	0	ANNUAL	ALL	1				
248		635024.5	4977334	0.00157	2093.8	2844.3	0	ANNUAL	ALL	1				
249		635049.5	4977334	0.00157	2085.23	2844.3	0	ANNUAL	ALL	1				
250		635074.5	4977334	0.00157	2078.76	2844.3	0	ANNUAL	ALL	1				
251		635099.5	4977334	0.00157	2074.53	2844.3	0	ANNUAL	ALL	1				
252		635399.5	4976159	0.00031	2171.27	2844.3	0	ANNUAL	ALL	1				
253		635424.5	4976159	0.00031	2169.98	2844.3	0	ANNUAL	ALL	1				
254		635449.5	4976159	0.00032	2167.61	2844.3	0	ANNUAL	ALL	1				
255		635474.5	4976159	0.00033	2164.06	2844.3	0	ANNUAL	ALL	1				
256		635499.5	4976159	0.00033	2161.76	2844.3	0	ANNUAL	ALL	1				
257		635524.5	4976159	0.00034	2160.48	2844.3	0	ANNUAL	ALL	1				
258		635549.5	4976159	0.00032	2162.19	2844.3	0	ANNUAL	ALL	1				
259		635574.5	4976159	0.00029	2168.15	2844.3	0	ANNUAL	ALL	1				
260		635599.5	4976159	0.00026	2173.85	2844.3	0	ANNUAL	ALL	1				
261		635399.5	4976184	0.00033	2168.06	2844.3	0	ANNUAL	ALL	1				
262		635424.5	4976184	0.00034	2166.17	2844.3	0	ANNUAL	ALL	1				
263		635449.5	4976184	0.00034	2163.95	2844.3	0	ANNUAL	ALL	1				
264		635474.5	4976184	0.00035	2161.05	2844.3	0	ANNUAL	ALL	1				
265		635499.5	4976184	0.00036	2158.86	2844.3	0	ANNUAL	ALL	1				
266		635524.5	4976184	0.00036	2157.1	2844.3	0	ANNUAL	ALL	1				
267		635549.5	4976184	0.00036	2157.07	2844.3	0	ANNUAL	ALL	1				
268		635574.5	4976184	0.00032	2164.59	2844.3	0	ANNUAL	ALL	1				
269		635599.5	4976184	0.00028	2172.06	2844.3	0	ANNUAL	ALL	1				
270		635399.5	4976209	0.00035	2165.29	2844.3	0	ANNUAL	ALL	1				
271		635424.5	4976209	0.00036	2163.14	2844.3	0	ANNUAL	ALL	1				
272		635449.5	4976209	0.00037	2160.76	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
273		635474.5	4976209	0.00038	2158.05	2844.3	0	ANNUAL	ALL	1				
274		635499.5	4976209	0.00038	2155.43	2844.3	0	ANNUAL	ALL	1				
275		635524.5	4976209	0.00039	2153.57	2844.3	0	ANNUAL	ALL	1				
276		635549.5	4976209	0.00037	2156.02	2844.3	0	ANNUAL	ALL	1				
277		635574.5	4976209	0.00032	2165.26	2844.3	0	ANNUAL	ALL	1				
278		635599.5	4976209	0.00027	2175.01	2844.3	0	ANNUAL	ALL	1				
279		635399.5	4976234	0.00038	2162.56	2844.3	0	ANNUAL	ALL	1				
280		635424.5	4976234	0.00039	2160.46	2844.3	0	ANNUAL	ALL	1				
281		635449.5	4976234	0.00039	2157.93	2844.3	0	ANNUAL	ALL	1				
282		635474.5	4976234	0.0004	2155.5	2844.3	0	ANNUAL	ALL	1				
283		635499.5	4976234	0.00041	2152.67	2844.3	0	ANNUAL	ALL	1				
284		635524.5	4976234	0.00041	2150.12	2844.3	0	ANNUAL	ALL	1				
285		635549.5	4976234	0.00038	2156.6	2844.3	0	ANNUAL	ALL	1				
286		635574.5	4976234	0.00032	2167.62	2844.3	0	ANNUAL	ALL	1				
287		635599.5	4976234	0.00026	2178.35	2844.3	0	ANNUAL	ALL	1				
288		634999.5	4978134	0.00108	2044.53	2844.3	0	ANNUAL	ALL	1				
289		635024.5	4978134	0.00113	2030.56	2844.3	0	ANNUAL	ALL	1				
290		635049.5	4978134	0.00119	2018.07	2844.3	0	ANNUAL	ALL	1				
291		635074.5	4978134	0.00124	2006.69	2844.3	0	ANNUAL	ALL	1				
292		635099.5	4978134	0.00123	2006.39	2844.3	0	ANNUAL	ALL	1				
293		635124.5	4978134	0.0012	2013.34	2844.3	0	ANNUAL	ALL	1				
294		635149.5	4978134	0.00116	2020.75	2844.3	0	ANNUAL	ALL	1				
295		635174.5	4978134	0.00113	2029.05	2844.3	0	ANNUAL	ALL	1				
296		635199.5	4978134	0.00109	2038.91	2844.3	0	ANNUAL	ALL	1				
297		634999.5	4978159	0.00107	2044.5	2844.3	0	ANNUAL	ALL	1				
298		635024.5	4978159	0.00112	2030.78	2844.3	0	ANNUAL	ALL	1				
299		635049.5	4978159	0.00119	2017.35	2844.3	0	ANNUAL	ALL	1				
300		635074.5	4978159	0.00124	2004.54	2844.3	0	ANNUAL	ALL	1				
301		635099.5	4978159	0.00124	2003.81	2844.3	0	ANNUAL	ALL	1				
302		635124.5	4978159	0.00121	2010.57	2844.3	0	ANNUAL	ALL	1				
303		635149.5	4978159	0.00117	2017.75	2844.3	0	ANNUAL	ALL	1				
304		635174.5	4978159	0.00113	2025.18	2844.3	0	ANNUAL	ALL	1				
305		635199.5	4978159	0.00109	2035.11	2844.3	0	ANNUAL	ALL	1				
306		634999.5	4978184	0.00106	2044.38	2844.3	0	ANNUAL	ALL	1				
307		635024.5	4978184	0.00112	2028.98	2844.3	0	ANNUAL	ALL	1				
308		635049.5	4978184	0.00119	2015.36	2844.3	0	ANNUAL	ALL	1				
309		635074.5	4978184	0.00124	2002.43	2844.3	0	ANNUAL	ALL	1				
310		635099.5	4978184	0.00125	2000.86	2844.3	0	ANNUAL	ALL	1				
311		635124.5	4978184	0.00121	2007.53	2844.3	0	ANNUAL	ALL	1				
312		635149.5	4978184	0.00118	2014.6	2844.3	0	ANNUAL	ALL	1				
313		635174.5	4978184	0.00114	2022.07	2844.3	0	ANNUAL	ALL	1				
314		635199.5	4978184	0.0011	2031.45	2844.3	0	ANNUAL	ALL	1				
315		634999.5	4978209	0.00105	2043.46	2844.3	0	ANNUAL	ALL	1				
316		635024.5	4978209	0.00112	2027.94	2844.3	0	ANNUAL	ALL	1				
317		635049.5	4978209	0.00119	2013.73	2844.3	0	ANNUAL	ALL	1				
318		635074.5	4978209	0.00124	2000.96	2844.3	0	ANNUAL	ALL	1				
319		635099.5	4978209	0.00125	1998.75	2844.3	0	ANNUAL	ALL	1				
320		635124.5	4978209	0.00122	2004.56	2844.3	0	ANNUAL	ALL	1				
321		635149.5	4978209	0.00118	2011.78	2844.3	0	ANNUAL	ALL	1				
322		635174.5	4978209	0.00114	2019.36	2844.3	0	ANNUAL	ALL	1				
323		635199.5	4978209	0.0011	2027.82	2844.3	0	ANNUAL	ALL	1				
324		634999.5	4978234	0.00104	2042.97	2844.3	0	ANNUAL	ALL	1				
325		635024.5	4978234	0.00112	2026.61	2844.3	0	ANNUAL	ALL	1				
326		635049.5	4978234	0.00119	2012.57	2844.3	0	ANNUAL	ALL	1				
327		635074.5	4978234	0.00124	2000.24	2844.3	0	ANNUAL	ALL	1				
328		635099.5	4978234	0.00126	1996.61	2844.3	0	ANNUAL	ALL	1				
329		635124.5	4978234	0.00122	2001.65	2844.3	0	ANNUAL	ALL	1				
330		635149.5	4978234	0.00119	2009.16	2844.3	0	ANNUAL	ALL	1				
331		635174.5	4978234	0.00115	2016.86	2844.3	0	ANNUAL	ALL	1				
332		635199.5	4978234	0.00111	2024.48	2844.3	0	ANNUAL	ALL	1				
333		634999.5	4978259	0.00104	2041.08	2844.3	0	ANNUAL	ALL	1				
334		635024.5	4978259	0.00112	2024.08	2844.3	0	ANNUAL	ALL	1				
335		635049.5	4978259	0.00118	2011.49	2844.3	0	ANNUAL	ALL	1				
336		635074.5	4978259	0.00123	2000.61	2844.3	0	ANNUAL	ALL	1				
337		635099.5	4978259	0.00126	1994.84	2844.3	0	ANNUAL	ALL	1				
338		635124.5	4978259	0.00123	1999.29	2844.3	0	ANNUAL	ALL	1				
339		635149.5	4978259	0.00119	2007.14	2844.3	0	ANNUAL	ALL	1				
340		635174.5	4978259	0.00115	2014.96	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
341		635199.5	4978259	0.00111	2023.44	2844.3	0	ANNUAL	ALL	1				
342		634999.5	4978284	0.00104	2039.02	2844.3	0	ANNUAL	ALL	1				
343		635024.5	4978284	0.00112	2022.69	2844.3	0	ANNUAL	ALL	1				
344		635049.5	4978284	0.00118	2010.11	2844.3	0	ANNUAL	ALL	1				
345		635074.5	4978284	0.00123	1999.28	2844.3	0	ANNUAL	ALL	1				
346		635099.5	4978284	0.00126	1993.94	2844.3	0	ANNUAL	ALL	1				
347		635124.5	4978284	0.00124	1996.86	2844.3	0	ANNUAL	ALL	1				
348		635149.5	4978284	0.0012	2004.78	2844.3	0	ANNUAL	ALL	1				
349		635174.5	4978284	0.00115	2012.7	2844.3	0	ANNUAL	ALL	1				
350		635199.5	4978284	0.00111	2021.78	2844.3	0	ANNUAL	ALL	1				
351		634999.5	4978309	0.00104	2036.72	2844.3	0	ANNUAL	ALL	1				
352		635024.5	4978309	0.00111	2023.32	2844.3	0	ANNUAL	ALL	1				
353		635049.5	4978309	0.00118	2010.1	2844.3	0	ANNUAL	ALL	1				
354		635074.5	4978309	0.00122	1999.36	2844.3	0	ANNUAL	ALL	1				
355		635099.5	4978309	0.00126	1992.81	2844.3	0	ANNUAL	ALL	1				
356		635124.5	4978309	0.00124	1994.13	2844.3	0	ANNUAL	ALL	1				
357		635149.5	4978309	0.0012	2001.68	2844.3	0	ANNUAL	ALL	1				
358		635174.5	4978309	0.00116	2009.75	2844.3	0	ANNUAL	ALL	1				
359		635199.5	4978309	0.00111	2018.84	2844.3	0	ANNUAL	ALL	1				
360		634999.5	4978334	0.00105	2033.58	2844.3	0	ANNUAL	ALL	1				
361		635024.5	4978334	0.0011	2021.76	2844.3	0	ANNUAL	ALL	1				
362		635049.5	4978334	0.00117	2009.59	2844.3	0	ANNUAL	ALL	1				
363		635074.5	4978334	0.00122	1999.33	2844.3	0	ANNUAL	ALL	1				
364		635099.5	4978334	0.00125	1991.74	2844.3	0	ANNUAL	ALL	1				
365		635124.5	4978334	0.00125	1991.62	2844.3	0	ANNUAL	ALL	1				
366		635149.5	4978334	0.00121	1998.49	2844.3	0	ANNUAL	ALL	1				
367		635174.5	4978334	0.00117	2006.18	2844.3	0	ANNUAL	ALL	1				
368		635199.5	4978334	0.00113	2015.32	2844.3	0	ANNUAL	ALL	1				
369		634299.5	4978134	0.00096	2065.05	2844.3	0	ANNUAL	ALL	1				
370		634324.5	4978134	0.00103	2052.1	2844.3	0	ANNUAL	ALL	1				
371		634349.5	4978134	0.00107	2045.24	2844.3	0	ANNUAL	ALL	1				
372		634374.5	4978134	0.00113	2034.94	2844.3	0	ANNUAL	ALL	1				
373		634399.5	4978134	0.00122	2020.36	2844.3	0	ANNUAL	ALL	1				
374		634424.5	4978134	0.00132	2003.67	2844.3	0	ANNUAL	ALL	1				
375		634449.5	4978134	0.00138	1995.29	2844.3	0	ANNUAL	ALL	1				
376		634474.5	4978134	0.0013	2007.74	2844.3	0	ANNUAL	ALL	1				
377		634499.5	4978134	0.00118	2026.56	2844.3	0	ANNUAL	ALL	1				
378		634299.5	4978159	0.00098	2056.37	2844.3	0	ANNUAL	ALL	1				
379		634324.5	4978159	0.00106	2043.39	2844.3	0	ANNUAL	ALL	1				
380		634349.5	4978159	0.00113	2031.51	2844.3	0	ANNUAL	ALL	1				
381		634374.5	4978159	0.00118	2023.05	2844.3	0	ANNUAL	ALL	1				
382		634399.5	4978159	0.00127	2009.29	2844.3	0	ANNUAL	ALL	1				
383		634424.5	4978159	0.00136	1995	2844.3	0	ANNUAL	ALL	1				
384		634449.5	4978159	0.00138	1992.7	2844.3	0	ANNUAL	ALL	1				
385		634474.5	4978159	0.00129	2006.88	2844.3	0	ANNUAL	ALL	1				
386		634499.5	4978159	0.00118	2023.97	2844.3	0	ANNUAL	ALL	1				
387		634299.5	4978184	0.001	2049.3	2844.3	0	ANNUAL	ALL	1				
388		634324.5	4978184	0.00108	2036.32	2844.3	0	ANNUAL	ALL	1				
389		634349.5	4978184	0.00116	2022.34	2844.3	0	ANNUAL	ALL	1				
390		634374.5	4978184	0.00125	2009.09	2844.3	0	ANNUAL	ALL	1				
391		634399.5	4978184	0.0013	1999.89	2844.3	0	ANNUAL	ALL	1				
392		634424.5	4978184	0.00138	1987.52	2844.3	0	ANNUAL	ALL	1				
393		634449.5	4978184	0.00136	1991.46	2844.3	0	ANNUAL	ALL	1				
394		634474.5	4978184	0.00128	2006.06	2844.3	0	ANNUAL	ALL	1				
395		634499.5	4978184	0.00119	2020.38	2844.3	0	ANNUAL	ALL	1				
396		634299.5	4978209	0.00102	2043.21	2844.3	0	ANNUAL	ALL	1				
397		634324.5	4978209	0.00109	2030.6	2844.3	0	ANNUAL	ALL	1				
398		634349.5	4978209	0.00118	2016.03	2844.3	0	ANNUAL	ALL	1				
399		634374.5	4978209	0.00126	2000.87	2844.3	0	ANNUAL	ALL	1				
400		634399.5	4978209	0.00133	1990.53	2844.3	0	ANNUAL	ALL	1				
401		634424.5	4978209	0.00139	1981.32	2844.3	0	ANNUAL	ALL	1				
402		634449.5	4978209	0.00135	1989.45	2844.3	0	ANNUAL	ALL	1				
403		634474.5	4978209	0.00126	2004.01	2844.3	0	ANNUAL	ALL	1				
404		634499.5	4978209	0.00119	2016.91	2844.3	0	ANNUAL	ALL	1				
405		634299.5	4978234	0.00103	2037.27	2844.3	0	ANNUAL	ALL	1				
406		634324.5	4978234	0.0011	2025.09	2844.3	0	ANNUAL	ALL	1				
407		634349.5	4978234	0.00119	2009.81	2844.3	0	ANNUAL	ALL	1				
408		634374.5	4978234	0.00126	1996.13	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
409		634399.5	4978234	0.00134	1984.05	2844.3	0	ANNUAL	ALL	1				
410		634424.5	4978234	0.00139	1975.87	2844.3	0	ANNUAL	ALL	1				
411		634449.5	4978234	0.00135	1984.97	2844.3	0	ANNUAL	ALL	1				
412		634474.5	4978234	0.00126	2000.36	2844.3	0	ANNUAL	ALL	1				
413		634499.5	4978234	0.0012	2011.73	2844.3	0	ANNUAL	ALL	1				
414		634299.5	4978259	0.00104	2030.97	2844.3	0	ANNUAL	ALL	1				
415		634324.5	4978259	0.00111	2018.02	2844.3	0	ANNUAL	ALL	1				
416		634349.5	4978259	0.00119	2002.99	2844.3	0	ANNUAL	ALL	1				
417		634374.5	4978259	0.00127	1990.41	2844.3	0	ANNUAL	ALL	1				
418		634399.5	4978259	0.00134	1978.88	2844.3	0	ANNUAL	ALL	1				
419		634424.5	4978259	0.00138	1972.17	2844.3	0	ANNUAL	ALL	1				
420		634449.5	4978259	0.00136	1977.85	2844.3	0	ANNUAL	ALL	1				
421		634474.5	4978259	0.00128	1992.52	2844.3	0	ANNUAL	ALL	1				
422		634499.5	4978259	0.00122	2003.44	2844.3	0	ANNUAL	ALL	1				
423		634299.5	4978284	0.00105	2023.26	2844.3	0	ANNUAL	ALL	1				
424		634324.5	4978284	0.00113	2008.98	2844.3	0	ANNUAL	ALL	1				
425		634349.5	4978284	0.0012	1996.31	2844.3	0	ANNUAL	ALL	1				
426		634374.5	4978284	0.00127	1984.2	2844.3	0	ANNUAL	ALL	1				
427		634399.5	4978284	0.00133	1973.37	2844.3	0	ANNUAL	ALL	1				
428		634424.5	4978284	0.00136	1969.23	2844.3	0	ANNUAL	ALL	1				
429		634449.5	4978284	0.00134	1975.58	2844.3	0	ANNUAL	ALL	1				
430		634474.5	4978284	0.00128	1989.07	2844.3	0	ANNUAL	ALL	1				
431		634499.5	4978284	0.00121	2000.53	2844.3	0	ANNUAL	ALL	1				
432		634299.5	4978309	0.00108	2012.41	2844.3	0	ANNUAL	ALL	1				
433		634324.5	4978309	0.00114	1999.74	2844.3	0	ANNUAL	ALL	1				
434		634349.5	4978309	0.00121	1988.62	2844.3	0	ANNUAL	ALL	1				
435		634374.5	4978309	0.00127	1977.79	2844.3	0	ANNUAL	ALL	1				
436		634399.5	4978309	0.00132	1967.1	2844.3	0	ANNUAL	ALL	1				
437		634424.5	4978309	0.00134	1968.14	2844.3	0	ANNUAL	ALL	1				
438		634449.5	4978309	0.0013	1977.66	2844.3	0	ANNUAL	ALL	1				
439		634474.5	4978309	0.00123	1992.31	2844.3	0	ANNUAL	ALL	1				
440		634499.5	4978309	0.00116	2006.23	2844.3	0	ANNUAL	ALL	1				
441		634299.5	4978334	0.00109	2000.94	2844.3	0	ANNUAL	ALL	1				
442		634324.5	4978334	0.00115	1991.1	2844.3	0	ANNUAL	ALL	1				
443		634349.5	4978334	0.00121	1980.66	2844.3	0	ANNUAL	ALL	1				
444		634374.5	4978334	0.00127	1970.39	2844.3	0	ANNUAL	ALL	1				
445		634399.5	4978334	0.00132	1961.38	2844.3	0	ANNUAL	ALL	1				
446		634424.5	4978334	0.0013	1968.29	2844.3	0	ANNUAL	ALL	1				
447		634449.5	4978334	0.00125	1980.95	2844.3	0	ANNUAL	ALL	1				
448		634474.5	4978334	0.00117	1997.36	2844.3	0	ANNUAL	ALL	1				
449		634499.5	4978334	0.00111	2012.52	2844.3	0	ANNUAL	ALL	1				
450		634299.5	4978359	0.00111	1991.4	2844.3	0	ANNUAL	ALL	1				
451		634324.5	4978359	0.00116	1982.72	2844.3	0	ANNUAL	ALL	1				
452		634349.5	4978359	0.00122	1972.75	2844.3	0	ANNUAL	ALL	1				
453		634374.5	4978359	0.00126	1962.87	2844.3	0	ANNUAL	ALL	1				
454		634399.5	4978359	0.0013	1958.17	2844.3	0	ANNUAL	ALL	1				
455		634424.5	4978359	0.00127	1968.79	2844.3	0	ANNUAL	ALL	1				
456		634449.5	4978359	0.0012	1984.24	2844.3	0	ANNUAL	ALL	1				
457		634474.5	4978359	0.00112	2002.2	2844.3	0	ANNUAL	ALL	1				
458		634499.5	4978359	0.00106	2016.76	2844.3	0	ANNUAL	ALL	1				
459		634299.5	4978384	0.00112	1982.57	2844.3	0	ANNUAL	ALL	1				
460		634324.5	4978384	0.00116	1975.68	2844.3	0	ANNUAL	ALL	1				
461		634349.5	4978384	0.00121	1964.84	2844.3	0	ANNUAL	ALL	1				
462		634374.5	4978384	0.00127	1956.29	2844.3	0	ANNUAL	ALL	1				
463		634399.5	4978384	0.00129	1955.61	2844.3	0	ANNUAL	ALL	1				
464		634424.5	4978384	0.00123	1968.65	2844.3	0	ANNUAL	ALL	1				
465		634449.5	4978384	0.00116	1986.09	2844.3	0	ANNUAL	ALL	1				
466		634474.5	4978384	0.00109	2004.63	2844.3	0	ANNUAL	ALL	1				
467		634499.5	4978384	0.00103	2018.69	2844.3	0	ANNUAL	ALL	1				
468		634299.5	4978409	0.00111	1975.4	2844.3	0	ANNUAL	ALL	1				
469		634324.5	4978409	0.00115	1967.52	2844.3	0	ANNUAL	ALL	1				
470		634349.5	4978409	0.00121	1957.04	2844.3	0	ANNUAL	ALL	1				
471		634374.5	4978409	0.00126	1949.69	2844.3	0	ANNUAL	ALL	1				
472		634399.5	4978409	0.00127	1951.43	2844.3	0	ANNUAL	ALL	1				
473		634424.5	4978409	0.00119	1967.3	2844.3	0	ANNUAL	ALL	1				
474		634449.5	4978409	0.00113	1986.39	2844.3	0	ANNUAL	ALL	1				
475		634474.5	4978409	0.00106	2005.28	2844.3	0	ANNUAL	ALL	1				
476		634499.5	4978409	0.001	2019.28	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
477		634299.5	4978434	0.00111	1965.22	2844.3	0	ANNUAL	ALL	1				
478		634324.5	4978434	0.00115	1958.88	2844.3	0	ANNUAL	ALL	1				
479		634349.5	4978434	0.00121	1950.79	2844.3	0	ANNUAL	ALL	1				
480		634374.5	4978434	0.00125	1943.73	2844.3	0	ANNUAL	ALL	1				
481		634399.5	4978434	0.00124	1949.4	2844.3	0	ANNUAL	ALL	1				
482		634424.5	4978434	0.00117	1965.04	2844.3	0	ANNUAL	ALL	1				
483		634449.5	4978434	0.00111	1984.59	2844.3	0	ANNUAL	ALL	1				
484		634474.5	4978434	0.00103	2004.45	2844.3	0	ANNUAL	ALL	1				
485		634499.5	4978434	0.00099	2017.53	2844.3	0	ANNUAL	ALL	1				
486		634249.4	4977384	0.00074	2291.4	2717.08	0	ANNUAL	ALL	1				
487		634274.4	4977384	0.00077	2282.65	2742	0	ANNUAL	ALL	1				
488		634299.4	4977384	0.00079	2273.71	2742	0	ANNUAL	ALL	1				
489		634324.4	4977384	0.00083	2263.84	2742	0	ANNUAL	ALL	1				
490		634349.4	4977384	0.00089	2250.84	2742	0	ANNUAL	ALL	1				
491		634374.4	4977384	0.00097	2238.58	2742.16	0	ANNUAL	ALL	1				
492		634399.4	4977384	0.00101	2232.43	2742.16	0	ANNUAL	ALL	1				
493		634424.4	4977384	0.00094	2242.73	2742.16	0	ANNUAL	ALL	1				
494		634449.4	4977384	0.00086	2255.36	2742	0	ANNUAL	ALL	1				
495		634249.4	4977409	0.00076	2284.43	2742	0	ANNUAL	ALL	1				
496		634274.4	4977409	0.00079	2274.53	2742	0	ANNUAL	ALL	1				
497		634299.4	4977409	0.00082	2264.56	2742	0	ANNUAL	ALL	1				
498		634324.4	4977409	0.00086	2254.44	2742	0	ANNUAL	ALL	1				
499		634349.4	4977409	0.00092	2243.93	2742.16	0	ANNUAL	ALL	1				
500		634374.4	4977409	0.00101	2231.37	2742.16	0	ANNUAL	ALL	1				
501		634399.4	4977409	0.00108	2226.02	2844.3	0	ANNUAL	ALL	1				
502		634424.4	4977409	0.00097	2236.92	2742.16	0	ANNUAL	ALL	1				
503		634449.4	4977409	0.00089	2249.43	2742.16	0	ANNUAL	ALL	1				
504		634249.4	4977434	0.00077	2279.34	2742	0	ANNUAL	ALL	1				
505		634274.4	4977434	0.00081	2267.65	2742	0	ANNUAL	ALL	1				
506		634299.4	4977434	0.00085	2255.85	2742	0	ANNUAL	ALL	1				
507		634324.4	4977434	0.0009	2244.86	2742	0	ANNUAL	ALL	1				
508		634349.4	4977434	0.00097	2234.48	2742.16	0	ANNUAL	ALL	1				
509		634374.4	4977434	0.00108	2223.18	2844.3	0	ANNUAL	ALL	1				
510		634399.4	4977434	0.00112	2218.5	2844.3	0	ANNUAL	ALL	1				
511		634424.4	4977434	0.00103	2230.27	2844.3	0	ANNUAL	ALL	1				
512		634449.4	4977434	0.00091	2243.66	2742.16	0	ANNUAL	ALL	1				
513		634249.4	4977459	0.00078	2275.78	2742	0	ANNUAL	ALL	1				
514		634274.4	4977459	0.00082	2262.83	2742	0	ANNUAL	ALL	1				
515		634299.4	4977459	0.00087	2248.74	2742	0	ANNUAL	ALL	1				
516		634324.4	4977459	0.00093	2237.43	2742.16	0	ANNUAL	ALL	1				
517		634349.4	4977459	0.00103	2226.72	2844.3	0	ANNUAL	ALL	1				
518		634374.4	4977459	0.00113	2214.97	2844.3	0	ANNUAL	ALL	1				
519		634399.4	4977459	0.00117	2211.75	2844.3	0	ANNUAL	ALL	1				
520		634424.4	4977459	0.00107	2223.34	2844.3	0	ANNUAL	ALL	1				
521		634449.4	4977459	0.00097	2237.29	2844.3	0	ANNUAL	ALL	1				
522		634249.4	4977484	0.00078	2272.5	2742	0	ANNUAL	ALL	1				
523		634274.4	4977484	0.00082	2258.48	2742	0	ANNUAL	ALL	1				
524		634299.4	4977484	0.00089	2243.77	2742	0	ANNUAL	ALL	1				
525		634324.4	4977484	0.00096	2231.45	2742.16	0	ANNUAL	ALL	1				
526		634349.4	4977484	0.00106	2219.9	2844.3	0	ANNUAL	ALL	1				
527		634374.4	4977484	0.00117	2207.94	2844.3	0	ANNUAL	ALL	1				
528		634399.4	4977484	0.00121	2204.62	2844.3	0	ANNUAL	ALL	1				
529		634424.4	4977484	0.00111	2216.76	2844.3	0	ANNUAL	ALL	1				
530		634449.4	4977484	0.001	2230.33	2844.3	0	ANNUAL	ALL	1				
531		634249.4	4977509	0.00078	2269.17	2742	0	ANNUAL	ALL	1				
532		634274.4	4977509	0.00083	2254.88	2742	0	ANNUAL	ALL	1				
533		634299.4	4977509	0.00089	2240.59	2742	0	ANNUAL	ALL	1				
534		634324.4	4977509	0.00099	2227.32	2844.3	0	ANNUAL	ALL	1				
535		634349.4	4977509	0.00109	2213.19	2844.3	0	ANNUAL	ALL	1				
536		634374.4	4977509	0.00122	2200.19	2844.3	0	ANNUAL	ALL	1				
537		634399.4	4977509	0.00125	2197.61	2844.3	0	ANNUAL	ALL	1				
538		634424.4	4977509	0.00113	2211.03	2844.3	0	ANNUAL	ALL	1				
539		634449.4	4977509	0.00104	2223.57	2844.3	0	ANNUAL	ALL	1				
540		634249.4	4977534	0.00079	2266.65	2742	0	ANNUAL	ALL	1				
541		634274.4	4977534	0.00083	2251.58	2742	0	ANNUAL	ALL	1				
542		634299.4	4977534	0.0009	2237.18	2742	0	ANNUAL	ALL	1				
543		634324.4	4977534	0.00099	2223.67	2844.3	0	ANNUAL	ALL	1				
544		634349.4	4977534	0.00111	2207.86	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
545		634374.4	4977534	0.00125	2193.38	2844.3	0	ANNUAL	ALL	1				
546		634399.4	4977534	0.00127	2191.95	2844.3	0	ANNUAL	ALL	1				
547		634424.4	4977534	0.00116	2205.88	2844.3	0	ANNUAL	ALL	1				
548		634449.4	4977534	0.00106	2217.63	2844.3	0	ANNUAL	ALL	1				
549		634249.4	4977559	0.00079	2264.12	2742	0	ANNUAL	ALL	1				
550		634274.4	4977559	0.00084	2247.26	2742	0	ANNUAL	ALL	1				
551		634299.4	4977559	0.00091	2232.74	2742	0	ANNUAL	ALL	1				
552		634324.4	4977559	0.00101	2218.55	2844.3	0	ANNUAL	ALL	1				
553		634349.4	4977559	0.00113	2203.35	2844.3	0	ANNUAL	ALL	1				
554		634374.4	4977559	0.00125	2189.62	2844.3	0	ANNUAL	ALL	1				
555		634399.4	4977559	0.0013	2184.96	2844.3	0	ANNUAL	ALL	1				
556		634424.4	4977559	0.00118	2200.77	2844.3	0	ANNUAL	ALL	1				
557		634449.4	4977559	0.0011	2211.07	2844.3	0	ANNUAL	ALL	1				
558		634249.4	4977584	0.0008	2258.01	2742	0	ANNUAL	ALL	1				
559		634274.4	4977584	0.00085	2242.66	2742	0	ANNUAL	ALL	1				
560		634299.4	4977584	0.00093	2227.67	2844.3	0	ANNUAL	ALL	1				
561		634324.4	4977584	0.00102	2213.51	2844.3	0	ANNUAL	ALL	1				
562		634349.4	4977584	0.00113	2199.5	2844.3	0	ANNUAL	ALL	1				
563		634374.4	4977584	0.00125	2185.33	2844.3	0	ANNUAL	ALL	1				
564		634399.4	4977584	0.00133	2177.11	2844.3	0	ANNUAL	ALL	1				
565		634424.4	4977584	0.00122	2192.43	2844.3	0	ANNUAL	ALL	1				
566		634449.4	4977584	0.00114	2203.16	2844.3	0	ANNUAL	ALL	1				
567		634999.5	4977834	0.0012	2055.79	2844.3	0	ANNUAL	ALL	1				
568		635024.5	4977834	0.00123	2048.42	2844.3	0	ANNUAL	ALL	1				
569		635049.5	4977834	0.00124	2043	2844.3	0	ANNUAL	ALL	1				
570		635074.5	4977834	0.00125	2037.93	2844.3	0	ANNUAL	ALL	1				
571		635099.5	4977834	0.00126	2034.24	2844.3	0	ANNUAL	ALL	1				
572		635124.5	4977834	0.00127	2031.45	2844.3	0	ANNUAL	ALL	1				
573		635149.5	4977834	0.00125	2038.5	2844.3	0	ANNUAL	ALL	1				
574		635174.5	4977834	0.00123	2050.35	2844.3	0	ANNUAL	ALL	1				
575		635199.5	4977834	0.00119	2063.26	2844.3	0	ANNUAL	ALL	1				
576		634999.5	4977859	0.0012	2052.63	2844.3	0	ANNUAL	ALL	1				
577		635024.5	4977859	0.00122	2046.41	2844.3	0	ANNUAL	ALL	1				
578		635049.5	4977859	0.00123	2040.95	2844.3	0	ANNUAL	ALL	1				
579		635074.5	4977859	0.00124	2036.03	2844.3	0	ANNUAL	ALL	1				
580		635099.5	4977859	0.00125	2032.3	2844.3	0	ANNUAL	ALL	1				
581		635124.5	4977859	0.00125	2030.17	2844.3	0	ANNUAL	ALL	1				
582		635149.5	4977859	0.00123	2038.33	2844.3	0	ANNUAL	ALL	1				
583		635174.5	4977859	0.00121	2049.93	2844.3	0	ANNUAL	ALL	1				
584		635199.5	4977859	0.00117	2062.54	2844.3	0	ANNUAL	ALL	1				
585		634999.5	4977884	0.00119	2049.11	2844.3	0	ANNUAL	ALL	1				
586		635024.5	4977884	0.00121	2044.13	2844.3	0	ANNUAL	ALL	1				
587		635049.5	4977884	0.00122	2038.92	2844.3	0	ANNUAL	ALL	1				
588		635074.5	4977884	0.00123	2034.26	2844.3	0	ANNUAL	ALL	1				
589		635099.5	4977884	0.00124	2030.48	2844.3	0	ANNUAL	ALL	1				
590		635124.5	4977884	0.00125	2029.04	2844.3	0	ANNUAL	ALL	1				
591		635149.5	4977884	0.00122	2038.45	2844.3	0	ANNUAL	ALL	1				
592		635174.5	4977884	0.0012	2049.51	2844.3	0	ANNUAL	ALL	1				
593		635199.5	4977884	0.00116	2061.56	2844.3	0	ANNUAL	ALL	1				
594		634999.5	4977909	0.00119	2047.27	2844.3	0	ANNUAL	ALL	1				
595		635024.5	4977909	0.0012	2042.16	2844.3	0	ANNUAL	ALL	1				
596		635049.5	4977909	0.00121	2036.97	2844.3	0	ANNUAL	ALL	1				
597		635074.5	4977909	0.00122	2032.48	2844.3	0	ANNUAL	ALL	1				
598		635099.5	4977909	0.00123	2028.7	2844.3	0	ANNUAL	ALL	1				
599		635124.5	4977909	0.00123	2028.77	2844.3	0	ANNUAL	ALL	1				
600		635149.5	4977909	0.0012	2038.62	2844.3	0	ANNUAL	ALL	1				
601		635174.5	4977909	0.00118	2049.12	2844.3	0	ANNUAL	ALL	1				
602		635199.5	4977909	0.00115	2060.48	2844.3	0	ANNUAL	ALL	1				
603		634999.5	4977934	0.00117	2046.79	2844.3	0	ANNUAL	ALL	1				
604		635024.5	4977934	0.00119	2040.92	2844.3	0	ANNUAL	ALL	1				
605		635049.5	4977934	0.0012	2034.68	2844.3	0	ANNUAL	ALL	1				
606		635074.5	4977934	0.00122	2029.58	2844.3	0	ANNUAL	ALL	1				
607		635099.5	4977934	0.00123	2025.61	2844.3	0	ANNUAL	ALL	1				
608		635124.5	4977934	0.00122	2027.68	2844.3	0	ANNUAL	ALL	1				
609		635149.5	4977934	0.00119	2038.09	2844.3	0	ANNUAL	ALL	1				
610		635174.5	4977934	0.00117	2048.68	2844.3	0	ANNUAL	ALL	1				
611		635199.5	4977934	0.00114	2059.02	2844.3	0	ANNUAL	ALL	1				
612		634999.5	4977959	0.00116	2045.95	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
613		635024.5	4977959	0.00118	2039.51	2844.3	0	ANNUAL	ALL	1				
614		635049.5	4977959	0.0012	2032.45	2844.3	0	ANNUAL	ALL	1				
615		635074.5	4977959	0.00122	2026.52	2844.3	0	ANNUAL	ALL	1				
616		635099.5	4977959	0.00123	2022.6	2844.3	0	ANNUAL	ALL	1				
617		635124.5	4977959	0.00121	2027.13	2844.3	0	ANNUAL	ALL	1				
618		635149.5	4977959	0.00118	2036.89	2844.3	0	ANNUAL	ALL	1				
619		635174.5	4977959	0.00116	2046.85	2844.3	0	ANNUAL	ALL	1				
620		635199.5	4977959	0.00113	2056.78	2844.3	0	ANNUAL	ALL	1				
621		634999.5	4977984	0.00115	2045.34	2844.3	0	ANNUAL	ALL	1				
622		635024.5	4977984	0.00117	2037.82	2844.3	0	ANNUAL	ALL	1				
623		635049.5	4977984	0.00119	2030.43	2844.3	0	ANNUAL	ALL	1				
624		635074.5	4977984	0.00122	2024.12	2844.3	0	ANNUAL	ALL	1				
625		635099.5	4977984	0.00123	2019.96	2844.3	0	ANNUAL	ALL	1				
626		635124.5	4977984	0.0012	2026.73	2844.3	0	ANNUAL	ALL	1				
627		635149.5	4977984	0.00117	2035.4	2844.3	0	ANNUAL	ALL	1				
628		635174.5	4977984	0.00115	2044.46	2844.3	0	ANNUAL	ALL	1				
629		635199.5	4977984	0.00112	2053.52	2844.3	0	ANNUAL	ALL	1				
630		634999.5	4978009	0.00114	2044.81	2844.3	0	ANNUAL	ALL	1				
631		635024.5	4978009	0.00116	2035.59	2844.3	0	ANNUAL	ALL	1				
632		635049.5	4978009	0.00119	2028.05	2844.3	0	ANNUAL	ALL	1				
633		635074.5	4978009	0.00121	2021.18	2844.3	0	ANNUAL	ALL	1				
634		635099.5	4978009	0.00123	2017.1	2844.3	0	ANNUAL	ALL	1				
635		635124.5	4978009	0.00119	2025.97	2844.3	0	ANNUAL	ALL	1				
636		635149.5	4978009	0.00116	2034.03	2844.3	0	ANNUAL	ALL	1				
637		635174.5	4978009	0.00114	2041.95	2844.3	0	ANNUAL	ALL	1				
638		635199.5	4978009	0.00112	2050.09	2844.3	0	ANNUAL	ALL	1				
639		634999.5	4978034	0.00113	2043.29	2844.3	0	ANNUAL	ALL	1				
640		635024.5	4978034	0.00117	2032.46	2844.3	0	ANNUAL	ALL	1				
641		635049.5	4978034	0.0012	2024.39	2844.3	0	ANNUAL	ALL	1				
642		635074.5	4978034	0.00122	2017.56	2844.3	0	ANNUAL	ALL	1				
643		635099.5	4978034	0.00123	2015.24	2844.3	0	ANNUAL	ALL	1				
644		635124.5	4978034	0.00119	2024.2	2844.3	0	ANNUAL	ALL	1				
645		635149.5	4978034	0.00116	2032.02	2844.3	0	ANNUAL	ALL	1				
646		635174.5	4978034	0.00113	2040.48	2844.3	0	ANNUAL	ALL	1				
647		635199.5	4978034	0.00111	2049.69	2844.3	0	ANNUAL	ALL	1				
648		634599.5	4976834	0.00042	2431.97	2717.08	0	ANNUAL	ALL	1				
649		634624.5	4976834	0.00041	2425.11	2717.08	0	ANNUAL	ALL	1				
650		634649.5	4976834	0.0004	2416.95	2717.08	0	ANNUAL	ALL	1				
651		634674.5	4976834	0.0004	2407.96	2717.08	0	ANNUAL	ALL	1				
652		634699.5	4976834	0.00039	2398.82	2717.08	0	ANNUAL	ALL	1				
653		634724.5	4976834	0.00039	2389.57	2717.08	0	ANNUAL	ALL	1				
654		634749.5	4976834	0.00038	2378.83	2717.08	0	ANNUAL	ALL	1				
655		634774.5	4976834	0.00038	2368.3	2717.08	0	ANNUAL	ALL	1				
656		634799.5	4976834	0.00038	2352.38	2717.08	0	ANNUAL	ALL	1				
657		634599.5	4976859	0.00043	2427	2717.08	0	ANNUAL	ALL	1				
658		634624.5	4976859	0.00042	2421.36	2717.08	0	ANNUAL	ALL	1				
659		634649.5	4976859	0.00042	2412.9	2717.08	0	ANNUAL	ALL	1				
660		634674.5	4976859	0.00041	2401.58	2717.08	0	ANNUAL	ALL	1				
661		634699.5	4976859	0.00041	2391.51	2717.08	0	ANNUAL	ALL	1				
662		634724.5	4976859	0.0004	2381.29	2717.08	0	ANNUAL	ALL	1				
663		634749.5	4976859	0.0004	2371.44	2717.08	0	ANNUAL	ALL	1				
664		634774.5	4976859	0.0004	2358.57	2717.08	0	ANNUAL	ALL	1				
665		634799.5	4976859	0.0004	2341.91	2742	0	ANNUAL	ALL	1				
666		634599.5	4976884	0.00044	2422.69	2717.08	0	ANNUAL	ALL	1				
667		634624.5	4976884	0.00043	2418.17	2717.08	0	ANNUAL	ALL	1				
668		634649.5	4976884	0.00043	2408.98	2717.08	0	ANNUAL	ALL	1				
669		634674.5	4976884	0.00043	2396.57	2717.08	0	ANNUAL	ALL	1				
670		634699.5	4976884	0.00042	2383.76	2717.08	0	ANNUAL	ALL	1				
671		634724.5	4976884	0.00042	2371.27	2717.08	0	ANNUAL	ALL	1				
672		634749.5	4976884	0.00042	2362.03	2717.08	0	ANNUAL	ALL	1				
673		634774.5	4976884	0.00042	2350.11	2717.08	0	ANNUAL	ALL	1				
674		634799.5	4976884	0.00042	2334.35	2742	0	ANNUAL	ALL	1				
675		634599.5	4976909	0.00045	2418.11	2717.08	0	ANNUAL	ALL	1				
676		634624.5	4976909	0.00045	2412.47	2717.08	0	ANNUAL	ALL	1				
677		634649.5	4976909	0.00044	2402.76	2717.08	0	ANNUAL	ALL	1				
678		634674.5	4976909	0.00044	2392.81	2717.08	0	ANNUAL	ALL	1				
679		634699.5	4976909	0.00044	2377.98	2717.08	0	ANNUAL	ALL	1				
680		634724.5	4976909	0.00044	2364.11	2717.08	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
681		634749.5	4976909	0.00043	2354.73	2717.08	0	ANNUAL	ALL	1				
682		634774.5	4976909	0.00043	2345.14	2717.08	0	ANNUAL	ALL	1				
683		634799.5	4976909	0.00044	2331	2742	0	ANNUAL	ALL	1				
684		634599.5	4976934	0.00046	2411.78	2717.08	0	ANNUAL	ALL	1				
685		634624.5	4976934	0.00046	2403.98	2717.08	0	ANNUAL	ALL	1				
686		634649.5	4976934	0.00046	2394.61	2717.08	0	ANNUAL	ALL	1				
687		634674.5	4976934	0.00045	2383.71	2717.08	0	ANNUAL	ALL	1				
688		634699.5	4976934	0.00045	2371.78	2717.08	0	ANNUAL	ALL	1				
689		634724.5	4976934	0.00045	2359.09	2717.08	0	ANNUAL	ALL	1				
690		634749.5	4976934	0.00045	2347.63	2717.08	0	ANNUAL	ALL	1				
691		634774.5	4976934	0.00045	2337.6	2742	0	ANNUAL	ALL	1				
692		634799.5	4976934	0.00045	2326.97	2742	0	ANNUAL	ALL	1				
693		634599.5	4976959	0.00048	2404.1	2717.08	0	ANNUAL	ALL	1				
694		634624.5	4976959	0.00047	2396.65	2717.08	0	ANNUAL	ALL	1				
695		634649.5	4976959	0.00047	2385.41	2717.08	0	ANNUAL	ALL	1				
696		634674.5	4976959	0.00047	2372.07	2717.08	0	ANNUAL	ALL	1				
697		634699.5	4976959	0.00047	2362.55	2717.08	0	ANNUAL	ALL	1				
698		634724.5	4976959	0.00047	2351.59	2717.08	0	ANNUAL	ALL	1				
699		634749.5	4976959	0.00047	2341.2	2717.08	0	ANNUAL	ALL	1				
700		634774.5	4976959	0.00047	2328.55	2742	0	ANNUAL	ALL	1				
701		634799.5	4976959	0.00047	2318.72	2742	0	ANNUAL	ALL	1				
702		634599.5	4976984	0.00049	2396.35	2717.08	0	ANNUAL	ALL	1				
703		634624.5	4976984	0.00049	2389.04	2717.08	0	ANNUAL	ALL	1				
704		634649.5	4976984	0.00049	2377.21	2717.08	0	ANNUAL	ALL	1				
705		634674.5	4976984	0.00049	2363.6	2717.08	0	ANNUAL	ALL	1				
706		634699.5	4976984	0.00049	2350.85	2717.08	0	ANNUAL	ALL	1				
707		634724.5	4976984	0.00049	2340.79	2717.08	0	ANNUAL	ALL	1				
708		634749.5	4976984	0.00049	2331.79	2742	0	ANNUAL	ALL	1				
709		634774.5	4976984	0.0005	2320.7	2742	0	ANNUAL	ALL	1				
710		634799.5	4976984	0.0005	2308.59	2742	0	ANNUAL	ALL	1				
711		634599.5	4977009	0.0005	2388.79	2717.08	0	ANNUAL	ALL	1				
712		634624.5	4977009	0.0005	2379.17	2717.08	0	ANNUAL	ALL	1				
713		634649.5	4977009	0.0005	2368.25	2717.08	0	ANNUAL	ALL	1				
714		634674.5	4977009	0.0005	2355.13	2717.08	0	ANNUAL	ALL	1				
715		634699.5	4977009	0.00051	2341.52	2717.08	0	ANNUAL	ALL	1				
716		634724.5	4977009	0.00052	2328.18	2742	0	ANNUAL	ALL	1				
717		634749.5	4977009	0.00052	2321.24	2742	0	ANNUAL	ALL	1				
718		634774.5	4977009	0.00052	2313.44	2742	0	ANNUAL	ALL	1				
719		634799.5	4977009	0.00052	2301.46	2742.16	0	ANNUAL	ALL	1				
720		634599.5	4977034	0.00051	2379.36	2717.08	0	ANNUAL	ALL	1				
721		634624.5	4977034	0.00052	2369.28	2717.08	0	ANNUAL	ALL	1				
722		634649.5	4977034	0.00052	2356.46	2717.08	0	ANNUAL	ALL	1				
723		634674.5	4977034	0.00052	2343.53	2717.08	0	ANNUAL	ALL	1				
724		634699.5	4977034	0.00053	2329.9	2742	0	ANNUAL	ALL	1				
725		634724.5	4977034	0.00054	2316.92	2742	0	ANNUAL	ALL	1				
726		634749.5	4977034	0.00055	2309.32	2742	0	ANNUAL	ALL	1				
727		634774.5	4977034	0.00055	2302.58	2742	0	ANNUAL	ALL	1				
728		634799.5	4977034	0.00055	2295.21	2742.16	0	ANNUAL	ALL	1				
729	**	CONCUNIT	ug/m^3											
730	**	DEPUNIT	g/m^2											

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	*	AERMOD	(	19191):	MIDAS	GOLD	STIBNITE	-	MODELING	R27	########			
2	*	AERMET	(	19191):	15:43:49									
3	*	MODELING	OPTIONS	USED:	RegDFAULT	CONC	ELEV	NOWARN	DRYDPLT	WETDPLT	RURAL	ADJ_U*		
4	*	PLOT	FILE	OF	ANNUAL	VALUES	AVERAGED	ACROSS	1	YEARS	FOR	SOURCE	GROUP:	ALL
5	*	FOR	A	TOTAL	OF	720	RECEPTORS.							
6	*	FORMAT:	(3(1X,F13.5),3(1X,F8.2),2X,A6,2X,A8,2X,I8.8,2X,A8)											
7	*	X	Y	AVERAGE	CONC	ZELEV	ZHILL	ZFLAG	AVE	GRP	NUM	YRS	NET	ID
8	*													
9	0.001280	635399.5	4975934	0.00059	2213.4	2844.3	0	ANNUAL	ALL	1				
10	max ↑	635424.5	4975934	0.00059	2212.64	2844.3	0	ANNUAL	ALL	1				
11		635449.5	4975934	0.0006	2211.27	2844.3	0	ANNUAL	ALL	1				
12		635474.5	4975934	0.00059	2212.5	2844.3	0	ANNUAL	ALL	1				
13		635499.5	4975934	0.00059	2215.21	2844.3	0	ANNUAL	ALL	1				
14		635524.5	4975934	0.00058	2215.98	2844.3	0	ANNUAL	ALL	1				
15		635549.5	4975934	0.00059	2215	2844.3	0	ANNUAL	ALL	1				
16		635574.5	4975934	0.00059	2215.74	2844.3	0	ANNUAL	ALL	1				
17		635599.5	4975934	0.00058	2218.34	2844.3	0	ANNUAL	ALL	1				
18		635399.5	4975959	0.00062	2202.75	2844.3	0	ANNUAL	ALL	1				
19		635424.5	4975959	0.00061	2204.36	2844.3	0	ANNUAL	ALL	1				
20		635449.5	4975959	0.00061	2204.87	2844.3	0	ANNUAL	ALL	1				
21		635474.5	4975959	0.00061	2206.39	2844.3	0	ANNUAL	ALL	1				
22		635499.5	4975959	0.0006	2208.99	2844.3	0	ANNUAL	ALL	1				
23		635524.5	4975959	0.00059	2210.99	2844.3	0	ANNUAL	ALL	1				
24		635549.5	4975959	0.00059	2211.29	2844.3	0	ANNUAL	ALL	1				
25		635574.5	4975959	0.0006	2210.92	2844.3	0	ANNUAL	ALL	1				
26		635599.5	4975959	0.00061	2208.83	2844.3	0	ANNUAL	ALL	1				
27		635399.5	4975984	0.00064	2195.09	2844.3	0	ANNUAL	ALL	1				
28		635424.5	4975984	0.00063	2198.19	2844.3	0	ANNUAL	ALL	1				
29		635449.5	4975984	0.00063	2198.7	2844.3	0	ANNUAL	ALL	1				
30		635474.5	4975984	0.00062	2201.57	2844.3	0	ANNUAL	ALL	1				
31		635499.5	4975984	0.00061	2203.99	2844.3	0	ANNUAL	ALL	1				
32		635524.5	4975984	0.00061	2206.27	2844.3	0	ANNUAL	ALL	1				
33		635549.5	4975984	0.0006	2206.83	2844.3	0	ANNUAL	ALL	1				
34		635574.5	4975984	0.00061	2205.61	2844.3	0	ANNUAL	ALL	1				
35		635599.5	4975984	0.00062	2202.99	2844.3	0	ANNUAL	ALL	1				
36		635399.5	4976009	0.00063	2195.69	2844.3	0	ANNUAL	ALL	1				
37		635424.5	4976009	0.00065	2189.65	2844.3	0	ANNUAL	ALL	1				
38		635449.5	4976009	0.00064	2194	2844.3	0	ANNUAL	ALL	1				
39		635474.5	4976009	0.00062	2200.13	2844.3	0	ANNUAL	ALL	1				
40		635499.5	4976009	0.00061	2202.83	2844.3	0	ANNUAL	ALL	1				
41		635524.5	4976009	0.00061	2203.57	2844.3	0	ANNUAL	ALL	1				
42		635549.5	4976009	0.00061	2203.82	2844.3	0	ANNUAL	ALL	1				
43		635574.5	4976009	0.00061	2202.81	2844.3	0	ANNUAL	ALL	1				
44		635599.5	4976009	0.00062	2200.59	2844.3	0	ANNUAL	ALL	1				
45		635399.5	4976034	0.00061	2198.23	2844.3	0	ANNUAL	ALL	1				
46		635424.5	4976034	0.00065	2186.98	2844.3	0	ANNUAL	ALL	1				
47		635449.5	4976034	0.00064	2190.14	2844.3	0	ANNUAL	ALL	1				
48		635474.5	4976034	0.00062	2198.63	2844.3	0	ANNUAL	ALL	1				
49		635499.5	4976034	0.00062	2198.93	2844.3	0	ANNUAL	ALL	1				
50		635524.5	4976034	0.00062	2199.39	2844.3	0	ANNUAL	ALL	1				
51		635549.5	4976034	0.00061	2201.1	2844.3	0	ANNUAL	ALL	1				
52		635574.5	4976034	0.00062	2200.59	2844.3	0	ANNUAL	ALL	1				
53		635599.5	4976034	0.00063	2197.96	2844.3	0	ANNUAL	ALL	1				
54		635399.5	4976059	0.00061	2196.33	2844.3	0	ANNUAL	ALL	1				
55		635424.5	4976059	0.00066	2184.09	2844.3	0	ANNUAL	ALL	1				
56		635449.5	4976059	0.00067	2180.82	2844.3	0	ANNUAL	ALL	1				
57		635474.5	4976059	0.00063	2193.11	2844.3	0	ANNUAL	ALL	1				
58		635499.5	4976059	0.00062	2194.5	2844.3	0	ANNUAL	ALL	1				
59		635524.5	4976059	0.00062	2197.17	2844.3	0	ANNUAL	ALL	1				
60		635549.5	4976059	0.00061	2199.4	2844.3	0	ANNUAL	ALL	1				
61		635574.5	4976059	0.00062	2198.27	2844.3	0	ANNUAL	ALL	1				
62		635599.5	4976059	0.00063	2194.62	2844.3	0	ANNUAL	ALL	1				
63		635399.5	4976084	0.00063	2188.98	2844.3	0	ANNUAL	ALL	1				
64		635424.5	4976084	0.00066	2180.22	2844.3	0	ANNUAL	ALL	1				
65		635449.5	4976084	0.00069	2174.51	2844.3	0	ANNUAL	ALL	1				
66		635474.5	4976084	0.00067	2180.27	2844.3	0	ANNUAL	ALL	1				
67		635499.5	4976084	0.00065	2185.71	2844.3	0	ANNUAL	ALL	1				
68		635524.5	4976084	0.00063	2191.13	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
69		635549.5	4976084	0.00062	2193.95	2844.3	0	ANNUAL	ALL	1				
70		635574.5	4976084	0.00064	2190.58	2844.3	0	ANNUAL	ALL	1				
71		635599.5	4976084	0.00067	2183.01	2844.3	0	ANNUAL	ALL	1				
72		635399.5	4976109	0.00064	2182.28	2844.3	0	ANNUAL	ALL	1				
73		635424.5	4976109	0.00066	2177.24	2844.3	0	ANNUAL	ALL	1				
74		635449.5	4976109	0.00069	2171.45	2844.3	0	ANNUAL	ALL	1				
75		635474.5	4976109	0.00069	2172.26	2844.3	0	ANNUAL	ALL	1				
76		635499.5	4976109	0.00067	2177.58	2844.3	0	ANNUAL	ALL	1				
77		635524.5	4976109	0.00066	2180.23	2844.3	0	ANNUAL	ALL	1				
78		635549.5	4976109	0.00067	2179.81	2844.3	0	ANNUAL	ALL	1				
79		635574.5	4976109	0.00068	2176.94	2844.3	0	ANNUAL	ALL	1				
80		635599.5	4976109	0.00068	2179.4	2844.3	0	ANNUAL	ALL	1				
81		635399.5	4976134	0.00065	2176.77	2844.3	0	ANNUAL	ALL	1				
82		635424.5	4976134	0.00066	2174.27	2844.3	0	ANNUAL	ALL	1				
83		635449.5	4976134	0.00068	2171.04	2844.3	0	ANNUAL	ALL	1				
84		635474.5	4976134	0.0007	2166.4	2844.3	0	ANNUAL	ALL	1				
85		635499.5	4976134	0.0007	2167.48	2844.3	0	ANNUAL	ALL	1				
86		635524.5	4976134	0.00069	2172.09	2844.3	0	ANNUAL	ALL	1				
87		635549.5	4976134	0.00069	2171.44	2844.3	0	ANNUAL	ALL	1				
88		635574.5	4976134	0.00069	2172.93	2844.3	0	ANNUAL	ALL	1				
89		635599.5	4976134	0.00067	2178.31	2844.3	0	ANNUAL	ALL	1				
90		635199.5	4976834	0.00063	2116.83	2844.3	0	ANNUAL	ALL	1				
91		635224.5	4976834	0.00065	2112.53	2844.3	0	ANNUAL	ALL	1				
92		635249.5	4976834	0.00067	2108.39	2844.3	0	ANNUAL	ALL	1				
93		635274.5	4976834	0.00068	2105.23	2844.3	0	ANNUAL	ALL	1				
94		635299.5	4976834	0.0007	2101.6	2844.3	0	ANNUAL	ALL	1				
95		635324.5	4976834	0.00071	2098.74	2844.3	0	ANNUAL	ALL	1				
96		635349.5	4976834	0.00069	2104.26	2844.3	0	ANNUAL	ALL	1				
97		635374.5	4976834	0.00066	2110.4	2844.3	0	ANNUAL	ALL	1				
98		635399.5	4976834	0.00063	2117.98	2844.3	0	ANNUAL	ALL	1				
99		635199.5	4976859	0.00064	2114.34	2844.3	0	ANNUAL	ALL	1				
100		635224.5	4976859	0.00066	2108.68	2844.3	0	ANNUAL	ALL	1				
101		635249.5	4976859	0.00068	2104.42	2844.3	0	ANNUAL	ALL	1				
102		635274.5	4976859	0.00069	2101.28	2844.3	0	ANNUAL	ALL	1				
103		635299.5	4976859	0.00071	2098.83	2844.3	0	ANNUAL	ALL	1				
104		635324.5	4976859	0.00072	2096.89	2844.3	0	ANNUAL	ALL	1				
105		635349.5	4976859	0.0007	2101.21	2844.3	0	ANNUAL	ALL	1				
106		635374.5	4976859	0.00066	2108.71	2844.3	0	ANNUAL	ALL	1				
107		635399.5	4976859	0.00063	2118.31	2844.3	0	ANNUAL	ALL	1				
108		635199.5	4976884	0.00065	2111.17	2844.3	0	ANNUAL	ALL	1				
109		635224.5	4976884	0.00067	2104.78	2844.3	0	ANNUAL	ALL	1				
110		635249.5	4976884	0.00069	2100.14	2844.3	0	ANNUAL	ALL	1				
111		635274.5	4976884	0.00071	2097.48	2844.3	0	ANNUAL	ALL	1				
112		635299.5	4976884	0.00072	2095.42	2844.3	0	ANNUAL	ALL	1				
113		635324.5	4976884	0.00072	2094.96	2844.3	0	ANNUAL	ALL	1				
114		635349.5	4976884	0.00071	2097.83	2844.3	0	ANNUAL	ALL	1				
115		635374.5	4976884	0.00066	2107.96	2844.3	0	ANNUAL	ALL	1				
116		635399.5	4976884	0.00062	2119.17	2844.3	0	ANNUAL	ALL	1				
117		635199.5	4976909	0.00065	2108.51	2844.3	0	ANNUAL	ALL	1				
118		635224.5	4976909	0.00068	2102.17	2844.3	0	ANNUAL	ALL	1				
119		635249.5	4976909	0.0007	2097.31	2844.3	0	ANNUAL	ALL	1				
120		635274.5	4976909	0.00071	2094.85	2844.3	0	ANNUAL	ALL	1				
121		635299.5	4976909	0.00072	2093.19	2844.3	0	ANNUAL	ALL	1				
122		635324.5	4976909	0.00072	2093.48	2844.3	0	ANNUAL	ALL	1				
123		635349.5	4976909	0.0007	2098.12	2844.3	0	ANNUAL	ALL	1				
124		635374.5	4976909	0.00065	2108.79	2844.3	0	ANNUAL	ALL	1				
125		635399.5	4976909	0.00061	2120.74	2844.3	0	ANNUAL	ALL	1				
126		635199.5	4976934	0.00066	2106.38	2844.3	0	ANNUAL	ALL	1				
127		635224.5	4976934	0.00068	2100.81	2844.3	0	ANNUAL	ALL	1				
128		635249.5	4976934	0.0007	2096.21	2844.3	0	ANNUAL	ALL	1				
129		635274.5	4976934	0.00072	2092.89	2844.3	0	ANNUAL	ALL	1				
130		635299.5	4976934	0.00073	2091.1	2844.3	0	ANNUAL	ALL	1				
131		635324.5	4976934	0.00072	2092.46	2844.3	0	ANNUAL	ALL	1				
132		635349.5	4976934	0.00069	2099.48	2844.3	0	ANNUAL	ALL	1				
133		635374.5	4976934	0.00064	2110.37	2844.3	0	ANNUAL	ALL	1				
134		635399.5	4976934	0.0006	2122.91	2844.3	0	ANNUAL	ALL	1				
135		635199.5	4976959	0.00066	2104.62	2844.3	0	ANNUAL	ALL	1				
136		635224.5	4976959	0.00068	2099.28	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
137		635249.5	4976959	0.00071	2094.41	2844.3	0	ANNUAL	ALL	1				
138		635274.5	4976959	0.00073	2090.59	2844.3	0	ANNUAL	ALL	1				
139		635299.5	4976959	0.00074	2088.8	2844.3	0	ANNUAL	ALL	1				
140		635324.5	4976959	0.00072	2092.02	2844.3	0	ANNUAL	ALL	1				
141		635349.5	4976959	0.00068	2100.12	2844.3	0	ANNUAL	ALL	1				
142		635374.5	4976959	0.00063	2112.07	2844.3	0	ANNUAL	ALL	1				
143		635399.5	4976959	0.00058	2125.69	2844.3	0	ANNUAL	ALL	1				
144		635199.5	4976984	0.00066	2102.45	2844.3	0	ANNUAL	ALL	1				
145		635224.5	4976984	0.00069	2097.29	2844.3	0	ANNUAL	ALL	1				
146		635249.5	4976984	0.00072	2091.62	2844.3	0	ANNUAL	ALL	1				
147		635274.5	4976984	0.00074	2087.92	2844.3	0	ANNUAL	ALL	1				
148		635299.5	4976984	0.00074	2086.81	2844.3	0	ANNUAL	ALL	1				
149		635324.5	4976984	0.00071	2092.65	2844.3	0	ANNUAL	ALL	1				
150		635349.5	4976984	0.00067	2101.3	2844.3	0	ANNUAL	ALL	1				
151		635374.5	4976984	0.00062	2114.13	2844.3	0	ANNUAL	ALL	1				
152		635399.5	4976984	0.00057	2128.46	2844.3	0	ANNUAL	ALL	1				
153		635199.5	4977009	0.00067	2099.39	2844.3	0	ANNUAL	ALL	1				
154		635224.5	4977009	0.0007	2093.66	2844.3	0	ANNUAL	ALL	1				
155		635249.5	4977009	0.00073	2087.97	2844.3	0	ANNUAL	ALL	1				
156		635274.5	4977009	0.00075	2084.9	2844.3	0	ANNUAL	ALL	1				
157		635299.5	4977009	0.00073	2087.43	2844.3	0	ANNUAL	ALL	1				
158		635324.5	4977009	0.0007	2094.55	2844.3	0	ANNUAL	ALL	1				
159		635349.5	4977009	0.00066	2103.74	2844.3	0	ANNUAL	ALL	1				
160		635374.5	4977009	0.0006	2116.64	2844.3	0	ANNUAL	ALL	1				
161		635399.5	4977009	0.00056	2131.12	2844.3	0	ANNUAL	ALL	1				
162		635199.5	4977034	0.00069	2094.63	2844.3	0	ANNUAL	ALL	1				
163		635224.5	4977034	0.00072	2088.76	2844.3	0	ANNUAL	ALL	1				
164		635249.5	4977034	0.00074	2084.27	2844.3	0	ANNUAL	ALL	1				
165		635274.5	4977034	0.00075	2082.71	2844.3	0	ANNUAL	ALL	1				
166		635299.5	4977034	0.00071	2089.9	2844.3	0	ANNUAL	ALL	1				
167		635324.5	4977034	0.00068	2098.21	2844.3	0	ANNUAL	ALL	1				
168		635349.5	4977034	0.00063	2107.49	2844.3	0	ANNUAL	ALL	1				
169		635374.5	4977034	0.00059	2119.09	2844.3	0	ANNUAL	ALL	1				
170		635399.5	4977034	0.00055	2133.38	2844.3	0	ANNUAL	ALL	1				
171		634899.5	4977134	0.00042	2221.02	2844.3	0	ANNUAL	ALL	1				
172		634924.5	4977134	0.00043	2207.85	2844.3	0	ANNUAL	ALL	1				
173		634949.5	4977134	0.00045	2190.45	2844.3	0	ANNUAL	ALL	1				
174		634974.5	4977134	0.00048	2169.12	2844.3	0	ANNUAL	ALL	1				
175		634999.5	4977134	0.00051	2150.64	2844.3	0	ANNUAL	ALL	1				
176		635024.5	4977134	0.00054	2135.97	2844.3	0	ANNUAL	ALL	1				
177		635049.5	4977134	0.00057	2122.38	2844.3	0	ANNUAL	ALL	1				
178		635074.5	4977134	0.0006	2113.7	2844.3	0	ANNUAL	ALL	1				
179		635099.5	4977134	0.00063	2105.9	2844.3	0	ANNUAL	ALL	1				
180		634899.5	4977159	0.00042	2213.37	2844.3	0	ANNUAL	ALL	1				
181		634924.5	4977159	0.00044	2201.16	2844.3	0	ANNUAL	ALL	1				
182		634949.5	4977159	0.00046	2181.17	2844.3	0	ANNUAL	ALL	1				
183		634974.5	4977159	0.00049	2161.72	2844.3	0	ANNUAL	ALL	1				
184		634999.5	4977159	0.00052	2145.73	2844.3	0	ANNUAL	ALL	1				
185		635024.5	4977159	0.00054	2132.12	2844.3	0	ANNUAL	ALL	1				
186		635049.5	4977159	0.00058	2119.59	2844.3	0	ANNUAL	ALL	1				
187		635074.5	4977159	0.00061	2109.27	2844.3	0	ANNUAL	ALL	1				
188		635099.5	4977159	0.00064	2101.29	2844.3	0	ANNUAL	ALL	1				
189		634899.5	4977184	0.00043	2206.56	2844.3	0	ANNUAL	ALL	1				
190		634924.5	4977184	0.00044	2193.64	2844.3	0	ANNUAL	ALL	1				
191		634949.5	4977184	0.00047	2172.29	2844.3	0	ANNUAL	ALL	1				
192		634974.5	4977184	0.0005	2154.5	2844.3	0	ANNUAL	ALL	1				
193		634999.5	4977184	0.00052	2141.04	2844.3	0	ANNUAL	ALL	1				
194		635024.5	4977184	0.00055	2128.3	2844.3	0	ANNUAL	ALL	1				
195		635049.5	4977184	0.00059	2114.34	2844.3	0	ANNUAL	ALL	1				
196		635074.5	4977184	0.00063	2102.7	2844.3	0	ANNUAL	ALL	1				
197		635099.5	4977184	0.00066	2096.47	2844.3	0	ANNUAL	ALL	1				
198		634899.5	4977209	0.00044	2199.13	2844.3	0	ANNUAL	ALL	1				
199		634924.5	4977209	0.00045	2184.15	2844.3	0	ANNUAL	ALL	1				
200		634949.5	4977209	0.00048	2163.72	2844.3	0	ANNUAL	ALL	1				
201		634974.5	4977209	0.00051	2146.68	2844.3	0	ANNUAL	ALL	1				
202		634999.5	4977209	0.00053	2136.15	2844.3	0	ANNUAL	ALL	1				
203		635024.5	4977209	0.00056	2124.22	2844.3	0	ANNUAL	ALL	1				
204		635049.5	4977209	0.00062	2105.9	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
205		635074.5	4977209	0.00065	2096.39	2844.3	0	ANNUAL	ALL	1				
206		635099.5	4977209	0.00067	2091.31	2844.3	0	ANNUAL	ALL	1				
207		634899.5	4977234	0.00045	2185.16	2844.3	0	ANNUAL	ALL	1				
208		634924.5	4977234	0.00047	2172.04	2844.3	0	ANNUAL	ALL	1				
209		634949.5	4977234	0.0005	2152.41	2844.3	0	ANNUAL	ALL	1				
210		634974.5	4977234	0.00052	2139.97	2844.3	0	ANNUAL	ALL	1				
211		634999.5	4977234	0.00054	2130.73	2844.3	0	ANNUAL	ALL	1				
212		635024.5	4977234	0.00058	2117.31	2844.3	0	ANNUAL	ALL	1				
213		635049.5	4977234	0.00064	2098.65	2844.3	0	ANNUAL	ALL	1				
214		635074.5	4977234	0.00066	2092.39	2844.3	0	ANNUAL	ALL	1				
215		635099.5	4977234	0.00069	2087.32	2844.3	0	ANNUAL	ALL	1				
216		634899.5	4977259	0.00046	2180.4	2844.3	0	ANNUAL	ALL	1				
217		634924.5	4977259	0.00049	2160.19	2844.3	0	ANNUAL	ALL	1				
218		634949.5	4977259	0.00051	2143.3	2844.3	0	ANNUAL	ALL	1				
219		634974.5	4977259	0.00054	2132.11	2844.3	0	ANNUAL	ALL	1				
220		634999.5	4977259	0.00056	2123.02	2844.3	0	ANNUAL	ALL	1				
221		635024.5	4977259	0.0006	2107.09	2844.3	0	ANNUAL	ALL	1				
222		635049.5	4977259	0.00065	2095.35	2844.3	0	ANNUAL	ALL	1				
223		635074.5	4977259	0.00067	2089.07	2844.3	0	ANNUAL	ALL	1				
224		635099.5	4977259	0.0007	2083.6	2844.3	0	ANNUAL	ALL	1				
225		634899.5	4977284	0.00046	2180.69	2844.3	0	ANNUAL	ALL	1				
226		634924.5	4977284	0.00049	2158.28	2844.3	0	ANNUAL	ALL	1				
227		634949.5	4977284	0.00052	2139.34	2844.3	0	ANNUAL	ALL	1				
228		634974.5	4977284	0.00056	2123.05	2844.3	0	ANNUAL	ALL	1				
229		634999.5	4977284	0.00058	2112.91	2844.3	0	ANNUAL	ALL	1				
230		635024.5	4977284	0.00062	2100.55	2844.3	0	ANNUAL	ALL	1				
231		635049.5	4977284	0.00065	2092.76	2844.3	0	ANNUAL	ALL	1				
232		635074.5	4977284	0.00068	2085.71	2844.3	0	ANNUAL	ALL	1				
233		635099.5	4977284	0.00072	2078.67	2844.3	0	ANNUAL	ALL	1				
234		634899.5	4977309	0.00046	2178.55	2844.3	0	ANNUAL	ALL	1				
235		634924.5	4977309	0.00049	2156.77	2844.3	0	ANNUAL	ALL	1				
236		634949.5	4977309	0.00053	2136.54	2844.3	0	ANNUAL	ALL	1				
237		634974.5	4977309	0.00056	2119.59	2844.3	0	ANNUAL	ALL	1				
238		634999.5	4977309	0.0006	2107.01	2844.3	0	ANNUAL	ALL	1				
239		635024.5	4977309	0.00064	2096.52	2844.3	0	ANNUAL	ALL	1				
240		635049.5	4977309	0.00067	2089.24	2844.3	0	ANNUAL	ALL	1				
241		635074.5	4977309	0.00069	2082.55	2844.3	0	ANNUAL	ALL	1				
242		635099.5	4977309	0.00073	2075.98	2844.3	0	ANNUAL	ALL	1				
243		634899.5	4977334	0.00047	2173.18	2844.3	0	ANNUAL	ALL	1				
244		634924.5	4977334	0.0005	2153.29	2844.3	0	ANNUAL	ALL	1				
245		634949.5	4977334	0.00053	2133.9	2844.3	0	ANNUAL	ALL	1				
246		634974.5	4977334	0.00057	2117.58	2844.3	0	ANNUAL	ALL	1				
247		634999.5	4977334	0.00061	2104.03	2844.3	0	ANNUAL	ALL	1				
248		635024.5	4977334	0.00064	2093.8	2844.3	0	ANNUAL	ALL	1				
249		635049.5	4977334	0.00068	2085.23	2844.3	0	ANNUAL	ALL	1				
250		635074.5	4977334	0.00071	2078.76	2844.3	0	ANNUAL	ALL	1				
251		635099.5	4977334	0.00073	2074.53	2844.3	0	ANNUAL	ALL	1				
252		635399.5	4976159	0.00066	2171.27	2844.3	0	ANNUAL	ALL	1				
253		635424.5	4976159	0.00067	2169.98	2844.3	0	ANNUAL	ALL	1				
254		635449.5	4976159	0.00068	2167.61	2844.3	0	ANNUAL	ALL	1				
255		635474.5	4976159	0.0007	2164.06	2844.3	0	ANNUAL	ALL	1				
256		635499.5	4976159	0.00071	2161.76	2844.3	0	ANNUAL	ALL	1				
257		635524.5	4976159	0.00072	2160.48	2844.3	0	ANNUAL	ALL	1				
258		635549.5	4976159	0.00072	2162.19	2844.3	0	ANNUAL	ALL	1				
259		635574.5	4976159	0.0007	2168.15	2844.3	0	ANNUAL	ALL	1				
260		635599.5	4976159	0.00068	2173.85	2844.3	0	ANNUAL	ALL	1				
261		635399.5	4976184	0.00066	2168.06	2844.3	0	ANNUAL	ALL	1				
262		635424.5	4976184	0.00067	2166.17	2844.3	0	ANNUAL	ALL	1				
263		635449.5	4976184	0.00069	2163.95	2844.3	0	ANNUAL	ALL	1				
264		635474.5	4976184	0.0007	2161.05	2844.3	0	ANNUAL	ALL	1				
265		635499.5	4976184	0.00072	2158.86	2844.3	0	ANNUAL	ALL	1				
266		635524.5	4976184	0.00073	2157.1	2844.3	0	ANNUAL	ALL	1				
267		635549.5	4976184	0.00073	2157.07	2844.3	0	ANNUAL	ALL	1				
268		635574.5	4976184	0.0007	2164.59	2844.3	0	ANNUAL	ALL	1				
269		635599.5	4976184	0.00068	2172.06	2844.3	0	ANNUAL	ALL	1				
270		635399.5	4976209	0.00066	2165.29	2844.3	0	ANNUAL	ALL	1				
271		635424.5	4976209	0.00067	2163.14	2844.3	0	ANNUAL	ALL	1				
272		635449.5	4976209	0.00069	2160.76	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
273		635474.5	4976209	0.0007	2158.05	2844.3	0	ANNUAL	ALL	1				
274		635499.5	4976209	0.00072	2155.43	2844.3	0	ANNUAL	ALL	1				
275		635524.5	4976209	0.00073	2153.57	2844.3	0	ANNUAL	ALL	1				
276		635549.5	4976209	0.00072	2156.02	2844.3	0	ANNUAL	ALL	1				
277		635574.5	4976209	0.00069	2165.26	2844.3	0	ANNUAL	ALL	1				
278		635599.5	4976209	0.00066	2175.01	2844.3	0	ANNUAL	ALL	1				
279		635399.5	4976234	0.00066	2162.56	2844.3	0	ANNUAL	ALL	1				
280		635424.5	4976234	0.00067	2160.46	2844.3	0	ANNUAL	ALL	1				
281		635449.5	4976234	0.00069	2157.93	2844.3	0	ANNUAL	ALL	1				
282		635474.5	4976234	0.0007	2155.5	2844.3	0	ANNUAL	ALL	1				
283		635499.5	4976234	0.00072	2152.67	2844.3	0	ANNUAL	ALL	1				
284		635524.5	4976234	0.00073	2150.12	2844.3	0	ANNUAL	ALL	1				
285		635549.5	4976234	0.00071	2156.6	2844.3	0	ANNUAL	ALL	1				
286		635574.5	4976234	0.00067	2167.62	2844.3	0	ANNUAL	ALL	1				
287		635599.5	4976234	0.00063	2178.35	2844.3	0	ANNUAL	ALL	1				
288		634999.5	4978134	0.00084	2044.53	2844.3	0	ANNUAL	ALL	1				
289		635024.5	4978134	0.00093	2030.56	2844.3	0	ANNUAL	ALL	1				
290		635049.5	4978134	0.001	2018.07	2844.3	0	ANNUAL	ALL	1				
291		635074.5	4978134	0.00108	2006.69	2844.3	0	ANNUAL	ALL	1				
292		635099.5	4978134	0.00107	2006.39	2844.3	0	ANNUAL	ALL	1				
293		635124.5	4978134	0.00102	2013.34	2844.3	0	ANNUAL	ALL	1				
294		635149.5	4978134	0.00097	2020.75	2844.3	0	ANNUAL	ALL	1				
295		635174.5	4978134	0.00091	2029.05	2844.3	0	ANNUAL	ALL	1				
296		635199.5	4978134	0.00085	2038.91	2844.3	0	ANNUAL	ALL	1				
297		634999.5	4978159	0.00084	2044.5	2844.3	0	ANNUAL	ALL	1				
298		635024.5	4978159	0.00092	2030.78	2844.3	0	ANNUAL	ALL	1				
299		635049.5	4978159	0.00101	2017.35	2844.3	0	ANNUAL	ALL	1				
300		635074.5	4978159	0.00109	2004.54	2844.3	0	ANNUAL	ALL	1				
301		635099.5	4978159	0.00108	2003.81	2844.3	0	ANNUAL	ALL	1				
302		635124.5	4978159	0.00104	2010.57	2844.3	0	ANNUAL	ALL	1				
303		635149.5	4978159	0.00099	2017.75	2844.3	0	ANNUAL	ALL	1				
304		635174.5	4978159	0.00094	2025.18	2844.3	0	ANNUAL	ALL	1				
305		635199.5	4978159	0.00087	2035.11	2844.3	0	ANNUAL	ALL	1				
306		634999.5	4978184	0.00084	2044.38	2844.3	0	ANNUAL	ALL	1				
307		635024.5	4978184	0.00093	2028.98	2844.3	0	ANNUAL	ALL	1				
308		635049.5	4978184	0.00102	2015.36	2844.3	0	ANNUAL	ALL	1				
309		635074.5	4978184	0.0011	2002.43	2844.3	0	ANNUAL	ALL	1				
310		635099.5	4978184	0.0011	2000.86	2844.3	0	ANNUAL	ALL	1				
311		635124.5	4978184	0.00106	2007.53	2844.3	0	ANNUAL	ALL	1				
312		635149.5	4978184	0.00101	2014.6	2844.3	0	ANNUAL	ALL	1				
313		635174.5	4978184	0.00095	2022.07	2844.3	0	ANNUAL	ALL	1				
314		635199.5	4978184	0.00089	2031.45	2844.3	0	ANNUAL	ALL	1				
315		634999.5	4978209	0.00085	2043.46	2844.3	0	ANNUAL	ALL	1				
316		635024.5	4978209	0.00094	2027.94	2844.3	0	ANNUAL	ALL	1				
317		635049.5	4978209	0.00103	2013.73	2844.3	0	ANNUAL	ALL	1				
318		635074.5	4978209	0.0011	2000.96	2844.3	0	ANNUAL	ALL	1				
319		635099.5	4978209	0.00111	1998.75	2844.3	0	ANNUAL	ALL	1				
320		635124.5	4978209	0.00107	2004.56	2844.3	0	ANNUAL	ALL	1				
321		635149.5	4978209	0.00102	2011.78	2844.3	0	ANNUAL	ALL	1				
322		635174.5	4978209	0.00097	2019.36	2844.3	0	ANNUAL	ALL	1				
323		635199.5	4978209	0.00091	2027.82	2844.3	0	ANNUAL	ALL	1				
324		634999.5	4978234	0.00085	2042.97	2844.3	0	ANNUAL	ALL	1				
325		635024.5	4978234	0.00094	2026.61	2844.3	0	ANNUAL	ALL	1				
326		635049.5	4978234	0.00103	2012.57	2844.3	0	ANNUAL	ALL	1				
327		635074.5	4978234	0.0011	2000.24	2844.3	0	ANNUAL	ALL	1				
328		635099.5	4978234	0.00112	1996.61	2844.3	0	ANNUAL	ALL	1				
329		635124.5	4978234	0.00109	2001.65	2844.3	0	ANNUAL	ALL	1				
330		635149.5	4978234	0.00104	2009.16	2844.3	0	ANNUAL	ALL	1				
331		635174.5	4978234	0.00098	2016.86	2844.3	0	ANNUAL	ALL	1				
332		635199.5	4978234	0.00093	2024.48	2844.3	0	ANNUAL	ALL	1				
333		634999.5	4978259	0.00086	2041.08	2844.3	0	ANNUAL	ALL	1				
334		635024.5	4978259	0.00096	2024.08	2844.3	0	ANNUAL	ALL	1				
335		635049.5	4978259	0.00104	2011.49	2844.3	0	ANNUAL	ALL	1				
336		635074.5	4978259	0.0011	2000.61	2844.3	0	ANNUAL	ALL	1				
337		635099.5	4978259	0.00113	1994.84	2844.3	0	ANNUAL	ALL	1				
338		635124.5	4978259	0.0011	1999.29	2844.3	0	ANNUAL	ALL	1				
339		635149.5	4978259	0.00105	2007.14	2844.3	0	ANNUAL	ALL	1				
340		635174.5	4978259	0.00099	2014.96	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
341		635199.5	4978259	0.00094	2023.44	2844.3	0	ANNUAL	ALL	1				
342		634999.5	4978284	0.00086	2039.02	2844.3	0	ANNUAL	ALL	1				
343		635024.5	4978284	0.00096	2022.69	2844.3	0	ANNUAL	ALL	1				
344		635049.5	4978284	0.00104	2010.11	2844.3	0	ANNUAL	ALL	1				
345		635074.5	4978284	0.0011	1999.28	2844.3	0	ANNUAL	ALL	1				
346		635099.5	4978284	0.00113	1993.94	2844.3	0	ANNUAL	ALL	1				
347		635124.5	4978284	0.00111	1996.86	2844.3	0	ANNUAL	ALL	1				
348		635149.5	4978284	0.00106	2004.78	2844.3	0	ANNUAL	ALL	1				
349		635174.5	4978284	0.00101	2012.7	2844.3	0	ANNUAL	ALL	1				
350		635199.5	4978284	0.00094	2021.78	2844.3	0	ANNUAL	ALL	1				
351		634999.5	4978309	0.00087	2036.72	2844.3	0	ANNUAL	ALL	1				
352		635024.5	4978309	0.00095	2023.32	2844.3	0	ANNUAL	ALL	1				
353		635049.5	4978309	0.00104	2010.1	2844.3	0	ANNUAL	ALL	1				
354		635074.5	4978309	0.0011	1999.36	2844.3	0	ANNUAL	ALL	1				
355		635099.5	4978309	0.00113	1992.81	2844.3	0	ANNUAL	ALL	1				
356		635124.5	4978309	0.00112	1994.13	2844.3	0	ANNUAL	ALL	1				
357		635149.5	4978309	0.00107	2001.68	2844.3	0	ANNUAL	ALL	1				
358		635174.5	4978309	0.00102	2009.75	2844.3	0	ANNUAL	ALL	1				
359		635199.5	4978309	0.00096	2018.84	2844.3	0	ANNUAL	ALL	1				
360		634999.5	4978334	0.00089	2033.58	2844.3	0	ANNUAL	ALL	1				
361		635024.5	4978334	0.00096	2021.76	2844.3	0	ANNUAL	ALL	1				
362		635049.5	4978334	0.00103	2009.59	2844.3	0	ANNUAL	ALL	1				
363		635074.5	4978334	0.00109	1999.33	2844.3	0	ANNUAL	ALL	1				
364		635099.5	4978334	0.00113	1991.74	2844.3	0	ANNUAL	ALL	1				
365		635124.5	4978334	0.00113	1991.62	2844.3	0	ANNUAL	ALL	1				
366		635149.5	4978334	0.00109	1998.49	2844.3	0	ANNUAL	ALL	1				
367		635174.5	4978334	0.00104	2006.18	2844.3	0	ANNUAL	ALL	1				
368		635199.5	4978334	0.00098	2015.32	2844.3	0	ANNUAL	ALL	1				
369		634299.5	4978134	0.00081	2065.05	2844.3	0	ANNUAL	ALL	1				
370		634324.5	4978134	0.00087	2052.1	2844.3	0	ANNUAL	ALL	1				
371		634349.5	4978134	0.00091	2045.24	2844.3	0	ANNUAL	ALL	1				
372		634374.5	4978134	0.00097	2034.94	2844.3	0	ANNUAL	ALL	1				
373		634399.5	4978134	0.00107	2020.36	2844.3	0	ANNUAL	ALL	1				
374		634424.5	4978134	0.00118	2003.67	2844.3	0	ANNUAL	ALL	1				
375		634449.5	4978134	0.00124	1995.29	2844.3	0	ANNUAL	ALL	1				
376		634474.5	4978134	0.00116	2007.74	2844.3	0	ANNUAL	ALL	1				
377		634499.5	4978134	0.00102	2026.56	2844.3	0	ANNUAL	ALL	1				
378		634299.5	4978159	0.00084	2056.37	2844.3	0	ANNUAL	ALL	1				
379		634324.5	4978159	0.00091	2043.39	2844.3	0	ANNUAL	ALL	1				
380		634349.5	4978159	0.00098	2031.51	2844.3	0	ANNUAL	ALL	1				
381		634374.5	4978159	0.00104	2023.05	2844.3	0	ANNUAL	ALL	1				
382		634399.5	4978159	0.00113	2009.29	2844.3	0	ANNUAL	ALL	1				
383		634424.5	4978159	0.00122	1995	2844.3	0	ANNUAL	ALL	1				
384		634449.5	4978159	0.00124	1992.7	2844.3	0	ANNUAL	ALL	1				
385		634474.5	4978159	0.00115	2006.88	2844.3	0	ANNUAL	ALL	1				
386		634499.5	4978159	0.00103	2023.97	2844.3	0	ANNUAL	ALL	1				
387		634299.5	4978184	0.00086	2049.3	2844.3	0	ANNUAL	ALL	1				
388		634324.5	4978184	0.00094	2036.32	2844.3	0	ANNUAL	ALL	1				
389		634349.5	4978184	0.00102	2022.34	2844.3	0	ANNUAL	ALL	1				
390		634374.5	4978184	0.00111	2009.09	2844.3	0	ANNUAL	ALL	1				
391		634399.5	4978184	0.00117	1999.89	2844.3	0	ANNUAL	ALL	1				
392		634424.5	4978184	0.00126	1987.52	2844.3	0	ANNUAL	ALL	1				
393		634449.5	4978184	0.00123	1991.46	2844.3	0	ANNUAL	ALL	1				
394		634474.5	4978184	0.00114	2006.06	2844.3	0	ANNUAL	ALL	1				
395		634499.5	4978184	0.00104	2020.38	2844.3	0	ANNUAL	ALL	1				
396		634299.5	4978209	0.00088	2043.21	2844.3	0	ANNUAL	ALL	1				
397		634324.5	4978209	0.00095	2030.6	2844.3	0	ANNUAL	ALL	1				
398		634349.5	4978209	0.00104	2016.03	2844.3	0	ANNUAL	ALL	1				
399		634374.5	4978209	0.00113	2000.87	2844.3	0	ANNUAL	ALL	1				
400		634399.5	4978209	0.00121	1990.53	2844.3	0	ANNUAL	ALL	1				
401		634424.5	4978209	0.00127	1981.32	2844.3	0	ANNUAL	ALL	1				
402		634449.5	4978209	0.00122	1989.45	2844.3	0	ANNUAL	ALL	1				
403		634474.5	4978209	0.00112	2004.01	2844.3	0	ANNUAL	ALL	1				
404		634499.5	4978209	0.00105	2016.91	2844.3	0	ANNUAL	ALL	1				
405		634299.5	4978234	0.0009	2037.27	2844.3	0	ANNUAL	ALL	1				
406		634324.5	4978234	0.00097	2025.09	2844.3	0	ANNUAL	ALL	1				
407		634349.5	4978234	0.00106	2009.81	2844.3	0	ANNUAL	ALL	1				
408		634374.5	4978234	0.00114	1996.13	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
409		634399.5	4978234	0.00122	1984.05	2844.3	0	ANNUAL	ALL	1				
410		634424.5	4978234	0.00128	1975.87	2844.3	0	ANNUAL	ALL	1				
411		634449.5	4978234	0.00123	1984.97	2844.3	0	ANNUAL	ALL	1				
412		634474.5	4978234	0.00113	2000.36	2844.3	0	ANNUAL	ALL	1				
413		634499.5	4978234	0.00107	2011.73	2844.3	0	ANNUAL	ALL	1				
414		634299.5	4978259	0.00091	2030.97	2844.3	0	ANNUAL	ALL	1				
415		634324.5	4978259	0.00099	2018.02	2844.3	0	ANNUAL	ALL	1				
416		634349.5	4978259	0.00107	2002.99	2844.3	0	ANNUAL	ALL	1				
417		634374.5	4978259	0.00115	1990.41	2844.3	0	ANNUAL	ALL	1				
418		634399.5	4978259	0.00123	1978.88	2844.3	0	ANNUAL	ALL	1				
419		634424.5	4978259	0.00127	1972.17	2844.3	0	ANNUAL	ALL	1				
420		634449.5	4978259	0.00125	1977.85	2844.3	0	ANNUAL	ALL	1				
421		634474.5	4978259	0.00116	1992.52	2844.3	0	ANNUAL	ALL	1				
422		634499.5	4978259	0.00109	2003.44	2844.3	0	ANNUAL	ALL	1				
423		634299.5	4978284	0.00093	2023.26	2844.3	0	ANNUAL	ALL	1				
424		634324.5	4978284	0.00101	2008.98	2844.3	0	ANNUAL	ALL	1				
425		634349.5	4978284	0.00108	1996.31	2844.3	0	ANNUAL	ALL	1				
426		634374.5	4978284	0.00116	1984.2	2844.3	0	ANNUAL	ALL	1				
427		634399.5	4978284	0.00123	1973.37	2844.3	0	ANNUAL	ALL	1				
428		634424.5	4978284	0.00126	1969.23	2844.3	0	ANNUAL	ALL	1				
429		634449.5	4978284	0.00123	1975.58	2844.3	0	ANNUAL	ALL	1				
430		634474.5	4978284	0.00116	1989.07	2844.3	0	ANNUAL	ALL	1				
431		634499.5	4978284	0.00109	2000.53	2844.3	0	ANNUAL	ALL	1				
432		634299.5	4978309	0.00096	2012.41	2844.3	0	ANNUAL	ALL	1				
433		634324.5	4978309	0.00103	1999.74	2844.3	0	ANNUAL	ALL	1				
434		634349.5	4978309	0.0011	1988.62	2844.3	0	ANNUAL	ALL	1				
435		634374.5	4978309	0.00117	1977.79	2844.3	0	ANNUAL	ALL	1				
436		634399.5	4978309	0.00122	1967.1	2844.3	0	ANNUAL	ALL	1				
437		634424.5	4978309	0.00124	1968.14	2844.3	0	ANNUAL	ALL	1				
438		634449.5	4978309	0.0012	1977.66	2844.3	0	ANNUAL	ALL	1				
439		634474.5	4978309	0.00112	1992.31	2844.3	0	ANNUAL	ALL	1				
440		634499.5	4978309	0.00105	2006.23	2844.3	0	ANNUAL	ALL	1				
441		634299.5	4978334	0.00099	2000.94	2844.3	0	ANNUAL	ALL	1				
442		634324.5	4978334	0.00105	1991.1	2844.3	0	ANNUAL	ALL	1				
443		634349.5	4978334	0.00111	1980.66	2844.3	0	ANNUAL	ALL	1				
444		634374.5	4978334	0.00118	1970.39	2844.3	0	ANNUAL	ALL	1				
445		634399.5	4978334	0.00123	1961.38	2844.3	0	ANNUAL	ALL	1				
446		634424.5	4978334	0.00121	1968.29	2844.3	0	ANNUAL	ALL	1				
447		634449.5	4978334	0.00115	1980.95	2844.3	0	ANNUAL	ALL	1				
448		634474.5	4978334	0.00106	1997.36	2844.3	0	ANNUAL	ALL	1				
449		634499.5	4978334	0.00099	2012.52	2844.3	0	ANNUAL	ALL	1				
450		634299.5	4978359	0.00101	1991.4	2844.3	0	ANNUAL	ALL	1				
451		634324.5	4978359	0.00106	1982.72	2844.3	0	ANNUAL	ALL	1				
452		634349.5	4978359	0.00112	1972.75	2844.3	0	ANNUAL	ALL	1				
453		634374.5	4978359	0.00117	1962.87	2844.3	0	ANNUAL	ALL	1				
454		634399.5	4978359	0.00121	1958.17	2844.3	0	ANNUAL	ALL	1				
455		634424.5	4978359	0.00117	1968.79	2844.3	0	ANNUAL	ALL	1				
456		634449.5	4978359	0.0011	1984.24	2844.3	0	ANNUAL	ALL	1				
457		634474.5	4978359	0.00101	2002.2	2844.3	0	ANNUAL	ALL	1				
458		634499.5	4978359	0.00095	2016.76	2844.3	0	ANNUAL	ALL	1				
459		634299.5	4978384	0.00102	1982.57	2844.3	0	ANNUAL	ALL	1				
460		634324.5	4978384	0.00107	1975.68	2844.3	0	ANNUAL	ALL	1				
461		634349.5	4978384	0.00112	1964.84	2844.3	0	ANNUAL	ALL	1				
462		634374.5	4978384	0.00118	1956.29	2844.3	0	ANNUAL	ALL	1				
463		634399.5	4978384	0.0012	1955.61	2844.3	0	ANNUAL	ALL	1				
464		634424.5	4978384	0.00114	1968.65	2844.3	0	ANNUAL	ALL	1				
465		634449.5	4978384	0.00107	1986.09	2844.3	0	ANNUAL	ALL	1				
466		634474.5	4978384	0.00098	2004.63	2844.3	0	ANNUAL	ALL	1				
467		634499.5	4978384	0.00092	2018.69	2844.3	0	ANNUAL	ALL	1				
468		634299.5	4978409	0.00103	1975.4	2844.3	0	ANNUAL	ALL	1				
469		634324.5	4978409	0.00107	1967.52	2844.3	0	ANNUAL	ALL	1				
470		634349.5	4978409	0.00113	1957.04	2844.3	0	ANNUAL	ALL	1				
471		634374.5	4978409	0.00118	1949.69	2844.3	0	ANNUAL	ALL	1				
472		634399.5	4978409	0.00119	1951.43	2844.3	0	ANNUAL	ALL	1				
473		634424.5	4978409	0.00111	1967.3	2844.3	0	ANNUAL	ALL	1				
474		634449.5	4978409	0.00104	1986.39	2844.3	0	ANNUAL	ALL	1				
475		634474.5	4978409	0.00096	2005.28	2844.3	0	ANNUAL	ALL	1				
476		634499.5	4978409	0.0009	2019.28	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
477		634299.5	4978434	0.00103	1965.22	2844.3	0	ANNUAL	ALL	1				
478		634324.5	4978434	0.00107	1958.88	2844.3	0	ANNUAL	ALL	1				
479		634349.5	4978434	0.00113	1950.79	2844.3	0	ANNUAL	ALL	1				
480		634374.5	4978434	0.00118	1943.73	2844.3	0	ANNUAL	ALL	1				
481		634399.5	4978434	0.00116	1949.4	2844.3	0	ANNUAL	ALL	1				
482		634424.5	4978434	0.00109	1965.04	2844.3	0	ANNUAL	ALL	1				
483		634449.5	4978434	0.00102	1984.59	2844.3	0	ANNUAL	ALL	1				
484		634474.5	4978434	0.00093	2004.45	2844.3	0	ANNUAL	ALL	1				
485		634499.5	4978434	0.00088	2017.53	2844.3	0	ANNUAL	ALL	1				
486		634249.4	4977384	0.00048	2291.4	2717.08	0	ANNUAL	ALL	1				
487		634274.4	4977384	0.00048	2282.65	2742	0	ANNUAL	ALL	1				
488		634299.4	4977384	0.00048	2273.71	2742	0	ANNUAL	ALL	1				
489		634324.4	4977384	0.00048	2263.84	2742	0	ANNUAL	ALL	1				
490		634349.4	4977384	0.00048	2250.84	2742	0	ANNUAL	ALL	1				
491		634374.4	4977384	0.00048	2238.58	2742.16	0	ANNUAL	ALL	1				
492		634399.4	4977384	0.00048	2232.43	2742.16	0	ANNUAL	ALL	1				
493		634424.4	4977384	0.00047	2242.73	2742.16	0	ANNUAL	ALL	1				
494		634449.4	4977384	0.00046	2255.36	2742	0	ANNUAL	ALL	1				
495		634249.4	4977409	0.00049	2284.43	2742	0	ANNUAL	ALL	1				
496		634274.4	4977409	0.00049	2274.53	2742	0	ANNUAL	ALL	1				
497		634299.4	4977409	0.00049	2264.56	2742	0	ANNUAL	ALL	1				
498		634324.4	4977409	0.00049	2254.44	2742	0	ANNUAL	ALL	1				
499		634349.4	4977409	0.00049	2243.93	2742.16	0	ANNUAL	ALL	1				
500		634374.4	4977409	0.00049	2231.37	2742.16	0	ANNUAL	ALL	1				
501		634399.4	4977409	0.00049	2226.02	2844.3	0	ANNUAL	ALL	1				
502		634424.4	4977409	0.00048	2236.92	2742.16	0	ANNUAL	ALL	1				
503		634449.4	4977409	0.00047	2249.43	2742.16	0	ANNUAL	ALL	1				
504		634249.4	4977434	0.00049	2279.34	2742	0	ANNUAL	ALL	1				
505		634274.4	4977434	0.00049	2267.65	2742	0	ANNUAL	ALL	1				
506		634299.4	4977434	0.0005	2255.85	2742	0	ANNUAL	ALL	1				
507		634324.4	4977434	0.0005	2244.86	2742	0	ANNUAL	ALL	1				
508		634349.4	4977434	0.0005	2234.48	2742.16	0	ANNUAL	ALL	1				
509		634374.4	4977434	0.0005	2223.18	2844.3	0	ANNUAL	ALL	1				
510		634399.4	4977434	0.0005	2218.5	2844.3	0	ANNUAL	ALL	1				
511		634424.4	4977434	0.00049	2230.27	2844.3	0	ANNUAL	ALL	1				
512		634449.4	4977434	0.00047	2243.66	2742.16	0	ANNUAL	ALL	1				
513		634249.4	4977459	0.0005	2275.78	2742	0	ANNUAL	ALL	1				
514		634274.4	4977459	0.0005	2262.83	2742	0	ANNUAL	ALL	1				
515		634299.4	4977459	0.00051	2248.74	2742	0	ANNUAL	ALL	1				
516		634324.4	4977459	0.00051	2237.43	2742.16	0	ANNUAL	ALL	1				
517		634349.4	4977459	0.00051	2226.72	2844.3	0	ANNUAL	ALL	1				
518		634374.4	4977459	0.00051	2214.97	2844.3	0	ANNUAL	ALL	1				
519		634399.4	4977459	0.00051	2211.75	2844.3	0	ANNUAL	ALL	1				
520		634424.4	4977459	0.0005	2223.34	2844.3	0	ANNUAL	ALL	1				
521		634449.4	4977459	0.00048	2237.29	2844.3	0	ANNUAL	ALL	1				
522		634249.4	4977484	0.00051	2272.5	2742	0	ANNUAL	ALL	1				
523		634274.4	4977484	0.00051	2258.48	2742	0	ANNUAL	ALL	1				
524		634299.4	4977484	0.00051	2243.77	2742	0	ANNUAL	ALL	1				
525		634324.4	4977484	0.00052	2231.45	2742.16	0	ANNUAL	ALL	1				
526		634349.4	4977484	0.00052	2219.9	2844.3	0	ANNUAL	ALL	1				
527		634374.4	4977484	0.00052	2207.94	2844.3	0	ANNUAL	ALL	1				
528		634399.4	4977484	0.00052	2204.62	2844.3	0	ANNUAL	ALL	1				
529		634424.4	4977484	0.00051	2216.76	2844.3	0	ANNUAL	ALL	1				
530		634449.4	4977484	0.00049	2230.33	2844.3	0	ANNUAL	ALL	1				
531		634249.4	4977509	0.00051	2269.17	2742	0	ANNUAL	ALL	1				
532		634274.4	4977509	0.00052	2254.88	2742	0	ANNUAL	ALL	1				
533		634299.4	4977509	0.00052	2240.59	2742	0	ANNUAL	ALL	1				
534		634324.4	4977509	0.00052	2227.32	2844.3	0	ANNUAL	ALL	1				
535		634349.4	4977509	0.00053	2213.19	2844.3	0	ANNUAL	ALL	1				
536		634374.4	4977509	0.00053	2200.19	2844.3	0	ANNUAL	ALL	1				
537		634399.4	4977509	0.00053	2197.61	2844.3	0	ANNUAL	ALL	1				
538		634424.4	4977509	0.00051	2211.03	2844.3	0	ANNUAL	ALL	1				
539		634449.4	4977509	0.0005	2223.57	2844.3	0	ANNUAL	ALL	1				
540		634249.4	4977534	0.00052	2266.65	2742	0	ANNUAL	ALL	1				
541		634274.4	4977534	0.00052	2251.58	2742	0	ANNUAL	ALL	1				
542		634299.4	4977534	0.00053	2237.18	2742	0	ANNUAL	ALL	1				
543		634324.4	4977534	0.00053	2223.67	2844.3	0	ANNUAL	ALL	1				
544		634349.4	4977534	0.00054	2207.86	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
545		634374.4	4977534	0.00054	2193.38	2844.3	0	ANNUAL	ALL	1				
546		634399.4	4977534	0.00054	2191.95	2844.3	0	ANNUAL	ALL	1				
547		634424.4	4977534	0.00052	2205.88	2844.3	0	ANNUAL	ALL	1				
548		634449.4	4977534	0.00051	2217.63	2844.3	0	ANNUAL	ALL	1				
549		634249.4	4977559	0.00053	2264.12	2742	0	ANNUAL	ALL	1				
550		634274.4	4977559	0.00053	2247.26	2742	0	ANNUAL	ALL	1				
551		634299.4	4977559	0.00053	2232.74	2742	0	ANNUAL	ALL	1				
552		634324.4	4977559	0.00054	2218.55	2844.3	0	ANNUAL	ALL	1				
553		634349.4	4977559	0.00055	2203.35	2844.3	0	ANNUAL	ALL	1				
554		634374.4	4977559	0.00055	2189.62	2844.3	0	ANNUAL	ALL	1				
555		634399.4	4977559	0.00055	2184.96	2844.3	0	ANNUAL	ALL	1				
556		634424.4	4977559	0.00053	2200.77	2844.3	0	ANNUAL	ALL	1				
557		634449.4	4977559	0.00052	2211.07	2844.3	0	ANNUAL	ALL	1				
558		634249.4	4977584	0.00053	2258.01	2742	0	ANNUAL	ALL	1				
559		634274.4	4977584	0.00054	2242.66	2742	0	ANNUAL	ALL	1				
560		634299.4	4977584	0.00054	2227.67	2844.3	0	ANNUAL	ALL	1				
561		634324.4	4977584	0.00055	2213.51	2844.3	0	ANNUAL	ALL	1				
562		634349.4	4977584	0.00055	2199.5	2844.3	0	ANNUAL	ALL	1				
563		634374.4	4977584	0.00056	2185.33	2844.3	0	ANNUAL	ALL	1				
564		634399.4	4977584	0.00056	2177.11	2844.3	0	ANNUAL	ALL	1				
565		634424.4	4977584	0.00054	2192.43	2844.3	0	ANNUAL	ALL	1				
566		634449.4	4977584	0.00053	2203.16	2844.3	0	ANNUAL	ALL	1				
567		634999.5	4977834	0.00079	2055.79	2844.3	0	ANNUAL	ALL	1				
568		635024.5	4977834	0.00083	2048.42	2844.3	0	ANNUAL	ALL	1				
569		635049.5	4977834	0.00086	2043	2844.3	0	ANNUAL	ALL	1				
570		635074.5	4977834	0.0009	2037.93	2844.3	0	ANNUAL	ALL	1				
571		635099.5	4977834	0.00092	2034.24	2844.3	0	ANNUAL	ALL	1				
572		635124.5	4977834	0.00094	2031.45	2844.3	0	ANNUAL	ALL	1				
573		635149.5	4977834	0.00089	2038.5	2844.3	0	ANNUAL	ALL	1				
574		635174.5	4977834	0.00081	2050.35	2844.3	0	ANNUAL	ALL	1				
575		635199.5	4977834	0.00073	2063.26	2844.3	0	ANNUAL	ALL	1				
576		634999.5	4977859	0.00081	2052.63	2844.3	0	ANNUAL	ALL	1				
577		635024.5	4977859	0.00084	2046.41	2844.3	0	ANNUAL	ALL	1				
578		635049.5	4977859	0.00088	2040.95	2844.3	0	ANNUAL	ALL	1				
579		635074.5	4977859	0.00091	2036.03	2844.3	0	ANNUAL	ALL	1				
580		635099.5	4977859	0.00093	2032.3	2844.3	0	ANNUAL	ALL	1				
581		635124.5	4977859	0.00094	2030.17	2844.3	0	ANNUAL	ALL	1				
582		635149.5	4977859	0.00088	2038.33	2844.3	0	ANNUAL	ALL	1				
583		635174.5	4977859	0.00081	2049.93	2844.3	0	ANNUAL	ALL	1				
584		635199.5	4977859	0.00073	2062.54	2844.3	0	ANNUAL	ALL	1				
585		634999.5	4977884	0.00083	2049.11	2844.3	0	ANNUAL	ALL	1				
586		635024.5	4977884	0.00085	2044.13	2844.3	0	ANNUAL	ALL	1				
587		635049.5	4977884	0.00089	2038.92	2844.3	0	ANNUAL	ALL	1				
588		635074.5	4977884	0.00092	2034.26	2844.3	0	ANNUAL	ALL	1				
589		635099.5	4977884	0.00094	2030.48	2844.3	0	ANNUAL	ALL	1				
590		635124.5	4977884	0.00095	2029.04	2844.3	0	ANNUAL	ALL	1				
591		635149.5	4977884	0.00088	2038.45	2844.3	0	ANNUAL	ALL	1				
592		635174.5	4977884	0.00081	2049.51	2844.3	0	ANNUAL	ALL	1				
593		635199.5	4977884	0.00074	2061.56	2844.3	0	ANNUAL	ALL	1				
594		634999.5	4977909	0.00084	2047.27	2844.3	0	ANNUAL	ALL	1				
595		635024.5	4977909	0.00087	2042.16	2844.3	0	ANNUAL	ALL	1				
596		635049.5	4977909	0.0009	2036.97	2844.3	0	ANNUAL	ALL	1				
597		635074.5	4977909	0.00093	2032.48	2844.3	0	ANNUAL	ALL	1				
598		635099.5	4977909	0.00095	2028.7	2844.3	0	ANNUAL	ALL	1				
599		635124.5	4977909	0.00095	2028.77	2844.3	0	ANNUAL	ALL	1				
600		635149.5	4977909	0.00088	2038.62	2844.3	0	ANNUAL	ALL	1				
601		635174.5	4977909	0.00081	2049.12	2844.3	0	ANNUAL	ALL	1				
602		635199.5	4977909	0.00074	2060.48	2844.3	0	ANNUAL	ALL	1				
603		634999.5	4977934	0.00084	2046.79	2844.3	0	ANNUAL	ALL	1				
604		635024.5	4977934	0.00087	2040.92	2844.3	0	ANNUAL	ALL	1				
605		635049.5	4977934	0.00091	2034.68	2844.3	0	ANNUAL	ALL	1				
606		635074.5	4977934	0.00094	2029.58	2844.3	0	ANNUAL	ALL	1				
607		635099.5	4977934	0.00097	2025.61	2844.3	0	ANNUAL	ALL	1				
608		635124.5	4977934	0.00095	2027.68	2844.3	0	ANNUAL	ALL	1				
609		635149.5	4977934	0.00088	2038.09	2844.3	0	ANNUAL	ALL	1				
610		635174.5	4977934	0.00081	2048.68	2844.3	0	ANNUAL	ALL	1				
611		635199.5	4977934	0.00075	2059.02	2844.3	0	ANNUAL	ALL	1				
612		634999.5	4977959	0.00084	2045.95	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
613		635024.5	4977959	0.00088	2039.51	2844.3	0	ANNUAL	ALL	1				
614		635049.5	4977959	0.00092	2032.45	2844.3	0	ANNUAL	ALL	1				
615		635074.5	4977959	0.00096	2026.52	2844.3	0	ANNUAL	ALL	1				
616		635099.5	4977959	0.00098	2022.6	2844.3	0	ANNUAL	ALL	1				
617		635124.5	4977959	0.00095	2027.13	2844.3	0	ANNUAL	ALL	1				
618		635149.5	4977959	0.00088	2036.89	2844.3	0	ANNUAL	ALL	1				
619		635174.5	4977959	0.00082	2046.85	2844.3	0	ANNUAL	ALL	1				
620		635199.5	4977959	0.00076	2056.78	2844.3	0	ANNUAL	ALL	1				
621		634999.5	4977984	0.00084	2045.34	2844.3	0	ANNUAL	ALL	1				
622		635024.5	4977984	0.00089	2037.82	2844.3	0	ANNUAL	ALL	1				
623		635049.5	4977984	0.00093	2030.43	2844.3	0	ANNUAL	ALL	1				
624		635074.5	4977984	0.00097	2024.12	2844.3	0	ANNUAL	ALL	1				
625		635099.5	4977984	0.001	2019.96	2844.3	0	ANNUAL	ALL	1				
626		635124.5	4977984	0.00095	2026.73	2844.3	0	ANNUAL	ALL	1				
627		635149.5	4977984	0.00089	2035.4	2844.3	0	ANNUAL	ALL	1				
628		635174.5	4977984	0.00083	2044.46	2844.3	0	ANNUAL	ALL	1				
629		635199.5	4977984	0.00078	2053.52	2844.3	0	ANNUAL	ALL	1				
630		634999.5	4978009	0.00085	2044.81	2844.3	0	ANNUAL	ALL	1				
631		635024.5	4978009	0.0009	2035.59	2844.3	0	ANNUAL	ALL	1				
632		635049.5	4978009	0.00095	2028.05	2844.3	0	ANNUAL	ALL	1				
633		635074.5	4978009	0.00099	2021.18	2844.3	0	ANNUAL	ALL	1				
634		635099.5	4978009	0.00101	2017.1	2844.3	0	ANNUAL	ALL	1				
635		635124.5	4978009	0.00095	2025.97	2844.3	0	ANNUAL	ALL	1				
636		635149.5	4978009	0.0009	2034.03	2844.3	0	ANNUAL	ALL	1				
637		635174.5	4978009	0.00084	2041.95	2844.3	0	ANNUAL	ALL	1				
638		635199.5	4978009	0.00079	2050.09	2844.3	0	ANNUAL	ALL	1				
639		634999.5	4978034	0.00085	2043.29	2844.3	0	ANNUAL	ALL	1				
640		635024.5	4978034	0.00092	2032.46	2844.3	0	ANNUAL	ALL	1				
641		635049.5	4978034	0.00097	2024.39	2844.3	0	ANNUAL	ALL	1				
642		635074.5	4978034	0.00101	2017.56	2844.3	0	ANNUAL	ALL	1				
643		635099.5	4978034	0.00102	2015.24	2844.3	0	ANNUAL	ALL	1				
644		635124.5	4978034	0.00096	2024.2	2844.3	0	ANNUAL	ALL	1				
645		635149.5	4978034	0.00091	2032.02	2844.3	0	ANNUAL	ALL	1				
646		635174.5	4978034	0.00085	2040.48	2844.3	0	ANNUAL	ALL	1				
647		635199.5	4978034	0.00079	2049.69	2844.3	0	ANNUAL	ALL	1				
648		634599.5	4976834	0.00035	2431.97	2717.08	0	ANNUAL	ALL	1				
649		634624.5	4976834	0.00035	2425.11	2717.08	0	ANNUAL	ALL	1				
650		634649.5	4976834	0.00035	2416.95	2717.08	0	ANNUAL	ALL	1				
651		634674.5	4976834	0.00035	2407.96	2717.08	0	ANNUAL	ALL	1				
652		634699.5	4976834	0.00035	2398.82	2717.08	0	ANNUAL	ALL	1				
653		634724.5	4976834	0.00035	2389.57	2717.08	0	ANNUAL	ALL	1				
654		634749.5	4976834	0.00036	2378.83	2717.08	0	ANNUAL	ALL	1				
655		634774.5	4976834	0.00036	2368.3	2717.08	0	ANNUAL	ALL	1				
656		634799.5	4976834	0.00036	2352.38	2717.08	0	ANNUAL	ALL	1				
657		634599.5	4976859	0.00035	2427	2717.08	0	ANNUAL	ALL	1				
658		634624.5	4976859	0.00035	2421.36	2717.08	0	ANNUAL	ALL	1				
659		634649.5	4976859	0.00035	2412.9	2717.08	0	ANNUAL	ALL	1				
660		634674.5	4976859	0.00035	2401.58	2717.08	0	ANNUAL	ALL	1				
661		634699.5	4976859	0.00036	2391.51	2717.08	0	ANNUAL	ALL	1				
662		634724.5	4976859	0.00036	2381.29	2717.08	0	ANNUAL	ALL	1				
663		634749.5	4976859	0.00036	2371.44	2717.08	0	ANNUAL	ALL	1				
664		634774.5	4976859	0.00036	2358.57	2717.08	0	ANNUAL	ALL	1				
665		634799.5	4976859	0.00036	2341.91	2742	0	ANNUAL	ALL	1				
666		634599.5	4976884	0.00035	2422.69	2717.08	0	ANNUAL	ALL	1				
667		634624.5	4976884	0.00035	2418.17	2717.08	0	ANNUAL	ALL	1				
668		634649.5	4976884	0.00035	2408.98	2717.08	0	ANNUAL	ALL	1				
669		634674.5	4976884	0.00036	2396.57	2717.08	0	ANNUAL	ALL	1				
670		634699.5	4976884	0.00036	2383.76	2717.08	0	ANNUAL	ALL	1				
671		634724.5	4976884	0.00036	2371.27	2717.08	0	ANNUAL	ALL	1				
672		634749.5	4976884	0.00036	2362.03	2717.08	0	ANNUAL	ALL	1				
673		634774.5	4976884	0.00036	2350.11	2717.08	0	ANNUAL	ALL	1				
674		634799.5	4976884	0.00037	2334.35	2742	0	ANNUAL	ALL	1				
675		634599.5	4976909	0.00036	2418.11	2717.08	0	ANNUAL	ALL	1				
676		634624.5	4976909	0.00035	2412.47	2717.08	0	ANNUAL	ALL	1				
677		634649.5	4976909	0.00036	2402.76	2717.08	0	ANNUAL	ALL	1				
678		634674.5	4976909	0.00036	2392.81	2717.08	0	ANNUAL	ALL	1				
679		634699.5	4976909	0.00036	2377.98	2717.08	0	ANNUAL	ALL	1				
680		634724.5	4976909	0.00036	2364.11	2717.08	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
681		634749.5	4976909	0.00036	2354.73	2717.08	0	ANNUAL	ALL	1				
682		634774.5	4976909	0.00036	2345.14	2717.08	0	ANNUAL	ALL	1				
683		634799.5	4976909	0.00037	2331	2742	0	ANNUAL	ALL	1				
684		634599.5	4976934	0.00036	2411.78	2717.08	0	ANNUAL	ALL	1				
685		634624.5	4976934	0.00036	2403.98	2717.08	0	ANNUAL	ALL	1				
686		634649.5	4976934	0.00036	2394.61	2717.08	0	ANNUAL	ALL	1				
687		634674.5	4976934	0.00036	2383.71	2717.08	0	ANNUAL	ALL	1				
688		634699.5	4976934	0.00036	2371.78	2717.08	0	ANNUAL	ALL	1				
689		634724.5	4976934	0.00036	2359.09	2717.08	0	ANNUAL	ALL	1				
690		634749.5	4976934	0.00036	2347.63	2717.08	0	ANNUAL	ALL	1				
691		634774.5	4976934	0.00037	2337.6	2742	0	ANNUAL	ALL	1				
692		634799.5	4976934	0.00037	2326.97	2742	0	ANNUAL	ALL	1				
693		634599.5	4976959	0.00036	2404.1	2717.08	0	ANNUAL	ALL	1				
694		634624.5	4976959	0.00036	2396.65	2717.08	0	ANNUAL	ALL	1				
695		634649.5	4976959	0.00036	2385.41	2717.08	0	ANNUAL	ALL	1				
696		634674.5	4976959	0.00036	2372.07	2717.08	0	ANNUAL	ALL	1				
697		634699.5	4976959	0.00036	2362.55	2717.08	0	ANNUAL	ALL	1				
698		634724.5	4976959	0.00036	2351.59	2717.08	0	ANNUAL	ALL	1				
699		634749.5	4976959	0.00037	2341.2	2717.08	0	ANNUAL	ALL	1				
700		634774.5	4976959	0.00037	2328.55	2742	0	ANNUAL	ALL	1				
701		634799.5	4976959	0.00037	2318.72	2742	0	ANNUAL	ALL	1				
702		634599.5	4976984	0.00036	2396.35	2717.08	0	ANNUAL	ALL	1				
703		634624.5	4976984	0.00036	2389.04	2717.08	0	ANNUAL	ALL	1				
704		634649.5	4976984	0.00036	2377.21	2717.08	0	ANNUAL	ALL	1				
705		634674.5	4976984	0.00036	2363.6	2717.08	0	ANNUAL	ALL	1				
706		634699.5	4976984	0.00037	2350.85	2717.08	0	ANNUAL	ALL	1				
707		634724.5	4976984	0.00037	2340.79	2717.08	0	ANNUAL	ALL	1				
708		634749.5	4976984	0.00037	2331.79	2742	0	ANNUAL	ALL	1				
709		634774.5	4976984	0.00037	2320.7	2742	0	ANNUAL	ALL	1				
710		634799.5	4976984	0.00037	2308.59	2742	0	ANNUAL	ALL	1				
711		634599.5	4977009	0.00036	2388.79	2717.08	0	ANNUAL	ALL	1				
712		634624.5	4977009	0.00036	2379.17	2717.08	0	ANNUAL	ALL	1				
713		634649.5	4977009	0.00036	2368.25	2717.08	0	ANNUAL	ALL	1				
714		634674.5	4977009	0.00037	2355.13	2717.08	0	ANNUAL	ALL	1				
715		634699.5	4977009	0.00037	2341.52	2717.08	0	ANNUAL	ALL	1				
716		634724.5	4977009	0.00037	2328.18	2742	0	ANNUAL	ALL	1				
717		634749.5	4977009	0.00037	2321.24	2742	0	ANNUAL	ALL	1				
718		634774.5	4977009	0.00037	2313.44	2742	0	ANNUAL	ALL	1				
719		634799.5	4977009	0.00038	2301.46	2742.16	0	ANNUAL	ALL	1				
720		634599.5	4977034	0.00036	2379.36	2717.08	0	ANNUAL	ALL	1				
721		634624.5	4977034	0.00037	2369.28	2717.08	0	ANNUAL	ALL	1				
722		634649.5	4977034	0.00037	2356.46	2717.08	0	ANNUAL	ALL	1				
723		634674.5	4977034	0.00037	2343.53	2717.08	0	ANNUAL	ALL	1				
724		634699.5	4977034	0.00037	2329.9	2742	0	ANNUAL	ALL	1				
725		634724.5	4977034	0.00038	2316.92	2742	0	ANNUAL	ALL	1				
726		634749.5	4977034	0.00038	2309.32	2742	0	ANNUAL	ALL	1				
727		634774.5	4977034	0.00038	2302.58	2742	0	ANNUAL	ALL	1				
728		634799.5	4977034	0.00038	2295.21	2742.16	0	ANNUAL	ALL	1				
729	**	CONCUNIT	ug/m^3											
730	**	DEPUNIT	g/m^2											

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	*	AERMOD	(	19191):	MIDAS	GOLD	STIBNITE	-	MODELING	R27	########			
2	*	AERMET	(	19191):	13:05:54									
3	*	MODELING	OPTIONS	USED:	RegDFAULT	CONC	ELEV	NOWARN	DRYDPLT	WETDPLT	RURAL	ADJ_U*		
4	*	PLOT	FILE	OF	ANNUAL	VALUES	AVERAGED	ACROSS	1	YEARS	FOR	SOURCE	GROUP:	ALL
5	*	FOR	A	TOTAL	OF	720	RECEPTORS.							
6	*	FORMAT:	(3(1X,F13.5),3(1X,F8.2),2X,A6,2X,A8,2X,I8.8,2X,A8)											
7	*	X	Y	AVERAGE	CONC	ZELEV	ZHILL	ZFLAG	AVE	GRP	NUM	YRS	NET	ID
8	*													
9	0.001020	635399.5	4975934	0.00066	2213.4	2844.3	0	ANNUAL	ALL	1				
10	max ↑	635424.5	4975934	0.00066	2212.64	2844.3	0	ANNUAL	ALL	1				
11		635449.5	4975934	0.00066	2211.27	2844.3	0	ANNUAL	ALL	1				
12		635474.5	4975934	0.00066	2212.5	2844.3	0	ANNUAL	ALL	1				
13		635499.5	4975934	0.00065	2215.21	2844.3	0	ANNUAL	ALL	1				
14		635524.5	4975934	0.00064	2215.98	2844.3	0	ANNUAL	ALL	1				
15		635549.5	4975934	0.00064	2215	2844.3	0	ANNUAL	ALL	1				
16		635574.5	4975934	0.00064	2215.74	2844.3	0	ANNUAL	ALL	1				
17		635599.5	4975934	0.00063	2218.34	2844.3	0	ANNUAL	ALL	1				
18		635399.5	4975959	0.00069	2202.75	2844.3	0	ANNUAL	ALL	1				
19		635424.5	4975959	0.00068	2204.36	2844.3	0	ANNUAL	ALL	1				
20		635449.5	4975959	0.00068	2204.87	2844.3	0	ANNUAL	ALL	1				
21		635474.5	4975959	0.00067	2206.39	2844.3	0	ANNUAL	ALL	1				
22		635499.5	4975959	0.00066	2208.99	2844.3	0	ANNUAL	ALL	1				
23		635524.5	4975959	0.00065	2210.99	2844.3	0	ANNUAL	ALL	1				
24		635549.5	4975959	0.00065	2211.29	2844.3	0	ANNUAL	ALL	1				
25		635574.5	4975959	0.00065	2210.92	2844.3	0	ANNUAL	ALL	1				
26		635599.5	4975959	0.00066	2208.83	2844.3	0	ANNUAL	ALL	1				
27		635399.5	4975984	0.00071	2195.09	2844.3	0	ANNUAL	ALL	1				
28		635424.5	4975984	0.0007	2198.19	2844.3	0	ANNUAL	ALL	1				
29		635449.5	4975984	0.00069	2198.7	2844.3	0	ANNUAL	ALL	1				
30		635474.5	4975984	0.00068	2201.57	2844.3	0	ANNUAL	ALL	1				
31		635499.5	4975984	0.00067	2203.99	2844.3	0	ANNUAL	ALL	1				
32		635524.5	4975984	0.00067	2206.27	2844.3	0	ANNUAL	ALL	1				
33		635549.5	4975984	0.00066	2206.83	2844.3	0	ANNUAL	ALL	1				
34		635574.5	4975984	0.00067	2205.61	2844.3	0	ANNUAL	ALL	1				
35		635599.5	4975984	0.00067	2202.99	2844.3	0	ANNUAL	ALL	1				
36		635399.5	4976009	0.0007	2195.69	2844.3	0	ANNUAL	ALL	1				
37		635424.5	4976009	0.00072	2189.65	2844.3	0	ANNUAL	ALL	1				
38		635449.5	4976009	0.00071	2194	2844.3	0	ANNUAL	ALL	1				
39		635474.5	4976009	0.00068	2200.13	2844.3	0	ANNUAL	ALL	1				
40		635499.5	4976009	0.00067	2202.83	2844.3	0	ANNUAL	ALL	1				
41		635524.5	4976009	0.00067	2203.57	2844.3	0	ANNUAL	ALL	1				
42		635549.5	4976009	0.00067	2203.82	2844.3	0	ANNUAL	ALL	1				
43		635574.5	4976009	0.00067	2202.81	2844.3	0	ANNUAL	ALL	1				
44		635599.5	4976009	0.00068	2200.59	2844.3	0	ANNUAL	ALL	1				
45		635399.5	4976034	0.00069	2198.23	2844.3	0	ANNUAL	ALL	1				
46		635424.5	4976034	0.00073	2186.98	2844.3	0	ANNUAL	ALL	1				
47		635449.5	4976034	0.00071	2190.14	2844.3	0	ANNUAL	ALL	1				
48		635474.5	4976034	0.00068	2198.63	2844.3	0	ANNUAL	ALL	1				
49		635499.5	4976034	0.00068	2198.93	2844.3	0	ANNUAL	ALL	1				
50		635524.5	4976034	0.00068	2199.39	2844.3	0	ANNUAL	ALL	1				
51		635549.5	4976034	0.00067	2201.1	2844.3	0	ANNUAL	ALL	1				
52		635574.5	4976034	0.00067	2200.59	2844.3	0	ANNUAL	ALL	1				
53		635599.5	4976034	0.00068	2197.96	2844.3	0	ANNUAL	ALL	1				
54		635399.5	4976059	0.00069	2196.33	2844.3	0	ANNUAL	ALL	1				
55		635424.5	4976059	0.00073	2184.09	2844.3	0	ANNUAL	ALL	1				
56		635449.5	4976059	0.00074	2180.82	2844.3	0	ANNUAL	ALL	1				
57		635474.5	4976059	0.0007	2193.11	2844.3	0	ANNUAL	ALL	1				
58		635499.5	4976059	0.00069	2194.5	2844.3	0	ANNUAL	ALL	1				
59		635524.5	4976059	0.00068	2197.17	2844.3	0	ANNUAL	ALL	1				
60		635549.5	4976059	0.00067	2199.4	2844.3	0	ANNUAL	ALL	1				
61		635574.5	4976059	0.00068	2198.27	2844.3	0	ANNUAL	ALL	1				
62		635599.5	4976059	0.00069	2194.62	2844.3	0	ANNUAL	ALL	1				
63		635399.5	4976084	0.00071	2188.98	2844.3	0	ANNUAL	ALL	1				
64		635424.5	4976084	0.00074	2180.22	2844.3	0	ANNUAL	ALL	1				
65		635449.5	4976084	0.00077	2174.51	2844.3	0	ANNUAL	ALL	1				
66		635474.5	4976084	0.00074	2180.27	2844.3	0	ANNUAL	ALL	1				
67		635499.5	4976084	0.00072	2185.71	2844.3	0	ANNUAL	ALL	1				
68		635524.5	4976084	0.0007	2191.13	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
69		635549.5	4976084	0.00069	2193.95	2844.3	0	ANNUAL	ALL	1				
70		635574.5	4976084	0.0007	2190.58	2844.3	0	ANNUAL	ALL	1				
71		635599.5	4976084	0.00073	2183.01	2844.3	0	ANNUAL	ALL	1				
72		635399.5	4976109	0.00072	2182.28	2844.3	0	ANNUAL	ALL	1				
73		635424.5	4976109	0.00075	2177.24	2844.3	0	ANNUAL	ALL	1				
74		635449.5	4976109	0.00077	2171.45	2844.3	0	ANNUAL	ALL	1				
75		635474.5	4976109	0.00077	2172.26	2844.3	0	ANNUAL	ALL	1				
76		635499.5	4976109	0.00075	2177.58	2844.3	0	ANNUAL	ALL	1				
77		635524.5	4976109	0.00074	2180.23	2844.3	0	ANNUAL	ALL	1				
78		635549.5	4976109	0.00074	2179.81	2844.3	0	ANNUAL	ALL	1				
79		635574.5	4976109	0.00075	2176.94	2844.3	0	ANNUAL	ALL	1				
80		635599.5	4976109	0.00074	2179.4	2844.3	0	ANNUAL	ALL	1				
81		635399.5	4976134	0.00074	2176.77	2844.3	0	ANNUAL	ALL	1				
82		635424.5	4976134	0.00075	2174.27	2844.3	0	ANNUAL	ALL	1				
83		635449.5	4976134	0.00077	2171.04	2844.3	0	ANNUAL	ALL	1				
84		635474.5	4976134	0.00079	2166.4	2844.3	0	ANNUAL	ALL	1				
85		635499.5	4976134	0.00078	2167.48	2844.3	0	ANNUAL	ALL	1				
86		635524.5	4976134	0.00076	2172.09	2844.3	0	ANNUAL	ALL	1				
87		635549.5	4976134	0.00077	2171.44	2844.3	0	ANNUAL	ALL	1				
88		635574.5	4976134	0.00076	2172.93	2844.3	0	ANNUAL	ALL	1				
89		635599.5	4976134	0.00074	2178.31	2844.3	0	ANNUAL	ALL	1				
90		635199.5	4976834	0.00085	2116.83	2844.3	0	ANNUAL	ALL	1				
91		635224.5	4976834	0.00088	2112.53	2844.3	0	ANNUAL	ALL	1				
92		635249.5	4976834	0.00091	2108.39	2844.3	0	ANNUAL	ALL	1				
93		635274.5	4976834	0.00094	2105.23	2844.3	0	ANNUAL	ALL	1				
94		635299.5	4976834	0.00098	2101.6	2844.3	0	ANNUAL	ALL	1				
95		635324.5	4976834	0.00101	2098.74	2844.3	0	ANNUAL	ALL	1				
96		635349.5	4976834	0.00096	2104.26	2844.3	0	ANNUAL	ALL	1				
97		635374.5	4976834	0.00091	2110.4	2844.3	0	ANNUAL	ALL	1				
98		635399.5	4976834	0.00086	2117.98	2844.3	0	ANNUAL	ALL	1				
99		635199.5	4976859	0.00085	2114.34	2844.3	0	ANNUAL	ALL	1				
100		635224.5	4976859	0.00089	2108.68	2844.3	0	ANNUAL	ALL	1				
101		635249.5	4976859	0.00093	2104.42	2844.3	0	ANNUAL	ALL	1				
102		635274.5	4976859	0.00096	2101.28	2844.3	0	ANNUAL	ALL	1				
103		635299.5	4976859	0.00099	2098.83	2844.3	0	ANNUAL	ALL	1				
104		635324.5	4976859	0.00101	2096.89	2844.3	0	ANNUAL	ALL	1				
105		635349.5	4976859	0.00097	2101.21	2844.3	0	ANNUAL	ALL	1				
106		635374.5	4976859	0.00091	2108.71	2844.3	0	ANNUAL	ALL	1				
107		635399.5	4976859	0.00084	2118.31	2844.3	0	ANNUAL	ALL	1				
108		635199.5	4976884	0.00086	2111.17	2844.3	0	ANNUAL	ALL	1				
109		635224.5	4976884	0.00091	2104.78	2844.3	0	ANNUAL	ALL	1				
110		635249.5	4976884	0.00095	2100.14	2844.3	0	ANNUAL	ALL	1				
111		635274.5	4976884	0.00098	2097.48	2844.3	0	ANNUAL	ALL	1				
112		635299.5	4976884	0.00101	2095.42	2844.3	0	ANNUAL	ALL	1				
113		635324.5	4976884	0.00101	2094.96	2844.3	0	ANNUAL	ALL	1				
114		635349.5	4976884	0.00099	2097.83	2844.3	0	ANNUAL	ALL	1				
115		635374.5	4976884	0.00091	2107.96	2844.3	0	ANNUAL	ALL	1				
116		635399.5	4976884	0.00083	2119.17	2844.3	0	ANNUAL	ALL	1				
117		635199.5	4976909	0.00086	2108.51	2844.3	0	ANNUAL	ALL	1				
118		635224.5	4976909	0.00092	2102.17	2844.3	0	ANNUAL	ALL	1				
119		635249.5	4976909	0.00096	2097.31	2844.3	0	ANNUAL	ALL	1				
120		635274.5	4976909	0.00099	2094.85	2844.3	0	ANNUAL	ALL	1				
121		635299.5	4976909	0.00101	2093.19	2844.3	0	ANNUAL	ALL	1				
122		635324.5	4976909	0.00101	2093.48	2844.3	0	ANNUAL	ALL	1				
123		635349.5	4976909	0.00097	2098.12	2844.3	0	ANNUAL	ALL	1				
124		635374.5	4976909	0.00089	2108.79	2844.3	0	ANNUAL	ALL	1				
125		635399.5	4976909	0.00081	2120.74	2844.3	0	ANNUAL	ALL	1				
126		635199.5	4976934	0.00086	2106.38	2844.3	0	ANNUAL	ALL	1				
127		635224.5	4976934	0.00091	2100.81	2844.3	0	ANNUAL	ALL	1				
128		635249.5	4976934	0.00096	2096.21	2844.3	0	ANNUAL	ALL	1				
129		635274.5	4976934	0.00099	2092.89	2844.3	0	ANNUAL	ALL	1				
130		635299.5	4976934	0.00102	2091.1	2844.3	0	ANNUAL	ALL	1				
131		635324.5	4976934	0.00101	2092.46	2844.3	0	ANNUAL	ALL	1				
132		635349.5	4976934	0.00095	2099.48	2844.3	0	ANNUAL	ALL	1				
133		635374.5	4976934	0.00086	2110.37	2844.3	0	ANNUAL	ALL	1				
134		635399.5	4976934	0.00079	2122.91	2844.3	0	ANNUAL	ALL	1				
135		635199.5	4976959	0.00086	2104.62	2844.3	0	ANNUAL	ALL	1				
136		635224.5	4976959	0.00091	2099.28	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
137		635249.5	4976959	0.00095	2094.41	2844.3	0	ANNUAL	ALL	1				
138		635274.5	4976959	0.001	2090.59	2844.3	0	ANNUAL	ALL	1				
139		635299.5	4976959	0.00102	2088.8	2844.3	0	ANNUAL	ALL	1				
140		635324.5	4976959	0.00099	2092.02	2844.3	0	ANNUAL	ALL	1				
141		635349.5	4976959	0.00093	2100.12	2844.3	0	ANNUAL	ALL	1				
142		635374.5	4976959	0.00084	2112.07	2844.3	0	ANNUAL	ALL	1				
143		635399.5	4976959	0.00076	2125.69	2844.3	0	ANNUAL	ALL	1				
144		635199.5	4976984	0.00086	2102.45	2844.3	0	ANNUAL	ALL	1				
145		635224.5	4976984	0.00091	2097.29	2844.3	0	ANNUAL	ALL	1				
146		635249.5	4976984	0.00096	2091.62	2844.3	0	ANNUAL	ALL	1				
147		635274.5	4976984	0.001	2087.92	2844.3	0	ANNUAL	ALL	1				
148		635299.5	4976984	0.00102	2086.81	2844.3	0	ANNUAL	ALL	1				
149		635324.5	4976984	0.00097	2092.65	2844.3	0	ANNUAL	ALL	1				
150		635349.5	4976984	0.0009	2101.3	2844.3	0	ANNUAL	ALL	1				
151		635374.5	4976984	0.00081	2114.13	2844.3	0	ANNUAL	ALL	1				
152		635399.5	4976984	0.00073	2128.46	2844.3	0	ANNUAL	ALL	1				
153		635199.5	4977009	0.00086	2099.39	2844.3	0	ANNUAL	ALL	1				
154		635224.5	4977009	0.00092	2093.66	2844.3	0	ANNUAL	ALL	1				
155		635249.5	4977009	0.00098	2087.97	2844.3	0	ANNUAL	ALL	1				
156		635274.5	4977009	0.00101	2084.9	2844.3	0	ANNUAL	ALL	1				
157		635299.5	4977009	0.001	2087.43	2844.3	0	ANNUAL	ALL	1				
158		635324.5	4977009	0.00094	2094.55	2844.3	0	ANNUAL	ALL	1				
159		635349.5	4977009	0.00087	2103.74	2844.3	0	ANNUAL	ALL	1				
160		635374.5	4977009	0.00078	2116.64	2844.3	0	ANNUAL	ALL	1				
161		635399.5	4977009	0.00071	2131.12	2844.3	0	ANNUAL	ALL	1				
162		635199.5	4977034	0.00088	2094.63	2844.3	0	ANNUAL	ALL	1				
163		635224.5	4977034	0.00094	2088.76	2844.3	0	ANNUAL	ALL	1				
164		635249.5	4977034	0.00099	2084.27	2844.3	0	ANNUAL	ALL	1				
165		635274.5	4977034	0.00101	2082.71	2844.3	0	ANNUAL	ALL	1				
166		635299.5	4977034	0.00095	2089.9	2844.3	0	ANNUAL	ALL	1				
167		635324.5	4977034	0.00089	2098.21	2844.3	0	ANNUAL	ALL	1				
168		635349.5	4977034	0.00082	2107.49	2844.3	0	ANNUAL	ALL	1				
169		635374.5	4977034	0.00076	2119.09	2844.3	0	ANNUAL	ALL	1				
170		635399.5	4977034	0.00069	2133.38	2844.3	0	ANNUAL	ALL	1				
171		634899.5	4977134	0.00039	2221.02	2844.3	0	ANNUAL	ALL	1				
172		634924.5	4977134	0.00041	2207.85	2844.3	0	ANNUAL	ALL	1				
173		634949.5	4977134	0.00043	2190.45	2844.3	0	ANNUAL	ALL	1				
174		634974.5	4977134	0.00047	2169.12	2844.3	0	ANNUAL	ALL	1				
175		634999.5	4977134	0.00051	2150.64	2844.3	0	ANNUAL	ALL	1				
176		635024.5	4977134	0.00056	2135.97	2844.3	0	ANNUAL	ALL	1				
177		635049.5	4977134	0.00061	2122.38	2844.3	0	ANNUAL	ALL	1				
178		635074.5	4977134	0.00065	2113.7	2844.3	0	ANNUAL	ALL	1				
179		635099.5	4977134	0.0007	2105.9	2844.3	0	ANNUAL	ALL	1				
180		634899.5	4977159	0.00039	2213.37	2844.3	0	ANNUAL	ALL	1				
181		634924.5	4977159	0.00041	2201.16	2844.3	0	ANNUAL	ALL	1				
182		634949.5	4977159	0.00044	2181.17	2844.3	0	ANNUAL	ALL	1				
183		634974.5	4977159	0.00047	2161.72	2844.3	0	ANNUAL	ALL	1				
184		634999.5	4977159	0.00051	2145.73	2844.3	0	ANNUAL	ALL	1				
185		635024.5	4977159	0.00056	2132.12	2844.3	0	ANNUAL	ALL	1				
186		635049.5	4977159	0.00061	2119.59	2844.3	0	ANNUAL	ALL	1				
187		635074.5	4977159	0.00066	2109.27	2844.3	0	ANNUAL	ALL	1				
188		635099.5	4977159	0.0007	2101.29	2844.3	0	ANNUAL	ALL	1				
189		634899.5	4977184	0.00039	2206.56	2844.3	0	ANNUAL	ALL	1				
190		634924.5	4977184	0.00041	2193.64	2844.3	0	ANNUAL	ALL	1				
191		634949.5	4977184	0.00044	2172.29	2844.3	0	ANNUAL	ALL	1				
192		634974.5	4977184	0.00048	2154.5	2844.3	0	ANNUAL	ALL	1				
193		634999.5	4977184	0.00051	2141.04	2844.3	0	ANNUAL	ALL	1				
194		635024.5	4977184	0.00055	2128.3	2844.3	0	ANNUAL	ALL	1				
195		635049.5	4977184	0.00061	2114.34	2844.3	0	ANNUAL	ALL	1				
196		635074.5	4977184	0.00067	2102.7	2844.3	0	ANNUAL	ALL	1				
197		635099.5	4977184	0.00071	2096.47	2844.3	0	ANNUAL	ALL	1				
198		634899.5	4977209	0.00039	2199.13	2844.3	0	ANNUAL	ALL	1				
199		634924.5	4977209	0.00041	2184.15	2844.3	0	ANNUAL	ALL	1				
200		634949.5	4977209	0.00044	2163.72	2844.3	0	ANNUAL	ALL	1				
201		634974.5	4977209	0.00048	2146.68	2844.3	0	ANNUAL	ALL	1				
202		634999.5	4977209	0.00051	2136.15	2844.3	0	ANNUAL	ALL	1				
203		635024.5	4977209	0.00055	2124.22	2844.3	0	ANNUAL	ALL	1				
204		635049.5	4977209	0.00063	2105.9	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
205		635074.5	4977209	0.00068	2096.39	2844.3	0	ANNUAL	ALL	1				
206		635099.5	4977209	0.00072	2091.31	2844.3	0	ANNUAL	ALL	1				
207		634899.5	4977234	0.0004	2185.16	2844.3	0	ANNUAL	ALL	1				
208		634924.5	4977234	0.00042	2172.04	2844.3	0	ANNUAL	ALL	1				
209		634949.5	4977234	0.00045	2152.41	2844.3	0	ANNUAL	ALL	1				
210		634974.5	4977234	0.00048	2139.97	2844.3	0	ANNUAL	ALL	1				
211		634999.5	4977234	0.00051	2130.73	2844.3	0	ANNUAL	ALL	1				
212		635024.5	4977234	0.00056	2117.31	2844.3	0	ANNUAL	ALL	1				
213		635049.5	4977234	0.00064	2098.65	2844.3	0	ANNUAL	ALL	1				
214		635074.5	4977234	0.00068	2092.39	2844.3	0	ANNUAL	ALL	1				
215		635099.5	4977234	0.00072	2087.32	2844.3	0	ANNUAL	ALL	1				
216		634899.5	4977259	0.00039	2180.4	2844.3	0	ANNUAL	ALL	1				
217		634924.5	4977259	0.00042	2160.19	2844.3	0	ANNUAL	ALL	1				
218		634949.5	4977259	0.00046	2143.3	2844.3	0	ANNUAL	ALL	1				
219		634974.5	4977259	0.00049	2132.11	2844.3	0	ANNUAL	ALL	1				
220		634999.5	4977259	0.00052	2123.02	2844.3	0	ANNUAL	ALL	1				
221		635024.5	4977259	0.00058	2107.09	2844.3	0	ANNUAL	ALL	1				
222		635049.5	4977259	0.00064	2095.35	2844.3	0	ANNUAL	ALL	1				
223		635074.5	4977259	0.00068	2089.07	2844.3	0	ANNUAL	ALL	1				
224		635099.5	4977259	0.00072	2083.6	2844.3	0	ANNUAL	ALL	1				
225		634899.5	4977284	0.00038	2180.69	2844.3	0	ANNUAL	ALL	1				
226		634924.5	4977284	0.00042	2158.28	2844.3	0	ANNUAL	ALL	1				
227		634949.5	4977284	0.00045	2139.34	2844.3	0	ANNUAL	ALL	1				
228		634974.5	4977284	0.0005	2123.05	2844.3	0	ANNUAL	ALL	1				
229		634999.5	4977284	0.00053	2112.91	2844.3	0	ANNUAL	ALL	1				
230		635024.5	4977284	0.00059	2100.55	2844.3	0	ANNUAL	ALL	1				
231		635049.5	4977284	0.00063	2092.76	2844.3	0	ANNUAL	ALL	1				
232		635074.5	4977284	0.00068	2085.71	2844.3	0	ANNUAL	ALL	1				
233		635099.5	4977284	0.00073	2078.67	2844.3	0	ANNUAL	ALL	1				
234		634899.5	4977309	0.00038	2178.55	2844.3	0	ANNUAL	ALL	1				
235		634924.5	4977309	0.00041	2156.77	2844.3	0	ANNUAL	ALL	1				
236		634949.5	4977309	0.00045	2136.54	2844.3	0	ANNUAL	ALL	1				
237		634974.5	4977309	0.00049	2119.59	2844.3	0	ANNUAL	ALL	1				
238		634999.5	4977309	0.00054	2107.01	2844.3	0	ANNUAL	ALL	1				
239		635024.5	4977309	0.00058	2096.52	2844.3	0	ANNUAL	ALL	1				
240		635049.5	4977309	0.00063	2089.24	2844.3	0	ANNUAL	ALL	1				
241		635074.5	4977309	0.00067	2082.55	2844.3	0	ANNUAL	ALL	1				
242		635099.5	4977309	0.00072	2075.98	2844.3	0	ANNUAL	ALL	1				
243		634899.5	4977334	0.00037	2173.18	2844.3	0	ANNUAL	ALL	1				
244		634924.5	4977334	0.0004	2153.29	2844.3	0	ANNUAL	ALL	1				
245		634949.5	4977334	0.00044	2133.9	2844.3	0	ANNUAL	ALL	1				
246		634974.5	4977334	0.00048	2117.58	2844.3	0	ANNUAL	ALL	1				
247		634999.5	4977334	0.00053	2104.03	2844.3	0	ANNUAL	ALL	1				
248		635024.5	4977334	0.00058	2093.8	2844.3	0	ANNUAL	ALL	1				
249		635049.5	4977334	0.00062	2085.23	2844.3	0	ANNUAL	ALL	1				
250		635074.5	4977334	0.00067	2078.76	2844.3	0	ANNUAL	ALL	1				
251		635099.5	4977334	0.00071	2074.53	2844.3	0	ANNUAL	ALL	1				
252		635399.5	4976159	0.00076	2171.27	2844.3	0	ANNUAL	ALL	1				
253		635424.5	4976159	0.00076	2169.98	2844.3	0	ANNUAL	ALL	1				
254		635449.5	4976159	0.00077	2167.61	2844.3	0	ANNUAL	ALL	1				
255		635474.5	4976159	0.00079	2164.06	2844.3	0	ANNUAL	ALL	1				
256		635499.5	4976159	0.00081	2161.76	2844.3	0	ANNUAL	ALL	1				
257		635524.5	4976159	0.00081	2160.48	2844.3	0	ANNUAL	ALL	1				
258		635549.5	4976159	0.00081	2162.19	2844.3	0	ANNUAL	ALL	1				
259		635574.5	4976159	0.00078	2168.15	2844.3	0	ANNUAL	ALL	1				
260		635599.5	4976159	0.00075	2173.85	2844.3	0	ANNUAL	ALL	1				
261		635399.5	4976184	0.00076	2168.06	2844.3	0	ANNUAL	ALL	1				
262		635424.5	4976184	0.00077	2166.17	2844.3	0	ANNUAL	ALL	1				
263		635449.5	4976184	0.00078	2163.95	2844.3	0	ANNUAL	ALL	1				
264		635474.5	4976184	0.0008	2161.05	2844.3	0	ANNUAL	ALL	1				
265		635499.5	4976184	0.00081	2158.86	2844.3	0	ANNUAL	ALL	1				
266		635524.5	4976184	0.00082	2157.1	2844.3	0	ANNUAL	ALL	1				
267		635549.5	4976184	0.00082	2157.07	2844.3	0	ANNUAL	ALL	1				
268		635574.5	4976184	0.00079	2164.59	2844.3	0	ANNUAL	ALL	1				
269		635599.5	4976184	0.00075	2172.06	2844.3	0	ANNUAL	ALL	1				
270		635399.5	4976209	0.00077	2165.29	2844.3	0	ANNUAL	ALL	1				
271		635424.5	4976209	0.00078	2163.14	2844.3	0	ANNUAL	ALL	1				
272		635449.5	4976209	0.00079	2160.76	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
273		635474.5	4976209	0.00081	2158.05	2844.3	0	ANNUAL	ALL	1				
274		635499.5	4976209	0.00082	2155.43	2844.3	0	ANNUAL	ALL	1				
275		635524.5	4976209	0.00083	2153.57	2844.3	0	ANNUAL	ALL	1				
276		635549.5	4976209	0.00082	2156.02	2844.3	0	ANNUAL	ALL	1				
277		635574.5	4976209	0.00078	2165.26	2844.3	0	ANNUAL	ALL	1				
278		635599.5	4976209	0.00073	2175.01	2844.3	0	ANNUAL	ALL	1				
279		635399.5	4976234	0.00077	2162.56	2844.3	0	ANNUAL	ALL	1				
280		635424.5	4976234	0.00079	2160.46	2844.3	0	ANNUAL	ALL	1				
281		635449.5	4976234	0.0008	2157.93	2844.3	0	ANNUAL	ALL	1				
282		635474.5	4976234	0.00081	2155.5	2844.3	0	ANNUAL	ALL	1				
283		635499.5	4976234	0.00083	2152.67	2844.3	0	ANNUAL	ALL	1				
284		635524.5	4976234	0.00084	2150.12	2844.3	0	ANNUAL	ALL	1				
285		635549.5	4976234	0.00081	2156.6	2844.3	0	ANNUAL	ALL	1				
286		635574.5	4976234	0.00076	2167.62	2844.3	0	ANNUAL	ALL	1				
287		635599.5	4976234	0.00071	2178.35	2844.3	0	ANNUAL	ALL	1				
288		634999.5	4978134	0.00028	2044.53	2844.3	0	ANNUAL	ALL	1				
289		635024.5	4978134	0.00029	2030.56	2844.3	0	ANNUAL	ALL	1				
290		635049.5	4978134	0.00031	2018.07	2844.3	0	ANNUAL	ALL	1				
291		635074.5	4978134	0.00032	2006.69	2844.3	0	ANNUAL	ALL	1				
292		635099.5	4978134	0.00033	2006.39	2844.3	0	ANNUAL	ALL	1				
293		635124.5	4978134	0.00033	2013.34	2844.3	0	ANNUAL	ALL	1				
294		635149.5	4978134	0.00033	2020.75	2844.3	0	ANNUAL	ALL	1				
295		635174.5	4978134	0.00032	2029.05	2844.3	0	ANNUAL	ALL	1				
296		635199.5	4978134	0.00032	2038.91	2844.3	0	ANNUAL	ALL	1				
297		634999.5	4978159	0.00027	2044.5	2844.3	0	ANNUAL	ALL	1				
298		635024.5	4978159	0.00029	2030.78	2844.3	0	ANNUAL	ALL	1				
299		635049.5	4978159	0.0003	2017.35	2844.3	0	ANNUAL	ALL	1				
300		635074.5	4978159	0.00031	2004.54	2844.3	0	ANNUAL	ALL	1				
301		635099.5	4978159	0.00032	2003.81	2844.3	0	ANNUAL	ALL	1				
302		635124.5	4978159	0.00032	2010.57	2844.3	0	ANNUAL	ALL	1				
303		635149.5	4978159	0.00032	2017.75	2844.3	0	ANNUAL	ALL	1				
304		635174.5	4978159	0.00032	2025.18	2844.3	0	ANNUAL	ALL	1				
305		635199.5	4978159	0.00031	2035.11	2844.3	0	ANNUAL	ALL	1				
306		634999.5	4978184	0.00026	2044.38	2844.3	0	ANNUAL	ALL	1				
307		635024.5	4978184	0.00028	2028.98	2844.3	0	ANNUAL	ALL	1				
308		635049.5	4978184	0.00029	2015.36	2844.3	0	ANNUAL	ALL	1				
309		635074.5	4978184	0.00031	2002.43	2844.3	0	ANNUAL	ALL	1				
310		635099.5	4978184	0.00031	2000.86	2844.3	0	ANNUAL	ALL	1				
311		635124.5	4978184	0.00031	2007.53	2844.3	0	ANNUAL	ALL	1				
312		635149.5	4978184	0.00031	2014.6	2844.3	0	ANNUAL	ALL	1				
313		635174.5	4978184	0.00031	2022.07	2844.3	0	ANNUAL	ALL	1				
314		635199.5	4978184	0.00031	2031.45	2844.3	0	ANNUAL	ALL	1				
315		634999.5	4978209	0.00026	2043.46	2844.3	0	ANNUAL	ALL	1				
316		635024.5	4978209	0.00028	2027.94	2844.3	0	ANNUAL	ALL	1				
317		635049.5	4978209	0.00029	2013.73	2844.3	0	ANNUAL	ALL	1				
318		635074.5	4978209	0.0003	2000.96	2844.3	0	ANNUAL	ALL	1				
319		635099.5	4978209	0.00031	1998.75	2844.3	0	ANNUAL	ALL	1				
320		635124.5	4978209	0.00031	2004.56	2844.3	0	ANNUAL	ALL	1				
321		635149.5	4978209	0.00031	2011.78	2844.3	0	ANNUAL	ALL	1				
322		635174.5	4978209	0.00031	2019.36	2844.3	0	ANNUAL	ALL	1				
323		635199.5	4978209	0.0003	2027.82	2844.3	0	ANNUAL	ALL	1				
324		634999.5	4978234	0.00025	2042.97	2844.3	0	ANNUAL	ALL	1				
325		635024.5	4978234	0.00027	2026.61	2844.3	0	ANNUAL	ALL	1				
326		635049.5	4978234	0.00028	2012.57	2844.3	0	ANNUAL	ALL	1				
327		635074.5	4978234	0.0003	2000.24	2844.3	0	ANNUAL	ALL	1				
328		635099.5	4978234	0.00031	1996.61	2844.3	0	ANNUAL	ALL	1				
329		635124.5	4978234	0.0003	2001.65	2844.3	0	ANNUAL	ALL	1				
330		635149.5	4978234	0.0003	2009.16	2844.3	0	ANNUAL	ALL	1				
331		635174.5	4978234	0.0003	2016.86	2844.3	0	ANNUAL	ALL	1				
332		635199.5	4978234	0.0003	2024.48	2844.3	0	ANNUAL	ALL	1				
333		634999.5	4978259	0.00025	2041.08	2844.3	0	ANNUAL	ALL	1				
334		635024.5	4978259	0.00027	2024.08	2844.3	0	ANNUAL	ALL	1				
335		635049.5	4978259	0.00028	2011.49	2844.3	0	ANNUAL	ALL	1				
336		635074.5	4978259	0.00029	2000.61	2844.3	0	ANNUAL	ALL	1				
337		635099.5	4978259	0.0003	1994.84	2844.3	0	ANNUAL	ALL	1				
338		635124.5	4978259	0.0003	1999.29	2844.3	0	ANNUAL	ALL	1				
339		635149.5	4978259	0.00029	2007.14	2844.3	0	ANNUAL	ALL	1				
340		635174.5	4978259	0.00029	2014.96	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
341		635199.5	4978259	0.00029	2023.44	2844.3	0	ANNUAL	ALL	1				
342		634999.5	4978284	0.00025	2039.02	2844.3	0	ANNUAL	ALL	1				
343		635024.5	4978284	0.00026	2022.69	2844.3	0	ANNUAL	ALL	1				
344		635049.5	4978284	0.00027	2010.11	2844.3	0	ANNUAL	ALL	1				
345		635074.5	4978284	0.00028	1999.28	2844.3	0	ANNUAL	ALL	1				
346		635099.5	4978284	0.0003	1993.94	2844.3	0	ANNUAL	ALL	1				
347		635124.5	4978284	0.0003	1996.86	2844.3	0	ANNUAL	ALL	1				
348		635149.5	4978284	0.00029	2004.78	2844.3	0	ANNUAL	ALL	1				
349		635174.5	4978284	0.00029	2012.7	2844.3	0	ANNUAL	ALL	1				
350		635199.5	4978284	0.00029	2021.78	2844.3	0	ANNUAL	ALL	1				
351		634999.5	4978309	0.00024	2036.72	2844.3	0	ANNUAL	ALL	1				
352		635024.5	4978309	0.00026	2023.32	2844.3	0	ANNUAL	ALL	1				
353		635049.5	4978309	0.00026	2010.1	2844.3	0	ANNUAL	ALL	1				
354		635074.5	4978309	0.00028	1999.36	2844.3	0	ANNUAL	ALL	1				
355		635099.5	4978309	0.00029	1992.81	2844.3	0	ANNUAL	ALL	1				
356		635124.5	4978309	0.00029	1994.13	2844.3	0	ANNUAL	ALL	1				
357		635149.5	4978309	0.00028	2001.68	2844.3	0	ANNUAL	ALL	1				
358		635174.5	4978309	0.00028	2009.75	2844.3	0	ANNUAL	ALL	1				
359		635199.5	4978309	0.00028	2018.84	2844.3	0	ANNUAL	ALL	1				
360		634999.5	4978334	0.00024	2033.58	2844.3	0	ANNUAL	ALL	1				
361		635024.5	4978334	0.00025	2021.76	2844.3	0	ANNUAL	ALL	1				
362		635049.5	4978334	0.00026	2009.59	2844.3	0	ANNUAL	ALL	1				
363		635074.5	4978334	0.00027	1999.33	2844.3	0	ANNUAL	ALL	1				
364		635099.5	4978334	0.00028	1991.74	2844.3	0	ANNUAL	ALL	1				
365		635124.5	4978334	0.00029	1991.62	2844.3	0	ANNUAL	ALL	1				
366		635149.5	4978334	0.00028	1998.49	2844.3	0	ANNUAL	ALL	1				
367		635174.5	4978334	0.00028	2006.18	2844.3	0	ANNUAL	ALL	1				
368		635199.5	4978334	0.00028	2015.32	2844.3	0	ANNUAL	ALL	1				
369		634299.5	4978134	0.00021	2065.05	2844.3	0	ANNUAL	ALL	1				
370		634324.5	4978134	0.00022	2052.1	2844.3	0	ANNUAL	ALL	1				
371		634349.5	4978134	0.00023	2045.24	2844.3	0	ANNUAL	ALL	1				
372		634374.5	4978134	0.00023	2034.94	2844.3	0	ANNUAL	ALL	1				
373		634399.5	4978134	0.00024	2020.36	2844.3	0	ANNUAL	ALL	1				
374		634424.5	4978134	0.00024	2003.67	2844.3	0	ANNUAL	ALL	1				
375		634449.5	4978134	0.00026	1995.29	2844.3	0	ANNUAL	ALL	1				
376		634474.5	4978134	0.00025	2007.74	2844.3	0	ANNUAL	ALL	1				
377		634499.5	4978134	0.00024	2026.56	2844.3	0	ANNUAL	ALL	1				
378		634299.5	4978159	0.00021	2056.37	2844.3	0	ANNUAL	ALL	1				
379		634324.5	4978159	0.00022	2043.39	2844.3	0	ANNUAL	ALL	1				
380		634349.5	4978159	0.00023	2031.51	2844.3	0	ANNUAL	ALL	1				
381		634374.5	4978159	0.00023	2023.05	2844.3	0	ANNUAL	ALL	1				
382		634399.5	4978159	0.00024	2009.29	2844.3	0	ANNUAL	ALL	1				
383		634424.5	4978159	0.00025	1995	2844.3	0	ANNUAL	ALL	1				
384		634449.5	4978159	0.00026	1992.7	2844.3	0	ANNUAL	ALL	1				
385		634474.5	4978159	0.00024	2006.88	2844.3	0	ANNUAL	ALL	1				
386		634499.5	4978159	0.00024	2023.97	2844.3	0	ANNUAL	ALL	1				
387		634299.5	4978184	0.00021	2049.3	2844.3	0	ANNUAL	ALL	1				
388		634324.5	4978184	0.00022	2036.32	2844.3	0	ANNUAL	ALL	1				
389		634349.5	4978184	0.00023	2022.34	2844.3	0	ANNUAL	ALL	1				
390		634374.5	4978184	0.00023	2009.09	2844.3	0	ANNUAL	ALL	1				
391		634399.5	4978184	0.00024	1999.89	2844.3	0	ANNUAL	ALL	1				
392		634424.5	4978184	0.00025	1987.52	2844.3	0	ANNUAL	ALL	1				
393		634449.5	4978184	0.00025	1991.46	2844.3	0	ANNUAL	ALL	1				
394		634474.5	4978184	0.00024	2006.06	2844.3	0	ANNUAL	ALL	1				
395		634499.5	4978184	0.00024	2020.38	2844.3	0	ANNUAL	ALL	1				
396		634299.5	4978209	0.00021	2043.21	2844.3	0	ANNUAL	ALL	1				
397		634324.5	4978209	0.00022	2030.6	2844.3	0	ANNUAL	ALL	1				
398		634349.5	4978209	0.00023	2016.03	2844.3	0	ANNUAL	ALL	1				
399		634374.5	4978209	0.00023	2000.87	2844.3	0	ANNUAL	ALL	1				
400		634399.5	4978209	0.00024	1990.53	2844.3	0	ANNUAL	ALL	1				
401		634424.5	4978209	0.00026	1981.32	2844.3	0	ANNUAL	ALL	1				
402		634449.5	4978209	0.00025	1989.45	2844.3	0	ANNUAL	ALL	1				
403		634474.5	4978209	0.00024	2004.01	2844.3	0	ANNUAL	ALL	1				
404		634499.5	4978209	0.00023	2016.91	2844.3	0	ANNUAL	ALL	1				
405		634299.5	4978234	0.00021	2037.27	2844.3	0	ANNUAL	ALL	1				
406		634324.5	4978234	0.00022	2025.09	2844.3	0	ANNUAL	ALL	1				
407		634349.5	4978234	0.00022	2009.81	2844.3	0	ANNUAL	ALL	1				
408		634374.5	4978234	0.00024	1996.13	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
409		634399.5	4978234	0.00025	1984.05	2844.3	0	ANNUAL	ALL	1				
410		634424.5	4978234	0.00026	1975.87	2844.3	0	ANNUAL	ALL	1				
411		634449.5	4978234	0.00025	1984.97	2844.3	0	ANNUAL	ALL	1				
412		634474.5	4978234	0.00023	2000.36	2844.3	0	ANNUAL	ALL	1				
413		634499.5	4978234	0.00023	2011.73	2844.3	0	ANNUAL	ALL	1				
414		634299.5	4978259	0.00021	2030.97	2844.3	0	ANNUAL	ALL	1				
415		634324.5	4978259	0.00022	2018.02	2844.3	0	ANNUAL	ALL	1				
416		634349.5	4978259	0.00022	2002.99	2844.3	0	ANNUAL	ALL	1				
417		634374.5	4978259	0.00024	1990.41	2844.3	0	ANNUAL	ALL	1				
418		634399.5	4978259	0.00025	1978.88	2844.3	0	ANNUAL	ALL	1				
419		634424.5	4978259	0.00026	1972.17	2844.3	0	ANNUAL	ALL	1				
420		634449.5	4978259	0.00026	1977.85	2844.3	0	ANNUAL	ALL	1				
421		634474.5	4978259	0.00024	1992.52	2844.3	0	ANNUAL	ALL	1				
422		634499.5	4978259	0.00023	2003.44	2844.3	0	ANNUAL	ALL	1				
423		634299.5	4978284	0.00021	2023.26	2844.3	0	ANNUAL	ALL	1				
424		634324.5	4978284	0.00021	2008.98	2844.3	0	ANNUAL	ALL	1				
425		634349.5	4978284	0.00023	1996.31	2844.3	0	ANNUAL	ALL	1				
426		634374.5	4978284	0.00024	1984.2	2844.3	0	ANNUAL	ALL	1				
427		634399.5	4978284	0.00025	1973.37	2844.3	0	ANNUAL	ALL	1				
428		634424.5	4978284	0.00025	1969.23	2844.3	0	ANNUAL	ALL	1				
429		634449.5	4978284	0.00025	1975.58	2844.3	0	ANNUAL	ALL	1				
430		634474.5	4978284	0.00024	1989.07	2844.3	0	ANNUAL	ALL	1				
431		634499.5	4978284	0.00023	2000.53	2844.3	0	ANNUAL	ALL	1				
432		634299.5	4978309	0.00021	2012.41	2844.3	0	ANNUAL	ALL	1				
433		634324.5	4978309	0.00022	1999.74	2844.3	0	ANNUAL	ALL	1				
434		634349.5	4978309	0.00023	1988.62	2844.3	0	ANNUAL	ALL	1				
435		634374.5	4978309	0.00024	1977.79	2844.3	0	ANNUAL	ALL	1				
436		634399.5	4978309	0.00025	1967.1	2844.3	0	ANNUAL	ALL	1				
437		634424.5	4978309	0.00025	1968.14	2844.3	0	ANNUAL	ALL	1				
438		634449.5	4978309	0.00025	1977.66	2844.3	0	ANNUAL	ALL	1				
439		634474.5	4978309	0.00023	1992.31	2844.3	0	ANNUAL	ALL	1				
440		634499.5	4978309	0.00022	2006.23	2844.3	0	ANNUAL	ALL	1				
441		634299.5	4978334	0.00021	2000.94	2844.3	0	ANNUAL	ALL	1				
442		634324.5	4978334	0.00022	1991.1	2844.3	0	ANNUAL	ALL	1				
443		634349.5	4978334	0.00024	1980.66	2844.3	0	ANNUAL	ALL	1				
444		634374.5	4978334	0.00024	1970.39	2844.3	0	ANNUAL	ALL	1				
445		634399.5	4978334	0.00025	1961.38	2844.3	0	ANNUAL	ALL	1				
446		634424.5	4978334	0.00025	1968.29	2844.3	0	ANNUAL	ALL	1				
447		634449.5	4978334	0.00024	1980.95	2844.3	0	ANNUAL	ALL	1				
448		634474.5	4978334	0.00023	1997.36	2844.3	0	ANNUAL	ALL	1				
449		634499.5	4978334	0.00022	2012.52	2844.3	0	ANNUAL	ALL	1				
450		634299.5	4978359	0.00022	1991.4	2844.3	0	ANNUAL	ALL	1				
451		634324.5	4978359	0.00023	1982.72	2844.3	0	ANNUAL	ALL	1				
452		634349.5	4978359	0.00024	1972.75	2844.3	0	ANNUAL	ALL	1				
453		634374.5	4978359	0.00025	1962.87	2844.3	0	ANNUAL	ALL	1				
454		634399.5	4978359	0.00025	1958.17	2844.3	0	ANNUAL	ALL	1				
455		634424.5	4978359	0.00024	1968.79	2844.3	0	ANNUAL	ALL	1				
456		634449.5	4978359	0.00024	1984.24	2844.3	0	ANNUAL	ALL	1				
457		634474.5	4978359	0.00021	2002.2	2844.3	0	ANNUAL	ALL	1				
458		634499.5	4978359	0.00021	2016.76	2844.3	0	ANNUAL	ALL	1				
459		634299.5	4978384	0.00023	1982.57	2844.3	0	ANNUAL	ALL	1				
460		634324.5	4978384	0.00023	1975.68	2844.3	0	ANNUAL	ALL	1				
461		634349.5	4978384	0.00024	1964.84	2844.3	0	ANNUAL	ALL	1				
462		634374.5	4978384	0.00025	1956.29	2844.3	0	ANNUAL	ALL	1				
463		634399.5	4978384	0.00025	1955.61	2844.3	0	ANNUAL	ALL	1				
464		634424.5	4978384	0.00024	1968.65	2844.3	0	ANNUAL	ALL	1				
465		634449.5	4978384	0.00023	1986.09	2844.3	0	ANNUAL	ALL	1				
466		634474.5	4978384	0.00021	2004.63	2844.3	0	ANNUAL	ALL	1				
467		634499.5	4978384	0.00021	2018.69	2844.3	0	ANNUAL	ALL	1				
468		634299.5	4978409	0.00023	1975.4	2844.3	0	ANNUAL	ALL	1				
469		634324.5	4978409	0.00023	1967.52	2844.3	0	ANNUAL	ALL	1				
470		634349.5	4978409	0.00024	1957.04	2844.3	0	ANNUAL	ALL	1				
471		634374.5	4978409	0.00025	1949.69	2844.3	0	ANNUAL	ALL	1				
472		634399.5	4978409	0.00025	1951.43	2844.3	0	ANNUAL	ALL	1				
473		634424.5	4978409	0.00024	1967.3	2844.3	0	ANNUAL	ALL	1				
474		634449.5	4978409	0.00022	1986.39	2844.3	0	ANNUAL	ALL	1				
475		634474.5	4978409	0.00021	2005.28	2844.3	0	ANNUAL	ALL	1				
476		634499.5	4978409	0.00021	2019.28	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
477		634299.5	4978434	0.00023	1965.22	2844.3	0	ANNUAL	ALL	1				
478		634324.5	4978434	0.00024	1958.88	2844.3	0	ANNUAL	ALL	1				
479		634349.5	4978434	0.00024	1950.79	2844.3	0	ANNUAL	ALL	1				
480		634374.5	4978434	0.00024	1943.73	2844.3	0	ANNUAL	ALL	1				
481		634399.5	4978434	0.00024	1949.4	2844.3	0	ANNUAL	ALL	1				
482		634424.5	4978434	0.00024	1965.04	2844.3	0	ANNUAL	ALL	1				
483		634449.5	4978434	0.00022	1984.59	2844.3	0	ANNUAL	ALL	1				
484		634474.5	4978434	0.0002	2004.45	2844.3	0	ANNUAL	ALL	1				
485		634499.5	4978434	0.0002	2017.53	2844.3	0	ANNUAL	ALL	1				
486		634249.4	4977384	0.00023	2291.4	2717.08	0	ANNUAL	ALL	1				
487		634274.4	4977384	0.00023	2282.65	2742	0	ANNUAL	ALL	1				
488		634299.4	4977384	0.00024	2273.71	2742	0	ANNUAL	ALL	1				
489		634324.4	4977384	0.00024	2263.84	2742	0	ANNUAL	ALL	1				
490		634349.4	4977384	0.00025	2250.84	2742	0	ANNUAL	ALL	1				
491		634374.4	4977384	0.00026	2238.58	2742.16	0	ANNUAL	ALL	1				
492		634399.4	4977384	0.00026	2232.43	2742.16	0	ANNUAL	ALL	1				
493		634424.4	4977384	0.00026	2242.73	2742.16	0	ANNUAL	ALL	1				
494		634449.4	4977384	0.00026	2255.36	2742	0	ANNUAL	ALL	1				
495		634249.4	4977409	0.00023	2284.43	2742	0	ANNUAL	ALL	1				
496		634274.4	4977409	0.00023	2274.53	2742	0	ANNUAL	ALL	1				
497		634299.4	4977409	0.00024	2264.56	2742	0	ANNUAL	ALL	1				
498		634324.4	4977409	0.00024	2254.44	2742	0	ANNUAL	ALL	1				
499		634349.4	4977409	0.00025	2243.93	2742.16	0	ANNUAL	ALL	1				
500		634374.4	4977409	0.00025	2231.37	2742.16	0	ANNUAL	ALL	1				
501		634399.4	4977409	0.00026	2226.02	2844.3	0	ANNUAL	ALL	1				
502		634424.4	4977409	0.00026	2236.92	2742.16	0	ANNUAL	ALL	1				
503		634449.4	4977409	0.00025	2249.43	2742.16	0	ANNUAL	ALL	1				
504		634249.4	4977434	0.00022	2279.34	2742	0	ANNUAL	ALL	1				
505		634274.4	4977434	0.00023	2267.65	2742	0	ANNUAL	ALL	1				
506		634299.4	4977434	0.00023	2255.85	2742	0	ANNUAL	ALL	1				
507		634324.4	4977434	0.00024	2244.86	2742	0	ANNUAL	ALL	1				
508		634349.4	4977434	0.00024	2234.48	2742.16	0	ANNUAL	ALL	1				
509		634374.4	4977434	0.00025	2223.18	2844.3	0	ANNUAL	ALL	1				
510		634399.4	4977434	0.00025	2218.5	2844.3	0	ANNUAL	ALL	1				
511		634424.4	4977434	0.00025	2230.27	2844.3	0	ANNUAL	ALL	1				
512		634449.4	4977434	0.00025	2243.66	2742.16	0	ANNUAL	ALL	1				
513		634249.4	4977459	0.00022	2275.78	2742	0	ANNUAL	ALL	1				
514		634274.4	4977459	0.00022	2262.83	2742	0	ANNUAL	ALL	1				
515		634299.4	4977459	0.00023	2248.74	2742	0	ANNUAL	ALL	1				
516		634324.4	4977459	0.00024	2237.43	2742.16	0	ANNUAL	ALL	1				
517		634349.4	4977459	0.00024	2226.72	2844.3	0	ANNUAL	ALL	1				
518		634374.4	4977459	0.00025	2214.97	2844.3	0	ANNUAL	ALL	1				
519		634399.4	4977459	0.00025	2211.75	2844.3	0	ANNUAL	ALL	1				
520		634424.4	4977459	0.00025	2223.34	2844.3	0	ANNUAL	ALL	1				
521		634449.4	4977459	0.00025	2237.29	2844.3	0	ANNUAL	ALL	1				
522		634249.4	4977484	0.00021	2272.5	2742	0	ANNUAL	ALL	1				
523		634274.4	4977484	0.00022	2258.48	2742	0	ANNUAL	ALL	1				
524		634299.4	4977484	0.00023	2243.77	2742	0	ANNUAL	ALL	1				
525		634324.4	4977484	0.00023	2231.45	2742.16	0	ANNUAL	ALL	1				
526		634349.4	4977484	0.00024	2219.9	2844.3	0	ANNUAL	ALL	1				
527		634374.4	4977484	0.00025	2207.94	2844.3	0	ANNUAL	ALL	1				
528		634399.4	4977484	0.00025	2204.62	2844.3	0	ANNUAL	ALL	1				
529		634424.4	4977484	0.00025	2216.76	2844.3	0	ANNUAL	ALL	1				
530		634449.4	4977484	0.00025	2230.33	2844.3	0	ANNUAL	ALL	1				
531		634249.4	4977509	0.00021	2269.17	2742	0	ANNUAL	ALL	1				
532		634274.4	4977509	0.00022	2254.88	2742	0	ANNUAL	ALL	1				
533		634299.4	4977509	0.00022	2240.59	2742	0	ANNUAL	ALL	1				
534		634324.4	4977509	0.00023	2227.32	2844.3	0	ANNUAL	ALL	1				
535		634349.4	4977509	0.00024	2213.19	2844.3	0	ANNUAL	ALL	1				
536		634374.4	4977509	0.00024	2200.19	2844.3	0	ANNUAL	ALL	1				
537		634399.4	4977509	0.00025	2197.61	2844.3	0	ANNUAL	ALL	1				
538		634424.4	4977509	0.00024	2211.03	2844.3	0	ANNUAL	ALL	1				
539		634449.4	4977509	0.00024	2223.57	2844.3	0	ANNUAL	ALL	1				
540		634249.4	4977534	0.00021	2266.65	2742	0	ANNUAL	ALL	1				
541		634274.4	4977534	0.00021	2251.58	2742	0	ANNUAL	ALL	1				
542		634299.4	4977534	0.00022	2237.18	2742	0	ANNUAL	ALL	1				
543		634324.4	4977534	0.00023	2223.67	2844.3	0	ANNUAL	ALL	1				
544		634349.4	4977534	0.00023	2207.86	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
545		634374.4	4977534	0.00024	2193.38	2844.3	0	ANNUAL	ALL	1				
546		634399.4	4977534	0.00024	2191.95	2844.3	0	ANNUAL	ALL	1				
547		634424.4	4977534	0.00024	2205.88	2844.3	0	ANNUAL	ALL	1				
548		634449.4	4977534	0.00024	2217.63	2844.3	0	ANNUAL	ALL	1				
549		634249.4	4977559	0.0002	2264.12	2742	0	ANNUAL	ALL	1				
550		634274.4	4977559	0.00021	2247.26	2742	0	ANNUAL	ALL	1				
551		634299.4	4977559	0.00022	2232.74	2742	0	ANNUAL	ALL	1				
552		634324.4	4977559	0.00022	2218.55	2844.3	0	ANNUAL	ALL	1				
553		634349.4	4977559	0.00023	2203.35	2844.3	0	ANNUAL	ALL	1				
554		634374.4	4977559	0.00024	2189.62	2844.3	0	ANNUAL	ALL	1				
555		634399.4	4977559	0.00024	2184.96	2844.3	0	ANNUAL	ALL	1				
556		634424.4	4977559	0.00024	2200.77	2844.3	0	ANNUAL	ALL	1				
557		634449.4	4977559	0.00024	2211.07	2844.3	0	ANNUAL	ALL	1				
558		634249.4	4977584	0.0002	2258.01	2742	0	ANNUAL	ALL	1				
559		634274.4	4977584	0.00021	2242.66	2742	0	ANNUAL	ALL	1				
560		634299.4	4977584	0.00021	2227.67	2844.3	0	ANNUAL	ALL	1				
561		634324.4	4977584	0.00022	2213.51	2844.3	0	ANNUAL	ALL	1				
562		634349.4	4977584	0.00023	2199.5	2844.3	0	ANNUAL	ALL	1				
563		634374.4	4977584	0.00023	2185.33	2844.3	0	ANNUAL	ALL	1				
564		634399.4	4977584	0.00024	2177.11	2844.3	0	ANNUAL	ALL	1				
565		634424.4	4977584	0.00024	2192.43	2844.3	0	ANNUAL	ALL	1				
566		634449.4	4977584	0.00023	2203.16	2844.3	0	ANNUAL	ALL	1				
567		634999.5	4977834	0.00037	2055.79	2844.3	0	ANNUAL	ALL	1				
568		635024.5	4977834	0.00039	2048.42	2844.3	0	ANNUAL	ALL	1				
569		635049.5	4977834	0.00041	2043	2844.3	0	ANNUAL	ALL	1				
570		635074.5	4977834	0.00043	2037.93	2844.3	0	ANNUAL	ALL	1				
571		635099.5	4977834	0.00044	2034.24	2844.3	0	ANNUAL	ALL	1				
572		635124.5	4977834	0.00046	2031.45	2844.3	0	ANNUAL	ALL	1				
573		635149.5	4977834	0.00045	2038.5	2844.3	0	ANNUAL	ALL	1				
574		635174.5	4977834	0.00043	2050.35	2844.3	0	ANNUAL	ALL	1				
575		635199.5	4977834	0.00041	2063.26	2844.3	0	ANNUAL	ALL	1				
576		634999.5	4977859	0.00036	2052.63	2844.3	0	ANNUAL	ALL	1				
577		635024.5	4977859	0.00038	2046.41	2844.3	0	ANNUAL	ALL	1				
578		635049.5	4977859	0.0004	2040.95	2844.3	0	ANNUAL	ALL	1				
579		635074.5	4977859	0.00042	2036.03	2844.3	0	ANNUAL	ALL	1				
580		635099.5	4977859	0.00043	2032.3	2844.3	0	ANNUAL	ALL	1				
581		635124.5	4977859	0.00044	2030.17	2844.3	0	ANNUAL	ALL	1				
582		635149.5	4977859	0.00044	2038.33	2844.3	0	ANNUAL	ALL	1				
583		635174.5	4977859	0.00042	2049.93	2844.3	0	ANNUAL	ALL	1				
584		635199.5	4977859	0.0004	2062.54	2844.3	0	ANNUAL	ALL	1				
585		634999.5	4977884	0.00036	2049.11	2844.3	0	ANNUAL	ALL	1				
586		635024.5	4977884	0.00037	2044.13	2844.3	0	ANNUAL	ALL	1				
587		635049.5	4977884	0.00039	2038.92	2844.3	0	ANNUAL	ALL	1				
588		635074.5	4977884	0.00041	2034.26	2844.3	0	ANNUAL	ALL	1				
589		635099.5	4977884	0.00042	2030.48	2844.3	0	ANNUAL	ALL	1				
590		635124.5	4977884	0.00043	2029.04	2844.3	0	ANNUAL	ALL	1				
591		635149.5	4977884	0.00042	2038.45	2844.3	0	ANNUAL	ALL	1				
592		635174.5	4977884	0.00041	2049.51	2844.3	0	ANNUAL	ALL	1				
593		635199.5	4977884	0.00039	2061.56	2844.3	0	ANNUAL	ALL	1				
594		634999.5	4977909	0.00035	2047.27	2844.3	0	ANNUAL	ALL	1				
595		635024.5	4977909	0.00036	2042.16	2844.3	0	ANNUAL	ALL	1				
596		635049.5	4977909	0.00038	2036.97	2844.3	0	ANNUAL	ALL	1				
597		635074.5	4977909	0.00039	2032.48	2844.3	0	ANNUAL	ALL	1				
598		635099.5	4977909	0.00041	2028.7	2844.3	0	ANNUAL	ALL	1				
599		635124.5	4977909	0.00042	2028.77	2844.3	0	ANNUAL	ALL	1				
600		635149.5	4977909	0.00041	2038.62	2844.3	0	ANNUAL	ALL	1				
601		635174.5	4977909	0.00039	2049.12	2844.3	0	ANNUAL	ALL	1				
602		635199.5	4977909	0.00038	2060.48	2844.3	0	ANNUAL	ALL	1				
603		634999.5	4977934	0.00034	2046.79	2844.3	0	ANNUAL	ALL	1				
604		635024.5	4977934	0.00035	2040.92	2844.3	0	ANNUAL	ALL	1				
605		635049.5	4977934	0.00037	2034.68	2844.3	0	ANNUAL	ALL	1				
606		635074.5	4977934	0.00039	2029.58	2844.3	0	ANNUAL	ALL	1				
607		635099.5	4977934	0.0004	2025.61	2844.3	0	ANNUAL	ALL	1				
608		635124.5	4977934	0.0004	2027.68	2844.3	0	ANNUAL	ALL	1				
609		635149.5	4977934	0.00039	2038.09	2844.3	0	ANNUAL	ALL	1				
610		635174.5	4977934	0.00038	2048.68	2844.3	0	ANNUAL	ALL	1				
611		635199.5	4977934	0.00037	2059.02	2844.3	0	ANNUAL	ALL	1				
612		634999.5	4977959	0.00033	2045.95	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
613		635024.5	4977959	0.00035	2039.51	2844.3	0	ANNUAL	ALL	1				
614		635049.5	4977959	0.00036	2032.45	2844.3	0	ANNUAL	ALL	1				
615		635074.5	4977959	0.00038	2026.52	2844.3	0	ANNUAL	ALL	1				
616		635099.5	4977959	0.00039	2022.6	2844.3	0	ANNUAL	ALL	1				
617		635124.5	4977959	0.00039	2027.13	2844.3	0	ANNUAL	ALL	1				
618		635149.5	4977959	0.00038	2036.89	2844.3	0	ANNUAL	ALL	1				
619		635174.5	4977959	0.00037	2046.85	2844.3	0	ANNUAL	ALL	1				
620		635199.5	4977959	0.00036	2056.78	2844.3	0	ANNUAL	ALL	1				
621		634999.5	4977984	0.00032	2045.34	2844.3	0	ANNUAL	ALL	1				
622		635024.5	4977984	0.00034	2037.82	2844.3	0	ANNUAL	ALL	1				
623		635049.5	4977984	0.00035	2030.43	2844.3	0	ANNUAL	ALL	1				
624		635074.5	4977984	0.00037	2024.12	2844.3	0	ANNUAL	ALL	1				
625		635099.5	4977984	0.00038	2019.96	2844.3	0	ANNUAL	ALL	1				
626		635124.5	4977984	0.00038	2026.73	2844.3	0	ANNUAL	ALL	1				
627		635149.5	4977984	0.00037	2035.4	2844.3	0	ANNUAL	ALL	1				
628		635174.5	4977984	0.00037	2044.46	2844.3	0	ANNUAL	ALL	1				
629		635199.5	4977984	0.00035	2053.52	2844.3	0	ANNUAL	ALL	1				
630		634999.5	4978009	0.00031	2044.81	2844.3	0	ANNUAL	ALL	1				
631		635024.5	4978009	0.00033	2035.59	2844.3	0	ANNUAL	ALL	1				
632		635049.5	4978009	0.00035	2028.05	2844.3	0	ANNUAL	ALL	1				
633		635074.5	4978009	0.00036	2021.18	2844.3	0	ANNUAL	ALL	1				
634		635099.5	4978009	0.00037	2017.1	2844.3	0	ANNUAL	ALL	1				
635		635124.5	4978009	0.00037	2025.97	2844.3	0	ANNUAL	ALL	1				
636		635149.5	4978009	0.00036	2034.03	2844.3	0	ANNUAL	ALL	1				
637		635174.5	4978009	0.00036	2041.95	2844.3	0	ANNUAL	ALL	1				
638		635199.5	4978009	0.00035	2050.09	2844.3	0	ANNUAL	ALL	1				
639		634999.5	4978034	0.00031	2043.29	2844.3	0	ANNUAL	ALL	1				
640		635024.5	4978034	0.00033	2032.46	2844.3	0	ANNUAL	ALL	1				
641		635049.5	4978034	0.00034	2024.39	2844.3	0	ANNUAL	ALL	1				
642		635074.5	4978034	0.00035	2017.56	2844.3	0	ANNUAL	ALL	1				
643		635099.5	4978034	0.00036	2015.24	2844.3	0	ANNUAL	ALL	1				
644		635124.5	4978034	0.00036	2024.2	2844.3	0	ANNUAL	ALL	1				
645		635149.5	4978034	0.00036	2032.02	2844.3	0	ANNUAL	ALL	1				
646		635174.5	4978034	0.00035	2040.48	2844.3	0	ANNUAL	ALL	1				
647		635199.5	4978034	0.00034	2049.69	2844.3	0	ANNUAL	ALL	1				
648		634599.5	4976834	0.00036	2431.97	2717.08	0	ANNUAL	ALL	1				
649		634624.5	4976834	0.00037	2425.11	2717.08	0	ANNUAL	ALL	1				
650		634649.5	4976834	0.00037	2416.95	2717.08	0	ANNUAL	ALL	1				
651		634674.5	4976834	0.00038	2407.96	2717.08	0	ANNUAL	ALL	1				
652		634699.5	4976834	0.00038	2398.82	2717.08	0	ANNUAL	ALL	1				
653		634724.5	4976834	0.00039	2389.57	2717.08	0	ANNUAL	ALL	1				
654		634749.5	4976834	0.00039	2378.83	2717.08	0	ANNUAL	ALL	1				
655		634774.5	4976834	0.0004	2368.3	2717.08	0	ANNUAL	ALL	1				
656		634799.5	4976834	0.0004	2352.38	2717.08	0	ANNUAL	ALL	1				
657		634599.5	4976859	0.00036	2427	2717.08	0	ANNUAL	ALL	1				
658		634624.5	4976859	0.00036	2421.36	2717.08	0	ANNUAL	ALL	1				
659		634649.5	4976859	0.00037	2412.9	2717.08	0	ANNUAL	ALL	1				
660		634674.5	4976859	0.00037	2401.58	2717.08	0	ANNUAL	ALL	1				
661		634699.5	4976859	0.00038	2391.51	2717.08	0	ANNUAL	ALL	1				
662		634724.5	4976859	0.00038	2381.29	2717.08	0	ANNUAL	ALL	1				
663		634749.5	4976859	0.00039	2371.44	2717.08	0	ANNUAL	ALL	1				
664		634774.5	4976859	0.00039	2358.57	2717.08	0	ANNUAL	ALL	1				
665		634799.5	4976859	0.0004	2341.91	2742	0	ANNUAL	ALL	1				
666		634599.5	4976884	0.00035	2422.69	2717.08	0	ANNUAL	ALL	1				
667		634624.5	4976884	0.00036	2418.17	2717.08	0	ANNUAL	ALL	1				
668		634649.5	4976884	0.00036	2408.98	2717.08	0	ANNUAL	ALL	1				
669		634674.5	4976884	0.00037	2396.57	2717.08	0	ANNUAL	ALL	1				
670		634699.5	4976884	0.00037	2383.76	2717.08	0	ANNUAL	ALL	1				
671		634724.5	4976884	0.00038	2371.27	2717.08	0	ANNUAL	ALL	1				
672		634749.5	4976884	0.00038	2362.03	2717.08	0	ANNUAL	ALL	1				
673		634774.5	4976884	0.00039	2350.11	2717.08	0	ANNUAL	ALL	1				
674		634799.5	4976884	0.0004	2334.35	2742	0	ANNUAL	ALL	1				
675		634599.5	4976909	0.00035	2418.11	2717.08	0	ANNUAL	ALL	1				
676		634624.5	4976909	0.00035	2412.47	2717.08	0	ANNUAL	ALL	1				
677		634649.5	4976909	0.00035	2402.76	2717.08	0	ANNUAL	ALL	1				
678		634674.5	4976909	0.00036	2392.81	2717.08	0	ANNUAL	ALL	1				
679		634699.5	4976909	0.00036	2377.98	2717.08	0	ANNUAL	ALL	1				
680		634724.5	4976909	0.00037	2364.11	2717.08	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
681		634749.5	4976909	0.00038	2354.73	2717.08	0	ANNUAL	ALL	1				
682		634774.5	4976909	0.00038	2345.14	2717.08	0	ANNUAL	ALL	1				
683		634799.5	4976909	0.00039	2331	2742	0	ANNUAL	ALL	1				
684		634599.5	4976934	0.00034	2411.78	2717.08	0	ANNUAL	ALL	1				
685		634624.5	4976934	0.00034	2403.98	2717.08	0	ANNUAL	ALL	1				
686		634649.5	4976934	0.00035	2394.61	2717.08	0	ANNUAL	ALL	1				
687		634674.5	4976934	0.00035	2383.71	2717.08	0	ANNUAL	ALL	1				
688		634699.5	4976934	0.00036	2371.78	2717.08	0	ANNUAL	ALL	1				
689		634724.5	4976934	0.00037	2359.09	2717.08	0	ANNUAL	ALL	1				
690		634749.5	4976934	0.00037	2347.63	2717.08	0	ANNUAL	ALL	1				
691		634774.5	4976934	0.00038	2337.6	2742	0	ANNUAL	ALL	1				
692		634799.5	4976934	0.00038	2326.97	2742	0	ANNUAL	ALL	1				
693		634599.5	4976959	0.00033	2404.1	2717.08	0	ANNUAL	ALL	1				
694		634624.5	4976959	0.00034	2396.65	2717.08	0	ANNUAL	ALL	1				
695		634649.5	4976959	0.00034	2385.41	2717.08	0	ANNUAL	ALL	1				
696		634674.5	4976959	0.00035	2372.07	2717.08	0	ANNUAL	ALL	1				
697		634699.5	4976959	0.00035	2362.55	2717.08	0	ANNUAL	ALL	1				
698		634724.5	4976959	0.00036	2351.59	2717.08	0	ANNUAL	ALL	1				
699		634749.5	4976959	0.00037	2341.2	2717.08	0	ANNUAL	ALL	1				
700		634774.5	4976959	0.00037	2328.55	2742	0	ANNUAL	ALL	1				
701		634799.5	4976959	0.00038	2318.72	2742	0	ANNUAL	ALL	1				
702		634599.5	4976984	0.00033	2396.35	2717.08	0	ANNUAL	ALL	1				
703		634624.5	4976984	0.00033	2389.04	2717.08	0	ANNUAL	ALL	1				
704		634649.5	4976984	0.00034	2377.21	2717.08	0	ANNUAL	ALL	1				
705		634674.5	4976984	0.00034	2363.6	2717.08	0	ANNUAL	ALL	1				
706		634699.5	4976984	0.00035	2350.85	2717.08	0	ANNUAL	ALL	1				
707		634724.5	4976984	0.00036	2340.79	2717.08	0	ANNUAL	ALL	1				
708		634749.5	4976984	0.00036	2331.79	2742	0	ANNUAL	ALL	1				
709		634774.5	4976984	0.00037	2320.7	2742	0	ANNUAL	ALL	1				
710		634799.5	4976984	0.00037	2308.59	2742	0	ANNUAL	ALL	1				
711		634599.5	4977009	0.00032	2388.79	2717.08	0	ANNUAL	ALL	1				
712		634624.5	4977009	0.00033	2379.17	2717.08	0	ANNUAL	ALL	1				
713		634649.5	4977009	0.00033	2368.25	2717.08	0	ANNUAL	ALL	1				
714		634674.5	4977009	0.00034	2355.13	2717.08	0	ANNUAL	ALL	1				
715		634699.5	4977009	0.00035	2341.52	2717.08	0	ANNUAL	ALL	1				
716		634724.5	4977009	0.00035	2328.18	2742	0	ANNUAL	ALL	1				
717		634749.5	4977009	0.00036	2321.24	2742	0	ANNUAL	ALL	1				
718		634774.5	4977009	0.00036	2313.44	2742	0	ANNUAL	ALL	1				
719		634799.5	4977009	0.00037	2301.46	2742.16	0	ANNUAL	ALL	1				
720		634599.5	4977034	0.00032	2379.36	2717.08	0	ANNUAL	ALL	1				
721		634624.5	4977034	0.00032	2369.28	2717.08	0	ANNUAL	ALL	1				
722		634649.5	4977034	0.00033	2356.46	2717.08	0	ANNUAL	ALL	1				
723		634674.5	4977034	0.00034	2343.53	2717.08	0	ANNUAL	ALL	1				
724		634699.5	4977034	0.00034	2329.9	2742	0	ANNUAL	ALL	1				
725		634724.5	4977034	0.00035	2316.92	2742	0	ANNUAL	ALL	1				
726		634749.5	4977034	0.00035	2309.32	2742	0	ANNUAL	ALL	1				
727		634774.5	4977034	0.00036	2302.58	2742	0	ANNUAL	ALL	1				
728		634799.5	4977034	0.00036	2295.21	2742.16	0	ANNUAL	ALL	1				
729	**	CONCUNIT	ug/m^3											
730	**	DEPUNIT	g/m^2											

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	*	AERMOD	(	19191):	MIDAS	GOLD	STIBNITE	-	MODELING	R27	########			
2	*	AERMET	(	19191):	13:54:00									
3	*	MODELING	OPTIONS	USED:	RegDFAULT	CONC	ELEV	NOWARN	DRYDPLT	WETDPLT	RURAL	ADJ_U*		
4	*	PLOT	FILE	OF	ANNUAL	VALUES	AVERAGED	ACROSS	1	YEARS	FOR	SOURCE	GROUP:	ALL
5	*	FOR	A	TOTAL	OF	720	RECEPTORS.							
6	*	FORMAT:	(3(1X,F13.5),3(1X,F8.2),2X,A6,2X,A8,2X,I8.8,2X,A8)											
7	*	X	Y	AVERAGE	CONC	ZELEV	ZHILL	ZFLAG	AVE	GRP	NUM	YRS	NET	ID
8	*													
9	0.002340	635399.5	4975934	0.00071	2213.4	2844.3	0	ANNUAL	ALL	1				
10	max ↑	635424.5	4975934	0.00071	2212.64	2844.3	0	ANNUAL	ALL	1				
11		635449.5	4975934	0.00071	2211.27	2844.3	0	ANNUAL	ALL	1				
12		635474.5	4975934	0.00071	2212.5	2844.3	0	ANNUAL	ALL	1				
13		635499.5	4975934	0.00069	2215.21	2844.3	0	ANNUAL	ALL	1				
14		635524.5	4975934	0.00069	2215.98	2844.3	0	ANNUAL	ALL	1				
15		635549.5	4975934	0.00069	2215	2844.3	0	ANNUAL	ALL	1				
16		635574.5	4975934	0.00069	2215.74	2844.3	0	ANNUAL	ALL	1				
17		635599.5	4975934	0.00068	2218.34	2844.3	0	ANNUAL	ALL	1				
18		635399.5	4975959	0.00075	2202.75	2844.3	0	ANNUAL	ALL	1				
19		635424.5	4975959	0.00074	2204.36	2844.3	0	ANNUAL	ALL	1				
20		635449.5	4975959	0.00074	2204.87	2844.3	0	ANNUAL	ALL	1				
21		635474.5	4975959	0.00073	2206.39	2844.3	0	ANNUAL	ALL	1				
22		635499.5	4975959	0.00072	2208.99	2844.3	0	ANNUAL	ALL	1				
23		635524.5	4975959	0.00071	2210.99	2844.3	0	ANNUAL	ALL	1				
24		635549.5	4975959	0.0007	2211.29	2844.3	0	ANNUAL	ALL	1				
25		635574.5	4975959	0.0007	2210.92	2844.3	0	ANNUAL	ALL	1				
26		635599.5	4975959	0.00071	2208.83	2844.3	0	ANNUAL	ALL	1				
27		635399.5	4975984	0.00078	2195.09	2844.3	0	ANNUAL	ALL	1				
28		635424.5	4975984	0.00076	2198.19	2844.3	0	ANNUAL	ALL	1				
29		635449.5	4975984	0.00076	2198.7	2844.3	0	ANNUAL	ALL	1				
30		635474.5	4975984	0.00075	2201.57	2844.3	0	ANNUAL	ALL	1				
31		635499.5	4975984	0.00073	2203.99	2844.3	0	ANNUAL	ALL	1				
32		635524.5	4975984	0.00072	2206.27	2844.3	0	ANNUAL	ALL	1				
33		635549.5	4975984	0.00072	2206.83	2844.3	0	ANNUAL	ALL	1				
34		635574.5	4975984	0.00072	2205.61	2844.3	0	ANNUAL	ALL	1				
35		635599.5	4975984	0.00073	2202.99	2844.3	0	ANNUAL	ALL	1				
36		635399.5	4976009	0.00077	2195.69	2844.3	0	ANNUAL	ALL	1				
37		635424.5	4976009	0.00081	2189.65	2844.3	0	ANNUAL	ALL	1				
38		635449.5	4976009	0.00078	2194	2844.3	0	ANNUAL	ALL	1				
39		635474.5	4976009	0.00075	2200.13	2844.3	0	ANNUAL	ALL	1				
40		635499.5	4976009	0.00074	2202.83	2844.3	0	ANNUAL	ALL	1				
41		635524.5	4976009	0.00073	2203.57	2844.3	0	ANNUAL	ALL	1				
42		635549.5	4976009	0.00073	2203.82	2844.3	0	ANNUAL	ALL	1				
43		635574.5	4976009	0.00073	2202.81	2844.3	0	ANNUAL	ALL	1				
44		635599.5	4976009	0.00074	2200.59	2844.3	0	ANNUAL	ALL	1				
45		635399.5	4976034	0.00076	2198.23	2844.3	0	ANNUAL	ALL	1				
46		635424.5	4976034	0.00082	2186.98	2844.3	0	ANNUAL	ALL	1				
47		635449.5	4976034	0.0008	2190.14	2844.3	0	ANNUAL	ALL	1				
48		635474.5	4976034	0.00075	2198.63	2844.3	0	ANNUAL	ALL	1				
49		635499.5	4976034	0.00075	2198.93	2844.3	0	ANNUAL	ALL	1				
50		635524.5	4976034	0.00075	2199.39	2844.3	0	ANNUAL	ALL	1				
51		635549.5	4976034	0.00074	2201.1	2844.3	0	ANNUAL	ALL	1				
52		635574.5	4976034	0.00074	2200.59	2844.3	0	ANNUAL	ALL	1				
53		635599.5	4976034	0.00075	2197.96	2844.3	0	ANNUAL	ALL	1				
54		635399.5	4976059	0.00076	2196.33	2844.3	0	ANNUAL	ALL	1				
55		635424.5	4976059	0.00083	2184.09	2844.3	0	ANNUAL	ALL	1				
56		635449.5	4976059	0.00085	2180.82	2844.3	0	ANNUAL	ALL	1				
57		635474.5	4976059	0.00078	2193.11	2844.3	0	ANNUAL	ALL	1				
58		635499.5	4976059	0.00077	2194.5	2844.3	0	ANNUAL	ALL	1				
59		635524.5	4976059	0.00075	2197.17	2844.3	0	ANNUAL	ALL	1				
60		635549.5	4976059	0.00074	2199.4	2844.3	0	ANNUAL	ALL	1				
61		635574.5	4976059	0.00075	2198.27	2844.3	0	ANNUAL	ALL	1				
62		635599.5	4976059	0.00076	2194.62	2844.3	0	ANNUAL	ALL	1				
63		635399.5	4976084	0.0008	2188.98	2844.3	0	ANNUAL	ALL	1				
64		635424.5	4976084	0.00085	2180.22	2844.3	0	ANNUAL	ALL	1				
65		635449.5	4976084	0.0009	2174.51	2844.3	0	ANNUAL	ALL	1				
66		635474.5	4976084	0.00085	2180.27	2844.3	0	ANNUAL	ALL	1				
67		635499.5	4976084	0.00081	2185.71	2844.3	0	ANNUAL	ALL	1				
68		635524.5	4976084	0.00078	2191.13	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
69		635549.5	4976084	0.00077	2193.95	2844.3	0	ANNUAL	ALL	1				
70		635574.5	4976084	0.00078	2190.58	2844.3	0	ANNUAL	ALL	1				
71		635599.5	4976084	0.00083	2183.01	2844.3	0	ANNUAL	ALL	1				
72		635399.5	4976109	0.00083	2182.28	2844.3	0	ANNUAL	ALL	1				
73		635424.5	4976109	0.00087	2177.24	2844.3	0	ANNUAL	ALL	1				
74		635449.5	4976109	0.00092	2171.45	2844.3	0	ANNUAL	ALL	1				
75		635474.5	4976109	0.00091	2172.26	2844.3	0	ANNUAL	ALL	1				
76		635499.5	4976109	0.00087	2177.58	2844.3	0	ANNUAL	ALL	1				
77		635524.5	4976109	0.00085	2180.23	2844.3	0	ANNUAL	ALL	1				
78		635549.5	4976109	0.00085	2179.81	2844.3	0	ANNUAL	ALL	1				
79		635574.5	4976109	0.00087	2176.94	2844.3	0	ANNUAL	ALL	1				
80		635599.5	4976109	0.00085	2179.4	2844.3	0	ANNUAL	ALL	1				
81		635399.5	4976134	0.00087	2176.77	2844.3	0	ANNUAL	ALL	1				
82		635424.5	4976134	0.00089	2174.27	2844.3	0	ANNUAL	ALL	1				
83		635449.5	4976134	0.00091	2171.04	2844.3	0	ANNUAL	ALL	1				
84		635474.5	4976134	0.00095	2166.4	2844.3	0	ANNUAL	ALL	1				
85		635499.5	4976134	0.00094	2167.48	2844.3	0	ANNUAL	ALL	1				
86		635524.5	4976134	0.0009	2172.09	2844.3	0	ANNUAL	ALL	1				
87		635549.5	4976134	0.00091	2171.44	2844.3	0	ANNUAL	ALL	1				
88		635574.5	4976134	0.0009	2172.93	2844.3	0	ANNUAL	ALL	1				
89		635599.5	4976134	0.00085	2178.31	2844.3	0	ANNUAL	ALL	1				
90		635199.5	4976834	0.00165	2116.83	2844.3	0	ANNUAL	ALL	1				
91		635224.5	4976834	0.0015	2112.53	2844.3	0	ANNUAL	ALL	1				
92		635249.5	4976834	0.00152	2108.39	2844.3	0	ANNUAL	ALL	1				
93		635274.5	4976834	0.00153	2105.23	2844.3	0	ANNUAL	ALL	1				
94		635299.5	4976834	0.00154	2101.6	2844.3	0	ANNUAL	ALL	1				
95		635324.5	4976834	0.00155	2098.74	2844.3	0	ANNUAL	ALL	1				
96		635349.5	4976834	0.00148	2104.26	2844.3	0	ANNUAL	ALL	1				
97		635374.5	4976834	0.00142	2110.4	2844.3	0	ANNUAL	ALL	1				
98		635399.5	4976834	0.00147	2117.98	2844.3	0	ANNUAL	ALL	1				
99		635199.5	4976859	0.00167	2114.34	2844.3	0	ANNUAL	ALL	1				
100		635224.5	4976859	0.00155	2108.68	2844.3	0	ANNUAL	ALL	1				
101		635249.5	4976859	0.00157	2104.42	2844.3	0	ANNUAL	ALL	1				
102		635274.5	4976859	0.00158	2101.28	2844.3	0	ANNUAL	ALL	1				
103		635299.5	4976859	0.00158	2098.83	2844.3	0	ANNUAL	ALL	1				
104		635324.5	4976859	0.00158	2096.89	2844.3	0	ANNUAL	ALL	1				
105		635349.5	4976859	0.00152	2101.21	2844.3	0	ANNUAL	ALL	1				
106		635374.5	4976859	0.00145	2108.71	2844.3	0	ANNUAL	ALL	1				
107		635399.5	4976859	0.00149	2118.31	2844.3	0	ANNUAL	ALL	1				
108		635199.5	4976884	0.00157	2111.17	2844.3	0	ANNUAL	ALL	1				
109		635224.5	4976884	0.0016	2104.78	2844.3	0	ANNUAL	ALL	1				
110		635249.5	4976884	0.00162	2100.14	2844.3	0	ANNUAL	ALL	1				
111		635274.5	4976884	0.00163	2097.48	2844.3	0	ANNUAL	ALL	1				
112		635299.5	4976884	0.00163	2095.42	2844.3	0	ANNUAL	ALL	1				
113		635324.5	4976884	0.00161	2094.96	2844.3	0	ANNUAL	ALL	1				
114		635349.5	4976884	0.00157	2097.83	2844.3	0	ANNUAL	ALL	1				
115		635374.5	4976884	0.00147	2107.96	2844.3	0	ANNUAL	ALL	1				
116		635399.5	4976884	0.00151	2119.17	2844.3	0	ANNUAL	ALL	1				
117		635199.5	4976909	0.00161	2108.51	2844.3	0	ANNUAL	ALL	1				
118		635224.5	4976909	0.00165	2102.17	2844.3	0	ANNUAL	ALL	1				
119		635249.5	4976909	0.00167	2097.31	2844.3	0	ANNUAL	ALL	1				
120		635274.5	4976909	0.00167	2094.85	2844.3	0	ANNUAL	ALL	1				
121		635299.5	4976909	0.00166	2093.19	2844.3	0	ANNUAL	ALL	1				
122		635324.5	4976909	0.00164	2093.48	2844.3	0	ANNUAL	ALL	1				
123		635349.5	4976909	0.00158	2098.12	2844.3	0	ANNUAL	ALL	1				
124		635374.5	4976909	0.00148	2108.79	2844.3	0	ANNUAL	ALL	1				
125		635399.5	4976909	0.00156	2120.74	2844.3	0	ANNUAL	ALL	1				
126		635199.5	4976934	0.00165	2106.38	2844.3	0	ANNUAL	ALL	1				
127		635224.5	4976934	0.00168	2100.81	2844.3	0	ANNUAL	ALL	1				
128		635249.5	4976934	0.00169	2096.21	2844.3	0	ANNUAL	ALL	1				
129		635274.5	4976934	0.0017	2092.89	2844.3	0	ANNUAL	ALL	1				
130		635299.5	4976934	0.0017	2091.1	2844.3	0	ANNUAL	ALL	1				
131		635324.5	4976934	0.00167	2092.46	2844.3	0	ANNUAL	ALL	1				
132		635349.5	4976934	0.00159	2099.48	2844.3	0	ANNUAL	ALL	1				
133		635374.5	4976934	0.00148	2110.37	2844.3	0	ANNUAL	ALL	1				
134		635399.5	4976934	0.00159	2122.91	2844.3	0	ANNUAL	ALL	1				
135		635199.5	4976959	0.00168	2104.62	2844.3	0	ANNUAL	ALL	1				
136		635224.5	4976959	0.00171	2099.28	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
137		635249.5	4976959	0.00173	2094.41	2844.3	0	ANNUAL	ALL	1				
138		635274.5	4976959	0.00174	2090.59	2844.3	0	ANNUAL	ALL	1				
139		635299.5	4976959	0.00173	2088.8	2844.3	0	ANNUAL	ALL	1				
140		635324.5	4976959	0.00169	2092.02	2844.3	0	ANNUAL	ALL	1				
141		635349.5	4976959	0.0016	2100.12	2844.3	0	ANNUAL	ALL	1				
142		635374.5	4976959	0.00148	2112.07	2844.3	0	ANNUAL	ALL	1				
143		635399.5	4976959	0.00162	2125.69	2844.3	0	ANNUAL	ALL	1				
144		635199.5	4976984	0.00172	2102.45	2844.3	0	ANNUAL	ALL	1				
145		635224.5	4976984	0.00174	2097.29	2844.3	0	ANNUAL	ALL	1				
146		635249.5	4976984	0.00177	2091.62	2844.3	0	ANNUAL	ALL	1				
147		635274.5	4976984	0.00177	2087.92	2844.3	0	ANNUAL	ALL	1				
148		635299.5	4976984	0.00176	2086.81	2844.3	0	ANNUAL	ALL	1				
149		635324.5	4976984	0.0017	2092.65	2844.3	0	ANNUAL	ALL	1				
150		635349.5	4976984	0.0016	2101.3	2844.3	0	ANNUAL	ALL	1				
151		635374.5	4976984	0.00148	2114.13	2844.3	0	ANNUAL	ALL	1				
152		635399.5	4976984	0.00165	2128.46	2844.3	0	ANNUAL	ALL	1				
153		635199.5	4977009	0.00176	2099.39	2844.3	0	ANNUAL	ALL	1				
154		635224.5	4977009	0.00179	2093.66	2844.3	0	ANNUAL	ALL	1				
155		635249.5	4977009	0.0018	2087.97	2844.3	0	ANNUAL	ALL	1				
156		635274.5	4977009	0.0018	2084.9	2844.3	0	ANNUAL	ALL	1				
157		635299.5	4977009	0.00177	2087.43	2844.3	0	ANNUAL	ALL	1				
158		635324.5	4977009	0.0017	2094.55	2844.3	0	ANNUAL	ALL	1				
159		635349.5	4977009	0.0016	2103.74	2844.3	0	ANNUAL	ALL	1				
160		635374.5	4977009	0.00166	2116.64	2844.3	0	ANNUAL	ALL	1				
161		635399.5	4977009	0.00169	2131.12	2844.3	0	ANNUAL	ALL	1				
162		635199.5	4977034	0.00182	2094.63	2844.3	0	ANNUAL	ALL	1				
163		635224.5	4977034	0.00183	2088.76	2844.3	0	ANNUAL	ALL	1				
164		635249.5	4977034	0.00184	2084.27	2844.3	0	ANNUAL	ALL	1				
165		635274.5	4977034	0.00183	2082.71	2844.3	0	ANNUAL	ALL	1				
166		635299.5	4977034	0.00177	2089.9	2844.3	0	ANNUAL	ALL	1				
167		635324.5	4977034	0.00168	2098.21	2844.3	0	ANNUAL	ALL	1				
168		635349.5	4977034	0.00159	2107.49	2844.3	0	ANNUAL	ALL	1				
169		635374.5	4977034	0.00169	2119.09	2844.3	0	ANNUAL	ALL	1				
170		635399.5	4977034	0.00172	2133.38	2844.3	0	ANNUAL	ALL	1				
171		634899.5	4977134	0.00115	2221.02	2844.3	0	ANNUAL	ALL	1				
172		634924.5	4977134	0.00128	2207.85	2844.3	0	ANNUAL	ALL	1				
173		634949.5	4977134	0.00153	2190.45	2844.3	0	ANNUAL	ALL	1				
174		634974.5	4977134	0.00194	2169.12	2844.3	0	ANNUAL	ALL	1				
175		634999.5	4977134	0.00226	2150.64	2844.3	0	ANNUAL	ALL	1				
176		635024.5	4977134	0.00231	2135.97	2844.3	0	ANNUAL	ALL	1				
177		635049.5	4977134	0.00219	2122.38	2844.3	0	ANNUAL	ALL	1				
178		635074.5	4977134	0.00181	2113.7	2844.3	0	ANNUAL	ALL	1				
179		635099.5	4977134	0.00185	2105.9	2844.3	0	ANNUAL	ALL	1				
180		634899.5	4977159	0.00125	2213.37	2844.3	0	ANNUAL	ALL	1				
181		634924.5	4977159	0.00139	2201.16	2844.3	0	ANNUAL	ALL	1				
182		634949.5	4977159	0.00172	2181.17	2844.3	0	ANNUAL	ALL	1				
183		634974.5	4977159	0.00211	2161.72	2844.3	0	ANNUAL	ALL	1				
184		634999.5	4977159	0.00232	2145.73	2844.3	0	ANNUAL	ALL	1				
185		635024.5	4977159	0.0023	2132.12	2844.3	0	ANNUAL	ALL	1				
186		635049.5	4977159	0.00212	2119.59	2844.3	0	ANNUAL	ALL	1				
187		635074.5	4977159	0.00184	2109.27	2844.3	0	ANNUAL	ALL	1				
188		635099.5	4977159	0.00189	2101.29	2844.3	0	ANNUAL	ALL	1				
189		634899.5	4977184	0.00135	2206.56	2844.3	0	ANNUAL	ALL	1				
190		634924.5	4977184	0.00153	2193.64	2844.3	0	ANNUAL	ALL	1				
191		634949.5	4977184	0.00192	2172.29	2844.3	0	ANNUAL	ALL	1				
192		634974.5	4977184	0.00224	2154.5	2844.3	0	ANNUAL	ALL	1				
193		634999.5	4977184	0.00234	2141.04	2844.3	0	ANNUAL	ALL	1				
194		635024.5	4977184	0.00227	2128.3	2844.3	0	ANNUAL	ALL	1				
195		635049.5	4977184	0.00205	2114.34	2844.3	0	ANNUAL	ALL	1				
196		635074.5	4977184	0.00189	2102.7	2844.3	0	ANNUAL	ALL	1				
197		635099.5	4977184	0.00192	2096.47	2844.3	0	ANNUAL	ALL	1				
198		634899.5	4977209	0.00147	2199.13	2844.3	0	ANNUAL	ALL	1				
199		634924.5	4977209	0.00171	2184.15	2844.3	0	ANNUAL	ALL	1				
200		634949.5	4977209	0.0021	2163.72	2844.3	0	ANNUAL	ALL	1				
201		634974.5	4977209	0.00232	2146.68	2844.3	0	ANNUAL	ALL	1				
202		634999.5	4977209	0.00232	2136.15	2844.3	0	ANNUAL	ALL	1				
203		635024.5	4977209	0.00222	2124.22	2844.3	0	ANNUAL	ALL	1				
204		635049.5	4977209	0.00187	2105.9	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
205		635074.5	4977209	0.00193	2096.39	2844.3	0	ANNUAL	ALL	1				
206		635099.5	4977209	0.00195	2091.31	2844.3	0	ANNUAL	ALL	1				
207		634899.5	4977234	0.00171	2185.16	2844.3	0	ANNUAL	ALL	1				
208		634924.5	4977234	0.00195	2172.04	2844.3	0	ANNUAL	ALL	1				
209		634949.5	4977234	0.00227	2152.41	2844.3	0	ANNUAL	ALL	1				
210		634974.5	4977234	0.00233	2139.97	2844.3	0	ANNUAL	ALL	1				
211		634999.5	4977234	0.00228	2130.73	2844.3	0	ANNUAL	ALL	1				
212		635024.5	4977234	0.00209	2117.31	2844.3	0	ANNUAL	ALL	1				
213		635049.5	4977234	0.00191	2098.65	2844.3	0	ANNUAL	ALL	1				
214		635074.5	4977234	0.00194	2092.39	2844.3	0	ANNUAL	ALL	1				
215		635099.5	4977234	0.00195	2087.32	2844.3	0	ANNUAL	ALL	1				
216		634899.5	4977259	0.0018	2180.4	2844.3	0	ANNUAL	ALL	1				
217		634924.5	4977259	0.00215	2160.19	2844.3	0	ANNUAL	ALL	1				
218		634949.5	4977259	0.0023	2143.3	2844.3	0	ANNUAL	ALL	1				
219		634974.5	4977259	0.00227	2132.11	2844.3	0	ANNUAL	ALL	1				
220		634999.5	4977259	0.00218	2123.02	2844.3	0	ANNUAL	ALL	1				
221		635024.5	4977259	0.00184	2107.09	2844.3	0	ANNUAL	ALL	1				
222		635049.5	4977259	0.00191	2095.35	2844.3	0	ANNUAL	ALL	1				
223		635074.5	4977259	0.00193	2089.07	2844.3	0	ANNUAL	ALL	1				
224		635099.5	4977259	0.00196	2083.6	2844.3	0	ANNUAL	ALL	1				
225		634899.5	4977284	0.00178	2180.69	2844.3	0	ANNUAL	ALL	1				
226		634924.5	4977284	0.00215	2158.28	2844.3	0	ANNUAL	ALL	1				
227		634949.5	4977284	0.00227	2139.34	2844.3	0	ANNUAL	ALL	1				
228		634974.5	4977284	0.00216	2123.05	2844.3	0	ANNUAL	ALL	1				
229		634999.5	4977284	0.00179	2112.91	2844.3	0	ANNUAL	ALL	1				
230		635024.5	4977284	0.00186	2100.55	2844.3	0	ANNUAL	ALL	1				
231		635049.5	4977284	0.00191	2092.76	2844.3	0	ANNUAL	ALL	1				
232		635074.5	4977284	0.00194	2085.71	2844.3	0	ANNUAL	ALL	1				
233		635099.5	4977284	0.00196	2078.67	2844.3	0	ANNUAL	ALL	1				
234		634899.5	4977309	0.00181	2178.55	2844.3	0	ANNUAL	ALL	1				
235		634924.5	4977309	0.00214	2156.77	2844.3	0	ANNUAL	ALL	1				
236		634949.5	4977309	0.00222	2136.54	2844.3	0	ANNUAL	ALL	1				
237		634974.5	4977309	0.00205	2119.59	2844.3	0	ANNUAL	ALL	1				
238		634999.5	4977309	0.0018	2107.01	2844.3	0	ANNUAL	ALL	1				
239		635024.5	4977309	0.00187	2096.52	2844.3	0	ANNUAL	ALL	1				
240		635049.5	4977309	0.00189	2089.24	2844.3	0	ANNUAL	ALL	1				
241		635074.5	4977309	0.00193	2082.55	2844.3	0	ANNUAL	ALL	1				
242		635099.5	4977309	0.00196	2075.98	2844.3	0	ANNUAL	ALL	1				
243		634899.5	4977334	0.00188	2173.18	2844.3	0	ANNUAL	ALL	1				
244		634924.5	4977334	0.00214	2153.29	2844.3	0	ANNUAL	ALL	1				
245		634949.5	4977334	0.00217	2133.9	2844.3	0	ANNUAL	ALL	1				
246		634974.5	4977334	0.002	2117.58	2844.3	0	ANNUAL	ALL	1				
247		634999.5	4977334	0.00179	2104.03	2844.3	0	ANNUAL	ALL	1				
248		635024.5	4977334	0.00185	2093.8	2844.3	0	ANNUAL	ALL	1				
249		635049.5	4977334	0.00188	2085.23	2844.3	0	ANNUAL	ALL	1				
250		635074.5	4977334	0.00192	2078.76	2844.3	0	ANNUAL	ALL	1				
251		635099.5	4977334	0.00195	2074.53	2844.3	0	ANNUAL	ALL	1				
252		635399.5	4976159	0.00091	2171.27	2844.3	0	ANNUAL	ALL	1				
253		635424.5	4976159	0.00092	2169.98	2844.3	0	ANNUAL	ALL	1				
254		635449.5	4976159	0.00094	2167.61	2844.3	0	ANNUAL	ALL	1				
255		635474.5	4976159	0.00097	2164.06	2844.3	0	ANNUAL	ALL	1				
256		635499.5	4976159	0.00099	2161.76	2844.3	0	ANNUAL	ALL	1				
257		635524.5	4976159	0.001	2160.48	2844.3	0	ANNUAL	ALL	1				
258		635549.5	4976159	0.00099	2162.19	2844.3	0	ANNUAL	ALL	1				
259		635574.5	4976159	0.00093	2168.15	2844.3	0	ANNUAL	ALL	1				
260		635599.5	4976159	0.00088	2173.85	2844.3	0	ANNUAL	ALL	1				
261		635399.5	4976184	0.00093	2168.06	2844.3	0	ANNUAL	ALL	1				
262		635424.5	4976184	0.00095	2166.17	2844.3	0	ANNUAL	ALL	1				
263		635449.5	4976184	0.00097	2163.95	2844.3	0	ANNUAL	ALL	1				
264		635474.5	4976184	0.001	2161.05	2844.3	0	ANNUAL	ALL	1				
265		635499.5	4976184	0.00102	2158.86	2844.3	0	ANNUAL	ALL	1				
266		635524.5	4976184	0.00103	2157.1	2844.3	0	ANNUAL	ALL	1				
267		635549.5	4976184	0.00103	2157.07	2844.3	0	ANNUAL	ALL	1				
268		635574.5	4976184	0.00096	2164.59	2844.3	0	ANNUAL	ALL	1				
269		635599.5	4976184	0.0009	2172.06	2844.3	0	ANNUAL	ALL	1				
270		635399.5	4976209	0.00095	2165.29	2844.3	0	ANNUAL	ALL	1				
271		635424.5	4976209	0.00097	2163.14	2844.3	0	ANNUAL	ALL	1				
272		635449.5	4976209	0.00099	2160.76	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
273		635474.5	4976209	0.00102	2158.05	2844.3	0	ANNUAL	ALL	1				
274		635499.5	4976209	0.00104	2155.43	2844.3	0	ANNUAL	ALL	1				
275		635524.5	4976209	0.00106	2153.57	2844.3	0	ANNUAL	ALL	1				
276		635549.5	4976209	0.00104	2156.02	2844.3	0	ANNUAL	ALL	1				
277		635574.5	4976209	0.00095	2165.26	2844.3	0	ANNUAL	ALL	1				
278		635599.5	4976209	0.00087	2175.01	2844.3	0	ANNUAL	ALL	1				
279		635399.5	4976234	0.00098	2162.56	2844.3	0	ANNUAL	ALL	1				
280		635424.5	4976234	0.001	2160.46	2844.3	0	ANNUAL	ALL	1				
281		635449.5	4976234	0.00102	2157.93	2844.3	0	ANNUAL	ALL	1				
282		635474.5	4976234	0.00104	2155.5	2844.3	0	ANNUAL	ALL	1				
283		635499.5	4976234	0.00107	2152.67	2844.3	0	ANNUAL	ALL	1				
284		635524.5	4976234	0.00109	2150.12	2844.3	0	ANNUAL	ALL	1				
285		635549.5	4976234	0.00103	2156.6	2844.3	0	ANNUAL	ALL	1				
286		635574.5	4976234	0.00092	2167.62	2844.3	0	ANNUAL	ALL	1				
287		635599.5	4976234	0.00084	2178.35	2844.3	0	ANNUAL	ALL	1				
288		634999.5	4978134	0.00078	2044.53	2844.3	0	ANNUAL	ALL	1				
289		635024.5	4978134	0.0008	2030.56	2844.3	0	ANNUAL	ALL	1				
290		635049.5	4978134	0.00083	2018.07	2844.3	0	ANNUAL	ALL	1				
291		635074.5	4978134	0.00084	2006.69	2844.3	0	ANNUAL	ALL	1				
292		635099.5	4978134	0.00086	2006.39	2844.3	0	ANNUAL	ALL	1				
293		635124.5	4978134	0.00087	2013.34	2844.3	0	ANNUAL	ALL	1				
294		635149.5	4978134	0.00088	2020.75	2844.3	0	ANNUAL	ALL	1				
295		635174.5	4978134	0.00088	2029.05	2844.3	0	ANNUAL	ALL	1				
296		635199.5	4978134	0.00089	2038.91	2844.3	0	ANNUAL	ALL	1				
297		634999.5	4978159	0.00075	2044.5	2844.3	0	ANNUAL	ALL	1				
298		635024.5	4978159	0.00077	2030.78	2844.3	0	ANNUAL	ALL	1				
299		635049.5	4978159	0.0008	2017.35	2844.3	0	ANNUAL	ALL	1				
300		635074.5	4978159	0.00082	2004.54	2844.3	0	ANNUAL	ALL	1				
301		635099.5	4978159	0.00083	2003.81	2844.3	0	ANNUAL	ALL	1				
302		635124.5	4978159	0.00084	2010.57	2844.3	0	ANNUAL	ALL	1				
303		635149.5	4978159	0.00085	2017.75	2844.3	0	ANNUAL	ALL	1				
304		635174.5	4978159	0.00086	2025.18	2844.3	0	ANNUAL	ALL	1				
305		635199.5	4978159	0.00086	2035.11	2844.3	0	ANNUAL	ALL	1				
306		634999.5	4978184	0.00072	2044.38	2844.3	0	ANNUAL	ALL	1				
307		635024.5	4978184	0.00075	2028.98	2844.3	0	ANNUAL	ALL	1				
308		635049.5	4978184	0.00078	2015.36	2844.3	0	ANNUAL	ALL	1				
309		635074.5	4978184	0.00079	2002.43	2844.3	0	ANNUAL	ALL	1				
310		635099.5	4978184	0.00081	2000.86	2844.3	0	ANNUAL	ALL	1				
311		635124.5	4978184	0.00081	2007.53	2844.3	0	ANNUAL	ALL	1				
312		635149.5	4978184	0.00083	2014.6	2844.3	0	ANNUAL	ALL	1				
313		635174.5	4978184	0.00083	2022.07	2844.3	0	ANNUAL	ALL	1				
314		635199.5	4978184	0.00084	2031.45	2844.3	0	ANNUAL	ALL	1				
315		634999.5	4978209	0.0007	2043.46	2844.3	0	ANNUAL	ALL	1				
316		635024.5	4978209	0.00072	2027.94	2844.3	0	ANNUAL	ALL	1				
317		635049.5	4978209	0.00075	2013.73	2844.3	0	ANNUAL	ALL	1				
318		635074.5	4978209	0.00077	2000.96	2844.3	0	ANNUAL	ALL	1				
319		635099.5	4978209	0.00078	1998.75	2844.3	0	ANNUAL	ALL	1				
320		635124.5	4978209	0.00079	2004.56	2844.3	0	ANNUAL	ALL	1				
321		635149.5	4978209	0.0008	2011.78	2844.3	0	ANNUAL	ALL	1				
322		635174.5	4978209	0.00081	2019.36	2844.3	0	ANNUAL	ALL	1				
323		635199.5	4978209	0.00081	2027.82	2844.3	0	ANNUAL	ALL	1				
324		634999.5	4978234	0.00068	2042.97	2844.3	0	ANNUAL	ALL	1				
325		635024.5	4978234	0.0007	2026.61	2844.3	0	ANNUAL	ALL	1				
326		635049.5	4978234	0.00072	2012.57	2844.3	0	ANNUAL	ALL	1				
327		635074.5	4978234	0.00074	2000.24	2844.3	0	ANNUAL	ALL	1				
328		635099.5	4978234	0.00076	1996.61	2844.3	0	ANNUAL	ALL	1				
329		635124.5	4978234	0.00076	2001.65	2844.3	0	ANNUAL	ALL	1				
330		635149.5	4978234	0.00077	2009.16	2844.3	0	ANNUAL	ALL	1				
331		635174.5	4978234	0.00078	2016.86	2844.3	0	ANNUAL	ALL	1				
332		635199.5	4978234	0.00079	2024.48	2844.3	0	ANNUAL	ALL	1				
333		634999.5	4978259	0.00066	2041.08	2844.3	0	ANNUAL	ALL	1				
334		635024.5	4978259	0.00068	2024.08	2844.3	0	ANNUAL	ALL	1				
335		635049.5	4978259	0.0007	2011.49	2844.3	0	ANNUAL	ALL	1				
336		635074.5	4978259	0.00072	2000.61	2844.3	0	ANNUAL	ALL	1				
337		635099.5	4978259	0.00074	1994.84	2844.3	0	ANNUAL	ALL	1				
338		635124.5	4978259	0.00074	1999.29	2844.3	0	ANNUAL	ALL	1				
339		635149.5	4978259	0.00074	2007.14	2844.3	0	ANNUAL	ALL	1				
340		635174.5	4978259	0.00076	2014.96	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
341		635199.5	4978259	0.00076	2023.44	2844.3	0	ANNUAL	ALL	1				
342		634999.5	4978284	0.00064	2039.02	2844.3	0	ANNUAL	ALL	1				
343		635024.5	4978284	0.00066	2022.69	2844.3	0	ANNUAL	ALL	1				
344		635049.5	4978284	0.00068	2010.11	2844.3	0	ANNUAL	ALL	1				
345		635074.5	4978284	0.0007	1999.28	2844.3	0	ANNUAL	ALL	1				
346		635099.5	4978284	0.00071	1993.94	2844.3	0	ANNUAL	ALL	1				
347		635124.5	4978284	0.00072	1996.86	2844.3	0	ANNUAL	ALL	1				
348		635149.5	4978284	0.00072	2004.78	2844.3	0	ANNUAL	ALL	1				
349		635174.5	4978284	0.00073	2012.7	2844.3	0	ANNUAL	ALL	1				
350		635199.5	4978284	0.00074	2021.78	2844.3	0	ANNUAL	ALL	1				
351		634999.5	4978309	0.00062	2036.72	2844.3	0	ANNUAL	ALL	1				
352		635024.5	4978309	0.00064	2023.32	2844.3	0	ANNUAL	ALL	1				
353		635049.5	4978309	0.00066	2010.1	2844.3	0	ANNUAL	ALL	1				
354		635074.5	4978309	0.00067	1999.36	2844.3	0	ANNUAL	ALL	1				
355		635099.5	4978309	0.00069	1992.81	2844.3	0	ANNUAL	ALL	1				
356		635124.5	4978309	0.0007	1994.13	2844.3	0	ANNUAL	ALL	1				
357		635149.5	4978309	0.0007	2001.68	2844.3	0	ANNUAL	ALL	1				
358		635174.5	4978309	0.00071	2009.75	2844.3	0	ANNUAL	ALL	1				
359		635199.5	4978309	0.00071	2018.84	2844.3	0	ANNUAL	ALL	1				
360		634999.5	4978334	0.0006	2033.58	2844.3	0	ANNUAL	ALL	1				
361		635024.5	4978334	0.00062	2021.76	2844.3	0	ANNUAL	ALL	1				
362		635049.5	4978334	0.00064	2009.59	2844.3	0	ANNUAL	ALL	1				
363		635074.5	4978334	0.00065	1999.33	2844.3	0	ANNUAL	ALL	1				
364		635099.5	4978334	0.00067	1991.74	2844.3	0	ANNUAL	ALL	1				
365		635124.5	4978334	0.00068	1991.62	2844.3	0	ANNUAL	ALL	1				
366		635149.5	4978334	0.00068	1998.49	2844.3	0	ANNUAL	ALL	1				
367		635174.5	4978334	0.00068	2006.18	2844.3	0	ANNUAL	ALL	1				
368		635199.5	4978334	0.00069	2015.32	2844.3	0	ANNUAL	ALL	1				
369		634299.5	4978134	0.00049	2065.05	2844.3	0	ANNUAL	ALL	1				
370		634324.5	4978134	0.00051	2052.1	2844.3	0	ANNUAL	ALL	1				
371		634349.5	4978134	0.00053	2045.24	2844.3	0	ANNUAL	ALL	1				
372		634374.5	4978134	0.00054	2034.94	2844.3	0	ANNUAL	ALL	1				
373		634399.5	4978134	0.00056	2020.36	2844.3	0	ANNUAL	ALL	1				
374		634424.5	4978134	0.00057	2003.67	2844.3	0	ANNUAL	ALL	1				
375		634449.5	4978134	0.0006	1995.29	2844.3	0	ANNUAL	ALL	1				
376		634474.5	4978134	0.00058	2007.74	2844.3	0	ANNUAL	ALL	1				
377		634499.5	4978134	0.00058	2026.56	2844.3	0	ANNUAL	ALL	1				
378		634299.5	4978159	0.00049	2056.37	2844.3	0	ANNUAL	ALL	1				
379		634324.5	4978159	0.00051	2043.39	2844.3	0	ANNUAL	ALL	1				
380		634349.5	4978159	0.00052	2031.51	2844.3	0	ANNUAL	ALL	1				
381		634374.5	4978159	0.00053	2023.05	2844.3	0	ANNUAL	ALL	1				
382		634399.5	4978159	0.00055	2009.29	2844.3	0	ANNUAL	ALL	1				
383		634424.5	4978159	0.00057	1995	2844.3	0	ANNUAL	ALL	1				
384		634449.5	4978159	0.00058	1992.7	2844.3	0	ANNUAL	ALL	1				
385		634474.5	4978159	0.00057	2006.88	2844.3	0	ANNUAL	ALL	1				
386		634499.5	4978159	0.00057	2023.97	2844.3	0	ANNUAL	ALL	1				
387		634299.5	4978184	0.00049	2049.3	2844.3	0	ANNUAL	ALL	1				
388		634324.5	4978184	0.0005	2036.32	2844.3	0	ANNUAL	ALL	1				
389		634349.5	4978184	0.00051	2022.34	2844.3	0	ANNUAL	ALL	1				
390		634374.5	4978184	0.00053	2009.09	2844.3	0	ANNUAL	ALL	1				
391		634399.5	4978184	0.00054	1999.89	2844.3	0	ANNUAL	ALL	1				
392		634424.5	4978184	0.00056	1987.52	2844.3	0	ANNUAL	ALL	1				
393		634449.5	4978184	0.00057	1991.46	2844.3	0	ANNUAL	ALL	1				
394		634474.5	4978184	0.00055	2006.06	2844.3	0	ANNUAL	ALL	1				
395		634499.5	4978184	0.00055	2020.38	2844.3	0	ANNUAL	ALL	1				
396		634299.5	4978209	0.00048	2043.21	2844.3	0	ANNUAL	ALL	1				
397		634324.5	4978209	0.00049	2030.6	2844.3	0	ANNUAL	ALL	1				
398		634349.5	4978209	0.0005	2016.03	2844.3	0	ANNUAL	ALL	1				
399		634374.5	4978209	0.00052	2000.87	2844.3	0	ANNUAL	ALL	1				
400		634399.5	4978209	0.00054	1990.53	2844.3	0	ANNUAL	ALL	1				
401		634424.5	4978209	0.00055	1981.32	2844.3	0	ANNUAL	ALL	1				
402		634449.5	4978209	0.00055	1989.45	2844.3	0	ANNUAL	ALL	1				
403		634474.5	4978209	0.00054	2004.01	2844.3	0	ANNUAL	ALL	1				
404		634499.5	4978209	0.00054	2016.91	2844.3	0	ANNUAL	ALL	1				
405		634299.5	4978234	0.00047	2037.27	2844.3	0	ANNUAL	ALL	1				
406		634324.5	4978234	0.00048	2025.09	2844.3	0	ANNUAL	ALL	1				
407		634349.5	4978234	0.00049	2009.81	2844.3	0	ANNUAL	ALL	1				
408		634374.5	4978234	0.00051	1996.13	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
409		634399.5	4978234	0.00053	1984.05	2844.3	0	ANNUAL	ALL	1				
410		634424.5	4978234	0.00053	1975.87	2844.3	0	ANNUAL	ALL	1				
411		634449.5	4978234	0.00054	1984.97	2844.3	0	ANNUAL	ALL	1				
412		634474.5	4978234	0.00053	2000.36	2844.3	0	ANNUAL	ALL	1				
413		634499.5	4978234	0.00053	2011.73	2844.3	0	ANNUAL	ALL	1				
414		634299.5	4978259	0.00046	2030.97	2844.3	0	ANNUAL	ALL	1				
415		634324.5	4978259	0.00047	2018.02	2844.3	0	ANNUAL	ALL	1				
416		634349.5	4978259	0.00048	2002.99	2844.3	0	ANNUAL	ALL	1				
417		634374.5	4978259	0.00051	1990.41	2844.3	0	ANNUAL	ALL	1				
418		634399.5	4978259	0.00051	1978.88	2844.3	0	ANNUAL	ALL	1				
419		634424.5	4978259	0.00052	1972.17	2844.3	0	ANNUAL	ALL	1				
420		634449.5	4978259	0.00052	1977.85	2844.3	0	ANNUAL	ALL	1				
421		634474.5	4978259	0.00053	1992.52	2844.3	0	ANNUAL	ALL	1				
422		634499.5	4978259	0.00052	2003.44	2844.3	0	ANNUAL	ALL	1				
423		634299.5	4978284	0.00045	2023.26	2844.3	0	ANNUAL	ALL	1				
424		634324.5	4978284	0.00047	2008.98	2844.3	0	ANNUAL	ALL	1				
425		634349.5	4978284	0.00048	1996.31	2844.3	0	ANNUAL	ALL	1				
426		634374.5	4978284	0.0005	1984.2	2844.3	0	ANNUAL	ALL	1				
427		634399.5	4978284	0.0005	1973.37	2844.3	0	ANNUAL	ALL	1				
428		634424.5	4978284	0.00051	1969.23	2844.3	0	ANNUAL	ALL	1				
429		634449.5	4978284	0.00051	1975.58	2844.3	0	ANNUAL	ALL	1				
430		634474.5	4978284	0.00052	1989.07	2844.3	0	ANNUAL	ALL	1				
431		634499.5	4978284	0.00051	2000.53	2844.3	0	ANNUAL	ALL	1				
432		634299.5	4978309	0.00045	2012.41	2844.3	0	ANNUAL	ALL	1				
433		634324.5	4978309	0.00046	1999.74	2844.3	0	ANNUAL	ALL	1				
434		634349.5	4978309	0.00048	1988.62	2844.3	0	ANNUAL	ALL	1				
435		634374.5	4978309	0.00049	1977.79	2844.3	0	ANNUAL	ALL	1				
436		634399.5	4978309	0.00049	1967.1	2844.3	0	ANNUAL	ALL	1				
437		634424.5	4978309	0.0005	1968.14	2844.3	0	ANNUAL	ALL	1				
438		634449.5	4978309	0.0005	1977.66	2844.3	0	ANNUAL	ALL	1				
439		634474.5	4978309	0.0005	1992.31	2844.3	0	ANNUAL	ALL	1				
440		634499.5	4978309	0.00049	2006.23	2844.3	0	ANNUAL	ALL	1				
441		634299.5	4978334	0.00045	2000.94	2844.3	0	ANNUAL	ALL	1				
442		634324.5	4978334	0.00046	1991.1	2844.3	0	ANNUAL	ALL	1				
443		634349.5	4978334	0.00047	1980.66	2844.3	0	ANNUAL	ALL	1				
444		634374.5	4978334	0.00048	1970.39	2844.3	0	ANNUAL	ALL	1				
445		634399.5	4978334	0.00048	1961.38	2844.3	0	ANNUAL	ALL	1				
446		634424.5	4978334	0.00048	1968.29	2844.3	0	ANNUAL	ALL	1				
447		634449.5	4978334	0.00049	1980.95	2844.3	0	ANNUAL	ALL	1				
448		634474.5	4978334	0.00049	1997.36	2844.3	0	ANNUAL	ALL	1				
449		634499.5	4978334	0.00047	2012.52	2844.3	0	ANNUAL	ALL	1				
450		634299.5	4978359	0.00045	1991.4	2844.3	0	ANNUAL	ALL	1				
451		634324.5	4978359	0.00046	1982.72	2844.3	0	ANNUAL	ALL	1				
452		634349.5	4978359	0.00046	1972.75	2844.3	0	ANNUAL	ALL	1				
453		634374.5	4978359	0.00047	1962.87	2844.3	0	ANNUAL	ALL	1				
454		634399.5	4978359	0.00047	1958.17	2844.3	0	ANNUAL	ALL	1				
455		634424.5	4978359	0.00047	1968.79	2844.3	0	ANNUAL	ALL	1				
456		634449.5	4978359	0.00048	1984.24	2844.3	0	ANNUAL	ALL	1				
457		634474.5	4978359	0.00046	2002.2	2844.3	0	ANNUAL	ALL	1				
458		634499.5	4978359	0.00046	2016.76	2844.3	0	ANNUAL	ALL	1				
459		634299.5	4978384	0.00044	1982.57	2844.3	0	ANNUAL	ALL	1				
460		634324.5	4978384	0.00045	1975.68	2844.3	0	ANNUAL	ALL	1				
461		634349.5	4978384	0.00046	1964.84	2844.3	0	ANNUAL	ALL	1				
462		634374.5	4978384	0.00046	1956.29	2844.3	0	ANNUAL	ALL	1				
463		634399.5	4978384	0.00047	1955.61	2844.3	0	ANNUAL	ALL	1				
464		634424.5	4978384	0.00046	1968.65	2844.3	0	ANNUAL	ALL	1				
465		634449.5	4978384	0.00047	1986.09	2844.3	0	ANNUAL	ALL	1				
466		634474.5	4978384	0.00045	2004.63	2844.3	0	ANNUAL	ALL	1				
467		634499.5	4978384	0.00045	2018.69	2844.3	0	ANNUAL	ALL	1				
468		634299.5	4978409	0.00044	1975.4	2844.3	0	ANNUAL	ALL	1				
469		634324.5	4978409	0.00044	1967.52	2844.3	0	ANNUAL	ALL	1				
470		634349.5	4978409	0.00045	1957.04	2844.3	0	ANNUAL	ALL	1				
471		634374.5	4978409	0.00045	1949.69	2844.3	0	ANNUAL	ALL	1				
472		634399.5	4978409	0.00046	1951.43	2844.3	0	ANNUAL	ALL	1				
473		634424.5	4978409	0.00046	1967.3	2844.3	0	ANNUAL	ALL	1				
474		634449.5	4978409	0.00046	1986.39	2844.3	0	ANNUAL	ALL	1				
475		634474.5	4978409	0.00044	2005.28	2844.3	0	ANNUAL	ALL	1				
476		634499.5	4978409	0.00044	2019.28	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
477		634299.5	4978434	0.00043	1965.22	2844.3	0	ANNUAL	ALL	1				
478		634324.5	4978434	0.00044	1958.88	2844.3	0	ANNUAL	ALL	1				
479		634349.5	4978434	0.00044	1950.79	2844.3	0	ANNUAL	ALL	1				
480		634374.5	4978434	0.00044	1943.73	2844.3	0	ANNUAL	ALL	1				
481		634399.5	4978434	0.00045	1949.4	2844.3	0	ANNUAL	ALL	1				
482		634424.5	4978434	0.00045	1965.04	2844.3	0	ANNUAL	ALL	1				
483		634449.5	4978434	0.00045	1984.59	2844.3	0	ANNUAL	ALL	1				
484		634474.5	4978434	0.00043	2004.45	2844.3	0	ANNUAL	ALL	1				
485		634499.5	4978434	0.00043	2017.53	2844.3	0	ANNUAL	ALL	1				
486		634249.4	4977384	0.00066	2291.4	2717.08	0	ANNUAL	ALL	1				
487		634274.4	4977384	0.00069	2282.65	2742	0	ANNUAL	ALL	1				
488		634299.4	4977384	0.00073	2273.71	2742	0	ANNUAL	ALL	1				
489		634324.4	4977384	0.00077	2263.84	2742	0	ANNUAL	ALL	1				
490		634349.4	4977384	0.00084	2250.84	2742	0	ANNUAL	ALL	1				
491		634374.4	4977384	0.00092	2238.58	2742.16	0	ANNUAL	ALL	1				
492		634399.4	4977384	0.00097	2232.43	2742.16	0	ANNUAL	ALL	1				
493		634424.4	4977384	0.00091	2242.73	2742.16	0	ANNUAL	ALL	1				
494		634449.4	4977384	0.00084	2255.36	2742	0	ANNUAL	ALL	1				
495		634249.4	4977409	0.00066	2284.43	2742	0	ANNUAL	ALL	1				
496		634274.4	4977409	0.0007	2274.53	2742	0	ANNUAL	ALL	1				
497		634299.4	4977409	0.00074	2264.56	2742	0	ANNUAL	ALL	1				
498		634324.4	4977409	0.00079	2254.44	2742	0	ANNUAL	ALL	1				
499		634349.4	4977409	0.00085	2243.93	2742.16	0	ANNUAL	ALL	1				
500		634374.4	4977409	0.00094	2231.37	2742.16	0	ANNUAL	ALL	1				
501		634399.4	4977409	0.00102	2226.02	2844.3	0	ANNUAL	ALL	1				
502		634424.4	4977409	0.00092	2236.92	2742.16	0	ANNUAL	ALL	1				
503		634449.4	4977409	0.00086	2249.43	2742.16	0	ANNUAL	ALL	1				
504		634249.4	4977434	0.00066	2279.34	2742	0	ANNUAL	ALL	1				
505		634274.4	4977434	0.0007	2267.65	2742	0	ANNUAL	ALL	1				
506		634299.4	4977434	0.00076	2255.85	2742	0	ANNUAL	ALL	1				
507		634324.4	4977434	0.00081	2244.86	2742	0	ANNUAL	ALL	1				
508		634349.4	4977434	0.00089	2234.48	2742.16	0	ANNUAL	ALL	1				
509		634374.4	4977434	0.001	2223.18	2844.3	0	ANNUAL	ALL	1				
510		634399.4	4977434	0.00105	2218.5	2844.3	0	ANNUAL	ALL	1				
511		634424.4	4977434	0.00097	2230.27	2844.3	0	ANNUAL	ALL	1				
512		634449.4	4977434	0.00087	2243.66	2742.16	0	ANNUAL	ALL	1				
513		634249.4	4977459	0.00065	2275.78	2742	0	ANNUAL	ALL	1				
514		634274.4	4977459	0.0007	2262.83	2742	0	ANNUAL	ALL	1				
515		634299.4	4977459	0.00076	2248.74	2742	0	ANNUAL	ALL	1				
516		634324.4	4977459	0.00083	2237.43	2742.16	0	ANNUAL	ALL	1				
517		634349.4	4977459	0.00093	2226.72	2844.3	0	ANNUAL	ALL	1				
518		634374.4	4977459	0.00103	2214.97	2844.3	0	ANNUAL	ALL	1				
519		634399.4	4977459	0.00108	2211.75	2844.3	0	ANNUAL	ALL	1				
520		634424.4	4977459	0.00099	2223.34	2844.3	0	ANNUAL	ALL	1				
521		634449.4	4977459	0.0009	2237.29	2844.3	0	ANNUAL	ALL	1				
522		634249.4	4977484	0.00064	2272.5	2742	0	ANNUAL	ALL	1				
523		634274.4	4977484	0.0007	2258.48	2742	0	ANNUAL	ALL	1				
524		634299.4	4977484	0.00076	2243.77	2742	0	ANNUAL	ALL	1				
525		634324.4	4977484	0.00084	2231.45	2742.16	0	ANNUAL	ALL	1				
526		634349.4	4977484	0.00095	2219.9	2844.3	0	ANNUAL	ALL	1				
527		634374.4	4977484	0.00106	2207.94	2844.3	0	ANNUAL	ALL	1				
528		634399.4	4977484	0.00111	2204.62	2844.3	0	ANNUAL	ALL	1				
529		634424.4	4977484	0.00102	2216.76	2844.3	0	ANNUAL	ALL	1				
530		634449.4	4977484	0.00093	2230.33	2844.3	0	ANNUAL	ALL	1				
531		634249.4	4977509	0.00063	2269.17	2742	0	ANNUAL	ALL	1				
532		634274.4	4977509	0.00069	2254.88	2742	0	ANNUAL	ALL	1				
533		634299.4	4977509	0.00075	2240.59	2742	0	ANNUAL	ALL	1				
534		634324.4	4977509	0.00086	2227.32	2844.3	0	ANNUAL	ALL	1				
535		634349.4	4977509	0.00096	2213.19	2844.3	0	ANNUAL	ALL	1				
536		634374.4	4977509	0.00109	2200.19	2844.3	0	ANNUAL	ALL	1				
537		634399.4	4977509	0.00113	2197.61	2844.3	0	ANNUAL	ALL	1				
538		634424.4	4977509	0.00103	2211.03	2844.3	0	ANNUAL	ALL	1				
539		634449.4	4977509	0.00094	2223.57	2844.3	0	ANNUAL	ALL	1				
540		634249.4	4977534	0.00062	2266.65	2742	0	ANNUAL	ALL	1				
541		634274.4	4977534	0.00068	2251.58	2742	0	ANNUAL	ALL	1				
542		634299.4	4977534	0.00075	2237.18	2742	0	ANNUAL	ALL	1				
543		634324.4	4977534	0.00085	2223.67	2844.3	0	ANNUAL	ALL	1				
544		634349.4	4977534	0.00097	2207.86	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
545		634374.4	4977534	0.00111	2193.38	2844.3	0	ANNUAL	ALL	1				
546		634399.4	4977534	0.00114	2191.95	2844.3	0	ANNUAL	ALL	1				
547		634424.4	4977534	0.00104	2205.88	2844.3	0	ANNUAL	ALL	1				
548		634449.4	4977534	0.00096	2217.63	2844.3	0	ANNUAL	ALL	1				
549		634249.4	4977559	0.00061	2264.12	2742	0	ANNUAL	ALL	1				
550		634274.4	4977559	0.00067	2247.26	2742	0	ANNUAL	ALL	1				
551		634299.4	4977559	0.00074	2232.74	2742	0	ANNUAL	ALL	1				
552		634324.4	4977559	0.00085	2218.55	2844.3	0	ANNUAL	ALL	1				
553		634349.4	4977559	0.00097	2203.35	2844.3	0	ANNUAL	ALL	1				
554		634374.4	4977559	0.00109	2189.62	2844.3	0	ANNUAL	ALL	1				
555		634399.4	4977559	0.00115	2184.96	2844.3	0	ANNUAL	ALL	1				
556		634424.4	4977559	0.00104	2200.77	2844.3	0	ANNUAL	ALL	1				
557		634449.4	4977559	0.00098	2211.07	2844.3	0	ANNUAL	ALL	1				
558		634249.4	4977584	0.00061	2258.01	2742	0	ANNUAL	ALL	1				
559		634274.4	4977584	0.00067	2242.66	2742	0	ANNUAL	ALL	1				
560		634299.4	4977584	0.00076	2227.67	2844.3	0	ANNUAL	ALL	1				
561		634324.4	4977584	0.00085	2213.51	2844.3	0	ANNUAL	ALL	1				
562		634349.4	4977584	0.00096	2199.5	2844.3	0	ANNUAL	ALL	1				
563		634374.4	4977584	0.00108	2185.33	2844.3	0	ANNUAL	ALL	1				
564		634399.4	4977584	0.00116	2177.11	2844.3	0	ANNUAL	ALL	1				
565		634424.4	4977584	0.00107	2192.43	2844.3	0	ANNUAL	ALL	1				
566		634449.4	4977584	0.001	2203.16	2844.3	0	ANNUAL	ALL	1				
567		634999.5	4977834	0.00115	2055.79	2844.3	0	ANNUAL	ALL	1				
568		635024.5	4977834	0.00119	2048.42	2844.3	0	ANNUAL	ALL	1				
569		635049.5	4977834	0.00121	2043	2844.3	0	ANNUAL	ALL	1				
570		635074.5	4977834	0.00124	2037.93	2844.3	0	ANNUAL	ALL	1				
571		635099.5	4977834	0.00127	2034.24	2844.3	0	ANNUAL	ALL	1				
572		635124.5	4977834	0.00129	2031.45	2844.3	0	ANNUAL	ALL	1				
573		635149.5	4977834	0.00129	2038.5	2844.3	0	ANNUAL	ALL	1				
574		635174.5	4977834	0.00128	2050.35	2844.3	0	ANNUAL	ALL	1				
575		635199.5	4977834	0.00124	2063.26	2844.3	0	ANNUAL	ALL	1				
576		634999.5	4977859	0.00112	2052.63	2844.3	0	ANNUAL	ALL	1				
577		635024.5	4977859	0.00115	2046.41	2844.3	0	ANNUAL	ALL	1				
578		635049.5	4977859	0.00118	2040.95	2844.3	0	ANNUAL	ALL	1				
579		635074.5	4977859	0.00121	2036.03	2844.3	0	ANNUAL	ALL	1				
580		635099.5	4977859	0.00123	2032.3	2844.3	0	ANNUAL	ALL	1				
581		635124.5	4977859	0.00125	2030.17	2844.3	0	ANNUAL	ALL	1				
582		635149.5	4977859	0.00125	2038.33	2844.3	0	ANNUAL	ALL	1				
583		635174.5	4977859	0.00124	2049.93	2844.3	0	ANNUAL	ALL	1				
584		635199.5	4977859	0.00121	2062.54	2844.3	0	ANNUAL	ALL	1				
585		634999.5	4977884	0.00109	2049.11	2844.3	0	ANNUAL	ALL	1				
586		635024.5	4977884	0.00112	2044.13	2844.3	0	ANNUAL	ALL	1				
587		635049.5	4977884	0.00114	2038.92	2844.3	0	ANNUAL	ALL	1				
588		635074.5	4977884	0.00117	2034.26	2844.3	0	ANNUAL	ALL	1				
589		635099.5	4977884	0.00119	2030.48	2844.3	0	ANNUAL	ALL	1				
590		635124.5	4977884	0.00121	2029.04	2844.3	0	ANNUAL	ALL	1				
591		635149.5	4977884	0.00121	2038.45	2844.3	0	ANNUAL	ALL	1				
592		635174.5	4977884	0.0012	2049.51	2844.3	0	ANNUAL	ALL	1				
593		635199.5	4977884	0.00117	2061.56	2844.3	0	ANNUAL	ALL	1				
594		634999.5	4977909	0.00106	2047.27	2844.3	0	ANNUAL	ALL	1				
595		635024.5	4977909	0.00108	2042.16	2844.3	0	ANNUAL	ALL	1				
596		635049.5	4977909	0.00111	2036.97	2844.3	0	ANNUAL	ALL	1				
597		635074.5	4977909	0.00113	2032.48	2844.3	0	ANNUAL	ALL	1				
598		635099.5	4977909	0.00115	2028.7	2844.3	0	ANNUAL	ALL	1				
599		635124.5	4977909	0.00117	2028.77	2844.3	0	ANNUAL	ALL	1				
600		635149.5	4977909	0.00117	2038.62	2844.3	0	ANNUAL	ALL	1				
601		635174.5	4977909	0.00116	2049.12	2844.3	0	ANNUAL	ALL	1				
602		635199.5	4977909	0.00114	2060.48	2844.3	0	ANNUAL	ALL	1				
603		634999.5	4977934	0.00102	2046.79	2844.3	0	ANNUAL	ALL	1				
604		635024.5	4977934	0.00105	2040.92	2844.3	0	ANNUAL	ALL	1				
605		635049.5	4977934	0.00107	2034.68	2844.3	0	ANNUAL	ALL	1				
606		635074.5	4977934	0.0011	2029.58	2844.3	0	ANNUAL	ALL	1				
607		635099.5	4977934	0.00112	2025.61	2844.3	0	ANNUAL	ALL	1				
608		635124.5	4977934	0.00113	2027.68	2844.3	0	ANNUAL	ALL	1				
609		635149.5	4977934	0.00113	2038.09	2844.3	0	ANNUAL	ALL	1				
610		635174.5	4977934	0.00113	2048.68	2844.3	0	ANNUAL	ALL	1				
611		635199.5	4977934	0.00111	2059.02	2844.3	0	ANNUAL	ALL	1				
612		634999.5	4977959	0.00099	2045.95	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
613		635024.5	4977959	0.00101	2039.51	2844.3	0	ANNUAL	ALL	1				
614		635049.5	4977959	0.00104	2032.45	2844.3	0	ANNUAL	ALL	1				
615		635074.5	4977959	0.00106	2026.52	2844.3	0	ANNUAL	ALL	1				
616		635099.5	4977959	0.00108	2022.6	2844.3	0	ANNUAL	ALL	1				
617		635124.5	4977959	0.00109	2027.13	2844.3	0	ANNUAL	ALL	1				
618		635149.5	4977959	0.0011	2036.89	2844.3	0	ANNUAL	ALL	1				
619		635174.5	4977959	0.0011	2046.85	2844.3	0	ANNUAL	ALL	1				
620		635199.5	4977959	0.00108	2056.78	2844.3	0	ANNUAL	ALL	1				
621		634999.5	4977984	0.00096	2045.34	2844.3	0	ANNUAL	ALL	1				
622		635024.5	4977984	0.00098	2037.82	2844.3	0	ANNUAL	ALL	1				
623		635049.5	4977984	0.00101	2030.43	2844.3	0	ANNUAL	ALL	1				
624		635074.5	4977984	0.00103	2024.12	2844.3	0	ANNUAL	ALL	1				
625		635099.5	4977984	0.00105	2019.96	2844.3	0	ANNUAL	ALL	1				
626		635124.5	4977984	0.00106	2026.73	2844.3	0	ANNUAL	ALL	1				
627		635149.5	4977984	0.00106	2035.4	2844.3	0	ANNUAL	ALL	1				
628		635174.5	4977984	0.00106	2044.46	2844.3	0	ANNUAL	ALL	1				
629		635199.5	4977984	0.00106	2053.52	2844.3	0	ANNUAL	ALL	1				
630		634999.5	4978009	0.00092	2044.81	2844.3	0	ANNUAL	ALL	1				
631		635024.5	4978009	0.00095	2035.59	2844.3	0	ANNUAL	ALL	1				
632		635049.5	4978009	0.00097	2028.05	2844.3	0	ANNUAL	ALL	1				
633		635074.5	4978009	0.001	2021.18	2844.3	0	ANNUAL	ALL	1				
634		635099.5	4978009	0.00102	2017.1	2844.3	0	ANNUAL	ALL	1				
635		635124.5	4978009	0.00102	2025.97	2844.3	0	ANNUAL	ALL	1				
636		635149.5	4978009	0.00103	2034.03	2844.3	0	ANNUAL	ALL	1				
637		635174.5	4978009	0.00103	2041.95	2844.3	0	ANNUAL	ALL	1				
638		635199.5	4978009	0.00103	2050.09	2844.3	0	ANNUAL	ALL	1				
639		634999.5	4978034	0.00089	2043.29	2844.3	0	ANNUAL	ALL	1				
640		635024.5	4978034	0.00092	2032.46	2844.3	0	ANNUAL	ALL	1				
641		635049.5	4978034	0.00095	2024.39	2844.3	0	ANNUAL	ALL	1				
642		635074.5	4978034	0.00097	2017.56	2844.3	0	ANNUAL	ALL	1				
643		635099.5	4978034	0.00099	2015.24	2844.3	0	ANNUAL	ALL	1				
644		635124.5	4978034	0.00099	2024.2	2844.3	0	ANNUAL	ALL	1				
645		635149.5	4978034	0.001	2032.02	2844.3	0	ANNUAL	ALL	1				
646		635174.5	4978034	0.001	2040.48	2844.3	0	ANNUAL	ALL	1				
647		635199.5	4978034	0.001	2049.69	2844.3	0	ANNUAL	ALL	1				
648		634599.5	4976834	0.00063	2431.97	2717.08	0	ANNUAL	ALL	1				
649		634624.5	4976834	0.00063	2425.11	2717.08	0	ANNUAL	ALL	1				
650		634649.5	4976834	0.00062	2416.95	2717.08	0	ANNUAL	ALL	1				
651		634674.5	4976834	0.00062	2407.96	2717.08	0	ANNUAL	ALL	1				
652		634699.5	4976834	0.00062	2398.82	2717.08	0	ANNUAL	ALL	1				
653		634724.5	4976834	0.00062	2389.57	2717.08	0	ANNUAL	ALL	1				
654		634749.5	4976834	0.00062	2378.83	2717.08	0	ANNUAL	ALL	1				
655		634774.5	4976834	0.00062	2368.3	2717.08	0	ANNUAL	ALL	1				
656		634799.5	4976834	0.00062	2352.38	2717.08	0	ANNUAL	ALL	1				
657		634599.5	4976859	0.00064	2427	2717.08	0	ANNUAL	ALL	1				
658		634624.5	4976859	0.00063	2421.36	2717.08	0	ANNUAL	ALL	1				
659		634649.5	4976859	0.00063	2412.9	2717.08	0	ANNUAL	ALL	1				
660		634674.5	4976859	0.00063	2401.58	2717.08	0	ANNUAL	ALL	1				
661		634699.5	4976859	0.00063	2391.51	2717.08	0	ANNUAL	ALL	1				
662		634724.5	4976859	0.00063	2381.29	2717.08	0	ANNUAL	ALL	1				
663		634749.5	4976859	0.00063	2371.44	2717.08	0	ANNUAL	ALL	1				
664		634774.5	4976859	0.00063	2358.57	2717.08	0	ANNUAL	ALL	1				
665		634799.5	4976859	0.00064	2341.91	2742	0	ANNUAL	ALL	1				
666		634599.5	4976884	0.00064	2422.69	2717.08	0	ANNUAL	ALL	1				
667		634624.5	4976884	0.00064	2418.17	2717.08	0	ANNUAL	ALL	1				
668		634649.5	4976884	0.00064	2408.98	2717.08	0	ANNUAL	ALL	1				
669		634674.5	4976884	0.00064	2396.57	2717.08	0	ANNUAL	ALL	1				
670		634699.5	4976884	0.00064	2383.76	2717.08	0	ANNUAL	ALL	1				
671		634724.5	4976884	0.00064	2371.27	2717.08	0	ANNUAL	ALL	1				
672		634749.5	4976884	0.00064	2362.03	2717.08	0	ANNUAL	ALL	1				
673		634774.5	4976884	0.00065	2350.11	2717.08	0	ANNUAL	ALL	1				
674		634799.5	4976884	0.00065	2334.35	2742	0	ANNUAL	ALL	1				
675		634599.5	4976909	0.00065	2418.11	2717.08	0	ANNUAL	ALL	1				
676		634624.5	4976909	0.00065	2412.47	2717.08	0	ANNUAL	ALL	1				
677		634649.5	4976909	0.00065	2402.76	2717.08	0	ANNUAL	ALL	1				
678		634674.5	4976909	0.00065	2392.81	2717.08	0	ANNUAL	ALL	1				
679		634699.5	4976909	0.00065	2377.98	2717.08	0	ANNUAL	ALL	1				
680		634724.5	4976909	0.00065	2364.11	2717.08	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
681		634749.5	4976909	0.00066	2354.73	2717.08	0	ANNUAL	ALL	1				
682		634774.5	4976909	0.00066	2345.14	2717.08	0	ANNUAL	ALL	1				
683		634799.5	4976909	0.00067	2331	2742	0	ANNUAL	ALL	1				
684		634599.5	4976934	0.00066	2411.78	2717.08	0	ANNUAL	ALL	1				
685		634624.5	4976934	0.00066	2403.98	2717.08	0	ANNUAL	ALL	1				
686		634649.5	4976934	0.00066	2394.61	2717.08	0	ANNUAL	ALL	1				
687		634674.5	4976934	0.00066	2383.71	2717.08	0	ANNUAL	ALL	1				
688		634699.5	4976934	0.00066	2371.78	2717.08	0	ANNUAL	ALL	1				
689		634724.5	4976934	0.00066	2359.09	2717.08	0	ANNUAL	ALL	1				
690		634749.5	4976934	0.00067	2347.63	2717.08	0	ANNUAL	ALL	1				
691		634774.5	4976934	0.00067	2337.6	2742	0	ANNUAL	ALL	1				
692		634799.5	4976934	0.00068	2326.97	2742	0	ANNUAL	ALL	1				
693		634599.5	4976959	0.00066	2404.1	2717.08	0	ANNUAL	ALL	1				
694		634624.5	4976959	0.00066	2396.65	2717.08	0	ANNUAL	ALL	1				
695		634649.5	4976959	0.00067	2385.41	2717.08	0	ANNUAL	ALL	1				
696		634674.5	4976959	0.00067	2372.07	2717.08	0	ANNUAL	ALL	1				
697		634699.5	4976959	0.00067	2362.55	2717.08	0	ANNUAL	ALL	1				
698		634724.5	4976959	0.00068	2351.59	2717.08	0	ANNUAL	ALL	1				
699		634749.5	4976959	0.00068	2341.2	2717.08	0	ANNUAL	ALL	1				
700		634774.5	4976959	0.00069	2328.55	2742	0	ANNUAL	ALL	1				
701		634799.5	4976959	0.00069	2318.72	2742	0	ANNUAL	ALL	1				
702		634599.5	4976984	0.00067	2396.35	2717.08	0	ANNUAL	ALL	1				
703		634624.5	4976984	0.00067	2389.04	2717.08	0	ANNUAL	ALL	1				
704		634649.5	4976984	0.00067	2377.21	2717.08	0	ANNUAL	ALL	1				
705		634674.5	4976984	0.00068	2363.6	2717.08	0	ANNUAL	ALL	1				
706		634699.5	4976984	0.00069	2350.85	2717.08	0	ANNUAL	ALL	1				
707		634724.5	4976984	0.00069	2340.79	2717.08	0	ANNUAL	ALL	1				
708		634749.5	4976984	0.0007	2331.79	2742	0	ANNUAL	ALL	1				
709		634774.5	4976984	0.00071	2320.7	2742	0	ANNUAL	ALL	1				
710		634799.5	4976984	0.00071	2308.59	2742	0	ANNUAL	ALL	1				
711		634599.5	4977009	0.00067	2388.79	2717.08	0	ANNUAL	ALL	1				
712		634624.5	4977009	0.00068	2379.17	2717.08	0	ANNUAL	ALL	1				
713		634649.5	4977009	0.00068	2368.25	2717.08	0	ANNUAL	ALL	1				
714		634674.5	4977009	0.00069	2355.13	2717.08	0	ANNUAL	ALL	1				
715		634699.5	4977009	0.0007	2341.52	2717.08	0	ANNUAL	ALL	1				
716		634724.5	4977009	0.00071	2328.18	2742	0	ANNUAL	ALL	1				
717		634749.5	4977009	0.00072	2321.24	2742	0	ANNUAL	ALL	1				
718		634774.5	4977009	0.00072	2313.44	2742	0	ANNUAL	ALL	1				
719		634799.5	4977009	0.00073	2301.46	2742.16	0	ANNUAL	ALL	1				
720		634599.5	4977034	0.00068	2379.36	2717.08	0	ANNUAL	ALL	1				
721		634624.5	4977034	0.00069	2369.28	2717.08	0	ANNUAL	ALL	1				
722		634649.5	4977034	0.0007	2356.46	2717.08	0	ANNUAL	ALL	1				
723		634674.5	4977034	0.00071	2343.53	2717.08	0	ANNUAL	ALL	1				
724		634699.5	4977034	0.00072	2329.9	2742	0	ANNUAL	ALL	1				
725		634724.5	4977034	0.00073	2316.92	2742	0	ANNUAL	ALL	1				
726		634749.5	4977034	0.00074	2309.32	2742	0	ANNUAL	ALL	1				
727		634774.5	4977034	0.00075	2302.58	2742	0	ANNUAL	ALL	1				
728		634799.5	4977034	0.00075	2295.21	2742.16	0	ANNUAL	ALL	1				
729	**	CONCUNIT	ug/m^3											
730	**	DEPUNIT	g/m^2											

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	*	AERMOD	(	19191):	MIDAS	GOLD	STIBNITE	-	MODELING	R27	########			
2	*	AERMET	(	19191):	14:54:17									
3	*	MODELING	OPTIONS	USED:	RegDFAULT	CONC	ELEV	NOWARN	DRYDPLT	WETDPLT	RURAL	ADJ_U*		
4	*	PLOT	FILE	OF	ANNUAL	VALUES	AVERAGED	ACROSS	1	YEARS	FOR	SOURCE	GROUP:	ALL
5	*	FOR	A	TOTAL	OF	720	RECEPTORS.							
6	*	FORMAT:	(3(1X,F13.5),3(1X,F8.2),2X,A6,2X,A8,2X,I8.8,2X,A8)											
7	*	X	Y	AVERAGE	CONC	ZELEV	ZHILL	ZFLAG	AVE	GRP	NUM	YRS	NET	ID
8	*													
9	0.000860	635399.5	4975934	0.0007	2213.4	2844.3	0	ANNUAL	ALL	1				
10	max ↑	635424.5	4975934	0.00071	2212.64	2844.3	0	ANNUAL	ALL	1				
11		635449.5	4975934	0.00072	2211.27	2844.3	0	ANNUAL	ALL	1				
12		635474.5	4975934	0.00072	2212.5	2844.3	0	ANNUAL	ALL	1				
13		635499.5	4975934	0.00071	2215.21	2844.3	0	ANNUAL	ALL	1				
14		635524.5	4975934	0.00071	2215.98	2844.3	0	ANNUAL	ALL	1				
15		635549.5	4975934	0.00072	2215	2844.3	0	ANNUAL	ALL	1				
16		635574.5	4975934	0.00072	2215.74	2844.3	0	ANNUAL	ALL	1				
17		635599.5	4975934	0.00071	2218.34	2844.3	0	ANNUAL	ALL	1				
18		635399.5	4975959	0.00073	2202.75	2844.3	0	ANNUAL	ALL	1				
19		635424.5	4975959	0.00073	2204.36	2844.3	0	ANNUAL	ALL	1				
20		635449.5	4975959	0.00074	2204.87	2844.3	0	ANNUAL	ALL	1				
21		635474.5	4975959	0.00073	2206.39	2844.3	0	ANNUAL	ALL	1				
22		635499.5	4975959	0.00073	2208.99	2844.3	0	ANNUAL	ALL	1				
23		635524.5	4975959	0.00072	2210.99	2844.3	0	ANNUAL	ALL	1				
24		635549.5	4975959	0.00072	2211.29	2844.3	0	ANNUAL	ALL	1				
25		635574.5	4975959	0.00073	2210.92	2844.3	0	ANNUAL	ALL	1				
26		635599.5	4975959	0.00074	2208.83	2844.3	0	ANNUAL	ALL	1				
27		635399.5	4975984	0.00076	2195.09	2844.3	0	ANNUAL	ALL	1				
28		635424.5	4975984	0.00075	2198.19	2844.3	0	ANNUAL	ALL	1				
29		635449.5	4975984	0.00075	2198.7	2844.3	0	ANNUAL	ALL	1				
30		635474.5	4975984	0.00074	2201.57	2844.3	0	ANNUAL	ALL	1				
31		635499.5	4975984	0.00074	2203.99	2844.3	0	ANNUAL	ALL	1				
32		635524.5	4975984	0.00073	2206.27	2844.3	0	ANNUAL	ALL	1				
33		635549.5	4975984	0.00073	2206.83	2844.3	0	ANNUAL	ALL	1				
34		635574.5	4975984	0.00074	2205.61	2844.3	0	ANNUAL	ALL	1				
35		635599.5	4975984	0.00076	2202.99	2844.3	0	ANNUAL	ALL	1				
36		635399.5	4976009	0.00074	2195.69	2844.3	0	ANNUAL	ALL	1				
37		635424.5	4976009	0.00077	2189.65	2844.3	0	ANNUAL	ALL	1				
38		635449.5	4976009	0.00076	2194	2844.3	0	ANNUAL	ALL	1				
39		635474.5	4976009	0.00073	2200.13	2844.3	0	ANNUAL	ALL	1				
40		635499.5	4976009	0.00073	2202.83	2844.3	0	ANNUAL	ALL	1				
41		635524.5	4976009	0.00073	2203.57	2844.3	0	ANNUAL	ALL	1				
42		635549.5	4976009	0.00073	2203.82	2844.3	0	ANNUAL	ALL	1				
43		635574.5	4976009	0.00074	2202.81	2844.3	0	ANNUAL	ALL	1				
44		635599.5	4976009	0.00076	2200.59	2844.3	0	ANNUAL	ALL	1				
45		635399.5	4976034	0.00071	2198.23	2844.3	0	ANNUAL	ALL	1				
46		635424.5	4976034	0.00077	2186.98	2844.3	0	ANNUAL	ALL	1				
47		635449.5	4976034	0.00076	2190.14	2844.3	0	ANNUAL	ALL	1				
48		635474.5	4976034	0.00072	2198.63	2844.3	0	ANNUAL	ALL	1				
49		635499.5	4976034	0.00073	2198.93	2844.3	0	ANNUAL	ALL	1				
50		635524.5	4976034	0.00073	2199.39	2844.3	0	ANNUAL	ALL	1				
51		635549.5	4976034	0.00073	2201.1	2844.3	0	ANNUAL	ALL	1				
52		635574.5	4976034	0.00074	2200.59	2844.3	0	ANNUAL	ALL	1				
53		635599.5	4976034	0.00076	2197.96	2844.3	0	ANNUAL	ALL	1				
54		635399.5	4976059	0.0007	2196.33	2844.3	0	ANNUAL	ALL	1				
55		635424.5	4976059	0.00077	2184.09	2844.3	0	ANNUAL	ALL	1				
56		635449.5	4976059	0.00079	2180.82	2844.3	0	ANNUAL	ALL	1				
57		635474.5	4976059	0.00074	2193.11	2844.3	0	ANNUAL	ALL	1				
58		635499.5	4976059	0.00074	2194.5	2844.3	0	ANNUAL	ALL	1				
59		635524.5	4976059	0.00073	2197.17	2844.3	0	ANNUAL	ALL	1				
60		635549.5	4976059	0.00072	2199.4	2844.3	0	ANNUAL	ALL	1				
61		635574.5	4976059	0.00074	2198.27	2844.3	0	ANNUAL	ALL	1				
62		635599.5	4976059	0.00076	2194.62	2844.3	0	ANNUAL	ALL	1				
63		635399.5	4976084	0.00071	2188.98	2844.3	0	ANNUAL	ALL	1				
64		635424.5	4976084	0.00077	2180.22	2844.3	0	ANNUAL	ALL	1				
65		635449.5	4976084	0.00081	2174.51	2844.3	0	ANNUAL	ALL	1				
66		635474.5	4976084	0.00078	2180.27	2844.3	0	ANNUAL	ALL	1				
67		635499.5	4976084	0.00076	2185.71	2844.3	0	ANNUAL	ALL	1				
68		635524.5	4976084	0.00074	2191.13	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
69		635549.5	4976084	0.00073	2193.95	2844.3	0	ANNUAL	ALL	1				
70		635574.5	4976084	0.00076	2190.58	2844.3	0	ANNUAL	ALL	1				
71		635599.5	4976084	0.00081	2183.01	2844.3	0	ANNUAL	ALL	1				
72		635399.5	4976109	0.00073	2182.28	2844.3	0	ANNUAL	ALL	1				
73		635424.5	4976109	0.00076	2177.24	2844.3	0	ANNUAL	ALL	1				
74		635449.5	4976109	0.0008	2171.45	2844.3	0	ANNUAL	ALL	1				
75		635474.5	4976109	0.00081	2172.26	2844.3	0	ANNUAL	ALL	1				
76		635499.5	4976109	0.00079	2177.58	2844.3	0	ANNUAL	ALL	1				
77		635524.5	4976109	0.00078	2180.23	2844.3	0	ANNUAL	ALL	1				
78		635549.5	4976109	0.00079	2179.81	2844.3	0	ANNUAL	ALL	1				
79		635574.5	4976109	0.00082	2176.94	2844.3	0	ANNUAL	ALL	1				
80		635599.5	4976109	0.00081	2179.4	2844.3	0	ANNUAL	ALL	1				
81		635399.5	4976134	0.00073	2176.77	2844.3	0	ANNUAL	ALL	1				
82		635424.5	4976134	0.00076	2174.27	2844.3	0	ANNUAL	ALL	1				
83		635449.5	4976134	0.00078	2171.04	2844.3	0	ANNUAL	ALL	1				
84		635474.5	4976134	0.00082	2166.4	2844.3	0	ANNUAL	ALL	1				
85		635499.5	4976134	0.00082	2167.48	2844.3	0	ANNUAL	ALL	1				
86		635524.5	4976134	0.00081	2172.09	2844.3	0	ANNUAL	ALL	1				
87		635549.5	4976134	0.00082	2171.44	2844.3	0	ANNUAL	ALL	1				
88		635574.5	4976134	0.00082	2172.93	2844.3	0	ANNUAL	ALL	1				
89		635599.5	4976134	0.0008	2178.31	2844.3	0	ANNUAL	ALL	1				
90		635199.5	4976834	0.00036	2116.83	2844.3	0	ANNUAL	ALL	1				
91		635224.5	4976834	0.00037	2112.53	2844.3	0	ANNUAL	ALL	1				
92		635249.5	4976834	0.00038	2108.39	2844.3	0	ANNUAL	ALL	1				
93		635274.5	4976834	0.00039	2105.23	2844.3	0	ANNUAL	ALL	1				
94		635299.5	4976834	0.0004	2101.6	2844.3	0	ANNUAL	ALL	1				
95		635324.5	4976834	0.00041	2098.74	2844.3	0	ANNUAL	ALL	1				
96		635349.5	4976834	0.00041	2104.26	2844.3	0	ANNUAL	ALL	1				
97		635374.5	4976834	0.00041	2110.4	2844.3	0	ANNUAL	ALL	1				
98		635399.5	4976834	0.0004	2117.98	2844.3	0	ANNUAL	ALL	1				
99		635199.5	4976859	0.00035	2114.34	2844.3	0	ANNUAL	ALL	1				
100		635224.5	4976859	0.00036	2108.68	2844.3	0	ANNUAL	ALL	1				
101		635249.5	4976859	0.00037	2104.42	2844.3	0	ANNUAL	ALL	1				
102		635274.5	4976859	0.00038	2101.28	2844.3	0	ANNUAL	ALL	1				
103		635299.5	4976859	0.00039	2098.83	2844.3	0	ANNUAL	ALL	1				
104		635324.5	4976859	0.0004	2096.89	2844.3	0	ANNUAL	ALL	1				
105		635349.5	4976859	0.0004	2101.21	2844.3	0	ANNUAL	ALL	1				
106		635374.5	4976859	0.0004	2108.71	2844.3	0	ANNUAL	ALL	1				
107		635399.5	4976859	0.00039	2118.31	2844.3	0	ANNUAL	ALL	1				
108		635199.5	4976884	0.00035	2111.17	2844.3	0	ANNUAL	ALL	1				
109		635224.5	4976884	0.00036	2104.78	2844.3	0	ANNUAL	ALL	1				
110		635249.5	4976884	0.00037	2100.14	2844.3	0	ANNUAL	ALL	1				
111		635274.5	4976884	0.00038	2097.48	2844.3	0	ANNUAL	ALL	1				
112		635299.5	4976884	0.00039	2095.42	2844.3	0	ANNUAL	ALL	1				
113		635324.5	4976884	0.00039	2094.96	2844.3	0	ANNUAL	ALL	1				
114		635349.5	4976884	0.0004	2097.83	2844.3	0	ANNUAL	ALL	1				
115		635374.5	4976884	0.00039	2107.96	2844.3	0	ANNUAL	ALL	1				
116		635399.5	4976884	0.00038	2119.17	2844.3	0	ANNUAL	ALL	1				
117		635199.5	4976909	0.00034	2108.51	2844.3	0	ANNUAL	ALL	1				
118		635224.5	4976909	0.00035	2102.17	2844.3	0	ANNUAL	ALL	1				
119		635249.5	4976909	0.00036	2097.31	2844.3	0	ANNUAL	ALL	1				
120		635274.5	4976909	0.00037	2094.85	2844.3	0	ANNUAL	ALL	1				
121		635299.5	4976909	0.00038	2093.19	2844.3	0	ANNUAL	ALL	1				
122		635324.5	4976909	0.00038	2093.48	2844.3	0	ANNUAL	ALL	1				
123		635349.5	4976909	0.00038	2098.12	2844.3	0	ANNUAL	ALL	1				
124		635374.5	4976909	0.00038	2108.79	2844.3	0	ANNUAL	ALL	1				
125		635399.5	4976909	0.00037	2120.74	2844.3	0	ANNUAL	ALL	1				
126		635199.5	4976934	0.00033	2106.38	2844.3	0	ANNUAL	ALL	1				
127		635224.5	4976934	0.00034	2100.81	2844.3	0	ANNUAL	ALL	1				
128		635249.5	4976934	0.00035	2096.21	2844.3	0	ANNUAL	ALL	1				
129		635274.5	4976934	0.00036	2092.89	2844.3	0	ANNUAL	ALL	1				
130		635299.5	4976934	0.00037	2091.1	2844.3	0	ANNUAL	ALL	1				
131		635324.5	4976934	0.00037	2092.46	2844.3	0	ANNUAL	ALL	1				
132		635349.5	4976934	0.00037	2099.48	2844.3	0	ANNUAL	ALL	1				
133		635374.5	4976934	0.00036	2110.37	2844.3	0	ANNUAL	ALL	1				
134		635399.5	4976934	0.00035	2122.91	2844.3	0	ANNUAL	ALL	1				
135		635199.5	4976959	0.00033	2104.62	2844.3	0	ANNUAL	ALL	1				
136		635224.5	4976959	0.00034	2099.28	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
137		635249.5	4976959	0.00035	2094.41	2844.3	0	ANNUAL	ALL	1				
138		635274.5	4976959	0.00036	2090.59	2844.3	0	ANNUAL	ALL	1				
139		635299.5	4976959	0.00036	2088.8	2844.3	0	ANNUAL	ALL	1				
140		635324.5	4976959	0.00036	2092.02	2844.3	0	ANNUAL	ALL	1				
141		635349.5	4976959	0.00036	2100.12	2844.3	0	ANNUAL	ALL	1				
142		635374.5	4976959	0.00035	2112.07	2844.3	0	ANNUAL	ALL	1				
143		635399.5	4976959	0.00034	2125.69	2844.3	0	ANNUAL	ALL	1				
144		635199.5	4976984	0.00032	2102.45	2844.3	0	ANNUAL	ALL	1				
145		635224.5	4976984	0.00033	2097.29	2844.3	0	ANNUAL	ALL	1				
146		635249.5	4976984	0.00034	2091.62	2844.3	0	ANNUAL	ALL	1				
147		635274.5	4976984	0.00035	2087.92	2844.3	0	ANNUAL	ALL	1				
148		635299.5	4976984	0.00035	2086.81	2844.3	0	ANNUAL	ALL	1				
149		635324.5	4976984	0.00035	2092.65	2844.3	0	ANNUAL	ALL	1				
150		635349.5	4976984	0.00035	2101.3	2844.3	0	ANNUAL	ALL	1				
151		635374.5	4976984	0.00034	2114.13	2844.3	0	ANNUAL	ALL	1				
152		635399.5	4976984	0.00033	2128.46	2844.3	0	ANNUAL	ALL	1				
153		635199.5	4977009	0.00032	2099.39	2844.3	0	ANNUAL	ALL	1				
154		635224.5	4977009	0.00033	2093.66	2844.3	0	ANNUAL	ALL	1				
155		635249.5	4977009	0.00034	2087.97	2844.3	0	ANNUAL	ALL	1				
156		635274.5	4977009	0.00034	2084.9	2844.3	0	ANNUAL	ALL	1				
157		635299.5	4977009	0.00035	2087.43	2844.3	0	ANNUAL	ALL	1				
158		635324.5	4977009	0.00034	2094.55	2844.3	0	ANNUAL	ALL	1				
159		635349.5	4977009	0.00034	2103.74	2844.3	0	ANNUAL	ALL	1				
160		635374.5	4977009	0.00033	2116.64	2844.3	0	ANNUAL	ALL	1				
161		635399.5	4977009	0.00032	2131.12	2844.3	0	ANNUAL	ALL	1				
162		635199.5	4977034	0.00031	2094.63	2844.3	0	ANNUAL	ALL	1				
163		635224.5	4977034	0.00032	2088.76	2844.3	0	ANNUAL	ALL	1				
164		635249.5	4977034	0.00033	2084.27	2844.3	0	ANNUAL	ALL	1				
165		635274.5	4977034	0.00033	2082.71	2844.3	0	ANNUAL	ALL	1				
166		635299.5	4977034	0.00034	2089.9	2844.3	0	ANNUAL	ALL	1				
167		635324.5	4977034	0.00033	2098.21	2844.3	0	ANNUAL	ALL	1				
168		635349.5	4977034	0.00033	2107.49	2844.3	0	ANNUAL	ALL	1				
169		635374.5	4977034	0.00032	2119.09	2844.3	0	ANNUAL	ALL	1				
170		635399.5	4977034	0.00031	2133.38	2844.3	0	ANNUAL	ALL	1				
171		634899.5	4977134	0.00019	2221.02	2844.3	0	ANNUAL	ALL	1				
172		634924.5	4977134	0.00019	2207.85	2844.3	0	ANNUAL	ALL	1				
173		634949.5	4977134	0.0002	2190.45	2844.3	0	ANNUAL	ALL	1				
174		634974.5	4977134	0.00022	2169.12	2844.3	0	ANNUAL	ALL	1				
175		634999.5	4977134	0.00023	2150.64	2844.3	0	ANNUAL	ALL	1				
176		635024.5	4977134	0.00024	2135.97	2844.3	0	ANNUAL	ALL	1				
177		635049.5	4977134	0.00025	2122.38	2844.3	0	ANNUAL	ALL	1				
178		635074.5	4977134	0.00026	2113.7	2844.3	0	ANNUAL	ALL	1				
179		635099.5	4977134	0.00027	2105.9	2844.3	0	ANNUAL	ALL	1				
180		634899.5	4977159	0.00019	2213.37	2844.3	0	ANNUAL	ALL	1				
181		634924.5	4977159	0.00019	2201.16	2844.3	0	ANNUAL	ALL	1				
182		634949.5	4977159	0.0002	2181.17	2844.3	0	ANNUAL	ALL	1				
183		634974.5	4977159	0.00022	2161.72	2844.3	0	ANNUAL	ALL	1				
184		634999.5	4977159	0.00023	2145.73	2844.3	0	ANNUAL	ALL	1				
185		635024.5	4977159	0.00024	2132.12	2844.3	0	ANNUAL	ALL	1				
186		635049.5	4977159	0.00025	2119.59	2844.3	0	ANNUAL	ALL	1				
187		635074.5	4977159	0.00026	2109.27	2844.3	0	ANNUAL	ALL	1				
188		635099.5	4977159	0.00027	2101.29	2844.3	0	ANNUAL	ALL	1				
189		634899.5	4977184	0.00019	2206.56	2844.3	0	ANNUAL	ALL	1				
190		634924.5	4977184	0.00019	2193.64	2844.3	0	ANNUAL	ALL	1				
191		634949.5	4977184	0.0002	2172.29	2844.3	0	ANNUAL	ALL	1				
192		634974.5	4977184	0.00022	2154.5	2844.3	0	ANNUAL	ALL	1				
193		634999.5	4977184	0.00023	2141.04	2844.3	0	ANNUAL	ALL	1				
194		635024.5	4977184	0.00024	2128.3	2844.3	0	ANNUAL	ALL	1				
195		635049.5	4977184	0.00025	2114.34	2844.3	0	ANNUAL	ALL	1				
196		635074.5	4977184	0.00026	2102.7	2844.3	0	ANNUAL	ALL	1				
197		635099.5	4977184	0.00027	2096.47	2844.3	0	ANNUAL	ALL	1				
198		634899.5	4977209	0.00019	2199.13	2844.3	0	ANNUAL	ALL	1				
199		634924.5	4977209	0.00019	2184.15	2844.3	0	ANNUAL	ALL	1				
200		634949.5	4977209	0.00021	2163.72	2844.3	0	ANNUAL	ALL	1				
201		634974.5	4977209	0.00022	2146.68	2844.3	0	ANNUAL	ALL	1				
202		634999.5	4977209	0.00022	2136.15	2844.3	0	ANNUAL	ALL	1				
203		635024.5	4977209	0.00023	2124.22	2844.3	0	ANNUAL	ALL	1				
204		635049.5	4977209	0.00025	2105.9	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
205		635074.5	4977209	0.00026	2096.39	2844.3	0	ANNUAL	ALL	1				
206		635099.5	4977209	0.00026	2091.31	2844.3	0	ANNUAL	ALL	1				
207		634899.5	4977234	0.00019	2185.16	2844.3	0	ANNUAL	ALL	1				
208		634924.5	4977234	0.0002	2172.04	2844.3	0	ANNUAL	ALL	1				
209		634949.5	4977234	0.00021	2152.41	2844.3	0	ANNUAL	ALL	1				
210		634974.5	4977234	0.00022	2139.97	2844.3	0	ANNUAL	ALL	1				
211		634999.5	4977234	0.00022	2130.73	2844.3	0	ANNUAL	ALL	1				
212		635024.5	4977234	0.00023	2117.31	2844.3	0	ANNUAL	ALL	1				
213		635049.5	4977234	0.00025	2098.65	2844.3	0	ANNUAL	ALL	1				
214		635074.5	4977234	0.00026	2092.39	2844.3	0	ANNUAL	ALL	1				
215		635099.5	4977234	0.00026	2087.32	2844.3	0	ANNUAL	ALL	1				
216		634899.5	4977259	0.00019	2180.4	2844.3	0	ANNUAL	ALL	1				
217		634924.5	4977259	0.0002	2160.19	2844.3	0	ANNUAL	ALL	1				
218		634949.5	4977259	0.00021	2143.3	2844.3	0	ANNUAL	ALL	1				
219		634974.5	4977259	0.00022	2132.11	2844.3	0	ANNUAL	ALL	1				
220		634999.5	4977259	0.00022	2123.02	2844.3	0	ANNUAL	ALL	1				
221		635024.5	4977259	0.00024	2107.09	2844.3	0	ANNUAL	ALL	1				
222		635049.5	4977259	0.00025	2095.35	2844.3	0	ANNUAL	ALL	1				
223		635074.5	4977259	0.00025	2089.07	2844.3	0	ANNUAL	ALL	1				
224		635099.5	4977259	0.00026	2083.6	2844.3	0	ANNUAL	ALL	1				
225		634899.5	4977284	0.00018	2180.69	2844.3	0	ANNUAL	ALL	1				
226		634924.5	4977284	0.0002	2158.28	2844.3	0	ANNUAL	ALL	1				
227		634949.5	4977284	0.00021	2139.34	2844.3	0	ANNUAL	ALL	1				
228		634974.5	4977284	0.00022	2123.05	2844.3	0	ANNUAL	ALL	1				
229		634999.5	4977284	0.00023	2112.91	2844.3	0	ANNUAL	ALL	1				
230		635024.5	4977284	0.00024	2100.55	2844.3	0	ANNUAL	ALL	1				
231		635049.5	4977284	0.00024	2092.76	2844.3	0	ANNUAL	ALL	1				
232		635074.5	4977284	0.00025	2085.71	2844.3	0	ANNUAL	ALL	1				
233		635099.5	4977284	0.00026	2078.67	2844.3	0	ANNUAL	ALL	1				
234		634899.5	4977309	0.00018	2178.55	2844.3	0	ANNUAL	ALL	1				
235		634924.5	4977309	0.00019	2156.77	2844.3	0	ANNUAL	ALL	1				
236		634949.5	4977309	0.0002	2136.54	2844.3	0	ANNUAL	ALL	1				
237		634974.5	4977309	0.00022	2119.59	2844.3	0	ANNUAL	ALL	1				
238		634999.5	4977309	0.00023	2107.01	2844.3	0	ANNUAL	ALL	1				
239		635024.5	4977309	0.00023	2096.52	2844.3	0	ANNUAL	ALL	1				
240		635049.5	4977309	0.00024	2089.24	2844.3	0	ANNUAL	ALL	1				
241		635074.5	4977309	0.00025	2082.55	2844.3	0	ANNUAL	ALL	1				
242		635099.5	4977309	0.00025	2075.98	2844.3	0	ANNUAL	ALL	1				
243		634899.5	4977334	0.00018	2173.18	2844.3	0	ANNUAL	ALL	1				
244		634924.5	4977334	0.00019	2153.29	2844.3	0	ANNUAL	ALL	1				
245		634949.5	4977334	0.0002	2133.9	2844.3	0	ANNUAL	ALL	1				
246		634974.5	4977334	0.00021	2117.58	2844.3	0	ANNUAL	ALL	1				
247		634999.5	4977334	0.00022	2104.03	2844.3	0	ANNUAL	ALL	1				
248		635024.5	4977334	0.00023	2093.8	2844.3	0	ANNUAL	ALL	1				
249		635049.5	4977334	0.00024	2085.23	2844.3	0	ANNUAL	ALL	1				
250		635074.5	4977334	0.00024	2078.76	2844.3	0	ANNUAL	ALL	1				
251		635099.5	4977334	0.00025	2074.53	2844.3	0	ANNUAL	ALL	1				
252		635399.5	4976159	0.00074	2171.27	2844.3	0	ANNUAL	ALL	1				
253		635424.5	4976159	0.00076	2169.98	2844.3	0	ANNUAL	ALL	1				
254		635449.5	4976159	0.00078	2167.61	2844.3	0	ANNUAL	ALL	1				
255		635474.5	4976159	0.00081	2164.06	2844.3	0	ANNUAL	ALL	1				
256		635499.5	4976159	0.00083	2161.76	2844.3	0	ANNUAL	ALL	1				
257		635524.5	4976159	0.00085	2160.48	2844.3	0	ANNUAL	ALL	1				
258		635549.5	4976159	0.00085	2162.19	2844.3	0	ANNUAL	ALL	1				
259		635574.5	4976159	0.00083	2168.15	2844.3	0	ANNUAL	ALL	1				
260		635599.5	4976159	0.0008	2173.85	2844.3	0	ANNUAL	ALL	1				
261		635399.5	4976184	0.00073	2168.06	2844.3	0	ANNUAL	ALL	1				
262		635424.5	4976184	0.00075	2166.17	2844.3	0	ANNUAL	ALL	1				
263		635449.5	4976184	0.00078	2163.95	2844.3	0	ANNUAL	ALL	1				
264		635474.5	4976184	0.0008	2161.05	2844.3	0	ANNUAL	ALL	1				
265		635499.5	4976184	0.00083	2158.86	2844.3	0	ANNUAL	ALL	1				
266		635524.5	4976184	0.00085	2157.1	2844.3	0	ANNUAL	ALL	1				
267		635549.5	4976184	0.00086	2157.07	2844.3	0	ANNUAL	ALL	1				
268		635574.5	4976184	0.00083	2164.59	2844.3	0	ANNUAL	ALL	1				
269		635599.5	4976184	0.00079	2172.06	2844.3	0	ANNUAL	ALL	1				
270		635399.5	4976209	0.00072	2165.29	2844.3	0	ANNUAL	ALL	1				
271		635424.5	4976209	0.00075	2163.14	2844.3	0	ANNUAL	ALL	1				
272		635449.5	4976209	0.00077	2160.76	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
273		635474.5	4976209	0.0008	2158.05	2844.3	0	ANNUAL	ALL	1				
274		635499.5	4976209	0.00082	2155.43	2844.3	0	ANNUAL	ALL	1				
275		635524.5	4976209	0.00084	2153.57	2844.3	0	ANNUAL	ALL	1				
276		635549.5	4976209	0.00084	2156.02	2844.3	0	ANNUAL	ALL	1				
277		635574.5	4976209	0.0008	2165.26	2844.3	0	ANNUAL	ALL	1				
278		635599.5	4976209	0.00076	2175.01	2844.3	0	ANNUAL	ALL	1				
279		635399.5	4976234	0.00071	2162.56	2844.3	0	ANNUAL	ALL	1				
280		635424.5	4976234	0.00074	2160.46	2844.3	0	ANNUAL	ALL	1				
281		635449.5	4976234	0.00076	2157.93	2844.3	0	ANNUAL	ALL	1				
282		635474.5	4976234	0.00078	2155.5	2844.3	0	ANNUAL	ALL	1				
283		635499.5	4976234	0.00081	2152.67	2844.3	0	ANNUAL	ALL	1				
284		635524.5	4976234	0.00084	2150.12	2844.3	0	ANNUAL	ALL	1				
285		635549.5	4976234	0.00081	2156.6	2844.3	0	ANNUAL	ALL	1				
286		635574.5	4976234	0.00077	2167.62	2844.3	0	ANNUAL	ALL	1				
287		635599.5	4976234	0.00072	2178.35	2844.3	0	ANNUAL	ALL	1				
288		634999.5	4978134	0.00014	2044.53	2844.3	0	ANNUAL	ALL	1				
289		635024.5	4978134	0.00014	2030.56	2844.3	0	ANNUAL	ALL	1				
290		635049.5	4978134	0.00015	2018.07	2844.3	0	ANNUAL	ALL	1				
291		635074.5	4978134	0.00015	2006.69	2844.3	0	ANNUAL	ALL	1				
292		635099.5	4978134	0.00015	2006.39	2844.3	0	ANNUAL	ALL	1				
293		635124.5	4978134	0.00015	2013.34	2844.3	0	ANNUAL	ALL	1				
294		635149.5	4978134	0.00015	2020.75	2844.3	0	ANNUAL	ALL	1				
295		635174.5	4978134	0.00015	2029.05	2844.3	0	ANNUAL	ALL	1				
296		635199.5	4978134	0.00015	2038.91	2844.3	0	ANNUAL	ALL	1				
297		634999.5	4978159	0.00014	2044.5	2844.3	0	ANNUAL	ALL	1				
298		635024.5	4978159	0.00014	2030.78	2844.3	0	ANNUAL	ALL	1				
299		635049.5	4978159	0.00015	2017.35	2844.3	0	ANNUAL	ALL	1				
300		635074.5	4978159	0.00015	2004.54	2844.3	0	ANNUAL	ALL	1				
301		635099.5	4978159	0.00015	2003.81	2844.3	0	ANNUAL	ALL	1				
302		635124.5	4978159	0.00015	2010.57	2844.3	0	ANNUAL	ALL	1				
303		635149.5	4978159	0.00015	2017.75	2844.3	0	ANNUAL	ALL	1				
304		635174.5	4978159	0.00015	2025.18	2844.3	0	ANNUAL	ALL	1				
305		635199.5	4978159	0.00015	2035.11	2844.3	0	ANNUAL	ALL	1				
306		634999.5	4978184	0.00014	2044.38	2844.3	0	ANNUAL	ALL	1				
307		635024.5	4978184	0.00014	2028.98	2844.3	0	ANNUAL	ALL	1				
308		635049.5	4978184	0.00015	2015.36	2844.3	0	ANNUAL	ALL	1				
309		635074.5	4978184	0.00015	2002.43	2844.3	0	ANNUAL	ALL	1				
310		635099.5	4978184	0.00015	2000.86	2844.3	0	ANNUAL	ALL	1				
311		635124.5	4978184	0.00015	2007.53	2844.3	0	ANNUAL	ALL	1				
312		635149.5	4978184	0.00015	2014.6	2844.3	0	ANNUAL	ALL	1				
313		635174.5	4978184	0.00015	2022.07	2844.3	0	ANNUAL	ALL	1				
314		635199.5	4978184	0.00015	2031.45	2844.3	0	ANNUAL	ALL	1				
315		634999.5	4978209	0.00014	2043.46	2844.3	0	ANNUAL	ALL	1				
316		635024.5	4978209	0.00014	2027.94	2844.3	0	ANNUAL	ALL	1				
317		635049.5	4978209	0.00014	2013.73	2844.3	0	ANNUAL	ALL	1				
318		635074.5	4978209	0.00015	2000.96	2844.3	0	ANNUAL	ALL	1				
319		635099.5	4978209	0.00015	1998.75	2844.3	0	ANNUAL	ALL	1				
320		635124.5	4978209	0.00015	2004.56	2844.3	0	ANNUAL	ALL	1				
321		635149.5	4978209	0.00015	2011.78	2844.3	0	ANNUAL	ALL	1				
322		635174.5	4978209	0.00015	2019.36	2844.3	0	ANNUAL	ALL	1				
323		635199.5	4978209	0.00014	2027.82	2844.3	0	ANNUAL	ALL	1				
324		634999.5	4978234	0.00013	2042.97	2844.3	0	ANNUAL	ALL	1				
325		635024.5	4978234	0.00014	2026.61	2844.3	0	ANNUAL	ALL	1				
326		635049.5	4978234	0.00014	2012.57	2844.3	0	ANNUAL	ALL	1				
327		635074.5	4978234	0.00015	2000.24	2844.3	0	ANNUAL	ALL	1				
328		635099.5	4978234	0.00016	1996.61	2844.3	0	ANNUAL	ALL	1				
329		635124.5	4978234	0.00015	2001.65	2844.3	0	ANNUAL	ALL	1				
330		635149.5	4978234	0.00015	2009.16	2844.3	0	ANNUAL	ALL	1				
331		635174.5	4978234	0.00014	2016.86	2844.3	0	ANNUAL	ALL	1				
332		635199.5	4978234	0.00014	2024.48	2844.3	0	ANNUAL	ALL	1				
333		634999.5	4978259	0.00013	2041.08	2844.3	0	ANNUAL	ALL	1				
334		635024.5	4978259	0.00014	2024.08	2844.3	0	ANNUAL	ALL	1				
335		635049.5	4978259	0.00014	2011.49	2844.3	0	ANNUAL	ALL	1				
336		635074.5	4978259	0.00015	2000.61	2844.3	0	ANNUAL	ALL	1				
337		635099.5	4978259	0.00016	1994.84	2844.3	0	ANNUAL	ALL	1				
338		635124.5	4978259	0.00015	1999.29	2844.3	0	ANNUAL	ALL	1				
339		635149.5	4978259	0.00015	2007.14	2844.3	0	ANNUAL	ALL	1				
340		635174.5	4978259	0.00014	2014.96	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
341		635199.5	4978259	0.00014	2023.44	2844.3	0	ANNUAL	ALL	1				
342		634999.5	4978284	0.00013	2039.02	2844.3	0	ANNUAL	ALL	1				
343		635024.5	4978284	0.00014	2022.69	2844.3	0	ANNUAL	ALL	1				
344		635049.5	4978284	0.00014	2010.11	2844.3	0	ANNUAL	ALL	1				
345		635074.5	4978284	0.00015	1999.28	2844.3	0	ANNUAL	ALL	1				
346		635099.5	4978284	0.00016	1993.94	2844.3	0	ANNUAL	ALL	1				
347		635124.5	4978284	0.00016	1996.86	2844.3	0	ANNUAL	ALL	1				
348		635149.5	4978284	0.00015	2004.78	2844.3	0	ANNUAL	ALL	1				
349		635174.5	4978284	0.00014	2012.7	2844.3	0	ANNUAL	ALL	1				
350		635199.5	4978284	0.00014	2021.78	2844.3	0	ANNUAL	ALL	1				
351		634999.5	4978309	0.00013	2036.72	2844.3	0	ANNUAL	ALL	1				
352		635024.5	4978309	0.00014	2023.32	2844.3	0	ANNUAL	ALL	1				
353		635049.5	4978309	0.00014	2010.1	2844.3	0	ANNUAL	ALL	1				
354		635074.5	4978309	0.00015	1999.36	2844.3	0	ANNUAL	ALL	1				
355		635099.5	4978309	0.00015	1992.81	2844.3	0	ANNUAL	ALL	1				
356		635124.5	4978309	0.00015	1994.13	2844.3	0	ANNUAL	ALL	1				
357		635149.5	4978309	0.00015	2001.68	2844.3	0	ANNUAL	ALL	1				
358		635174.5	4978309	0.00014	2009.75	2844.3	0	ANNUAL	ALL	1				
359		635199.5	4978309	0.00014	2018.84	2844.3	0	ANNUAL	ALL	1				
360		634999.5	4978334	0.00013	2033.58	2844.3	0	ANNUAL	ALL	1				
361		635024.5	4978334	0.00013	2021.76	2844.3	0	ANNUAL	ALL	1				
362		635049.5	4978334	0.00014	2009.59	2844.3	0	ANNUAL	ALL	1				
363		635074.5	4978334	0.00014	1999.33	2844.3	0	ANNUAL	ALL	1				
364		635099.5	4978334	0.00015	1991.74	2844.3	0	ANNUAL	ALL	1				
365		635124.5	4978334	0.00015	1991.62	2844.3	0	ANNUAL	ALL	1				
366		635149.5	4978334	0.00015	1998.49	2844.3	0	ANNUAL	ALL	1				
367		635174.5	4978334	0.00014	2006.18	2844.3	0	ANNUAL	ALL	1				
368		635199.5	4978334	0.00014	2015.32	2844.3	0	ANNUAL	ALL	1				
369		634299.5	4978134	0.00013	2065.05	2844.3	0	ANNUAL	ALL	1				
370		634324.5	4978134	0.00014	2052.1	2844.3	0	ANNUAL	ALL	1				
371		634349.5	4978134	0.00014	2045.24	2844.3	0	ANNUAL	ALL	1				
372		634374.5	4978134	0.00014	2034.94	2844.3	0	ANNUAL	ALL	1				
373		634399.5	4978134	0.00014	2020.36	2844.3	0	ANNUAL	ALL	1				
374		634424.5	4978134	0.00014	2003.67	2844.3	0	ANNUAL	ALL	1				
375		634449.5	4978134	0.00015	1995.29	2844.3	0	ANNUAL	ALL	1				
376		634474.5	4978134	0.00014	2007.74	2844.3	0	ANNUAL	ALL	1				
377		634499.5	4978134	0.00014	2026.56	2844.3	0	ANNUAL	ALL	1				
378		634299.5	4978159	0.00013	2056.37	2844.3	0	ANNUAL	ALL	1				
379		634324.5	4978159	0.00014	2043.39	2844.3	0	ANNUAL	ALL	1				
380		634349.5	4978159	0.00014	2031.51	2844.3	0	ANNUAL	ALL	1				
381		634374.5	4978159	0.00014	2023.05	2844.3	0	ANNUAL	ALL	1				
382		634399.5	4978159	0.00014	2009.29	2844.3	0	ANNUAL	ALL	1				
383		634424.5	4978159	0.00015	1995	2844.3	0	ANNUAL	ALL	1				
384		634449.5	4978159	0.00015	1992.7	2844.3	0	ANNUAL	ALL	1				
385		634474.5	4978159	0.00014	2006.88	2844.3	0	ANNUAL	ALL	1				
386		634499.5	4978159	0.00014	2023.97	2844.3	0	ANNUAL	ALL	1				
387		634299.5	4978184	0.00013	2049.3	2844.3	0	ANNUAL	ALL	1				
388		634324.5	4978184	0.00014	2036.32	2844.3	0	ANNUAL	ALL	1				
389		634349.5	4978184	0.00014	2022.34	2844.3	0	ANNUAL	ALL	1				
390		634374.5	4978184	0.00014	2009.09	2844.3	0	ANNUAL	ALL	1				
391		634399.5	4978184	0.00014	1999.89	2844.3	0	ANNUAL	ALL	1				
392		634424.5	4978184	0.00015	1987.52	2844.3	0	ANNUAL	ALL	1				
393		634449.5	4978184	0.00015	1991.46	2844.3	0	ANNUAL	ALL	1				
394		634474.5	4978184	0.00014	2006.06	2844.3	0	ANNUAL	ALL	1				
395		634499.5	4978184	0.00014	2020.38	2844.3	0	ANNUAL	ALL	1				
396		634299.5	4978209	0.00013	2043.21	2844.3	0	ANNUAL	ALL	1				
397		634324.5	4978209	0.00013	2030.6	2844.3	0	ANNUAL	ALL	1				
398		634349.5	4978209	0.00014	2016.03	2844.3	0	ANNUAL	ALL	1				
399		634374.5	4978209	0.00014	2000.87	2844.3	0	ANNUAL	ALL	1				
400		634399.5	4978209	0.00015	1990.53	2844.3	0	ANNUAL	ALL	1				
401		634424.5	4978209	0.00015	1981.32	2844.3	0	ANNUAL	ALL	1				
402		634449.5	4978209	0.00015	1989.45	2844.3	0	ANNUAL	ALL	1				
403		634474.5	4978209	0.00014	2004.01	2844.3	0	ANNUAL	ALL	1				
404		634499.5	4978209	0.00014	2016.91	2844.3	0	ANNUAL	ALL	1				
405		634299.5	4978234	0.00013	2037.27	2844.3	0	ANNUAL	ALL	1				
406		634324.5	4978234	0.00013	2025.09	2844.3	0	ANNUAL	ALL	1				
407		634349.5	4978234	0.00013	2009.81	2844.3	0	ANNUAL	ALL	1				
408		634374.5	4978234	0.00014	1996.13	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
409		634399.5	4978234	0.00015	1984.05	2844.3	0	ANNUAL	ALL	1				
410		634424.5	4978234	0.00015	1975.87	2844.3	0	ANNUAL	ALL	1				
411		634449.5	4978234	0.00015	1984.97	2844.3	0	ANNUAL	ALL	1				
412		634474.5	4978234	0.00014	2000.36	2844.3	0	ANNUAL	ALL	1				
413		634499.5	4978234	0.00014	2011.73	2844.3	0	ANNUAL	ALL	1				
414		634299.5	4978259	0.00013	2030.97	2844.3	0	ANNUAL	ALL	1				
415		634324.5	4978259	0.00013	2018.02	2844.3	0	ANNUAL	ALL	1				
416		634349.5	4978259	0.00014	2002.99	2844.3	0	ANNUAL	ALL	1				
417		634374.5	4978259	0.00014	1990.41	2844.3	0	ANNUAL	ALL	1				
418		634399.5	4978259	0.00015	1978.88	2844.3	0	ANNUAL	ALL	1				
419		634424.5	4978259	0.00015	1972.17	2844.3	0	ANNUAL	ALL	1				
420		634449.5	4978259	0.00015	1977.85	2844.3	0	ANNUAL	ALL	1				
421		634474.5	4978259	0.00015	1992.52	2844.3	0	ANNUAL	ALL	1				
422		634499.5	4978259	0.00014	2003.44	2844.3	0	ANNUAL	ALL	1				
423		634299.5	4978284	0.00013	2023.26	2844.3	0	ANNUAL	ALL	1				
424		634324.5	4978284	0.00013	2008.98	2844.3	0	ANNUAL	ALL	1				
425		634349.5	4978284	0.00014	1996.31	2844.3	0	ANNUAL	ALL	1				
426		634374.5	4978284	0.00014	1984.2	2844.3	0	ANNUAL	ALL	1				
427		634399.5	4978284	0.00015	1973.37	2844.3	0	ANNUAL	ALL	1				
428		634424.5	4978284	0.00015	1969.23	2844.3	0	ANNUAL	ALL	1				
429		634449.5	4978284	0.00015	1975.58	2844.3	0	ANNUAL	ALL	1				
430		634474.5	4978284	0.00014	1989.07	2844.3	0	ANNUAL	ALL	1				
431		634499.5	4978284	0.00014	2000.53	2844.3	0	ANNUAL	ALL	1				
432		634299.5	4978309	0.00013	2012.41	2844.3	0	ANNUAL	ALL	1				
433		634324.5	4978309	0.00013	1999.74	2844.3	0	ANNUAL	ALL	1				
434		634349.5	4978309	0.00014	1988.62	2844.3	0	ANNUAL	ALL	1				
435		634374.5	4978309	0.00014	1977.79	2844.3	0	ANNUAL	ALL	1				
436		634399.5	4978309	0.00015	1967.1	2844.3	0	ANNUAL	ALL	1				
437		634424.5	4978309	0.00015	1968.14	2844.3	0	ANNUAL	ALL	1				
438		634449.5	4978309	0.00015	1977.66	2844.3	0	ANNUAL	ALL	1				
439		634474.5	4978309	0.00014	1992.31	2844.3	0	ANNUAL	ALL	1				
440		634499.5	4978309	0.00013	2006.23	2844.3	0	ANNUAL	ALL	1				
441		634299.5	4978334	0.00013	2000.94	2844.3	0	ANNUAL	ALL	1				
442		634324.5	4978334	0.00014	1991.1	2844.3	0	ANNUAL	ALL	1				
443		634349.5	4978334	0.00014	1980.66	2844.3	0	ANNUAL	ALL	1				
444		634374.5	4978334	0.00015	1970.39	2844.3	0	ANNUAL	ALL	1				
445		634399.5	4978334	0.00015	1961.38	2844.3	0	ANNUAL	ALL	1				
446		634424.5	4978334	0.00015	1968.29	2844.3	0	ANNUAL	ALL	1				
447		634449.5	4978334	0.00014	1980.95	2844.3	0	ANNUAL	ALL	1				
448		634474.5	4978334	0.00014	1997.36	2844.3	0	ANNUAL	ALL	1				
449		634499.5	4978334	0.00013	2012.52	2844.3	0	ANNUAL	ALL	1				
450		634299.5	4978359	0.00014	1991.4	2844.3	0	ANNUAL	ALL	1				
451		634324.5	4978359	0.00014	1982.72	2844.3	0	ANNUAL	ALL	1				
452		634349.5	4978359	0.00014	1972.75	2844.3	0	ANNUAL	ALL	1				
453		634374.5	4978359	0.00015	1962.87	2844.3	0	ANNUAL	ALL	1				
454		634399.5	4978359	0.00015	1958.17	2844.3	0	ANNUAL	ALL	1				
455		634424.5	4978359	0.00015	1968.79	2844.3	0	ANNUAL	ALL	1				
456		634449.5	4978359	0.00014	1984.24	2844.3	0	ANNUAL	ALL	1				
457		634474.5	4978359	0.00013	2002.2	2844.3	0	ANNUAL	ALL	1				
458		634499.5	4978359	0.00013	2016.76	2844.3	0	ANNUAL	ALL	1				
459		634299.5	4978384	0.00014	1982.57	2844.3	0	ANNUAL	ALL	1				
460		634324.5	4978384	0.00014	1975.68	2844.3	0	ANNUAL	ALL	1				
461		634349.5	4978384	0.00014	1964.84	2844.3	0	ANNUAL	ALL	1				
462		634374.5	4978384	0.00015	1956.29	2844.3	0	ANNUAL	ALL	1				
463		634399.5	4978384	0.00015	1955.61	2844.3	0	ANNUAL	ALL	1				
464		634424.5	4978384	0.00014	1968.65	2844.3	0	ANNUAL	ALL	1				
465		634449.5	4978384	0.00014	1986.09	2844.3	0	ANNUAL	ALL	1				
466		634474.5	4978384	0.00013	2004.63	2844.3	0	ANNUAL	ALL	1				
467		634499.5	4978384	0.00013	2018.69	2844.3	0	ANNUAL	ALL	1				
468		634299.5	4978409	0.00014	1975.4	2844.3	0	ANNUAL	ALL	1				
469		634324.5	4978409	0.00014	1967.52	2844.3	0	ANNUAL	ALL	1				
470		634349.5	4978409	0.00014	1957.04	2844.3	0	ANNUAL	ALL	1				
471		634374.5	4978409	0.00015	1949.69	2844.3	0	ANNUAL	ALL	1				
472		634399.5	4978409	0.00015	1951.43	2844.3	0	ANNUAL	ALL	1				
473		634424.5	4978409	0.00014	1967.3	2844.3	0	ANNUAL	ALL	1				
474		634449.5	4978409	0.00014	1986.39	2844.3	0	ANNUAL	ALL	1				
475		634474.5	4978409	0.00013	2005.28	2844.3	0	ANNUAL	ALL	1				
476		634499.5	4978409	0.00013	2019.28	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
477		634299.5	4978434	0.00014	1965.22	2844.3	0	ANNUAL	ALL	1				
478		634324.5	4978434	0.00014	1958.88	2844.3	0	ANNUAL	ALL	1				
479		634349.5	4978434	0.00014	1950.79	2844.3	0	ANNUAL	ALL	1				
480		634374.5	4978434	0.00015	1943.73	2844.3	0	ANNUAL	ALL	1				
481		634399.5	4978434	0.00015	1949.4	2844.3	0	ANNUAL	ALL	1				
482		634424.5	4978434	0.00014	1965.04	2844.3	0	ANNUAL	ALL	1				
483		634449.5	4978434	0.00014	1984.59	2844.3	0	ANNUAL	ALL	1				
484		634474.5	4978434	0.00013	2004.45	2844.3	0	ANNUAL	ALL	1				
485		634499.5	4978434	0.00013	2017.53	2844.3	0	ANNUAL	ALL	1				
486		634249.4	4977384	0.00012	2291.4	2717.08	0	ANNUAL	ALL	1				
487		634274.4	4977384	0.00012	2282.65	2742	0	ANNUAL	ALL	1				
488		634299.4	4977384	0.00012	2273.71	2742	0	ANNUAL	ALL	1				
489		634324.4	4977384	0.00012	2263.84	2742	0	ANNUAL	ALL	1				
490		634349.4	4977384	0.00013	2250.84	2742	0	ANNUAL	ALL	1				
491		634374.4	4977384	0.00013	2238.58	2742.16	0	ANNUAL	ALL	1				
492		634399.4	4977384	0.00013	2232.43	2742.16	0	ANNUAL	ALL	1				
493		634424.4	4977384	0.00013	2242.73	2742.16	0	ANNUAL	ALL	1				
494		634449.4	4977384	0.00013	2255.36	2742	0	ANNUAL	ALL	1				
495		634249.4	4977409	0.00012	2284.43	2742	0	ANNUAL	ALL	1				
496		634274.4	4977409	0.00012	2274.53	2742	0	ANNUAL	ALL	1				
497		634299.4	4977409	0.00012	2264.56	2742	0	ANNUAL	ALL	1				
498		634324.4	4977409	0.00012	2254.44	2742	0	ANNUAL	ALL	1				
499		634349.4	4977409	0.00013	2243.93	2742.16	0	ANNUAL	ALL	1				
500		634374.4	4977409	0.00013	2231.37	2742.16	0	ANNUAL	ALL	1				
501		634399.4	4977409	0.00013	2226.02	2844.3	0	ANNUAL	ALL	1				
502		634424.4	4977409	0.00013	2236.92	2742.16	0	ANNUAL	ALL	1				
503		634449.4	4977409	0.00013	2249.43	2742.16	0	ANNUAL	ALL	1				
504		634249.4	4977434	0.00012	2279.34	2742	0	ANNUAL	ALL	1				
505		634274.4	4977434	0.00012	2267.65	2742	0	ANNUAL	ALL	1				
506		634299.4	4977434	0.00012	2255.85	2742	0	ANNUAL	ALL	1				
507		634324.4	4977434	0.00012	2244.86	2742	0	ANNUAL	ALL	1				
508		634349.4	4977434	0.00013	2234.48	2742.16	0	ANNUAL	ALL	1				
509		634374.4	4977434	0.00013	2223.18	2844.3	0	ANNUAL	ALL	1				
510		634399.4	4977434	0.00013	2218.5	2844.3	0	ANNUAL	ALL	1				
511		634424.4	4977434	0.00013	2230.27	2844.3	0	ANNUAL	ALL	1				
512		634449.4	4977434	0.00013	2243.66	2742.16	0	ANNUAL	ALL	1				
513		634249.4	4977459	0.00011	2275.78	2742	0	ANNUAL	ALL	1				
514		634274.4	4977459	0.00012	2262.83	2742	0	ANNUAL	ALL	1				
515		634299.4	4977459	0.00012	2248.74	2742	0	ANNUAL	ALL	1				
516		634324.4	4977459	0.00012	2237.43	2742.16	0	ANNUAL	ALL	1				
517		634349.4	4977459	0.00013	2226.72	2844.3	0	ANNUAL	ALL	1				
518		634374.4	4977459	0.00013	2214.97	2844.3	0	ANNUAL	ALL	1				
519		634399.4	4977459	0.00013	2211.75	2844.3	0	ANNUAL	ALL	1				
520		634424.4	4977459	0.00013	2223.34	2844.3	0	ANNUAL	ALL	1				
521		634449.4	4977459	0.00013	2237.29	2844.3	0	ANNUAL	ALL	1				
522		634249.4	4977484	0.00011	2272.5	2742	0	ANNUAL	ALL	1				
523		634274.4	4977484	0.00012	2258.48	2742	0	ANNUAL	ALL	1				
524		634299.4	4977484	0.00012	2243.77	2742	0	ANNUAL	ALL	1				
525		634324.4	4977484	0.00012	2231.45	2742.16	0	ANNUAL	ALL	1				
526		634349.4	4977484	0.00012	2219.9	2844.3	0	ANNUAL	ALL	1				
527		634374.4	4977484	0.00013	2207.94	2844.3	0	ANNUAL	ALL	1				
528		634399.4	4977484	0.00013	2204.62	2844.3	0	ANNUAL	ALL	1				
529		634424.4	4977484	0.00013	2216.76	2844.3	0	ANNUAL	ALL	1				
530		634449.4	4977484	0.00013	2230.33	2844.3	0	ANNUAL	ALL	1				
531		634249.4	4977509	0.00011	2269.17	2742	0	ANNUAL	ALL	1				
532		634274.4	4977509	0.00011	2254.88	2742	0	ANNUAL	ALL	1				
533		634299.4	4977509	0.00012	2240.59	2742	0	ANNUAL	ALL	1				
534		634324.4	4977509	0.00012	2227.32	2844.3	0	ANNUAL	ALL	1				
535		634349.4	4977509	0.00012	2213.19	2844.3	0	ANNUAL	ALL	1				
536		634374.4	4977509	0.00013	2200.19	2844.3	0	ANNUAL	ALL	1				
537		634399.4	4977509	0.00013	2197.61	2844.3	0	ANNUAL	ALL	1				
538		634424.4	4977509	0.00013	2211.03	2844.3	0	ANNUAL	ALL	1				
539		634449.4	4977509	0.00013	2223.57	2844.3	0	ANNUAL	ALL	1				
540		634249.4	4977534	0.00011	2266.65	2742	0	ANNUAL	ALL	1				
541		634274.4	4977534	0.00011	2251.58	2742	0	ANNUAL	ALL	1				
542		634299.4	4977534	0.00012	2237.18	2742	0	ANNUAL	ALL	1				
543		634324.4	4977534	0.00012	2223.67	2844.3	0	ANNUAL	ALL	1				
544		634349.4	4977534	0.00012	2207.86	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
545		634374.4	4977534	0.00013	2193.38	2844.3	0	ANNUAL	ALL	1				
546		634399.4	4977534	0.00013	2191.95	2844.3	0	ANNUAL	ALL	1				
547		634424.4	4977534	0.00013	2205.88	2844.3	0	ANNUAL	ALL	1				
548		634449.4	4977534	0.00012	2217.63	2844.3	0	ANNUAL	ALL	1				
549		634249.4	4977559	0.00011	2264.12	2742	0	ANNUAL	ALL	1				
550		634274.4	4977559	0.00011	2247.26	2742	0	ANNUAL	ALL	1				
551		634299.4	4977559	0.00011	2232.74	2742	0	ANNUAL	ALL	1				
552		634324.4	4977559	0.00012	2218.55	2844.3	0	ANNUAL	ALL	1				
553		634349.4	4977559	0.00012	2203.35	2844.3	0	ANNUAL	ALL	1				
554		634374.4	4977559	0.00012	2189.62	2844.3	0	ANNUAL	ALL	1				
555		634399.4	4977559	0.00013	2184.96	2844.3	0	ANNUAL	ALL	1				
556		634424.4	4977559	0.00012	2200.77	2844.3	0	ANNUAL	ALL	1				
557		634449.4	4977559	0.00012	2211.07	2844.3	0	ANNUAL	ALL	1				
558		634249.4	4977584	0.00011	2258.01	2742	0	ANNUAL	ALL	1				
559		634274.4	4977584	0.00011	2242.66	2742	0	ANNUAL	ALL	1				
560		634299.4	4977584	0.00011	2227.67	2844.3	0	ANNUAL	ALL	1				
561		634324.4	4977584	0.00012	2213.51	2844.3	0	ANNUAL	ALL	1				
562		634349.4	4977584	0.00012	2199.5	2844.3	0	ANNUAL	ALL	1				
563		634374.4	4977584	0.00012	2185.33	2844.3	0	ANNUAL	ALL	1				
564		634399.4	4977584	0.00013	2177.11	2844.3	0	ANNUAL	ALL	1				
565		634424.4	4977584	0.00012	2192.43	2844.3	0	ANNUAL	ALL	1				
566		634449.4	4977584	0.00012	2203.16	2844.3	0	ANNUAL	ALL	1				
567		634999.5	4977834	0.00017	2055.79	2844.3	0	ANNUAL	ALL	1				
568		635024.5	4977834	0.00017	2048.42	2844.3	0	ANNUAL	ALL	1				
569		635049.5	4977834	0.00017	2043	2844.3	0	ANNUAL	ALL	1				
570		635074.5	4977834	0.00017	2037.93	2844.3	0	ANNUAL	ALL	1				
571		635099.5	4977834	0.00017	2034.24	2844.3	0	ANNUAL	ALL	1				
572		635124.5	4977834	0.00018	2031.45	2844.3	0	ANNUAL	ALL	1				
573		635149.5	4977834	0.00018	2038.5	2844.3	0	ANNUAL	ALL	1				
574		635174.5	4977834	0.00018	2050.35	2844.3	0	ANNUAL	ALL	1				
575		635199.5	4977834	0.00018	2063.26	2844.3	0	ANNUAL	ALL	1				
576		634999.5	4977859	0.00016	2052.63	2844.3	0	ANNUAL	ALL	1				
577		635024.5	4977859	0.00017	2046.41	2844.3	0	ANNUAL	ALL	1				
578		635049.5	4977859	0.00017	2040.95	2844.3	0	ANNUAL	ALL	1				
579		635074.5	4977859	0.00017	2036.03	2844.3	0	ANNUAL	ALL	1				
580		635099.5	4977859	0.00017	2032.3	2844.3	0	ANNUAL	ALL	1				
581		635124.5	4977859	0.00017	2030.17	2844.3	0	ANNUAL	ALL	1				
582		635149.5	4977859	0.00017	2038.33	2844.3	0	ANNUAL	ALL	1				
583		635174.5	4977859	0.00017	2049.93	2844.3	0	ANNUAL	ALL	1				
584		635199.5	4977859	0.00017	2062.54	2844.3	0	ANNUAL	ALL	1				
585		634999.5	4977884	0.00016	2049.11	2844.3	0	ANNUAL	ALL	1				
586		635024.5	4977884	0.00016	2044.13	2844.3	0	ANNUAL	ALL	1				
587		635049.5	4977884	0.00017	2038.92	2844.3	0	ANNUAL	ALL	1				
588		635074.5	4977884	0.00017	2034.26	2844.3	0	ANNUAL	ALL	1				
589		635099.5	4977884	0.00017	2030.48	2844.3	0	ANNUAL	ALL	1				
590		635124.5	4977884	0.00017	2029.04	2844.3	0	ANNUAL	ALL	1				
591		635149.5	4977884	0.00017	2038.45	2844.3	0	ANNUAL	ALL	1				
592		635174.5	4977884	0.00017	2049.51	2844.3	0	ANNUAL	ALL	1				
593		635199.5	4977884	0.00017	2061.56	2844.3	0	ANNUAL	ALL	1				
594		634999.5	4977909	0.00016	2047.27	2844.3	0	ANNUAL	ALL	1				
595		635024.5	4977909	0.00016	2042.16	2844.3	0	ANNUAL	ALL	1				
596		635049.5	4977909	0.00016	2036.97	2844.3	0	ANNUAL	ALL	1				
597		635074.5	4977909	0.00017	2032.48	2844.3	0	ANNUAL	ALL	1				
598		635099.5	4977909	0.00017	2028.7	2844.3	0	ANNUAL	ALL	1				
599		635124.5	4977909	0.00017	2028.77	2844.3	0	ANNUAL	ALL	1				
600		635149.5	4977909	0.00017	2038.62	2844.3	0	ANNUAL	ALL	1				
601		635174.5	4977909	0.00017	2049.12	2844.3	0	ANNUAL	ALL	1				
602		635199.5	4977909	0.00017	2060.48	2844.3	0	ANNUAL	ALL	1				
603		634999.5	4977934	0.00016	2046.79	2844.3	0	ANNUAL	ALL	1				
604		635024.5	4977934	0.00016	2040.92	2844.3	0	ANNUAL	ALL	1				
605		635049.5	4977934	0.00016	2034.68	2844.3	0	ANNUAL	ALL	1				
606		635074.5	4977934	0.00016	2029.58	2844.3	0	ANNUAL	ALL	1				
607		635099.5	4977934	0.00017	2025.61	2844.3	0	ANNUAL	ALL	1				
608		635124.5	4977934	0.00017	2027.68	2844.3	0	ANNUAL	ALL	1				
609		635149.5	4977934	0.00017	2038.09	2844.3	0	ANNUAL	ALL	1				
610		635174.5	4977934	0.00017	2048.68	2844.3	0	ANNUAL	ALL	1				
611		635199.5	4977934	0.00017	2059.02	2844.3	0	ANNUAL	ALL	1				
612		634999.5	4977959	0.00015	2045.95	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
613		635024.5	4977959	0.00016	2039.51	2844.3	0	ANNUAL	ALL	1				
614		635049.5	4977959	0.00016	2032.45	2844.3	0	ANNUAL	ALL	1				
615		635074.5	4977959	0.00016	2026.52	2844.3	0	ANNUAL	ALL	1				
616		635099.5	4977959	0.00016	2022.6	2844.3	0	ANNUAL	ALL	1				
617		635124.5	4977959	0.00016	2027.13	2844.3	0	ANNUAL	ALL	1				
618		635149.5	4977959	0.00016	2036.89	2844.3	0	ANNUAL	ALL	1				
619		635174.5	4977959	0.00016	2046.85	2844.3	0	ANNUAL	ALL	1				
620		635199.5	4977959	0.00016	2056.78	2844.3	0	ANNUAL	ALL	1				
621		634999.5	4977984	0.00015	2045.34	2844.3	0	ANNUAL	ALL	1				
622		635024.5	4977984	0.00016	2037.82	2844.3	0	ANNUAL	ALL	1				
623		635049.5	4977984	0.00016	2030.43	2844.3	0	ANNUAL	ALL	1				
624		635074.5	4977984	0.00016	2024.12	2844.3	0	ANNUAL	ALL	1				
625		635099.5	4977984	0.00016	2019.96	2844.3	0	ANNUAL	ALL	1				
626		635124.5	4977984	0.00016	2026.73	2844.3	0	ANNUAL	ALL	1				
627		635149.5	4977984	0.00016	2035.4	2844.3	0	ANNUAL	ALL	1				
628		635174.5	4977984	0.00016	2044.46	2844.3	0	ANNUAL	ALL	1				
629		635199.5	4977984	0.00016	2053.52	2844.3	0	ANNUAL	ALL	1				
630		634999.5	4978009	0.00015	2044.81	2844.3	0	ANNUAL	ALL	1				
631		635024.5	4978009	0.00015	2035.59	2844.3	0	ANNUAL	ALL	1				
632		635049.5	4978009	0.00016	2028.05	2844.3	0	ANNUAL	ALL	1				
633		635074.5	4978009	0.00016	2021.18	2844.3	0	ANNUAL	ALL	1				
634		635099.5	4978009	0.00016	2017.1	2844.3	0	ANNUAL	ALL	1				
635		635124.5	4978009	0.00016	2025.97	2844.3	0	ANNUAL	ALL	1				
636		635149.5	4978009	0.00016	2034.03	2844.3	0	ANNUAL	ALL	1				
637		635174.5	4978009	0.00016	2041.95	2844.3	0	ANNUAL	ALL	1				
638		635199.5	4978009	0.00016	2050.09	2844.3	0	ANNUAL	ALL	1				
639		634999.5	4978034	0.00015	2043.29	2844.3	0	ANNUAL	ALL	1				
640		635024.5	4978034	0.00015	2032.46	2844.3	0	ANNUAL	ALL	1				
641		635049.5	4978034	0.00015	2024.39	2844.3	0	ANNUAL	ALL	1				
642		635074.5	4978034	0.00016	2017.56	2844.3	0	ANNUAL	ALL	1				
643		635099.5	4978034	0.00016	2015.24	2844.3	0	ANNUAL	ALL	1				
644		635124.5	4978034	0.00016	2024.2	2844.3	0	ANNUAL	ALL	1				
645		635149.5	4978034	0.00016	2032.02	2844.3	0	ANNUAL	ALL	1				
646		635174.5	4978034	0.00016	2040.48	2844.3	0	ANNUAL	ALL	1				
647		635199.5	4978034	0.00016	2049.69	2844.3	0	ANNUAL	ALL	1				
648		634599.5	4976834	0.00017	2431.97	2717.08	0	ANNUAL	ALL	1				
649		634624.5	4976834	0.00017	2425.11	2717.08	0	ANNUAL	ALL	1				
650		634649.5	4976834	0.00017	2416.95	2717.08	0	ANNUAL	ALL	1				
651		634674.5	4976834	0.00017	2407.96	2717.08	0	ANNUAL	ALL	1				
652		634699.5	4976834	0.00018	2398.82	2717.08	0	ANNUAL	ALL	1				
653		634724.5	4976834	0.00018	2389.57	2717.08	0	ANNUAL	ALL	1				
654		634749.5	4976834	0.00018	2378.83	2717.08	0	ANNUAL	ALL	1				
655		634774.5	4976834	0.00019	2368.3	2717.08	0	ANNUAL	ALL	1				
656		634799.5	4976834	0.00019	2352.38	2717.08	0	ANNUAL	ALL	1				
657		634599.5	4976859	0.00017	2427	2717.08	0	ANNUAL	ALL	1				
658		634624.5	4976859	0.00017	2421.36	2717.08	0	ANNUAL	ALL	1				
659		634649.5	4976859	0.00017	2412.9	2717.08	0	ANNUAL	ALL	1				
660		634674.5	4976859	0.00017	2401.58	2717.08	0	ANNUAL	ALL	1				
661		634699.5	4976859	0.00017	2391.51	2717.08	0	ANNUAL	ALL	1				
662		634724.5	4976859	0.00018	2381.29	2717.08	0	ANNUAL	ALL	1				
663		634749.5	4976859	0.00018	2371.44	2717.08	0	ANNUAL	ALL	1				
664		634774.5	4976859	0.00018	2358.57	2717.08	0	ANNUAL	ALL	1				
665		634799.5	4976859	0.00019	2341.91	2742	0	ANNUAL	ALL	1				
666		634599.5	4976884	0.00016	2422.69	2717.08	0	ANNUAL	ALL	1				
667		634624.5	4976884	0.00016	2418.17	2717.08	0	ANNUAL	ALL	1				
668		634649.5	4976884	0.00017	2408.98	2717.08	0	ANNUAL	ALL	1				
669		634674.5	4976884	0.00017	2396.57	2717.08	0	ANNUAL	ALL	1				
670		634699.5	4976884	0.00017	2383.76	2717.08	0	ANNUAL	ALL	1				
671		634724.5	4976884	0.00018	2371.27	2717.08	0	ANNUAL	ALL	1				
672		634749.5	4976884	0.00018	2362.03	2717.08	0	ANNUAL	ALL	1				
673		634774.5	4976884	0.00018	2350.11	2717.08	0	ANNUAL	ALL	1				
674		634799.5	4976884	0.00019	2334.35	2742	0	ANNUAL	ALL	1				
675		634599.5	4976909	0.00016	2418.11	2717.08	0	ANNUAL	ALL	1				
676		634624.5	4976909	0.00016	2412.47	2717.08	0	ANNUAL	ALL	1				
677		634649.5	4976909	0.00017	2402.76	2717.08	0	ANNUAL	ALL	1				
678		634674.5	4976909	0.00017	2392.81	2717.08	0	ANNUAL	ALL	1				
679		634699.5	4976909	0.00017	2377.98	2717.08	0	ANNUAL	ALL	1				
680		634724.5	4976909	0.00017	2364.11	2717.08	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
681		634749.5	4976909	0.00018	2354.73	2717.08	0	ANNUAL	ALL	1				
682		634774.5	4976909	0.00018	2345.14	2717.08	0	ANNUAL	ALL	1				
683		634799.5	4976909	0.00018	2331	2742	0	ANNUAL	ALL	1				
684		634599.5	4976934	0.00016	2411.78	2717.08	0	ANNUAL	ALL	1				
685		634624.5	4976934	0.00016	2403.98	2717.08	0	ANNUAL	ALL	1				
686		634649.5	4976934	0.00016	2394.61	2717.08	0	ANNUAL	ALL	1				
687		634674.5	4976934	0.00017	2383.71	2717.08	0	ANNUAL	ALL	1				
688		634699.5	4976934	0.00017	2371.78	2717.08	0	ANNUAL	ALL	1				
689		634724.5	4976934	0.00017	2359.09	2717.08	0	ANNUAL	ALL	1				
690		634749.5	4976934	0.00017	2347.63	2717.08	0	ANNUAL	ALL	1				
691		634774.5	4976934	0.00018	2337.6	2742	0	ANNUAL	ALL	1				
692		634799.5	4976934	0.00018	2326.97	2742	0	ANNUAL	ALL	1				
693		634599.5	4976959	0.00016	2404.1	2717.08	0	ANNUAL	ALL	1				
694		634624.5	4976959	0.00016	2396.65	2717.08	0	ANNUAL	ALL	1				
695		634649.5	4976959	0.00016	2385.41	2717.08	0	ANNUAL	ALL	1				
696		634674.5	4976959	0.00016	2372.07	2717.08	0	ANNUAL	ALL	1				
697		634699.5	4976959	0.00017	2362.55	2717.08	0	ANNUAL	ALL	1				
698		634724.5	4976959	0.00017	2351.59	2717.08	0	ANNUAL	ALL	1				
699		634749.5	4976959	0.00017	2341.2	2717.08	0	ANNUAL	ALL	1				
700		634774.5	4976959	0.00018	2328.55	2742	0	ANNUAL	ALL	1				
701		634799.5	4976959	0.00018	2318.72	2742	0	ANNUAL	ALL	1				
702		634599.5	4976984	0.00016	2396.35	2717.08	0	ANNUAL	ALL	1				
703		634624.5	4976984	0.00016	2389.04	2717.08	0	ANNUAL	ALL	1				
704		634649.5	4976984	0.00016	2377.21	2717.08	0	ANNUAL	ALL	1				
705		634674.5	4976984	0.00016	2363.6	2717.08	0	ANNUAL	ALL	1				
706		634699.5	4976984	0.00017	2350.85	2717.08	0	ANNUAL	ALL	1				
707		634724.5	4976984	0.00017	2340.79	2717.08	0	ANNUAL	ALL	1				
708		634749.5	4976984	0.00017	2331.79	2742	0	ANNUAL	ALL	1				
709		634774.5	4976984	0.00018	2320.7	2742	0	ANNUAL	ALL	1				
710		634799.5	4976984	0.00018	2308.59	2742	0	ANNUAL	ALL	1				
711		634599.5	4977009	0.00015	2388.79	2717.08	0	ANNUAL	ALL	1				
712		634624.5	4977009	0.00016	2379.17	2717.08	0	ANNUAL	ALL	1				
713		634649.5	4977009	0.00016	2368.25	2717.08	0	ANNUAL	ALL	1				
714		634674.5	4977009	0.00016	2355.13	2717.08	0	ANNUAL	ALL	1				
715		634699.5	4977009	0.00016	2341.52	2717.08	0	ANNUAL	ALL	1				
716		634724.5	4977009	0.00017	2328.18	2742	0	ANNUAL	ALL	1				
717		634749.5	4977009	0.00017	2321.24	2742	0	ANNUAL	ALL	1				
718		634774.5	4977009	0.00017	2313.44	2742	0	ANNUAL	ALL	1				
719		634799.5	4977009	0.00018	2301.46	2742.16	0	ANNUAL	ALL	1				
720		634599.5	4977034	0.00015	2379.36	2717.08	0	ANNUAL	ALL	1				
721		634624.5	4977034	0.00016	2369.28	2717.08	0	ANNUAL	ALL	1				
722		634649.5	4977034	0.00016	2356.46	2717.08	0	ANNUAL	ALL	1				
723		634674.5	4977034	0.00016	2343.53	2717.08	0	ANNUAL	ALL	1				
724		634699.5	4977034	0.00016	2329.9	2742	0	ANNUAL	ALL	1				
725		634724.5	4977034	0.00017	2316.92	2742	0	ANNUAL	ALL	1				
726		634749.5	4977034	0.00017	2309.32	2742	0	ANNUAL	ALL	1				
727		634774.5	4977034	0.00017	2302.58	2742	0	ANNUAL	ALL	1				
728		634799.5	4977034	0.00018	2295.21	2742.16	0	ANNUAL	ALL	1				
729	**	CONCUNIT	ug/m^3											
730	**	DEPUNIT	g/m^2											

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	*	AERMOD	(	19191):	MIDAS	GOLD	STIBNITE	-	MODELING	R27	########			
2	*	AERMET	(	19191):	15:42:12									
3	*	MODELING	OPTIONS	USED:	RegDFAULT	CONC	ELEV	NOWARN	DRYDPLT	WETDPLT	RURAL	ADJ_U*		
4	*	PLOT	FILE	OF	ANNUAL	VALUES	AVERAGED	ACROSS	1	YEARS	FOR	SOURCE	GROUP:	ALL
5	*	FOR	A	TOTAL	OF	720	RECEPTORS.							
6	*	FORMAT:	(3(1X,F13.5),3(1X,F8.2),2X,A6,2X,A8,2X,I8.8,2X,A8)											
7	*	X	Y	AVERAGE	CONC	ZELEV	ZHILL	ZFLAG	AVE	GRP	NUM	YRS	NET	ID
8	*													
9	0.000900	635399.5	4975934	0.00061	2213.4	2844.3	0	ANNUAL	ALL	1				
10	max ↑	635424.5	4975934	0.00061	2212.64	2844.3	0	ANNUAL	ALL	1				
11		635449.5	4975934	0.00062	2211.27	2844.3	0	ANNUAL	ALL	1				
12		635474.5	4975934	0.00062	2212.5	2844.3	0	ANNUAL	ALL	1				
13		635499.5	4975934	0.00061	2215.21	2844.3	0	ANNUAL	ALL	1				
14		635524.5	4975934	0.0006	2215.98	2844.3	0	ANNUAL	ALL	1				
15		635549.5	4975934	0.00061	2215	2844.3	0	ANNUAL	ALL	1				
16		635574.5	4975934	0.0006	2215.74	2844.3	0	ANNUAL	ALL	1				
17		635599.5	4975934	0.0006	2218.34	2844.3	0	ANNUAL	ALL	1				
18		635399.5	4975959	0.00064	2202.75	2844.3	0	ANNUAL	ALL	1				
19		635424.5	4975959	0.00063	2204.36	2844.3	0	ANNUAL	ALL	1				
20		635449.5	4975959	0.00063	2204.87	2844.3	0	ANNUAL	ALL	1				
21		635474.5	4975959	0.00063	2206.39	2844.3	0	ANNUAL	ALL	1				
22		635499.5	4975959	0.00062	2208.99	2844.3	0	ANNUAL	ALL	1				
23		635524.5	4975959	0.00061	2210.99	2844.3	0	ANNUAL	ALL	1				
24		635549.5	4975959	0.00061	2211.29	2844.3	0	ANNUAL	ALL	1				
25		635574.5	4975959	0.00061	2210.92	2844.3	0	ANNUAL	ALL	1				
26		635599.5	4975959	0.00062	2208.83	2844.3	0	ANNUAL	ALL	1				
27		635399.5	4975984	0.00066	2195.09	2844.3	0	ANNUAL	ALL	1				
28		635424.5	4975984	0.00065	2198.19	2844.3	0	ANNUAL	ALL	1				
29		635449.5	4975984	0.00065	2198.7	2844.3	0	ANNUAL	ALL	1				
30		635474.5	4975984	0.00064	2201.57	2844.3	0	ANNUAL	ALL	1				
31		635499.5	4975984	0.00063	2203.99	2844.3	0	ANNUAL	ALL	1				
32		635524.5	4975984	0.00062	2206.27	2844.3	0	ANNUAL	ALL	1				
33		635549.5	4975984	0.00062	2206.83	2844.3	0	ANNUAL	ALL	1				
34		635574.5	4975984	0.00063	2205.61	2844.3	0	ANNUAL	ALL	1				
35		635599.5	4975984	0.00063	2202.99	2844.3	0	ANNUAL	ALL	1				
36		635399.5	4976009	0.00065	2195.69	2844.3	0	ANNUAL	ALL	1				
37		635424.5	4976009	0.00067	2189.65	2844.3	0	ANNUAL	ALL	1				
38		635449.5	4976009	0.00066	2194	2844.3	0	ANNUAL	ALL	1				
39		635474.5	4976009	0.00064	2200.13	2844.3	0	ANNUAL	ALL	1				
40		635499.5	4976009	0.00063	2202.83	2844.3	0	ANNUAL	ALL	1				
41		635524.5	4976009	0.00063	2203.57	2844.3	0	ANNUAL	ALL	1				
42		635549.5	4976009	0.00063	2203.82	2844.3	0	ANNUAL	ALL	1				
43		635574.5	4976009	0.00063	2202.81	2844.3	0	ANNUAL	ALL	1				
44		635599.5	4976009	0.00064	2200.59	2844.3	0	ANNUAL	ALL	1				
45		635399.5	4976034	0.00063	2198.23	2844.3	0	ANNUAL	ALL	1				
46		635424.5	4976034	0.00067	2186.98	2844.3	0	ANNUAL	ALL	1				
47		635449.5	4976034	0.00066	2190.14	2844.3	0	ANNUAL	ALL	1				
48		635474.5	4976034	0.00063	2198.63	2844.3	0	ANNUAL	ALL	1				
49		635499.5	4976034	0.00063	2198.93	2844.3	0	ANNUAL	ALL	1				
50		635524.5	4976034	0.00063	2199.39	2844.3	0	ANNUAL	ALL	1				
51		635549.5	4976034	0.00063	2201.1	2844.3	0	ANNUAL	ALL	1				
52		635574.5	4976034	0.00063	2200.59	2844.3	0	ANNUAL	ALL	1				
53		635599.5	4976034	0.00064	2197.96	2844.3	0	ANNUAL	ALL	1				
54		635399.5	4976059	0.00063	2196.33	2844.3	0	ANNUAL	ALL	1				
55		635424.5	4976059	0.00067	2184.09	2844.3	0	ANNUAL	ALL	1				
56		635449.5	4976059	0.00069	2180.82	2844.3	0	ANNUAL	ALL	1				
57		635474.5	4976059	0.00064	2193.11	2844.3	0	ANNUAL	ALL	1				
58		635499.5	4976059	0.00064	2194.5	2844.3	0	ANNUAL	ALL	1				
59		635524.5	4976059	0.00063	2197.17	2844.3	0	ANNUAL	ALL	1				
60		635549.5	4976059	0.00063	2199.4	2844.3	0	ANNUAL	ALL	1				
61		635574.5	4976059	0.00063	2198.27	2844.3	0	ANNUAL	ALL	1				
62		635599.5	4976059	0.00064	2194.62	2844.3	0	ANNUAL	ALL	1				
63		635399.5	4976084	0.00064	2188.98	2844.3	0	ANNUAL	ALL	1				
64		635424.5	4976084	0.00068	2180.22	2844.3	0	ANNUAL	ALL	1				
65		635449.5	4976084	0.0007	2174.51	2844.3	0	ANNUAL	ALL	1				
66		635474.5	4976084	0.00068	2180.27	2844.3	0	ANNUAL	ALL	1				
67		635499.5	4976084	0.00066	2185.71	2844.3	0	ANNUAL	ALL	1				
68		635524.5	4976084	0.00065	2191.13	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
69		635549.5	4976084	0.00064	2193.95	2844.3	0	ANNUAL	ALL	1				
70		635574.5	4976084	0.00065	2190.58	2844.3	0	ANNUAL	ALL	1				
71		635599.5	4976084	0.00068	2183.01	2844.3	0	ANNUAL	ALL	1				
72		635399.5	4976109	0.00066	2182.28	2844.3	0	ANNUAL	ALL	1				
73		635424.5	4976109	0.00068	2177.24	2844.3	0	ANNUAL	ALL	1				
74		635449.5	4976109	0.00071	2171.45	2844.3	0	ANNUAL	ALL	1				
75		635474.5	4976109	0.00071	2172.26	2844.3	0	ANNUAL	ALL	1				
76		635499.5	4976109	0.00069	2177.58	2844.3	0	ANNUAL	ALL	1				
77		635524.5	4976109	0.00068	2180.23	2844.3	0	ANNUAL	ALL	1				
78		635549.5	4976109	0.00068	2179.81	2844.3	0	ANNUAL	ALL	1				
79		635574.5	4976109	0.0007	2176.94	2844.3	0	ANNUAL	ALL	1				
80		635599.5	4976109	0.00069	2179.4	2844.3	0	ANNUAL	ALL	1				
81		635399.5	4976134	0.00067	2176.77	2844.3	0	ANNUAL	ALL	1				
82		635424.5	4976134	0.00068	2174.27	2844.3	0	ANNUAL	ALL	1				
83		635449.5	4976134	0.0007	2171.04	2844.3	0	ANNUAL	ALL	1				
84		635474.5	4976134	0.00072	2166.4	2844.3	0	ANNUAL	ALL	1				
85		635499.5	4976134	0.00072	2167.48	2844.3	0	ANNUAL	ALL	1				
86		635524.5	4976134	0.0007	2172.09	2844.3	0	ANNUAL	ALL	1				
87		635549.5	4976134	0.00071	2171.44	2844.3	0	ANNUAL	ALL	1				
88		635574.5	4976134	0.0007	2172.93	2844.3	0	ANNUAL	ALL	1				
89		635599.5	4976134	0.00068	2178.31	2844.3	0	ANNUAL	ALL	1				
90		635199.5	4976834	0.00064	2116.83	2844.3	0	ANNUAL	ALL	1				
91		635224.5	4976834	0.00066	2112.53	2844.3	0	ANNUAL	ALL	1				
92		635249.5	4976834	0.00068	2108.39	2844.3	0	ANNUAL	ALL	1				
93		635274.5	4976834	0.0007	2105.23	2844.3	0	ANNUAL	ALL	1				
94		635299.5	4976834	0.00072	2101.6	2844.3	0	ANNUAL	ALL	1				
95		635324.5	4976834	0.00074	2098.74	2844.3	0	ANNUAL	ALL	1				
96		635349.5	4976834	0.00071	2104.26	2844.3	0	ANNUAL	ALL	1				
97		635374.5	4976834	0.00068	2110.4	2844.3	0	ANNUAL	ALL	1				
98		635399.5	4976834	0.00065	2117.98	2844.3	0	ANNUAL	ALL	1				
99		635199.5	4976859	0.00065	2114.34	2844.3	0	ANNUAL	ALL	1				
100		635224.5	4976859	0.00068	2108.68	2844.3	0	ANNUAL	ALL	1				
101		635249.5	4976859	0.0007	2104.42	2844.3	0	ANNUAL	ALL	1				
102		635274.5	4976859	0.00072	2101.28	2844.3	0	ANNUAL	ALL	1				
103		635299.5	4976859	0.00073	2098.83	2844.3	0	ANNUAL	ALL	1				
104		635324.5	4976859	0.00075	2096.89	2844.3	0	ANNUAL	ALL	1				
105		635349.5	4976859	0.00072	2101.21	2844.3	0	ANNUAL	ALL	1				
106		635374.5	4976859	0.00068	2108.71	2844.3	0	ANNUAL	ALL	1				
107		635399.5	4976859	0.00064	2118.31	2844.3	0	ANNUAL	ALL	1				
108		635199.5	4976884	0.00066	2111.17	2844.3	0	ANNUAL	ALL	1				
109		635224.5	4976884	0.00069	2104.78	2844.3	0	ANNUAL	ALL	1				
110		635249.5	4976884	0.00071	2100.14	2844.3	0	ANNUAL	ALL	1				
111		635274.5	4976884	0.00073	2097.48	2844.3	0	ANNUAL	ALL	1				
112		635299.5	4976884	0.00074	2095.42	2844.3	0	ANNUAL	ALL	1				
113		635324.5	4976884	0.00075	2094.96	2844.3	0	ANNUAL	ALL	1				
114		635349.5	4976884	0.00073	2097.83	2844.3	0	ANNUAL	ALL	1				
115		635374.5	4976884	0.00068	2107.96	2844.3	0	ANNUAL	ALL	1				
116		635399.5	4976884	0.00063	2119.17	2844.3	0	ANNUAL	ALL	1				
117		635199.5	4976909	0.00066	2108.51	2844.3	0	ANNUAL	ALL	1				
118		635224.5	4976909	0.00069	2102.17	2844.3	0	ANNUAL	ALL	1				
119		635249.5	4976909	0.00072	2097.31	2844.3	0	ANNUAL	ALL	1				
120		635274.5	4976909	0.00074	2094.85	2844.3	0	ANNUAL	ALL	1				
121		635299.5	4976909	0.00075	2093.19	2844.3	0	ANNUAL	ALL	1				
122		635324.5	4976909	0.00075	2093.48	2844.3	0	ANNUAL	ALL	1				
123		635349.5	4976909	0.00072	2098.12	2844.3	0	ANNUAL	ALL	1				
124		635374.5	4976909	0.00067	2108.79	2844.3	0	ANNUAL	ALL	1				
125		635399.5	4976909	0.00062	2120.74	2844.3	0	ANNUAL	ALL	1				
126		635199.5	4976934	0.00067	2106.38	2844.3	0	ANNUAL	ALL	1				
127		635224.5	4976934	0.0007	2100.81	2844.3	0	ANNUAL	ALL	1				
128		635249.5	4976934	0.00072	2096.21	2844.3	0	ANNUAL	ALL	1				
129		635274.5	4976934	0.00074	2092.89	2844.3	0	ANNUAL	ALL	1				
130		635299.5	4976934	0.00076	2091.1	2844.3	0	ANNUAL	ALL	1				
131		635324.5	4976934	0.00075	2092.46	2844.3	0	ANNUAL	ALL	1				
132		635349.5	4976934	0.00071	2099.48	2844.3	0	ANNUAL	ALL	1				
133		635374.5	4976934	0.00066	2110.37	2844.3	0	ANNUAL	ALL	1				
134		635399.5	4976934	0.0006	2122.91	2844.3	0	ANNUAL	ALL	1				
135		635199.5	4976959	0.00067	2104.62	2844.3	0	ANNUAL	ALL	1				
136		635224.5	4976959	0.0007	2099.28	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
137		635249.5	4976959	0.00072	2094.41	2844.3	0	ANNUAL	ALL	1				
138		635274.5	4976959	0.00075	2090.59	2844.3	0	ANNUAL	ALL	1				
139		635299.5	4976959	0.00076	2088.8	2844.3	0	ANNUAL	ALL	1				
140		635324.5	4976959	0.00074	2092.02	2844.3	0	ANNUAL	ALL	1				
141		635349.5	4976959	0.0007	2100.12	2844.3	0	ANNUAL	ALL	1				
142		635374.5	4976959	0.00064	2112.07	2844.3	0	ANNUAL	ALL	1				
143		635399.5	4976959	0.00059	2125.69	2844.3	0	ANNUAL	ALL	1				
144		635199.5	4976984	0.00067	2102.45	2844.3	0	ANNUAL	ALL	1				
145		635224.5	4976984	0.0007	2097.29	2844.3	0	ANNUAL	ALL	1				
146		635249.5	4976984	0.00073	2091.62	2844.3	0	ANNUAL	ALL	1				
147		635274.5	4976984	0.00076	2087.92	2844.3	0	ANNUAL	ALL	1				
148		635299.5	4976984	0.00077	2086.81	2844.3	0	ANNUAL	ALL	1				
149		635324.5	4976984	0.00073	2092.65	2844.3	0	ANNUAL	ALL	1				
150		635349.5	4976984	0.00069	2101.3	2844.3	0	ANNUAL	ALL	1				
151		635374.5	4976984	0.00063	2114.13	2844.3	0	ANNUAL	ALL	1				
152		635399.5	4976984	0.00057	2128.46	2844.3	0	ANNUAL	ALL	1				
153		635199.5	4977009	0.00068	2099.39	2844.3	0	ANNUAL	ALL	1				
154		635224.5	4977009	0.00071	2093.66	2844.3	0	ANNUAL	ALL	1				
155		635249.5	4977009	0.00075	2087.97	2844.3	0	ANNUAL	ALL	1				
156		635274.5	4977009	0.00077	2084.9	2844.3	0	ANNUAL	ALL	1				
157		635299.5	4977009	0.00075	2087.43	2844.3	0	ANNUAL	ALL	1				
158		635324.5	4977009	0.00071	2094.55	2844.3	0	ANNUAL	ALL	1				
159		635349.5	4977009	0.00067	2103.74	2844.3	0	ANNUAL	ALL	1				
160		635374.5	4977009	0.00061	2116.64	2844.3	0	ANNUAL	ALL	1				
161		635399.5	4977009	0.00056	2131.12	2844.3	0	ANNUAL	ALL	1				
162		635199.5	4977034	0.0007	2094.63	2844.3	0	ANNUAL	ALL	1				
163		635224.5	4977034	0.00074	2088.76	2844.3	0	ANNUAL	ALL	1				
164		635249.5	4977034	0.00076	2084.27	2844.3	0	ANNUAL	ALL	1				
165		635274.5	4977034	0.00078	2082.71	2844.3	0	ANNUAL	ALL	1				
166		635299.5	4977034	0.00073	2089.9	2844.3	0	ANNUAL	ALL	1				
167		635324.5	4977034	0.00069	2098.21	2844.3	0	ANNUAL	ALL	1				
168		635349.5	4977034	0.00064	2107.49	2844.3	0	ANNUAL	ALL	1				
169		635374.5	4977034	0.0006	2119.09	2844.3	0	ANNUAL	ALL	1				
170		635399.5	4977034	0.00055	2133.38	2844.3	0	ANNUAL	ALL	1				
171		634899.5	4977134	0.00041	2221.02	2844.3	0	ANNUAL	ALL	1				
172		634924.5	4977134	0.00042	2207.85	2844.3	0	ANNUAL	ALL	1				
173		634949.5	4977134	0.00044	2190.45	2844.3	0	ANNUAL	ALL	1				
174		634974.5	4977134	0.00046	2169.12	2844.3	0	ANNUAL	ALL	1				
175		634999.5	4977134	0.0005	2150.64	2844.3	0	ANNUAL	ALL	1				
176		635024.5	4977134	0.00053	2135.97	2844.3	0	ANNUAL	ALL	1				
177		635049.5	4977134	0.00056	2122.38	2844.3	0	ANNUAL	ALL	1				
178		635074.5	4977134	0.00059	2113.7	2844.3	0	ANNUAL	ALL	1				
179		635099.5	4977134	0.00062	2105.9	2844.3	0	ANNUAL	ALL	1				
180		634899.5	4977159	0.00041	2213.37	2844.3	0	ANNUAL	ALL	1				
181		634924.5	4977159	0.00042	2201.16	2844.3	0	ANNUAL	ALL	1				
182		634949.5	4977159	0.00045	2181.17	2844.3	0	ANNUAL	ALL	1				
183		634974.5	4977159	0.00047	2161.72	2844.3	0	ANNUAL	ALL	1				
184		634999.5	4977159	0.0005	2145.73	2844.3	0	ANNUAL	ALL	1				
185		635024.5	4977159	0.00053	2132.12	2844.3	0	ANNUAL	ALL	1				
186		635049.5	4977159	0.00057	2119.59	2844.3	0	ANNUAL	ALL	1				
187		635074.5	4977159	0.0006	2109.27	2844.3	0	ANNUAL	ALL	1				
188		635099.5	4977159	0.00064	2101.29	2844.3	0	ANNUAL	ALL	1				
189		634899.5	4977184	0.00042	2206.56	2844.3	0	ANNUAL	ALL	1				
190		634924.5	4977184	0.00043	2193.64	2844.3	0	ANNUAL	ALL	1				
191		634949.5	4977184	0.00045	2172.29	2844.3	0	ANNUAL	ALL	1				
192		634974.5	4977184	0.00048	2154.5	2844.3	0	ANNUAL	ALL	1				
193		634999.5	4977184	0.00051	2141.04	2844.3	0	ANNUAL	ALL	1				
194		635024.5	4977184	0.00054	2128.3	2844.3	0	ANNUAL	ALL	1				
195		635049.5	4977184	0.00058	2114.34	2844.3	0	ANNUAL	ALL	1				
196		635074.5	4977184	0.00062	2102.7	2844.3	0	ANNUAL	ALL	1				
197		635099.5	4977184	0.00065	2096.47	2844.3	0	ANNUAL	ALL	1				
198		634899.5	4977209	0.00042	2199.13	2844.3	0	ANNUAL	ALL	1				
199		634924.5	4977209	0.00044	2184.15	2844.3	0	ANNUAL	ALL	1				
200		634949.5	4977209	0.00046	2163.72	2844.3	0	ANNUAL	ALL	1				
201		634974.5	4977209	0.00049	2146.68	2844.3	0	ANNUAL	ALL	1				
202		634999.5	4977209	0.00051	2136.15	2844.3	0	ANNUAL	ALL	1				
203		635024.5	4977209	0.00054	2124.22	2844.3	0	ANNUAL	ALL	1				
204		635049.5	4977209	0.0006	2105.9	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
205		635074.5	4977209	0.00064	2096.39	2844.3	0	ANNUAL	ALL	1				
206		635099.5	4977209	0.00067	2091.31	2844.3	0	ANNUAL	ALL	1				
207		634899.5	4977234	0.00043	2185.16	2844.3	0	ANNUAL	ALL	1				
208		634924.5	4977234	0.00045	2172.04	2844.3	0	ANNUAL	ALL	1				
209		634949.5	4977234	0.00048	2152.41	2844.3	0	ANNUAL	ALL	1				
210		634974.5	4977234	0.0005	2139.97	2844.3	0	ANNUAL	ALL	1				
211		634999.5	4977234	0.00052	2130.73	2844.3	0	ANNUAL	ALL	1				
212		635024.5	4977234	0.00056	2117.31	2844.3	0	ANNUAL	ALL	1				
213		635049.5	4977234	0.00063	2098.65	2844.3	0	ANNUAL	ALL	1				
214		635074.5	4977234	0.00066	2092.39	2844.3	0	ANNUAL	ALL	1				
215		635099.5	4977234	0.00068	2087.32	2844.3	0	ANNUAL	ALL	1				
216		634899.5	4977259	0.00044	2180.4	2844.3	0	ANNUAL	ALL	1				
217		634924.5	4977259	0.00046	2160.19	2844.3	0	ANNUAL	ALL	1				
218		634949.5	4977259	0.00049	2143.3	2844.3	0	ANNUAL	ALL	1				
219		634974.5	4977259	0.00052	2132.11	2844.3	0	ANNUAL	ALL	1				
220		634999.5	4977259	0.00054	2123.02	2844.3	0	ANNUAL	ALL	1				
221		635024.5	4977259	0.00059	2107.09	2844.3	0	ANNUAL	ALL	1				
222		635049.5	4977259	0.00063	2095.35	2844.3	0	ANNUAL	ALL	1				
223		635074.5	4977259	0.00066	2089.07	2844.3	0	ANNUAL	ALL	1				
224		635099.5	4977259	0.00069	2083.6	2844.3	0	ANNUAL	ALL	1				
225		634899.5	4977284	0.00043	2180.69	2844.3	0	ANNUAL	ALL	1				
226		634924.5	4977284	0.00046	2158.28	2844.3	0	ANNUAL	ALL	1				
227		634949.5	4977284	0.0005	2139.34	2844.3	0	ANNUAL	ALL	1				
228		634974.5	4977284	0.00053	2123.05	2844.3	0	ANNUAL	ALL	1				
229		634999.5	4977284	0.00056	2112.91	2844.3	0	ANNUAL	ALL	1				
230		635024.5	4977284	0.00061	2100.55	2844.3	0	ANNUAL	ALL	1				
231		635049.5	4977284	0.00064	2092.76	2844.3	0	ANNUAL	ALL	1				
232		635074.5	4977284	0.00067	2085.71	2844.3	0	ANNUAL	ALL	1				
233		635099.5	4977284	0.00071	2078.67	2844.3	0	ANNUAL	ALL	1				
234		634899.5	4977309	0.00043	2178.55	2844.3	0	ANNUAL	ALL	1				
235		634924.5	4977309	0.00046	2156.77	2844.3	0	ANNUAL	ALL	1				
236		634949.5	4977309	0.0005	2136.54	2844.3	0	ANNUAL	ALL	1				
237		634974.5	4977309	0.00054	2119.59	2844.3	0	ANNUAL	ALL	1				
238		634999.5	4977309	0.00058	2107.01	2844.3	0	ANNUAL	ALL	1				
239		635024.5	4977309	0.00062	2096.52	2844.3	0	ANNUAL	ALL	1				
240		635049.5	4977309	0.00065	2089.24	2844.3	0	ANNUAL	ALL	1				
241		635074.5	4977309	0.00068	2082.55	2844.3	0	ANNUAL	ALL	1				
242		635099.5	4977309	0.00072	2075.98	2844.3	0	ANNUAL	ALL	1				
243		634899.5	4977334	0.00044	2173.18	2844.3	0	ANNUAL	ALL	1				
244		634924.5	4977334	0.00047	2153.29	2844.3	0	ANNUAL	ALL	1				
245		634949.5	4977334	0.0005	2133.9	2844.3	0	ANNUAL	ALL	1				
246		634974.5	4977334	0.00054	2117.58	2844.3	0	ANNUAL	ALL	1				
247		634999.5	4977334	0.00058	2104.03	2844.3	0	ANNUAL	ALL	1				
248		635024.5	4977334	0.00062	2093.8	2844.3	0	ANNUAL	ALL	1				
249		635049.5	4977334	0.00066	2085.23	2844.3	0	ANNUAL	ALL	1				
250		635074.5	4977334	0.0007	2078.76	2844.3	0	ANNUAL	ALL	1				
251		635099.5	4977334	0.00072	2074.53	2844.3	0	ANNUAL	ALL	1				
252		635399.5	4976159	0.00068	2171.27	2844.3	0	ANNUAL	ALL	1				
253		635424.5	4976159	0.00069	2169.98	2844.3	0	ANNUAL	ALL	1				
254		635449.5	4976159	0.0007	2167.61	2844.3	0	ANNUAL	ALL	1				
255		635474.5	4976159	0.00072	2164.06	2844.3	0	ANNUAL	ALL	1				
256		635499.5	4976159	0.00074	2161.76	2844.3	0	ANNUAL	ALL	1				
257		635524.5	4976159	0.00075	2160.48	2844.3	0	ANNUAL	ALL	1				
258		635549.5	4976159	0.00074	2162.19	2844.3	0	ANNUAL	ALL	1				
259		635574.5	4976159	0.00072	2168.15	2844.3	0	ANNUAL	ALL	1				
260		635599.5	4976159	0.00069	2173.85	2844.3	0	ANNUAL	ALL	1				
261		635399.5	4976184	0.00068	2168.06	2844.3	0	ANNUAL	ALL	1				
262		635424.5	4976184	0.0007	2166.17	2844.3	0	ANNUAL	ALL	1				
263		635449.5	4976184	0.00071	2163.95	2844.3	0	ANNUAL	ALL	1				
264		635474.5	4976184	0.00073	2161.05	2844.3	0	ANNUAL	ALL	1				
265		635499.5	4976184	0.00074	2158.86	2844.3	0	ANNUAL	ALL	1				
266		635524.5	4976184	0.00075	2157.1	2844.3	0	ANNUAL	ALL	1				
267		635549.5	4976184	0.00076	2157.07	2844.3	0	ANNUAL	ALL	1				
268		635574.5	4976184	0.00072	2164.59	2844.3	0	ANNUAL	ALL	1				
269		635599.5	4976184	0.00069	2172.06	2844.3	0	ANNUAL	ALL	1				
270		635399.5	4976209	0.00068	2165.29	2844.3	0	ANNUAL	ALL	1				
271		635424.5	4976209	0.0007	2163.14	2844.3	0	ANNUAL	ALL	1				
272		635449.5	4976209	0.00071	2160.76	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
273		635474.5	4976209	0.00073	2158.05	2844.3	0	ANNUAL	ALL	1				
274		635499.5	4976209	0.00075	2155.43	2844.3	0	ANNUAL	ALL	1				
275		635524.5	4976209	0.00076	2153.57	2844.3	0	ANNUAL	ALL	1				
276		635549.5	4976209	0.00075	2156.02	2844.3	0	ANNUAL	ALL	1				
277		635574.5	4976209	0.00071	2165.26	2844.3	0	ANNUAL	ALL	1				
278		635599.5	4976209	0.00067	2175.01	2844.3	0	ANNUAL	ALL	1				
279		635399.5	4976234	0.00069	2162.56	2844.3	0	ANNUAL	ALL	1				
280		635424.5	4976234	0.0007	2160.46	2844.3	0	ANNUAL	ALL	1				
281		635449.5	4976234	0.00071	2157.93	2844.3	0	ANNUAL	ALL	1				
282		635474.5	4976234	0.00073	2155.5	2844.3	0	ANNUAL	ALL	1				
283		635499.5	4976234	0.00075	2152.67	2844.3	0	ANNUAL	ALL	1				
284		635524.5	4976234	0.00076	2150.12	2844.3	0	ANNUAL	ALL	1				
285		635549.5	4976234	0.00074	2156.6	2844.3	0	ANNUAL	ALL	1				
286		635574.5	4976234	0.00069	2167.62	2844.3	0	ANNUAL	ALL	1				
287		635599.5	4976234	0.00065	2178.35	2844.3	0	ANNUAL	ALL	1				
288		634999.5	4978134	0.00066	2044.53	2844.3	0	ANNUAL	ALL	1				
289		635024.5	4978134	0.00073	2030.56	2844.3	0	ANNUAL	ALL	1				
290		635049.5	4978134	0.00081	2018.07	2844.3	0	ANNUAL	ALL	1				
291		635074.5	4978134	0.00088	2006.69	2844.3	0	ANNUAL	ALL	1				
292		635099.5	4978134	0.00089	2006.39	2844.3	0	ANNUAL	ALL	1				
293		635124.5	4978134	0.00085	2013.34	2844.3	0	ANNUAL	ALL	1				
294		635149.5	4978134	0.0008	2020.75	2844.3	0	ANNUAL	ALL	1				
295		635174.5	4978134	0.00076	2029.05	2844.3	0	ANNUAL	ALL	1				
296		635199.5	4978134	0.0007	2038.91	2844.3	0	ANNUAL	ALL	1				
297		634999.5	4978159	0.00065	2044.5	2844.3	0	ANNUAL	ALL	1				
298		635024.5	4978159	0.00072	2030.78	2844.3	0	ANNUAL	ALL	1				
299		635049.5	4978159	0.0008	2017.35	2844.3	0	ANNUAL	ALL	1				
300		635074.5	4978159	0.00088	2004.54	2844.3	0	ANNUAL	ALL	1				
301		635099.5	4978159	0.00089	2003.81	2844.3	0	ANNUAL	ALL	1				
302		635124.5	4978159	0.00085	2010.57	2844.3	0	ANNUAL	ALL	1				
303		635149.5	4978159	0.00081	2017.75	2844.3	0	ANNUAL	ALL	1				
304		635174.5	4978159	0.00077	2025.18	2844.3	0	ANNUAL	ALL	1				
305		635199.5	4978159	0.00071	2035.11	2844.3	0	ANNUAL	ALL	1				
306		634999.5	4978184	0.00064	2044.38	2844.3	0	ANNUAL	ALL	1				
307		635024.5	4978184	0.00072	2028.98	2844.3	0	ANNUAL	ALL	1				
308		635049.5	4978184	0.0008	2015.36	2844.3	0	ANNUAL	ALL	1				
309		635074.5	4978184	0.00088	2002.43	2844.3	0	ANNUAL	ALL	1				
310		635099.5	4978184	0.0009	2000.86	2844.3	0	ANNUAL	ALL	1				
311		635124.5	4978184	0.00086	2007.53	2844.3	0	ANNUAL	ALL	1				
312		635149.5	4978184	0.00082	2014.6	2844.3	0	ANNUAL	ALL	1				
313		635174.5	4978184	0.00078	2022.07	2844.3	0	ANNUAL	ALL	1				
314		635199.5	4978184	0.00072	2031.45	2844.3	0	ANNUAL	ALL	1				
315		634999.5	4978209	0.00063	2043.46	2844.3	0	ANNUAL	ALL	1				
316		635024.5	4978209	0.00071	2027.94	2844.3	0	ANNUAL	ALL	1				
317		635049.5	4978209	0.0008	2013.73	2844.3	0	ANNUAL	ALL	1				
318		635074.5	4978209	0.00088	2000.96	2844.3	0	ANNUAL	ALL	1				
319		635099.5	4978209	0.0009	1998.75	2844.3	0	ANNUAL	ALL	1				
320		635124.5	4978209	0.00086	2004.56	2844.3	0	ANNUAL	ALL	1				
321		635149.5	4978209	0.00082	2011.78	2844.3	0	ANNUAL	ALL	1				
322		635174.5	4978209	0.00078	2019.36	2844.3	0	ANNUAL	ALL	1				
323		635199.5	4978209	0.00073	2027.82	2844.3	0	ANNUAL	ALL	1				
324		634999.5	4978234	0.00062	2042.97	2844.3	0	ANNUAL	ALL	1				
325		635024.5	4978234	0.00071	2026.61	2844.3	0	ANNUAL	ALL	1				
326		635049.5	4978234	0.00079	2012.57	2844.3	0	ANNUAL	ALL	1				
327		635074.5	4978234	0.00087	2000.24	2844.3	0	ANNUAL	ALL	1				
328		635099.5	4978234	0.0009	1996.61	2844.3	0	ANNUAL	ALL	1				
329		635124.5	4978234	0.00087	2001.65	2844.3	0	ANNUAL	ALL	1				
330		635149.5	4978234	0.00082	2009.16	2844.3	0	ANNUAL	ALL	1				
331		635174.5	4978234	0.00078	2016.86	2844.3	0	ANNUAL	ALL	1				
332		635199.5	4978234	0.00074	2024.48	2844.3	0	ANNUAL	ALL	1				
333		634999.5	4978259	0.00062	2041.08	2844.3	0	ANNUAL	ALL	1				
334		635024.5	4978259	0.00071	2024.08	2844.3	0	ANNUAL	ALL	1				
335		635049.5	4978259	0.00078	2011.49	2844.3	0	ANNUAL	ALL	1				
336		635074.5	4978259	0.00085	2000.61	2844.3	0	ANNUAL	ALL	1				
337		635099.5	4978259	0.0009	1994.84	2844.3	0	ANNUAL	ALL	1				
338		635124.5	4978259	0.00087	1999.29	2844.3	0	ANNUAL	ALL	1				
339		635149.5	4978259	0.00082	2007.14	2844.3	0	ANNUAL	ALL	1				
340		635174.5	4978259	0.00078	2014.96	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
341		635199.5	4978259	0.00074	2023.44	2844.3	0	ANNUAL	ALL	1				
342		634999.5	4978284	0.00062	2039.02	2844.3	0	ANNUAL	ALL	1				
343		635024.5	4978284	0.0007	2022.69	2844.3	0	ANNUAL	ALL	1				
344		635049.5	4978284	0.00078	2010.11	2844.3	0	ANNUAL	ALL	1				
345		635074.5	4978284	0.00085	1999.28	2844.3	0	ANNUAL	ALL	1				
346		635099.5	4978284	0.00089	1993.94	2844.3	0	ANNUAL	ALL	1				
347		635124.5	4978284	0.00088	1996.86	2844.3	0	ANNUAL	ALL	1				
348		635149.5	4978284	0.00082	2004.78	2844.3	0	ANNUAL	ALL	1				
349		635174.5	4978284	0.00078	2012.7	2844.3	0	ANNUAL	ALL	1				
350		635199.5	4978284	0.00074	2021.78	2844.3	0	ANNUAL	ALL	1				
351		634999.5	4978309	0.00062	2036.72	2844.3	0	ANNUAL	ALL	1				
352		635024.5	4978309	0.00069	2023.32	2844.3	0	ANNUAL	ALL	1				
353		635049.5	4978309	0.00076	2010.1	2844.3	0	ANNUAL	ALL	1				
354		635074.5	4978309	0.00083	1999.36	2844.3	0	ANNUAL	ALL	1				
355		635099.5	4978309	0.00088	1992.81	2844.3	0	ANNUAL	ALL	1				
356		635124.5	4978309	0.00088	1994.13	2844.3	0	ANNUAL	ALL	1				
357		635149.5	4978309	0.00083	2001.68	2844.3	0	ANNUAL	ALL	1				
358		635174.5	4978309	0.00079	2009.75	2844.3	0	ANNUAL	ALL	1				
359		635199.5	4978309	0.00074	2018.84	2844.3	0	ANNUAL	ALL	1				
360		634999.5	4978334	0.00062	2033.58	2844.3	0	ANNUAL	ALL	1				
361		635024.5	4978334	0.00068	2021.76	2844.3	0	ANNUAL	ALL	1				
362		635049.5	4978334	0.00075	2009.59	2844.3	0	ANNUAL	ALL	1				
363		635074.5	4978334	0.00082	1999.33	2844.3	0	ANNUAL	ALL	1				
364		635099.5	4978334	0.00087	1991.74	2844.3	0	ANNUAL	ALL	1				
365		635124.5	4978334	0.00088	1991.62	2844.3	0	ANNUAL	ALL	1				
366		635149.5	4978334	0.00084	1998.49	2844.3	0	ANNUAL	ALL	1				
367		635174.5	4978334	0.00079	2006.18	2844.3	0	ANNUAL	ALL	1				
368		635199.5	4978334	0.00075	2015.32	2844.3	0	ANNUAL	ALL	1				
369		634299.5	4978134	0.00048	2065.05	2844.3	0	ANNUAL	ALL	1				
370		634324.5	4978134	0.00052	2052.1	2844.3	0	ANNUAL	ALL	1				
371		634349.5	4978134	0.00055	2045.24	2844.3	0	ANNUAL	ALL	1				
372		634374.5	4978134	0.00059	2034.94	2844.3	0	ANNUAL	ALL	1				
373		634399.5	4978134	0.00066	2020.36	2844.3	0	ANNUAL	ALL	1				
374		634424.5	4978134	0.00076	2003.67	2844.3	0	ANNUAL	ALL	1				
375		634449.5	4978134	0.00083	1995.29	2844.3	0	ANNUAL	ALL	1				
376		634474.5	4978134	0.00075	2007.74	2844.3	0	ANNUAL	ALL	1				
377		634499.5	4978134	0.00066	2026.56	2844.3	0	ANNUAL	ALL	1				
378		634299.5	4978159	0.00049	2056.37	2844.3	0	ANNUAL	ALL	1				
379		634324.5	4978159	0.00053	2043.39	2844.3	0	ANNUAL	ALL	1				
380		634349.5	4978159	0.00058	2031.51	2844.3	0	ANNUAL	ALL	1				
381		634374.5	4978159	0.00062	2023.05	2844.3	0	ANNUAL	ALL	1				
382		634399.5	4978159	0.0007	2009.29	2844.3	0	ANNUAL	ALL	1				
383		634424.5	4978159	0.0008	1995	2844.3	0	ANNUAL	ALL	1				
384		634449.5	4978159	0.00083	1992.7	2844.3	0	ANNUAL	ALL	1				
385		634474.5	4978159	0.00074	2006.88	2844.3	0	ANNUAL	ALL	1				
386		634499.5	4978159	0.00066	2023.97	2844.3	0	ANNUAL	ALL	1				
387		634299.5	4978184	0.00049	2049.3	2844.3	0	ANNUAL	ALL	1				
388		634324.5	4978184	0.00054	2036.32	2844.3	0	ANNUAL	ALL	1				
389		634349.5	4978184	0.0006	2022.34	2844.3	0	ANNUAL	ALL	1				
390		634374.5	4978184	0.00067	2009.09	2844.3	0	ANNUAL	ALL	1				
391		634399.5	4978184	0.00073	1999.89	2844.3	0	ANNUAL	ALL	1				
392		634424.5	4978184	0.00082	1987.52	2844.3	0	ANNUAL	ALL	1				
393		634449.5	4978184	0.00081	1991.46	2844.3	0	ANNUAL	ALL	1				
394		634474.5	4978184	0.00072	2006.06	2844.3	0	ANNUAL	ALL	1				
395		634499.5	4978184	0.00066	2020.38	2844.3	0	ANNUAL	ALL	1				
396		634299.5	4978209	0.0005	2043.21	2844.3	0	ANNUAL	ALL	1				
397		634324.5	4978209	0.00054	2030.6	2844.3	0	ANNUAL	ALL	1				
398		634349.5	4978209	0.00061	2016.03	2844.3	0	ANNUAL	ALL	1				
399		634374.5	4978209	0.00069	2000.87	2844.3	0	ANNUAL	ALL	1				
400		634399.5	4978209	0.00077	1990.53	2844.3	0	ANNUAL	ALL	1				
401		634424.5	4978209	0.00084	1981.32	2844.3	0	ANNUAL	ALL	1				
402		634449.5	4978209	0.0008	1989.45	2844.3	0	ANNUAL	ALL	1				
403		634474.5	4978209	0.00071	2004.01	2844.3	0	ANNUAL	ALL	1				
404		634499.5	4978209	0.00065	2016.91	2844.3	0	ANNUAL	ALL	1				
405		634299.5	4978234	0.0005	2037.27	2844.3	0	ANNUAL	ALL	1				
406		634324.5	4978234	0.00055	2025.09	2844.3	0	ANNUAL	ALL	1				
407		634349.5	4978234	0.00061	2009.81	2844.3	0	ANNUAL	ALL	1				
408		634374.5	4978234	0.0007	1996.13	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
409		634399.5	4978234	0.00078	1984.05	2844.3	0	ANNUAL	ALL	1				
410		634424.5	4978234	0.00085	1975.87	2844.3	0	ANNUAL	ALL	1				
411		634449.5	4978234	0.0008	1984.97	2844.3	0	ANNUAL	ALL	1				
412		634474.5	4978234	0.00071	2000.36	2844.3	0	ANNUAL	ALL	1				
413		634499.5	4978234	0.00066	2011.73	2844.3	0	ANNUAL	ALL	1				
414		634299.5	4978259	0.0005	2030.97	2844.3	0	ANNUAL	ALL	1				
415		634324.5	4978259	0.00055	2018.02	2844.3	0	ANNUAL	ALL	1				
416		634349.5	4978259	0.00063	2002.99	2844.3	0	ANNUAL	ALL	1				
417		634374.5	4978259	0.00071	1990.41	2844.3	0	ANNUAL	ALL	1				
418		634399.5	4978259	0.00079	1978.88	2844.3	0	ANNUAL	ALL	1				
419		634424.5	4978259	0.00084	1972.17	2844.3	0	ANNUAL	ALL	1				
420		634449.5	4978259	0.00082	1977.85	2844.3	0	ANNUAL	ALL	1				
421		634474.5	4978259	0.00074	1992.52	2844.3	0	ANNUAL	ALL	1				
422		634499.5	4978259	0.00068	2003.44	2844.3	0	ANNUAL	ALL	1				
423		634299.5	4978284	0.00051	2023.26	2844.3	0	ANNUAL	ALL	1				
424		634324.5	4978284	0.00057	2008.98	2844.3	0	ANNUAL	ALL	1				
425		634349.5	4978284	0.00064	1996.31	2844.3	0	ANNUAL	ALL	1				
426		634374.5	4978284	0.00072	1984.2	2844.3	0	ANNUAL	ALL	1				
427		634399.5	4978284	0.00079	1973.37	2844.3	0	ANNUAL	ALL	1				
428		634424.5	4978284	0.00083	1969.23	2844.3	0	ANNUAL	ALL	1				
429		634449.5	4978284	0.0008	1975.58	2844.3	0	ANNUAL	ALL	1				
430		634474.5	4978284	0.00074	1989.07	2844.3	0	ANNUAL	ALL	1				
431		634499.5	4978284	0.00068	2000.53	2844.3	0	ANNUAL	ALL	1				
432		634299.5	4978309	0.00053	2012.41	2844.3	0	ANNUAL	ALL	1				
433		634324.5	4978309	0.00059	1999.74	2844.3	0	ANNUAL	ALL	1				
434		634349.5	4978309	0.00066	1988.62	2844.3	0	ANNUAL	ALL	1				
435		634374.5	4978309	0.00073	1977.79	2844.3	0	ANNUAL	ALL	1				
436		634399.5	4978309	0.0008	1967.1	2844.3	0	ANNUAL	ALL	1				
437		634424.5	4978309	0.0008	1968.14	2844.3	0	ANNUAL	ALL	1				
438		634449.5	4978309	0.00077	1977.66	2844.3	0	ANNUAL	ALL	1				
439		634474.5	4978309	0.0007	1992.31	2844.3	0	ANNUAL	ALL	1				
440		634499.5	4978309	0.00063	2006.23	2844.3	0	ANNUAL	ALL	1				
441		634299.5	4978334	0.00056	2000.94	2844.3	0	ANNUAL	ALL	1				
442		634324.5	4978334	0.00061	1991.1	2844.3	0	ANNUAL	ALL	1				
443		634349.5	4978334	0.00068	1980.66	2844.3	0	ANNUAL	ALL	1				
444		634374.5	4978334	0.00074	1970.39	2844.3	0	ANNUAL	ALL	1				
445		634399.5	4978334	0.0008	1961.38	2844.3	0	ANNUAL	ALL	1				
446		634424.5	4978334	0.00078	1968.29	2844.3	0	ANNUAL	ALL	1				
447		634449.5	4978334	0.00072	1980.95	2844.3	0	ANNUAL	ALL	1				
448		634474.5	4978334	0.00065	1997.36	2844.3	0	ANNUAL	ALL	1				
449		634499.5	4978334	0.00058	2012.52	2844.3	0	ANNUAL	ALL	1				
450		634299.5	4978359	0.00058	1991.4	2844.3	0	ANNUAL	ALL	1				
451		634324.5	4978359	0.00063	1982.72	2844.3	0	ANNUAL	ALL	1				
452		634349.5	4978359	0.00069	1972.75	2844.3	0	ANNUAL	ALL	1				
453		634374.5	4978359	0.00075	1962.87	2844.3	0	ANNUAL	ALL	1				
454		634399.5	4978359	0.00078	1958.17	2844.3	0	ANNUAL	ALL	1				
455		634424.5	4978359	0.00075	1968.79	2844.3	0	ANNUAL	ALL	1				
456		634449.5	4978359	0.00068	1984.24	2844.3	0	ANNUAL	ALL	1				
457		634474.5	4978359	0.0006	2002.2	2844.3	0	ANNUAL	ALL	1				
458		634499.5	4978359	0.00055	2016.76	2844.3	0	ANNUAL	ALL	1				
459		634299.5	4978384	0.0006	1982.57	2844.3	0	ANNUAL	ALL	1				
460		634324.5	4978384	0.00064	1975.68	2844.3	0	ANNUAL	ALL	1				
461		634349.5	4978384	0.0007	1964.84	2844.3	0	ANNUAL	ALL	1				
462		634374.5	4978384	0.00074	1956.29	2844.3	0	ANNUAL	ALL	1				
463		634399.5	4978384	0.00076	1955.61	2844.3	0	ANNUAL	ALL	1				
464		634424.5	4978384	0.00072	1968.65	2844.3	0	ANNUAL	ALL	1				
465		634449.5	4978384	0.00065	1986.09	2844.3	0	ANNUAL	ALL	1				
466		634474.5	4978384	0.00057	2004.63	2844.3	0	ANNUAL	ALL	1				
467		634499.5	4978384	0.00052	2018.69	2844.3	0	ANNUAL	ALL	1				
468		634299.5	4978409	0.00061	1975.4	2844.3	0	ANNUAL	ALL	1				
469		634324.5	4978409	0.00065	1967.52	2844.3	0	ANNUAL	ALL	1				
470		634349.5	4978409	0.0007	1957.04	2844.3	0	ANNUAL	ALL	1				
471		634374.5	4978409	0.00073	1949.69	2844.3	0	ANNUAL	ALL	1				
472		634399.5	4978409	0.00074	1951.43	2844.3	0	ANNUAL	ALL	1				
473		634424.5	4978409	0.0007	1967.3	2844.3	0	ANNUAL	ALL	1				
474		634449.5	4978409	0.00062	1986.39	2844.3	0	ANNUAL	ALL	1				
475		634474.5	4978409	0.00055	2005.28	2844.3	0	ANNUAL	ALL	1				
476		634499.5	4978409	0.00051	2019.28	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
477		634299.5	4978434	0.00062	1965.22	2844.3	0	ANNUAL	ALL	1				
478		634324.5	4978434	0.00066	1958.88	2844.3	0	ANNUAL	ALL	1				
479		634349.5	4978434	0.00069	1950.79	2844.3	0	ANNUAL	ALL	1				
480		634374.5	4978434	0.00072	1943.73	2844.3	0	ANNUAL	ALL	1				
481		634399.5	4978434	0.00072	1949.4	2844.3	0	ANNUAL	ALL	1				
482		634424.5	4978434	0.00068	1965.04	2844.3	0	ANNUAL	ALL	1				
483		634449.5	4978434	0.00061	1984.59	2844.3	0	ANNUAL	ALL	1				
484		634474.5	4978434	0.00053	2004.45	2844.3	0	ANNUAL	ALL	1				
485		634499.5	4978434	0.0005	2017.53	2844.3	0	ANNUAL	ALL	1				
486		634249.4	4977384	0.0004	2291.4	2717.08	0	ANNUAL	ALL	1				
487		634274.4	4977384	0.0004	2282.65	2742	0	ANNUAL	ALL	1				
488		634299.4	4977384	0.0004	2273.71	2742	0	ANNUAL	ALL	1				
489		634324.4	4977384	0.0004	2263.84	2742	0	ANNUAL	ALL	1				
490		634349.4	4977384	0.00041	2250.84	2742	0	ANNUAL	ALL	1				
491		634374.4	4977384	0.00041	2238.58	2742.16	0	ANNUAL	ALL	1				
492		634399.4	4977384	0.00041	2232.43	2742.16	0	ANNUAL	ALL	1				
493		634424.4	4977384	0.00041	2242.73	2742.16	0	ANNUAL	ALL	1				
494		634449.4	4977384	0.0004	2255.36	2742	0	ANNUAL	ALL	1				
495		634249.4	4977409	0.0004	2284.43	2742	0	ANNUAL	ALL	1				
496		634274.4	4977409	0.0004	2274.53	2742	0	ANNUAL	ALL	1				
497		634299.4	4977409	0.0004	2264.56	2742	0	ANNUAL	ALL	1				
498		634324.4	4977409	0.00041	2254.44	2742	0	ANNUAL	ALL	1				
499		634349.4	4977409	0.00041	2243.93	2742.16	0	ANNUAL	ALL	1				
500		634374.4	4977409	0.00042	2231.37	2742.16	0	ANNUAL	ALL	1				
501		634399.4	4977409	0.00042	2226.02	2844.3	0	ANNUAL	ALL	1				
502		634424.4	4977409	0.00041	2236.92	2742.16	0	ANNUAL	ALL	1				
503		634449.4	4977409	0.0004	2249.43	2742.16	0	ANNUAL	ALL	1				
504		634249.4	4977434	0.0004	2279.34	2742	0	ANNUAL	ALL	1				
505		634274.4	4977434	0.0004	2267.65	2742	0	ANNUAL	ALL	1				
506		634299.4	4977434	0.00041	2255.85	2742	0	ANNUAL	ALL	1				
507		634324.4	4977434	0.00041	2244.86	2742	0	ANNUAL	ALL	1				
508		634349.4	4977434	0.00041	2234.48	2742.16	0	ANNUAL	ALL	1				
509		634374.4	4977434	0.00042	2223.18	2844.3	0	ANNUAL	ALL	1				
510		634399.4	4977434	0.00042	2218.5	2844.3	0	ANNUAL	ALL	1				
511		634424.4	4977434	0.00041	2230.27	2844.3	0	ANNUAL	ALL	1				
512		634449.4	4977434	0.0004	2243.66	2742.16	0	ANNUAL	ALL	1				
513		634249.4	4977459	0.0004	2275.78	2742	0	ANNUAL	ALL	1				
514		634274.4	4977459	0.0004	2262.83	2742	0	ANNUAL	ALL	1				
515		634299.4	4977459	0.00041	2248.74	2742	0	ANNUAL	ALL	1				
516		634324.4	4977459	0.00041	2237.43	2742.16	0	ANNUAL	ALL	1				
517		634349.4	4977459	0.00042	2226.72	2844.3	0	ANNUAL	ALL	1				
518		634374.4	4977459	0.00042	2214.97	2844.3	0	ANNUAL	ALL	1				
519		634399.4	4977459	0.00042	2211.75	2844.3	0	ANNUAL	ALL	1				
520		634424.4	4977459	0.00042	2223.34	2844.3	0	ANNUAL	ALL	1				
521		634449.4	4977459	0.00041	2237.29	2844.3	0	ANNUAL	ALL	1				
522		634249.4	4977484	0.0004	2272.5	2742	0	ANNUAL	ALL	1				
523		634274.4	4977484	0.0004	2258.48	2742	0	ANNUAL	ALL	1				
524		634299.4	4977484	0.00041	2243.77	2742	0	ANNUAL	ALL	1				
525		634324.4	4977484	0.00041	2231.45	2742.16	0	ANNUAL	ALL	1				
526		634349.4	4977484	0.00042	2219.9	2844.3	0	ANNUAL	ALL	1				
527		634374.4	4977484	0.00043	2207.94	2844.3	0	ANNUAL	ALL	1				
528		634399.4	4977484	0.00043	2204.62	2844.3	0	ANNUAL	ALL	1				
529		634424.4	4977484	0.00042	2216.76	2844.3	0	ANNUAL	ALL	1				
530		634449.4	4977484	0.00041	2230.33	2844.3	0	ANNUAL	ALL	1				
531		634249.4	4977509	0.0004	2269.17	2742	0	ANNUAL	ALL	1				
532		634274.4	4977509	0.0004	2254.88	2742	0	ANNUAL	ALL	1				
533		634299.4	4977509	0.00041	2240.59	2742	0	ANNUAL	ALL	1				
534		634324.4	4977509	0.00042	2227.32	2844.3	0	ANNUAL	ALL	1				
535		634349.4	4977509	0.00042	2213.19	2844.3	0	ANNUAL	ALL	1				
536		634374.4	4977509	0.00043	2200.19	2844.3	0	ANNUAL	ALL	1				
537		634399.4	4977509	0.00043	2197.61	2844.3	0	ANNUAL	ALL	1				
538		634424.4	4977509	0.00042	2211.03	2844.3	0	ANNUAL	ALL	1				
539		634449.4	4977509	0.00041	2223.57	2844.3	0	ANNUAL	ALL	1				
540		634249.4	4977534	0.0004	2266.65	2742	0	ANNUAL	ALL	1				
541		634274.4	4977534	0.0004	2251.58	2742	0	ANNUAL	ALL	1				
542		634299.4	4977534	0.00041	2237.18	2742	0	ANNUAL	ALL	1				
543		634324.4	4977534	0.00042	2223.67	2844.3	0	ANNUAL	ALL	1				
544		634349.4	4977534	0.00042	2207.86	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
545		634374.4	4977534	0.00043	2193.38	2844.3	0	ANNUAL	ALL	1				
546		634399.4	4977534	0.00043	2191.95	2844.3	0	ANNUAL	ALL	1				
547		634424.4	4977534	0.00042	2205.88	2844.3	0	ANNUAL	ALL	1				
548		634449.4	4977534	0.00041	2217.63	2844.3	0	ANNUAL	ALL	1				
549		634249.4	4977559	0.00039	2264.12	2742	0	ANNUAL	ALL	1				
550		634274.4	4977559	0.0004	2247.26	2742	0	ANNUAL	ALL	1				
551		634299.4	4977559	0.00041	2232.74	2742	0	ANNUAL	ALL	1				
552		634324.4	4977559	0.00042	2218.55	2844.3	0	ANNUAL	ALL	1				
553		634349.4	4977559	0.00042	2203.35	2844.3	0	ANNUAL	ALL	1				
554		634374.4	4977559	0.00044	2189.62	2844.3	0	ANNUAL	ALL	1				
555		634399.4	4977559	0.00044	2184.96	2844.3	0	ANNUAL	ALL	1				
556		634424.4	4977559	0.00042	2200.77	2844.3	0	ANNUAL	ALL	1				
557		634449.4	4977559	0.00042	2211.07	2844.3	0	ANNUAL	ALL	1				
558		634249.4	4977584	0.00039	2258.01	2742	0	ANNUAL	ALL	1				
559		634274.4	4977584	0.0004	2242.66	2742	0	ANNUAL	ALL	1				
560		634299.4	4977584	0.00041	2227.67	2844.3	0	ANNUAL	ALL	1				
561		634324.4	4977584	0.00042	2213.51	2844.3	0	ANNUAL	ALL	1				
562		634349.4	4977584	0.00043	2199.5	2844.3	0	ANNUAL	ALL	1				
563		634374.4	4977584	0.00044	2185.33	2844.3	0	ANNUAL	ALL	1				
564		634399.4	4977584	0.00044	2177.11	2844.3	0	ANNUAL	ALL	1				
565		634424.4	4977584	0.00043	2192.43	2844.3	0	ANNUAL	ALL	1				
566		634449.4	4977584	0.00042	2203.16	2844.3	0	ANNUAL	ALL	1				
567		634999.5	4977834	0.00069	2055.79	2844.3	0	ANNUAL	ALL	1				
568		635024.5	4977834	0.00074	2048.42	2844.3	0	ANNUAL	ALL	1				
569		635049.5	4977834	0.00077	2043	2844.3	0	ANNUAL	ALL	1				
570		635074.5	4977834	0.00081	2037.93	2844.3	0	ANNUAL	ALL	1				
571		635099.5	4977834	0.00083	2034.24	2844.3	0	ANNUAL	ALL	1				
572		635124.5	4977834	0.00085	2031.45	2844.3	0	ANNUAL	ALL	1				
573		635149.5	4977834	0.00081	2038.5	2844.3	0	ANNUAL	ALL	1				
574		635174.5	4977834	0.00073	2050.35	2844.3	0	ANNUAL	ALL	1				
575		635199.5	4977834	0.00066	2063.26	2844.3	0	ANNUAL	ALL	1				
576		634999.5	4977859	0.0007	2052.63	2844.3	0	ANNUAL	ALL	1				
577		635024.5	4977859	0.00074	2046.41	2844.3	0	ANNUAL	ALL	1				
578		635049.5	4977859	0.00078	2040.95	2844.3	0	ANNUAL	ALL	1				
579		635074.5	4977859	0.00081	2036.03	2844.3	0	ANNUAL	ALL	1				
580		635099.5	4977859	0.00084	2032.3	2844.3	0	ANNUAL	ALL	1				
581		635124.5	4977859	0.00085	2030.17	2844.3	0	ANNUAL	ALL	1				
582		635149.5	4977859	0.0008	2038.33	2844.3	0	ANNUAL	ALL	1				
583		635174.5	4977859	0.00073	2049.93	2844.3	0	ANNUAL	ALL	1				
584		635199.5	4977859	0.00066	2062.54	2844.3	0	ANNUAL	ALL	1				
585		634999.5	4977884	0.00072	2049.11	2844.3	0	ANNUAL	ALL	1				
586		635024.5	4977884	0.00075	2044.13	2844.3	0	ANNUAL	ALL	1				
587		635049.5	4977884	0.00078	2038.92	2844.3	0	ANNUAL	ALL	1				
588		635074.5	4977884	0.00081	2034.26	2844.3	0	ANNUAL	ALL	1				
589		635099.5	4977884	0.00084	2030.48	2844.3	0	ANNUAL	ALL	1				
590		635124.5	4977884	0.00085	2029.04	2844.3	0	ANNUAL	ALL	1				
591		635149.5	4977884	0.00079	2038.45	2844.3	0	ANNUAL	ALL	1				
592		635174.5	4977884	0.00072	2049.51	2844.3	0	ANNUAL	ALL	1				
593		635199.5	4977884	0.00066	2061.56	2844.3	0	ANNUAL	ALL	1				
594		634999.5	4977909	0.00072	2047.27	2844.3	0	ANNUAL	ALL	1				
595		635024.5	4977909	0.00075	2042.16	2844.3	0	ANNUAL	ALL	1				
596		635049.5	4977909	0.00078	2036.97	2844.3	0	ANNUAL	ALL	1				
597		635074.5	4977909	0.00082	2032.48	2844.3	0	ANNUAL	ALL	1				
598		635099.5	4977909	0.00084	2028.7	2844.3	0	ANNUAL	ALL	1				
599		635124.5	4977909	0.00084	2028.77	2844.3	0	ANNUAL	ALL	1				
600		635149.5	4977909	0.00078	2038.62	2844.3	0	ANNUAL	ALL	1				
601		635174.5	4977909	0.00072	2049.12	2844.3	0	ANNUAL	ALL	1				
602		635199.5	4977909	0.00066	2060.48	2844.3	0	ANNUAL	ALL	1				
603		634999.5	4977934	0.00071	2046.79	2844.3	0	ANNUAL	ALL	1				
604		635024.5	4977934	0.00075	2040.92	2844.3	0	ANNUAL	ALL	1				
605		635049.5	4977934	0.00079	2034.68	2844.3	0	ANNUAL	ALL	1				
606		635074.5	4977934	0.00083	2029.58	2844.3	0	ANNUAL	ALL	1				
607		635099.5	4977934	0.00085	2025.61	2844.3	0	ANNUAL	ALL	1				
608		635124.5	4977934	0.00084	2027.68	2844.3	0	ANNUAL	ALL	1				
609		635149.5	4977934	0.00078	2038.09	2844.3	0	ANNUAL	ALL	1				
610		635174.5	4977934	0.00071	2048.68	2844.3	0	ANNUAL	ALL	1				
611		635199.5	4977934	0.00066	2059.02	2844.3	0	ANNUAL	ALL	1				
612		634999.5	4977959	0.00071	2045.95	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
613		635024.5	4977959	0.00075	2039.51	2844.3	0	ANNUAL	ALL	1				
614		635049.5	4977959	0.00079	2032.45	2844.3	0	ANNUAL	ALL	1				
615		635074.5	4977959	0.00084	2026.52	2844.3	0	ANNUAL	ALL	1				
616		635099.5	4977959	0.00086	2022.6	2844.3	0	ANNUAL	ALL	1				
617		635124.5	4977959	0.00084	2027.13	2844.3	0	ANNUAL	ALL	1				
618		635149.5	4977959	0.00077	2036.89	2844.3	0	ANNUAL	ALL	1				
619		635174.5	4977959	0.00072	2046.85	2844.3	0	ANNUAL	ALL	1				
620		635199.5	4977959	0.00066	2056.78	2844.3	0	ANNUAL	ALL	1				
621		634999.5	4977984	0.0007	2045.34	2844.3	0	ANNUAL	ALL	1				
622		635024.5	4977984	0.00075	2037.82	2844.3	0	ANNUAL	ALL	1				
623		635049.5	4977984	0.0008	2030.43	2844.3	0	ANNUAL	ALL	1				
624		635074.5	4977984	0.00084	2024.12	2844.3	0	ANNUAL	ALL	1				
625		635099.5	4977984	0.00087	2019.96	2844.3	0	ANNUAL	ALL	1				
626		635124.5	4977984	0.00083	2026.73	2844.3	0	ANNUAL	ALL	1				
627		635149.5	4977984	0.00077	2035.4	2844.3	0	ANNUAL	ALL	1				
628		635174.5	4977984	0.00072	2044.46	2844.3	0	ANNUAL	ALL	1				
629		635199.5	4977984	0.00067	2053.52	2844.3	0	ANNUAL	ALL	1				
630		634999.5	4978009	0.0007	2044.81	2844.3	0	ANNUAL	ALL	1				
631		635024.5	4978009	0.00075	2035.59	2844.3	0	ANNUAL	ALL	1				
632		635049.5	4978009	0.0008	2028.05	2844.3	0	ANNUAL	ALL	1				
633		635074.5	4978009	0.00085	2021.18	2844.3	0	ANNUAL	ALL	1				
634		635099.5	4978009	0.00088	2017.1	2844.3	0	ANNUAL	ALL	1				
635		635124.5	4978009	0.00082	2025.97	2844.3	0	ANNUAL	ALL	1				
636		635149.5	4978009	0.00077	2034.03	2844.3	0	ANNUAL	ALL	1				
637		635174.5	4978009	0.00073	2041.95	2844.3	0	ANNUAL	ALL	1				
638		635199.5	4978009	0.00068	2050.09	2844.3	0	ANNUAL	ALL	1				
639		634999.5	4978034	0.0007	2043.29	2844.3	0	ANNUAL	ALL	1				
640		635024.5	4978034	0.00076	2032.46	2844.3	0	ANNUAL	ALL	1				
641		635049.5	4978034	0.00082	2024.39	2844.3	0	ANNUAL	ALL	1				
642		635074.5	4978034	0.00086	2017.56	2844.3	0	ANNUAL	ALL	1				
643		635099.5	4978034	0.00088	2015.24	2844.3	0	ANNUAL	ALL	1				
644		635124.5	4978034	0.00082	2024.2	2844.3	0	ANNUAL	ALL	1				
645		635149.5	4978034	0.00078	2032.02	2844.3	0	ANNUAL	ALL	1				
646		635174.5	4978034	0.00073	2040.48	2844.3	0	ANNUAL	ALL	1				
647		635199.5	4978034	0.00068	2049.69	2844.3	0	ANNUAL	ALL	1				
648		634599.5	4976834	0.00035	2431.97	2717.08	0	ANNUAL	ALL	1				
649		634624.5	4976834	0.00035	2425.11	2717.08	0	ANNUAL	ALL	1				
650		634649.5	4976834	0.00035	2416.95	2717.08	0	ANNUAL	ALL	1				
651		634674.5	4976834	0.00035	2407.96	2717.08	0	ANNUAL	ALL	1				
652		634699.5	4976834	0.00036	2398.82	2717.08	0	ANNUAL	ALL	1				
653		634724.5	4976834	0.00036	2389.57	2717.08	0	ANNUAL	ALL	1				
654		634749.5	4976834	0.00036	2378.83	2717.08	0	ANNUAL	ALL	1				
655		634774.5	4976834	0.00036	2368.3	2717.08	0	ANNUAL	ALL	1				
656		634799.5	4976834	0.00036	2352.38	2717.08	0	ANNUAL	ALL	1				
657		634599.5	4976859	0.00035	2427	2717.08	0	ANNUAL	ALL	1				
658		634624.5	4976859	0.00035	2421.36	2717.08	0	ANNUAL	ALL	1				
659		634649.5	4976859	0.00035	2412.9	2717.08	0	ANNUAL	ALL	1				
660		634674.5	4976859	0.00035	2401.58	2717.08	0	ANNUAL	ALL	1				
661		634699.5	4976859	0.00036	2391.51	2717.08	0	ANNUAL	ALL	1				
662		634724.5	4976859	0.00036	2381.29	2717.08	0	ANNUAL	ALL	1				
663		634749.5	4976859	0.00036	2371.44	2717.08	0	ANNUAL	ALL	1				
664		634774.5	4976859	0.00036	2358.57	2717.08	0	ANNUAL	ALL	1				
665		634799.5	4976859	0.00037	2341.91	2742	0	ANNUAL	ALL	1				
666		634599.5	4976884	0.00035	2422.69	2717.08	0	ANNUAL	ALL	1				
667		634624.5	4976884	0.00035	2418.17	2717.08	0	ANNUAL	ALL	1				
668		634649.5	4976884	0.00035	2408.98	2717.08	0	ANNUAL	ALL	1				
669		634674.5	4976884	0.00035	2396.57	2717.08	0	ANNUAL	ALL	1				
670		634699.5	4976884	0.00036	2383.76	2717.08	0	ANNUAL	ALL	1				
671		634724.5	4976884	0.00036	2371.27	2717.08	0	ANNUAL	ALL	1				
672		634749.5	4976884	0.00036	2362.03	2717.08	0	ANNUAL	ALL	1				
673		634774.5	4976884	0.00036	2350.11	2717.08	0	ANNUAL	ALL	1				
674		634799.5	4976884	0.00037	2334.35	2742	0	ANNUAL	ALL	1				
675		634599.5	4976909	0.00035	2418.11	2717.08	0	ANNUAL	ALL	1				
676		634624.5	4976909	0.00035	2412.47	2717.08	0	ANNUAL	ALL	1				
677		634649.5	4976909	0.00035	2402.76	2717.08	0	ANNUAL	ALL	1				
678		634674.5	4976909	0.00035	2392.81	2717.08	0	ANNUAL	ALL	1				
679		634699.5	4976909	0.00036	2377.98	2717.08	0	ANNUAL	ALL	1				
680		634724.5	4976909	0.00036	2364.11	2717.08	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
681		634749.5	4976909	0.00036	2354.73	2717.08	0	ANNUAL	ALL	1				
682		634774.5	4976909	0.00036	2345.14	2717.08	0	ANNUAL	ALL	1				
683		634799.5	4976909	0.00037	2331	2742	0	ANNUAL	ALL	1				
684		634599.5	4976934	0.00035	2411.78	2717.08	0	ANNUAL	ALL	1				
685		634624.5	4976934	0.00035	2403.98	2717.08	0	ANNUAL	ALL	1				
686		634649.5	4976934	0.00035	2394.61	2717.08	0	ANNUAL	ALL	1				
687		634674.5	4976934	0.00035	2383.71	2717.08	0	ANNUAL	ALL	1				
688		634699.5	4976934	0.00036	2371.78	2717.08	0	ANNUAL	ALL	1				
689		634724.5	4976934	0.00036	2359.09	2717.08	0	ANNUAL	ALL	1				
690		634749.5	4976934	0.00036	2347.63	2717.08	0	ANNUAL	ALL	1				
691		634774.5	4976934	0.00036	2337.6	2742	0	ANNUAL	ALL	1				
692		634799.5	4976934	0.00037	2326.97	2742	0	ANNUAL	ALL	1				
693		634599.5	4976959	0.00035	2404.1	2717.08	0	ANNUAL	ALL	1				
694		634624.5	4976959	0.00035	2396.65	2717.08	0	ANNUAL	ALL	1				
695		634649.5	4976959	0.00035	2385.41	2717.08	0	ANNUAL	ALL	1				
696		634674.5	4976959	0.00036	2372.07	2717.08	0	ANNUAL	ALL	1				
697		634699.5	4976959	0.00036	2362.55	2717.08	0	ANNUAL	ALL	1				
698		634724.5	4976959	0.00036	2351.59	2717.08	0	ANNUAL	ALL	1				
699		634749.5	4976959	0.00036	2341.2	2717.08	0	ANNUAL	ALL	1				
700		634774.5	4976959	0.00037	2328.55	2742	0	ANNUAL	ALL	1				
701		634799.5	4976959	0.00037	2318.72	2742	0	ANNUAL	ALL	1				
702		634599.5	4976984	0.00035	2396.35	2717.08	0	ANNUAL	ALL	1				
703		634624.5	4976984	0.00035	2389.04	2717.08	0	ANNUAL	ALL	1				
704		634649.5	4976984	0.00035	2377.21	2717.08	0	ANNUAL	ALL	1				
705		634674.5	4976984	0.00036	2363.6	2717.08	0	ANNUAL	ALL	1				
706		634699.5	4976984	0.00036	2350.85	2717.08	0	ANNUAL	ALL	1				
707		634724.5	4976984	0.00036	2340.79	2717.08	0	ANNUAL	ALL	1				
708		634749.5	4976984	0.00036	2331.79	2742	0	ANNUAL	ALL	1				
709		634774.5	4976984	0.00037	2320.7	2742	0	ANNUAL	ALL	1				
710		634799.5	4976984	0.00037	2308.59	2742	0	ANNUAL	ALL	1				
711		634599.5	4977009	0.00035	2388.79	2717.08	0	ANNUAL	ALL	1				
712		634624.5	4977009	0.00035	2379.17	2717.08	0	ANNUAL	ALL	1				
713		634649.5	4977009	0.00035	2368.25	2717.08	0	ANNUAL	ALL	1				
714		634674.5	4977009	0.00036	2355.13	2717.08	0	ANNUAL	ALL	1				
715		634699.5	4977009	0.00036	2341.52	2717.08	0	ANNUAL	ALL	1				
716		634724.5	4977009	0.00036	2328.18	2742	0	ANNUAL	ALL	1				
717		634749.5	4977009	0.00037	2321.24	2742	0	ANNUAL	ALL	1				
718		634774.5	4977009	0.00037	2313.44	2742	0	ANNUAL	ALL	1				
719		634799.5	4977009	0.00037	2301.46	2742.16	0	ANNUAL	ALL	1				
720		634599.5	4977034	0.00035	2379.36	2717.08	0	ANNUAL	ALL	1				
721		634624.5	4977034	0.00035	2369.28	2717.08	0	ANNUAL	ALL	1				
722		634649.5	4977034	0.00036	2356.46	2717.08	0	ANNUAL	ALL	1				
723		634674.5	4977034	0.00036	2343.53	2717.08	0	ANNUAL	ALL	1				
724		634699.5	4977034	0.00036	2329.9	2742	0	ANNUAL	ALL	1				
725		634724.5	4977034	0.00037	2316.92	2742	0	ANNUAL	ALL	1				
726		634749.5	4977034	0.00037	2309.32	2742	0	ANNUAL	ALL	1				
727		634774.5	4977034	0.00037	2302.58	2742	0	ANNUAL	ALL	1				
728		634799.5	4977034	0.00037	2295.21	2742.16	0	ANNUAL	ALL	1				
729	**	CONCUNIT	ug/m^3											
730	**	DEPUNIT	g/m^2											

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	*	AERMOD	(	19191):	MIDAS	GOLD	STIBNITE	-	MODELING	R27	########			
2	*	AERMET	(	19191):	16:35:34									
3	*	MODELING	OPTIONS	USED:	RegDFAULT	CONC	ELEV	NOWARN	DRYDPLT	WETDPLT	RURAL	ADJ_U*		
4	*	PLOT	FILE	OF	ANNUAL	VALUES	AVERAGED	ACROSS	1	YEARS	FOR	SOURCE	GROUP:	ALL
5	*	FOR	A	TOTAL	OF	720	RECEPTORS.							
6	*	FORMAT:	(3(1X,F13.5),3(1X,F8.2),2X,A6,2X,A8,2X,I8.8,2X,A8)											
7	*	X	Y	AVERAGE	CONC	ZELEV	ZHILL	ZFLAG	AVE	GRP	NUM	YRS	NET	ID
8	*													
9	0.006830	635399.5	4975934	0.00035	2213.4	2844.3	0	ANNUAL	ALL	1				
10	max ↑	635424.5	4975934	0.00035	2212.64	2844.3	0	ANNUAL	ALL	1				
11		635449.5	4975934	0.00035	2211.27	2844.3	0	ANNUAL	ALL	1				
12		635474.5	4975934	0.00034	2212.5	2844.3	0	ANNUAL	ALL	1				
13		635499.5	4975934	0.00033	2215.21	2844.3	0	ANNUAL	ALL	1				
14		635524.5	4975934	0.00033	2215.98	2844.3	0	ANNUAL	ALL	1				
15		635549.5	4975934	0.00032	2215	2844.3	0	ANNUAL	ALL	1				
16		635574.5	4975934	0.00032	2215.74	2844.3	0	ANNUAL	ALL	1				
17		635599.5	4975934	0.00031	2218.34	2844.3	0	ANNUAL	ALL	1				
18		635399.5	4975959	0.00038	2202.75	2844.3	0	ANNUAL	ALL	1				
19		635424.5	4975959	0.00037	2204.36	2844.3	0	ANNUAL	ALL	1				
20		635449.5	4975959	0.00037	2204.87	2844.3	0	ANNUAL	ALL	1				
21		635474.5	4975959	0.00036	2206.39	2844.3	0	ANNUAL	ALL	1				
22		635499.5	4975959	0.00035	2208.99	2844.3	0	ANNUAL	ALL	1				
23		635524.5	4975959	0.00034	2210.99	2844.3	0	ANNUAL	ALL	1				
24		635549.5	4975959	0.00034	2211.29	2844.3	0	ANNUAL	ALL	1				
25		635574.5	4975959	0.00033	2210.92	2844.3	0	ANNUAL	ALL	1				
26		635599.5	4975959	0.00033	2208.83	2844.3	0	ANNUAL	ALL	1				
27		635399.5	4975984	0.00041	2195.09	2844.3	0	ANNUAL	ALL	1				
28		635424.5	4975984	0.0004	2198.19	2844.3	0	ANNUAL	ALL	1				
29		635449.5	4975984	0.00039	2198.7	2844.3	0	ANNUAL	ALL	1				
30		635474.5	4975984	0.00038	2201.57	2844.3	0	ANNUAL	ALL	1				
31		635499.5	4975984	0.00037	2203.99	2844.3	0	ANNUAL	ALL	1				
32		635524.5	4975984	0.00036	2206.27	2844.3	0	ANNUAL	ALL	1				
33		635549.5	4975984	0.00035	2206.83	2844.3	0	ANNUAL	ALL	1				
34		635574.5	4975984	0.00035	2205.61	2844.3	0	ANNUAL	ALL	1				
35		635599.5	4975984	0.00035	2202.99	2844.3	0	ANNUAL	ALL	1				
36		635399.5	4976009	0.00042	2195.69	2844.3	0	ANNUAL	ALL	1				
37		635424.5	4976009	0.00043	2189.65	2844.3	0	ANNUAL	ALL	1				
38		635449.5	4976009	0.00041	2194	2844.3	0	ANNUAL	ALL	1				
39		635474.5	4976009	0.00039	2200.13	2844.3	0	ANNUAL	ALL	1				
40		635499.5	4976009	0.00038	2202.83	2844.3	0	ANNUAL	ALL	1				
41		635524.5	4976009	0.00037	2203.57	2844.3	0	ANNUAL	ALL	1				
42		635549.5	4976009	0.00037	2203.82	2844.3	0	ANNUAL	ALL	1				
43		635574.5	4976009	0.00037	2202.81	2844.3	0	ANNUAL	ALL	1				
44		635599.5	4976009	0.00036	2200.59	2844.3	0	ANNUAL	ALL	1				
45		635399.5	4976034	0.00042	2198.23	2844.3	0	ANNUAL	ALL	1				
46		635424.5	4976034	0.00045	2186.98	2844.3	0	ANNUAL	ALL	1				
47		635449.5	4976034	0.00043	2190.14	2844.3	0	ANNUAL	ALL	1				
48		635474.5	4976034	0.0004	2198.63	2844.3	0	ANNUAL	ALL	1				
49		635499.5	4976034	0.0004	2198.93	2844.3	0	ANNUAL	ALL	1				
50		635524.5	4976034	0.00039	2199.39	2844.3	0	ANNUAL	ALL	1				
51		635549.5	4976034	0.00038	2201.1	2844.3	0	ANNUAL	ALL	1				
52		635574.5	4976034	0.00038	2200.59	2844.3	0	ANNUAL	ALL	1				
53		635599.5	4976034	0.00038	2197.96	2844.3	0	ANNUAL	ALL	1				
54		635399.5	4976059	0.00044	2196.33	2844.3	0	ANNUAL	ALL	1				
55		635424.5	4976059	0.00047	2184.09	2844.3	0	ANNUAL	ALL	1				
56		635449.5	4976059	0.00047	2180.82	2844.3	0	ANNUAL	ALL	1				
57		635474.5	4976059	0.00043	2193.11	2844.3	0	ANNUAL	ALL	1				
58		635499.5	4976059	0.00042	2194.5	2844.3	0	ANNUAL	ALL	1				
59		635524.5	4976059	0.00041	2197.17	2844.3	0	ANNUAL	ALL	1				
60		635549.5	4976059	0.0004	2199.4	2844.3	0	ANNUAL	ALL	1				
61		635574.5	4976059	0.00039	2198.27	2844.3	0	ANNUAL	ALL	1				
62		635599.5	4976059	0.0004	2194.62	2844.3	0	ANNUAL	ALL	1				
63		635399.5	4976084	0.00047	2188.98	2844.3	0	ANNUAL	ALL	1				
64		635424.5	4976084	0.00049	2180.22	2844.3	0	ANNUAL	ALL	1				
65		635449.5	4976084	0.0005	2174.51	2844.3	0	ANNUAL	ALL	1				
66		635474.5	4976084	0.00048	2180.27	2844.3	0	ANNUAL	ALL	1				
67		635499.5	4976084	0.00045	2185.71	2844.3	0	ANNUAL	ALL	1				
68		635524.5	4976084	0.00043	2191.13	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
69		635549.5	4976084	0.00042	2193.95	2844.3	0	ANNUAL	ALL	1				
70		635574.5	4976084	0.00042	2190.58	2844.3	0	ANNUAL	ALL	1				
71		635599.5	4976084	0.00043	2183.01	2844.3	0	ANNUAL	ALL	1				
72		635399.5	4976109	0.00051	2182.28	2844.3	0	ANNUAL	ALL	1				
73		635424.5	4976109	0.00051	2177.24	2844.3	0	ANNUAL	ALL	1				
74		635449.5	4976109	0.00052	2171.45	2844.3	0	ANNUAL	ALL	1				
75		635474.5	4976109	0.00051	2172.26	2844.3	0	ANNUAL	ALL	1				
76		635499.5	4976109	0.00049	2177.58	2844.3	0	ANNUAL	ALL	1				
77		635524.5	4976109	0.00047	2180.23	2844.3	0	ANNUAL	ALL	1				
78		635549.5	4976109	0.00047	2179.81	2844.3	0	ANNUAL	ALL	1				
79		635574.5	4976109	0.00047	2176.94	2844.3	0	ANNUAL	ALL	1				
80		635599.5	4976109	0.00045	2179.4	2844.3	0	ANNUAL	ALL	1				
81		635399.5	4976134	0.00054	2176.77	2844.3	0	ANNUAL	ALL	1				
82		635424.5	4976134	0.00054	2174.27	2844.3	0	ANNUAL	ALL	1				
83		635449.5	4976134	0.00054	2171.04	2844.3	0	ANNUAL	ALL	1				
84		635474.5	4976134	0.00054	2166.4	2844.3	0	ANNUAL	ALL	1				
85		635499.5	4976134	0.00053	2167.48	2844.3	0	ANNUAL	ALL	1				
86		635524.5	4976134	0.00051	2172.09	2844.3	0	ANNUAL	ALL	1				
87		635549.5	4976134	0.0005	2171.44	2844.3	0	ANNUAL	ALL	1				
88		635574.5	4976134	0.00049	2172.93	2844.3	0	ANNUAL	ALL	1				
89		635599.5	4976134	0.00047	2178.31	2844.3	0	ANNUAL	ALL	1				
90		635199.5	4976834	0.00234	2116.83	2844.3	0	ANNUAL	ALL	1				
91		635224.5	4976834	0.00233	2112.53	2844.3	0	ANNUAL	ALL	1				
92		635249.5	4976834	0.00231	2108.39	2844.3	0	ANNUAL	ALL	1				
93		635274.5	4976834	0.0023	2105.23	2844.3	0	ANNUAL	ALL	1				
94		635299.5	4976834	0.0023	2101.6	2844.3	0	ANNUAL	ALL	1				
95		635324.5	4976834	0.00229	2098.74	2844.3	0	ANNUAL	ALL	1				
96		635349.5	4976834	0.00217	2104.26	2844.3	0	ANNUAL	ALL	1				
97		635374.5	4976834	0.00204	2110.4	2844.3	0	ANNUAL	ALL	1				
98		635399.5	4976834	0.00192	2117.98	2844.3	0	ANNUAL	ALL	1				
99		635199.5	4976859	0.00244	2114.34	2844.3	0	ANNUAL	ALL	1				
100		635224.5	4976859	0.00243	2108.68	2844.3	0	ANNUAL	ALL	1				
101		635249.5	4976859	0.00243	2104.42	2844.3	0	ANNUAL	ALL	1				
102		635274.5	4976859	0.00241	2101.28	2844.3	0	ANNUAL	ALL	1				
103		635299.5	4976859	0.00239	2098.83	2844.3	0	ANNUAL	ALL	1				
104		635324.5	4976859	0.00237	2096.89	2844.3	0	ANNUAL	ALL	1				
105		635349.5	4976859	0.00226	2101.21	2844.3	0	ANNUAL	ALL	1				
106		635374.5	4976859	0.00212	2108.71	2844.3	0	ANNUAL	ALL	1				
107		635399.5	4976859	0.00198	2118.31	2844.3	0	ANNUAL	ALL	1				
108		635199.5	4976884	0.00252	2111.17	2844.3	0	ANNUAL	ALL	1				
109		635224.5	4976884	0.00255	2104.78	2844.3	0	ANNUAL	ALL	1				
110		635249.5	4976884	0.00254	2100.14	2844.3	0	ANNUAL	ALL	1				
111		635274.5	4976884	0.00252	2097.48	2844.3	0	ANNUAL	ALL	1				
112		635299.5	4976884	0.00249	2095.42	2844.3	0	ANNUAL	ALL	1				
113		635324.5	4976884	0.00244	2094.96	2844.3	0	ANNUAL	ALL	1				
114		635349.5	4976884	0.00236	2097.83	2844.3	0	ANNUAL	ALL	1				
115		635374.5	4976884	0.00219	2107.96	2844.3	0	ANNUAL	ALL	1				
116		635399.5	4976884	0.00203	2119.17	2844.3	0	ANNUAL	ALL	1				
117		635199.5	4976909	0.00263	2108.51	2844.3	0	ANNUAL	ALL	1				
118		635224.5	4976909	0.00263	2102.17	2844.3	0	ANNUAL	ALL	1				
119		635249.5	4976909	0.00263	2097.31	2844.3	0	ANNUAL	ALL	1				
120		635274.5	4976909	0.0026	2094.85	2844.3	0	ANNUAL	ALL	1				
121		635299.5	4976909	0.00256	2093.19	2844.3	0	ANNUAL	ALL	1				
122		635324.5	4976909	0.0025	2093.48	2844.3	0	ANNUAL	ALL	1				
123		635349.5	4976909	0.00242	2098.12	2844.3	0	ANNUAL	ALL	1				
124		635374.5	4976909	0.00224	2108.79	2844.3	0	ANNUAL	ALL	1				
125		635399.5	4976909	0.00207	2120.74	2844.3	0	ANNUAL	ALL	1				
126		635199.5	4976934	0.00272	2106.38	2844.3	0	ANNUAL	ALL	1				
127		635224.5	4976934	0.00271	2100.81	2844.3	0	ANNUAL	ALL	1				
128		635249.5	4976934	0.0027	2096.21	2844.3	0	ANNUAL	ALL	1				
129		635274.5	4976934	0.00267	2092.89	2844.3	0	ANNUAL	ALL	1				
130		635299.5	4976934	0.00263	2091.1	2844.3	0	ANNUAL	ALL	1				
131		635324.5	4976934	0.00257	2092.46	2844.3	0	ANNUAL	ALL	1				
132		635349.5	4976934	0.00246	2099.48	2844.3	0	ANNUAL	ALL	1				
133		635374.5	4976934	0.00228	2110.37	2844.3	0	ANNUAL	ALL	1				
134		635399.5	4976934	0.00211	2122.91	2844.3	0	ANNUAL	ALL	1				
135		635199.5	4976959	0.00281	2104.62	2844.3	0	ANNUAL	ALL	1				
136		635224.5	4976959	0.00279	2099.28	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
137		635249.5	4976959	0.00276	2094.41	2844.3	0	ANNUAL	ALL	1				
138		635274.5	4976959	0.00272	2090.59	2844.3	0	ANNUAL	ALL	1				
139		635299.5	4976959	0.00269	2088.8	2844.3	0	ANNUAL	ALL	1				
140		635324.5	4976959	0.00262	2092.02	2844.3	0	ANNUAL	ALL	1				
141		635349.5	4976959	0.00251	2100.12	2844.3	0	ANNUAL	ALL	1				
142		635374.5	4976959	0.00233	2112.07	2844.3	0	ANNUAL	ALL	1				
143		635399.5	4976959	0.00214	2125.69	2844.3	0	ANNUAL	ALL	1				
144		635199.5	4976984	0.00289	2102.45	2844.3	0	ANNUAL	ALL	1				
145		635224.5	4976984	0.00287	2097.29	2844.3	0	ANNUAL	ALL	1				
146		635249.5	4976984	0.00283	2091.62	2844.3	0	ANNUAL	ALL	1				
147		635274.5	4976984	0.00278	2087.92	2844.3	0	ANNUAL	ALL	1				
148		635299.5	4976984	0.00274	2086.81	2844.3	0	ANNUAL	ALL	1				
149		635324.5	4976984	0.00267	2092.65	2844.3	0	ANNUAL	ALL	1				
150		635349.5	4976984	0.00256	2101.3	2844.3	0	ANNUAL	ALL	1				
151		635374.5	4976984	0.00239	2114.13	2844.3	0	ANNUAL	ALL	1				
152		635399.5	4976984	0.0022	2128.46	2844.3	0	ANNUAL	ALL	1				
153		635199.5	4977009	0.00297	2099.39	2844.3	0	ANNUAL	ALL	1				
154		635224.5	4977009	0.00292	2093.66	2844.3	0	ANNUAL	ALL	1				
155		635249.5	4977009	0.00287	2087.97	2844.3	0	ANNUAL	ALL	1				
156		635274.5	4977009	0.00283	2084.9	2844.3	0	ANNUAL	ALL	1				
157		635299.5	4977009	0.00278	2087.43	2844.3	0	ANNUAL	ALL	1				
158		635324.5	4977009	0.00272	2094.55	2844.3	0	ANNUAL	ALL	1				
159		635349.5	4977009	0.00259	2103.74	2844.3	0	ANNUAL	ALL	1				
160		635374.5	4977009	0.00245	2116.64	2844.3	0	ANNUAL	ALL	1				
161		635399.5	4977009	0.00224	2131.12	2844.3	0	ANNUAL	ALL	1				
162		635199.5	4977034	0.00304	2094.63	2844.3	0	ANNUAL	ALL	1				
163		635224.5	4977034	0.00297	2088.76	2844.3	0	ANNUAL	ALL	1				
164		635249.5	4977034	0.00292	2084.27	2844.3	0	ANNUAL	ALL	1				
165		635274.5	4977034	0.00288	2082.71	2844.3	0	ANNUAL	ALL	1				
166		635299.5	4977034	0.00282	2089.9	2844.3	0	ANNUAL	ALL	1				
167		635324.5	4977034	0.00276	2098.21	2844.3	0	ANNUAL	ALL	1				
168		635349.5	4977034	0.00263	2107.49	2844.3	0	ANNUAL	ALL	1				
169		635374.5	4977034	0.0025	2119.09	2844.3	0	ANNUAL	ALL	1				
170		635399.5	4977034	0.00229	2133.38	2844.3	0	ANNUAL	ALL	1				
171		634899.5	4977134	0.00236	2221.02	2844.3	0	ANNUAL	ALL	1				
172		634924.5	4977134	0.00266	2207.85	2844.3	0	ANNUAL	ALL	1				
173		634949.5	4977134	0.00303	2190.45	2844.3	0	ANNUAL	ALL	1				
174		634974.5	4977134	0.00344	2169.12	2844.3	0	ANNUAL	ALL	1				
175		634999.5	4977134	0.00364	2150.64	2844.3	0	ANNUAL	ALL	1				
176		635024.5	4977134	0.00369	2135.97	2844.3	0	ANNUAL	ALL	1				
177		635049.5	4977134	0.00365	2122.38	2844.3	0	ANNUAL	ALL	1				
178		635074.5	4977134	0.00357	2113.7	2844.3	0	ANNUAL	ALL	1				
179		635099.5	4977134	0.00348	2105.9	2844.3	0	ANNUAL	ALL	1				
180		634899.5	4977159	0.00271	2213.37	2844.3	0	ANNUAL	ALL	1				
181		634924.5	4977159	0.00291	2201.16	2844.3	0	ANNUAL	ALL	1				
182		634949.5	4977159	0.00336	2181.17	2844.3	0	ANNUAL	ALL	1				
183		634974.5	4977159	0.00364	2161.72	2844.3	0	ANNUAL	ALL	1				
184		634999.5	4977159	0.00375	2145.73	2844.3	0	ANNUAL	ALL	1				
185		635024.5	4977159	0.00377	2132.12	2844.3	0	ANNUAL	ALL	1				
186		635049.5	4977159	0.00371	2119.59	2844.3	0	ANNUAL	ALL	1				
187		635074.5	4977159	0.00358	2109.27	2844.3	0	ANNUAL	ALL	1				
188		635099.5	4977159	0.0035	2101.29	2844.3	0	ANNUAL	ALL	1				
189		634899.5	4977184	0.00299	2206.56	2844.3	0	ANNUAL	ALL	1				
190		634924.5	4977184	0.00326	2193.64	2844.3	0	ANNUAL	ALL	1				
191		634949.5	4977184	0.00363	2172.29	2844.3	0	ANNUAL	ALL	1				
192		634974.5	4977184	0.00379	2154.5	2844.3	0	ANNUAL	ALL	1				
193		634999.5	4977184	0.00382	2141.04	2844.3	0	ANNUAL	ALL	1				
194		635024.5	4977184	0.00383	2128.3	2844.3	0	ANNUAL	ALL	1				
195		635049.5	4977184	0.00373	2114.34	2844.3	0	ANNUAL	ALL	1				
196		635074.5	4977184	0.00359	2102.7	2844.3	0	ANNUAL	ALL	1				
197		635099.5	4977184	0.00352	2096.47	2844.3	0	ANNUAL	ALL	1				
198		634899.5	4977209	0.00327	2199.13	2844.3	0	ANNUAL	ALL	1				
199		634924.5	4977209	0.00355	2184.15	2844.3	0	ANNUAL	ALL	1				
200		634949.5	4977209	0.0038	2163.72	2844.3	0	ANNUAL	ALL	1				
201		634974.5	4977209	0.00389	2146.68	2844.3	0	ANNUAL	ALL	1				
202		634999.5	4977209	0.00387	2136.15	2844.3	0	ANNUAL	ALL	1				
203		635024.5	4977209	0.00381	2124.22	2844.3	0	ANNUAL	ALL	1				
204		635049.5	4977209	0.0037	2105.9	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
205		635074.5	4977209	0.00358	2096.39	2844.3	0	ANNUAL	ALL	1				
206		635099.5	4977209	0.00349	2091.31	2844.3	0	ANNUAL	ALL	1				
207		634899.5	4977234	0.0037	2185.16	2844.3	0	ANNUAL	ALL	1				
208		634924.5	4977234	0.00384	2172.04	2844.3	0	ANNUAL	ALL	1				
209		634949.5	4977234	0.00392	2152.41	2844.3	0	ANNUAL	ALL	1				
210		634974.5	4977234	0.00394	2139.97	2844.3	0	ANNUAL	ALL	1				
211		634999.5	4977234	0.00392	2130.73	2844.3	0	ANNUAL	ALL	1				
212		635024.5	4977234	0.00386	2117.31	2844.3	0	ANNUAL	ALL	1				
213		635049.5	4977234	0.00368	2098.65	2844.3	0	ANNUAL	ALL	1				
214		635074.5	4977234	0.00357	2092.39	2844.3	0	ANNUAL	ALL	1				
215		635099.5	4977234	0.00345	2087.32	2844.3	0	ANNUAL	ALL	1				
216		634899.5	4977259	0.00385	2180.4	2844.3	0	ANNUAL	ALL	1				
217		634924.5	4977259	0.00396	2160.19	2844.3	0	ANNUAL	ALL	1				
218		634949.5	4977259	0.00398	2143.3	2844.3	0	ANNUAL	ALL	1				
219		634974.5	4977259	0.00398	2132.11	2844.3	0	ANNUAL	ALL	1				
220		634999.5	4977259	0.00391	2123.02	2844.3	0	ANNUAL	ALL	1				
221		635024.5	4977259	0.0038	2107.09	2844.3	0	ANNUAL	ALL	1				
222		635049.5	4977259	0.00367	2095.35	2844.3	0	ANNUAL	ALL	1				
223		635074.5	4977259	0.00354	2089.07	2844.3	0	ANNUAL	ALL	1				
224		635099.5	4977259	0.00346	2083.6	2844.3	0	ANNUAL	ALL	1				
225		634899.5	4977284	0.0039	2180.69	2844.3	0	ANNUAL	ALL	1				
226		634924.5	4977284	0.00399	2158.28	2844.3	0	ANNUAL	ALL	1				
227		634949.5	4977284	0.00402	2139.34	2844.3	0	ANNUAL	ALL	1				
228		634974.5	4977284	0.00398	2123.05	2844.3	0	ANNUAL	ALL	1				
229		634999.5	4977284	0.00391	2112.91	2844.3	0	ANNUAL	ALL	1				
230		635024.5	4977284	0.00378	2100.55	2844.3	0	ANNUAL	ALL	1				
231		635049.5	4977284	0.00366	2092.76	2844.3	0	ANNUAL	ALL	1				
232		635074.5	4977284	0.00354	2085.71	2844.3	0	ANNUAL	ALL	1				
233		635099.5	4977284	0.00349	2078.67	2844.3	0	ANNUAL	ALL	1				
234		634899.5	4977309	0.00398	2178.55	2844.3	0	ANNUAL	ALL	1				
235		634924.5	4977309	0.00403	2156.77	2844.3	0	ANNUAL	ALL	1				
236		634949.5	4977309	0.00403	2136.54	2844.3	0	ANNUAL	ALL	1				
237		634974.5	4977309	0.004	2119.59	2844.3	0	ANNUAL	ALL	1				
238		634999.5	4977309	0.00389	2107.01	2844.3	0	ANNUAL	ALL	1				
239		635024.5	4977309	0.00379	2096.52	2844.3	0	ANNUAL	ALL	1				
240		635049.5	4977309	0.00365	2089.24	2844.3	0	ANNUAL	ALL	1				
241		635074.5	4977309	0.00357	2082.55	2844.3	0	ANNUAL	ALL	1				
242		635099.5	4977309	0.0035	2075.98	2844.3	0	ANNUAL	ALL	1				
243		634899.5	4977334	0.00406	2173.18	2844.3	0	ANNUAL	ALL	1				
244		634924.5	4977334	0.00407	2153.29	2844.3	0	ANNUAL	ALL	1				
245		634949.5	4977334	0.00406	2133.9	2844.3	0	ANNUAL	ALL	1				
246		634974.5	4977334	0.00402	2117.58	2844.3	0	ANNUAL	ALL	1				
247		634999.5	4977334	0.00389	2104.03	2844.3	0	ANNUAL	ALL	1				
248		635024.5	4977334	0.00377	2093.8	2844.3	0	ANNUAL	ALL	1				
249		635049.5	4977334	0.00365	2085.23	2844.3	0	ANNUAL	ALL	1				
250		635074.5	4977334	0.0036	2078.76	2844.3	0	ANNUAL	ALL	1				
251		635099.5	4977334	0.00353	2074.53	2844.3	0	ANNUAL	ALL	1				
252		635399.5	4976159	0.00057	2171.27	2844.3	0	ANNUAL	ALL	1				
253		635424.5	4976159	0.00057	2169.98	2844.3	0	ANNUAL	ALL	1				
254		635449.5	4976159	0.00056	2167.61	2844.3	0	ANNUAL	ALL	1				
255		635474.5	4976159	0.00057	2164.06	2844.3	0	ANNUAL	ALL	1				
256		635499.5	4976159	0.00056	2161.76	2844.3	0	ANNUAL	ALL	1				
257		635524.5	4976159	0.00056	2160.48	2844.3	0	ANNUAL	ALL	1				
258		635549.5	4976159	0.00054	2162.19	2844.3	0	ANNUAL	ALL	1				
259		635574.5	4976159	0.00052	2168.15	2844.3	0	ANNUAL	ALL	1				
260		635599.5	4976159	0.00049	2173.85	2844.3	0	ANNUAL	ALL	1				
261		635399.5	4976184	0.0006	2168.06	2844.3	0	ANNUAL	ALL	1				
262		635424.5	4976184	0.00059	2166.17	2844.3	0	ANNUAL	ALL	1				
263		635449.5	4976184	0.00059	2163.95	2844.3	0	ANNUAL	ALL	1				
264		635474.5	4976184	0.00059	2161.05	2844.3	0	ANNUAL	ALL	1				
265		635499.5	4976184	0.00059	2158.86	2844.3	0	ANNUAL	ALL	1				
266		635524.5	4976184	0.00059	2157.1	2844.3	0	ANNUAL	ALL	1				
267		635549.5	4976184	0.00058	2157.07	2844.3	0	ANNUAL	ALL	1				
268		635574.5	4976184	0.00054	2164.59	2844.3	0	ANNUAL	ALL	1				
269		635599.5	4976184	0.00051	2172.06	2844.3	0	ANNUAL	ALL	1				
270		635399.5	4976209	0.00063	2165.29	2844.3	0	ANNUAL	ALL	1				
271		635424.5	4976209	0.00062	2163.14	2844.3	0	ANNUAL	ALL	1				
272		635449.5	4976209	0.00062	2160.76	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
273		635474.5	4976209	0.00062	2158.05	2844.3	0	ANNUAL	ALL	1				
274		635499.5	4976209	0.00062	2155.43	2844.3	0	ANNUAL	ALL	1				
275		635524.5	4976209	0.00061	2153.57	2844.3	0	ANNUAL	ALL	1				
276		635549.5	4976209	0.0006	2156.02	2844.3	0	ANNUAL	ALL	1				
277		635574.5	4976209	0.00055	2165.26	2844.3	0	ANNUAL	ALL	1				
278		635599.5	4976209	0.00051	2175.01	2844.3	0	ANNUAL	ALL	1				
279		635399.5	4976234	0.00066	2162.56	2844.3	0	ANNUAL	ALL	1				
280		635424.5	4976234	0.00065	2160.46	2844.3	0	ANNUAL	ALL	1				
281		635449.5	4976234	0.00065	2157.93	2844.3	0	ANNUAL	ALL	1				
282		635474.5	4976234	0.00065	2155.5	2844.3	0	ANNUAL	ALL	1				
283		635499.5	4976234	0.00065	2152.67	2844.3	0	ANNUAL	ALL	1				
284		635524.5	4976234	0.00064	2150.12	2844.3	0	ANNUAL	ALL	1				
285		635549.5	4976234	0.00061	2156.6	2844.3	0	ANNUAL	ALL	1				
286		635574.5	4976234	0.00056	2167.62	2844.3	0	ANNUAL	ALL	1				
287		635599.5	4976234	0.00052	2178.35	2844.3	0	ANNUAL	ALL	1				
288		634999.5	4978134	0.00382	2044.53	2844.3	0	ANNUAL	ALL	1				
289		635024.5	4978134	0.00388	2030.56	2844.3	0	ANNUAL	ALL	1				
290		635049.5	4978134	0.00388	2018.07	2844.3	0	ANNUAL	ALL	1				
291		635074.5	4978134	0.00379	2006.69	2844.3	0	ANNUAL	ALL	1				
292		635099.5	4978134	0.00384	2006.39	2844.3	0	ANNUAL	ALL	1				
293		635124.5	4978134	0.00399	2013.34	2844.3	0	ANNUAL	ALL	1				
294		635149.5	4978134	0.00412	2020.75	2844.3	0	ANNUAL	ALL	1				
295		635174.5	4978134	0.00417	2029.05	2844.3	0	ANNUAL	ALL	1				
296		635199.5	4978134	0.00416	2038.91	2844.3	0	ANNUAL	ALL	1				
297		634999.5	4978159	0.00365	2044.5	2844.3	0	ANNUAL	ALL	1				
298		635024.5	4978159	0.00372	2030.78	2844.3	0	ANNUAL	ALL	1				
299		635049.5	4978159	0.00369	2017.35	2844.3	0	ANNUAL	ALL	1				
300		635074.5	4978159	0.00359	2004.54	2844.3	0	ANNUAL	ALL	1				
301		635099.5	4978159	0.00363	2003.81	2844.3	0	ANNUAL	ALL	1				
302		635124.5	4978159	0.00377	2010.57	2844.3	0	ANNUAL	ALL	1				
303		635149.5	4978159	0.00391	2017.75	2844.3	0	ANNUAL	ALL	1				
304		635174.5	4978159	0.004	2025.18	2844.3	0	ANNUAL	ALL	1				
305		635199.5	4978159	0.00404	2035.11	2844.3	0	ANNUAL	ALL	1				
306		634999.5	4978184	0.00349	2044.38	2844.3	0	ANNUAL	ALL	1				
307		635024.5	4978184	0.0035	2028.98	2844.3	0	ANNUAL	ALL	1				
308		635049.5	4978184	0.00349	2015.36	2844.3	0	ANNUAL	ALL	1				
309		635074.5	4978184	0.00339	2002.43	2844.3	0	ANNUAL	ALL	1				
310		635099.5	4978184	0.00342	2000.86	2844.3	0	ANNUAL	ALL	1				
311		635124.5	4978184	0.00356	2007.53	2844.3	0	ANNUAL	ALL	1				
312		635149.5	4978184	0.00369	2014.6	2844.3	0	ANNUAL	ALL	1				
313		635174.5	4978184	0.00381	2022.07	2844.3	0	ANNUAL	ALL	1				
314		635199.5	4978184	0.0039	2031.45	2844.3	0	ANNUAL	ALL	1				
315		634999.5	4978209	0.00333	2043.46	2844.3	0	ANNUAL	ALL	1				
316		635024.5	4978209	0.00333	2027.94	2844.3	0	ANNUAL	ALL	1				
317		635049.5	4978209	0.0033	2013.73	2844.3	0	ANNUAL	ALL	1				
318		635074.5	4978209	0.00322	2000.96	2844.3	0	ANNUAL	ALL	1				
319		635099.5	4978209	0.00323	1998.75	2844.3	0	ANNUAL	ALL	1				
320		635124.5	4978209	0.00335	2004.56	2844.3	0	ANNUAL	ALL	1				
321		635149.5	4978209	0.00349	2011.78	2844.3	0	ANNUAL	ALL	1				
322		635174.5	4978209	0.00362	2019.36	2844.3	0	ANNUAL	ALL	1				
323		635199.5	4978209	0.0037	2027.82	2844.3	0	ANNUAL	ALL	1				
324		634999.5	4978234	0.00317	2042.97	2844.3	0	ANNUAL	ALL	1				
325		635024.5	4978234	0.00316	2026.61	2844.3	0	ANNUAL	ALL	1				
326		635049.5	4978234	0.00312	2012.57	2844.3	0	ANNUAL	ALL	1				
327		635074.5	4978234	0.00306	2000.24	2844.3	0	ANNUAL	ALL	1				
328		635099.5	4978234	0.00305	1996.61	2844.3	0	ANNUAL	ALL	1				
329		635124.5	4978234	0.00316	2001.65	2844.3	0	ANNUAL	ALL	1				
330		635149.5	4978234	0.00329	2009.16	2844.3	0	ANNUAL	ALL	1				
331		635174.5	4978234	0.00343	2016.86	2844.3	0	ANNUAL	ALL	1				
332		635199.5	4978234	0.00353	2024.48	2844.3	0	ANNUAL	ALL	1				
333		634999.5	4978259	0.00299	2041.08	2844.3	0	ANNUAL	ALL	1				
334		635024.5	4978259	0.003	2024.08	2844.3	0	ANNUAL	ALL	1				
335		635049.5	4978259	0.00296	2011.49	2844.3	0	ANNUAL	ALL	1				
336		635074.5	4978259	0.00291	2000.61	2844.3	0	ANNUAL	ALL	1				
337		635099.5	4978259	0.00288	1994.84	2844.3	0	ANNUAL	ALL	1				
338		635124.5	4978259	0.00299	1999.29	2844.3	0	ANNUAL	ALL	1				
339		635149.5	4978259	0.00312	2007.14	2844.3	0	ANNUAL	ALL	1				
340		635174.5	4978259	0.00325	2014.96	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
341		635199.5	4978259	0.00336	2023.44	2844.3	0	ANNUAL	ALL	1				
342		634999.5	4978284	0.00285	2039.02	2844.3	0	ANNUAL	ALL	1				
343		635024.5	4978284	0.00284	2022.69	2844.3	0	ANNUAL	ALL	1				
344		635049.5	4978284	0.0028	2010.11	2844.3	0	ANNUAL	ALL	1				
345		635074.5	4978284	0.00276	1999.28	2844.3	0	ANNUAL	ALL	1				
346		635099.5	4978284	0.00274	1993.94	2844.3	0	ANNUAL	ALL	1				
347		635124.5	4978284	0.00282	1996.86	2844.3	0	ANNUAL	ALL	1				
348		635149.5	4978284	0.00295	2004.78	2844.3	0	ANNUAL	ALL	1				
349		635174.5	4978284	0.00307	2012.7	2844.3	0	ANNUAL	ALL	1				
350		635199.5	4978284	0.00319	2021.78	2844.3	0	ANNUAL	ALL	1				
351		634999.5	4978309	0.00272	2036.72	2844.3	0	ANNUAL	ALL	1				
352		635024.5	4978309	0.00271	2023.32	2844.3	0	ANNUAL	ALL	1				
353		635049.5	4978309	0.00266	2010.1	2844.3	0	ANNUAL	ALL	1				
354		635074.5	4978309	0.00263	1999.36	2844.3	0	ANNUAL	ALL	1				
355		635099.5	4978309	0.00261	1992.81	2844.3	0	ANNUAL	ALL	1				
356		635124.5	4978309	0.00265	1994.13	2844.3	0	ANNUAL	ALL	1				
357		635149.5	4978309	0.00278	2001.68	2844.3	0	ANNUAL	ALL	1				
358		635174.5	4978309	0.0029	2009.75	2844.3	0	ANNUAL	ALL	1				
359		635199.5	4978309	0.00302	2018.84	2844.3	0	ANNUAL	ALL	1				
360		634999.5	4978334	0.00259	2033.58	2844.3	0	ANNUAL	ALL	1				
361		635024.5	4978334	0.00257	2021.76	2844.3	0	ANNUAL	ALL	1				
362		635049.5	4978334	0.00253	2009.59	2844.3	0	ANNUAL	ALL	1				
363		635074.5	4978334	0.0025	1999.33	2844.3	0	ANNUAL	ALL	1				
364		635099.5	4978334	0.00249	1991.74	2844.3	0	ANNUAL	ALL	1				
365		635124.5	4978334	0.00253	1991.62	2844.3	0	ANNUAL	ALL	1				
366		635149.5	4978334	0.00262	1998.49	2844.3	0	ANNUAL	ALL	1				
367		635174.5	4978334	0.00273	2006.18	2844.3	0	ANNUAL	ALL	1				
368		635199.5	4978334	0.00285	2015.32	2844.3	0	ANNUAL	ALL	1				
369		634299.5	4978134	0.00204	2065.05	2844.3	0	ANNUAL	ALL	1				
370		634324.5	4978134	0.00211	2052.1	2844.3	0	ANNUAL	ALL	1				
371		634349.5	4978134	0.00219	2045.24	2844.3	0	ANNUAL	ALL	1				
372		634374.5	4978134	0.00228	2034.94	2844.3	0	ANNUAL	ALL	1				
373		634399.5	4978134	0.00233	2020.36	2844.3	0	ANNUAL	ALL	1				
374		634424.5	4978134	0.00233	2003.67	2844.3	0	ANNUAL	ALL	1				
375		634449.5	4978134	0.00234	1995.29	2844.3	0	ANNUAL	ALL	1				
376		634474.5	4978134	0.00245	2007.74	2844.3	0	ANNUAL	ALL	1				
377		634499.5	4978134	0.00256	2026.56	2844.3	0	ANNUAL	ALL	1				
378		634299.5	4978159	0.00194	2056.37	2844.3	0	ANNUAL	ALL	1				
379		634324.5	4978159	0.00202	2043.39	2844.3	0	ANNUAL	ALL	1				
380		634349.5	4978159	0.0021	2031.51	2844.3	0	ANNUAL	ALL	1				
381		634374.5	4978159	0.00215	2023.05	2844.3	0	ANNUAL	ALL	1				
382		634399.5	4978159	0.00217	2009.29	2844.3	0	ANNUAL	ALL	1				
383		634424.5	4978159	0.00218	1995	2844.3	0	ANNUAL	ALL	1				
384		634449.5	4978159	0.00221	1992.7	2844.3	0	ANNUAL	ALL	1				
385		634474.5	4978159	0.00231	2006.88	2844.3	0	ANNUAL	ALL	1				
386		634499.5	4978159	0.00242	2023.97	2844.3	0	ANNUAL	ALL	1				
387		634299.5	4978184	0.00185	2049.3	2844.3	0	ANNUAL	ALL	1				
388		634324.5	4978184	0.00193	2036.32	2844.3	0	ANNUAL	ALL	1				
389		634349.5	4978184	0.00198	2022.34	2844.3	0	ANNUAL	ALL	1				
390		634374.5	4978184	0.00202	2009.09	2844.3	0	ANNUAL	ALL	1				
391		634399.5	4978184	0.00204	1999.89	2844.3	0	ANNUAL	ALL	1				
392		634424.5	4978184	0.00208	1987.52	2844.3	0	ANNUAL	ALL	1				
393		634449.5	4978184	0.00211	1991.46	2844.3	0	ANNUAL	ALL	1				
394		634474.5	4978184	0.00219	2006.06	2844.3	0	ANNUAL	ALL	1				
395		634499.5	4978184	0.00228	2020.38	2844.3	0	ANNUAL	ALL	1				
396		634299.5	4978209	0.00177	2043.21	2844.3	0	ANNUAL	ALL	1				
397		634324.5	4978209	0.00183	2030.6	2844.3	0	ANNUAL	ALL	1				
398		634349.5	4978209	0.00188	2016.03	2844.3	0	ANNUAL	ALL	1				
399		634374.5	4978209	0.00191	2000.87	2844.3	0	ANNUAL	ALL	1				
400		634399.5	4978209	0.00193	1990.53	2844.3	0	ANNUAL	ALL	1				
401		634424.5	4978209	0.00199	1981.32	2844.3	0	ANNUAL	ALL	1				
402		634449.5	4978209	0.00201	1989.45	2844.3	0	ANNUAL	ALL	1				
403		634474.5	4978209	0.00207	2004.01	2844.3	0	ANNUAL	ALL	1				
404		634499.5	4978209	0.00215	2016.91	2844.3	0	ANNUAL	ALL	1				
405		634299.5	4978234	0.00169	2037.27	2844.3	0	ANNUAL	ALL	1				
406		634324.5	4978234	0.00174	2025.09	2844.3	0	ANNUAL	ALL	1				
407		634349.5	4978234	0.00178	2009.81	2844.3	0	ANNUAL	ALL	1				
408		634374.5	4978234	0.00181	1996.13	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
409		634399.5	4978234	0.00186	1984.05	2844.3	0	ANNUAL	ALL	1				
410		634424.5	4978234	0.00191	1975.87	2844.3	0	ANNUAL	ALL	1				
411		634449.5	4978234	0.00192	1984.97	2844.3	0	ANNUAL	ALL	1				
412		634474.5	4978234	0.00196	2000.36	2844.3	0	ANNUAL	ALL	1				
413		634499.5	4978234	0.00203	2011.73	2844.3	0	ANNUAL	ALL	1				
414		634299.5	4978259	0.00162	2030.97	2844.3	0	ANNUAL	ALL	1				
415		634324.5	4978259	0.00166	2018.02	2844.3	0	ANNUAL	ALL	1				
416		634349.5	4978259	0.0017	2002.99	2844.3	0	ANNUAL	ALL	1				
417		634374.5	4978259	0.00173	1990.41	2844.3	0	ANNUAL	ALL	1				
418		634399.5	4978259	0.00179	1978.88	2844.3	0	ANNUAL	ALL	1				
419		634424.5	4978259	0.00182	1972.17	2844.3	0	ANNUAL	ALL	1				
420		634449.5	4978259	0.00185	1977.85	2844.3	0	ANNUAL	ALL	1				
421		634474.5	4978259	0.00185	1992.52	2844.3	0	ANNUAL	ALL	1				
422		634499.5	4978259	0.00191	2003.44	2844.3	0	ANNUAL	ALL	1				
423		634299.5	4978284	0.00154	2023.26	2844.3	0	ANNUAL	ALL	1				
424		634324.5	4978284	0.00158	2008.98	2844.3	0	ANNUAL	ALL	1				
425		634349.5	4978284	0.00162	1996.31	2844.3	0	ANNUAL	ALL	1				
426		634374.5	4978284	0.00167	1984.2	2844.3	0	ANNUAL	ALL	1				
427		634399.5	4978284	0.00171	1973.37	2844.3	0	ANNUAL	ALL	1				
428		634424.5	4978284	0.00174	1969.23	2844.3	0	ANNUAL	ALL	1				
429		634449.5	4978284	0.00177	1975.58	2844.3	0	ANNUAL	ALL	1				
430		634474.5	4978284	0.00177	1989.07	2844.3	0	ANNUAL	ALL	1				
431		634499.5	4978284	0.00182	2000.53	2844.3	0	ANNUAL	ALL	1				
432		634299.5	4978309	0.00148	2012.41	2844.3	0	ANNUAL	ALL	1				
433		634324.5	4978309	0.00152	1999.74	2844.3	0	ANNUAL	ALL	1				
434		634349.5	4978309	0.00156	1988.62	2844.3	0	ANNUAL	ALL	1				
435		634374.5	4978309	0.00161	1977.79	2844.3	0	ANNUAL	ALL	1				
436		634399.5	4978309	0.00164	1967.1	2844.3	0	ANNUAL	ALL	1				
437		634424.5	4978309	0.00167	1968.14	2844.3	0	ANNUAL	ALL	1				
438		634449.5	4978309	0.00169	1977.66	2844.3	0	ANNUAL	ALL	1				
439		634474.5	4978309	0.00169	1992.31	2844.3	0	ANNUAL	ALL	1				
440		634499.5	4978309	0.00174	2006.23	2844.3	0	ANNUAL	ALL	1				
441		634299.5	4978334	0.00143	2000.94	2844.3	0	ANNUAL	ALL	1				
442		634324.5	4978334	0.00147	1991.1	2844.3	0	ANNUAL	ALL	1				
443		634349.5	4978334	0.00151	1980.66	2844.3	0	ANNUAL	ALL	1				
444		634374.5	4978334	0.00154	1970.39	2844.3	0	ANNUAL	ALL	1				
445		634399.5	4978334	0.00157	1961.38	2844.3	0	ANNUAL	ALL	1				
446		634424.5	4978334	0.0016	1968.29	2844.3	0	ANNUAL	ALL	1				
447		634449.5	4978334	0.00161	1980.95	2844.3	0	ANNUAL	ALL	1				
448		634474.5	4978334	0.00162	1997.36	2844.3	0	ANNUAL	ALL	1				
449		634499.5	4978334	0.00166	2012.52	2844.3	0	ANNUAL	ALL	1				
450		634299.5	4978359	0.00138	1991.4	2844.3	0	ANNUAL	ALL	1				
451		634324.5	4978359	0.00142	1982.72	2844.3	0	ANNUAL	ALL	1				
452		634349.5	4978359	0.00146	1972.75	2844.3	0	ANNUAL	ALL	1				
453		634374.5	4978359	0.00148	1962.87	2844.3	0	ANNUAL	ALL	1				
454		634399.5	4978359	0.0015	1958.17	2844.3	0	ANNUAL	ALL	1				
455		634424.5	4978359	0.00153	1968.79	2844.3	0	ANNUAL	ALL	1				
456		634449.5	4978359	0.00154	1984.24	2844.3	0	ANNUAL	ALL	1				
457		634474.5	4978359	0.00155	2002.2	2844.3	0	ANNUAL	ALL	1				
458		634499.5	4978359	0.00159	2016.76	2844.3	0	ANNUAL	ALL	1				
459		634299.5	4978384	0.00135	1982.57	2844.3	0	ANNUAL	ALL	1				
460		634324.5	4978384	0.00137	1975.68	2844.3	0	ANNUAL	ALL	1				
461		634349.5	4978384	0.0014	1964.84	2844.3	0	ANNUAL	ALL	1				
462		634374.5	4978384	0.00142	1956.29	2844.3	0	ANNUAL	ALL	1				
463		634399.5	4978384	0.00144	1955.61	2844.3	0	ANNUAL	ALL	1				
464		634424.5	4978384	0.00147	1968.65	2844.3	0	ANNUAL	ALL	1				
465		634449.5	4978384	0.00147	1986.09	2844.3	0	ANNUAL	ALL	1				
466		634474.5	4978384	0.00148	2004.63	2844.3	0	ANNUAL	ALL	1				
467		634499.5	4978384	0.00151	2018.69	2844.3	0	ANNUAL	ALL	1				
468		634299.5	4978409	0.0013	1975.4	2844.3	0	ANNUAL	ALL	1				
469		634324.5	4978409	0.00132	1967.52	2844.3	0	ANNUAL	ALL	1				
470		634349.5	4978409	0.00134	1957.04	2844.3	0	ANNUAL	ALL	1				
471		634374.5	4978409	0.00136	1949.69	2844.3	0	ANNUAL	ALL	1				
472		634399.5	4978409	0.00138	1951.43	2844.3	0	ANNUAL	ALL	1				
473		634424.5	4978409	0.00141	1967.3	2844.3	0	ANNUAL	ALL	1				
474		634449.5	4978409	0.00141	1986.39	2844.3	0	ANNUAL	ALL	1				
475		634474.5	4978409	0.00142	2005.28	2844.3	0	ANNUAL	ALL	1				
476		634499.5	4978409	0.00144	2019.28	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
477		634299.5	4978434	0.00125	1965.22	2844.3	0	ANNUAL	ALL	1				
478		634324.5	4978434	0.00127	1958.88	2844.3	0	ANNUAL	ALL	1				
479		634349.5	4978434	0.00129	1950.79	2844.3	0	ANNUAL	ALL	1				
480		634374.5	4978434	0.0013	1943.73	2844.3	0	ANNUAL	ALL	1				
481		634399.5	4978434	0.00133	1949.4	2844.3	0	ANNUAL	ALL	1				
482		634424.5	4978434	0.00135	1965.04	2844.3	0	ANNUAL	ALL	1				
483		634449.5	4978434	0.00136	1984.59	2844.3	0	ANNUAL	ALL	1				
484		634474.5	4978434	0.00136	2004.45	2844.3	0	ANNUAL	ALL	1				
485		634499.5	4978434	0.00138	2017.53	2844.3	0	ANNUAL	ALL	1				
486		634249.4	4977384	0.00244	2291.4	2717.08	0	ANNUAL	ALL	1				
487		634274.4	4977384	0.00262	2282.65	2742	0	ANNUAL	ALL	1				
488		634299.4	4977384	0.00284	2273.71	2742	0	ANNUAL	ALL	1				
489		634324.4	4977384	0.00318	2263.84	2742	0	ANNUAL	ALL	1				
490		634349.4	4977384	0.00383	2250.84	2742	0	ANNUAL	ALL	1				
491		634374.4	4977384	0.00471	2238.58	2742.16	0	ANNUAL	ALL	1				
492		634399.4	4977384	0.00516	2232.43	2742.16	0	ANNUAL	ALL	1				
493		634424.4	4977384	0.00407	2242.73	2742.16	0	ANNUAL	ALL	1				
494		634449.4	4977384	0.00311	2255.36	2742	0	ANNUAL	ALL	1				
495		634249.4	4977409	0.00269	2284.43	2742	0	ANNUAL	ALL	1				
496		634274.4	4977409	0.00297	2274.53	2742	0	ANNUAL	ALL	1				
497		634299.4	4977409	0.00333	2264.56	2742	0	ANNUAL	ALL	1				
498		634324.4	4977409	0.00382	2254.44	2742	0	ANNUAL	ALL	1				
499		634349.4	4977409	0.00449	2243.93	2742.16	0	ANNUAL	ALL	1				
500		634374.4	4977409	0.00555	2231.37	2742.16	0	ANNUAL	ALL	1				
501		634399.4	4977409	0.00603	2226.02	2844.3	0	ANNUAL	ALL	1				
502		634424.4	4977409	0.00473	2236.92	2742.16	0	ANNUAL	ALL	1				
503		634449.4	4977409	0.0036	2249.43	2742.16	0	ANNUAL	ALL	1				
504		634249.4	4977434	0.00291	2279.34	2742	0	ANNUAL	ALL	1				
505		634274.4	4977434	0.00333	2267.65	2742	0	ANNUAL	ALL	1				
506		634299.4	4977434	0.00391	2255.85	2742	0	ANNUAL	ALL	1				
507		634324.4	4977434	0.00463	2244.86	2742	0	ANNUAL	ALL	1				
508		634349.4	4977434	0.00547	2234.48	2742.16	0	ANNUAL	ALL	1				
509		634374.4	4977434	0.00648	2223.18	2844.3	0	ANNUAL	ALL	1				
510		634399.4	4977434	0.00661	2218.5	2844.3	0	ANNUAL	ALL	1				
511		634424.4	4977434	0.00563	2230.27	2844.3	0	ANNUAL	ALL	1				
512		634449.4	4977434	0.00416	2243.66	2742.16	0	ANNUAL	ALL	1				
513		634249.4	4977459	0.00308	2275.78	2742	0	ANNUAL	ALL	1				
514		634274.4	4977459	0.00362	2262.83	2742	0	ANNUAL	ALL	1				
515		634299.4	4977459	0.00447	2248.74	2742	0	ANNUAL	ALL	1				
516		634324.4	4977459	0.00536	2237.43	2742.16	0	ANNUAL	ALL	1				
517		634349.4	4977459	0.00636	2226.72	2844.3	0	ANNUAL	ALL	1				
518		634374.4	4977459	0.00683	2214.97	2844.3	0	ANNUAL	ALL	1				
519		634399.4	4977459	0.00672	2211.75	2844.3	0	ANNUAL	ALL	1				
520		634424.4	4977459	0.00626	2223.34	2844.3	0	ANNUAL	ALL	1				
521		634449.4	4977459	0.00498	2237.29	2844.3	0	ANNUAL	ALL	1				
522		634249.4	4977484	0.00322	2272.5	2742	0	ANNUAL	ALL	1				
523		634274.4	4977484	0.0039	2258.48	2742	0	ANNUAL	ALL	1				
524		634299.4	4977484	0.00489	2243.77	2742	0	ANNUAL	ALL	1				
525		634324.4	4977484	0.0059	2231.45	2742.16	0	ANNUAL	ALL	1				
526		634349.4	4977484	0.00672	2219.9	2844.3	0	ANNUAL	ALL	1				
527		634374.4	4977484	0.00664	2207.94	2844.3	0	ANNUAL	ALL	1				
528		634399.4	4977484	0.00637	2204.62	2844.3	0	ANNUAL	ALL	1				
529		634424.4	4977484	0.00656	2216.76	2844.3	0	ANNUAL	ALL	1				
530		634449.4	4977484	0.00567	2230.33	2844.3	0	ANNUAL	ALL	1				
531		634249.4	4977509	0.00336	2269.17	2742	0	ANNUAL	ALL	1				
532		634274.4	4977509	0.00412	2254.88	2742	0	ANNUAL	ALL	1				
533		634299.4	4977509	0.00513	2240.59	2742	0	ANNUAL	ALL	1				
534		634324.4	4977509	0.00628	2227.32	2844.3	0	ANNUAL	ALL	1				
535		634349.4	4977509	0.00669	2213.19	2844.3	0	ANNUAL	ALL	1				
536		634374.4	4977509	0.00607	2200.19	2844.3	0	ANNUAL	ALL	1				
537		634399.4	4977509	0.00583	2197.61	2844.3	0	ANNUAL	ALL	1				
538		634424.4	4977509	0.0065	2211.03	2844.3	0	ANNUAL	ALL	1				
539		634449.4	4977509	0.00617	2223.57	2844.3	0	ANNUAL	ALL	1				
540		634249.4	4977534	0.00345	2266.65	2742	0	ANNUAL	ALL	1				
541		634274.4	4977534	0.00429	2251.58	2742	0	ANNUAL	ALL	1				
542		634299.4	4977534	0.00533	2237.18	2742	0	ANNUAL	ALL	1				
543		634324.4	4977534	0.00633	2223.67	2844.3	0	ANNUAL	ALL	1				
544		634349.4	4977534	0.00636	2207.86	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
545		634374.4	4977534	0.00533	2193.38	2844.3	0	ANNUAL	ALL	1				
546		634399.4	4977534	0.00522	2191.95	2844.3	0	ANNUAL	ALL	1				
547		634424.4	4977534	0.00617	2205.88	2844.3	0	ANNUAL	ALL	1				
548		634449.4	4977534	0.00634	2217.63	2844.3	0	ANNUAL	ALL	1				
549		634249.4	4977559	0.00352	2264.12	2742	0	ANNUAL	ALL	1				
550		634274.4	4977559	0.0045	2247.26	2742	0	ANNUAL	ALL	1				
551		634299.4	4977559	0.00553	2232.74	2742	0	ANNUAL	ALL	1				
552		634324.4	4977559	0.00628	2218.55	2844.3	0	ANNUAL	ALL	1				
553		634349.4	4977559	0.00589	2203.35	2844.3	0	ANNUAL	ALL	1				
554		634374.4	4977559	0.0051	2189.62	2844.3	0	ANNUAL	ALL	1				
555		634399.4	4977559	0.00499	2184.96	2844.3	0	ANNUAL	ALL	1				
556		634424.4	4977559	0.00575	2200.77	2844.3	0	ANNUAL	ALL	1				
557		634449.4	4977559	0.00621	2211.07	2844.3	0	ANNUAL	ALL	1				
558		634249.4	4977584	0.00375	2258.01	2742	0	ANNUAL	ALL	1				
559		634274.4	4977584	0.00469	2242.66	2742	0	ANNUAL	ALL	1				
560		634299.4	4977584	0.00574	2227.67	2844.3	0	ANNUAL	ALL	1				
561		634324.4	4977584	0.00602	2213.51	2844.3	0	ANNUAL	ALL	1				
562		634349.4	4977584	0.0055	2199.5	2844.3	0	ANNUAL	ALL	1				
563		634374.4	4977584	0.00489	2185.33	2844.3	0	ANNUAL	ALL	1				
564		634399.4	4977584	0.00491	2177.11	2844.3	0	ANNUAL	ALL	1				
565		634424.4	4977584	0.00501	2192.43	2844.3	0	ANNUAL	ALL	1				
566		634449.4	4977584	0.00569	2203.16	2844.3	0	ANNUAL	ALL	1				
567		634999.5	4977834	0.00521	2055.79	2844.3	0	ANNUAL	ALL	1				
568		635024.5	4977834	0.00538	2048.42	2844.3	0	ANNUAL	ALL	1				
569		635049.5	4977834	0.00553	2043	2844.3	0	ANNUAL	ALL	1				
570		635074.5	4977834	0.00566	2037.93	2844.3	0	ANNUAL	ALL	1				
571		635099.5	4977834	0.00576	2034.24	2844.3	0	ANNUAL	ALL	1				
572		635124.5	4977834	0.00581	2031.45	2844.3	0	ANNUAL	ALL	1				
573		635149.5	4977834	0.00546	2038.5	2844.3	0	ANNUAL	ALL	1				
574		635174.5	4977834	0.00496	2050.35	2844.3	0	ANNUAL	ALL	1				
575		635199.5	4977834	0.00452	2063.26	2844.3	0	ANNUAL	ALL	1				
576		634999.5	4977859	0.00524	2052.63	2844.3	0	ANNUAL	ALL	1				
577		635024.5	4977859	0.00539	2046.41	2844.3	0	ANNUAL	ALL	1				
578		635049.5	4977859	0.00551	2040.95	2844.3	0	ANNUAL	ALL	1				
579		635074.5	4977859	0.00567	2036.03	2844.3	0	ANNUAL	ALL	1				
580		635099.5	4977859	0.00577	2032.3	2844.3	0	ANNUAL	ALL	1				
581		635124.5	4977859	0.00577	2030.17	2844.3	0	ANNUAL	ALL	1				
582		635149.5	4977859	0.00544	2038.33	2844.3	0	ANNUAL	ALL	1				
583		635174.5	4977859	0.00498	2049.93	2844.3	0	ANNUAL	ALL	1				
584		635199.5	4977859	0.00456	2062.54	2844.3	0	ANNUAL	ALL	1				
585		634999.5	4977884	0.00526	2049.11	2844.3	0	ANNUAL	ALL	1				
586		635024.5	4977884	0.00537	2044.13	2844.3	0	ANNUAL	ALL	1				
587		635049.5	4977884	0.0055	2038.92	2844.3	0	ANNUAL	ALL	1				
588		635074.5	4977884	0.00564	2034.26	2844.3	0	ANNUAL	ALL	1				
589		635099.5	4977884	0.00571	2030.48	2844.3	0	ANNUAL	ALL	1				
590		635124.5	4977884	0.00572	2029.04	2844.3	0	ANNUAL	ALL	1				
591		635149.5	4977884	0.00539	2038.45	2844.3	0	ANNUAL	ALL	1				
592		635174.5	4977884	0.00498	2049.51	2844.3	0	ANNUAL	ALL	1				
593		635199.5	4977884	0.0046	2061.56	2844.3	0	ANNUAL	ALL	1				
594		634999.5	4977909	0.00518	2047.27	2844.3	0	ANNUAL	ALL	1				
595		635024.5	4977909	0.0053	2042.16	2844.3	0	ANNUAL	ALL	1				
596		635049.5	4977909	0.00545	2036.97	2844.3	0	ANNUAL	ALL	1				
597		635074.5	4977909	0.00558	2032.48	2844.3	0	ANNUAL	ALL	1				
598		635099.5	4977909	0.00563	2028.7	2844.3	0	ANNUAL	ALL	1				
599		635124.5	4977909	0.00562	2028.77	2844.3	0	ANNUAL	ALL	1				
600		635149.5	4977909	0.00531	2038.62	2844.3	0	ANNUAL	ALL	1				
601		635174.5	4977909	0.00496	2049.12	2844.3	0	ANNUAL	ALL	1				
602		635199.5	4977909	0.00462	2060.48	2844.3	0	ANNUAL	ALL	1				
603		634999.5	4977934	0.00507	2046.79	2844.3	0	ANNUAL	ALL	1				
604		635024.5	4977934	0.00519	2040.92	2844.3	0	ANNUAL	ALL	1				
605		635049.5	4977934	0.00537	2034.68	2844.3	0	ANNUAL	ALL	1				
606		635074.5	4977934	0.00546	2029.58	2844.3	0	ANNUAL	ALL	1				
607		635099.5	4977934	0.00554	2025.61	2844.3	0	ANNUAL	ALL	1				
608		635124.5	4977934	0.00551	2027.68	2844.3	0	ANNUAL	ALL	1				
609		635149.5	4977934	0.00524	2038.09	2844.3	0	ANNUAL	ALL	1				
610		635174.5	4977934	0.00491	2048.68	2844.3	0	ANNUAL	ALL	1				
611		635199.5	4977934	0.00461	2059.02	2844.3	0	ANNUAL	ALL	1				
612		634999.5	4977959	0.00495	2045.95	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
613		635024.5	4977959	0.00507	2039.51	2844.3	0	ANNUAL	ALL	1				
614		635049.5	4977959	0.00526	2032.45	2844.3	0	ANNUAL	ALL	1				
615		635074.5	4977959	0.00534	2026.52	2844.3	0	ANNUAL	ALL	1				
616		635099.5	4977959	0.00539	2022.6	2844.3	0	ANNUAL	ALL	1				
617		635124.5	4977959	0.00537	2027.13	2844.3	0	ANNUAL	ALL	1				
618		635149.5	4977959	0.00517	2036.89	2844.3	0	ANNUAL	ALL	1				
619		635174.5	4977959	0.00489	2046.85	2844.3	0	ANNUAL	ALL	1				
620		635199.5	4977959	0.00463	2056.78	2844.3	0	ANNUAL	ALL	1				
621		634999.5	4977984	0.00481	2045.34	2844.3	0	ANNUAL	ALL	1				
622		635024.5	4977984	0.00495	2037.82	2844.3	0	ANNUAL	ALL	1				
623		635049.5	4977984	0.00507	2030.43	2844.3	0	ANNUAL	ALL	1				
624		635074.5	4977984	0.00517	2024.12	2844.3	0	ANNUAL	ALL	1				
625		635099.5	4977984	0.0052	2019.96	2844.3	0	ANNUAL	ALL	1				
626		635124.5	4977984	0.00521	2026.73	2844.3	0	ANNUAL	ALL	1				
627		635149.5	4977984	0.00509	2035.4	2844.3	0	ANNUAL	ALL	1				
628		635174.5	4977984	0.00488	2044.46	2844.3	0	ANNUAL	ALL	1				
629		635199.5	4977984	0.00463	2053.52	2844.3	0	ANNUAL	ALL	1				
630		634999.5	4978009	0.00466	2044.81	2844.3	0	ANNUAL	ALL	1				
631		635024.5	4978009	0.00481	2035.59	2844.3	0	ANNUAL	ALL	1				
632		635049.5	4978009	0.00491	2028.05	2844.3	0	ANNUAL	ALL	1				
633		635074.5	4978009	0.00497	2021.18	2844.3	0	ANNUAL	ALL	1				
634		635099.5	4978009	0.00497	2017.1	2844.3	0	ANNUAL	ALL	1				
635		635124.5	4978009	0.00504	2025.97	2844.3	0	ANNUAL	ALL	1				
636		635149.5	4978009	0.00497	2034.03	2844.3	0	ANNUAL	ALL	1				
637		635174.5	4978009	0.00481	2041.95	2844.3	0	ANNUAL	ALL	1				
638		635199.5	4978009	0.00464	2050.09	2844.3	0	ANNUAL	ALL	1				
639		634999.5	4978034	0.00452	2043.29	2844.3	0	ANNUAL	ALL	1				
640		635024.5	4978034	0.00466	2032.46	2844.3	0	ANNUAL	ALL	1				
641		635049.5	4978034	0.00473	2024.39	2844.3	0	ANNUAL	ALL	1				
642		635074.5	4978034	0.00474	2017.56	2844.3	0	ANNUAL	ALL	1				
643		635099.5	4978034	0.00474	2015.24	2844.3	0	ANNUAL	ALL	1				
644		635124.5	4978034	0.00486	2024.2	2844.3	0	ANNUAL	ALL	1				
645		635149.5	4978034	0.00485	2032.02	2844.3	0	ANNUAL	ALL	1				
646		635174.5	4978034	0.0047	2040.48	2844.3	0	ANNUAL	ALL	1				
647		635199.5	4978034	0.00456	2049.69	2844.3	0	ANNUAL	ALL	1				
648		634599.5	4976834	0.00061	2431.97	2717.08	0	ANNUAL	ALL	1				
649		634624.5	4976834	0.0006	2425.11	2717.08	0	ANNUAL	ALL	1				
650		634649.5	4976834	0.0006	2416.95	2717.08	0	ANNUAL	ALL	1				
651		634674.5	4976834	0.00059	2407.96	2717.08	0	ANNUAL	ALL	1				
652		634699.5	4976834	0.00059	2398.82	2717.08	0	ANNUAL	ALL	1				
653		634724.5	4976834	0.00059	2389.57	2717.08	0	ANNUAL	ALL	1				
654		634749.5	4976834	0.00059	2378.83	2717.08	0	ANNUAL	ALL	1				
655		634774.5	4976834	0.00058	2368.3	2717.08	0	ANNUAL	ALL	1				
656		634799.5	4976834	0.00059	2352.38	2717.08	0	ANNUAL	ALL	1				
657		634599.5	4976859	0.00063	2427	2717.08	0	ANNUAL	ALL	1				
658		634624.5	4976859	0.00062	2421.36	2717.08	0	ANNUAL	ALL	1				
659		634649.5	4976859	0.00062	2412.9	2717.08	0	ANNUAL	ALL	1				
660		634674.5	4976859	0.00061	2401.58	2717.08	0	ANNUAL	ALL	1				
661		634699.5	4976859	0.00061	2391.51	2717.08	0	ANNUAL	ALL	1				
662		634724.5	4976859	0.00061	2381.29	2717.08	0	ANNUAL	ALL	1				
663		634749.5	4976859	0.00061	2371.44	2717.08	0	ANNUAL	ALL	1				
664		634774.5	4976859	0.00061	2358.57	2717.08	0	ANNUAL	ALL	1				
665		634799.5	4976859	0.00063	2341.91	2742	0	ANNUAL	ALL	1				
666		634599.5	4976884	0.00065	2422.69	2717.08	0	ANNUAL	ALL	1				
667		634624.5	4976884	0.00064	2418.17	2717.08	0	ANNUAL	ALL	1				
668		634649.5	4976884	0.00063	2408.98	2717.08	0	ANNUAL	ALL	1				
669		634674.5	4976884	0.00063	2396.57	2717.08	0	ANNUAL	ALL	1				
670		634699.5	4976884	0.00064	2383.76	2717.08	0	ANNUAL	ALL	1				
671		634724.5	4976884	0.00064	2371.27	2717.08	0	ANNUAL	ALL	1				
672		634749.5	4976884	0.00064	2362.03	2717.08	0	ANNUAL	ALL	1				
673		634774.5	4976884	0.00064	2350.11	2717.08	0	ANNUAL	ALL	1				
674		634799.5	4976884	0.00066	2334.35	2742	0	ANNUAL	ALL	1				
675		634599.5	4976909	0.00066	2418.11	2717.08	0	ANNUAL	ALL	1				
676		634624.5	4976909	0.00066	2412.47	2717.08	0	ANNUAL	ALL	1				
677		634649.5	4976909	0.00065	2402.76	2717.08	0	ANNUAL	ALL	1				
678		634674.5	4976909	0.00065	2392.81	2717.08	0	ANNUAL	ALL	1				
679		634699.5	4976909	0.00066	2377.98	2717.08	0	ANNUAL	ALL	1				
680		634724.5	4976909	0.00067	2364.11	2717.08	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
681		634749.5	4976909	0.00067	2354.73	2717.08	0	ANNUAL	ALL	1				
682		634774.5	4976909	0.00067	2345.14	2717.08	0	ANNUAL	ALL	1				
683		634799.5	4976909	0.00068	2331	2742	0	ANNUAL	ALL	1				
684		634599.5	4976934	0.00068	2411.78	2717.08	0	ANNUAL	ALL	1				
685		634624.5	4976934	0.00068	2403.98	2717.08	0	ANNUAL	ALL	1				
686		634649.5	4976934	0.00068	2394.61	2717.08	0	ANNUAL	ALL	1				
687		634674.5	4976934	0.00068	2383.71	2717.08	0	ANNUAL	ALL	1				
688		634699.5	4976934	0.00068	2371.78	2717.08	0	ANNUAL	ALL	1				
689		634724.5	4976934	0.00069	2359.09	2717.08	0	ANNUAL	ALL	1				
690		634749.5	4976934	0.0007	2347.63	2717.08	0	ANNUAL	ALL	1				
691		634774.5	4976934	0.0007	2337.6	2742	0	ANNUAL	ALL	1				
692		634799.5	4976934	0.00071	2326.97	2742	0	ANNUAL	ALL	1				
693		634599.5	4976959	0.0007	2404.1	2717.08	0	ANNUAL	ALL	1				
694		634624.5	4976959	0.0007	2396.65	2717.08	0	ANNUAL	ALL	1				
695		634649.5	4976959	0.0007	2385.41	2717.08	0	ANNUAL	ALL	1				
696		634674.5	4976959	0.00071	2372.07	2717.08	0	ANNUAL	ALL	1				
697		634699.5	4976959	0.00071	2362.55	2717.08	0	ANNUAL	ALL	1				
698		634724.5	4976959	0.00072	2351.59	2717.08	0	ANNUAL	ALL	1				
699		634749.5	4976959	0.00073	2341.2	2717.08	0	ANNUAL	ALL	1				
700		634774.5	4976959	0.00074	2328.55	2742	0	ANNUAL	ALL	1				
701		634799.5	4976959	0.00075	2318.72	2742	0	ANNUAL	ALL	1				
702		634599.5	4976984	0.00073	2396.35	2717.08	0	ANNUAL	ALL	1				
703		634624.5	4976984	0.00072	2389.04	2717.08	0	ANNUAL	ALL	1				
704		634649.5	4976984	0.00073	2377.21	2717.08	0	ANNUAL	ALL	1				
705		634674.5	4976984	0.00074	2363.6	2717.08	0	ANNUAL	ALL	1				
706		634699.5	4976984	0.00075	2350.85	2717.08	0	ANNUAL	ALL	1				
707		634724.5	4976984	0.00076	2340.79	2717.08	0	ANNUAL	ALL	1				
708		634749.5	4976984	0.00076	2331.79	2742	0	ANNUAL	ALL	1				
709		634774.5	4976984	0.00078	2320.7	2742	0	ANNUAL	ALL	1				
710		634799.5	4976984	0.0008	2308.59	2742	0	ANNUAL	ALL	1				
711		634599.5	4977009	0.00075	2388.79	2717.08	0	ANNUAL	ALL	1				
712		634624.5	4977009	0.00075	2379.17	2717.08	0	ANNUAL	ALL	1				
713		634649.5	4977009	0.00076	2368.25	2717.08	0	ANNUAL	ALL	1				
714		634674.5	4977009	0.00077	2355.13	2717.08	0	ANNUAL	ALL	1				
715		634699.5	4977009	0.00078	2341.52	2717.08	0	ANNUAL	ALL	1				
716		634724.5	4977009	0.00081	2328.18	2742	0	ANNUAL	ALL	1				
717		634749.5	4977009	0.00081	2321.24	2742	0	ANNUAL	ALL	1				
718		634774.5	4977009	0.00082	2313.44	2742	0	ANNUAL	ALL	1				
719		634799.5	4977009	0.00085	2301.46	2742.16	0	ANNUAL	ALL	1				
720		634599.5	4977034	0.00078	2379.36	2717.08	0	ANNUAL	ALL	1				
721		634624.5	4977034	0.00078	2369.28	2717.08	0	ANNUAL	ALL	1				
722		634649.5	4977034	0.00079	2356.46	2717.08	0	ANNUAL	ALL	1				
723		634674.5	4977034	0.00081	2343.53	2717.08	0	ANNUAL	ALL	1				
724		634699.5	4977034	0.00083	2329.9	2742	0	ANNUAL	ALL	1				
725		634724.5	4977034	0.00086	2316.92	2742	0	ANNUAL	ALL	1				
726		634749.5	4977034	0.00087	2309.32	2742	0	ANNUAL	ALL	1				
727		634774.5	4977034	0.00088	2302.58	2742	0	ANNUAL	ALL	1				
728		634799.5	4977034	0.0009	2295.21	2742.16	0	ANNUAL	ALL	1				
729	**	CONCUNIT	ug/m^3											
730	**	DEPUNIT	g/m^2											

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	*	AERMOD	(	19191):	MIDAS	GOLD	STIBNITE	-	MODELING	R27	########			
2	*	AERMET	(	19191):	11:44:06									
3	*	MODELING	OPTIONS	USED:	RegDFAULT	CONC	ELEV	NOWARN	DRYDPLT	WETDPLT	RURAL	ADJ_U*		
4	*	PLOT	FILE	OF	ANNUAL	VALUES	AVERAGED	ACROSS	1	YEARS	FOR	SOURCE	GROUP:	ALL
5	*	FOR	A	TOTAL	OF	720	RECEPTORS.							
6	*	FORMAT:	(3(1X,F13.5),3(1X,F8.2),2X,A6,2X,A8,2X,I8.8,2X,A8)											
7	*	X	Y	AVERAGE	CONC	ZELEV	ZHILL	ZFLAG	AVE	GRP	NUM	YRS	NET	ID
8	*													
9	0.007000	635399.5	4975934	0.00028	2213.4	2844.3	0	ANNUAL	ALL	1				
10	max ↑	635424.5	4975934	0.00028	2212.64	2844.3	0	ANNUAL	ALL	1				
11		635449.5	4975934	0.00028	2211.27	2844.3	0	ANNUAL	ALL	1				
12		635474.5	4975934	0.00027	2212.5	2844.3	0	ANNUAL	ALL	1				
13		635499.5	4975934	0.00027	2215.21	2844.3	0	ANNUAL	ALL	1				
14		635524.5	4975934	0.00026	2215.98	2844.3	0	ANNUAL	ALL	1				
15		635549.5	4975934	0.00026	2215	2844.3	0	ANNUAL	ALL	1				
16		635574.5	4975934	0.00026	2215.74	2844.3	0	ANNUAL	ALL	1				
17		635599.5	4975934	0.00025	2218.34	2844.3	0	ANNUAL	ALL	1				
18		635399.5	4975959	0.0003	2202.75	2844.3	0	ANNUAL	ALL	1				
19		635424.5	4975959	0.0003	2204.36	2844.3	0	ANNUAL	ALL	1				
20		635449.5	4975959	0.0003	2204.87	2844.3	0	ANNUAL	ALL	1				
21		635474.5	4975959	0.00029	2206.39	2844.3	0	ANNUAL	ALL	1				
22		635499.5	4975959	0.00028	2208.99	2844.3	0	ANNUAL	ALL	1				
23		635524.5	4975959	0.00028	2210.99	2844.3	0	ANNUAL	ALL	1				
24		635549.5	4975959	0.00027	2211.29	2844.3	0	ANNUAL	ALL	1				
25		635574.5	4975959	0.00027	2210.92	2844.3	0	ANNUAL	ALL	1				
26		635599.5	4975959	0.00027	2208.83	2844.3	0	ANNUAL	ALL	1				
27		635399.5	4975984	0.00033	2195.09	2844.3	0	ANNUAL	ALL	1				
28		635424.5	4975984	0.00032	2198.19	2844.3	0	ANNUAL	ALL	1				
29		635449.5	4975984	0.00031	2198.7	2844.3	0	ANNUAL	ALL	1				
30		635474.5	4975984	0.0003	2201.57	2844.3	0	ANNUAL	ALL	1				
31		635499.5	4975984	0.0003	2203.99	2844.3	0	ANNUAL	ALL	1				
32		635524.5	4975984	0.00029	2206.27	2844.3	0	ANNUAL	ALL	1				
33		635549.5	4975984	0.00029	2206.83	2844.3	0	ANNUAL	ALL	1				
34		635574.5	4975984	0.00028	2205.61	2844.3	0	ANNUAL	ALL	1				
35		635599.5	4975984	0.00029	2202.99	2844.3	0	ANNUAL	ALL	1				
36		635399.5	4976009	0.00034	2195.69	2844.3	0	ANNUAL	ALL	1				
37		635424.5	4976009	0.00035	2189.65	2844.3	0	ANNUAL	ALL	1				
38		635449.5	4976009	0.00033	2194	2844.3	0	ANNUAL	ALL	1				
39		635474.5	4976009	0.00031	2200.13	2844.3	0	ANNUAL	ALL	1				
40		635499.5	4976009	0.00031	2202.83	2844.3	0	ANNUAL	ALL	1				
41		635524.5	4976009	0.0003	2203.57	2844.3	0	ANNUAL	ALL	1				
42		635549.5	4976009	0.0003	2203.82	2844.3	0	ANNUAL	ALL	1				
43		635574.5	4976009	0.0003	2202.81	2844.3	0	ANNUAL	ALL	1				
44		635599.5	4976009	0.0003	2200.59	2844.3	0	ANNUAL	ALL	1				
45		635399.5	4976034	0.00034	2198.23	2844.3	0	ANNUAL	ALL	1				
46		635424.5	4976034	0.00037	2186.98	2844.3	0	ANNUAL	ALL	1				
47		635449.5	4976034	0.00035	2190.14	2844.3	0	ANNUAL	ALL	1				
48		635474.5	4976034	0.00032	2198.63	2844.3	0	ANNUAL	ALL	1				
49		635499.5	4976034	0.00032	2198.93	2844.3	0	ANNUAL	ALL	1				
50		635524.5	4976034	0.00032	2199.39	2844.3	0	ANNUAL	ALL	1				
51		635549.5	4976034	0.00031	2201.1	2844.3	0	ANNUAL	ALL	1				
52		635574.5	4976034	0.00031	2200.59	2844.3	0	ANNUAL	ALL	1				
53		635599.5	4976034	0.00031	2197.96	2844.3	0	ANNUAL	ALL	1				
54		635399.5	4976059	0.00035	2196.33	2844.3	0	ANNUAL	ALL	1				
55		635424.5	4976059	0.00039	2184.09	2844.3	0	ANNUAL	ALL	1				
56		635449.5	4976059	0.0004	2180.82	2844.3	0	ANNUAL	ALL	1				
57		635474.5	4976059	0.00035	2193.11	2844.3	0	ANNUAL	ALL	1				
58		635499.5	4976059	0.00034	2194.5	2844.3	0	ANNUAL	ALL	1				
59		635524.5	4976059	0.00033	2197.17	2844.3	0	ANNUAL	ALL	1				
60		635549.5	4976059	0.00032	2199.4	2844.3	0	ANNUAL	ALL	1				
61		635574.5	4976059	0.00032	2198.27	2844.3	0	ANNUAL	ALL	1				
62		635599.5	4976059	0.00033	2194.62	2844.3	0	ANNUAL	ALL	1				
63		635399.5	4976084	0.00039	2188.98	2844.3	0	ANNUAL	ALL	1				
64		635424.5	4976084	0.00042	2180.22	2844.3	0	ANNUAL	ALL	1				
65		635449.5	4976084	0.00044	2174.51	2844.3	0	ANNUAL	ALL	1				
66		635474.5	4976084	0.0004	2180.27	2844.3	0	ANNUAL	ALL	1				
67		635499.5	4976084	0.00038	2185.71	2844.3	0	ANNUAL	ALL	1				
68		635524.5	4976084	0.00036	2191.13	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
69		635549.5	4976084	0.00034	2193.95	2844.3	0	ANNUAL	ALL	1				
70		635574.5	4976084	0.00035	2190.58	2844.3	0	ANNUAL	ALL	1				
71		635599.5	4976084	0.00037	2183.01	2844.3	0	ANNUAL	ALL	1				
72		635399.5	4976109	0.00042	2182.28	2844.3	0	ANNUAL	ALL	1				
73		635424.5	4976109	0.00044	2177.24	2844.3	0	ANNUAL	ALL	1				
74		635449.5	4976109	0.00046	2171.45	2844.3	0	ANNUAL	ALL	1				
75		635474.5	4976109	0.00045	2172.26	2844.3	0	ANNUAL	ALL	1				
76		635499.5	4976109	0.00042	2177.58	2844.3	0	ANNUAL	ALL	1				
77		635524.5	4976109	0.00041	2180.23	2844.3	0	ANNUAL	ALL	1				
78		635549.5	4976109	0.0004	2179.81	2844.3	0	ANNUAL	ALL	1				
79		635574.5	4976109	0.00041	2176.94	2844.3	0	ANNUAL	ALL	1				
80		635599.5	4976109	0.00039	2179.4	2844.3	0	ANNUAL	ALL	1				
81		635399.5	4976134	0.00046	2176.77	2844.3	0	ANNUAL	ALL	1				
82		635424.5	4976134	0.00047	2174.27	2844.3	0	ANNUAL	ALL	1				
83		635449.5	4976134	0.00048	2171.04	2844.3	0	ANNUAL	ALL	1				
84		635474.5	4976134	0.0005	2166.4	2844.3	0	ANNUAL	ALL	1				
85		635499.5	4976134	0.00049	2167.48	2844.3	0	ANNUAL	ALL	1				
86		635524.5	4976134	0.00046	2172.09	2844.3	0	ANNUAL	ALL	1				
87		635549.5	4976134	0.00045	2171.44	2844.3	0	ANNUAL	ALL	1				
88		635574.5	4976134	0.00044	2172.93	2844.3	0	ANNUAL	ALL	1				
89		635599.5	4976134	0.00041	2178.31	2844.3	0	ANNUAL	ALL	1				
90		635199.5	4976834	0.00183	2116.83	2844.3	0	ANNUAL	ALL	1				
91		635224.5	4976834	0.00166	2112.53	2844.3	0	ANNUAL	ALL	1				
92		635249.5	4976834	0.00165	2108.39	2844.3	0	ANNUAL	ALL	1				
93		635274.5	4976834	0.00164	2105.23	2844.3	0	ANNUAL	ALL	1				
94		635299.5	4976834	0.00162	2101.6	2844.3	0	ANNUAL	ALL	1				
95		635324.5	4976834	0.00161	2098.74	2844.3	0	ANNUAL	ALL	1				
96		635349.5	4976834	0.00154	2104.26	2844.3	0	ANNUAL	ALL	1				
97		635374.5	4976834	0.00147	2110.4	2844.3	0	ANNUAL	ALL	1				
98		635399.5	4976834	0.00152	2117.98	2844.3	0	ANNUAL	ALL	1				
99		635199.5	4976859	0.00188	2114.34	2844.3	0	ANNUAL	ALL	1				
100		635224.5	4976859	0.00174	2108.68	2844.3	0	ANNUAL	ALL	1				
101		635249.5	4976859	0.00173	2104.42	2844.3	0	ANNUAL	ALL	1				
102		635274.5	4976859	0.00171	2101.28	2844.3	0	ANNUAL	ALL	1				
103		635299.5	4976859	0.00169	2098.83	2844.3	0	ANNUAL	ALL	1				
104		635324.5	4976859	0.00167	2096.89	2844.3	0	ANNUAL	ALL	1				
105		635349.5	4976859	0.0016	2101.21	2844.3	0	ANNUAL	ALL	1				
106		635374.5	4976859	0.00153	2108.71	2844.3	0	ANNUAL	ALL	1				
107		635399.5	4976859	0.00157	2118.31	2844.3	0	ANNUAL	ALL	1				
108		635199.5	4976884	0.00181	2111.17	2844.3	0	ANNUAL	ALL	1				
109		635224.5	4976884	0.00181	2104.78	2844.3	0	ANNUAL	ALL	1				
110		635249.5	4976884	0.00181	2100.14	2844.3	0	ANNUAL	ALL	1				
111		635274.5	4976884	0.00179	2097.48	2844.3	0	ANNUAL	ALL	1				
112		635299.5	4976884	0.00176	2095.42	2844.3	0	ANNUAL	ALL	1				
113		635324.5	4976884	0.00173	2094.96	2844.3	0	ANNUAL	ALL	1				
114		635349.5	4976884	0.00167	2097.83	2844.3	0	ANNUAL	ALL	1				
115		635374.5	4976884	0.00157	2107.96	2844.3	0	ANNUAL	ALL	1				
116		635399.5	4976884	0.00162	2119.17	2844.3	0	ANNUAL	ALL	1				
117		635199.5	4976909	0.00188	2108.51	2844.3	0	ANNUAL	ALL	1				
118		635224.5	4976909	0.00189	2102.17	2844.3	0	ANNUAL	ALL	1				
119		635249.5	4976909	0.00188	2097.31	2844.3	0	ANNUAL	ALL	1				
120		635274.5	4976909	0.00186	2094.85	2844.3	0	ANNUAL	ALL	1				
121		635299.5	4976909	0.00183	2093.19	2844.3	0	ANNUAL	ALL	1				
122		635324.5	4976909	0.00179	2093.48	2844.3	0	ANNUAL	ALL	1				
123		635349.5	4976909	0.00172	2098.12	2844.3	0	ANNUAL	ALL	1				
124		635374.5	4976909	0.00161	2108.79	2844.3	0	ANNUAL	ALL	1				
125		635399.5	4976909	0.0017	2120.74	2844.3	0	ANNUAL	ALL	1				
126		635199.5	4976934	0.00196	2106.38	2844.3	0	ANNUAL	ALL	1				
127		635224.5	4976934	0.00195	2100.81	2844.3	0	ANNUAL	ALL	1				
128		635249.5	4976934	0.00194	2096.21	2844.3	0	ANNUAL	ALL	1				
129		635274.5	4976934	0.00192	2092.89	2844.3	0	ANNUAL	ALL	1				
130		635299.5	4976934	0.00189	2091.1	2844.3	0	ANNUAL	ALL	1				
131		635324.5	4976934	0.00184	2092.46	2844.3	0	ANNUAL	ALL	1				
132		635349.5	4976934	0.00176	2099.48	2844.3	0	ANNUAL	ALL	1				
133		635374.5	4976934	0.00165	2110.37	2844.3	0	ANNUAL	ALL	1				
134		635399.5	4976934	0.00176	2122.91	2844.3	0	ANNUAL	ALL	1				
135		635199.5	4976959	0.00203	2104.62	2844.3	0	ANNUAL	ALL	1				
136		635224.5	4976959	0.00202	2099.28	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
137		635249.5	4976959	0.00201	2094.41	2844.3	0	ANNUAL	ALL	1				
138		635274.5	4976959	0.00199	2090.59	2844.3	0	ANNUAL	ALL	1				
139		635299.5	4976959	0.00196	2088.8	2844.3	0	ANNUAL	ALL	1				
140		635324.5	4976959	0.0019	2092.02	2844.3	0	ANNUAL	ALL	1				
141		635349.5	4976959	0.00181	2100.12	2844.3	0	ANNUAL	ALL	1				
142		635374.5	4976959	0.00169	2112.07	2844.3	0	ANNUAL	ALL	1				
143		635399.5	4976959	0.00182	2125.69	2844.3	0	ANNUAL	ALL	1				
144		635199.5	4976984	0.00211	2102.45	2844.3	0	ANNUAL	ALL	1				
145		635224.5	4976984	0.0021	2097.29	2844.3	0	ANNUAL	ALL	1				
146		635249.5	4976984	0.00209	2091.62	2844.3	0	ANNUAL	ALL	1				
147		635274.5	4976984	0.00206	2087.92	2844.3	0	ANNUAL	ALL	1				
148		635299.5	4976984	0.00203	2086.81	2844.3	0	ANNUAL	ALL	1				
149		635324.5	4976984	0.00195	2092.65	2844.3	0	ANNUAL	ALL	1				
150		635349.5	4976984	0.00185	2101.3	2844.3	0	ANNUAL	ALL	1				
151		635374.5	4976984	0.00173	2114.13	2844.3	0	ANNUAL	ALL	1				
152		635399.5	4976984	0.00188	2128.46	2844.3	0	ANNUAL	ALL	1				
153		635199.5	4977009	0.00219	2099.39	2844.3	0	ANNUAL	ALL	1				
154		635224.5	4977009	0.00218	2093.66	2844.3	0	ANNUAL	ALL	1				
155		635249.5	4977009	0.00217	2087.97	2844.3	0	ANNUAL	ALL	1				
156		635274.5	4977009	0.00213	2084.9	2844.3	0	ANNUAL	ALL	1				
157		635299.5	4977009	0.00208	2087.43	2844.3	0	ANNUAL	ALL	1				
158		635324.5	4977009	0.00199	2094.55	2844.3	0	ANNUAL	ALL	1				
159		635349.5	4977009	0.00189	2103.74	2844.3	0	ANNUAL	ALL	1				
160		635374.5	4977009	0.00194	2116.64	2844.3	0	ANNUAL	ALL	1				
161		635399.5	4977009	0.00195	2131.12	2844.3	0	ANNUAL	ALL	1				
162		635199.5	4977034	0.00229	2094.63	2844.3	0	ANNUAL	ALL	1				
163		635224.5	4977034	0.00227	2088.76	2844.3	0	ANNUAL	ALL	1				
164		635249.5	4977034	0.00225	2084.27	2844.3	0	ANNUAL	ALL	1				
165		635274.5	4977034	0.00221	2082.71	2844.3	0	ANNUAL	ALL	1				
166		635299.5	4977034	0.00212	2089.9	2844.3	0	ANNUAL	ALL	1				
167		635324.5	4977034	0.00203	2098.21	2844.3	0	ANNUAL	ALL	1				
168		635349.5	4977034	0.00192	2107.49	2844.3	0	ANNUAL	ALL	1				
169		635374.5	4977034	0.00201	2119.09	2844.3	0	ANNUAL	ALL	1				
170		635399.5	4977034	0.00202	2133.38	2844.3	0	ANNUAL	ALL	1				
171		634899.5	4977134	0.00193	2221.02	2844.3	0	ANNUAL	ALL	1				
172		634924.5	4977134	0.00211	2207.85	2844.3	0	ANNUAL	ALL	1				
173		634949.5	4977134	0.00241	2190.45	2844.3	0	ANNUAL	ALL	1				
174		634974.5	4977134	0.00287	2169.12	2844.3	0	ANNUAL	ALL	1				
175		634999.5	4977134	0.0032	2150.64	2844.3	0	ANNUAL	ALL	1				
176		635024.5	4977134	0.00322	2135.97	2844.3	0	ANNUAL	ALL	1				
177		635049.5	4977134	0.00308	2122.38	2844.3	0	ANNUAL	ALL	1				
178		635074.5	4977134	0.00268	2113.7	2844.3	0	ANNUAL	ALL	1				
179		635099.5	4977134	0.00269	2105.9	2844.3	0	ANNUAL	ALL	1				
180		634899.5	4977159	0.00218	2213.37	2844.3	0	ANNUAL	ALL	1				
181		634924.5	4977159	0.00229	2201.16	2844.3	0	ANNUAL	ALL	1				
182		634949.5	4977159	0.00271	2181.17	2844.3	0	ANNUAL	ALL	1				
183		634974.5	4977159	0.00314	2161.72	2844.3	0	ANNUAL	ALL	1				
184		634999.5	4977159	0.00333	2145.73	2844.3	0	ANNUAL	ALL	1				
185		635024.5	4977159	0.00329	2132.12	2844.3	0	ANNUAL	ALL	1				
186		635049.5	4977159	0.00309	2119.59	2844.3	0	ANNUAL	ALL	1				
187		635074.5	4977159	0.00279	2109.27	2844.3	0	ANNUAL	ALL	1				
188		635099.5	4977159	0.0028	2101.29	2844.3	0	ANNUAL	ALL	1				
189		634899.5	4977184	0.00237	2206.56	2844.3	0	ANNUAL	ALL	1				
190		634924.5	4977184	0.00259	2193.64	2844.3	0	ANNUAL	ALL	1				
191		634949.5	4977184	0.00303	2172.29	2844.3	0	ANNUAL	ALL	1				
192		634974.5	4977184	0.00336	2154.5	2844.3	0	ANNUAL	ALL	1				
193		634999.5	4977184	0.00343	2141.04	2844.3	0	ANNUAL	ALL	1				
194		635024.5	4977184	0.00334	2128.3	2844.3	0	ANNUAL	ALL	1				
195		635049.5	4977184	0.00311	2114.34	2844.3	0	ANNUAL	ALL	1				
196		635074.5	4977184	0.00292	2102.7	2844.3	0	ANNUAL	ALL	1				
197		635099.5	4977184	0.00291	2096.47	2844.3	0	ANNUAL	ALL	1				
198		634899.5	4977209	0.00257	2199.13	2844.3	0	ANNUAL	ALL	1				
199		634924.5	4977209	0.00287	2184.15	2844.3	0	ANNUAL	ALL	1				
200		634949.5	4977209	0.00332	2163.72	2844.3	0	ANNUAL	ALL	1				
201		634974.5	4977209	0.00353	2146.68	2844.3	0	ANNUAL	ALL	1				
202		634999.5	4977209	0.0035	2136.15	2844.3	0	ANNUAL	ALL	1				
203		635024.5	4977209	0.00338	2124.22	2844.3	0	ANNUAL	ALL	1				
204		635049.5	4977209	0.00302	2105.9	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
205		635074.5	4977209	0.00304	2096.39	2844.3	0	ANNUAL	ALL	1				
206		635099.5	4977209	0.00302	2091.31	2844.3	0	ANNUAL	ALL	1				
207		634899.5	4977234	0.00301	2185.16	2844.3	0	ANNUAL	ALL	1				
208		634924.5	4977234	0.00327	2172.04	2844.3	0	ANNUAL	ALL	1				
209		634949.5	4977234	0.0036	2152.41	2844.3	0	ANNUAL	ALL	1				
210		634974.5	4977234	0.00363	2139.97	2844.3	0	ANNUAL	ALL	1				
211		634999.5	4977234	0.00355	2130.73	2844.3	0	ANNUAL	ALL	1				
212		635024.5	4977234	0.00335	2117.31	2844.3	0	ANNUAL	ALL	1				
213		635049.5	4977234	0.00316	2098.65	2844.3	0	ANNUAL	ALL	1				
214		635074.5	4977234	0.00315	2092.39	2844.3	0	ANNUAL	ALL	1				
215		635099.5	4977234	0.00311	2087.32	2844.3	0	ANNUAL	ALL	1				
216		634899.5	4977259	0.00321	2180.4	2844.3	0	ANNUAL	ALL	1				
217		634924.5	4977259	0.00361	2160.19	2844.3	0	ANNUAL	ALL	1				
218		634949.5	4977259	0.00375	2143.3	2844.3	0	ANNUAL	ALL	1				
219		634974.5	4977259	0.00368	2132.11	2844.3	0	ANNUAL	ALL	1				
220		634999.5	4977259	0.00357	2123.02	2844.3	0	ANNUAL	ALL	1				
221		635024.5	4977259	0.00322	2107.09	2844.3	0	ANNUAL	ALL	1				
222		635049.5	4977259	0.00326	2095.35	2844.3	0	ANNUAL	ALL	1				
223		635074.5	4977259	0.00324	2089.07	2844.3	0	ANNUAL	ALL	1				
224		635099.5	4977259	0.00322	2083.6	2844.3	0	ANNUAL	ALL	1				
225		634899.5	4977284	0.00328	2180.69	2844.3	0	ANNUAL	ALL	1				
226		634924.5	4977284	0.00371	2158.28	2844.3	0	ANNUAL	ALL	1				
227		634949.5	4977284	0.00382	2139.34	2844.3	0	ANNUAL	ALL	1				
228		634974.5	4977284	0.0037	2123.05	2844.3	0	ANNUAL	ALL	1				
229		634999.5	4977284	0.00331	2112.91	2844.3	0	ANNUAL	ALL	1				
230		635024.5	4977284	0.00335	2100.55	2844.3	0	ANNUAL	ALL	1				
231		635049.5	4977284	0.00336	2092.76	2844.3	0	ANNUAL	ALL	1				
232		635074.5	4977284	0.00335	2085.71	2844.3	0	ANNUAL	ALL	1				
233		635099.5	4977284	0.00333	2078.67	2844.3	0	ANNUAL	ALL	1				
234		634899.5	4977309	0.00341	2178.55	2844.3	0	ANNUAL	ALL	1				
235		634924.5	4977309	0.0038	2156.77	2844.3	0	ANNUAL	ALL	1				
236		634949.5	4977309	0.00387	2136.54	2844.3	0	ANNUAL	ALL	1				
237		634974.5	4977309	0.00371	2119.59	2844.3	0	ANNUAL	ALL	1				
238		634999.5	4977309	0.00344	2107.01	2844.3	0	ANNUAL	ALL	1				
239		635024.5	4977309	0.00347	2096.52	2844.3	0	ANNUAL	ALL	1				
240		635049.5	4977309	0.00345	2089.24	2844.3	0	ANNUAL	ALL	1				
241		635074.5	4977309	0.00345	2082.55	2844.3	0	ANNUAL	ALL	1				
242		635099.5	4977309	0.00344	2075.98	2844.3	0	ANNUAL	ALL	1				
243		634899.5	4977334	0.00362	2173.18	2844.3	0	ANNUAL	ALL	1				
244		634924.5	4977334	0.00391	2153.29	2844.3	0	ANNUAL	ALL	1				
245		634949.5	4977334	0.00393	2133.9	2844.3	0	ANNUAL	ALL	1				
246		634974.5	4977334	0.00377	2117.58	2844.3	0	ANNUAL	ALL	1				
247		634999.5	4977334	0.00355	2104.03	2844.3	0	ANNUAL	ALL	1				
248		635024.5	4977334	0.00357	2093.8	2844.3	0	ANNUAL	ALL	1				
249		635049.5	4977334	0.00357	2085.23	2844.3	0	ANNUAL	ALL	1				
250		635074.5	4977334	0.00356	2078.76	2844.3	0	ANNUAL	ALL	1				
251		635099.5	4977334	0.00354	2074.53	2844.3	0	ANNUAL	ALL	1				
252		635399.5	4976159	0.0005	2171.27	2844.3	0	ANNUAL	ALL	1				
253		635424.5	4976159	0.0005	2169.98	2844.3	0	ANNUAL	ALL	1				
254		635449.5	4976159	0.00051	2167.61	2844.3	0	ANNUAL	ALL	1				
255		635474.5	4976159	0.00052	2164.06	2844.3	0	ANNUAL	ALL	1				
256		635499.5	4976159	0.00053	2161.76	2844.3	0	ANNUAL	ALL	1				
257		635524.5	4976159	0.00053	2160.48	2844.3	0	ANNUAL	ALL	1				
258		635549.5	4976159	0.00051	2162.19	2844.3	0	ANNUAL	ALL	1				
259		635574.5	4976159	0.00048	2168.15	2844.3	0	ANNUAL	ALL	1				
260		635599.5	4976159	0.00044	2173.85	2844.3	0	ANNUAL	ALL	1				
261		635399.5	4976184	0.00054	2168.06	2844.3	0	ANNUAL	ALL	1				
262		635424.5	4976184	0.00054	2166.17	2844.3	0	ANNUAL	ALL	1				
263		635449.5	4976184	0.00055	2163.95	2844.3	0	ANNUAL	ALL	1				
264		635474.5	4976184	0.00056	2161.05	2844.3	0	ANNUAL	ALL	1				
265		635499.5	4976184	0.00056	2158.86	2844.3	0	ANNUAL	ALL	1				
266		635524.5	4976184	0.00056	2157.1	2844.3	0	ANNUAL	ALL	1				
267		635549.5	4976184	0.00056	2157.07	2844.3	0	ANNUAL	ALL	1				
268		635574.5	4976184	0.00051	2164.59	2844.3	0	ANNUAL	ALL	1				
269		635599.5	4976184	0.00046	2172.06	2844.3	0	ANNUAL	ALL	1				
270		635399.5	4976209	0.00057	2165.29	2844.3	0	ANNUAL	ALL	1				
271		635424.5	4976209	0.00057	2163.14	2844.3	0	ANNUAL	ALL	1				
272		635449.5	4976209	0.00058	2160.76	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
273		635474.5	4976209	0.00059	2158.05	2844.3	0	ANNUAL	ALL	1				
274		635499.5	4976209	0.0006	2155.43	2844.3	0	ANNUAL	ALL	1				
275		635524.5	4976209	0.0006	2153.57	2844.3	0	ANNUAL	ALL	1				
276		635549.5	4976209	0.00058	2156.02	2844.3	0	ANNUAL	ALL	1				
277		635574.5	4976209	0.00052	2165.26	2844.3	0	ANNUAL	ALL	1				
278		635599.5	4976209	0.00046	2175.01	2844.3	0	ANNUAL	ALL	1				
279		635399.5	4976234	0.0006	2162.56	2844.3	0	ANNUAL	ALL	1				
280		635424.5	4976234	0.00061	2160.46	2844.3	0	ANNUAL	ALL	1				
281		635449.5	4976234	0.00061	2157.93	2844.3	0	ANNUAL	ALL	1				
282		635474.5	4976234	0.00062	2155.5	2844.3	0	ANNUAL	ALL	1				
283		635499.5	4976234	0.00063	2152.67	2844.3	0	ANNUAL	ALL	1				
284		635524.5	4976234	0.00063	2150.12	2844.3	0	ANNUAL	ALL	1				
285		635549.5	4976234	0.00059	2156.6	2844.3	0	ANNUAL	ALL	1				
286		635574.5	4976234	0.00052	2167.62	2844.3	0	ANNUAL	ALL	1				
287		635599.5	4976234	0.00045	2178.35	2844.3	0	ANNUAL	ALL	1				
288		634999.5	4978134	0.00547	2044.53	2844.3	0	ANNUAL	ALL	1				
289		635024.5	4978134	0.00558	2030.56	2844.3	0	ANNUAL	ALL	1				
290		635049.5	4978134	0.00566	2018.07	2844.3	0	ANNUAL	ALL	1				
291		635074.5	4978134	0.00559	2006.69	2844.3	0	ANNUAL	ALL	1				
292		635099.5	4978134	0.00561	2006.39	2844.3	0	ANNUAL	ALL	1				
293		635124.5	4978134	0.00572	2013.34	2844.3	0	ANNUAL	ALL	1				
294		635149.5	4978134	0.00578	2020.75	2844.3	0	ANNUAL	ALL	1				
295		635174.5	4978134	0.00573	2029.05	2844.3	0	ANNUAL	ALL	1				
296		635199.5	4978134	0.00561	2038.91	2844.3	0	ANNUAL	ALL	1				
297		634999.5	4978159	0.00532	2044.5	2844.3	0	ANNUAL	ALL	1				
298		635024.5	4978159	0.00542	2030.78	2844.3	0	ANNUAL	ALL	1				
299		635049.5	4978159	0.00547	2017.35	2844.3	0	ANNUAL	ALL	1				
300		635074.5	4978159	0.00538	2004.54	2844.3	0	ANNUAL	ALL	1				
301		635099.5	4978159	0.0054	2003.81	2844.3	0	ANNUAL	ALL	1				
302		635124.5	4978159	0.00551	2010.57	2844.3	0	ANNUAL	ALL	1				
303		635149.5	4978159	0.00561	2017.75	2844.3	0	ANNUAL	ALL	1				
304		635174.5	4978159	0.00562	2025.18	2844.3	0	ANNUAL	ALL	1				
305		635199.5	4978159	0.00555	2035.11	2844.3	0	ANNUAL	ALL	1				
306		634999.5	4978184	0.00517	2044.38	2844.3	0	ANNUAL	ALL	1				
307		635024.5	4978184	0.00523	2028.98	2844.3	0	ANNUAL	ALL	1				
308		635049.5	4978184	0.00526	2015.36	2844.3	0	ANNUAL	ALL	1				
309		635074.5	4978184	0.00517	2002.43	2844.3	0	ANNUAL	ALL	1				
310		635099.5	4978184	0.00518	2000.86	2844.3	0	ANNUAL	ALL	1				
311		635124.5	4978184	0.0053	2007.53	2844.3	0	ANNUAL	ALL	1				
312		635149.5	4978184	0.00541	2014.6	2844.3	0	ANNUAL	ALL	1				
313		635174.5	4978184	0.00547	2022.07	2844.3	0	ANNUAL	ALL	1				
314		635199.5	4978184	0.00545	2031.45	2844.3	0	ANNUAL	ALL	1				
315		634999.5	4978209	0.00502	2043.46	2844.3	0	ANNUAL	ALL	1				
316		635024.5	4978209	0.00506	2027.94	2844.3	0	ANNUAL	ALL	1				
317		635049.5	4978209	0.00506	2013.73	2844.3	0	ANNUAL	ALL	1				
318		635074.5	4978209	0.00497	2000.96	2844.3	0	ANNUAL	ALL	1				
319		635099.5	4978209	0.00495	1998.75	2844.3	0	ANNUAL	ALL	1				
320		635124.5	4978209	0.00509	2004.56	2844.3	0	ANNUAL	ALL	1				
321		635149.5	4978209	0.0052	2011.78	2844.3	0	ANNUAL	ALL	1				
322		635174.5	4978209	0.00529	2019.36	2844.3	0	ANNUAL	ALL	1				
323		635199.5	4978209	0.0053	2027.82	2844.3	0	ANNUAL	ALL	1				
324		634999.5	4978234	0.00487	2042.97	2844.3	0	ANNUAL	ALL	1				
325		635024.5	4978234	0.00489	2026.61	2844.3	0	ANNUAL	ALL	1				
326		635049.5	4978234	0.00485	2012.57	2844.3	0	ANNUAL	ALL	1				
327		635074.5	4978234	0.00476	2000.24	2844.3	0	ANNUAL	ALL	1				
328		635099.5	4978234	0.00474	1996.61	2844.3	0	ANNUAL	ALL	1				
329		635124.5	4978234	0.00488	2001.65	2844.3	0	ANNUAL	ALL	1				
330		635149.5	4978234	0.005	2009.16	2844.3	0	ANNUAL	ALL	1				
331		635174.5	4978234	0.00511	2016.86	2844.3	0	ANNUAL	ALL	1				
332		635199.5	4978234	0.00516	2024.48	2844.3	0	ANNUAL	ALL	1				
333		634999.5	4978259	0.00468	2041.08	2844.3	0	ANNUAL	ALL	1				
334		635024.5	4978259	0.00471	2024.08	2844.3	0	ANNUAL	ALL	1				
335		635049.5	4978259	0.00466	2011.49	2844.3	0	ANNUAL	ALL	1				
336		635074.5	4978259	0.0046	2000.61	2844.3	0	ANNUAL	ALL	1				
337		635099.5	4978259	0.00453	1994.84	2844.3	0	ANNUAL	ALL	1				
338		635124.5	4978259	0.00465	1999.29	2844.3	0	ANNUAL	ALL	1				
339		635149.5	4978259	0.00481	2007.14	2844.3	0	ANNUAL	ALL	1				
340		635174.5	4978259	0.00492	2014.96	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
341		635199.5	4978259	0.005	2023.44	2844.3	0	ANNUAL	ALL	1				
342		634999.5	4978284	0.00452	2039.02	2844.3	0	ANNUAL	ALL	1				
343		635024.5	4978284	0.00453	2022.69	2844.3	0	ANNUAL	ALL	1				
344		635049.5	4978284	0.00448	2010.11	2844.3	0	ANNUAL	ALL	1				
345		635074.5	4978284	0.0044	1999.28	2844.3	0	ANNUAL	ALL	1				
346		635099.5	4978284	0.00436	1993.94	2844.3	0	ANNUAL	ALL	1				
347		635124.5	4978284	0.00445	1996.86	2844.3	0	ANNUAL	ALL	1				
348		635149.5	4978284	0.00461	2004.78	2844.3	0	ANNUAL	ALL	1				
349		635174.5	4978284	0.00472	2012.7	2844.3	0	ANNUAL	ALL	1				
350		635199.5	4978284	0.00483	2021.78	2844.3	0	ANNUAL	ALL	1				
351		634999.5	4978309	0.00435	2036.72	2844.3	0	ANNUAL	ALL	1				
352		635024.5	4978309	0.00436	2023.32	2844.3	0	ANNUAL	ALL	1				
353		635049.5	4978309	0.0043	2010.1	2844.3	0	ANNUAL	ALL	1				
354		635074.5	4978309	0.00423	1999.36	2844.3	0	ANNUAL	ALL	1				
355		635099.5	4978309	0.00419	1992.81	2844.3	0	ANNUAL	ALL	1				
356		635124.5	4978309	0.00424	1994.13	2844.3	0	ANNUAL	ALL	1				
357		635149.5	4978309	0.00441	2001.68	2844.3	0	ANNUAL	ALL	1				
358		635174.5	4978309	0.00453	2009.75	2844.3	0	ANNUAL	ALL	1				
359		635199.5	4978309	0.00465	2018.84	2844.3	0	ANNUAL	ALL	1				
360		634999.5	4978334	0.00418	2033.58	2844.3	0	ANNUAL	ALL	1				
361		635024.5	4978334	0.00419	2021.76	2844.3	0	ANNUAL	ALL	1				
362		635049.5	4978334	0.00413	2009.59	2844.3	0	ANNUAL	ALL	1				
363		635074.5	4978334	0.00406	1999.33	2844.3	0	ANNUAL	ALL	1				
364		635099.5	4978334	0.00402	1991.74	2844.3	0	ANNUAL	ALL	1				
365		635124.5	4978334	0.00406	1991.62	2844.3	0	ANNUAL	ALL	1				
366		635149.5	4978334	0.00419	1998.49	2844.3	0	ANNUAL	ALL	1				
367		635174.5	4978334	0.00434	2006.18	2844.3	0	ANNUAL	ALL	1				
368		635199.5	4978334	0.00446	2015.32	2844.3	0	ANNUAL	ALL	1				
369		634299.5	4978134	0.00395	2065.05	2844.3	0	ANNUAL	ALL	1				
370		634324.5	4978134	0.00393	2052.1	2844.3	0	ANNUAL	ALL	1				
371		634349.5	4978134	0.004	2045.24	2844.3	0	ANNUAL	ALL	1				
372		634374.5	4978134	0.00403	2034.94	2844.3	0	ANNUAL	ALL	1				
373		634399.5	4978134	0.00405	2020.36	2844.3	0	ANNUAL	ALL	1				
374		634424.5	4978134	0.00402	2003.67	2844.3	0	ANNUAL	ALL	1				
375		634449.5	4978134	0.00401	1995.29	2844.3	0	ANNUAL	ALL	1				
376		634474.5	4978134	0.0042	2007.74	2844.3	0	ANNUAL	ALL	1				
377		634499.5	4978134	0.0044	2026.56	2844.3	0	ANNUAL	ALL	1				
378		634299.5	4978159	0.0037	2056.37	2844.3	0	ANNUAL	ALL	1				
379		634324.5	4978159	0.00371	2043.39	2844.3	0	ANNUAL	ALL	1				
380		634349.5	4978159	0.00371	2031.51	2844.3	0	ANNUAL	ALL	1				
381		634374.5	4978159	0.00378	2023.05	2844.3	0	ANNUAL	ALL	1				
382		634399.5	4978159	0.00377	2009.29	2844.3	0	ANNUAL	ALL	1				
383		634424.5	4978159	0.00374	1995	2844.3	0	ANNUAL	ALL	1				
384		634449.5	4978159	0.00378	1992.7	2844.3	0	ANNUAL	ALL	1				
385		634474.5	4978159	0.00398	2006.88	2844.3	0	ANNUAL	ALL	1				
386		634499.5	4978159	0.00419	2023.97	2844.3	0	ANNUAL	ALL	1				
387		634299.5	4978184	0.00345	2049.3	2844.3	0	ANNUAL	ALL	1				
388		634324.5	4978184	0.00344	2036.32	2844.3	0	ANNUAL	ALL	1				
389		634349.5	4978184	0.0035	2022.34	2844.3	0	ANNUAL	ALL	1				
390		634374.5	4978184	0.0035	2009.09	2844.3	0	ANNUAL	ALL	1				
391		634399.5	4978184	0.00351	1999.89	2844.3	0	ANNUAL	ALL	1				
392		634424.5	4978184	0.00353	1987.52	2844.3	0	ANNUAL	ALL	1				
393		634449.5	4978184	0.0036	1991.46	2844.3	0	ANNUAL	ALL	1				
394		634474.5	4978184	0.00378	2006.06	2844.3	0	ANNUAL	ALL	1				
395		634499.5	4978184	0.00395	2020.38	2844.3	0	ANNUAL	ALL	1				
396		634299.5	4978209	0.00324	2043.21	2844.3	0	ANNUAL	ALL	1				
397		634324.5	4978209	0.00323	2030.6	2844.3	0	ANNUAL	ALL	1				
398		634349.5	4978209	0.00327	2016.03	2844.3	0	ANNUAL	ALL	1				
399		634374.5	4978209	0.00329	2000.87	2844.3	0	ANNUAL	ALL	1				
400		634399.5	4978209	0.00329	1990.53	2844.3	0	ANNUAL	ALL	1				
401		634424.5	4978209	0.00333	1981.32	2844.3	0	ANNUAL	ALL	1				
402		634449.5	4978209	0.00342	1989.45	2844.3	0	ANNUAL	ALL	1				
403		634474.5	4978209	0.00358	2004.01	2844.3	0	ANNUAL	ALL	1				
404		634499.5	4978209	0.00373	2016.91	2844.3	0	ANNUAL	ALL	1				
405		634299.5	4978234	0.003	2037.27	2844.3	0	ANNUAL	ALL	1				
406		634324.5	4978234	0.00305	2025.09	2844.3	0	ANNUAL	ALL	1				
407		634349.5	4978234	0.00307	2009.81	2844.3	0	ANNUAL	ALL	1				
408		634374.5	4978234	0.00309	1996.13	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
409		634399.5	4978234	0.00312	1984.05	2844.3	0	ANNUAL	ALL	1				
410		634424.5	4978234	0.00316	1975.87	2844.3	0	ANNUAL	ALL	1				
411		634449.5	4978234	0.00324	1984.97	2844.3	0	ANNUAL	ALL	1				
412		634474.5	4978234	0.00337	2000.36	2844.3	0	ANNUAL	ALL	1				
413		634499.5	4978234	0.00349	2011.73	2844.3	0	ANNUAL	ALL	1				
414		634299.5	4978259	0.00283	2030.97	2844.3	0	ANNUAL	ALL	1				
415		634324.5	4978259	0.00287	2018.02	2844.3	0	ANNUAL	ALL	1				
416		634349.5	4978259	0.0029	2002.99	2844.3	0	ANNUAL	ALL	1				
417		634374.5	4978259	0.00291	1990.41	2844.3	0	ANNUAL	ALL	1				
418		634399.5	4978259	0.00295	1978.88	2844.3	0	ANNUAL	ALL	1				
419		634424.5	4978259	0.003	1972.17	2844.3	0	ANNUAL	ALL	1				
420		634449.5	4978259	0.00306	1977.85	2844.3	0	ANNUAL	ALL	1				
421		634474.5	4978259	0.00315	1992.52	2844.3	0	ANNUAL	ALL	1				
422		634499.5	4978259	0.00329	2003.44	2844.3	0	ANNUAL	ALL	1				
423		634299.5	4978284	0.00267	2023.26	2844.3	0	ANNUAL	ALL	1				
424		634324.5	4978284	0.00269	2008.98	2844.3	0	ANNUAL	ALL	1				
425		634349.5	4978284	0.00273	1996.31	2844.3	0	ANNUAL	ALL	1				
426		634374.5	4978284	0.00276	1984.2	2844.3	0	ANNUAL	ALL	1				
427		634399.5	4978284	0.0028	1973.37	2844.3	0	ANNUAL	ALL	1				
428		634424.5	4978284	0.00284	1969.23	2844.3	0	ANNUAL	ALL	1				
429		634449.5	4978284	0.00291	1975.58	2844.3	0	ANNUAL	ALL	1				
430		634474.5	4978284	0.003	1989.07	2844.3	0	ANNUAL	ALL	1				
431		634499.5	4978284	0.0031	2000.53	2844.3	0	ANNUAL	ALL	1				
432		634299.5	4978309	0.00249	2012.41	2844.3	0	ANNUAL	ALL	1				
433		634324.5	4978309	0.00253	1999.74	2844.3	0	ANNUAL	ALL	1				
434		634349.5	4978309	0.00258	1988.62	2844.3	0	ANNUAL	ALL	1				
435		634374.5	4978309	0.00261	1977.79	2844.3	0	ANNUAL	ALL	1				
436		634399.5	4978309	0.00264	1967.1	2844.3	0	ANNUAL	ALL	1				
437		634424.5	4978309	0.0027	1968.14	2844.3	0	ANNUAL	ALL	1				
438		634449.5	4978309	0.00277	1977.66	2844.3	0	ANNUAL	ALL	1				
439		634474.5	4978309	0.00285	1992.31	2844.3	0	ANNUAL	ALL	1				
440		634499.5	4978309	0.00297	2006.23	2844.3	0	ANNUAL	ALL	1				
441		634299.5	4978334	0.00237	2000.94	2844.3	0	ANNUAL	ALL	1				
442		634324.5	4978334	0.0024	1991.1	2844.3	0	ANNUAL	ALL	1				
443		634349.5	4978334	0.00244	1980.66	2844.3	0	ANNUAL	ALL	1				
444		634374.5	4978334	0.00248	1970.39	2844.3	0	ANNUAL	ALL	1				
445		634399.5	4978334	0.00251	1961.38	2844.3	0	ANNUAL	ALL	1				
446		634424.5	4978334	0.00257	1968.29	2844.3	0	ANNUAL	ALL	1				
447		634449.5	4978334	0.00264	1980.95	2844.3	0	ANNUAL	ALL	1				
448		634474.5	4978334	0.00273	1997.36	2844.3	0	ANNUAL	ALL	1				
449		634499.5	4978334	0.00283	2012.52	2844.3	0	ANNUAL	ALL	1				
450		634299.5	4978359	0.00224	1991.4	2844.3	0	ANNUAL	ALL	1				
451		634324.5	4978359	0.00228	1982.72	2844.3	0	ANNUAL	ALL	1				
452		634349.5	4978359	0.00232	1972.75	2844.3	0	ANNUAL	ALL	1				
453		634374.5	4978359	0.00235	1962.87	2844.3	0	ANNUAL	ALL	1				
454		634399.5	4978359	0.00238	1958.17	2844.3	0	ANNUAL	ALL	1				
455		634424.5	4978359	0.00245	1968.79	2844.3	0	ANNUAL	ALL	1				
456		634449.5	4978359	0.00252	1984.24	2844.3	0	ANNUAL	ALL	1				
457		634474.5	4978359	0.00262	2002.2	2844.3	0	ANNUAL	ALL	1				
458		634499.5	4978359	0.00272	2016.76	2844.3	0	ANNUAL	ALL	1				
459		634299.5	4978384	0.00213	1982.57	2844.3	0	ANNUAL	ALL	1				
460		634324.5	4978384	0.00217	1975.68	2844.3	0	ANNUAL	ALL	1				
461		634349.5	4978384	0.0022	1964.84	2844.3	0	ANNUAL	ALL	1				
462		634374.5	4978384	0.00223	1956.29	2844.3	0	ANNUAL	ALL	1				
463		634399.5	4978384	0.00227	1955.61	2844.3	0	ANNUAL	ALL	1				
464		634424.5	4978384	0.00233	1968.65	2844.3	0	ANNUAL	ALL	1				
465		634449.5	4978384	0.00241	1986.09	2844.3	0	ANNUAL	ALL	1				
466		634474.5	4978384	0.00249	2004.63	2844.3	0	ANNUAL	ALL	1				
467		634499.5	4978384	0.00258	2018.69	2844.3	0	ANNUAL	ALL	1				
468		634299.5	4978409	0.00203	1975.4	2844.3	0	ANNUAL	ALL	1				
469		634324.5	4978409	0.00206	1967.52	2844.3	0	ANNUAL	ALL	1				
470		634349.5	4978409	0.00208	1957.04	2844.3	0	ANNUAL	ALL	1				
471		634374.5	4978409	0.0021	1949.69	2844.3	0	ANNUAL	ALL	1				
472		634399.5	4978409	0.00215	1951.43	2844.3	0	ANNUAL	ALL	1				
473		634424.5	4978409	0.00223	1967.3	2844.3	0	ANNUAL	ALL	1				
474		634449.5	4978409	0.0023	1986.39	2844.3	0	ANNUAL	ALL	1				
475		634474.5	4978409	0.00237	2005.28	2844.3	0	ANNUAL	ALL	1				
476		634499.5	4978409	0.00245	2019.28	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
477		634299.5	4978434	0.00193	1965.22	2844.3	0	ANNUAL	ALL	1				
478		634324.5	4978434	0.00196	1958.88	2844.3	0	ANNUAL	ALL	1				
479		634349.5	4978434	0.00198	1950.79	2844.3	0	ANNUAL	ALL	1				
480		634374.5	4978434	0.00199	1943.73	2844.3	0	ANNUAL	ALL	1				
481		634399.5	4978434	0.00204	1949.4	2844.3	0	ANNUAL	ALL	1				
482		634424.5	4978434	0.00212	1965.04	2844.3	0	ANNUAL	ALL	1				
483		634449.5	4978434	0.00218	1984.59	2844.3	0	ANNUAL	ALL	1				
484		634474.5	4978434	0.00225	2004.45	2844.3	0	ANNUAL	ALL	1				
485		634499.5	4978434	0.00233	2017.53	2844.3	0	ANNUAL	ALL	1				
486		634249.4	4977384	0.00239	2291.4	2717.08	0	ANNUAL	ALL	1				
487		634274.4	4977384	0.00252	2282.65	2742	0	ANNUAL	ALL	1				
488		634299.4	4977384	0.00268	2273.71	2742	0	ANNUAL	ALL	1				
489		634324.4	4977384	0.00292	2263.84	2742	0	ANNUAL	ALL	1				
490		634349.4	4977384	0.00341	2250.84	2742	0	ANNUAL	ALL	1				
491		634374.4	4977384	0.00406	2238.58	2742.16	0	ANNUAL	ALL	1				
492		634399.4	4977384	0.00439	2232.43	2742.16	0	ANNUAL	ALL	1				
493		634424.4	4977384	0.00356	2242.73	2742.16	0	ANNUAL	ALL	1				
494		634449.4	4977384	0.00282	2255.36	2742	0	ANNUAL	ALL	1				
495		634249.4	4977409	0.0026	2284.43	2742	0	ANNUAL	ALL	1				
496		634274.4	4977409	0.0028	2274.53	2742	0	ANNUAL	ALL	1				
497		634299.4	4977409	0.00306	2264.56	2742	0	ANNUAL	ALL	1				
498		634324.4	4977409	0.00341	2254.44	2742	0	ANNUAL	ALL	1				
499		634349.4	4977409	0.00391	2243.93	2742.16	0	ANNUAL	ALL	1				
500		634374.4	4977409	0.00471	2231.37	2742.16	0	ANNUAL	ALL	1				
501		634399.4	4977409	0.00508	2226.02	2844.3	0	ANNUAL	ALL	1				
502		634424.4	4977409	0.00407	2236.92	2742.16	0	ANNUAL	ALL	1				
503		634449.4	4977409	0.0032	2249.43	2742.16	0	ANNUAL	ALL	1				
504		634249.4	4977434	0.00276	2279.34	2742	0	ANNUAL	ALL	1				
505		634274.4	4977434	0.00307	2267.65	2742	0	ANNUAL	ALL	1				
506		634299.4	4977434	0.0035	2255.85	2742	0	ANNUAL	ALL	1				
507		634324.4	4977434	0.00403	2244.86	2742	0	ANNUAL	ALL	1				
508		634349.4	4977434	0.00466	2234.48	2742.16	0	ANNUAL	ALL	1				
509		634374.4	4977434	0.00545	2223.18	2844.3	0	ANNUAL	ALL	1				
510		634399.4	4977434	0.00558	2218.5	2844.3	0	ANNUAL	ALL	1				
511		634424.4	4977434	0.00476	2230.27	2844.3	0	ANNUAL	ALL	1				
512		634449.4	4977434	0.00363	2243.66	2742.16	0	ANNUAL	ALL	1				
513		634249.4	4977459	0.00289	2275.78	2742	0	ANNUAL	ALL	1				
514		634274.4	4977459	0.00329	2262.83	2742	0	ANNUAL	ALL	1				
515		634299.4	4977459	0.00392	2248.74	2742	0	ANNUAL	ALL	1				
516		634324.4	4977459	0.00458	2237.43	2742.16	0	ANNUAL	ALL	1				
517		634349.4	4977459	0.00537	2226.72	2844.3	0	ANNUAL	ALL	1				
518		634374.4	4977459	0.00581	2214.97	2844.3	0	ANNUAL	ALL	1				
519		634399.4	4977459	0.00576	2211.75	2844.3	0	ANNUAL	ALL	1				
520		634424.4	4977459	0.00528	2223.34	2844.3	0	ANNUAL	ALL	1				
521		634449.4	4977459	0.00425	2237.29	2844.3	0	ANNUAL	ALL	1				
522		634249.4	4977484	0.00301	2272.5	2742	0	ANNUAL	ALL	1				
523		634274.4	4977484	0.0035	2258.48	2742	0	ANNUAL	ALL	1				
524		634299.4	4977484	0.00424	2243.77	2742	0	ANNUAL	ALL	1				
525		634324.4	4977484	0.00501	2231.45	2742.16	0	ANNUAL	ALL	1				
526		634349.4	4977484	0.00571	2219.9	2844.3	0	ANNUAL	ALL	1				
527		634374.4	4977484	0.0058	2207.94	2844.3	0	ANNUAL	ALL	1				
528		634399.4	4977484	0.00564	2204.62	2844.3	0	ANNUAL	ALL	1				
529		634424.4	4977484	0.00558	2216.76	2844.3	0	ANNUAL	ALL	1				
530		634449.4	4977484	0.00479	2230.33	2844.3	0	ANNUAL	ALL	1				
531		634249.4	4977509	0.00311	2269.17	2742	0	ANNUAL	ALL	1				
532		634274.4	4977509	0.00367	2254.88	2742	0	ANNUAL	ALL	1				
533		634299.4	4977509	0.00443	2240.59	2742	0	ANNUAL	ALL	1				
534		634324.4	4977509	0.00533	2227.32	2844.3	0	ANNUAL	ALL	1				
535		634349.4	4977509	0.0058	2213.19	2844.3	0	ANNUAL	ALL	1				
536		634374.4	4977509	0.00558	2200.19	2844.3	0	ANNUAL	ALL	1				
537		634399.4	4977509	0.00547	2197.61	2844.3	0	ANNUAL	ALL	1				
538		634424.4	4977509	0.00563	2211.03	2844.3	0	ANNUAL	ALL	1				
539		634449.4	4977509	0.00522	2223.57	2844.3	0	ANNUAL	ALL	1				
540		634249.4	4977534	0.00318	2266.65	2742	0	ANNUAL	ALL	1				
541		634274.4	4977534	0.0038	2251.58	2742	0	ANNUAL	ALL	1				
542		634299.4	4977534	0.00459	2237.18	2742	0	ANNUAL	ALL	1				
543		634324.4	4977534	0.00542	2223.67	2844.3	0	ANNUAL	ALL	1				
544		634349.4	4977534	0.00568	2207.86	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
545		634374.4	4977534	0.00529	2193.38	2844.3	0	ANNUAL	ALL	1				
546		634399.4	4977534	0.0052	2191.95	2844.3	0	ANNUAL	ALL	1				
547		634424.4	4977534	0.00553	2205.88	2844.3	0	ANNUAL	ALL	1				
548		634449.4	4977534	0.00543	2217.63	2844.3	0	ANNUAL	ALL	1				
549		634249.4	4977559	0.00324	2264.12	2742	0	ANNUAL	ALL	1				
550		634274.4	4977559	0.00397	2247.26	2742	0	ANNUAL	ALL	1				
551		634299.4	4977559	0.00477	2232.74	2742	0	ANNUAL	ALL	1				
552		634324.4	4977559	0.00547	2218.55	2844.3	0	ANNUAL	ALL	1				
553		634349.4	4977559	0.00548	2203.35	2844.3	0	ANNUAL	ALL	1				
554		634374.4	4977559	0.00526	2189.62	2844.3	0	ANNUAL	ALL	1				
555		634399.4	4977559	0.00532	2184.96	2844.3	0	ANNUAL	ALL	1				
556		634424.4	4977559	0.00535	2200.77	2844.3	0	ANNUAL	ALL	1				
557		634449.4	4977559	0.00545	2211.07	2844.3	0	ANNUAL	ALL	1				
558		634249.4	4977584	0.00342	2258.01	2742	0	ANNUAL	ALL	1				
559		634274.4	4977584	0.00413	2242.66	2742	0	ANNUAL	ALL	1				
560		634299.4	4977584	0.00499	2227.67	2844.3	0	ANNUAL	ALL	1				
561		634324.4	4977584	0.00539	2213.51	2844.3	0	ANNUAL	ALL	1				
562		634349.4	4977584	0.00532	2199.5	2844.3	0	ANNUAL	ALL	1				
563		634374.4	4977584	0.00532	2185.33	2844.3	0	ANNUAL	ALL	1				
564		634399.4	4977584	0.00554	2177.11	2844.3	0	ANNUAL	ALL	1				
565		634424.4	4977584	0.00509	2192.43	2844.3	0	ANNUAL	ALL	1				
566		634449.4	4977584	0.00526	2203.16	2844.3	0	ANNUAL	ALL	1				
567		634999.5	4977834	0.00626	2055.79	2844.3	0	ANNUAL	ALL	1				
568		635024.5	4977834	0.00647	2048.42	2844.3	0	ANNUAL	ALL	1				
569		635049.5	4977834	0.00666	2043	2844.3	0	ANNUAL	ALL	1				
570		635074.5	4977834	0.00682	2037.93	2844.3	0	ANNUAL	ALL	1				
571		635099.5	4977834	0.00693	2034.24	2844.3	0	ANNUAL	ALL	1				
572		635124.5	4977834	0.00698	2031.45	2844.3	0	ANNUAL	ALL	1				
573		635149.5	4977834	0.00652	2038.5	2844.3	0	ANNUAL	ALL	1				
574		635174.5	4977834	0.00586	2050.35	2844.3	0	ANNUAL	ALL	1				
575		635199.5	4977834	0.00527	2063.26	2844.3	0	ANNUAL	ALL	1				
576		634999.5	4977859	0.00635	2052.63	2844.3	0	ANNUAL	ALL	1				
577		635024.5	4977859	0.00655	2046.41	2844.3	0	ANNUAL	ALL	1				
578		635049.5	4977859	0.00672	2040.95	2844.3	0	ANNUAL	ALL	1				
579		635074.5	4977859	0.0069	2036.03	2844.3	0	ANNUAL	ALL	1				
580		635099.5	4977859	0.007	2032.3	2844.3	0	ANNUAL	ALL	1				
581		635124.5	4977859	0.007	2030.17	2844.3	0	ANNUAL	ALL	1				
582		635149.5	4977859	0.00654	2038.33	2844.3	0	ANNUAL	ALL	1				
583		635174.5	4977859	0.00592	2049.93	2844.3	0	ANNUAL	ALL	1				
584		635199.5	4977859	0.00536	2062.54	2844.3	0	ANNUAL	ALL	1				
585		634999.5	4977884	0.00647	2049.11	2844.3	0	ANNUAL	ALL	1				
586		635024.5	4977884	0.00661	2044.13	2844.3	0	ANNUAL	ALL	1				
587		635049.5	4977884	0.00676	2038.92	2844.3	0	ANNUAL	ALL	1				
588		635074.5	4977884	0.00693	2034.26	2844.3	0	ANNUAL	ALL	1				
589		635099.5	4977884	0.007	2030.48	2844.3	0	ANNUAL	ALL	1				
590		635124.5	4977884	0.007	2029.04	2844.3	0	ANNUAL	ALL	1				
591		635149.5	4977884	0.00653	2038.45	2844.3	0	ANNUAL	ALL	1				
592		635174.5	4977884	0.00597	2049.51	2844.3	0	ANNUAL	ALL	1				
593		635199.5	4977884	0.00544	2061.56	2844.3	0	ANNUAL	ALL	1				
594		634999.5	4977909	0.00646	2047.27	2844.3	0	ANNUAL	ALL	1				
595		635024.5	4977909	0.00661	2042.16	2844.3	0	ANNUAL	ALL	1				
596		635049.5	4977909	0.00678	2036.97	2844.3	0	ANNUAL	ALL	1				
597		635074.5	4977909	0.00692	2032.48	2844.3	0	ANNUAL	ALL	1				
598		635099.5	4977909	0.00699	2028.7	2844.3	0	ANNUAL	ALL	1				
599		635124.5	4977909	0.00695	2028.77	2844.3	0	ANNUAL	ALL	1				
600		635149.5	4977909	0.0065	2038.62	2844.3	0	ANNUAL	ALL	1				
601		635174.5	4977909	0.006	2049.12	2844.3	0	ANNUAL	ALL	1				
602		635199.5	4977909	0.00551	2060.48	2844.3	0	ANNUAL	ALL	1				
603		634999.5	4977934	0.0064	2046.79	2844.3	0	ANNUAL	ALL	1				
604		635024.5	4977934	0.00655	2040.92	2844.3	0	ANNUAL	ALL	1				
605		635049.5	4977934	0.00676	2034.68	2844.3	0	ANNUAL	ALL	1				
606		635074.5	4977934	0.00689	2029.58	2844.3	0	ANNUAL	ALL	1				
607		635099.5	4977934	0.00698	2025.61	2844.3	0	ANNUAL	ALL	1				
608		635124.5	4977934	0.00689	2027.68	2844.3	0	ANNUAL	ALL	1				
609		635149.5	4977934	0.00647	2038.09	2844.3	0	ANNUAL	ALL	1				
610		635174.5	4977934	0.00599	2048.68	2844.3	0	ANNUAL	ALL	1				
611		635199.5	4977934	0.00556	2059.02	2844.3	0	ANNUAL	ALL	1				
612		634999.5	4977959	0.00633	2045.95	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
613		635024.5	4977959	0.00649	2039.51	2844.3	0	ANNUAL	ALL	1				
614		635049.5	4977959	0.00672	2032.45	2844.3	0	ANNUAL	ALL	1				
615		635074.5	4977959	0.00685	2026.52	2844.3	0	ANNUAL	ALL	1				
616		635099.5	4977959	0.00691	2022.6	2844.3	0	ANNUAL	ALL	1				
617		635124.5	4977959	0.00679	2027.13	2844.3	0	ANNUAL	ALL	1				
618		635149.5	4977959	0.00646	2036.89	2844.3	0	ANNUAL	ALL	1				
619		635174.5	4977959	0.00604	2046.85	2844.3	0	ANNUAL	ALL	1				
620		635199.5	4977959	0.00564	2056.78	2844.3	0	ANNUAL	ALL	1				
621		634999.5	4977984	0.00625	2045.34	2844.3	0	ANNUAL	ALL	1				
622		635024.5	4977984	0.00642	2037.82	2844.3	0	ANNUAL	ALL	1				
623		635049.5	4977984	0.00659	2030.43	2844.3	0	ANNUAL	ALL	1				
624		635074.5	4977984	0.00675	2024.12	2844.3	0	ANNUAL	ALL	1				
625		635099.5	4977984	0.00678	2019.96	2844.3	0	ANNUAL	ALL	1				
626		635124.5	4977984	0.00668	2026.73	2844.3	0	ANNUAL	ALL	1				
627		635149.5	4977984	0.00643	2035.4	2844.3	0	ANNUAL	ALL	1				
628		635174.5	4977984	0.00609	2044.46	2844.3	0	ANNUAL	ALL	1				
629		635199.5	4977984	0.00572	2053.52	2844.3	0	ANNUAL	ALL	1				
630		634999.5	4978009	0.00614	2044.81	2844.3	0	ANNUAL	ALL	1				
631		635024.5	4978009	0.00635	2035.59	2844.3	0	ANNUAL	ALL	1				
632		635049.5	4978009	0.0065	2028.05	2844.3	0	ANNUAL	ALL	1				
633		635074.5	4978009	0.00661	2021.18	2844.3	0	ANNUAL	ALL	1				
634		635099.5	4978009	0.00662	2017.1	2844.3	0	ANNUAL	ALL	1				
635		635124.5	4978009	0.00655	2025.97	2844.3	0	ANNUAL	ALL	1				
636		635149.5	4978009	0.00636	2034.03	2844.3	0	ANNUAL	ALL	1				
637		635174.5	4978009	0.00608	2041.95	2844.3	0	ANNUAL	ALL	1				
638		635199.5	4978009	0.0058	2050.09	2844.3	0	ANNUAL	ALL	1				
639		634999.5	4978034	0.00605	2043.29	2844.3	0	ANNUAL	ALL	1				
640		635024.5	4978034	0.00626	2032.46	2844.3	0	ANNUAL	ALL	1				
641		635049.5	4978034	0.00639	2024.39	2844.3	0	ANNUAL	ALL	1				
642		635074.5	4978034	0.00644	2017.56	2844.3	0	ANNUAL	ALL	1				
643		635099.5	4978034	0.00643	2015.24	2844.3	0	ANNUAL	ALL	1				
644		635124.5	4978034	0.00643	2024.2	2844.3	0	ANNUAL	ALL	1				
645		635149.5	4978034	0.00629	2032.02	2844.3	0	ANNUAL	ALL	1				
646		635174.5	4978034	0.00603	2040.48	2844.3	0	ANNUAL	ALL	1				
647		635199.5	4978034	0.00575	2049.69	2844.3	0	ANNUAL	ALL	1				
648		634599.5	4976834	0.00057	2431.97	2717.08	0	ANNUAL	ALL	1				
649		634624.5	4976834	0.00056	2425.11	2717.08	0	ANNUAL	ALL	1				
650		634649.5	4976834	0.00055	2416.95	2717.08	0	ANNUAL	ALL	1				
651		634674.5	4976834	0.00055	2407.96	2717.08	0	ANNUAL	ALL	1				
652		634699.5	4976834	0.00054	2398.82	2717.08	0	ANNUAL	ALL	1				
653		634724.5	4976834	0.00054	2389.57	2717.08	0	ANNUAL	ALL	1				
654		634749.5	4976834	0.00054	2378.83	2717.08	0	ANNUAL	ALL	1				
655		634774.5	4976834	0.00054	2368.3	2717.08	0	ANNUAL	ALL	1				
656		634799.5	4976834	0.00054	2352.38	2717.08	0	ANNUAL	ALL	1				
657		634599.5	4976859	0.00059	2427	2717.08	0	ANNUAL	ALL	1				
658		634624.5	4976859	0.00058	2421.36	2717.08	0	ANNUAL	ALL	1				
659		634649.5	4976859	0.00057	2412.9	2717.08	0	ANNUAL	ALL	1				
660		634674.5	4976859	0.00057	2401.58	2717.08	0	ANNUAL	ALL	1				
661		634699.5	4976859	0.00057	2391.51	2717.08	0	ANNUAL	ALL	1				
662		634724.5	4976859	0.00057	2381.29	2717.08	0	ANNUAL	ALL	1				
663		634749.5	4976859	0.00056	2371.44	2717.08	0	ANNUAL	ALL	1				
664		634774.5	4976859	0.00057	2358.57	2717.08	0	ANNUAL	ALL	1				
665		634799.5	4976859	0.00058	2341.91	2742	0	ANNUAL	ALL	1				
666		634599.5	4976884	0.00061	2422.69	2717.08	0	ANNUAL	ALL	1				
667		634624.5	4976884	0.0006	2418.17	2717.08	0	ANNUAL	ALL	1				
668		634649.5	4976884	0.00059	2408.98	2717.08	0	ANNUAL	ALL	1				
669		634674.5	4976884	0.00059	2396.57	2717.08	0	ANNUAL	ALL	1				
670		634699.5	4976884	0.00059	2383.76	2717.08	0	ANNUAL	ALL	1				
671		634724.5	4976884	0.00059	2371.27	2717.08	0	ANNUAL	ALL	1				
672		634749.5	4976884	0.00059	2362.03	2717.08	0	ANNUAL	ALL	1				
673		634774.5	4976884	0.0006	2350.11	2717.08	0	ANNUAL	ALL	1				
674		634799.5	4976884	0.00061	2334.35	2742	0	ANNUAL	ALL	1				
675		634599.5	4976909	0.00063	2418.11	2717.08	0	ANNUAL	ALL	1				
676		634624.5	4976909	0.00062	2412.47	2717.08	0	ANNUAL	ALL	1				
677		634649.5	4976909	0.00062	2402.76	2717.08	0	ANNUAL	ALL	1				
678		634674.5	4976909	0.00062	2392.81	2717.08	0	ANNUAL	ALL	1				
679		634699.5	4976909	0.00062	2377.98	2717.08	0	ANNUAL	ALL	1				
680		634724.5	4976909	0.00062	2364.11	2717.08	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
681		634749.5	4976909	0.00062	2354.73	2717.08	0	ANNUAL	ALL	1				
682		634774.5	4976909	0.00062	2345.14	2717.08	0	ANNUAL	ALL	1				
683		634799.5	4976909	0.00063	2331	2742	0	ANNUAL	ALL	1				
684		634599.5	4976934	0.00065	2411.78	2717.08	0	ANNUAL	ALL	1				
685		634624.5	4976934	0.00065	2403.98	2717.08	0	ANNUAL	ALL	1				
686		634649.5	4976934	0.00065	2394.61	2717.08	0	ANNUAL	ALL	1				
687		634674.5	4976934	0.00064	2383.71	2717.08	0	ANNUAL	ALL	1				
688		634699.5	4976934	0.00064	2371.78	2717.08	0	ANNUAL	ALL	1				
689		634724.5	4976934	0.00065	2359.09	2717.08	0	ANNUAL	ALL	1				
690		634749.5	4976934	0.00065	2347.63	2717.08	0	ANNUAL	ALL	1				
691		634774.5	4976934	0.00065	2337.6	2742	0	ANNUAL	ALL	1				
692		634799.5	4976934	0.00066	2326.97	2742	0	ANNUAL	ALL	1				
693		634599.5	4976959	0.00068	2404.1	2717.08	0	ANNUAL	ALL	1				
694		634624.5	4976959	0.00068	2396.65	2717.08	0	ANNUAL	ALL	1				
695		634649.5	4976959	0.00067	2385.41	2717.08	0	ANNUAL	ALL	1				
696		634674.5	4976959	0.00068	2372.07	2717.08	0	ANNUAL	ALL	1				
697		634699.5	4976959	0.00068	2362.55	2717.08	0	ANNUAL	ALL	1				
698		634724.5	4976959	0.00068	2351.59	2717.08	0	ANNUAL	ALL	1				
699		634749.5	4976959	0.00068	2341.2	2717.08	0	ANNUAL	ALL	1				
700		634774.5	4976959	0.00069	2328.55	2742	0	ANNUAL	ALL	1				
701		634799.5	4976959	0.0007	2318.72	2742	0	ANNUAL	ALL	1				
702		634599.5	4976984	0.00071	2396.35	2717.08	0	ANNUAL	ALL	1				
703		634624.5	4976984	0.0007	2389.04	2717.08	0	ANNUAL	ALL	1				
704		634649.5	4976984	0.0007	2377.21	2717.08	0	ANNUAL	ALL	1				
705		634674.5	4976984	0.00071	2363.6	2717.08	0	ANNUAL	ALL	1				
706		634699.5	4976984	0.00072	2350.85	2717.08	0	ANNUAL	ALL	1				
707		634724.5	4976984	0.00072	2340.79	2717.08	0	ANNUAL	ALL	1				
708		634749.5	4976984	0.00072	2331.79	2742	0	ANNUAL	ALL	1				
709		634774.5	4976984	0.00073	2320.7	2742	0	ANNUAL	ALL	1				
710		634799.5	4976984	0.00075	2308.59	2742	0	ANNUAL	ALL	1				
711		634599.5	4977009	0.00074	2388.79	2717.08	0	ANNUAL	ALL	1				
712		634624.5	4977009	0.00074	2379.17	2717.08	0	ANNUAL	ALL	1				
713		634649.5	4977009	0.00074	2368.25	2717.08	0	ANNUAL	ALL	1				
714		634674.5	4977009	0.00074	2355.13	2717.08	0	ANNUAL	ALL	1				
715		634699.5	4977009	0.00075	2341.52	2717.08	0	ANNUAL	ALL	1				
716		634724.5	4977009	0.00077	2328.18	2742	0	ANNUAL	ALL	1				
717		634749.5	4977009	0.00077	2321.24	2742	0	ANNUAL	ALL	1				
718		634774.5	4977009	0.00077	2313.44	2742	0	ANNUAL	ALL	1				
719		634799.5	4977009	0.00079	2301.46	2742.16	0	ANNUAL	ALL	1				
720		634599.5	4977034	0.00077	2379.36	2717.08	0	ANNUAL	ALL	1				
721		634624.5	4977034	0.00077	2369.28	2717.08	0	ANNUAL	ALL	1				
722		634649.5	4977034	0.00078	2356.46	2717.08	0	ANNUAL	ALL	1				
723		634674.5	4977034	0.00079	2343.53	2717.08	0	ANNUAL	ALL	1				
724		634699.5	4977034	0.0008	2329.9	2742	0	ANNUAL	ALL	1				
725		634724.5	4977034	0.00082	2316.92	2742	0	ANNUAL	ALL	1				
726		634749.5	4977034	0.00083	2309.32	2742	0	ANNUAL	ALL	1				
727		634774.5	4977034	0.00083	2302.58	2742	0	ANNUAL	ALL	1				
728		634799.5	4977034	0.00084	2295.21	2742.16	0	ANNUAL	ALL	1				
729	**	CONCUNIT	ug/m^3											
730	**	DEPUNIT	g/m^2											

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	*	AERMOD	(	19191):	MIDAS	GOLD	STIBNITE	-	MODELING	R27	########			
2	*	AERMET	(	19191):	12:50:44									
3	*	MODELING	OPTIONS	USED:	RegDFAULT	CONC	ELEV	NOWARN	DRYDPLT	WETDPLT	RURAL	ADJ_U*		
4	*	PLOT	FILE	OF	ANNUAL	VALUES	AVERAGED	ACROSS	1	YEARS	FOR	SOURCE	GROUP:	ALL
5	*	FOR	A	TOTAL	OF	720	RECEPTORS.							
6	*	FORMAT:	(3(1X,F13.5),3(1X,F8.2),2X,A6,2X,A8,2X,I8.8,2X,A8)											
7	*	X	Y	AVERAGE	CONC	ZELEV	ZHILL	ZFLAG	AVE	GRP	NUM	YRS	NET	ID
8	*													
9	0.006730	635399.5	4975934	0.00087	2213.4	2844.3	0	ANNUAL	ALL	1				
10	max ↑	635424.5	4975934	0.00087	2212.64	2844.3	0	ANNUAL	ALL	1				
11		635449.5	4975934	0.00087	2211.27	2844.3	0	ANNUAL	ALL	1				
12		635474.5	4975934	0.00086	2212.5	2844.3	0	ANNUAL	ALL	1				
13		635499.5	4975934	0.00085	2215.21	2844.3	0	ANNUAL	ALL	1				
14		635524.5	4975934	0.00084	2215.98	2844.3	0	ANNUAL	ALL	1				
15		635549.5	4975934	0.00084	2215	2844.3	0	ANNUAL	ALL	1				
16		635574.5	4975934	0.00084	2215.74	2844.3	0	ANNUAL	ALL	1				
17		635599.5	4975934	0.00082	2218.34	2844.3	0	ANNUAL	ALL	1				
18		635399.5	4975959	0.00092	2202.75	2844.3	0	ANNUAL	ALL	1				
19		635424.5	4975959	0.00091	2204.36	2844.3	0	ANNUAL	ALL	1				
20		635449.5	4975959	0.00091	2204.87	2844.3	0	ANNUAL	ALL	1				
21		635474.5	4975959	0.00089	2206.39	2844.3	0	ANNUAL	ALL	1				
22		635499.5	4975959	0.00088	2208.99	2844.3	0	ANNUAL	ALL	1				
23		635524.5	4975959	0.00087	2210.99	2844.3	0	ANNUAL	ALL	1				
24		635549.5	4975959	0.00086	2211.29	2844.3	0	ANNUAL	ALL	1				
25		635574.5	4975959	0.00086	2210.92	2844.3	0	ANNUAL	ALL	1				
26		635599.5	4975959	0.00087	2208.83	2844.3	0	ANNUAL	ALL	1				
27		635399.5	4975984	0.00097	2195.09	2844.3	0	ANNUAL	ALL	1				
28		635424.5	4975984	0.00094	2198.19	2844.3	0	ANNUAL	ALL	1				
29		635449.5	4975984	0.00094	2198.7	2844.3	0	ANNUAL	ALL	1				
30		635474.5	4975984	0.00092	2201.57	2844.3	0	ANNUAL	ALL	1				
31		635499.5	4975984	0.00091	2203.99	2844.3	0	ANNUAL	ALL	1				
32		635524.5	4975984	0.00089	2206.27	2844.3	0	ANNUAL	ALL	1				
33		635549.5	4975984	0.00089	2206.83	2844.3	0	ANNUAL	ALL	1				
34		635574.5	4975984	0.00089	2205.61	2844.3	0	ANNUAL	ALL	1				
35		635599.5	4975984	0.0009	2202.99	2844.3	0	ANNUAL	ALL	1				
36		635399.5	4976009	0.00097	2195.69	2844.3	0	ANNUAL	ALL	1				
37		635424.5	4976009	0.001	2189.65	2844.3	0	ANNUAL	ALL	1				
38		635449.5	4976009	0.00097	2194	2844.3	0	ANNUAL	ALL	1				
39		635474.5	4976009	0.00093	2200.13	2844.3	0	ANNUAL	ALL	1				
40		635499.5	4976009	0.00091	2202.83	2844.3	0	ANNUAL	ALL	1				
41		635524.5	4976009	0.00091	2203.57	2844.3	0	ANNUAL	ALL	1				
42		635549.5	4976009	0.0009	2203.82	2844.3	0	ANNUAL	ALL	1				
43		635574.5	4976009	0.0009	2202.81	2844.3	0	ANNUAL	ALL	1				
44		635599.5	4976009	0.00091	2200.59	2844.3	0	ANNUAL	ALL	1				
45		635399.5	4976034	0.00095	2198.23	2844.3	0	ANNUAL	ALL	1				
46		635424.5	4976034	0.00102	2186.98	2844.3	0	ANNUAL	ALL	1				
47		635449.5	4976034	0.00099	2190.14	2844.3	0	ANNUAL	ALL	1				
48		635474.5	4976034	0.00094	2198.63	2844.3	0	ANNUAL	ALL	1				
49		635499.5	4976034	0.00093	2198.93	2844.3	0	ANNUAL	ALL	1				
50		635524.5	4976034	0.00093	2199.39	2844.3	0	ANNUAL	ALL	1				
51		635549.5	4976034	0.00092	2201.1	2844.3	0	ANNUAL	ALL	1				
52		635574.5	4976034	0.00092	2200.59	2844.3	0	ANNUAL	ALL	1				
53		635599.5	4976034	0.00093	2197.96	2844.3	0	ANNUAL	ALL	1				
54		635399.5	4976059	0.00097	2196.33	2844.3	0	ANNUAL	ALL	1				
55		635424.5	4976059	0.00104	2184.09	2844.3	0	ANNUAL	ALL	1				
56		635449.5	4976059	0.00105	2180.82	2844.3	0	ANNUAL	ALL	1				
57		635474.5	4976059	0.00097	2193.11	2844.3	0	ANNUAL	ALL	1				
58		635499.5	4976059	0.00096	2194.5	2844.3	0	ANNUAL	ALL	1				
59		635524.5	4976059	0.00094	2197.17	2844.3	0	ANNUAL	ALL	1				
60		635549.5	4976059	0.00093	2199.4	2844.3	0	ANNUAL	ALL	1				
61		635574.5	4976059	0.00093	2198.27	2844.3	0	ANNUAL	ALL	1				
62		635599.5	4976059	0.00095	2194.62	2844.3	0	ANNUAL	ALL	1				
63		635399.5	4976084	0.00101	2188.98	2844.3	0	ANNUAL	ALL	1				
64		635424.5	4976084	0.00106	2180.22	2844.3	0	ANNUAL	ALL	1				
65		635449.5	4976084	0.00109	2174.51	2844.3	0	ANNUAL	ALL	1				
66		635474.5	4976084	0.00105	2180.27	2844.3	0	ANNUAL	ALL	1				
67		635499.5	4976084	0.00102	2185.71	2844.3	0	ANNUAL	ALL	1				
68		635524.5	4976084	0.00098	2191.13	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
69		635549.5	4976084	0.00096	2193.95	2844.3	0	ANNUAL	ALL	1				
70		635574.5	4976084	0.00098	2190.58	2844.3	0	ANNUAL	ALL	1				
71		635599.5	4976084	0.00102	2183.01	2844.3	0	ANNUAL	ALL	1				
72		635399.5	4976109	0.00105	2182.28	2844.3	0	ANNUAL	ALL	1				
73		635424.5	4976109	0.00108	2177.24	2844.3	0	ANNUAL	ALL	1				
74		635449.5	4976109	0.00112	2171.45	2844.3	0	ANNUAL	ALL	1				
75		635474.5	4976109	0.00111	2172.26	2844.3	0	ANNUAL	ALL	1				
76		635499.5	4976109	0.00107	2177.58	2844.3	0	ANNUAL	ALL	1				
77		635524.5	4976109	0.00105	2180.23	2844.3	0	ANNUAL	ALL	1				
78		635549.5	4976109	0.00105	2179.81	2844.3	0	ANNUAL	ALL	1				
79		635574.5	4976109	0.00106	2176.94	2844.3	0	ANNUAL	ALL	1				
80		635599.5	4976109	0.00104	2179.4	2844.3	0	ANNUAL	ALL	1				
81		635399.5	4976134	0.00109	2176.77	2844.3	0	ANNUAL	ALL	1				
82		635424.5	4976134	0.0011	2174.27	2844.3	0	ANNUAL	ALL	1				
83		635449.5	4976134	0.00112	2171.04	2844.3	0	ANNUAL	ALL	1				
84		635474.5	4976134	0.00115	2166.4	2844.3	0	ANNUAL	ALL	1				
85		635499.5	4976134	0.00114	2167.48	2844.3	0	ANNUAL	ALL	1				
86		635524.5	4976134	0.0011	2172.09	2844.3	0	ANNUAL	ALL	1				
87		635549.5	4976134	0.0011	2171.44	2844.3	0	ANNUAL	ALL	1				
88		635574.5	4976134	0.00109	2172.93	2844.3	0	ANNUAL	ALL	1				
89		635599.5	4976134	0.00105	2178.31	2844.3	0	ANNUAL	ALL	1				
90		635199.5	4976834	0.00275	2116.83	2844.3	0	ANNUAL	ALL	1				
91		635224.5	4976834	0.00275	2112.53	2844.3	0	ANNUAL	ALL	1				
92		635249.5	4976834	0.00275	2108.39	2844.3	0	ANNUAL	ALL	1				
93		635274.5	4976834	0.00275	2105.23	2844.3	0	ANNUAL	ALL	1				
94		635299.5	4976834	0.00276	2101.6	2844.3	0	ANNUAL	ALL	1				
95		635324.5	4976834	0.00276	2098.74	2844.3	0	ANNUAL	ALL	1				
96		635349.5	4976834	0.00263	2104.26	2844.3	0	ANNUAL	ALL	1				
97		635374.5	4976834	0.00248	2110.4	2844.3	0	ANNUAL	ALL	1				
98		635399.5	4976834	0.00235	2117.98	2844.3	0	ANNUAL	ALL	1				
99		635199.5	4976859	0.00284	2114.34	2844.3	0	ANNUAL	ALL	1				
100		635224.5	4976859	0.00285	2108.68	2844.3	0	ANNUAL	ALL	1				
101		635249.5	4976859	0.00287	2104.42	2844.3	0	ANNUAL	ALL	1				
102		635274.5	4976859	0.00286	2101.28	2844.3	0	ANNUAL	ALL	1				
103		635299.5	4976859	0.00285	2098.83	2844.3	0	ANNUAL	ALL	1				
104		635324.5	4976859	0.00284	2096.89	2844.3	0	ANNUAL	ALL	1				
105		635349.5	4976859	0.00272	2101.21	2844.3	0	ANNUAL	ALL	1				
106		635374.5	4976859	0.00256	2108.71	2844.3	0	ANNUAL	ALL	1				
107		635399.5	4976859	0.00239	2118.31	2844.3	0	ANNUAL	ALL	1				
108		635199.5	4976884	0.00293	2111.17	2844.3	0	ANNUAL	ALL	1				
109		635224.5	4976884	0.00297	2104.78	2844.3	0	ANNUAL	ALL	1				
110		635249.5	4976884	0.00299	2100.14	2844.3	0	ANNUAL	ALL	1				
111		635274.5	4976884	0.00298	2097.48	2844.3	0	ANNUAL	ALL	1				
112		635299.5	4976884	0.00295	2095.42	2844.3	0	ANNUAL	ALL	1				
113		635324.5	4976884	0.00291	2094.96	2844.3	0	ANNUAL	ALL	1				
114		635349.5	4976884	0.00283	2097.83	2844.3	0	ANNUAL	ALL	1				
115		635374.5	4976884	0.00263	2107.96	2844.3	0	ANNUAL	ALL	1				
116		635399.5	4976884	0.00244	2119.17	2844.3	0	ANNUAL	ALL	1				
117		635199.5	4976909	0.00303	2108.51	2844.3	0	ANNUAL	ALL	1				
118		635224.5	4976909	0.00306	2102.17	2844.3	0	ANNUAL	ALL	1				
119		635249.5	4976909	0.00308	2097.31	2844.3	0	ANNUAL	ALL	1				
120		635274.5	4976909	0.00306	2094.85	2844.3	0	ANNUAL	ALL	1				
121		635299.5	4976909	0.00303	2093.19	2844.3	0	ANNUAL	ALL	1				
122		635324.5	4976909	0.00298	2093.48	2844.3	0	ANNUAL	ALL	1				
123		635349.5	4976909	0.00287	2098.12	2844.3	0	ANNUAL	ALL	1				
124		635374.5	4976909	0.00267	2108.79	2844.3	0	ANNUAL	ALL	1				
125		635399.5	4976909	0.00247	2120.74	2844.3	0	ANNUAL	ALL	1				
126		635199.5	4976934	0.00313	2106.38	2844.3	0	ANNUAL	ALL	1				
127		635224.5	4976934	0.00314	2100.81	2844.3	0	ANNUAL	ALL	1				
128		635249.5	4976934	0.00314	2096.21	2844.3	0	ANNUAL	ALL	1				
129		635274.5	4976934	0.00313	2092.89	2844.3	0	ANNUAL	ALL	1				
130		635299.5	4976934	0.0031	2091.1	2844.3	0	ANNUAL	ALL	1				
131		635324.5	4976934	0.00304	2092.46	2844.3	0	ANNUAL	ALL	1				
132		635349.5	4976934	0.0029	2099.48	2844.3	0	ANNUAL	ALL	1				
133		635374.5	4976934	0.0027	2110.37	2844.3	0	ANNUAL	ALL	1				
134		635399.5	4976934	0.00249	2122.91	2844.3	0	ANNUAL	ALL	1				
135		635199.5	4976959	0.00321	2104.62	2844.3	0	ANNUAL	ALL	1				
136		635224.5	4976959	0.00321	2099.28	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
137		635249.5	4976959	0.0032	2094.41	2844.3	0	ANNUAL	ALL	1				
138		635274.5	4976959	0.00319	2090.59	2844.3	0	ANNUAL	ALL	1				
139		635299.5	4976959	0.00316	2088.8	2844.3	0	ANNUAL	ALL	1				
140		635324.5	4976959	0.00309	2092.02	2844.3	0	ANNUAL	ALL	1				
141		635349.5	4976959	0.00294	2100.12	2844.3	0	ANNUAL	ALL	1				
142		635374.5	4976959	0.00274	2112.07	2844.3	0	ANNUAL	ALL	1				
143		635399.5	4976959	0.00251	2125.69	2844.3	0	ANNUAL	ALL	1				
144		635199.5	4976984	0.00328	2102.45	2844.3	0	ANNUAL	ALL	1				
145		635224.5	4976984	0.00329	2097.29	2844.3	0	ANNUAL	ALL	1				
146		635249.5	4976984	0.00328	2091.62	2844.3	0	ANNUAL	ALL	1				
147		635274.5	4976984	0.00325	2087.92	2844.3	0	ANNUAL	ALL	1				
148		635299.5	4976984	0.00322	2086.81	2844.3	0	ANNUAL	ALL	1				
149		635324.5	4976984	0.00312	2092.65	2844.3	0	ANNUAL	ALL	1				
150		635349.5	4976984	0.00298	2101.3	2844.3	0	ANNUAL	ALL	1				
151		635374.5	4976984	0.00277	2114.13	2844.3	0	ANNUAL	ALL	1				
152		635399.5	4976984	0.00256	2128.46	2844.3	0	ANNUAL	ALL	1				
153		635199.5	4977009	0.00337	2099.39	2844.3	0	ANNUAL	ALL	1				
154		635224.5	4977009	0.00335	2093.66	2844.3	0	ANNUAL	ALL	1				
155		635249.5	4977009	0.00333	2087.97	2844.3	0	ANNUAL	ALL	1				
156		635274.5	4977009	0.00331	2084.9	2844.3	0	ANNUAL	ALL	1				
157		635299.5	4977009	0.00325	2087.43	2844.3	0	ANNUAL	ALL	1				
158		635324.5	4977009	0.00315	2094.55	2844.3	0	ANNUAL	ALL	1				
159		635349.5	4977009	0.003	2103.74	2844.3	0	ANNUAL	ALL	1				
160		635374.5	4977009	0.00282	2116.64	2844.3	0	ANNUAL	ALL	1				
161		635399.5	4977009	0.00259	2131.12	2844.3	0	ANNUAL	ALL	1				
162		635199.5	4977034	0.00345	2094.63	2844.3	0	ANNUAL	ALL	1				
163		635224.5	4977034	0.00341	2088.76	2844.3	0	ANNUAL	ALL	1				
164		635249.5	4977034	0.00339	2084.27	2844.3	0	ANNUAL	ALL	1				
165		635274.5	4977034	0.00336	2082.71	2844.3	0	ANNUAL	ALL	1				
166		635299.5	4977034	0.00327	2089.9	2844.3	0	ANNUAL	ALL	1				
167		635324.5	4977034	0.00317	2098.21	2844.3	0	ANNUAL	ALL	1				
168		635349.5	4977034	0.00301	2107.49	2844.3	0	ANNUAL	ALL	1				
169		635374.5	4977034	0.00285	2119.09	2844.3	0	ANNUAL	ALL	1				
170		635399.5	4977034	0.00262	2133.38	2844.3	0	ANNUAL	ALL	1				
171		634899.5	4977134	0.00252	2221.02	2844.3	0	ANNUAL	ALL	1				
172		634924.5	4977134	0.00281	2207.85	2844.3	0	ANNUAL	ALL	1				
173		634949.5	4977134	0.00318	2190.45	2844.3	0	ANNUAL	ALL	1				
174		634974.5	4977134	0.00359	2169.12	2844.3	0	ANNUAL	ALL	1				
175		634999.5	4977134	0.0038	2150.64	2844.3	0	ANNUAL	ALL	1				
176		635024.5	4977134	0.00387	2135.97	2844.3	0	ANNUAL	ALL	1				
177		635049.5	4977134	0.00387	2122.38	2844.3	0	ANNUAL	ALL	1				
178		635074.5	4977134	0.00383	2113.7	2844.3	0	ANNUAL	ALL	1				
179		635099.5	4977134	0.00378	2105.9	2844.3	0	ANNUAL	ALL	1				
180		634899.5	4977159	0.00286	2213.37	2844.3	0	ANNUAL	ALL	1				
181		634924.5	4977159	0.00305	2201.16	2844.3	0	ANNUAL	ALL	1				
182		634949.5	4977159	0.00349	2181.17	2844.3	0	ANNUAL	ALL	1				
183		634974.5	4977159	0.00378	2161.72	2844.3	0	ANNUAL	ALL	1				
184		634999.5	4977159	0.0039	2145.73	2844.3	0	ANNUAL	ALL	1				
185		635024.5	4977159	0.00395	2132.12	2844.3	0	ANNUAL	ALL	1				
186		635049.5	4977159	0.00393	2119.59	2844.3	0	ANNUAL	ALL	1				
187		635074.5	4977159	0.00384	2109.27	2844.3	0	ANNUAL	ALL	1				
188		635099.5	4977159	0.0038	2101.29	2844.3	0	ANNUAL	ALL	1				
189		634899.5	4977184	0.00312	2206.56	2844.3	0	ANNUAL	ALL	1				
190		634924.5	4977184	0.00338	2193.64	2844.3	0	ANNUAL	ALL	1				
191		634949.5	4977184	0.00376	2172.29	2844.3	0	ANNUAL	ALL	1				
192		634974.5	4977184	0.00392	2154.5	2844.3	0	ANNUAL	ALL	1				
193		634999.5	4977184	0.00397	2141.04	2844.3	0	ANNUAL	ALL	1				
194		635024.5	4977184	0.004	2128.3	2844.3	0	ANNUAL	ALL	1				
195		635049.5	4977184	0.00396	2114.34	2844.3	0	ANNUAL	ALL	1				
196		635074.5	4977184	0.00387	2102.7	2844.3	0	ANNUAL	ALL	1				
197		635099.5	4977184	0.00383	2096.47	2844.3	0	ANNUAL	ALL	1				
198		634899.5	4977209	0.00338	2199.13	2844.3	0	ANNUAL	ALL	1				
199		634924.5	4977209	0.00367	2184.15	2844.3	0	ANNUAL	ALL	1				
200		634949.5	4977209	0.00391	2163.72	2844.3	0	ANNUAL	ALL	1				
201		634974.5	4977209	0.00403	2146.68	2844.3	0	ANNUAL	ALL	1				
202		634999.5	4977209	0.00402	2136.15	2844.3	0	ANNUAL	ALL	1				
203		635024.5	4977209	0.004	2124.22	2844.3	0	ANNUAL	ALL	1				
204		635049.5	4977209	0.00395	2105.9	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
205		635074.5	4977209	0.00387	2096.39	2844.3	0	ANNUAL	ALL	1				
206		635099.5	4977209	0.00381	2091.31	2844.3	0	ANNUAL	ALL	1				
207		634899.5	4977234	0.0038	2185.16	2844.3	0	ANNUAL	ALL	1				
208		634924.5	4977234	0.00394	2172.04	2844.3	0	ANNUAL	ALL	1				
209		634949.5	4977234	0.00404	2152.41	2844.3	0	ANNUAL	ALL	1				
210		634974.5	4977234	0.00407	2139.97	2844.3	0	ANNUAL	ALL	1				
211		634999.5	4977234	0.00408	2130.73	2844.3	0	ANNUAL	ALL	1				
212		635024.5	4977234	0.00405	2117.31	2844.3	0	ANNUAL	ALL	1				
213		635049.5	4977234	0.00395	2098.65	2844.3	0	ANNUAL	ALL	1				
214		635074.5	4977234	0.00386	2092.39	2844.3	0	ANNUAL	ALL	1				
215		635099.5	4977234	0.00378	2087.32	2844.3	0	ANNUAL	ALL	1				
216		634899.5	4977259	0.00394	2180.4	2844.3	0	ANNUAL	ALL	1				
217		634924.5	4977259	0.00407	2160.19	2844.3	0	ANNUAL	ALL	1				
218		634949.5	4977259	0.0041	2143.3	2844.3	0	ANNUAL	ALL	1				
219		634974.5	4977259	0.00412	2132.11	2844.3	0	ANNUAL	ALL	1				
220		634999.5	4977259	0.00408	2123.02	2844.3	0	ANNUAL	ALL	1				
221		635024.5	4977259	0.00402	2107.09	2844.3	0	ANNUAL	ALL	1				
222		635049.5	4977259	0.00394	2095.35	2844.3	0	ANNUAL	ALL	1				
223		635074.5	4977259	0.00385	2089.07	2844.3	0	ANNUAL	ALL	1				
224		635099.5	4977259	0.00379	2083.6	2844.3	0	ANNUAL	ALL	1				
225		634899.5	4977284	0.00398	2180.69	2844.3	0	ANNUAL	ALL	1				
226		634924.5	4977284	0.00409	2158.28	2844.3	0	ANNUAL	ALL	1				
227		634949.5	4977284	0.00414	2139.34	2844.3	0	ANNUAL	ALL	1				
228		634974.5	4977284	0.00413	2123.05	2844.3	0	ANNUAL	ALL	1				
229		634999.5	4977284	0.00409	2112.91	2844.3	0	ANNUAL	ALL	1				
230		635024.5	4977284	0.00401	2100.55	2844.3	0	ANNUAL	ALL	1				
231		635049.5	4977284	0.00393	2092.76	2844.3	0	ANNUAL	ALL	1				
232		635074.5	4977284	0.00384	2085.71	2844.3	0	ANNUAL	ALL	1				
233		635099.5	4977284	0.00383	2078.67	2844.3	0	ANNUAL	ALL	1				
234		634899.5	4977309	0.00406	2178.55	2844.3	0	ANNUAL	ALL	1				
235		634924.5	4977309	0.00412	2156.77	2844.3	0	ANNUAL	ALL	1				
236		634949.5	4977309	0.00415	2136.54	2844.3	0	ANNUAL	ALL	1				
237		634974.5	4977309	0.00415	2119.59	2844.3	0	ANNUAL	ALL	1				
238		634999.5	4977309	0.00408	2107.01	2844.3	0	ANNUAL	ALL	1				
239		635024.5	4977309	0.00402	2096.52	2844.3	0	ANNUAL	ALL	1				
240		635049.5	4977309	0.00392	2089.24	2844.3	0	ANNUAL	ALL	1				
241		635074.5	4977309	0.00387	2082.55	2844.3	0	ANNUAL	ALL	1				
242		635099.5	4977309	0.00385	2075.98	2844.3	0	ANNUAL	ALL	1				
243		634899.5	4977334	0.00413	2173.18	2844.3	0	ANNUAL	ALL	1				
244		634924.5	4977334	0.00416	2153.29	2844.3	0	ANNUAL	ALL	1				
245		634949.5	4977334	0.00417	2133.9	2844.3	0	ANNUAL	ALL	1				
246		634974.5	4977334	0.00417	2117.58	2844.3	0	ANNUAL	ALL	1				
247		634999.5	4977334	0.00408	2104.03	2844.3	0	ANNUAL	ALL	1				
248		635024.5	4977334	0.00401	2093.8	2844.3	0	ANNUAL	ALL	1				
249		635049.5	4977334	0.00392	2085.23	2844.3	0	ANNUAL	ALL	1				
250		635074.5	4977334	0.00391	2078.76	2844.3	0	ANNUAL	ALL	1				
251		635099.5	4977334	0.00387	2074.53	2844.3	0	ANNUAL	ALL	1				
252		635399.5	4976159	0.00113	2171.27	2844.3	0	ANNUAL	ALL	1				
253		635424.5	4976159	0.00113	2169.98	2844.3	0	ANNUAL	ALL	1				
254		635449.5	4976159	0.00115	2167.61	2844.3	0	ANNUAL	ALL	1				
255		635474.5	4976159	0.00117	2164.06	2844.3	0	ANNUAL	ALL	1				
256		635499.5	4976159	0.00118	2161.76	2844.3	0	ANNUAL	ALL	1				
257		635524.5	4976159	0.00118	2160.48	2844.3	0	ANNUAL	ALL	1				
258		635549.5	4976159	0.00117	2162.19	2844.3	0	ANNUAL	ALL	1				
259		635574.5	4976159	0.00112	2168.15	2844.3	0	ANNUAL	ALL	1				
260		635599.5	4976159	0.00108	2173.85	2844.3	0	ANNUAL	ALL	1				
261		635399.5	4976184	0.00116	2168.06	2844.3	0	ANNUAL	ALL	1				
262		635424.5	4976184	0.00116	2166.17	2844.3	0	ANNUAL	ALL	1				
263		635449.5	4976184	0.00117	2163.95	2844.3	0	ANNUAL	ALL	1				
264		635474.5	4976184	0.00119	2161.05	2844.3	0	ANNUAL	ALL	1				
265		635499.5	4976184	0.0012	2158.86	2844.3	0	ANNUAL	ALL	1				
266		635524.5	4976184	0.00121	2157.1	2844.3	0	ANNUAL	ALL	1				
267		635549.5	4976184	0.0012	2157.07	2844.3	0	ANNUAL	ALL	1				
268		635574.5	4976184	0.00115	2164.59	2844.3	0	ANNUAL	ALL	1				
269		635599.5	4976184	0.00109	2172.06	2844.3	0	ANNUAL	ALL	1				
270		635399.5	4976209	0.00118	2165.29	2844.3	0	ANNUAL	ALL	1				
271		635424.5	4976209	0.00119	2163.14	2844.3	0	ANNUAL	ALL	1				
272		635449.5	4976209	0.0012	2160.76	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
273		635474.5	4976209	0.00121	2158.05	2844.3	0	ANNUAL	ALL	1				
274		635499.5	4976209	0.00123	2155.43	2844.3	0	ANNUAL	ALL	1				
275		635524.5	4976209	0.00123	2153.57	2844.3	0	ANNUAL	ALL	1				
276		635549.5	4976209	0.00121	2156.02	2844.3	0	ANNUAL	ALL	1				
277		635574.5	4976209	0.00114	2165.26	2844.3	0	ANNUAL	ALL	1				
278		635599.5	4976209	0.00108	2175.01	2844.3	0	ANNUAL	ALL	1				
279		635399.5	4976234	0.0012	2162.56	2844.3	0	ANNUAL	ALL	1				
280		635424.5	4976234	0.00121	2160.46	2844.3	0	ANNUAL	ALL	1				
281		635449.5	4976234	0.00122	2157.93	2844.3	0	ANNUAL	ALL	1				
282		635474.5	4976234	0.00124	2155.5	2844.3	0	ANNUAL	ALL	1				
283		635499.5	4976234	0.00125	2152.67	2844.3	0	ANNUAL	ALL	1				
284		635524.5	4976234	0.00126	2150.12	2844.3	0	ANNUAL	ALL	1				
285		635549.5	4976234	0.00121	2156.6	2844.3	0	ANNUAL	ALL	1				
286		635574.5	4976234	0.00113	2167.62	2844.3	0	ANNUAL	ALL	1				
287		635599.5	4976234	0.00106	2178.35	2844.3	0	ANNUAL	ALL	1				
288		634999.5	4978134	0.00391	2044.53	2844.3	0	ANNUAL	ALL	1				
289		635024.5	4978134	0.004	2030.56	2844.3	0	ANNUAL	ALL	1				
290		635049.5	4978134	0.00402	2018.07	2844.3	0	ANNUAL	ALL	1				
291		635074.5	4978134	0.00394	2006.69	2844.3	0	ANNUAL	ALL	1				
292		635099.5	4978134	0.00399	2006.39	2844.3	0	ANNUAL	ALL	1				
293		635124.5	4978134	0.00414	2013.34	2844.3	0	ANNUAL	ALL	1				
294		635149.5	4978134	0.00427	2020.75	2844.3	0	ANNUAL	ALL	1				
295		635174.5	4978134	0.00431	2029.05	2844.3	0	ANNUAL	ALL	1				
296		635199.5	4978134	0.00428	2038.91	2844.3	0	ANNUAL	ALL	1				
297		634999.5	4978159	0.00374	2044.5	2844.3	0	ANNUAL	ALL	1				
298		635024.5	4978159	0.00383	2030.78	2844.3	0	ANNUAL	ALL	1				
299		635049.5	4978159	0.00382	2017.35	2844.3	0	ANNUAL	ALL	1				
300		635074.5	4978159	0.00373	2004.54	2844.3	0	ANNUAL	ALL	1				
301		635099.5	4978159	0.00378	2003.81	2844.3	0	ANNUAL	ALL	1				
302		635124.5	4978159	0.00392	2010.57	2844.3	0	ANNUAL	ALL	1				
303		635149.5	4978159	0.00406	2017.75	2844.3	0	ANNUAL	ALL	1				
304		635174.5	4978159	0.00414	2025.18	2844.3	0	ANNUAL	ALL	1				
305		635199.5	4978159	0.00417	2035.11	2844.3	0	ANNUAL	ALL	1				
306		634999.5	4978184	0.00358	2044.38	2844.3	0	ANNUAL	ALL	1				
307		635024.5	4978184	0.00362	2028.98	2844.3	0	ANNUAL	ALL	1				
308		635049.5	4978184	0.00362	2015.36	2844.3	0	ANNUAL	ALL	1				
309		635074.5	4978184	0.00354	2002.43	2844.3	0	ANNUAL	ALL	1				
310		635099.5	4978184	0.00357	2000.86	2844.3	0	ANNUAL	ALL	1				
311		635124.5	4978184	0.0037	2007.53	2844.3	0	ANNUAL	ALL	1				
312		635149.5	4978184	0.00384	2014.6	2844.3	0	ANNUAL	ALL	1				
313		635174.5	4978184	0.00395	2022.07	2844.3	0	ANNUAL	ALL	1				
314		635199.5	4978184	0.00402	2031.45	2844.3	0	ANNUAL	ALL	1				
315		634999.5	4978209	0.00342	2043.46	2844.3	0	ANNUAL	ALL	1				
316		635024.5	4978209	0.00345	2027.94	2844.3	0	ANNUAL	ALL	1				
317		635049.5	4978209	0.00343	2013.73	2844.3	0	ANNUAL	ALL	1				
318		635074.5	4978209	0.00336	2000.96	2844.3	0	ANNUAL	ALL	1				
319		635099.5	4978209	0.00338	1998.75	2844.3	0	ANNUAL	ALL	1				
320		635124.5	4978209	0.0035	2004.56	2844.3	0	ANNUAL	ALL	1				
321		635149.5	4978209	0.00363	2011.78	2844.3	0	ANNUAL	ALL	1				
322		635174.5	4978209	0.00376	2019.36	2844.3	0	ANNUAL	ALL	1				
323		635199.5	4978209	0.00383	2027.82	2844.3	0	ANNUAL	ALL	1				
324		634999.5	4978234	0.00327	2042.97	2844.3	0	ANNUAL	ALL	1				
325		635024.5	4978234	0.00328	2026.61	2844.3	0	ANNUAL	ALL	1				
326		635049.5	4978234	0.00325	2012.57	2844.3	0	ANNUAL	ALL	1				
327		635074.5	4978234	0.00319	2000.24	2844.3	0	ANNUAL	ALL	1				
328		635099.5	4978234	0.00319	1996.61	2844.3	0	ANNUAL	ALL	1				
329		635124.5	4978234	0.00331	2001.65	2844.3	0	ANNUAL	ALL	1				
330		635149.5	4978234	0.00344	2009.16	2844.3	0	ANNUAL	ALL	1				
331		635174.5	4978234	0.00357	2016.86	2844.3	0	ANNUAL	ALL	1				
332		635199.5	4978234	0.00366	2024.48	2844.3	0	ANNUAL	ALL	1				
333		634999.5	4978259	0.00309	2041.08	2844.3	0	ANNUAL	ALL	1				
334		635024.5	4978259	0.00312	2024.08	2844.3	0	ANNUAL	ALL	1				
335		635049.5	4978259	0.00309	2011.49	2844.3	0	ANNUAL	ALL	1				
336		635074.5	4978259	0.00305	2000.61	2844.3	0	ANNUAL	ALL	1				
337		635099.5	4978259	0.00302	1994.84	2844.3	0	ANNUAL	ALL	1				
338		635124.5	4978259	0.00313	1999.29	2844.3	0	ANNUAL	ALL	1				
339		635149.5	4978259	0.00326	2007.14	2844.3	0	ANNUAL	ALL	1				
340		635174.5	4978259	0.00338	2014.96	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
341		635199.5	4978259	0.00349	2023.44	2844.3	0	ANNUAL	ALL	1				
342		634999.5	4978284	0.00296	2039.02	2844.3	0	ANNUAL	ALL	1				
343		635024.5	4978284	0.00297	2022.69	2844.3	0	ANNUAL	ALL	1				
344		635049.5	4978284	0.00293	2010.11	2844.3	0	ANNUAL	ALL	1				
345		635074.5	4978284	0.0029	1999.28	2844.3	0	ANNUAL	ALL	1				
346		635099.5	4978284	0.00287	1993.94	2844.3	0	ANNUAL	ALL	1				
347		635124.5	4978284	0.00296	1996.86	2844.3	0	ANNUAL	ALL	1				
348		635149.5	4978284	0.00309	2004.78	2844.3	0	ANNUAL	ALL	1				
349		635174.5	4978284	0.00321	2012.7	2844.3	0	ANNUAL	ALL	1				
350		635199.5	4978284	0.00332	2021.78	2844.3	0	ANNUAL	ALL	1				
351		634999.5	4978309	0.00282	2036.72	2844.3	0	ANNUAL	ALL	1				
352		635024.5	4978309	0.00283	2023.32	2844.3	0	ANNUAL	ALL	1				
353		635049.5	4978309	0.00279	2010.1	2844.3	0	ANNUAL	ALL	1				
354		635074.5	4978309	0.00276	1999.36	2844.3	0	ANNUAL	ALL	1				
355		635099.5	4978309	0.00274	1992.81	2844.3	0	ANNUAL	ALL	1				
356		635124.5	4978309	0.00279	1994.13	2844.3	0	ANNUAL	ALL	1				
357		635149.5	4978309	0.00292	2001.68	2844.3	0	ANNUAL	ALL	1				
358		635174.5	4978309	0.00303	2009.75	2844.3	0	ANNUAL	ALL	1				
359		635199.5	4978309	0.00315	2018.84	2844.3	0	ANNUAL	ALL	1				
360		634999.5	4978334	0.00269	2033.58	2844.3	0	ANNUAL	ALL	1				
361		635024.5	4978334	0.00269	2021.76	2844.3	0	ANNUAL	ALL	1				
362		635049.5	4978334	0.00266	2009.59	2844.3	0	ANNUAL	ALL	1				
363		635074.5	4978334	0.00264	1999.33	2844.3	0	ANNUAL	ALL	1				
364		635099.5	4978334	0.00262	1991.74	2844.3	0	ANNUAL	ALL	1				
365		635124.5	4978334	0.00266	1991.62	2844.3	0	ANNUAL	ALL	1				
366		635149.5	4978334	0.00276	1998.49	2844.3	0	ANNUAL	ALL	1				
367		635174.5	4978334	0.00286	2006.18	2844.3	0	ANNUAL	ALL	1				
368		635199.5	4978334	0.00298	2015.32	2844.3	0	ANNUAL	ALL	1				
369		634299.5	4978134	0.0021	2065.05	2844.3	0	ANNUAL	ALL	1				
370		634324.5	4978134	0.00218	2052.1	2844.3	0	ANNUAL	ALL	1				
371		634349.5	4978134	0.00226	2045.24	2844.3	0	ANNUAL	ALL	1				
372		634374.5	4978134	0.00236	2034.94	2844.3	0	ANNUAL	ALL	1				
373		634399.5	4978134	0.00242	2020.36	2844.3	0	ANNUAL	ALL	1				
374		634424.5	4978134	0.00244	2003.67	2844.3	0	ANNUAL	ALL	1				
375		634449.5	4978134	0.00245	1995.29	2844.3	0	ANNUAL	ALL	1				
376		634474.5	4978134	0.00255	2007.74	2844.3	0	ANNUAL	ALL	1				
377		634499.5	4978134	0.00266	2026.56	2844.3	0	ANNUAL	ALL	1				
378		634299.5	4978159	0.00201	2056.37	2844.3	0	ANNUAL	ALL	1				
379		634324.5	4978159	0.0021	2043.39	2844.3	0	ANNUAL	ALL	1				
380		634349.5	4978159	0.00219	2031.51	2844.3	0	ANNUAL	ALL	1				
381		634374.5	4978159	0.00224	2023.05	2844.3	0	ANNUAL	ALL	1				
382		634399.5	4978159	0.00228	2009.29	2844.3	0	ANNUAL	ALL	1				
383		634424.5	4978159	0.00229	1995	2844.3	0	ANNUAL	ALL	1				
384		634449.5	4978159	0.00233	1992.7	2844.3	0	ANNUAL	ALL	1				
385		634474.5	4978159	0.00242	2006.88	2844.3	0	ANNUAL	ALL	1				
386		634499.5	4978159	0.00252	2023.97	2844.3	0	ANNUAL	ALL	1				
387		634299.5	4978184	0.00193	2049.3	2844.3	0	ANNUAL	ALL	1				
388		634324.5	4978184	0.00201	2036.32	2844.3	0	ANNUAL	ALL	1				
389		634349.5	4978184	0.00208	2022.34	2844.3	0	ANNUAL	ALL	1				
390		634374.5	4978184	0.00212	2009.09	2844.3	0	ANNUAL	ALL	1				
391		634399.5	4978184	0.00215	1999.89	2844.3	0	ANNUAL	ALL	1				
392		634424.5	4978184	0.00219	1987.52	2844.3	0	ANNUAL	ALL	1				
393		634449.5	4978184	0.00222	1991.46	2844.3	0	ANNUAL	ALL	1				
394		634474.5	4978184	0.0023	2006.06	2844.3	0	ANNUAL	ALL	1				
395		634499.5	4978184	0.00238	2020.38	2844.3	0	ANNUAL	ALL	1				
396		634299.5	4978209	0.00185	2043.21	2844.3	0	ANNUAL	ALL	1				
397		634324.5	4978209	0.00192	2030.6	2844.3	0	ANNUAL	ALL	1				
398		634349.5	4978209	0.00198	2016.03	2844.3	0	ANNUAL	ALL	1				
399		634374.5	4978209	0.00201	2000.87	2844.3	0	ANNUAL	ALL	1				
400		634399.5	4978209	0.00204	1990.53	2844.3	0	ANNUAL	ALL	1				
401		634424.5	4978209	0.0021	1981.32	2844.3	0	ANNUAL	ALL	1				
402		634449.5	4978209	0.00212	1989.45	2844.3	0	ANNUAL	ALL	1				
403		634474.5	4978209	0.00218	2004.01	2844.3	0	ANNUAL	ALL	1				
404		634499.5	4978209	0.00226	2016.91	2844.3	0	ANNUAL	ALL	1				
405		634299.5	4978234	0.00177	2037.27	2844.3	0	ANNUAL	ALL	1				
406		634324.5	4978234	0.00183	2025.09	2844.3	0	ANNUAL	ALL	1				
407		634349.5	4978234	0.00188	2009.81	2844.3	0	ANNUAL	ALL	1				
408		634374.5	4978234	0.00192	1996.13	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
409		634399.5	4978234	0.00197	1984.05	2844.3	0	ANNUAL	ALL	1				
410		634424.5	4978234	0.00202	1975.87	2844.3	0	ANNUAL	ALL	1				
411		634449.5	4978234	0.00204	1984.97	2844.3	0	ANNUAL	ALL	1				
412		634474.5	4978234	0.00207	2000.36	2844.3	0	ANNUAL	ALL	1				
413		634499.5	4978234	0.00213	2011.73	2844.3	0	ANNUAL	ALL	1				
414		634299.5	4978259	0.00171	2030.97	2844.3	0	ANNUAL	ALL	1				
415		634324.5	4978259	0.00175	2018.02	2844.3	0	ANNUAL	ALL	1				
416		634349.5	4978259	0.0018	2002.99	2844.3	0	ANNUAL	ALL	1				
417		634374.5	4978259	0.00184	1990.41	2844.3	0	ANNUAL	ALL	1				
418		634399.5	4978259	0.0019	1978.88	2844.3	0	ANNUAL	ALL	1				
419		634424.5	4978259	0.00193	1972.17	2844.3	0	ANNUAL	ALL	1				
420		634449.5	4978259	0.00196	1977.85	2844.3	0	ANNUAL	ALL	1				
421		634474.5	4978259	0.00196	1992.52	2844.3	0	ANNUAL	ALL	1				
422		634499.5	4978259	0.00202	2003.44	2844.3	0	ANNUAL	ALL	1				
423		634299.5	4978284	0.00163	2023.26	2844.3	0	ANNUAL	ALL	1				
424		634324.5	4978284	0.00168	2008.98	2844.3	0	ANNUAL	ALL	1				
425		634349.5	4978284	0.00173	1996.31	2844.3	0	ANNUAL	ALL	1				
426		634374.5	4978284	0.00177	1984.2	2844.3	0	ANNUAL	ALL	1				
427		634399.5	4978284	0.00182	1973.37	2844.3	0	ANNUAL	ALL	1				
428		634424.5	4978284	0.00185	1969.23	2844.3	0	ANNUAL	ALL	1				
429		634449.5	4978284	0.00188	1975.58	2844.3	0	ANNUAL	ALL	1				
430		634474.5	4978284	0.00189	1989.07	2844.3	0	ANNUAL	ALL	1				
431		634499.5	4978284	0.00192	2000.53	2844.3	0	ANNUAL	ALL	1				
432		634299.5	4978309	0.00157	2012.41	2844.3	0	ANNUAL	ALL	1				
433		634324.5	4978309	0.00162	1999.74	2844.3	0	ANNUAL	ALL	1				
434		634349.5	4978309	0.00167	1988.62	2844.3	0	ANNUAL	ALL	1				
435		634374.5	4978309	0.00171	1977.79	2844.3	0	ANNUAL	ALL	1				
436		634399.5	4978309	0.00175	1967.1	2844.3	0	ANNUAL	ALL	1				
437		634424.5	4978309	0.00178	1968.14	2844.3	0	ANNUAL	ALL	1				
438		634449.5	4978309	0.0018	1977.66	2844.3	0	ANNUAL	ALL	1				
439		634474.5	4978309	0.0018	1992.31	2844.3	0	ANNUAL	ALL	1				
440		634499.5	4978309	0.00184	2006.23	2844.3	0	ANNUAL	ALL	1				
441		634299.5	4978334	0.00152	2000.94	2844.3	0	ANNUAL	ALL	1				
442		634324.5	4978334	0.00157	1991.1	2844.3	0	ANNUAL	ALL	1				
443		634349.5	4978334	0.00161	1980.66	2844.3	0	ANNUAL	ALL	1				
444		634374.5	4978334	0.00165	1970.39	2844.3	0	ANNUAL	ALL	1				
445		634399.5	4978334	0.00168	1961.38	2844.3	0	ANNUAL	ALL	1				
446		634424.5	4978334	0.00171	1968.29	2844.3	0	ANNUAL	ALL	1				
447		634449.5	4978334	0.00172	1980.95	2844.3	0	ANNUAL	ALL	1				
448		634474.5	4978334	0.00173	1997.36	2844.3	0	ANNUAL	ALL	1				
449		634499.5	4978334	0.00176	2012.52	2844.3	0	ANNUAL	ALL	1				
450		634299.5	4978359	0.00149	1991.4	2844.3	0	ANNUAL	ALL	1				
451		634324.5	4978359	0.00153	1982.72	2844.3	0	ANNUAL	ALL	1				
452		634349.5	4978359	0.00156	1972.75	2844.3	0	ANNUAL	ALL	1				
453		634374.5	4978359	0.00159	1962.87	2844.3	0	ANNUAL	ALL	1				
454		634399.5	4978359	0.00161	1958.17	2844.3	0	ANNUAL	ALL	1				
455		634424.5	4978359	0.00164	1968.79	2844.3	0	ANNUAL	ALL	1				
456		634449.5	4978359	0.00165	1984.24	2844.3	0	ANNUAL	ALL	1				
457		634474.5	4978359	0.00165	2002.2	2844.3	0	ANNUAL	ALL	1				
458		634499.5	4978359	0.00168	2016.76	2844.3	0	ANNUAL	ALL	1				
459		634299.5	4978384	0.00145	1982.57	2844.3	0	ANNUAL	ALL	1				
460		634324.5	4978384	0.00148	1975.68	2844.3	0	ANNUAL	ALL	1				
461		634349.5	4978384	0.00151	1964.84	2844.3	0	ANNUAL	ALL	1				
462		634374.5	4978384	0.00153	1956.29	2844.3	0	ANNUAL	ALL	1				
463		634399.5	4978384	0.00155	1955.61	2844.3	0	ANNUAL	ALL	1				
464		634424.5	4978384	0.00158	1968.65	2844.3	0	ANNUAL	ALL	1				
465		634449.5	4978384	0.00158	1986.09	2844.3	0	ANNUAL	ALL	1				
466		634474.5	4978384	0.00158	2004.63	2844.3	0	ANNUAL	ALL	1				
467		634499.5	4978384	0.00161	2018.69	2844.3	0	ANNUAL	ALL	1				
468		634299.5	4978409	0.0014	1975.4	2844.3	0	ANNUAL	ALL	1				
469		634324.5	4978409	0.00143	1967.52	2844.3	0	ANNUAL	ALL	1				
470		634349.5	4978409	0.00145	1957.04	2844.3	0	ANNUAL	ALL	1				
471		634374.5	4978409	0.00147	1949.69	2844.3	0	ANNUAL	ALL	1				
472		634399.5	4978409	0.00149	1951.43	2844.3	0	ANNUAL	ALL	1				
473		634424.5	4978409	0.00152	1967.3	2844.3	0	ANNUAL	ALL	1				
474		634449.5	4978409	0.00152	1986.39	2844.3	0	ANNUAL	ALL	1				
475		634474.5	4978409	0.00152	2005.28	2844.3	0	ANNUAL	ALL	1				
476		634499.5	4978409	0.00154	2019.28	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
477		634299.5	4978434	0.00136	1965.22	2844.3	0	ANNUAL	ALL	1				
478		634324.5	4978434	0.00138	1958.88	2844.3	0	ANNUAL	ALL	1				
479		634349.5	4978434	0.00139	1950.79	2844.3	0	ANNUAL	ALL	1				
480		634374.5	4978434	0.00141	1943.73	2844.3	0	ANNUAL	ALL	1				
481		634399.5	4978434	0.00144	1949.4	2844.3	0	ANNUAL	ALL	1				
482		634424.5	4978434	0.00146	1965.04	2844.3	0	ANNUAL	ALL	1				
483		634449.5	4978434	0.00146	1984.59	2844.3	0	ANNUAL	ALL	1				
484		634474.5	4978434	0.00146	2004.45	2844.3	0	ANNUAL	ALL	1				
485		634499.5	4978434	0.00148	2017.53	2844.3	0	ANNUAL	ALL	1				
486		634249.4	4977384	0.00249	2291.4	2717.08	0	ANNUAL	ALL	1				
487		634274.4	4977384	0.00267	2282.65	2742	0	ANNUAL	ALL	1				
488		634299.4	4977384	0.00289	2273.71	2742	0	ANNUAL	ALL	1				
489		634324.4	4977384	0.00321	2263.84	2742	0	ANNUAL	ALL	1				
490		634349.4	4977384	0.00385	2250.84	2742	0	ANNUAL	ALL	1				
491		634374.4	4977384	0.0047	2238.58	2742.16	0	ANNUAL	ALL	1				
492		634399.4	4977384	0.00514	2232.43	2742.16	0	ANNUAL	ALL	1				
493		634424.4	4977384	0.00409	2242.73	2742.16	0	ANNUAL	ALL	1				
494		634449.4	4977384	0.00317	2255.36	2742	0	ANNUAL	ALL	1				
495		634249.4	4977409	0.00273	2284.43	2742	0	ANNUAL	ALL	1				
496		634274.4	4977409	0.003	2274.53	2742	0	ANNUAL	ALL	1				
497		634299.4	4977409	0.00335	2264.56	2742	0	ANNUAL	ALL	1				
498		634324.4	4977409	0.00383	2254.44	2742	0	ANNUAL	ALL	1				
499		634349.4	4977409	0.00448	2243.93	2742.16	0	ANNUAL	ALL	1				
500		634374.4	4977409	0.0055	2231.37	2742.16	0	ANNUAL	ALL	1				
501		634399.4	4977409	0.00598	2226.02	2844.3	0	ANNUAL	ALL	1				
502		634424.4	4977409	0.00472	2236.92	2742.16	0	ANNUAL	ALL	1				
503		634449.4	4977409	0.00363	2249.43	2742.16	0	ANNUAL	ALL	1				
504		634249.4	4977434	0.00294	2279.34	2742	0	ANNUAL	ALL	1				
505		634274.4	4977434	0.00335	2267.65	2742	0	ANNUAL	ALL	1				
506		634299.4	4977434	0.00391	2255.85	2742	0	ANNUAL	ALL	1				
507		634324.4	4977434	0.00461	2244.86	2742	0	ANNUAL	ALL	1				
508		634349.4	4977434	0.00542	2234.48	2742.16	0	ANNUAL	ALL	1				
509		634374.4	4977434	0.0064	2223.18	2844.3	0	ANNUAL	ALL	1				
510		634399.4	4977434	0.00653	2218.5	2844.3	0	ANNUAL	ALL	1				
511		634424.4	4977434	0.00558	2230.27	2844.3	0	ANNUAL	ALL	1				
512		634449.4	4977434	0.00416	2243.66	2742.16	0	ANNUAL	ALL	1				
513		634249.4	4977459	0.00309	2275.78	2742	0	ANNUAL	ALL	1				
514		634274.4	4977459	0.00362	2262.83	2742	0	ANNUAL	ALL	1				
515		634299.4	4977459	0.00444	2248.74	2742	0	ANNUAL	ALL	1				
516		634324.4	4977459	0.0053	2237.43	2742.16	0	ANNUAL	ALL	1				
517		634349.4	4977459	0.00627	2226.72	2844.3	0	ANNUAL	ALL	1				
518		634374.4	4977459	0.00673	2214.97	2844.3	0	ANNUAL	ALL	1				
519		634399.4	4977459	0.00664	2211.75	2844.3	0	ANNUAL	ALL	1				
520		634424.4	4977459	0.00619	2223.34	2844.3	0	ANNUAL	ALL	1				
521		634449.4	4977459	0.00495	2237.29	2844.3	0	ANNUAL	ALL	1				
522		634249.4	4977484	0.00323	2272.5	2742	0	ANNUAL	ALL	1				
523		634274.4	4977484	0.00388	2258.48	2742	0	ANNUAL	ALL	1				
524		634299.4	4977484	0.00484	2243.77	2742	0	ANNUAL	ALL	1				
525		634324.4	4977484	0.00582	2231.45	2742.16	0	ANNUAL	ALL	1				
526		634349.4	4977484	0.00662	2219.9	2844.3	0	ANNUAL	ALL	1				
527		634374.4	4977484	0.00655	2207.94	2844.3	0	ANNUAL	ALL	1				
528		634399.4	4977484	0.0063	2204.62	2844.3	0	ANNUAL	ALL	1				
529		634424.4	4977484	0.00648	2216.76	2844.3	0	ANNUAL	ALL	1				
530		634449.4	4977484	0.00561	2230.33	2844.3	0	ANNUAL	ALL	1				
531		634249.4	4977509	0.00336	2269.17	2742	0	ANNUAL	ALL	1				
532		634274.4	4977509	0.00408	2254.88	2742	0	ANNUAL	ALL	1				
533		634299.4	4977509	0.00507	2240.59	2742	0	ANNUAL	ALL	1				
534		634324.4	4977509	0.00618	2227.32	2844.3	0	ANNUAL	ALL	1				
535		634349.4	4977509	0.00659	2213.19	2844.3	0	ANNUAL	ALL	1				
536		634374.4	4977509	0.006	2200.19	2844.3	0	ANNUAL	ALL	1				
537		634399.4	4977509	0.00578	2197.61	2844.3	0	ANNUAL	ALL	1				
538		634424.4	4977509	0.00642	2211.03	2844.3	0	ANNUAL	ALL	1				
539		634449.4	4977509	0.00609	2223.57	2844.3	0	ANNUAL	ALL	1				
540		634249.4	4977534	0.00344	2266.65	2742	0	ANNUAL	ALL	1				
541		634274.4	4977534	0.00425	2251.58	2742	0	ANNUAL	ALL	1				
542		634299.4	4977534	0.00525	2237.18	2742	0	ANNUAL	ALL	1				
543		634324.4	4977534	0.00623	2223.67	2844.3	0	ANNUAL	ALL	1				
544		634349.4	4977534	0.00627	2207.86	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
545		634374.4	4977534	0.00528	2193.38	2844.3	0	ANNUAL	ALL	1				
546		634399.4	4977534	0.00518	2191.95	2844.3	0	ANNUAL	ALL	1				
547		634424.4	4977534	0.0061	2205.88	2844.3	0	ANNUAL	ALL	1				
548		634449.4	4977534	0.00626	2217.63	2844.3	0	ANNUAL	ALL	1				
549		634249.4	4977559	0.0035	2264.12	2742	0	ANNUAL	ALL	1				
550		634274.4	4977559	0.00445	2247.26	2742	0	ANNUAL	ALL	1				
551		634299.4	4977559	0.00544	2232.74	2742	0	ANNUAL	ALL	1				
552		634324.4	4977559	0.00617	2218.55	2844.3	0	ANNUAL	ALL	1				
553		634349.4	4977559	0.00582	2203.35	2844.3	0	ANNUAL	ALL	1				
554		634374.4	4977559	0.00506	2189.62	2844.3	0	ANNUAL	ALL	1				
555		634399.4	4977559	0.00497	2184.96	2844.3	0	ANNUAL	ALL	1				
556		634424.4	4977559	0.00569	2200.77	2844.3	0	ANNUAL	ALL	1				
557		634449.4	4977559	0.00613	2211.07	2844.3	0	ANNUAL	ALL	1				
558		634249.4	4977584	0.00372	2258.01	2742	0	ANNUAL	ALL	1				
559		634274.4	4977584	0.00463	2242.66	2742	0	ANNUAL	ALL	1				
560		634299.4	4977584	0.00564	2227.67	2844.3	0	ANNUAL	ALL	1				
561		634324.4	4977584	0.00593	2213.51	2844.3	0	ANNUAL	ALL	1				
562		634349.4	4977584	0.00544	2199.5	2844.3	0	ANNUAL	ALL	1				
563		634374.4	4977584	0.00486	2185.33	2844.3	0	ANNUAL	ALL	1				
564		634399.4	4977584	0.00489	2177.11	2844.3	0	ANNUAL	ALL	1				
565		634424.4	4977584	0.00498	2192.43	2844.3	0	ANNUAL	ALL	1				
566		634449.4	4977584	0.00563	2203.16	2844.3	0	ANNUAL	ALL	1				
567		634999.5	4977834	0.00531	2055.79	2844.3	0	ANNUAL	ALL	1				
568		635024.5	4977834	0.0055	2048.42	2844.3	0	ANNUAL	ALL	1				
569		635049.5	4977834	0.00568	2043	2844.3	0	ANNUAL	ALL	1				
570		635074.5	4977834	0.00583	2037.93	2844.3	0	ANNUAL	ALL	1				
571		635099.5	4977834	0.00595	2034.24	2844.3	0	ANNUAL	ALL	1				
572		635124.5	4977834	0.00602	2031.45	2844.3	0	ANNUAL	ALL	1				
573		635149.5	4977834	0.00565	2038.5	2844.3	0	ANNUAL	ALL	1				
574		635174.5	4977834	0.00512	2050.35	2844.3	0	ANNUAL	ALL	1				
575		635199.5	4977834	0.00466	2063.26	2844.3	0	ANNUAL	ALL	1				
576		634999.5	4977859	0.00533	2052.63	2844.3	0	ANNUAL	ALL	1				
577		635024.5	4977859	0.00551	2046.41	2844.3	0	ANNUAL	ALL	1				
578		635049.5	4977859	0.00566	2040.95	2844.3	0	ANNUAL	ALL	1				
579		635074.5	4977859	0.00584	2036.03	2844.3	0	ANNUAL	ALL	1				
580		635099.5	4977859	0.00596	2032.3	2844.3	0	ANNUAL	ALL	1				
581		635124.5	4977859	0.00597	2030.17	2844.3	0	ANNUAL	ALL	1				
582		635149.5	4977859	0.00562	2038.33	2844.3	0	ANNUAL	ALL	1				
583		635174.5	4977859	0.00513	2049.93	2844.3	0	ANNUAL	ALL	1				
584		635199.5	4977859	0.00469	2062.54	2844.3	0	ANNUAL	ALL	1				
585		634999.5	4977884	0.00536	2049.11	2844.3	0	ANNUAL	ALL	1				
586		635024.5	4977884	0.00549	2044.13	2844.3	0	ANNUAL	ALL	1				
587		635049.5	4977884	0.00564	2038.92	2844.3	0	ANNUAL	ALL	1				
588		635074.5	4977884	0.00581	2034.26	2844.3	0	ANNUAL	ALL	1				
589		635099.5	4977884	0.00589	2030.48	2844.3	0	ANNUAL	ALL	1				
590		635124.5	4977884	0.00591	2029.04	2844.3	0	ANNUAL	ALL	1				
591		635149.5	4977884	0.00556	2038.45	2844.3	0	ANNUAL	ALL	1				
592		635174.5	4977884	0.00513	2049.51	2844.3	0	ANNUAL	ALL	1				
593		635199.5	4977884	0.00472	2061.56	2844.3	0	ANNUAL	ALL	1				
594		634999.5	4977909	0.00528	2047.27	2844.3	0	ANNUAL	ALL	1				
595		635024.5	4977909	0.00542	2042.16	2844.3	0	ANNUAL	ALL	1				
596		635049.5	4977909	0.00559	2036.97	2844.3	0	ANNUAL	ALL	1				
597		635074.5	4977909	0.00573	2032.48	2844.3	0	ANNUAL	ALL	1				
598		635099.5	4977909	0.00581	2028.7	2844.3	0	ANNUAL	ALL	1				
599		635124.5	4977909	0.0058	2028.77	2844.3	0	ANNUAL	ALL	1				
600		635149.5	4977909	0.00548	2038.62	2844.3	0	ANNUAL	ALL	1				
601		635174.5	4977909	0.0051	2049.12	2844.3	0	ANNUAL	ALL	1				
602		635199.5	4977909	0.00473	2060.48	2844.3	0	ANNUAL	ALL	1				
603		634999.5	4977934	0.00517	2046.79	2844.3	0	ANNUAL	ALL	1				
604		635024.5	4977934	0.00531	2040.92	2844.3	0	ANNUAL	ALL	1				
605		635049.5	4977934	0.00551	2034.68	2844.3	0	ANNUAL	ALL	1				
606		635074.5	4977934	0.00563	2029.58	2844.3	0	ANNUAL	ALL	1				
607		635099.5	4977934	0.00571	2025.61	2844.3	0	ANNUAL	ALL	1				
608		635124.5	4977934	0.00569	2027.68	2844.3	0	ANNUAL	ALL	1				
609		635149.5	4977934	0.0054	2038.09	2844.3	0	ANNUAL	ALL	1				
610		635174.5	4977934	0.00505	2048.68	2844.3	0	ANNUAL	ALL	1				
611		635199.5	4977934	0.00473	2059.02	2844.3	0	ANNUAL	ALL	1				
612		634999.5	4977959	0.00505	2045.95	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
613		635024.5	4977959	0.00519	2039.51	2844.3	0	ANNUAL	ALL	1				
614		635049.5	4977959	0.0054	2032.45	2844.3	0	ANNUAL	ALL	1				
615		635074.5	4977959	0.0055	2026.52	2844.3	0	ANNUAL	ALL	1				
616		635099.5	4977959	0.00556	2022.6	2844.3	0	ANNUAL	ALL	1				
617		635124.5	4977959	0.00554	2027.13	2844.3	0	ANNUAL	ALL	1				
618		635149.5	4977959	0.00533	2036.89	2844.3	0	ANNUAL	ALL	1				
619		635174.5	4977959	0.00502	2046.85	2844.3	0	ANNUAL	ALL	1				
620		635199.5	4977959	0.00474	2056.78	2844.3	0	ANNUAL	ALL	1				
621		634999.5	4977984	0.00491	2045.34	2844.3	0	ANNUAL	ALL	1				
622		635024.5	4977984	0.00507	2037.82	2844.3	0	ANNUAL	ALL	1				
623		635049.5	4977984	0.00521	2030.43	2844.3	0	ANNUAL	ALL	1				
624		635074.5	4977984	0.00533	2024.12	2844.3	0	ANNUAL	ALL	1				
625		635099.5	4977984	0.00537	2019.96	2844.3	0	ANNUAL	ALL	1				
626		635124.5	4977984	0.00537	2026.73	2844.3	0	ANNUAL	ALL	1				
627		635149.5	4977984	0.00524	2035.4	2844.3	0	ANNUAL	ALL	1				
628		635174.5	4977984	0.00501	2044.46	2844.3	0	ANNUAL	ALL	1				
629		635199.5	4977984	0.00475	2053.52	2844.3	0	ANNUAL	ALL	1				
630		634999.5	4978009	0.00476	2044.81	2844.3	0	ANNUAL	ALL	1				
631		635024.5	4978009	0.00493	2035.59	2844.3	0	ANNUAL	ALL	1				
632		635049.5	4978009	0.00505	2028.05	2844.3	0	ANNUAL	ALL	1				
633		635074.5	4978009	0.00513	2021.18	2844.3	0	ANNUAL	ALL	1				
634		635099.5	4978009	0.00514	2017.1	2844.3	0	ANNUAL	ALL	1				
635		635124.5	4978009	0.0052	2025.97	2844.3	0	ANNUAL	ALL	1				
636		635149.5	4978009	0.00512	2034.03	2844.3	0	ANNUAL	ALL	1				
637		635174.5	4978009	0.00494	2041.95	2844.3	0	ANNUAL	ALL	1				
638		635199.5	4978009	0.00476	2050.09	2844.3	0	ANNUAL	ALL	1				
639		634999.5	4978034	0.00461	2043.29	2844.3	0	ANNUAL	ALL	1				
640		635024.5	4978034	0.00478	2032.46	2844.3	0	ANNUAL	ALL	1				
641		635049.5	4978034	0.00487	2024.39	2844.3	0	ANNUAL	ALL	1				
642		635074.5	4978034	0.00489	2017.56	2844.3	0	ANNUAL	ALL	1				
643		635099.5	4978034	0.00491	2015.24	2844.3	0	ANNUAL	ALL	1				
644		635124.5	4978034	0.00501	2024.2	2844.3	0	ANNUAL	ALL	1				
645		635149.5	4978034	0.00499	2032.02	2844.3	0	ANNUAL	ALL	1				
646		635174.5	4978034	0.00483	2040.48	2844.3	0	ANNUAL	ALL	1				
647		635199.5	4978034	0.00466	2049.69	2844.3	0	ANNUAL	ALL	1				
648		634599.5	4976834	0.00084	2431.97	2717.08	0	ANNUAL	ALL	1				
649		634624.5	4976834	0.00083	2425.11	2717.08	0	ANNUAL	ALL	1				
650		634649.5	4976834	0.00083	2416.95	2717.08	0	ANNUAL	ALL	1				
651		634674.5	4976834	0.00083	2407.96	2717.08	0	ANNUAL	ALL	1				
652		634699.5	4976834	0.00083	2398.82	2717.08	0	ANNUAL	ALL	1				
653		634724.5	4976834	0.00083	2389.57	2717.08	0	ANNUAL	ALL	1				
654		634749.5	4976834	0.00083	2378.83	2717.08	0	ANNUAL	ALL	1				
655		634774.5	4976834	0.00083	2368.3	2717.08	0	ANNUAL	ALL	1				
656		634799.5	4976834	0.00085	2352.38	2717.08	0	ANNUAL	ALL	1				
657		634599.5	4976859	0.00085	2427	2717.08	0	ANNUAL	ALL	1				
658		634624.5	4976859	0.00084	2421.36	2717.08	0	ANNUAL	ALL	1				
659		634649.5	4976859	0.00084	2412.9	2717.08	0	ANNUAL	ALL	1				
660		634674.5	4976859	0.00084	2401.58	2717.08	0	ANNUAL	ALL	1				
661		634699.5	4976859	0.00085	2391.51	2717.08	0	ANNUAL	ALL	1				
662		634724.5	4976859	0.00085	2381.29	2717.08	0	ANNUAL	ALL	1				
663		634749.5	4976859	0.00085	2371.44	2717.08	0	ANNUAL	ALL	1				
664		634774.5	4976859	0.00086	2358.57	2717.08	0	ANNUAL	ALL	1				
665		634799.5	4976859	0.00088	2341.91	2742	0	ANNUAL	ALL	1				
666		634599.5	4976884	0.00086	2422.69	2717.08	0	ANNUAL	ALL	1				
667		634624.5	4976884	0.00086	2418.17	2717.08	0	ANNUAL	ALL	1				
668		634649.5	4976884	0.00085	2408.98	2717.08	0	ANNUAL	ALL	1				
669		634674.5	4976884	0.00086	2396.57	2717.08	0	ANNUAL	ALL	1				
670		634699.5	4976884	0.00087	2383.76	2717.08	0	ANNUAL	ALL	1				
671		634724.5	4976884	0.00087	2371.27	2717.08	0	ANNUAL	ALL	1				
672		634749.5	4976884	0.00088	2362.03	2717.08	0	ANNUAL	ALL	1				
673		634774.5	4976884	0.00088	2350.11	2717.08	0	ANNUAL	ALL	1				
674		634799.5	4976884	0.0009	2334.35	2742	0	ANNUAL	ALL	1				
675		634599.5	4976909	0.00087	2418.11	2717.08	0	ANNUAL	ALL	1				
676		634624.5	4976909	0.00087	2412.47	2717.08	0	ANNUAL	ALL	1				
677		634649.5	4976909	0.00087	2402.76	2717.08	0	ANNUAL	ALL	1				
678		634674.5	4976909	0.00087	2392.81	2717.08	0	ANNUAL	ALL	1				
679		634699.5	4976909	0.00088	2377.98	2717.08	0	ANNUAL	ALL	1				
680		634724.5	4976909	0.00089	2364.11	2717.08	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
681		634749.5	4976909	0.0009	2354.73	2717.08	0	ANNUAL	ALL	1				
682		634774.5	4976909	0.0009	2345.14	2717.08	0	ANNUAL	ALL	1				
683		634799.5	4976909	0.00092	2331	2742	0	ANNUAL	ALL	1				
684		634599.5	4976934	0.00089	2411.78	2717.08	0	ANNUAL	ALL	1				
685		634624.5	4976934	0.00089	2403.98	2717.08	0	ANNUAL	ALL	1				
686		634649.5	4976934	0.00089	2394.61	2717.08	0	ANNUAL	ALL	1				
687		634674.5	4976934	0.00089	2383.71	2717.08	0	ANNUAL	ALL	1				
688		634699.5	4976934	0.0009	2371.78	2717.08	0	ANNUAL	ALL	1				
689		634724.5	4976934	0.00091	2359.09	2717.08	0	ANNUAL	ALL	1				
690		634749.5	4976934	0.00092	2347.63	2717.08	0	ANNUAL	ALL	1				
691		634774.5	4976934	0.00093	2337.6	2742	0	ANNUAL	ALL	1				
692		634799.5	4976934	0.00094	2326.97	2742	0	ANNUAL	ALL	1				
693		634599.5	4976959	0.0009	2404.1	2717.08	0	ANNUAL	ALL	1				
694		634624.5	4976959	0.0009	2396.65	2717.08	0	ANNUAL	ALL	1				
695		634649.5	4976959	0.00091	2385.41	2717.08	0	ANNUAL	ALL	1				
696		634674.5	4976959	0.00092	2372.07	2717.08	0	ANNUAL	ALL	1				
697		634699.5	4976959	0.00093	2362.55	2717.08	0	ANNUAL	ALL	1				
698		634724.5	4976959	0.00094	2351.59	2717.08	0	ANNUAL	ALL	1				
699		634749.5	4976959	0.00095	2341.2	2717.08	0	ANNUAL	ALL	1				
700		634774.5	4976959	0.00097	2328.55	2742	0	ANNUAL	ALL	1				
701		634799.5	4976959	0.00098	2318.72	2742	0	ANNUAL	ALL	1				
702		634599.5	4976984	0.00092	2396.35	2717.08	0	ANNUAL	ALL	1				
703		634624.5	4976984	0.00092	2389.04	2717.08	0	ANNUAL	ALL	1				
704		634649.5	4976984	0.00093	2377.21	2717.08	0	ANNUAL	ALL	1				
705		634674.5	4976984	0.00094	2363.6	2717.08	0	ANNUAL	ALL	1				
706		634699.5	4976984	0.00096	2350.85	2717.08	0	ANNUAL	ALL	1				
707		634724.5	4976984	0.00097	2340.79	2717.08	0	ANNUAL	ALL	1				
708		634749.5	4976984	0.00098	2331.79	2742	0	ANNUAL	ALL	1				
709		634774.5	4976984	0.001	2320.7	2742	0	ANNUAL	ALL	1				
710		634799.5	4976984	0.00102	2308.59	2742	0	ANNUAL	ALL	1				
711		634599.5	4977009	0.00094	2388.79	2717.08	0	ANNUAL	ALL	1				
712		634624.5	4977009	0.00094	2379.17	2717.08	0	ANNUAL	ALL	1				
713		634649.5	4977009	0.00095	2368.25	2717.08	0	ANNUAL	ALL	1				
714		634674.5	4977009	0.00097	2355.13	2717.08	0	ANNUAL	ALL	1				
715		634699.5	4977009	0.00099	2341.52	2717.08	0	ANNUAL	ALL	1				
716		634724.5	4977009	0.00101	2328.18	2742	0	ANNUAL	ALL	1				
717		634749.5	4977009	0.00102	2321.24	2742	0	ANNUAL	ALL	1				
718		634774.5	4977009	0.00103	2313.44	2742	0	ANNUAL	ALL	1				
719		634799.5	4977009	0.00107	2301.46	2742.16	0	ANNUAL	ALL	1				
720		634599.5	4977034	0.00096	2379.36	2717.08	0	ANNUAL	ALL	1				
721		634624.5	4977034	0.00097	2369.28	2717.08	0	ANNUAL	ALL	1				
722		634649.5	4977034	0.00098	2356.46	2717.08	0	ANNUAL	ALL	1				
723		634674.5	4977034	0.001	2343.53	2717.08	0	ANNUAL	ALL	1				
724		634699.5	4977034	0.00103	2329.9	2742	0	ANNUAL	ALL	1				
725		634724.5	4977034	0.00106	2316.92	2742	0	ANNUAL	ALL	1				
726		634749.5	4977034	0.00108	2309.32	2742	0	ANNUAL	ALL	1				
727		634774.5	4977034	0.00109	2302.58	2742	0	ANNUAL	ALL	1				
728		634799.5	4977034	0.00111	2295.21	2742.16	0	ANNUAL	ALL	1				
729	**	CONCUNIT	ug/m^3											
730	**	DEPUNIT	g/m^2											

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	*	AERMOD	(	19191):	MIDAS	GOLD	STIBNITE	-	MODELING	R27	########			
2	*	AERMET	(	19191):	14:16:44									
3	*	MODELING	OPTIONS	USED:	RegDFAULT	CONC	ELEV	NOWARN	DRYDPLT	WETDPLT	RURAL	ADJ_U*		
4	*	PLOT	FILE	OF	ANNUAL	VALUES	AVERAGED	ACROSS	1	YEARS	FOR	SOURCE	GROUP:	ALL
5	*	FOR	A	TOTAL	OF	720	RECEPTORS.							
6	*	FORMAT:	(3(1X,F13.5),3(1X,F8.2),2X,A6,2X,A8,2X,I8.8,2X,A8)											
7	*	X	Y	AVERAGE	CONC	ZELEV	ZHILL	ZFLAG	AVE	GRP	NUM	YRS	NET	ID
8	*													
9	0.006420	635399.5	4975934	0.00017	2213.4	2844.3	0	ANNUAL	ALL	1				
10	max ↑	635424.5	4975934	0.00017	2212.64	2844.3	0	ANNUAL	ALL	1				
11		635449.5	4975934	0.00017	2211.27	2844.3	0	ANNUAL	ALL	1				
12		635474.5	4975934	0.00017	2212.5	2844.3	0	ANNUAL	ALL	1				
13		635499.5	4975934	0.00017	2215.21	2844.3	0	ANNUAL	ALL	1				
14		635524.5	4975934	0.00016	2215.98	2844.3	0	ANNUAL	ALL	1				
15		635549.5	4975934	0.00016	2215	2844.3	0	ANNUAL	ALL	1				
16		635574.5	4975934	0.00016	2215.74	2844.3	0	ANNUAL	ALL	1				
17		635599.5	4975934	0.00016	2218.34	2844.3	0	ANNUAL	ALL	1				
18		635399.5	4975959	0.00018	2202.75	2844.3	0	ANNUAL	ALL	1				
19		635424.5	4975959	0.00018	2204.36	2844.3	0	ANNUAL	ALL	1				
20		635449.5	4975959	0.00018	2204.87	2844.3	0	ANNUAL	ALL	1				
21		635474.5	4975959	0.00017	2206.39	2844.3	0	ANNUAL	ALL	1				
22		635499.5	4975959	0.00017	2208.99	2844.3	0	ANNUAL	ALL	1				
23		635524.5	4975959	0.00017	2210.99	2844.3	0	ANNUAL	ALL	1				
24		635549.5	4975959	0.00017	2211.29	2844.3	0	ANNUAL	ALL	1				
25		635574.5	4975959	0.00017	2210.92	2844.3	0	ANNUAL	ALL	1				
26		635599.5	4975959	0.00017	2208.83	2844.3	0	ANNUAL	ALL	1				
27		635399.5	4975984	0.00019	2195.09	2844.3	0	ANNUAL	ALL	1				
28		635424.5	4975984	0.00018	2198.19	2844.3	0	ANNUAL	ALL	1				
29		635449.5	4975984	0.00018	2198.7	2844.3	0	ANNUAL	ALL	1				
30		635474.5	4975984	0.00018	2201.57	2844.3	0	ANNUAL	ALL	1				
31		635499.5	4975984	0.00018	2203.99	2844.3	0	ANNUAL	ALL	1				
32		635524.5	4975984	0.00018	2206.27	2844.3	0	ANNUAL	ALL	1				
33		635549.5	4975984	0.00017	2206.83	2844.3	0	ANNUAL	ALL	1				
34		635574.5	4975984	0.00017	2205.61	2844.3	0	ANNUAL	ALL	1				
35		635599.5	4975984	0.00017	2202.99	2844.3	0	ANNUAL	ALL	1				
36		635399.5	4976009	0.00019	2195.69	2844.3	0	ANNUAL	ALL	1				
37		635424.5	4976009	0.0002	2189.65	2844.3	0	ANNUAL	ALL	1				
38		635449.5	4976009	0.00019	2194	2844.3	0	ANNUAL	ALL	1				
39		635474.5	4976009	0.00018	2200.13	2844.3	0	ANNUAL	ALL	1				
40		635499.5	4976009	0.00018	2202.83	2844.3	0	ANNUAL	ALL	1				
41		635524.5	4976009	0.00018	2203.57	2844.3	0	ANNUAL	ALL	1				
42		635549.5	4976009	0.00018	2203.82	2844.3	0	ANNUAL	ALL	1				
43		635574.5	4976009	0.00018	2202.81	2844.3	0	ANNUAL	ALL	1				
44		635599.5	4976009	0.00018	2200.59	2844.3	0	ANNUAL	ALL	1				
45		635399.5	4976034	0.0002	2198.23	2844.3	0	ANNUAL	ALL	1				
46		635424.5	4976034	0.00021	2186.98	2844.3	0	ANNUAL	ALL	1				
47		635449.5	4976034	0.0002	2190.14	2844.3	0	ANNUAL	ALL	1				
48		635474.5	4976034	0.00019	2198.63	2844.3	0	ANNUAL	ALL	1				
49		635499.5	4976034	0.00019	2198.93	2844.3	0	ANNUAL	ALL	1				
50		635524.5	4976034	0.00019	2199.39	2844.3	0	ANNUAL	ALL	1				
51		635549.5	4976034	0.00018	2201.1	2844.3	0	ANNUAL	ALL	1				
52		635574.5	4976034	0.00018	2200.59	2844.3	0	ANNUAL	ALL	1				
53		635599.5	4976034	0.00018	2197.96	2844.3	0	ANNUAL	ALL	1				
54		635399.5	4976059	0.00021	2196.33	2844.3	0	ANNUAL	ALL	1				
55		635424.5	4976059	0.00022	2184.09	2844.3	0	ANNUAL	ALL	1				
56		635449.5	4976059	0.00022	2180.82	2844.3	0	ANNUAL	ALL	1				
57		635474.5	4976059	0.0002	2193.11	2844.3	0	ANNUAL	ALL	1				
58		635499.5	4976059	0.0002	2194.5	2844.3	0	ANNUAL	ALL	1				
59		635524.5	4976059	0.00019	2197.17	2844.3	0	ANNUAL	ALL	1				
60		635549.5	4976059	0.00019	2199.4	2844.3	0	ANNUAL	ALL	1				
61		635574.5	4976059	0.00019	2198.27	2844.3	0	ANNUAL	ALL	1				
62		635599.5	4976059	0.00019	2194.62	2844.3	0	ANNUAL	ALL	1				
63		635399.5	4976084	0.00022	2188.98	2844.3	0	ANNUAL	ALL	1				
64		635424.5	4976084	0.00022	2180.22	2844.3	0	ANNUAL	ALL	1				
65		635449.5	4976084	0.00023	2174.51	2844.3	0	ANNUAL	ALL	1				
66		635474.5	4976084	0.00022	2180.27	2844.3	0	ANNUAL	ALL	1				
67		635499.5	4976084	0.00021	2185.71	2844.3	0	ANNUAL	ALL	1				
68		635524.5	4976084	0.0002	2191.13	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
69		635549.5	4976084	0.0002	2193.95	2844.3	0	ANNUAL	ALL	1				
70		635574.5	4976084	0.0002	2190.58	2844.3	0	ANNUAL	ALL	1				
71		635599.5	4976084	0.00021	2183.01	2844.3	0	ANNUAL	ALL	1				
72		635399.5	4976109	0.00023	2182.28	2844.3	0	ANNUAL	ALL	1				
73		635424.5	4976109	0.00023	2177.24	2844.3	0	ANNUAL	ALL	1				
74		635449.5	4976109	0.00024	2171.45	2844.3	0	ANNUAL	ALL	1				
75		635474.5	4976109	0.00024	2172.26	2844.3	0	ANNUAL	ALL	1				
76		635499.5	4976109	0.00023	2177.58	2844.3	0	ANNUAL	ALL	1				
77		635524.5	4976109	0.00022	2180.23	2844.3	0	ANNUAL	ALL	1				
78		635549.5	4976109	0.00022	2179.81	2844.3	0	ANNUAL	ALL	1				
79		635574.5	4976109	0.00022	2176.94	2844.3	0	ANNUAL	ALL	1				
80		635599.5	4976109	0.00021	2179.4	2844.3	0	ANNUAL	ALL	1				
81		635399.5	4976134	0.00024	2176.77	2844.3	0	ANNUAL	ALL	1				
82		635424.5	4976134	0.00025	2174.27	2844.3	0	ANNUAL	ALL	1				
83		635449.5	4976134	0.00025	2171.04	2844.3	0	ANNUAL	ALL	1				
84		635474.5	4976134	0.00025	2166.4	2844.3	0	ANNUAL	ALL	1				
85		635499.5	4976134	0.00025	2167.48	2844.3	0	ANNUAL	ALL	1				
86		635524.5	4976134	0.00024	2172.09	2844.3	0	ANNUAL	ALL	1				
87		635549.5	4976134	0.00024	2171.44	2844.3	0	ANNUAL	ALL	1				
88		635574.5	4976134	0.00023	2172.93	2844.3	0	ANNUAL	ALL	1				
89		635599.5	4976134	0.00022	2178.31	2844.3	0	ANNUAL	ALL	1				
90		635199.5	4976834	0.0008	2116.83	2844.3	0	ANNUAL	ALL	1				
91		635224.5	4976834	0.0008	2112.53	2844.3	0	ANNUAL	ALL	1				
92		635249.5	4976834	0.00079	2108.39	2844.3	0	ANNUAL	ALL	1				
93		635274.5	4976834	0.00079	2105.23	2844.3	0	ANNUAL	ALL	1				
94		635299.5	4976834	0.00078	2101.6	2844.3	0	ANNUAL	ALL	1				
95		635324.5	4976834	0.00078	2098.74	2844.3	0	ANNUAL	ALL	1				
96		635349.5	4976834	0.00075	2104.26	2844.3	0	ANNUAL	ALL	1				
97		635374.5	4976834	0.00072	2110.4	2844.3	0	ANNUAL	ALL	1				
98		635399.5	4976834	0.00068	2117.98	2844.3	0	ANNUAL	ALL	1				
99		635199.5	4976859	0.00083	2114.34	2844.3	0	ANNUAL	ALL	1				
100		635224.5	4976859	0.00083	2108.68	2844.3	0	ANNUAL	ALL	1				
101		635249.5	4976859	0.00083	2104.42	2844.3	0	ANNUAL	ALL	1				
102		635274.5	4976859	0.00082	2101.28	2844.3	0	ANNUAL	ALL	1				
103		635299.5	4976859	0.00082	2098.83	2844.3	0	ANNUAL	ALL	1				
104		635324.5	4976859	0.00081	2096.89	2844.3	0	ANNUAL	ALL	1				
105		635349.5	4976859	0.00078	2101.21	2844.3	0	ANNUAL	ALL	1				
106		635374.5	4976859	0.00074	2108.71	2844.3	0	ANNUAL	ALL	1				
107		635399.5	4976859	0.0007	2118.31	2844.3	0	ANNUAL	ALL	1				
108		635199.5	4976884	0.00087	2111.17	2844.3	0	ANNUAL	ALL	1				
109		635224.5	4976884	0.00087	2104.78	2844.3	0	ANNUAL	ALL	1				
110		635249.5	4976884	0.00087	2100.14	2844.3	0	ANNUAL	ALL	1				
111		635274.5	4976884	0.00086	2097.48	2844.3	0	ANNUAL	ALL	1				
112		635299.5	4976884	0.00085	2095.42	2844.3	0	ANNUAL	ALL	1				
113		635324.5	4976884	0.00084	2094.96	2844.3	0	ANNUAL	ALL	1				
114		635349.5	4976884	0.00081	2097.83	2844.3	0	ANNUAL	ALL	1				
115		635374.5	4976884	0.00076	2107.96	2844.3	0	ANNUAL	ALL	1				
116		635399.5	4976884	0.00072	2119.17	2844.3	0	ANNUAL	ALL	1				
117		635199.5	4976909	0.00091	2108.51	2844.3	0	ANNUAL	ALL	1				
118		635224.5	4976909	0.00091	2102.17	2844.3	0	ANNUAL	ALL	1				
119		635249.5	4976909	0.00091	2097.31	2844.3	0	ANNUAL	ALL	1				
120		635274.5	4976909	0.0009	2094.85	2844.3	0	ANNUAL	ALL	1				
121		635299.5	4976909	0.00089	2093.19	2844.3	0	ANNUAL	ALL	1				
122		635324.5	4976909	0.00087	2093.48	2844.3	0	ANNUAL	ALL	1				
123		635349.5	4976909	0.00083	2098.12	2844.3	0	ANNUAL	ALL	1				
124		635374.5	4976909	0.00078	2108.79	2844.3	0	ANNUAL	ALL	1				
125		635399.5	4976909	0.00073	2120.74	2844.3	0	ANNUAL	ALL	1				
126		635199.5	4976934	0.00095	2106.38	2844.3	0	ANNUAL	ALL	1				
127		635224.5	4976934	0.00095	2100.81	2844.3	0	ANNUAL	ALL	1				
128		635249.5	4976934	0.00094	2096.21	2844.3	0	ANNUAL	ALL	1				
129		635274.5	4976934	0.00093	2092.89	2844.3	0	ANNUAL	ALL	1				
130		635299.5	4976934	0.00092	2091.1	2844.3	0	ANNUAL	ALL	1				
131		635324.5	4976934	0.0009	2092.46	2844.3	0	ANNUAL	ALL	1				
132		635349.5	4976934	0.00085	2099.48	2844.3	0	ANNUAL	ALL	1				
133		635374.5	4976934	0.0008	2110.37	2844.3	0	ANNUAL	ALL	1				
134		635399.5	4976934	0.00075	2122.91	2844.3	0	ANNUAL	ALL	1				
135		635199.5	4976959	0.00099	2104.62	2844.3	0	ANNUAL	ALL	1				
136		635224.5	4976959	0.00098	2099.28	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
137		635249.5	4976959	0.00098	2094.41	2844.3	0	ANNUAL	ALL	1				
138		635274.5	4976959	0.00097	2090.59	2844.3	0	ANNUAL	ALL	1				
139		635299.5	4976959	0.00096	2088.8	2844.3	0	ANNUAL	ALL	1				
140		635324.5	4976959	0.00093	2092.02	2844.3	0	ANNUAL	ALL	1				
141		635349.5	4976959	0.00088	2100.12	2844.3	0	ANNUAL	ALL	1				
142		635374.5	4976959	0.00082	2112.07	2844.3	0	ANNUAL	ALL	1				
143		635399.5	4976959	0.00077	2125.69	2844.3	0	ANNUAL	ALL	1				
144		635199.5	4976984	0.00103	2102.45	2844.3	0	ANNUAL	ALL	1				
145		635224.5	4976984	0.00103	2097.29	2844.3	0	ANNUAL	ALL	1				
146		635249.5	4976984	0.00103	2091.62	2844.3	0	ANNUAL	ALL	1				
147		635274.5	4976984	0.00102	2087.92	2844.3	0	ANNUAL	ALL	1				
148		635299.5	4976984	0.001	2086.81	2844.3	0	ANNUAL	ALL	1				
149		635324.5	4976984	0.00096	2092.65	2844.3	0	ANNUAL	ALL	1				
150		635349.5	4976984	0.0009	2101.3	2844.3	0	ANNUAL	ALL	1				
151		635374.5	4976984	0.00084	2114.13	2844.3	0	ANNUAL	ALL	1				
152		635399.5	4976984	0.00078	2128.46	2844.3	0	ANNUAL	ALL	1				
153		635199.5	4977009	0.00108	2099.39	2844.3	0	ANNUAL	ALL	1				
154		635224.5	4977009	0.00108	2093.66	2844.3	0	ANNUAL	ALL	1				
155		635249.5	4977009	0.00108	2087.97	2844.3	0	ANNUAL	ALL	1				
156		635274.5	4977009	0.00107	2084.9	2844.3	0	ANNUAL	ALL	1				
157		635299.5	4977009	0.00104	2087.43	2844.3	0	ANNUAL	ALL	1				
158		635324.5	4977009	0.00098	2094.55	2844.3	0	ANNUAL	ALL	1				
159		635349.5	4977009	0.00093	2103.74	2844.3	0	ANNUAL	ALL	1				
160		635374.5	4977009	0.00086	2116.64	2844.3	0	ANNUAL	ALL	1				
161		635399.5	4977009	0.0008	2131.12	2844.3	0	ANNUAL	ALL	1				
162		635199.5	4977034	0.00114	2094.63	2844.3	0	ANNUAL	ALL	1				
163		635224.5	4977034	0.00114	2088.76	2844.3	0	ANNUAL	ALL	1				
164		635249.5	4977034	0.00114	2084.27	2844.3	0	ANNUAL	ALL	1				
165		635274.5	4977034	0.00112	2082.71	2844.3	0	ANNUAL	ALL	1				
166		635299.5	4977034	0.00106	2089.9	2844.3	0	ANNUAL	ALL	1				
167		635324.5	4977034	0.001	2098.21	2844.3	0	ANNUAL	ALL	1				
168		635349.5	4977034	0.00095	2107.49	2844.3	0	ANNUAL	ALL	1				
169		635374.5	4977034	0.00089	2119.09	2844.3	0	ANNUAL	ALL	1				
170		635399.5	4977034	0.00082	2133.38	2844.3	0	ANNUAL	ALL	1				
171		634899.5	4977134	0.00115	2221.02	2844.3	0	ANNUAL	ALL	1				
172		634924.5	4977134	0.00121	2207.85	2844.3	0	ANNUAL	ALL	1				
173		634949.5	4977134	0.00128	2190.45	2844.3	0	ANNUAL	ALL	1				
174		634974.5	4977134	0.00137	2169.12	2844.3	0	ANNUAL	ALL	1				
175		634999.5	4977134	0.0014	2150.64	2844.3	0	ANNUAL	ALL	1				
176		635024.5	4977134	0.0014	2135.97	2844.3	0	ANNUAL	ALL	1				
177		635049.5	4977134	0.00142	2122.38	2844.3	0	ANNUAL	ALL	1				
178		635074.5	4977134	0.00143	2113.7	2844.3	0	ANNUAL	ALL	1				
179		635099.5	4977134	0.00142	2105.9	2844.3	0	ANNUAL	ALL	1				
180		634899.5	4977159	0.0013	2213.37	2844.3	0	ANNUAL	ALL	1				
181		634924.5	4977159	0.00128	2201.16	2844.3	0	ANNUAL	ALL	1				
182		634949.5	4977159	0.0014	2181.17	2844.3	0	ANNUAL	ALL	1				
183		634974.5	4977159	0.00147	2161.72	2844.3	0	ANNUAL	ALL	1				
184		634999.5	4977159	0.00148	2145.73	2844.3	0	ANNUAL	ALL	1				
185		635024.5	4977159	0.00148	2132.12	2844.3	0	ANNUAL	ALL	1				
186		635049.5	4977159	0.0015	2119.59	2844.3	0	ANNUAL	ALL	1				
187		635074.5	4977159	0.00151	2109.27	2844.3	0	ANNUAL	ALL	1				
188		635099.5	4977159	0.00151	2101.29	2844.3	0	ANNUAL	ALL	1				
189		634899.5	4977184	0.0014	2206.56	2844.3	0	ANNUAL	ALL	1				
190		634924.5	4977184	0.00145	2193.64	2844.3	0	ANNUAL	ALL	1				
191		634949.5	4977184	0.00153	2172.29	2844.3	0	ANNUAL	ALL	1				
192		634974.5	4977184	0.00156	2154.5	2844.3	0	ANNUAL	ALL	1				
193		634999.5	4977184	0.00156	2141.04	2844.3	0	ANNUAL	ALL	1				
194		635024.5	4977184	0.00157	2128.3	2844.3	0	ANNUAL	ALL	1				
195		635049.5	4977184	0.00159	2114.34	2844.3	0	ANNUAL	ALL	1				
196		635074.5	4977184	0.00161	2102.7	2844.3	0	ANNUAL	ALL	1				
197		635099.5	4977184	0.0016	2096.47	2844.3	0	ANNUAL	ALL	1				
198		634899.5	4977209	0.00148	2199.13	2844.3	0	ANNUAL	ALL	1				
199		634924.5	4977209	0.00156	2184.15	2844.3	0	ANNUAL	ALL	1				
200		634949.5	4977209	0.00165	2163.72	2844.3	0	ANNUAL	ALL	1				
201		634974.5	4977209	0.00166	2146.68	2844.3	0	ANNUAL	ALL	1				
202		634999.5	4977209	0.00165	2136.15	2844.3	0	ANNUAL	ALL	1				
203		635024.5	4977209	0.00166	2124.22	2844.3	0	ANNUAL	ALL	1				
204		635049.5	4977209	0.00171	2105.9	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
205		635074.5	4977209	0.00172	2096.39	2844.3	0	ANNUAL	ALL	1				
206		635099.5	4977209	0.0017	2091.31	2844.3	0	ANNUAL	ALL	1				
207		634899.5	4977234	0.00169	2185.16	2844.3	0	ANNUAL	ALL	1				
208		634924.5	4977234	0.00173	2172.04	2844.3	0	ANNUAL	ALL	1				
209		634949.5	4977234	0.00178	2152.41	2844.3	0	ANNUAL	ALL	1				
210		634974.5	4977234	0.00177	2139.97	2844.3	0	ANNUAL	ALL	1				
211		634999.5	4977234	0.00176	2130.73	2844.3	0	ANNUAL	ALL	1				
212		635024.5	4977234	0.00178	2117.31	2844.3	0	ANNUAL	ALL	1				
213		635049.5	4977234	0.00183	2098.65	2844.3	0	ANNUAL	ALL	1				
214		635074.5	4977234	0.00182	2092.39	2844.3	0	ANNUAL	ALL	1				
215		635099.5	4977234	0.0018	2087.32	2844.3	0	ANNUAL	ALL	1				
216		634899.5	4977259	0.0018	2180.4	2844.3	0	ANNUAL	ALL	1				
217		634924.5	4977259	0.00188	2160.19	2844.3	0	ANNUAL	ALL	1				
218		634949.5	4977259	0.00189	2143.3	2844.3	0	ANNUAL	ALL	1				
219		634974.5	4977259	0.00189	2132.11	2844.3	0	ANNUAL	ALL	1				
220		634999.5	4977259	0.00188	2123.02	2844.3	0	ANNUAL	ALL	1				
221		635024.5	4977259	0.00192	2107.09	2844.3	0	ANNUAL	ALL	1				
222		635049.5	4977259	0.00193	2095.35	2844.3	0	ANNUAL	ALL	1				
223		635074.5	4977259	0.00192	2089.07	2844.3	0	ANNUAL	ALL	1				
224		635099.5	4977259	0.0019	2083.6	2844.3	0	ANNUAL	ALL	1				
225		634899.5	4977284	0.00188	2180.69	2844.3	0	ANNUAL	ALL	1				
226		634924.5	4977284	0.00198	2158.28	2844.3	0	ANNUAL	ALL	1				
227		634949.5	4977284	0.002	2139.34	2844.3	0	ANNUAL	ALL	1				
228		634974.5	4977284	0.00203	2123.05	2844.3	0	ANNUAL	ALL	1				
229		634999.5	4977284	0.00203	2112.91	2844.3	0	ANNUAL	ALL	1				
230		635024.5	4977284	0.00205	2100.55	2844.3	0	ANNUAL	ALL	1				
231		635049.5	4977284	0.00204	2092.76	2844.3	0	ANNUAL	ALL	1				
232		635074.5	4977284	0.00203	2085.71	2844.3	0	ANNUAL	ALL	1				
233		635099.5	4977284	0.00203	2078.67	2844.3	0	ANNUAL	ALL	1				
234		634899.5	4977309	0.00198	2178.55	2844.3	0	ANNUAL	ALL	1				
235		634924.5	4977309	0.00207	2156.77	2844.3	0	ANNUAL	ALL	1				
236		634949.5	4977309	0.0021	2136.54	2844.3	0	ANNUAL	ALL	1				
237		634974.5	4977309	0.00215	2119.59	2844.3	0	ANNUAL	ALL	1				
238		634999.5	4977309	0.00217	2107.01	2844.3	0	ANNUAL	ALL	1				
239		635024.5	4977309	0.00217	2096.52	2844.3	0	ANNUAL	ALL	1				
240		635049.5	4977309	0.00216	2089.24	2844.3	0	ANNUAL	ALL	1				
241		635074.5	4977309	0.00215	2082.55	2844.3	0	ANNUAL	ALL	1				
242		635099.5	4977309	0.00214	2075.98	2844.3	0	ANNUAL	ALL	1				
243		634899.5	4977334	0.00212	2173.18	2844.3	0	ANNUAL	ALL	1				
244		634924.5	4977334	0.00218	2153.29	2844.3	0	ANNUAL	ALL	1				
245		634949.5	4977334	0.00221	2133.9	2844.3	0	ANNUAL	ALL	1				
246		634974.5	4977334	0.00226	2117.58	2844.3	0	ANNUAL	ALL	1				
247		634999.5	4977334	0.00228	2104.03	2844.3	0	ANNUAL	ALL	1				
248		635024.5	4977334	0.00229	2093.8	2844.3	0	ANNUAL	ALL	1				
249		635049.5	4977334	0.00229	2085.23	2844.3	0	ANNUAL	ALL	1				
250		635074.5	4977334	0.00228	2078.76	2844.3	0	ANNUAL	ALL	1				
251		635099.5	4977334	0.00225	2074.53	2844.3	0	ANNUAL	ALL	1				
252		635399.5	4976159	0.00026	2171.27	2844.3	0	ANNUAL	ALL	1				
253		635424.5	4976159	0.00026	2169.98	2844.3	0	ANNUAL	ALL	1				
254		635449.5	4976159	0.00026	2167.61	2844.3	0	ANNUAL	ALL	1				
255		635474.5	4976159	0.00026	2164.06	2844.3	0	ANNUAL	ALL	1				
256		635499.5	4976159	0.00026	2161.76	2844.3	0	ANNUAL	ALL	1				
257		635524.5	4976159	0.00026	2160.48	2844.3	0	ANNUAL	ALL	1				
258		635549.5	4976159	0.00025	2162.19	2844.3	0	ANNUAL	ALL	1				
259		635574.5	4976159	0.00024	2168.15	2844.3	0	ANNUAL	ALL	1				
260		635599.5	4976159	0.00023	2173.85	2844.3	0	ANNUAL	ALL	1				
261		635399.5	4976184	0.00027	2168.06	2844.3	0	ANNUAL	ALL	1				
262		635424.5	4976184	0.00027	2166.17	2844.3	0	ANNUAL	ALL	1				
263		635449.5	4976184	0.00027	2163.95	2844.3	0	ANNUAL	ALL	1				
264		635474.5	4976184	0.00027	2161.05	2844.3	0	ANNUAL	ALL	1				
265		635499.5	4976184	0.00027	2158.86	2844.3	0	ANNUAL	ALL	1				
266		635524.5	4976184	0.00027	2157.1	2844.3	0	ANNUAL	ALL	1				
267		635549.5	4976184	0.00026	2157.07	2844.3	0	ANNUAL	ALL	1				
268		635574.5	4976184	0.00025	2164.59	2844.3	0	ANNUAL	ALL	1				
269		635599.5	4976184	0.00024	2172.06	2844.3	0	ANNUAL	ALL	1				
270		635399.5	4976209	0.00028	2165.29	2844.3	0	ANNUAL	ALL	1				
271		635424.5	4976209	0.00028	2163.14	2844.3	0	ANNUAL	ALL	1				
272		635449.5	4976209	0.00028	2160.76	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
273		635474.5	4976209	0.00028	2158.05	2844.3	0	ANNUAL	ALL	1				
274		635499.5	4976209	0.00028	2155.43	2844.3	0	ANNUAL	ALL	1				
275		635524.5	4976209	0.00028	2153.57	2844.3	0	ANNUAL	ALL	1				
276		635549.5	4976209	0.00027	2156.02	2844.3	0	ANNUAL	ALL	1				
277		635574.5	4976209	0.00026	2165.26	2844.3	0	ANNUAL	ALL	1				
278		635599.5	4976209	0.00024	2175.01	2844.3	0	ANNUAL	ALL	1				
279		635399.5	4976234	0.00029	2162.56	2844.3	0	ANNUAL	ALL	1				
280		635424.5	4976234	0.00029	2160.46	2844.3	0	ANNUAL	ALL	1				
281		635449.5	4976234	0.00029	2157.93	2844.3	0	ANNUAL	ALL	1				
282		635474.5	4976234	0.00029	2155.5	2844.3	0	ANNUAL	ALL	1				
283		635499.5	4976234	0.00029	2152.67	2844.3	0	ANNUAL	ALL	1				
284		635524.5	4976234	0.00029	2150.12	2844.3	0	ANNUAL	ALL	1				
285		635549.5	4976234	0.00028	2156.6	2844.3	0	ANNUAL	ALL	1				
286		635574.5	4976234	0.00027	2167.62	2844.3	0	ANNUAL	ALL	1				
287		635599.5	4976234	0.00025	2178.35	2844.3	0	ANNUAL	ALL	1				
288		634999.5	4978134	0.00516	2044.53	2844.3	0	ANNUAL	ALL	1				
289		635024.5	4978134	0.00527	2030.56	2844.3	0	ANNUAL	ALL	1				
290		635049.5	4978134	0.00535	2018.07	2844.3	0	ANNUAL	ALL	1				
291		635074.5	4978134	0.0053	2006.69	2844.3	0	ANNUAL	ALL	1				
292		635099.5	4978134	0.00531	2006.39	2844.3	0	ANNUAL	ALL	1				
293		635124.5	4978134	0.00539	2013.34	2844.3	0	ANNUAL	ALL	1				
294		635149.5	4978134	0.00542	2020.75	2844.3	0	ANNUAL	ALL	1				
295		635174.5	4978134	0.00535	2029.05	2844.3	0	ANNUAL	ALL	1				
296		635199.5	4978134	0.00521	2038.91	2844.3	0	ANNUAL	ALL	1				
297		634999.5	4978159	0.00503	2044.5	2844.3	0	ANNUAL	ALL	1				
298		635024.5	4978159	0.00513	2030.78	2844.3	0	ANNUAL	ALL	1				
299		635049.5	4978159	0.00518	2017.35	2844.3	0	ANNUAL	ALL	1				
300		635074.5	4978159	0.00512	2004.54	2844.3	0	ANNUAL	ALL	1				
301		635099.5	4978159	0.00513	2003.81	2844.3	0	ANNUAL	ALL	1				
302		635124.5	4978159	0.00521	2010.57	2844.3	0	ANNUAL	ALL	1				
303		635149.5	4978159	0.00528	2017.75	2844.3	0	ANNUAL	ALL	1				
304		635174.5	4978159	0.00527	2025.18	2844.3	0	ANNUAL	ALL	1				
305		635199.5	4978159	0.00517	2035.11	2844.3	0	ANNUAL	ALL	1				
306		634999.5	4978184	0.0049	2044.38	2844.3	0	ANNUAL	ALL	1				
307		635024.5	4978184	0.00496	2028.98	2844.3	0	ANNUAL	ALL	1				
308		635049.5	4978184	0.005	2015.36	2844.3	0	ANNUAL	ALL	1				
309		635074.5	4978184	0.00493	2002.43	2844.3	0	ANNUAL	ALL	1				
310		635099.5	4978184	0.00494	2000.86	2844.3	0	ANNUAL	ALL	1				
311		635124.5	4978184	0.00503	2007.53	2844.3	0	ANNUAL	ALL	1				
312		635149.5	4978184	0.0051	2014.6	2844.3	0	ANNUAL	ALL	1				
313		635174.5	4978184	0.00515	2022.07	2844.3	0	ANNUAL	ALL	1				
314		635199.5	4978184	0.00509	2031.45	2844.3	0	ANNUAL	ALL	1				
315		634999.5	4978209	0.00478	2043.46	2844.3	0	ANNUAL	ALL	1				
316		635024.5	4978209	0.00481	2027.94	2844.3	0	ANNUAL	ALL	1				
317		635049.5	4978209	0.00483	2013.73	2844.3	0	ANNUAL	ALL	1				
318		635074.5	4978209	0.00476	2000.96	2844.3	0	ANNUAL	ALL	1				
319		635099.5	4978209	0.00474	1998.75	2844.3	0	ANNUAL	ALL	1				
320		635124.5	4978209	0.00485	2004.56	2844.3	0	ANNUAL	ALL	1				
321		635149.5	4978209	0.00492	2011.78	2844.3	0	ANNUAL	ALL	1				
322		635174.5	4978209	0.00499	2019.36	2844.3	0	ANNUAL	ALL	1				
323		635199.5	4978209	0.00497	2027.82	2844.3	0	ANNUAL	ALL	1				
324		634999.5	4978234	0.00465	2042.97	2844.3	0	ANNUAL	ALL	1				
325		635024.5	4978234	0.00466	2026.61	2844.3	0	ANNUAL	ALL	1				
326		635049.5	4978234	0.00464	2012.57	2844.3	0	ANNUAL	ALL	1				
327		635074.5	4978234	0.00457	2000.24	2844.3	0	ANNUAL	ALL	1				
328		635099.5	4978234	0.00456	1996.61	2844.3	0	ANNUAL	ALL	1				
329		635124.5	4978234	0.00467	2001.65	2844.3	0	ANNUAL	ALL	1				
330		635149.5	4978234	0.00475	2009.16	2844.3	0	ANNUAL	ALL	1				
331		635174.5	4978234	0.00484	2016.86	2844.3	0	ANNUAL	ALL	1				
332		635199.5	4978234	0.00486	2024.48	2844.3	0	ANNUAL	ALL	1				
333		634999.5	4978259	0.00447	2041.08	2844.3	0	ANNUAL	ALL	1				
334		635024.5	4978259	0.00451	2024.08	2844.3	0	ANNUAL	ALL	1				
335		635049.5	4978259	0.00448	2011.49	2844.3	0	ANNUAL	ALL	1				
336		635074.5	4978259	0.00443	2000.61	2844.3	0	ANNUAL	ALL	1				
337		635099.5	4978259	0.00438	1994.84	2844.3	0	ANNUAL	ALL	1				
338		635124.5	4978259	0.00447	1999.29	2844.3	0	ANNUAL	ALL	1				
339		635149.5	4978259	0.00459	2007.14	2844.3	0	ANNUAL	ALL	1				
340		635174.5	4978259	0.00467	2014.96	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
341		635199.5	4978259	0.00472	2023.44	2844.3	0	ANNUAL	ALL	1				
342		634999.5	4978284	0.00433	2039.02	2844.3	0	ANNUAL	ALL	1				
343		635024.5	4978284	0.00435	2022.69	2844.3	0	ANNUAL	ALL	1				
344		635049.5	4978284	0.00431	2010.11	2844.3	0	ANNUAL	ALL	1				
345		635074.5	4978284	0.00425	1999.28	2844.3	0	ANNUAL	ALL	1				
346		635099.5	4978284	0.00422	1993.94	2844.3	0	ANNUAL	ALL	1				
347		635124.5	4978284	0.0043	1996.86	2844.3	0	ANNUAL	ALL	1				
348		635149.5	4978284	0.00442	2004.78	2844.3	0	ANNUAL	ALL	1				
349		635174.5	4978284	0.0045	2012.7	2844.3	0	ANNUAL	ALL	1				
350		635199.5	4978284	0.00458	2021.78	2844.3	0	ANNUAL	ALL	1				
351		634999.5	4978309	0.00418	2036.72	2844.3	0	ANNUAL	ALL	1				
352		635024.5	4978309	0.0042	2023.32	2844.3	0	ANNUAL	ALL	1				
353		635049.5	4978309	0.00415	2010.1	2844.3	0	ANNUAL	ALL	1				
354		635074.5	4978309	0.0041	1999.36	2844.3	0	ANNUAL	ALL	1				
355		635099.5	4978309	0.00408	1992.81	2844.3	0	ANNUAL	ALL	1				
356		635124.5	4978309	0.00411	1994.13	2844.3	0	ANNUAL	ALL	1				
357		635149.5	4978309	0.00425	2001.68	2844.3	0	ANNUAL	ALL	1				
358		635174.5	4978309	0.00433	2009.75	2844.3	0	ANNUAL	ALL	1				
359		635199.5	4978309	0.00442	2018.84	2844.3	0	ANNUAL	ALL	1				
360		634999.5	4978334	0.00403	2033.58	2844.3	0	ANNUAL	ALL	1				
361		635024.5	4978334	0.00404	2021.76	2844.3	0	ANNUAL	ALL	1				
362		635049.5	4978334	0.00399	2009.59	2844.3	0	ANNUAL	ALL	1				
363		635074.5	4978334	0.00395	1999.33	2844.3	0	ANNUAL	ALL	1				
364		635099.5	4978334	0.00392	1991.74	2844.3	0	ANNUAL	ALL	1				
365		635124.5	4978334	0.00396	1991.62	2844.3	0	ANNUAL	ALL	1				
366		635149.5	4978334	0.00405	1998.49	2844.3	0	ANNUAL	ALL	1				
367		635174.5	4978334	0.00417	2006.18	2844.3	0	ANNUAL	ALL	1				
368		635199.5	4978334	0.00426	2015.32	2844.3	0	ANNUAL	ALL	1				
369		634299.5	4978134	0.0039	2065.05	2844.3	0	ANNUAL	ALL	1				
370		634324.5	4978134	0.00387	2052.1	2844.3	0	ANNUAL	ALL	1				
371		634349.5	4978134	0.00393	2045.24	2844.3	0	ANNUAL	ALL	1				
372		634374.5	4978134	0.00396	2034.94	2844.3	0	ANNUAL	ALL	1				
373		634399.5	4978134	0.004	2020.36	2844.3	0	ANNUAL	ALL	1				
374		634424.5	4978134	0.00401	2003.67	2844.3	0	ANNUAL	ALL	1				
375		634449.5	4978134	0.00401	1995.29	2844.3	0	ANNUAL	ALL	1				
376		634474.5	4978134	0.00416	2007.74	2844.3	0	ANNUAL	ALL	1				
377		634499.5	4978134	0.00432	2026.56	2844.3	0	ANNUAL	ALL	1				
378		634299.5	4978159	0.00364	2056.37	2844.3	0	ANNUAL	ALL	1				
379		634324.5	4978159	0.00365	2043.39	2844.3	0	ANNUAL	ALL	1				
380		634349.5	4978159	0.00365	2031.51	2844.3	0	ANNUAL	ALL	1				
381		634374.5	4978159	0.00374	2023.05	2844.3	0	ANNUAL	ALL	1				
382		634399.5	4978159	0.00375	2009.29	2844.3	0	ANNUAL	ALL	1				
383		634424.5	4978159	0.00376	1995	2844.3	0	ANNUAL	ALL	1				
384		634449.5	4978159	0.0038	1992.7	2844.3	0	ANNUAL	ALL	1				
385		634474.5	4978159	0.00395	2006.88	2844.3	0	ANNUAL	ALL	1				
386		634499.5	4978159	0.00411	2023.97	2844.3	0	ANNUAL	ALL	1				
387		634299.5	4978184	0.0034	2049.3	2844.3	0	ANNUAL	ALL	1				
388		634324.5	4978184	0.00339	2036.32	2844.3	0	ANNUAL	ALL	1				
389		634349.5	4978184	0.00346	2022.34	2844.3	0	ANNUAL	ALL	1				
390		634374.5	4978184	0.00348	2009.09	2844.3	0	ANNUAL	ALL	1				
391		634399.5	4978184	0.00351	1999.89	2844.3	0	ANNUAL	ALL	1				
392		634424.5	4978184	0.00358	1987.52	2844.3	0	ANNUAL	ALL	1				
393		634449.5	4978184	0.00363	1991.46	2844.3	0	ANNUAL	ALL	1				
394		634474.5	4978184	0.00376	2006.06	2844.3	0	ANNUAL	ALL	1				
395		634499.5	4978184	0.00389	2020.38	2844.3	0	ANNUAL	ALL	1				
396		634299.5	4978209	0.00319	2043.21	2844.3	0	ANNUAL	ALL	1				
397		634324.5	4978209	0.00318	2030.6	2844.3	0	ANNUAL	ALL	1				
398		634349.5	4978209	0.00324	2016.03	2844.3	0	ANNUAL	ALL	1				
399		634374.5	4978209	0.0033	2000.87	2844.3	0	ANNUAL	ALL	1				
400		634399.5	4978209	0.00333	1990.53	2844.3	0	ANNUAL	ALL	1				
401		634424.5	4978209	0.00341	1981.32	2844.3	0	ANNUAL	ALL	1				
402		634449.5	4978209	0.00346	1989.45	2844.3	0	ANNUAL	ALL	1				
403		634474.5	4978209	0.00357	2004.01	2844.3	0	ANNUAL	ALL	1				
404		634499.5	4978209	0.00369	2016.91	2844.3	0	ANNUAL	ALL	1				
405		634299.5	4978234	0.00296	2037.27	2844.3	0	ANNUAL	ALL	1				
406		634324.5	4978234	0.00302	2025.09	2844.3	0	ANNUAL	ALL	1				
407		634349.5	4978234	0.00306	2009.81	2844.3	0	ANNUAL	ALL	1				
408		634374.5	4978234	0.00311	1996.13	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
409		634399.5	4978234	0.00318	1984.05	2844.3	0	ANNUAL	ALL	1				
410		634424.5	4978234	0.00326	1975.87	2844.3	0	ANNUAL	ALL	1				
411		634449.5	4978234	0.0033	1984.97	2844.3	0	ANNUAL	ALL	1				
412		634474.5	4978234	0.00337	2000.36	2844.3	0	ANNUAL	ALL	1				
413		634499.5	4978234	0.00346	2011.73	2844.3	0	ANNUAL	ALL	1				
414		634299.5	4978259	0.00279	2030.97	2844.3	0	ANNUAL	ALL	1				
415		634324.5	4978259	0.00285	2018.02	2844.3	0	ANNUAL	ALL	1				
416		634349.5	4978259	0.0029	2002.99	2844.3	0	ANNUAL	ALL	1				
417		634374.5	4978259	0.00295	1990.41	2844.3	0	ANNUAL	ALL	1				
418		634399.5	4978259	0.00304	1978.88	2844.3	0	ANNUAL	ALL	1				
419		634424.5	4978259	0.00312	1972.17	2844.3	0	ANNUAL	ALL	1				
420		634449.5	4978259	0.00315	1977.85	2844.3	0	ANNUAL	ALL	1				
421		634474.5	4978259	0.00318	1992.52	2844.3	0	ANNUAL	ALL	1				
422		634499.5	4978259	0.00328	2003.44	2844.3	0	ANNUAL	ALL	1				
423		634299.5	4978284	0.00264	2023.26	2844.3	0	ANNUAL	ALL	1				
424		634324.5	4978284	0.00268	2008.98	2844.3	0	ANNUAL	ALL	1				
425		634349.5	4978284	0.00275	1996.31	2844.3	0	ANNUAL	ALL	1				
426		634374.5	4978284	0.00282	1984.2	2844.3	0	ANNUAL	ALL	1				
427		634399.5	4978284	0.00291	1973.37	2844.3	0	ANNUAL	ALL	1				
428		634424.5	4978284	0.00297	1969.23	2844.3	0	ANNUAL	ALL	1				
429		634449.5	4978284	0.00301	1975.58	2844.3	0	ANNUAL	ALL	1				
430		634474.5	4978284	0.00304	1989.07	2844.3	0	ANNUAL	ALL	1				
431		634499.5	4978284	0.0031	2000.53	2844.3	0	ANNUAL	ALL	1				
432		634299.5	4978309	0.00247	2012.41	2844.3	0	ANNUAL	ALL	1				
433		634324.5	4978309	0.00254	1999.74	2844.3	0	ANNUAL	ALL	1				
434		634349.5	4978309	0.00262	1988.62	2844.3	0	ANNUAL	ALL	1				
435		634374.5	4978309	0.00269	1977.79	2844.3	0	ANNUAL	ALL	1				
436		634399.5	4978309	0.00277	1967.1	2844.3	0	ANNUAL	ALL	1				
437		634424.5	4978309	0.00283	1968.14	2844.3	0	ANNUAL	ALL	1				
438		634449.5	4978309	0.00286	1977.66	2844.3	0	ANNUAL	ALL	1				
439		634474.5	4978309	0.00288	1992.31	2844.3	0	ANNUAL	ALL	1				
440		634499.5	4978309	0.00296	2006.23	2844.3	0	ANNUAL	ALL	1				
441		634299.5	4978334	0.00237	2000.94	2844.3	0	ANNUAL	ALL	1				
442		634324.5	4978334	0.00243	1991.1	2844.3	0	ANNUAL	ALL	1				
443		634349.5	4978334	0.0025	1980.66	2844.3	0	ANNUAL	ALL	1				
444		634374.5	4978334	0.00258	1970.39	2844.3	0	ANNUAL	ALL	1				
445		634399.5	4978334	0.00266	1961.38	2844.3	0	ANNUAL	ALL	1				
446		634424.5	4978334	0.00269	1968.29	2844.3	0	ANNUAL	ALL	1				
447		634449.5	4978334	0.00271	1980.95	2844.3	0	ANNUAL	ALL	1				
448		634474.5	4978334	0.00274	1997.36	2844.3	0	ANNUAL	ALL	1				
449		634499.5	4978334	0.00281	2012.52	2844.3	0	ANNUAL	ALL	1				
450		634299.5	4978359	0.00226	1991.4	2844.3	0	ANNUAL	ALL	1				
451		634324.5	4978359	0.00233	1982.72	2844.3	0	ANNUAL	ALL	1				
452		634349.5	4978359	0.0024	1972.75	2844.3	0	ANNUAL	ALL	1				
453		634374.5	4978359	0.00247	1962.87	2844.3	0	ANNUAL	ALL	1				
454		634399.5	4978359	0.00253	1958.17	2844.3	0	ANNUAL	ALL	1				
455		634424.5	4978359	0.00256	1968.79	2844.3	0	ANNUAL	ALL	1				
456		634449.5	4978359	0.00257	1984.24	2844.3	0	ANNUAL	ALL	1				
457		634474.5	4978359	0.00262	2002.2	2844.3	0	ANNUAL	ALL	1				
458		634499.5	4978359	0.00269	2016.76	2844.3	0	ANNUAL	ALL	1				
459		634299.5	4978384	0.00217	1982.57	2844.3	0	ANNUAL	ALL	1				
460		634324.5	4978384	0.00223	1975.68	2844.3	0	ANNUAL	ALL	1				
461		634349.5	4978384	0.0023	1964.84	2844.3	0	ANNUAL	ALL	1				
462		634374.5	4978384	0.00236	1956.29	2844.3	0	ANNUAL	ALL	1				
463		634399.5	4978384	0.00241	1955.61	2844.3	0	ANNUAL	ALL	1				
464		634424.5	4978384	0.00244	1968.65	2844.3	0	ANNUAL	ALL	1				
465		634449.5	4978384	0.00245	1986.09	2844.3	0	ANNUAL	ALL	1				
466		634474.5	4978384	0.00248	2004.63	2844.3	0	ANNUAL	ALL	1				
467		634499.5	4978384	0.00255	2018.69	2844.3	0	ANNUAL	ALL	1				
468		634299.5	4978409	0.00208	1975.4	2844.3	0	ANNUAL	ALL	1				
469		634324.5	4978409	0.00214	1967.52	2844.3	0	ANNUAL	ALL	1				
470		634349.5	4978409	0.0022	1957.04	2844.3	0	ANNUAL	ALL	1				
471		634374.5	4978409	0.00225	1949.69	2844.3	0	ANNUAL	ALL	1				
472		634399.5	4978409	0.0023	1951.43	2844.3	0	ANNUAL	ALL	1				
473		634424.5	4978409	0.00232	1967.3	2844.3	0	ANNUAL	ALL	1				
474		634449.5	4978409	0.00233	1986.39	2844.3	0	ANNUAL	ALL	1				
475		634474.5	4978409	0.00236	2005.28	2844.3	0	ANNUAL	ALL	1				
476		634499.5	4978409	0.00242	2019.28	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
477		634299.5	4978434	0.002	1965.22	2844.3	0	ANNUAL	ALL	1				
478		634324.5	4978434	0.00205	1958.88	2844.3	0	ANNUAL	ALL	1				
479		634349.5	4978434	0.0021	1950.79	2844.3	0	ANNUAL	ALL	1				
480		634374.5	4978434	0.00214	1943.73	2844.3	0	ANNUAL	ALL	1				
481		634399.5	4978434	0.00219	1949.4	2844.3	0	ANNUAL	ALL	1				
482		634424.5	4978434	0.00221	1965.04	2844.3	0	ANNUAL	ALL	1				
483		634449.5	4978434	0.00222	1984.59	2844.3	0	ANNUAL	ALL	1				
484		634474.5	4978434	0.00224	2004.45	2844.3	0	ANNUAL	ALL	1				
485		634499.5	4978434	0.00229	2017.53	2844.3	0	ANNUAL	ALL	1				
486		634249.4	4977384	0.00202	2291.4	2717.08	0	ANNUAL	ALL	1				
487		634274.4	4977384	0.00212	2282.65	2742	0	ANNUAL	ALL	1				
488		634299.4	4977384	0.00225	2273.71	2742	0	ANNUAL	ALL	1				
489		634324.4	4977384	0.00246	2263.84	2742	0	ANNUAL	ALL	1				
490		634349.4	4977384	0.00288	2250.84	2742	0	ANNUAL	ALL	1				
491		634374.4	4977384	0.00346	2238.58	2742.16	0	ANNUAL	ALL	1				
492		634399.4	4977384	0.00375	2232.43	2742.16	0	ANNUAL	ALL	1				
493		634424.4	4977384	0.00296	2242.73	2742.16	0	ANNUAL	ALL	1				
494		634449.4	4977384	0.00228	2255.36	2742	0	ANNUAL	ALL	1				
495		634249.4	4977409	0.00223	2284.43	2742	0	ANNUAL	ALL	1				
496		634274.4	4977409	0.0024	2274.53	2742	0	ANNUAL	ALL	1				
497		634299.4	4977409	0.00262	2264.56	2742	0	ANNUAL	ALL	1				
498		634324.4	4977409	0.00293	2254.44	2742	0	ANNUAL	ALL	1				
499		634349.4	4977409	0.00338	2243.93	2742.16	0	ANNUAL	ALL	1				
500		634374.4	4977409	0.0041	2231.37	2742.16	0	ANNUAL	ALL	1				
501		634399.4	4977409	0.0044	2226.02	2844.3	0	ANNUAL	ALL	1				
502		634424.4	4977409	0.00346	2236.92	2742.16	0	ANNUAL	ALL	1				
503		634449.4	4977409	0.00265	2249.43	2742.16	0	ANNUAL	ALL	1				
504		634249.4	4977434	0.0024	2279.34	2742	0	ANNUAL	ALL	1				
505		634274.4	4977434	0.00268	2267.65	2742	0	ANNUAL	ALL	1				
506		634299.4	4977434	0.00306	2255.85	2742	0	ANNUAL	ALL	1				
507		634324.4	4977434	0.00354	2244.86	2742	0	ANNUAL	ALL	1				
508		634349.4	4977434	0.00411	2234.48	2742.16	0	ANNUAL	ALL	1				
509		634374.4	4977434	0.0048	2223.18	2844.3	0	ANNUAL	ALL	1				
510		634399.4	4977434	0.00487	2218.5	2844.3	0	ANNUAL	ALL	1				
511		634424.4	4977434	0.00412	2230.27	2844.3	0	ANNUAL	ALL	1				
512		634449.4	4977434	0.00307	2243.66	2742.16	0	ANNUAL	ALL	1				
513		634249.4	4977459	0.00255	2275.78	2742	0	ANNUAL	ALL	1				
514		634274.4	4977459	0.00291	2262.83	2742	0	ANNUAL	ALL	1				
515		634299.4	4977459	0.00348	2248.74	2742	0	ANNUAL	ALL	1				
516		634324.4	4977459	0.00409	2237.43	2742.16	0	ANNUAL	ALL	1				
517		634349.4	4977459	0.00478	2226.72	2844.3	0	ANNUAL	ALL	1				
518		634374.4	4977459	0.00513	2214.97	2844.3	0	ANNUAL	ALL	1				
519		634399.4	4977459	0.00504	2211.75	2844.3	0	ANNUAL	ALL	1				
520		634424.4	4977459	0.00463	2223.34	2844.3	0	ANNUAL	ALL	1				
521		634449.4	4977459	0.00367	2237.29	2844.3	0	ANNUAL	ALL	1				
522		634249.4	4977484	0.00267	2272.5	2742	0	ANNUAL	ALL	1				
523		634274.4	4977484	0.00313	2258.48	2742	0	ANNUAL	ALL	1				
524		634299.4	4977484	0.00381	2243.77	2742	0	ANNUAL	ALL	1				
525		634324.4	4977484	0.00451	2231.45	2742.16	0	ANNUAL	ALL	1				
526		634349.4	4977484	0.00512	2219.9	2844.3	0	ANNUAL	ALL	1				
527		634374.4	4977484	0.00511	2207.94	2844.3	0	ANNUAL	ALL	1				
528		634399.4	4977484	0.0049	2204.62	2844.3	0	ANNUAL	ALL	1				
529		634424.4	4977484	0.00491	2216.76	2844.3	0	ANNUAL	ALL	1				
530		634449.4	4977484	0.0042	2230.33	2844.3	0	ANNUAL	ALL	1				
531		634249.4	4977509	0.00279	2269.17	2742	0	ANNUAL	ALL	1				
532		634274.4	4977509	0.0033	2254.88	2742	0	ANNUAL	ALL	1				
533		634299.4	4977509	0.00401	2240.59	2742	0	ANNUAL	ALL	1				
534		634324.4	4977509	0.00483	2227.32	2844.3	0	ANNUAL	ALL	1				
535		634349.4	4977509	0.0052	2213.19	2844.3	0	ANNUAL	ALL	1				
536		634374.4	4977509	0.00487	2200.19	2844.3	0	ANNUAL	ALL	1				
537		634399.4	4977509	0.00471	2197.61	2844.3	0	ANNUAL	ALL	1				
538		634424.4	4977509	0.00496	2211.03	2844.3	0	ANNUAL	ALL	1				
539		634449.4	4977509	0.00462	2223.57	2844.3	0	ANNUAL	ALL	1				
540		634249.4	4977534	0.00288	2266.65	2742	0	ANNUAL	ALL	1				
541		634274.4	4977534	0.00345	2251.58	2742	0	ANNUAL	ALL	1				
542		634299.4	4977534	0.00419	2237.18	2742	0	ANNUAL	ALL	1				
543		634324.4	4977534	0.00493	2223.67	2844.3	0	ANNUAL	ALL	1				
544		634349.4	4977534	0.00508	2207.86	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
545		634374.4	4977534	0.00456	2193.38	2844.3	0	ANNUAL	ALL	1				
546		634399.4	4977534	0.00443	2191.95	2844.3	0	ANNUAL	ALL	1				
547		634424.4	4977534	0.00485	2205.88	2844.3	0	ANNUAL	ALL	1				
548		634449.4	4977534	0.00482	2217.63	2844.3	0	ANNUAL	ALL	1				
549		634249.4	4977559	0.00295	2264.12	2742	0	ANNUAL	ALL	1				
550		634274.4	4977559	0.00363	2247.26	2742	0	ANNUAL	ALL	1				
551		634299.4	4977559	0.00437	2232.74	2742	0	ANNUAL	ALL	1				
552		634324.4	4977559	0.00498	2218.55	2844.3	0	ANNUAL	ALL	1				
553		634349.4	4977559	0.00488	2203.35	2844.3	0	ANNUAL	ALL	1				
554		634374.4	4977559	0.00455	2189.62	2844.3	0	ANNUAL	ALL	1				
555		634399.4	4977559	0.00455	2184.96	2844.3	0	ANNUAL	ALL	1				
556		634424.4	4977559	0.00468	2200.77	2844.3	0	ANNUAL	ALL	1				
557		634449.4	4977559	0.00483	2211.07	2844.3	0	ANNUAL	ALL	1				
558		634249.4	4977584	0.00314	2258.01	2742	0	ANNUAL	ALL	1				
559		634274.4	4977584	0.00381	2242.66	2742	0	ANNUAL	ALL	1				
560		634299.4	4977584	0.00459	2227.67	2844.3	0	ANNUAL	ALL	1				
561		634324.4	4977584	0.00491	2213.51	2844.3	0	ANNUAL	ALL	1				
562		634349.4	4977584	0.00474	2199.5	2844.3	0	ANNUAL	ALL	1				
563		634374.4	4977584	0.00462	2185.33	2844.3	0	ANNUAL	ALL	1				
564		634399.4	4977584	0.00477	2177.11	2844.3	0	ANNUAL	ALL	1				
565		634424.4	4977584	0.0044	2192.43	2844.3	0	ANNUAL	ALL	1				
566		634449.4	4977584	0.00462	2203.16	2844.3	0	ANNUAL	ALL	1				
567		634999.5	4977834	0.00562	2055.79	2844.3	0	ANNUAL	ALL	1				
568		635024.5	4977834	0.00581	2048.42	2844.3	0	ANNUAL	ALL	1				
569		635049.5	4977834	0.00599	2043	2844.3	0	ANNUAL	ALL	1				
570		635074.5	4977834	0.00613	2037.93	2844.3	0	ANNUAL	ALL	1				
571		635099.5	4977834	0.00623	2034.24	2844.3	0	ANNUAL	ALL	1				
572		635124.5	4977834	0.00627	2031.45	2844.3	0	ANNUAL	ALL	1				
573		635149.5	4977834	0.0058	2038.5	2844.3	0	ANNUAL	ALL	1				
574		635174.5	4977834	0.00512	2050.35	2844.3	0	ANNUAL	ALL	1				
575		635199.5	4977834	0.00454	2063.26	2844.3	0	ANNUAL	ALL	1				
576		634999.5	4977859	0.00574	2052.63	2844.3	0	ANNUAL	ALL	1				
577		635024.5	4977859	0.00592	2046.41	2844.3	0	ANNUAL	ALL	1				
578		635049.5	4977859	0.00607	2040.95	2844.3	0	ANNUAL	ALL	1				
579		635074.5	4977859	0.00624	2036.03	2844.3	0	ANNUAL	ALL	1				
580		635099.5	4977859	0.00634	2032.3	2844.3	0	ANNUAL	ALL	1				
581		635124.5	4977859	0.00632	2030.17	2844.3	0	ANNUAL	ALL	1				
582		635149.5	4977859	0.00585	2038.33	2844.3	0	ANNUAL	ALL	1				
583		635174.5	4977859	0.00522	2049.93	2844.3	0	ANNUAL	ALL	1				
584		635199.5	4977859	0.00465	2062.54	2844.3	0	ANNUAL	ALL	1				
585		634999.5	4977884	0.00588	2049.11	2844.3	0	ANNUAL	ALL	1				
586		635024.5	4977884	0.00602	2044.13	2844.3	0	ANNUAL	ALL	1				
587		635049.5	4977884	0.00616	2038.92	2844.3	0	ANNUAL	ALL	1				
588		635074.5	4977884	0.00631	2034.26	2844.3	0	ANNUAL	ALL	1				
589		635099.5	4977884	0.00637	2030.48	2844.3	0	ANNUAL	ALL	1				
590		635124.5	4977884	0.00636	2029.04	2844.3	0	ANNUAL	ALL	1				
591		635149.5	4977884	0.00587	2038.45	2844.3	0	ANNUAL	ALL	1				
592		635174.5	4977884	0.0053	2049.51	2844.3	0	ANNUAL	ALL	1				
593		635199.5	4977884	0.00477	2061.56	2844.3	0	ANNUAL	ALL	1				
594		634999.5	4977909	0.00591	2047.27	2844.3	0	ANNUAL	ALL	1				
595		635024.5	4977909	0.00605	2042.16	2844.3	0	ANNUAL	ALL	1				
596		635049.5	4977909	0.0062	2036.97	2844.3	0	ANNUAL	ALL	1				
597		635074.5	4977909	0.00633	2032.48	2844.3	0	ANNUAL	ALL	1				
598		635099.5	4977909	0.0064	2028.7	2844.3	0	ANNUAL	ALL	1				
599		635124.5	4977909	0.00633	2028.77	2844.3	0	ANNUAL	ALL	1				
600		635149.5	4977909	0.00587	2038.62	2844.3	0	ANNUAL	ALL	1				
601		635174.5	4977909	0.00535	2049.12	2844.3	0	ANNUAL	ALL	1				
602		635199.5	4977909	0.00487	2060.48	2844.3	0	ANNUAL	ALL	1				
603		634999.5	4977934	0.00588	2046.79	2844.3	0	ANNUAL	ALL	1				
604		635024.5	4977934	0.00602	2040.92	2844.3	0	ANNUAL	ALL	1				
605		635049.5	4977934	0.00622	2034.68	2844.3	0	ANNUAL	ALL	1				
606		635074.5	4977934	0.00633	2029.58	2844.3	0	ANNUAL	ALL	1				
607		635099.5	4977934	0.00642	2025.61	2844.3	0	ANNUAL	ALL	1				
608		635124.5	4977934	0.00631	2027.68	2844.3	0	ANNUAL	ALL	1				
609		635149.5	4977934	0.00587	2038.09	2844.3	0	ANNUAL	ALL	1				
610		635174.5	4977934	0.00538	2048.68	2844.3	0	ANNUAL	ALL	1				
611		635199.5	4977934	0.00494	2059.02	2844.3	0	ANNUAL	ALL	1				
612		634999.5	4977959	0.00584	2045.95	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
613		635024.5	4977959	0.00599	2039.51	2844.3	0	ANNUAL	ALL	1				
614		635049.5	4977959	0.0062	2032.45	2844.3	0	ANNUAL	ALL	1				
615		635074.5	4977959	0.00633	2026.52	2844.3	0	ANNUAL	ALL	1				
616		635099.5	4977959	0.00638	2022.6	2844.3	0	ANNUAL	ALL	1				
617		635124.5	4977959	0.00625	2027.13	2844.3	0	ANNUAL	ALL	1				
618		635149.5	4977959	0.00589	2036.89	2844.3	0	ANNUAL	ALL	1				
619		635174.5	4977959	0.00545	2046.85	2844.3	0	ANNUAL	ALL	1				
620		635199.5	4977959	0.00505	2056.78	2844.3	0	ANNUAL	ALL	1				
621		634999.5	4977984	0.00578	2045.34	2844.3	0	ANNUAL	ALL	1				
622		635024.5	4977984	0.00595	2037.82	2844.3	0	ANNUAL	ALL	1				
623		635049.5	4977984	0.00611	2030.43	2844.3	0	ANNUAL	ALL	1				
624		635074.5	4977984	0.00626	2024.12	2844.3	0	ANNUAL	ALL	1				
625		635099.5	4977984	0.00628	2019.96	2844.3	0	ANNUAL	ALL	1				
626		635124.5	4977984	0.00616	2026.73	2844.3	0	ANNUAL	ALL	1				
627		635149.5	4977984	0.00589	2035.4	2844.3	0	ANNUAL	ALL	1				
628		635174.5	4977984	0.00553	2044.46	2844.3	0	ANNUAL	ALL	1				
629		635199.5	4977984	0.00515	2053.52	2844.3	0	ANNUAL	ALL	1				
630		634999.5	4978009	0.00571	2044.81	2844.3	0	ANNUAL	ALL	1				
631		635024.5	4978009	0.00591	2035.59	2844.3	0	ANNUAL	ALL	1				
632		635049.5	4978009	0.00605	2028.05	2844.3	0	ANNUAL	ALL	1				
633		635074.5	4978009	0.00615	2021.18	2844.3	0	ANNUAL	ALL	1				
634		635099.5	4978009	0.00616	2017.1	2844.3	0	ANNUAL	ALL	1				
635		635124.5	4978009	0.00606	2025.97	2844.3	0	ANNUAL	ALL	1				
636		635149.5	4978009	0.00585	2034.03	2844.3	0	ANNUAL	ALL	1				
637		635174.5	4978009	0.00556	2041.95	2844.3	0	ANNUAL	ALL	1				
638		635199.5	4978009	0.00526	2050.09	2844.3	0	ANNUAL	ALL	1				
639		634999.5	4978034	0.00565	2043.29	2844.3	0	ANNUAL	ALL	1				
640		635024.5	4978034	0.00584	2032.46	2844.3	0	ANNUAL	ALL	1				
641		635049.5	4978034	0.00597	2024.39	2844.3	0	ANNUAL	ALL	1				
642		635074.5	4978034	0.00602	2017.56	2844.3	0	ANNUAL	ALL	1				
643		635099.5	4978034	0.006	2015.24	2844.3	0	ANNUAL	ALL	1				
644		635124.5	4978034	0.00597	2024.2	2844.3	0	ANNUAL	ALL	1				
645		635149.5	4978034	0.00581	2032.02	2844.3	0	ANNUAL	ALL	1				
646		635174.5	4978034	0.00553	2040.48	2844.3	0	ANNUAL	ALL	1				
647		635199.5	4978034	0.00524	2049.69	2844.3	0	ANNUAL	ALL	1				
648		634599.5	4976834	0.00025	2431.97	2717.08	0	ANNUAL	ALL	1				
649		634624.5	4976834	0.00025	2425.11	2717.08	0	ANNUAL	ALL	1				
650		634649.5	4976834	0.00025	2416.95	2717.08	0	ANNUAL	ALL	1				
651		634674.5	4976834	0.00025	2407.96	2717.08	0	ANNUAL	ALL	1				
652		634699.5	4976834	0.00025	2398.82	2717.08	0	ANNUAL	ALL	1				
653		634724.5	4976834	0.00025	2389.57	2717.08	0	ANNUAL	ALL	1				
654		634749.5	4976834	0.00025	2378.83	2717.08	0	ANNUAL	ALL	1				
655		634774.5	4976834	0.00025	2368.3	2717.08	0	ANNUAL	ALL	1				
656		634799.5	4976834	0.00026	2352.38	2717.08	0	ANNUAL	ALL	1				
657		634599.5	4976859	0.00027	2427	2717.08	0	ANNUAL	ALL	1				
658		634624.5	4976859	0.00026	2421.36	2717.08	0	ANNUAL	ALL	1				
659		634649.5	4976859	0.00026	2412.9	2717.08	0	ANNUAL	ALL	1				
660		634674.5	4976859	0.00026	2401.58	2717.08	0	ANNUAL	ALL	1				
661		634699.5	4976859	0.00026	2391.51	2717.08	0	ANNUAL	ALL	1				
662		634724.5	4976859	0.00026	2381.29	2717.08	0	ANNUAL	ALL	1				
663		634749.5	4976859	0.00026	2371.44	2717.08	0	ANNUAL	ALL	1				
664		634774.5	4976859	0.00026	2358.57	2717.08	0	ANNUAL	ALL	1				
665		634799.5	4976859	0.00027	2341.91	2742	0	ANNUAL	ALL	1				
666		634599.5	4976884	0.00028	2422.69	2717.08	0	ANNUAL	ALL	1				
667		634624.5	4976884	0.00027	2418.17	2717.08	0	ANNUAL	ALL	1				
668		634649.5	4976884	0.00027	2408.98	2717.08	0	ANNUAL	ALL	1				
669		634674.5	4976884	0.00027	2396.57	2717.08	0	ANNUAL	ALL	1				
670		634699.5	4976884	0.00027	2383.76	2717.08	0	ANNUAL	ALL	1				
671		634724.5	4976884	0.00028	2371.27	2717.08	0	ANNUAL	ALL	1				
672		634749.5	4976884	0.00028	2362.03	2717.08	0	ANNUAL	ALL	1				
673		634774.5	4976884	0.00028	2350.11	2717.08	0	ANNUAL	ALL	1				
674		634799.5	4976884	0.00029	2334.35	2742	0	ANNUAL	ALL	1				
675		634599.5	4976909	0.00029	2418.11	2717.08	0	ANNUAL	ALL	1				
676		634624.5	4976909	0.00029	2412.47	2717.08	0	ANNUAL	ALL	1				
677		634649.5	4976909	0.00029	2402.76	2717.08	0	ANNUAL	ALL	1				
678		634674.5	4976909	0.00028	2392.81	2717.08	0	ANNUAL	ALL	1				
679		634699.5	4976909	0.00029	2377.98	2717.08	0	ANNUAL	ALL	1				
680		634724.5	4976909	0.00029	2364.11	2717.08	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
681		634749.5	4976909	0.00029	2354.73	2717.08	0	ANNUAL	ALL	1				
682		634774.5	4976909	0.00029	2345.14	2717.08	0	ANNUAL	ALL	1				
683		634799.5	4976909	0.0003	2331	2742	0	ANNUAL	ALL	1				
684		634599.5	4976934	0.00031	2411.78	2717.08	0	ANNUAL	ALL	1				
685		634624.5	4976934	0.0003	2403.98	2717.08	0	ANNUAL	ALL	1				
686		634649.5	4976934	0.0003	2394.61	2717.08	0	ANNUAL	ALL	1				
687		634674.5	4976934	0.0003	2383.71	2717.08	0	ANNUAL	ALL	1				
688		634699.5	4976934	0.0003	2371.78	2717.08	0	ANNUAL	ALL	1				
689		634724.5	4976934	0.00031	2359.09	2717.08	0	ANNUAL	ALL	1				
690		634749.5	4976934	0.00031	2347.63	2717.08	0	ANNUAL	ALL	1				
691		634774.5	4976934	0.00031	2337.6	2742	0	ANNUAL	ALL	1				
692		634799.5	4976934	0.00032	2326.97	2742	0	ANNUAL	ALL	1				
693		634599.5	4976959	0.00032	2404.1	2717.08	0	ANNUAL	ALL	1				
694		634624.5	4976959	0.00032	2396.65	2717.08	0	ANNUAL	ALL	1				
695		634649.5	4976959	0.00032	2385.41	2717.08	0	ANNUAL	ALL	1				
696		634674.5	4976959	0.00032	2372.07	2717.08	0	ANNUAL	ALL	1				
697		634699.5	4976959	0.00032	2362.55	2717.08	0	ANNUAL	ALL	1				
698		634724.5	4976959	0.00032	2351.59	2717.08	0	ANNUAL	ALL	1				
699		634749.5	4976959	0.00033	2341.2	2717.08	0	ANNUAL	ALL	1				
700		634774.5	4976959	0.00033	2328.55	2742	0	ANNUAL	ALL	1				
701		634799.5	4976959	0.00034	2318.72	2742	0	ANNUAL	ALL	1				
702		634599.5	4976984	0.00034	2396.35	2717.08	0	ANNUAL	ALL	1				
703		634624.5	4976984	0.00034	2389.04	2717.08	0	ANNUAL	ALL	1				
704		634649.5	4976984	0.00034	2377.21	2717.08	0	ANNUAL	ALL	1				
705		634674.5	4976984	0.00034	2363.6	2717.08	0	ANNUAL	ALL	1				
706		634699.5	4976984	0.00034	2350.85	2717.08	0	ANNUAL	ALL	1				
707		634724.5	4976984	0.00035	2340.79	2717.08	0	ANNUAL	ALL	1				
708		634749.5	4976984	0.00035	2331.79	2742	0	ANNUAL	ALL	1				
709		634774.5	4976984	0.00035	2320.7	2742	0	ANNUAL	ALL	1				
710		634799.5	4976984	0.00036	2308.59	2742	0	ANNUAL	ALL	1				
711		634599.5	4977009	0.00037	2388.79	2717.08	0	ANNUAL	ALL	1				
712		634624.5	4977009	0.00036	2379.17	2717.08	0	ANNUAL	ALL	1				
713		634649.5	4977009	0.00036	2368.25	2717.08	0	ANNUAL	ALL	1				
714		634674.5	4977009	0.00036	2355.13	2717.08	0	ANNUAL	ALL	1				
715		634699.5	4977009	0.00037	2341.52	2717.08	0	ANNUAL	ALL	1				
716		634724.5	4977009	0.00038	2328.18	2742	0	ANNUAL	ALL	1				
717		634749.5	4977009	0.00038	2321.24	2742	0	ANNUAL	ALL	1				
718		634774.5	4977009	0.00038	2313.44	2742	0	ANNUAL	ALL	1				
719		634799.5	4977009	0.00039	2301.46	2742.16	0	ANNUAL	ALL	1				
720		634599.5	4977034	0.00039	2379.36	2717.08	0	ANNUAL	ALL	1				
721		634624.5	4977034	0.00039	2369.28	2717.08	0	ANNUAL	ALL	1				
722		634649.5	4977034	0.00039	2356.46	2717.08	0	ANNUAL	ALL	1				
723		634674.5	4977034	0.00039	2343.53	2717.08	0	ANNUAL	ALL	1				
724		634699.5	4977034	0.0004	2329.9	2742	0	ANNUAL	ALL	1				
725		634724.5	4977034	0.00041	2316.92	2742	0	ANNUAL	ALL	1				
726		634749.5	4977034	0.00041	2309.32	2742	0	ANNUAL	ALL	1				
727		634774.5	4977034	0.00041	2302.58	2742	0	ANNUAL	ALL	1				
728		634799.5	4977034	0.00042	2295.21	2742.16	0	ANNUAL	ALL	1				
729	**	CONCUNIT	ug/m^3											
730	**	DEPUNIT	g/m^2											

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	*	AERMOD	(	19191):	MIDAS	GOLD	STIBNITE	-	MODELING	R27	########			
2	*	AERMET	(	19191):	11:43:34									
3	*	MODELING	OPTIONS	USED:	RegDFAULT	CONC	ELEV	NOWARN	DRYDPLT	WETDPLT	RURAL	ADJ_U*		
4	*	PLOT	FILE	OF	ANNUAL	VALUES	AVERAGED	ACROSS	1	YEARS	FOR	SOURCE	GROUP:	ALL
5	*	FOR	A	TOTAL	OF	720	RECEPTORS.							
6	*	FORMAT:	(3(1X,F13.5),3(1X,F8.2),2X,A6,2X,A8,2X,I8.8,2X,A8)											
7	*	X	Y	AVERAGE	CONC	ZELEV	ZHILL	ZFLAG	AVE	GRP	NUM	YRS	NET	ID
8	*													
9	0.001050	635399.5	4975934	0.00079	2213.4	2844.3	0	ANNUAL	ALL	1				
10	max ↑	635424.5	4975934	0.0008	2212.64	2844.3	0	ANNUAL	ALL	1				
11		635449.5	4975934	0.00081	2211.27	2844.3	0	ANNUAL	ALL	1				
12		635474.5	4975934	0.0008	2212.5	2844.3	0	ANNUAL	ALL	1				
13		635499.5	4975934	0.00079	2215.21	2844.3	0	ANNUAL	ALL	1				
14		635524.5	4975934	0.00079	2215.98	2844.3	0	ANNUAL	ALL	1				
15		635549.5	4975934	0.00079	2215	2844.3	0	ANNUAL	ALL	1				
16		635574.5	4975934	0.00079	2215.74	2844.3	0	ANNUAL	ALL	1				
17		635599.5	4975934	0.00078	2218.34	2844.3	0	ANNUAL	ALL	1				
18		635399.5	4975959	0.00083	2202.75	2844.3	0	ANNUAL	ALL	1				
19		635424.5	4975959	0.00082	2204.36	2844.3	0	ANNUAL	ALL	1				
20		635449.5	4975959	0.00082	2204.87	2844.3	0	ANNUAL	ALL	1				
21		635474.5	4975959	0.00082	2206.39	2844.3	0	ANNUAL	ALL	1				
22		635499.5	4975959	0.00081	2208.99	2844.3	0	ANNUAL	ALL	1				
23		635524.5	4975959	0.0008	2210.99	2844.3	0	ANNUAL	ALL	1				
24		635549.5	4975959	0.0008	2211.29	2844.3	0	ANNUAL	ALL	1				
25		635574.5	4975959	0.0008	2210.92	2844.3	0	ANNUAL	ALL	1				
26		635599.5	4975959	0.00081	2208.83	2844.3	0	ANNUAL	ALL	1				
27		635399.5	4975984	0.00085	2195.09	2844.3	0	ANNUAL	ALL	1				
28		635424.5	4975984	0.00084	2198.19	2844.3	0	ANNUAL	ALL	1				
29		635449.5	4975984	0.00084	2198.7	2844.3	0	ANNUAL	ALL	1				
30		635474.5	4975984	0.00083	2201.57	2844.3	0	ANNUAL	ALL	1				
31		635499.5	4975984	0.00082	2203.99	2844.3	0	ANNUAL	ALL	1				
32		635524.5	4975984	0.00081	2206.27	2844.3	0	ANNUAL	ALL	1				
33		635549.5	4975984	0.00081	2206.83	2844.3	0	ANNUAL	ALL	1				
34		635574.5	4975984	0.00082	2205.61	2844.3	0	ANNUAL	ALL	1				
35		635599.5	4975984	0.00083	2202.99	2844.3	0	ANNUAL	ALL	1				
36		635399.5	4976009	0.00083	2195.69	2844.3	0	ANNUAL	ALL	1				
37		635424.5	4976009	0.00086	2189.65	2844.3	0	ANNUAL	ALL	1				
38		635449.5	4976009	0.00085	2194	2844.3	0	ANNUAL	ALL	1				
39		635474.5	4976009	0.00082	2200.13	2844.3	0	ANNUAL	ALL	1				
40		635499.5	4976009	0.00082	2202.83	2844.3	0	ANNUAL	ALL	1				
41		635524.5	4976009	0.00082	2203.57	2844.3	0	ANNUAL	ALL	1				
42		635549.5	4976009	0.00082	2203.82	2844.3	0	ANNUAL	ALL	1				
43		635574.5	4976009	0.00082	2202.81	2844.3	0	ANNUAL	ALL	1				
44		635599.5	4976009	0.00083	2200.59	2844.3	0	ANNUAL	ALL	1				
45		635399.5	4976034	0.00082	2198.23	2844.3	0	ANNUAL	ALL	1				
46		635424.5	4976034	0.00086	2186.98	2844.3	0	ANNUAL	ALL	1				
47		635449.5	4976034	0.00085	2190.14	2844.3	0	ANNUAL	ALL	1				
48		635474.5	4976034	0.00082	2198.63	2844.3	0	ANNUAL	ALL	1				
49		635499.5	4976034	0.00082	2198.93	2844.3	0	ANNUAL	ALL	1				
50		635524.5	4976034	0.00082	2199.39	2844.3	0	ANNUAL	ALL	1				
51		635549.5	4976034	0.00082	2201.1	2844.3	0	ANNUAL	ALL	1				
52		635574.5	4976034	0.00082	2200.59	2844.3	0	ANNUAL	ALL	1				
53		635599.5	4976034	0.00083	2197.96	2844.3	0	ANNUAL	ALL	1				
54		635399.5	4976059	0.00081	2196.33	2844.3	0	ANNUAL	ALL	1				
55		635424.5	4976059	0.00086	2184.09	2844.3	0	ANNUAL	ALL	1				
56		635449.5	4976059	0.00087	2180.82	2844.3	0	ANNUAL	ALL	1				
57		635474.5	4976059	0.00083	2193.11	2844.3	0	ANNUAL	ALL	1				
58		635499.5	4976059	0.00083	2194.5	2844.3	0	ANNUAL	ALL	1				
59		635524.5	4976059	0.00082	2197.17	2844.3	0	ANNUAL	ALL	1				
60		635549.5	4976059	0.00081	2199.4	2844.3	0	ANNUAL	ALL	1				
61		635574.5	4976059	0.00082	2198.27	2844.3	0	ANNUAL	ALL	1				
62		635599.5	4976059	0.00084	2194.62	2844.3	0	ANNUAL	ALL	1				
63		635399.5	4976084	0.00083	2188.98	2844.3	0	ANNUAL	ALL	1				
64		635424.5	4976084	0.00086	2180.22	2844.3	0	ANNUAL	ALL	1				
65		635449.5	4976084	0.00088	2174.51	2844.3	0	ANNUAL	ALL	1				
66		635474.5	4976084	0.00086	2180.27	2844.3	0	ANNUAL	ALL	1				
67		635499.5	4976084	0.00085	2185.71	2844.3	0	ANNUAL	ALL	1				
68		635524.5	4976084	0.00083	2191.13	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
69		635549.5	4976084	0.00082	2193.95	2844.3	0	ANNUAL	ALL	1				
70		635574.5	4976084	0.00084	2190.58	2844.3	0	ANNUAL	ALL	1				
71		635599.5	4976084	0.00087	2183.01	2844.3	0	ANNUAL	ALL	1				
72		635399.5	4976109	0.00084	2182.28	2844.3	0	ANNUAL	ALL	1				
73		635424.5	4976109	0.00086	2177.24	2844.3	0	ANNUAL	ALL	1				
74		635449.5	4976109	0.00088	2171.45	2844.3	0	ANNUAL	ALL	1				
75		635474.5	4976109	0.00088	2172.26	2844.3	0	ANNUAL	ALL	1				
76		635499.5	4976109	0.00087	2177.58	2844.3	0	ANNUAL	ALL	1				
77		635524.5	4976109	0.00086	2180.23	2844.3	0	ANNUAL	ALL	1				
78		635549.5	4976109	0.00086	2179.81	2844.3	0	ANNUAL	ALL	1				
79		635574.5	4976109	0.00088	2176.94	2844.3	0	ANNUAL	ALL	1				
80		635599.5	4976109	0.00087	2179.4	2844.3	0	ANNUAL	ALL	1				
81		635399.5	4976134	0.00085	2176.77	2844.3	0	ANNUAL	ALL	1				
82		635424.5	4976134	0.00086	2174.27	2844.3	0	ANNUAL	ALL	1				
83		635449.5	4976134	0.00087	2171.04	2844.3	0	ANNUAL	ALL	1				
84		635474.5	4976134	0.00089	2166.4	2844.3	0	ANNUAL	ALL	1				
85		635499.5	4976134	0.00089	2167.48	2844.3	0	ANNUAL	ALL	1				
86		635524.5	4976134	0.00088	2172.09	2844.3	0	ANNUAL	ALL	1				
87		635549.5	4976134	0.00088	2171.44	2844.3	0	ANNUAL	ALL	1				
88		635574.5	4976134	0.00088	2172.93	2844.3	0	ANNUAL	ALL	1				
89		635599.5	4976134	0.00086	2178.31	2844.3	0	ANNUAL	ALL	1				
90		635199.5	4976834	0.00087	2116.83	2844.3	0	ANNUAL	ALL	1				
91		635224.5	4976834	0.0009	2112.53	2844.3	0	ANNUAL	ALL	1				
92		635249.5	4976834	0.00094	2108.39	2844.3	0	ANNUAL	ALL	1				
93		635274.5	4976834	0.00097	2105.23	2844.3	0	ANNUAL	ALL	1				
94		635299.5	4976834	0.001	2101.6	2844.3	0	ANNUAL	ALL	1				
95		635324.5	4976834	0.00103	2098.74	2844.3	0	ANNUAL	ALL	1				
96		635349.5	4976834	0.00098	2104.26	2844.3	0	ANNUAL	ALL	1				
97		635374.5	4976834	0.00093	2110.4	2844.3	0	ANNUAL	ALL	1				
98		635399.5	4976834	0.00088	2117.98	2844.3	0	ANNUAL	ALL	1				
99		635199.5	4976859	0.00087	2114.34	2844.3	0	ANNUAL	ALL	1				
100		635224.5	4976859	0.00092	2108.68	2844.3	0	ANNUAL	ALL	1				
101		635249.5	4976859	0.00096	2104.42	2844.3	0	ANNUAL	ALL	1				
102		635274.5	4976859	0.00098	2101.28	2844.3	0	ANNUAL	ALL	1				
103		635299.5	4976859	0.00101	2098.83	2844.3	0	ANNUAL	ALL	1				
104		635324.5	4976859	0.00104	2096.89	2844.3	0	ANNUAL	ALL	1				
105		635349.5	4976859	0.001	2101.21	2844.3	0	ANNUAL	ALL	1				
106		635374.5	4976859	0.00094	2108.71	2844.3	0	ANNUAL	ALL	1				
107		635399.5	4976859	0.00087	2118.31	2844.3	0	ANNUAL	ALL	1				
108		635199.5	4976884	0.00088	2111.17	2844.3	0	ANNUAL	ALL	1				
109		635224.5	4976884	0.00093	2104.78	2844.3	0	ANNUAL	ALL	1				
110		635249.5	4976884	0.00098	2100.14	2844.3	0	ANNUAL	ALL	1				
111		635274.5	4976884	0.00101	2097.48	2844.3	0	ANNUAL	ALL	1				
112		635299.5	4976884	0.00103	2095.42	2844.3	0	ANNUAL	ALL	1				
113		635324.5	4976884	0.00104	2094.96	2844.3	0	ANNUAL	ALL	1				
114		635349.5	4976884	0.00102	2097.83	2844.3	0	ANNUAL	ALL	1				
115		635374.5	4976884	0.00093	2107.96	2844.3	0	ANNUAL	ALL	1				
116		635399.5	4976884	0.00085	2119.17	2844.3	0	ANNUAL	ALL	1				
117		635199.5	4976909	0.00088	2108.51	2844.3	0	ANNUAL	ALL	1				
118		635224.5	4976909	0.00094	2102.17	2844.3	0	ANNUAL	ALL	1				
119		635249.5	4976909	0.00099	2097.31	2844.3	0	ANNUAL	ALL	1				
120		635274.5	4976909	0.00102	2094.85	2844.3	0	ANNUAL	ALL	1				
121		635299.5	4976909	0.00104	2093.19	2844.3	0	ANNUAL	ALL	1				
122		635324.5	4976909	0.00104	2093.48	2844.3	0	ANNUAL	ALL	1				
123		635349.5	4976909	0.001	2098.12	2844.3	0	ANNUAL	ALL	1				
124		635374.5	4976909	0.00091	2108.79	2844.3	0	ANNUAL	ALL	1				
125		635399.5	4976909	0.00083	2120.74	2844.3	0	ANNUAL	ALL	1				
126		635199.5	4976934	0.00088	2106.38	2844.3	0	ANNUAL	ALL	1				
127		635224.5	4976934	0.00093	2100.81	2844.3	0	ANNUAL	ALL	1				
128		635249.5	4976934	0.00098	2096.21	2844.3	0	ANNUAL	ALL	1				
129		635274.5	4976934	0.00102	2092.89	2844.3	0	ANNUAL	ALL	1				
130		635299.5	4976934	0.00104	2091.1	2844.3	0	ANNUAL	ALL	1				
131		635324.5	4976934	0.00103	2092.46	2844.3	0	ANNUAL	ALL	1				
132		635349.5	4976934	0.00097	2099.48	2844.3	0	ANNUAL	ALL	1				
133		635374.5	4976934	0.00089	2110.37	2844.3	0	ANNUAL	ALL	1				
134		635399.5	4976934	0.00081	2122.91	2844.3	0	ANNUAL	ALL	1				
135		635199.5	4976959	0.00088	2104.62	2844.3	0	ANNUAL	ALL	1				
136		635224.5	4976959	0.00093	2099.28	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
137		635249.5	4976959	0.00098	2094.41	2844.3	0	ANNUAL	ALL	1				
138		635274.5	4976959	0.00102	2090.59	2844.3	0	ANNUAL	ALL	1				
139		635299.5	4976959	0.00105	2088.8	2844.3	0	ANNUAL	ALL	1				
140		635324.5	4976959	0.00102	2092.02	2844.3	0	ANNUAL	ALL	1				
141		635349.5	4976959	0.00095	2100.12	2844.3	0	ANNUAL	ALL	1				
142		635374.5	4976959	0.00086	2112.07	2844.3	0	ANNUAL	ALL	1				
143		635399.5	4976959	0.00078	2125.69	2844.3	0	ANNUAL	ALL	1				
144		635199.5	4976984	0.00088	2102.45	2844.3	0	ANNUAL	ALL	1				
145		635224.5	4976984	0.00093	2097.29	2844.3	0	ANNUAL	ALL	1				
146		635249.5	4976984	0.00099	2091.62	2844.3	0	ANNUAL	ALL	1				
147		635274.5	4976984	0.00103	2087.92	2844.3	0	ANNUAL	ALL	1				
148		635299.5	4976984	0.00105	2086.81	2844.3	0	ANNUAL	ALL	1				
149		635324.5	4976984	0.001	2092.65	2844.3	0	ANNUAL	ALL	1				
150		635349.5	4976984	0.00092	2101.3	2844.3	0	ANNUAL	ALL	1				
151		635374.5	4976984	0.00083	2114.13	2844.3	0	ANNUAL	ALL	1				
152		635399.5	4976984	0.00076	2128.46	2844.3	0	ANNUAL	ALL	1				
153		635199.5	4977009	0.00088	2099.39	2844.3	0	ANNUAL	ALL	1				
154		635224.5	4977009	0.00094	2093.66	2844.3	0	ANNUAL	ALL	1				
155		635249.5	4977009	0.001	2087.97	2844.3	0	ANNUAL	ALL	1				
156		635274.5	4977009	0.00104	2084.9	2844.3	0	ANNUAL	ALL	1				
157		635299.5	4977009	0.00102	2087.43	2844.3	0	ANNUAL	ALL	1				
158		635324.5	4977009	0.00096	2094.55	2844.3	0	ANNUAL	ALL	1				
159		635349.5	4977009	0.00089	2103.74	2844.3	0	ANNUAL	ALL	1				
160		635374.5	4977009	0.0008	2116.64	2844.3	0	ANNUAL	ALL	1				
161		635399.5	4977009	0.00073	2131.12	2844.3	0	ANNUAL	ALL	1				
162		635199.5	4977034	0.0009	2094.63	2844.3	0	ANNUAL	ALL	1				
163		635224.5	4977034	0.00096	2088.76	2844.3	0	ANNUAL	ALL	1				
164		635249.5	4977034	0.00101	2084.27	2844.3	0	ANNUAL	ALL	1				
165		635274.5	4977034	0.00104	2082.71	2844.3	0	ANNUAL	ALL	1				
166		635299.5	4977034	0.00098	2089.9	2844.3	0	ANNUAL	ALL	1				
167		635324.5	4977034	0.00091	2098.21	2844.3	0	ANNUAL	ALL	1				
168		635349.5	4977034	0.00085	2107.49	2844.3	0	ANNUAL	ALL	1				
169		635374.5	4977034	0.00078	2119.09	2844.3	0	ANNUAL	ALL	1				
170		635399.5	4977034	0.00072	2133.38	2844.3	0	ANNUAL	ALL	1				
171		634899.5	4977134	0.0004	2221.02	2844.3	0	ANNUAL	ALL	1				
172		634924.5	4977134	0.00042	2207.85	2844.3	0	ANNUAL	ALL	1				
173		634949.5	4977134	0.00045	2190.45	2844.3	0	ANNUAL	ALL	1				
174		634974.5	4977134	0.00049	2169.12	2844.3	0	ANNUAL	ALL	1				
175		634999.5	4977134	0.00053	2150.64	2844.3	0	ANNUAL	ALL	1				
176		635024.5	4977134	0.00058	2135.97	2844.3	0	ANNUAL	ALL	1				
177		635049.5	4977134	0.00062	2122.38	2844.3	0	ANNUAL	ALL	1				
178		635074.5	4977134	0.00067	2113.7	2844.3	0	ANNUAL	ALL	1				
179		635099.5	4977134	0.00071	2105.9	2844.3	0	ANNUAL	ALL	1				
180		634899.5	4977159	0.0004	2213.37	2844.3	0	ANNUAL	ALL	1				
181		634924.5	4977159	0.00042	2201.16	2844.3	0	ANNUAL	ALL	1				
182		634949.5	4977159	0.00045	2181.17	2844.3	0	ANNUAL	ALL	1				
183		634974.5	4977159	0.00049	2161.72	2844.3	0	ANNUAL	ALL	1				
184		634999.5	4977159	0.00053	2145.73	2844.3	0	ANNUAL	ALL	1				
185		635024.5	4977159	0.00057	2132.12	2844.3	0	ANNUAL	ALL	1				
186		635049.5	4977159	0.00062	2119.59	2844.3	0	ANNUAL	ALL	1				
187		635074.5	4977159	0.00067	2109.27	2844.3	0	ANNUAL	ALL	1				
188		635099.5	4977159	0.00072	2101.29	2844.3	0	ANNUAL	ALL	1				
189		634899.5	4977184	0.0004	2206.56	2844.3	0	ANNUAL	ALL	1				
190		634924.5	4977184	0.00042	2193.64	2844.3	0	ANNUAL	ALL	1				
191		634949.5	4977184	0.00046	2172.29	2844.3	0	ANNUAL	ALL	1				
192		634974.5	4977184	0.00049	2154.5	2844.3	0	ANNUAL	ALL	1				
193		634999.5	4977184	0.00053	2141.04	2844.3	0	ANNUAL	ALL	1				
194		635024.5	4977184	0.00057	2128.3	2844.3	0	ANNUAL	ALL	1				
195		635049.5	4977184	0.00062	2114.34	2844.3	0	ANNUAL	ALL	1				
196		635074.5	4977184	0.00068	2102.7	2844.3	0	ANNUAL	ALL	1				
197		635099.5	4977184	0.00073	2096.47	2844.3	0	ANNUAL	ALL	1				
198		634899.5	4977209	0.0004	2199.13	2844.3	0	ANNUAL	ALL	1				
199		634924.5	4977209	0.00043	2184.15	2844.3	0	ANNUAL	ALL	1				
200		634949.5	4977209	0.00046	2163.72	2844.3	0	ANNUAL	ALL	1				
201		634974.5	4977209	0.0005	2146.68	2844.3	0	ANNUAL	ALL	1				
202		634999.5	4977209	0.00053	2136.15	2844.3	0	ANNUAL	ALL	1				
203		635024.5	4977209	0.00056	2124.22	2844.3	0	ANNUAL	ALL	1				
204		635049.5	4977209	0.00064	2105.9	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
205		635074.5	4977209	0.0007	2096.39	2844.3	0	ANNUAL	ALL	1				
206		635099.5	4977209	0.00074	2091.31	2844.3	0	ANNUAL	ALL	1				
207		634899.5	4977234	0.00041	2185.16	2844.3	0	ANNUAL	ALL	1				
208		634924.5	4977234	0.00043	2172.04	2844.3	0	ANNUAL	ALL	1				
209		634949.5	4977234	0.00047	2152.41	2844.3	0	ANNUAL	ALL	1				
210		634974.5	4977234	0.0005	2139.97	2844.3	0	ANNUAL	ALL	1				
211		634999.5	4977234	0.00052	2130.73	2844.3	0	ANNUAL	ALL	1				
212		635024.5	4977234	0.00057	2117.31	2844.3	0	ANNUAL	ALL	1				
213		635049.5	4977234	0.00066	2098.65	2844.3	0	ANNUAL	ALL	1				
214		635074.5	4977234	0.0007	2092.39	2844.3	0	ANNUAL	ALL	1				
215		635099.5	4977234	0.00074	2087.32	2844.3	0	ANNUAL	ALL	1				
216		634899.5	4977259	0.00041	2180.4	2844.3	0	ANNUAL	ALL	1				
217		634924.5	4977259	0.00044	2160.19	2844.3	0	ANNUAL	ALL	1				
218		634949.5	4977259	0.00047	2143.3	2844.3	0	ANNUAL	ALL	1				
219		634974.5	4977259	0.0005	2132.11	2844.3	0	ANNUAL	ALL	1				
220		634999.5	4977259	0.00053	2123.02	2844.3	0	ANNUAL	ALL	1				
221		635024.5	4977259	0.00059	2107.09	2844.3	0	ANNUAL	ALL	1				
222		635049.5	4977259	0.00065	2095.35	2844.3	0	ANNUAL	ALL	1				
223		635074.5	4977259	0.0007	2089.07	2844.3	0	ANNUAL	ALL	1				
224		635099.5	4977259	0.00074	2083.6	2844.3	0	ANNUAL	ALL	1				
225		634899.5	4977284	0.0004	2180.69	2844.3	0	ANNUAL	ALL	1				
226		634924.5	4977284	0.00043	2158.28	2844.3	0	ANNUAL	ALL	1				
227		634949.5	4977284	0.00047	2139.34	2844.3	0	ANNUAL	ALL	1				
228		634974.5	4977284	0.00051	2123.05	2844.3	0	ANNUAL	ALL	1				
229		634999.5	4977284	0.00055	2112.91	2844.3	0	ANNUAL	ALL	1				
230		635024.5	4977284	0.0006	2100.55	2844.3	0	ANNUAL	ALL	1				
231		635049.5	4977284	0.00065	2092.76	2844.3	0	ANNUAL	ALL	1				
232		635074.5	4977284	0.00069	2085.71	2844.3	0	ANNUAL	ALL	1				
233		635099.5	4977284	0.00075	2078.67	2844.3	0	ANNUAL	ALL	1				
234		634899.5	4977309	0.00039	2178.55	2844.3	0	ANNUAL	ALL	1				
235		634924.5	4977309	0.00042	2156.77	2844.3	0	ANNUAL	ALL	1				
236		634949.5	4977309	0.00046	2136.54	2844.3	0	ANNUAL	ALL	1				
237		634974.5	4977309	0.00051	2119.59	2844.3	0	ANNUAL	ALL	1				
238		634999.5	4977309	0.00055	2107.01	2844.3	0	ANNUAL	ALL	1				
239		635024.5	4977309	0.0006	2096.52	2844.3	0	ANNUAL	ALL	1				
240		635049.5	4977309	0.00064	2089.24	2844.3	0	ANNUAL	ALL	1				
241		635074.5	4977309	0.00069	2082.55	2844.3	0	ANNUAL	ALL	1				
242		635099.5	4977309	0.00074	2075.98	2844.3	0	ANNUAL	ALL	1				
243		634899.5	4977334	0.00039	2173.18	2844.3	0	ANNUAL	ALL	1				
244		634924.5	4977334	0.00042	2153.29	2844.3	0	ANNUAL	ALL	1				
245		634949.5	4977334	0.00046	2133.9	2844.3	0	ANNUAL	ALL	1				
246		634974.5	4977334	0.0005	2117.58	2844.3	0	ANNUAL	ALL	1				
247		634999.5	4977334	0.00055	2104.03	2844.3	0	ANNUAL	ALL	1				
248		635024.5	4977334	0.00059	2093.8	2844.3	0	ANNUAL	ALL	1				
249		635049.5	4977334	0.00064	2085.23	2844.3	0	ANNUAL	ALL	1				
250		635074.5	4977334	0.00069	2078.76	2844.3	0	ANNUAL	ALL	1				
251		635099.5	4977334	0.00072	2074.53	2844.3	0	ANNUAL	ALL	1				
252		635399.5	4976159	0.00085	2171.27	2844.3	0	ANNUAL	ALL	1				
253		635424.5	4976159	0.00086	2169.98	2844.3	0	ANNUAL	ALL	1				
254		635449.5	4976159	0.00087	2167.61	2844.3	0	ANNUAL	ALL	1				
255		635474.5	4976159	0.00089	2164.06	2844.3	0	ANNUAL	ALL	1				
256		635499.5	4976159	0.0009	2161.76	2844.3	0	ANNUAL	ALL	1				
257		635524.5	4976159	0.00091	2160.48	2844.3	0	ANNUAL	ALL	1				
258		635549.5	4976159	0.00091	2162.19	2844.3	0	ANNUAL	ALL	1				
259		635574.5	4976159	0.00089	2168.15	2844.3	0	ANNUAL	ALL	1				
260		635599.5	4976159	0.00087	2173.85	2844.3	0	ANNUAL	ALL	1				
261		635399.5	4976184	0.00085	2168.06	2844.3	0	ANNUAL	ALL	1				
262		635424.5	4976184	0.00086	2166.17	2844.3	0	ANNUAL	ALL	1				
263		635449.5	4976184	0.00087	2163.95	2844.3	0	ANNUAL	ALL	1				
264		635474.5	4976184	0.00089	2161.05	2844.3	0	ANNUAL	ALL	1				
265		635499.5	4976184	0.0009	2158.86	2844.3	0	ANNUAL	ALL	1				
266		635524.5	4976184	0.00091	2157.1	2844.3	0	ANNUAL	ALL	1				
267		635549.5	4976184	0.00091	2157.07	2844.3	0	ANNUAL	ALL	1				
268		635574.5	4976184	0.00089	2164.59	2844.3	0	ANNUAL	ALL	1				
269		635599.5	4976184	0.00086	2172.06	2844.3	0	ANNUAL	ALL	1				
270		635399.5	4976209	0.00085	2165.29	2844.3	0	ANNUAL	ALL	1				
271		635424.5	4976209	0.00086	2163.14	2844.3	0	ANNUAL	ALL	1				
272		635449.5	4976209	0.00088	2160.76	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
273		635474.5	4976209	0.00089	2158.05	2844.3	0	ANNUAL	ALL	1				
274		635499.5	4976209	0.0009	2155.43	2844.3	0	ANNUAL	ALL	1				
275		635524.5	4976209	0.00092	2153.57	2844.3	0	ANNUAL	ALL	1				
276		635549.5	4976209	0.00091	2156.02	2844.3	0	ANNUAL	ALL	1				
277		635574.5	4976209	0.00087	2165.26	2844.3	0	ANNUAL	ALL	1				
278		635599.5	4976209	0.00084	2175.01	2844.3	0	ANNUAL	ALL	1				
279		635399.5	4976234	0.00085	2162.56	2844.3	0	ANNUAL	ALL	1				
280		635424.5	4976234	0.00086	2160.46	2844.3	0	ANNUAL	ALL	1				
281		635449.5	4976234	0.00088	2157.93	2844.3	0	ANNUAL	ALL	1				
282		635474.5	4976234	0.00089	2155.5	2844.3	0	ANNUAL	ALL	1				
283		635499.5	4976234	0.0009	2152.67	2844.3	0	ANNUAL	ALL	1				
284		635524.5	4976234	0.00092	2150.12	2844.3	0	ANNUAL	ALL	1				
285		635549.5	4976234	0.00089	2156.6	2844.3	0	ANNUAL	ALL	1				
286		635574.5	4976234	0.00085	2167.62	2844.3	0	ANNUAL	ALL	1				
287		635599.5	4976234	0.00082	2178.35	2844.3	0	ANNUAL	ALL	1				
288		634999.5	4978134	0.00029	2044.53	2844.3	0	ANNUAL	ALL	1				
289		635024.5	4978134	0.00031	2030.56	2844.3	0	ANNUAL	ALL	1				
290		635049.5	4978134	0.00033	2018.07	2844.3	0	ANNUAL	ALL	1				
291		635074.5	4978134	0.00035	2006.69	2844.3	0	ANNUAL	ALL	1				
292		635099.5	4978134	0.00035	2006.39	2844.3	0	ANNUAL	ALL	1				
293		635124.5	4978134	0.00035	2013.34	2844.3	0	ANNUAL	ALL	1				
294		635149.5	4978134	0.00035	2020.75	2844.3	0	ANNUAL	ALL	1				
295		635174.5	4978134	0.00034	2029.05	2844.3	0	ANNUAL	ALL	1				
296		635199.5	4978134	0.00033	2038.91	2844.3	0	ANNUAL	ALL	1				
297		634999.5	4978159	0.00029	2044.5	2844.3	0	ANNUAL	ALL	1				
298		635024.5	4978159	0.0003	2030.78	2844.3	0	ANNUAL	ALL	1				
299		635049.5	4978159	0.00032	2017.35	2844.3	0	ANNUAL	ALL	1				
300		635074.5	4978159	0.00034	2004.54	2844.3	0	ANNUAL	ALL	1				
301		635099.5	4978159	0.00035	2003.81	2844.3	0	ANNUAL	ALL	1				
302		635124.5	4978159	0.00035	2010.57	2844.3	0	ANNUAL	ALL	1				
303		635149.5	4978159	0.00034	2017.75	2844.3	0	ANNUAL	ALL	1				
304		635174.5	4978159	0.00034	2025.18	2844.3	0	ANNUAL	ALL	1				
305		635199.5	4978159	0.00033	2035.11	2844.3	0	ANNUAL	ALL	1				
306		634999.5	4978184	0.00028	2044.38	2844.3	0	ANNUAL	ALL	1				
307		635024.5	4978184	0.0003	2028.98	2844.3	0	ANNUAL	ALL	1				
308		635049.5	4978184	0.00032	2015.36	2844.3	0	ANNUAL	ALL	1				
309		635074.5	4978184	0.00033	2002.43	2844.3	0	ANNUAL	ALL	1				
310		635099.5	4978184	0.00034	2000.86	2844.3	0	ANNUAL	ALL	1				
311		635124.5	4978184	0.00034	2007.53	2844.3	0	ANNUAL	ALL	1				
312		635149.5	4978184	0.00034	2014.6	2844.3	0	ANNUAL	ALL	1				
313		635174.5	4978184	0.00033	2022.07	2844.3	0	ANNUAL	ALL	1				
314		635199.5	4978184	0.00033	2031.45	2844.3	0	ANNUAL	ALL	1				
315		634999.5	4978209	0.00028	2043.46	2844.3	0	ANNUAL	ALL	1				
316		635024.5	4978209	0.00029	2027.94	2844.3	0	ANNUAL	ALL	1				
317		635049.5	4978209	0.00031	2013.73	2844.3	0	ANNUAL	ALL	1				
318		635074.5	4978209	0.00033	2000.96	2844.3	0	ANNUAL	ALL	1				
319		635099.5	4978209	0.00033	1998.75	2844.3	0	ANNUAL	ALL	1				
320		635124.5	4978209	0.00033	2004.56	2844.3	0	ANNUAL	ALL	1				
321		635149.5	4978209	0.00033	2011.78	2844.3	0	ANNUAL	ALL	1				
322		635174.5	4978209	0.00033	2019.36	2844.3	0	ANNUAL	ALL	1				
323		635199.5	4978209	0.00032	2027.82	2844.3	0	ANNUAL	ALL	1				
324		634999.5	4978234	0.00027	2042.97	2844.3	0	ANNUAL	ALL	1				
325		635024.5	4978234	0.00029	2026.61	2844.3	0	ANNUAL	ALL	1				
326		635049.5	4978234	0.00031	2012.57	2844.3	0	ANNUAL	ALL	1				
327		635074.5	4978234	0.00032	2000.24	2844.3	0	ANNUAL	ALL	1				
328		635099.5	4978234	0.00033	1996.61	2844.3	0	ANNUAL	ALL	1				
329		635124.5	4978234	0.00033	2001.65	2844.3	0	ANNUAL	ALL	1				
330		635149.5	4978234	0.00033	2009.16	2844.3	0	ANNUAL	ALL	1				
331		635174.5	4978234	0.00032	2016.86	2844.3	0	ANNUAL	ALL	1				
332		635199.5	4978234	0.00032	2024.48	2844.3	0	ANNUAL	ALL	1				
333		634999.5	4978259	0.00027	2041.08	2844.3	0	ANNUAL	ALL	1				
334		635024.5	4978259	0.00028	2024.08	2844.3	0	ANNUAL	ALL	1				
335		635049.5	4978259	0.0003	2011.49	2844.3	0	ANNUAL	ALL	1				
336		635074.5	4978259	0.00031	2000.61	2844.3	0	ANNUAL	ALL	1				
337		635099.5	4978259	0.00032	1994.84	2844.3	0	ANNUAL	ALL	1				
338		635124.5	4978259	0.00032	1999.29	2844.3	0	ANNUAL	ALL	1				
339		635149.5	4978259	0.00032	2007.14	2844.3	0	ANNUAL	ALL	1				
340		635174.5	4978259	0.00032	2014.96	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
341		635199.5	4978259	0.00031	2023.44	2844.3	0	ANNUAL	ALL	1				
342		634999.5	4978284	0.00026	2039.02	2844.3	0	ANNUAL	ALL	1				
343		635024.5	4978284	0.00028	2022.69	2844.3	0	ANNUAL	ALL	1				
344		635049.5	4978284	0.0003	2010.11	2844.3	0	ANNUAL	ALL	1				
345		635074.5	4978284	0.00031	1999.28	2844.3	0	ANNUAL	ALL	1				
346		635099.5	4978284	0.00031	1993.94	2844.3	0	ANNUAL	ALL	1				
347		635124.5	4978284	0.00031	1996.86	2844.3	0	ANNUAL	ALL	1				
348		635149.5	4978284	0.00031	2004.78	2844.3	0	ANNUAL	ALL	1				
349		635174.5	4978284	0.00031	2012.7	2844.3	0	ANNUAL	ALL	1				
350		635199.5	4978284	0.0003	2021.78	2844.3	0	ANNUAL	ALL	1				
351		634999.5	4978309	0.00026	2036.72	2844.3	0	ANNUAL	ALL	1				
352		635024.5	4978309	0.00027	2023.32	2844.3	0	ANNUAL	ALL	1				
353		635049.5	4978309	0.00029	2010.1	2844.3	0	ANNUAL	ALL	1				
354		635074.5	4978309	0.0003	1999.36	2844.3	0	ANNUAL	ALL	1				
355		635099.5	4978309	0.00031	1992.81	2844.3	0	ANNUAL	ALL	1				
356		635124.5	4978309	0.00031	1994.13	2844.3	0	ANNUAL	ALL	1				
357		635149.5	4978309	0.00031	2001.68	2844.3	0	ANNUAL	ALL	1				
358		635174.5	4978309	0.00031	2009.75	2844.3	0	ANNUAL	ALL	1				
359		635199.5	4978309	0.0003	2018.84	2844.3	0	ANNUAL	ALL	1				
360		634999.5	4978334	0.00026	2033.58	2844.3	0	ANNUAL	ALL	1				
361		635024.5	4978334	0.00027	2021.76	2844.3	0	ANNUAL	ALL	1				
362		635049.5	4978334	0.00028	2009.59	2844.3	0	ANNUAL	ALL	1				
363		635074.5	4978334	0.00029	1999.33	2844.3	0	ANNUAL	ALL	1				
364		635099.5	4978334	0.0003	1991.74	2844.3	0	ANNUAL	ALL	1				
365		635124.5	4978334	0.0003	1991.62	2844.3	0	ANNUAL	ALL	1				
366		635149.5	4978334	0.0003	1998.49	2844.3	0	ANNUAL	ALL	1				
367		635174.5	4978334	0.0003	2006.18	2844.3	0	ANNUAL	ALL	1				
368		635199.5	4978334	0.0003	2015.32	2844.3	0	ANNUAL	ALL	1				
369		634299.5	4978134	0.00022	2065.05	2844.3	0	ANNUAL	ALL	1				
370		634324.5	4978134	0.00023	2052.1	2844.3	0	ANNUAL	ALL	1				
371		634349.5	4978134	0.00024	2045.24	2844.3	0	ANNUAL	ALL	1				
372		634374.5	4978134	0.00025	2034.94	2844.3	0	ANNUAL	ALL	1				
373		634399.5	4978134	0.00026	2020.36	2844.3	0	ANNUAL	ALL	1				
374		634424.5	4978134	0.00027	2003.67	2844.3	0	ANNUAL	ALL	1				
375		634449.5	4978134	0.00028	1995.29	2844.3	0	ANNUAL	ALL	1				
376		634474.5	4978134	0.00027	2007.74	2844.3	0	ANNUAL	ALL	1				
377		634499.5	4978134	0.00026	2026.56	2844.3	0	ANNUAL	ALL	1				
378		634299.5	4978159	0.00023	2056.37	2844.3	0	ANNUAL	ALL	1				
379		634324.5	4978159	0.00024	2043.39	2844.3	0	ANNUAL	ALL	1				
380		634349.5	4978159	0.00024	2031.51	2844.3	0	ANNUAL	ALL	1				
381		634374.5	4978159	0.00025	2023.05	2844.3	0	ANNUAL	ALL	1				
382		634399.5	4978159	0.00026	2009.29	2844.3	0	ANNUAL	ALL	1				
383		634424.5	4978159	0.00027	1995	2844.3	0	ANNUAL	ALL	1				
384		634449.5	4978159	0.00027	1992.7	2844.3	0	ANNUAL	ALL	1				
385		634474.5	4978159	0.00027	2006.88	2844.3	0	ANNUAL	ALL	1				
386		634499.5	4978159	0.00026	2023.97	2844.3	0	ANNUAL	ALL	1				
387		634299.5	4978184	0.00023	2049.3	2844.3	0	ANNUAL	ALL	1				
388		634324.5	4978184	0.00024	2036.32	2844.3	0	ANNUAL	ALL	1				
389		634349.5	4978184	0.00024	2022.34	2844.3	0	ANNUAL	ALL	1				
390		634374.5	4978184	0.00025	2009.09	2844.3	0	ANNUAL	ALL	1				
391		634399.5	4978184	0.00026	1999.89	2844.3	0	ANNUAL	ALL	1				
392		634424.5	4978184	0.00027	1987.52	2844.3	0	ANNUAL	ALL	1				
393		634449.5	4978184	0.00027	1991.46	2844.3	0	ANNUAL	ALL	1				
394		634474.5	4978184	0.00026	2006.06	2844.3	0	ANNUAL	ALL	1				
395		634499.5	4978184	0.00025	2020.38	2844.3	0	ANNUAL	ALL	1				
396		634299.5	4978209	0.00023	2043.21	2844.3	0	ANNUAL	ALL	1				
397		634324.5	4978209	0.00024	2030.6	2844.3	0	ANNUAL	ALL	1				
398		634349.5	4978209	0.00024	2016.03	2844.3	0	ANNUAL	ALL	1				
399		634374.5	4978209	0.00025	2000.87	2844.3	0	ANNUAL	ALL	1				
400		634399.5	4978209	0.00026	1990.53	2844.3	0	ANNUAL	ALL	1				
401		634424.5	4978209	0.00028	1981.32	2844.3	0	ANNUAL	ALL	1				
402		634449.5	4978209	0.00027	1989.45	2844.3	0	ANNUAL	ALL	1				
403		634474.5	4978209	0.00026	2004.01	2844.3	0	ANNUAL	ALL	1				
404		634499.5	4978209	0.00025	2016.91	2844.3	0	ANNUAL	ALL	1				
405		634299.5	4978234	0.00023	2037.27	2844.3	0	ANNUAL	ALL	1				
406		634324.5	4978234	0.00023	2025.09	2844.3	0	ANNUAL	ALL	1				
407		634349.5	4978234	0.00024	2009.81	2844.3	0	ANNUAL	ALL	1				
408		634374.5	4978234	0.00025	1996.13	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
409		634399.5	4978234	0.00027	1984.05	2844.3	0	ANNUAL	ALL	1				
410		634424.5	4978234	0.00027	1975.87	2844.3	0	ANNUAL	ALL	1				
411		634449.5	4978234	0.00027	1984.97	2844.3	0	ANNUAL	ALL	1				
412		634474.5	4978234	0.00026	2000.36	2844.3	0	ANNUAL	ALL	1				
413		634499.5	4978234	0.00025	2011.73	2844.3	0	ANNUAL	ALL	1				
414		634299.5	4978259	0.00023	2030.97	2844.3	0	ANNUAL	ALL	1				
415		634324.5	4978259	0.00023	2018.02	2844.3	0	ANNUAL	ALL	1				
416		634349.5	4978259	0.00024	2002.99	2844.3	0	ANNUAL	ALL	1				
417		634374.5	4978259	0.00025	1990.41	2844.3	0	ANNUAL	ALL	1				
418		634399.5	4978259	0.00027	1978.88	2844.3	0	ANNUAL	ALL	1				
419		634424.5	4978259	0.00027	1972.17	2844.3	0	ANNUAL	ALL	1				
420		634449.5	4978259	0.00027	1977.85	2844.3	0	ANNUAL	ALL	1				
421		634474.5	4978259	0.00026	1992.52	2844.3	0	ANNUAL	ALL	1				
422		634499.5	4978259	0.00025	2003.44	2844.3	0	ANNUAL	ALL	1				
423		634299.5	4978284	0.00023	2023.26	2844.3	0	ANNUAL	ALL	1				
424		634324.5	4978284	0.00023	2008.98	2844.3	0	ANNUAL	ALL	1				
425		634349.5	4978284	0.00024	1996.31	2844.3	0	ANNUAL	ALL	1				
426		634374.5	4978284	0.00026	1984.2	2844.3	0	ANNUAL	ALL	1				
427		634399.5	4978284	0.00027	1973.37	2844.3	0	ANNUAL	ALL	1				
428		634424.5	4978284	0.00027	1969.23	2844.3	0	ANNUAL	ALL	1				
429		634449.5	4978284	0.00027	1975.58	2844.3	0	ANNUAL	ALL	1				
430		634474.5	4978284	0.00026	1989.07	2844.3	0	ANNUAL	ALL	1				
431		634499.5	4978284	0.00025	2000.53	2844.3	0	ANNUAL	ALL	1				
432		634299.5	4978309	0.00023	2012.41	2844.3	0	ANNUAL	ALL	1				
433		634324.5	4978309	0.00024	1999.74	2844.3	0	ANNUAL	ALL	1				
434		634349.5	4978309	0.00024	1988.62	2844.3	0	ANNUAL	ALL	1				
435		634374.5	4978309	0.00026	1977.79	2844.3	0	ANNUAL	ALL	1				
436		634399.5	4978309	0.00026	1967.1	2844.3	0	ANNUAL	ALL	1				
437		634424.5	4978309	0.00026	1968.14	2844.3	0	ANNUAL	ALL	1				
438		634449.5	4978309	0.00026	1977.66	2844.3	0	ANNUAL	ALL	1				
439		634474.5	4978309	0.00025	1992.31	2844.3	0	ANNUAL	ALL	1				
440		634499.5	4978309	0.00024	2006.23	2844.3	0	ANNUAL	ALL	1				
441		634299.5	4978334	0.00023	2000.94	2844.3	0	ANNUAL	ALL	1				
442		634324.5	4978334	0.00024	1991.1	2844.3	0	ANNUAL	ALL	1				
443		634349.5	4978334	0.00025	1980.66	2844.3	0	ANNUAL	ALL	1				
444		634374.5	4978334	0.00026	1970.39	2844.3	0	ANNUAL	ALL	1				
445		634399.5	4978334	0.00026	1961.38	2844.3	0	ANNUAL	ALL	1				
446		634424.5	4978334	0.00026	1968.29	2844.3	0	ANNUAL	ALL	1				
447		634449.5	4978334	0.00026	1980.95	2844.3	0	ANNUAL	ALL	1				
448		634474.5	4978334	0.00024	1997.36	2844.3	0	ANNUAL	ALL	1				
449		634499.5	4978334	0.00024	2012.52	2844.3	0	ANNUAL	ALL	1				
450		634299.5	4978359	0.00023	1991.4	2844.3	0	ANNUAL	ALL	1				
451		634324.5	4978359	0.00025	1982.72	2844.3	0	ANNUAL	ALL	1				
452		634349.5	4978359	0.00025	1972.75	2844.3	0	ANNUAL	ALL	1				
453		634374.5	4978359	0.00026	1962.87	2844.3	0	ANNUAL	ALL	1				
454		634399.5	4978359	0.00026	1958.17	2844.3	0	ANNUAL	ALL	1				
455		634424.5	4978359	0.00026	1968.79	2844.3	0	ANNUAL	ALL	1				
456		634449.5	4978359	0.00025	1984.24	2844.3	0	ANNUAL	ALL	1				
457		634474.5	4978359	0.00024	2002.2	2844.3	0	ANNUAL	ALL	1				
458		634499.5	4978359	0.00023	2016.76	2844.3	0	ANNUAL	ALL	1				
459		634299.5	4978384	0.00024	1982.57	2844.3	0	ANNUAL	ALL	1				
460		634324.5	4978384	0.00025	1975.68	2844.3	0	ANNUAL	ALL	1				
461		634349.5	4978384	0.00025	1964.84	2844.3	0	ANNUAL	ALL	1				
462		634374.5	4978384	0.00026	1956.29	2844.3	0	ANNUAL	ALL	1				
463		634399.5	4978384	0.00026	1955.61	2844.3	0	ANNUAL	ALL	1				
464		634424.5	4978384	0.00025	1968.65	2844.3	0	ANNUAL	ALL	1				
465		634449.5	4978384	0.00024	1986.09	2844.3	0	ANNUAL	ALL	1				
466		634474.5	4978384	0.00023	2004.63	2844.3	0	ANNUAL	ALL	1				
467		634499.5	4978384	0.00023	2018.69	2844.3	0	ANNUAL	ALL	1				
468		634299.5	4978409	0.00024	1975.4	2844.3	0	ANNUAL	ALL	1				
469		634324.5	4978409	0.00025	1967.52	2844.3	0	ANNUAL	ALL	1				
470		634349.5	4978409	0.00025	1957.04	2844.3	0	ANNUAL	ALL	1				
471		634374.5	4978409	0.00025	1949.69	2844.3	0	ANNUAL	ALL	1				
472		634399.5	4978409	0.00025	1951.43	2844.3	0	ANNUAL	ALL	1				
473		634424.5	4978409	0.00025	1967.3	2844.3	0	ANNUAL	ALL	1				
474		634449.5	4978409	0.00024	1986.39	2844.3	0	ANNUAL	ALL	1				
475		634474.5	4978409	0.00023	2005.28	2844.3	0	ANNUAL	ALL	1				
476		634499.5	4978409	0.00022	2019.28	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
477		634299.5	4978434	0.00024	1965.22	2844.3	0	ANNUAL	ALL	1				
478		634324.5	4978434	0.00025	1958.88	2844.3	0	ANNUAL	ALL	1				
479		634349.5	4978434	0.00025	1950.79	2844.3	0	ANNUAL	ALL	1				
480		634374.5	4978434	0.00025	1943.73	2844.3	0	ANNUAL	ALL	1				
481		634399.5	4978434	0.00025	1949.4	2844.3	0	ANNUAL	ALL	1				
482		634424.5	4978434	0.00025	1965.04	2844.3	0	ANNUAL	ALL	1				
483		634449.5	4978434	0.00024	1984.59	2844.3	0	ANNUAL	ALL	1				
484		634474.5	4978434	0.00022	2004.45	2844.3	0	ANNUAL	ALL	1				
485		634499.5	4978434	0.00022	2017.53	2844.3	0	ANNUAL	ALL	1				
486		634249.4	4977384	0.00023	2291.4	2717.08	0	ANNUAL	ALL	1				
487		634274.4	4977384	0.00024	2282.65	2742	0	ANNUAL	ALL	1				
488		634299.4	4977384	0.00024	2273.71	2742	0	ANNUAL	ALL	1				
489		634324.4	4977384	0.00025	2263.84	2742	0	ANNUAL	ALL	1				
490		634349.4	4977384	0.00026	2250.84	2742	0	ANNUAL	ALL	1				
491		634374.4	4977384	0.00026	2238.58	2742.16	0	ANNUAL	ALL	1				
492		634399.4	4977384	0.00027	2232.43	2742.16	0	ANNUAL	ALL	1				
493		634424.4	4977384	0.00027	2242.73	2742.16	0	ANNUAL	ALL	1				
494		634449.4	4977384	0.00026	2255.36	2742	0	ANNUAL	ALL	1				
495		634249.4	4977409	0.00023	2284.43	2742	0	ANNUAL	ALL	1				
496		634274.4	4977409	0.00024	2274.53	2742	0	ANNUAL	ALL	1				
497		634299.4	4977409	0.00024	2264.56	2742	0	ANNUAL	ALL	1				
498		634324.4	4977409	0.00025	2254.44	2742	0	ANNUAL	ALL	1				
499		634349.4	4977409	0.00025	2243.93	2742.16	0	ANNUAL	ALL	1				
500		634374.4	4977409	0.00026	2231.37	2742.16	0	ANNUAL	ALL	1				
501		634399.4	4977409	0.00027	2226.02	2844.3	0	ANNUAL	ALL	1				
502		634424.4	4977409	0.00026	2236.92	2742.16	0	ANNUAL	ALL	1				
503		634449.4	4977409	0.00026	2249.43	2742.16	0	ANNUAL	ALL	1				
504		634249.4	4977434	0.00023	2279.34	2742	0	ANNUAL	ALL	1				
505		634274.4	4977434	0.00023	2267.65	2742	0	ANNUAL	ALL	1				
506		634299.4	4977434	0.00024	2255.85	2742	0	ANNUAL	ALL	1				
507		634324.4	4977434	0.00025	2244.86	2742	0	ANNUAL	ALL	1				
508		634349.4	4977434	0.00025	2234.48	2742.16	0	ANNUAL	ALL	1				
509		634374.4	4977434	0.00026	2223.18	2844.3	0	ANNUAL	ALL	1				
510		634399.4	4977434	0.00026	2218.5	2844.3	0	ANNUAL	ALL	1				
511		634424.4	4977434	0.00026	2230.27	2844.3	0	ANNUAL	ALL	1				
512		634449.4	4977434	0.00026	2243.66	2742.16	0	ANNUAL	ALL	1				
513		634249.4	4977459	0.00022	2275.78	2742	0	ANNUAL	ALL	1				
514		634274.4	4977459	0.00023	2262.83	2742	0	ANNUAL	ALL	1				
515		634299.4	4977459	0.00024	2248.74	2742	0	ANNUAL	ALL	1				
516		634324.4	4977459	0.00024	2237.43	2742.16	0	ANNUAL	ALL	1				
517		634349.4	4977459	0.00025	2226.72	2844.3	0	ANNUAL	ALL	1				
518		634374.4	4977459	0.00026	2214.97	2844.3	0	ANNUAL	ALL	1				
519		634399.4	4977459	0.00026	2211.75	2844.3	0	ANNUAL	ALL	1				
520		634424.4	4977459	0.00026	2223.34	2844.3	0	ANNUAL	ALL	1				
521		634449.4	4977459	0.00026	2237.29	2844.3	0	ANNUAL	ALL	1				
522		634249.4	4977484	0.00022	2272.5	2742	0	ANNUAL	ALL	1				
523		634274.4	4977484	0.00023	2258.48	2742	0	ANNUAL	ALL	1				
524		634299.4	4977484	0.00023	2243.77	2742	0	ANNUAL	ALL	1				
525		634324.4	4977484	0.00024	2231.45	2742.16	0	ANNUAL	ALL	1				
526		634349.4	4977484	0.00025	2219.9	2844.3	0	ANNUAL	ALL	1				
527		634374.4	4977484	0.00026	2207.94	2844.3	0	ANNUAL	ALL	1				
528		634399.4	4977484	0.00026	2204.62	2844.3	0	ANNUAL	ALL	1				
529		634424.4	4977484	0.00026	2216.76	2844.3	0	ANNUAL	ALL	1				
530		634449.4	4977484	0.00025	2230.33	2844.3	0	ANNUAL	ALL	1				
531		634249.4	4977509	0.00022	2269.17	2742	0	ANNUAL	ALL	1				
532		634274.4	4977509	0.00022	2254.88	2742	0	ANNUAL	ALL	1				
533		634299.4	4977509	0.00023	2240.59	2742	0	ANNUAL	ALL	1				
534		634324.4	4977509	0.00024	2227.32	2844.3	0	ANNUAL	ALL	1				
535		634349.4	4977509	0.00025	2213.19	2844.3	0	ANNUAL	ALL	1				
536		634374.4	4977509	0.00025	2200.19	2844.3	0	ANNUAL	ALL	1				
537		634399.4	4977509	0.00026	2197.61	2844.3	0	ANNUAL	ALL	1				
538		634424.4	4977509	0.00025	2211.03	2844.3	0	ANNUAL	ALL	1				
539		634449.4	4977509	0.00025	2223.57	2844.3	0	ANNUAL	ALL	1				
540		634249.4	4977534	0.00021	2266.65	2742	0	ANNUAL	ALL	1				
541		634274.4	4977534	0.00022	2251.58	2742	0	ANNUAL	ALL	1				
542		634299.4	4977534	0.00023	2237.18	2742	0	ANNUAL	ALL	1				
543		634324.4	4977534	0.00023	2223.67	2844.3	0	ANNUAL	ALL	1				
544		634349.4	4977534	0.00024	2207.86	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
545		634374.4	4977534	0.00025	2193.38	2844.3	0	ANNUAL	ALL	1				
546		634399.4	4977534	0.00025	2191.95	2844.3	0	ANNUAL	ALL	1				
547		634424.4	4977534	0.00025	2205.88	2844.3	0	ANNUAL	ALL	1				
548		634449.4	4977534	0.00025	2217.63	2844.3	0	ANNUAL	ALL	1				
549		634249.4	4977559	0.00021	2264.12	2742	0	ANNUAL	ALL	1				
550		634274.4	4977559	0.00022	2247.26	2742	0	ANNUAL	ALL	1				
551		634299.4	4977559	0.00022	2232.74	2742	0	ANNUAL	ALL	1				
552		634324.4	4977559	0.00023	2218.55	2844.3	0	ANNUAL	ALL	1				
553		634349.4	4977559	0.00024	2203.35	2844.3	0	ANNUAL	ALL	1				
554		634374.4	4977559	0.00025	2189.62	2844.3	0	ANNUAL	ALL	1				
555		634399.4	4977559	0.00025	2184.96	2844.3	0	ANNUAL	ALL	1				
556		634424.4	4977559	0.00025	2200.77	2844.3	0	ANNUAL	ALL	1				
557		634449.4	4977559	0.00025	2211.07	2844.3	0	ANNUAL	ALL	1				
558		634249.4	4977584	0.00021	2258.01	2742	0	ANNUAL	ALL	1				
559		634274.4	4977584	0.00021	2242.66	2742	0	ANNUAL	ALL	1				
560		634299.4	4977584	0.00022	2227.67	2844.3	0	ANNUAL	ALL	1				
561		634324.4	4977584	0.00023	2213.51	2844.3	0	ANNUAL	ALL	1				
562		634349.4	4977584	0.00024	2199.5	2844.3	0	ANNUAL	ALL	1				
563		634374.4	4977584	0.00024	2185.33	2844.3	0	ANNUAL	ALL	1				
564		634399.4	4977584	0.00025	2177.11	2844.3	0	ANNUAL	ALL	1				
565		634424.4	4977584	0.00025	2192.43	2844.3	0	ANNUAL	ALL	1				
566		634449.4	4977584	0.00024	2203.16	2844.3	0	ANNUAL	ALL	1				
567		634999.5	4977834	0.00038	2055.79	2844.3	0	ANNUAL	ALL	1				
568		635024.5	4977834	0.00041	2048.42	2844.3	0	ANNUAL	ALL	1				
569		635049.5	4977834	0.00042	2043	2844.3	0	ANNUAL	ALL	1				
570		635074.5	4977834	0.00044	2037.93	2844.3	0	ANNUAL	ALL	1				
571		635099.5	4977834	0.00046	2034.24	2844.3	0	ANNUAL	ALL	1				
572		635124.5	4977834	0.00047	2031.45	2844.3	0	ANNUAL	ALL	1				
573		635149.5	4977834	0.00047	2038.5	2844.3	0	ANNUAL	ALL	1				
574		635174.5	4977834	0.00045	2050.35	2844.3	0	ANNUAL	ALL	1				
575		635199.5	4977834	0.00043	2063.26	2844.3	0	ANNUAL	ALL	1				
576		634999.5	4977859	0.00038	2052.63	2844.3	0	ANNUAL	ALL	1				
577		635024.5	4977859	0.0004	2046.41	2844.3	0	ANNUAL	ALL	1				
578		635049.5	4977859	0.00042	2040.95	2844.3	0	ANNUAL	ALL	1				
579		635074.5	4977859	0.00043	2036.03	2844.3	0	ANNUAL	ALL	1				
580		635099.5	4977859	0.00045	2032.3	2844.3	0	ANNUAL	ALL	1				
581		635124.5	4977859	0.00046	2030.17	2844.3	0	ANNUAL	ALL	1				
582		635149.5	4977859	0.00045	2038.33	2844.3	0	ANNUAL	ALL	1				
583		635174.5	4977859	0.00044	2049.93	2844.3	0	ANNUAL	ALL	1				
584		635199.5	4977859	0.00041	2062.54	2844.3	0	ANNUAL	ALL	1				
585		634999.5	4977884	0.00037	2049.11	2844.3	0	ANNUAL	ALL	1				
586		635024.5	4977884	0.00039	2044.13	2844.3	0	ANNUAL	ALL	1				
587		635049.5	4977884	0.00041	2038.92	2844.3	0	ANNUAL	ALL	1				
588		635074.5	4977884	0.00042	2034.26	2844.3	0	ANNUAL	ALL	1				
589		635099.5	4977884	0.00044	2030.48	2844.3	0	ANNUAL	ALL	1				
590		635124.5	4977884	0.00045	2029.04	2844.3	0	ANNUAL	ALL	1				
591		635149.5	4977884	0.00044	2038.45	2844.3	0	ANNUAL	ALL	1				
592		635174.5	4977884	0.00042	2049.51	2844.3	0	ANNUAL	ALL	1				
593		635199.5	4977884	0.0004	2061.56	2844.3	0	ANNUAL	ALL	1				
594		634999.5	4977909	0.00037	2047.27	2844.3	0	ANNUAL	ALL	1				
595		635024.5	4977909	0.00038	2042.16	2844.3	0	ANNUAL	ALL	1				
596		635049.5	4977909	0.0004	2036.97	2844.3	0	ANNUAL	ALL	1				
597		635074.5	4977909	0.00041	2032.48	2844.3	0	ANNUAL	ALL	1				
598		635099.5	4977909	0.00043	2028.7	2844.3	0	ANNUAL	ALL	1				
599		635124.5	4977909	0.00043	2028.77	2844.3	0	ANNUAL	ALL	1				
600		635149.5	4977909	0.00042	2038.62	2844.3	0	ANNUAL	ALL	1				
601		635174.5	4977909	0.00041	2049.12	2844.3	0	ANNUAL	ALL	1				
602		635199.5	4977909	0.00039	2060.48	2844.3	0	ANNUAL	ALL	1				
603		634999.5	4977934	0.00036	2046.79	2844.3	0	ANNUAL	ALL	1				
604		635024.5	4977934	0.00037	2040.92	2844.3	0	ANNUAL	ALL	1				
605		635049.5	4977934	0.00039	2034.68	2844.3	0	ANNUAL	ALL	1				
606		635074.5	4977934	0.0004	2029.58	2844.3	0	ANNUAL	ALL	1				
607		635099.5	4977934	0.00042	2025.61	2844.3	0	ANNUAL	ALL	1				
608		635124.5	4977934	0.00042	2027.68	2844.3	0	ANNUAL	ALL	1				
609		635149.5	4977934	0.00041	2038.09	2844.3	0	ANNUAL	ALL	1				
610		635174.5	4977934	0.0004	2048.68	2844.3	0	ANNUAL	ALL	1				
611		635199.5	4977934	0.00039	2059.02	2844.3	0	ANNUAL	ALL	1				
612		634999.5	4977959	0.00035	2045.95	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
613		635024.5	4977959	0.00036	2039.51	2844.3	0	ANNUAL	ALL	1				
614		635049.5	4977959	0.00038	2032.45	2844.3	0	ANNUAL	ALL	1				
615		635074.5	4977959	0.0004	2026.52	2844.3	0	ANNUAL	ALL	1				
616		635099.5	4977959	0.00041	2022.6	2844.3	0	ANNUAL	ALL	1				
617		635124.5	4977959	0.00041	2027.13	2844.3	0	ANNUAL	ALL	1				
618		635149.5	4977959	0.0004	2036.89	2844.3	0	ANNUAL	ALL	1				
619		635174.5	4977959	0.00039	2046.85	2844.3	0	ANNUAL	ALL	1				
620		635199.5	4977959	0.00038	2056.78	2844.3	0	ANNUAL	ALL	1				
621		634999.5	4977984	0.00034	2045.34	2844.3	0	ANNUAL	ALL	1				
622		635024.5	4977984	0.00036	2037.82	2844.3	0	ANNUAL	ALL	1				
623		635049.5	4977984	0.00037	2030.43	2844.3	0	ANNUAL	ALL	1				
624		635074.5	4977984	0.00039	2024.12	2844.3	0	ANNUAL	ALL	1				
625		635099.5	4977984	0.0004	2019.96	2844.3	0	ANNUAL	ALL	1				
626		635124.5	4977984	0.0004	2026.73	2844.3	0	ANNUAL	ALL	1				
627		635149.5	4977984	0.00039	2035.4	2844.3	0	ANNUAL	ALL	1				
628		635174.5	4977984	0.00038	2044.46	2844.3	0	ANNUAL	ALL	1				
629		635199.5	4977984	0.00037	2053.52	2844.3	0	ANNUAL	ALL	1				
630		634999.5	4978009	0.00033	2044.81	2844.3	0	ANNUAL	ALL	1				
631		635024.5	4978009	0.00035	2035.59	2844.3	0	ANNUAL	ALL	1				
632		635049.5	4978009	0.00036	2028.05	2844.3	0	ANNUAL	ALL	1				
633		635074.5	4978009	0.00038	2021.18	2844.3	0	ANNUAL	ALL	1				
634		635099.5	4978009	0.00039	2017.1	2844.3	0	ANNUAL	ALL	1				
635		635124.5	4978009	0.00039	2025.97	2844.3	0	ANNUAL	ALL	1				
636		635149.5	4978009	0.00038	2034.03	2844.3	0	ANNUAL	ALL	1				
637		635174.5	4978009	0.00038	2041.95	2844.3	0	ANNUAL	ALL	1				
638		635199.5	4978009	0.00037	2050.09	2844.3	0	ANNUAL	ALL	1				
639		634999.5	4978034	0.00033	2043.29	2844.3	0	ANNUAL	ALL	1				
640		635024.5	4978034	0.00034	2032.46	2844.3	0	ANNUAL	ALL	1				
641		635049.5	4978034	0.00036	2024.39	2844.3	0	ANNUAL	ALL	1				
642		635074.5	4978034	0.00037	2017.56	2844.3	0	ANNUAL	ALL	1				
643		635099.5	4978034	0.00039	2015.24	2844.3	0	ANNUAL	ALL	1				
644		635124.5	4978034	0.00038	2024.2	2844.3	0	ANNUAL	ALL	1				
645		635149.5	4978034	0.00037	2032.02	2844.3	0	ANNUAL	ALL	1				
646		635174.5	4978034	0.00037	2040.48	2844.3	0	ANNUAL	ALL	1				
647		635199.5	4978034	0.00036	2049.69	2844.3	0	ANNUAL	ALL	1				
648		634599.5	4976834	0.00036	2431.97	2717.08	0	ANNUAL	ALL	1				
649		634624.5	4976834	0.00037	2425.11	2717.08	0	ANNUAL	ALL	1				
650		634649.5	4976834	0.00037	2416.95	2717.08	0	ANNUAL	ALL	1				
651		634674.5	4976834	0.00037	2407.96	2717.08	0	ANNUAL	ALL	1				
652		634699.5	4976834	0.00038	2398.82	2717.08	0	ANNUAL	ALL	1				
653		634724.5	4976834	0.00038	2389.57	2717.08	0	ANNUAL	ALL	1				
654		634749.5	4976834	0.00039	2378.83	2717.08	0	ANNUAL	ALL	1				
655		634774.5	4976834	0.00039	2368.3	2717.08	0	ANNUAL	ALL	1				
656		634799.5	4976834	0.0004	2352.38	2717.08	0	ANNUAL	ALL	1				
657		634599.5	4976859	0.00036	2427	2717.08	0	ANNUAL	ALL	1				
658		634624.5	4976859	0.00036	2421.36	2717.08	0	ANNUAL	ALL	1				
659		634649.5	4976859	0.00036	2412.9	2717.08	0	ANNUAL	ALL	1				
660		634674.5	4976859	0.00037	2401.58	2717.08	0	ANNUAL	ALL	1				
661		634699.5	4976859	0.00037	2391.51	2717.08	0	ANNUAL	ALL	1				
662		634724.5	4976859	0.00038	2381.29	2717.08	0	ANNUAL	ALL	1				
663		634749.5	4976859	0.00038	2371.44	2717.08	0	ANNUAL	ALL	1				
664		634774.5	4976859	0.00039	2358.57	2717.08	0	ANNUAL	ALL	1				
665		634799.5	4976859	0.0004	2341.91	2742	0	ANNUAL	ALL	1				
666		634599.5	4976884	0.00035	2422.69	2717.08	0	ANNUAL	ALL	1				
667		634624.5	4976884	0.00035	2418.17	2717.08	0	ANNUAL	ALL	1				
668		634649.5	4976884	0.00036	2408.98	2717.08	0	ANNUAL	ALL	1				
669		634674.5	4976884	0.00036	2396.57	2717.08	0	ANNUAL	ALL	1				
670		634699.5	4976884	0.00037	2383.76	2717.08	0	ANNUAL	ALL	1				
671		634724.5	4976884	0.00038	2371.27	2717.08	0	ANNUAL	ALL	1				
672		634749.5	4976884	0.00038	2362.03	2717.08	0	ANNUAL	ALL	1				
673		634774.5	4976884	0.00039	2350.11	2717.08	0	ANNUAL	ALL	1				
674		634799.5	4976884	0.00039	2334.35	2742	0	ANNUAL	ALL	1				
675		634599.5	4976909	0.00034	2418.11	2717.08	0	ANNUAL	ALL	1				
676		634624.5	4976909	0.00035	2412.47	2717.08	0	ANNUAL	ALL	1				
677		634649.5	4976909	0.00035	2402.76	2717.08	0	ANNUAL	ALL	1				
678		634674.5	4976909	0.00036	2392.81	2717.08	0	ANNUAL	ALL	1				
679		634699.5	4976909	0.00036	2377.98	2717.08	0	ANNUAL	ALL	1				
680		634724.5	4976909	0.00037	2364.11	2717.08	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
681		634749.5	4976909	0.00038	2354.73	2717.08	0	ANNUAL	ALL	1				
682		634774.5	4976909	0.00038	2345.14	2717.08	0	ANNUAL	ALL	1				
683		634799.5	4976909	0.00039	2331	2742	0	ANNUAL	ALL	1				
684		634599.5	4976934	0.00034	2411.78	2717.08	0	ANNUAL	ALL	1				
685		634624.5	4976934	0.00034	2403.98	2717.08	0	ANNUAL	ALL	1				
686		634649.5	4976934	0.00035	2394.61	2717.08	0	ANNUAL	ALL	1				
687		634674.5	4976934	0.00035	2383.71	2717.08	0	ANNUAL	ALL	1				
688		634699.5	4976934	0.00036	2371.78	2717.08	0	ANNUAL	ALL	1				
689		634724.5	4976934	0.00037	2359.09	2717.08	0	ANNUAL	ALL	1				
690		634749.5	4976934	0.00037	2347.63	2717.08	0	ANNUAL	ALL	1				
691		634774.5	4976934	0.00038	2337.6	2742	0	ANNUAL	ALL	1				
692		634799.5	4976934	0.00038	2326.97	2742	0	ANNUAL	ALL	1				
693		634599.5	4976959	0.00033	2404.1	2717.08	0	ANNUAL	ALL	1				
694		634624.5	4976959	0.00034	2396.65	2717.08	0	ANNUAL	ALL	1				
695		634649.5	4976959	0.00034	2385.41	2717.08	0	ANNUAL	ALL	1				
696		634674.5	4976959	0.00035	2372.07	2717.08	0	ANNUAL	ALL	1				
697		634699.5	4976959	0.00035	2362.55	2717.08	0	ANNUAL	ALL	1				
698		634724.5	4976959	0.00036	2351.59	2717.08	0	ANNUAL	ALL	1				
699		634749.5	4976959	0.00037	2341.2	2717.08	0	ANNUAL	ALL	1				
700		634774.5	4976959	0.00037	2328.55	2742	0	ANNUAL	ALL	1				
701		634799.5	4976959	0.00038	2318.72	2742	0	ANNUAL	ALL	1				
702		634599.5	4976984	0.00033	2396.35	2717.08	0	ANNUAL	ALL	1				
703		634624.5	4976984	0.00033	2389.04	2717.08	0	ANNUAL	ALL	1				
704		634649.5	4976984	0.00034	2377.21	2717.08	0	ANNUAL	ALL	1				
705		634674.5	4976984	0.00035	2363.6	2717.08	0	ANNUAL	ALL	1				
706		634699.5	4976984	0.00035	2350.85	2717.08	0	ANNUAL	ALL	1				
707		634724.5	4976984	0.00036	2340.79	2717.08	0	ANNUAL	ALL	1				
708		634749.5	4976984	0.00036	2331.79	2742	0	ANNUAL	ALL	1				
709		634774.5	4976984	0.00037	2320.7	2742	0	ANNUAL	ALL	1				
710		634799.5	4976984	0.00038	2308.59	2742	0	ANNUAL	ALL	1				
711		634599.5	4977009	0.00033	2388.79	2717.08	0	ANNUAL	ALL	1				
712		634624.5	4977009	0.00033	2379.17	2717.08	0	ANNUAL	ALL	1				
713		634649.5	4977009	0.00034	2368.25	2717.08	0	ANNUAL	ALL	1				
714		634674.5	4977009	0.00034	2355.13	2717.08	0	ANNUAL	ALL	1				
715		634699.5	4977009	0.00035	2341.52	2717.08	0	ANNUAL	ALL	1				
716		634724.5	4977009	0.00035	2328.18	2742	0	ANNUAL	ALL	1				
717		634749.5	4977009	0.00036	2321.24	2742	0	ANNUAL	ALL	1				
718		634774.5	4977009	0.00036	2313.44	2742	0	ANNUAL	ALL	1				
719		634799.5	4977009	0.00037	2301.46	2742.16	0	ANNUAL	ALL	1				
720		634599.5	4977034	0.00032	2379.36	2717.08	0	ANNUAL	ALL	1				
721		634624.5	4977034	0.00033	2369.28	2717.08	0	ANNUAL	ALL	1				
722		634649.5	4977034	0.00033	2356.46	2717.08	0	ANNUAL	ALL	1				
723		634674.5	4977034	0.00034	2343.53	2717.08	0	ANNUAL	ALL	1				
724		634699.5	4977034	0.00035	2329.9	2742	0	ANNUAL	ALL	1				
725		634724.5	4977034	0.00035	2316.92	2742	0	ANNUAL	ALL	1				
726		634749.5	4977034	0.00036	2309.32	2742	0	ANNUAL	ALL	1				
727		634774.5	4977034	0.00036	2302.58	2742	0	ANNUAL	ALL	1				
728		634799.5	4977034	0.00037	2295.21	2742.16	0	ANNUAL	ALL	1				
729	**	CONCUNIT	ug/m^3											
730	**	DEPUNIT	g/m^2											

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	*	AERMOD	(	19191):	MIDAS	GOLD	STIBNITE	-	MODELING	R27	########			
2	*	AERMET	(	19191):	12:35:50									
3	*	MODELING	OPTIONS	USED:	RegDFAULT	CONC	ELEV	NOWARN	DRYDPLT	WETDPLT	RURAL	ADJ_U*		
4	*	PLOT	FILE	OF	ANNUAL	VALUES	AVERAGED	ACROSS	1	YEARS	FOR	SOURCE	GROUP:	ALL
5	*	FOR	A	TOTAL	OF	720	RECEPTORS.							
6	*	FORMAT:	(3(1X,F13.5),3(1X,F8.2),2X,A6,2X,A8,2X,I8.8,2X,A8)											
7	*	X	Y	AVERAGE	CONC	ZELEV	ZHILL	ZFLAG	AVE	GRP	NUM	YRS	NET	ID
8	*													
9	0.000530	635399.5	4975934	0.00049	2213.4	2844.3	0	ANNUAL	ALL	1				
10	max ↑	635424.5	4975934	0.0005	2212.64	2844.3	0	ANNUAL	ALL	1				
11		635449.5	4975934	0.0005	2211.27	2844.3	0	ANNUAL	ALL	1				
12		635474.5	4975934	0.0005	2212.5	2844.3	0	ANNUAL	ALL	1				
13		635499.5	4975934	0.0005	2215.21	2844.3	0	ANNUAL	ALL	1				
14		635524.5	4975934	0.0005	2215.98	2844.3	0	ANNUAL	ALL	1				
15		635549.5	4975934	0.00051	2215	2844.3	0	ANNUAL	ALL	1				
16		635574.5	4975934	0.00051	2215.74	2844.3	0	ANNUAL	ALL	1				
17		635599.5	4975934	0.0005	2218.34	2844.3	0	ANNUAL	ALL	1				
18		635399.5	4975959	0.00051	2202.75	2844.3	0	ANNUAL	ALL	1				
19		635424.5	4975959	0.00051	2204.36	2844.3	0	ANNUAL	ALL	1				
20		635449.5	4975959	0.00051	2204.87	2844.3	0	ANNUAL	ALL	1				
21		635474.5	4975959	0.00051	2206.39	2844.3	0	ANNUAL	ALL	1				
22		635499.5	4975959	0.00051	2208.99	2844.3	0	ANNUAL	ALL	1				
23		635524.5	4975959	0.00051	2210.99	2844.3	0	ANNUAL	ALL	1				
24		635549.5	4975959	0.00051	2211.29	2844.3	0	ANNUAL	ALL	1				
25		635574.5	4975959	0.00051	2210.92	2844.3	0	ANNUAL	ALL	1				
26		635599.5	4975959	0.00052	2208.83	2844.3	0	ANNUAL	ALL	1				
27		635399.5	4975984	0.00051	2195.09	2844.3	0	ANNUAL	ALL	1				
28		635424.5	4975984	0.00051	2198.19	2844.3	0	ANNUAL	ALL	1				
29		635449.5	4975984	0.00051	2198.7	2844.3	0	ANNUAL	ALL	1				
30		635474.5	4975984	0.00051	2201.57	2844.3	0	ANNUAL	ALL	1				
31		635499.5	4975984	0.00051	2203.99	2844.3	0	ANNUAL	ALL	1				
32		635524.5	4975984	0.00051	2206.27	2844.3	0	ANNUAL	ALL	1				
33		635549.5	4975984	0.00051	2206.83	2844.3	0	ANNUAL	ALL	1				
34		635574.5	4975984	0.00052	2205.61	2844.3	0	ANNUAL	ALL	1				
35		635599.5	4975984	0.00053	2202.99	2844.3	0	ANNUAL	ALL	1				
36		635399.5	4976009	0.0005	2195.69	2844.3	0	ANNUAL	ALL	1				
37		635424.5	4976009	0.00051	2189.65	2844.3	0	ANNUAL	ALL	1				
38		635449.5	4976009	0.00051	2194	2844.3	0	ANNUAL	ALL	1				
39		635474.5	4976009	0.0005	2200.13	2844.3	0	ANNUAL	ALL	1				
40		635499.5	4976009	0.0005	2202.83	2844.3	0	ANNUAL	ALL	1				
41		635524.5	4976009	0.00051	2203.57	2844.3	0	ANNUAL	ALL	1				
42		635549.5	4976009	0.00051	2203.82	2844.3	0	ANNUAL	ALL	1				
43		635574.5	4976009	0.00052	2202.81	2844.3	0	ANNUAL	ALL	1				
44		635599.5	4976009	0.00053	2200.59	2844.3	0	ANNUAL	ALL	1				
45		635399.5	4976034	0.00048	2198.23	2844.3	0	ANNUAL	ALL	1				
46		635424.5	4976034	0.0005	2186.98	2844.3	0	ANNUAL	ALL	1				
47		635449.5	4976034	0.0005	2190.14	2844.3	0	ANNUAL	ALL	1				
48		635474.5	4976034	0.0005	2198.63	2844.3	0	ANNUAL	ALL	1				
49		635499.5	4976034	0.0005	2198.93	2844.3	0	ANNUAL	ALL	1				
50		635524.5	4976034	0.0005	2199.39	2844.3	0	ANNUAL	ALL	1				
51		635549.5	4976034	0.0005	2201.1	2844.3	0	ANNUAL	ALL	1				
52		635574.5	4976034	0.00051	2200.59	2844.3	0	ANNUAL	ALL	1				
53		635599.5	4976034	0.00052	2197.96	2844.3	0	ANNUAL	ALL	1				
54		635399.5	4976059	0.00047	2196.33	2844.3	0	ANNUAL	ALL	1				
55		635424.5	4976059	0.00049	2184.09	2844.3	0	ANNUAL	ALL	1				
56		635449.5	4976059	0.0005	2180.82	2844.3	0	ANNUAL	ALL	1				
57		635474.5	4976059	0.00049	2193.11	2844.3	0	ANNUAL	ALL	1				
58		635499.5	4976059	0.0005	2194.5	2844.3	0	ANNUAL	ALL	1				
59		635524.5	4976059	0.0005	2197.17	2844.3	0	ANNUAL	ALL	1				
60		635549.5	4976059	0.0005	2199.4	2844.3	0	ANNUAL	ALL	1				
61		635574.5	4976059	0.0005	2198.27	2844.3	0	ANNUAL	ALL	1				
62		635599.5	4976059	0.00052	2194.62	2844.3	0	ANNUAL	ALL	1				
63		635399.5	4976084	0.00047	2188.98	2844.3	0	ANNUAL	ALL	1				
64		635424.5	4976084	0.00048	2180.22	2844.3	0	ANNUAL	ALL	1				
65		635449.5	4976084	0.00049	2174.51	2844.3	0	ANNUAL	ALL	1				
66		635474.5	4976084	0.00049	2180.27	2844.3	0	ANNUAL	ALL	1				
67		635499.5	4976084	0.0005	2185.71	2844.3	0	ANNUAL	ALL	1				
68		635524.5	4976084	0.00049	2191.13	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
69		635549.5	4976084	0.00049	2193.95	2844.3	0	ANNUAL	ALL	1				
70		635574.5	4976084	0.00051	2190.58	2844.3	0	ANNUAL	ALL	1				
71		635599.5	4976084	0.00052	2183.01	2844.3	0	ANNUAL	ALL	1				
72		635399.5	4976109	0.00046	2182.28	2844.3	0	ANNUAL	ALL	1				
73		635424.5	4976109	0.00047	2177.24	2844.3	0	ANNUAL	ALL	1				
74		635449.5	4976109	0.00048	2171.45	2844.3	0	ANNUAL	ALL	1				
75		635474.5	4976109	0.00049	2172.26	2844.3	0	ANNUAL	ALL	1				
76		635499.5	4976109	0.00049	2177.58	2844.3	0	ANNUAL	ALL	1				
77		635524.5	4976109	0.00049	2180.23	2844.3	0	ANNUAL	ALL	1				
78		635549.5	4976109	0.0005	2179.81	2844.3	0	ANNUAL	ALL	1				
79		635574.5	4976109	0.00051	2176.94	2844.3	0	ANNUAL	ALL	1				
80		635599.5	4976109	0.00051	2179.4	2844.3	0	ANNUAL	ALL	1				
81		635399.5	4976134	0.00045	2176.77	2844.3	0	ANNUAL	ALL	1				
82		635424.5	4976134	0.00046	2174.27	2844.3	0	ANNUAL	ALL	1				
83		635449.5	4976134	0.00047	2171.04	2844.3	0	ANNUAL	ALL	1				
84		635474.5	4976134	0.00047	2166.4	2844.3	0	ANNUAL	ALL	1				
85		635499.5	4976134	0.00048	2167.48	2844.3	0	ANNUAL	ALL	1				
86		635524.5	4976134	0.00048	2172.09	2844.3	0	ANNUAL	ALL	1				
87		635549.5	4976134	0.00049	2171.44	2844.3	0	ANNUAL	ALL	1				
88		635574.5	4976134	0.00049	2172.93	2844.3	0	ANNUAL	ALL	1				
89		635599.5	4976134	0.0005	2178.31	2844.3	0	ANNUAL	ALL	1				
90		635199.5	4976834	0.00017	2116.83	2844.3	0	ANNUAL	ALL	1				
91		635224.5	4976834	0.00018	2112.53	2844.3	0	ANNUAL	ALL	1				
92		635249.5	4976834	0.00018	2108.39	2844.3	0	ANNUAL	ALL	1				
93		635274.5	4976834	0.00019	2105.23	2844.3	0	ANNUAL	ALL	1				
94		635299.5	4976834	0.00019	2101.6	2844.3	0	ANNUAL	ALL	1				
95		635324.5	4976834	0.0002	2098.74	2844.3	0	ANNUAL	ALL	1				
96		635349.5	4976834	0.0002	2104.26	2844.3	0	ANNUAL	ALL	1				
97		635374.5	4976834	0.00019	2110.4	2844.3	0	ANNUAL	ALL	1				
98		635399.5	4976834	0.00019	2117.98	2844.3	0	ANNUAL	ALL	1				
99		635199.5	4976859	0.00017	2114.34	2844.3	0	ANNUAL	ALL	1				
100		635224.5	4976859	0.00018	2108.68	2844.3	0	ANNUAL	ALL	1				
101		635249.5	4976859	0.00018	2104.42	2844.3	0	ANNUAL	ALL	1				
102		635274.5	4976859	0.00018	2101.28	2844.3	0	ANNUAL	ALL	1				
103		635299.5	4976859	0.00019	2098.83	2844.3	0	ANNUAL	ALL	1				
104		635324.5	4976859	0.00019	2096.89	2844.3	0	ANNUAL	ALL	1				
105		635349.5	4976859	0.00019	2101.21	2844.3	0	ANNUAL	ALL	1				
106		635374.5	4976859	0.00019	2108.71	2844.3	0	ANNUAL	ALL	1				
107		635399.5	4976859	0.00019	2118.31	2844.3	0	ANNUAL	ALL	1				
108		635199.5	4976884	0.00017	2111.17	2844.3	0	ANNUAL	ALL	1				
109		635224.5	4976884	0.00018	2104.78	2844.3	0	ANNUAL	ALL	1				
110		635249.5	4976884	0.00018	2100.14	2844.3	0	ANNUAL	ALL	1				
111		635274.5	4976884	0.00018	2097.48	2844.3	0	ANNUAL	ALL	1				
112		635299.5	4976884	0.00019	2095.42	2844.3	0	ANNUAL	ALL	1				
113		635324.5	4976884	0.00019	2094.96	2844.3	0	ANNUAL	ALL	1				
114		635349.5	4976884	0.00019	2097.83	2844.3	0	ANNUAL	ALL	1				
115		635374.5	4976884	0.00019	2107.96	2844.3	0	ANNUAL	ALL	1				
116		635399.5	4976884	0.00018	2119.17	2844.3	0	ANNUAL	ALL	1				
117		635199.5	4976909	0.00017	2108.51	2844.3	0	ANNUAL	ALL	1				
118		635224.5	4976909	0.00017	2102.17	2844.3	0	ANNUAL	ALL	1				
119		635249.5	4976909	0.00018	2097.31	2844.3	0	ANNUAL	ALL	1				
120		635274.5	4976909	0.00018	2094.85	2844.3	0	ANNUAL	ALL	1				
121		635299.5	4976909	0.00019	2093.19	2844.3	0	ANNUAL	ALL	1				
122		635324.5	4976909	0.00019	2093.48	2844.3	0	ANNUAL	ALL	1				
123		635349.5	4976909	0.00019	2098.12	2844.3	0	ANNUAL	ALL	1				
124		635374.5	4976909	0.00018	2108.79	2844.3	0	ANNUAL	ALL	1				
125		635399.5	4976909	0.00018	2120.74	2844.3	0	ANNUAL	ALL	1				
126		635199.5	4976934	0.00017	2106.38	2844.3	0	ANNUAL	ALL	1				
127		635224.5	4976934	0.00017	2100.81	2844.3	0	ANNUAL	ALL	1				
128		635249.5	4976934	0.00018	2096.21	2844.3	0	ANNUAL	ALL	1				
129		635274.5	4976934	0.00018	2092.89	2844.3	0	ANNUAL	ALL	1				
130		635299.5	4976934	0.00018	2091.1	2844.3	0	ANNUAL	ALL	1				
131		635324.5	4976934	0.00019	2092.46	2844.3	0	ANNUAL	ALL	1				
132		635349.5	4976934	0.00018	2099.48	2844.3	0	ANNUAL	ALL	1				
133		635374.5	4976934	0.00018	2110.37	2844.3	0	ANNUAL	ALL	1				
134		635399.5	4976934	0.00018	2122.91	2844.3	0	ANNUAL	ALL	1				
135		635199.5	4976959	0.00016	2104.62	2844.3	0	ANNUAL	ALL	1				
136		635224.5	4976959	0.00017	2099.28	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
137		635249.5	4976959	0.00017	2094.41	2844.3	0	ANNUAL	ALL	1				
138		635274.5	4976959	0.00018	2090.59	2844.3	0	ANNUAL	ALL	1				
139		635299.5	4976959	0.00018	2088.8	2844.3	0	ANNUAL	ALL	1				
140		635324.5	4976959	0.00018	2092.02	2844.3	0	ANNUAL	ALL	1				
141		635349.5	4976959	0.00018	2100.12	2844.3	0	ANNUAL	ALL	1				
142		635374.5	4976959	0.00017	2112.07	2844.3	0	ANNUAL	ALL	1				
143		635399.5	4976959	0.00017	2125.69	2844.3	0	ANNUAL	ALL	1				
144		635199.5	4976984	0.00016	2102.45	2844.3	0	ANNUAL	ALL	1				
145		635224.5	4976984	0.00017	2097.29	2844.3	0	ANNUAL	ALL	1				
146		635249.5	4976984	0.00017	2091.62	2844.3	0	ANNUAL	ALL	1				
147		635274.5	4976984	0.00018	2087.92	2844.3	0	ANNUAL	ALL	1				
148		635299.5	4976984	0.00018	2086.81	2844.3	0	ANNUAL	ALL	1				
149		635324.5	4976984	0.00018	2092.65	2844.3	0	ANNUAL	ALL	1				
150		635349.5	4976984	0.00017	2101.3	2844.3	0	ANNUAL	ALL	1				
151		635374.5	4976984	0.00017	2114.13	2844.3	0	ANNUAL	ALL	1				
152		635399.5	4976984	0.00016	2128.46	2844.3	0	ANNUAL	ALL	1				
153		635199.5	4977009	0.00016	2099.39	2844.3	0	ANNUAL	ALL	1				
154		635224.5	4977009	0.00016	2093.66	2844.3	0	ANNUAL	ALL	1				
155		635249.5	4977009	0.00017	2087.97	2844.3	0	ANNUAL	ALL	1				
156		635274.5	4977009	0.00018	2084.9	2844.3	0	ANNUAL	ALL	1				
157		635299.5	4977009	0.00018	2087.43	2844.3	0	ANNUAL	ALL	1				
158		635324.5	4977009	0.00017	2094.55	2844.3	0	ANNUAL	ALL	1				
159		635349.5	4977009	0.00017	2103.74	2844.3	0	ANNUAL	ALL	1				
160		635374.5	4977009	0.00016	2116.64	2844.3	0	ANNUAL	ALL	1				
161		635399.5	4977009	0.00016	2131.12	2844.3	0	ANNUAL	ALL	1				
162		635199.5	4977034	0.00016	2094.63	2844.3	0	ANNUAL	ALL	1				
163		635224.5	4977034	0.00017	2088.76	2844.3	0	ANNUAL	ALL	1				
164		635249.5	4977034	0.00017	2084.27	2844.3	0	ANNUAL	ALL	1				
165		635274.5	4977034	0.00017	2082.71	2844.3	0	ANNUAL	ALL	1				
166		635299.5	4977034	0.00017	2089.9	2844.3	0	ANNUAL	ALL	1				
167		635324.5	4977034	0.00016	2098.21	2844.3	0	ANNUAL	ALL	1				
168		635349.5	4977034	0.00016	2107.49	2844.3	0	ANNUAL	ALL	1				
169		635374.5	4977034	0.00016	2119.09	2844.3	0	ANNUAL	ALL	1				
170		635399.5	4977034	0.00017	2133.38	2844.3	0	ANNUAL	ALL	1				
171		634899.5	4977134	0.0001	2221.02	2844.3	0	ANNUAL	ALL	1				
172		634924.5	4977134	0.00011	2207.85	2844.3	0	ANNUAL	ALL	1				
173		634949.5	4977134	0.00012	2190.45	2844.3	0	ANNUAL	ALL	1				
174		634974.5	4977134	0.00012	2169.12	2844.3	0	ANNUAL	ALL	1				
175		634999.5	4977134	0.00012	2150.64	2844.3	0	ANNUAL	ALL	1				
176		635024.5	4977134	0.00013	2135.97	2844.3	0	ANNUAL	ALL	1				
177		635049.5	4977134	0.00013	2122.38	2844.3	0	ANNUAL	ALL	1				
178		635074.5	4977134	0.00013	2113.7	2844.3	0	ANNUAL	ALL	1				
179		635099.5	4977134	0.00014	2105.9	2844.3	0	ANNUAL	ALL	1				
180		634899.5	4977159	0.0001	2213.37	2844.3	0	ANNUAL	ALL	1				
181		634924.5	4977159	0.00011	2201.16	2844.3	0	ANNUAL	ALL	1				
182		634949.5	4977159	0.00012	2181.17	2844.3	0	ANNUAL	ALL	1				
183		634974.5	4977159	0.00012	2161.72	2844.3	0	ANNUAL	ALL	1				
184		634999.5	4977159	0.00012	2145.73	2844.3	0	ANNUAL	ALL	1				
185		635024.5	4977159	0.00012	2132.12	2844.3	0	ANNUAL	ALL	1				
186		635049.5	4977159	0.00013	2119.59	2844.3	0	ANNUAL	ALL	1				
187		635074.5	4977159	0.00013	2109.27	2844.3	0	ANNUAL	ALL	1				
188		635099.5	4977159	0.00013	2101.29	2844.3	0	ANNUAL	ALL	1				
189		634899.5	4977184	0.0001	2206.56	2844.3	0	ANNUAL	ALL	1				
190		634924.5	4977184	0.00011	2193.64	2844.3	0	ANNUAL	ALL	1				
191		634949.5	4977184	0.00011	2172.29	2844.3	0	ANNUAL	ALL	1				
192		634974.5	4977184	0.00012	2154.5	2844.3	0	ANNUAL	ALL	1				
193		634999.5	4977184	0.00012	2141.04	2844.3	0	ANNUAL	ALL	1				
194		635024.5	4977184	0.00012	2128.3	2844.3	0	ANNUAL	ALL	1				
195		635049.5	4977184	0.00012	2114.34	2844.3	0	ANNUAL	ALL	1				
196		635074.5	4977184	0.00013	2102.7	2844.3	0	ANNUAL	ALL	1				
197		635099.5	4977184	0.00014	2096.47	2844.3	0	ANNUAL	ALL	1				
198		634899.5	4977209	0.0001	2199.13	2844.3	0	ANNUAL	ALL	1				
199		634924.5	4977209	0.00011	2184.15	2844.3	0	ANNUAL	ALL	1				
200		634949.5	4977209	0.00011	2163.72	2844.3	0	ANNUAL	ALL	1				
201		634974.5	4977209	0.00012	2146.68	2844.3	0	ANNUAL	ALL	1				
202		634999.5	4977209	0.00012	2136.15	2844.3	0	ANNUAL	ALL	1				
203		635024.5	4977209	0.00012	2124.22	2844.3	0	ANNUAL	ALL	1				
204		635049.5	4977209	0.00013	2105.9	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
205		635074.5	4977209	0.00013	2096.39	2844.3	0	ANNUAL	ALL	1				
206		635099.5	4977209	0.00014	2091.31	2844.3	0	ANNUAL	ALL	1				
207		634899.5	4977234	0.00011	2185.16	2844.3	0	ANNUAL	ALL	1				
208		634924.5	4977234	0.00011	2172.04	2844.3	0	ANNUAL	ALL	1				
209		634949.5	4977234	0.00011	2152.41	2844.3	0	ANNUAL	ALL	1				
210		634974.5	4977234	0.00012	2139.97	2844.3	0	ANNUAL	ALL	1				
211		634999.5	4977234	0.00011	2130.73	2844.3	0	ANNUAL	ALL	1				
212		635024.5	4977234	0.00012	2117.31	2844.3	0	ANNUAL	ALL	1				
213		635049.5	4977234	0.00013	2098.65	2844.3	0	ANNUAL	ALL	1				
214		635074.5	4977234	0.00013	2092.39	2844.3	0	ANNUAL	ALL	1				
215		635099.5	4977234	0.00014	2087.32	2844.3	0	ANNUAL	ALL	1				
216		634899.5	4977259	0.00011	2180.4	2844.3	0	ANNUAL	ALL	1				
217		634924.5	4977259	0.00011	2160.19	2844.3	0	ANNUAL	ALL	1				
218		634949.5	4977259	0.00011	2143.3	2844.3	0	ANNUAL	ALL	1				
219		634974.5	4977259	0.00011	2132.11	2844.3	0	ANNUAL	ALL	1				
220		634999.5	4977259	0.00012	2123.02	2844.3	0	ANNUAL	ALL	1				
221		635024.5	4977259	0.00012	2107.09	2844.3	0	ANNUAL	ALL	1				
222		635049.5	4977259	0.00013	2095.35	2844.3	0	ANNUAL	ALL	1				
223		635074.5	4977259	0.00013	2089.07	2844.3	0	ANNUAL	ALL	1				
224		635099.5	4977259	0.00014	2083.6	2844.3	0	ANNUAL	ALL	1				
225		634899.5	4977284	0.0001	2180.69	2844.3	0	ANNUAL	ALL	1				
226		634924.5	4977284	0.00011	2158.28	2844.3	0	ANNUAL	ALL	1				
227		634949.5	4977284	0.00011	2139.34	2844.3	0	ANNUAL	ALL	1				
228		634974.5	4977284	0.00011	2123.05	2844.3	0	ANNUAL	ALL	1				
229		634999.5	4977284	0.00011	2112.91	2844.3	0	ANNUAL	ALL	1				
230		635024.5	4977284	0.00012	2100.55	2844.3	0	ANNUAL	ALL	1				
231		635049.5	4977284	0.00013	2092.76	2844.3	0	ANNUAL	ALL	1				
232		635074.5	4977284	0.00013	2085.71	2844.3	0	ANNUAL	ALL	1				
233		635099.5	4977284	0.00013	2078.67	2844.3	0	ANNUAL	ALL	1				
234		634899.5	4977309	0.0001	2178.55	2844.3	0	ANNUAL	ALL	1				
235		634924.5	4977309	0.00011	2156.77	2844.3	0	ANNUAL	ALL	1				
236		634949.5	4977309	0.00011	2136.54	2844.3	0	ANNUAL	ALL	1				
237		634974.5	4977309	0.00011	2119.59	2844.3	0	ANNUAL	ALL	1				
238		634999.5	4977309	0.00012	2107.01	2844.3	0	ANNUAL	ALL	1				
239		635024.5	4977309	0.00012	2096.52	2844.3	0	ANNUAL	ALL	1				
240		635049.5	4977309	0.00013	2089.24	2844.3	0	ANNUAL	ALL	1				
241		635074.5	4977309	0.00013	2082.55	2844.3	0	ANNUAL	ALL	1				
242		635099.5	4977309	0.00013	2075.98	2844.3	0	ANNUAL	ALL	1				
243		634899.5	4977334	0.0001	2173.18	2844.3	0	ANNUAL	ALL	1				
244		634924.5	4977334	0.0001	2153.29	2844.3	0	ANNUAL	ALL	1				
245		634949.5	4977334	0.00011	2133.9	2844.3	0	ANNUAL	ALL	1				
246		634974.5	4977334	0.00011	2117.58	2844.3	0	ANNUAL	ALL	1				
247		634999.5	4977334	0.00012	2104.03	2844.3	0	ANNUAL	ALL	1				
248		635024.5	4977334	0.00012	2093.8	2844.3	0	ANNUAL	ALL	1				
249		635049.5	4977334	0.00013	2085.23	2844.3	0	ANNUAL	ALL	1				
250		635074.5	4977334	0.00013	2078.76	2844.3	0	ANNUAL	ALL	1				
251		635099.5	4977334	0.00013	2074.53	2844.3	0	ANNUAL	ALL	1				
252		635399.5	4976159	0.00044	2171.27	2844.3	0	ANNUAL	ALL	1				
253		635424.5	4976159	0.00045	2169.98	2844.3	0	ANNUAL	ALL	1				
254		635449.5	4976159	0.00045	2167.61	2844.3	0	ANNUAL	ALL	1				
255		635474.5	4976159	0.00046	2164.06	2844.3	0	ANNUAL	ALL	1				
256		635499.5	4976159	0.00047	2161.76	2844.3	0	ANNUAL	ALL	1				
257		635524.5	4976159	0.00047	2160.48	2844.3	0	ANNUAL	ALL	1				
258		635549.5	4976159	0.00048	2162.19	2844.3	0	ANNUAL	ALL	1				
259		635574.5	4976159	0.00048	2168.15	2844.3	0	ANNUAL	ALL	1				
260		635599.5	4976159	0.00049	2173.85	2844.3	0	ANNUAL	ALL	1				
261		635399.5	4976184	0.00043	2168.06	2844.3	0	ANNUAL	ALL	1				
262		635424.5	4976184	0.00044	2166.17	2844.3	0	ANNUAL	ALL	1				
263		635449.5	4976184	0.00044	2163.95	2844.3	0	ANNUAL	ALL	1				
264		635474.5	4976184	0.00045	2161.05	2844.3	0	ANNUAL	ALL	1				
265		635499.5	4976184	0.00046	2158.86	2844.3	0	ANNUAL	ALL	1				
266		635524.5	4976184	0.00046	2157.1	2844.3	0	ANNUAL	ALL	1				
267		635549.5	4976184	0.00047	2157.07	2844.3	0	ANNUAL	ALL	1				
268		635574.5	4976184	0.00047	2164.59	2844.3	0	ANNUAL	ALL	1				
269		635599.5	4976184	0.00048	2172.06	2844.3	0	ANNUAL	ALL	1				
270		635399.5	4976209	0.00042	2165.29	2844.3	0	ANNUAL	ALL	1				
271		635424.5	4976209	0.00042	2163.14	2844.3	0	ANNUAL	ALL	1				
272		635449.5	4976209	0.00043	2160.76	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
273		635474.5	4976209	0.00044	2158.05	2844.3	0	ANNUAL	ALL	1				
274		635499.5	4976209	0.00044	2155.43	2844.3	0	ANNUAL	ALL	1				
275		635524.5	4976209	0.00045	2153.57	2844.3	0	ANNUAL	ALL	1				
276		635549.5	4976209	0.00046	2156.02	2844.3	0	ANNUAL	ALL	1				
277		635574.5	4976209	0.00046	2165.26	2844.3	0	ANNUAL	ALL	1				
278		635599.5	4976209	0.00046	2175.01	2844.3	0	ANNUAL	ALL	1				
279		635399.5	4976234	0.00041	2162.56	2844.3	0	ANNUAL	ALL	1				
280		635424.5	4976234	0.00041	2160.46	2844.3	0	ANNUAL	ALL	1				
281		635449.5	4976234	0.00042	2157.93	2844.3	0	ANNUAL	ALL	1				
282		635474.5	4976234	0.00043	2155.5	2844.3	0	ANNUAL	ALL	1				
283		635499.5	4976234	0.00043	2152.67	2844.3	0	ANNUAL	ALL	1				
284		635524.5	4976234	0.00044	2150.12	2844.3	0	ANNUAL	ALL	1				
285		635549.5	4976234	0.00044	2156.6	2844.3	0	ANNUAL	ALL	1				
286		635574.5	4976234	0.00045	2167.62	2844.3	0	ANNUAL	ALL	1				
287		635599.5	4976234	0.00045	2178.35	2844.3	0	ANNUAL	ALL	1				
288		634999.5	4978134	0.00008	2044.53	2844.3	0	ANNUAL	ALL	1				
289		635024.5	4978134	0.00008	2030.56	2844.3	0	ANNUAL	ALL	1				
290		635049.5	4978134	0.00009	2018.07	2844.3	0	ANNUAL	ALL	1				
291		635074.5	4978134	0.0001	2006.69	2844.3	0	ANNUAL	ALL	1				
292		635099.5	4978134	0.0001	2006.39	2844.3	0	ANNUAL	ALL	1				
293		635124.5	4978134	0.0001	2013.34	2844.3	0	ANNUAL	ALL	1				
294		635149.5	4978134	0.00009	2020.75	2844.3	0	ANNUAL	ALL	1				
295		635174.5	4978134	0.00009	2029.05	2844.3	0	ANNUAL	ALL	1				
296		635199.5	4978134	0.00009	2038.91	2844.3	0	ANNUAL	ALL	1				
297		634999.5	4978159	0.00008	2044.5	2844.3	0	ANNUAL	ALL	1				
298		635024.5	4978159	0.00008	2030.78	2844.3	0	ANNUAL	ALL	1				
299		635049.5	4978159	0.00009	2017.35	2844.3	0	ANNUAL	ALL	1				
300		635074.5	4978159	0.00009	2004.54	2844.3	0	ANNUAL	ALL	1				
301		635099.5	4978159	0.00009	2003.81	2844.3	0	ANNUAL	ALL	1				
302		635124.5	4978159	0.0001	2010.57	2844.3	0	ANNUAL	ALL	1				
303		635149.5	4978159	0.00009	2017.75	2844.3	0	ANNUAL	ALL	1				
304		635174.5	4978159	0.00009	2025.18	2844.3	0	ANNUAL	ALL	1				
305		635199.5	4978159	0.00008	2035.11	2844.3	0	ANNUAL	ALL	1				
306		634999.5	4978184	0.00008	2044.38	2844.3	0	ANNUAL	ALL	1				
307		635024.5	4978184	0.00008	2028.98	2844.3	0	ANNUAL	ALL	1				
308		635049.5	4978184	0.00009	2015.36	2844.3	0	ANNUAL	ALL	1				
309		635074.5	4978184	0.00009	2002.43	2844.3	0	ANNUAL	ALL	1				
310		635099.5	4978184	0.00009	2000.86	2844.3	0	ANNUAL	ALL	1				
311		635124.5	4978184	0.00009	2007.53	2844.3	0	ANNUAL	ALL	1				
312		635149.5	4978184	0.00009	2014.6	2844.3	0	ANNUAL	ALL	1				
313		635174.5	4978184	0.00009	2022.07	2844.3	0	ANNUAL	ALL	1				
314		635199.5	4978184	0.00008	2031.45	2844.3	0	ANNUAL	ALL	1				
315		634999.5	4978209	0.00008	2043.46	2844.3	0	ANNUAL	ALL	1				
316		635024.5	4978209	0.00008	2027.94	2844.3	0	ANNUAL	ALL	1				
317		635049.5	4978209	0.00009	2013.73	2844.3	0	ANNUAL	ALL	1				
318		635074.5	4978209	0.00009	2000.96	2844.3	0	ANNUAL	ALL	1				
319		635099.5	4978209	0.00009	1998.75	2844.3	0	ANNUAL	ALL	1				
320		635124.5	4978209	0.00009	2004.56	2844.3	0	ANNUAL	ALL	1				
321		635149.5	4978209	0.00009	2011.78	2844.3	0	ANNUAL	ALL	1				
322		635174.5	4978209	0.00009	2019.36	2844.3	0	ANNUAL	ALL	1				
323		635199.5	4978209	0.00008	2027.82	2844.3	0	ANNUAL	ALL	1				
324		634999.5	4978234	0.00008	2042.97	2844.3	0	ANNUAL	ALL	1				
325		635024.5	4978234	0.00008	2026.61	2844.3	0	ANNUAL	ALL	1				
326		635049.5	4978234	0.00009	2012.57	2844.3	0	ANNUAL	ALL	1				
327		635074.5	4978234	0.00009	2000.24	2844.3	0	ANNUAL	ALL	1				
328		635099.5	4978234	0.00009	1996.61	2844.3	0	ANNUAL	ALL	1				
329		635124.5	4978234	0.00009	2001.65	2844.3	0	ANNUAL	ALL	1				
330		635149.5	4978234	0.00009	2009.16	2844.3	0	ANNUAL	ALL	1				
331		635174.5	4978234	0.00009	2016.86	2844.3	0	ANNUAL	ALL	1				
332		635199.5	4978234	0.00008	2024.48	2844.3	0	ANNUAL	ALL	1				
333		634999.5	4978259	0.00008	2041.08	2844.3	0	ANNUAL	ALL	1				
334		635024.5	4978259	0.00008	2024.08	2844.3	0	ANNUAL	ALL	1				
335		635049.5	4978259	0.00009	2011.49	2844.3	0	ANNUAL	ALL	1				
336		635074.5	4978259	0.00009	2000.61	2844.3	0	ANNUAL	ALL	1				
337		635099.5	4978259	0.00009	1994.84	2844.3	0	ANNUAL	ALL	1				
338		635124.5	4978259	0.00009	1999.29	2844.3	0	ANNUAL	ALL	1				
339		635149.5	4978259	0.00009	2007.14	2844.3	0	ANNUAL	ALL	1				
340		635174.5	4978259	0.00009	2014.96	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
341		635199.5	4978259	0.00008	2023.44	2844.3	0	ANNUAL	ALL	1				
342		634999.5	4978284	0.00008	2039.02	2844.3	0	ANNUAL	ALL	1				
343		635024.5	4978284	0.00008	2022.69	2844.3	0	ANNUAL	ALL	1				
344		635049.5	4978284	0.00009	2010.11	2844.3	0	ANNUAL	ALL	1				
345		635074.5	4978284	0.00009	1999.28	2844.3	0	ANNUAL	ALL	1				
346		635099.5	4978284	0.00009	1993.94	2844.3	0	ANNUAL	ALL	1				
347		635124.5	4978284	0.00009	1996.86	2844.3	0	ANNUAL	ALL	1				
348		635149.5	4978284	0.00009	2004.78	2844.3	0	ANNUAL	ALL	1				
349		635174.5	4978284	0.00009	2012.7	2844.3	0	ANNUAL	ALL	1				
350		635199.5	4978284	0.00008	2021.78	2844.3	0	ANNUAL	ALL	1				
351		634999.5	4978309	0.00008	2036.72	2844.3	0	ANNUAL	ALL	1				
352		635024.5	4978309	0.00008	2023.32	2844.3	0	ANNUAL	ALL	1				
353		635049.5	4978309	0.00009	2010.1	2844.3	0	ANNUAL	ALL	1				
354		635074.5	4978309	0.00009	1999.36	2844.3	0	ANNUAL	ALL	1				
355		635099.5	4978309	0.00009	1992.81	2844.3	0	ANNUAL	ALL	1				
356		635124.5	4978309	0.00009	1994.13	2844.3	0	ANNUAL	ALL	1				
357		635149.5	4978309	0.00009	2001.68	2844.3	0	ANNUAL	ALL	1				
358		635174.5	4978309	0.00009	2009.75	2844.3	0	ANNUAL	ALL	1				
359		635199.5	4978309	0.00008	2018.84	2844.3	0	ANNUAL	ALL	1				
360		634999.5	4978334	0.00008	2033.58	2844.3	0	ANNUAL	ALL	1				
361		635024.5	4978334	0.00008	2021.76	2844.3	0	ANNUAL	ALL	1				
362		635049.5	4978334	0.00009	2009.59	2844.3	0	ANNUAL	ALL	1				
363		635074.5	4978334	0.00009	1999.33	2844.3	0	ANNUAL	ALL	1				
364		635099.5	4978334	0.00009	1991.74	2844.3	0	ANNUAL	ALL	1				
365		635124.5	4978334	0.00009	1991.62	2844.3	0	ANNUAL	ALL	1				
366		635149.5	4978334	0.00009	1998.49	2844.3	0	ANNUAL	ALL	1				
367		635174.5	4978334	0.00009	2006.18	2844.3	0	ANNUAL	ALL	1				
368		635199.5	4978334	0.00009	2015.32	2844.3	0	ANNUAL	ALL	1				
369		634299.5	4978134	0.00008	2065.05	2844.3	0	ANNUAL	ALL	1				
370		634324.5	4978134	0.00008	2052.1	2844.3	0	ANNUAL	ALL	1				
371		634349.5	4978134	0.00008	2045.24	2844.3	0	ANNUAL	ALL	1				
372		634374.5	4978134	0.00008	2034.94	2844.3	0	ANNUAL	ALL	1				
373		634399.5	4978134	0.00008	2020.36	2844.3	0	ANNUAL	ALL	1				
374		634424.5	4978134	0.00008	2003.67	2844.3	0	ANNUAL	ALL	1				
375		634449.5	4978134	0.00008	1995.29	2844.3	0	ANNUAL	ALL	1				
376		634474.5	4978134	0.00008	2007.74	2844.3	0	ANNUAL	ALL	1				
377		634499.5	4978134	0.00008	2026.56	2844.3	0	ANNUAL	ALL	1				
378		634299.5	4978159	0.00008	2056.37	2844.3	0	ANNUAL	ALL	1				
379		634324.5	4978159	0.00008	2043.39	2844.3	0	ANNUAL	ALL	1				
380		634349.5	4978159	0.00008	2031.51	2844.3	0	ANNUAL	ALL	1				
381		634374.5	4978159	0.00008	2023.05	2844.3	0	ANNUAL	ALL	1				
382		634399.5	4978159	0.00008	2009.29	2844.3	0	ANNUAL	ALL	1				
383		634424.5	4978159	0.00008	1995	2844.3	0	ANNUAL	ALL	1				
384		634449.5	4978159	0.00008	1992.7	2844.3	0	ANNUAL	ALL	1				
385		634474.5	4978159	0.00008	2006.88	2844.3	0	ANNUAL	ALL	1				
386		634499.5	4978159	0.00008	2023.97	2844.3	0	ANNUAL	ALL	1				
387		634299.5	4978184	0.00008	2049.3	2844.3	0	ANNUAL	ALL	1				
388		634324.5	4978184	0.00008	2036.32	2844.3	0	ANNUAL	ALL	1				
389		634349.5	4978184	0.00008	2022.34	2844.3	0	ANNUAL	ALL	1				
390		634374.5	4978184	0.00008	2009.09	2844.3	0	ANNUAL	ALL	1				
391		634399.5	4978184	0.00008	1999.89	2844.3	0	ANNUAL	ALL	1				
392		634424.5	4978184	0.00008	1987.52	2844.3	0	ANNUAL	ALL	1				
393		634449.5	4978184	0.00008	1991.46	2844.3	0	ANNUAL	ALL	1				
394		634474.5	4978184	0.00008	2006.06	2844.3	0	ANNUAL	ALL	1				
395		634499.5	4978184	0.00008	2020.38	2844.3	0	ANNUAL	ALL	1				
396		634299.5	4978209	0.00008	2043.21	2844.3	0	ANNUAL	ALL	1				
397		634324.5	4978209	0.00008	2030.6	2844.3	0	ANNUAL	ALL	1				
398		634349.5	4978209	0.00008	2016.03	2844.3	0	ANNUAL	ALL	1				
399		634374.5	4978209	0.00008	2000.87	2844.3	0	ANNUAL	ALL	1				
400		634399.5	4978209	0.00008	1990.53	2844.3	0	ANNUAL	ALL	1				
401		634424.5	4978209	0.00008	1981.32	2844.3	0	ANNUAL	ALL	1				
402		634449.5	4978209	0.00008	1989.45	2844.3	0	ANNUAL	ALL	1				
403		634474.5	4978209	0.00008	2004.01	2844.3	0	ANNUAL	ALL	1				
404		634499.5	4978209	0.00008	2016.91	2844.3	0	ANNUAL	ALL	1				
405		634299.5	4978234	0.00008	2037.27	2844.3	0	ANNUAL	ALL	1				
406		634324.5	4978234	0.00008	2025.09	2844.3	0	ANNUAL	ALL	1				
407		634349.5	4978234	0.00008	2009.81	2844.3	0	ANNUAL	ALL	1				
408		634374.5	4978234	0.00008	1996.13	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
409		634399.5	4978234	0.00008	1984.05	2844.3	0	ANNUAL	ALL	1				
410		634424.5	4978234	0.00008	1975.87	2844.3	0	ANNUAL	ALL	1				
411		634449.5	4978234	0.00008	1984.97	2844.3	0	ANNUAL	ALL	1				
412		634474.5	4978234	0.00008	2000.36	2844.3	0	ANNUAL	ALL	1				
413		634499.5	4978234	0.00008	2011.73	2844.3	0	ANNUAL	ALL	1				
414		634299.5	4978259	0.00007	2030.97	2844.3	0	ANNUAL	ALL	1				
415		634324.5	4978259	0.00007	2018.02	2844.3	0	ANNUAL	ALL	1				
416		634349.5	4978259	0.00008	2002.99	2844.3	0	ANNUAL	ALL	1				
417		634374.5	4978259	0.00008	1990.41	2844.3	0	ANNUAL	ALL	1				
418		634399.5	4978259	0.00008	1978.88	2844.3	0	ANNUAL	ALL	1				
419		634424.5	4978259	0.00008	1972.17	2844.3	0	ANNUAL	ALL	1				
420		634449.5	4978259	0.00008	1977.85	2844.3	0	ANNUAL	ALL	1				
421		634474.5	4978259	0.00008	1992.52	2844.3	0	ANNUAL	ALL	1				
422		634499.5	4978259	0.00008	2003.44	2844.3	0	ANNUAL	ALL	1				
423		634299.5	4978284	0.00007	2023.26	2844.3	0	ANNUAL	ALL	1				
424		634324.5	4978284	0.00008	2008.98	2844.3	0	ANNUAL	ALL	1				
425		634349.5	4978284	0.00008	1996.31	2844.3	0	ANNUAL	ALL	1				
426		634374.5	4978284	0.00008	1984.2	2844.3	0	ANNUAL	ALL	1				
427		634399.5	4978284	0.00008	1973.37	2844.3	0	ANNUAL	ALL	1				
428		634424.5	4978284	0.00008	1969.23	2844.3	0	ANNUAL	ALL	1				
429		634449.5	4978284	0.00008	1975.58	2844.3	0	ANNUAL	ALL	1				
430		634474.5	4978284	0.00008	1989.07	2844.3	0	ANNUAL	ALL	1				
431		634499.5	4978284	0.00008	2000.53	2844.3	0	ANNUAL	ALL	1				
432		634299.5	4978309	0.00008	2012.41	2844.3	0	ANNUAL	ALL	1				
433		634324.5	4978309	0.00008	1999.74	2844.3	0	ANNUAL	ALL	1				
434		634349.5	4978309	0.00008	1988.62	2844.3	0	ANNUAL	ALL	1				
435		634374.5	4978309	0.00008	1977.79	2844.3	0	ANNUAL	ALL	1				
436		634399.5	4978309	0.00008	1967.1	2844.3	0	ANNUAL	ALL	1				
437		634424.5	4978309	0.00008	1968.14	2844.3	0	ANNUAL	ALL	1				
438		634449.5	4978309	0.00008	1977.66	2844.3	0	ANNUAL	ALL	1				
439		634474.5	4978309	0.00008	1992.31	2844.3	0	ANNUAL	ALL	1				
440		634499.5	4978309	0.00008	2006.23	2844.3	0	ANNUAL	ALL	1				
441		634299.5	4978334	0.00008	2000.94	2844.3	0	ANNUAL	ALL	1				
442		634324.5	4978334	0.00008	1991.1	2844.3	0	ANNUAL	ALL	1				
443		634349.5	4978334	0.00008	1980.66	2844.3	0	ANNUAL	ALL	1				
444		634374.5	4978334	0.00008	1970.39	2844.3	0	ANNUAL	ALL	1				
445		634399.5	4978334	0.00008	1961.38	2844.3	0	ANNUAL	ALL	1				
446		634424.5	4978334	0.00008	1968.29	2844.3	0	ANNUAL	ALL	1				
447		634449.5	4978334	0.00008	1980.95	2844.3	0	ANNUAL	ALL	1				
448		634474.5	4978334	0.00008	1997.36	2844.3	0	ANNUAL	ALL	1				
449		634499.5	4978334	0.00008	2012.52	2844.3	0	ANNUAL	ALL	1				
450		634299.5	4978359	0.00008	1991.4	2844.3	0	ANNUAL	ALL	1				
451		634324.5	4978359	0.00008	1982.72	2844.3	0	ANNUAL	ALL	1				
452		634349.5	4978359	0.00008	1972.75	2844.3	0	ANNUAL	ALL	1				
453		634374.5	4978359	0.00008	1962.87	2844.3	0	ANNUAL	ALL	1				
454		634399.5	4978359	0.00008	1958.17	2844.3	0	ANNUAL	ALL	1				
455		634424.5	4978359	0.00008	1968.79	2844.3	0	ANNUAL	ALL	1				
456		634449.5	4978359	0.00008	1984.24	2844.3	0	ANNUAL	ALL	1				
457		634474.5	4978359	0.00008	2002.2	2844.3	0	ANNUAL	ALL	1				
458		634499.5	4978359	0.00007	2016.76	2844.3	0	ANNUAL	ALL	1				
459		634299.5	4978384	0.00007	1982.57	2844.3	0	ANNUAL	ALL	1				
460		634324.5	4978384	0.00008	1975.68	2844.3	0	ANNUAL	ALL	1				
461		634349.5	4978384	0.00008	1964.84	2844.3	0	ANNUAL	ALL	1				
462		634374.5	4978384	0.00008	1956.29	2844.3	0	ANNUAL	ALL	1				
463		634399.5	4978384	0.00008	1955.61	2844.3	0	ANNUAL	ALL	1				
464		634424.5	4978384	0.00008	1968.65	2844.3	0	ANNUAL	ALL	1				
465		634449.5	4978384	0.00008	1986.09	2844.3	0	ANNUAL	ALL	1				
466		634474.5	4978384	0.00008	2004.63	2844.3	0	ANNUAL	ALL	1				
467		634499.5	4978384	0.00007	2018.69	2844.3	0	ANNUAL	ALL	1				
468		634299.5	4978409	0.00007	1975.4	2844.3	0	ANNUAL	ALL	1				
469		634324.5	4978409	0.00007	1967.52	2844.3	0	ANNUAL	ALL	1				
470		634349.5	4978409	0.00007	1957.04	2844.3	0	ANNUAL	ALL	1				
471		634374.5	4978409	0.00008	1949.69	2844.3	0	ANNUAL	ALL	1				
472		634399.5	4978409	0.00008	1951.43	2844.3	0	ANNUAL	ALL	1				
473		634424.5	4978409	0.00008	1967.3	2844.3	0	ANNUAL	ALL	1				
474		634449.5	4978409	0.00008	1986.39	2844.3	0	ANNUAL	ALL	1				
475		634474.5	4978409	0.00008	2005.28	2844.3	0	ANNUAL	ALL	1				
476		634499.5	4978409	0.00007	2019.28	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
477		634299.5	4978434	0.00007	1965.22	2844.3	0	ANNUAL	ALL	1				
478		634324.5	4978434	0.00007	1958.88	2844.3	0	ANNUAL	ALL	1				
479		634349.5	4978434	0.00007	1950.79	2844.3	0	ANNUAL	ALL	1				
480		634374.5	4978434	0.00007	1943.73	2844.3	0	ANNUAL	ALL	1				
481		634399.5	4978434	0.00007	1949.4	2844.3	0	ANNUAL	ALL	1				
482		634424.5	4978434	0.00008	1965.04	2844.3	0	ANNUAL	ALL	1				
483		634449.5	4978434	0.00007	1984.59	2844.3	0	ANNUAL	ALL	1				
484		634474.5	4978434	0.00007	2004.45	2844.3	0	ANNUAL	ALL	1				
485		634499.5	4978434	0.00007	2017.53	2844.3	0	ANNUAL	ALL	1				
486		634249.4	4977384	0.00006	2291.4	2717.08	0	ANNUAL	ALL	1				
487		634274.4	4977384	0.00006	2282.65	2742	0	ANNUAL	ALL	1				
488		634299.4	4977384	0.00006	2273.71	2742	0	ANNUAL	ALL	1				
489		634324.4	4977384	0.00006	2263.84	2742	0	ANNUAL	ALL	1				
490		634349.4	4977384	0.00007	2250.84	2742	0	ANNUAL	ALL	1				
491		634374.4	4977384	0.00007	2238.58	2742.16	0	ANNUAL	ALL	1				
492		634399.4	4977384	0.00007	2232.43	2742.16	0	ANNUAL	ALL	1				
493		634424.4	4977384	0.00007	2242.73	2742.16	0	ANNUAL	ALL	1				
494		634449.4	4977384	0.00007	2255.36	2742	0	ANNUAL	ALL	1				
495		634249.4	4977409	0.00006	2284.43	2742	0	ANNUAL	ALL	1				
496		634274.4	4977409	0.00006	2274.53	2742	0	ANNUAL	ALL	1				
497		634299.4	4977409	0.00006	2264.56	2742	0	ANNUAL	ALL	1				
498		634324.4	4977409	0.00006	2254.44	2742	0	ANNUAL	ALL	1				
499		634349.4	4977409	0.00007	2243.93	2742.16	0	ANNUAL	ALL	1				
500		634374.4	4977409	0.00007	2231.37	2742.16	0	ANNUAL	ALL	1				
501		634399.4	4977409	0.00007	2226.02	2844.3	0	ANNUAL	ALL	1				
502		634424.4	4977409	0.00007	2236.92	2742.16	0	ANNUAL	ALL	1				
503		634449.4	4977409	0.00007	2249.43	2742.16	0	ANNUAL	ALL	1				
504		634249.4	4977434	0.00006	2279.34	2742	0	ANNUAL	ALL	1				
505		634274.4	4977434	0.00006	2267.65	2742	0	ANNUAL	ALL	1				
506		634299.4	4977434	0.00006	2255.85	2742	0	ANNUAL	ALL	1				
507		634324.4	4977434	0.00006	2244.86	2742	0	ANNUAL	ALL	1				
508		634349.4	4977434	0.00007	2234.48	2742.16	0	ANNUAL	ALL	1				
509		634374.4	4977434	0.00007	2223.18	2844.3	0	ANNUAL	ALL	1				
510		634399.4	4977434	0.00007	2218.5	2844.3	0	ANNUAL	ALL	1				
511		634424.4	4977434	0.00007	2230.27	2844.3	0	ANNUAL	ALL	1				
512		634449.4	4977434	0.00007	2243.66	2742.16	0	ANNUAL	ALL	1				
513		634249.4	4977459	0.00006	2275.78	2742	0	ANNUAL	ALL	1				
514		634274.4	4977459	0.00006	2262.83	2742	0	ANNUAL	ALL	1				
515		634299.4	4977459	0.00006	2248.74	2742	0	ANNUAL	ALL	1				
516		634324.4	4977459	0.00006	2237.43	2742.16	0	ANNUAL	ALL	1				
517		634349.4	4977459	0.00007	2226.72	2844.3	0	ANNUAL	ALL	1				
518		634374.4	4977459	0.00007	2214.97	2844.3	0	ANNUAL	ALL	1				
519		634399.4	4977459	0.00007	2211.75	2844.3	0	ANNUAL	ALL	1				
520		634424.4	4977459	0.00007	2223.34	2844.3	0	ANNUAL	ALL	1				
521		634449.4	4977459	0.00007	2237.29	2844.3	0	ANNUAL	ALL	1				
522		634249.4	4977484	0.00006	2272.5	2742	0	ANNUAL	ALL	1				
523		634274.4	4977484	0.00006	2258.48	2742	0	ANNUAL	ALL	1				
524		634299.4	4977484	0.00006	2243.77	2742	0	ANNUAL	ALL	1				
525		634324.4	4977484	0.00006	2231.45	2742.16	0	ANNUAL	ALL	1				
526		634349.4	4977484	0.00007	2219.9	2844.3	0	ANNUAL	ALL	1				
527		634374.4	4977484	0.00007	2207.94	2844.3	0	ANNUAL	ALL	1				
528		634399.4	4977484	0.00007	2204.62	2844.3	0	ANNUAL	ALL	1				
529		634424.4	4977484	0.00007	2216.76	2844.3	0	ANNUAL	ALL	1				
530		634449.4	4977484	0.00007	2230.33	2844.3	0	ANNUAL	ALL	1				
531		634249.4	4977509	0.00006	2269.17	2742	0	ANNUAL	ALL	1				
532		634274.4	4977509	0.00006	2254.88	2742	0	ANNUAL	ALL	1				
533		634299.4	4977509	0.00006	2240.59	2742	0	ANNUAL	ALL	1				
534		634324.4	4977509	0.00006	2227.32	2844.3	0	ANNUAL	ALL	1				
535		634349.4	4977509	0.00007	2213.19	2844.3	0	ANNUAL	ALL	1				
536		634374.4	4977509	0.00007	2200.19	2844.3	0	ANNUAL	ALL	1				
537		634399.4	4977509	0.00007	2197.61	2844.3	0	ANNUAL	ALL	1				
538		634424.4	4977509	0.00007	2211.03	2844.3	0	ANNUAL	ALL	1				
539		634449.4	4977509	0.00007	2223.57	2844.3	0	ANNUAL	ALL	1				
540		634249.4	4977534	0.00006	2266.65	2742	0	ANNUAL	ALL	1				
541		634274.4	4977534	0.00006	2251.58	2742	0	ANNUAL	ALL	1				
542		634299.4	4977534	0.00006	2237.18	2742	0	ANNUAL	ALL	1				
543		634324.4	4977534	0.00006	2223.67	2844.3	0	ANNUAL	ALL	1				
544		634349.4	4977534	0.00007	2207.86	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
545		634374.4	4977534	0.00007	2193.38	2844.3	0	ANNUAL	ALL	1				
546		634399.4	4977534	0.00007	2191.95	2844.3	0	ANNUAL	ALL	1				
547		634424.4	4977534	0.00007	2205.88	2844.3	0	ANNUAL	ALL	1				
548		634449.4	4977534	0.00007	2217.63	2844.3	0	ANNUAL	ALL	1				
549		634249.4	4977559	0.00006	2264.12	2742	0	ANNUAL	ALL	1				
550		634274.4	4977559	0.00006	2247.26	2742	0	ANNUAL	ALL	1				
551		634299.4	4977559	0.00006	2232.74	2742	0	ANNUAL	ALL	1				
552		634324.4	4977559	0.00006	2218.55	2844.3	0	ANNUAL	ALL	1				
553		634349.4	4977559	0.00007	2203.35	2844.3	0	ANNUAL	ALL	1				
554		634374.4	4977559	0.00007	2189.62	2844.3	0	ANNUAL	ALL	1				
555		634399.4	4977559	0.00007	2184.96	2844.3	0	ANNUAL	ALL	1				
556		634424.4	4977559	0.00007	2200.77	2844.3	0	ANNUAL	ALL	1				
557		634449.4	4977559	0.00007	2211.07	2844.3	0	ANNUAL	ALL	1				
558		634249.4	4977584	0.00006	2258.01	2742	0	ANNUAL	ALL	1				
559		634274.4	4977584	0.00006	2242.66	2742	0	ANNUAL	ALL	1				
560		634299.4	4977584	0.00006	2227.67	2844.3	0	ANNUAL	ALL	1				
561		634324.4	4977584	0.00006	2213.51	2844.3	0	ANNUAL	ALL	1				
562		634349.4	4977584	0.00007	2199.5	2844.3	0	ANNUAL	ALL	1				
563		634374.4	4977584	0.00007	2185.33	2844.3	0	ANNUAL	ALL	1				
564		634399.4	4977584	0.00007	2177.11	2844.3	0	ANNUAL	ALL	1				
565		634424.4	4977584	0.00007	2192.43	2844.3	0	ANNUAL	ALL	1				
566		634449.4	4977584	0.00007	2203.16	2844.3	0	ANNUAL	ALL	1				
567		634999.5	4977834	0.00009	2055.79	2844.3	0	ANNUAL	ALL	1				
568		635024.5	4977834	0.0001	2048.42	2844.3	0	ANNUAL	ALL	1				
569		635049.5	4977834	0.0001	2043	2844.3	0	ANNUAL	ALL	1				
570		635074.5	4977834	0.0001	2037.93	2844.3	0	ANNUAL	ALL	1				
571		635099.5	4977834	0.0001	2034.24	2844.3	0	ANNUAL	ALL	1				
572		635124.5	4977834	0.0001	2031.45	2844.3	0	ANNUAL	ALL	1				
573		635149.5	4977834	0.0001	2038.5	2844.3	0	ANNUAL	ALL	1				
574		635174.5	4977834	0.0001	2050.35	2844.3	0	ANNUAL	ALL	1				
575		635199.5	4977834	0.0001	2063.26	2844.3	0	ANNUAL	ALL	1				
576		634999.5	4977859	0.00009	2052.63	2844.3	0	ANNUAL	ALL	1				
577		635024.5	4977859	0.00009	2046.41	2844.3	0	ANNUAL	ALL	1				
578		635049.5	4977859	0.0001	2040.95	2844.3	0	ANNUAL	ALL	1				
579		635074.5	4977859	0.0001	2036.03	2844.3	0	ANNUAL	ALL	1				
580		635099.5	4977859	0.0001	2032.3	2844.3	0	ANNUAL	ALL	1				
581		635124.5	4977859	0.0001	2030.17	2844.3	0	ANNUAL	ALL	1				
582		635149.5	4977859	0.0001	2038.33	2844.3	0	ANNUAL	ALL	1				
583		635174.5	4977859	0.0001	2049.93	2844.3	0	ANNUAL	ALL	1				
584		635199.5	4977859	0.0001	2062.54	2844.3	0	ANNUAL	ALL	1				
585		634999.5	4977884	0.00009	2049.11	2844.3	0	ANNUAL	ALL	1				
586		635024.5	4977884	0.00009	2044.13	2844.3	0	ANNUAL	ALL	1				
587		635049.5	4977884	0.00009	2038.92	2844.3	0	ANNUAL	ALL	1				
588		635074.5	4977884	0.0001	2034.26	2844.3	0	ANNUAL	ALL	1				
589		635099.5	4977884	0.0001	2030.48	2844.3	0	ANNUAL	ALL	1				
590		635124.5	4977884	0.0001	2029.04	2844.3	0	ANNUAL	ALL	1				
591		635149.5	4977884	0.0001	2038.45	2844.3	0	ANNUAL	ALL	1				
592		635174.5	4977884	0.0001	2049.51	2844.3	0	ANNUAL	ALL	1				
593		635199.5	4977884	0.0001	2061.56	2844.3	0	ANNUAL	ALL	1				
594		634999.5	4977909	0.00009	2047.27	2844.3	0	ANNUAL	ALL	1				
595		635024.5	4977909	0.00009	2042.16	2844.3	0	ANNUAL	ALL	1				
596		635049.5	4977909	0.00009	2036.97	2844.3	0	ANNUAL	ALL	1				
597		635074.5	4977909	0.00009	2032.48	2844.3	0	ANNUAL	ALL	1				
598		635099.5	4977909	0.0001	2028.7	2844.3	0	ANNUAL	ALL	1				
599		635124.5	4977909	0.0001	2028.77	2844.3	0	ANNUAL	ALL	1				
600		635149.5	4977909	0.0001	2038.62	2844.3	0	ANNUAL	ALL	1				
601		635174.5	4977909	0.0001	2049.12	2844.3	0	ANNUAL	ALL	1				
602		635199.5	4977909	0.0001	2060.48	2844.3	0	ANNUAL	ALL	1				
603		634999.5	4977934	0.00009	2046.79	2844.3	0	ANNUAL	ALL	1				
604		635024.5	4977934	0.00009	2040.92	2844.3	0	ANNUAL	ALL	1				
605		635049.5	4977934	0.00009	2034.68	2844.3	0	ANNUAL	ALL	1				
606		635074.5	4977934	0.00009	2029.58	2844.3	0	ANNUAL	ALL	1				
607		635099.5	4977934	0.00009	2025.61	2844.3	0	ANNUAL	ALL	1				
608		635124.5	4977934	0.00009	2027.68	2844.3	0	ANNUAL	ALL	1				
609		635149.5	4977934	0.00009	2038.09	2844.3	0	ANNUAL	ALL	1				
610		635174.5	4977934	0.00009	2048.68	2844.3	0	ANNUAL	ALL	1				
611		635199.5	4977934	0.00009	2059.02	2844.3	0	ANNUAL	ALL	1				
612		634999.5	4977959	0.00009	2045.95	2844.3	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
613		635024.5	4977959	0.00009	2039.51	2844.3	0	ANNUAL	ALL	1				
614		635049.5	4977959	0.00009	2032.45	2844.3	0	ANNUAL	ALL	1				
615		635074.5	4977959	0.00009	2026.52	2844.3	0	ANNUAL	ALL	1				
616		635099.5	4977959	0.00009	2022.6	2844.3	0	ANNUAL	ALL	1				
617		635124.5	4977959	0.00009	2027.13	2844.3	0	ANNUAL	ALL	1				
618		635149.5	4977959	0.00009	2036.89	2844.3	0	ANNUAL	ALL	1				
619		635174.5	4977959	0.00009	2046.85	2844.3	0	ANNUAL	ALL	1				
620		635199.5	4977959	0.00009	2056.78	2844.3	0	ANNUAL	ALL	1				
621		634999.5	4977984	0.00009	2045.34	2844.3	0	ANNUAL	ALL	1				
622		635024.5	4977984	0.00009	2037.82	2844.3	0	ANNUAL	ALL	1				
623		635049.5	4977984	0.00009	2030.43	2844.3	0	ANNUAL	ALL	1				
624		635074.5	4977984	0.00009	2024.12	2844.3	0	ANNUAL	ALL	1				
625		635099.5	4977984	0.00009	2019.96	2844.3	0	ANNUAL	ALL	1				
626		635124.5	4977984	0.00009	2026.73	2844.3	0	ANNUAL	ALL	1				
627		635149.5	4977984	0.00009	2035.4	2844.3	0	ANNUAL	ALL	1				
628		635174.5	4977984	0.00009	2044.46	2844.3	0	ANNUAL	ALL	1				
629		635199.5	4977984	0.00009	2053.52	2844.3	0	ANNUAL	ALL	1				
630		634999.5	4978009	0.00009	2044.81	2844.3	0	ANNUAL	ALL	1				
631		635024.5	4978009	0.00009	2035.59	2844.3	0	ANNUAL	ALL	1				
632		635049.5	4978009	0.00009	2028.05	2844.3	0	ANNUAL	ALL	1				
633		635074.5	4978009	0.00009	2021.18	2844.3	0	ANNUAL	ALL	1				
634		635099.5	4978009	0.00009	2017.1	2844.3	0	ANNUAL	ALL	1				
635		635124.5	4978009	0.00009	2025.97	2844.3	0	ANNUAL	ALL	1				
636		635149.5	4978009	0.00009	2034.03	2844.3	0	ANNUAL	ALL	1				
637		635174.5	4978009	0.00009	2041.95	2844.3	0	ANNUAL	ALL	1				
638		635199.5	4978009	0.00009	2050.09	2844.3	0	ANNUAL	ALL	1				
639		634999.5	4978034	0.00009	2043.29	2844.3	0	ANNUAL	ALL	1				
640		635024.5	4978034	0.00009	2032.46	2844.3	0	ANNUAL	ALL	1				
641		635049.5	4978034	0.00009	2024.39	2844.3	0	ANNUAL	ALL	1				
642		635074.5	4978034	0.00009	2017.56	2844.3	0	ANNUAL	ALL	1				
643		635099.5	4978034	0.0001	2015.24	2844.3	0	ANNUAL	ALL	1				
644		635124.5	4978034	0.00009	2024.2	2844.3	0	ANNUAL	ALL	1				
645		635149.5	4978034	0.00009	2032.02	2844.3	0	ANNUAL	ALL	1				
646		635174.5	4978034	0.00009	2040.48	2844.3	0	ANNUAL	ALL	1				
647		635199.5	4978034	0.00009	2049.69	2844.3	0	ANNUAL	ALL	1				
648		634599.5	4976834	0.00008	2431.97	2717.08	0	ANNUAL	ALL	1				
649		634624.5	4976834	0.00008	2425.11	2717.08	0	ANNUAL	ALL	1				
650		634649.5	4976834	0.00008	2416.95	2717.08	0	ANNUAL	ALL	1				
651		634674.5	4976834	0.00008	2407.96	2717.08	0	ANNUAL	ALL	1				
652		634699.5	4976834	0.00008	2398.82	2717.08	0	ANNUAL	ALL	1				
653		634724.5	4976834	0.00008	2389.57	2717.08	0	ANNUAL	ALL	1				
654		634749.5	4976834	0.00009	2378.83	2717.08	0	ANNUAL	ALL	1				
655		634774.5	4976834	0.00009	2368.3	2717.08	0	ANNUAL	ALL	1				
656		634799.5	4976834	0.00009	2352.38	2717.08	0	ANNUAL	ALL	1				
657		634599.5	4976859	0.00008	2427	2717.08	0	ANNUAL	ALL	1				
658		634624.5	4976859	0.00008	2421.36	2717.08	0	ANNUAL	ALL	1				
659		634649.5	4976859	0.00008	2412.9	2717.08	0	ANNUAL	ALL	1				
660		634674.5	4976859	0.00008	2401.58	2717.08	0	ANNUAL	ALL	1				
661		634699.5	4976859	0.00008	2391.51	2717.08	0	ANNUAL	ALL	1				
662		634724.5	4976859	0.00008	2381.29	2717.08	0	ANNUAL	ALL	1				
663		634749.5	4976859	0.00009	2371.44	2717.08	0	ANNUAL	ALL	1				
664		634774.5	4976859	0.00009	2358.57	2717.08	0	ANNUAL	ALL	1				
665		634799.5	4976859	0.00009	2341.91	2742	0	ANNUAL	ALL	1				
666		634599.5	4976884	0.00008	2422.69	2717.08	0	ANNUAL	ALL	1				
667		634624.5	4976884	0.00008	2418.17	2717.08	0	ANNUAL	ALL	1				
668		634649.5	4976884	0.00008	2408.98	2717.08	0	ANNUAL	ALL	1				
669		634674.5	4976884	0.00008	2396.57	2717.08	0	ANNUAL	ALL	1				
670		634699.5	4976884	0.00008	2383.76	2717.08	0	ANNUAL	ALL	1				
671		634724.5	4976884	0.00008	2371.27	2717.08	0	ANNUAL	ALL	1				
672		634749.5	4976884	0.00008	2362.03	2717.08	0	ANNUAL	ALL	1				
673		634774.5	4976884	0.00009	2350.11	2717.08	0	ANNUAL	ALL	1				
674		634799.5	4976884	0.00009	2334.35	2742	0	ANNUAL	ALL	1				
675		634599.5	4976909	0.00008	2418.11	2717.08	0	ANNUAL	ALL	1				
676		634624.5	4976909	0.00008	2412.47	2717.08	0	ANNUAL	ALL	1				
677		634649.5	4976909	0.00008	2402.76	2717.08	0	ANNUAL	ALL	1				
678		634674.5	4976909	0.00008	2392.81	2717.08	0	ANNUAL	ALL	1				
679		634699.5	4976909	0.00008	2377.98	2717.08	0	ANNUAL	ALL	1				
680		634724.5	4976909	0.00008	2364.11	2717.08	0	ANNUAL	ALL	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
681		634749.5	4976909	0.00008	2354.73	2717.08	0	ANNUAL	ALL	1				
682		634774.5	4976909	0.00009	2345.14	2717.08	0	ANNUAL	ALL	1				
683		634799.5	4976909	0.00009	2331	2742	0	ANNUAL	ALL	1				
684		634599.5	4976934	0.00008	2411.78	2717.08	0	ANNUAL	ALL	1				
685		634624.5	4976934	0.00008	2403.98	2717.08	0	ANNUAL	ALL	1				
686		634649.5	4976934	0.00008	2394.61	2717.08	0	ANNUAL	ALL	1				
687		634674.5	4976934	0.00008	2383.71	2717.08	0	ANNUAL	ALL	1				
688		634699.5	4976934	0.00008	2371.78	2717.08	0	ANNUAL	ALL	1				
689		634724.5	4976934	0.00008	2359.09	2717.08	0	ANNUAL	ALL	1				
690		634749.5	4976934	0.00008	2347.63	2717.08	0	ANNUAL	ALL	1				
691		634774.5	4976934	0.00009	2337.6	2742	0	ANNUAL	ALL	1				
692		634799.5	4976934	0.00009	2326.97	2742	0	ANNUAL	ALL	1				
693		634599.5	4976959	0.00008	2404.1	2717.08	0	ANNUAL	ALL	1				
694		634624.5	4976959	0.00008	2396.65	2717.08	0	ANNUAL	ALL	1				
695		634649.5	4976959	0.00008	2385.41	2717.08	0	ANNUAL	ALL	1				
696		634674.5	4976959	0.00008	2372.07	2717.08	0	ANNUAL	ALL	1				
697		634699.5	4976959	0.00008	2362.55	2717.08	0	ANNUAL	ALL	1				
698		634724.5	4976959	0.00008	2351.59	2717.08	0	ANNUAL	ALL	1				
699		634749.5	4976959	0.00008	2341.2	2717.08	0	ANNUAL	ALL	1				
700		634774.5	4976959	0.00009	2328.55	2742	0	ANNUAL	ALL	1				
701		634799.5	4976959	0.00009	2318.72	2742	0	ANNUAL	ALL	1				
702		634599.5	4976984	0.00007	2396.35	2717.08	0	ANNUAL	ALL	1				
703		634624.5	4976984	0.00008	2389.04	2717.08	0	ANNUAL	ALL	1				
704		634649.5	4976984	0.00008	2377.21	2717.08	0	ANNUAL	ALL	1				
705		634674.5	4976984	0.00008	2363.6	2717.08	0	ANNUAL	ALL	1				
706		634699.5	4976984	0.00008	2350.85	2717.08	0	ANNUAL	ALL	1				
707		634724.5	4976984	0.00008	2340.79	2717.08	0	ANNUAL	ALL	1				
708		634749.5	4976984	0.00008	2331.79	2742	0	ANNUAL	ALL	1				
709		634774.5	4976984	0.00008	2320.7	2742	0	ANNUAL	ALL	1				
710		634799.5	4976984	0.00009	2308.59	2742	0	ANNUAL	ALL	1				
711		634599.5	4977009	0.00007	2388.79	2717.08	0	ANNUAL	ALL	1				
712		634624.5	4977009	0.00008	2379.17	2717.08	0	ANNUAL	ALL	1				
713		634649.5	4977009	0.00008	2368.25	2717.08	0	ANNUAL	ALL	1				
714		634674.5	4977009	0.00008	2355.13	2717.08	0	ANNUAL	ALL	1				
715		634699.5	4977009	0.00008	2341.52	2717.08	0	ANNUAL	ALL	1				
716		634724.5	4977009	0.00008	2328.18	2742	0	ANNUAL	ALL	1				
717		634749.5	4977009	0.00008	2321.24	2742	0	ANNUAL	ALL	1				
718		634774.5	4977009	0.00008	2313.44	2742	0	ANNUAL	ALL	1				
719		634799.5	4977009	0.00009	2301.46	2742.16	0	ANNUAL	ALL	1				
720		634599.5	4977034	0.00007	2379.36	2717.08	0	ANNUAL	ALL	1				
721		634624.5	4977034	0.00008	2369.28	2717.08	0	ANNUAL	ALL	1				
722		634649.5	4977034	0.00008	2356.46	2717.08	0	ANNUAL	ALL	1				
723		634674.5	4977034	0.00008	2343.53	2717.08	0	ANNUAL	ALL	1				
724		634699.5	4977034	0.00008	2329.9	2742	0	ANNUAL	ALL	1				
725		634724.5	4977034	0.00008	2316.92	2742	0	ANNUAL	ALL	1				
726		634749.5	4977034	0.00008	2309.32	2742	0	ANNUAL	ALL	1				
727		634774.5	4977034	0.00008	2302.58	2742	0	ANNUAL	ALL	1				
728		634799.5	4977034	0.00009	2295.21	2742.16	0	ANNUAL	ALL	1				
729	**	CONCUNIT	ug/m^3											
730	**	DEPUNIT	g/m^2											

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1																
2																
3																
4																
5																
6																
7				Modeled Arsenic Concentrations for W1-W4 and max nonW					Lifetime Arsenic Exposure Per Receptor				Max. Lifetime Arsenic Exposure			
8		X	Y	W1	W2	W3	W4	max nonW	W1	W2	W3	W4	W1	W2	W3	W4
9		635399.5	4975934	0.00035	0.00028	0.00087	0.00017	0.00079	0.00013	0.000122	0.00019	0.00011	0.000910	0.000945	0.000898	0.000874
10		635424.5	4975934	0.00035	0.00028	0.00087	0.00017	0.0008	0.000131	0.000123	0.000191	0.000111				
11		635449.5	4975934	0.00035	0.00028	0.00087	0.00017	0.00081	0.000133	0.000125	0.000192	0.000112				
12		635474.5	4975934	0.00034	0.00027	0.00086	0.00017	0.0008	0.00013	0.000122	0.00019	0.000111				
13		635499.5	4975934	0.00033	0.00027	0.00085	0.00017	0.00079	0.000128	0.000121	0.000187	0.00011				
14		635524.5	4975934	0.00033	0.00026	0.00084	0.00016	0.00079	0.000128	0.00012	0.000186	0.000109				
15		635549.5	4975934	0.00032	0.00026	0.00084	0.00016	0.00079	0.000127	0.00012	0.000186	0.000109				
16		635574.5	4975934	0.00032	0.00026	0.00084	0.00016	0.00079	0.000127	0.00012	0.000186	0.000109				
17		635599.5	4975934	0.00031	0.00025	0.00082	0.00016	0.00078	0.000125	0.000118	0.000183	0.000107				
18		635399.5	4975959	0.00038	0.0003	0.00092	0.00018	0.00083	0.000138	0.000129	0.0002	0.000115				
19		635424.5	4975959	0.00037	0.0003	0.00091	0.00018	0.00082	0.000136	0.000128	0.000198	0.000114				
20		635449.5	4975959	0.00037	0.0003	0.00091	0.00018	0.00082	0.000136	0.000128	0.000198	0.000114				
21		635474.5	4975959	0.00036	0.00029	0.00089	0.00017	0.00082	0.000135	0.000127	0.000195	0.000113				
22		635499.5	4975959	0.00035	0.00028	0.00088	0.00017	0.00081	0.000133	0.000125	0.000193	0.000112				
23		635524.5	4975959	0.00034	0.00028	0.00087	0.00017	0.0008	0.00013	0.000123	0.000191	0.000111				
24		635549.5	4975959	0.00034	0.00027	0.00086	0.00017	0.0008	0.00013	0.000122	0.00019	0.000111				
25		635574.5	4975959	0.00033	0.00027	0.00086	0.00017	0.0008	0.000129	0.000122	0.00019	0.000111				
26		635599.5	4975959	0.00033	0.00027	0.00087	0.00017	0.00081	0.00013	0.000123	0.000192	0.000112				
27		635399.5	4975984	0.00041	0.00033	0.00097	0.00019	0.00085	0.000144	0.000135	0.000208	0.000119				
28		635424.5	4975984	0.0004	0.00032	0.00094	0.00018	0.00084	0.000142	0.000133	0.000203	0.000117				
29		635449.5	4975984	0.00039	0.00031	0.00094	0.00018	0.00084	0.000141	0.000131	0.000203	0.000117				
30		635474.5	4975984	0.00038	0.0003	0.00092	0.00018	0.00083	0.000138	0.000129	0.0002	0.000115				
31		635499.5	4975984	0.00037	0.0003	0.00091	0.00018	0.00082	0.000136	0.000128	0.000198	0.000114				
32		635524.5	4975984	0.00036	0.00029	0.00089	0.00018	0.00081	0.000134	0.000126	0.000194	0.000113				
33		635549.5	4975984	0.00035	0.00029	0.00089	0.00017	0.00081	0.000133	0.000126	0.000194	0.000112				
34		635574.5	4975984	0.00035	0.00028	0.00089	0.00017	0.00082	0.000134	0.000126	0.000195	0.000113				
35		635599.5	4975984	0.00035	0.00029	0.0009	0.00017	0.00083	0.000135	0.000128	0.000198	0.000114				
36		635399.5	4976009	0.00042	0.00034	0.00097	0.00019	0.00083	0.000143	0.000134	0.000206	0.000117				
37		635424.5	4976009	0.00043	0.00035	0.001	0.0002	0.00086	0.000147	0.000138	0.000213	0.000121				
38		635449.5	4976009	0.00041	0.00033	0.00097	0.00019	0.00085	0.000144	0.000135	0.000208	0.000119				
39		635474.5	4976009	0.00039	0.00031	0.00093	0.00018	0.00082	0.000138	0.000129	0.0002	0.000114				
40		635499.5	4976009	0.00038	0.00031	0.00091	0.00018	0.00082	0.000137	0.000129	0.000198	0.000114				
41		635524.5	4976009	0.00037	0.0003	0.00091	0.00018	0.00082	0.000136	0.000128	0.000198	0.000114				
42		635549.5	4976009	0.00037	0.0003	0.0009	0.00018	0.00082	0.000136	0.000128	0.000197	0.000114				
43		635574.5	4976009	0.00037	0.0003	0.0009	0.00018	0.00082	0.000136	0.000128	0.000197	0.000114				
44		635599.5	4976009	0.00036	0.0003	0.00091	0.00018	0.00083	0.000136	0.000129	0.000199	0.000115				
45		635399.5	4976034	0.00042	0.00034	0.00095	0.0002	0.00082	0.000142	0.000133	0.000202	0.000117				
46		635424.5	4976034	0.00045	0.00037	0.00102	0.00021	0.00086	0.00015	0.000141	0.000215	0.000122				
47		635449.5	4976034	0.00043	0.00035	0.00099	0.0002	0.00085	0.000146	0.000137	0.00021	0.00012				
48		635474.5	4976034	0.0004	0.00032	0.00094	0.00019	0.00082	0.000139	0.00013	0.000201	0.000115				
49		635499.5	4976034	0.0004	0.00032	0.00093	0.00019	0.00082	0.000139	0.00013	0.0002	0.000115				
50		635524.5	4976034	0.00039	0.00032	0.00093	0.00019	0.00082	0.000138	0.00013	0.0002	0.000115				
51		635549.5	4976034	0.00038	0.00031	0.00092	0.00018	0.00082	0.000137	0.000129	0.000199	0.000114				
52		635574.5	4976034	0.00038	0.00031	0.00092	0.00018	0.00082	0.000137	0.000129	0.000199	0.000114				
53		635599.5	4976034	0.00038	0.00031	0.00093	0.00018	0.00083	0.000138	0.00013	0.000201	0.000115				
54		635399.5	4976059	0.00044	0.00035	0.00097	0.00021	0.00081	0.000143	0.000133	0.000203	0.000117				
55		635424.5	4976059	0.00047	0.00039	0.00104	0.00022	0.00086	0.000152	0.000143	0.000217	0.000123				
56		635449.5	4976059	0.00047	0.0004	0.00105	0.00022	0.00087	0.000153	0.000145	0.000219	0.000125				
57		635474.5	4976059	0.00043	0.00035	0.00097	0.0002	0.00083	0.000144	0.000135	0.000206	0.000118				
58		635499.5	4976059	0.00042	0.00034	0.00096	0.0002	0.00083	0.000143	0.000134	0.000205	0.000118				
59		635524.5	4976059	0.00041	0.00033	0.00094	0.00019	0.00082	0.000141	0.000131	0.000201	0.000115				
60		635549.5	4976059	0.0004	0.00032	0.00093	0.00019	0.00081	0.000138	0.000129	0.000199	0.000114				
61		635574.5	4976059	0.00039	0.00032	0.00093	0.00019	0.00082	0.000138	0.00013	0.0002	0.000115				
62		635599.5	4976059	0.0004	0.00033	0.00095	0.00019	0.00084	0.000142	0.000134	0.000205	0.000118				
63		635399.5	4976084	0.00047	0.00039	0.00101	0.00022	0.00083	0.000149	0.000139	0.00021	0.00012				
64		635424.5	4976084	0.00049	0.00042	0.00106	0.00022	0.00086	0.000154	0.000146	0.000219	0.000123				
65		635449.5	4976084	0.0005	0.00044	0.00109	0.00023	0.0009	0.00016	0.000153	0.000227	0.000129				
66		635474.5	4976084	0.00048	0.0004	0.00105	0.00022	0.00086	0.000153	0.000144	0.000218	0.000123				
67		635499.5	4976084	0.00045	0.00038	0.00102	0.00021	0.00085	0.000149	0.000141	0.000214	0.000121				
68		635524.5	4976084	0.00043	0.00036	0.00098	0.0002	0.00083	0.000144	0.000136	0.000207	0.000118				
69		635549.5	4976084	0.00042	0.00034	0.00096	0.0002	0.00082	0.000142	0.000133	0.000203	0.000117				
70		635574.5	4976084	0.00042	0.00035	0.00098	0.0002	0.00084	0.000144	0.000136	0.000208	0.000119				
71		635599.5	4976084	0.00043	0.00037	0.00102	0.00021	0.00087	0.000149	0.000142	0.000216	0.000123				
72		635399.5	4976109	0.00051	0.00042	0.00105	0.00023	0.00084	0.000154	0.000144	0.000216	0.000122				
73		635424.5	4976109	0.00051	0.00044	0.00108	0.00023	0.00087	0.000158	0.00015	0.000223	0.000126				
74		635449.5	4976109	0.00052	0.00046	0.00112	0.00024	0.00092	0.000165	0.000158	0.000233	0.000133				
75		635474.5	4976109	0.00051	0.00045	0.00111	0.00024	0.00091	0.000162	0.000155	0.000231	0.000131				
76		635499.5	4976109	0.00049	0.00042	0.00107	0.00023	0.00087	0.000155	0.000147	0.000222	0.000126				
77		635524.5	4976109	0.00047	0.00041	0.00105	0.00022	0.00086	0.000152	0.000145	0.000218	0.000123				
78		635549.5	4976109	0.00047	0.0004	0.00105	0.00022	0.00086	0.000152	0.000144	0.000218	0.000123				
79		635574.5	4976109	0.00047	0.00041	0.00106	0.00022	0.00088	0.000154	0.000147	0.000222	0.000126				
80		635599.5	4976109	0.00045	0.00039	0.00104	0.00021	0.00087	0.000151	0.000144	0.000218	0.000123				
81		635399.5	4976134	0.00054	0.00046	0.00109	0.00024	0.00087	0.000161	0.000152	0.000224	0.000127				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
82		635424.5	4976134	0.00054	0.00047	0.0011	0.00025	0.00089	0.000163	0.000155	0.000227	0.00013				
83		635449.5	4976134	0.00054	0.00048	0.00112	0.00025	0.00091	0.000166	0.000159	0.000232	0.000133				
84		635474.5	4976134	0.00054	0.0005	0.00115	0.00025	0.00095	0.00017	0.000166	0.00024	0.000137				
85		635499.5	4976134	0.00053	0.00049	0.00114	0.00025	0.00094	0.000168	0.000163	0.000238	0.000136				
86		635524.5	4976134	0.00051	0.00046	0.0011	0.00024	0.0009	0.000161	0.000155	0.000229	0.00013				
87		635549.5	4976134	0.0005	0.00045	0.0011	0.00024	0.00091	0.000161	0.000155	0.00023	0.000131				
88		635574.5	4976134	0.00049	0.00044	0.00109	0.00023	0.0009	0.000159	0.000153	0.000227	0.000129				
89		635599.5	4976134	0.00047	0.00041	0.00105	0.00022	0.00086	0.000152	0.000145	0.000218	0.000123				
90		635199.5	4976834	0.00234	0.00183	0.00275	0.0008	0.00165	0.000456	0.000398	0.000503	0.00028				
91		635224.5	4976834	0.00233	0.00166	0.00275	0.0008	0.0015	0.000438	0.000361	0.000486	0.000263				
92		635249.5	4976834	0.00231	0.00165	0.00275	0.00079	0.00152	0.000438	0.000362	0.000488	0.000264				
93		635274.5	4976834	0.0023	0.00164	0.00275	0.00079	0.00153	0.000438	0.000362	0.000489	0.000265				
94		635299.5	4976834	0.0023	0.00162	0.00276	0.00078	0.00154	0.000439	0.000361	0.000491	0.000265				
95		635324.5	4976834	0.00229	0.00161	0.00276	0.00078	0.00155	0.000439	0.000361	0.000493	0.000266				
96		635349.5	4976834	0.00217	0.00154	0.00263	0.00075	0.00148	0.000417	0.000345	0.00047	0.000255				
97		635374.5	4976834	0.00204	0.00147	0.00248	0.00072	0.00142	0.000395	0.00033	0.000446	0.000245				
98		635399.5	4976834	0.00192	0.00152	0.00235	0.00068	0.00147	0.000387	0.000342	0.000437	0.000246				
99		635199.5	4976859	0.00244	0.00188	0.00284	0.00083	0.00167	0.00047	0.000406	0.000515	0.000286				
100		635224.5	4976859	0.00243	0.00174	0.00285	0.00083	0.00155	0.000455	0.000376	0.000503	0.000272				
101		635249.5	4976859	0.00243	0.00173	0.00287	0.00083	0.00157	0.000457	0.000377	0.000507	0.000274				
102		635274.5	4976859	0.00241	0.00171	0.00286	0.00082	0.00158	0.000456	0.000376	0.000507	0.000274				
103		635299.5	4976859	0.00239	0.00169	0.00285	0.00082	0.00158	0.000454	0.000374	0.000506	0.000274				
104		635324.5	4976859	0.00237	0.00167	0.00284	0.00081	0.00158	0.000451	0.000371	0.000505	0.000273				
105		635349.5	4976859	0.00226	0.0016	0.00272	0.00078	0.00152	0.000432	0.000357	0.000485	0.000263				
106		635374.5	4976859	0.00212	0.00153	0.00256	0.00074	0.00145	0.000408	0.000341	0.000458	0.00025				
107		635399.5	4976859	0.00198	0.00157	0.00239	0.0007	0.00149	0.000397	0.00035	0.000443	0.00025				
108		635199.5	4976884	0.00252	0.00181	0.00293	0.00087	0.00157	0.000467	0.000386	0.000514	0.000279				
109		635224.5	4976884	0.00255	0.00181	0.00297	0.00087	0.0016	0.000474	0.00039	0.000522	0.000282				
110		635249.5	4976884	0.00254	0.00181	0.00299	0.00087	0.00162	0.000475	0.000392	0.000527	0.000285				
111		635274.5	4976884	0.00252	0.00179	0.00298	0.00086	0.00163	0.000474	0.000391	0.000527	0.000285				
112		635299.5	4976884	0.00249	0.00176	0.00295	0.00085	0.00163	0.000471	0.000387	0.000523	0.000283				
113		635324.5	4976884	0.00244	0.00173	0.00291	0.00084	0.00161	0.000463	0.000382	0.000517	0.00028				
114		635349.5	4976884	0.00236	0.00167	0.00283	0.00081	0.00157	0.000449	0.00037	0.000503	0.000272				
115		635374.5	4976884	0.00219	0.00157	0.00263	0.00076	0.00147	0.000418	0.000347	0.000469	0.000255				
116		635399.5	4976884	0.00203	0.00162	0.00244	0.00072	0.00151	0.000405	0.000358	0.000451	0.000255				
117		635199.5	4976909	0.00263	0.00188	0.00303	0.00091	0.00161	0.000485	0.000399	0.00053	0.000288				
118		635224.5	4976909	0.00263	0.00189	0.00306	0.00091	0.00165	0.000489	0.000405	0.000538	0.000293				
119		635249.5	4976909	0.00263	0.00188	0.00308	0.00091	0.00167	0.000491	0.000406	0.000543	0.000295				
120		635274.5	4976909	0.0026	0.00186	0.00306	0.0009	0.00167	0.000488	0.000403	0.000541	0.000294				
121		635299.5	4976909	0.00256	0.00183	0.00303	0.00089	0.00166	0.000482	0.000399	0.000536	0.000291				
122		635324.5	4976909	0.0025	0.00179	0.00298	0.00087	0.00164	0.000473	0.000392	0.000528	0.000287				
123		635349.5	4976909	0.00242	0.00172	0.00287	0.00083	0.00158	0.000457	0.000377	0.000509	0.000275				
124		635374.5	4976909	0.00224	0.00161	0.00267	0.00078	0.00148	0.000425	0.000353	0.000474	0.000258				
125		635399.5	4976909	0.00207	0.0017	0.00247	0.00073	0.00156	0.000415	0.000373	0.000461	0.000262				
126		635199.5	4976934	0.00272	0.00196	0.00313	0.00095	0.00165	0.000499	0.000413	0.000546	0.000297				
127		635224.5	4976934	0.00271	0.00195	0.00314	0.00095	0.00168	0.000502	0.000415	0.000551	0.000301				
128		635249.5	4976934	0.0027	0.00194	0.00314	0.00094	0.00169	0.000502	0.000415	0.000552	0.000301				
129		635274.5	4976934	0.00267	0.00192	0.00313	0.00093	0.0017	0.000499	0.000414	0.000552	0.000301				
130		635299.5	4976934	0.00263	0.00189	0.0031	0.00092	0.0017	0.000495	0.00041	0.000549	0.000299				
131		635324.5	4976934	0.00257	0.00184	0.00304	0.0009	0.00167	0.000485	0.000401	0.000538	0.000294				
132		635349.5	4976934	0.00246	0.00176	0.0029	0.00085	0.00159	0.000463	0.000383	0.000513	0.000279				
133		635374.5	4976934	0.00228	0.00165	0.0027	0.0008	0.00148	0.00043	0.000358	0.000478	0.000261				
134		635399.5	4976934	0.00211	0.00176	0.00249	0.00075	0.00159	0.000423	0.000383	0.000466	0.000267				
135		635199.5	4976959	0.00281	0.00203	0.00321	0.00099	0.00168	0.000513	0.000424	0.000559	0.000305				
136		635224.5	4976959	0.00279	0.00202	0.00321	0.00098	0.00171	0.000514	0.000426	0.000562	0.000307				
137		635249.5	4976959	0.00276	0.00201	0.0032	0.00098	0.00173	0.000513	0.000427	0.000563	0.00031				
138		635274.5	4976959	0.00272	0.00199	0.00319	0.00097	0.00174	0.00051	0.000426	0.000563	0.00031				
139		635299.5	4976959	0.00269	0.00196	0.00316	0.00096	0.00173	0.000505	0.000422	0.000559	0.000307				
140		635324.5	4976959	0.00262	0.0019	0.00309	0.00093	0.00169	0.000493	0.00041	0.000546	0.000299				
141		635349.5	4976959	0.00251	0.00181	0.00294	0.00088	0.0016	0.00047	0.00039	0.000519	0.000283				
142		635374.5	4976959	0.00233	0.00169	0.00274	0.00082	0.00148	0.000435	0.000362	0.000482	0.000263				
143		635399.5	4976959	0.00214	0.00182	0.00251	0.00077	0.00162	0.00043	0.000393	0.000472	0.000273				
144		635199.5	4976984	0.00289	0.00211	0.00328	0.00103	0.00172	0.000527	0.000438	0.000571	0.000314				
145		635224.5	4976984	0.00287	0.0021	0.00329	0.00103	0.00174	0.000527	0.000439	0.000575	0.000317				
146		635249.5	4976984	0.00283	0.00209	0.00328	0.00103	0.00177	0.000526	0.000441	0.000577	0.00032				
147		635274.5	4976984	0.00278	0.00206	0.00325	0.00102	0.00177	0.00052	0.000438	0.000574	0.000319				
148		635299.5	4976984	0.00274	0.00203	0.00322	0.001	0.00176	0.000514	0.000433	0.000569	0.000315				
149		635324.5	4976984	0.00267	0.00195	0.00312	0.00096	0.0017	0.000499	0.000417	0.000551	0.000304				
150		635349.5	4976984	0.00256	0.00185	0.00298	0.0009	0.0016	0.000475	0.000394	0.000523	0.000286				
151		635374.5	4976984	0.00239	0.00173	0.00277	0.00084	0.00148	0.000442	0.000367	0.000486	0.000265				
152		635399.5	4976984	0.0022	0.00188	0.00256	0.00078	0.00165	0.00044	0.000403	0.000481	0.000278				
153		635199.5	4977009	0.00297	0.00219	0.00337	0.00108	0.00176	0.000541	0.000451	0.000586	0.000325				
154		635224.5	4977009	0.00292	0.00218	0.00335	0.00108	0.00179	0.000538	0.000454	0.000587	0.000328				
155		635249.5	4977009	0.00287	0.00217	0.00333	0.00108	0.0018	0.000534	0.000454	0.000586	0.000329				
156		635274.5	4977009	0.00283	0.00213	0.00331	0.00107	0.0018	0.000529	0.000449	0.000584	0.000328				
157		635299.5	4977009	0.00278	0.00208	0.00325	0.00104	0.00177	0.00052	0.00044	0.000574	0.000321				
158		635324.5	4977009	0.00272	0.00199	0.00315	0.00098	0.0017	0.000505	0.000422	0.000554	0.000306				
159		635349.5	4977009	0.00259	0.00189	0.003	0.00093	0.0016	0.000479	0.000399	0.000526	0.000289				
160		635374.5	4977009	0.00245	0.00194	0.00282	0.00086	0.00166	0.00047	0.000411	0.000512	0.000288				
161		635399.5	4977009	0.00224	0.00195	0.00259	0.0008	0.00169	0.000449	0.000416	0.000489	0.000285				
162		635199.5	4977034	0.00304	0.00229	0.00345	0.00114	0.00182	0.000555	0.00047	0.000602	0.000338				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
163		635224.5	4977034	0.00297	0.00227	0.00341	0.00114	0.00183	0.000549	0.000469	0.000599	0.000339				
164		635249.5	4977034	0.00292	0.00225	0.00339	0.00114	0.00184	0.000544	0.000467	0.000598	0.000341				
165		635274.5	4977034	0.00288	0.00221	0.00336	0.00112	0.00183	0.000538	0.000462	0.000593	0.000337				
166		635299.5	4977034	0.00282	0.00212	0.00327	0.00106	0.00177	0.000525	0.000445	0.000576	0.000323				
167		635324.5	4977034	0.00276	0.00203	0.00317	0.001	0.00168	0.000507	0.000424	0.000554	0.000306				
168		635349.5	4977034	0.00263	0.00192	0.00301	0.00095	0.00159	0.000482	0.000401	0.000526	0.00029				
169		635374.5	4977034	0.0025	0.00201	0.00285	0.00089	0.00169	0.000479	0.000423	0.000519	0.000295				
170		635399.5	4977034	0.00229	0.00202	0.00262	0.00082	0.00172	0.000458	0.000427	0.000496	0.00029				
171		634899.5	4977134	0.00236	0.00193	0.00252	0.00115	0.00115	0.000401	0.000352	0.000419	0.000263				
172		634924.5	4977134	0.00266	0.00211	0.00281	0.00121	0.00128	0.00045	0.000387	0.000467	0.000285				
173		634949.5	4977134	0.00303	0.00241	0.00318	0.00128	0.00153	0.000521	0.00045	0.000538	0.000321				
174		634974.5	4977134	0.00344	0.00287	0.00359	0.00137	0.00194	0.000615	0.00055	0.000632	0.000378				
175		634999.5	4977134	0.00364	0.0032	0.0038	0.0014	0.00226	0.000674	0.000624	0.000693	0.000418				
176		635024.5	4977134	0.00369	0.00322	0.00387	0.0014	0.00231	0.000686	0.000632	0.000706	0.000424				
177		635049.5	4977134	0.00365	0.00308	0.00387	0.00142	0.00219	0.000667	0.000602	0.000693	0.000413				
178		635074.5	4977134	0.00357	0.00268	0.00383	0.00143	0.00181	0.000615	0.000513	0.000645	0.00037				
179		635099.5	4977134	0.00348	0.00269	0.00378	0.00142	0.00185	0.000609	0.000519	0.000643	0.000374				
180		634899.5	4977159	0.00271	0.00218	0.00286	0.0013	0.00125	0.000453	0.000392	0.00047	0.000291				
181		634924.5	4977159	0.00291	0.00229	0.00305	0.00128	0.00139	0.000491	0.000421	0.000507	0.000305				
182		634949.5	4977159	0.00336	0.00271	0.00349	0.0014	0.00172	0.000581	0.000506	0.000595	0.000357				
183		634974.5	4977159	0.00364	0.00314	0.00378	0.00147	0.00211	0.000657	0.0006	0.000673	0.000409				
184		634999.5	4977159	0.00375	0.00333	0.0039	0.00148	0.00232	0.000694	0.000646	0.000711	0.000434				
185		635024.5	4977159	0.00377	0.00329	0.00395	0.00148	0.0023	0.000694	0.000639	0.000714	0.000432				
186		635049.5	4977159	0.00371	0.00309	0.00393	0.0015	0.00212	0.000666	0.000595	0.000691	0.000414				
187		635074.5	4977159	0.00358	0.00279	0.00384	0.00151	0.00184	0.000619	0.000529	0.000649	0.000383				
188		635099.5	4977159	0.0035	0.0028	0.0038	0.00151	0.00189	0.000616	0.000536	0.00065	0.000389				
189		634899.5	4977184	0.00299	0.00237	0.00312	0.0014	0.00135	0.000496	0.000425	0.000511	0.000314				
190		634924.5	4977184	0.00326	0.00259	0.00338	0.00145	0.00153	0.000547	0.000471	0.000561	0.000341				
191		634949.5	4977184	0.00363	0.00303	0.00376	0.00153	0.00192	0.000634	0.000566	0.000649	0.000394				
192		634974.5	4977184	0.00379	0.00336	0.00392	0.00156	0.00224	0.000689	0.00064	0.000704	0.000434				
193		634999.5	4977184	0.00382	0.00343	0.00397	0.00156	0.00234	0.000704	0.000659	0.000721	0.000446				
194		635024.5	4977184	0.00383	0.00334	0.004	0.00157	0.00227	0.000697	0.000641	0.000717	0.000439				
195		635049.5	4977184	0.00373	0.00311	0.00396	0.00159	0.00205	0.000661	0.00059	0.000687	0.000416				
196		635074.5	4977184	0.00359	0.00292	0.00387	0.00161	0.00189	0.000626	0.00055	0.000658	0.0004				
197		635099.5	4977184	0.00352	0.00291	0.00383	0.0016	0.00192	0.000622	0.000552	0.000657	0.000402				
198		634899.5	4977209	0.00327	0.00257	0.00338	0.00148	0.00147	0.000542	0.000462	0.000554	0.000337				
199		634924.5	4977209	0.00355	0.00287	0.00367	0.00156	0.00171	0.000601	0.000523	0.000615	0.000374				
200		634949.5	4977209	0.0038	0.00332	0.00391	0.00165	0.0021	0.000674	0.000619	0.000687	0.000429				
201		634974.5	4977209	0.00389	0.00353	0.00403	0.00166	0.00232	0.00071	0.000669	0.000726	0.000455				
202		634999.5	4977209	0.00387	0.0035	0.00402	0.00165	0.00232	0.000707	0.000665	0.000725	0.000454				
203		635024.5	4977209	0.00381	0.00338	0.004	0.00166	0.00222	0.000689	0.00064	0.000711	0.000443				
204		635049.5	4977209	0.0037	0.00302	0.00395	0.00171	0.00187	0.000637	0.000559	0.000665	0.000409				
205		635074.5	4977209	0.00358	0.00304	0.00387	0.00172	0.00193	0.00063	0.000568	0.000663	0.000417				
206		635099.5	4977209	0.00349	0.00302	0.00381	0.0017	0.00195	0.000622	0.000568	0.000658	0.000417				
207		634899.5	4977234	0.0037	0.00301	0.0038	0.00169	0.00171	0.000618	0.000539	0.00063	0.000389				
208		634924.5	4977234	0.00384	0.00327	0.00394	0.00173	0.00195	0.000662	0.000597	0.000673	0.000421				
209		634949.5	4977234	0.00392	0.0036	0.00404	0.00178	0.00227	0.000707	0.000671	0.000721	0.000463				
210		634974.5	4977234	0.00394	0.00363	0.00407	0.00177	0.00233	0.000717	0.000681	0.000731	0.000469				
211		634999.5	4977234	0.00392	0.00355	0.00408	0.00176	0.00228	0.000709	0.000666	0.000727	0.000462				
212		635024.5	4977234	0.00386	0.00335	0.00405	0.00178	0.00209	0.00068	0.000622	0.000702	0.000442				
213		635049.5	4977234	0.00368	0.00316	0.00395	0.00183	0.00191	0.000639	0.000579	0.00067	0.000427				
214		635074.5	4977234	0.00357	0.00315	0.00386	0.00182	0.00194	0.00063	0.000582	0.000663	0.00043				
215		635099.5	4977234	0.00345	0.00311	0.00378	0.0018	0.00195	0.000617	0.000578	0.000655	0.000429				
216		634899.5	4977259	0.00385	0.00321	0.00394	0.0018	0.0018	0.000646	0.000573	0.000656	0.000411				
217		634924.5	4977259	0.00396	0.00361	0.00407	0.00188	0.00215	0.000698	0.000658	0.000711	0.000461				
218		634949.5	4977259	0.00398	0.00375	0.0041	0.00189	0.0023	0.000718	0.000691	0.000731	0.000479				
219		634974.5	4977259	0.00398	0.00368	0.00412	0.00189	0.00227	0.000714	0.00068	0.00073	0.000475				
220		634999.5	4977259	0.00391	0.00357	0.00408	0.00188	0.00218	0.000696	0.000657	0.000715	0.000464				
221		635024.5	4977259	0.0038	0.00322	0.00402	0.00192	0.00184	0.000645	0.000578	0.00067	0.00043				
222		635049.5	4977259	0.00367	0.00326	0.00394	0.00193	0.00191	0.000638	0.000591	0.000669	0.000439				
223		635074.5	4977259	0.00354	0.00324	0.00385	0.00192	0.00193	0.000625	0.000591	0.000661	0.00044				
224		635099.5	4977259	0.00346	0.00322	0.00379	0.0019	0.00196	0.000619	0.000592	0.000657	0.000441				
225		634899.5	4977284	0.0039	0.00328	0.00398	0.00188	0.00178	0.000649	0.000578	0.000658	0.000418				
226		634924.5	4977284	0.00399	0.00371	0.00409	0.00198	0.00215	0.000702	0.00067	0.000713	0.000472				
227		634949.5	4977284	0.00402	0.00382	0.00414	0.002	0.00227	0.000719	0.000696	0.000733	0.000488				
228		634974.5	4977284	0.00398	0.0037	0.00413	0.00203	0.00216	0.000702	0.00067	0.000719	0.000479				
229		634999.5	4977284	0.00391	0.00331	0.00409	0.00203	0.00179	0.000651	0.000583	0.000672	0.000437				
230		635024.5	4977284	0.00378	0.00335	0.00401	0.00205	0.00186	0.000645	0.000595	0.000671	0.000447				
231		635049.5	4977284	0.00366	0.00336	0.00393	0.00204	0.00191	0.000637	0.000602	0.000667	0.000451				
232		635074.5	4977284	0.00354	0.00335	0.00384	0.00203	0.00194	0.000626	0.000605	0.000661	0.000454				
233		635099.5	4977284	0.00349	0.00333	0.00383	0.00203	0.00196	0.000623	0.000605	0.000662	0.000456				
234		634899.5	4977309	0.00398	0.00341	0.00406	0.00198	0.00181	0.000662	0.000597	0.000671	0.000433				
235		634924.5	4977309	0.00403	0.0038	0.00412	0.00207	0.00214	0.000705	0.000679	0.000715	0.000481				
236		634949.5	4977309	0.00403	0.00387	0.00415	0.0021	0.00222	0.000714	0.000696	0.000728	0.000494				
237		634974.5	4977309	0.004	0.00371	0.00415	0.00215	0.00205	0.000691	0.000658	0.000709	0.00048				
238		634999.5	4977309	0.00389	0.00344	0.00408	0.00217	0.0018	0.00065	0.000599	0.000672	0.000454				
239		635024.5	4977309	0.00379	0.00347	0.00402	0.00217	0.00187	0.000647	0.00061	0.000673	0.000462				
240		635049.5	4977309	0.00365	0.00345	0.00392	0.00216	0.00189	0.000633	0.00061	0.000664	0.000463				
241		635074.5	4977309	0.00357	0.00345	0.00387	0.00215	0.00193	0.000629	0.000615	0.000663	0.000466				
242		635099.5	4977309	0.0035	0.00344	0.00385	0.00214	0.00196	0.000624	0.000617	0.000664	0.000469				
243		634899.5	4977334	0.00406	0.00362	0.00413	0.00212	0.00188	0.000679	0.000629	0.000687	0.000457				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
244		634924.5	4977334	0.00407	0.00391	0.00416	0.00218	0.00214	0.00071	0.000691	0.00072	0.000494				
245		634949.5	4977334	0.00406	0.00393	0.00417	0.00221	0.00217	0.000712	0.000697	0.000725	0.000501				
246		634974.5	4977334	0.00402	0.00377	0.00417	0.00226	0.002	0.000688	0.000659	0.000705	0.000487				
247		634999.5	4977334	0.00389	0.00355	0.00408	0.00228	0.00179	0.000649	0.00061	0.000671	0.000465				
248		635024.5	4977334	0.00377	0.00357	0.00401	0.00229	0.00185	0.000642	0.000619	0.00067	0.000473				
249		635049.5	4977334	0.00365	0.00357	0.00392	0.00229	0.00188	0.000632	0.000623	0.000663	0.000477				
250		635074.5	4977334	0.0036	0.00356	0.00391	0.00228	0.00192	0.000631	0.000626	0.000666	0.00048				
251		635099.5	4977334	0.00353	0.00354	0.00387	0.00225	0.00195	0.000626	0.000627	0.000665	0.00048				
252		635399.5	4976159	0.00057	0.0005	0.00113	0.00026	0.00091	0.000169	0.000161	0.000233	0.000134				
253		635424.5	4976159	0.00057	0.0005	0.00113	0.00026	0.00092	0.00017	0.000162	0.000234	0.000135				
254		635449.5	4976159	0.00056	0.00051	0.00115	0.00026	0.00094	0.000171	0.000166	0.000239	0.000137				
255		635474.5	4976159	0.00057	0.00052	0.00117	0.00026	0.00097	0.000176	0.00017	0.000245	0.000141				
256		635499.5	4976159	0.00056	0.00053	0.00118	0.00026	0.00099	0.000177	0.000174	0.000248	0.000143				
257		635524.5	4976159	0.00056	0.00053	0.00118	0.00026	0.001	0.000178	0.000175	0.000249	0.000144				
258		635549.5	4976159	0.00054	0.00051	0.00117	0.00025	0.00099	0.000175	0.000171	0.000247	0.000142				
259		635574.5	4976159	0.00052	0.00048	0.00112	0.00024	0.00093	0.000166	0.000161	0.000234	0.000134				
260		635599.5	4976159	0.00049	0.00044	0.00108	0.00023	0.00088	0.000157	0.000151	0.000224	0.000127				
261		635399.5	4976184	0.0006	0.00054	0.00116	0.00027	0.00093	0.000175	0.000168	0.000239	0.000137				
262		635424.5	4976184	0.00059	0.00054	0.00116	0.00027	0.00095	0.000176	0.00017	0.000241	0.000139				
263		635449.5	4976184	0.00059	0.00055	0.00117	0.00027	0.00097	0.000178	0.000174	0.000245	0.000142				
264		635474.5	4976184	0.00059	0.00056	0.00119	0.00027	0.001	0.000182	0.000178	0.00025	0.000145				
265		635499.5	4976184	0.00059	0.00056	0.0012	0.00027	0.00102	0.000184	0.000181	0.000254	0.000147				
266		635524.5	4976184	0.00059	0.00056	0.00121	0.00027	0.00103	0.000185	0.000182	0.000256	0.000149				
267		635549.5	4976184	0.00058	0.00056	0.0012	0.00026	0.00103	0.000184	0.000182	0.000255	0.000147				
268		635574.5	4976184	0.00054	0.00051	0.00115	0.00025	0.00096	0.000171	0.000168	0.000241	0.000138				
269		635599.5	4976184	0.00051	0.00046	0.00109	0.00024	0.0009	0.000161	0.000155	0.000227	0.00013				
270		635399.5	4976209	0.00063	0.00057	0.00118	0.00028	0.00095	0.000181	0.000174	0.000243	0.000141				
271		635424.5	4976209	0.00062	0.00057	0.00119	0.00028	0.00097	0.000182	0.000176	0.000247	0.000143				
272		635449.5	4976209	0.00062	0.00058	0.0012	0.00028	0.00099	0.000184	0.000179	0.00025	0.000145				
273		635474.5	4976209	0.00062	0.00059	0.00121	0.00028	0.00102	0.000187	0.000184	0.000255	0.000149				
274		635499.5	4976209	0.00062	0.0006	0.00123	0.00028	0.00104	0.00019	0.000187	0.000259	0.000151				
275		635524.5	4976209	0.00061	0.0006	0.00123	0.00028	0.00106	0.000191	0.00019	0.000262	0.000153				
276		635549.5	4976209	0.0006	0.00058	0.00121	0.00027	0.00104	0.000187	0.000185	0.000257	0.00015				
277		635574.5	4976209	0.00055	0.00052	0.00114	0.00026	0.00095	0.000171	0.000168	0.000239	0.000138				
278		635599.5	4976209	0.00051	0.00046	0.00108	0.00024	0.00087	0.000158	0.000152	0.000223	0.000127				
279		635399.5	4976234	0.00066	0.0006	0.0012	0.00029	0.00098	0.000187	0.000181	0.000249	0.000145				
280		635424.5	4976234	0.00065	0.00061	0.00121	0.00029	0.001	0.000189	0.000184	0.000253	0.000147				
281		635449.5	4976234	0.00065	0.00061	0.00122	0.00029	0.00102	0.000191	0.000186	0.000256	0.00015				
282		635474.5	4976234	0.00065	0.00062	0.00124	0.00029	0.00104	0.000193	0.00019	0.000261	0.000152				
283		635499.5	4976234	0.00065	0.00063	0.00125	0.00029	0.00107	0.000197	0.000194	0.000265	0.000155				
284		635524.5	4976234	0.00064	0.00063	0.00126	0.00029	0.00109	0.000198	0.000197	0.000269	0.000158				
285		635549.5	4976234	0.00061	0.00059	0.00121	0.00028	0.00103	0.000187	0.000185	0.000256	0.00015				
286		635574.5	4976234	0.00056	0.00052	0.00113	0.00027	0.00092	0.000169	0.000165	0.000234	0.000136				
287		635599.5	4976234	0.00052	0.00045	0.00106	0.00025	0.00084	0.000155	0.000147	0.000217	0.000125				
288		634999.5	4978134	0.00382	0.00547	0.00391	0.00516	0.00108	0.00056	0.000749	0.00057	0.000713				
289		635024.5	4978134	0.00388	0.00558	0.004	0.00527	0.00113	0.000573	0.000767	0.000586	0.000731				
290		635049.5	4978134	0.00388	0.00566	0.00402	0.00535	0.00119	0.000579	0.000783	0.000595	0.000747				
291		635074.5	4978134	0.00379	0.00559	0.00394	0.0053	0.00124	0.000575	0.000781	0.000592	0.000747				
292		635099.5	4978134	0.00384	0.00561	0.00399	0.00531	0.00123	0.000579	0.000782	0.000597	0.000747				
293		635124.5	4978134	0.00399	0.00572	0.00414	0.00539	0.0012	0.000593	0.000791	0.00061	0.000753				
294		635149.5	4978134	0.00412	0.00578	0.00427	0.00542	0.00116	0.000603	0.000793	0.000621	0.000752				
295		635174.5	4978134	0.00417	0.00573	0.00431	0.00535	0.00113	0.000606	0.000784	0.000622	0.000741				
296		635199.5	4978134	0.00416	0.00561	0.00428	0.00521	0.00109	0.0006	0.000766	0.000614	0.00072				
297		634999.5	4978159	0.00365	0.00532	0.00374	0.00503	0.00107	0.000539	0.00073	0.00055	0.000697				
298		635024.5	4978159	0.00372	0.00542	0.00383	0.00513	0.00112	0.000553	0.000747	0.000566	0.000714				
299		635049.5	4978159	0.00369	0.00547	0.00382	0.00518	0.00119	0.000558	0.000761	0.000573	0.000728				
300		635074.5	4978159	0.00359	0.00538	0.00373	0.00512	0.00124	0.000552	0.000757	0.000568	0.000727				
301		635099.5	4978159	0.00363	0.0054	0.00378	0.00513	0.00124	0.000557	0.000759	0.000574	0.000728				
302		635124.5	4978159	0.00377	0.00551	0.00392	0.00521	0.00121	0.000569	0.000768	0.000586	0.000734				
303		635149.5	4978159	0.00391	0.00561	0.00406	0.00528	0.00117	0.000581	0.000775	0.000598	0.000737				
304		635174.5	4978159	0.004	0.00562	0.00414	0.00527	0.00113	0.000586	0.000771	0.000602	0.000731				
305		635199.5	4978159	0.00404	0.00555	0.00417	0.00517	0.00109	0.000586	0.000759	0.000601	0.000715				
306		634999.5	4978184	0.00349	0.00517	0.00358	0.0049	0.00106	0.00052	0.000712	0.00053	0.000681				
307		635024.5	4978184	0.0035	0.00523	0.00362	0.00496	0.00112	0.000528	0.000726	0.000542	0.000695				
308		635049.5	4978184	0.00349	0.00526	0.00362	0.005	0.00119	0.000535	0.000737	0.00055	0.000707				
309		635074.5	4978184	0.00339	0.00517	0.00354	0.00493	0.00124	0.000529	0.000733	0.000546	0.000705				
310		635099.5	4978184	0.00342	0.00518	0.00357	0.00494	0.00125	0.000534	0.000735	0.000551	0.000707				
311		635124.5	4978184	0.00356	0.0053	0.0037	0.00503	0.00121	0.000545	0.000744	0.000561	0.000713				
312		635149.5	4978184	0.00369	0.00541	0.00384	0.0051	0.00118	0.000557	0.000753	0.000574	0.000718				
313		635174.5	4978184	0.00381	0.00547	0.00395	0.00515	0.00114	0.000566	0.000755	0.000582	0.000719				
314		635199.5	4978184	0.0039	0.00545	0.00402	0.00509	0.0011	0.000571	0.000749	0.000585	0.000707				
315		634999.5	4978209	0.00333	0.00502	0.00342	0.00478	0.00105	0.000501	0.000694	0.000511	0.000666				
316		635024.5	4978209	0.00333	0.00506	0.00345	0.00481	0.00112	0.000509	0.000706	0.000522	0.000678				
317		635049.5	4978209	0.0033	0.00506	0.00343	0.00483	0.00119	0.000513	0.000714	0.000528	0.000688				
318		635074.5	4978209	0.00322	0.00497	0.00336	0.00476	0.00124	0.00051	0.00071	0.000526	0.000686				
319		635099.5	4978209	0.00323	0.00495	0.00338	0.00474	0.00125	0.000512	0.000709	0.000529	0.000685				
320		635124.5	4978209	0.00335	0.00509	0.0035	0.00485	0.00122	0.000522	0.000721	0.000539	0.000694				
321		635149.5	4978209	0.00349	0.0052	0.00363	0.00492	0.00118	0.000534	0.000729	0.00055	0.000697				
322		635174.5	4978209	0.00362	0.00529	0.00376	0.00499	0.00114	0.000544	0.000735	0.00056	0.000701				
323		635199.5	4978209	0.0037	0.0053	0.00383	0.00497	0.0011	0.000549	0.000731	0.000563	0.000694				
324		634999.5	4978234	0.00317	0.00487	0.00327	0.00465	0.00104	0.000481	0.000675	0.000493	0.00065				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
325		635024.5	4978234	0.00316	0.00489	0.00328	0.00466	0.00112	0.000489	0.000687	0.000503	0.000661				
326		635049.5	4978234	0.00312	0.00485	0.00325	0.00464	0.00119	0.000493	0.00069	0.000507	0.000666				
327		635074.5	4978234	0.00306	0.00476	0.00319	0.00457	0.00124	0.000491	0.000686	0.000506	0.000664				
328		635099.5	4978234	0.00305	0.00474	0.00319	0.00456	0.00126	0.000493	0.000686	0.000509	0.000665				
329		635124.5	4978234	0.00316	0.00488	0.00331	0.00467	0.00122	0.000501	0.000697	0.000518	0.000673				
330		635149.5	4978234	0.00329	0.005	0.00344	0.00475	0.00119	0.000512	0.000707	0.000529	0.000679				
331		635174.5	4978234	0.00343	0.00511	0.00357	0.00484	0.00115	0.000523	0.000715	0.000539	0.000685				
332		635199.5	4978234	0.00353	0.00516	0.00366	0.00486	0.00111	0.00053	0.000717	0.000545	0.000682				
333		634999.5	4978259	0.00299	0.00468	0.00309	0.00447	0.00104	0.000461	0.000654	0.000472	0.00063				
334		635024.5	4978259	0.003	0.00471	0.00312	0.00451	0.00112	0.000471	0.000666	0.000485	0.000643				
335		635049.5	4978259	0.00296	0.00466	0.00309	0.00448	0.00118	0.000473	0.000667	0.000488	0.000647				
336		635074.5	4978259	0.00291	0.0046	0.00305	0.00443	0.00123	0.000473	0.000666	0.000489	0.000647				
337		635099.5	4978259	0.00288	0.00453	0.00302	0.00438	0.00126	0.000473	0.000662	0.000489	0.000645				
338		635124.5	4978259	0.00299	0.00465	0.00313	0.00447	0.00123	0.000482	0.000672	0.000498	0.000651				
339		635149.5	4978259	0.00312	0.00481	0.00326	0.00459	0.00119	0.000493	0.000686	0.000509	0.000661				
340		635174.5	4978259	0.00325	0.00492	0.00338	0.00467	0.00115	0.000503	0.000694	0.000518	0.000665				
341		635199.5	4978259	0.00336	0.005	0.00349	0.00472	0.00111	0.000511	0.000698	0.000526	0.000666				
342		634999.5	4978284	0.00285	0.00452	0.00296	0.00433	0.00104	0.000445	0.000635	0.000457	0.000614				
343		635024.5	4978284	0.00284	0.00453	0.00297	0.00435	0.00112	0.000453	0.000646	0.000467	0.000625				
344		635049.5	4978284	0.0028	0.00448	0.00293	0.00431	0.00118	0.000455	0.000647	0.00047	0.000627				
345		635074.5	4978284	0.00276	0.0044	0.0029	0.00425	0.00123	0.000456	0.000643	0.000472	0.000626				
346		635099.5	4978284	0.00274	0.00436	0.00287	0.00422	0.00126	0.000457	0.000642	0.000472	0.000626				
347		635124.5	4978284	0.00282	0.00445	0.00296	0.0043	0.00124	0.000464	0.00065	0.00048	0.000633				
348		635149.5	4978284	0.00295	0.00461	0.00309	0.00442	0.0012	0.000474	0.000664	0.00049	0.000642				
349		635174.5	4978284	0.00307	0.00472	0.00321	0.0045	0.00115	0.000482	0.000671	0.000498	0.000646				
350		635199.5	4978284	0.00319	0.00483	0.00332	0.00458	0.00111	0.000491	0.000679	0.000506	0.00065				
351		634999.5	4978309	0.00272	0.00435	0.00282	0.00418	0.00104	0.00043	0.000616	0.000441	0.000597				
352		635024.5	4978309	0.00271	0.00436	0.00283	0.0042	0.00111	0.000437	0.000625	0.00045	0.000607				
353		635049.5	4978309	0.00266	0.0043	0.00279	0.00415	0.00118	0.000439	0.000626	0.000454	0.000609				
354		635074.5	4978309	0.00263	0.00423	0.00276	0.0041	0.00122	0.00044	0.000623	0.000455	0.000608				
355		635099.5	4978309	0.00261	0.00419	0.00274	0.00408	0.00126	0.000442	0.000623	0.000457	0.00061				
356		635124.5	4978309	0.00265	0.00424	0.00279	0.00411	0.00124	0.000445	0.000626	0.000461	0.000611				
357		635149.5	4978309	0.00278	0.00441	0.00292	0.00425	0.0012	0.000455	0.000641	0.000471	0.000623				
358		635174.5	4978309	0.0029	0.00453	0.00303	0.00433	0.00116	0.000464	0.00065	0.000479	0.000627				
359		635199.5	4978309	0.00302	0.00465	0.00315	0.00442	0.00111	0.000472	0.000658	0.000487	0.000632				
360		634999.5	4978334	0.00259	0.00418	0.00269	0.00403	0.00105	0.000416	0.000598	0.000427	0.000581				
361		635024.5	4978334	0.00257	0.00419	0.00269	0.00404	0.0011	0.000419	0.000605	0.000433	0.000587				
362		635049.5	4978334	0.00253	0.00413	0.00266	0.00399	0.00117	0.000423	0.000606	0.000438	0.00059				
363		635074.5	4978334	0.0025	0.00406	0.00264	0.00395	0.00122	0.000425	0.000603	0.000441	0.000591				
364		635099.5	4978334	0.00249	0.00402	0.00262	0.00392	0.00125	0.000427	0.000602	0.000442	0.000591				
365		635124.5	4978334	0.00253	0.00406	0.00266	0.00396	0.00125	0.000432	0.000607	0.000447	0.000595				
366		635149.5	4978334	0.00262	0.00419	0.00276	0.00405	0.00121	0.000438	0.000617	0.000454	0.000601				
367		635174.5	4978334	0.00273	0.00434	0.00286	0.00417	0.00117	0.000446	0.00063	0.000461	0.00061				
368		635199.5	4978334	0.00285	0.00446	0.00298	0.00426	0.00113	0.000455	0.000639	0.00047	0.000616				
369		634299.5	4978134	0.00204	0.00395	0.0021	0.0039	0.00096	0.000343	0.000561	0.00035	0.000555				
370		634324.5	4978134	0.00211	0.00393	0.00218	0.00387	0.00103	0.000359	0.000567	0.000367	0.00056				
371		634349.5	4978134	0.00219	0.004	0.00226	0.00393	0.00107	0.000373	0.000579	0.000381	0.000571				
372		634374.5	4978134	0.00228	0.00403	0.00236	0.00396	0.00113	0.00039	0.00059	0.000399	0.000582				
373		634399.5	4978134	0.00233	0.00405	0.00242	0.004	0.00122	0.000406	0.000602	0.000416	0.000597				
374		634424.5	4978134	0.00233	0.00402	0.00244	0.00401	0.00132	0.000417	0.00061	0.00043	0.000609				
375		634449.5	4978134	0.00234	0.00401	0.00245	0.00401	0.00138	0.000425	0.000616	0.000438	0.000616				
376		634474.5	4978134	0.00245	0.0042	0.00255	0.00416	0.0013	0.000429	0.000629	0.00044	0.000624				
377		634499.5	4978134	0.00256	0.0044	0.00266	0.00432	0.00118	0.000427	0.000638	0.000439	0.000629				
378		634299.5	4978159	0.00194	0.0037	0.00201	0.00364	0.00098	0.000334	0.000535	0.000342	0.000528				
379		634324.5	4978159	0.00202	0.00371	0.0021	0.00365	0.00106	0.000352	0.000545	0.000361	0.000538				
380		634349.5	4978159	0.0021	0.00371	0.00219	0.00365	0.00113	0.000369	0.000553	0.000379	0.000546				
381		634374.5	4978159	0.00215	0.00378	0.00224	0.00374	0.00118	0.000381	0.000567	0.000391	0.000562				
382		634399.5	4978159	0.00217	0.00377	0.00228	0.00375	0.00127	0.000393	0.000576	0.000406	0.000574				
383		634424.5	4978159	0.00218	0.00374	0.00229	0.00376	0.00136	0.000405	0.000583	0.000417	0.000585				
384		634449.5	4978159	0.00221	0.00378	0.00233	0.0038	0.00138	0.00041	0.00059	0.000424	0.000592				
385		634474.5	4978159	0.00231	0.00398	0.00242	0.00395	0.00129	0.000411	0.000602	0.000424	0.000599				
386		634499.5	4978159	0.00242	0.00419	0.00252	0.00411	0.00118	0.000411	0.000614	0.000423	0.000605				
387		634299.5	4978184	0.00185	0.00345	0.00193	0.0034	0.001	0.000326	0.000509	0.000335	0.000503				
388		634324.5	4978184	0.00193	0.00344	0.00201	0.00339	0.00108	0.000344	0.000517	0.000353	0.000511				
389		634349.5	4978184	0.00198	0.0035	0.00208	0.00346	0.00116	0.000359	0.000533	0.00037	0.000528				
390		634374.5	4978184	0.00202	0.0035	0.00212	0.00348	0.00125	0.000374	0.000543	0.000385	0.000541				
391		634399.5	4978184	0.00204	0.00351	0.00215	0.00351	0.0013	0.000382	0.00055	0.000394	0.00055				
392		634424.5	4978184	0.00208	0.00353	0.00219	0.00358	0.00138	0.000395	0.000561	0.000408	0.000567				
393		634449.5	4978184	0.00211	0.0036	0.00222	0.00363	0.00136	0.000397	0.000567	0.000409	0.00057				
394		634474.5	4978184	0.00219	0.00378	0.0023	0.00376	0.00128	0.000397	0.000578	0.000409	0.000576				
395		634499.5	4978184	0.00228	0.00395	0.00238	0.00389	0.00119	0.000397	0.000587	0.000408	0.000581				
396		634299.5	4978209	0.00177	0.00324	0.00185	0.00319	0.00102	0.000319	0.000487	0.000328	0.000481				
397		634324.5	4978209	0.00183	0.00323	0.00192	0.00318	0.00109	0.000334	0.000494	0.000344	0.000488				
398		634349.5	4978209	0.00188	0.00327	0.00198	0.00324	0.00118	0.00035	0.000509	0.000361	0.000505				
399		634374.5	4978209	0.00191	0.00329	0.00201	0.0033	0.00126	0.000362	0.00052	0.000374	0.000521				
400		634399.5	4978209	0.00193	0.00329	0.00204	0.00333	0.00133	0.000373	0.000528	0.000385	0.000533				
401		634424.5	4978209	0.00199	0.00333	0.0021	0.00341	0.00139	0.000386	0.000539	0.000399	0.000549				
402		634449.5	4978209	0.00201	0.00342	0.00212	0.00346	0.00135	0.000384	0.000545	0.000397	0.00055				
403		634474.5	4978209	0.00207	0.00358	0.00218	0.00357	0.00126	0.000381	0.000553	0.000393	0.000552				
404		634499.5	4978209	0.00215	0.00373	0.00226	0.00369	0.00119	0.000382	0.000562	0.000394	0.000558				
405		634299.5	4978234	0.00169	0.003	0.00177	0.00296	0.00103	0.000311	0.000461	0.00032	0.000456				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
406		634324.5	4978234	0.00174	0.00305	0.00183	0.00302	0.0011	0.000325	0.000474	0.000335	0.000471				
407		634349.5	4978234	0.00178	0.00307	0.00188	0.00306	0.00119	0.000339	0.000487	0.000351	0.000486				
408		634374.5	4978234	0.00181	0.00309	0.00192	0.00311	0.00126	0.000351	0.000497	0.000363	0.000499				
409		634399.5	4978234	0.00186	0.00312	0.00197	0.00318	0.00134	0.000366	0.00051	0.000378	0.000517				
410		634424.5	4978234	0.00191	0.00316	0.00202	0.00326	0.00139	0.000377	0.00052	0.00039	0.000531				
411		634449.5	4978234	0.00192	0.00324	0.00204	0.0033	0.00135	0.000374	0.000525	0.000387	0.000531				
412		634474.5	4978234	0.00196	0.00337	0.00207	0.00337	0.00126	0.000368	0.000529	0.000381	0.000529				
413		634499.5	4978234	0.00203	0.00349	0.00213	0.00346	0.0012	0.000369	0.000536	0.000381	0.000533				
414		634299.5	4978259	0.00162	0.00283	0.00171	0.00279	0.00104	0.000304	0.000442	0.000314	0.000438				
415		634324.5	4978259	0.00166	0.00287	0.00175	0.00285	0.00111	0.000317	0.000455	0.000327	0.000453				
416		634349.5	4978259	0.0017	0.0029	0.0018	0.0029	0.00119	0.00033	0.000467	0.000342	0.000467				
417		634374.5	4978259	0.00173	0.00291	0.00184	0.00295	0.00127	0.000343	0.000478	0.000355	0.000482				
418		634399.5	4978259	0.00179	0.00295	0.0019	0.00304	0.00134	0.000358	0.00049	0.00037	0.000501				
419		634424.5	4978259	0.00182	0.003	0.00193	0.00312	0.00138	0.000366	0.000501	0.000378	0.000514				
420		634449.5	4978259	0.00185	0.00306	0.00196	0.00315	0.00136	0.000367	0.000505	0.000379	0.000515				
421		634474.5	4978259	0.00185	0.00315	0.00196	0.00318	0.00128	0.000358	0.000506	0.00037	0.00051				
422		634499.5	4978259	0.00191	0.00329	0.00202	0.00328	0.00122	0.000358	0.000515	0.00037	0.000514				
423		634299.5	4978284	0.00154	0.00267	0.00163	0.00264	0.00105	0.000296	0.000425	0.000306	0.000422				
424		634324.5	4978284	0.00158	0.00269	0.00168	0.00268	0.00113	0.00031	0.000437	0.000321	0.000435				
425		634349.5	4978284	0.00162	0.00273	0.00173	0.00275	0.0012	0.000322	0.000449	0.000335	0.000451				
426		634374.5	4978284	0.00167	0.00276	0.00177	0.00282	0.00127	0.000336	0.000461	0.000347	0.000467				
427		634399.5	4978284	0.00171	0.0028	0.00182	0.00291	0.00133	0.000347	0.000472	0.00036	0.000485				
428		634424.5	4978284	0.00174	0.00284	0.00185	0.00297	0.00136	0.000354	0.00048	0.000367	0.000495				
429		634449.5	4978284	0.00177	0.00291	0.00188	0.00301	0.00134	0.000355	0.000486	0.000368	0.000497				
430		634474.5	4978284	0.00177	0.003	0.00189	0.00304	0.00128	0.000349	0.000489	0.000362	0.000494				
431		634499.5	4978284	0.00182	0.0031	0.00192	0.0031	0.00121	0.000346	0.000493	0.000358	0.000493				
432		634299.5	4978309	0.00148	0.00249	0.00157	0.00247	0.00108	0.000293	0.000408	0.000303	0.000406				
433		634324.5	4978309	0.00152	0.00253	0.00162	0.00254	0.00114	0.000304	0.000419	0.000315	0.000421				
434		634349.5	4978309	0.00156	0.00258	0.00167	0.00262	0.00121	0.000317	0.000433	0.000329	0.000438				
435		634374.5	4978309	0.00161	0.00261	0.00171	0.00269	0.00127	0.000329	0.000443	0.000341	0.000453				
436		634399.5	4978309	0.00164	0.00264	0.00175	0.00277	0.00132	0.000338	0.000453	0.000351	0.000467				
437		634424.5	4978309	0.00167	0.0027	0.00178	0.00283	0.00134	0.000344	0.000462	0.000357	0.000477				
438		634449.5	4978309	0.00169	0.00277	0.0018	0.00286	0.0013	0.000342	0.000465	0.000354	0.000475				
439		634474.5	4978309	0.00169	0.00285	0.0018	0.00288	0.00123	0.000334	0.000466	0.000346	0.00047				
440		634499.5	4978309	0.00174	0.00297	0.00184	0.00296	0.00116	0.000331	0.000472	0.000343	0.000471				
441		634299.5	4978334	0.00143	0.00237	0.00152	0.00237	0.00109	0.000288	0.000395	0.000298	0.000395				
442		634324.5	4978334	0.00147	0.0024	0.00157	0.00243	0.00115	0.000299	0.000406	0.000311	0.000409				
443		634349.5	4978334	0.00151	0.00244	0.00161	0.0025	0.00121	0.000311	0.000417	0.000322	0.000424				
444		634374.5	4978334	0.00154	0.00248	0.00165	0.00258	0.00127	0.000321	0.000429	0.000334	0.00044				
445		634399.5	4978334	0.00157	0.00251	0.00168	0.00266	0.00132	0.00033	0.000438	0.000343	0.000455				
446		634424.5	4978334	0.0016	0.00257	0.00171	0.00269	0.0013	0.000331	0.000442	0.000344	0.000456				
447		634449.5	4978334	0.00161	0.00264	0.00172	0.00271	0.00125	0.000327	0.000445	0.000339	0.000453				
448		634474.5	4978334	0.00162	0.00273	0.00173	0.00274	0.00117	0.000319	0.000446	0.000331	0.000447				
449		634499.5	4978334	0.00166	0.00283	0.00176	0.00281	0.00111	0.000317	0.00045	0.000328	0.000448				
450		634299.5	4978359	0.00138	0.00224	0.00149	0.00226	0.00111	0.000285	0.000383	0.000297	0.000385				
451		634324.5	4978359	0.00142	0.00228	0.00153	0.00233	0.00116	0.000295	0.000393	0.000307	0.000399				
452		634349.5	4978359	0.00146	0.00232	0.00156	0.0024	0.00122	0.000306	0.000405	0.000318	0.000414				
453		634374.5	4978359	0.00148	0.00235	0.00159	0.00247	0.00126	0.000313	0.000413	0.000326	0.000426				
454		634399.5	4978359	0.0015	0.00238	0.00161	0.00253	0.0013	0.00032	0.000421	0.000333	0.000438				
455		634424.5	4978359	0.00153	0.00245	0.00164	0.00256	0.00127	0.00032	0.000425	0.000333	0.000438				
456		634449.5	4978359	0.00154	0.00252	0.00165	0.00257	0.0012	0.000313	0.000425	0.000326	0.000431				
457		634474.5	4978359	0.00155	0.00262	0.00165	0.00262	0.00112	0.000305	0.000427	0.000317	0.000427				
458		634499.5	4978359	0.00159	0.00272	0.00168	0.00269	0.00106	0.000303	0.000432	0.000313	0.000429				
459		634299.5	4978384	0.00135	0.00213	0.00145	0.00217	0.00112	0.000282	0.000371	0.000294	0.000376				
460		634324.5	4978384	0.00137	0.00217	0.00148	0.00223	0.00116	0.000289	0.000381	0.000302	0.000387				
461		634349.5	4978384	0.0014	0.0022	0.00151	0.0023	0.00121	0.000298	0.00039	0.000311	0.000401				
462		634374.5	4978384	0.00142	0.00223	0.00153	0.00236	0.00127	0.000307	0.0004	0.00032	0.000415				
463		634399.5	4978384	0.00144	0.00227	0.00155	0.00241	0.00129	0.000312	0.000407	0.000325	0.000423				
464		634424.5	4978384	0.00147	0.00233	0.00158	0.00244	0.00123	0.000309	0.000407	0.000321	0.000419				
465		634449.5	4978384	0.00147	0.00241	0.00158	0.00245	0.00116	0.000301	0.000408	0.000313	0.000413				
466		634474.5	4978384	0.00148	0.00249	0.00158	0.00248	0.00109	0.000294	0.000409	0.000305	0.000408				
467		634499.5	4978384	0.00151	0.00258	0.00161	0.00255	0.00103	0.00029	0.000413	0.000302	0.000409				
468		634299.5	4978409	0.0013	0.00203	0.0014	0.00208	0.00111	0.000275	0.000359	0.000287	0.000365				
469		634324.5	4978409	0.00132	0.00206	0.00143	0.00214	0.00115	0.000282	0.000367	0.000295	0.000376				
470		634349.5	4978409	0.00134	0.00208	0.00145	0.0022	0.00121	0.000291	0.000376	0.000304	0.00039				
471		634374.5	4978409	0.00136	0.0021	0.00147	0.00225	0.00126	0.000299	0.000384	0.000312	0.000401				
472		634399.5	4978409	0.00138	0.00215	0.00149	0.0023	0.00127	0.000303	0.000391	0.000315	0.000408				
473		634424.5	4978409	0.00141	0.00223	0.00152	0.00232	0.00119	0.000297	0.000391	0.00031	0.000401				
474		634449.5	4978409	0.00141	0.0023	0.00152	0.00233	0.00113	0.00029	0.000392	0.000303	0.000395				
475		634474.5	4978409	0.00142	0.00237	0.00152	0.00236	0.00106	0.000283	0.000392	0.000295	0.000391				
476		634499.5	4978409	0.00144	0.00245	0.00154	0.00242	0.001	0.000279	0.000394	0.00029	0.000391				
477		634299.5	4978434	0.00125	0.00193	0.00136	0.002	0.00111	0.00027	0.000347	0.000282	0.000355				
478		634324.5	4978434	0.00127	0.00196	0.00138	0.00205	0.00115	0.000277	0.000355	0.000289	0.000366				
479		634349.5	4978434	0.00129	0.00198	0.00139	0.0021	0.00121	0.000286	0.000365	0.000297	0.000378				
480		634374.5	4978434	0.0013	0.00199	0.00141	0.00214	0.00125	0.000291	0.00037	0.000304	0.000387				
481		634399.5	4978434	0.00133	0.00204	0.00144	0.00219	0.00124	0.000294	0.000375	0.000306	0.000392				
482		634424.5	4978434	0.00135	0.00212	0.00146	0.00221	0.00117	0.000288	0.000376	0.000301	0.000386				
483		634449.5	4978434	0.00136	0.00218	0.00146	0.00222	0.00111	0.000282	0.000376	0.000294	0.000381				
484		634474.5	4978434	0.00136	0.00225	0.00146	0.00224	0.00103	0.000273	0.000375	0.000285	0.000374				
485		634499.5	4978434	0.00138	0.00233	0.00148	0.00229	0.00099	0.000271	0.000379	0.000282	0.000375				
486		634249.4	4977384	0.00244	0.00239	0.00249	0.00202	0.00074	0.000363	0.000358	0.000369	0.000315				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
487		634274.4	4977384	0.00262	0.00252	0.00267	0.00212	0.00077	0.000387	0.000376	0.000393	0.00033				
488		634299.4	4977384	0.00284	0.00268	0.00289	0.00225	0.00079	0.000415	0.000397	0.000421	0.000347				
489		634324.4	4977384	0.00318	0.00292	0.00321	0.00246	0.00083	0.000458	0.000429	0.000462	0.000376				
490		634349.4	4977384	0.00383	0.00341	0.00385	0.00288	0.00089	0.000539	0.000491	0.000542	0.000431				
491		634374.4	4977384	0.00471	0.00406	0.0047	0.00346	0.00097	0.000649	0.000575	0.000648	0.000506				
492		634399.4	4977384	0.00516	0.00439	0.00514	0.00375	0.00101	0.000705	0.000617	0.000703	0.000544				
493		634424.4	4977384	0.00407	0.00356	0.00409	0.00296	0.00094	0.000573	0.000514	0.000575	0.000446				
494		634449.4	4977384	0.00311	0.00282	0.00317	0.00228	0.00086	0.000454	0.000421	0.000461	0.000359				
495		634249.4	4977409	0.00269	0.0026	0.00273	0.00223	0.00076	0.000394	0.000384	0.000399	0.000342				
496		634274.4	4977409	0.00297	0.0028	0.003	0.0024	0.00079	0.00043	0.00041	0.000433	0.000365				
497		634299.4	4977409	0.00333	0.00306	0.00335	0.00262	0.00082	0.000474	0.000443	0.000477	0.000393				
498		634324.4	4977409	0.00382	0.00341	0.00383	0.00293	0.00086	0.000535	0.000488	0.000536	0.000433				
499		634349.4	4977409	0.00449	0.00391	0.00448	0.00338	0.00092	0.000618	0.000552	0.000617	0.000491				
500		634374.4	4977409	0.00555	0.00471	0.0055	0.0041	0.00101	0.00075	0.000654	0.000744	0.000584				
501		634399.4	4977409	0.00603	0.00508	0.00598	0.0044	0.00108	0.000813	0.000704	0.000807	0.000626				
502		634424.4	4977409	0.00473	0.00407	0.00472	0.00346	0.00097	0.000651	0.000576	0.00065	0.000506				
503		634449.4	4977409	0.0036	0.0032	0.00363	0.00265	0.00089	0.000513	0.000467	0.000517	0.000405				
504		634249.4	4977434	0.00291	0.00276	0.00294	0.0024	0.00077	0.000421	0.000403	0.000424	0.000362				
505		634274.4	4977434	0.00333	0.00307	0.00335	0.00268	0.00081	0.000473	0.000443	0.000475	0.000399				
506		634299.4	4977434	0.00391	0.0035	0.00391	0.00306	0.00085	0.000544	0.000497	0.000544	0.000447				
507		634324.4	4977434	0.00463	0.00403	0.00461	0.00354	0.0009	0.000632	0.000563	0.00063	0.000507				
508		634349.4	4977434	0.00547	0.00466	0.00542	0.00411	0.00097	0.000736	0.000643	0.00073	0.000581				
509		634374.4	4977434	0.00648	0.00545	0.0064	0.0048	0.00108	0.000864	0.000746	0.000855	0.000672				
510		634399.4	4977434	0.00661	0.00558	0.00653	0.00487	0.00112	0.000883	0.000766	0.000874	0.000685				
511		634424.4	4977434	0.00563	0.00476	0.00558	0.00412	0.00103	0.000761	0.000662	0.000755	0.000589				
512		634449.4	4977434	0.00416	0.00363	0.00416	0.00307	0.00091	0.000579	0.000519	0.000579	0.000455				
513		634249.4	4977459	0.00308	0.00289	0.00309	0.00255	0.00078	0.000441	0.000419	0.000442	0.000381				
514		634274.4	4977459	0.00362	0.00329	0.00362	0.00291	0.00082	0.000507	0.00047	0.000507	0.000426				
515		634299.4	4977459	0.00447	0.00392	0.00444	0.00348	0.00087	0.00061	0.000547	0.000607	0.000497				
516		634324.4	4977459	0.00536	0.00458	0.0053	0.00409	0.00093	0.000719	0.00063	0.000712	0.000574				
517		634349.4	4977459	0.00636	0.00537	0.00627	0.00478	0.00103	0.000845	0.000731	0.000834	0.000664				
518		634374.4	4977459	0.00683	0.00581	0.00673	0.00513	0.00113	0.00091	0.000793	0.000898	0.000715				
519		634399.4	4977459	0.00672	0.00576	0.00664	0.00504	0.00117	0.000902	0.000792	0.000893	0.00071				
520		634424.4	4977459	0.00626	0.00528	0.00619	0.00463	0.00107	0.000838	0.000726	0.00083	0.000651				
521		634449.4	4977459	0.00498	0.00425	0.00495	0.00367	0.00097	0.00068	0.000597	0.000677	0.00053				
522		634249.4	4977484	0.00322	0.00301	0.00323	0.00267	0.00078	0.000457	0.000433	0.000458	0.000394				
523		634274.4	4977484	0.0039	0.0035	0.00388	0.00313	0.00082	0.000539	0.000494	0.000537	0.000451				
524		634299.4	4977484	0.00489	0.00424	0.00484	0.00381	0.00089	0.000661	0.000586	0.000655	0.000537				
525		634324.4	4977484	0.0059	0.00501	0.00582	0.00451	0.00096	0.000784	0.000682	0.000775	0.000625				
526		634349.4	4977484	0.00672	0.00571	0.00662	0.00512	0.00106	0.000889	0.000774	0.000878	0.000706				
527		634374.4	4977484	0.00664	0.0058	0.00655	0.00511	0.00117	0.000893	0.000797	0.000882	0.000718				
528		634399.4	4977484	0.00637	0.00564	0.0063	0.0049	0.00121	0.000866	0.000783	0.000858	0.000698				
529		634424.4	4977484	0.00656	0.00558	0.00648	0.00491	0.00111	0.000877	0.000765	0.000867	0.000688				
530		634449.4	4977484	0.00567	0.00479	0.00561	0.0042	0.001	0.000762	0.000662	0.000755	0.000594				
531		634249.4	4977509	0.00336	0.00311	0.00336	0.00279	0.00078	0.000473	0.000445	0.000473	0.000408				
532		634274.4	4977509	0.00412	0.00367	0.00408	0.0033	0.00083	0.000566	0.000514	0.000561	0.000472				
533		634299.4	4977509	0.00513	0.00443	0.00507	0.00401	0.00089	0.000688	0.000608	0.000681	0.00056				
534		634324.4	4977509	0.00628	0.00533	0.00618	0.00483	0.00099	0.000831	0.000722	0.000819	0.000665				
535		634349.4	4977509	0.00669	0.0058	0.00659	0.0052	0.00109	0.000889	0.000787	0.000878	0.000719				
536		634374.4	4977509	0.00607	0.00558	0.006	0.00487	0.00122	0.000833	0.000777	0.000825	0.000696				
537		634399.4	4977509	0.00583	0.00547	0.00578	0.00471	0.00125	0.000809	0.000768	0.000803	0.000681				
538		634424.4	4977509	0.0065	0.00563	0.00642	0.00496	0.00113	0.000872	0.000773	0.000863	0.000696				
539		634449.4	4977509	0.00617	0.00522	0.00609	0.00462	0.00104	0.000824	0.000715	0.000815	0.000647				
540		634249.4	4977534	0.00345	0.00318	0.00344	0.00288	0.00079	0.000485	0.000454	0.000483	0.000419				
541		634274.4	4977534	0.00429	0.0038	0.00425	0.00345	0.00083	0.000585	0.000529	0.000581	0.000489				
542		634299.4	4977534	0.00533	0.00459	0.00525	0.00419	0.0009	0.000712	0.000627	0.000703	0.000582				
543		634324.4	4977534	0.00633	0.00542	0.00623	0.00493	0.00099	0.000837	0.000733	0.000825	0.000677				
544		634349.4	4977534	0.00636	0.00568	0.00627	0.00508	0.00111	0.000854	0.000776	0.000843	0.000707				
545		634374.4	4977534	0.00533	0.00529	0.00528	0.00456	0.00125	0.000752	0.000747	0.000746	0.000664				
546		634399.4	4977534	0.00522	0.0052	0.00518	0.00443	0.00127	0.000742	0.000739	0.000737	0.000651				
547		634424.4	4977534	0.00617	0.00553	0.0061	0.00485	0.00116	0.000838	0.000765	0.00083	0.000687				
548		634449.4	4977534	0.00634	0.00543	0.00626	0.00482	0.00106	0.000846	0.000742	0.000837	0.000672				
549		634249.4	4977559	0.00352	0.00324	0.0035	0.00295	0.00079	0.000493	0.000461	0.00049	0.000427				
550		634274.4	4977559	0.0045	0.00397	0.00445	0.00363	0.00084	0.00061	0.00055	0.000605	0.000511				
551		634299.4	4977559	0.00553	0.00477	0.00544	0.00437	0.00091	0.000736	0.000649	0.000726	0.000603				
552		634324.4	4977559	0.00628	0.00547	0.00617	0.00498	0.00101	0.000833	0.000741	0.000821	0.000685				
553		634349.4	4977559	0.00589	0.00548	0.00582	0.00488	0.00113	0.000802	0.000755	0.000794	0.000687				
554		634374.4	4977559	0.0051	0.00526	0.00506	0.00455	0.00125	0.000726	0.000744	0.000721	0.000663				
555		634399.4	4977559	0.00499	0.00532	0.00497	0.00455	0.0013	0.000719	0.000757	0.000717	0.000669				
556		634424.4	4977559	0.00575	0.00535	0.00569	0.00468	0.00118	0.000792	0.000746	0.000785	0.00067				
557		634449.4	4977559	0.00621	0.00545	0.00613	0.00483	0.0011	0.000835	0.000749	0.000826	0.000678				
558		634249.4	4977584	0.00375	0.00342	0.00372	0.00314	0.0008	0.00052	0.000482	0.000517	0.00045				
559		634274.4	4977584	0.00469	0.00413	0.00463	0.00381	0.00085	0.000633	0.000569	0.000626	0.000533				
560		634299.4	4977584	0.00574	0.00499	0.00564	0.00459	0.00093	0.000762	0.000677	0.000751	0.000631				
561		634324.4	4977584	0.00602	0.00539	0.00593	0.00491	0.00102	0.000805	0.000733	0.000794	0.000678				
562		634349.4	4977584	0.0055	0.00532	0.00544	0.00474	0.00113	0.000758	0.000737	0.000751	0.000671				
563		634374.4	4977584	0.00489	0.00532	0.00486	0.00462	0.00125	0.000702	0.000751	0.000698	0.000671				
564		634399.4	4977584	0.00491	0.00554	0.00489	0.00477	0.00133	0.000713	0.000785	0.000711	0.000697				
565		634424.4	4977584	0.00501	0.00509	0.00498	0.0044	0.00122	0.000712	0.000721	0.000709	0.000642				
566		634449.4	4977584	0.00569	0.00526	0.00563	0.00462	0.00114	0.000781	0.000731	0.000774	0.000658				
567		634999.5	4977834	0.00521	0.00626	0.00531	0.00562	0.0012	0.000733	0.000853	0.000744	0.000779				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
568		635024.5	4977834	0.00538	0.00647	0.0055	0.00581	0.00123	0.000755	0.00088	0.000769	0.000805				
569		635049.5	4977834	0.00553	0.00666	0.00568	0.00599	0.00124	0.000774	0.000903	0.000791	0.000826				
570		635074.5	4977834	0.00566	0.00682	0.00583	0.00613	0.00125	0.00079	0.000922	0.000809	0.000843				
571		635099.5	4977834	0.00576	0.00693	0.00595	0.00623	0.00127	0.000803	0.000937	0.000825	0.000857				
572		635124.5	4977834	0.00581	0.00698	0.00602	0.00627	0.00129	0.000811	0.000945	0.000835	0.000864				
573		635149.5	4977834	0.00546	0.00652	0.00565	0.0058	0.00129	0.000771	0.000893	0.000793	0.00081				
574		635174.5	4977834	0.00496	0.00586	0.00512	0.00512	0.00128	0.000713	0.000816	0.000731	0.000731				
575		635199.5	4977834	0.00452	0.00527	0.00466	0.00454	0.00124	0.000658	0.000744	0.000674	0.000661				
576		634999.5	4977859	0.00524	0.00635	0.00533	0.00574	0.0012	0.000736	0.000863	0.000746	0.000793				
577		635024.5	4977859	0.00539	0.00655	0.00551	0.00592	0.00122	0.000755	0.000888	0.000769	0.000816				
578		635049.5	4977859	0.00551	0.00672	0.00566	0.00607	0.00123	0.00077	0.000909	0.000787	0.000834				
579		635074.5	4977859	0.00567	0.0069	0.00584	0.00624	0.00124	0.00079	0.00093	0.000809	0.000855				
580		635099.5	4977859	0.00577	0.007	0.00596	0.00634	0.00125	0.000802	0.000943	0.000824	0.000867				
581		635124.5	4977859	0.00577	0.007	0.00597	0.00632	0.00125	0.000802	0.000943	0.000825	0.000865				
582		635149.5	4977859	0.00544	0.00654	0.00562	0.00585	0.00125	0.000765	0.00089	0.000785	0.000811				
583		635174.5	4977859	0.00498	0.00592	0.00513	0.00522	0.00124	0.000711	0.000818	0.000728	0.000738				
584		635199.5	4977859	0.00456	0.00536	0.00469	0.00465	0.00121	0.000659	0.000751	0.000674	0.00067				
585		634999.5	4977884	0.00526	0.00647	0.00536	0.00588	0.00119	0.000737	0.000875	0.000749	0.000808				
586		635024.5	4977884	0.00537	0.00661	0.00549	0.00602	0.00121	0.000752	0.000894	0.000766	0.000826				
587		635049.5	4977884	0.0055	0.00676	0.00564	0.00616	0.00122	0.000768	0.000912	0.000784	0.000843				
588		635074.5	4977884	0.00564	0.00693	0.00581	0.00631	0.00123	0.000785	0.000933	0.000805	0.000862				
589		635099.5	4977884	0.00571	0.007	0.00589	0.00637	0.00124	0.000794	0.000942	0.000815	0.00087				
590		635124.5	4977884	0.00572	0.007	0.00591	0.00636	0.00125	0.000797	0.000943	0.000818	0.00087				
591		635149.5	4977884	0.00539	0.00653	0.00556	0.00587	0.00122	0.000755	0.000886	0.000775	0.00081				
592		635174.5	4977884	0.00498	0.00597	0.00513	0.0053	0.0012	0.000706	0.000819	0.000723	0.000743				
593		635199.5	4977884	0.0046	0.00544	0.00472	0.00477	0.00117	0.000659	0.000755	0.000673	0.000679				
594		634999.5	4977909	0.00518	0.00646	0.00528	0.00591	0.00119	0.000728	0.000874	0.000739	0.000811				
595		635024.5	4977909	0.0053	0.00661	0.00542	0.00605	0.0012	0.000743	0.000893	0.000757	0.000829				
596		635049.5	4977909	0.00545	0.00678	0.00559	0.0062	0.00121	0.000761	0.000913	0.000777	0.000847				
597		635074.5	4977909	0.00558	0.00692	0.00573	0.00633	0.00122	0.000777	0.00093	0.000794	0.000863				
598		635099.5	4977909	0.00563	0.00699	0.00581	0.0064	0.00123	0.000784	0.000939	0.000805	0.000872				
599		635124.5	4977909	0.00562	0.00695	0.0058	0.00633	0.00123	0.000783	0.000935	0.000803	0.000864				
600		635149.5	4977909	0.00531	0.0065	0.00548	0.00587	0.0012	0.000744	0.00088	0.000763	0.000808				
601		635174.5	4977909	0.00496	0.006	0.0051	0.00535	0.00118	0.000702	0.000821	0.000718	0.000746				
602		635199.5	4977909	0.00462	0.00551	0.00473	0.00487	0.00115	0.000659	0.000761	0.000672	0.000688				
603		634999.5	4977934	0.00507	0.0064	0.00517	0.00588	0.00117	0.000713	0.000865	0.000725	0.000806				
604		635024.5	4977934	0.00519	0.00655	0.00531	0.00602	0.00119	0.000729	0.000885	0.000743	0.000824				
605		635049.5	4977934	0.00537	0.00676	0.00551	0.00622	0.0012	0.000751	0.00091	0.000767	0.000848				
606		635074.5	4977934	0.00546	0.00689	0.00563	0.00633	0.00122	0.000763	0.000927	0.000783	0.000863				
607		635099.5	4977934	0.00554	0.00698	0.00571	0.00642	0.00123	0.000774	0.000938	0.000793	0.000874				
608		635124.5	4977934	0.00551	0.00689	0.00569	0.00631	0.00122	0.000769	0.000927	0.00079	0.000861				
609		635149.5	4977934	0.00524	0.00647	0.0054	0.00587	0.00119	0.000735	0.000875	0.000753	0.000807				
610		635174.5	4977934	0.00491	0.00599	0.00505	0.00538	0.00117	0.000695	0.000818	0.000711	0.000749				
611		635199.5	4977934	0.00461	0.00556	0.00473	0.00494	0.00114	0.000657	0.000766	0.000671	0.000695				
612		634999.5	4977959	0.00495	0.00633	0.00505	0.00584	0.00116	0.000698	0.000856	0.00071	0.0008				
613		635024.5	4977959	0.00507	0.00649	0.00519	0.00599	0.00118	0.000714	0.000877	0.000728	0.000819				
614		635049.5	4977959	0.00526	0.00672	0.0054	0.0062	0.0012	0.000738	0.000905	0.000754	0.000846				
615		635074.5	4977959	0.00534	0.00685	0.0055	0.00633	0.00122	0.00075	0.000922	0.000768	0.000863				
616		635099.5	4977959	0.00539	0.00691	0.00556	0.00638	0.00123	0.000757	0.00093	0.000776	0.00087				
617		635124.5	4977959	0.00537	0.00679	0.00554	0.00625	0.00121	0.000752	0.000914	0.000771	0.000853				
618		635149.5	4977959	0.00517	0.00646	0.00533	0.00589	0.00118	0.000726	0.000873	0.000744	0.000808				
619		635174.5	4977959	0.00489	0.00604	0.00502	0.00545	0.00116	0.000691	0.000823	0.000706	0.000755				
620		635199.5	4977959	0.00463	0.00564	0.00474	0.00505	0.00113	0.000658	0.000774	0.000671	0.000706				
621		634999.5	4977984	0.00481	0.00625	0.00491	0.00578	0.00115	0.000681	0.000846	0.000693	0.000792				
622		635024.5	4977984	0.00495	0.00642	0.00507	0.00595	0.00117	0.000699	0.000867	0.000713	0.000814				
623		635049.5	4977984	0.00507	0.00659	0.00521	0.00611	0.00119	0.000715	0.000889	0.000731	0.000834				
624		635074.5	4977984	0.00517	0.00675	0.00533	0.00626	0.00122	0.00073	0.000911	0.000749	0.000855				
625		635099.5	4977984	0.0052	0.00678	0.00537	0.00628	0.00123	0.000735	0.000915	0.000754	0.000858				
626		635124.5	4977984	0.00521	0.00668	0.00537	0.00616	0.0012	0.000733	0.000901	0.000751	0.000841				
627		635149.5	4977984	0.00509	0.00643	0.00524	0.00589	0.00117	0.000715	0.000869	0.000733	0.000807				
628		635174.5	4977984	0.00488	0.00609	0.00501	0.00553	0.00115	0.000689	0.000827	0.000704	0.000763				
629		635199.5	4977984	0.00463	0.00572	0.00475	0.00515	0.00112	0.000657	0.000782	0.000671	0.000717				
630		634999.5	4978009	0.00466	0.00614	0.00476	0.00571	0.00114	0.000663	0.000832	0.000674	0.000783				
631		635024.5	4978009	0.00481	0.00635	0.00493	0.00591	0.00116	0.000682	0.000858	0.000696	0.000808				
632		635049.5	4978009	0.00491	0.0065	0.00505	0.00605	0.00119	0.000697	0.000879	0.000713	0.000827				
633		635074.5	4978009	0.00497	0.00661	0.00513	0.00615	0.00121	0.000706	0.000894	0.000725	0.000841				
634		635099.5	4978009	0.00497	0.00662	0.00514	0.00616	0.00123	0.000709	0.000897	0.000728	0.000845				
635		635124.5	4978009	0.00504	0.00655	0.0052	0.00606	0.00119	0.000712	0.000885	0.00073	0.000829				
636		635149.5	4978009	0.00497	0.00636	0.00512	0.00585	0.00116	0.000701	0.000859	0.000718	0.000801				
637		635174.5	4978009	0.00481	0.00608	0.00494	0.00556	0.00114	0.00068	0.000825	0.000695	0.000766				
638		635199.5	4978009	0.00464	0.0058	0.00476	0.00526	0.00112	0.000658	0.000791	0.000672	0.000729				
639		634999.5	4978034	0.00452	0.00605	0.00461	0.00565	0.00113	0.000646	0.000821	0.000656	0.000775				
640		635024.5	4978034	0.00466	0.00626	0.00478	0.00584	0.00117	0.000666	0.000849	0.00068	0.000801				
641		635049.5	4978034	0.00473	0.00639	0.00487	0.00597	0.0012	0.000678	0.000867	0.000694	0.000819				
642		635074.5	4978034	0.00474	0.00644	0.00489	0.00602	0.00122	0.000681	0.000875	0.000698	0.000827				
643		635099.5	4978034	0.00474	0.00643	0.00491	0.006	0.00123	0.000682	0.000875	0.000702	0.000826				
644		635124.5	4978034	0.00486	0.00643	0.00501	0.00597	0.00119	0.000691	0.000871	0.000709	0.000818				
645		635149.5	4978034	0.00485	0.00629	0.00499	0.00581	0.00116	0.000687	0.000851	0.000703	0.000797				
646		635174.5	4978034	0.0047	0.00603	0.00483	0.00553	0.00113	0.000666	0.000818	0.000681	0.000761				
647		635199.5	4978034	0.00456	0.00575	0.00466	0.00524	0.00111	0.000648	0.000784	0.000659	0.000726				
648		634599.5	4976834	0.00061	0.00057	0.00084	0.00025	0.00063	0.000142	0.000137	0.000168	0.000101				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
649		634624.5	4976834	0.0006	0.00056	0.00083	0.00025	0.00063	0.000141	0.000136	0.000167	0.000101				
650		634649.5	4976834	0.0006	0.00055	0.00083	0.00025	0.00062	0.000139	0.000134	0.000166	9.94E-05				
651		634674.5	4976834	0.00059	0.00055	0.00083	0.00025	0.00062	0.000138	0.000134	0.000166	9.94E-05				
652		634699.5	4976834	0.00059	0.00054	0.00083	0.00025	0.00062	0.000138	0.000133	0.000166	9.94E-05				
653		634724.5	4976834	0.00059	0.00054	0.00083	0.00025	0.00062	0.000138	0.000133	0.000166	9.94E-05				
654		634749.5	4976834	0.00059	0.00054	0.00083	0.00025	0.00062	0.000138	0.000133	0.000166	9.94E-05				
655		634774.5	4976834	0.00058	0.00054	0.00083	0.00025	0.00062	0.000137	0.000133	0.000166	9.94E-05				
656		634799.5	4976834	0.00059	0.00054	0.00085	0.00026	0.00062	0.000138	0.000133	0.000168	0.000101				
657		634599.5	4976859	0.00063	0.00059	0.00085	0.00027	0.00064	0.000145	0.000141	0.00017	0.000104				
658		634624.5	4976859	0.00062	0.00058	0.00084	0.00026	0.00063	0.000143	0.000138	0.000168	0.000102				
659		634649.5	4976859	0.00062	0.00057	0.00084	0.00026	0.00063	0.000143	0.000137	0.000168	0.000102				
660		634674.5	4976859	0.00061	0.00057	0.00084	0.00026	0.00063	0.000142	0.000137	0.000168	0.000102				
661		634699.5	4976859	0.00061	0.00057	0.00085	0.00026	0.00063	0.000142	0.000137	0.000169	0.000102				
662		634724.5	4976859	0.00061	0.00057	0.00085	0.00026	0.00063	0.000142	0.000137	0.000169	0.000102				
663		634749.5	4976859	0.00061	0.00056	0.00085	0.00026	0.00063	0.000142	0.000136	0.000169	0.000102				
664		634774.5	4976859	0.00061	0.00057	0.00086	0.00026	0.00063	0.000142	0.000137	0.00017	0.000102				
665		634799.5	4976859	0.00063	0.00058	0.00088	0.00027	0.00064	0.000145	0.000139	0.000174	0.000104				
666		634599.5	4976884	0.00065	0.00061	0.00086	0.00028	0.00064	0.000147	0.000143	0.000171	0.000105				
667		634624.5	4976884	0.00064	0.0006	0.00086	0.00027	0.00064	0.000146	0.000142	0.000171	0.000104				
668		634649.5	4976884	0.00063	0.00059	0.00085	0.00027	0.00064	0.000145	0.000141	0.00017	0.000104				
669		634674.5	4976884	0.00063	0.00059	0.00086	0.00027	0.00064	0.000145	0.000141	0.000171	0.000104				
670		634699.5	4976884	0.00064	0.00059	0.00087	0.00027	0.00064	0.000146	0.000141	0.000173	0.000104				
671		634724.5	4976884	0.00064	0.00059	0.00087	0.00028	0.00064	0.000146	0.000141	0.000173	0.000105				
672		634749.5	4976884	0.00064	0.00059	0.00088	0.00028	0.00064	0.000146	0.000141	0.000174	0.000105				
673		634774.5	4976884	0.00064	0.0006	0.00088	0.00028	0.00065	0.000147	0.000143	0.000175	0.000106				
674		634799.5	4976884	0.00066	0.00061	0.0009	0.00029	0.00065	0.00015	0.000144	0.000177	0.000107				
675		634599.5	4976909	0.00066	0.00063	0.00087	0.00029	0.00065	0.00015	0.000146	0.000174	0.000107				
676		634624.5	4976909	0.00066	0.00062	0.00087	0.00029	0.00065	0.00015	0.000145	0.000174	0.000107				
677		634649.5	4976909	0.00065	0.00062	0.00087	0.00029	0.00065	0.000149	0.000145	0.000174	0.000107				
678		634674.5	4976909	0.00065	0.00062	0.00087	0.00028	0.00065	0.000149	0.000145	0.000174	0.000106				
679		634699.5	4976909	0.00066	0.00062	0.00088	0.00029	0.00065	0.00015	0.000145	0.000175	0.000107				
680		634724.5	4976909	0.00067	0.00062	0.00089	0.00029	0.00065	0.000151	0.000145	0.000176	0.000107				
681		634749.5	4976909	0.00067	0.00062	0.0009	0.00029	0.00066	0.000152	0.000146	0.000178	0.000109				
682		634774.5	4976909	0.00067	0.00062	0.0009	0.00029	0.00066	0.000152	0.000146	0.000178	0.000109				
683		634799.5	4976909	0.00068	0.00063	0.00092	0.0003	0.00067	0.000154	0.000149	0.000182	0.000111				
684		634599.5	4976934	0.00068	0.00065	0.00089	0.00031	0.00066	0.000153	0.00015	0.000177	0.000111				
685		634624.5	4976934	0.00068	0.00065	0.00089	0.0003	0.00066	0.000153	0.00015	0.000177	0.00011				
686		634649.5	4976934	0.00068	0.00065	0.00089	0.0003	0.00066	0.000153	0.00015	0.000177	0.00011				
687		634674.5	4976934	0.00068	0.00064	0.00089	0.0003	0.00066	0.000153	0.000149	0.000177	0.00011				
688		634699.5	4976934	0.00068	0.00064	0.0009	0.0003	0.00066	0.000153	0.000149	0.000178	0.00011				
689		634724.5	4976934	0.00069	0.00065	0.00091	0.00031	0.00066	0.000154	0.00015	0.000179	0.000111				
690		634749.5	4976934	0.0007	0.00065	0.00092	0.00031	0.00067	0.000157	0.000151	0.000182	0.000112				
691		634774.5	4976934	0.0007	0.00065	0.00093	0.00031	0.00067	0.000157	0.000151	0.000183	0.000112				
692		634799.5	4976934	0.00071	0.00066	0.00094	0.00032	0.00068	0.000159	0.000153	0.000185	0.000114				
693		634599.5	4976959	0.0007	0.00068	0.0009	0.00032	0.00066	0.000155	0.000153	0.000178	0.000112				
694		634624.5	4976959	0.0007	0.00068	0.0009	0.00032	0.00066	0.000155	0.000153	0.000178	0.000112				
695		634649.5	4976959	0.0007	0.00067	0.00091	0.00032	0.00067	0.000157	0.000153	0.000181	0.000113				
696		634674.5	4976959	0.00071	0.00068	0.00092	0.00032	0.00067	0.000158	0.000154	0.000182	0.000113				
697		634699.5	4976959	0.00071	0.00068	0.00093	0.00032	0.00067	0.000158	0.000154	0.000183	0.000113				
698		634724.5	4976959	0.00072	0.00068	0.00094	0.00032	0.00068	0.00016	0.000155	0.000185	0.000114				
699		634749.5	4976959	0.00073	0.00068	0.00095	0.00033	0.00068	0.000161	0.000155	0.000186	0.000115				
700		634774.5	4976959	0.00074	0.00069	0.00097	0.00033	0.00069	0.000163	0.000158	0.00019	0.000117				
701		634799.5	4976959	0.00075	0.0007	0.00098	0.00034	0.00069	0.000165	0.000159	0.000191	0.000118				
702		634599.5	4976984	0.00073	0.00071	0.00092	0.00034	0.00067	0.00016	0.000158	0.000182	0.000115				
703		634624.5	4976984	0.00072	0.0007	0.00092	0.00034	0.00067	0.000159	0.000157	0.000182	0.000115				
704		634649.5	4976984	0.00073	0.0007	0.00093	0.00034	0.00067	0.00016	0.000157	0.000183	0.000115				
705		634674.5	4976984	0.00074	0.00071	0.00094	0.00034	0.00068	0.000162	0.000159	0.000185	0.000117				
706		634699.5	4976984	0.00075	0.00072	0.00096	0.00034	0.00069	0.000165	0.000161	0.000189	0.000118				
707		634724.5	4976984	0.00076	0.00072	0.00097	0.00035	0.00069	0.000166	0.000161	0.00019	0.000119				
708		634749.5	4976984	0.00076	0.00072	0.00098	0.00035	0.0007	0.000167	0.000162	0.000192	0.00012				
709		634774.5	4976984	0.00078	0.00073	0.001	0.00035	0.00071	0.00017	0.000165	0.000195	0.000121				
710		634799.5	4976984	0.0008	0.00075	0.00102	0.00036	0.00071	0.000173	0.000167	0.000198	0.000122				
711		634599.5	4977009	0.00075	0.00074	0.00094	0.00037	0.00067	0.000162	0.000161	0.000184	0.000119				
712		634624.5	4977009	0.00075	0.00074	0.00094	0.00036	0.00068	0.000163	0.000162	0.000185	0.000119				
713		634649.5	4977009	0.00076	0.00074	0.00095	0.00036	0.00068	0.000165	0.000162	0.000186	0.000119				
714		634674.5	4977009	0.00077	0.00074	0.00097	0.00036	0.00069	0.000167	0.000163	0.00019	0.00012				
715		634699.5	4977009	0.00078	0.00075	0.00099	0.00037	0.0007	0.000169	0.000166	0.000193	0.000122				
716		634724.5	4977009	0.00081	0.00077	0.00101	0.00038	0.00071	0.000174	0.000169	0.000197	0.000125				
717		634749.5	4977009	0.00081	0.00077	0.00102	0.00038	0.00072	0.000175	0.00017	0.000199	0.000126				
718		634774.5	4977009	0.00082	0.00077	0.00103	0.00038	0.00072	0.000176	0.00017	0.0002	0.000126				
719		634799.5	4977009	0.00085	0.00079	0.00107	0.00039	0.00073	0.000181	0.000174	0.000206	0.000128				
720		634599.5	4977034	0.00078	0.00077	0.00096	0.00039	0.00068	0.000167	0.000166	0.000187	0.000122				
721		634624.5	4977034	0.00078	0.00077	0.00097	0.00039	0.00069	0.000168	0.000167	0.00019	0.000123				
722		634649.5	4977034	0.00079	0.00078	0.00098	0.00039	0.0007	0.00017	0.000169	0.000192	0.000125				
723		634674.5	4977034	0.00081	0.00079	0.001	0.00039	0.00071	0.000174	0.000171	0.000195	0.000126				
724		634699.5	4977034	0.00083	0.0008	0.00103	0.0004	0.00072	0.000177	0.000174	0.0002	0.000128				
725		634724.5	4977034	0.00086	0.00082	0.00106	0.00041	0.00073	0.000182	0.000177	0.000205	0.00013				
726		634749.5	4977034	0.00087	0.00083	0.00108	0.00041	0.00074	0.000184	0.000179	0.000208	0.000131				
727		634774.5	4977034	0.00088	0.00083	0.00109	0.00041	0.00075	0.000186	0.000181	0.00021	0.000133				
728		634799.5	4977034	0.0009	0.00084	0.00111	0.00042	0.00075	0.000189	0.000182	0.000213	0.000134				

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
Nicole C. Hancock, ISB No. 6899
nicole.hancock@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 _____ NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioner, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC. Intervenor-Respondent.	Case Docket No. 0101-22-01 OAH Case No. 23-245-01 **NOTICE OF APPEARANCE**

COMES NOW Nicole C. Hancock and enters her appearance as co-counsel for Intervenor-Respondent Perpetua Resources Idaho, Inc. All correspondence, pleadings, papers, and matters with regard to the above-captioned matter shall additionally be directed to:

Nicole C. Hancock
STOEL RIVES LLP
101 S. Capitol Boulevard, Suite 1900
Boise, ID 83702-7705
Telephone: (208) 389-9000
Facsimile: (208) 389-9040
Email: nicole.hancock@stoel.com

DATED: August 29, 2024.

STOEL RIVES LLP

/s/ Nicole C. Hancock
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole C. Hancock

Attorneys for Perpetua Resources Idaho, Inc.

CERTIFICATE OF SERVICE

I hereby certify that on August 29, 2024, a true and correct copy of the **NOTICE OF APPEARANCE** was served on the following:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Dylan B. Lawrence
Hearing Officer
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Bryan Hurlbutt
Laurence ("Laird") J. Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Michael A. Short
Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
michael.short@deq.idaho.gov
hannah.young@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
ann.yribar@ag.idaho.gov
via electronic service

Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, Idaho 83706
paula.wilson@deq.idaho.gov
via electronic service

/s/ Wade C. Foster
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
Nicole C. Hancock, ISB No. 6899
nicole.hancock@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 _____ NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioner, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC. Intervenor-Respondent.	Case Docket No. 0101-22-01 OAH Case No. 23-245-01 **NOTICE OF EXPERT DECLARATIONS**

Perpetua Resources Idaho, Inc. ("Perpetua"), through undersigned counsel, and pursuant to the July 8, 2024 Scheduling Order entered in the above captioned matter, hereby provides expert witness declarations of expert witnesses it intends to call at the hearing in this matter.

Filed concurrently with this Notice are the following:

1. Declaration of Kevin Lewis. To the extent not already part of the record, documents relied upon by Mr. Lewis are attached to his Declaration.
2. Declaration of Theresa Lopez. To the extent not already part of the record, documents relied upon, or prepared by, by Ms. Lopez are attached to her Declaration, including the Memorandum in Support of Declaration.
3. Documents identified in Attachment A of Ms. Lopez's Memorandum in Support of Declaration.

DATED: August 30, 2024.

STOEL RIVES LLP

/s/ Wade C. Foster
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole C. Hancock

Attorneys for Perpetua Resources Idaho, Inc.

CERTIFICATE OF SERVICE

I hereby certify that on August 30, 2024, a true and correct copy of the **NOTICE OF EXPERT DECLARATIONS** was served on the following:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Dylan B. Lawrence
Hearing Officer
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Bryan Hurlbutt
Laurence ("Laird") J. Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Michael A. Short
Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
michael.short@deq.idaho.gov
hannah.young@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
ann.yribar@ag.idaho.gov
via electronic service

Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, Idaho 83706
paula.wilson@deq.idaho.gov
via electronic service

/s/ Wade C. Foster
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
Nicole C. Hancock, ISB No. 6899
nicole.hancock@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioner, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC. Intervenor-Respondent.	Case Docket No. 0101-22-01 OAH Case No. 23-245-01 **EXPERT DECLARATION OF KEVIN LEWIS**

I, Kevin Lewis, hereby declare and affirm as follows:

1. I am currently a Principal Air Quality Engineer at Air Sciences Inc. (Air Sciences). I have prepared this declaration in support of the Permit to Construct (PTC) issued for the Stibnite Gold Project (SGP) on June 17, 2022. Perpetua Resources Idaho, Inc. (Perpetua) received the PTC that was challenged in this proceeding, Case Docket No. 0101-22-01; OAH Case No. 23-245-01.

A. Qualifications and Experience

2. I earned a Bachelor of Science (BS) degree in Chemical Engineering from the University of Wisconsin, Madison, in 1990.

3. From 1990 to 1992, I worked at the Wisconsin Department of Natural Resources, where I wrote air quality permits for toxic pollutants and conducted compliance inspections.

4. In 1993, I joined Air Sciences, became an owner in 1996, and served as President from 2011 to 2021. Air Sciences is a consulting firm specializing in ambient air quality analyses, permitting, and compliance.

5. With over 33 years of experience in air quality, I have conducted air quality analyses for permits across more than 25 states and internationally. At Air Sciences, I focus primarily on air permitting for the gold mining industry. In collaboration with the Nevada Mining Association and the U.S. Environmental Protection Agency (EPA), I compiled, analyzed, and summarized technical data to help develop the National Emissions Standard for Hazardous Air Pollutants (NESHAP): Gold Mine Ore Processing and Production Area Source Category rules under 40 CFR Part 63, Subpart EEEEEEE, which applies to the SGP.

6. During my time at Air Sciences, I developed air quality analyses for hundreds of air permits, renewals, and modifications. I also provided technical support to state agencies throughout the technical review, permit drafting, and public comment phases.

7. I led the modeling and permit development for Perpetua, ensuring compliance with ambient air quality standards while achieving project objectives. This included using reliable emissions data and appropriate modeling techniques to reflect permit conditions.

8. I began working with Perpetua as an air quality consultant in 2017, and I continue to provide consultancy services to this day.

B. Scope of Review

9. I reviewed the in the *Final Order* issued by the Board of Environmental Quality (Board) on May 9, 2024 in the Matter of Air Quality Permit to Construct P-2019.0047 (Final Order), which remanded "this matter back for the development of further evidence regarding ambient air concentrations of arsenic that will be produced by the SGP and whether those levels comply with the Air Rules." Final Order at 23. Based on my review of the Final Order the Board found the following issues to be addressed on remand:

a. DEQ did not act reasonably in using a five-year rolling average for T-RACT that was not properly supported by permit conditions.

b. There was insufficient evidence to support the T-RACT analysis limiting the non-West End pit production limit.

c. DEQ did not act reasonably and in accordance with law when it applied the 16/70 calculation to the ambient arsenic air concentration analysis.

10. I will address items (a), (b) and (c) in this declaration.

C. Documents Reviewed

11. I have reviewed the permitting record in this case, the expert declarations of Theresa Lopez, Norka Paden, and Kevin Schilling, and documents referenced below and attached as an exhibit to this declaration.

D. Summary of Opinions

12. Based on my expertise and multi-state permitting experiences:

a. DEQ properly established a five-year rolling average compliance demonstration in the PTC for ambient arsenic concentrations from the SGP.

b. DEQ sufficiently supported the permitting for the non-West End Pit activities.

c. DEQ correctly applied the provisions of IDAPA[1] 586 to perform an "apples to apples" toxic air pollutant (TAP) risk evaluation using an adjusted arsenic concentration and exposure duration to compare to the T-RACT Acceptable Ambient Concentration for Carcinogens (AACC).

Following rigorous analyses of Perpetua's application, as well as addressing repeated comments from stakeholders, DEQ prepared a thorough and conservative record in support of the PTC.

E. General Permitting and Modeling Context

13. With over thirty years of experience as an air permit consultant, including the development and review of hundreds of permits, I have identified two key objectives in the permitting process:

a. The permittee must submit a thorough and complete permit application.

[1] The Rules for the Control of Air Pollution in Idaho (Air Rules), IDAPA 58.01.01, provide for the control of air pollution in Idaho and govern issuance of air quality permits, including permits to construct. For brevity, citations to the Air Rules are abbreviated "IDAPA," followed by the specific section of IDAPA 58.01.01.

b. The permitting agency must issue a permit that includes operating restrictions and monitoring requirements to ensure compliance with air quality regulations.

14. Integral to these objectives is the creation of accurate emissions data and modeling to support compliance with ambient air quality standards.

15. To obtain a permit in Idaho, an applicant must satisfy for DEQ that the proposal will comply with all applicable state or federal emission standards, will not cause or contribute to a violation of the National Ambient Air Quality Standards, and using the methods provided in IDAPA 210, the emissions of toxic air pollutants will not injure or unreasonably affect human or animal life or vegetation as required by IDAPA 161. IDAPA 202.01, 202.02, 202.03.

16. Compliance with all applicable toxic air pollutant carcinogenic increments demonstrates preconstruction compliance with IDAPA 161 with regards to the pollutants listed in IDAPA 586: the Ambient Air Concentrations for Carcinogenic increments. IDAPA 202.03.

17. Modeling is necessary to meet the requirements of IDAPA 202.02 and 202.03. Specifically, the project proponent must determine the ambient concentrations of relevant toxic air pollutants from the project and compare these concentrations to the AACC.

18. Perpetua and DEQ took a conservative approach throughout the process of demonstrating compliance with IDAPA 202. Specifically, the analyses included arsenic emissions from fugitive dust related to mining activities. This is significant because fugitive dust is the primary source of arsenic emissions from the project. Furthermore, fugitive dust emissions of arsenic are "addressed" by NESHAP Subpart EEEEEEE and therefore would normally be

excluded from the analysis per IDAPA 210.20. *See* Statement of Basis, Permit to Construct No. P-2019.0047 at 28 (Feb. 18, 2021) (Proposed for Public Comment).[2]

19. Modeling of arsenic emissions from the SGP to comply with the Air Rules included fugitive dust from mining activities and involved the following steps: (1) quantifying annual arsenic emissions from all sources while accounting for process scenarios and emission control measures, (2) inputting the emissions data, emission locations, and initial dispersion parameters into the model, and (3) running the model with one year of onsite meteorological data to determine the annual average concentration at specific receptors located at and beyond the ambient air boundary.

20. The results of the modeling performed by Air Sciences and DEQ contain multiple layers of conservatism.

21. First, the model itself is conservative. EPA's evaluation studies for the type of modeling conducted for the SGP showed that the model, specifically AERMOD, over predicts pollutant concentrations by 1.41 to 3.21 times. REC 1834

22. Second, the quantification of arsenic emissions from the SGP was conservative. For haul road dust, the largest source of arsenic emissions, we used the higher of the two published emission factors in the emissions calculations. The emission factor used is five times greater than the lower factor. REC 1834

23. Third, the control and reduction in arsenic emissions from haul road dust was calculated conservatively. We used a control efficiency of 90% for chemical suppressants; the actual range is 90-99%. We also used a control efficiency of 33% for watering dust; the actual range is 75-95%. REC 1834

[2] The 2021 Statement of Basis, along with selected appendices, is attached hereto as Attachment 1.

24. Finally, we conducted fourteen modeling scenarios, each using conservative process and operating assumptions. Each scenario assumed mining activity in a single deposit and hauling to a single location year-round at the maximum permitted production level to maximize predicted arsenic impacts. Actual operation will be more varied in location and rates resulting in significantly lower arsenic impacts.

25. These analyses led to predicted arsenic impacts that are one to two orders of magnitude higher than the actual impacts will be.

26. In my experience, applying multiple layers of conservatism in the permitting review process is standard practice across all air quality permitting agencies, and DEQ's process is no exception. The goal is always to ensure compliance with air quality regulations under all circumstances.

27. DEQ also provided extra opportunities for public involvement. DEQ provided the most robust opportunity for public participation in the SGP permitting process that I've encountered in my 33 years of permitting experience. DEQ afforded commenters unprecedented accommodations that responded to public input. All comments, suggestions, and challenges were thoroughly reviewed. DEQ addressed each comment and, in some instances, conducted additional, more conservative analyses in response to the comments submitted.

F. Opinions

The IDAPA 586 AACC Annual Averaging Period is Not the Compliance Period.

28. As an expert on the relationship between air quality regulations and air quality modeling, I have a comprehensive understanding of the meaning and purpose of IDAPA 586 that reads "The AACC in this section are annual averages."

29. This text led the Board to infer that "the rule specifies compliance on an annual basis." Final Order at 19. This inference incorrectly conflates the AACC *averaging period* specified in IDAPA 586 with the *compliance period* described in IDAPA 006.125.[3]

30. Regulations often differentiate between the averaging period and the compliance period for health-based air contaminant concentration standards, especially when assessing long-term health risks.[4]

31. Treatment of the AACC as requiring compliance on an annual basis introduces an improper compliance period into IDAPA 586 and overlooks the adopted rules defining the methods and EPA scientific principles for determining cancer risk probability.

32. Within the full context of IDAPA 586, "The AACC in this section are annual averages" describes the annual average concentration that will result in a 1-in-1,000,000 excess cancer risk probability assuming constant lifetime exposure (70 years) to that concentration of ambient air emissions.

33. The AACC values listed in IDAPA 586 encompass three components:

a. The ***annual average*** concentration (0.00023 µg/m³ for arsenic) that correlates to

b. The ***1-in-1,000,000*** cancer risk probability as defined by the URF in IDAPA 586 over

c. A ***70-year*** exposure duration or compliance period per IDAPA 006.125.

[3] Definition from Air Rules in effect during the PTC application review: "**Toxic Air Pollutant Carcinogenic Increments**. Those ambient air quality increments based on the probability of developing excess cancers over a seventy (70) year lifetime exposure to one (1) microgram per cubic meter (1 ug/m3) of a given carcinogen and expressed in terms of a screening emission level or an acceptable ambient concentration for a carcinogenic toxic air pollutant. They are listed in Section 586."

[4] For example, the new $PM_{2.5}$ National Ambient Air Quality Standard of 9.0 µg/m³ specifies an averaging period as the "annual arithmetic mean" (or annual average) per 40 CFR 50.20(a), while the compliance period is defined as a three-year average according to 40 CFR Part 50, Appendix N. *See* 89 Fed. Reg. 16202, 16203 (Mar. 6, 2024).

34. Neglecting any of these components when assessing the cancer risk probability, such as the 70-year exposure duration, not only conflicts with the rule, but fundamentally alters the rule itself and ignores the EPA scientific principles underlying the rule.

35. When comparing modeling results to the AACC values listed in IDAPA 586, all three components must align for a correct comparison:

a. The model output must be expressed as an ***annual average*** in $\mu g/m^3$;

b. The target cancer risk probability must be ***1-in-1,000,000;*** and

c. The exposure duration must occur or be permitted to occur over a ***70-year*** period.

36. The Final Order's statement that "the rule specifies compliance on an annual basis," Final Order at 19, rewrites one of the three essential components of the AACC, namely the exposure duration. Under the Board's interpretation, a project with a 5-year operational permit limit would pose the same risk as a project without a limit. Limiting the exposure duration reduces the cancer risk, as demonstrated by the EPA's risk calculation methods. Declaration of Norka Paden (Paden Decl.) ¶¶ 4, 13.

37. If the project proposal includes a different actual exposure duration that is less than the 70-year lifetime default or the project proposal includes a different target risk (like the 1-in-100,000 T-RACT), then either the model output concentration, the AACC itself, or both must be adjusted according to EPA's methods to ensure all components align.

38. Adjustment for actual project facts is necessary for a correct assessment of cancer risk. Failing to adjust components of the AACC is inconsistent with the rule and contrary to the EPA scientific principles upon which the rule is based.

DEQ Properly Established a Five-Year Rolling Average Compliance Demonstration Period.

39. The IDAPA 586 "annual average" does not represent the compliance period for project emissions; it represents the annual average concentration of emissions that presents a 1-in-1,000,000 (or 1-in-100,000 T-RACT) cancer risk probability assuming constant exposure over a 70-year lifetime.

40. The Final Order stated that "there was no evidence in the record explaining how the five-year rolling average comports with the annual AACC limits." This conclusion conflated the averaging period specified in IDAPA 586 with the notion of a compliance period.

41. The AACC value is defined as a lifetime of exposure, specifically 70 years. This means that cumulative exposure over this 70-year period must not exceed levels that would result in a cancer risk probability of 1-in-1,000,000, or 1-in-100,000 for T-RACT sources.

42. DEQ imposed a daily production limit of 135,000 tons per day (T/day) because production generates arsenic emissions (primarily from fugitive dust emissions). Limiting production proportionally reduces arsenic emissions, concentrations and exposure.

43. DEQ correctly established a compliance demonstration period of 5 years for the 135,000-T/day limit using a 5-year rolling average. The 5-year rolling average represents a more conservative (shorter) timeframe than the exposure duration of 70 years inherent in the AACC. The 5-year rolling average is also a more conservative (shorter) timeframe than the T-RACT AACC exposure duration for the SGP of 16 years.

44. A five-year rolling average production limit in Permit Condition 3.5 is appropriate because "any permit limits must only assure that concentrations in ambient air over the total duration of the project do not cause a potential exposure concentration associated with a 1-in

1,000,000 [AACC] or a 1-in-100,000 [T-RACT] cancer risk." Declaration of Kevin Schilling (Schilling Decl.) ¶ 25.

45. The Board asserted that a "five-year rolling average allows considerable daily and annual increases in exposures which are contrary to limits set forth in the Air Rules." As explained by Theresa Lopez in her Declaration, the T-RACT AACC represents the lifetime probability of cancer risk from a ***cumulative*** dose of arsenic over a specific period of exposure. During the 16-year SGP project life, the ***cumulative*** dose is unaffected by variability in exposures (daily or annual) that may occur over the 5-year averaging period. In addition, Kevin Schilling states, "any daily and annual variability is inconsequential to the exposure concentration and resulting risk." Schilling Decl. ¶ 26.

46. The notion that the Air Rules prohibit daily variability in exposure, and therefore, a daily production limit with a daily compliance demonstration is needed to protect public health, is inaccurate. Limiting daily production activity does not eliminate exposure variability. The modeled output emissions concentration is inherently variable due to a multitude of factors unrelated to production and emissions. For example, for a given day when the wind blows from northeast to southwest, the predicted concentration (and exposure) at the northeast side of the ambient air boundary will be zero, regardless of the production and emissions.

DEQ Sufficiently Justified the Permitting for the Non-West End Pit Activities.

47. The permit imposes a total mining production limit of 788.4 million tons for the life of the project (Permit Condition 3.6). This limit applies to the aggregate amount of mining from all deposits, whether from a single deposit or a combination of deposits, ensuring that the total does not exceed 788.4 million tons over the life of the mine.

48. During permit development, Air Sciences performed 14 different model runs reflecting 14 different operating scenarios to assess arsenic concentrations based on production activity from each of the deposits individually

49. The modeling analysis for arsenic emissions from the Non-West End Pit (non-WEP) deposit scenarios demonstrated that mining activities at the non-WEP deposits result in ambient arsenic concentrations at or below the T-RACT adjusted AACC, even when the full 788.4 million tons of production comes from any one of those deposits. Schilling Decl. ¶¶ 28, 30.

50. The modeling analyses for arsenic emissions from the West End Pit (WEP) deposit scenarios resulted in proportionally higher impacts. This is attributed to the WEP's proximity to the northeastern ambient air boundary and prevailing wind patterns, as illustrated in Figure 1, attached as Exhibit A.

51. To address these elevated arsenic impacts associated with mining at the WEP, DEQ imposed an additional specific production limit for WEP activity. The limit is set at 394.2 million tons over the life of the project (Permit Condition 3.6), which represents 50% of the total mining production limit of 788.4 million tons.

52. Two life-of-mine production limits effectively constrain operations as follows:

a. Total mining from WEP and non-WEP locations cannot exceed 788.4 million tons.

b. Mining at the WEP cannot exceed 394.2 million tons.

c. Mining at non-WEP locations cannot exceed 788.4 million tons minus any mining at the WEP.

53. These restrictions work together as follows: A + B = C, where A represents WEP mining, B represents non-WEP mining, and C represents total mining. There is no need to

establish another limit for non-WEP mining because B can only be the difference between the total (788.4 million) and the volume from the WEP (limited to 394.2 million) as set forth in Permit Condition 3.6. Imposing an additional production limit for non-WEP activity would not offer any further protection of public health or the environment.

DEQ Correctly Applied the Permit Conditions Limiting the Project Life to 16 Years to the Analysis of Compliance with the T-RACT AACC

54. Based on my extensive multi-state permitting experience, DEQ's interpretation and analyses of the cancer risk associated with arsenic from the SGP followed sound permitting practices and scientific methods for TAPs evaluations.

55. In specific, DEQ correctly interpreted that "annual average" referred to in IDAPA 586 is simply the output of the air dispersion model that will result in a **1-in-1,000,000** excess cancer risk probability assuming the emissions impact will occur ***each year for 70 years***. Schilling Decl. ¶ 20.

56. The air dispersion model, specifically EPA's AERMOD, predicts ambient air concentrations as annual averages. For assessing long-term health impacts, such cancer risk probability (the AACC), the annual average output from the model serves as the default long-term averaging period. Defining the AACC as "annual averages" is consistent with the model's output and informs the compliance demonstration. It does not negate the other components of the AACC essential to properly assessing the cancer risk from the project's arsenic emissions.

57. Again, the AACC values in IDAPA 586 encompass three components: (1) the annual average concentration (0.00023 $\mu g/m^3$ for arsenic), (2) a cancer risk probability of 1-in-1,000,000, and (3) a 70-year exposure duration. For a proper comparison of modeling results all three components must align.

58. The annual average output concentration from the model can only be compared directly to AACC values in IDAPA 586 under the following conditions: 1) a target risk of ***1-in-1,000,000*** and 2) an emissions impact duration (or exposure duration) of ***70 years***. If one or both conditions are adjusted, then an adjustment to either the AACC and/or the annual average model output concentration must also be made for an "apple-to-apples" comparison.

59. For example, the annual average concentration for a 5-year project cannot be compared to the listed AACC because the exposure durations differ: five (5) years for the actual project and 70 years for the listed AACC. This example is found in IDAPA 210.15. To adjust for exposure duration, the example found in IDAPA 210.15 prompts the AACC to be multiplied by 10 to adjust for the shorter duration of the project. See Schilling Decl. ¶ 19.

60. DEQ properly applied these principles in the arsenic analysis for the SGP. The listed AACC was adjusted in accordance with IDAPA 210.12 to reflect the permit conditions establishing T-RACT. Per IDAPA 210.12 the AACC was multiplied by 10 to represent a risk of ***1-in-100,000*** for an emissions impact duration of ***70 years***; this is the T-RACT AACC. Then the annual average output concentration from the model was adjusted for the life-of-mine permit condition to reflect a 16-year exposure duration. This is shown mathematically by multiplying the modeled concentration by 16/70. This adjustment represents the equivalent modeled concentration over a 70-year period, known as the Exposure Concentration (EC). Detailed explanations are provided in the declarations of Norka Paden (¶¶ 4, 13) and Kevin Schilling (¶¶ 6.c, 18, 20).

61. With the AACC adjusted to the T-RACT AACC and the modeled annual average concentration adjusted to the EC, DEQ established a scientifically appropriate comparison to

determine acceptable risk. If the EC is less than the T-RACT AACC, as in the case of the SGP, then the risk of the project is less than ***1-in-100,000***.

62. As described in the declarations of Kevin Schilling and Norka Paden, DEQ applied these adjustments properly in their analyses of the SGP arsenic emissions impacts. Not applying these adjustments would be contrary to DEQ's toxic air pollutant rule and contrary to EPA's scientific approach and risk factors used for calculating excess risk probability adopted by the rule.

I declare under penalty of perjury under the laws of the United States that the foregoing is true and correct to the best of my knowledge, information, and belief.

DATED: August 30, 2024.

Kevin Lewis, Air Sciences Inc.

CERTIFICATE OF SERVICE

I hereby certify that on August 30, 2024, a true and correct copy of the **EXPERT DECLARATION OF KEVIN LEWIS** was served on the following:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Dylan B. Lawrence
Hearing Officer
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Bryan Hurlbutt
Laurence ("Laird") J. Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Michael A. Short
Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
michael.short@deq.idaho.gov
hannah.young@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

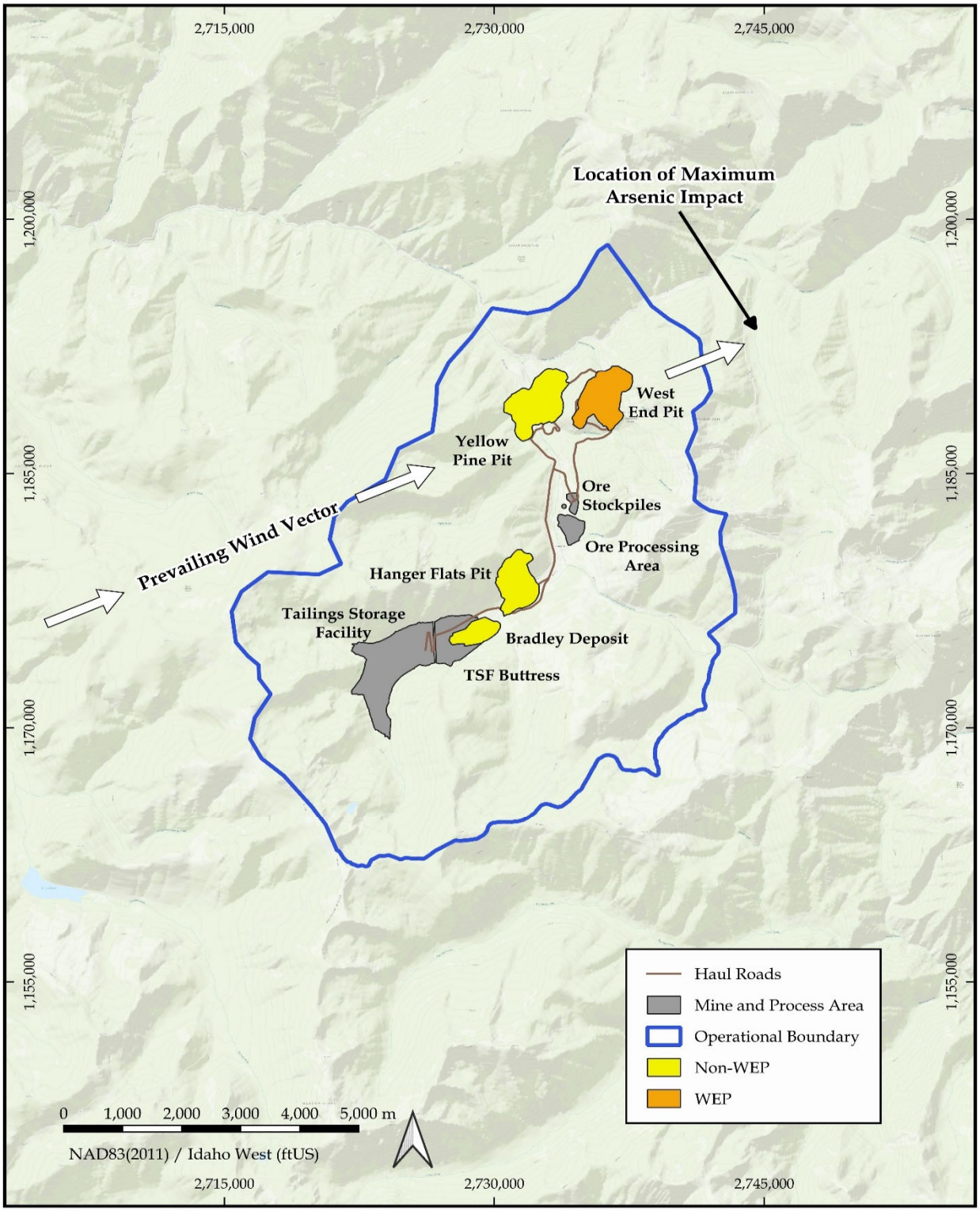
Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
ann.yribar@ag.idaho.gov
via electronic service

Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, Idaho 83706
paula.wilson@deq.idaho.gov
via electronic service

/s/ Wade C. Foster
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

EXHIBIT A
Figure 1. Location of Maximum Arsenic Impacts



Attachment 1

Attachment 1

Statement of Basis

Permit to Construct No. P-2019.0047
Project ID 62288

Midas Gold Idaho, Inc.
Stibnite, Idaho

Facility ID 085-00011

Proposed for Public Comment

February 18, 2021
Morrie Lewis
Permit Writer

The purpose of this Statement of Basis is to satisfy the requirements of IDAPA 58.01.01.et seq, Rules for the Control of Air Pollution in Idaho, for issuing air permits.

ACRONYMS, UNITS, AND CHEMICAL NOMENCLATURE **3**
FACILITY INFORMATION **6**
Description 6
Permitting History 8
Application Scope 8
Application Chronology 9
TECHNICAL ANALYSIS **11**
Emissions Units and Control Equipment 11
Emissions Inventories 16
Ambient Air Quality Impact Analyses 25
REGULATORY ANALYSIS **26**
Attainment Designation (40 CFR 81.313) 26
Facility Classification 26
Permit to Construct (IDAPA 58.01.01.201) 27
Tier II Operating Permit (IDAPA 58.01.01.401) 27
Subsection 210.20 (IDAPA 58.01.01.210.20) 27
Mercury Emission Standard (IDAPA 58.01.01.215) 29
Particulate Matter – New Equipment Process Weight Limitations (IDAPA 58.01.01.701) 29
Title V Classification (IDAPA 58.01.01.300, 40 CFR Part 70) 30
PSD Classification (40 CFR 52.21) 30
NSPS Applicability (40 CFR 60) 30
NESHAP Applicability (40 CFR 61) 35
MACT/GACT Applicability (40 CFR 63) 35
Permit Conditions Review 42
PUBLIC REVIEW **46**
Public Comment Opportunity 46
Public Comment Period 46

APPENDIX A – EMISSIONS INVENTORIES
APPENDIX B – AMBIENT AIR QUALITY IMPACT ANALYSES REVIEW MEMORANDUM
APPENDIX C – FACILITY DRAFT COMMENTS
APPENDIX D – PROCESSING FEE
APPENDIX E – ACCESS MANAGEMENT
APPENDIX F – SUBSECTION 210.20 INTERPRETATION OF ADDRESSED

ACRONYMS, UNITS, AND CHEMICAL NOMENCLATURE

AAC	acceptable ambient concentrations
AACC	acceptable ambient concentrations for carcinogens
acfm	actual cubic feet per minute
ANFO	ammonium nitrate/fuel oil
As	arsenic
ASTM	American Society for Testing and Materials
bkW	brake kilowatt
BT	Bradley Tailings
Btu	British thermal units
CAA	Clean Air Act
CAM	Compliance Assurance Monitoring
CAS No.	Chemical Abstracts Service registry number
Cd	cadmium
CEMS	continuous emission monitoring systems
cfm	cubic feet per minute
CFR	Code of Federal Regulations
CI	compression ignition
CIP	Carbon-in-Pulp
CIL	Carbon-in-Leach
CMS	continuous monitoring systems
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	CO_2 equivalent emissions
COC	contaminants of concern
COMS	continuous opacity monitoring systems
DEQ	Department of Environmental Quality
DR	development rock
DRSF	development rock storage facilities
dscf	dry standard cubic feet
EF	emission factors
EIS	Environmental Impact Statement required by the National Environmental Policy Act
EL	screening emission levels
EPA	United States Environmental Protection Agency
FDCP	Fugitive Dust Control Plan
FDRSF	Fiddle Development Rock Storage Facility
Forest Service	United States Forest Service
GACT	Generally Available Control Technology
gpm	gallons per minute
gr	grains (1 lb = 7,000 grains)
H_2SO_4	Sulfuric Acid
HAP	hazardous air pollutants
HFDRSF	Hangar Flats Development Rock Storage Facility
HFP	Hangar Flats Pit
Hg	mercury
hp	horsepower
hr/yr	hours per consecutive 12-calendar-month period
HVAC	heating, ventilation, and air conditioning
ICE	internal combustion engines
IDAPA	a numbering designation for all administrative rules in Idaho promulgated in accordance with the Idaho Administrative Procedures Act
km	kilometers

lb/hr	pounds per hour
lb/qtr	pound per quarter
LMP	lime manufacturing plant
MACT	Maximum Achievable Control Technology
Midas Gold	Midas Gold Idaho, Inc.
MMBtu	million British thermal units
MMscf	million standard cubic feet
NAAQS	National Ambient Air Quality Standard
NESHAP	National Emission Standards for Hazardous Air Pollutants
Ni	nickel
NF	National Forest System road
NMMP	nonmetallic mineral processing
NO_2	nitrogen dioxide
NO_x	oxides of nitrogen
NSPS	New Source Performance Standards
NSR	New Source Review
O&M	operation and maintenance
O_2	oxygen
PAH	polycyclic aromatic hydrocarbons
Pb	lead
PM	particulate matter
$PM_{2.5}$	particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers
PM_{10}	particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers
POM	polycyclic organic matter
POX	pressure oxidation
ppm	parts per million
PSD	Prevention of Significant Deterioration
PTC	permit to construct
PTE	potential to emit
PW	process weight rate
RICE	reciprocating internal combustion engines
Rules	*Rules for the Control of Air Pollution in Idaho*
SAG	semi-autogenous grinding
Sb	antimony
scf	standard cubic feet
SCL	significant contribution limits
Se	selenium
SGP	Stibnite Gold Project
SIP	State Implementation Plan
SM	synthetic minor
SM80	synthetic minor facility with emissions greater than or equal to 80% of a major source threshold
SO_2	sulfur dioxide
STKP	crusher stockpile
Subsection 210.20	HAP TAP exemption for NSPS and NESHAP sources in IDAPA 58.01.01.210.20
T/day	tons per calendar day
T/hr	tons per hour
T/yr	tons per consecutive 12-calendar-month period
TAP	toxic air pollutants
ULSD	ultra-low sulfur diesel
U.S.C.	United States Code
VOC	volatile organic compounds

WEDRSF	West End Development Rock Storage Facility
WEP	West End pit
YPDRSF	Yellow Pine Development Rock Storage Facility
YPP	Yellow Pine Pit
$\mu g/m^3$	micrograms per cubic meter

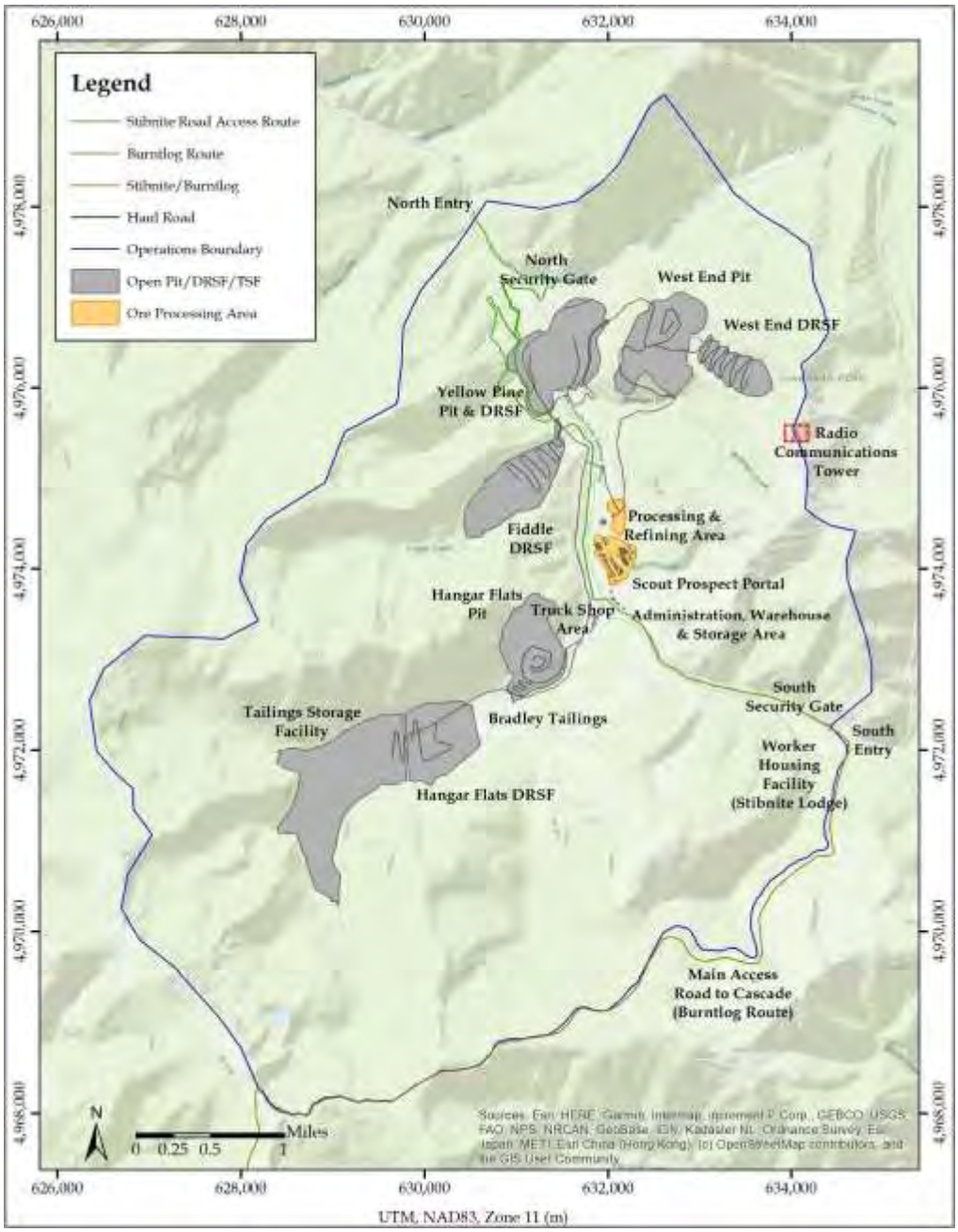
FACILITY INFORMATION

Description

Midas Gold Idaho, Inc. (Midas Gold) proposes to construct and operate the Stibnite Gold Project (SGP), consisting of conventional open-pit mining, ore preparation, and gold extraction operations.

SGP is to be located in Valley County at the intersection Forest Service roads NF-374 and NF-412 (Stibnite Road), approximately 10 miles east of Yellow Pine. The proposed Burntlog Route access road will provide year-round access to the site. The project comprises a combination of public national forest and private lands. The mining operations boundary within which public access will be excluded is defined in Figure 1. This operations boundary also defines the ambient air boundary used in all ambient air quality impact analyses.

Figure 1 PROJECT AREA OF OPERATIONS

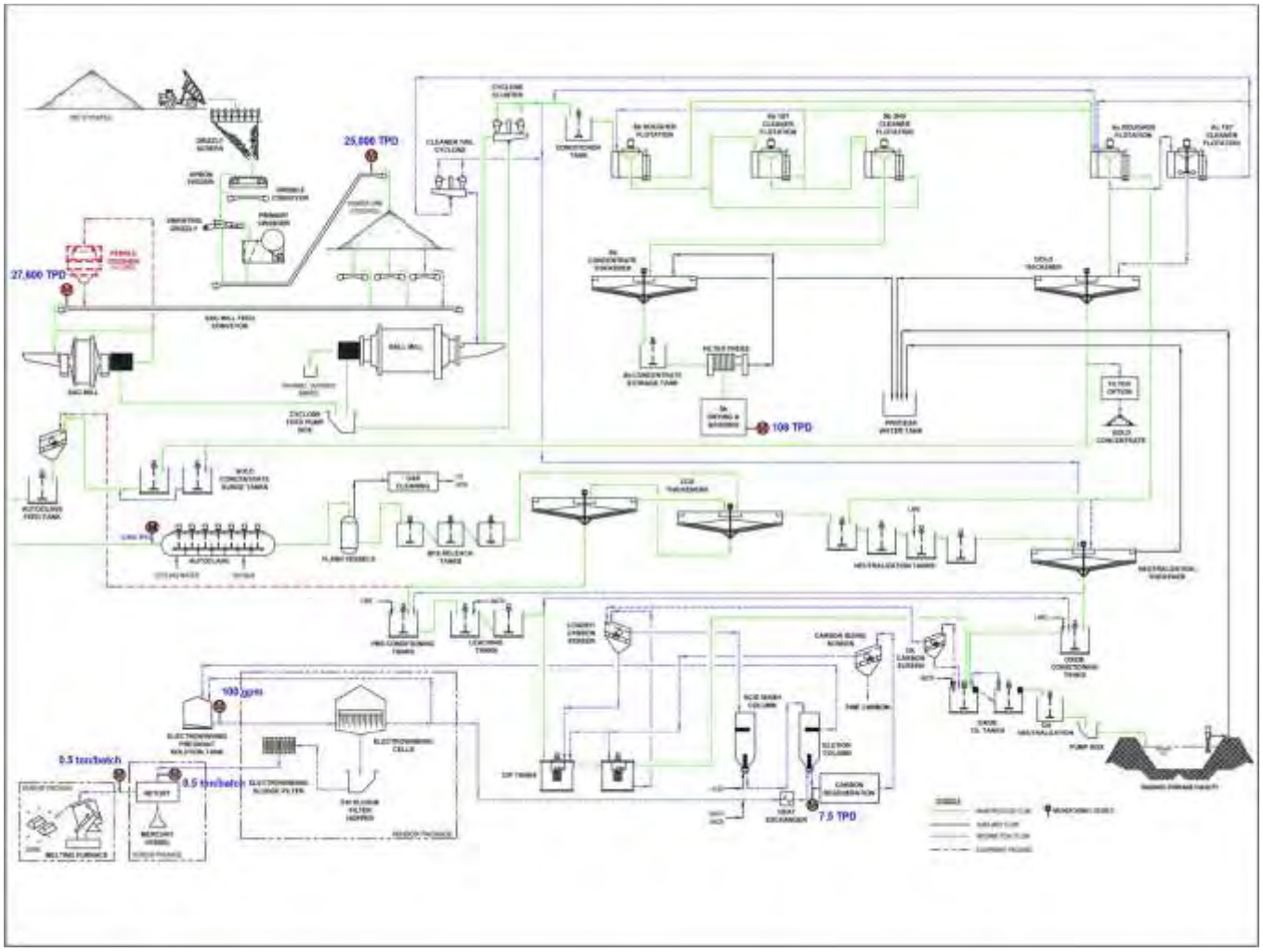


SGP will require the construction of significant infrastructure, including a power transmission line, a primary mine site access road, onsite haul roads, an ore processing facility, onsite workspaces, employee housing and recreation, water storage and distribution facilities, and sewage disposal facilities.

Conventional open-pit mining methods including drilling, blasting, excavating, and hauling will be used to extract ore and waste rock, termed development rock (DR). Hydraulic shovels and front-end loaders will be used to load ore and DR into haul trucks. DR will be used for construction, restoration, and backfilling, or hauled to the dedicated development rock storage facilities (DRSF). Approximately 340 million tons of DR will be handled over the life of the mine.

The SGP will include three years of pre-mining development and construction activities, followed by an operating mine life of approximately 12 years. Mining will occur in three open pits: Yellow Pine Pit (YPP), Hangar Flats pit (HFP), and West End pit (WEP). Although there will be overlap in mine development construction and operations, the general sequence of mining will be the YPP deposit, followed by the HFP and WEP deposits. Legacy tailings from the Meadow Creek valley (Bradley Tailings [BT]) will also be reclaimed and reprocessed during the initial project schedule. Surface exploration drilling will occur within the pits and within the Scout Prospect decline (underground exploration) throughout the mine operation period. Restoration and reclamation of other legacy mining features will occur prior to mining, throughout the life of the mine, and as part of the mine closure.

Figure 2 DIAGRAM OF PROCESS FLOWS



Ore will be hauled to the primary crusher area, where it will be fed directly into the crusher dump pocket or stockpiled. The ore crushing plant will be designed to operate at a maximum rate of 25,000 tons per calendar day (T/day). Approximately 100 million tons of ore will be mined from the three pits over the life of the project. The metal-recovery process from ore will include conventional crushing and grinding, followed by froth-flotation circuits that will generate separate gold-silver and antimony-silver concentrates. The antimony-silver concentrate will be shipped offsite for refining, whereas additional onsite processing of the gold-silver concentrate will include pressure oxidation, carbon-in-leach circuits, and refining processes to recover gold and minor amounts of silver. The finely ground leftover ore material from the mineral-recovery process, termed tailings, will be neutralized, thickened, and transported via a pipeline to the tailings storage facility. A diagram of ore processing and ore concentration and refining process flows is provided in Figure 2.

Permitting History

This is the initial PTC for a new facility, thus there is no permitting history.

Application Scope

This permit is the initial PTC for this facility.

The applicant has proposed to conduct mining operations and to install and operate ore processing, ore concentration and refining, and ancillary equipment:

- Drilling, blasting, excavating, and hauling operations;
- Ore processing operations (OC1–OC13, PS);
- Ore concentration and refining operations (AC, EW, MR, MF, CKD);
- Process heating (ACB, CKB, PV, HS, LKC);
- Lime production operations (LS1–LS12, LSBM, LS-L/U, LK, LCR, LS1-L/U, MillS2-L/U, ACS1–ACS4);
- Aggregate production operations (PCSP1, PCSP2);
- Concrete production operations (CM; CS1–CS2-L/U, CA-L/U);
- Heating, Ventilation, and Air Conditioning heaters (H1M–H2M, HM, HAC, HR, HA, HMO, HTS, HW);
- Emergency generator engines (EDG1–EDG3, EDFP); and
- Fuel storage (TG1–TG2, TD3—TD10).

Application Chronology

August 20, 2019	DEQ received an application and an application fee.
August 29 – September 13, 2019	DEQ provided an opportunity to request a public comment period on the application and proposed permitting action.
September 19, 2019	DEQ determined that the application was incomplete.
October 4, 2019	DEQ received a preliminary response and supplemental information from the applicant, including a request to delegate authority of responsible official.
October 9, 2019	DEQ approved the request to delegate authority of responsible official.
October 15, 2019	DEQ met with the applicant to review and discuss the preliminary response.
October 22, 2019	DEQ determined that the application remained incomplete while the applicant prepared a response to the remaining items previously identified (9/19/19), and included a summary of recommendations provided at the meeting (10/15/19).
November 8, 2019	DEQ requested additional information from the applicant via email, relating to items previously identified (9/19/19).
November 21, 2019	DEQ received a request from the applicant for extension until November 27, 2019 to respond.
November 27, 2019	DEQ received supplemental information from the applicant, including a revised application with updated emissions inventories and modeling analyses.
December 24, 2019	DEQ determined that the application was incomplete.
January 8, 2020	DEQ received a request from the applicant for extension until February 7, 2020 to respond.
January 31, 2020	DEQ requested additional information from the applicant via email, relating to items previously identified (12/24/19).
February 5, 2020	DEQ received supplemental information from the applicant, including a revised application with updated emissions inventories and modeling analyses.
March 6, 2020	DEQ determined that the application was incomplete.
April 2, 2020	DEQ received a request from the applicant for extension until April 15, 2020 to respond.
April 15, 2020	DEQ received supplemental information from the applicant, including updated modeling analyses.
May 15, 2020	DEQ determined that the application was complete.
June 24, 2020	DEQ received the final application including all updates.
July 6, 2020	DEQ made available the draft permit and statement of basis for peer and regional office review.
July 14, 2020	DEQ made available the draft permit and statement of basis for applicant review.
July 31, 2020	DEQ made available an updated draft statement of basis Appendix B for applicant review.

August 3 and 13, 2020	DEQ received comments from the applicant on the draft permit and statement of basis.
August 20, 2020	DEQ received the permit processing fee.
September 10 – October 12, 2020	DEQ provided a public comment period on the proposed action.
October 12, 2020	DEQ received a request to extend the public comment period.
October 13 – November 11, 2020	DEQ extended the public comment period on the proposed action.
October 27, 2020	DEQ provided an information meeting during the extended public comment period.
November 20, 2020	DEQ requested additional information from the applicant to address substantive public comments received, including missing TAP and HAP emission estimates.
November 25 and December 11, 2020	DEQ extended the response to public comment period until February 22, 2021 to allow additional time for the applicant and DEQ to respond to substantive public comments.
December 17, 2020	DEQ received a response to the request for additional information from the applicant.[1]
December 18 and 21, 2020	DEQ received supplemental information from the applicant, including a response and HAP/TAP addendum to the application,[2] updated HAP and TAP emissions estimates,[3] updated TAP modeling analyses,[4] and supporting references.[5]
January 28, 2021	DEQ received updated modeling files with corrections for formaldehyde and sulfuric acid, and an updated figure showing TAP modeled impacts.
February XX – March XX, 2021	DEQ provided a public comment period on the proposed action as updated to address the HAP and TAP addendum and updates.
February XX, 2020	DEQ provided an information meeting during the public comment period.
DRAFT February 18, 2021	DEQ issued the final permit, statement of basis, and response to public comments.

[1] "Response to DEQ's Request for Information," Midas Gold, December 17, 2020 (2020AAG2130).

[2] "HAP/TAP Addendum," Midas Gold, December 18, 2020. (2020AAG2150)

[3] "20200623-Midas Gold SGP PTC EI - Final-TAPr2.2.xls," Midas Gold, December 21, 2020. (2020AAG2152)

[4] "Modeling Files 2020-12.zip," Midas Gold, December 21, 2020. (2020AAG2154)

[5] "References-20201222T020853Z-001.zip," Midas Gold, December 21, 2020. (2020AAG2153)

TECHNICAL ANALYSIS

Emissions Units and Control Equipment

Table 1 lists all sources of regulated emissions for informational purposes.

Table 1 EMISSIONS UNIT AND CONTROL EQUIPMENT INFORMATION

Source ID No.	Source	Control Equipment	Maximum Process Rate
Mining			
	Drilling activities	Reasonable control and Fugitive Dust Control Plan (FDCP)	1,200 holes/day
	Blasting activities	Reasonable control & FDCP	2 blasts/day
	Excavating and hauling activities	Reasonable control & FDCP – Chemical suppression and water sprays Control efficiency: 93.3% for PM/PM_{10} (haul roads)	180,000 T/day
	Rock dumps and storage piles	Reasonable control & FDCP	n/a
PS1–2-L/U	(2) Prill Silos #1-2 Maximum capacity: 100 T (each)	Loading – None Unloading – None	200 T/day and 9,000 T/yr (combined)
Ore Processing			
OC1	Loader Transfer of Ore to Grizzly	Reasonable control & FDCP – Water sprays and moisture carryover	25,000 T/day
OC2	Grizzly to Apron Feeder		
OC3	Conveyor – Apron Feeder to Dribble		
OC4	Conveyor – Apron Feeder to Grizzly		
OC5	Conveyor – Dribble to Grizzly		
OC6	Grizzly to Primary Crusher or Coarse Ore Stockpile Feed		
OC7	Primary Crusher	Reasonable control & FDCP – Water sprays and moisture carryover	
OC8	Conveyor – Coarse Ore Stockpile Feed Transfer to Stockpile		
OC9	Stockpile Transfer to Reclaim Conveyors	Reasonable control & FDCP – Below-grade of storage piles Control efficiency: 80% for PM/PM_{10}	27,600 T/day
OC10	Conveyor – Reclaim Conveyors to SAG Mill Feed Conveyor		
OC11	Conveyor – SAG Mill Feed Transfer to SAG Mill	Reasonable control & FDCP – Enclosure Control efficiency: 80% for PM/PM_{10}	
OC12	Pebble Crusher	Reasonable control & FDCP – Water sprays and moisture carryover	
OC13	Pebble Discharge to SAG Mill Feed		
Ore Concentration and Refining			
CIP Leach 1–4	Carbon-in-Pulp Leach Tanks	Chemical treatment (lime, caustic soda, hydrogen peroxide, copper sulfate, etc.)	125 g/m^3 CN, 10.25 pH, and 1,700 T/yr PAX
CIL 1–6	Carbon-in-Leach Tanks	Chemical treatment	
CIP 1–6	Carbon-in-Pulp Tanks	Chemical treatment	
CN Detox 1–2	Cyanide Detox Tanks	Chemical treatment	25 g/m^3 CN, and 8.5 pH

Table 1 EMISSIONS UNIT AND CONTROL EQUIPMENT INFORMATION

Source ID No.	Source	Control Equipment	Maximum Process Rate
AC	Autoclave (AC)	Venturi Scrubber (VS1) Vent Gas Cleaning Tower (ST1) Vent Gas Steam Condensation Tower (CT1) Carbon Filter (CA5) Type: sulfur-impregnated activated carbon Form: granulated	6,960 T/day
EW	Electrowinning Cells and Pregnant Solution Tank	Shared Carbon Filter (CA2) Type: sulfur-impregnated activated carbon Form: granulated	100 gpm
MR	Mercury Retort	Condenser Carbon Filter (CA3) Type: sulfur-impregnated activated carbon Form: granulated	1,000 lb/batch and 21 T/yr
MF	Induction Melting Furnace	Baghouse (BH2) Carbon Filter (CA4) Type: sulfur-impregnated activated carbon Form: granulated	
CKD	Carbon Regeneration Kiln (Drum)	Wet Scrubber (WS2) Carbon Filter (CA1) Type: sulfur-impregnated activated carbon Form: granulated	7.2 T/day
	Tailings and Maintenance Pond activities	Chemical treatment, reasonable control & FDCP	1 g/m^3 CN
Process Heating			
ACB	POX Boiler (for AC) Maximum capacity: 17 MMBtu/hr Fuel: propane	None	operation is limited to AC startup only
HS	Strip Circuit Solution Heater Maximum capacity: 5 MMBtu/hr Fuel: propane	None	n/a
CKB	Carbon Regeneration Kiln Burners Maximum capacity: 2.255 MMBtu/hr Fuel: propane	None	(n/a)
PV	Propane Vaporizer Maximum capacity: 0.1 MMBtu/hr Fuel: propane	None	n/a
LKC	PFR Shaft Lime Kiln Combustion Maximum capacity: 22.0 MMBtu/hr Fuel: propane	None	n/a

Table 1 EMISSIONS UNIT AND CONTROL EQUIPMENT INFORMATION

Source ID No.	Source	Control Equipment	Maximum Process Rate
Lime Production			
LS1	Limestone transfer to Primary Crusher Hopper	None	1,130 T/day
LS2	Primary Crusher Maximum capacity: 1,130 T/day	None	
LS3	Primary Screen	None	
LS4	Secondary Crusher	None	
LS5	Secondary Screen	None	
LS6	Conveyor – Limestone to Ball Mill Feed Bin	None	
LS7	Conveyor – Limestone to Ball Mill Feed	None	
LS8	Conveyor – Ball Mill Feed to Ball Mill	None	
LSBM	Limestone Ball Mill	Baghouse (BH3)	
LS9	Conveyor – Limestone to Kiln Feed Bin	None	267 T/day
LS10	Conveyor – Limestone to Lime Kiln Feed	None	
LS11	Fines Screen	None	
LS12	Conveyor – Kiln Feed to PFR Shaft Lime Kiln	None	
LK	Parallel Flow Regenerative (PFR) Shaft Kiln	Baghouse (BH4)	169 T/day and 52,377 T/yr
LCR	Lime Mill Crusher	Baghouse (BH5)	
LS-L/U	Bucket Elevator – Pebble Lime Silo Loading	Loading – Bin Vent Filter	
	Pebble Lime Silo discharge to Lime Slaker	Unloading – Wet Scrubber (WS3)	
LS1-L/U	SAG Mill Lime Silo #1 Maximum capacity: 250 T/day	Loading – Bin Vent Filter Unloading – None	4,000 T/day and 70,000 T/yr (combined)
MillS2-L/U	SAG Mill Lime Silo #2 Maximum capacity: 250 T/day	Loading – Bin Vent Filter Unloading – None	
ACS1	AC Lime Silo #1 Maximum capacity: 1,000 T/day	Loading – Bin Vent Filter Unloading – None	
ACS2	AC Lime Silo #2 Maximum capacity: 1,000 T/day	Loading – Bin Vent Filter Unloading – None	
ACS3	AC Lime Silo #3 Maximum capacity: 1,000 T/day	Loading – Bin Vent Filter Unloading – None	
ACS4	AC Lime Silo #4 Maximum capacity: 500 T/day	Loading – Bin Vent Filter Unloading – None	
Aggregate Production			
PCSP1	Portable Crushing and Screening Plant 1 Crushers, screens, and conveyors	Reasonable control & FDCP – water sprays and moisture carryover	2,000 T/day (aggregate)
PCSP2	Portable Crushing and Screening Plant 2 Crushers, screens, and conveyors	Reasonable control & FDCP – water sprays and moisture carryover	2,000 T/day (aggregate)
Concrete Production			
CM	Central Mixer Loading Maximum capacity: 120 T/hr	Reasonable control & FDCP – Controls may include water sprays, enclosures, hoods, curtains, shrouds, movable and telescoping chutes, and central duct collection systems.	2,480 T/day and 560,000 T/yr (cement + aggregate)
CS1-L/U	Cement/Shotcrete Silo #1 Maximum capacity: 80 T	Loading – Bin Vent Filter Unloading – None	
CS2-L/U	Cement/Shotcrete Silo #2 Maximum capacity: 80 T	Loading – Bin Vent Filter Unloading – None	
CA-L/U	Aggregate Bin Maximum capacity: 2,400 T	Loading – None Unloading – None	

Table 1 EMISSIONS UNIT AND CONTROL EQUIPMENT INFORMATION

Source ID No.	Source	Control Equipment	Maximum Process Rate
Heating, Ventilation, and Air Conditioning (HVAC)			
H1M	Mine Air Heater #1 Maximum capacity: 4 MMBtu/hr Fuel: propane	None	n/a
H2M	Mine Air Heater #2 Maximum capacity: 4 MMBtu/hr Fuel: propane	None	n/a
HM	(4) Mill HVAC Heaters #1-4 Maximum capacity: 1.0 MMBtu/hr (each) Fuel: propane	None	n/a
HAC	Autoclave HVAC Heater Maximum capacity: 0.25 MMBtu/hr Fuel: propane	None	n/a
HR	Refinery HVAC Heater Maximum capacity: 0.25 MMBtu/hr Fuel: propane	None	n/a
HA	Admin HVAC Heater Maximum capacity: 0.25 MMBtu/hr Fuel: propane	None	n/a
HMO	(2) Mine Ops. HVAC Heaters Maximum capacity: 0.25 MMBtu/hr (each) Fuel: propane	None	n/a
HTS	(2) Truck Shop HVAC Heaters Maximum capacity: 1.0 MMBtu/hr (each) Fuel: propane	None	n/a
HW	(3) Warehouse HVAC Heaters Maximum capacity: 1.0 MMBtu/hr (each) Fuel: propane	None	n/a

Table 1 EMISSIONS UNIT AND CONTROL EQUIPMENT INFORMATION

Source ID No.	Source	Control Equipment	Maximum Process Rate
Emergency Power Generation and Fire Suppression			
EDG1	Camp Emergency Generator Date of construction: 2007 or later Maximum capacity: 1,000 bkW Maximum operation: 100 hr/yr (non-emergency) Fuel: ultra-low sulfur diesel (ULSD) Displacement: <10 L/cyl	EPA Tier 2 technologies	1 hr/day and 100 hr/yr
EDG2	Plant Emergency Generator #1 Date of construction: 2007 or later Maximum capacity: 1,000 bkW Maximum operation: 100 hr/yr (non-emergency) Fuel: ULSD Displacement: <10 L/cyl	EPA Tier 2 technologies	1 hr/day and 100 hr/yr
EDG3	Plant Emergency Generator #2 Date of construction: 2007 or later Maximum capacity: 1,000 bkW Maximum operation: 100 hr/yr (non-emergency) Fuel: ULSD Displacement: <10 L/cyl	EPA Tier 2 technologies	1 hr/day and 100 hr/yr
EDFP	Mill Fire Pump Date of construction: 2009 or later Maximum capacity: 200 bkW Maximum operation: 100 hr/yr (non-emergency) Fuel: ULSD Displacement: <10 L/cyl	None	1 hr/day and 100 hr/yr
Fuel Storage			
TG1–TG2	Mine Site Gasoline Tanks (#1 through #2) Maximum capacity: 5,000 gal each	Lids or other appropriate closure with gasketed seal and submerged filling	<100,000 gal/mo
TD3–TD10	Mine Site Diesel Tanks (#3 through #10)	Lids or other appropriate closure	n/a

Emissions Inventories

Potential to Emit

IDAPA 58.01.01 defines Potential to Emit (PTE) as the maximum capacity of a facility or stationary source to emit an air pollutant under its physical and operational design. Any physical or operational limitation on the capacity of the facility or source to emit an air pollutant, including air pollution control equipment and restrictions on hours of operation or on the type or amount of material combusted, stored or processed, shall be treated as part of its design if the limitation or the effect it would have on emissions is state or federally enforceable. Secondary emissions did not count in determining the PTE of a facility or stationary source.

Using this definition of PTE, an emissions inventory was developed for the SGP (see Appendix A). Emissions estimates of criteria pollutant and hazardous air pollutant (HAP) PTE were based on project-specific activity rates (e.g., continuous operation with the exception of the POX Boiler and emergency generator engines, design production rates, material haul rates, blasting agent usage rates, reagent usage rates, etc.), process design (e.g., open-pit mining, process concentration and pH, parallel flow regenerative lime production, central mix concrete production, haul fleet, etc.), emission abatement techniques (e.g., dust suppressant, chemical treatment, carbon filter, baghouse, bin vent filtration, wet scrubber, venturi scrubber, vent gas cleaning tower, and vent gas steam condensation tower control equipment), material characteristics (e.g., moisture content, road silt content, haul route distances, etc.), site conditions (onsite meteorological data, precipitation, etc.), and emission factors based on AP-42,[6] representative source test emissions data, and representative emission limits. Estimated emissions from the autoclave and the carbon regeneration kiln relied on emissions data from representative source test emissions data, scaled to the proposed equipment capacity. Estimated emissions from fuel storage tanks relied on TANKS[7] emission estimation software and projected annual gasoline and ULSD usage rates. Estimated emissions from the emergency generator engines relied on the use of certified engine emission factors.

Uncontrolled PTE

Using the definition of PTE, uncontrolled PTE is then defined as the maximum capacity of a facility or stationary source to emit an air pollutant under its physical and operational design. Any physical or operational limitation on the capacity of the facility or source to emit an air pollutant, including air pollution control equipment and restrictions on hours of operation or on the type or amount of material combusted, stored or processed, shall **not** be treated as part of its design **since** the limitation or the effect it would have on emissions **is not** state or federally enforceable.

The uncontrolled PTE is used to determine if a facility is a "synthetic minor" source of emissions. Synthetic minor sources are facilities that have an uncontrolled PTE for regulated air pollutants or HAP above an applicable major source threshold without permit limits.

For Midas Gold, uncontrolled PTE was based upon a worst-case for operation of the facility of continuous operation at proposed maximum material throughput and fuel input rates (Table 1), without consideration of control equipment. For batch operations, the number of operations necessary to achieve the proposed daily throughput rates was assumed in estimating emissions (MR, MF). Silo loading and unloading operations were assumed to occur at most once per day (LS1-L/U, MillS2-L/U, LS-L/U, PS-L/U, ACS1–ACS4-L/U, CS1–CS2-L/U, CA-L/U). Fuel storage was based on estimated facility-wide fuel usage rates (TG1, TG2 and TD3—TD10). For the purposes of maintenance and testing, emergency power generation operations were assumed to occur 1 hour per day and 100 hours per year (EDG1–EDG3, EDFP). With the exception of the POX Boiler in which operation is limited to AC startup only, continuous operation at maximum fuel input rates was assumed for all process heating and HVAC equipment.

---

[6] Compilation of Air Pollutant Emission Factors, AP-42, Volume I, Fifth Edition (AP-42), Section 1.3 –Fuel Oil Combustion, 1.4 –Natural Gas Combustion, 1.5 – LPG Combustion, 3.2 – Natural Gas-Fired Reciprocating Engines, 3.3 – Gasoline and Diesel Industrial Engines, 3.4 – Large Stationary Diesel and All Stationary Dual-Fuel Engines, 8.3 – Ammonium Nitrate, 11.9 – Western Surface Coal Mining, 11.12 – Concrete Batching, 11.17 – Lime Manufacturing, 11.19 – Construction and Aggregate Processing, 13.2 – Fugitive Dust Sources, and 13.3 – Explosives Detonation, Office of Air Quality Planning and Standards Office of Air and Radiation (OAQPS), EPA, updated as of August 2011.

[7] TANKS Storage Tank Emissions Calculation Software Version 4.09D, OAQPS, EPA, released October 5, 2006.

The following table presents the uncontrolled PTE for regulated air pollutants as submitted by the applicant and verified by DEQ staff. Refer to Appendix A for a summary of the calculations and the assumptions used to determine emissions for each source, and the Facility Classification section for a review of facility classification based on uncontrolled and controlled PTE.

Table 2 UNCONTROLLED POTENTIAL TO EMIT FOR CRITERIA AIR POLLUTANTS

Source	PM	PM_{10}	$PM_{2.5}$	CO	NO_x	VOC	SO_2
	T/yr	T/yr	T/yr	T/yr	T/yr	T/yr	T/yr
OC1	13.69	5.02	0.78				
OC2	13.69	5.02	0.78				
OC3	13.69	5.02	0.78				
OC4	13.69	5.02	0.78				
OC5	13.69	5.02	0.78				
OC6	13.69	5.02	0.78				
OC7	24.64	10.95	1.64				
OC8	13.69	5.02	0.78				
OC9	15.11	5.54	0.86				
OC10	15.11	5.54	0.86				
OC11	15.11	5.54	0.86				
OC12	27.20	12.09	1.81				
OC13	15.11	5.54	0.86				
PS-L	0.07	0.03	0.004				
PS-U	0.07	0.03	0.004				
AC	74.10	74.10	74.10				2.86
MF	1.77	1.77	1.77				
CKD (EW, MR)	6.13	6.13	6.13	0.53	0.05	0.48	
LS1	0.48	0.17	0.03				
LS2	0.86	0.38	0.06				
LS3	3.97	1.38	0.21				
LS4	0.86	0.38	0.06				
LS5	3.97	1.38	0.21				
LS6	0.48	0.17	0.03				
LSBM	64.22	53.89	19.23				
LS7	0.48	0.17	0.03				
LS8	0.48	0.17	0.03				
LS9	0.12	0.05	0.007				
LS10	0.12	0.05	0.007				
LS11	1.03	0.36	0.05				
LS12	0.12	0.05	0.007				
LS-L	0.23	0.23	0.23				
LS-U	0.02	0.02	0.02				
LK	34.05	34.05	34.05	11.78	6.29		0.03
LCR	10.58	8.88	3.17				
LS1-L	1.60	1.03	0.16				
LS1-U	0.01	0.006	0.001				
MillS2-L	1.60	1.03	0.16				
MillS2-U	0.01	0.006	0.001				
ACS1-L	6.39	4.11	0.62				
ACS1-U	0.04	0.02	0.004				
ACS2-L	6.39	4.11	0.62				
ACS2-U	0.04	0.02	0.004				
ACS3-L	6.39	4.11	0.62				
ACS3-U	0.04	0.02	0.004				
ACS4-L	3.19	2.06	0.31				
ACS4-U	0.02	0.01	0.002				
PCSP1	27.67	10.11	1.54				
PCSP2	27.67	10.11	1.54				
CM	17.16	4.68	0.71				
CS1-L	21.90	14.10	2.14				
CS1-U	0.14	0.08	0.01				
CS2-L	21.90	14.10	2.14				

Table 2 UNCONTROLLED POTENTIAL TO EMIT FOR CRITERIA AIR POLLUTANTS

Source	PM	PM_{10}	$PM_{2.5}$	CO	NO_x	VOC	SO_2
	T/yr	T/yr	T/yr	T/yr	T/yr	T/yr	T/yr
CS2-U	0.14	0.08	0.01				
CA-L	1.73	0.83	0.13				
CA-U	1.73	0.83	0.13				
ACB	0.002	0.002	0.002	0.02	0.04	0.002	0.004
CKB	0.08	0.08	0.08	0.81	1.40	0.09	0.17
PV	0.003	0.003	0.003	0.04	0.06	0.004	0.008
HS	0.17	0.17	0.17	1.80	3.11	0.19	0.38
LKC	0.63	0.63	0.63	6.72	11.65	0.72	1.42
H1M	0.13	0.13	0.13	1.44	2.49	0.15	0.30
H2M	0.13	0.13	0.13	1.44	2.49	0.15	0.30
HM	0.13	0.13	0.13	1.44	2.49	0.15	0.30
HAC	0.008	0.008	0.008	0.09	0.16	0.01	0.02
HR	0.008	0.008	0.008	0.09	0.16	0.01	0.02
HA	0.008	0.008	0.008	0.09	0.16	0.01	0.02
HMO	0.02	0.02	0.02	0.18	0.31	0.02	0.04
HTS	0.07	0.07	0.07	0.72	1.24	0.08	0.15
HW	0.10	0.10	0.10	1.08	1.87	0.11	0.23
EDG1	0.02	0.02	0.02	0.39	0.71	0.14	0.001
EDG2	0.02	0.02	0.02	0.39	0.71	0.14	0.001
EDG3	0.02	0.02	0.02	0.39	0.71	0.14	0.001
EDFP	0.004	0.004	0.004	0.08	0.09	0.09	0.0001
TG1–TG2						1.91	
TD3—TD10						0.06	
Total	**560**	**337**	**164**	**29.47**	**36.16**	**4.68**	**6.27**

Although not explicitly calculated, it was confirmed by Midas Gold in the response to a request for additional information[1] that the uncontrolled HAP PTE for SGP is estimated to exceed 25 tons per year (T/yr) without application of the specified control equipment (Table 1). Arsenic HAP PTE from haul roads at a controlled emission rate of 0.464 pounds per hour (lb/hr) and accounting for 93.3% control efficiency exceeds 20 T/yr, supporting that uncontrolled HAP PTE exceeds 10 T/yr of single HAP and 25 T/yr of total HAP.

Pre-Project PTE

Pre-project PTE is used to establish the change in emissions at a facility as a result of this project. Because this is a new facility, pre-project emissions are set to zero for all criteria pollutants.

Post-Project PTE

Post-project PTE is used in determining the change in emissions at a facility and in determining the facility's classification as a result of this project. Post-project PTE includes all permit limits resulting from this project.

In addition to assuming continuous operation of the facility at the proposed material throughput and fuel input rates, post-project emissions estimates account for the use of dust suppressant, chemical treatment, carbon filter, baghouse, bin vent filtration, wet scrubber, venturi scrubber, vent gas cleaning tower, and vent gas steam condensation tower control equipment.

A variety of factors impact emissions from unpaved roadways, and it was recognized that accurate determination of site-specific parameters characterizing road conditions and vehicle traffic was critical to estimating particulate matter emissions and ambient air impacts. Midas Gold provided site-specific information to support parameters such as silt content, mean vehicle weight, and dust suppressant control efficiencies, and provided an analysis evaluating the conservatism of the resulting emission factor (AP-42).[8] To ensure operation consistent with these parameters and to reasonably control fugitive emissions, compliance with requirements identified in the FDCP is

[8] Appendix A – Model Parameter / Assumption / Data Level of Conservatism IDEQ Forms to the Stibnite Gold Project Permit to Construct Application, Midas Gold, revised June 23, 2020 (2020AAG1078).

required by the permit. Further discussion of the sensitivity of predicted air quality impacts is provided in the Ambient Air Quality Impact Analyses section.

The following table presents the post-project PTE for criteria pollutants from all emissions units at the facility as determined by DEQ staff. Because this is a new facility, the post-project PTE is equivalent to the facility-wide PTE. Refer to Appendix A for a summary of the calculations and the assumptions used to determine emissions from each source, and the Facility Classification section for a review of facility classifications based on uncontrolled and controlled PTE.

Table 3 POST-PROJECT POTENTIAL TO EMIT FOR CRITERIA AIR POLLUTANTS

Source	PM	PM_{10}	$PM_{2.5}$	CO	NO_x	VOC	SO_2
	T/yr [(a)a]	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]
POINT SOURCE EMISSIONS							
OC1	0.64	0.21	0.06				
OC2	0.64	0.21	0.06				
OC3	0.64	0.21	0.06				
OC4	0.64	0.21	0.06				
OC5	0.64	0.21	0.06				
OC6	0.64	0.21	0.06				
OC7	5.48	2.46	0.46				
OC8	0.64	0.21	0.06				
OC9	3.02	1.11	0.17				
OC10	3.02	1.11	0.17				
OC11	3.02	1.11	0.17				
OC12	6.04	2.72	0.50				
OC13	0.71	0.23	0.07				
PS-L	0.07	0.03	0.004				
PS-U	0.07	0.03	0.004				
AC	22.23	22.23	22.23				2.86
EW	0.31	0.31	0.31				
MR	0.006	0.006	0.006				
MF	0.89	0.89	0.89				
CKD	1.84	1.84	1.84	0.53	0.05	0.48	
LS1	0.48	0.18	0.03				
LS2	0.86	0.38	0.06				
LS3	3.97	1.38	0.21				
LS4	0.86	0.38	0.06				
LS5	3.97	1.38	0.21				
LS6	0.48	0.18	0.03				
LSBM	6.42	5.39	1.92				
LS7	0.48	0.18	0.03				
LS8	0.48	0.18	0.03				
LS9	0.12	0.05	0.01				
LS10	0.12	0.05	0.01				
LS11	1.03	0.36	0.06				
LS12	0.12	0.05	0.01				
LS-L	0.02	0.02	0.02				
LS-U	0.002	0.002	0.002				
LK	3.40	3.40	3.40	11.79	6.29		0.03
LCR	1.06	0.89	0.32				
LS1-L	0.002	0.001	0.0001				
LS1-U	0.01	0.006	0.001				
MillS2-L	0.002	0.001	0.0001				
MillS2-U	0.01	0.006	0.001				
ACS1-L	0.009	0.003	0.0004				
ACS1-U	0.04	0.02	0.004				
ACS2-L	0.009	0.003	0.0004				
ACS2-U	0.04	0.02	0.004				
ACS3-L	0.009	0.003	0.0004				
ACS3-U	0.04	0.02	0.004				
ACS4-L	0.004	0.001	0.0002				

Table 3 POST-PROJECT POTENTIAL TO EMIT FOR CRITERIA AIR POLLUTANTS

Source	PM	PM_{10}	$PM_{2.5}$	CO	NO_x	VOC	SO_2
	T/yr [(a)a)]	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]
ACS4-U	0.02	0.01	0.002				
PCSP1	2.74	1.02	0.13				
PCSP2	2.74	1.02	0.13				
CM	0.55	0.17	0.02				
CS1-L	0.03	0.01	0.002				
CS1-U	0.14	0.08	0.01				
CS2-L	0.03	0.01	0.002				
CS2-U	0.14	0.08	0.01				
CA-L	1.73	0.83	0.13				
CA-U	1.73	0.83	0.13				
ACB	0.002	0.002	0.002	0.02	0.04	0.002	0.004
CKB	0.08	0.08	0.08	0.81	1.40	0.09	0.17
PV	0.003	0.003	0.003	0.04	0.06	0.004	0.008
HS	0.17	0.17	0.17	1.80	3.11	0.19	0.38
LKC	0.63	0.63	0.63	6.72	11.65	0.72	1.42
H1M	0.13	0.13	0.13	1.44	2.49	0.15	0.30
H2M	0.13	0.13	0.13	1.44	2.49	0.15	0.30
HM	0.13	0.13	0.13	1.44	2.49	0.15	0.30
HAC	0.008	0.008	0.008	0.09	0.16	0.01	0.02
HR	0.008	0.008	0.008	0.09	0.16	0.01	0.02
HA	0.008	0.008	0.008	0.09	0.16	0.01	0.02
HMO	0.02	0.02	0.02	0.18	0.31	0.02	0.04
HTS	0.07	0.07	0.07	0.72	1.24	0.08	0.15
HW	0.10	0.10	0.10	1.08	1.87	0.12	0.23
EDG1	0.02	0.02	0.02	0.39	0.71	0.14	0.001
EDG2	0.02	0.02	0.02	0.39	0.71	0.14	0.001
EDG3	0.02	0.02	0.02	0.39	0.71	0.14	0.001
EDFP	0.004	0.004	0.004	0.08	0.09	0.09	0.0001
TG1–TG2						1.91	
TD3—TD10						0.06	
Post-Project PTE [(c)]	**86.6**	**55.7**	**35.8**	**29.5**	**36.2**	**4.7**	**6.3**
FUGITIVE EMISSIONS							
Blasting activities	117.35	61.02	3.52	635.83	17.08		0.03
Drilling activities	284.70	148.04	8.54				
Hauling	2901.27	712.95	71.29				
Material load / unload (L/UL) [(b)]	15.00	7.10	1.07				
Dozing	103.56	19.78	10.87				
Grading	36.80	11.04	1.14				
Water Truck Travel	109.27	26.85	2.69				
Access Roads	6.95	1.72	0.17				
Wind Erosion [(b)]	5.72	2.86	0.43				
Surface Exploration	1.12	0.39	0.06				
Underground Exploration	0.002	0.001	0.0001				
Fugitive Total [(b)]	**3,569**	**986**	**100**	**636**	**17.1**		**0.03**

a) Controlled average emission rate in tons per year is an annual average, based on the proposed annual operating scenarios and annual limits.

b) Estimated emissions from the "W3" scenario resulted in the most emissions across most activities, with the exception of material load/unload and wind erosion activities, which occurred in the Y1, H1, W1, and B1 scenarios. Totals reported are for the "W3" scenario.

c) In the response to a request for additional information, Midas Gold confirmed that antimony process dryer and bagging operation emission sources (Sb1 and Sb2) initially proposed would be replaced by a dewatering/packaging circuit. As a result, these emission sources have been removed from the permit and post-project PTE.

Fourteen operational scenarios were evaluated by the applicant and verified by DEQ in order to estimate maximum hourly, daily, and annual potential emissions from sources. These scenarios encompassed all feasible origin and destination location combinations for locating ore and development rock. A summary of these scenarios is provided in Table 4. Although drilling, blasting, excavating, and hauling activities are not expected to be confined to a single scenario in practice, emissions in each scenario were conservatively estimated at the maximum daily proposed processing rate (180,000 of ore and rock) to allow for maximum operational flexibility, and to evaluate potential air quality impacts. Scenarios having the greatest potential emissions (i.e., the top seven) were those with the longest origin-to-destination distances, which resulted in increased emissions evident in onsite hauling and material loading and unloading activities. Consequently, the W3 scenario having the maximum origin-to-destination distance (16,415 daily vehicle miles traveled) is representative of maximum potential emissions.

Table 4 OPERATING SCENARIOS

Scenario	Origin [a]	Destination [a]
Y1	YPP	STKP
Y2	YPP	FDRSF
Y3	YPP	HFDRSF
H1	HFP	STKP
H2	HFP	FDRSF
H3	HFP	HFDRSF
H4	HFP	YPDRSF
W1	WEP	STKP
W2	WEP	FDRSF
W3	WEP	HFDRSF
W4	WEP	YPDRSF
W5	WEP	WEDRSF
B1	BT	STKP
B2	BT	HFDRSF

a) Where ore and rock origin and destination locations as depicted in Figure 1 are abbreviated as follows:
YPP = Yellow Pine Pit, HFP = Hangar Flats pit, WEP = West End pit, BT = Bradley Tailings, STKP = Primary Crusher Stockpile, FDRSF = Fiddle DRSF, HFDRSF = Hangar Flats DRSF, YPDRSF = Yellow Pine DRSF, WEDRSF = West End DRSF, and DRSF = development rock storage facilities.

There are numerous sources of fugitive dust emissions at the facility, including drilling and blasting activities, crushing and ore handling equipment, ore and rock storage piles, and unpaved roadways. Calculated at maximum daily processing rates, emissions from these sources would tend to be conservatively estimated. But it is also recognized that uncertainties exist in some of the emission factors used, and that predicted modeled impacts may be sensitive to emissions from such sources. In particular, it may prove challenging to consistently and continuously achieve the targeted level of fugitive dust control for emissions from traffic on unpaved roadways, with over 55 miles of haul truck routes within the mining operations boundary, a fleet of 32 haul trucks weighing between 37 and 357 tons, and a targeted dust control efficiency of 93.3% accomplished by application of both dust suppressant and water controls. Based on this, and the scale of operations, a detailed Fugitive Dust Control Plan (FDCP) was required (Permit Conditions 2.6). It is noted that Midas Gold projected actual annual production at approximately 42.7 million T/yr, or 65% of the permitted annual production limit of 65.7 million T/yr (Permit Condition 3.5), and that as a result actual emissions are expected to be lower than presented.

Change in PTE

The change in facility-wide PTE is used to determine if a public comment period may be required and to determine the processing fee per IDAPA 58.01.01.225. The following table presents the facility-wide change in the potential to emit for criteria pollutants, which for a new source is equivalent to the facility-wide and post-project PTE.

Table 5 CHANGES IN PTE FOR REGULATED AIR POLLUTANTS

Source	PM	PM_{10}	$PM_{2.5}$	CO	NO_x	VOC	SO_2
	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]	T/yr [(a)]
Changes in Potential to Emit	**86.6**	**55.7**	**35.8**	**29.5**	**36.2**	**4.70**	**6.30**

Controlled Hazardous and Toxic Air Pollutant Emissions

Table 6 POTENTIAL TO EMIT FOR HAZARDOUS & TOXIC AIR POLLUTANTS (HAP/TAP) [a]

HAP/TAP	Mining and Leaching Emissions		Processing and Production Emissions		Facility-Wide Total Emissions		Adjusted TAP Emissions	Screening Emission Level
	lb/hr [b]	T/yr [c]	lb/hr [b]	T/yr [c]	lb/hr [b]	T/yr [c]	lb/hr [b,d]	lb/hr [d]
1,3-Butadiene [e]	0	0	8.4E-07	3.7E-06	8.4E-07	3.7E-06	0	2.4E-05
2-Methylnaphthalene [e,f]	0	0	1.1E-06	4.6E-06	1.1E-06	4.6E-06	0	9.1E-05
3-Methylcholanthrene [e]	0	0	7.8E-08	3.4E-07	7.8E-08	3.4E-07	3.2E-08	2.5E-06
7,12-Dimethylbenz(a)anthracene [e,f]	0	0	7.6E-07	3.0E-06	7.6E-07	3.0E-06	0	9.1E-05
Acenaphthene [e,f]	0	0	5.7E-06	7.1E-06	5.7E-06	7.1E-06	0	9.1E-05
Acenaphthylene [e,f]	0	0	1.1E-05	1.4E-05	1.1E-05	1.4E-05	0	9.1E-05
Acetaldehyde [e]	0	0	2.5E-05	1.1E-04	2.5E-05	1.1E-04	0	3.0E-03
Acrolein	0	0	1.6E-05	2.0E-05	1.6E-05	2.0E-05	0	0.017
Anthracene [e,f]	0	0	1.7E-06	2.4E-06	1.7E-06	2.4E-06	0	9.1E-05
Antimony	0.019	0.082	5.7E-04	2.5E-03	0.019	0.085	0	0.033
Arsenic [e]	0.544	2.381	4.5E-03	0.020	0.548	2.400	**5.7E-06**	1.5E-06
Benzene [e]	0	0	7.4E-03	0.032	7.4E-03	0.032	3.8E-05	8.0E-04
Benzo(a)pyrene [e,f]	0	0	1.4E-07	6.1E-07				
Benz(a)anthracene [e,f]	0	0	3.1E-07	1.4E-06				
Benzo(b)fluoranthene [e,f]	0	0	4.4E-07	1.9E-06				
Benzo(k)fluoranthene [e,f]	0	0	1.5E-07	6.6E-07	2.0E-06	8.8E-06	2.0E-07	2.0E-06
Chrysene [e,f]	0	0	5.8E-07	2.5E-06				
Dibenz(a,h)anthracene [e,f]	0	0	1.8E-07	7.7E-07				
Indeno(1,2,3-cd)pyrene [e,f]	0	0	2.2E-07	9.6E-07				
Benzo(g,h,i)perylene [e,f]	0	0	7.5E-07	1.1E-06	7.5E-07	1.1E-06	0	9.1E-05
Beryllium [e]	2.6E-03	0.011	4.3E-04	1.9E-03	3.0E-03	0.013	2.3E-07	2.8E-05
Biphenyl	0	0	4.4E-05	1.9E-04	4.4E-05	1.9E-04	0	0.1
Cadmium [e]	4.1E-04	1.8E-03	4.6E-04	2.0E-03	8.7E-04	3.8E-03	**2.0E-05**	3.7E-06
Carbon disulfide	0.014	0.063	0	0	0.014	0.063	0	2
Chromium	7.3E-03	0.032	6.8E-04	2.8E-03	8.0E-03	0.035	2.7E-05	0.033
Chromium (VI) [e]	0	0	3.4E-07	1.5E-06	3.4E-07	1.5E-06	3.4E-07	5.6E-07
Cobalt	3.3E-03	0.014	4.7E-04	2.0E-03	3.7E-03	0.016	1.5E-06	3.3E-03
Cyanide	0.453	1.983	1.2E-03	5.3E-03	0.454	1.988	0	0.333
Dichlorobenzene	0	0	5.7E-05	2.3E-04	5.7E-05	2.3E-04	2.1E-05	20 [j]
Fluoranthene [e,f]	0	0	5.5E-06	7.0E-06	5.5E-06	7.0E-06	0	9.1E-05
Fluorene [e,f]	0	0	1.7E-05	2.1E-05	1.7E-05	2.1E-05	0	9.1E-05
Formaldehyde [e]	0	0	3.3E-03	0.015	3.3E-03	0.015	**1.3E-03**	5.1E-04
Hexane	0	0	0.117	0.480	0.117	0.48	0.032	12
Hydrogen Chloride	0	0	0.986	3.666	0.986	**3.666**	0	0.05
Lead	6.5E-03	0.029	4.8E-04	2.1E-03	7.0E-03	0.031	0	
Manganese	0.244	1.067	4.6E-03	0.017	0.248	1.085	3.6E-05	0.067
Mercury [g]	1.3E-03	5.7E-03	7.1E-04	2.9E-03	*< 0.028*	*< 0.122*	*0.041 lb/yr*	*25 lb/yr*
Naphthalene	0	0	2.1E-03	8.8E-03	2.1E-03	8.8E-03	1.1E-05	3.33
Nickel [e]	1.6E-03	7.1E-03	5.5E-04	2.4E-03	2.2E-03	9.5E-03	**4.0E-05**	2.7E-05
Phenanthrene [e,f]	0	0	5.1E-05	6.3E-05	5.1E-05	6.3E-05	0	9.1E-05
Phenol	0	0	2.4E-04	1.1E-03	2.4E-04	1.1E-03	0	1.27
Phosphorus	0.53	2.32	5.6E-03	0.023	0.535	2.343	8.2E-06	7.0E-03
Pyrene [e,f]	0	0	5.0E-06	6.6E-06	5.0E-06	6.6E-06	0	9.1E-05
Selenium	3.3E-04	1.4E-03	4.1E-04	1.8E-03	7.4E-04	3.2E-03	4.3E-07	0.013
Toluene	0	0	0.032	0.139	0.032	0.139	6.1E-05	25
Xylene	0	0	0.032	0.138	0.032	0.138	0	29
Total HAP [h]	1.83	8.00	1.20	4.57	3.05	12.68	0.03	

Table 6 POTENTIAL TO EMIT FOR HAZARDOUS & TOXIC AIR POLLUTANTS (HAP/TAP) [a]

HAP/TAP	Mining and Leaching Emissions		Processing and Production Emissions		Facility-Wide Total Emissions		Adjusted TAP Emissions	Screening Emission Level
	lb/hr [b]	T/yr [c]	lb/hr [b]	T/yr [c]	lb/hr [b]	T/yr [c]	lb/hr [b,d]	lb/hr [d]
Aluminum [i]	57.855	253	0.648	2.577	58.504	256	**58.504**	0.667
Barium [i]	0.652	2.855	6.8E-03	0.028	0.659	2.883	**0.659**	0.033
Calcium Carbonate [i]	11.408	49.967	2.244	8.125	13.652	58.092	**13.652**	0.667
Calcium Oxide [i]	0	0	0.696	0.952	0.696	0.952	**0.696**	0.133
Copper [i]	4.1E-03	0.018	5.3E-04	2.2E-03	4.6E-03	0.020	0.0046	0.067
Cyclohexane [i]	0	0	1.0E-03	4.6E-03	1.0E-03	4.6E-03	0.0010	70
Hydrogen Sulfide [i]	0	0	0.900	3.942	0.900	3.942	0.900	0.933
Iron [i]	14.831	64.958	0.213	0.812	15.043	65.770	**15.043**	0.067
Molybdenum [i]	8.1E-04	3.6E-03	4.7E-04	2.0E-03	1.3E-03	5.6E-03	0.0013	0.333
Pentane [i]	0	0	0.123	0.495	0.123	0.495	0.123	118
Silver [i]	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.2E-4	3.6E-03	0.00082	7.0E-03
Sulfuric Acid [i]	0	0	2.030	8.891	2.030	8.891	**2.030**	0.067
Thallium [i]	8.1E-03	0.036	5.2E-04	2.2E-03	8.7E-03	0.038	**0.0087**	0.007
Uranium [i]	8.1E-03	0.036	5.2E-04	2.2E-03	8.7E-03	0.038	0.0087	0.013
Vanadium [i]	0.023	0.100	8.4E-04	3.5E-03	0.024	0.103	**0.024**	0.003
Trimethyl Benzene [i]	0	0	0.011	0.048	0.011	0.048	0.011	8.2
Tungsten [i]	8.1E-03	0.036	5.2E-04	2.2E-03	8.7E-03	0.038	0.0087	0.333
Zinc [i]	0.029	0.125	2.2E-03	8.8E-03	0.031	0.134	0.031	0.667

a) HAP and TAP PTE emissions estimates are for the highest emissions year Scenario W3, referenced from Table B1-W3 of Appendix B to the HAP/TAP addendum and 'TblB1' worksheet in the supporting spreadsheet. Process and production activities include ore processing; ore concentration and refining; process heating; aggregate production; concrete production; heating, ventilation, and air conditioning (HVAC); emergency power generation and fire suppression; and fuel storage. Mining and leaching activities include drilling, blasting, excavating, hauling, prill silos, rock dumps and storage piles, and tailings.
b) Controlled average emissions rates in pounds per hour (lb/hr). Emissions rates for non-carcinogens are daily averages, based on the proposed daily operating scenarios and limits. Emissions rates for carcinogens are annual averages, based on the proposed annual operating scenarios and limits.
c) Controlled average emissions rates in tons per year (T/yr) are annual averages, based on the proposed annual operating scenarios and annual limits.
d) Adjusted TAP emissions and screening emission levels (EL) as specified in IDAPA 58.01.01.585-586 for purposes of TAP preconstruction compliance demonstrations. For TAP, adjusted emissions do not include sources addressed by NSPS and NESHAP in accordance with IDAPA 58.01.01.210.20Table 8.
e) Carcinogenic TAP as identified in IDAPA 58.01.01.586.
f) Polycyclic aromatic hydrocarbon (PAH). The group of seven PAH with a single EL are regulated as polycyclic organic matter (POM) equivalent in potency to benzo(a)pyrene as specified in IDAPA 58.01.01.586.
g) Adjusted mercury emissions (which are not TAP) are reported in pounds per year (lb/yr) and do not include fugitive sources and sources addressed by NESHAP 40 CFR 63 for comparison to the Mercury Emission Standard threshold of 25 lb/yr. Facility-wide mercury PTE emission rates were calculated as annual average based on federally-enforceable NESHAP Subpart EEEEEEE limits, and exceed values referenced from Table B1-W3 of Appendix B to the HAP/TAP addendum and 'TblB1' worksheet in the supporting spreadsheet (which account for the proposed mercury control devices for refinery process sources AC, EW, MR, MF, CKD).
h) Total hazardous air pollutant (HAP) emissions from all permitted sources and activities (combined). The maximum potential emissions of any single HAP is hydrogen chloride.
i) Toxic air pollutant that is not also a hazardous air pollutant (i.e., non-HAP TAP) and is not included in HAP totals.
j) Dichlorobenzene is regulated as both the ortho- and para- isomers (o-dichlorobenzene and 1,4-dichlorobenzene). For the purposes of TAP compliance, the lowest EL (and therefore most conservative) is listed.

HAP and TAP particulate metals are indirectly regulated via facility-wide fugitive dust requirements for particulate matter (PM) (Permit Conditions 2.1–2.8, 3.9, 5.9), material throughput and operational limits (Permit Conditions 3.3–3.8, 4.7–4.12, 5.4–5.8, 6.2), PM emission limits (Permit Conditions 4.3, 5.3), control device requirements (Permit Conditions 3.10, 4.13–4.17, 5.9–5.15), and associated testing, monitoring, recordkeeping, and reporting requirements. Because usage of process reagents were not correlated to material throughput rates and not otherwise inherently limited, HAP emissions limits and usage limits were established for potassium amyl xanthate (PAX) and sodium cyanide (Permit Conditions 4.4–4.6). Cyanide emissions were sensitive to leachant concentration and basicity, and monitoring of these parameters was established (Permit Condition 4.5) to ensure compliance with the emission limit. Monitoring of these limits and process parameters also ensure compliance with the major threshold for each individual HAP of 10 tons per year (T/yr).

Ambient Air Quality Impact Analyses

The applicant has demonstrated preconstruction compliance to DEQ's satisfaction that emissions from this facility will not cause nor significantly contribute to a violation of any ambient air quality standard. The applicant has also demonstrated preconstruction compliance to DEQ's satisfaction that the emissions increase due to this permitting action will not exceed any acceptable ambient concentration (AAC) or acceptable ambient concentration for carcinogens (AACC) for toxic air pollutants (TAP). A summary of the Ambient Air Impact Analysis for TAP is provided in Appendix B.

As presented in the modeling memorandum in Appendix B, the estimated emission rates of PM_{10}, $PM_{2.5}$, SO_2, CO, NO_x, and certain TAP from this project exceeded applicable screening emission levels (EL) and published DEQ modeling thresholds established in IDAPA 58.01.01.585-586 and in the State of Idaho Air Quality Modeling Guideline.[12] The facility-wide emission rate of lead (Pb) was determined to be below the "below regulatory concern" (BRC) threshold level of less than 10% of the "significant" emission rate defined in IDAPA 58.01.01.006 (i.e., less than 0.06 T/yr) and therefore modeling was not required.[12] Refer to the Emissions Inventories section for additional information concerning the emissions inventories.

New and updated TAP increment compliance demonstrations[4] were provided after evaluation of fugitive particulate TAP emissions from emission sources (Table 6) as identified in public comments and in a response and HAP/TAP addendum to the application provided by Midas Gold.[2] For non-HAP TAP, all sources were evaluated for TAP compliance by comparison of facility-wide emissions to applicable screening emission levels (EL). After exclusion of sources addressed by NSPS and NESHAP (Table 8), applicable concrete production and HVAC emission sources were evaluated for HAP TAP compliance by comparison of adjusted emissions to applicable EL. Refer to the Emissions Inventories section for estimates of HAP and TAP emissions (as summarized in Table 6) and to the Subsection 210.20 (IDAPA 58.01.01.210.20) section for relevant guidance and discussion of sources addressed by NSPS and NESHAP. With the exception of 12 TAP, estimated emission increases of non-carcinogenic and carcinogenic TAP demonstrated preconstruction compliance with TAP standards in accordance with IDAPA 58.01.01.210.07 using controlled average emission rates. Modeling analyses conducted in the development of TAP rules supports that if controlled average emission rates do not exceed applicable screening emission levels (EL) in IDAPA 58.01.01.585–586, controlled ambient concentrations are expected to be below the applicable acceptable ambient concentration (AAC/AACC).

Estimated emission increases of aluminum, arsenic, barium, cadmium, calcium carbonate, calcium oxide, formaldehyde, iron, nickel, sulfuric acid, thallium, and vanadium (12 TAP) demonstrated preconstruction compliance with TAP standards in accordance with IDAPA 58.01.01.210.08 for controlled ambient concentrations. Modeling analyses demonstrated preconstruction compliance with the acceptable ambient concentrations for these TAP (AAC/AACC) in IDAPA 58.01.01.585–586. Emission limits (Permit Condition 4.3), operational and material throughput limits (Permit Conditions 3.3–3.8, 4.5–4.12, and 5.4–5.8), fugitive dust control requirements (Permit Conditions 2.1–2.8), and control equipment requirements (Permit Conditions 2.6, 3.9–3.11, 4.13–4.17, and 5.9–5.15) limit these TAP emissions in accordance with IDAPA 58.01.01.210.08.c, limit Pb to BRC, and limit PM, PM_{10} ,and $PM_{2.5}$ to below the emission rates relied upon in the NAAQS evaluation of ambient air impacts in the modeling analyses.

Arsenic represented the single greatest HAP TAP emission; adjusted arsenic HAP TAP emissions at 5.7E-06 pounds per hour (lb/hr) did not exceed 2% of the applicable EL. Iron (Fe) represented the greatest single non-HAP TAP emission at over 15 lb/hr, which did not exceed 15% of the applicable EL. Any uncertainties in metal TAP emission estimates are not expected to affect compliance with TAP provisions.

It was recognized that accurately defining the mining operations boundary and controlling public access within that boundary was critical to estimating ambient air impacts. To ensure operation consistent with the defined mining operations boundary, site-specific access control measures will be employed. Midas Gold has committed

[12] Criteria pollutant thresholds in Table 2, State of Idaho Guideline for Performing Air Quality Impact Analyses, Doc ID AQ-011, September 2013, criteria pollutant BRC thresholds as provided in IDAPA 58.01.01.221.01, and DEQ guidance pertaining to BRC (2014ACF3).

to identifying and complying with these site-specific access control measures in an Access Management Plan (AMP, as required by Permit Condition 2.7).[13] Refer to Appendix E for a description and discussion of the mining operations boundary and control measures that may be included in this plan.

An ambient air quality impact analyses document has been crafted by DEQ based on a review of the modeling analysis submitted in the application. That document is part of the final permit package for this permitting action (refer to Appendix B). Refer to the Emissions Inventories section and Appendix A for additional information concerning development of the emissions inventories.

REGULATORY ANALYSIS

Attainment Designation (40 CFR 81.313)

The facility is located in Valley County, which is designated as attainment or unclassifiable for $PM_{2.5}$, PM_{10}, SO_2, NO_2, CO, and Ozone. Refer to 40 CFR 81.313 for additional information.

Facility Classification

The AIRS/AFS facility classification codes are as follows:

For HAP (hazardous air pollutants) only:

A = Use when any one HAP has permitted emissions > 10 T/yr or if the aggregate of all HAP (Total HAP) has permitted emissions > 25 T/yr.

SM80 = Use if a synthetic minor (uncontrolled HAP emissions are > 10 T/yr or if the aggregate of all uncontrolled HAP (Total HAP) emissions are > 25 T/yr and permitted emissions fall below applicable major source thresholds) and the permit sets limits > 8 T/yr of a single HAP or ≥ 20 T/yr of Total HAP.

SM = Use if a synthetic minor (uncontrolled HAP emissions are > 10 T/yr or if the aggregate of all uncontrolled HAP (Total HAP) emissions are > 25 T/yr and permitted emissions fall below applicable major source thresholds) and the permit sets limits < 8 T/yr of a single HAP and/or < 20 T/yr of Total HAP.

B = Use when the potential to emit (i.e. uncontrolled emissions and permitted emissions) are below the 10 and 25 T/yr HAP major source thresholds.

UNK = Class is unknown.

For All Other Pollutants:

A = Use when permitted emissions of a pollutant are > 100 T/yr.

SM80 = Use if a synthetic minor for the applicable pollutant (uncontrolled emissions are > 100 T/yr and permitted emissions fall below 100 T/yr) and permitted emissions of the pollutant are ≥ 80 T/yr.

SM = Use if a synthetic minor for the applicable pollutant (uncontrolled emissions are > 100 T/yr and permitted emissions fall below 100 T/yr) and permitted emissions of the pollutant are < 80 T/yr.

B = Use when the potential to emit (i.e. uncontrolled emissions and permitted emissions) are below the 100 T/yr major source threshold.

UNK = Class is unknown.

[13] Attachment 2 – Stibnite Road Access Management Plan to the Stibnite Gold Project Permit to Construct Application, Midas Gold, revised June 23, 2020 (2020AAG1078).

Table 7 REGULATED AIR POLLUTANT FACILITY CLASSIFICATION

Pollutant	Uncontrolled PTE (T/yr)	Permitted PTE (T/yr)	Major Source Thresholds (T/yr)	AIRS/AFS Classification
PM	560	86.6	**100**	SM80
PM_{10}	337	55.7	**100**	SM
$PM_{2.5}$	164	35.8	**100**	SM
SO_2	6.27	6.3	**100**	B
NO_x	36.16	36.2	**100**	B
CO	29.47	29.5	**100**	B
VOC	4.68	4.7	**100**	B
HAP (single)	>20	3.666	**10**	SM
Total HAP	>25	12.68	**25**	SM

Based on the uncontrolled PTE summarized in Table 2 and controlled PTE summarized above and in Table 3, Table 6, and Appendix A, the permittee will be a "synthetic minor" source of PM, PM_{10}, $PM_{2.5}$, and HAP emissions for new source review and Title V (Tier I) permitting purposes. The uncontrolled PTE for the remaining criteria pollutants (SO_2, NO_x, CO, VOC) confirm Midas Gold will be a natural minor source for these emissions.

Permit to Construct (IDAPA 58.01.01.201)

The permittee has requested that a PTC be issued to the facility for the proposed new emission sources. Therefore, a permit to construct is required in accordance with IDAPA 58.01.01.201. This permitting action was processed in accordance with the procedures of IDAPA 58.01.01.200-228.

Tier II Operating Permit (IDAPA 58.01.01.401)

IDAPA 58.01.01.401 ..... Tier II Operating Permit

The application was submitted for a permit to construct (refer to the Permit to Construct (IDAPA 58.01.01.201) section), and an optional Tier II operating permit has not been requested. Therefore, the procedures of IDAPA 58.01.01.400–410 were not applicable to this permitting action.

Subsection 210.20 (IDAPA 58.01.01.210.20)

IDAPA 58.01.01.210.20..... NSPS and NESHAP Sources

No demonstration of compliance with the TAP provisions is required to obtain a PTC or to demonstrate PTC exemption criteria for a new source or for modification of an existing source if the TAP is also a listed HAP from:

- *The equipment or activity covered by a NSPS or NESHAP; or*
- *The source category of equipment or activity addressed by a NSPS or NESHAP even if the equipment or activity is not subject to compliance requirements under the federal rule.*

Emission sources covered or addressed by NSPS or NESHAP are identified in the following table, and guidance on interpretation of "addressed" is provided in Appendix F. Each emission source and activity listed in the table is addressed by the corresponding NSPS and NESHAP. For the sources identified, emissions of TAP that are also HAP (HAP TAP) were excluded from TAP compliance demonstrations (i.e., excluded from comparison to TAP EL and from modeling to demonstrate compliance with TAP AAC/AACC, as discussed in the Ambient Air Quality Impact Analyses).

Table 8 NSPS and NESHAP Sources

NESHAP / NSPS	Source Category Subject & Addressed	Sources
NESHAP Subpart ZZZZ [a] NSPS Subpart IIII	Any industry using a stationary internal combustion engine	*Emergency Power Generation* EDG1, EDG2, EDG3, EDFP
NESHAP Subpart AAAAA [a] NSPS Subpart HH	Any lime manufacturing plant	*Lime Production* LK, LKC, LS1–LS12, LSBM, LS-L/U, LCR, LS1-L/U, MillS2-L/U, and ACS1-4-L/U
NESHAP Subpart DDDDD [a] NESHAP Subpart JJJJJJ [a] NSPS Subpart Dc etc.	Any facility using a boiler or process heater (indirect fire)	*Process Heating* ACB, CKB, PV, HS [b]
NESHAP Subpart CCCCCC [a]	Any gasoline dispensing facility Includes any operation that transfers and stores gasoline	*Gasoline Fuel Storage and Dispensing* TG1–TG2
NESHAP Subpart EEEEEEE [a]	Gold ore mining Includes an establishment engaged in developing the mine site, mining, and/or beneficiating ores valued chiefly for their gold content, or in transformation of gold into bullion or doré bar in combination with mining activities	*Mining* drilling, blasting, excavating, hauling, prill silos, rock dumps and storage piles, tailings *Ore Processing* OC1–OC13 [b] *Ore Concentration and Refining* CIP Leach 1–4, CIL 1–6, CIP 1–6, CN Detox 1–2, AC, EW, MR, MF, CKD *Process Heating* ACB, CKB, PV, HS [b]
NSPS Subpart LL	Any metallic mineral plant Includes any combination of equipment that extracts aluminum, copper, gold, iron, lead, molybdenum, silver, titanium, tungsten, uranium, zinc, and zirconium	*Ore Processing* OC1–OC13 [b]
NSPS Subpart OOO	Any nonmetallic mineral plant Includes plants processing crushed and broken stone, crushed and broken limestone, lime plants, sand and gravel, clay, etc.	*Aggregate Production* PCSP1, PCSP2 *Concrete Production* CA-L/U *Lime Production* LK, LKC, LS1–LS12, LSBM, LS-L/U, LCR, LS1-L/U, MillS2-L/U, and ACS1-4-L/U [b]
Source category that may not be subject to and may not be addressed by NSPS or NESHAP		*Concrete Production* CM, CS1-L/U, CS2-L/U *Heating, Ventilation, and Air Conditioning* H1M–H2M, HM, HAC, HR, HA, HMO, HTS, HW

a) NESHAP in 40 CFR 63.
b) Ore Processing emission sources are addressed by both the gold ore mining and metallic mineral plant source categories, Process Heating emission sources are addressed by both the gold ore mining and boiler/process heater source categories, and Lime Production emission sources are addressed by both the lime production and nonmetallic mineral processing plant source categories.

After exclusion of sources addressed by NSPS and/or NESHAP, concrete production (central mixer, cement/shotcrete silos, aggregate bin) and heating, ventilation, and air conditioning (HVAC) units comprise the remaining sources that are applicable to compliance with TAP provisions. Emissions of each TAP from these sources (non-NESHAP-addressed) were estimated and compared to the applicable screening emission level (as summarized in Table 6).

Mercury Emission Standard (IDAPA 58.01.01.215)

IDAPA 58.01.01.215..... Mercury Emission Standard for New or Modified Sources

No owner or operator may commence construction or modification of a stationary source or facility that results in an increase in annual potential emissions of mercury of 25 pounds or more unless the owner or operator has obtained a PTC under Sections 200–228 of the Rules. The PTC application shall include an MBACT analysis for the new or modified source or sources for review and approval by DEQ. A determination of applicability under Section 215 shall be based upon the best available information.

Fugitive emissions shall not be included in a determination of applicability under Section 215.

New or modified stationary sources within a source category subject to 40 CFR 63 are exempt from the requirements of Section 215.

IDAPA 58.01.01.215 sets requirements for mercury emissions. For this standard, fugitive emissions and sources in a source category subject to 40 CFR 63 are exempt. As identified in Table 8, emission sources within a source category subject to NESHAP 40 CFR 63, including Subpart ZZZZ, Subpart AAAAA, Subpart CCCCCC, and Subpart EEEEEEE were therefore exempt from this standard. Although non-applicable to area sources of HAP such as Midas Gold, as a source category lime manufacturing plants are subject to NESHAP 40 CFR 63, Subpart AAAAA and associated sources (identified in Table 8) therefore exempt from this standard. Fugitive emissions from drilling, blasting, excavating, roadways (hauling), dozing, grading, storage piles, tailings and other fugitive and mobile emission sources were also exempt from this standard. Refer to the MACT/GACT Applicability (40 CFR 63) section for regulatory applicability analysis. No mercury emissions are expected from fuel storage, emergency power generation, and fire suppression sources.

After exclusion of sources within a source category subject to an area source NESHAP (40 CFR 63), aggregate production (crushers, screens, and conveyors), concrete production (aggregate bin), and heating, ventilation, and air conditioning (HVAC) units comprise the remaining sources that are applicable to the Mercury Emission Standard. Mercury emissions from these sources (non-fugitive and non-NESHAP-addressed) were estimated at less than 0.041 pounds per year (lb/yr), below the level at which MBACT review is required. Mercury emissions from propane combustion in HVAC sources are uncontrolled. Mercury emissions from materials processed in aggregate production and concrete production are controlled via water sprays and moisture carryover. As such controls are required for the portable crushing and screening plant, central mixer, and cement/shotcrete silos (Permit Conditions 2.1–2.8, 5.9, 5.10, and 5.15).

For the autoclave, electrowinning cells and pregnant solution tank, mercury retort, and induction melting furnace refinery sources (AC, EW, MR, MF) with enforceable NESHAP Subpart EEEEEEE mercury emission limits, potential emissions estimates (PTE) calculated consistent with these limits were included in the facility-wide mercury emission totals in Table 6. These values were substituted in lieu of the controlled emission estimates referenced from Table B1-W3 of Appendix B to the HAP/TAP addendum and 'TblB1' worksheet in the supporting spreadsheet. Although the mercury emissions from these sources are ultimately not included in the adjusted mercury emission totals for the purposes of the Mercury Emission Standard, these were used for the purposes of estimating HAP PTE consistent with enforceable limits.

Particulate Matter – New Equipment Process Weight Limitations (IDAPA 58.01.01.701)

IDAPA 58.01.01.701 ..... Particulate Matter – New Equipment Process Weight Limitations

IDAPA 58.01.01.700 through 703 set PM emission limits for process equipment based on when the piece of equipment commenced operation and the piece of equipment's process weight (PW) in pounds per hour (lb/hr). IDAPA 58.01.01.701 establishes PM emission limits for equipment that commenced operation on or after October 1, 1979.

For equipment commencing operation on or after October 1, 1979, the PM allowable emission rate (E) is based on one of the following equations:

IDAPA 58.01.01.701.01.a: If PW is $< 9{,}250$ lb/hr; $E = 0.045\ (PW)^{0.60}$

IDAPA 58.01.01.701.01.b: If PW is $\geq 9{,}250$ lb/hr; $E = 1.10\ (PW)^{0.25}$

For the new ore processing, ore concentration and refining, lime production, aggregate production, and concrete production equipment sources (Table 1) emissions (E) were calculated at the proposed maximum throughput rates (Table 1), and estimated emissions from all sources demonstrated compliance with this requirement. Compliance with operational and material throughput limits (Permit Conditions 3.3–3.8, 4.5–4.12, and 5.4–5.8) and control equipment requirements (Permit Conditions 2.6, 3.9–3.11, 4.13–4.17, and 5.9–5.15) assure compliance with this standard, resulting in much lower emission rates.

Title V Classification (IDAPA 58.01.01.300, 40 CFR Part 70)

IDAPA 58.01.01.301 ..... Requirement to Obtain Tier I Operating Permit

Any source subject to 40 CFR 63, Subpart EEEEEEE is a Tier I source as defined in IDAPA 58.01.01.006.122.c. In accordance with IDAPA 58.01.01.313.01.b., the permittee must submit a complete application to DEQ for an initial Tier I operating permit within 12 months of becoming a Tier I source.

Midas Gold has committed to applying for a Tier I permit. Detailed federal regulatory applicability were provided in the PTC application, and specific federally-applicable requirements will be incorporated into the Tier I. Refer to the NSPS Applicability (40 CFR 60), NESHAP Applicability (40 CFR 61), and MACT/GACT Applicability (40 CFR 63) sections below for additional information regarding applicable requirements.

Post-project facility-wide emissions from this facility do not have a PTE greater than 100 tons per year for criteria pollutants or 10 tons per year for any one HAP or 25 tons per year for all HAP combined as demonstrated previously in the Emissions Inventories section of this analysis. Although not a major facility as defined in IDAPA 58.01.01.008.10, any source subject to 40 CFR 63, Subpart EEEEEEE is a Tier I source as defined in IDAPA 58.01.01.006.122.c. In accordance with IDAPA 58.01.01.313.01.b., the permittee must submit a complete application to DEQ for an initial Tier I operating permit within 12 months of becoming a Tier I source. Refer to the NESHAP Applicability (40 CFR 61) section for additional discussion of Subpart EEEEEEE applicability.

Permit Condition 2.24 incorporates the requirement to obtain a Tier I permit in accordance with IDAPA 58.01.01.313.01.b.

PSD Classification (40 CFR 52.21)

40 CFR 52.21 ..... Prevention of Significant Deterioration of Air Quality

The facility is not a major stationary source as defined in 40 CFR 52.21(b)(1), nor is it undergoing any physical change at a stationary source not otherwise qualifying under paragraph 40 CFR 52.21(b)(1) as a major stationary source which would constitute a major stationary source by itself as defined in 40 CFR 52. PSD requirements were therefore not applicable to this permitting action in accordance with 40 CFR 52.21(a)(2).

The facility includes a lime manufacturing plant (LMP) that uses a Parallel Flow Regenerative Shaft Kiln (LK, LKC) to produce lime product from limestone by calcination, which is a designated facility as defined in 40 CFR 52.21(b)(1)(i)(a). For each criteria pollutant, LMP emissions do not exceed 100 T/yr and facility-wide emissions do not exceed 250 T/yr.

NSPS Applicability (40 CFR 60)

The permittee has affected facilities subject to New Source Performance Standards (NSPS). The POX Boiler (ACB) meets the definition of process heater rather than steam generating unit, and the use of a rotary lime kiln has not been proposed in the production of lime; therefore Subpart Dc and Subpart HH are not applicable. Initial regulatory applicability analyses and determinations are provided below; detailed analyses and explicit incorporation of applicable requirements is left to the required Tier I permit action as discussed in the Title V Classification (IDAPA 58.01.01.300, 40 CFR Part 70) section.

- Standards of Performance for New Stationary Sources (NSPS) 40 CFR 60, Subpart A – General Provisions. DEQ is delegated this Subpart.

- NSPS 40 CFR 60, Subpart LL – Standards of Performance for Metallic Mineral Processing Plants. DEQ is delegated this Subpart. Each crusher, conveyor belt transfer point, and truck unloading station is an affected facility.
- NSPS 40 CFR 60, Subpart OOO – Standards of Performance for Nonmetallic Mineral Processing Plants. DEQ is delegated this Subpart. Each crusher, grinding mill, screening operation, belt conveyor, and storage bin is an affected facility.
- NSPS 40 CFR 60, Subpart IIII – Standards of Performance for Stationary Compression Ignition Internal Combustion Engines. DEQ is delegated this Subpart. Each emergency generator engine and fire pump is an affected facility.

Emission sources regulated by Subpart LL, Subpart OOO, and Subpart IIII are identified in the incorporation of federal requirements condition (Permit Condition 2.22)

40 CFR 60, Subpart A ..... General Provisions

§60.1 ..... Applicability

(a) Except as provided in subparts B and C, the provisions of this part apply to the owner or operator of any stationary source which contains an affected facility, the construction or modification of which is commenced after the date of publication in this part of any standard (or, if earlier, the date of publication of any proposed standard) applicable to that facility.

(b) Any new or revised standard of performance promulgated pursuant to section 111(b) of the Act shall apply to the owner or operator of any stationary source which contains an affected facility, the construction or modification of which is commenced after the date of publication in this part of such new or revised standard (or, if earlier, the date of publication of any proposed standard) applicable to that facility.

Because the permittee will own or operate NSPS affected facilities, which have been proposed to commence construction after the date of publication of the relevant applicable NSPS standards (as listed above), general provisions in Subpart A are applicable.

40 CFR 60, Subpart A is incorporated by reference into Permit Condition 2.22, and specific applicable requirements will be incorporated into the Tier I operating permit.

40 CFR 60, Subpart Dc ..... Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units

§60.40c ..... Applicability and delegation of authority.

(a) Except as provided in paragraphs (d), (e), (f), and (g) of this section, the affected facility to which this subpart applies is each steam generating unit for which construction, modification, or reconstruction is commenced after June 9, 1989 and that has a maximum design heat input capacity of 29 megawatts (MW) (100 million British thermal units per hour (MMBtu/h)) or less, but greater than or equal to 2.9 MW (10 MMBtu/h).

§60.41c ..... Definitions.

As used in this subpart, all terms not defined herein shall have the meaning given them in the Clean Air Act and in subpart A of this part.

...

Heat input *means heat derived from combustion of fuel in a steam generating unit and does not include the heat derived from preheated combustion air, recirculated flue gases, or exhaust gases from other sources (such as stationary gas turbines, internal combustion engines, and kilns).*

Heat transfer medium *means any material that is used to transfer heat from one point to another point.*

...

Process heater *means a device that is primarily used to heat a material to initiate or promote a chemical reaction in which the material participates as a reactant or catalyst.*

…

Steam generating unit *means a device that combusts any fuel and produces steam or heats water or heats any heat transfer medium. This term includes any duct burner that combusts fuel and is part of a combined cycle system. This term does not include process heaters as defined in this subpart.*

Although the Pressure Oxidation Boiler (POX Boiler) is between 10 and 100 MMBtu/hr in design heat input capacity (17 MMBtu/hr) and is proposed for construction after June 9, 1989, it meets the definition of process heater rather than steam generating unit, and therefore is not applicable to this subpart. The POX Boiler (ACB) is a device used to directly heat ore material via steam injection into the autoclave, to promote chemical oxidation reactions in which the heated ore participates as a reactant. DEQ is delegated this Subpart.

40 CFR 60, Subpart HH ..... Standards of Performance for Lime Manufacturing Plants

§60.340 ..... Applicability and designation of affected facility.

(a) The provisions of this subpart are applicable to each rotary lime kiln used in the manufacture of lime.

(b) The provisions of this subpart are not applicable to facilities used in the manufacture of lime at kraft pulp mills.

(c) Any facility under paragraph (a) of this section that commences construction or modification after May 3, 1977, is subject to the requirements of this subpart.

§60.341 ..... Definitions.

As used in this subpart, all terms not defined herein shall have the same meaning given them in the Act and in the General Provisions.

(a) Lime manufacturing plant *means any plant which uses a rotary lime kiln to produce lime product from limestone by calcination.*

(b) Lime product *means the product of the calcination process including, but not limited to, calcitic lime, dolomitic lime, and dead-burned dolomite.*

(c) Positive-pressure fabric filter *means a fabric filter with the fans on the upstream side of the filter bags.*

(d) Rotary lime kiln *means a unit with an inclined rotating drum that is used to produce a lime product from limestone by calcination.*

(e) Stone feed *means limestone feedstock and mill scale or other iron oxide additives that become part of the product.*

The use of a rotary lime kiln has not been proposed in the production of lime, and therefore the requirements of Subpart HH are not applicable. DEQ is delegated this Subpart.

40 CFR 60, Subpart LL ..... Standards of Performance for Metallic Mineral Processing Plants

§60.380 ..... Applicability and designation of affected facility.

(a) The provisions of this subpart are applicable to the following affected facilities in metallic mineral processing plants: Each crusher and screen in open-pit mines; each crusher, screen, bucket elevator, conveyor belt transfer point, thermal dryer, product packaging station, storage bin, enclosed storage area, truck loading station, truck unloading station, railcar loading station, and railcar unloading station at the mill or concentrator with the following exceptions. All facilities located in underground mines are exempted from the provisions of this subpart. At uranium ore processing plants, all facilities subsequent to and including the beneficiation of uranium ore are exempted from the provisions of this subpart.

(b) An affected facility under paragraph (a) of this section that commences construction or modification after August 24, 1982, is subject to the requirements of this part.

Because the permittee will own or operate a metallic mineral processing plant with a crusher at an open-pit mine; with crushers, conveyor belt transfer points, and truck unloading stations at the mill or concentrator; and because these are proposed to commence construction after August 24, 1982, requirements in Subpart LL are applicable.

40 CFR 60, Subpart LL is incorporated by reference into Permit Condition 2.22, and specific applicable requirements will be incorporated into the Tier I operating permit.

40 CFR 60, Subpart OOO ..... Standards of Performance for Nonmetallic Mineral Processing Plants

§60.670 ..... Applicability and designation of affected facility.

(a)(1) Except as provided in paragraphs (a)(2), (b), (c), and (d) of this section, the provisions of this subpart are applicable to the following affected facilities in fixed or portable nonmetallic mineral processing plants: each crusher, grinding mill, screening operation, bucket elevator, belt conveyor, bagging operation, storage bin, enclosed truck or railcar loading station. Also, crushers and grinding mills at hot mix asphalt facilities that reduce the size of nonmetallic minerals embedded in recycled asphalt pavement and subsequent affected facilities up to, but not including, the first storage silo or bin are subject to the provisions of this subpart.

(2) The provisions of this subpart do not apply to the following operations: All facilities located in underground mines; plants without crushers or grinding mills above ground; and wet material processing operations (as defined in §60.671).

(b) An affected facility that is subject to the provisions of subparts F or I of this part or that follows in the plant process any facility subject to the provisions of subparts F or I of this part is not subject to the provisions of this subpart.

(c) Facilities at the following plants are not subject to the provisions of this subpart:

(1) Fixed sand and gravel plants and crushed stone plants with capacities, as defined in §60.671, of 23 megagrams per hour (25 tons per hour) or less;

(2) Portable sand and gravel plants and crushed stone plants with capacities, as defined in §60.671, of 136 megagrams per hour (150 tons per hour) or less; and

(3) Common clay plants and pumice plants with capacities, as defined in §60.671, of 9 megagrams per hour (10 tons per hour) or less.

(d)(1) When an existing facility is replaced by a piece of equipment of equal or smaller size, as defined in §60.671, having the same function as the existing facility, and there is no increase in the amount of emissions, the new facility is exempt from the provisions of §§60.672, 60.674, and 60.675 except as provided for in paragraph (d)(3) of this section.

(2) An owner or operator complying with paragraph (d)(1) of this section shall submit the information required in §60.676(a).

(3) An owner or operator replacing all existing facilities in a production line with new facilities does not qualify for the exemption described in paragraph (d)(1) of this section and must comply with the provisions of §§60.672, 60.674 and 60.675.

(e) An affected facility under paragraph (a) of this section that commences construction, modification, or reconstruction after August 31, 1983, is subject to the requirements of this part.

(f) Table 1 of this subpart specifies the provisions of subpart A of this part 60 that do not apply to owners and operators of affected facilities subject to this subpart or that apply with certain exceptions.

Because the project contains crushers, grinding mills, screening operations, belt conveyors, and storage bins in a fixed or portable nonmetallic mineral processing plant, which are proposed to commence construction after August 31, 1983, requirements in Subpart OOO are applicable. The portable crushing and screening plants (PCSP1, PCSP2) will be rated at below 150 tons per hour (T/hr), and are therefore not subject to the provisions of Subpart OOO.

40 CFR 60, Subpart OOO is incorporated by reference into Permit Condition 2.22, and specific applicable requirements will be incorporated into the Tier I operating permit.

40 CFR 60, Subpart IIII..... Standards of Performance for Stationary Compression Ignition Internal Combustion Engines

§60.4200..... Am I subject to this subpart?

(a) The provisions of this subpart are applicable to manufacturers, owners, and operators of stationary compression ignition (CI) internal combustion engines (ICE) and other persons as specified in paragraphs (a)(1) through (4) of this section. For the purposes of this subpart, the date that construction commences is the date the engine is ordered by the owner or operator.

(1) Manufacturers of stationary CI ICE with a displacement of less than 30 liters per cylinder where the model year is:

(i) 2007 or later, for engines that are not fire pump engines;

(ii) The model year listed in Table 3 to this subpart or later model year, for fire pump engines.

(2) Owners and operators of stationary CI ICE that commence construction after July 11, 2005, where the stationary CI ICE are:

(i) Manufactured after April 1, 2006, and are not fire pump engines, or

(ii) Manufactured as a certified National Fire Protection Association (NFPA) fire pump engine after July 1, 2006.

(3) Owners and operators of any stationary CI ICE that are modified or reconstructed after July 11, 2005 and any person that modifies or reconstructs any stationary CI ICE after July 11, 2005.

(4) The provisions of §60.4208 of this subpart are applicable to all owners and operators of stationary CI ICE that commence construction after July 11, 2005.

(b) The provisions of this subpart are not applicable to stationary CI ICE being tested at a stationary CI ICE test cell/stand.

(c) If you are an owner or operator of an area source subject to this subpart, you are exempt from the obligation to obtain a permit under 40 CFR part 70 or 40 CFR part 71, provided you are not required to obtain a permit under 40 CFR 70.3(a) or 40 CFR 71.3(a) for a reason other than your status as an area source under this subpart. Notwithstanding the previous sentence, you must continue to comply with the provisions of this subpart applicable to area sources.

(d) Stationary CI ICE may be eligible for exemption from the requirements of this subpart as described in 40 CFR part 1068, subpart C (or the exemptions described in 40 CFR part 89, subpart J and 40 CFR part 94, subpart J, for engines that would need to be certified to standards in those parts), except that owners and operators, as well as manufacturers, may be eligible to request an exemption for national security.

(e) Owners and operators of facilities with CI ICE that are acting as temporary replacement units and that are located at a stationary source for less than 1 year and that have been properly certified as meeting the standards that would be applicable to such engine under the appropriate nonroad engine provisions, are not required to meet any other provisions under this subpart with regard to such engines.

Because the permittee will own or operate compression ignition (CI) internal combustion engines (ICE) which are proposed to commence construction after July 11, 2005 and which will be ordered after April 1, 2006 for the emergency generator engines, and which will be ordered after July 1, 2006 for the fire pump engine, requirements in Subpart IIII are applicable. The permittee has not requested or qualified for exemption pursuant to §60.4200(b), (d), or (e).

40 CFR 60, Subpart IIII is incorporated by reference into Permit Condition 2.22, and specific applicable requirements will be incorporated into the Tier I operating permit.

NESHAP Applicability (40 CFR 61)

The facility is not subject to any NESHAP requirements in 40 CFR 61.

MACT/GACT Applicability (40 CFR 63)

The permittee has proposed to operate as a minor source of hazardous air pollutant (HAP) emissions, and has affected facilities subject to the following National Emission Standards for Hazardous Air Pollutants (NESHAP). The lime manufacturing plant is proposed at an area source of HAP, and therefore is not applicable to Subpart AAAAA. The process boiler is at an area source of Applicability determinations and regulatory analyses are provided below.

- National Emission Standards for Hazardous Air Pollutants for Source Categories (NESHAP) 40 CFR 63, Subpart A – General Provisions. DEQ is delegated this Subpart for Tier I sources.
- NESHAP 40 CFR 63, Subpart ZZZZ – National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines (RICE). DEQ is delegated this Subpart. The emergency generator and fire pump engines (EDG1, EDG2, EDG3, and EDFP) are affected sources.
- NESHAP 40 CFR 63, Subpart CCCCCC – National Emission Standards for Hazardous Air Pollutants for Source Category: Gasoline Dispensing Facilities. DEQ is delegated this Subpart for Tier I sources. The gasoline fuel storage tanks (TG1, TG2) are affected sources.
- NESHAP 40 CFR 63, Subpart EEEEEEE – National Emission Standards for Hazardous Air Pollutants: Gold Mine Ore Processing and Production Area Source Category. DEQ is delegated this Subpart for Tier I sources. The collection of ore pretreatment processes and the carbon process with mercury retort are affected sources. Ore pretreatment processes include the autoclave (AC). Carbon processes with mercury retort include the electrowinning cells and pregnant solution tank (EW), the mercury retort (MR), induction melting furnace (MF), and the carbon regeneration kiln (CKD).

Emission sources regulated by Subpart EEEEEEE, Subpart CCCCCC, and Subpart ZZZZ are identified in the incorporation of federal requirements condition (Permit Condition 2.22)

40 CFR 63, Subpart A ..... General Provisions

§63.1 ..... Applicability.

(a) General. *(1) Terms used throughout this part are defined in §63.2 or in the Clean Air Act (Act) as amended in 1990, except that individual subparts of this part may include specific definitions in addition to or that supersede definitions in §63.2.*

(2) This part contains national emission standards for hazardous air pollutants (NESHAP) established pursuant to section 112 of the Act as amended November 15, 1990. These standards regulate specific categories of stationary sources that emit (or have the potential to emit) one or more hazardous air pollutants listed in this part pursuant to section 112(b) of the Act. This section explains the applicability of such standards to sources affected by them. The standards in this part are independent of NESHAP contained in 40 CFR part 61. The NESHAP in part 61 promulgated by signature of the Administrator before November 15, 1990 (i.e., the date of enactment of the Clean Air Act Amendments of 1990) remain in effect until they are amended, if appropriate, and added to this part.

(3) No emission standard or other requirement established under this part shall be interpreted, construed, or applied to diminish or replace the requirements of a more stringent emission limitation or other applicable requirement established by the Administrator pursuant to other authority of the Act (section 111, part C or D or any other authority of this Act), or a standard issued under State authority. The Administrator may specify in a specific standard under this part that facilities subject to other provisions under the Act need only comply with the provisions of that standard.

(4)(i) Each relevant standard in this part 63 must identify explicitly whether each provision in this subpart A is or is not included in such relevant standard.

(ii) If a relevant part 63 standard incorporates the requirements of 40 CFR part 60, part 61 or other part 63 standards, the relevant part 63 standard must identify explicitly the applicability of each corresponding part 60, part 61, or other part 63 subpart A (General) provision.

(iii) The General Provisions in this subpart A do not apply to regulations developed pursuant to section 112(r) of the amended Act, unless otherwise specified in those regulations.

…

(b) Initial applicability determination for this part. *(1) The provisions of this part apply to the owner or operator of any stationary source that—*

(i) Emits or has the potential to emit any hazardous air pollutant listed in or pursuant to section 112(b) of the Act; and

(ii) Is subject to any standard, limitation, prohibition, or other federally enforceable requirement established pursuant to this part.

(2) [Reserved]

(3) An owner or operator of a stationary source who is in the relevant source category and who determines that the source is not subject to a relevant standard or other requirement established under this part must keep a record as specified in §63.10(b)(3).

Because the permittee will own or operate stationary sources that emit HAP which are subject to standards, limitations, prohibitions, or other federally-enforceable requirements established pursuant to NESHAP, provisions in Subpart A are applicable.

40 CFR 63, Subpart A is incorporated by reference into Permit Condition 2.22, and specific applicable requirements will be incorporated into the Tier I operating permit.

40 CFR 63, Subpart ZZZZ..... National Emissions Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines

§63.6580..... What is the purpose of subpart ZZZZ?

Subpart ZZZZ establishes national emission limitations and operating limitations for hazardous air pollutants (HAP) emitted from stationary reciprocating internal combustion engines (RICE) located at major and area sources of HAP emissions. This subpart also establishes requirements to demonstrate initial and continuous compliance with the emission limitations and operating limitations.

§63.6585..... Am I subject to this subpart?

You are subject to this subpart if you own or operate a stationary RICE at a major or area source of HAP emissions, except if the stationary RICE is being tested at a stationary RICE test cell/stand.

(a) A stationary RICE is any internal combustion engine which uses reciprocating motion to convert heat energy into mechanical work and which is not mobile. Stationary RICE differ from mobile RICE in that a stationary RICE is not a non-road engine as defined at 40 CFR 1068.30, and is not used to propel a motor vehicle or a vehicle used solely for competition.

(b) A major source of HAP emissions is a plant site that emits or has the potential to emit any single HAP at a rate of 10 tons (9.07 megagrams) or more per year or any combination of HAP at a rate of 25 tons (22.68 megagrams) or more per year, except that for oil and gas production facilities, a major source of HAP emissions is determined for each surface site.

(c) An area source of HAP emissions is a source that is not a major source.

(d) If you are an owner or operator of an area source subject to this subpart, your status as an entity subject to a standard or other requirements under this subpart does not subject you to the obligation to obtain a permit under 40 CFR part 70 or 71, provided you are not required to obtain a permit under 40 CFR 70.3(a) or 40 CFR 71.3(a) for a reason other than your status as an area source under this subpart. Notwithstanding the previous sentence, you must continue to comply with the provisions of this subpart as applicable.

(e) If you are an owner or operator of a stationary RICE used for national security purposes, you may be eligible to request an exemption from the requirements of this subpart as described in 40 CFR part 1068, subpart C.

(f) The emergency stationary RICE listed in paragraphs (f)(1) through (3) of this section are not subject to this subpart. The stationary RICE must meet the definition of an emergency stationary RICE in §63.6675, which includes operating according to the provisions specified in §63.6640(f).

(1) Existing residential emergency stationary RICE located at an area source of HAP emissions that do not operate or are not contractually obligated to be available for more than 15 hours per calendar year for the purposes specified in §63.6640(f)(2)(ii) and (iii) and that do not operate for the purpose specified in §63.6640(f)(4)(ii).

(2) Existing commercial emergency stationary RICE located at an area source of HAP emissions that do not operate or are not contractually obligated to be available for more than 15 hours per calendar year for the purposes specified in §63.6640(f)(2)(ii) and (iii) and that do not operate for the purpose specified in §63.6640(f)(4)(ii).

(3) Existing institutional emergency stationary RICE located at an area source of HAP emissions that do not operate or are not contractually obligated to be available for more than 15 hours per calendar year for the purposes specified in §63.6640(f)(2)(ii) and (iii) and that do not operate for the purpose specified in §63.6640(f)(4)(ii).

Because the permittee will own or operate stationary RICE at an area source of HAP which are subject to standards, limitations, prohibitions, or other federally-enforceable requirements established pursuant to NESHAP, requirements in Subpart ZZZZ are applicable.

40 CFR 63, Subpart ZZZZ is incorporated by reference into Permit Condition 2.22, and specific applicable requirements will be incorporated into the Tier I operating permit.

40 CFR 63, Subpart AAAAA..... National Emission Standards for Hazardous Air Pollutants for Lime Manufacturing Plants

§63.7080..... What is the purpose of this subpart?

This subpart establishes national emission standards for hazardous air pollutants (NESHAP) for lime manufacturing plants. This subpart also establishes requirements to demonstrate initial and continuous compliance with the emission limitations.

§63.7081..... Am I subject to this subpart?

(a) You are subject to this subpart if you own or operate a lime manufacturing plant (LMP) that is a major source, or that is located at, or is part of, a major source of hazardous air pollutant (HAP) emissions, unless the LMP is located at a kraft pulp mill, soda pulp mill, sulfite pulp mill, beet sugar manufacturing plant, or only processes sludge containing calcium carbonate from water softening processes.

(1) An LMP is an establishment engaged in the manufacture of lime product (calcium oxide, calcium oxide with magnesium oxide, or dead burned dolomite) by calcination of limestone, dolomite, shells or other calcareous substances.

(2) A major source of HAP is a plant site that emits or has the potential to emit any single HAP at a rate of 9.07 megagrams (10 tons) or more per year or any combination of HAP at a rate of 22.68 megagrams (25 tons) or more per year from all emission sources at the plant site.

(b) [Reserved]

§63.7143..... What definitions apply to this subpart?

Terms used in this subpart are defined in the Clean Air Act, in §63.2, and in this section as follows:

...

Lime manufacturing plant (LMP) *means any plant which uses a lime kiln to produce lime product from limestone or other calcareous material by calcination.*

Lime product *means the product of the lime kiln calcination process including, calcitic lime, dolomitic lime, and dead-burned dolomite.*

Limestone *means the material comprised primarily of calcium carbonate (referred to sometimes as calcitic or high calcium limestone), magnesium carbonate, and/or the double carbonate of both calcium and magnesium (referred to sometimes as dolomitic limestone or dolomite).*

...

The lime manufacturing plant is proposed at an area source of HAP, and therefore is not subject to this Subpart.

40 CFR 60, Subpart CCCCCC..... National Emission Standards for Hazardous Air Pollutants for Source Category: Gasoline Dispensing Facilities

§63.11110..... What is the purpose of this subpart?

This subpart establishes national emission limitations and management practices for hazardous air pollutants (HAP) emitted from the loading of gasoline storage tanks at gasoline dispensing facilities (GDF). This subpart also establishes requirements to demonstrate compliance with the emission limitations and management practices.

§63.11111..... Am I subject to the requirements in this subpart?

(a) The affected source to which this subpart applies is each GDF that is located at an area source. The affected source includes each gasoline cargo tank during the delivery of product to a GDF and also includes each storage tank.

(b) If your GDF has a monthly throughput of less than 10,000 gallons of gasoline, you must comply with the requirements in §63.11116.

(c) If your GDF has a monthly throughput of 10,000 gallons of gasoline or more, you must comply with the requirements in §63.11117.

(d) If your GDF has a monthly throughput of 100,000 gallons of gasoline or more, you must comply with the requirements in §63.11118.

(e) An affected source shall, upon request by the Administrator, demonstrate that their monthly throughput is less than the 10,000-gallon or the 100,000-gallon threshold level, as applicable. For new or reconstructed affected sources, as specified in §63.11112(b) and (c), recordkeeping to document monthly throughput must begin upon startup of the affected source. For existing sources, as specified in §63.11112(d), recordkeeping to document monthly throughput must begin on January 10, 2008. For existing sources that are subject to this subpart only because they load gasoline into fuel tanks other than those in motor vehicles, as defined in §63.11132, recordkeeping to document monthly throughput must begin on January 24, 2011. Records required under this paragraph shall be kept for a period of 5 years.

(f) If you are an owner or operator of affected sources, as defined in paragraph (a) of this section, you are not required to obtain a permit under 40 CFR part 70 or 40 CFR part 71 as a result of being subject to this subpart. However, you must still apply for and obtain a permit under 40 CFR part 70 or 40 CFR part 71 if you meet one or more of the applicability criteria found in 40 CFR 70.3(a) and (b) or 40 CFR 71.3(a) and (b).

(g) The loading of aviation gasoline into storage tanks at airports, and the subsequent transfer of aviation gasoline within the airport, is not subject to this subpart.

(h) Monthly throughput is the total volume of gasoline loaded into, or dispensed from, all the gasoline storage tanks located at a single affected GDF. If an area source has two or more GDF at separate locations within the area source, each GDF is treated as a separate affected source.

(i) If your affected source's throughput ever exceeds an applicable throughput threshold, the affected source will remain subject to the requirements for sources above the threshold, even if the affected source throughput later falls below the applicable throughput threshold.

(j) The dispensing of gasoline from a fixed gasoline storage tank at a GDF into a portable gasoline tank for the on-site delivery and subsequent dispensing of the gasoline into the fuel tank of a motor vehicle or other gasoline-fueled engine or equipment used within the area source is only subject to §63.11116 of this subpart.

(k) For any affected source subject to the provisions of this subpart and another Federal rule, you may elect to comply only with the more stringent provisions of the applicable subparts. You must consider all provisions of the rules, including monitoring, recordkeeping, and reporting. You must identify the affected source and provisions with which you will comply in your Notification of Compliance Status required under §63.11124. You also must demonstrate in your Notification of Compliance Status that each provision with which you will comply is at least as stringent as the otherwise applicable requirements in this subpart. You are responsible for making accurate determinations concerning the more stringent provisions, and noncompliance with this rule is not excused if it is later determined that your determination was in error, and, as a result, you are violating this subpart. Compliance with this rule is your responsibility and the Notification of Compliance Status does not alter or affect that responsibility.

§63.11132..... What definitions apply to this subpart?

As used in this subpart, all terms not defined herein shall have the meaning given them in the Clean Air Act (CAA), or in subparts A and BBBBBB of this part. For purposes of this subpart, definitions in this section supersede definitions in other parts or subparts.

Dual-point vapor balance system *means a type of vapor balance system in which the storage tank is equipped with an entry port for a gasoline fill pipe and a separate exit port for a vapor connection.*

Gasoline *means any petroleum distillate or petroleum distillate/alcohol blend having a Reid vapor pressure of 27.6 kilopascals or greater, which is used as a fuel for internal combustion engines.*

Gasoline cargo tank *means a delivery tank truck or railcar which is loading or unloading gasoline, or which has loaded or unloaded gasoline on the immediately previous load.*

Gasoline dispensing facility (GDF) *means any stationary facility which dispenses gasoline into the fuel tank of a motor vehicle, motor vehicle engine, nonroad vehicle, or nonroad engine, including a nonroad vehicle or nonroad engine used solely for competition. These facilities include, but are not limited to, facilities that dispense gasoline into on- and off-road, street, or highway motor vehicles, lawn equipment, boats, test engines, landscaping equipment, generators, pumps, and other gasoline-fueled engines and equipment.*

Monthly throughput *means the total volume of gasoline that is loaded into, or dispensed from, all gasoline storage tanks at each GDF during a month. Monthly throughput is calculated by summing the volume of gasoline loaded into, or dispensed from, all gasoline storage tanks at each GDF during the current day, plus the total volume of gasoline loaded into, or dispensed from, all gasoline storage tanks at each GDF during the previous 364 days, and then dividing that sum by 12.*

Motor vehicle *means any self-propelled vehicle designed for transporting persons or property on a street or highway.*

Nonroad engine *means an internal combustion engine (including the fuel system) that is not used in a motor vehicle or a vehicle used solely for competition, or that is not subject to standards promulgated under section 7411 of this title or section 7521 of this title.*

Nonroad vehicle *means a vehicle that is powered by a nonroad engine, and that is not a motor vehicle or a vehicle used solely for competition.*

Submerged filling *means, for the purposes of this subpart, the filling of a gasoline storage tank through a submerged fill pipe whose discharge is no more than the applicable distance specified in §63.11117(b) from the bottom of the tank. Bottom filling of gasoline storage tanks is included in this definition.*

Vapor balance system *means a combination of pipes and hoses that create a closed system between the vapor spaces of an unloading gasoline cargo tank and a receiving storage tank such that vapors displaced from the storage tank are transferred to the gasoline cargo tank being unloaded.*

Vapor-tight *means equipment that allows no loss of vapors. Compliance with vapor-tight requirements can be determined by checking to ensure that the concentration at a potential leak source is not equal to or greater than 100 percent of the Lower Explosive Limit when measured with a combustible gas detector, calibrated with propane, at a distance of 1 inch from the source.*

Vapor-tight gasoline cargo tank *means a gasoline cargo tank which has demonstrated within the 12 preceding months that it meets the annual certification test requirements in §63.11092(f) of this part.*

Because the permittee will own or operate a gasoline dispensing facility (GDF) at an area source of HAP, requirements in Subpart CCCCCC are applicable. Because the permittee has committed to loading and dispensing of less than 100,000 gallons of gasoline per month (gal/mo), the requirements of 40 CFR 63.11117 will become applicable in accordance with 40 CFR 63.11111(b) and (c). Gasoline loading and dispensing is limited by Permit Condition 2.18 to avoid requirements applicable to GDF exceeding 100,000 gal/mo, and requires recordkeeping in accordance with 40 CFR 63.11111(e).

40 CFR 63, Subpart CCCCCC is incorporated by reference into Permit Condition 2.22, and specific applicable requirements will be incorporated into the Tier I operating permit.

40 CFR 63, Subpart EEEEEEE..... National Emission Standards for Hazardous Air Pollutants: Gold Mine Ore Processing and Production Area Source Category

§40 CFR 63.11640..... Am I subject to this subpart?

(a) You are subject to this subpart if you own or operate a gold mine ore processing and production facility as defined in §63.11651, that is an area source.

(b) This subpart applies to each new or existing affected source. The affected sources are each collection of "ore pretreatment processes" at a gold mine ore processing and production facility, each collection of "carbon processes with mercury retorts" at a gold mine ore processing and production facility, each collection of "carbon processes without mercury retorts" at a gold mine ore processing and production facility, and each collection of "non-carbon concentrate processes" at a gold mine ore processing and production facility, as defined in §63.11651.

(1) An affected source is existing if you commenced construction or reconstruction of the affected source on or before April 28, 2010.

(2) An affected source is new if you commenced construction or reconstruction of the affected source after April 28, 2010.

(c) This subpart does not apply to research and development facilities, as defined in section 112(c)(7) of the Clean Air Act (CAA).

(d) If you own or operate a source subject to this subpart, you must have or you must obtain a permit under 40 CFR part 70 or 40 CFR part 71.

§40 CFR 63.11651..... What definitions apply to this subpart?

Terms used in this subpart are defined in the Clean Air Act, in §63.2, and in this section as follows:

Autoclave *means a pressure oxidation vessel that is used to treat gold ores (primarily sulfide refractory ore) and involves pumping a slurry of milled ore into the vessel which is highly pressurized with oxygen and heated to temperatures of approximately 350° to 430 °F.*

Calomel-based mercury control system *means a mercury emissions control system that uses scrubbers to remove mercury from the gas stream of a roaster or combination of roasters by complexing the mercury from the gas stream with mercuric chloride to form mercurous chloride (calomel). These scrubbers are also referred to as "mercury scrubbers."*

Carbon adsorber *means a control device consisting of a single fixed carbon bed, multiple carbon beds or columns, carbon filter packs or modules, and other variations that uses activated carbon to remove pollutants from a gas stream.*

Carbon kiln *means a kiln or furnace where carbon is regenerated by heating, usually in the presence of steam, after the gold has been stripped from the carbon.*

Carbon processes with mercury retorts *means the affected source that includes carbon kilns, preg tanks, electrowinning cells, mercury retorts, and melt furnaces at gold mine ore processing and production facilities that use activated carbon, or resins that can be used as a substitute for activated carbon, to recover (adsorb) gold from the pregnant cyanide solution.*

Carbon processes without mercury retorts *means the affected source that includes carbon kilns, preg tanks, electrowinning cells, and melt furnaces, but has no retorts, at gold mine ore processing and production facilities that use activated carbon, or resins that can be used as a substitute for activated carbon, to recover (adsorb) gold from the pregnant cyanide solution.*

Concentrate *means the sludge-like material that is loaded with gold along with various other metals (such as silver, copper, and mercury) and various other substances, that is produced by electrowinning, the Merrill-Crowe process, flotation and gravity separation processes. Concentrate is measured as the input to mercury retorts, or for facilities without mercury retorts, as the input to melt furnaces before any drying takes place. For facilities without mercury retorts or melt furnaces, concentrate is measured as the quantity shipped.*

Deviation *means any instance where an affected source subject to this subpart, or an owner or operator of such a source:*

(1) Fails to meet any requirement or obligation established by this subpart, including but not limited to any emissions limitation or work practice standard;

(2) Fails to meet any term or condition that is adopted to implement an applicable requirement in this subpart and that is included in the operating permit for any affected source required to obtain such a permit; or

(3) Exceeds any operating limit established under this subpart.

Electrowinning *means a process that uses induced voltage on anode and cathode plates to remove metals from the continuous flow of solution, where the gold in solution is plated onto the cathode. Steel wool is typically used as the plating surface.*

Electrowinning Cells *means a tank in which the electrowinning takes place.*

Gold mine ore processing and production facility *means any industrial facility engaged in the processing of gold mine ore that uses any of the following processes: Roasting operations, autoclaves, carbon kilns, preg tanks, electrowinning, mercury retorts, or melt furnaces. Laboratories (see CAA section 112(c)(7)), individual prospectors, and very small pilot scale mining operations that processes or produces less than 100 pounds of concentrate per year are not a gold mine ore processing and production facility. A facility that produces primarily metals other than gold, such as copper, lead, zinc, or nickel (where these metals other than gold comprise 95 percent or more of the total metal production) that may also recover some gold as a byproduct is not a gold mine ore processing and production facility. Those facilities whereby 95 percent or more of total mass of metals produced are metals other than gold, whether final metal production is onsite or offsite, are not part of the gold mine ore processing and production source category.*

Melt furnace *means a furnace (typically a crucible furnace) that is used for smelting the gold-bearing material recovered from mercury retorting, or the gold-bearing material from electrowinning, the Merrill-Crowe process, or other processes for facilities without mercury retorts.*

Mercury retort *means a vessel that is operated under a partial vacuum at approximately 1,100° to 1,300 °F to remove mercury and moisture from the gold bearing sludge material that is recovered from electrowinning, the Merrill-Crowe process, or other processes. Mercury retorts are usually equipped with condensers that recover liquid mercury during the processing.*

Merrill-Crowe process *means a precipitation technique using zinc oxide for removing gold from a cyanide solution. Zinc dust is added to the solution, and gold is precipitated to produce a concentrate.*

Non-carbon concentrate processes *means the affected source that includes mercury retorts and melt furnaces at gold mine ore processing and production facilities that use the Merrill-Crowe process or other processes and do not use carbon (or resins that substitute for carbon) to recover (adsorb) gold from the pregnant cyanide solution.*

Ore dry grinding *means a process in which the gold ore is ground and heated (dried) prior to additional preheating or prior to entering the roaster.*

Ore preheating *means a process in which ground gold ore is preheated prior to entering the roaster.*

Ore pretreatment processes *means the affected source that includes roasting operations and autoclaves that are used to pre-treat gold mine ore at gold mine ore processing and production facilities prior to the cyanide leaching process.*

Pregnant solution tank (or preg tank) *means a storage tank for pregnant solution, which is the cyanide solution that contains gold-cyanide complexes that is generated from leaching gold ore with cyanide solution.*

Pregnant cyanide solution *means the cyanide solution that contains gold-cyanide complexes that are generated from leaching gold ore with a dilute cyanide solution.*

Quenching *means a process in which the hot calcined ore is cooled and quenched with water after it leaves the roaster.*

Roasting operation *means a process that uses an industrial furnace in which milled ore is combusted across a fluidized bed to oxidize and remove organic carbon and sulfide mineral grains in refractory gold ore. The emissions points of the roasting operation subject to this subpart include ore dry grinding, ore preheating, the roaster stack, and quenching.*

Because the permittee will own or operate a gold mine ore processing and production facility at an area source of HAP, requirements in Subpart EEEEEEE are applicable. The collection of ore pretreatment processes and the carbon process with mercury retort are affected sources. Ore pretreatment processes include the autoclave (AC). Carbon processes with mercury retort include the electrowinning cells and pregnant solution tank (EW), the mercury retort (MR), induction melting furnace (MF), and the carbon regeneration kiln (CKD).

Any source subject to 40 CFR 63, Subpart EEEEEEE is a Tier I source as defined in IDAPA 58.01.01.006.122.c. In accordance with IDAPA 58.01.01.313.01.b., the permittee must submit a complete application to DEQ for an initial Tier I operating permit within 12 months of becoming a Tier I source.

This subpart includes mercury emissions limits for the collection of new ore pretreatment processes and for the new carbon processes with mercury retort. This subpart also requires weight measurement devices for measuring ore throughput for the autoclave (AC) and mineral-bearing solution throughput for the electrowinning cells and pregnant solution tank (EW). Requires monitoring of mercury emissions, and monitoring of either inlet gas temperature for each process unit with a carbon filter (EW, MR, MF, CKD) or both water flow and pressure drop for each process unit with a wet scrubber not followed by a carbon filter (AC).

40 CFR 63, Subpart EEEEEEE is incorporated by reference into Permit Condition 2.22, and specific applicable requirements will be incorporated into the Tier I operating permit.

Permit Conditions Review

This section describes the permit conditions for this initial permit.

Permit Conditions 1.1–1.2 describe the purpose of this permitting action and the emission sources and the control equipment regulated by this permit. This reflects information presented in the application and relied upon in the development of emissions inventories, and in the evaluation of ambient air impacts in the modeling analyses. Refer to the Emissions Inventories and the Ambient Air Quality Impact Analyses sections for additional information concerning these analyses.

Because specific vendor and manufacturer information was unavailable at the time of permitting, documentation and testing requirements were included (Permit Condition 2.20) to verify consistency with the information specified in the application. Production values and limits were based on process flow diagrams and engineering design information provided.

Permit Conditions 2.1–2.8 incorporate fugitive dust emission limits and control requirements as required by IDAPA 58.01.01.650-651. Compliance is ensured by implementing reasonable control precautions and corrective actions when appropriate, excluding public access to operations, and complying with inspection, monitoring, recordkeeping, and notification requirements. Specific precautions are identified and required in the fugitive dust control plan (FDCP), and specific measures to control public access within the operations boundary are identified in and required by the Access Management Plan (AMP; Permit Conditions 2.6 and 2.7, respectively). A trigger level for haul roads was also established requiring employment of control measures (Permit Condition 2.5).

Reduction of PM emissions from each of the identified conveyors by 80% was supported by assuming location of these material transfers at below grade (OC9, OC10) or enclosure on all sides (OC11). Reduction of PM emissions from haul roads by a combined 93.3% was supported by assuming appropriate application of water and magnesium chloride dust suppression; DEQ is cognizant that to consistently achieve this level of control requires conscientious efforts, vigilant inspection and monitoring, and a comprehensive FDCP. Because continuous operation was proposed, suppression measures will need to account for and accommodate all weather conditions including diurnal and seasonal variability, and all traffic loads including mining and public traffic along publicly accessible roads. Conditions outside of what may normally be anticipated may require additional measures such as a reduction in vehicle speeds or selection of a more effective chemical dust suppressant. Although the FDCP specifies a minimum of efforts required, additional operational limits and monitoring are to be considered moving forward and evaluated for incorporation into the FDCP. Certification of employees for visible emissions inspection, training and orientation of relevant employees, and periodic evaluation of FDCP requirements are also required.

Access control measures are described in the Ambient Air Boundary section of the application (Section 5.6), and address primary access points, secondary access points, and surveillance.

Permit Conditions 2.9–2.12 incorporate visible emission limits and control requirements (Permit Condition 2.9) in accordance with IDAPA 58.01.01.625. Compliance is ensured by implementing corrective actions when appropriate and complying with inspection, monitoring, and recordkeeping requirements. Certification of employees for visible emissions inspection is also required.

Permit Condition 2.13 incorporates PM emission limits for process equipment as defined in IDAPA 58.01.01.006, in accordance with IDAPA 58.01.01.700-703, which includes all ore processing, ore concentration and refining, lime production, aggregate production, and concrete production equipment (Table 1). Compliance with operational and material throughput limits (Permit Conditions 3.3–3.8, 4.5–4.12, and 5.4–5.8) and control equipment requirements (Permit Conditions 2.6, 3.9–3.11, 4.13–4.17, and 5.9–5.15) and associated monitoring were considered adequate to ensure compliance with process weight-based PM emission limitations.

Permit Conditions 2.14–2.15 incorporate odorous emission limits in accordance with IDAPA 58.01.01.776.01. Compliance is ensured by complying with monitoring and recordkeeping requirements, including corrective action when appropriate.

Permit Conditions 2.16–2.17 incorporate sulfur content limits for distillate fuel oil, in accordance with IDAPA 58.01.01.725. Compliance is ensured by complying with monitoring and recordkeeping requirements.

Permit Conditions 2.18–2.19 limit facility-wide gasoline fuel throughput. Limiting gasoline throughput limits PTE, ensures avoidance of Subpart CCCCCC requirements applicable to GDF exceeding 100,000 gal/mo, and requires recordkeeping in accordance with 40 CFR 63.11111(e). Compliance is ensured by complying with monitoring and recordkeeping requirements.

Permit Conditions 2.20–2.21 require developing and complying with the requirements of an O&M manual to ensure compliance with control equipment maintenance and operation general provisions (Permit Condition 7.2). Documentation of as-built process equipment specifications and control equipment performance guarantees and establishing control equipment operating parameters and procedures were required, since these were relied upon in the development of emissions inventories, and in the evaluation of ambient air impacts in the modeling analyses. Compliance is ensured by complying with monitoring and recordkeeping requirements.

Permit Condition 2.22 incorporates applicable general compliance, notification, recordkeeping, reporting, general provisions, and other federal requirements by reference in accordance with IDAPA 58.01.01.107.03 and 590-591. Compliance is ensured by complying with applicable federal testing, monitoring, recordkeeping, and reporting requirements. In the event there is a conflict between the subparts and/or emission sources listed (Permit Condition 2.22), the federal requirements shall apply.

With regard to permit conditions referenced in accordance with federal requirements (i.e., NSPS and NESHAP requirements), should there be a conflict between the language of the permit condition and the language of the requirement, the language of the requirement shall govern. Refer to NSPS Applicability (40 CFR 60) and MACT/GACT Applicability (40 CFR 63) sections for additional information concerning applicable requirements.

Permit Conditions 2.23–2.24 require notification upon becoming a Tier I source and require the permittee to obtain a Tier I operation permit within 12 months of commencement of operation of any ore concentration and refining equipment (i.e., NESHAP Subpart EEEEEEE-affected sources) in accordance with IDAPA 58.01.01.313.01.b.

Permit Condition 2.25 specifies recommended test methods to be used when performance testing is required, unless otherwise specified in the permit, in accordance with IDAPA 58.01.01.157. The permittee is required to comply with notification and reporting requirements and is encouraged to submit performance test protocol to DEQ for approval prior to any performance testing in accordance with the performance testing general provisions (Permit Condition 7.7–7.9).

Permit Condition 2.26 provides DEQ agency contact information.

Permit Conditions 3.1–3.2 describe mining and ore processing equipment and controls. This reflects information presented in the application and relied upon in the development of emissions inventories, and in the evaluation of ambient air impacts in the modeling analyses.

Permit Conditions 3.3–3.8 and 3.11–3.16 establish limits on material throughput and production. These limits were relied upon in the development of emissions inventories and in the evaluation of ambient air impacts in the modeling analyses. Overall mine throughput is limited by hauling and excavating limits (Permit Condition 3.5). Compliance is ensured by complying with monitoring and recordkeeping requirements (Permit Conditions 3.11–3.16).

Permit Conditions 3.9–3.10 require measures to include in the FDCP to control fugitive emissions. Use of reasonable controls were relied upon in the development of emissions inventories and in the evaluation of ambient air impacts in the modeling analyses. Compliance is ensured by complying with fugitive dust monitoring and recordkeeping requirements (Permit Conditions 2.1–2.8).

Permit Conditions 4.1–4.2 describe ore concentration and refining equipment and controls. This reflects information presented in the application and relied upon in the development of emissions inventories, and in the evaluation of ambient air impacts in the modeling analyses.

Permit Condition 4.3, and 4.33–4.34 establish emissions limits for ore concentration and refining equipment, consistent with estimates relied upon in the development of emissions inventories and in the evaluation of ambient air impacts in the modeling analyses for these sources. A sulfuric acid emission limit consistent with the modeled TAP emission rate from the autoclave was established in accordance with IDAPA 58.01.01.210.08. Compliance is ensured by complying with equipment operating and testing requirements (Permit Conditions 4.5–4.17, and 4.33–4.34).

Permit Conditions 4.4, 4.5–4.6, 4.7–4.12 and 4.18–4.25 limit operations of ore concentration and refining process equipment, consistent with the hours of operation, reagent usage, and material throughput assumptions relied upon in the development of emissions inventories and in the evaluation of ambient air impacts in the modeling analyses for these sources. Compliance is ensured by complying with monitoring and recordkeeping requirements (Permit Conditions 4.18–4.25). Cyanide is consumed, recycled, and destroyed in the process, and cyanide HAP emissions (and emission factors) dependent upon leachant concentration and basicity. Monitoring of these parameters was established to ensure that emissions do not exceed 10 T/yr of cyanide HAP to avoid classification as a HAP major source. Re-classification as a major source would affect NSPS and NESHAP applicability determinations, such as Subpart AAAAA as discussed in the NESHAP Applicability (40 CFR 61) section.

Permit Conditions 4.13–4.17 and 4.26–4.32 require control equipment for ore concentration and refining processes, consistent with controls relied upon in the development of emissions inventories and in the evaluation of ambient air impacts in the modeling analyses. Compliance is ensured by complying with monitoring and recordkeeping requirements (Permit Conditions 4.26–4.32).

Permit Condition 4.33 and 4.34 require testing of ore concentration and refining emission sources to demonstrate compliance with emissions limits (Permit Condition 4.3).

Permit Conditions 5.1–5.2 describe lime, aggregate, and concrete production equipment and controls. This reflects information presented in the application and relied upon in the development of emissions inventories, and in the evaluation of ambient air impacts in the modeling analyses.

Permit Condition 5.3 establishes emissions limits for lime, aggregate, and concrete production equipment, consistent with estimates relied upon in the development of emissions inventories and in the evaluation of ambient air impacts in the modeling analyses for these sources. Compliance is ensured by complying with equipment operating requirements (Permit Conditions 5.4–5.15).

Permit Conditions 5.4–5.8 and 5.16–5.20 limit operations of each lime, aggregate, and concrete production process equipment, consistent with material throughput assumptions relied upon in the development of emissions inventories and in the evaluation of ambient air impacts in the modeling analyses for these sources. Compliance is ensured by complying with monitoring and recordkeeping requirements (Permit Conditions 5.15–5.20).

Permit Conditions 5.9–5.10 require measures to include in the FDCP to control fugitive emissions. Use of water sprays, building enclosures, and reasonable controls were relied upon in the development of emissions inventories and in the evaluation of ambient air impacts in the modeling analyses. Compliance is ensured by complying with fugitive dust monitoring and recordkeeping requirements (Permit Conditions 2.1–2.8).

Permit Conditions 5.11–5.15 and 5.21–5.24 require control equipment for lime, aggregate, and concrete production processes, consistent with controls relied upon in the development of emissions inventories and in the evaluation of ambient air impacts in the modeling analyses. Compliance is ensured by complying with monitoring and recordkeeping requirements (Permit Conditions 5.21–5.24).

Permit Condition 6.1 describes the emergency power generation equipment. This reflects information presented in the application and relied upon in the development of emissions inventories, and in the evaluation of ambient air impacts in the modeling analyses.

Permit Conditions 6.2 and 6.3–6.4 limit operations of each emergency power generation engine, consistent with the purpose and hours of operation assumptions relied upon in the development of emissions inventories, in the determination of federal regulatory applicability, and in the evaluation of ambient air impacts in the modeling analyses for these sources. Compliance is ensured by complying with monitoring, recordkeeping, and notification requirements (Permit Conditions 6.3–6.4).

Permit Condition 7.1, the duty to comply general compliance provision, requires that the permittee comply with all of the permit terms and conditions pursuant to Idaho Code §39-101.

Permit Condition 7.2, the maintenance and operation general compliance provision, requires that the permittee maintain and operate all treatment and control facilities at the facility in accordance with IDAPA 58.01.01.211.

Permit Condition 7.3, the obligation to comply general compliance provision, specifies that no permit condition is intended to relieve or exempt the permittee from compliance with applicable state and federal requirements, in accordance with IDAPA 58.01.01.212.01.

Permit Condition 7.4, the inspection and entry provision, requires that the permittee allow DEQ inspection and entry pursuant to Idaho Code §39-108.

Permit Condition 7.5, the permit expiration construction and operation provision, specifies that the permit expires if construction has not begun within two years of permit issuance or if construction has been suspended for a year in accordance with IDAPA 58.01.01.211.02.

Permit Condition 7.6, the notification of construction and operation provision, requires that the permittee notify DEQ of the dates of construction and operation, in accordance with IDAPA 58.01.01.211.01 and 211.03.

Permit Condition 7.7, the performance testing notification of intent provision, requires that the permittee notify DEQ at least 15 days prior to any performance test to provide DEQ the option to have an observer present, in accordance with IDAPA 58.01.01.157.03.

Permit Condition 7.8, the performance test protocol provision, requires that any performance testing be conducted in accordance with the procedures of IDAPA 58.01.01.157 and encourages the permittee to submit a protocol to DEQ for approval prior to testing.

Permit Condition 7.9, the performance test report provision, requires that the permittee report any performance test results to DEQ within 60 days of completion, in accordance with IDAPA 58.01.01.157.04-05.

Permit Condition 7.10, the monitoring and recordkeeping provision, requires that the permittee maintain sufficient records to ensure compliance with permit conditions, in accordance with IDAPA 58.01.01.211.

Permit Condition 7.11, the excess emissions provision, requires that the permittee follow the procedures required for excess emissions events, in accordance with IDAPA 58.01.01.130-136.

Permit Condition 7.12, the certification provision, requires that a responsible official certify all documents submitted to DEQ, in accordance with IDAPA 58.01.01.123.

Permit Condition 7.13, the false statement provision, requires that no person make false statements, representations, or certifications, in accordance with IDAPA 58.01.01.125.

Permit Condition 7.14, the tampering provision, requires that no person render inaccurate any required monitoring device or method, in accordance with IDAPA 58.01.01.126.

Permit Condition 7.15, the transferability provision, specifies that this permit to construct is transferable, in accordance with the procedures of IDAPA 58.01.01.209.06.

Permit Condition 7.16, the severability provision, specifies that permit conditions are severable, in accordance with IDAPA 58.01.01.211.

PUBLIC REVIEW

Public Comment Opportunity

An opportunity for public comment period on the application was provided in accordance with IDAPA 58.01.01.209.01.c. During this time, there was a request for a public comment period on DEQ's proposed action. Refer to the Application Chronology for public comment opportunity dates.

Public Comment Period

Comment periods were made available to the public in accordance with IDAPA 58.01.01.209.01.c. An initial comment period and extension were provided to address the initial application and proposed action (i.e., permit and technical statement of basis), and a final comment period was provided to address updates to the proposed action resulting from a HAP/TAP application addendum[2] submitted by Midas Gold that included new HAP and TAP emission estimates, additional information and discussion supporting HAP and TAP emission estimates, new and updated TAP increment compliance demonstrations which included particulate TAP emissions from fugitive sources, and a source-by-source inventory of HAP and TAP emissions. During this time, comments were submitted in response to DEQ's proposed action. Refer to the Application Chronology for the dates of each public comment period.

A response to public comments document has been crafted by DEQ based on comments submitted during each public comment period. That document is part of the final permit package for this permitting action.

APPENDIX B – AMBIENT AIR QUALITY IMPACT ANALYSES REVIEW MEMORANDUM

M E M O R A N D U M

DATE: February 8, 2021

TO: Morrie Lewis, Permit Writer, Air Program

FROM: Pao Baylon, Modeling Review Analyst, Air Program
Through Kevin Schilling, Modeling Supervisor, Air Program

PROJECT: P-2019.0047 PROJ 62288, Permit for an Open-pit Gold Mine and On-site Ore Preparation and Gold Extraction Operation located in Valley County, Idaho.

SUBJECT: Demonstration of Compliance with IDAPA 58.01.01.203.02 (NAAQS) and 203.03 (TAPs) as it relates to air quality impact analyses.

Contents

Acronyms, Units, and Chemical Nomenclature 3

1.0 Summary 6

2.0 Background Information 11

2.1 Project Description 12

2.2 Facility Location and Area Classification 13

2.3 Air Impact Analyses Required for All Permits to Construct 15

2.4 Significant Impact Level and Cumulative NAAQS Impact Analyses 16

2.5 Toxic Air Pollutant Analyses 18

3.0 Analytical Methods and Data 19

3.1 Emission Source Data 19

3.1.1 Criteria Pollutant Modeling Applicability and Modeled Emission Rates 20

3.1.2 TAPs Modeling Applicability and Modeled Emission Rates 27

3.1.3 Modeling Scenarios 32

3.1.4 Processing, Refining, and Ancillary Sources 33

3.1.5 Fugitive Sources: Blasting, Material Origin and Destination, and Underground Exploration Emissions 34

3.1.6 Fugitive Sources: Haul Roads 36

3.1.7 Fugitive Sources: Burntlog Route Access Road 39

3.1.8 Emission Release Parameters 39

3.1.9 Emission Release Parameter Justification 43

3.2 Background Concentrations 45
3.2.1 Onsite Particulate Monitoring 45
3.2.2 Gaseous Pollutant Background Concentrations 46
3.2.3 Medium-Traffic Pollutant Background Concentrations 46
3.3 Impact Modeling Methodology 47
3.3.1 General Overview of Impact Analyses 47
3.3.2 Modeling Protocol 48
3.3.3 Modeling Methodology 48
3.3.4 Model Selection 48
3.3.5 Meteorological Data 48
3.3.6 Effects of Terrain on Modeled Impacts 52
3.3.7 Facility Layout and Downwash 54
3.3.8 NOx Chemistry 54
3.3.9 Particulate Deposition 55
3.3.10 Ambient Air Boundary 57
3.3.11 Nearby Co-Contributing Sources 59
3.3.12 Receptor Network 59
3.3.13 Good Engineering Practice Stack Height 61
4.0 NAAQS and TAPs Impact Modeling Results 61
4.1 Results for NAAQS Analyses 61
4.1.1 Significant Impact Level Analyses 61
4.1.2 Cumulative NAAQS Impact Analyses 61
4.1.3 DEQ's Sensitivity Analyses for 1-hour and annual NO_2 64
4.1.4 DEQ's Weight-of-Evidence Analyses for 24-hour PM_{10} 64
4.1.5 DEQ's Sensitivity Analyses for a Lower Fugitive Road Dust Control Efficiency 73
4.2 Results for TAPs Impact Analyses 76
5.0 Conclusions 78
References 79

Acronyms, Units, and Chemical Nomenclature

AAC	Acceptable Ambient Concentration of a non-carcinogenic TAP
AACC	Acceptable Ambient Concentration of a Carcinogenic TAP
acfm	Actual cubic feet per minute
ADJ_U*	AERMOD Adjusted Friction Velocity Model Option
AERMAP	The terrain data preprocessor for AERMOD
AERMET	The meteorological data preprocessor for AERMOD
AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
Air Sciences	Air Sciences, Inc. (permittee's permitting and modeling consultant)
amsl	Above mean sea level
ANFO	Ammonium Nitrate Fuel Oil
Appendix W	40 CFR 51, Appendix W – Guideline on Air Quality Models
ASOS	Automated Surface Observing System
B_o	Bowen Ratio
BNF	Boise National Forest
BPIP	Building Profile Input Program
BRC	Below Regulatory Concern
BT	Bradley Tailings
BULKRN	Meteorological data processed using Bulk Richardson Method
CAPCOA	California Air Pollution Control Officers Association
CFR	Code of Federal Regulations
CMAQ	Community Multi-Scale Air Quality Modeling System
CO	Carbon Monoxide
CSIRO	Commonwealth Scientific and Industrial Research Organization
DEQ	Idaho Department of Environmental Quality
DR	Development Rock
DRSF	Development Rock Storage Facility
DV	Design Values
EF	Emission Factors
EFSFSR	East Fork of the South Fork of the Salmon River
EIS	Environmental Impact Statement
EL	Emissions Screening Level of a TAP
EPA	United States Environmental Protection Agency
FDRSF	Fiddle Development Rock Storage Facility
g/cm^3	Grams per Cubic Centimeter
GEP	Good Engineering Practice
H_2SO_4	Sulfuric Acid Gas
HAP	Hazardous Air Pollutant
HFDRSF	Hangar Flats Development Rock Storage Facility
HFP	Hangar Flats Pit
Hg	Mercury
hr	Hours
Idaho Air Rules	Rules for the Control of Air Pollution in Idaho, located in the Idaho Administrative Procedures Act 58.01.01

in	Inches
ISCST3	Industrial Source Complex Short Term 3 dispersion model
K	Kelvin
km	Kilometers
lb/hr	Pounds per hour
lb/yr	Pounds per year
LOM	Life of Mine
m	Meters
m/sec	Meters per second
MBACT	Mercury Best Available Control Technology
MERPs	Modeled Emission Rates for Precursors
mg/m^3	Milligrams per Cubic Meter
Midas Gold	Midas Gold Idaho, Inc. (permittee)
MM	Million
MMBtu	Million British Thermal Units
mph	Miles per hour
NAAQS	National Ambient Air Quality Standards
NAD83	North American Datum of 1983
NED	National Elevation Dataset
NESHAP	National Emission Standards for Hazardous Air Pollutants
NO	Nitrogen Oxide
NO_2	Nitrogen Dioxide
NON-BULKRN	Meteorological data processed without Bulk Richardson Method
NOx	Oxides of Nitrogen
NSPS	New Source Performance Standards
NSR	New Source Review
NW AIRQUEST	Northwest International Air Quality Environmental Science and Technology Consortium
NWS	National Weather Service
O_3	Ozone
OLM	Ozone Limiting Method
Pb	Lead
PM_{10}	Particulate matter with an aerodynamic particle diameter less than or equal to a nominal 10 micrometers
$PM_{2.5}$	Particulate matter with an aerodynamic particle diameter less than or equal to a nominal 2.5 micrometers
PNF	Payette National Forest
ppb	parts per billion
ppm	parts per million
PRIME	Plume Rise Model Enhancement
PRO	Midas Gold Plan of Restoration and Operations
PSD	Prevention of Significant Deterioration
PTC	Permit to Construct
PTE	Potential to Emit
PVMRM	Plume Volume Molar Ratio Method
r	Albedo

scfm	Standard cubic feet per minute
SED	Segment Emission Denominator
SGP	Stibnite Gold Project
SIL	Significant Impact Level
SO_2	Sulfur Dioxide
STKP	Crusher Stockpile
TAP	Toxic Air Pollutant
ton/day	Tons per Day
ton/year	Tons per Year
TSF	Tailings Storage Facility
TSP	Total Suspended Particulate
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
VOC	Volatile Organic Compounds
WBAN	Weather-Bureau-Army-Navy
WEDRSF	West End Development Rock Storage Facility
WEP	West End Pit
YPDRSF	Yellow Pine Development Rock Storage Facility
YPP	Yellow Pine Pit
z_o	Surface Roughness Length
ºF	Degrees Fahrenheit
µg/m^3	Micrograms per cubic meter of air
µm	Microns

1.0 Summary

Midas Gold Idaho, Inc. (Midas Gold) submitted a Permit to Construct (PTC) application to construct and operate the Stibnite Gold Project (SGP) in Valley County, Idaho. The SGP will consist of conventional open-pit mining operations and onsite ore preparation and gold extraction processes. The potential air emissions from the SGP are less than the applicable major source thresholds for both criteria and hazardous air pollutants (HAP), and therefore, the facility is designated as a minor source for Title V and New Source Review (NSR) requirements, and an area source for National Emission Standards for Hazardous Air Pollutants (NESHAP) applicability. Project-specific air quality analyses involving atmospheric dispersion modeling of estimated emissions associated with the facility were submitted to DEQ to demonstrate that applicable emissions do not result in violation of a National Ambient Air Quality Standard (NAAQS) or Toxic Air Pollutant (TAP) increment as required by the Idaho Administrative Procedures Act 58.01.01.203.02 and 203.03 (Idaho Air Rules Section 203.02 and 203.03). This memorandum provides a summary of the applicability assessment for analyses and air impact analyses used to demonstrate compliance with applicable NAAQS and TAP increments, as required by Idaho Air Rules Section 203.02 and 203.03.

Air Sciences, Inc. (Air Sciences), on behalf of Midas Gold, prepared the PTC application and performed ambient air impact analyses for this project. DEQ review of submitted data and DEQ analyses summarized by this memorandum addressed only the rules, policies, methods, and data pertaining to the air impact analyses used to demonstrate that estimated emissions associated with operation of the facility will not cause or significantly contribute to a violation of any applicable air quality standard. This review did not address/evaluate compliance with other rules or analyses not pertaining to the air impact analyses. Evaluation of emission estimates was the responsibility of the DEQ permit writer and is addressed in the main body of the DEQ Statement of Basis, and emission calculation methods were not evaluated in this modeling review memorandum.

Table 1 presents key assumptions and results to be considered in the development of the permit. Idaho Air Rules require air impact analyses be conducted in accordance with methods outlined in 40 Code of Federal Regulations (CFR) 51, Appendix W *Guideline on Air Quality Models* (Appendix W). Appendix W requires that air quality impacts be assessed using atmospheric dispersion models with emissions and operations representative of design capacity or as limited by a federally enforceable permit condition.

The submitted information and analyses: 1) utilized appropriate methods and models; 2) was conducted using reasonably accurate or conservative model parameters and input data (review of emission estimates was addressed by the DEQ permit writer); 3) adhered to established DEQ guidelines for new source review dispersion modeling; 4) showed either a) that estimated potential/allowable emissions are at a level defined as below regulatory concern (BRC) and do not require a NAAQS compliance demonstration; b) that predicted pollutant concentrations from emissions associated with the project as modeled were below Significant Impact Levels (SILs) or other applicable regulatory thresholds; or c) that predicted pollutant concentrations from emissions associated with the project, when appropriately combined with co-contributing sources and background concentrations, were below applicable NAAQS at ambient air locations where and when the project has a significant impact; 5) showed that TAP emission increases associated with the project will not result in increased ambient air impacts exceeding allowable TAP increments. This conclusion assumes that conditions in Table 1 are representative of facility design capacity or operations as limited by a federally enforceable permit condition. The DEQ permit writer should use Table 1 and other information presented in this memorandum to generate appropriate permit provisions/restrictions to assure emissions do not exceed applicable regulatory thresholds requiring further analyses and to assure the requirements of Appendix W are met regarding emissions representative of design capacity or permit allowable rates.

Table 1. KEY ASSUMPTIONS USED IN MODELING ANALYSES.	
Criteria/Assumption/Result	**Explanation/Consideration**
General Emission Rates. Emission rates used in the air impact analyses must represent maximum potential emissions as given by design capacity, inherently limited by the nature of the process or configuration of the facility, or as limited by the issued permit for the specific pollutant and averaging period.	Compliance has not been demonstrated for emission rates greater than those used in the air impact analyses.
Air Impact Analyses for Criteria Pollutant Emissions. Stibnite Gold Project (SGP) facility-wide maximum potential to emit are greater than the respective Level I thresholds for all criteria pollutants and averaging periods except for Lead. Therefore, modeling is triggered for applicable averaging periods for $PM_{2.5}$[a], PM_{10}[b], CO[c], NOx[d], and SO_2[e]. Modeling was not required for Lead.	Project-specific air impact analyses demonstrating compliance with NAAQS, as required by Idaho Air Rules Section 203.02, are required for pollutant increases above Below Regulatory Concern (BRC) thresholds, or for pollutants having an emissions increase that is greater than Level I modeling applicability thresholds (where the BRC exclusion cannot be used).
Air Impact Analyses for TAP Emissions. SGP facility-wide potential Toxic Air Pollutant (TAP) emissions exceed the respective screening emission levels (ELs) for arsenic, cadmium, formaldehyde, nickel, aluminum, barium, calcium carbonate, calcium oxide, iron, sulfuric acid, thallium, and vanadium. Therefore, air dispersion modeling was required for these 12 TAPs. TAPs also classified as Hazardous Air Pollutants (HAPs) emitted from sources addressed by New Source Performance Standards (NSPS) or National Emission Standards for Hazardous Air Pollutants (NESHAP) were not required to be evaluated for compliance with TAP increments in accordance with IDAPA 58.01.01.210.20.	A TAP increment compliance demonstration would be required for any TAPs with emissions above ELs. IDAPA 58.01.01.210.20 states that if TAP emissions from a specific source are addressed by NSPS or NESHAP, then a TAP impact analysis is not required for that TAP from that specific source.
Significant Impact Level Analysis Not Conducted. A Significant Impact Level (SIL) analysis was not conducted for the SGP facility.	Based on the magnitude of the facility-wide emissions and preliminary modeling analyses, it was determined that the impacts from the SGP emissions exceeded the SIL for most criteria pollutants. Therefore, SIL analyses were considered redundant and not performed for the project.
Multiple Modeling Scenarios. To evaluate the worst-case air impacts from the SGP facility, a total of 14 scenarios were modeled. These scenarios represent the hauling of material, which can be either ore or development rock (DR), from four possible origins (three pits and a tailings facility) to five possible destinations (ore will be hauled to the crushing area while DR will be hauled to one of four development rock storage facilities [DRSF]). Modeled design values listed in this modeling memo represent the worst-case modeling scenario for every modeled pollutant and averaging period.	Conventional open-pit methods will be used to extract ore and DR from four possible origins (Yellow Pine Pit [YPP], Hangar Flats Pit [HFP], West End Pit [WEP], and Bradley Tailings [BT]). Ore and DR will be hauled to five possible destinations (Stockpile [STKP], Yellow Pine DRSF [YPDRSF], Hangar Flats DRSF [HFDRSF], West End DRSF [WEDRSF], and Fiddle DRSF [FDRSF]). Only 14 of the 20 possible scenarios were modeled. Six scenarios were not feasible because the timing of the activity within the sequence of mine operations makes the scenarios logistically impossible. Modeled results listed in this memo represent worst-case modeling scenarios.
Modeling of Material Origin and Destination. Each material origin location (YPP, HFP, WEP, and BT) was modeled as an AREA source. Ore destination (STKP) was modeled as a VOLUME source. Each DR destination (YPDRSF, HFDRSF, WEDRSF, and FDRSF) was modeled as a VOLUME source.	Each material origin location comprised appropriate emissions from drilling, material loading, dozing, and surface exploration. Ore destination comprised ore unloading emissions. Each DR destination comprised appropriate emissions from DR unloading, dozing, and wind erosion. For the four AREA and five VOLUME sources, the dimensions were developed by reasonably fitting an equal-area rectangle within the actual footprint of each fugitive source. For the pit and DRSF fugitive activity locations, the release height was based on the haul truck height. The applicable initial lateral dispersion for each VOLUME source was calculated from the respective shorter dimension and EPA-specified methods. The applicable initial vertical dispersion for each AREA and VOLUME source was

Table 1. KEY ASSUMPTIONS USED IN MODELING ANALYSES.	
Criteria/Assumption/Result	**Explanation/Consideration**
	calculated from the respective vertical dimension and EPA-specified methods.
Modeling of Haul Roads. A representative haul road network for hauling material from inside the pit to various destinations was developed for each of the 14 modeling scenarios.	The haul road network was divided into 22 sections. Each section was further divided into multiple segments with a length equal to twice the adjusted haul road width. Each of the segments was characterized as an individual VOLUME source in the model. Material hauling emissions associated with each origin-destination route were assigned to each segment along the route based on estimated total emissions along the route and traffic distribution along each section.
Modeling of Blasting Emissions. Blasting emissions were represented by a VOLUME source inside a pit (YPPBL, HFPBL, and WEPBL). Blasting is not expected to occur in BT but was modeled (BTBL) in order to streamline the permitting process.	The blasting physical parameters were developed from dimensions based on blast area used in the emission calculation. The blasting release height was the midpoint of the blasting height. The initial lateral and vertical dispersion dimensions for blasting were calculated per methods specified in the AERMOD User's Guide.
Modeling of Burntlog Route Access Road. The access road portion within the operations boundary was characterized by a series of LINE sources laid along the actual route.	Emissions associated with the portion of the Burntlog Route mine access road that is within project boundary (from the south gate to the process area) are included in the SGP analyses. These include dust emissions generated from travel of maintenance equipment, light-duty pickup trucks and buses used for employee, visitor, and contractor transportation, and heavy-duty trucks used for cargo (including fuel, consumables, machine parts, ore processing supplies, ore concentrate, etc.) and services (including food supplies, trash, recyclables, etc.) transportation. Release parameters for the LINE sources were based on an estimated average vehicle height. The access road emissions were evenly distributed along the road by dividing the total access road emissions by its total area.
Control of Fugitive Dust from Roadways. Fugitive particulate emissions from roadways were assumed to be controlled above 93%, which is an aggressive level of control.	The high level of emission control was needed to demonstrate compliance with NAAQS. Compliance is not demonstrated for emissions greater than those associated with above 93% control.
NOx Chemistry and NO_2/NOx In-Stack Ratios. Ozone Limiting Method (OLM), a Tier 3 NO_2 screening method, was used to estimate the 1-hour and annual NO_2 impacts. The following NO_2/NOx In-Stack Ratios (ISR) were used in the modeling analyses: Blasting: 0.036 Diesel engines: 0.11 Propane heaters: 0.10	The OLM method requires an input of NO_2/NOx ISRs for each modeled source. The NO_2/NOx ratio for blasting was based on blasting plume measurements provided in published literature. The NO_2/NOx ratio for stationary diesel combustion sources was based on heavy-duty diesel trucks in the California Air Pollution Control Officers Association (CAPCOA) Guidance Document. This NO_2/NOx ratio (11 percent) is conservatively higher than the diesel combustion NO_2/NOx ratio provided in the EPA ISR database: 6 percent average, 9.8 percent maximum. The CAPCOA document and the EPA ISR database do not provide an NO_2/NOx ratio for propane boilers. The CAPCOA-recommended NO_2/NOx ratio for natural gas boilers was selected for the propane boilers. The natural gas boilers NO_2/NOx ratio is considered appropriate for the propane boilers because both are gaseous fuels with relatively similar combustion characteristics and are expected to have similar NO_2/NOx ratios. DEQ performed a sensitivity analysis using Tier 2 (Ambient Ratio Method 2), a more conservative NO_2 screening method, and found that the facility is safely below the 1-hour and annual NO_2 NAAQS.

Table 1. KEY ASSUMPTIONS USED IN MODELING ANALYSES.	
Criteria/Assumption/Result	**Explanation/Consideration**
Alternate Meteorological Data Processed Using Cloud Cover. An alternative meteorological dataset was processed without using the Bulk Richardson (BULKRN) method. This alternate processing (NON-BULKRN) used upper air data from Boise airport, supplemented with the cloud-cover data collected at the National Weather Service station in McCall, Idaho.	Meteorological data processing with and without BULKRN are considered acceptable regulatory options by EPA. The NON-BULKRN meteorological data yielded lower modeled design values than the meteorological data processed using the BULKRN method.
Ambient Air Boundary. Midas Gold will legally control the SGP, an active industrial site where mining activities will occur, such as heavy equipment operation. Most areas of the mine will require strict safety protocols and controlled access. Midas Gold has established an operations boundary to identify the area where public access will be excluded. Public access inside the operations boundary will be restricted for the life of the mine by physical barriers at points of potential access, including the current Stibnite Road point of entry and proposed site access via the Burntlog Route, as well as natural features of the landscape that prevent access.	Ambient air is defined in Section 006 of the Idaho Air Rules as "that portion of the atmosphere, external to buildings, to which the general public has access." Receptors must be placed at any portion of the atmosphere that is considered ambient air.
Onsite Background $PM_{2.5}$ and PM_{10} Concentrations. The following background $PM_{2.5}$ and PM_{10} concentrations were measured at SGP in 2014 and used in the cumulative NAAQS impact analysis: Annual $PM_{2.5}$: 3.5 $\mu g/m^3$ (weighted average of quarterly means) 24-hour $PM_{2.5}$: 15.0 $\mu g/m^3$ (98^{th} percentile/8^{th} high) 24-hour PM_{10}: 37.0 $\mu g/m^3$ (highest 1^{st} high)	Midas Gold developed an onsite monitoring program to collect site-specific meteorological parameters and determine ambient particulate matter ($PM_{2.5}$ and PM_{10}) concentrations at its Stibnite monitoring station. $PM_{2.5}$ and PM_{10} background concentrations were based on calendar year 2014 instead of the complete dataset (November 2013 through June 2015). For 24-hour PM_{10}, the design value is the *second-highest* 24-hour average concentration in a given year. However, the background value that was used in the modeling analyses represents the *first-highest* 24-hour average concentration measured in 2014. Therefore, using a larger background concentration adds a layer of conservatism to the calculated total impact for 24-hour PM_{10}.
NW AIRQUEST Background CO, NO_2, and SO_2 Concentrations. The following background concentrations for CO, NO_2, and SO_2 were used in the cumulative NAAQS impact analysis: 1-hour CO: 1,740 $\mu g/m^3$ 8-hour CO: 1,110 $\mu g/m^3$ 1-hour NO_2: 4.3 $\mu g/m^3$ Annual NO_2: 0.9 $\mu g/m^3$ 1-hour SO_2: 12.3 $\mu g/m^3$ 3-hour SO_2: 16.8 $\mu g/m^3$	Gaseous pollutant background concentrations were determined using the Northwest International Air Quality Environmental Science and Technology Consortium (NW AIRQUEST) online tool. The NW AIRQUEST tool uses regional scale modeling of pollutants in Washington, Oregon, and Idaho, with model results adjusted according to available monitoring data.
Medium-Traffic Background Concentrations. To provide additional information regarding the relative contribution of traffic emissions, background concentrations were obtained from NW AIRQUEST for the road section between mile markers 143 and 144 on Highway 55 passing through the town of McCall.	The McCall location is approximately 38 miles west of the SGP. The annual average daily traffic count for this road section is over 10,000 vehicles per day. Although the background concentrations at McCall are not representative of the rural SGP area, they provide additional information regarding the relative contribution of traffic emissions.
Weight-of-Evidence Analyses for 24-hour PM_{10}. PM_{10} modeling with meteorological dataset processed using the site-specific BULKRN method shows up to five hotspot receptors for Scenario W5 (the highest PM_{10} modeling scenario) that exceed NAAQS. All modeled violations occur during winter when the average snow depth and average precipitation at the project site are 21-68 inches and 6.0 inches, respectively. Therefore, fugitive road dust emissions during high-modeled impact hours could be overestimated. PM_{10} modeling simulation was based on a mining production rate of 180,000 ton/day of development rock (65,700,000 ton/year, which is more conservative than the	Meteorological data processing with and without BULKRN are considered acceptable by EPA, with the BULKRN method utilizing more of the onsite collected meteorological parameters. However, the BULKRN-processed meteorological data yielded higher modeled design value impacts for the SGP facility than the meteorological data processed without the BULKRN method. DEQ's supplemental analyses suggest that when emissions are more-closely representative of typical daily mining production rates for a high-production period (everything else held constant), the SGP facility is able to demonstrate

Table 1. KEY ASSUMPTIONS USED IN MODELING ANALYSES.	
Criteria/Assumption/Result	**Explanation/Consideration**
expected peak production rate of 42,692,000 ton/year). To investigate the effect of a lower modeled mining production rate on design value concentrations, DEQ performed a modeling simulation where mining production rate was assumed to be 120,000 ton/day instead of 180,000 ton/day, but everything else was held constant. Maximum modeled concentration, when summed with the background concentration, is lower than the 24-hour PM_{10} NAAQS thereby demonstrating NAAQS compliance. DEQ's weight-of-evidence analyses conclude that, considering all the collective conservative layers of the modeling analyses, including the use of meteorological data processed by two different methods, there is a satisfactory level of confidence that operation of the project as described in the application will not cause or contribute to a violation of NAAQS.	compliance with 24-hour PM_{10} NAAQS at those few receptors showing a potential violation when using meteorological data processed with the BULKRN method.

[a.] Particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers.
[b.] Particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers.
[c.] Carbon monoxide.
[d.] Nitrogen oxides.
[e.] Sulfur dioxide.

Summary of Submittals and Actions

May 30, 2019	Modeling protocol was submitted to DEQ by Brown and Caldwell on behalf of the applicant.
June 27, 2019	Conditional modeling protocol approval was provided to Brown and Caldwell by DEQ.
August 21, 2019	Regulatory start date. PTC application and modeling report were prepared by Air Sciences on behalf of the applicant.
September 19, 2019	Application deemed incomplete by DEQ.
October 4, 2019	DEQ received a preliminary response and supplemental information from the applicant.
October 15, 2019	DEQ met with the applicant to review and discuss the preliminary response.
October 22, 2019	DEQ determined that the application remained incomplete while the applicant prepared a response to remaining items previously identified, and included a summary of recommendations provided at the meeting.
November 8, 2019	DEQ requested additional information from the applicant via e-mail, relating to items previously identified.
November 21, 2019	Applicant requested extension until November 27, 2019 to respond to incompleteness.
November 27, 2019	DEQ received supplemental information from the applicant, including a revised application with updated emission inventories and modeling analyses.

December 24, 2019	DEQ determined that the application was incomplete.
January 8, 2020	Applicant requested extension until February 7, 2020 to respond to incompleteness.
February 5, 2020	DEQ received supplemental information from the applicant, including a revised application with updated emission inventories and modeling analyses.
March 6, 2020	DEQ determined that the application was incomplete.
April 2, 2020	Applicant requested extension until April 15, 2020 to respond to incompleteness.
April 15, 2020	DEQ received supplemental information from the applicant, including updated modeling analyses.
May 15, 2020	DEQ determined that the application was complete.
June 24, 2020	DEQ received the final updated application.
July 14, 2020	DEQ made available the draft permit and statement of basis for applicant review.
July 31, 2020	DEQ made available an updated draft statement of basis for applicant review.
August 3 and 13, 2020	DEQ received comments from the applicant on the draft permit and statement of basis.
September 10 – October 12, 2020	DEQ provided a public comment period on the proposed action.
October 12, 2020	DEQ received a request to extend the public comment period.
October 13 – November 11, 2020	DEQ extended the public comment period.
November 20, 2020	DEQ requested additional information from the applicant to address substantive public comments received, including missing HAP and TAP emission estimates.
December 18, 2020	DEQ received supplemental information from the applicant, including a HAP/TAP addendum, updated HAP and TAP emission estimates, and updated TAP modeling analyses.
January 28, 2021	DEQ received updated modeling files with corrections for formaldehyde and sulfuric acid, and an updated figure showing TAP modeled impacts.

2.0 Background Information

This section provides background information applicable to the project and the site proposed for the facility. It also provides a brief description of the applicable air impact analyses requirements for the project.

2.1 Project Description

The SGP will require the construction of significant infrastructure, including a power transmission line, a primary mine site access road, onsite haul roads, an ore processing facility, onsite workspaces, employee housing and recreation, water storage and distribution facilities, and sewage disposal facilities.

The SGP will include three years of pre-mining development and construction activities, followed by an operating mine life of approximately 12 years. Mining will occur in three open pits: Yellow Pine Pit (YPP), Hangar Flats Pit (HFP), and West End Pit (WEP). The general sequence of mining will be the YPP deposit, followed by the HFP and WEP deposits. Legacy tailings from the Meadow Creek valley (Bradley Tailings [BT]) also will be reclaimed and reprocessed during the initial project schedule. Surface exploration drilling will continue within the pits and the Scout Prospect decline (underground exploration) throughout the mine operation period. Restoration and reclamation of other legacy mining features will occur prior to mining, throughout the life of the mine, and as part of the mine closure.

Conventional open-pit methods including drilling, blasting, excavating, and hauling will be used to extract ore and waste rock, termed development rock (DR). Hydraulic shovels and front-end loaders will be used to load ore and DR into haul trucks. DR will be used for construction, restoration, and backfilling, or hauled to the dedicated development rock storage facilities (DRSF). Approximately 340 million tons of DR will be handled over the life of the mine. Ore will be hauled to the primary crusher area, where it will be fed directly into the crusher dump pocket or stockpiled. The ore crushing plant will be designed to operate at a maximum rate of 25,000 tons per day (ton/day). Approximately 100 million tons of ore will be mined from the three pits over the life of the project.

The metal-recovery process from ore will include conventional crushing and grinding, followed by froth-flotation circuits that will generate separate gold-silver and antimony-silver concentrates. The antimony-silver concentrate will be shipped offsite for refining, whereas additional onsite processing of the gold-silver concentrate will include pressure oxidation, carbon-in-leach circuits, and refining processes to recover gold and minor amounts of silver. The finely ground leftover ore material from the mineral-recovery process, termed tailings, will be neutralized, thickened, and transported via a pipeline to the tailings storage facility (TSF).

Lime used in the ore processing will either be purchased or manufactured onsite from limestone available at the site. In addition, certain construction and maintenance activities during operations may require sized aggregate. To allow for the operational flexibility to produce construction aggregate onsite, the application included two portable crushing and screening plants.

The following air pollutants are expected from operations at the SGP facility:

- Criteria air pollutants: carbon monoxide (CO), oxides of nitrogen (NOx), particulate matter less than 2.5 microns (μm) and 10 μm ($PM_{2.5}$ and PM_{10}), sulfur dioxide (SO_2), lead (Pb), and ozone (O_3) precursor volatile organic compounds (VOC)
- Hazardous air pollutants (HAP), including mercury (Hg)
- Other non-HAP toxic air pollutants (TAP)
- Greenhouse gases

Based on the uncontrolled potential to emit (PTE) and controlled PTE, the SGP facility will be a "synthetic minor" source of PM, PM_{10}, $PM_{2.5}$, and HAP emissions for new source review (NSR) and Title V (Tier I) permitting purposes. The uncontrolled PTE for the remaining criteria pollutants (SO_2, NOx,

CO, VOC) confirm that the SGP facility will be a natural minor source for these emissions. Facility classification is reviewed by the permit writer. Detailed calculations and explanations are provided in the DEQ Statement of Basis.

The PTC addresses all air pollutant-emitting activities associated with the facility.

2.2 Facility Location and Area Classification

The SGP is located in the Stibnite-Yellow Pine Mining District in Valley County, central Idaho (Northing: 4,973,751 meters [m]; Easting: 632,038 m; UTM Zone 11), approximately 100 miles northeast of Boise, 38 miles east of McCall, and approximately 10 miles east of Yellow Pine. A facility location map for the SGP is presented in Figure 1. This figure also shows the proposed Burntlog Route (access road) that will provide a year-round safe access to the site. The SGP site layout is presented in Figure 2.

The Stibnite-Yellow Pine Mining District is characterized by historic mining activities and unpatented (federal land) and patented (private land) mining claims that include deposits of gold, silver, tungsten, and antimony. The district lies in both Boise National Forest (BNF) and Payette National Forest (PNF), but is administered by the PNF's Krassel Ranger District (Midas Gold 2017a). The project area terrain is characterized by narrow valleys 6,000 to 6,600 feet above mean sea level (amsl), surrounded by steep mountains ranging over 8,500 feet amsl. The main drainage basin in the project area is the East Fork of the South Fork of the Salmon River (EFSFSR).

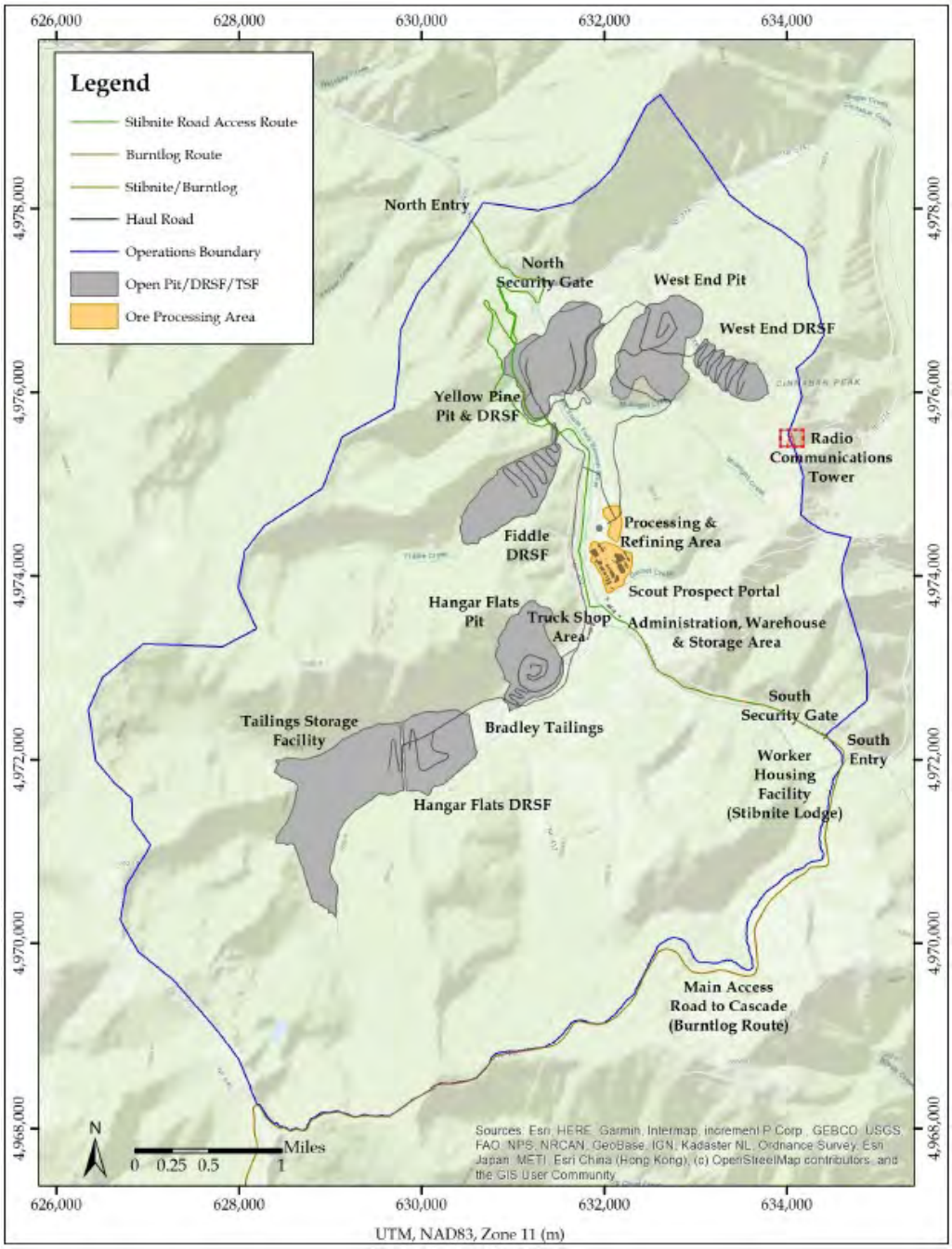
The EFSFSR joins Johnson Creek 16 miles downstream, near the village of Yellow Pine. The project area is encompassed by the watersheds of EFSFSR tributaries, including Sugar Creek, Meadow Creek, Johnson Creek, Riordan Creek, Burntlog Creek, Midnight Creek, and Trout Creek. Primary commercial activity in the area comprises mineral exploration, mining, logging, and dispersed recreation.

This area is designated as an attainment or unclassifiable area for SO_2, NO_2, CO, Lead, O_3, PM_{10}, and $PM_{2.5}$. The area is not classified as non-attainment for any criteria pollutants.

Figure 1. SGP FACILITY LOCATION MAP.



Figure 2. SGP SITE LAYOUT AND STIBNITE ROAD ACCESS ROUTE.



2.3 Air Impact Analyses Required for All Permits to Construct

Idaho Air Rules Sections 203.02 and 203.03:

> *No permit to construct shall be granted for a new or modified stationary source unless the applicant shows to the satisfaction of the Department all of the following:*

***02. NAAQS**. The stationary source or modification would not cause or significantly contribute to a violation of any ambient air quality standard.*

***03. Toxic Air Pollutants.** Using the methods provided in Section 210, the emissions of toxic air pollutants from the stationary source or modification would not injure or unreasonably affect human or animal life or vegetation as required by Section 161. Compliance with all applicable toxic air pollutant carcinogenic increments and toxic air pollutant non-carcinogenic increments will also demonstrate preconstruction compliance with Section 161 with regards to the pollutants listed in Sections 585 and 586.*

Atmospheric dispersion modeling, using computerized simulations, is used to demonstrate compliance with both NAAQS and TAPs. Idaho Air Rules Section 202.02 states:

***02. Estimates of Ambient Concentrations**. All estimates of ambient concentrations shall be based on the applicable air quality models, data bases, and other requirements specified in 40 CFR 51 Appendix W (Guideline on Air Quality Models).*

2.4 Significant Impact Level and Cumulative NAAQS Impact Analyses

If specific criteria pollutant emission increases associated with the proposed permitting project cannot qualify for a BRC exemption as per Idaho Air Rules Section 221, then the permit cannot be issued unless the application demonstrates that applicable emission increases will not cause or significantly contribute to a violation of NAAQS, as required by Idaho Air Rules Section 203.02.

The first phase of a NAAQS compliance demonstration is to evaluate whether the proposed facility/project could have a significant impact to ambient air. Section 3.1.1 of this memorandum describes the applicability evaluation of Idaho Air Rules Section 203.02. The Significant Impact Level (SIL) analysis for a new facility or proposed modification to a facility involves modeling estimated criteria air pollutant emissions from the facility or modification to determine the potential impacts to ambient air. Air impact analyses are required by Idaho Air Rules to be conducted in accordance with methods outlined in Appendix W. Appendix W requires that facilities be modeled using emissions and operations representative of design capacity or as limited by a federally enforceable permit condition.

A facility or modification is considered to have a significant impact on air quality if maximum modeled impacts to ambient air exceed the established SIL listed in Idaho Air Rules Section 006 (referred to as a "significant contribution" in Idaho Air Rules) or as incorporated by reference as per Idaho Air Rules Section 107.03.b. Table 2 lists the applicable SILs.

Table 2. APPLICABLE REGULATORY LIMITS.

Pollutant	Averaging Period	Significant Impact Levels[a] (µg/m^3)[b]	Regulatory Limit [c] (µg/m^3)	Modeled Design Value Used[d]
PM_{10}[e]	24-hour	5.0	150[f]	Maximum 6th highest[g]
$PM_{2.5}$[h]	24-hour	1.2	35[i]	Mean of maximum 8th highest[j]
	Annual	0.2	12[k]	Mean of maximum 1st highest[l]
Carbon monoxide (CO)	1-hour	2,000	40,000[m]	Maximum 2nd highest[n]
	8-hour	500	10,000[m]	Maximum 2nd highest[n]
Sulfur Dioxide (SO_2)	1-hour	3 ppb[o] (7.8 µg/m^3)	75 ppb[p] (196 µg/m^3)	Mean of maximum 4th highest[q]
	3-hour	25	1,300[m]	Maximum 2nd highest[n]
Nitrogen Dioxide (NO_2)	1-hour	4 ppb (7.5 µg/m^3)	100 ppb[s] (188 µg/m^3)	Mean of maximum 8th highest[t]
	Annual	1.0	100[r]	Maximum 1st highest[n]
Lead (Pb)	3-month[u]	NA	0.15[r]	Maximum 1st highest[n]

	Quarterly	NA	1.5[r]	Maximum 1st highest[n]
Ozone (O_3)	8-hour	40 TPY VOC[v]	70 ppb[w]	Not typically modeled

a. Idaho Air Rules Section 006 (definition for significant contribution) or as incorporated by reference as per Idaho Air Rules Section 107.03.b.
b. Micrograms per cubic meter.
c. Incorporated into Idaho Air Rules by reference, as per Idaho Air Rules Section 107.
d. The maximum 1st highest modeled value is always used for the significant impact analysis unless indicated otherwise. Modeled design values are calculated for each ambient air receptor.
e. Particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers.
f. Not to be exceeded more than once per year on average over 3 years.
g. Concentration at any modeled receptor when using five years of meteorological data.
h. Particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers.
i. 3-year mean of the upper 98th percentile of the annual distribution of 24-hour concentrations.
j. 5-year mean of the 8th highest modeled 24-hour concentrations at the modeled receptor for each year of meteorological data modeled. For the SIL analysis, the 5-year mean of the 1st highest modeled 24-hour impacts at the modeled receptor for each year.
k. 3-year mean of annual concentration.
l. 5-year mean of annual averages at the modeled receptor.
m. Not to be exceeded more than once per year.
n. Concentration at any modeled receptor.
o. Interim SIL established by EPA policy memorandum.
p. 3-year mean of the upper 99th percentile of the annual distribution of maximum daily 1-hour concentrations.
q. 5-year mean of the 4th highest daily 1-hour maximum modeled concentrations for each year of meteorological data modeled. For the significant impact analysis, the 5-year mean of 1st highest modeled 1-hour impacts for each year is used.
r. Not to be exceeded in any calendar year.
s. 3-year mean of the upper 98th percentile of the annual distribution of maximum daily 1-hour concentrations.
t. 5-year mean of the 8th highest daily 1-hour maximum modeled concentrations for each year of meteorological data modeled. For the significant impact analysis, the 5-year mean of maximum modeled 1-hour impacts for each year is used.
u. 3-month rolling average.
v. An annual emissions rate of 40 ton/year of VOCs is considered significant for O_3.
w. Annual 4th highest daily maximum 8-hour concentration averaged over three years.

If modeled maximum pollutant impacts to ambient air from the emission sources associated with a new facility or modification exceed the SILs, then a cumulative NAAQS impact analysis is necessary to demonstrate compliance with NAAQS and Idaho Air Rules Section 203.02.

A cumulative NAAQS impact analysis for attainment area pollutants involves assessing ambient impacts (typically the design values consistent with the form of the standard) from potential/allowable emissions resulting from the project and emissions from any nearby co-contributing sources (including existing emissions from the facility that are unrelated to the project), and then adding a DEQ-approved background concentration value to the modeled result that is appropriate for the criteria pollutant/averaging-period at the facility location and the area of significant impact. The resulting pollutant concentrations in ambient air are then compared to the NAAQS listed in Table 2. Table 2 also specifies the modeled design value that must be used for comparison to the NAAQS. NAAQS compliance is evaluated on a receptor-by-receptor basis for the modeling domain.

If the cumulative NAAQS impact analysis indicates an exceedance of NAAQS, a culpability analysis can determine if this exceedance is due to emissions from the proposed project. The permit may not be issued if the proposed project has a significant contribution (exceeding the SIL) to the modeled violation. If project-specific impacts are below the SIL, then the project does not have a significant contribution to the specific violations.

Compliance with Idaho Air Rules Section 203.02 is generally demonstrated if: a) applicable specific criteria pollutant emission increases are at a level defined as BRC, using the criteria established by DEQ regulatory interpretation (DEQ 2014); or b) all modeled impacts of the SIL analysis are below the

applicable SIL or other level determined to be inconsequential to NAAQS compliance; or c) modeled design values of the cumulative NAAQS impact analysis (modeling all emissions from the facility and co-contributing sources, and adding a background concentration) are less than applicable NAAQS at receptors where impacts from the proposed facility/modification exceeded the SIL or other identified level of consequence; or d) if the cumulative NAAQS analysis showed NAAQS violations, the impact of proposed facility/modification to any modeled violation was inconsequential (typically assumed to be less than the established SIL) for that specific receptor and for the specific modeled time when the violation occurred.

2.5 Toxic Air Pollutant Analyses

Emissions of toxic substances are generally addressed by Idaho Air Rules Section 161:

> *Any contaminant which is by its nature toxic to human or animal life or vegetation shall not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation.*

Permitting requirements for toxic air pollutants (TAPs) from new or modified sources are specifically addressed by Idaho Air Rules Section 203.03 and require the applicant to demonstrate to the satisfaction of DEQ the following:

> *Using the methods provided in Section 210, the emissions of toxic air pollutants from the stationary source or modification would not injure or unreasonably affect human or animal life or vegetation as required by Section 161. Compliance with all applicable toxic air pollutant carcinogenic increments and toxic air pollutant non-carcinogenic increments will also demonstrate preconstruction compliance with Section 161 with regards to the pollutants listed in Sections 585 and 586.*

Per Section 210, if the total project-wide emission increase of any TAP associated with a new source or modification exceeds screening emission levels (ELs) of Idaho Air Rules Section 585 or 586, then the ambient impact of the emission increase must be estimated. If ambient impacts are less than applicable Acceptable Ambient Concentrations (AACs) for non-carcinogens of Idaho Air Rules Section 585 and Acceptable Ambient Concentrations for Carcinogens (AACCs) of Idaho Air Rules Section 586, then compliance with TAP requirements has been demonstrated.

TAPs also classified as HAPs emitted from sources addressed by New Source Performance Standards (NSPS) or National Emission Standards for Hazardous Air Pollutants (NESHAP) were not required to be evaluated for compliance with TAP increments in accordance with IDAPA 58.01.01.210.20 (Subsection 210.20). The DEQ permit writer evaluates the applicability of specific TAPs to the Subsection 210.20 exclusion. Guidance and clarification of Subsection 210.20 source exemptions are included in the DEQ Statement of Basis.

IDAPA 58.01.01.215 sets requirements for mercury emissions. For this standard, fugitive emissions and sources in a source category subject to 40 CFR 63 are exempt. The DEQ permit writer evaluates the applicability of mercury emissions to the exemption criteria. Details are provided in the DEQ Statement of Basis. Adjusted mercury emissions from non-fugitive and non-NESHAP-addressed sources were below the level (25 pounds per year) at which Mercury Best Available Control Technology (MBACT) review is required.

3.0 Analytical Methods and Data

This section describes the methods and data used in the analyses to demonstrate compliance with applicable air quality impact requirements. The DEQ Statement of Basis provides a discussion of the methods and data used to estimate criteria and TAP emission rates.

3.1 Emission Source Data

Emissions of criteria pollutants and TAPs resulting from operation of the SGP facility were estimated by Air Sciences for various applicable averaging periods. The calculation of potential emissions is the responsibility of the DEQ permit writer, and the representativeness and accuracy of emission estimates is not addressed in this modeling memorandum. DEQ air impact analysts are responsible for assuring that potential emission rates provided in the emission inventory are properly used in the model. The rates listed must represent the maximum allowable rate as averaged over the specified period.

Emission rates used in the impact modeling applicability analyses and any modeling analyses, as listed in this memorandum, should be reviewed by the DEQ permit writer and compared with those in the final emission inventory. All modeled criteria air pollutant and TAP emission rates must be equal to or greater than the facility's potential emissions calculated in the PTC emission inventory or proposed permit allowable emission rates.

Emissions from unpaved roads were calculated based on a control efficiency of 90% from chemical application and 33% from watering (combined control efficiency above 93%). Emission controls and emission calculations are not reviewed in this modeling memorandum. However, it is critical for NAAQS compliance that this high level of control be achieved.

Activity-specific (e.g., drilling, blasting, material crushing and conveying, refining, and other ancillary sources) emissions were estimated based on maximum activity rates, coupled with applicable emission estimation techniques. Maximum emissions were calculated on a short-term (hourly and daily) and long-term (annual) basis for ore processing and mining operations, as discussed below.

The ore-processing rate will range from 20,000 ton/day to 25,000 ton/day at full production. Therefore, maximum potential daily ore processing emissions were based on the maximum design rate of 25,000 ton/day. Maximum potential annual emissions were based on potential daily emissions multiplied by 365 days per year.

Emissions from mining operations (drilling, blasting, material extraction and movement, mobile mine machinery use, and other ancillary sources) vary for each year of the life of the mine (LOM). However, for the modeling analyses, the mining operation potential emissions were estimated using conservatively high maximum activity rates provided in Table 3.

Table 3. MINING ACTIVITY RATES FOR POTENTIAL EMISSION CALCULATIONS.

Activity	Maximum Rate		Comments
Drilling	600	holes per blast	--
Blasting	2	blasts per day	--
	1	blast per hour	--
Material extraction and hauling	180,000	tons per day	Ore or DR
Onsite dozing	144	hours per day	6 dozers operating continuously
Onsite grading	72	hours per day	3 graders operating continuously
Onsite water trucking	48	hours per day	2 trucks operating continuously

The potential hourly emission rates for ore processing and mining operation activities were calculated by dividing the daily rate by the 24 hour-per-day operation schedule, and annual rates were calculated by multiplying maximum daily emissions with 365 days per year. This is conservative because the mine is expected to operate for only 355 days per year.

The maximum mine production rate is approximately 42.7 million (MM) tons per year (ton/yr); however, a maximum daily production rate of 180,000 ton/day used for potential emission calculations results in a conservatively higher production rate of approximately 65.7 MMton/yr, approximately 50 percent higher than the projected production rate.

Midas Gold will employ newer model year mining and maintenance machines (excavators, shovels, haul trucks, dozers, graders, portable light plants, etc.) that are expected to meet or exceed applicable regulatory emission standards. Non-road mobile equipment engines are exempt from permitting requirements; therefore, the tailpipe emissions resulting from fuel combustion in the non-road mobile equipment are not quantified for the SGP facility. Background concentrations from McCall, 38 miles west of the SGP, were used in the cumulative NAAQS impact analyses (Section 4.1.2) to conservatively account for the impact contribution of traffic emissions.

The approximately 38-mile long Burntlog Route mine access road will be outside the project ambient air boundary and open to the public. Traffic emissions on public roads generally are considered to be part of background concentrations. Therefore, emissions on the Burntlog Route mine access road that are outside of the project boundary are not included in the SGP analyses. However, the emissions associated with the portion of the Burntlog Route mine access road that is within project boundary (from the south gate to the process area) are included in the SGP analyses. These include dust emissions generated from travel of maintenance equipment, light-duty pickup trucks and buses used for employee, visitor, and contractor transportation, and heavy-duty trucks used for cargo (including fuel, consumables, machine parts, ore processing supplies, ore concentrate, etc.) and services (including food supplies, trash, recyclables, etc.) transportation.

3.1.1 Criteria Pollutant Modeling Applicability and Modeled Emission Rates

If project-specific emission increases for criteria pollutants would qualify for a BRC permit exemption as per Idaho Air Rules Section 221 if it were not for potential emissions of one or more pollutants exceeding the BRC threshold of 10 percent of emissions defined by Idaho Air Rules as significant, then a NAAQS compliance demonstration may not be required for those pollutants with emissions below BRC levels. DEQ's regulatory interpretation policy of exemption provisions of Idaho Air Rules is that: "*A DEQ NAAQS compliance assertion will not be made by the DEQ modeling group for specific criteria pollutants having a project emissions increase below BRC levels, provided the proposed project would have qualified for a Category I Exemption for BRC emissions quantities except for the emissions of another criteria pollutant*" (DEQ 2014). The interpretation policy also states that the exemption criteria of uncontrolled potential to emit (PTE) not to exceed 100 ton/year (Idaho Air Rules Section 220.01.a.i) is not applicable when evaluating whether a NAAQS impact analyses is required. A permit will be issued limiting PTE below 100 ton/year, thereby negating the need to maintain calculated uncontrolled PTE under 100 ton/year. The BRC exemption cannot be used to exempt a project from a pollutant-specific NAAQS compliance demonstration in most cases where a PTC is required for the action regardless of emission quantities, such as the modification of an existing emission or throughput limit.

A NAAQS compliance demonstration must be performed for pollutant increases that would not qualify for the BRC exemption from the requirement to demonstrate compliance with NAAQS.

Site-specific air impact modeling analyses may not be necessary for some pollutants, even where such emissions do not qualify for the BRC exemption. DEQ has developed modeling applicability thresholds, below which a site-specific modeling analysis is not required. DEQ generic air impact modeling analyses that were used to develop the modeling thresholds provide a conservative SIL analysis for projects with emissions below identified threshold levels. Project-specific modeling applicability thresholds are provided in the *Idaho Air Modeling Guideline* (DEQ 2013). These thresholds were based on assuring an ambient impact of less than the established SIL for specific pollutants and averaging periods.

If total project-specific emission rate increases of a pollutant are below Level I Modeling Applicability Thresholds, then project-specific air impact analyses are not necessary for permitting. Use of Level II Modeling Applicability Thresholds is conditional, requiring DEQ approval. DEQ approval is based on dispersion-affecting characteristics of the emission sources such as stack height, stack gas exit velocity, stack gas temperature, distance from sources to ambient air, presence of elevated terrain, and potential exposure to sensitive public receptors.

For the SGP analyses, several modeling scenarios were considered to evaluate the worst-case air impacts from the SGP facility. The different modeling scenarios are discussed in Section 3.1.3. Table 4 provides a comparison between facility-wide maximum PTE for the highest-emitting scenario (W3) and modeling applicability thresholds. The short-term and long-term PTE emissions are equal to the sum of process and ancillary emissions and mining fugitive emissions. It is important to note that the process and ancillary source emissions remain the same for each modeling scenario discussed in Section 3.1.3.

Table 4. SITE-SPECIFIC CRITERIA POLLUTANT MODELING APPLICABILITY.

Source Category	Carbon Monoxide (CO)	Nitrogen Oxides (NOx)		$PM_{2.5}$[a]		PM_{10}[b]	Sulfur Dioxide (SO_2)		Lead (Pb)
	lb/hr[c]	ton/yr[d]	lb/hr	ton/yr	lb/hr	lb/hr	ton/yr	lb/hr	lb/month[e]
Process and ancillary	33.5	37.9	55.4	36.4	13.4	21.7	6.5	1.88	0.0437
Mining fugitive	1,742.0	17.1	46.8	98.9	22.5	224.7	0.03	0.09	--
Total	1,775.5	55.0	102.2	135.3	35.9	246.4	6.5	1.97	0.0437
Level I threshold	15.0	1.2	0.2	0.35	0.054	0.22	1.2	0.21	14.0
Modeling required	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

a. Particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers.
b. Particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometer.
c. Pounds per hour.
d. Tons per year.
e. Pounds per month.

As indicated in Table 4, the SGP facility-wide maximum PTE are greater than the respective Level I thresholds for all criteria pollutants and averaging periods except for Pb. Therefore, modeling is triggered for applicable averaging periods for CO, NOx, $PM_{2.5}$, PM_{10}, and SO_2. Modeling is not required for Pb. The use of Level II modeling thresholds was not approved by DEQ for this project.

Tables 5-7 list criteria pollutant emission rates used in the cumulative NAAQS impact analyses for the worst-case modeling scenarios. Significant Impact Level (SIL) analyses were not performed. Based on the magnitude of the facility-wide emissions and preliminary modeling analyses, it was determined that the impacts from the SGP emissions exceeded the SIL for most criteria pollutants. Therefore, SIL

analyses were considered redundant and not performed for this report. Table 5 lists the source-specific modeled emission rates for 24-hour and annual $PM_{2.5}$ and 24-hour PM_{10} (worst-case modeling scenario: W5). Table 6 lists the source-specific modeled emission rates for 1-hour and 8-hour CO and annual NO_2 (worst-case modeling scenario: W1). Table 7 lists the source-specific modeled emission rates for 1-hour NO_2 and 1-hour and 3-hour SO_2 (worst-case modeling scenario: B1). Modeling scenarios are discussed in Section 3.1.3. For 1-, 3-, and 8-hour averaging times, hourly emission rates provided in pounds per hour were used. For 24-hour averaging time, daily emission rates provided in pounds per day were used. For the annual averaging time, annual emission rates provided in tons per year were used. All modeled emission rates in Tables 5-7 are listed in units of pounds per hour (lb/hr). The total modeled input emission rates (highest emission scenario) are listed in Table 8.

Table 5. MODELED 24-HOUR PM_{10}, 24-HOUR $PM_{2.5}$, AND ANNUAL $PM_{2.5}$ EMISSION RATES FOR CUMULATIVE NAAQS IMPACT ANALYSES (WORST-CASE MODELING SCENARIO, W5).

Type of Source	Source ID	Description	24-hour PM_{10} (lb/hr)[a]	24-hour $PM_{2.5}$ (lb/hr)	Annual $PM_{2.5}$ (lb/hr)
Point Sources	LS1L	Mill Lime Silo #1 Loading	3.54E-03	5.21E-04	2.50E-05
	MILLS2L	Mill Lime Silo #2 Loading	3.54E-03	5.21E-04	2.50E-05
	SB1	Sb Dryer (2.72 MMBtu/hr Propane-Fired)	2.08E-02	2.08E-02	2.08E-02
	SB2	Sb Bagging	1.18E-01	1.18E-01	1.18E-01
	AC	Autoclave	5.08E+00	5.08E+00	5.08E+00
	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	5.42E-03	5.42E-03	4.45E-04
	ACS1L	AC Lime Silo #1 Loading	1.42E-02	2.08E-03	9.99E-05
	ACS2L	AC Lime Silo #2 Loading	1.42E-02	2.08E-03	9.99E-05
	ACS3L	AC Lime Silo #3 Loading	1.42E-02	2.08E-03	9.99E-05
	ACS4L	AC Lime Silo #4 Loading	7.08E-03	1.04E-03	4.99E-05
	CKD	Carbon Regeneration (Drum)	4.20E-01	4.20E-01	4.20E-01
	CKB	Carbon Regeneration (Kiln)	1.73E-02	1.73E-02	1.73E-02
	EW	Electrowinning Cells and Pregnant Solution Tank	7.00E-02	7.00E-02	7.00E-02
	MR	Mercury Retort	1.00E-02	1.00E-02	1.42E-03
	MF	Induction Melting Furnace	1.42E+00	1.42E+00	2.02E-01
	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	1.84E-02	1.84E-02	5.03E-03
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	1.84E-02	1.84E-02	5.03E-03
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	1.84E-02	1.84E-02	5.03E-03
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	3.67E-03	3.67E-03	1.01E-03
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	7.65E-04	7.65E-04	7.65E-04
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	3.83E-02	3.83E-02	3.83E-02
	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	3.06E-02	3.06E-02	3.06E-02
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	3.06E-02	3.06E-02	3.06E-02
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	3.06E-02	3.06E-02	3.06E-02
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	1.91E-03	1.91E-03	1.91E-03
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	1.91E-03	1.91E-03	1.91E-03
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	1.91E-03	1.91E-03	1.91E-03

Table 5. MODELED 24-HOUR PM_{10}, 24-HOUR $PM_{2.5}$, AND ANNUAL $PM_{2.5}$ EMISSION RATES FOR CUMULATIVE NAAQS IMPACT ANALYSES (WORST-CASE MODELING SCENARIO, W5).					
Type of Source	**Source ID**	**Description**	**24-hour PM_{10} (lb/hr)[a]**	**24-hour $PM_{2.5}$ (lb/hr)**	**Annual $PM_{2.5}$ (lb/hr)**
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	3.83E-03	3.83E-03	3.83E-03
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	1.53E-02	1.53E-02	1.53E-02
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	2.30E-02	2.30E-02	2.30E-02
	PSL	Prill Silos Loading (2 x 100 ton)	5.83E-02	8.83E-03	8.83E-04
	CS1L	Cement/Shotcrete Silo #1 Loading	1.13E-03	1.67E-04	3.42E-04
	CS2L	Cement/Shotcrete Silo #2 Loading	1.13E-03	1.67E-04	3.42E-04
	LS6	Limestone transfer to Ball Mill Feed Bin	5.18E-02	8.00E-03	6.17E-03
	LSBM	Limestone Ball Mill	1.60E+00	5.70E-01	4.39E-01
	LS9	Limestone transfer to Kiln Feed Bin	1.22E-02	1.89E-03	1.60E-03
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	9.15E-01	9.15E-01	7.77E-01
	LKC	PFR Shaft Lime Kiln Combustion	1.69E-01	1.69E-01	1.43E-01
	LCR	Lime Mill Crushing and associated transfers In and Out	2.39E-01	8.52E-02	7.23E-02
	LSL	Pebble Lime Silo Loading via Bucket Elevator	6.20E-03	6.20E-03	5.26E-03
Area Sources	WEP	West End Pit	3.69E+01	3.32E+00	3.32E+00
	UGEXP	Underground Exploration	1.66E-04	2.51E-05	2.51E-05
Line Sources	AR01	Access Road within Operations Boundary	7.02E-02	7.02E-03	7.03E-03
	AR02	Access Road within Operations Boundary	5.39E-02	5.40E-03	5.41E-03
	AR03	Access Road within Operations Boundary	1.36E-01	1.36E-02	1.37E-02
	AR04	Access Road within Operations Boundary	1.31E-01	1.31E-02	1.31E-02
Volume Sources	WEPBL	West End Pit Blasting	1.39E+01	8.04E-01	8.04E-01
	WEDRSF	West End Pit Development Rock Storage Facility	2.38E+00	1.26E+00	1.26E+00
	OC1	Loader Transfer of Ore to Grizzly	4.79E-02	1.35E-02	1.35E-02
	OC2	Grizzly to Apron Feeder	4.79E-02	1.35E-02	1.35E-02
	OC3	Apron Feeder to Dribble Conveyor	4.79E-02	1.35E-02	1.35E-02
	OC4	Apron Feeder to Vibrating Grizzly	4.79E-02	1.35E-02	1.35E-02
	OC5	Dribble Conveyor to Vibrating Grizzly	4.79E-02	1.35E-02	1.35E-02
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	4.79E-02	1.35E-02	1.35E-02
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	5.63E-01	1.04E-01	1.04E-01
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	4.79E-02	1.35E-02	1.35E-02
	OC9	Stockpile Transfers to Reclaim Conveyors	2.53E-01	3.91E-02	3.91E-02
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	2.53E-01	3.91E-02	3.91E-02
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	2.53E-01	3.91E-02	3.91E-02
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	6.21E-01	1.15E-01	1.15E-01
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	5.29E-02	1.50E-02	1.50E-02
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	2.92E-02	4.37E-03	2.10E-04
	MILLS2U	Mill Lime Silo #2 Unloading to SAG Mill	2.92E-02	4.37E-03	2.10E-04

Table 5. MODELED 24-HOUR PM_{10}, 24-HOUR $PM_{2.5}$, AND ANNUAL $PM_{2.5}$ EMISSION RATES FOR CUMULATIVE NAAQS IMPACT ANALYSES (WORST-CASE MODELING SCENARIO, W5).					
Type of Source	**Source ID**	**Description**	**24-hour PM_{10} (lb/hr)[a]**	**24-hour $PM_{2.5}$ (lb/hr)**	**Annual $PM_{2.5}$ (lb/hr)**
		Conveyor			
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	5.60E-02	8.00E-03	7.99E-04
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	5.60E-02	8.00E-03	7.99E-04
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	5.60E-02	8.00E-03	7.99E-04
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	5.60E-02	8.00E-03	4.00E-04
	PSU	Prill Silos Unloading (2 x 100 ton)	5.83E-02	8.83E-03	8.83E-04
	CS1U	Cement/Shotcrete Silo #1 Unloading	9.33E-03	1.33E-03	2.74E-03
	CS2U	Cement/Shotcrete Silo #2 Unloading	9.33E-03	1.33E-03	2.74E-03
	CAL	Aggregate Bin Loading	3.30E-01	5.00E-02	2.85E-02
	CAU	Aggregate Bin Unloading	3.30E-01	5.00E-02	2.85E-02
	CM	Central Mixer Loading	1.83E-02	2.67E-03	5.48E-03
	PCSP1	Portable Crushing and Screening Plant 1	2.33E-01	3.04E-02	3.04E-02
	PCSP2	Portable Crushing and Screening Plant 2	2.33E-01	3.04E-02	3.04E-02
	LS1	Limestone transfer to Primary Crusher Hopper	5.18E-02	8.00E-03	6.17E-03
	LS2	Primary Crushing and Associated Transfers In and Out	1.13E-01	1.69E-02	1.31E-02
	LS3	Primary Screening and Associated Transfers In and Out	4.10E-01	6.21E-02	4.79E-02
	LS4	Secondary Crushing and Associated Transfers In and Out	1.13E-01	1.69E-02	1.31E-02
	LS5	Secondary Screening and Associated Transfers In and Out	4.10E-01	6.21E-02	4.79E-02
	LS7	Limestone transfer to Ball Mill Feed Conveyor	5.18E-02	8.00E-03	6.17E-03
	LS8	Ball Mill Feed transfer to Ball Mill	5.18E-02	8.00E-03	6.17E-03
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	1.22E-02	1.89E-03	1.60E-03
	LS11	Fines Screening and Associated Transfers In and Out	9.68E-02	1.47E-02	1.25E-02
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	1.22E-02	1.89E-03	1.60E-03
	LSU	Pebble Lime Silo discharge to Lime Slaker	6.20E-04	6.20E-04	5.26E-04
	HRT001-HRT072	Haul Road[b]	9.09E-01	9.10E-02	9.11E-02
	HRN001-HRN022	Haul Road[b]	9.09E-01	9.10E-02	9.11E-02

a. Pounds per hour.

b. The Haul Road was represented in the model as a series of volume sources. The emission rates listed in this table represent each individual volume source.

Table 6. MODELED 1-HOUR CO, 8-HOUR CO, and ANNUAL NO_2 EMISSION RATES FOR CUMULATIVE NAAQS IMPACT ANALYSES (WORST-CASE MODELING SCENARIO, W1).				
Type of Source	**Source ID**	**Description**	**1-hour, 8-hour CO (lb/hr)[a]**	**Annual NO_2 (lb/hr)**
Point Sources	SB1	Sb Dryer (2.72 MMBtu/hr Propane-Fired)	2.23E-01	3.86E-01
	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	1.39E+00	8.27E-03
	CKD	Carbon Regeneration (Drum)	1.20E-01	1.20E-02
	CKB	Carbon Regeneration (Kiln)	1.85E-01	3.20E-01
	EDG1	Camp Emergency Generator (Mfr. Yr.	7.72E+00	1.61E-01

		>2007; diesel)		
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	7.72E+00	1.61E-01
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	7.72E+00	1.61E-01
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	1.54E+00	2.01E-02
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	8.20E-03	1.42E-02
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	4.10E-01	7.10E-01
	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	3.28E-01	5.68E-01
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	3.28E-01	5.68E-01
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	3.28E-01	5.68E-01
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	2.05E-02	3.55E-02
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	2.05E-02	3.55E-02
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	2.05E-02	3.55E-02
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	4.10E-02	7.10E-02
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	1.64E-01	2.84E-01
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	2.46E-01	4.26E-01
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	3.17E+00	1.44E+00
	LKC	PFR Shaft Lime Kiln Combustion	1.81E+00	2.66E+00
Volume Source	WEPBL	West End Pit Blasting	1.74E+03	3.90E+00

[a.] Pounds per hour.

Table 7. MODELED 1-HOUR NO_2, 1-HOUR SO_2, AND 3-HOUR SO_2 EMISSION RATES FOR CUMULATIVE NAAQS IMPACT ANALYSES (WORST-CASE MODELING SCENARIO, B1).

Type of Source	Source ID	Description	1-hour NO_2 (lb/hr)[a]	1-hour, 3-hour SO_2 (lb/hr)
Point Sources	SB1	Sb Dryer (2.72 MMBtu/hr Propane-Fired)	3.86E-01	4.73E-02
	AC	Autoclave	0.00E+00	6.53E-01
	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	2.42E+00	2.95E-01
	CKD	Carbon Regeneration (Drum)	1.20E-02	0.00E+00
	CKB	Carbon Regeneration (Kiln)	3.20E-01	3.92E-02
	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0.00E+00	1.45E-02
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0.00E+00	1.45E-02
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0.00E+00	1.45E-02
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0.00E+00	2.90E-03
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	1.42E-02	1.74E-03
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	7.10E-01	8.69E-02
	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-	5.68E-01	6.95E-02

		Fired)		
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	5.68E-01	6.95E-02
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	5.68E-01	6.95E-02
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	3.55E-02	4.34E-03
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	3.55E-02	4.34E-03
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	3.55E-02	4.34E-03
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	7.10E-02	8.69E-03
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	2.84E-01	3.48E-02
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	4.26E-01	5.21E-02
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	1.69E+00	8.45E-03
	LKC	PFR Shaft Lime Kiln Combustion	3.13E+00	3.83E-01
Volume Source	BTBL	Bradley Tailings Blasting	4.68E+01	9.36E-02

[a.] Pounds per hour.

Table 8. CRITERIA POLLUTANT TOTAL MODELED EMISSION RATES (WORST-CASE MODELING SCENARIOS).

Pollutant	Averaging Time	Emissions[a]	
CO	8 hours	1,775.50	lb/hr
	1 hour	1,775.50	lb/hr
NO_2	1 year	54.93	ton/yr
	1 hour	58.07	lb/hr
$PM_{2.5}$	1 year	135.23	ton/yr
	24 hours	781.69	lb/day
PM_{10}	24 hours	5,768.93	lb/day
SO_2	3 hours	1.97	lb/hr
	1 hour	1.97	lb/hr

[a.] Combined process, ancillary, and fugitive emissions modeled. Fugitive emissions vary by pit scenario. Maximum pit scenario emissions are shown.

Ozone (O_3) differs from other criteria pollutants in that it is not typically emitted directly into the atmosphere. O_3 is formed in the atmosphere through reactions of VOCs, NOx, and sunlight. Atmospheric dispersion models used in stationary source air permitting analyses cannot be used to estimate O_3 impacts resulting from VOC and NOx emissions from an industrial facility. O_3 concentrations resulting from area-wide emissions are predicted by using more complex airshed models such as the Community Multi-Scale Air Quality (CMAQ) modeling system. Use of the CMAQ model is very resource-intensive and DEQ asserts that performing a CMAQ analysis for a particular permit application is not typically a reasonable or necessary requirement for air quality permitting.

Addressing secondary formation of O_3 within the context of permitting a new stationary source has been somewhat addressed in EPA regulation and policy. As stated in a letter from Gina McCarthy of EPA to Robert Ukeiley, acting on behalf of the Sierra Club (letter from Gina McCarthy, Assistant Administrator, United States Environmental Protection Agency, to Robert Ukeiley, January 4, 2012):

. . . footnote 1 to sections 51.166(I)(5)(I) of the EPA's regulations says the following: "No de minimis air quality level is provided for ozone. However, any net emission increase of 100 tons per year or more of volatile organic compounds or nitrogen oxides subject to PSD would be required to perform an ambient impact analysis, including the gathering of air quality data."

"The EPA believes it unlikely a source emitting below these levels would contribute to such a violation of the 8-hour ozone NAAQS, but consultation with an EPA Regional Office should still be conducted in accordance with section 5.2.1.c. of Appendix W when reviewing an application for sources with emissions of these ozone precursors below 100 TPY."

DEQ determined it was not appropriate or necessary to require a quantitative source-specific O_3 impact analysis because allowable emission estimates of VOCs and NOx are below the 100 tons/year threshold.

3.1.2 TAPs Modeling Applicability and Modeled Emission Rates

A comparison of the applicable non-carcinogenic and carcinogenic screening emission levels (EL) for the TAP from IDAPA 58.01.01, Sections 585 and 586, respectively, with applicable facility-wide maximum potential TAP emissions for the highest-emitting scenario (W3) is provided in Table 9. Note that TAPs also classified as HAPs emitted from sources addressed by NSPS or NESHAP were not required to be evaluated for compliance with TAP increments in accordance with IDAPA 58.01.01.210.20.

Table 9. TAP MODELING APPLICABILITY DETERMINATION.

HAP/TAP	Emissions (lb/hr)			EL (lb/hr)		Determination
	(a)	(b)	Total	(c)	(d)	
1,3-Butadiene	--	--	--	--	2.4E-5	EL not exceeded
3-Methylchloranthrene	--	3.2E-8	3.2E-8	--	2.5E-6	EL not exceeded
Acetaldehyde	--	--	--	--	3.0E-3	EL not exceeded
Acrolein	--	--	--	1.7E-2	--	EL not exceeded
Antimony	--	--	--	3.3E-2	--	EL not exceeded
Arsenic	--	5.7E-6	5.7E-6	--	1.5E-6	Carcinogenic EL exceeded
Benzene	--	3.8E-5	3.8E-5	--	8.0E-4	EL not exceeded
Benzo(a)pyrene[e]	--	2.1E-8	2.0E-7	--	2.0E-6	EL not exceeded
Benz(a)anthracene[e]	--	3.2E-8				
Benzo(b)fluoranthene[e]	--	3.2E-8				
Benzo(k)fluoranthene[e]	--	3.2E-8				
Chrysene[e]	--	3.2E-8				
Dibenzo(a,h)anthracene[e]	--	2.1E-8				
Indenol(1,2,3-cd)pyrene[e]	--	3.2E-8				
Beryllium	--	2.3E-7	2.3E-7	--	2.8E-5	EL not exceeded
Biphenyl	--	--	--	1.0E-1	--	EL not exceeded
Cadmium	--	2.0E-5	2.0E-5	--	3.7E-6	Carcinogenic EL exceeded
Carbon disulfide	--	--	--	2.0E+0	--	EL not exceeded
Chromium	--	2.7E-5	2.7E-5	3.3E-2	--	EL not exceeded
Chromium (VI)	--	3.4E-7	3.4E-7	--	5.6E-7	EL not exceeded
Cobalt	--	1.5E-6	1.5E-6	3.3E-3	--	EL not exceeded
Cyanide	--	--	--	3.3E-1	--	EL not exceeded
Dichlorobenzene	--	2.1E-5	2.1E-5	3.0E+1	--	EL not exceeded
Formaldehyde	--	1.3E-3	1.3E-3	--	5.1E-4	Carcinogenic EL exceeded
Hexane	--	3.2E-2	3.2E-2	1.2E+1	--	EL not exceeded
Hydrogen Chloride	--	--	--	--	5.0E-2	EL not exceeded
Manganese	--	3.6E-5	3.6E-5	6.7E-2	--	EL not exceeded
Naphthalene	--	1.1E-5	1.1E-5	3.3E+0	--	EL not exceeded
Nickel	--	4.0E-5	4.0E-5	--	2.7E-5	Carcinogenic EL exceeded

Table 9. TAP MODELING APPLICABILITY DETERMINATION.						
HAP/TAP	Emissions (lb/hr)			EL (lb/hr)		Determination
	(a)	(b)	Total	(c)	(d)	
Phenol	--	--	--	1.3E+0	--	EL not exceeded
Phosphorus	--	8.2E-6	8.2E-6	7.0E-3	--	EL not exceeded
PAH (except 7-PAH) [e]	--	--	--	--	9.1E-5	EL not exceeded
Selenium	--	4.3E-7	4.3E-7	1.3E-2	--	EL not exceeded
Toluene	--	6.1E-5	6.1E-5	2.5E+1	--	EL not exceeded
Xylene	--	--	--	2.9E+1	--	EL not exceeded
Aluminum	57.9	6.5E-1	58.5	6.7E-1	--	Non-carcinogenic EL exceeded
Barium	6.5E-1	6.8E-3	6.6E-1	3.3E-2	--	Non-carcinogenic EL exceeded
Calcium Carbonate	11.4	2.24	13.7	6.7E-1	--	Non-carcinogenic EL exceeded
Calcium Oxide	--	7.0E-1	7.0E-1	1.3E-1	--	Non-carcinogenic EL exceeded
Copper	4.1E-3	5.3E-4	4.6E-3	6.7E-2	--	EL not exceeded
Cyclohexane	--	1.0E-3	1.0E-3	7.0E+1	--	EL not exceeded
Hydrogen Sulfide	--	9.0E-1	9.0E-1	9.3E-1	--	EL not exceeded
Iron	14.8	2.1E-1	15.0	6.7E-2	--	Non-carcinogenic EL exceeded
Molybdenum	8.1E-4	4.7E-4	1.3E-3	3.3E-1	--	EL not exceeded
Pentane	--	1.2E-1	1.2E-1	1.2E+2	--	EL not exceeded
Silver	4.1E-4	4.1E-4	8.2E-4	7.0E-3	--	EL not exceeded
Sulfuric Acid	--	2.03	2.03	6.7E-2	--	Non-carcinogenic EL exceeded
Thallium	8.1E-3	5.2E-4	8.7E-3	7.0E-3	--	Non-carcinogenic EL exceeded
Uranium	8.1E-3	5.2E-4	8.7E-3	1.3E-2	--	EL not exceeded
Vanadium	2.3E-2	8.4E-4	2.4E-2	3.0E-3	--	Non-carcinogenic EL exceeded
Trimethyl Benzene	--	1.1E-2	1.1E-2	8.2E+0	--	EL not exceeded
Tungsten	8.1E-3	5.2E-4	8.7E-3	3.3E-1	--	EL not exceeded
Zinc	2.9E-2	2.2E-3	3.1E-2	6.7E-1	--	EL not exceeded

a. Total HAP/TAP emissions for EL evaluation from mining (i.e., pits, blasting, haul roads, stockpiles and DRSF, access road, and underground exploration) and leaching. Emissions from sources addressed by NSPS/NESHAP are not included in the evaluation for modeling applicability.

b. Total HAP/TAP emissions for EL evaluation from processing and production (i.e., ore processing, ore concentration and refining, process heating, lime production, aggregate production, concrete production, HVAC, emergency power, fuel storage). Emissions from sources addressed by NSPS/NESHAP are not included in the evaluation for modeling applicability.

c. Non-carcinogenic EL from IDAPA 58.01.01 Section 585.

d. Carcinogenic EL from IDAPA 58.01.01 Section 586.

e. Polycyclic aromatic hydrocarbon (PAH). The group of seven PAH with a single EL are regulated as polycyclic organic matter (POM) equivalent in potency to benzo(a)pyrene as specified in IDAPA 58.01.01.586.

Table 9 shows that the SGP facility-wide potential TAP emissions exceed the respective EL for arsenic, cadmium, formaldehyde, nickel, aluminum, barium, calcium carbonate, calcium oxide, iron, sulfuric acid, thallium, and vanadium. Therefore, modeling was required for these 12 TAPs.

Table 10 lists the source-specific modeled emission rates for all 12 TAPs (worst-case modeling scenario: W5).

Table 10. MODELED TAP EMISSION RATES (WORST-CASE MODELING SCENARIO, W5).													
Type of Source	**Source ID**	**ALUM[a] (lb/hr)[b]**	**ARSE[c] (lb/hr)**	**BARI[d] (lb/hr)**	**CACA[e] (lb/hr)**	**CADM[f] (lb/hr)**	**CAOX[g] (lb/hr)**	**FORM[h] (lb/hr)**	**IRON (lb/hr)**	**NICK[i] (lb/hr)**	**SULF[j] (lb/hr)**	**THAL[k] (lb/hr)**	**VANA[l] (lb/hr)**
Point Sources	LS1L	2.33E-04	0	1.50E-06	0	0	7.63E-03	0	1.07E-04	0	0	5.16E-08	1.60E-07
	MILLS2L	2.33E-04	0	1.50E-06	0	0	7.63E-03	0	1.07E-04	0	0	5.16E-08	1.60E-07
	SB1	0	0	0	0	0	0	0	0	0	0	0	0
	SB2	0	0	0	0	0	0	0	0	0	0	0	0
	AC	2.31E-05	0	2.31E-05	2.31E-05	0	0	0	2.31E-05	0	2.03E+00	2.31E-05	2.31E-05
	ACB	0	0	3.06E-06	0	0	0	0	0	0	0	0	1.60E-06
	ACS1L	9.32E-04	0	5.98E-06	0	0	3.05E-02	0	4.27E-04	0	0	2.06E-07	6.39E-07
	ACS2L	9.32E-04	0	5.98E-06	0	0	3.05E-02	0	4.27E-04	0	0	2.06E-07	6.39E-07
	ACS3L	9.32E-04	0	5.98E-06	0	0	3.05E-02	0	4.27E-04	0	0	2.06E-07	6.39E-07
	ACS4L	4.66E-04	0	2.99E-06	0	0	1.53E-02	0	2.13E-04	0	0	1.03E-07	3.20E-07
	CKD	9.59E-05	0	9.59E-05	9.59E-05	0	0	0	9.59E-05	0	0	9.59E-05	9.59E-05
	CKB	0	0	9.73E-06	0	0	0	0	0	0	0	0	5.08E-06
	EW	9.59E-05	0	9.59E-05	9.59E-05	0	0	0	9.59E-05	0	0	9.59E-05	9.59E-05
	MR	9.59E-05	0	9.59E-05	9.59E-05	0	0	0	9.59E-05	0	0	9.59E-05	9.59E-05
	MF	9.59E-05	0	9.59E-05	9.59E-05	0	0	0	9.59E-05	0	0	9.59E-05	9.59E-05
	EDG1	0	0	0	0	0	0	0	0	0	0	0	0
	EDG2	0	0	0	0	0	0	0	0	0	0	0	0
	EDG3	0	0	0	0	0	0	0	0	0	0	0	0
	EDFP	0	0	0	0	0	0	0	0	0	0	0	0
	PV	0	0	4.31E-07	0	0	0	0	0	0	0	0	2.25E-07
	HS	0	0	2.16E-05	0	0	0	0	0	0	0	0	1.13E-05
	H1M	0	7.84E-07	1.73E-05	0	4.31E-06	0	2.94E-04	0	8.24E-06	0	0	9.02E-06
	H2M	0	7.84E-07	1.73E-05	0	4.31E-06	0	2.94E-04	0	8.24E-06	0	0	9.02E-06
	HM	0	7.84E-07	1.73E-05	0	4.31E-06	0	2.94E-04	0	8.24E-06	0	0	9.02E-06
	HAC	0	4.90E-08	1.08E-06	0	2.70E-07	0	1.84E-05	0	5.15E-07	0	0	5.64E-07
	HR	0	4.90E-08	1.08E-06	0	2.70E-07	0	1.84E-05	0	5.15E-07	0	0	5.64E-07
	HA	0	4.90E-08	1.08E-06	0	2.70E-07	0	1.84E-05	0	5.15E-07	0	0	5.64E-07
	HMO	0	9.80E-08	2.16E-06	0	5.39E-07	0	3.68E-05	0	1.03E-06	0	0	1.13E-06
	HTS	0	3.92E-07	8.63E-06	0	2.16E-06	0	1.47E-04	0	4.12E-06	0	0	4.51E-06
	HW	0	5.88E-07	1.29E-05	0	3.24E-06	0	2.21E-04	0	6.18E-06	0	0	6.76E-06
	PSL	0	0	0	0	0	0	0	0	0	0	0	0
	CS1L	0	2.90E-08	0	0	0	0	0	0	2.86E-07	0	0	0
	CS2L	0	2.90E-08	0	0	0	0	0	0	2.86E-07	0	0	0
	LS6	3.19E-03	0	2.05E-05	3.88E-02	0	0	0	1.46E-03	0	0	7.06E-07	2.19E-06
	LSBM	4.30E-02	0	2.76E-04	5.22E-01	0	0	0	1.97E-02	0	0	9.51E-06	2.95E-05
	LS9	7.54E-04	0	4.84E-06	9.16E-03	0	0	0	3.45E-04	0	0	1.67E-07	5.17E-07
	LK	2.07E-02	0	1.33E-04	2.51E-01	0	0	0	9.47E-03	0	0	4.58E-06	1.42E-05

Table 10. MODELED TAP EMISSION RATES (WORST-CASE MODELING SCENARIO, W5).													
Type of Source	**Source ID**	**ALUM[a] (lb/hr)[b]**	**ARSE[c] (lb/hr)**	**BARI[d] (lb/hr)**	**CACA[e] (lb/hr)**	**CADM[f] (lb/hr)**	**CAOX[g] (lb/hr)**	**FORM[h] (lb/hr)**	**IRON (lb/hr)**	**NICK[i] (lb/hr)**	**SULF[j] (lb/hr)**	**THAL[k] (lb/hr)**	**VANA[l] (lb/hr)**
	LKC	0	0	9.51E-05	0	0	0	0	0	0	0	0	4.97E-05
	LCR	6.43E-03	0	4.12E-05	0	0	2.11E-01	0	2.94E-03	0	0	1.42E-06	4.41E-06
	LSL	1.40E-04	0	8.99E-07	0	0	4.59E-03	0	6.41E-05	0	0	3.10E-08	9.60E-08
Area Sources	WEP	5.59E+00	0	6.29E-02	1.10E+00	0	0	0	0	0	0	0	0
	UGEXP	2.49E-05	0	2.80E-07	4.91E-06	0	0	0	0	0	0	0	0
Line Sources	AR01	2.02E-02	0	2.28E-04	3.99E-03	0	0	0	0	0	0	0	0
	AR02	1.56E-02	0	1.75E-04	3.07E-03	0	0	0	0	0	0	0	0
	AR03	3.93E-02	0	4.43E-04	7.75E-03	0	0	0	0	0	0	0	0
	AR04	3.77E-02	0	4.25E-04	7.43E-03	0	0	0	0	0	0	0	0
Volume Sources	WEPBL	1.90E+00	0	2.14E-02	3.75E-01	0	0	0	4.88E-01	0	0	2.68E-04	7.50E-04
	WEDRSF	8.58E-01	0	9.66E-03	1.69E-01	0	0	0	2.20E-01	0	0	1.21E-04	3.38E-04
	OC1	1.04E-02	0	1.17E-04	2.04E-03	0	0	0	2.65E-03	0	0	1.46E-06	4.08E-06
	OC2	1.04E-02	0	1.17E-04	2.04E-03	0	0	0	2.65E-03	0	0	1.46E-06	4.08E-06
	OC3	1.04E-02	0	1.17E-04	2.04E-03	0	0	0	2.65E-03	0	0	1.46E-06	4.08E-06
	OC4	1.04E-02	0	1.17E-04	2.04E-03	0	0	0	2.65E-03	0	0	1.46E-06	4.08E-06
	OC5	1.04E-02	0	1.17E-04	2.04E-03	0	0	0	2.65E-03	0	0	1.46E-06	4.08E-06
	OC6	1.04E-02	0	1.17E-04	2.04E-03	0	0	0	2.65E-03	0	0	1.46E-06	4.08E-06
	OC7	8.87E-02	0	1.00E-03	1.75E-02	0	0	0	2.28E-02	0	0	1.25E-05	3.50E-05
	OC8	1.04E-02	0	1.17E-04	2.04E-03	0	0	0	2.65E-03	0	0	1.46E-06	4.08E-06
	OC9	4.90E-02	0	5.52E-04	9.66E-03	0	0	0	1.26E-02	0	0	6.90E-06	1.93E-05
	OC10	4.90E-02	0	5.52E-04	9.66E-03	0	0	0	1.26E-02	0	0	6.90E-06	1.93E-05
	OC11	4.90E-02	0	5.52E-04	9.66E-03	0	0	0	1.26E-02	0	0	6.90E-06	1.93E-05
	OC12	9.80E-02	0	1.10E-03	1.93E-02	0	0	0	2.51E-02	0	0	1.38E-05	3.86E-05
	OC13	1.14E-02	0	1.29E-04	2.25E-03	0	0	0	2.93E-03	0	0	1.61E-06	4.51E-06
	LS1U	1.13E-03	0	7.25E-06	0	0	3.70E-02	0	5.18E-04	0	0	2.50E-07	7.75E-07
	MILLS2U	1.13E-03	0	7.25E-06	0	0	3.70E-02	0	5.18E-04	0	0	2.50E-07	7.75E-07
	ACS1U	2.17E-03	0	1.39E-05	0	0	7.10E-02	0	9.94E-04	0	0	4.80E-07	1.49E-06
	ACS2U	2.17E-03	0	1.39E-05	0	0	7.10E-02	0	9.94E-04	0	0	4.80E-07	1.49E-06
	ACS3U	2.17E-03	0	1.39E-05	0	0	7.10E-02	0	9.94E-04	0	0	4.80E-07	1.49E-06
	ACS42U	2.17E-03	0	1.39E-05	0	0	7.10E-02	0	9.94E-04	0	0	4.80E-07	1.49E-06
	PSU	0	0	0	0	0	0	0	0	0	0	0	0
	CS1U	0	2.90E-08	0	0	0	0	0	0	2.86E-07	0	0	0
	CS2U	0	2.90E-08	0	0	0	0	0	0	2.86E-07	0	0	0
	CAL	1.56E-02	0	1.00E-04	0	0	0	0	7.14E-03	0	0	3.45E-06	1.07E-05
	CAU	1.56E-02	0	1.00E-04	0	0	0	0	7.14E-03	0	0	3.45E-06	1.07E-05
	CM	0	2.03E-06	0	0	4.86E-09	0	0	0	1.70E-06	0	0	0
	PCSP1	1.41E-02	0	9.06E-05	1.72E-01	0	0	0	6.47E-03	0	0	3.12E-06	9.69E-06

Table 10. MODELED TAP EMISSION RATES (WORST-CASE MODELING SCENARIO, W5).													
Type of Source	**Source ID**	**ALUM[a] (lb/hr)[b]**	**ARSE[c] (lb/hr)**	**BARI[d] (lb/hr)**	**CACA[e] (lb/hr)**	**CADM[f] (lb/hr)**	**CAOX[g] (lb/hr)**	**FORM[h] (lb/hr)**	**IRON (lb/hr)**	**NICK[i] (lb/hr)**	**SULF[j] (lb/hr)**	**THAL[k] (lb/hr)**	**VANA[l] (lb/hr)**
	PCSP2	1.41E-02	0	9.06E-05	1.72E-01	0	0	0	6.47E-03	0	0	3.12E-06	9.69E-06
	LS1	3.19E-03	0	2.05E-05	3.88E-02	0	0	0	1.46E-03	0	0	7.06E-07	2.19E-06
	LS2	5.75E-03	0	3.69E-05	6.98E-02	0	0	0	2.63E-03	0	0	1.27E-06	3.94E-06
	LS3	2.66E-02	0	1.71E-04	3.23E-01	0	0	0	1.22E-02	0	0	5.88E-06	1.82E-05
	LS4	5.75E-03	0	3.69E-05	6.98E-02	0	0	0	2.63E-03	0	0	1.27E-06	3.94E-06
	LS5	2.66E-02	0	1.71E-04	3.23E-01	0	0	0	1.22E-02	0	0	5.88E-06	1.82E-05
	LS7	3.19E-03	0	2.05E-05	3.88E-02	0	0	0	1.46E-03	0	0	7.06E-07	2.19E-06
	LS8	3.19E-03	0	2.05E-05	3.88E-02	0	0	0	1.46E-03	0	0	7.06E-07	2.19E-06
	LS10	7.54E-04	0	4.84E-06	9.16E-03	0	0	0	3.45E-04	0	0	1.67E-07	5.17E-07
	LS11	6.29E-03	0	4.03E-05	7.63E-02	0	0	0	2.88E-03	0	0	1.39E-06	4.31E-06
	LS12	7.54E-04	0	4.84E-06	9.16E-03	0	0	0	3.45E-04	0	0	1.67E-07	5.17E-07
	LSU	1.40E-05	0	8.99E-08	0	0	4.59E-04	0	6.41E-06	0	0	3.10E-09	9.60E-09
	HRT001-HRT072[m]	2.62E-01	0	2.95E-03	5.16E-02	0	0	0	6.71E-02	0	0	3.69E-05	1.03E-04
	HRN001-HRN022[m]	2.62E-01	0	2.95E-03	5.16E-02	0	0	0	6.71E-02	0	0	3.69E-05	1.03E-04

a. Aluminum.
b. Pounds per hour.
c. Arsenic.
d. Barium.
e. Calcium carbonate.
f. Cadmium.
g. Calcium oxide.
h. Formaldehyde.
i. Nickel.
j. Sulfuric acid.
k. Thallium.
l. Vanadium.
m. The Haul Road was represented in the model as a series of volume sources. The emission rates listed in this table represent each individual volume source.

3.1.3 Modeling Scenarios

As discussed in Section 2.1, conventional open-pit methods will be used to extract ore and DR from three pits: YPP, HFP, and WEP, and legacy tailings from BT. Ore will be hauled to the crushing area, and the DR will be moved to four DRSF: Yellow Pine (YPDRSF), Hangar Flats (HFDRSF), West End (WEDRSF), and Fiddle (FDRSF). The SGP site layout provided later in Figure 4 shows these locations.

Midas Gold plans for an up to three-year construction schedule to build mine site facilities and infrastructure, as well as the power transmission line, followed by 12 years of mining operations (i.e., LOM Years 1 through 12). Depending on the mine design and operating schedule, mining activity rates will vary temporally and spatially during the 12 years of mine production and operation. For example, ore production varies from approximately 6.8 MMton in LOM Year 1 (67% in YPP, 26% in WEP, and 7% in BT) to 9 MMton in LOM 3 (78% in YPP, 10% in BT, 7% in WEP, and 5% in HFP). Similarly, DR production varies from approximately 4.8 MMton in LOM Year 12 (100% in WEP) to 34 MMton in each of LOM Years 4 through 9, with varying distribution among the four DRSF for each LOM Year. The total material (ore and DR) production varies from approximately 12.5 MMton in LOM Year 12 to 42.7 MMton in LOM Year 4.

Similar to the material production, the distribution and hauling of DR to the four destinations (YPDRSF, HFDRSF, WEDRSF, FDRSF) also will vary for each LOM year. Depending on the material origin (pits and BT) and destination (crushing area and DRSF), material hauling distances also will vary for each LOM year.

Therefore, depending on material production rates and origin, DR destination, and hauling distances, mining emissions will vary spatially and temporally throughout the mine life. For permitting purposes, Midas Gold used a maximum production rate of 180,000 tons of material (ore and/or DR) per day, for an annual production rate of 65.7 MMton/yr. This annual production rate is more than 50% higher than the estimated maximum total material production rate of 42.7 MMton/yr.

In order to allow Midas Gold with operation flexibility and to capture variability in material origin and destination in the air quality analyses, several pit scenarios were developed for the SGP air quality analyses. Each pit scenario uses the maximum production rate of 180,000 ton/day in a single pit and uses a single material destination. Each pit has a dedicated ore scenario that assumes all material produced is ore and is hauled to the crusher area; and depending on mine design multiple DR destination scenarios each assuming all material produced is DR and is transported to a single DRSF. For example, most of the DR from HFP will be moved to HFDRSF and during LOM Years 2 through 10, but a fraction of this rock will be moved to FDRSF during LOM Years 3 and 8, and a fraction to YPDRSF during LOM Year 9. Therefore, in order to evaluate all hauling scenarios originating from HFP, the following four (one for ore hauling, three for DR hauling) HFP scenarios were modeled:

1. HFP Scenario 1 – 180,000 ton/day of ore produced and hauled to the crusher area
2. HFP Scenario 2 – 180,000 ton/day of DR produced and hauled to the FDRSF
3. HFP Scenario 3 – 180,000 ton/day of DR produced and hauled to the HFDRSF
4. HFP Scenario 4 – 180,000 ton/day of DR produced and hauled to the YPDRSF

Overall, 14 scenarios were modeled for $PM_{2.5}$ and PM_{10} analyses to cover all possible origin and destination combinations. Each modeling scenario included processing and ancillary source potential emissions. The multiple scenarios modeled for $PM_{2.5}$ and PM_{10} analyses are presented in Table 11. This table also shows the six origin/destination options that are not applicable to the SGP Project as denoted by

"0 ton/day." These six scenarios are not feasible because the timing of the activity within the sequence of mine operations makes the scenarios logistically impossible.

Table 11. MODELING SCENARIOS FOR $PM_{2.5}$ AND PM_{10} ANALYSES.									
Pit Scenario	**Pit/Origin (ton/day)**				**Ore Destination (ton/day)**	**DR Destination (ton/day)**			
	YPP	**HFP**	**WEP**	**BT**	**STKP**	**FDRSF**	**HFDRSF**	**YPDRSF**	**WEDRSF**
Y1	180,000	--	--	--	180,000	--	--	--	--
Y2	180,000	--	--	--	--	180,000	--	--	--
Y3	180,000	--	--	--	--	--	180,000	--	--
Y4	0	--	--	--	--	--	--	0	--
Y5	0	--	--	--	--	--	--	--	0
H1	--	180,000	--	--	180,000	--	--	--	--
H2	--	180,000	--	--	--	180,000	--	--	--
H3	--	180,000	--	--	--	--	180,000	--	--
H4	--	180,000	--	--	--	--	--	180,000	--
H5	--	0	--	--	--	--	--	--	0
W1	--	--	180,000	--	180,000	--	--	--	--
W2	--	--	180,000	--	--	180,000	--	--	--
W3	--	--	180,000	--	--	--	180,000	--	--
W4	--	--	180,000	--	--	--	--	180,000	--
W5	--	--	180,000	--	--	--	--	--	180,000
B1	--	--	--	180,000	180,000	--	--	--	--
B2	--	--	--	180,000	--	--	180,000	--	--
B3	--	--	--	0	--	0	--	--	--
B4	--	--	--	0	--	--	--	0	--
B5	--	--	--	0	--	--	--	--	0

Scenario Y4 is not applicable because the YPDRSF and the YPP are in the same area; therefore, the pit cannot be backfilled with development rock until after mining of the pit is completed. Scenarios Y5 and H5 are not applicable because the WEDRSF will only be utilized by the WEP because of its proximity; it is only accessible from the WEP. Scenarios B3, B4 and B5 are not applicable because the development rock from the BT will only be hauled to the HFDRSF because of its proximity. All other development rock storage facilities are significantly farther away from BT.

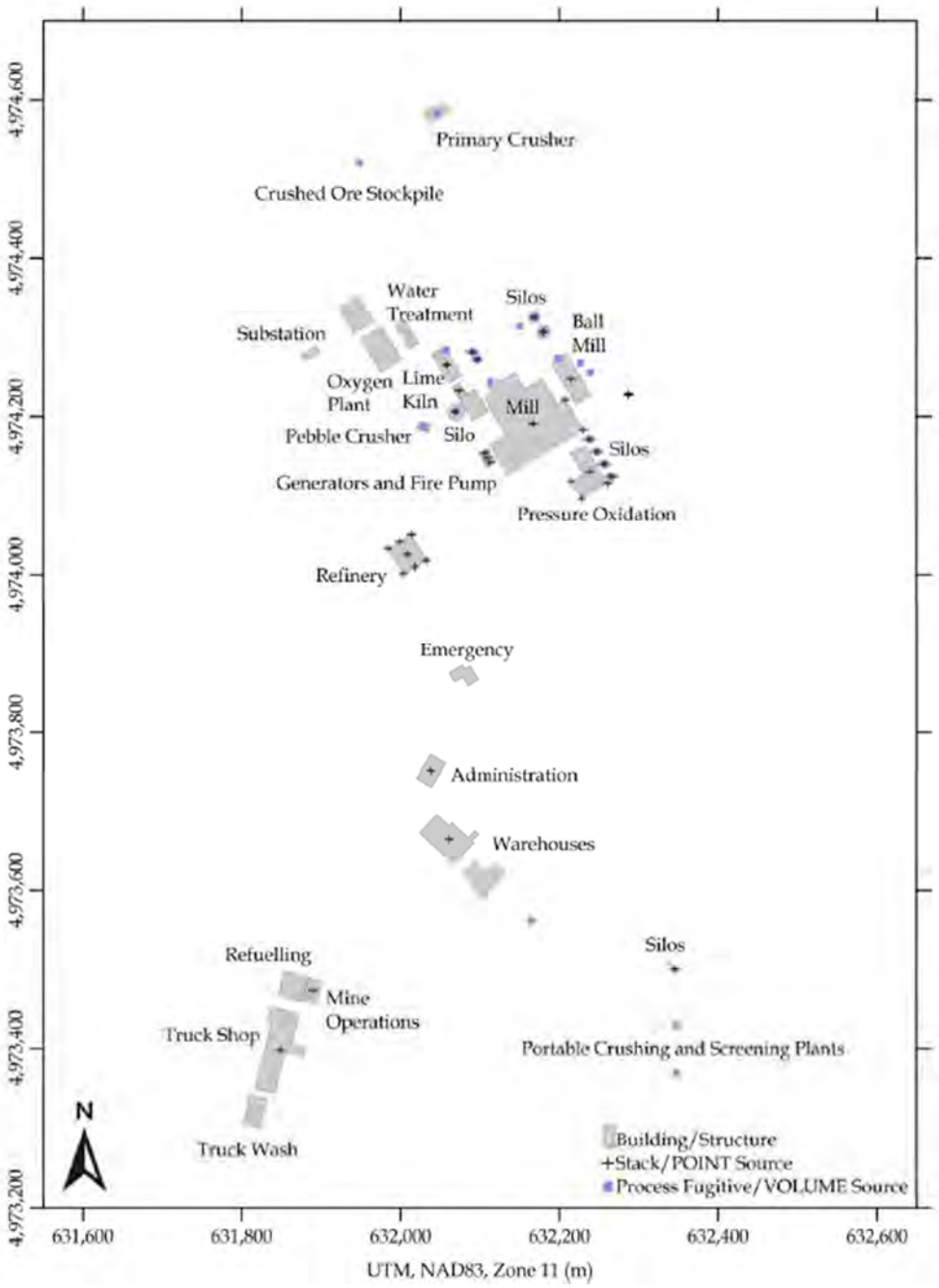
The fugitive CO, NO_2, and SO_2 emissions are limited to pits only, and they do not vary by ore and/or DR hauling and destinations. Therefore, for these pollutants, one scenario for each pit, including processing and ancillary source potential emissions, was modeled, i.e., scenarios Y1, H1, W1, and B1.

The TAP emissions are limited to processing and ancillary sources, so a single scenario was modeled for each applicable TAP analysis.

3.1.4 Processing, Refining, and Ancillary Sources

The processing, refining, and ancillary sources with exhaust stacks, such as baghouse-equipped sources, generators, process and building heaters, autoclave, retort, smelting furnace, carbon kiln, lime kiln, etc., were modeled as POINT sources. The process sources without exhaust stacks, such as material transfers, ore screening and crushing, etc., were modeled as VOLUME sources. A plot plan showing the processing and refining area buildings and sources is provided in Figure 3. Process and ancillary source model input parameters are provided later in Tables 15 and 16.

Figure 3. PROCESSING AND REFINING AREA BUILDING AND SOURCE LAYOUT.



3.1.5 Fugitive Sources: Blasting, Material Origin and Destination, and Underground Exploration Emissions

Blasting emissions were represented by a VOLUME source located inside a pit. Each material origin location (YPP, HFP, WEP, BT) was modeled as an AREA source and comprised appropriate emissions from drilling, material loading, dozing, and surface exploration. Ore destination (crusher area) was modeled as a VOLUME source and comprised ore unloading emissions. Each DR destination (FDRSF,

HFDRSF, YPDRSF, WEDRSF) was modeled as a VOLUME source comprising appropriate emissions from DR unloading, dozing, and wind erosion. Emissions from underground core sampling drilling (UGEXP) in the Scout prospect decline were represented by an AREA source characterized by the portal opening dimensions.

Model input physical characteristics for blasting and possible material origin and destination locations, and Scout portal are presented in Table 12. This table also shows the source type and associated dimensions for each of the modeled fugitive source/location. The VOLUME source dimensions for blasting provided in Table 12 were based on an estimated blast area. For the remaining AREA and VOLUME sources listed in Table 12, the dimensions were developed by reasonably fitting an equal-area rectangle within the actual footprint of each fugitive source. Blasting is not expected to occur in BT. However, blasting emissions were modeled in BT (BTBL) in order to streamline the permitting process.

Table 12. MODELED FUGITIVE ACTIVITY LOCATIONS.

Model ID	Activity Location	Type	Lateral Dimensions (m)	Emission Sources
YPP	Yellow Pine Pit	AREA	882 × 882	Drilling, loading, dozing, surface exploration
HFP	Hangar Flats Pit	AREA	491 × 491	Drilling, loading, dozing, surface exploration
WEP	West End Pit	AREA	376 × 376	Drilling, loading, dozing, surface exploration
BT	Bradley Tailings	AREA	820 × 420	Loading, dozing, wind erosion
YPPBL	Yellow Pine Pit (Blasting)	VOLUME	87 × 87	Blasting
HFPBL	Hangar Flats Pit (Blasting)	VOLUME	87 × 87	Blasting
WEPBL	West End Pit (Blasting)	VOLUME	87 × 87	Blasting
BTBL	Bradley Tailings (Blasting)	VOLUME	87 × 87	Blasting
STKP	PC Stockpile	VOLUME	229 × 229	Unloading, dozing, wind erosion
FDRSF	Fiddle DRSF	VOLUME	775 × 775	Unloading, dozing, wind erosion
HFDRSF	Hangar Flats DRSF	VOLUME	752 × 752	Unloading, dozing, wind erosion
YPDRSF	Yellow Pine DRSF	VOLUME	784 × 784	Unloading, dozing, wind erosion
WEDRSF	West End DRSF	VOLUME	533 × 533	Unloading, dozing, wind erosion
UGEXP	Scout Portal	AREA	4.9 × 4.9	Sample core drilling

The model input physical parameters for blasting, material origin and destination locations, and Scout portal are provided in Table 13.

Table 13. MODEL INPUT PARAMETERS FOR FUGITIVE ACTIVITY LOCATIONS.

Model ID	Base Elevation (m)	Release Height (m)	Initial Lateral Dispersion (m)	Initial Vertical Dispersion (m)
YPP	1,832.4	4.7	N/A	4.4
HFP	1,993.3	4.7	N/A	4.4
WEP	2,191.8	4.7	N/A	4.4
BT	2,011.7	4.7	N/A	4.4
YPPBL	1,717.2	15.0	20.2	7.0
HFPBL	1,890.6	15.0	20.2	7.0
WEPBL	1,994.0	15.0	20.2	7.0

BTBL	2,011.7	15.0	20.2	7.0
STKP	1,979.8	4.7	53.3	4.4
FDRSF	2,115.2	4.7	180.2	4.4
HFDRSF	2,079.8	4.7	174.8	4.4
YPDRSF	1,904.1	4.7	182.2	4.4
WEDRSF	2,376.5	4.7	124.1	4.4
UGEXP	2,018.0	0	N/A	0

The blasting physical parameters were developed from dimensions (provided in Table 12) based on blast area used in the emission calculation. The blasting release height is the midpoint of the blasting height (30 m).

The initial lateral and vertical dispersion dimensions for blasting were calculated per methods specified in (EPA 2018c) for a volume source not on or adjacent to a building, as:

$$Initial\ Lateral\ Dispesion = \frac{Width\ (87\ m)}{4.3}$$

$$Initial\ Vertical\ Dispesion = \frac{Height\ (30\ m)}{4.3}$$

For the pit and DRSF fugitive activity locations listed in Table 12, i.e., YPP, HFP, WEP, BT, FDRSF, HFDRSF, and WEDRSF, the release height was based on the haul truck height (weighted based on model-specific usage) and calculated using the recommendations provided in the Haul Road Workgroup Report (EPA 2012), as:

$$Release\ Height = \frac{Plume\ Top\ (Weighted\ Truck\ Height \times 1.7)}{2}$$

The applicable initial lateral dispersion for each VOLUME source was calculated from the respective shorter dimension and EPA-specified methods (EPA 2018c) (EPA 2016) as follows:

$$Initial\ Lateral\ Dispesion = \frac{Short\ Lateral\ Dimension}{2.15}$$

The applicable initial vertical dispersion for each AREA and VOLUME source was calculated from the respective vertical dimension and EPA-specified methods (EPA 2018c) (EPA 2016) as follows:

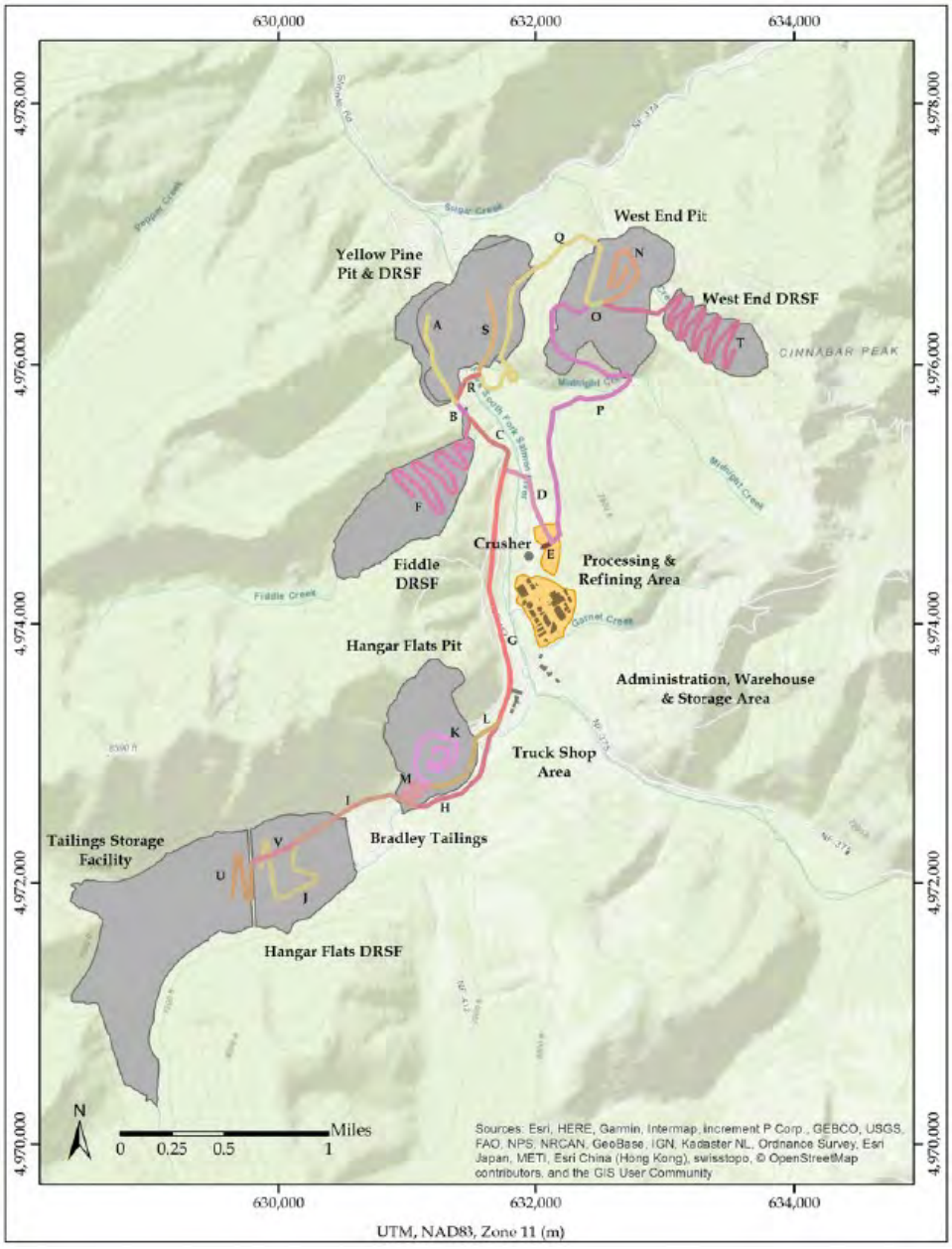
$$Initial\ Vertical\ Dispersion = \frac{Plume\ Top\ (Weighted\ Truck\ Height \times 1.7)}{2.15}$$

Scout portal was modeled as a surface-based AREA source with zero release height.

3.1.6 Fugitive Sources: Haul Roads

A representative haul road network for hauling material from inside the pit (or origin) to various destinations was developed for each pit scenario provided in Table 11. The haul road network is presented in Figure 4.

Figure 4. HAUL ROAD NETWORK AND SECTIONS.



As shown in Figure 4, the haul road network was divided into 22 sections, A through V. Each section was further divided into multiple segments with a length equal to twice the adjusted haul road width of 32.5 m (26 m road width plus 6 m (EPA 2012)). Each of the segments was characterized as an individual VOLUME source in the model, with a release height of 4.75 m (weighted-average truck height times 1.7, divided by 2 (EPA 2012)), an initial lateral dispersion of 15.1 m (adjusted road width divided by 2.15 (EPA 2012)), and an initial vertical dispersion of 4.42 m (weighted-average top-of-plume height divided by 2.15 (EPA 2012)). Material hauling emissions associated with each origin-destination route were assigned to each segment along the route based on estimated total emissions along the route and traffic distribution along each section, as provided in Table 14 for the four HFP scenarios.

Table 14. HAUL ROAD EMISSION DISTRIBUTION GRID FOR HFP SCENARIOS.					
Pit Scenario		**H1**	**H2**	**H3**	**H4**
Route: Origin-Destination		**HFP-STKP**	**HFP-FDRSF**	**HFP-HFDRSF**	**HFP-YPDRSF**
Segment Emission Denominator		96	148	87	115
Section	**No. of Segments**	**Traffic Distribution per Route**			
A	37	--	--	--	--
B	3	--	--	--	1
C	11	--	1	--	1
D	14	1	--	--	--
E	2	--	--	--	--
F	55	--	1	--	--
G	38	1	1	--	1
H	20	--	--	--	--
I	20	--	--	1	--
J	27	--	--	1	--
K	28	1	1	1	1
L	16	1	1	--	1
M	12	--	--	1	--
N	22	--	--	--	--
O	2	--	--	--	--
P	57	--	--	--	--
Q	49	--	--	--	--
R	6	--	--	--	1
S	13	--	--	--	1
T	72	--	--	--	--
U	19	--	--	--	--
V	7	--	--	--	--

The top row in Table 14 shows the pit scenarios, and the next two rows show hauling route and the associated segment emission denominator (SED) used to distribute segment emissions along each route. The remainder of Table 14 presents the number of segments for each road section (shown in Figure 4) and the associated traffic distribution factor for each route. The emission distribution for each applicable segment is illustrated in the following example.

For route: HFP–STKP (Hangar Flats pit to crusher stockpile), Figure 4 shows that material from HFP will be hauled to the crusher area following the route along Sections K, L, G, and D. All (100%) of the ore from HFP will travel on each of these sections; therefore, each of these sections has a traffic distribution factor of 1.0 for this route.

The SED for each route is the sum-product of the number of segments and traffic distribution for the applicable sections. The SED for the HFP–STKP route is calculated as:

$$SED_{(HFP-STKP)} = (28 \times 1) + (16 \times 1) + (38 \times 1) + (14 \times 1) = 96$$

Emissions for each section-segment were estimated by dividing the total emissions along the route by its SED and multiplying by the section distribution factor. For example, the emission rate for each of the 28 segments along Section K was calculated as:

$$Emission\ Rate - Section\ K_{(Segments\ 1-28)} = \frac{Total\ Emissions_{(HFP-STKP)}}{96} \times 1$$

3.1.7 Fugitive Sources: Burntlog Route Access Road

The access road portion within the operations boundary was characterized by a series of LINE sources laid along the actual route. Emissions associated along this access road include dust emissions generated from travel of maintenance equipment, light-duty pickup trucks and buses used for employee, visitor, and contractor transportation, and heavy-duty trucks used for cargo and services transportation. These sources were assigned a release height of 3 m and an initial vertical dispersion of 2.8 m. These release parameters were based on an estimated average vehicle height of 3.5 m, which is representative of an overall approximation of anticipated vehicle heights (grader – 3.7 m, heavy-duty truck – 3.6 m, and pickup truck – 3.2 m) and the AREA source parameterization recommendations provided in the Haul Road Workgroup Report (EPA 2012). The AERMOD emission input units for AREA source are grams per meter square. The access road emissions were evenly distributed along the road by dividing the total access road emissions by its total area, i.e., the Burntlog Route section within the operations boundary (2,950 m) multiplied by the road width (6.1 m).

3.1.8 Emission Release Parameters

Table 15 lists the emission release parameters, including stack height, exhaust temperature, exhaust velocity, and stack diameter for SGP's process and ancillary point sources in metric units (English units are in parentheses). Table 16 lists the emission release parameters for SGP's process and ancillary volume sources in metric units (English units are in parentheses). Emission release parameters were based on information provided in the application. Justification for emission release parameters is summarized in the next section.

Table 15. PROCESS AND ANCILLARY POINT SOURCE EMISSION RELEASE PARAMETERS IN METRIC UNITS (ENGLISH UNITS IN PARENTHESES).

Release Point	Description	UTM[a] Coordinates		Stack Height in m (ft)[c]	Stack Exhaust Temp. in K (°F)[d]	Stack Exhaust Velocity in m/sec (fps)[e]	Stack Diameter in m (ft)	Orient. Of Release[f]
		Easting-X in m[b]	Northing-Y in m					
LS1L	Mill Lime Silo #1 Loading	632,095	4,974,272	13.3 (43.7)	0.0 (-459.7)	18.1 (59.4)	0.15 (0.49)	D
MillS2L	Mill Lime Silo #2 Loading	632,090	4,974,282	13.3 (43.7)	0.0 (-459.7)	18.1 (59.4)	0.15 (0.49)	D
SB1	Sb Dryer (2.72 MMBtu/hr Propane-Fired)	632,231	4,974,183	45.7 (150.0)	455.4 (360.0)	6.9 (22.8)	0.30 (0.98)	D
SB2	Sb Bagging	632,208	4,974,221	45.7 (150.0)	0.0 (-459.7)	6.5 (21.2)	0.30 (0.98)	D
AC	Autoclave	632,229	4,974,096	23.5 (77.0)	364.3 (196.1)	7.4 (24.3)	1.52 (4.99)	D
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	632,261	4,974,116	23.5 (77.0)	455.4 (360.0)	10.8 (35.6)	0.61 (2.00)	D
ACS1L	AC Lime Silo #1 Loading	632,267	4,974,124	17.4 (57.2)	0.0 (-459.7)	16.1 (52.8)	0.23 (0.75)	D
ACS2L	AC Lime Silo #2 Loading	632,257	4,974,140	17.4 (57.2)	0.0 (-459.7)	16.1 (52.8)	0.23 (0.75)	D
ACS3L	AC Lime Silo #3 Loading	632,248	4,974,156	17.4 (57.2)	0.0 (-459.7)	16.1 (52.8)	0.23 (0.75)	D
ACS4L	AC Lime Silo #4 Loading	632,238	4,974,171	14.5 (47.5)	0.0 (-459.7)	16.1 (52.8)	0.23 (0.75)	D
CKD	Carbon	632,013	4,974,051	16.8	338.7	5.1	0.15	D

Table 15. PROCESS AND ANCILLARY POINT SOURCE EMISSION RELEASE PARAMETERS IN METRIC UNITS (ENGLISH UNITS IN PARENTHESES).								
Release Point	**Description**	**UTM[a] Coordinates**		**Stack Height in m (ft)[c]**	**Stack Exhaust Temp. in K (°F)[d]**	**Stack Exhaust Velocity in m/sec (fps)[e]**	**Stack Diameter in m (ft)**	**Orient. Of Release[f]**
		Easting-X in m[b]	**Northing-Y in m**					
	Regeneration Kiln (Drum)			(55.0)	(150.0)	(16.6)	(0.49)	
CKB	Carbon Regeneration Kiln (Burners)	631,998	4,974,042	14.0 (46.0)	455.4 (360.0)	5.8 (18.9)	0.30 (0.98)	D
EW	Electrowinning Cells and Pregnant Solution Tank	631,983	4,974,033	16.8 (55.0)	310.9 (100.0)	24.2 (79.4)	0.30 (0.98)	D
MR	Mercury Retort	632,003	4,974,001	16.8 (55.0)	338.7 (150.0)	1.5 (5.1)	0.09 (0.30)	D
MF	Induction Melting Furnace	632,032	4,974,019	16.8 (55.0)	338.7 (150.0)	21.5 (70.6)	0.38 (1.25)	D
EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	634,274	4,972,050	2.1 (7.0)	866.5 (1,100.0)	29.7 (97.4)	0.46 (1.51)	D
EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	632,105	4,974,154	2.1 (7.0)	866.5 (1,100.0)	29.7 (97.4)	0.46 (1.51)	D
EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	632,109	4,974,148	2.1 (7.0)	866.5 (1,100.0)	29.7 (97.4)	0.46 (1.51)	D
EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	632,113	4,974,141	2.1 (7.0)	866.5 (1,100.0)	23.8 (78.0)	0.23 (0.75)	D
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	632,216	4,974,118	20.7 (68.0)	455.4 (360.0)	1.6 (5.2)	0.12 (0.39)	D
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	632,017	4,974,010	14.0 (46.0)	455.4 (360.0)	7.5 (24.8)	0.40 (1.31)	D
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	632,287	4,974,227	2.1 (7.0)	455.4 (360.0)	6.0 (19.8)	0.40 (1.31)	D
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	632,288	4,974,228	2.1 (7.0)	455.4 (360.0)	20.8 (68.3)	0.21 (0.69)	D
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	632,168	4,974,191	43.0 (141.0)	455.4 (360.0)	28.3 (92.9)	0.09 (0.30)	D
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	632,238	4,974,130	20.7 (68.0)	455.4 (360.0)	7.1 (23.3)	0.09 (0.30)	D
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	632,008	4,974,026	14.0 (46.0)	455.4 (360.0)	7.1 (23.3)	0.09 (0.30)	D
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	632,038	4,973,751	6.4 (21.0)	455.4 (360.0)	7.1 (23.3)	0.09 (0.30)	D

Table 15. PROCESS AND ANCILLARY POINT SOURCE EMISSION RELEASE PARAMETERS IN METRIC UNITS (ENGLISH UNITS IN PARENTHESES).								
Release Point	**Description**	**UTM[a] Coordinates**		**Stack Height in m (ft)[c]**	**Stack Exhaust Temp. in K (°F)[d]**	**Stack Exhaust Velocity in m/sec (fps)[e]**	**Stack Diameter in m (ft)**	**Orient. Of Release[f]**
		Easting-X in m[b]	**Northing-Y in m**					
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	631,889	4,973,472	12.5 (41.0)	455.4 (360.0)	1.3 (4.3)	0.21 (0.69)	D
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	631,848	4,973,398	12.5 (41.0)	455.4 (360.0)	5.2 (17.1)	0.21 (0.69)	D
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	632,060	4,973,664	12.5 (41.0)	455.4 (360.0)	5.2 (17.1)	0.21 (0.69)	D
PSL	Prill Silos Loading (2 x 100 ton)	632,346	4,973,500	7.8 (25.5)	0.0 (-459.7)	18.1 (59.4)	0.15 (0.49)	D
CS1L	Cement/Shotcrete Silo #1 Loading	632,095	4,974,272	13.3 (43.7)	0.0 (-459.7)	24.1 (78.9)	0.15 (0.49)	D
CS2L	Cement/Shotcrete Silo #2 Loading	632,095	4,974,272	13.3 (43.7)	0.0 (-459.7)	24.1 (78.9)	0.15 (0.49)	D
LS6	Limestone transfer to Ball Mill Feed Bin	632,181	4,974,307	8.8 (29.0)	0.0 (-459.7)	0.001 (0.003)	0.30 (0.98)	D
LSBM	Limestone Ball Mill	632,215	4,974,248	21.3 (70.0)	0.0 (-459.7)	26.7 (87.5)	0.61 (2.00)	D
LS9	Limestone transfer to Kiln Feed Bin	632,169	4,974,325	8.8 (29.0)	0.0 (-459.7)	0.001 (0.003)	0.30 (0.98)	D
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	632,057	4,974,265	45.7 (150.0)	449.8 (350.0)	26.4 (86.5)	0.61 (2.00)	D
LKC	PFR Shaft Lime Kiln Combustion	632,057	4,974,265	45.7 (150.0)	449.8 (350.0)	26.4 (86.5)	0.61 (2.00)	D
LCR	Lime Mill Crushing and associated transfers In and Out	632,073	4,974,233	15.2 (50.0)	0.0 (-459.7)	28.7 (94.3)	0.23 (0.75)	D
LSL	Pebble Lime Silo Loading via Bucket Elevator	632,069	4,974,206	8.8 (29.0)	0.0 (-459.7)	4.1 (13.4)	0.10 (0.33)	D

a. Universal Transverse Mercator.
b. m: meters.
c. ft: feet.
d. K: Kelvin; °F: degrees Fahrenheit.
e. m/sec: meters per second; fps: feet per second.
f. D: default (vertical, uninterrupted release); R: raincap; H: horizontal.
g. The exhaust temperature for the new silo was set to 0 K. This triggers AERMOD to use the actual temperatures from the meteorological data input files.

Table 16. PROCESS AND ANCILLARY VOLUME SOURCE EMISSION RELEASE PARAMETERS IN METRIC UNITS (ENGLISH UNITS IN PARENTHESES).						
Release Point	**Description**	**UTM[a] Coordinates**		**Release Height in m (ft)[c]**	**Init. Horiz. Dim. in m (ft)**	**Init. Vert. Dim. in m (ft)**
		Easting-X in m[b]	**Northing-Y in m**			
OC1	Loader Transfer of Ore to Grizzly	632,045	4,974,583	19.5 (64.0)	3.8 (12.3)	18.1 (59.5)
OC2	Grizzly to Apron Feeder	632,045	4,974,583	19.5 (64.0)	3.8 (12.3)	18.1 (59.5)
OC3	Apron Feeder to Dribble Conveyor	632,045	4,974,583	19.5 (64.0)	3.8 (12.3)	18.1 (59.5)
OC4	Apron Feeder to Vibrating Grizzly	632,045	4,974,583	19.5 (64.0)	3.8 (12.3)	18.1 (59.5)
OC5	Dribble Conveyor to Vibrating Grizzly	632,045	4,974,583	19.5 (64.0)	3.8 (12.3)	18.1 (59.5)
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	632,045	4,974,583	19.5 (64.0)	3.8 (12.3)	18.1 (59.5)
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	632,045	4,974,583	19.5 (64.0)	3.8 (12.3)	18.1 (59.5)
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	631,947	4,974,520	10.9 (35.8)	0.2 (0.7)	10.2 (33.3)
OC9	Stockpile Transfers to Reclaim Conveyors	631,947	4,974,520	1.2 (4.0)	0.6 (1.9)	1.1 (3.7)
OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	631,947	4,974,520	1.2 (4.0)	0.6 (1.9)	1.1 (3.7)
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	632,113	4,974,243	20.7 (69.0)	0.3 (0.9)	0.6 (1.9)
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	632,028	4,974,187	3.0 (10.0)	2.3 (7.6)	2.8 (9.3)
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	632,028	4,974,187	3.0 (10.0)	2.3 (7.6)	2.8 (9.3)
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	632,095	4,974,272	1.4 (4.5)	0.1 (0.2)	0.1 (0.5)
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	632,090	4,974,282	1.4 (4.5)	0.1 (0.2)	0.1 (0.5)
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	632,267	4,974,124	1.4 (4.5)	0.1 (0.2)	0.1 (0.5)
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	632,257	4,974,140	1.4 (4.5)	0.1 (0.2)	0.1 (0.5)
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	632,248	4,974,156	1.4 (4.5)	0.1 (0.2)	0.1 (0.5)
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	632,238	4,974,171	1.4 (4.5)	0.1 (0.2)	0.1 (0.5)
PSU	Prill Silos Unloading (2 x 100 ton)	632,346	4,973,500	1.4 (4.5)	0.1 (0.2)	0.1 (0.5)
CS1U	Cement/Shotcrete Silo #1 Unloading	632,095	4,974,272	1.5 (5.0)	5.1 (16.8)	1.4 (4.7)
CS2U	Cement/Shotcrete Silo #2 Unloading	632,095	4,974,272	1.5 (5.0)	5.1 (16.8)	1.4 (4.7)
CAL	Aggregate Bin Loading	632,095	4,974,272	1.5 (5.0)	5.1 (16.8)	1.4 (4.7)
CAU	Aggregate Bin Unloading	632,095	4,974,272	1.5 (5.0)	5.1 (16.8)	1.4 (4.7)
CM	Central Mixer Loading	632,095	4,974,272	1.5	5.1	1.4

Table 16. PROCESS AND ANCILLARY VOLUME SOURCE EMISSION RELEASE PARAMETERS IN METRIC UNITS (ENGLISH UNITS IN PARENTHESES).						
Release Point	Description	UTM[a] Coordinates		Release Height in m (ft)[c]	Init. Horiz. Dim. in m (ft)	Init. Vert. Dim. in m (ft)
		Easting-X in m[b]	Northing-Y in m			
				(5.0)	(16.8)	(4.7)
PCSP1	Portable Crushing and Screening Plant 1	632,348	4,973,429	2.1 (7.0)	13.1 (43.1)	2.0 (6.5)
PCSP2	Portable Crushing and Screening Plant 2	632,348	4,973,369	2.1 (7.0)	13.1 (43.1)	2.0 (6.5)
LS1	Limestone transfer to Primary Crusher Hopper	632,239	4,974,256	3.4 (11.3)	1.6 (5.2)	3.2 (10.5)
LS2	Primary Crushing and Associated Transfers In and Out	632,239	4,974,256	3.4 (11.3)	1.6 (5.2)	3.2 (10.5)
LS3	Primary Screening and Associated Transfers In and Out	632,239	4,974,256	3.4 (11.3)	1.6 (5.2)	3.2 (10.5)
LS4	Secondary Crushing and Associated Transfers In and Out	632,227	4,974,268	3.4 (11.3)	1.6 (5.2)	3.2 (10.5)
LS5	Secondary Screening and Associated Transfers In and Out	632,227	4,974,268	3.4 (11.3)	1.6 (5.2)	3.2 (10.5)
LS7	Limestone transfer to Ball Mill Feed Conveyor	632,181	4,974,307	1.1 (3.5)	0.1 (0.2)	0.4 (1.4)
LS8	Ball Mill Feed transfer to Ball Mill	632,200	4,974,273	8.5 (28.0)	0.3 (0.9)	0.6 (1.9)
LS10	Limestone transfer to Lime Kiln Feed Conveyor	632,169	4,974,325	1.1 (3.5)	0.1 (0.2)	0.4 (1.4)
LS11	Fines Screening and Associated Transfers In and Out	632,151	4,974,314	0.8 (2.5)	0.6 (1.9)	0.7 (2.3)
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	632,056	4,974,285	20.7 (68.0)	0.3 (0.9)	0.6 (1.9)
LSU	Pebble Lime Silo discharge to Lime Slaker	632,069	4,974,206	1.1 (3.5)	0.1 (0.2)	0.4 (1.4)

a. Universal Transverse Mercator.
b. m: meters.
c. ft: feet.

3.1.9 Emission Release Parameter Justification

Modeled Process and Ancillary Point Sources

The pneumatic transfer silo loadings and bin transfers (LS1L, MillS2L, ACS1L, ACS2L, ACS3L, ACS4L, PSL, CS1L, CS2L, LS6, LSBM, LS9, LSL) were modeled as POINT sources with a 3-foot bin vent above standard silo height as release height. Exit velocity was estimated using the standard stack diameter and flow rates for similar sources (NDEP 2019) or 0.001 meter per second for horizontal exhaust. These sources were modeled with ambient exhaust temperature.

For propane-fired process (Sb1, ACB, CKB, PV, HS) and building heaters (H1M, H2M, HM, HAC, HR, HA, HMO, HTS, HW), exhaust flow rates were calculated using EPA Method 9 with 3% oxygen content and 15% moisture content. Standard stack diameters were selected based on the heater rating. The process heaters were modeled with a 10-foot stack above the building, whereas the building heaters were modeled with a release height of 1 foot above the respective buildings.

Similar source exhaust temperature, flow, and diameter from (NDEP 2017) were used for refinery sources, including the carbon regeneration kiln (CKD), electrowinning cells (EW), mercury retort (MR),

and induction furnace (MF). Each of these sources was modeled with a 10- foot stack above the refinery building.

For emergency generators (EDG1, EDG2, EDG3) and the fire pump (EDFP), the exhaust flow rates were calculated using EPA Method 9 with 9% oxygen content and 8% moisture content. Standard stack diameters were selected based on engine rating. Each engine was modeled with a 7-foot-high stack.

Antimony bagging (Sb2), autoclave (AC), lime kiln (LK) (common stack with kiln burner (LKC)), and lime crushing (LCR) were characterized with similar source parameters from (NDEP 2015b), (APT 2013), and (NDEP 2010). Each of these sources was modeled with a 10-foot stack above its respective building.

Release parameters for the process and ancillary point sources were appropriately documented and justified. DEQ's source-group analysis (Table 29 in Section 4.1.4) suggests that the process and ancillary point sources contribute a small amount to the modeled design concentrations.

Modeled Process and Ancillary Volume Sources

For the following VOLUME source characterization discussion, release height was estimated as half of the vertical length (for example, building height), initial vertical dispersion was calculated by dividing the vertical length by the applicable EPA-recommended constant (EPA 2018c) for a single VOLUME source (4.3), and initial lateral dispersion was determined using the lesser lateral dimension (for example, building width) divided by the applicable EPA-recommended constant (EPA 2018c) for the surface source or elevated source with a building (2.15).

The sources associated with the primary crusher building, including loader transfer (OC1), grizzly feeder (OC2), apron feeders (OC3, OC4), ore transfers (OC5, OC6), and primary crusher (OC7), were characterized by the primary crusher building dimensions: 128' high and 52.9' wide.

The stockpile height (71.6') and the conveyor width (3') were used to determine the VOLUME source parameters for the stockpile feed conveyor (OC8).

Tunnel exit dimensions (8' high and 8' wide) were used to estimate the VOLUME release parameters for the stockpile transfer points (OC9, OC10). The SAG mill feed conveyor transfer (OC11) was characterized by a building opening (4' high and 4' wide) at the mid-height (70') of the mill building.

Pebble crusher building dimensions (20' high and 32.7' wide) were used to characterize the pebble crusher-associated sources (OC12, OC13).

Silo/bin unloading sources (LS1U, Mill2SU, ACS1U, ACS2U, ACS3U, ACS42U, PSU) were characterized by a typical screw discharge feeder characteristic, i.e., 5' above the ground with a 1' diameter.

Aggregate transfer and handling sources (CS1U, CS2U, CAL, CAU, CM) were characterized by the aggregate stockpile dimensions: 20' high and 72.2' wide.

Each portable crushing and screening plant was characterized by typical portable crushing and screening plant dimensions: 14' high and 185' wide.

Sources associated with limestone crushing (LS1, LS2, LS3, LS4, LS5) were characterized by the associated crusher building dimensions: 22.6’ high and 22.6’ wide.

The crushed limestone/pebble lime transfers (LS7, LS10, LSU) were characterized by a typical screw discharge to a conveyor characteristic, i.e., 5’ above the ground, 3’ drop, and a 1’ diameter.

The limestone ball mill feed discharge (LS8) was characterized by a building opening (4’ high and 4’ wide) at the mid-height (30’) of the ball mill building.
The limestone fines screening (LS11) was characterized by screen dimensions: 5’ drop and 8’ wide.

The limestone kiln feed (LS12) was characterized by a building opening (4’ high and 4’ wide) at the mid-height (70’) of the kiln building.

Model input source characterization for fugitive emissions is described in Sections 3.1.5 and 3.1.6. Fugitive activity locations and their respective dimensions are provided in Table 12 and associated release parameters are listed in Table 13.

Release parameters for the process and ancillary volume sources were appropriately documented and justified. DEQ’s source-group analysis (Table 29 in Section 4.1.4) suggests that the process and ancillary volume sources contribute a small amount to the modeled design concentrations.

3.2 Background Concentrations

Background concentrations are used if a cumulative NAAQS impact analysis is needed to demonstrate compliance with applicable NAAQS.

3.2.1 Onsite Particulate Monitoring

To establish background ambient air conditions for the SGP area, Midas Gold developed an onsite monitoring program to collect site-specific meteorological parameters and determine ambient particulate matter ($PM_{2.5}$ and PM_{10}) concentrations at its Stibnite monitoring station.

In September 2015, Midas Gold submitted the data collected at the Stibnite monitoring station for the period of November 2013 through June 2015 to DEQ. After reviewing the data and associated quality control procedures, DEQ concluded that the $PM_{2.5}$ and PM_{10} data collected at the Stibnite monitoring station satisfied the applicable regulatory requirements and approved the data to be used for background concentrations in the SGP air quality analyses (DEQ 2015). In its conclusions, DEQ recommended that the $PM_{2.5}$ and PM_{10} background concentrations should be based on calendar year 2014 instead of the complete dataset (November 2013 through June 2015).

DEQ-approved $PM_{2.5}$ and PM_{10} background concentrations, in units of micrograms per cubic meter ($\mu g/m^3$), are provided in Table 17. For 24-hour PM_{10}, the design value is the *second-highest* 24-hour average concentration in a given year. However, review of the Meteorological and Air Quality Data Summary for the SGP Monitoring Network (Midas Gold 2015) indicates that the DEQ-approved background for 24-hour PM_{10} (37.0 $\mu g/m^3$) is the *first-highest* 24-hour average concentration measured in 2014 (DEQ 2015). Therefore, using the first-high instead of the second-high as background adds a layer of conservatism to the cumulative NAAQS impact analyses for 24-hour PM_{10}.

Table 17. DEQ-APPROVED $PM_{2.5}$ AND PM_{10} BACKGROUND CONCENTRATIONS FOR SGP.			
Pollutant	**Averaging Time**	**Background Concentration ($\mu g/m^3$)**	**Design Value Rank**
$PM_{2.5}$	1 year	3.5	Weighted average of quarterly means
	24 hours	15.0	98th percentile/8th high
PM_{10}	24 hours	37.0	Highest 1st high

3.2.2 Gaseous Pollutant Background Concentrations

With a few exceptions of very large facilities or facilities located in nonattainment areas, regulatory agencies do not require the collection of gaseous criteria pollutants, including CO, NOx (and/or nitrogen dioxide [NO_2]), O_3, and SO_2. For these gaseous pollutants, data collected at government-regulated monitoring stations located in settings similar to the project area in terms of terrain, land use, and proximity of emission sources are typically used to establish background concentrations.

To determine representative background concentrations of CO, NOx, O_3, and SO_2 for the SGP site, which is located in a remote rural area, the DEQ-maintained ambient monitoring network was reviewed by Air Sciences. This review revealed that DEQ only conducts limited trace monitoring for CO, NOx, O_3, and SO_2 in the Boise metropolitan area along the Interstate 84 corridor. Thus, the data collected at these monitors are exposed to high emissions from industrial, urban, and transportation sources (DEQ 2015a) (DEQ 2018). For this reason, the gaseous pollutant concentrations recorded at these urban monitoring locations were not considered to be representative of a rural area, like the SGP site.

The EPA-maintained monitoring stations (EPA 2018a) in Idaho and surrounding states also were reviewed by Air Sciences to determine representative gaseous pollutant background concentrations for the SGP site. This review also did not identify any representative monitoring station to establish background gaseous pollutant concentrations for the SGP site.

The DEQ-recommended (DEQ 2019) CO, NOx, O_3, and SO_2 background concentrations for the SGP air quality analyses in units of parts per billion (ppb) and $\mu g/m^3$, are provided in Table 18. These background concentrations were obtained from the Northwest International Air Quality Environmental Science and Technology Consortium (NW AIRQUEST; https://arcg.is/1jXmHH) online tool using the project site coordinates. These background air pollutant levels are based on regional-scale air pollution modeling of pollutants in Washington, Oregon, and Idaho, with modeling results adjusted according to available monitoring data.

Table 18. DEQ-RECOMMENDED GASEOUS POLLUTANT BACKGROUND CONCENTRATIONS FOR SGP.				
Pollutant	**Averaging Time**	**Background Concentration**		**Reference**
		(ppb)	**($\mu g/m^3$)**	
CO	8 hours	970	1,110	NW AIRQUEST, 2014-2017 design value
	1 hour	1,520	1,740	
NO_2	1 year	0.5	0.9	
	1 hour	2.3	4.3	
O_3 (for NO_2 modeling)	8 hours	55	107.9	
SO_2	3 hours	6.4	16.8	
	1 hour	4.7	12.3	

3.2.3 Medium-Traffic Pollutant Background Concentrations

For additional information, background concentrations were obtained from NW AIRQUEST for the road section between mile markers 143 and 144 on Highway 55 passing through the town of McCall. This site (latitude 44.906° N, longitude 116.098° W) is approximately 38 miles west of the SGP. The annual average daily traffic count for this road section is over 10,000 vehicles per day. Table 19 provides the background concentrations for this medium-traffic site. Although these concentrations are not representative of the rural SGP area, they do provide additional information regarding the relative contribution of traffic emissions.

Table 19. MEDIUM-TRAFFIC BACKGROUND CONCENTRATIONS.

Pollutant	Averaging Time	Background Concentration		Reference
		(ppb)	($\mu g/m^3$)	
CO	8 hours	1,000	1,145	NW AIRQUEST, 2014-2017 design value, near McCall, ID (44.91°N, 116.10°W)
	1 hour	1,570	1,797	
NO_2	1 year	1.4	2.6	
	1 hour	7.6	14.3	
$PM_{2.5}$	1 year	--	5.1	
	24 hours	--	17.5	
PM_{10}	24 hours	--	60.1	
SO_2	3 hours	6.4	16.8	
	1 hour	4.7	12.3	

3.3 Impact Modeling Methodology

This section describes the modeling methods used by the applicant/consultant to demonstrate preconstruction compliance with applicable air quality standards.

3.3.1 General Overview of Impact Analyses

Air Sciences performed the project-specific air pollutant emission inventory and air impact analyses that were submitted with the application. The submitted information/analyses, in combination with results from DEQ's air impact analyses, demonstrate compliance with applicable air quality standards to DEQ's satisfaction, provided the facility is operated as described in the submitted application and in this memorandum.

Table 20 provides a brief description of parameters used in the modeling analyses.

Table 20. MODELING PARAMETERS.

Parameter	Description/Values	Documentation/Addition Description
General Facility Location	Stibnite, Idaho	The area is an attainment or unclassified area for all criteria pollutants.
Model	AERMOD	AERMOD with the PRIME downwash algorithm, version 19191.
Meteorological Data	Onsite and McCall, Idaho surface data; Boise, Idaho upper air data	See Section 3.3.5 of this memorandum for additional details of the meteorological data.
Terrain	Considered	1/3 arc second National Elevation Dataset (NED) was acquired from the USGS for the surrounding area. AERMAP version 18081 was used to process terrain elevation data for all buildings and receptors. See Section 3.3.6 for more details.
Building Downwash	Considered	Plume downwash was considered for the structures associated with the facility. BPIP-PRIME was used to evaluate building dimensions for consideration of downwash effects in AERMOD. See Section 3.3.7.
NOx Chemistry	Ozone Limiting	See Section 3.3.8.

	Method	
Receptor Grid	**SIL Analysis** A SIL analysis was not performed.	
	Cumulative NAAQS Impact Analysis The selection of receptors for use in the cumulative NAAQS impact analysis is as follows (see Section 3.3.12):	
	Boundary	25-meter (m) spacing
	Grid 1	50-m spacing, 0.25 kilometers (km) out
	Grid 2	100-m spacing, 0.25 km to 1.25 km out
	Grid 3	500-m spacing, 1.25 km to 5 km out
	Grid 4	1,000-m spacing, 5 km to 10 km out
	Hotspot	25-m spacing, 200-m × 200-m around highest model impacts
	TAPs Analysis The receptor network used in the cumulative NAAQS impact analysis was also used in the TAPs analysis.	

3.3.2 Modeling Protocol

A modeling protocol for the SGP analyses was submitted to DEQ prior to the application, on May 30, 2019. The protocol was submitted by Brown and Caldwell on behalf of Midas Gold. Conditional DEQ protocol approval was provided to Brown and Caldwell on June 27, 2019.

3.3.3 Modeling Methodology

Project-specific modeling and other required impact analyses were generally conducted using data and methods described in the *Idaho Air Quality Modeling Guideline* (DEQ 2013).

3.3.4 Model Selection

Idaho Air Rules Section 202.02 requires that estimates of ambient concentrations be based on air quality models specified in Appendix W. The refined, steady-state, multiple-source, Gaussian dispersion model AERMOD was promulgated as the replacement model for ISCST3 in December 2005. AERMOD retains the single straight-line trajectory of ISCST3, but it includes more advanced algorithms to assess turbulent mixing processes in the planetary boundary layer for both convective and stable stratified layers.

AERMOD version 19191 was used by Air Sciences for the modeling analyses to evaluate impacts of the facility. This version was the current version at the time the application was received by DEQ.

3.3.5 Meteorological Data

AERMOD requires an input of hourly meteorological data to estimate pollutant concentrations in ambient air resulting from modeled source emissions. These data are commonly obtained from National Weather Service (NWS) stations at airports throughout the state. Applicants select data from an airport site that is determined to be reasonably representative of the permitted site location. Collection of meteorological data from the permitted site is not typically required by DEQ for minor source permit applications. The collection of one year of onsite data is required for permitting projects subject to the Prevention of Significant Deterioration (PSD) program, which is triggered by larger non-fugitive emission quantities.

Site-specific hourly surface meteorological data were collected and used in air impact analyses for this project, as described in the submitted modeling report. These data were collected from January 1, 2014 through December 31, 2014 at the Stibnite monitoring station. They were collected for analyses supporting an Environmental Impact Statement (EIS) and the Idaho DEQ minor source permit.

The site-specific surface data were supplemented with the twice-daily upper-air data (all levels) collected at the National Weather Service (NWS) station in Boise, Idaho (WBAN 24131).

These meteorological datasets were processed with the most recent version (19191) of the AERMOD meteorological pre-processor, AERMET, to produce AERMOD-input-ready hourly surface and profile meteorological files. The default option of adjusted surface friction velocity (ADJ_U*) and the Bulk Richardson (BULKRN) method for boundary layer parameter calculations was used for this meteorological data processing.

Additionally, an alternative meteorological dataset was processed without using the BULKRN method (NON-BULKRN). This alternate processing used the onsite and upper air datasets discussed above, supplemented with the cloud-cover data collected at the NWS station in McCall, Idaho (WBAN 94182).

Both processing methods (BULKRN and NON-BULKRN) are considered default for regulatory modeling analyses. EPA Region X Regional Modeling Contact, Jay McAlpine, PhD, was consulted for guidance on which data processing procedure to require for the analyses supporting the Idaho PTC. The BULKRN method was used for air impact analyses supporting the EIS after consultation with EPA, DEQ, and the US Forest Service. EPA recommended (June 18, 2019, email from Jay McAlpine, EPA, to Kevin Schilling, DEQ) using the BULKRN method since "use of the onsite data best fulfills the Guidance, and ensures consistency with the EIS, but this should be looked upon as technical advice only and not a requirement of the EPA."

Compliance with all NAAQS was easily demonstrated using meteorological data processed by the NON-BULKRN method; however, a small number of receptors showed 24-hour PM_{10} violations when the meteorological data processed with BULKRN method was used. DEQ performed a weight of evidence analyses (see Section 4.1.4 of this memorandum) to further evaluate the confidence of NAAQS compliance, using sensitivity analyses of various model input variables and the meteorological data processed using the BULKRN method.

AERMET requires the input of three surface boundary layer parameters: midday Bowen ratio (B_o), midday albedo (r), and surface roughness length (z_o). These parameters are dependent on the land use and vegetative cover of the area being evaluated. The EPA-recommended model, AERSURFACE, was used to estimate these surface parameters for the Stibnite meteorological data processing. AERSURFACE uses 1992 National Land Cover Data to determine these surface characteristics.

The determination of B_o is dependent on ambient moisture conditions (i.e., wet, average, or dry). For this purpose, historic 30-year (1985–2014) precipitation data from the Taylor Ranch station in Idaho (the closest station from which this type of data is available) were used.

The 70th and 30th percentile values estimated from the 30-year precipitation data were used to assign a moisture class to each calendar month per the following scheme: monthly precipitation greater than the 70th percentile was considered "wet"; between the 70th and 30th percentiles was considered "average"; and less than the 30th percentile was considered "dry." The monthly season and moisture classifications and estimated r and B_o for 2014 Stibnite meteorological data processing are presented in Table 21.

Table 21. 2014 MONTHLY SEASON AND MOISTURE CLASSIFICATION, AND CALCULATED *r* AND *B_O*.

Month	Season	*r*	30-Year Precipitation	2014 Precipitation	Moisture Classification	*Bo*

			Percentile (in)		(in)		
			30th	70th			
January	Winter	0.38	0.64	1.29	0.74	Average	0.50
February	Winter	0.38	0.40	0.81	0.99	Wet	0.50
March	Spring	0.13	0.83	1.23	2.33	Wet	0.34
April	Spring	0.13	1.11	1.57	0.99	Dry	1.57
May	Spring	0.13	1.43	2.23	0.74	Dry	1.57
June	Summer	0.13	1.17	1.80	1.32	Average	0.37
July	Summer	0.13	0.46	1.45	0.40	Dry	0.76
August	Summer	0.13	0.42	1.11	2.03	Wet	0.25
September	Fall	0.13	0.27	1.23	0.43	Average	0.87
October	Fall	0.13	0.59	1.69	1.75	Wet	0.35
November	Fall	0.13	0.72	1.44	3.73	Wet	0.35
December	Winter	0.38	0.64	1.16	0.83	Average	0.50

The seasonal z_o values in m for each 30-degree sector of the 1-km radius for the Stibnite monitoring station are provided in Table 22 (i.e., Sector 1 is 0° to 30° clockwise from the north, Sector 2 is 30° to 60° clockwise from the north, etc.).

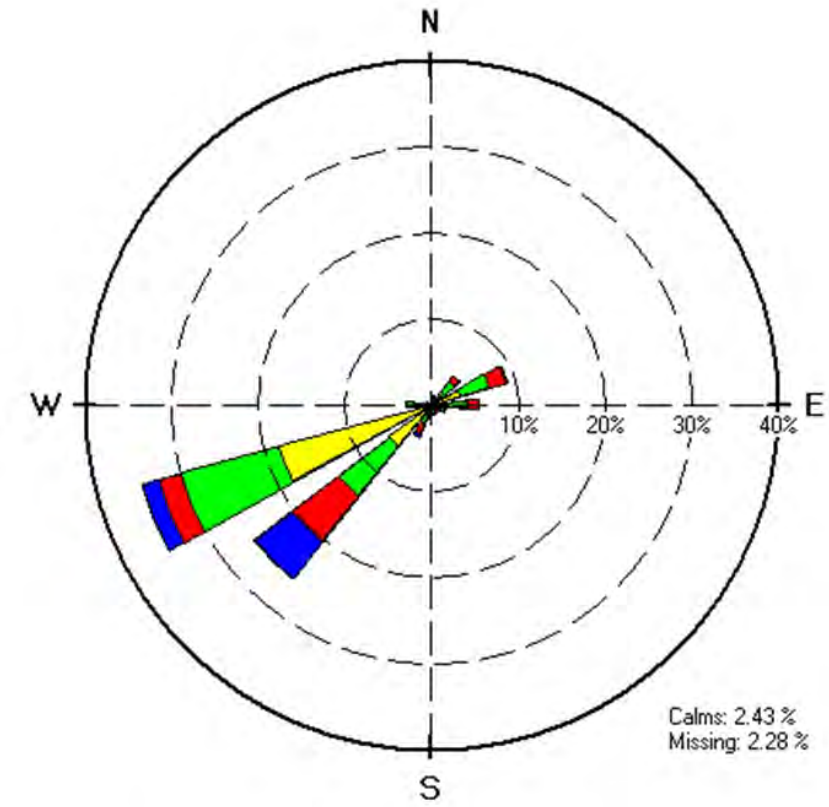
Table 22. CALCULATED SEASONAL *zo* VALUES (m).

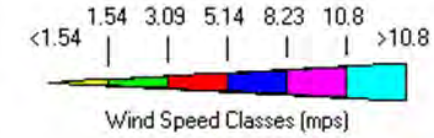
Sector	Winter	Spring	Summer	Fall
1	0.410	0.564	0.610	0.607
2	0.212	0.347	0.392	0.387
3	0.517	0.640	0.671	0.669
4	0.769	0.865	0.894	0.894
5	0.989	1.044	1.055	1.055
6	0.741	0.874	0.918	0.915
7	0.400	0.563	0.617	0.614
8	0.414	0.522	0.552	0.550
9	0.049	0.171	0.244	0.243
10	0.060	0.197	0.274	0.274
11	0.183	0.372	0.449	0.449
12	0.576	0.710	0.743	0.742

Winter = December, January, February
Spring = March, April, May
Summer = June, July, August
Fall = September, October, November

Wind frequency distribution for the 2014 Stibnite meteorological dataset is presented in Figure 5, and a map showing the location of the meteorological monitoring stations used for this meteorological data processing is presented in Figure 6.

Figure 5. WIND FREQUENCY DISTRIBUTION FOR 2014 SGP METEOROLOGICAL DATA (NON-BULKRN).





Note: Diagram of the frequency of occurrence of each wind direction.

Met File Type: AERMET SFC
File: STIBNITE_2014U.SFC

Figure 6. METEOROLOGICAL STATION LOCATIONS FOR SGP MODELING.



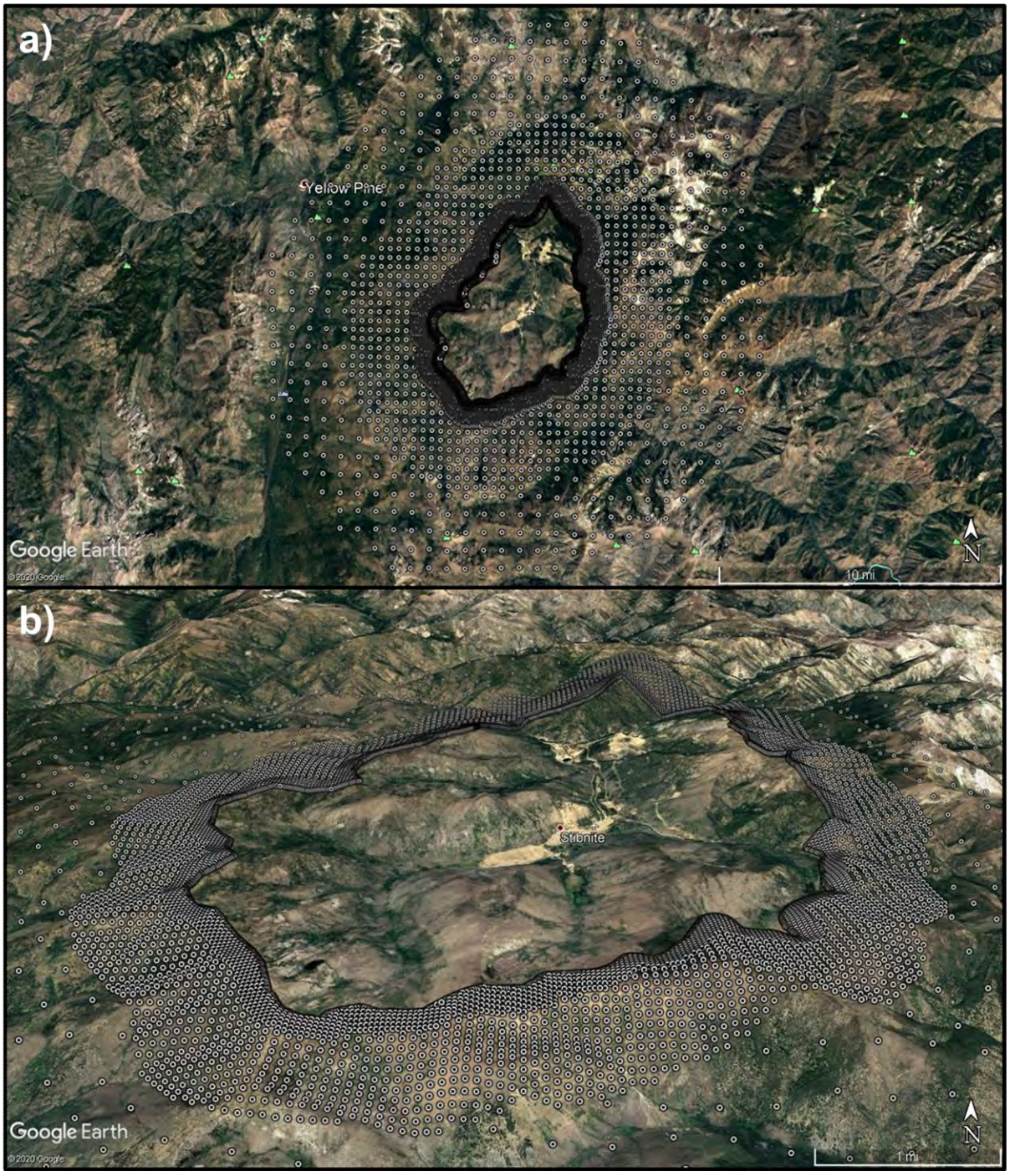
3.3.6 Effects of Terrain on Modeled Impacts

Submitted ambient air impact analyses used terrain data extracted from United States Geological Survey (USGS) National Elevation Dataset (NED) files.

The terrain preprocessor AERMAP version 18081 was used by Air Sciences to extract the elevations from the NED files and assign them to receptors in the modeling domain in a format usable by AERMOD. AERMAP also determined the hill-height scale for each receptor. The hill-height scale is an

elevation value based on the surrounding terrain which has the greatest effect on that individual receptor. AERMOD uses those heights to evaluate whether the emission plume has sufficient energy to travel up and over the terrain or if the plume will travel around the terrain. Figure 7a depicts the full receptor grid used in the modeling analyses and Figure 7b illustrates a close-up of Figure 7a, overlaid on a terrain image from Google Earth.

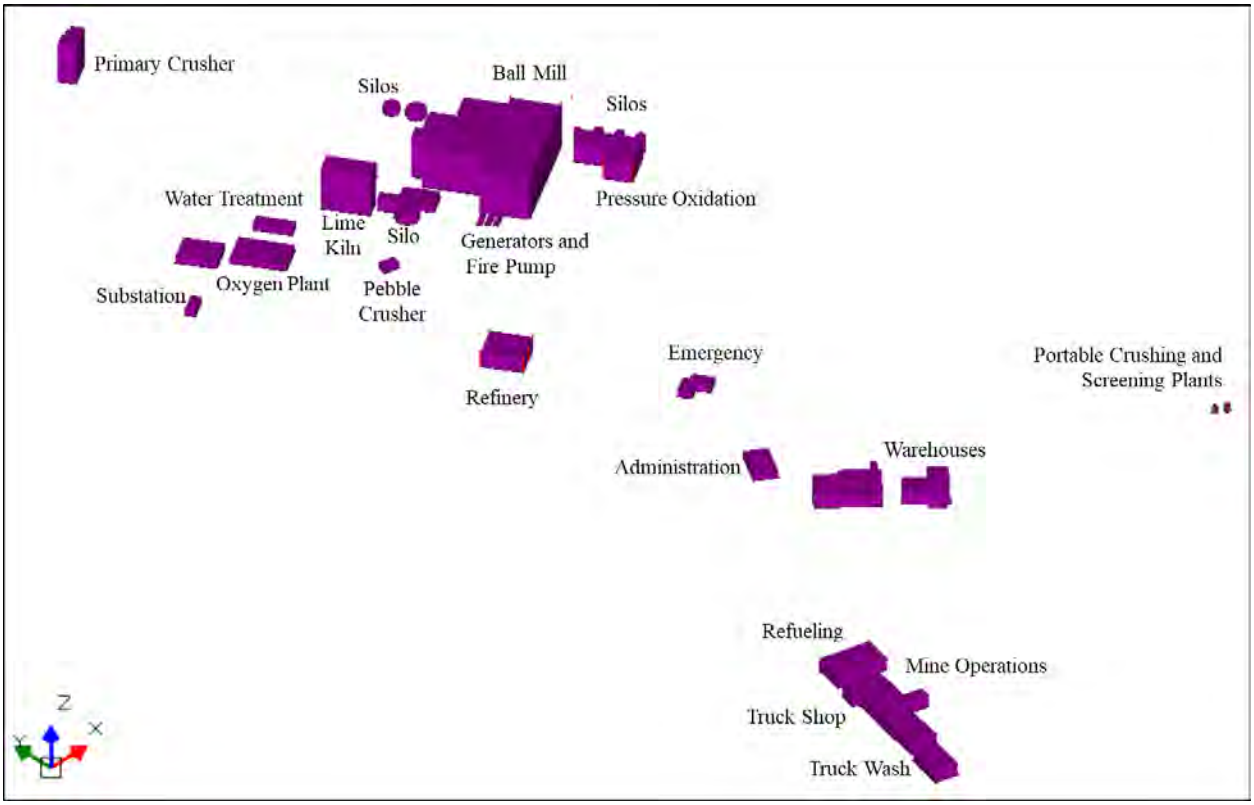
Figure 7. RECEPTOR GRID CENTERED AT THE SGP FACILITY.



3.3.7 Facility Layout and Downwash

Figure 3 shows the processing and refining area buildings and sources at the SGP facility. Figure 8 below depicts a three-dimensional view of Figure 3, as viewed from the southwest.

Figure 8. THREE-DIMENSIONAL VIEW OF PROCESSING AND REFINING AREA BUILDINGS AND SOURCES AT THE SGP FACILITY AS VIEWED FROM THE SOUTHWEST.



DEQ verified proper identification of the site location and the ambient air boundary by comparing a graphical representation of the modeling input file to aerial photographs on Google Earth (available at https://www.google.com/earth).

Potential downwash effects on emission plumes were accounted for in the model by using building dimensions and locations (locations of building corners, base elevation, and building heights). Dimensions and orientation of proposed buildings were used as input to the Building Profile Input Program for the Plume Rise Model Enhancements downwash algorithm (BPIP-PRIME version 04274) to calculate direction-specific dimensions and Good Engineering Practice (GEP) stack height information for input to AERMOD.

3.3.8 NOx Chemistry

The atmospheric chemistry of NO, NO_2, and O_3 complicates accurate prediction of NO_2 impacts resulting from NOx emissions. The conversion of NO to NO_2 can be conservatively addressed through the use of

several methods as outlined in a *2014 EPA NO_2 Modeling Clarification Memorandum* (EPA 2014). The guidance outlines a three-tiered approach:

- Tier 1 – assume full conversion of NO to NO_2 where total NOx emissions are modeled and modeled impacts are assumed to be 100 percent NO_2.

- Tier 2 – use an ambient ratio to adjust impacts from the Tier 1 analysis.

- Tier 3 – use a detailed screening method to account for $NO/NO_2/O_3$ chemistry such as the Ozone Limiting Method (OLM) or the Plume Volume Molar Ratio Method (PVMRM).

The default option of the Ozone Limiting Method (OLM), a third-tier method from 40 CFR 51, Appendix W, was used by Air Sciences to estimate the NO_2 1-hour and annual impacts for these analyses. The OLM method requires an input of in-stack NO_2/NOx ratio for each modeled source.

An in-depth literature review was conducted by Air Sciences to identify reasonable NO_2/NOx ratios for different combustion source categories. Based on this research, the NO_2/NOx ratio recommended for the heavy-duty diesel trucks in the California Air Pollution Control Officers Association (CAPCOA) Guidance Document (CAPCOA 2011) was selected for stationary diesel combustion sources. This NO_2/NOx ratio (11 percent) is conservatively higher than the diesel combustion NO_2/NOx ratio provided in the EPA ISR (In-Stack Ratio) database: 6 percent average, 9.8 percent maximum. The CAPCOA document and the EPA ISR database do not provide an NO_2/NOx ratio for propane boilers. The CAPCOA-recommended NO_2/NOx ratio for natural gas boilers was selected for the propane boilers. The natural gas boilers NO_2/NOx ratio is considered appropriate for the propane boilers because both are gaseous fuels with relatively similar combustion characteristics and are expected to have similar NO_2/NOx ratios. The NO_2/NOx ratio for blasting is based on blasting plume measurements provided in an Australian study (CSIRO 2008). The NO_2/NOx ratios used for the SGP NO_2 analyses are presented in Table 23.

Table 23. NO_2/NOx RATIOS.

Source Type	NO_2/NO_X Ratio	Reference
Blasting	0.036	Commonwealth Scientific and Industrial Research Organization (CSIRO 2008)
Diesel Engines	0.11	CAPCOA Guidance Document, heavy-duty diesel trucks (CAPCOA 2011)
Propane Heaters	0.10	CAPCOA Guidance Document, natural gas boilers (CAPCOA 2011)

DEQ performed a sensitivity analysis using a Tier 2 screening method (ARM2), which is more conservative than OLM, and found that the SGP facility is safely below the 1-hour and annual NO_2 NAAQS. Results are summarized in Section 4.1.3.

3.3.9 Particulate Deposition

For $PM_{2.5}$ and PM_{10} analyses, default particulate modeling methods, including deposition (Method 1, to account for depletion due to particulate settling), were used. To account for particulate settling, AERMOD requires the following source-specific variables:

1. Mass-mean aerodynamic particle diameter (PARTDIAM) for each particle size bin
2. Mass fraction (MASSFRAX) for each particle size bin
3. Particle density (PARTDENS) for each particle size bin

A list of references that were used to develop the broad source category particle size bins and associated mass fractions was provided in the application. Midas Gold (Midas Gold 2017b) provided the ore and DR material densities. The diesel and propane combustion particulate densities were adopted from technical literature (UMN 2002) and (Khalizov et al. 2012), respectively. Densities for the remaining materials were obtained from the Engineering Toolbox (https://www.engineeringtoolbox.com/density-materials-d_1652.html). An average density was used when a material-specific density range was available.

For sources that were aggregated and modeled as activity locations, deposition parameters were selected for the dominant source within the activity location. For open-pits (YPP, HFP, WEP), approximately 90% of emissions were associated with drilling; therefore, drilling deposition parameters were assigned to these sources. Similarly, emissions from dozing accounted for over 70% of emissions in the DRSF (FDRSF, HFDRSF, WEDRSF) and BT; therefore, these sources were assigned deposition parameters based on a dozing particulate profile.

The deposition parameters including mass fractions, mass mean diameters, and densities for the different source categories/groups are provided in Table 24.

Table 24. DEPOSITION PARAMETERS BY SOURCE CATEGORY.

Source Category	Parameter	PM_{10}				$PM_{2.5}$	
		Bin 1	Bin 2	Bin 3	Bin 4	Bin 1	Bin 2
Haul Roads	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction	0.10	0.90	--	--	1.00	--
	Mass Mean Diameter (µm)	2.50	10.00	--	--	2.50	--
	Density (g/cm^3) (YPP, HFP, WEP DR average)	2.46	2.46	--	--	2.46	--
Material Handling (Ore, DR, Limestone)	Bin Upper Diameter (µm)	2.50	5.00	10.00	--	2.50	--
	Mass Fraction	0.15	0.42	0.43	--	1.00	--
	Mass Mean Diameter (µm)	2.50	5.00	10.00	--	2.50	--
	Density (g/cm^3) (Ore)	Pit-specific, see Table 25.					
	Density (g/cm^3) (Ore and Waste)	Pit-specific, see Table 25.					
	Density (g/cm^3) (Limestone)	1.09	1.09	1.09	--	1.09	--
Baghouses	Bin Upper Diameter (µm)	2.50	6.00	10.00	--	2.50	--
	Mass Fraction	0.28	0.50	0.22	--	1.00	--
	Mass Mean Diameter (µm)	2.50	6.00	10.00	--	2.50	--
	Density (g/cm^3) (Ore)	Pit-specific, see Table 25.					
Diesel Engines	Bin Upper Diameter (µm)	1.00	2.50	6.00	10.00	1.00	2.50
	Mass Fraction	0.85	0.08	0.03	0.03	0.91	0.09
	Mass Mean Diameter (µm)	1.00	2.50	6.00	10.00	1.00	2.50
	Density (g/cm^3) (Diesel Combustion)	1.00	1.00	1.00	1.00	1.00	1.00
Heaters and Boilers	Bin Upper Diameter (µm)	1.00	2.50	6.00	10.00	1.00	2.50
	Mass Fraction	0.29	0.28	0.32	0.11	0.51	0.49
	Mass Mean Diameter (µm)	1.00	2.50	6.00	10.00	1.00	2.50
	Density (g/cm^3) (Propane Combustion)	1.24	1.24	1.24	1.24	1.24	1.24
Lime Loading and Unloading (Quick, Pebble)	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction	0.15	0.85	--	--	1.00	--
	Mass Mean Diameter	2.50	10.00	--	--	2.50	--
	Density (g/cm^3) (Quick)	0.44	0.44	--	--	0.44	--
	Density (g/cm^3) (Pebble)	0.96	0.96	--	--	0.96	--
Lime Unloading (Quick, Pebble)	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction	0.15	0.85	--	--	1.00	--
	Mass Mean Diameter (µm)	2.50	10.00	--	--	2.50	--
	Density (g/cm^3) (Quick)	0.44	0.44	--	--	0.44	--
	Density (g/cm^3) (Pebble)	0.96	0.96	--	--	0.96	--
Cement and Aggregate	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction	0.15	0.85	--	--	1.00	--

Table 24. DEPOSITION PARAMETERS BY SOURCE CATEGORY.							
Source Category	**Parameter**	**PM_{10}**				**$PM_{2.5}$**	
		Bin 1	**Bin 2**	**Bin 3**	**Bin 4**	**Bin 1**	**Bin 2**
Loading and Unloading	Mass Mean Diameter (µm)	2.50	10.00	--	--	2.50	--
	Density (g/cm^3) (Cement)	1.44	1.44	--	--	1.44	--
	Density (g/cm^3) (Aggregate)	1.28	1.28	--	--	1.28	--
Prill Loading and Unloading	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction	0.15	0.85	--	--	1.00	--
	Mass Mean Diameter (µm)	2.50	10.00	--	--	2.50	--
	Density (g/cm^3) (Prill)	0.84	0.84	--	--	0.84	--
Refining Processes	Bin Upper Diameter (µm)	1.00	2.50	6.00	10.00	1.00	2.50
	Mass Fraction	0.78	0.11	0.08	0.03	0.88	0.12
	Mass Mean Diameter (µm)	1.00	2.50	6.00	10.00	1.00	2.50
	Density (g/cm^3) (Diesel Combustion)	1.00	1.00	1.00	1.00	1.00	1.00
Portable Crushing and Screening Plant	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction	0.13	0.87	--	--	1.00	--
	Mass Mean Diameter (µm)	2.50	10.00	--	--	2.50	--
	Density (g/cm^3) (YPP, HFP, WEP DR average)	2.46	2.46	--	--	2.46	--
Lime Kiln and Ball Mill	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction (Kiln)	0.49	0.51	--	--	1.00	--
	Mass Fraction (Ball Mill)	0.36	0.64	--	--	1.00	--
	Mass Mean Diameter (µm)	2.50	10.00	--	--	2.50	--
	Density (g/cm^3)	1.09	1.09	--	--	1.09	--
Blasting and Drilling	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction	0.06	0.94	--	--	1.00	--
	Mass Mean Diameter (µm)	2.50	10.00	--	--	2.50	--
	Density (g/cm^3) (Ore or DR)	Pit-specific, see Table 25.					
Dozing	Bin Upper Diameter (µm)	2.50	10.00	--	--	2.50	--
	Mass Fraction	0.55	0.45	--	--	1.00	--
	Mass Mean Diameter (µm)	2.50	10.00	--	--	2.50	--
	Density (g/cm^3) (DR)	Pit-specific, see Table 25.					

In order to account for variability in ore and DR densities for different pits, pit-specific densities were used for the ore and DR for each modeling scenario, with the following exception – for haul roads, access roads, and portable crushers, the average DR density from YPP, HFP, and WEP was used. Note that the BT density was excluded from those sources because the BT material will not be used for roads or construction. The pit-specific ore and DR densities are provided in Table 25.

Table 25. PIT-SPECIFIC ORE AND DEVELOPMENT ROCK DENSITIES FOR DEPOSITION.		
Pit	**Material**	**Density (g/cm^3)**
YPP	Ore	2.59
BT	Ore	2.00
HFP	Ore	2.59
WEP	Ore	2.68
YPP	DR	2.48
BT	DR	2.00
HFP	DR	2.34
WEP	DR	2.57
Average (YPP,HFP, WEP)	DR	2.46

3.3.10 Ambient Air Boundary

Ambient air is defined in Section 006 of the Idaho Air Rules as "that portion of the atmosphere, external to buildings, to which the general public has access."

Midas Gold will legally control the SGP, an active industrial site where mining activities will occur, such as heavy equipment operation. Most areas of the mine will require strict safety protocols and controlled access. Midas Gold has established an operations boundary to identify the area where public access will be excluded. Public access inside the operations boundary will be restricted for the life of the mine by physical barriers at points of potential access, including the current Stibnite Road point of entry and proposed site access via the Burntlog Route, as well as natural features of the landscape that prevent access. Consistent with the guidance provided in the EPA's draft revised policy on ambient air (EPA 2018b), public access control will include the following measures:

- Primary Access Points: The Stibnite Road (north) and Burntlog Route (south) access points will include locked gates. Guard shacks will be located at each gate to monitor all vehicle ingress/egress. Each gate also will include appropriate adjacent barriers (i.e., fencing, bollards, boulders, or other barriers) to prevent any vehicle from circumventing the gate and gaining site access. These primary access points are also controlled by adjacent natural features, such as streams and creeks, steep topography, and areas of thick vegetation and undergrowth that serve as natural barriers or impediments to access.

- Secondary Access Points: Other potential access points, such as secondary roadways and trails, will include posted signs warning the public against entry into the site. At these locations, boulders will be placed across the trail and at an appropriate width adjacent to the trail to prevent any vehicle from circumventing the barrier. These secondary access points also incorporate adjacent natural features, such as streams and creeks, steep topography, and areas of thick vegetation and undergrowth that serve as natural barriers or impediments to access. Some mine features, such as the TSF and process plant areas, will include perimeter fencing.

- Surveillance: Midas Gold security personnel will routinely patrol mine facilities and roadways for unauthorized individuals. In addition, all onsite personnel will be trained on the necessity of restricting public access to areas within the operations boundary. Any suspected trespassing by unauthorized individuals will be reported immediately to security, and trespassers will be escorted off the site.

In response to comments from local community citizens, Midas Gold will manage an access route to provide the general public with limited access through the SGP site between Stibnite Road at Sugar Creek and Thunder Mountain Road at Meadow Creek (shown in Figure 2). This route will be managed in accordance with the Stibnite Road Access Management Plan which is summarized as follows:

The proposed Stibnite Road access route through the SGP site is meant to provide controlled through-site access that is safe, provides travel-time comparable to current conditions and is consistent with the United States Forest Service travel management plan. The Stibnite Road access route extends from the north entry point southward to the Administration, Warehouse and Storage Area. Continuing southward, the Stibnite Road access route incorporates the Burntlog access road segment that occurs within the operations area and extends to the south entry point as shown on Figure 2. Midas Gold has the legal authority to control access to the Stibnite Road access route and would provide seasonal (non-winter conditions) access only. At the discretion of Midas Gold, additional access controls may occur during various phases of construction, during mine operations that present potential safely hazards such as blasting, due to inclement weather, or under any other circumstances that may present a threat to the protection of public or employee health and safety. Midas Gold has the legal and practical ability to

enforce its control over roadway access and to monitor traffic passing through the SGP site. Signage will be placed at the North Security Gate (near the bridge over Sugar Creek) and the South Security Gate (near the Stibnite Lodge) to provide information to travelers, and guard shacks will be located at each gate to monitor all vehicle ingress/egress. Persons wishing to traverse the SGP site on the Stibnite Road access route will be required to check in at the security gate to receive a safety briefing and to alert mine staff of their presence. Travelers will be required to check out upon exiting the site to ensure passage through the site in a safe and timely manner. Travelers will not be allowed to stop or loiter while traveling though the operations area. Along its full length, the Stibnite Road access route would have appropriate signage to direct travelers and would be separated from mine haul roads and areas of mine operations by fencing, berms, or gates to prevent travelers from straying from the route. When possible and to the degree practicable, anticipated public access restrictions will be communicated to the public in a timely manner so that they may plan appropriately. Receptors on the Stibnite Road access route were not included in the SGP air quality analyses as this road is not considered ambient air.

The worker housing facility will be located within the project operations boundary, near the south access security gate. This housing facility will be used strictly for accommodating employees, contractors, and official visitors, and it will not be accessible to the general public. Therefore, the atmosphere over the land occupied by the worker housing facility is not considered ambient air, and receptors were not placed at this location for the air quality analyses.

The operations boundary, shown in Figure 2 above and Figure 9 below, was used to define the ambient air boundary for air dispersion modeling purposes.

3.3.11 Nearby Co-Contributing Sources

If impacts of neighboring emission sources on receptors showing a significant impact from the sources subject to the permitting action are not adequately accounted for by the background concentration used, then emissions from those sources must be modeled. The nearest significant permitted facility to SGP is Tamarack Mill, located more than 75 kilometers (km) west. This facility is located too far away to cause a significant concentration gradient along the periphery of the SGP and was therefore not included in the cumulative impact analyses for SGP.

3.3.12 Receptor Network

DEQ determined that the receptor grid used in the submitted modeling analyses was adequate to resolve maximum modeled impacts.

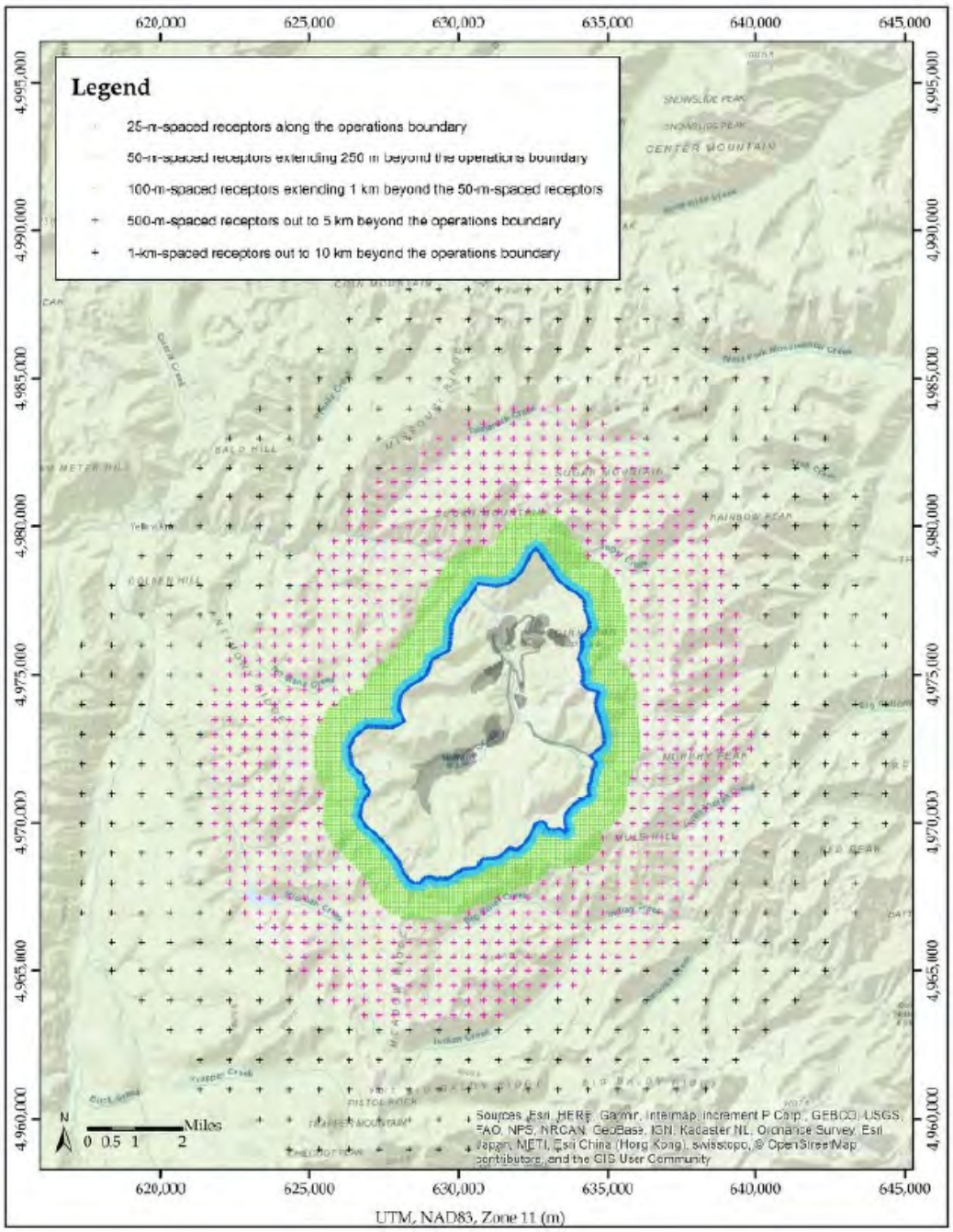
The SGP air quality analyses were performed using the following receptor spacing and extents (Table 20):

- 25-m-spaced receptors placed along the ambient air boundary;
- 50-m-spaced receptors extending 250 m beyond the ambient air boundary;
- 100-m-spaced receptors extending 1 km beyond the 50-m-spaced receptors;
- 500-m-spaced receptors extending 5 km beyond the ambient air boundary; and
- 1-km-spaced receptors extending 10 km beyond the ambient air boundary.

In addition, each highest modeled impact was evaluated further by performing a hot-spot analysis using a finer 25-m-spacing receptor grid. The modeling receptor grid is shown below in Figure 9. The full grid, along with the fenceline receptors, includes a total of 9,631 receptors. A SIL analysis was not conducted. The full receptor grid was used in the cumulative NAAQS impact and TAPs impact analyses.

The receptor grid used in the submitted modeling analyses met the minimum recommendations specified in the *Idaho Air Quality Modeling Guideline* (DEQ 2013), and DEQ determined that the receptor network was effective in reasonably assuring compliance with applicable air quality standards at all ambient air locations.

Figure 9. SGP AMBIENT AIR BOUNDARY AND MODELING RECEPTOR GRID.



3.3.13 Good Engineering Practice Stack Height

An allowable good engineering practice (GEP) stack height may be established using the following equation in accordance with Idaho Air Rules Section 512.03.b:

H = S + 1.5L, where:

H = good engineering practice stack height measured from the ground-level elevation at the base of the stack.

S = height of the nearby structure(s) measured from the ground-level elevation at the base of the stack.

L = lesser dimension, height or projected width, of the nearby structure.

Sources from the SGP facility are below GEP stack height. Therefore, consideration of downwash caused by nearby buildings was required.

4.0 NAAQS and TAPs Impact Modeling Results

4.1 Results for NAAQS Analyses

4.1.1 Significant Impact Level Analyses

A SIL analysis was not performed for the SGP project.

4.1.2 Cumulative NAAQS Impact Analyses

Table 26 provides results (highest of 14 scenarios) for the cumulative NAAQS impact analysis. It provides the model-predicted maximum design concentration (including the hot-spot analyses) and the associated modeling scenario, the background concentration, and the estimated total concentration (SGP impact plus background) for each pollutant-averaging time combination. A comparison of the estimated total concentrations with the applicable NAAQS is also provided in this table. For each pollutant and averaging period, two modeled design concentrations are listed, each corresponding to the meteorological data processed with (BULKRN) and without (NON-BULKRN, grey shading) the Bulk Richardson method.

Table 26. RESULTS FOR CUMULATIVE NAAQS IMPACT ANALYSES.

Pollutant	Averaging Time	Max. Conc.[a] (µg/m^3)[b]	Model Scenario	Back. Conc.[c] (µg/m^3)	Total Conc.[d] (µg/m^3)	NAAQS (µg/m^3)	Percent of NAAQS
Carbon monoxide	8 hours	6,218[e]	W1	1,110	7,328	10,000	73.3%
		3,516[f]	W1		4,626		46.3%
	1 hour	17,054	W1	1,740	18,794	40,000	47.0%
		9,467	W1		11,207		28.0%
Nitrogen dioxide	1 year	2.3	W1	0.9	3.2	100	3.2%
		1.4	W1		2.3		2.3%
	1 hour	116.7	B1	4.3	121.0	188	64.4%
		111.0	W1		115.3		61.3%
$PM_{2.5}$[g]	1 year	7.7	W5	3.5	11.2	12	93.3%

		4.2	W5		7.7		64.2%
	24 hours	18.6	W5	15.0	33.6	35	96.0%
		11.0	W5		26.0		74.3%
PM_{10}[h]	24 hours	121.5	W5	37.0[i]	158.5	150	105.7%[j]
		75.7	W5		112.7		75.1%
Sulfur dioxide	3 hours	1.8	B1	16.8	18.6	1,300	1.4%
		1.2	B1		18.0		1.4%
	1 hour	3.2	B1	12.3	15.5	196	7.9%
		2.7	B1		15.0		7.7%

a. Max. Conc. = maximum modeled design concentration.
b. Micrograms per cubic meter.
c. Back. Conc. = background concentration.
d. Total Conc. = total (modeled + background) concentration.
e. The first Max. Conc. value for each pollutant and averaging time represents results using the BULKRN meteorological data.
f. The second (grey-shaded) Max. Conc. value for each pollutant and averaging time represents results using the NON-BULKRN meteorological data.
g. Particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers.
h. Particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers.
i. For 24-hour PM_{10}, the design value is the *second-highest* 24-hour average concentration in a given year. However, the background value that was used in the modeling analyses represents the *first-highest* 24-hour average concentration measured in 2014. Therefore, using a larger background concentration adds a layer of conservatism to the calculated total impact for 24-hour PM_{10}.
j. Results for 24-hour PM_{10} with meteorological data processed using BULKRN show up to five hotspot receptors that exceed NAAQS. Refer to Section 4.1.4 of this modeling memo for a weight-of-evidence analysis demonstrating NAAQS compliance.

Table 26 shows that modeled concentrations derived using the BULKRN meteorological data are higher than the NON-BULKRN dataset. It also shows that the total (modeled + background) concentrations from the SGP cumulative impact analyses do not exceed the applicable NAAQS, except for when the BULKRN meteorological data are used in modeling 24-hour PM_{10} (total concentration is 105.7% of the 24-hour PM_{10} NAAQS).

PM_{10} modeling with the meteorological dataset processed with the BULKRN method shows up to five hotspot receptors for three modeling scenarios (W1, W3, and W5) with slight exceedance of NAAQS. Scenario W5 is the worst-case scenario, with a maximum total concentration of 158.5 $\mu g/m^3$ which exceeds the NAAQS of 150 $\mu g/m^3$. A weight-of-evidence analysis demonstrating PM_{10} NAAQS compliance is presented in Section 4.1.4 of this modeling memo.

The locations of the maximum impacts for each pollutant and averaging time are illustrated in Figure 10. The results presented in this figure include the hot-spot analyses conducted for each applicable pollutant-averaging time combination. For $PM_{2.5}$ and PM_{10}, the alternate meteorological data (NON-BULKRN) were used.

Modeling for ozone and secondary $PM_{2.5}$ were not performed for this minor stationary source. These analyses are typically associated with applications for major stationary sources. Nonetheless, taking the ratio of the VOC, NOx, and SO_2 emissions from the SGP facility by the emissions and resulting concentrations of O_3 and secondary $PM_{2.5}$ from EPA's modeled emission rates for precursors (MERPs) guidance yields estimated O_3 and secondary $PM_{2.5}$ concentrations of less than 1 ppb of O_3 and less than 0.1 $\mu g/m^3$ of $PM_{2.5}$ (24-hour and annual) for the SGP. These estimated concentrations have a negligible effect on compliance demonstration with the NAAQS.

Figure 10. SGP CUMULATIVE IMPACTS (µg/m^3) AND LOCATIONS.



Higher background concentrations from McCall that include medium-traffic emissions provided in Section 3.2.3 were then combined with the SGP model-predicted maximum design concentrations to provide an additional level of conservatism in demonstrating compliance. These results are shown in Table 27. For $PM_{2.5}$ and PM_{10}, the alternate meteorological data (NON-BULKRN) were used. For the rest of the criteria pollutants, the BULKRN meteorological data were used.

Table 27. RESULTS FOR CUMULATIVE NAAQS IMPACT ANALYSES WITH MEDIUM-TRAFFIC BACKGROUND.							
Pollutant	**Averaging Time**	**Max. Conc.[a] (µg/m³)[b]**	**Model Scenario**	**Back. Conc.[c] (µg/m³)**	**Total Conc.[d] (µg/m³)**	**NAAQS (µg/m³)**	**Percent of NAAQS**
Carbon monoxide	8 hours	6,218	W1	1,145	7,363	10,000	73.6%
	1 hour	17,054	W1	1,797	18,851	40,000	47.1%
Nitrogen dioxide	1 year	2.3	W1	2.6	4.9	100	4.9%
	1 hour	116.7	B1	14.3	131.0	188	69.7%
$PM_{2.5}$[e]	1 year	4.2	W5	5.1	9.3	12	77.5%
	24 hours	11.0	W5	17.5	28.5	35	81.4%
PM_{10}[f]	24 hours	75.7	W5	60.1	135.8	150	90.5%
Sulfur dioxide	3 hours	1.8	B1	16.8	18.6	1,300	1.4%
	1 hour	3.2	B1	12.3	15.5	196	7.9%

a. Max. Conc. = maximum modeled design concentration.
b. Micrograms per cubic meter.
c. Back. Conc. = background concentration.
d. Total Conc. = total (modeled + background) concentration.
e. Particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers.
f. Particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers.

4.1.3 DEQ's Sensitivity Analyses for 1-hour and annual NO_2

DEQ performed a sensitivity analysis for 1-hour and annual NO_2 using a Tier 2 (ARM2) screening method. Minimum and maximum NO_2/NOx ratios of 0.5 and 0.9, respectively, were used. Results from DEQ's cumulative NAAQS impact analyses, summarized below in Table 28, indicate that the SGP facility is safely below the 1-hour and annual NO_2 NAAQS even when using a more conservative NO_2 screening method.

Table 28. RESULTS FOR DEQ'S NO_2 SENSITIVITY ANALYSES USING TIER 2 (AMBIENT RATIO METHOD 2) SCREENING METHOD.							
Pollutant	**Averaging Time**	**Max. Conc.[a] (µg/m³)[b]**	**Model Scenario**	**Back. Conc.[c] (µg/m³)**	**Total Conc.[d] (µg/m³)**	**NAAQS (µg/m³)**	**Percent of NAAQS**
Nitrogen dioxide	1 year	1.8	B1	0.9	2.7	100	2.7%
		1.8	H1		2.7		2.7%
		2.3	W1		3.2		3.2%
		1.8	Y1		2.7		2.7%
	1 hour	110.9	B1	4.3	115.2	188	61.3%
		73.0	H1		77.3		41.1%
		162.6	W1		166.9		88.8%
		59.8	Y1		64.1		34.1%

a. Max. Conc. = maximum modeled design concentration.
b. Micrograms per cubic meter.
c. Back. Conc. = background concentration.
d. Total Conc. = total (modeled + background) concentration.

4.1.4 DEQ's Weight-of-Evidence Analyses for 24-hour PM_{10}

This section describes a weight-of-evidence analysis that provides additional analytical information to evaluate the degree of NAAQS compliance confidence for 24-hour PM_{10}. NAAQS compliance was demonstrated in the submitted application using meteorological data processed with an EPA-approved method using regional cloud cover to calculate stability parameters rather than site-specific monitored solar radiation and measured temperature differences with height. Both methods are considered default for regulatory purposes, and modeling using this dataset shows that the facility is well below NAAQS.

As described in Section 4.1.2, PM_{10} modeling with meteorological dataset processed using the site-specific BULKRN method shows up to five hotspot receptors for Scenario W5 (the highest PM_{10} modeling scenario) that exceed NAAQS (150 µg/m^3). The hotspot receptors have a 25-meter grid spacing. Hotspot receptors that exceed 24-hour PM_{10} NAAQS have total (modeled + background) concentrations of 152.7, 154.3, 155.0, 155.7, and 158.5 µg/m^3. Locations of these receptors are illustrated in Figure 11. Figure 12 shows these receptors overlaid on Google Earth. As noted in Section 3.2.1 of this modeling memorandum, the design value for 24-hour PM_{10} is the *second-highest* 24-hour average concentration in a given year. However, the background value that was used in the modeling analyses (37.0 µg/m^3) represents the *first-highest* 24-hour average concentration measured in 2014. Therefore, using a larger background concentration adds another layer of conservatism to the calculated total impact for 24-hour PM_{10}. If the *second-highest* 24-hour average concentration (34.0 µg/m^3) were used in the modeling analyses, the number of receptors that exceed the 24-hour PM_{10} NAAQS is reduced from five to four.

REC 4258

Figure 11. HOTSPOT RECEPTORS THAT EXCEED 24-HOUR PM_{10} NAAQS (SCENARIO W5, BULKRN METEOROLOGICAL DATA).

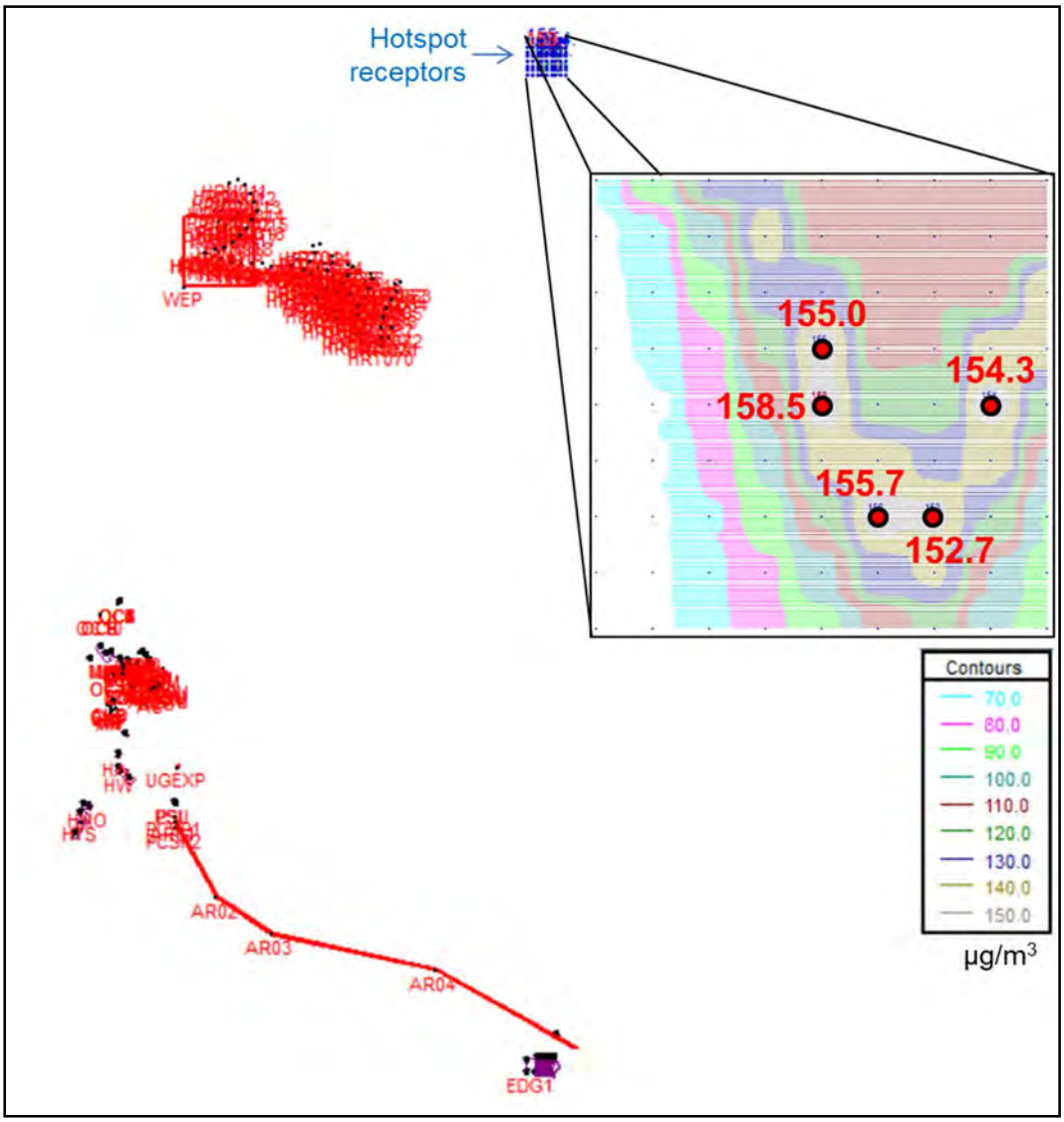
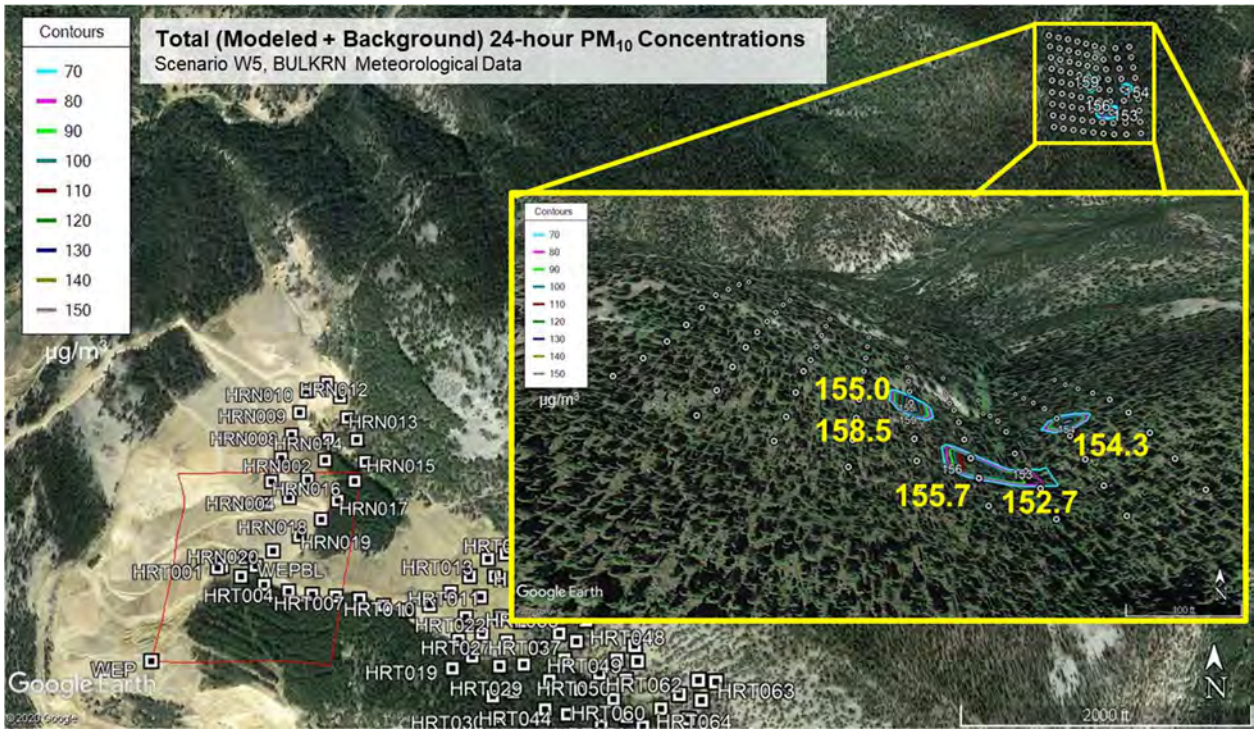


Figure 12. HOTSPOT RECEPTORS THAT EXCEED 24-HOUR PM_{10} NAAQS, OVERLAID ON GOOGLE EARTH IMAGE (SCENARIO W5, BULKRN METEOROLOGICAL DATA).



Figures 11 and 12 show that the modeled PM_{10} NAAQS exceedances are located northeast of the SGP facility. These receptors are located 2 km away from the center of the West End Pit (WEP). The AERMOD output files indicate that all modeled violations occur during winter (all modeled violations occur on December 23, 2014). Data provided in the SGP baseline study (Midas Gold 2017a) specify an average snow depth of 21-68 inches and an average precipitation of 6.0 inches at the project site during this period. Therefore, fugitive road dust emissions during high-modeled impact hours could be overestimated.

DEQ performed a source-group analysis (Table 29) which indicates that emissions from the WEP and the Haul Road (HR) are the largest contributors to the maximum modeled PM_{10} design concentrations. For comparison, source-group analyses using the NON-BULKRN meteorological data are also listed in Table 29.

Table 29. SOURCE-GROUP ANALYSES FOR 24-HOUR PM_{10} (SCENARIO W5).

Emission Source Group	Modeled Design Concentration ($\mu g/m^3$)[a]	
	BULKRN	NON-BULKRN
ALL	121.5	75.7
West End Pit (WEP)	89.3	24.5
West End Pit Blasting (WEPBL)	1.94	1.81
West End Pit Development Rock Storage Facility (WEDRSF)	0.98	3.47
Haul Road (HR)	51.0	52.5
Access Road (ACCRD)	0.0064	0.0074
Underground Exploration (UGEXP)	0.00001	0.00001

Process & Ancillary Point Sources	0.23	0.76
Process & Ancillary Volume Sources	0.20	0.29

[a] Micrograms per cubic meter.

The six source groups listed in Table 29 that are related to mining activity and emissions (WEP, WEPBL, WEDRSF, HR, ACCRD, UGEXP) were examined further. Table 30 lists the daily modeled PM_{10} emissions (in pounds per day [lb/day]), grouped according to mining activity. Key assumptions for calculating the daily emissions are also listed in this table. Total modeled PM_{10} emission from mining activity for Scenario W5 is 3,336.76 lb/day. The contribution from each source group is listed in the second column of Table 30, and a pie chart is illustrated in Figure 13.

Table 30. KEY ASSUMPTIONS FOR CALCULATING DAILY MINING ACTIVITY EMISSIONS FOR 24-HOUR PM_{10} (SCENARIO W5).

Mining Activity	Emissions (lb/day)[a]
WEP (West End Pit)	**885.54**
Open Pit Drilling	
• Blasting 180,000 tons of material (DR) per day • Drilling 1,200 holes per day	811.20
Material Loading	
• Blasting 180,000 tons of material (DR) per day	18.00
Dozing	
• Dozers operating 144 hours per day • Surface material silt content of 6.9% • Material moisture content of 7.9%	54.20
Surface Exploration	
• Total wet drilling holes of 700 divided by 14 years • 50 holes per year	2.15
WEPBL (West End Pit Blasting)	**334.38**
Open Pit Blasting	
• Blasting 180,000 tons of material (DR) per day • Two blasts per day	334.38
WEDRSF (West End Pit Development Rock Storage Facility)	**57.12**
Material Unloading	
• Blasting 180,000 tons of material (DR) per day	2.88
Dozing	
• Six dozers operating 144 hours per day • Surface material silt content of 6.9% • Material moisture content of 7.9%	54.20
Wind Erosion	0.04
HR (Haul Road)	**2,050.34**
Onsite Hauling	
• Blasting 180,000 tons of material (DR) per day • One-way hauling distance of 3.07 miles • Total travel of 7,758 vehicle miles traveled (VMT) per day • Surface material silt content of 4% • Daily PM_{10} emission factor of 3.55 pounds per VMT • Control efficiency of 90% for chemical suppressant • Control efficiency of 33% for watering	1,842.97
Grading	
• Grader average speed of 6.5 mph • Three graders operating 72 hours per day • Control efficiency of 90% for chemical suppressant	60.51
Water Truck Travel	
• Two water trucks operating 48 hours per day	146.86

• Average truck speed of 15 mph • Surface material silt content of 4% • Daily PM_{10} emission factor of 3.04 pounds per VMT • Control efficiency of 90% for chemical suppressant • Control efficiency of 33% for watering	
ACCRD (Access Road) *Vehicle Travel* • Access road length of 1.6 miles (within project boundary) • Surface material silt content of 4% • Daily PM_{10} emission factor of 1.26 pounds per VMT • Control efficiency of 90% for chemical suppressant • Control efficiency of 33% for watering *Grading* • PM_{10} emission factor of 1.3 pounds per VMT • Control efficiency of 90% for chemical suppressant	**9.38** 9.17 0.21
UGEXP (Underground Exploration) *Underground Exploration* • Wet drilling 25 holes per year	**0.004** 0.004

[a] Pounds per day.

Figure 13. PIE CHART FOR DAILY MODELED PM_{10} EMISSIONS FROM MINING ACTIVITY (SCENARIO W5).

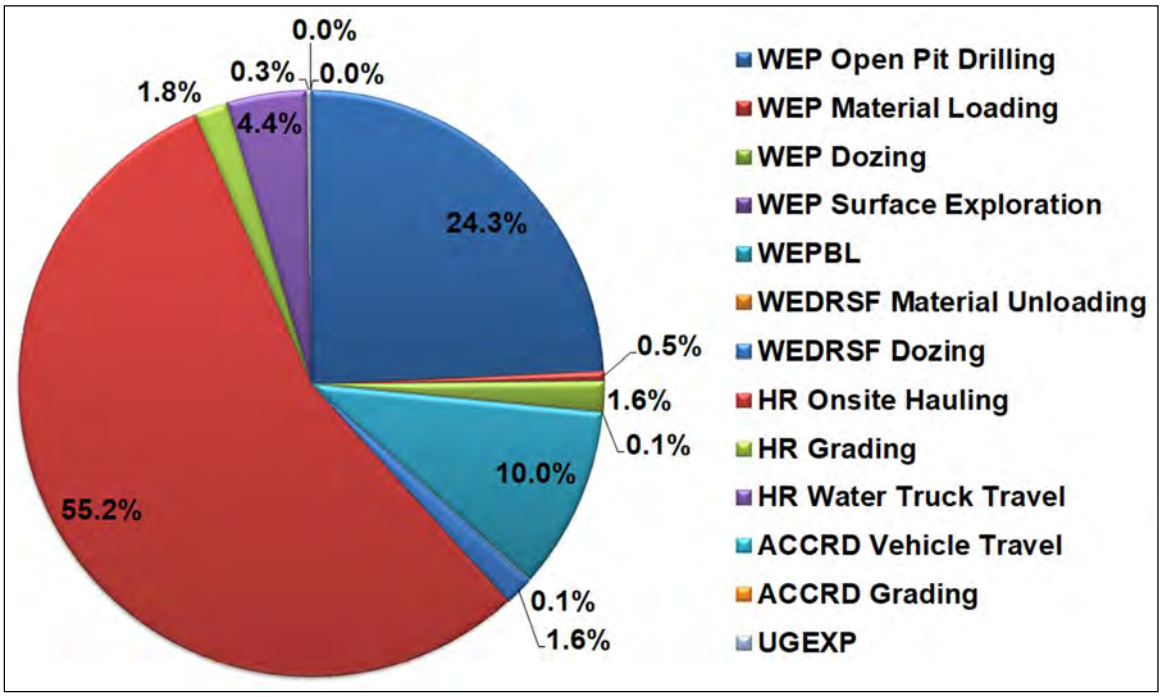


Figure 13 shows that onsite hauling on haul roads ("HR Onsite Hauling") accounts for 55.2% of the total daily PM_{10} emissions. Open pit drilling at the WEP ("WEP Open Pit Drilling") and blasting ("WEPBL") account for 24.3% and 10.0% of the daily PM_{10} emissions, respectively. Therefore, it is not surprising that HR, WEP, and WEPBL are associated with the highest modeled design concentrations in Table 29.

Table 31 shows the ten highest-ranked modeled 24-hour PM_{10} impacts from each emission source group. Note that for 24-hour PM_{10}, the design value is the *second-highest* 24-hour average concentration in a given year. Therefore, the second-high modeled value for source group ALL (121.5 $\mu g/m^3$) was summed

with the background concentration for comparison to NAAQS. The calculated total impact (modeled design value + background concentration) is conservative because the background value that was used in the cumulative NAAQS impact analyses (37.0 µg/m^3) represents the *first-highest* 24-hour average concentration measured in 2014.

Table 31. TEN HIGHEST-RANKED MODELED 24-HOUR PM_{10} IMPACTS IN µg/m^3 FROM DIFFERENT SOURCE GROUPS (SCENARIO W5, BULKRN METEOROLOGICAL DATA).

Rank	ALL[a]	WEP[b]	WEPBL[c]	WEDRSF[d]	HR[e]	ACCRD[f]	UGEXP[g]	PRCSPT[h]	PRCSVOL[i]
1ST	142.2	102.5	2.27	1.02	52.1	7.26E-03	1.00E-05	0.24	0.23
2ND	121.5	89.3	1.94	0.98	51.0	6.41E-03	1.00E-05	0.23	0.20
3RD	113.4	78.1	1.83	0.96	49.6	5.31E-03	1.00E-05	0.22	0.13
4TH	110.1	77.0	1.73	0.93	49.4	3.39E-03	1.00E-05	0.20	0.10
5TH	108.5	76.9	1.62	0.90	46.1	3.39E-03	1.00E-05	0.18	0.09
6TH	107.7	75.7	1.57	0.85	45.5	3.22E-03	1.00E-05	0.17	0.08
7TH	105.7	73.3	1.49	0.84	43.4	3.21E-03	0	0.16	0.08
8TH	105.6	72.3	1.30	0.77	42.9	2.91E-03	0	0.15	0.08
9TH	101.5	71.4	1.28	0.77	41.8	2.87E-03	0	0.15	0.08
10TH	99.8	71.2	1.23	0.76	41.8	2.56E-03	0	0.15	0.08

a. ALL = all emission sources.
b. WEP = West End Pit.
c. WEPBL = West End Pit Blasting.
d. WEDRSF = West End Pit Development Rock Storage Facility.
e. HR = Haul Road.
f. ACCRD = Access Road.
g. UGEXP = Underground Exploration.
h. PRCSPT = Process & Ancillary Point Sources.
i. PRCSVOL = Process & Ancillary Volume Sources.

Given a background of 37.0 µg/m^3 and a NAAQS of 150 µg/m^3, the critical modeled concentration threshold for any 24-hour PM_{10} NAAQS violation is therefore 113.0 µg/m^3. Table 31 shows that the third-high modeled value for source group ALL (113.4 µg/m^3) barely exceeds NAAQS. Fourth-high (and lower-ranked) modeled impacts, when added to the background concentration, are below NAAQS.

As discussed earlier in this section, HR Onsite Hauling, WEP Open Pit Drilling, and WEP Blasting are the three largest components of the total daily PM_{10} emissions. Therefore, it is not surprising that HR, WEP, and WEPBL are associated with the highest modeled concentrations among all source groups.

To investigate the potential culpability of each source group to the modeled 24-hour PM_{10} NAAQS violation, DEQ performed a culpability analysis using the MAXIFILE output option in AERMOD. The MAXIFILE option provides the receptor location and date of an impact. DEQ performed two MAXIFILE runs. In the first MAXIFILE simulation, the model was run using source group ALL. A threshold value (113.0 µg/m^3) equal to the NAAQS minus background was set. The output file provided a list of the receptors where the NAAQS is exceeded. In the second MAXIFILE simulation, the model was run using only the receptors identified by the first MAXIFILE run. Source groups were included in the second modeling simulation. A threshold value equal to the 24-hour PM_{10} SIL (5.0 µg/m^3) was set. The output file provided a date stamp for any day when a source group exceeds the SIL and potentially contributes to a violation of the NAAQS. A significant contribution to a NAAQS violation would be predicted to occur if the date stamps for source group ALL (from the first MAXIFILE run) and for a specific source group (from the second MAXIFILE run) matched.

DEQ's culpability analyses confirm that emission source groups HR and WEP are culpable for the 24-hour PM_{10} NAAQS exceedances. The date stamps indicate NAAQS violations during the winter season (January 6, January 15, and December 23). We show next that when modeled emissions are more-closely

representative of typical daily mining production rates for a high-production period (everything else held constant), the SGP facility is able to demonstrate compliance with 24-hour PM_{10} NAAQS at those few receptors showing a potential violation when using meteorological data processed with the BULKRN method. We also discuss next the implication of NAAQS violations occurring during the winter season.

As listed in Table 30, PM_{10} modeling simulation for Scenario W5 was based on a mining production rate of 180,000 ton/day of development rock. This corresponds to 65,700,000 ton/year, which is more conservative than the expected peak production rate of 42,692,000 ton/year (116,964 ton/day). To investigate the effect of a lower modeled mining production rate on design value concentrations, DEQ performed a modeling simulation ("DEQ Run 1") where mining production rate was assumed to be 120,000 ton/day instead of 180,000 ton/day, but all other model variables were held constant. This adjustment lowered the modeled daily emission rates for WEP, WEDRSF, and HR, which are summarized in Table 32. Because the modeled emission rates were lower, the modeled design concentrations were also lower. Results for DEQ's sensitivity analyses are summarized in Table 33.

Table 32. DAILY MINING ACTIVITY EMISSIONS USED IN DEQ'S SENSITIVITY ANALYSES FOR 24-HOUR PM_{10} (SCENARIO W5).

Mining Activity	Emissions (lb/day)[a]	
	Applicant's Submittal	DEQ Run 1
WEP (West End Pit)	**885.54**	**879.54**
Open Pit Drilling	811.20	811.20
Material Loading	18.00	12.00
Dozing	54.20	54.20
Surface Exploration	2.15	2.14
WEPBL (West End Pit Blasting)	**334.38**	**334.38**
Open Pit Blasting	334.38	334.38
WEDRSF (West End Pit Development Rock Storage Facility)	**57.12**	**56.15**
Material Unloading	2.88	1.92
Dozing	54.20	54.20
Wind Erosion	0.04	0.03
HR (Haul Road)	**2,050.34**	**1,436.50**
Onsite Hauling	1,842.97	1,229.13
Grading	60.51	60.51
Water Truck Travel	146.86	146.86
ACCRD (Access Road)	**9.38**	**9.38**
Vehicle Travel	9.17	9.17
Grading	0.21	0.21
UGEXP (Underground Exploration)	**0.004**	**0.004**
Underground Exploration	0.004	0.004
Total	**3,336.76**	**2,715.95**

a. Pounds per day.

Table 33. RESULTS FOR DEQ'S SENSITIVITY ANALYSES FOR 24-HOUR PM_{10} (SCENARIO W5, BULKRN METEOROLOGICAL DATA).

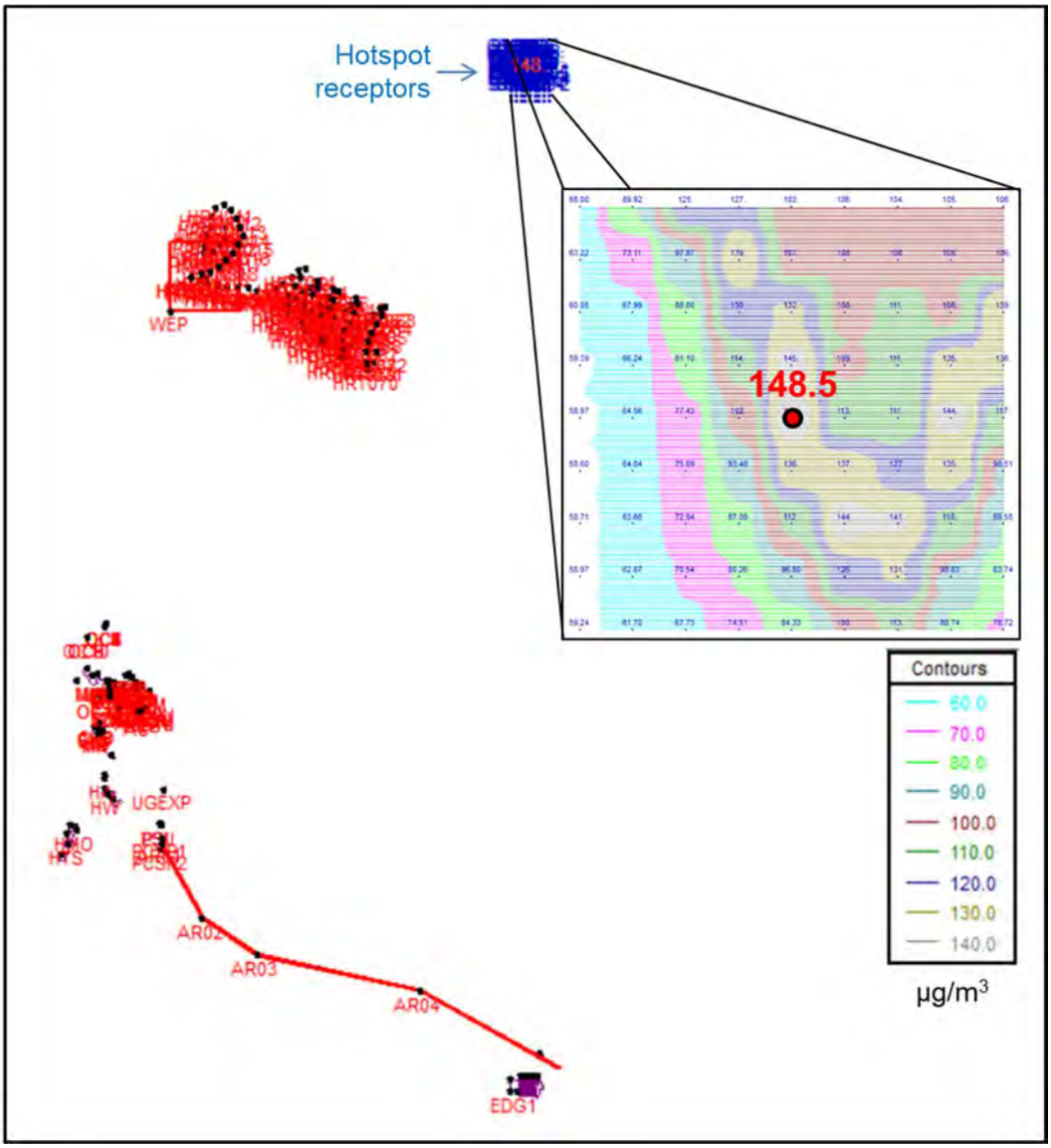
Pollutant	Averaging Time	Max. Conc.[a] ($\mu g/m^3$)[b]	Model Scenario	Back. Conc.[c] ($\mu g/m^3$)	Total Conc.[d] ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	Percent of NAAQS
PM_{10}[e]	24 hours	111.5[f]	W5	37.0[g]	148.5	150	99.0%

a. Max. Conc. = maximum modeled design concentration.
b. Micrograms per cubic meter.

c. Back. Conc. = background concentration.
d. Total Conc. = total (modeled + background) concentration.
e. Particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers.
f. DEQ Run 1: mining production rate was modeled at 120,000 ton/day instead of 180,000 ton/day. Everything else was held constant.
g. For 24-hour PM_{10}, the design value is the *second-highest* 24-hour average concentration in a given year. However, the background value that was used in the modeling analyses represents the *first-highest* 24-hour average concentration measured in 2014. Therefore, using a larger background concentration adds a layer of conservatism to the calculated total impact for 24-hour PM_{10}.

Maximum modeled concentration for "DEQ Run 1", when summed with the background concentration, is lower than NAAQS thereby demonstrating NAAQS compliance. Total (modeled + background) concentrations for all hotspot receptors are depicted in Figure 14; maximum total impact is depicted by the red circle. The SGP facility complies with the 24-hour PM_{10} NAAQS when daily mining production rates closer to a more typical daily rate for a high-production period are used in the model, instead of a very conservative mining production rate, even when using site-specific BULKRN meteorological data.

Figure 14. RESULTS FOR DEQ'S SENSITIVITY ANALYSES SHOWING TOTAL (MODELED + BACKGROUND) 24-HOUR PM_{10} CONCENTRATIONS AT HOTSPOT RECEPTORS (SCENARIO W5, BULKRN METEOROLOGICAL DATA).



Meteorological data processing with and without BULKRN are considered acceptable by EPA. However, the BULKRN meteorological data yielded higher modeled design values for the SGP facility than the meteorological data processed without the BULKRN method. DEQ's analyses suggest that when daily mining production rates closer to a more typical daily rate for a high-production period are used (everything else held constant), the SGP facility is able to demonstrate compliance with 24-hour PM_{10} NAAQS at those few receptors showing a potential violation when using meteorological data processed with the BULKRN method.

Maximum modeled design value 24-hour PM_{10} impacts, even with the use of more reasonably expected daily production rates, are still just under the 150 $\mu g/m^3$ NAAQS. As noted earlier in this section, these high values were observed during the winter season. During this period, not only are fugitive emissions minimized because of the higher moisture content of material handled or driven over, but background concentrations in such remote areas are generally much lower because of the absence of wildfires and dust-generating sources.

To summarize, DEQ considered the following assumptions and results in its weight-of-evidence analyses:

a. All modeled impacts are below NAAQS for meteorological data with stability parameters calculated by regional cloud cover data.
b. Modeled impacts over the 24-hour PM_{10} NAAQS using BULKRN meteorological data are limited to a small area and limited period of time.
c. Modeled 24-hour PM_{10} NAAQS exceedances are limited to the winter season, where emissions and background levels are likely overestimated.
d. The model assumes maximum allowable operations/emissions.
e. The model assumes minimum allowable controls on emissions. The permit would require at least 93% control of maximum potential fugitive emissions, but the fugitive emissions may in fact be controlled by more than that, especially during winter and periods of precipitation.
f. Finally, 24-hour PM_{10} background concentrations represent the maximum 1st high (instead of the maximum 2nd high) which is on the higher end of the distribution.

DEQ's weight-of-evidence analyses show that, considering all the collective conservative layers of the modeling analyses, modeling efforts using both site-specific and alternative meteorological datasets show acceptable impacts. DEQ is highly confident that operation of the SGP will not cause or contribute to a violation of NAAQS. This is based on: (1) the submitted application materials and analyses; (2) DEQ's supplemental analyses; and (3) the assumption that the facility is constructed and operated as described in the application and limited by the PTC.

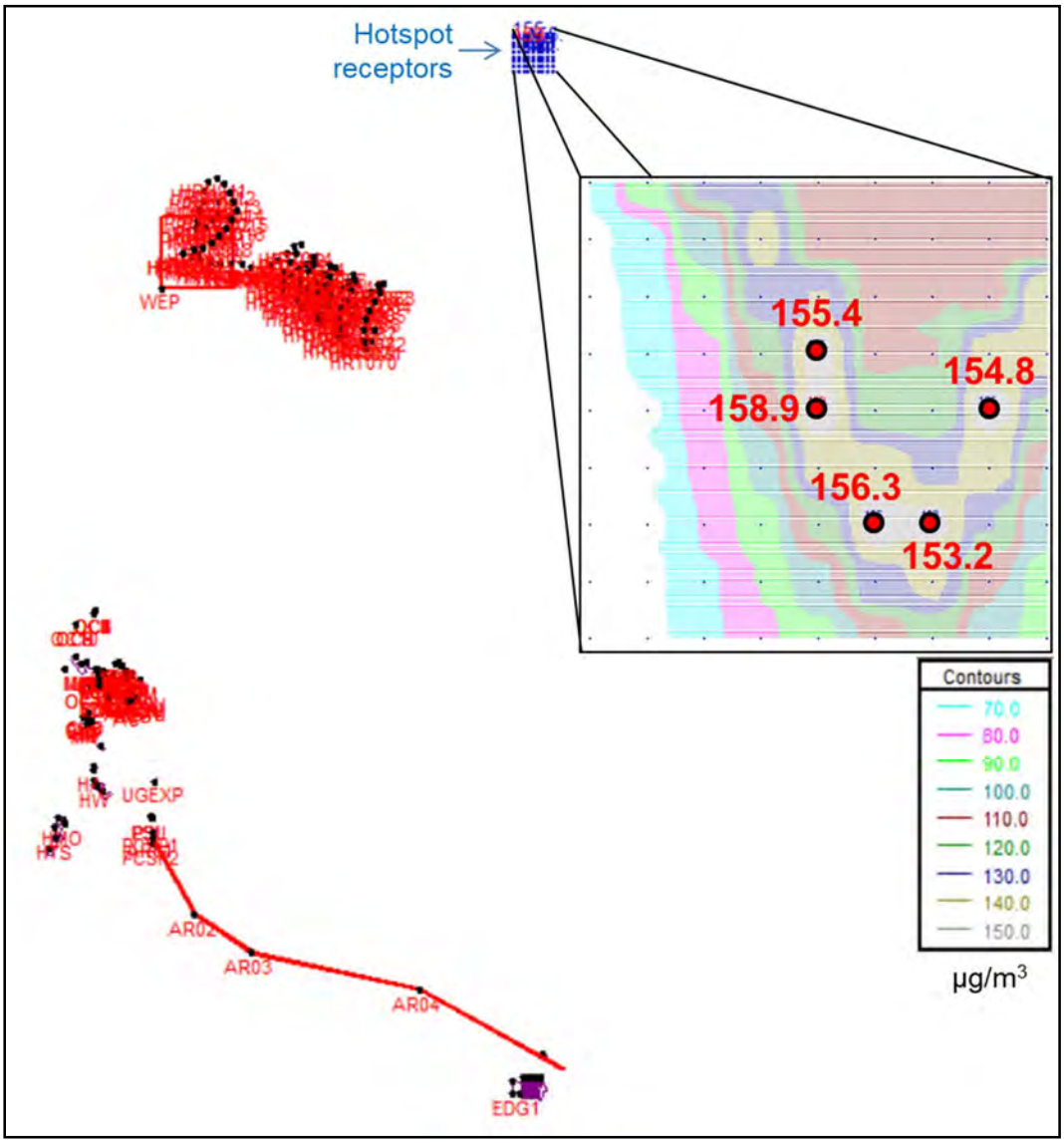
4.1.5 DEQ's Sensitivity Analyses for a Lower Fugitive Road Dust Control Efficiency

Fugitive particulate emissions from roadways were estimated by the applicant to be controlled above 93%, which is an aggressive level of control. The high level of emission control was needed to demonstrate compliance with NAAQS. To investigate the effect of lower unpaved road emission control efficiency, DEQ performed a modeling simulation ("DEQ Run 2") where the control efficiency was set to 90%. The daily mining production rate was assumed to be 120,000 ton/day instead of 180,000 ton/day, but everything else was held constant. These adjustments lowered the daily modeled emission rates for WEP and WEDRSF, but increased the daily modeled emission rate for HR and the Access Road (ACCRD) (Table 34). Five receptors exceed the 24-hour PM_{10} NAAQS. Figure 15 shows the locations of these receptors.

Table 34. DAILY MINING ACTIVITY EMISSIONS USED IN DEQ'S SENSITIVITY ANALYSES FOR 24-HOUR PM_{10} (SCENARIO W5).		
Mining Activity	**Emissions (lb/day)[a]**	
	Applicant's Submittal	**DEQ Run 2**
WEP (West End Pit)	**885.54**	**879.54**
Open Pit Drilling	811.20	811.20
Material Loading	18.00	12.00
Dozing	54.20	54.20
Surface Exploration	2.15	2.14
WEPBL (West End Pit Blasting)	**334.38**	**334.38**
Open Pit Blasting	334.38	334.38
WEDRSF (West End Pit Development Rock Storage Facility)	**57.12**	**56.15**
Material Unloading	2.88	1.92
Dozing	54.20	54.20
Wind Erosion	0.04	0.03
HR (Haul Road)	**2,050.34**	**2,114.24**
Onsite Hauling	1,842.97	1,834.53
Grading	60.51	60.51
Water Truck Travel	146.86	219.20
ACCRD (Access Road)	**9.38**	**13.90**
Vehicle Travel	9.17	13.69
Grading	0.21	0.21
UGEXP (Underground Exploration)	**0.004**	**0.004**
Underground Exploration	0.004	0.004
Total	**3,336.76**	**3,398.21**

a. Pounds per day.

Figure 15. RESULTS FOR DEQ'S SENSITIVITY ANALYSES SHOWING HOTSPOT RECEPTORS THAT EXCEED 24-HOUR PM_{10} NAAQS, ASSUMING MINING PRODUCTION RATE OF 120,000 TONS PER DAY AND FUGITIVE ROAD DUST CONTROL EFFICIENCY OF 90% (SCENARIO W5, BULKRN METEOROLOGICAL DATA).



DEQ's sensitivity analyses suggest that a few hotspot receptors exceed the 24-hour PM_{10} NAAQS when the unpaved road control efficiency falls below 93% and the meteorological data processed with the BULKRN method is used. When the meteorological data processed without the BULKRN method is used, all the hotspot receptors demonstrate compliance with NAAQS at a 90% control efficiency and at both examined production levels:

- maximum impact at 120,000 ton per day: 73.9 $\mu g/m^3$ + 37.0 $\mu g/m^3$ = 110.9 $\mu g/m^3$.
- maximum impact at 180,000 ton per day: 84.6 $\mu g/m^3$ + 37.0 $\mu g/m^3$ = 121.6 $\mu g/m^3$.

While using alternative meteorological data processed without the BULKRN method safely demonstrates

compliance with NAAQS, using site-specific BULKRN meteorological data does not. Therefore, DEQ's modeling team recommends that the permit require an aggressive implementation of measures to achieve above 93% control efficiency for fugitive particulate emissions from roadways.

4.2 Results for TAPs Impact Analyses

The SGP TAP modeling results and their comparison with the applicable AACs/AACCs are provided in Table 35.

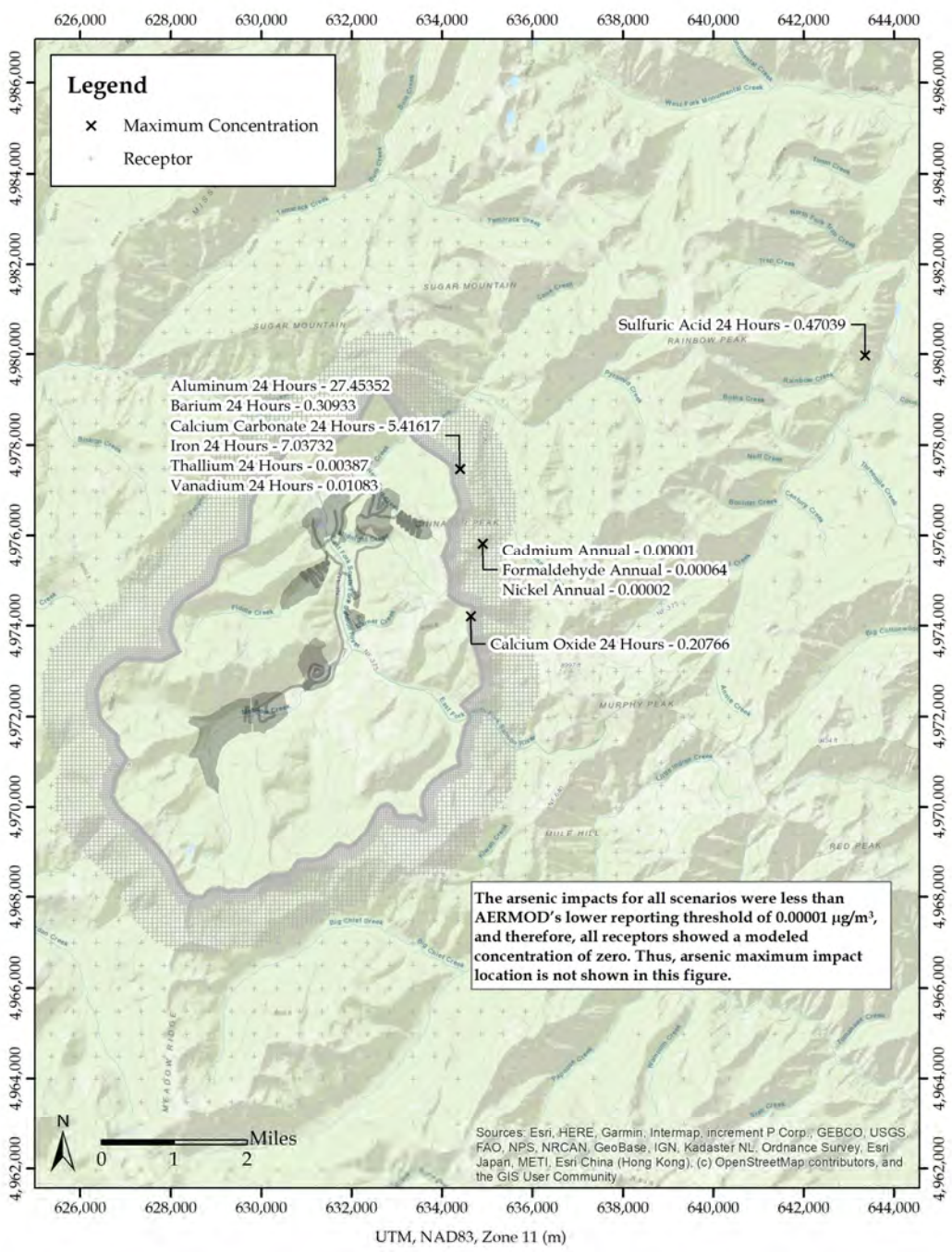
Table 35. RESULTS FOR TAPS IMPACT ANALYSES.

Toxic Air Pollutant	Averaging Time	Maximum Modeled Concentration ($\mu g/m^3$)[a]	Model Scenario	AAC[b] ($\mu g/m^3$)	AACC[c] ($\mu g/m^3$)	Percent of AAC/AACC
Arsenic	Annual	<1.00E-06	All	--	0.00023	<0.4%
Cadmium	Annual	0.00001	All	--	0.00056	1.8%
Formaldehyde	Annual	0.00064[d]	All	--	0.077	0.8%
Nickel	Annual	0.00002	All	--	0.042	0.05%
Aluminum	24-hour	27.454	W5	500	--	5.5%
Barium	24-hour	0.309	W5	25	--	1.2%
Calcium carbonate	24-hour	5.416	W5	500	--	1.1%
Calcium oxide	24-hour	0.208	All	100	--	0.2%
Iron	24-hour	7.037	W5	50	--	14.1%
Sulfuric acid	24-hour	0.470[d]	All	50	--	0.9%
Thallium	24-hour	0.00387	W5	5	--	0.1%
Vanadium	24-hour	0.0108	W5	2.5	--	0.4%

a. Micrograms per cubic meter.
b. Acceptable Ambient Concentration of a non-carcinogenic TAP.
c. Acceptable Ambient Concentration of a Carcinogenic TAP.
d. Deposition was not applied for formaldehyde and sulfuric acid (non-particulate TAPs).

Table 35 shows that the modeled TAP impacts from the SGP sources do not exceed the applicable AACs/AACCs. The locations of the maximum impacts for each TAP are presented in Figure 16.

Figure 16. SGP TAP IMPACTS (µg/m^3) AND LOCATIONS.



To investigate the effect of deposition on modeled TAP impacts, DEQ performed a sensitivity analysis where deposition was not applied in the model (Table 36). Results show that modeled TAP impacts for non-carcinogens are higher than when deposition is applied (Table 35). However, modeled TAP impacts are still well below AACs/AACCs even when deposition is not applied in the model. This result illustrates that deposition is not a critical factor for demonstrating compliance with TAP increments.

Table 36. RESULTS FOR DEQ'S SENSITIVITY ANALYSES FOR TAPS IMPACT MODELING (WITHOUT DEPOSITION).						
Toxic Air Pollutant	**Averaging Time**	**Maximum Modeled Concentration ($\mu g/m^3$)[a]**	**Model Scenario**	**AAC[b] ($\mu g/m^3$)**	**AACC[c] ($\mu g/m^3$)**	**Percent of AAC/AACC**
Arsenic	Annual	<1.00E-06	All	--	0.00023	<0.4%
Cadmium	Annual	0.00001	All	--	0.00056	1.8%
Formaldehyde	Annual	0.00064	All	--	0.077	0.8%
Nickel	Annual	0.00002	All	--	0.042	0.05%
Aluminum	24-hour	54.101	W5	500	--	10.8%
Barium	24-hour	0.610	W5	25	--	2.4%
Calcium carbonate	24-hour	10.670	W5	500	--	2.1%
Calcium oxide	24-hour	0.226	All	100	--	0.2%
Iron	24-hour	13.868	W5	50	--	27.7%
Sulfuric acid	24-hour	0.470	All	50	--	0.9%
Thallium	24-hour	0.00762	W5	5	--	0.2%
Vanadium	24-hour	0.0213	W5	2.5	--	0.9%

a. Micrograms per cubic meter.
b. Acceptable Ambient Concentration of a non-carcinogenic TAP.
c. Acceptable Ambient Concentration of a Carcinogenic TAP.

5.0 Conclusions

The information submitted with the PTC application, combined with DEQ's air impact analyses and the assumption that the facility is constructed and operated as described in the application and limited by the PTC, demonstrated to DEQ's satisfaction that emissions from the Stibnite Gold Project in Valley County, Idaho will not cause or significantly contribute to a violation of any applicable ambient air quality standard or TAP increment.

References

APT. 2009. "Source Emissions Testing Report, Barrick Cortez, Inc." *Hydrogen Cyanide Emissions, Electrowinning Cells #1 & #2.* November 11.

APT. 2013. "Source Emissions Test Report for Barrick Goldstrike Mines, Inc.: Carlin, Nevada Facility Title V Compliance Testing Operating Permit No. AP1041-0739.02." Report prepared for: Barrick Goldstrike Mines, Inc., August 28.

CAPCOA. 2011. "Modeling Compliance of The Federal 1-Hour NO_2 NAAQS." California Air Pollution Control Officers Association, October 27.

CSIRO. 2008. "NOx Emissions from Blasting Operations in Open-Cut Coal Mining." *Atmospheric Environment.* November.

DEQ. 2013. "State of Idaho Guideline for Performing Air Quality Impact Analyses." Idaho Department of Environmental Quality. September. State of Idaho DEQ Air Doc. ID AQ-011. http://www.deq.idaho.gov/media/1029/modeling-guideline.pdf.

DEQ. 2014. "Policy on NAAQS Compliance Demonstration Requirements." Idaho Department of Environmental Quality Policy Memorandum. July 11.

DEQ. 2015. "Approval Re: Meteorological and Air Quality Data Summary - Stibnite Gold Project Monitoring Network." October 8.

EPA. 2012. "Haul Road Workgroup Final Report Submission to EPA-OAQPS." Memorandum from Tyler Fox (EPA Air Quality Modeling Group Leader) to Regional Office Modeling Contacts, March 2. Accessed July 2, 2015. http://www.epa.gov/scram001/reports/Haul_Road_Workgroup-Final_Report_Package-20120302.pdf.

EPA. 2014. "Clarification on the Use of AERMOD Dispersion Modeling for Demonstrating Compliance with the NO_2 National Ambient Air Quality Standard." Guidance memorandum from R. Chris Owen and Roger Brode to Regional Dispersion Modeling Contacts. Office of Air Quality Planning and Standards. Air Quality Modeling Group. Research Triangle Park, NC. September 30.

EPA. 2016. "AERMOD Implementation Guide." EPA-454/B-16-013. Office of Air Quality Planning and Standards Air Quality Assessment Division AERMOD Implementation Workgroup. Research Triangle Park, North Carolina, December.

EPA. 2018a. "Air Data: Air Quality Data Collected at Outdoor Monitors Across the US." Accessed March 17, 2018. https://www.epa.gov/outdoor-air-quality-data.

EPA. 2018b. "Draft. Revised Policy on Exclusions from Ambient Air." United States Environmental Protection Agency, November.

EPA. 2018c. "User's Guide for the AMS/EPA Regulatory Model (AERMOD)." EPA-454/B-18-001. Office of Air Quality Planning and Standards Air Quality Assessment Division Air Quality Modeling Group. Research Triangle Park, North Carolina, April.

Khalizov et al. 2012. "Characterization of Soot Aerosol Produced from Combustion of Propane in a

Shock Tube." Alexei F. Khalizov, Brian Hogan, Chong Qiu, Eric L. Petersen, and Renyi Zhang. *Aerosol Science and Technology*, 46:925–936, 2012. https://doi.org/10.1080/02786826.2012.683839.

Midas Gold. 2015. "Meteorological and Air Quality Data Summary: Stibnite Gold Project Monitoring Network (Project Data Summary)." Stantec Consulting Services, Inc. September 23.

Midas Gold. 2017a. "Air Quality Baseline Study. Stibnite Gold Project." Stantec Consulting Services, Inc. And Trinity Consultants, Inc. December 2015 - Revised April 2017, April.

Midas Gold. 2017b. "Equipment Fuel Burn." *Attachment: Midas Stibnite Mine Plan and Equipment Schedule (13Sep17).xlsx.* Email from R. McCluskey, Midas Gold Idaho, to E. Memon, Air Sciences., September 12.

NDEP. 2010. "Class I Air Quality Operating Permit No. AP3274-1329.01. Issued to Graymont Western US Inc." Nevada Department of Conservation and Natural Resources. Division of Environmental Protection. Bureau of Air Pollution Control, May 7.

NDEP. 2015b. "Class II Air Quality Operating Permit No. AP3295-3398. Issued to Hectatone, Inc." Nevada Department of Conservation and Natural Resources. Division of Environmental Protection. Bureau of Air Pollution Control, April 6.

NDEP. 2017. "Mercury Operating Permit to Construct: Phase 2. Issued to: Smokey Valley Common Operation - Round Mountain Gold Corporation." Nevada Division of Environmental Protection (NDEP) Bureau of Air Pollution Control, July 5.

NDEP. 2019. "Class II Air Quality Operating Permit AP1041-3955." Issued to: Round Mountain Gold Corporation." Nevada Department of Conservation and Natural Resources. Division of Environmental Protection (NDEP). Bureau of Air Pollution Control, June 17. Accessed June 28, 2019. , June 17.

UMN. 2002. "Diesel Aerosol Sampling Methodology - CRC E-43." University of Minnesota Department of Mechanical Engineering, August 19.

APPENDIX F – SUBSECTION 210.20 INTERPRETATION OF ADDRESSED

STATE OF IDAHO
DEPARTMENT OF
ENVIRONMENTAL QUALITY

1410 N Hilton Street, Boise, ID 83706
(208) 373-0502

Brad Little, Governor
Jess Byrne, Director

Examples of How DEQ Interprets the Word "Addressed" in Subsection 210.20

For example, 40 CFR 63 Subpart 6J - National Emission Standards for Hazardous Air Pollutants for Industrial, Commercial, and Institutional Boilers Area Sources regulates HAP emissions from coal, biomass, and oil-fired boilers. However, the subpart specifically exempts gas-fired (i.e. natural gas-fired) boilers because EPA determined that HAP emissions from these sources were too inconsequential to be regulated by the Subpart. DEQ interprets this to mean EPA did "address" natural gas boiler HAP emissions by choosing to exempt them. Thus, HAP emissions that are also TAP emissions from coal, biomass, oil-fired boilers, and natural gas-fired boilers are not required to demonstrate compliance with IDAPA 58.01.01.210 per section 210.20.

For example, 40 CFR 63 Subpart ZZZZ - National Emissions Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines regulates HAP emissions from IC engines by regulating CO emissions as a surrogate for HAP emissions. Therefore, HAP emissions from IC engines are not directly regulated by the Subpart. DEQ interprets this to mean EPA "addressed" HAP emissions by regulating CO emissions as a surrogate. Therefore HAP emissions that are also TAP emissions from IC engines are not required to demonstrate compliance with IDAPA 58.01.01.210 per section 210.20.

For example, HAP/TAP emissions from lumber drying kilns were evaluated in promulgating 40 CFR 63 Subpart DDDD - National Emission Standard for Hazardous Air Pollutants: Plywood and Composite Wood Products (PCWP). This Subpart regulates major sources of HAP emissions and includes lumber drying kilns at PCWP manufacturing facilities and "at any other kind of facility" as affected sources, even though this subpart does not include any substantive requirements to control or limit emissions from the kilns. In developing Subpart DDDD EPA stated "…we know of no other lumber kilns that are controlled for HAP, and we know of no cost effective HAP controls for lumber kilns…" (see Fed. Reg. /Vol 68, No. 6/Thursday, Jan 9, 2003/Proposed Rules page 1285). DEQ interprets this to mean EPA "addressed" HAPS that are also TAPS for both major and minor sources of HAP emissions; and therefore, lumber kilns are not required to demonstrate compliance with IDAPA 58.01.01.210, per section 210.20.

For example, when EPA regulated Phosphoric Acid Manufacturing for new sources, only the wet-process phosphoric acid line, superphosphoric acid process line, phosphate rock dryer, and the phosphate rock calciner have specific emissions limits in the rule. However, other emissions sources at facility were also looked at but they were determined by EPA to be insignificant and were not regulated in the rule. Therefore, when EPA looks at a source category to regulate, all emissions sources associated with the source category are "addressed" whether EPA establishes specific emissions limits for the emissions sources or not.
In sum, the term "addressed" is interpreted to mean EPA (1) specifically regulated, (2) specifically regulated by a surrogate, (3) reviewed, or (4) evaluated, the HAP emissions that are also TAPs.

Please note that in all cases it is presumed that EPA evaluated the 187 HAPs when developing the emission standards for new, modified or existing stationary sources regulated by 40 CFR Part 63 Subparts. Therefore, in all cases IDAPA Toxic Air Pollutants that are not one of the 187 Hazardous Air Pollutants will still need to be evaluated for compliance with IDAPA 58.01.01 Section 210.

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
Nicole C. Hancock, ISB No. 6899
nicole.hancock@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioner, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC. Intervenor-Respondent.	Case Docket No. 0101-22-01 OAH Case No. 23-245-01 **EXPERT DECLARATION OF THERESA LOPEZ**

I, Theresa Lopez, hereby declare and affirm as follows:

1. My name is Theresa Lopez. I am employed by Tetra Tech, Inc. as a Principal Toxicologist.

2. In addition to this Declaration, I have prepared a supporting memorandum that further elaborates on my testimony (Memorandum). A copy is attached.

A. Qualifications and Experience

3. My curriculum vitae is attached as Attachment C to the Memorandum.

4. I received a Master of Science degree in Public Health from the University of Colorado in 1991 and a Bachelor of Science degree in Nutritional Science with a minor in Zoology from the University of Florida in 1989. My relevant areas of expertise include chemical risk assessment, human health risk assessment, regulatory toxicology, and exposure assessments.

5. I worked extensively in the areas of public health, epidemiology, human health risk assessment, toxicology, and occupational health and safety, representing both the public and private sector for over 32 years with Tetra Tech.

6. My work included a variety of human health risk assessment projects at the federal and state levels, as well as international work. I led the investigation and assessment of chemical releases and environmentally compromised sites such as former nuclear weapons plants, active and closing naval bases, Superfund Sites, and mining, commercial, and school sites.

7. My work includes assisting in risk assessments and remediation of former mining sites with heavy metal, pesticides, petroleum compounds and other chemicals; and risk assessments for proposed mines, hazardous waste release sites, and petroleum remediation in the United States and Canada. I prepared human exposure assessments for schools and recreational settings and assessed clean-up goals and remediation strategies for closed industrial, mining,

redevelopment, and other sites. These sites often include the consideration of native and indigenous peoples. I provided exposure and dose reconstruction for Oak Ridge Associated Universities to quantify radiation doses to former nuclear weapons workers.

8. Recent relevant work includes review of human exposures, livestock exposures, plant, and food ingestion pathways for the development of water quality standards for the Navajo Nation; technical support for the Agency for Toxic Substances and Disease Registry (ATSDR) to provide scientific advise and education on public health assessment methodologies, review of toxicity data, and probabilistic risk assessment methodology, and primary experiments, for example to assess uptake measurements of metals and PFAS from soil to common food plants; and peer review of chemical assessments for the Consumer Product Safety Commission. I author and review reports for Health Canada related to Existing Substances Risk Assessment Bureau mandates. For these projects I am often designated as lead toxicologist.

B. Scope of Review

9. I have been retained as an expert witness by Perpetua Resources Idaho, Inc. (Perpetua) in the above-captioned case, to address issues raised in the Final Order issued by the Board of Environmental Quality on May 9, 2024 and to evaluate the risks presented by emissions of arsenic from the Stibnite Gold Project (SGP). Specifically, I have been asked to evaluate:

a. Whether the Idaho Department of Environmental Quality (DEQ) used appropriate risk assessment methodology by adjusting the maximum modeled lifetime arsenic emissions from the SGP by 16/70 to reflect the operational life of the SGP;

b. Whether, as conditioned by the Air Quality Permit to Construct (PTC) issued to Perpetua, arsenic emissions from the SGP present a greater than 1 in 100,000 cancer risk; and

c. Whether DEQ's use of a five-year rolling average production limit to demonstrate compliance with T-RACT is protective of public health and the environment.

C. Summary of Opinions

10. Based on my review of the permitting record in this matter, the Declarations of Norka Paden, Kevin Schilling, and Kevin Lewis, and the documents cited in, and attached to, my Memorandum, I conclude as follows:

a. I conclude that the 16/70 calculation was consistent with good scientific methodology for assessing cancer risk and consistent with the applicable rules. DEQ appropriately calculated, and considered, the exposure duration of 16 years of SGP operational life when evaluating the risk posed by arsenic emissions from the SGP. Cancer risk cannot be evaluated without taking into consideration the length of time a potential receptor will be exposed to carcinogen.

b. The Rules for the Control of Air Pollution in Idaho (Air Rules), IDAPA 58.01.01, provide a default formula for calculating cancer risk from carcinogen emissions from stationary sources. The Air Rules, specifically Section 586, adopted EPA risk assessment information and methodology, which inherently requires consideration of exposure duration.

c. The use of a 10-times adjustment to the Acceptable Ambient Concentration for Carcinogens (AACC) when a project will operate for five years or less is an example of an adjustment of exposure duration when evaluating cancer risk and does not preclude adjustment for exposure duration when a project will operate for less than 70 years.

d. I conclude that the incremental increase in cancer risk caused by arsenic emissions from the SGP is 1 in 240,000, which is less than the acceptable risk of 1

in 100,000. This conclusion is based on the maximum modeled annual concentration of arsenic predicted for SGP operations, the operational life of the SGP established by conditions in the PTC, and risk assessment methodology established by EPA.

e. I conclude that the use of a five-year rolling average production limit to demonstrate compliance with T-RACT is sufficiently protective to ensure that the ambient concentration of arsenic from the SGP will not cause a cancer risk above 1 in 100,000.

f. The PTC includes both daily production limits and limits production from the SGP to 135,000 tons per year based on a five-year rolling average. EPA's risk assessment methodology evaluates the incremental increase in cancer risk for each incremental increase in carcinogen dose over the exposure duration. Use of a five-year rolling average ensures that a receptor's total exposure to arsenic caused by the SGP will not exceed a 1 in 100,000 cancer risk. Although there may be short term increases in production, and the ambient concentration of arsenic, these short-term increases will not, alone, cause unacceptable cancer risk.

D. Background

11. Arsenic comes in several forms and occurs naturally in soil and minerals. Arsenic can enter the atmosphere from wind-blown dust. Arsenic concentrations in soil are variable across the country, and when soil is disturbed arsenic can become airborne and be carried with dust particles. Since arsenic is naturally in the environment, everyone is exposed to some arsenic by eating food, drinking water, or breathing air. People normally ingest small amounts of arsenic from breathing air, drinking water, and eating food. Indeed, food is considered the largest source of arsenic exposure for humans.

12. EPA analyzes the long-term, or carcinogenic, health effects of arsenic through animal and worker studies. The arsenic inhalation unit risk (IUR) published by EPA in the Integration Risk Information System (IRIS) reflects many years of research and evaluation and was developed using a linear extrapolation method that assumes that any level of exposure carries a risk. Under a linear risk extrapolation method, the dose is cumulative over the duration of exposure and cancer risk increases linearly as the cumulative total dose increases. Exposure is assumed to occur over a lifetime, assumed to be 70 years. See Memorandum, Figure 1.
13. All IURs (including for arsenic) are based on an incremental lifetime risk of 1 in one million from exposure to 1 $\mu g/m^3$ of a substance continuously (24 hours day and 365 days/ year) over a lifetime of exposure (assumed to be 70 years). Importantly, this is an incremental risk that does not consider other, unrelated risks present over a lifetime.
14. DEQ adopted EPA's cancer risk values and risk assessment methodology when it promulgated the Air Rules for toxic air pollutants from stationary sources. IDAPA 58.01.01.586; Memorandum at 5-7; Memorandum, Attachment A, Idaho DEQ 1993 at 33.
15. The unit risk factor (URF) of 4.3E-03$\mu g/m^3$ for arsenic that DEQ adopted in IDAPA 58.01.01.586 is the IUR developed by EPA and reflected in the IRIS.
16. Similarly, the AACC that DEQ adopted in IDAPA 58.01.01.586 is taken from the IRIS database and is referred to by EPA as the "Air Concentration at Specific Risk Levels." The AACC is calculated by dividing the acceptable lifetime risk (1 in 1,000,000) by the URF. See Memorandum, Figure 1.

17. The AACC in Section 586 of the Air Rules reflects the ambient concentration of arsenic to which a person could be exposed 24 hours a day, 365 days a year, for a 70-year lifetime before the cancer risk level exceeds 1 in 1,000,000 (AACC = 0.00023$\mu g/m^3$).

18. The AACC does not represent an annual emission limit; it is the concentration that a person may be exposed to for a lifetime continuously, with an incremental risk of cancer of 1 in 1,000,000. *See* Idaho DEQ 1993 at 32.

19. Both the URF and AACC are derived using a linear risk extrapolation method, meaning that cancer risk from arsenic exposure increases linearly as the dose or exposure duration increases. See Memorandum at 4. Therefore, although the URF and AACC are based on lifetime exposure, the ultimate determinate of cancer risk is the cumulative dose, regardless of the timeframe over which that dose is delivered.

E. Opinions

DEQ Appropriately Adjusted the Exposure Duration of SGP to 16 Years Consistent with Permit Conditions Limiting the Project Life.

20. When considering carcinogenic exposure, a critical factor to determine the cancer risk is the exposure duration. Although the AACC assumes a 70-year constant exposure, where the exposure duration is less than 70 years, the exposure duration must be adjusted for an accurate risk calculation. In the case of the SGP, the maximum exposure duration is 16 years. Therefore, the cancer risk from the ambient concentration of arsenic caused by the SGP cannot be compared to the AACC (that assumes 70 years) without adjusting for exposure duration.

21. Comparing unadjusted emissions to the AACC would result in an over-estimation of cancer risk because the dose will not continue for the 70-year lifetime exposure assumed

in the development of the AACC. For an "apples to apples" comparison, evaluation of SGP emissions must be adjusted for the shorter exposure duration.

22. EPA provides the following formula to compare the exposure concentration from a project that operates for less than 70 years to the lifetime exposure concentration that would cause a specified cancer risk (shaded notes are presented by author for clarification):

Cair-adj=Cair x ET x 1day/24 hours x EF x ED/AT

Where:
$C_{air-adj}$ = Air Concentration adjusted for exposure
C_{air} = Concentration of contaminant in air (mg/m^3) (this is the modeled or measured annual air concentration)
ET = Exposure time (hours/day) (this is assumed to be 24 hours/day)
EF = Exposure frequency (days/year) (this is assumed to be 365 days/year)
ED = Exposure duration (years) (this is 16 years – the life of operations)
AT = Averaging time (days) (this is lifetime – 70 years x 365 days/year; it never changes for any carcinogen)

See Memorandum at 9-10.

23. DEQ used this formula when it determined the acceptable risk from the ambient arsenic concentration caused by SGP operations.

24. Using the highest modelled annual average arsenic concentration from the project of 0.00414 $\mu g/m^3$ (REC 716) the calculation of the air concentration adjusted for exposure from the SGP is as follows:

$$\left[0.00414\,\frac{\mu g}{m3}\,x\,24\,\frac{hours}{day}\,x\,\frac{1\,day}{24\,hours}\,x\,365\,\frac{days}{year}\,x\,16\,years\right] / \left[365\,\frac{days}{year}\,x\,70\,years\right] = 0.00095\,\frac{\mu g}{m3}$$

25. Using EPA methodology, as adopted by DEQ, the adjusted lifetime-exposure concentration from the SGP is 0.00095$\mu g/m^3$. This is the correct project-specific arsenic

concentration to compare to the T-RACT AACC of 0.0023 µg/ m^3 for a cancer risk of 1:100,000. *See* REC 716.

The Cancer Risk Caused by Arsenic Emissions from the SGP is 1-in-240,000 -- Less than the Acceptable Risk of 1-in-100,000.

26. The highest air concentration of arsenic from the project is below the acceptable lifetime risk established by the T-RACT AACC.

27. Once the ambient arsenic concentration has been adjusted from a lifetime exposure to a project specific duration, to provide an "apples-to-apples" comparison to the AACC, then that ambient concentration is used to determine the cancer risk from arsenic from SGP.

28. Calculation of the incremental increase in cancer risk from SGP arsenic emissions is as follows:

$$\frac{1}{100{,}000} T\text{–}RACT\ Risk\ x\ 0.00095 \frac{\mu g}{m3} C_{air-adj} \ /\ 0.0023 \frac{\mu g}{m3}\ T\text{–}RACT\ AACC$$
$$= 4.1E\text{–}6\ or\ \frac{1}{240{,}000} Actual\ Risk$$

29. The incremental increase in cancer risk from SGP arsenic emissions is 1 in 240,000, meaning that if 240,000 people are exposed to the maximum ambient arsenic air concentration from the SGP continuously over 16 years, then one excess cancer would probabilistically be expected to develop over a lifetime. This is less than 1 excess cancer in 100,000 people, which is the acceptable risk limit in the T-RACT AACC for SGP.

30. DEQ utilized the formulas described in paragraphs 24 and 28 to compare the risk of exposure to arsenic emissions from the SGP. This analysis is consistent with EPA methodology and provides an "apples to apples" comparison of risk between SGP emissions of 16 years and the AACC concentration that assumes exposure over 70 years.

31. DEQ's assessment ensured that the PTC, and the conditions imposed on SGP, would ensure that the cancer risk from SGP emissions would be less than 1-in-100,000.

32. Section 210.15 of the Air Rules is an example of the proper adjustment for exposure duration and does not preclude this adjustment in other circumstances for an "apples to apples" comparison, where the project life is limited to less than 70 years.
33. In its analysis, DEQ analogized the SGP exposure duration adjustment to the short-term adjustment factor for sources that operate for 5 years or less in Section 210.15 of the Air Rules. The Final Order expressed concern that the Air Rules do not explicitly allow for an adjustment for sources that will operate for more than 5 years but less than 70 years.
34. Section 210.15 of the Air Rules is an example of an appropriate adjustment for exposure duration. This is consistent with EPA's methods for risk assessment and reliance on the URFs and AACCs. Sections 210.02 and 210.03 allow DEQ to develop analyses using project specific information, such as exposure duration. In my opinion these rules cannot be read to impede DEQ's use of EPA's methods and scientific practices to perform an appropriate risk assessment under the Air Rules.
35. Adjusting exposure duration is necessary and proper from a scientific and toxicological standpoint to apply the AACCs accurately. Omitting this adjustment is contrary to common scientific practice and the intent of the Air Rules as reflect DEQ documents. Memorandum Attachment A, References, Idaho DEQ 1992 and Idaho DEQ 1993.
36. This is particularly true when comparing project specific risk to the AACC because the AACC, and the URF upon which it is based, assumes a 70 year (lifetime) exposure.
37. The AACCs are not annual average air concentration limits or standards.
38. Treating the AACC as an annual emission limitation or annual limit on ambient exposure concentration is inconsistent with the purpose and development of the AACC. The

AACC is an ambient concentration that if emitted over time (default 70 years) could result in a risk of cancer response.

39. Treating the AACC as an annual emissions limitation significantly lowers acceptable risk. If the T-RACT AACC of 0.0023 $\mu g/m^3$ for arsenic were based on a one-year exposure, then the risk represented by that value would be about 1-in-7,000,000.

40. The URF and the AACC derived from it represent the upper-bound excess lifetime cancer risk estimated to result from continuous exposure to a contaminant over a lifetime at an air concentration of 1 $\mu g/m^3$.

41. In other words, the AACC and T-RACT AACC represent the chemical-specific airborne concentration at which the risk to an individual if exposed all day, every day for a lifetime is 1-in-1,000,000 (AACC) or 1-in-100,000 (T-RACT AACC). Any other interpretation defies fundamental toxicological science used by the EPA in the development of IURs (URFs).

42. The AACC and T-RACT AACC do not represent the risk of a cancer response following a single exposure.

The Use of a Five-Year Rolling Average Production Limit to Demonstrate Compliance with T-RACT is Sufficiently Protective to Ensure that the Ambient Concentration of Arsenic from the SGP Will Not Cause a Cancer Risk Above 1-in-100,000.

43. Finally, use of a 5-year rolling average production limit is as protective as an annual production limit, for purposes of determining an acceptable cancer risk.

44. Cancer risk increases from cumulative long-term exposure, not short-term annual emissions. Cancer risk is assessed based on total cumulative dose over the exposure duration, as demonstrated in the Memorandum, Figure 1, column D.

45. As shown in Figure 1, a total dose of 0.16 $\mu g/m^3$ of arsenic would cause an increased cancer risk of 1-in-100,000. The risk does not change if this total cumulative dose occurs in 1 year, 5 years, 16 years, or 70 years. Therefore, the 5-year rolling average is as protective as an annual production limit.

46. The 5-year average production limit ensures that if production is above the limit in one year, then future production must be reduced below the limit. This ensures that the cumulative ambient arsenic concentration does not exceed the acceptable ambient concentration level for the defined risk.

47. The 5-year average production limit in the PTC ensures that the ambient arsenic concentration from the SGP over the project life (exposure duration of 16 years) results in an acceptable cancer risk under the Air Rules.

I declare under penalty of perjury under the laws of the United States that the foregoing is true and correct to the best of my knowledge, information, and belief.

DATED: August 30, 2024.

Theresa K. Lopez

Theresa Lopez, TetraTech

CERTIFICATE OF SERVICE

I hereby certify that on August 30, 2024, a true and correct copy of the **EXPERT DECLARATION OF THERESA LOPEZ** was served on the following:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Dylan B. Lawrence
Hearing Officer
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Bryan Hurlbutt
Laurence ("Laird") J. Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Michael A. Short
Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
michael.short@deq.idaho.gov
hannah.young@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
ann.yribar@ag.idaho.gov
via electronic service

Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, Idaho 83706
paula.wilson@deq.idaho.gov
via electronic service

/s/ Wade C. Foster
Wade C. Foster

Attorneys for Perpetua Resources Idaho, Inc.

Memorandum in Support of Declaration: DEQ's Review of Risk for the Stibnite Gold Project

TETRA TECH, INC.

Author:	Theresa Lopez MSPH Tetra Tech, Inc.
Date:	August 30, 2024
Subject:	Memorandum in Support of Declaration: DEQ's Review of Risk for the Stibnite Gold Project

I. INTRODUCTION

This memorandum and my opinions address certain of the issues remanded by the Idaho Board of Environmental Quality (Board) in *In re Matter of Air Quality Permit to Construct* P-2019.0047 regarding the Idaho Department of Environmental Quality's (DEQ) issuance on June 17, 2022 of a permit to construct (PTC) to Perpetua Resources Idaho, Inc. for the Stibnite Gold Project (SGP). This memorandum concludes that, as issued, the PTC for the SGP is protective of public health and establishes conditions that ensure a less than 1 in 100,000 cancer risk from worst-case exposure to arsenic, applying established toxicological principles. This memorandum confirms that the DEQ properly interpreted and applied the toxic air pollutant (TAPs) rules (including the ambient TAP carcinogenic increments and the acceptable risk represented by Sections 161, 210.12 and 586 of the Rules for the Control of Air Pollution in Idaho, IDAPA 58.01.01 (IDAPA or the Air Rules)) consistent with scientific methods and EPA guidelines.

II. STATEMENT OF QUALIFICATIONS

Attached hereto as Attachment C is a copy of my curriculum vitae.

III. DOCUMENTS REVIEWED

To form the opinions expressed in this memorandum, I reviewed the following documents:

- Board's Final Order
- PTC, issued June 17, 2022
- Statement of Basis (SOB) for the PTC issued June 17, 2022
- References listed in Attachment A
- Expert Declaration of Kevin Lewis (Filed Aug. 30, 2024)
- Expert Declaration of Kevin Schilling (Filed Aug. 13, 2024)
- Expert Declaration of Norka Paden (Filed Aug. 13, 2024)

IV. OVERVIEW OF ISSUES REMANDED BY THE BOARD AND ADDRESSED BY THIS MEMORANDUM

In its *Final Order* dated May 9, 2024, the Board remanded this case to the Hearing Officer for the development of further evidence related to DEQ's risk assessment for the Acceptable Ambient Concentration for Carcinogens (AACC) for arsenic as set forth in Section 586 of the Air Rules. Specifically, the Board directed that on remand, the Hearing Officer address the following:

- DEQ's application of the project exposure duration of 16 years when assessing compliance with the AACC. Specifically, the Board indicated that "DEQ did not provide sufficient evidence in the form of an expert opinion from a toxicologist or other qualified expert regarding the cancer risk associated with the 16/70 adjustment."
- DEQ's use of a five-year rolling average for T-RACT that the Board concluded was not supported by sufficient evidence.
- The T-RACT analysis limiting the non-West End Pit production limit.

This memorandum supports my expert opinion on the first two issues.

- This memorandum explains the role of exposure duration, including the current state of scientific methods for assessing risk from inhalation exposure and U.S. Environmental Protection Agency (EPA) directives on the use of toxicity values and risk assessment.
- This memorandum addresses the use by DEQ of a project specific adjustment factor of 16/70 to account for the operational life of the SGP.
- This memorandum addresses the use of a short-term adjustment factor, provided for in IDAPA 210.15 of the Air Rules, allowing a 10-times adjustment to the AACC for short-term projects. This is an example of the use of exposure duration in risk assessment, and adjustment for exposure duration in other risk assessments is also appropriate.
- This memorandum clarifies that AACCs are not annual average air concentration limits or standards.
- This memorandum explains why the use of a 5-year rolling average production limit is equally protective as an annual production limit.

V. TOXICOLOGY, THE TAPs RULES, AND ARSENIC

Toxicology is the study of the adverse effects (called "responses") of exposures to chemicals (as well as other compounds) on biological systems (called "doses"). In toxicology, dose-response is critical to characterizing risk of experiencing adverse effects. A dose-response assessment is a mathematical relationship between the extent of a biological response in an organism (if any) to a substance at varying levels of exposure (i.e., concentration) for varying periods of time (i.e., the duration of the exposure). The goal of a dose-response assessment is to define an exposure threshold above which a substance may cause adverse effects. In other words, the goal is to define the rate at which adverse effects may be experienced as the dose (concentration and exposure) increases.

EPA uses established dose-response assessments for various chemicals to characterize both non-cancer and cancer risks. For carcinogens, these assessments result in inhalation unit risk (IUR) values and are set forth in the EPA Integrated Risk Information System (IRIS). EPA uses the IUR to develop ambient concentrations that reflect cancer risk levels from continuous exposure over a 70-year lifetime. These concentrations can be found in the EPA IRIS.

Based on my review of the relevant documents, in my opinion, the foundation of the TAPs rules is consistent with the scientific principles underlying dose-response assessments that are established by EPA. IDAPA 586 reflects EPA risk assessment methodology that prompts adjustment of the exposure duration to assess the dose-response risk assessment properly. DEQ appropriately

considered exposure duration when applying the TAPs rules to the PTC, consistent with the EPA assessments on which they are based. In this PTC, DEQ applied the Air Rules consistent with the best available scientific practices in establishing cancer risk levels, and evaluating the environmental and health risks of exposure to arsenic from the SGP:

A. DEQ interpreted and applied the TAPs Rules consistent with EPA's risk assessment methodology including accepted scientific principles governing toxicity values, exposure evaluations, and cancer risk.
B. Based on EPA methods and DEQ policies and methodologies, DEQ appropriately adjusted the exposure duration to 16 years from the assumed 70 years reflecting conditions in the PTC that limit the project life to 16 years; this adjustment was necessary for a scientifically defensible "apples to apples" comparison with the AACC.
C. The highest air concentration projections modelled for arsenic emissions from SGP are below the acceptable lifetime risk established by the T-RACT AACC in IDAPA 586 and 210.12, and therefore, the PTC authorizes risks that are acceptable for human health and the environment.
D. IDAPA 210.15 allows for a 10-times adjustment to the AACC when a project will operate for 5 years or less. This is an example of applying exposure duration when evaluating cancer risk. The Air Rules do not limit DEQ's analyses that follow EPA methodology and scientific principles for exposure duration adjustment in risk assessment for permits issued under the Air Rules.
E. Idaho's AACCs are not annual average air concentration limits or standards.

As described in the *Final Order*, the primary TAP of concern from the SGP is Arsenic. Arsenic comes in several forms, occurs naturally in soil and minerals, and volcanic eruptions are a source of arsenic. Arsenic can enter the atmosphere from wind-blown dust. Arsenic concentrations in soil are variable, as some areas having higher arsenic levels than others. When soil is disturbed arsenic can become airborne and carried with dust particles. Since arsenic is naturally in the environment, everyone is exposed to some arsenic by eating food, drinking water, or breathing air. People normally ingest small amounts of arsenic from breathing air, drinking water, and eating food. "Of these, food is usually the largest source of arsenic. The predominant dietary source of arsenic is seafood, followed by rice/rice cereal, mushrooms, and poultry." (ATSDR 2007)

Impacts of arsenic exposure are also well-studied. Arsenic presents risks of both noncarcinogenic (acute) and carcinogenic (long-term) health effects. Long-term, or carcinogenic, health effects are evaluated through animal or worker studies. EPA states that risk assessment is a scientific process that depends on 3 factors: (2024 - About Risk Assessment | US EPA)

1. **How much of a stressor is present** in an environmental medium (e.g., soil, water, air) over what geographic area,
2. **How much contact (exposure)** a person has with that environmental medium, and
3. **How it affects** the health of humans (e.g., **toxicity)**

EPA published toxicity values for both carcinogenic and noncarcinogenic health effects of arsenic (EPA 1984). These toxicity values are the result of many years of research and evaluation. The

carcinogenic toxicity values for arsenic via inhalation were developed by EPA using a linear extrapolation method that assumes that any level of exposure carries a risk. EPA stated: "It is assumed, unless evidence exists to the contrary, that if a carcinogenic response occurs at the dose levels used in a study, then responses at all lower doses will occur with an incidence that can be determined by an appropriate extrapolation model." (EPA 1984). The linear model used by EPA incorporated 4 different studies and resulted in the calculation of an IUR of 4.3Ex 10^{-3} per µg/m^3 for arsenic. According to EPA, the mode provides a plausible estimate of the upper limit of risk; the true risk could be considerably lower. The figure below is one of several created by EPA; a combined figure for all studies from which the IUR was calculated is not available. (EPA 1984).

Figure 1

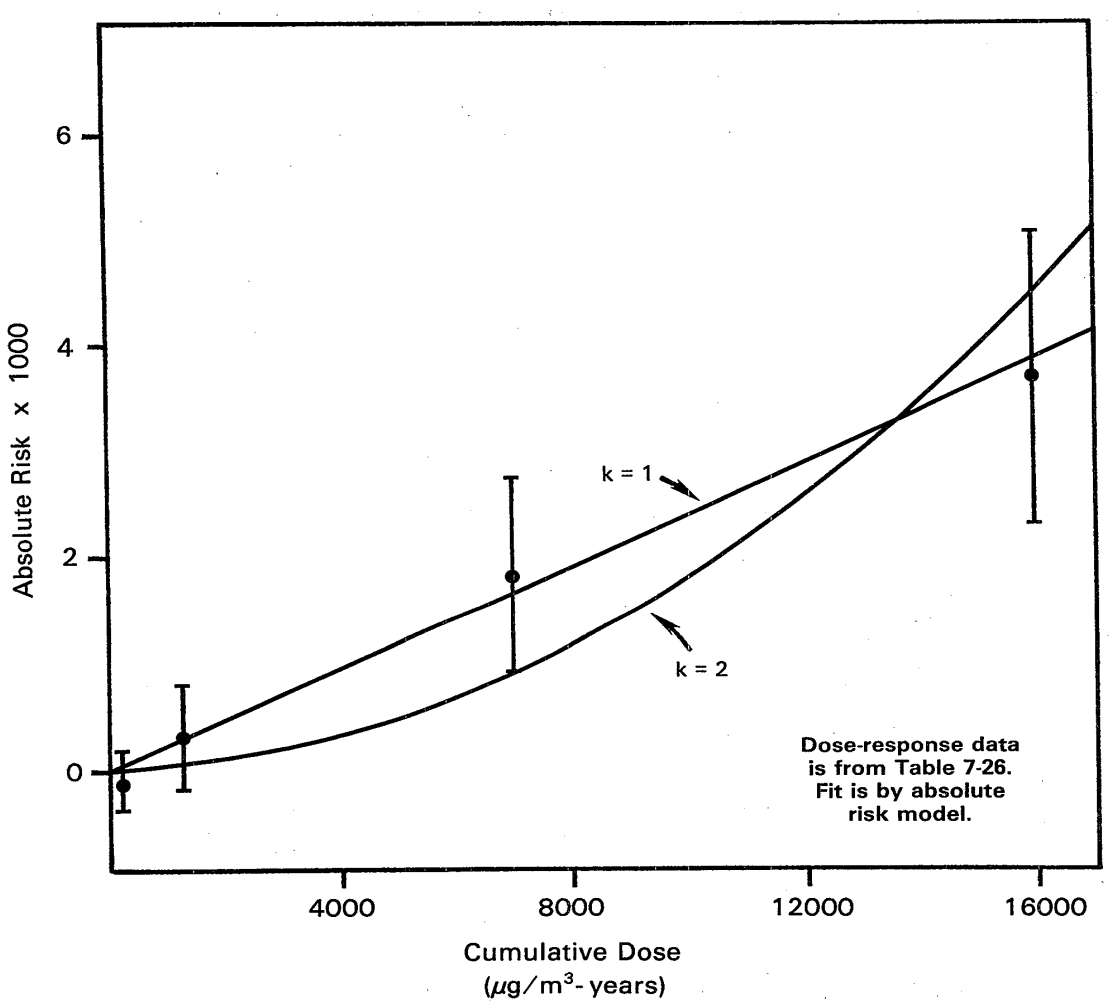


Figure 7-5. Absolute risks and 90% confidence limits for data of Higgins (1982).

The figure highlights EPA's scientific bases for risk assessment using the IUR for arsenic. The dose is cumulative. The exposure is assumed to occur over years. The IUR provides a measure of risk per unit exposure over a lifetime, assumed to be 70 years.

All IURs are based on an incremental lifetime risk of 1 in one million from exposure to 1 µg/m^3 of a substance continuously, every day over a lifetime of exposure (assumed to be 70 years). Importantly, this is an incremental risk considering unrelated risks present over a lifetime.[1]

VI. SUPPORT FOR OPINIONS INCLUDED IN DECLARATION

A. DEQ interpreted and applied the Air Rules to the SGP consistent with EPA's risk assessment methodology including accepted scientific principles governing toxicity values, exposure evaluations, and cancer risk.

DEQ adopted the EPA's values for assessment of risk in the TAPs rules. Correspondingly, DEQ adopted EPA's risk assessment methodology and underlying scientific principles governing those adopted values and risks. To interpret the Air Rules any other way would be to defy the science, toxicology, and application of these values established by EPA.

IDAPA 586 explicitly includes both a Unit Risk Factor (URF) and an Acceptable Ambient Concentration for Carcinogens (AACC) for each listed compound, including arsenic. Neither the URF (4.3E-03/µg/m^3) nor the AACC (2.3E-04 µg/m^3) for arsenic were developed by DEQ. EPA developed these values and published them in the IRIS (EPA 2024b), which is a database maintained by EPA (and only EPA). DEQ adopted these values into the TAPs Rules in 1993-1994. (Idaho DEQ 1992, Appendix 6; Idaho DEQ 1993)

DEQ adopted the URF directly from EPA's IUR, and the URF reflects the *cancer risk* based on continuous exposure to a concentration of 1 µg/m^3 of a particular compound over a lifetime. (Idaho DEQ 1992, Appendix 6; Idaho DEQ 1993). Separately, the AACC reflects that *ambient concentration* that would result in a 1 in 1 million risk of developing cancer assuming a constant exposure to that ambient concentration over a 70-year lifetime.

As noted above, the IUR represents the incremental increased cancer risk from a lifetime (70 years) inhalation exposure to a constant (24 hours/ day and 365 days/ year) dose concentration of 1 µg/m^3. In other words, the exposure duration is assumed within the IUR and the cancer risk assumes constant, lifetime (70 years) exposure. Because the IUR estimates cancer risk based on continuous

[1] The National Institute of Health (Cancer Statistics - NCI) states that approximately 40.5% of men and women in the US will be diagnosed with cancer at some point during their lifetimes (based on 2017–2019 data); that is roughly a risk of 4 persons in every 10 persons developing cancer over a lifetime. Risks of 1 in one million or one in 1 hundred thousand are very low. To put that risk in perspective, the National Oceanic and Atmospheric Association estimates that the chances of getting struck by lightning is much higher—1 in 15,300 in a lifetime (How Dangerous is Lightning? (weather.gov)

exposure to 1 µg/m^3 of a chemical over a lifetime (70 years), the IUR does not represent the lifetime risk of developing cancer after a single exposure.[2]

The URF in IDAPA 586 and the EPA IUR for arsenic are presented in Figure 1. EPA considers a lifetime to be 70 years. EPA recognizes that exposure duration is not always this long.

The AACC for each chemical is based on and derived from the EPA URF and a lifetime (70 years) exposure duration. The AACC is the identified risk divided by the URF. The AACC reflects the ambient concentration of arsenic to which a person could be exposed 24 hours a day, 365 days a year, for a 70-year lifetime before the identified cancer risk level is exceeded. The AACC value appears in EPA's IRIS database. EPA calls this value the "Air Concentration at Specific Risk Levels," and these levels assume a lifetime of 70 years and a constant exposure for 70 years.

Figure 1 illustrates: (A) risk level: (B) how the AACC is derived, (C) the AACC concentration, and (D) the ambient air concentration of arsenic that an individual would need to be exposed to for a full year to equal a full lifetime (70-year) exposure at a cancer risk expressed in the AACC (1 in 1,000,000).

Figure 2:
Inhalation Unit Risk — 4.3E-3 per (µg/m^3)
Extrapolation Method —absolute-risk linear model

A	B	C	D
Risk Level	**How AACC is derived *(risk level /URF)***	**AACC Concentration *(risk level/URF)***	**Annual Air Concentration equating to a 70-year constant exposure**
E-4 (1 in 10,000)	0.0001 / 4.3E-3	2.3E-2 µg/m^3	1.6 µg/m^3 (0.023 x 70 years)
E-5 (1 in 100,000)	0.00001 / 4.3E-3	2.3E-3 µg/m^3	0.16 µg/m^3 (0.0023 x 70 years)
E-6 (1 in 1,000,000)	0.000001 /4.3E-3	2.3E-4 µg/m^3	0.016 µg/m^3 (0.00023 x 70 years)

Source: Arsenic IUR from EPA [*Integrated Risk Information System (*Arsenic, inorganic (CASRN 7440-38-2) | IRIS | US EPA*), modified by adding Column B to illustrate how the AACC is derived and Column D showing the Annual Air Concentration equating to a 70-year constant exposure.]*

As illustrated, the risk in Column A may manifest when the annual air concentration shown in Column D is emitted 24 hours per day, 7 days per week, for 365 days in one year. One year of constant exposure at the levels in Column D is to equal the constant exposure of the AACC concentration in Column C, over 70 years.

DEQ applied the TAPs rules to the SGP consistent with EPA's risk assessment methodology including accepted scientific principles governing toxicity values, exposure evaluations, and cancer risk. The

[2] EPA IRIS defines Inhalation Unit Risk (called URF in the IDAPA 586 table) as: Inhalation unit risk (IUR) is an estimate of the increased cancer risk from inhalation exposure to a concentration of 1 µg/m^3 for a lifetime. The IUR can be multiplied by an estimate of lifetime exposure (in µg/m^3) to estimate the lifetime cancer risk.

worst case SGP annual air concentration is 0.00414 µg/m^3 (page 305 of 506 in the SOB dated 6/17/2022) and is significantly lower than the annual air concentrations in Column D. This means that if arsenic were emitted from SGP at the worst-case level (0.00414 µg/m^3) constantly for a single year, the dose would not equal the dose of the AACC level (Column C) over 70 years. The Board's concern that SGP could emit the equivalent of 70-year emissions in one year is not possible. I confirmed this conclusion applying EPA methods and common toxicology analyses.

DEQ also applied the TAPs rules to the SGP consistent with the agency's principles reflected in Idaho DEQ 1992 that explained the bases for the Board's adoption of the TAPs rules. The statements explain that EPA risk assessment methodology formed the foundation of the TAPs rules.[3] Specifically, the document directs use of refined modeling, consistent with guidance documents from EPA at the time, updated guidance on the use of URFs, and adjustments for exposure duration in the assessment of risk.

The statements explain the basis of the Board's adoption of the TAPS rules are consistent with DEQ's calculation of an exposure concentration, indicate that the AACCs are screening levels, allow for refined modeling as needed, and reference EPA as the source of URFs (and the AACCs) with the indication that their use should be consistent with EPA risk assessment guidance. The 1992 Meeting Packet refers to the AACCs (as well as all other TAPs values) as "screening levels." Specifically:

> The DEQ list of regulated air toxics is quite large in scope. However, this was not done to burden industry. Quite the contrary. It was done in order, to the maximum extent possible, provide industry with a ready reference to acceptable screening levels of these various compounds. This enables new sources to review their processes and see if controls, may be needed early on in the planning process, there by maximizing start up budget planning. In addition, it allows existing sources to review their emissions and see how they compare to the screening levels that DEQ considers reasonably protective of human health and the environment.

Appendix 6 describes that the exposure must be 24 hours/day for 70 years to interpret the risk associated with a URF or AACC properly. The appendix describes that the URFs in IDAPA 586 are the same as EPA's IURs, noting that the URF is the probability of developing excess cancers over a 70-year lifetime exposure to 1 µg/m^3 of a carcinogen expressed in terms of a screening emission level or an acceptable ambient concentration for a carcinogenic TAP. (Idaho DEQ 1992, Appendix 6).

Appendix 7 describes that URFs are applied to determine the risk to off-site receptors and that refined modeling is used to evaluate the risks. According to DEQ's statements in Appendix 7, refined modeling can include adjusting model parameters such as emission, topography, meteorology, or receptors. (Idaho DEQ 1992, Appendix 7).

[3] This packet was first introduced in this proceeding when the Idaho Conservation League (ICL) submitted a declaration that included reference to a 1992 document titled "Meeting Packet: Idaho Department of Environmental Quality, Monday July 13, 1992" (Idaho DEQ 1992).

These adjustments are made in compliance with IDAPA 210.02 as described in a relevant rulemaking document (Idaho DEQ 1993, Comment 108, page 30).

DEQ's approach to implementing the TAP rules is rooted in rulemaking documents that express its intentions and authority to follow well established risk assessment methodologies adopted by EPA.

B. Based on methods consistent with EPA and DEQ policies and methodologies, DEQ appropriately adjusted the exposure duration to 16 years (16/70) consistent with conditions in the PTC limiting project life because this adjustment was necessary for a scientifically defensible "apples to apples" comparison with the AACC.

The values set forth in IDAPA 586 and applied by DEQ are based on EPA toxicological determinations and derived from EPA's IRIS database. DEQ's application of the AACCs to comply with the Air Rules conforms to EPA guidance for evaluating risk, including accounting for the appropriate exposure duration. As detailed in this section, DEQ appropriately conducted its analysis following EPA methodology by comparing modeled concentrations from the SGP to the arsenic AACC.

One of the critical considerations in evaluating risk is exposure duration. EPA's definition for IUR reads (emphasis added):

> Inhalation unit risk (IUR) is an estimate of the increased cancer risk from inhalation exposure to a concentration of 1 µg/m^3 for a lifetime. The IUR can be multiplied by an estimate of lifetime exposure (in µg/m^3) to estimate the lifetime cancer risk.[4]

The AACCs set forth in IDAPA 586 assume an estimate of lifetime cancer risk based on 70 years of constant exposure and a 70-year lifetime. The assumed exposure is 24 hours /day and 365 days /year for 70 years. In other words, at a specific risk level, say 1 in 1,000,000, a person can be exposed to the AACC level (0.00023 µg/m^3) of arsenic every day, 24 hours/day, for 70 years and will have a 1 in 1,000,000 risk of developing cancer. A project that is permitted to operate for 70 years or more would properly assume a 70-year lifetime exposure when comparing modeled concentrations against the AACC.

If 70 years is not the exposure duration, then adjustments to the exposure duration are necessary to appropriately evaluate the cancer risk, as directed by EPA and as intended by the Air Rules (Idaho DEQ 1993, Comment 108, p.30)[5]. For a project like SGP with a 16-year project life, the analysis is adjusted to reflect the actual exposure duration for an "apples to apples" comparison with the AACC.

In this case, the AACC (0.00023 µg/m^3) is based on an assumed 70-year exposure. The SGP exposure duration is shorter (16 years), so the cancer risk cannot be determined accurately by comparing the modeled exposure concentration (0.00414 µg/m^3) to the AACC. Comparing those emissions to the AACC would result in an over-estimation of cancer risk because the dose will not continue for the 70-year lifetime exposure assumed in the development of the AACC. For an "apples to apples" comparison, evaluation of SGP emissions must take into account the shorter exposure duration.

[4] https://www.epa.gov/iris/basic-information-about-integrated-risk-information-system

[5] IDHW believes that the revised [IDAPA] Section 210. 02 Quantification of Emissions Rates and Ambient Concentrations, which allows site specific data gives adequate flexibility in compliance with toxic standards.

EPA guidance provides methodologies to assess risk, taking into consideration the exposure to an air concentration based on a formula for "air concentration adjusted for exposure." EPA guidance reflects this approach through a calculation methodology called the "adjusted air concentration" ($\mathbf{C_{air\text{-}adj}}$), which considers "the timeframe over which inhalation exposure occurs." (EPA 2009, EPA 2024a) (Exposure Assessment Tools by Routes - Inhalation | US EPA).

According to EPA, and as undertaken by DEQ, the exposure concentration must be adjusted for exposure duration to accurately reflect the exposure, associated dose, and resultant risk of cancer response. This adjustment allows for a correct ("apples to apples") comparison of exposure concentration to the AACC. This adjustment allows DEQ to evaluate whether the risk from actual exposure over the life of the project is acceptable under EPA methods and the AACCs.

DEQ followed this EPA methodology to assess the risk of arsenic emissions from the SGP.[6] The approach taken by DEQ for the SGP is set forth below (shaded notes are presented by author clarification):

Cair-adj=Cair x ET x 1day/24 hours x EF x ED/AT

Where:

$\mathbf{C_{air\text{-}adj}}$ = Air Concentration adjusted for exposure
$\mathbf{C_{air}}$ = Concentration of contaminant in air (mg/m^3) (this is the modeled or measured annual air concentration)
ET = Exposure time (hours/day) (this is assumed to be 24 hours/day)
EF = Exposure frequency (days/year) (this is assumed to be 365 days/year)
ED = Exposure duration (years) (this is 16 years – the life of operations)
AT = Averaging time (days) (this is lifetime – 70 years x 365 days/year; it never changes for any carcinogen)

EPA specifies that the first variable, concentration in air ($\mathbf{C_{air}}$) is either a measured or modeled value based on an annual average concentration. *For the SGP, DEQ used the highest modelled concentration after considering 14 different scenarios (0.00414 $\mu g/m^3$)*[7]

The temporal parameters in the equation include the following:

- Exposure time (**ET**) and exposure frequency (**EF**), which refer to the frequency with which the exposure occurs and might be provided in hours per day and days per year, respectively. *For the SGP DEQ used 24 hours/day for ET and 365 days/year for EF for the SGP review.*

[6] EPA established three calculations to assess risk properly. For completeness the additional EPA calculation methods for are presented in Attachment B.
[7] See Kevin Lewis Declaration

- Exposure duration (**ED**) is the amount of time that an individual or population is exposed to the contaminant being evaluated and is typically given in years. *For the SGP, DEQ used the 16-year life of mine ED reflected in enforceable PTC conditions.*
- Averaging time (**AT**) is the amount of time over which exposure is averaged and is equal to ED for assessing non-cancer risks. For chronic assessments (e.g., cancer), potential lifetime average daily dose (LADD) is calculated in which lifetime (LT, in days) is substituted for AT. *For the SGP, DEQ used 70 years, the default value, for the SGP review.*

Inclusion of a project-specific exposure duration in the calculation of the exposure concentration is essential for an accurate assessment of potential risks and for an appropriate comparison to the AACC to determine compliance with the Air Rules.

Using the highest modelled annual average arsenic concentration from the project of 0.00414 µg/m^3 (page 305 of 506 in the SOB dated 6/17/2022)[8] the calculation of the air concentration adjusted for exposure from the SGP is as follows:

$C_{air\text{-}adj}$ (Air Concentration adjusted for exposure) =

$$\left[\ C_{air}\ x\ ET\ x\ {}^{1}/_{24}\ x\ EF\ x\ ED\ \right] / \left[\ AT\ \right] = C_{air-adj}$$

$$\left[0.00414\,\frac{\mu g}{m3}\,x\,24\,\frac{hours}{day}\,x\,\frac{1\,day}{24\,hours}\,x\,365\,\frac{days}{year}\,x\,16\,years\right] / \left[365\,\frac{days}{year}\,x\,70\,years\right] = 0.00095\,\frac{\mu g}{m3}$$

In this analysis, the numerator (ET x EF x ED = 24 hours/day x 1 day/24 hours x 365 days/year x 16 years) reflects the exposure duration and the denominator of the equation (AT = 365 days/year x 70 years) reflects the 70-year averaging time for carcinogens. The resulting arsenic air concentration from the SGP adjusted for exposure risk review is 0.00095 µg/ m^3.

This approach follows the underlying rulemaking documents, including the authority noted in IDAPA 210.02. (Idaho DEQ 1993, Comment 108, p.30). DEQ appropriately adjusted the SGP evaluation to use 16 years (the actual exposure duration) because there can be no exposure to emissions beyond the life of mine. DEQ evaluated the highest annual air concentration modelled to determine the risk of a maximum 16-year exposure over a 70-year lifetime (modelled concentration x Exposure Duration (16 years)/70-year lifetime x URF. DEQ's approach followed EPA scientific principles, accepted risk assessment method, and foundational DEQ rulemaking documents.

C. The highest air concentration projections modelled for arsenic emissions from SGP are below the acceptable lifetime risk established by the T-RACT AACC listed in IDAPA 210.12 and 586, and therefore the risk from the SGP as permitted is protective of human health and the environment.

The calculated air concentration adjusted for exposure is 0.00095 µg/ m^3 -- this is the proper project-specific arsenic concentration to compare to the T-RACT AACC of 0.0023 µg/ m^3 for a cancer risk of 1:100,000 (see page 305 of 506 of the 6/17/2022 SOB).

This method is reflected in the permitting reviews to determine that the arsenic emissions risk was acceptable. Comparison to the T-RACT AACC is as follows:

[8] See Kevin Lewis declaration

$$\frac{1}{100{,}000} T\text{–}RACT\ Risk\ x\ 0.00095 \frac{\mu g}{m3} C_{air-adj} \ /\ 0.0023 \frac{\mu g}{m3}\ T\text{–}RACT\ AACC =$$

$$= 4.1E\text{–}6\ or\ \frac{1}{240{,}000} Actual\ Risk$$

This acceptable method provides an "apples to apples" comparison of SGP arsenic air concentrations to the AACC adjusted for T-RACT. This is the mathematical equivalent of 16-year emission rate of arsenic, plus 54 years of zero arsenic emissions, divided by 70 years to produce an annual exposure concentration that can be compared to the AACC.

DEQ's use of EPA toxicity values and risk assessment methodology in evaluating emissions from the SGP is consistent with IDAPA 586 because the same EPA toxicity values and risk assessment methodology formed the basis of the AACCs.

D. IDAPA 210.15 allows for a 10-times adjustment to the AACC when a project will operate for 5 years or less and is an example of DEQ's use of EPA's methods to achieve "apples to apples" analyses to compare with the AACC values.

IDAPA 210.15 provides that "[f]or short term sources, the applicant may utilize a short-term adjustment factor of ten (10). For a carcinogen, multiply either the applicable acceptable ambient concentration (AACC) or the screening emission rate, but not both, by ten (10), to demonstrate preconsturction compliance."

The *Final Order* held that the Air Rules do not explicitly authorize an adjustment for sources that will operate for more than 5, but less than 70 years. *Final Order* at 21. The Air Rules and IDAPA 210.15 should not be read to impede adjustment for exposure duration when a project will operate for less than 70 years. (Idaho DEQ 1993, Comment 108, p.30). An exposure duration is necessary and proper from a scientific and toxicological standpoint to apply the AACCs accurately. Omitting this adjustment is contrary to common scientific practice and the intent of the Air Rules as reflect DEQ documents (Idaho DEQ 1992 and Idaho DEQ 1993). Specifically the refernce from Petitioners reads:

> For short term sources (usually less than five years in duration), such as remediation projects, a probability of greater than one in a million risk (over 70 years) will generally be acceptable to account for the decreased term of exposure. It is not acceptable however, for exposed individuals to receive a full 70 year exposure during the life of a short term project. (Idaho DEQ 1992).

Unpacking this content may be helpful. First, the accepted scientific approach to determine risk is to calculate a lifetime average daily dose that includes the air concentration for the duration of exposure. In other words, to compare "apples to apples" an evaluator must adjust the default exposure duration (70 years) to the actual of exposure duration (16 years for SGP) then divide by 70 years to account for a lifetime-based URF. This is the proper method to determine "a probability of greater than one in a million risk (over 70 years)" as described.

Next, to expose individuals to "a full 70-year exposure" means that the AACC value is multiplied by 70 to derive the full exposure. See Figure 1 above. For arsenic emissions, the calculations follow:

- At a risk of 1E-6, using the AACC of 0.00023 µg/m^3 arsenic air concentration
  - 0.00023 µg/m^3 x 70 years = 0.016 µg/m^3
  - Exposure to 0.016 µg/m^3 air concentration every day for one year would expose an individual to the full 70-year exposure in one year.
- At a risk of 1E-5, using the T-RACT AACC of 0.0023 µg/m^3 air concentration
  - 0.0023 µg/m^3 x 70 years = 0.16 µg/m^3
  - Exposure to 0.16 µg/m^3 air concentration every day for one year would expose an individual to the full 70- year exposure in one year.

The AACC is not a one-year exposure limit and such an interpretation ignores both the definition of the URF and the definition of the AACC.

E. Idaho's AACCs are not annual average air concentration limits or standards.

The AACCs are distinct from annual average air concentrations and are not limits or standards. (Idaho DEQ 1993, Comment 31, page 10; Comment 111, page 32). One is an apple, the other an orange. The reference to an annual average concentration represents the longest period for which air concentrations are projected by air emission models, specifically AERMOD. Models only project concentration estimates over certain time periods of prediction (hourly, daily, monthly) within one year or over an annual duration. Models do not address exposure duration.[9]

The AACCs (derived from EPA's URFs) reflect exposure duration (i.e., 70-year lifetime) and present an acceptable constant dose of a contaminant over a known averaging time (70 years is the default averaging time for carcinogens). The AACC is the concentration that a person may be exposed to for a lifetime continuously, with an incremental risk of cancer of 1 in 1,000,000. The T-RACT AACC is the concentration that a person may be exposed to for a lifetime continuously, with an incremental increased risk of cancer of 1 in 100,000. The AACCs are not one-year limits. Compliance with IDAPA 586 is not based on comparing annual air concentrations from the model to an AACC. (Idaho DEQ 1993, Comment 111, page 32).[10]

Comparing an annual average concentration from a model to the AACC is not a risk evaluation and does not demonstrate acceptable risk. Nor is the annual average concentration predicted from modeling the same as an exposure concentration.[11]

DEQ understood and applied these distinct parameters properly in the PTC reviews for the SGP. For the SGP PTC, DEQ reviewed maximum daily emissions under 14 modeling scenarios that were each modeled for 365 days/year to produce an annual average arsenic concentration for each of the 14 scenarios. DEQ then used the highest annual average concentration—0.00414 µg/m^3—to conduct its risk evaluation calculations following EPA and DEQ guidance referred to above to compare to the AACC. This conservative approach assumed that the highest annual concentration modelled is

[9] See Kevin Lewis Declaration
[10] In the design of this rule, the AAC relates to a stack emission rate. In the most prescribed sense, the AAC would be assured by a permit ted emission limit. This emission limit then might be guaranteed by some ample control technology design or perhaps an operational limit prescribed in the permit.
[11] See Kevin Lewis Declaration

emitted for all the years of operation at SGP. To demonstrate compliance with the arsenic AACC, DEQ adjusted the exposure duration as directed by EPA (methodology explained above) and the DEQ guidance referred to above. Based on the modeling and scientific risk evaluation methods, DEQ concluded that the maximum arsenic emissions from SGP would cause an increased cancer risk of less than 1 in 100,000. This use of the annual average concentration in DEQ's AACC risk evaluation followed appropriate scientific methods.

Treating the AACC as an annual emission limitation or annual limit on ambient exposure concentration would result in significantly lower acceptable risk from TAPS emissions than envisioned by the Air Rules. If the T-RACT AACC of 0.0023 µg/m^3 were based on a one-year exposure, then the risk represented by that value would be about 1 in 7,000,000. Using the EPA guidance for URFs, and assuming continuous exposure to the T-RACT AACC concentration for an exposure duration of 1 year, the $CA_{air\text{-}adj}$ is:

0.0023 µg/m^3 x 24 hrs/day x 365 days/yr x 1 yr / (70 yrs x 365 days/yr x 24 hrs/day) = 0.000033 µg/m^3

And the associated risk of developing cancer over a 70-year lifetime is:

0.0043 (µg/m^3) x 0.000033 µg/m^3 = 1.4 E-7 (about 1 in 7,000,000)

The AACC (and the URF it is based on) represent the upper-bound excess lifetime cancer risk estimated to result from continuous exposure to a contaminant over a lifetime at an air concentration of 1 µg/m^3. In other words, the AACC and T-RACT AACC represent the risk to an individual if exposed all day, every day for a lifetime to a concentration of 1 µg/m^3. The AACC and T-RACT AACC do not represent the risk of a cancer response following a single exposure. The latter interpretation defies fundamental toxicological science used by the EPA in the development of IURs (URFs).

F. The 5-year rolling average production limit will ensure that the ambient arsenic concentration caused by the SGP does not cause unacceptable cancer risk.

The *Final Order* expresses concern that the use of a 5-year rolling average production limit will allow for smoothing out of peak ambient concentrations of ambient arsenic and may not be equally protective of ambient air as the AACC limits set forth in IDAPA 586.

First, the AACC is not a limit based on my reading of the relevant documents cited in this memorandum, in particular Idaho DEQ 1992 and Idaho DEQ 1993. Second, in my opinion, for purposes of evaluating cancer risk, use of a 5-year rolling average production limit is as protective as an annual production limit.

As described earlier in the report, risk assessment evaluates the probable response to a particular dose of a carcinogen over time. Risks increase from cumulative long-term exposure, not short-term annual emissions. Risks are assessed based on total cumulative dose, as demonstrated in Figure 1, column D. As shown in Figure 1, a total cumulative dose of 0.16 µg/m^3 of arsenic would cause an increased cancer risk of 1 in 100,000. However, whether this dose occurs in 1 year, 5 years, 16 years, or 70 years, the risk would not change.

The 5-year average production limit ensures that if production is above the limit in one year, then future production must be reduced below the limit. This ensures that the cumulative ambient arsenic concentration does not exceed the acceptable ambient concentration level for the defined risk. The 5-year average production limit in the PTC ensures that the ambient arsenic concentration from the SGP over the project life (exposure duration of 16 years) results in an acceptable cancer risk under the Air Rules.

VII. CONCLUSIONS

Based on my review of the modeled emissions from the SGP, the Air Rules, and EPA risk assessment methodology, and relevant explanatory documents, arsenic emissions from the SGP will result in an increased cancer risk of less than 1 in 100,000. DEQ appropriately applied a project specific adjustment factor to account for exposure duration, consistent with established EPA risk assessment methodology. The permit issued to SGP, including the five-year rolling average production limit, represents acceptable risk confirmed by methods that follow EPA's approaches for using URF, IUR values in risk assessments.

ATTACHMENT A
References

Idaho DEQ 1992. Meeting Packet in Petitioners in Motion for Reconsideration.

Idaho DEQ 1993. Idaho Department of Health and Welfare, Responses to Comments and Questions Submitted During a Public Comment Period and Public Hearings on the Proposed Repeal and Reissuance of Rules for the Control of Air Pollution in Idaho.

Idaho DEQ 2021. Guideline for Performing Air Quality Impact Analyses. Stationary Source Program AQ Division. Idaho Department of Environmental Quality, July.

Idaho DEQ 2018. Risk Evaluation Manual for Petroleum Releases. August 2018.

EPA 1984. Health Assessment Document for Inorganic Arsenic. Final Report March 1984. EPA/600-8-83-021F. Office of Health and Environmental Assessment.

EPA 2009. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment). EPA-540-R-070-002 OSWER 9285.7-82. January.

EPA 2022. Conducting a Human Health Risk Assessment | US EPA. Last updated June 22, 2022.

EPA 2023 Risk Assessment for Carcinogenic Effects | US EPA. Last updated on November 14, 2023.

EPA 2024a. EPA ExpoBox. Available at Exposure Assessment Tools by Routes - Inhalation | US EPA. Last updated on April 12, 2024.

EPA 2024b. Integrated Risk Information System (IRIS), Arsenic, inorganic (CASRN 7440-38-2) | IRIS | US EPA

EPA 2024c. Regional Screening Levels, May 2024. Available at Regional Screening Levels (RSLs) - Generic Tables | US EPA.

ATSDR 2007. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Arsenic. U.S. Department of Health and Human Services. Public Health Service.

National Cancer Institute. 2024. Cancer Statistics – NCI.

National Oceanic and Atmospheric Administration (NOAA). National Weather Service. How Dangerous is Lightning? (weather.gov)

ATTACHMENT B

For completeness the additional EPA calculation methods for are presented here.

Method 2: Calculate the risk associated with the air concentration

The second option for correct use of the URF in the evaluation of project risk is to forward-calculate a risk from the modelled concentrations and using the IUR (URF) as shown in the "Equation 6" from EPA 2009 (below).

The EPA screening levels, associated risk calculator and several guidance documents published by EPA rely on the unit risk factor (again, called IUR by EPA and called URF in the Air Rules). For arsenic, the IUR is 0.0043/(µg/m^3)(from EPA 2024b and shown in IDAPA 58.01.01.586 as the URF). Exposure for inhalation is determined by the following equation for carcinogenic chemicals (EPA 2009), which necessarily relies upon an exposure time, frequency and duration to estimate dose. Exposure concentration (EC) is the parameter that is to be evaluated by use of the URF; Concentration in Air (CA) is the estimated contaminant concentration that is predicted by the model. The exposure concentration is the equivalent to the adjusted air concentration described in Method 1.

From EPA 2009, Risk Assessment Guidance for Superfund, Part F. Page 14

EC = (CA x ET x EF x ED)/AT **(Equation 6)**

Where:
EC (µg/m^3) = exposure concentration;
CA (µg/m^3) = contaminant concentration in air;
ET (hours/day) = exposure time;
EF (days/year) = exposure frequency; ED
(years) = exposure duration; and
AT (lifetime in years x 365 days/year x 24 hours/day) = averaging time

The EC is then multiplied by the URF to calculate incremental lifetime risk.

Using the SGP highest modeled air concentration for arsenic of 0.00414 µg/m^3:

Exposure Concentration (µg/ m^3) =

$$[\quad CA \quad x \quad ET \quad x \quad EF \quad x \quad ED \quad] / [\quad AT \quad] = \quad EC$$

$$\left[0.00414 \frac{\mu g}{m3} x\ 24 \frac{hours}{day}\ x\ 365 \frac{days}{year}\ x\ 16\ years\right] / \left[70\ years\ x\ 365 \frac{days}{year}\ x\ 24 \frac{hours}{day}\right] = 0.0095 \frac{\mu g}{m3}$$

Then, the Exposure Concentration (EC) x IUR (or URF) estimates the risk:

$$0.00095 \frac{\mu g}{m3} EC\ x\ 0.0043 \left(\frac{\mu g}{m3}\right)^{-1} IUR = 4.1E{-}6\ or\ \frac{1}{240{,}000} Risk$$

Method 3: Adjust the AACC to reflect the Project Duration

The same calculation can be re-arranged to estimate a screening concentration in air, as shown in Table 4 from EPA 2009 (below).

TABLE 4

RECOMMENDED PROCEDURE FOR CALCULATING RISK-BASED SCREENING CONCENTRATIONS FOR CONTAMINANTS IN AIR

	Cancer Risk-Based	Hazard-Based[1]
Step 1: Select Target Levels	Select target cancer risk (e.g., 1 x 10^{-6}).	Select target HQ (e.g., 1).
Step 2: Identify Toxicity Value[2]	Identify inhalation cancer potency value (e.g., IUR). If none exists, proceed with hazard-based screening level calculation.	Identify inhalation reference value (e.g., RfC) to match exposure scenario (acute, subchronic, or chronic). If none exist, proceed with cancer screening level calculation.
Step 3: Calculate CA	Using target cancer risk from Step 1 along with the receptor- and scenario-specific exposure parameter values, calculate CA; the following equation is recommended: CA = (AT x Target Risk)/(IUR x ET x EF x ED)	Using target HQ from Step 1 along with the receptor- and scenario-specific exposure parameter values, calculate CA; the following equation is recommended: CA = (AT x Target HQ x RfC x 1000 µg/mg)/(ET x EF x ED)
Step 4: Select Screening Concentration	Select minimum of predicted cancer risk- and hazard-based values as screening concentrations.[3] Repeat for each receptor/scenario combination of interest.	

[1] Hazard-based screening concentrations are typically derived from reference values such as RfCs. These values may be available for non-cancer effects but may include cancer, if a nonlinear MOA is thought to operate for a chemical. [2] If no inhalation toxicity value is available for a chemical, contact STSC for further direction on how to proceed.

[3] Screening levels estimated from the equations presented in Step 3 could yield concentrations that exceed the maximum possible vapor concentration for a chemical. In such cases, it may be useful to calculate the maximum possible vapor concentration of the pure contaminant at the temperature of interest, using the following formula: C_{max} = S x H x 10^3 L/m^3, where S = solubility at 25° C (or temperature of interest) and H (unitless) = Henry's Law Constant at 25° C (or temperature of interest). This equation is based on an established relationship (see, for example, Schwartzenbach et al. 1993), that allows the Henry's Law Constant to be estimated as the ratio of a compound's vapor pressure and aqueous solubility for compounds that are slightly to moderately soluble in water. When the dimensionless Henry's Law constant, H, is used, the relationship described above can be used to calculate the vapor concentration of a saturated solution of a given compound, assuming equilibrium between the vapor and aqueous phases.

Note: MOA = Mode of Action, which refers to the way in which a chemical exerts a health effect.

In Step 3 of this table AT is averaging time as described in "Equation 6" from EPA 2009 or 70 years x 365 days for carcinogens (note - for noncarcinogens only, AT is equal to the Exposure Duration) (source: EPA RSLs 2024c, EPA Risk Assessment Guidance for Superfund 2009).

As shown in Step 3 the third option for assessing risk is to adjust the screening value (here, the AACC) to reflect the project-specific exposure duration. The default exposure duration assumed in the AACC is 70 years. The AACC values represent a concentration in air (CA) for a 24 hour/day, 365 day/year, and for 70-years of exposure (using both a lifetime exposure duration and lifetime for averaging time). At a T-RACT risk of 1:100,000 the calculation of the T-RACT AACC is as follows, using the equation in Step 3 of EPA guidance (2009):

$$[\ AT\ \ x\ \text{Target Risk}]\ /\left[\ \ \text{IUR}\ \ x\ \ \text{ET}\ \left(\frac{\text{hours}}{\text{day}}\right)\ x\ \ {}^{1\ day}/_{24\ hours}\ \ \ x\ \ \ \text{EF}\ \ \ x\ \ \ \text{ED}\ \right] = CA$$

$$specifically$$

$$\left[70\ years\ x\ 365\,\frac{days}{year}\ x\ {}^{1}/_{100{,}000}\right] / \left[4.3E{-}3/\frac{\mu g}{m3}\ x\ 24\,\frac{hours}{day}\ x\ \frac{1\ day}{24\ hours}\ x\ 365\ \frac{days}{year}\ x\ 70\ years\right] =$$

$$= 0.0023\,\frac{\mu g}{m3}\ Screening\ concentration, CA_{70-year\ ED}$$

The adjustment used by DEQ for the exposure duration reflects the 16-year life of the mine (i.e., there can be no operations related exposure after operations cease). Accordingly, the appropriate AACC for this project is:

$$[\ AT\ \ x\ \text{Target Risk}]/\left[\ \ \text{IUR}\ \ \ x\ \ \ \text{ET}\ \ \ x\ \ {}^{1\ day}/_{24\ hours}\ \ x\ \ \ \text{EF}\ \ \ x\ \ \ \text{ED}\ \ \ \right] = CA$$

specifically,

$$\left[70\ years\ x\ 365\,\frac{days}{year}\ x\ {}^{1}/_{100{,}000}\right] / \left[4.3E{-}3/\frac{\mu g}{m3}\ x\ 24\,\frac{hours}{day}\ x\ \frac{1\ day}{24\ hours}\ x\ 365\ \frac{days}{year}\ x\ 16\ years\right] =$$

$$= 0.0102\,\frac{\mu g}{m3} Screening\ concentration, CA_{16-year\ ED}$$

The adjusted AACC of 0.0102 µg/m^3 is used to compare the highest annual average concentration from the modeling without further adjustment to determine the risk. In this case it would be:

$$\frac{1}{100{,}000} Target\ Risk\ x\ 0.00414\,\frac{\mu g}{m3} C_{air}\ /\ 0.0102\,\frac{\mu g}{m3}\ CA_{16-year\ ED} =$$

$$= 4.1E{-}6\ or\ \frac{1}{240{,}000} Actual\ Risk$$

Using Method 1 (presented in the memorandum) or Method 2 or 3 presented here, the same estimate of lifetime risk is obtained, which for this project is 4.1E-6.

ATTACHMENT C

TETRA TECH

Theresa K. Lopez, MSPH
Principal Toxicologist

EXPERIENCE SUMMARY

Ms. Lopez has worked extensively in public health, epidemiology, human health risk assessment, toxicology, and occupational health and safety, representing both the public and private sector for over 30 years. She has been a task manager for a variety of human health risk assessment projects, including developing a disease burden reduction model for the optimized placement of infrastructure. She has led investigation and assessment of chemical releases and environmentally compromised sites such as former nuclear weapons plants, active and closing naval bases, and mining, commercial, and school sites. Ms. Lopez has worked extensively for federal, State, Provincial, and private clients. Her work includes assisting in remediation of former mining sites in the United States (US) and Canada with heavy metal, pesticides, TPH and other chemicals of concern; and risk assessments for proposed mines, hazardous waste release sites, and TPH remediation in the US and Canada. She has prepared human exposure assessments for schools and recreational settings, and assessed clean-up goals and remediation strategies for closed industrial, mining, redevelopment, and other sites. These sites often include the consideration of native and indigenous peoples.

In addition, she has provided exposure and dose reconstruction for Oak Ridge Associated Universities to quantify radiation doses to former nuclear weapons workers. She provided the exposure assessment information and mathematical evaluation for the development of a computer-based mouthing exposure tool for Health Canada which involved comparative evaluation of equations selected from a variety of countries and multi-national interest groups (including Japan, European Chemicals Agency, US, and UK). Currently, Ms. Lopez is performing the human health risk assessments involving both radionuclide and chemical impacts, modeling of indirect exposure pathways, TPH evaluations, and exposure assessments for private clients and US and international regulatory agencies, as well as providing scientific peer reviews and authoring reports for Health Canada related to the Existing Substances Risk Assessment Bureau mandates.

EMPLOYMENT HISTORY

Tetra Tech, Inc., Senior Toxicologist, 1997–present

PRC Environmental Management (NKA Tetra Tech EMI), Senior Toxicologist/Toxicology Group Leader, 1992–1997

University of Colorado Health Science Center, Student/Professional research Assistant, 1989-1992.

EDUCATION

MS, Public Health, University of Colorado, 1991

BS, Nutritional Science (Zoology minor), University of Florida, 1989

AREAS OF EXPERTISE

- Human Health Risk Assessment
- Chemical Risk Assessment
- Radiological Risk Assessment
- Regulatory toxicology
- Risk-based Remediation
- Public Health
- Epidemiology
- Guidance Development
- Exposure Assessments

TRAINING/CERTIFICATIONS

- Qualified Person, Site Assessment Chapter and Corrective Action Plan Chapter, Saskatchewan
- FEMA Emergency Response Training IS-00005.a, 230.d, and00029

PROFESSIONAL AFFILIATIONS

Society for Risk Analysis

Society for Environmental Toxicology and Chemistry

RELEVANT EXPERIENCE

Peer Review of Chemical Assessments, Consumer Product Safety Commission (2022-present). Program manager and lead toxicologist for peer review of chemical and nanomaterial risk assessments developed for and by the Consumer Product Safety Commission. Current project is the review of class-based assessment for organic flame retardants. The peer review will include response to charge questions as well as commentary on the approach and case study to evaluate scientifically defensibility, thoroughness, and accuracy.

Navajo EPA Ambient Water Quality Standards. **(8/2018 – present)**. Provided a review of existing ambient water standards and calculated health-based standards for the Navajo Nation based on human exposures, livestock exposures, plants, and food ingestion pathways. The report will be the basis of Navajo EPA water standards for surface water bodies and specifically the San Juan River within the Navajo Nation boundaries.

Technical Support Services, Agency for Toxic Substances and Disease Registry (ATSDR) (US-Nationwide). (12/2016-present). Managing a contract with ATSDR to provide ad-hoc scientific advice on a variety of public health assessment issues, including chemical toxicity, public health, environmental risk assessment and education and

outreach activities as needed. Projects to date have involved being a subject matter expert in public health assessments methodology, review of minimal risk levels and toxicity data used by ATSDR, and reviewing EPA databases (including the TRI) for potential uses in public health evaluation and outreach as well as providing technical support for ATSDR's soilSHOP outreach (a lead poisoning prevention program). The most current project involves measuring uptake of metals and PFAS from soil to common food plants.

Arizona Department of Environmental Quality. Phoenix AZ. (11/2019 – present). Providing toxicology and risk assessment review of reports submitted to ADEQ for approval under the Voluntary Cleanup Program, as well as conducting site-specific risk assessments for historic mining sites to facilitate remediation. Reviewing a variety of submitted reports for former industrial facilities and release sites throughout Arizona.

Toxicological Literature Reviews and Summaries, Health Canada. Ottawa, Ontario. (1/2015-present) Provided literature search and summary for various chemicals and exposures. A specific example include a literature review and data summary for 36 organic flame retardants and 45 salicylates. A literature search was conducted for each chemical in these two efforts, and summaries of material ranged from a few pages to over 120 pages per chemical depending on the amount of literature identified. Both carcinogenic and noncarcinogenic endpoints were included in the search, and endpoints included acute toxicity (single exposure), short-term toxicity (2 to 89 days), subchronic toxicity (90 days to 1 year), chronic toxicity (more than 90 days), carcinogenicity, reproductive and development toxicity, genotoxicity, endocrine effects, immune system, sensitization, and irritation. In addition, a data extraction project for ultrafine particles was also undertaken, reviewing health outcomes for human exposure to ultrafine particles in over 130 epidemiological papers.

Peer Review of Screening Assessment Reports (SARs), Health Canada. Ottawa Ontario. (1/2015 – present) Providing peer review of screening assessment reports for a variety of chemicals in consumer products for the Existing Substances Risk Assessment Bureau under the Chemicals Management Plan. Reviews include a literature search, review of identified literature, qualitative and quantitative exposure assessments, toxicity assessment, calculation of margins of exposure for each exposure pathway, and recommendations on the methodology used to assess the chemicals. Over 50 reviews have been conducted to date.

Peer Review of New Assessment Methodologies, State of the Science Reports, and Occupational Exposure Guidelines, Health Canada, Ottawa, Ontario (4/2017-present). Providing peer review of new assessment methodology reports (including *in silico* learning and transcriptomics), State of the Science (including PFAS compounds and Vitamin A) , and Occupational Exposure Guidelines (STOT RE for carbon black) for Health Canada under the Chemicals Management Plan and Hazardous Products Regulations.

Review of Proposed Drinking Water Guidelines, Health Canada, Ottawa, Ontario (8/2021- 12/ 2023). Providing peer review of six drinking water guidelines, focused on health-based standards and toxicological concerns, for several inorganic and organic chemicals under the Chemical Management Plan for the Water and Air Quality Bureau (WAQB). The reviews included verification of toxicological information, calculation of a guideline, and other technical issues relevant to water guideline development.

Exposure Assessment Studies, Health Canada, Ottawa, Ontario 4/2017-present). Provided peer review of exposure assessment reports, including internal backgrounders on body weight, drinking water intake rates, inhalation rates, and soil/dust intake rates, dermal surface area, and breast milk and formula intake. Collected literature and provided detailed reports for Health Canada on vapor recovery systems and air quality, chemical exposure in nail salon settings. Created and implemented consumer product surveys for hand sanitizer, automobile products, certain arts and crafts products, paint remover and essential oils. The hand sanitizer project was published while the paint remover and essential oil surveys are currently in progress. The automobile products and arts and craft product surveys remained internal to Health Canada but follow-up work may be planned.

UNICEF WASH Program, Pacific Island Countries. (4/2024-present). Assessed current disease burden rates for Solomon Islands including diarrheal disease and other water-related illness to determine economic benefits from placement of water and sanitation infrastructure improvements. The public health evaluation identified areas with potentially the highest rates of diarrheal disease and the reduction in disease burden that can be achieved by providing chlorinated water supplies and sanitation systems. The model that was created also can estimate disease reduction through reduced flooding and drainage improvements. A mathematical model was developed for this effort that included weighting factors to account for poverty and age, and different percentages for infrastructure improvements, to estimate disease and mortality reduction from the provision of disinfected water and sanitation infrastructure.

Relative Risk Ranking Model for Sanitary System Overflow Diversions, Metro Vancouver. (3/2024 – present). A model was developed for the relative risk to humans and ecological receptors from 5 options for based on options developed for consideration. This evaluation considered several inputs to evaluate potential risks to receptors from the overflow to conveyances, surface water, and eventually the bays surrounding Metro Vancouver. This is was not a quantitative risk assessment but rather a relative ranking of the risks associated with each option. Inputs to the model included overflow volume, distance to conveyance from overflow, distance to receiving body, dilution, chemical/bacterial measurements, and percent paved area surrounding conveyance. Special status ecological receptors in the areas of interest were identified, as well as human uses of the land and communities of special consideration. A ranked score was created for each option, under the broad categories of logistical, ecological risk, human health, and chemical inputs.

Public Health Assessment and Disease Burden Reduction, Millennial Challenge Corporation, Timor-Leste. (1/2020 - 9/2022). Assessed current disease burden rates for Dili, Timor Leste, including diarrheal disease and other water-related illness to determine areas that will achieve greatest disease burden reduction from proposed infrastructure improvements. The public health evaluation identified areas with potentially the highest rates of diarrheal disease and the reduction in disease burden that can be achieved by providing chlorinated water supplies, sanitation systems, and drainage improvements to reduce flooding. These improvements may be implemented individually or together, depending on the area. A mathematical model was developed for this effort that included weighting factors to account for poverty, age, and gender differences in the population.

Development of Biomonitoring Equivalents for Glyphosate and Ethylene Thiourea (1/2021-12/2023). In partnership with Summit Toxicology, gathered biomonitoring data, regulatory information, and adsorption, distribution, metabolism and excretion (ADME) data for these two pesticides. Data were used to develop biomonitoring equivalents and manuscripts have been developed documenting the results (one has been published and the other has been submitted).

City of Campbell River, British Columbia, Canada. (1/2023-present). Performing human health and ecological risk assessment for soil and groundwater with PFOS and PFOA impacts from firefighting training at an airport. Exposure pathways include drinking water, soil contact, and impacts to off-site freshwater bodies.

Human Health and Ecological Risk Assessment, Duck Lake, British Columbia. (4/2018-11/2018). Conducted a human health and ecological risk assessment of a former railway right-of-way using. The intent of the risk assessment was to document any potential risks associated with legacy polycyclic aromatic hydrocarbon residue from Site use as a railway, and the community plans to redevelop the right-of-way into a multi-use recreational trail. Site was submitted for closure and redevelopment in November 2018 based on the risk assessment findings.

Human Health and Ecological Risk Assessment, Aitchelitz, BC. (7/2021-7/2023). Conducting a human health and ecological risk assessment of a former industrial operations area. The intent of the risk assessment was to document any potential risks associated with current and legacy buried wastes and petroleum releases from the area, including any discharge of groundwater to the Aitchelitz Creek and use of groundwater as a drinking water source. As well, ecological effects in the Aitchelitz Creek were evaluated, particularly for endangered species.

Human Health and Ecological Risk Assessment, Kitsumkalum, BC. (3/2018 – 3/2019). Conducted a human health and ecological risk assessment of a former industrial and woodmill operations area. The intent of the risk assessment was to document any potential risks associated with legacy buried wood waste and petroleum releases from the area, including any discharge of groundwater to the Kitsumkalum River and use of groundwater as a drinking water source. The community planned to redevelop a portion of the Site for industrial re-use, while a portion was being considered for residential redevelopment. The Site was submitted for closure and redevelopment in March 2019 based on the risk assessment findings.

Human Health and Ecological Risk Assessment, Wei Wai Kum First Nation (WWK), Myra Fall Mine (MFM) and Indigenous Services Canada (ISC), Campbell River BC. **(2021-2022)**. Providing human health and ecological risk assessment for Wei Wai Kum First Nations for this former port area located on Vancouver Island. Chemicals of potential concern include metals and PAHs, with a particular concern regarding marine life in the area and food chain exposures.

Evaluation of Human Toxicity Data for PFAS and PCBs to Determine Applicability to Marine Mammals, British Columbia Ministry of Environment and Climate Change (BMOECC). (**9/2020-3/2021).** Vancouver, British Columbia. Provided BCMOECC and federal agencies with a methodology and example of how data developed for the assessment of human toxicity could be extrapolated for use in protecting the endangered

Southern Resident Killer Whale population, as well as other marine mammals. Specific chemicals of interest were PCBs and PFAS.

San Juan River Risk Assessment, Utah Department of Environmental Quality. (2/2017 – 3/2018). Task leader for the human health and agricultural risk assessments of the San Juan River. Evaluating impacts of heavy metals (including arsenic) from the Gold King Mine release to residents, ranchers, farmers, and other users of the San Juan River water. Providing data evaluation including comparisons to background values, assessment of data from tributaries to the San Juan River, as well calculating exposure point concentrations. Providing assessment of current and future risks, including consideration of regulatory levels as well as site- and receptor-specific exposure parameters to fully evaluate potential long-term impacts of the release on receptors and the eventual deposition of impacted sediment in Lake Powell.

Exposure Assessment for Nanoform Cerium Oxide Silver, Titanium Dioxide and Zinc Oxide, National Industrial Chemicals Notification and Assessment Scheme, Australian Government Department of Health and Ageing. (11/2012 – 6/2013). Provided an exposure assessment of the public to nanoform cerium oxide, silver, titanium dioxide, and zinc oxide present in consumer products. Assessed both qualitative and quantitative measures of exposure, based on a range of nanomaterial content and use of consumer products. For each nanomaterial, provided current information on commercial uses, sources, synthesis methods, characterization, potential exposure routes, toxicokinetics, and environmental fate and transport, as well as addressing data gaps where information was not found. Developed exposure scenarios for each of the four nanomaterials, including exposure to workers, the public (consumers), and the environment, and provided estimates of exposure to the extent possible. Identified data gaps that introduced uncertainty into the estimates or prevented a quantitative estimate of exposure, including that the toxicity of nanomaterials may be related to the number of particles rather than mass of particles present, and that measures of exposure based on mass of material may therefore underestimate potential toxic effects.

Use of Biomonitoring Data and Biomonitoring Equivalents in Risk Assessment, Health Canada, Ottawa, Ontario. (1/2015-7/2015). Prepared a report for Health Canada regarding the current use and application of biomonitoring data and biomonitoring equivalents (BE) in regulatory settings as well as considerations for varying types of pharmacokinetic data used to interpret biomonitoring data for various matrices. Authored chapters defining BEs as the translation of screening exposure guidelines or criteria to chemical- and biological media-specific concentrations that can be used interpret biomonitoring results for specific chemicals in a health risk context. Provided an overview of its application in regulatory risk assessment as well as considerations for varying pharmacokinetic data in both animals and humans, and described international efforts in biomonitoring of several chemicals, including perfluorinated compounds, mercury, lead, 2,4-D, and phthalates. In addition, the report contains a discussion of how pharmacokinetic data can be used to interpret biomonitoring data for regulatory risk assessment of industrial chemicals under the Chemicals Management Plan.

Peer Review of Personal Care Products (PCP) Module III, Assessment of Exposures to Chemicals in Personal Care Products for the Hair. Health Canada, Ottawa, Ontario. (12/2014-4/2015). Provided a peer review for the Existing Substances Risk Assessment Bureau (ESRAB) - Healthy Environments and Consumer Safety Branch (HECSB) of the proposed Health Canada methodology for assessing consumer exposure to chemicals in hair care products, including an evaluation of recommended default exposure parameters for all receptors and a literature review to determine if additional applicable data were available for use in the effort.

Peer Review of OECD Documents, Health Canada Risk Assessment Bureau, Ottawa, Ontario. (8/12-8/13). Performed peer reviews of regulatory and advisory health summary documents for Health Canada for the Organization for Economic Co-Operation and Development (OECD) Cooperative Chemicals Assessment Meeting No. 4 (CoCAM 4). Peer review included verification of health effects data reported in IUCLID Dossier, Screening Information Data Set (SIDS) Initial Assessment Reports, and SIDS Initial Assessment Profiles documents.

Mouthing Exposure in Young Children: In Silico Tool. Health Canada, Ottawa, Ontario. (11/2013-7/2014). Designed exposure assessment and mathematical models for 26 separate equations to assess chemical exposure to children through mouthing of various consumer products. Provided a variety of algorithms that may be used with default or user-specified parameters to assess mouthing exposures in children from birth to 8 years of age. Identified mathematical approaches and modeling tools from a targeted search of the scientific literature, as well as various government sources, using on-line search engines and established medical information search tools and included a discussion of the circumstances and modulating factors surrounding an attempt at assessing object-to-mouth exposures in children as well as limitations to assessing such exposure. Also authored the user's guide to accompany the computer-based model that included description of mathematical similarities and differences in assessing exposure to non-food substances through direct mouthing, hand-to-mouth behavior, and swallowing as

well as compiling exposure data to provide users with a range of parameter values to assess chemical intake.

Human Health and Ecological Risk Assessment, Cantung Mine site, Northwest Territories, Canada. (**3/2017-present).** Lead human health and ecological risk assessor for this closed tungsten mine. Providing a detailed quantitative assessment of potential human exposure to metals, petroleum hydrocarbons, and other chemicals of concern at this site, including exposures through hunting, fishing, and gathering of plants as traditional food sources given the remote location and First Nations traditional land uses. Provided assessment of direct exposures including soil ingestion, particulate inhalation, dermal contact with impacted soil and tailings; and ingestion and incidental contact with surface water. Provided a detailed background comparison for metals in soils that will be used to guide soil remediation.

Risk Assessment, Public Works and Government Services Canada, Tulita NWT and Fort Reliance, NWT, and Yellowknife, NWT. (9/2017-3/2018). Currently performing human health and ecological risk assessment for petroleum hydrocarbon releases at three sites in Canada related to previous spills and releases at Royal Mounted Canadian Police detachments and Crown-owned residences. Provided methodology and risk calculations to evaluate indoor air exposure, soil exposure, groundwater impacts, and ecological receptor exposure.

Confidential Maryland Redevelopment Site, Baltimore Maryland. (3/2022 – 7/2022). Conducted a multimedia, Site-Specific Risk Assessment for redevelopment of a former electrical manufacturing facility located in Baltimore, Maryland. Using soil, groundwater and soil vapor data, evaluated the potential risk to future residential, commercial, and recreational receptors for Chemicals of Potential Concern (COPCs) included PCBs, chlorinated compounds, petroleum compounds, metals (including lead), and PAHs. Working collaboratively with the Maryland Department of the Environment, the risk assessment was completed in accordance with voluntary cleanup guidance and provided a health-protective path forward to redevelopment.

Risk Assessment, Beazer, L.A. Paint Site, Vernon, California. **(5/2014 – present).** Performing a human health risk assessment for vapor intrusion to indoor air from soil gas and groundwater data at historical release site, including paint manufacturing process solvents and petroleum products. Providing risk calculations and correlation of soil, soil gas, and groundwater data to provide multiple lines of evidence to assess potential risks from site reuse and redevelopment. Working cooperatively with both State and local regulators involved in this risk assessment process to address concerns and obtain site closure.

Indoor Air Risk Assessment, Lockheed Martin Corporation, Palo Alto, California. (9/2016-10/2021). Risk assessor for ongoing monitoring and assessment of soil vapor plume for solvent release site for Lockheed Martin Corporation (LMC) in Palo Alto, California. Provide updates of indoor air modeling and risk assessment every 6 months using soil gas data collected from 3 impacted areas**.**

Risk and Dose Assessment, American Jewish University, Simi Valley, California. (2/2016-5/2018). Performed a review of historic data and risk assessments conducted for the site. Evaluated the potential for the AJU campus, which is downgradient of the Santa Susana Field Laboratory (SSFL), to receive storm water discharge, groundwater, and air-dispersed particulates from former operations at the SSFL. Reviewed AJU and SSFL data related to release of metals, dioxins, perchlorate, polycyclic aromatic hydrocarbons, and TCE, as well as radionuclides. Evaluated historic data and recently collected data to determine if any risks currently exist to patrons of the AJU campus. Conducted site evaluation involving tracing potential migration pathways of contaminants from origin to the campus, and review of soil, sediment, surface water, groundwater, and food data, as well as gamma survey results. Evaluation of impacts to the campus relied upon establishing background and ambient conditions that could influence sampling results, including the effects of forest fires and releases from other facilities in the surrounding urban areas. Exposure evaluation included delineating areas of specific use on the campus, as well as the types of activities, exposure durations, and populations that have access to the areas. Currently providing technical and scientific support as needed.

Human Health Criteria Development using 2000 Human Health Criteria Methodology for U.S. EPA. (Nationwide). (2/2015-5/2018) Supported EPA in updating the human health ambient water quality criteria for 94 chemicals published in late 2014 and researched bioaccumulation factors (BAFs) using EPA's 2000 *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health* and its 2003 *Technical Support Document Volume 2: Development of National Bioaccumulation Factors*. Conducted a systematic review of peer-reviewed available literature and peer-reviewed public toxicology databases to obtain data to update the BAFs, as well as conducting research of peer reviewed sources to update the relative source contribution (RSC) values used in the 2014 criteria. Also helped provide exposure information to support relative source contribution values using the decision tree in EPA's 2000 Methodology and is currently assisting in producing BAFs and AWQC for 24 metals (including arsenic) and persistent organic pollutants.

Policy Briefings and Update to Human Health Ambient Water Quality Criteria Methodology Document for U.S. EPA (Nationwide). (9/14-1/15). Assisted in reviewing toxicological information, exposure factors, relative source contributions, and bioaccumulation potential of the contaminants included in this project. Provided technical input to the methodology recommendations that included recommendations for using human surveillance data as an input in the development of human health criteria, identification of exposure factors, and determination of exposure factors to appropriately assess minority and low-income populations engaged in subsistence fishing practices. Reviewed the use of NHANES data for determining fish consumption rates for this project and provided technical review of several issue papers and briefings discussing options for calculating different exposure factors, use of probabilistic methods for deriving criteria, and developing technically defensible approaches for filling critical data gaps.

Computer Program to Evaluate Risks from Residential Indoor Water Use, Agency for Toxic Substances and Disease Registry (ATSDR). (6/15-8/17). Assisted in providing exposure and risk assessment support in the development of a desk top computer application to assess potential risks associated with volatile organics and other compounds from the use of contaminated groundwater for showering, bathing, and other household residential uses. Provided input to the assessment of inhalation and dermal exposures, as well as consideration of background exposure concentrations in ambient air. Performed detailed QA/QC of the model through numerous test runs of each exposure scenario for various chemicals and concentrations. Reviewed EPA databases, including the TRI, to determine if a component could be added to this program to incorporate anthropogenic sources to address background concentrations.

Human Health and Ecological Risk Assessment, Treasury Metals, Goliath Mine, Ontario. (6/2014-6/2016). Provided oversight of the Screening Level Risk Assessment (SLRA) for a Proposed Mine Site in Ontario in support of the Environmental Impact Statement, which included a preliminary human health risk assessment and assessment of ecological health risks associated with potential exposures to dust, tailings, waste rock, and mine effluent in the operational and post-closure phases of the proposed mine. Performed the human health risk assessment using guidance from Health Canada, and relied upon site assessment and chemical of concern selection performed using guidance from Environment Canada's Federal Contaminated Sites Action Plan (FCSAP) and Canadian Council of Ministers of the Environment (CCME) as well as Ontario's Provincial Water Quality Objectives (PWQO) and CCME's Water Quality Guidelines. Performed a country foods risk assessment to determine risks from exposures through food items harvested from the proposed mining site during both the operational period and post-closure phases, focusing on mercury and lead. Also attended three public meetings on behalf of the mine proponent to discuss human health risk concerns with the community and First Nations members.

Human Health Risk and Dose Assessment Review, United States Forest Service, Sundance, Wyoming. (1/2014-6/2015). Provided a review of the radiological dose from rare earth mining at this proposed mine site. Performed radiological and nonradiological human health risk assessment for the proposed mine based on the Plan of Operations and baseline studies to date, including soil, ore, air, and water data. Provided calculations and predicted risks and hazards from the estimated heavy metal releases from mining operations combined with ore concentrations, rare earth recovery rates, transportation concerns, and radiological dose. Assigned estimated risks to both the operational and post-closure site conditions as determined in the Plan of Operations as part of this predictive risk assessment. The reports are under consideration as part of the Environmental Impact Statement (EIS) process and permitting processes related to mining and radiological material handling.

Human Health Risk Assessment of Metals and Radionuclides, United States Forest Service, Riley Pass, South Dakota.). (4/2015 – 1/2018). Reevaluated 2006 risk assessment and risk-based cleanup goals for arsenic, molybdenum, copper, radium-226, uranium, and thorium at a former uranium mine. The risk-based cleanup goals focus on site-specific receptors as determined by the U.S. Forest Service and land use patterns of Native Americans for the site. In addition, reevaluated food ingestion pathways related to hunting and ranching in developing updated risk-based goals. Currently, providing risk assessment input to the clean-up actions being performed at the Site.

Risk-based Remediation Goal Calculations, State of Montana, Grant Kohrs Remediation Site. (12/2014-2/2015). Calculated site-specific remediation concentrations for soil to remediate heavy metals, including arsenic, from former mining releases at a currently used recreational area. Evaluation and calculations involved identifying site-specific exposure parameters for different areas of the site based on usage patterns of different occupational and recreational receptors, and were used by the State to guide remediation of the site.

Human Health Risk Assessment, Ross Adams Uranium Mine, Newmont Mining, Prince of Wales Island, Alaska. (8/2009 – 6/2016). Responsible for human health screening evaluation of data from inactive mines, mine roads, shoreline area, and surrounding marine area. Environmental media of interest include soil, surface water,

stream sediment, and marine sediment. Determined the background dataset and selected chemicals of potential concern (COPCs) for different media and locations throughout the mine area; the selected COPCs (uranium, thorium, arsenic, and lead) formed the basis of both the human health and ecological risk evaluations. Included food ingestion pathways related to hunting and gathering activities in the risk assessment for both terrestrial and marine foods. Evaluated historical data to provide recommendations for future sampling and analysis, as well as to define the conceptual site model to be used to assess human health risks.

Human Health Risk Assessment of Lead Exposures, Confidential Client, Former Mining Site, Colorado. (2011). Conducted a risk assessment for school-aged children exposed to lead in soils from historical mining activity. Results of the risk assessment determined the acceptability of continuing to use the site for a school, as well as the need for any alteration in plans to renovate and expand the existing school grounds.

Human Health Risk assessment in Support of Permitting, Sheep Mountain Uranium Mine, Titan Uranium, Jeffrey City, Wyoming. (2011). Responsible for input regarding impacts to human health in application for NRC license, including portions of the Environmental Report regarding public and occupational health impacts from the preferred alternative. Assisted health physicists in incorporating information from their evaluations into appropriate sections of the Technical Report and Environmental Report that were submitted to the NRC.

Environmental Sampling QAPP, Cameco, Wyoming. (2011). Prepared a draft Quality Assurance Project Plan (QAPP) for the Smith Ranch-Highland Uranium Project (SR-HUP) facility that included environmental sample collection and laboratory procedures for environmental samples. Report included data quality assurance procedures, quality control specifications, and other technical activities that assure that the data collected at SR-HUP meet appropriate data objectives and protocol per NRC guidance.

Screening Level Evaluation of an Off-site Relocation of the Large Tailings Pile, Homestake Mining Company, Grants Site. (2012). Compiled and evaluated of costs and risks associated with moving a large tailings pile from the Site to an off-site location. The purpose of the report was to explore costs, efforts, and regulatory requirements to be met under the alternatives of continuing with the current remediation and reclamation strategy or a hypothetical move of the tailings pile to a location outside of the San Andres Aquifer basin and the Village of Milan. For costing purposes, a distance of 30 miles for relocation was chosen in this evaluation. Costs, impacts, and potential risks of the off-site removal were evaluated to assist in long-term remediation decisions.

TENORM Dose Assessment, Waste Management of Colorado. (9/2017-5/2018). Provide radiation dose assessment for 2 landfills and one solidification plant in Colorado. Used site-specific inputs to provide dose assessment for current workers and future hypothetical resident farmers at the Sites, and to support alternative disposal limits for technologically enhanced naturally occurring radioactive material (TENORM).

Human Health Risk Assessment, American Bumper and Plating, Missoula, Montana. (2/2015-2/2016). Responsible for calculating risks and hazard indices associated with residual metal impacts in soils for potential current and future receptors. Evaluation included site-specific exposure pathways of soil ingestion, dermal contact, and inhalation of particulates by adult and child receptors, as well as an evaluation of the acceptability of lead concentration in soil for each of the four areas of the Site that were sampled and, in some cases, remediated.

Review of Subsurface Vapor Intrusion Model and Risk Assessment, Lockheed Martin Corporation, Torrance, California. (2011). On behalf of LMC, conducted an internal review of a human health risk assessment for the site related to subsurface vapor intrusion from a large, heterogeneous groundwater plume in several hydrogeologic formations. Identified potential issues surrounding the vapor intrusion modeling used, as well recommending a revision of the selection of chemicals of concern. Identified potential issues for LMC from calculating risks associated with non-detected chemicals and recommended a different approach to assessing non-detect data.

Human Health Risk Assessment, Department of Toxic Substances Control, Los Angeles, California. (2/2010 – 5/2010). Assisted in conducting a human health risk assessment for Chatsworth Park South, a park owned by the City of Los Angeles that had residual contamination from former skeet shooting activities. Assessment included metals related to dissolved lead pellets and PAHs from clay pigeons in shallow soil. The risk assessment will be used to guide remediation activities to re-open the facility.

Human Health Risk Assessments, Los Angeles Unified School District, Los Angeles, California. (2005-2010). Task leader for conducting risk assessments for proposed school sites in the greater Los Angeles Area. Environmental contamination assessed varied by site, but included petroleum products, pesticides, and heavy metals. In general, soil was the medium of interest and both direct and indirect exposure pathways were of concern. Provided risk assessments that focused on school-based and residential receptors to conform to California

guidance. In some cases, investigations were required at existing schools; in these cases, provided an evaluation of indoor exposure to impacted air or dust to current receptors. Data from these projects was shared with Department of Toxic Substances Control to establish a regional background concentration of arsenic in soil, which is still in regulatory use in the greater Los Angeles area.

Radiation Dose Reconstruction, Oak Ridge Associated Universities, Various Sites. (2003-2009). Reviewed historical documents and estimated potential occupational medical radiation exposures at former nuclear weapons facilities as part of the U.S. Department of Labor's Energy Employees Occupational Illness Compensation Program Act (EEOICPA). Duties included site research of former nuclear facilities and reconstruction of occupational medical practices at each facility that would contribute to worker radiation exposures. Dose reconstruction project at former nuclear weapon facilities was conducted as part of CDC's National Institute for Occupational Safety and Health program to facilitate their response to concerns of DOE workers and contractors requesting compensation for radiation-related cancers resulting from work-related exposure.

Human Health Risk Assessments, Naval Air Station Moffett, Naval Air Station Alameda, Naval Air Station Lemoore, Naval Air Weapons Station China Lake, Naval Auxiliary Landing Field Crows Landing, Naval Fuel Depot Point Molate, and Naval Station Treasure Island, California. **(1996-2000)**. Task Leader for Risk Assessment of propellants, explosives, jet fuel, diesel, and gasoline releases to soil and groundwater and the potential to migrate to surface waters. Integrated ASTM Risk based Corrective Action (RBCA) processes and the California RWQCB's guidance documents, developed methods for screening potentially hazardous components. Method proved to be cost effective by allowing use of all data collected and decreasing the cost of confirmation sampling. Successfully negotiated site specific approach to evaluating volatilization into buildings, resulting in lower site specific air concentrations and cost savings by avoiding expensive air sampling. Site specific environmental conditions were used to demonstrate an increased rate of degradation of the components.

Human Health Risk Assessments, Naval Air Station Lemoore, Naval Air Station Alameda, Naval Air Weapons Station China Lake, Naval Air Station Moffett and Naval Auxiliary Landing Field Crow's Landing, California. **(1996-2000)**. Task Manager for oversight of human health risk assessments and statistical programs, including evaluation of exposure scenarios and pathways; validation of toxicity values and calculated risks; negotiation of appropriate exposure areas based on current and future land use plans for the base and surrounding communities; statistical evaluation of several data acts; selection of chemicals of concern from combined data sets; and estimation of risks using several data aggregation methods. Evaluated exposure concerns including migration of contaminants from soil to groundwater and surface water. Chemicals of concern included chlorinated pesticides, herbicides, volatile organic chemicals, semi-volatile organic chemicals, metals (including arsenic), TPH, dioxins, furans, and perfluorinated compounds. Provided risk analyses of many different environmentally contaminated areas, including landfills, pesticide/herbicide storage, mixing, and application areas, industrial complexes, artillery ranges, and areas impacted by runoff or groundwater infiltration from these sites. Developed confirmation sampling plans for several sites based on grid sampling patterns and statistical methodology, as well as deriving risk-based concentrations for remediation and compliance studies involving PCBs, pesticides, and explosives.

Technical Support for Human Health Risk Assessments, U.S. Environmental Protection Agency. **(1992-1996)**. Provided technical support on epidemiology, public health, and statistical issues to EPA's RCRA/CERCLA program as part of a technical enforcement support (TES) contract. Conducted technical reviews of human health risk assessment documents submitted to EPA to evaluate compliance with CERCLA guidelines. Also reviewed work plans, technical memoranda, and risk assessments submitted to EPA regarding RFETS. Provided oversight for RFETS, and assisted EPA in the development of Monte Carlo simulations for the site. Acted as EPA's representative in negotiating all phases of risk assessments for Rocky Flats, including sampling procedures, data evaluation, exposure scenarios and pathways, chemical intake assumptions and risk characterization. RFETS risk assessments included radionuclides and nonradioactive chemicals such as heavy metals, polycyclic aromatic hydrocarbons, and solvents. Also provided technical oversight in EPA Region VIII include F.E. Warren Air Force Base in Wyoming; Tooele Army Depot in Utah; and Hill Air Force Base in Utah. Project Manager and provided technical oversight for human health and ecological risk assessments at Amoco Mandan Refinery, a RCRA site in EPA Region VIII.

PUBLICATIONS

Peer-Reviewed Journal Articles

Hays, S., C. Kirman, J. Flippin**, T.K. Lopez.** Biomonitoring Equivalents for Ethylene Thiourea. Regulatory Toxicology and Pharmacology 150 (2024) 105618.

Hays, S., C. Kirman, J. Flippin**, T.K. Lopez.** Biomonitoring Equivalents for Glyphosate. Regulatory Toxicology and Pharmacology 144 (2023) 105481.

Lopez T.K., K. Jones, A. Roseberry-Lincoln, A. Zidek, L. MacKinnon, L. Marro**.** Adult and children's use of Hand sanitizer during a pandemic - an observational study. Journal of Exposure Science and Environmental Epidemiology, September 24, 2022. DOI 10.1038/s41370-022-00479-w.

Lopez, T.K., J.A. Marshall, S.M. Shetterly, J. Baxter, R.F. Hamman, 1995. Ethnic Differences in Micronutrient Intake in a Rural Biethnic Population. American Journal of Preventive Medicine, 11:301 305.

Marshall J.A., **T.K. Lopez**, S.M. Shetterly, J. Baxter, and R.F. Hamman, 1995. Association of Education Level with Atherogenic Diets in Rural Biethnic Population. American Journal of Preventive Medicine, 11:294 300.

Baxter J., R.F. Hamman, **T.K. Lopez**, et al., 1993. Excess Incidence of Known Non Insulin Dependent Diabetes Mellitus (NIDDM) in Hispanics Compared with Non Hispanic Whites in the San Luis Valley, Colorado. Ethnicity and Disease, 3(1):11 21.

Conference Presentations

Session Lead and Presenter, 2024. "The Intersection of Human Health and Environmental Risk Assessment: A One- Health Perspective." Society for Environmental Toxicology and Chemistry. Fort Worth, Texas, October 20-24, 2024.

Poster Presentation, 2022. Society for Risk Analysis Annual Meeting, Tampa, Florida, December 4-8, 2022. "**Optimization of Infrastructure Placement Using a Novel Disease Burden Reduction Model Using Public Health Data to Save Lives through Informed Engineering Design."**

Platform Presentation, 2019. Society for Environmental Toxicology and Chemistry, Helsinki, Finland. May 29, 2019, **"Applying a "One Health" Approach to the Assessment of PFAS: Opportunity to Prevent Unintended Consequences."**

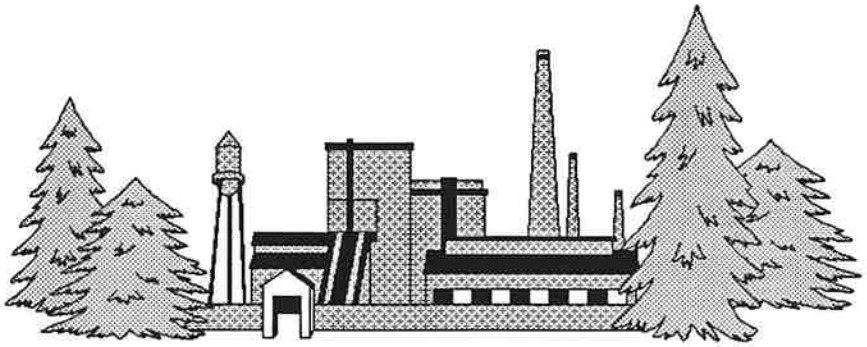
Poster Presentation, 2018. Society for Environmental Toxicology and Chemistry, Sacramento, CA, November 6, 2018. **"Applying a "One Health" Approach to the Assessment of PFAS."**

Poster Presentation, 2017. Society for Risk Analysis Annual Meeting, Arlington, VA, December 11-13, 2017. **"Alternate Approach to Deriving Metals Bioaccumulation Factors in Fish."**

5318

IDAHO DIVISION of

ENVIRONMENTAL QUALITY



MONDAY, JULY 13, 1992

Our Goal for Air Toxics Policy/Rule Making:

To protect the public health and the environment from the harmful effects of toxic air pollutants (TAP) per our responsibilities set forth in IDAPA 16.01.1011,01 and 1601.1952,02. and provide regulated industries with a reasonable, flexible, minimally burdensome framework with which to work.

Our Goal for this meeting:

To successfully negotiate air quality rules revisions that will satisfy the regulated industries need to have reasonable, flexible regulations that do not place an unwarranted impediment to their ability to do business in Idaho, while at the same time providing adequate protection to the public from the harmful effects of TAP. We hope that these revisions will provide industry with an awareness of what DEQ considers harmful and provide the basis for a straight forward and efficient permitting process.

Brief History of the DEQ TAP List

The DEQ TAP list (hereafter referred to as the list), was conceived as part of the New Source Review Policy, which was a response to the need to control the emissions of airborne toxic chemicals in the absence of effective EPA regulations. NESHAP (National Emmision Standards for Hazardous Air Pollutants, §122 of the 1970 Clean Air Act) had proven to be an ineffective means of of controling TAP as only seven pollutants were ever regulated after 17 years of the NESHAPS program.

It was the position of the DEQ that given the resources that we had available to us, that we would only attempt to hold the line on air quality and try to insure that new sources of air pollution did not "injure or unreasonably affect human or animal life or vegetation." One of the principal ways that we chose to do this was the development of a comprehensive list of TAP and, where possible, health based emissions limits and or acceptable ambient concentrations.

Our list was developed from a combination of sources. We surveyed what other states were doing and found that New Mexico had the most logical, straight approach to air toxics. The New Mexico list was chosen as the basis for our own TAP list. In addition, we looked at the Occupational Health and Safty Administration (OSHA), American Conference of Government and Industrial Hygenests (ACGIH) and National Institute for Occupational Safty and Health (NIOSH) occupational exposure limits (OEL) and threshold limit values (TLV) for non-carcinogens. For carcinogens we looked at the

data from the International Agency for Research on Cancer (IARC) and the Carcinogen Assesment Group of the EPA (CAG). In addition, we reviewed data from the Agency for Toxic Substances and Disease Registry of the Public Health Service. As many who have received periodic updates know, we have tried to continuously refine the list to reflect new data and to correct inaccuracies.

The DEQ list of regulated air toxics is quite large in scope. However, this was not done to burden industry. Quite the contrary. It was done in order, to the maximum extent possible, to provide industry with a ready reference to acceptable screening levels of these various compounds. This enables new sources to review their processes and see if controls, may be needed early on in the planning process, there by maximixing start up budget planning. In addition, it allows existing sources to review their emissions and see how they compare to the screening levels that the DEQ considers reasonably protective of human health and the environment. Please see appendix 6 for the derivation of emissions limits (EL) and acceptable ambient concentrations (AALC).

DEQ Position on the EPA "198" List

The EPA list of 189 compounds to be regulated represents a political process by the congress, rather than being put together by any environmental agency. This list is inadequate in and of it self to protect the air quality of Idaho or other specific location in the nation. This opinion is based on the following:

* The EPA 189 list is not an attempt to protect people or the environment of any specific area but a compromise list to address some of the major nation-wide sources of air pollution. The original proposed list contained 224 compounds, including ammonia and hydrogen sulfide which were later removed. We do not believe that this nation-wide effort can be effectively applied to Idaho and be adequate to address the unique Idaho situation. All along, EPA admitted that their agenda was not to protect all communities completely, rather their intent and design has been to address only pollutants and source catagories that are national in scope.

* The EPA 189 list does not include all the well documented carcinogens that have been assigned unit risk factors[1], let alone most possible and suspected carcinogens as listed in DEQ Appendix A2 of the New Source Review Policy. State and local agencies need to have the flexibility to protect public health by regulating the emission into the air of these very dangerous compounds should they be present locally.

* From only a partial inventory, we have found that there are currently being emitted into the ambient air of Idaho three known or suspected carcinogens which are not addressed by the EPA 189 list. In addition there are about 35 non-carcinogens of varying toxicity levels currently being emitted or being reviewed for new source permits.

* While it is not possible to predict the future, in a fast growing state like Idaho it is very reasonable to assume that new industries will be moving to Idaho as our work force expands with new residents. In addition, as environmental regulations in California and other states become more restrictive, Idaho will look more attractive to many of these regulated industries. This is already occurring in Nevada. While we certainly want the jobs and incomes that these industries may represent, just as certainly, we do not want to become a "toxic magnet" for polluting industries that other states don't want.

---

[1] Unit Risk Factors for a known or suspected carcinogen describes the possibility of developing excess cancers over a 70 year lifetime of exposure to 1 microgram per cubic meter of that substance.

* Title III of the Clean Air Act Amendments of 1990 (CAAA) requires EPA to publish a list of source categories and then promulgate maximum achievable control technology (MACT) for the first 40 categories. MACT standards are then required for the rest of the categories on a phased in schedule. Even if this time schedule was adhered to, the first MACT standards would not be available before November of 1992. Without its own TAP policy or rules and regulations, Idaho is thus without any appropriate air toxics regulation until EPA is finished. EPA is already late in publishing the first source category list.

* If a particular source in Idaho is not addressed in the first 40 source categories, the DEQ could be unable to address toxic emissions from that source no mater how toxic the emissions might be or in what quantity the emissions may be emitted until EPA finally promulgates MACT standards. Given the past history of EPA deadlines, this is a very real concern. Even if EPA adhered to all deadlines, some sources would conceivably still be able to emit unregulated toxics until the year 2000, if that source was in the last group to have standards promulgated. It should also be noted that not all sources are covered by these MACT standards. As a consequence, sources not covered by this MACT standard would be essentially unregulated in Idaho. Further, the majority of covered sources are associated with surface coating and manufacturing of the regulated chemicals, while fore most sources of TAP in Idaho, the TAP in question is used in or produced as a by-product of their processes.

* Finally, Congress itself apparently felt that this list was not final. Congress required the EPA to periodically review the list and add pollutants "...which present or may present ...a threat of adverse human health effects (including but not limited to, substances which are known to be, or may be reasonably be anticipated to be, carcinogenic, mutagenic, teratogenic, neurotoxic, which cause reproductive dysfunction, or which are acuity or chronically toxic) or adverse environmental effects..." The EPA 189 list should be considered to be a starting point for toxics regulations.

* It is not the intent of DEQ to require sources to do an emissions inventory of every compound on the DEQ list. It is quite reasonable to assume that any source, including the small sources, be familiar with their own processes. There are common, readily available sources of information, such as Material Safty Data Sheets (MSDS)[2] that will assist a source

---

[2] MSDS provides data concerning the nature and concentrations of hazardous or toxic components of substances used by a source. These sheets are available from the manufacturers of all compounds with hazardous or toxic components.

to ascertain what compounds can be reasonably assumed to be present in their process. They then need only inventory those compounds that can reasonably assumed to be emitted. In addition, the DEQ will be happy to assist sources in identifying potential TAP.

Some Options for Discussion

Option 1: Maintain current situation.
Pros: Would, of course, make DEQ happy; require no further legislation; all ready in place and functional.
Cons: Could make several in industry unhappy; may be seen as burdensome by industry; a policy is not as clear as a standard.

Option 2: Go with Maximum Achievable Control Technology (MACT) as per the 1990 CAAA or Best Available Control Technology (BACT) or Lowest Achievable Emissions Reduction (LAER) or Adaqualtly Demonstrated Control Technology (ADCT) or some other control technology based standard.
Pros: No EL or AALC; single consistent standard.
Cons: MACT/BACT etc. difficult to define: must be industry and chemical specific; lack flexibility esp. for relatively "clean" industries; no provision for new pollutants; may not adequately protect human health and the environment, esp. in the case where MACT/BACT has not been defined for various toxic chemicals.

Option 3: Regulate EPA "189 List" only
Pros: Would reduce the list in size; could possibly speed up permitting process
Cons: Not protective enough of human health and the environment; lacks flexibility; would not address many pollutants that are commonly emitted by modern industry; no provision for new pollutants; somewhat pointless as the EPA is already doing it; could complicate and slow the permitting process by increasing public comment over pollutants not covered.

Option 4: Regulate EPA "189 list" plus currently known TAP
Pros: list would be somewhat shorter and simpler;
Cons: no provision for adding new pollutants; could require more extensive and costly emissions inventories.

Option 5: Regulate EPA "189 List" plus any thing that has been identified elsewhere as toxic, hazardous or a carcinogen
Pros: Would be comprehensive; would regulate only pollutants that have been demonstrated to be of concern; would be similar to current policy, require little or no new legislation;
Cons: Could be a large list; May be seen as burdensome by some in industry; no provision for adding pollutants.

Option 6: Develop a series of "source specific" TAP lists
Pros: Would be easier for specific industries to know what to report on; A number of useful references available See Appendix 9.
Cons: Could require emissions inventories of some regulated industries; no provision for variation among industries of the same type; MSDS will not reflect bi-product compounds.

Option 7: Options 1 and 3 through 6 with the addtion of a method out side of DEQ to add TAP to lists. (Pros and Cons would, of course depend on the method for adding to the list, but in general, a board or review panel of some sort seems to be a common notion.)
Pros: Would provide DEQ with industry input on additions to lists; would provide DEQ with industry input on standards; would provide DEQ and industry with input by public interest groups;
Cons: Could slow down the process of adding new toxics and there for probably slow down the permitting process because of the public particapation process; could cause a political battle over the structure of the addition process; could convert the health based process for additions to list into a political one; depending on the make up of the committee/board, could be less protective of the public health.

Appendix 1

The following are known or possible carcinogens that have a URF but are not listed by EPA on the list of 189 toxics but are listed on Appendix A2 (carcinogens)

Aldrin* insecticide
Bis(2-chloroethyel)ether solvent
chloromethane methyl chloride
DDT insecticide, most uses banned; used for Tussock moth
1,2-dibromoethane solvent chemical industry
1,1-dichloroethane solvent
1,2-dichloroethane degreaser, ore flotation, solvent, paint, finish removers
1.1-dichloroethylene solvent
Dieldrin* insecticide
diethylstilbestrol synthetic estrogen
dimethylnitrosamine solvent
heptachlor epoxide insecticide
hexachlorodibenzo-p-dioxin (1:2 mixture) Possible. herbicide, a contaminant, poison
hydrazine sulfate mineral analysis, determination of arsenic in metals, fungicide, fumigant
3-methylcholanthrene biochemical research
N-nitroso-n-butylamine**
N-nitrosopyrrolidine**
pronamide herbicide
reserpine antihypertensive [lowers blood pressure], tranquilizer
thiourea photography, analytical reagent chemical intermediate

* part of current permit analysis at INEL Chem. Lab.
** no reference located
Benzo(a)pyrene, dibenz(a,h)anthracene, chrysene and other polynuclear aromatic hydrocarbons can be regulated under polycyclic organic mater (POM) which, as a category, is listed on the EPA list of 189.

Only two of these chemicals are currently under review. However, many of these chemicals are solvents which would seem to have the potential for use in industries common to Idaho (light manufacturing, electronics and so forth).

Appendix 2

The following are carcinogenic substances that are or have been reviewed in conjunction with permit applications in Idaho. These substances are not on the EPA 189 list but are on Appendix A2 (carcinogens):

Aldrin and **Dieldrin** as noted above
dimethyl sulfide from craft pulping black liquor

Appendix 3

The following are non-carcinogenic substances that are or have been reviewed in conjunction with permit applications in Idaho. These substances are not on the EPA 189 list but are on Appendix A1 (non-carcinogens): Note: many of these compounds are on the EPA Extremely Hazardous substances list, and the Community Right to Know list.

hydrogen sulfide: rotten eggs smell, human poison by inhalation, severe irritant, violent reaction with various metals & chemicals
methyl mercaptan: poison by inhalation,
turpentine: toxic by inhalation, irritant, experimental tumorigen
methanol: toxic by inhalation, experimental teratogen, reproductive effects, human mutagenic data.
fluorine: toxic by inhalation, irritant, mutagenic data
aluminum: possible cause of pulmonary fibrosis by inhalation
copper: tumorigen, teratogen, experimental reproductive effects
iron: potentially toxic by inhalation (arc welders lung)
magnesium: toxic by inhalation
zinc: relatively nontoxic
terphenyl: little toxicological data available
nitric acid: poison, corrosive, experimental teratogen and reproductive effects
isophorone diiysocyanate: poison by inhalation,
methyl ethyl ketone peroxide: moderately toxic by inhalation, experimental tumorigen
cyclohexanone: moderately toxic by inhalation, irritant
acetone: moderately toxic by various routes, irritant
hydrogen peroxide, 90%: moderately toxic by inhalation, skin contact, corrosive irritant, experimental tumorigen, suspected carcinogen
dimethyl disulfide: poison by inhalation
dimethyl sulfide: volitile liquid, gas odorant, solvent

Appendix 4

The following are non-carcinogenic substances that are or have been listed on the Toxic Release Inventory (TRI)[3] for Idaho. These substances are not on the EPA 189 list but are on Appendix A1 (non-carcinogens). Note: many of these compounds are on the EPA Extremely Hazardous substances list, and the Community Right to Know list.

sodium hydroxide: corrosive irritant, mutagenic data
methanol: toxic by inhalation, experimental teratogen, reproductive effects, human mutagenic data.
nitric acid: poison, corrosive, experimental teratogen and reproductive effects
hydrofluoric acid: human poison by inhalation, corrosive irritant, experimental teratogenic, reproductive effects, mutagenic data
chlorine: Moderately toxic by inhalation, irritant, human mutagenic data
ammonia: experimental poison by inhalation, irritant, mutagenic data
phosphoric acid: human poison, corrosive irritant
copper: tumorigen, teratogen, experimental reproductive effects
Methylene diphenyl diisocyanate (MDI): poison by inhalation, irritant, mutagenic data
Freon 113: most uses will be fazed out by 1995
ammonium sulfate: moderately toxic by several routes
ammonium nitrate: powerful allergen
zinc compounds: relatively nontoxic
barium compounds: low toxicity
hydrochloric acid: poison by unspecified route, mildly toxic by inhalation, corrosive irritant
manganese compounds: toxic by inhalation

The following substances are non-carcinogenic substances that are being reviewed in conjunction with permit applications or field inspections. These substances are not on the EPA 189 or currently on the DEQ list. ***This points out the need to be able to respond to changing circumstances.***

Acenaphthylene: irritant, mutagenic data
Amino functional Siloxane: organosilicon oxide polymer, mild to severe irritant
Busan 1127D (2-(thiocyanomethylthio)benzothiazole): mist is considered moderatly to highly toxic.
Carbitol Acetate (2-(2-Ethyoxyethoxy) Ethyl Acetate): solvent and placticizer
dimethyl disulfide: poison by inhalation

---

[3] The TRI is a report of all emissions of compounds required to be disclosed under SARA Title III.

Appendix 5

The following are examples of sources now existing in Idaho that have air releases of substances not on the EPA 189 list:

American Micro systems Inc.
Basic American Foods
Blount Industries
Borden Inc. Dairy
Del Monte Foods USA #130
Deming Industries
Fiberglass Systems Inc.
FMC Corp.
Gustafson
Hewlett Packard
IBP Inc.
INEL
J.R. Simplot
J.R. Simplot Food Di.
John E. Quinn
Kerr McGee Vanadium Facility
Kraft Inc.
MIcron Technology
Monsanto
N.A Degerstrom Inc.
Nu-West Industries Inc
Ore-Ida Foods
Peabody Spunstrand
Penford Products Co.
Pondarosa Paint Mfg. Inc.
Post Falls Particalboard
Potlatch
Spears Manufacturing Inc.
Unitech Composites Inc.
Zilog

Appendix 6

In developing emissions limits for new permitted facilities, the Idaho DEQ uses the terms Unit Risk Factors and Threshold Limit Values. The following is an explanation of these terms and how they are used.

UNIT RISK FACTOR

A unit risk factor (URF) is used to describe the possibility of developing excess cancers over an average 70 year lifetime. This is based on being exposed to concentration of one microgram of a carcinogenic (cancer causing) substance in one cubic meter ($1\ ug/m^3$) of air over 70 years. The term excess cancers means cases of cancers in excess of what would be normal for a given population. For example, if there was normally 5 cases of a given type of cancer in Anytown USA before a given exposure to some substance and 7 after the exposure, there would be 2 excess cancers.

Inhalation URFs are developed for carcinogenic substances by the EPA. Each URF represents months of research and often years of policy process. Teams of toxicologists gather toxicological data for each known or suspected carcinogen. The available data are then rated or point factored per the quality of the research involved. A URF is then a probability statement derived from this process. Each URF proposed by EPA is extensively reviewed and debated in public by scientists, health officials and industry representatives. Every URF represents a consensus of the best science and health opinion of the potency of a given carcinogen.

URFs are usually expressed as a number times 10 to some negative power. For example, benzene, an organic hydrocarbon found in various petroleum products and cigarette smoke has a unit risk factor of 8.3×10^{-6}. This means that are 8.3 chances in one million of getting cancer if a person is exposed to $1\ \mu g/m^3$ 24 hours a day for 70 years.

Another example would be asbestos. Asbestos has a URF of 2.3×10^{-1}. That means that if exposed to $1\ ug/m^3$ concentration for 70 years, the chances of getting cancer would be .23 in 10.

Within IAQB New Source Review (NSR) policy, URFs are used to calculate acceptable ambient levels for a given carcinogen. IAQB generally establishes that an ambient concentration which causes no more excess cancers than one in a million (1×10^{-6}) is acceptable. Once an acceptable ambient level is established, IAQB can then back calculate via engineering equations to an acceptable emission rate (in pounds per hour) for a given stack.

THRESHOLD LIMIT VALUE

Threshold Limit Value (TLV) is a time weighted exposure limit developed by the Occupation and Safety Administration or the American Council of Government Industrial Hygienists. This value is used to limit the exposure of informed workers to a given toxic substance in the work place. The value is based on exposure of adult males working an eight hour shift. The DEQ uses TLV information to screen proposed new source emissions levels. The DEQ divides the TLV first by a value of 10 due to the fact that an ambient air exposure of a carcinogen means people are usually living under that exposure longer than eight hours out of 24. This value is then again divided by 10 to compensate for the fact that not everyone who is potentially exposed is an adult male. Other people may be more sensitive. The TLV thus is divided by a total of 100 for use in setting an acceptable ambient level.

For example, the TLV for cyanide is 5 milligrams per cubic meter (mg/m^3). An acceptable ambient level under DEQ policy would be 5 divided by 100 or 0.05 mg/m^3. For another example, the TLV for Lindane (an insecticide) would be 0.5 mg/m^3 concentration. The acceptable ambient level would be 0.5 divided by 100 or 0.005 mg/m^3. As with carcinogens, the TLV derived acceptable ambient levels are used by the DEQ engineers to back calculate an acceptable stack emission rate for any proposed new source.

EL and AAL(C) as listed in the TAP list are *screening levels*, not standards. If a proposed source, at any level of review is shown to be under the screening level for the TAP in question then the source goes forward in the permitting process. If, on the other hand, the source is shown to likely exceed the screening level, then there is a number of options such as further analysis or enhanced controls that can be pursued. See: Idaho DEQ Procedures for Modeling Impacts of Toxic Air Emissions and Assessing Associated Risk Appendix 7, and the General Summary of DEQ's New Source Review Policy for Toxic Air Pollutants, Appendix 8 for a more complete discussion of this topic.

APPENDIX 7

DRAFT

Idaho DEQ Procedures for Modeling Impacts of Toxic Air Emissions and Assessing Associated Risk

Procedures for modeling the dispersion of air emissions are consistent for criteria pollutants and toxics.

Emissions are calculated for the specific operation, with EPA's AP-42 as the standard guidance document. Impacts for any toxic air pollutant (TAP) emitted in potentially significant amounts are estimated through a three tiered evaluation approach, using the Division of Environmental Quality (DEQ) TAP list and models approved by EPA for regulatory use.

The emissions screening levels as listed on the DEQ TAP list are a quick way to determine if modeling is needed. If a toxic air pollutant has the maximum potential to be emitted at levels below the screening emission level, the proposed emission is typically approved by the DEQ.

If the maximum potential emissions are above the screening levels, then modeling is performed. The models most commonly used for the first modeling run are TSCREEN and SCREEN for single emission points, or ISC with worst case meteorological data for multiple emission points. In "screening modeling", quantified emissions and stack (or fugitive) data are required, as well as distance to property boundary or, with DEQ approval, an off site receptor. Estimates of off site concentrations of the pollutant(s) are output by the model, which assumes a variety of worst case dispersion conditions. Model output is typically in one hour averages. Persistence factors are usually used to estimate worst case impacts for other averaging periods. Unit risk factors are then applied to translate the predicted off site concentrations to determine risk to those exposed.

If, after "screening modeling", unacceptable risks still are shown to be possible, refined modeling may be done. Refined modeling replaces many worst case assumptions in screening modeling with actual conditions. In refined modeling, a more realistic three dimensional simulation of emissions, topography, meteorology, and receptors is supplied. Actual on site meteorological data typically helps the applicant, since the alternative is a worst case meteorological data file like that used in screening modeling. The most commonly used models are ISC, COMPLEX1, and FDM. Refined modeling provides the most detailed and accurate assessment of potential air quality impacts.

After ambient concentrations are determined, these ambient levels are, in the case of known or suspected carcinogens (TAP list Appendix A2), converted to annual concentrations using persistence factors as mentioned above. They are then multiplied by the EPA

unit risk factor (URF) to obtain a risk level. A risk level of one in a million is generally considered acceptable for a long term or permanent emissions source. The acceptable ambient levels for a carcinogen (AALC) listed in the TAP list Appendix A2 reflect this one in a million risk level for carcinogens with established URFs.

For short term sources (usually less than five years in duration), such as remediation projects, a probability of greater than one in a million risk (over a 70 years) will generally be acceptable to account for the decreased term of exposure. It is not acceptable however, for exposed individuals to receive a full 70 year exposure during the life of a short term project. In addition, first impacts at receptor sites farther from the source than property boundaries may be considered for short duration projects.

For non-carcinogens (TAP list Appendix A1) the risk assessment procedures are similar. Ambient concentrations are compared with 1/100 of the published American Council of Government and Industrial Hygienists (ACGIH) Occupational Exposure Limits (OEL) or other ambient standard adopted by the DEQ in the absence of a published ACGIH OEL.

The 1/100 factor was derived to accommodate two levels of extrapolation of potential risk to the general public:

1. ACGIH factors assume an eight hour exposure; source exposures are generally continuous (24 hrs.).

2. ACGIH factors are derived from historical data that comes essentially from a work force of healthy adult males.

Thus we have used an uncertainty factor of 100 (10X for each of the above conditions) to accommodate the more sensitive populations.

In the absence of any published URF or OEL. the acceptable ambient concentration will be considered the detection limit unless it can be demonstrated to the satisfaction of the DEQ that an ambient level higher than the detection limit will not have an adverse effect on human health or the environment. In such cases we have allowed the toxicological profiles of like chemicals or compounds to be substituted for the unknowns.

General Summary of Idaho Air Quality Bureau's New Source Review Policy for Toxic Air Pollutants

Regulation Summary

January 1991

Toxic substances within ambient air are regulated in Idaho by IDAPA 16.01.1011,01. Toxic Substances, which states:

> *Any contaminant which is by its nature toxic to human or animal life or vegetation, but is not specifically controlled elsewhere in Idaho Department of Health and Welfare Rules and Regulations, Title 1, Chapter 1, "Rules and Regulations for the Control of Air Pollution in Idaho," shall not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation. As information becomes available, limits will be specified for concentration of toxic materials in the ambient air and emission limits will be set accordingly.*
>
> *(1-24-69)*

Any new source of air pollutants (including toxic pollutants) not specifically covered by the thirteen (13) specific New Source Performance Standards is regulated by IDAPA 16.01.1952,02 Sources Not Specifically Regulated which states:

> *Sources not specifically regulated under Idaho Department of Health and Welfare Rules and Regulations Sections 01.1955 through 01.1999 shall achieve the greatest degree of emission reduction that has been adequately demonstrated.*
>
> *(1-1-75)*

Idaho Air Quality Bureau (IAQB) has developed a method for permitting new sources of toxic air pollutants consistent with our responsibilities and authority under the Rules and Regulations for the Control of Air Pollution in Idaho. For that method, IAQB compiled a list of toxic air pollutants (TAP) and screening level emission limits for those substances.

Permit Decisions

If the Bureau finds that an eight-hour average ambient concentration of a toxic air pollutant will likely not exceed one hundredth (.01) of the OEL for non carcinogens, or is below detection levels for a compound without an OEL or URF, the Bureau shall grant the permit.

Similarly, if the Bureau can substantiate that ambient concentrations due to emissions of known or suspected carcinogens are not likely to cause excess cancers of more than one in a million (10^{-6}) then the bureau shall grant a permit.

If potential new source emissions are shown to likely cause ambient concentrations:

1. in excess of 1/100 of the OEL or

2. which could cause cancers in excess of one in one hundred thousand (10^{-5}) or

3. which exceed minimum detection levels for TAP without an OEL or URF,

the Bureau may grant the permit if the applicant implements the best available control technology (BACT) for that source or pollutant and after considering other factors.

If the TAP screening level is shown to likely be exceeded the Bureau will make a final decision considering the following factors:

(a) the health and environmental assessment prepared by the applicant (if one is required by the Bureau);

(b) the nature of the toxic air pollutant and the susceptibility and proximity of the human population;

(c) other health and environmental impacts associated with the anticipated level of exposure.

The Bureau may grant a permit for a new source to emit carcinogens which are likely to cause excess cancers between 1/100,000 and 1/1,000,000 (between 10^{-5} and 10^{-6}) after the applicant proves that additional controls would be a severe hardship.

Appendix 9

Samples of Industry Specific TAP Emissions Data for an Example Industry; the Asphalt Paving Mixtures and Block Industry, SIC Code 2951

This appendix contains excerpts from:

Toxic Air Pollutant Emission Factors - A Compilation for Selected Air Toxic Compounds and Sources, Second Edition EPA-450/2-90-011

Toxic Air Pollutant/Source Crosswalk - A screening tool For Locating Possible Sources Emitting Toxic Air Pollutants, Second Edition EPA 450/2-89-017

Compilation of Air Pollution Emission Factors, AP-42 Fourth Edition September 1985 Volume I Stationary Point And Area Sources. (While this document is not specifically for TAP, the emission factors for VOC's can be useful for calculations and it is a standard reference.

MSDS for the same industry.

United States
Environmental Protection
Agency

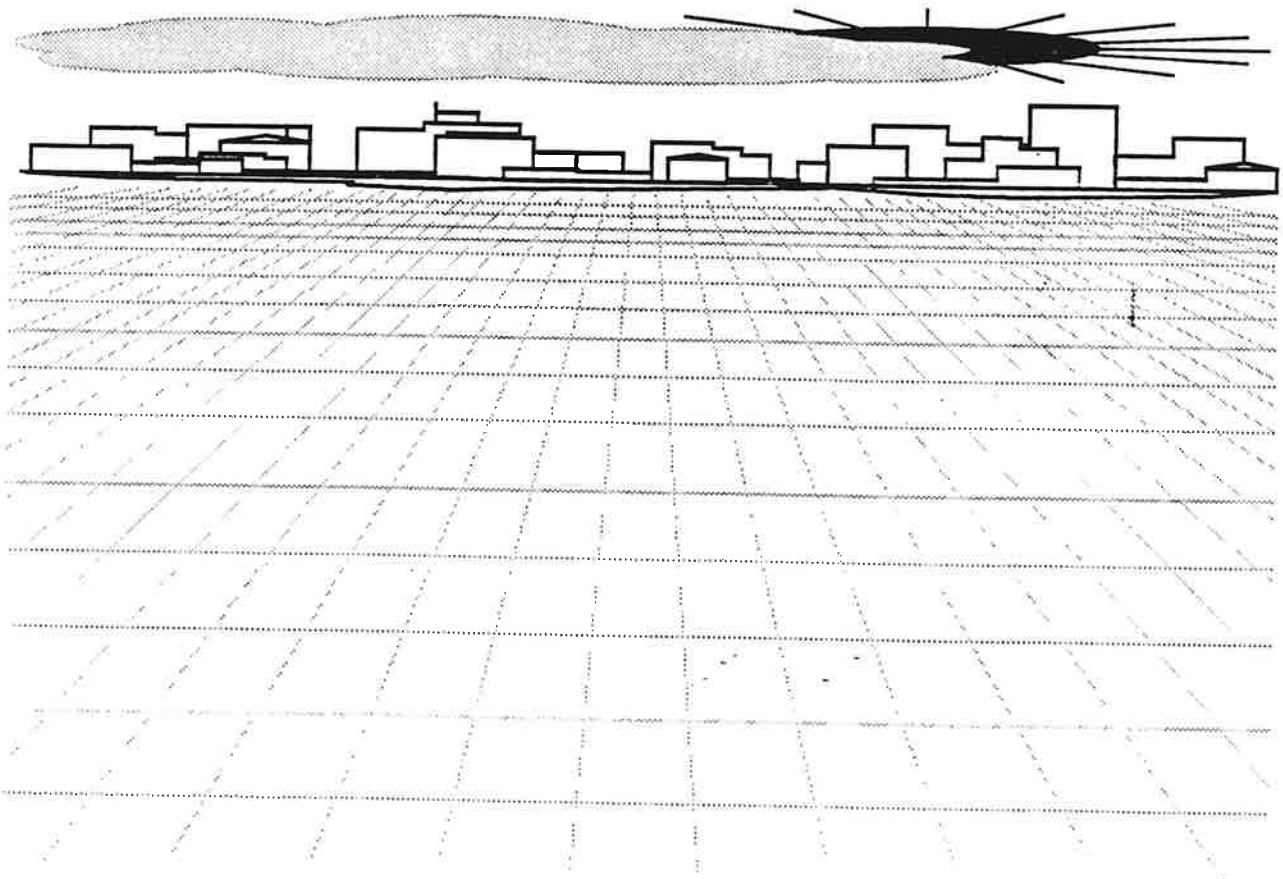
Office of Air Quality
Planning And Standards
Research Triangle Park, NC 27711

EPA-450/2-90-011
October 1990

AIR

EPA

TOXIC AIR POLLUTANT EMISSION FACTORS - A COMPILATION FOR SELECTED AIR TOXIC COMPOUNDS AND SOURCES, SECOND EDITION



REC 4338

SIC	SIC Code Description	SCC Code	Associated Pollutants
2951	Asphalt paving mixtures and blocks		ACETALDEHYDE (27); ACETATE, METHYL (29); ACETONE (27,28); ALUMINUM OXIDE (27); AMMONIA (21,22,23,27,29); ANILINE, 3-NITRO- (28); ANTHRACENE (27); ANTIMONY (27); ASBESTOS (21,22,23,27,28,29); ASPHALT (22); BENZENE (20,21,23,27,28,29); BENZENE, CHLORO- (28); BENZENE, ETHYL- (27,28); BENZENE, HEXACHLORO- (22,28); BENZIDINE (28); BENZO(A)PYRENE (21,23,28); BIPHENYL (27); BUTANETHIOL, N- (28); 1-BUTANOL (27); BUTYRALDEHYDE (26); CHLORINE (27); CHROMIUM (21,23,27,29); CUMENE (27); CYCLOHEXANE (27,28); DIBUTYL PHTHALATE (27); DIOCTYL PHTHALATE (27); EPOXY RESINS (25); ETHANE, CHLORO- (27); ETHANE, 1,2-DICHLORO- (27); ETHANE, 1,1,1-TRICHLORO- (21,22,23,28,29); ETHANOL, 2-ETHOXY-, ACETATE (22); ETHYLENE (27); ETHYLENE GLYCOL (27); ETHYLENE OXIDE (27); FORMALDEHYDE (20,21,22,26,28,29); FORMAMIDE, N,N-DIMETHYL- (28); FURAN, DIBENZO- (27); FURAN, 1,2,3,6,7,8-HEXACHLORODIBENZO- (27); FURAN, 1,2,3,7,8,9-HEXACHLORODIBENZO- (27); HEPTANE (22); HEXANE (22); HYDROGEN CHLORIDE (27,28); ISOPROPANOL (27); KEROSINE (29); LEAD (27); MANGANESE (29); MERCURY (23,29); METHANOL (27); METHYL ETHYL KETONE (21,22,27,28); METHYL ISOBUTYL KETONE (27); METHYLISOCYANATE (21,22,23,29); NAPHTHALENE (21,24,27,28); NICKEL (29); N-OCTYL PHTHALATE (27); 2-PENTANOL, 4-METHYL- (29); PHENOL, 2,4-DICHLORO- (27); POLYCYCLIC ORGANIC MATTER (21,23,26,29); POLYETHYLENE GLYCOL (25); POLYVINYL CHLORIDE LATEX (28); PROPYLENE (27); SODIUM HYDROXIDE (27); SORBITAN, MONO-9-OCTADECENOATE, POLY(OXY-1,2-ETHANDIYL) (2)- (29); STYRENE (28); SULFURIC ACID (21,22,27,28); TETRACHLOROETHYLENE (22,28); THALLIUM COMPOUNDS (28); TOLUENE (20,21,22,23,27,28,29); XYLENE, M- (27); XYLENE, O- (27); XYLENE, P- (27); XYLENES (MIXED ISOMERS) (27,28); ZINC COMPOUNDS (27)
		3-05-002	BUTYRALDEHYDE (26); FORMALDEHYDE (26)
		3-05-002-01	BENZENE (20); FORMALDEHYDE (20); POLYCYCLIC ORGANIC MATTER (26); TOLUENE (20)
		3-05-002-03	NAPHTHALENE (21,24)
		3-05-002-05	POLYCYCLIC ORGANIC MATTER (26)

United States
Environmental Protection
Agency

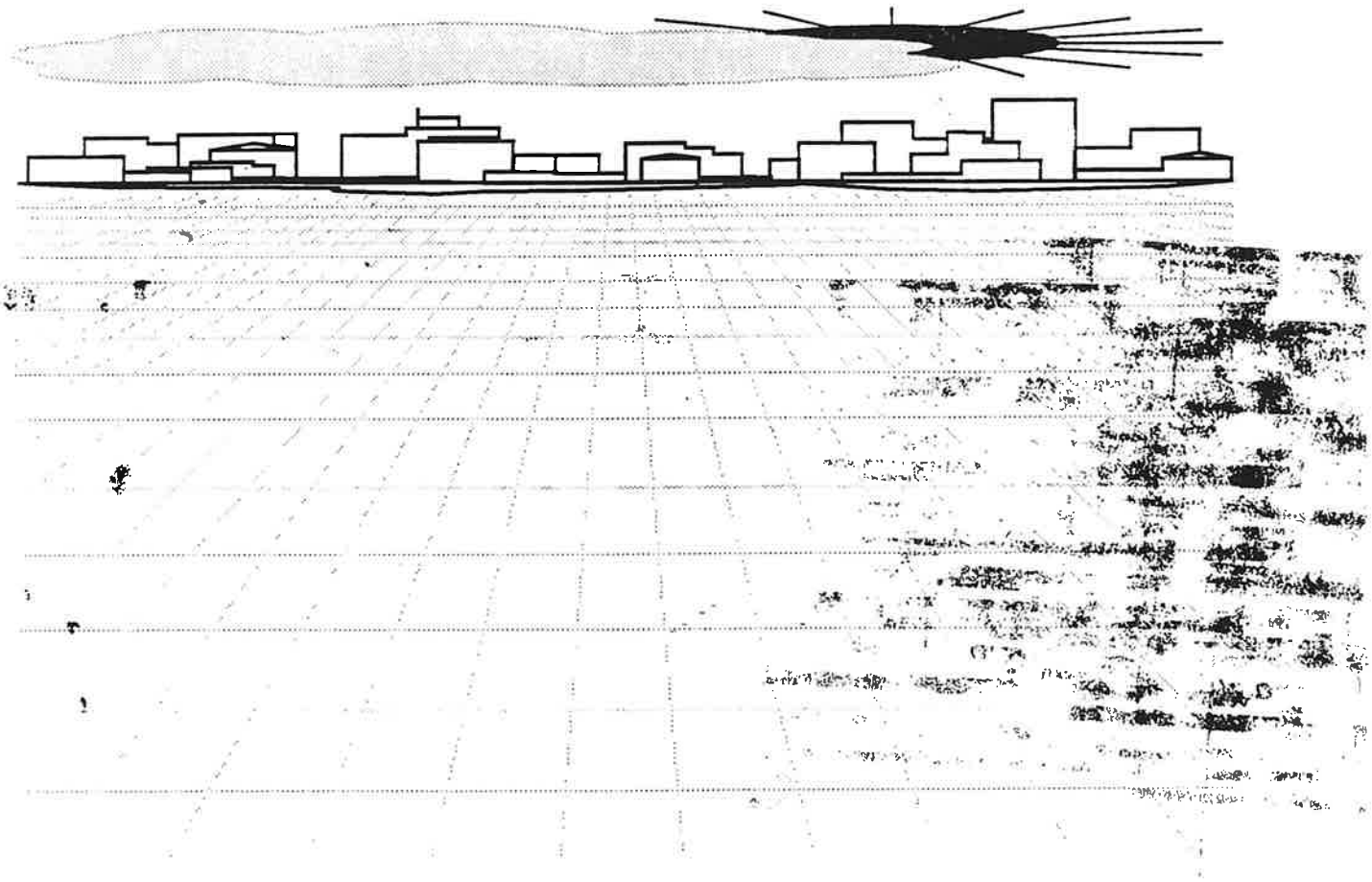
Office of Air Quality
Planning And Standards
Research Triangle Park, NC 27711

EPA-450/2-89-017
December 1989

AIR

EPA

TOXIC AIR POLLUTANT/SOURCE CROSSWALK - A SCREENING TOOL FOR LOCATING POSSIBLE SOURCES EMITTING TOXIC AIR POLLUTANTS, SECOND EDITION



REC 4340

INDUSTRIAL PROCESS	SIC CODE	EMISSION SOURCE	SCC CODE	POLLUTANT	CAS NUMBER	EMISSION FACTOR	NOTES	REFERENCE
Asphaltic concrete production	2951	Plant stack	305002	Magnesium	7439954	8.8 x 10E-9 lb/ton concrete	Controlled (unspecified) from a single plant, mean of 2 values, range is 4.4 x 10E-9 - 1.32 x 10E-8 lb ton	170
Asphaltic concrete production	2951	Plant stack	305002	Magnesium	7439954	2.96 x 10E-7 lb/ton concrete	Uncontrolled from a single plant, mean of 2 values, range is 2.05 x 10E-7 - 3.87 x 10E-7 lb/ton	170
Asphaltic concrete production	2951	Plant stack	305002	Manganese	7439965	3.02 x 10E-10 lb/ton concrete	Controlled (unspecified) from a single plant, average of 2 values, range is 1.63 x 10E-10 - 4.4 x 10E-10 lb/ton	170
Asphaltic concrete production	2951	Plant stack	305002	Manganese	7439965	5.72 x 10E-9 lb/ton concrete	Uncontrolled from a single plant, average of 2 values, range is 3.3 x 10E-9 - 8.1 x 10E-9 lb/ton	170
Asphaltic concrete production	2951	Plant stack	305002	Mercury	7439976	<1.1 x 10E-9 lb/ton concrete	Controlled (unspecified) from a single plant, average of 2 values, range is 8.8 x 10E-10 - 1.3 x 10E-9	170
Asphaltic concrete production	2951	Plant stack	305002	Mercury	7439976	<2.07 x 10E-9 lb/ton concrete	Uncontrolled from a single plant, average of 2 values, range is 1.5 x 10E-9 - 2.6 x 10E-9	170
Asphaltic concrete production	2951	Plant stack	305002	Nickel	7440020	1.48 x 10E-10 lb/ton concrete	Controlled (unspecified) from a single plant, avg. of 2 values, range is 1.44 x 10E-10 - 1.51 x 10E-10 lb/ton	170
Asphaltic concrete production	2951	Plant stack	305002	Nickel	7440020	7.7 x 10E-10 lb/ton concrete	Uncontrolled from a single plant, avg. of 2 values, range is 6.6 x 10E-10 - 8.8 x 10E-10 lb/ton	170
Asphaltic concrete production	2951	Plant stack	305002	Vanadium	7440622	1.87 x 10E-9 lb/ton concrete	Controlled (unspecified) from a single plant, avg. of 2 values, range is 1.76 x 10E-9 - 1.98 x 10E-9	170
Asphaltic concrete production	2951	Plant stack	305002	Vanadium	7440622	<3.9 x 10E-9 lb/ton concrete	Uncontrolled from a single plant, avg. of 2 values, range is 1.98 x 10E-9 - 5.7 x 10E-9	170
Asphaltic concrete production	2951	Plant stack	305002	Vanadium	7440622	8.00E-7 g/ton concrete	Controlled (unspecified) from a single plant	170
Asphaltic concrete production	2951	Plant stack	305002	Zinc	7440666	5.5 x 10E-10 lb/ton concrete	Controlled (unspecified) from a single plant, avg. of 2 values, range is 4.4 x 10E-10 - 6.6 x 10E-10 lb/ton	170
Asphaltic concrete production	2951	Plant stack	305002	Zinc	7440666	1.98 x 10E-9 lb/ton concrete	Uncontrolled from a single plant, avg. of 2 values, range is 1.76 x 10E-9 - 2.2 x 10E-9 lb/ton	170
Automobile carburetor manufacture	3592	Manual plating cleaning tanks		Sodium hydroxide	1310732	0.03 lb/hr/ft2 tank	Developed by State agency and plant personnel, assume NaOH is 5.7% soln.	158
Automotive products use		End use		Xylenes (mixed isomers)	1330207	2000 lb/ton xylene consumed	Engineering Judgement	77
Bagasse combustion	0133	Industrial boilers	10201101	Polycyclic organic matter		179.7 lb/10E12 Btu heat input	2 boilers each w/ multicyclone vented to 1 common stack. Represents both gaseous & particulate POM	114
Bagasse combustion	0133	Industrial boilers	10201101	Polycyclic organic matter		99.9 lb/10E12 Btu heat input	Average of 2 (17.2-68.9), multicyclone, represents both gaseous and particulate POM.	114

REC 4341

1671-PRINT

INDUSTRIAL PROCESS	SIC CODE	EMISSION SOURCE	SCC CODE	POLLUTANT	CAS NUMBER	EMISSION FACTOR	NOTES	REFERENCE
Asphaltic concrete production	2951	Plant stack	305002	Aluminum	7429905	1.2 x 10E-7 - 2.67 x 10E-7 lb/ton concrete	Uncontrolled from a single plant	170
Asphaltic concrete production	2951	Plant stack	305002	Aluminum	7429905	1.76 x 10E-9 - 5.1 x 10E-9 lb/ton concrete	Controlled (unspecified) from a single plant	170
Asphaltic concrete production	2951	Plant stack	305002	Beryllium	7440417	2.50 x 10E-11 lb/ton concrete	Uncontrolled from a single plant, avg. of 2 values, range is 2.1 - 2.9 x 10E-11 lb/ton	170
Asphaltic concrete production	2951	Plant stack	305002	Beryllium	7440417	1.98 x 10E-12 lb/ton concrete	Controlled (unspecified) from a single plant	170
Asphaltic concrete production	2951	Plant stack	305002	Butyraldehyde	123728	0.0024 lb/ton concrete	Based on limited test data, cyclone/wet scrubber control	97
Asphaltic concrete production	2951	Plant stack	305002	Cadmium	7440439	2.46 x 10E-10 lb/ton concrete	Controlled (unspecified) from a single plant, avg. of 2 values, range is 5.24 x 10E-11 - 4.4 x 10E-10 lb/ton	170
Asphaltic concrete production	2951	Plant stack	305002	Cadmium	7440439	1.82 x 10E-10 lb/ton concrete	Uncontrolled from a single plant, avg. of 2 values, range is 1.81 x 10E-10 - 1.83 x 10E-10 lb/ton	170
Asphaltic concrete production	2951	Plant stack	305002	Calcium	7440702	1.73 x 10E-5 lb/ton concrete	Uncontrolled from a single plant, avg. of 2 values, range is 1.03 x 10E-5 - 2.42 x 10E-5 lb/ton	170
Asphaltic concrete production	2951	Plant stack	305002	Calcium	7440702	2.76 x 10E-7 lb/ton concrete	Controlled (unspecified) from a single plant, avg. of 2 values, range is 1.72 x 10E-7 - 3.81 x 10E-7 lb/ton	170
Asphaltic concrete production	2951	Plant stack	305002	Calcium	7440702	3.3 x 10E-11 lb/ton concrete	Controlled (unspecified) from a single plant	170
Asphaltic concrete production	2951	Plant stack	305002	Chromium	7440473	1.24 x 10E-10 lb/ton concrete	Controlled (unspecified) from a single plant. Avg. of 2 values, range is 7.57 x 10E-11 - 1.71 x 10E-10 lb/ton	170
Asphaltic concrete production	2951	Plant stack	305002	Chromium	7440473	1.21 x 10E-9 lb/ton	Uncontrolled from a single plant, avg. of 2 values, range is 1.10 x 10E-9 - 1.32 x 10E-9 lb/ton	170
Asphaltic concrete production	2951	Plant stack	305002	Formaldehyde	50000	0.00015 lb/ton concrete	Based on limited test data, cyclone/wet scrubber control	97
Asphaltic concrete production	2951	Plant stack	305002	Iron	15438310	3.72 x 10E-7 lb/ton concrete	Uncontrolled from a single plant, avg. of 2 values, range is 2.22 x 10E-7 - 5.21 x 10E-7 lb/ton	170
Asphaltic concrete production	2951	Plant stack	305002	Iron	15438310	4.73 x 10E-9 lb/ton concrete	Controlled (unspecified) from a single plant, avg. of 2 values, range is 3.08 x 10E-9 - 6.38 x 10E-9 lb/ton	170
Asphaltic concrete production	2951	Plant stack	305002	Lead	7439921	3.98 x 10E-11 lb/ton	Controlled (unspecified) from a single plant, avg. of 2 values, range is 3.7 x 10E-11 - 4.25 x 10E-11 lb/ton	170
Asphaltic concrete production	2951	Plant stack	305002	Lead	7439921	9.9 x 10E-10 lb/ton concrete	Uncontrolled from a single plant, average of 2 values, range is 8.8 x 10E-10 - 1.1 x 10E-9 lb/ton	170

REC 4342

INDUSTRIAL PROCESS	SIC CODE	EMISSION SOURCE	SCC CODE	POLLUTANT	CAS NUMBER	EMISSION FACTOR	NOTES	REFERENCE
Asphalt (hot mix) production	2951	Drum mix plant	30500205	Polycyclic organic matter		7.18 x 10E-5 lb/ton asphalt produced	Knock out box, using recycled feed	114
Asphalt (hot mix) production	2951	Drum mix plant	30500205	Polycyclic organic matter		3.38 x 10E-5 lb/ton asphalt produced	Knock out box and venturi scrubber, using recycled feed	114
Asphalt (hot mix) production	2951	Drum mix plant	30500205	Polycyclic organic matter		4.42 x 10E-5 lb/ton asphalt produced	Knock out box	114
Asphalt (hot mix) production	2951	Drum mix plant	30500205	Polycyclic organic matter		2.7 x 10E-5 lb/ton asphalt produced	Knock out box and venturi scrubber	114
Asphalt distribution/use	5032	Entire process		Benzene	71432	0.077 lb/ton asphalt applied	Benzene assumed to be 9.6% of THC	92
Asphalt distribution/use	5032	Entire process		Formaldehyde	50000	0.004 lb/ton asphalt applied	Formaldehyde assumed to be 0.5% of THC	92
Asphalt distribution/use	5032	Entire process		Polycyclic organic matter		0.0008 lb/ton asphalt applied	POM assumed to be 0.1% of THC	92
Asphalt production		Entire process		Formaldehyde	50000	0.00015 lb/ton asphalt produced	Control uncertain	94
Asphalt roofing material production	2952	Asphalt blowing still	30500101	Polycyclic organic matter		0.0304 lb/ton asphalt blown	Uncontrolled	114
Asphalt roofing material production	2952	Asphalt blowing still	30500101	Polycyclic organic matter		9.6 x 10E-5 lb/ton asphalt blown	Afterburner	114
Asphalt roofing material production	2952	Asphalt blowing still	30500101	Polycyclic organic matter		4.2 x 10E-6 lb/ton asphalt blown	Fume incinerator	114
Asphalt roofing material production	2952	Asphalt blowing still	30500101	Polycyclic organic matter		1.16 x 10E-5 lb/ton asphalt blown	Process heater furnace	114
Asphalt roofing material production	2952	Asphalt blowing still	30500101	Polycyclic organic matter		0.0096 lb/ton asphalt blown	Stack baffles, represents particulate POM	114
Asphalt roofing material production	2952	Saturator	30500103	Polycyclic organic matter		4.2 x 10E-4 lb/ton produced	Uncontrolled	114
Asphalt roofing material production	2952	Saturator	30500103	Polycyclic organic matter		1.92 x 10E-4 lb/ton produced	ESP controlled	114
Asphalt roofing material production	2952	Saturator	30500103	Polycyclic organic matter		6.6 x 10E-4 lb/ton produced	Uncontrolled	114
Asphalt roofing material production	2952	Saturator and asphalt storage tanks	30500103	Polycyclic organic matter		0.042 lb/ton produced	High velocity air filter	114

REC 4343

LASERPRINT

INDUSTRIAL PROCESS	SIC CODE	EMISSION SOURCE	SCC CODE	POLLUTANT	CAS NUMBER	EMISSION FACTOR	NOTES	REFERENCE
Asbestos product fabrication	3292	Floor tile		Asbestos	1332214	1.0 lb/ton asbestos produced	Controlled	33
Asbestos product fabrication	3292	Friction material production		Asbestos	1332214	6 lb/ton asbestos produced	Controlled	33
Asbestos product fabrication	3292	Grinding brake shoes		Asbestos	1332214	465 fibers/cc air/g asbestos machined	Average of test results	22
Asbestos product fabrication	3292	Sawing asbestos cement sheet		Asbestos	1332214	1838 fibers/cc air/g asbestos machined	Average of test results, cut-off wheel saw	22
Asbestos product fabrication	3292	Sawing asbestos cement sheet		Asbestos	1332214	305 fibers/cc air/g asbestos machined	Average of test results, toothed blade saw	22
Asbestos product fabrication	3292	Sawing asbestos millboard		Asbestos	1332214	647 fibers/cc air/g asbestos machined	Average of test results, toothed blade saw	22
Asbestos product fabrication	3292	Textiles		Asbestos	1332214	40 lb/ton asbestos produced	Uncontrolled	33
Asbestos product fabrication	3292	Textiles		Asbestos	1332214	2 lb/ton asbestos produced	Controlled	33
Asbestos product usage		Brake linings		Asbestos	1332214	10 lb/ton asbestos produced	Uncontrolled	33
Asbestos product usage		Construction industry		Asbestos	1332214	26 lb/ton asbestos produced		33
Asbestos product usage		Insulating cement		Asbestos	1332214	26 lb/ton asbestos produced	Controlled	33
Asbestos product usage		Steel fireproofing		Asbestos	1332214	10 lb/ton asbestos produced	Controlled	33
Asbestos textiles manufacturing	3292	Entire process		Asbestos	1332214	63.7 lb/ton asbestos consumed	Calculated average uncontrolled factor, calculated range 26.7-88.8	100
Asbestos textiles manufacturing	3292	Entire process		Asbestos	1332214	3.54 lb/ton asbestos consumed	Calculated average controlled factor, calculated range 0.026-35.5	100
Asbestos-reinforced plastics manufacturing	3292	Entire process		Asbestos	1332214	930.8 lb/ton asbestos consumed	Calculated average uncontrolled factor, calculated range 0.96-2000	100
Asbestos-reinforced plastics manufacturing	3292	Entire process		Asbestos	1332214	5.70 lb/ton asbestos consumed	Calculated average controlled factor, calculated range 9.66 x 10-5 - 200	100
Ascorbic acid production	2833	Plantwide emissions	301060	Chloroform	67663	4.92 x 10E5 lb/yr	Based on one facility (30 million lb/yr production)	160
Asphalt (hot mix) production	2951	Batch mix plant, rotary dryer and mixer	30500201	Polycyclic organic matter		3.94 x 10E-5 lb/ton asphalt produced	Cyclone and wet scrubber, virgin feed material	114

REC 4344

1/7/4PRINT

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

COMPILATION OF AIR POLLUTANT EMISSION FACTORS, AP-42

FOURTH EDITION

September 1985

Volume I: Stationary Point And Area Sources

Stock No. 055-000-00251-7, $20.00

And

Volume II: Mobile Sources

Stock No. 055-000-00252-5, $19.00

SUPPLEMENT A

To

Volume I: Stationary Point And Area Sources

October 1986

Stock No. 055-000-00265-7, $21.00

These volumes should be ordered from:

Superintendent Of Documents
Government Printing Office
Washington, DC 20402-9325

(202) 783-3238

4.5 CUTBACK ASPHALT, EMULSIFIED ASPHALT AND ASPHALT CEMENT

4.5.1 General[1-3]

Asphalt surfaces and pavements are composed of compacted aggregate and an asphalt binder. Aggregate materials are produced from rock quarries as manufactured stone or are obtained from natural gravel or soil deposits. Metal ore refining processes produce artificial aggregates as a byproduct. In asphalt, the aggregate performs three functions. It transmits the load from the surface to the base course, takes the abrasive wear of traffic, and provides a nonskid surface. The asphalt binder holds the aggregate together, preventing displacement and loss of aggregate and providing a waterproof cover for the base.

Asphalt binders take the form of asphalt cement (the residue of the distillation of crude oils) and liquified asphalts. To be used for pavement, asphalt cement, which is semisolid, must be heated prior to mixing with aggregate. The resulting hot mix asphalt concrete is generally applied in thicknesses of from two to six inches. Liquified asphalts are (1) asphalt cutbacks (asphalt cement thinned or "cutback" with volatile petroleum distillates such as naptha, kerosene, etc.) and (2) asphalt emulsions (nonflammable liquids produced by combining asphalt and water with an emulsifying agent, such as soap). Liquified asphalts are used in tack and seal operations, in priming roadbeds for hot mix application, and for paving operations up to several inches thick.

Cutback asphalts fall into three broad categories: rapid cure (RC), medium cure (MC), and slow cure (SC) road oils. SC, MC and RC cutbacks are prepared by blending asphalt cement with heavy residual oils, kerosene-type solvents, or naptha and gasoline solvents, respectively. Depending on the viscosity desired, the proportions of solvent added generally range from 25 to 45 percent by volume.

Emulsified asphalts are of two basic types. One type relies on water evaporation to cure. The other type (cationic emulsions) relies on ionic bonding of the emulsion and the aggregate surface. Emulsified asphalt can substitute for cutback in almost any application. Emulsified asphalts are gaining in popularity, because of the energy and environmental problems associated with the use of cutback asphalts.

4.5.2 Emissions[1,2]

The primary pollutants of concern from asphalts and asphalt paving operations are volatile organic compounds (VOC). Of the three types of asphalts, the major source of VOC is cutback. Only minor amounts of VOC are emitted from emulsified asphalts and asphalt cement.

VOC emissions from cutback asphalts result from the evaporation of the petroleum distillate solvent, or diluent, used to liquify the asphalt cement. Emissions occur at both the job site and the mixing plant. At the job site, VOCs are emitted from the equipment used to apply the asphaltic product and from the road surface. At the mixing plant, VOCs are released during mixing and stockpiling. The largest source of emissions, however, is the road surface itself.

For any given amount of cutback asphalt, total emissions are believed to be the same, regardless of stockpiling, mixing and application times. The two major variables affecting both the quantity of VOC emitted and the time over which emissions occur are the type and the quantity of petroleum distillate used as a diluent. As an approximation, long term emissions from cutback asphalts can be estimated by assuming that 95 percent of the diluent evaporates from rapid cure (RC) cutback asphalts, 70 percent from medium cure (MC) cutbacks, and about 25 percent from slow cure (SC) asphalts, by weight percent. Some of the diluent appears to be retained permanently in the road surface after application. Limited test data suggest that, from rapid cure (RC) asphalt, 75 percent of the total diluent loss occurs on the first day after

REC 4346

application, 90 percent occurs within the first month, and 95 percent in three to four months. Evaporation takes place more slowly from medium cure (MC) asphalts, with roughly 20 percent of the diluent being emitted during the first day, 50 percent during the first week, and 70 percent after three to four months. No measured data are available for slow cure (SC) asphalts, although the quantity emitted is believed to be considerably less than with either rapid or medium cure asphalts, and the time during which emissions take place is expected to be considerably longer (Figure 4.5-1). An example calculation for determining VOC emissions from cutback asphalts is given below:

Example: Local records indicate that 10,000 kg of RC cutback asphalt (containing 45 percent diluent, by volume) was applied in a given area during the year. Calculate the mass of VOC emitted during the year from this application.

To determine VOC emissions, the volume of diluent present in the cutback asphalt must first be determined. Because of density of naptha (0.7 kg/l) differs from that of asphalt cement (1.1 kg/l), the following equations should be solved to determine the volume of diluent (x) and the volume of asphalt cement (y) in the cutback asphalt:

$$10{,}000 \text{ kg cutback asphalt} = (x \text{ liter, diluent}) \cdot \left(\frac{0.7 \text{ kg}}{\text{liter}}\right) + (y \text{ liter, asphalt cement}) \cdot \left(\frac{1.1 \text{ kg}}{\text{liter}}\right)$$

and

$$x \text{ liter, diluent} = 0.45\ (x \text{ liter, diluent} + y \text{ liter, asphalt cement})$$

From these equations, the volume of diluent present in the cutback asphalt is determined to be about 4900 liters, or about 3400 kg. Assuming that 95 percent of this is evaporative VOC, emissions are then: 3400 kg x 0.95 = 3200 kg (i.e., 32% by weight, of the cutback asphalt eventually evaporates).

These equations can be used for medium cure and slow cure asphalts by assuming typical diluent densities of 0.8 and 0.9 kg/liter, respectively. Of course, if actual density values are known from local records, they should be used in the above equations rather than typical values. Also, if different diluent contents are used, they should also be reflected in the above calculations. If actual diluent contents are not known, a typical value of 35 percent may be assumed for inventory purposes.

In lieu of solving the equations in the above example, Table 4.5-1 may be used to estimate long term emissions from cutback asphalts. Table 4.5-1 directly yields long term emissions as a function of the volume of diluent added to the cutback and of the density of the diluents and asphalt cement used in the cutback asphalt. If short term emissions are to be estimated, Figure 4.5-1 should be used in conjunction with Table 4.5-1.

No control devices are employed to reduce evaporative emissions from cutback asphalts. Asphalt emulsions are typically used in place of cutback asphalts to eliminate VOC emissions.

REC 4347

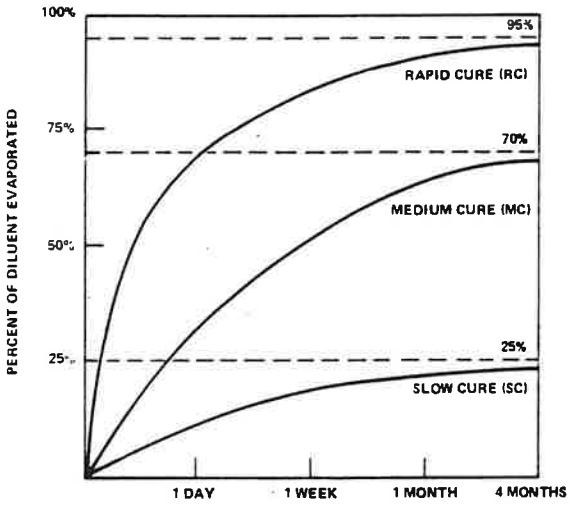


Figure 4.5-1. Percent of diluent evaporated from cutback asphalt over time.

TABLE 4.5-1. EVAPORATIVE VOC EMISSIONS FROM CUTBACK ASPHALTS AS A FUNCTION OF DILUENT CONTENT AND CUTBACK ASPHALT TYPE[a]

EMISSION FACTOR RATING: C

Type of Cutback[b]	Percent, by Volume, of Diluent in Cutback[c]		
	25%	35%	45%
Rapid cure	17	24	32
Medium cure	14	20	26
Slow cure	5	8	10

[a]These numbers represent the percent, by weight, of cutback asphalt evaporated. Factors are based on References 1 and 2.

[b]Typical densities assumed for diluents used in RC, MC and SC cutbacks are 0.7, 0.8 and 0.9 kg/liter, respectively.

[c]Diluent contents typically range between 25-45%, by volume. Emissions may be linearly interpolated for any given type of cutback between these values.

REC 4348

References for Section 4.5

1. R. Keller and R. Bohn, *Nonmethane Volatile Organic Emissions from Asphalt Cement and Liquified Asphalts*, EPA-450/3-78-124, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 1978.

2. F. Kirwan and C. Maday, *Air Quality and Energy Conservation Benefits from Using Emulsions To Replace Asphalt Cutbacks in Certain Paving Operations*, EPA-450/2-78-004. U.S. Environmental Protection Agency, Research Triangle Park. NC, January 1978.

3. David W. Markwordt, *Control of Volatile Organic Compounds from Use of Cutback Asphalt*, EPA-450/2-77-037, U.S. Environmental Protection Agency, Research Triangle Park. NC, December 1977.

REC 4349

M A T E R I A L S A F E T Y D A T A S H E E T

IDAHO ASPHALT SUPPLY INC.
Nampa, Idaho

CRS-1, CRS-2, CRS-2f, CRS-2h

MATERIAL IDENTIFICATION

Chemical Name: Cationic Rapid Set Asphalt Emulsion
Manufacturer: Idaho Asphalt Supply Inc.
Address: P.O. Box 966, Nampa, Id. 83651
Hazard Rating (NFPA)
Health: 1
Fire: 0
Reactivity: 0
Special: None

CAS Registry No. N/A
Date Prepared; 5/19/89

Hazard Rating Scale:
0 - Minimal
1 - Slight
2 - Moderate
3 - Serious
4 - Severe

HAZARDOUS INGREDIENTS

Ingredients	CAS #	Percent	PEL	STEL	TLV
Asphalt cement	8052-42-4	65-70%	N/A	10mg/m	5mg/m
Naptha	8032-32-4	0-3%	100ppm	N/A	400ppm
Emulsifier	TSCA	0.15-0.5%	N/A	N/A	N/A

PHYSICAL DATA

Boiling Point - 212f
Vapor Pressure - <1
Vapor Density - >0.062
Specific Gravity @ 60f - 1.025 to 1.06
Melting Point - N/A
Evaporation Rate - <1
Solubility in water - up to 100%
Appearance and Odor - Viscous brown to black liquid ; odor of amines and hydrocarbons

FIRE AND EXPLOSIVE DATA

Flash Point - N/A
Autoignition Temperature NFPA - N/A
Extinguishing Media - CO2, Class "B" extinguisher, foam and water fog.
Special Fire Fighting Procedures - Avoid breathing vapors, wear self-contained breathing apparatus.
Unusual Fire Explosion Hazards - DO NOT heat material above 212f to avoid generating excessive steam pressure.

REACTIVITY DATA

Stable: X Unstable:

Conditions to Avoid	-	DO NOT HEAT ABOVE 212f, Ignition sources.
Incompatible Materials	-	Avoid strong oxidizing agents
Hazardous Decomposition Products	-	Combustion may form CO2, CO, and sulfur oxide.
Hazardous Polymerization	-	Will not occur.

HEALTH HAZARD DATA

Route of Exposure	Primary Route	Signs and Symptoms
Inhalation	[X]	Use with good ventilation. May cause respiratory tract irritation
Skin Absorption	[ ]	No significant symptoms indicative of skin absorption expected.
Skin Irritation	[X]	Will cause burns when product is hot. May cause dermatitis and acne like lesions on prolonged exposure.
Ingestion	[ ]	May cause nausea and diarrhea.
Eye Contact	[X]	Will burn and irritate.

Listed as Carcinogen? Not listed by NTP, IARC, or OSHA.

EMERGENCY FIRST AID

Inhalation:	Remove to fresh air. Give oxygen or artificial respiration as needed Obtain medical attention promptly.
Eye Contact:	Flush eyes with low pressure water for at least 15 minutes and obtain medical attention immediately.
Skin Contact:	If product is hot, cool with cold water. Otherwise wash thoroughly with soap and water.
Ingestion:	Call physician. Do not induce vomiting.

PROTECTIVE EQUIPMENT / CONTROL MEASURES

Respiratory Protection:	Avoid breathing vapors in confined spaces. NIOSH approved respirators may be required if TLV's are exceeded.
Eye Protection:	Use safety glasses, goggles or face shields.
Skin Protection:	Use rubber gloves, coveralls and impervious footwear.
Engineering controls:	Local exhaust ventilation may be required to meet exposure standards in confined areas.
Handling Precautions:	Avoid heating over 212f.

SPILL AND DISPOSAL

Spill or Release:	Stop release, prevent flow from entering sewers or public waters. Allow to cool. Recover large spill. Let product cure or soak up with sand on smaller spills.
Waste Disposal Method:	Handle in accordance with federal, state and local regulations.

DISCLAIMER

Some of the information presented and conclusions drawn herein are from sources other than direct test data on the product itself. The information in this MSDS was obtained from sources which we believe reliable. However, the information is provided without any warranty, expressed or implied, regarding its correctness.

The condition or methods of handling, storage, use and disposal of the products are beyond our control and may be beyond our knowledge. For this and other reasons, we do not assume responsibility and expressly disclaim liability for loss, damage or expense arising out of or in any way connected with the handling, storage, use or disposal of the product.

This MSDS was prepared and is to be used only for this product. If the product is used as a component in another product, this MSDS information may not be applicable.

This MSDS has been prepared in accordance with the requirements of the OSHA Hazardous Communication Standard (29 CFR 1200)

MATERIAL SAFETY DATA SHEET

IDAHO ASPHALT SUPPLY INC.
(Hauser) Post Falls, ID

RECEIVED
JUN 26 1992
DIV. OF ENVIRONMENTAL QUALITY
PERMITS & ENFORCEMENTS

LMCRS-2, LMCRS-2h, CRS-2R

MATERIAL IDENTIFICATION

Chemical Name: Cationic Rapid Set Asphalt Emulsion
Manufacturer: Idaho Asphalt Supply Inc.
Address: P.O. Box 966, Nampa, Id. 83651
Hazard Rating (NFPA)
Health: 1
Fire: 0
Reactivity: 0
Special: None

CAS Registry No. N/A
Date Prepared: 5/19/89

Hazard Rating Scale:
0 - Minimal
1 - Slight
2 - Moderate
3 - Serious
4 - Severe

HAZARDOUS INGREDIENTS

Ingredients	CAS #	Percent	PEL	STEL	TLV
Asphalt cement	8052-42-4	57-68%	N/A	10mg/m	5 mg/m
Naptha	8032-32-4	0-3%	100ppm	N/A	400ppm
Elastomers	126-99-8	1.5-3%	10ppm	N/A	10ppm
Emulsifier	TSCA	1-3%	N/A	N/A	N/A

PHYSICAL DATA

Boiling Point - 212f
Vapor Pressure - <1
Vapor Density - >0.062
Specific Gravity @ 60f - 1.025 to 1.06
Melting Point - N/A
Evaporation Rate - <1
Solubility in water - up to 100%
Appearance and Odor - Viscous brown to black liquid ; odor of amines and hydrocarbons

FIRE AND EXPLOSIVE DATA

Flash Point - N/A
Autoignition Temperature NFPA - N/A
Extinguishing Media - CO2, Class "B" extinguisher, foam and water fog.
Special Fire Fighting Procedures - Avoid breathing vapors, wear self-contained breathing apparatus.
Unusual Fire Explosion Hazards - DO NOT heat material above 212f to avoid generating excessive steam pressure.

REACTIVITY DATA

Stable: X Unstable:

Conditions to Avoid	-	DO NOT HEAT ABOVE 212f, Ignition sources.
Incompatible Materials	-	Avoid strong oxidizing agents
Hazardous Decomposition Products	-	Combustion may form CO2, CO, and sulfur dioxide.
Hazardous Polymerization	-	Will not occur.

HEALTH HAZARD DATA

Route of Exposure	Primary Route	Signs and Symptoms
Inhalation	[X]	Use with good ventilation. May cause respiratory tract irritation
Skin Absorption	[ ]	No significant symptoms indicative of skin absorption expected.
Skin Irritation	[X]	Will cause burns when product is hot. May cause dermatitis and acne like lesions on prolonged exposure.
Ingestion	[ ]	May cause nausea and diarrhea.
Eye Contact	[X]	Will burn and irritate.

Listed as Carcinogen? Not listed by NTP, IARC, or OSHA.

EMERGENCY FIRST AID

Inhalation:	Remove to fresh air. Give oxygen or artificial respiration as needed Obtain medical attention promptly.
Eye Contact:	Flush eyes with low pressure water for at least 15 minutes and obtain medical attention immediately.
Skin Contact:	If product is hot, cool with cold water. Otherwise wash thoroughly with soap and water.
Ingestion:	Call physician. Do not induce vomiting.

PROTECTIVE EQUIPMENT / CONTROL MEASURES

Respiratory Protection:	Avoid breathing vapors in confined spaces. NIOSH approved respirators may be required if TLV's are exceeded.
Eye Protection:	Use safety glasses, goggles or face shields.
Skin Protection:	Use rubber gloves, coveralls and impervious footwear.
Engineering controls:	Local exhaust ventilation may be required to meet exposure standards in confined areas.
Handling Precautions:	Avoid heating over 212f.

SPILL AND DISPOSAL

Spill or Release:	Stop release, prevent flow from entering sewers or public waters. Allow to cool. Recover large spill. Let product cure or soak up with sand on smaller spills.
Waste Disposal Method:	Handle in accordance with federal, state and local regulations.

DISCLAIMER

Some of the information presented and conclusions drawn herein are from sources other than direct test data on the product itself. The information in this MSDS was obtained from sources which we believe reliable. However, the information is provided without any warranty, expressed or implied, regarding its correctness.

The condition or methods of handling, storage, use and disposal of the products are beyond our control and may be beyond our knowledge. For this and other reasons, we do not assume responsibility and expressly disclaim liability for loss, damage or expense arising out of or in any way connected with the handling, storage, use or disposal of the product.

This MSDS was prepared and is to be used only for this product. If the product is used as a component in another product, this MSDS information may not be applicable.

This MSDS has been prepared in accordance with the requirements of the OSHA Hazardous Communication Standard (29 CFR 1200)

M A T E R I A L S A F E T Y D A T A S H E E T

IDAHO ASPHALT SUPPLY INC.
Nampa, Idaho

MC Cutbacks

MATERIAL IDENTIFICATION

Chemical Name: Medium Cure Cutback Asphalts
Manufacturer: Idaho Asphalt Supply Inc.
Address: P.O. Box 966, Nampa, Id. 83651
Hazard Rating (NFPA)
Health: 2
Fire: 2
Reactivity: 0
Special: None

CAS Registry No. N/A
Date Prepared: 5/19/89

Hazard Rating Scale:
0 - Minimal 3 - Serious
1 - Slight 4 - Severe
2 - Moderate

HAZARDOUS INGREDIENTS

Ingredients	CAS #	Percent	PEL	STEL	TLV
Asphalt cement	8052-42-4	60-90%	N/A	10mg/m	5mg/m
Benzene	100-14-1	>0.1%?	N/A	25 ppm	10ppm
No.1 Fuel	8032-32-4	40-10%	100ppm	N/A	400ppm

PHYSICAL DATA

Boiling Point - > 300f
Vapor Pressure - < 1
Vapor Density - > 1
Solubility in water - No
Specific Gravity @ 60f - 0.90 to 1.10
Melting Point - N/A
Evaporation Rate - <1
Appearance and Odor - Black liquid or solid. Odor of hydrocarbons.

FIRE AND EXPLOSIVE DATA

Flash Point - > 100f TOC
Autoignition Temperature NFPA - N/A
Extinguishing Media - CO2. Class "B" extinguisher. foam or water fog.
Special Fire Fighting Procedures - Avoid breathing vapors. Avoid subsurface penetration with water; may cause foaming or frothing which could spread hazard
Unusual Fire Explosion Hazards - None

REACTIVITY DATA

Stable: X Unstable:

Conditions to Avoid	-	Ignition sources.
Incompatible Materials	-	Avoid strong oxidizing agents
Hazardous Decomposition Products	-	Combustion may form CO2, CO, and sulfur dioxide.
Hazardous Polymerization	-	Will not occur.

HEALTH HAZARD DATA

Route of Exposure	Primary Route	Signs and Symptoms
Inhalation	[X]	Use with good ventilation. May cause respiratory tract irritation
Skin Absorption	[ ]	No significant symptoms indicative of skin absorption expected.
Skin Irritation	[X]	Will cause burns when product is hot. May cause dermatitis and acne like lesions on prolonged exposure.
Ingestion	[ ]	May cause nausea and diarrhea.
Eye Contact	[X]	Will burn and irritate.

Listed as Carcinogen? Not listed by NTP, IARC, or OSHA.

EMERGENCY FIRST AID

Inhalation:	Remove to fresh air. Give oxygen or artificial respiration as needed Obtain medical attention promptly.
Eye Contact:	Flush eyes with low pressure water for at least 15 minutes and obtain medical attention immediately.
Skin Contact:	If product is hot, cool with cold water. Otherwise wash thoroughly with soap and water.
Ingestion:	Call physician. Do not induce vomiting.

PROTECTIVE EQUIPMENT / CONTROL MEASURES

Respiratory Protection:	Avoid breathing vapors in confined spaces. NIOSH approved respirators may be required if TLV's are exceeded.
Eye Protection:	Use safety glasses, goggles or face shields.
Skin Protection:	Use rubber gloves, coveralls and impervious footwear
Engineering controls:	Local exhaust ventilation may be required to meet exposure standards in confined areas.
Handling Precautions:	Storage tanks and trucks must be emptied, cooled, ventilated, and tested for absence of vapors before allowing personel entry.

SPILL AND DISPOSAL

Spill or Release:	Stop release, prevent flow from entering sewers or public waters. Allow to cool. Recover large spill. Let product cure or soak up with sand on smaller spills.
Waste Disposal Method:	Handle in accordance with federal, state and local regulations.

DISCLAIMER

Some of the information presented and conclusions drawn herein are from sources other than direct test data on the product itself. The information in this MSDS was obtained from sources which we believe reliable. However, the information is provided without any warranty, expressed or implied, regarding its correctness.

The condition or methods of handling, storage, use and disposal of the products are beyond our control and may be beyond our knowledge. For this and other reasons, we do not assume responsibility and expressly disclaim liability for loss, damage or expense arising out of or in any way connected with the handling, storage, use or disposal of the product.

This MSDS was prepared and is to be used only for this product. If the product is used as a component in another product, this MSDS information may not be applicable.

This MSDS has been prepared in accordance with the requirements of the OSHA Hazardous Communication Standard (29 CFR 1200)

M A T E R I A L S A F E T Y D A T A S H E E T

IDAHO ASPHALT SUPPLY INC.
Nampa, Idaho

CMS-2, CMS-2h, CMS-2s, CMS-2R

MATERIAL IDENTIFICATION

Chemical Name: Cationic Medium Set Asphalt Emulsion
Manufacturer: Idaho Asphalt Supply Inc.
Address: P.O. Box 966, Nampa, Id. 83651
Hazard Rating (NFPA)
Health: 1
Fire: 1
Reactivity: 0
Special: None

CAS Registry No. N/A
Date Prepared; 5/19/89

Hazard Rating Scale:
0 - Minimal 3 - Serious
1 - Slight 4 - Severe
2 - Moderate

HAZARDOUS INGREDIENTS

Ingredients	CAS #	Percent	PEL	STEL	TLV
Asphalt cement	8052-42-4	60-70%	N/A	10mg/m	5mg/m
Benzene	100-14-1	>0.1%?	N/A	25 ppm	10ppm
Naptha	8032-32-4	5-15%	100ppm	N/A	400ppm
Emulsifier	TSCA	0.15-0.5%	N/A	N/A	N/A

PHYSICAL DATA

Boiling Point - 212f
Vapor Pressure - <1
Vapor Density - >0.062
Specific Gravity @ 60f - 1.025 to 1.06
Melting Point - N/A
Evaporation Rate - <1
Solubility in water - up to 100%
Appearance and Odor - Viscous brown to black liquid ; odor of amines and hydrocarbons

FIRE AND EXPLOSIVE DATA

Flash Point - N/A
Autoignition Temperature NFPA - N/A
Extinguishing Media - CO2, Class "B" extinguisher, foam and water fog.
Special Fire Fighting Procedures - Avoid breathing vapors, wear self-contained breathing apparatus.
Unusual Fire Explosion Hazards - DO NOT heat material above 212f to avoid generating excessive steam pressure.

REACTIVITY DATA

Stable: X Unstable:

Conditions to Avoid	-	DO NOT HEAT ABOVE 212f, Ignition sources.
Incompatible Materials	-	Avoid strong oxidizing agents
Hazardous Decomposition Products	-	Combustion may form CO2, CO, and sulfur dioxide.
Hazardous Polymerization	-	Will not occur.

HEALTH HAZARD DATA

Route of Exposure	Primary Route	Signs and Symptoms
Inhalation	[X]	Use with good ventilation. May cause respiratory tract irritation
Skin Absorption	[ ]	No significant symptoms indicative of skin absorption expected.
Skin Irritation	[X]	Will cause burns when product is hot. May cause dermatitis and acne like lesions on prolonged exposure.
Ingestion	[ ]	May cause nausea and diarrhea.
Eye Contact	[X]	Will burn and irritate.

Listed as Carcinogen? Not listed by NTP, IARC, or OSHA

EMERGENCY FIRST AID

Inhalation:	Remove to fresh air. Give oxygen or artificial respiration as needed Obtain medical attention promptly.
Eye Contact:	Flush eyes with low pressure water for at least 15 minutes and obtain medical attention immediately.
Skin Contact:	If product is hot, cool with cold water. Otherwise wash thoroughly with soap and water.
Ingestion:	Call physician. Do not induce vomiting.

PROTECTIVE EQUIPMENT / CONTROL MEASURES

Respiratory Protection:	Avoid breathing vapors in confined spaces. NIOSH approved respirators may be required if TLV's are exceeded.
Eye Protection:	Use safety glasses, goggles or face shields.
Skin Protection:	Use rubber gloves, coveralls and impervious footwear.
Engineering controls:	Local exhaust ventilation may be required to meet exposure standards in confined areas.
Handling Precautions:	Avoid heating over 212f.

SPILL AND DISPOSAL

Spill or Release:	Stop release, prevent flow from entering sewers or public waters. Allow to cool. Recover large spill. Let product cure or soak up with sand on smaller spills.
Waste Disposal Method:	Handle in accordance with federal, state and local regulations.

DISCLAIMER

Some of the information presented and conclusions drawn herein are from sources other than direct test data on the product itself. The information in this MSDS was obtained from sources which we believe reliable. However, the information is provided without any warranty, expressed or implied, regarding its correctness.

The condition or methods of handling, storage, use and disposal of the products are beyond our control and may be beyond our knowledge. For this and other reasons, we do not assume responsibility and expressly disclaim liability for loss, damage or expense arising out of or in any way connected with the handling, storage, use or disposal of the product.

This MSDS was prepared and is to be used only for this product. If the product is used as a component in another product, this MSDS information may not be applicable.

This MSDS has been prepared in accordance with the requirements of the OSHA Hazardous Communication Standard (29 CFR 1200)

M A T E R I A L S A F E T Y D A T A S H E E T

IDAHO ASPHALT SUPPLY INC.
Nampa, Idaho

CSS-1, CSS-1H

MATERIAL IDENTIFICATION

Chemical Name: Cationic Slow Set Asphalt Emulsion
Manufacturer: Idaho Asphalt Supply Inc.
Address: P.O. Box 966, Nampa, Id. 83651
Hazard Rating (NFPA)
Health: 1
Fire: 0
Reactivity: 0
Special: None

CAS Registry No. N/A
Date Prepared: 7/1/89

Hazard Rating Scale:
0 - Minimal
1 - Slight
2 - Moderate
3 - Serious
4 - Severe

HAZARDOUS INGREDIENTS

Ingredients	CAS #	Percent	PEL	STEL	LV
Asphalt cement	8052-42-4	57-68%	N/A	10mg/m	mg/m
Emulsifier	TSCA	1-3%	N/A	N/A	N/A

PHYSICAL DATA

Boiling Point - 212f
Vapor Pressure - <1
Vapor Density - >0.062
Solubility in water - up to 100%
Specific Gravity @ 60f - 1.025 to 1.06
Melting Point - N/A
Evaporation Rate - <1
Appearance and Odor - Viscous brown to black liquid ; odor of amines and hydrocarbons

FIRE AND EXPLOSIVE DATA

Flash Point - N/A
Autoignition Temperature NFPA - N/A
Extinguishing Media - CO2, Class "B" extinguisher, foam and water fog.
Special Fire Fighting Procedures - Avoid breathing vapors, wear self-contained breathing apparatus.
Unusual Fire Explosion Hazards - DO NOT heat material above 212f to avoid generating excessive steam pressure.

REACTIVITY DATA

Stable: X Unstable:

Conditions to Avoid	-	DO NOT HEAT ABOVE 212f, Ignition sources.
Incompatible Materials	-	Avoid strong oxidizing agents
Hazardous Decomposition Products	-	Combustion may form CO2, CO, and sulfur dioxide.
Hazardous Polymerization	-	Will not occur.

HEALTH HAZARD DATA

Route of Exposure	Primary Route	Signs and Symptoms
Inhalation	[X]	Use with good ventilation. May cause respiratory tract irritation
Skin Absorption	[ ]	No significant symptoms indicative of skin absorption expected.
Skin Irritation	[X]	Will cause burns when product is hot. May cause dermatitis and acne like lesions on prolonged exposure.
Ingestion	[ ]	May cause nausea and diarrhea.
Eye Contact	[X]	Will burn and irritate.

Listed as Carcinogen? Not listed by NTP, IARC, or OSHA.

EMERGENCY FIRST AID

Inhalation:	Remove to fresh air. Give oxygen or artificial respiration as needed Obtain medical attention promptly.
Eye Contact:	Flush eyes with low pressure water for at least 15 minutes and obtain medical attention immediately.
Skin Contact:	If product is hot, cool with cold water. Otherwise wash thoroughly with soap and water.
Ingestion:	Call physician. Do not induce vomiting.

PROTECTIVE EQUIPMENT / CONTROL MEASURES

Respiratory Protection:	Avoid breathing vapors in confined spaces. NIOSH approved respirators may be required if TLV's are exceeded.
Eye Protection:	Use safety glasses, goggles or face shields.
Skin Protection:	Use rubber gloves, coveralls and impervious footwear.
Engineering controls:	Local exhaust ventilation may be required to meet exposure standards in confined areas.
Handling Precautions:	Avoid heating over 212f.

REVISION #1

LABEL INFORMATION

Chemical name: Asphalt Cements
Common name: Penetration Graded Asphalt AASHTO M-20;
Viscosity Graded Asphalt AASHTO M-226.

DANGER! VAPOR HARMFUL
DO NOT INTRODUCE WATER

Keep away from flames and other sources of ignition
Stable unless moisture is introduced
Extinguishing media - CO_2 or Class 'B' extinguisher
DO NOT APPLY WATER
Avoid breathing vapors. May contain low concentrations of hydrogen sulfide. Wear self-contained breathing apparatus when fire fighting. May cause dermatitis and acne lesions on prolonged and repeated exposure. Can cause severe burns when hot material contacts unprotected skin. Wear chemical resistant gloves, goggles or face shield, long sleeve shirt and pants. Use NIOSH approved respirator if TVL's are exceeded.

FIRST AID

Inhalation - Remove victim to fresh air. Start artificial resuscitation if necessary. Call a physician.

Eyes - Flush eyes with water for at least 15 minutes. Call a physician.

Skin- If hot material contacts skin, place affected part in cold water. Have a physician remove material or for small amounts use mineral oil for removal.

Ingestion - If ingested call a physician.

For further information refer to data sheet for Asphalt Cements.

Farmers Union Central Exchange, Inc. (CENEX)
P. O. Box 909
Laurel, Montana 59044
Telephone: (406)628-4311 or (406)628-4518

REVISION #1

CENEX

FARMERS UNION CENTRAL EXCHANGE, INC.

P.O. Box 909, Laurel, Montana 59044

Asphalt Cements
Quick Identifier

MATERIAL SAFETY DATA SHEET

The information contained herein is based on data considered accurate, however, no warranty is expressed or implied regarding the accuracy of these data or the results to be obtained from the use thereof. Vendor assumes no responsibility for injury to vendee or third person proximately caused by the material if reasonable safety procedures are not adhered to as stipulated in the data sheet. Additionally, vendor assumes no responsibility for injury to vendee or third persons proximately caused by abnormal use of the material even if reasonable safety procedures are followed. Furthermore, vendee assumes the risk in his use of the material.

SECTION 1 GENERAL

Manufacturer's Name: Farmers Union Central Exchange, Inc. (CENEX)

Emergency Telephone No. 406/628-4518 | Information Telephone No. 406/628-4311

Chemical Name: Asphalt Cements | Date Prepared: 9/20/85

Chemical Family: Petroleum Asphalt Cements

Common Name(s): Penetration graded asphalt AASHTO M-20; Viscosity graded asphalt AASHTO M-22(

SECTION 2 HAZARDOUS INGREDIENTS/IDENTITY

This product, when heated above the softening point, may contain low concentrations of hydrogen sulfide. This gas, at low concentrations, may be irritating to eyes, skin and respiratory tract.

OSHA PEL: Petroleum Asphalt Cement Not Available

ACGIH TLV'S: Asphalt Cements - 5mg/m^3 Fumes; STEL - 10mg/m^3

SECTION 3 PHYSICAL/CHEMICAL CHARACTERISTICS

Boiling Point	Above 1050°F	Specific Gravity	1.02-1.06
Vapor Pressure	<1	Melting Point	Unknown
Vapor Density	>1	Evaporation Rate	Unknown

Solubility in Water: No

Appearance and Odor: Black semi-solid thermoplastic material; odor of hydrocarbon.

Becomes liquid above 90-130°F

SECTION 4 FIRE AND EXPLOSION HAZARD DATA

Flash Point in Degrees F (Method Used)	Above 325°F COC (D-92)	Flammable Limits in air % by volume	LEL Unknown	UEL Unknown

Extinguishing Media: CO_2 and Class 'B' extinguisher

Special Fire Fighting Procedures: Avoid breathing vapors, wear self-contained breathing apparatus. DO NOT APPLY WATER.

Unusual Fire and Explosion Hazards: Flammable at temperatures above 500°F.

DO NOT MIX WITH WATER.

SECTION 5 REACTIVITY DATA

Stability	Unstable		Conditions to Avoid	Stable unless moisture is introduced
	Stable	X		Flames and other sources of ignition

Incompatability (Materials to Avoid): Water, hydrocarbon solvents, strong oxidizing agents

Hazardous Decomposition Products: Fumes, smoke, carbon monoxide in the case of incomplete combustion

Hazardous Polymerization	May Occur	REC 4365	Conditions to Avoid	
	Will Not Occur	X		

SECTION 6 HEALTH HAZARDS

Acute Will cause severe burns if hot material contacts unprotected skin.

Chronic Respiratory tract irritation

Signs & Symptoms of Exposure May cause dermatitis and acne like lesions on prolonged and repeated exposure to dust or vapors.

Medical Conditions Generally Aggravated by Exposure Respiratory disease and infection; cardiovascular diseases

Chemical Listed as Carcinogen or Potential Carcinogen	National Toxicology Program	Yes	No	X	IARC	Yes	No	X	OSHA	Yes	No	X

ROUTES OF ENTRY WITH EMERGENCY & FIRST AID PROCEDURES

1. Inhalation Remove victim to fresh air. Start artificial resuscitation if necessary. Call a physician.
2. Eyes Flush eyes with water for at least 15 minutes. Call a physician.
3. Skin If hot material contacts skin, place affected part in cold water. Have a physician remove material or for small amounts use mineral oil for removal.
4. Ingestion If ingested call a physician.

SECTION 7 SPECIAL PRECAUTIONS

Precautions to be Taken in Handling and Storing Never introduce water when hot. Avoid skin exposure to hot material. Avoid breathing vapors in confined spaces. Avoid sources of ignition.

Shipping Information DOT ID #NA1999 - No Placard Required

Steps to be Taken in Case Material is Spilled or Released In case of spillage allow to cool and pick up when solid or semi-solid. Have proper extinguishing media present.

Waste Disposal Methods Handle in accordance with federal, state and local regulations.

SECTION 8 CONTROL MEASURES

Ventilation 1. Local Exhaust 2. Mechanical — If possibility of vapor or fume accumulation exists, utiliz explosion proof ventilating equipment, to avoid toxic or explosive concentrations.

Protective Gloves Chemical Resistant

Eye Protection Goggles or Face Shield

Respiratory Protection (Specify Type) Use appropriate NIOSH approved respirator if TLV's are exceeded.

Other Protective Clothing or Equipment Long sleeve shirt and pants to minimize skin contact.

Work & Hygienic Wash exposed skin with soap and water after work periods and before

DRAFT

Idaho Division of Environmental Quality

Air Permitting Screening Policy for Air Strippers used in the Cleanup of Petroleum Contaminated Groundwater

DRAFT

This policy is designed to quickly identify air stripper cleanups of petroleum contaminated ground water which pose limited risk to the public through the air pathway, and to expedite the approval for such air emissions. This policy is designed to work together with DEQ's Screening Model and Risk Assessment Procedures For Air Quality Permitting of Vapor Extraction Systems and Air Stripping Used for Leaking Underground Storage Tank Cleanup. Version 1.0 of that document is being updated to include this screening policy for air stripping.

The policy is implemented through a simple question and answer form (a copy of which follows), which conservatively estimates the significance of the emissions given the distance to the nearest property boundary or receptor. Sources with relatively insignificant emissions, as determined by answering the questions on the form and documented as required on the form, are offered DEQ review and final action within two weeks of the date of receipt. This significantly accelerates DEQ turnaround time to expedite the cleanup, since the timeline on processing air permit applications is typically 90 days or more.

For the purposes of this policy, a sensitive receptor is defined as any building or location occupied or frequented by persons who, due to age, infirmity or other health based criteria as defined by the Division of Environmental Quality, may be more susceptible to the deleterious effects of a toxic air pollutant(s) than the general population. Examples of sensitive receptors include but are not limited to: elementary and secondary schools, licensed day care centers, playgrounds and parks, hospitals, clinics and nursing homes.

The existence of a sensitive receptor within 500 feet of the proposed action will not necessarily result in a permit denial, but will trigger tighter DEQ scrutiny of risks to the surrounding population.

This screening policy does not supersede any other DEQ policies or requirements, but instead complements existing DEQ policies by identifying low risk sources, removing them from the standard air permit workload, and accelerating their review. Sources not approvable through this screening policy still may be approvable through the DEQ air quality permitting program. In those cases, a more thorough risk assessment will be required and DEQ review will remain on traditional timelines.

DRAFT

AIR PERMIT SCREENING TEST FOR AIR STRIPPING PETROLEUM CONTAMINATED WATER

Company/facility name _____
Facility address _____

A. PRESENCE OF SENSITIVE RECEPTORS

Is the proposed air stripping site located within 500 feet of a sensitive recepto: defined in the attached Air Permitting Screening Policy for Air Strippers used i: Cleanup of Petroleum Contaminated Ground water?

YES _____ NO _____

B. CALCULATE UNCONTROLLED BENZENE LEVELS IN AIR EMISSIONS

1. Flow rate of water into Air Stripper in gallons per minute. The proposed flow must have DEQ approval. The proposed flow rate must be sufficient to adequ: control, contain, and remove the petroleum contamination. Please a: documentation verifying DEQ approval of the proposed flow rate.

_____ gal./min.

2. Convert flow rate to liters per minute.
Multiply line 1 by 3.785. _____ *l*/min.

3. Determine Benzene concentration in ground water.

Is free product present in any ground water well associated with this petroleum release site? YES _____ NO _____

a. If you marked YES, you must conduct a pilot test to determine expected ber concentrations. See the attached "Directions for Conducting a Pilot Tes Determine Benzene Concentrations in Ground Water" for more information. I the benzene concentration here.

Benzene concentration from pilot test = _____ ppb (ug,

b. If you marked NO and free product is <u>not</u> present in any well, determine benzene concentration in the ground water by one of the following two meth

i. Enter the Benzene concentration from a ground water well with the hic benzene concentration. Use only the most recent analysis.

Benzene concentration from single well = _____ ppb (ug,

ii. Conduct a pilot test to determine benzene concentrations following directions of the attached "Directions for Conducting Pilot a Tes Determine Benzene Concentrations in Ground Water."

Benzene concentration from pilot test = _____ ppb (ug,

4. Calculate benzene flow rate to air stripper.
Multiply line 2 by line 3a or 3b, whichever is appropriate. _____ ug/min.

5. Convert uncontrolled benzene air emission rate from ug/min to lbs/day. Multiply line 4 by 3.18E-6. _____ lbs./day

B. CALCULATION OF MAXIMUM ALLOWABLE BENZENE EMISSION RATE

6. a. Distance to nearest property line. _____ ft
b. Distance to nearest offsite structure serving as a workplace or residence _____ ft

DRAFT

7. **Allowable Benzene emission level.**

a. Divide Line 6a by 100. _____
b. Divide line 6b by 200. _____
c. Enter the larger of line 7a or Line 7b _____
d. Enter the value 1.5 or the result from 7c, whichever is smaller. _____ lbs./day

The result in line 7d is the maximum allowable benzene emission rate for the proposed stripping operation at this site. Is the uncontrolled emission rate for benzene in li less than the maximum allowable benzene emission level in line 7d?

Yes ____ Control of benzene air emissions shall not be required. You ay skip Sec C. of this form and proceed directly to Section D. Document all data ent and enclose complete set of most recent water sampling results, a site map c to scale showing monitoring wells, and your monitoring plan. Send them with form to Division of Environmental Quality, Permits and Enforcement Program, N. Hilton, Boise, ID 83706.

No ____ Control of benzene air emissions shall be required. Call (208) 334-5898 review air quality permit requirements or proceed to the following page complete questions on emissions controls.

C. **CALCULATE CONTROLLED BENZENE LEVELS IN AIR EMISSIONS**
(please complete lines 1 to 7 before proceeding with this section)

8. Describe the type of emissions control you propose to use.

_____
_____
_____

9. Control Efficiency (0 < eff. < 1) 0.

10. 1.0 - Control Efficiency 0.

11. Enter uncontrolled benzene air emission rate from line 7 on reverse side. _____ lbs/day

12. Controlled benzene emissions Multiply lines 10 and 11. _____ lbs/day

Is the controlled emission rate for Benzene in line 12 less than the maximum allow Benzene emission rate calculated in line 7d?

Yes ____ Document all data entries and enclose complete set of most recent water samp results, a site map drawn to scale showing monitoring wells, your monito plan, and documentation on the control equipment (manufacturer's specificatio its application at the proposed site, and its efficiency if credit is take emission controls through this process. Send them with this form to Div of Environmental Quality, Permits and Enforcement Program, 1410 N. Hilton, Bo ID 83706.

No ____ Call (208) 334-5898, to review air quality permit requirements with DEQ staff

D. **SIGNATURE AND CONTACT INFORMATION**

Applications approved through this process will be required to document emissions rat DEQ during the initial two months of operation. Emissions rates exceeding those calcu above may result in further emissions limitations. DEQ may, in its sole discretion, rec modification to any project plans in order to protect public health.

_____ _____
Signature of preparer

DRAFT

( ) _____ Phone number REC 4371

DRAFT

Directions for Conducting a Pilot Test to Determine Benzene Concentrations in Ground Water (Air Stripping)

Benzene emission rates in air associated with air stripping operations are estimated using a benzene concentration in ground water. These data are then used to determine whether air emissions from the air stripping equipment require controls. The Division of Environmental Quality (DEQ) has determined that a short-term, full-scale pumping test with ground water sampling is an appropriate method for determining the benzene concentration in ground water in some cases. This procedure is required for determining benzene concentrations in ground water when free product is present in monitoring or recovery wells. It is also an acceptable, but not required, method of determining benzene concentrations when free product is not present.

For purposes of this guidance, the term "pilot test" shall mean the process of pumping ground water from the contaminated subsurface in the area targeted for remediation. Water samples shall be collected for laboratory analysis to determine benzene concentrations prior to treatment by the air stripping equipment. The criteria contained herein are designed specifically as a means of determining the concentration of benzene in pumped ground water. It may be possible to modify an aquifer test (designed to determine subsurface hydraulic parameters) conducted during site investigation work to obtain the same data. Alternatively, it may be appropriate to design or modify the pilot test so that subsurface hydraulic parameters are determined along with the expected benzene concentration.

Note that DEQ does not require air stripping equipment to be installed prior to conducting the pilot test. The pilot test may be conducted at any time within the site investigation as long as the benzene concentration is not likely to increase appreciably over time and site conditions are expected to be comparable between the time of sampling and cleanup. The criteria to be followed in performance of an acceptable pilot test are:

- Pumping shall take place from recovery well(s) expected to be used in the full-scale cleanup.

- The pumping rate shall be the same rate used in the full-scale cleanup. Usually, the pumping rate is approved by DEQ

REC 4372

through submission of a written cleanup plan. The pumping system shall operate continuously at the desired rate for a minimum of two (2) hours and a maximum of twelve (12) hours. Upon completion of pumping, one (1) grab sample shall be collected and analyzed for benzene, toluene, ethylbenzene, and xylenes (BTEX).

- One (1) duplicate sample shall be collected and analyzed for BTEX. Duplicate sample analyses must result in a relative percent difference (RPD) of 25% or less.

- Samples shall be collected from the pumping system at a location representative of inflow to the air stripper but after any preliminary treatment equipment (i.e., oil/water separators, etc.).

- The laboratory analysis method must be an EPA-approved method and must have a lower detection limit of no greater than one (1) ug/l (ppb). Sampling must be conducted in accordance with the RCRA Ground Water Monitoring Technical Enforcement Guidance Document (National Water Well Association, 1986) or equivalent.

- Contaminated water generated during the pilot test must be treated or disposed of in a safe and acceptable manner. On-site storage prior to treatment system completion is acceptable as long as all applicable regulations and ordinances are followed. The treatment and disposal of all generated wastes are the sole responsibility of the person(s) conducting the pilot test.

C. List appropriate soil sample analytical results from excavated contaminated soil. Samples collected shall be representative of the respective stockpiled PCS. If the petroleum is not gasoline or fuel oil, attach separate table.

col.1 Stockpile volume (yd^3)	col.2 Sample I.D.	col.3 Sample type TPH-Gas TPH-Diesel	col.4 Grab or composite sample?	col.5 Sample TPH (ppm)	col.6 Average TPH per stockpile	col.7 Multiply average TPH (col. 6) by stockpile volume (col. 1)
_____	_____	_____	_____	_____		
	_____	_____	_____	_____		
	_____	_____	_____	_____		
	_____	_____	_____	_____		
	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____		
	_____	_____	_____	_____		
	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____		
	_____	_____	_____	_____		
	_____	_____	_____	_____	_____	_____

sum of col. 1 _____ sum of col. 7 = _____

Note: Copies of lab results and chain of custody forms must be included.

IV. **Screening test for air emissions.**

A. Calculate average TPH for all PCS to be treated.

1. Enter TOTAL TPH x VOL. (sum of col. 7) here. _____
2. Enter TOTAL VOLUME (sum of col. 1) here. _____
3. Calculate AVERAGE TPH. Divide line 1 (TOTAL TPH x VOL.) by line 2 (TOTAL VOLUME) and enter quotient here. _____

B. Refer to table 2 to determine setback requirement based upon the TOTAL VOLUME and AVERAGE TPH values calculated above. Enter the setback requirement here. _____

Note: If the setback requirement is greater than the distance to the nearest building or residential property line appearing in line II.D, then the land-treatment proposal will not be approved under this expedited format and further review of the land-treatment proposal will be required.

V. **Include the following figures:**

A. Copy of county soil survey map (if the county has been mapped) with copies of the interpretation tables or sheets. CLEARLY MARK location of site on the soil map.

B. Map with exact land treatment site location marked.

VI. **Proposed end use of PCS:** _____

_____

_____

****

_____
Applicant's signature

_____ ( ) _____
Date Telephone

Consultant (or other) preparing this form

Company name_____

Street_____

City, zip_____

Telephone_____

DRAFT

DRAFT

OFFSET DISTANCES FOR LANDFARMING GASOLINE PETROLEUM CONTAMINATED SOIL

(Distances given in feet)

TOTAL PETROLEUM HYDROCARBON CONCENTRATIONS (PPM)

CUBIC YARDS OF MATERIAL

	150	200	250	300	350	400	500	600	700	800	900	1000	1200	1400	1500	1600	1800	2000	2200	2400	2600	2800	3000	3500	4000
50	50	50	50	50	50	50	50	50	50	50	53	60	74	87	94	100	113	125	137	148	160	170	181	206	229
100	50	50	50	50	50	50	50	53	65	76	87	98	119	140	149	159	177	195	212	229	244	260	274	309	343
150	50	50	50	50	50	50	57	72	87	101	116	129	156	181	193	205	227	249	270	290	310	329	355	396	436
200	50	50	50	50	50	52	70	89	106	123	140	156	187	216	230	243	270	295	319	343	367	390	412	462	511
250	50	50	50	50	51	62	83	104	124	143	161	179	214	247	262	278	308	336	364	392	420	445	470	530	588
300	50	50	50	50	59	71	95	117	139	160	181	201	239	275	292	309	343	379	408	437	466	495	523	590	656
350	50	50	50	53	66	79	104	128	150	171	191	210	244	301	320	339	376	412	448	485	522	562	603	719	858
400	50	50	50	59	73	88	115	142	167	192	216	239	284	326	347	367	407	445	482	517	552	587	621	703	781
450	50	50	50	65	80	95	125	153	180	207	232	257	304	350	372	394	437	477	516	555	593	630	667	755	839
500	50	50	54	70	87	103	134	164	193	220	247	273	324	373	397	420	464	508	550	591	632	672	711	804	894
550	50	50	58	76	93	110	142	174	204	234	262	290	343	395	420	444	491	537	582	626	669	712	753	852	947
600	50	50	62	81	99	116	151	184	215	246	276	305	361	417	442	468	517	566	614	660	706	750	794	898	998
650	50	50	66	86	104	123	159	193	226	258	289	320	381	436	464	490	543	594	644	693	741	788	833	943	1047
700	50	50	70	90	110	129	165	202	237	270	303	335	396	453	481	508	562	613	663	711	757	801	843	942	1028
750	50	53	74	95	115	135	174	211	247	282	315	352	414	475	505	534	592	648	703	756	808	859	909	1026	1141
800	50	56	78	99	120	141	181	219	257	293	328	365	430	493	525	555	615	674	731	786	840	893	945	1065	1186
850	50	59	81	104	125	147	188	228	265	304	340	376	446	512	544	576	638	699	758	816	872	927	980	1108	1230
900	50	62	85	108	130	152	195	236	275	314	352	389	461	530	563	596	661	724	785	845	903	959	1015	1147	1273
950	50	64	88	112	135	158	201	244	285	325	364	403	476	547	582	616	683	748	811	873	933	991	1048	1185	1315
1000	50	67	92	116	140	163	209	251	294	335	375	415	491	564	600	635	705	772	837	901	962	1023	1081	1222	1356
1050	50	70	95	120	144	168	214	259	302	345	386	426	506	581	618	655	726	795	862	928	991	1053	1114	1259	1397
1100	50	72	98	124	149	173	220	266	311	355	396	439	520	596	636	673	747	818	887	954	1020	1083	1146	1295	1436
1150	50	75	101	127	153	178	226	274	319	364	409	451	534	614	653	692	767	840	911	980	1048	1113	1177	1330	1476
1200	50	77	104	131	157	183	232	281	328	374	420	463	549	630	670	710	787	862	935	1006	1075	1142	1207	1365	1514
1250	51	80	107	135	161	187	239	286	336	383	430	474	562	646	687	726	807	884	959	1031	1102	1171	1238	1399	1552
1300	53	82	110	138	165	192	244	295	344	393	440	486	575	662	704	745	827	905	982	1056	1128	1199	1267	1432	1589
1350	55	84	113	142	169	197	250	301	352	402	450	497	588	677	720	763	846	926	1005	1081	1154	1226	1297	1465	1626
1400	56	87	116	145	173	201	255	308	360	411	460	508	602	692	736	780	865	947	1027	1105	1180	1254	1325	1496	1662
1450	58	89	119	148	177	206	261	315	368	420	470	519	615	707	752	797	884	968	1049	1129	1206	1281	1354		
1500	60	91	122	152	181	210	266	321	375	428	479	529	627	722	766	813	902	988	1071	1152	1231	1307	1382		

REC 4375

DRAFT

OFFSET DISTANCES FOR LANDFARMING DIESEL CONTAMINATED SOIL

(Distances given in feet)

TOTAL PETROLEUM HYDROCARBON CONCENTRATIONS (PPM)

CUBIC YARDS OF MATERIAL	150	200	250	300	350	400	500	600	700	800	900	1000	1200	1400	1500	1600	1800	2000	2200	2400	2600	2800	3000	3500	4000
50	50	50	50	50	50	50	50	50	50	50	53	60	74	87	94	100	113	125	137	148	160	170	181	206	229
100	50	50	50	50	50	50	50	53	65	76	87	98	119	140	149	159	177	195	212	229	244	260	276	300	300
150	50	50	50	50	50	50	57	72	87	101	116	129	156	181	193	205	227	249	270	290	300	300	300	300	300
200	50	50	50	50	50	52	70	89	106	123	140	156	187	216	230	243	270	295	300	300	300	300	300	300	300
250	50	50	50	50	51	62	83	104	124	143	161	179	214	247	262	278	300	300	300	300	300	300	300	300	300
300	50	50	50	50	59	71	95	117	139	160	181	201	239	275	292	300	300	300	300	300	300	300	300	300	300
350	50	50	50	53	66	79	104	128	150	171	191	210	244	300	300	300	300	300	300	300	300	300	300	300	300
400	50	50	50	59	73	88	115	142	167	192	216	239	284	300	300	300	300	300	300	300	300	300	300	300	300
450	50	50	50	65	80	95	125	153	180	207	232	257	300	300	300	300	300	300	300	300	300	300	300	300	300
500	50	50	54	70	87	103	134	164	193	220	247	273	300	300	300	300	300	300	300	300	300	300	300	300	300
550	50	50	58	76	93	110	142	174	204	234	262	290	300	300	300	300	300	300	300	300	300	300	300	300	300
600	50	50	62	81	99	116	151	184	215	246	276	300	300	300	300	300	300	300	300	300	300	300	300	300	300
650	50	50	66	86	104	123	159	193	226	258	289	300	300	300	300	300	300	300	300	300	300	300	300	300	300
700	50	50	70	90	110	129	166	202	237	270	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
750	50	53	74	95	115	135	174	211	247	282	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
800	50	56	78	99	120	141	181	219	257	293	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
850	50	59	81	104	125	147	188	228	268	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
900	50	62	85	108	130	152	195	236	275	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
950	50	64	88	112	135	158	201	244	285	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
1000	50	67	92	116	140	163	208	251	294	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
1050	50	70	95	120	144	168	214	259	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
1100	50	72	98	124	149	173	220	266	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
1150	50	75	101	127	153	178	226	274	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
1200	50	77	104	131	157	183	232	281	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
1250	51	80	107	135	161	187	238	288	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
1300	53	82	110	138	165	192	244	295	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
1350	55	84	113	142	169	197	250	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
1400	56	87	116	145	173	201	255	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
1450	58	89	119	148	177	206	261	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
1500	60	91	122	152	181	210	266	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300

REC 4376

Idaho Department of Health and Welfare

Responses to Comments and Questions Submitted
During a Public Comment Period and Public Hearings
on the Proposed Repeal and Reissuance of
Rules for the Control of Air Pollution in Idaho

INTRODUCTION

The Notice of Proposed Rules for the Idaho Department of Health and Welfare's proposed repeal and reissuance of the Rules for the Control of Air Pollution was published in the Administrative Bulletin on September 3, 1993. The public comment period for the proposed rules was held from September 3, 1993 through October 8, 1993. Hearings were held in Coeur d'Alene, Pocatello and Boise, Idaho on September 30, October 5 and October 7, 1993, respectively. In addition, the portions of the proposed rules addressing toxic air pollutants were released for public comment in accordance with the old Administrative Procedures Act from March 12, 1993 through April 21, 1993. Hearings were held in Idaho Falls, Coeur d'Alene, Pocatello, Lewiston, Twin Falls and Boise, Idaho on April 6, March 23, March 24, March 24, March 25 and March 29, respectively.

IDHW is proposing a repeal and reissuance of the chapter due primarily to the extensive renumbering, restructuring and reformatting requirements of the Administrative Rules Coordinator. Most sections of the rules are not substantively affected by this rulemaking, and thus, comments regarding such sections are not considered to be substantive.

Substantive public comments which concern the proposed rulemaking have been summarized below. Each comment is followed by the Department's response. Some comments have been combined and paraphrased in order to eliminate duplication and provide a clearer summary. Each response to a comment discusses only the facts necessary to address the comment.

GENERAL COMMENTS

Comment #1: The State's proposed permitting rule is extremely restrictive; and we believe the State permit program should deviate as little as possible from the federal permitting program, in order to avoid inconsistent liabilities and to protect Idaho from possible loss of primacy.

IDHW Response: Many sections of 40 CFR Part 70 are left to the discretion of the implementing state. The Department has incorporated the basic frame work from 40 CFR Part 70 into these rules while designing an operating permit program that meshes with existing Idaho programs. The Department has incorporated the legislated directive to take advantage of the flexibility authorized in the Clean Air Act into these rules.

Comment #2: The proposed permitting regulations also lack implementing detail. The implementation of these regulations provides the "teeth" to the permitting process.

- **How are PTC/PSDs to be "rolled" into the operating permits?**
- **What is the schedule for submittal of permit applications?**
- **What is the schedule for approval of permit applications?**
- **What is the schedule for reissuing permits after initial approval?**
- **What is the recommended format for permit application?**
- **When will permit application forms be provided?**

IDHW Response: The Department has reworked the Tier I rules in response to this and other similar comments. The final rules have been rearranged to improve the logical organization and to clarify the procedures and requirements of the Tier I operating permit program.

Comment #3: The portions of the rules addressing toxic air pollutants are too complex and confusing.

IDHW Response: The rules have been changed in response to this comment. The rules have been revised and reorganized for the sake of clarity.

Comment #4 : The lists are too broad.

IDHW Response: The rules have not been changed in response to this comment. IDHW has attempted to regulate common industrial chemicals for which there is adequate data and for which there may be a reasonable anticipation of exposure to the public. There are currently millions of industrial chemicals in use. There is health data on about 70,000. IDHW is currently proposing to regulate less than 600 non-carcinogenic chemicals and less than 100 carcinogenic chemicals. Lacking a comprehensive emissions inventory, it is impossible to develop a list of regulated substances that take into account only those substances actually emitted at this time in Idaho. Processes change, and new business start so this sort of a "snapshot in time" list of chemicals becomes problematic if not impossible. Finally, if we do not have a reasonable program to control TAP in Idaho, both present and future, we run the risk of becoming a "toxic magnet" for businesses desiring to move to a more unregulated area.

After receiving similar comments after the withdrawn toxics rulemaking we reviewed the proposed list with such comments in mind and removed a number of compounds that we agreed did not materially add to the protection of the public health or the environment. It is IDHW's position that the TAP lists as currently compiled are a reasonable compromise between the need of industry to do business and the need to protect human health and the environment.

Comment #5 : The regulatory levels are too stringent.

IDHW Response: The rules have not been changed in response to this comment. IDHW has attempted to strike a balance between the needs of industry to do business and the need to protect human health and the environment. We believe that IDHW formula for figuring ambient and emissions levels for both carcinogen and non-carcinogens alike is reasonable and strikes the above noted balance. Finally, when compared to the ambient levels of other states, the ambient levels developed and adopted by IDHW are within regulatory norms.

Comment #6: The proposed regulations require too much IDHW involvement in the permitting process. Deminimis levels should be provided and department approved language should be eliminated.

IDHW Response: The rules have not been changed in response to this comment. The proposed rules and the rules as proposed for adoption already provide "deminimis levels" for permits to construct. If the source is not otherwise required to obtain a permit to construct, emissions of toxic air pollutants that are below the screening emissions levels are exempted without further action by the owner or operator of the source and emissions of toxic air pollutants that are above the screening emissions levels but below the acceptable ambient concentrations are exempted upon sending notice of the emissions to IDHW. If the source is otherwise required to obtain a permit to construct, emissions of toxic air pollutants that are below the screening emissions level are analyzed quickly. Emissions that are above the screening emissions level may be analyzed using several methods.

Deletion of the language requiring approval by IDHW would eliminate IDHW's oversight responsibility and allow the owners and operators of sources to decide for themselves whether they should receive a permit.

Comment #7: IDHW should adopt rules requiring an applicant to demonstrate compliance with the National Environmental Policy Act (NEPA) and DOE Orders in order to receive an air quality permit. Also recommend procedures for ensuring compliance with NEPA and DOE Orders.

IDHW Response: The rules have not been changed in response to this comment. IDHW believes that the Board of Health and Welfare may not be authorized by the air quality provisions of the Environmental Protection and Health Act to adopt rules requiring an applicant to demonstrate compliance with NEPA and DOE Orders in order to receive an air quality permit.

Comment #8: **Include a table of contents.**

IDHW Response: The form of the rules is dictated by the Office of the Administrative Rules Coordinator (ARC). The ARC does not publish a table of contents in the Administrative Bulletin, however, a table of contents for the final rules will be available in other publications and services.

Comment #9: **By restructuring and streamlining the federal regulation as a state rule, the requirements of 40 CFR 70.1(b), 70.7(b), and 70.7(c)(iii) that a source have and comply with a Title V permit has been omitted. In order for the Idaho operating permit program to be approvable, it must clearly require that all the affected sources must have an operating permit and must operate in compliance with that permit.**

IDHW Response: The Department has modified the rules in response to this comment. A prohibition has been added in Section 301.

Comment #10: **The existing Idaho rules regarding confidentiality of business information are too broad and may provide prohibit the public release of information on emissions or other materials in a permit application. In order for the Idaho operating permit program to receive full approval, these confidentiality rules must be revised to be consistent with the requirements of §114(c) of the Clean Air Act and 40 CFR 70.4(b)(3)(vii).**

IDHW Response: The Department has modified the rules in response to this comment. Section 126 has been modified to match a change in Idaho statute effective January 1, 1994. The change requires a person to certify that the information designated as confidential qualifies in accordance with Idaho Code 39-111.

Comment #11: **Although it is acceptable for Idaho to forego adopting phase II acid rain permitting requirements at this time (provided the Governor commits to timely adoption and submittal of rules for phase II permits), Idaho must adopt at this time all of the Title V permit provisions which relate to Title IV (acid rain) sources. The Title V provisions are necessary to address the potential need to permit some Title IV affected sources (e.g., new units, opt-in units) under Title V prior to the effective date of Phase II permits.**

IDHW Response: The Department believes the modifications to Sections 300 through 399 have addressed this comment. Responses to specific comments on Acid Rain provisions can be found in later sections of this document.

Comment #12: The rules do not address interstate contributions to air pollution.

IDHW Response: The rules have not been changed in response to this comment. This is beyond the scope of this rulemaking.

Comment #13: Some concern was expressed over the cost to regulate the substances on our appendices.

IDHW Response: The rules have not been changed in response to this comment. Under the current rule addressing toxic substances, IDHW has been regulating a broader list of chemicals than is regulated by the toxic air pollutants carcinogenic and noncarcinogenic increments. IDHW expects the costs per source to decrease as a result of this rulemaking.

Comment #14: It is unfair that these rules apply only to new sources.

IDHW Response: The rules have not been changed in response to this comment. The new portions of the rules addressing toxic air pollutants apply only to the net emissions increases from new and modifying sources of toxic air pollutants. It is common for new rules to "grandfather" existing sources and exempt them from compliance with the new rule. The existing portions of the rules regulating toxic substances will be applicable to all sources of toxic substances, including existing sources. The toxic substances rule will be implemented through the Tier II operating permit program on a case-by-case basis.

Comment #15: It will be nearly impossible for sources, especially small ones to identify what may come out of their stack.

IDHW Response: The rules have been changed in response to this comment. New section 210.01 has been added to provide information regarding how to identify toxic air pollutants emitted by the source.

Comment #16: IDHW has inadequate resources to enforce the requirements of the permit to construct program in general, and the new rules addressing toxic air pollutants in particular.

IDHW Response: The rules have not been changed in response to this comment. Under the current rule addressing toxic substances, IDHW has been effectively regulating a broader list of chemicals than is regulated by the toxic air pollutants carcinogenic and noncarcinogenic increments. IDHW expects to receive adequate

resources to implement and enforce the proposed rules addressing toxic air pollutants.

Comment #17: Any rules more stringent than the federal regulations must be approved by the legislature which may cause Idaho to have only the EPA minimums.

IDHW Response: The rules have not been changed in response to this comment. Idaho Code § 39-118B states in part "...that where EPA adopts or has adopted a specific standard, emission limitation or control technology requirement under the clean air act a more stringent standard, emission limitation or control technology requirement promulgated by the board shall not become effected until specifically approved by statute." The terms "specific standard," "specific emission limitation" and "specific control technology requirement" limit the scope of the section, and thus, the section is not applicable to "any state rule" as suggested by the commenter. In addition, the rules addressing toxic air pollutants are not more stringent than any such federal provision and will not need statutory approval to become effective.

Comment #18: Does EPA have to approve state air toxics rules?

IDHW Response: The rules have not been changed in response to this comment. With few exceptions, Idaho's air quality programs are adopted and implemented under state authorities. Federal approval of state air quality programs is only necessary to avoid federal sanctions and obtain federal benefits. The toxic air pollutant program is not mandated by the federal Clean Air Act and IDHW does not expect to submit them to EPA for federal approval.

Comment #19: The IDHW makes its permitting decisions based only on the data that the source provides.

IDHW Response: The rules have not been changed in response to this comment. IDHW conducts a thorough engineering review of all data submitted by the applicant. This data is checked for completeness and accuracy. A permit is issued only after IDHW engineers, meteorologists and other professionals are satisfied that the data submitted are complete and accurate. Furthermore follow up source testing and other appropriate methods for demonstrating actual and continuing compliance are required in permits.

Comment #20: It was suggested that IDHW determine T-Ract for source categories. Additionally, the question was asked, how will IDHW know what control technology is available for each regulated chemical.

IDHW Response: The rules have not been changed in response to this comment. Industries in Idaho are dissimilar enough in process to make this very difficult.

Any given control technology will control more than one specific substance. There is substantial literature available on what technologies control what categories of substances. IDHW will work with the applicants on a case by case basis to identify T-RACT.

Comment #21: A few commenters suggested that the IDHW restrict its new source review policy to the list of 189 substances listed in Section 112 of Title Three of the 1990 Clean Air Act Amendments (CAAA).

IDHW Response: The rules have not been changed in response to this comment. It is the position of the IDHW that this is not in the best interests of the people of Idaho for a number of reasons.

First, the EPA 189 list is not an attempt to protect people or the environment of any specific area but a compromise list to address some of the major nation-wide air pollution source types of air pollution. The EPA and congress have both reiterated that they do not wish negatively impact current state air toxics programs. The original proposed list contained 224 compounds, including ammonia and hydrogen sulfide which were later removed as the result of the political process. We do not believe that this nation-wide effort can be effectively applied to Idaho and be adequate to address the unique Idaho situation.

The EPA 189 list does not include all the well documented carcinogens that have been assigned unit risk factors. State and local agencies need to have the flexibility to protect public health by regulating the emission of TAP into the air.

While it is not possible to predict the future, in a fast growing state like Idaho it is very reasonable to assume that new industries will be moving to Idaho as our work force expands with new residents. In addition, as environmental regulations in California and other states become more restrictive, Idaho will look more attractive to many of these regulated industries. While we certainly want the jobs and incomes that these industries may represent, just as certainly, we do not want to become a "toxic magnet" for polluting industries that other states don't want.

Title III of the Clean Air Act Amendments of 1990 (CAAA) requires EPA to publish a list of source categories and then promulgate maximum achievable control technology (MACT) for the first 40 categories. MACT standards are then required for the rest of the categories on a phased in schedule. If a particular source in Idaho is not addressed in the first 40 source categories, the IDHW without TAP rules, could be unable to address toxic emissions from that source no mater how toxic the emissions might be or in what quantity the emissions may be emitted until EPA finally promulgates MACT standards. Given the past history of EPA deadlines, this is a very real concern. Even if EPA adhered to all

deadlines, some sources would conceivably still be able to emit unregulated toxics until the year 2000, if that source was in the last group to have standards promulgated. It should also be noted that not all sources are covered by these MACT standards. As a consequence, sources not covered by this MACT standard would be unregulated for air toxics in Idaho.

Finally, Congress itself apparently felt that this list was not final. Congress required the EPA to periodically review the list and add pollutants "...which present or may present ...a threat of adverse human health effects (including but not limited to, substances which are known to be, or may be reasonably be anticipated to be, carcinogenic, mutagenic, teratogenic, neurotoxic, which cause reproductive dysfunction, or which are acuity or chronically toxic) or adverse environmental effects..."

COMMENTS ON SPECIFIC SECTIONS OF THE PROPOSED RULES

SECTION 100

Comment #22: **There should be a general exemption from all air quality rules for agriculture and agriculture-related industries. This suggestion was made in the context of several definitions.**

IDHW Response: The rules have not been changed in response to this comment. Most agricultural activities and services are exempted from permit to construct requirements, including those addressing toxic air pollutants. Federal statutes and regulations mandate which sources of total suspended particulates and other air pollutants will be required to obtain Tier I operating permits. Except as prohibited by statute, it is appropriate to retain the ability to review all agricultural practices through the Tier II operating permit program. In addition, many of the definitions identified by the commenter have not been substantively changed by this rulemaking. IDHW does not consider it appropriate to respond to comments concerning aspects of the rules that were not substantively addressed in this rule making, but only renumbered, reformatted and restructured as required by The Administrative Rules Coordinator for this rule making.

Comment #23: **Section 100. DEFINITIONS. Definitions of the term "emissions allowable under the permit," must be added to comply with the requirements of Title V of the Act and 40 CFR Part 70.**

IDHW Response: The Department has incorporated a definition of this term into Section 103 of the final rules.

Comment #24: **Section 100.03. Definitions of Actual Emissions. The phrase added in subpart "6" appears to unnecessarily limit when**

permitted emission rates may be considered actual emissions and should be deleted.

IDHW Response: The Department has not modified the rules in response to this comment. This phrase was added to clarify under what circumstances the Department could consider permitted emission rates to be equivalent to actual emissions.

Comment #25: Section 100.03. Actual Emissions. The phrase "January of the current year or the date on which an application for a permit was filed" must be changed to "a particular date". There are many provisions in the permit rules where the actual emissions of a stationary source or emissions unit will need to be determined for some date in the past and this provision would not allow or provide for that determination.

IDHW Response: The Department has made the suggested modification.

Comment #26: Section 100.06 Agricultural Activities and 100.07 Agricultural Field. As drafted, the definition applies only to the agricultural activities "at the point of cultivation," which immediately exempts all animal husbandry activities. The definition should include all agricultural activities. Revised language was suggested. For Agricultural Field, the phrase for commercial sale should be deleted.

IDHW Response: The rules have been changed in response to this comment. IDHW agrees that these definitions need revision but had concerns with the specific language suggested. The rules now define the term "agricultural activities and services". The Definition of "agricultural field" has been deleted.

Comment #27: Section 100.08. Affected States. This definition should be revised to refer to the State of Idaho and not to any "State in which a Tier I permit...".

IDHW Response: The Department has modified this section of the rules in response to this comment.

Comment #28: Section 100.08. Air Pollutant. The use of the term "air pollutant' is likely to cause some confusion with the term "air contaminant," as used in the Idaho Code Section 39-103.04. Revised language was suggested.

IDHW Response: The rules have not been changed in response to this comment. The definition of "air pollutant/air contaminant" in the rules is consistent with the language and intent of the Environmental Protection and Health Act, Idaho Code §§ 39-101 et

seq., and the federal Clean Air Act, 42 U.S.C. §§ 7401 et seq., so that Idaho may obtain and retain federal delegation of several air quality programs.

Comment #29: Section 100.11. Air Pollutant. This definition must be revised to cover every pollutant regulated under the federal Clean Air Act, not just those covered by the Idaho Act and these rules.

IDHW Response: The Department has modified this section of the rules in response to this comment.

Comment #30: Section 100.12. Air Pollution. This definition should use the term "air pollutant," not "contaminant" since only "air pollutant" is defined herein.

IDHW Response: The Department has incorporated the suggested modification into the rules.

Comment #31: Section 100.15 Definition of Ambient Air quality Standards and Violations. There is no definition of the term "ambient air quality standard." The definition of "ambient air quality violation" suggests that any locality may set standards which would them be enforced by IDHW. There may be some confusion with the Air Toxic Increments being assumed to be "air quality standards."

IDHW Response: The rules have not been changed in response to this comment. Local entities may be able to adopt emission standards or ambient air quality standards depending upon the powers and duties that they have been granted by the Idaho Constitution and Idaho Code. If a local entity adopts such standards, IDHW is required to determine whether a proposed source complies with the standard before issuing a permit to construct. This type of determination is usually accomplished by asking the local entity to certify that the proposed source complies with the local standard. IDHW would probably include terms or conditions in the permit to construct that are relevant to the local standard, and thus, a violation of the local standard would probably also be a violation of the permit to construct. Although IDHW could enforce the permit to construct term directly, in most cases the local entity would take the lead in the matter and initiate an enforcement action.

The Toxic Air Pollutant Carcinogenic and Noncarcinogenic Increments are expressed in terms of an ambient air concentration, but they are not ambient air quality standards.

Comment #32: Section 100.16. Allowance. Note that this definition uses the term "affected unit" which either needs to be defined or replaced with the term "Phase II unit."

IDHW Response: The Department has incorporated the suggested modification into the rules.

Comment #33: In Section 100.16 "Unit" is not defined. Replace "unit" with "emissions unit."

See response to comment #32(the comment above).

Comment #34: Section 100.19. Applicable Requirement. This definition must be revised in a number of ways in order to meet the requirements of Title V:

(1) The parenthetical phrase in the opening sentence must be revised to indicate that applicable requirements are only those that have been promulgated or approved by EPA. Rules promulgated by Idaho that have not been approved by EPA are not applicable requirements for purposes of Title V of the Act.

IDHW Response: The Department has modified this section in response to this comment.

Comment #35: Section 100.19. (2) Subsection (a) must be revised to include any standard or requirement promulgated by EPA under Title I of the Clean Air Act.

IDHW Response: The Department has modified this section in response to this comment.

Comment #36: Section 100.19. (3) Subsection (b) must be revised to include terms and conditions in preconstruction permits issued by EPA under Title I (there are permits issued by EPA before Idaho's preconstruction review program was approved by EPA). Furthermore, the clause beginning with "solely excluding..." must be deleted since this definition by its own terms, only applies to Tier I sources.

IDHW Response: The Department has modified this section in response to this comment. The Department has maintained the clarification that terms and conditions relevant only to toxic air pollutants are not applicable requirements.

Comment #37: Section 100.19. (4) Subsection (c) should be revised to refer to all provisions under section 111 of the Act, such as 40 CFR Part 62.

IDHW Response: The Department has modified this section in response to this comment.

Comment #38: Section 100.19. (5) Subsection (d) should be revised to refer to all provisions under section 112 of the Act, such as 40 CFR Part 63.

IDHW Response: The Department has modified this section in response to this comment.

Comment #39: Section 100.19. (6) Subsection (f) must be revised to reference any monitoring requirements promulgated under Section 504(b) of the Act.

IDHW Response: The Department has modified this section in response to this comment.

Comment #40: Section 100.19. (7) Subsection (h) must be revised to avoid any possible confusion in combing the references to 42 U.S.C. §§ 7511b(e) and (f). We suggest the phrase "and tank vessels" be added after the words "consumer and commercial products."

IDHW Response: The Department has incorporated the suggested modification in the rules.

Comment #41: Section 100.19. (8) Subsection (i) must be revised to include reference to Title VI of the Act since future Title VI requirements could be promulgated under provisions other than 40 CFR. Part 82.

IDHW Response: The Department has modified this section in response to this comment.

Comment #42: Section 100.19. (9) An additional subsection must be added, consistent with the EPA regulations, to include any national ambient air quality standard or increment or visibility requirement under part C of Title I of the CAA as applied to temporary sources.

IDHW Response: The Department has added a section to the rules in response to this comment.

Comment #43: Section 100.25. Best Available Control Technology (BACT). This definition must be revised to include reference to 40 CFR Part 63, since all National Emission Standards for Hazardous Air Pollutants are not included in 40 CFR Part 61.

IDHW Response: The Department has modified this section in response to this comment.

Comment #44: Section 100.26. Collection Efficiency. The term "contaminant" should be changed to "air pollutant."

IDHW Response: The Department did not modify the rules in response to this comment. However, the definition of air pollutant has been modified.

Comment #45: Section 100.39. Designated Representative. This definition must be revised to use the term "affected unit", not just "unit". Also it must be consistent with the definition in EPA's Acid Rain regulations. "Unit" is not defined. Replace "unit" with "emissions unit."

IDHW Response: The Department has modified this section to clarify that a "unit" is a "phase II unit".

Comment #46: Section 100.39. Effective Dose Equivalent. While this definition is taken directly from the Code of Federal Regulations, it could be written more clearly. Different language was suggested.

IDHW Response: The rules have not been changed in response to this comment. Changing the definition would adversely affect the regulatory scheme for radionuclides from sources regulated under 40 CFR Part 61 or 40 CFR Part 63 since the emission standards for such air pollutants are based on "effective dose equivalent" as defined in the federal regulations.

Comment #47: 100.51. Excess Emissions. The definition is not tagged to stationary sources nor are time limits given. Suggest that the language be clarified and appropriate exemptions included in the rule.

IDHW Response: The rules have not been changed in response to this comment. The definition does not need to reference "stationary sources" or "time limits." The term is only used in the context of provisions regulating stationary sources and there is no time limit associated with the term.

Comment #48: Section 100.45. Emission Standard. This definition must be revised to include any requirement established by the EPA, not just the Department. Again, this definition must also reference 40 CFR Part 63 to cover all of the National Emission Standards for Hazardous air pollutants.

IDHW Response: The Department has modified this section in partial response to this comment. The Department will incorporate future federal requirements into these rules in accordance with state rule-making procedures.

Comment #49: Section 100.46. Definition of Environmental Remediation Source. Sources, which are not remediating oil or hazardous wastes, but which generate Air toxics should be included in the definition.

IDHW Response: IDHW has looked at this definition and has revised it by taking out the reference to hazardous materials. This was done because of potential conflicts with RCRA regulations. However Section 210.12 Specialized Method E: Department Approved methods can be used to allow review of a non-petroleum remediation project that may generate emissions of a toxic air pollutant. IDHW believes that this will remove potential RCRA conflicts while allowing flexibility in permitting non-petroleum remediation sources.

Comment #50: Section 100.47. Emission Unit. This definition must be expanded to indicate that it does not alter or affect the definition of the term "unit" for purposes of title IV of the Clean Air Act.

IDHW Response: The Department has incorporated the suggested modification in the rules.

Comment #51: Sections 100.47., 100.137. and 100.142. The definitions of Emissions unit, Source and Stationary Source all seem to be talking about the same thing. Choose one and use it throughout the rules.

IDHW Response: The rules have not been changed in response to this comment. This comment will, however, be considered when IDHW drafts future rulemakings regarding air quality.

Comment #52: Section 100.63. Hazardous Air Pollutant. This definition must be revised to include the pollutants listed in or pursuant to section 112(b) of the Clean Air Act. These pollutants are "hazardous air pollutants" even though they may not yet be subject to a standard under section 112.

IDHW Response: The Department has modified this section in response to this comment.

Comment #53: Section 100.68. Insignificant Activities. This definition is not used in the text of the rules and needs to be referenced therein to implement the concept. This approach is important to maintain a manageable program that is well understood by both the agency and public. New definition language was suggested.

IDHW Response: The Department has not modified this section in response to this comment. However, a subsection has been added to Section 314 that does incorporate the term "insignificant activities". This term was added to the rules solely for use in the Tier I operating permit program.

Comment #54: Section 100.71. Insignificant Activities. The item for space heating must include a size cutoff so that large central heating systems are not inappropriately exempted from permit requirements.

IDHW Response: The Department has modified this section in response to this comment.

Comment #55: Section 100.75, 100.76 Major Facility and Modifications. One commenter questioned the import of the changes to these definitions in the proposed rules. Another commenter stated that Section 100.75.b.ii and Section 100.76.c are not consistent.

IDHW Response: The Department modified the rules in response to this comment and the following comment. The Department has returned the existing definition of Major Facility. This definition is consistent with the definition of Major Modification.

A second definition of Major Facility has been placed in the new Section 103 "Definitions for the Purposes of Sections 300 through 399".

Comment #56: Section 100.75. Major Facility. This definition must be revised in a number of ways:

(1) Either the term "facility" must be used instead of "stationary source" or the definition must be substantially revised to conform with the EPA definition of "major stationary source".

(2) In subsection (a) the term "hazardous regulated air pollutant" must be changed to simply "hazardous air pollutant" and the provisions allowing EPA to establish lesser quantities for some pollutants and alternatives for radionuclides must be added.

(3) In subsection (b), the term "stationary source" must be changed to "facility," and paragraph (ii) must be revised to cover all regulated pollutants, not just those covered by the standards to comply with 50 CFR 51.166, and reference to 40 CFR Part 63 must be included. Note that this provision is now inconsistent with the

definition of "major modification" in that this definition exempts all "fugitive emissions" whereas the definition of "major modification" only exempts "fugitive dust."

IDHW Response: The Department has modified this section in response to this comment.

Comment #57: Section 100.76. Major Modification. Subsection c. must be revised to include reference to 40 CFR Part 63 in order to cover all sources regulated under section 112 of the Clean Air Act.

IDHW Response: The Department has incorporated the suggested modification into the rules.

Comment #58: Section 100.79. Member of the Public. The definition of "member of the public" as it applies to the regulation of radionuclide emissions should be amended to mean "any human being who is in any public access area, who receives the maximum potential dose exposure."

IDHW Response: The rules have not been changed in response to this comment. Changing the definition would adversely affect the regulatory scheme for radionuclides from sources regulated under 40 CFR Part 61 or 40 CFR Part 63 since the emission standards for such air pollutants are based on the effective dose equivalent for a "member of the public" as defined in the federal regulations.

Comment #59: Section 100.94. Nonattainment Area. The proposed change in this definition makes the basis for the designation less clear, and the parenthetical appears to extend the traditional reach of a non-attainment area.

This definition must be revised to include reference to Section 107(d) of the Clean Air Act. Although the state can add additional areas, it must consider as nonattainment all areas designated by EPA under section 107(d).

IDHW Response: The Department has modified this section in response to these comments.

Comment #60: Section 100.102. Process or Process Equipment. Delete the word "whatever" from the definition.

IDHW Response: The Department did not modify the rules in response to this comment.

Comment #61: The change in definition of PM-10 Emissions might be interpreted to also imply a change in reference method. We do not

support such a change, particularly in this manner. We would appreciate the opportunity to discuss the intended import of this change or the deletion of the proposed language.

IDHW Response: The Department did not change the rules in response to this comment. This definition was updated to match the federal definition of PM-10.

Comment #62: Section 100.105. Phase II Source and 100.106. Phase II Unit. These definitions must either be made consistent with the definitions of the EPA terms "affected source" and "affected unit" or replaced with those terms and their definitions.

IDHW Response: The Department has modified this section in response to this comment.

Comment #63: Section 100.110. Potential to Emit/Potential Emissions. This definition must be revised to include "facilities" as well as stationary sources since it is used primarily to determine if a facility is major. Second, the provision ensuring that this term will not alter or affect the term "capacity factor" used in title IV of the Clean Air Act must be added.

IDHW Response: The Department has modified this section in response to this comment.

Comment #64: Section 100.112. PPM (parts per million). The term "contaminant" should be changed to "air pollutant."

IDHW Response: The Department did not modify this section in response to this comment. See the definition of Air Pollutant.

Comment #65: Section 100.118.a.xx. One commenter made three related suggestions regarding the definition of "significant" as it applies to radionuclide emissions from sources regulated under 40 CFR Part 61 or 40 CFR Part 63. The commenter suggested that there should be a clearer determination of how the Department determines PSD so that a source knows whether to submit a PSD application; the designation of any radionuclide emission as significant, if total facility-wide emissions exceed an EDE of 3 mrem/yr, is overly conservative, and not based on any known scientific reasoning or regulatory precedence; and the definition should include only those radionuclide emissions that result in an EDE of at least 0.1 mrem/yr (NESHAP below-regulatory-concern level) if total facility-wide emissions are maintained below the NESHAP standard of 10 mrem/yr. Another commenter suggested that the existing definition of "significant" should not be amended, and thus, "any" amount of radionuclides would remain a "significant" emission.

IDHW Response: The rules have not been changed in response to these comments. The rules delineate application and permit to construct requirements based upon whether a proposed source is "major" and whether the proposed source is, or is located at, a facility with a potential to emit 250 tons or more of any air pollutant. If the proposed source is located at an existing major facility, it is a "modification" and the definition of "major modification" is based upon whether the proposed source has a net "significant" increase in emissions. The definition of "significant" is based on specified amounts of listed air pollutants. Therefor, an applicant should refer to the definition of "significant" and to whether the facility has the potential to emit 250 tons of air pollutants to determine what application information is required and what type of permit review will be conducted.

The regulatory scheme for radionuclides included in the definition of "significant" reflects many aspects of the federal scheme, but is also designed to meet the needs of the State of Idaho. It reflects a balancing of diverse and complex public, governmental and industry interests.

Comment #66: Section 100.118.b. One commenter suggested that Section 100.118.b be deleted because of his understanding of the provisions. He states that prior to these proposed regulations, this provision had relatively little impact since it only applied to pollutants regulated by the Clean Air Act and that now that there is no distinction between an air contaminant and pollutant in Idaho's regulations, this provision defines emission of any pollutant regulated by either the Clean Air Act or Idaho's regulations as significant.

IDHW Response: The rules have been changed in response to this comment. Without confirming the commenter's reasoning, IDHW has amended the section so that toxic air pollutants will not be "significant" emissions.

Comment #67: Section 100.118.a. The phrase "or any radionuclide emission rate, if the Department determines that Section 205 shall apply" should be deleted.

IDHW Response: The rules have been changed in response to this comment. The phrase was deleted.

Comment #68: Section 100.118.b. Prior to these proposed regulations, this provision had relatively little impact since it only applied to pollutants regulated by the Clean Air Act. Now that there is no distinction between an air contaminant and pollutant in Idaho's regulations, this provision defines emission of any pollutant regulated by either the Clean Air Act or Idaho's

regulations as significant. It is recommended that Section 100.118.b. be deleted.

IDHW Response: The rules have been changed in response to this comment. Without confirming the commenter's reasoning, IDHW has amended the section so that toxic air pollutants will not be "significant" emissions.

Comment #69: Section 100.131. Significant. Subsection (b) must be revised to include the phrase "or facility" since potential to emit applies to facilities as well as sources.

IDHW Response: The Department has incorporated the suggested modification in the rules.

Comment #70: Section 100.131. A TIER II Source. If the Tier I Source and Tier II Source are going to define the two types of permits, there should be a definition of each and more descriptive names.

IDHW Response: The Department has modified the rules in partial response to this comment. Section 302 has been moved to the general definition section of the rules. The Department has not defined "Tier II Source" in these rules. However, Section 401 describes which facilities are affected by the Tier II operating permit rules.

Comment #71: SectionS 100.146-149. These four definitions are used in many general schema for environmental calculations. Many of the conclusions are directly applicable to normal practice of agriculture and should be exempted.

IDHW Response: Agricultural activities and services are specifically exempt for new source review for toxic air pollutants.

Comment #72: One commenter noted that the rules appear to be incorporating Clean Air Act Section 114 Letter Authority by rule in Section 122 of the proposed rules. The commenter does not support this action and suggests that it is not required for an approvable Title V Program. The commenter also questions IDHW's legislative authority for the action and suggests that Section 122 be totally deleted.

IDHW Response: The rules have not been changed in response to this comment. This rulemaking is not limited to rules required for approval of the Tier I operating permit program. The Environmental Protection and Health Act grants the Board of Health and Welfare adequate authority to adopt Section 122.

Section 122 is an important aspect of this rulemaking. It will provide IDHW with the ability to obtain certain types of information from specified persons as necessary to develop, implement and enforce Idaho's air quality programs. It will drastically increase the efficiency and effectiveness of several of Idaho's air quality programs, including enforcement and the development and implementation of the area plans for the nonattainment areas. The State of Idaho and the public face severe sanctions if the nonattainment areas are not brought into attainment by the federally mandated deadlines. In addition, the United States Environmental Protection Agency's (EPA) ability to request information is very similar to the ability provided by Section 122. Section 122 will allow IDHW to request information directly from industry and other members of the public, and thus, IDHW will be able to collect necessary information without contacting or involving EPA.

Comment #73: Section 123. Certification of Documents. It appears that neither the federal regulations nor the Clean Air Act require notarization on all forms, documents, progress report, monitoring data, test data, and other information to be submitted. Requiring notarization in the proposed rules is overly burdensome and unnecessary.

IDHW Response: The rules have been changed in response to this comment. The phrase requiring notarization has been deleted and a section requiring all documents to be truthful, accurate and complete has been added to accomplish the same goal as notarization.

Comment #74: New Section 100. Permit Successions. It would be useful in administration of the air quality program to establish by regulation the relationship between permits to construct and operating permits (both Tier I and Tier II). Section 150, a new proposal, attempts to define this relationship.

IDHW Response: The Department did not make the suggested modification to the rules. However, the Department has modified Section 209.06 (now 209.05) to clarify how the permit to construct program interacts with the Tier I operating permit program. Section 401 describes how a Tier II operating permit can be used to net out of the Tier I operating permit program.

Comment #75: Section 100.161. Toxic Substances. Referring to the listed acceptable ambient impact levels as ambient air quality standards (those levels that cannot be exceeded, regardless of the source) is confusing and conflicts with what IDHW indicated the toxics regulations would apply to. The definition of these limits to the increase in ambient concentrations should be changed to more

clearly indicate that they are ambient increments, similar to PSD increments.

IDHW Response: The rules have been changed in response to this comment. The Department has incorporated the suggested modification into the rules.

Comment #76: Section 100.161. Toxic Substances. Other sections of the regulations deal more specifically with emissions of toxics. This section is unnecessary since the other regulations are more specific and should be deleted.

IDHW Response: The rules have not been changed in response to this comment. This sections contains the definition of toxic substances on which the other sections are based. In addition this section allows the IDHW the option of addressing a situation that may present a threat to public health or the environment by imposing a Tier II operating permit. IDHW believes that this section is basic to the state's efforts to protect the environment and human health by controlling toxic air pollutants.

Comment #77: Section 161. TOXIC SUBSTANCES. The structure of this provision is confusing. Paragraphs .02 and .03 should be subparagraphs under the provision in paragraph .01 (i.e. delete the number .01, and renumber .02 and .03 to .01 and .02, respectively).

IDHW Response: The rules have been changed in response to this comment. This Section has been rewritten to be clearer.

Comment #78: Section 121.01. This paragraph should be clarified to specify that the schedule prepared by the source is a "proposed" compliance schedule.

IDHW Response: The rules have been changed in response to this comment. The Department has incorporated the suggested modification into the rules.

Comment #79: Section 130. UPSET CONDITIONS, BREAKDOWN. This provision is not approvable as a part of the Idaho SIP as it fails to comply with the requirements of the Clean Air Act for violations of applicable SIP emission limits.

IDHW Response: The Department did not modify the rules in response to this comment.

Comment #80: Sections 140 through 149. VARIANCES et seq. These sections are not approvable as revisions to the Idaho SIP. First,

EPA does not approve "variances" to Idaho rules. EPA can approve revisions to the Idaho SIP which have been adopted by the Department and submitted to EPA, including variances that the Director has granted pursuant to this provision. As such, this section must be revised significantly. Furthermore, the variance provisions must either be inapplicable to Title V sources, or the rules must clarify that a variance must be accomplished through a revision to the source's Title V permit.

IDHW Response: The Department has replaced "EPA" with "Department" to correct this section. Sections 300 through 399 have been revised to clarify the requirements that apply to facilities affected by the Tier I operating permit program.

Comment #81: Section 141.02. Petitions. It is unclear what the term "petitioner and other..." refers to. Modified language is suggested.

IDHW Response: The Department has modified this section in response to this comment.

Comment #82: Section 145.03 Authorization of Hearing. Suggested that this section could be more clearly worded.

IDHW Response: The Department has modified this section to clarify that the Department, not EPA, may authorize a hearing. The suggested modification has been incorporated into the rules.

SECTION 200

Comment #83: Section 200 Procedures & Requirements for Permits to Construct. The proposed rules do not contain guidelines as to how the State of Idaho will develop MACT standards, if the EPA misses its deadline to develop MACT standards (Section 112 (j) of the Clean Air Act). As a result, we recommend that the Department issue guidance on how they will determine MACT standards, if and when the EPA does not meet its deadline, these Procedures should be developed through rulemaking.

This incrementalism approach will end up costing industry more to comply because they will go ahead with an addition, approved under a new source review permit but then have to make major modifications to that new source as part of the operating permit later on.

IDHW Response: The rules have not been changed in response to this comment. As EPA finalizes its various implementations procedures for §112(g) and 112(j) IDHW will respond appropriately. Until these federal rules and guidance are done, IDHW considers it inappropriate to attempt to develop rules by trying to guess what

EPA might do. When IDHW develops its responses to federal requirements IDHW will comply with all state and federal guidelines for public participation.

IDHW has built in a high degree of flexibility onto these rules in order to assist industry in complying with required controls. However, given the unsettled nature of new source MACT, IDHW has chosen to defer this issue until EPA finalizes and promulgates regulations in this area.

Comment #84: Section 201. Put the original effective date (January 24, 1969) into the regulation to eliminate any confusion as to what date it is.

IDHW Response: The rules have been changed in response to this comment. The phrase "after the original effective date of Sections 200 et seq." was deleted.

Comment #85: Section 201. Permit to Construct Applicability. As stated in previous comments to the Department on an earlier draft of these proposed revisions, the changes to the permit to construct rules which are being made to incorporate the hazardous air pollutant sources will adversely impact the currently-approved SIP provisions for criteria pollutant sources. If adopted as currently proposed, EPA would be required to disapprove these rules and the Idaho permit to construct program.

As discussed in my letter of June 29, 1993 (copy attached), the proposed revisions to the permit to construct applicability provision will not be approvable as revisions to the Idaho SIP for a number of reasons.

(1) The new exemptions for Category I, II, III, and IV sources inappropriately relaxes the currently approved SIP, and fails to comply with the requirements of section 110(a)(2)(C) of the Clean Air Act and 40 CFR Part 51, Subpart I of EPA regulations. Specifically, the four categories are not mutually exclusive and therefore would allow a source to be exempted under one provision where another provision would require a permit.

IDHW Response: The Department has not modified the rules in response to this comment. Categories I through III specifically require that the source not cause or significantly contribute to a violation of an ambient air quality standard. Category IV sources are either already exempted from obtaining permits to construct in the currently effective rules or are activities that the Department has historically not regulated.

The exemptions were not designed to be mutually exclusive. If a source qualifies under any of the categories, it is exempt from obtaining a permit to construct. The Department carefully examined sources and activities that have been exempted from obtaining a permit to construct in the past. This information was used to develop the categories in these rules.

Comment #86: (2) Broad discretionary exemptions such as 201.01.g., 202.02.d.i., etc. are not approvable.

IDHW Response: The Department has modified the rules in partial response to this comment. However, the Department has exercised discretion to exempt sources from obtaining a permit to construct under existing rules (16.01.01012,02.h). The Department is not aware of any concern expressed by EPA in its use of the discretion allowed by this rule.

Comment #87: (3) Section 201.02.a. exempts all major sources by using the term "Not."

IDHW Response: The Department has modified this section in response to this comment.

Comment #88: (4) The reference in 201.03. to "Section 200 et seq." should be changed to 201.03 since the source need not verify compliance with all of Sections 200 to 299, only the provisions of 201.03.a. through d.

IDHW Response: The Department has modified this section in response to this comment.

Comment #89: (5) In subparagraph (vi), the phrase "agricultural activities and services" is used, whereas the definition section defines only "agricultural activities." Also, the clarification of what are not agricultural activities (i.e. manufacturing, bulk storage and handling for resale or formulating any listed chemical) should be moved to the definition section unless this exempted activity is intended to be narrower than all "agricultural activities"

IDHW Response: The Department has modified the definition of Agricultural Activities.

Comment #90: (6) The permit to construct applicability provisions must ensure that all new, modified, or reconstructed stationary sources subject to any standard under sections 111 or 112 of the Clean Air Act are required to obtain a permit to construct. Idaho's Title V operating permit program cannot be approved unless it demonstrates that it can implement and enforce all of the requirements of sections 111 and 112 for subject sources, including the requirements for preconstruction review and initial source compliance determinations.

IDHW Response: The Department has not modified the rules in response to this comment. The Department is committed to updating the rules in accordance with future federal rule-making.

Comment #91: Sections 201.01.f, 201.02.d.i, 201.03.d.ii: Category I, II, and III Sources. The State requirements should be consistent with the Federal NESHAP requirements in 40 CFR 61.96 Applications to Construct or Modify.

IDHW Response: The rules have not been changed in response to this comment. The regulatory scheme for radionuclides reflects many aspects of the federal scheme, but is also designed to meet the needs of the State of Idaho. It reflects a balancing of diverse and complex public, governmental and industry interests.

Comment #92: Section 201.02.iii-iv. Each of these sections represent the use of equipment essential to some phases of agriculture. These engines are potentially used in remote or populated locations. As such, an agricultural exempted may be appropriate.

IDHW Response: An agricultural activities and services exemption is provided for in Section 220 Category IV exemption

Comment #93: Section 201.03.d. Pilot Plants. Pilot plants pose a serious potential risk of radiation exposure. and should not have any exclusions from PTC requirements.

IDHW Response: The rules have not been changed in response to this comment. To qualify for an exemption, pilot plants may have no emissions of a radionuclide for which a National Emission Standard for Hazardous Air Pollutant (NESHAP) exists. The IDHW considers this adequately protective.

Comment #94: Section 201.04. Each of the above sections would be more clearly defined and interpreted if an agricultural exemption consistent with Idaho Environmental Protection and Health Act, Idaho Code Sections 39-101 et seq. (1993), which is clearly incorporated into this rule making.

IDHW Response: An agricultural activities and services exemption is provided for in Section 220 Category IV exemption

Comment #95: Section 201.04.c Permits to Construct, Category IV Exemptions. Section viii. needs to be expanded to allow the Director to exempt sources other than "equipment." This will allow the concept of "insignificant activities" which was earlier defined

but never used in the text of the rule, to be compiled into a publicly available list. This would allow the list to be compiled over time in a less expensive fashion than listing all insignificant sources in the rule. The additions list should be published annually in the Idaho Administrative Bulletin.

IDHW Response: The Department has modified this section in partial response to this comment. It should be noted that Insignificant Activities have been defined solely for the purposes of the Tier I operating permit program.

Comment #96: Section 201.04.c. Grain storage and handling facilities do not always fit cleanly under the agricultural exemption for a number of reasons.A new section should be added to exempt Country Grain Elevators under the 1 million bushel PSD size in PM-10 attainment areas.

IDHW Response: The Department has not modified the rules in response to this comment. Because there are no enforceable limits on the potential to emit from these facilities, the Department cannot exempt them from the requirement to obtain a permit to construct.

Comment #97: Section 202. APPLICATION PROCEDURES. The phrase "by the owner or operator" should be replaced with "in accordance with Section 123" now that section 123 sets out who must be the certifying official for permits to construct. Furthermore, Section 202.01.c. should be expanded to include a reference to 205.07

IDHW Response: The Department has incorporated the suggested modification into the rules.

Comment #98: Section 203. The old Section 203 stated that IDHW shall conduct a T-Ract evaluation for specific sources within 180 days, while Section 209 requires that a proposed permit be issued or denied within 60 days after the permit is declared complete. Recommended that the time frame in Section 209 take precedence.

IDHW Response: The rules have been changed in response to this comment. New Section 210.07 provides the applicant with two alternative procedures and timelines. Under Section 210.07.a, the applicant will submit the information regarding T-RACT in her initial application and IDHW will issue a permit action in accordance with the timelines in Section 209. Under Section 210.07.b, the applicant may supplement her application and the timelines in Section 209 will be reinitiated when a complete supplemental application is received.

Comment #99: Section 202.b.viii. Application Procedures. The list of Ambient concentrations is hard to read.

IDHW Response: The rules have not been changed in response to this comment. The form of the rules is dictated by the Office of the Administrative Rules Coordinator.

Comment #100: Section 203.03.c and d Adjustment Factors. Incorporate language to allow use of the adjustment factors for applicability determinations.

IDHW Response: The rules have not been changed in response to this comment. This concept is inherent in the language of the existing section.

Comment #101: Section 203.03 through 05. Recognize that these provisions for new and modified air toxics sources do not meet the requirements of section 112(g) of the Clean Air Act. When EPA's regulations to implement section 112(g) are promulgated, Idaho will have to substantially revise and tighten these requirements.

IDHW Response: The rules have not been changed in response to this comment. The IDHW rules concerning toxic air pollutants are for the control of toxic air pollution from new and modified sources and were not drafted with the intent of mirroring potential federal regulations. Additionally, the EPA has not finalized its guidance on §112(g) yet so IDHW believes that this comment is premature. As EPA promulgates further 112(g) guidance, IDHW will propose legislation to respond to these future federal requirements. IDHW acknowledges that this may entail extensive revisions of these rules.

Comment #102: Section 203.04. T-RACT. Best Available Control Technology (BACT) should not be changed to Reasonably Available Control Technology for Toxics (T-RACT). Some thought that T-RACT should not be available in non-attainment areas. (There were multiple comments expressing this sentiment)

IDHW Response: The rules have not been changed in response to this comment. The change from BACT in the old TAP policy to RACT in the proposed rules will allow a greater degree of flexibility, both economic and technological, in complying with the various emissions and ambient levels of the toxic air pollution (TAP) regulations. BACT is a term applied to prevention of significant deterioration (PSD) in classified airsheds and as such is not directly relatable to toxics. This change in control technology will address a small segment of carcinogenic emissions falling between the one in a million and one in a hundred thousand risk levels. It will have no effect on non-carcinogens. Emissions of carcinogens of greater

risk than one in a hundred thousand will not be allowed regardless of the control technology used. In real application, T-RACT as defined and implemented will closely approximate BACT

The assumptions that the IDHW uses when figuring these risk levels are conservative, that is, likely to err on the side of caution. These assumptions protect the maximally exposed individual as opposed to the average exposed individual. It is the position of the IDHW that given the combination of these very conservative assumptions and the limited segment of potential emissions that this change will cover, these changes represent a feasible compromise between the needs of industry and protection of public health.

Nonattainment for air quality pertains to a number of criteria pollutants (oxides of nitrogen and sulfur, particulates, etc.) and does not pertain to TAP. Therefor this concern is not directly relevant to the proposed TAP rules.

Comment #103: **Section 203.04 T-RACT Determination. A few commenters suggested that the economic feasibility aspects of the T-RACT determination are an unreasonable burden on industry and could be used arbitrarily. They asserted that old Section 203.04.e requires the applicant to determine the economic feasibility of every control technology approved by the Department and that this could be quite expensive and time consuming. If there are only one or two options worth considering, an economic analysis should only be done for them. Provisions to allow the applicant and the Department to agree on what control technology scenario will be evaluated should be included.**

IDHW Response: The rules have been changed in response to this comment. Without confirming the reasoning of the commenters, IDHW deleted old Section 203.04.e. The proposed rules and the rules that are submitted for adoption both provide that the applicant is to submit proposals that are technologically and economically feasible; not proposals that are technologically or economically feasible.

Comment #104: **Section 203.05.a. Emissions Screening. Since this requirement is only meant to address new sources, the language needs to be modified to reflect that.**

IDHW Response: The rules have been changed in response to this comment. This section has been rewritten to be more clear.

Comment #105: **Some commenters expressed concerns that the toxics provisions should apply only to new sources and that "the limiting factor is the additional quantity of a specific toxic in the atmosphere that results from operation of the proposed new source."**

Existing background should be taken into account when permitting new sources. Are the incremental increases to become part of background to be ignored if another addition was made in the future ad infinitum.

IDHW Response: The rules have been changed in response to this comment. On the issue of clarifying that the toxics policy applies to new sources and modifications, IDHW has rewritten and an reorganized sections to make this more clear. That the current toxics policy and the proposed rules deal with new sources and modifications only has been the IDHW position since the inception on the toxics policy in 1989.

The concern that the incremental increase will become part of the background is addressed the definition of Net Emissions Increase, §102.07 of the revised rules. This definition excludes this possibility and has been applied to Section 209.

IDHW acknowledges the tensions between the ability of industry to operate effectively and efficiently and the public's right to a safe and clean environment. It is IDHW's position that the rules changes noted above strikes a middle ground between these needs.

Comment #106: Air toxic impacts, both non-carcinogenic and carcinogenic, should only be evaluated at or beyond the facilities property boundary, even if the public has access to the property. The words "or the closest point of public access" should be deleted.

IDHW Response: The rules have been not changed in response to this comment. Section 209.b. (which replaces 203.05.c.) allows the use of the point of greatest impact located at or beyond the facility property boundary nearest the source or closest point of public access. Generally, people going to a source on business are not considered part of the "public" while on the property. Therefor, parking lots and the like will not generally be considered the closest point of public access.

Comment #107: Section 203.05.f. This section is redundant as the concept is already addressed in 203.05.h. and should be deleted.

IDHW Response: The rules have been changed in response to this comment. Section 203 has been reorganized to make it clearer and in so doing, subsection 203.05.f has been deleted.

Comment #108: Section 203.05.g. Unit Risk Factors are based on a 70-year exposure. This is not appropriate for an industrial park situation that will never be a residential application. The refined analysis should be liberalized to include a different model, actual meteorological data, more appropriate risk factors, actual hours of operation, more accurate emissions factors obtained

through source testing, more accurate annual potential to emit scenarios and any other justifiable refinements. New wording for this section has been suggested to reflect this.

IDHW Response: The rules have been changed in response to this comment. IDHW agrees that for industrial areas that will never be used for residential purposes, a 70 year risk base may be conservative. However, it is hard to predict future land use patterns. Examples of unforeseen new land uses with significant environmental and human health concerns have become quite common.

IDHW has based its emission numbers on the best available data. IDHW has strived to take a balanced approach taking into account the needs of industry to operate and the need to protect human health and the environment. Since it is not possible to account for such real life factors as lifetime exposures, additive or multiplicative effects of exposures to the large variety of industrial chemicals in use in Idaho, it is necessary to make our emissions standards generally applicable and reasonably conservative.

It is not possible for IDHW to carve out special exemptions or emissions factors for potential or hypothetical new or modified industrial sources or exposure scenarios. Our rules must take a balanced approach that is generally applicable and consistently applied. IDHW can not develop special emissions factors specifically for industry dominated areas. IDHW believes that the revised Section 210.02 Quantification of Emissions Rates and Ambient Concentrations, which allows site specific data gives adequate flexibility in compliance with toxic standards.

Comment #109: Section 203.05.j Screening Emissions Tables. Commenter recommends that ammonia be eliminated from the list of toxic pollutants or, alternatively, that emission levels for ammonia applicable to the danger caused by high concentrations and which also recognize the harmless effect of low concentrations be established. This request is based on a number of issues. First, ammonia was deleted from the EPA "189 list". Second, ammonia is generally considered relatively non or mildly toxic in very low concentrations. Third, ammonia is regulated under SARA Tile III for accidental release. Fourth, substantial releases of ammonia come from animal wastes and other organic materials. Fifth, the control of ammonia at the levels specified in the proposed rules would be severely burdensome for industry, particularly the fertilizer and sugar beet industries.

IDHW Response: The rules have not been changed in response to this comment. IDHW disagrees that Ammonia should be unregulated in Idaho. IDHW also declines to modify its screening emissions levels (EL) and acceptable ambient (AAC) concentration for ammonia.

In general, IDHW basis its non-carcinogenic standards on the work and occupational exposure limits developed by the American Conference of Government Industrial Hygienists. These standards

are set relative to the toxicity of the compound in question so the relatively low toxicity of ammonia is already reflected in the numbers.

In addition, IDHW has identified a specific procedure for developing ELs and AACs that is consistent for all sources and compounds. IDHW believes that deviating from this procedure would be unfair to other applicants and the public and introduce too much subjectivity into the process.

IDHW will address the specific areas of concern cited in the request to remove ammonia from the rules:

First, ammonia was deleted from the EPA "189 list". IDHW has reiterated its position on the "189 list" on numerous occasions. However, in brief the IDHW does not consider this to be a valid point because the "189 list" is a result of a political process on the national level. The "189 list" represents a list of pollutants that have significant national concern. The "189 list" was never meant to necessarily protect environments on a local level. Congress has made it clear the "189 list" and the Title III/ NESHAP program was not meant to replace state air toxics programs. Consequently, IDHW disagrees that the presences or absences of a compound on the EPA "189 list" is necessarily relevant to the Idaho TAP program.

Second, ammonia is generally considered relatively non or mildly toxic in very low concentrations. IDHW agrees that this is a valid point. However as mentioned above, the EL and AAC for this compound has taken the level of toxicity into account. In addition, 22 state and local air pollution control agencies have set standards for ammonia in air, some less stringent and some more stringent than Idaho. In addition, the Division of Health has been consulted and has recommended that ammonia continue to be regulated on the basis of its significant irritant effects.

Third, ammonia is regulated under SARA Title III for accidental release. SARA Title III is concerned with the catastrophic release of large quantities of dangerous chemicals and the communities right to know that these chemicals are being used and stored nearby. SARA Title III does not regulate these chemicals but only requires reporting of their presence. IDHW does not consider this to be excessive "double regulation". The intent of the IDHW TAP program and SARA Title III are very different so IDHW disagrees that this sort of "double regulation" is either unwarranted or unreasonable.

Fourth, substantial releases of ammonia come from animal wastes and other organic materials. While IDHW agrees that this is true, IDHW disagrees that this point is germane. The intent of the rules concerning toxic air pollutants is to control the emissions of toxics air pollutants from new and modified sources. Agricultural activities and services are generally exempted from the toxics rules.

Fifth, the control of ammonia at the levels specified in the proposed rules would be severely burdensome for industry, particularly the fertilizer and sugar beet industries. IDHW is very sensitive to the potential economic impacts of these proposed rules and economic impacts are always considered. However, these regulations apply to new and modified sources only. IDHW does not agree that economic effect on the regulated community will be so severe so as to out weigh their environmental benefit. Further, IDHW does not believe that it is appropriate carve out regulatory exemptions for the economic benefit of a particular industry or industries.

Comment #110: Section 203.05(j). Remove Phosphorous pentoxide from the Table in Section 203 .05(j).

IDHW Response: The rules have not been changed in response to this comment. The IDHW believes that our regulation of this chemical is both reasonable and responsible. Phosphorus pentoxide is an irritant and is being regulated on that basis.

Phosphorous pentoxide is listed on the EPA extremely hazardous substance list; It is listed in the Toxic Substances Control Act (TSCA) Substances Inventory; It is listed by the Department of Transportation (DOT) as a corrosive material; Sax's Dangerous Properties of Dangerous Materials. Vol. III. Eighth Ed. Richard J. Lewis, Sr. New York: Van Norstrand Reinhold 1992. 2795. notes that it is a "Poison by inhalation. A corrosive irritant to the eyes, skin and mucous membranes"; The Hazardous Substances Data Base (HSDB) produced by Micromedix, Inc. Vol. 16 notes that "Particles of solid Phosphorous pentoxide in contact with eye react vigorously, & even small amounts may cause burns of lids, conjunctivae, & corneas, producing blue-white opacities, which may be permanent."

Since phosphorous pentoxide in quite hydrophilic and rapidly forms phosphoric acid, the ACGIH Threshold Limit Value (TLV) of 1mg/m3 for phosphoric acid was used. In addition the HSDB reports that Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd Ed New York: John Wiley Sons, 1981-1982. recommends a Hygienic Std. of 1mg/m3.

Comment #111: Section 203.05.j. and 203.05.k. There should be short term ambient standards for non-carcinogens (8 and or 24 hr. standards). A formula for the development of such standards was submitted.

IDHW Response: The rules have been changed in response to this comment. An annual averaging period will be used for both screening and refined models for all toxic air pollutants. The issue is complex and important enough to deserve clarification.

The acceptable ambient concentrations (AAC) are not ambient air quality standards. Rather they are acceptable increments of

toxic air pollutants that are responsibly protective of human health and reasonably permissive of industrial expansion. Because the AAC are not ambient standards the air quality management techniques of averaging collective emissions to some total ambient build up do not apply.

In the design of this rule, the AAC relates to a stack emission rate. In the most prescribed sense, the AAC would be assured by a permitted emission limit. This emission limit then might be guaranteed by some ample control technology design or perhaps an operational limit prescribed in the permit.

Comment #112: Section 203.05.j. and 203.05.k. There is inadequate health based data for the ambient levels set. OSHA standards "were struck down in court" as a result of "OSHA's unlawful rule making" because OSHA's standards were not based the "significant risk" and "feasibility" requirements of the OSHA statutes" our ambient standards were on "...very shaky legal ground..."

IDHW Response: The rules have not been changed in response to this comment. The IDHW bases its non-carcinogenic levels on work done by the American Conference of Government Industrial Hygienists (ACGIH), not OSHA. The ACGIH is a respected health effects research body and the IDHW has every confidence in ACGIH data. For carcinogens, the IDHW used published unit risk factors from EPA and supporting data from the National Institutes of Health and the International Agency for Research on Cancer (IARC). It does not seem reasonable for IDHW to attempt to "reinvent the wheel" in the face of so much available data. To do so would be an astronomical undertaking, far beyond the capabilities of most if not all state governments.

Comment #113: Section 203.05.j. and 203.05.k. Standards derived from those of other states should be removed.

IDHW Response: The rules have not been changed in response to this comment. IDHW has included substances on our lists that we feel have valid health concerns. Some of these substances do not have Occupational Exposure Levels (OEL) published by an agency such as the ACGIH. However they do have substantial health data. On occasion, some states have looked at some of these chemicals and developed emissions and or ambient standards. We have no reason to believe that states such as Washington or New York are frivolous or capricious in their risk assessment actives. Quite the contrary, we consider other states to be responsible agencies subject to oversight by their respective legislatures, industry groups and the public, much like Idaho.

The IDHW then looks at these standards to see if we consider them reasonable, based on the available literature and other criteria. If we find that to be the case we may then adopt these standards or modify them as the data warrant. If, in the future,

the ACGIH develops standards differing from the standards we have adopted, we will seek to modify our rules accordingly.

Comment #114: **Section 203.05.j. and 203.05.k. Are some of the compounds on Appendix 1 are suspected carcinogens?**

IDHW Response: The rules have been changed in response to this comment. It is the policy the IDHW to regard any substance that is considered a B2 ranking by EPA (or equivalent ranking by IARC) a carcinogen for purposes of regulation. A B2 carcinogen is one that has sufficient animal evidence. C (or equivalent ranking by IARC) ranked compounds have limited animal evidence and inadequate or less human evidence. The IDHW does not believe that C ranked carcinogens have sufficient data available to support the regulatory scheme required by carcinogens. Therefore some compounds on Appendix 1 may be suspected carcinogens in other references. In addition, some carcinogens were mistakenly listed on both appendices. These errors have been corrected.

Comment #115: **Section 203.05.j. and 203.05.k. The range of allowable emissions of carcinogens is too narrow and the accuracy of the models used to calculate potential risks is inadequate.**

IDHW Response: The rules have not been changed in response to this comment. The narrow range of allowable carcinogenic risk reflects a upper limit of one in a hundred thousand, above which the IDHW considers risk to be unacceptable. The IDHW considers this to be reasonable and in line with risk acceptability of other states and the EPA.

The IDHW acknowledges that models used to calculate potential risk are not exact and that there are variations in the appropriateness of the models vis a vis specific applications. The IDHW has tried to allow maximum flexibility in model selection by requiring only that the model must be EPA approved and must be reviewed for appropriate application by the IDHW. The IDHW considers that EPA approval and IDHW review of all models used is a reasonable requirement.

Comment #116: **Section 203.05.j and 203.05.k Screening Emissions Tables. The publication in the rules of OEL and URF values that are based on continually changing OSHA, and EPA exposure criteria will contribute to confusion and errors in use of the most current (and appropriate) criteria.**

For modeling analyses, URFs should be taken from the EPA IRIS database, which is updated on a monthly basis. OELs should be taken from their source documents - either OSHA PELs, ACGIH TLVs, or NIOSH RELs, which are updated on an annual basis. The regulations should either reference these sources or include a statement to the effect that the OEL, URF, AAC, and AACC values may

change (based on the latest revision to the source) without requiring change to these regulations.

IDHW Response: The rules have not been changed in response to this comment. IDHW believes that annual updates through rulemaking and emergency rulemaking, if necessary, will provide an adequate and reasonable method to keep the appendices updated. Providing the appendices as part of the rules insures consistency. In addition, the Administrative Procedures Act of Idaho prohibits language that automatically incorporates by reference the latest edition of a reference. A specific document must be incorporated. IDHW would also note that this aspect of the rules was partially in response to industry's strongly stated desire to have the various references made part of the rules so that there would be regulatory consistency.

Comment #117: Section 205.06 - The cited Section 205.01.b. should be Section 205.01.b.ii.

IDHW Response: The Department did not modify this section in response to this comment. The cites are correct.

Comment #118: Section 209. PROCEDURE FOR ISSUING PERMITS. This section should perhaps be moved to after Section 400, et seq, since it applies to both permits to construct and tier II permits. In addition, the second reference to "major modification" in 209.01.c. must be changed to "modification." Finally, the last sentence in 209.05 must be deleted since permits to construct do not expire and are not "renewed" like operating permits.

IDHW Response: The Department has modified the rules in response to this comment. The sections in 209 that also apply to Tier II permits have been incorporated into Section 404.

Comment #119: Section 209 provides no time frame for conduction public comment periods or hearings after a proposed permit to construct is issued for major facilities or modifications. Language is suggested.

IDHW Response: The Department has not changed the rules in response to this comment. The Department makes every effort to conduct public comment periods and hearings in a timely manner.

Comment #120: Emissions Screening levels should take into account such realistic assumptions as reactivity of gaseous air toxics and deposition rates of dusts. It was suggested that the values be recalculated using these realistic assumptions.

IDHW Response: While IDHW agrees that gas reactivity and deposition rates of dusts are real world occurrences, it is impossible to use these assumptions in figuring emissions screening levels because of their site specific nature. Reactivity of gases varies considerably with different circumstances. For instance, the concentration of hydroxyl radicals in the atmosphere, the amount of sunlight present and various aspects of reaction kinetics are items that have a significant effect on atmospheric gas reactivity. Deposition rates of dusts and other particles can vary greatly with circumstances such as wind velocity and precipitation rates.

Comment #121: Section 209.01. This section should provide for language to a permit to be automatically deemed complete if the Department does not notify the applicant of incompleteness within 60 days, similar to Section 342.03

IDHW Response: The Department has not modified the rules in response to this comment. The rules provide for a completeness determination within 30 days. The Department has not had a permitting backlog for four years. Therefore, the Department believes that the suggested modification is unwarranted.

SECTION 300

Comment #122: Section 302.05. This provision must be expanded to include source categories designated by EPA.

IDHW Response: The Department has not modified this section (although it has been moved to section 101) in response to this comment. The Department is committed to updating the rules in accordance with future federal rule-making.

Comment #123: Section 313. Timely Application. We recommend that Section 342.02.a. be reworded to require one-third of Tier I facilities to submit their application before the end of the 12-month period, to enable the first third to be processed by the end of the 12-month period.

IDHW Response: The Department has modified the rules in response to this comment. Sections 313 and 367 have been modified to clarify how the Department will act on applications during the transition period.

Comment #124: Section 313.02. Preconstruction Permits. The Federal Program allows states to provide for concurrent processing of pre-construction permits and operating permits, provided that the procedural requirements of both programs are met. We recommend that applicants in Idaho be given this option.

IDHW Response: The Department has modified Section 209 in response to this comment. Subsection 209.05 describes the permit to construct procedures for Tier I sources.

Comment #125: Section 313.04. Renewal Applications. For purposes of permit renewal, redefine timely renewal application, a timely application is one that is submitted at least six months prior to the date of expiration, unless the applicant requests and the operating permit specifies a longer period (not to exceed 18 months).

IDHW Response: The Department has modified the rules in response to this comment. Sections 313 and 367 have been modified to clarify how the Department will act on applications during the transition period.

Comment #126: Section 313.04. In accordance with 40 CFR 70.5(a)(a)(iii), the State must require that applications for permit renewals be submitted between 6 and 18 months before expiration of the permit. Requiring renewal applications to be submitted more than 18 months before expiration is not approvable. This provision needs to be reworded to ensure that the application is submitted no earlier than 18 months prior to expiration and no later than (some time between 6 and 18) months prior to expiration.

The rules defining a timely application will be hard on commenter because of the need for very rapid turn around time needed in the semiconductor business.

IDHW Response: The Department has modified the rules in response to these comments. See Section 313.03.

Comment #127: Section 314.02. Standard Application Form and Required Information. Please clarify what type of description is required by this section. The Department should include in a Checklist or detailed Instructions on the level of detail and what criteria the Department will use to determine whether any response to this requirement is "complete."

The description of the source's products and processes must include information about the applicable SIC codes.

IDHW Response: The Department has modified the rules in response to these comments. Subsection 314.02.b clarifies that the description must include narrative and applicable SIC codes.

The Department has developed a completeness checklist and a draft Tier I operating permit guidance manual. These documents are available on request to the Department. The guidance manual will not be finalized until after the rules are final.

Comment #128: Section 314.04.a. Emissions Information. The application must also include information on all air pollutants, that are not also regulated air pollutants, for which the source is major. The Department must also have authority to require additional information to determine the applicability of applicable requirements for all air pollutants, not just regulated air pollutants and as necessary to collect any permit fees. In addition, the reference to exempted units must be more specific than simply "Section 314, et seq."

IDHW Response: The Department has modified this section in response to this comment.

Comment #129: 314.04.a. Emissions Information. This section requires specification of emissions of regulated air pollutants emitted from any non-exempt emissions unit. this requirement should be limited to information about "relevant emissions units," meaning only those emissions units that are subject to applicable requirements.

IDHW Response: The Department has not modified the rules in response to this comment. The Department must receive information as described in the preceding comment. Section 314 has been revised to clarify what information must be submitted in the Tier I operating permit application.

Comment #130: 314.04.a. Emissions Information. The second sentence of Section 314.04 states that the Department shall require additional information related to the emissions of regulated air pollutants sufficient to verify which requirements are applicable. This should be written in the form of a requirement for the applicant, rather than an instruction to the Department, to avoid having the Department requesting additional information after the application has been submitted. Suggested language is submitted.

IDHW Response: The Department has deleted this sentence.

Comment #131: Section 314.04.b. and 314.05.b. Emission Information. This section refers to requirements of the "Act." This should be a reference to the "Clean Air Act," since Title V permits are required to implement the applicable requirements of the Clean Air Act (which includes requirements under an approved SIP or preconstruction program). Requirements that applicable to the source pursuant to the (State) Act or these Rules only, are to be segregated from those requirements that are federally enforceable "applicable requirements" under the Federal Clean Air Act.

IDHW Response: The Department's modifications to the rules address this comment. See sections 314.04 and 322.17.j.

Comment #132: Section 314.04.c. Emission Information. We recommend using "applicable standard reference test method, if any" instead of "applicable test method."

IDHW Response: The Department has not modified this section in response to this comment. If there is no applicable test method, then the applicant will not have to identify terms necessary to establish compliance with the applicable test method.

Comment #133: Section 314.04.f. Emission Information. Since Title V operating permits address "regulated air pollutants," this requirement should be so limited.

IDHW Response: The Department has not modified the rules in response to this comment. The applicant is required to submit information regarding all air pollutants that are regulated by the Clean Air Act. In addition, any applicant that has a permit to construct that addresses Toxic Air Pollutants will be required to submit information regarding those emission.

Comment #134: Section 314.08. Additional Information. This section should include, in addition to "alternate operating scenarios," other provisions, such as emissions trading and emissions caps, allowed by the Clean Air Act. These alternate provisions, if incorporated into the permit, may be implemented without a permit revision.

Alternative Operating Scenarios. This section should clearly provide intent of alternative operating scenarios and include permit allowances for emissions trading, emissions caps, or other optional requirements pertinent to maintaining operational flexibility.

The last phrase needs to be revised to clarify that the additional information relates to permit terms and conditions allowing for emissions trading and cross reference the appropriate Idaho bubble rules.

IDHW Response: The Department has modified Section 314 to include a section relating to alternative operating scenarios (314.09) and a section relating to trading scenarios (314.12).

Comment #135: Section 314.09. Pursuant to 40 CFR 70.5(c)(8)(iv), the compliance plan must also include a schedule for submission of certified progress reports no less frequently than every 6 months for every source required to have a compliance schedule to remedy a violation.

Section 314.11.c. Certification of Compliance. Compliance certifications will require an enormous commitment of resources because of the certifications as to accuracy and completeness required of a senior official. Requiring certification more frequently than annually will be costly and will serve little purpose. We recommend that the Idaho Program be consistent with the Federal Program, except where the applicant and the Department have agreed to a more frequent certification in a compliance schedule.

Section 314.11.d. This paragraph must be revised to require a statement indicating "whether" the source is in compliance, not "that the source is in compliance."

IDHW Response: The Department has rewritten the sections covering Compliance Certifications and Compliance Plans (now Sections 314.10 and 314.11). These sections were rewritten to improve the organization and to clarify what information is required. The modifications to these sections address these comments.

Comment #136: Section 314.13. The phrase "activities which are exempted from permitting requirements of Sections 200 et seq." must be changed to "insignificant activities." The requirements of Title V (operating permits) of the Clean Air Act are completely different from the requirements of Title I (new source review) and the exemptions for construction permits are not approvable as exemptions from operating permits. Also, in the case of insignificant activities, the source must also submit such information as is necessary to demonstrate that the exemption applies.

IDHW Response: The Department has deleted this section. New Section 314.04.b has been added to clarify that Insignificant Activities need only be listed in the Tier I operating permit application. The Department believes that the list of Insignificant Activities is specific enough that sources do not need to demonstrate that the definition applies.

Comment #137: Section 315. Duty to Supplement or Correct Application. One commenter notes that Section 315 provides that the Department may request additional information deemed to be necessary to evaluate or take final action on the application and recommends adding language to allow the applicant to file a contested case, if the applicant believes the information is not authorized by law or the rules, or is not reasonably necessary to evaluate or take final action on the application.

IDHW Response: The rules have not been changed in response to this comment. Completeness determinations are based on a limited review of the application so IDHW often needs to request additional information from applicants in order to conduct the full review of

the application and issue a permit action. The request is not a final action, and thus, it is not appealable as a contested case. Applicants may respond to the request from IDHW by explaining why the applicant believes the information has already been provided or why the information is unnecessary. If IDHW agrees with the applicants explanation, IDHW continues with the review. If IDHW disagrees, it notifies the applicant and the applicant may provide the information or IDHW will deny the permit application. A denial of the permit application is an appealable action.

Comment #138: Section 317. Permit Continuance. For additional clarity, this paragraph should cross reference the provision which gives sources the ability to operate without a permit if the source submitted a timely application.

IDHW Response: The Department has deleted this section and has modified Section 301 (see 301.02.a) to clarify that sources may continue to operate if the source is in compliance with Sections 311 through 315.

Comment #139: Section 322. Standard Permit Requirements. The permit must also require the reporting of deviations from permit requirements and must define promptness in relation to the degree and type of deviation likely to occur and the applicable requirements in accordance with 40 CFR 70.6(a)(3)(iii)(B).

IDHW Response: The Department has not modified this section in response to this comment. Section 326 covers deviations from permit requirements and provides time frames for reporting for each type of excess emission event.

Comment #140: Section 322.01. Standard Permit Requirements. The permit must include emission limitations that assure compliance with all applicable requirements even if such requirements are identified after submission of the application.

IDHW Response: The Department has not modified this section in response to this comment. However, Section 315 requires the applicant to promptly provide information regarding requirements that become applicable after the date a complete application was file by prior to the release of a proposed action.

Comment #141: Section 322.03. Standard Permit Requirements. This provision needs to be revised to clarify that there must be at least one permit term for each requirement.

IDHW Response: The Department has incorporated the suggested modification into the rules.

Comment #142: Section 322.04. Alternative Operating Scenarios. Commenter commends IDHW for incorporating the alternative operating scenario provisions, and is recommending that two phrases be added to clarify that the source must outline reasonably foreseeable operating scenarios in its permit application for IDHW to approve them as a part of the operating permit.

IDHW Response: The Department has not modified the rules in response to this comment. The Department does not want to be put in the position of deciding whether or not an applicant could reasonably foresee operating under a proposed operating scenario. Maximum flexibility requires that the Department to base approval of alternative operating scenarios based on their compliance with underlying requirements not on whether or not a facility would ever operate under the requested scenario.

Comment #143: Section 322.04. Alternative Operating Scenarios. The reference to operating scenarios approved in accordance with Section 314.08 is confusing because Section 314.08 does not address the approval of such scenarios, only the information to include in an application. The permit must also include provisions that assure compliance with all applicable requirements for each such scenario.

IDHW Response: The Department has modified this section in response to this comment.

Comment #144: Section 322.10.e. Compliance Certifications. The state is the only regulatory agency, so the reference for sending certifications to EPA could be deleted.

IDHW Response: The Department has not modified the rules in response to this comment. This section is required by 40 CFR 70.6(c)(5)iv.

Comment #145: Section 322.13. Tier II Applicable Requirements. This provision must be deleted since no Tier II requirements can be applicable to Tier I sources. A source is either subject to Title V of the Clean Air Act or it is not.

IDHW Response: The Department has deleted this section.

Comment #146: Section 322.14. Provisions Stating the Following. This section lists provisions that are included in the permit. A subsection needs to be added that allows PTC/PSD permits to be automatically included into the operating permit. Without this, a PTC/PSD permit could be obtained but the modification could not take place until the operating permit was also changed. Rather

than have the delay and duplication of two separate permitting activities there should be one activity.

IDHW Response: The Department did not modify the rules in response to this comment. Sections 209.05 and 385 cover the relationship between these two programs.

Comment #147: Section 322.14(f). Provisions Stating the Following. It is unclear whether requiring all information requested under Section 122 is as broad as 40 CFR 70.6(a)(6)(v). This could perhaps be clarified by the Attorney General opinion.

IDHW Response: The Department has not modified the rules in response to this comment. The Attorney General opinion on the final rules will cover this issue.

Comment #148: Section 322.14(h). Provisions Stating the Following. This provision is contrary to 40 CFR 70.6(f) and Section 325 of the Idaho regulations in that it doesn't provide that the permit is a shield only as to applicable requirements listed in the application and expressly determined in writing by the permitting authority not to be applicable.

IDHW Response: The Department has deleted this section. The Department has rewritten Section 325 to clarify the shield provisions and to replace instructional language with actual language.

Comment #149: Section 322.15. Provisions Prohibiting. The last clause should be revised to clarify that it refers to a "modification under any provision of 42 U.S.C. Section 7401 to 7515."

IDHW Response: The Department has modified this section to prohibit facility alterations without complying with Sections 380 through 387.

Comment #150: Section 322.17. TIER I Limits. This section seems to render everything federally enforceable. This section should be modified to differentiate between State enforceable regulations and Federally enforceable regulations. Suggested language is included.

IDHW Response: The Department has modified this section (now 322.17.j) in response to this comment.

Comment #151: Section 322.20. Provisions Requiring Registration Fees. As discussed below, Idaho must demonstrate that all Tier I sources are subject to Sections 525 through 538. For example, it

is not clear that Tier I sources which are major only for hazardous air pollutants would be subject to registration fees.

IDHW Response: The Department has not modified this section in response to this comment.

Comment #152: Section 322.22. Permit Duration. The phrasing is awkward and could possibly be revised to state: "...a permit term of five years; except...." Also, the provision allowing for permits of shorter duration during the first four years after EPA approval cannot be applicable to acid rain sources.

IDHW Response: The Department has modified this section (now 322.15) in response to this comment.

Comment #153: Section 326. Excess Emissions. One commenter has suggested substantial additions, deletions and modifications to Section 326.

Section 326.01. This provision is not approvable and will preclude EPA from approving Idaho's Title V operating permit program. An upset must still be considered a violation. A state may, however, provide reasonable procedures for the exercise of enforcement discretion for upsets. Also, exercise of enforcement discretion for scheduled maintenance, start up and shut down is strictly limited. Idaho's provision is far too broad.

Section 326.03(a). By linking reporting to detection, the rule is much more permissive than Idaho's existing upset rule, which links reporting to occurrence. By linking reporting to detection, they can always say they didn't know about the upset. This provision must be revised to be consistent with the current requirements.

Section 326.03.d. This section allows the Division to shut down an entire facility if one emissions unit is the cause of excess emissions. The conditions under which an entire facility will be shut down should be well defined. Prior to the last sentence before i., add: "The decision regarding whether to shut down a facility will be based on the amount the rest of the facility contributes to excess emissions. Under no circumstances will an entire facility be shut down, if the shut down of the emissions unit resolves the problem."

IDHW Response: The Department has modified Section 326 in response to these comments. Most of the suggested modifications have been incorporated into this section. For suggested changes to sections 329.03 e-g, the Department has responded by editing these sections and deleting the "avoidable" and "absolve" clauses. The Department has retained the ability to revoke or modify the procedures because the approval will be issued with 48 hours to allow continued operations so there will be very limited review. The ability to revoke or modify will allow the Department to more liberally grant approvals initially because the Department can revoke or modify the

approval if new information becomes available, the permittee abuses the approval, or if the public objects.

Comment #154: Section 326.04. Excess Emissions. Allowing sources to send written notice within 15 days is more liberal than their current upset provision, which requires written notice by the end of business on the next working day. This provision must be revised to be consistent with the current requirement.

IDHW Response: The Department has not modified this section in response to this comment. For startup, shutdown and scheduled maintenance, the permittee is required to notify the Department no later than 2 hours prior to the start of the excess emissions event. For upset and breakdown, the permittee must notify the Department of the event no later than 24 hours after occurrence. The permittee is then required to submit a written report for each excess emissions event no later than 15 days after the beginning of the event.

Comment #155: Section 326. Excess Emissions. The section on permit content must include a provision meeting 40 CFR 70.6(b) regarding designation of state only requirements in the Tier I permit.

IDHW Response: The Department has modified the rules in response to this comment. See Section 322.17.k.

Comment #156: Section 342.03. Action on Applications. Section 342.03 provides that the Department shall promptly provide notice to the applicant of whether the application is complete and that, unless it is within the one year after EPA approves Idaho's Tier I Operating Permit Program or the Department requests additional information, or otherwise notifies the applicant of incompleteness within 60 days of receipt of an application, the application shall be deemed complete. Commenter recommends that the completeness determination be made with 60 days of submission of the application, regardless of when the application is submitted and that the permit shield be extended, and an application check list be provided.

This provision is contrary to 40 CFR 70.7(a)(4) in that it suspends the 60 day automatic completeness for applications submitted within one year after EPA approval of the program.

IDHW Response: The Department has modified the rules in response to this comment. See Section 361.

Comment #157: Section 342.01. Action on Applications. Clauses (b) and (c) appear to apply to the same actions, but use different

language. Making them consistent would avoid any possible ambiguity.

IDHW Response: The Department has modified these sections in response to this comment.

Comment #158: Section 342.01(f). Action on Applications. This provision does not appear to relate to any other subparagraphs in Section 342.01. It seems awkwardly placed. In addition, it is unclear whether this provision also includes increases in emissions of acid rain authorized by allowances, which, pursuant to 40 CFR 70.6(a)(4), must also be allowed without permit revision.

IDHW Response: The Department has deleted this section.

Comment #159: Section 342.02(a). Action on Applications. This provision also appears awkwardly placed, since it does not relate to the lead in provision of 342.02. Perhaps 342.02(a) should be renumbered 324.02, and the rest of what is now Section 342.02 should be renumbered 342.03.

IDHW Response: The Department has modified the rules in response to this comment.

Comment #160: Section 342.02.c and 342.06. Action on Applications. The definition of complete application allows open time limit if the Department determines application is not complete within 60 days. This section should require the Department to take final action on any complete Tier I operating permit application within six months of the permit application submittal.

IDHW Response: The Department has not modified the rules in response to this comment. Assuming that a complete application has been submitted, the Department must make a completeness determination within 60 days. Once the completeness determination has been made the Department must produce a draft Tier I operating permit within 60 days. The Department must provide a 30 day public comment period. The Department must then respond to comment and prepare a proposed permit within 30 days. The proposed permit will be sent to EPA for review period not to exceed 45 days. Therefore the expected time from submittal of a complete application to issuance of a final permit is seven and a half months barring any appeals.

The Department will reexamine the time required to take final action on a permit in the third year of the transition period. If warranted, the Department will shorten the 18 month deadline for final action on complete applications.

Comment #161: Section 342.02(d). Action on Applications. For clarification, this sentence should be revised: "Submittal of Tier I operating applications for and the permitting of...."

IDHW Response: The Department has modified this section in response to this comment.

Comment #162: Section 342.04. Action on Applications. This provision should be revised to clarify that the memorandum must set forth the "legal and factual basis" for the proposed permit.

IDHW Response: The Department has modified the rules in response to this comment. See Section 362.

Comment #163: Section 342.05. Action on Applications. For further clarity, this provision should be revised to make clear it refers to a complete Tier I application.

IDHW Response: The Department has modified the rules in response to this comment. See Section 361.03.

Comment #164: Section 342.06. This provision does not include the requirement that a responsible official must certify the submitted information.

IDHW Response: The Department has modified the rules in response to this comment. See Section 314.01.

Comment #165: Section 343.03.a. Permit Renewal & Expiration. While 343.03.a includes Tier II operating permits, 343.03.b. does not. Suggested language is included.

Section 343.03. and (b). This provision must be revised to clarify that the application must be both timely and complete. Furthermore, the references to "permit to construct" and "Tier II operating permit" must be deleted as Sections 300 et seq. do not apply to those permits.

IDHW Response: The Department has modified this section (now 368) in response to this comment.

Comment #166: Section 344. Off Permit Changes. The Department has included provisions incorporating this requirement in its draft regulations. Commenter is asking that additional language be added to specifically authorize trading of emission increases and decreases, and to otherwise accommodate SIP-authorized emissions trading. Additional language is included.

IDHW Response: The Department has modified the rules in response to this comment. See Sections 314.12 and 322.05.

Comment #167: Section 344. Off Permit Changes. Entitling this provision "off permit" changes is confusing, because Part 70 refers to changes of the type referred to in Section 322.16 as "off permit" changes. Changes of the type referred to in this paragraph are authorized under 40 CFR 70.4(b)(12). It may help to clarify Idaho's Title V program if all provisions allowing for operational changes outside the permit revision process were in the same place, such as off-permit changes, 502(b)(10) changes, and other operational flexibility provisions. Currently, some such provisions are here and some are either also or only in the permit content provision. This paragraph must also be revised to expressly exclude acid rain sources from making changes of the type permitted under this Section 344. In addition, this paragraph uses the term "emissions allowable under the permit," but that terms is not defined in Idaho's regulations. The term "emergencies" should also be defined.

IDHW Response: The Department has made modifications to the rules that address this comment. The Department has created a new section entitled "Alterations". The purpose of this section is to clarify what changes are allowed, the procedures that must be followed for each alteration, and the permit shield applicability of each type of alteration.

The Department has added or expanded the definitions mentioned in the comment. See Section 103.

Comment #168: Section 345. Administrative Permit Amendments. This provision can not apply for the acid rain portion of the permit. Instead, such amendments shall be governed by acid rain regulations.

IDHW Response: The Department has modified the rules in response to this comment. See Section 384.01.b.

Comment #169: Section 346. Minor Permit Modification Procedures. This provision can not apply for the acid rain portion of the permit. Instead, such modification shall be governed by acid rain regulations.

IDHW Response: The Department has modified this section (now 385) in response to this comment.

Comment #170: Section 346. Minor Permit Modification Procedures. IDHW has adopted minor permit modifications procedures. Commenter concurs with this approach, and has suggested some additional

language to make the purpose of the minor permit modification procedures more apparent. Commenter has also suggested a provision to allow group processing of minor modifications.

IDHW Response: The Department has modified this section (now 385) in response to this comment. The Department has added provisions allowing group processing of minor modifications (Section 385.07).

Comment #171: Section 346.01(d)(i). Minor Permit Modification Procedures. This provision must be clarified to provide that the emissions cap must be federally enforceable. Also, is the reference to "act" to Idaho law or to the Clean Air Act. The reference should include Title I modifications.

IDHW Response: The Department has not modified the rules in response to this comment.

Comment #172: Section 346.03. Minor Permit Modification Procedures. This provision must also require the State promptly to send any notice required under 40 CFR 70.8(b)(2).

IDHW Response: The Department has added this provision to the rules. See Section 385.04.

Comment #173: Section 346.04. Minor Permit Modification Procedures. This provision must be revised to provide: "Within 90 days of the Department's receipt of a complete application under the minor permit modification procedures or within 15 days after the end of EPA's 45 day review period, which ever is later,..."

IDHW Response: The Department has modified the rules in response to this comment. See Section 385.04.

Comment #174: Section 346.05. Minor Permit Modification Procedures. Based on the idea that the source also needs to comply with both the applicable requirements governing the change and the proposed permit terms and conditions until the Department takes action on 364.04.d. Commenter submitted new language.

IDHW Response: The Department has modified this section in response to this comment and to use terms consistent with the new Section 380.

Comment #175: Section 346.06. Minor Permit Modification Procedures. The permit shield does not apply to minor permit modifications at any time per 40 CFR 70.7(2)(vi).

IDHW Response: The Department has modified this section (now 385.06) in response to this comment.

Comment #176: Section 346. Minor Permit Modification Procedures. This section does not contain the requirements set forth in 40 CFR 70.7(e)(2)(iv) on the prohibition on issuance until after EPA review.

IDHW Response: The Department has modified the rules in response to this comment. See Section 385.04.

Comment #177: Section 348.01. Reopening For Cause. Subparagraphs (c) and (g) appear redundant. Also, the program must allow for reopenings for new requirements for acid rain sources in accordance with 40 CFR 70.7(f)(ii).

IDHW Response: The Department has modified this section (now 387) in response to this comment.

Comment #178: Section 348.02. Reopening For Cause. This provision must provide that reopenings shall be as expeditiously as possible. In the alternative, this assurance could be made elsewhere in the program submittal.

IDHW Response: The Department has modified this section (now 387.03) in response to this comment.

Comment #179: Section 349.03. Reopening For Cause by EPA. This provision should be revised to provide that the 90 days runs from receipt of an EPA objection.

IDHW Response: The Department has modified this section (now 387.05) in response to this comment.

Comment #180: Section 350.05. Public Participation. The language "...unless the director deems that additional time is required..." should be changed to provide for a 90 day maximum.

IDHW Response: The Department has not modified the rules in response to this comment. The Department makes every effort to respond to public comment expeditiously.

SECTION 400

Comment #181: Section 401. TIER II OPERATING PERMIT. Section 401.01. must be revised so that it applies to sources that are

subject to Section 300 et seq. not just Section 525. Tier II operating permits must be available to all sources which are not subject to Tier I operating permits and the applicability provisions of Section 525 are not the same as for Tier I operating permits. Furthermore, the parenthetical phrase must be revised because a source doesn't "net out" of applicability but rather limits its potential to emit to levels below the applicability provisions.

IDHW Response: The Department has modified this section in partial response to this comment. The Department has not changed the "net out" language.

Comment #182: Section 401.02. TIER II Operating Permit. Section 02. requires "that anyone with a permit to construct which establishes any emission standard different from those in these rules" to acquire a Tier II permit. If the Permit to Construct is valid for the life of the source then the emissions limitations included in the permit are also enforceable for the life of the source and nothing is really gained by the process of applying for additional permits. Section 03. is sufficiently broad to cover nearly any other circumstances. Delete section 02. and renumber the subsequent sections.

IDHW Response: The Department has not modified this section. This requirement is in the currently effective rules. Permits to construct do not have expiration dates but are superseded by operating permits issued after the permit to construct was issued.

Comment #183: Section 408.03. Conditions for TIER II Operating Permits. This section requires that all tier II operating permits be reissued every 5 years. The director, under section 401.03, has a great deal of discretion to modify or revise a Tier II permit. A permit to construct is issued for the life of the source. Delete Section 03. and renumber section 04.

IDHW Response: The Department has not modified this section. This requirement is in the currently effective rules.

Comment #184: Section 402. APPLICATION PROCEDURES. The phrase "by the owner or operator" should be replaced with "in accordance with Section 123" now that section 123 sets out who must be the certifying official for permits to operate. Furthermore, the reference to Section 300 must be replaced with Section 400.

IDHW Response: The Department has modified this section in response to this comment.

Comment #185: Section 402. APPLICATION PROCEDURES. The structure of this provision is confusing. Since all of section 402 applies to Tier II permits, the lead in to Section 402.01 should perhaps be revised to state: "An application for a Tier II permit must contain the following:" Also, the reference to Section 200 in 402.03 should be changed to Section 400 et seq.

IDHW Response: The Department has modified Section 402 to incorporate all applicable requirements from Sections 200 through 299.

Comment #186: Section 403. REQUIREMENTS FOR ALTERNATIVE EMISSION LIMITS (BUBBLES), Section 404. REQUIREMENT FOR BANKING EMISSION REDUCTION CREDITS (ERC'S), Section 405. REQUIREMENTS FOR EMISSION REDUCTION CREDIT and Section 406. DEMONSTRATION OF AMBIENT EQUIVALENCE. The structure of this part of the state's regulation is strained since Sections 400 et seq. apply to Tier II operating permits yet these Sections cover both Tier I and Tier II operating permits. These Sections should be relocated after Sections 400 - 499, since they apply to all sources, not just sources subject to Tier I operating permits.

IDHW Response: The Department has relocated these sections in response to this comment. See Sections 440, 441, 460 and 461.

Comment #187: Section 403.04. REQUIREMENTS FOR ALTERNATIVE EMISSION LIMITS (BUBBLES). This section needs to refer to all of the National Emission Standards for Hazardous Air Pollutants, not just those in 40 CFR Part 61 but those in Part 63 as well.

IDHW Response: The Department has modified this section in response to this comment.

Comment #188: Section 407.03. Procedures for Issuing Permits. Idaho may wish to consider using the term "permit revision" rather than "permit modification"

IDHW Response: The Department has modified this section in response to this comment.

Comment #189: Section 408.02. Conditions for Tier II Operating Permits. To ensure enforceability, this provision should specify a time period within which the source must provide the Department with a copy of the test results.

IDHW Response: The Department has not modified the rules in response to this comment. The Department can specify time periods for submission of test results in the Tier II operating permit.

Comment #190: Section 997. CONFIDENTIALITY OF RECORDS. One commenter noted that the Idaho rules which are incorporated by reference into these rules in Section 997 do not meet the requirements of 40 CFR Part 70 and Section 114 of the Clean Air Act. The rules must be revised in order for Idaho's Tier I operating permit program to receive full federal approval. In addition, another commenter noted that under Section 316 Tier I operating permit applicants may claim confidentiality for application information.

IDHW Response: The rules have been changed in response to this comment and to more accurately reflect the language and intent of current Idaho statutes. Old Sections 316 and 997 have been deleted and replaced with new Section 126. Section 126 provides procedures for a person to request IDHW to treat information as confidential information, requires Tier I operating permit applicants and permittees to submit copies of confidential information directly to EPA and clarifies that all information is subject to disclosure in accordance with Idaho Code §§ 39-111 and 9-301 et seq.

Guideline for Performing Air Quality Impact Analyses

Stationary Source Program
AQ Division

State of Idaho
Department of Environmental Quality
July 2021

Table of Contents

1 Introduction 1
1.1 Overview 1
1.2 Responsibility for Modeling Analyses 3
2 Use of the Modeling Guideline 4
2.1 This Guideline Most Useful in Common Instances 4
2.2 Level of Knowledge Required to Use This Guideline 5
3 Requirements to Perform Air Impact Analyses 6
3.1 Air Impact Analysis Regulatory Requirements for Permit Issuance 6
3.1.1 NAAQS and TAP Compliance Demonstration Requirements 6
3.1.2 Below Regulatory Concern Exemption from Demonstration Requirement 6
3.1.3 Regulatory Requirements of the Air Impact Analyses 7
3.2 Emission Thresholds Triggering Site-Specific Impact Analyses 7
3.3 Emission Increase Calculation for Project-Specific Modeling Applicability 12
3.3.1 Determining Whether Modeling is Needed for a New Source or Facility 13
3.3.2 Determining Whether Modeling is Needed for Modifications 13
4 Applicable Standards 16
4.1 Criteria Pollutants 16
4.2 TAPs Increments 17
4.3 Toxics 17
5 Modeling Methodology 18
5.1 Requirements for Permit Applications 18
5.1.1 Significant Impact Analysis 18
5.1.2 Cumulative NAAQS Analysis 19
5.2 Additional Requirements for PSD Applications 19
5.3 Facility Emission Cap (FEC) Permit Modeling 23
6 Performing a Modeling Analysis 23
6.1 Modeling Protocol 23
6.2 Choosing the Appropriate Models 25
6.2.1 Readily Available Models 25
6.2.2 Replacement of ISC by AERMOD 26
6.3 Pollutants and Sources to be Included in the Impact Analyses 27
6.3.1 Permits to Construct 30
6.3.2 Facility-Wide Tier II Operating Permits 32
6.3.3 FEC Permits 32

6.4 Source Information Required 32
6.4.1 Emission Rates 33
6.4.2 Source Parameters 34
6.4.3 Scaled Plot Plan 36
6.4.4 Building Downwash Parameters 37
6.4.5 Source, Building, and Receptor Coordinates and Elevations 37
6.5 Ambient Air Boundary 37
6.6 Receptor Network 39
6.7 Elevation Data 39
6.8 Meteorological Data 39
6.9 Land-Use Classification 41
6.10 Background Concentrations 41
6.11 Evaluation of Compliance with Standards 42
6.11.1 Approval Criteria 42
6.11.2 Adequacy of Analyses Results 44
6.12 Air Quality Modeling Report 45
7 DEQ Review of Modeling Analyses 47
8 Summary 48
References 48
Appendix A. Guidance for 1-Hour NO_2 Modeling of Intermittent Sources 50
Appendix B. Class I Areas 53
Appendix C. Idaho DEQ Air Dispersion Modeling Checklist 56
Appendix D. Modeling Protocol Checklists 58
Appendix E. Land-Use Classification Procedure 61
Appendix F. Example Tables for Air Quality Modeling Report 63

List of Tables

Table 1. Sections of the Guideline Used in Performing an Air Impact Analysis 3
Table 2. Modeling Applicability Thresholds (values in pounds/hour[(a)]) 9
Table 3. Significant Impact Levels (IDAPA 58.01.01.006) 16
Table 4. National Ambient Air Quality Standards 17
Table 5. Significant Emissions Rates (40 CFR 52.21 (b)(23); IDAPA 58.01.01.006)[(a)] 22
Table 6. Prevention of Significant Deterioration Increment Limits 22
Table 7. Modeled Impacts Above which Preconstruction Monitoring cannot be Exempted for PSD-Applicable Projects 23

List of Figures

Figure 1. Pollutant-Specific Modeling Applicability Flow Chart for New Facilities in Attainment or Unclassifiable Areas 10
Figure 2 Pollutant-Specific Modeling Applicability Flow Chart for Modifications to Existing Facilities in Attainment or Unclassifiable Areas 11
Figure 3. Flow Chart for Criteria Pollutant Ambient Impact Analysis for Permit to Construct Application 20

Abbreviations, Acronyms, and Symbols

DEQ	Idaho Department of Environmental Quality
EPA	US Environmental Protection Agency
Acfm	actual cubic feet per minute
AERMIC	American Meteorological Society/Environmental Protection Agency Regulatory Model Improvement
AQCR	air quality control region
AQRV	air quality related value
BPIP	Building Profile Input Program
Btu	British thermal unit
CO	carbon monoxide
DEM	digital elevation model
DEQ	Department of Environmental Quality
EL	screening emission level
EPA	Environmental Protection Agency
FEC	facility emission cap
ft	feet
GEP	good engineering practice
H_2S	hydrogen sulfide
IBR	incorporate by reference
IDAPA	A numbering designation for all administrative rules in Idaho promulgated in accordance with the Idaho Administrative Procedures Act.
ISCST3	Industrial Source Complex, Short Term Ver. 3; a refined air pollution model
K	Kelvin
lb/hr	pounds per hour
m	meter
m/sec	meters per second
mg/m^3	milligrams per cubic meter
mrem/yr	millirem per year
NAA	nonattainment area
NAAQS	National Ambient Air Quality Standards
NO_2	nitrogen dioxide
NO_x	oxides of nitrogen

NWS	National Weather Service
Pb	lead
$PM_{2.5}$	Particulate matter with an aerodynamic diameter less than or equal to 2.5 micrometers
PM_{10}	Particulate matter with an aerodynamic diameter less than or equal to 10 micrometers
PSD	prevention of significant deterioration
PTC	permit to construct
SCREEN3	An air pollution model used to establish the general distance to the maximum concentration from the facility
SIL	significant impact level
SIP	state implementation plan
SO_2	sulfur dioxide
TAP	toxic air pollutant
T/yr	tons per year
URF	unit risk factor
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
VOC	volatile organic compounds
F	Degrees Fahrenheit
$\mu g/m^3$	micrograms per cubic meter

1 Introduction

1.1 Overview

This guideline is intended to assist air permit applicants, air quality specialists, and others who are reasonably proficient at performing atmospheric dispersion modeling analyses, in understanding the Idaho Department of Environmental Quality's (DEQ's) expectations for performing ambient air quality impact analyses associated with air quality permitting. This guideline does not have the force and effect of a rule and is not intended to supersede statutory or regulatory requirements or recommendations of the state of Idaho or the Environmental Protection Agency (EPA). It is provided as general guidance and does not alter the discretionary authority of DEQ to protect public health.

A working-level knowledge of air pollutant dispersion and air quality assessment is needed to understand and use this guideline. Applicants not proficient in atmospheric dispersion modeling are encouraged to use environmental consultants specializing in air quality modeling or other sufficiently experienced professionals having such modeling capabilities. DEQ does not have available resources to educate applicants or consultants in the fundamentals of performing atmospheric pollutant dispersion modeling analyses.

DEQ staff will not recommend a specific consultant; however, DEQ may provide a list of consultants used by applicants for recent permit applications for which dispersion modeling was required. Recent permit applications, DEQ-issued permits, and the Statement of Basis for issued permits are available on DEQ's website, and consultants used by specific applicants are often identified in application materials and the DEQ modeling memorandum (the modeling review memorandum is typically included as an appendix to the Statement of Basis). DEQ may perform the atmospheric dispersion modeling analyses for applicants in some circumstances. Section 1.2 of this guideline describes cases in which DEQ may perform the analyses.

Table 1 provides a basic step-by-step description of an air quality impact analysis, with specific sections of this guideline referenced for each step.

The purpose of an air quality impact analysis, performed in support of an air quality permit application, is to demonstrate that all applicable ambient air quality standards will be met if a proposed project is implemented or to demonstrate an existing facility's compliance with the standards.

Demonstration of compliance with the National Ambient Air Quality Standards (NAAQS), toxic air pollutant (TAP) increments, and prevention of significant deterioration (PSD) increments is required by the state of Idaho for permit issuance and certain exemptions. DEQ has determined this demonstration generally requires the applicant to perform air quality impact analyses using an atmospheric dispersion model, referred to as modeling analyses in this guideline.

The extent of the required modeling analyses will vary from one project to another depending on the type and magnitude of emissions and applicability of specific permitting requirements. For simple facilities (e.g., few sources and buildings), compliance may be shown by using screening- level techniques, including a screening-level model. No further analyses will be required if compliance can be adequately demonstrated with the use of an appropriate screening technique. Projects for which compliance cannot be demonstrated using screening techniques must use more refined methods. Complex multi-point emitting sources or sources with unusual pollutant dispersion environments, for

which screening techniques are not appropriate, are also required to use more refined modeling techniques. Facilities submitting applications for which the PSD requirements are applicable are required to perform more extensive analyses than when submitting a minor source application. This guideline focuses on the requirements for non-PSD applications. Facilities submitting a PSD application should refer to the New Source Review Workshop Manual (EPA 1990) and other available materials from EPA for additional guidance and should consult with DEQ before performing the required analyses.

This guideline follows the Rules for the Control of Air Pollution in Idaho (IDAPA 58.01.01 {Idaho Air Rules}), EPA guidance in the New Source Review Workshop Manual (EPA 1990), and the Guideline on Air Quality Models (EPA 2005). The 2005 version of the Guideline on Air Quality Models was used to develop this version of the guideline. However, the most current version of the Guideline on Air Quality Models should always be used when evaluating appropriate methods and data for a specific project.

The Guideline on Air Quality Models specifies:

"…air quality modeling techniques that should be applied to State Implementation Plan (SIP) revisions for existing sources and to new source reviews (NSR), including prevention of significant deterioration (PSD). Applicable only to criteria pollutants, it is intended for use by EPA Regional Offices, in judging the adequacy of modeling analyses performed by EPA, State and local agencies and by industry. The guidance is appropriate for use by other Federal agencies and by State agencies with air quality and land management responsibilities."

DEQ highly recommends that a modeling protocol be developed and submitted to DEQ for approval before performing any modeling analyses. A DEQ-approved protocol will help assure that methods and data used in the modeling analyses are appropriate and will be acceptable to DEQ reviewers. Guidance on the contents of a protocol is provided in Section 6.1.

Table 1. Sections of the Guideline Used in Performing an Air Impact Analysis

Step in Air Impact Analysis	Section
1) Determine whether professional assistance is needed for performance of the air impact analyses?	1.1, 1.2, 2.0
2) Review general modeling requirements and develop a methodology.	5.0, 6.0
3) Calculate the emissions increase for modeling applicability purposes.	3.3, 6.3
4) Determine whether dispersion modeling is required – compare applicability inventory to modeling thresholds.	3.1, 3.2
5) Select the appropriate model.	6.2, 5.0
6) Set up the modeling analysis, including facility layout, buildings, ambient air boundary, receptors, and elevation data.	6.4.3, 6.4.4, 6.4.5, 6.5, 6.6, 6.7, 6.9
7) Select meteorological data.	6.8
8) Determine background concentrations.	6.10
9) Prepare and submit protocol, and obtain DEQ approval.	6.1
10) Calculate emissions for significant impact analyses and TAPs analyses.	5.1.1, 6.3, 6.3.1, 6.3.2, 6.3.3, 6.4.1
11) Calculate/obtain emissions release parameters and document.	6.4.2
12) Evaluate model results for significant impact analyses and TAPs analyses.	4.1, 4.2, 4.3, 6.11
13) Calculate emissions for cumulative NAAQS analyses and document.	5.1.2, 6.3.1, 6.3.2, 6.3.3, 6.4.1
14) Evaluate model results for cumulative NAAQS analyses.	4.1, 6.11.1
15) Perform comprehensive quality assurance/control of the analyses and evaluation of results.	2.0, 6.11.2
16) Prepare permit application and modeling report.	6.12, 7.0

1.2 Responsibility for Modeling Analyses

The accuracy and representativeness of methods and data used in the modeling analyses is the responsibility of the applicant. DEQ may provide applicants with appropriate meteorological data (not always preprocessed and ready for model input) and default background pollutant concentration values, as described later in this guideline.

DEQ modeling staff may assist applicants or may perform the required modeling analyses in some instances. The following are cases in which DEQ may perform the modeling analyses for permit applicants:

- Renewal of a Tier II operating permit. If a facility has not been modified since issuance of a previous Tier II operating permit, DEQ may use the previously performed modeling results to demonstrate compliance with NAAQS. Previously conducted modeling analyses will not be acceptable if DEQ identifies errors in methods or data used, or if the model used is substantially outdated, such that compliance with NAAQS may be questionable. Changes in applicable standards would also trigger the need to remodel the facility.
- DEQ has current modeling files for the facility. In instances where DEQ has a current model for the facility, slight changes to account for a new source or modification can sometimes be easily made by DEQ modeling staff. The applicant will be responsible for providing, justifying, and

documenting all input parameters needed to adequately address the proposed changes. Modeling analyses performed by DEQ staff will be done outside of the regulatory time limit for permit application review and will be dependent on DEQ staff workload. The applicant must include justification and documentation of all parameters, even those provided in previously submitted analyses. DEQ's permitting process requires that each application be a complete package in itself and not merely reference previously submitted applications.
If compliance with standards cannot be easily demonstrated by DEQ's analyses it will be the applicant's responsibility to conduct more refined analyses.

- Simplistic modeling analyses for small businesses. DEQ may conduct the modeling analyses for small business in situations where there are a small number of sources and a simple facility layout. These decisions will be made on a case- by-case basis and will depend on current DEQ workload.

Modeling analyses performed by DEQ for permit applicants will typically be done outside of the regulatory review process and any review timelines. Data and results will typically be forwarded to the applicant for their review when the analyses are completed by DEQ staff. The applicant will then combine those analyses with other components of the application and submit the complete application to DEQ to initiate the agency review process.

Permit applicants will be responsible for submitting the following information/data to enable DEQ to perform modeling analyses:

- Detailed description of operations and equipment used.
- Requested allowable emissions rates for all criteria pollutants and TAPs for all applicable averaging periods.
- Maximum operational and material processing rates.
- Site description and scaled site plot plan, including a detailed description of any structures. Universal Transverse Mercator (UTM) coordinates, with the applicable datum listed, must be provided for all building corners, and heights of all building tiers must be provided.
- Emissions point information (stack location in UTM coordinates with the applicable datum listed, stack height, stack diameter, stack gas temperature, and flow rate) with thorough justification and documentation of such information.

If DEQ's analyses do not initially demonstrate compliance with applicable standards, it will be the applicant's responsibility to refine the analyses to achieve an adequate compliance demonstration.

DEQ has developed, or is in the process of developing, specific modeling approaches for several industrial types. For example, DEQ has conducted non-site-specific modeling for truck-mix concrete batch plants and portable hot-mix asphalt plants; and no source- specific modeling is require for these plants if they meet the production rate limits, minimum stack parameter specifications, and setback distances from specific receptors. DEQ air dispersion modeling staff should be consulted regarding availability and details of industry-specific modeling approaches.

2 Use of the Modeling Guideline

2.1 This Guideline Most Useful in Common Instances

This modeling guideline is presented as suggestions and instructions for performing a modeling analysis in the most common instances. The methods and data presented are not appropriate for all sources,

locations, and/or situations, and use of a method presented in the guideline does not necessarily assure DEQ approval of the method. DEQ may approve or require methods and/or data differing from those presented in this guideline, depending on the characteristics of the specific situation.

2.2 Level of Knowledge Required to Use This Guideline

This guideline is not intended to educate permit applicants or consultants in the basic principles of atmospheric dispersion or in the operation of various dispersion models, as stated in Section 1.1. A wide variety of commercially available courses are available for applicants to develop the level of knowledge needed to correctly perform pollutant dispersion modeling analyses.

If your specialist (your staff) or consultant and cannot easily answer the following questions, they may not be adequately skilled to properly perform an air impact analysis involving dispersion modeling for air permitting purposes:

1. Have you performed an atmospheric dispersion modeling analysis within the last five years?
2. Do you understand why a stack with a horizontal or rain-capped release is sometimes modeled using a stack flow velocity of 0.001 meters per second?
3. Do you know what a significant impact is, and its implications for modeled impacts?
4. Do you know when background concentrations are used in a modeling analysis and when they are not?
5. Do you understand the difference between a significant impact analysis and a cumulative NAAQS impact analysis?
6. Do you know what surface roughness, Bowen ratio, and surface albedo are and how they are used in the model programs and preprocessor programs?
7. Do you understand the difference in how point sources, area sources, and volume sources are treated in AERMOD, SCREEN3, and/or AERSCREEN?
8. Do you know whether AERMOD uses daily or hourly meteorological data?

Permitting regulations require the applicant to demonstrate that emissions will not cause or significantly contribute to a violation of a standard. The regulations do not require that the analyses estimate actual impacts to the greatest degree possible. Therefore, it is advised that applicants use reasonably conservative data and methods to demonstrate compliance – data and methods that both DEQ and the applicant agree will generate impacts greater than those that would be reasonably expected. However, overly conservative estimates of input parameters, especially emission quantities, may substantially overstate impacts. This could result in the inappropriate applicability of certain requirements and/or the imposition of unnecessary permit provisions and restrictions.

Use of unrealistic release parameters, such as stack flow rates or stack gas temperatures, could shift the location of maximum impacts. In situations where the modeling analyses involve numerous sources, this could result in either under-estimation or over-estimation of combined impacts. Therefore, it is recommended that reasonably accurate release parameters be used when modeling multiple sources, rather than overly conservative parameters. In some instances, where reasonably expected parameters are highly variable, it may be more appropriate to use multiple operational scenarios to evaluate the effects of varying parameters.

3 Requirements to Perform Air Impact Analyses

This section outlines the permitting requirement to demonstrate compliance with NAAQS and TAP increments, and it describes when project-specific air impact modeling analyses are needed for issuance of a PTC or Tier II Operating Permit. It discusses pollutant-specific regulatory applicability, regulatory requirements for permit issuance, and calculation of emission increases for project modeling applicability.

3.1 Air Impact Analysis Regulatory Requirements for Permit Issuance

3.1.1 NAAQS and TAP Compliance Demonstration Requirements

Idaho Air Rules Section 203.02 states that "no permit to construct shall be granted for a new or modified stationary source or modified stationary source unless the applicant shows to the satisfaction of the Department" that the source or modification "would not cause or significantly contribute to a violation of any ambient air quality standard." Section 203.03 similarly requires that no permit be issued unless it is demonstrated through the use of methods in Section 210 that the source or modification would not "injure or unreasonably affect human or animal life or vegetation as required by Section 161."

Air impact analyses are also required for the issuance of Tier II Operating Permits, with requirements of Idaho Air Rules Section 403.02 mirroring Section 203.02 for PTCs. There are no TAP impact analysis requirements for Tier II Operating Permits.

3.1.2 Below Regulatory Concern Exemption from Demonstration Requirement

Certain projects may be exempt from the requirement to demonstrate compliance with NAAQS or TAP increments. If a project would qualify for a Below Regulatory Concern (BRC) permit exemption as per Idaho Air Rules Section 221 if it were not for potential annual emissions of one or more pollutants exceeding the BRC threshold of 10 percent of emissions defined by Idaho Air Rules as "significant," then a NAAQS compliance demonstration may not be required for those pollutants with emissions below BRC levels. DEQ's regulatory interpretation policy of exemption provisions of Idaho Air Rules Section 221.01 is that: "A DEQ NAAQS compliance assertion will not be made by the DEQ modeling group for specific criteria pollutants having a project emissions increase below BRC levels, provided the proposed project would have qualified for a Category I Exemption for BRC emissions quantities except for the emissions of another criteria pollutant.[1]" The interpretation policy also states that the exemption criteria of uncontrolled potential to emit (PTE) not to exceed 100 ton/year (Idaho Air Rules Section 220.01.a.i) is not applicable when evaluating whether a NAAQS impact analysis is required. A permit will be issued limiting PTE below 100 ton/year, thereby negating the need to maintain calculated uncontrolled PTE under 100 ton/year.

The BRC exemption cannot generally be used to exempt a project from a pollutant-specific NAAQS compliance demonstration where a PTC is required for the action regardless of emission quantities, such as the modification of an existing emission or throughput limit.

However, in this instance, if post-project facility-wide annual emissions of the criteria pollutant are also below BRC thresholds, then a NAAQS compliance demonstration is not required.

3.1.3 Regulatory Requirements of the Air Impact Analyses

Once a permit is required for a proposed project, an air impact analysis is required for permit issuance unless the pollutant can be exempt from the requirement to demonstrate compliance with NAAQS and TAP increments, as described above in Section 3.1.2. Idaho Air Rules Section 203 for PTCs and Section 403 for Tier II Operating Permits require that air impact analyses demonstrate compliance with NAAQS and TAP increments "to the satisfaction of the Department." A key consideration is what constitutes DEQ satisfaction of compliance.

Use of unquestionably-conservative methods and data for all components of the analyses will generate predicted impacts that demonstrate compliance at near complete certainty. As analyses move back from methods and data that are highly conservative, then the certainty of NAAQS and TAP increment compliance decreases. Determining the point at which analyses no longer satisfactorily demonstrate compliance then becomes an important concern. This point is not defined in the regulations. DEQ asserts that a satisfactory compliance demonstration is an analysis where NAAQS and TAPs increment compliance is "highly confident," considering all variability and uncertainty in analytical methods and data.

The confidence level of compliance with air quality standards will be affected by the following:

- Magnitude and spatial extent of modeled impacts in comparison to applicable thresholds or standards.
- Potential for public exposure to impacts exceeding standards.
- Representativeness of meteorological data used, and the accuracy/conservatism of meteorological data processing methods used.
- Uncertainty and variability of estimated emissions. Emissions that will be verified by source testing will be considered as near certainty, while emissions based on low-ranked AP-42 factors (which usually represent an average across the industry) will be considered as low confidence.
- Method used to account for atmospheric chemistry (NO/NOx chemistry primarily).
- Representativeness and conservatism of background concentrations (note that using design value background levels with design value modeled results is more conservative for short-averaging periods than for annual averaging periods).
- Level of conservatism in modeling expected operational scenarios (handling variable load conditions, multiple intermittent sources, etc.).
- Representativeness/conservatism of methods used to handle complex emission points such as fugitive releases.
- Handling of building downwash.
- Handling of complex terrain.
- Methods use to hand co-contributing sources in a cumulative impact analysis.

3.2 Emission Thresholds Triggering Site-Specific Impact Analyses

Emission quantities from a source directly affect pollutant impacts to ambient air, and therefore affect the likelihood of a source to cause or contribute to a violation of an ambient air quality standard. Where emission rates are minimal, DEQ can be highly confident that the source will not cause or contribute to a standard violation without performing an impact analysis using pollutant dispersion modeling. Screening Emission Levels (ELs) are specified in the Idaho Air Rules as a de *minimis* TAP emission quantity, below which compliance with the TAP increment is assured. De *minimis* levels for criteria pollutants are not specified in Idaho Air Rules. However, this section presents criteria pollutant de *minimis* levels that DEQ

asserts will reasonably assure NAAQS compliance for various circumstances. These levels were established using the professional judgement of DEQ scientists and engineers, combined with results from computerized pollutant dispersion models for various generic configurations.

DEQ established emission de *minimis* levels as a function of the Significant Emission Rates (SERs) defined in Idaho Air Rules Section 005.108. The SERs are expressed as annual emission rates. To use SERs for NAAQS with short-term averaging periods, the SER is divided by 8,760 hours/year and compared to maximum hourly emissions for 1-hour standards or maximum daily emissions divided by 24 for 24-hour standards. DEQ also developed Significant Impact Level (SIL) thresholds for modification projects; emissions less than these rates are reasonably assured to have impacts less than the applicable SIL. SIL thresholds were developed by DEQ using dispersion modeling analyses of a generic facility with one point source.

Whether a specific emission quantity can cause or contribute to a violation greatly depends on whether those emissions occur from a new facility or are added to those of an existing facility, and whether the existing facility has recently demonstrated NAAQS compliance on a facility- wide basis through dispersion modeling. The confidence of NAAQS compliance is high where project emissions occur from a proposed new facility in an attainment area and predicted emission quantities are low. NAAQS compliance confidence is also high for projects at existing facilities where facility-wide air impact analyses were recently performed and emissions associated with the modification are minimal. Even if the increase in emissions at a previously modeled existing facility could cause impacts exceeding the SIL, it is unlikely that impacts could exceed the NAAQS when combined with co-contributing sources and background concentrations. This is because any high impacts from new sources are not likely to coincide in time and space with high impacts from the existing facility. In the unlikely event that such minimal emissions combine with a high background concentration and impacts from nearby sources to produce an impact exceeding the NAAQS, it is likely that such impacts would only occur in a small area, would only occur for limited periods, and would not affect areas where sensitive individuals could be present.

A modeling applicability threshold assuring project impacts less than the SIL is used for modification projects to facilities where facility-wide NAAQS compliance demonstrations have not been recently performed. This threshold assures with high confidence that the project will not significantly contribute to any potentially existing NAAQS violation. These threshold values were based on modeling of a generic DEQ-generated facility, using the AERMOD regulatory model with Idaho meteorological data. The analyses used the following parameters: stack height = 10 meters; stack diameter = 0.5 meters; velocity at stack exit = 10 meters/second; stack gas temperature at exit = 200 ^{o}F; ambient air is at a distance of 100 meters from the stack; the stack is centered on a 10 meter square building, 5 meters high. The SIL thresholds are emission rates that, when modeled using the generic DEQ-generated facility, result in impacts just below the applicable SIL.

Figures 1 and 2 show the project-specific air impact analysis applicability determination process for new facilities and modifications to existing facilities, respectively. This process should only be used for projects proposed in attainment or unclassifiable areas. DEQ should be consulted if a proposed project is located in a non-attainment area. Also, if DEQ observes project-specific conditions that suggest a threshold is not appropriate or protective of NAAQS, then DEQ may require project-specific air impact modeling even though emissions are below the listed threshold.

Table 2 lists the modeling applicability threshold values referenced in Figures 1 and 2.

Table 2. Modeling Applicability Thresholds (values in pounds/hour[(a)])

Pollutant and Averaging Period	SIL Threshold	BRC	1/8 SER	1/4 SER	SER
CO 1-hr	84	2.3[b,c]	2.9[b]	5.7[b]	100 ton/yr
CO 8-hr	26	2.3[b,c]	2.9[b]	5.7[b]	100 ton/yr
NO_2 1-hr	0.38	0.91[c]	1.14	2.3	40 ton/yr
NO_2 ann	0.43 (1.9 ton/yr)	4.0 ton/yr	5.0 ton/yr	10.0 ton/yr	40 ton/yr
SO_2 1-hr	0.40	0.91[c]	1.14	2.3	40 ton/yr
PM_{10} 24-hr	0.32	0.34[c]	0.43	0.86	15 ton/yr
$PM_{2.5}$ 24-hr	0.092	0.23[c]	0.29	0.57	10 ton/yr
$PM_{2.5}$ ann	0.085 (0.37ton/yr)	1.00 ton/yr	1.25 ton/yr	2.5 ton/yr	10 ton/yr
Pb 3-month	0.00102 (0.73 lb/mon)	9.9 lb/mon	12.3 lb/mon	24.7 lb/mon	0.6 ton/yr

a) Values in pounds/hour as averaged over the averaging period of the NAAQS, unless noted otherwise. Pound/hour values listed as a function of the SER were calculated by dividing the annual SER value by 8,760.

b) These values are more restrictive than the SIL Threshold. Therefore, the SIL Threshold may be used in place of these values.

c) BRC is based only on annual emissions. The pounds/hour values listed as BRC for short term standards are the annual BRC rate divided by 8,760 hours/year. Annual emissions from the project should be divided by 8,760 hours/year and then compared to the listed pounds/hour BRC threshold to evaluate whether the project can be exempt from NAAQS compliance demonstration requirements for the applicable pollutant.

d) These values are more restrictive than the SIL Threshold. Therefore, the SIL Threshold may be used in place of these values.

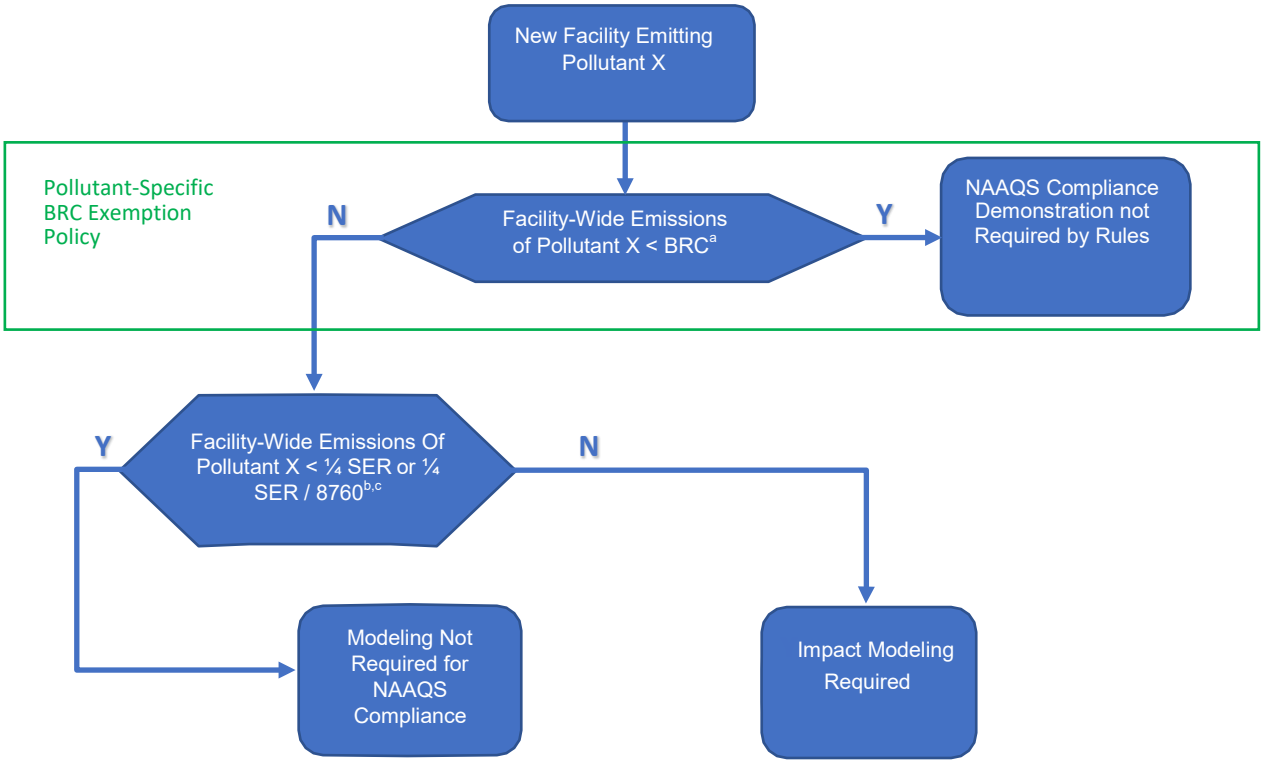


Figure 1. Pollutant-Specific Modeling Applicability Flow Chart for New Facilities in Attainment or Unclassifiable Areas

a) This evaluation is DEQ's regulatory interpretation of permit exemption rules, as described in: *Policy on NAAQS Compliance Demonstration Requirements*. Idaho Department of Environmental Quality Policy Memorandum. July 11, 2014. The evaluation is based only on annual emissions, and emissions qualifying as "fugitive" as defined by Idaho Air Rules for permit applicability are not included in the evaluation. Example: A company proposes to construct a widget maker facility. The project would qualify for a BRC permitting exemption under Idaho Air Rules Section 221.01, with emissions of Pollutant X below the BRC threshold, except that emissions of Pollutant Y exceed the BRC threshold and trigger the requirement to obtain a PTC. By DEQ regulatory interpretation, a NAAQS compliance demonstration for Pollutant X is not required by Idaho Air Rules for permit issuance.

b) Emissions calculated according to DEQ-specified methods. Fugitive emissions associated with the project are included in this evaluation. The threshold of 1/4 SER is applicable to NAAQS regulated on an annual average; and 1/4 SER/8760 is applicable to NAAQS on a short-term average, with the pound/hour threshold value compared to the maximum potential/allowable emission for the averaging period divided by the hours in the averaging period.

c) If DEQ observes project-specific conditions that suggest these thresholds are not appropriate or protective of NAAQS, then DEQ may require project-specific air impact modeling even though emissions are below listed thresholds.

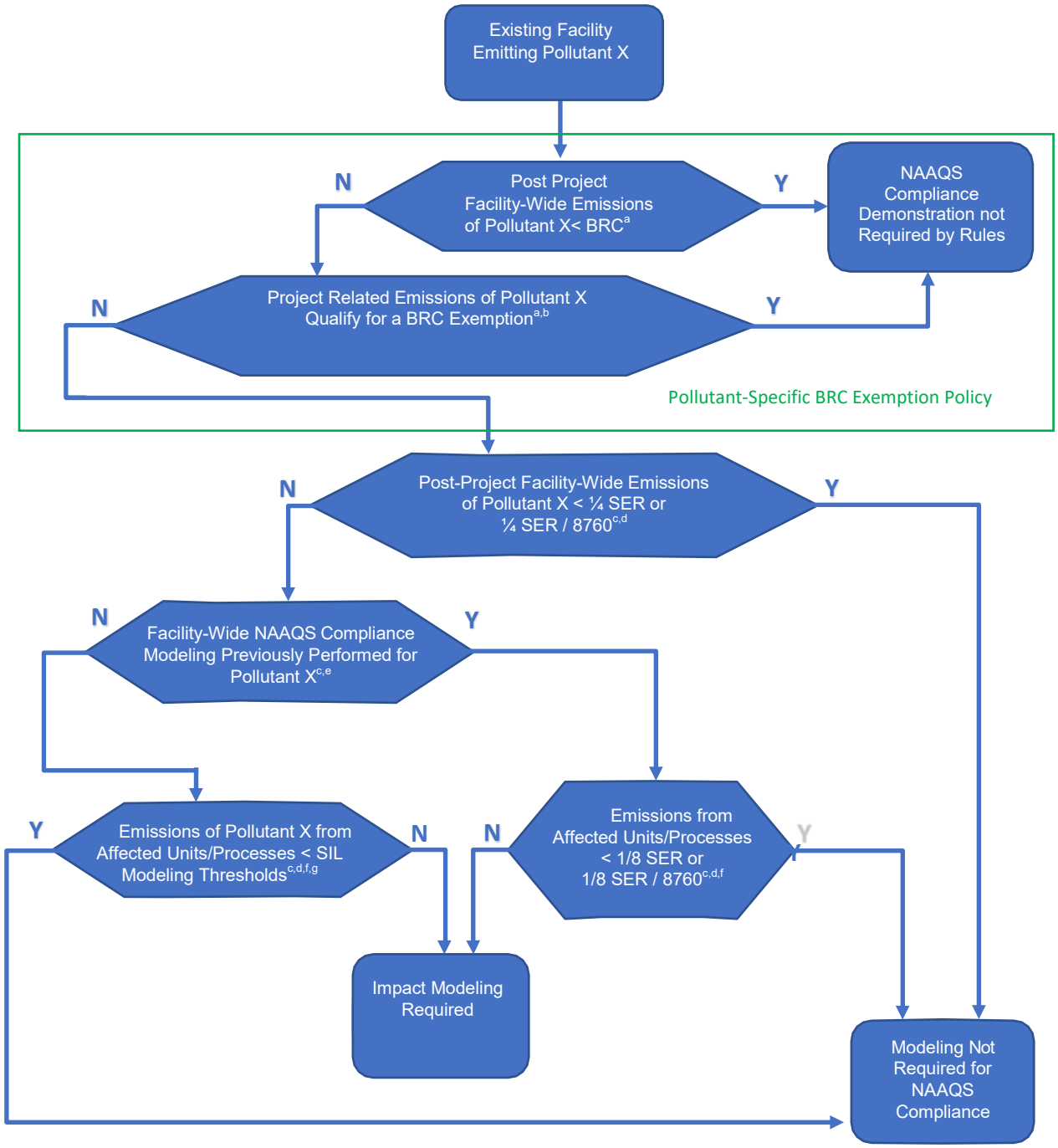


Figure 2 Pollutant-Specific Modeling Applicability Flow Chart for Modifications to Existing Facilities in Attainment or Unclassifiable Areas

a) This evaluation is DEQ's regulatory interpretation of permit exemption rules, as described in: Policy on NAAQS Compliance Demonstration Requirements. Idaho Department of Environmental Quality Policy Memorandum. July 11, 2014. The evaluation is based only on annual emissions, and emissions qualifying as "fugitive" as defined by Idaho Air Rules for permit applicability are not included in the evaluation.

b) Examples:

1. A company proposes to construct a widget maker at their existing facility. The project would qualify for a BRC permitting exemption under Idaho Air Rules Section 221.01, with emissions of Pollutant X below the BRC threshold, except emissions of Pollutant Y exceed the BRC threshold and trigger the

requirement to obtain a PTC. By DEQ regulatory interpretation, a NAAQS compliance demonstration for Pollutant X is not required by Idaho Air Rules for permit issuance.

2. A facility proposes to increase production at their existing, permitted widget maker. The existing permit limits widget production at 50 widgets per hour. The project proposes to increase production to 100 widgets per hour. The increase in emissions of Pollutant X is below the BRC threshold, but total emissions of Pollutant X from the unit are above the BRC threshold. A NAAQS compliance demonstration for Pollutant X is required because the project could not qualify for a permitting exemption, regardless of the emissions from other pollutants. The modification requires changing an existing permit condition, and therefore, could not qualify for a BRC exemption.

c) Fugitive emissions associated with the project are included in this evaluation.

d) If DEQ observes project-specific conditions that suggest these thresholds are not appropriate or protective of NAAQS, then DEQ may require project-specific air impact modeling even though emissions are below listed thresholds.

e) This applies if facility-wide modeling of the specific pollutant was performed for the averaging period of the NAAQS. Facility-wide modeling may be associated with a past permitting project or performed independently, and it may conservatively use allowable emissions or a more-refined reflection of actual emissions. Modeling must have been approved by DEQ, performed within the previous five years, be representative of the existing facility and operations, and include the pollutant of interest.

f) Emissions increase calculated according to DEQ-specified methods, including methods to handle projects involving relaxation of an emission-affecting permit limit.

g) SIL Modeling Threshold based on modeling of a generic hypothetical source.

3.3 Emission Increase Calculation for Project-Specific Modeling Applicability

Whether project-specific air impact modeling is required for a project depends on the increase in emissions resulting from implementation of the project. The emission increase for a new facility is simply the sum of potential or permit-allowable emissions from all emission sources associated with the project. The emission increase for a modification is defined in Idaho Air Rules as “the amount by which projected actual emissions exceed baseline actual emissions of an emissions unit.” Section 3.3.2 provides more details on calculating the emission increase associated with modifications for modeling applicability.

The following types of emissions sources should be included in the modeling applicability calculation:

- All emissions sources that may be included in the permitting analyses or the issued permit, regardless of whether those sources may have (or will be issued) emissions or operating limits. Sources that are exempt from permitting as per Idaho Air Rules Section 220-223 must normally be included in the modeling applicability calculation. DEQ’s modeling group should be consulted if there are questions regarding the inclusion or exclusion of emission sources in the modeling applicability determination.
- Process fugitive emissions from material handling, processing, etc. Fugitive emissions from vehicle traffic on facility roadways and wind erosion emissions from storage piles will not typically be considered for minor source permitting applicability unless DEQ determines such sources may have a substantial contribution to ambient concentrations. Mining facilities are typically in this category where such fugitive sources must be included.
- Intermittent sources such as batch processes, flaring, bin dumping, engine testing, etc. Emissions of NOx from intermittent testing of engines powering emergency generators and fire suppression water pumps can typically be excluded from the modeling applicability

determination for 1-hour NO2 NAAQS compliance demonstrations. Appendix A provides DEQ's final guidance on the modeling of NOx from intermittent testing and maintenance operations of engines powering emergency generators and fire suppression water pumps.

Sections 3.3.1 and 3.3.2 describe how emission quantities should be calculated for various scenarios to evaluate the need to conduct project-specific impact modeling. The modeling applicability emission inventory (used to determine whether modeling is needed) may be different than the modeling analysis emission inventory (used to conduct a significant impact analysis), as explained in Section 6.3.1.

3.3.1 Determining Whether Modeling is Needed for a New Source or Facility

Proposed allowable emissions, as specified in a permit application or calculated as potential to emit, of all new emissions sources will be used to evaluate the need for modeling a proposed new emissions source or new facility. No emission sources are typically exempt from the evaluation of whether modeling is needed. Also, any reductions in emissions at a different source cannot be considered at the modeling applicability stage.

3.3.2 Determining Whether Modeling is Needed for Modifications

Air impact modeling requirements for a modification hinge on the quantity of increased emissions that could occur as a result of the modification. For the purpose of project-specific applicability for performing an air impact analysis, any emission decreases are not typically considered. Creditable decreases may be considered in air impact modeling performed once the requirement to perform impact modeling has been established. If removal of an existing source or installation of control equipment on a source occurs concurrently with a modification, the emission reduction associated with such activities will not typically be considered in the evaluation of whether emissions exceed modeling applicability thresholds.

Emission increases for a modification must be carefully calculated to obtain an accurate or conservative assessment. From a regulatory standpoint, "Emissions Increase" is defined in Idaho Air Rules Section 007.04 as, "The amount by which projected actual emissions exceed baseline actual emissions of an emissions unit." Baseline actual emissions are a best-estimate of emissions that could realistically occur by operation of the source before modification. If the source is permitted, such emissions may be those allowed under the restrictions of the existing permit (using best available emission estimation methods and considering the permit limits that are the most restrictive to emission-causing operations). The following should be considered when calculating baseline actual emissions to evaluate the need for project-specific modeling:

- For a given process, the same emission calculation method and emission-affecting assumptions should be used for baseline actuals as is used for calculating future permit allowables, unless there are changes in the process that necessitate using different methods and assumptions. A change in emission factors or methods used to estimate emissions from a given process cannot be used to reduce the change in emissions associated with a proposed modification.
- Emissions considered as a conservative estimate for post-project allowable emissions (over-estimation of emissions), will result in an overestimate of baseline actual emissions for future projects. This may then result in an underestimation of the future project emission increase. DEQ approval of a conservatively high emission estimate of a source for initial permitting may not be appropriate for calculating baseline emissions for a future modification. However, the same emission factor or estimation method should be used for a given process, as noted in the previous bullet. For example, if a project involves increasing allowable throughput and the

emission generating mechanism does not change, the same emission factor should be used for both baseline actual emissions and post-project allowable emissions. Also, the applicant should use a factor they are confident does not underestimate post-project allowable emissions, even if it is suspected use of the factor overstates baseline actual emissions.

- Permit applicants should not simply use emission factors and other emission-affecting parameters from previous air impact analyses as a representation of baseline actual conditions. Many previous analyses were only required to demonstrate that the project will not cause a violation, and this was often accomplished by using simplistic estimates that substantially overestimate emissions. More accurate and updated emission rate data and release parameter information are frequently available for a source after initial permit issuance. This results from performance tests or from changes in emission factors. Baseline actual emissions should generally be calculated using the most accurate methods available. Overestimating baseline emissions will result in underestimation of the change in emissions resulting from a modification.
- Full operational levels (as allowed by the existing permit) can be considered in the calculation of baseline actual emissions, provided the facility/equipment could have accommodated such a level of operation. For example, a certain unit has a throughput limit of 1,000 units per day, and operational records indicate that only a maximum of 900 units per day has been processed. Baseline emissions can be calculated by assuming 1,000 units per day if it can be demonstrated that the facility could effectively attain those levels without a facility modification.
- Many permits contain both specific emission limits and limits on production. Baseline emissions must be based on the most restrictive limitation in the permit. As an example, consider a case where source testing has demonstrated that emissions per unit of production are lower than anticipated during initial permitting. As part of a proposed modification, the facility would like to raise the allowable production rate but not change the permitted emission rate. In this case, there will be an increase in allowable emissions because there is an increase in throughput. However, the applicant may calculate the increase in emissions using an updated emission factor that is based on recent source testing.

Future projected actual emissions will simply be permit-allowable emissions. Conservative emission estimates that overstate these emissions are acceptable and encouraged to facilitate expeditious DEQ approval of the modeling-applicability calculation.

Relaxation of Existing Permit Restrictions

Some modification projects involve the relaxation of an existing emission-affecting permit restriction, such as throughput limit, limit on hours of operation, material restriction on the type of material processed, or a direct emissions limit. In these cases, especially where the existing limit was needed to assure compliance with a NAAQS or a TAP increment, DEQ may require that the entirety of emissions from the unit be considered for modeling applicability rather than the increase alone. This approach is used because of the following:

- An increase in emissions at an existing emission point is more likely to cause or contribute to a NAAQS or TAP increment violation than if those emissions occurred at a new point. This is because emissions at two separate points must have overlapping plumes for their impacts to be additive.
- If a limit was needed on an emission point to assure NAAQS or TAP increment compliance, then increasing emissions at such a point would likely cause a violation.

This approach is intended to address potential "sham" permitting. A sham permit occurs when a facility originally intends to operate at a certain level, and equipment permitted is fully capable of operating at such levels, but NAAQS or TAP increment compliance cannot be demonstrated. As a result, the facility is issued a permit limit on the source(s) to assure compliance. Sometime after permit issuance, the facility then submits a permit application to relax the limit, addressing only the increase from the previous limit for impact analyses. This approach effectively circumvents the requirement to comply with NAAQS and/or TAP increments. To address this concern, the emission increase is calculated using a baseline associated with the facility prior to issuance of the permit establishing the limit that the facility now proposes to relax.

Generally, DEQ will use a 5-year period during which a project that involves relaxation of a limit (without a physical change at the facility) will be considered an adjustment/correction of previous permitting project rather than a new project. The emission increase will be calculated using the base emissions allowable prior to the previous permitting project (the project that established the limit to be relaxed) and the new proposed limit.

Replacement Projects

The need for modeling replacement projects that do not qualify as routine replacement is based on total allowable emissions from the proposed new source. The decrease in emissions associated with the removal of the old equipment is not generally considered for modeling applicability.

For example, if a sawmill proposes replacing an existing kiln with a new kiln (not routine replacement), modeling applicability would be based on the proposed allowable emissions of the new kiln without any consideration of the decrease in emissions associated with removal of the older kiln. The creditable emissions decrease associated with the kiln removed can be used in the air impact modeling to offset the emissions from the new kiln, modeled as negative values to evaluate the net impact of the project.

Modification of a Permitted Source

This scenario involves alteration of an existing and permitted emissions source. The need for modeling is normally based on the emission increase as determined by the difference between baseline actual emissions and future projected emissions (permit allowables). However, if the modification alters the release characteristics of the source (temperature, stack gas flow rate, stack height, etc.), then the entire allowable emissions from the modified source must be included for the purpose of modeling applicability. If the emission release characteristics do not change, then the applicable emissions will be considered as the increase resulting from the modification. An example of this is increased emissions-generating activities (that do not affect the temperature or volume of air exhausted) in a room where air is exhausted to the atmosphere through an existing stack. The emissions increase would be calculated as the difference between the current emissions rate and the new proposed allowable emissions rate. Determining the need for project-specific air impact modeling based on only the increase in emissions is approved by DEQ on a case-by-case basis, considering whether the point of release and release characteristics are very similar between the existing and modified emissions points.

A permit is not specifically required for instances where physical changes made at a facility affect dispersion but do not meet the definition of a "modification." Although such changes do not typically require a permit, they do effectively invalidate any dispersion modeling analyses performed prior to those changes and could alter the NAAQS compliance status of the facility. In some cases, DEQ may request facilities to perform air quality dispersion modeling analyses to affirm compliance with applicable standards.

4 Applicable Standards

This section discusses the applicable standards for assessing impacts on ambient air.

4.1 Criteria Pollutants

Table 3 lists the significant impact levels (SILs) used to determine whether or not the proposed project would have a significant impact on the air quality in the area. The proposed project has a significant impact on the ambient air quality if the resulting ambient concentrations exceed these levels due to an emissions increase.

Table 4 presents the NAAQS which are incorporated by reference (IBR) into Idaho Air Rules Section 107.03.b. Typically, there is about a year of lag time between when a new NAAQS is promulgated by EPA and the time when it is IBR into Idaho Air Rules. A NAAQS compliance demonstration involving modeling analyses for a specific standard is only required for permits issued after the date the standard is IBR into Idaho Air Rules. In cases where a NAAQS has been promulgated by EPA but not yet IBR to Idaho Air Rules, DEQ should be consulted for a determination on what specific analyses may be required for permit issuance.

Table 3. Significant Impact Levels (IDAPA 58.01.01.006)

Pollutant	Averaging Time	Significant Impact Levels (µg/m^3)[a]
CO	1-hour	2000
CO	8-hour	500
NO2	1-hour	4 ppb[b,c] (7.5 µg/m^3)[d]
NO2	Annual	1.0
SO2	1-hour	3 ppb[e] (7.9 µg/m^3)[d]
SO2	3-hour	25
SO2	24-hour	5
SO2	Annual	1.0
PM_{10}	24-hour	5.0
PM_{10}	Annual	1.0
$PM_{2.5}$	24-hour	1.2
$PM_{2.5}$	Annual	0.3[f]

a) Micrograms per cubic meter

b) ppb - parts per billion

c) Interim SIL (EPA 2010a)

d) µg/m3 value calculated for standard conditions

e) Interim SIL (EPA 2010b)

f) This value is the upper limit as listed in 40 CFR 51.165(b)(2). Without monitoring data supporting this value, DEQ will use the 0.2 µg/m^3 value recommended by EPA (EPA 2018)

Table 4. National Ambient Air Quality Standards

Pollutant	Averaging Time	Standard (µg/m^3)[a]
CO	1-hour	40,000[b]
CO	8-hour	10,000[b]
NO2	1-hour	100 ppb [c] (188 µg/m3)
NO2	Annual	100[d]
SO2	1-hour	75 ppb[e] (196 µg/m3)
SO2	3-hour	1,300[b]
SO2	24-hour	365[b]
SO2	Annual	80[c]
PM_{10}	24-hour	150[f]
PM_{10}	Annual	50[g]
$PM_{2.5}$	24-hour	35[h]
$PM_{2.5}$	Annual	12[i]
Pb	Quarterly	1.5[j]
Pb	3-month	0.15[k]

a) Micrograms per cubic meter.
b) Not to be exceeded more than once per year.
c) Three-year average of the 98th percentile of the annual distribution of 1-hour average daily maximum concentrations not to exceed standard.
d) Not to be exceeded in any calendar year.
e) Three-year average of the 99th percentile of the annual distribution of 1-hour average daily maximum concentrations not to exceed standard.
f) Never expected to be exceeded more than once in any calendar year.
g) Standard has been revoked.
h) Three-year average of the 98th percentile of the annual distribution of 24-hour average concentrations not to exceed standard,
i) Three-year average of the annual mean concentrations not to exceed standard.
j) Not to be exceeded in any quarter of any calendar year.
k) Not to be exceeded in any 3-month rolling average of any calendar year.

4.2 TAPs Increments

Applicable TAPs increments are listed in Idaho Air Rules Section 585 for non-carcinogens (AACs) and 586 for carcinogens (AACCs). The tables found in these sections of Idaho Air Rules list the ELs in pounds per hour (lb/hr) as well as the AACs for non-carcinogens and AACCs for carcinogens. Note that the concentrations for the non-carcinogens are in units of milligrams per cubic meter (mg/m3) and the concentrations for carcinogens are in units of micrograms per cubic meter (□g/m3).

4.3 Toxics

Idaho Air Rules Section 161 states, “Any contaminant which is by its nature toxic to human or animal life or vegetation shall not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation.” DEQ may

require toxics analyses as a case-by-case basis in instances where DEQ suspects impacts of toxics may have an unacceptable impact.

5 Modeling Methodology

The required level of analysis will generally depend on the complexity of the proposed construction or modification, surrounding emissions sources and terrain features, current air quality levels, and classification (attainment vs non-attainment) in the impact area. Screening techniques may be adequate for simplistic or isolated sources. Screening techniques are not appropriate in complex situations such as a large number of buildings in the immediate area that create downwash for a point source or the presence of complex terrain within the modeling domain. More refined modeling will be necessary when screening modeling is inappropriate or cannot demonstrate compliance with applicable air quality impact limits.

5.1 Requirements for Permit Applications

As recommended by EPA (EPA 1990), dispersion modeling analysis generally involves two distinct phases. The first phase is the preliminary analysis, also known as the significant impact analysis; the second phase is the full impact analysis, also known as the cumulative NAAQS analysis. These analyses may be performed with either a simple “screening model” or with a more complex “refined model.” A flowchart showing the general modeling methodology for permit modeling is presented in Figure 3.

5.1.1 Significant Impact Analysis

In the significant impact level (SIL) analysis, the highest estimated concentration in ambient air is compared to the SILs in Table 3. A five-year mean of the highest estimated concentration from each year can be used in the SIL analysis for pollutants with probabilistic standards. These pollutants include 24-hour PM2.5, annual PM2.5, 1-hour NO2, and 1-hour SO2. Only the changes in emissions associated with the proposed project are modeled in the significant impact analysis for new sources or modifications. Impacts from nearby and other background sources, including background concentrations, are not considered in the significant impact analysis. Section 6.3 provides guidance on sources and emissions to include in the significant impact analysis. No further analysis is generally required for the NAAQS or PSD increments if the estimated concentration is below applicable SILs. The source or modification is determined to have a significant impact on ambient air if the estimated impact exceeds the SILs. In this case, a cumulative NAAQS analysis will be necessary to demonstrate to the satisfaction of DEQ that the stationary source or modification would not cause or significantly contribute to a violation of any ambient air quality standard. Also, if DEQ has information that indicates existing facility emissions may not meet NAAQS, then DEQ may require the facility to demonstrate full NAAQS compliance at the time of the current permitting action or a later date.

The ambient concentration due to any proposed construction or modification cannot exceed the SILs listed in Table 3 for minor stationary sources in non-attainment areas (NAAs). Offsets are required even if the ambient impacts are below the SILs for major stationary sources or major modifications at major stationary sources in NAAs. The DEQ air modeling coordinator should be contacted for locations of NAAs in Idaho.

5.1.2 Cumulative NAAQS Analysis

In a cumulative NAAQS analysis, the scope of the analysis is expanded from the significant impact analysis to include impacts from all other sources at the facility and background concentrations. Assessing impacts from potential co-contributing sources may also be required in the cumulative NAAQS analyses. It is the applicant's responsibility to identify potential co- contributing sources. The factors to be reviewed include the type of source, distance between the facilities, location of potential impact, pollutants emitted, and emission rates of pollutants of interest. If impacts of neighboring sources, on receptors showing a significant impact from the sources subject to the permitting action, are not adequately accounted for by the background concentration used, then emissions from those sources must be modeled.

When conducting cumulative NAAQS modeling, the sources not explicitly included in the model (e.g., mobile sources; small, stationary sources; some fugitive sources; and large, distant sources) are accounted for by adding a background concentration representative of the air quality in the area. Background concentrations are based on ambient air monitoring data collected in the area or from similar areas determined to be reasonably representative. Section 6.10 provides a more detailed discussion of appropriate background concentrations. Background concentrations must account for all impacts not accounted for by sources specifically modeled. Current default background concentrations must be obtained from a DEQ air quality modeler.

Modeling assessments for major new source/modifications subject to the PSD program, and where project emissions cause an impact exceeding SILs, must include emissions from all point sources within the radius of significant impact and all sources outside the radius of significant impact that cause a significant impact within the radius of significant impact.

5.2 Additional Requirements for PSD Applications

Major facilities subject to PSD rules have many more responsibilities in the permitting process. DEQ engineers and analysts make the final determination of PSD applicability. If the proposed project is subject to PSD, the applicant should consult with DEQ during the early phases of the project development. If the proposed project is subject to PSD, the applicant should consult with DEQ during the early phases of the project development. This guideline only provides a brief summary of the PSD permitting program.

A PSD review is required if a proposed new facility is defined as a designated facility (Table 5) and emits or has projected actual emissions, after controls, of 100 tons per year (T/yr) or more of any regulated air pollutant. If the new facility is not one of the types listed in Table 5, then a PSD review is required if the facility emits or has projected actual emissions, after controls, of 250 T/yr or more of any regulated air pollutant. For PSD review, the potential to emit is defined as the maximum capacity of a stationary source to emit a pollutant under its physical and operational design (defined in Idaho Air Rules Section 006). A PSD review is also required if proposed emissions from a modification to an existing PSD major source are greater than the significant emissions rates listed in Table 6.

The location of the facility is important, as it determines the applicable increment of allowable air quality deterioration. Other factors, such as the topography and meteorology of the area and the proximity to a Class I area (specified areas of pristine air quality such as certain national parks, wilderness areas, etc.) or NAA, also determine the control requirements. The allowable increments, as of the publication of this document, for Class I, II, and III areas are listed in Table 7. Additional increment

limits can be promulgated by the EPA or DEQ, so it remains the applicant's responsibility to verify applicable PSD increment limits. The Class I areas in Idaho and surrounding states are shown in Appendix B. The remainder of the state is currently designated as Class II. There are no Class III areas in Idaho.

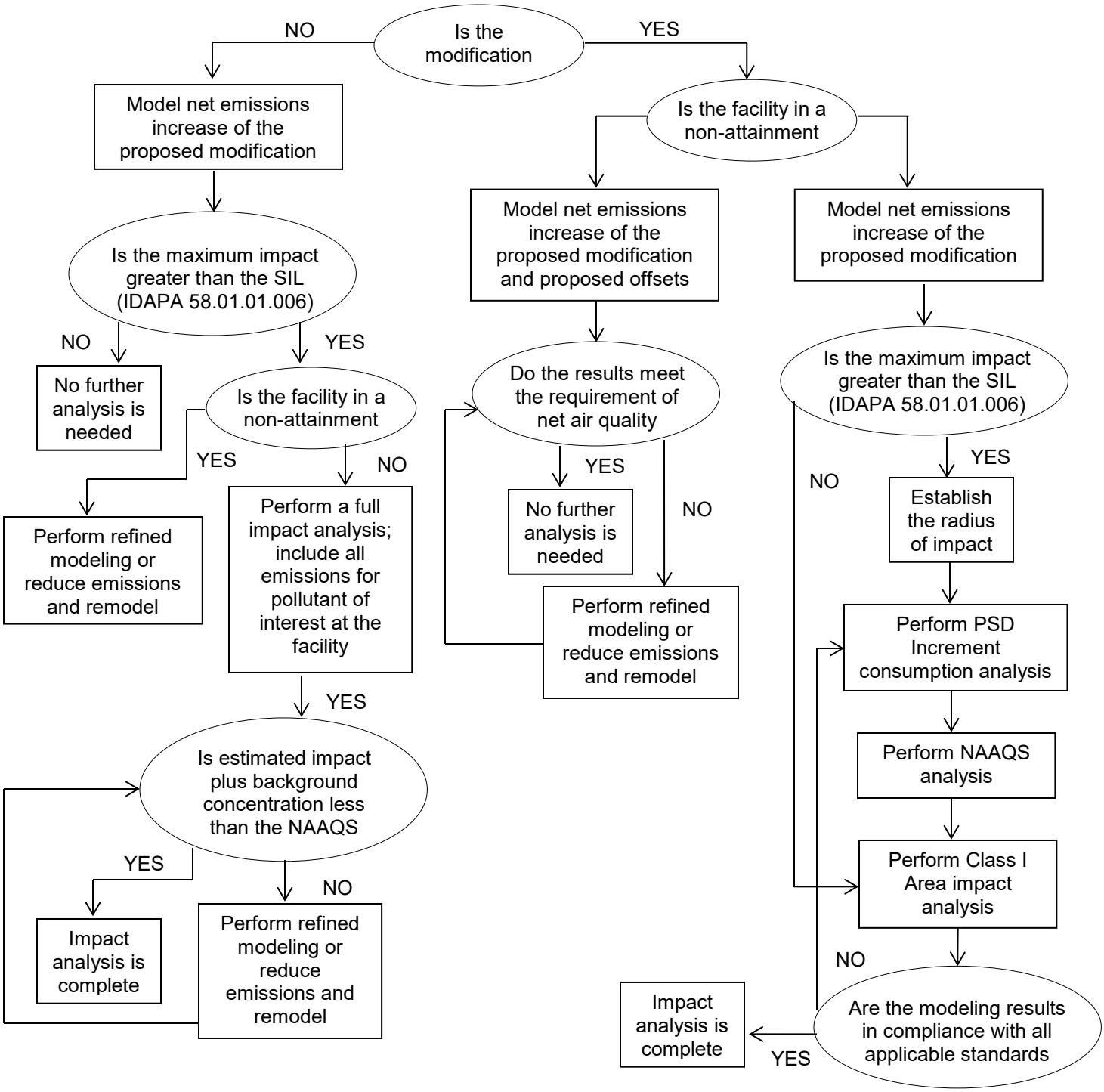


Figure 3. Flow Chart for Criteria Pollutant Ambient Impact Analysis for Permit to Construct Application

Pre-construction air quality is determined through ambient air monitoring. In some cases, there may already be enough data to establish the baseline. However, the applicant may be required to conduct up to one year of ambient monitoring at strategic locations if monitoring data are not available for the source area of the proposed construction site. Pre-construction monitoring will automatically be required if the model-predicted impact of the proposed source exceeds the levels in Table 8 and there are no current ambient air monitoring data available. DEQ may require pre-construction monitoring in other situations.

The following additional analyses are required in PSD applications:

- PSD increment consumption
- Class I area visibility and Air Quality Related Values (AQRVs) analysis
- Growth analysis
- Ambient air quality impact analysis (during construction)
- Soils and vegetation impacts
- Visibility impairment (in impact area, separate from the Class I area visibility analysis)

Refer to the *New Source Review Workshop Manual* (EPA 1990) for additional guidance.

Designated Facility Types as found in IDAPA.58.01.01.006:

1. Fossil fuel-fired, steam electric plants of more than 250 million British thermal units (Btu)per hour heat input
2. Coal cleaning plants (with thermal dryers)
3. Kraft pulp mills
4. Portland cement plants
5. Primary zinc smelters
6. Iron and steel mill plants
7. Primary aluminum ore reduction plants
8. Primary copper smelters
9. Municipal incinerators capable of charging more than 250 tons of refuse per day
10. Hydrofluoric acid plants
11. Sulfuric acid plants
12. Nitric acid plants
13. Petroleum refineries
14. Lime plants
15. Phosphate rock processing plants
16. Coke oven batteries
17. Sulfur recovery plants
18. Carbon black plants (furnace process)
19. Primary lead smelters
20. Fuel conversion plants
21. Sintering plants
22. Secondary metal production plants
23. Chemical process plants
24. Fossil fuel boilers (or combination thereof) totaling more than 250 million Btu/hour heat input
25. Petroleum storage and transfer units with a total storage capacity exceeding 300,000 barrels
26. Taconite ore processing plants
27. Glass fiber processing plants
28. Charcoal production plants

Table 5. Significant Emissions Rates (40 CFR 52.21 (b)(23); IDAPA 58.01.01.006)[a]

Pollutant	Emission Rate (T/yr)
CO	100
NOX	40
SO2	40
PM_{10}	15
$PM_{2.5}$	10 (40)[b]
Particulate matter	25
Ozone (VOC)	40 (of VOCs)
Pb	0.6
Asbestos	0.007
Beryllium	0.0004
Mercury	0.1
Vinyl chloride	1
Fluorides	3
Sulfuric Acid Mist	7
Hydrogen Sulfide (H_2S)	10
Total Reduced Sulfur (including H_2S)	10
Radionuclides from facilities regulated under40 CFR Par 61, Subpart H	0.1 mrem/yr
Reduced sulfur compounds (Including H_2S)	10
Any other pollutant regulated under the Clean Air Act including radionuclides	Any emission rate
Each regulated pollutant (from a major facility or major modification)	Emission rate that causes air quality impact of 1 µg/m3 or greater (24-hour basis) in any Class I area located within 10

a) A PSD review is required if the operation is modified and actual emissions of a pollutant will be greater than shown above

b) SO_2, NOx, and VOCs as precursors

Table 6. Prevention of Significant Deterioration Increment Limits

Pollutant	Averaging Period	Class I (µg/m^3)	Class II(µg/m^3)	Class III (µg/m^3)
NO_2	Annual[c]	2.5	25	50
SO_2	Annual[b]	2	20	40
SO_2	24-hour[c]	5	91	182
SO_2	3-hour[c]	25	512	700
PM_{10}	Annual[b]	4	17	34
PM_{10}	24-hour[c]	8	30	60
$PM_{2.5}$	Annual[b]	1	4	8
$PM_{2.5}$	24-hour[c]	2	9	18

a) The Class I, II, and III areas are defined and shown in Appendix A.

b) Never to be exceeded.
c) Not to be exceeded more than once a year.

Table 7. Modeled Impacts Above which Preconstruction Monitoring cannot be Exempted for PSD-Applicable Projects

Pollutant	Ambient Concentration (μg/m^3)	Averaging Period
CO	575	8-hour
NO2	14	Annual
SO2	13	24-hour
PM10	10	24-hour
PM2.5	4	24-hour
Ozone	100 T/yr increase of VOCs	N/A
Pb	0.1	Quarterly
Mercury	0.25	24-hour
Beryllium	0.0001	24-hour
Fluorides	0.25	24-hour
Vinyl chloride	15	24-hour
Hydrogen sulfide	0.2	1-hour

5.3 Facility Emission Cap (FEC) Permit Modeling

Contact DEQ for guidance on modeling requirements for FEC permits. In general, the modeling submitted must support all possible future emissions rates sources, and facility configuration.

6 Performing a Modeling Analysis

An application will be considered incomplete if it lacks sufficient information and/or a valid modeling analysis, supported by adequate documentation and justification of methods and data. Appendix C includes a copy of the DEQ modeling checklist, which is designed to help the applicant prepare the information necessary for a complete modeling package.

The procedures in this document, as well as the EPA documents *Guideline on Air Quality Models* (EPA 2005), *New Source Review Workshop Manual* (EPA 1990), and other more issue- specific guidance should typically be followed when conducting the modeling analysis. These documents provide guidance on appropriate model applications. DEQ will work with the applicant to determine acceptable impact assessment procedures where EPA or state policies are not clear cut or involve case-by-case review.

6.1 Modeling Protocol

Applicants are highly advised to contact the DEQ stationary source air quality modeling supervisor at (208) 373-0502 and submit a modeling protocol, as suggested in the modeling checklist (Appendix C), to ensure appropriate models, meteorological data, background concentrations, and procedures are applied. Use of a modeling protocol is a key component of DEQ's permit streamlining program, which

focuses on establishing mutually agreed upon methods and data prior to permit application submittal. This approach substantially reduces DEQ review time and the potential for the application to be determined incomplete or the permit denied because of problems with the modeling analyses.

The content of the modeling protocol is dependent on the type of permit application. A modeling protocol for a new, major source or a major modification at a major facility will be more detailed than one for a new, minor source or a minor modification. A modeling protocol checklist is presented in Appendix D. A description of the general methodology, as well as justification for assumptions and data used, should be included in the modeling protocol.

A modeling protocol, in written form and agreed upon by DEQ, provides the applicant the assurance that their approach and methodology as described will be accepted. However, the approval of a modeling protocol is not meant to imply approval of a completed modeling analysis. The facility should submit as much detailed information as possible in the modeling protocol to increase the likelihood of having the modeling analysis approved. The applicant should prepare the application with the understanding that DEQ will require a higher degree of documentation/justification of data and methods in cases where modeled concentrations are very near regulatory thresholds/standards.

A modeling protocol may be submitted in hard-copy format or may be emailed to the DEQ stationary source modeling coordinator. DEQ will typically provide comments on or approval of the protocol within two weeks from the date the protocol was received.

The following are key issues that should be addressed in the protocol:

- Ambient air boundary. It is the applicant's responsibility to accurately evaluate the ambient air boundary and identify any unique situations affecting the ambient air boundary that may exist at the facility. Such unique situations may include rivers bisecting the facility, easements or public roadways bisecting the facility, railways, lease agreements, and operating a business where the general public is allowed on site. See Section 6.5.
- Justification/documentation of stack parameters. The protocol should thoroughly describe how emissions release parameters (flow rates and stack temperatures) were measured or estimated, if such data are available at that time. A simple indication that parameters were checked will not be accepted as documentation and justification. Calculations of initial dispersion coefficients for volume sources should be provided such that DEQ reviewers can easily and quickly verify the values. See Section 6.4.2.
- Design concentrations. The protocol should clearly state what modeled concentrations will be used to evaluate compliance. For example, the maximum of 6th highest modeled concentrations at each receptor is typically used as the PM10 24-hour design value when modeling a five-year data set. See Section 6.11.1.
- Meteorological data. If meteorological data are not provided by DEQ, the applicant should thoroughly justify selection of the data, demonstrating how the data used are representative for the application site. The protocol should also describe the quality of the data, clearly demonstrating the data are adequate for use in an air impact analysis. See Section 6.8.
- Receptor grid. The receptor grid spacing proposed for the analyses should be thoroughly described. See Section 6.6.
- Background concentrations. Within the protocol, the applicant may either propose appropriate background concentrations or request that DEQ provide reasonably conservative background concentrations. See Section 6.10.
- Unique circumstances or scenarios used in the analyses. Any atypical conditions associated with the site or the project that could affect the results of the air impact analyses, or DEQ's approval

of the project, should be described in the protocol. Protocol approval only assures acceptability that those conditions or issues accurately described in the protocol are acceptable.

6.2 Choosing the Appropriate Models

Air quality models approved by the EPA for regulatory use are required (Idaho Air Rules Section 202.02 and 402.03). The DEQ modeling coordinator should be consulted to discuss or verify the model most appropriate for the release being simulated. Factors to consider when determining the appropriate model include, but are not limited to, type of release (e.g., elevated point or area), downwash, location of ambient air, meteorological conditions (e.g., stagnation), and availability of meteorological data. All modeling must use the current versions of models recommended in the EPA's *Guideline on Air Quality Models* (EPA 2005). Many of these models can be found on the EPA's Support Center for Regulatory Air Models (SCRAM) website (http://www.epa.gov/ttn/scram). Modeling performed with older versions may be rejected. Any modification or alteration of a guideline model must be approved by DEQ and, in most instances, the EPA. Approval of the use of other models is completely at the discretion of DEQ. When alternative models are used, DEQ may require the submittal of additional data (e.g., sensitivity analysis) for verification. The use of proprietary models (those models that are not available free of charge to the public) is generally not allowed for the demonstration of compliance with NAAQS, PSD increment, or TAPs increments. Proprietary graphical user interfaces (GUIs) that use unaltered publicly available regulatory models are not considered proprietary models. Results generated by such GUIs will be accepted provided input and output files are submitted and such files can be readily used as input for the publicly available model without the proprietary GUI.

6.2.1 Readily Available Models

The following is a summary of the most commonly used air quality models:

AERMOD – AERMIC (American Meteorological Society/Environmental Protection Agency Regulatory Model Improvement Committee) was formed to introduce state-of-the-art modeling concepts into EPA's air quality models. AERMIC's focus is on a new platform for regulatory steady-state plume modeling. This platform includes: 1) air turbulence structure, scaling, and concepts; 2) treatment of both surface and elevated sources; and 3) simple and complex terrain. The modeling system has three components: AERMOD - the air dispersion model; AERMET - the meteorological data preprocessor; and AERMAP - the terrain data preprocessor. AERMOD is the replacement model for ISCST3.

AERSCREEN – AERSCREEN is the screening-level model for applications where AERMOD would be appropriate.

SCREEN3 – SCREEN3 is a screening version of the ISCST3 model.

SCREEN3 is not considered an acceptable screening model for AERMOD, which is the model replacing ISCST3. *Analyses performed with SCREEN3 will no longer be accepted by DEQ for permitting purposes in most instances.*

CTSCREEN – (Complex Terrain Screening model) –A screening technique when complex terrain is important. CTSCREEN is a screening version of the CTDMPLUS model. CTSCREEN and CTDMPLUS are the same basic model. The primary difference is that CTSCREEN uses

an extensive array of predetermined meteorological conditions where site-specific meteorological data are not available.

AERMOD is considered a more refined model for complex terrain. AERSCREEN incorporates the same terrain algorithms as AERMOD, and may yield more favorable results than CTSCREEN.

ISCST3 – (Industrial Source Complex Model) – Historically, the most commonly used refined Gaussian plume model.

ISCST3 has been replaced as an EPA guideline model by AERMOD. *DEQ will generally no longer accept air quality analyses conducted with ISCST3 for permitting purposes.*

CTDMPLUS – (Complex Terrain Dispersion Model Plus Algorithms for Unstable Situations) – A refined air quality model for use in all atmospheric stabilities with sources located in or near complex topography. Since the model accounts for the three-dimensional nature of plume and terrain interaction, it requires detailed terrain and meteorological data that are representative of the modeling domain.

CALPUFF – A multi-layer, multi-species, non-steady-state, puff dispersion model that simulates the effects of time- and space-varying meteorological conditions on pollutant transport, transformation, and removal. CALPUFF is most commonly used to assess impacts on Class I areas and is applied at distances over 50 kilometers. It includes algorithms for subgrid scale effects (such as terrain impingement), as well as longer range effects (such as pollutant removal due to wet scavenging and dry deposition, chemical transformation, and visibility effects of particulate matter concentrations).

CALPUFF is not an EPA-approved model for near-field impact assessment (within 50 kilometers of a source). Any use of CALPUFF in the near-field must be thoroughly justified and approved specifically by DEQ and often by EPA.

VISCREEN – A screening model to assess visibility impacts on Class I areas. Calculates the potential impact of a plume of specified emissions for specific transport and dispersion conditions.

Screening models, such as SCREEN3 and AERSCREEN, are used to simulate the probable worst-case condition under normal, maximum operating conditions. They are generally simplistic representations, typically taking less computer time and yielding conservative impact predictions. A screening analysis must follow EPA guidance in *Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised* (EPA 1992) or any current EPA guidance for AERSCREEN. If a properly conducted screening analysis does not indicate an exceedance of the ambient standards from a proposed construction or modification, then a more refined analysis is not necessary to adequately demonstrate compliance.

6.2.2 Replacement of ISC by AERMOD

AERMOD was promulgated as the replacement model for ISC. During the one-year transitional period, between November 2005 and November 2006, applicants could use either ISCST3 or AERMOD to demonstrate compliance. After that, ISCST3 was no longer a guideline model and analyses conducted with ISCST3 were not typically accepted by DEQ.

There are several modeling scenarios that are problematic when using AERMOD:

1. Hot, buoyant plumes released horizontally or with a rain cap. With ISCST3 the typical approach is to set the exit velocity to 0.01 or 0.001 meters per second (m/sec) to effectively eliminate the plume vertical momentum flux, then increase the exit diameter to a point where the modeled volumetric flow is equal to that of the source. This approach cannot be used for AERMOD if plume downwash is considered because downwash behavior is a function of stack diameter in the PRIME downwash algorithm within AERMOD.

   Modeling with the actual stack diameter and a 0.001 m/sec exit velocity is recommended as a conservative measure. This method effectively eliminates vertical momentum of the plume; however, it also eliminates thermal buoyancy effects. In some instances, hand calculations of plume rise, using those equations in the AERMOD algorithms, may show that thermal buoyancy is overwhelmingly the dominant plume rise mechanism. In such cases, the source may be modeled as an uninterrupted vertical release. Use of this method or other methods should be discussed with DEQ prior to use.

   Methods to accurately model hot horizontal releases and capped vertical releases within AERMOD have been developed for Beta versions of AERMOD. Applicants should contact DEQ as to the availability of AERMOD versions to handle hot horizontal and capped releases.

2. Representative meteorological data are rather limited for many areas within Idaho. More site-specific meteorological and land surface characteristics are needed to run AERMOD than what is used for ISC. Therefore, using meteorological data from a distant station is more of a concern when using AERMOD.

   It is the applicant's responsibility to demonstrate the meteorological data used are representative of meteorological conditions at the application site. Applicants may be required to use specialized methods to demonstrate compliance in cases where available meteorological data are of questionable representativeness. Such methods could involve running additional modeling analyses using multiple meteorological data sets or otherwise providing a demonstration that use of on-site data could not reasonably be expected to give results that exceed applicable regulatory thresholds or standards.

6.3 Pollutants and Sources to be Included in the Impact Analyses

This section discusses what pollutants and sources should be included in modeling analyses submitted in support of applications for permits to construct (PTCs), Tier II operating permits, and FEC permits. Specific emissions sources that are exempt from permitting requirements are not necessarily exempt from a modeling analysis when a PTC or Tier II Operating Permit is required for other sources/reasons. DEQ modeling staff should be consulted before any emissions sources eliminated from the modeling analyses.

DEQ does have a list of activities that may be treated as "trivial" and are not required to be addressed in the permit application. In addition to the trivial activities listed below, Idaho Air Rules Section 317 list activities that are "presumptively insignificant emission units." DEQ has determined that these activities must generally be included in Tier II and PTC applications when facility-wide modeling is required. The list below was generated from an EPA white paper entitled Streamlined Development of Part 70 Permit Applications (EPA 1995).

Activities That May be Treated as "Trivial" (EPA 1995):

1. Combustion emissions from propulsion of mobile sources, except for vessel emissions from outer continental shelf sources.
2. Air-conditioning units used for human comfort that do not have applicable requirements under Title VI of the Clean Air Act.
3. Ventilating units used for human comfort that do not exhaust air pollutants into the ambient air from any manufacturing/industrial or commercial process.
4. Noncommercial food preparation.
5. Consumer use of office equipment and products, not including printers or businesses primarily involved in photographic reproduction.
6. Janitorial services and consumer use of janitorial products.
7. Internal combustion engines used for landscaping purposes.
8. Laundry activities, except for dry cleaning and steam boilers.
9. Bathroom/toilet vent emissions.
10. Emergency (backup) electrical generators at residential locations.
11. Tobacco smoking rooms and areas.
12. Blacksmith forges.
13. Plant maintenance and upkeep activities (e.g., grounds keeping, general repairs, cleaning, painting, welding, plumbing, re-tarring roofs, installing insulation, and paving parking lots) provided these activities are not conducted as part of a manufacturing process, are not related to the source's primary business activity, and do not otherwise trigger a permit modification.[(a)]
14. Repair or maintenance shop activities not related to the source's primary business activity, not including emissions from surface-coating or degreasing (solvent metal cleaning) activities, and not otherwise triggering a permit modification.
15. Portable electrical generators that can be moved by hand from one location to another.[(b)]
16. Hand-held equipment for buffing, polishing, cutting, drilling, sawing, grinding, turning or machining wood, metal or plastic.
17. Brazing, soldering and welding equipment, and cutting torches related to manufacturing and construction activities that do not result in emission of hazardous air pollutant metals.[(c)]
18. Air compressors and pneumatically operated equipment, including hand tools.
19. Batteries and battery charging stations, except at battery manufacturing plants.
20. Storage tanks, vessels, and containers holding or storing liquid substances that will not emit any volatile organic compound or hazardous air pollutant.[(d)]
21. Storage tanks, reservoirs, and pumping and handling equipment of any size containing soaps, vegetable oil, grease, animal fat, and nonvolatile aqueous salt solutions, provided appropriate lids and covers are utilized.
22. Equipment used to mix package soaps, vegetable oil, grease, animal fat, and nonvolatile aqueous salt solutions, provided appropriate lids and covers are utilized.
23. Drop hammers or hydraulic presses for forging or metalworking.
24. Equipment used exclusively to slaughter animals, but not including other equipment at slaughterhouses, such as rendering cookers, boilers, heating plants, incinerators, and electrical power generating equipment.
25. Vents from continuous emissions monitors and other analyzers.
26. Natural gas pressure-regulator vents, excluding venting at oil and gas production facilities.
27. Hand-held applicator equipment for hot-melt adhesives with no volatile organic compounds in the adhesive formulation.

28. Equipment used for surface coating, painting, dipping, or spraying operations, except those that will emit any volatile organic compound or hazardous air pollutant.
29. Carbon dioxide lasers, used only on metals and other materials that do not emit hazardous air pollutants in the process.
30. Consumer use of paper trimmers/binders.
31. Electric- or steam-heated drying ovens and autoclaves, but not the emissions from the articles or substances being processed in the ovens or autoclaves, or the boilers delivering the steam.
32. Salt baths using nonvolatile salts that do not result in emissions of any regulated air pollutant.
33. Laser trimmers using dust collection to prevent fugitive emissions.
34. Bench-scale, laboratory equipment used for physical or chemical analysis, but not for lab fume hoods or vents.[(e)]
35. Routine calibration and maintenance of laboratory equipment or other analytical instruments.
36. Equipment used for quality control/assurance or inspection purposes, including sampling equipment used to withdraw materials for analysis.
37. Hydraulic and hydrostatic testing equipment.
38. Environmental chambers not using hazardous air pollutant gasses.
39. Shock chambers.
40. Humidity chambers.
41. Solar simulators.
42. Fugitive emissions related to movement of passenger vehicles, provided the emissions are not counted for applicability purposes and any required fugitive-dust-control plan or its equivalent is submitted.
43. Process-water filtration systems and demineralizers.
44. Demineralized-water tanks and demineralizer vents.
45. Boiler-water treatment operations, not including cooling towers.
46. Oxygen scavenging (de-aeration) of water.
47. Ozone generators.
48. Fire suppression systems.
49. Emergency road flares.
50. Steam vents and safety relief valves.
51. Steam leaks.
52. Steam cleaning operations.
53. Steam sterilizers.

a) Cleaning and painting activities qualify as trivial they are not subject to volatile organic compound or hazardous air pollutant control requirements. Asphalt batch plant owners/operators must still get a permit if otherwise required.

b) “Moved by hand” means the generator can be moved without the assistance of any motorized or non-motorized vehicle, conveyance, or device.

c) Brazing, soldering and welding equipment, and cutting torches that emit hazardous air pollutant metals and are related to manufacturing and construction activities are more appropriate for treatment as insignificant activities instead of trivial activities based on size or production-level thresholds. Brazing, soldering, welding, and cutting torches that emit hazardous air pollutant metals and are directly related to plant maintenance, upkeep, and repair, or maintenance shop activities, are appropriately treated as trivial.

d) Consideration of storage tanks containing petroleum liquids or other volatile organic liquids as a trivial source should be based on size limits such as storage tank capacity and vapor pressure of liquids stored are not appropriate for this list.

e) Many lab fume hoods or vents might qualify for treatment as insignificant (depending on the applicable State Implementation Plan) or can be grouped together for purposes of description.

6.3.1 Permits to Construct

Criteria Pollutants

All increases in emissions of criteria pollutants are generally required to be accounted for in the significant impact analyses for PTC applications. However, the emissions sources and inventory used to evaluate the need for modeling, described in Section 3 of this guideline, may differ from the sources and inventory used for the significant impact analyses. All emissions changes associated with a proposed project are generally used in the significant impact analyses, including emissions reductions associated with sources removed from operation. Also, sources included in the significant impact analyses for minor source permitting may differ from sources included for PSD permitting. For minor source permitting, the significant impact analyses for criteria pollutants generally includes: all emissions increases and decreases associated with the proposed project. For PSD permitting, the net emissions increase, as defined in Idaho Air Rules Section 007, is modeled. The net emissions increase includes all increases and decreases that occurred within the previous five years or since the issuance of any PSD permit to the facility, whichever is a shorter period.

Cumulative impact analyses are required if impacts associated with the significant impact analyses exceed SILs, as described in Sections 5.1.1 and 5.1.2. A cumulative impact analysis involves modeling facility-wide emissions, modeling any co-contributing sources, and adding an appropriate background value to results.

DEQ highly suggests that applicants specify in a modeling protocol those sources to be included and/or excluded in the significant impact analyses with thorough justification and documentation. The following provides general guidance for the significant impact analyses performed for specific minor source scenarios:

- Modification to an existing emissions unit where the release parameters (flow rate, stack gas temperature, etc.) do not change. The emissions increase associated with the modification is modeled. If the existing source is currently permitted, the emissions increase will be calculated as the differences between the current permit limit (or whatever emissions rate was used in previous modeling analyses) and the future proposed limit. If the source is not currently regulated by a permit emissions limit, then current emissions should be based on actual emissions as defined by Idaho Air Rules.
- Modification to an existing emissions unit where the release parameters change as a result of the modification. Existing emissions for permitted and non-permitted sources should be calculated as described for scenario “a;” however, current emissions should be modeled as negative emissions (using the existing release parameters) and future allowable emissions modeled as positive emissions (using the new release parameters).
- Removal of, or emissions reductions from, an existing emissions unit. Emissions reductions from such units should be modeled as negative emissions to account for the net project impacts. Existing permit-allowable emissions rates may be used, or actual emissions (based on two years of operations within the previous ten years) for units not regulated by an existing emissions limit.

- Replacement or relocation of an existing emissions unit. Replaced units should be treated in the same manner as removed units, described in scenario "c."
- Addition or removal of units exempt from permitting. Units that are exempt from permitting should be included in the significant impact analyses in most instances, unless such units are considered as trivial per Table 9 in Section 6.3 of this guideline. Existing and future emissions should be based on maximum potential emissions unless otherwise directed or approved by DEQ.

TAPs

All TAPs, except those exempted under Idaho Air Rules Section 210.20, with project-total emissions increases above the DEQ TAP ELs (discussed in Section 4.0) must be included in the modeling analysis. The DEQ TAPs checklist, available on the DEQ website, should be used to demonstrate compliance with TAPs.

Fugitive Sources

Fugitive emissions are defined in Idaho Air Rules Section 006 as, "those emissions which could not reasonably pass through a stack, chimney, vent, or other functionally equivalent opening." This definition includes windblown dust from a stockpile. Generally, modeling is required for all fugitive emissions sources determined not to be unquantifiable. Fugitive emissions from vehicle traffic on roads and wind erosion from material storage piles are normally not included in the modeling analyses for minor source applications. However, DEQ may require modeling of these sources in instances where these emissions could substantially contribute to ambient concentrations and a potential exceedance of air quality standards. Process fugitive emissions such as those from material handling operations and equipment leaks should be included in the modeling analyses.

Intermittent Sources

Emissions sources that operate intermittently may be excluded from the SIL analysis and/or cumulative NAAQS analysis, approved by DEQ on a case-by-case basis, to the extent that it can be reasonably concluded that such sources could not measurably affect the compliance determination. If the intermittent sources are engines powering emergency generators or fire suppression water pumps, and operations are less than 100 hours/year for operational testing and maintenance, the sources can be excluded from compliance demonstrations for the 1-hour NO2 NAAQS, unless specifically required at the discretion of the DEQ Director. This guidance is explained in more detail in Appendix A.

Inconsequential Sources

The applicant may determine that some sources are "inconsequential" when estimating the design concentration (i.e., only contribute to a small percentage of the total, maximum, ambient impact for that project) and exclude them from the modeling analysis. If this is the case, the applicant must justify the exclusion of these sources. This justification, which is pollutant and averaging-period specific, must be based on emissions rates and a qualitative discussion of impacts. For example, if an emissions unit operates 24 hours per day but only 500 hours per year, the source may be "inconsequential" for the annual emissions, but not for the 24-hour emissions. The justification should include the following two phases:

1. Compare the emissions and operating conditions of each emissions source to the total emissions that would be modeled. If the uncontrolled emissions are "negligible" compared to the total emissions and are not expected to impact the maximum ambient concentration, the individual

emissions source may be deemed as “inconsequential” and may be excluded from the modeling analysis.

Unless there are a large number of negligible sources that will substantially slow the model run time, it may be easier to include such sources in the analyses rather than provide justification for their exclusion.

2. If more than one emissions source is excluded from the modeling analysis, the total emissions of those sources excluded and the total estimated ambient concentration must be compared to the total modeled emissions and qualitatively evaluated for impacts. This will ensure that all of the excluded sources are still “inconsequential” as a whole.

Non-Attainment Areas

Facilities located in an a non-attainment area for a specified pollutant may be required to model all the emissions for that specified pollutant, even those emissions that are deemed to be inconsequential. This process will be treated on a case-by-case basis. It is recommended that the applicant meet with DEQ staff prior to beginning the modeling analysis to discuss what sources will be included.

6.3.2 Facility-Wide Tier II Operating Permits

All emissions for the entire facility, excluding those listed in Table 9, are required to be included in a facility-wide Tier II application. All criteria pollutant emissions are generally required to be included in the modeling analysis submitted with the Tier II operating permit application. Facility-wide TAPs emissions are not typically required to be included in the modeling analysis for the Tier II application. DEQ reserves the right to request additional information or analysis, including the modeling of other pollutants, under Idaho Air Rules Section 402.04, if there is a concern relative to compliance with Idaho Air Rules Section 161. Modeling of all fugitive emissions may be required if DEQ determines it necessary to protect ambient air quality standards.

As with the PTC application, the applicant may determine that some criteria pollutant sources are “inconsequential” when estimating the design concentration (i.e., only contribute to a small percentage of the total, maximum, ambient impact for that project) and exclude them from the modeling analysis. The applicant should use the process presented above in Section 6.3.1. Facilities located in non-attainment areas for a specified pollutant must contact the DEQ modeling coordinator at (208) 373-0112 prior to submitting the Tier II application. DEQ modeling staff will review the current SIP for the area to determine the appropriate level of analysis. This process will be treated on a case-by-case basis. It is recommended that the applicant meet with DEQ staff prior to beginning the modeling analysis to discuss what sources will be included.

6.3.3 FEC Permits

Permit applications utilizing a facility emissions cap (FEC) must provide sufficient modeling scenarios to reasonably assess maximum impacts of potential source configurations. The modeling requirements for these permits are facility-specific and will vary greatly depending on the operational flexibility desired by the permit applicant.

6.4 Source Information Required

This section discusses the source information that is required for a modeling analysis.

6.4.1 Emission Rates

Tables 8.1 and 8.2 in the *Guideline on Air Quality Models* (EPA 2005) present the emissions information required for air dispersion modeling. The emissions rate used in the modeling analysis must be that associated with maximum design capacity or a federally enforceable permit condition (40 CFR 51, Appendix W, Table 9-2). For a major modification, the emissions rate to be modeled in the significant impact analysis for criteria pollutants is the net emission rate increase, as defined in Idaho Air Rules Section 007. To demonstrate compliance with applicable standards, potential emissions must be used in the modeling analyses rather than future projected actual emissions. For minor modifications, the emissions modeled are the emissions changes associated with the proposed project, as described in Section 6.3.1 of this guideline. Emissions decreases are modeled as negative values in the significant impact analyses. However, in instances where NAAQS compliance may be questionable, DEQ may require facility-wide modeling even though results of the significant impact analysis indicate impacts are below SILs. When a cumulative NAAQS analysis is required, the potential emissions for all sources and, if requested, any co-contributing sources are used in the modeling analyses.

For PTCs, the project-wide emissions rate increase of TAPs is compared to the EL in Idaho Air Rules Section 585 and 586. Any TAP that has a total project emissions increase that exceeds the EL must be modeled.

The maximum emissions rate for each averaging period must be identified. For example, PM2.5 has both a 24-hour and an annual standard. If a source will only operate 7,000 hours per year but can operate for 24 hours in a single 24-hour period, then different emissions rates would be modeled for the 24-hour standard and annual standard.

If any pounds per hour emissions rate used in a modeling analysis differs from that used in the emissions inventory, the application should clearly show how the modeled rate was calculated. For example, a source has a maximum hourly emissions rate of 2.0 pounds per hour and a maximum daily operations rate of 12 hours per day (not restricted to any specific daily schedule). The modeled emissions rate for demonstrating compliance with a 24-hour standard would be 1.0 pounds per hour ((2.0 lb/hr x 12 hr/day) / 24 hr = 1.0 lb/hr).

Modeling intermittent sources in a representative and worst-case manner can present a challenge to the modeler. These sources can be modeled in two ways:

1. The allowable emissions can be modeled for a time period equal to that of the actual source. The emissions event is then selected to reasonably represent worst-case impacts or a series of potential operational scenarios are modeled.
2. The allowable emissions for the event are evenly divided over the pollutant averaging period of interest.

As an example, a mill may have fugitive PM2.5 emissions from periodic loadout of a waste bin. The emissions may occur for one hour, three times per week. Modeling must demonstrate compliance with both the 24-hour and annual standards. It is determined that only one loadout can occur during any 24-hour period. Since there is no specific time when the loadout is likely to occur, 24-hour modeling was conducted by evenly dividing the emissions from one loadout throughout the entire 24-hour period. Annual impacts were modeled by calculating annual allowable emissions, and evenly dividing those emissions among each hour of the year.

If it is known that emissions are most likely to occur during a certain time of the day, it may be appropriate to distribute emissions only over those hours of the day. The applicant should consult with DEQ modeling staff to obtain approval of such methods prior to modeling intermittent sources.

DEQ may allow exclusion of some very infrequent periodic emissions from the modeling analyses. Monthly testing of an emergency generator for 35 minutes could be an example of an infrequent periodic emissions source. Approval of excluding such sources from the modeling analyses will be made by DEQ on a case-by-case basis considering:

- The pollutant of interest and the averaging period of the standard
- Quantity of emissions from the source
- Frequency of the emissions
- Averaging period of standards associated with pollutants emitted
- Number of sources to be excluded
- Distance from source to ambient air receptors
- Nearby sensitive receptors (hospitals, schools, residences)
- Modeled impact of other sources in relation to applicable standards

As indicated in Section 6.3.1. Intermittent Sources, DEQ allows the exclusion of NOx emissions from intermittent testing and maintenance of engines powering emergency generators and fire suppression water pumps for demonstrating compliance with the 1-hour NO2 NAAQS.

6.4.2 Source Parameters

Stack parameters for each point source that are required to be modeled are as follows:

- Stack base elevation (feet or meters)
- Stack height (feet or meters)
- Stack inside diameter (feet or meters) (If the stack is not circular, use equivalent dimensions determined by Area = d2/4, where d is the stack's inner diameter)
- Stack exit velocity (meters/second) or exit flow rate (actual cubic feet per minute (acfm))
- Stack exit temperature (F or K)

Source parameters for area sources include the following:

- Source height (meters)
- Easterly dimension (meters)
- Northerly dimension (meters)
- Initial vertical dimension (meters)
- Angle from North (degrees)

Source parameters for volume sources include the following:

- Source height (meters)
- Initial horizontal dimension (meters)
- Initial vertical dimension (meters)

The application must provide detailed documentation and justification of all source parameters used in the analyses, including calculations where appropriate. Applications not providing sufficient documentation/justification of source parameters will be declared incomplete or denied. Stating that parameters were provided by the manufacturer or design engineer is not considered as adequate documentation/justification.

Flow Rates and Stack Gas Temperatures

Maximum flow rates and maximum stack gas temperatures should not typically be used in the modeling analyses unless the source predominantly operates at such a rate. Although maximum emissions are typically associated with maximum flow rates and stack gas temperatures, maximum impacts are often associated with lower emissions rates and lower stack gas flow rates and temperatures. Applicants should either use multiple scenarios of emissions, flow rates, and temperatures, or conservatively use maximum emissions with more typical stack gas flow rates and temperatures.

Submitted modeling analyses should provide detailed documentation and justification of all release parameters used in the analyses. Stack gas temperatures and flow rates substantially affect dispersion, and the application should clearly show how these parameters were calculated or measured. If gas temperatures are based on measurements made at locations other than near the stack exit, the temperature used in the model should be adjusted to derive a temperature appropriate for the stack exit. Stack gas exit velocities exceeding 50 m/sec will generally be viewed as suspect by DEQ reviewers, and greater documentation of values used will be required.

Unrealistic stack parameters submitted in applications are most commonly associated with internal combustion engines, and typically involve overly high exit velocities and stack temperatures. Applicants often use temperature and flow data obtained for the exhaust manifold rather than for the point of release to the atmosphere. Actual flows and temperatures at the release point will be substantially lower after heat loss through the walls of an exhaust pipe and through an exhaust muffler.

Stack Orientation

DEQ also requires the following be included in the application and modeling analysis:

- Orientation of the stack (horizontal or vertical)
- Indication of the presence or absence of a rain cap or other obstruction in the released flow from a stack

Stack orientation information is important because it affects the dispersion characteristics of the pollutants. If either a horizontal stack or rain cap (or other obstruction) is present, it must be accounted for in the modeling analysis, since upward plume momentum is zero because of either the obstruction or the orientation of the stack.

The method recommended by DEQ for modeling horizontal or rain-capped sources, when using the model AERMOD where downwash is not considered, is based on a procedure recommended by EPA (July 9, 1993, memorandum from Joseph A. Tikvart, Source Receptor Analysis Branch, to Ken Eng, Chief, Air Compliance Branch, Region II). The method involves setting the stack velocity to 0.001 meters per second to effectively turn off momentum plume rise. The memo also recommends turning stack tip downwash off for horizontal releases.

The recommended method for modeling point sources of non-buoyant emissions with horizontal release or vertical release with the presence of a rain cap is as follows:

1. Define the emissions source as a point source, entering in the model the actual height of release, stack gas temperature, and the Universal Transverse Mercator (UTM) coordinates.
2. Plumes from horizontal emissions releases or vertical stacks with rain caps experience no momentum induced plume rise. Set the stack gas exit velocity to 0.001 meters per second to effectively prevent the model from accounting for momentum plume rise.

3. Stack tip downwash is not appropriate for horizontally released emissions. If the emissions vent in the horizontal direction, the stack diameter can be set to 0.001 meters to prevent stack tip downwash effects. This step should not be used for sources that vent vertically with a rain cap over the stack, since the rain cap will not prevent stack tip downwash effects. The actual inside stack diameter should be used for rain-capped stacks.
4. Run the model as otherwise required.

By setting the flow velocity and/or stack diameter to 0.001, plume rise from hot, buoyant plumes is inappropriately eliminated. Since the PRIME downwash algorithm within AERMOD is affected by stack diameter, it is not acceptable to artificially increase the diameter by a substantial degree to generate a more accurate mass of hot stack gas emitted.

Non-regulatory versions of AERMOD allow the modeler to identify sources as a horizontal release or rain-capped source, and the model will consider the thermal buoyancy flux in the plume rise calculation while not considering a vertical momentum flux. To use the non- regulatory version, the actual temperature, stack diameter, and flow rate are entered into the model, then the source is identified in the AERMOD input file as a capped or horizontal release. DEQ must approve the use of any non-regulatory options in AERMOD.

Alternate methods may be approved by DEQ on a case-by-case basis if there are unique circumstances. In such cases, DEQ strongly advises that the permit applicant or consultant contact DEQ prior to modeling to discuss the issue, prepare a modeling protocol, and obtain prior approval from DEQ to use the proposed method.

Initial Plume Dimensions for Volume Sources

Initial horizontal plume dimensions for volume sources should be calculated as follows:

- Single volume source:
  $\sigma y0$ = side length of source divided by 4.3
- Line source represented as a series of volume sources (separated or adjacent):
  $\sigma y0$ = side length of source divided by 2.15

Initial vertical plume dimensions for volume sources should be calculated as follows:

- Surface based source:
  $\sigma z0$ = height of source divided by 2.15
- Elevated source on or adjacent to a building:
  $\sigma z0$ = building height divided by 2.15
- Elevated source not on or adjacent to a building:
  $\sigma z0$ = building height divided by 4.3

6.4.3 Scaled Plot Plan

A scaled plot plan showing emissions release locations, nearby buildings, property lines, fence lines, and roads is required (Section 8.1.2(b), *Guideline on Air Quality Models* (EPA 2005). The dimensions of the buildings (height, width, and length) should be noted either on the plot plan or in a table in the report. If building dimensions are listed in a table format, then it should be easy to cross-reference between the plot plan, model input file, and table.

The use of site plot plans generated directly from the modeling files does not meet the scaled plot plan submittal requirement. The submittal should include those scaled plot plans used to generate the modeling files.

6.4.4 Building Downwash Parameters

According to Section 6.2.2 in the *Guideline on Air Quality Models* (EPA 2005), the air quality impacts associated with cavity and wake effects due to the nearby building structures should be determined for any stacks with stack heights less than good engineering practice (GEP). If AERSCREEN is used with the option of entering dimensions of a single building, the building with the greatest corresponding GEP stack height should be analyzed. This may not necessarily be the building closest to the stack. When the EPA's AERMOD model is used and stacks are less than GEP stack height, building profile information is required for use in the modeling. The recommended building profile software is the EPA's *Building Profile Input Program* (BPIP). This program can also be used to determine which building should be used in the screening analysis. BPIP is available on EPA's SCRAM website.

6.4.5 Source, Building, and Receptor Coordinates and Elevations

UTM coordinates are typically used to define locations of emissions points, building corners, and receptor locations. The datum (e.g., NAD27, NAD83, WGS84) must be specified for the coordinates used, and the same datum must be used for all locations specified in the modeling analysis to assure consistency. The same coordinate system should also be used to evaluate elevations for emissions points, buildings, and receptors.

6.5 Ambient Air Boundary

The ambient air boundary must be determined before an ambient air assessment can be completed. The definition of ambient air in Idaho Air Rules Section 006 is, "that portion of the atmosphere, external to buildings, to which the general public has access." The EPA has further stated that "the exemption from ambient air is available only for the atmosphere over land owned or controlled by the source and to which public access is precluded by a fence or other physical barriers" (Costle 1980). Based on these definitions, DEQ has developed the following guidance to be used when determining the ambient air boundary for a facility.

It shall be assumed that the air within the facility boundaries is ambient air unless the facility can demonstrate that public access is precluded. The facility-proposed ambient air boundary must include justification that demonstrates the facility has reasonable control of the area and effectively precludes public access on a routine basis. The following criteria must be satisfied when developing a facility-proposed, ambient-air boundary justification. A justification must accompany the answers.

For the purpose of defining ambient air, the "general public" is considered anyone not directly associated with the facility. In general, if someone present at the site would not be subject to OSHA or other worker exposure regulations, then they are considered as the general public.

1. Facility Control
    - Is general public access precluded by a physical barrier (e.g., fence with a gate)? If "yes," the facility is assumed to be controlled and public access effectively precluded, and the ambient air boundary can be set at the fence line. Proceed to No. 2. If "no," then proceed to No. 1b. Rugged terrain or a water body is not typically considered as a physical barrier.

- Is general public access discouraged by the type of area (e.g., industrial park site away from residential or recreational areas), size of the facility (e.g., the facility is surrounded by a buffer zone that is controlled by the facility), or a remote location away from the proximity of human habitation or activities? Is the facility controlled by reasonable posting of the property with "no trespassing" signs, or reasonable patrol of the property by a security person who routinely asks trespassers to leave? If "yes" to BOTH questions, the facility is assumed to be controlled, with public access effectively precluded, and the ambient air boundary is determined to be at the property boundary. Proceed to No. 2. If "no," to EITHER question, proceed to No. 1c.
- If the facility is not controlled by a physical barrier AND/OR general public access is not discouraged by the type of area, size of the facility, or the remoteness of the facility location, then the ambient air boundary is determined to be inside the property boundary. The actual point at which the ambient air boundary occurs is dependent on several factors, such as the type of operation at the facility (e.g., are employees outside on a regular basis?) and whether employees have a clear view, from the location where the employees normally work, of the entire property (e.g., are trees blocking the sight?). The ambient air boundary is determined to be at a point where employees are not regularly present and where they do not have a clear view of the property. To meet this criteria, a very detailed description of the facility and property must be provided. If a justification cannot be provided, the ambient air boundary is determined to be all air that is external to the buildings. Proceed to No. 2.

2. Facility Business
   Is the general public invited as part of the normal business conducted on the facility site (e.g., the facility includes a commercial establishment or service provider)? If "yes," then the area into which the public is invited is determined to be ambient air. Adjust the ambient air boundary determined in No. 1. If "no," the ambient air boundary determined in No. 1 is not changed. Proceed to No. 3.
3. Right-of-Way Access
   Is the general public allowed on site as a part of a right-of-way easement or a common service road? If "yes," then the right-of-way is determined to be ambient air. Adjust the ambient air boundary determined in No. 1. If "no," the ambient air boundary determined in No. 1 is not changed. Any streams or rivers transecting a facility will be considered as ambient air at all locations between high water levels unless the applicant adequately demonstrates and documents that public access can be legally precluded. Idaho Department of Lands and Fish and Game rules governing public access should be used for such a demonstration.
4. Leased Property
   Does the facility lease a portion of their site to another industry, business, or individual OR does the facility lease property from another entity? For example, if a facility leases part of its property to a farmer for growing crops, that portion leased may be considered as ambient air. These situations are frequently complicated, and DEQ should be consulted regarding any specific case involving leased property as it affects the ambient air boundary.

Any area outside the facility's (or facilities' if they are under common ownership) control will be considered ambient air. This includes other industrial facilities. The employees of other facilities are considered to be general public for the facility in question. Evaluation of the ambient air quality must include all sources within facility control if the source or source modification exceeds the SILs defined in IDAPA 58.01.01.006 (definition of significant contribution).

6.6 Receptor Network

A receptor network establishes locations where the air dispersion model calculates a pollutant concentration. Each location is called a receptor, to represent a receptor that might be exposed to that concentration at that location. Receptors are required to be placed in all areas considered to be ambient air.

Modeling must be conducted using a sufficiently dense receptor grid to reasonably resolve the maximum modeled concentration and confidently demonstrate compliance with standards.

DEQ may determine an application incomplete or may deny a permit if DEQ is not confident the receptor grid spacing used is adequate to confidently demonstrate NAAQS compliance. DEQ may also include additional receptors during verification modeling if it is questionable whether the maximum concentrations have been resolved, and approval will not be granted if results do not comply with applicable standards. Adequacy of the receptor grid can be evaluated by reviewing a plot of modeled design value concentrations and considering the following:

- Maximum modeled concentrations in relation to a trigger value (SILs, NAAQS, or AACs/AACCs)
- Concentrations at receptors immediately adjacent to the maximum modeled concentration
- Terrain features within the modeling domain and areas beyond the domain if maximum modeled concentrations are near the boundary of the domain

6.7 Elevation Data

Terrain elevations for sources and receptors should be used when appropriate (EPA 2005). Where AERMOD is the model used to demonstrate compliance, the applicant should generally use the latest established procedures and guidance provided by EPA (see the SCRAM website on EPA's TTNWeb-Technology Transfer Network (*http://www.epa.gov/ttn/scram*). Prior to 2009, elevations of receptors, sources, and buildings used in the modeling analyses were determined from U.S. Geological Survey (USGS) Digital Elevation Model (DEM) files. AERMAP now supports processing terrain elevations from the National Elevation Dataset (NED) developed by the USGS. Since the DEM files will no longer be updated, NED represents more up-to-date and accurate data, and these should be used in preference to DEM files. These data can be downloaded in a seamless data set in GeoTiff format for use in AERMAP.

A single, consistent source of terrain data should be used to establish elevations for receptors, emissions sources, and site structures. Using different datums within a single modeling analysis can result in critical problems such as sources located beneath ground-level, buildings suspended above ground-level, or facilities located on hillsides rather than valley floors.

6.8 Meteorological Data

The meteorological data used in the modeling analysis should be representative of the meteorological conditions at the particular site of the proposed construction or modification. Section 8.3 in the *Guideline on Air Quality Models* (EPA 2005) states that representativeness of the meteorological data is dependent on the following: (1) the distance from the meteorological monitoring site to the area under consideration; (2) the complexity of the terrain surrounding both the meteorological monitoring site and the area under consideration; (3) the exposure of the meteorological monitoring site; and (4) the period of time during which data are collected.

When using AERMOD, representativeness will also depend on the similarity between the monitoring site and the application site for: 1) surface roughness; 2) land type characteristics that influence parameters such as albedo and Bowen Ratio (vegetative cover and moisture content). Consult with the DEQ air quality modeling coordinator to determine if representative meteorological data are available for the area under consideration. If the only available meteorological data are of questionable representativeness, DEQ may require applicants to perform modeling analyses using multiple meteorological data sets. Alternatively, site-specific data could be acquired by the facility. Site-specific meteorological data are typically only required for PSD applications or when DEQ has concern regarding NAAQS compliance.

The collection of site-specific meteorological data should follow the recommendations provided in *Meteorological Monitoring Guidance for Regulatory Modeling Applications* (EPA 2000), as well as Section 8.3.3 in the *Guideline on Air Quality Models* (EPA 2005). Site-specific meteorological data must be approved prior to use in a modeling analysis. Generally, following EPA recommendations and procedures is determined to be adequate for DEQ approval. To receive approval, the facility must provide DEQ staff with standard operating procedures, the quality assurance plan for operating the meteorological tower, and quality control audit reports that cover the entire year of data. DEQ will review this information and respond with either an approval or denial letter. The facility should either reference or include a copy of the approval letter when meteorological data are used in a modeling analysis. This will help to expedite the review process of the permit application. If DEQ does not approve the data for air modeling purposes, the analyses will not be approved and alternate approaches must be developed.

There are several sources of meteorological data besides on-site collected data. The National Weather Service (NWS) collects data throughout the country. Much of these data are collected at airports. These and other data are available through the National Climatic Data Center (*http://www.ncdc.noaa.gov/oa/ncdc.html*), through EPA's SCRAM website, or possibly through DEQ's modeling coordinator.

As stated in Section 8.3.1.1 in the *Guideline on Air Quality Models* (EPA 2005), the model user should "acquire enough meteorological data to ensure that worst-case meteorological conditions are adequately represented in the model results." Section 8.3.1.2 recommends using five years of NWS data or at least one year of site-specific data. If more than one year of site-specific data are available, then all years, up to five years, should be used (see Section 8.3.1.2(b) in EPA 2005). Site-specific meteorological data must be subjected to DEQ-approved quality assurance procedures.

The following should be considered when generating meteorological data with AERMET:

- Surface characteristics specified for landuse types in AERMET are based on the meteorological measurement site, not the facility application site.
- The EPA program AERSURFACE should be used, following recommendations specified in the user's guide, to define season- and sector-specific surface parameters (albedo, Bowen Ratio, and surface roughness).
- A current aerial photograph of the meteorological measurement site, or a detailed land- use map, should be used to check the accuracy of land-use files used in AERSURFACE.
- Sector-specific values of surface characteristics should be calculated for each season.
- Documentation of the surface characteristics analyses should be submitted with the application. Sufficient detail must be provided such that DEQ staff can regenerate the AERMET output meteorological files.

6.9 Land-Use Classification

Determining if the area surrounding the facility is urban or rural is necessary before a dispersion modeling analysis can be conducted correctly. Two methods of classifying an area as urban or rural are described in Section 7.2.3.c in the *Guideline on Air Quality Models* (EPA 2005). The first is the land-use method. The area is classified according to the current land usage (according to the meteorological land-use typing scheme proposed by Auer [1978]) of its surroundings in a three-kilometer (approximately 1.8-mile) radius centered at the source. If 50 percent or more of the surrounding area is classified as I1, I2, C1, R2, or R3 (using classifications listed in Auer 1978), the source would be considered an urban source. Otherwise, the source would be considered rural. Appendix E provides a summary of the meteorological land-use typing scheme proposed by Auer (1978).

A second method relies on population density. If the population density within a three-kilometer (approximately 1.8-mile) radius, centered at the facility, is greater than 750 people per square kilometer, the urban modeling option for the area can be used. However, the population density method of source classification should not be applied to highly industrialized areas. This is because highly industrialized areas typically have low population densities, but the presence of buildings and areas of asphalt and concrete make the source more urban in nature. The *Guideline on Air Quality Models*, Section 7.2.3.e, states that, of the two methods, the land-use procedure is more definitive (EPA 2005).

6.10 Background Concentrations

Section 8.2 in the *Guideline on Air Quality Models* (EPA 2005) discusses the use of background concentrations in a cumulative NAAQS analysis. Background concentrations of regulated criteria pollutants must be included in cumulative NAAQS analyses for both PSD and non-PSD applications. The modeler is required to contact DEQ prior to performing the modeling analysis to obtain the appropriate, reasonably conservative background concentration(s) for the area and time intervals of concern. A different pollutant-specific concentration is needed for each applicable averaging period.

Background concentrations are developed based on air quality monitoring data collected from the area of the proposed project or from similar areas determined to be reasonably representative. DEQ has developed applicable background concentrations for specific areas and default concentrations for areas where monitoring data are not available. Facilities may propose alternate/refined background concentrations based on their own analyses. Use of an alternate background concentration should be proposed within a modeling protocol submitted to DEQ. An alternate background concentration proposal analysis should include the following:

- Description of monitoring data proposed as representative of the proposed project area. The description should include the statistics of the data set and the quality control/assurance measures conducted for the data if data were not provided by DEQ.
- Description of all emissions sources in the area of the proposed project and sources in the area(s) where claimed representative monitoring data were obtained. This should include both point sources and area/mobile sources, and should also address emissions source density. A discussion should be provided that compares the two areas and supports the use of the monitoring data for the project site.
- A detailed assessment of the meteorology of the project area and the area where monitoring data were obtained. Differences between the areas should be assessed for the effects they may have on pollutant dispersion and concentrations in ambient air.

Air monitoring data for Idaho can be obtained at the following EPA website address: *http://www.epa.gov/air/data/index.html*. In most instances, background concentrations calculated in the following manner will be accepted by DEQ:

- 24-hour PM2.5: The maximum 3-year mean of 98th percentile of 24-hour average concentrations over 1-year periods.
- Annual PM2.5: The maximum 3-year mean of annual averages, using 5 consecutive years of data.
- Short term standards of PM10, SO2, and CO: The maximum 2nd highest monitored value over each year of applicable data.
- 1-hour NO2: The maximum 3-year mean of the 98th percentile of the daily maximum 1-hour average concentrations over 1-year periods.
- 1-hour SO2: The maximum 3-year mean of the 99th percentile of the daily maximum 1-hour average concentrations over 1-year periods.
- Annual Standards of SO2 and NO2: The maximum annual average for the applicable data. The most recent 5-year data set should be used.

Existing emissions from a facility may have a measurable impact to monitored concentrations in some instances. It is the facility's responsibility to assess their contribution to the background concentration. Prior to this assessment, a protocol must be submitted to, and approved by, DEQ. The assessment must then be done in accordance with the DEQ-approved protocol. In such cases, the facility's impact may be subtracted from the monitored value to establish an appropriate background concentration value. The following should be considered in such analyses:

- To evaluate a facility's impact on background monitored values, modeling must be performed using meteorological data collected during the same period when monitoring data were collected.
- Site-specific meteorological data must be used. These data must be highly representative for both the facility site and the monitoring site.
- Actual emissions for the period modeled must be used in the analyses.
- Monitored and modeled values must be paired in time and space; i.e. modeled values subtracted from monitoring results must be those values modeled at the site of the monitor for the averaging period associated with the monitored value.
- One suggested approach would be to start with the highest monitored value and model the facility's impact on that value. If the result is lower than the next-highest monitored value, this process should be repeated for that monitored value. This process is repeated until the highest adjusted value is greater than the next unadjusted value. The highest adjusted value is used for the background concentration.

Use of other methods to calculate a background concentration will be evaluated on a case-by- case basis. Proposals for such methods should be thoroughly described in the protocol.

6.11 Evaluation of Compliance with Standards

6.11.1 Approval Criteria

The applicant must demonstrate compliance with all other applicable impact limits in addition to demonstrating compliance with NAAQS. For PSD applications, these include impact limits for Class I areas within 300 kilometers, non-attainment area impact limits (when in or potentially significantly impacting a non-attainment area), and TAPs increment standards in Idaho Air Rules Sections 585 and

586 (when emitting TAPs above DEQ ELs). Federal land managers have the responsibility to protect the natural and cultural resources of Class I areas from adverse impacts of air pollution. Refer to the Federal Land Managers Air Quality Related Values Workgroup (FLAG) Phase I Report- Revised (USFS et al 2010). In some cases, deposition of airborne pollutants (e.g., radionuclides or fluorides, for example) or human risk pathways associated with deposition of airborne emissions may be subject to regulatory impact limits.

The highest modeled ambient concentration must be used for comparison against the SILs for all applicable criteria pollutants. A multi-year average, consistent with the years of meteorological data modeled, of the maximum modeled concentration of each year modeled can be used for the probabilistic standards, including 24-hour PM2.5, annual PM2.5, 1-hour NO2, and 1-hour SO2.

The following design concentrations must be used when demonstrating compliance with the cumulative NAAQS:

- CO
  - 1-hour averaging period – maximum of second highest ambient concentrations at each receptor
  - 8-hour averaging period – maximum of second highest ambient concentrations at each receptor
- NO2
  - 1-hour averaging period – maximum of 5-year averages (at each modeled receptor) of the 98th percentile of the annual distribution (equal to the 8th high) of maximum daily 1-hour ambient concentrations
  - Annual averaging period – maximum of ambient concentrations at each receptor
- SO2
  - 1-hour averaging period – maximum of 5-year averages (at each modeled receptor) of the 99th percentile of the annual distribution (equal to the 4th high) of maximum daily 1-hour ambient concentrations
  - 3-hour averaging period – maximum of second highest ambient concentrations at each receptor
  - 24-hour averaging period – maximum of second highest ambient concentrations at each receptor
  - Annual averaging period – maximum of ambient concentrations at each receptor
- PM10
  - 24-hour averaging period – “the projected 24-hour average concentrations will not exceed the 24-hour NAAQS more than once per year on average” (EPA 2005). The design concentration is dependent on the number of meteorological data years used in the analysis. For example, if five years of NWS data were used, then the design concentration would be the sixth highest 24-hour ambient concentration that occurred at each receptor over that five-year period.
- PM2.5
  - 24-hour averaging period – maximum of multi-year average of annual maximum 24- hour ambient concentrations at each receptor. Using the multi-year average of the 98th percentile of the annual distribution (equal to the 8th high) of 24-hour concentrations for both the modeled design value and background is not adequately conservative because background concentrations are frequently the controlling factor for PM2.5.
  - Annual Averaging Period - maximum of multi-year average of annual ambient concentrations at each receptor.

- Pb
  - Quarterly averaging period – maximum of ambient concentrations at each receptor
  - 3-month rolling average – maximum of ambient concentrations at each receptor

If meteorological data used in the analyses are of questionable representativeness, DEQ may require a more stringent design value. DEQ may also require analyses using multiple meteorological data sets to compensate somewhat for increased uncertainty.

The following design concentrations must be used when demonstrating compliance with TAPs requirements:

- Noncarcinogens – 24-hour averaging period – maximum of ambient concentrations at each receptor
- Carcinogens – total averaging period (1-5 years depending on meteorological data availability) – maximum of ambient concentrations at each receptor

6.11.2 Adequacy of Analyses Results

The submitted analyses must demonstrate to the satisfaction of DEQ that applicable emissions do not cause or significantly contribute to a violation of any air quality standard, as per Idaho Air Rules Section 203 for PTCs and Idaho Air Rules Section 403 for Tier II operating permits. Approvability of the submitted analyses will depend on the results of the analyses as well as the representativeness and quality of input data and parameters used. DEQ recognizes the uncertainty in typical dispersion modeling analyses and the variability and uncertainty associated with input parameters such as background concentrations, emission quantities, operational characteristics, etc. These uncertainties will be considered in DEQ's evaluation and determination of acceptability.

DEQ will evaluate model inputs and parameters more carefully as modeling results more closely approach applicable standards. Modeled concentrations within about 90 percent of the standard will be more closely reviewed by DEQ. At these concentrations, approval will be based on a "weight of evidence" type approach, considering the model results, input data/parameters, potentially exposed public, any monitoring requirements specified in the proposed permit, and operational variability. DEQ will not approve any modeling results that do not show compliance with applicable standards. The following provides discussion on how DEQ will evaluate compliance in situations where modeled concentrations are very near applicable standards:

- Modeled Concentrations: Results within about 90 percent of the air quality standard will generally trigger DEQ to more carefully evaluate the analyses. In some instances, the analysis may not adequately demonstrate compliance even though modeled concentrations are below a standard.
- Emissions Estimates: Estimates of emissions can be a substantial source of uncertainty and/or variability. It is important to evaluate both uncertainty in the estimate and variability, and to distinguish between them. Where estimates of maximum emissions are highly uncertain and the estimate is not necessarily conservative, DEQ may consider modeling results slightly below the standard as not adequately demonstrating compliance. Alternatively, if emissions are highly variable and the allowable emission rate is set at the maximum, DEQ will consider the likelihood of high emissions occurring concurrently with conditions of poor dispersion.
- Representativeness of Meteorological Data: Using meteorological data from a distant location where the representativeness is questionable will add to the uncertainty of the modeling analyses. Applicants may be requested by DEQ to provide a more detailed assessment of the area's meteorology and qualitative comparisons to data used in the analyses. Such assessments

should be performed by meteorologists or those having considerable knowledge in surface meteorology. In some instances, DEQ may request an applicant to install and operate a meteorological station to resolve concerns with data representativeness. In cases where meteorological data used in the analyses are of questionable representativeness, DEQ may require the use of multiple meteorological data sets in the analyses.

- Background Concentrations: Background concentrations are often a very large source of uncertainty and variability, especially for 1-hour NO2, PM10, and PM2.5, where background concentrations can be a considerable fraction of the standard. When modeled 1-hour NO2, PM10 and PM2.5 concentrations are very near the standard, applicants should review and compare the meteorological conditions associated with the modeled result and the background concentration.
- Modeled Emissions Release Parameters: Parameters characterizing the release of emissions (stack temperature, flow rate, initial plume dimensions for volume sources, etc.) greatly impact the modeling results. The conservatism of these parameters will be considered by DEQ during the review.
- Permit Requirements: As modeled concentrations approach applicable standards, DEQ may require more extensive emissions monitoring, source testing, and possibly ambient air monitoring.
- Areas with High Concentration Impacts: DEQ will consider the land use of areas where models project high concentrations. DEQ will require a higher degree of certainty for areas where there is a high potential for exposures to the public, such as actual residences, businesses, parks, etc. However, it is important to consider that dispersion models are reasonably accurate at predicting the magnitude of maximum concentrations but often perform poorly at predicting the location or time of maximum concentrations.

6.12 Air Quality Modeling Report

The applicant must supply an air quality modeling report that presents the case as to how the modeling results demonstrate compliance with all applicable air quality standards. The level of detail of the report will depend on the complexity of the proposed facility and the permitting project.

Each submitted application must be a complete package in itself. Referencing previously submitted materials, such as those submitted in an earlier application, will not generally be considered as meeting the stated requirements to provide documentation/justification of air quality analyses and data used as inputs for those analyses.

Below is an example annotated outline of an air quality modeling report. The report should thoroughly describe all aspects of the air impact analyses performed. Specific sections of this guideline should be consulted to evaluate the details needed for the modeling report regarding certain aspects of the analyses.

I Purpose

- State the purpose of the air quality modeling analyses (i.e., demonstrating compliance for a permit to construct or a Tier II operating permit).
- Provide a detailed description of regulatory requirements as they relate to modeling, citing specific applicable regulations.

II Model Description/Justification

- Discuss what model was chosen and justify why it is the appropriate model for the situation. This discussion may be very brief if the applicant is proposing to use AERMOD for near-field impacts.

III Emissions and Source Data

- Present tables showing the current (either actual or permit allowable) emission rates, future allowable emissions rates (maximum for each applicable averaging period), and the requested emission increase (future allowable minus actual or current allowable).
- If cumulative NAAQS impact analyses are required, the applicant must thoroughly document all emissions used in the model, even when such sources are not affected by the particular proposed project. Emissions calculations, source test data, and/or other information justifying the value used should be provided for all sources unless those emissions are based on a specific emissions limit presented in an issued permit.
- Provide justification for those sources and/or pollutants determined to be "inconsequential" (if applicable).
- Provide stack parameters (emissions rates, stack height, stack elevation, stack diameter, stack gas exit velocity, and stack gas exit temperature) for each modeled emissions point. Values for stack parameters should be justified and well documented, indicating whether values are estimated or measured.
- Provide a facility plot plan to scale showing the fence line, ambient air boundary, emission sources at the facility, and buildings. Include the height, width, and base elevation of each building at the facility.
- Provide UTM coordinates of all emissions points, and list the datum used.

IV Ambient air boundary

- Thoroughly describe how the public are precluded from accessing all areas excluded from the receptor network, describing any complicating ambient air issues such as rivers bisecting the facility, leasing agreements, retail sales operations at the site, right of ways, etc.

V Receptor Network

- Describe the receptor network used. Include the distance between receptors for the fine and coarse grids. Justify any deviation from minimum recommendations in EPA or state guidelines, and provide a demonstration that the receptor grid allows for resolution of the maximum modeled concentration.

VI Elevation Data

- Describe any elevation data used and the source of the information, including the datum for the coordinates used. If necessary, include a USGS 7.5-minute map showing the location of the facility. A justification must be provided if elevation data are not used.

VII Meteorological Data

- Describe the source of the meteorological data and present a representative analysis according to Section 6.8. Electronic copies of the files must be included with the modeling report if meteorological data were not provided in model-ready format to the applicant from DEQ. If site-specific data are used, provide documentation that DEQ has reviewed and approved the data.
- If the applicant has generated AERMOD input meteorological files by running AERMET, rather than using AERMOD input files provided by DEQ, supporting AERMET documentation must be submitted with the application. A detailed report on the processing of meteorological data

should be submitted, including a report on running AERSURFACE to evaluate surface characteristics and a detailed report on data collection and quality for any on-site data processed. Copies of the raw meteorological data must also be submitted to DEQ.

VIII Land-Use Classification

- State the land-use classification for the area surrounding the source and provide the justification.

IX Background Concentrations

- State whether background concentrations were used and identify the source of the information.
- If DEQ default background concentrations were not used, the report must thoroughly describe and document how background concentrations were determined.

X Evaluation of Compliance with Standards

- Include tables summarizing the air quality model output (example tables are shown in Appendix F).

XI Electronic Copies of the Modeling Files

- Provide modeling input/output files (including BPIP and meteorological data, and intermediate files generated by AERMET, AERMAP, and AERMOD) on compact disk or other means.

7 DEQ Review of Modeling Analyses

DEQ dispersion modeling staff will review the submitted air quality analyses prior to approval and issuance of the permit. Review of the analyses will occur in two phases: 1) completeness review; 2) technical review of submitted analyses. The completeness review will focus on evaluating whether the required analyses were performed and the primary components of the air quality analyses were submitted with the application. The technical review will evaluate whether the data and methods used in the analyses are accurate and appropriate for the project.

Several methods and approaches can be used by the applicant to ensure the submitted modeling analyses are approved by DEQ or, if there are problems with the analyses, such problems are identified early in the completeness review and will minimize delays to the project:

1. Submit a modeling analyses protocol prior to conducting the analyses. The protocol, as described in Section 6.1, should provide details on the proposed methods and data to the greatest degree possible.
2. Provide a detailed and well-organized modeling analyses report, as described in Section 6.12. This will allow DEQ staff to quickly assess the appropriateness and technical accuracy of the analyses. If a modeling protocol was submitted to DEQ prior to the application, a copy of the protocol and DEQ's protocol approval notification should be included with the application.
3. Provide clear justification for methods and data used, and provide supporting documentation. Calculations should be provided such that the DEQ reviewer can easily verify the calculated values.
4. Ensure that emissions sources are named consistently between the emissions inventory used for the permit application forms and the modeling analyses.

Conduct quality assurance/control measures to minimize error in the submitted analyses. The following are some measures that will help minimize or identify errors in the analyses:

- Print or view a three-dimensional representation of the sources, building, receptors, and the ambient air boundary. This will identify any errors in UTM coordinates and elevations.
- Check that all sources included in the application are included in the modeling analyses. If some sources are not included, a detailed justification should be provided. If facility-wide modeling is needed for a cumulative impact analysis, the emissions inventory of other sources, not directly addressed by the current permitting action, should be thoroughly documented.
- Emissions rates used in the modeling analyses should be identical to those listed in the permit application forms and the emissions calculation section of the application. Any differences between emissions rates should be thoroughly documented and all calculation steps should be shown. This will allow DEQ reviewers to quickly evaluate how emissions rates were calculated.

8 Summary

This document provides guidance for performing an ambient air assessment, for permitting purposes, in the state of Idaho. This document should be used in conjunction with the EPA's *Guideline on Air Quality Models* (EPA 2005) and *New Source Review Workshop Manual* (EPA 1990), and other applicable guidance materials. Following the guidance in this document, as well as EPA guidance, will help expedite DEQ's review of the application.

References

40 CFR 52.21, *Prevention of Significant Deterioration of Air Quality.*

Auer, A.H., Jr., 1978. *Correlation of Land Use and Cover with Meteorological Anomalies*. Journal of Applied Meteorology, 17(5): 636-643.

Costle, Douglas, M., 1980. *Correspondence to Senator Jennings Randolph*. December 19, 1980.

EPA, 1990. *New Source Review Workshop Manual, Prevention of Significant Deterioration and Nonattainment Area Permitting*. New Source Review Section, Noncriteria Pollutants Program Branch, Air Quality Management Division, U.S. Environmental Protection Agency, Research Triangle Park, NC.

EPA, 1992. *Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised*. EPA Publication No. EPA-454/R-92-019. U.S. Environmental Protection Agency, Research Triangle Park, NC.

EPA, 1995. *Streamlined Development of Part 70 Permit Applications*. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards.

EPA, 2000. *Meteorological Monitoring Guidance for Regulatory Modeling Applications*. EPA Publication No. EPA-454/R-99-005. U.S. Environmental Protection Agency, Research Triangle Park, NC.

EPA, 2004. *User's Guide for the AERMOD Terrain Preprocessor (AERMAP)*. EPA Publication No. EPA-454/B-03-003. U.S. Environmental Protection Agency, Research Triangle Park, NC.

EPA, 2005. *Guideline on Air Quality Models*. 40 CFR Part 51, Appendix W, Federal Register Vol 70, No. 216, Wednesday, November 9, 2005.

EPA, 2009a. *Addendum – User's Guide for the AERMOD Terrain Preprocessor (AERMAP)*. EPA Publication No. EPA-454/B-03-003. U.S. Environmental Protection Agency, Research Triangle Park, NC.

EPA 2009b. *AERMOD Implementation Guide*. AERMOD Implementation Workgroup. U.S. Environmental Protection Agency, Research Triangle Park, NC.

EPA 2010a. *General Guidance for Implementing the 1-hour NO2 National Ambient Air Quality Standard in Prevention of Significant Deterioration Permits, Including an Interim 1-hour NO2 Significant Impact Level*. EPA Memorandum from Anna Marie Wood, Acting Director, Air Quality Policy Division, to Regional Air Division Directors. U.S. Environmental Protection Agency, Research Triangle Park, NC. June 28, 2010.

EPA 2010b. *General Guidance for Implementing the 1-hour SO2 National Ambient Air Quality Standard in Prevention of Significant Deterioration Permits, Including an Interim 1-hour SO2 Significant Impact Level.* EPA Memorandum from Anna Marie Wood, Acting Director, Air Quality Policy Division. U.S. Environmental Protection Agency, Research Triangle Park, NC. August 23, 2010.

EPA 2018. Guidance on Significant Impact Levels for Ozone and Fine Particles in the Prevention of Significant Deterioration Permitting Program. EPA Memorandum from Peter Tsirigotis, Director, Office of Air Quality Planning and Standards. U.S. Environmental Protection Agency, Research Triangle Park, NC. April 17, 2018.

EPA's SCRAM website: http://www.epa.gov/scram001/index.htm

IDAPA 58.01.01, et seq. *Rules for the Control of Air Pollution in Idaho*

Idaho Department of Environmental Quality Policy Memorandum, *Policy on NAAQS Compliance Demonstration Requirements*, July 11, 2014.

Appendix A. Guidance for 1-Hour NO_2 Modeling of Intermittent Sources

DEQ Guidance for Minor New Source Review Modeling of 1-Hour NO_2 from Intermittent Testing of Emergency Engines

State of Idaho
Department of Environmental Quality

September 2013

Certain industrial facilities have internal combustion (IC) engines that are used only to power emergency generators or fire-suppression pumps. These engines only operate for periodic testing and during an actual emergency. As such, these sources with intermittent emissions are difficult to model in a way that accounts for impacts in a reasonably accurate but conservative manner. As a result, Tyler Fox, leader of Environmental Protection Agency's (EPA) Air Quality Modeling Group, developed a memorandum entitled "Additional Clarification Regarding Application of Appendix W Modeling Guideline for the 1-hour NO2 National Ambient Air Quality Standard, dated March 1, 2011. The memo provides states with the flexibility to exclude certain types of sources with intermittent emissions from Appendix W modeling.

Upon a review of other states' application of the Tyler Fox memo, comments from the public and Idaho industry, an internal review of Idaho sources, NO2 background levels, and various sample model runs; DEQ has determined that Nitrogen Oxides (NOx) emissions from the intermittent operational testing of engines powering emergency generators or fire-suppression water pumps may be excluded from the project-specific significant impact level (SIL) analysis and the cumulative NAAQS analysis for 1-hour NO2, providing the annual hours of operation from testing and maintenance are less than or equal to 100 hours per engine.

This determination is applicable to minor source air permitting projects and is not limited to any specific number of engines present at a facility. The Director may require deviation from this guidance if deemed appropriate to assure compliance with 1-hour NO2 NAAQS and IDAPA 58.01.01.203 or 01.403. DEQ will determine how emergency engines are included in permits for major sources, specifically those applicable to the Prevention of Significant Deterioration (PSD) program, on a case-by-case basis.

This guidance does not have the force and effect of a rule and is not intended to supersede statutory or regulatory requirements or recommendations of the state of Idaho or EPA. This guidance may be altered upon new or revised guidance from EPA, development of new methods to appropriately handle such emissions, or new information gained from technical analyses.

Contact the DEQ stationary source air modeling coordinator at (208) 373-0112 for any questions or additional information regarding data and methods for assessing air quality impacts from intermittently operated sources.

Appendix B. Class I Areas

Class I Areas

This appendix shows Class I areas in and near Idaho. The areas represent situations where air quality impact limits are stricter than the NAAQS. The information in this appendix is current as of the date of this document. Please check with DEQ to verify if it is still current.

Area Classifications

The Class I, II, and III areas are defined below (shown in Figure 1).

1. Class I - National park, recreation, and wilderness areas that were already established when the 1977 Clean Air Act was passed, and other designated parts of the country that now benefit from high quality air and where a high priority has been established for the maintenance of pristine conditions. Additional degradation of the air is severely restricted.
2. Class II - Areas that need reasonably or moderately good air quality protection. This is presently the class designation of most areas in the United States. Increments of deterioration have been stipulated that will generally accommodate most proposed development projects.
3. Class III - Areas that can, at the discretion of the states, be designated as allowing for larger increments of air quality degradation and therefore greater growth and development potential. No Class III areas have been designated in Idaho.

The Class I areas in Idaho include the following: Hells Canyon, Sawtooth, and Selway- Bitterroot wilderness areas, Craters of the Moon National Monument, and Yellowstone National Park.

Class I areas near Idaho's borders include the following: Spokane Indian Reservation, Washington; Hells Canyon and Eagle Cap Wilderness areas, Oregon; Cabinet Mountain and Anaconda-Pintler Wilderness areas, Red Rock Lakes, and Flathead Indian Reservation, Montana; Yellowstone National Park, Montana and Wyoming; Teton National Park, Wyoming; and Jarbidge Wilderness, Nevada.

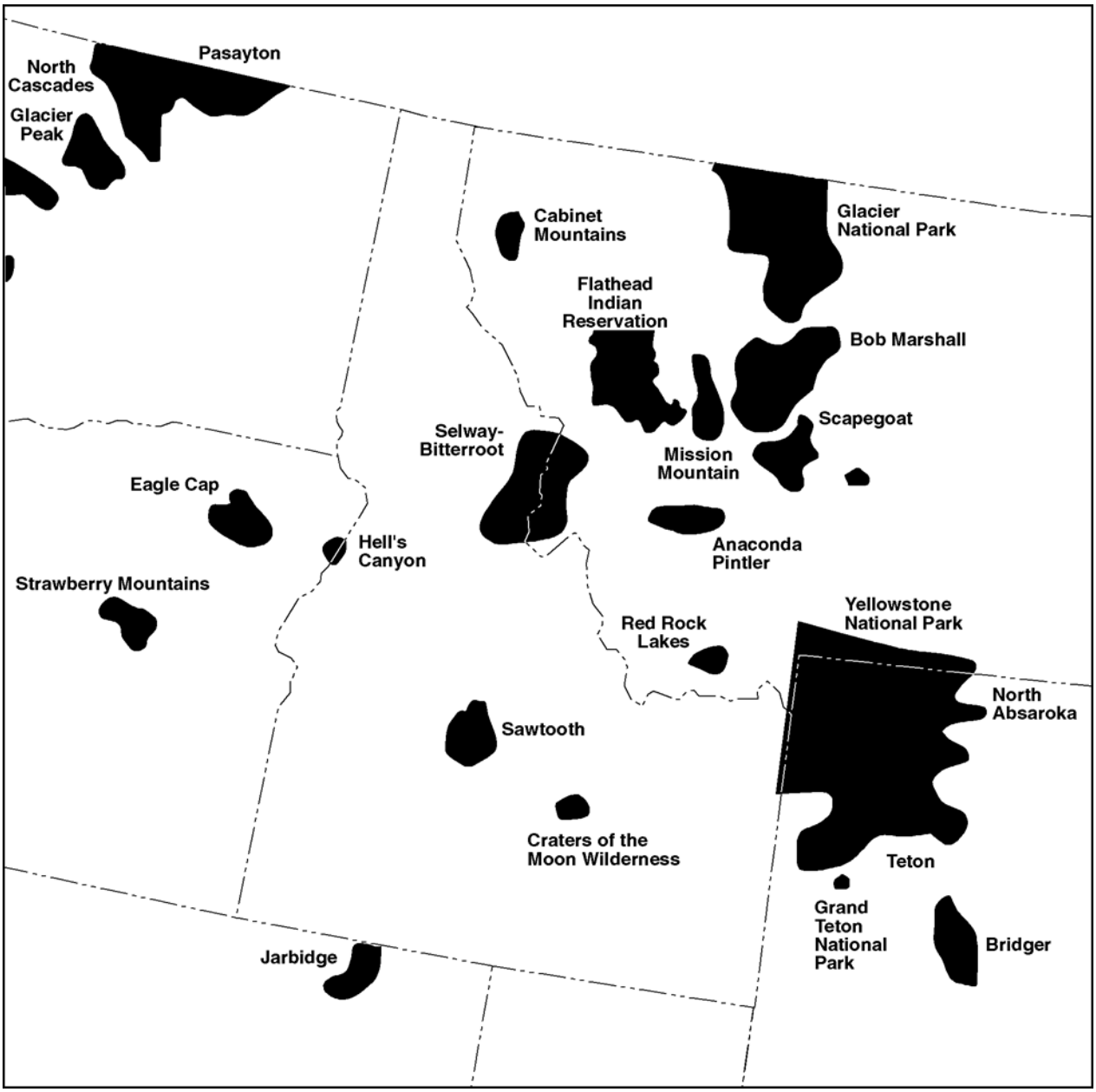


Figure A-1. Class I areas in and near Idaho.

Appendix C. Idaho DEQ Air Dispersion Modeling Checklist

Idaho DEQ Stationary Source Air Dispersion Modeling Checklist

- ☐ Reviewed the Idaho Air Quality Modeling Guideline and have determined the appropriate methods and data for use in this permitting action, contacting DEQ as needed to provide clarification.
- ☐ A modeling applicability analysis was performed for all criteria pollutants emitted by the new facility or modification, and modeling was performed for those pollutants having a total increase in emissions exceeding DEQ modeling thresholds.
- ☐ A TAPs modeling applicability analysis was performed for all TAPs emissions increases associated with the project, and TAPs modeling was performed for those TAPs having a project total emissions rate exceeding the emissions screening levels.
- ☐ Provided a description of the ambient air boundary and demonstrated how public access will be precluded from all areas excluded from ambient air.
- ☐ The receptor grid used meets minimal requirements specified by DEQ AND is adequate to reasonably resolve the maximum modeled concentration and confidently demonstrate compliance with applicable standards.
- ☐ The modeling domain used is sufficiently large to resolve the maximum impacts, accounting for impacts on distant elevated terrain.
- ☐ A scaled site plot plan was included in the application, showing emissions sources, buildings, and the ambient air boundary.
- ☐ Thoroughly documented all release parameters used in the model and provided justification for their use.
- ☐ Emissions rates provided in the emissions inventory section of the application are identical to those used in the modeling analyses or, if emissions rates are not identical, thorough justification of modeled rates has been provided.
- ☐ A cumulative NAAQS impact analysis was performed for all criteria pollutants for which modeled impacts from the significant impact analysis exceeded SILs. The cumulative NAAQS impact analysis included facility-wide emissions, emissions from any co-contributing sources, and a DEQ approved background concentration. Documentation of all emissions rates and release parameters used in the cumulative NAAQS impact analyses are provided in the application.
- ☐ Included all input and output modeling files for all pollutants and averaging periods.
- ☐ If a modeling protocol was prepared and submitted to DEQ prior to performing the air impact analyses, the protocol and DEQ's protocol approval notice is included with the application.

Appendix D. Modeling Protocol Checklists

Modeling Protocol Checklist for New Minor Sources or Minor Modifications

The following should be thoroughly addressed in a modeling protocol submitted to DEQ:
Introduction and Purpose

- General overview, facility description, description of area where facility is located.
- Project overview.
- Goals of the air quality impact analysis (i.e., demonstrate compliance for a PTC for a modification, PTC for a new facility, or a Tier II operating permit).
- Applicable regulations and requirements.
- Pollutants of concern.

Emissions and Source Data

- Description of facility processes and emissions controls affected by the permitting action.
- List of emissions points that will be included in the modeling analyses. Present a table showing current actual/allowable and future allowable emission rates (using pounds per hour rates for all applicable averaging periods) and the requested emissions increase (future allowable minus current actual or allowable).
- Good engineering practice (GEP) stack-height analysis for any stacks approaching GEP height.
- Graphic showing the facility layout: location of sources, buildings, emissions points, and fence lines.
- Description of methods used to calculate or otherwise determine source parameters (emissions rates, UTM coordinates, stack height, stack elevation, stack diameter, stack- gas exit velocity, and stack-gas exit temperature) for each source included in the modeling analyses.
- Methodology for including area and volume sources in the modeling analysis, including justification and calculations of initial dispersion coefficients and release heights.
- Methodology for including/excluding sources from the modeling analyses.

Air Quality Modeling Methodology

- Description of model selection and justification. This may be minimal in cases where the regulatory guideline model is used (AERMOD in most cases).
- Description of model setup and application
  - Model options (i.e., regulatory default). Describe and provide justification for any non-default settings.
  - Averaging periods used in the analyses and how emissions rates were calculated for specific averaging periods.
  - Land-use analysis in all cases where “urban” is used and in cases where land use is not obviously “rural.”
  - Methods used to account for building downwash in the analyses.
  - Treatment of any chemical transformations (e.g., NO to NO2) accounted for in the analyses.
  - Any other unique methods or data used.Description of how elevations of sources, buildings, and receptors were determined.
- Receptor network
  - Description of receptor grids – include methodology for ensuring the maximum concentration will be estimated
  - Discussion/justification of ambient air boundary, including a description of how the general public will be excluded from areas not considered ambient air.

- Meteorological data
  - Selection of meteorological databases – justification of appropriateness of meteorological data to area of interest
  - Meteorological data processing
  - Meteorological data analysis (e.g., wind rose)
- Background concentrations

Applicable Regulatory Limits

- Methodology for evaluation of compliance with standards (i.e., determination of design concentration)
- Significant Impact analysis
  - Comparison to SILs
  - TAPs analysis
- Cumulative NAAQS impact analysis
  - NAAQS analysis
- Presentation of results – state how the results of the modeling analysis will be displayed (i.e., list what information will be included)

Appendix E. Land-Use Classification Procedure

Land-Use Classification Procedure

See Section 8.2.8.b of *Guideline on Air Quality Models* (EPA 2001) for additional information.

1. Determine a circular area centered on the source with a radius of three kilometers.
2. Classify the land use within this area using the meteorological land-use typing scheme presented in Table D-1.
3. If land-use types I1, I2, C1, R2, and R3 account for 50 percent or more of the area, use urban dispersion coefficients; otherwise, use rural dispersion coefficients.

Table D-1. Identification and Classification of Land-Use Types (Auer 1978)

Type	Use	Structures	Vegetation
I1	Heavy Industrial	Major chemical, steel, and fabrication industries; generally 3-5 story buildings, flat roofs	Grass and tree growth extremely rare; <5% vegetation
I2	Light-moderate Industrial	Rail yards, truck depots, warehouses, industrial parks, minor fabrications; generally 1-3 story buildings, flat roofs	Very limited grass, trees almost totally absent; <5% vegetation
C1	Commercial	Office and apartment buildings, hotels; >10 story heights, flat roofs	Limited grass and trees; <15% vegetation
R1	Common residential	Single family dwellings with normal easements; generally one story, pitched roof structures; frequent driveways	Abundant grass lawns and light-moderately wooded; >70% vegetation
R2	Compact residential	Single, some multiple, family dwellings with close spacing; generally <2 story, pitched roof structures; garages (via alley), no driveways	Limited lawn size and shade trees; <30% vegetation
R3	Compact residential	Old multi-family dwellings with close (<2m) lateral separation; generally 2 story, flat roof structures; garages (via alley) and ash pits, no driveways	Limited lawn size, old established shade trees; <35% vegetation
R4	Estate residential	Expansive family dwellings on multi-acre tracts	Abundant grass lawns and lightly wooded; >80% vegetation
A1	Metropolitan natural	Major municipal, state, or federal parks, golf courses, cemeteries, campuses; occasionally single story structures	Nearly total grass and lightly wooded; >95% vegetation
A2	Agricultural natural		Local crops (e.g., corn, soybeans); >95% vegetation
A3	Undeveloped	Uncultivated; wasteland	Mostly wild grasses and weeds, lightly wooded; >90% vegetation
A4	Undeveloped rural		Heavily wooded; >95% vegetation
A5	Water surfaces	Rivers, Lakes	Not applicable

Appendix F. Example Tables for Air Quality Modeling Report

Example Tables for Air Quality Modeling Reports

This appendix contains examples of tables that are useful in presenting information in modeling reports.

Table E-1. Example Stack Parameters Table

Parameter[a]	Generator Stack	Boiler Stack
Computer Model Identifier (Alias)		
Emissions Rate (lb/hr)		
Stack Height (ft)		
Stack Diameter (ft)		
Exit Temperature (°F)		
Exit Flow Rate (acfm)		

a) Provide thorough justification/documentation of values used in the model, including calculations used to generate values.

Table E-2. Example Significant Impacts Summary ($PM_{2.5}$)

Year	5-Year Mean of Highest Annual Concentration ($\mu g/m^3$)	Radius of Significant Annual Impact (m)	5-Year Mean of Highest 24-hour Concentration ($\mu g/m^3$)	Radius of Significant 24-hour Impact (m)
1987-1991				
Significant Impact Level	0.3	Not applicable	1.2	Not applicable

Table E-3. Example Maximum Impacts for Cumulative NAAQS Analysis (NO_2 impacts, 1-hour averaging period)

Years Modeled	Multi-Year Mean of 8th Highest Daily Maximum 1-Hour Concentration ($\mu g/m^3$)	Receptor Location		
		East (m)	North (m)	Elevation (m)

Table E-4. Example Maximum Impacts for Toxic Air Pollutants Analysis (Carcinogens)

TAPs	Period Average (5-year) Concentration ($\mu g/m^3$)	Receptor Location		
		East (m)	North (m)	Elevation (m)

Table E-5. Example Maximum Impacts for Toxic Air Pollutants Analysis (Noncarcinogens)

TAPs	Highest 24-hour Concentration ($\mu g/m^3$)	Receptor Location		
		East (m)	North (m)	Elevation (m)

Table E-6. Example NAAQS and Toxic Air Pollutants Impact Analysis Summary

Pollutant	Averaging Period	Total Ambient Impact (Baseline Plus Modification and Co-Contributing Sources) ($\mu g/m^3$)	Background Conc. ($\mu g/m^3$)	Total NAAQS Conc. ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)
CO	1-hour				40,000
CO	8-hour				10,000
NO_2	1-hour				188
NO_2	Annual				100
SO_2	1-hour				196
SO_2	3-hour				1,300
SO_2	24-hour				365
SO_2	Annual				80
$PM_{2.5}$	24-hour				35
$PM_{2.5}$	Annual				12
PM_{10}	24-hour				150

Idaho
Risk Evaluation Manual for Petroleum Releases

Idaho Department of Environmental Quality
1410 North Hilton
Boise, Idaho 83706

August 2018

This page intentionally left blank for correct double-sided printing.

Idaho
Risk Evaluation Manual for Petroleum Releases

Idaho Department of Environmental Quality
1410 North Hilton
Boise, Idaho 83706

REC 4504

This page intentionally left blank for correct double-sided printing.

Table of Contents

Introduction 1
Organization of This Document 1
Section 1. Overview of the Risk Evaluation Process 1
1.1 Steps in the Risk Evaluation Process 1
1.1.1 Site Discovery 1
1.1.2 Determination of Imminent Threat 3
1.1.3 Initial Site Characterization and Evaluation 4
1.1.4 Comparison with Screening Levels 4
1.1.5 Development and Validation of a Site Conceptual Model 4
1.1.6 Identify and Collect Data for Risk Evaluation 5
1.1.7 Site Specific Risk Evaluation 5
1.1.8 Comparison with Acceptable Target Risk Levels and Decision Making 5
1.1.9 Development and Implementation of a Corrective Action Plan 6
1.1.10 Evaluation of Progress Toward Remedial Goals and Modification of the Corrective Action Plan if Necessary 6
1.1.11 Site Closure with a Corrective Action Plan 6
1.1.12 Certification by a Registered Professional 6
Section 2. Site Discovery and Initial Steps 7
2.1 Determining Imminent Threats 7
2.2 Initial Site Characterization 7
2.2.1 Site Characterization Introduction 7
2.2.2 Site Description and Adjacent Land Use 7
2.2.3 Soil Source Characterization 8
2.2.4 Groundwater Source Characterization 8
2.2.5 Documentation of Initial Site Characterization 8
Section 3. Screening Level Evaluation 9
3.1 Screening Levels 9
3.2 Comparison of Site Concentrations with Screening Levels 11
3.3 Screening Level Evaluation Report 11
Section 4. Site-Specific Risk Evaluation 12
4.1 Site Conceptual Model 12
4.1.1 Site Characteristics 12
4.1.2 Contaminant Source Areas 14
4.1.3 Pathways and Transport Mechanisms 15
4.1.4 Land Use and Receptors 17
4.2 Data Requirements and Evaluation 20

4.2.1 Data Collection Planning 20
4.2.2 Quality Assurance/Quality Control Considerations 21
4.2.3 Documentation of the Data Collected 22
4.2.4 Data Collection Methods 22
4.2.5 Vadose Zone Soil Characteristics 23
4.2.6 Saturated Zone Characteristics 25
4.2.7 Indicators of Biodegradation 26
4.2.8 Distribution of Petroleum Chemicals of Interest 27
4.3 Exposure Assessment 31
4.3.1 Physical Setting 31
4.3.2 Potentially Exposed Populations/Receptors 33
4.3.3 Exposure Pathways 33
4.3.4 Exposure Point Concentrations 34
4.3.5 Fate and Transport and Exposure Models 37
4.3.6 Estimation of Chemical Intake 38
4.4 Toxicity Assessment 39
4.4.1 Chemical-Specific Toxicological Factors 39
4.4.2 Carcinogens with a Mutagenic Mode of Action 41
4.5 Risk Characterization 42
4.6 Risk-Based Target Levels 43
4.6.1 Developing RATL Concentrations for Groundwater and Surface Water Protection 44
4.6.2 Determination of Applicable Risk Based Levels 47
4.7 Deliverables 48
4.7.1 Work Plan 48
4.7.2 Implementing the Work Plan 50
4.7.3 Risk Evaluation Report 50
Section 5. Developing and Implementing Corrective Action Plans 50
5.1 Contents of a Corrective Action Plan 50
5.2 Implementing a Corrective Action Plan 51
Section 6. Activity and Use Limitations 53
6.1 Environmental Covenants 53
6.2 Specific Application of Activity and Use Limitations at Petroleum Release Sites 54
6.3 Use of Activity and Use Limitations at Impacted Neighboring Properties 54
6.4 Non-Remedial Land Use Restrictions 54
Section 7. References 55
7.1 References Cited 55
7.2 Additional Resources for Data Collection 57
7.3 Additional Resources for Risk Evaluation 57

Tables

Table 1. Comparison of Risk Evaluation Options 3
Table 2. Screening Level Concentrations for Soil, Groundwater, and Soil Vapor..... 10
Table 3. Example Table Describing Derivation of Exposure Point Concentrations 35
Table 4. Default Toxicity Values for Risk Evaluation. 40

Figures

Figure 1. Idaho Petroleum Release Risk Evaluation Process Flowchart. 2
Figure 2. Sample Graphical Display of a Site Conceptual Model..... 32
Figure 3. Schematic of Leachate Migration from the Soil Source to the Stream 46

Appendices

Appendix A: Default Exposure Factors
Appendix B: Default Fate and Transport Parameter Values
Appendix C: Default Physical and Chemical Properties
Appendix D: Default Toxicity Values
Appendix E: Models and Equations
Appendix F: Methodology and Example Calculation for Remedial Action Target Levels
Appendix G: Evaluation of the Vapor Intrusion Pathway
Appendix H: Application of Natural Attenuation
Appendix I: Estimation of Exposure Point Concentrations in Soil and Ground Water
Appendix J: Sample Table of Contents for a Risk Evaluation Report
Appendix K: Practical Quantitation Limits
Appendix L: Quality Assurance Project Plan Template

Acronyms and Abbreviations

µg	Microgram
AST	Above Ground Storage Tank
ASTM	American Society for Testing and Materials
AUL	Activity and Use Limitation
BTEX	Benzene, Toluene, Ethyl Benzene, and Xylene
CAL-EPA	California Environmental Protection Agency
CAP	Corrective Action Plan
CAS	Chemical Abstract Service
cm^3	Cubic Centimeter
CLP	Contract Laboratory Program
COI	Chemical(s) of Interest
C_{cw}	Concentration in Groundwater (Between Source and Surface Water) at Alternate Point of Compliance
cm^2	Square Centimeter
CSF	Cancer Slope Factor
C_{soil}	Source Area Concentration in Soil
C_{swpoe}	Point of Exposure Concentration in Surface Water
DAF	Dilution Attenuation Factor
DEQ	State of Idaho, Department of Environmental Quality
DOE	U.S. Department of Energy
DQO	Data Quality Objective
Eh	Redox Potential
EPA	U.S. Environmental Protection Agency
EU	Exposure Unit
ft	Foot
gm	Gram
GW	Groundwater
GWP	Groundwater Protection
HI	Hazard Index
HQ	Hazard Quotient
IDAPA	Idaho Administrative Procedures Act
IDWR	Idaho Department of Water Resources
IELCR	Individual Excess Lifetime Cancer Risk
IRIS	Integrated Risk Information System
ISCE	Initial Site Characterization and Evaluation
IUPAC	International Union of Pure and Applied Chemists
IUR	Inhalation Unit Risk
kg	Kilogram

L	Liter
LNAPL	Light Non-Aqueous Phase Liquid
m	Meter
MCL	Maximum Contaminant Level
mg	Milligram
MTBE	Methyl Tertiary Butyl Ether
NA	Natural Attenuation
NAPL	Non-Aqueous Phase Liquid
NCEA	National Center for Environmental Assessment
NFA	No Further Action
NPDES	National Pollutant Discharge Elimination System
PAH	Polycyclic Aromatic Hydrocarbons
POC	Point of Compliance
POE	Point of Exposure
PSC	Petition for Site Closure
PST	Petroleum Storage Tank
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RA	Relative Absorption
RATL	Remedial Action Target Level
RBCA	Risk-Based Corrective Action
RCRA	Resource Conservation and Recovery Act
REDOX	Reduction-Oxidization
REM	Risk Evaluation Manual
RE	Risk Evaluation
RF	Reduction Factor
RfD	Reference Dose
RfC	Reference Concentration
RMP	Risk Management Plan
RNA	Remediation by Natural Attenuation
ROE	Route(s) of Exposure
RSL	EPA Regional Screening Level
RUSL	Residential Use Screening Level
SAB	EPA's Science Advisory Board
SCM	Site Conceptual Model
SF	Slope Factor
SVOC	Semi-Volatile Organic Chemical
STATECOMM	State Communications Center
SW	Surface Water
TEQ	Total Toxic Equivalency

TEF	Toxic Equivalency Factors
UCL	Upper Confidence Limit
UECA	Uniform Environmental Covenants Act
USACE	United States Army Corps of Engineers
VOC	Volatile Organic Compound

Introduction

In April 2009, the Idaho Legislature approved the Department of Environmental Quality (DEQ) Rules IDAPA 58.01.24, Standards and Procedures for Application of Risk Based Corrective Action at Petroleum Release Sites (the Rule). This rule required that DEQ prepare a risk evaluation manual for petroleum releases which would be used as guidance for implementation of the Rule. This document represents that implementation guidance. The Rule may be obtained at: *http://adminrules.idaho.gov/rules/2012/58/0124.pdf*

Organization of This Document

The document begins with a general description of the steps in the risk evaluation (RE) process, which is then followed by detailed implementation information for each step. DEQ has developed software that complements the process described and is provided at no charge. Contact DEQ regarding its availability.

Information in the body of this manual is supported by 12 appendices. Appendices A–D address default exposure factors, fate and transport parameter values, physical and chemical properties, and toxicity values. Appendix E presents models and equations. Appendix F provides the methodology and calculations for remedial action target levels (RATLs). Appendix G discusses the vapor intrusion pathway, and Appendix H addresses the application of natural attenuation. Appendix I describes the estimation of exposure point concentrations. A sample table of contents from a risk evaluation report is provided in Appendix J. Appendix K addresses practical quantitation limits, and Appendix L contains a quality assurance project plan (QAPP) template.

Section 1. Overview of the Risk Evaluation Process

1.1 Steps in the Risk Evaluation Process

The overall evaluation process for a site where a petroleum release is discovered and reported to DEQ is illustrated in Figure 1. The process consists of multiple steps, each of which is briefly described in the pages following Figure 1. In some cases, when adequate data are available concerning a release, the owner or operator (as defined IDAPA 58.01.24.010) of the release site may skip the screening level evaluation and proceed directly to the site-specific RE, a more detailed level of evaluation, without formally completing the intermediate steps. DEQ should be notified in these instances. A comparison of the two RE options, with the types of values, models, and other factors used in each option, is presented in Table 1.

1.1.1 Site Discovery

The risk-based site management process begins with the discovery of a petroleum release site. A petroleum release site may be discovered and reported to DEQ under a variety of circumstances. These include, but are not limited to, citizen complaints, investigations conducted as a part of real estate transactions, environmental impacts observed in surface water bodies, and notification of accidents and spills. It is the owner/operator's responsibility to ensure that DEQ is notified.

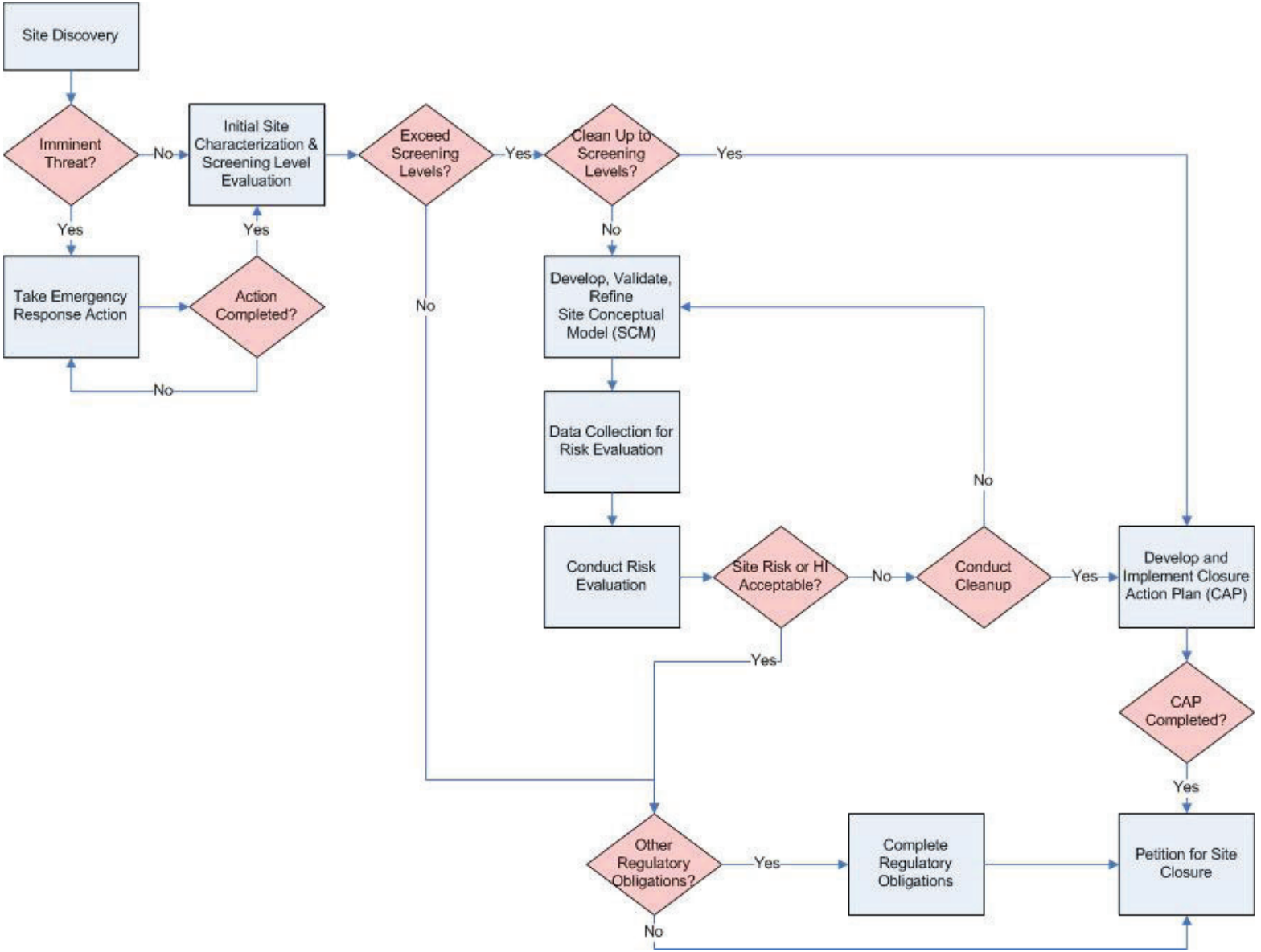


Figure 1. Idaho Petroleum Release Risk Evaluation Process Flowchart. This process allows for moving directly to a detailed risk evaluation without first completing a general screening level evaluation.

Table 1. Comparison of Risk Evaluation Options

Factors	Screening Level Evaluation	Site-Specific Risk Evaluation
Exposure Factors	Default	Site-specific/default
Toxicity Factors	Rule-specified values	Rule-specified values
Physical and Chemical Properties	Default	Default or DEQ accepted values
Fate and Transport Parameters	Default	Default/Site-specific
Unsaturated Zone Attenuation	None	None/Site-specific
Fate and Transport Models	Default	Default or other models acceptable to DEQ
Exposure Point Concentrations	Maximum	Statistical evaluation: Conservative Estimate of Mean:
Acceptable Target Risk	1×10^{-6}	Cumulative effects considered; target of 1×10^{-5}
Acceptable Target Hazard Quotient/Hazard Index	Hazard Quotient = 1	Cumulative effects considered; Hazard Index Target of 1
Groundwater Protection	Maximum contaminant level or risk based target levels	Maximum contaminant level or risk based target levels
Outcome of Evaluation	Either: • Petition for Site Closure, or • Risk Evaluation, or • Corrective Action Plan	• Petition for Site Closure, or • Refine RE, or • Corrective Action Plan
Soil Concentration Protective of Groundwater	Default model with point of exposure at source	Default model with point of exposure determined as per Section 4. Flexibility in model may be used subject to DEQ approval
Surface Water Classification	See Section 4	See Section 4
Point of Exposure	Source	See Section 4
Activity and Use Limitations	None	See Section 6

1.1.2 Determination of Imminent Threat

Upon site discovery, the owner/operator should carefully evaluate the available information to determine whether the site poses any imminent threat to human health or safety, or to the environment. Threats include, but are not limited to, impacts to water wells; vapors or odors in residential and commercial structures; concentrations approaching explosive levels; impacts to a surface waterbody; and impacts to human health and the environment. If any imminent threats are identified, the owner/operator should notify DEQ or State Communications Center (STATECOMM) immediately (see Section 2) and take immediate steps to abate the threat. Documentation of abatement activities and confirmation that imminent threats have been removed should be provided to DEQ. Further details of this step are provided in Section 2.

1.1.3 Initial Site Characterization and Evaluation

Upon completion of the emergency response action, if any, it is necessary to perform an initial site characterization and evaluation (ISCE). As a part of the ISCE, media-specific data (for soil, soil vapor, and groundwater media) should be collected to characterize the source. This step is intended to identify the maximum contaminant concentrations for the identified petroleum products in soil and groundwater. Since a site may be a candidate for closure after the completion of the screening level evaluation (see ☐), it is very important that the data collected at this time identify the maximum media-specific concentrations. Further details of this step are provided in Section 2.

1.1.4 Comparison with Screening Levels

This step involves the comparison of the maximum media-specific concentration of each contaminant, identified in the ISCE, with the screening levels developed by DEQ and presented in Table 2. There is a screening level for each contaminant in each media. The screening level is the lowest of the media-specific (soil, soil vapor, and groundwater) risk-based concentrations for the applicable exposure pathways. Screening levels are considered criteria that, if met (that is, maximum contaminant concentrations are below the screening levels), will allow unrestricted (residential) use of the property. Since exposure to these low concentrations (below the screening levels) of contaminants does not pose a threat to human health, if the owner/operator chooses to meet these criteria, they will not be required to evaluate site-specific exposure pathways and develop a site conceptual model (SCM), and no land use restrictions will be needed on the property.

When DEQ and the owner/operator agree that a petroleum release has been adequately characterized, DEQ will not require any further action of the owner/operator related to the release if the maximum contaminant concentrations in soil, surface water, and groundwater do not exceed the screening levels, subject to other applicable requirements, if any, as referenced in IDAPA 58.01.24.001.02. If any of the maximum soil, groundwater, or soil vapor concentrations exceed the screening levels, the owner/operator may either:

- adopt the screening levels as cleanup criteria and develop a corrective action plan (CAP) to achieve these levels, or
- perform a site-specific RE. Further details of this step are provided in Sections 3 and 4.

1.1.5 Development and Validation of a Site Conceptual Model

If the screening levels are exceeded, and the owner/operator chooses to conduct a more detailed (site-specific) RE, it is first necessary to develop and validate an SCM. An SCM provides the framework for the overall management of the site and should help guide data collection and risk management activities while the RE is being performed. The key elements of the SCM are:

- release scenario(s),
- source description,
- petroleum chemicals of interest (COI),
- an exposure model that incorporates the appropriate receptors,
- exposure pathways and routes of exposure (ROE),
- the site stratigraphy and hydrogeology, and
- the spatial and temporal distribution of the petroleum COI.

An important part of this step is to validate the SCM based on site-specific data. Further details of this step are provided in section 4.1.

1.1.6 Identify and Collect Data for Risk Evaluation

Depending on the site-specific conditions, the RE may require the collection of additional site-specific data. To prepare for conducting an RE, the owner/operator should review the SCM, identify requirements for filling data gaps, and collect additional data if necessary. This data will be used to calculate estimates of site-specific exposure point concentrations (see section 4.3.4 and Appendix I) and an estimate of the site-specific cumulative risk (see section 4.5) and, potentially, to develop RATL concentrations using the guidance provided in this document. Further details of this step are provided in section 4.2.

1.1.7 Site Specific Risk Evaluation

Conducting the RE requires developing site-specific estimates of exposure point concentrations for soil and groundwater, estimating site-specific cumulative risk, comparing these with acceptable target risk levels and, if necessary, developing media-specific RATL concentrations. RATLs are target concentrations developed by the owner/operator using a combination of conservative default and site-specific parameters. These concentrations depend on the receptor, media, pathway, and ROE and are developed for each petroleum COI and each media identified in the SCM. Using RATL concentrations instead of the defaults (the screening level criteria) may require that limitations be placed on activities and land uses that are allowed on the property. This step is discussed in section 4.6 and Appendix F.

1.1.8 Comparison with Acceptable Target Risk Levels and Decision Making

Once the site-specific cumulative risk has been estimated, it is compared to acceptable target risk levels, as specified in the Rule. If acceptable target risk levels are not exceeded, the site is eligible for closure, subject to other applicable requirements, if any, as referenced in IDAPA 58.01.24.001.02. If the site-specific cumulative risk exceeds the acceptable target risk levels, two options are available:

- Calculate and adopt media-specific RATL concentrations for each petroleum COI and develop and implement a CAP to achieve these concentrations.
- Refine the SCM and RE. It is possible that the site-specific cumulative risk is lower than initially estimated and may not pose an unacceptable risk, but this can only be determined with a more refined SCM and RE. This may involve the collection of additional data or the use of other models. Before collecting these additional data, it is optional to develop a work plan that outlines additional data needs and the overall approach for the refined evaluation. The plan may be submitted to DEQ for review and approval before proceeding with data collection and the evaluation. Although optional, the work plan and suggestions from DEQ may help with completing the required work more efficiently than might be the case without a DEQ-reviewed work plan. Details of this step, including the basic contents of a work plan, are included in section 4.7.

Upon completion of the RE, the owner/operator should provide recommendations to DEQ. In most cases, it is anticipated that DEQ and the owner/operator will work together to identify the best alternative. Note that it is not necessary to complete a screening level evaluation before conducting an RE, however, it is recommended that the owner/operator inform DEQ whether they will do a screening level evaluation or not. Often, DEQ can make suggestions to improve efficiency in the overall process.

1.1.9 Development and Implementation of a Corrective Action Plan

Based on the results of the RE process, the owner/operator proposes a set of remediation standards and prepares a CAP describing the measures that will be used to achieve the standards. The CAP is submitted to DEQ for approval. The CAP may include a combination of options for active remediation and passive remediation along with limitations on activities and land uses that were assumed in the RE step. Details of this step are included in Section 5.

1.1.10 Evaluation of Progress Toward Remedial Goals and Modification of the Corrective Action Plan if Necessary

The data collected during implementation of the CAP must be evaluated by the owner/operator and submitted to DEQ so that DEQ can determine whether the CAP is progressing as anticipated. Modifications to the CAP may be necessary in some circumstances. Circumstances that might require modifying the CAP include identification of significant deviations from the remedial strategy or unacceptable risk levels to receptors, by either DEQ or the owner/operator. Modification of the CAP also might be required if the data indicate that site cleanup is not progressing at the rate anticipated. In these cases, appropriate modifications to the CAP should be considered and an amended CAP should be submitted to DEQ for approval The specific modifications to the CAP that are needed will vary from site to site.

1.1.11 Site Closure with a Corrective Action Plan

The primary objective of the CAP at any site is to ensure the long-term protection of human health and the environment, taking into consideration the current conditions at the site and conditions that are reasonable to expect in the future. When the regulatory obligations specified in the DEQ-approved CAP have been achieved, the site is eligible for closure. Closure typically involves the owner/operator submitting documentation that all the work specified in the CAP has been completed and all remedial action goals have been achieved accompanied with a request for site closure.

1.1.12 Certification by a Registered Professional

If work is performed that the State of Idaho requires a professional geologist or professional engineer (Idaho Code, Title 54, Chapters 12 and 28) to perform, the owner/operator shall employ the use of, and obtain certification from, a professional geologist or professional engineer registered in Idaho for that work.

Section 2. Site Discovery and Initial Steps

2.1 Determining Imminent Threats

The first step, once an impacted site has been identified or a release is known to have happened, is to determine whether contamination poses any imminent threat to human health or the environment. If so, abatement measures must be completed before any other activities. Examples of abatement measures include taking action to prevent further release into the environment, providing an alternate water supply if drinking water supplies are impacted, evacuating residents/commercial workers if they are or could be exposed to vapors at high concentrations, installing booms on surface waterbodies that have a sheen, or ventilating utility facilities where vapors are present. If there is an imminent threat, or uncertainty regarding potential threats, associated with a release, call DEQ or STATECOMM at 1-800-632-8000 or (208) 846-7610. Releases that do not pose an imminent threat do not have to be reported to STATECOMM, but do have to be reported to DEQ. Owner/operators shall follow the Petroleum Release Reporting, Release Response and Initial Abatement Measures as provided in IDAPA 58.01.02.851 and 852.

2.2 Initial Site Characterization

2.2.1 Site Characterization Introduction

Within the RE process, initial site characterization is performed after any necessary emergency response actions are completed. The overall objective of the initial site characterization is, at a minimum, to identify the maximum chemical concentrations on the site in each of the affected media. These maximum concentrations are then compared with screening level criteria to determine the need for any further action.

A brief description of the initial site characterization process is presented below.

2.2.2 Site Description and Adjacent Land Use

The owner/operator should conduct a thorough site reconnaissance and a historical review of site operations to identify source(s) of contamination on site. Sources may be identified based on knowledge of a known or documented release; location of certain structures that typically represent a contamination source such as underground storage tanks (USTs), pipes, pumps, etc.; interviews with current and former site employees who may have knowledge of source areas.

In addition to identifying sources, the owner/operator should collect data related to historic, current, and future land use on and adjacent to the site. A chronology of relevant site activities is often useful in understanding the site.

Based on this information, the owner/operator should identify the type of petroleum that may have been released at the site. Data collected during initial site characterization should, at a minimum, satisfy the following requirements:

- Quality Assurance/Quality Control (QA/QC) measures recommended by the United States Environmental Protection Agency (EPA) have been met,
- Analyte quantitation limits (the minimum amount that can be detected by the laboratory), where feasible, do not exceed screening levels,

- Appropriate petroleum COI have been identified and included for analysis,
- Source areas have been adequately characterized to identify the maximum concentration, and
- Analytical methods used are appropriate for petroleum COI at the site.

2.2.3 Soil Source Characterization

The owner/operator should collect soil data representative of the release's maximum concentration of petroleum COI. The exact number of samples, the analytical methods used, and the specific technology used to collect data will vary among sites. It is recommended, but not required, that the owner/operator develop a work plan and have it reviewed and approved by DEQ before beginning the work. At a minimum, the owner/operator should verbally confer with DEQ before collecting any data.

The overall intent of initial site characterization is to identify maximum concentrations of petroleum COI. However, for sites that will likely require further characterization, it may be efficient and cost-effective to collect additional data at this stage of the evaluation. Additional data may be used to identify the nature and extent of contamination and potential for exposure. For example, if contamination is suspected to exist in both surficial and subsurface soil zones, samples representing maximum concentrations in both zones should be collected.

2.2.4 Groundwater Source Characterization

In the initial site characterization, if there is evidence of possible groundwater impact from the site release, the owner/operator should collect groundwater samples below or immediately adjacent to the source. For sites with a very localized source, it may be sufficient to collect only one groundwater sample using a temporary well. Sites with multiple sources may require multiple wells and samples. For sites that will require further characterization, it may be more efficient and cost-effective to install at least three monitoring wells so the magnitude and the direction of groundwater flow can also be established.

2.2.5 Documentation of Initial Site Characterization

The owner/operator should document the initial site characterization results in a brief report that is submitted to DEQ. The chemical data collected should initially be evaluated using the screening levels as discussed in Section 3, all of which should be described in this report. The report should discuss:

- Site history,
- Site description,
- Current site use,
- Sources and petroleum COI identified at the site,
- Methods used to collect and analyze soil samples,
- Locations of all samples (identified on a site map), including sample depths,
- Results from soil chemical data analyses,
- Methods used to collect and analyze groundwater samples,
- Location, construction, and lithology of all wells,
- Results of groundwater chemical data analyses,
- Other site hydrogeological test data results, and
- QA/QC information.

Section 3. Screening Level Evaluation

Data collected during the initial site characterization is typically initially evaluated using screening levels. This evaluation is intended to achieve the following objectives of the screening level evaluation:

- Demonstrate that the site or portions of the site do not pose a threat to human health and hence does not require any further evaluation, and
- Identify areas of the site that need further evaluation.

These objectives are achieved by comparing the maximum site concentrations with the screening level values.

3.1 Screening Levels

The screening levels for the petroleum COI in the Rule have been developed by DEQ and are included in Table 2. The screening levels are risk-based target concentrations developed with the following:

- the assumption that receptors will be residential,
- conservative input parameter values,
- an acceptable target risk of 10^{-6}, and
- a hazard quotient (HQ) of 1.

Specific exposure factors and models used to develop screening levels are presented in Appendices A and E. Screening levels are the lowest target concentrations for the following exposure pathways and ROE for soil, soil vapor, and groundwater.

Specifically, screening levels for soil are the lowest of the following concentrations:

- Surficial and subsurface soil concentrations protective of exposure via groundwater ingestion at maximum contaminant levels (MCLs) or risk-based concentrations at the downgradient edge of the source or
- Subsurface soil concentrations protective of exposure via indoor inhalation of vapors emanating from soil for a residential scenario, or
- Surficial soil concentrations protective of combined ingestion, dermal contact, and outdoor inhalation exposures for a residential scenario.

Screening levels for groundwater are the lowest of the following concentrations:

- MCLs for chemicals that have them or calculated values for ingestion of water in a residential scenario, or
- Groundwater concentrations protective of exposure via indoor inhalation of vapors emanating from groundwater for a residential scenario.

Screening levels for soil vapor are protective of exposure via indoor inhalation of vapors emitted from contaminated soil or groundwater. Screening levels in sub-slab and near-source soil gas are derived by applying attenuation factors of 0.03, to the EPA Regional Screening Levels (RSLs) for both residential and industrial ambient air.

Table 2 lists the screening levels for unrestricted use. For comparison, Table 2 provides the risk-based concentrations in soil and groundwater for all the pathways and ROE listed above. The screening level values incorporated in the Rule are indicated in bold.

Because of the methods and assumptions used in the development of the screening levels and the current limitations of laboratory analytical methods, the calculated screening levels may be lower than the practical quantitation limit reported by a laboratory for selected chemicals. In these situations, site-specific review by DEQ will be required based on the criteria provided in Section 500 of the Rule and Appendix K.

Table 2. Screening Level Concentrations for Soil, Groundwater, and Soil Vapor

	SOIL (mg/kg)			GROUNDWATER (mg/L)		TARGET SUB-SLAB AND NEAR-SOURCE SOIL GAS CONCENTRATIONS (ug/m3)	
						Unrestricted Use	Commercial/ Industrial
CHEMICAL	Vapor Intrusion	Direct Contact	Groundwater Protection	Vapor Intrusion	Ingestion	Vapor Intrusion	Vapor Intrusion
Benzene	0.08	8.3	**0.025**	0.044	**0.005**	**12**	53
Toluene	1300	7930	**6.6**	340	**1**	**170000**	733333
Ethylbenzene	**0.25**	39	7.4	**0.05**	0.700	**37**	163
Xylenes	**27**	6100	93	**8.7**	10	**3500**	14667
Naphthalene	**0.12**	44	21	**0.07**	0.73	**2.8**	12
MTBE	2.4	340	**0.08**	6.8	**0.04**	**360**	1567
1,2-Dichloroethane	0.02	3.7	**0.013**	0.03	**0.005**	**3.6**	16
Ethylene Dibromide	0.001	0.27	**0.00014**	0.004	**0.00005**	**0.16**	0.67
Acenaphthene	NA	4470	**200**	NA	**2.2**	NA	NA
Anthracene	NA	22300	**3200**	NA	**11**	NA	NA
Benzo(a)anthracene	106	1.4	**0.68**	0.60	**0.00022**	**0.56**	6.67
Benzo(a)pyrene	NA	**0.14**	2.1	NA	**0.0002**	NA	NA
Benzo(b)fluoranthene	NA	**1.4**	2.29	NA	**0.00022**	NA	NA
Benzo(k)fluoranthene	NA	**14**	22.5	NA	**0.0022**	NA	NA
Chrysene	NA	139	**69**	NA	**0.022**	NA	NA
Fluoranthene	NA	2970	**1400**	NA	**1.5**	NA	NA
Fluorene	NA	2970	**240**	NA	**1.5**	NA	NA
Pyrene	NA	2230	**1000**	NA	**1.1**	NA	NA

Values in bold are current screening level values. Screening level values for sub-slab and near-soil gas concentration are equivalent to EPA Regional Screening Levels (EPA, 2018) for residential and industrial ambient air divided by an attenuation factor of 0.03.

NA: not applicable because the chemical does not meet EPA volatility criteria or does not have a Regional Screening Level for ambient air.

3.2 Comparison of Site Concentrations with Screening Levels

Based on the initial site characterization (discussed in Section 2), the owner/operator should identify the maximum soil and ground water petroleum COI concentrations at the site. These maximum concentrations are then compared with screening levels, obtained from Table 2.

If the maximum site concentration does not exceed the screening level for any petroleum COI in any media, the site is eligible for closure subject to other regulatory obligations (IDAPA 58.01.24.200) The owner/operator may request DEQ approval for site closure. If the maximum site concentration for any petroleum COI exceeds the screening level, the owner/operator must select one of the following options:

- Option 1: Adopt screening levels as cleanup remediation standards and develop a CAP (see Section 1).
- Option 2: Perform a more detailed, site-specific RE.

The owner/operator should clearly indicate to DEQ which option has been chosen.

3.3 Screening Level Evaluation Report

The owner/operator must submit a screening level evaluation report to DEQ if they have chosen option 1 above. The report should include, at a minimum:

- Site maps indicating land use, structures on site, locations and depths of samples, and locations of contaminant sources,
- A description of site history and activities leading to the release,
- A description of current land use adjacent to the site,
- A summary of initial site characterization results for soil and, as appropriate, groundwater,
- A discussion of data quality,
- A comparison of maximum soil and, as appropriate, groundwater concentrations with screening levels,
- A list of recommendations, and
- Laboratory reporting sheets, including QA/QC data.

Section 4. Site-Specific Risk Evaluation

Site-specific RE is needed only if the owner/operator chooses not to conduct a screening level evaluation or to use the default screening levels as the remediation standards.

Conducting a site-specific RE requires the completion of several important steps. These include developing an SCM, identifying the chemicals present in environmental media, assessing exposure and exposure pathways, assessing the toxicity of the chemicals present, characterizing human risks, and characterizing the impacts on or risks to the environment. This section describes each of these steps and also provides the suggested format for some of the deliverables (most of which are reports) that assist in developing and documenting the evaluation.

4.1 Site Conceptual Model

An SCM provides an overall understanding of the site and an SCM report can be a convenient format for compiling all the relevant data associated with a release. The SCM provides a framework for the entire project and can help identify specific data needs (the correct quality and quantity of data that will be needed). An SCM is necessary in the development of any data collection work plan and is also an important communication tool for regulators, owner/operators, and stakeholders.

In addition to basic site information (discussed in section 4.1.1), there are three key elements that should be included in the SCM. Each element will require certain types of data in order to validate the SCM. The amount of data required is typically based on site-specific considerations. The SCM is a dynamic entity that should be revisited and potentially refined any time additional data is collected for a site. The resulting SCM refinements should be incorporated, if necessary, into the RE.

The three key elements are:

- **Sources**: Contaminant source areas (nature, magnitude, and extent of release) and COI (see section 4.1.2).
- **Pathways**: Release fate and transport mechanisms, exposure pathways, and ROE (see section 4.1.3).
- **Receptors**: Characteristics of land use and likely receptors (see section 4.1.4).

More detailed information on these elements is provided below and in the sections on data requirements (section 4.2) and exposure assessment (section 4.3).

4.1.1 Site Characteristics

The following basic site characteristics should be included in the RE; each is described in the following sections:

- Site history and map,
- Ground surface conditions,

- Location of utilities on and adjacent to the site, and
- Location and description of site structures.

4.1.1.1 Site History and Map

The SCM should include a comprehensive chronology of events including remediation projects, tank removal activity, reported releases, etc. The chronology of events must be clearly and accurately documented.

All maps should be made to scale, with a bar scale and a north arrow. As appropriate, multiple site maps should be prepared to show sample collection points and locations of various site structures. A detailed facility map showing the layout of USTs, above ground storage tanks (ASTs), pipes, loading and unloading areas, sumps, paved and unpaved areas, canopy buildings, etc. should be prepared. A second facility map should be prepared to show locations of all on-site monitoring wells, water use wells, soil borings, soil vapor extraction wells, and soil excavation areas. All on-site structures should be clearly identified.

4.1.1.2 Ground Surface Conditions

Before conducting an RE, DEQ highly recommends the owner/operator and any other parties that will be involved make a site visit and walk through. It is important to document areas of the site that are paved, unpaved, landscaped, or covered with buildings. It is also highly useful to note the type, extent, slope, and general condition of the ground surface, and current land uses.

4.1.1.3 Location of Utilities on and Adjacent to the Site

Due to potential for preferential flow of contaminated groundwater and vapors into underground utility lines and conduits, a thorough documentation of the location of and potential impacts to underground utilities should be performed. Utilities may include phone lines, water lines, sanitary sewers, storm sewers, and natural gas lines. A combination of site observations, knowledge of buried utilities, and discussions with utility representatives and the site owner should reveal the utility locations.

At a minimum the following activities should be performed:

- Locate all underground utility lines and conduits within the area of known or potential soil and groundwater impact, both on site and off site, where the release may have migrated, or may migrate in the future.
- Determine the direction of flow in the utilities (water, storm water, and sewage).
- Identify utility lines/conduits on a base map that illustrates the extent of soil and groundwater impacts.
- Determine depth of utility lines/conduits relative to the depth of groundwater. Seasonal fluctuations of groundwater levels should be carefully evaluated. As appropriate, a cross-sectional diagram should be provided illustrating the depth to groundwater and the locations and depths of the lines/conduits.
- Determine any past impacts to utilities and any pertinent complaints that may have been previously filed with DEQ.

4.1.1.4 Existing Structures

The location, condition, and construction characteristics of each structure on and adjacent to the site should be described.

4.1.2 Contaminant Source Areas

This element of the SCM should include a discussion of the nature, location, timing, and magnitude of petroleum products spilled at the site. The petroleum COI should be determined. Any actions performed as a part of emergency response should be delineated and their impact on the source evaluated. The residual size of the source after any emergency or interim actions should be determined.

Knowledge about the nature, magnitude, and extent of the release is necessary to identify the petroleum source in soil and/or the groundwater at the site as well as to identify the petroleum COIs. The following information regarding a release, if available, is critical:

- Release location,
- Release quantity,
- Petroleum product released, and
- Interim corrective action measures performed.

Release-related information can be obtained by reviewing inventory records, interviewing current and past employees, and checking any spill incident reports filed with DEQ. Information related to site activities can also help identify source location and petroleum COIs.

4.1.2.1 Location of Release

The location of the release defines the source of the petroleum that is in the soil and potentially the groundwater. Likely release locations include, but are not limited to, corroded or damaged tanks, pipe bends and joints, and loading and unloading areas.

The owner/operator should review operational history to determine the likely location of the source. The assessment should focus on the identified release area; however, the exact location and timing of the spill source area may not be known. In these cases, soil and groundwater sampling should be used to identify the extent (vertical and horizontal) of residual soil and/or groundwater source. The exact number and location of necessary samples shall be determined on a site-specific basis using professional judgment. It will be important to understand the location and timing of past spills and releases in making decisions regarding assessment needs related to current releases. It is recommended, but not required, that the owner/operator consult with DEQ before conducting sampling. DEQ may be able to provide information at this point that can help the owner/operator improve the overall efficiency of sample collection or the entire RE.

4.1.2.2 Quantity of Release

The RE process does not necessarily require knowledge of the exact release quantity. However, an estimate of the amount released may help evaluate the severity of the impact and extent of contamination, and may help in planning site characterization measures. Estimation of release quantities is typically based on inventory records.

4.1.2.3 Chemicals of Interest and Spatial and Temporal Trends

This section should include a discussion of chemicals detected in each media and their spatial and temporal distribution. As appropriate, contour maps indicating concentrations of individual petroleum COIs may be useful. Graphs of petroleum COI groundwater concentrations in individual wells and concentration along the flow line (concentration vs. distance plots) may be useful as well. Based on data collected over time, it should be determined whether the chemical concentrations are stable, declining, or expanding.

Identification of specific petroleum product(s) spilled or released is important to identify the petroleum COIs. Evaluation of non-petroleum chemicals in addition to those in Subsection 800.01 (Table 1) may be required by DEQ when there is a reasonable basis based on site-specific information. A reasonable basis shall be demonstrated by DEQ when it can show documentation of releases or suspected releases of other non-petroleum chemicals. The environmental behavior (mobility, persistence, bio-degradation, and inter-media transport) of the petroleum product and its adverse environmental and human health effects depend on chemical properties and their concentrations in the petroleum product.

If a release can be identified as a single petroleum product based on a documented release, free product analysis, or location of impact (e.g., tank bottom of a particular product tank), only the COIs for that petroleum product need to be analyzed. If the product released cannot be conclusively identified, it is recommended that monitoring samples be analyzed for all petroleum COIs associated with the products suspected to have been stored at the site. Additional assessment may be required to identify the source of the release.

If previously collected data did not include all suspected site petroleum COIs, additional sampling may be necessary for petroleum COIs before an RE can be performed.

4.1.3 Pathways and Transport Mechanisms

The objective for this portion of the SCM is to describe site characteristics and mechanisms which have influenced or will influence the release, fate, and transport of chemicals of interest and to determine which exposure pathways and ROE will be most likely to occur.

4.1.3.1 Site Stratigraphy and Hydrogeology

The owner/operator should conduct a review of published literature and any investigations conducted on adjacent sites to determine regional hydrogeology, soil types, and aquifer characteristics. This evaluation should be used to determine the type and depth of aquifers in the area and whether they are confined, semi-confined, or unconfined. Regional information will help the owner/operator in efficiently collecting site-specific soil and groundwater information. The SCM should include a detailed discussion of site-specific stratigraphy and hydrogeology. Site stratigraphy should be determined based on boring logs and an adequate number of geologic cross sections.

The hydrogeologic discussion should include estimates of horizontal and vertical hydraulic gradients, seasonal variations in groundwater elevations and flow direction, and hydraulic conductivity of relevant water-bearing zones. How these characteristics may influence the fate and transport of chemicals to potential receptors should be discussed.

The survey should also locate potentially impacted surface waterbodies located within one-half (1/2) mile of the site. If a surface water body is identified, information including the type (perennial or intermittent), water flow rate, flow direction, depth of water, width or surface area of the water body, and water use should be provided. The location of the water body must be indicated on an area map.

4.1.3.2 Complete Exposure Pathways and Routes of Exposure

A complete exposure pathway involves a source of petroleum products, release and transport mechanisms, ROE, and potential receptors. The definition of complete exposure pathways starts with knowledge of the release, petroleum COIs, and site physical conditions (described above), then combines these with assumptions about land use and likely receptors. Exposure pathways and ROE are described and discussed in more detail in section 4.3.3.

The SCM should identify each of these components in its descriptions of exposure pathways. One example of a common exposure pathway would be leaching of petroleum chemicals from a gasoline release in soils (release) to the groundwater with subsequent transport (fate and transport) to a residential well where water is extracted for drinking water and ingested by residents (land use and likely receptors). Another would be volatilization of petroleum chemical vapors from a soil source with subsequent transport through the soil and into the air in an occupied structure where they are inhaled.

Another part of defining the complete or potentially complete exposure pathways and ROE in an SCM is identifying the locations where exposure to petroleum chemicals can occur and the media of concern at those locations. These known or potential exposure locations are commonly called exposure units. The exposure unit for each complete pathway and receptor should be described. The exposure unit may consist of a specific location such as a well or it may be an area, such as a parcel, over which receptors move. For large sites, it may be useful or necessary to subdivide the site into multiple exposure units. This may also be true at sites where impacts of the release have moved offsite.

Exposure pathways defined in the SCM are subsequently used in the exposure assessment phase of the RE, which is described in detail in section 4.3.

4.1.3.3 Protection of Groundwater

During the development of the SCM, it should be assumed groundwater may be used for drinking water. Consequently, if groundwater is not remediated to levels suitable for ingestion, the CAP must also include provisions in the final remedy for implementing limitations on activities and land uses. Such limitations are achieved through environmental covenants (activity and use limitations [AULs]) to prevent exposure via groundwater ingestion throughout the horizontal and vertical extent of the plume that has concentrations exceeding the criteria for groundwater ingestion presented in Table 2.

The SCM, as it relates to the use of groundwater, should include characterization and evaluation of the following groundwater aspects.

- The current and historical use of the groundwater for drinking water or irrigation.

- The location and approved use of existing groundwater wells within a one-half (1/2) mile radius from the release point at the contaminated site.
- The potential for communication between the impacted groundwater and other groundwater-bearing zones or surface water.
- The location of delineated source water protection areas for public drinking water systems.

This information, along with other data collected for the evaluation, will be used to determine if groundwater ingestion is a complete exposure pathway in the SCM, and will guide the selection and use of appropriate remedial target concentrations, measures, timeframes, and compliance conditions.

A water well survey should be conducted to identify all water use wells within a one-half (1/2) mile radius. Information sources include the U.S. Geological Survey, the Idaho Department of Water Resources (IDWR), water system operators, and local residents. If available, well characteristics including depth, water use, and screened interval should be documented. It is necessary to identify any dewatering wells located within a 1,000-foot radius of the site (or greater if the groundwater plume is extensive).

Land use considerations include, but are not limited to:

- Current zoning and land use. Consultation with local planning and zoning officials regarding future land use planning direction and interpretation of planning and zoning policies.
- Land use development trends. Conversion of agricultural land to residential land uses requires development of drinking water sources. The proximity of these conversions to urban centers and available public drinking water supplies should be taken into account.
- Local ordinances that include agreements with IDWR governing well drilling or state-designated restrictions or specifications for constructing wells into groundwater in a locality for drinking water purposes.
- The existence of source water assessment delineations and source water protection plans and ordinances associated with public drinking water supplies.
- The availability of alternative water supplies.

4.1.4 Land Use and Receptors

This portion of the SCM describes the current and future assumptions about land use as they relate to identifying potential receptors. The identification of land uses includes both the site of the release as well as adjacent properties which may be impacted by the release.

4.1.4.1 Land Use

Evaluating current and reasonably likely future land uses at and adjacent to the release site is a critical component when determining potential exposure points, exposure pathways, receptors, and exposure factors during the RE process and when determining cleanup concentrations.

Residential land use generally requires lower target concentrations. Cleanup to residential standards will usually allow unrestricted land use. Whenever assumed land use is other than

residential and cleanup is not to residential standards, DEQ may require that an AUL be imposed on the property through the use of an environmental covenant.

Residential land uses include use by sensitive subpopulations. Examples of land uses with sensitive subpopulations include but are not limited to hospitals, nursing homes, schools, childcare centers, farms with houses, and any other areas/structures with sensitive human activity.

The owner/operator should submit to DEQ illustrated land use maps clearly identifying current land uses at the site and the adjacent properties. One map should clearly show the area within one-half (1/2) mile of the known or likely extent of contamination. At sites where there is likelihood that the extent of impacts may be greater, due to the magnitude of the spill or other site-specific conditions, a land use map covering the entire impacted and potentially impacted area is necessary. A walking land use survey should be conducted for the area within a 500-foot radius of the source, with an emphasis on the down-gradient direction and potential offsite impacts. The survey should clearly identify the following: schools, hospitals, residences (apartments, single-family homes, and others), day care centers, nursing homes, and types of businesses. In addition to this survey, efforts should be made to identify structures with basements (which may enhance the transport of contamination) in areas in closer proximity to the source and where site conditions warrant it, such as where shallow groundwater or non-aqueous phase liquid (NAPL) is present. The map should also identify surface water bodies, parks, recreational areas, wildlife sanctuaries, wetlands, and agricultural areas.

Current land use refers to land use as it exists today and that can be readily determined by a site visit. A site visit should identify homes, playgrounds, parks, businesses, industries, or other land uses at, and in close proximity of, the release site. As appropriate, state or local zoning boards; the U.S. Census Bureau; zoning, topographic, land use, housing and other types of maps; and aerial photographs can provide information for determining land use.

Undeveloped land should be characterized by the most likely future use of that property, considering current zoning restrictions. If the undeveloped parcel is located in a predominantly nonresidential area, nonresidential classification may be appropriate. However, if the setting is more rural or land-use is mixed, the undeveloped land should be considered residential unless the owner/operator develops and implements an AUL as a part of a DEQ-approved CAP.

The exposures to be evaluated in an RE depend upon the activities that could occur under likely future uses of land and groundwater at the site. The future groundwater use should be consistent with the most likely future land use.

For example, consider property that is currently used as farmland. If the impacted farmland includes a residence, the current land use is residential. However, if the owner/operator provides information establishing clear plans to develop the residence into a nonresidential building in the near future, the likely future use may be evaluated as nonresidential.

While evaluating likely future land use(s) presents uncertainties, DEQ has identified certain factors that assist in this evaluation. These factors include, but are not limited to, local zoning ordinances; knowledge of current land use and changing land use patterns; zoning decisions; community master plans; interviews with current property owners; nonresidential appraisal

reports; proximity to wetlands, critical habitat, and other environmentally sensitive areas, such as source water protection areas; and the use of remedial action institutional controls at a site.

Assumed future land use designations other than residential must be justified and there should be a high likelihood that the land will be used for those purposes. Absent such a justification, DEQ will consider the residential land use scenario as the default future land use.

Site characterization will include a determination of the on-site and off-site areas of impact. These areas are considered in determining the pathway-specific exposure units for each type of receptor. Exposure units are discussed in more detail in section 4.3 and Appendix I.

4.1.4.2 Receptors

The objective of the RE is to quantify the adverse health effects to current and potential future receptors both onsite and offsite. For simplification, the following definitions should be used:

- On-Site −The area located within the legal property boundaries within which the source of the release is located. This includes soil, groundwater, surface water, and air within those boundaries. Adjacent property purchased subsequent to the release will be considered off-site.
- Off-Site −The areas of concern located outside the boundaries of the property where the release source is located. This includes soil, groundwater, surface water, and air located outside the property boundaries.

In a residential exposure scenario, risk is evaluated for either a child receptor or a composite receptor, depending on the specific exposure route, and whether the petroleum COI is noncarcinogenic, carcinogenic, or carcinogenic with a mutagenic mode of action. The composite receptor is based on an exposure duration of 30 years, and for some chemicals and exposure routes risk calculations incorporate modifications based on exposure occurring at different life stages.

For land uses other than residential, a typical receptor might be a commercial or industrial worker where the risk to adults is considered. Finally, under a construction scenario adult construction workers are considered. If warranted by site-specific conditions, other types of receptors may need to be defined and evaluated.

4.1.4.3 Ecological Risk Considerations

In addition to identifying potential impacts to human receptors the SCM should also attempt to identify potential pathways by which sensitive habitats, such as wetlands, surface water bodies, or other ecologically significant environments near the site, may be impacted by the release where wildlife may be the potential receptors.

Threatened and endangered species that may be exposed to site-specific chemicals should be identified. Note that within the RE process, protection of surface waters and streams is independent of ecological RE. As appropriate, a walking survey in the vicinity of the site may be necessary to identify ecological receptors.

Contact DEQ to obtain additional guidance on these issues.

4.2 Data Requirements and Evaluation

Once the SCM has been developed, an evaluation of data collection needs, data quality needs, and data collection methodology should be conducted. Depending on the amount and complexity of the proposed data collection effort, a work plan may be needed to guide the data collection process. The suggested contents of this work plan are discussed in section 4.7.

This section describes general data collection objectives and requirements for the RE process. This includes the general QA/QC considerations to help ensure the data collected is of sufficient quality and quantity to meet desired objectives, the categories of data necessary to meet these objectives, and data collection techniques.

Data collection objectives for RE include, but are not limited to:

- Accurately characterize the magnitude, nature, and extent of contamination, including the characterization of petroleum chemical concentrations for all impacted media, as appropriate,
- Allow the development and/or validation of an accurate SCM, and
- Develop sound estimates of risks posed by the release.

4.2.1 Data Collection Planning

Sound data collection planning involves a careful review of all available site information and data for its suitability in the RE. This process, in the context of the SCM, should identify any data gaps with the goal of determining the types, locations, quality, and numbers of samples or measurements needed.

Depending on what stage of the RE process is in for a given site, the relative importance of each objective described above will vary and specific data requirements will also vary. The goal of data collection for RE is to efficiently reduce uncertainty in those areas that contribute the most to potential or actual risk and for which the greatest uncertainty exists.

For example, it may be determined through the SCM that vapor intrusion represents the largest potential source of risk at a site, but little is known about subsurface conditions which may impact exposure point concentrations and only soil or groundwater data are available. In order to more realistically model this pathway, it may be most effective to better characterize subsurface stratigraphy and properties, document the conditions supporting biodegradation, and collect soil vapor data.

At many impacted sites, data collection efforts may have been conducted multiple times over an extended period of time. For example, interim corrective action measures may have been undertaken prior to planning for the RE. Soil and groundwater data collected prior to such activities may not be representative of current conditions and generally should not be used in RE. At such sites, collection of additional soil and groundwater concentration data may be needed after completion of interim corrective measures.

The exact number of samples required is a site-specific decision based on the balance between cost and representativeness and requires professional judgment and expertise. Numerous tools are available to assist in estimating the number of samples required for statistical analysis, but

none provide a definitive number and statistical analysis may not be practical in many cases. These tools include, but are not limited to, data quality objectives (DQO) and statistical and geo-statistical evaluation. Selected references to assist in developing and completing sound data collection efforts are listed in section 7.2.

4.2.2 Quality Assurance/Quality Control Considerations

The RE process relies on site-specific data to make decisions related to the magnitude of site risk, nature and extent of remedial activity, and site-closure. Thus it is very important that data be reliable, representative, complete, and of known quality.

In order to assure the data will be of appropriate quality, QA/QC activities must be applied to all environmental data collection activities throughout the RE process (site characterization, risk evaluation, remediation implementation, and monitoring).

Elements of QA/QC include:

- Using approved methodologies to collect data,
- Decontaminating field equipment as appropriate,
- Using EPA approved methods for laboratory analysis, and
- Including QA/QC samples, such as duplicates, equipment blanks, trip blanks, etc.

While the level of QA/QC applied to data collection efforts will vary (depending on factors such as site complexity, size of the release, and the immediacy of the response) all the elements of QA/QC described above that were used during a given data collection effort should be provided to DEQ when reporting the results of environmental sampling. This will allow an adequate review of the quality of the data used in the analysis.

If a work plan is submitted to DEQ for approval, it should include a QAPP. The QAPP integrates the appropriate technical and quality aspects of a project, including planning, implementation, and assessment. The purpose of the QAPP is to document planning for the collection of environmental data and to provide a project-specific "blueprint" for obtaining the type and quality of data needed for a specific decision or use. The QAPP documents the QA/QC procedures applied to various aspects of the project to assure that the data obtained are of the type and quality required.

The EPA has developed guidance for the development of QAPPs which can be obtained at: *http://www.epa.gov/quality/qs-docs/g5-final.pdf*.

To further assist in the development of a QAPP, DEQ has also developed an abbreviated QAPP template. The purpose of the template is to provide the user with an annotated outline format of a QAPP with all the required elements. From there, it is a simple matter to fill in appropriate site-specific information applicable to each element. The QAPP template is reproduced in Appendix L. This template is periodically updated. Contact DEQ for the latest version.

Documentation of all QA/QC efforts implemented during data collection, analysis, and reporting phases is important to data users, who can then consider the impact of these control efforts on data quality.

The QAPP is implemented during the data collection process. Problems can be identified and corrected at this stage. The impact of field and laboratory techniques and sampling and analysis conditions on data quality are determined using field and laboratory QC samples and periodic audits. Oversight and corrective action can prevent improper procedures or techniques from continuing.

Data verification, validation, and assessment should be performed to validate data quality and assess data quality and usability. Data verification and validation is particularly dependent on compliance with field and laboratory procedures for sample collection, identification, handling, preservation, chain of custody management, shipping, analysis, and reporting.

EPA provides several guidance documents to assist in performing data verification and validation (EPA, 1999; EPA, 2002a). The EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (EPA, 1999) provides guidance on data verification and validation of contract laboratory program (CLP) data, but may also be used as guidance for non-CLP data. EPA 2002a provides more generic guidance on conducting these tasks.

4.2.3 Documentation of the Data Collected

Once data have been collected, a field investigation report should be prepared and include:

- Dates when data were collected and names of individuals who collected the data.
- A list of data collected and reference to any work plan that may have been followed.
- All data collected, clearly tabulated, and contoured (if necessary),
- All boring logs and relevant cross-sections, where appropriate, to depict site stratigraphy,
- All QA/QC data, laboratory results, data validation and verification, assessment of data usability, and chain of custody forms,
- Contour maps of groundwater potentiometric surface indicating the predominant direction of groundwater flow, and
- A discussion of the SCM.

4.2.4 Data Collection Methods

The common categories of data that are the focus of data collection efforts for RE include:

- Vadose zone soil characteristics,
- Saturated zone characteristics, and
- Distribution of petroleum COIs in soil, soil vapor, groundwater, and surface water bodies.

DEQ has developed default values for many of the vadose and saturated zone characteristics that affect the fate and transport of petroleum COIs. These values are presented in Appendix B. For site-specific REs, these default values can be used or site-specific values can be established. This appendix describes typical collection methods for those properties of the vadose zone and saturated zone important for RE. It also addresses the collection of chemical concentration data from these media.

4.2.5 Vadose Zone Soil Characteristics

The vadose zone or unsaturated zone soil is the media through which petroleum COIs can migrate to the groundwater and vapors can move upward to the surface and into an enclosed space. Thus, characteristics of vadose zone soils have considerable impact on risk estimates and target concentration calculations. Relevant vadose zone characteristics include:

- Vadose zone thickness and depth to groundwater,
- Bulk density,
- Porosity,
- Water and air content, and
- Fractional organic carbon content.

In addition to parameters mentioned above, additional site-specific, pathway-specific parameters that may be valuable to measure include:

- Vapor permeability, effective diffusion coefficient, and building characteristics where indoor inhalation is a potentially complete pathway, and
- Infiltration rates for developing a detailed evaluation of the potential for leaching to groundwater.

4.2.5.1 Thickness of Vadose Zone and Depth to Groundwater

Vadose zone thickness is determined from boring logs. This thickness is the distance from the ground surface to the depth at which the water table is encountered, less capillary fringe thickness.

Depth to groundwater is used in estimating vapor emissions from groundwater. For indoor inhalation, depth to groundwater below the "floor" of an existing structure of concern or the most likely location of a future structure should be used.

For sites with considerable seasonal fluctuation in water table level, depending on the data available and the nature of the fluctuations, a yearly average depth or a time-weighted depth may be used. The vadose zone depth that is estimated should also form the basis for the selection of soil samples to be used in evaluation of subsurface soil vapor emissions to indoor air. Shallower water table depths often result in groundwater target levels set at lower concentrations to be protective of inhalation pathways.

4.2.5.2 Porosity

Porosity is the ratio of the volume of voids to the total undisturbed field volume of soil. Many laboratories use dry bulk density and specific gravity data to determine porosity using the following equation:

$$n = 1 - \rho_b / \rho_s \qquad (4\text{-}1)$$

where,

n	=	porosity (cubic centimeter per cubic centimeter [cc/cc])
ρ_b	=	dry bulk density (grams per cubic centimeter [gm/cc])
ρ_s	=	specific gravity or particle density (gm/cc)

Dry bulk density is the dry weight of a soil sample divided by the field volume of the soil sample. An accurate measurement of bulk density requires determining the dry weight and volume of an undisturbed sample. This method involves collecting a core of known volume, using a thin-walled sampler, such as a Shelby tube or similar coring device, to minimize disturbance of the sample, and transporting the core to a laboratory for analysis. This method is described in American Society for Testing and Materials (ASTM) Method D2937-00, Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method (ASTM, 2000a).

The Standard Test Method for Specific Gravity of Soil, ASTM Method D854-00 (ASTM, 2002), may be used to determine specific gravity. If specific gravity is not assessed, then 2.65 gm/cc can be assumed as the particle density.

Consideration should be given to collecting multiple samples if multiple lithologies are present that might affect COI transport.

If site-specific values of porosity are not available, it should be estimated based on values provided in an appropriate literature source.

4.2.5.3 Volumetric Water Content/Moisture Content

Volumetric water content is the ratio of water volume to the total soil volume. The ASTM Method D2216-98, Standard Test Method for Laboratory Determination of Water [Moisture] Content of Soil and Rock by Mass (ASTM, 1998) is a gravimetric oven-drying method; however, the water content value used in most models is the volumetric water content.

Hence, it may be necessary to use the following equation to convert gravimetric water content to a volumetric basis:

$$\theta_{wv} = \theta_{wg} * \frac{\rho_b}{\rho_l} \qquad (4\text{-}2)$$

where,

θ_{wv} = volumetric water content (cc water/cc soil)

θ_{wg} = gravimetric water content, typically reported by the laboratory (gm of water/gm of soil)

ρ_b = dry bulk density (gm of dry soil/cc of soil)

ρ_l = density of water (gm/cc)

Volumetric water content can also be measured in the field through the use of a variety of instruments such as a neutron probe, time domain reflectometer, or gypsum block sensors. For more information on these methods, see Part VII of Wilson et al. (2000).

4.2.5.4 Fractional Organic Carbon Content in Soil

Fractional organic carbon content is the organic carbon weight in the soil divided by soil weight and is expressed either as a ratio or as a percent. The Walkley Black Method (Page et al., 1982)

is a chemical oxidation method (rapid dichromatic oxidation) while ASTM Method 2974-00 is a furnace method (ASTM, 2000b) for determining fractional organic carbon content in soil. Results are usually reported as percent organic carbon content. The reported value can be converted to a fraction by dividing by 100.

If measurements of total organic matter content are available, they should be divided by 1.724 to estimate the fractional organic carbon content. This adjusts for the portion of soil organic matter that is actually carbon. Typically, total organic carbon content is estimated using ASTM Method 2974-00. Organic carbon content should be determined using soil samples not impacted by the release.

4.2.6 Saturated Zone Characteristics

Petroleum COIs that reach the water table typically travel horizontally through the saturated zone. However, if a vertical gradient is present, chemicals may also move vertically in the direction of the gradient. Saturated zone characteristics that determine the travel time and direction for the petroleum COIs include:

- Horizontal hydraulic conductivity,
- Horizontal and vertical hydraulic gradients (magnitude and direction), and
- Saturated zone soil characteristics (fractional organic carbon content and porosity).

4.2.6.1 Hydraulic Conductivity

Hydraulic conductivity is the discharge of water per unit area per unit hydraulic gradient in a subsurface formation. Estimates of site-specific hydraulic conductivity can be obtained by conducting aquifer tests such as slug or pump tests. Data gathered during the tests are then analyzed using appropriate methods. Slug tests are easier to conduct than pump tests, generate no wastewater for treatment, and may be more appropriate for low-permeability formations. The primary disadvantages are the small aquifer volume that is explored, resulting in the need to conduct multiple tests across the site. Properly conducted pump tests will often provide better estimates of hydraulic conductivity. The simplest pump tests are single-well short-duration (2 to 4 hours) tests. The best pump tests employ a pumping well and multiple observation wells and are of longer duration (12 hours or more). These tests will identify boundary effects. Regardless of the type of test conducted, different methods of data analysis will often yield different estimates of hydraulic conductivity. ASTM Method D4043 provides guidance on the selection of aquifer test methods (ASTM, 1996).

In the absence of these tests, estimates of hydraulic conductivity may be obtained from literature, with values corresponding to the type of soil in the saturated zone, using empirical equations based on the grain size distribution of the porous formation, or they may use specific capacity data from well logs of wells in the vicinity of the site that are representative of the aquifer being investigated. In either case, adequate references and justification for the value chosen should be provided.

4.2.6.2 Hydraulic Gradient

The magnitude and direction of the hydraulic gradient is estimated by comparing water levels measured in the monitoring wells. Typically, water level contour maps are prepared based on

measured data using a computer program or manual calculations along with professional judgment. Calculations done using automated procedures should be spot-checked with hand calculations. Three wells or more are needed to adequately estimate the direction of flow and magnitude of the gradient. When drawing the contour maps, care should be taken to ensure that the measurements used are from monitoring wells that are screened in the same interval or hydrologic unit.

For sites that have seasonal variation in hydraulic gradient, estimate the average hydraulic gradient for each season. Consideration should also be given to determining any vertical gradients. This requires a comparison of adjacent water levels in wells screened in different intervals.

In areas where the shallow aquifer has been impacted and a deeper aquifer is used for drinking water, the vertical gradient should be determined. When drilling deep wells, care should be taken to avoid cross contamination.

4.2.6.3 Saturated Zone Soil Characteristics

In addition to hydraulic conductivity, other important saturated zone soil characteristics include fractional organic carbon content, porosity, and bulk density. These parameters are required to quantify the movement of chemicals within the saturated zone. The laboratory methods to measure these parameters were discussed in section 4.2.5.

4.2.7 Indicators of Biodegradation

Biodegradation of petroleum chemicals occurs in all media (soil, soil vapor, groundwater). Depending on the media, different indicators (chemical concentrations, geochemical indicators, microorganisms, oxygen, and carbon dioxide) can be measured at a site to demonstrate the occurrence of biodegradation of these organic substances.

When evaluating the potential for biodegradation in groundwater, these indicators are commonly classified into three groups: primary, secondary, and tertiary lines of evidence. Data collected under each line of evidence can be evaluated qualitatively or quantitatively to determine the occurrence of biodegradation.

The primary line of evidence demonstrates spatial stability or a reduction in chemical concentrations at a site by evaluating measured concentrations within monitoring wells, groundwater velocity, rates of contaminant transport, and time of the release.

The secondary line of evidence refers to measurement of geochemical indicators including reduction-oxidization (REDOX) potential, dissolved oxygen, dissolved nitrates, manganese, ferrous iron, sulfate, and methane. These indicators should be measured in at least three wells located along the flow line, one of which should be located at a background or up-gradient location, one within the plume near the source, and one within the plume down-gradient from the source.

The tertiary line of evidence involves microbiological studies such as identification of types of subsurface microbial populations and microbe cell counts.

Commonly used methods to estimate biodegradation rates include mass balance analysis for expanding, stable, or shrinking plumes and plots of plume concentration vs. distance. Additional details on biodegradation for petroleum COIs in groundwater are provided in Appendix H.

When evaluating the potential for, or presence of, biodegradation in soil or soil vapor, the most common indicators used are soil vapor concentrations, oxygen, and carbon dioxide. These are commonly measured at multiple depths in the subsurface and related to a potential source. More information on evaluation of biodegradation of petroleum vapors in relation to the vapor intrusion pathway is provided in Appendix G.

4.2.8 Distribution of Petroleum Chemicals of Interest

Petroleum COI may be distributed between soil, soil vapor, groundwater, surface water, and sediments present at a release location. Knowledge of contaminant distribution entails a determination of the spatial extent and magnitude of concentrations in each of these media, where they are present.

4.2.8.1 Distribution of Petroleum Chemicals of Interest in Soil

Adequate soil concentration data are necessary to estimate risk to receptors, compare representative concentrations for each complete pathway to target levels, and define the soil source dimensions. Sufficient data should be collected to define horizontal and vertical extent of impacts. The vadose zone investigation(s) should be organized to:

- Identify the horizontal and vertical extent of soil impacts. Unless otherwise directed by DEQ, the extent of impact should be defined as those areas where petroleum COI concentrations exceed screening level concentrations.
- Identify areas of maximum concentration of petroleum COIs.
- Collect samples adequate to estimate exposure point concentrations for the potentially complete exposure pathways that have been defined based on the SCM.

To determine the spatial extent of contamination, soil borings should be drilled starting from the known or suspected source area and drilling outwards until borings with sample concentrations at or below screening levels are reached in all directions. To determine the vertical extent of contamination, soil borings should be extended to the base of petroleum impact and samples collected from surface and subsurface soil zones as explained in the following sections.

The soil analytical data should help identify the soil source area. If more than one source area is identified at a site, each source area should be evaluated separately. Once the soil source(s) is identified, source dimensions can be estimated. These dimensions are used in the computational software which accompanies the guidance and rule, along with other input parameters, to estimate risk and RATL concentrations protective of indoor inhalation and to evaluate the soil to groundwater leaching pathway. Depth to subsurface soil source (used to estimate the target concentrations) should be the depth, in the source area, from the surface to the zone where concentrations are above quantification limits. Professional judgment should be used in choosing the representative depth.

4.2.8.1.1 Surficial Soil Sampling

The RE process distinguishes between surficial soil and subsurface soil zones. Surficial soil is defined as the soil zone from the ground surface to 1 foot below ground surface. Pathways that may apply to the surficial soil zone include direct contact exposure via incidental ingestion, inhalation of vapors and particulates, dermal contact, and leaching of petroleum COIs to groundwater and surface water.

Evaluation of soil exposure pathways within the surficial soil zone requires collection of an adequate number of soil samples to estimate both maximum and representative concentrations of all potential petroleum COIs. Given the small vertical depth interval of this soil zone, close attention should be given to vertical variations in contamination. The acceptability of vertical depth-composite samples versus samples from discrete depth intervals is a site-specific decision. Criteria that influence this decision include the type of petroleum COIs, vertical extent of contamination, and areal extent of the contaminated zone. Sampling within the surficial soil zone is typically done from test pits using hand samplers such as trowels or corers.

The presence of impervious (paved) surfaces poses difficulties for sampling. In some cases, very permeable material may be located 2 inches below the pavement. Residues from the paved surface may also be present. When sampling beneath impervious surfaces, sampling should begin 2 inches or deeper below concrete or asphalt pavement. Cracked areas in impervious surfaces may represent conduits for chemical migration or leaching and should be evaluated during the selection of sampling locations.

4.2.8.1.2 Subsurface Soil Sampling

Soil below the surficial soil zone (more than one foot below ground surface) and extending to the water table is termed the subsurface soil zone. Pathways evaluated for this zone include volatilization from soil to indoor air and leaching to groundwater and surface water. Most receptors will not have direct exposure to this soil. However, some construction workers may be involved in excavation activities below the surficial soil zone and subsurface soil removed during excavation may be deposited at the surface allowing greater exposure. This possibility should be considered during the development of the SCM.

To test for indoor inhalation of vapors from subsurface soils, it is preferable to collect soil vapor data however soil data can also be used. Soil samples should be collected to characterize the complete horizontal and vertical extent of contamination. Soil moisture conditions and soil vapor permeability are also important parameters affecting soil vapor transport. If petroleum contamination exists adjacent to existing structures, additional sampling should be focused in these areas. More information on evaluation of the vapor intrusion pathway is provided in Appendix G.

To test for exposure to a construction or utility worker during excavation activities, soil samples should be collected from both surface and subsurface soil zones to depths where construction-related activities are likely to occur.

To test for leaching of petroleum COIs in soil to groundwater, it is critical to determine the thickness of the contaminated soil zone, the distance from the bottom of the contaminated zone to the water table, if any, and representative concentrations of petroleum COIs within the contaminated zone.

Soil sampling must be done in accordance with the following guidelines and procedures:

- Samples must be collected from the source area(s). Samples must be collected to determine the full horizontal and vertical extent of soil contamination. Sampling should strive to characterize any horizontal or vertical stratigraphic variation at the site that could impact petroleum COI fate and transport. Where required to fully characterize the vertical extent of contamination, borings should be extended to the water table and features such as the capillary fringe and any smear zone, if encountered, should be characterized. Vertical sampling intervals generally should not be greater than 5 feet.
- Soil borings should be logged and samples for laboratory analyses collected in accordance with current industry practice.
- All samples must be adequately preserved according to requirements of the laboratory analyses and analyzed within holding times required by each method. Sample analyses must be conducted in accordance with current, EPA Office of Solid Waste and Emergency Response SW-846 Methods, or other accepted methods.
- Adequate QA/QC procedures must be used to ensure sample quality and integrity. Section 4.2.2 contains additional information on QA/QC considerations.
- All sampling equipment must be decontaminated using current state of industry practice such as described in ASTM D-5088-90, Practice for Decontamination of Field Equipment Used At Nonradioactive Waste Sites (ASTM, 1990).
- Abandonment of boreholes that extend to the water table, which are considered wells by IDWR, should follow IDWR abandonment procedures (IDAPA 37.03.09.16). Appropriate methodology for abandoning other boreholes is described in detail in the Standard Guide for Decommissioning Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities, Standard Guide D5299-99 (ASTM, 1999a).

4.2.8.1.3 Subsurface Soil vapor Data

At sites where petroleum COIs in soil or groundwater are volatile and there is concern about potential indoor inhalation of vapors, it may be useful to assess soil vapor concentrations. For details about these samples, refer to Appendix G (Evaluation of the Vapor Intrusion Pathway).

4.2.8.1.4 Logging of Soil Boreholes

Each soil boring must be logged to record depths correlating with changes in lithology (with lithologic descriptions), soil vapor (e.g., photo-ionization detector) analyses, occurrence of groundwater, total depth, visual and olfactory observations, and any other pertinent data.

When a monitoring well is installed, as-built diagrams with depth to groundwater and construction details must be submitted for each well. A continuous soil profile from at least one boring with detailed lithologic descriptions may be useful. Particular emphasis should be placed on characteristics that control chemical migration and distribution, such as zones of greater or lesser permeability, changes in lithology, correlation between soil vapor concentrations and different lithologic zones, obvious areas of soil discoloration, organic content, fractures, and other lithologic characteristics.

4.2.8.2 Distribution of Petroleum Chemicals of Interest in Groundwater

Adequate groundwater samples should be collected to delineate the extent of free product, dissolved contaminant plumes in all directions, maximum petroleum COI concentrations, and representative concentrations based on the SCM. This sampling should take into account knowledge of the soil source and the direction of groundwater flow.

4.2.8.2.1 Groundwater Sampling

If groundwater has been impacted, temporary sampling points may be used to screen levels of groundwater impacts and to assist in determining optimal locations of permanent monitoring wells. A sufficient number of monitoring wells should be installed to identify source areas and to document petroleum COI migration and groundwater flow. The monitoring wells should be installed in accordance with current IDWR rules (IDAPA 37.03.09) and industry standards such as ASTM D 5092-95, Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers (ASTM, 1995b). EPA documents such as the Resource Conservation and Recovery Act (RCRA) technical guidance for groundwater monitoring (EPA, 1986, 1992a) are also useful references.

Adequate numbers of monitoring wells must be installed to sufficiently delineate the horizontal and the vertical extent of the groundwater plume. The number and location of wells should also allow a site-specific estimate of the direction of groundwater flow. Well placement and design must consider the concentration of petroleum COIs in the source area, and the occurrence of NAPL at the site.

Well casing and screen materials must be properly selected. The screen interval length should be minimized to the extent possible but should be set at least 2 to 3 feet above the expected high water table and encompass the range of expected variation in water table depth. EPA (1992) recommends screen interval lengths of 10 to 15 feet except where specific monitoring objectives or site knowledge result in other requirements. Wells must be properly developed and gauged after installation. A site survey must be conducted to establish well casing elevations. Based on the groundwater elevations, groundwater flow direction and gradient should be determined and plotted on a map.

Groundwater samples must be collected in accordance with the following guidelines and procedures:

- Monitoring wells must be purged of an adequate number of well volumes prior to collecting a sample (usually 3 to 5 volumes). Low-flow purging and sampling techniques (EPA, 2002b) may also be acceptable when included in a DEQ-approved QAPP.
- Samples must be collected using EPA approved methods and equipment.
- All samples must be adequately preserved according to the requirements of the laboratory analyses and analyzed within holding times required by each method.
- Sample analyses must be conducted in accordance with EPA Office of Solid Waste and Emergency Response SW846 Methods, or other accepted methods.
- Adequate QA/QC procedures must be used to ensure sample quality and integrity. See section 4.2.2 for additional information on QA/QC considerations. All sampling equipment must be decontaminated using current state of industry practice such as

described in ASTM D-5088-90, Practice for Decontamination of Field Equipment Used At Nonradioactive Waste Sites (ASTM, 1990).

- If the plume is not delineated in all directions, locations of new monitoring wells must be chosen based on groundwater flow direction and location of the soil source area.

4.2.8.3 Surface Water and Sediment Sampling

Appropriate samples should be collected when petroleum COI migration is known or suspected to have impacted surface water. Water samples should be collected from upstream and downstream of a groundwater discharge point. Sediment samples should be collected if the SCM indicates a potential for releases to surface water.

In places where a groundwater plume may discharge into a stream, it is necessary to estimate the discharge concentration into the stream. This can be achieved by installing one or more monitoring wells or temporary wells within the plume adjacent to the stream.

4.3 Exposure Assessment

The goals of the exposure assessment portion of the RE are to:

- Characterize the physical setting,
- Identify potentially exposed populations,
- Identify complete or potentially complete exposure pathways,
- Estimate exposure concentrations, and
- Estimate petroleum chemical intakes.

The exposure assessment uses much of the data collected in support of and assumptions contained in the SCM (described earlier in section 4.1). A graphical display of the SCM like the sample shown in Figure 2 is helpful for assessing exposure.

4.3.1 Physical Setting

Characterization of the physical setting for exposure assessment identifies those site factors which may influence the fate and transport of chemicals from the source to a receptor. These factors include climate, meteorology, geologic and hydrogeologic setting, soil types, biodegradation potential, and surface water hydrology. When these factors are considered in the context of the media from which petroleum COIs are released (surficial soils, subsurface soils, groundwater, surface water, etc.), the transport mechanisms for the petroleum COIs from each media (leaching, groundwater transport, volatilization, etc.), and the chemical concentrations and distribution of the petroleum COIs in each media, the potential for a chemical to reach a receptor can be assessed. A more thorough discussion of the data needs related to description of the physical setting can be found in section 4.1 (Site Conceptual Model).

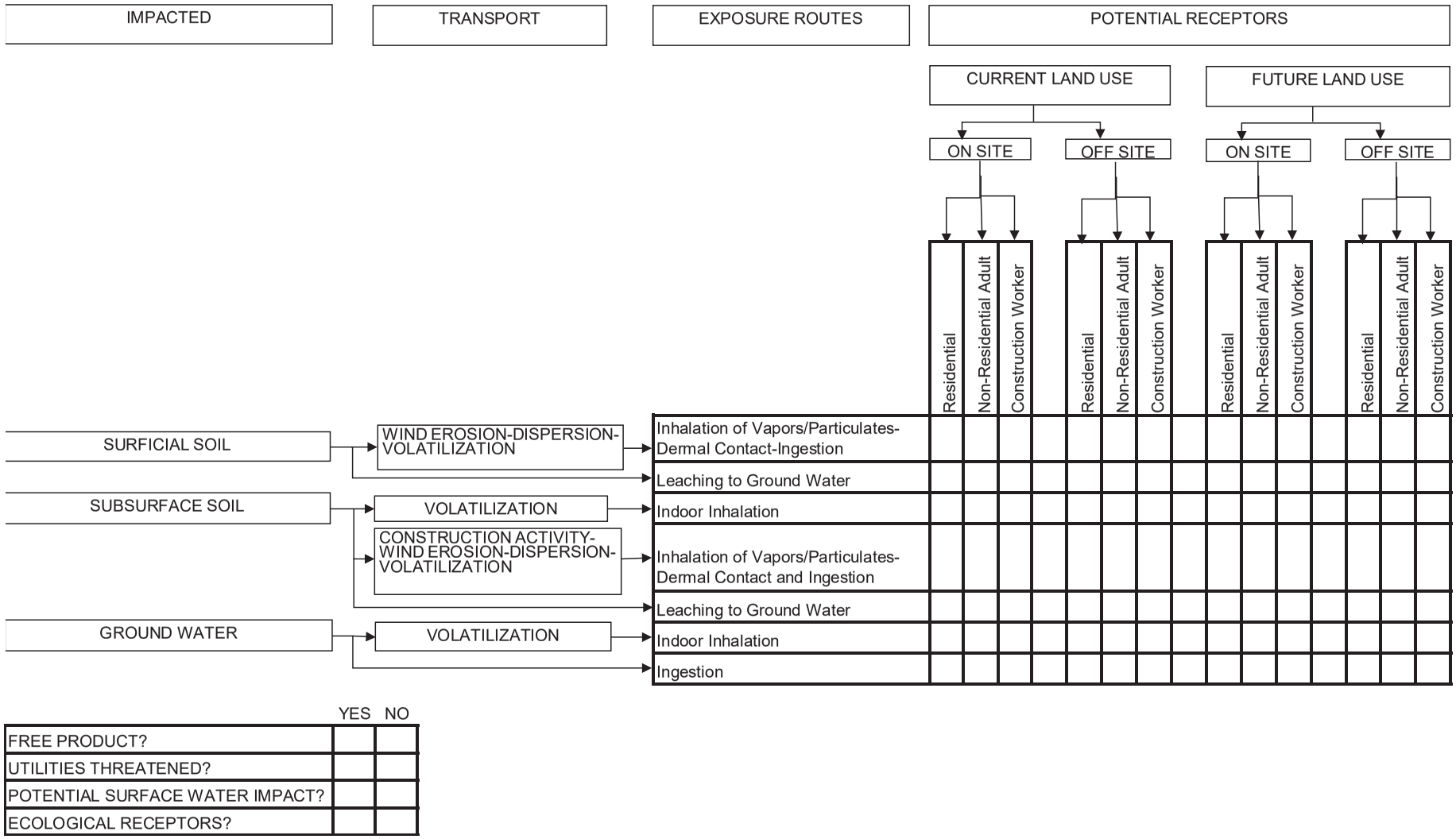


Figure 2. Sample Graphical Display of a Site Conceptual Model

4.3.2 Potentially Exposed Populations/Receptors

Potential exposure populations/receptors should be identified from the information contained in section 4.1 (Site Conceptual Model).

4.3.3 Exposure Pathways

A receptor comes in contact with petroleum COIs through a complete exposure pathway. If some but not all of the following elements are present, the pathway is incomplete. For a pathway to be complete, all of the following must be present:

1. a source of petroleum,
2. a mechanism by which the petroleum is released,
3. a transport medium through which petroleum travels from the point of release to the receptor location,
4. an ROE by which the petroleum chemical enters the receptor's body (ingestion, inhalation, or dermal contact) and
5. a potential receptor.

If the migration of petroleum chemicals to a receptor or contact by a receptor is not possible (e.g., due to formal engineering controls such as a paved site that will prevent human contact with petroleum-contaminated soil) under current and most likely future land use conditions, the site-specific petroleum COI concentrations may not pose a risk.

DEQ has identified the most commonly encountered exposure pathways for various environmental media for which an evaluation must be conducted. These pathways are discussed below. At sites where receptors, exposure pathways, or ROE other than those discussed below are important, the owner/operator must identify them and discuss their quantitative evaluation with DEQ. In some cases it may be determined that one or more of the pathways are incomplete and therefore do not need to be quantitatively evaluated. Adequate justification for exclusion of these pathways must be provided to and approved by DEQ.

4.3.3.1 Pathways for Surficial Soils (0–1 foot below ground surface)

Surficial soils are defined as soils extending from the surface to 1 foot below ground surface. For construction worker exposure, however, the applicable depth is the depth of excavation. The exposure pathways associated with impacted surficial soils include:

- Groundwater protection (leaching of petroleum chemicals from soil to groundwater with subsequent potential ingestion of groundwater),
- Surface water protection (leaching of petroleum chemicals from soil to groundwater with subsequent migration to a surface waterbody), and
- Ingestion of soil, outdoor inhalation of vapors and particulate emissions from soil, and dermal contact with soil.

4.3.3.2 Pathways for Subsurface Soils (1 foot below ground surface to the water table)

Subsurface soils are defined as soils extending from 1 foot below the ground surface to the water table. The exposure pathways associated with subsurface soils include:

- Indoor inhalation of vapor emissions from soil,
- Groundwater protection (leaching of petroleum chemicals from soil to groundwater with subsequent potential ingestion of groundwater), and
- Surface water protection (leaching of petroleum chemicals from soil to groundwater with subsequent migration to a surface waterbody).

4.3.3.3 Pathways for Groundwater

Potentially complete exposure pathways for impacted groundwater include:

- Indoor inhalation of vapor emissions from groundwater, and
- Current and/or future ingestion of water on or off site.

Appendix G describes in detail the process used to evaluate potential exposure via indoor inhalation of vapors from soil and groundwater.

4.3.3.4 Pathways for Surface Water and Sediments

Depending on the beneficial use designation of impacted surface waters, complete pathways for surface water include:

- Intentional ingestion of surface water and ingestion of fish when surface water is used as a drinking water supply, and
- Ingestion of fish from surface waters designated for recreational use.

4.3.3.5 Other Exposure Pathways

Other complete or potentially complete exposure pathways, such as ingestion of produce grown in impacted soils, ingestion of fish, contact with contaminated sediments, or use of groundwater for irrigation purposes, should be evaluated on a case-by-case basis. The owner/operator should contact DEQ for further guidance.

4.3.4 Exposure Point Concentrations

Exposure point concentrations are the average petroleum chemical concentrations to which receptors could be exposed over a specified duration within a specified geographical area. The geographical area about which a receptor moves and within which a receptor contacts contaminated media during the specified exposure duration is termed an exposure unit (EPA, 2001). The exposure unit of all receptors must be considered and described. The exposure unit, or spatial area over which a given receptor is likely to be exposed, must be established for on-site receptors as well as any off-site impacted or potentially impacted receptors and for each exposure pathway or ROE. The same site may have different exposure units for current and future use scenarios.

A detailed discussion of the estimation of exposure point concentrations and the use of exposure units for RE is provided in Appendix I. This appendix describes the sources of uncertainty which affect the estimation of exposure point concentrations, strategies to reduce this uncertainty, and methodologies to evaluate data quality. It also provides guidance on the selection of appropriate data for various ROE and appropriate statistical methods for analysis of available data.

The RE report should clearly identify specific data and methods used to estimate the exposure point concentrations, and provide a rationale for the method and data used. The following information should be provided in a table:

- Media
- ROE/pathway
- Receptor
- Data used
- Method of estimation

Table 3 shows how such a table might be constructed with examples of the type of information that would be supplied.

Table 3. Example Table Describing Derivation of Exposure Point Concentrations

Media	Route of Exposure	Receptor	Data Obtained From	Method
Surficial Soil	Direct Contact	Construction Worker	Unpaved Area	Average
Subsurface Soil	Indoor Inhalation	Commercial Worker	Building Footprint	Maximum
Groundwater	Ingestion	Residential	Source Area	Upper Confidence Limit
Soil Vapor	Indoor Inhalation	Commercial Worker	Sub-slab and near soil gas samples	Maximum

As presented in Table 3, an exposure point concentration is estimated for each complete ROE. Various methods available to estimate the exposure point concentrations are discussed in Appendix I. Use of the maximum concentration as the exposure point concentration is most conservative and also the easiest to calculate when compared with other ways of calculating exposure point concentration (average, area-weighted average, upper limit of the confidence interval around the mean). Thus, if the risk that is calculated using the maximum concentration is acceptable, considerable computational effort can be avoided.

4.3.4.1 Soil

Exposure point soil concentrations used to evaluate protection of the groundwater pathway should be calculated based on soil data collected within the source area only.

Soil data from the most recent investigation (assuming it was a comprehensive investigation) should be used. The use of older soil data (more than 4 years old), while discouraged, may be

acceptable if site conditions that would result in an increase in petroleum COI concentrations (such as a new release) have not changed. If a new release has or may have occurred, additional soil assessment activities that adequately characterize current conditions should be performed. New data collection efforts may be documented in a work plan and submitted for approval by DEQ.

4.3.4.2 Groundwater

Based on the SCM, several exposure point groundwater concentrations at a site may have to be estimated. These could include exposure point concentrations for the source area, at compliance locations, for protection of indoor inhalation on-site and off-site, and for off-site areas. Estimation of these concentrations will often require the use of fate and transport models, discussed in section 4.3.5.

In order to account for site-specific conditions such as source characteristics in relation to the depth to groundwater and the age of the release, it is typically necessary to perform multiple sampling events over time to ensure that the potential for the release to impact groundwater has been accounted for and that groundwater concentrations are representative. However, if these factors can be accounted for, it may be possible to perform an RE using data from one sampling event. If temporal data indicate significant variability, additional sampling events may be required prior to conducting the RE. Subsequent to RE, DEQ may require additional monitoring data to be collected. If recent groundwater data (less than one year old) is unavailable, current data may be necessary for the RE. The owner/operator may elect to document data collection objectives in a work plan submitted to DEQ for review and approval.

4.3.4.3 Point of Exposure and Point of Compliance

The point of exposure (POE) is the location where a receptor has or could come in contact with petroleum COIs under current and likely future conditions. A separate POE is associated with each complete exposure pathway-receptor combination identified in the SCM. For direct exposure pathways, the POE is located at the source of the petroleum COIs. For example, for the ingestion of surface soil, the POE is at the same location as the soil source. For indirect exposure pathways, the POE and the source of petroleum COIs are physically separate. For example, for the case of indoor inhalation of vapors from soil, the POE is inside the building (the breathing space) whereas the source is the soil below and adjacent to the building. The POE location for the protection of the groundwater for groundwater ingestion is discussed in section 4.3.3.3.

A point of compliance (POC) is a location where concentrations are measured to determine if compliance with remedial goals has been achieved. Concentration measurements at the POC may be in any media (e.g., soil, groundwater, soil vapor, etc.). The location of a POC may be identical to the POE or may be located between the source and the POE. In the latter case, the target concentrations at the POC are back-calculated to ensure that the concentrations at the POE do not exceed the target concentration at the POE. For example, for the protection of the groundwater pathway, the POC well may serve as a sentry well for protection of the POE. The calculated target levels for the POC are then compared to measured concentrations. POC locations may be predetermined based on program-specific requirements. Most sites, particularly those involving groundwater impacts, will have multiple POC locations.

4.3.4.4 Estimating Point of Compliance Well Concentrations

As a part of the RE process, it is necessary to designate and monitor appropriate POCs. The POCs, located onsite and/or offsite, are used to provide additional assurance that approved concentrations at a selected POE are not exceeded. Monitoring of POC locations is required, and data obtained are compared with approved RATL concentrations. Monitoring of POC locations must be continued until the concentrations stabilize below approved levels. Concentrations at the POC may also be used to determine the need for additional remedial activities.

4.3.5 Fate and Transport and Exposure Models

Different types of models or equations, uptake equations, risk equations, and fate and transport models, are required to calculate chemical intake, risk, exposure point concentrations, and target concentrations. Fate and transport models simulate the transfer of chemicals from one media (such as soil) to another (air). They also are used to simulate the movement of chemicals within a given media, such as the transport of chemicals in groundwater from a source area to a POE. They allow the estimation of concentrations at points distant from the source. A schematic and the equations for each of these models are presented in Appendix E. DEQ has selected the following default fate and transport models:

Indoor Inhalation of Volatile Emissions from Soil and Water: This pathway requires an emissions model and an indoor air-mixing model. These models are combined together and included in the Johnson and Ettinger Model (Johnson and Ettinger, 1991; EPA, 2003). The Johnson and Ettinger Model does not include the effects of attenuation by biodegradation, which may be significant for petroleum COI.

Surficial Soil Outdoor Inhalation: This pathway requires an emissions model for vapors, an emissions model for particulates, and an outdoor air-mixing model. The vapor emissions model used is based on the volatilization model developed by Jury et al. (1983) for an infinite source, the particulate emissions model is the Cowherd model (Cowherd, et al., 1985), and the outdoor air-mixing model is based on a simplified form of the Gaussian Dispersion model. These models are presented in Soil Screening Guidance: Technical Background Document (EPA, 1996a).

Leaching to Groundwater: This pathway uses a three-phase equilibrium partitioning equation to convert soil concentrations to leachate concentrations. These leachate concentrations are then used with a dilution attenuation model to simulate mixing of leachate with regional groundwater. Models used are described in Soil Screening Guidance: Technical Background Document (EPA, 1996).

Horizontal Migration in Groundwater: The Domenico steady-state analytical infinite-source model is used to quantify down-gradient migration of chemicals (Domenico, 1982, 1990). This model incorporates the processes of advection, sorption, three-dimensional dispersion, and degradation.

Alternative models may be used with prior DEQ approval.

4.3.5.1 Fate and Transport Parameters

Fate and transport parameters are necessary in the models used to estimate exposure point concentrations and compliance point concentrations for indirect pathways such as vapor intrusion and protection of groundwater. These parameters characterize the physical site properties such as depth to groundwater, soil porosity, and infiltration rate. DEQ has selected the conservative default values listed in Appendix B. Justification for these parameters is included in Appendix B. For RE, a combination of site-specific and default values for these parameters is typically used. However, the value of each parameter used, whether site-specific or default, must be justified based on site-specific conditions. Where fate and transport models other than those selected by DEQ are used, the specific fate and transport parameters required to calculate exposure point concentrations and risk may vary and have specific data collection requirements.

4.3.5.2 Physical and Chemical Properties of the Petroleum Chemicals of Interest

The development of target levels requires the selection of values for the physical and chemical properties of petroleum COIs. Values of these parameters are listed in Appendix C. To use different values, the owner/operator must provide sufficient justification to DEQ. The use of different values will be allowed only with prior DEQ approval. DEQ will update the data in Appendix C as new information becomes available.

4.3.6 Estimation of Chemical Intake

Risk evaluation requires quantifying the magnitude, frequency, and duration of exposure for the receptor populations and exposure pathways selected for analysis. Oral exposures are quantified on a dose per unit body weight basis while inhalation exposure is based on concentration in air.

4.3.6.1 Exposure Factors

In order to determine receptor and pathway-specific intake estimates, it is necessary to select values for a number of exposure parameters in the equations used to calculate intake. The selection of values for the following parameters is based on an assessment of recommendations in various guidance documents, as well as the open scientific literature. When determining these values, it is often necessary to make assumptions. Details and rationale regarding these assumptions are provided in Appendix A. Exposure assumptions for surface water related pathways are incorporated into the toxics criteria for surface water discussed in section 4.6.

Exposure factors describe the physiological and behavioral characteristics of the receptor. These factors include the following:

- Water ingestion rate,
- Body weight,
- Exposure duration for each ROE,
- Exposure frequency,
- Soil ingestion rate,
- Exposure times for indoor/outdoor inhalation,
- Dermal relative absorption factor,

- Skin surface area for dermal contact with soil,
- Soil-skin adherence factor, and
- Oral relative absorption factor.

A list of default exposure factors values selected by DEQ and justification for their choice is presented in Appendix A. Site-specific values of exposure factors, other than default values, may be used. However, the owner/operator must submit a proposal for the use of alternative values to DEQ for approval, and approval must be obtained before using alternative values for exposure factors.

4.4 Toxicity Assessment

4.4.1 Chemical-Specific Toxicological Factors

The toxicity of chemicals with carcinogenic adverse health effects is quantified using cancer slope factors (CSF) for oral and dermal ROE, or inhalation unit risk (IUR) for the inhalation route. A CSF is an upper-bound estimate of the probability of a response (developing cancer) per unit intake of a chemical over a lifetime. The IUR is the upper-bound excess cancer risk estimated to result from continuous exposure to a chemical at a concentration of 1 $\mu g/m^3$ in air.

For chemicals that cause noncarcinogenic health effects, toxicity is typically quantified by reference doses (RfD) for oral and dermal ROE, and reference concentrations (RfC) for the inhalation ROE. The RfD is an estimate of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without risk of adverse health effects during a lifetime. Since RfDs are based on oral exposure, they are modified for use in dermal exposure assessment to take account of differences between gastrointestinal and dermal absorption. The RfC is an estimate of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of adverse health effects over a lifetime.

The primary source of information for toxicity factors for the petroleum COI is the EPA RSL tables (RSL) (EPA, 2018) found at:
http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm

Toxicity factors selected by DEQ for the petroleum COIs are presented in Appendix D.

Table 4. Default Toxicity Values for Risk Evaluation.

DEFAULT TOXICITY VALUES FOR RISK EVALUATION							
CHEMICALS	**CAS Number[a]**	**Oral Slope Factor (SF_o) (kg-day/mg)**	**Inhalation Unit Risk (IUR) (ug/m^3)**	**Oral Reference Dose (RfD_o) (mg/kg-day)**	**Inhalation Reference Concentration (RfC) (mg/m^3)**	**Oral RA[b] Factor (RAF_o)**	**Dermal RA Factor (RAF_d)**
Benzene	71-43-2	0.055	7.8E-06	0.004	0.03	1	0
Toluene	108-88-3	NA	NA	0.08	5.0	1	0
Ethylbenzene	100-41-4	0.011	2.5E-06	0.1	1.0	1	0
Total Xylenes	1330-20-7	NA	NA	0.2	0.1	1	0
Naphthalene	91-20-3	NA	3.4E-05	0.02	0.003	1	0.13
MTBE[c]	1634-04-4	0.0018	2.6E-07	NA	3.0	1	0
1,2-Dichloroethane	107-06-2	0.091	2.6E-05	0.006	0.007	1	0
Ethylene Dibromide	106-93-4	2	6.0E-04	0.009	0.009	1	0
Acenaphthene	83-32-9	NA	NA	0.06	NA	1	0.13
Anthracene	120-12-7	NA	NA	0.3	NA	1	0.13
Benz(a)anthracene	56-55-3	0.1	1.1E-04	NA	NA	1	0.13
Benzo(a)pyrene	50-32-8	1	1.1E-03	3.0E-04	NA	1	0.13
Benzo(b)fluoranthene	205-99-2	0.1	1.1E-04	NA	NA	1	0.13
Benzo(k)fluoranthene	207-08-9	0.01	1.1E-04	NA	NA	1	0.13
Chrysene	218-01-9	0.001	1.1E-05	NA	NA	1	0.13
Fluoranthene	206-44-0	NA	NA	0.04	NA	1	0.13
Fluorene	86-73-7	NA	NA	0.04	NA	1	0.13

Pyrene	129-00-0	NA	NA	0.03	NA	1	0.13
Notes:							
a Chemical Abstract Service							
b Relative Absorption							
c Methyl tert-butyl ether							
NA: No data available							
Source of toxicity values is the Regional Screening Level Summary Table (May 2018) found at the U.S. EPA Regional Screening Table website. The website is located at http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm.							

4.4.2 Carcinogens with a Mutagenic Mode of Action

Current EPA guidance for risk assessment of carcinogens addresses the potential for increased susceptibility to cancer from exposure to carcinogens that occurs early in life (EPA, 2005a; EPA, 2005b). When information is available to establish the mode of action of a chemical for early-life and adult exposures, it may be appropriate to develop separate risk estimates for childhood exposure and exposure occurring later in life. When the mode of action cannot be established, risk estimates are based on a lifetime daily average exposure without adjustment. Currently, there is sufficient information to develop separate risk estimates only for chemicals having a mutagenic mode of action.

Specifically, when data indicate a mutagenic mode of action for a chemical, meaning that the chemical interacts directly with DNA, available studies indicate higher cancer risk for a given exposure when it occurs early in life compared to a similar exposure in adulthood. Among the petroleum chemicals of interest, the following carcinogenic chemicals are considered mutagens:

- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Benzo(k)fluoranthene
- Chrysene

For these chemicals, the following adjustments are made to risk estimates:

- For exposures between birth and two years of age, a ten-fold adjustment (multiplication factor) is applied. Toxicokinetic and toxicodynamic differences between children and adults are greatest for this age group.
- For exposures occurring to those in the age categories of two to six years of age and between six and sixteen years of age, a three-fold adjustment is applied.
- For exposures occurring after 16 years of age, no adjustment is applied.

These adjustments are combined with corresponding age-specific exposure parameters to assess cancer risk. For a standard residential exposure scenario of 30 years, a ten-fold adjustment is made for the first two years, a three-fold adjustment is made for the next fourteen years, and no adjustment is made for the final fourteen years of the exposure period.

The screening levels are based on unrestricted (residential) exposure; therefore they incorporate the adjustments described here. The effect of the adjustments will be a somewhat higher estimate of risk for a given exposure (and thus somewhat lower screening levels) compared to risk estimates without age-specific adjustment. Calculated risk estimates for residential exposure will incorporate these adjustments, but nonresidential risk estimates will not, as they are based on adult exposure.

4.5 Risk Characterization

The process of risk characterization consists of combining the intake estimates developed through the exposure assessment and toxicity information for the petroleum COIs and calculating carcinogenic risk and noncarcinogenic hazard. Calculations are made for each pathway-receptor combination and are summed to calculate a cumulative risk and a hazard index (HI) for each receptor. These risk results are then presented and discussed in a risk summary and are compared to acceptable target risk levels.

Risk and hazard calculations are completed using a standard set of risk equations provided by the EPA in their User's Guide for RSLs (EPA, 2012) and presented in Appendix E. Estimates made using these equations should be presented using one significant figure, although an additional significant digit should be carried through the supporting calculations, such as when summing risks from multiple petroleum chemicals or pathways, in order to minimize rounding errors. For example, calculated cancer risks would be presented as $1 \times 10^{-4}$and HQs or HIs would be expressed as 2, 0.7, or 0.03.

This risk-based decision-making process specifies the acceptable risk levels for both carcinogenic and noncarcinogenic health effects. For carcinogenic effects, risk is quantified using the individual excess lifetime cancer risk (IELCR) that represents an increase over background in the probability of an individual developing cancer due to exposure to specific petroleum COI through a specific exposure pathway. Since a receptor may be exposed to multiple petroleum chemicals through multiple ROEs, the acceptable risk level should account for the effect of simultaneous exposure to multiple petroleum chemicals and multiple ROEs. Overall site carcinogenic risk is calculated as the sum of the individual chemical risk estimates. The probability of a receptor getting cancer is thus the sum of the probabilities of getting cancer from exposure to each petroleum chemical through each exposure route. In this calculation there is an assumption of independence of action of the individual chemicals. If the carcinogenic actions of different petroleum chemicals are not independent there is the possibility of synergistic interaction in which case risk may be underestimated. However, information is generally not available to address this possibility.

For noncarcinogenic effects, risk is quantified using an HQ that represents the ratio of the estimated dose of a petroleum chemical for a ROE to the reference or allowable dose. When a

receptor is exposed to multiple chemicals and multiple ROEs, individual HQs are added together to estimate the HI.

For site-specific REs, the following target risk criteria must be satisfied at the POE:

Acceptable Target Risk Level: For combined exposure to all carcinogens and ROE, IELCR must be less than or equal to $1x10^{-5}$ for a receptor at a reasonable maximum exposure.

Acceptable HI: The summation of HQs for all petroleum chemicals that have noncarcinogenic health effects and ROE must be less than or equal to 1.

The target risk level and HI must be met for each current and potential future receptor at the site. If the initial calculated HI exceeds 1 further evaluation, including analysis of mode of action and target organ for each petroleum chemical, can be completed. If this analysis indicates sufficient independence of target organs and mode of action for different chemicals, it may be acceptable to present separate HQs, and/or one or more HI for subsets of the chemicals. This kind of analysis should be performed by a toxicologist.

In addition to the target risk levels, DEQ requires that MCLs, or comparable risk-based values for groundwater ingestion, be met at the POE when there is a high probability of groundwater use. When there is a low probability of groundwater use for drinking water, alternate risk-based groundwater target concentrations, based on the other potentially complete exposure pathways identified for the site, must be met at the POE. Similarly, for impacts to surface water bodies, calculated target concentrations must be met.

The risk summary should include an analysis and discussion of the sources of uncertainty so that the risk estimates can be placed in perspective. The uncertainty analysis can be qualitative or quantitative in nature. It is more important during the analysis to identify the key site-related parameters and assumptions in the SCM that contribute the most to the uncertainty than to precisely quantify the degree of uncertainty (EPA, 1989). It is typically the case that there is insufficient information available at a given site to be able to reliably quantify the uncertainty in a given risk estimate, such as through conducting a probabilistic risk assessment or sensitivity analysis. The typical sources of uncertainty that are included in the analysis include the petroleum COIs selected and their estimated site concentrations, the toxicity values used, the fate and transport models used to estimate exposure point concentrations, the exposure parameter values used in the exposure assessment, and the summing of risks from multiple pathways or petroleum chemicals.

4.6 Risk-Based Target Levels

As described in the Risk Characterization section 4.5, if the calculated risk or hazard for all petroleum COIs and complete ROE for identified potential receptors exceeds the Acceptable Target Risk or Hazard Levels and corrective action is required, then risk-based target concentrations (RATLs) to achieve these targets should be calculated. Ingestion of water is not included in this calculation. The procedure used to calculate RATLs requires chemical-specific toxicological factors, receptor-specific exposure factors, fate and transport parameters, physical and chemical properties of the petroleum COIs, and mathematical models. In calculating risk-

based target concentrations, all of these factors, properties, and models are typically the same as used for calculations of other risk-based levels.

Target concentrations should be estimated using an allocated risk process that apportions the acceptable target cumulative risk and HI among the different chemical-pathway combinations. The primary goal is to develop target concentrations in all media such that the acceptable target risk levels and hazard levels are met. There is no standard way to apportion the cumulative risk. To develop RATL concentrations, the default option selected by DEQ apportions cumulative risk and HI equally among all contributing petroleum chemical-pathway combinations such that those petroleum chemicals which contribute the greatest proportion of the total risk have the most stringent remediation standards. This methodology is described in detail, with examples, in Appendix D and is implemented in the computational software provided by DEQ to complement this guidance.

If a petroleum COI has toxicity that is based on both carcinogenic and noncarcinogenic effects, the applicable RATL for that chemical should be the lower of the two calculated allowable concentrations.

Site-specific considerations may result in an owner/operator choosing to utilize a different method for calculating target concentrations. For example, at a site having volatile and semi-volatile petroleum COIs contributing to the cumulative risk, the owner/operator may choose a technology that specifically reduces the volatile chemical's concentrations but marginally reduces the concentration of the semi-volatile chemical. A different owner/operator may choose to significantly reduce the concentration of the semi-volatile chemical and marginally reduce the concentration of the volatile chemical. The two strategies will result in different cleanup levels for each chemical; however, both will be acceptable provided cumulative risk meets the acceptable target risk criteria.

4.6.1 Developing RATL Concentrations for Groundwater and Surface Water Protection

For groundwater and surface water protection, target concentrations are calculated using somewhat different procedures, described below.

4.6.1.1 Groundwater Protection

The RATL concentrations for groundwater ingestion are equivalent to the federal MCLs or a risk-based calculated equivalent. MCLs are health-protective target concentrations promulgated by the EPA and adopted by the state of Idaho for the protection of drinking water and specified groundwater resources. For any petroleum COI that has an MCL, the RATL concentration for groundwater ingestion is equal to the MCL. For any petroleum COI that does not have an MCL, the risk-based equivalent level is calculated using the following input values and equations:

- A target risk level of $1x10^{-6}$ for carcinogenic effects and an HQ of 1 for noncarcinogenic effects,
- The residential exposure factors in Appendix A,
- The toxicity values in Appendix D, and
- Risk equations for the direct ingestion of water.

Calculations are made for residential receptors.

The RATL concentrations will apply at the POE. The POE will be the down-gradient property boundary, as it existed when the release occurred, or the nearest down-gradient location where a well exists or could be reasonably placed. Depending on site-specific conditions it is also possible to have multiple points of exposure.

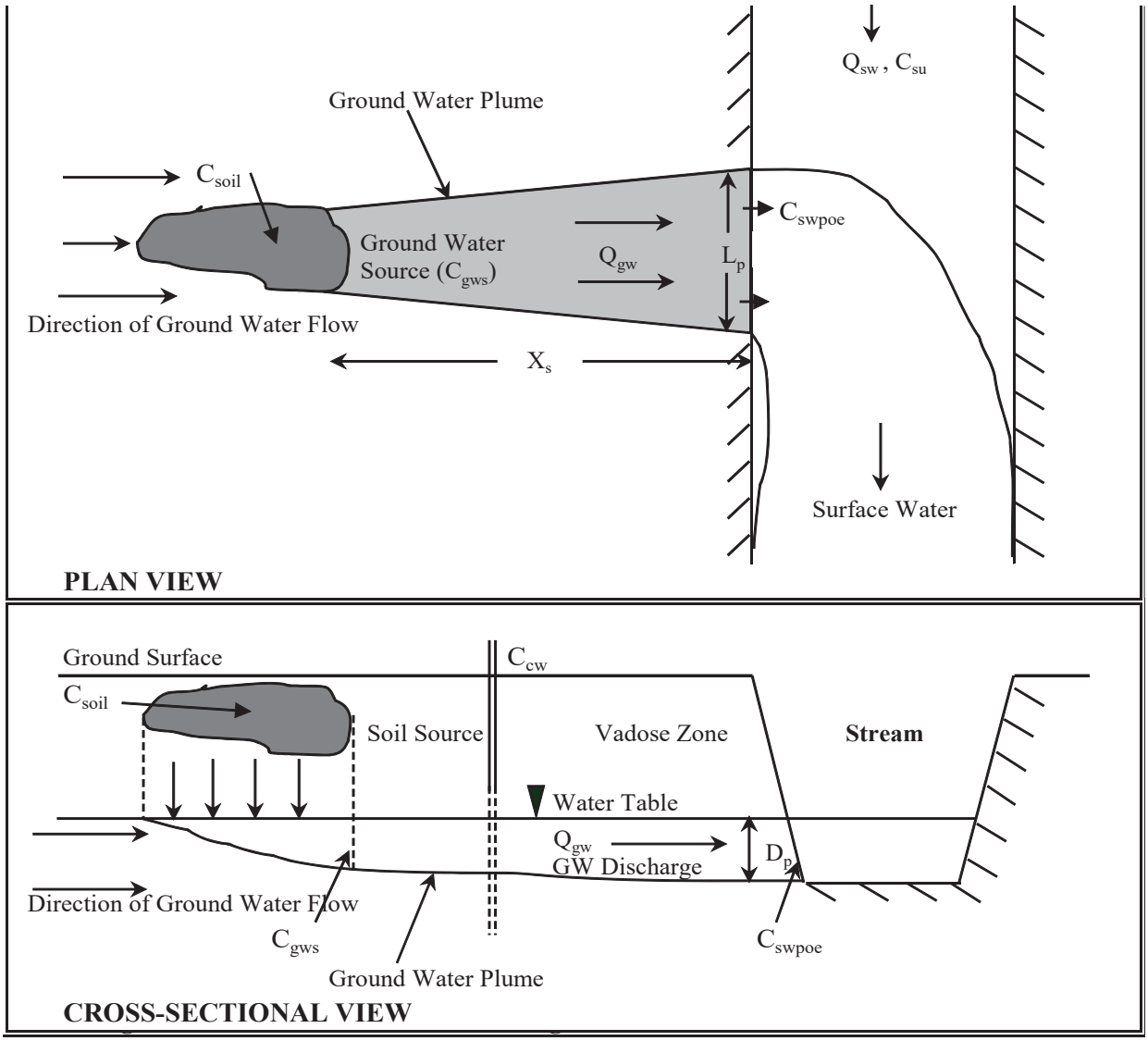
4.6.1.2 Surface Water Protection

Potential impacts to streams and other surface waterbodies from a petroleum release must be evaluated and surface water quality must be protected as per IDAPA 58.01.02 (Water Quality Standards and Wastewater Treatment Requirements). The primary receptors and ROE for potentially impacted surface waters evaluated in the RE process are described in section 4.6.1.2.1. Other ROE, such as contact with contaminated sediments or overland flow discharge, are evaluated on a case-by-case basis.

This section describes the evaluation of potential impacts to surface water via discharge of impacted groundwater to a surface waterbody. A schematic illustrating this exposure pathway is shown in Figure 3. This figure shows the relevant compliance and exposure locations and associated concentrations. Within the RE process, protection of surface waterbodies requires the owner/operator to determine or calculate the applicable surface water standards at the point where groundwater discharges into a surface waterbody (C_{swpoe}). Once the appropriate surface water standard is determined, compliance with the standard may be achieved in a number of ways. These include measuring surface water concentrations at the point of groundwater discharge, measuring groundwater concentrations at the point of discharge into the surface waterbody, or determining appropriate alternate concentrations in other media and at POC locations. Selection of alternate locations may be most appropriate for those sites where contamination has not yet reached a surface waterbody. Alternate concentrations (or RATLs) and POC locations can include:

- Source area soils (C_{soil}), or
- Compliance points in groundwater at different distances between the surface water and the source (C_{cw}) other than the point where groundwater discharges into the surface waterbody.

The owner/operator can back-calculate allowable soil (C_{soil}) and compliance well concentrations (C_{cw}) using dilution attenuation factors (DAFs). Specific equations, combining the Summer's mixing model and the Domenico analytical groundwater transport model, are presented in Appendix E. If measured concentration(s) at the soil source or the compliance well exceeds corresponding allowable concentrations, cleanup to RATL concentrations or performance of a more detailed, site-specific evaluation to refine DAFs are options.



Explanation of Symbols

Q_{sw} = Stream flow upstream of the point of ground water discharge
C_{su} = Concentration upstream of the ground water discharge
Q_{gw} = Impacted ground water discharge into the stream
C_{sw} = Allowable downstream concentration after uniform mixing
C_{swpoe} = Allowable concentration at the point of ground water discharge to the stream
C_{gws} = Allowable concentration in the ground water at the edge of the soil source
C_{soil} = Allowable soil concentration at the source protective of the stream
C_{cw} = Allowable soil concentration in ground water at different distances between the stream and the source
L_p = Width of ground water plume discharging to the stream
D_p = Thickness of ground water plume discharging to the stream
X_s = Distance from the downgradient edge of the ground water source to the stream

Figure 3. Schematic of Leachate Migration from the Soil Source to the Stream

4.6.1.2.1 Surface Water Quality Standards

The allowable concentration at the point of groundwater discharge into the surface water (C_{swpoe}), or the surface water quality standard, depends on the beneficial use designations of the surface waterbody as per IDAPA 58.01.02.100 and criteria assigned to protect those beneficial uses (IDAPA 58.01.02.200-250).

Beneficial uses include:

- Aquatic life: Cold water, salmonid spawning, seasonal cold water, warm water, or modified.
- Recreation: Primary contact or secondary contact.
- Water supply: Domestic, agricultural, or industrial.

Each beneficial use has associated numerical and narrative criteria. Numerical criteria are specified values that are not to be exceeded. For narrative criteria involving toxic substances, concentrations are not specified, but must be low enough to ensure that designated beneficial uses are not impaired. When necessary, development of numeric criteria for toxic substances is governed by IDAPA 58.01.02.210.05.

The allowable concentrations for certain toxic substances associated with these beneficial uses are tabulated in IDAPA 58.01.02.210.01.b .

4.6.2 Determination of Applicable Risk Based Levels

The calculated allowable RATL concentrations for protection of groundwater and/or surface water and those calculated for other potentially complete exposure pathways are compared to determine which media-specific concentrations will guide the cleanup. Typically, the lower of these concentrations will be selected.

Using groundwater as an example, target POE concentrations will be based on the most limiting concentrations determined from evaluation of the complete or potentially complete pathways in addition to the groundwater ingestion pathway. These pathways may include indoor inhalation of vapors volatilized from groundwater, groundwater impacts to surface water, impacts to deeper groundwater systems with the potential for use as drinking water supplies, and also incidental ingestion of and dermal exposure from irrigation water. Also included is potential impairment of other beneficial uses of groundwater such as for agricultural or industrial water supplies.

The applicable POE will be based on the location of the plume (on-site vs. off-site) and which pathway(s) and receptors are limiting with respect to risk and allowable groundwater concentration. In many cases, particularly if a plume has migrated off-site, there may be multiple POE and pathways that will need to be considered.

For example, a petroleum-sourced volatile organic compound (VOC) plume may have migrated off-site into a residential area and have the potential to discharge to a down-gradient stream. Source area groundwater concentrations on-site must be controlled such that concentrations at the POE where groundwater discharges to the stream meet applicable criteria. In addition, unless vapor intrusion has been separately addressed, such as through the use of soil vapor, residential

vapor intrusion criteria in groundwater would need to be met at the down-gradient boundary of the source property and commercial criteria for on-site POE.

4.7 Deliverables

The primary deliverables associated with conducting a site-specific RE typically include an optional work plan for the collection and evaluation of data, an optional data collection report, and the required RE report. In many cases, the results of a data collection effort are combined with the RE report. If the results of the RE report indicate the need for corrective action, a CAP must also be developed and submitted. The contents of CAPs are discussed in Section 5. This section describes the contents of a work plan.

4.7.1 Work Plan

A work plan may be desirable where extensive data collection activities or significant departures from default exposure assumptions or modeling are being proposed.

As appropriate, a work plan to fill identified data gaps may be prepared and submitted to DEQ for review. The amount of detail to be included in the work plan will vary among sites. At sites where a considerable amount of data has already been collected, the work plan may be a brief letter indicating activities to be performed to fill in the data gaps. For a complex or large site, a very detailed work plan, including the SCM, data collection methodology, analysis methods, a data QAPP, and a health and safety plan may need to be developed.

An RE work plan should address each item discussed in sections 4.7.1.1 through 4.7.1.11 as appropriate to the purpose and goals of the RE.

4.7.1.1 Purpose and Goals

The purpose and goals of the work plan should be clearly stated. If the purpose is to fill data gaps, then a listing and description of the data gaps should be provided along with an explanation as to why they constitute data gaps and how the work proposed will fill those gaps.

If the purpose of the work plan is to propose use of alternative models, exposure factors, physical and chemical properties, toxicity factors, or methods of calculating remedial target concentrations, then a rationale should be provided as to why the alternatives proposed are needed. A short description of the scope and nature of the work proposed should be provided.

4.7.1.2 Site Background

This portion of the work plan may refer to documents previously submitted to DEQ; it is not necessary to repeat the entire site background description. Reference should be made to document(s) that contain a comprehensive chronology of site investigations.

4.7.1.3 Site Conceptual Model

A concise summary of the existing SCM should be provided. In those cases where the goal of the work plan is to revise a previously completed RE, then an SCM already exists that can be referenced rather than repeated. If validation or revision of a previous SCM is necessary, those

aspects of the current SCM that are the target of the work plan should be described. Refer to section 4.1 for the suggested content of the SCM.

4.7.1.4 Exposure Factors

If alternate exposure factors values are proposed in the work plan these factors must be justified and acceptable to DEQ. The default exposure factor values are listed in Appendix A.

4.7.1.5 Physical and Chemical Properties

Owner/operators should use the default physical and chemical properties for the petroleum COIs as listed in Appendix C.

4.7.1.6 Toxicity

The Rule specifies that toxicity values for petroleum chemicals listed in Appendix D must be used in the RE.

If additional chemicals need to be included in the RE, as provided for in Section 100.02 of the Rule, their physical chemical properties and toxicity values should be obtained from the EPA RSL website (EPA, 2018).

4.7.1.7 Fate and Transport Models

If alternative models are being proposed, the work plan should include reasons for using alternative models; it should demonstrate that the proposed models will better simulate site-specific conditions, and that the sufficient site-specific data are available or will be collected to justify the use of the proposed model. Alternative models must be approved by DEQ before they are used.

4.7.1.8 Fate and Transport Parameters

Data collection may be proposed to collect site-specific values in lieu of using DEQ default values for fate and transport parameters (listed in Appendix B) used in models for the RE. The parameters for which values are to be obtained should be specified and the methodology used to obtain those values described.

DEQ accepts the use of chemical-specific biological decay rates or attenuation factors in the fate and transport models. Use of decay rates in a RE must use values supported by site-specific information. Refer to Appendices G and H for data necessary to demonstrate occurrence of natural attenuation and methods to calculate decay rates. Examples of this type of information include, but are not limited to:

- Consistent stable or decreasing concentration (above the Residential Use Screening Levels [RUSLs]) trends in properly located and constructed monitoring wells, and
- Measurements of natural attenuation parameters that provide evidence of biodegradation.

4.7.1.9 Calculating RATL Concentrations

The process of calculating target concentrations (RATLs) is described in section 4.6 and Appendix F. If a method of apportioning risk and calculating RATLs different than the DEQ

default method is desired, the proposed methodology and rationale for the choice should be described.

4.7.1.10 Methodology and Quality Control

Work plans in support of data collection efforts should describe the methodology that will be used to obtain the data and provide a clear description of the level of data quality required to meet the stated objectives, and how this data quality will be achieved and ensured.

4.7.1.11 Schedule and Deliverables

The optional work plan should include an overall project schedule and deliverables that will be submitted to DEQ. The schedule should include any agency meetings necessary during work plan implementation.

4.7.2 Implementing the Work Plan

Upon receipt of a work plan approval, the owner/operator should implement the work plan according to the schedule in the work plan. In case there are delays, it is the owner/operator's duty to inform DEQ of the delay and revised schedule. If there were deviations in the work performed from that specified in the approved work plan, DEQ should be notified of the deviations and their impact on the goals and purposes of the work plan.

Upon completion of work specified in the work plan, the owner/operator should document the results and submit them to DEQ. If the purpose of the work plan included data collection, the data collection results can be summarized in a separate data collection report or incorporated into a revised RE report.

4.7.3 Risk Evaluation Report

The RE for a site must be clearly and concisely documented and submitted to DEQ for review. An example outline of an RE report is presented in Appendix J.

Section 5. Developing and Implementing Corrective Action Plans

Development and implementation of a CAP may be necessary if, after the screening level evaluation or site-specific RE, concentrations exceed screening levels or an unacceptable risk is identified and the owner/operator has chosen not to perform additional evaluation. The owner/operator must then develop cleanup criteria (also referred to as remediation standards) and create a CAP to achieve those standards or to ensure that the remaining risk is acceptable. The risk management strategy described in the CAP depends on the results of the RE (which pathways, petroleum chemicals, and media are responsible for the unacceptable risk) and other circumstances unique to the site.

5.1 Contents of a Corrective Action Plan

As required in the Rule, the CAP must include:

- A description of remediation standards selected, points of exposure, and points of compliance,
- A description of the remedial strategy and actions to be taken to achieve the remediation standards,
- Current and future land use and use of groundwater and surface water both onsite and offsite,
- AULs that will be required as part of the remedial strategy and the associated environmental covenants,
- Estimated timeline for completion of remedial actions,
- The monitoring plan to gauge effectiveness of the remedial strategy, and
- A description of practical quantitation limits and background concentrations as they apply to the remediation.

Additional elements that should also be a part of the plan include:

- A brief site description,
- A brief description of the RE approved by DEQ, including assumptions used for receptors and land use, and a list of approved cleanup levels for specific pathways, media, chemicals, and specific areas of the site (if applicable),
- A clear description of reasons a CAP is needed,
- An identification of the area(s) to be managed under the CAP,
- A description of the strategy selected to achieve cleanup goals, including a comparison and evaluation of remedial alternatives considered in development of the overall strategy. A rationale for the strategy selected should be presented; any data collected in support of or to determine the feasibility of a particular remedial measure such as pilot testing, should be presented,
- A description of what QA/QC measures will be implemented to ensure that data collected in support of remedial decision making is of adequate quality,
- A description of project closure requirements, and
- A reporting schedule to document progress of the corrective action.

5.2 Implementing a Corrective Action Plan

The CAP should not be implemented until approved by DEQ. Within 30 days of receiving a CAP, DEQ must provide an approval, an approval with modifications, or a rejection (specifying reasons for the rejection) in writing. Provisions are made in the Rule (Section 200.04) for extending this timeframe.

While DEQ is reviewing the CAP, implementation of interim corrective action measures may take place. However, as provided in IDAPA 58.01.02.852.06.c, owner/operators may, in the interest of minimizing environmental contamination and promoting more effective cleanup, begin cleanup of soil, surface water, and groundwater before the CAP is approved provided that they fulfill certain conditions including:

- Notifying DEQ of their intention to begin cleanup;
- Compliance with any conditions imposed by DEQ, including halting cleanup or mitigating adverse consequences from cleanup activities; and

- Incorporation of these self-initiated cleanup measures in the CAP that is submitted to DEQ for approval.

Typical interim corrective actions include excavating and disposing contaminated soil, removing free product, extracting soil vapor, and pumping and treating groundwater.

Upon approval of the CAP, the owner/operator must implement the plan according to the proposed schedule. All performance data should be submitted to DEQ in a timely manner. This data should be carefully evaluated by both the owner/operator and DEQ to determine if the CAP is progressing as anticipated. Major deviations in schedule or plan implementation should be communicated to DEQ for review and approval well in advance of proposed implementation, along with recommended modifications if necessary. The specific modifications that may be needed will vary from site to site.

When the CAP has been successfully implemented, the owner/operator should document these conditions in a completion report along with a petition to DEQ for site closure.

Section 6. Activity and Use Limitations

An AUL is a restriction or obligation, with respect to real property, that is created by an Environmental Covenant pursuant to the Uniform Environmental Covenants Act (UECA), Chapter 30, Title 55, Idaho Code. It is available at:
http://legislature.idaho.gov/idstat/Title55/T55CH30.htm

The purpose of AULs is to reduce the potential for exposure to contaminants at a release site. AULs are also commonly referred to as "institutional controls." AULs are typically proposed to DEQ for approval through the RE process. Non-remedial land use restrictions (e.g., local zoning ordinances) may reinforce the sustainability of AULs; however, they are not considered sufficient by themselves. These types of non-remedial land use restrictions, such as zoning ordinances, may change or be removed without DEQ approval and therefore are not approved by DEQ as part of a CAP. However, non-remedial land use restrictions may be relevant to evaluating current and reasonably likely future use and exposure scenarios at a site.

6.1 Environmental Covenants

Owner/operators may propose an Environmental Covenant as part of the CAP which will include the AUL language. Any proposed Environmental Covenant must be consistent with UECA. Each proposed Environmental Covenant is reviewed and evaluated on a site specific basis.

Following is a *non-exclusive* list of the types of activity and use limitations that may be included in an Environmental Covenant:

- Restrictions on Water Use:
  - Prohibit use
  - Limit use
  - Monitor use
  - Report use
  - Operation and maintenance procedures for physical controls and devices
  - Prohibit well installation and operation
  - Abandon an existing well.
- Restrictions on Land Use:
  - Prohibit, or require DEQ approval for, disturbance of soil, cap, or vegetation
  - Limit activities and land use
  - Limit structures and buildings.
- Actions Regarding Access:
  - Right of Access necessary to implement the activity and use limitation
  - Limit or deny public access.
- Obligations to perform certain actions in order to maintain the effectiveness of an approved corrective action. For example, this may involve the need to do periodic inspections and maintenance in order to ensure that a cover or barrier retains its primary

function. In this case there might be a specific reference in the Environmental Covenant to an Operations and Maintenance Plan, developed as part of the corrective action.

DEQ has an Environmental Covenant template that owner/operators can use when proposing activity and use limitations as part of a CAP. The DEQ website includes a copy of the latest Environmental Covenant template at *http://www.deq.idaho.gov/environmental-covenants*. The owner/operator can propose an environmental covenant consistent with UECA for consideration and approval by DEQ.

6.2 Specific Application of Activity and Use Limitations at Petroleum Release Sites

Section 600.01 of the Rule outlines the circumstances under which AULs will be included as part of a CAP. These include:

- Where the assumed onsite land use for the purpose of the RE is not residential and either the maximum media concentrations exceed the screening levels or the calculated risk for a residential receptor is unacceptable
- Where off-site groundwater concentrations exceed RUSLs or risk-based concentrations, and
- Where DEQ determines, based on the proposed CAP, that such AULs are required to assure the continued protection of human health and the environment or the integrity of the cleanup action.

6.3 Use of Activity and Use Limitations at Impacted Neighboring Properties

Implementability and enforceability issues become more complicated when an owner/operator proposes use of AULs on impacted neighboring properties. It is the owner/operators's obligation to negotiate language and reach agreement with both the impacted property owner and DEQ.

6.4 Non-Remedial Land Use Restrictions

Non-remedial land use restrictions (e.g., local zoning ordinances) may reinforce the sustainability of AULs; however, they are not considered sufficient by themselves. These types of non-remedial land use restrictions, typically implemented by other governmental agencies, may change or be removed without DEQ approval and therefore are not approved by DEQ as part of a CAP. The presence of such non-remedial restrictions may be relevant when determining the current and likely future uses of impacted properties.

Section 7. References

7.1 References Cited

ASTM, 1990, Practice for Decontamination of Field Equipment Used At Nonradioactive Waste Sites, Designation D-5088-90, American Society for Testing and Materials, West Conshohocken, Pennsylvania.

ASTM, 1995, Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers, Designation: D 5092-95, American Society for Testing and Materials, West Conshohocken, Pennsylvania.

ASTM, 1996, Standard Guide for Selection of Aquifer Test Method in Determining Hydraulic Properties by Well Techniques, Designation: D 4043-96, American Society for Testing and Materials, West Conshohocken, Pennsylvania.

ASTM, 1998, Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass, Method D2216-98, American Society for Testing and Materials, West Conshohocken, Pennsylvania.

ASTM, 1999, Standard Guide for Decommissioning Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities, Standard Guide D5299-99, American Society for Testing and Materials, West Conshohocken, Pennsylvania.

ASTM, 2000a, Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method, Method D2937-00, American Society for Testing and Materials, West Conshohocken, Pennsylvania.

ASTM, 2000b. Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils, Method D2974-00, American Society for Testing and Materials, West Conshohocken, Pennsylvania.

ASTM, 2002, Standard Test Method for Specific Gravity of Soil Solids by Water Pycnometer, Method D854-00, American Society for Testing and Materials, West Conshohocken, Pennsylvania.

Cowherd, C., Muleski, G., Englehart, P., and Gillete, D. 1985. Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination. Prepared for EPA Office of Health and Environmental Assessment. EPA/600/8-85/002.

Domenico, P. A. and V.V. Palciauskas, 1982, Alternative Boundaries in Solid Waste Management, in Ground Water, volume 20, number 3, pages 303 - 311.

Domenico, P. A., 1990, Physical and Chemical Hydrogeology, John Wiley and Sons, New York, New York.

EPA, 1986, RCRA Ground-Water Monitoring Technical Enforcement Guidance Document Draft, OSWER-9950.1, Office of Solid Waste and Emergency Response, Washington, D.C.

EPA, 1992, RCRA Groundwater Monitoring: Draft Technical Guidance, Office of Solid Waste, Washington D.C., November 1992.

EPA, 1994, Air Emissions Models for Waste and Wastewater, EPA-453/R-94-080A, November, 1994, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.

EPA, 1995, Guidance for Data Quality Assessment, External Working Draft, EPA QA/G-9, Quality Assurance Management Staff, Washington D.C.

EPA, 1996, Soil Screening Guidance: Technical Background Document, EPA/540/R-95-128, Office of Solid Waste and Emergency Response, Washington, D.C.

EPA, 1999, USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review, EPA/540/R-99/008, Office of Emergency and Remedial Response, Washington, D.C.

EPA, 2002a, Guidance on Environmental Data Verification and Data Validation, U.S. Environmental Protection Agency, Office of Environmental Information, Washington, D.C., EPA/240/R-02/004, November 2002.

EPA, 2002b, Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers. Ground Water Forum Issue Paper. Technology Innovation Office. OSWER.EPA 542-S-02-001.

EPA, 2003, User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings, Office of Emergency Response and Management, Washington, D.C. June 2003.

EPA, 2005a. Guidelines for Carcinogen Risk Assessment. Risk Assessment Forum. U.S. Environmental Protection Agency, Washington, DC. EPA/630/P-03/001F. March 2005.

EPA. 2005b. Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens. Risk Assessment Forum. U.S. Environmental Protection Agency, Washington, DC. EPA/630/R-03/003F. March 2005.

EPA, 2009b. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance*. U.S. Environmental Protection Agency. Office of Resource Conservation and Recovery. Program Implementation and Information Division. March 2009.

EPA, 2012. United States Environmental Protection Agency Regions 3, 6, and 9. April 2012. Regional Screening Levels for Chemical Contaminants at Superfund Sites. *http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm*

Gilbert, 1987, Statistical Methods for Environmental Pollution Monitoring, Van Nostrand Reinhold Company, NY.

Johnson, P. C. and R. A. Ettinger, 1991, Heuristic Model for Predicting the Intrusion Rate of Contaminant Vapors into Buildings, Environmental Science and Technology, Volume 25(8), Pages 1445-52.

Jury, W.A., W.F. Spencer, and W.J. Farmer, 1983, Behavior Assessment Model for Trace Organics in Soil- 1. Model Description, Journal of Environmental Quality, Volume 12, Pages 558-564.

Page et al., 1982, Method of Soil Analysis, Part 2. Chemical and Microbiological Properties, pp. 570-571, Second Edition.

Wilson, L.G., Lorne G. Everett, and Stephen J. Cullen, 2000, Editors, Handbook of Vadose Zone Characterization and Monitoring, Lewis Publishers, Boca Raton, Florida.

7.2 Additional Resources for Data Collection

EPA, 1988, Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, OSWER-9335.3-01, Office of Solid Waste and Emergency Response, Washington, D.C.

EPA, 1992, Guidance for Data Usability in Risk Assessment, Part A, Office of Solid Waste and Emergency Response, 92857-09A, Office of Emergency and Remedial Response, Washington, D.C.

EPA, 1993, Data Quality Objectives Process for Superfund, Interim Final Guidance, EPA/540-R-93-071, Office of Solid Waste and Emergency Response, Washington, D.C.

EPA, 1994, Guidance for the Data Quality Objectives Process, Office of Research and Development, EPA/600/R-96/055, Washington, D.C.

EPA, 1997, Expedited Site Assessment Tools for Underground Storage Tank Sites, EPA/510 B-97-001, Office of Solid Waste and Emergency Response, Washington, D.C.

EPA, 1998, Guidance for Data Quality Assessment: Practical Methods for Data Analysis, Office of Research and Development, EPA/600/R-96/084, Washington, D.C.

7.3 Additional Resources for Risk Evaluation

ASTM, 1999b, RBCA Fate and Transport Models: Compendium and Selection Guidance, ASTM, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428.

EPA, 1988, Superfund Exposure Assessment Manual, EPA/540/1-88/001, Office of Remedial Response, Washington, D. C.

EPA, 1989a, Risk Assessment Guidance for Superfund, Volume II Environmental Evaluation Manual, Interim Final, EPA/540 1-89/001, Office of Emergency and Remedial Response, Washington, D.C.

EPA, 1989b, Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual (Part A) Interim Final, EPA/540/1-89/002, Superintendent of Documents, Number EP1.8:Su7/3/989, Office of Emergency and Remedial Response, Washington, D.C.

EPA, 1997a, Exposure Factors Handbook Volume 1 General Factors, EPA/600/P-95/002Fa, Office of Research and Development, National Center for Environmental Assessment, Washington, D.C.

EPA, 1997b, Exposure Factors Handbook Volume 2 - Food Ingestion Factors, EPA/600/P-95/002Fb, Office of Research and Development, National Center for Environmental Assessment, Washington, D.C.

EPA, 1997c, Exposure Factors Handbook Volume 3 Activity Factors, EPA/600/P-95/002Fc, Office of Research and Development, National Center for Environmental Assessment, Washington, D. C.

EPA, 2002a, IRIS, Integrated Risk Information System, Office of Research and Development, National Center for Environmental Assessment, Cincinnati, Ohio.

EPA, 2004, Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). EPA-540-R-099-005. July 2004.

EPA, 2009a, Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment). EPA-540-R-070-002. January 2009.

EPA, 2011, Exposure Factors Handbook: 2011 Edition, EPA/600/R-090/052F, Office of Research and Development, National Center for Environmental Assessment, Washington D.C.

Appendix A: Default Exposure Factors

This page intentionally left blank for correct double-sided printing.

Exposure Factors

Risk assessment requires quantifying the magnitude, frequency, and duration of exposure for the receptor populations and exposure pathways selected for analysis. To determine pathway-specific intake estimates, it is necessary to select values for a number of variables in the equations used to calculate intake. The following variables were selected based on an assessment of recommendations in various guidance documents and scientific literature. When determining these values, it is often necessary to make assumptions, and in these cases, the rationale for the assumption is provided. These exposure factors are summarized in Table 1.

Averaging Time

The period over which exposure to chemicals is averaged depends on the type of toxic effect being assessed. For chronic exposure to noncarcinogenic toxicants, intakes are averaged over the period of exposure, so the averaging time is equal to the exposure duration. Intakes of carcinogens are calculated by prorating the total cumulative dose over a lifetime. The different approach is based on the idea that for carcinogens, a higher dose received over a shorter period is equivalent to a corresponding lower dose spread over a lifetime. The averaging time selected for carcinogens, 70 years, is based on the U.S. Environmental Protection Agency's (EPA) *Risk Assessment Guidance for Superfund* (EPA 1989).

Body Weight

It is appropriate to use an average value for this parameter. The default body weight for adult receptors is 70 kilograms (kg) and represents the EPA standard default exposure factor (EPA 1991a). There is evidence presented in the *Exposure Factors Handbook* (EPA 2011) that Americans are getting heavier, and currently the actual average adult body weight is 80 kg. However, the derivation of cancer slope factors assumes a body weight of 70 kg, so it is more appropriate to also use this value for average body weight. The child body weight value is 15 kg, which is the mean value for children aged 6 months to 6 years (EPA 2011). It is also a standard default value in EPA's 1991 *Risk Assessment Guidance for Superfund* (EPA 1991a).

Exposure Duration

The residential exposure duration is the EPA standard default of 30 years (EPA 1991a). This period is divided into 6 years of exposure as a child and 24 years as an adult. These time periods are used in combination with other age group–specific exposure parameters to assess exposure to carcinogenic chemicals. Noncarcinogenic chemical exposure is conservatively assessed using the child receptor and an exposure duration of 6 years. For the nonresidential adult receptor, the exposure duration is 25 years, which is an EPA standard default exposure factor (EPA 1991a) and is also used in *Risk Assessment Guidance for Superfund, Part B* (EPA 1991b). This value was a 95th-percentile value for men in the manufacturing sector, based on an analysis of U. S. Bureau of Labor Statistics data (EPA 2002). An exposure duration of 25 years is considered protective across a wide spectrum of industrial and commercial sectors (EPA 2002) and so is an appropriate default for nonresidential receptors. The exposure duration for the construction

worker is 30 days (0.08 year); this is assumed to be a conservative estimate of exposure for most construction projects.

Exposure Frequency

The exposure frequency for residential receptors is 350 days per year for all exposure routes that do not involve direct contact with soil. This exposure frequency is the EPA standard default exposure factor (EPA 1991a). The nonresidential scenario assumes an exposure frequency of 250 days per year. This value is the EPA standard default for commercial or industrial scenarios (EPA 1991a) and so was considered appropriate for all nonresidential receptors except for construction workers. For the construction worker scenario, the exposure frequency is 30 days per year.

Exposure Frequency for Direct Contact with Soil

For exposure routes involving direct contact with soil—including soil ingestion, dermal exposure, and vapor and particulate inhalation—it is assumed that receptors have contact with soil primarily in warmer months when the ground is not frozen or snow covered. For this reason, an exposure frequency of 270 days per year is used for these exposure routes for the residential scenario; 180 days per year is used for the nonresidential scenario. The direct contact exposure frequency for construction workers is 30 days per year.

Soil Ingestion Rate

The soil ingestion rate for residential child and adult receptors is 200 milligrams per day (mg/day) and 100 mg/day, respectively. These values are EPA standard default exposure factors (1991a). Although both EPA (1991a) and the *Exposure Factors Handbook* (EPA 1997) recommend a soil ingestion rate of 50 mg/day for workers other than construction workers, it was decided to use a value of 100 mg/day to adequately address the potential soil exposures encountered by all nonresidential adult receptors.

For example, a value of 50 mg/day might be appropriate for office workers, but it would not adequately address exposure of outdoor workers, for whom a value of 100 mg/day is more appropriate (EPA 2002). The construction worker soil ingestion rate is 330 mg/day. This value is based on the 95th percentile for adult soil intake rates reported in a soil ingestion mass-balance study (Stanek et al. 1997, cited in EPA 2002).

Water Ingestion Rate

The water ingestion rate for children is 1 liter per day (L/day). Currently EPA uses 1 L/day as a default drinking water ingestion rate for infants and children, and it is considered to be an appropriate upper percentile tap water ingestion rate for children less than 10 years of age (EPA 2008). The residential adult receptor ingestion rate is 2 L/day. This value is an EPA standard default exposure factor (EPA 1991a). According to EPA (1997), the intake rate of 2 L/day corresponds to the 84th percentile of the intake rate distribution among adults in a study by Ershow and Cantor (1989). EPA (1997) lists an average tap water intake for adults of 1.41 L/day. The nonresidential adult ingestion rate is 1 L/day; this value is an EPA standard default exposure factor (EPA 1991a).

Exposure Time for Outdoor Inhalation

Residential receptors are assumed to spend 2 hours outdoors at their residence. This is an EPA-recommended value (1997). Nonresidential receptors are assumed to spend 6 hours outside; this value overestimates exposure of indoor workers, but it is appropriate for outdoor workers. Construction workers are assumed to spend 10 hours per day outdoors, as construction workers often work 10-hour days. These exposure times are used in the inhalation portion of the direct contact equations used to derive screening levels and risk.

Dermal Relative Absorption Factor

The dermal relative absorption factor values are based on recommendations contained in the EPA's *Risk Assessment Guidance for Superfund, Part E, Supplemental Guidance for Dermal Risk Assessment* (EPA 2004). The EPA recommends an absorption factor of 0.13 for benzo(a)pyrene and other polynuclear aromatic hydrocarbons (PAHs) and 0 for volatile organic compounds (VOCs).

Soil-to-Skin Adherence Factor

The soil-to-skin adherence factor values are derived from recommendations from an analysis of soil adherence study data by the EPA (EPA 2004). This analysis calculated body-part-weighted adherence factor values using studies involving upper-end activities for soil-skin adherence and median values of body surface area. The recommended adult residential value, based on a central-tendency-weighted adherence factor of a high-end soil contact activity (e.g., gardening), is consistent with a reasonable maximum exposure (RME) for contact rates in a variety of activities. The same approach of using the high end of a mean is used for the recommended child value, which is the 50th percentile weighted adherence factor for children playing in wet soil. Similarly, the commercial/industrial worker recommended adherence factor is based on the 50th percentile weighted adherence factor for utility workers, a high-end contact activity. For the construction worker, a 95th percentile weighted adherence factor is used to represent RME.

Skin Surface Area for Dermal Contact with Soil

Skin surface areas for dermal soil contact are based on residential and industrial RME recommended values contained in EPA's *Risk Assessment Guidance for Superfund, Part E, Supplemental Guidance for Dermal Risk Assessment* (EPA 2004).

Table 1. Default Exposure Factors

Exposure Parameter	Symbol	Units	Default Value	Reference
Averaging Time (AT)				
Averaging Time—Carcinogen	ATc	years	70	EPA 1989 (p. 6-23)
Averaging Time—Noncarcinogen	ATnc	years	Equivalent to exposure duration	EPA 1989 (p. 6-23)
Body Weight (BW)				
Child	BWc	kg	15	EPA 1991a (p. 15)
Adult	BWa	kg	70	EPA 1991a (p. 15)
Exposure Duration (ED)				
Resident (child)	EDc	years	6	EPA 1991a (p. 15)
Resident (adult)	EDa	years	24	EPA 1991a (p. 15)
Nonresidential Worker	ED	years	25	EPA 1991a (p. 15)
Construction Worker	ED	years	1	EPA 2002 (Exhibit 5-1)
Exposure Frequency (EF)				
Resident	EFr	days/yr	350	EPA,1991a (p.15)
Nonresidential Worker	EF	days/yr	250	EPA 1991a (p.15)
Construction Worker	EF	days/yr	30	Professional judgment
Exposure Frequency for Direct Contact Pathways (EF)				
Resident	EFres	days/yr	270	Professional judgment
Nonresidential Worker	EFd	days/yr	180	Professional judgment
Construction Worker	EFd	days/yr	30	Professional judgment
Soil Ingestion Rate (IR)				
Resident (child)	IRs-c	mg/day	200	EPA 1991a (p. 15)
Resident (adult)	IRs-a	mg/day	100	EPA 1991a (p. 15)
Nonresidential Worker	IRs	mg/day	100	EPA 2002 (Exhibit 1-2)
Construction Worker	IRs	mg/day	330	EPA 2002 (Exhibit 1-2)
Daily Water Ingestion Rate (IRw)				
Resident (child)	IRw-c	L/day	1	EPA 2008
Resident (adult)	IRw-a	L/day	2	EPA 1991a (p. 15)
Nonresidential Worker	IRw	L/day	1	EPA 1991a (p. 15)
Exposure Time for Inhalation (ET)				
Resident (child)	ETo-c	hr/day	Outdoor: 2 Indoor: 24	EPA 1997 (p. 15-17)

Exposure Parameter	Symbol	Units	Default Value	Reference
Resident (adult)	ETo-a	hr/day	Outdoor: 2 Indoor: 24	EPA 1997 (p. 15-17)
Nonresidential Worker	ETo	hr/day	Outdoor: 6 Indoor: 8	Professional judgment
Construction Worker (outdoor only)	ETo	hr/day	10	Professional judgment
Oral Relative Absorption Factor (RAF)				
Oral Relative Absorption Factor	RAFo	—	Assume 100%	EPA 2004 (p. 4-2)
Dermal Relative Absorption Factor (RAFd)				
Volatile organic compounds	RAFd	—	0	EPA 2004 (pg. 3-18)
Benzo(a)pyrene and other polynuclear aromatic hydrocarbons	RAFd	—	0.13	EPA 2004 (Exhibit 3-4)
Soil-to-Skin Adherence Factor (M)				
Residential (child)	Mc	mg/cm^2	0.2	EPA 2004 (p.3-14)
Residential (adult)	Ma	mg/cm2	0.07	EPA 2004 (p. 3-14)
Nonresidential Worker	M	mg/cm^2	0.2	EPA 2004 (p. 3-17)
Construction Worker	M	mg/cm^2	0.3	EPA 2004 (Exhibit 3-3)
Skin Surface Area for Dermal Contact with Soil (SA)				
Child Receptors	SAc	cm^2/day	2800	EPA 2004 (Exhibit 3-5)
Adult Receptors	SAa	cm^2/day	5700	EPA 2004 (Exhibit 3-5)
Nonresidential Worker Receptors	SA	cm^2/day	3300	EPA 2004 (Exhibit 3-5)
Construction Worker Receptors	SA	cm^2/day	3300	EPA 2004 (Exhibit 3-5)

Note: Exposure factors for the age-adjusted resident are calculated from the values listed for child and adult receptors using the equations in Appendix E.

Exposure to Mutagenic Carcinogens

Exposure to these chemicals carries greater risk when it occurs early in life. Therefore, the age at which exposure occurs must be considered for residential receptors. For these receptors, the 30-year exposure duration is divided into four periods: exposures occurring between the ages of 0–2 years, 2–6 years, 6–16 years, and 16–30 years (EPA 2005).

Different multipliers are incorporated for these time periods so that early-life exposure is weighted more heavily. The 0–2 year and 2–6 year exposure periods use the child-specific values for several exposure parameters: body weight, soil ingestion rate, soil-to-skin adherence factor, and skin surface area for dermal contact. The corresponding adult-specific values are used for the 6–16 year and 16–30 year exposure periods.

This page intentionally left blank for correct double-sided printing.

References

EPA (U.S. Environmental Protection Agency). 1989. *Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual, Part A.* EPA/540/1-89/002. United States Environmental Protection Agency, Office of Emergency and Remedial Response.

EPA (U.S. Environmental Protection Agency). 1991a. *Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual Supplemental Guidance, Standard Default Exposure Factors, Interim Final*. OSWER Directive: 9285.6-03. United States Environmental Protection Agency, OSWER.

EPA (U.S. Environmental Protection Agency). 1991b. *Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual, (Part B Development of Risk-based Preliminary Remediation Goals).* EPA/540/R-92/003. United States Environmental Protection Agency, Office of Emergency and Remedial Response.

EPA (U.S. Environmental Protection Agency). 1997. *Exposure Factors Handbook*. EPA/600/P-95/002Fa. United States Environmental Protection Agency, ORD.

EPA (U.S. Environmental Protection Agency). 2002. *Supplemental Guidance for Developing Soil Screening Levels at Superfund Sites*. Office of Emergency and Remedial Response, United States Environmental Protection Agency, OSWER 9355.4-24. December 2002.

EPA (U.S. Environmental Protection Agency). 2004. *Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual, Part E, Supplemental Guidance for Dermal Risk Assessment, Final.* OSWER Directive: 9285.7-02EP. EPA/540/R/99/005. United States Environmental Protection Agency, OSWER. October 2004.

EPA (U.S. Environmental Protection Agency). 2005. *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens*. Risk Assessment Forum, United States Environmental Protection Agency, EPA/630/R-03/003F. March 2005.

EPA (U.S. Environmental Protection Agency). 2008. *Child-Specific Exposure Factors Handbook*. EPA/600/R-06/096F. United States Environmental Protection Agency, NCEA, ORD. September, 2008

EPA (U.S. Environmental Protection Agency). 2011. *Exposure Factors Handbook: 2011 Edition*. EPA/600/R-090/052F. United States Environmental Protection Agency, ORD. September 2011.

Ershow, A.G., and K.P. Cantor. 1989. Total water and tapwater intake in the United States: population-based estimates of quantities and sources. Life Sciences Research Office, Federation of American Societies for Experimental Biology.

Stanek, E.J., E.J. Calabrese, R. Barnes, and P. Pekow. 1997. Soil Ingestion in Adults—Results of a Second Pilot Study. *Ecotoxicology and Environmental Safety* 36:249–257.

This page intentionally left blank for correct double-sided printing.

Appendix B: Default Fate and Transport Parameter Values

This page intentionally left blank for correct double-sided printing.

Introduction

Several routes of exposure evaluated in the *Idaho Risk Evaluation Manual for Petroleum Releases* (REM) involve pathways where chemicals transfer across media. These pathways include inhalation of vapors originating from the volatilization of chemicals of interest (COI) from petroleum-impacted soil or ground water in indoor air, ingestion of ground water containing chemicals leached from soil, and inhalation of volatiles and particulates from surficial soil. Models are used to simulate these cross-media transfer processes, estimate exposure point concentrations, and calculate target levels. This appendix describes the models and selection criteria for the default fate and transport parameter values used to develop the Idaho default screening levels and to some degree the remedial action target levels. A summary of the parameters and sources used to develop them is provided in Table 1 at the end of this appendix.

Soil Properties

Unsaturated Zone

Generic unsaturated zone soil properties were based on an assumed sandy loam soil textural class. Nielson and Rogers (1990) and Hers (2002) present data on average soil physical and hydraulic properties for 12 Natural Resources Conservation Service soil textural classes. Data obtained from these compilations include mean particle diameter, total porosity, saturated moisture content, residual moisture content, van Genuchten parameters describing the shape of the moisture characteristic curve, and saturated hydraulic conductivity. Bulk density was calculated from total porosity. Soil vapor permeability was calculated using van Genuchten equations described in the U.S. Environmental Protection Agency's (EPA) *User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings* (EPA 2003), the hydraulic properties of the sandy loam soil noted above, and average moisture content conditions. Derivation of the average moisture contents is described below.

Infiltration rates for high- and low-precipitation areas of Idaho were developed, and the value for high-precipitation areas is used as the Idaho default target level value. The high-precipitation area annual infiltration rate of 25 centimeters is based on field studies and water balance calculations done in northern Idaho on the Rathdrum Prairie (Hammel et al. 1995). This value represents about 40% of the total annual precipitation. The annual infiltration rate for low-precipitation areas (1.4 centimeters) is based on investigations by Cecil et al. (1992). This latter work was conducted in areas of native vegetation at the Idaho National Laboratory in eastern Idaho. Using stable isotopes and other tracers, a long-term estimate of 1 centimeter per year infiltration was calculated.

This infiltration rate represents approximately 5% of total annual precipitation. This percentage was applied to the total annual precipitation in Boise (11.7 inches/year), with the assumption that Boise conditions represent average low-precipitation conditions.

Average soil moisture content values for low- and high-precipitation conditions were derived by simulating infiltration into a homogeneous soil profile with the sandy loam hydraulic properties discussed above. The variably saturated flow and transport code HYDRUS-1D (Kool and van Genuchten 1991) was used to conduct the simulations. The simulations were run until steady-state conditions were achieved, and the moisture content at that time was noted. These values (0.17 cm^3/cm^3, low precipitation, and 0.20 cm^3/cm^3, high precipitation) are consistent with field capacity (0.33 bar) moisture content values for sandy loam texture class soils presented by Rawls et al. (1982).

The moisture content in the capillary fringe and the capillary fringe thickness were derived using methods and equations described in the EPA *User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings* (2003). The mean particle diameter of 0.03 centimeters used in these calculations is typical of a sandy loam soil type.

The default value for fractional organic carbon content in the vadose zone (0.001) was selected from the statistical analysis of national soil survey data by Carsel et al. (1988). It represents the median value for subsoils with sandy loam textures.

Saturated Zone

The default scenario selected to represent the saturated zone is a sandy, alluvial aquifer of moderate hydraulic conductivity. Selected saturated zone properties and ground water mixing zone thickness were taken from those developed for the soils protective of ground water pathway in Appendix A of the *Risk Based Corrective Action Guidance Document for Petroleum Releases* (DEQ 1996). Total porosity, bulk density, and fraction organic carbon are similar to that of the unsaturated zone soil.

Enclosed Space Parameters

The enclosed space parameters are used in combination with soil and ground water properties to define the conditions controlling the volatilization of COI vapors from petroleum-impacted soil, ground water, and soil vapor into indoor spaces and to predict exposure point concentrations of chemicals in indoor air. Scenarios were developed for residential and nonresidential settings. Both the residential and nonresidential scenarios selected consist of one-story, slab-on-grade structures lying directly over the source of contamination. For structures with finished basements, reasonable values for basement depth below grade of 200 cm and height of enclosed space of 366 cm (EPA 2003) can be assumed. Structures with crawl spaces are not as readily characterized because of the common occurrence of earthen floors and variable size and ventilation. The primary differences between the two scenarios are the size of the structure and the number of air exchanges per time period. The nonresidential structure is larger and exchanges more air than the residential structure.

The size of structure for each scenario was based on residential and commercial building survey data collected by the U.S. Department of Energy (DOE 1995, 2001). Data from the western census region of the 1993 housing survey (DOE 1995) were used to further describe residential structures. In this region, 33% of all homes had heated floor space square footage between 1,000

and 1,599 square feet, constituting the largest proportion of all size classes. Approximately 50% of all homes were one-story, single-family homes. The next largest category was multistory apartment buildings, accounting for 29% of all residential structures. Homes with concrete slabs or crawl spaces each constituted about 33% of all homes, while 15% had basements. A sensitivity analysis evaluating the impact of concrete slabs versus crawl spaces on target levels showed little difference.

For nonresidential structures, data from the mountain division of the western region of the 1999 Commercial Building Energy Consumption Survey was used (DOE 2001). The median square footage per commercial building in this area was 5,000 square feet, and 66% of all buildings in this area were one story. A slab-on-grade foundation and indoor building height of 8 feet were assumed. These values can be modified during the development of a site-specific evaluation to accommodate actual structure conditions.

The default value chosen for air exchange rates in commercial buildings is based on expected values for buildings built to meet ventilation standards of the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE 2004). The default value for residential structures is based on an analysis by the Michigan Department of Environmental Quality (MDEQ 1998). Values for other structural parameters—specifically the dimensions of foundation cracks, wall/foundation thickness, and pressure differentials between the space and the outdoors—are based on data presented in the *User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings* (EPA 2003).

In the Johnson-Ettinger model equations, there is a dependent relationship between the width of foundation cracks (equivalent crack radius) and the fraction of the total floor space below grade occupied by cracks. It was decided to fix the equivalent crack width at 0.1 centimeters and allow the fraction of cracks to vary, with a minimum value of 0.0005 specified, during the calculation of the total area of cracks in the default structure. This minimum value is what is suggested as a reasonable lower end of the range for this parameter by Johnson (2005).

Source characteristics for calculation of indoor air pathways assumed a 1-foot separation distance between the top of the soil or ground water source and the building foundation. This distance is the minimum that can be considered by the model and was considered extremely conservative with respect to maximizing vapor migration into a structure.

For ground water sources, this soil separation distance includes the capillary fringe thickness of 25 centimeters. In making finite mass calculations, the soil source was assumed to be 5 feet (153 centimeters) thick.

Particulate Emission Factor Parameters

All parameter values used in the calculation of the particulate emission factor are taken directly from the EPA's *Soil Screening Guidance* (EPA 1996). Idaho-specific values for the Q/C dispersion factor for a 0.5-acre size source and the average wind speed for Boise were selected as default values.

Models

The default models selected to estimate the transport of chemicals between various media and within select media, such as ground water, include the following:

- The Johnson-Ettinger model (Johnson and Ettinger 1991) for transport of volatile chemicals between soil, soil vapor, or ground water and indoor air—Implementation of the model includes the effects of advection near the building and diffusion to the building from the source and infinite and finite source masses. This model does not incorporate biodegradation of chemicals during transport from the source into the indoor air.
- The dilution attenuation factor model for the soil to ground water pathway implemented in the EPA *Soil Screening Guidance* (EPA 1996)—Soil leachate generated using the high infiltration rate is mixed with ground water having the Darcy velocity described above. Target levels are estimated in ground water directly below the source.
- The Domenico model for transport of chemicals in the saturated zone—This is a steady-state model that includes advection, sorption, three-dimensional dispersion, and decay (Domenico 1990). Equations for calculating dispersivity values for use in the ground water transport model are those derived by Xu and Eckstein (1995).
- The Cowherd equation for transport and dispersion of particulates as described in the EPA *Soil Screening Guidance* (EPA 1996).

Table 1. Default fate and transport parameter values

Parameter	Symbol	Units[a]	Default Value	Reference
Soil Parameters				
Unsaturated Zone Soil				
Source-building separation	LTs	cm	30	Professional judgment, see discussion
Source bottom-building separation	LTSB	cm	183	Professional judgment, see discussion
Vapor permeability	kv	cm^2	5.0E-9	Calculated
Mean particle diameter	D	cm	0.030	EPA 2003
Van Genuchten curve shape parameter	n	—	1.449	EPA 2003
Thickness of capillary fringe zone	hcap	cm	25	EPA 2003
Dilution attenuation factor (DAF) in the unsaturated zone (user-defined)	DAFunsat	—	1	No attenuation in the unsaturated zone is assumed to occur.
Total soil porosity in the vadose zone	θT	cm^3/cm^3-soil	0.39	EPA 2003
Volumetric water content in vadose zone	θws	cm^3/cm^3	0.17	Professional judgment, see discussion
Volumetric air content in vadose zone	θas	cm^3/cm^3	0.22	Calculated
Dry soil bulk density	ρs	g/cm^3	1.64	Nielson and Rogers 1990; Hers 2002
Fractional organic carbon content in the vadose zone	foc	g-C/g-soil	0.001	Carsel et al. 1988
Volumetric water content in the foundation/wall cracks	θwcrack	cm^3/cm^3	0.17	Assumed equal to that in the adjacent soil
Volumetric air content in the foundation/wall cracks	θacrack	cm^3/cm^3	0.22	Calculated
Volumetric water content in capillary fringe zone	θwcap	cm^3/cm^3	0.32	EPA 2003
Volumetric air content in capillary fringe zone	θacap	cm^3/cm^3	0.07	EPA 2003
Saturated Zone Soil				
Dry soil bulk density	ρss	g/cm^3	1.64	Nielson and Rogers 1990; Hers 2002
Fractional organic carbon content	focs	g-C/g-soil	0.001	Professional judgment, see discussion
Total soil porosity	θTs	cm^3/cm^3-soil	0.39	Nielson and Rogers 1990; Hers 2002

Parameter	Symbol	Units[a]	Default Value	Reference
Volumetric water content	θwss	cm^3/cm^3	0.39	Equivalent to total porosity
Volumetric air content	θass	cm^3/cm^3	0.0	
Air Property				
Viscosity of air		g/cm-sec	1.8E-4	
Ground Water Parameters				
Water table-building separation	LTgw	cm	30	Professional judgment, see discussion
Ground water Darcy velocity	Ugw	cm/year	3340	DEQ 1996
Ground water mixing zone thickness	δgw	cm	153	DEQ 1996
Length of ground water source parallel to ground water flow direction	Lmz	cm	1220	Equivalent to source area dimensions
Width of ground water source perpendicular to ground water flow direction	Wgw	cm	1220	Equivalent to source area dimensions
Infiltration rate	I	cm/year	25	Hammel et al. 1995
Enclosed Space Parameters				
Area of the Enclosed Space Below Grade				
Residential—Slab on Grade	AB	cm^2	1488400	Calculated
Residential—Basement	AB	cm^2	2464400	Calculated
Nonresidential	AB	cm^2	4652649	Calculated
Enclosed Space Foundation/Wall Thickness				
Residential	Lcrack	cm	15	EPA 2003
Nonresidential	Lcrack	cm	15	EPA 2003
Total area of Cracks				
Residential	Acrack	cm^2	744	Calculated
Nonresidential	Acrack	cm^2	2326	Calculated
Number of Air Exchanges per Hour				
Residential	ER	1/hour	1	MDEQ 1998
Nonresidential	ER	1/hour	1	ASHRAE 2004
Length of Enclosed Space				
Residential	LB	cm	1220	DOE 1995
Nonresidential	LB	cm	2157	DOE 2001

Parameter	Symbol	Units[a]	Default Value	Reference
Width of Enclosed Space				
Residential	WB	cm	1220	DOE 1995
Nonresidential	WB	cm	2157	DOE 2001
Height of Enclosed Space				
Residential—Slab on Grade	HB	cm	244	EPA 2003
Residential—Basement	HB	cm	366	EPA 2003
Nonresidential	HB	cm	244	Professional judgment
Floor-Wall Seam Perimeter				
Residential	Xcrack	cm	4880	Calculated
Nonresidential	Xcrack	cm	8628	Calculated
Crack depth below grade	Zcrack	cm	15	Calculated
Equivalent crack radius	rcrack	cm	0.1	EPA 2003
Pressure differential between enclosed space and soil surface beneath	ΔP	g/cm-sec^2	40	EPA 2003
Cowherd Particulate Emission Model				
Inverse of the mean concentration at the center of a square source	Q/C	(g/m^2-sec)/ (kg/m^3)	69.41	EPA 1996
Fractional vegetative cover	V	m^2/m^2	0.5	EPA 1996
Mean annual wind speed	Um	m/sec	3.98	EPA 1996
Equivalent threshold value of wind speed at 7 meters	Ut	m/sec	11.32	EPA 1996
Wind speed distribution function from Cowherd et al. 1985	F(x)	—	4.95E-2	EPA 1996
Averaging Time For Vapor Flux				
Resident child	AT	sec	1.89E8	Equal to exposure duration
Resident adult	AT	sec	9.46E8	Equal to exposure duration
Age Adjusted Resident	AT	sec	7.57E8	Equal to exposure duration
Nonresidential adult worker	AT	sec	7.88E8	Equal to exposure duration
Construction worker	AT	sec	3.15E7	Equal to exposure duration
Ground Water Protection				
Distance to the point of exposure	Xpoe	cm	0	Professional judgment
Distance to the point of compliance	Xpoc	cm	0	Professional judgment

[a] cm = centimeters; g = grams; C = carbon; m = meters; sec = seconds; kg = kilograms

This page intentionally left blank for correct double-sided printing.

References

ASHRAE (American Society of Heating, Refrigeration, and Air Conditioning Engineers). 2004. Ventilation for Acceptable Indoor Air Quality. Standard 62.1. American Society of Heating, Refrigeration, and Air Conditioning Engineers.

Carsel, R.F., R.S. Parrish, R.L. Jones, J.L. Hansen, and R.L. Lamb. 1988. Characterizing the Uncertainty of Pesticide Leaching in Agricultural Soils. Journal of Contaminant Hydrology 2:111–124.

Cecil, L.D., J.R. Pittman, T.M. Beasley, R.L. Michel, P.W. Kubik, U. Fehn, and H. Gove. 1992. Water Infiltration Rates in the Unsaturated Zone at the Idaho National Engineering Laboratory Estimated from Chlorine-36 and Tritium Profiles, and Neutron Logging. In: Proceedings of the 7th International Symposium on Water-Rock Interaction-WRI-7, Y.K. Kharaka and A.S. Maest (eds.), Park City, Utah.

Cowherd, C., G. Muleski, P. Englehart, and D. Gillete. 1985. Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination. Prepared for U.S. Environmental Protection Agency, Office of Health and Environmental Assessment. EPA/600/8-85/002.

DEQ (Idaho Department of Environmental Quality). 1996. Risk Based Corrective Action Guidance Document for Petroleum Releases. Boise, ID: DEQ.

DOE (U.S. Department of Energy). 1995. Housing Characteristics 1993. DOE, Energy Information Administration. DOE/EIA-0314 (93).

DOE (U.S. Department of Energy). 2001. Commercial Building Energy Consumption Survey. DOE, Energy Information Administration. Summary Table B2. Available at http://www.eia.doe.gov/emeu/cbecs/

Domenico, P.A. 1990. Physical and Chemical Hydrogeology. New York: John Wiley and Sons.

EPA (U.S. Environmental Protection Agency). 1996. Soil Screening Guidance: Technical Background Document. EPA, Office of Solid Waste and Emergency Response. 9355.4-17A. EPA/540/R-95/128.

EPA (U.S. Environmental Protection Agency). 2003. User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings (Revised). Washington, DC: EPA, Office of Solid Waste and Emergency Response.

Hammel, J.E., R.L. Mahler, and J.J. Hutchings. 1995. Impact of Nitrogen Fertilizer Use in Bluegrass Production on Water Quality of the Rathdrum Prairie Aquifer. Moscow, ID: University of Idaho, Soil Science Department. Final Report. Contract No. 5207. Submitted to Idaho Division of Environmental Quality.

Hers, I. 2002. Input Parameters for OSWER Wide Guidance for Vapor Intrusion Pathway. Technical memorandum to Debbie Newberry, U.S. Environmental Protection Agency, OSW, dated June 3, 2002.

Johnson, P.C. 2005. Identification of Application-Specific Critical Inputs for the 1991 Johnson and Ettinger Vapor Intrusion Algorithm. Ground Water Monitoring and Remediation 25(1):63–78.

Johnson, P.C., and R.A. Ettinger. 1991. Heuristic Model for Predicting the Intrusion Rate of Contaminant Vapors into Buildings. Environmental Science and Technology 25:1445–1452.

Kool, J.B., and M. Th. van Genuchten. 1991. HYDRUS, One-Dimensional Variably Saturated Flow and Transport Model, Including Hysteresis and Root Water Uptake. Research Report 124. Riverside, CA: U.S. Salinity Laboratory.

MDEQ (Michigan Department of Environmental Quality). 1998. Part 201 Generic Groundwater and Soil Volatilization to Indoor Air Inhalation Criteria: Technical Support Document. Lansing, MI: MDEQ, Environmental Response Division.

Nielson, K.K., and V.C. Rogers. 1990. Radon transport properties of soil classes for estimating indoor radon entry. In: Proceedings of the 29th Hanford Symposium of Health and the Environment. Indoor Radon and Lung Cancer: Reality or Myth? Part 1. F.T. Cross (ed.). Richland, WA: Battelle Press.

Rawls, W.J., D.L. Brakensiek, and K.E. Saxton. 1982. Estimation of Soil Water Properties. Transactions of the American Society of Engineers 25(5):1316–1320.

Xu, M., and Y. Eckstein. 1995. Use of Weighted Least-Squares Method in Evaluation and Relationship Between Dispersivity and Field Scale. Ground Water 33(6):905–908.

Appendix C: Default Physical and Chemical Properties

This page intentionally left blank for correct double-sided printing.

Chemicals	CAS Number	Molecular Weight	Water Solubility (milligrams/ liter)	Henry's Law Constant (liters air/ liters water)	Organic Carbon Adsorption Coefficient Koc (milliliters/gram)	Vapor Pressure (millimeters mercury)[a]	Diffusion Coefficient in Air (square centimeters/ second)	Diffusion Coefficient in Water (square centimeters/ second)
Acenaphthene	83-32-9	154.2	3.9	7.5E-03	5027	1.6E-03	0.051	8.3E-06
Anthracene	120-12-7	178.2	0.0434	2.3E-03	16360	2.0E-04	0.039	7.9E-06
Benzene	71-43-2	78.1	1790	2.3E-01	145.8	9.5E+01	0.09	1.0E-05
Benzo(a)anthracene	56-55-3	228.3	0.0094	4.9E-04	176900	1.1E-07	0.026	6.7E-06
Benzo(a)pyrene	50-32-8	252.3	0.0016	1.9E-05	587400	5.5E-09	0.048	5.6E-06
Benzo(b)fluoranthene	205-99-2	252.3	0.0015	2.7E-05	599400	5.0E-07	0.048	5.6E-06
Benzo(k)fluoranthene	207-08-9	252.3	0.0008	2.4E-05	587400	9.6E-11	0.048	5.6E-06
Chrysene	218-01-9	228.3	0.002	2.1E-04	180500	6.3E-09	0.026	6.7E-06
1,2-Dichloroethane	107-06-2	99.0	8600	4.8E-02	40	8.7E+01	0.086	1.1E-05
Ethylbenzene	100-41-4	106.2	169	3.2E-01	446	1.0E+01	0.068	8.5E-06
Ethylene Dibromide	106-93-4	187.9	3910	2.7E-02	40	1.1E+01	0.043	1.0E-05
Fluoranthene	206-44-0	202.3	0.26	3.6E-04	55450	5.0E-06	0.028	7.2E-06
Fluorene	86-73-7	166.2	1.69	3.9E-03	9160	1.0E-04	0.044	7.9E-06
MTBE	1634-04-4	88.2	51000	2.4E-02	12	2.49E+02	0.075	8.6E-06
Naphthalene	91-20-3	128.0	31	1.8E-02	1544	2.3E-01	0.06	8.4E-06
Pyrene	129-00-0	202.3	0.135	4.9E-04	54340	6.9E-07	0.028	7.2E-06
Toluene	108-88-3	92.1	526	2.7E-01	234	2.2E+01	0.078	9.2E-06
Total Xylenes	1330-20-7	106.2	106	2.7E-01	383	8.8 E+00	0.069	8.5E-06

Note: Values for physical and chemical properties (with the exception of vapor pressure) are taken from the U.S. Environmental Protection Agency regional screening levels website (accessed May 2018) chemical specific parameter supporting table

[a] Values for vapor pressure at 20–25 degrees Celsius were obtained from the *Groundwater Chemicals Desk Reference, Volume 1* by John H. Montgomery and Linda M. Welkom (1991, Lewis Publishers) and the *Groundwater Chemicals Desk Reference, Volume 2* by John H. Montgomery (1991, Lewis Publishers).

This page intentionally left blank for correct double-sided printing.

Appendix D: Default Toxicity Values

This page intentionally left blank for correct double-sided printing.

The table below provides a list of the default carcinogenic and noncarcinogenic toxicity factors and oral and dermal relative absorption factors used in the risk evaluation process. All toxicity factor values, oral relative absorption factors, and dermal relative absorption factors for polynuclear aromatic hydrocarbons were obtained from the U.S. Environmental Protection Agency (EPA) regional screening level website and are current as of May 2018:

http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm

In their *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual* (Part E, Supplemental Guidance for Dermal Risk Assessment), the EPA did not provide dermal relative absorption factors for volatile organic compounds based on the rationale that these compounds would tend to be volatilized from the soil on skin. Based on this rationale, the dermal relative absorption factors for volatile organic compounds is assumed to be zero.

Chemicals	CAS Number	Oral Slope Factor (kg-day/mg)[a]	Unit Inhalation Risk (µg/m^3)[b]	Oral Reference Dose (mg/kg-day)[c]	Inhalation Reference Concentration (mg/m^3)[d]	Oral Relative Absorption Factor	Dermal Relative Absorption Factor
Acenaphthene	83-32-9	NA	NA	6.0E-2	NA	1	0.13
Anthracene	120-12-7	NA	NA	3.0E-1	NA	1	0.13
Benzene	71-43-2	5.5E-2	7.8E-6	4.0E-3	3.0E-2	1	0
Benzo(a)anthracene	56-55-3	0.1	1.1E-4	NA	NA	1	0.13
Benzo(a)pyrene	50-32-8	1	1.1E-3	0.0003	NA	1	0.13
Benzo(b)fluoranthene	205-99-2	0.1	1.1E-4	NA	NA	1	0.13
Benzo(k)fluoranthene	207-08-9	0.01	1.1E-4	NA	NA	1	0.13
Chrysene	218-01-9	0.001	1.1E-5	NA	NA	1	0.13
1,2-Dichloroethane	107-06-2	9.1E-2	2.6E-5	6.0E-3	7.0E-3	1	0
Ethylbenzene	100-41-4	1.1E-2	2.5E-6	1.0E-1	1.0E0	1	0
Ethylene Dibromide	106-93-4	2.0E0	6.0E-4	9.0E-3	9.0E-3	1	0
Fluoranthene	206-44-0	NA	NA	4.0E-2	NA	1	0.13
Fluorene	86-73-7	NA	NA	4.0E-2	NA	1	0.13
MTBE	1634-04-4	1.8E-3	2.6E-7	NA	3.0E0	1	0
Naphthalene	91-20-3	NA	3.4E-5	2.0E-2	3.0E-3	1	0.13
Pyrene	129-00-0	NA	NA	3.0E-2	NA	1	0.13
Toluene	108-88-3	NA	NA	8.0E-2	5.0E0	1	0
Total Xylenes	1330-20-7	NA	NA	2.0E-1	1.0E-1	1	0

[a] kg-day/mg = kilogram-day per milligram
[b] µg/m^3 = microgram per cubic meter
[c] mg/kg-day = milligram per kilogram-day
[d] mg/m^3 = milligram per cubic meter

This page intentionally left blank for correct double-sided printing.

Appendix E: Models and Equations

This page intentionally left blank for correct double-sided printing.

TABLE OF CONTENTS

1 Target Levels for Non-Residential and Construction Worker Exposures 1
1.1 Indoor Inhalation of Vapor Emissions 1
1.2 Outdoor Inhalation of Vapors and Particulates from Surficial Soil 2
1.3 Direct Ingestion of Surficial Soil 3
1.4 Dermal Contact with Surficial Soil 4
1.5 Combined Direct Contact Soil Pathway: Ingestion, Inhalation of Vapors and Particulates, and Dermal Contact 5
1.6 Subsurface Soil Concentrations Protective of Indoor Vapor Inhalation 6
1.7 Ground Water Concentrations Protective of Indoor Vapor Inhalation 7
1.8 Direct Ingestion of Ground Water 8
1.9 Johnson and Ettinger Infinite Source Model 9
1.10 Johnson and Ettinger Finite Source Model 11
2 Target Levels for Residential Exposures 12
2.1 Indoor Inhalation of Vapor Emissions 12
2.2 Outdoor Inhalation of Vapors and Particulates from Surficial Soil 13
2.3 Direct Ingestion of Surficial Soil 14
2.4 Dermal Contact with Surficial Soil 15
2.5 Combined Direct Contact Soil Pathway: Ingestion, Inhalation of Vapors and Particulates, and Dermal Contact 16
2.6 Subsurface Soil Concentrations Protective of Indoor Vapor Inhalation 17
2.7 Ground Water Concentrations Protective of Indoor Vapor Inhalation 18
2.8 Direct Ingestion of Ground Water 19
3 Target Levels for Ground Water Resource Protection 20
3.1 Domenico Model: Dilution Attenuation Factor (DAF) in the Saturated Zone 20
3.2 Soil to Ground Water Leaching Factor 21
3.3 Soil Saturation Limit 22
3.4 Soil and Ground Water Concentration for Ground Water Protection 23
4 Volatilization Factor, Particulate Emission Factor, and Effective Diffusion Coefficients 24
4.1 Volatilization Factor from Surface Soil to Outdoor (ambient) Air 24
4.2 Particulate Emission Factor 25
4.3 Effective Diffusion Coefficients 25
4.3.1 Effective Diffusion Coefficient in Soil 25
4.3.2 Effective Diffusion Coefficient between Ground Water and Surface Soil 26
4.3.3 Effective Diffusion Coefficient In Capillary Fringe Soil 26
4.3.4 Effective Diffusion Coefficient In Foundation/Wall Cracks 27
4.4 Water Content in Soil in the Capillary Fringe 27
References 29

This page intentionally left blank for correct double-sided printing.

1 Target Levels for Non-Residential and Construction Worker Exposures

1.1 Indoor Inhalation of Vapor Emissions

Carcinogenic effects

$$RBTL_{ai} = \frac{TR \times AT_c \times 365}{ED \times EF \times ET_i \times IUR \times 1000}$$

Noncarcinogenic effects

$$RBTL_{ai} = \frac{THQ \times AT_{nc} \times 365}{ED \times EF \times ET_i \times \left(\frac{1}{RfC}\right)}$$

Source: EPA 2009, modified from equations 6 and 11

Where:

$RBTL_{ai}$	=	Risk-based target level for indoor air inhalation [mg/m^3]
TR	=	Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ	=	Target hazard quotient for individual constituents [-]
AT_c	=	Averaging time for carcinogens [years]
AT_{nc}	=	Averaging time for noncarcinogens [years]
ED	=	Exposure duration [years]
EF	=	Exposure frequency [days/year]
ET_i	=	Exposure time for indoor inhalation [hours/day]
RfC	=	Chemical-specific inhalation reference concentration [mg/m^3]
IUR	=	Chemical-specific inhalation unit risk [(µg/m^3)$^{-1}$]
365	=	Conversion factor [days/year]

1.2 Outdoor Inhalation of Vapors and Particulates from Surficial Soil

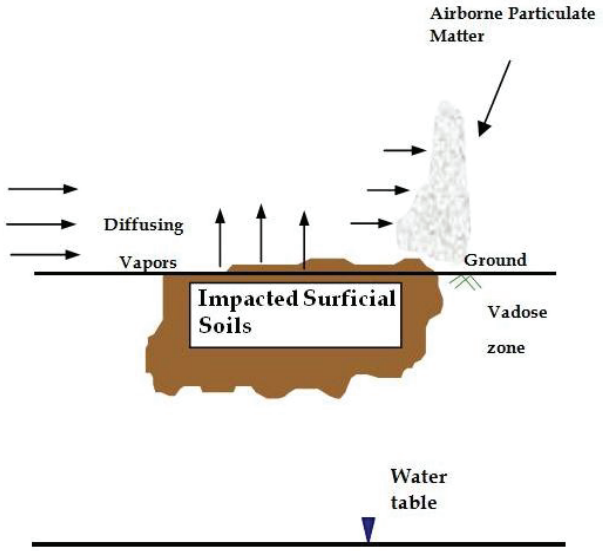
Carcinogenic effects

$$RBTL_{SS} = \frac{TR \times AT_c \times 365}{ED \times EF_d \times ET \times IUR \times \left(\frac{1}{VF} + \frac{1}{PEF}\right) \times 1000}$$

Noncarcinogenic effects

$$RBTL_{SS} = \frac{THQ \times AT_{nc} \times 365}{ED \times EF_d \times ET \times \left(\frac{1}{RfC}\right) \times \left(\frac{1}{VF} + \frac{1}{PEF}\right)}$$

Source: EPA 2011



Where:

$RBTL_{SS}$	=	Risk-based target level for outdoor inhalation of vapors and particulates from surficial soil [mg/kg dry weight]
TR	=	Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ	=	Target hazard quotient for individual constituents [-]
VF	=	Surficial soil to ambient air volatilization factor [(m^3-air)/(kg-soil)]
PEF	=	Particulate emission factor [(m^3-air)/(kg-soil)]
AT_c	=	Averaging time for carcinogens [years]
AT_{nc}	=	Averaging time for noncarcinogens [years]
ED	=	Exposure duration [years]
EF_d	=	Exposure frequency for direct contact pathway [days/year]
ET	=	Exposure time [hours/day]
RfC	=	Chemical-specific inhalation reference concentration [mg/m^3]
IUR	=	Chemical-specific inhalation unit risk [$(\mu g/m^3)^{-1}$]
365	=	Conversion factor [days/year]

1.3 Direct Ingestion of Surficial Soil

Carcinogenic effects

$$RBTLs = \frac{TR \times BW \times AT_c \times 365}{SF_o \times EF_d \times ED \times IR_s \times RAF_o \times 10^{-6}}$$

Noncarcinogenic effects

$$RBTLs = \frac{THQ \times BW \times AT_{nc} \times 365}{EF_d \times ED \times \left(\frac{1}{RAF_o \times RfD_o}\right) IR_s \times 10^{-6}}$$

Source: EPA 1996, p. 19

Where:

$RBTLs$	=	Risk-based target level for the ingestion of soil [mg/kg-wet soil]
TR	=	Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ	=	Target hazard quotient for individual constituents [-]
BW	=	Body weight [kg]
AT_c	=	Averaging time for carcinogens [years]
AT_{nc}	=	Averaging time for noncarcinogens [years]
ED	=	Exposure duration [years]
EF_d	=	Exposure frequency [days/year]
IR_s	=	Soil ingestion rate [mg/day]
RAF_o	=	Oral relative absorption factor [-]
RfD_o	=	Chemical-specific oral reference dose [mg/(kg-day)]
SF_o	=	Chemical-specific oral cancer slope or potency factor $[mg/(kg\text{-}day)]^{-1}$
365	=	Conversion factor [days/year]
10^{-6}	=	Conversion factor [kg/mg]

1.4 Dermal Contact with Surficial Soil

Carcinogenic effects

$$RBTL_{DC} = \frac{TR \times BW \times AT_c \times 365}{SF_o \times SA \times M \times RAF_d \times ED \times EF_d \times 10^{-6}}$$

Noncarcinogenic effects

$$RBTL_{DC} = \frac{THQ \times BW \times AT_{nc} \times 365}{SA \times M \times \left(\frac{1}{RfD_o \times RAF_d}\right) \times ED \times EF_d \times 10^{-6}}$$

Source: Modified from EPA 1989, p. 6-41; See also EPA 2007, Appendix D, p. D-6

Where:

$RBTL_{DC}$	=	Risk-based target level for dermal contact with soil [mg/kg-wet soil]
TR	=	Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ	=	Target hazard quotient for individual constituents [-]
BW	=	Body weight [kg]
AT_c	=	Averaging time for carcinogens [years]
AT_{nc}	=	Averaging time for noncarcinogens [years]
ED	=	Exposure duration [years]
EF_d	=	Exposure frequency for direct contact pathway [days/year]
RAF_d	=	Dermal relative absorption factor [-]
SA	=	Skin surface area [cm^2/day]
M	=	Soil to skin adherence factor [mg/cm^2]
RfD_o	=	Chemical-specific oral reference dose [mg/(kg-day)]
SF_o	=	Chemical-specific oral cancer slope or potency factor $[mg/(kg\text{-}day)]^{-1}$
365	=	Conversion factor [days/year]
10^{-6}	=	Conversion factor [kg/mg]

1.5 Combined Direct Contact Soil Pathway: Ingestion, Inhalation of Vapors and Particulates, and Dermal Contact

Carcinogenic effects

$$RBTL_{ss-combined} = \frac{TR \times BW \times AT_c \times 365}{ED \times EF_d \times SF_o \times 10^{-6}\left[\left(IR_s \times RAF_o\right) + \left(SA \times M \times RAF_d\right)\right]} + \frac{TR \times AT_c \times 365}{ED \times EF_d \times ET \times IUR \times \left(\frac{1}{VF} + \frac{1}{PEF}\right) \times 1000}$$

Noncarcinogenic effects

$$RBTL_{ss-combined} = \frac{THQ \times BW \times AT_{nc} \times 365}{ED \times EF_d \times 10^{-6} \times \frac{1}{RfD_o}\left[\left(IR_s \times RAF_o\right) + \left(SA \times M \times RAF_d\right)\right]} + \frac{THQ \times AT_{nc} \times 365}{ED \times EF_d \times ET \times \frac{1}{RfC}\left(\frac{1}{VF} + \frac{1}{PEF}\right)}$$

Note: All parameters are defined under the individual pathway equations above (sections 1.2–1.4).

1.6 Subsurface Soil Concentrations Protective of Indoor Vapor Inhalation

$$RBTL_{si} = \frac{RBTL_{ai}}{\alpha} * EF$$

Where:

$RBTL_{si}$ = Risk-based target level for indoor inhalation of vapors from subsurface soils [mg/kg-dry soil]

$RBTL_{ai}$ = Risk-based target level for indoor inhalation of air [mg/m^3-air]

α = Chemical-specific attenuation factor from subsurface soil to indoor (enclosed space) air derived from the Johnson-Ettinger model [-]

EF = Equilibrium factor to convert vapor target level to total soil target level

$$= \frac{\theta_{ws} + (K_D \rho_s) + (H \theta_{as})}{(H \rho_s)} * 0.001$$

Where:

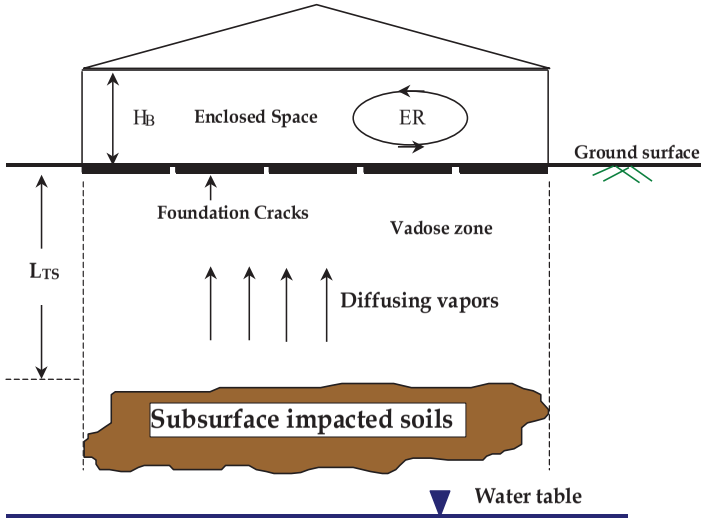
ρ_s = Dry soil bulk density [g-soil/cm^3-soil]

H = Chemical-specific Henry's Law constant [(L-H_2O)/(L-air)]

θ_{as} = Volumetric air content in the vadose zone soils [cm^3-air/cm^3-soil]

θ_{ws} = Volumetric water content in vadose zone soils [cm^3-H_2O/cm^3- soil]

K_D = $f_{oc} \times K_{oc}$ = Chemical-specific soil-water sorption coefficient [cm^3-H_2O/g-soil]



1.7 Ground Water Concentrations Protective of Indoor Vapor Inhalation

$$RBTL_{wi} = \frac{RBTL_{ai}}{\alpha} * EF$$

Where:

$RBTL_{wi}$ = Risk-based target level for indoor inhalation of vapors from ground water [mg/L-H_2O]

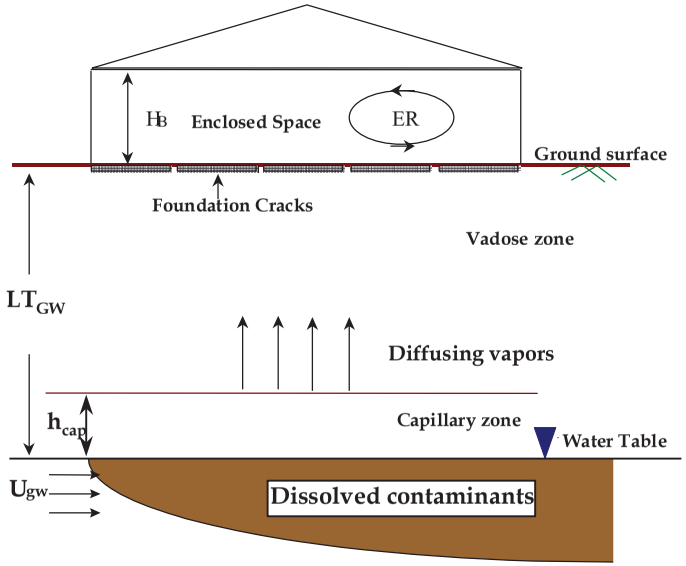
$RBTL_{ai}$ = Risk-based target level for indoor inhalation of air (mg/m^3-air)

α = Chemical-specific attenuation factor from ground water to indoor (enclosed space) air derived from the Johnson-Ettinger model [-]

EF = Equilibrium factor to convert vapor target level to water target level
= (1/H)*0.001m^3/L

Where:

H = Henry's Law Constant [-]



1.8 Direct Ingestion of Ground Water

Carcinogenic effects

$$RBTL_w = \frac{TR \times BW \times AT_c \times 365}{IR_w \times ED \times EF \times SF_o}$$

Noncarcinogenic effects

$$RBTL_w = \frac{THQ \times BW \times AT_{nc} \times 365}{IR_w \times \left(\frac{1}{RfD_o}\right) \times ED \times EF}$$

Source: Modified from EPA 1989, p. 6-35

Where:

$RBTL_w$	=	Risk-based target level for ingestion of ground water [mg/L-H_2O]
TR	=	Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ	=	Target hazard quotient for individual constituents [-]
BW	=	Body weight [kg]
AT_c	=	Averaging time for carcinogens [years]
AT_{nc}	=	Averaging time for noncarcinogens [years]
IR_w	=	Water ingestion rate [L/day]
ED	=	Exposure duration [years]
EF	=	Exposure frequency [days/year]
RfD_o	=	Chemical-specific oral reference dose [mg/(kg-day)]
SF_o	=	Chemical-specific oral cancer slope or potency factor [mg/(kg-day)]$^{-1}$
365	=	Conversion factor [days/year]

1.9 Johnson and Ettinger Infinite Source Model

The model predicts the vapor concentration inside a building from the measured soil-vapor, soil, or ground water concentration.

$$C_{building} = \alpha \times C_{source}$$

Where:

$$C_{source} = \frac{H \times C_{soil} \times \rho_s}{\theta_{ws} + K_d \times \rho_s + H \times \theta_{as}}$$

OR

$$C_{source} = H \times C_w$$

OR

C_{source} = Measured soil-vapor concentration [mg/L]

$C_{building}$ = Steady-state vapor-phase concentration in the building [mg/L]
α = Attenuation coefficient in the vapor phase [-]
C_{source} = Vapor-phase concentration at the source [mg/L]
C_{soil} = Concentration in soil [mg/kg]
C_w = Concentration in ground water [mg/L]
H = Chemical-specific Henry's Law constant [(L-H_2O)/(L-air)]
ρ_s = Dry soil bulk density [g-soil/cm^3-soil]
θ_{ws} = Volumetric water content in vadose zone soils [cm^3-H_2O/cm^3-soil]
K_d = $f_{oc} \times K_{oc}$
= Chemical-specific soil-water sorption coefficient [cm^3-H_2O/g-soil]
θ_{as} = Volumetric air content in vadose zone soils [cm^3-air/cm^3-soil]

$$\alpha = \frac{\frac{D_T^{eff} A_B}{Q_{building} L_T} \times EXP\left(\frac{Q_{soil} L_{crack}}{D_{crack}^{eff} A_{crack}}\right)}{EXP\left(\frac{Q_{soil} L_{crack}}{D_{crack}^{eff} A_{crack}}\right) + \frac{D_T^{eff} A_B}{Q_{building} L_T} + \frac{D_T^{eff} A_B}{Q_{soil} L_T} \times \left[EXP\left(\frac{Q_{soil} L_{crack}}{D_{crack}^{eff} A_{crack}}\right) - 1\right]}$$

Source: EPA 2003

D_T^{eff} = Total overall effective diffusion coefficient [cm^2/s]
D_{crack}^{eff} = Effective diffusion coefficient through cracks [cm^2/s]
A_B = Area of the enclosed space below grade [cm^2]
$Q_{building}$ = Building ventilation rate [cm^3/s]
L_T = Source-building separation [cm]
Q_{soil} = Volumetric flow rate of soil gas into the enclosed space [cm^3/s]
L_{crack} = Enclosed space foundation or slab thickness [cm]
A_{crack} = Total area of cracks [cm^2]

1.9 Johnson and Ettinger Infinite Source Model (continued)

Where:

$$Q_{building} = L_B W_B H_B ER$$

$$Q_{soil} = \frac{2\pi \Delta P k_v X_{crack}}{\mu \ln\left(\frac{2Z_{crack}}{r_{crack}}\right)}$$

For vapor release from soil:

$$D_T^{eff} = \frac{L_T}{\sum_{i=0}^{n} \frac{L_i}{D_i^{eff}}}$$

For vapor release from ground water:

$$D_T^{eff} = D_s^{eff} \qquad D_{crack}^{eff} = D_s^{eff}$$

$$D_T^{eff} = D_{ws}^{eff} = \frac{L_T}{\frac{h_{cap}}{D_{cap}^{eff}} + \frac{\left(L_T - h_{cap}\right)}{D_s^{eff}}} \qquad h_{cap} = \frac{0.75}{D}$$

$Q_{building}$	=	Building ventilation rate [cm^3/s]
L_B	=	Length of building [cm]
W_B	=	Width of building [cm]
H_B	=	Height of building [cm]
ER	=	Air exchange rate [1/s]
Q_{soil}	=	Volumetric flow rate of soil gas into the enclosed space [cm^3/s]
π	=	3.14159
ΔP	=	Pressure differential between the soil surface and the enclosed space [$g/cm\text{-}s^2$]
k_v	=	Soil vapor permeability [cm^2]
X_{crack}	=	Floor-wall seam perimeter [cm]
μ	=	Viscosity of air [g/cm-s]
Z_{crack}	=	Crack depth below grade [cm]
r_{crack}	=	Equivalent crack radius [cm]
D_T^{eff}	=	Total overall effective diffusion coefficient [cm^2/s]
L_T	=	Source-building separation [cm]
L_i	=	Thickness of soil layer *i* [cm]
D_i^{eff}	=	Effective diffusion coefficient in soil layer *i* [cm^2/s]
n	=	Number of soil layers [-]
D_s^{eff}	=	Effective diffusion coefficient in soil [cm^2/s]
D_{ws}^{eff}	=	Effective diffusion coefficient in capillary fringe [cm^2/s]
h_{cap}	=	Thickness of capillary fringe zone [cm]
D_{cap}^{eff}	=	Effective diffusion coefficient in the capillary fringe soil [cm^2/s]
D_{crack}^{eff}	=	Effective diffusion coefficient in the foundation/wall cracks [cm^2/s]
D	=	Mean particle diameter [cm]

1.10 Johnson and Ettinger Finite Source Model

The model predicts the vapor concentration inside a building from the measured soil concentration when the thickness of soil contamination is known.

$$C_{building} = \alpha \times C_{source}$$

Where:

$$C_{source} = \frac{H \times C_{soil} \times \rho_s}{\theta_{ws} + K_d \times \rho_s + H \times \theta_{as}}$$

$$\alpha = \frac{\rho_s \; C_{soil} \; \Delta H_c \; A_B}{Q_{building} \; C_{source} \; \tau} \left(\frac{L_T^0}{\Delta H_c} \right) \left[\left(\beta^2 + 2 \; \psi \; \tau \right)^{1/2} - \beta \right]$$

$$\beta = \left(\frac{D_T^{eff} \; A_B}{L_T^0 \; Q_{soil}} \right) \left[1 - \exp\left(- \frac{Q_{soil} \; L_{crack}}{D_{crack}^{eff} \; A_{crack}} \right) \right] + 1$$

$$\psi = \frac{D_T^{eff} \; C_{source}}{\left(L_T^0 \right)^2 \; \rho_s \; C_{soil}}$$

$$\tau_D = \frac{\left[\Delta H_c / L_T^0 + \beta \right]^2 - \beta^2}{2 \psi}$$

Source: EPA 2003

$C_{building}$	=	Steady-state vapor-phase concentration in the building [mg/L]
α	=	Attenuation coefficient in the vapor phase [-]
C_{source}	=	Vapor-phase concentration at the source [mg/L]
C_{soil}	=	Original concentration in soil [mg/kg]
H	=	Chemical-specific Henry's Law constant [(L-H_2O)/(L-air)]
ρ_s	=	Dry soil bulk density [g-soil/cm^3-soil]
θ_{ws}	=	Volumetric water content in vadose zone soils [cm^3-H_2O/cm^3-soil]
K_d	=	$f_{oc} \times K_{oc}$
	=	Chemical-specific soil-water sorption coefficient [cm^3-H_2O/g-soil]
θ_{as}	=	Volumetric air content in vadose zone soils [cm^3-air/cm^3-soil]
ΔH_c	=	Initial thickness of contamination [cm]
τ_D	=	Time for source depletion [seconds]
τ	=	Exposure interval [seconds]
D_T^{eff}	=	Total overall effective diffusion coefficient [cm^2/s]
D_{crack}^{eff}	=	Effective diffusion coefficient through cracks [cm^2/s]
A_B	=	Area of the enclosed space below grade [cm^2]
$Q_{building}$	=	Building ventilation rate [cm^3/s]
L_T^0	=	Source-building separation at time = 0 [cm]
Q_{soil}	=	Volumetric flow rate of soil gas into the enclosed space [cm^3/s]
A_{crack}	=	Total area of cracks [cm^2]
L_{crack}	=	Enclosed space foundation or slab thickness [cm]

2 Target Levels for Residential Exposures

2.1 Indoor Inhalation of Vapor Emissions

Carcinogenic effects

$$RBTL_{ai\text{-}res} = \frac{TR \times AT_c \times 365}{EF_r \times ED_r \times ET_{ra} \times IUR}$$

Noncarcinogenic effects

$$RBTL_{ai\text{-}res} = \frac{THQ \times AT_{nc} \times 365}{EF_r \times ED_r \times ET_{ra} \times \left(\frac{1}{RfC}\right)}$$

Source: EPA 2009, modified from equations 6 and 11

Where:

$RBTL_{ai\text{-}res}$	=	Residential risk-based target level in indoor air [mg/m^3]
TR	=	Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ	=	Target hazard quotient for individual constituents [-]
AT_c	=	Averaging time for carcinogens [years]
AT_{nc}	=	Averaging time for noncarcinogens [years]
ED_r	=	Exposure duration for resident [years]
EF_r	=	Residential exposure frequency [days/year]
ET_{ra}	=	Indoor residential exposure time [hours/day]
RfC	=	Chemical-specific inhalation reference concentration [mg/m^3]
IUR	=	Chemical-specific inhalation unit risk [µg/m^3]$^{-1}$
365	=	Conversion factor [days/year]

2.2 Outdoor Inhalation of Vapors and Particulates from Surficial Soil

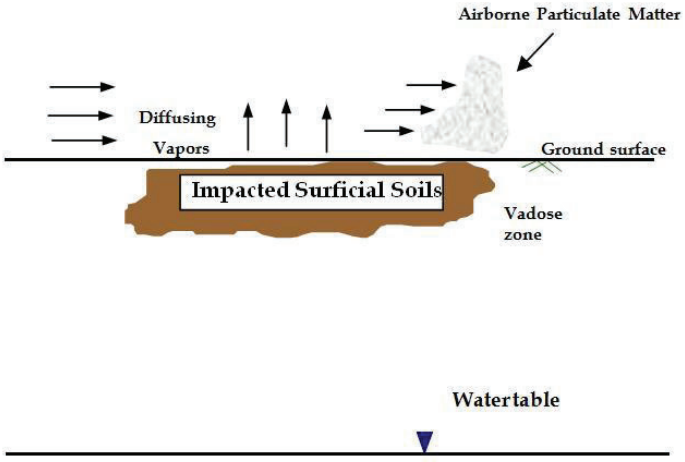
Carcinogenic effects

$$RBTL_{SS} = \frac{TR \times AT_c \times 365}{ED_r \times EF_{res} \times ET_{o-r} \times IUR \times \left(\frac{1}{VF} + \frac{1}{PEF}\right) \times 1000}$$

Noncarcinogenic effects

$$RBTL_{SS} = \frac{THQ \times AT_{nc} \times 365}{ED_c \times EF_{res} \times ET_{o-r} \times \left(\frac{1}{RfC}\right) \times \left(\frac{1}{VF} + \frac{1}{PEF}\right)}$$

Source: EPA 1996



Where:

$RBTL_{ss}$	=	Risk-based target level in surficial soil [mg/kg]
TR	=	Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ	=	Target hazard quotient for individual constituents [-]
VF	=	Surficial soil to ambient air volatilization factor [(m^3-air)/(kg-soil)]
PEF	=	Particulate emission factor [(m^3-air)/(kg-soil)]
AT_c	=	Averaging time for carcinogens [years]
AT_{nc}	=	Averaging time for noncarcinogens [years]
ED_c	=	Exposure duration for child [years]
ED_r	=	Residential exposure duration [years]
EF_{res}	=	Residential exposure frequency for direct contact pathway [days/year]
ET_{o-r}	=	Residential outdoor exposure time [hours/day]
RfC	=	Chemical-specific reference concentration [mg/(m^3)]
IUR	=	Chemical-specific inhalation unit risk [µg/m^3]$^{-1}$
365	=	Conversion factor [days/year]

2.3 Direct Ingestion of Surficial Soil

Carcinogenic effects

$$RBTL_{S-adj} = \frac{TR \times AT_c \times 365}{SF_o \times IR_{s-aa} \times RAF_o \times 10^{-6} \times EF_{res}}$$

Where:

$$IR_{s-aa} = \frac{ED_c \times IR_{s-c}}{BW_c} + \frac{(ED_{res} - ED_c) \times IR_{s-a}}{BW_a}$$

Noncarcinogenic effects

$$RBTL_S = \frac{THQ \times AT_{nc} \times 365 \times BW_c}{IR_{s-c} \times \left(\frac{1}{RfD_o}\right) \times 10^{-6} \times EF_{res} \times ED_c}$$

Source: EPA 1996, p. 20

Where:

$RBTL_{s\text{-}adj}$ = Age-adjusted risk-based target level for ingestion of soil for carcinogenic effects [mg/kg soil]
$RBTL_S$ = Risk-based target level for ingestion of soil for noncarcinogenic effects [mg/kg-soil]
TR = Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ = Target hazard quotient for individual constituents [-]

AT_c = Averaging time for carcinogens [years]
AT_{nc} = Averaging time for noncarcinogens [years]

RAF_o = Oral relative absorption factor [-]
RfD_o = Chemical-specific oral reference dose [mg/(kg-day)]
SF_o = Chemical-specific oral cancer slope or potency factor $[mg/(kg\text{-}day)]^{-1}$

$IR_{s\text{-}aa}$ = Age-adjusted soil ingestion rate [mg-yr/kg-day]
$IR_{s\text{-}c}$ = Resident child soil ingestion rate [mg/day]
$IR_{s\text{-}a}$ = Resident adult soil ingestion rate [mg/day]

BW_c = Resident child body weight [kg]
BW_a = Resident adult body weight [kg]

ED_c = Resident child exposure duration [year]
ED_a = Resident adult exposure duration [year]
ED_{res} = Resident exposure duration [year]

EF_{res} = Exposure frequency for a resident for direct contact pathway [days/year]

365 = Conversion factor [days/year]
10^{-6} = Conversion factor [kg/mg]

2.4 Dermal Contact with Surficial Soil

Carcinogenic effects

$$RBTL_{DC\text{-}adj} = \frac{TR \times AT_c \times 365}{SF_o \times SA_{aa} \times RAF_d \times 10^{-6} \times EF_{res}}$$

Where:

$$SA_{aa} = \frac{ED_c \times M_c \times SA_c}{BW_c} + \frac{ED_a \times M_a \times SA_a}{BW_a}$$

Noncarcinogenic effects

$$RBTL_{DC} = \frac{ED_c \times THQ \times AT_{nc} \times 365 \times BW_c}{RAF_d \times EF_{dc} \times ED_c \times M_c \times SA_c \times \left(\frac{1}{RfD_o \times RAF_o}\right) \times 10^{-6}}$$

Source: EPA 2007, Appendix D, p. D-6

Where:

$RBTL_{DC\text{-}adj}$	=	Age-adjusted risk-based target level for carcinogenic effects of dermal contact with soil [mg/kg soil]
$RBTL_{DC}$	=	Risk-based target level for noncarcinogenic effects of dermal contact with soil [mg/kg soil]
TR	=	Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ	=	Target hazard quotient for individual constituents [-]
AT_c	=	Averaging time for carcinogens [years]
AT_{nc}	=	Averaging time for noncarcinogens [years]
EF_{res}	=	Exposure frequency for a resident for direct contact pathway [days/year]
RAF_d	=	Chemical-specific dermal relative absorption factor [-]
RAF_o	=	Oral relative absorption factor [-]
M_c	=	Resident child soil-to-skin adherence factor [mg/cm^2]
M_a	=	Resident adult soil-to-skin adherence factor [mg/cm^2]
RfD_o	=	Chemical-specific oral reference dose [mg/(kg-day)]
SF_o	=	Chemical-specific oral cancer slope or potency factor [mg/(kg-day)]$^{-1}$
SA_{aa}	=	Age-adjusted skin surface area [mg-yr/ kg-day]
BW_c	=	Resident child body weight [kg]
BW_a	=	Resident adult body weight [kg]
ED_c	=	Resident child exposure duration [year]
ED_a	=	Resident adult exposure duration [year]
SA_c	=	Resident child skin surface area [cm^2/day]
SA_a	=	Resident adult skin surface area [cm^2/day]
365	=	Conversion factor [days/year]
10^{-6}	=	Conversion factor [kg/mg]

2.5 Combined Direct Contact Soil Pathway: Ingestion, Inhalation of Vapors and Particulates, and Dermal Contact

Carcinogenic effects

$$RBTL_{ss-combined} = \frac{TR \times AT_c \times 365}{SF_o \times 10^{-6} \times \left[\left(IR_{s-aa} \times RAF_o\right) + \left(SA_{aa} \times RAF_d\right)\right]} + \frac{TR \times AT_c \times 365}{ED_r \times EF_{res} \times ET_{o-r} \times IUR \times \left(\frac{1}{VF} + \frac{1}{PEF}\right) \times 1000}$$

Noncarcinogenic effects

$$RBTL_{ss-combined} = \frac{THQ \times AT_{nc} \times 365}{\frac{1}{RfD_o} \times 10^{-6} \times \left[\left(\left(\frac{ED_c + EF_{res} + IR_{s-c}}{BW_c}\right) \times RAF_o\right) + \left(\left(\frac{ED_c + EF_{res} + M_c + SA_c}{BW_c}\right) \times RAF_d\right)\right]} + \frac{THQ \times AT_{nc} \times 365}{ED_r \times EF_{res} \times ET_{o-r} \times \left(\frac{1}{RfC}\right) \times \left(\frac{1}{VF} + \frac{1}{PEF}\right)}$$

Note: All parameters are defined under the individual pathway equations above (sections 2.2–2.4).

2.6 Subsurface Soil Concentrations Protective of Indoor Vapor Inhalation

$$RBTL_{si} = \frac{RBTL_{ai}}{\alpha} * EF$$

Where:

$RBTL_{si}$ = Risk-based target level for indoor inhalation of vapors from subsurface soils [mg/kg-dry soil]

$RBTL_{ai}$ = Risk-based target level for indoor inhalation of air [mg/m^3-air]

α = Chemical-specific attenuation factor from subsurface soil to indoor (enclosed space) air derived from the Johnson-Ettinger model [-]

EF = Equilibrium factor to convert vapor target level to total soil target level

$$= \frac{\Theta_{ws} + (K_D\ \rho_s) + (H\ \Theta_{as})}{(H\ \rho_s)} * 0.001$$

Where:

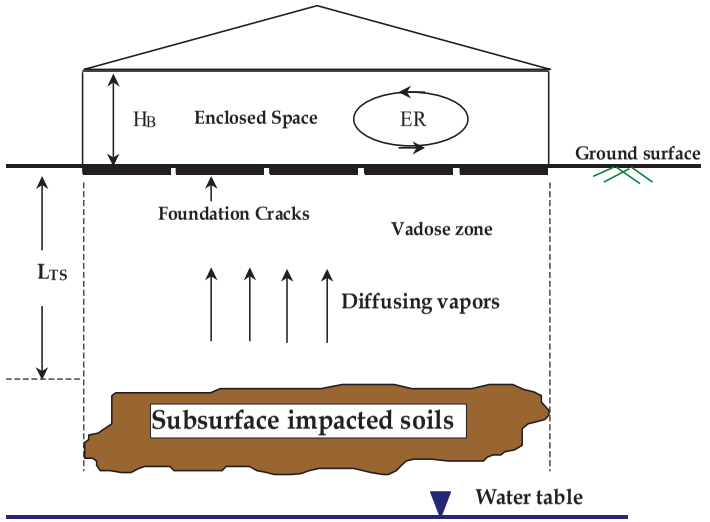
ρ_s = Dry soil bulk density [g-soil/cm^3-soil]

H = Chemical-specific Henry's Law constant [(L-H_2O)/(L-air)]

θ_{as} = Volumetric air content in the vadose zone soils [cm^3-air/cm^3-soil]

θ_{ws} = Volumetric water content in vadose zone soils [cm^3-H_2O/cm^3- soil]

K_D = $f_{oc} \times K_{oc}$ = Chemical-specific soil-water sorption coefficient [cm^3-H_2O/g-soil]



Source: Modified from EPA 2003

2.7 Ground Water Concentrations Protective of Indoor Vapor Inhalation

$$RBTL_{wi} = \frac{RBTL_{ai}}{\alpha} * EF$$

Where:

$RBTL_{wi}$ = Risk-based target level for indoor inhalation of vapors from ground water [mg/L-H_2O]

$RBTL_{ai}$ = Risk-based target level for indoor inhalation of air (mg/m^3-air)

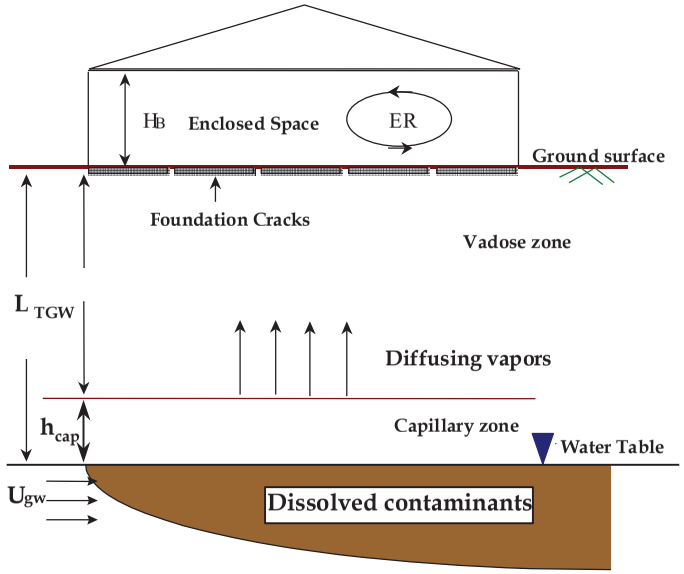
α = Chemical-specific attenuation factor from ground water to indoor (enclosed space) air derived from the Johnson-Ettinger model [-]

EF = Equilibrium factor to convert vapor target level to water target level

= (1/H)*0.001m^3/L

Where:

H = Henry's Constant [-]



Source: Modified from EPA 2003

2.8 Direct Ingestion of Ground Water

Carcinogenic effects

$$RBTL_{w\text{-}adj} = \frac{TR \times AT_c \times 365}{IR_{w\text{-}aa} \times SF_o}$$

Where:

$$IR_{w\text{-}aa} = \frac{ED_c \times EF_{res} \times IR_{w-c}}{BW_c} + \frac{ED_a \times EF_{res} \times IR_{w-a}}{BW_a}$$

Noncarcinogenic effects

$$RBTL_w = \frac{THQ \times AT_{nc} \times 365 \times RfD_o \times BW_a}{IR_{w\text{-}a} \times EF_{res} \times ED_a}$$

Source: Modified from EPA 1989, p. 6-35

Where:

$RBTL_{w\text{-}adj}$	=	Age-adjusted risk-based target level for ingestion of ground water [mg/L-H_2O]
$RBTL_w$	=	Risk-based target level for ingestion of ground water [mg/L-H_2O]
TR	=	Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ	=	Target hazard quotient for individual constituents [-]
AT_c	=	Averaging time for carcinogens [years]
AT_{nc}	=	Averaging time for noncarcinogens [years]
RfD_o	=	Chemical-specific oral reference dose [mg/(kg-day)]
SF_o	=	Chemical-specific oral cancer slope or potency factor [mg/(kg-day)]$^{-1}$
$IR_{w\text{-}aa}$	=	Age-adjusted ground water ingestion rate [L/kg]
$IR_{w\text{-}c}$	=	Resident child ground water ingestion rate [L/day]
$IR_{w\text{-}a}$	=	Resident adult ground water ingestion rate [L/day]
BW_c	=	Resident child body weight [kg]
BW_a	=	Resident adult body weight [kg]
ED_c	=	Resident child exposure duration [year]
ED_a	=	Resident adult exposure duration [year]
EF_r	=	Exposure frequency for a resident [days/year]
365	=	Conversion factor [days/year]

3 Target Levels for Ground Water Resource Protection

3.1 Domenico Model: Dilution Attenuation Factor (DAF) in the Saturated Zone

Domenico model for multi-dimensional transport with decay and infinite source:

$$\frac{C(x,y,z,t)}{C_o} = (1/8)\ exp\left[\frac{x}{2\alpha_x}\left[1-\sqrt{1+\frac{4\,k\,\alpha_x}{v}}\right]\right]\times erfc\left[\frac{\left[(x-vt)\sqrt{1+\frac{4\,k\,\alpha_x}{v}}\right]}{2\sqrt{\alpha_x\times v\times t}}\right]\times$$

$$\left[erf\left[\frac{\left(y+\frac{W_{gw}}{2}\right)}{2\sqrt{\alpha_y\,x}}\right]-erf\left[\frac{\left(y-\frac{W_{gw}}{2}\right)}{2\sqrt{\alpha_y\,x}}\right]\right]\times\left[erf\left[\frac{\left(z+\delta_{gw}\right)}{2\sqrt{\alpha_z\,x}}\right]-erf\left[\frac{\left(z-\delta_{gw}\right)}{2\sqrt{\alpha_z\,x}}\right]\right]$$

Where:

C	=	Dissolved-phase concentration [mg/L]
C_o	=	Dissolved-phase concentration at the source (at $x = y = z = 0$) [mg/L]
v	=	Retarded seepage velocity [m/sec]
k	=	Overall first order bio-decay rate [1/day]
α_x	=	Longitudinal dispersivity [m] ($\alpha_x = x/10$)
α_y	=	Lateral dispersivity [m] ($\alpha_y = x/30$)
α_z	=	Vertical dispersivity [m] ($\alpha_z = x/200$)
x, y, z	=	Spatial coordinates [m]
t	=	Time [day]
x	=	Distance along the centerline to point of exposure from the downgradient edge of dissolved-plume, source zone, or source well [m]
W_{gw}	=	Ground water mixing zone width [m]
δ_{gw}	=	Ground water mixing zone thickness [m]
DAF	=	C_o/C

Source: Domenico 1990, Eqn. 17.21

At the centerline, for steady-state (after a long time) with decay the concentration can be obtained by setting $y = 0$, $z = 0$, and $x << v \times t$ as:

$$\frac{C(x)}{C_o} = exp\left[\frac{x}{2\alpha_x}\left[1-\sqrt{1+\frac{4\,k\,\alpha_x}{v}}\right]\right]\times erf\left[\frac{W_{gw}}{4\sqrt{\alpha_y\,x}}\right]\times erf\left[\frac{\delta_{gw}}{2\sqrt{\alpha_z\,x}}\right]$$

At the centerline, for steady-state the concentration without decay can be obtained by setting $y = 0$, $z = 0$, $x << v \times t$, and $k = 0$ as:

$$\frac{C(x)}{C_o} = erf\left[\frac{W_{gw}}{4\sqrt{\alpha_y\,x}}\right]\times erf\left[\frac{\delta_{gw}}{2\sqrt{\alpha_z\,x}}\right]$$

Retarded seepage velocity v is given by the equation:

$$v = \frac{U_{gw}}{R\times\theta_T}$$

Where:

U_{gw}	=	ground water Darcy velocity [m/s]
R	=	retardation factor in the saturated zone [-]
θ_T	=	Total soil porosity in the saturated zone

3.2 Soil to Ground Water Leaching Factor

$$LF_{SW} = \frac{1}{DAF_{Summers} \times K_{Water-soil}}$$

$$DAF_{Summers} = 1 + \frac{U_{gw} \times \delta_{gw}}{I \times W_{gw}} \qquad \text{(The Summers Model)}$$

$$K_{Water-soil} = \frac{\theta_{ws} + K_d \rho_s + H \times \theta_{as}}{\rho_s}$$

Where:

LF_{SW}	=	Soil to ground water leaching factor [mg/L-H_20)/mg/kg-soil)]
$DAF_{Summers}$	=	Dilution attenuation factor in the mixing zone [-]
$K_{Water-soil}$	=	Water-soil partitioning coefficient [(mg/kg-soil)/(mg/L-H_2O)]
ρ_s	=	Dry soil bulk density [g-soil/cm^3-soil]
θ_{ws}	=	Volumetric water content in vadose zone soils [cm^3-H_2O/cm^3- soil]
K_d	=	$f_{oc} \times K_{oc}$
	=	Chemical-specific soil-water sorption coefficient [cm^3-H_2O/g-soil]
H	=	Chemical-specific Henry's Law constant [(L-H_2O)/(L-air)]
θ_{as}	=	Volumetric air content in the vadose zone soils [cm^3-air/cm^3-soil]
U_{gw}	=	Ground water Darcy velocity [cm/yr]
δ_{gw}	=	Ground water mixing zone thickness [cm]
I	=	Infiltration rate of water through soil [cm/year]
W_{gw}	=	Ground water mixing zone length [cm]

Source: EPA 1996

3.3 Soil Saturation Limit

$$C_s^{sat} = \frac{S}{\rho_s} \times [H \times \theta_{as} + \theta_{ws} + K_d \rho_s]$$

Where:

C_s^{SAT}	=	Soil concentration at which dissolved pore water and vapor phases become saturated [(mg/kg-soil)]
S	=	Pure component solubility in water [mg/L-H_2O]
ρ_s	=	Dry soil bulk density [g-soil/cm^3-soil]
H	=	Chemical-specific Henry's Law constant [(L-H_2O)/(L-air)]
θ_{as}	=	Volumetric air content in the vadose zone soils [cm^3-air/cm^3-soil]
θ_{ws}	=	Volumetric water content in vadose zone soils [cm^3-H_2O/cm^3- soil]
K_d	=	$f_{oc} \times K_{oc}$
	=	Chemical-specific soil-water sorption coefficient [cm^3-H_2O/g-soil]

Source: ASTM 1995

3.4 Soil and Ground Water Concentration for Ground Water Protection

$$\textit{Allowable soil concentration at the source} = \textit{Target groundwater concentration at the POE} \times \frac{DAF_{POE}}{LF_{SW}} \times DAF_{unsat}$$

$$\textit{Allowable groundwater concentration at the source} = \textit{Target groundwater concentration at the POE} \times DAF_{POE}$$

$$\textit{Allowable groundwater concentration at the POC} = \textit{Target groundwater concentration at the POE} \times \frac{DAF_{POE}}{DAF_{POC}}$$

Where:

POE	=	Point of exposure
POC	=	Point of compliance
DAF_{POE}	=	Dilution Attenuation Factor (in the saturated zone) between the point of exposure and the source
DAF_{POC}	=	Dilution Attenuation Factor (in the saturated zone) between the point of compliance and the source
DAF_{unsat}	=	Dilution Attenuation Factor (in the vadose zone) between water table and soil source
LF_{SW}	=	Dry soil leaching factor

Additional relationships used in the calculation of allowable soil and ground water concentration with chemical degradation:

$$\textit{First order decay rate} = \frac{0.693}{Half - Life}$$

$$\text{Retardation Factor for Organics in saturated zone} = 1 + \left(\frac{\rho_{ss} \times K_{ds}}{\theta_{TS}} \right)$$

Where:

ρ_{ss}	=	Dry soil bulk density of the saturated zone soil [g-soil/cm^3-soil]
K_{ds}	=	Chemical-specific soil-water distribution coefficient in the saturated zone [mL/g]
	=	$K_{oc} \times f_{ocs}$
Koc	=	Organic carbon distribution coefficient in the saturated zone [mL/g]
f_{ocs}	=	Fractional organic carbon content in the saturated zone [-]
θ_{TS}	=	Total soil porosity in the saturated zone [cm^3/cm^3-soil]

4 Volatilization Factor, Particulate Emission Factor, and Effective Diffusion Coefficients

4.1 Volatilization Factor from Surface Soil to Outdoor (ambient) Air

$$VF = Q/C \times \frac{\left(3.14 \times D_A \times \tau\right)^{1/2}}{\left(2 \times \rho_s \times D_A\right)} \times 10^{-4}$$

Where:

$$D_A = \frac{\left(\theta_{as}^{10/3} \times D^a \times H + \theta_{ws}^{10/3} \times D^w\right)/\theta_T^2}{\rho_s \times K_d + \theta_{ws} + \theta_{as} \times H}$$

Where:

VF	=	Volatilization factor from surface soil to outdoor (ambient) air [(m^3-air)/(kg-soil)]
Q/C	=	Inverse of the mean concentration at the center of square source [cm^2/s]
D_A	=	Apparent diffusivity [cm^2/s]
τ	=	Averaging time for vapor flux [s]
ρ_s	=	Dry soil bulk density [g-soil/cm^3-soil]
K_d	=	Chemical-specific solid-water sorption coefficient [cm^3-H_2O/g-soil]
D^a	=	Chemical-specific diffusion coefficient in air [cm^2/s]
D^w	=	Chemical-specific diffusion coefficient in water [cm^2/s]
θ_T	=	Total soil porosity in the impacted zone [cm^3/cm^3-soil]
θ_{as}	=	Volumetric air content in the vadose zone soils [cm^3-air/cm^3-soil]
θ_{ws}	=	Volumetric water content in the capillary fringe soils [cm^3-H_2O/cm^3-soil]
H	=	Chemical-specific Henry's Law constant [(L-H_2O)/(L-air)]
10^{-4}	=	Conversion factor [m^2/cm^2]

Source: EPA 1996

4.2 Particulate Emission Factor

$$PEF = Q/C \times \frac{3600}{0.036 \times (1 - V) \times (U_m/U_t)^3 \times F(x)}$$

Where:

PEF	=	Particulate emission factor [(m^3-air)/(kg-soil)]
Q/C	=	Inverse of the mean concentration at the center of square source [(g/m^2-s)/(kg/m^3)]
V	=	Fraction of vegetative cover [-]
U_m	=	Mean annual wind speed [m/s]
U_t	=	Equivalent threshold value of wind speed at 7 m [m/s]
$F(x)$	=	Function dependent on U_m/U_t derived using Cowherd et al. 1985 [-]
0.036	=	Empirical constant [m^2-hr/g]

Source: EPA 1996

4.3 Effective Diffusion Coefficients

4.3.1 Effective Diffusion Coefficient in Soil

$$D_s^{eff} = D^a \times \frac{\theta_{as}^{3.33}}{\theta_T^{2.0}} + D^w \times \frac{1}{H} \times \frac{\theta_{ws}^{3.33}}{\theta_T^{2.0}}$$

Where:

D_s^{eff}	=	Effective diffusion coefficient in soil based on vapor-phase concentration [cm^2/s]
D^a	=	Chemical-specific diffusion coefficient in air [cm^2/s]
D^w	=	Chemical-specific diffusion coefficient in water [cm^2/s]
θ_{as}	=	Volumetric air content in capillary fringe soils [cm^3-air/cm^3-soil]
θ_{ws}	=	Volumetric water content in capillary fringe soils [cm^3-H_2O/cm^3-soil]
θ_T	=	Total soil porosity in the impacted zone [cm^3/cm^3-soil]
H	=	Chemical-specific Henry's Law constant [(L-H_2O)/(L-air)]

4.3.2 Effective Diffusion Coefficient between Ground Water and Surface Soil

$$D_{ws}^{eff} = L_{TGW} \times \left[\frac{h_{cap}}{D_{cap}^{eff}} + \frac{\left(L_{TGW} - h_{cap}\right)}{D_{s}^{eff}} \right]^{-1}$$

Where:

D_{ws}^{eff}	=	Effective diffusion coefficient between ground water and surface soil [cm^2/s]
h_{cap}	=	Thickness of capillary fringe [cm]
D_{cap}^{eff}	=	Effective diffusion coefficient through capillary fringe [cm^2/s]
D_{s}^{eff}	=	Effective diffusion coefficient in soil based on vapor-phase concentration [cm^2/s]
L_{TGW}	=	Source-building separation [cm]

4.3.3 Effective Diffusion Coefficient In Capillary Fringe Soil

$$D_{cap}^{eff} = D^{a} \times \frac{\theta_{acap}^{3.33}}{\theta_{T}^{2.0}} + D^{w} \times \frac{1}{H} \times \frac{\theta_{wcap}^{3.33}}{\theta_{T}^{2.0}}$$

Where:

D_{cap}^{eff}	=	Effective diffusion coefficient for the capillary fringe [cm^2/s]
D^{a}	=	Chemical-specific diffusion coefficient in air [cm^2/s]
D^{w}	=	Chemical-specific diffusion coefficient in water [cm^2/s]
θ_{acap}	=	Volumetric air content in capillary fringe soils [cm^3-air/cm^3-soil]
θ_{wcap}	=	Volumetric water content in capillary fringe soils [cm^3-H_2O/cm^3-soil]
θ_{T}	=	Total soil porosity [cm^3/cm^3-soil]
H	=	Chemical-specific Henry's Law constant [(L-H_2O)/(L-air)]

Source: ASTM 1995

4.3.4 Effective Diffusion Coefficient In Foundation/Wall Cracks

$$D_{crack}^{eff} = D^a \times \frac{\theta_{acrack}^{3.33}}{\theta_T^{2.0}} + D^w \times \frac{1}{H} \times \frac{\theta_{wcrack}^{3.33}}{\theta_T^{2.0}}$$

Where:

D_{crack}^{eff}	=	Effective diffusion coefficient through foundation cracks [cm^2/s]
D^a	=	Chemical-specific diffusion coefficient in air [cm^2/s]
D^w	=	Chemical-specific diffusion coefficient in water [cm^2/s]
θ_{acrack}	=	Volumetric air content in foundation/wall cracks [cm^3-air/cm^3-total volume]
θ_{wcrack}	=	Volumetric water content in foundation/wall cracks [cm^3-H_2O/cm^3-total volume]
θ_T	=	Total soil porosity [cm^3/cm^3-soil]
H	=	Chemical-specific Henry's Law constant [(L-H_2O)/(L-air)]

4.4 Water Content in Soil in the Capillary Fringe

$$\theta_{wcap} = \theta_r + \frac{\theta_{Tcap} - \theta_r}{\left[1 + (\alpha h)^N\right]^M}$$

Where:

θ_{wcap}	=	Water content in the capillary fringe zone soil [cm^3-water/cm^3-soil]
θ_r	=	Residual soil water content [cm^3-water/cm^3-soil]
θ_{Tcap}	=	Total porosity of soil in the capillary fringe zone [cm^3-voids/cm^3-soil]
α	=	Point of inflection in the water retention curve where $d\theta_w/dh$ is maximal [1/cm]
h	=	Air-entry pressure head [cm]
	=	$1/\alpha$ and assumed to be positive
N	=	Van Genuchten curve shape parameter [-]
M	=	$1 - (1/N)$

This page intentionally left blank for correct double-sided printing.

References

ASTM (American Society for Testing and Materials). 1995. Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites E1739-95.

Cowherd, C., G.E. Muleski, P.J. Englehart, and D.A. Gilbert. 1985. *Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination Sites.* Midwest Research Institute.

Domenico, P.A., and F.W. Schwartz. 1990. *Physical and Chemical Hydrogeology.* New York: John Wiley and Sons, 824 p.

EPA (U.S. Environmental Protection Agency). 1989. *Risk Assessment Guidance for Superfund*, Vol. I., Part A.

EPA (U.S. Environmental Protection Agency). 1996. *Soil Screening Guidance: Technical Background Document.* EPA, Office of Solid Waste and Emergency Response. EPA/540/R-95/128.

EPA (U.S. Environmental Protection Agency). 2003. *User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings*. EPA, Office of Solid Waste and Emergency Response.

EPA (U.S. Environmental Protection Agency). 2007. *Risk Assessment Guidance for Superfund*, Vol. I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). EPA, Office of Solid Waste and Emergency Response. 9285.7-02EP.

EPA (U.S. Environmental Protection Agency). 2009. *Risk Assessment Guidance for Superfund*, Vol. I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment). EPA, Office of Solid Waste and Emergency Response. 9285.7-82.

EPA (U.S. Environmental Protection Agency). 2011. *Regional Screening Levels for Chemical Contaminants at Superfund Sites*, Users Guide and Equations. Accessed November 2011. Available at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/equations.htm.

This page intentionally left blank for correct double-sided printing.

Appendix F: Methodology and Example Calculation for Remedial Action Target Levels

This page intentionally left blank for correct double-sided printing.

Introduction

For each receptor, the cumulative risk for carcinogenic effects and hazard index (HI) for noncarcinogenic effects at a site for all petroleum chemicals of interest (COIs) and complete routes of exposures (ROE) (except ingestion of water) should not exceed 1×10^{-5} and 1, respectively. This appendix describes the default methodology used by the Idaho Department of Environmental Quality (DEQ) to apportion risk and derive remedial action target level (RATL) concentrations for petroleum COIs in various media at sites where the risk or hazard is estimated to exceed the acceptable target risk level or acceptable HI.

Developing Target Levels: Method

The default method for developing target levels can be summarized by the following steps:

Step 1: Based on complete or potentially complete routes of exposure identified earlier and estimated representative concentrations, calculate the corresponding risk ($Risk_{i,j}^{rep}$) and hazard quotient ($HQ_{i,j}^{rep}$) for each chemical (i) for each complete pathway (j).

Results can be used to generate a matrix of risk and hazard quotient (HQ) values as shown in Table 1 below.

Table 1. Example matrix for calculation of remedial action target levels

Petroleum Chemical of Interest	Pathway 1		Pathway 2		Pathway 3		Cumulative		Number of Pathways	
	Risk	HQ	Risk	HQ	Risk	HQ	Risk	HI	Carcino-genic	Noncarcino-genic
C1	X	N/A	X	N/A	—	N/A	SUM	SUM	2	0
C2	N/A	X	N/A	X	N/A	X	SUM	SUM	0	3
C3	N/A	X	—	X	N/A	X	SUM	SUM	0	3
C4	X	N/A	X	N/A	X	N/A	SUM	SUM	3	0
C5	X	X	N/A	X	N/A	X	SUM	SUM	1	3
Cumulative							$Risk_{site}$ = SUM(SUM)	HI_{site} = SUM(SUM)	6	9

Note: **X** indicates pathway complete
N/A indicates not applicable because there is no relevant toxicity data or physical-chemical property.
A dash (—) indicates the value was not calculated because there was no entry under representative concentrations. This could mean that the chemical is not a petroleum chemical of interest for the pathway being evaluated based on release history or based on site characterization data.

Step 2: Calculate cumulative risk (site risk) and site HI.

$$Risk_{site} = \sum_{i=1}^{n_c} \sum_{j=1}^{m_i} Risk_{i,j}$$

$$HI_{site} = \sum_{i=1}^{n_{nc}} \sum_{j=1}^{m_i} HQ_{i,j}$$

Where:

$Risk_{i,j}$ = risk from exposure to chemical i through pathway j

$HQ_{i,j}$ = hazard quotient for exposure to chemical i through pathway j

m_i = number of complete pathways for chemical i (the suffix to m indicates that the number of complete pathways can be different for different chemicals)

n_c = number of carcinogenic chemicals at the site

n_{nc} = number of noncarcinogenic chemicals at the site

If the cumulative risk and HI for all the receptors at the site are below the acceptable levels, the site does not require the development of RATL. Site closure may be appropriate if other required regulatory issues have been resolved.

Step 3: Determine the number of chemical-pathway combinations (for carcinogens and noncarcinogens separately) at the site.

For the number of chemical-pathway combinations for carcinogens,

$$N_c = \sum_{i=1}^{n_c} \sum_{j=1}^{m_i} p_{i,j}$$

For the number of chemical-pathway combinations for non-carcinogens,

$$N_{nc} = \sum_{i=1}^{n_{nc}} \sum_{j=1}^{m_i} p_{i,j}$$

Where:**Error! Objects cannot be created from editing field codes.**

$p_{i,j}$ = complete pathway for chemical i and pathway j

m_i = number of complete pathways for chemical i (the suffix to m indicates that the number of complete pathways can be different for different chemicals)

n_c = number of carcinogenic chemicals at the site

n_{nc} = number of noncarcinogenic chemicals at the site

Note that some chemicals show both carcinogenic and noncarcinogenic toxicity and should be counted in both categories. For example, chemical C5 in the example above (Table 1) has 3 complete pathways for the noncarcinogenic effects and 1 pathway for the carcinogenic effects.

Step 4: Based on equal apportioning of target cumulative risk and HI, compute allocated risk and HQ contribution by chemical *i* through pathway *j* using the following equations:

$$Risk_{i,j}^{allocated} = \frac{1 \times 10^{-5}}{N_c}$$

$$HQ_{i,j}^{allocated} = \frac{1}{N_c}$$

Step 5: Estimate the risk reduction factor (RRF) in risk or HQ required so the contribution by chemical *i* acting through pathway *j* is equal to the allocated risk or allocated HQ.

Calculate the RRF for chemical *i* acting through pathway *j* with the following equation:

$$RRF_{i,j} = \frac{Risk_{i,j}^{rep}}{Risk_{i,j}^{allocated}}$$

Calculate the hazard quotient reduction factor (HQRF) for chemical *i* acting through pathway *j* with the following equation:

$$HQRF_{i,j} = \frac{HQ_{i,j}^{rep}}{HQ_{i,j}^{allocated}}$$

Step 6: Calculate the target level (i.e., allowable concentration) for chemical *i* acting through pathway *j*.

For carcinogens,

$$C_{i,j}^{allowable} = \frac{C_{i,j}^{rep}}{RRF_{i,j}}.$$

For noncarcinogens,

$$C_{i,j}^{allowable} = \frac{C_{i,j}^{rep}}{HQRF_{i,j}}.$$

If a chemical has $C_{i,j}^{allowable}$ based on carcinogenic and noncarcinogenic toxicity, the applicable RATL for that chemical should be the lower of the two allowable concentrations.

Developing Target Levels: Example

The following is an example of the target level calculations described above. Table 2 presents fictitious representative concentrations for each of five chemicals and three pathways (two soil and one ground water).

Table 2. Fictitious representative concentrations used in target level calculation example

Petroleum Chemical of Interest	Pathway 1 (milligrams/ kilogram)	Pathway 2 (milligrams/ kilograms)	Pathway 3 (milligrams/ liter)
C1	1	2	—
C2	2	4	2
C3	3	6	3
C4	4	8	4
C5	5	10	5

Step 1: Use these representative concentrations to calculate risk and HQ for each chemical and pathway the chemical acts through. The resulting matrix of risk and HQ values are shown in Table 3.

Table 3. Example of risk/chemical-of-interest/pathway matrix for target level calculation

Petroleum Chemical of Interest	Pathway 1		Pathway 2		Pathway 3		Cumulative		Number of Pathways	
	Risk	HQ	Risk	HQ	Risk	HQ	Risk	HI	Carcino-genic	Noncarcino-genic
C1	1E-5	N/A	2E-5	N/A	N/A	N/A	3E-5	N/A	2	0
C2	N/A	1	N/A	3	N/A	1	N/A	5	0	3
C3	N/A	1	—	1	N/A	3	N/A	5	0	3
C4	1E-5	N/A	1E-5	N/A	1E-5	N/A	3E-5	N/A	3	0
C5	2E-5	1	N/A	1	N/A	1	2E-5	3	1	3
Cumulative							$Risk_{site}$ = 8E-5	HI_{site} = 13	6	9

Note: **N/A** indicates not applicable because there is no relevant toxicity data or physical-chemical property .
A dash (—) indicates the value was not calculated because there was no entry under representative concentrations. This could mean that the chemical is not a petroleum chemical of interest for the pathway being evaluated based on release history or based on site characterization data.

Step 2: Calculate the cumulative site risk and HI for all chemicals and pathways for a given receptor. (In this case, the site risk and HI are 7×10^{-5} and 13, respectively.)

Step 3: Determine the number of chemical-pathway combinations (for carcinogens and noncarcinogens separately) at the site. In this example, the number of chemical-pathway combinations for carcinogens is 6, and the number of chemical-pathway combinations for noncarcinogens is 9.

Step 4: Based on equal apportioning of the target cumulative risk and HI, calculate the allocated risk and HQ contribution by chemical *i* through pathway *j*.

$$Risk_{i,j}^{allocated} = \frac{1 \times 10^{-5}}{6} = 1.7 \times 10^{-6}$$

$$HQ_{i,j}^{allocated} = \frac{1}{9} = 0.11$$

Step 5: Estimate the RRF in risk or HQ required so that the contribution by a given chemical acting through a particular pathway is equal to the allocated risk or allocated HQ.

The RRF for chemical *i* acting through pathway *j* is found with the following equation:

$$RRF_{i,j} = \frac{Risk_{i,j}^{rep}}{Risk_{i,j}^{allocated}}$$

The HQ reduction factor for chemical *i* acting through pathway *j* is calculated with the following equation:

$$HQRF_{i,j} = \frac{HQ_{i,j}^{rep}}{HQ_{i,j}^{allocated}}$$

The calculations of the RFs for the example are presented in Table 4. At actual sites, the reduction factors are rarely as uniform as they are in the example.

Table 4. Reduction factor example for target level calculations

Petroleum Chemical of Interest	Pathway 1		Pathway 2		Pathway 3	
	RRF	HQRF	RRF	HQRF	RRF	HQRF
C1	1E-5/1.7E-6 = 6.0	N/A	2E-5/1.7E-6 = 12	N/A	—	N/A
C2	N/A	1/0.11 = 9.0	N/A	3/0.11 = 27	N/A	1/0.11 = 9.0
C3	N/A	1/0.11 = 9.0	—	1/0.11 = 9.0	N/A	3/0.11 = 27
C4	1E-5/1.67E-6 = 6.0	N/A	1E-5/1. 7E-6 = 6.0	N/A	1E-5/1. 7E-6 = 6.0	N/A
C5	2E-5/1.67E-6 = 12	1/0.11 = 9.0	N/A	1/0.11 = 9.0	N/A	1/0.11 = 9.0

Note: **N/A** indicates not applicable because there is no relevant toxicity data or physical-chemical property.
A dash (—) indicates the value was not calculated because there was no entry under representative concentrations. This could mean that the chemical is not a petroleum chemical of interest for the pathway being evaluated based on release history or based on site characterization data.

Step 6: Calculate the target level for a chemical acting through a given pathway.

For carcinogens,

$$C_{i,j}^{allowable} = \frac{C_{i,j}^{rep}}{RRF_{i,j}};$$

and for non-carcinogens,

$$C_{i,j}^{allowable} = \frac{C_{i,j}^{rep}}{HQRF_{i,j}}.$$

The resulting RATL calculations, carcinogenic and/or noncarcinogenic, for the example are presented in Table 5. The RATL concentrations are presented in bold.

Table 5. Example remedial action target level (RATL) concentrations for target level calculations

Petroleum Chemical of Interest	Pathway 1 (milligrams/kilogram)		Pathway 2 (milligrams/kilogram)		Pathway 3 (milligrams/liter)	
	$RATL_c$	$RATL_{nc}$	$RATL_c$	$RATL_{nc}$	$RATL_c$	$RATL_{nc}$
C1	1/6.0 = **0.17**	N/A	2/12 = 0.17	N/A	—	N/A
C2	N/A	2/9.0 = 0.22	N/A	4/27= **0.15**	N/A	2/9.0 = **0.22**
C3	N/A	3/9.0 = **0.33**	—	6/9.0 = 0.67	N/A	3/27 = **0.11**
C4	4/6.0 = **0.67**	N/A	8/6.0 = 1.3	N/A	4/6.0 = **0.67**	N/A
C5	5/12 = **0.42**	5/9.0 = 0.56	N/A	10/9.0 = 1.1	N/A	5/9.0 = **0.56**

Note: **N/A** indicates not applicable because there is no relevant toxicity data or physical-chemical property.
A dash (—) indicates the value was not calculated because there was no entry under representative concentrations. This could mean that the chemical is not a petroleum chemical of interest for the pathway being evaluated based on release history or based on site characterization data.

In this example, for chemical C5 and pathway P1, both carcinogenic and noncarcinogenic RATLs are calculated. The lower of the two, 0.42 milligrams/kilogram (the carcinogenic RATL), would be used.

Appendix G: Evaluation of the Vapor Intrusion Pathway

This page intentionally left blank for correct double-sided printing.

EPA 510-R-15-001

Technical Guide For Addressing Petroleum Vapor Intrusion At Leaking Underground Storage Tank Sites

U.S. Environmental Protection Agency
Office of Underground Storage Tanks
Washington, D.C.

June 2015

REC 4644

Contents

Recommendations 1

Background 1

Overview Of Petroleum Vapor Intrusion (PVI) 2

Scope And Applicability 3

Recommended Actions For Addressing PVI 3

Supporting Technical Information 10

1. Petroleum Vapor Intrusion (PVI) 11
2. Typical PVI Scenarios 33
3. Site Characterization And Conceptual Site Model (CSM) 39
4. Lateral Inclusion Zone 44
5. Vertical Separation Distance 48
6. Mobile And Residual Light Non-Aqueous Phase Liquid (LNAPL) 57
7. Groundwater Flow And Dissolved Contaminant Plumes 61
8. Soil Gas Profile 66
9. Clean, Biologically Active Soil 75
10. Non-PHC Fuel Additives 81
11. Seasonal And Weather Effects 96
12. Vapor Intrusion Attenuation Factor (α) 100
13. Computer Modeling Of Petroleum Vapor Intrusion 106

Glossary 117

Tables

1. Recommended Actions For Addressing PVI At Leaking Underground Storage Tank Sites..... 7

2. Summary Of Characteristics Of Typical Scenarios Of Petroleum Vapor Sources And Potential Receptors 36

3. Recommended Vertical Separation Distance Between Contamination And Building Floor Foundation, Or Crawlspace Surface 52

4. Equations For Target Indoor Air Screening Concentrations For Volatile Chemicals..... 85

5. Example Target Residential Indoor Air Concentrations For EDB And 1,2-DCA 85

6. Equations For Groundwater And Soil Gas Screening Levels Based On Target Indoor Air Screening Levels 86

7. Example Screening Concentrations For EDB And 1,2-DCA In Groundwater And Soil Gas 88

8. Comparison Of Risk Levels And Achievable Analytical Detection Limits For The Lead Scavengers EDB And 1,2-DCA In Indoor Air 89

Figures

1. Flowchart For Addressing PVI At Leaking Underground Storage Tank Sites 9

2. Conceptual Model Of Typical Petroleum Hydrocarbon Release..... 13

3. Difference In Potential For PVI Based On Type Of Source: a) LNAPL b) Dissolved Phase..... 33

4. Typical Scenarios Of Potential PVI Sources And Potential Receptors..... 35

5. Lateral Separation Distance Between Source Of PHC Contamination And Hypothetical Receptor 45

6. Vertical Separation Distances Between Source Of PHC Contaminants And Hypothetical Receptor: (a) Dissolved Source, (b) LNAPL Source..... 49

7. Conceptual Model Illustrating The Potential For Vapor Intrusion For a) Free-Phase LNAPL Source, b) Residual-Phase LNAPL Source, And c) Dissolved-Phase Source 58

8. Typical Vertical Concentration Profile In The Unsaturated Zone For PHCs (Plus Methane), Carbon Dioxide, And Oxygen..... 66

9. Relationship Between Source Vapor Concentration And Vapor Intrusion Attenuation Factor (α) As A Function Of Vertical Separation Depth Between Contaminant Source And Base Of Building (Receptor)..... 101

10. Rescaled Figure 9 That Expresses Source Vapor Concentration In Conventional Units..... 103

Acronyms

1,2-DCA	1,2-Dichloroethane (also known as ethylene dichloride or EDC)
ATSDR	Agency for Toxic Substances and Disease Registry
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes (there are three isomers of xylene)
CFR	Code of Federal Regulations
CSM	Conceptual Site Model
EDB	Ethylene Dibromide (also known as 1,2-dibromoethane)
IUR	Inhalation Unit Risk
ILCR	Incremental Lifetime Cancer Risk
IRIS	Integrated Risk Information System
ITRC	Interstate Technology & Regulatory Council
JEM	Johnson-Ettinger Model
LNAPL	Light Non-Aqueous Phase Liquid
MTBE	Methyl Tertiary-Butyl Ether
NAPL	Non-Aqueous Phase Liquid
OIG	Office of Inspector General
OSWER	Office of Solid Waste and Emergency Response
OUST	Office of Underground Storage Tanks
PHC	Petroleum Hydrocarbon
PPRTV	Provisional Peer Reviewed Toxicity Value
PVI	Petroleum Vapor Intrusion
RBC_v	Risk-based Concentration, Soil Vapor
RfC	Reference Concentration (inhalation)
RSL	Regional Screening Level (for Chemical Contaminants at Superfund Sites)
SIM	Selective Ion Monitoring
TAME	Tertiary-Amyl Methyl Ether
TBA	Tertiary-Butyl Alcohol
TEL	Tetraethyl Lead
TMB	Trimethylbenzene
TML	Tetramethyl Lead
TPH	Total Petroleum Hydrocarbons
UST	Underground Storage Tank
VI	Vapor Intrusion
VISL	Vapor Intrusion Screening Level
VOC	Volatile Organic Compound

Disclaimer

This document presents current technical recommendations of the U.S. Environmental Protection Agency (EPA) based on our current understanding of petroleum vapor intrusion (PVI) into indoor air from subsurface sources. This document provides technical information to EPA, state, tribal, and local agencies. It also informs the public and the regulated community on how EPA intends to implement its regulations. This guidance document does not impose any requirements or obligations on the EPA, the states, or local or tribal governments, or the regulated community. Rather, the sources of authority and requirements for addressing subsurface vapor intrusion are the relevant statutes and regulations. Decisions regarding a particular situation should be made based upon statutory and regulatory authority. Decision-makers retain the discretion to adopt or approve approaches on a case-by-case basis that differ from this document. Contact information for your state's UST-implementing agency may be found at *http://www.epa.gov/oust/states/statcon1.htm*. EPA may revise this document in the future, as appropriate.

REC 4649

Recommendations

This document provides technical information to regulatory personnel from the U.S. Environmental Protection Agency (EPA) and state[1], tribal, and local agencies for investigating and assessing petroleum vapor intrusion (PVI) at sites where petroleum hydrocarbons (PHCs) have been released from underground storage tanks (USTs). This document is comprised of two parts: *Recommendations*, which provides a description of EPA's recommended approach for addressing PVI, and *Supporting Technical Information*, which provides detailed technical information supporting the recommendations.

Background

In 2002, EPA's Office of Solid Waste and Emergency Response (OSWER) issued draft vapor intrusion guidance, *OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Draft Vapor Intrusion Guidance)* (EPA, 2002).[2] This draft guidance explicitly states that it is not recommended for addressing petroleum vapor intrusion (PVI) at UST sites regulated under Subtitle I of the Solid Waste Disposal Act through the Hazardous and Solid Waste Amendments of 1984.

In 2009, EPA's Office of Underground Storage Tanks (OUST), at the request of partners and stakeholders, initiated a collaborative effort to develop a technical guide for petroleum vapor intrusion. Further highlighting the need for information on PVI, EPA's Office of Inspector General later that year released an evaluation report, *Lack of Final Guidance on Vapor Intrusion Impedes Efforts to Address Indoor Air Risks* (Report No. 10-P-0042).[3] The report included recommendations, one of which was for EPA to issue final vapor intrusion guidance that incorporates information on how risks from petroleum hydrocarbon vapors should be addressed. In response to stakeholder requests, EPA's Office of Underground Storage Tanks developed this technical guide, which is a companion to OSWER's more general vapor intrusion guide.[4] Together, these two documents replace the 2002 Draft Vapor Intrusion Guide.

EPA developed the two guides to address different scenarios and meet the needs of different audiences. The UST program regulates a very large universe of sites, typically gas stations, which share many similar characteristics, including small release volumes (compared to pipelines and tank farms, for example) and the potential for aerobic biodegradation of petroleum vapors. Based on these facts, and to meet the request of UST regulators and practitioners, EPA developed a guide specifically focused on petroleum UST releases. This PVI guide provides screening criteria based on physical separation distances between vapor sources and potential receptors. EPA OUST derived the screening criteria from an analysis of a large

[1] The term *state* refers to regulatory agencies of states, territories, and the District of Columbia.
[2] The OSWER draft guidance is accessible at http://www.epa.gov/osw/hazard/correctiveaction/eis/vapor/complete.pdf
[3] The OIG report is accessible at http://www.epa.gov/oig/reports/2010/20091214-10-P-0042.pdf
[4] *OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway From Subsurface Sources To Indoor Air* (OSWER Publication 9200.2-154), accessible at http://www.epa.gov/oswer/vaporintrusion/.

data set of samples from leaking UST sites.[5] In contrast, the OSWER Vapor Intrusion Guide addresses a wide variety of sites and a broader range of contaminants.

Overview Of Petroleum Vapor Intrusion

Vapor intrusion is the general term given to migration of volatile organic chemicals (VOCs) from any subsurface contaminant source, such as contaminated soil or groundwater, through the soil and into an overlying building. There are two general classes of VOCs that account for a large number of soil and groundwater contamination sites in the United States:

- Petroleum hydrocarbons (PHCs) and non-PHC fuel additives
- Chlorinated solvents (e.g., the dry cleaning chemical tetrachloroethylene, also known as perchloroethylene, (PCE), and the degreasing solvents trichloroethylene (TCE), 1,1,1-trichloroethane (TCA)).

In this guide, petroleum vapor intrusion (PVI) is defined as the intrusion of vapors from subsurface PHCs and non-PHC fuel additives into overlying or nearby buildings or structures.

Vapors emanating from petroleum-contaminated soil or groundwater that enter buildings may result in indoor air concentrations that pose a risk to building occupants. PVI may pose both immediate threats to safety (e.g., fire or explosion potential from petroleum vapors or methane) and possible adverse health effects from inhalation of toxic chemicals (e.g., exposure to benzene from gasoline). PVI may be associated with three groups of volatile chemicals:

- PHCs found in gasoline, diesel, and jet fuel (e.g., benzene, trimethylbenzenes (TMBs), naphthalene)
- Volatile chemicals other than PHCs that may be found in petroleum fuels, such as ethers, alcohols, and other fuel additives (e.g., methyl tertiary-butyl ether (MTBE), tertiary-butyl alcohol (TBA), ethylene dibromide (EDB), and 1,2-dichloroethane (1,2-DCA))
- Methane, which is generated from anaerobic biodegradation of PHCs and other constituents of petroleum fuels (especially ethanol), and organic matter in soil

In contrast to chlorinated solvents, PHCs generally biodegrade rapidly under aerobic conditions and if biodegradation is complete, produce only water and carbon dioxide. If biodegradation is incomplete a variety of intermediate degradation products may be formed, but these are usually less toxic than the parent PHCs.[6] If chlorinated solvents biodegrade it is usually under

[5] *Evaluation Of Empirical Data To Support Soil Vapor Intrusion Screening Criteria For Petroleum Hydrocarbon Compounds* (EPA 510-R-13-001), accessible at http://www.epa.gov/oust/cat/pvi/PVI_Database_Report.pdf

[6] Some petroleum hydrocarbons may also degrade anaerobically and may produce methane, particularly if the source is from an ethanol-blended gasoline. A recent modeling study cautions that for releases of high ethanol fuel blends (i.e., greater than E-20) advective methane transport may result in methane buildup inside buildings and pose a risk of explosion (Ma, et al., 2014, Numerical Model Investigation for Potential Methane Explosion and Benzene Vapor Intrusion Associated with High-Ethanol Blend Releases, *Environmental Science and Technology* 48(1):474-481).

anaerobic conditions, which is slower and may produce intermediate degradation products that are more toxic than the parent compounds.

The aerobic biodegradability of PHCs typically reduces the potential for PVI and justifies a different approach for addressing PVI than for vapor intrusion from chlorinated solvents and other non-aerobically biodegradable VOCs.[7]

Scope And Applicability

This PVI guide focuses on releases of petroleum-based fuels (e.g., gasoline, diesel), including both PHCs and non-PHC fuel additives, from underground storage tanks (USTs) regulated under Subtitle I of the Solid Waste Disposal Act of 1984, which are typically located at gas stations.[8] This guide applies to new and existing releases of PHCs and non-PHC fuel additives from leaking USTs and to previously closed sites where the implementing agency has reason to suspect that there may be a potential for PVI. Although EPA developed the PVI guide based on data from typical UST sites, this technical guide may also be helpful when addressing petroleum contamination at comparable non-UST sites. Petroleum contamination at sites that are not comparable to UST sites (such as refineries, petrochemical plants, terminals, aboveground storage tank farms, pipelines, and large scale fueling and storage operations at federal facilities), or sites with releases of non-petroleum chemicals including comingled plumes of petroleum and chlorinated solvents regardless of the source, should be addressed under OSWER's more general vapor intrusion guide.

This PVI guide does not impose legally binding requirements on implementing agencies or the regulated community. Decision-makers retain the discretion to adopt or approve approaches on a case-by-case basis that differ from this technical guide.

Recommended Actions For Addressing PVI

Addressing the potential for PVI is an integral part of the normal response to a suspected or confirmed release from any Subtitle I regulated UST system. At any leaking UST site, it is important to have a thorough understanding of the release (i.e., source, composition, and magnitude) and other factors that may influence the distribution and transport of contaminants that impact human safety and health. Until it is clear that human health and the environment are adequately protected from adverse impacts caused by the release, appropriate site characterization, risk assessment, and corrective action activities should continue.

---

[7] For more information on the differences between PHCs and chlorinated solvents, see *Petroleum Hydrocarbons And Chlorinated Solvents Differ In Their Potential For Vapor Intrusion* (http://www.epa.gov/oust/cat/pvi/pvicvi.pdf)

[8] EPA's UST regulations are contained in 40 CFR Parts 280, 281, and 282.50-282.105 (see http://www.epa.gov/oust/fedlaws/cfr.htm). Definitions of key terms such as UST and petroleum are found in 40 CFR 280. These definitions may change if the regulations are revised in the future.

EPA recommends the following actions for situations in which EPA, state, tribal, and local agencies are investigating releases of petroleum-based fuels (including addressing potential risks due to PVI) at leaking UST sites or where 40 CFR 280 requires[9] UST owners and operators to undertake release investigation and corrective action activities:

- ✓ **Assess and mitigate immediate threats to safety – see Section 1** (p.11)
  Identify whether there is a potential threat of explosion or fire due to the presence of flammable PHCs and non-PHC fuel additive vapors or methane[10]. A threat could be indicated by reports of the presence of odors, disagreeable taste of water, or visible signs of PHC contamination by building occupants. If so, alert first responders so they can, if necessary, evacuate these buildings until the potential threat to human safety from fire or explosion due to PVI has been assessed and mitigated as needed.

- ✓ **Conduct a site characterization and develop a conceptual site model (CSM) – see Section 3** (p.39)
  Site characterization data should be integrated into a conceptual site model (CSM). This includes characterization of the physical, biological, and chemical systems at the site, with emphasis on determining the spatial and temporal relationships between receptors and sources of contamination. The CSM should be used as the basis for planning the PVI investigation and making informed risk management decisions about the site and the threat posed by PVI to nearby receptors. EPA recommends that the site characterization include:

  - Determining the full extent and location of contamination and its nature
  - Assessing the potential for biodegradation of PHCs (and non-PHC fuel additives)
  - Defining the hydrologic and geologic characteristics of the site
  - Identifying potential receptors in the vicinity
  - Determining whether preferential transport pathways are present and connect PHC vapor sources with potential receptors[11]
  - Considering whether there are any other factors that may preclude the use of screening criteria

[9] In the case of a suspected or confirmed release from a regulated UST system, Subparts E and F of 40 CFR 280 require owners and operators to investigate, report, and perform corrective action (including recovery of light non-aqueous phase liquid (LNAPL) to the maximum extent practicable) if contamination is present, and submit timely reports of activities and findings to the implementing agency.

[10] Note that methane cannot be detected based on odor, taste or visible signs. Methane-detecting devices must be used. For additional information on evaluating the presence of methane and potential hazards, see ASTM's "New Practice for Evaluating Potential Hazard Due to Methane in the Vadose Zone", which is accessible at *http://www.astm.org/DATABASE.CART/WORKITEMS/WK32621.htm*.

[11] Preferential transport pathways can short-circuit the protectiveness provided by the extent of the lateral inclusion zone and the vertical separation distances described in this guide. If preferential transport pathways connect a vapor source directly to a building, indoor air sampling paired with sub-slab vapor sampling is recommended.

- ✓ **Delineate a lateral inclusion zone – see Section 4** (p.44)
  Delineate a lateral inclusion zone to focus the investigation on buildings located within these boundaries. The lateral inclusion zone is based on the spacing between clean monitoring points; the closer the spacing of the clean monitoring points, the less extensive the lateral inclusion zone.

- ✓ **Determine vertical separation distances for each building within the lateral inclusion zone – see Section 5** (p.48)
  Further narrow the investigation to potential receptors (e.g., buildings) within the lateral inclusion zone and directly overlie contamination. For such buildings, determine the vertical distance between the contamination and the building basement, foundation, or slab. This distance is determined by collecting soil gas, soil, and groundwater samples as necessary. The thickness of clean soil separating contamination from the deepest point of the building basement, foundation, or slab is the vertical separation distance.

  Additional investigation is generally unnecessary if the vertical separation distance is greater than 6 feet for dissolved contamination beneath buildings of any size, or 15 feet for light non-aqueous phase liquid (LNAPL) if the overlying building has at least one side shorter than 66 feet in length. If the distance to contamination is less than the appropriate vertical separation distance (i.e., 6 feet or 15 feet; see **Section 5**), then additional investigation is recommended.

- ✓ **Evaluate vapor source and attenuation of PHC vapors – see Section 5** (p.48), **Section 8** (p.66), **Section 9** (p.75), **Section 10** (p.81), **Section 12** (p.100), **and Section 13** (p.106)
  If contamination (either dissolved, or LNAPL whether mobile or residual) is in direct contact with a building EPA recommends indoor air sampling. In the case of direct contact, sub-slab samples cannot be collected because there is no subsurface soil between the contamination and the building. Where contamination is not in direct contact with an overlying building, then choose one of two options: (1) collect near-slab (exterior) shallow soil gas samples paired with deep (source) soil gas samples, or (2) collect indoor air samples paired with sub-slab soil gas samples. If the potential for PVI cannot be ruled out based on near-slab and deep soil gas sampling, then EPA recommends indoor air sampling paired with sub-slab vapor sampling. If the attenuation factor calculated from results of analysis of the chosen pair or vapor samples indicates that there may be a potential for PVI above applicable exposure limits, EPA recommends gathering additional information and data to determine whether mitigation is appropriate.

- ✓ **Mitigate PVI, as appropriate – see Section 1** (p.11)
  Mitigation involves interruption of the transport pathway for vapors between the source of contamination and potential receptors. Select a remedial design that is appropriate for the building and site. As necessary, establish institutional controls to limit or prohibit access to affected areas. Remediate the source of the contamination, including recovery of LNAPL (if present) to the maximum extent practicable.

Community Engagement

When conducting PVI assessments and follow-up actions, it is important to consider proactive community engagement. EPA acknowledges there is no single correct approach to engage the potentially impacted community in cleanup decisions. Community engagement can occur at any step in the process and may occur more than once. It is generally recognized that earlier and more frequent communication yields positive results, particularly for sites that pose a threat to human health or the environment, or when the public expresses an elevated level of concern or interest in the site. Depending on site circumstances, obtaining meaningful community input is a sound approach that may result in better-informed decisions. EPA developed several community engagement resources, which are available on the Office of Underground Storage Tanks website: Community Engagement And The Underground Storage Tank Program.[12] Some of the resources include:

- Guidelines For Tailoring Community Engagement Activities To Circumstances At Leaking Underground Storage Tank Sites.
- Community Engagement Resources (Toolbox) For Underground Storage Tank Programs.

Table 1 and **Figure 1** briefly outline the **Recommended Actions for Addressing PVI**. Note that this process is not necessarily linear and some of these activities may occur in a different order or recur throughout the PVI investigation; this is especially true for community engagement. Additional technical information is presented in the second part of this guide, *Supporting Technical Information.*

[12] The URL for this web site is *http://www.epa.gov/oust/communityengagement/index.htm*.

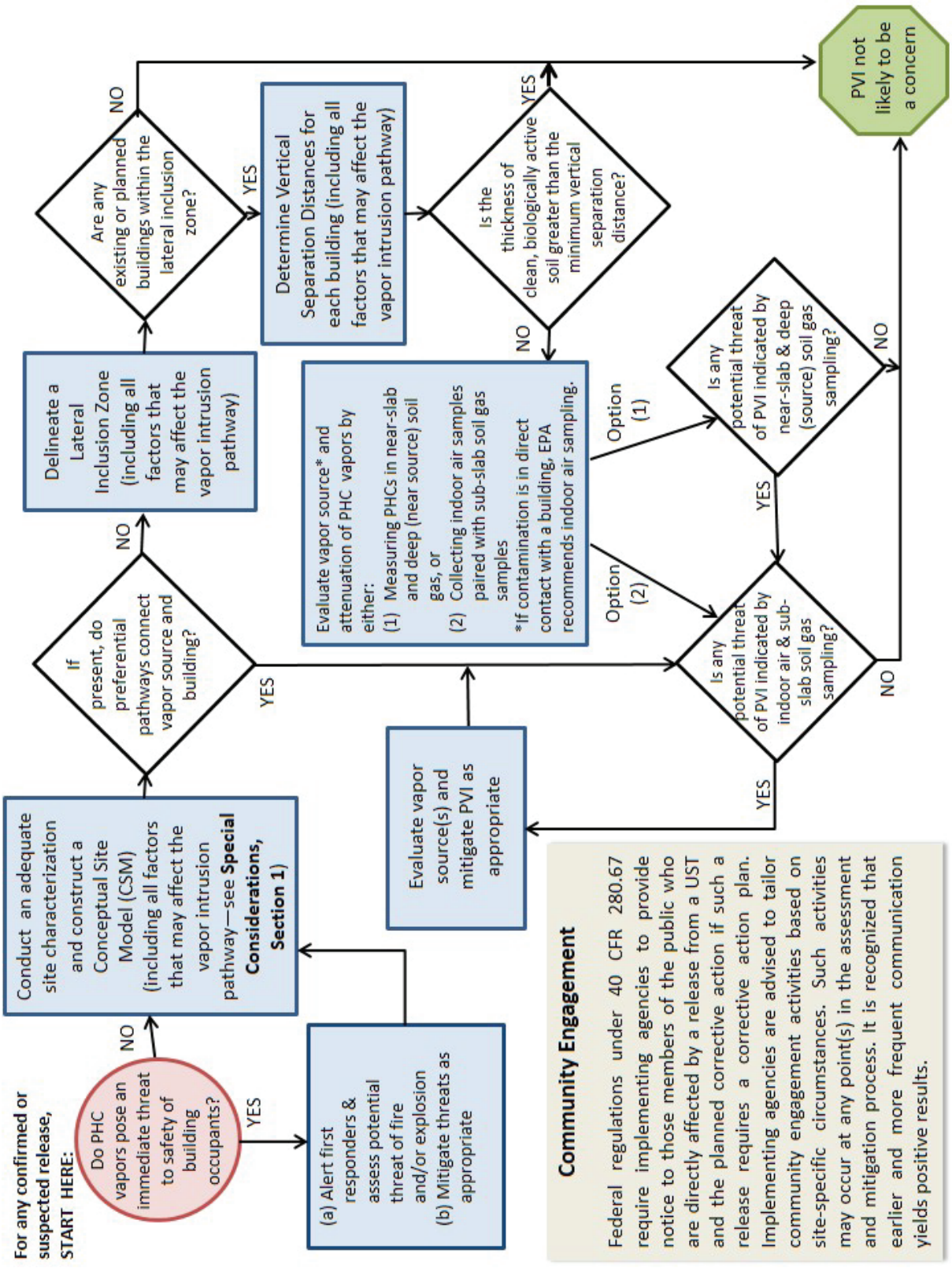
REC 4655

Table 1. Recommended Actions For Addressing PVI At Leaking Underground Storage Tank Sites

Recommended Actions	Purpose And Objectives	Procedures
Assess and mitigate immediate threats to safety (see Section 1, p.11)	Identify potential threat of explosion or fire due to petroleum vapors or methane. Threat may be indicated by: • LNAPL visible in building, possibly as sheen in sump • Noticeable petroleum odor; headache, dizziness, or nausea • Atypical, unusual, or disagreeable taste or smell in the water supply NOTE: Methane cannot be detected on the basis of odor, taste, or visible signs	• Investigate all reports of petroleum odors and other indicators within buildings • Detection of the presence of methane; requires specialized devices • Alert first responders so that they can, if necessary, evacuate building occupants as necessary until the potential for fire or explosion has been assessed and mitigated as needed
Conduct a site characterization and develop a conceptual site model (CSM) (see Section 3, p.39)	Characterize the physical, biological and chemical systems at the site, with emphasis on determining the spatial and temporal relationship between receptors and sources of contamination by: • Determining the full extent and location of contamination and its nature • Assessing the potential for biodegradation of PHCs • Defining the hydrologic and geologic characteristics of the site • Identifying potential receptors in the vicinity • Identifying whether preferential transport pathways are present and connect PHC vapor sources with potential receptors. Preferential transport pathways Include both natural (i.e., geologic) and man-made (i.e., underground utilities, excavations) features.	• Collect sufficient site data and information to construct CSM • Identify data gaps • Update CSM as new data become available • Where preferential transport pathways connect PHC vapor sources to receptors (e.g., buildings), indoor air sampling paired with sub-slab vapor sampling is recommended
Delineate a lateral inclusion zone (see Section 4, p.44)	Screen out buildings that are not likely to be impacted by PVI to narrow the investigation to only those buildings that have a greater potential for PVI and for which further investigation should be conducted. The lateral inclusion zone is site-specific and: • Based on the extent of contamination and distance between clean monitoring points • Decreases in extent as additional data are collected to reduce uncertainty in the CSM	• Construct lateral inclusion zone based on distance between clean monitoring points (includes consideration of the presence of preferential transport pathways)
Determine vertical separation distances (see Section 5, p.48)	Further screen out buildings that are not likely to be impacted by PVI to focus the investigation on potential receptors that overlie contamination in the dissolved, vapor, and/or LNAPL phase. The vertical separation distance is: • The thickness of clean, biologically-active soil	• For each building within the lateral inclusion zone, collect additional soil gas, soil, and groundwater samples as necessary to determine the vertical separation distance. Additional investigation is generally unnecessary

Recommended Actions	Purpose And Objectives	Procedures
	(see **Section 9**, p.75) separating contamination from overlying buildings or other potential receptors • Determined by site-specific sampling to determine the depth at which contamination is present	If the distance to contamination is greater than: • 6 feet for dissolved contamination beneath buildings of any size, or • 15 feet for LNAPL if the overlying building has at least one side shorter than 66 feet in length • If the distance to contamination is less than those indicated above, then additional investigation is recommended.
Evaluate vapor source and attenuation of PHC vapors (see Section 5, p.48, Section 8, p.66, Section 9, p.75, Section 10, p.81, Section 12, p.100, and Section 13, p.106)	Carefully evaluate the potential for PVI into those buildings identified as being the most likely to be impacted by PVI. This is a building-by-building evaluation based on sampling conducted within close proximity to the building or inside the building as necessary.	If contamination is in direct contact with building basement, foundation, or slab, then collect indoor air samples. Otherwise choose either option (1) or (2) below: 1. Collect near-slab soil gas samples coupled with deep (source) soil gas samples. If a potential threat of PVI is indicated, then proceed to option 2. If not, PVI is not likely to be a concern. 2. Collect indoor air samples paired with sub-slab soil gas samples. If these results indicate a potential threat of PVI, mitigate PVI as appropriate.
Mitigate PVI as appropriate (see Section 1, p.11)	Interrupt the pathway between the source of contamination and potential receptors. • Numerous approaches depending on building characteristics	• Select a remedial design that is appropriate for building and site • Remediate source of contamination, including recovery of LNAPL (if present) to the maximum extent practicable • Establish institutional controls to limit or prohibit access to affected areas of building, as necessary

Figure 1. Flowchart For Addressing PVI At Leaking Underground Storage Tank Sites



Supporting Technical Information

The following sections provide technical information in support of EPA's recommended actions as outlined in **Table 1** (p.7) and depicted in **Figure 1** (p.9). Each section presents information in a standardized format, which is easy to follow and allows for future revisions, as necessary.

Additional sources of information may be found in the Petroleum Vapor Intrusion Compendium (*http://www.epa.gov/oust/cat/pvi/*), located on the Office of Underground Storage Tanks (OUST) website (*http://www.epa.gov/oust/*).

Page

1. Petroleum Vapor Intrusion (PVI) 11
2. Typical PVI Scenarios 33
3. Site Characterization And Conceptual Site Model (CSM) 39
4. Lateral Inclusion Zone 44
5. Vertical Separation Distance 48
6. Mobile And Residual Light Non-Aqueous Phase Liquid (LNAPL) 57
7. Groundwater Flow And Dissolved Contaminant Plumes 61
8. Soil Gas Profile 66
9. Clean, Biologically Active Soil 75
10. Non-PHC Fuel Additives 81
11. Seasonal And Weather Effects 96
12. Vapor Intrusion Attenuation Factor (α) 100
13. Computer Modeling Of Petroleum Vapor Intrusion 106

1. Petroleum Vapor Intrusion (PVI)

Description

Petroleum vapor intrusion (PVI) occurs when vapors from petroleum hydrocarbons (PHCs) migrate through the subsurface into overlying or nearby buildings. Fuels such as gasoline, diesel, aviation gasoline, and jet fuel are comprised primarily of PHCs with some non-petroleum based additives. Under certain circumstances, PVI may result in indoor air concentrations that pose a risk to building occupants. PVI may pose immediate threats to safety (e.g., fire or explosion potential from petroleum vapors or methane) or possible adverse health effects from inhalation of toxic chemicals (e.g., exposure to benzene from gasoline). Vapor concentrations generally decrease with increasing distance from a subsurface vapor source due to aerobic biodegradation, and eventually at some distance the concentrations become negligible.

Composition Of Petroleum Fuels

Petroleum fuels are comprised of hundreds of individual compounds. PHCs present in petroleum fuels generally belong to one of two major groups: aromatics and aliphatics. The aromatic PHCs are characterized as having one or more benzene rings. Benzene, toluene, ethylbenzene, and the three isomers of xylene are collectively referred to as BTEX. The aliphatics are non-aromatic PHCs consisting of straight-chains, branched chains, or non-aromatic rings. Although BTEX represent the group of PHCs that receive the most attention at typical leaking underground storage tank (UST) sites, they are not the only compounds that may pose a risk to human health.[13] Petroleum fuels may also contain a variety of non-PHC volatile organic chemicals (VOCs) as additives to enhance performance. Fuel oxygenates such as methyl

[13] The federal UST program does not prescribe human health values for contaminants; implementing authorities should use exposure values and attenuation factors appropriate for the contaminants present and the characteristics of exposure (e.g., residential vs industrial). Although there is a lack of toxicological data for many PHCs, EPA provides some information that may be applicable. For example, EPA provides vapor intrusion screening levels (VISLs) for a variety of volatile chemicals known to pose a potential cancer risk or noncancer hazard through the inhalation pathway. These VISLs, which are calculated by the VISL Calculator (EPA, 2014b), are generally recommended, medium-specific, risk-based screening-level concentrations intended for use in identifying areas or buildings that may warrant further investigation and mitigation of vapor intrusion, as appropriate. VISLs are calculated for concentrations of volatile chemicals in groundwater, soil gas (exterior to buildings and sub-slab), and indoor air for default target risk levels and exposure scenarios. The VISL Calculator does not account for biodegradation so attenuation factors may need to be adjusted for biodegradable chemicals. The VISL Calculator draws on toxicity values from Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites, accessible at *http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm*. Both the *VISL Calculator User's Guide* (EPA, 2014a) and *VISL Calculato*r (EPA, 2014b) may be downloaded from EPA's web site: *http://www.epa.gov/oswer/vaporintrusion/guidance.html*. RSLs are drawn from a variety of sources according to EPA's three-tiered hierarchy of toxicity data (see "Human Health Toxicity Values in Superfund Risk Assessments" OSWER Directive 9285.7-53, 2003). Tier 1 (highest quality data) is EPA's Integrated Risk Information System (IRIS), accessible at *http://www.epa.gov/iris/*. Tier 2 are Provisional Peer Reviewed Toxicity Values (PPRTVs), accessible at *http://hhpprtv.ornl.gov/* (also see EPA, 2009). Tier 3 include toxicity values from other sources such as the Agency for Toxic Substances and Disease Registry (ATSDR). Several states have also developed toxicity values, including California (CA DTSC, 2009), Hawai'i (HI DOH, 2008, 2012), Massachusetts (MA DEP, 2003), New Jersey (NJ DEP, 2013), and Washington (WA DEC, 2006). Links to these sources are provided under *References Cited* at the end of this section.

tertiary-butyl ether (MTBE) and tertiary-butyl alcohol (TBA), and the lead scavengers[14] ethylene dibromide (EDB), and 1,2-dichloroethane (1,2-DCA), plus other PHCs (e.g., naphthalene), may also pose a risk to human health. If present, their vapor intrusion potential should be assessed (see **Section 10**, p.81). The presence of biodegradable VOCs other than benzene may result in depletion of oxygen that is necessary for aerobic biodegradation of benzene, potentially resulting in farther migration of benzene vapors.

Phase Partitioning

When petroleum fuels are released into the subsurface from a leaking UST, PHCs may partition into several phases:

- Globules of light non-aqueous phase liquid (LNAPL) trapped within soil pore spaces (i.e., residual LNAPL)
- Dissolved in soil moisture
- Adhered onto the surface of, or absorbed into, soil solids
- Vapors in soil gas
- Accumulations of mobile LNAPL on and in the capillary fringe[15]
- Dissolved in groundwater

Low volume releases may result in contamination of only soil (including soil gas and soil moisture) and remain in the vadose zone. If the volume of a fuel release is sufficient, the fuel may accumulate on and in the capillary fringe and become mobile LNAPL. The mobile LNAPL generally spreads in the direction of groundwater flow, and may accumulate in monitoring wells. Temporal fluctuations in the elevation of the water table typically create a vertical smear zone of residual LNAPL contamination both above and below the average water table elevation. The more soluble components of the LNAPL mass dissolve into groundwater and are transported down gradient by the flowing groundwater as an aqueous phase. The remaining LNAPL mass will contain a sizeable fraction of aliphatic and relatively insoluble PHCs (e.g., naphthalene), especially if the source is large or unweathered (Lahvis, et al., 2013; EPA, 2013a). PHCs in the residual phase (both above and below the water table), the mobile phase (i.e., free product, LNAPL plume), and the dissolved phase (i.e., contaminant plume) all can serve as sources of PHC vapors. **Figure 2** illustrates the typical distribution of petroleum fuels in the subsurface resulting from a leaking UST. See **Section 2** (p.33) for a more detailed discussion of typical PVI scenarios.

[14] Older sites, where leaded gasoline was released to the subsurface, should be assessed for EDB and 1,2-DCA as they may represent a potential source of vapors (see **Section 10**). For more information about lead scavengers, see Appendix F in *Evaluation Of Empirical Data To Support Soil Vapor Intrusion Screening Criteria For Petroleum Hydrocarbon Compounds* (EPA, 2013) and EPA's Lead Scavengers web site at *http://www.epa.gov/oust/cat/leadscav.htm*.

[15] Mobile LNAPL is often referred to as free product, especially in older documents and 40 CFR 280.

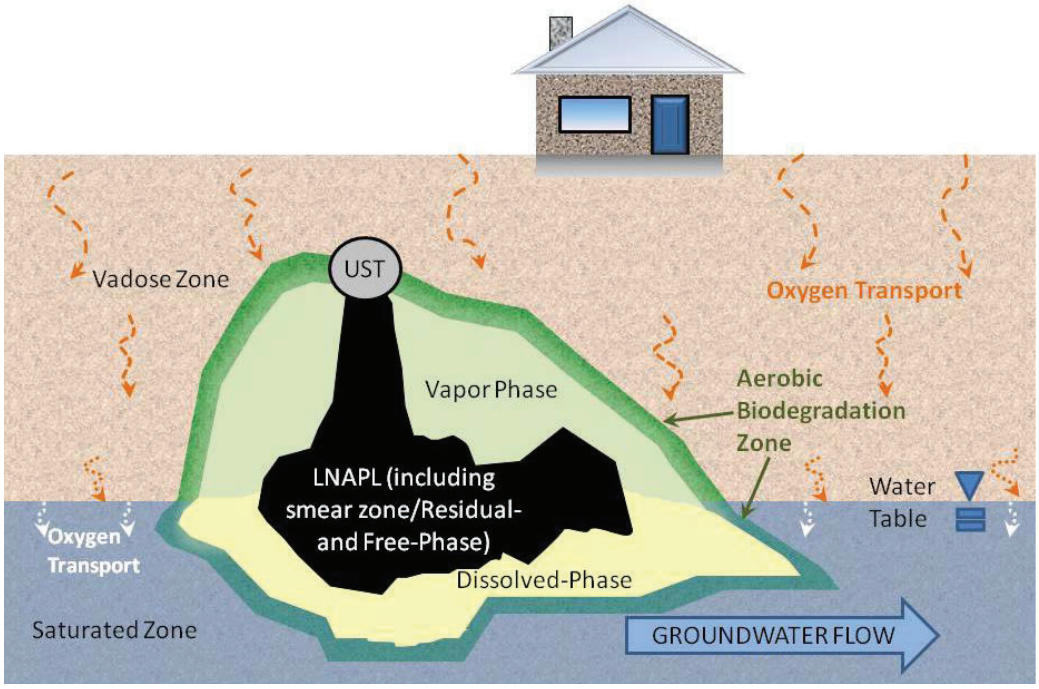


Figure 2. Conceptual Model Of Typical Petroleum Hydrocarbon Release

Aerobic biodegradation of PHCs along the perimeter of the vapor and dissolved plumes may limit the spread of subsurface contamination. Effective oxygen transport (dashed arrows) maintains aerobic conditions in the biodegradation zone. Petroleum LNAPL collects at the capillary fringe between the saturated and unsaturated zones (EPA, 2012).

Vapor Migration

Vapor migration results from two processes: diffusion and advection. Diffusion is the process whereby net transport of vapors from a source area of higher concentration (e.g., LNAPL, residual LNAPL, or dissolved plume) to an area of lower concentration occurs as a result of random molecular motion. Diffusion can also lead to chemical migration into buildings directly through a dirt floor or crawlspace, or through openings in the building slab and foundation such as passages for utility lines, sumps, and elevator pits. Also, intact concrete has appreciable permeability to diffusive gas movement (Kobayashi and Shuttoh, 1991; Sanjuan and Munoz-Martialay, 1996; and Tittarelli, 2009) and the permeability increases substantially when cracks are present (Daoud and Renken, 1999; EPA, 1995).

Advection refers to the movement of soil gas in response to pressure gradients. Advection can be an important mechanism for drawing soil gas and contaminant vapors through cracks in the basement floor or foundation into the building or back into the soil beneath the building. Heating and cooling systems can create differential pressures inside the building. When the pressure inside the building is lower than the pressure in the subsurface, vapors are drawn into the building. Conversely, when the pressure inside the building is greater than the pressure in

the subsurface, air within the building may be forced into the subsurface causing some degree of reoxygenation (Lundegard, Johnson, and Dahlen, 2008). Wind or changes in barometric pressure may also drive advective transport of oxygen into the subsurface beneath the building (Lundegard, Johnson, and Dahlen, 2008; Patterson and Davis, 2009; McHugh, DeBlanc, and Pokluda, 2006; Luo and Johnson, 2011; Robinson, Sextro, and Riley, 1997; Luo, et al., 2009; and Hong, Holton, and Johnson, 2012) (see **Section 11**).

Biodegradation Of PHCs

Biodegradation of PHCs is recognized as one of the primary mechanisms by which petroleum and other hydrocarbon pollutants are removed from the environment (Baedecker, Cozzarelli, and Hoppel, 1987; Leahy and Colwell, 1990). The biodegradability of PHCs often reduces the potential for human exposure from PVI (McHugh, et al., 2010; EPA, 2012; Interstate Technology & Regulatory Council [ITRC], 2014). Microorganisms are widely distributed in the environment and most are recognized as having some ability to metabolize PHCs (Gale, 1951; Ward, Singh, and Van Hamme, 2003; Prince, 2010). Although most microbes degrade a narrow range of organic compounds, they typically exist as a mixed consortium that collectively can biodegrade a wide range of organic compounds. Biodegradation progresses through stages with certain microbes being predominant until environmental conditions (e.g., availability of specific hydrocarbons, micronutrients, electron acceptors) become unfavorable for them at which time different microbes then become dominant (Wang and Deshusses, 2006; Suflita and Mormile, 1993; Corseuil, et al., 1998; Moyer, et al., 1996; Boopathy, 2004; Alexander, 1980; Prince, Parkerton, and Lee, 2007; Prince, 2010; and Bekins, et al., 2001). Thus, aerobic and anaerobic microbes may coexist with one class essentially dormant while the other is active.

Gasoline and diesel fuel (including biodiesel) may be completely biodegraded under aerobic conditions (Hult, 1987; Prince and Douglas, 2010; Prince, Parkerton, and Lee, 2007; Marchal, et al., 2003), though diesel fuel is more difficult and slower to biodegrade (Marchal, et al., 2003).[16] The end products of complete biodegradation (mineralization) of PHCs are water and carbon dioxide. Mineralization of PHCs is almost always the consequence of microbial activity (Alexander, 1981). If aerobic biodegradation of PHCs is incomplete, a variety of intermediate degradation products may be formed, but none of these are more toxic than the parent PHCs.

Aerobic biodegradation is well documented for many individual PHCs and classes of PHCs including:

- N-alkanes (Bouchard, et al., 2005; Prince, Parkerton, and Lee, 2007; Bailey, Jobson, and Rogers, 1973; Hult, 1989; Baedecker, et al., 2011)
- Branched alkanes (Prince and Douglas, 2010; Prince, Parkerton, and Lee, 2007); cycloalkanes (Bouchard, et al., 2005)

[16] The rate of aerobic biodegradation slows down with decreasing concentration of oxygen. Many aerobic microorganisms continue to function at concentrations as low as 0.1 mg/L of available oxygen, which is equivalent to an air concentration of 0.2%. For more information see research by Alagappan and Cowan (2004), Miralles-Wilhelm, Gelhar, and Kapoor (1997), and Mohamed, Saleh, and Sherif (2010).

- Aromatics (Wang and Deshusses, 2007; Phelps and Young, 1999; Landmeyer and Bradley, 2003; Lahvis, Baker, and Baehr, 2004; Lahvis, Baehr, and Baker, 1999; Bailey, Jobson, and Rogers, 1973; ZoBell, 1946; Corseuil, et al., 1998; Richnow et al., 2003)
- Naphthenes (Prince, Parketon, and Lee, 2007; Bailey, Jobson, and Rogers, 1973; Anderson, et al., 1999; ZoBell, 1946)
- Phenols (ZoBell, 1946; Basha, Rajendran, and Thangavelu, 2010)
- Trimethylbenzenes (Chen, et al., 2009)

Though aerobic biodegradation has been studied for over a century, anaerobic biodegradation of PHCs has been recognized only within the past three decades (Widdel, Boetius, and Rabus, 2006; Spormann and Widdel, 2000; and Townsend, et al., 2003). Anaerobic microorganisms degrade PHCs by using an electron acceptor other than oxygen (e.g., sulfate, nitrate, ferrous iron, or carbon dioxide). Anaerobic biodegradation is a slower process than aerobic biodegradation (Widdel, Boetius, and Rabus, 2006; Bailey, Jobson, and Rogers, 1973; and Lanham et al., 2013) and anaerobes grow slower than their aerobic counterparts (Widdel, Knittel, and Galushko, 2010). Instead of water and carbon dioxide, complete anaerobic biodegradation of PHCs (and naturally-occurring organic matter in soil, such as peat) can produce methane (Zengler, et al., 1999), especially with a release of an ethanol-blended gasoline (Jewell and Wilson, 2011; Ma, et al., 2012; Ma, et al., 2014). Incomplete anaerobic biodegradation of PHCs can produce compounds of higher toxicity, but these vapors are readily biodegraded in the vadose zone under aerobic conditions, and thus should not present a threat of vapor intrusion. Anaerobic biodegradation is typically the predominant mechanism of biodegradation in the source zone (Anderson and Lovley, 1997). Additional references documenting anaerobic biodegradation of PHCs are listed under *Additional Information* at the end of this section.

Importance

Important factors cited by Lahvis and Baehr (1996) and Suarez and Rifai (1999) as being influential for aerobic biodegradation of PHC vapors include:

- Vapor source hydrocarbon concentration, flux, and composition (including methane)
- Oxygen demand (i.e., the oxygen required to biodegrade the available hydrocarbons and any other organic matter present) and oxygen availability
- Soil type and properties (including texture and moisture content)
- Availability of essential micronutrients
- Ambient temperature in the subsurface
- The pH of the soil and groundwater

Additional factors cited by EPA (2012) as influencing the potential for PVI include:

- Size and characteristics of the building and adjacent land surface
- Distance between the vapor source and the building

Assessment
An assessment of the potential for PVI is not an isolated activity, but rather an integral part of the normal response to a suspected or confirmed release of PHCs from a leaking UST. At any leaking UST site (including abandoned sites or those that will be redeveloped for other uses), it is important to have a thorough understanding of the nature and magnitude of the release; the physical, biological, and chemical characteristics of the subsurface environment; an understanding of the preferential pathways for contaminant transport; and locations of receptors in the vicinity of the release. This is determined through collection and analysis of samples of soil, soil gas, groundwater, and sometimes LNAPL. Any other conditions (e.g., seasonal, weather-related; see **Section 11**, p.96) that may influence the transport of contaminants and potentially impact the safety and health of nearby building occupants should also be investigated.

Vapors emanating from dissolved-phase sources are primarily water soluble compounds, the more soluble aromatic hydrocarbons (e.g., BTEX) and other volatile and semi-volatile hydrocarbons and fuel additives (Lahvis, et al, 2013; EPA, 2013a). Vapors emanating from LNAPL sources contain a significantly larger fraction of aliphatic compounds and relatively insoluble hydrocarbons, especially if the source is large or unweathered (Lahvis, et al., 2013; EPA, 2012). Analyses of samples of soil, soil gas, groundwater, and LNAPL collected during site characterization (see **Section 3**, p.39) will provide information on specific contaminants that may warrant assessment for potential vapor intrusion.

Special Considerations
Several factors may preclude the effectiveness of aerobic biodegradation to mitigate the threat of vapor intrusion. They include:

- Source volume and composition (including PHCs and non-PHC fuel additives)
- Soil properties (moisture content, permeability, high organic carbon content, especially peat)
- Large building size
- Extensive impermeable surface covering (e.g., asphalt, concrete)
- Preferential transport pathways (including both natural and man-made)

If present, these factors may reduce the potential for biodegradation of PHC vapors and warrant additional investigative steps (e.g., collection of soil gas samples—see **Section 8**, p.66) to determine if the use of screening criteria (e.g., vertical separation distance) is appropriate.

The age and volume of release should be determined or estimated. When the release is relatively recent or if the volume of the release is relatively large[17], there is greater potential for PVI than for smaller or older releases, which may be more weathered. Large volume PHC

[17] The adjective *large* refers to either the total volume of the release or the areal extent (footprint) of the LNAPL mass in the subsurface.

releases may require a greater separation distance for biodegradation to be effective due to increased oxygen demand (EPA, 2013a).

Biodegradation of recent releases of high ethanol blended gasoline (i.e., E-20 or greater) may consume oxygen that would otherwise be available for biodegradation of PHCs resulting in an increased potential for PVI (Ma et al., 2014). In addition, the biodegradation of ethanol may result in the advective transport of methane and a potential risk of explosion. Thus, larger separation distances may be necessary to mitigate the threat of explosion or PVI at sites where high ethanol blended fuel has been released into the subsurface (Ma et al., 2014).

Preferential transport pathways may be either natural (e.g., fractures in rock, solution channels in karst terrain, bedding planes, joints, high permeability layers) or man-made (e.g., utility corridors including sewer lines themselves, trenches, excavations). Because they increase the speed at which the contaminants move through the subsurface, preferential transport pathways can potentially short circuit protectiveness that would otherwise be provided by biodegradation of PHCs and other fuel additives in homogeneous soils. Typically, it is difficult to detect and map natural preferential transport pathways, and contamination may present itself in unexpected locations. Local government offices have maps of utility corridors that can provide information on the presence and location of man-made preferential transport pathways.[18]

Recommended Steps For Addressing The Potential Risk From PVI

EPA recommends the following actions for situations in which EPA, state, tribal, and local agencies are investigating releases of petroleum-based fuels (including addressing potential risks due to PVI) at leaking UST sites or where 40 CFR 280 requires[19] UST owners and operators to undertake release investigation and corrective action activities:

- ✓ ***Assess and mitigate immediate threats to safety***

Some releases from UST systems are discovered through noticeable sensory indicators on neighboring properties. Indicators may include sight, smell, taste, or physiological effects (e.g., dizziness, headache, nausea, vomiting, and confusion). The presence of odors does not necessarily correspond to adverse health or safety impacts from PVI, as the odors could be the result of indoor vapor sources. However, it is generally prudent to investigate any reports of odors in close proximity to UST systems as the odor threshold for some chemicals exceeds their acceptable health-based concentrations. PHC odors are a nuisance and may trigger the need

[18] A federally mandated national call center was established to ensure that utility lines are marked before digging or boring. Dial 811 to have the locations of utilities marked before conducting site work that involves digging or boring. For more information, visit *http://www.call811.com/default.aspx*

[19] In the case of a suspected or confirmed release from a regulated UST system, Subparts E and F of 40 CFR 280 require owners and operators to investigate, report, and perform corrective action (including recovery of LNAPL to the maximum extent practicable) if contamination is present, and submit timely reports of activities and findings to the implementing agency.

for abatement or mitigation even if the concentration in indoor air is below acute or chronic health-based levels.

In confined spaces, the presence of flammable PHC vapors and non-PHC fuel additive vapors or methane may pose a threat of fire or explosion and endanger building occupants. Federal regulations (40 CFR 280.61) require that immediate action be taken to prevent any further release of the regulated substance into the environment and that fire, explosion, and vapor hazards be identified and mitigated (*Federal Register*, 1988). Section 280.64 requires that free product (mobile LNAPL) be recovered to the maximum extent practicable and that records be kept of the volumes recovered. First responders, typically fire department personnel, should be notified if there are reports of either odor from petroleum or the presence of an oily sheen on basement floors or in sumps, drains, or elevator pits. It may be necessary to evacuate building occupants until the threat from fire or explosion has been mitigated. Since methane is odorless and colorless, monitoring devices are required if methane is suspected.

- ✓ ***Conduct a site characterization and develop a conceptual site model (CSM)***

Once the immediate threats to safety have been mitigated (or it is determined that immediate threats do not exist), determine whether there is a long-term threat to human health and the environment from intrusion of petroleum vapors. Site characterization[20] and CSM development provide information about the full extent and location of the contamination; the nature and characteristics of the contamination; the characteristics of the site that influence contaminant migration, including the potential for biodegradation of PHCs; and the locations of receptors. Information derived from the CSM helps ensure that sources, pathways, and receptors throughout the site are considered; this knowledge can lead to selection of the most appropriate sampling locations and techniques. A systematic soil gas sampling program may also aid in defining the full extent and location of contamination, detecting the presence of preferential transport pathways, and locating pockets of PHC vapors. Preferential transport pathways are avenues of least resistance to the migration of contaminants whether in the dissolved phase, LNAPL phase, or vapor phase. They include both natural and man-made features such as:

Natural	**Man-made**
• gravel lenses and channels	• utility corridors (including sewer lines themselves) and trenches
• solution channels in karst terrain	• elevator pits
• bedding planes	• sumps and drainage pits
• fractures, joints, and faults in consolidated rock	• other types of excavations

[20]The term *site characterization* is used throughout this document for consistency. *Site characterization* is often used interchangeably with *site assessment*, *site evaluation*, *site investigation*, and sometimes *site check* as they all mean assembling and collecting information and data about a site.

Preferential transport pathways increase the speed at which contamination moves through the subsurface such that contaminants may not biodegrade by the time they reach receptors. They can also allow atypical movement, which in some cases may be opposite groundwater flow (ITRC, 2014). Because preferential transport pathways can short-circuit the protectiveness provided by lateral and vertical separation distances described in this PVI guide, indoor air sampling is recommended in situations where they connect vapor sources and receptors. See **Section 3** (p.39) for more information about site characterization and CSMs.

- ✓ ***Delineate a lateral inclusion zone***

Based on the CSM, delineate a lateral inclusion zone. The lateral inclusion zone is the area surrounding a contaminant mass through which petroleum vapors may travel, intrude into buildings, and potentially pose a threat to human health and the environment. Buildings directly above contamination sources, whether as mobile LNAPL, residual LNAPL, or PHCs dissolved in groundwater, are considered within the lateral inclusion zone. Buildings outside this zone generally may be excluded from further assessment for PVI unless:

- Site conditions change (e.g., groundwater flow direction changes, contaminant plume migrates beyond the lateral inclusion zone, development or redevelopment of nearby properties)
- Preferential transport pathways are present

In such instances, additional investigation may be warranted to more fully evaluate the risk from PVI. See **Section 4** (p.44) for more information on delineating a lateral inclusion zone.

- ✓ ***Determine vertical separation distances***

The vertical separation distance is the thickness of clean, biologically active soil (see **Section 9**, p.75) between a contaminant mass and the lowest point of an overlying receptor (e.g., building basement floor, foundation, or crawl space surface). Consolidated rock is not soil and should not be included in the vertical separation distance. For example, for a situation in which there is 3 feet of soil above fractured rock and the depth to contaminated groundwater is 7 feet, the vertical separation distance is 3 feet, not 7 feet. Some buildings within the lateral inclusion zone will overlie PHC contamination that exists as either a mobile LNAPL mass, residual soil contamination (including the smear zone), or dissolved in a groundwater plume. However, not all of these buildings will be threatened by PVI due to aerobic biodegradation of PHCs provided there is sufficient vertical separation distance between the receptor and the vapor source. The vertical separation distance between contamination and overlying buildings is determined as part of the normal site characterization process. The full extent and location of contaminant sources should have been adequately mapped in the subsurface and the nature and characteristics of the contamination should have been determined during site characterization and conceptual site model development (see **Section 3**, p.39).

EPA (2013a) presents analysis of petroleum vapor source data and soil gas data from a number of leaking UST sites across the United States. The report findings support screening criteria for dissolved and LNAPL PHC releases from leaking USTs. For dissolved PHC sources that are separated from overlying buildings by more than 6 feet of clean, biologically active soil, the potential threat of PVI is negligible and further investigation for PVI is generally unnecessary. For LNAPL sources that are separated from overlying buildings by more than 15 feet of clean, biologically active soil, the potential threat of PVI is negligible and further investigation for PVI is generally unnecessary. These separation distances are believed to be sufficiently protective in most situations because they include a number of built-in safety factors, which are discussed in more detail in **Section 5** (p.48). If the distance separating the source of PHC vapors and overlying buildings is less than 6 feet for dissolved sources and 15 feet for LNAPL sources, additional investigation is recommended.

EPA (2013a) recognizes that there are a number of precluding factors that may justify a greater vertical separation distance in some cases. These factors include:

- Influence of methanogenesis on oxygen demand (especially for higher ethanol blends of gasoline)
- Effect of extensive high organic matter content soils (e.g., peat) with potentially high natural oxygen demand
- Reduced oxygen flux caused by certain geologic conditions (e.g., low permeability surface layer overlying coarse-grained soils, soil moisture from precipitation (Luo et al., 2009))
- Limited knowledge of vapor attenuation behavior in fractured rock
- Limited soil gas data for non-UST (e.g., petroleum refinery, fuel terminal) sites
- Limited data on vapor attenuation behavior of aliphatic compounds
- Lack of soil vapor data for the lead scavengers ethylene dibromide (EDB) and 1,2-dichloroethane (1,2-DCA) (see **Section 10**, p.81, for more information on these contaminants)

Other site characteristics that may warrant additional investigation include exceptionally dry soils (<2 percent soil moisture), areas covered by extensive impervious paving or large buildings, and presence of preferential transport pathways (see **Section 3**, p.39). Also, soil gas movement may vary seasonally in response to differential pressures created by heating and cooling of overlying buildings (see **Section 11**, p.96).

- ✓ ***Evaluate vapor source and attenuation of PHC vapors***

Where contamination is not in direct contact with an overlying building, EPA recommends one of two options: (1) collection of near-slab (exterior) shallow soil gas samples paired with deep (near source) soil gas samples, or (2) collection of indoor air samples paired with sub-slab soil

gas samples to evaluate attenuation of PHC vapors and the potential for PVI.[21] When collecting soil gas samples[22], use option 1 under the following conditions (EPA, 2013b):

- A building, with the shortest side no longer than 66 feet, overlies LNAPL and the vertical separation distance is less than 15 feet, but not in direct contact with the building basement floor, foundation, or crawl space surface.
- A building, of any dimension, overlies dissolved PHC contamination and the vertical separation distance is less than 6 feet, but not in direct contact with the building basement floor, foundation, or crawl space surface.

Use option 2 for buildings larger than 66 feet on a side or if near-slab soil gas samples from around smaller buildings do not clearly demonstrate that biodegradation is sufficient to mitigate the threat of PVI by reducing PHC concentrations to below applicable human health thresholds (see Footnote #13).

The purpose of collecting paired samples is to enable determination of a building-specific vapor intrusion attenuation factor. Generic attenuation factors that do not account for biodegradation of PHCs are conservative and, likely overestimate the transfer of contaminants from soil gas to indoor air in most buildings. Attenuation factors (see **Section 12**, p.100) that account for biodegradation can be derived from models such as *BioVapor* or *PVIScreen* (see **Section 13**, p.106). Additional information may be found in Wilson *et al.* (2014).

If contamination (either dissolved, or LNAPL whether mobile or residual) is in direct contact with a building basement floor, foundation, or crawlspace surface, EPA recommends indoor air sampling (these samples cannot be paired with subsurface soil gas samples because there is no clean, biologically active soil between the contamination and the building). Information on collecting and analyzing sub-slab vapor samples and indoor air samples is beyond the scope of this document, but is provided in other documents, for example ITRC (2014) and EPA (2015).

Indoor air in many buildings will contain detectable levels of a number of vapor-forming compounds whether or not the building overlies a subsurface source of vapors, because indoor air can be impacted by a variety of indoor and outdoor sources. The composition of outdoor air surrounding a building is referred to as ambient air throughout this document. The combined contribution of indoor and outdoor sources of vapors to indoor air concentrations is referred to as background throughout this document. To differentiate and quantify the relative contribution of contaminants from PVI versus background sources, indoor air samples must be collected in conjunction with sub-slab (or near-slab, as appropriate) soil gas samples. ITRC

[21] Implementing authorities may opt for sub-slab soil gas and indoor air sampling in any situation they deem necessary to protect the safety and health of building occupants.

[22] Soil gas samples should be analyzed for oxygen, carbon dioxide, PHCs (and any other fuel constituents likely to be present including fuel additives), and methane. As a quality assurance/quality control check, nitrogen can be added to the analyte list at a nominal cost. This will enable determination of whether significant concentrations of other gases are unaccounted for as these gases should account for nearly 100 percent of the total present. (See **Section 8**).

(2014) and EPA (2015) provide information on background sources, techniques, and methods to account for background contributions to indoor air concentrations.

Information on historic concentrations of background vapors is presented in *Background Indoor Air Concentrations of Volatile Organic Compounds in North American Residences (1990 – 2005): A Compilation of Statistics for Assessing Vapor Intrusion* (EPA, 2011b). In addition, the Montana Department of Environmental Quality (MT DEQ, 2012) conducted an extensive investigation of the indoor air quality of typical uncontaminated buildings in Montana. The objective of these studies is to illustrate the ranges and variability of VOC concentrations in indoor air resulting from sources other than vapor intrusion. While these studies provide expected ranges of indoor air contaminants, EPA recommends building-specific sampling (rather than using literature values) to characterize actual contaminant levels. If measured indoor air concentrations are found to greatly exceed the historic range of background levels, there is a greater likelihood that the indoor air concentrations are the result of vapor intrusion. Studies such as EPA (2011) and MT DEQ (2012) can be employed to determine whether measured indoor air concentrations exceed the historic range of background concentrations.

If the attenuation factor calculated from results of analysis of the chosen pair or vapor samples indicates that there may be a potential for PVI above applicable exposure limits, EPA recommends additional investigation to determine whether mitigation is appropriate.

- ✓ ***Mitigate petroleum vapor intrusion, as appropriate***

If contaminant concentrations represent a potential threat of fire or explosion (i.e., vapor concentrations are more than 10% of the lower explosive limit), or indoor air sampling indicates that PVI is occurring, EPA recommends that active mitigation measures be immediately initiated. ITRC (2014) and EPA (2015) provide information on mitigation and remediation of vapor intrusion. In addition, the source of contamination should be remediated per Subpart F of the Federal Regulations (40 CFR 280.60 through 280.67) (Federal Register, 1988). In particular, 40 CFR 280.64 requires the recovery of LNAPL to the “maximum extent practicable”.

See the following sections for more information on the factors discussed in the paragraphs above:

- **Section 3** (p.39) Site Characterization and Conceptual Site Model (CSM)
- **Section 4** (p.44) Lateral Inclusion Zone
- **Section 5** (p.48) Vertical Separation Distance
- **Section 6** (p.57) Mobile and Residual Light Non-Aqueous Phase Liquid (LNAPL)
- **Section 7** (p.61) Groundwater Flow and Dissolved Contaminant Plumes.
- **Section 8** (p.66) Soil Gas Profile
- **Section 9** (p.75) Clean, Biologically Active Soil

References Cited

Alagappan, G. and R.M. Cowan. 2004. Effect of Temperature and Dissolved Oxygen on the Growth Kinetics of *Pseudomonas putida* F1 Growing on Benzene and Toluene. *Chemosphere* 54:1255-1265.

Alexander, M. 1981. Biodegradation of Chemicals of Environmental Concern. *Science* 211(9):132-138.

Amos, R.T., K.U. Mayer, B.A. Bekins, G.N. Delin, and R.L. Williams. 2005. Use of Dissolved and Vapor-Phase Gases to Investigate Methanogenic Degradation of Petroleum Hydrocarbon Contamination in the Subsurface. *Water Resources Research* 41(2):W02001.

Anderson, R.T., and D.R. Lovley. 1997. Ecology and Biogeochemistry of In Situ Groundwater Bioremediation, in Jones, J.G. (ed) *Advances in Microbial Ecology*, Volume 15, Plenum Press, New York, NY, pp. 289-350.

Agency for Toxic Substances and Disease Registry (ATSDR). 1999. *Toxicological Profile for Total Petroleum Hydrocarbons*. U.S. Department of Health and Human Services, Atlanta, GA. *http://www.atsdr.cdc.gov/toxprofiles/tp123.pdf*

ASTM International (ASTM). 2014. New Practice for Evaluating the Potential Hazard Due to Methane in the Vadose Zone. ASTM WK3221. West Conshohocken, Pennsylvania. *http://www.astm.org/DATABASE.CART/WORKITEMS/WK32621.htm*

Baedecker, M.J., I.M. Cozzarelli, and J.A. Hopple. 1987. The Composition and Fate of Hydrocarbons in a Shallow Glacial-Outwash Aquifer, *in* Franks, B.J., ed., *U.S. Geological Survey Program on Toxic Waste--Ground-Water Contamination--Proceedings of the third technical meeting, Pensacola, Florida, March 23-27, 1987*: U.S. Geological Survey Open-File Report 87-109, pp. C-23 - C-24.

Baedecker, M.J., R.P. Eganhouse, B.A. Bekins, and G.N. Delin. 2011. Loss of Volatile Hydrocarbons from an LNAPL Oil Source. *Journal of Contaminant Hydrology* 126(3-4):140-152.

Bailey, N.J.L., A.M. Jobson, and M.A. Rogers. 1973. Bacterial Degradation of Crude Oil: Comparison of Field and Experimental Data. *Chemical Geology* 11(3):203-221.

Basha, K.M., A. Rajendran, and V. Thangavelu. 2010. Recent advances in the Biodegradation of Phenol: A review. *Asian Journal of Experimental Biological Science* 1(2): 219-234.

Bekins, B.A., I.M. Cozzarelli, E.M. Godsy, E.Warren, H.I. Essaid, M.E. Tuccillo. 2001. Progression of Natural Attenuation Processes at a Crude Oil Spill Site: II. Controls on Spatial Distribution of Microbial Populations. *Journal of Contaminant Hydrology* 53(3-4):387-406.

Bouchard, D., D. Hunkeler, P. Hoehener, R. Aravena, M. Broholm, and P. Kjeldsen. 2005. Use of Stable Isotope Analysis to Assess Biodegradation of Petroleum Hydrocarbons in the Unsaturated Zone. Laboratory Studies, Field studies, and Mathematical Simulations. *Reactive Transport in Soil and Groundwater* 1:17-37.

Brewer, R., J. Nagashima, M. Kelley, M. Heskett, and M. Rigby. 2013. Risk-Based Evaluation of Total Petroleum Hydrocarbons in Vapor Intrusion Studies. *International Journal of Environmental Research and Public Health*. 10: 2441-2467. *http://www.mdpi.com/1660-4601/10/6/2441/pdf*

California Department of Toxic Substances Control (CA DTSC). 2009. *Evaluating Human Health Risks from Total Petroleum Hydrocarbons.* Human and Ecological Risk Division, Sacramento, CA. *http://www.oehha.ca.gov/risk/chemicalDB/index.asp*

Chen, Y.D., L. Gui, J.F. Barker, and Y. Jiang. 2009. Biodegradability of Trimethylbenzene Isomers under the Strictly Anaerobic Conditions in Groundwater Contaminated by Gasoline. *Environmental Geology* 56(6):1123-1128.

Corseuil, H.X., C. Hunt, R. dos Santos Ferreira, and P.J.J. Alvarez. 1998. The Influence of the Gasoline Oxygenate Ethanol on Aerobic and Anaerobic BTX Biodegradation. *Water Research* 32(7):2065-2072.

Daoud, W.Z. and K.J. Renken. 1999. Laboratory Measurements of the Radon Gas Diffusion Coefficient for a Fractured Concrete Sample and Radon Gas Barrier Systems. Proceedings, International Radon Symposium (AARST), Las Vegas, Nevada. pp.14.0-14.12.

EPA. 1995. Laboratory Assessment of the Permeability and Diffusion Characteristics of Florida Concretes: Phase II. Field Samples and Analysis. Project Summary (EPA/600/SR-95/103). *http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=30003X6Q.TXT*

EPA. 2009. Provisional Peer-Reviewed Toxicity Values for Complex Mixtures of Aliphatic and Aromatic Hydrocarbons (CASRN Various) FINAL 9-30-2009. Superfund Health Risk Technical Support Center, National Center for Environmental Assessment, Office of Research and Development. *http://hhpprtv.ornl.gov/issue_papers/ComplexMixturesofAliphaticandAromaticHydrocarbons.pdf*

EPA. 2011a. Exposure Factors Handbook: 2011 Edition. Office of Research and Development. National Center for Environmental Assessment. http://www.epa.gov/ncea/efh/pdfs/efh-complete.pdf

EPA. 2011b. *Background Indoor Air Concentrations of Volatile Organic Compounds in North American Residences (1990-2005): A Compilation of Statistics for Assessing Vapor Intrusion* (EPA 530-R-10-001, June). http://www.epa.gov/oswer/vaporintrusion/documents/oswer-vapor-intrusion-background-Report-062411.pdf

EPA. 2012. *Petroleum Hydrocarbons And Chlorinated Solvents Differ In Their Potential For Vapor Intrusion.* http://www.epa.gov/oust/cat/pvi/pvicvi.pdf

EPA. 2013a. *Evaluation Of Empirical Data To Support Soil Vapor Intrusion Screening Criteria For Petroleum Hydrocarbon Compounds* (EPA 510-R-13-001). http://www.epa.gov/oust/cat/pvi/PVI_Database_Report.pdf

EPA. 2013b. *3-D Modeling of Aerobic Biodegradation of Petroleum Vapors: Effect of Building Area Size on Oxygen Concentration Below the Slab* (EPA 510-R-13-002). http://www.epa.gov/oust/cat/pvi/building-size-modeling.pdf

EPA. 2014a. *Vapor Intrusion Screening Level (VISL) Calculator: User's Guide*. Office of Solid Waste and Emergency Response. http://www.epa.gov/oswer/vaporintrusion/documents/VISL-UsersGuide.pdf

EPA. 2014b. *Vapor Intrusion Screening Level (VISL) Calculator*. Office of Solid Waste and Emergency Response. (MS Excel Spreadsheet) http://www.epa.gov/oswer/vaporintrusion/documents/VISL-Calculator.xlsm

EPA. 2015. *OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway From Subsurface Sources To Indoor Air* (OSWER Publication 9200.2-154). Office of Solid Waste and Emergency Response. http://www.epa.gov/oswer/vaporintrusion/

Federal Register. 1988. *40 CFR Parts 280 and 281: Underground Storage Tanks; Technical Requirements and State Program Approval; Final Rules*. September 23, 1988. 53(185): 37082-38344. http://www.epa.gov/oust/fedlaws/cfr.htm

Gale, E.F. 1951. The Chemical Activities of Bacteria (3rd Edition). Academic Press, New York.

Hawai'i Department of Health (HI DOH). 2008. *Screening for Environmental Hazards at Sites with Contaminated Soil and Groundwater*. Office of Hazard Evaluation and Emergency Response: Honolulu, HI. http://eha-web.doh.hawaii.gov/eha-cma/Leaders/HEER/environmental-hazard-evaluation-and-environmental-action-levels

Hawai'i Department of Health (HI DOH). 2012. *Field Investigation of the Chemistry and Toxicity of TPH in Petroleum Vapors: Implications for Potential Vapor Intrusion Hazards*. Office of Hazard Evaluation and Emergency Response: Honolulu, HI. http://www.hawaiidoh.org/tgm.aspx

Hers, I., R. Zapf-Gilje, P.C. Johnson, and L. Li. 2003. Evaluation of the Johnson and Ettinger Model for Prediction of Indoor Air Quality. *Ground Water Monitoring and Remediation* 23(1):62-76.

Hong, L., C. Holton, and P.C. Johnson. 2012. Field Study and Numerical Simulation of Indoor Air Sources Effects on Soil Gas Chemical Concentrations at a Vapor Intrusion Study Site. 22nd Annual International Conference on Soil, Water, Energy, and Air and AEHS [Association for Environmental Health and Sciences] Foundation Meeting March 19-22, San Diego, California.

Hult, M.F. 1987. Microbial Oxidation of Petroleum Vapors in the Unsaturated Zone, *in* Franks, B.J., ed., *U.S. Geological Survey Program on Toxic Waste--Ground-Water Contamination--Proceedings of the third technical meeting, Pensacola, Florida, March 23-27, 1987*: U.S. Geological Survey Open-File Report 87-109, pp. C-25 - C-26.

Hult, M.F. 1989. Mobilization, Transport, and Fate of Hydrocarbon Vapors in the Unsaturated Zone, *in* Mallard, G.E., and Ragone, S.E., eds., *U.S. Geological Survey Toxic Substances Hydrology Program--Proceedings of the technical meeting, Phoenix, Arizona, September 26-30, 1988*: U.S. Geological Survey Water-Resources Investigations Report 88-4220, p. 53.

Interstate Technology & Regulatory Council (ITRC). 2014. Petroleum Vapor Intrusion: . Fundamentals of Screening, Investigation, and Management. Interstate Technology and Regulatory Council, Vapor Intrusion Team, Washington, D.C. October. http://itrcweb.org/PetroleumVI-Guidance

Jewell, K.P. and J.T. Wilson. 2011. A New Screening Method for Methane in Soil Gas Using Existing Groundwater Monitoring Wells. *Ground Water Monitoring and Remediation* 31(3):82–94.

Kobayashi, K. and K. Shuttoh. 1991. Oxygen Diffusivity of Various Cementitious Materials. *Cement and Concrete Research* 21(2-3):274-284.

Lahvis, M.A., and A.L. Baehr. 1996. Estimation of rates of aerobic hydrocarbon biodegradation by simulation of gas transport in the unsaturated zone. *Water Resources Research* 32(7):2231-2249.

Lahvis, M.A., A.L. Baehr, and R.J. Baker. 1999. Quantification of aerobic biodegradation and volatilization rates of gasoline hydrocarbons near the water table under natural attenuation conditions. *Water Resources Research* 35(3):753-765.

Lahvis, M.A., A.L. Baehr, and R.J. Baker. 2004. Evaluation of volatilization as a natural attenuation pathway for MTBE. *Ground Water* 42(2):258-267.

Lahvis, M.A., I. Hers, R.V. Davis, J. Wright, and G.E. DeVaull. 2013. Vapor Intrusion Screening at Petroleum UST Release Sites. *Groundwater Monitoring and Remediation* 33(2):53-67.

Landmeyer, J.E., and P.M. Bradley. 2003. Effect of hydrologic and geochemical conditions on oxygen-enhanced bioremediation in a gasoline-contaminated aquifer. *Bioremediation Journal* 7(3-4):165-177.

Landon, M.K., C.A. Burton, T.A. Davis, K Belitz, and T.D. Johnson. 2013. Statistical Evaluation of Variables Affecting Occurrence of Hydrocarbons in Aquifers Used for Public Supply, California. *Journal of the American Water Resources Association* 1-17. DOI: 10.1111/jawr.12129.

Leahy, J.G. and R.R. Colwell. 1990. Microbial degradation of hydrocarbons in the environment. *Microbiological Reviews* 54(3):305-315.

Lundegard, P.D., P.C. Johnson, and P. Dahlen. 2008. Oxygen transport from the atmosphere to soil gas beneath a slab-on-grade foundation overlying petroleum-impacted soil. *Environmental Science and Technology* 42(15):5534–5540.

Luo, H., P.Dahlen, P.C. Johnson, T. Peargin, and T. Creamer. 2009. Spatial Variability of Soil-Gas Concentrations Near and Beneath a Building Overlying Shallow Petroleum Hydrocarbon-Impacted Soils. *Groundwater Monitoring and Remediation* 29(1):81-91.

Luo, H., and P.C. Johnson. 2011. Incorporating Barometric Pressure and Wind Effects into Vapor Intrusion Simulations. Association for Environmental Health and Sciences Conference, Petroleum Hydrocarbon Vapor Intrusion Session, March 16, San Diego, California.

Ma, J. W.G. Rixey, G.E. DeVaull, B.P. Stafford, and P.J. J. Alvarez. 2012. Methane Bioattenuation and Implications for Explosion Risk Reduction along the Groundwater to Soil Surface Pathway above a Plume of Dissolved Ethanol. *Environmental Science & Technology* 46(11):6013-6019.

Ma, J., H. Luo, G.E. DeVaull, W.G. Rixey, and P.J. J. Alvarez. 2014. Numerical Model Investigation for Potential Methane Explosion and Benzene Vapor Intrusion Associated with High-Ethanol Blend Releases. *Environmental Science & Technology* 48(1):474-481.

Marchal, R., S. Penet, F. Solano-Serena, and J.-P. Vandecasteele. 2003. Gasoline and oil biodegradation. *Oil and Gas Science and Technology* 58(4):441-448.

Massachusetts Department of Environmental Protection (MA DEP). 2003. *Updated Petroleum Hydrocarbon Fraction Toxicity Values for the VPH/EPH/EPH Methodology.* Bureau of Waste Site Cleanup, Boston, MA. http://www.mass.gov/eea/docs/dep/cleanup/laws/tphtox03.pdf

McHugh, T. E., P.C. DeBlanc, and R.J.Pokluda. 2006. Indoor Air as a Source of VOC Contamination in Shallow Soils Below Buildings. *Soil & Sediment Contamination* 15(1): 103–122.

McHugh, T., R. Davis, G. DeVaull, H. Hopkins, J. Menatti, and T. Peargin. 2010. Evaluation of Vapor Attenuation at Petroleum Hydrocarbon Sites. *Soil and Sediment Contamination: An International Journal* 19(6):725-745.

Miralles-Wilhelm, F., L.W. Gelhar, and V. Kapoor. 1997. Stochastic Analysis of Oxygen-Limited Biodegradation in Three-Dimensionally Heterogeneous Aquifers. *Water Resources Research* 33(6):1251-1263.

Mohamed, M.M., N.E. Saleh, and M.M. Sherif. 2010. Sensitivity of Benzene Natural Attenuation to Variations in Kinetic and Transport Parameters in Liwa Aquifer, UAE. *Bulletin of Environmental Contamination and Toxicology* 84:443-449.

Montana Department of Environmental Quality (MT DEQ). 2012. Typical Indoor Air Concentrations of Volatile Organic Compounds in Non-Smoking Montana Residences not Impacted by Vapor Intrusion: A Montana Indoor Air Quality Investigation. August. http://deq.mt.gov/statesuperfund/viguide.mcpx#Typical_Indoor_Air_Study

New Jersey Department of Environmental Protection (NJ DEP). 2013. Vapor Intrusion Technical Guidance. Version 3.1. Site Remediation Division. March. http://www.nj.gov/dep/srp/guidance/vaporintrusion/vig_main.pdf

Patterson, B. M. and G. Davis. 2009. Quantification of Vapor Intrusion Pathways into a Slab-on-Ground Building under Varying Environmental Conditions. *Environmental Science & Technology* 43(3):650-656.

Phelps, C.D., and L.Y. Young. 1999. Anaerobic Biodegradation of BTEX and Gasoline in Various Aquatic Sediments. *Biodegradation* 10(1):15-25.

Prince, R.C. 2010. Eukaryotic Hydrocarbon Degraders, in Timmis, K.N. (ed) *Handbook of Hydrocarbon and Lipid Microbiology: Part 33*, Springer-Verlag, Berlin.

Prince, R.C. and G.S. Douglas. 2010. Remediation of Petrol and Diesel in Subsurface from Petrol Station Leaks, in Timmis, K.N. (ed) *Handbook of Hydrocarbon and Lipid Microbiology: Part 14*, Springer-Verlag, Berlin.

Prince, R.C., T.F. Parkerton, and C. Lee. 2007. The Primary Aerobic Biodegradation of Gasoline Hydrocarbons. *Environmental Science and Technology* 41(9):3316-3321.

Richnow, H. H., E. Annweiler, W. Michaelis, and R.U. Meckenstock. 2003. Microbial in situ Degradation of Aromatic Hydrocarbons in a Contaminated Aquifer Monitored by Carbon Isotope Fractionation. *Journal of Contaminant Hydrology* 65(1-2):101−120.

Robinson, A.L., R.G. Sextro, and W. J. Riley. 1997. Soil-Gas Entry Into Houses Driven by Atmospheric Pressure Fluctuations-The Influence of Soil Properties. *Atmospheric Environment* 31(10):1487-1495.

Sanjuan, M.A. and R. Munoz-Martialay. 1996. Influence of the Water/Cement Ratio on the Air Permeability of Concrete. *Journal of Materials Research* 31:2829-2832.

Spormann, A.M. and F. Widdel. 2000. Metabolism of Alkylbenzenes, Alkanes, and other Hydrocarbons in Anaerobic Bacteria. *Biodegradation* 11(2-3):85-105.

Suarez, M.P. and H.S. Rifai. 1999. Biodegradation Rates for Fuel Hydrocarbons and Chlorinated Solvents in Groundwater. *Bioremediation Journal* 3(4):337-362.

Tittarelli, F. 2009. Oxygen Diffusion Through Hydrophobic Cement-Based Materials. *Cement and Concrete Research* 39(10): 924–928.

Townsend, G.T., R.C. Prince, and J.M. Suflita. 2003. Anaerobic Oxidation of Crude Oil Hydrocarbons by the Resident Microorganisms of a Contaminated Anoxic Aquifer. *Environmental Science and Technology* 37(22):5213-5218.

Wang, X. and M.A. Deshusses. 2007. Biotreatment of Groundwater Contaminated with MTBE: Interaction of Common Environmental Co-Contaminants. *Biodegradation* 18(1):37-50.

Ward, O., A. Singh, and J. Van Hamme. 2003. Accelerated Biodegradation of Petroleum Hydrocarbon Waste. *Journal of Industrial and Microbiological Biotechnology* 30(5):260-270.

Washington Department of Ecology (WA DEC). 2006. *Cleanup Levels and Risk Calculations Focus Sheets: Reference Doses for Petroleum Mixtures.* Lacey, WA. https://fortress.wa.gov/ecy/clarc/FocusSheets/petroToxParameters.pdf

Widdel, F., K. Knittel, and A. Galushko. 2010. Anaerobic Hydrocarbon-Degrading Microorganisms: An Overview, in Timmis, K.N. (ed) *Handbook of Hydrocarbon and Lipid Microbiology: Part 24*, Springer-Verlag, Berlin.

Widdel, F., A. Boetius, and R. Rabus. 2006. Anaerobic Biodegradation of Hydrocarbons Including Methane. *Prokaryotes* 2:1028-1049.

Wilson, J.T., K. Jewell, C. Adair, C. Paul, C. Ruybal, G. DeVaull, and J. Weaver. 2014. *An Approach that Uses the Concentrations of Hydrocarbon Compounds in Soil Gas at the Source of Contamination to Evaluate the Potential for Intrusion of Petroleum Vapors into Buildings (PVI)*. (EPA/600/R-14/318). ORD Issue Paper, U.S. Environmental Protection Agency, Washington, DC. http://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=305910

Zengler, K., H.H. Richnow, R. Rossello-Mora, W. Michaelis, and F. Widdel. 1999. Methane Formation from Long-Chain Alkanes by Anaerobic Microorganisms. *Nature* 401(6750):266-269.

ZoBell, C.E. 1946. Action of Microorganisms on Hydrocarbons. *Bacteriological Reviews* 10(1-2):1-49.

Additional Information

Acton, D.W. and J.F. Barker. 1992. In Situ Biodegradation Potential of Aromatic Hydrocarbons in Anaerobic Groundwaters. *Journal of Contaminant Hydrology* 9(4):325-352.

Anderson, R.T., and D.R. Lovley. 2000. Hexadecane Decay by Methanogenesis. *Nature* 404(6779):722-723.

Anderson, R.T., J.N. Rooney-Varga, C.V. Gaw, and D.R. Lovley. 1999. Aromatic and Polyaromatic Hydrocarbon Degradation Under Fe(III)-Reducing Conditions, *in* Morganwalp, D.W., and Buxton, H.T., eds., *U.S. Geological Survey Toxic Substances Hydrology Program--Proceedings of the Technical Meeting, Charleston, South Carolina, March 8-12, 1999--Volume 3 of 3--Subsurface Contamination from Point Sources*. U.S. Geological Survey Water-Resources Investigations Report 99-4018C, pp. 177-186.

Boopathy, R. 2004. Anaerobic Biodegradation of No. 2 Diesel Fuel in Soil: A Soil Column Study. *Bioresource Technology* 94(2):143-151.

Chakraborty, R. and J.D. Coates. 2004. Anaerobic Degradation of Monoaromatic Hydrocarbons. *Applied and Environmental Microbiology* 64(4):437-446.

Davis, R.V. 2009. Bioattenuation of Petroleum Hydrocarbon Vapors in the Subsurface: Update on Recent Studies and Proposed Screening Criteria for the Vapor-Intrusion Pathway. *LUSTLine Bulletin* 61:11-14. New England Interstate Water Pollution Control Commission, Massachusetts. http://www.neiwpcc.org/lustline/lustline_pdf/lustline_61.pdf

Davis, R.V. 2011a. Evaluating the Petroleum Vapor Intrusion Pathway: Studies of Natural Attenuation of Subsurface Petroleum Hydrocarbons & Recommended Screening Criteria. AEHS 21st Annual West Coast International Conference on Soil, Sediment, Water & Energy, Mission Valley, San Diego, California, March 15.

Davis, R.V. 2011b. Attenuation of Subsurface Petroleum Hydrocarbon Vapors: Spatial and Temporal Observations. AEHS 21st Annual West Coast International Conference on Soil, Sediment, Water & Energy, Mission Valley, San Diego, California, March 16.

DeVaull, G. 2007. Indoor Vapor Intrusion with Oxygen-Limited Biodegradation for a Subsurface Gasoline Source. *Environmental Science and Technology* 41(9):3241–3248.

DeVaull, G., R. Ettinger, and J. Gustafson. 2002. Chemical Vapor Intrusion from Soil or Groundwater to Indoor Air: Significance of Unsaturated Zone Biodegradation of Aromatic Hydrocarbons. *Soil and Sediment Contamination* 11(4):625-641.

Edwards, E.A. and D. Grbic-Galic. 1994. Anaerobic Degradation of Toluene and O-xylene by a Methanogenic Consortium. *Applied and Environmental Microbiology* 60(1):313-322.

EPA. 2008. *Brownfields Technology Primer: Vapor Intrusion Considerations for Redevelopment* (EPA 542-R-08-001). http://www.epa.gov/tio/download/char/542-r-08-001.pdf

EPA. (undated). Key Groundwater Guidance and Reports. http://www.epa.gov/superfund/health/conmedia/gwdocs/

Fischer, M., A. Bentley, K. Dunkin, A. Hodgson, W. Nazaroff, R. Sextro, and J. Daisey. 1996. Factors Affecting Indoor Air Concentrations of Volatile Organic Compounds at a Site of Subsurface Gasoline Contamination. *Environmental Science and Technology* 30(10): 2948-2957.

Johnson, P., P. Lundegard, and Z. Liu. 2006. Source Zone Natural Attenuation at Petroleum Hydrocarbon Spill Sites-I: Site-Specific Assessment Approach. *Ground Water Monitoring and Remediation* 26(4):82-92.

Lovley, D.R., and D.J. Lonergan. 1990. Anaerobic Oxidation of Toluene, Phenol, and P-Cresol by the Dissimilatory Iron-Reducing Organism, GS-15. *Applied and Environmental Microbiology* 56(6):1858-1864.

McHugh, T., D. Hammond, T. Nickels, and B. Hartman. 2008. Use of Radon Measurements for Evaluation of Volatile Organic Compound (VOC) Vapor Intrusion. *Environmental Forensics* 9(1):107-114.

Mills, W., S. Liu, M. Rigby, and D. Brenner. 2007. Time-Variable Simulation of Soil Vapor Intrusion into a Building with a Combined Crawl Space and Basement. *Environmental Science and Technology* 41(14):4993-5001.

Reinhard, M., G.D. Hopkins, E. Steinle-Darling, and C.A. LeBron. 2005. In Situ Biotransformation of BTEX Compounds Under Methanogenic Conditions. *Ground Water Monitoring and Remediation* 25(4):50-59.

Siddique, T., P.M. Fedorak, and J.M. Foght. 2006. Biodegradation of Short-Chain *n*-Alkanes in Oil Sands Tailings under Methanogenic Conditions. *Environmental Science and Technology* 40(17):5459-5464.

Siddique, T., P.M. Fedorak, M.D. Mackinnon, and J.M. Foght. 2007. Metabolism of BTEX and Naphtha Compounds to Methane in Oil Sands Tailings. *Environmental Science and Technology* 41(7):2350-2356.

Solano-Serena, F., R. Marchal, M. Ropars, J.-M. Lebeault, and J.-P. Vandecasteele. 2003. Gasoline and Oil Biodegradation. *Applied and Environmental Microbiology* 86(6):1008-1016.

Uhler, A., K. McCarthy, S. Emsbo-Mattingly, S. Stout, and G. Douglas. 2010. Predicting Chemical Fingerprints of Vadose Zone Soil Gas and Indoor Air from Non-Aqueous Phase Liquid Composition. *Environmental Forensics* 11(4):342-354.

2. Typical PVI Scenarios

Description

The potential for PVI is primarily a function of the location of the contamination source relative to a potential receptor, source volume and strength, and the source mass distribution in the subsurface. Source concentrations are typically much higher for LNAPL sources than for dissolved-phase sources. Higher source concentrations will generate higher rates of mass diffusion (flux). The higher mass flux will also be more sustained over time because LNAPL sources will contain significantly more mass compared to dissolved-phase sources. Oxygen demand and the potential for encountering anaerobic conditions are also uniquely different between LNAPL and dissolved-phase sources. For both dissolved and LNAPL sources, the biodegradation reaction front is relatively narrow, but it occurs higher in the unsaturated zone (closer to land surface) over an LNAPL source than it does over a dissolved-phase source (**Figure 3**).

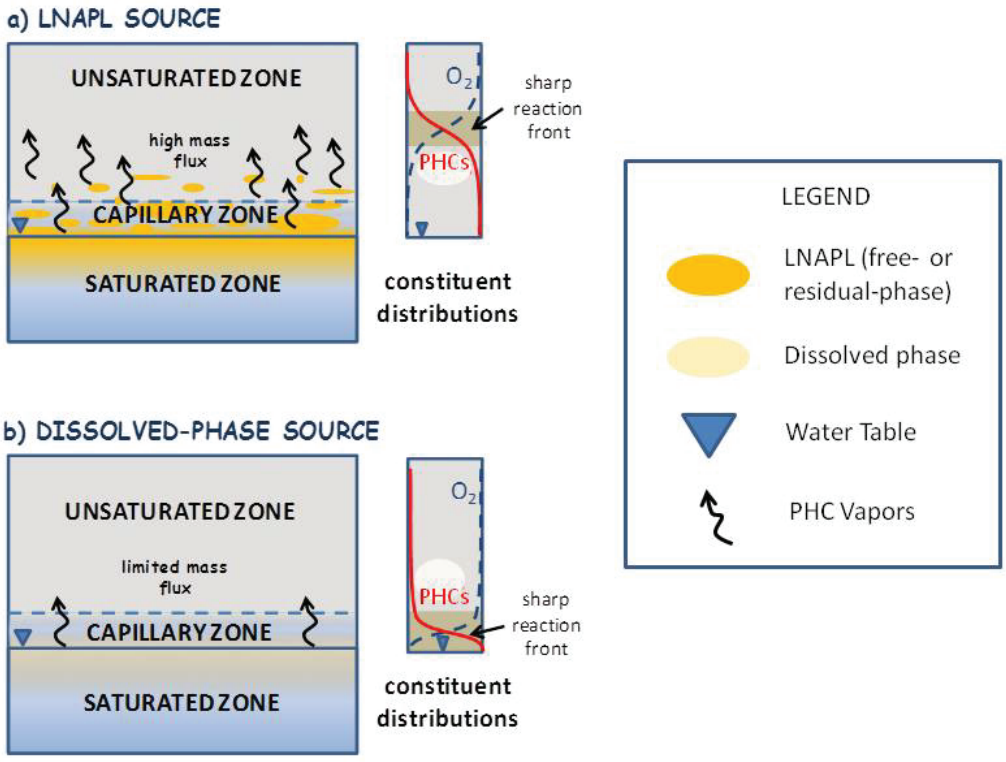


Figure 3. Difference In Potential For PVI Based On Type Of Source: a) LNAPL, b) Dissolved Phase (Source: Lahvis, et al., 2013. Reprinted from *Groundwater Monitoring & Remediation* with permission of the National Ground Water Association. Copyright 2013.)

LNAPL sources may be distributed both above and below the capillary fringe as a result of smearing from water-table fluctuations. This phenomenon will tend to enhance mass flux to the unsaturated zone because of direct partitioning between LNAPL (residual) and vapor phases. Conversely, the mass flux will be more limited for dissolved-phase sources because vapor transport through water is reduced relative to diffusion in soil gas (Golder Associates, 2006; Lahvis and Baehr, 1996). Vapor diffusion is limited by low effective air-phase porosity (i.e., high moisture saturation) and biodegradation in the capillary zone.

Importance

Relatively few confirmed occurrences of PVI at petroleum sites are reported in the literature (EPA, 2013, Section 2.6, p.9). The most likely scenarios for PVI to occur are shallow PHC sources directly beneath buildings and mobile LNAPL or groundwater plumes with high concentrations of PHCs that are in direct contact with buildings (Davis, 2009; and McHugh, et al., 2010). A study by Peargin and Kolhatkar (2011) suggests that a dissolved source with benzene greater than 1 mg/L may behave like a LNAPL source in terms of vapor-generating capability.

Assessment

Recommended steps for investigating PVI are discussed in **Section 1** (p.11). Application of the screening criteria allow for the determination of which buildings are threatened by PVI. Using this approach, resources can be appropriately focused on those buildings potentially impacted by PVI.

Figure 4 presents typical scenarios of the spatial relationship between PHC sources and potential receptors. However, it is not intended to be a comprehensive depiction of all possible configurations of such a relationship.

Table 2 summarizes the characteristics of these six scenarios relative to lateral and vertical distances from contamination and necessary investigation activities.

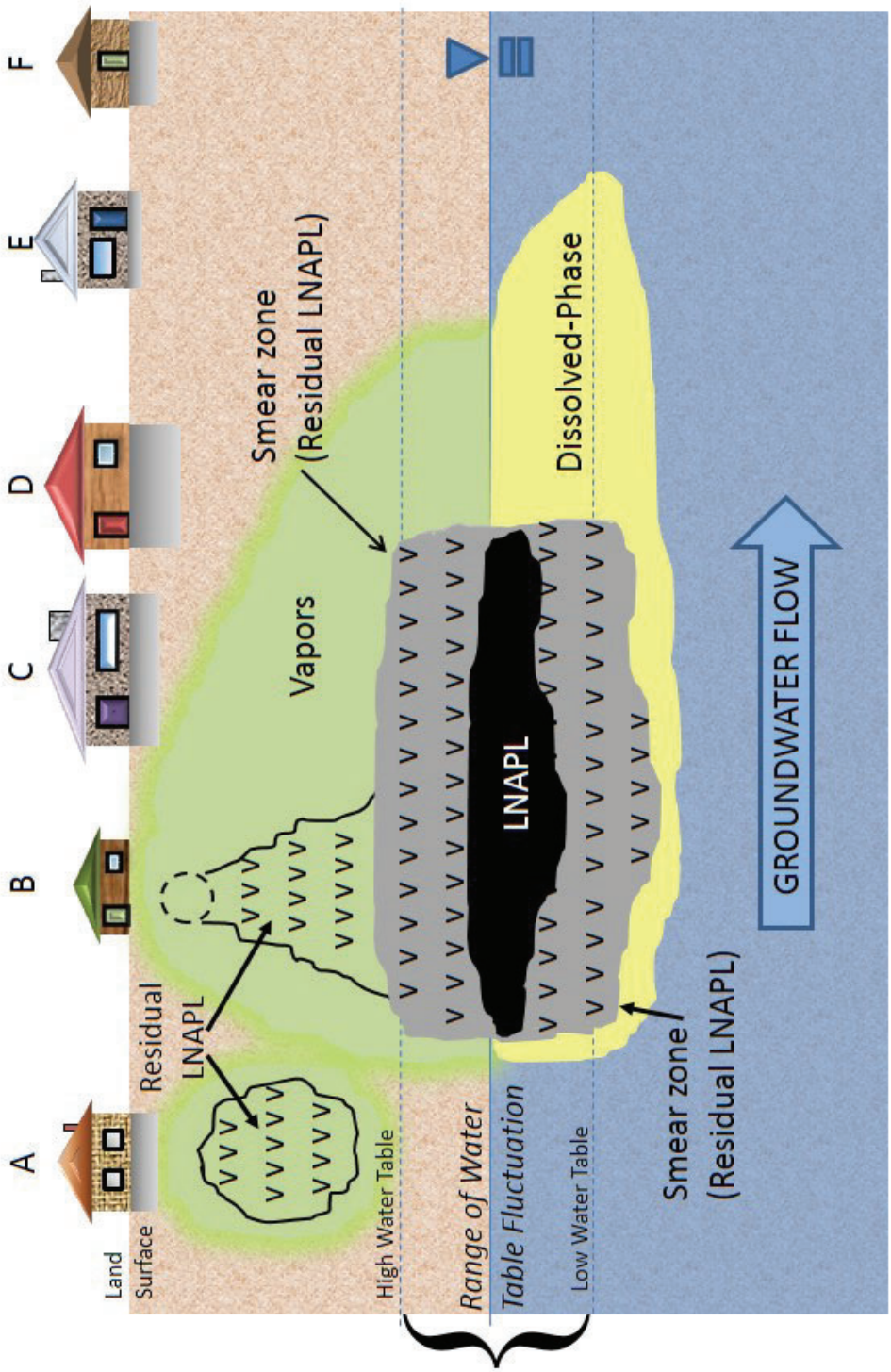


Figure 4. Typical Scenarios Of Potential PVI Sources And Potential Receptors

Table 2. Summary Of Characteristics Of Typical Scenarios Of Petroleum Vapor Sources And Potential Receptors.

Scenario (as illustrated in Figure 4)	Contamination Beneath Building? (building is within lateral inclusion zone)	Potential For PVI	Near-Slab* Soil Gas Sampling Recommended?
A	Yes; shallow residual LNAPL in the vadose zone	High	Yes, if vertical separation distance is less than 15 feet from the top of residual LNAPL, otherwise No
B	Yes; residual including smear zone, LNAPL, dissolved in groundwater	High	Yes, if vertical separation distance is less than 15 feet from the top of the smear zone, otherwise No
C	Yes; smear zone, LNAPL, dissolved in groundwater	Medium	Yes, if vertical separation distance is less than 15 feet from the top of the smear zone, otherwise No
D	Yes; dissolved in groundwater	Low	Yes, if vertical separation distance is less than 6 feet from the historical high water table elevation, otherwise No
E	Maybe; plume may be diving beneath water table	Low – None	Yes, if vertical separation distance is less than 6 feet from the historical high water table elevation, otherwise No
F	No	None	No

*Near-slab soil gas samples should be collected from each side of the potentially impacted building and as close to the building as possible. These samples should be paired with deep (near source) soil gas samples. If these samples do not clearly demonstrate that biodegradation is sufficient to mitigate the threat of PVI into the building, EPA recommends collection of indoor air samples paired with sub-slab soil gas samples.

Special Considerations

While biodegradation may reduce the potential for human exposure to petroleum vapors, its effectiveness in mitigating PVI may be limited by precluding factors such as:

- Migration of contaminants, especially plumes in flowing groundwater
- Presence of non-PHC chemicals that biodegrade too slowly (or the rate is not known with certainty)
- Presence of preferential transport pathways
- Extensive impermeable surface cover, or very large buildings
- Presence of higher blends of ethanol in gasoline that consumes oxygen that would otherwise be available for aerobic biodegradation of PHCs
- Generation of methane from higher blends of ethanol in gasoline that exerts high oxygen demand and presents a vapor intrusion threat itself
- Soils with high organic content (e.g., peat) that exert a high oxygen demand
- Soil conditions that are inhospitable to microorganisms such as insufficient soil moisture
- Insufficient thickness of clean, biologically active soil
- LNAPL source is relatively unweathered and rich in volatile PHCs

Recommendation

EPA recommends conducting an adequate PVI investigation and following the steps described in **Section 1** (p.11) to determine which buildings may be at risk for PVI.

References Cited

Davis, R.V. 2009. Bioattenuation of Petroleum Hydrocarbon Vapors in the Subsurface: Update on Recent Studies and Proposed Screening Criteria for the Vapor-Intrusion Pathway. *LUSTLine Bulletin* 61:11-14. New England Interstate Water Pollution Control Commission, Massachusetts. http://www.neiwpcc.org/lustline/lustline_pdf/lustline_61.pdf

EPA. 2012. *Petroleum Hydrocarbons And Chlorinated Solvents Differ In Their Potential For Vapor Intrusion.* March. http://www.epa.gov/oust/cat/pvi/pvicvi.pdf

EPA. 2013. *Evaluation Of Empirical Data To Support Soil Vapor Intrusion Screening Criteria For Petroleum Hydrocarbon Compounds* (EPA 510-R-13-001). http://www.epa.gov/oust/cat/pvi/PVI_Database_Report.pdf

Golder Associates. 2006. NJDEP-Golder Subsurface Vapor Intrusion Research Project: Report On: Investigation of Indoor Air Quality in Structures Located above VOC-Contaminated Groundwater, Year Two, Part 1: Evaluation of Soil Vapor Intrusion at Mount Holly Site, New Jersey, 22 pp.

Lahvis, M.A., and A.L. Baehr. 1996. Estimating Rates of Aerobic Hydrocarbon Biodegradation by Simulation of Gas Transport in the Unsaturated Zone. *Water Resources Research* 32(7): 2231-2249.

Lahvis, M.A., I. Hers, R.V. Davis, J. Wright, and G.E. DeVaull. 2013. Vapor Intrusion Screening at Petroleum UST Release Sites. *Groundwater Monitoring and Remediation* 33(2):53-67.

McHugh, T., R. Davis, G. DeVaull, H. Hopkins, J. Menatti, and T. Peargin. 2010. Evaluation of Vapor Attenuation at Petroleum Hydrocarbon Sites. *Soil and Sediment Contamination: An International Journal* 19(6):725-745.

Peargin, T. and R. Kolhatkar. 2011. *Empirical Data Supporting Groundwater Benzene Concentration Exclusion Criteria for PVI Investigations.* Proceedings of Battelle 8th International Symposium on Bioremediation and Sustainable Environmental Technologies, Reno, Nevada, June 27-30.

Additional Information

Davis, R.V. 2011a. *Evaluating the Petroleum Vapor Intrusion Pathway: Studies of Natural Attenuation of Subsurface Petroleum Hydrocarbons & Recommended Screening Criteria.* Association for Environmental Health and Sciences 21st Annual West Coast International Conference on Soil, Sediment, Water & Energy, Mission Valley, San Diego, California, March 15.

Davis, R.V. 2011b. *Attenuation of Subsurface Petroleum Hydrocarbon Vapors: Spatial and Temporal Observations.* Association for Environmental Health and Sciences 21st Annual West Coast International Conference on Soil, Sediment, Water & Energy, Mission Valley, San Diego, California, March 16.

Roggemans, S., C.L. Bruce, and P.C. Johnson. 2002. *Vadose Zone Natural Attenuation of Hydrocarbon Vapors: An Empirical Assessment of Soil Gas Vertical Profile Data.* API Technical Bulletin No. 15. American Petroleum Institute, Washington, D.C. http://www.api.org/environment-health-and-safety/clean-water/ground-water/vapor-intrusion/vi-publications/attenuation-hydrocarbon-vapors

Roggemans, S. 1998. *Natural Attenuation of Hydrocarbon Vapors in the Vadose Zone.* M.S. Thesis, Arizona State University.

3. Site Characterization And Conceptual Site Model (CSM)

Description

Site characterization is the process by which site-specific information and data are gathered from a variety of sources to characterize the physical, biological, and chemical systems at a contaminated site. A conceptual site model (CSM) integrates all data and information into a three-dimensional picture of site conditions that illustrates contaminant distributions, release mechanisms, migration routes, exposure pathways, and potential receptors (EPA, 2012; ITRC, 2014). The CSM uses a combination of text and graphics to portray both known and hypothetical information (EPA, 2011). The CSM documents current conditions at the site and is supported by maps, cross-sections, and site diagrams. The CSM illustrates potential human and environmental exposure through contaminant release and migration toward receptors (EPA, 1995, 1996a). The CSM should be refined as new data are collected.

Importance

At any leaking UST site, it is important to have a thorough understanding of the full extent and location of contamination (including both PHCs and non-PHC fuel additives), the characteristics of the site that influence contaminant migration (especially the presence of preferential transport pathways), and the locations of potential receptors. A CSM helps ensure that sources, pathways, and receptors throughout the site have been considered; this knowledge can lead to selection of the most appropriate sampling locations and techniques. The CSM assists the site manager in evaluating the interaction of different site features. Risk assessors use conceptual models to help plan for risk assessment activities (EPA, 1995). The CSM is the basis for making informed risk management decisions about the site and the threat posed by PVI to nearby buildings and their occupants. In addition, remedial action costs are influenced by the quality of the CSM (EPA, 1996b).

Assessment

An investigation for PVI potential is not separate from the normal response to a confirmed UST release; an adequate site characterization is essential in order to construct an accurate CSM. A primary objective of site characterization is delineation of the aerial and vertical extent of contamination in the subsurface (per 40 CFR 280.65(a)) so that lateral and vertical separation distances can be accurately determined.[23] It is also important to determine whether preferential transport pathways are present and, if so, delineate them to determine if they connect vapor sources directly to potential receptors. Site characterization generally proceeds in a systematic manner, often beginning in or near the source area and working outward and in the downgradient direction in which groundwater flows.

[23] The separation distances described in this document (**Section 5**, Table 3, p.52) and the protectiveness provided by clean, biologically active soil against vapor intrusion by PHCs may be insufficient to protect against vapor intrusion by non-PHC fuel additives. Additional investigation should be conducted where certain additives are present (see **Section 10**, p.81).

All information and data about the site should be integrated into a CSM, which is continually updated and refined to account for changing conditions and new information. Basic activities associated with developing a CSM include:

- Identification of potential contaminants[24]
- Identification and characterization of the source of contaminants
- Characterization of the geochemical parameters that affect biodegradation
- Characterization of the geologic and hydrogeologic characteristics of the subsurface
- Delineation of potential migration pathways, including preferential transport pathways, through environmental media
- Establishment of background levels of contaminants and areas of contamination for each contaminated medium
- Identification and characterization of potential receptors
- Determination of the limits of the study area or system boundaries

Tracking contaminant migration from sources to receptors is one of the most important uses of the CSM (ASTM, 2008). Uncertainties associated with the CSM should also be identified as well as the efforts taken to reduce uncertainties to acceptable levels (ASTM, 2008). As new information and data become available, the CSM should continually be refined (EPA, 1993; ITRC, 2007). ITRC (2014), EPA (2013, 2015), and Wilson et al., (2014) provide additional information about developing CSMs.

Special Considerations

The separation distances described in this document (**Section 5**, Table 3, p.52) and the protectiveness provided by clean, biologically active soil against vapor intrusion by PHCs may be insufficient to protect against vapor intrusion by non-PHC fuel additives. Additional investigation should be conducted where certain additives are present (see **Section 10**, p.81).

The presence and locations of preferential transport pathways should be identified and incorporated into the CSM. All new information and data about a site, including potential future land uses, should also be identified to refine the CSM.

Recommendation

Per Subparts E and F in 40 CFR 280.50 through 280.67 (see *http://www.epa.gov/oust/fedlaws/cfr.htm*), EPA recommends that an adequate site characterization considers the following:

- §280.52(b) Release Investigation and Confirmation Steps:

  "Owners and operators must measure for the presence of a release where contamination is most likely to be present at the UST site. In selecting sample types, sample locations, and measurement methods, owners and operators must consider the nature of the stored

[24] The list of potential contaminants should include BTEX and other PHCs as well as non-PHC fuel additives likely to have been present in the fuel stored at the site. See **Section1** (p.11) and **Section 10** (p.81) for more information.

substance, the type of initial alarm or cause for suspicion, the type of backfill, the depth of ground water, and other factors appropriate for identifying the presence and source of the release."

- §280.62(a)(5) Initial Abatement Measures and Site Checks

"Measure for the presence of a release where contamination is most likely to be present at the UST site, unless the presence and source of the release have been confirmed in accordance with the site check required by §280.52(b) or the closure site assessment of §280.72(a). In selecting sample types, sample locations, and measurement methods, the owner and operator must consider the nature of the stored substance, the type of backfill, depth to ground water and other factors as appropriate for identifying the presence and source of the release. . ."

- §280.63(a)(1-4) Initial Site Characterization

". . .owners and operators must assemble information about the site and nature of the release, including information gained while confirming the release or completing the initial abatement measures. . . This information must include, but is not necessarily limited to the following: (1) Data on the nature and estimated quantity of release; (2) Data from available sources or site investigations concerning the following factors: surrounding populations, water quality, use and approximate locations of wells potentially affected by the release, subsurface soil conditions, locations of subsurface sewers, climatological conditions, and land use; (3) Results of the site check required under §280.62(a)(5); and (4) Results of the free product investigations. . ."

- §280.64 Free product removal

"At sites where investigations under §280.62(a)(6) indicate the presence of free product, owners and operators must remove free product to the maximum extent practicable as determined by the implementing agency while continuing, as necessary, any actions initiated under §§280.61 through 280.63, or preparing for actions required under §§280.65 through 280.66. In meeting the requirements of this section, owners and operators must: . . . (d) Unless directed to do otherwise by the implementing agency, prepare and submit to the implementing agency, within 45 days after confirming a release, a free product removal report that provides at least the following information: . . . (2) The estimated quantity, type, and thickness of free product observed or measured in wells, boreholes, and excavations;"

- §280.65(a) Investigation for soil and ground water cleanup

"In order to determine the full extent and location of soils contaminated by the release and the presence and concentrations of dissolved product contamination in the groundwater, owners and operators must conduct investigations of the release, the release site, and the surrounding area possibly affected by the release. . ."

- §280.66(b)(1-6) Corrective Action Plan

"In making this determination, the implementing agency should consider the following factors as appropriate: (1) The physical and chemical characteristics of the regulated

substance, including its toxicity, persistence, and potential for migration; (2) The hydrogeologic characteristics of the facility and the surrounding area; (3) The proximity, quality and current and future uses of nearby surface water and ground water; (4) The potential effects of residual contamination on nearby surface water and ground water; (5) An exposure assessment; and (6) Any information assembled in compliance with this subpart."

References Cited

ASTM International (ASTM). 2008. *Standard Guide for Developing Conceptual Site Models for Contaminated Sites.* E1689-95. West Conshohocken, Pennsylvania. http://www.astm.org/Standards/E1689.htm

EPA. 1993. *Guidance for Evaluating the Technical Impracticability of the Ground-Water Restoration.* OSWER Directive 9234.2-25. http://www.epa.gov/superfund/health/conmedia/gwdocs/techimp.htm

EPA. 1995. *Superfund Program Representative Sampling Guidance. Volume 4: Waste.* Interim Final. OSWER Directive 9360.4-10 (EPA 540-R-95-141). http://www.epa.gov/tio/download/char/sf_rep_samp_guid_waste.pdf

EPA. 1996a. *Soil Screening Guidance: User's Guide.* Publication 9355.4-23 (EPA 540-R-96-018). http://www.epa.gov/superfund/health/conmedia/soil/

EPA. 1996b. *The Role of Cost in the Superfund Remedy Selection Process*. Quick Reference Fact Sheet. Publication 9200.3-23FS (EPA 540-F-96-018). http://www.epa.gov/superfund/policy/remedy/pdfs/cost_dir.pdf

EPA. 2011. *Environmental Cleanup Best Management Practices: Effective Use of the Project Life Cycle Conceptual Site Model.* Quick Reference Fact Sheet (EPA 542-F-11-011). http://www.epa.gov/tio/download/remed/csm-life-cycle-fact-sheet-final.pdf

EPA. 2013. *Introduction to In Situ Bioremediation of Groundwater.* (EPA 542-R-13-018). http://www.clu-in.org/download/remed/introductiontoinsitubioremediationofgroundwater_dec2013.pdf

EPA. 2015. *OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway From Subsurface Sources To Indoor Air* (OSWER Publication 9200.2-154). Office of Solid Waste and Emergency Response. http://www.epa.gov/oswer/vaporintrusion/

Federal Register. 1988. *40 CFR Parts 280 and 281: Underground storage tanks; technical requirements and state program approval; final rules*. September 23, 1988. 53(185): 37082-38344. http://www.epa.gov/oust/fedlaws/cfr.htm

Interstate Technology & Regulatory Council (ITRC). 2014. *Petroleum Vapor Intrusion: Fundamentals of Screening, Investigation, and Management.* Interstate Technology and Regulatory Council, Vapor Intrusion Team, Washington, D.C. October. http://itrcweb.org/PetroleumVI-Guidance

Wilson, J.T., K. Jewell, C. Adair, C. Paul, C. Ruybal, G. DeVaull, and J. Weaver. 2014. *An Approach that Uses the Concentrations of Hydrocarbon Compounds in Soil Gas at the Source of Contamination to Evaluate the Potential for Intrusion of Petroleum Vapors into Buildings (PVI)*. (EPA/600/R-14/318). ORD Issue Paper, U.S. Environmental Protection Agency, Washington, DC. http://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=305910

Additional Information

EPA. 2003. Improving Decision Quality: Making The Case For Adopting Next-Generation Site Characterization Practices (EPA 542-F-03-012). http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=100046CK.TXT

EPA. 2004. *Improving Sampling, Analysis, and Data Management for Site Investigation and Cleanup* (EPA 542-F-04-001a). http://www.epa.gov/tio/download/char/2004triadfactsheeta.pdf

EPA. 2008. *Triad Issue Paper: Using Geophysical Tools to Develop the Conceptual Site Model* (EPA 542-F-08-007). http://www.epa.gov/tio/download/char/Geophysics-Issue-Paper.pdf

EPA. 2010. *Innovations in Site Characterization: Streamlining Cleanup at Vapor Intrusion and Product Removal Sites Using the Triad Approach: Hartford Plume Site, Hartford, Illinois* (EPA 542-R-10-006). http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P100GG1G.TXT

EPA. (undated). Key Groundwater Guidance and Reports. http://www.epa.gov/superfund/health/conmedia/gwdocs/

4. Lateral Inclusion Zone

Description

The lateral inclusion zone is the area surrounding a contaminant source through which vapor-phase contamination may travel and intrude into buildings. Determination of the lateral distance within which buildings and other structures may be threatened by PVI is site-specific. In general, with increasing confidence in the site characterization and the CSM, there can be a corresponding decrease in the distance the lateral inclusion zone extends from clean monitoring points.[25] All buildings within the lateral inclusion zone should be further assessed to determine if they are separated from vapor sources by an adequate vertical separation distance (see **Section 5**, p.48). Further assessment may be unnecessary for those buildings outside the lateral inclusion zone unless preferential transport pathways are present. If contaminated groundwater is the source of vapors, migration of the contaminant plume (in the longitudinal, transverse, and vertical directions) should be assessed when evaluating the potential for future risks.

Importance

The lateral inclusion zone is a screening criterion to help determine which sites should definitely be assessed further for PVI; which sites might need additional site characterization and assessment for PVI; and which sites can reliably be excluded from consideration for further evaluation of PVI. All buildings that overlie, or are reasonably expected to overlie, contamination, whether LNAPL or the dissolved phase, are considered to be within the lateral inclusion zone.

Assessment

Lateral separation distance is schematically depicted in **Figure 5**. Though in theory the length of the lateral separation distance may be on the same scale as the vertical separation distance (EPA, 2013a; ITRC, 2014), a greater lateral distance is generally warranted in the down gradient direction (Lahvis, et al, 2013; EPA, 2013a). This is because the lateral boundaries of a migrating plume are more difficult to accurately delineate, as they are not stationary. Groundwater elevations fluctuate which may result in changes in the direction and velocity of groundwater flow. The lateral and down gradient investigation should continue until the full extent and location of contamination is determined. This is typically achieved by surrounding the dissolved-phase plume with clean monitoring points.

Both mobile LNAPL and dissolved contaminant plumes are dynamic and may move from one monitoring event to the next. As discussed in **Section 7** (p.61), periodic monitoring of groundwater flow directions and plume migration should be conducted, possibly over more than one annual cycle.

[25] A *monitoring point* is defined as a sampling point at which soil and groundwater samples are collected (typically from monitoring wells, though not exclusively) and which define the full extent and location of contamination. A *clean monitoring point* is defined by dissolved benzene concentration less than 5 µg/L and soil TPH concentration less than 20 mg/Kg.

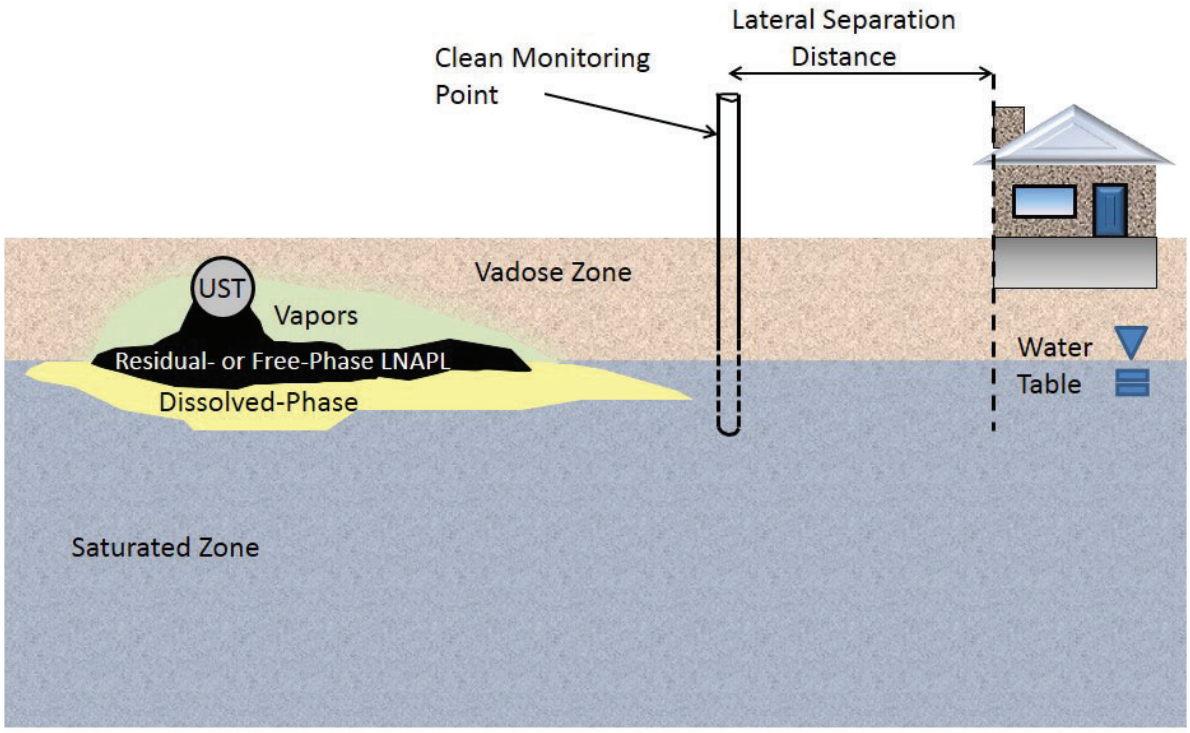


Figure 5. Lateral Separation Distance Between Source Of PHC Contamination And Hypothetical Receptor

Special Considerations

It can be difficult to accurately determine the exact location of contamination relative to potential receptors. This is in part due to the dynamic nature of contaminant plumes (both LNAPL and dissolved PHCs); the presence of heterogeneities and preferential transport pathways in geologic material; and the distance between monitoring points, such as soil borings and monitoring wells. It may be necessary to assess some nearby buildings for PVI before all site characterization activities have been completed.

It is important to consider whether, and what type of preferential transport pathways are present and could facilitate the migration of petroleum vapors. The presence of preferential transport pathways may circumvent the protectiveness that a sufficiently thick layer of clean, biologically active soil would otherwise provide. Preferential transport pathways such as utility conduits typically enter buildings through holes in the foundation or slab and can facilitate the entry of PHC vapors into the building. For example, if the transport of vapors from the source

area to the building could occur along utility conduits, then vapor sampling inside those utility conduits (e.g., sewers) should be considered. Field instrument screening at utility access points may help determine if the utility is acting as a conduit for vapors. Although specific guidance for utility sampling is beyond the scope of this document, EPA recommends that any utility sampling program include safety precautions to protect personnel (e.g., oxygen and combustible gas monitoring, confined-space entry requirements) and to avoid damage to utilities. For guidance on utility sampling, see *A Practical Strategy for Assessing the Subsurface Vapor-to-Indoor Air Migration Pathway at Petroleum Hydrocarbon Sites* (API, 2005).

Lateral separation distances that are usually protective against PVI may not be sufficiently protective in situations where methane is produced in large quantity, such as sites where high-ethanol blends of gasoline (i.e., E-20 or greater) have been released (Ma et al., 2014), and at sites where non-PHC fuel additives are present (see **Section 10**, p.81). In both of these cases, additional investigation should be conducted to assess the potential for vapor intrusion.

Another consideration is changing site conditions. Factors to consider in deciding whether to include sites for further evaluation of PVI may include future land use—that is, whether: future new buildings will be constructed within the lateral inclusion zone, utility trenches will be excavated through or near previous contamination, groundwater usage will potentially be increased, and additional releases of contaminants may occur.

Recommendation

Delineation of a lateral inclusion zone is site-specific. EPA recently published *An Approach for Developing Site-Specific Lateral and Vertical Inclusion Zones within which Structures Should be Evaluated for Petroleum Vapor Intrusion due to Releases of Motor Fuel from Underground Storage Tanks (EPA, 2013b)*. This Issue Paper describes a procedure for constructing a lateral inclusion zone that decision makers may find useful. EPA recommends that all buildings within the lateral inclusion zone be further assessed to determine if they are separated from vapor sources by an adequate vertical separation distance. Further assessment may be unnecessary for those buildings outside the lateral inclusion zone unless:

- Preferential transport pathways are present that connect PHC vapor sources to receptors
- Impermeable surface cover (e.g., concrete, asphalt, ice, very large buildings) is so extensive that there is concern whether there is sufficient oxygen in the subsurface to support biodegradation
- Soil conditions are inhospitable to microorganisms (e.g., dry soils with less than 2 percent soil moisture by dry weight) such that biodegradation is insufficient to mitigate the threat of PVI

References Cited

API. 2005. *A Practical Strategy for Assessing the Subsurface Vapor-to-Indoor Air Migration Pathway at Petroleum Hydrocarbon Sites*. API Publication 4741.

EPA. 2013a. *Evaluation Of Empirical Data To Support Soil Vapor Intrusion Screening Criteria For Petroleum Hydrocarbon Compounds* (EPA 510 R-13-001). http://www.epa.gov/oust/cat/pvi/PVI_Database_Report.pdf

EPA. 2013b. *An Approach for Developing Site-Specific Lateral and Vertical Inclusion Zones within which Structures Should be Evaluated for Petroleum Vapor Intrusion due to Releases of Motor Fuel from Underground Storage Tanks* (EPA 600/R-13/047). *http://www.epa.gov/oust/cat/pvi/epa600r13047.pdf*

Interstate Technology & Regulatory Council (ITRC). 2014. *Petroleum Vapor Intrusion: Fundamentals of Screening, Investigation, and Management.* Interstate Technology and Regulatory Council, Vapor Intrusion Team, Washington, D.C. October. *http://itrcweb.org/PetroleumVI-Guidance*

Ma, J., H. Luo, G.E. DeVaull, W.G. Rixey, and P.J. J. Alvarez. 2014. Numerical Model Investigation for Potential Methane Explosion and Benzene Vapor Intrusion Associated with High-Ethanol Blend Releases. *Environmental Science & Technology* 48(1):474-481.

5. Vertical Separation Distance

Description

The vertical separation distance is the thickness of clean, biologically active soil (see **Section 9**, p.75) between the highest vertical extent of a contaminant source and the lowest point of an overlying building. This lowest point could be a building basement floor, foundation, or crawlspace surface.

Importance

If the thickness of clean, biologically active soil is sufficient and oxygen and soil moisture are present, aerobic biodegradation will usually degrade vapor-phase PHCs before they can intrude into buildings. EPA (2013a) presents a compilation and analysis of soil gas data from a large number of sites that represent many different hydrogeologic settings where gasoline was released from USTs.[26] This analysis builds on the work of Davis (2009, 2010, 2011a, and 2011b). In addition, EPA (2013a) summarizes the results of a number of parallel efforts (Lahvis, et al., 2013; Peargin and Kolhatkar, 2011; Wright, 2011, 2012). Although these studies used somewhat different data sets, there is a high degree of consistency among them. This consistency supports the establishment of vertical screening distances based on whether PHC contamination is present as LNAPL or dissolved PHCs; that is, the thickness required to aerobically biodegrade PHCs is directly related to the strength of the source. Because LNAPL sources are capable of producing higher concentrations of vapors compared to dissolved sources, the necessary separation distance between receptors and LNAPL is greater than the necessary separation distance between dissolved sources and receptors. At sites where non-PHC fuel additives are present (see **Section 10**, p.81), the vertical separation distance may not be sufficient to protect against vapor intrusion. In this case, additional investigation should be conducted to assess the potential for vapor intrusion.

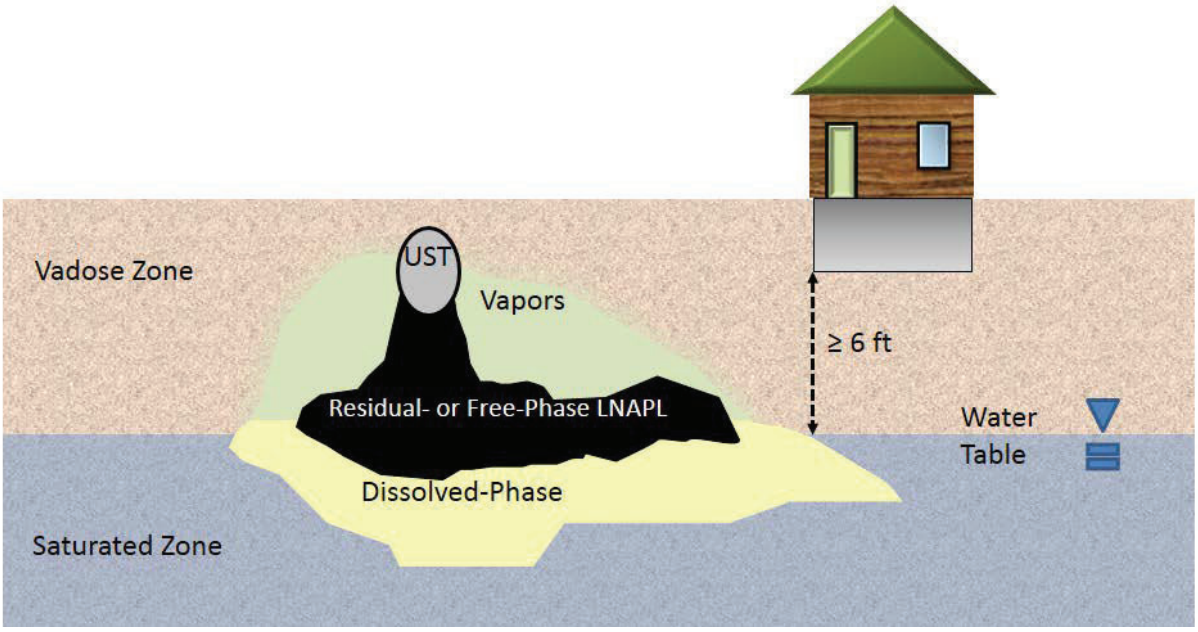
Assessment

The vertical separation distance is measured from the lowest point of the overlying building basement floor, foundation, slab, or crawlspace surface and the highest vertical extent of contamination. For dissolved sources this is the historic high water table elevation; for LNAPL sources this is the top of the smear zone or residual LNAPL in the source area. Vertical separation distances for dissolved plumes and LNAPL sources are schematically depicted in **Figure 6a and 6b**, respectively. Both mobile LNAPL and dissolved contaminant plumes are dynamic and may move from one monitoring event to the next. As discussed in **Section 7** (p.61), periodic monitoring of groundwater flow directions and plume migration are recommended, possibly over more than one annual cycle.

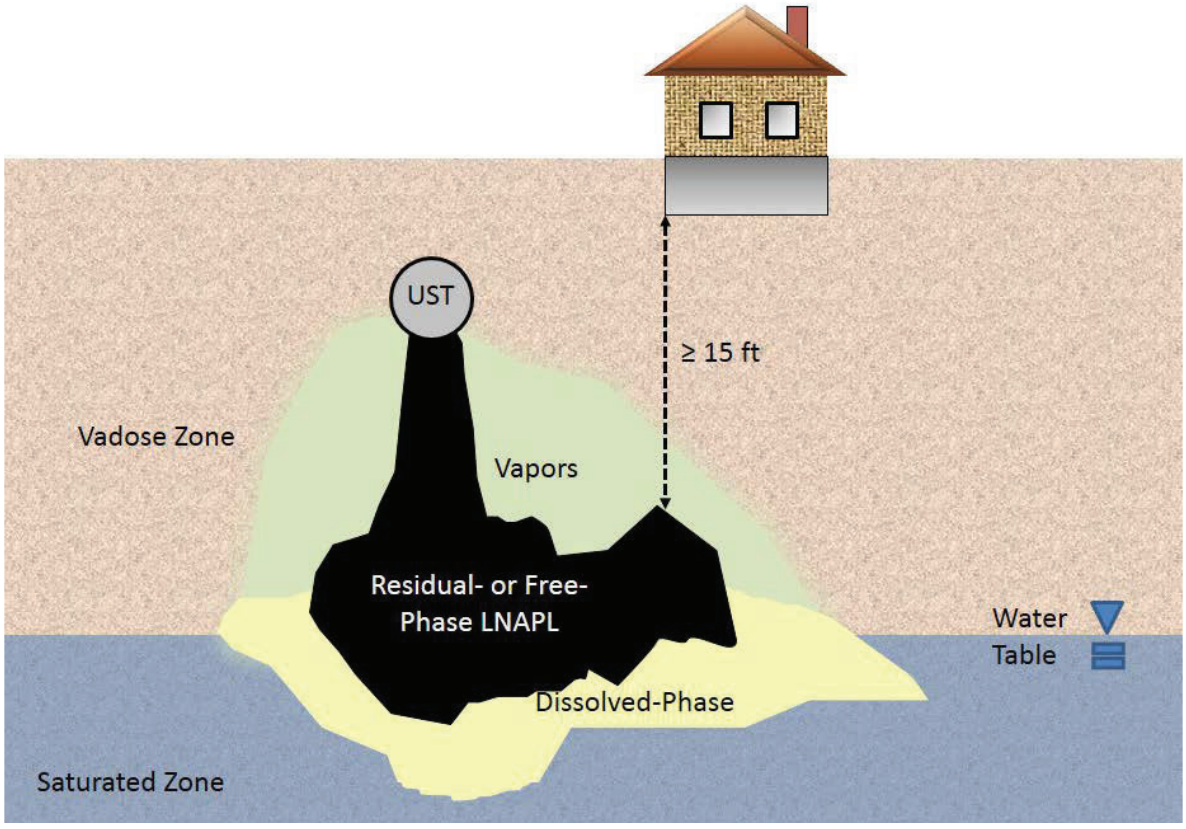
The presence of LNAPL may be determined from direct or indirect evidence. Direct evidence includes measureable accumulations of free product in monitoring wells, an oily sheen or floating globules on the water table, and petroleum hydrocarbon-saturated bulk soil samples.

[26] The final report (EPA, 2013a) addresses the peer review comments received. The report, database, and peer review record are accessible on EPA's PVI Compendium Web page: *http://www.epa.gov/oust/cat/pvi/index.htm*.

REC 4697



(a) Vertical separation distance for dissolved-phase source of PHCs.



(b) Vertical separation distance for LNAPL (residual or mobile phase) source of PHCs.

Figure 6. Vertical Separation Distances Between Source Of PHC Contaminants And Hypothetical Receptor: (a) Dissolved Source, (b) LNAPL Source.

Lahvis et al. (2013) caution that the presence or absence of free-phase LNAPL in monitoring wells may not be a reliable indicator of the presence of residual-phase LNAPL. The absence of LNAPL can only be determined through analysis of core samples. This is important to recognize because free-phase and residual LNAPL have a greater vapor-generating capability than dissolved sources. Indirect evidence includes high concentrations of benzene and other PHCs, often measured as TPH.[27] There is considerable variation and uncertainty in LNAPL thresholds determined from indirect evidence and Lahvis et al. (2013) suggest that multiple indicators of the presence of LNAPL be evaluated. EPA (2013a) selected a benzene concentration of 5 mg/L to differentiate between dissolved and LNAPL sources. A study by Peargin and Kolhatkar (2011) suggests that a dissolved source with benzene greater than 1 mg/L may behave like a LNAPL source in terms of vapor-generating capability. For more information on indicators of LNAPL, see **Section 6** (p.57).

Special Considerations

Preferential transport pathways such as utility conduits typically enter buildings through holes in the foundation or slab and can facilitate the entry of PHC vapors into the building. Consideration should be given to field instrument screening at utility access point(s) as an initial step to determine if the utility is acting as a conduit for vapors. If the transport of vapors from the source area to the building could occur along utility conduits, then vapor sampling inside the utility conduits, manholes, or sumps should be considered in addition to vadose zone and sub-slab soil gas sampling. Any utility sampling program should include safety precautions to protect personnel (e.g., oxygen and combustible gas monitoring, confined-space entry requirements) and to avoid damage to utilities. Specific guidance for utility sampling is available in *A Practical Strategy for Assessing the Subsurface Vapor-to-Indoor Air Migration Pathway at Petroleum Hydrocarbon Sites* (API, 2005).

Vertical separation distances that are usually protective against PVI may not be sufficiently protective in situations where methane is produced in large quantity, such as sites where high-ethanol blends of gasoline (i.e., E-20 or greater) have been released (Ma et al., 2014), or beneath very large buildings, or where the ground surface is covered by extensive impermeable material (e.g., pavement) (EPA, 2013c).

In addition, consideration should be given to whether future new buildings will be constructed within the lateral inclusion zone and whether they may be impacted by PVI.

[27] Toxicological data for TPH fractions may be found in EPA (2009, 2013b), ATSDR (1999), Tveit et al. (1999), and HI DOH (2012). More recently, Brewer et al. (2013) have developed a quantitative method for risk-based evaluation of TPH in PVI investigations.

Recommendation

EPA recommends using the criteria presented in **Table 3** to determine the necessary vertical separation distance between PHC contamination from leaking USTs and an overlying building foundation, basement, or slab. These distances are 6 feet for dissolved vapor sources (beneath buildings of any size) and 15 feet for LNAPL sources (beneath buildings up to 66 feet on the shortest side).[28] Where the respective vertical separation distance is met or exceeded, generally no further investigation for PVI is necessary if there are no precluding factors present (e.g., preferential transport pathways) and the PCH source is not a high-ethanol blend (i.e., E-20 or greater) of gasoline. If the applicable separation distance is not met and where contamination is not in direct contact with an overlying building, then choose one of two options: (1) collect near-slab (exterior) shallow soil gas samples paired with deep (source) soil gas samples, or (2) collect indoor air samples paired with sub-slab soil gas samples. If the potential for PVI cannot be ruled out based on near-slab and deep soil gas sampling, then EPA recommends indoor air sampling paired with sub-slab vapor sampling. If the attenuation factor calculated from results of analysis of the chosen pair or vapor samples indicates that there may be a potential for PVI above applicable exposure limits, EPA recommends gathering additional information and data to determine whether mitigation is appropriate.

Although biodegradation is known to occur for many individual non-PHC fuel additives and classes of additives, the rate of biodegradation in soil gas has not necessarily been rigorously quantified; this is especially true for the lead scavengers EDB and 1,2-DCA. Therefore, for these two chemicals in particular, vertical separation distances recommended in this guide may not be sufficient for petroleum fuel releases that contain EDB and 1,2-DCA and additional investigation may be necessary to assess their potential for vapor intrusion (See **Section 10**, p.81 for more information).

[28] See *3-D Modeling of Aerobic Biodegradation of Petroleum Vapors: Effect of Building Area Size on Oxygen Concentration Below the Slab* (EPA 510-R-13-002)(EPA, 2013c).

Table 3. Recommended Vertical Separation Distance Between Contamination And Building Basement Floor, Foundation, Or Crawlspace Surface.

Media	Benzene	TPH	Vertical Separation Distance (feet)*
Soil (mg/Kg)	≤10	≤ 100 (unweathered gasoline), or ≤ 250 (weathered gasoline, diesel)	6
	>10 (LNAPL)	> 100 (unweathered gasoline) >250 (weathered gasoline, diesel)	15
Groundwater (mg/L)	≤5	≤30	6
	>5 (LNAPL)	>30 (LNAPL)	15

The thresholds for LNAPL indicated in this table are indirect evidence of the presence of LNAPL. These thresholds may vary depending on site-specific conditions (e.g., soil type, LNAPL source). The value of 5 mg/L benzene is from EPA (2013a, p.31). A study by Peargin and Kolhatkar (2011) suggests that a dissolved source with benzene greater than 1 mg/L may behave like a LNAPL source in terms of vapor-generating capability. Decision-makers may have different experiences with LNAPL indicators and may use them as appropriate. For more information, see **Section 6** (p.57) and **Figure 7** in particular.

Bulk soil samples should be analyzed for Total Petroleum Hydrocarbon (TPH) and BTEX (plus any other potential contaminants). The objective of measuring TPH is to quantify the total vapor phase concentration of PHCs. TPH may be analyzed by methods appropriate for the type of fuel released. These methods may be designated as TPH-gasoline (or sometimes gasoline range organics or GRO), TPH-diesel (or sometimes diesel range organics or DRO). Method TO-15 (see *http://www.epa.gov/ttn/amtic/files/ambient/airtox/to-15r.pdf*) by itself only measures a small fraction of PHCs that may be present in the vapor-phase. TO-15 analyses require a correction factor to estimate bulk TPH. An extended TO-15 analysis can provide such an estimate. For more information on TPH in vapor intrusion studies, see Brewer et al. (2013).

*The vertical separation distance represents the thickness of clean, biologically active soil between the source of PHC vapors (LNAPL, residual LNAPL, or dissolved PHCs) and the lowest (deepest) point of a receptor (building basement floor, foundation, or crawlspace surface).

References Cited

American Petroleum Institute (API). 2005. *A Practical Strategy for Assessing the Subsurface Vapor-to-Indoor Air Migration Pathway at Petroleum Hydrocarbon Sites*. API Publication 4741. http://www.api.org/environment-health-and-safety/clean-water/ground-water/vapor-intrusion/vi-publications/assessing-vapor-intrusion.aspx

Agency for Toxic Substances and Disease Registry (ATSDR). 1999. *Toxicological Profile for Total Petroleum Hydrocarbons*. U.S. Department of Health and Human Services, Atlanta, GA. http://www.atsdr.cdc.gov/toxprofiles/tp123.pdf

Brewer, R., J. Nagashima, M. Kelley, M. Heskett, and M. Rigby. 2013. Risk-based evaluation of total petroleum hydrocarbons in vapor intrusion studies. *International Journal of Environmental Research and Public Health*. 10: 2441-2467. http://www.mdpi.com/1660-4601/10/6/2441/pdf

Bruce, L., T. Miller, and B. Hockman. 1991. *Solubility Versus Equilibrium Saturation of Gasoline Compounds: A Method to Estimate Fuel/Water Partition Coefficient Using Solubility or K_{oc}.* In: Proceedings of the NWWA/API Conference on Petroleum Hydrocarbons in Ground Water, p. 571-582, by National Water Well Association, Dublin, Ohio. http://info.nqwa.org/gwol/pdf/910155295.PDF

California Department of Toxic Substances Control (CA DTSC). 2009. *Evaluating Human Health Risks from Total Petroleum Hydrocarbons.* Human and Ecological Risk Division, Sacramento, CA. http://www.oehha.ca.gov/risk/chemicalDB/index.asp

Davis, R.V. 2009. Bioattenuation of Petroleum Hydrocarbon Vapors in the Subsurface: Update on Recent Studies and Proposed Screening Criteria for the Vapor-Intrusion Pathway. *LUSTLine Bulletin* 61:11-14. New England Interstate Water Pollution Control Commission, Massachusetts. http://www.neiwpcc.org/lustline/lustline_pdf/lustline_61.pdf

Davis, R.V. 2011a. *Evaluating the Petroleum Vapor Intrusion Pathway: Studies of Natural Attenuation of Subsurface Petroleum Hydrocarbons & Recommended Screening Criteria.* Association for Environmental Health and Sciences 21st Annual West Coast International Conference on Soil, Sediment, Water & Energy, Mission Valley, San Diego, California, March 15.

Davis, R.V. 2011b. *Attenuation of Subsurface Petroleum Hydrocarbon Vapors: Spatial and Temporal Observations.* AEHS 21st Annual West Coast International Conference on Soil, Sediment, Water & Energy, Mission Valley, San Diego, California, March 16.

EPA. 2009. *Provisional Peer-Reviewed Toxicity Values for Complex Mixtures of Aliphatic and Aromatic Hydrocarbons (CASRN Various) FINAL 9-30-2009*. Superfund Health Risk Technical Support Center, National Center for Environmental Assessment, Office of Research and Development. http://hhpprtv.ornl.gov/issue_papers/ComplexMixturesofAliphaticandAromaticHydrocarbons.pdf

EPA. 2013a. *Evaluation Of Empirical Data To Support Soil Vapor Intrusion Screening Criteria For Petroleum Hydrocarbon Compounds* (EPA 510-R-13-001). http://www.epa.gov/oust/cat/pvi/PVI_Database_Report.pdf

EPA. 2013b. *Regional Screening Levels, Generic Tables, Residential Air and Industrial Air*. November. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm

EPA. 2013c. *3-D Modeling of Aerobic Biodegradation of Petroleum Vapors: Effect of Building Area Size on Oxygen Concentration Below the Slab* (EPA 510-R-13-002). http://www.epa.gov/oust/cat/pvi/building-size-modeling.pdf

Hawai'i Department of Health (HI DOH). 2012. *Field Investigation of the Chemistry and Toxicity of TPH in Petroleum Vapors: Implications for Potential Vapor Intrusion Hazards*. Office of Hazard Evaluation and Emergency Response: Honolulu, HI. http://www.hawaiidoh.org/tgm.aspx

Lahvis, M.A., I. Hers, R.V. Davis, J. Wright, and G.E. DeVaull. 2013. Vapor Intrusion Screening at Petroleum UST Release Sites. *Groundwater Monitoring and Remediation* 33(2):53-67.

Ma, J., H. Luo, G.E. DeVaull, W.G. Rixey, and P.J. J. Alvarez. 2014. Numerical Model Investigation for Potential Methane Explosion and Benzene Vapor Intrusion Associated with High-Ethanol Blend Releases. *Environmental Science & Technology* 48(1):474-481.

Massachusetts Department of Environmental Protection (MA DEP). 2003. *Updated Petroleum Hydrocarbon Fraction Toxicity Values for the VPH/EPH/EPH Methodology.* Bureau of Waste Site Cleanup, Boston, MA.

McHugh, T., R. Davis, G. DeVaull, H. Hopkins, J. Menatti, and T. Peargin. 2010. Evaluation of Vapor Attenuation at Petroleum Hydrocarbon Sites. *Soil and Sediment Contamination: An International Journal* 19(6):725-745.

Peargin, T. and R. Kolhatkar. 2011. *Empirical Data Supporting Groundwater Benzene Concentration Exclusion Criteria for PVI Investigations.* Proceedings of Battelle 8th International Symposium on Bioremediation and Sustainable Environmental Technologies, Reno, Nevada, June 27-30.

Tveit, A., L.A. Hayes, S.H. Youngren, D.V. Nakles. 1997. *Total Petroleum Hydrocarbon Working Group Series, Volume 4: Development of Fraction Specific Reference Doses (RfDs) and Reference Concentrations (RfCs) for Total Petroleum Hydrocarbons.* Association for Environmental Health and Sciences: Amherst, MA.

Washington Department of Ecology (WA DEC). 2006. *Cleanup Levels and Risk Calculations Focus Sheets: Reference Doses for Petroleum Mixtures.* Lacey, WA. https://fortress.wa.gov/ecy/clarc/FocusSheets/petroToxParameters.pdf

Wright, J. 2011. *Establishing Exclusion Criteria from Empirical Data for Assessing Petroleum Hydrocarbon Vapour Intrusion.* CleanUp 2011: Proceedings of the 4th International Contaminated Site Remediation Conference, September 11-15, Adelaide, Australia.

Wright, J. 2012. *Evaluation of the Australian Petroleum Hydrocarbon VI Database: Exclusion Criteria.* Presented at: Recent Advances to VI Application & Implementation—A State-of-the-Science Update. Association for Environmental Health and Sciences West Coast Conference, San Diego, California. March 19-22. https://iavi.rti.org/WorkshopsAndConferences.cfm?PageID=documentDetails&AttachID=549

Additional Information

DeVaull, G. 2007. Indoor Vapor Intrusion with Oxygen-Limited Biodegradation for a Subsurface Gasoline Source. *Environmental Science and Technology* 41(9):3241–3248.

Hers, I., J. Atwater, L. Li, and R. Zapf-Gilje. 2000. Evaluation of Vadose Zone Biodegradation of BTX Vapours. *Journal of Contaminant Hydrology 46*:233-264.

Hers, I., D. Evans, R. Zapf-Gilje, and L. Li. 2002. Comparison, Validation and Use of Models for Predicting Indoor Air Quality from Soil and Groundwater Contamination. *Journal of Soil and Sediment Contamination* 11(4):491-527.

Hers, I., P. Jourabchi, M. Lahvis, P. Dahlen, E.H. Luo, P. Johnson, and U. Mayer. 2012 (in preparation). Cold Climate Study of Soil Vapor Intrusion at a Residential House above a Petroleum Hydrocarbon Plume.

Interstate Technology & Regulatory Council (ITRC). 2014. *Petroleum Vapor Intrusion: Fundamentals of Screening, Investigation, and Management.* Interstate Technology and Regulatory Council, Vapor Intrusion Team, Washington, D.C. October. http://itrcweb.org/PetroleumVI-Guidance

Lahvis, M.A., A.L. Baehr, and R.J. Baker. 1999. Quantification of Aerobic Biodegradation and Volatilization Rates of Gasoline Hydrocarbons Near the Water Table under Natural Attenuation Conditions. *Water Resources Research* 35(3):753-765.

Lahvis, M.A., A.L. Baehr, and R.J. Baker. 1996. Estimation of Rates of Aerobic Hydrocarbon Biodegradation by Simulation of Gas Transport in the Unsaturated Zone. *Water Resources Research* 32(7):2231-2249.

Leahy, J. G., and R.R. Colwell. 1990. Microbial Degradation of Hydrocarbons in the Environment. *Microbiological Reviews* 54(3):305–315.

6. Mobile And Residual Light Non-Aqueous Phase Liquid (LNAPL)

Description

LNAPLs released from petroleum USTs are typically fuel products such as gasoline and diesel fuel. Fuel products are comprised of a large number of volatile and semi-volatile PHCs and synthetic additives. Among these compounds are some that are volatile and some that are semi-volatile. Newer, unweathered releases typically contain a higher proportion of more volatile PHCs than do older releases that may be more weathered and depleted in the more volatile PHCs. Similarly, gasoline contains a higher proportion of more volatile PHCs than does diesel fuel and other middle distillates such as heating oil and kerosene. Vapors emanating from dissolved-phase sources are primarily BTEX and other aromatic hydrocarbons, and relatively water-soluble PHCs. Vapors emanating from LNAPL sources contain the same constituents in addition to a sizeable fraction of aliphatic and relatively insoluble hydrocarbons (e.g., naphthalene), especially if the source is large or unweathered (Lahvis, et al., 2013; EPA, 2013).

Importance

Depending upon the volume of the release and the characteristics of the soil, PHC vapors from LNAPL sources can reach concentrations high enough to deplete oxygen needed by microorganisms to biodegrade them. Compared to a dissolved plume, a LNAPL plume from a leaking UST does not typically migrate far from the site of release (e.g., the leaking UST or connected piping). However, the larger the mass of the release the greater the potential for the LNAPL plume to migrate. When LNAPL underlies a receptor or comes into direct contact with a basement, foundation, or slab, there is increased potential for explosive levels of vapors to accumulate within the building or other structure.

Residual PHCs are non-mobile in the subsurface and occur when the release stops prior to the accumulation of a sufficient amount of LNAPL for flow to occur, or when a fluctuating water table smears the LNAPL across the water table and reduces the LNAPL saturation of the soil. This smearing inhibits the lateral migration of LNAPL. Although residual contamination is not free flowing, residual sources represent a large mass of contaminants that can persist for long periods of time and generate considerable volumes of PHC vapors as well as dissolved-phase contaminants.

Monitoring wells with residual LNAPL may not have a measurable accumulation of LNAPL so they look exactly like monitoring wells with only dissolved contamination (that is, there is no measurable LNAPL in the monitoring well). However, due to the presence of residual LNAPL, the vapor source area acts like a free-phase LNAPL source in terms of vapor-generating character (Lahvis, et al., 2013). A study by Peargin and Kolhatkar (2011) suggests that a dissolved source with benzene concentration greater than 1 mg/L may have the same vapor-generating capacity as a LNAPL source. This situation is depicted in **Figure 7**.

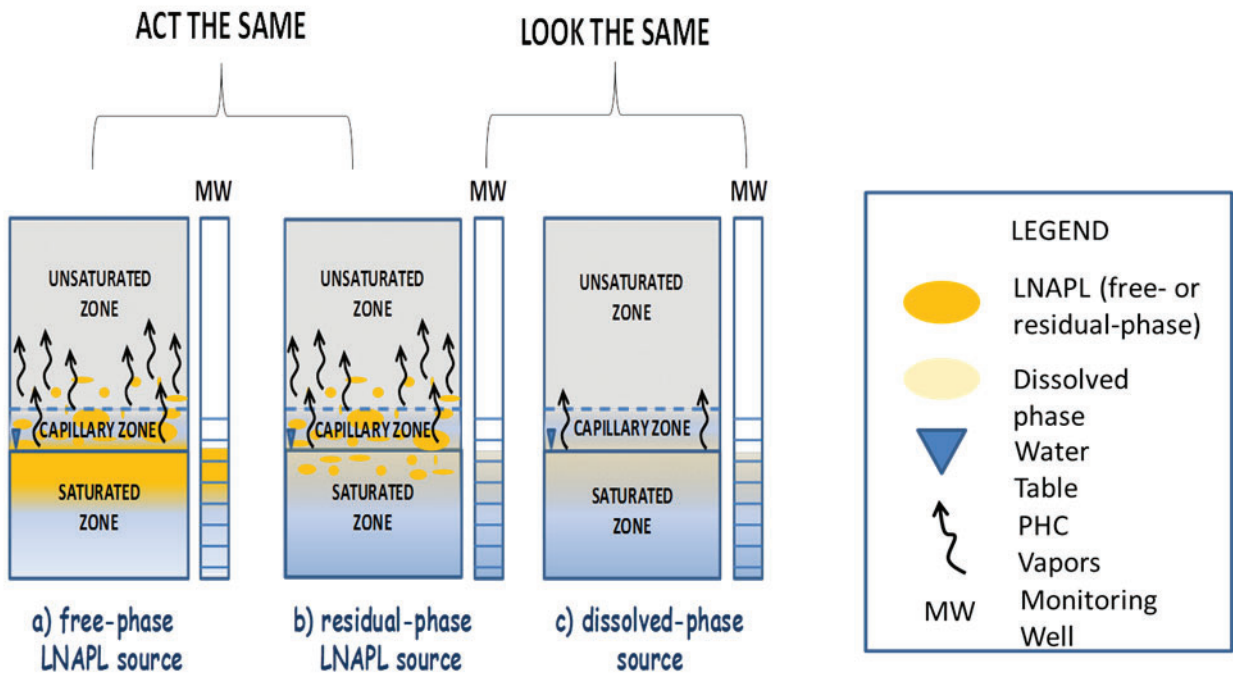


Figure 7. Conceptual Model Illustrating The Potential For Vapor Intrusion For a) Free-Phase LNAPL Source, b) Residual-Phase LNAPL Source, And c) Dissolved-Phase Source (Source: Lahvis, et al., 2013. Reprinted from *Groundwater Monitoring & Remediation* with permission of the National Ground Water Association. Copyright 2013.)

Assessment

The distinction between petroleum contamination present as LNAPL and contamination present purely as a dissolved phase is important. Unfortunately, there is no precise concentration threshold between dissolved phase PHCs and PHCs present in a mixed phase that includes LNAPL.[29] EPA (2013) used a threshold for the benzene groundwater concentration equal to 5 mg/L and a total petroleum hydrocarbon (TPH) threshold groundwater concentration of 30 mg/L for identification of LNAPL sites. The TPH threshold adopted by EPA (2013) is based on the calculated approximate average ratio of the concentration of benzene to TPH in groundwater at UST sites. A site with a LNAPL source was identified on the basis of either the benzene or TPH groundwater concentration exceeding the threshold. The thresholds adopted for identifying LNAPL sites based on soil concentrations are 10 mg/Kg benzene, 100 mg/Kg TPH for unweathered gasoline, and 250 mg/Kg TPH for diesel or weathered gasoline.

[29] Table 4 in EPA (2013) presents a variety of direct and indirect indicators of LNAPL. For example, Bruce, et al. (1991) suggest groundwater concentrations greater than one-fifth (0.2) of the effective solubility of LNAPL as indirect evidence of the presence of LNAPL. However, because the effective solubility depends on characteristics of the LNAPL mass (e.g., composition, weathering); there is uncertainty in the threshold. Additional discussions of screening concentrations for LNAPL are presented in *Evaluating Hydrocarbon Removal from Source Zones and its Effect on Dissolved Plume Longevity and Concentration* (API, 2002), and ITRC (2014).

Special Considerations

Direct means for detecting the presence of LNAPL include measurable accumulations of free product in monitoring wells, an oily sheen on the water, and saturation of bulk soil samples.[30] The presence of residual LNAPL may not be recognizable from monitoring well data. This is because the soil is not sufficiently saturated with LNAPL to allow it to flow into wells. Lahvis et al. (2013) suggest that multiple indicators (both direct and indirect) be evaluated to determine whether or not LNAPL is present.

Recommendation

EPA recommends subsurface sampling to determine the full extent and location of LNAPL (both mobile LNAPL and residual). LNAPL may be present even when there is no measureable accumulation of free product in a monitoring well. In addition, federal regulations (40 CFR 280.64) require that when free product is present, it must be "removed to the maximum extent practicable as determined by the implementing agency." Effective source removal will mitigate a long term source of PHC vapors as well as mitigate dissolved and residual LNAPL contamination.

EPA recommends analyzing bulk soil samples collected in the source area for TPH (e.g., gasoline or diesel depending on which fuels were stored on site) and specific petroleum constituents (e.g., BTEX and other volatile and semi-volatile organic chemicals, and fuel additives). EPA also recommends analysis of LNAPL samples (if present) to determine the degree of weathering and potential for vapor generation.

References Cited

American Petroleum Institute (API). 2002. *Evaluating Hydrocarbon Removal from Source Zones and its Effect on Dissolved Plume Longevity and Concentration*. API Publication 4715. *http://www.api.org/environment-health-and-safety/clean-water/ground-water/lnapl/hydrocarbon-removal*

EPA. 1996. How To Effectively Recover Free Product At Leaking Underground Storage Tank Sites: A Guide For State Regulators. OUST (EPA 510-R-96-001). *http://www.epa.gov/swerust1/pubs/fprg.htm*

EPA. 2013. *Evaluation Of Empirical Data Studies To Support Soil Vapor Intrusion Screening Criteria For Petroleum Hydrocarbon Compounds* (EPA 510-R-13-001). *http://www.epa.gov/oust/cat/pvi/PVI_Database_Report.pdf*

[30] Consistent with the findings in EPA (2013) EPA recommends that these same thresholds also be applied for PVI investigations conducted using this guide. These thresholds are presented in **Table 3** in **Section 5** (p.52).

Federal Register. 1988. *40 CFR Parts 280 and 281: Underground Storage Tanks; Technical Requirements and State Program Approval; Final Rules*. September 23, 1988. 53(185): 37082-38344. http://www.epa.gov/oust/fedlaws/cfr.htm

Interstate Technology & Regulatory Council (ITRC). 2014. Petroleum Vapor Intrusion: Fundamentals of Screening, Investigation, and Management. Interstate Technology and Regulatory Council, Vapor Intrusion Team, Washington, D.C. October. http://itrcweb.org/PetroleumVI-Guidance

Lahvis, M.A., I. Hers, R.V. Davis, J. Wright, and G.E. DeVaull. 2013. Vapor Intrusion Screening at Petroleum UST Release Sites. *Groundwater Monitoring and Remediation* 33(2):53-67.

Peargin, T. and R. Kolhatkar. 2011. Empirical Data Supporting Groundwater Benzene Concentration Exclusion Criteria for PVI Investigations. *Proceedings of Battelle 8th International Symposium on Bioremediation and Sustainable Environmental Technologies*, Reno, Nevada, June 27-30.

Additional Information

Abdul, A.S., S.F. Kia, and T.L. Gibson. 1989. Limitations of Monitoring Wells for the Detection and Quantification of Petroleum Products in Soils and Aquifers. *Ground Water Monitoring Review* 9(2):90-99.

Ballestero, T.P., F.R. Fiedler and N.E. Kinner. 1994. An Investigation of the Relationship Between Actual and Apparent Gasoline Thickness in a Uniform Sand Aquifer. *Ground Water* 32(5): 708-718.

Cohen, R.M., A.P. Bryda, S.T. Shaw, and C.P. Spalding. 1992. Evaluation of Visual Methods to Detect NAPL in Soil and Water. *Ground Water Monitoring Review* 12(4):132-141.

Farr, A.M., R.J. Houghtalen and D.B. McWhorter. 1990. Volume Estimation of Light Nonaqueous Phase Liquids in Porous Media. *Ground Water* 28(1):48-56.

Kemblowski, M.W. and C.Y. Chiang. 1990. Hydrocarbon Thickness Fluctuations in Monitoring Wells. *Ground Water* 28(2):244-252.

Lenhard, R.J. and J.C. Parker. 1990. Estimation of Free Hydrocarbon Volume from Fluid Levels in Monitoring Wells. *Ground Water* 28(1):57-67.

Newell, C.J., S.D. Acree, R.R. Ross, and S.G. Huling. 1995. Light Nonaqueous Phase Liquids. USEPA/ORD Robert S. Kerr Environmental Research Laboratory, Ada, Oklahoma (EPA-540-5-95-500).

7. Groundwater Flow And Dissolved Contaminant Plumes

Description

Contaminant plumes are dynamic, three-dimensional distributions of contaminants in groundwater. Contaminants dissolved in groundwater can migrate with flowing groundwater thereby spreading contamination. In some aquifers, where the direction and speed of groundwater flow are stable, the plumes are usually long and narrow. Other plumes appear to spread in both the transverse as well as the longitudinal direction. This apparent transverse dispersion may be the direct result of changes in the direction of groundwater flow. What may appear to be transverse dispersion is actually longitudinal dispersion occurring in different directions as the direction of flow changes (EPA, 2005; Wilson, 2003).

Importance

The potential for PVI from dissolved PHC contaminant plumes is typically limited to sites where there are high concentrations of dissolved contaminants or the plume is in direct contact with a building foundation, basement, or slab. A study by Peargin and Kolhatkar (2011) suggests that a dissolved source with benzene greater than 1 mg/L may have the same vapor-generating capacity as a LNAPL source.

Assessment

Contaminant plumes generally necessitate three-dimensional monitoring to assess the transient behavior of groundwater flow and the movement of contaminant plumes (EPA, 2004a, b). Contaminant plumes migrate with flowing groundwater, which can exhibit seasonal variations as well as responses to pumping, tides, or stage of a nearby river.[31] Groundwater flow directions can and often change over time, and may necessitate periodic monitoring over more than one annual cycle to understand the groundwater flow regime at a given site.

(Note: This monitoring need not delay additional investigation activities and measures to mitigate or remediate threats to safety and health.) As the plume migrates, appropriate adjustments to the sampling plan should be made to ensure that potential receptors are

[31] Groundwater flow directions can change frequently and relatively quickly. Changes in groundwater flow directions may be more prevalent than is realized, because the variation in the direction of groundwater flow is rarely evaluated in any formal way (EPA, 2005). Wilson (2003) studied data from a site in North Carolina where groundwater flow was influenced by the stage of a nearby river. Over the course of one year of monthly monitoring, groundwater flow directions fluctuated by 120 degrees. Wilson et al. (2005) also studied data from a gas station site in New Jersey. Over a six-year period groundwater monitoring data were collected on 23 occasions; the predominant flow direction was 90-degrees from the presumed direction on which the conceptual model was constructed, and the direction of flow fluctuated by nearly 180 degrees. Mace et al. (1997) studied the variation in groundwater flow directions at 132 gas stations in Texas. Fluctuations in flow directions occurred over a range of 120 degrees. Goode and Konikow (1990) characterized a site where PHCs leaked to the water table. Groundwater flow directions changed nearly 90 degrees in less than four months in response to changing flow conditions in a nearby intermittent stream.

protected. If new PHC releases to groundwater occur, then appropriate mitigation steps can be implemented.

Plume monitoring networks should be able to detect changes in plume boundaries as well as fluctuations in the concentrations of geochemical parameters and contaminant concentrations. Collection of samples from the contaminant plume is needed to determine the extent of contamination and provide information that can be used to estimate the vapor generation capacity of the dissolved contamination. The contaminant plume should be surrounded by sampling points that are free of contamination (i.e., *clean monitoring points*).

Conventional monitoring wells may provide an incomplete picture of the true distribution of contaminants in groundwater. If the length of the screen in a monitoring well is long compared to the thickness of the plume of contamination, the sample obtained will be diluted by the inflow of clean(er) groundwater from above or below the plume. Also, plumes may dive below the screened interval of the wells leading to the false impression that the plume is shorter than it actually is (EPA, 2005).

Special Considerations

Dissolved plumes are dynamic and contamination may migrate beneath buildings over time. This is best evaluated by determining the range of fluctuation in groundwater flow direction and water table elevations beneath buildings over at least one annual cycle. However, in the interim, the remaining PVI-related activities should continue. Preferential transport pathways, if present, may facilitate the intrusion of petroleum vapors into buildings.[32] When contaminant plumes intersect preferential transport pathways, the spread of contamination can be very rapid compared to the velocity of groundwater flow through the soil.

Volatilization of contaminants from the plume into soil gas is greatly reduced when a plume dives beneath the water table surface. Volatile contaminants diffuse more slowly through the water column than through soil gas.

Recommendation

EPA recommends groundwater monitoring and sampling to determine the depth to contaminated groundwater and the vertical distribution of contaminants in the water column beneath overlying buildings[33]. Due to the transient nature of groundwater migration, EPA recommends periodic monitoring and sampling over more than one annual cycle to fully

[32] Dissolved petroleum contaminants may threaten building inhabitant's health through their water supply rather than through vapor intrusion. Exposure may occur from wells drawing from a contaminated plume, or contamination permeating the water supply piping. Though fuel constituents generally impart a disagreeable odor and taste, building occupants may still be exposed to potentially harmful levels of contaminants. Such exposure may occur when PHCs volatilize from the dissolved phase during showering or washing clothes and dishes, or through ingesting contaminated water. Identifying the mechanism of exposure is important because methods for remediation/mitigation of PVI will be different than treatment or remediation of contaminated groundwater.

[33] If groundwater samples contain greater than 30 mg/L TPH (or greater than 5 mg/L benzene), it is possible that residual LNAPL is present (see **Section 6**, p.57).

understand the groundwater flow regime at a given site. Where the respective vertical separation distance (see **Section 5**) is met or exceeded, generally no further investigation for PVI is necessary if there are no precluding factors present (e.g., preferential transport pathways) and the PCH source is not a high-ethanol blend (i.e., E-20 or greater) of gasoline. If the applicable separation distance is not met and where contamination is not in direct contact with an overlying building, then choose one of two options: (1) collect near-slab (exterior) shallow soil gas samples paired with deep (source) soil gas samples, or (2) collect indoor air samples paired with sub-slab soil gas samples. If the potential for PVI cannot be ruled out based on near-slab and deep soil gas sampling, then EPA recommends indoor air sampling paired with sub-slab vapor sampling. If the attenuation factor calculated from results of analysis of the chosen pair or vapor samples indicates that there may be a potential for PVI above applicable exposure limits, EPA recommends gathering additional information and data to determine whether mitigation is appropriate.

Even in cases where there is no threat of PVI from contaminated groundwater, EPA recommends that the plume be assessed to determine if remediation is necessary to prevent ingestion of contaminated drinking water and protect and restore actual or potential sources of drinking water.

References Cited

EPA. 2004a. *Performance Monitoring of MNA Remedies for VOCs in Ground Water.* Office of Research and Development, National Risk Management Research Laboratory, Ada, Oklahoma. April (EPA/600/R-04/027). *http://www.epa.gov/nrmrl/pubs/600r04027.html*

EPA. 2004b. *Monitored Natural Attenuation.* Chapter IX in *How To Evaluate Alternative Cleanup Technologies For Underground Storage Tank Sites: A Guide For Corrective Action Plan Reviewers* (EPA 510-B-94-003; EPA 510-B-95-007; and EPA 510-R-04-002). *http://www.epa.gov/swerust1/pubs/tums.htm*

EPA. 2005. *Monitored Natural Attenuation of MTBE as a Risk Management Option at Leaking Underground Storage Tank Sites* (EPA/600/R-04/1790). *http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=20017I6R.txt*

Goode, D.J. and L.F. Konikow. 1990. Apparent Dispersion in Transient Groundwater Flow. *Water Resources Research* 26(10):2339-2351.

Mace, R. E., R. S. Fisher, D. M. Welch, and S. P. Parra. 1997. *Extent, Mass, and Duration of Hydrocarbon Plumes from Leaking Petroleum Storage Tank Sites in Texas*. Geological Circular 97-1, Bureau of Economic Geology, University of Texas, Austin, Texas.

Peargin, T. and R. Kolhatkar. 2011. Empirical Data Supporting Groundwater Benzene Concentration Exclusion Criteria for PVI Investigations. *Proceedings of Battelle 8th International Symposium on Bioremediation and Sustainable Environmental Technologies*, Reno, Nevada, June 27-30.

Wilson, J. T. 2003. Fate and Transport of MTBE and Other Gasoline Components. In: *MTBE Remediation Handbook,* Amherst, Massachusetts: Amherst Scientific Publishers, pp.19-61.

Wilson, J.T., C. Adair, P.M. Kaiser, and R. Kolhatkar. 2005. Anaerobic Biodegradation of MTBE at a Gasoline Spill Site. *Ground Water Monitoring and Remediation* 25(3):103-115.

Additional Information

Bredehoeft, J.D. and G.F. Pinder. 1973. Mass Transport in Flowing Groundwater. *Water Resources Research* 9(1):194-210.

EPA. (undated). Key Groundwater Guidance and Reports. http://www.epa.gov/superfund/health/conmedia/gwdocs/

Gelhar, L.W., C. Welty and K.R. Rehfeldt. 1992. A Critical Review of Data on Field-Scale Dispersion in Aquifers. *Water Resources Research* 28(7):1955-1974.

Greenkorn, R.A. and D.P. Kessler. 1969. Dispersion in Heterogeneous Nonuniform Anisotropic Porous Media. *Industrial and Engineering Chemistry* 61(9):14-32.

Pickens, J.F. and G.E. Grisak. 1981. Scale-Dependent Dispersion in a Stratified Granular Aquifer. *Water Resources Research* 17(4):1191-1211.

Scheidegger, A.E. 1954. Statistical Hydrodynamics in Porous Media. *Journal of Applied Physics* 25(8):994-1001.

Scheidegger, A.E. 1961. General Theory of Dispersion in Porous Media. *Journal of Geophysical Research* 66(10):3273-3278.

Schwartz, F.W. 1977. Macroscopic Dispersion in Porous Media: The Controlling Factors. *Water Resources Research* 13(4):743-752.

U.S. Geological Survey. 2013. *Factors Affecting Public-Supply Well Vulnerability to Contamination: Understanding Observed Water Quality and Anticipating Future Water Quality. Circular 1385.* U.S. Department of the Interior, National Water-Quality Assessment Program. http://pubs.usgs.gov/circ/1385/

Wilkin, R.T., M.S. McNeil, S.J. Adair, and J.T. Wilson. 2001. Field Measurement of Dissolved Oxygen: A Comparison of Methods. *Ground Water Monitoring and Remediation* 21(4):124-132.

Zheng, C. and S.M. Gorelick. 2003. Analysis of Solute Transport in Flow Fields Influenced by Preferential Flowpaths at the Decimeter Scale. *Ground Water* 41(2):142-155.

8. Soil Gas Profile

Description

Aerobic biodegradation of PHC vapors occurs in many subsurface environments (Lahvis, Baker, and Behr, 1998; McHugh, et al., 2010; Roggemans, 1998; Roggemans, Bruce, and Johnson, 2002; ZoBell, 1946; Atlas, 1981; Leahy and Colwell, 1990; DeVaull, 2007). The soil gas profile can provide confirmation that aerobic biodegradation is occurring in the subsurface. Decreasing oxygen concentration and increasing carbon dioxide and methane concentrations indicate biodegradation of PHCs (Hult and Grabbe, 1988). Shallow soil gas typically contains water vapor and fixed gases: nitrogen, oxygen, carbon dioxide, carbon monoxide, and argon. These gases infiltrate into the soil from the atmosphere. Vapor phase PHC contamination may be the result of volatilization from mobile LNAPL released into the subsurface, residual soil contamination (including the smear zone), and dissolved phase contamination. The lower proportion of volatile hydrocarbon compounds in diesel fuel will lead to a comparatively smaller vapor plume in comparison to the release of a similar volume of gasoline (Prince and Douglas, 2010; Marchal, et al., 2003). In addition to PHCs, soil gas may also contain degradation products from the breakdown of PHCs and naturally occurring organic matter. The principal gases resulting from the biodegradation of PHCs are carbon dioxide (under aerobic conditions) or methane (under anaerobic conditions).

Figure 8 presents a characteristic vertical concentration profile in the unsaturated zone; oxygen concentrations decrease with depth and PHCs (including methane) and carbon dioxide

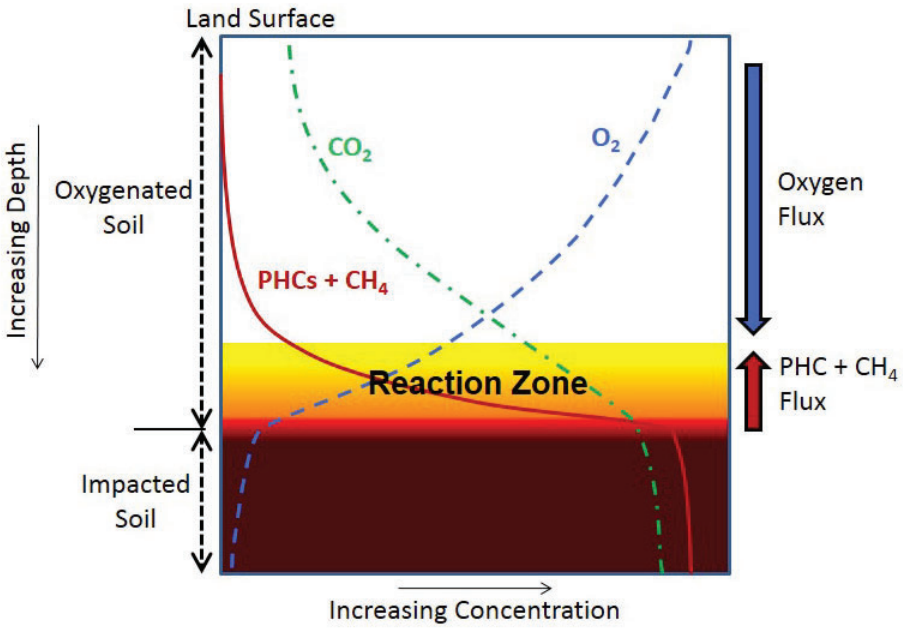


Figure 8. Typical Vertical Concentration Profile In The Unsaturated Zone For PHCs (Plus Methane), Carbon Dioxide And Oxygen

concentrations increase with depth toward the source of contamination. This typical vertical profile may vary somewhat in shape depending on site-specific conditions (Roggemans, Bruce, and Johnson, 2002). During aerobic biodegradation in unsaturated soils, PHCs degrade, oxygen is consumed, and carbon dioxide is produced. The aerobic biodegradation zone is within oxygenated soil (generally greater than 1 percent oxygen in soil gas). In the oxygenated soil zone (where aerobic biodegradation occurs between land surface and the depth of impacted soil) the decrease in PHC concentrations is typically quite rapid and occurs over a narrow interval (the reaction zone in **Figure 8**) (Abreu, Ettinger, and McAlary, 2009).

The impacted soil zone, which is anaerobic, is characterized by the maximum PHC concentrations (and often LNAPL) and biodegradation is slow (EPA, 2012a). Generally, PHC vapor concentrations will be much greater adjacent to a LNAPL source than adjacent to a dissolved hydrocarbon plume. If PHC concentrations are high enough, available oxygen may be depleted, which in turn limits aerobic biodegradation. The core of any PHC contaminant mass is typically depleted with respect to oxygen, thus anaerobic biodegradation of LNAPL or other organic sources (e.g., ethanol) can produce significant amounts of methane (Anderson and Lovley, 1997; Wiedemeier, et al., 1999; Koenigsberg and Norris, 1999; Ma et al., 2014). Methane readily biodegrades under aerobic conditions and, when present, will create an additional oxygen demand (Jewell and Wilson, 2011; Ma, et al, 2012). High concentrations of methane, oxygen, and a source of ignition can create a fire or explosion hazard in confined spaces (e.g., utility vaults and passages, basements, or garages) (Ma et al., 2014). For additional information on evaluating the presence of methane and potential hazards, see ASTM's "*New Practice for Evaluating Potential Hazard Due to Methane in the Vadose Zone*".[34]

Differences between near-slab soil gas profiles and sub-slab soil gas profiles are reported in two EPA modeling studies: the conceptual model scenarios report EPA (2012b) and the building size modeling report for PVI (EPA, 2013a). However, EPA (2012b) assumed that building foundations, basements, and slabs were impermeable and, thus, oxygen transport was not simulated through the foundation, basement, or slab into the subsurface beneath the building. Simulations presented in EPA (2013a) allowed for oxygen transport using reasonably expected oxygen permeability values for concrete (Fischer et al., 1996; McHugh, DeBlanc, and Pokluda, 2006; Lundegard, Johnson, and Dahlen, 2008; Patterson and Davis, 2009; Tittarelli, 2009). When oxygen transport is accounted for, the differences in soil gas profiles were less pronounced between near-slab and sub-slab samples very close to the building basement and slab. Thus, near-slab soil gas samples can be substituted for sub-slab samples in situations where dissolved contamination is present within 6 feet of (but not in contact with) a building basement floor, foundation, or crawlspace surface, and where LNAPL is present within 15 feet of (but not in contact with) a building basement floor, foundation, or crawlspace surface. For dissolved sources this holds for buildings of any size, and for LNAPL sources it applies to buildings with the shortest side being no longer than 66 feet (EPA, 2013a). Deep soil gas samples are needed to determine the depth to contaminated soil and the thickness of clean,

[34] The new ASTM methane guide is accessible at *http://www.astm.org/DATABASE.CART/WORKITEMS/WK32621.htm*

biologically active soil necessary to attenuate PHC vapors. Shallow soil gas samples should be paired with deep (near source) soil gas samples to evaluate the strength of the PHC vapor source and the attenuation of PHC vapors.

Importance

The potential for PVI is a function of the oxygen demand exerted by all biodegradable vapors, not just the key chemicals of potential concern (Jewell and Wilson, 2011; Ma, et al., 2012). When present, volatile PHCs and methane also exert an oxygen demand that may limit aerobic biodegradation of benzene (Abreu, Ettinger, and McAlary, 2009; Wilson, 2011). An estimate of the biodegradation rate can be determined from the stoichiometric relationship between the flux of oxygen, carbon dioxide, and methane (Lahvis and Baehr, 1996). PHC vapor concentrations generally decrease with increasing distance from a subsurface vapor source. At a relatively short distance from the source, concentrations of PHCs in soil gas will typically fall below potentially significant levels of concern provided that oxygen replenishment is adequate to ensure complete aerobic biodegradation. Lahvis, Baehr, and Baker (1999) observed that PHC vapors from a dissolved plume were almost completely degraded within 1 meter (3.3 feet) above the water table and that significant transport of PHC vapors may only be significant if the vapor source is LNAPL. This is consistent with the findings of EPA's (2013b) PVI database analysis report and Lahvis et al. (2013).

Assessment

Soil gas samples provide information on the distribution of contamination near the source area, whether biodegradation is occurring, and how effective it is in reducing the potential for PVI. When there is an impermeable surface cover adjacent to a building, soil gas probes should be installed beneath the surface in order for the soil gas profile to adequately characterize conditions below the surface. For very large buildings, or where there is extensive impermeable surface cover and the vapor source is relatively shallow, additional investigation is recommended to verify that biodegradation is occurring beneath the building.[35] Vapor samples should be analyzed for PHCs (and non-PHC fuel additives), methane, oxygen, and carbon dioxide (Lahvis, Baehr, and Baker, 1999).

[35] EPA (2013a) presents modeling results for a variety of soil types, building sizes, vapor source strengths, and vertical separation distances. These results, while not exhaustive, indicate that for dissolved sources and very large buildings, an oxygen shadow does not form, thus the subsurface stays sufficiently oxygenated to support aerobic biodegradation and preclude the potential for PVI. For LNAPL sources, an oxygen shadow was not observed to form beneath buildings up to 66 feet on the shortest side. This length represents the threshold below which oxygen replenishment is sufficient to support aerobic biodegradation; above this length oxygen replenishment may be impeded and there may be insufficient oxygen present to support aerobic biodegradation. For larger buildings underlain by LNAPL within 15 feet of the foundation, basement, or slab, sub-slab soil gas sampling paired with indoor air sampling is necessary to assess whether PVI is occurring. Another potential concern for large buildings and extensive, impermeable surface cover (e.g., asphalt, concrete) is formation of a moisture shadow, which represents soil moisture content too low to support microbial biodegradation (see **Section 9,** p.75, for more information).

An estimate of the total oxygen demand can be determined in two ways: sample for methane and petroleum hydrocarbons (PHCs); or sample and measure the oxygen demand for all the organic compounds in the soil gas at the source.[36] If methane and all the PHCs in soil gas are measured, these concentrations should be converted to an equivalent concentration of benzene and summed. The total oxygen demand of the aggregate of methane and the PHCs (expressed as an equivalent concentration of benzene) can be used to determine an attenuation factor (α) that can be used along with the actual concentration of benzene in soil gas at the source to determine whether aerobic biodegradation is capable of degrading the PHC vapors to acceptable concentrations (see **Section 12,** p.106, **Figure 9**, p.101, and **Figure 10,** p.103).

In some cases, relatively shallow soil gas samples (less than five feet below ground surface) will be needed to characterize active biodegradation zones in the shallow soil (e.g., in the presence of shallow contamination sources). Some state regulatory programs do not allow soil gas sampling at depths less than 5 feet based on the concern that accurate sampling may not be possible at shallow depths because air from the surface may leak into the sample. However, recent research has shown that the collection of accurate shallow-soil gas samples is possible at depths as shallow as 2 feet below ground surface using appropriate field methods (e.g., leak testing), such as those documented in *Temporal Variation of VOCs in Soils from Groundwater to the Surface* (EPA, 2010). It is also possible under certain conditions to collect representative soil gas samples using previously installed groundwater monitoring wells (see Wilson et al., 2014).

Special Considerations

There are several factors that can limit replenishment of oxygen to deep soils. These include presence of low permeability layers, concrete or asphalt covering at the surface, high soil moisture from a recent rainfall event or from irrigation, and buildings that are so large that oxygen is depleted beneath the center of the building (Patterson and Davis, 2009). However, a recent study by EPA (2013a) indicates that for an oxygen shadow[37] to form beneath a building, the PHC vapor source must be shallow LNAPL and the building must be greater than 66 feet in length on the shortest side. For simulations with dissolved sources, no oxygen shadow formed even under a square building with sides that were 2,073 feet in length.

At sites with a new release or unweathered LNAPL source, the oxygen demand will be high. It is important to determine whether temporal variations in oxygen flux into the vadose zone will limit the effectiveness of aerobic biodegradation, potentially resulting in intermittent vapor intrusion impacts. For such sites, more than one round of soil gas monitoring may be needed to confirm that aerobic biodegradation consistently prevents PVI impacts at the site.

[36] EPA recommends using modified Method TO-15 (*see* http://www.epa.gov/ttn/amtic/files/ambient/airtox/to-15r.pdf) for organic compounds. The concentration of methane measured as a fixed gas can then be added to the results of TO-15 to give an approximation of TPH.

[37] For the purposes of this modeling study, an oxygen shadow is defined as less than 1 percent oxygen.

Recommendation

EPA recommends that soil gas samples be analyzed for PHCs, non-PHC fuel additives, methane, oxygen, and carbon dioxide. Sampling for nitrogen (and other fixed gases) in soil gas can provide a check on the quality of the analyses since the sum of these gases should be 100 percent. If they are substantially less than 100 percent, then some constituents are unaccounted for and the analyses should be interpreted with caution.

For buildings of any size within the lateral inclusion zone if the vertical separation distance between the building basement, foundation, or slab and dissolved contamination is less than 6 feet, but not in contact with the building EPA recommends that near-slab soil gas samples paired with deep (near source) soil gas be collected. For buildings up to 66 feet on the shortest side that directly overlie LNAPL masses, and the vertical separation distance is less than 15 feet (but the building is not in direct contact with LNAPL), EPA recommends collection of near-slab soil gas samples paired with deep (near source) soil gas samples. Near-slab soil gas samples should be collected from each side of the building and as close to the building as practicable. If the attenuation factor calculated from results of analysis of the chosen pair or vapor samples indicates that there may be a potential for PVI above applicable exposure limits, EPA recommends gathering additional information and data to determine whether mitigation is appropriate. If contamination is in direct contact with an overlying building (and thus, collection of shallow soil gas samples is not possible), indoor air sampling is recommended.

In addition, for very large buildings or where there is extensive impermeable surface covering, EPA recommends that near-slab or sub-slab soil gas samples be collected if there is concern that these conditions may impede the flux of oxygen to the subsurface and create an oxygen or soil moisture shadow.

References Cited

Abreu, L.D.V, R. Ettinger, and T. McAlary. 2009. Simulated Soil Vapor Intrusion Attenuation Factors Including Biodegradation for Petroleum Hydrocarbons. *Ground Water Monitoring and Remediation* 29(1):105-117.

Anderson, R.T., and D.R. Lovley. 1997. Ecology and Biogeochemistry of In Situ Groundwater Bioremediation, in Jones, J.G. (ed) *Advances in Microbial Ecology*, Volume 15, Plenum Press, New York, New York, pp.289-350.

ASTM International (ASTM). 2014. New Practice for Evaluating the Potential Hazard Due to Methane in the Vadose Zone. ASTM WK3221. West Conshohocken, Pennsylvania. *http://www.astm.org/DATABASE.CART/WORKITEMS/WK32621.htm*

Atlas, R.M. 1981. Petroleum Microbiology. *Microbiological Reviews* 45(1):180-209.

DeVaull, G.E. 2007a. Indoor Vapor Intrusion with Oxygen-Limited Biodegradation for a Subsurface Gasoline Source. *Environmental Science & Technology* 41(9):3241-3248.

EPA. 2010. *Temporal Variation of VOCs in Soils from Groundwater to the Surface/Subslab* (EPA/600/R-10/118). http://www.epa.gov/esd/cmb/pdf/EPA600R-10-118.pdf

EPA. 2012a. *Petroleum Hydrocarbons And Chlorinated Solvents Differ In Their Potential For Vapor Intrusion.* March. http://www.epa.gov/oust/cat/pvi/pvicvi.pdf

EPA. 2012b. *Conceptual Model Scenarios for the Vapor Intrusion Pathway.* (EPA 530-R-10-003) http://www.epa.gov/oswer/vaporintrusion/documents/vi-cms-v11final-2-24-2012.pdf

EPA. 2013a. *3-D Modeling of Aerobic Biodegradation of Petroleum Vapors: Effect of Building Area Size on Oxygen Concentration Below the Slab* (EPA 510-R-13-002). http://www.epa.gov/oust/cat/pvi/building-size-modeling.pdf

EPA. 2013b. *Evaluation Of Empirical Data To Support Soil Vapor Intrusion Screening Criteria For Petroleum Hydrocarbon Compounds* (EPA 510 R-13-001). http://www.epa.gov/oust/cat/pvi/PVI_Database_Report.pdf

Fischer, M.L., Bentley, A.J., Dunkin, K.A., Hodgson, A.T., Nazaroff, W.W., Sextro, R.G., and J.M. Daisey. 1996. Factors affecting indoor air concentrations of volatile organic compounds at a site of subsurface gasoline contamination. *Environmental Science & Technology* 30: 2948–2957.

Jewell, K.P. and J.T. Wilson. 2011. A New Screening Method for Methane in Soil Gas Using Existing Groundwater Monitoring Wells. *Ground Water Monitoring and Remediation* 31(3):82–94.

Koenigsberg, S.S. and R.D. Norris (eds). 1999. *Accelerated Bioremediation Using Slow Release Compounds: Selected Battelle Conference Papers 1993-1999.* California: Regenesis Bioremediation Products.

Lahvis, M.A., and A.L. Baehr. 1996. Estimation of Rates of Aerobic Hydrocarbon Biodegradation by Simulation of Gas Transport in the Unsaturated Zone. *Water Resources Research* 32(7):2231-2249.

Lahvis, M., A. Baehr, and R. Baker. 1999. Quantification of Aerobic Biodegradation and Volatilization Rates of Gasoline Hydrocarbons near the Water Table under Natural Attenuation Conditions. *Water Resources Research* 35(3):753-765.

Lahvis, M.A., I. Hers, R.V. Davis, J. Wright, and G.E. DeVaull. 2013. Vapor Intrusion Screening at Petroleum UST Release Sites. *Groundwater Monitoring and Remediation* 33(2):53-67.

Leahy, J.G., and R.R. Colwell. 1990. Microbial Degradation of Hydrocarbons in the Environment. *Microbiological Reviews 54*(3):305-315.

Lundegard, P.D., P.C. Johnson, and P. Dahlen. 2008. Oxygen transport from the atmosphere to soil gas beneath a slab-on-grade foundation overlying petroleum-impacted soil. *Environmental Science and Technology* 42(15):5534–5540.

Ma, J. W.G. Rixey, G.E. DeVaull, B.P. Stafford, and P.J. J. Alvarez. 2012. Methane Bioattenuation and Implications for Explosion Risk Reduction along the Groundwater to Soil Surface Pathway above a Plume of Dissolved Ethanol. *Environmental Science & Technology* 46(11):6013-6019.

Ma, J., H. Luo, G.E. DeVaull, W.G. Rixey, and P.J. J. Alvarez. 2014. Numerical Model Investigation for Potential Methane Explosion and Benzene Vapor Intrusion Associated with High-Ethanol Blend Releases. *Environmental Science & Technology* 48(1):474-481.

Marchal, R., S. Penet, F. Solano-Serena, and J.-P. Vandecasteele. 2003. Gasoline and Oil Biodegradation. *Oil and Gas Science and Technology* 58(4):441-448.

McHugh, T. E., P.C. DeBlanc, and R.J.Pokluda. 2006. Indoor Air as a Source of VOC Contamination in Shallow Soils Below Buildings. *Soil & Sediment Contamination* 15(1): 103–122.

McHugh, T., R. Davis, G. DeVaull, H. Hopkins, J. Menatti, and T. Peargin. 2010. Evaluation of vapor attenuation at petroleum hydrocarbon sites. *Soil and Sediment Contamination: An International Journal* 19(6):725-745.

Patterson, B.M., and G.B. Davis. 2009. Quantification of Vapor Intrusion Pathways into a Slab-on-Ground Building under Varying Environmental Conditions. *Environmental Science and Technology* 43(3):650-656.

Prince, R.C. and G.S. Douglas. 2010. Remediation of Petrol and Diesel in Subsurface from Petrol Station Leaks, in Timmis, K.N. (ed) *Handbook of Hydrocarbon and Lipid Microbiology: Part 14*, Springer-Verlag, Berlin.

Roggemans, S. 1998. *Natural Attenuation of Hydrocarbon Vapors in the Vadose Zone.* M.S. Thesis, Arizona State University.

Roggemans, S., C.L. Bruce, and P.C. Johnson. 2002. *Vadose Zone Natural Attenuation of Hydrocarbon Vapors: An Empirical Assessment of Soil Gas Vertical Profile Data.* API Technical Bulletin No. 15. American Petroleum Institute, Washington, D.C. *http://www.api.org/environment-health-and-safety/clean-water/ground-water/vapor-intrusion/vi-publications/attenuation-hydrocarbon-vapors*

Tittarelli, F. 2009. Oxygen Diffusion Through Hydrophobic Cement-Based Materials. *Cement and Concrete Research* 39(10):924–928.

Wiedemeier, T.H., H.S. Rifai, C.J. Newell, and J.T. Wilson. 1999. *Natural Attenuation of Fuels and Chlorinated Solvents.* New York: John Wiley & Sons.

Wilkin, R.T., M.S. McNeil, S.J. Adair, and J.T. Wilson. 2001. Field Measurement of Dissolved Oxygen: A Comparison of Methods. *Ground Water Monitoring and Remediation* 21(4):124-132.

Wilson, J.T. 2011. *Impact of Methane at Gasoline Spill Sites on the Potential for Vapor Intrusion*. Webinar on January 11th, sponsored by the Groundwater Resources Association of California, Sacramento, California.

Wilson, J.T., K. Jewell, C. Adair, C. Paul, C. Ruybal, G. DeVaull, and J. Weaver. 2014. *An Approach that Uses the Concentrations of Hydrocarbon Compounds in Soil Gas at the Source of Contamination to Evaluate the Potential for Intrusion of Petroleum Vapors into Buildings (PVI)*. (EPA/600/R-14/318). ORD Issue Paper, U.S. Environmental Protection Agency, Washington, DC. http://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=305910

ZoBell, C.E. 1946. Action of Microorganisms on Hydrocarbons. *Bacteriological Reviews* 10(1-2):1-49.

Additional Information

Amos, R.T., K.U. Mayer, B.A. Bekins, G.N. Delin, and R.L. Williams. 2005. Use of Dissolved and Vapor-Phase Gases to Investigate Methanogenic Degradation of Petroleum Hydrocarbon Contamination in the Subsurface. *Water Resources Research* 41(2):W02001.

Brenner, D. 2010. Results of a Long-Term Study of Vapor Intrusion at Large Buildings at the NASA Ames Research Center. *Journal of the Air and Waste Management Association* 60(6):747-758.

Hawai'i Department of Health (HI DOH). 2011. *Evaluation of Environmental Hazards at Sites with Contaminated Soil and Groundwater*. Office of Hazard Evaluation and Emergency Response: Honolulu, HI.

Hawai'i Department of Health (HI DOH). 2012. *Field Investigation of the Chemistry and Toxicity of TPH in Petroleum Vapors: Implications for Potential Vapor Intrusion Hazards*. Office of Hazard Evaluation and Emergency Response: Honolulu, HI. http://www.hawaiidoh.org/tgm.aspx

Kristensen, A., T. Poulsen, L. Mortensen, and P. Moldrup. 2010. Variability of Soil Potential for Biodegradation of Petroleum Hydrocarbons in a Heterogeneous Subsurface. *Journal of Hazardous Materials* 179(1-3):573-580.

Lahvis, M., A. Baehr, and R. Baker. 1999. Quantification of Aerobic Biodegradation and Volatilization Rates of Gasoline Hydrocarbons near the Water Table under Natural Attenuation Conditions. *Water Resources Research* 35(3):753-765.

Luo, H., P. Dahlen, P. Johnson, T. Peargin, and T. Creamer. 2009. Spatial Variability of Soil-Gas Concentrations near and beneath a Building Overlying Shallow Petroleum Hydrocarbon-Impacted Soils. *Ground Water Monitoring and Remediation* 29(1):81-91.

9. Clean, Biologically Active Soil

Description

For a PVI investigation, clean soil does not necessarily mean that it is contaminant-free, but rather that the level of any contamination present is low enough so that the biological activity of the soil is not diminished and the subsurface environment will support sufficient populations of microorganisms to aerobically biodegrade PHC vapors. This means that LNAPL is not present. The oxygen demand of all of the contamination present in the soil should not deplete the available supply of oxygen to such an extent that the rate of biodegradation is reduced.

Effective aerobic biodegradation of PHCs depends on the soil having sufficient oxygen and enough moisture to provide a habitat for adequate populations of active microorganisms. Although most soils contain indigenous microorganisms capable of degrading PHC vapors, typically there is an acclimation period between the time they are exposed to the PHC vapors and the time they begin to biodegrade the vapors. Prior exposure to PHCs has been observed to both increase the number of microbes and the microbial mass available for biodegradation of the PHCs and consequently speed up the degradation rate (ZoBell, 1946; Moyer, et al., 1996; Phelps and Young, 1999; and Siddique, et al., 2007).

The habitat of soil bacteria is the thin film of water held to the surface of soil particles by capillary attraction. EPA (2013a) notes that soil moisture content greater than 2 percent is adequate to support biodegradation activity (Leeson and Hinchee, 1996), although biodegradation is limited when the moisture content is at or below the permanent wilting point (Zwick, et al., 1995; Holden, Halverson, and Firestone, 1997). Adequate soil moisture is also indicated if the landscape supports the growth of non-irrigated vegetation (Riser-Roberts, 1992).

Certain geologic materials do not qualify as biologically active soil and should not be included in the vertical separation distance (see **Section 5**, p.48). These geologic materials include:

- Coarse sand and gravel with a low content of silt, clay, and organic matter, and low moisture content that is less than 2 percent dry weight
- Fractured, faulted, or jointed consolidated rock
- Consolidated rock with solution channels (i.e., karst)

Importance

Effective aerobic biodegradation of PHCs depends on a thick layer of soil having sufficient oxygen and enough soil water to provide a habitat for adequate populations of active microorganisms. If oxygen is present, these organisms will generally consume available PHCs. Furthermore, aerobic biodegradation of petroleum compounds can occur relatively quickly, with degradation half-lives as short as hours or days under some conditions (DeVaull, 2007).

Some petroleum compounds can also biodegrade under anaerobic conditions; however, above the water table, where oxygen is usually available in the soil zone, this process is less important because it is generally much slower than aerobic biodegradation (Widdel, Boetius, and Rabus, 2006; Bailey, Jobson, and Rogers, 1973; and Bruce, Kolhatkar, Cuthbertson, 2010).

Assessment

Scientific research and site characterizations have demonstrated that microorganisms capable of aerobically degrading many PHCs are present in nearly all subsurface soil environments (ZoBell, 1946; Atlas, 1981; Wilson, et al., 1986; Leahy and Colwell, 1990; Bedient, Rifai, and Newell, 1994; EPA, 1999). A number of well-characterized field studies demonstrate extensive aerobic biodegradation of PHC vapors in unsaturated soils (Kampbell, et al., 1987; Ostendorf and Kampbell, 1991; Ririe and Sweeney, 1995; Ririe, et al., 1998; Ostendorf, et al., 2000; Hers, et al., 2000; Roggemans, Bruce, and Johnson, 2002; Sanders and Hers, 2006; Davis, Patterson, and Trefry, 2009; Patterson and Davis, 2009; Lahvis, Baehr, and Baker, 1999; and Lavhis and Baehr, 1996). Several of these studies document vapor concentrations at least two to three orders of magnitude lower than would be predicted to occur merely by simple diffusion in the absence of biodegradation.

EPA (2013a) presents findings of an analysis of a large number of vapor samples from leaking UST sites. These results, which are consistent with several recent analyses of different PVI databases (and which are summarized in the report), indicate that in most settings, PHC vapors are biodegraded over relatively short distances in clean, biologically active soil.

Special Considerations

Preferential transport pathways are avenues of least resistance to the migration of contaminants whether in the dissolved phase, LNAPL phase, or vapor phase. The presence of preferential transport pathways can increase the speed at which contamination moves through the subsurface such that contaminants may not biodegrade by the time they reach receptors. Preferential transport pathways include both natural and man-made features (e.g., solution channels, gravel layers, utility corridors and excavations). Natural geologic materials such as coarse sand and gravel with a low content of silt and clay; fractured consolidated rock; or consolidated rock with solution channels, may not have enough soil moisture in contact with soil gas to support adequate densities of biologically active microorganisms. Particularly in cases with shallow contamination, site investigations should evaluate whether a sufficiently thick layer of clean, biologically active soil is present below buildings in the lateral inclusion zone.

In addition, beneath very large buildings or under areas of extensive impermeable surface cover, soil moisture content may be lower than optimal[38] to support an adequate population of biologically active microorganisms necessary to degrade PHC vapors and prevent PVI (see Tillman and Weaver, 2007; EPA, 2013b).

[38] Such reduced soil moisture beneath large buildings is referred to as a *soil moisture shadow*.

Recommendation

Based on EPA (2013a), clean, biologically active soil does not contain LNAPL, EPA recommends LNAPL thresholds of 100 mg/Kg TPH (fresh gasoline) and 250 mg/Kg TPH (weathered gasoline and diesel). Except for the geological materials identified in *Special Considerations*, most soils contain indigenous microorganisms, sufficient oxygen, and adequate soil moisture necessary for degrading PHC vapors. Thus, it is typically not necessary to run microcosm studies or plate counts to test for microbial presence. However, if the conditions at the site are uncertain for supporting aerobic biodegradation, EPA recommends that appropriate samples be collected and analyzed to verify conditions at the site.

Due in part to difficulties in measuring this level of accuracy in the field, EPA recommends vertical separation distances of 6 feet for purely dissolved sources of PHCs and 15 feet for LNAPL sources. These distances are believed to be conservative in most environmental settings. The vertical separation distances described in this guidance (see **Table 3** in **Section 5**, p.52) should not be used at sites where the geologic materials may not have enough soil moisture in direct contact with soil gas. EPA recommends collection and analysis of adequate soil samples for soil moisture, which should be greater than 2 percent by dry weight. In situations where densities of biologically active microorganisms may not be adequate to biodegrade PHCs then soil gas samples should be collected following the recommendations in **Section 8**. If the attenuation factor calculated from results of analysis of the chosen pair or vapor samples indicates that there may be a potential for PVI above applicable exposure limits, EPA recommends gathering additional information and data to determine whether mitigation is appropriate.

References Cited

Atlas, R.M. 1981. Microbial Degradation of Petroleum Hydrocarbons: An Environmental Perspective. *Microbiological Reviews* 45(1):180–209.

Bailey, N.J.L., A.M. Jobson, and M.A. Rogers. 1973. Bacterial Degradation of Crude Oil: Comparison of Field and Experimental Data. *Chemical Geology* 11(3):203-221.

Bedient, P.B., H.S. Rifai, and C.J. Newell. 1994. *Ground Water Contamination: Transport and Remediation*. PTR Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

Bruce, L., A. Kolhatkar, and J. Cuthbertson. 2010. Comparison of BTEX Attenuation Rates Under Anaerobic Conditions. *International Journal of Soil, Sediment and Water* 3(2): Article 11.

DeVaull, G. 2007. Indoor Vapor Intrusion with Oxygen-Limited Biodegradation for a Subsurface Gasoline Source. *Environmental Science and Technology* 41(9):3241-3248.

EPA. 1999. *Monitored Natural Attenuation of Petroleum Hydrocarbons*. Remedial Technology Fact Sheet (EPA/600/F-98/021). http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=30002379.txt

EPA. 2013a. *Evaluation Of Empirical Data To Support Soil Vapor Intrusion Screening Criteria For Petroleum Hydrocarbon Compounds* (EPA 510-R-13-001). http://www.epa.gov/oust/cat/pvi/PVI_Database_Report.pdf

EPA. 2013b. *3-D Modeling of Aerobic Biodegradation of Petroleum Vapors: Effect of Building Area Size on Oxygen Concentration Below the Slab* (EPA 510-R-13-002). http://www.epa.gov/oust/cat/pvi/building-size-modeling.pdf

Hers, I., J. Atwater, L. Li, and R. Zapf-Gilje. 2000. Evaluation of Vadose Zone Biodegradation of BTX Vapours. *Journal of Contaminant Hydrology* 46(3-4):233–264.

Holden, P.A., L.J. Halverson, and M.K. Firestone. 1997. Water Stress Effects on Toluene Biodegradation by *Pseudomonas putida*. *Biodegradation* 8(3):143-151.

Kampbell, D.H., J.T. Wilson, H.W. Read, and T.T. Stocksdale. 1987. Removal of Volatile Aliphatic Hydrocarbons in a Soil Bioreactor. *Journal of the Air Pollution Control Association* 37:1236-1240.

Lahvis, M.A., A.L. Baehr, and R.J. Baker. 1999. Quantification of Aerobic Biodegradation and Volatilization Rates of Gasoline Hydrocarbons near the Water Table under Natural Attenuation Conditions. *Water Resources Research* 35(3):753-765.

Lahvis, M.A., A.L. Baehr, and R.J. Baker. 1996. Estimation of Rates of Aerobic Hydrocarbon Biodegradation by Simulation of Gas Transport in the Unsaturated Zone. *Water Resources Research* 32(7):2231-2249.

Leahy, J. G., and R.R. Colwell. 1990. Microbial Degradation of Hydrocarbons in the Environment. *Microbiological Reviews* 54(3):305-315.

Leeson, A., and R.E. Hinchee. 1996. *Principles and Practices of Bioventing. Volume 1: Bioventing Principles* and *Volume 2: Bioventing Design*. Battelle Memorial Institute. September.

Moyer, E.E., D.W. Ostendorf, R.J. Richards, and S. Goodwin. 1996. Petroleum Hydrocarbon Bioventing Kinetics Determined in Soil Core, Microcosm, and Tubing Cluster Studies. *Groundwater Monitoring and Remediation* 16(1):141-153.

Ostendorf, D.W., E.S. Hinlein, A.J. Lutenegger, and S.P. Kelley. 2000. Soil Gas Transport Above a Jet Fuel/Solvent Spill at Plattsburgh Air Force Base. *Water Resources Research* 36(9): 2531-2547.

Ostendorf, D.W., and D.H. Kampbell. 1991. Biodegradation of Hydrocarbon Vapors in the Unsaturated Zone. *Water Resources Research* 27(4):453-462.

Patterson, B.M., and G.B. Davis. 2009. Quantification of Vapor Intrusion Pathways into a Slab-on-Ground Building under Varying Environmental Conditions. *Environmental Science and Technology* 43(3):650-656.

Phelps, C.D., and L.Y. Young. 1999. Anaerobic Biodegradation of BTEX and Gasoline in Various Aquatic Sediments. *Biodegradation* 10(1):15-25.

Ririe, T., and R. Sweeney. 1995. Fate and Transport of Volatile Hydrocarbons in the Vadose Zone. In: *Proceedings of the 1995 Petroleum Hydrocarbon and Organic Chemicals in Groundwater Conference*, American Petroleum Institute and the National Ground Water Association, Houston, Texas, pp. 529-542.

Ririe, T., R. Sweeney, S. Daughery, and P. Peuron. 1998. A Vapor Transport Model that is Consistent with Field and Laboratory Data. In: *Proceedings of the 1998 Petroleum Hydrocarbon and Organic Chemicals in Groundwater Conference*, American Petroleum Institute and the National Ground Water Association, Houston, Texas.

Riser-Roberts, E. 1992. *Bioremediation of Petroleum Contaminated Sites*. Florida: CRC Press, Inc.

Roggemans, S., C.L. Bruce, and P.C. Johnson. 2002. *Vadose Zone Natural Attenuation of Hydrocarbon Vapors: An Empirical Assessment of Soil Gas Vertical Profile Data.* API Technical Bulletin No. 15. American Petroleum Institute, Washington, D.C. *http://www.api.org/environment-health-and-safety/clean-water/ground-water/vapor-intrusion/vi-publications/attenuation-hydrocarbon-vapors*

Sanders, P.F., and I. Hers. 2006. Vapor Intrusion into Homes over Gasoline-Contaminated Ground Water in Stafford, New Jersey. *Groundwater Monitoring and Remediation* 26(1):63-72.

Siddique, T., P.M. Fedorak, M.D. Mackinnon, and J.M. Foght. 2007. Metabolism of BTEX and Naphtha Compounds to Methane in Oil Sands Tailings. *Environmental Science and Technology* 41(7):2350-2356.

Tillman, F. and J. Weaver. 2007. Temporal Moisture Content Variability Beneath and External to a Building and the Potential Effects on Vapor Intrusion Risk Assessment. *Science of the Total Environment* 379:1-15.

Wang, X. and M.A. Deshusses. 2007. Biotreatment of Groundwater Contaminated with MTBE: Interaction of Common Environmental Co-Contaminants. *Biodegradation* 18(1):37-50.

Widdel, F., A. Boetius, and R. Rabus. 2006. Anaerobic Biodegradation of Hydrocarbons Including Methane. *Prokaryotes* 2:1028-1049.

Wilson, J.T., L.E. Leach, M. Henson, and J.N. Jones. 1986. In Situ Biorestoration as a Ground Water Remediation Technique. *Ground Water Monitoring Review* 6(4):56-64.

ZoBell, C.E. 1946. Action of Microorganisms on Hydrocarbons. *Bacteriological Reviews* 10(1-2): 1-49.

Zwick, T.C., A. Leeson, R.E. Hinchee, L. Hoeppel, and L. Bowling. 1995. Soil Moisture Effects During Bioventing in Fuel-Contaminated Arid Soils. Third International In-Situ and On-Site Bioreclamation Symposium. In-Situ Aeration, v. 3, Battelle Press, San Diego, California.

10. Non-PHC Fuel Additives

Description

Petroleum fuels are comprised of hundreds of compounds; both natural components of petroleum as well as a number of synthetic (non-PHC) additives intended to improve certain performance properties of the fuel. Contaminants other than PHCs may be present at a site as the result of releases of petroleum fuels that contain additives, including alcohols (e.g., ethanol and tertiary-butyl alcohol [TBA]), ethers (e.g., MTBE), organic lead (e.g., the tetraalkyl lead compounds: tetraethyl lead [TEL], and tetramethyl lead [TML]), and lead scavengers (e.g., ethylene dibromide [EDB] and 1,2-dichloroethane [1,2-DCA]).[39] Non-petroleum contaminants may also be from releases of substances (e.g., chlorinated solvents) other than petroleum fuels. Their presence may be from prior uses of the site or as the result of migration from an off-site source (e.g., dry cleaner, chemical plant, landfill).[40]

Importance

When assessing the potential threat of vapor intrusion, the presence of non-PHC fuel additives may pose a variety of additional challenges. Depending on the class of additive, the challenges include:

- Uncertainty regarding the aerobic biodegradation rates of some additives as well as some that do not biodegrade aerobically (or do not biodegrade quickly enough) in the shallow subsurface
- Biodegradation of an additive such as ethanol that consumes oxygen that would otherwise be available for biodegradation of other PHCs and produces a VOC (methane), which may migrate into buildings and hasten the spread of PHC vapors
- Toxicity levels of some additives are below the detection limit of conventional analytical methods

[39] Although leaded gasoline, which also contains the lead scavengers EDB and 1,2-DCA, is no longer used for automotive fuel, it is still used for certain off-road applications such as automobile racing and in aviation fuel (Avgas). At these and older automotive fuel sites where leaded gasoline was released to the subsurface, lead scavengers may be present and could represent a potential source of vapors that should be assessed. For more information about lead scavengers, see Appendix F in *Evaluation Of Empirical Data To Support Soil Vapor Intrusion Screening Criteria For Petroleum Hydrocarbon Compounds* (EPA, 2013).

[40] While these substances are not the primary focus of a petroleum UST release investigation (including site characterization and subsequent cleanup, if necessary), there is the possibility that their presence may be detected through the use of certain analytical methods for identification of contaminants in groundwater, soil, and vapor samples. In particular, both EPA methods 8260B (EPA, 1996a) and 8021B (EPA, 1996b) can detect a number of volatile chlorinated solvents that are not associated with petroleum fuels or typically stored in USTs. The Leaking Underground Storage Tank Trust Fund cannot be used to assess or cleanup contamination from non-UST and non-petroleum sources. Volatile chlorinated solvents (e.g., PCE, TCE, TCA, Carbon tetrachloride, Chloroform) also do not biodegrade under aerobic conditions, therefore their potential for vapor intrusion should instead be assessed using the *OSWER Final Guidance For Assessing and Mitigating the Vapor Intrusion Pathway From Subsurface Sources to Indoor Air* (OSWER Publication 9200.2-154)(EPA, 2015). Should any contaminants from non-UST sources be discovered at a leaking UST site, contact the appropriate state or federal implementing agency.

The separation distances described in this document (**Section 5**, Table 3, p.52) and the protectiveness provided by clean, biologically active soil against vapor intrusion by PHCs may be insufficient to protect against vapor intrusion by non-PHC fuel additives. Additional investigation should be conducted where certain additives are present. The following narrative provides additional information on several additives and introduces the Vapor Intrusion Screening Levels (VISL) Calculator, which may be particularly useful when investigating vapor intrusion from non-PHC fuel additives.

Although biodegradation is known to occur for many individual additives and classes of additives,[41] the rate of biodegradation in soil gas has not necessarily been rigorously quantified; this is especially true for the lead scavengers EDB and 1,2-DCA. Therefore, for these two chemicals in particular, vertical separation distances recommended in this guide may not be sufficient for petroleum fuel releases that contain EDB and 1,2-DCA and additional investigation may be necessary to assess their potential for vapor intrusion. Note: Though the use of ethers and lead scavengers in gasoline has been reduced or eliminated in recent years, these compounds may still be present at some older petroleum release sites (Weaver, et al., 2005, 2008, 2009; EPA, 2008).

Alternative fuels, especially those that contain higher percentages of ethanol present a challenge because ethanol readily biodegrades to create methane (Jewell and Wilson, 2011; Ma, et al., 2012 and 2014; Freitas, et al., 2010). The use of ethanol in motor fuels is increasing. Methane generation may be more significant at sites where large volumes of ethanol-blended gasoline (and higher ethanol content fuels, greater than E-20) have been released into the subsurface (Ma et al., 2014). Methane production can increase soil gas pressures and may result in advective soil gas flow toward receptors. In such situations, intrusion of methane into confined spaces may result in the accumulation of very high concentrations creating a risk of fire and explosion. In addition, methane also biodegrades under aerobic conditions and depletes oxygen that otherwise could be available for the biodegradation of PHCs. The depletion of oxygen may result in PHC vapors being transported farther than they otherwise would be, possibly increasing the threat of PVI.

[41] Aerobic biodegradation has been observed for the lead scavengers EDB (Prince and Douglas, 2010; Pignatello, 1986), and 1,2-DCA (Falta, 2004); the ethers MTBE (Prince and Douglas, 2010; Wang and Deshusses, 2007; Phelps and Young, 1999; Landmeyer and Bradley, 2003; Landmeyer, et al., 2010; Bradley and Landmeyer, 2006; Kuder, 2005; Lesser, et al., 2008; Baehr, Charles, and Baker, 2001) and Tertiary-amyl methyl ether (TAME) (Landmeyer, et al., 2010); the alcohols Ethanol (Powers, et al., 2001; Corseuil et. al, 1998), TBA (Wang and Deshusses, 2007; Landmeyer, et al., 2010), and Methanol (Powers, et al., 2001); and some organic lead compounds (Prince and Douglas, 2010; Gallert and Winter, 2004). Although anaerobic biodegradation is slower than aerobic biodegradation, anaerobic biodegradation may be a significant mechanism for destruction of non-PHCs fuel additives (and PHCs, especially in source areas.) Selected references on anaerobic biodegradation of various non-PHC fuel additives are listed under *Additional Information* at the end of this section.

Thus, separation distances that are usually protective against PVI may not be sufficiently protective in situations where methane is produced in large quantity (Ma et al., 2014). For additional information on sampling for the presence of methane, assessing potential risks, and how to manage the risks, see ASTM's "*New Practice for Evaluating Potential Hazard Due to Methane in the Vadose Zone*".[42]

Finally, in addition to the uncertainties regarding the rates of biodegradation of the lead scavengers EDB and 1,2-DCA,existing analytical methods are not able to detect them at very low concentrations representative of a cancer risk level of 1E-06. However, EPA (2013) suggests that although there are no soil gas data for lead scavengers in the PVI database, "a screening approach is feasible where groundwater concentrations are measured to determine the potential for vapor intrusion risks from EDB and 1,2-DCA." (see Section F.6). This approach is illustrated in the *Assessment* subsection through a sequence of equations and detailed discussion of the results for EDB and 1,2-DCA.

Assessment

Federal UST regulations (40 CFR 280.52(b)) stipulate that when conducting an investigation of a release from a regulated UST, investigators "must measure for the presence of a release where contamination is most likely to be present. In selecting sample types, sample locations, and measurement methods investigators must consider the nature of the stored substance, the type of initial alarm or cause for suspicion, the type of backfill, the depth of groundwater, and other factors appropriate for identifying the presence and source of release". Results of this sampling should also identify which contaminants should be assessed for potential vapor intrusion.

Once the candidate contaminants have been identified, the next step is to determine the target indoor air screening level for each of them. While the federal UST program does not prescribe human health values for contaminants, implementing authorities should use exposure values appropriate for the contaminants present and the characteristics of exposure (e.g., residential vs industrial). EPA provides a source of such exposure values in the Vapor Intrusion Screening Levels (VISL) Calculator. [43] VISLs for human health protection are generally recommended, medium-specific, risk-based screening-level concentrations intended for use in identifying areas or buildings that may warrant further investigation and mitigation as appropriate.

These VISLs are calculated and documented in the VISL Calculator and are based on:

---

[42] The new ASTM methane guide is accessible at *http://www.astm.org/DATABASE.CART/WORKITEMS/WK32621.htm*

[43]The VISL Calculator provides recommended, but not mandatory, screening levels for use in evaluating the vapor intrusion pathway at Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Resource Conservation and Recovery Act (RCRA) sites. The user's guide for the VISL Calculator provides additional information about derivation of the indoor air and subsurface screening levels (EPA, 2014a). Both the VISL Calculator (EPA, 2014b) and user's guide may be downloaded from EPA's website: *http://www.epa.gov/oswer/vaporintrusion/guidance.html*.

Current toxicity values selected considering OSWER's hierarchy of sources for toxicity values (EPA, 2003)[44]

- Physical-chemical parameters for vapor forming chemicals
- EPA recommended approaches for human health risk assessment

The VISLs include target indoor air screening levels for long-term (i.e., chronic) exposures that consider the potential for cancer and non-cancer effects of vapor-forming chemicals. The VISLs also include subsurface screening levels for comparison to sampling results for sub-slab soil gas, "near-source" soil gas, and groundwater. These subsurface screening levels are back-calculated from the target indoor air screening levels for chronic exposures using medium-specific, generic attenuation factors that reflect generally reasonable worst-case conditions (EPA, 2015, Appendix B). VISLs are not automatically response action levels, although EPA recommends that similar calculation algorithms be employed to derive cleanup levels (see EPA, 2015, Section 7.6 for more information).

The VISL Calculator allows users to specify an exposure scenario, target risk for carcinogens (TCR) and target hazard for non-carcinogens (THQ), and the average groundwater temperature at a site, and calculates screening levels for the target indoor air concentration, sub slab and exterior soil gas concentrations, and ground water concentration.

In the VISL Calculator, target indoor air concentrations are calculated using the equations presented in **Table 4**. For carcinogens, the inhalation unit risk (IUR) is the appropriate toxicity value. For non-carcinogens, the reference concentration (RfC) is the appropriate toxicity value. Each of these toxicity values is weighted by the appropriate exposure factors to determine the target indoor air screening concentrations. The smaller value (between $C_{ia,c}$ and $C_{ia,nc}$) is used as the target indoor air screening value.

Example calculations using the equations in **Table 4** are presented in **Table 5** for EDB and 1,2-DCA in indoor air under a residential exposure scenario. Note that the cancer screening levels ($C_{ia,c}$) are consistently lower than the non-cancer screening levels ($C_{ia,\ nc}$), thus the cancer screening levels would generally be used to assess risk to receptors for a given chemical.

[44] OSWER's toxicity data hierarchy is three-tiered. Tier 1 are values from EPA's Integrated Risk Information System (IRIS). The IRIS database is web accessible at *http://www.epa.gov/iris/*. Tier 2 are Provisional Peer Reviewed Toxicity Values (PPRTVs), which are accessible at *http://hhpprtv.ornl.gov/*. Tier 3 are "Other"sources, such as the Agency for Toxic Substances and Disease Registry (ATSDR), and various states (e.g., California (CA DTSC, 2009), Hawai'i (HI DOH, 2011, 2012), Massachusetts (MA DEP, 2009), New Jersey (NJ DEP, 2013), Washington (WA DEC, 2006). Links to these sources are provided under *References Cited* at the end of this section.) EPA's Regional Screening Levels (RSLs) for Superfund Sites compiles available toxicity information based on this hierarchy. The VISL Calculator draws on these RSL tables for toxicity values that are used to calculate VISLs. RSLs are accessible at *http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm*.

Table 4. Equations For Target Indoor Air Screening Concentrations For Volatile Chemicals

Cancer	$C_{ia,c} = \frac{TCR \cdot ATc \cdot 365\ (days/year) \cdot 24(hours/day)}{EF \cdot ED \cdot ET \cdot IUR}$
Non-Cancer	$C_{ia,nc} = \frac{THQ \cdot RfC \cdot ATnc \cdot 365 \cdot 24 \cdot 1000(ug/mg)}{EF \cdot ED \cdot ET}$
$C_{ia,c}$ is the indoor air concentration for cancer risk, and $C_{ia,nc}$ is the indoor air concentration for non-cancer risk; the smaller value is used as the indoor air screening value. ATc and ATnc are the averaging times for cancer and non-cancer, respectively, and EF, ED and ET are exposure parameters (exposure frequency, duration, and time). The exposure factors should be consistent with those in Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors OSWER Directive 9200.1-120 *http://www.epa.gov/oswer/riskassessment/pdf/superfund-hh-exposure/OSWER-Directive-9200-1-120-ExposureFactors.pdf*	

Table 5. Example Target Residential Indoor Air Concentrations For EDB And 1,2-DCA

Chemical	**$C_{ia,c}$** ($\mu g/m^3$)	**$C_{ia,nc}$** ($\mu g/m^3$)
1,2-Dibromoethane (EDB)	4.7E-03	9.4
1,2-Dichloroethane (1,2-DCA)	1.1E-1	7.3

Values (and units) of other variables used in these example residential calculations (equations in **Table 4**) are:

Variable	Cancer (c)	Non-Cancer (nc)
IUR(c) or RfC(nc) (EDB)	6.0E-04 $(\mu g/m^3)^{-1}$	9 (mg/m^3)
IUR(c) or RfC(nc) (1,2-DCA)	2.6E-05 $(\mu g/m^3)^{-1}$	7 (mg/m^3)
TCR(c) or THQ(nc) (unitless)	10^{-6}	1.0
ATc or ATnc (years)	70	26
ED (years)	26	26
EF (days/year)	350	350
ET (hours/day)	24	24

After target indoor air screening levels (C_{ia}) have been established, the next step is to determine vapor source concentrations and assess whether these are high enough to potentially pose a threat of vapor intrusion. The equations in **Table 6** are used by the VISL Calculator to calculate groundwater and soil gas screening levels based on target indoor air screening levels. These groundwater and soil gas screening levels can then be compared to actual field measurements of groundwater and/or soil gas concentrations. If the measured concentrations are greater than the screening levels, then there is a potential for vapor intrusion, otherwise not.[45]

Table 6. Equations For Groundwater And Soil Gas Screening Levels Based On Target Indoor Air Screening Levels.

Ground Water Concentration	$C_{gw} = \frac{C_{ia}}{\alpha_{gw} \cdot 1000 \cdot HLC}$
Soil Gas Concentration	$C_{sg} = \frac{C_{ia}}{\alpha_{sg}}$

C_{ia} is the target indoor air screening level concentration (µg/m^3).
Cgw is the screening concentration in groundwater (µg/L).
Csg is the screening concentration in soil gas (µg/m^3).
HLC is the unitless Henry's Law constant.
α_{gw} and α_{sg} are the groundwater and soil gas vapor intrusion attenuation factors, respectively (both unitless).
1,000 is the number of liters per m^3 (to convert from units of µg/m^3 to µg/L).

[45] An individual subsurface sampling result that exceeds the respective, chronic screening level does not establish that vapor intrusion will pose an unacceptable human health risk to building occupants. Conversely, these generic, single-chemical VISLs do not account for the cumulative effect of all vapor-forming chemicals that may be present. Thus, if multiple chemicals that have a common, non-cancer toxic effect are present, a significant health threat may exist at a specific building or site even if none of the individual substances exceeds its VISL (see discussion of non-cancer hazard index in EPA (2015) Section 7.4.1).

These equations also may be rearranged to calculate a potential upper-bound indoor air screening concentration based on actual field measurements of groundwater and/or soil gas concentrations. For groundwater, the equation is rearranged like this:

$$(upper\ bound)C_{ia} = C_{gw} \cdot \alpha_{gw} \cdot 1000 \cdot HLC$$

Note that in order to calculate a screening level concentration in groundwater, a value for Henry's Law constant (HLC) is necessary.[46]

For soil gas the equation is rearranged like this:

$$(upper\ bound)C_{ia} = C_{sg} \cdot \alpha_{sg}$$

Appropriate values for the field measured concentration in groundwater or soil gas, and for the respective attenuation factors are plugged into the equation to yield an upper bound indoor air screening level for C_{ia}. The respective upper-bound indoor air screening level (derived from either groundwater or soil gas sampling data) is then compared to the target indoor air screening concentration (C_{ia}) from the VISL Calculator. If the upper-bound value is greater than the target value, then there is a potential for vapor intrusion, otherwise not (see Footnote #45).

In both cases, if there is a potential for vapor intrusion and where contamination is not in direct contact with an overlying building, then paired vapor samples should be collected to assess vapor attenuation. These paired samples should either be (a) near-slab (exterior) shallow soil gas samples paired with deep (source) soil gas samples, or (b) indoor air samples paired with sub-slab soil gas samples.

Table 7 presents example screening concentrations of EDB and 1,2-DCA in groundwater and soil gas using the equations in **Table 6**. These values represent the upper-bound concentrations according to Henry's Law that could be present in groundwater and soil gas, respectively, and not result in indoor air concentrations in excess of the target screening levels (i.e., VISLs) presented in **Table 5**. If concentrations measured in groundwater (C_{gw}) exceed these thresholds, it is possible that the target indoor air concentration will also be exceeded and mitigation may be necessary.

[46] The VISL Calculator is one source of Henry's Law constants. Because these constants are temperature dependent, the VISL Calculator automatically calculates the correct constant based on a temperature that is selected by the user.

Table 7. Example Screening Concentrations For EDB And 1,2-DCA In Groundwater And Soil Gas

Chemical	C_{gw} (µg/L)	C_{sg} (µg/m^3)
1,2-Dibromoethane (EDB)	0.18	.16
1,2-Dichloroethane (1,2-DCA)	2.2	3.7
Target residential indoor air concentrations ($C_{ia,c}$) are from **Table 5**. Selected attenuation factors (α) are 0.001 for groundwater and 0.03 for soil gas. These are taken from the VISL Calculator and do not account for biodegradation. Dimensionless Henry's Law constants (HLC) for groundwater at 25°C are 0.0266 for EDB and 0.048 for 1,-DCA. These values are also taken from the current version of the VISL Calculator.		

The lead scavengers present an additional challenge in that existing analytical methodology is not able to detect them at very low concentrations representative of a cancer risk level of 1E-06 for either EDB or 1,2-DCA. As shown in **Table 8**, Selective Ion Monitoring (SIM) is able to achieve a detection limit representative of the 1.0E-04 risk level for EDB and 1.0E-05 for 1,2-DCA. Commercial low level is able to achieve a detection limit representative of the 1.0E-05 risk level for 1,2-DCA. However, an analytical detection limit does not impact the risk level for a certain chemical. The chemical may be present at a concentration greater than the appropriate risk level concentration, but below the limit of detection, which may result in undetected risk to potential receptors. Approaches to compensate for such analytical limitations include using available modeling data and professional judgment to evaluate whether the chemical may be present and having samples reanalyzed by special analytical services. For the screening level assessment, the chemical should be carried through assuming that it is present at the concentration equivalent to the quantitation limit. This allows the risk at the quantitation limit to be compared to the risks associated with other chemicals at the site. At minimum, the chemical should be addressed qualitatively. These topics are beyond the scope of this PVI guide; additional information may found in EPA's *Risk Assessment Guidance for Superfund* (RAGS).[47]

[47] The *Risk Assessment Guidance for Superfund (RAGS)* document is accessible at http://www.epa.gov/oswer/riskassessment/ragsa/index.htm. In particular see Section 5.3 in Part A, and Part F: Supplemental Guidance for Inhalation Risk Assessment.

Table 8. Comparison Of Risk Levels And Achievable Analytical Detection Limits For The Lead Scavengers EDB And 1,2-DCA In Indoor Air.

Compound	Target Indoor Air Concentration			Analytical Method		
	Risk Level 1.0E-04	Risk Level 1.0E-05	Risk Level 1.0E-06	Commercial conventional	Commercial low level	Commercial SIM
EDB	0.47	0.047	0.0047	3.8	0.77	0.23
1,2-DCA	11	1.1	0.11	2.0	0.40	0.12

NOTE: all values in µg/m^3
1.0E-04 = increased lifetime cancer risk of 1 per 10,000
1.0E-05 = increased lifetime cancer risk of 1 per 100,000
1.0E-06 = increased lifetime cancer risk of 1 per 1,000,000
Commercial conventional = EPA Method TO-15 (see *http://www.epa.gov/ttn/amtic/files/ambient/airtox/to-15r.pdf*)
Commercial low level = EPA Method TO-15 (modified)
SIM = Selective Ion Monitoring
The achievable detection limits in this table are representative of the general state of the technology as of the present date. Some laboratories may be able to achieve lower detection limits using modified techniques. Future technological improvements may also result in lower detection limits.
Achievable
Not Achievable

Special Considerations

VISL Calculator screening levels do not include the effects of biodegradation on the concentrations of vapors in soil that could potentially intrude into indoor air. The generic attenuation factors used in calculating VISLs (i.e., 0.001 for groundwater, 0.03 for soil gas) are conservative, and may overestimate the transfer of some contaminants (e.g., those that biodegrade aerobically) from soil gas to indoor air in some buildings. As a result these screening levels will usually overestimate the true indoor air concentrations of aerobically-biodegradable volatile contaminants (e.g., PHCs). Decision-makers may choose to use alternate approaches (e.g., attenuation factors that account for biodegradation) that may be more appropriate for specific sites where circumstances do not match the underlying assumptions used in calculating the VISLs.

When Information is available on the separation distance between the source of contamination and the receptor, on the total concentration of biodegradable compounds in soil gas, and on the rate constant for degradation of contaminant vapors in soil, it is possible to refine the estimate of the attenuation factor (α) between soil gas and indoor air for some VOCs and PHCs. Approaches to refine the estimate of the attenuation factor (α) for PHCs are discussed in **Section 12** (p.100) and by Wilson et al. (2014). Also see **Section 13** (p.106) for information on the use of models to estimate attenuation factors. However, until more is known about the rates of biodegradation of EDB and 1,2-DCA in soil gas, the separation distances for PHCs shown in Section 5 and the approaches described in **Section 12** or **Section 13** for determining attenuation factors are not recommended for these two contaminants.

In addition to concerns discussed earlier, other potential concerns with increasing ethanol content are in relation to (re)mobilization of LNAPL (McDowell, et al., 2003; Yu, et al., 2009) and increased solubility of PHCs (Powers, et al., 2001). The implications of these impacts may extend beyond vapor intrusion; see **Section 7** (p.61) for information about LNAPL and **Section 6** (p.57) for information about dissolved contaminant plumes.

Recommendation

EPA recommends that groundwater samples be analyzed for PHCs and non-PHC fuel additives (e.g., alcohols, ethers, organic lead, lead scavengers) typically found in petroleum-based fuels, when appropriate. At the present level of knowledge, the groundwater and soil gas screening levels in **Table 7** are the best values to use to determine whether indoor air target levels will be exceeded for EDB and 1,2-DCA. If measured concentrations of EDB and 1,2-DCA in groundwater exceed the screening levels in **Table 7**, EPA recommends gathering additional information and data to determine whether mitigation is appropriate. The methodology illustrated in the *Assessment* subsection above can be applied to any non-PHC (or any VOC for that matter) for which an appropriate toxicity value and attenuation factor are available.

References Cited

Agency for Toxic Substances and Disease Registry (ATSDR). 1999. *Toxicological Profile for Total Petroleum Hydrocarbons*. U.S. Department of Health and Human Services, Atlanta, GA. http://www.atsdr.cdc.gov/toxprofiles/tp123.pdf

ASTM International (ASTM). 2014. New Practice for Evaluating the Potential Hazard Due to Methane in the Vadose Zone. ASTM WK3221. West Conshohocken, Pennsylvania. http://www.astm.org/DATABASE.CART/WORKITEMS/WK32621.htm

Baehr, A.L., E.G. Charles, and R.J. Baker. 2001. Methyl Tert-Butyl Ether Degradation in the Unsaturated Zone and the Relation between MTBE in the Atmosphere and Shallow Groundwater. *Water Resources Research* 37(2):223-233.

Bradley, P.M., and J.E. Landmeyer. 2006. Low-Temperature MTBE Biodegradation in Aquifer Sediments with a History of Low, Seasonal Ground Water Temperatures. *Ground Water Monitoring and Remediation* 26(1):101-105.

California Department of Toxic Substances Control (CA DTSC). 2009. *Evaluating Human Health Risks from Total Petroleum Hydrocarbons.* Human and Ecological Risk Division, Sacramento, CA. http://www.oehha.ca.gov/risk/chemicalDB/index.asp

Corseuil, H.X., C. Hunt, R. dos Santos Ferreira, and P.J.J. Alvarez. 1998. The Influence of the Gasoline Oxygenate Ethanol on Aerobic and Anaerobic BTX Biodegradation. *Water Research* 32(7):2065-2072.

EPA. 1996a. Method 8021B: Aromatic and Halogenated Volatiles by Gas Chromatography using Photoionization and/or Electrolytic Conductivity Detectors. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.* EPA publication SW-846. http://www.epa.gov/wastes/hazard/testmethods/sw846/pdfs/8021b.pdf

EPA. 1996b. Method 8260B: Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS). *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.* EPA publication SW-846. http://www.epa.gov/wastes/hazard/testmethods/sw846/pdfs/8260b.pdf

EPA. 2003. Human Health Toxicity Values in Superfund Risk Assessments. OSWER Directive 9285.7-53. Office of Solid Waste and Emergency Response. http://www.epa.gov/oswer/riskassessment/pdf/hhmemo.pdf

EPA. 2006. Lead Scavengers Compendium: Overview Of Properties, Occurrence, And Remedial Technologies. http://www.epa.gov/oust/cat/pbcompnd.htm

EPA. 2008. Natural Attenuation of the Lead Scavengers 1,2-Dibromoethane (EDB) and 1,2-Dichloroethane (1,2-DCA) at Motor Fuel Release Sites and Implications for Risk Management (EPA 600/R-08/107). http://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1002UTI.PDF

EPA. 2009. Provisional Peer-Reviewed Toxicity Values for Complex Mixtures of Aliphatic and Aromatic Hydrocarbons (CASRN Various) FINAL 9-30-2009. Superfund Health Risk Technical Support Center, National Center for Environmental Assessment, Office of Research and Development. http://hhpprtv.ornl.gov/issue_papers/ComplexMixturesofAliphaticandAromaticHydrocarbons.pdf

EPA. 2011. Exposure Factors Handbook: 2011 Edition. Office of Research and Development. National Center for Environmental Assessment. http://www.epa.gov/ncea/efh/pdfs/efh-complete.pdf)

EPA. 2013. *Evaluation Of Empirical Data To Support Soil Vapor Intrusion Screening Criteria For Petroleum Hydrocarbon Compounds* (EPA 510-R-13-001). http://www.epa.gov/oust/cat/pvi/PVI_Database_Report.pdf

EPA. 2014a. *Vapor Intrusion Screening Level (VISL) Calculator: User's Guide*. Office of Solid Waste and Emergency Response. http://www.epa.gov/oswer/vaporintrusion/documents/VISL-UsersGuide.pdf

EPA. 2014b. *Vapor Intrusion Screening Level (VISL) Calculator*. Office of Solid Waste and Emergency Response. http://www.epa.gov/oswer/vaporintrusion/documents/VISL-Calculator.xlsm

EPA. 2015. *OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway From Subsurface Sources To Indoor Air* (OSWER Publication 9200.2-154). Office of Solid Waste and Emergency Response. http://www.epa.gov/oswer/vaporintrusion/

Falta, R.W. 2004. The Potential for Ground Water Contamination by the Gasoline Lead Scavengers Ethylene Dibromide and 1,2-Dichloroethane. *Ground Water Monitoring and Remediation* 24(3):76-87.

Freitas, J.G., B. Fletcher, R. Aravena, and J.F. Barker. 2010. Methane Production and Isotopic Fingerprinting in Ethanol Fuel Contaminated Sites. *Ground Water* 48(6):844-857.

Gallert, C. and J. Winter. 2004. Degradation of Alkyllead Compounds to Inorganic Lead in Contaminated Soil. *Water Research* 38(19):4204-4212.

Hawai'i Department of Health (HI DOH). 2008. *Screening for Environmental Hazards at Sites with Contaminated Soil and Groundwater*. Office of Hazard Evaluation and Emergency Response: Honolulu, HI. http://eha-web.doh.hawaii.gov/eha-cma/Leaders/HEER/environmental-hazard-evaluation-and-environmental-action-levels

Hawai'i Department of Health (HI DOH). 2012. *Field Investigation of the Chemistry and Toxicity of TPH in Petroleum Vapors: Implications for Potential Vapor Intrusion Hazards*. Office of Hazard Evaluation and Emergency Response: Honolulu, HI. http://www.hawaiidoh.org/tgm.aspx

Jewell, K.P. and J.T. Wilson. 2011. A New Screening Method for Methane in Soil Gas Using Existing Groundwater Monitoring Wells. *Ground Water Monitoring and Remediation* 31(3):82-94.

Kuder, T., J.T. Wilson, P. Kaiser, R. Kolhatkar, P. Philp, and J. Allen. 2005. Enrichment of Stable Carbon and Hydrogen Isotopes during Anaerobic Biodegradation of MTBE: Microcosm and Field Evidence. *Environmental Science and Technology* 39(1):213-220.

Landmeyer, J.E., and P.M. Bradley. 2003. Effect of Hydrologic and Geochemical Conditions on Oxygen-Enhanced Bioremediation in a Gasoline-Contaminated Aquifer. *Bioremediation Journal* 7(3-4):165-177.

Landmeyer, J.E., P.M. Bradley, D.A. Trego, K.G. Hale, and J.E. Haas, II. 2010. MTBE, TBA, and TAME Attenuation in Diverse Hyporheic Zones. *Ground Water* 48(1):30-41.

Lesser, L. E., P.C. Johnson, R. Aravena, G.E. Spinnler, C.L. Bruce, and J.P. Salanitro. 2008. An Evaluation of Compound-Specific Isotope Analyses for Assessing the Biodegradation of MTBE at Port Hueneme, California. *Environmental Science and Technology* 42(17):6637−6643.

Ma, J. W.G. Rixey, G.E. DeVaull, B.P. Stafford, and P.J. J. Alvarez. 2012. Methane Bioattenuation and Implications for Explosion Risk Reduction along the Groundwater to Soil Surface Pathway above a Plume of Dissolved Ethanol. *Environmental Science & Technology* 46(11):6013-6019.

Ma, J., H. Luo, G.E. DeVaull, W.G. Rixey, and P.J. J. Alvarez. 2014. Numerical Model Investigation for Potential Methane Explosion and Benzene Vapor Intrusion Associated with High-Ethanol Blend Releases. *Environmental Science & Technology* 48(1):474-481.

Massachusetts Department of Environmental Protection (MA DEP). 2003. *Updated Petroleum Hydrocarbon Fraction Toxicity Values for the VPH/EPH/EPH Methodology.* Bureau of Waste Site Cleanup, Boston, MA. http://www.mass.gov/eea/docs/dep/cleanup/laws/tphtox03.pdf

McDowell, C.J., T. Buscheck, and S.E. Powers. 2003. Behaviour of Gasoline Pools Following a Denatured Ethanol Spill. *Ground Water* 41(6):746-757.

New Jersey Department of Environmental Protection (NJ DEP). 2013. Vapor Intrusion Technical Guidance. Version 3.1. Site Remediation Division. March. http://www.nj.gov/dep/srp/guidance/vaporintrusion/vig_main.pdf

Phelps, C.D., and L.Y. Young. 1999. Anaerobic Biodegradation of BTEX and Gasoline in Various Aquatic Sediments. *Biodegradation* 10(1):15-25.

Pignatello, J.J. 1986. Ethylene Dibromide Mineralization in Soils under Aerobic Conditions. *Applied and Environmental Microbiology* 51(3):588-592.

Powers, S.E., C.S. Hunt, S.E. Heermann, H.X. Corseuil, D. Rice, and P.J.J. Alvarez. 2001. The Transport and Fate of Ethanol and BTEX in Groundwater Contaminated by Gasohol. *Critical Reviews in Environmental Science and Technology* 31(1):79-123.

Prince, R.C. and G.S. Douglas. 2010. Remediation of Petrol and Diesel in Subsurface from Petrol Station Leaks, in Timmis, K.N. (ed) *Handbook of Hydrocarbon and Lipid Microbiology: Part 14*, Springer-Verlag, Berlin.

Wang, X. and M.A. Deshusses. 2007. Biotreatment of Groundwater Contaminated with MTBE: Interaction of Common Environmental Co-Contaminants. *Biodegradation* 18(1):37-50.

Washington Department of Ecology (WA DEC). 2006. *Cleanup Levels and Risk Calculations Focus Sheets: Reference Doses for Petroleum Mixtures.* Lacey, WA. https://fortress.wa.gov/ecy/clarc/FocusSheets/petroToxParameters.pdf

Weaver, J.W., L. Jordan and D.B. Hall. 2005. *Predicted Ground Water, Soil and Soil Gas Impacts from US Gasolines, 2004: First Analysis of the Autumnal Data* (EPA/600/R-05/032). United States Environmental Protection Agency, Washington, D.C. http://www.epa.gov/athens/publications/reports/Weaver600R05032PredictedGroundWater.pdf

Weaver, J.W., L.R. Exum, L.M. Prieto. 2008. *Gasoline Composition Regulations Affecting LUST Sites* (EPA/600/R-10/001). United States Environmental Protection Agency, Washington, D.C. http://www.epa.gov/athens/publications/reports/Weaver_EPA600R10001_Gasoline_Composition_Regulations_Affecting_LUST_Sites_final.pdf

Weaver, J.W., S. A. Skaggs, D.L. Spidle, and G.C. Stone. 2009. *Composition and Behavior of Fuel Ethanol* (EPA/600/R-09/037). United States Environmental Protection Agency, Washington, D.C. http://www.epa.gov/athens/publications/reports/Weaver_EPA600R09037_Composition_Fuel_Ethanol.pdf

Wilson, J.T., K. Jewell, C. Adair, C. Paul, C. Ruybal, G. DeVaull, and J. Weaver. 2014. *An Approach that Uses the Concentrations of Hydrocarbon Compounds in Soil Gas at the Source of Contamination to Evaluate the Potential for Intrusion of Petroleum Vapors into Buildings (PVI)*. (EPA/600/R-14/318). ORD Issue Paper, U.S. Environmental Protection Agency, Washington, DC. http://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=305910

Yu, S., J.G. Freitas, A.J.A. Unger, J.F. Barker, and J. Chatzis. 2009. Simulating the Evolution of an Ethanol and Gasoline Source Zone within the Capillary Fringe. *Journal of Contaminant Hydrology* 105(1-2):1-17.

Additional Information

Donaldson, C.B., J.F. Barker, and I. Chatzis. 1994. Subsurface Fate and Transport of a Methanol/Gasoline Blend (M85). Report prepared for the American Petroleum Institute, Washington D.C., Publication number 4569.

Eichler, B. and B. Schink. 1984. Oxidation of Primary Aliphatic Alcohols by *Acetobacterium carbinolicum* sp. nov., a Homoacetogenic Anaerobe. *Archives of Microbiology* 140(1-2):147-152.

Henderson, J. K., D.L. Freedman, R.W. Falta, T. Kuder, and J.T. Wilson. 2008. Anaerobic Biodegradation of Ethylene Dibromide and 1,2-Dichloroethane in the Presence of Fuel Hydrocarbons. *Environmental Science and Technology* 42(3):864-870.

Mormile, M.R., S. Liu, and J. Suflita. 1994. Anaerobic Biodegradation of Gasoline Oxygenates: Extrapolation of Information to Multiple Sites and Redox Conditions. *Environmental Science and Technology* 28(9):1727-1732.

Peargin, T. and R. Kolhatkar. 2011. Empirical Data Supporting Groundwater Benzene Concentration Exclusion Criteria for Petroleum Vapor Intrusion Investigations. *Proceedings of Battelle 8th International Symposium on Bioremediation and Sustainable Environmental Technologies*, Reno, Nevada, June 27-30.

Suflita, J.M. and M.R. Mormile. 1993. Anaerobic Biodegradation of Known and Potential Gasoline Oxygenates in the Terrestrial Subsurface. *Environmental Science and Technology* 27(6):976-978.

Vogel, T. M. and M. Reinhard. 1986. Reaction-Products and Rates of Disappearance of Simple Bromoalkanes, 1,2-Dibromopropane, and 1,2-Dibromoethane in Water. *Environmental Science and Technology* 20(10):992-997.

Widdel, F. 1986. Growth of Methanogenic Bacteria in Pure Culture with 2-Propanol and other Alcohols as Hydrogen Donors. *Applied Environmental Microbiology* 51(5):1056-1062.

11. Seasonal And Weather Effects

Description

The generation and movement of petroleum vapors are subject to seasonal effects such as temperature trends and fluctuations; and weather effects such as precipitation, barometric pressure changes, and wind (Lundegard, Johnson, and Dahlen, 2008). Cycling of heating and cooling systems inside buildings in response to seasonal and weather effects may also influence vapor intrusion.

Importance

Biological processes slow down with decreasing temperatures, though microorganisms continue to biodegrade PHCs at environmentally significant rates even when temperatures are near freezing (Bradley and Chapelle, 1995; Bradley, Richmond, and Chapelle, 2005; Hers, et al., 2011). Bradley and Landmeyer (2006) documented microbial degradation of MTBE in the wintertime when groundwater temperatures were below 5˚C.

There is conflicting evidence as to whether, and under what additional conditions, frozen or ice-covered soil reduces the movement of oxygen into the subsurface. Hers, et al. (2011) studied a residential site in Canada where subsurface oxygen readings taken throughout the winter did not indicate a decrease in oxygen content of soil gas and there was evidence that biodegradation was occurring. However, the residence was above a crawl space and the soil below the house was never covered by ice or snow. It is known that the air permeability of a snow layer is a complex function of pore size, grain size, ice fraction, and density (Armstrong, 2008; Bender, 1957; Conway and Abrahamson, 1984). Rike (2003) observed ongoing biodegradation in frozen arctic soils. In that study, a lengthy period of subfreezing soil temperatures at a petroleum contaminated site did not result in decreasing oxygen concentrations. In contrast, Freyman (1967) and Yanaia (2010) report that oxygen depletion has been observed in other studies of soils under ice sheets and snow cover. More study is needed to resolve this issue.

Precipitation events can impact biodegradation of petroleum vapors. A certain amount of soil moisture is necessary for microorganisms to live; not enough and they are not actively degrading PHC vapors; too much and reoxygenation is impeded, possibly leading to anaerobic conditions at greater depths (Silver, 1999; Ludemann, 2000; Pezeschki, 2001). Wind and barometric pressure changes can produce pressure gradients inside buildings. Negative pressure inside buildings can result in enhanced intrusion of PHC vapors. Positive pressure inside buildings can both prevent intrusion of PHC vapors into buildings and facilitate oxygen transport through cracks in the foundation into the subsurface. This can result in reoxygenation of the soil beneath the building that would otherwise be depleted of oxygen (Lundegard, Johnson, and Dahlen, 2008).

Heating systems in buildings, which operate most frequently during winter months, can create a chimney effect, whereby PHC vapors are pulled into buildings at much higher rates than they would ordinarily. Cooling systems, which operate only during summer months, can have the opposite effect, creating positive pressure gradients in basements that both prevent intrusion of PHC vapors into buildings and allow oxygen to enter the soil (Lundegard, Johnson, and Dahlen, 2008).

Assessment
Seasonal and weather conditions can influence the characteristics of PHC vapor migration over time. Data on temporal changes in temperature, barometric pressure, wind speed and direction, relative humidity, and precipitation can aid in correctly identifying trends and result in a more accurate CSM.

In addition, site characteristics that may indicate susceptibility to the effects of seasonal and weather factors should be assessed. These include:

- Poor drainage around the building indicated by flooded soils
- Area subject to permafrost/long lasting snow cover (based on altitude or latitude)
- Shallow and highly variable water table

Special Considerations
Seasonal effects may also influence the formation and migration of dissolved plumes and LNAPL. Changes in water table elevation can create a smear zone of residual LNAPL contamination. LNAPL in the smear zone can act as a long-term source of dissolved contamination during periods of high water table elevation and as a source of petroleum vapors during periods of low water table elevation when contaminants reemerge from a previously submerged condition. Groundwater levels in the vicinity of USTs may also be subject to the influence of water within the tank pit. After rainfall events (and potentially snowmelt) water levels within tank pits are typically above the level of ambient groundwater; consequently a groundwater recharge mound may form. This mound disrupts the local groundwater flow field and contaminants can migrate away from the tank excavation, potentially in all directions.

Recommendation
During site characterization activities, weather conditions such as temperature, barometric pressure, and wind speed/direction should be recorded to aid in recognizing the cause of trends or anomalies in the PVI data and not merely attributed to unknown factors. This information may be obtained from the National Oceanic and Atmospheric Administration (NOAA) (see *http://www.noaa.gov/wx.html*) or a nearby airport where weather data are recorded hourly.

References Cited

Armstrong, R.L., and E. Brun. 2008. *Snow and Climate: Physical Processes, Surface Energy Exchange and Modeling*. Cambridge University Press.

Bender, J.A. 1957. *Air Permeability of Snow*. Res. Rep. 37 Snow, Ice and Permafrost Research Establishment (US Army Corps of Engineers) Wilmette, Illinois p 46-62.

Bradley, P. M., and F. H. Chapelle. 1995. Rapid Toluene Mineralization by Aquifer Microorganisms at Adak, Alaska: Implications for Intrinsic Bioremediation in Cold Environments. *Environmental Science and Technology* 29(11):2778-2781.

Bradley, P.M., and J.E. Landmeyer. 2006. Low-Temperature MTBE Biodegradation in Aquifer Sediments with a History of Low, Seasonal Ground Water Temperatures. *Ground Water Monitoring and Remediation* 26(1):101-105.

Bradley, P. M., S. Richmond and F. H. Chapelle. 2005. Chloroethene Biodegradation in Sediments at 4˚C. *Applied Environmental Microbiology* 71(10):6414-6417.

Conway, H. and J. Abrahamson. 1985. Air Permeability as a Textural Indicator of Snow. *Journal of Glaciology* 30(106):328-333.

Freyman, S. 1967. *The Nature of Ice Sheet Injury to Forage Plants*. Ph.D. Thesis, University of British Columbia.
https://circle.ubc.ca/handle/2429/37752

Hers, I., Lahvis, M., Dahlen, P., Luo, E.H., DeVaull, G., and P. Johnson. 2011. *Cold Climate Vapor Intrusion Research Study – Results of Seasonal Monitoring of House at North Battleford, Saskatchewan*, in Proceedings 21st Annual International Conference on Soil, Water, Energy and Air and AEHS [Association for Environmental Health and Sciences] Foundation Annual Meeting, March 14-17, 2011, San Diego, California.

Lüdemann, H. I. Arth, and W. Liesack. 2000. Spatial Changes in the Bacterial Community Structure along a Vertical Oxygen Gradient in Flooded Paddy Soil Cores. *Applied Environmental Microbiology* 66(2):754-762.

Lundegard, P.D., P.C. Johnson, and P. Dahlen. 2008. Oxygen Transport from the Atmosphere to Soil Gas Beneath a Slab-on-Grade Foundation Overlying Petroleum-Impacted Soil. *Environmental Science and Technology* 42(15):5534–5540.

Luo, H., P. Dahlen, P.C. Johnson, T. Peargin, and T. Creamer. 2009. Spatial Variability of Soil-Gas Concentrations Near and beneath a Building Overlying Shallow Petroleum Hydrocarbon–Impacted Soils. *Ground Water Monitoring and Remediation* 29(1):81-91.

Pezeshki, S.R. 2001. Wetland Plant Responses to Soil Flooding. *Environmental and Experimental Botany* 46(3):299-312.

Rike, A.G., K.B. Haugen, M. Børresen, B. Engenec, P. Kolstad. 2003. In Situ Biodegradation of Petroleum Hydrocarbons in Frozen Arctic Soils. *Cold Regions Science and Technology* 37(2):97- 120.

Silver, W.L., A.E. Lugo, and M.Keller. 1999. Soil Oxygen Availability and Biogeochemistry Along Rainfall and Topographic Gradients in Upland Wet Tropical Forest Soils. *Biogeochemistry* 44(3):301-328.

Yanaia,Y. , T. Hirotab, Y. Iwataa, M. Nemotob, O. Nagatac, N. Kogaa. 2011. Accumulation of Nitrous Oxide and Depletion of Oxygen in Seasonally Frozen Soils in Northern Japan – Snow Cover Manipulation Experiments. *Soil Biology and Biochemistry* 43(9):1779-1786.

Additional Information

Hintenlang, E.E., and K.K Al-Ahmady. 1992. Pressure Differentials for Radon Entry Coupled to Periodic Atmospheric Pressure Differentials. *Indoor Air* 2:208-215.

Luo, H., and P.C. Johnson. 2011. Incorporating Barometric Pressure and Wind Effects into Vapor Intrusion Simulations. Association for Environmental Health and Sciences Conference, Petroleum Hydrocarbon Vapor Intrusion Session, March 16, San Diego, California.

Tillman, F. and J. Weaver. 2007. Temporal Moisture Content Variability Beneath and External to a Building and the Potential Effects on Vapor Intrusion Risk Assessment. *Science of the Total Environment* 379:1-15.

U.S. Geological Survey. 1998. *Assessment of the Potential for Biodegradation of Petroleum Hydrocarbons in the Railroad Industrial Area, Fairbanks, Alaska, 1993-1994.* Open-File Report 98-287. Fairbanks, Alaska. 10p. *http://pubs.usgs.gov/of/1998/0287/report.pdf*

Web Resources

U.S. Geological Survey's Soil Surveys
http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

U.S. Department of Homeland Security Federal Emergency Management Agency's flood plain maps *https://msc.fema.gov/portal*

2012 U.S. Department of Agriculture Plant Hardiness Zone Map
http://planthardiness.ars.usda.gov/PHZMWeb/

12. Vapor Intrusion Attenuation Factor (α)

Description

When Johnson and Ettinger (1991) published their vapor intrusion model they introduced a parameter to relate the vapor concentration of a volatile chemical inside a building to its vapor concentration at the subsurface source. The parameter, designated alpha (α), is also called the vapor intrusion attenuation factor. It is defined mathematically as the concentration in indoor air divided by the concentration in soil gas at the source (with concentrations in the same units). The source is defined as the region of highest vapor concentration in the vadose zone. Large values of α (i.e., values approaching one) indicate that little attenuation is taking place, whereas small values of α (i.e., values much smaller than one) indicate that significant attenuation is taking place.

Importance

As part of a risk evaluation, the concentrations of a chemical in indoor air can actually be measured, or they can be predicted. The attenuation factor is used as a part of a risk evaluation to predict or estimate the concentration of a chemical in indoor air from the concentration measured in soil gas below or near a building. To predict the indoor air concentration, the measured concentration in soil gas is multiplied by the suitable attenuation factor.

Assessment

U.S. EPA (2013, Table 6-1) provides recommended vapor attenuation factors for risk-based screening of the vapor intrusion pathway for residential buildings. For example, the generic values of α in EPA (2015) are 1.0E-03 (0.001) for groundwater, 3.0E-02 (0.03) for sub-slab soil gas, and 3.0E-02 (0.03) for deep (near-source) soil gas. These values of α are derived from measurements made during case studies of the vapor intrusion of chlorinated solvents such as trichloroethylene (TCE), which are not biologically degraded in aerobic unsaturated soil or sediment. Likewise, values for concentrations in indoor air that are derived from the model of Johnson and Ettinger (1991) also do not include any consideration of biodegradation. As a result, the generic values of α in U.S. EPA (2015) and values for indoor air that are calculated using the Johnson and Ettinger model (JEM) overestimate the indoor air concentrations of PHCs. Thus, these values of α are not applicable to PVI from leaking USTs.[48] For additional information on estimation of sub-slab attenuation factors, see Brewer et al. (2014).

To provide estimates of α that are more suitable for PHCs, Abreu, Ettinger, and McAlary (2009) developed a three-dimensional computer model to predict the effects of biodegradation in the unsaturated zone below a building on the concentrations of chemicals in the indoor air of the building. They performed a series of model simulations to estimate semi-generic values of α from site-specific information on the vertical separation distance between the receptor building

[48] Attenuation factors that account for biodegradation can be derived from models such as *BioVapor* or *PVIScreen* (see **Section 13**, p.106 for more information). Additional guidance may be found in Wilson *et al.* (2014).

and the source, and the total concentration of biodegradable compounds in soil gas at the source of the hydrocarbons. **Figure 9** compiles the computer simulations conducted by Abreu, Ettinger, and McAlary (2009) of the attenuation factor during vapor intrusion into a building with a basement. This figure presents the concentration of biologically degradable hydrocarbon in an unconventional unit (mg/L as benzene).

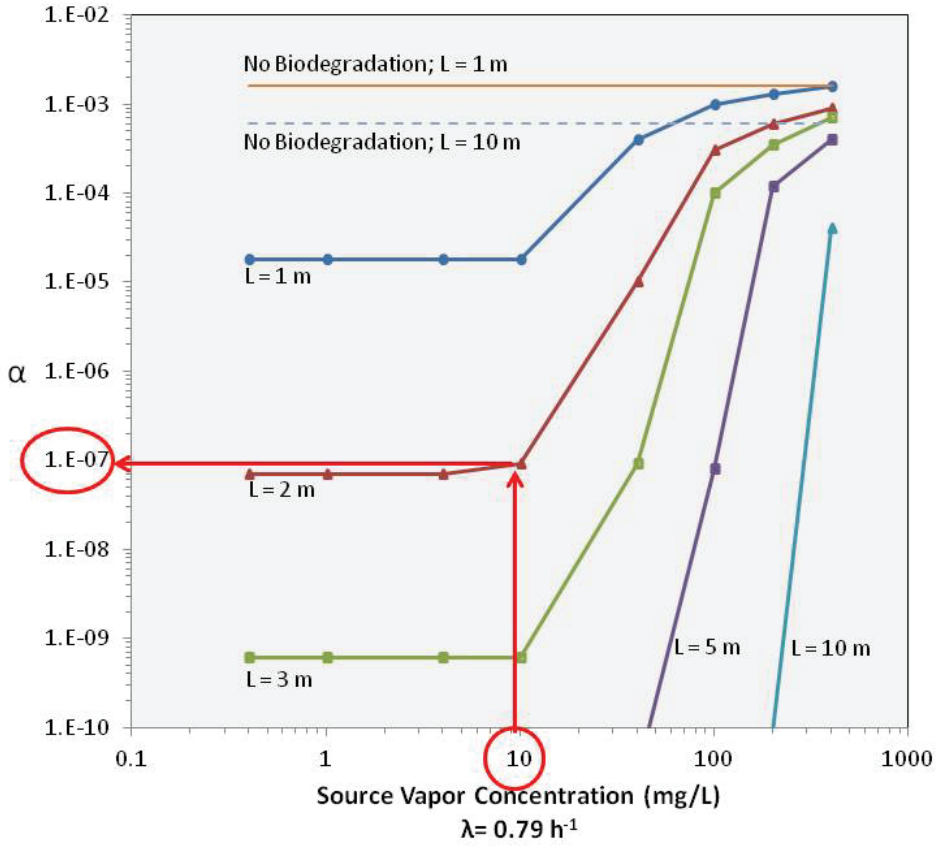


Figure 9. Relationship Between Source Vapor Concentration And Vapor Intrusion Attenuation Factor (α) As A Function Of Vertical Separation Depth Between Contaminant Source And Base Of Building (Receptor) (Source: modified from Abreu, Ettinger, and McAlary, 2009, Figure 7, page 114. Reprinted from *Groundwater Monitoring & Remediation* with permission of the National Ground Water Association. Copyright 2009.)

To generate **Figure 9**, Abreu, Ettinger, and McAlary (2009) used conservative assumptions for the rate of biodegradation. In this particular set of simulations, the first order rate constant for biodegradation (λ) was set at 0.79 h^{-1}, a reasonable average rate based on the range of rates published in the literature (DeVaull 2007). Model simulations assume the building has a basement and that it is surrounded by homogeneous, uniform sandy soil that is directly exposed to the atmosphere and that preferential pathways for vapor migration into the building or through the vadose zone are not present. As a result, the concentration of oxygen

in the soil gas in the topmost layer of exposed soil is the concentration of oxygen in the atmosphere. Compared to silty or clayey soils, sandy soils have more air filled porosity and as a result, vapors diffuse more rapidly through them (and they also allow more oxygen to diffuse from the atmosphere). The simulations assumed that the square building was 10 meters (33 feet) on each side.

Figure 9 can be used to estimate the value of α for situations where the total concentration of vapors at the source and the vertical separation distance between the contaminant source and the bottom of the building are known and all of the other input parameters match site conditions. For example, for a source vapor concentration of 10 mg/L and a vertical separation distance (L) of 2 meters (6.6 feet), the estimated value of α would be approximately 1.0E-07. To complete the exposure assessment, the measured concentration of benzene in soil gas at the source of contamination is multiplied by the value of α, to predict the indoor air concentration in a building.

Figure 10 is a redraft of **Figure 9**, where the source concentration of vapors is expressed in more conventional units for vapors in soil gas ($\mu g/m^3$). The oxygen demand of all the hydrocarbons that might be in soil gas is expressed as the concentration of TPH (gasoline) plus the concentration of methane. The concentration of TPH (gasoline) can be determined by modified EPA Method TO-15 (see *http://www.epa.gov/ttn/amtic/files/ambient/airtox/to-15r.pdf*) referenced to heptane. The concentration of methane can be determined as a fixed gas or by EPA Method 3C. The concentration of methane is multiplied by 1.136 to correct for the differences between the theoretical oxygen demand of methane and heptane.

Special Considerations

Figure 9 or **Figure 10** should only be used for UST sites with the same characteristics that were simulated by Abreu, Ettinger, and McAlary (2009). These conditions were relatively conservative. **Figure 9** and **Figure 10** are not appropriate for use at sites where the oxygen flux from the surface is impeded.

Some documents define the vapor intrusion attenuation factor differently than defined by Johnson and Ettinger (1991) and discussed in this section. The JEM (see **Section 13**, p.106) ignores background sources when estimating the indoor air concentration arising from vapor intrusion. When used in this PVI guide, the Greek letter alpha (α) refers strictly to attenuation during vapor intrusion, which might be observable if there were no background (ambient) vapor sources. In contrast, some empirical attenuation factors (sometimes designated *AF*) are based on indoor air concentrations that include both background sources and vapor concentrations that intrude into the building from a subsurface vapor source. Thus, when there is a measurable contribution from an ambient source, an attenuation factor such as *AF* (which includes the contribution of ambient sources) would be somewhat greater than the Johnson & Ettinger alpha (α), which would indicate less attenuation than is actually occurring.

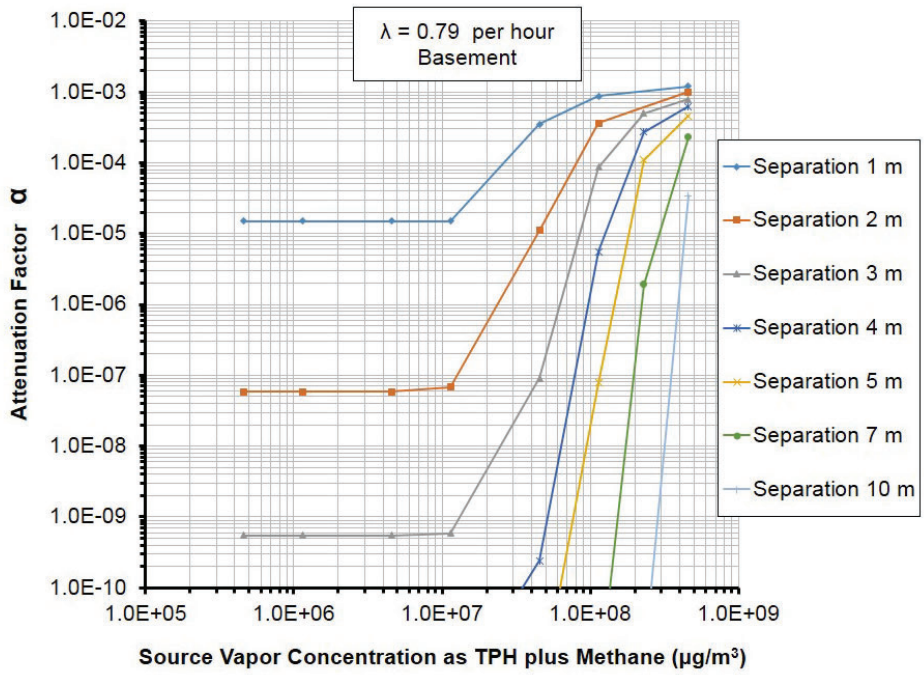


Figure 10. Rescaled Figure 9 That Expresses The Source Vapor Concentration In Conventional Units.

Recommendation

When evaluating the vapor source and attenuation of PHC vapors, paired vapor samples are required to measure the actual attenuation that occurs due to aerobic biodegradation. Where contamination is not in direct contact with an overlying building, choose one of two options: (1) collect near-slab (exterior) shallow soil gas samples paired with deep (source) soil gas samples, or (2) collect indoor air samples paired with sub-slab soil gas samples. Note that for option 2 if the measured concentration of vapor in indoor air is below the applicable allowable indoor concentration there is no need to measure sub-slab vapor concentration. If contamination is in direct contact with a building basement, foundation, or slab, it is necessary to collect indoor air samples as it will not be feasible to collect sub-slab vapor samples. If a generic vapor intrusion attenuation factor and the measured concentration of a PHC in shallow soil gas predict an acceptable concentration in indoor air, that prediction may be adequate to support a screening decision. However, generic attenuation factors may not be appropriately representative of conditions at a particular site.

Models may provide better estimates of α, but only if the actual conditions at a specific site match the assumptions of a particular model. For biodegradable PHCs it would be better to implement a transport and fate model that is designed to simulate the contribution of biodegradation. The three-dimensional models of Abreu, Ettinger, and McAlary (2009) and Verginelli and Baciocchi (2014) are potential options. BioVapor, a model developed by the American Petroleum Institute, is another option. U.S. EPA is developing a model called PVIScreen that is intended for this purpose. See **Section 13** (p.106) for more discussion of the appropriate use of computer models for PVI investigations.

References Cited

Abreu, L.D.V, R. Ettinger, and T. McAlary. 2009. Simulated Soil Vapor Intrusion Attenuation Factors Including Biodegradation for Petroleum Hydrocarbons. *Ground Water Monitoring and Remediation* 29(1): 105-117.

Brewer, R., J. Nagashima, M. Rigby, M. Schmidt, and H. O'Neill. (2014). Estimation of Generic Subslab Attenuation Factors for Vapor Intrusion Investigations. *Groundwater Monitoring & Remediation* 34(4):79–92.

DeVaull, G. 2007. Indoor Vapor Intrusion with Oxygen-Limited Biodegradation for a Subsurface Gasoline Source. *Environmental Science and Technology* 41(9):3241-3248.

EPA. 2015. *OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway From Subsurface Sources To Indoor Air* (OSWER Publication 9200.2-154). Office of Solid Waste and Emergency Response. *http://www.epa.gov/oswer/vaporintrusion/*

Johnson, P.C. and R.J. Ettinger. 1991. Heuristic Model for Predicting the Intrusion Rate of Contaminant Vapors into Buildings. *Environmental Science and Technology* 25(8):1445-1452.

Lahvis, M.A., Baehr, A.L., and R.J. Baker. 1999. Quantification of Aerobic-Biodegradation and Volatilization Rates of Gasoline Hydrocarbons Near the Water Table During Natural-Attenuation Conditions. *Water Resources Research* 35(3):753-765.

Verginelli, I. and R. Baciocchi. (2014). Vapor Intrusion Screening Model for the Evaluation of Risk-Based Vertical Exclusion Distances at Petroleum Contaminated Sites. *Environmental Science & Technology* 48:13263−13272.

Wilson, J.T., K. Jewell, C. Adair, C. Paul, C. Ruybal, G. DeVaull, and J. Weaver. 2014. *An Approach that Uses the Concentrations of Hydrocarbon Compounds in Soil Gas at the Source of Contamination to Evaluate the Potential for Intrusion of Petroleum Vapors into Buildings (PVI)*. (EPA/600/R-14/318). ORD Issue Paper, U.S. Environmental Protection Agency, Washington, DC. *http://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=305910*

Additional Information

Abreu, L.D., and P.C. Johnson. 2005. Effect of Vapor Source, Building Separation and Building Construction on Soil Vapor Intrusion as Studied with a Three-Dimensional Numerical Model. *Environmental Science & Technology* 3(12):4550-4561.

Abreu, L.D., and P.C. Johnson. 2006. Simulating the Effect of Aerobic Biodegradation on Soil Vapor Intrusion into Buildings: Influence of Degradation Rate, Source Concentrations. *Environmental Science & Technology* 40(7):2304-2315.

EPA. 2013. *3-D Modeling of Aerobic Biodegradation of Petroleum Vapors: Effect of Building Area Size on Oxygen Concentration Below the Slab* (EPA 510-R-13-002). *http://www.epa.gov/oust/cat/pvi/building-size-modeling.pdf*

Johnson, P., R.A. Ettinger, J. Kurtz, R. Bryan, and J.E. Kester. 2002. Migration of Soil Gas Vapors to Indoor Air: Determining Vapor Attenuation Factors Using a Screening-Level Model and Field Data from the CDOT-MTL Denver, Colorado Site. API Soil and Groundwater Research Bulletin No. 16. *http://www.api.org/environment-health-and-safety/clean-water/ground-water/vapor-intrusion/vi-publications/determining-vapor-attenuation-factors*

13. Computer Modeling Of Petroleum Vapor Intrusion

Description

A number of models have been developed and applied in estimating transport of volatile chemicals from subsurface soil and groundwater to indoor air (Bekele, et al. 2013). Lahvis (2011) presents a summary of 35 different analytical screening-level models, including a discussion of features, and assumptions. Models generally used for simulation of PVI are either the Johnson-Ettinger model (JEM) or BioVapor.

Johnson-Ettinger Model (JEM)

Johnson and Ettinger introduced one of the first vapor intrusion models in 1991. This model is referred to as the Johnson-Ettinger Model or JEM. Features of the JEM include:

- A steady or transient source of subsurface vapors from groundwater or residual chemicals
- Gaseous-phase diffusive vapor flow through a layer of soil
- Vapor transport through a slab-on-grade or basement foundation
- Building air exchange

The JEM presumes that the concrete foundation is impermeable and vapor movement occurs only through cracks and other openings. However, concrete is permeable to vapors and gases. Effective diffusion rates for intact air-dry concrete have been measured for hydrocarbons, oxygen, methane, and radon with an overall measured range from 1.08 to 15.6 cm^2/hr (Haghighat, et al., 2002; Patterson and Davis, 2009; Kobayashi and Shuttoh, 1991; Tittarelli, 2009; Yu, et al., 1993). Thus, diffusive vapor flow for typical foundation areas and thicknesses can be significant (McHugh, de Blanc, and Pokluda, 2006; Luo, et al., 2012). Actual measurement of differential pressure across varied building foundations show a significantly variable component over time (Nazaroff, et al., 1985; Hintenlang and Al-Ahmady, 1992; Robinson, et al., 1997a,b; McHugh , de Blanc, and Pokluda, 2006; Lundegard, Johnson, and Dahlen, 2008; Patterson and Davis, 2009; Luo and Johnson, 2011).

For sites where PHCs are present and aerobic biodegradation of PHCs occurs in the vadose zone, comparisons to JEM consistently show the model to over-predict indoor air concentrations by at least several orders of magnitude (Fitzpatrick and Fitzgerald, 2002; Sinke, 2001; Ririe, Sweeny, and Daugherty, 2002; Hers, et al., 2003; Davis, 2006; Golder Associates, 2008; Davis 2009). The potential for over-prediction is greatest for sites with low concentrations of PHCs in soil and groundwater (API, 2009; Davis, 2009; Energy Institute, 2009).

The original model has been revised numerous times to attempt to account for biodegradation, which was not included in the original JEM (see Johnson, Kemblowski, and Johnson, 1998; Ririe, et al., 1998; Johnson, Hermes, and Roggemans, 2000; Spence and Walden, 2010; Parker, 2003; Environmental Systems and Technologies, 2004; DeVaull, 2007a; Mills, et al., 2007; Turczynowicz and Robinson, 2007; API, 2010; Lahvis, 2011). EPA also revised the original JEM.

The most current information on EPA's revised model may be found on EPA's website at http://www.epa.gov/oswer/riskassessment/airmodel/johnson_ettinger.htm.

BioVapor

The BioVapor model (DeVaull, 2007a; API, 2010) is a Microsoft Excel© macro that uses a conceptual model similar to the JEM. BioVapor includes the following features:

- A steady subsurface petroleum vapor source.
- Gaseous-phase diffusive vapor flow through a layer of soil.
- Vapor transport through a slab-on-grade or basement foundation.
- Building air exchange.

In contrast to JEM, BioVapor accounts for oxygen-limited, aerobic biodegradation. Aerobic biodegradation is included as a coupled reaction between petroleum vapors and oxygen. Oxygen availability in the subsurface is dictated by transport through and around the building foundation, and by diffusion into the soil. The BioVapor model requires estimates of chemical-specific aerobic degradation rates for vadose zone soils. DeVaull (2007a,b) provides default values based on measured data. DeVaull (2011) provides improved estimates of both median values and observed ranges for an expanded set of specific chemicals.

PVIScreen

PVIScreen (Weaver, 2015) is based on the equations of BioVapor but is coded in Java to improve computational efficiency and allow for implementation of algorithms to automate uncertainty analysis. Most computer models must be run multiple times with varying input parameters in order to conduct a typical sensitivity analysis. PVIScreen automates this function by treating input variables as ranges and then conducting a Monte Carlo analysis. The results, which are provided in a matter of seconds, are presented as the probability that the indoor air concentration is less than a risk-based level. This is in contrast to most models that provide single values for various output parameters. PVIScreen also allows for flexible unit choices and presents results in an automatically-generated report.

Importance

Vapor intrusion models that include oxygen limited biodegradation support development of petroleum-specific exclusion distance criteria (i.e., lateral inclusion zone—see **Section 4**, p.44; vertical separation distance—see **Section 5**, p.48). Model results are consistent with empirical exclusion distance values derived from several PVI field investigations. These include Lahvis, et al. (2013); Davis (2009); Peargin and Kolhatkar (2011); Wright (2011); McHugh, et al. (2010), and Verginelli and Baciocchi (2014). Site assessment and field data including the depth to contamination, source strength, and type (LNAPL or dissolved) are key parameters for determining these exclusion distance criteria.

Estimates using the BioVapor model indicate that for moderate or weak sources (especially dissolved plumes), biodegradation effectively eliminates the potential for PVI. Conversely, where vapor sources are both high in concentration and in close proximity to the bottom of a foundation, the BioVapor model predicts significant potential for PVI.[49] Notably, in these cases the BioVapor model predicts significantly higher potential for PVI below a foundation, where oxygen availability is more limited, than adjacent to the foundation where the soil surface is open to air and oxygen availability is greater. This prediction is consistent with measured vertical profiles of hydrocarbons and oxygen for high concentration vapor sources taken both below a foundation and beside a foundation (Patterson and Davis, 2009; Laubacher, et al., 1997).

Weaver (2012) presents results of a sensitivity analysis that indicates when biodegradation occurs, it dominates the other processes included in the BioVapor model. In these cases, the parameters representing aerobic biodegradation, source depth, and source strength dominate the model results. In the other cases where biodegradation is insignificant, building parameters become more important, as they are in the JEM (Tillman and Weaver, 2007).

More complex numerical models including oxygen-limited biodegradation have been developed and applied. Abreu and Johnson (2006) present results for a three-dimensional model. With matched model parameters, there is reasonable agreement between the three dimensional results and those predicted with the BioVapor model (DeVaull, 2007b) and PVIScreen (Weaver, 2015). Each of these model results show similar sensitivities to changes in model parameters, and support the use of exclusion distances such as those recommended in this document (see **Section 4**, p.44, lateral inclusion zone, and **Section 5**, p.48, vertical separation distance).

Assessment

When selecting an appropriate computer model, the mathematical formulation needs to be consistent with conditions at the site and the CSM. If the computer model is not matched to conditions at the site, then error is likely introduced into the computer model results. This means that input parameters for the computer model should be representative of the actual physical, chemical, and biological properties of the site. Typically all factors influencing vapor intrusion are not included in currently available models. Even with more advanced modeling, resource limitations would prevent the detailed characterization necessary to determine representative values for some of the input parameters. Some of these factors include subsurface heterogeneity, variation in building operation, subsurface moisture content, variations in weather and others. For most other types of environmental models, limitations in characterization are mitigated by calibration to known endpoints, typically concentration distributions. Though calibration results may not be unique (that is the same results could potentially be obtained using different values for the same suite of input parameters), when these results match field conditions, a model is deemed to be useful for predictive simulations.

[49] Moderate or weak sources are associated with dissolved plumes. Strong sources are associated with LNAPL. **Table 3** on page 52 presents concentration thresholds associated with dissolved plumes and LNAPL.

Special Considerations

Most of the parameters describing model processes will not be known with certainty. A common limitation is that field measurements of all the input parameters (e.g., biodegradation rates, soil moisture content beneath buildings, air exchange rates) are typically not available, and those that are (e.g., source concentration) may be spatially or temporally variable. Literature values are typically substituted for site-specific data. This leads to uncertainty as to whether parameter values are truly representative of site conditions. Model results will likewise inevitably lack certainty (Bekele, et al, 2013). The importance of these (and other) parameters is determined through an uncertainty analysis. By determining the impact of parameter variability on the model results, the uncertainty analysis adds confidence to the conclusions drawn from the model.

Recommendation

An appropriate framework for the use of a mathematical model and understanding of model characteristics is critical when using the results of mathematical models for regulatory purposes (Hers, et al., 2003). The appropriate role for a model in a PVI investigation is as a means to explain observed behavior. EPA recommends the use of a model that considers aerobic biodegradation when assessing the potential for PVI. Regardless of which model is used to simulate PVI, EPA recommends that an uncertainty analysis be conducted to provide error bounds on predictions of the computer model.

Model results obtained by using site-specific inputs can provide results that inform decision-making. In particular, model results can be used to demonstrate that: sufficient oxygen exists to degrade petroleum contaminants, contaminant vapor distributions are plausible given conditions at the site, estimates of the vapor attenuation anticipated in the subsurface due to biodegradation are reasonable. Models may also be used for purposes such as improving a site-specific sampling strategy, validation (or refutation) of the CSM by comparing a model to measured soil gas data, and in estimating the effect of varied or changed site conditions (e.g., including construction of a new building on a brownfields site).

Model results can thus be used as one line of evidence that a building is not likely to be impacted by PHC vapors. At the present time and state of knowledge, EPA cautions that model results should not be used as the sole rationale for determining that a building is not threatened or impacted by PVI.

References Cited

Abreu, L. D. V. and P. C. Johnson. 2006. Simulating the Effect of Aerobic Biodegradation on Soil Vapor Intrusion into Buildings: Influence of Degradation Rate, Source Concentration, and Depth. *Environmental Science and Technology* 40(7):2304-2315.

American Petroleum Institute (API). 2009. *Simulating the Effect of Aerobic Biodegradation on Soil Vapor Intrusion into Buildings—Evaluation of Low Strength Sources Associated with*

Dissolved Gasoline Plumes. Publication No. 4775; American Petroleum Institute: Washington, D.C. http://www.api.org/environment-health-and-safety/clean-water/ground-water/vapor-intrusion/vi-publications/simulating-aerobic-biodegredation

American Petroleum Institute (API). 2010. *BioVapor Indoor Vapor Intrusion Model*. http://www.api.org/environment-health-and-safety/clean-water/ground-water/vapor-intrusion/biovapor-form

Bekele, D.N., R. Naidu, M. Bowman, and S. Chadalavada. 2013. Vapor Intrusion Models for Petroleum and Chlorinated Volatile Organic Compounds: Opportunities for Future Improvements. *Vadose Zone Journal* 12(2).

Davis, R. 2006. Vapor Attenuation in the Subsurface from Petroleum Hydrocarbon Sources: An Update and Discussion on the Ramifications of the Vapor-Intrusion Risk Pathway. *LUSTLine Bulletin* 52:22-25. New England Interstate Water Pollution Control Commission, Massachusetts. http://www.neiwpcc.org/lustline/lustline_pdf/lustline52.pdf

Davis, R.V. 2009. Bioattenuation of Petroleum Hydrocarbon Vapors in the Subsurface: Update on Recent Studies and Proposed Screening Criteria for the Vapor-Intrusion Pathway. *LUSTLine Bulletin* 61:11-14. New England Interstate Water Pollution Control Commission, Massachusetts. http://www.neiwpcc.org/lustline/lustline_pdf/lustline_61.pdf

DeVaull, G.E. 2007a. Indoor Vapor Intrusion with Oxygen-Limited Biodegradation for a Subsurface Gasoline Source. *Environmental Science and Technology* 41(9):3241-3248.

DeVaull, G. 2007b. Indoor Air Vapor Intrusion: Predictive Estimates for Biodegrading Petroleum Chemicals. Presentation at: Air and Waste Management Association (A&WMA) Specialty Conference: Vapor Intrusion: Learning from the Challenges, Providence, Rhode Island. September 26-28.

DeVaull, G. E. 2011. Biodegradation Rates for Petroleum Hydrocarbons in Aerobic soils: A Summary of Measured Data. *Proceedings of Battelle 8th International Symposium on Bioremediation and Sustainable Environmental Technologies*, Reno, Nevada, June 27-30.

Energy Institute. 2009. Screening the Potential for Hydrocarbon Vapour Intrusion Risks, Petroleum Review August 2009, Energy Institute, London, United Kingdom, p. 40-42.

Environmental Systems and Technologies, Inc. 2004. VAPEX4. 3708 South Main Street, Suite D, Blacksburg, Virginia.

Fitzpatrick, N.A. and J.J. Fitzgerald. 2002. An Evaluation of Vapor Intrusion Into Buildings through a Study of Field Data. *Soil and Sediment Contamination* 11(4):603-623.

Golder Associates. 2008. Report on Evaluation of Vadose Zone Biodegradation of Petroleum Hydrocarbons: Implications for Vapour Intrusion Guidance. Research study for Health Canada and the Canadian Petroleum Products Institute. Golder Associates Ltd., Burnaby, British Columbia, July.

Haghighat, F., C.S. Lee, and W.S. Ghaly. 2002. Measurement of Diffusion Coefficients of VOCs for Building Materials: Review and Development of a Calculation Procedure. *Indoor Air* 12(2): 81-91.

Hers, I., R. Zapf-Gilje, P.C. Johnson, and L. Li. 2003. Evaluation of the Johnson and Ettinger Model for Prediction of Indoor Air Quality. *Ground Water Monitoring and Remediation* 23(1): 62–76.

Hintenlang, D. E. and K. K. Al-Ahmady. 1992. Pressure Differentials for Radon Entry Coupled to Periodic Atmospheric Pressure Variations. *Indoor Air* 2(4):208-215.

Johnson, P.C. and R.J. Ettinger. 1991. Heuristic Model for Predicting the Intrusion Rate of Contaminant Vapors into Buildings. *Environmental Science and Technology* 25(8):1445-1452.

Johnson, P.C., M.W. Kemblowski, R.L. Johnson. 1998. *Assessing the Significance of Subsurface Contaminant Vapor Migration to Enclosed Spaces: Site-Specific Alternatives to Generic Estimates*, Publication No. 4674, API, Washington, D.C., December, 44p.

Johnson, P.C., V.A. Hermes, S. Roggemans. 2000. An Oxygen-Limited Hydrocarbon Vapor Migration Attenuation Screening Model, written communication, Paul C. Johnson, Department of Civil and Environmental Engineering, Arizona State University, Tempe, Arizona.

Kobayashi, K. and K. Shuttoh. 1991. Oxygen Diffusivity of Various Cementitious Materials. *Cement and Concrete Research* 21(2-3):273-284.

Lahvis, M.A., I. Hers, R.V. Davis, J. Wright, and G.E. DeVaull. 2013. Vapor Intrusion Screening at Petroleum UST Release Sites. *Groundwater Monitoring and Remediation* 33(2):53-67.

Lahvis, M. 2011. Vapour Transport from Soil and Groundwater to Indoor Air: Analytical Modeling Approach, Chapter 5., in Vapor Emissions to Outdoor Air and Enclosed Spaces for Human Health Risk Assessment: Site Characterization, Monitoring, and Modeling. S. Saponaro, E. Sezenna, L. Bonomo, Eds., Nova Science Publishers, Inc., New York. pp. 91-112.

Laubacher, R.C., Bartholomae, P., Velasco, P., Reisinger, H.J. 1997. An Evaluation of the Vapour Profile in the Vadose Zone above a Gasoline Plume. Proceedings of 1997 Petroleum Hydrocarbon and Organic Chemicals in Ground Water, Houston, Texas, November, pp. 396-409.

Lundegard, P.D., P.C. Johnson, and P. Dahlen. 2008. Oxygen Transport from the Atmosphere to Soil Gas Beneath a Slab-on-Grade Foundation Overlying Petroleum-Impacted Soil. *Environmental Science and Technology* 42(15):5534-5540.

Luo, H. and P.C. Johnson. 2011. Incorporating Barometric Pressure and Wind Effects into Vapor Intrusion Simulations, Association for Environmental Health and Sciences Conference Session, March 16, San Diego - Petroleum Hydrocarbon Vapor Intrusion.

Luo, E.H., C. Holton, Y. Guo, and P.C. Johnson. 2012. Field and Modeling Studies of Indoor Air Source Effects on Subslab Soil Gas Concentrations. 22nd Annual International Conference on Soil, Water, Energy, and Air. March 19-22, 2012, San Diego, California.

McHugh, T.E., P.C. de Blanc, and R.J. Pokluda. 2006. Indoor Air as a Source of VOC Contamination in Shallow Soils Below Buildings. *Soil and Sediment Contamination* 15(1):103-122.

McHugh, T.E., R. Davis, G. DeVaull, H. Hopkins, J. Menatti, and T. Peargin. 2010. Evaluation of Vapor Attenuation at Petroleum Hydrocarbon Sites: Considerations for Site Screening and Investigation. *Soil and Sediment Contamination* 19(1):1–21.

Mills, W.B., S. Liu, M.C. Rigby, and D. Brenner. 2007. Time-Variable Simulation of Soil Vapor Intrusion into a Building with a Combined Crawl Space and Basement. *Environmental Science and Technology* 41(14):4993-5001.

Nazaroff, W. W., H. Feustel, A.V. Nero, K.L. Revzan, D.T. Grimsrud, M.A. Essling, and R.E. Toohey. 1985. Radon Transport into a Detached One-Story House with a Basement. *Atmospheric Environment* 19(1):31-46.

Parker, J.C. 2003. Modeling Volatile Chemical Transport, Biodecay, and Emission to Indoor Air. *Ground Water Monitoring and Remediation* 23(1):107-120.

Patterson, B. M. and G.B. Davis. 2009. Quantification of Vapor Intrusion Pathways into a Slab-on-Ground Building under Varying Environmental Conditions. *Environmental Science and Technology* 43(3):650-656.

Peargin, T. and R. Kolhatkar. 2011. Empirical Data Supporting Groundwater Benzene Concentration Exclusion Criteria for Petroleum Vapor Intrusion Investigations. *Proceedings of Battelle 8th International Symposium on Bioremediation and Sustainable Environmental Technologies*, Reno, Nevada, June 27-30.

Ririe, G.T., R.E. Sweeney, S.J. Daugherty, and P.M. Peuron. 1998. A Vapor Transport Model that is Consistent with Field and Laboratory Data, in, *Petroleum Hydrocarbons and Organic Chemicals in Ground Water: Prevention, Detection, and Remediation Conference*, Ground Water Association Publishing, Houston, Texas, pp.299-308.

Ririe, G.T., R.E. Sweeney, and S.J. Daugherty. 2002. A Comparison of Hydrocarbon Vapor Attenuation in the Field with Predictions from Vapor Diffusion Models. *Soil and Sediment Contamination* 11(4):529–544.

Robinson, A. L., R.G. Sextro, and W.J. Fisk. 1997a. Soil-Gas Entry into an Experimental Basement Driven by Atmospheric Pressure Fluctuations – Measurements, Spectral Analysis, and Model Comparison. *Atmospheric Environment* 31(10):1477-1485.

Robinson, A. L., R.G. Sextro, and W.J. Fisk. 1997b. Soil-Gas Entry into Houses Driven by Atmospheric Pressure Fluctuations – The Influence of Soil Properties. *Atmospheric Environment* 31(10):1487-1495.

Sinke, A.J.C. 2001. Risk Reduction of Volatile Compounds by Degradation in the Unsaturated Zone, Project no. 96-030, Dutch Research Programme on Biotechnological In-Situ Remediation, (NOBIS).

Spence, L.R. and T. Walden. 2010. RISC5 – Risk Integrated Software for Cleanups – Version 5.0, GroundwaterSoftware.com, Groton, Massachusetts.

Tillman, F.D. and J.W. Weaver. 2007. Parameter Sets for Upper and Lower Bounds on Soil-to-Indoor-Air Contaminant Attenuation Predicted by the Johnson and Ettinger Vapor Intrusion Model. *Atmospheric Environment* 41(27):5797-5806.

Tillman, F.D. and J.W. Weaver. 2006. Uncertainty from Synergistic Effects of Multiple Parameters in the Johnson and Ettinger (1991) Vapor Intrusion Model. *Atmospheric Environment* 40(22):4098-4112.

Tillman, F.D., and J.W. Weaver. 2005. Review of Recent Research on Vapor Intrusion., U. S. Environmental Protection Agency Office of Research and Development, Washington, D.C., September (EPA/600/R-05/106). *http://www.epa.gov/athens/publications/reports/Weaver600R05106ReviewRecentResearch.pdf*

Tittarelli, F. 2009. Oxygen Diffusion through Hydrophobic Cement-Based Materials. *Cement and Concrete Research* 39(10):924–928.

Turczynowicz, L. and N. I. Robinson. 2007. Exposure Assessment Modeling for Volatiles--Towards an Australian Indoor Vapor Intrusion Model. *Journal of Toxicology and Environmental Health Part A* 70(19):1619-1634.

Verginelli, I. and R. Baciocchi. (2014). Vapor Intrusion Screening Model for the Evaluation of Risk-Based Vertical Exclusion Distances at Petroleum Contaminated Sites. *Environmental Science & Technology* 48:13263−13272.

Weaver, J. 2012. BioVapor Model Evaluation in Bio-Vapor Hands-On Workshop. *23rd National Tanks Conference Pre-Conference Workshop*, St. Louis, Missouri, March 18.

Weaver, J. 2015. Petroleum Vapor Intrusion Modeling Assessment with PVIScreen, US EPA, Office of Research and Development. (in preparation)

Wright, J. 2011. Establishing Exclusion Criteria from Empirical Data for Assessing Petroleum Hydrocarbon Vapour Intrusion. CleanUp 2011: Proceedings of the 4th International Contaminated Site Remediation Conference, September 11-15, Adelaide, Australia.

Yu, C., C. Loureiro, J.-J. Cheng, L.G. Jones, Y.Y. Wang, Y.P. Chia, and E. Faillace. 1993. Data Collection Handbook to Support Modeling Impacts of Radioactive Material in Soil, Environmental Assessment and Information Sciences Division, Argonne National Laboratory, Argonne, Illinois.

Additional Information

Abreu, L. D. V., P.C . Johnson. 2005. Effect of Vapor Source-Building Separation and Building Construction on Soil Vapor Intrusion as Studied with a Three-Dimensional Numerical Model. *Environmental Science and Technology* 39(12):4550-4561.

Bozkurt, O., K. Pennell, and E. Suuberg. 2009. Simulation of the Vapor Intrusion Process for Nonhomogeneous Soils Using a Three-Dimensional Numerical Model. *Ground Water Monitoring and Remediation* 29(1):92-104.

Davis, G.B., M.G. Trefry, and B.M. Patterson. 2009. Petroleum Vapour Model Comparison, CRC for Contamination Assessment and Remediation of the Environment, Technical Report Number 9, 24p.

EPA. 2005. *Uncertainty and the Johnson-Ettinger Model for Vapor Intrusion Calculations* (EPA/600/R-05/110). *http://www.epa.gov/athens/publications/reports/Weaver600R05110UncertaintyJohnsonEttinger.pdf*

Hers, I., R. Zapf-Gilje, D. Evans, and L. Li. 2002. Comparison, Validation, and Use of Models for Predicting Indoor Air Quality from Soil and Groundwater Contamination. *Soil and Sediment Contamination* 11(4):491-527.

Interstate Technology & Regulatory Council (ITRC). 2014. Petroleum Vapor Intrusion: Fundamentals of Screening, Investigation, and Management. Interstate Technology and Regulatory Council, Vapor Intrusion Team, Washington, D.C. October. http://itrcweb.org/PetroleumVI-Guidance

Johnson, P. 2005. Identification of Application-Specific Critical Inputs for the 1991 Johnson and Ettinger Vapor Intrusion Algorithm. *Ground Water Monitoring and Remediation* 25(1):63-78.

Ma, J., H. Luo, G.E. DeVaull, W.G. Rixey, and P.J. J. Alvarez. 2014. Numerical Model Investigation for Potential Methane Explosion and Benzene Vapor Intrusion Associated with High-Ethanol Blend Releases. *Environmental Science & Technology* 48(1):474-481.

Park, H. 1999. A Method For Assessing Soil Vapor Intrusion From Petroleum Release Sites: Multi-Phase/Multi-Fraction Partitioning. *Global Nest* 1(3):195-204.

Pennell K.G., O. Bozkurt, E.M. Suuberg. 2009. Development and Application of a Three-Dimensional Finite Element Vapor Intrusion Model. *Journal of Air and Waste Management* 59(4):447-460.

Provoost, J., A. Bosman, L. Reijnders, J. Bronders, K. Touchant, and F. Swartjes. 2009. Vapour Intrusion from the Vadose Zone - Seven Algorithms Compared. *Journal of Soils and Sediments* 10(3):473-483.

Sanders, P. and N. Talimcioglu. 1997. Soil-to-Indoor Air Exposure Models for Volatile Organic Compounds: The Effect of Soil Moisture. *Environmental Toxicology and Chemistry* 16(12):2597-2604.

Schreüder W. 2006. Uncertainty Approach to the Johnson and Ettinger Vapor Intrusion Model. *Proceedings of the 4th Annual National Ground Water Association Ground Water And Environmental Law Conference*, July 6-7, Chicago, Illinois, pp. 164-173.

Tillman, F.D. and J.W. Weaver. 2006. Uncertainty from Synergistic Effects of Multiple Parameters in the Johnson and Ettinger (1991) Vapor Intrusion Model. *Atmospheric Environment* 40(22):4098-4112.

Van Wijnen, H.J. and J.P.A. Lijzen. 2006. Validation of the VOLASOIL Model Using Air Measurements from Dutch Contaminated Sites: Concentrations of Four Chlorinated Compounds RIVM Report 711701041/2006, Rijksinstituut Voor Volksgezondheid en Milieu, Bilthoven, 68 pp.

Yao, Y., R. Shen, K. Pennell, and E. Suuberg. 2011. Comparison of the Johnson-Ettinger Vapor Intrusion Screening Model Predictions with Full Three-Dimensional Model Results. *Environmental Science and Technology* 45(6):2227-2235.

Glossary

Note: Most of these definitions are from EPA's on-line glossaries (see http://iaspub.epa.gov/sor_internet/registry/termreg/searchandretrieve/termsandacronyms/search.do).

Absorption: the penetration of atoms, ions, or molecules into the bulk mass of a substance. In contrast, adsorption is the retention of atoms, ions, or molecules onto the surface of another substance

Advection: the process of transfer of fluids (vapors or liquid) through a geologic formation in response to a pressure gradient that may be caused by changes in barometric pressure, water table levels, wind fluctuations, or infiltration

Aerobic: able to live, grow, or take place only when free oxygen is present

Anaerobic: able to live, grow, or take place where free oxygen is not present

Analyte: the element, ion, or compound that an analysis seeks to identify; the element of interest

Attenuation: the reduction or lessening in amount (*e.g.*, a reduction in the amount of contaminants in a plume as it migrates away from the source)

Biodegradability (or biodegradation potential): the relative ease with which organic chemicals will degrade as the result of biological metabolism. With respect to petroleum hydrocarbons, although virtually all petroleum hydrocarbons are biodegradable, biodegradability is highly variable and dependent somewhat on the specific type of hydrocarbon. In general, biodegradability increases with increasing solubility; solubility is inversely proportional to molecular weight.

Biodegradation: a process by which microbial organisms transform or alter (through metabolic or enzymatic action) the structure of chemicals introduced into the environment

Biologically active soil: in the context of a PVI investigation means that the subsurface soil environment will support populations of microorganisms that are present in sufficient quantities to aerobically degrade PHC vapors before they intrude into a receptor. Effective aerobic biodegradation of petroleum hydrocarbons depends on the soil having sufficient oxygen and enough soil water to provide a habitat for adequate populations of active microorganisms. The presence of sufficient oxygen must be determined by the collection and analysis of soil gas. Soil that is too dry will not support microbial life. The soil generally will not be too dry for bacteria if the depth to the water table is less than 300 feet, or if the soil around the receptor supports the growth of plants characteristic of temperate climates. (NOTE that in hot, arid climates lack of soil moisture may inhibit biodegradation of PHCs) Concentrations of carbon dioxide which are ten-fold higher than concentrations in the atmosphere are an acceptable indication that conditions support microbial respiration. The actual habitat of soil bacteria is the thin film of water held to the surface of soil particles by capillary attraction. Coarse sand and gravel with a low content of silt or clay or organic matter, or fractured consolidated rock, or consolidated rock with solution channels, may not have enough soil water in intimate contact with soil gas to support adequate densities of biologically active microorganisms. These geological materials do not qualify as "biologically active soil."

BTEX: acronym for the aromatic hydrocarbons benzene, toluene, ethylbenzene, and xylenes (three isomers)

Capillary fringe: the zone of a porous medium above the water table within which the porous medium is saturated by water under pressure that is less than atmospheric pressure. See also *vadose zone* and *unsaturated zone*.

Clean monitoring point: Concentration thresholds for "clean" monitoring points are: the BTEX concentration in groundwater is equal to or less than the respective maximum contaminant level (e.g., 5 µg/L for benzene); the TPH concentration in soil is less than 20 mg/Kg; there is no potential presence of liquid or residual phase LNAPL; the oxygen concentration is greater than 0.2 percent; and the combustible gas concentration in soil gas is less than 100 ppm (v/v).

Clean soil: In the context of a PVI investigation, clean soil does not necessarily mean that the soil is free from all contamination, but rather that any contamination present is at concentrations low enough that the biological activity of the soil is sufficient to biodegrade PHC vapors before they reach a receptor.

Computer model: a mathematical representation of a physical process or system. Computer models are based upon sound conceptual site models to provide meaningful information. As the complexity of computer models increases, so does the amount of data required, and the quality of the output from computer models is directly related to the quality of the input data. Because of the complexity of natural systems, models necessarily rely on simplifying assumptions that may or may not accurately represent the dynamics of the natural system. Calibration and sensitivity analyses are important steps in the appropriate use of models.

Conceptual site model (CSM): a three-dimensional representation that conveys what is known or suspected about potential contamination sources, release mechanisms, and the transport and fate of those contaminants. The conceptual model provides the basis for assessing potential remedial technologies at the site. "Conceptual site model" is not synonymous with "computer model"; however, a computer model may be helpful for understanding and visualizing current site conditions or for predictive simulations of potential future conditions.

Contamination: in the context of a PVI investigation, contamination means that: the BTEX concentration in groundwater is greater than the respective MCL; or the TPH concentration in soil is greater than 100 mg/Kg; or there is potential presence of liquid or residual phase LNAPL; or the combustible gas concentration in soil gas is greater than 100 ppm (v/v).

Diffusion: the process by which molecules in a single phase equilibrate to a zero concentration gradient by random molecular motion (Brownian motion). The flux of molecules is from regions of high concentration to low concentration and is governed by Fick's Second Law.

Dispersion: the process by which a substance or chemical spreads and dilutes in flowing groundwater or soil gas

Downgradient: in the direction of decreasing potentiometric head; the general direction of groundwater flow

First responder: refers to those individuals who in the early stages of an incident are responsible for the protection and preservation of life, property, evidence, and the environment. Typically these are police, firefighters, or emergency medical personnel.

Fixed gases: refers to the gases nitrogen, oxygen, argon, carbon dioxide, and carbon monoxide. The volume of these gases together accounts for virtually 100 percent of the composition of the earth's atmosphere. Presence and concentration of these gases are determined using gas chromatography (GC).

Flux: the rate of movement of mass through a unit cross-sectional area per unit time in response to a concentration gradient or some advective force

Free product: a petroleum hydrocarbon in the liquid ("free" or non-aqueous) phase (see also light non-aqueous phase liquid, LNAPL)

Gradient: the rate of change in value of a physical or chemical parameter per unit change in position For example, hydraulic gradient is equal to the difference in head measured at two points (usually wells) divided by the distance separating the two points. The dimensions of head and distance are both lengths, therefore the gradient is expressed as a dimensionless ratio (L/L).

Groundwater: the water contained in the pore spaces of saturated geologic media

Henry's law constant: the ratio of the concentration of a compound in air (or vapor) to the concentration of the compound in water under equilibrium conditions

Henry's law: the relationship between the partial pressure of a compound and the equilibrium concentration in the liquid through a proportionality constant known as the Henry's law constant

Heterogeneous: varying in structure or composition at different locations in space

Homogeneous: uniform in structure or composition at all locations in space

Hydraulic gradient: the change in total potentiometric (or piezometric) head between two points divided by the horizontal distance separating the two points

Hydrocarbon: chemical compounds composed only of carbon and hydrogen

Inclusion zone: the area surrounding a contaminant mass through which vapor-phase contamination may travel and intrude into buildings and potentially result in adverse health effects to inhabitants

Indian country: (1) All land within limits of any Indian reservation under the jurisdiction of the United States government, notwithstanding the issuance of any patent, and, including rights-of-way running through the reservation; (2) All dependent Indian communities within the borders of the United States whether within the original or subsequently acquired territory thereof, and whether within or without the limits of a state; and (3) All Indian allotments, the Indian titles to which have not been extinguished, including rights-of-way running through the same.

Indigenous: living or occurring naturally in a specific area or environment; native

Isotropic: the condition in which hydraulic properties of an aquifer are equal when measured in any direction

Lateral inclusion zone: the area surrounding a contaminant mass and for which all buildings within its boundaries should be assessed for potential PVI. By definition, all buildings that overlie contamination in any phase are within the lateral inclusion zone.

Light non-aqueous phase liquid (LNAPL): contaminants that remain as the original bulk liquid with a density less than that of water (see also free product)

Microorganisms: microscopic organisms including bacteria, protozoans, yeast, fungi, mold, viruses, and algae

Permeability: a qualitative description of the relative ease with which rock, soil, or sediment will transmit a fluid (liquid or gas). Often used as a synonym for hydraulic conductivity or coefficient of permeability.

Petroleum: 40CFR280.12 defines the term *petroleum* to include crude oil or any fraction thereof that is liquid at standard conditions of temperature and pressure (60 degrees Fahrenheit and 14.7 pounds per square inch absolute).

Petroleum hydrocarbons (PHCs): hydrocarbons (i.e., compounds comprised of combinations of hydrogen and carbon atoms) that are components of petroleum (crude oil), including the various products that result from distillation of crude oil

Petroleum vapor intrusion (PVI): intrusion of petroleum hydrocarbon vapors into buildings or other structures

Porosity: the volume fraction of a rock or unconsolidated sediment not occupied by solid material but usually occupied by water or air (gas)

Preferential transport pathways: pathways through which contaminants may be transported at a higher rate than through surrounding materials. Preferential transport pathways are heterogeneities within geologic media and include features that are natural (such as facies changes, sand or gravel stringers, solution channels in karst, bedding planes and weathered surfaces, fractures, and joints) as well as man-made (such as utility corridors, trenches, other types of excavations).

Regulated substance: (a) Any substance defined in section 101(14) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980 (but not including any substance regulated as a hazardous waste under subtitle C), and (b) Petroleum, including crude oil or any fraction thereof that is liquid at standard conditions of temperature and pressure (60 degrees Fahrenheit and 14.7 pounds per square inch absolute). The term regulated substance includes but is not limited to petroleum and petroleum-based substances comprised of a complex blend of hydrocarbons derived from crude oil through processes of separation, conversion, upgrading, and finishing, such as motor fuels, jet fuels, distillate fuel oils, residual fuel oils, lubricants, petroleum solvents, and used oils.

RfC (reference concentration, inhalation): an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure of a chemical to the human population through inhalation (including sensitive subpopulations), that is likely to be without risk of deleterious noncancer effects during a lifetime

Selective ion monitoring (SIM): a mass spectrometry scanning mode in which only a limited mass-to-charge ratio range is transmitted or detected by the instrument, as opposed to the full spectrum range

Semi-volatile organic compound (SVOC): an organic compound which has a boiling point higher than water and which may vaporize when exposed to temperatures above room temperature. Semi-volatile organic compounds include phenols and polynuclear aromatic hydrocarbons (PAHs).

Site assessment: see site characterization

Site characterization: (verb) the process by which site-specific information and data are gathered from a variety of sources to characterize the physical, biological, and chemical systems at a contaminated site. A primary objective of site characterization is delineation of the areal (both horizontal—longitudinal and lateral—transverse) and vertical extent of contamination. This includes changes in plume boundaries, changes in geochemical parameters that affect biodegradation, and contaminant mass (or concentration) increases or decreases. (noun) The product (e.g., CSM, report) resulting from the site characterization process. (Note: Site assessment, site investigation, site evaluation, and site check are all synonyms of site characterization.)

Site check: see site characterization

Site evaluation: see site characterization

Site investigation: see site characterization

Soil moisture: the water contained in the pore spaces in the unsaturated zone

Solubility: the amount of mass of a compound that will dissolve in a unit volume of solution

Sorption: a general term used to encompass the processes of absorption, adsorption, ion exchange, and chemisorption

Source material: material that includes or contains contaminants that act as a reservoir (either stationary or mobile) for migration of contamination to the ground water, to surface water, to air, (or other environmental media), or acts as a source for direct exposure. Contaminated ground water generally is not considered to be a source material although non-aqueous phase liquids (NAPLS [occurring either as residual- or free-phase]) may be viewed as source materials.

Source zone: the impacted area immediately surrounding the source of a release of regulated substances comprising source materials

Total petroleum hydrocarbons (TPH): a measure of the concentration or mass of petroleum hydrocarbon constituents present in a given amount of air, soil, or water. (Note: The term total is a misnomer, in that few, if any, of the procedures for quantifying hydrocarbons are capable of measuring all fractions of petroleum hydrocarbons present in the sample. Volatile hydrocarbons are usually lost in the process and not quantified. Additionally, some non-petroleum hydrocarbons may be included in the analysis.)

Travel time: the time it takes a contaminant to travel from the source to a particular point downgradient

Tribe: Indian tribe or tribe means an Indian or Alaska Native tribe, band, nation, pueblo, village, or community that the Secretary of the Interior acknowledges to exist as an Indian tribe pursuant to the federally Recognized Indian Tribe List Act of 1944, 25 U.S.C. 479a.

Underground storage tank (UST): 40CFR280.12 defines an *underground storage tank* as any one or combination of tanks (including underground pipes connected thereto) that is used to contain an accumulation of regulated substances, and the volume of which (including the volume of underground pipes connected thereto) is 10 percent or more beneath the surface of the ground. This term does not include any: (a) Farm or residential tank of 1,100 gallons or less capacity used for storing motor fuel for noncommercial purposes; (b) Tank used for storing heating oil for consumptive use on the premises where stored; (c) Septic tank; (d) Pipeline facility (including gathering lines) regulated under: (1) The Natural Gas Pipeline Safety Act of 1968 (49 U.S.C. App. 1671, *et seq.*), or (2) The Hazardous Liquid Pipeline Safety Act of 1979 (49 U.S.C. App. 2001, *et seq.*), or (3) Which is an intrastate pipeline facility regulated under state laws comparable to the provisions of the law referred to in paragraph (d)(1) or (d)(2) of this definition; (e) Surface impoundment, pit, pond, or lagoon; (f) Storm-water or wastewater collection system; (g) Flow-through process tank; (h) Liquid trap or associated gathering lines directly related to oil or gas production and gathering operations; or (i) Storage tank situated in an underground area (such as a basement, cellar, mine working, drift, pit, or tunnel) if the storage tank is situated upon or above the surface of the floor. The term underground storage tank or UST does not include any pipes connected to any tank which is described in paragraphs (a) through (i) of this definition.

Unsaturated zone: the zone between land surface and the capillary fringe within which the moisture content is less than saturation and pressure is less than atmospheric. Soil pore spaces also typically contain air or other gases. The capillary fringe is not included in the unsaturated zone.

Vadose zone: the zone between land surface and the water table within which the moisture content is less than saturation (except in the capillary fringe) and pressure is less than atmospheric. Soil pore spaces also typically contain air or other gases. The capillary fringe is included in the vadose zone.

Vapor intrusion attenuation factor (α): a parameter defined by Johnson and Ettinger (1991) to relate the vapor concentration of a volatile chemical inside the building to its vapor concentration at the subsurface source. This parameter, designated alpha (α), is defined mathematically as the vapor concentration in indoor air divided by the vapor concentration in soil gas at the source (with concentration being in the same units), and thus it is a ratio. The source is defined as the region of highest vapor concentration. Therefore, α values are always less than one. The vapor intrusion attenuation factor is an inverse measurement of the attenuation: α values *decrease* with *increasing* attenuation and α values *increase* with *decreasing* attenuation. In other words, α values represent the fraction of soil gas contaminant that reaches indoor air. Large α values (i.e., values approaching 1) indicate that a large fraction of the soil gas contaminant has reached the indoor air; therefore, little attenuation is taking place, whereas small α values indicate that a small fraction of the soil gas contaminant has reached the indoor air; therefore, significant attenuation is taking place.

Vapor pressure: the force per unit area exerted by a vapor in an equilibrium state with its pure solid, liquid, or solution at a given temperature. Vapor pressure is a measure of a substance's propensity to evaporate. Vapor pressure increases exponentially with an increase in temperature.

Vertical separation distance: the thickness of clean, biologically active soil that separates the source of contamination from a building basement, foundation, or slab

Volatile: is a tendency of a substance to vaporize or the speed at which it vaporizes. Volatility is indicated by a substance's vapor pressure. Substances with a higher vapor pressure will vaporize more readily at a given temperature than substances with a lower vapor pressure. A volatile organic compound is an organic compound which has a boiling point below that of water and which can easily vaporize or volatilize.

Volatile organic compound (VOC): organic compound that at room temperature and normal atmospheric pressure produces vapors that escape easily from volatile liquid chemicals. Volatile organic compounds include a variety of chemicals such as gasoline, benzene, toluene, xylene, formaldehyde, tetrachloroethylene, and perchloroethylene.

Volatilization: the process of transfer of a chemical from the aqueous or liquid phase to the gas phase. Solubility, molecular weight, and vapor pressure of the liquid and the nature of the gas-liquid interface affect the rate of volatilization.

Water table: the water surface in an unconfined aquifer at which the fluid pressure in the pore spaces is at atmospheric pressure

Weathering: the process during which a complex compound is reduced to its simpler component parts, transported via physical processes, or biodegraded over time

Wilting point: the minimal point of soil moisture the plant requires not to wilt. Wilting point values under field conditions are not constant for any given soil, but are determined by the integrated effects of plant, soil and atmospheric conditions.

Appendix I: Estimation of Exposure Point Concentrations in Soil and Ground Water

This page intentionally left blank for correct double-sided printing.

TABLE OF CONTENTS

1 Background 1
2 Statistical Considerations for Estimating Exposure Point Concentrations 2
2.1 Maximum Detected Concentration 2
2.2 Upper Confidence Limit 3
2.3 Arithmetic Average 4
2.4 Geometric Average 4
2.5 Area-Weighted Average 4
2.6 Depth-Weighted Average 5
2.7 Volume-Weighted Average 5
3 General Considerations for Estimating Exposure Point Concentrations 5
3.1 Surface and Subsurface Soil Concentrations 5
3.2 Ground Water Concentrations 6
4 Calculation of Exposure Point Concentrations 8
4.1 Surficial Soil (0–1 Foot below Ground Surface) 8
4.1.1 Exposure Point Surficial Soil Concentration for the Ground Water Protection Pathway 8
4.1.2 Exposure Point Surficial Soil Concentrations for the Direct Contact Pathway 9
4.2 Subsurface Soil (Greater Than 1 Foot below Ground Surface) 10
4.2.1 Exposure Point Subsurface Soil Concentration for Ground Water Protection Pathway 10
4.2.2 Exposure Point Subsurface Soil Concentration for Vapor Intrusion Pathway 10
4.3 Exposure Point Concentration for Protection of a Construction Worker 11
4.4 Ground Water 12
4.4.1 Exposure Point Compliance Well Concentration for Ground Water Protection Pathway 12
4.4.2 Exposure Point Ground Water Concentration for Protection of Indoor Inhalation Pathway 13
4.5. Soil Vapor 14
5 Estimating Area-Weighted Exposure Point Concentrations 14
5.1 Step 1: Identify the Exposure Unit 14
5.2 Step 2: Subdivide the Exposure Unit 15
5.3 Step 3: Estimate Exposure Point Concentrations for Each Thiessen Polygon 15
5.4 Step 4: Estimate Area-Weighted Average Concentration for the Exposure Unit 15
6 Recommendations 17
References 19
Other Useful References 20

LIST OF FIGURES

Figure 1. Schematic of soil leaching to ground water 9
Figure 2. Thiessen polygon method 16

1 Background

Exposure point concentrations (EPC) are the **average** chemical concentrations to which receptors are exposed over a specified duration within a specified geographical area. The geographical area about which a receptor moves and contacts contaminated media during the specified exposure duration is termed an exposure unit (EU). EPCs are also often referred to as representative concentrations.

This appendix describes the concept and methodology that should be used to estimate EPCs. This guidance provides general recommendations on procedures to accurately determine EPCs. These recommendations may not apply to all sites, particularly large, complex sites. Site-specific circumstances may require consultation with the Idaho Department of Environmental Quality (DEQ), the application of professional judgment, and reference to the more detailed literature cited herein. Other useful references are also included at the conclusion of this appendix.

In the site-specific application of the risk evaluation process, EPCs are used as input parameters in estimating the risk to a specified receptor for each complete route of exposure identified in the site conceptual exposure model (SCM) and each petroleum chemical of interest (COI). Risk management decisions are then made based on a comparison of the estimated risk with the regulatory specified target risk. This comparison is termed a forward-mode calculation. EPCs can also be used in what are termed backward-mode calculations when they are compared with calculated target levels for each complete route of exposure and each petroleum COI. In either mode, the calculation of EPCs is critical in the outcome of the risk evaluation.

Complications in the calculation of the EPCs may arise because the concept of EPC is often mistakenly associated with a site as opposed to an exposure pathway or the source. Since there may be several complete pathways at a site, several EPCs, one for each complete pathway, should be estimated. For example, estimation of the soil EPC for the pathway involving soil leaching and protection of ground water ingestion typically considers data over the entire soil profile from the source area. At the same site, soil EPC estimates for the direct contact route of exposure involving surficial soil would typically consider only the upper several feet of the soil profile and would focus on the portions of the site where receptors may travel. The accurate estimation of EPCs is complicated by several factors, including the following:

- Spatial variability in the concentrations
- Temporal variability in the concentrations
- Lack of sufficient, appropriately located, site-specific concentration data
- Poor definition or uncertainty in the location, size, or other characteristics of the EU

The uncertainty in the EPC introduced by some of these factors can be reduced by considering them during the development of the SCM and the sampling and analysis plan.

After samples have been collected and analyzed, the results need to be appropriately evaluated to produce sound estimates of EPCs. This evaluation includes assessing the following:

- Data quantity
- Data quality (which data are acceptable for use)
- Statistical methods (which methods to use)
- Which usable data apply to a specific EU

This guidance focuses primarily on the latter two issues.

2 Statistical Considerations for Estimating Exposure Point Concentrations

Numerous statistical methods can be employed to develop estimates of the exposure point (average) chemical concentration to which a receptor will be exposed. These methods include examining the maximum detected concentration, upper confidence limit (UCL) of the mean (for example the 95% UCL), arithmetic average, geometric average, area-weighted average, depth-weighted average, and volume-weighted average concentration (very rarely used). Associated with each of these methods are certain advantages, disadvantages, and constraints on their appropriate use. There is no uniformly accepted statistical methodology to estimate the EPC. Implicit in the decision to use any particular method is the need to acknowledge and account for the representativeness of the samples collected, the homogeneity of the defined EU, the statistical distribution of the data, the minimum data requirements of the statistical method used, and the uncertainty in the resultant data used to derive the estimated concentration.

From a practical perspective, several factors common to petroleum release sites may make the use of statistical methods to develop EPCs at a given site unrealistic, particularly for ground water. These factors include the following:

- Small release areas
- Dominantly subsurface releases, often at great depth
- Focus on source areas and not exposure pathways
- Limited sample numbers due to temporal/spatial constraints

2.1 Maximum Detected Concentration

The use of the maximum detected chemical concentration is required for comparison to screening levels during the screening level evaluation (see Section 3, Screening Level Evaluation, in the main body of the document). Depending on the quality of the site characterization data available, the maximum detected concentration can be used as EPCs in site-specific risk evaluations and will typically represent a conservative estimate of the average concentrations, particularly when sample numbers are low (i.e., four or less).

The effort necessary to calculate EPCs for certain complete pathways can be avoided by using the maximum media-specific concentrations when they do not exceed the target

levels or when the cumulative risk, calculated using maximum concentrations, does not exceed the target risk.

2.2 Upper Confidence Limit

The true population mean is a unique value that can be calculated only if the entire population has been sampled (i.e., the entire contaminated media analyzed). Since the entire population is almost never sampled, the true mean is never known. Thus, at best, only an estimate of the true population mean concentration is possible.

To account for the uncertainty associated with the estimated mean concentration, a confidence interval about the true but unknown mean is often constructed. The interval estimate includes a range and an associated degree of confidence that the true unknown mean lies within this range. In risk assessment applications, instead of calculating a two-sided confidence interval, a one-sided confidence interval is most often estimated.

For the calculation of EPCs, the U.S. Environmental Protection Agency (EPA) has recommended, in most cases, using the 95% upper confidence limit (UCL) of the mean (EPA 1992a). The upper limit for a one-sided 95% confidence interval of the mean is defined as a value that, when calculated repeatedly for randomly drawn subsets of site data, equals or exceeds the true mean 95% of the time. Alternatively, the true mean exceeds the UCL only 5% of the time. Ideally, a minimum of 8 to 10 samples is desirable to generate a 95% UCL. Although the UCL can be determined with fewer samples, doing so tends to results in the 95% UCL estimate being larger (large variances) than the arithmetic average and will sometimes exceed the maximum measured concentration. In these instances, the maximum measured concentration can be substituted for the 95% UCL or the user can decide to collect more samples to reduce the sampling variance.

Several issues commonly arise with environmental data sets that complicate the development of the confidence limit and should be evaluated through the use of an exploratory analysis prior to performing the calculation. These issues include the following:

- Determination of the distribution of the data chosen to represent the EU (normal, lognormal, or nonparametric [i.e., not conforming to a specific distribution]). This determination includes decisions as to what analysis and statistical tests to perform, how to interpret the test results, and how to treat the data once a determination is made.
- How to handle censored data and/or skewed data (typically due to non-detect [ND] values).

Depending on the nature of the underlying distribution of the data (or lack thereof), the one-sided 95% UCL can be calculated using a number of methodologies. The details regarding these methodologies are beyond the scope of this guidance.

EPA has developed technical guidance, a user's guide, and computer software (ProUCL 4.1) for calculating the UCL based on parametric (normal and lognormal distributions) and nonparametric distributions and when data sets have ND observations

(EPA 2011a, 2011b). The ProUCL technical guidance (Sections 1.7.1 and 1.7.2) describes the minimum data set conditions under which the ProUCL software will perform UCL calculations. These guidelines generally involve data set sizes greater than or equal to five with more than one detected value.

For samples collected using a multi-increment sampling approach, data set sizes as small as three may be sufficient to calculate a UCL. The Interstate Technology Regulatory Council (ITRC) has developed a guide for incremental sampling methodology (ITRC 2012).

For simpler data sets (with few or no ND values), DEQ has developed the IdahoUCL software, which is available at http://www.deq.idaho.gov/risk-evaluation-manual.

2.3 Arithmetic Average

Using the arithmetic average (or mean) is similar to the UCL with the disadvantage that no estimate of the uncertainty, variability of the average, or information regarding the underlying distribution of the population is incorporated into the value generated. For a population that is normally distributed, the estimates generated using the 95% UCL versus the mean tend to converge as the number of samples approaches 20 to 30 (EPA 1992a).

2.4 Geometric Average

The geometric average is sometimes used as an estimate of the mean of lognormally distributed variables. It represents the value in the original scale of the mean of the transformed variable. It is, however, a biased estimate of the mean, and statistical texts such as *Statistical Methods for Environmental Pollution Monitoring* (Gilbert 1987) caution against its use in environmental applications. *Statistical Methods for Environmental Pollution Monitoring* (Gilbert 1987) or *ProUCL 4.1 Technical Guide* (EPA 2011a) should be consulted when attempting to develop an unbiased estimate of the mean of a lognormally distributed variable. Exploratory data analysis should be conducted to confirm an assumption that the variable is lognormally distributed prior to calculating an EPC. As with the arithmetic average, no estimate of the uncertainty or variability is incorporated into the value generated by the geometric average and it may not be conservative.

2.5 Area-Weighted Average

Where sampling locations are unevenly spaced, area-weighted averaging methods can be employed to generate an estimate of the average concentration across an area. This calculation is done by generating an area (or Thiessen polygon) associated with each sampling location, assigning a "weight" to each data point based on the area of the polygon associated with that point, and summing the weighted data point values. One advantage of the method is that it is useful in characterizing areas where the number of sample points is low.

The method also has several disadvantages. First, the shape, and consequently the contribution of an area associated with a sample location to the "average," is totally dependent on the spatial distribution of all data points and may not be reflective of the true distribution of contaminants at a site. Second, since each polygon is associated with one sample point, no estimate of the accuracy or error in the average value is possible. Finally, the method, unlike several other interpolation schemes, does not assume that points that are closer together are more similar than points that are farther apart. The method for calculating an area-weighted average using Thiessen polygons is discussed in section 5.

2.6 Depth-Weighted Average

Depth-weighted averaging methods are used to develop an average or EPC for a specific borehole where multiple samples at varying depth intervals have been obtained. In characterizing a source area with multiple boreholes, the depth-weighted averages from each borehole can be used in a 95% UCL calculation. The methodology for depth-weighted averaging is described in EPA's *Soil Screening Guidance: User's Guide* (EPA 1996, section 2.3).

2.7 Volume-Weighted Average

Volume-weighted averaging methods are a combination of area- and depth-weighted averaging techniques. They are rarely used in risk assessment evaluations.

3 General Considerations for Estimating Exposure Point Concentrations

Estimating EPCs requires considering several issues. Prior to performing the computations, consider the information in the following sections.

3.1 Surface and Subsurface Soil Concentrations

When evaluating exposure point soil concentrations consider the following:

- The spatial resolution of the data must be sufficient. While the exact number of necessary samples cannot be specified, data should be available from areas of known or likely sources, and the EU should be defined for a given pathway and receptor.
- Historical data should be examined closely prior to inclusion in the EPC estimate, particularly if the petroleum COIs are susceptible to biodegradation (such as petroleum hydrocarbons), volatilization, or leaching. If sufficient new data are collected, they may be used for risk evaluation and the old data may be disregarded. A new release requires the collection of additional data.
- If there is a "high" density of soil samples (>30) for a homogeneous EU and sample locations are approximately equally spaced, the arithmetic average may be

used instead of the 95% UCL or the area-weighted average. This method is acceptable because the area-weighted average, arithmetic average, and UCL concentrations will tend to converge (EPA 1992a) if the underlying population can be assumed to be normally distributed. The >30 value mentioned above should also be considered in relation to the size of the EU and may not be appropriate for very large EUs.

- ND soil samples located at the periphery of the EU (e.g., the footprint of a building) should not be used.
- ND samples (also referred to as left-censored data) located within the EU require special treatment. The EPA has recently discouraged using replacement methods (such as half the detection limit) (EPA 2011a). The proportion of ND samples in the subject data set and whether multiple detection limits exist will affect the specific methods used to generate summary statistics and the UCL. EPA ProUCL 4.1 software has several options for handling left-censored data. Consult the technical guidance accompanying the software to determine which method is most appropriate for the specific data set and how to treat the censored data (EPA 2011a).
- If multiple surficial soil samples and/or multiple subsurface soil samples are available from the same borehole within the EU, the depth-weighted average or arithmetic average concentration of these samples may be used. If the samples are equally spaced, the depth-weighted average concentration will be the same as the arithmetic average concentration.
- An alternative to using discrete soil samples to calculate the UCL is to use incremental sampling methodologies (USACE 2009; Hawaii DOH, section 4 2008; Alaska DEC 2009; ITRC 2012). Incremental sampling is a sampling approach to obtain a pooled sample for analysis that has an analyte concentration representative of the EU. While it is similar to composite sampling, the incremental approach takes into account sample size to reduce variability and also allows for the calculation of a UCL while only requiring a few samples for laboratory analysis. It typically requires greater up-front planning with respect to sampling design, methodology, and defining of data quality objectives than traditional composite sampling.
- If vapor intrusion is a potentially complete pathway, collecting soil vapor data, in lieu of soil samples, for characterizing the potential risk should be considered. Consult Appendix G (Evaluation of the Vapor Intrusion Pathway) and section 4.5 of this appendix for sampling details.

3.2 Ground Water Concentrations

Follow the guidelines listed below to account for the temporal and spatial variation in ground water concentrations. These recommendations apply primarily to evaluation of ground water data for the purpose of estimating EPCs for risk evaluation.

They are not intended for cases where other monitoring objectives, such as determining compliance with cleanup criteria or site closure, are the primary goals.

- For wells with a clear increasing or a decreasing trend, data from the most recent 12 months or the 4 most recent measurements should be averaged (use whichever covers the longer duration). Note that for wells with increasing trends, continued monitoring may be needed until the trend stabilizes or decreases. The need for additional monitoring is a site-specific determination that is dependent on a number of factors, including the magnitude of measured concentrations in relation to risk-based criteria, the degree to which samples are representative and address site factors such as seasonality, and the estimated travel time of contamination from the release area to ground water and to potential receptors. For example, four measurements, taken at appropriate intervals over the course of a year, show an increasing trend but are all below applicable risk criteria. Further monitoring to develop an EPC may not be necessary.
- For wells with stable or fluctuating concentrations with no apparent trend, data from either the most recent 24 months or the 8 most recent measurements should be used to develop a 95% UCL.
- If site ground water analytical data are limited (number of wells or number of sampling events) and prevent adequate statistical analysis, using the maximum concentrations is preferred. Using the average concentration is discouraged, particularly if the plume stability status (increasing, decreasing, or stable) with respect to the release is unknown or the representativeness of the available data is in question.
- While developing the EPC for wells described by the first two bullets above, the treatment of left-censored data (concentrations below detection limits) deserves special consideration and may require specialized analysis techniques. Replacement techniques (such as using half the detection limit) are currently discouraged by the EPA (EPA 2011a). If the percentage of ND values is a significant percentage of the total number of data points (>25%), the representativeness of the data set for the EU in question should be evaluated.
- Wells with concentrations consistently below detection limits in the periphery of the EU should not be used.
- For wells that contain free product where it is not possible to obtain a representative dissolved phase sample, the use of the effective solubility of petroleum COIs should be considered as a conservative surrogate for their chemical concentration in estimating EPCs.

Two useful documents that provide guidance on the statistical evaluation of ground water monitoring data are the EPA's unified guidance (EPA 2009) and DEQ's *Statistical Guidance for Determining Background Ground Water Quality and Degradation* (DEQ 2009).

4 Calculation of Exposure Point Concentrations

An EPC is necessary for each complete exposure pathway at a site. Based on the pathways typically considered in the risk evaluation process, the EPCs listed below are typically needed for each media.

4.1 Surficial Soil (0–1 Foot below Ground Surface)

The risk evaluation process requires consideration of two pathways of exposure associated with the surficial soil: 1) the ingestion of chemicals in ground water due to leaching of residual chemicals present in the surficial soil and 2) the accidental ingestion of soil, outdoor inhalation of vapors and particulates from surficial soil emissions, and dermal contact with surficial soil. These two pathways are referred to as the ground water protection and direct soil contact pathways, respectively. Thus, at most, two different surficial soil EPCs are required, though typically one EPC estimate can be used for both pathways.

4.1.1 Exposure Point Surficial Soil Concentration for the Ground Water Protection Pathway

Figure 1 shows a schematic of the soil leaching to ground water pathway. The evaluation of this pathway for surficial soil assumes that the contamination does not extend greater than 1 foot below ground surface. If this is not the case, then samples taken in the surficial soil zone should be included with those from greater depth and evaluated together.

The conceptual model for this pathway also assumes that the leachate from the surficial (or subsurface) soil source travels vertically downwards to the water table without any lateral or transverse spreading. Thus, the horizontal dimensions of the surficial (or subsurface) soil source and the ground water source are identical. Estimating the source dimensions requires considerable professional judgment. Factors typically considered in making these estimates include historical knowledge of where a spill or source was located, visual clues such as soil discoloration, and laboratory data (taking care not to include samples with ND results.

Irrespective of the manner in which the source area is identified, it is important to indicate the dimensions of the source on a map. The exposure point surficial soil source concentration should be estimated using only the surficial soil data collected within the delineated source zone. The method used to derive the EPC should typically be either the UCL of the mean (when the quantity and characteristics of the data available allow a statistical analysis) or the values derived from an incremental sampling approach.

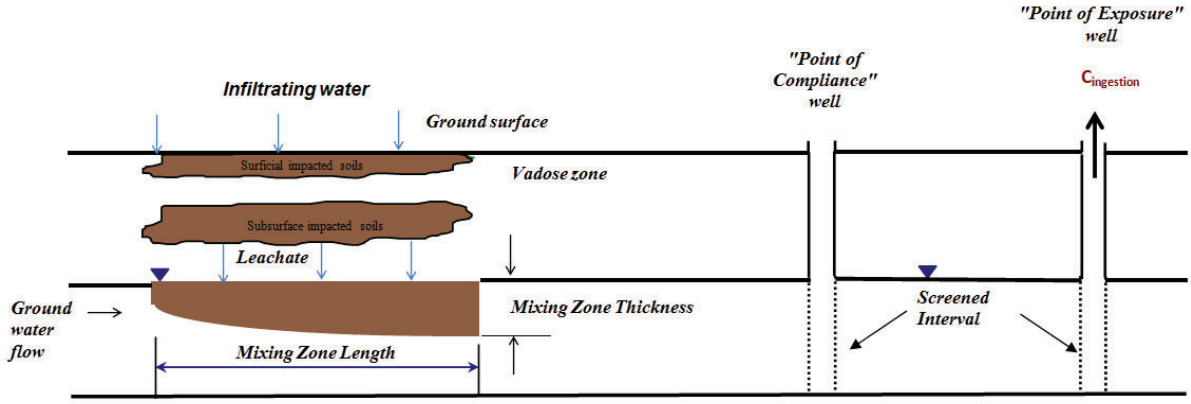


Figure 1. Schematic of soil leaching to ground water

4.1.2 Exposure Point Surficial Soil Concentrations for the Direct Contact Pathway

For this pathway, the exposure point surficial soil concentration has to be based on the receptor's EU (i.e., the area over which the receptor may be exposed to the surficial soil). The exact location of this area is often difficult to estimate since it must be representative of a period of time equal to the receptor's exposure duration (for example, up to 30 years for residential land use and about 7 years for nonresidential land use). In most cases, it is reasonable to assume that the receptor will access all portions of the EU in a random manner. Under current conditions, in the absence of specific information about the receptor's activities, the unpaved portion of the site may be considered as the receptor's approximate EU. Where volatile organic compounds (VOCs) are included in the list of potential petroleum COIs and/or the paved portion is in poor condition or consists of a material that does not limit VOC migration, this guide would not apply. For potential future exposures, if current condition cannot be assumed to continue, the assumption should be made that the pavement is removed, exposure to surficial soil is possible, and the entire site should be considered as the EU.

If the possibility exists that, for a future use residential scenario, contaminated subsurface soil existing under a current nonresidential scenario may be brought to the surface and result in direct contact residential exposures at the surface, the appropriate subsurface data should be included in the estimate of the EPC.

To estimate the EPC for this pathway, it would be necessary to estimate the receptor's area of exposure and determine the number of soil samples available within this EU. This information should be used to estimate the 95% UCL or an area-weighted average concentration using the procedures discussed in section 5. The use of an incremental sampling approach for characterizing EPCs for this route of exposure may be particularly well-suited and efficient.

4.2 Subsurface Soil (Greater Than 1 Foot below Ground Surface)

The risk evaluation process includes two pathways of exposure associated with subsurface soil: 1) the ingestion of chemicals in ground water or exposure to surface water impacted by discharge of contaminated ground water resulting from leaching of chemicals in subsurface soil and 2) indoor inhalation of vapor emissions. These two pathways are referred to as the ground water protection and vapor intrusion pathways, respectively. Thus, two different subsurface soil EPCs are required (one for each complete pathway). Additional EPCs may be required if the receptor's EU for current and future conditions is different.

4.2.1 Exposure Point Subsurface Soil Concentration for Ground Water Protection Pathway

The leachate from the subsurface soil source is assumed to travel vertically downwards without any lateral or horizontal spreading (Figure 1). Thus, the EPC for this pathway should be based on the subsurface soil concentrations measured within the source area.

As in the case of the surficial soil concentration protective of ground water (section 4.1.1), the exposure point subsurface soil source concentration would be the average concentration calculated using the data within the soil source area. If the source area is small (several tens of feet across), typically smaller numbers of soil samples are available. In this case, the 95% UCL should first be calculated if the sample numbers for applicable data are adequate. If the 95% UCL exceeds the maximum concentration, it may be appropriate to use the maximum concentration.

4.2.2 Exposure Point Subsurface Soil Concentration for Vapor Intrusion Pathway

The use of soil concentration data and development of exposure point soil concentrations for evaluation of vapor intrusion, while allowable, is not as desirable as the use of soil vapor data. The use of soil vapor data is discussed in more detail in Appendix G (Evaluation of the Vapor Intrusion Pathway) and in section 4.5 of this appendix.

The default methodology and model used to estimate the risks resulting from the indoor inhalation of vapors emanating from a contaminated subsurface soil source is the Johnson and Ettinger model (Johnson and Ettinger 1991). The Johnson and Ettinger model assumes that the chemicals volatilize from a subsurface soil source, travel vertically upwards via diffusion without any lateral or transverse spreading, and enter the building via advection through cracks in the foundation. Because this model does not account for biodegradation (an important attenuation process for petroleum hydrocarbon chemicals), the predictions are generally considered conservative for these chemicals. Other models that do incorporate biodegradation, such as the BioVapor model (API 2010) may also have applicability.

To be completely consistent with the Johnson and Ettinger conceptual model, the EPC for this pathway would be based on the soil concentrations measured in the soil directly below the enclosed space. In many cases, this is not possible. Furthermore, depending on site conditions (such as the location of pavement, preferential pathways, and site lithology), vapors from source areas adjacent to but not under an existing structure may contribute to indoor inhalation exposures. The goal should be to characterize the average soil concentration in the source area that may potentially contribute vapors to any existing or potential future structures. If the pathway is considered complete for current conditions, appropriate samples for EPC estimates should be selected to achieve this goal. Samples should be focused in the immediate vicinity of any existing structures as well as within 50 feet of the structure. If free product is suspected or known to exist in the area around the structure, sampling locations should be extended to 100 feet. If current and reasonably anticipated future land uses are the same, the EPC calculation is unchanged for future uses.

To evaluate EPCs for potential future vapor intrusion (e.g., in the event that an enclosed structure is constructed on top of contaminated soil), it is necessary to determine the nature of any future structure and estimate the size (footprint) of the structure and its location.

If the location and characteristics of future structures are known, the EPC should be conservatively estimated using samples from that vicinity, including the buffers mentioned above for existing structures. If the nature of future structures is not known, the assumption should be made that a structure could be placed anywhere on the property in question and potentially located directly over the source. The size of the structure would be assumed to be similar to that of the likely future land use, in most cases either residential or nonresidential. The default size of a residential structure assumed in this guidance is approximately 40 feet by 40 feet. For sites where the footprint of the current and likely future enclosed spaces are different, different exposure point subsurface soil concentrations (one for current conditions and one for future conditions) may be necessary. The 95% UCL or area-weighted average methods may be used, as appropriate. Where multiple boreholes with several depth interval samples are available, a depth-weighted average from individual boreholes can be developed.

4.3 Exposure Point Concentration for Protection of a Construction Worker

The risk evaluation process includes the evaluation of one pathway of exposure for construction workers: accidental ingestion, dermal contact, and outdoor inhalation of vapors and particulates from soil.

For the construction worker, no distinction is made between the surficial and subsurface soil because subsurface soils may be exposed during construction. To estimate the EPC for the construction worker, it is necessary to identify the depth, areal extent, and number of samples taken within the zone of construction. The potential future depth of construction can be estimated by contacting local construction firms and identifying the typical depth of utilities on and adjacent to the site, contacting local utility companies, or

using as-built plans for proposed facilities if they exist. If the areal extent of the construction area is not known, it may be conservatively estimated as the source area. If sample results are available for several depth intervals, these should be averaged using depth weighting. The depth-weighted averaged values from multiple boreholes could then be combined to calculate a 95% UCL or area-weighted average, as appropriate. The EPC would be the depth-weighted average concentration within this zone of construction.

4.4 Ground Water

The risk evaluation process requires evaluating two routes of exposure associated with shallow ground water: 1) ingestion of ground water and 2) indoor inhalation of vapor emissions from ground water. Where multiple aquifers are present, the shallowest aquifer is typically the aquifer first considered for both pathways. Site-specific circumstances—such as the disappearance of the shallow aquifer or transport of contamination to the deeper aquifer—may require evaluation of both aquifers. Characterization of petroleum COIs in both aquifers should still be performed. At a minimum, two different ground water EPCs, one for each complete pathway, are required.

4.4.1 Exposure Point Compliance Well Concentration for Ground Water Protection Pathway

For the ingestion of ground water pathway, maximum contaminant levels (MCLs) or equivalent concentrations have to be met at the point of exposure location. Often, the point of exposure well location is hypothetical and data may not be available. Alternatively, if a point of exposure well is present, an upgradient sentry or compliance well is often used as an early warning monitoring location. In both of these cases, ground water transport models are used to calculate the predicted concentrations at the point of exposure based on source area concentrations, the allowable concentrations in the source area, or an alternate point of compliance location concentration that will result in acceptable concentration at the point of exposure. In any case, EPCs will need to be estimated for the source area or for the alternate point of compliance location. In addition, one or more compliance wells have to be identified, and target compliance well concentrations (typically higher than the exposure well concentration) have to be calculated at these wells.

To evaluate this pathway, the EPCs in the source area, point of compliance, or point of exposure locations should be calculated based on the measured concentrations as discussed below. In most cases, a rule of thumb is that measurements taken more frequently than quarterly would not be considered statistically independent samples, would not be accepted to meet the specified number of measurements, and should not be used for statistical analysis and hypothesis testing (DEQ 2009). Methods to evaluate temporal independence are discussed in EPA 2009 and DEQ 2009.

- For wells with no clear trend, the EPC should be estimated as the 95% UCL if the data permit. Where the calculated 95% UCL exceeds the maximum concentration or if the data are not suitable for statistical analysis, the maximum concentration should be used as the EPC. For compliance wells with stable, clearly decreasing,

or clearly increasing trends, the EPC is estimated as the 95% UCL of the most recent 1 year of data or most recent 4 measurements, whichever represents the longer time duration. For wells with an increasing concentration trend, continued monitoring may be needed until the trend stabilizes. Quarterly data for at least 1 year is recommended. The data should be pooled for source area characterization where multiple wells are available (DEQ 2009). Wells clearly not part of the source area of contamination should not be included in the calculations.

4.4.2 Exposure Point Ground Water Concentration for Protection of Indoor Inhalation Pathway

Ground water concentrations protective of indoor inhalation are commonly estimated using the Johnson and Ettinger model (Johnson and Ettinger 1991). This model assumes no lateral or transverse spreading or attenuation of the vapors as they migrate upward from the water table through the capillary fringe, the unsaturated zone, and into the enclosed space. Thus, the EPCs for this pathway should be based on the ground water concentration measured within and adjacent to the footprint of the building. Refer to section 4.2.2 for discussion related to the future land use footprints and their relationship to the impacted area.

For the indoor inhalation of vapor emissions from ground water, multiple EPCs may be required if the plume has migrated below several current or potential future buildings. For example, if a plume has migrated or is likely to migrate below two different buildings (for example on-site and off-site buildings), separate on-site and off-site EPCs should be estimated.

If the plume has migrated below several buildings with similar receptors (residential or commercial), it may be sufficient to evaluate this pathway only for the building below which the concentrations are the highest and/or the depth to ground water is the lowest. If this building is protective of indoor inhalation exposures, it may not be necessary to evaluate other buildings.

The plume may not be in the proximity of current structures. If assumed future land use includes the possibility of building structures in the vicinity of the plume, a similar calculation of EPCs and risk should be made using appropriate assumptions about the location and type of future structures.

While the target ground water concentrations are based on the assumption of no lateral or transverse spreading of the vapors as they diffuse upwards to the building, site characteristics such as site lithology and preferential pathways may result in lateral migration towards a structure. For this reason, the EPCs should be conservatively based on data gathered adjacent to the structure. After identifying the locations of the building footprints and the appropriate ground water monitoring data within and adjacent to each footprint, the 95% UCL or area-weighted average concentration within each footprint may be estimated, as discussed in section 5.

4.5. Soil Vapor

Soil vapor is used exclusively to evaluate the risk posed via the vapor intrusion pathway. Many of the same considerations discussed for the development of EPCs using soil data in section 4.2.2 also apply to soil vapor data. However, one important difference is that, similar to ground water concentrations, the number of soil vapor sample locations is typically fewer than with soil data and the use of statistical methods is precluded. In most cases, because of the variability commonly observed with vapor measurements and the uncertainty of vapor flow paths from the subsurface into indoor spaces, it is preferable to use the maximum concentrations measured within the defined EU. Where multidepth sampling of soil vapor has demonstrated attenuation of concentrations and the presence of a sufficient thickness of oxygenated soil conditions, the use of lower concentrations may be acceptable. Sufficient sample numbers are more often available where source areas or the buildings under consideration are large. In these situations, the use of area-weighted averaging or other statistical methods may be appropriate.

5 Estimating Area-Weighted Exposure Point Concentrations

Area-weighted EPCs can be estimated using the Thiessen polygon method (Fetters 1993; Linsley et al. 1975). If the available data are located on a uniform grid, the area-weighted average would be the same as the arithmetic average. If the dimensions of the source and the receptor's EU are relatively small (several tens of feet across) and very few (1 to 6) soil samples are available within the soil source, the arithmetic average concentration may be used as an approximation of the area-weighted average concentration.

5.1 Step 1: Identify the Exposure Unit

The first and most critical step is to identify the size and location of the EU over which the area-weighted EPC has to be estimated. The location and size of this EU will often vary depending on the pathway being evaluated. Specific guidance on the location of the receptor's area of exposure has been discussed in sections 3 and 4. Area-weighted concentrations can only be estimated if multiple samples have been collected within the unit. If several samples are available just outside the EU, it may be reasonable to extend the size of the unit to include this data. If the values of these samples are ND, they should not be included. This exclusion is technically justified since at most sites the location of the EU is approximate at best.

As part of Step 1, the various EUs for which area-weighted concentrations are desired should be drawn on a site map. The location of data points (soil borings, monitoring wells, etc.) should also be clearly labeled on the map.

If the borings or monitoring wells within the EU are located in a regular grid, the calculation of an area-weighted average is unnecessary and the user should proceed with an EPC calculation using a different method, such as the 95% UCL.

5.2 Step 2: Subdivide the Exposure Unit

The EU, identified in Step 1, is discretized into polygonal elements by connecting the sampling points within each EU (also identified in Step 1) and drawing perpendicular bisectors to these lines to form polygons. The area of each Thiessen polygon is then estimated.

5.3 Step 3: Estimate Exposure Point Concentrations for Each Thiessen Polygon

The concentration measured at the sampling location within each polygon is considered representative of the area of each polygon. As discussed in section 3, if multiple data are available from a location (either multiple depths or dates), compute the arithmetic average concentration of each petroleum COI measured at that location. The arithmetic concentration is then considered representative of the polygon.

5.4 Step 4: Estimate Area-Weighted Average Concentration for the Exposure Unit

The area-weighted average concentration for the EU is estimated using Equation 1:

$$C_{area} = \frac{\sum_{i=1}^{i=n} (A_i * C_{avg,i})}{A_{Total}} \qquad \text{(Equation 1)}$$

Where,

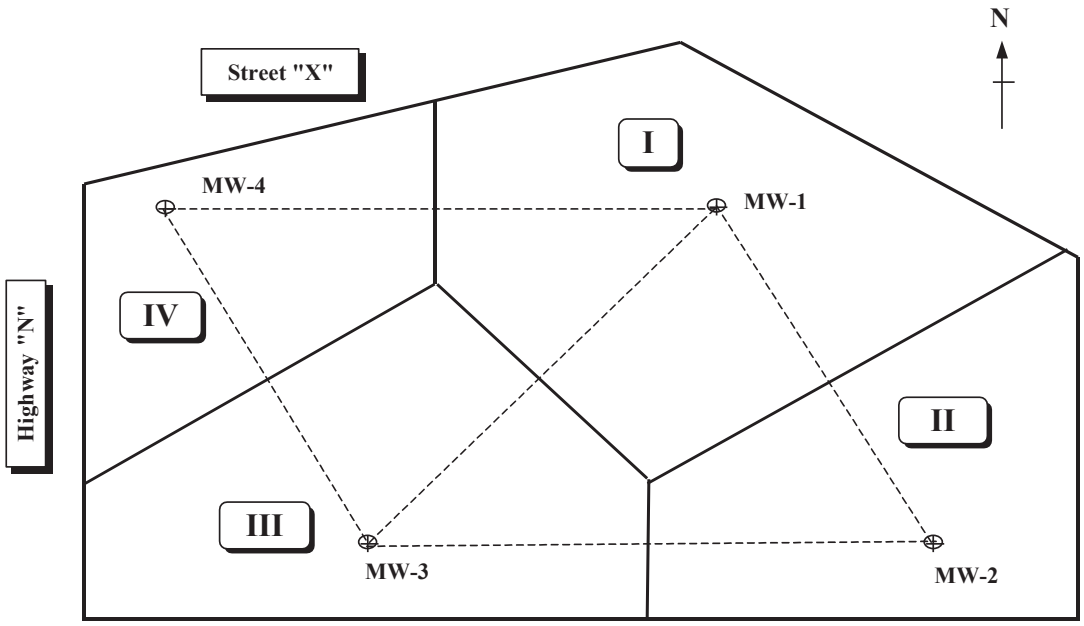
C_{area} = area-weighted average concentration over the EU [mg/kg]

A_i = area of each Thiessen polygon [m^2]

A_{Total} = total area of the polygons (i.e., area of the EU) [m^2]

$C_{avg,i}$ = mean of soil or ground water concentrations measured within the polygonal element *i* [mg/kg]

An example application of the Thiessen polygon method is schematically shown in Figure 2.



Polygonal Element	Mean Soil Concentration $C_{avg,i}$ mg/kg	Area of the Element A_i m^2	$A_i * C_{avg,i}$ m^2 - mg/kg	Area Weighted Average Concentration mg/kg
I	2	604	1208	
II	1.8	398	716.4	
III	1.2	578	693.6	
IV	1	234	234	
	TOTAL	**1814**	**2852**	
Area Weighted Average Concentration = $C_{area} = \frac{\sum_{i=1}^{i=n}(A_i * C_{avg,i})}{A_{Total}}$				**1.57**

Figure 2. Thiessen polygon method

6 Recommendations

- For most pathways, 95% UCL techniques are recommended for development of EPC estimates of average concentrations. For cases where the number of samples is low (four or fewer) and/or the number of ND values is high, the use of the maximum concentration may be most appropriate. The use of the maximum may also be appropriate when the calculated 95% UCL exceeds the maximum concentration measured at the site and the collected data are considered representative of site and EU conditions.
- The use of area-weighted average methods is not recommended for most pathways, but may be justified in developing EPCs for the surficial soil pathways. The inclusion of methods that evaluate and incorporate spatial uncertainty into the area-weighted average calculation increases the validity of the estimate derived (Burmaster and Thompson 1997).

This page intentionally left blank for correct double-sided printing.

References

API (American Petroleum Institute). 2010. BioVapor Indoor Vapor Intrusion Model. http://www.api.org/ehs/groundwater/vapor/bio-vapor-intrusion.cfm

Alaska DEC (Alaska Department of Environmental Conservation). 2009. *Draft Guidance on Multi-Increment Sampling*. Juneau, AK: Alaska DEC, Division of Spill Prevention and Response.

Burmaster, D. E., and K. M. Thompson. 1997. *Estimating Exposure Point Concentrations for Surface Soils for Use in Deterministic and Probabilistic Risk Assessments*. Human and Ecological Risk Assessment 3(3):363–384.

DEQ (U.S. Department of Environmental Quality). 2009. *Statistical Guidance for Determining Background Ground Water Quality and Degradation*. Boise, ID: DEQ. Version 2008-1.

EPA (U.S. Environmental Protection Agency). 1992a. *Supplemental Guidance to RAGS: Calculating the Concentration Term*. Washington, DC: EPA, Office of Emergency and Remedial Response, Hazardous Site Evaluation Division. OSWER Directive 9285.7.08.

EPA (U.S. Environmental Protection Agency). 1996. *Soil Screening Guidance: User's Guide*. Second edition. Washington, DC: EPA, Office of Solid Waste and Emergency Response. Publication 9355.4-23.

EPA (U.S. Environmental Protection Agency). 2009. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance.* Washington, DC: EPA, Office of Resource Conservation and Recovery, Program Implementation and Information Division.

EPA (U.S. Environmental Protection Agency). 2011a. *ProUCL Version 4.1 Technical Guide (Draft).* Washington, DC: EPA. EPA/600/R-07/041. Available at: http://www.epa.gov/osp/hstl/tsc/softwaredocs.htm .

EPA (U.S. Environmental Protection Agency). 2011b. *ProUCL Version 4.1 Users Guide (Draft).* United States Environmental Protection Agency. EPA/600/R-07/038. May 2011. Available at: http://www.epa.gov/osp/hstl/tsc/softwaredocs.htm.

Fetters, C. W. 1993. *Contaminant Hydrogeology*. New York: MacMillan.

Gilbert, R. O. 1987. *Statistical Methods for Environmental Pollution Monitoring*. Van Nostrand Reinhold Company Inc.

Hawaii DOH (Hawaii Department of Health). 2008. *Technical Guidance Manual for the Implementation of the Hawaii State Contingency Plan*. Interim Final. Honolulu, HI: Hawaii DOH. Section 4 available at http://www.hawaiidoh.org/tgm-pdfs/HTGM%20Section%2004-02.pdf.

ITRC (Interstate Technology Regulatory Council). 2012. Incremental Sampling Methodology. *Technical and Regulatory Guidance*. February 2012. Available at: http://www.itrcweb.org/ism-1/.

Johnson, P. C., and R. A. Ettinger. 1991. *Heuristic Model for Predicting the Intrusion Rate of Contaminant Vapors into Buildings*. Environmental Science and Technology 25(8):1445–1452.

Linsley, R. K., M. A. Kohler, and J. L. H. Paulhus. 1975. *Hydrology for Engineers*. Second Edition. Columbus, OH: McGraw-Hill Publishing Company.

USACE (U.S. Army Corps of Engineers). 2009. *Implementation of Incremental Sampling (IS) of Soil for the Military Munitions Response Program*. Huntsville, AL: USACE, Environmental and Munitions Center of Expertise. Interim Guidance 09-02. July 20 2009.

Other Useful References

EPA (U.S. Environmental Protection Agency). 1988. *Superfund Exposure Assessment Manual*. Washington, DC: EPA. OSWER Directive 9285.5-1. EPA/540/1-88/001.

EPA (U.S. Environmental Protection Agency). 1992b. *Guidance for Data Usability in Risk Assessment, Part A*. Washington, DC: EPA, Office of Solid Waste and Emergency Response. Publication 9285.7-09A.See especially chapters 5 and 6.

EPA (U.S. Environmental Protection Agency). 1997. *The Lognormal Distribution in Environmental Applications*. Washington, DC: EPA, Office of Solid Waste and Emergency Response. EPA/600/R-97/006. EPA (U.S. Environmental Protection Agency). 2001. *Risk Assessment Guidance for Superfund*: *Volume III—Part A*, *Process for Conducting Probabilistic Risk Assessment*. Washington, DC: EPA, Office of Emergency and Remedial Response. EPA 540-R-02-002. OSWER 9285.7-45.

EPA (U.S. Environmental Protection Agency). 2002a. *Estimation of the Exposure Point Concentration Term Using a Gamma Distribution*. Washington, DC: EPA, Office of Solid Waste and Emergency Response. EPA/600/R-02/084.

EPA (U.S. Environmental Protection Agency). 2002b. *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites*. Washington, DC: Office of Emergency and Remedial Response. OSWER 9285.6-10.

EPA (U.S. Environmental Protection Agency). 2006a. *On the Computation of a 95% Upper Confidence Limit on the Unknown Population Mean Based Upon Data Sets with Below Detection Limit Observations*. Washington, DC: EPA, Office of Research and Development. EPA/600/R-06/022.

EPA (U.S. Environmental Protection Agency). 2006b. *Data Quality Assessment: Statistical Methods for Practitioners, EPA QA-G-9S.* Washington, DC: EPA, Office of Environmental Information. EPA/240/B-06/003. Available at http://www.epa.gov/quality/qs-docs/g9s-final.pdf.

Remington, R. 2003. *Robust Confidence Interval Estimation on the Lognormal Mean*. M.S. Thesis. Moscow, ID: University of Idaho.

This page intentionally left blank for correct double-sided printing.

Appendix H: Application of Natural Attenuation

This page intentionally left blank for correct double-sided printing.

TABLE OF CONTENTS

Introduction 1
PART I: The Science of Natural Attenuation 1
1 The Concept of Natural Attenuation 1
2 Overview of Natural Attenuation Processes 2
2.1 Advection 3
2.2 Molecular Diffusion 4
2.3 Mechanical Dispersion 4
2.4 Hydrodynamic Dispersion 5
2.5 Sorption 5
2.6 Volatilization 5
2.7 Biodegradation 5
2.8 Overall Effect of Natural Attenuation Processes 6
2.8.1 Expanding Plume 7
2.8.2 Stable Plume 7
2.8.3 Shrinking Plume 7
2.8.4 Lifecycle of a Plume 7
3 Biodegradation of Petroleum Hydrocarbons 8
3.1 Composition and Amount of Hydrocarbons 9
3.2 Available Electron Acceptors 9
3.3 Quantity and Quality of Nutrients 10
3.4 Characteristics of Microorganisms 11
3.5 Indicators of Natural Attenuation of Hydrocarbon Plumes 11
3.5.1 Primary Line of Evidence 11
3.5.2 Secondary Line of Evidence 11
3.5.3 Tertiary (Optional) Line of Evidence 12
PART II: Process for the Implementation of Remediation by Natural Attenuation 14
4 Risk Management Plan for Remediation by Natural Attenuation 15
5 Source Characterization and Control 15
6 Plume Characterization 16
7 Reasonable Time Frame Determination 17
8 Monitoring to Demonstrate the Effectiveness of Remediation by Natural Attenuation 18
9 Contingency Measures 19
PART III: Techniques Available to Demonstrate Natural Attenuation 20
10 Techniques to Demonstrate the Occurrence of Natural Attenuation 20
10.1 Graphical Techniques 20

10.2 Statistical Evaluations 22
11 Techniques to Estimate the Site-specific Rate of Natural Attenuation 22
11.1 Mass Balance Analysis 23
11.2 Well Concentration-versus-Time Plot 23
11.3 Well Concentration-versus-Distance Plot 24
11.4 Evaluation of Plume Behavior with a Recalcitrant Tracer 25
12 Techniques to Quantify the Future Behavior of the Plume 25
References 27

LIST OF TABLES

Table 1. Expected pattern of natural attenuation indicators (secondary line of evidence) 12

LIST OF FIGURES

Figure 1. Schematic of a hydrocarbon release 3
Figure 2. Concentration profile as a function of distance (ideal behavior and data from an actual site) 6
Figure 3. Expected pattern of natural attenuation indicators (secondary line of evidence) 10
Figure 4. Concentration-versus-time plot of benzene 21

Introduction

This appendix presents general guidance on the applicability and implementation of remediation by natural attenuation (RNA) at petroleum release sites in Idaho. Its primary focus is on attenuation of ground water contamination. Attenuation of petroleum hydrocarbons has also been documented in other media such as soil and soil vapor. Attenuation in soil vapor is addressed in Appendix G, which discusses evaluation of the vapor intrusion pathway. This appendix is divided into three parts:

- Part I presents a brief overview of the science of natural attenuation (NA)
- Part II presents the regulatory requirements for implementing NA as a remedial option
- Part III discusses the techniques available to support, quantify, and implement NA as a remedial option

This document should be used in conjunction with the *Idaho Risk Evaluation Manual for Petroleum Releases* (REM) and publicly available literature when implementing RNA. Additional information is available in the references provided at the end of this document.

PART I: The Science of Natural Attenuation

Part I presents an overview of the science of NA, including the following topics:

- A brief overview of the processes that constitute NA (section 2)
- A description of how biodegradation operates in attenuating petroleum hydrocarbons (section 3)
- A description of the indicators of NA of hydrocarbon plumes (section 3.5)

1 The Concept of Natural Attenuation

The term natural attenuation refers to the reduction in concentration or mass of chemicals in a media due to the effects of various environmental fate and transport processes. NA occurs without human intervention. Although NA is applicable to a reduction in concentration in any medium (e.g., air, surface water, ground water), in this appendix it refers to the reduction in concentration of a dissolved ground water contaminant plume. For a ground water plume, environmental fate and transport processes include physical processes (advection, dispersion, dilution, sorption, and volatilization); chemical processes (hydrolysis, oxidation, and reduction); and biodegradation processes (aerobic and anaerobic). Physical processes are nondestructive in that they redistribute the chemicals in the environment without affecting the total mass of the individual chemical. Chemical transformation processes and biodegradation result in the transformation of the parent chemical into other chemicals referred to as daughter products.

The only human action involved in RNA is monitoring to demonstrate that concentration reduction is occurring at a reasonable rate. Depending on site-specific conditions, RNA may be used as a stand-alone corrective action strategy or in combination with other engineered remediation alternatives.

This guidance focuses on using NA on sites contaminated with petroleum products. NA has also been used at sites with other classes of contaminants, such as metals, explosives, and pesticides (USACE 1999; SNL 1997). The same concepts for evaluation, requirements for site characterization, and demonstrations as to effectiveness are required regardless of the class of contaminant. A general approach to the evaluation of the bioremediation aspects of NA for a range of biotreatable compounds is described in ITRC 2002.

2 Overview of Natural Attenuation Processes

Although each contaminated site is unique, for this discussion it is useful to consider a generic site where a petroleum spill has occurred. The soil immediately below and around the point of release becomes contaminated, and the contaminant front moves downward. The downward movement of the contaminant front continues until one of the following three conditions occurs:

- The soil sorption capacity exceeds the amount of contaminant available.
- An impermeable barrier is encountered and the contaminant spreads horizontally.
- The contaminant reaches the water table and, if it is a light non-aqueous phase liquid (LNAPL), spreads horizontally.

The term LNAPL relates to the density of the released contaminant. LNAPLs are chemicals that are liquid at ambient temperature but lighter than water. For example, the density of toluene is 0.866 grams per cubic centimeter (g/cc) compared to a density of 1 g/cc for water.

After the contaminant movement has stopped, the soil through which it traveled is contaminated with residual chemicals that act as a contaminant source for the ground water plume. Figure 1 shows a schematic of a LNAPL moving through the soil to the ground water.

When rainwater infiltrates through the residual contaminated soils, it dissolves and leaches out the soluble components. For petroleum hydrocarbons, the toxic soluble chemicals include, but are not limited to, benzene, toluene, ethylbenzene, and xylene (BTEX); the soluble additives methyl tertiary butyl ether (MTBE) and ethylene dibromide; and smaller fractions of other less-soluble constituents. After undergoing NA processes in the unsaturated zone, these dissolved chemicals reach the water table, mix with ground water, and move with the ground water to form a dissolved plume. At sites where the spill is of a sufficient quantity to reach the water table and form an LNAPL layer on the water table, soluble constituents from the LNAPL gradually dissolve in ground water and form a dissolved ground water plume.

Additionally, vapors of volatile hydrocarbons (chemicals with a Henry's Law constant greater than 1×10^{-5} atm-m^3/mole) will spread outwards from the contaminated soil and dissolve in soil moisture and ground water.

As the dissolved plume moves through the unsaturated and the saturated zones, its concentration decreases due to the combined influence of several NA processes. Each of these processes is briefly discussed below.

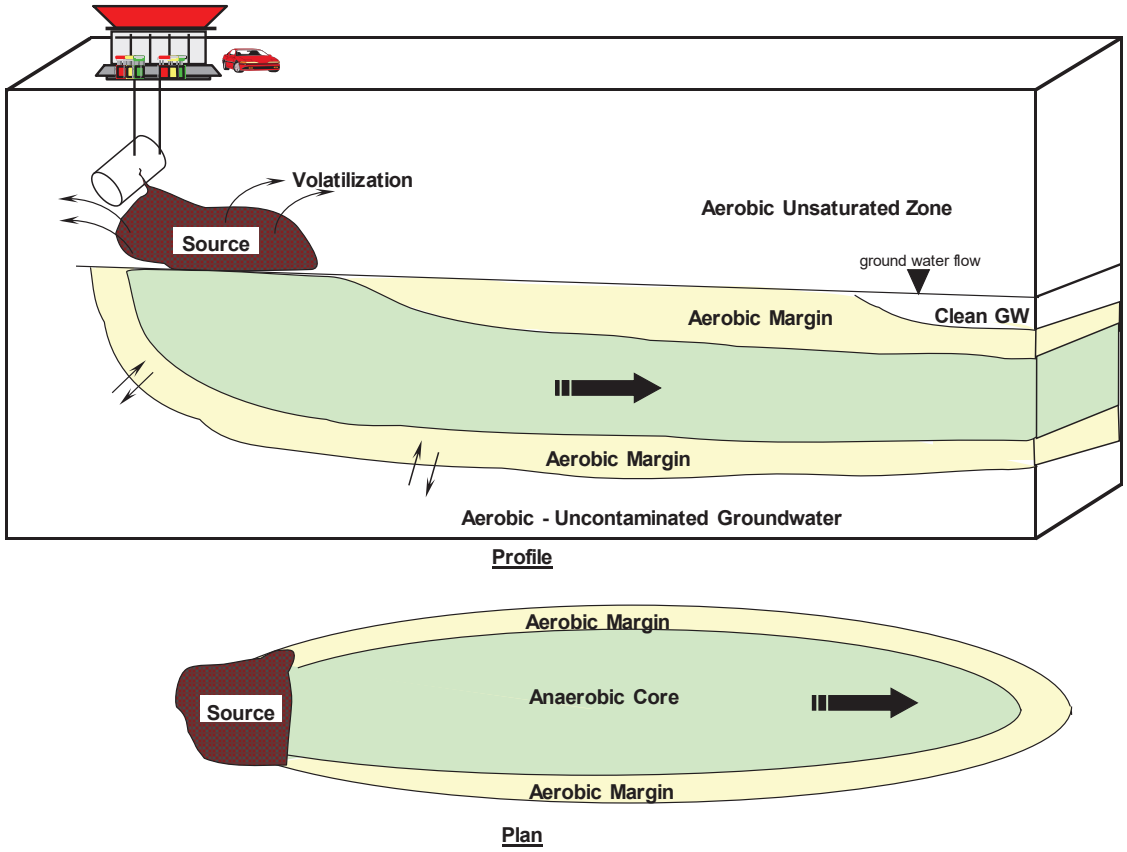


Figure 1. Schematic of a hydrocarbon release

2.1 Advection

Advection refers to the bulk movement or flow of water caused by differences in density, temperature, or pressure. In most aquifers, flow occurs predominantly due to hydraulic gradients, which may be natural—resulting in regional ground water movement—or man-made, caused by pumping or artificial recharge. In saturated zones, hydraulic gradients may exist in horizontal and vertical directions, resulting in complex three-dimensional flow patterns. However, at most sites there exists a predominant flow direction that results in the migration of most mass.

As water moves in the saturated zone, it carries with it the dissolved constituents. The process results in the migration of dissolved constituents in the saturated zone without a change in concentration and is termed advection.

Parameters required to estimate the volume of water moving through a saturated zone include the Darcy velocity and the cross-sectional flow area. Darcy velocity is estimated using hydraulic conductivity and hydraulic gradient.

Hydraulic conductivity may be estimated using a variety of methods, including slug tests, pump tests, grain size distribution, and literature values corresponding to the site stratigraphy. For most saturated zones, hydraulic conductivity varies in the horizontal and vertical directions.

Site-specific values of hydraulic gradients are estimated based on water-level measurements in monitoring wells, or piezometers. When estimating horizontal hydraulic gradients, it is important to compare data from wells screened in the same saturated zone. Wells screened in different zones or at different depths (e.g., cluster wells) can be used to estimate the vertical hydraulic gradient between the zones. Site-specific hydraulic gradients may exhibit seasonal and spatial variations (in magnitude and direction) due to a variety of factors such as pumping, seasonal flow in surface water bodies, and seasonal variations in rainfall.

Another related parameter used to estimate the travel time of a chemical due to advection is the seepage velocity, which requires an estimate of the porosity of the media. Typically, literature values corresponding to the aquifer type (e.g., sand or silt) are used to estimate porosity.

2.2 Molecular Diffusion

Molecular diffusion refers to the transport of chemical mass from a zone of higher concentration to a zone of lower concentration due to the movement of molecules. The effect of diffusion is to spread the chemical mass over a large area and hence reduce the overall concentration. Thus, diffusion results in a reduction in concentration by dilution. In most ground water systems where there is advection, the attenuation in concentration or the chemical mass transport due to diffusion is small and often negligible. However, in no-flow or low-flow situations, diffusion can be an important attenuation mechanism.

Molecular diffusion is quantified using Fick's Law, and the parameter required to quantify diffusion is the effective diffusion coefficient of the chemical (Freeze and Cherry 1979).

2.3 Mechanical Dispersion

Mechanical dispersion refers to the spreading of the contaminant plume that occurs due to variations in the flow velocity. In the saturated zone, velocity variations occur due to a variety of factors, including inter-pore and intra-pore velocity variations and the tortuosity of the porous media. The net effect of mechanical dispersion is that the chemical spreads both horizontally and vertically, thus reducing the overall concentration in the plume. Thus, like diffusion, dispersion is a dilution process.

The transport of mass due to mechanical dispersion is quantified using Fick's Law. The key parameters are the dispersivity coefficients in the three cardinal (x, y, and z) directions. Dispersivity values have been measured using tracers at several research sites, based on which empirical dispersivity relationships have been developed (EPRI 1985; Xu and Eckstein 1995). For most site-specific applications of fate and transport models, these empirical relationships are used. Higher dispersivity values result in larger plumes, which result in increased dilution and lower concentrations.

2.4 Hydrodynamic Dispersion

The term hydrodynamic dispersion refers to the sum of molecular diffusion and mechanical dispersion. In most ground water systems where there is advection, hydrodynamic dispersion is approximately equal to mechanical dispersion, since the effect of molecular diffusion is negligible.

2.5 Sorption

Sorption refers to the transfer or distribution of mass between the liquid and solid phases. Sorption has the overall effect of reducing the mobility of the chemical, which increases its residence time in the subsurface and hence the amount of microbial degradation. This distribution is quantified by the soil water partition coefficient. For organic chemicals, the partition coefficient depends on the chemical-specific normalized organic carbon partition coefficient and the organic carbon content in the soil. The partition coefficient is used to estimate the retardation factor for the chemical, which is a measure of the "stickiness" of the chemical to the formation. Parameters required to estimate the retardation factor include porosity, organic carbon content of soil, bulk density of soil, and chemical-specific normalized organic partition coefficient.

2.6 Volatilization

Volatilization refers to the transfer of chemical from the LNAPL or dissolved phase to the vapor phase. Vapors can migrate by diffusion alone (in the absence of a pressure gradient) and by diffusion and advection if a pressure gradient exists in the formation. Chemicals volatilizing from the dissolved plume occupy the pores in the unsaturated zone and migrate outwards due to the combined influences of molecular diffusion and vapor-phase advection if pressure gradients exist. Thus, volatilization can result in a net loss of chemical from the dissolved phase or from the LNAPL.

The chemical-specific factors controlling volatilization from a dilute solution and LNAPL are the Henry's Law constant and saturated vapor pressure, respectively. These factors are sensitive to the temperature of the media where volatilization occurs.

2.7 Biodegradation

Biodegradation refers to the destruction of chemicals by indigenous microorganisms present in the aquifer. For petroleum hydrocarbons, biodegradation is the primary

destruction mechanism. Due to the significance of biodegradation within the overall process of NA, biodegradation is discussed at length in section 3. In certain situations, additional compounds (e.g., ozone, oxygen, peroxide); nutrients; or microorganisms may be added to the contaminant plume to enhance the rate of biodegradation.

2.8 Overall Effect of Natural Attenuation Processes

As explained above, the process of NA refers to a combination of advection, molecular diffusion, dispersion, sorption, volatilization, chemical reactions, and biodegradation.

The combined effect of these processes is to spread or reduce the chemical mass in the dissolved plume. Thus, the concentration of the chemical decreases as distance from the source increases. Figure 2 shows the concentration profiles in actual monitoring wells down-gradient of a source and the expected concentrations under ideal conditions. Although such patterns have been observed at several sites, fluctuations in water levels, flow direction, and climatic conditions often result in nonideal behavior. Additional complications occur due to errors in data collection, analytical measurements, and the existence of multiple sources (in space and time) at a site.

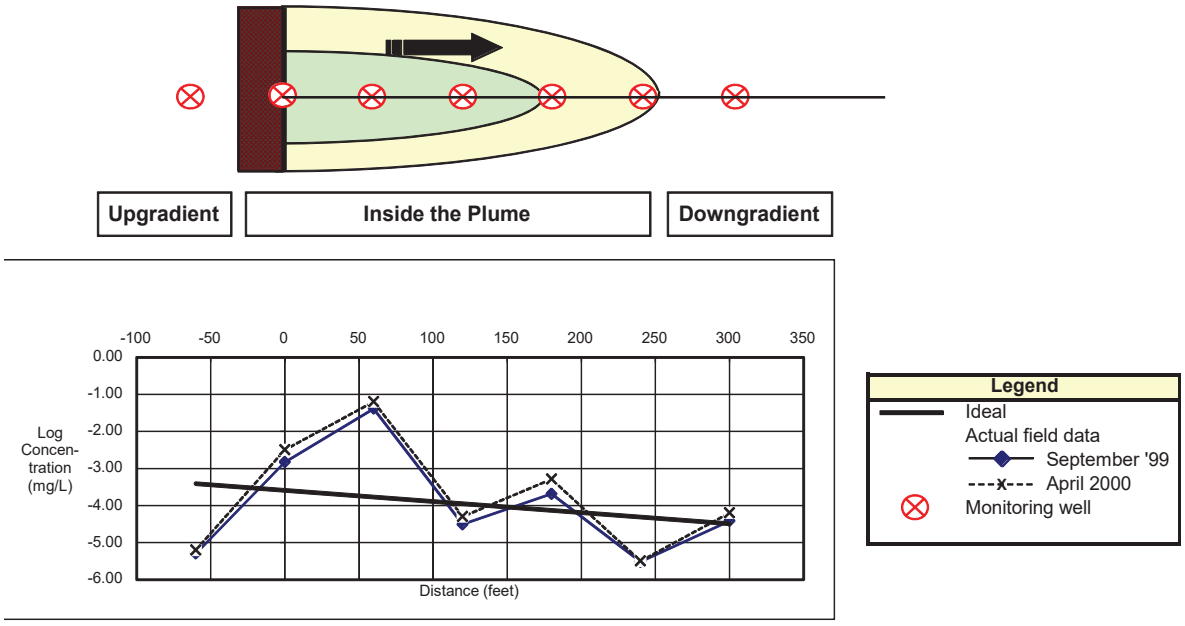


Figure 2. Concentration profile as a function of distance (ideal behavior and data from an actual site)

Depending on the overall rate of NA and the on-going contribution of chemicals to the ground water plume from the residual soil source, ground water plumes may be classified as expanding, stable, or shrinking. These concepts are discussed below.

2.8.1 Expanding Plume

An expanding plume is characterized by increasing concentrations within the plume and/or an outward movement of the plume that increases the size of the plume. An expanding plume occurs when the chemical mass loading to the plume from leaching or dissolution of residual LNAPL exceeds the mass loss due to NA processes.

In an expanding plume, NA processes continue to occur but at a rate too slow to prevent the increase in concentrations or the size of the plume.

2.8.2 Stable Plume

A stable plume is characterized by stable concentrations within the plume and at the periphery of the plume (i.e., the concentrations do not show a decreasing or increasing trend). For a plume to be stable in size or concentration, the rate of chemical mass addition to the plume from the source is equal to the rate of chemical mass loss by NA processes. The source may be the chemicals leaching from adsorbed and residual concentrations in the capillary/water table fluctuation zone or in the vadose zone or the dissolution of chemicals from the LNAPL source.

2.8.3 Shrinking Plume

A shrinking plume is characterized by decreasing ground water concentrations within the plume, decreasing concentrations at the periphery of the plume, or a decrease in the area of the plume. For a shrinking plume, the addition of chemical mass from the source is less than the mass lost due to NA processes. Thus, unless site-specific conditions change that result in an increase in chemical mass addition to the plume or a decrease in the rate of NA, the plume will eventually disappear.

2.8.4 Lifecycle of a Plume

Initially, when a chemical reaches the ground water and a plume forms, it is an expanding plume. The plume continues to expand as long as the addition of chemical mass from the source exceeds mass loss by NA processes. As the plume expands and occupies an ever-increasing portion of the aquifer, the loss of mass by NA processes increases. Thus, a point is reached when the mass addition equals mass lost, and the plume becomes stable. Because of the phenomenon of NA, most BTEX plumes resulting from service station spills become stable at lengths less than 500 feet, as demonstrated by numerous plume studies (Buscheck et al. 1996; Rice et al. 1995). At most sites, the chemical source is finite; in time, the mass loading from the source to the dissolved plume decreases. Meanwhile, the rate of mass loss due to NA processes increases or stays the same, so eventually the plume begins to shrink.

Under ideal conditions, all dissolved chemical plumes would follow the above lifecycle; however, real plumes may not follow this pattern due to a number of confounding factors, including the following:

- Variations in ground water velocities that affect the rate of NA
- Fluctuations in the water table that affect the source mass loading due to the release of chemicals trapped in the capillary fringe
- Variations in climatic conditions that affect the rate of NA
- Variations in rainfall and infiltration that affect mass loading to ground water
- Additions to the plume from new releases and spills from operating facilities

Because of the above complications, it is important to collect and evaluate all the site data and look at multiple lines of evidence to understand the plume behavior and predict its future behavior (see section 3.5).

3 Biodegradation of Petroleum Hydrocarbons

This section discusses the biodegradation of dissolved petroleum hydrocarbons and identifies the various indicators that should be measured to confirm biodegradation.

The biodegradation of hydrocarbons is the process by which naturally occurring subsurface microorganisms biodegrade contaminants. The process of biodegradation, as facilitated by microorganisms, can be represented by the general reaction:

Hydrocarbon + Electron Acceptors + Nutrients YIELDS *Carbon Dioxide + Water + Microorganisms + Waste Products*

The above biologically mediated reaction produces energy for cell growth and reproduction of the microbial population. The process of electron transfer results in the oxidation of the donor (hydrocarbon), reduction of the electron acceptor, and the production of usable energy for the organisms. Based on the principles of thermodynamics, biologically mediated reactions that yield the most energy are favored over reactions that yield less usable energy for the organisms. For hydrocarbons, biologically mediated reactions ideally occur in the following order:

1. Dissolved oxygen in the ground water is used as the electron acceptor.
2. After all oxygen has been depleted and anaerobic conditions exist within the dissolved plume, dissolved nitrate is used as the electron acceptor.
3. After the depletion of dissolved oxygen and nitrate, ferric iron is used as an electron acceptor and is reduced to ferrous iron.
4. After the depletion of oxygen, nitrate, and iron, sulfate is used by sulfate-reducing bacteria to degrade the hydrocarbons.
5. Finally, methanogenesis degrades the hydrocarbons.

While all petroleum hydrocarbons are biodegradable, the rate of biodegradation can differ significantly from site to site depending on the composition and amount of hydrocarbons; type and amount of available electron acceptors; type, number, and characteristics of the microorganisms; and quantity and quality of nutrients.

Site-specific measurements of these factors, comparison of these factors within and outside the plume, and temporal variations in these factors can be used to demonstrate the occurrence of biodegradation. Each of these factors is discussed below.

3.1 Composition and Amount of Hydrocarbons

Almost all petroleum hydrocarbons are biodegradable under aerobic conditions. The ease of biodegradation depends on the type of hydrocarbon. Low molecular weight hydrocarbons (e.g., C10 to C24 alkenes) and single-ring aromatics are the most easily biodegradable. As molecular weight increases, resistance to biodegradation also increases. Individual compounds degrade at different rates under aerobic and anaerobic conditions.

For most hydrocarbon-impacted sites, the primary chemicals of interest (from a risk perspective) are BTEX, MTBE, and naphthalene. Naphthalene and BTEX are readily degradable under aerobic conditions. Benzene typically degrades slower than other BTEX hydrocarbons under anaerobic conditions. The biodegradation and NA of MTBE has been a topic of current research (Moyer and Kostecki 2003; EPA 2005; API 2007). MTBE degrades under both aerobic and anaerobic conditions. However, the rates of MTBE degradation and controlling factors have not yet been firmly established.

3.2 Available Electron Acceptors

The biodegradation of hydrocarbons is essentially an oxidation-reduction reaction. In this reaction, the hydrocarbon donates the electron (i.e., the hydrocarbon is oxidized) and a second compound (the electron acceptor) is reduced. Of the several electron acceptors available in the subsurface environment, oxygen, because of its high energy yield, is typically used first by microorganisms. Anaerobic bacteria can use other electron acceptors, including the following:

- Nitrate (NO_3^-) that is reduced to nitrogen (N_2)
- Manganese (Mn^{4+}) that is reduced to water soluble Mn^{2+}
- Ferric iron (Fe^{3+}) that is reduced to water soluble Fe^{2+}
- Sulfate (SO_4^{--}) that is reduced to sulfide (S^-)
- Carbon dioxide (CO_2) that may be used by methanogens to yield methane (CH_4)

As the biodegradation of hydrocarbons occurs, the concentration of the electron acceptors decreases and the concentration of the products formed increases. This concept can be used to demonstrate the occurrence of biodegradation (i.e., secondary line of evidence, see section 3.5.2). Table 1 shows the expected relationship between the BTEX concentration and the electron acceptors and the products of the oxidation reduction reaction.

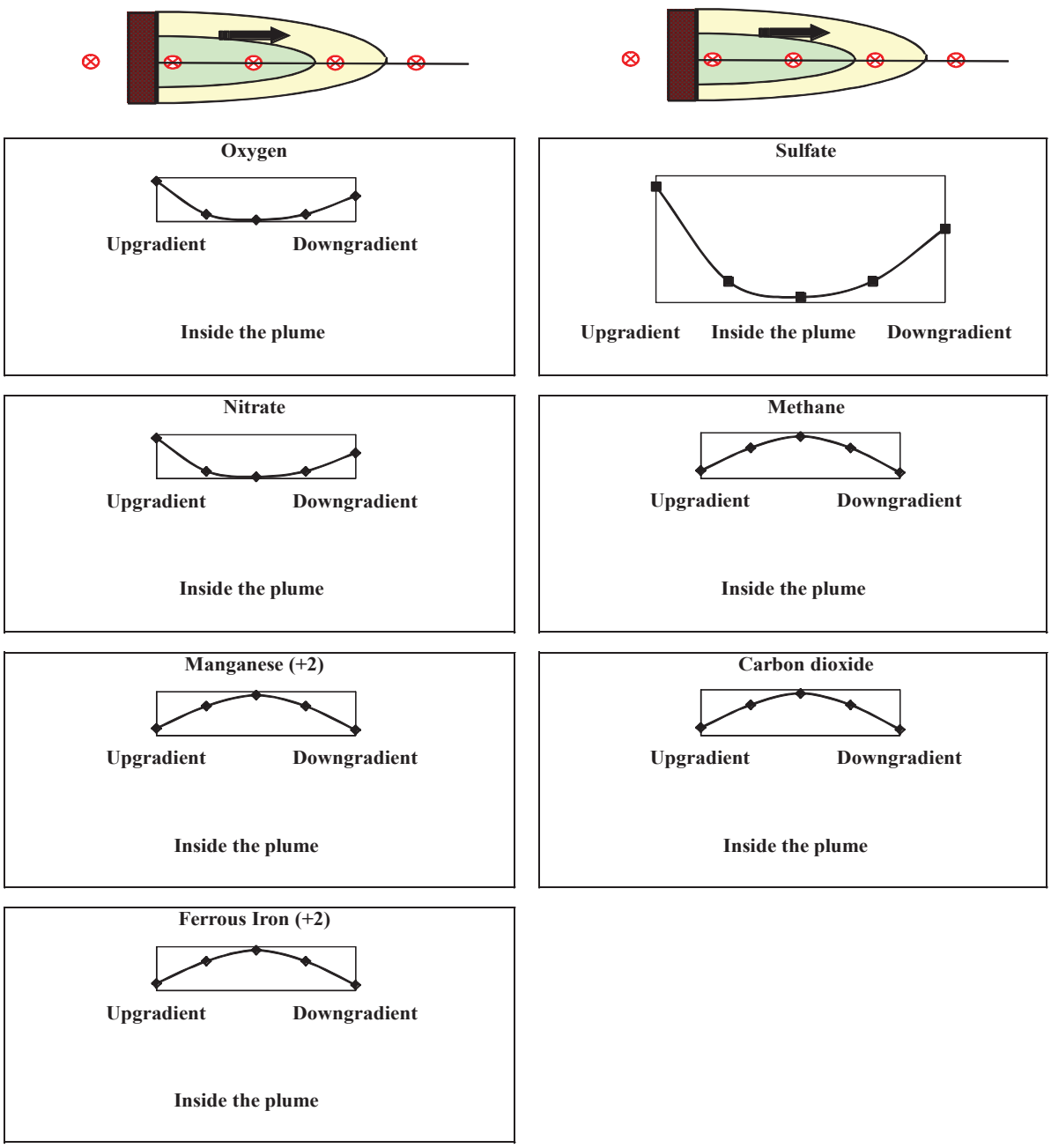


Figure 3. Expected pattern of natural attenuation indicators (secondary line of evidence)

3.3 Quantity and Quality of Nutrients

In addition to the electron acceptors, microorganisms also require nutrients. These nutrients are incorporated into the biomass and are necessary to form cells. The nutrients nitrogen and phosphorous are required in relatively large amounts. Small amounts of micro-nutrients—such as sulfur, manganese, and magnesium—are also required.

Certain compounds, such as nitrates and sulfates, can serve either as nutrients or electron acceptors. Nutrients are rarely a limiting factor in the subsurface biodegradation of petroleum hydrocarbons. A decrease in nutrient levels within the zone of degradation can indicate biodegradation.

3.4 Characteristics of Microorganisms

The ability of microorganisms to degrade a wide variety of petroleum hydrocarbons is well documented. Hydrocarbon-degrading microorganisms are widespread in the environment, as they occur in fresh water, salt water, soil, and ground water. The number of cells per milliliter of water can also be used as an indicator of biodegradation. As hydrocarbons degrade, the cell count for hydrocarbon-degrading bacteria increases. McKee et al. (1972) found 50,000 or more hydrocarbon-degrading bacteria per milliliter of water in samples from wells containing traces of gasoline, while a noncontaminated well had only 200 microorganisms per milliliter.

3.5 Indicators of Natural Attenuation of Hydrocarbon Plumes

Based on the information presented above, concentrations of several substances (hydrocarbons, electron acceptors, microorganisms, nutrients, and carbon dioxide) can be measured to demonstrate the occurrence of NA.

These measurements are typically divided into three tiers, or "lines of evidence" (i.e., primary, secondary, and tertiary lines of evidence), to demonstrate NA. Data collected under each line of evidence can be evaluated qualitatively or quantitatively.

3.5.1 Primary Line of Evidence

The purpose of the primary line of evidence of NA is to demonstrate the loss of chemical mass by evaluating measured petroleum hydrocarbon concentrations. Of all the methods available to demonstrate the occurrence of NA, this is perhaps the simplest and most useful to demonstrate site-specific reductions in risk. Site-specific application of the primary line of evidence requires an adequate number of correctly installed sampling points (monitoring wells), an adequate amount of chemical data from these points, and a thorough evaluation of these data. These issues are discussed in Parts II and III of this document.

Although the primary line of evidence can show whether the concentration of a plume is attenuating, it does not show whether the decrease is due to destructive mechanisms or merely dilution. Secondary lines of evidence are necessary to determine whether the decrease is due to biodegradation.

3.5.2 Secondary Line of Evidence

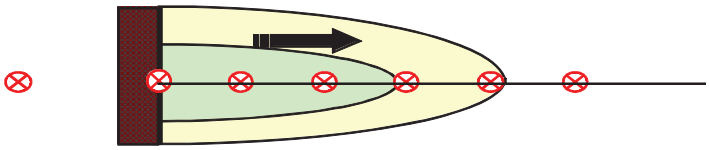
Secondary evidence of NA refers to measurements of electron acceptors and products of metabolism within the plume and their comparison with concentrations in the unimpacted area of the aquifer, where no biodegradation activity would be expected to occur.

Parameters that are typically measured in the field include dissolved oxygen, REDOX potential, dissolved nitrates, manganese, ferrous iron, sulfate, and methane. These parameters should be measured at up-gradient locations, inside the plume near the source, and at down-gradient locations. Expected patterns of these parameters that are indicative of biodegradation are shown in Table 1 and Figure 3.

As microorganisms consume chemicals, there is a corresponding consumption of the compounds that serve as electron acceptors. Thus, the concentration of these compounds would decrease in the portion of the plume where biodegradation is occurring. For example, under aerobic biodegradation, the concentration of oxygen would decrease, assuming oxygen is not being added to the plume. Similarly, under anaerobic conditions, a depletion of nitrate, ferric (III) iron, and sulfate can be expected.

Biodegradation also results in an increase in the concentration of metabolic byproducts. For example, increased concentrations of nitrite and ferrous (II) iron within the plume would be indicative of biodegradation.

Table 1. Expected pattern of natural attenuation indicators (secondary line of evidence)



	Upgradient	Inside the plume		Downgradient
BTEX	ND	High	Low	ND

Type of Reaction	Geochemical Indicator	Geochemical Indicator Concentration		
Aerobic	Oxygen	High	Low	High
Anaerobic	Nitrate	High	Low	High
	Manganese	Low	High	Low
	Ferrous Iron	Low	High	Low
	Sulfate	High	Low	High
	Methane	Low	High	Low
	Carbon dioxide	Low	High	Low

The secondary line of evidence demonstrates the occurrence of biodegradation only. It does not provide any data on the occurrence of other NA processes.

3.5.3 Tertiary (Optional) Line of Evidence

The tertiary (optional) line of evidence involves performing microbiological studies, such as identifying the microorganisms present in the formation and counting their cells, in an effort to demonstrate the occurrence of NA. Thus, the objectives of secondary and tertiary lines of evidence are similar. In the portion of the plume where NA is occurring, the ratio of petroleum degraders to the total number of bacteria should be higher than in

the uncontaminated portion of the plume due to the readily available petroleum energy source. Tertiary lines of evidence are seldom required at petroleum hydrocarbon impacted sites and are not discussed further.

PART II: Process for the Implementation of Remediation by Natural Attenuation

Remediation by natural attenuation refers to the achievement of site-specific cleanup goals using NA. As discussed in Part I, NA consists of several processes that occur at all contaminated sites at varying rates. As with any other remedial option, the site-specific applicability of RNA must be carefully evaluated before it is selected as the remedial alternative of choice. RNA should not be considered a presumptive remedy; rather, it is one of several available strategies that should be evaluated to ensure its applicability based on site-specific conditions.

The first step in any evaluation of NA is the collection of appropriate site characterization data. In general, the data collected need to confirm the occurrence of NA, the effectiveness of RNA, and that the receptors are not exposed to unacceptable risk throughout the period when the site is being remediated by NA. The data collected should help answer the following questions and support the activities described in the questions.

- Has the full horizontal and vertical extent of the source and the plume been delineated?
- Is the plume at steady state and is it stable or shrinking in size?
- Can contaminant degradation be demonstrated and quantified?
- Can the long-term behavior of the source and the plume be modeled?
- Can the time frame to achieve remedial cleanup goals be estimated?
- What is the impact of source removal/reduction on the remedial time frame?

Once the site has been characterized to document the feasibility of NA, an evaluation as to the site-specific appropriateness of NA as the preferred remedy should be performed. RNA is applicable only at the following types of sites:

- Sites where immediate threats to human health, safety, and the environment do not exist or have been mitigated
- Sites where "active" sources, such as leaking tanks, drums, etc., have been removed
- Sites where the projected time frame to achieve remedial objectives is "reasonable," as defined in section 7
- Sites where the plume is stable or shrinking and is not likely to impact current receptors or sensitive habitat
- Sites where active remediation has removed the bulk of the contaminants and the role of RNA is to perform the "final touchup"
- Sites where any necessary institutional controls can be reliably implemented

Upon selection of RNA as part or all of the preferred remedy, a corrective action plan will be developed to document the selection process and provide details about implementation of the remedy. The Idaho Department of Environmental Quality (DEQ) must approve this corrective action plan. At all sites, RNA will be accompanied by long-term monitoring to demonstrate that RNA is occurring at the rate anticipated when RNA

was selected as the remedial option. Monitoring will continue until the specified cleanup goals have been achieved. If the monitoring data indicate that RNA is not occurring at an acceptable rate, the remedial plan will need to be modified.

4 Risk Management Plan for Remediation by Natural Attenuation

At sites where RNA is part of the preferred remedial option, the responsible party should include a discussion in the corrective action plan that addresses the following elements:

- A summary of site characterization activities that demonstrates a thorough understanding of the nature and extent of the source and the nature and extent of the impacts, provides data supporting the likely effectiveness of RNA, and discusses any source removal/control activities performed at the site
- A discussion of remedial endpoints and points of compliance, and the manner in which these were determined
- A discussion of the time frame over which the endpoints are expected to be achieved
- A demonstration that during this time frame, risks to human health and the environment are acceptable
- A discussion of monitoring locations, the rationale for monitoring location selection, and the type and frequency of data that will be collected to monitor the performance of RNA and the achievement of remedial goals
- A description of the tools to be used to evaluate/analyze the monitoring data
- A description of the institutional controls that may be required and documentation of their implementation
- A description of a contingency plan that will be implemented if the monitoring results indicate that RNA is not sufficiently effective or is not proceeding at the expected rate
- A description of the frequency and form of the reports to be submitted to DEQ during the course of implementing RNA

A brief discussion of critical components of the RNA portion of the corrective action plan is presented below.

5 Source Characterization and Control

Characterizing and controlling the source are important aspects of RNA. Sufficient data should be collected during the site investigation phase to delineate the nature and extent of the source and estimate the source lifetime. The term “nature” refers to an evaluation of the chemicals of interest and a determination that the chemicals are amenable to NA. The extent refers to the physical dimensions of the source as well as a determination of the mass of residual chemicals present in the source. An estimate of the lifetime of the source can be made by calculating the mass flux out of the source area (using ground water flow characteristics and contaminant concentrations in the source area) and

comparing this to the total contaminant mass in the source area (including free phase product, soils, and ground water).

DEQ requires that all active sources (e.g., leaking pipes, tanks, spills) be stopped and any free phase product in ground water be removed, to the maximum extent practicable. It is best to reduce the source and remediate soils containing residual product that are significant sources of contamination to ground water. Such control measures will reduce the time required to achieve remedial objectives. At a minimum, sufficient source material should be removed to ensure a declining plume. The amount of active remedial activity necessary should be determined on a case-by-cases basis and clearly presented in the risk management plan.

6 Plume Characterization

The goals of collecting data to characterize the plume are to demonstrate the magnitude and direction of contaminant transport and the stability status of the plume, to confirm degradation is occurring, and to estimate the contaminant degradation rate or the ability of the aquifer to assimilate the contamination.

To achieve these goals, the responsible party must construct wells to account for aquifer heterogeneity and dominant zones of contaminant transport, select appropriate monitoring locations, collect samples at an adequate frequency, and collect and evaluate the appropriate analytical data. How to determine the appropriate monitoring locations, sampling frequency, and data is discussed below.

The location and number of ground water samples collected and analyzed must be determined based on site-specific conditions.

At a minimum, sampling points should be located so as to achieve the following:

- Locate the distribution of contaminants within the plume
- Locate the plume boundaries
- Track plume movement and migration

While they do help define the extent of the plume, sampling points at nondetect locations provide little useful information for documenting plume characteristics for an NA evaluation. Most sampling points need to be located within the plume boundaries for NA evaluation purposes.

Monitoring wells should be located up-gradient of the source, within or immediately down-gradient of the source area, and within the plume aligned along the plume axis. Data should be collected from an unimpacted down-gradient well also. A down-gradient clean well can be used to help characterize the extent of the plume and may be used to protect down-gradient receptors by providing early detection of plume movement. This function is described in section 8. Wells delineating the sides of the plume assist in determining if there are significant seasonal changes in ground water flow direction.

As discussed in sections 3.5.1 and 3.5.2, data related to the primary and secondary lines of evidence should be collected. In rare cases, it may be necessary to collect data to demonstrate tertiary lines of evidence as well. Based on the data collected, a determination should be made whether the plume is expanding, stable, or shrinking. The specific analytical tools that may be used to conduct this characterization are discussed in Part III of this document.

Expanding plumes require continued monitoring. Depending on site conditions, such as the risk to current or potential future receptors and the rate at which the plume is expanding, additional assessment of the plume and/or source removal and reduction may be necessary. An expanding plume typically requires active remediation.

Plumes documented to be stable or shrinking are candidates for the use of NA. These plumes will also require continued monitoring, though perhaps at a lower frequency than expanding plumes. Depending on site conditions and the time frame of remediation, a stable plume may require residual source characterization or removal.

The frequency and duration of monitoring during the plume characterization phase should be determined on a site-specific basis and in consultation with DEQ. However, in most cases, 1–2 years of quarterly monitoring data are necessary to evaluate the degree of seasonal variations in water levels and flow directions present at a site. This information is necessary to characterize a plume as expanding, stable, or shrinking and to estimate degradation rates. As clear trends emerge in the data, the monitoring frequency may be modified. The actual duration of sampling will depend on the time it takes to demonstrate a clear trend in the concentrations.

7 Reasonable Time Frame Determination

The determination as to what constitutes a reasonable time frame for RNA is a complex, site-specific determination not amenable to simple rules of thumb or quantification. In making this determination, DEQ will take into account factors that include, but are not limited to, the following:

- The time frame for RNA compared to that for other remedies being evaluated
- The time frame in which affected portions of the aquifer might be needed for various uses
- The likelihood that impacted ground water will be utilized
- The degree of uncertainty in site characterization and NA estimates
- The reliability of institutional controls over the time frames for which they may be required to function
- The ability of the responsible party to maintain the required monitoring and plume evaluation required when NA is used as a remedy

8 Monitoring to Demonstrate the Effectiveness of Remediation by Natural Attenuation

Due to the uncertainties associated with the site-specific implementation of RNA, long-term monitoring is necessary to demonstrate its effectiveness. Long-term monitoring is used to ensure that the behavior of the plume does not change (EPA 1999) and that predictions of plume behavior are accurate. The objectives of long-term monitoring are to demonstrate NA is continuing to occur, human health and the environment are being protected, and the plume is not expanding.

The specifics of the monitoring plan (e.g., the location, frequency, and type of samples to be collected and the analytical procedures to be used) should be determined on a site-specific basis. The primary factors that should be considered when designing a long-term monitoring program include the following:

- Distance to potential receptor exposure points
- Ground water seepage velocity and direction
- Types of contaminants
- Aquifer heterogeneity
- Three-dimensional distribution of chemicals of interest
- Areas of unique geochemical conditions
- Surface water impacts
- Effects of active remediation systems (Wiedemeier et al. 2000)

The secondary factors that should be considered include the following:

- Access issues
- Property lines
- Contaminant contributions from offsite sources (Wiedemeier et al. 2000)

Two types of wells are required for any long-term monitoring program: performance monitoring wells and contingency monitoring wells. Performance monitoring wells are used to demonstrate that NA is proceeding according to expectations; document that geochemical conditions continue to be adequate to support NA processes; identify any toxic products resulting from NA processes; determine if plume conditions remain stable or are shrinking; identify changes in ground water conditions, such as change in flow direction, recharge, etc.; and document that cleanup criteria have been met.

Contingency monitoring wells are placed beyond the predicted down-gradient boundary of the plume and up gradient from known or potential receptor exposure points. Their purpose is to provide an “early-warning” if unexpected plume expansion occurs and allow implementation of a contingent remedy if needed. Multiple contingency wells may be needed, particularly if seasonal variations in ground water flow direction are known to occur.

Sampling frequency should be based on the following factors:

- The natural variability observed in contaminant concentrations
- The distance and travel time from the source to the point of compliance
- The reduction in concentrations needed to meet target levels

9 Contingency Measures

The RNA corrective action plan should include a contingency plan to be implemented if the site data indicate that RNA is not occurring at the expected rate or the exposure conditions at the site have changed, resulting in an unacceptable risk to human health or the environment.

Contingency measures will prevent delays in site remediation and provide a clear roadmap for site remediation. Triggers should be established and included in the plan that would cause the responsible party to implement alternative active strategies to enhance RNA. The triggers should be as objective and quantitative as possible. Examples of triggers that would cause the responsible party to implement alternative strategies include, but are not limited to, the following:

- A consistent increase in concentrations in one or more wells
- A failure of any of the institutional conditions necessary to protect human health and the environment during the period of RNA
- A change in the exposure conditions (e.g., removal of pavement)
- Continued expansion of the plume
- Unacceptably low rates of RNA

PART III: Techniques Available to Demonstrate Natural Attenuation

Several techniques are available to evaluate the data collected to demonstrate NA or to design and implement an RNA program. These techniques can be divided into three categories: techniques to demonstrate the occurrence of NA, techniques to estimate the site-specific rate of NA, and techniques to quantify the future behavior of the plume. The available techniques for each of these evaluations are presented below.

10 Techniques to Demonstrate the Occurrence of Natural Attenuation

The occurrence of NA may be demonstrated by using graphical and/or statistical techniques. The specific techniques used will vary depending on site conditions and the specifics of the data. To the extent possible, multiple techniques should be used to provide added insight into the NA process.

10.1 Graphical Techniques

Chemicals-of-interest data collected from strategically located monitoring wells can be used to draw site-wide contour maps of individual constituent concentrations for each monitoring event, create concentration-versus-time plots for each well with detectable constituent levels and at least four rounds of data, and create concentration-versus-distance plots along the flow direction for several monitoring events. Depending on the variability in the concentrations, it may be better to plot the natural logarithm of concentration versus time and distance. An example plot is shown in Figure 4. When creating these plots, care should be taken to ensure that the selected scale clearly demonstrates the trend. Since the concentrations are affected by water level fluctuations, it is important to also plot water levels as a function of time.

These plots can indicate whether the concentration trend is decreasing, stable (no significant trend), increasing, or mixed. The latter refers to a situation where different wells (source wells versus periphery wells) exhibit different trends. Increasing concentrations in the source well and decreasing concentrations in the down-gradient wells may occur due to a variety of reasons. For example, the mass loading to the source may cause an increase in the source wells due to an increase in the infiltration rate, or the rate of biodegradation near the source may be reduced due to a depletion of oxygen.

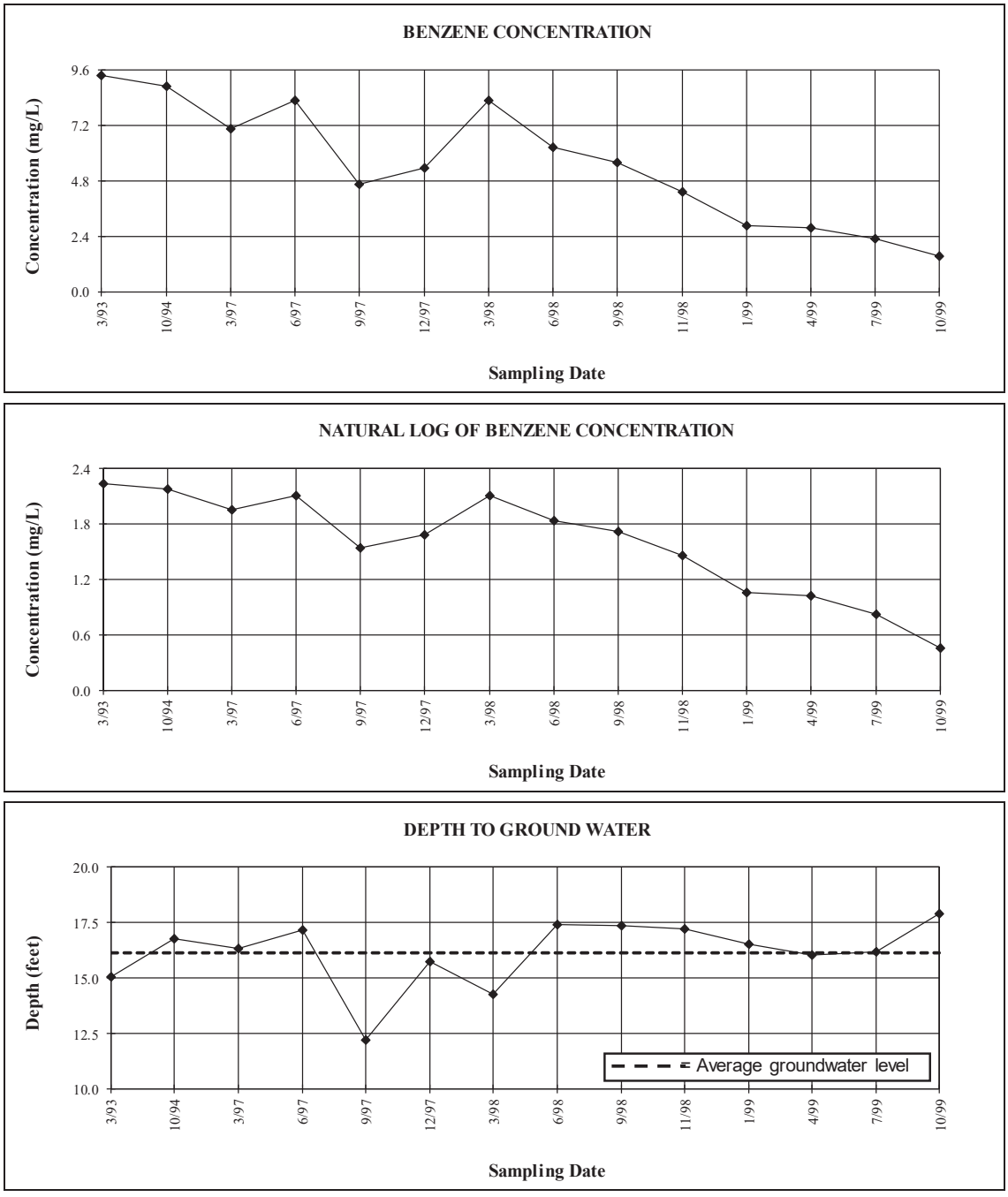


Figure 4. Concentration-versus-time plot of benzene

Conversely, increasing concentrations in down-gradient wells and decreasing concentrations near the source may indicate that the plume is moving but the source has depleted. Conclusions related to concentration trends based on visual observations of the data must be supported by statistical analysis.

In addition to the chemical-of-interest concentrations, indicator chemical concentrations should be plotted along the plume axis (in the concentration-versus-distance plots) along with the hydrocarbon concentrations. The observed pattern of concentrations can be used

to demonstrate NA. For example, low dissolved oxygen concentrations within the plume and higher concentrations up-gradient and down-gradient of the source are indicative of biodegradation within the plume.

10.2 Statistical Evaluations

Statistical tools may be used to determine and quantify the concentration trend. These tests can be used to test a null hypothesis and an alternative hypothesis. A null hypothesis might be that there is no time trend in the concentrations-versus-distance or time, and the alternative hypothesis might be that there is a downward trend. Application of the statistical test would then result in accepting or rejecting the null hypothesis at a specified level of significance.

A nonparametric test, called the Mann-Kendall test, is often used to determine whether a trend exists in the data. This test is particularly useful for environmental data for several reasons:

- The test is nonparametric, which implies that the test is applicable irrespective of the underlying distribution of the data.
- The test is simple to implement.
- Concentration values below the detection limit can be used.
- The results are not affected by missing data.

The Mann-Kendall test is applicable only when there is no seasonality in the data. This is the case if the data do not show any seasonal variations or the data were collected from one season. When data indicate seasonality, the seasonal Kendall test may be used. For details on both of these tests, refer to Gilbert (1987), Gibbons (1994), or other books on statistical analysis.

DEQ strongly recommends the use of the Mann-Kendall test to determine the trend in nonseasonal data except in situations where a visual plot of data indicates without **any** ambiguity that a trend exists in the data.

If the concentration-versus-time or concentration-versus-distance data indicate a decreasing trend, a regression analysis may be used to estimate the slope of the best-fit line.

As explained in section 11.2 and 11.3, the slope of the line can be used to estimate the NA or the biodegradation rate. For additional information on regression analysis, refer to any statistics textbook.

11 Techniques to Estimate the Site-specific Rate of Natural Attenuation

The data collected to demonstrate the primary line of evidence of NA can be used to estimate site-specific NA rates and biodegradation rates. Since NA includes multiple processes in addition to biodegradation, the NA rate would be higher than the

biodegradation rate. The latter can be used as an input into a ground water fate and transport model, such as Domenico's model (Domenico 1987), to estimate the future migration of the plume, and to estimate a site-specific dilution attenuation factor. Three methods are available to estimate the NA rate: 1) mass balance analysis for expanding, stable, or shrinking plumes; 2) plume concentration-versus-time plots; and 3) plume concentration-versus-distance plots. Descriptions of each of these methods are presented below. An excellent discussion of the calculation and use of rate constants for use in NA evaluations is presented in EPA (2002). This section also includes a discussion of calculating biodegradation rates using recalcitrant tracers.

11.1 Mass Balance Analysis

This method of estimating the NA rate is based on the concept of mass balance. For a stable plume, the mass entering the ground water plume must equal the mass lost by NA. Thus, if the mass entering the plume can be estimated, it should be possible to estimate the NA rate. A detailed description of the application of mass balance analysis to estimate the NA rate of a petroleum release is described in Section X6.1 of the *Standard Guide for Remediation of Groundwater by Natural Attenuation at Petroleum Release Sites* (ASTM 2004).

11.2 Well Concentration-versus-Time Plot

The estimate of the overall attenuation rate for a shrinking plume can be calculated assuming a first-order decay rate and is represented mathematically by Equation 1:

$$\frac{dC}{dt} = exp^{(-kt)} \qquad \text{(Equation 1)}$$

Where:
C = concentration
t = time [years]
k = NA rate [1/yr]

The solution to the above differential equation results in the familiar exponential decay equation (Equation 2):

$$C(t) = C(t=0)\,exp^{(-kt)} \qquad \text{(Equation 2)}$$

Where:
$C(t)$ = Concentration at any time t (mg/L)

Taking the natural logarithms of both sides of Equation 2 results in Equation 3:

$$ln\,C(t) - ln\,C(t=0) = -kt \qquad \text{(Equation 3)}$$

Thus, a plot of natural log of concentration versus time would be a straight line with a slope equal to k (the NA rate).

11.3 Well Concentration-versus-Distance Plot

Advective travel time can be expressed as below (Equation 4):

$$t = \frac{x}{v} \qquad \text{(Equation 4)}$$

Where:
x = Advective travel distance (cm)
v = Seepage velocity (cm/yr)

Substituting Equation 4 in Equation 2 results in Equation 5:

$$C(t) = C(t=0)\,exp^{(-k\frac{x}{v})} \qquad \text{(Equation 5)}$$

Taking the natural log of both sides of the equation results in Equation 6:

$$ln[C(t=0)] - ln[C(t)] = -k\frac{x}{v} \qquad \text{(Equation 6)}$$

For a shrinking plume that follows the first-order attenuation rate presented above, a plot of log concentration versus distance would be a straight line with a slope of k/v. By multiplying the slope with the seepage velocity, the NA rate (k) can be estimated.

Buscheck and Alcantar (1995) used the solution of the one-dimensional transport equation with biodegradation to estimate the biodegradation rate based on the slope of the log concentration-versus-distance plot. Specifically, they derived the following expression (Equation 7) for the biodegradation rate:

$$\lambda = \frac{v}{4\alpha_x}\left\{\left[1+2\alpha_x\left(\frac{k}{v}\right)\right]^2 - 1\right\} \qquad \text{(Equation 7)}$$

Where:
λ = Biodegradation rate, assumed to occur at equal rates in the dissolved and sorbed phases
α_x = Longitudinal dispersivity (0.1x)

Zhang and Heathcote (2003) modified this method to account for situations with finite source size and lateral dispersion to improve the estimates of the biodegradation rate.

The following step-by-step description of the biodegradation rate estimation process can be implemented on a site-specific basis.

Step 1: Determine the ground water flow direction based on the water level measurements for each monitoring event.

Step 2: For each monitoring event, identify the wells located along the direction of flow (i.e., along the plume center line). Since the flow direction may vary seasonally, different wells may be used for different monitoring events.

Step 3: Tabulate the concentrations of the chemicals of interest and calculate the natural log concentrations.

Step 4: Plot the natural log concentrations on the *y*-axis and the distance along the *x*-axis.

Step 5: Calculate the slope of the best-fit line and the confidence in this estimate by examining the 95% confidence limits of the slope.

Step 6: Estimate the ground water seepage velocity.

Step 7: Multiply the slope of the best-fit line calculated in Step 5 with the seepage velocity. The result will represent the overall NA rate. This NA rate represents the reduction in concentration due to the combined influence of the various NA processes mentioned in section 2. This decay rate should not be confused with the biodegradation rate (λ) that is an input to ground water models.

Step 8: Estimate the biodegradation rate from Equation 7.

Steps 1–8 should be completed for each time period for which data are available and the results presented as a range of NA and biodegradation rates. The latter can be used as an input to the Domenico model (Domenico 1987) to estimate the dilution attenuation factor. Due to confounding factors such as seasonal variations in ground water velocity, fluctuations in water levels, and errors in sampling and analysis methods, the NA and biodegradation rates may vary significantly (by as much as a factor of 10). Therefore, it is best to present the range as well as the average rates.

11.4 Evaluation of Plume Behavior with a Recalcitrant Tracer

Physical, chemical, and biological processes act together to decrease contaminant concentrations away from a source. However, monitored NA requires that accurate biodegradation rates for a site be known. To estimate accurate biodegradation rates, conservative tracers can be employed. The concentrations of these tracers are not affected by biodegradation processes and so can be used to delineate between the effects of biodegradation and other NA processes such as dilution and sorption. Generally, tracers are biologically recalcitrant and have chemical properties similar to the contaminant of interest. Examples of common tracers include MTBE for petroleum hydrocarbon plumes.

12 Techniques to Quantify the Future Behavior of the Plume

The future behavior of the plume can be estimated by using fate and transport models. A number of analytical and numerical models are available. Commonly used analytical

models include the Domenico model (Domenico 1987) and BIOSCREEN. BIOSCREEN can be downloaded from www.epa.gov/ada/csmos/models/bioscrn.html.

These models can be used to estimate plume length, concentrations at down-gradient receptor locations, and dilution attenuation factors and can be calibrated to site-specific ground water data. The correct application of fate and transport models requires experience and specialized knowledge that is beyond the scope of this document.

References

API (American Petroleum Institute). 2007. *Technical Protocol for Evaluating the Natural Attenuation of MtBE*. Washington DC: API, Regulatory and Scientific Affairs Department. API Publication 4761.

ASTM (American Society for Testing and Materials). 2004. *Standard Guide for Remediation of Ground Water by Natural Attenuation at Petroleum Release Sites.* Conshohocken, PA: ASTM. Standard E1943-98(04).

Buscheck, T.E., and C.M. Alcantar. 1995. *Regression Techniques and Analytical Solutions to Demonstrate Intrinsic Bioremediation.* In R.E. Hinchee, J.T. Wilson, and D.C. Downey, eds. *Intrinsic Bioremediation*. Columbia, OH: Batelle Press. pp. 109–116.

Buscheck, T.E., D.C. Wickland, and D.L. Kuehne. 1996. *Multiple Lines of Evidence to Demonstrate Natural Attenuation of Petroleum Hydrocarbons*. Proceedings of the Conference on Petroleum Hydrocarbons and Organic Chemicals in Groundwater. NGWA/API, Houston, TX.

Domenico, P.A. 1987. *An Analytical Model for Multidimensional Transport of a Decaying Contaminant Species*. Journal of Hydrology 91:49–58.

EPA (U.S. Environmental Protection Agency). 1999. *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action and Underground Storage Tank Sites*. Washington DC: EPA, Office of Solid Waste and Emergency Response. Directive 9200.4-17P.

EPA (U.S. Environmental Protection Agency). 2002. *Calculation and Use of First-Order Rate Constants for Monitored Natural Attenuation Studies.* Cincinnati, OH: EPA, National Risk Management Research Laboratory. Ground Water Issue Paper, EPA/540/S-02/500.

EPA (U.S. Environmental Protection Agency). 2005. *Monitored Natural Attenuation of MTBE as a Risk Management Option at Leaking Underground Storage Tank Sites.* Cincinnati, OH: EPA, National Risk Management Research Laboratory. EPA/600/R014/179.

EPRI (Electric Power Research Institute). 1985. *A Review of Field-Scale Physical Solute Transport Processes in Saturated and Unsaturated Porous Media*. Palo Alto, CA: EPRI. Report EA-4190.

Freeze, A.R., and J. A. Cherry. 1979. *Groundwater*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Gibbons, R.D. 1994. *Statistical Methods for Groundwater Monitoring*. New York: John Wiley & Sons, Inc.

Gilbert, R.O. 1987. *Statistical Methods for Environmental Pollution Monitoring*. New York: Van Nostrand Reinhold Company.

ITRC (Interstate Technology and Regulatory Council). 2002. *A Systematic Approach to In Situ Bioremediation in Groundwater Including Decision Trees on In Situ Bioremediation for Nitrates, Carbon Tetrachloride, and Perchlorate.* ITRC, In Situ Bioremediation Team.

McKee, J.E., F.B. Laverty, and R.M. Hertel. 1972. *Gasoline in Ground Water*. J. Water Pollution Control Federation 44(2):293–302.

Moyer, E.E., and P.T. Kostecki. 2003. *MTBE Remediation Handbook.* Amherst, MA: Amherst Scientific Publishers.

Rice, D.W., R.D. Grose, J.C. Michaelson, B.P. Dooher, D.H. Macqueen, S.J. Cullen, W.E. Kastenberg, L.G. Everett, and M.A. Marino. 1995. *California Leaking Underground Fuel Tank (LUFT) Historical Case Analysis.* Livermore, CA: Lawrence Livermore National Laboratory, Environmental Protection Department, Environmental Restoration Division.

SNL (Sandia National Laboratories). 1997. *Natural Attenuation of Metals and Radionuclides*: *Report from a Workshop held by Sandia National Laboratories*. SNL. SAND97-2727.UC-800.

USACE (U.S. Army Corps of Engineers). 1999. *Draft Protocol for Evaluating, Selecting, and Implementing Monitored Natural Attenuation at Explosives-Contaminated Sites*. Vicksburg, MS: USACE, Engineer Research and Development Center. Technical Report EL-99-10.

Wiedemeier, T.H., M.A. Lucas, and P.E. Haas. 2000. *Designing Monitoring Programs to Effectively Evaluate the Performance of Natural Attenuation*. Brooks Air Force Base, TX: U.S. Air Force, Air Force Center for Environmental Excellence.

Xu, M., and Y. Eckstein. 1995. *Use of the Least-Squares Method in Evaluation of the Relationship Between Dispersivity and Field Scale*. Ground Water 33(6):905–908.

Zhang, Y., and R.C. Heathcote. 2003. *An Improved Method for Estimation of Biodegradation Rate with Field Data*. Ground Water Monitoring and Remediation 23(3):112–116.

Other Useful References

Alaska DEC (Alaska Department of Environmental Conservation). 2000. *Guidance on the Selection of Natural Attenuation as a Cleanup Alternative for the Restoration of Soil and Groundwater at Contaminated Sites*. Juneau, AK: Alaska DEC, Division of Spill Prevention and Response. Guidance No. SPAR 2000-1.

Bauer, S., C. Beyer, and O. Kolditz. 2006. *Assessing Measurement Uncertainty of First-Order Degradation Rates in Heterogeneous Aquifers.* Water Resources Research Vol. 42, W01420, 14 p.

Wiedemeier, T.H., J.T. Wilson, and D.H. Kampbell. 1996. *Natural Attenuation of Chlorinated Aliphatic Hydrocarbons at Plattsburg Air Force Base, New York*. Symposium on Natural Attenuation of Chlorinated Organics in Ground Water. Dallas, TX, September 1996.

Wiedemeier, T.H., J.T. Wilson, R.N. Miller, and J.E. Hanson. 1999. *Technical Protocol for Implementing Intrinsic Remediation for Long-Term Monitoring for Natural Remediation of Fuel Contamination Dissolved in Groundwater,* Volume I. Brooks Air Force Base, TX: U.S. Air Force, Air Force Center for Environmental Excellence.

Wisconsin DNR (Wisconsin Department of Natural Resources). 2003. *Guidance On Natural Attenuation For Petroleum Releases*. Madison, WI: Wisconsin DNR, Bureau for Remediation and Redevelopment. PUB-RR-614.

This page intentionally left blank for correct double-sided printing.

Appendix J: Sample Table of Contents for a Risk Evaluation Report

This page intentionally left blank for correct double-sided printing.

TABLE OF CONTENTS

LIST OF TABLES
LIST OF FIGURES
EXECUTIVE SUMMARY
1.0 INTRODUCTION
1.1 SCOPE
1.2 OBJECTIVES
2.0 REVIEW AND ANALYSIS OF AVAILABLE DATA
2.1 INTRODUCTION
2.2 SITE DESCRIPTION AND LAND USE
2.2.1 Location and Vicinity
2.2.2 Topography
2.2.3 Current Land Use
2.2.4 Future Land Use
2.3 CHRONOLOGY OF EVENTS
2.4 SITE GEOLOGY AND SOIL STRATIGRAPHY
2.4.1 Regional Geology
2.4.2 Stratigraphy
2.4.3 Ground Water Flow Direction and Magnitude (horizontal and vertical)
2.5 WATER USE
2.5.1 Current Water Use
2.5.2 Future Water Use
2.6 RELEASE SCENARIO AND SOURCE
2.6.1 Chemicals of Concern
2.6.2 Distribution of Chemicals
2.6.2.1 Chemicals in Soil
2.6.2.2 Chemicals in Ground Water
2.6.2.3 Chemicals in Surface Water
2.6.2.4 Chemicals in Soil Vapors

3.0 SCREENING LEVEL EVALUATION
3.1 COMPARISON WITH RUSL
3.2 RECOMMENDATIONS
4.0 EXPOSURE ASSESSMENT
4.1 INTRODUCTION
4.1.1 Source
4.1.2 Release Mechanism
4.1.3 Transport Media
4.1.4 Receptors
4.1.5 Route of Exposure
4.2 SITE DISCRETIZATION INTO EXPOSURE UNITS
4.3 SITE CONCEPTUAL EXPOSURE MODELS FOR EACH EXPOSURE UNIT
4.3.1 Site Conceptual Exposure Model for Current Conditions
4.3.2 Site Conceptual Exposure Model for Future Conditions
4.4 GROUND WATER PROTECTION
5.0 INPUT PARAMETERS FOR RISK EVALUATION, ESTIMATING RISK, AND DEVELOPING REMEDIAL ACTION TARGET LEVELS
5.1 JUSTIFICATION OF SITE-SPECIFIC FATE AND TRANSPORT PARAMETERS
5.2 JUSTIFICATION OF SITE-SPECIFIC EXPOSURE FACTORS
5.3 JUSTIFICATION OF ALTERNATIVE TOXICITY FACTORS AND PHYSICAL AND CHEMICAL PROPERTIES
5.4 REPRESENTATIVE CONCENTRATIONS FOR EACH RECEPTOR, ROUTE OF EXPOSURE, AND EXPOSURE UNIT
5.5 JUSTIFICATION OF MODELS AND EQUATIONS
5.6 COMPARISON OF CALCULATED RISK WITH TARGET RISK CRITERIA FOR EACH EXPOSURE UNIT
5.7 TARGET RISK LEVEL
5.7.1 Treatment of Carcinogenic Chemicals
5.7.2 Treatment of Non-Carcinogenic Chemicals
5.8 CALCULATION OF REMEDIAL ACTION TARGET LEVELS
5.9 RECOMMENDATIONS FOR EACH EXPOSURE UNIT
6.0 CONCLUSIONS AND RECOMMENDATIONS
7.0 REFERENCES

Appendix K: Practical Quantitation Limits

This page intentionally left blank for correct double-sided printing.

Introduction

During the risk evaluation process when collecting media-specific chemical concentration data and establishing remediation standards, situations may arise where practical quantitation limits (PQLs) for specific chemicals and samples may exceed screening levels or site-specific, risk-based concentrations. Section 500 of IDAPA 58.01.24, Application of Risk Based Corrective Action at Petroleum Release Sites, delineates the following factors that may be used to allow the use of PQLs as remediation standards:

- Analytical method
- Method detection limit
- Sampling procedures
- Estimated risk levels
- Other

This appendix provides background on the concepts of PQLs, MDLs and Remediation Standards and provides guidance on using the above factors when a REM user is proposing PQLs as remediation standards.

Background— Practical Quantitation Limits, Method Detection Limits and Remediation Standards

What are PQLs and MDLs?

A PQL is defined in part in 58.01.24.010 as "The lowest concentration of a chemical that can be reliably quantified among laboratories within specified limits of precision and accuracy for a specific laboratory analytical method during routine laboratory operating conditions." The method detection limit (MDL) is defined as "The minimum concentration of a substance that can be reported with 99% confidence is greater than zero."

How are PQLs Derived?

PQL values are derived in a number of ways, and there is no consensus as to the process used to develop them. In some cases, they are derived as a fixed multiplier applied to the MDL value or the standard deviation of samples used to develop the MDL. The multiplier commonly ranges from 3 to 5 and may be as great as 10. In other cases, PQLs may be derived by analysis of data from actual laboratory performance studies. In these cases, PQL values are a function of analytical methods, a given laboratory's equipment, operating protocols, operating conditions, quality assurance/quality control procedures, and sampling and media considerations. Values are sometimes reported by laboratories at levels between the MDL and the PQL and are commonly qualified as estimated quantities. The closer the estimated value is to the PQL, the more confidence in the estimated value.

How did DEQ derive the PQLs and MDLs in Table 1?

For the petroleum chemicals of interest (COI) listed in the rule, the common analytical methods for soil and water employed at petroleum release sites are established by the U.S. Environmental Protection Agency (EPA) in SW-846 (EPA 2011). For soil vapor and ambient air other EPA methods are applied (EPA 1999).Table 1 lists these methods employed in the analysis of the petroleum COI along with typically achieved detection and quantitation limits.

These detection and quantitation values were obtained from sample laboratory reports for site investigations done for the Idaho Department of Environmental Quality (DEQ) at a number of sites where petroleum COI were suspected. In their method descriptions, EPA lists examples of lower limits of quantitation for individual analytes but indicates that they are instrument-dependent and influenced by sample preparation/introduction technique (EPA 2006) or highly matrix-dependent and are provided for guidance only (EPA 2007).

For a given media, sampling considerations may have an impact on achievable detection limits. For example, when sampling soil vapor or ambient air with certain methods, the achievable quantitation limit can be a function of the amount of vapor or air sampled. Quantitation limits are commonly reduced as the amount of air sampled increases.

Specialized analytical techniques can sometimes provide lower MDL and PQL values. Table 1 illustrates this with a comparison of values achieved with the use of standard method 8270 for semivolatile compounds versus employing 8270 using selective ion monitoring (SIM). PQL values are 6 times lower for soils and 20 times lower for water samples.

Depending on the petroleum product released, levels of contamination, chemicals present, and media in question (soil, water, and vapor), interferences to analytical detection and quantitation may be present. Procedures such as sample dilution may allow quantification of petroleum COI concentrations but will also result in elevated detection and quantitation limits.

Remediation Standard

A remediation standard is defined in IDAPA 58.01.24 as a “media specific concentration which, when attained, is considered to provide adequate protection of human health and the environment.”

Remediation standards are established at petroleum release sites where corrective action has been determined to be required. The need for corrective action is commonly determined after completion of a risk evaluation. Remediation standards are commonly established as part of a risk evaluation or an approved corrective action plan (CAP).

The magnitude of a remediation standard that is established for a given chemical and the potential that it may be exceeded by a PQL is dependent on a number of factors, including, but not limited to, the following:

- Assumptions regarding current and future site land use, both on and off site
- What petroleum products were released and the relative distribution of chemicals detected
- The magnitude and distribution of contamination (which media are impacted)
- The routes of exposure determined to pose the greatest threats

The two risk evaluation scenarios where elevated PQL values may require the reevaluation of initially selected remediation standards are as follows:

1) Screening Level Evaluation
The screening level evaluation described in IDAPA 58.01.24 employs the simplest and most straightforward use of remediation standards in the form of the residential use screening levels. The screening levels are conservative, calculated, risk-based concentrations determined to be protective of unrestricted use exposures.

Because laboratory analytical technology is continually changing, these media-specific chemical concentrations are established without consideration of the ability of standard laboratory methods to detect and quantify these values. For the petroleum COI in Table 1, the compounds benzo(a)anthracene (BAA) and benzo(b)fluoranthene (BBF) in water and ethylene dibromide (EDB) in soil pose the greatest potential challenges with respect to PQL values meeting screening level concentrations.

For BAA and BBF, common practical quantitation limits in water using EPA Method 8270 with SIM (0.00005 mg/liter) slightly exceed the groundwater screening levels (0.00003 mg/liter) while the method detection limits (0.00002 mg/liter) are slightly below the screening values. At petroleum release sites where these chemicals are COI and groundwater analytical results for these chemicals are reported either as estimated values (between the quantitation and detection limits) or below the detection limit the screening levels will be assumed to have been achieved. Additional support for this determination is provided if all other PAH chemicals are also reported at concentrations below screening levels.

The most commonly used analytical method for EDB in soils (EPA Method 8260) has typical quantitation (0.001 mg/kg) and detection (0.0003 mg/kg) limits that exceed the soil screening level concentration (0.00014 mg/kg). The soil screening level for EDB is based on protection of groundwater. The groundwater quantitation limit for EDB is below groundwater screening level. Examination of Table 2 of the guidance shows that for EDB the soil quantitation limits are low enough to evaluate the other relevant pathways and routes of exposure, 0.27 mg/kg for direct contact and 0.001 mg/kg for vapor intrusion. At petroleum release sites where EDB is a COI and groundwater is potentially impacted and representative groundwater samples report EDB below the screening level but soil quantitation limits are above the soil screening level the groundwater results will take precedence.

In the screening level evaluation, the user must compare maximum media-specific concentrations measured during site assessment activities to the screening levels. If the measured concentrations do not exceed the screening levels, the site may be eligible for site closure. If the measured concentrations do exceed screening levels, the user may select screening levels as the remediation standards upon which corrective action is based and develop a CAP. The user may also choose to conduct additional investigation or evaluation and perform a site-specific risk evaluation. Samples may also have results reported as undetected at a concentration that is less than the PQL but higher than the screening level. In this case, a potentially unacceptable risk would be indicated.

2) Site-Specific Risk Evaluation

During the site-specific risk evaluation process, media-specific chemical concentration data are collected and used, along with assumptions regarding exposure pathways and receptors, to calculate risk to expected receptors. If the calculated risk is unacceptable, media-specific, risk-based chemical concentrations are established. These risk-based concentrations become the remediation standards for site corrective action. Samples are then taken during and after corrective action to demonstrate the standards have been attained.

PQLs for selected analytes in a given media sample may exceed one or more of the calculated risk-based remediation standards, making the demonstration that the standard has been attained problematic. It is also problematic when samples with results below a PQL are included in the calculation of exposure point concentrations and risk.

Remediation standards are oftentimes the lowest at sites where:

- screening levels have been selected as the standards,
- unrestricted use is the desired corrective action land use goal,
- contamination has migrated offsite in groundwater,
- on-site vapor intrusion risk is determined to exist, or
- diesel fuel contamination (and polynuclear aromatic hydrocarbon chemicals) is present in surface soil or in close proximity to surface water.

Accordingly, PQL-related issues often arise at such sites.

Table 1. Method detection limit (MDL) and practical quantitation limit (PQL) soil, water, and vapor concentrations for petroleum chemicals of interest using selected analytical methods

	SOIL			WATER			VAPOR		
CHEMICALS	Method	MDL (mg/kg)	PQL (mg/kg)	Method	MDL (mg/L)	PQL (mg/L)	Method	MDL ($\mu g/m^3$)	PQL ($\mu g/m^3$)
Acenaphthene	8270(SIM)	0.0087 (0.0016)	0.036 (0.006)	8270(SIM)	0.0004 (0.000013)	0.001 (0.00005)	NA		
Anthracene	8270(SIM)	0.0074 (0.0008)	0.036 (0.006)	8270(SIM)	0.00036 (0.000012)	0.001 (0.00005)	NA		
Benzo(a)anthracene	8270(SIM)	0.0093 (0.0011)	0.036 (0.006)	8270(SIM)	0.0004 (0.000023)	0.001 (0.00005)	NA		
Benzo(a)pyrene	8270(SIM)	0.0098 (0.0008)	0.036 (0.006)	8270(SIM)	0.00053 (0.000013)	0.001 (0.00005)	NA		
Benzo(b)fluoranthene	8270(SIM)	0.0098 (0.0011)	0.036 (0.006)	8270(SIM)	0.00046 (0.000024)	0.001 (0.00005)	NA		
Benzo(k)fluoranthene	8270(SIM)	0.0089 (0.0005)	0.036 (0.006)	8270(SIM)	0.00036 (0.000020)	0.001 (0.00005)	NA		
Chrysene	8270(SIM)	0.013 (0.0006)	0.036 (0.006)	8270(SIM)	0.00028 (0.000018)	0.001 (0.00005)	NA		
Fluoranthene	8270(SIM)	0.011 (0.0008)	0.036 (0.006)	8270(SIM)	0.0004 (0.000020)	0.001 (0.00005)	NA		
Fluorene	8270(SIM)	0.0078 (0.0018)	0.036 (0.006)	8270(SIM)	0.00042 (0.000012)	0.001 (0.00005)	NA		
Pyrene	8270(SIM)	0.010 (0.0006)	0.036 (0.006)	8270(SIM)	0.00035 (0.000022)	0.001 (0.00005)	NA		
1,2-Dichloroethane	8260	0.00053	0.001	8260	0.00027	0.001	TO-17	--	0.4
Ethylene Dibromide	8260	0.0003	0.001	8011	0.0000057	0.00001	TO-15 SIM	--	0.8
Benzene	8260	0.00033	0.001	8260	0.00029	0.001	TO-17	--	0.32
Ethylbenzene	8260	0.00023	0.001	8260	0.00022	0.001	TO-17	--	0.43
Toluene	8260	0.0012	0.005	8260	0.00027	0.005	TO-17	--	0.38
Total Xylenes	8260	0.00046	0.003	8260	0.00086	0.003	TO-17	--	0.43
MTBE	8260	0.00028	0.001	8260	0.00019	0.001	TO-15 SIM	--	0.5
Naphthalene	8260	0.0004	0.005	8260	0.00017	0.005	TO-17	--	0.05

Checklist for Proposals to Use PQLs as Remediation Standards

Proposals to DEQ for the use of PQLs as remediation standards at petroleum release sites should include:

- the results of any risk evaluation,
- the remediation standards developed from that process,
- the proposed PQL, and
- the site-specific issues, with supporting information, that justify the use of the proposed PQL(s) as a remediation standard(s).

The supporting information that should be provided in the proposal is listed below along with a discussion of how DEQ will evaluate that information along with potential solutions to various issues, as they may be relevant to the site being evaluated, Given the number and variety of factors which may arise regarding PQLs in relation to remediation standards both the list and the discussion are not considered all-inclusive.

1. Risk Evaluation

- Describe the conceptual site model.
- Identify the level of risk evaluation, the chemicals, media, and pathway or route of exposure that are at issue.
- State the magnitude of the proposed PQL and MDL vs. the remediation standard.

Screening Level Evaluation

For sites where a screening level evaluation has taken place and the proposal is to use PQLs in place of screening levels as remediation standards for specific COI and media, the information provided will be reviewed in a number of ways. The proposed PQLs will first be reviewed relative to the conceptual site model and the pathway/routes of exposure, which are the basis of the screening levels for the chemicals under consideration.

- If the PQL for a chemical exceeds a soil screening level based on groundwater protection but the PQL achieves the groundwater screening level (also based on groundwater protection) for the same chemical, the soil PQL may be used as the soil remediation standard for that chemical.
- If the PQL for a chemical exceeds a soil or groundwater screening level for other routes of exposure (groundwater ingestion, vapor inhalation, or direct contact), DEQ will review the magnitude of the difference between the PQL/MDL and the screening level (whether greater than or less than the screening level) for all COI with a common route of exposure to estimate the potential impact on the cumulative risk from that pathway.
- If the pathway or route of exposure for the media-specific screening level for that chemical can be considered incomplete and the PQL is below the

screening levels for any other complete/potentially complete pathways/routes of exposure for that chemical and media the PQL may be acceptable as a remediation standard. DEQ will use Table 2 of this guidance for evaluation. Alternatively, the screening level for the most appropriate pathway or route of exposure may be considered as a remediation standard.

If only a screening level evaluation has been done completion of a site-specific evaluation may revise the remediation standards and still allow unrestricted use of the site, if that is the desired/expected future land use condition.

Site-Specific Evaluation

PQL issues may be related to cleanup criteria from a site specific risk evaluation. Site specific evaluations depend on the calculation of cumulative risk to a receptor from all pathways/routes of exposure and chemicals, based on estimated exposure point concentrations. The calculation of exposure point concentrations can be influenced by the number of chemicals with PQL issues, proportion of samples with <PQL values, the magnitude of the PQL, and how these censored data are treated in the calculation procedure. If the calculations result in unacceptable risks cleanup levels for individual COI are calculated, some of which may be low enough to be exceeded by PQLs. DEQ will evaluate whether and to what extent < PQL data were used appropriately in these calculations, if the resultant calculated risks are over or under estimated, the degree to which the < PQL data contribute to overall risk, and whether the calculated cleanup criteria can be modified to avoid the PQL issue or if use of a PQL will not materially affect the protectiveness of the cleanup.

The assumptions of the conceptual site model and risk evaluation will be reviewed to determine if the land use scenarios, receptors, and input parameter values are appropriate. For example, while an assumption of residential use may be appropriate all of the specific pathways and routes of exposure assumed to be complete may not be. Exclusion of an inappropriate pathway may eliminate the specific PQL concern. Alternatively, the pathways/routes of exposure may be appropriate but the receptor/land use scenario may not be.

If the PQL for a COI is above a remediation standard but the MDL is at or below the standard there may be instances where sample results falling between these limits can be considered to have met the remediation standard. If a sample result is reported as an estimated value and that concentration is at or below the remediation standard the standard will have been met, Sample results reported as undetected (less than the detection limit, provided the limit is at or below the standard) will have met the standard.

Additional guidance on the treatment of PQL/MDL data and issues in site-specific risk evaluation are available in the EPA *Guidance for Data Useability in Risk Assessment (Part A)* (EPA 1992), the *Risk Assessment Guidance for Superfund*,

Volume I, Part A (EPA 1989), and the EPA ProUCL statistical software technical guide (EPA 2010).

2. Analytical Issues

- Identify the analytical methods used that are the basis of the PQL
- Provide all relevant QA/QC information from the laboratory sheets for the analyses in question including data quality assessment and summaries provided by the laboratory.

When reviewing the proposal DEQ will evaluate whether the data quality assessment and QA/QC accompanying the analytical results adequately explain and support the PQLs proposed. Generally, PQL proposals should be based on PQLs derived from undiluted samples. Elevated PQLs resulting from sample dilution are typically the result of an attempt to quantitate all the COI when the concentrations of one or more chemicals (some of which may not be COI) are highly elevated, often referred to as matrix interference.

Matrix interference can also occur due to the nature of the media (soils in particular) which can impair the quantitation of a COI. The matrix spike and matrix spike duplicate portions of the laboratory QA procedures can sometimes clarify whether there are matrix interferences and whether they are causing over or underestimation of actual concentrations of a COI.

3. Sampling

- Provide information on the number of sampling events completed to support the PQL proposal.
- Provide information on the sampling procedures and QA/QC measures implemented during each of the sampling programs undertaken at the release site. Copies of quality assurance project plans and evaluations of adherence to and departure from those plans for the site in question for each event should be included.

The owner/operator may select alternative sampling procedures, which may provide for a lower PQL. The PQLs for analysis of air and vapor samples can be dramatically affected by the volume of air which is sampled.

DEQ will review the proposal for use of a specific PQL as a remediation standard as part of the overall CAP and approve or deny the request along with specifying any conditions of approval or reasons for denial.

References

EPA (U.S. Environmental Protection Agency). 1989. *Risk Assessment Guidance for Superfund, Volume 1, Human Health Manual (Part A)*. United States Environmental Protection Agency. EPA/540/1-89/002.

EPA (U.S. Environmental Protection Agency). 1992. *Guidance for Data Useability in Risk Assessment (Part A)*. United States Environmental Protection Agency. 9285.7-09A.

EPA (U.S. Environmental Protection Agency). 1999. *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition*. United States Environmental Protection Agency. EPA/625/R-96/010b.

EPA (U.S. Environmental Protection Agency). 2001. *The Relationship Between SW-846, PBMS, and Innovative Analytical Techniques*. United States Environmental Protection Agency. EPA 542-R-01-015.

EPA (U.S. Environmental Protection Agency). 2006. Method 8260C. Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS), Revision 3, August 2006 in *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*. United States Environmental Protection Agency. SW-846.

EPA (U.S. Environmental Protection Agency). 2007. Method 8270D. Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS).), Revision 4, February 2007 in *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*. United States Environmental Protection Agency. SW-846.

EPA (U.S. Environmental Protection Agency). 2010. *ProUCL Version 4.1.00 Technical Guide (Draft), Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations*. United States Environmental Protection Agency. EPA/600/R-07/041.

EPA (U.S. Environmental Protection Agency). 2011. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*. United States Environmental Protection Agency. SW-846. Update IV of the Third Edition. Available at: http://www.epa.gov/epawaste/hazard/testmethods/index.htm

This page intentionally left blank for correct double-sided printing.

Appendix L: Quality Assurance Project Plan Template

This appendix provides an example of the elements and general description of the content that should be included in a Quality Assurance Project Plan. It was current as of July 2012. Please contact DEQ to obtain a copy of the most current version.

This page intentionally left blank for correct double-sided printing.

State of Idaho
Department of Environmental Quality

Quality Assurance Project Plan

Idaho Department of Environmental Quality

Title: Enter the title of your project here

Region/Division: Enter the name of the applicable Region or Division

Revision # Enter the document revision number. This number should increase by 1 each time the document is revised and approved.

Date: mm/dd/yyyy This date should be reasonably close to the final approval signature date

TRIM Record Number: To be filled in by staff member who enters document into TRIM

This Page Intentionally Left Blank

THE INFORMATIONAL TEXT CONTAINED ON THE NEXT FEW PAGES (UP TO "SECTION 1 – TITLE AND APPROVAL PAGE") IS INTENDED FOR USE BY STAFF TASKED WITH GENERATING A NEW PROJECT QAPP, AND SHOULD BE DELETED FROM THE DOCUMENT PRIOR TO FINALIZATION.

Example/Template QAPP – Rev 1.2 – 01/13/2012

The following few pages contain important information and general instructions for all Department of Environmental Quality (DEQ) personnel assigned the task of generating, reviewing, or approving a DEQ Quality Assurance Project Plan (QAPP). A thorough understanding of these instructions will expedite the QAPP development process, and all personnel involved in these tasks are highly encouraged to read these pages prior to initiating the process. Before submission of the QAPP for approval, these four pages of instructional notes should be deleted, including this page and all the following pages up to Section 1 – "Title and Approval Page".

All DEQ staff involved in generating a project QAPP are also strongly encouraged to read the current revision of the DEQ Quality Management Plan (QMP), and the "EPA Guidance for Quality Assurance Project Plans, EPA QA/G-5" document, which explains each section of a project QAPP in more detail. These two documents can be accessed via hyperlinks located on the Inside DEQ Intranet "Quality Assurance" page, and on the last page of these instructions.

This document is intended to be both an example QAPP, and a template for use, by those who need to author a DEQ project QAPP. The format of this document is designed to comply with the DEQ Quality Management Plan, and to meet the minimum quality system requirements as established by the EPA. Previous versions of the DEQ QAPP outline should no longer be used.

In order to ensure progressive QAPP document improvement across the agency, the latest version of this example/template QAPP should be obtained from the DEQ intranet each time that a new project QAPP is to be developed. Through the incorporation of feedback and input from project personnel, this example/template QAPP will continue to improve over time.

The text in this document, which is highlighted in grey, is considered example language which must be revised and edited as necessary to reflect the needs of the actual individual project for which the new QAPP is being written. Text in this document that is NOT highlighted in grey is considered language that is critical to meeting the minimum intent of the DEQ QMP. Much of this non-highlighted language is expected to be applicable to most DEQ QAPP's. If the non-highlighted text is edited to satisfy specific project requirements, the revision must address the intent of the original text in an equivalent or superior fashion.

The format (Sections 1 through 25) of this document shall not be changed, as it is specifically designed to comply with the DEQ QMP, and to meet current EPA requirements. Please also note that all sections in the included outline must be filled out, leaving no blank sections. If a section is not applicable to the project, an explanation of why that section is not relevant is required.

Through the use of this example/template QAPP, rather than a blank template, the individual project author will have the opportunity to use portions of the existing language that are applicable to their project. This example/template document is based on a Nitrate Priority Area QAPP, originally authored by the Boise Regional Office, and further enhanced by the Idaho Falls Regional Office. The example language serves to illustrate the level of detail necessary for a typical DEQ project QAPP.

Use of this example/template QAPP is intended to make the process of creating a new DEQ project QAPP simpler, more robust, and increasingly uniform throughout the agency. For additional guidance on what information should be included in each section of the example/template QAPP, please refer to the "EPA QA/G-5 Guidance for Quality Assurance Project Plans" document, which explains each section in more detail.

Please note that this example/template QAPP is not intended to be an "off-the-shelf" completed project QAPP. It is intended as an aid for QAPP development, and to help ensure a level of consistency across the agency. While it is not possible to develop an example QAPP that will satisfy the detailed needs of all projects which may arise in the performance of DEQ project work, the provided example language will guide project personnel in their efforts to produce an acceptable QAPP.

This example/template QAPP is also based upon the assumption that the project for which a QAPP is being developed uses a laboratory to analyze samples. Not all DEQ projects gather samples in the process of gathering project data. In cases where only data is gathered, some portions of the non-shaded language may not be applicable, and should be removed. However, please remember that no section can be left blank. If a section is not applicable to the project, an explanation of why that section is not relevant is necessary.

For projects requiring the use of existing data, DEQ QAPP authors should follow the steps outlined in Chapter 3 of the EPA "Guidance for Quality Assurance Project Plans" document (EPA QA/G-5).

As mentioned previously, this document will be revised on a regular basis, based on input from Regional and State Office staff. The DEQ will also be revising the entire DEQ Quality Management Plan (QMP), based on comments received from the EPA during the September 2011 Quality System Review (QSR) of the DEQ quality assurance program.

The DEQ QMP revision process will involve frequent consultation with the EPA, and will likely result in several changes to the current program. During this transitional period, the example/template QAPP may occasionally be revised to reflect the most significant changes made to the overall DEQ quality system.

Suggestions for improvement of this document, which meet EPA requirements, are highly encouraged. Please bring all suggestions to the attention of the DEQ Quality Assurance Director.

REC 4854

To help alleviate confusion with respect to the general roles of various project personnel, please refer to Table 2 of the example/template QAPP for an in-depth description of these roles and responsibilities.
The following links contain resources that will provide helpful information and guidance to all DEQ personnel tasked with generating a project QAPP. The first link provided below will bring the user to the "Quality Assurance" area of the "Inside DEQ" Intranet Page.

For DEQ personnel tasked with writing a project Quality Assurance Project Plan, the **EPA QA/G-5 Guidance document** provides clear and detailed explanations on how to fill out the required sections. This example/template QAPP only provides the framework for a project QAPP, the bulk of the information must be supplied by the author of the QAPP. The EPA QA/G-5 guidance document will be of significant assistance to the QAPP author, and use of that document (see link below) is highly recommended.

Link to the DEQ intranet page which provides several links to the major EPA and DEQ QA System documents:
http://insidedeq.deq-intra/director/quality.htm

Link to the "DEQ Quality Management Plan" (QMP):
This document describes the overall quality assurance system used by the DEQ. It provides the general description of how the DEQ quality assurance system functions, what the elements of the system are, and basic requirements for DEQ quality system documents.
http://insidedeq.deq-intra/director/quality/quality_mgmt_plan_07.pdf

Link to the EPA "Guidance for Quality Assurance Project Plans" (EPA QA/G-5) document:
In conjunction with the DEQ QMP, this document provides detailed guidance to project personnel with respect to how to write a project QAPP.
http://www.epa.gov/quality/qs-docs/g5-final.pdf

Link to the EPA page listing several resources related to writing a project QAPP:
http://www.epa.gov/quality/qapps.html

Link to the EPA Agency-wide quality system document resource page:
http://www.epa.gov/quality/qa_docs.html

Link to the EPA Quality System main page:
http://www.epa.gov/quality/

Note that for most of the EPA "Requirement" documents, there is a companion EPA "Guidance" document. These guidance documents generally have the same title as the requirements document, but have the letter "G" rather than "R" associated with their title. The EPA has may other quality system guidance and requirement documents, all of which can be easily found at the EPA Quality System main internet page (see link above).

(Links verified operational on 1-13-2012)

This Page Intentionally Left Blank

1. Title and Approval Page

Quality Assurance Project Plan

Title: Enter the title of your project here
Region/Division: Enter the name of the applicable Region or Division
Revision # Enter the document revision number. This number should increase by 1 each time the document is revised and approved
Date: mm/dd/yyyy This date must be the same as that used on the cover page and header. This date should be reasonably close to the final approval signature

Approval Signatures
Note: This QAPP becomes effective on the date of the last approval signature

DEQ Quality Assurance Director

Signature: *(If Required – See QAPP instruction pages)* _____
Name: Mark K. Clough, Quality Assurance Director, State Office Date

Program/Regional Manager

Signature: _____ _____
Name: Staff Name, Position, Office/Region Date

Project Quality Assurance Officer

Signature: _____ _____
Name: Staff Name, Position, Office/Region Date

Project Manager

Signature: _____ _____
Name: Staff Name, Position, Office/Region Date

Project Technical Lead / Author

Signature: _____ _____
Name: Staff Name, Position, Office/Region Date

This Page Intentionally Left Blank

2. Table of Contents

The Table of Contents (Below) must be updated following the completion of the new QAPP.

This can easily be accomplished using Microsoft Word, through use of the following steps:

1. After the draft project QAPP has been completed, open the document in Microsoft Word 2010
2. Print this page so that you have these directions (if needed), then delete these shaded "table of contents directions" so that they will not be included in your newly created table of contents.
3. Using the mouse, single left click the table of contents, which will turn the table grey.
4. After a few seconds, a tab with the words "Update Table" on it will open at the top of the table of contents.
5. Click on the "Update Table" tab, and then select the "Update Entire Table" option.
6. Click "OK", and the table of contents will immediately update.
7. Click anywhere in the document, outside the table of contents, and the table of contents update procedure will be completed.

Contents

3. DISTRIBUTION LIST 11

4. PROJECT/TASK ORGANIZATION 12

5. PROBLEM DEFINITION/BACKGROUND 15

A. Problem Statement 15
B. Intended Usage of Data 16

6. PROJECT/TASK DESCRIPTION 16

A. General Overview of Project 16
B. Project Timetable 17

7. QUALITY OBJECTIVES AND CRITERIA 17

A. Data Precision, Accuracy, Measurement Range 18
B. Data Representativeness 19
C. Data Comparability 19
D. Data Completeness 20

8. SPECIAL TRAINING/CERTIFICATION 20

9. DOCUMENTATION AND RECORDS 20

10. SAMPLING PROCESS DESIGN 21

A. Rationale for Selection of Sampling Sites 21
B. Sample Design Logistics 21

11. SAMPLING METHODS 21

12. SAMPLE HANDLING AND CUSTODY 23

13. ANALYTICAL METHODS 23

14. QUALITY CONTROL 26

A. FIELD QC CHECKS 26
Duplicates 26
Field and Equipment Blanks 26
B. LABORATORY QC CHECKS 27
C. DATA ANALYSIS QC CHECKS 28

15. INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE 28

16. INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY 28

17. INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES 29

18. NON-DIRECT MEASUREMENTS & DATA ACQUISITION 29

19. DATA MANAGEMENT 29

20. ASSESSMENT AND RESPONSE ACTIONS 30

21. REPORTS TO MANAGEMENT 30

22. DATA REVIEW, VERIFICATION, AND VALIDATION 30

23. VERIFICATION AND VALIDATION METHODS 31

24. RECONCILIATION WITH USER REQUIREMENTS 31

25. REFERENCES 33

APPENDIX A - GROUND WATER SAMPLING PROCEDURES, IFRO SAMPLING PROJECTS 35

APPENDIX B - GROUND WATER SAMPLING FIELD SHEET - IFRO 39

APPENDIX C - GROUND WATER SAMPLING PERMISSION FORM 41

3. DISTRIBUTION LIST

The following personnel and analytical laboratory contacts, at a minimum, will receive either an electronic copy or a hard copy of the final signed QAPP:

Table 1: Project QAPP distribution list.

Name	**Project Affiliation**	**Organization and address/location**	**Contact Number**
Mark K. Clough	DEQ Quality Assurance Director	Idaho DEQ – Directors Office	208-373-0528
Name	Program Manager	Idaho DEQ	###
Name	Project Quality Assurance Officer	Idaho DEQ	###
Name	Project Manager	Idaho DEQ	###
Name	Project technical Lead	Idaho DEQ	###
Contact Name	Analytical Laboratory	Laboratory Name	###
Contact Name	Analytical Laboratory	Laboratory Name	###
Contact Name	Analytical Laboratory	Laboratory Name	###

4. PROJECT/TASK ORGANIZATION

Table 2: Key project personnel and associated responsibilities.

Name	Project Title/Responsibility
Name of assigned DEQ Staff	**Program Manager:** This person is the regional manager or state office program manager who will assist in the development, review, and approval of the project QAPP. Responsible for ensuring that the project QAPP is designed to meet the data needs of the program, and references current approved program procedures and policies. The Program Manager will also select a qualified Project Quality Assurance Officer, and after obtaining approval for this selection from the DEQ Quality Assurance Director, assign this individual to the project. This process is designed to enhance impartiality, and to ensure the accuracy of the authorized Project QA Officer list maintained by the DEQ Quality Assurance Director.
Name of assigned DEQ Staff	**Project Quality Assurance Officer**: Each project is to have an assigned Project QA Officer (QAO). This person will assist in the development, review, and approval of the project QAPP, and project related documents such as Field Sampling Plans (FSPs). The Project QAO will perform periodic project reviews/audits in accordance with the DEQ QMP, and provide data verification and validation per the project QAPP and FSP. The Project QA Officer may also be part of the review team for project final reports. In matters of project quality assurance, this individual will have a direct line of communication to the DEQ Quality Assurance Director. Per EPA requirements, the Project QA Officer shall review the QAPP annually, to determine if revision is necessary. The Project QA Officer shall not be the Project Technical Lead, the Project Manager, the Program Manager, or be otherwise assigned to the project data generation efforts. Neither the Project Manager nor the Project Quality Assurance Officer may directly report to the other within the DEQ organizational structure, and both of these individuals may not be directly supervised by the same person. All assigned Project QA Officers shall, prior to signing for the approval of any project QAPP, contact the DEQ Quality Assurance Director to discuss the project. At that time, the DEQ QA Director shall also verify that the assigned Project QA Officer is on the authorized Project QA Officer list. This process is designed to ensure that all DEQ QAPPs are approved, and issued, in accordance with the DEQ Quality Management Plan.

Name	Project Title/Responsibility
Name of assigned DEQ Staff	**Project Manager:** This person is responsible for overall project planning, document development and approval, sample planning and coordination, laboratory coordination, data review and verification, reporting functions, project report/summary development, and documentation of all project activities in the TRIM system and elsewhere as required by the project documents. Responsible for ensuring all project work is conducted in accordance with the DEQ QMP, and the approved project QAPP and associated FSPs. The Project Manager is responsible for ensuring that personnel assigned to this project are appropriately trained and qualified, with the corresponding training records on file in Human Resources. This individual will also perform periodic project reviews/audits in accordance with the DEQ QMP, and provide data verification and validation per the project QAPP and associated FSPs. The Project Manager may also be part of the review team for project final reports. The Project Manager shall review the project QAPP annually, and determine if revision is necessary. If the QAPP does require revision, the revised QAPP must be submitted for approval prior to implementation, per the DEQ QMP.
Name of assigned DEQ Staff	**Project Technical Lead**: This individual is to be familiar with the technical aspects of the project, and is assigned by the Program / Project Manager to be the technical lead and to assist in the development of the project specific QAPP. This individual should have experience in the methods, procedures, and equipment to be employed in the conduct of the work described in the QAPP. Also responsible for Coordination with sample location contacts, management of day-to-day aspects of sampling; planning, data collection, sample handling, coordination with the labs for sample shipping and analysis, receipt of resulting data, and data review and verification per the approved project QAPP and associated FSPs. This individual should be familiar with the information contained in the EPA Guidance for Quality Assurance Project Plans, EPA QA/G-5 document.
Name of assigned DEQ Staff	**Laboratory Contact/Manager**: Laboratory sample receipt, analysis, and laboratory data review.

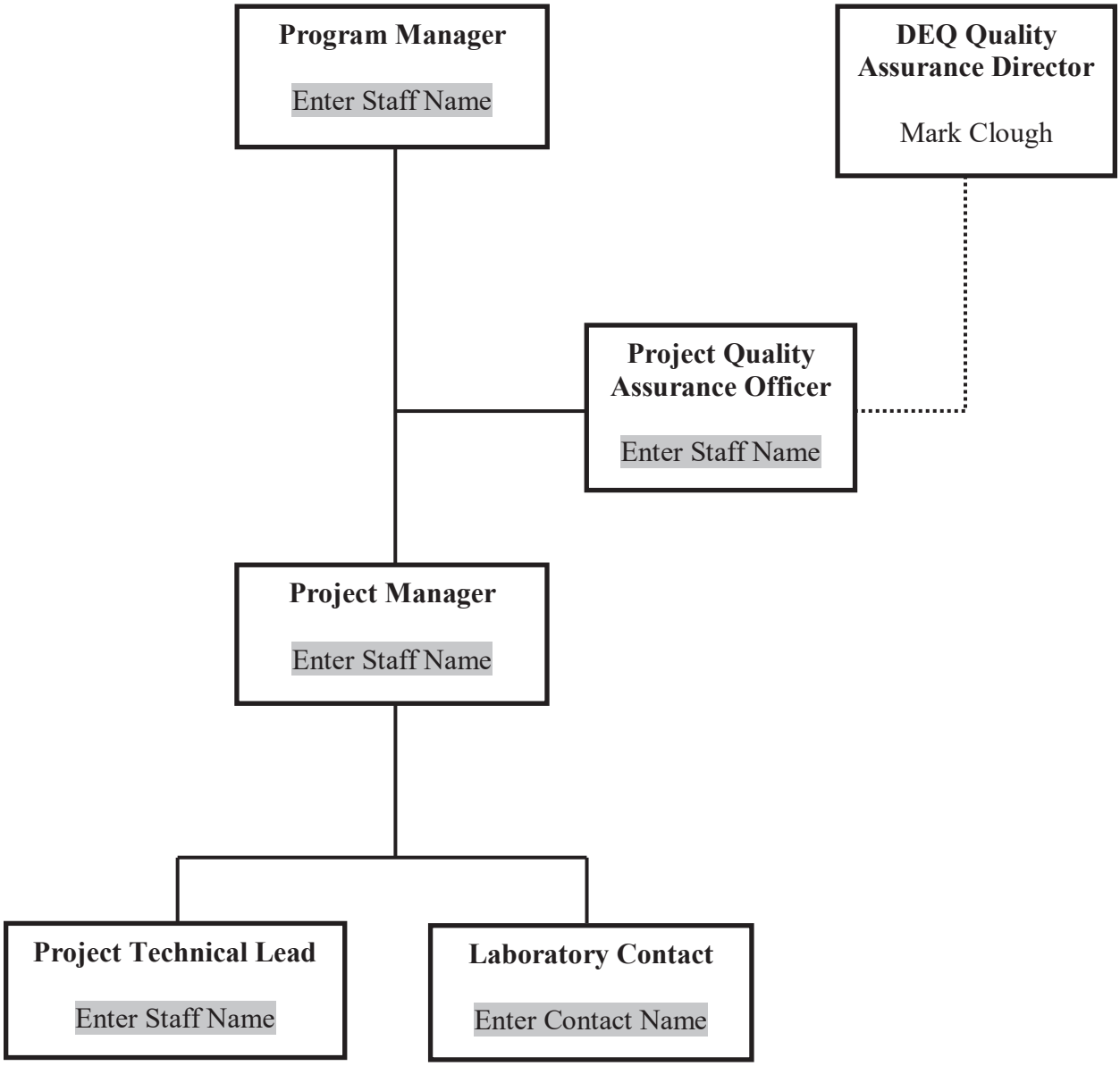


Figure 1: Project organizational chart

5. PROBLEM DEFINITION/BACKGROUND

A. Problem Statement

The Idaho Department of Environmental Quality (DEQ) is responsible for conducting regional ground water monitoring activities, per the Idaho Ground Water Quality Plan. The DEQ Idaho Falls Regional Office (IFRO) develops monitoring projects to investigate regional ground water quality issues. These issues can be the result of local public concern, regional office priority, or State-wide Departmental emphasis. Regional projects may include nitrate source or trend-related investigations focusing on Nitrate Priority Areas (NPAs), and sampling to address specific local concerns such as arsenic. The DEQ regional office is also charged with facilitating drinking water source protection. Projects may include sampling to support protection implementation strategies.

The overall rational for regional nitrate monitoring activities is to address DEQ's responsibilities under the Ground Water Quality Plan, summed up as to provide ground water monitoring data that will aid in:

- identifying areas of high vulnerability
- assess concentration trends in areas of degraded ground water quality
- identify, delineate, and explain sources of variability and degradation at regional and local levels,
- informing, directing, and prioritizing ground water protection programs and efforts, and
- Providing a means of evaluating effectiveness of best management practices, improving these best management practices, and to support regulatory decisions.

This Quality Assurance Project Plan (QAPP) provides a framework for data collection to identify potential sources of impact to ground water within the region. More specifically, this QAPP includes elements consistent for ground water monitoring events focusing on identifying potential sources of nitrate impacts to drinking water sources, primarily ground water. Nitrate-related sampling campaigns shall reference this QAPP, and include a Field Sampling Plan (FSP) detailing specific objectives, analytes, sampling strategies, pertinent background and sample locations.

B. Intended Usage of Data

The data collected for the Regional NPA Monitoring will be used to determine the nature and extent of ground water contamination due to nitrate. The sample results will be shared with Idaho State Department of Agriculture (ISDA) or other agencies, as necessary, to determine appropriate response activities. All sample results will be entered into the DEQ Ground Water Quality Database and be available through the online mapping application.

Sample results for NPA monitoring will be presented in either an annual DEQ ground water monitoring report or a campaign/project-specific report that will be included in the DEQ Ground Water Technical Report Series. Nitrate data may also be used in the NPA ranking process.

Private well owners will receive a report of analytical data from samples collected from their well. Appropriate data interpretation and recommendations may also be included.

6. PROJECT/TASK DESCRIPTION

A. General Overview of Project

Sampling projects will assess regional and local ground water quality impacts to the public due to the nitrates in ground water. The framework for monitoring to assess regional and local water quality and impacts will be described in a regional nitrate monitoring design document to be developed. A project/campaign-specific description, including network design/site selection will be included in the FSP for each monitoring campaign. Sites will be selected based on a combination of criteria, as pertinent to the specific project, including; well completion depth, location, accessibility, and historic sample results. Random or stratified random selection processes may be employed. Preference may be given to wells representative of sensitive populations and wells screened in the upper-most aquifer or portion of the aquifer. Priority may also be given to previously sampled wells to allow development/evaluation of trends.

Samples may be collected at each location for analysis of one or more of the following, as required for the specific sampling campaign:

- Major cations (e.g. calcium, magnesium, sodium, potassium)
- anions (e.g., nitrate, nitrite, sulfate, chloride, bromide, fluoride and o-phosphate)
- ammonia
- bacteria: total coliform bacteria , E. coli

- nitrogen isotope ($\delta^{15}N$)
- oxygen/deuterium isotopic ($\delta^{2}H$- $\delta^{18}O$)
- nitrogen and oxygen isotopic for nitrate anion ($\delta^{15}N_{NO3}$, $\delta^{18}O_{NO3}$)
- tritium
- Pharmaceuticals and Personal Care Products (PPCPs)

Sample submission may follow a staged approach to maximize cost vs. diagnostic benefits; for example while samples collected for less costly analyses such as $\delta^{15}N$, and $\delta^{18}O$ may be collected and submitted for all sites, samples for more expensive analyses such as $\delta^{15}N_{NO3}$ and $\delta^{18}O_{NO3}$ or PPCPs may be collected at all sites, but not submitted for analysis unless initial results indicate that such information may confirm contamination sources or geochemical processes are occurring. These tiered analyses may aid in correctly identifying the primary factors to explain contaminant conditions observed. Holding times and sample preservation requirements would allow for this staged approach.

B. Project Timetable

The specific project timetable will be designated for each monitoring project in the FSP.

7. QUALITY OBJECTIVES AND CRITERIA

The objective of quality assurance and quality control (QA/QC) is to assure that analytical results obtained by sample analyses are representative of actual chemical and physical compositions of the ground water. Field QA/QC will consist of following a standard protocol for sample collection and by collecting and analyzing sample duplicates and field blanks. The duplicates will be used to determine both field and laboratory precision. The field blank will be used to check the integrity of the sample collection and handling process. Both the duplicate and field blank samples are stored and handled with the normal sample load for shipment to the laboratory. Project goals and sampling conditions may require additional field QC samples, including equipment blanks or spiked samples. Field QC samples will be submitted "blind". Ideally, at least one set of field quality assurance samples will accompany each sample shipment or analysis batch.

Field QC samples will comprise at least 10% of all samples with a goal of 20% QC samples.

Field screening data (e.g., field parameters of pH, temperature, specific conductivity, and dissolved oxygen) are at data quality Level I (field parameter/ screening level data). Laboratory analytical data (i.e., data from samples submitted to a laboratory for analysis) are at data quality Level III (standard laboratory procedures and data reviewed by standard Quality Assurance protocols). Specific data quality objectives or requirements will be included in the FSP if not included in the project QAPP.

A. Data Precision, Accuracy, Measurement Range

Accuracy is a measure of the closeness of the agreement between a "true" or reference value and the associated measured value. A sampling campaign may include spiked samples with a known matrix submitted blind to the laboratory or may rely on reported recoveries for Laboratory Control Samples (LCS). The recoveries of laboratory control samples (LCS), matrix spikes, and surrogate spikes will be used to evaluate the accuracy of the measurements. These recoveries are typically calculated as "percent recovery" represented by the following equations:

Spiked sample or LCS Percent Recovery:

$$\%R = C_M / C_T * 100$$

Where: C_M = Measured spike/LCS concentration
C_T = True spike/LCS concentration

Matrix Spike and Surrogate Recoveries:

$$\%R = (C_S - C_{US}) / C_T * 100$$

Where : C_S = Measured concentration of Spiked Sample
C_{US} = Measured concentration of Un-Spiked Sample
C_T = True Concentration of Spike Added

Laboratory accuracy for each analysis is set by a statistical analysis of the laboratory equipment and the acceptable accuracy range for the laboratory equipment will be indicated in the laboratory sheets. Any outliers from the acceptable range in % Recovery, as determined by the laboratory, will be flagged by the laboratory. Typical accuracy goals will be ± 20%. Accuracy goals will be specified in the FSP if not specified in the QAPP.

Precision is a measure of agreement between two measurements of the same property under prescribed conditions. Sampling campaigns may include duplicate samples (field replicates or split samples) or may rely on LCS split sample results. The Relative Percent Difference (RPD) of duplicate samples will be used to assess data precision. For laboratory duplicates, field duplicates and matrix spike duplicates, the following equation will be used to calculate Relative Percent Difference (RPD):

$$RPD = \frac{(C_1 - C_2)}{(C_1 + C_2) / 2} * 100$$

Where: C_1 = Concentration in first sample
C_2 = Concentration in the second/duplicate sample
Where both C_1 and C_2 > 5 times the laboratory Method Detection Limit (MDL).
Where one or both C_1 and C_2 are less than 5 times the MDL, the results will be considered within control limits where C_1 and C_2 are ± MDL.

For radiological samples, such as tritium, precision will be assessed by RPD where both results exceed 5 times the MDL, otherwise results will be considered within control limits when within 3 times Pooled Standard Error (PSE):

$$PSE = /R_1-R_2/ \leq 3(S_1^2 + S_2^2)^{1/2}$$

Where:

R_1 = concentration in first sample
R_2 = concentration in second/duplicate sample
S_1 = analytical uncertainty (counting error associated with laboratory measurement of the first sample)
S_2 = analytical uncertainty (counting error associated with laboratory measurement of the duplicate sample)

The goal for precision and what that precision will be based on for each sampling campaign will be included in the FSP if not included in the QAPP. In general, precision will be based on field duplicates with a goal of ± 20%.

Appropriate **Measurement Range** is determined by reviewing results with comparison to the laboratory reporting levels/MDL. Reporting requirements are determined prior to sampling through review of historical data for the analytes and region of interest, and reflected in choice of analytical laboratories, analysis methods and requested reporting levels/MDL. Assessment criteria and goals will be described in the FSP if not included in the QAPP.

B. Data Representativeness

Representativeness is defined as the degree to which the sample data accurately and precisely represent site conditions. The representativeness criterion is best satisfied by confirming that sampling locations are properly selected, sample collection procedures are appropriate and consistently followed, a sufficient number of samples are collected, and analytical results meet data quality objectives. All sampling procedures will follow the sampling procedures in the sampling protocol in Appendix A. Representativeness is evaluated by comparing the combination of data accuracy, precision, appropriate measurement range and methods, and assessing other potential sources of bias; including sample holding times, blank samples, and laboratory quality assurance review. Any additional specific assessment criteria and goals will be described in the FSP if not included in the QAPP.

C. Data Comparability

Comparability is defined as the confidence with which one data set can be compared to another data set. Using standard sampling and analytical procedures will maximize

comparability. In an effort to ensure data comparability, sample collection protocols (included in Appendix A) will be consistently followed, the same analytical procedures will be used, and the same laboratory will be used to analyze the samples throughout each project. The FSP for each project will include the laboratory to be used for each analyte.

D. Data Completeness

Completeness is defined as the percentage of valid data relative to the total possible data points. For data to be considered valid, it must meet all of the acceptance criteria, including accuracy and precision, as well as any other criteria specified by the analytical method used. The overall data quality objective for completeness for the sampling events conducted under this QAPP is 80%. Any required departure from this goal will be justified and explained in the FSP.

8. SPECIAL TRAINING/CERTIFICATION

The Project Manager and/or Program Manager is responsible for ensuring that personnel assigned to this project are appropriately trained and qualified, with the appropriate training records on file in DEQ Human Resources.

All work performed by DEQ personnel will be conducted in accordance with the State of Idaho Worker Health and Safety Plan.

No special training for ground water sample collection is required; staff will have previous ground water sampling experience and on-the-job training.

9. DOCUMENTATION AND RECORDS

Project documents will be filed electronically in TRIM, in accordance with applicable program filing procedures. The Project Manager is responsible for ensuring that the most current approved revision of the project QAPP, with related FSPs and SOPs, is available in the DEQ TRIM electronic records management system.

Field personnel will document each day's activities in field notes. Information is to be recorded as follows:

- Project data must be recorded directly, promptly, and legibly.
- Field logbook or field sheet entries must be made in black or blue permanent ink and must be signed/initialed and dated by the person making the entry.
- Changes or corrections to data must be indicated with a single line through the original entry.
- Changes must be initialed, dated, and explained.

In addition to field notes (as identified in Appendix B at a minimum), documentation is to include all data used to develop the monitoring network, well sampling permission documentation, a sampling procedures document, the reports summarizing the sampling events and results.

10. SAMPLING PROCESS DESIGN

A. Rationale for Selection of Sampling Sites

The nitrate priority area monitoring network will consist of existing private domestic, irrigation or public water system wells that are selected following the protocol (to be developed) for the IFRO Regional Ground Water Monitoring Network Design. Sampling frequency, where not described in the regional ground water monitoring design document, will be described in the associated FSP. The specific FSP will identify the number of sample locations and specify analytes, collection and analysis requirements, special handling or follow-up criteria and reporting requirements. Permission from the well owner will be obtained prior to sampling each well.

B. Sample Design Logistics

Sampling logistics will be identified in the specific monitoring campaign FSP if not identified in this QAPP.

11. SAMPLING METHODS

QA/QC procedures as specified for sample collection will be followed by sampling personnel. The QA/QC procedures will be fulfilled by adhering to all requirements detailed in this QAPP and the ground water sampling procedure located in Appendix A of this QAPP. Such adherence will be demonstrated through appropriate documentation of sampling procedures within the field logbook or field sheets as described herein. Field audits by the Project QA Officer may also be part of QA/QC procedures.

Samples collected from private domestic wells, irrigation or public supply wells will utilize the existing pump and distribution system. Water samples will be collected from a faucet or sample port nearest the well and before any treatment system. Samples collected from monitoring wells will utilize a submersible pump, peristaltic pump, or disposable bailer. If a pump is used, dedicated or disposable tubing will also be used. Equipment blanks may be included with the complement of quality assurance samples.

A portable meter will be used to measure pH, specific conductance, dissolved oxygen, and temperature at each sample location. A GPS will be used to determine the longitude and latitude of the well/sampling point.

Field work quality will be controlled by following standard sampling protocols (Appendix A) during each sampling event, using consistent sampling containers and laboratories, and collecting sample duplicates and blanks. Protocols for items such as equipment decontamination, chain of custody forms, sample blanks, etc, are found in Appendix A, and further detailed in the project FSP. Detailed field notes will be taken for quality control and proper sample identification.

Analytes, laboratories, shipping addresses, and current contract numbers as appropriate are included in Table 3. Analytical methods, sample container, preservation and holding times are identified in Section 13 and Table 4.

Table 3: Analytes, laboratories, and contract numbers.

Analytes	**Preferred analyzing Laboratory**	**Shipping address**	**DEQ Contract number**
Major anions, Major cations, nutrients	State of Idaho Bureau of Laboratories	2220 Old Penitentiary Rd Boise ID 83712	MOA
Bacteria: Total Coliforms, E. Coli	IAS-EnviroChem	3314 Pole Line Road Pocatello, ID 83201	Vendor
Stable isotopes: ^{15}N, ^{18}O, ^{2}H	University of Arizona Environmental Isotope Geosciences Laboratory	Department of Geosciences Gould-Simpson Building Tucson, AZ 85721-0077	C515
tritium	Idaho State University Environmental Monitoring Laboratory	Department of Physics 785 Sth 8th Bldg3 RmB107A Pocatello, ID 83209	research partner
Stable isotopes: $^{15}N_{NO3}$, $^{18}O_{NO3}$	University of Waterloo Environmental Isotope Laboratory	UwEILAB C/O Chemistry Stores University of Waterloo 200 University Ave. W. Waterloo, ON Canada N2L 3G1	(Update)
Stable isotopes: ^{15}N, ^{18}O, ^{2}H, $^{15}N_{NO3}$, $^{18}O_{NO3}$	Northern Arizona University Colorado Plateau Stable Isotope Laboratory	Northern Arizona University CPSIL/CPAL Room 108 115 W Dupont Ave Building 88 Flagstaff, AZ 86011 Tel: 928-853-1983	Vendor

Analytes	Preferred analyzing Laboratory	Shipping address	DEQ Contract number
Pharmaceuticals and Personal Care Products (PPCPs)	(Appropriate Laboratories and contacts will be developed as needed)	(Update)	(Update)

12. SAMPLE HANDLING AND CUSTODY

Samples will be collected by DEQ personnel into laboratory-supplied sampling containers, labeled, placed in an ice-chilled cooler and transported directly to the laboratory or shipment location. Samples collected for $^{15}N_{NO3}$ and $^{18}O_{NO3}$ analysis will be frozen at DEQ until the chemistry and other stable isotope results from the sample location are received and reviewed.

Where analytical results for a sample location exceed 5 mg/L, and/or supporting results suggest chemical evolution of nitrogen in groundwater samples collected for $^{15}N_{NO3}$ and $^{18}O_{NO3}$ analysis may be sent to University of Waterloo EIL or Northern Arizona University CPSIL for analysis. DEQ personnel will oversee proper storage and handling of all samples collected until transferred into the care of others. Properly filled out chain of custody forms will be used and maintained at all times. Protocols for chain of custody forms, sample handling, etc, are found in Appendix A, and further detailed in the project FSP. Chain of custody forms will accompany the samples from the time of sample collection throughout the duration of the shipping process.

13. ANALYTICAL METHODS

All sample containers, labels, and preservatives will be obtained from the analytical laboratory. Samples must be preserved and analyzed within the holding times. The laboratory will be notified prior to sample shipment to ensure the holding time is not exceeded. All other instructions provided by the analytical laboratory will be followed throughout the duration of each project.

Table 3 lists analytical laboratories for the NPA monitoring projects, including the potential parameters to be analyzed by that laboratory and the location of the laboratory. Samples may be sent to other laboratories as needed to achieve specific sample campaign objectives. In general, samples for major ion/common ion chemistry and nutrients will be sent to Idaho Bureau of Laboratories, Boise; bacteria to IAS-Envirochem, Pocatello; and environmental-level tritium to Idaho State University EML. Stable isotope analysis may be sent to one or more laboratories based on factors including proven quality of results, timeliness of result

receipt, cost, and convenience. Inter laboratory comparisons may be conducted to determine long-term laboratory choices. Initially, the University of Arizona Environmental Isotope Laboratory will be used for ^{15}N, ^{18}O, ^{2}H analysis. A selection of samples for $^{15}N_{NO3}$, $^{18}O_{NO3}$ will be sent to University of Waterloo EIL, with comparison samples sent to Northern Arizona University CPSIL for analysis and method comparison. Future analysis result comparisons for ^{15}N, ^{18}O, and ^{2}H may also be made between University of Arizona and Northern Arizona University.

Table 4: Analytical method, container, preservation and sampling holding times.

Sample	Parameter	Analytical Method	Sample container	Preservative	Holding Time
Major cations	Ca, Mg, Na, K,	EPA 200.7	1 L LDPE	HNO_3, 4^0 C	6 months
Major anions	Cl, F, SO_4,	EPA 300.0	1 L LDPE	4^0 C	28 days
	Alkalinity (as $CaCO_3$)	SM2320B		4^0 C	14 days
	Total Dissolved Solids	SM2540C		4^0 C	7 days
Nutrients	NO2+NO3-N	EPA 353.2	1 L LDPE	H_2SO_4, 4^0 C	28 Days
	Ammonia	EPA 350.1		H_2SO_4, 4^0 C	28 Days
	Ortho-phosphorus	SM 4500P-E		H_2SO_4, 4^0 C	28 Days
Tritium	Low-level tritium	HASL 300	1 L HDPE	None	180 days
bacteria	Total Coli form, E. Coli bacteria	9223B	120 ml polystyrene	4^0 C	30 hours
Stable isotopes	^{15}N	TP11	1 L LDPE	Freeze samples	Unlimited if frozen
	$^{15}N_{NO3}$, $^{18}O_{NO3}$	Carlo Erba[2] 1500 EA, VG PRISM, Denitrifying[2] bacteria	2L LDPE[2], 60 ml x2 HDPE[2]	Freeze samples[2], Filter and freeze[2]	56 days[1], Unlimited[2]
	^{18}O	TP13	250 ml HDPE	None	None
	Deuterium	TP04		None	None
PPCPs	(Specific parameter, analysis methods and sampling requirements will be identified as needed)				

[1] Waterloo EIL
[2]Northern Arizona University CPSIL

14. QUALITY CONTROL

A. Field QC Checks

Field QC samples, typically duplicates and blanks, will be submitted blind (not identified as a QC sample) for analysis. The overall field QC frequency will be at least 10% of the sample load. Submission of QC samples will be scheduled to ensure that at least one QC sample set will be included with each batch of samples submitted to the laboratory. Field QC checks are to be as evenly distributed as project conditions allow between duplicates, blanks, and spikes.

Duplicates

Duplicate samples are two samples collected from the same location and representing the same sampling event and are carried through all assessment and analytical procedures in an identical manner. Duplicate can be "replicates" (samples taken one immediately after the other, separated only be the actual time required to fill the sample container), or "splits" (subsamples drawn from the same initial volume of matrix). The FSP will describe the method for obtaining duplicate samples. Field sampling procedures outlined in Appendix A will also be followed for each of the sampling events to ensure consistency in sample collection. All relevant information will be recorded for the duplicates in the field logbook or field sheet. The duplicates will allow assessment of repeatability and accuracy of the sampling procedures and will also be used to assist in assessment of any cross-contamination issues. Results from the field duplicate analysis will be presented in the analytical report.

Field and Equipment Blanks

A blank is a sample of known matrix where the specific constituents requested for analysis are known to not be present, or are present at concentrations less than the laboratory lower limit of detection.

Field blanks are samples of blank matrix, typically deionized water, prepared in the field under similar conditions, processed the same as and included for analysis as a regular sample. Field blanks are a quality control check to identify potential problems with the sample collection, handling and analysis process. Equipment blanks are blank sample matrix passed through or over non-dedicated sampling equipment to check the decontamination process between samples or sample sites.

Equipment blanks may be collected when sampling equipment requiring decontamination (portable pumps, sampling manifolds, ect.) are carried from well to well. Equipment

blanks when collected, will also be submitted blind for analysis and may be included in the overall 10% QC sample calculation.

Field spikes
Samples from a third party vendor that include a known concentration of analytes of concern may be submitted blind to the analyzing laboratory. These "spiked" samples may be included in the sample load to allow for an independent accuracy assessment or for inter laboratory comparisons. Due to the added cost of procuring or preparing field spike samples these may not be included with all sampling campaigns. Use of spiked samples will be described in the FSP.

B. Laboratory QC Checks

Laboratory quality control checks are routinely performed as part of the analysis process. Frequency and type of QC samples are often analysis method-dependent and include reagent blanks, matrix spikes, and internal laboratory splits. Analyzing laboratories will report any variance from QC control limits impacting quality of sample results and may report details of internal laboratory QC if requested. The analytical laboratory may provide appropriate sample containers, chain of custody forms, sample labels, and any necessary container seals. Laboratory QA/QC and data reports will be filed in TRIM following applicable filing protocols.

Quality control checks include internal checks for sampling analysis activities, duplicate samples and blanks. Quality Control procedures for the laboratories have been certified through the U.S. Environmental Protection Agency. The following list documents key components of the laboratory QA/QC program for this project.

Laboratory Blanks

A laboratory blank is a sample of an uncontaminated reference matrix. The laboratory blank is analyzed to evaluate the accuracy of the analysis.

Laboratory Quality Control Samples
Laboratory control samples (LCSs) are samples that contain a known concentration of analytes and are analyzed to assess the overall method performance. They undergo the same preparatory and determinative procedures as the project environmental samples and are the primary indicator of laboratory performance. LCS recoveries are used to measure accuracy. The relative percent difference (RPD) for duplicate LCS recoveries is used to measure precision.

Laboratory Duplicate Sample

A laboratory duplicate sample is a sample that is split by the laboratory into two separate and identical samples. The two samples are analyzed and a comparison of the results (RPD) is used to assess laboratory precision.

Matrix Spike and Matrix Spike Duplicate (MS/MSD) Samples
A matrix spike (MS) is a sample with known amount of the target analyte added to project matrix before analysis to assess possible matrix interferences on the analysis. Percent recoveries (%R) on MS samples should be compared to %R of LCS samples. A MS, matrix spike duplicate (MSD) pair can be used to assess precision.

C. Data Analysis QC Checks

The QC check data may be checked/reviewed for quality by the Project Technical Lead, the Project Manager, or the Project QA Officer at any time during the project, and must be checked once all of the data is collected. Corrective actions, as needed, will be documented in the event that control limits are exceeded. Data qualifiers will be assigned following appropriate data verification/validation procedures. Any qualifiers added will be defined in the project summary/technical report and will be consistent with appropriate EPA guidance, EPA QA/G-8.

15. INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

Laboratory instrument/equipment testing, inspection, and maintenance are performed by and documented by the laboratory as required by or consistent with the State of Idaho laboratory certification process. Procedures and schedules for preventive maintenance of sampling equipment are the responsibility of the laboratory. Each instrument or item of laboratory equipment will be maintained periodically to ensure accuracy. These procedures and frequency of performance are designated in the individual instrument manuals.

Project field instrument/equipment testing, inspection, and maintenance will be performed in accordance with the individual instrument/equipment manual.

16. INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

Laboratory instrument calibration is conducted, and documented by the laboratories laboratory as required by or consistent with the State of Idaho certification process.

All field monitoring equipment for the measurement of field parameters (temperature, pH, specific conductance, dissolved oxygen) will be calibrated and maintained as recommended by the manufacturer, or as found in individual instrument/equipment manuals, to ensure accuracy within specified limits. Field equipment used to collect samples will be calibrated according to manufacturers' procedures or internal guidelines at the start of each field day (at a minimum) and/or at intervals recommended by the manufacturer or found in individual instrument/equipment manuals. Calibration details will be recorded in the field logbook or field sheet.

17. INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

The equipment and supplies required for monitoring campaigns will be consistent with the included ground water sampling procedure (Appendix A). Sampling equipment and personal protective equipment beyond that listed in the ground water sampling procedure will be documented in the FSP (i.e. if antibiotics or steroids are collected, a face mask will be used). All sample containers may be obtained from the analytical laboratory. All gloves, face masks, and sample containers will be new, and will be used once during each sample collection. Each instrument or item will be calibrated per the individual instrument/equipment manuals, and also visually inspected by field sampling personnel for damage and operability.

18. NON-DIRECT MEASUREMENTS & DATA ACQUISITION

This section addresses data obtained from existing data sources, not directly measured or generated in the scope of this project.

The laboratories shall provide DEQ with a data package that includes the analytical results of the submitted samples, the QA/QC report for the analyses, and a copy of the chain-of-custody record. Laboratories may be requested to provide results and reports in an electronic format.

No other non-direct data is expected to be acquired.

19. DATA MANAGEMENT

Hard copies of field notes and laboratory data reports will be kept at least until data review and reporting is complete. Electronic copies of all field notes and laboratory reports will be kept in TRIM. The analytical results will be uploaded to the DEQ Ground Water Quality

database after review by the Project QA officer and will be available to the public through the DEQ online mapping application.

20. ASSESSMENT AND RESPONSE ACTIONS

Assessment of the project quality control plan will be performed by reviewing field notes and laboratory reports and by conducting field audits where possible. This assessment will be completed or directed by the Project QA Officer. Any errors or inconsistencies identified in the field notes will be investigated and corrected to ensure the integrity of the data and conformation to the QAPP and FSP. Review of internal laboratory quality assurance, audits, and surveillances or other types of laboratory assessments will also be taken into account. If unexpected analytical results are reported for any reason, the laboratory will be contacted to perform an additional quality review of the data in question. The Project QA Officer will perform additional assessment of the plan independently of the Project Manager and sampling lead.

A note to the file will be included with the field notes and laboratory reports if any follow up quality assurance activities regarding field notes or laboratory reports are conducted.

The Project QA Officer shall review the QAPP annually, to determine if revision is necessary. The Project Manager should also review the project QAPP on an annual basis to ensure that the project QAPP continues to meet the needs of the data users. If the project QAPP does require revision, the revised QAPP must be submitted for approval, prior to implementation, per the DEQ QMP.

21. REPORTS TO MANAGEMENT

Sample results for NPA-related monitoring will be presented in either an annual DEQ ground water monitoring report or a site-specific report that will be included in the DEQ Ground Water Technical Report Series.

22. DATA REVIEW, VERIFICATION, AND VALIDATION

Data collected under this QAPP will be reviewed by the Project Manager, Project Technical Lead, and the Project QA Officer to ensure the data has been recorded, transmitted, and processed correctly. RPDs will be calculated for all field duplicates and the laboratory %R and RPDs will be reviewed. Review by the Project QA Officer shall include a minimum of 10 percent of all project data with a goal of 20 percent. This review will include verification/validation to the original laboratory data reports.

Data verification and validation efforts will be recorded in project documentation.

23. VERIFICATION AND VALIDATION METHODS

DEQ personnel performing data verification and validation are encouraged to review the EPA guidance on methods for this task, found in EPA Guidance on environmental Data Verification and Data Validation, EPA QA/G-8.

Data verification will be performed by the Project Manager and/or Project Technical Lead by reviewing all chain-of-custody sheets, surrogate recoveries, method blanks and LCS and MS sample/sample duplicates to assess %R and range of RPDs. The %R and RPDs will be compared to project goals as described in the QAPP and FSP and an assessment of completeness will be made.

Data validation will be performed by the Project Manager and/or Project Technical Lead, and the Project QA Officer, extending the data evaluation beyond method and procedural compliance, to determine the analytical quality of the data set. Assignment of data validation qualifiers will be completed by the Project Manager and/or Project Technical Lead consistent with appropriate EPA guidance. Validation by the Project QA Officer will include review of data qualifiers. The intent of data validation is to determine if the data are adequate to support the objectives of the project. Items to be considered include: Does the data meet the needs of the project, does the data meet the quality objectives of the project, and are the conclusions drawn from the gathered data supportable. Data validation will also include a determination, where possible of the reasons for any failure to meet method, procedural, or contractual requirements, and an evaluation of the impact of such failure on the overall data set.

Any discrepancies from requirements of the QAPP, with respect to the data, will be noted during the verification and validation process. As determined by the Project Manager, the Project Technical Lead, or the Project QA Officer, if the data do not meet the needs of the project, or the quality objectives of the QAPP, and/or if the conclusions drawn from the data do not appear to be reasonable, the Project Manager and the Project QA Officer shall immediately report such findings to the appropriate Regional Manager and State Office Program Manager for determination of the necessary corrective actions.

24. RECONCILIATION WITH USER REQUIREMENTS

Data quality objectives (DQOs) will be discussed with the analytical laboratory as needed by the Project Manager or Project Technical Lead when DQOs are not met to insure that the laboratory is taking appropriate corrective action. Corrective actions may be initiated to suggest updates to internal laboratory QA procedures in order to rectify QA issues. If no

corrective actions are being implemented and no plan can be developed to address QA issues, the Project Manager will consider changing laboratories for future sampling events.

Data Quality Assessment (DQA) will be performed in accordance with the DEQ QMP. Additional guidance can also be found in EPA Data Quality Assessment: A Reviewer's Guide, EPA QA/G-9R, or in EPA, 2006, Data Quality Assessment: Statistical Methods for Practitioners, EPA QA/G-9S, EPA/240/B-06/003.

The DQA, performed by the Project Manager and the Project QA Officer, addresses the determination of if a data set is of the right type, quality, and quantity to achieve the objectives of the project and can confidently be used to make an informed decision.

As previously stated in Section 23, if the Project Manager, the Project Technical Lead, or the Project QA Officer, reach the conclusion that the project data do not meet the needs of the project, or the quality objectives of the QAPP, and/or if the conclusions drawn from the data do not appear to be reasonable, the Project Manager and the Project QA Officer shall immediately report such findings to the appropriate Regional Manager and State Office Program Manager for determination of the necessary corrective actions

If sampling activities require revision, the project QAPP and/or the project FSP will be revised as necessary. Following revision, and prior to implementation, the revised project QAPP and/or FSP must be re-approved in accordance with the Idaho DEQ QMP.

REC 4882

25. REFERENCES

DEQ, 2007, Quality Management Plan, Revision 2

DEQ, 20XX. Idaho Falls Regional Office Regional Ground Water Monitoring Network Design, (in process).

EPA, 2006, Data Quality Assessment: A Reviewer's Guide, EPA QA/G-9R, EPA/240/B-06/002

EPA, 2006, Data Quality Assessment: Statistical Methods for Practitioners, EPA QA/G-9S, EPA/240/B-06/003

EPA, 2002, Guidance for Quality Assurance Project Plans, EPA QA/G-5, EPA/240/R-02/009

EPA, 2001, Requirements for Quality Assurance Project Plans, EPA QA/R-5, EPA/240/B-01/003

EPA, 2002. Guidance on environmental Data Verification and Data Validation, EPA QA/G-8, EPA/240/R-02/004

EPA, 2004. USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, OSWER 9240.1-45, EPA 540-R-04-004, October 2004

Tetra Tech, Inc, 1992. State of Idaho Worker Health and Safety Program, Volumes I and II.

This Page Intentionally Left Blank

APPENDIX A - GROUND WATER SAMPLING PROCEDURES, IFRO SAMPLING PROJECTS

Note: In this example, a standard procedure for water sampling was incorporated into the project QAPP as an appendix. Not all project QAPP's will require this, but this example illustrates how this can be done. Another way to accomplish this is to reference an approved DEQ Standard Operating Procedure (SOP).

It must be noted and understood that this "Appendix A" is NOT the Field Sampling Plan (FSP) referenced in this example QAPP. A FSP is a stand-alone document that gives project specific information and direction with respect to project sampling. This example QAPP assumes that a FSP will be written to accompany the QAPP. If the project for which a QAPP is being written (using this example/template) will not have a specific FSP written for it, then all the information that this example/template QAPP defers to the FSP will need to be included within the new project QAPP itself.

Equipment required: field log book with collection data sheets, sample labels, water-proof pens and markers, cell phone, GPS, instruments for field parameter measurement, sample collection equipment (may include hose bib, sample collection port and associated tubing, peristaltic pump, bucket, submersible pump and generator), sample containers, preservatives, sample cooler and ice, powder-free nitrile or vinyl gloves, safety glasses or face shield, paper towels, first-aid equipment, bag for trash.

1.0 Well Purging Procedures

Each well/sample point will be purged until the field parameters stabilize as defined in Section 2 of this Appendix. The volume of water and amount of time required to properly purge each well will be dependent on the size and yielding characteristics of each well.

2.0 Field Parameter Measuring Procedures

Field measurements of pH, temperature, and specific conductance will be measured throughout the purging sequence and recorded on the field data sheet or logbook. Field parameters will be recorded at least once for every five minutes while the well is purged. Stabilization of these parameters is considered successful when three successive readings (a minimum of five minutes apart) meet the following criteria:

pH :	± 0.1 standard unit
Specific Conductance:	± 10µmhos/cm or ten percent of the preceding reading

Temperature: ± 0.5° C

Measurements of field parameters will be taken using a field parameter meter that is calibrated prior to each day of sampling. Water used in field parameter measurements will be collected into a dedicated bucket or flow-through from the sampling hose connected to a faucet nearest to the wellhead. All measurements collected will be recorded in the field sheets and field logbook with appropriate times and well identification information. When possible, static water level measurements will be recorded.

3.0 Sample Collection Procedures

Once the field parameters have stabilized, collect the sample from the faucet or sample port. If a hose must be used for sample collection, a dedicated hose supplied by DEQ will be used. Samples should be collected as quickly as possible following stabilization of the field parameters. Collect the sample directly into the appropriate container. If a filtered sample is required, use an in-line filter connected with tubing at the faucet or sample port. If the sample point or conditions do not allow use of an inline filter, a peristaltic pump can be used. Collect water from the sample point in a bucket that has been triple rinsed in the sample matrix. Purge the pump line by running at least 500 ml of the water through the pump and proceed to collect samples. Samplers will wear a new pair of vinyl/nitrile gloves at each location, and will keep gloves on until samples are collected and required preservatives added. Samples should be collected and handled in a way that reduces the potential for losing the analyte from the sample matrix; for a VOC samples, reduce the discharge to a low, laminar flow, leaving a positive meniscus but not allowing the container to overflow and thereby losing preservative from the container. Typically, sample containers that are not pre-preserved should be triple rinsed with the sample matrix prior to collection.

The samples will be labeled with durable labels and water-resistant ink to provide proper identification. Labels will have the following information: unique sample identification number, date and time of collection, parameters requested, and project name/number.

Preservation of the collected samples will follow laboratory instructions. Samples to be chilled will be placed on ice in an ice chest at less than 4° C from the time of sampling until the analysis is complete. All samples will be transported in ice chests with ice packs and chain of custody forms.

4.0 Decontamination Procedures

The sample collection equipment carried from one location to another will be rinsed with deionized water or sample matrix prior to collecting measurements at the new site. Equipment that cannot be sufficiently purged with the sample matrix prior to sample collection will be rinsed with deionized water. Decontamination between sites may

require a stronger solution, depending on the nature of the contaminant. Special decontamination procedures will be detailed in the FSP.

5.0 Field sampling sheets

Field sampling sheets within a bound logbook will be completed for each well at each site visit. An example field sample sheet is included in Appendix B. At a minimum, the following information, as available, will be documented for each site visited during each sampling event:

- Identification of the well
- Total well depth
- Approximate purge volume and rate
- Date and time of sample collection
- Sample identification numbers and parameters requested
- Field parameter measurements and methods
- Field observations and remarks
- Name of collectors
- Weather conditions

6.0 Chain of Custody Forms

Once the samples have been collected, they will be placed in an ice chest (with ice) while in the field, and stored in a designated sample refrigerator until delivered or shipped to the lab. A chain of custody form will accommodate each ice chest during shipment to the lab. The chain of custody form will include the following information:

- Project name/code
- Laboratory name and address
- Sample identification number
- Date and time of collection
- Type of sample, number of containers, and analysis requested
- Sample preservation methods
- Signature of sample collector(s)/shipper
- Date and time of release to shipper/common carrier

The following procedures will be followed to ensure proper chain of custody:

- The chain of custody record will be checked for a signature
- The sample will be stored in a secure area until it is analyzed.

7.0 Quality Assurance/Quality Control

The objective of quality assurance and quality control is to make certain that the ground water analytical results represent the actual chemical and physical composition of the ground water at the site. DEQ will be responsible for the QA/QC activities of the samples and analytical laboratories. Components of the QA/QC program are as follows:

Laboratory: The analytical laboratory will provide or assist in the sampling containers, preservatives, chain of custody, labels and seals. A laboratory QA/QC report with continuing calibration checks will accompany each data report and will be kept on file by DEQ.

Sample Collection: QA/QC procedures for sample collection will be accomplished by the sampling personnel. A standardized field logbook or field sheet will be kept for each sampling event following the format described above. It will include all label and seal numbers and documentation of QA/QC procedures related to sample collection.

Trip Blank: Trip blanks may be included if samples for VOA analysis are included with the project.

Field Blank: Field blanks will be collected at the rate of at least 5 percent.

Duplicate Samples: Duplicate samples will be collected at the rate of at least 5 percent.

Field Spike: Spikes prepared by an independent source and submitted blind to the lab may be included with field QC samples.

Field QC Sample Goals: Field QC samples (duplicates, blanks, and spikes) will constitute at least 10%-20% of samples submitted to the analyzing laboratory.

REC 4888

APPENDIX B - GROUND WATER SAMPLING FIELD SHEET - IFRO

In this example, this appendix was used to supply an approved field sheet to the staff engaged in sampling efforts. Not all project QAPP's will require this appendix, but this illustrates how this type of information is included in a QAPP.

This Page Intentionally Left Blank

APPENDIX C - GROUND WATER SAMPLING PERMISSION FORM

In this example, this appendix was used to supply an approved access permission form to the staff engaged in sampling efforts. Not all project QAPP's will require this appendix, but this illustrates how this type of information is included in a QAPP.

This Page Intentionally Left Blank

United States
Environmental Protection
Agency

Office of Health and
Environmental Assessment
Washington DC 20460

EPA-600/8-83-021F
March 1984
Final Report

Research and Development

EPA

Health Assessment Document for Inorganic Arsenic

Final Report

REC 4893

EPA-600/8-83-021F
March 1984
Final Report

Health Assessment Document for Inorganic Arsenic

FINAL REPORT

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Research and Development
Office of Health and Environmental Assessment
Environmental Criteria and Assessment Office
Research Triangle Park, NC 27711

REC 4895

NOTICE

This document has been reviewed in accordance with the U.S. Environmental Protection Agency's peer and administrative review policies and approved for presentation and publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

REC 4896

PREFACE

The Office of Health and Environmental Assessment, in consultation with other Agency and non-Agency scientists, has prepared this health assessment to serve as a "source document" for Agency-wide use. Specifically, this document was prepared at the request of the Office of Air Quality Planning and Standards.

In the development of this assessment document, the scientific literature has been inventoried, key studies have been evaluated, and summary/conclusions have been prepared such that the toxicity of arsenic is qualitatively and, where possible, quantitatively identified. Observed effect levels and dose-response relationships are discussed where appropriate in order to place adverse health responses in perspective with observed environmental levels.

REC 4897

ABSTRACT

This document summarizes current scientific information regarding the effects of inorganic arsenic on man and the environment. The observed effects, as presented herein, constitute the health basis from which the U.S. Environmental Protection Agency will make determinations regarding regulatory initiatives pursuant to the Clean Air Act. Specifically, this document discusses the following topics--physical and chemical properties of inorganic arsenic; environmental distribution and cycling; inorganic arsenic metabolism; toxicology, including mutagenic and carcinogenic properties; and essentiality--and identifies the factors most germane to assessing quantitative and qualitative human health risks.

REC 4898

TABLE OF CONTENTS

	Page
LIST OF TABLES	ix
LIST OF FIGURES	xi
1. INTRODUCTION	1-1
2. SUMMARY AND CONCLUSIONS	2-1
2.1 BACKGROUND INFORMATION	2-1
2.1.1 Chemical/Physical Aspects of Arsenic	2-1
2.1.2 The Environmental Cycling of Arsenic	2-3
2.1.3 Levels of Arsenic in Various Media	2-4
2.1.3.1 Levels of Arsenic in Ambient Air	2-4
2.1.3.2 Levels of Arsenic in Drinking Water	2-4
2.1.3.3 Arsenic in Food	2-5
2.1.3.4 Arsenic in Soils	2-5
2.1.3.5 Other Sources of Arsenic	2-5
2.2 ARSENIC METABOLISM	2-6
2.2.1 Routes of Absorption	2-6
2.2.1.1 Respiratory Absorption	2-6
2.2.1.2 Gastrointestinal Absorption	2-6
2.2.1.3 Transplacental Transfer	2-6
2.2.2 Biotransformation of Inorganic Arsenic *In Vivo*	2-7
2.2.3 Distribution of Arsenic in Man and Animals	2-8
2.2.4 Arsenic Accumulation	2-9
2.2.5 Arsenic Excretion	2-10
2.3 ARSENIC TOXICOLOGY	2-10
2.3.1 Acute Toxicity	2-10
2.3.2 Chronic Toxicity	2-11
2.3.2.1 Mutagenesis of Inorganic Arsenic	2-11
2.3.2.2 Carcinogenesis of Inorganic Arsenic	2-12
2.3.2.2.1 Human Epidemiology of Arsenic Carcinogenesis	2-13
2.3.2.2.2 Experimental Studies of Arsenic Carcinogenesis	2-18
2.3.2.3 Chronic Neurological Effects of Arsenic Exposure	2-19
2.3.2.4 Cardiovascular Effects of Arsenic Exposure	2-20
2.3.2.5 Other Systemic Effects of Arsenic	2-20
2.3.3 Factors Affecting Arsenic Toxicity	2-21
2.4 ARSENIC AS AN ESSENTIAL ELEMENT	2-21
2.5 HUMAN HEALTH RISK ASSESSMENT FOR ARSENIC	2-22
2.5.1 Exposure Aspects of Arsenic	2-22
2.5.2 Effect/Response Aspects of Arsenic	2-23
2.5.2.1 Relevant Health Effects	2-23
2.5.2.2 Dose-Effect/Dose-Response Relationships	2-24
2.5.3 Populations at Special Risk to Health Effects of Arsenic	2-27

REC 4899

TABLE OF CONTENTS
(continued)

		Page
3.	BACKGROUND INFORMATION	3-1
	3.1 CHEMICAL/PHYSICOCHEMICAL ASPECTS	3-1
	3.2 ENVIRONMENTAL CYCLING OF ARSENIC	3-4
	3.3 LEVELS OF ARSENIC IN VARIOUS MEDIA	3-8
	3.3.1 Levels of Arsenic in Ambient Air	3-9
	3.3.2 Levels of Arsenic in Drinking Water	3-15
	3.3.3 Arsenic in Food	3-16
	3.3.4 Arsenic in Soils	3-19
	3.3.5 Other Sources of Arsenic	3-20
4.	ARSENIC METABOLISM	4-1
	4.1 ROUTES OF ARSENIC ABSORPTION	4-1
	4.1.1 Respiratory Absorption	4-1
	4.1.2 Gastrointestinal Absorption	4-6
	4.1.3 Transplacental Passage	4-10
	4.2 BIOTRANSFORMATION PROCESSES IN VIVO	4-11
	4.2.1 Biomethylation of Inorganic Arsenic in Humans and Experimental Animals	4-11
	4.2.1.1 Human Studies	4-12
	4.2.1.2 Animal Studies	4-15
	4.2.2 *In Vivo* Oxidation/Reduction of Inorganic Arsenic in Mammalian Systems	4-15
	4.2.3 Chemical Stability of Trivalent and Pentavalent Inorganic Arsenic to Oxidation-Reduction	4-20
	4.3 DISTRIBUTION OF ARSENIC IN MAN AND ANIMALS	4-20
	4.4 ARSENIC ACCUMULATION	4-23
	4.5 ARSENIC EXCRETION IN MAN AND ANIMALS	4-24
5.	ARSENIC TOXICOLOGY	5-1
	5.1 ACUTE TOXICITY OF ARSENIC IN MAN AND ANIMALS	5-1
	5.2 CHRONIC TOXICITY OF ARSENIC IN MAN AND ANIMALS	5-2
	5.2.1 Neurotoxic Effects	5-2
	5.2.2 Cardiovascular Effects	5-8
	5.2.3 Teratogenesis and Developmental Effects	5-11
	5.2.3.1 Animal Studies	5-11
	5.2.3.2 Human Studies	5-16
	5.2.4 Hematological Effects	5-17
	5.2.5 Hepatic Effects	5-18
	5.2.6 Renal Effects	5-19
	5.2.7 Respiratory Effects Other Than Cancer	5-20
	5.2.8 Immunosuppressant Effects	5-20
	5.3 FACTORS AFFECTING ARSENIC TOXICITY	5-21
6.	ARSENIC MUTAGENICITY	6-1
	6.1 GENE MUTATION STUDIES	6-1
	6.1.1 Prokaryotic Test Systems (Bacteria)	6-1
	6.1.2 Eukaryotic Microorganisms (Yeast, Fungi)	6-7
	6.1.3 Mammalian Cells *In Vitro*	6-7
	6.2 CHROMOSOMAL ABERRATION STUDIES	6-8

TABLE OF CONTENTS
(continued)

		Page
6.2.1	Chromosomal Aberrations *In Vitro*	6-8
6.2.2	Chromosomal Aberrations *In Vivo*	6-15
6.2.3	Chromosomal Aberrations and SCE in Cells of Arsenic-Exposed Human Beings	6-16
6.3	OTHER STUDIES INDICATIVE OF MUTAGENIC DAMAGE	6-23
6.3.1	Preferential Killing of Repair-Deficient Bacterial Strains	6-23
6.3.2	DNA Damage in Mammalian Cells *In Vitro*	6-30
6.3.3	Fidelity of DNA Synthesis	6-30
6.3.4	Induction of Sister Chromatid Exchanges (SCE) *In Vitro*	6-31
6.4	INTERACTIONS OF ARSENIC WITH OTHER MUTAGENS	6-32
6.4.1	Bacterial Studies	6-32
6.4.2	Mammalian Cells *In Vitro*	6-37
6.4.3	Mammalian Cells *In Vivo*	6-37
6.5	POSSIBLE MECHANISMS OF ACTION	6-39
7.	ARSENIC CARCINOGENICITY	7-1
7.1	HUMAN STUDIES	7-1
7.1.1	Clinical Aspects of Human Carcinogenesis	7-1
7.1.2	Epidemiological Aspects of Human Arsenic Carcinogenesis	7-12
7.1.2.1	Cancer of the Lung	7-12
7.1.2.2	Cancer of the Skin and Precancerous Skin Lesions	7-52
7.1.2.3	Other Cancers	7-74
7.2	ANIMAL STUDIES	7-77
7.3	QUANTITATIVE CARCINOGEN RISK ESTIMATES	7-88
7.3.1	Introduction	7-88
7.3.2	Unit Risk for Air	7-90
7.3.2.1	Methodology for Quantitative Risk Estimates	7-90
7.3.2.2	Risk Estimates from Epidemiologic Studies	7-94
7.3.2.2.1	The Lee-Feldstein (1983) Study	7-95
7.3.2.2.2	The Higgins et al. (1982) Study	7-104
7.3.2.2.3	The Brown and Chu Estimates from the Anaconda Data	7-110
7.3.2.2.4	The Enterline and Marsh (1982) Study	7-118
7.3.2.2.5	The Ott et al. (1974) Study	7-128
7.3.2.3	Discussion	7-132
7.3.3	Unit Risk for Water	7-135
7.3.4	Relative Potency	7-141
7.3.5	Summary and Conclusions of the Carcinogenicity of Arsenic	7-145
7.3.5.1	Qualitative Summary	7-145
7.3.5.2	Quantitative Summary	7-148
7.3.5.3	Conclusions	7-148

REC 4901

TABLE OF CONTENTS
(continued)

		Page
8.	ARSENIC AS AN ESSENTIAL ELEMENT	8-1
9.	HUMAN HEALTH RISK ASSESSMENT FOR ARSENIC	9-1
	9.1 AGGREGATE EXPOSURE LEVELS TO ARSENIC IN THE U.S. POPULATION	9-1
	9.2 SIGNIFICANT HUMAN HEALTH EFFECTS ASSOCIATED WITH AMBIENT EXPOSURES	9-4
	9.2.1 Acute Exposure Effects	9-4
	9.2.2 Chronic Exposure Effects	9-5
	9.3 DOSE-EFFECT/DOSE-RESPONSE RELATIONSHIPS	9-6
	9.3.1 General Considerations	9-6
	9.3.2 Effects and Dose-Response Relationships	9-8
	9.3.2.1 Respiratory Cancer	9-8
	9.3.2.2 Skin Cancer	9-9
	9.3.2.3 Non-cancerous Skin Lesions	9-9
	9.3.2.4 Peripheral Neuropathological Effects and Cardiovascular Changes	9-10
	9.4 POPULATIONS AT SPECIAL RISK TO ARSENIC EXPOSURE	9-10
10.	REFERENCES	10-1

REC 4902

LIST OF TABLES

Table		Page
3-1	Physical Properties of Arsenic and Arsenic Compounds	3-2
3-2	Cumulative Frequency Distribution of NASN Individual 24-Hour Ambient Air Arsenic Levels	3-10
3-3	Primary Copper Smelters in the United States	3-13
3-4	Levels of Arsenic by Food Class in Adult Food Composites from 20 U.S. Cities	3-17
3-5	Levels of Arsenic by Food Class in Infant and Toddler Food Composites from 10 U.S. Cities	3-18
3-6	A Comparison of Arsenic Levels in Arsenic-Treated and Uncontaminated Soils in North America	3-21
5-1	Prevalence of Blackfoot Disease (per 1000) by Age and Arsenic Exposure	5-9
6-1	Summary of Mutagenicity of Arsenic: Gene Mutations	6-2
6-2	Summary of Mutagenicity of Arsenic: Chromosomal Aberrations	6-9
6-3	Summary of Mutagenicity of Arsenic: Chromosomal Aberrations and SCE in Cells of Exposed Humans	6-17
6-4	Mutagenicity of Arsenic: Assays Indicative of DNA Damage or Repair	6-24
6-5	Summary of Mutagenicity of Arsenic: Interactions With Mutagens	6-33
7-1	Summary of Case Reports and Epidemiologic Studies of Cancer or Precancerous Lesions in Persons Exposed to Arsenic	7-2
7-2	Observed and Expected Deaths Due to Respiratory Malignancies, By Exposure Category	7-15
7-3	Observed and Expected Deaths for Selected Causes in Retrospective Cohort Analysis (1940-1973)	7-17
7-4	Observed and Expected Deaths and Standardized Mortality Ratios for Selected Causes of Death of 527 Males of Cohort Under Study	7-26
7-5	Observed and Expected Respiratory Cancer Deaths and Standardized Mortality Ratios by Arsenic Exposure Index	7-27
7-6	Observed and Expected Respiratory Cancer Deaths and Standardized Mortality Ratios by Intensity and Duration of Exposure to Arsenic	7-27
7-7	Respiratory Cancer Deaths and SMRs By Cumulative Arsenic Exposure Lagged 0 and 10 years, Tacoma Smelter Workers	7-29
7-8	Respiratory Cancer Deaths and SMRs by Duration of Exposure and Latency, Tacoma Smelter Workers	7-30
7-9	Respiratory Cancer Deaths and SMRs by Duration and Intensity of Exposures, Tacoma Smelter Workers	7-32
7-10	1965 Smelter Survey Atmospheric Arsenic Concentrations	7-36
7-11	Observed and Expected Deaths from Respiratory Cancer, with Standardized Mortality Ratios (SMR), by Cohort and Degree of Arsenic Exposure, 1938-63	7-37
7-12	Mortality for All Causes and Respiratory Cancer from 1938 to 1978 by Time-Weighted Average (TWA) Arsenic Exposure as of Entrance into Cohort	7-44
7-13	Mortality for All Causes and Respiratory Cancer by Ceiling Arsenic Exposure as of Entrance into Cohort	7-44
7-14	Respiratory Cancer Mortality by Method of Analysis and TWA Arsenic Category	7-45

REC 4903

LIST OF TABLES (continued)

Table		Page
7-15	Respiratory Cancer Mortality by Method of Analysis and Ceiling Arsenic Category	7-46
7-16	Prevalence of Skin Cancer (per 1000) by Age and Arsenic Exposure (ppm)	7-54
7-17	Results of Total Arsenic Analysis and Arsenite and Arsenate Determination in the Yenshei Water Samples	7-57
7-18	Lane County Water Arsenic Levels 1974-1978	7-63
7-19	Age Specific Death Rates for Utah and Three Millard County Communities	7-67
7-20	Summary Table of Experimental Studies of Arsenic Carcinogenesis	7-78
7-21	Observed and Expected Deaths Due to Selected Causes, With Standardized Mortality Ratios (SMRs) Among Smelter Workers, 1938-1977	7-96
7-22	Description of Length of Employment Groups, With Numbers of Smelter Workers, Numbers of Deaths, Person-Years at Risk, and Duration of Smelter Employment (Based on Total Work Experience Through September 30, 1977)	7-97
7-23	Observed and Expected Deaths from Respiratory Cancer, With Person-Years of Follow-Up, By Cohort and Degree of Arsenic Exposure	7-98
7-24	Dose-Response Data from Lee-Feldstein (1983) Used for Risk Assessment	7-100
7-25	Summary of Quantitative Risk Analyses	7-103
7-26	Respiratory Cancer Mortality 1938-1978 from Cumulative Exposure to Arsenic for 1800 Men Working at the Anaconda Copper Smelter	7-106
7-27	Observed and Expected Lung Cancer Deaths and Person-Years By Level of Exposure, Duration of Employment and Age at Initial Employment	7-113
7-28	Arsenic Exposures: 1965 Smelter Survey Atmospheric Arsenic Concentrations	7-115
7-29	Observed and Expected Number of Respiratory Cancer Deaths for Each Cell in the Low-Exposure Group of Table 7-27	7-118
7-30	Cells from Table 7-29 Combined Within Rows to Obtain Cells With Three or More Expected Respiratory Cancer Deaths	7-119
7-31	Cells from Table 7-29 Combined Within Columns to Obtain Cells With Three or More Expected Respiratory Cancer Deaths	7-119
7-32	Observed Deaths and SMRs for 2802 Smelter Workers Who Worked a Year or More 1940-64, Followed Through 1976, By Cause of Death	7-120
7-33	Data From Table 8 of Enterline and Marsh (1982), With Person-Years of Observation Added	7-122
7-34	Data From Table 4 of Ott et al. (1974)	7-129
7-35	Combined Unit Risk Estimates for Absolute-Risk Linear Models	7-134
7-36	Age-Exposure-Specific Prevalence Rates for Skin Cancer	7-137
7-37	Data Utilized to Obtain Predictor Equation and Figure 7-11	7-138
7-38	Relative Carcinogenic Potencies Among 52 Chemicals Evaluated by the Carcinogen Assessment Group as Suspect Human Carcinogens	7-143
9-1	Routes of Daily Human Arsenic Intake	9-2

REC 4904

LIST OF FIGURES

Figure		Page
3-1	The Generalized Geochemical Cycle for Arsenic	3-5
3-2	Biological Cycling of Arsenic	3-7
3-3	NASN Annual Average Arsenic Concentrations	3-11
4-1	Arsenic Retention in Rat Lungs Following Intratracheal Instillation of a Single Dose	4-4
4-2	Lung Concentrations of Arsenic in Hamsters Given Weekly Intratracheal Instillations of Arsenic Trioxide, Arsenic Trisulfide or Calcium Arsenate	4-7
6-1	The Induction of Chromosome Aberrations in Cultured Human Peripheral Lymphocytes by Six Arsenic Compounds	6-14
7-1	Comparison of Census Tracts Experiencing Exposure to the Fisher Formation and Exhibiting High Skin Cancer Occurrence	7-64
7-2	Relative Risks and 90% Confidence Limits for Data of Lee-Feldstein (1983)	7-101
7-3	Absolute Risks and 90% Confidence Limits for Data of Lee-Feldstein (1983)	7-102
7-4	Relative Risks and 90% Confidence Limits for Data of Higgins (1982)	7-108
7-5	Absolute Risks and 90% Confidence Limits for Data of Higgins (1982)	7-109
7-6	Relative Risks and 90% Confidence Limits for Zero-Lag Data of Enterline and Marsh (1982)	7-124
7-7	Relative Risks and 90% Confidence Limits for 10-Year Lag Data of Enterline and Marsh (1982)	7-125
7-8	Absolute Risks and 90% Confidence Limits for Zero-Lag Data of Enterline and Marsh (1982)	7-126
7-9	Absolute Risks and 90% Confidence Limits for 10-Year Lag Data of Enterline and Marsh (1982)	7-127
7-10	Relative Risks and 90% Confidence Limits for Data of Ott et al. (1974) With Highest Exposure Group Omitted	7-131
7-11	Relationship Between Transformed Prevalence and Log ppm Arsenic in Water, Log Age	7-139
7-12	Histogram Representing the Frequency Distribution of the Potency Indices of 52 Suspect Carcinogens Evaluated by the Carcinogen Assessment Group	7-142

REC 4905

AUTHORS AND REVIEWERS

The principal authors of this document are:

Dr. David Jacobson-Kram
Reproductive Effects Assessment Group
U.S. Environmental Protection Agency
Washington, D.C.

Dr. Paul Mushak
Department of Pathology
University of North Carolina
Chapel Hill, North Carolina

Dr. Magnus Piscator
Karolinska Institute
Stockholm, Sweden

Donna J. Sivulka
Environmental Criteria and Assessment Office
U.S. Environmental Protection Agency
Research Triangle Park, North Carolina

Carcinogen Assessment Group
U.S. Environmental Protection Agency
Washington, D.C.

Participating members of the CAG are listed below:

(Principal authors and contributors to carcinogenicity sections of this document are designated by *).

Roy Albert, M.D. (Chairman)
Elizabeth Anderson, Ph.D.
Larry D. Anderson, Ph.D.
Steven Bayard, Ph.D.
David Bayliss, M.S.
Chao W. Chen, Ph.D.
Margaret Chu, Ph.D.*
Herman J. Gibb, M.S., M.P.H.*
Bernard H. Haberman, D.V.M., M.S.
Charalingayya B. Hiremath, Ph.D.
Robert McGaughy, Ph.D.
Dharm V. Singh, D.V.M., Ph.D.
Todd W. Thorslund, Sc.D.*

Kenny S. Crump, Ph.D. (consultant)*
Science Research Systems, Inc.
Ruston, Louisiana

REC 4906

Contributing authors:

Dr. Warren Galke
Department of Biostatistics and Epidemiology
School of Allied Health
Greenville, North Carolina

Dr. Lester Grant
Environmental Criteria and Assessment Office
U.S. Environmental Protection Agency
Research Triangle Park, North Carolina

Dr. Victor Hasselblad
Health Effects Research Laboratory
U.S. Environmental Protection Agency
Research Triangle Park, North Carolina

Project Manager:

Donna J. Sivulka
Environmental Criteria and Assessment Office
U.S. Environmental Protection Agency
Research Triangle Park, North Carolina

The following individuals reviewed earlier drafts of this document and submitted valuable comments:

Dr. Thomas Clarkson
Department of Environmental Health Sciences
University of Rochester
Rochester, New York

Dr. Annemarie Crocetti
New York Medical College
New York, New York

Dr. Philip Enterline
Department of Biostatistics
Graduate School of Public Health
University of Pittsburgh
Pittsburgh, Pennsylvania

Dr. Paul Hammond
Kettering Laboratory
University of Cincinnati
Cincinnati, Ohio

Dr. Dinko Kello
Institute for Medical Research
Zagreb, Yugoslavia

Dr. Paul Mushak
Department of Pathology
University of North Carolina
Chapel Hill, North Carolina

Dr. Magnus Piscator
Karolinska Institute
Department of Environmental Hygiene
Stockholm, Sweden

Dr. Samuel Shibko
Division of Toxicology
U.S. Food and Drug Administration
Washington, D.C.

In addition, there are several scientists who contributed valuable information and/or constructive criticism to interim drafts of this report. Of specific note are the contributions of: Gerald Akland, Victor Archer, Anna Baetjer, Gary Evans, John Fink, Jack Fowle, Joseph Fraumeni, Jr., Ian Higgins, Kurt Irgolic, Ernest Jackson, Casey Jason, Kantharajapura S. Lavappa, Anna Lee-Feldstein, Frank Letkiewicz, Gary Marsh, Charles Nauman, Warren Peters, Terry Risher, Sheila Rosenthal, Vicki Vaughan-Dellarco, Peter Voytek, and Mary Yurachek.

SCIENCE ADVISORY BOARD ENVIRONMENTAL HEALTH COMMITTEE

The substance of this document was independently peer-reviewed in public session by the Environmental Health Committee, Environmental Protection Agency Science Advisory Board.

Chairman, Environmental Health Committee

Dr. Herschel E. Griffin, Associate Dean, College of Human Services, San Diego State University, San Diego, California 92182

Director, Science Advisory Board

Dr. Terry F. Yosie, Science Advisory Board, U.S. Environmental Protection Agency, Washington, D.C. 20460

Executive Secretary

Mr. Ernst Linde, Scientist Administrator, Science Advisory Board, A-101, U.S. Environmental Protection Agency, Washington, D.C. 20460

REC 4908

Members

Dr. Herman E. Collier Jr., President, Moravian College, Bethlehem, Pennsylvania 18018

Dr. Morton Corn, Professor and Director, Division of Environmental Health Engineering, School of Hygiene and Public Health, The Johns Hopkins University, 615 N. Wolfe Street, Baltimore, Maryland 21205

Dr. John Doull, Professor of Pharmacology and Toxicology, University of Kansas Medical Center, Kansas City, Kansas 66207

Dr. Jack D. Hackney, Chief, Environmental Health Laboratories, Professor of Medicine, Rancho Los Amigos Hospital Campus of the University of Southern California, 7601 Imperial Highway, Downey, California 90242

Dr. Marvin Kuschner, Dean of School of Medicine, Health Science Center, Level 4, State University of New York, Stony Brook, New York 11794

Dr. Daniel Menzel, Director and Professor, Pharmacology and Medicine, Director, Cancer Toxicology & Chemical Carcinogenesis Program, Duke University Medical Center, Durham, North Carolina 27710

Dr. D. Warner North, Principal, Decision Focus Inc., Los Altos Office Center, Suite 200, 4984 El Camino Real, Los Altos, California 94022

Dr. William J. Schull, Director and Professor of Population Genetics, Center for Demographic and Population Genetics, School of Public Health, University of Texas Health Science Center at Houston, Houston, Texas 77030

Dr. Michael J. Symons, Professor, Department of Biostatistics, School of Public Health, University of North Carolina, Chapel Hill, North Carolina 27711

Consultants

Dr. Seymour Abrahamson, Professor of Zoology and Genetics, Department of Zoology, University of Wisconsin, Madison, Wisconsin 53706

Dr. Thomas W. Clarkson, Professor and Head, Division of Toxicology, University of Rochester, School of Medicine, P.O. Box RBB, Rochester, New York 14642

Dr. Edward F. Ferrand, Assistant Commissioner for Science and Technology, New York City Department of Environmental Protection, 51 Astor Place, New York, New York 10003

Dr. Ronald D. Hood, Professor, Department of Biology, P.O. Box 1927, University of Alabama, University, Alabama 35486

Dr. William F. Sunderman, Professor of Laboratory Medicine and Pharmacology and Head, Department of Laboratory Medicine, University of Connecticut Health Center, Room C 2021, Farmington, Connecticut 06032

Dr. Bernard Weiss, Professor, Division of Toxicology, P.O. Box RBB, University of Rochester, School of Medicine, Rochester, New York 14642

TECHNICAL ASSISTANCE

Project management, editing, production, and word processing from Northrop Services, Inc., under contract to the Environmental Criteria and Assessment Office:

Ms. Barbara Best-Nichols
Ms. Anita Flintall
Ms. Kathryn Flynn
Ms. Miriam Gattis
Ms. Varetta Powell
Ms. Carolyn Stephens
Ms. Patricia Tierney

Word processing and other technical assistance at the Office of Health and Environmental Assessment:

Ms. Frances P. Bradow
Ms. Diane Chappell
Mr. William Clark
Ms. Renee Cook
Ms. Jean Ewing
Mr. Doug Fennell
Mr. John Ferrell
Mr. Allen Hoyt
Ms. P. Jacobson-Kram
Ms. Barbara Kearney
Ms. Emily Lee
Ms. Marie Pfaff
Ms. Tonya Richardson
Ms. Scottie Schaeffer
Ms. Michelle Taylor
Ms. Judy Theisen
Ms. Donna Wicker

REC 4910

1. INTRODUCTION

This report evaluates health effects associated with arsenic exposure, with particular emphasis placed on health effects thought to be of most concern in regard to exposure to inorganic arsenic of the general U.S. population. Organic arsenic compounds are considered only insofar as certain forms of the element arise via transformation of arsenic in man and other species, or arise by environmental transformation.

This report is organized into chapters which provide a cohesive discussion of all aspects of inorganic arsenic and delineate a logical linking of this information to human health risk. The chapters include: an executive summary (Chapter 2) of the information contained within the text of later chapters; background information on the chemical and environmental aspects of arsenic, including levels of arsenic in media with which U.S. population groups come into contact (Chapter 3); arsenic metabolism, where factors of absorption, biotransformation, tissue distribution, and excretion of inorganic arsenic are discussed with reference to the toxicity of the element (Chapter 4); arsenic toxicology, discussing the various acute, subacute, and chronic health effects of inorganic arsenic in man and animals (Chapter 5); arsenic mutagenesis, discussing the ability of inorganic arsenic to cause gene mutations, chromosomal aberrations, sister chromatid exchanges and inhibition of DNA synthesis (Chapter 6); arsenic carcinogenesis, including discussion of selected dose-effect and dose-response relationships (Chapter 7); arsenic as an essential element, which deals with the current status of inorganic arsenic as a required nutrient in at least some species of animals (Chapter 8); and a human health risk assessment for arsenic, where key information from the preceding chapters is placed in an interpretive and quantitative perspective highlighting those health effects of most concern for U.S. populations (Chapter 9).

REC 4911

This report is not intended to be an exhaustive review of all the arsenic literature, but is focused upon those data thought to be most useful and relevant for human health risk assessment purposes. Particular emphasis is placed on delineation of health effects and risks associated with exposure to airborne arsenic, in view of the most immediate use intended for the present report, i.e., to serve as a basis for decision making regarding the regulation of inorganic arsenic as a hazardous air pollutant under pertinent sections of the Clean Air Act, as amended in 1977. Health effects associated with the ingestion of arsenic or with exposure via other routes are also discussed, providing a basis for possible use for multimedia risk assessment purposes, as well. The background information provided at the outset on sources, emissions, and ambient concentrations of arsenic in various media is presented in order to provide a general perspective against which to view the health effects evaluations contained in later chapters of the document. More detailed exposure assessments, taking into account even more recent, up-to-date emission and ambient concentration data have been prepared separately for use in subsequent EPA regulatory decision making regarding arsenic.

The Agency recognizes that the regulatory decision-making process is a continuous one; therefore, should new information become available in the future that would warrent a reevaluation of the information contained herein, the Agency will undertake such an evaluation as part of its mandate to protect the health of the general U.S. population.

REC 4912

2. SUMMARY AND CONCLUSIONS

As a toxic agent, inorganic arsenic possesses several properties that are not shared with many environmental pollutants. The element exists in various chemical states, e.g., tri- and pentavalent inorganic arsenic and methylated organic arsenic, with each having differing toxicological potential. In man, experimental animals, and other organisms, arsenic undergoes a variety of transformations, the full significance and mechanisms of which are, as yet, not well understood. Furthermore, there appears to be a nutritional requirement for low levels of arsenic in certain experimental animals and this may also be the case for man. All of these factors complicate the analyses of the toxicological effects and the risk for human health associated with environmental exposure to arsenic compounds. The following chapter summarizes these factors as they are presented in depth in the ensuing document text.

2.1 BACKGROUND INFORMATION

2.1.1 Chemical/Physical Aspects of Arsenic

It is the various compounds of arsenic which have been of most importance in the extensive history of the toxicology of the element, the zero-valent metallic form being of minor toxicological interest.

Arsenic is encountered as a component of sulfidic ores of metals such as copper, cobalt and nickel. The smelting of these ores is associated with arsenic release into the environment. Arsenic trioxide, As_2O_3, a toxicologically significant form, is a smelter product arising from air roasting of these sulfidic ores.

Arsenic trioxide, white arsenic, is only sparingly soluble in water and other solvents which do not promote chemical transformation. The compound dissolves in acidic or alkaline aqueous media to yield either the free acid or

REC 4913

salts, with these being soluble in a number of solvents. The oxide readily sublimes (135°C), and this factor is of importance in considering analytical methods for measuring levels of the compound.

The pentavalent arsenic pentoxide, As_2O_5, may be prepared by nitric acid oxidation of the trioxide or the element itself. This form has high solubility in water (63 g/100 g water), forming the strongly oxidizing arsenic acid, H_3AsO_4 ($E^o = 0.56V$).

Stability of the valency forms of arsenic in solution is dependent on the nature of the medium. Oxygenated media and higher pH favor the pentavalent form, while reducing and/or acidic media favor the trivalent state.

The acids of both valency forms of arsenic readily form alkali and alkaline metal salts, with the former being much more soluble than the latter. Organic ester derivatives of arsenic are quite labile to hydrolysis and this chemical behavior has biochemical/toxicological implications in the postulated role of arsenate ion in interfering with phosphorylation reactions.

Arsine (arsenic trihydride, AsH_3) is the most poisonous of the arsenicals, being a strong hemolytic agent, and it can be formed under certain restricted conditions, i.e., reduction of the oxy compounds in the presence of a strong hydrogen source.

Monomethyl and dimethyl arsenic arise by both environmental and *in vivo* transformation processes.

In high-temperature processes, arsenic is released as a vapor which is then adsorbed or condensed onto small particles. Such adherence to particles of 1-2 μm or less may result in enhanced health risk from the agent since particles in this size range are inhaled and deposited in the deepest part of the respiratory tract.

Arsenic compounds tend to form insoluble complexes with soils and sediments. In the case of soils, the interaction occurs with amorphous aluminum or iron oxides.

2.1.2 The Environmental Cycling of Arsenic

Primary smelting, biocide use and glass manufacturing constitute some of the major inputs of arsenic into the various environmental compartments. Of an estimated total release of approximately 10,000 short tons annually in the U.S., smelter activity accounts for about 50 percent, biocide (pesticide, fungicide, herbicide) use contributes 32 percent, and glass production contributes about 7.0 percent, with the remaining amount being released from various other sources.

The atmosphere is a major conduit for arsenic emitted from anthropogenic sources to the other environmental compartments via wet and dry precipitation processes. Dry and wet fall onto soils may be followed by movement through soils either into groundwater or surface water. Passage of arsenic into surface waters may be followed by transfer to sediments. Such cycling is made complex by chemical and biological transformations which have been reported as occurring in the various environmental compartments.

Trivalent arsenic in the atmosphere or in aerated surface waters can undergo oxidation to the pentavalent state, while pentavalent arsenic in media which are below pH 7.0 and contain oxidizable material can react to form the trivalent form via reduction.

Biological transformations of arsenic have been documented as occurring via both sedimentary bacteria and suspended marine algae. Several different hypotheses have been advanced to explain the biological cycling of arsenic.

Reduction and methylation of inorganic arsenic occur only to a limited extent in soils, one report noting a conversion of only 1-2 percent over a period of months.

REC 4915

With reference to the relative amounts of the annual environmental burden of arsenic, it has been calculated for 1974 that land is the major sink for arsenic, approximately 90 percent, with the atmosphere accounting for 7-8 percent and the smallest quantity appearing in waters.

2.1.3 Levels of Arsenic in Various Media

Available data on levels of arsenic in various media with which man interacts are generally presented as total arsenic, with limited information available for identifying specific chemical forms of arsenic.

2.1.3.1 Levels of Arsenic in Ambient Air--Based on the comprehensive data for U.S. air levels of arsenic obtained by the U.S. EPA's National Air Sampling Network, air levels of arsenic in the U.S. generally do not exceed 0.1 $\mu g/m^3$.

Generally, airborne arsenic is adhered to particulate matter. Although the immediate areas around smelters may contain some arsenic in the vapor form, data are available to indicate rapid adherence to particulate matter when sampling 2-3 km from these emission sites.

The specific chemical form(s) of airborne arsenic is still unclear. Generally, in most urban/suburban areas, arsenic is mainly in the form of a mixture of inorganic arsenic in the tri- and pentavalent states. Only in areas where methylated arsenic is used agriculturally or where biotic transformation can occur has methylated arsenic been found in air samples.

2.1.3.2 Levels of Arsenic in Drinking Water--The National Interim Primary Drinking Water Regulations, promulgated under the Safe Drinking Water Act, set the Maximum Contaminant Level (MCL) for arsenic in U.S. public water supplies at 50 µg/l. In general, arsenic is not found in drinking water at levels exceeding this MCL. Well waters in the western U.S. and Alaska, however, may have much higher levels owing to geochemical enrichment. In Lane County, Oregon, recent analyses report levels up to 2.2 ppm (2.2 mg/liter), while the

REC 4916

highest figure in Alaska was 10 ppm (10 mg/liter), representing both natural and mining residue contributions.

It is reasonable to assume that the chief chemical form of arsenic in most public water supplies would be the pentavalent inorganic form, owing to both aeration and chlorination. Similarly, well waters in Alaska and the western U.S. are reported to mainly contain pentavalent inorganic arsenic.

2.1.3.3 Arsenic in Food--The most recent data base for the arsenic content of foods is the 1975-1976 survey carried out by the U.S. Food and Drug Administration. Shellfish and other marine foods have the highest levels on a food category basis. Overall, the total dietary intake of arsenic in 1975-1976 was approximately 50 μg (elemental arsenic), representing an increase from the preceding years. Whether this increase represents a trend or merely reflects analytical variation in sampling from year to year is still to be determined.

The chemical forms of arsenic in foods are varied and complex. Crustaceans and other marine life store arsenic in complex organoarsenical forms which, based on recent reports, are assimilated by man and generally excreted intact. Toxicologically, these forms are comparatively inert.

2.1.3.4 Arsenic in Soils--Background soil arsenic levels range from less than 1 ppm to over 40 ppm, the latter reflecting agricultural practices as well as air fallout. Soil arsenic is usually bound to clay surfaces, and its mobility is a function of soil pH, phosphate levels, iron and aluminum content, and soil type. The mobile fraction, usually in the pentavalent form, is of concern in terms of movement to plants and water. Little reductive methylation occurs in most soils.

2.1.3.5 Other Sources of Arsenic--Limited data on arsenic content of tobacco suggest that more recent values range from around 1.5 ppm or less, while in the past (1945) values up to 40 ppm were measured. This decrease reflects reduced use of arsenical biocides in tobacco production.

REC 4917

2.2 ARSENIC METABOLISM

2.2.1 Routes of Absorption

Major routes of absorption of arsenic in the general population are inhalation and ingestion. The ingestion of arsenic may be either through the direct intake of food and water or through secondary intake via inhalation and swallowing. Arsenic uptake through the skin appears to be a minor route of exposure. Factors affecting the extent of absorption include chemical forms, particle size, and solubility.

2.2.1.1 Respiratory Absorption--Limited data from human subjects suggest that about 40 percent of most forms of inhaled arsenic is deposited in the lungs, all of which is eventually absorbed, yielding a net absorption of approximately 30 percent or greater of the inhaled amount.

Several studies of smelter workers also confirm that significant absorption of inhaled arsenic occurs, as judged by rapidly rising urine arsenic levels when exposure first occurs. Furthermore, the levels excreted are correlated with workplace air levels.

Animal data also indicate respiratory tract absorption when exposure occurs by inhalation of aerosols or by intratracheal instillation.

2.2.1.2 Gastrointestinal Absorption--Based on a number of reports using human subjects, soluble inorganic arsenic is almost totally absorbed from the gastrointestinal tract. Similar data have been obtained for such experimental animal species as the rat, pig, and monkey.

Less soluble forms of arsenic, such as arsenic trioxide in suspension, lead to considerably lower absorption while insoluble arsenic triselenide passes through the human GI tract with negligible absorption.

2.2.1.3 Transplacental Transfer--Transplacental transfer of arsenic in man appears to occur, based on autopsy data and on one report showing that newborn

REC 4918

cord blood levels approximate those of the mothers. Measurable levels of arsenic in fetal tissue have been determined by the fourth month of gestation, increasing to month seven.

In animals, inorganic arsenic appears to rapidly cross the placental barrier where it is distributed in embryonic tissue.

2.2.2 Biotransformation of Inorganic Arsenic In Vivo

An understanding of inorganic arsenic metabolism in man and other species is complicated by recently revealed biotransformation processes, discovered because of the development of analytical techniques which permit the chemical speciation of arsenic into its various forms. These processes not only relate to pharmacokinetic parameters such as tissue distribution and excretion, but also figure in the toxicology of the element. The two processes of significance for consideration here are the methylation of inorganic arsenic and oxidation-reduction interconversion of inorganic arsenic.

An extensive recent literature documents the *in vivo* methylation of inorganic arsenic to monomethyl and dimethyl arsenic (the latter being the major methylated metabolite) in every mammalian system studied to date, including man.

While the quantitative features of this phenomenon may vary among species, one can generally state that: 1) dimethyl arsenic is the major transformation product in both humans and animals, with the amount of monomethyl arsenic, when formed, being greater in humans; 2) methylation is assumed to be a route of detoxification, the methylated forms being not only much less toxic but also more rapidly excreted; 3) the methylating capacity of a given system can persist over a range of inorganic arsenic exposure but at some point can be overwhelmed; and 4) retrospective assessment of early data on arsenic

REC 4919

metabolism must be reviewed in light of the current knowledge about biomethylation. In man, dimethyl arsenic represents approximately 75 percent of total arsenic excretion, with monomethyl arsenic being excreted in lesser amounts.

The demonstration of interconversion of the two valency forms of inorganic arsenic claimed in earlier literature must be considered in light of the biomethylation phenomenon, and only more recent studies addressing this problem using chemical speciation techniques can be considered reliable. Invariably, the giving of inorganic penta- or trivalent arsenic to experimental animals or human volunteers leads to predominantly methylated forms, with any inorganic arsenic being present in small amounts. These observations and supporting data showing reduction of pentavalent arsenic *in vivo* are consistent with a reductive biomethylation mechanism, including initial reduction of pentavalent to trivalent arsenic prior to methylation. A recent study using speciation methods and human subjects also establishes the *in vivo* reduction of pentavalent to trivalent arsenic in humans.

Even with sophisticated analytical methods permitting chemical speciation in biological media, the lability of arsenic in dosing solution to oxidation-reduction requires careful assessment of the actual form being administered.

2.2.3 Distribution of Arsenic in Man and Animals

Blood is the main vehicle for transport of arsenicals following absorption, and from which arsenic is cleared relatively rapidly to tissues in all species except the rat. In the rat, arsenic-erythrocyte interaction tends to preclude rapid movement to tissues, with a biological half-time of up to 90 days, versus a corresponding time of several days in all other species. Arsenic movement from blood appears to conform to a three-compartment model which must reflect in part the biomethylation of inorganic arsenic noted above.

Exposure of various experimental animals to either tri- or pentavalent inorganic arsenic leads to initial accumulation of the element in liver, kidney, spleen, aorta, and skin. In most species, arsenic clearance from soft tissue is relatively rapid except for the skin, where the high sulfhydryl group content probably promotes tight arsenical binding.

In man, tissue partitioning data are mainly available from autopsy data. Heart, kidney, liver and lung have highest levels on a concentration basis, but skin and excretory/storage organs such as nails and hair have the highest absolute amounts. Brain tissue has levels only slightly below those of other soft tissues.

Recent data on valency and exposure level effects on tissue distribution of arsenic indicate that levels of arsenic in kidney, liver, bile, brain, skeleton, skin, and blood are 2- to 25-fold higher for the trivalent form than for the pentavalent state, and are greatly increased at higher dosing. The difference is held to be due to the relative methylating capacity of either form as well as the level of exposure.

2.2.4 Arsenic Accumulation

The long-held view of arsenic as an element which accumulates in the body was mainly based on the behavior of arsenic in the rat, an anomalous model which does not reflect the case with other species. For other species, including man, long-term accumulation does not generally occur in physiologically active compartments in the body.

In man, the only evidence for tissue accumulation is autopsy data from retired workers with a history of metal smelter exposure in which lung arsenic levels were 8-fold higher than in a control population. This suggests the existence of a very insoluble form of arsenic in smelter ambient air.

REC 4921

2.2.5 Arsenic Excretion

Renal clearance appears to be the major route of excretion of absorbed arsenic in man and animals. Biliary transport of the element leads to enteric reabsorption, with little carriage in feces.

In man, inorganic arsenic is excreted rather rapidly, and in several studies in which continuous exposure resulted in the acquisition of steady state, around 60 percent of a given dose was excreted within one day.

The pattern of renal excretion reflects the *in vivo* biotransformation capacity for inorganic arsenic, one study noting that trivalent arsenic was excreted more slowly than an equivalent dose of the pentavalent form, and higher doses of both forms were cleared relatively more slowly than lower doses.

2.3 ARSENIC TOXICOLOGY

2.3.1 Acute Toxicity

Acute symptoms of arsenic poisoning are similar in both man and experimental animals. With oral exposure, the acute symptoms include severe gastrointestinal damage resulting in vomiting and diarrhea and general vascular collapse leading to shock, coma, and death. Other acute effects are muscular cramps, facial edema, and cardiovascular reactions. Airborne exposure at high levels also results in severe irritation of nasal mucosa, larynx, and bronchi. Sequelae of acute contact with inorganic arsenic include peripheral nervous system disturbances with slow recovery and reversible effects on the hematopoietic system.

Levels of exposure associated with acute arsenic toxicity vary with the valency form of the element, the trivalent state being approximately 4-fold more toxic than pentavalent arsenic. Oral LD_{50} values for trivalent arsenic

vary from 15 to 293 mg/kg b.w. in rats and from 10-150 mg/kg in other test species.

While a number of outbreaks of acute arsenic poisoning have been described, few data exist on actual doses and type of arsenical involved. One report has estimated the human lethal dose for arsenic trioxide to be anywhere from 70 to 180 mg.

2.3.2 Chronic Toxicity

Two categories of chronic arsenic toxicity can be discerned from the available literature: 1) the mutagenicity/carcinogenicity of arsenic; and 2) various non-carcinogenic chronic effects.

2.3.2.1 Mutagenesis of Inorganic Arsenic--Various inorganic compounds of arsenic have been tested for mutagenicity in a variety of test systems ranging in complexity from bacteria to peripheral lymphocytes of exposed human beings. Although many of the data are contradictory, the weight of evidence supports the following conclusions:

1) Arsenic is either inactive or extremely weak for the induction of gene mutations *in vitro*.
2) Arsenic is clastogenic and induces sister chromatid exchanges (SCE) in a variety of cell types, including human cells *in vitro*; trivalent arsenic is approximately an order of magnitude more potent than pentavalent arsenic.
3) Arsenic does not appear to induce chromosome aberrations *in vivo* in experimental animals.
4) Several studies suggest that human beings exposed to arsenic demonstrate higher frequencies of SCE and chromosomal aberrations in peripheral lymphocytes; however, the quality of these studies is generally poor.

REC 4923

5) Arsenic may affect DNA by the inhibition of DNA repair processes or by its occasional substitution for phosphorus in the DNA backbone.

From these conclusions, it can be surmised that arsenic may have the potential to cause chromosomal changes in human beings. Although additional information is needed, it appears that the mutagenic potency of arsenic is weak compared to other known metal mutagens.

2.3.2.2 Carcinogenesis of Inorganic Arsenic--The current status of inorganic arsenic as a human and experimental animal carcinogen has been extensively and critically reviewed by public agencies such as the National Institutes of Occupational Safety and Health, scientific bodies such as the National Academy of Science and the International Agency for Research on Cancer, and in a number of individual assessments.

At present, the collective evidence for an etiological role of inorganic arsenic in human cancers is strongest for cancers of the skin and lung.

In man, chronic oral exposure to arsenic induces a sequence of changes in skin epithelium, proceeding from hyperpigmentation to hyperkeratosis characterized as keratin proliferation of a verrucose nature, and leading in some cases to late onset skin cancers. The skin cancers can be histopathologically characterized as either squamous carcinomas in the keratotic areas or basal cell carcinomas.

Arsenic-associated skin cancers, regardless of type of exposure, differ from those having an ultraviolet light etiology in that they occur on unexposed areas such as the palms and soles and occur as multiple lesions. The latency period for such lesions has been reported to range from 6 to 50 years for skin cancer induced by the administration of arsenical medicinals. The most reliable study of skin cancer associated with arsenic-contaminated drinking water found the minimum human latency period to be 24 years.

REC 4924

Lung cancers associated with occupational exposure to arsenic appear to be mainly of the poorly differentiated and small-cell undifferentiated epidermoid carcinoma type, although well-differentiated epidermoid carcinoma and acinar-type adenocarcinoma have also been noted. The latency period for such lung cancer due to occupational arsenic exposure at smelters has been reported to range from 13 to 50 years.

While other visceral cancers such as hepatic angiosarcomas have also been claimed to be associated with arsenic exposure, the data base for such association is less conclusive than for cancers of the skin and lung.

2.3.2.2.1 Human Epidemiology of Arsenic Carcinogenesis. Cancer- and possible precancerous lesion-producing inorganic arsenic exposures have been demonstrated in both occupational populations, such as copper smelters, pesticide manufacturers and argricultural workers, and in non-occupational populations using arsenical drugs or consuming arsenic-contaminated drinking water and/or food.

Cancer or possible precancerous skin lesions associated with arsenic exposure include lung cancer, skin cancer, peripheral vasculopathy, hyperkeratosis, hyperpigmentation, and depigmentation. Of these, cancers of the lung and skin have received the most attention. Furthermore, epidemiologic reports of cancer or possible precancerous lesions related to arsenic exposures have a wide geographical distribution, with studies reported in the United States, Europe, Asia and South America.

Lung Cancer

An excess mortality in respiratory cancer has been noted among smelter workers and among workers engaged in the production and use of arsenical pesticides. In a number of these studies, the levels of exposure are uncertain and there is simultaneous exposure to agents such as other metals and sulfur dioxide. Furthermore, some of these studies did not take into account the effects of cigarette smoking.

REC 4925

A proportionate mortality study of an English factory which manufactured arsenite as a sheep dip powder found that workers at the facility had a proportion of lung cancer deaths twice that for other workers in the geographic area. Of the total factory group, the chemical workers, who were the most closely associated with the arsenite production, accounted for all of the lung cancer deaths and had a higher proportion of deaths from all cancers than the total factory population. Air exposure information was limited, levels up to 4 mg As/m^3 having been reported only for 1945-1946. The outcome of the earlier English study has been supported by studies of two facilities in the United States. At one facility manufacturing lead-, calcium-, and magnesium arsenate and copper acetoarsenite over the period 1919-1956, the ratio of observed-to-expected lung cancer deaths among workers was evaluated on the basis of exposure level, giving ratios ranging up to 7:1 in the highest exposure category.

The second U.S. facility, in Baltimore, Maryland, has been the subject of two occupational studies. At this operation, production of lead-, calcium-, and sodium arsenate was started in the early 1950s. Air levels of arsenic were not available. In the most recent report--a follow-up of workers employed from 1946 to 1974--statistically significant increases in lung cancer deaths were found in "predominantly arsenical production workers." Information on smoking history was not obtained.

Occupational exposure to arsenic also occurs in smelters. Several reports have centered on workers at a copper smelter in the state of Washington. In the most recent publication concerning cancer deaths at this facility, an increase in overall mortality, a significant increase in cancer deaths, and a highly significant increase in deaths from lung cancer were noted. Although

REC 4926

cigarette smoking data were not available, a clear lung cancer dose response by arsenic exposure was found, suggesting that smoking probably did not confound the lung cancer response believed to be due to arsenic.

Other U.S. studies have been done at smelter sites in Utah and Montana. In the Utah study, smelter workers showed a 3-fold increase in the lung cancer death rate compared to the general population of the state. Exposures to sulfur dioxide and copper, as well as arsenic, were found to be significantly higher for the lung cancer cases. Differences in smoking habits could not explain the excess lung cancer mortality. Smelter workers at the Montana smelter were found to follow a lung cancer dose response by arsenic exposure. Differences in smoking habits could not explain the differences in lung cancer mortality. Little association, if any, was found between sulfur dioxide exposure and lung cancer mortality.

Some of the evidence from the U.S. smelter studies suggests that arsenic may be acting as either a late-stage carcinogen in the multistage theory of carcinogenesis or as a promoter in the carcinogenesis process. Either hypothesis requires further study, however.

Excess lung cancer mortality has also been reported for workers in foreign smelters. Several reports have concerned the smelter facility in Sweden. In this operation, it was found that arsenic exposure was associated with increases in lung cancer deaths, the ratio being 4.6 for a work history of more than 17 years. Sulfur dioxide exposure was not found to be associated with lung cancer, nor could the results be explained by differences in smoking habits. A study of smelter workers in Japan has also reported a positive association between smelter employment and lung cancer. Workers in the highest exposure and longest follow-up category were reported to have a 25-fold increase in lung cancer mortality.

REC 4927

Several studies suggest that populations surrounding arsenic-emitting sources are at a greater risk of lung cancer. One study found that lung cancer in counties with smelters was significantly higher than in counties without smelters. Another study found an association between residence in an area surrounding an arsenic pesticide plant and lung cancer mortality even after controlling for employment at the pesticide plant. Two lung cancer mortality studies of populations in the vicinity of smelters are inconclusive with regard to lung cancer risk in the general population because lung cancer deaths of workers at the smelters were included in the analyses. It should be noted that none of these studies addressed the effects of population migration, however.

Skin Cancer and Precancerous Lesions

All of the occupational studies on arsenic have been mortality studies. Because skin cancer is rarely fatal, the occupational studies, in general, do not report excesses of skin cancer. The English study referred to in the preceding section, however, did note that cancer deaths among those factory workers with skin cancer was 13.6 percent compared to a figure of 1.3 percent in the reference population.

Most of the available information on the association of arsenic with skin cancer has involved non-occupational populations in geographical areas as diverse as Taiwan, Argentina, and northern Europe, and has involved arsenic in drinking water or medicinal preparations.

In Taiwan, exposure started in 1910-1920 with the availability of water from deep wells. In the most comprehensive study of this group, 37 villages with a population of 40,421 were surveyed in 1965 and the prevalence rate of skin cancer was categorized by arsenic exposure and age. The prevalence rate of skin cancer increased with both well water arsenic and age. The greatest

REC 4928

prevalence rate was in the >60-years age group (192.0/1,000 subjects) exposed to well water with an arsenic content of >0.6 ppm. There was a similar ascending gradient for hyperkeratosis, an apparent precondition for the later onset of skin cancer.

In Cordoba, Argentina, arsenical waters have also been reported to be associated with increased rates of skin cancer among the population using this water. In the various reports on this area, it has been noted that over 81 percent of persons with "arsenical-type" skin epitheliomas presenting themselves at a particular dermatology clinic came from areas where high levels of arsenic were known to be present in the water supplies and where arsenicism among individuals was known to occur. Lack of information on the size of the populations in each geographic area limits the conclusions that can be drawn from these studies, however.

In a number of epidemiological surveys conducted in Antofagasta, Chile, the presence of a relatively high level of arsenic, 0.6 ppm, in the public drinking water from 1958 to 1970, was shown to have resulted in a high number of skin lesions including hyperkeratosis which may be a precondition for skin cancer. In one report of cases seen and diagnosed from 1968 to 1971 in Antofagasta, the author reported 457 patients with various cutaneous lesions including leukoderma, melanoderma, hyperkeratosis, and squamous-cell carcinoma; all had high arsenic content in the hair. The number of cases for each diagnosis was not specified.

An investigation of the population having contact with well waters containing elevated levels of arsenic in an area of Oregon did not yield any evidence for skin cancer associated with such exposure, nor did a similar study in Utah. Factors which may have contributed to the difference in results between these studies and the studies in Taiwan, where an association between

skin cancer and arsenic in drinking water was found, include: (1) in addition to arsenic, ergotamine was found in the Taiwan drinking water, (2) the socioeconomic level of the Taiwanese who experienced skin cancer was rather low, which may have had ramifications in terms of diet, personal hygiene and medical care, and (3) racial differences between the Taiwanese and U.S. populations may have had an effect. However, the population sample sizes of the Oregon and Utah studies were too small to detect the risk from skin cancer that would have been predicted, on the basis of arsenic ingestion, from a linear model of the Taiwanese data.

The chronic ingestion of trivalent arsenic present in the medicinal preparation, Fowler's Solution, has been shown to be associated with the typical arsenic dermatopathology, including skin cancer. In one detailed study of patients with a history of Fowler's Solution use, 21 cases of skin cancer and 106 cases of hyperkeratoses were found among 262 subjects. Both the hyperkeratosis and skin cancer prevalence rates were found to increase as the total ingested amounts of the arsenical increased. The minimal latency period for hyperkeratosis was 2.5 years while the minimal latency period for skin cancer was 6 years, with an average of 14 years.

Internal neoplasms associated with arsenic exposure have been reported in subjects exposed to medicinal arsenic as well as in such occupational groups as vintners and smelter workers.

2.3.2.2.2 Experimental studies of arsenic carcinogenesis. Consistent demonstration of arsenic carcinogenicity in test animals, using different chemical forms, routes of exposure, and various experimental species, has not been observed. Part of the difficulty may lie in the selection of an appropriate animal model. The absence of skin cancers in the experimental animals used could be accounted for by their skin being poor models of human skin. Rat

results must be considered suspect because the rat is anomalous in how it metabolizes arsenic.

Recent data indicate that tumorigenicity and possibly carcinogenicity can be demonstrated in animals if the retention of arsenic in the lung is increased. The additional observations that calcium arsenate, as reported from two laboratories, is only slowly cleared from the lung, strongly suggest that this agent may be carcinogenic.

2.3.2.3 Chronic Neurological Effects of Arsenic Exposure--Both peripheral and central nervous system effects have been documented in man and animals exposed to inorganic arsenic.

Peripheral nervous system effects have been noted in workers occupationally exposed to arsenic and in individuals accidentally exposed to food contaminated with arsenic. Some of these effects follow an insidious course, appearing months or years after onset of exposure. Effects are of both the sensory and motor types, sensory deficits manifesting themselves first. The resulting polyneuropathies tend to follow a slow course of recovery over months or years. More subtle neurological effects, such as neuromuscular disturbances and altered nerve conduction velocity, have also been reported by various investigators.

While there are documented cases of central nervous system (CNS) effects in children due to acute or subacute exposure, chronic arsenic intoxication as a factor in such abnormalities as hearing impairment has not been confirmed.

Few useful animal models exist for the central and peripheral nervous system effects seen in humans. One study has reported evidence of CNS functional deficits in rats exposed to arsenic trioxide aerosol, while a second report claims impaired behavioral responses in rats given arsenic trioxide via stomach intubation. Since rats handle arsenic differently than all other species, the significance of these data is not clear.

REC 4931

2.3.2.4 Cardiovascular Effects of Arsenic Exposure--Cardiovascular effects associated with chronic arsenic intake include Blackfoot disease seen in Taiwanese consuming well water having elevated arsenic. This is a peripheral vascular disease leading to gangrene of the extremities. Since ergotamine-like compounds were also present in the waters, the conclusive role for arsenic is not clear. Peripheral vascular changes have been documented among German vintners who were exposed occupationally to arsenic pesticides as well as arsenic in wine.

2.3.2.5 Other Systemic Effects of Arsenic--Non-cancerous respiratory effects of inorganic arsenic are mainly seen with occupational exposure and with arsenic trioxide. In one study of smelter workers, those handling refined arsenic showed nasal septum perforation and rhinopharyngolaryngitis, while workers in roaster, furnace, and convertor areas showed tracheobronchitis and pulmonary insufficiency.

Teratogenic effects of arsenic compounds at relatively high exposure levels have been demonstrated in a number of animal species, including hamsters, rats, and mice. Generally, such effects have been observed after parenteral administration of either arsenite or arsenate. Oral exposures of animals to these same arsenic compounds at lower doses, by contrast, have not been shown to produce any notable effects on reproduction and development. Methylated arsenic, while potentially teratogenic at high doses, is of lower potency than inorganic forms. There is little evidence that inorganic arsenic is a human teratogen.

Hepatic effects have been noted in a number of studies dealing with chronic intake of arsenic. These disturbances present as cirrhosis and portal hypertension. One complicating factor in occupational exposure assessment has been the effect of alcohol consumption.

REC 4932

Chronic exposure to arsenic via well water contaminated by arsenic, medicinals, or the workplace, produces a reversible anemia. Rats, mice, and cats fed either arsenite or arsenate show reduced hemoglobin production via disturbance of the ALA-synthetase and heme-synthetase steps in the heme biosynthetic pathway.

Renal effects seen with arsenite or arsenate exposure in either man or animals have been poorly characterized.

2.3.3 Factors Affecting Arsenic Toxicity

The most widely recognized and studied interactive behavior of arsenic is with selenium, the pair being antagonistic in effect in all animal species studied. Dietary arsenic supplementation is known to protect against selenium toxicity, while selenium protects against either tri- or pentavalent arsenic. Arsenite shows a protective effect for selenite toxicity in cell cultures, but the reverse does not appear to be the case.

Few data exist for interactive relationships between arsenic and other elements. One report notes that cadmium and arsenic given simultaneously by the oral route retarded weight gain in young adult rats to a greater extent than either element given alone.

2.4 ARSENIC AS AN ESSENTIAL ELEMENT

Inorganic arsenic appears to be an essential element in certain animal species--rats, goats, chicks, and minipigs--based on the observation of detrimental effects using diets deficient in the element.

In rats, arsenic-deficient diets in pregnant dams are associated with slow growth, enlarged spleens, erythrocyte dysfunction in post-weaning offspring, and greater perinatal mortality.

In studies using goats and minipigs, diets having less than 50 ppb As produced effects in the adult animals as well as in their offspring. Morta-

REC 4933

lity of adult goats was increased as was the mortality of both kids and piglets. In chicks, arsenic deprivation influenced the effects of dietary arginine, manganese, and zinc, the fluctuations of which variously affected metabolic activity.

Remaining to be independently demonstrated are a physiological role for arsenic, the existence of any specific carrier in the body, or arsenic essentiality in man.

2.5 HUMAN HEALTH RISK ASSESSMENT FOR ARSENIC

This portion of the summary contains the data summarized earlier, presented within a perspective of the possible quantitative risk posed to the general population of the United States by arsenic exposure. Categories of consideration include: (1) levels of arsenic in media relevant to the U.S. population; (2) those effects relevant to the general population; (3) indicators of exposure, specifically "internal dose" measures; (4) dose-effect and dose-response relationships which can be determined from available information; and (5) the identification of groups within the general population who may be at increased risk for the health effects of arsenic.

2.5.1 Exposure Aspects of Arsenic

Arsenic exposure in the general population of the United States occurs via inhalation and ingestion of water and food.

Respiratory intake of arsenic on a daily basis is approximately 0.12 µg, of which 0.03 µg would be absorbed, assuming 30 percent absorption and based on a 1981 national average air value of 0.006 $\mu g/m^3$ of air and a daily ventilation rate of 20 m^3.

Since much of the U.S. drinking water supply is below the 10 µg/liter level, daily consumption of water at a rate of 2 liters would lead to an intake $\leq$ 20 µg.

REC 4934

Based on 1975-76 figures from the Food and Drug Administration, daily arsenic intake from food is approximately 50 μg (elemental arsenic) for adults. If one assumes at least 80 percent absorption of this daily intake, approximately 40 μg is the absorbed amount. It should be noted, however, that arsenic in certain foods is known to be in a chemically complex form that is relatively resistant to metabolism and toxicologically inert; consequently, it is rapidly excreted intact. Therefore, the amount of absorbed food arsenic considered to be toxicologically significant is relatively small compared to total arsenic intake.

Cigarette smoking contributes about 6 μg/pack of cigarettes in mainstream smoke, of which approximately 2.0 μg/pack would be absorbed.

Thus, the aggregate absorbed amount is approximately $\leq$ 60 μg for non-smokers. However, the actual amount of toxicologically significant arsenic taken in daily would probably be closer to 20 μg or less.

2.5.2 Effect/Response Aspects of Arsenic

2.5.2.1 Relevant Health Effects--General population concerns are with effects arising from long-term exposure to moderate levels of arsenic.

One can rank health effects germane to the general population as follows:

1. Respiratory tract cancer.
2. Skin cancer.
3. Non-cancerous skin lesions.
4. Peripheral neuropathological effects.
5. Cardiovascular changes.

Cancer of the respiratory system is clearly associated with exposure to arsenic via inhalation. This association has been especially noted among workers engaged in the production and usage of pesticides and among smelter workers. The latency period for lung cancer due to occupational arsenic exposure has been reported to range from 13 to 50 years.

REC 4935

Cancer of the skin has been found as a dose-dependent effect in a Taiwanese population with lifetime exposure to well water arsenic as well as among people who were treated with large doses of arsenite for skin disorders. Arsenic-associated skin cancers occur on areas of the body generally unexposed to the ultraviolet light of the sun, such as the palms of hands and soles of feet. The latency period for skin cancer has been reported to range from 6 to 50 years for cancers induced via administration of arsenical medicinals. In the Taiwanese drinking water study, the minimum latency period was reported to be about 24 years.

The Carcinogen Assessment Group (CAG) of the U.S. Environmental Protection Agency (EPA) has concluded that there is sufficient evidence that inorganic compounds of arsenic are both lung and skin carcinogens in humans.

Hyperkeratosis and hyperpigmentation, sometimes with precancerous changes, have been a common finding in persons ingesting arsenic. These skin lesions, like the manifest cancer, develop on surfaces usually unexposed to sunlight.

Peripheral nervous system effects range from sensory-motor deficits with higher exposure to changes in electromyography and nerve conduction velocity at long-term, low levels of contact with arsenic.

Vascular effects, such as Blackfoot disease (peripheral vasculopathy) have been noted in a Taiwanese population having life-long arsenic exposure; however, these effects may have been confounded by the presence of ergotamine-like compounds. Peripheral vascular changes have also been found in German vintners exposed occupationally to arsenic pesticides as well as arsenic in wine.

2.5.2.2 Dose-Effect/Dose-Response Relationships--The general question of how to define and employ a dose factor in attempts at quantitative assessments of human health risk for any toxicant is highly dependent upon: 1) the available

REC 4936

information on the body's ability to metabolize the agent, and 2) the assessment of the relative utility of various internal indices of exposure.

The time period over which a given total intake occurs is highly important. For example, intake of one gram of arsenic over a period of years would be quite different pathophysiologically from assimilating this amount at one time, the latter probably having a lethal outcome. This time-dependent behavior is related in part to the relative ability of the body to detoxify inorganic arsenic by methylation as a function of both dose and time.

In cases of acute and sub-acute exposure, indicators of internal exposures, such as blood or urine arsenic levels, are probably appropriate for assessing the intensity of exposure.

With chronic low-level exposure, however, the available data would indicate that the total amount assimilated is probably more important than an indicator concentration without knowledge of the total exposure period. An added problem is the background level of arsenic found in some indicators due to dietary habit. Therefore, in low-level chronic exposures, arsenic levels in blood or urine would only be moderately increased over background levels. Hair arsenic levels cannot be employed as reliable indicators of exposure because no methods exist for distinguishing external contamination levels from those accumulated via absorption and metabolic distribution.

Given the above limitations concerning the use of blood, urinary or hair arsenic concentrations as internal indices of cumulative, long-term low-level arsenic exposure, the dose-effect/dose-response relationships summarized below are done so mainly in terms of external arsenic exposure levels via either inhalation or ingestion.

From available data, the Carcinogen Assessment Group (CAG) has estimated carcinogenic unit risks for both air and water exposures to arsenic. The

REC 4937

quantitative aspect of carcinogen risk assessment is included here because it may be of use in setting regulatory priorities, evaluating the adequacy of technology-based controls, and other aspects of the regulatory decision-making process. However, the imprecision of presently available technology for estimating cancer risks to humans at low levels of exposure should be recognized. At best, the linear extrapolation model used (see Section 7.3) provides a rough but plausible estimate of the upper limit of risk--that is, with this model it is not likely that the true risk would be much more than the estimated risk, but it could be considerably lower. The risk estimates presented below should not be regarded, therefore, as accurate representations of true cancer risks even when the exposures involved are accurately defined. The estimates presented may, however, be factored into regulatory decisions to the extent that the concept of upper-risk limits is found to be useful.

The air estimates were based on data obtained in five separate studies involving three independently exposed worker populations. Linear and quadratic response models in both the absolute and relative form were fitted to the worker data. It was found that for the models that fit the data at the $p = 0.01$ or better level, the corresponding unit risk estimates ranged from 1.05×10^{-4} to 1.36×10^{-2}. However, linear models were found to fit better than quadratic models and absolute models fit better than relative models. The CAG also felt that exposure to trivalent arsenic was more representative of low environmental exposure than pentavalent arsenic. Restricting their unit risk estimates to those obtained from linear absolute models where exposure was to trivalent arsenic gave a range of 1.25×10^{-3} to 7.6×10^{-3}. A weighted average of the five estimates in this range gave a composite estimate of 4.29×10^{-3}.

REC 4938

The unit risk estimates for water were based on an extensive drinking water study which was conducted in a rural area of Taiwan. An association between arsenic in well water and skin cancer was observed in the study population. Using the male population, who appeared to be more susceptible, the CAG estimated that the unit risk associated with drinking water contaminated with 1 μg/ℓ of arsenic was 4.3×10^{-4}.

To compare the air and water unit risks, the CAG converted the exposure units in both cases to mg/kg/day absorbed doses, which resulted in unit risk estimates of 50.1 and 15.0, respectively.

The potency of arsenic compared to other carcinogens was evaluated by noting that an arsenic potency of $2.25 \times 10^{+3}$ $(\text{mMol/kg/day})^{-1}$ lies in the first quartile of the 52 suspect carcinogens that have been evaluated by the CAG.

The U.S. EPA is presently examining information from studies on both patient and general populations which have been exposed to arsenic via medicinals or drinking water, respectively, in order to determine whether quantitative dose-response relationships can be established for non-cancerous skin lesions.

While the qualitative evidence for peripheral neurological effects and cardiovascular changes in arsenic-exposed populations is well established, the data are insufficient for determining quantitative dose-response relationships at the present time.

2.5.3 Populations at Special Risk to Health Effects of Arsenic

From a Japanese study, which reported on the poisoning of children exposed to arsenic in infant milk formula, young children may be considered at risk for acute exposure to arsenic. From the clinical reports published at the time of the mass poisoning, as well as those from follow-up studies, a

REC 4939

number of signs of central nervous system involvement were noted at both the time of the episode and much later, with the follow-up studies showing behavioral problems, abnormal brain wave patterns, marked cognitive deficits, and severe hearing loss.

Because children consume more water per unit body weight than do adults, the daily intake of arsenic via drinking water per kilogram body weight would be greater in children. This might have implications regarding chronic exposure effects in children. However, it should be noted that serious health effects due to chronic exposure of arsenic in drinking water have not been found at a greater frequency in children than adults.

Individuals residing in the vicinity of certain arsenic-emitting sources, e.g., certain types of smelters, may be at risk for increased arsenic intake because of both direct exposure to arsenic in air and indirect exposure via arsenic secondarily deposited from air onto soil or other human exposure media. The relative contribution from such indirect exposures to increased risk would be difficult to define, however.

A less defined group at risk would be cigarette smokers due to some arsenic in tobacco, but it is not clear just what the quantitative increase in risk would be.

REC 4940

3. BACKGROUND INFORMATION

3.1 CHEMICAL/PHYSICOCHEMICAL ASPECTS

Compounds of arsenic in various chemical forms have most prominently figured in the extensive history of the toxicology of the element. The physical properties for several of these compounds are presented in Table 3-1. In contrast, the element in the metallic, zero-valent form is of minor toxicological interest.

Geochemically, arsenic is encountered as a component of sulfidic ores, occurring as the arsenides and diarsenides of metals such as nickel, cobalt, and copper, and is present in rocks and soils at trace levels. Smelting of commercially important metal ores, therefore, often has associated with it the release into the environment of significant quantities of certain arsenic compounds. For example, arsenic trioxide, As_2O_3, a major form of the element in terms of its toxicological history, is a smelter product arising from air roasting of metallic arsenides or arsenic-containing sulfides.

Arsenic trioxide, white arsenic, is only slightly soluble in water and other solvents which do not promote chemical transformation. Its solubility in solvents which mimic physiological media may not necessarily be the same as for simple solvents, e.g., gastric juice versus water. Arsenic trioxide sublimes, the process becoming pronounced at 135°C. This property appears to have been overlooked through the years in considering analytical methods for measuring levels of the compound. Dissolution of the trioxide in aqueous media leads to formation of arsenous acid, H_3AsO_3, while alkaline treatment leads to formation of the arsenite ion, $AsO(OH)^-_2$, with both the acid and the salt being freely soluble in a number of solvents.

REC 4941

TABLE 3-1. PHYSICAL PROPERTIES OF ARSENIC AND ARSENIC COMPOUNDS

Chemical name	Atomic/ molecular weight	Melting point (°C)	Boiling point (°C)	Density (g/cm^3)	Crystal system	CAS Number
Arsanilic acid	217.07	232	---	1.9571^{20}	monoclinic needles from water or ethanol	98-50-0
Arsenic	74.92	817 (28 atm) (triple-point)	613 (sublimes)	5.727^{14}	hexagonal, rhombic	7440-38-2
Arsenic pentoxide	229.84	315 (dec.)	---	4.32	amorphous	1303-28-2
Arsenic sulphide	246.04	300	707	3.43	yellow or red monoclinic needles (change from yellow to red at ~170°C)	1303-33-9
Arsenic trioxide[a]	197.84	312.3	465	3.738	amorphous or vitreous	1327-53-3
Arsine	77.95	-113.5	-55 (dec. 230)	2.695 (gas)[b] 1.689^{849} (liq.)	colourless gas	7784-42-1
Calcium arsenate	398.08	---	---	3.62	amorphic powder	7778-44-1
Dimethylarsinic acid	138.00	200	---	---	prism	75-60-5
Lead arsenate	347.12	720 (dec.)	---	5.79	monoclinic leaves	7784-40-9
Methanearsonic acid, disodium salt	183.9	132-139	---	---	crystalline	144-21-8
Methanearsonic acid, monosodium salt	161.9	115-119	---	---	crystalline	2163-80-6
Potassium arsenate	180.04	288	---	2.867	tetrahedral	7784-41-0
Potassium arsenite	254.8	---	---	---	powder	13464-35-2
Sodium arsenate dodecahydrate	423.93	86.6	---	1.752-1.804	trigonal or hexagonal prism	7631-89-2
Sodium arsenite	129.91	---	---	1.87	powder	7784-46-5
Sodium cacodylate	159.98		200	---	crystalline	124-65-2

[a]Vapour pressure 0.653 (200°C)

[b]Specific gravity (air = 1)

Source: Adapted from International Agency for Research on Cancer (1980).

REC 4942

Arsenic pentoxide, As_2O_5, may be readily prepared by nitric acid oxidation of elemental arsenic or the trioxide. Compared to the trioxide, the pentoxide has considerable solubility in water (63.0 g/100 g water), presumably dissolving to form the relatively strong arsenic acid, H_3AsO_4. In acid media, arsenic acid has oxidizing potential (E^o=0.56V).

The relative stability of solutions of arsenic or arsenous acids to oxidation-reduction is of considerable importance in terms of valency-dependent arsenic toxicity. In oxygenated media, one would expect the pentavalent form to dominate, while reducing media would favor the trivalent state.

Arsenous and arsenic acids both form mono-, di- and tri-metal salts, the alkali-metal salts such as potassium and sodium arsenite being freely soluble in water and the alkaline salts such as calcium or magnesium arsenite being slightly soluble.

While tri-organic esters of the tri- and pentavalent arsenic acids are known, they are labile to hydrolysis and one would expect the mono- and di-organic derivatives to be even more so. This behavior has implications in the postulated role of arsenate ions in interfering with phosphorylation reactions.

Arsine (arsenic trihydride, AsH_3) is a strong hemolytic toxicant and probably the most poisonous of the arsenicals. Although generally a minor factor in the environmental chemistry of arsenicals, it can form under certain restricted conditions, i.e., via reduction in the presence of an active hydrogen-generating source.

Monomethyl and dimethyl arsenic, in the form of methylarsonous and methyl arsonic, dimethylarsinous and dimethylarsinic (cacodylic) acids, occur both in the environment and are formed via <u>in vivo</u> transformation in many mammalian

species, including man. Such organic arsenic compounds are also of commercial significance. For instance, both methylarsonic and dimethylarsinic acids, usually in the form of the mono- or dialkali salts, are employed as herbicides which, when released into the environment, may undergo reduction to the corresponding labile arsine compounds, CH_3AsH_2 (methylarsine) and $(CH_3)_2$ AsH (dimethylarsine) (Arsenic. NAS, 1977). Like trivalent inorganic arsenic, methylarsonous acid can interact with thiol groups (as can cacodylic acid) to form the CH_3-As(-S-)$_2$ and $(CH_3)_2$-As-S groups, respectively. The physical forms of arsenic in the environment depend on its mode of emission and subsequent interactions with other materials.

Arsenic, along with other trace metals, can be mobilized in association with airborne particles derived from high-temperature sources such as fossil-fueled power plants, metallurgical smelters and blast furnaces.

Arsenic compounds form insoluble complexes with soils and sediments. With soils, the interaction involves clay surfaces containing amorphous aluminum or iron oxides (Woolson, 1976).

3.2 ENVIRONMENTAL CYCLING OF ARSENIC

Inorganic arsenic is released into the environment from a number of anthropogenic sources which include primary copper, zinc and lead smelters, glass manufacturers (specifically those that add arsenic to the raw materials) and arsenic chemical manufacturers. Figure 3-1 presents a generalized scheme for the geochemical cycling of arsenic through various compartments of the environment. The atmosphere is a major conduit for arsenic emitted from anthropogenic sources to the balance of the cycle via wet and dry precipitation processes. The rate of movement of arsenic from the atmosphere is not known at present.

REC 4944

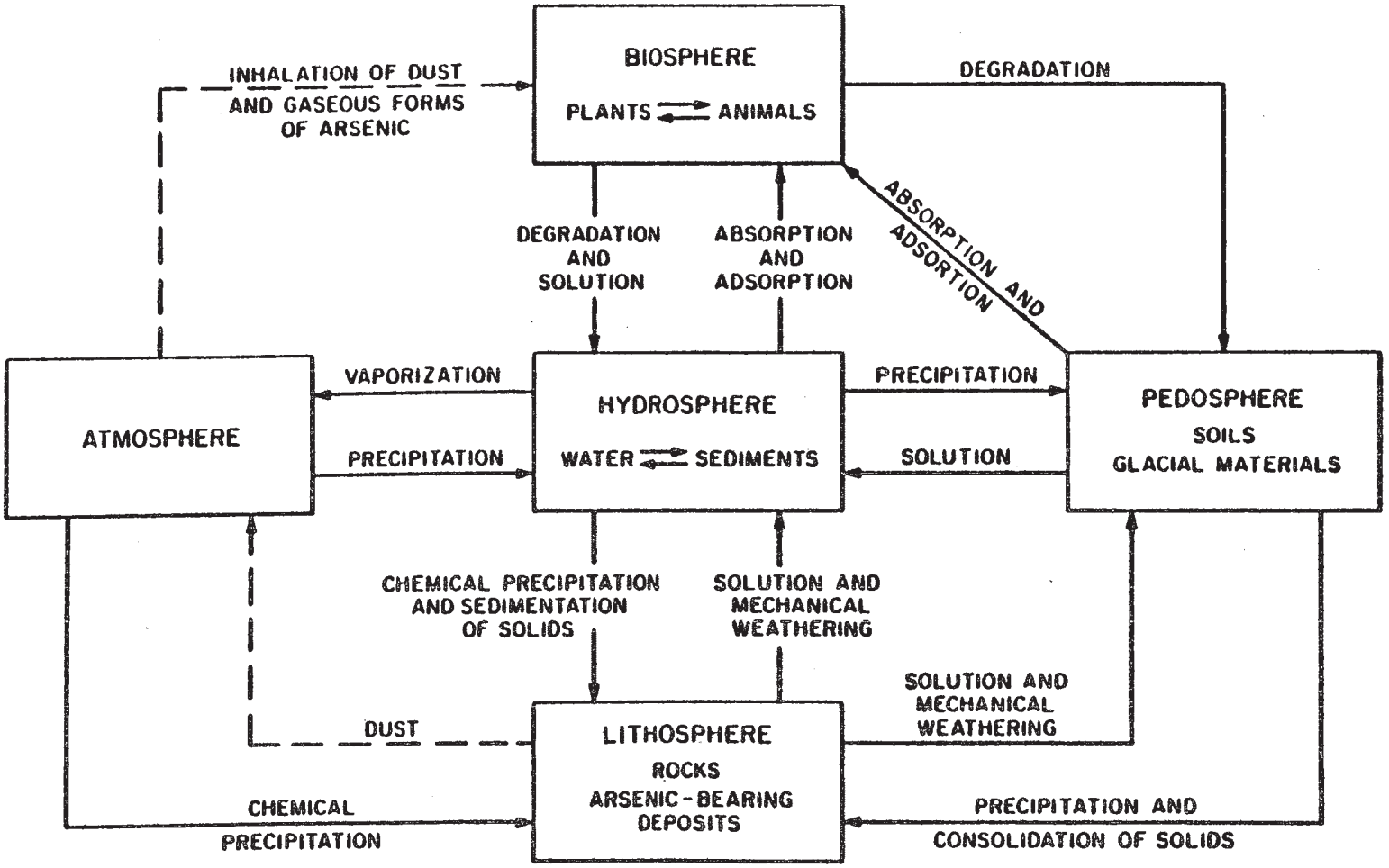


Figure 3-1. The generalized geochemical cycle for arsenic.

Source: Union Carbide (1977).

Dry and wet fall onto soils may be followed by movement through soils either into ground water or surface water. Passage of arsenic into surface waters may then be followed by further transfer to sediments.

Complicating an understanding of the environmental cycling of arsenic is the existence of chemical and biochemical transformations which occur within the cycle.

Trivalent arsenic in the atmosphere can undergo oxidation to the pentavalent state. Such conversion can also occur in aerated surface waters. On the other hand, pentavalent arsenic in an aqueous medium which is somewhat acidic is an oxidant, and, in the presence of oxidizable material, it will react to form trivalent arsenic (NAS, 1977).

One hypothesis of the biological cycling of arsenic is presented in a generalized scheme set forth in Figure 3-2. In this scheme, Wood (1974) proposes that sedimentary bacteria reduce arsenate to arsenite, which in turn may be altered to form methyl- and dimethyloxy arsenicals. Further action of bacteria and molds transforms these intermediates to di-and tri-methyl arsine. These volatile products pass into the hydrosphere and then into the atmosphere, where oxidative transformation to dimethyl-arsinic acid and, further, to inorganic arsenic occurs.

More recent reports by Andreae and co-workers (Andreae and Klumpp, 1979; Andreae, 1979; 1980; 1983) dispute this hypothesis with respect to marine environments. In analyses performed by Andreae and other workers, no volatile organoarsenic compounds were found to be formed in seawater, negating the hypothesis suggesting that reductive biomethylation resulting in volatile compounds serves as a contributing source to the atmospheric cycling of arsenic.

REC 4946

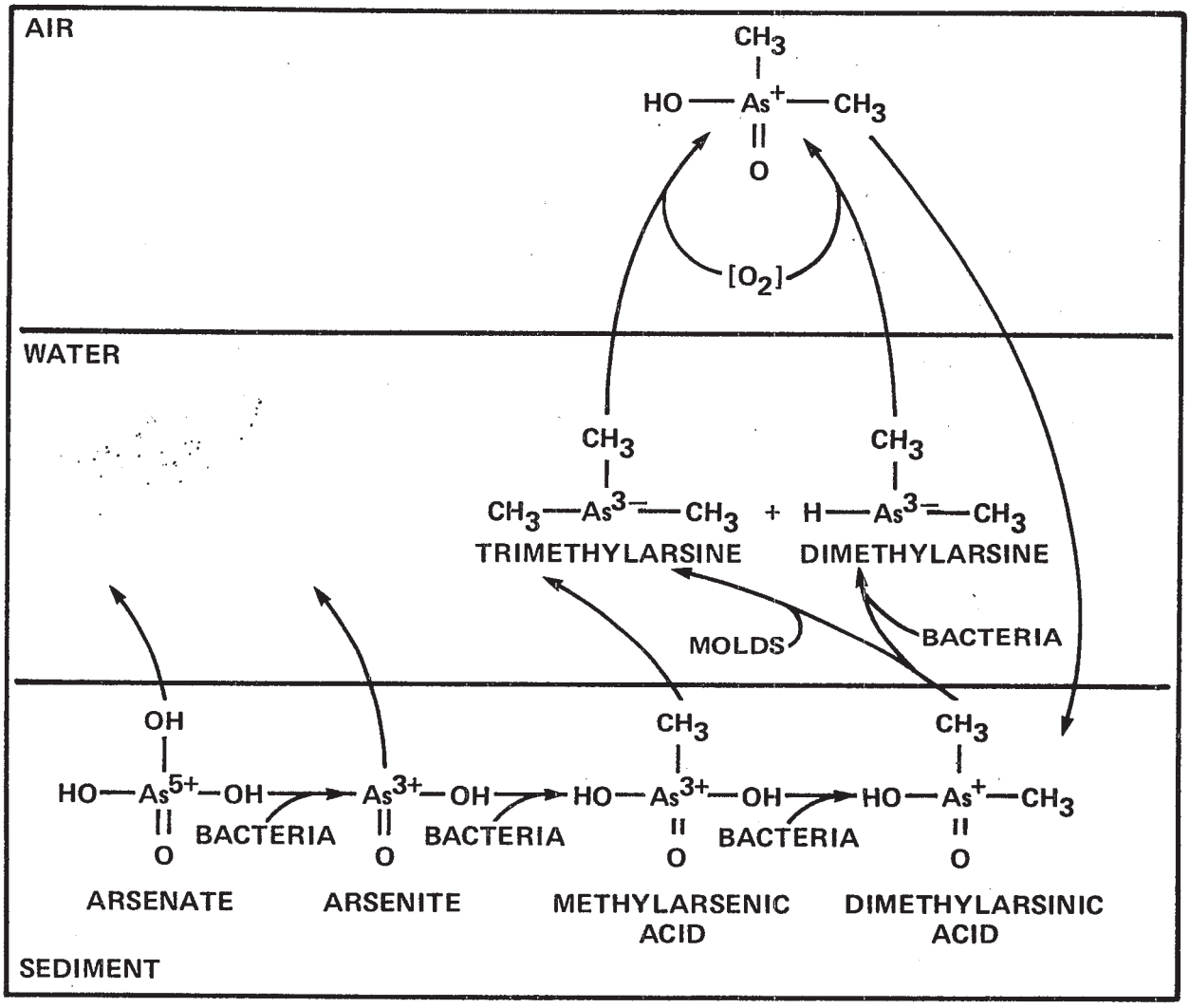


Figure 3-2. The proposed biological cycle for arsenic.

Source: Wood (1974)

While the authors did note the occurrence of biomethylation, the observed products were non-volatile, water-soluble methylated oxoacids of low toxicity. Further, the site of biotransformation was reported to be planktonic algae residing in the photic zone, rather than sedimentary bacteria. Similarly, the authors noted that methylated species were not found in a number of rain samples collected along the Pacific coast between 1976-1978. Such species would be expected if significant ocean-to-atmosphere transfer by biomethylation reactions was occurring. Andreae suggested that a global mass balance could be constructed for the atmospheric arsenic cycle which derived its major input from anthropogenic, rather than biogenic, sources.

Reduction and methylation of inorganic arsenic occur only to a limited extent in soils, 1-2 percent over a period of months having been reported in one study (Woolson, 1976).

In terms of the relative amounts of arsenic partitioned among the various environmental compartments, Suta (1980) has calculated that land is the major sink for arsenic, accounting for approximately 90 percent of the dissipation for the year 1974. The atmosphere accounts for 7-8 percent dissipation with the least quantity appearing in waterborne effluents.

3.3 LEVELS OF ARSENIC IN VARIOUS MEDIA

As was noted in the previous section, geochemical and biological cycling mechanisms contribute to arsenic burden in various media. Such burdening of a given medium is augmented from specific sources, e.g., agro chemicals containing arsenic applied to agricultural lands.

Available information on the arsenic content of media with which man interacts is generally in the form of total amounts of the element, with limited data available for assessing specific chemical forms. Since the toxicity of arsenicals varies with chemical form, any supporting data for determining chemical states will be discussed in this report, however fragmentary.

REC 4948

3.3.1 Levels of Arsenic in Ambient Air

The most comprehensive data for ambient air levels of arsenic in the U.S. are those of the National Air Sampling Network conducted by the U.S. EPA. Measurements from this network are summarized in Table 3-2. All values were determined from nuclear activation analysis of individual 24-hour high volume particulate samples. As shown in Table 3-2, the number of observations available is considerably different from year to year. This is due to changes in the participation of state and local agencies operating the individual sites and, for the year 1981, only about half the samples collected have been analyzed and reported into the network data base at this time. Thus, direct comparison of the summary statistics from year to year may be of limited utility.

A closer examination of the NASN data by site indicates that in areas not influenced by copper smelters, maximum 24-hour concentrations do not exceed 0.1 $\mu g/m^3$. There are only two exceptions of approximately 600 site/years represented in the table where there were observations above 0.1 $\mu g/m^3$--Omaha, Nebraska, and Charleston, West Virginia. The site in Charleston ceased operation after 1978; therefore, it is difficult to interpret the single value above 0.1 $\mu g/m^3$. Repeated observations above 0.1 $\mu g/m^3$ have occurred at the site in Omaha, Nebraska.

Using the NASN data base, U.S. annual arithmetic mean arsenic concentrations are plotted in Figure 3-3. The plot suggests considerable variability over the five-year period with no clear direction of trend. Perhaps the most striking feature in the data is the relatively low annual arsenic level observed in 1980. A partial explanation for this observation may be the strike which idled most of the nation's copper smelters from June through September of 1980 (Eldred et al., 1983).

REC 4949

TABLE 3-2. CUMULATIVE FREQUENCY DISTRIBUTION OF NASN INDIVIDUAL 24-HOUR AMBIENT AIR ARSENIC LEVELS

Year	Minimum Detection Limit	Number of Observations	Percentile[a]				Arithmetic Mean	(SD)
			30	50	70	99		
1977	.004	5385	0	0	.004	.048	.0049	.0165
1978	.006	1679	.006	.006	.008	.075	.0109	.0253
1979	.005	1263	.005	.005	.005	.077	.0091	.0192
1980	.007	2934	0	0	0	.037	.0026	.0113
1981	.007	688	0	0	0	.058	.0059	.0275

[a]Percentile values indicate the percentage of stations below the given air level. Values in $\mu g/m^3$.

Source: National Arsenic Data Base, OAQPS/OANR, U.S. Environmental Protection Agency (Akland, 1983).

REC 4950

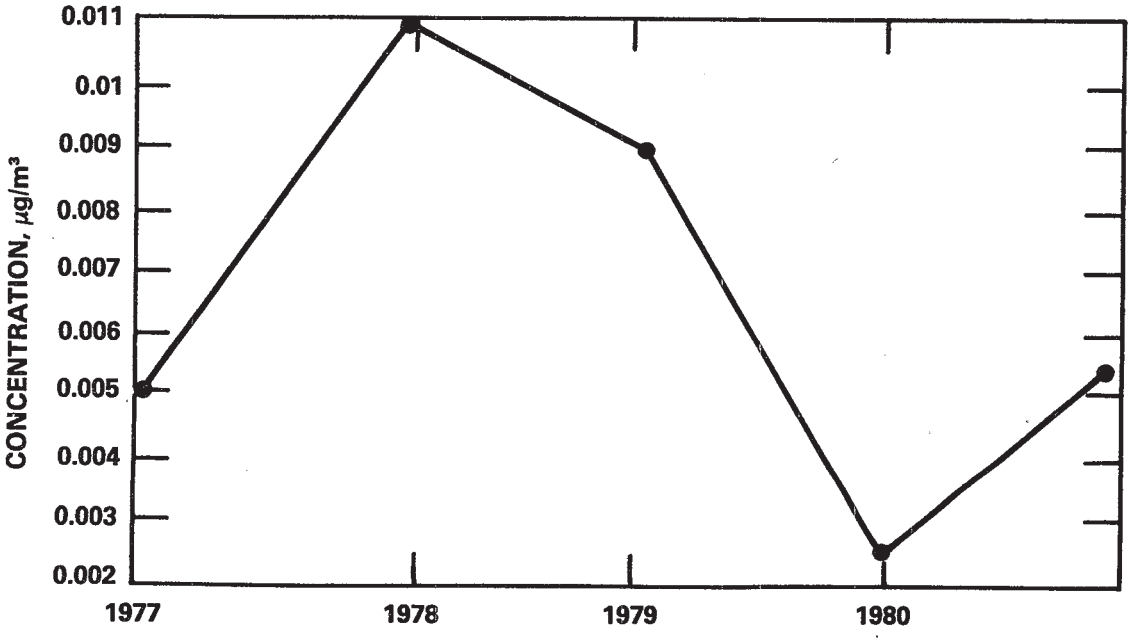


Figure 3-3. NASN annual average arsenic concentrations.

Source: National Atmospheric Data Base, OAQPS/OANR, U.S. Environmental Protection Agency (Akland, 1983).

REC 4951

The locations of these primary copper smelters in the U.S. are listed in Table 3-3. Examination of the NASN data by individual sites shows that the highest arsenic levels are consistently recorded in areas of Arizona, Montana, Tennessee, Texas, and Washington, which are impacted by the copper smelting industry. Thus, the closure of many of these plants for a substantial period in 1980 may have had the effect of depressing the nationwide average concentration of arsenic in ambient air for that year. Unfortunately, the possible effect of the 1980 copper smelter strike cannot explain the low arsenic levels observed in that year nationwide. Even urban areas in the Northeast, which would not be affected, exhibited lowered concentrations and the possibility that the analytical methodology may have systematically affected results cannot be ruled out.

Several factors of importance in assessing these data concern the partitioning of arsenic between particulate-bound fractions and vapor material as well as the lability of arsenic on air sampling filters. Non-particulate arsenic would chiefly be a problem in the immediate area of smelter emissions, adhesion to particulates increasing with residence time and distance from the emission source. Thompson (1976) has noted that all of the arsenic in the air in regions of smelters is adhered to particulates when sampled 2-3 kilometers from the operation. Lao et al. (1974) have cautioned about the hazard of arsenic loss, chiefly as the trioxide, from samplers at levels of 1.0 microgram or less. Walsh et al. (1977a), however, could not remobilize particulate arsenic once trapped in samplers. Whatever the hazard, the NASN values are internally consistent, remote areas having the lowest values and regions of smelter operations having the highest levels.

An important consideration in assessing the significance of air exposure of arsenic to health risk is the chemical form or forms of arsenic in the

REC 4952

TABLE 3-3. PRIMARY COPPER SMELTERS IN THE UNITED STATES

	Location	Company
1.	Anaconda, Montana	Anaconda Company
2.	Tacoma, Washington	Asarco, Inc.
3.	Garfield, Utah	Kennecott Copper Corp.
4.	El Paso, Texas	Asarco, Inc.
5.	McGill, Nevada	Kennecott Copper Corp.
6.	Hidalgo, New Mexico	Phelps Dodge Corp.
7.	Hurley, New Mexico	Kennecott Copper Corp.
8.	Hayden, Arizona	Kennecott Copper Corp.
9.	Hayden, Arizona	Asarco, Inc.
10.	Miami, Arizona	Inspiration Consolidated Copper Corp.
11.	Morenci, Arizona	Phelps Dodge Corp.
12.	Ajo, Arizona	Phelps Dodge Corp.
13.	Douglas, Arizona	Phelps Dodge Corp.
14.	San Manuel, Arizona	Magma Copper Company
15.	Copper Hill, Tennessee	Cities Services Company
16.	White Pine, Michigan	Copper Range Company

Source: National Arsenic Data Base, OAQPS/OANR, U.S. Environmental Protection Agency (Akland, 1983).

REC 4953

ambient air of the United States. Work by Johnson and Braman (1975), as well as that of Attrep and Anirudhan (1977), indicates that methylated arsenic, possibly in significant amounts, has been found in air samples, but its presence can likely be ascribed to either biotic activity or the use of methylated arsenics as herbicides. This is not in total agreement with Andreae (1983), who suggests that methylated atmospheric arsenic is due predominantly to anthropogenic sources, based upon his studies of marine environments. Methylated forms become a minor factor in suburban and urban areas.

It is not clear from the available data what forms of inorganic arsenic are in most air samples: trivalent, pentavalent or mixtures of these two oxidation forms. Crecelius (1974) found that rain water samples for an urban area of the western U.S. contained only about one-third (35 percent) trivalent arsenic. In a study conducted at various sites along the Pacific coast, Andreae (1980) observed wide variations in the ratio of arsenite to arsenate in rain. He attributed this variability to emissions of predominantly pentavalent arsenic from the sea surface and trivalent arsenic from industrial emissions (particularly those from a copper smelter in the Northwest), and by redox reactions during the residence of arsenic in atmospheric particulates and hydrometeors. Caution should be exercised, however, in interpreting any extrapolations from washout samples to original air composition, given the lability of inorganic arsenic to oxidize or reduce depending on aeration, acidity of the rain sample, and presence of oxidizable matter.

In summary, then, one can assume that methylated arsenic is of minor concern in suburban and urban/industrial air samples, and that the major inorganic portion is a variable mixture of the trivalent and pentavalent forms.

REC 4954

3.3.2 Levels of Arsenic in Drinking Water

The National Interim Primary Drinking Water Regulations, promulgated under the Safe Drinking Water Act, set the Maximum Contaminant Level (MCL) for arsenic in U.S. public water supplies at 50 µg/l (40 CFR Part 141). EPA is currently reviewing the arsenic MCL as part of its program to promulgate National Revised Primary Drinking Water Regulations (EPA, 1983).

In general, arsenic is not found in drinking water at levels exceeding the MCL. The Community Water Supply Survey conducted in 1969 found only 2 of the 969 supplies examined (0.2 percent) with levels exceeding 50 µg/l (McCabe et al., 1970). More recently, the Rural Water Survey conducted in 1978 reported that 0.8 percent of rural households exceeded the 50 µg/l level. Small rural communities showed a much higher population (6.6 percent) of households exceeding 50 µg/l than large rural communities (0.0 percent) and other rural areas (0.4 percent). The proportion of households exceeding 50 µg/l was greatest in the West (2.1 percent) and North Central (1.8 percent); none were found to exceed 50 µg/l in the Northeast or South (Francis et al., 1982). Compliance monitoring of public water supplies as required by the current drinking water regulations has revealed that approximately 100 of the nation's 60,000 public water supplies (0.2 percent) have levels exceeding the current MCL (Wentworth, 1983).

Notable exceptions to the generally favorable picture for U.S. population exposure to drinking water arsenic are isolated well water sources associated with geochemical enrichment by arsenic found mainly in the western U.S. and Alaska (Arsenic. NAS, 1977; Whanger et al., 1977; Harrington et al., 1978; Southwick et al., 1981). Whanger et al. (1977) have noted that well water arsenic levels in Lane County, Oregon, have ranged up to 2.2 ppm (one well) with levels generally increasing with well depth. Harrington et al. (1978) also noted that an area of Fairbanks, Alaska, had well water levels

REC 4955

ranging as high as 10 ppm, representing geochemical input as well as contamination by residues from prior gold-mining activity. Southwick et al. (1981) reported levels ranging from 0.18-0.27 ppm in desert communities in Utah.

As with arsenic in air, it is important to take into account available information regarding the chemical forms of arsenic in the potable water supplies. It is reasonable to assume that the chief form of arsenic in most municipal water supplies, particularly surface reservoirs, would be pentavalent arsenic due to aeration and chlorination. Similarly, the major forms of arsenic in well waters relatively enriched in arsenic have been analyzed and also appear to be predominantly in the pentavalent inorganic state (Whanger et al., 1977; Harrington et al., 1978; Southwick et al., 1981). The chemical character of arsenic-rich well water in the U.S. versus other regions of the world will be taken up elsewhere.

3.3.3 Arsenic in Food

Perhaps the most useful body of data for assessment of the contribution of food arsenic to the total exposure picture in the U.S. is the recent survey carried out from August 1975 to July 1976 by the U.S. Food and Drug Administration (Johnson et al., 1981a,b). In Table 3-4 are summarized the average arsenic levels in various adult food classes for the period noted above; values are expressed analytically as arsenic trioxide. Corresponding average arsenic levels in food classes of 6-month-old infants and 2-year-old toddlers are summarized in Table 3-5.

In comparing the mean levels in comparable food categories, it appears that for children and adults, meat, fish, and poultry constitute the greatest dietary source of arsenic. Within this category, shellfish and other marine foods contain the highest levels of arsenic (Jelenik and Corneliussen, 1977). For infants, grain and cereal products constitute the only known source of arsenic intake from the categories measured.

REC 4956

TABLE 3-4. LEVELS OF ARSENIC (As_2O_3) BY FOOD CLASS IN ADULT FOOD COMPOSITES FROM 20 U.S. CITIES (AUGUST, 1975 - JULY, 1976)

Food Class Composite	No. of Positive Composites	As, ppm Mean (Range)
Dairy products	1	0.004(0.08)[a]
Meat, fish and poultry	17	0.19(0.03-0.46)
Grain and cereal products	8	0.02(0.03-0.10)
Potatoes	ND[b]	----
Leafy vegetables	ND	----
Legume vegetables	1	0.004(0.07)
Root vegetables	1	0.004(0.07)
Garden fruits	1	0.005(0.10)
Fruits	ND	----
Oils, fats and shortening	1	0.002(0.04)
Sugar and adjuncts	ND	----
Beverages (including drinking water)	1	0.008(0.15)

[a]Mean values are based on 20 composites for every food class.

[b]ND = not detected

Source: Adapted from Johnson et al. (1981a).

REC 4957

TABLE 3-5. LEVELS OF ARSENIC (As_2O_3) BY FOOD CLASS IN INFANT AND TODDLER FOOD COMPOSITES FROM 10 U.S. CITIES (AUGUST, 1975 - JULY, 1976)

Food Class Composite	No. of Positive Composites	As, ppm Mean (Range)	
		Infant	Toddler
Water	ND[a]	----	----
Whole milk, fresh	ND	----	----
Other dairy and substitutions	ND	----	----
Meat, fish and poultry	ND(I) 7(T)	----	0.092 (0.06-0.29)[b]
Grain and cereal products	3(I) 2(T)	0.018(0.04-0.09)	0.008(0.03-0.05)
Potatoes	ND	----	----
Vegetables	ND	----	----
Fruits and fruit juices	ND	----	----
Oils and fats	ND(I) 1(T)	----	0.003(0.03)
Sugar and adjuncts	ND(I) 1(T)	----	0.004(0.04)
Beverages	ND	----	----

[a]ND = not detected

[b]Mean values are based on 10 composites for every food class.

Source: Adapted from Johnson et al. (1981a).

REC 4958

Johnson et al. (1981a) have calculated that the total adult daily intake of arsenic (as As_2O_3) for August 1975 to July 1976 was approximately 65 µg. (Corresponding elemental content can be obtained by multiplying by 0.75. Thus, the intake of elemental arsenic would be 50 µg.) This represents an increase over the 1974 value of 21 µg reported by Jelenik and Corneliussen (1977). Differences in the two years can primarily be accounted for by increases in the arsenic content of meat, fish, and poultry; grains and cereal products; beverages; and dairy products. Johnson et al. (1981a) did not discuss whether the apparent increase in arsenic levels in certain categories represented a trend or merely reflected analytical variation from year to year. It should be noted, however, that arsenic mean levels in all food categories generally declined over the years 1967-1974. Therefore, data collected over the past few years (1977-present) but, as yet, unanalyzed, should be closely examined in order to determine whether the increases seen in 1975-1976 have actually constituted the beginning of a new trend.

In no other medium is the issue of chemical forms of arsenic more complex and simultaneously more important than in food, given the fact that the diet is a major, if not the main, source of arsenic for most of the U.S. population. As will be pointed out in a later section, arsenic in crustaceans and other marine life is present in the form of various chemically complex organoarsenicals, which appear to be not only resistant to metabolism but are rapidly excreted intact. Comparatively speaking, then, these forms are regarded as being toxicologically inert.

3.3.4 Arsenic in Soils

Soil arsenic levels are mainly of concern in this section to the extent that arsenic mobility and transformation in this medium allow for passage of the element to ground water, air and the food chain (via plant uptake). This

REC 4959

area has been reviewed in some detail (Arsenic. NAS, 1977; Woolson, 1977; Walsh et al., 1977b).

Background levels of arsenic in soils range from less than 1 ppm to above 40 ppm, and the relative enrichment of this background level with agricultural practices is secondary to fallout from air in the regions of industrial activity and can be of the order of 100 times. In Table 3-6 are listed some comparative values for uncontaminated soils versus soils contaminated by the repeated use of defoliants and insecticides containing arsenic (Walsh and Keeney, 1975).

Arsenic in soils is usually bound to clay surfaces containing amorphous aluminum or iron oxides, the degree of immobilization (adsorption) being a function of soil type, soil pH, phosphate levels, levels of iron or aluminum as well as residence in soil. Soil-adsorbed arsenic is rather inert to transformation or movement and it is the soluble fraction which is of interest, usually in the pentavalent form. Pentavalent arsenic arises from both soil aeration and degradation of methylated arsenic herbicides. Little reductive methylation of arsenic occurs in typical soils compared to sediments, Woolson (1976) observing that only 1-2 percent conversion of arsenate occurred over a period of months.

Transfer of soil arsenic to plants entails the soluble, labile fraction of arsenic and the site of uptake is the root system where highest levels are found. Edible portions of most food plant classes are low. This is also the case for terrestrial flora, but marine plant life such as algae accumulates considerable levels of arsenic (Irgolic et al., 1977).

3.3.5 Other Sources of Arsenic

Small and McCants (1962) found an average of 1.5 ppm arsenic in tobacco residues taken from U.S. tobacco grown in soils having average arsenic levels

REC 4960

TABLE 3-6. A COMPARISON OF ARSENIC LEVELS IN ARSENIC-TREATED AND UNCONTAMINATED SOILS IN NORTH AMERICA

Sampling site	Total As content, ppm: uncontaminated soil	Total As content, ppm: treated soil[a]	Crop
Colorado	1.3 - 2.3	13 - 69	Orchard
Florida	8	18 - 28	Potato
Idaho	0 - 10	138-204	Orchard
Indiana	2 - 4	56 - 250	Orchard
Maine	9	10 - 40	Blueberry
Maryland	19 - 41	21 - 238	Orchard
New Jersey	10.0	92 - 270	Orchard
New York	3 - 12	90 - 625	Orchard
North Carolina	4	1 - 5	Tobacco
Nova Scotia	0 - 7.9	10 - 124	Orchard
Ontario	1.1 - 8.6	10 - 121	Orchard
Oregon	2.9 - 14.0	17 - 439	Orchard
	3 - 32	4 - 103	Orchard
Washington	6 - 13	106 - 830	Orchard
	8 - 80	106 - 2553	Orchard
	4 - 13	48	Orchard
Wisconsin	2.2	6 - 26	Potato

[a]These are results from soils that had been repeatedly treated with an As pesticide or defoliant. Soils treated experimentally are not included.

Source: Walsh and Keeney (1975).

REC 4961

of 3 ppm. Of the total arsenic content of cigarette tobacco, 10-15 percent is in mainstream smoke (Thomas and Collier, 1945) in an unidentified form. In the past, levels of up to 40 ppm arsenic were detected in U.S. cigarettes (Holland and Acevedo, 1966) owing to arsenical use as pesticides. Lower current levels probably reflect curtailed use of arsenic as a pesticide in tobacco growing.

While current levels of arsenic may be lower in tobacco than had been the case, past exposure of cigarette smokers remains a health factor in considering respiratory cancer risk, given the long clinical induction period (decades) for this health effect (see Chapter 7).

REC 4962

4. ARSENIC METABOLISM

4.1 ROUTES OF ARSENIC ABSORPTION

The significance of various routes of arsenical intake for man and various other animal species is dependent upon the physical and chemical form of the arsenical, the mode of exposure, and the animal species under study. The major routes that are of significance to general public health are inhalation and ingestion, either via direct intake of food and water or secondary intake via the inhalation of arsenic in a form and size where it is eventually swallowed. Inhalation is probably of more significance in occupational settings, while oral intake is the major exposure route for the population at large.

Percutaneous absorption of arsenic, while poorly studied, appears to be a relatively minor route of exposure except under certain occupational exposure conditions.

4.1.1 Respiratory Absorption

Some quantitative and qualitative information about the respiratory deposition and absorption of arsenic by human subjects has been reported. Holland and co-workers (1959) used a group of hospital patients (lung cancer) to assess the deposition and absorption of inhaled arsenic using arsenite-containing cigarettes labeled with arsenic-74 as well as arsenite-containing aerosols. Deposition amounted to approximately 40 percent and more than three-fourths (75 to 85 percent) of the deposited arsenic was absorbed from the lungs within 4 days. While it may be argued that the health status of these subjects may have influenced the extent of absorption, it is nevertheless reasonable to infer that relatively rapid and extensive absorption of arsenic from the human lung likely occurs.

REC 4963

A study of a group of workers (Pinto et al., 1976) exposed to airborne arsenic in a copper smelter in 5-day test periods demonstrated average urinary arsenic excretion values ranging from 38 to 539 µg/liter to be associated with averages of air levels of arsenic ranging from 3 to 295 µg/m^3 (overall 53 µg As/m^3). Urinary arsenic was correlated with workplace air exposure (0.53, $p < 0.01$). Either direct pulmonary absorption or swallowing of larger particulate matter was evident as seen from elevations of urinary arsenic within 24 hours.

In a later study of copper smelter workers in which urinary excretion of arsenic was determined as total levels and chemically variant forms, Smith et al. (1977) studied control subjects and individuals from low, medium, and high arsenic exposure groups. In that study, the variations in concentrations of all arsenic forms isolated in urine--trivalent, pentavalent, methyl, and dimethylarsenic--were directly correlated with levels of airborne exposure (the relevant issue of arsenic biotransformation in vivo being discussed elsewhere in this chapter). An important feature of the Smith et al. (1977) report was the observation of a difference in the tightness of the correlation between excretion and exposure as a function of particle size. Both smaller, clearly respirable (<5 µm) and larger, less respirable (>5 µm) arsenic particles correlated well with excretion levels, but the less respirable arsenic-excretion relationship was seen to be much stronger than that for the finer mode particles. According to the authors, this is due to the swallowing of the large particle fraction and significant absorption from the GI tract.

Some animal data have also been reported on arsenic absorption via the respiratory tract. Bencko and Symon (1970) observed that hairless mice breathing a solid aerosol of fly ash containing 180 µg As/m^3 for several weeks had

REC 4964

increases in tissue arsenic values. Since the particle size was determined to be only less than 10 μm, part of this intake may have occurred via the GI tract. Increases in tissue arsenic in two exposure groups also occurred when rats were exposed to arsenic trioxide (condensation aerosols: 1.0, 3.7, and 46 $\mu g/m^3$) for 90 days (Rozenshtein, 1970).

Relatively rapid absorption of pentavalent arsenic (arsenate solution) was noted by Dutkiewicz (1977) when rats were exposed intratracheally (arsenate solution labeled with arsenic-74; 0.1 and 4.0 mg/kg). Arsenic tissue distribution dynamics were similar for intratracheal and companion intravenous exposure studies, indicating that the rate of intratracheal arsenic uptake more closely resembles that from parenteral administration than do oral or percutaneous exposures.

The pulmonary retention of arsenic compounds with different solubilities has recently been studied by two research groups.

Inamasu et al. (1982) gave 61 male Wistar rats single intratracheal instillations of arsenic trioxide or calcium arsenate suspended in phosphate buffer (pH 6.9). Controls (19) were given instillations of the phosphate buffer solution. The total dose of arsenic administered to each animal was about 2 mg in 0.2 ml suspensions.

Four to five of the arsenic-exposed animals were killed at intervals from 15 minutes to 168 hours after instillation. The average amounts of arsenic recovered in lungs of rats at 15 minutes after the instillation of calcium arsenate and arsenic trioxide were 1146 μg and 620 μg, respectively. After 24 hours, almost all of the deposited arsenic trioxide had disappeared from the lungs, whereas only about 50 percent of the calcium arsenate had been cleared as shown in Figure 4-1.

REC 4965

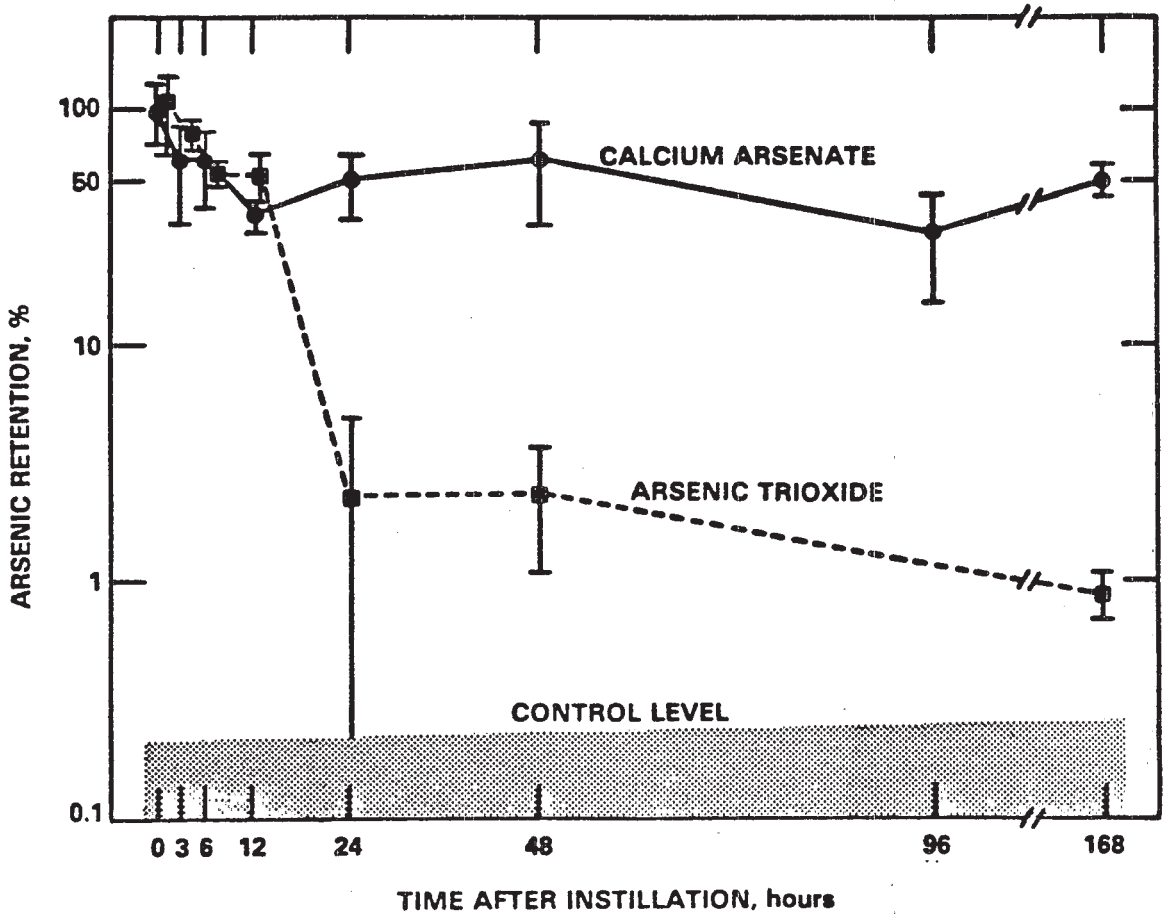


Figure 4-1. Arsenic retention in rat lungs following intratracheal instillation of a single dose. Percentage values are based on the average amount of arsenic present in rat lungs at 15 minutes after instillation of arsenic trioxide (- ■ -) or calcium arsenate (—●—). Vertical bars: means ± S.D.

Source: Inamasu et al. (1982).

Of the small remaining amount of arsenic trioxide, most gradually disappeared over the next several days, declining to a level of 5.6 µg at 168 hours after instillation, a level slightly higher than that seen in the controls (1.3 µg). In contrast, calcium arsenate remained at about the same level 168 hours after instillation as was observed after 24 hours (768 µg), clearly demonstrating a much higher level of retention compared to arsenic trioxide.

In the study by Pershagen et al. (1982), male Syrian golden hamsters were given four weekly intratracheal instillations of suspensions of arsenic trioxide, arsenic trisulfide and calcium arsenate in doses of 0.3, 0.5 and 0.5 mg arsenic, respectively. The suspensions were made in 0.9 percent NaCl, and sulfuric acid was added accordingly to equalize the acidity of the three different suspensions. Twenty animals were assigned to each treatment group. Five animals in each group were killed immediately after the first instillation. Two to five animals were then killed one week after two or four instillations and two weeks after four instillations.

The mortality was highest among the animals exposed to arsenic trioxide. In this group, 9 of the remaining 11 animals not sacrificed for tissue analysis had died by the week following the third instillation. In contrast, at the second instillation, two animals died in the group receiving arsenic trisulfide but no further deaths occurred in this group. A total of three animals receiving calcium arsenate died during the first week following the fourth instillation. Aside from those animals specifically sacrificed for tissue analysis, no other deaths occurred in this group either.

In the lungs, the amounts of arsenic were 386, 755 and 866 mg/kg wet weight immediately following instillation of arsenic trioxide, arsenic sulfide and calcium arsenate, respectively. One week after the second instillation

REC 4967

the amounts were 0.81, 9.2 and 579 mg/kg, respectively. In Figure 4-2 it can be seen that after the fourth instillation the differences between arsenate-exposed animals and the other groups were even more pronounced. Examination of the lungs revealed severe lung damage only among animals exposed to calcium arsenate. In all groups, areas with epithelial hyperplasia and metaplasia were seen.

Although different species and different time intervals were used in the above studies, the results were very consistent, i.e. arsenic trioxide was rapidly cleared from the lungs, whereas calcium arsenate was very slowly eliminated. The differences appear to be related to the relative solubility of the compounds, calcium arsenate having the lowest solubility. The doses in these two experiments were of the same magnitude, but the lung damage reported by Pershagen et al. among the arsenate-exposed animals might have influenced the clearance mechanisms. In addition, the possibility of higher acidity in the suspensions used by Pershagen et al. may also have had an influence.

The large differences in retention of arsenic compounds demonstrated in these two studies are of great interest in relation to the association between airborne arsenic and lung cancer. These differences in retention might explain the relatively high concentration of arsenic found in deceased smelter workers whose last exposure to arsenic occurred many years prior to death (Brune et al., 1980) (see Section 4.4). These workers were thought to be exposed to arsenic trioxide, but it may be that the retained fraction noted in the lungs was another arsenic compound of less solubility.

4.1.2 Gastrointestinal Absorption

In both man and experimental animals, factors which govern the absorption of arsenic from the gastrointestinal tract include the chemical form of the element, its physical characteristics, and dosing level. It can be stated

REC 4968

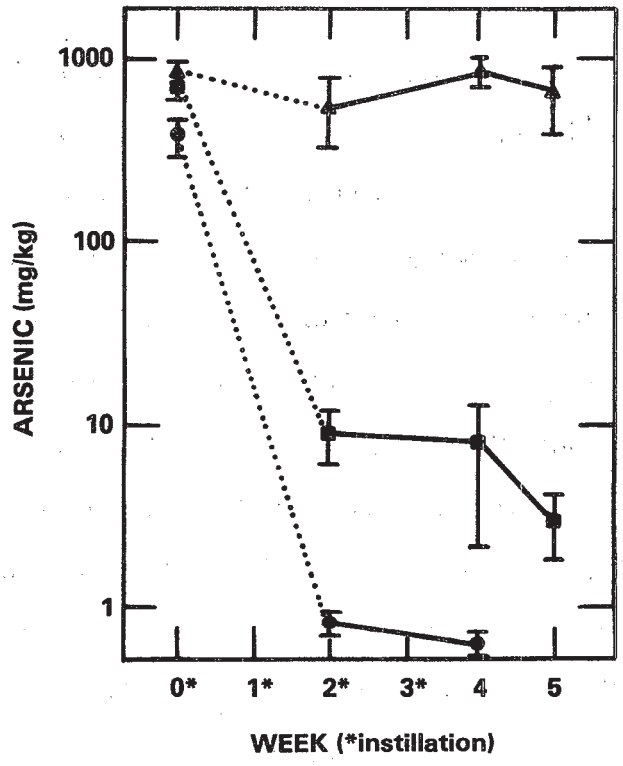


Figure 4-2. Lung concentrations of arsenic in hamsters given weekly intratracheal instillations of arsenic trioxide (●), arsenic trisulfide (■), or calcium arsenate (▲) (bars indicate ±1 S.D.). Animals at Week 0 were killed immediately following the first instillation; other animals were killed either 1 or 2 weeks after an instillation.

Source: Pershagen et al. (1982).

that soluble arsenicals will be generally more extensively absorbed than the insoluble forms. On the other hand, one should be cautious in extending correlations of simple water solubility to the chemical milieu existing in the GI tracts of various species.

Taken collectively, the reports of Coulson et al. (1935), Ray-Bettley and O'Shea (1975), Crecelius (1977), Mappes (1977), and Buchet et al. (1981a,b) demonstrate that very substantial absorption of soluble inorganic trivalent arsenic from the GI tract into the bloodstream typically occurs. Greater than 95 percent of inorganic arsenic taken orally by man appears to be absorbed, with less than 5 percent of the administered amount appearing in feces (Coulson et al., 1935; Ray-Bettley and O'Shea, 1975).

Consistent with the above observations, Mappes (1977) observed that daily oral intake of an aqueous solution of around 0.8 mg trivalent arsenic resulted in a daily urinary excretion of 69 to 72 percent of the daily dose in one subject. Also, Crecelius (1977) reported that ingestion of 50 µg trivalent and 13 µg pentavalent inorganic arsenic in a wine sample led to the appearance of 80 percent of all the ingested arsenic in urine within 61 hours. Crecelius (1977), however, reported that ingestion of well water mainly containing identified pentavalent inorganic arsenic led to urinary clearance of half the intake within approximately 3 days.

More recently, Buchet et al. (1981b) found that daily arsenic excretion via urine in human volunteers exposed to the dose range 125-1000 µg/day amounted to 60 percent of the dose. Steady state was achieved within 5 days after arsenic dosing began.

In contrast to the relatively high absorptive rate for soluble inorganic arsenic, Mappes (1977) reported that insoluble arsenic triselenide (As_2Se_3), when taken orally, passes through the GI tract with negligible absorption.

Arsenic intake via the diet of non-occupationally exposed populations requires that one consider the issue of bioavailability. Arsenic in foodstuffs is probably incorporated into the matrix of these commodities in a variety of ways.

The "shrimp" arsenic present in crustaceans and other fish appears to represent a complex organic form of the element which has prompted considerable recent study (LeBlanc and Jackson, 1973; Westöö and Rydälv, 1972; Munro, 1976; Edmonds et al., 1977; Penrose et al., 1977; Crecelius, 1977; Edmonds and Francesconi, 1977). In brief, the results of such studies indicate that the arsenic present in shellfish and other marine foods appears to be extensively absorbed and rapidly excreted intact as a complex organoarsenical by man and animals, and, as such, does not appear to pose a particular health threat to man.

Studies of the oral intake and absorption of arsenicals in experimental animals have also been conducted and generally confirm the findings derived from the above human studies. More specifically, soluble inorganic arsenic, delivered as either trivalent or pentavalent solutions, is almost completely absorbed from the GI tract of rats (Coulson et al., 1935), with 88 percent absorption being observed for arsenic trioxide solution (Urakabo et al., 1975; Dutkiewicz, 1977) and 70 to 90 percent for arsenate solution. Similar observations have been made for pigs (Munro et al., 1974), with 90 percent of arsenic trioxide solution being absorbed, and monkeys (Charbonneau et al., 1978a), with 98 percent of arsenic trioxide being absorbed. Also, Charbonneau et al. (1978b) fed arsenic-containing fish (Atlantic grey sole) to adult female monkeys as a homogenate (1 mg fish arsenic/kg body weight) and noted that about 90 percent of the intake was absorbed, of which about 75 percent appeared in urine after 14 days. In a related study, swine and adolescent

monkeys were seen to absorb approximately 70 and 50 percent, respectively. On the other hand, arsenic trioxide in suspension given orally to rabbits and rats was reported to result in only about 40 and 30 percent absorption, respectively (Ariyoshi and Ikeda, 1974).

4.1.3 Transplacental Passage

Potential fetal exposure to toxic elements via the mother is a matter of major importance given the potential sensitivity of *in utero* development to deleterious impacts of exogenous toxic agents.

In an arsenic-detection study of maternal-newborn blood groups, Kagey et al. (1977) reported that cord blood levels approximated those of mothers in 101 subject sets. Tissue analysis (Kadowaki, 1960) of fetus arsenic in a presumably healthy Japanese population indicated measurable element levels by at least month four of gestation which increased to month seven. Of importance in this study was the observation that brain levels, as well as those of bone, liver, and skin, were the highest of all tissue tested.

Complicating the issue is the chemical nature of the tissue arsenic assayed in either of the two studies noted above, inasmuch as precise chemical speciation was not attempted. Also, the Japanese study presumably did not select material in a manner such that dietary histories could be discerned. Thus, questions can be raised regarding implications of these data for fetotoxicity.

Transplacental transfer of arsenic has also been demonstrated in experimental animals. Transplacental transfer of arsenate administered parenterally in hamsters has been demonstrated by Ferm's laboratory (Ferm, 1977; Hanlon and Ferm, 1977). The movement was rapid, with embryonic tissues showing levels close to those in maternal blood 24 hours after dosing. Trivalent arsenic exposure results in transplacental passage in pregnant rats. Arsenic was detected in newborn rats when the dams received arsenic trioxide in their diets.

4.2 BIOTRANSFORMATION PROCESSES IN VIVO

An understanding of the metabolism of inorganic arsenic by man and a number of other species is substantially complicated by a series of newly-revealed biotransformations, including methylation of inorganic arsenic. It is thus appropriate to discuss *in vivo* transformation processes at this point, since many of the data dealing with blood transport, tissue distribution and subsequent excretion are much better understood in light of these findings.

A major factor in the determination of transformation processes for arsenic in man and other animals was the evolution of appropriate analytical methods within the decade which permit chemical speciation of chemically variant forms of arsenic with reference to both oxidation-state lability and inorganic versus organo-substituted arsenic.

These procedures involve different analytical approaches and include selective reduction of various arsenic forms to the hydride, and subsequent analysis by colorimetry (Lakso et al., 1979), emission spectrometry (Braman and Foreback, 1973; Crecelius, 1977), atomic absorption spectrometry (Edmonds and Francesconi, 1977; Buchet et al., 1980), and gas-liquid chromatography (Andreae, 1977; Talmi and Bostick, 1975). Alternatively, inorganic arsenic (III) or (V) and methylated forms can be directly measured by ion-exchange chromatographic techniques (Tam et al., 1978; Henry and Thorpe, 1980).

There are a number of points germane to consideration of *in vivo* transformations of arsenic: 1) biomethylation of inorganic arsenic; 2) oxidation-reduction of inorganic arsenic *in vivo*; 3) the relative chemical stability of inorganic arsenic to oxidation-reduction as it affects experimental dosing and chemical speciation in biological media.

4.2.1 Biomethylation of Inorganic Arsenic in Humans and Experimental Animals

An extensive literature has recently appeared documenting the *in vivo* methylation of inorganic arsenic to monomethyl and dimethyl arsenic (the latter

REC 4973

being the major methylated metabolite) in every mammalian system studied to date, including man.

While the quantitative features of this phenomenon may vary among species, one can generally state that: 1) dimethyl arsenic is the major transformation product in both humans and animals, with higher amounts of monomethyl arsenic, when formed, found in humans; 2) methylation is assumed to be a route of detoxification of the more toxic inorganic forms; 3) dimethyl arsenic appears to be a terminal metabolite, formed relatively rapidly and rapidly excreted; 4) while the in vivo methylating capacity of a given system may persist over a range of inorganic arsenic exposure, at some point the body burden of the unmethylated fraction is enough to induce toxic effects, evidenced by the extensive literature dealing with inorganic arsenic toxicity; 5) retrospective assessment of earlier data dealing with arsenic metabolism, including distribution and excretion, must be viewed in light of current knowledge about biomethylation in different species; and 6) biomethylation appears to be a reductive process involving step-wise arsenic reduction and methyl transfer steps.

4.2.1.1 Human Studies--Using a method that permits the determination of tri- and pentavalent inorganic arsenic as well as mono- and dimethylarsenic acids via selective reduction, volatilization, and helium-arc emission detection, Braman and Foreback (1973) analyzed the urinary excretion of arsenic in four human subjects. About 66 percent of the total urine arsenic concentration (22.5 ppb) was present as dimethylarsinic acid and 17 percent as pentavalent inorganic arsenic. Trivalent inorganic arsenic and methylarsonic acid were present in equal amount, approximately eight percent each.

Crecelius (1977) reported the urinary excretion of form-variable arsenic when a human subject ingested arsenic-rich wine (50 µg trivalent and 13 µg pentavalent). About 80 percent of the arsenic ingested with the wine was

REC 4974

excreted within 61 hours. Of the total excreted, 63 percent was in the form of dimethylarsenic acid, 18 percent was monomethyl arsenic acid, and approximately 9 percent each was in the two inorganic forms.

Consumption of well water containing 200 μg of arsenate by a subject in the same study showed urinary trivalent arsenic at near background levels with an elevation in pentavalent form as well as significant excretion of dimethylarsenic. Of the total amount ingested, about 50 percent was recovered in urine by 3 days. Arsenic as contained in canned crab tissue was also studied in this experiment. It has been established that arsenic is present in marine foods in an organic form which is excreted intact.

The study of Smith et al. (1977), using basically the same speciation/analysis techniques noted in the previous study and involving urinary profiles for a group of copper smelter workers, also confirmed transformation processes in vivo. In controls, as well as in three study groups that varied as to intensity of airborne trivalent arsenic oxide exposure, dimethyl arsenic was the dominant species in urine, followed by methyl arsenic, trivalent arsenic and pentavalent arsenic, in descending order.

In another smelter worker study, Buchet et al. (1980) assessed the distribution of arsenic and metabolites in urine samples in different groups according to the degree of inorganic arsenic exposure. Total urinary arsenic in exposure groups ranged from 74 to 934 μg/liter, of which 75 percent represented methylated forms (mono- and dimethyl), with dimethyl arsenic predominating. Control subjects showed a somewhat higher level of methylated arsenic in urine, approximately 90 percent, suggesting some dependency of the extent of methylation on the level of exposure.

A number of recent studies have described in more detail the biomethylation of inorganic arsenic using human volunteers.

REC 4975

Buchet et al. (1981a) followed the urinary excretion of inorganic and methylated arsenic in 3-5 volunteers ingesting single amounts of arsenic at a dose of 500 µg, in the form of either arsenite, monomethyl or dimethyl arsenic. After 96 hours, 46 percent of the dose in subjects given arsenite (trivalent arsenic) was excreted, 25 percent in the inorganic form and 75 percent as methylated metabolites. Of the latter, one-third was monomethyl arsenic and two-thirds was the dimethylated form. Dimethyl arsenic was excreted intact, 75 percent of the ingested amount appearing in urine by 96 hours. With monomethyl arsenic, excretion reached 80 percent by 96 hours, with around 13 percent of the urine level representing conversion to the dimethyl form.

In a follow-up report, these workers (Buchet et al., 1981b) monitored the urinary excretion of various arsenical forms in 4 human subjects undergoing repeated ingestion (5 days) of trivalent inorganic arsenic as a meta arsenite salt at 4 levels--125, 250, 500 or 1000 µg As. By 14 days, the percent of methylated forms of total forms ranged from 74-93 percent over the intake range. From this study, it would appear that the methylating capacity of the human subject was unaffected up to the 500-µg As level, at which point some decrease in methylated arsenic as a percentage of total was observed.

Yamauchi and Yamamura (1979) reported their results with 3 volunteer subjects who ingested an arsenic-rich extract (prepared from a particular kind of seaweed) containing 2.88 ppm total arsenic. Of the total amount, 86 percent was pentavalent inorganic arsenic, 7 percent was trivalent inorganic arsenic and 7 percent was dimethyl arsenic. These volunteers ingested the preparation as a single dose at a level of 10 µg/kg body weight, for total amounts of 650, 680, and 760 µg in the three subjects. By 48 hours, urine levels of total arsenic amounted to 36 percent of the dose. Of the excreted amount, dimethyl and monomethyl arsenic accounted for 47.4 and 25.3 percent, respectively.

REC 4976

4.2.1.2 Animal Studies--To date, biomethylation processes involving inorganic arsenic and experimental animals have been documented in dogs (Lakso and Peoples, 1975; Charbonneau et al., 1978a; Tam et al., 1979a), mice (Vahter, 1981), rabbits (Marafante et al., 1980; Bertolero et al., 1981), the bovine (Lakso and Peoples, 1975), and the rat (Odanaka et al., 1978). While the level of methylated forms of arsenic in most experimental species resembles that in man, approximately 80 percent, there is a greater amount of the dimethyl and a lesser amount of monomethyl arsenic.

Vahter (1981) has shown: (1) that the degree of biomethylation is dose-dependent, at least in mice, falling off in relative percentage with increasing level of dosing; (2) that this dependency probably accounts for the observation of dose-dependent retention in mice; and (3) methylation occurs to a greater extent with trivalent arsenic than with the pentavalent form, although retention, relative to total dose, is greater with the trivalent form.

Recently, Vahter et al. (1982) have reported that the Marmoset monkey, alone among all mammalian experimental species studied thus far, does not methylate inorganic arsenic.

4.2.2 In Vivo Oxidation/Reduction of Inorganic Arsenic In Mammalian Systems

From all available evidence, the biochemical mechanism of *in vivo* methylation of inorganic arsenic appears to be a reductive process, and sequential arsenic reduction and transmethylation steps in the pathway have been documented in microbial systems (Challenger, 1978; McBride et al., 1978). In mammalian systems, recent studies support a similar reduction/methylation sequence as observed in microflora.

Oxidation of trivalent inorganic arsenic to the pentavalent state has been claimed in dogs (Ginsberg, 1965), rats (Winkler, 1962), mice (Bencko et al., 1976), and humans (Mealey et al., 1959). An important factor in considering these studies critically is the fact that none of the reports considered

REC 4977

the presence of methylated arsenic, which may well have affected the analytical techniques employed and the analytical data obtained. Secondly, except for the Bencko et al. (1976) study, it is not clear that careful attention was paid to the oxidation state composition of dosing media or the effect of sample handling on oxidation state stability. In the Mealey et al. (1959) report, the analytical method involved acidification of urine with hydrochloric acid and extraction of the presumed "trivalent" arsenic into benzene, leaving the presumed "pentavalent" form in the aqueous phase. Since Mushak et al. (1977) have shown that methylarsonic and dimethylarsinic (cacodylic) acid behave like the pentavalent inorganic form in this extraction procedure, it is probable that the "arsenate" fraction was mainly methylated arsenic.

In the study of Crecelius (1977), where chemical speciation techniques were employed, it does not appear that ingestion of a sample containing mainly arsenite (trivalent form) is associated with excretion of pentavalent inorganic arsenic as the chief inorganic form. After 61 hours, 80 percent of the ingested amount appeared in urine, with the two inorganic forms each constituting minor fractions, mono- and dimethyl arsenic being the main forms.

Evidence for the in vivo reduction of pentavalent to trivalent inorganic arsenic has been claimed in several early reports. Lanz et al. (1950) reported some reductive conversion (10-15 percent) of arsenate to arsenite in rats, using as a method the precipitation from urine of arsenate as a mixed salt and analysis of the supernatant for arsenic (III). The accuracy of this method for partitioning trace arsenic levels is questionable. Furthermore, at the time of this study, the presence of methylated arsenic was not known. Therefore, it is not possible to accept the authors' conclusions since unprecipitated arsenic could also have consisted of methylated forms.

Ginsberg (1965) reported that 14 percent of urinary and 6 percent of plasma arsenic in dogs receiving intravenous infusion of arsenate was in the

REC 4978

form of trivalent arsenic. In this study, trivalent was presumably separated from pentavalent arsenic by chelation-extraction using ethyl xanthate. Based on current knowledge that methylated arsenic was present, it is difficult to accept the data without knowledge of the behavior of mono- and dimethyl arsenic in this analytical method.

In the recent report of Tam et al. (1979b) using dogs dosed with arsenate, a small amount of trivalent inorganic arsenic was detected in urine, using ion-exchange and thin-layer chromatographic techniques. These authors did not independently determine the extent of artifactive interconversion between the two forms using these techniques.

In a recent study by Vahter (1981), in which mice and rats were administered ^{74}As-labeled trivalent or pentavalent arsenic, the author reported that increases in retention with dose were less pronounced for the pentavalent form than for the trivalent form due to the fact that elimination of pentavalent arsenic seemed to be less dependent on methylation. Nevertheless, increases in retention with pentavalent arsenic were observed. Vahter discussed the possibility that the observed dose-related increase in retention after exposure to pentavalent arsenic may have been partly due to *in vivo* reduction of the pentavalent to trivalent form. Noting the work of McBride et al. (1978), whose studies indicated that certain microorganisms required reduction of pentavalent arsenic to trivalent before methylation could proceed, Vahter suggested that a similar mechanism might have been functioning in both the mice and rats. Evidence to support this hypothesis was presented in the author's observation that trivalent arsenic seemed more readily methylated than pentavalent.

Two recent studies, carefully designed for the specific purpose of addressing the oxidation/reduction issue for inorganic arsenic *in vivo*, have demonstrated that pentavalent arsenic (arsenate) undergoes reduction *in vivo* to

the trivalent state in the rat (Rowland and Davies, 1982) as well as in mice and rabbits (Vahter and Envall, 1983). In both of these investigations, the issue of artifactual interconversion of these two valence states was carefully addressed.

In the rat (Rowland and Davies, 1982), administration of moderate doses of pentavalent arsenic led to rapid reduction to the trivalent form. In mice and rabbits, the rate of conversion was somewhat slower than in the rat, but still occurred at a significant rate. Trivalent arsenic was measured in arsenate-dosed mice plasma by 1 hour post-dosing.

In a summary report, Peoples (1983) reported, without experimental detail, that the feeding of sawdust containing chromated copper arsenate did not result in measurable urinary levels of trivalent arsenic. Since these animals were exposed to copper as well as chromium (VI), in addition to arsenate, it is difficult to differentiate any influence these agents may have had on the results. Peoples (1983) also noted that renal perfusion of dogs with a very dilute solution of arsenate did not lead to renal reduction of pentavalent to trivalent arsenic. In the absence of experimental details, it is not possible to determine what steps were taken to avoid artifactual conversion of trivalent back to pentavalent arsenic, if the lower valence form was indeed formed.

Studies by Lerman and Clarkson (1983) of penta- and trivalent arsenic in the rat are fully consistent with a reductive methylation process. Using in vivo and in vitro techniques, the authors showed that the isolated rat liver hepatocyte readily methylates trivalent arsenic, while virtually no conversion occurs with the pentavalent form, although it is known that pentavalent arsenic is also extensively methylated in vivo. These data suggest that arsenate must first be converted to arsenite elsewhere in the organism.

Two recent studies using human subjects and identical chemical speciation techniques for arsenic appear to offer conflicting data regarding pentavalent arsenic reduction.

Crecelius (1977) noted that ingestion, by a single subject, of a sample of well water tested as having 200 µg As only in the pentavalent form resulted in a urinary level of trivalent arsenic which was virtually the same as background concentration before taking the arsenic sample. Although urine was collected for approximately 3 days, a significant amount of the total dose was unaccounted for, making it difficult to draw any conclusions from the study.

Yamauchi and Yamamura (1979) fed a preparation of seaweed containing 86 percent pentavalent arsenic and 7 percent each of trivalent inorganic and dimethyl arsenic to 3 human subjects as one dose at a total dosing of 650, 680, and 760 µg total arsenic. By 48 hours, based on their method which was the Braman et al. (1977) procedure, 36 percent of the original dose appeared in urine, with 75 percent present as methylated forms and about 17 percent present as trivalent arsenic (6.3 percent of the total amount ingested). The authors calculated that the amount of trivalent inorganic arsenic was greater than could be ascribed to the small amount ingested originally and they stated that the fraction represented *in vivo* reduction of pentavalent arsenic. Since the mean intake was approximately 700 µg, the 7 percent present as trivalent inorganic arsenic amounted to 49 µg, of which 36 percent or 18 µg would have been expected to appear in urine in some form. Using 75 percent methylation, only approximately 4-5 µg would have been present as the trivalent form, when in fact a mean value of 43.4 was found (range: 36-51 µg). Since the Braman et al. (1977) method is a reasonably accurate speciating technique and there is little evidence that samples were handled in a way to promote artifactive formation of trivalent arsenic after excretion, the data cannot be readily questioned on this basis.

REC 4981

4.2.3 Chemical Stability of Trivalent and Pentavalent Inorganic Arsenic to Oxidation-Reduction

In aerated water, trivalent inorganic arsenic will undergo extensive oxidation to the pentavalent form, particularly when present at low levels (Feldman, 1979).

The pH of aqueous solutions appears to be the major factor in the relative stability of either valency form. Buchet et al. (1980) found that trivalent arsenic in solutions at pH of 7.0 or 9.6 were oxidized to the extent of 70-90 percent within one week, compared to 25 percent conversion at pH 4.8.

Vahter and Norin (1980) also noted rapid oxidation of As (III) in aqueous solution at room temperature, while storage at 4°C showed little conversion.

Pentavalent inorganic arsenic, on the other hand, is stable at neutral or alkaline pH but undergoes reduction with decreasing pH (Durrant and Durrant, 1966).

In studies directed to *in vivo* transformations of inorganic arsenic, urine levels are commonly used and some data exist regarding valency stability of arsenic in urine.

Buchet et al. (1980) found that trivalent inorganic arsenic in urine at pH 7.0 or less was relatively stable, with only 10 percent oxidation occurring by 7 days. At pH 9.5, 50 percent of oxidation occurred within one day.

4.3 DISTRIBUTION OF ARSENIC IN MAN AND ANIMALS

Blood is the main vehicle for transport of arsenicals from absorption sites to the tissues, with the hemokinetic character of arsenic being dependent on the animal species studied.

It is readily apparent from the literature that the rat constitutes an anomalous model for studies of the fate of inorganic arsenicals *in vivo* and this includes the clearance behavior of rat blood-borne arsenic (Hunter et al., 1942; Ducoff et al., 1948; Lanz et al., 1950; Ariyoshi and Ikeda, 1974;

Klaassen, 1974; Tsutsumi and Kato, 1975; Dutkiewicz, 1977). In the case of the rat, arsenic in blood is only slowly cleared following exposure, with about 80 percent of the total blood arsenic content localized in the erythrocyte. The half-times of blood clearance for inorganic arsenic in the rat (trivalent or pentavalent) is on the order of 60 to 90 days (Lanz et al., 1950; Ariyoshi and Ikeda, 1974).

Arsenic in the blood of other species--man (Ducoff et al., 1948; Mealey et al., 1959; Tam et al., 1979b), mice (Lanz et al., 1950; Crema, 1955), rabbit (Hunter et al., 1942; Ducoff, 1948; Klaassen, 1974), dog (Lanz et al., 1950; Hunter et al., 1942), and primates (Hunter et al., 1942; Klaassen, 1974)--whether given as the pentavalent form or as the trivalent form, is rapidly cleared. Normal blood arsenic values for individuals in the U.S. and Europe are in the range of 1-5 μg total arsenic/liter whole blood (Bergstromn and Wester, 1969; Damsgaard et al., 1973; Kagey et al., 1977; and Valentine et al., 1979). According to Kagey et al. (1977), cigarette smokers showed mean blood arsenic levels approximately 50 percent higher than nonsmokers. It is reasonable to assume that human background blood levels reflect mainly dietary arsenic, much of which would likely be in various organo-arsenical forms that are extensively absorbed and rapidly cleared.

Clearance of arsenic in dog and man was found to fit a three-compartment model by Charbonneau et al. (1978a) and Tam et al. (1979b) with half-times of 1, 5, and 35 hours, respectively. When contrasted with the work of Tam et al. (1978), which reported the time-dependent in vivo methylation of arsenic and excretion in dogs, the various components presumably relate to initial excretion of inorganic arsenic, followed by clearance of dimethyl arsenic.

The tissue partitioning of arsenic in man has been studied using both autopsy and dosing data. Kadowaki (1960) found (measurements in ppm, wet

REC 4983

weight) that nails (0.89), hair (0.18), bone (0.07-0.12), teeth (0.08) and skin (0.06) generally housed the highest absolute amounts of arsenic, while heart, kidney, liver and lung contained somewhat lower levels (0.04-0.05). Brain tissue (0.03) had an arsenic level only slightly lower than other soft tissues. Liebscher and Smith (1968), analyzing tissue samples (ppm dry weight) from non-exposed sources in Scotland, observed lung to have the highest levels (0.09), with liver and kidney levels (0.03) not materially different from other soft tissue. Like the Kadowaki study, hair (0.46), nails (0.28) and skin (0.08) had the highest absolute values; however, bone and teeth (0.05) did not contain levels appreciably different from some other tissues (pectoral muscles, 0.06; ovary, 0.05; and pancreas, 0.05).

In addition to the autopsy studies by Kadowaki (1960) and Liebscher and Smith (1968), Larsen et al. (1979) have recently reported on a detailed study of the topographical distribution of arsenic in normal human brain tissue. Arsenic is distributed throughout all brain regions, with white matter showing higher levels than gray matter.

In looking at tissue distribution of arsenic in experimental animals, exposure of various species to either tri -or pentavalent arsenic leads to the initial accumulation of the element in liver, kidney, lung, spleen, aorta, and skin (Hunter et al., 1942; Ducoff et al., 1948; Lanz et al., 1950; Peoples, 1964; Ariyoshi and Ikeda, 1974; Cikrt and Bencko, 1974; Klaassen, 1974; Tsutsumi and Kato, 1975; Urakabo et al., 1975; Dutkiewicz, 1977; Sabbioni et al., 1979; Marafante et al., 1980). With the exception of the rat, a species in which metabolism of arsenic is only a very limited model for study of this element (vide supra), clearance from soft tissue is rather rapid except for the skin, where the high sulfhydryl group content may promote tight trivalent arsenical binding. As also seen with human tissue, arsenic is apparently lodged in

brain of experimental animals exposed to arsenic, with slow clearance reported (Crema, 1955).

Recently, Vahter and Norin (1980) compared the dependency of dose and valency form of inorganic arsenic on tissue compartmentalization of arsenic in mice. Unlike most of the earlier reports, these workers used chemical speciation techniques (ion-exchange chromatography) to verify that their dosing media contained purely tri- or pentavalent arsenic. Using single oral dosing at 0.4 or 4.0 mg/kg levels and radioisotopic tri- or pentavalent arsenic, levels of arsenic in kidney, liver, bile, brain, skeleton, skin and blood were always greater (2-10 fold) in terms of percent total dose for the trivalent form than for the pentavalent form, and most pronounced at the higher dose. These workers ascribe much of this difference to relative methylating efficiency as a function of exposure level and valence form.

In a similar study using Golden Hamsters exposed to injected tri- or pentavalent radioisotopic arsenic, with care taken to assure valence purity, Ckirt et al. (1980) found that levels of arsenic in liver, kidneys, gut wall and bile were always greater, 2 to 25-fold, with trivalent arsenic exposure.

4.4 ARSENIC ACCUMULATION

The long-held view of arsenic as an element that accumulates in the body was mainly based on the behavior of arsenic in the rat, an animal model which in retrospect was the least helpful in understanding the fate of the toxicant *in vivo* for other mammalian species and man.

Based on current arsenic elimination data for all mammalian species studied other than the rat (*vide supra*), one concludes that marked long-term accumulation of arsenic generally does not occur in physiologically vital components of the body. This is in contrast to, say, long-term lead accumulation in bone or cadmium accumulation in renal cortex. Autopsy tissue data for

REC 4985

human subjects of different ages are not conclusive regarding possible long-term tissue accumulation. Kadowaki (1960) did observe higher mean levels of arsenic in skin and kidney samples of subjects approximately 50 years of age versus infant values, but dietary histories of the subjects were not available to allow for differentiation of increases in arsenic levels due to current versus past exposures for the older subjects. Deposition in hair is really excretory in nature, not accumulative.

Brune et al. (1980) have reported that lung tissue from retired smelter workers from the Rönnskär smelter in Sweden, on autopsy, had median values for arsenic which were about 8 times higher than that for a control group. Kidney and liver values, however, were not significantly different between smelter worker groups and controls. Arsenic accumulation in the lung of smelter workers even after several years of retirement and removal from workplace exposure (interval of 2-19 years) suggests that a very insoluble form of arsenic exists in smelter ambient air and is inhaled by these workers.

Lindh et al. (1980) measured the arsenic in autopsy femur samples of 7 occupationally exposed workers. The time between retirement and death ranged from 0-21 years. A control sampling from 5 autopsy cases was included. Using both neutron activation analysis and proton-induced X-ray emission (PIXIE) techniques, no clear evidence of significant arsenic accumulation in bone was seen. The scatter of levels was wide in the worker group, 0.006-0.21 ppm, with a median of 0.014 ppm, versus a range of 0.005-0.007 ppm in the control samples.

4.5 ARSENIC EXCRETION IN MAN AND ANIMALS

Renal clearance appears to be the major route of excretion of absorbed arsenic in man and animals, biliary transport of the element leading to enteric reabsorption with little carriage in feces.

REC 4986

Recent data for normal or background levels of arsenic in urine of human subjects in the U.S. reveal values of less than 20 µg/liter (20 ppb). If seafood has been consumed, such values can rise considerably to levels of 1,000 µg/liter or higher (Westöö and Rydälv, 1972; Pinto, 1976).

In a study designed to assess the utility of urine arsenic measurement in occupational exposure settings, Mappes (1977) reported excretion data for both single and multiple daily dosing for a human subject ingesting an arsenite solution. By 3 hours, renal excretion was maximal, with about one-quarter of the single dose appearing in the urine by day 1 post-exposure. With successive arsenite ingestion (0.8 mg As), daily urinary clearance after 5 days was about two-thirds of daily intake.

Buchet et al. (1981b), in their study of human subjects ingesting arsenite in amounts ranging from 125-1000 µg/day for 5 days, calculated a steady state occurring within 5 days. With steady state, 60 percent of daily intake is excreted daily. This figure is in good agreement with that of Mappes (1977) cited above.

Crecelius (1977) noted that following ingestion of arsenic in wine [50 µg As (III), 13 µg As (V)], approximately 80 percent of the dose was excreted within 61 hours. Oral ingestion of arsenic (V) in well water (200 µg), however, led to about 50 percent urinary excretion by 3 days post-ingestion. Mealey et al. (1959) measured urine arsenic in patients given trivalent arsenic by intravenous administration, with approximately 60 percent of the dose amount appearing in the urine within 24 hours. Hunter et al. (1942) noted that a group of human subjects given arsenic via parenteral administration exhibited considerable variance in the urinary clearance of arsenic, ranging from 30 to 80 percent after 4 to 5 days.

As might be predicted from the in vivo behavior of arsenicals in the rat, urinary excretion of arsenic in this species is very slow (due to erythrocyte

REC 4987

retention) on the order of two to five percent of the arsenic intake by several days post-dosing (Coulson et al., 1935; Ariyoshi and Ikeda, 1974). Urakabo et al. (1975) calculated a half-time of 84 days for arsenic in the rat.

Slow clearance of arsenic from the rat gave rise to the widely-held assumption for many years that arsenic was one of the elements that accumulated in the body. Other species excrete arsenic rapidly. Mice, rabbits, swine, dogs, and monkeys clear the majority of injected trivalent arsenic within 24 hours, with excretion usually being $\geq$70 percent within that time period (Ducoff et al., 1948; Crema, 1955; Munro et al., 1974; Lakso and Peoples, 1975; Tam et al., 1978; Charbonneau et al., 1978a). Other studies also indicate rapid urinary clearance of arsenic given in the pentavalent form to species other than the rat (DuPont et al., 1942; Ginsberg and Lotspeich, 1963; Peoples, 1964; Lakso and Peoples, 1975).

Several studies have compared the relative rates of elimination of radiolabeled (^{74}As) trivalent and pentavalent inorganic arsenic (Vahter and Norin, 1980; Vahter, 1981) where precautions were taken to assure the purity of the respective dosing solutions as to valency state. Whole-body retention of trivalent inorganic arsenic in mice was 2-3 times greater than that of arsenate while retention times for both forms were dose-dependent, increasing with increasing exposure. In these studies, the animals received single oral doses of either form at levels of 0.04 to 4.0 mg As/kg. Differences in elimination rates appeared to relate to the relative degree of methylation of inorganic arsenic to the rapidly excreted methylated forms, chiefly dimethyl arsenic. Furthermore, differences in excretion rates were dose-dependent. At 0.04 mg As/kg, there was no difference between tri- and pentavalent arsenic elimination (Vahter, 1981).

Biliary transport of arsenic has been reported for a number of species. Bile-excreted arsenic is reabsorbed. Cikrt and Bencko (1974) noted that the

rat had a higher biliary excretion rate for the trivalent than for the pentavalent form (approximately 10:1). Klaassen (1974) noted that the biliary excretion rate was much greater for the rat than for either the rabbit or the dog.

Cikrt et al. (1980) monitored biliary exretion in the Golden Hamster using penta- or trivalent inorganic arsenic. Significant differences in biliary excretion rates and cumulative excretion were seen between the two forms, being much greater for the trivalent form. However, fecal and urine arsenic content were greater with pentavalent arsenic administration. Biliary transport data for man are not available.

Deposition of arsenic in such organs as hair and nails can be considered an excretory mechanism for arsenic. Although hair analysis has had a long history in the chemical and forensic arsenic literature, for reasons of both analytical convenience and the possibility of establishing an exposure history from sectional analysis, many questions remain unanswered. The relationship between arsenic deposition in hair and various exposure parameters has not been well defined on a quantitative basis, nor are the physiological mechanisms well understood. The chemical nature of hair arsenic is also largely unknown.

REC 4989

5. ARSENIC TOXICOLOGY

The acute and chronic toxicity of arsenic will largely depend on the chemical form and physical state of the compound involved. Inorganic trivalent arsenic is generally regarded as being more acutely toxic than inorganic pentavalent arsenic, which in turn is more toxic than methylated forms of arsenic (NAS, 1977; Pershagen and Vahter, 1979; WHO, 1981). The previously noted (Chapter 3) "fish arsenic" is regarded as nontoxic. It is thus necessary to always specify, if possible, arsenic compounds when discussing effects and constructing dose-effect and dose-response relationships. In addition, factors like particle size and solubility must be taken into account. Trivalent compounds with low solubility, e.g., arsenic sulfide, will have low oral toxicity but may be retained in the lung (Pershagen et al., 1982).

The following chapter discusses the non-mutagenic/non-carcinogenic effects of exposure to inorganic arsenic. Because of the large volume of information available regarding the mutagenic and carcinogenic effects of inorganic arsenic, these topics have been discussed in the following chapters.

5.1 ACUTE TOXICITY OF ARSENIC IN MAN AND ANIMALS

In animal experiments the oral LD_{50} has been found to vary from 15 to 293 mg/kg body weight in rats and from 10-150 mg/kg in other animals (Dieke and Richter, 1946; Harrison et al., 1958). The lower values refer to experiments with soluble arsenic compounds. Franke and Moxon (1936) found that the LD_{75} 48 hours after i.p. administration was 4-5 mg As/kg body weight for sodium arsenite and 14-18 mg/kg for sodium arsenate.

Acute effects seen in animals after oral exposure are similar to effects seen in human beings and include gastroenteritis, diarrhea and cardiovascular effects (Nelson et al., 1971; Selby et al., 1977).

REC 4991

A large number of acute arsenic poisonings are described in the literature, but few data exist on actual doses and type of compound. Vallee et al. (1960) estimated the lethal dose to be on the order of 70 to 180 mg for arsenic trioxide. Acute symptoms are due to severe gastrointestinal damage, resulting in vomiting and diarrhea and general vascular injury which may lead to shock, coma or even death. Other acute symptoms are muscular cramps, facial edema, and cardiovascular reactions (Holland, 1904; Done and Peart, 1971).

Acute symptoms have also been seen after airborne exposure to high concentrations of arsenic trioxide, causing severe irritation of nasal mucosa, larynx, and bronchi (Holmqvist, 1951; Pinto and McGill, 1953).

Reversible effects on the hematopoietic and cardiovascular systems and peripheral nervous disturbances with slow recovery have also been noted (Ohta, 1970; Heyman et al., 1956; Jenkins, 1966; Nagamatsu and Igata, 1975: O'Shaughnessy and Kraft, 1976; Hamamoto, 1955; Chhuttani et al., 1967; LeQuesne and McLeod, 1977).

Over the years, a number of large-scale poisonings have occurred due to contamination of beer (Kelynack et al., 1900), soy sauce (Mizuta et al., 1956), dried infant milk (Tokanehara et al., 1956), and well water (Yoshikawa et al., 1960). These episodes mainly caused subacute and chronic symptoms and will be discussed in the following sections.

5.2 CHRONIC TOXICITY OF ARSENIC IN MAN AND ANIMALS

5.2.1 Neurotoxic Effects

Arsenic neurotoxicity, including both peripheral and central nervous system injury, has long been recognized as being associated with acute, subacute, and chronic exposures to relatively high levels of inorganic arsenic. These have been well characterized as to their major pathophysiological features, clinical course, sequelae and associated histopathology.

REC 4992

Reynolds (1901) provided one of the earliest detailed descriptions of arsenic-induced neurotoxic effects in his report on the clinical assessment of more than 500 patients who had consumed arsenic-contaminated beer.

Neurological involvement started with sensory changes, e.g., paresthesias, hyperesthesias, and neuralgias, accompanied by considerable muscle tenderness. Varying degrees of motor weakness, progressing from distal to proximal muscle groups, also occurred and culminated at times in paralysis of affected muscle groups or extremities. Certain indications of central nervous system (CNS) damage, e.g., loss of memory and general mental confusion, were also observed but were discounted by Reynolds (1901) as being less likely due to arsenic than chronic alcoholism or concurrent excessive selenium intake.

Peripheral nervous system (PNS) effects similar to those described by Reynolds (1901) have since been observed in numerous other cases of acute, subacute, and chronic arsenic exposures (Silver and Wainman, 1952; Mizuta et al., 1956; Heyman et al., 1956; Jenkins, 1966; Hara et al., 1968; Chhuttani et al., 1967; Ishinishi et al., 1973; Nakamura et al., 1973; Nagamatsu and Igata, 1975; O'Shaughnessy and Kraft, 1976; Frank, 1976; Garb and Hine, 1977; LeQuesne and McLeod, 1977) and are now recognized as classic clinical symptoms of arsenic poisoning. Such symptoms include peripheral sensory effects characterized by the appearance of numbness, tingling, or "pins and needles" sensations in the hands and feet, as well as decreases in touch, pain, and temperature sensations in a symmetrical distribution. These symptoms are often variously accompanied by burning sensations, sharp or shooting pains, and marked muscle tenderness in the extremities. Peripheral neuritis symptoms originate distally and, over the course of a few weeks, often progressively become more widespread in both lower and upper extremities, usually appearing first in the feet and later in the hands.

REC 4993

Collectively, the above components of the classical clinical syndrome associated with excessive arsenic exposure are highly indicative of progressive peripheral polyneuropathy, involving both sensory and motor nerves, and most intensively affecting long-axon neurons. In addition, biopsy and autopsy studies have provided histopathological evidence verifying peripheral nerve damage, especially Wallerian degeneration of long-axon myelinated nerve fibers in cases of human arsenic exposure where frank neurological signs and symptoms were manifested (Heyman et al., 1956; Jenkins, 1966; Chhuttani et al., 1967; Ohta, 1970; LeQuesne and McLeod, 1977).

The pattern of development of peripheral neuropathic effects is closely associated with the type of exposure. Acute exposure to a single high dose of arsenic can produce a fairly rapid onset of both motor dysfunctions and paresthesias. In one report, the onset was within 10 days (LeQuesne and McLeod, 1977) after exposure. Slow, incomplete recovery is usually seen in these cases.

Under more chronic occupational exposure conditions to lower levels of arsenic compounds, the development of neuropathy symptoms can be more gradual and insidious, and not only bilateral, but unilateral polyneuropathies without motor paralysis have been reported (Ishinishi et al., 1973; Nakamura et al., 1973). Again, the time course for recovery from the neuropathies, once induced, tends to be slow and on the order of years. Gradual onsets of peripheral neuropathies and slow recoveries have also been reported with subacute or chronic exposures to arsenic via ingestion of contaminated soy sauce (Mizuta et al., 1956) or anti-asthmatic herbal preparations containing arsenic trioxide or arsenic sulfide (Tay and Seah, 1975).

It is difficult to determine the levels of arsenic associated with the induction of peripheral neuropathies. For subacute or chronic poisoning situations, information has been provided in only a few studies by which

effective exposure parameters can be estimated. Mizuta et al. (1956), for example, reported that peripheral neuropathies occurred in 20 percent of 220 patients of all age groups poisoned by ingestion of arsenic-contaminated soy sauce, with approximately 3 mg arsenic (likely as calcium arsenate) estimated to be ingested daily for 2-3 weeks, resulting in total effective doses up to approximately 60 mg. Also, Tay and Seah (1975) reported polyneuropathies in approximately 50 percent of 74 patients poisoned by daily ingestion of 3.3 or 10.3 mg/day of arsenic trioxide or arsenic sulfide in anti-asthmatic medicinal pills.

More subtle peripheral neurotoxic effects arising from chronic exposure to lower levels of arsenic in occupational or non-occupational groups are more difficult to establish, particularly as indexed by abnormal electromyographic or nerve conduction velocity findings. In one such study, Landau et al. (1977) reported relationships between length and intensity of occupational arsenic exposure (mainly to arsenic trioxide via inhalation) of smelter workers and alterations in peripheral nerve functioning. The manner in which the data were reported, however, precludes precise characterization of dose-effect/dose-response relationships.

In their study of arsenic in the drinking water of residents from Millard County, Utah, Southwick et al. (1981) conducted neurological examinations on all study participants 47 years of age and younger (see Section 7.1.2.2 for discussion of the total study population). Neurological examination revealed that conduction velocities for nerves studied (ulnar motor, median motor, ulnar sensory, median sensory, peroneal, sural) did not vary significantly with respect to age or community. In those individuals that exhibited below-normal conduction velocities, a slightly greater proportion was seen in exposed participants--12 percent of 67 controls versus 16 percent of 83 exposed. The

REC 4995

sural nerve seemed most often to be affected even after adjusting by a correction factor of 1.8 m/s/degree in individuals who had nerve temperatures below 30° C. (Velocities below 37 m/s at 30° C or above were considered abnormal). Slowing of sural nerve conduction was reported equally in exposed and control participants. Nerve conduction velocities regressed against annual arsenic dose and the log of the dose showed no significant associations.

Similar difficulties have been encountered in attempts to characterize dose-effect/dose-response relationships for arsenic-induced peripheral nerve functional deficits (as demonstrated by electromyographic recording techniques) in studies of two other populations chronically exposed to arsenic: (1) a population of Yellowknife Canadian Indians exposed via occupational contact with arsenic in a gold mining and smelting facility, or, in the case of the families of such workers, via arsenic emissions from the facility into the ambient environment (Canadian Public Health Assoc., 1978); and (2) a Nova Scotia population exposed, via geological arsenic contamination of wells, to levels >0.05 ppm arsenic in drinking water (Hindmarsh et al., 1977).

Several of the clinical reports discussed above not only document peripheral nerve damage but also contain descriptions of arsenic-induced central nervous system (CNS) disturbances or encephalopathy effects ranging in severity from memory losses and general mental confusion to convulsions, stupor, coma and even death (Heyman et al., 1956; Jenkins, 1966: Frank, 1976; Nagamatsu and Igata, 1975; O'Shaughnessy and Kraft, 1976; Garb and Hine, 1977). The onset and courses of such CNS effects have not been well defined, but they appear to closely parallel the development of peripheral neuropathy effects. Cases of prolonged encephalopathy indexed by electroencephalogram (EEG) recordings of abnormal brain wave patterns up to a year after cessation of exposure have been reported (Freeman and Couch, 1978; Bental et al., 1961). Such effects

REC 4996

appear to be a much less constant feature of arsenic-induced neurotoxic effects in adults than are peripheral neuropathies.

Certain studies suggest, in contrast, that children may be more susceptible to arsenic-induced CNS damage. For example, severe CNS deficits have been observed in children exposed for several months as babies to arsenic-contaminated powdered milk formulas in Morinaga, Japan (Hamamoto, 1955; Okamura et al., 1956; Yamashita et al., 1972; Masahiki and Hideyasu, 1973; Japanese Pediatric Society, 1973). Follow-up studies on the children exposed to arsenic as infants have revealed: (1) increased incidence of severe hearing loss (>30 dB) in 18 percent of 415 children examined compared to less than 1 percent incidence of hearing loss in corresponding age-group children; (2) increased incidence of abnormal electroencephalographic (EEG) brain wave patterns in 14 percent of the exposed children, more than double the expected rate for comparable normal pediatric populations; and (3) observations of increased incidences of persisting mental retardation, epilepsy, and other indications of severe brain damage.

In another study (Bencko and Syman, 1977), hearing losses in children were reported to be associated with arsenic exposure derived from emissions from a nearby coal-fired power plant combusting high-arsenic-content coal. Both air and bone conduction hearing losses were observed, suggesting inner ear damage. Failure to find analogous hearing losses in children exposed to atmospheric arsenic emitted from a copper smelter in the United States (Milham, 1977) has raised questions regarding arsenic-induced damage to the inner ear in children.

Very few animal toxicology studies have focused on investigation of neurotoxic effects of arsenic on the CNS. Rozenshtein (1970), for example, reported evidence of CNS functional deficits, as indexed by altered conditioned reflexes, as well as histopathologic evidence of CNS structural damage,

REC 4997

e.g,. pericellular edema and neuronal cytolysis in the brain, in rats exposed for three months to an arsenic trioxide aerosol resulting in an arsenic concentration of 46 $\mu g/m^3$. Similar but less severe effects were also obtained with exposure of other rats to a 3.7 $\mu g\ As/m^3$ aerosol. CNS deficits, indexed by impaired avoidance conditioning in the absence of demonstrable histopathologic changes in brain tissue, were also reported (Osato, 1977) for suckling rats administered 2 or 10 mg arsenic trioxide via stomach intubation over a 40-day period.

5.2.2 Cardiovascular Effects

A specific cardiovascular effect is "Blackfoot" disease, a peripheral vascular disease leading to gangrene of the toes, feet, legs and fingers. This disease has been reported in an area of Taiwan, where exposure to inorganic arsenic via drinking water is known to occur. In their skin cancer study of the Taiwanese population (see Section 7.1.2.2 for complete discussion of the total study population), Tseng and co-workers (1968, 1977) also investigated the occurrence of Blackfoot disease. The total prevalence of Blackfoot disease was lower than the prevalence of skin cancer, but higher in the younger age groups (Table 5-1). The overall prevalence rate for Blackfoot disease was 0.9-1.2 percent for males and 0.7 percent for females after age 39.

A group of 1108 patients with Blackfoot disease from the endemic area was identified during 1958 to 1975 (Tseng, 1977). There were 669 males and 439 females. Patients were included in the series if they had: 1) objective signs of ischemia, and 2) subjective symptoms of ischemia. Follow-up was attempted using a variety of methods to trace the subjects. At the end of follow-up, 528 patients had died, a fatality rate of 47.7 percent.

A history of typical ischemic symptoms such as numbness was used to estimate the date of onset of Blackfoot disease. Duration of intake of arsenic

REC 4998

TABLE 5-1. PREVALENCE OF BLACKFOOT DISEASE (per 1000) BY AGE AND ARSENIC EXPOSURE (ppm)

Arsenic content of drinking water (ppm)	Age 20-39	40-59	>60
<0.3	4.5	10.5	20.3
0.3 - 0.6	13.2	32.0	32.2
>0.6	14.2	46.9	61.4

Source: Adapted from Tseng, 1977.

water at the time of onset represents the period of time between first use of such intake and the time of onset of the disease. Duration of intake of arsenical water represents the duration of time during which the patient started drinking artesian well water up to the time of survey or up to the time of change of source of drinking water. For native patients, the duration is estimated to be equivalent to their ages, but for patients who came from areas without artesian wells the duration was counted as starting from the year of arrival.

A classification system of percentage of permanent disability was created and each patient was assigned to the appropriate category.

It was determined (determination not specified) that all patients with Blackfoot disease had consumed artesian well water before the onset of disease, and none of the residents of the endemic area who had consumed surface water or water from shallow wells developed Blackfoot disease.

In some parts of the arsenic endemic area, a new source of drinking water was provided in 1956. The incidence of Blackfoot disease was therefore examined in year of onset periods (1955 and before, 1956-1965, and 1966-1975). There were no cases of Blackfoot disease among area residents who were born after

REC 4999

the tap water supply was instituted in 1956. Furthermore, as the duration of intake of arsenical water increased (across all 3 exposure levels) the incidence of Blackfoot disease increased. In addition, the degree of permanent disability of patients was significantly correlated with duration of intake of arsenical water at time of onset of the disease.

There are also data indicating that other substances may be involved in the etiology of Blackfoot disease. Lu et al. (1977, 1978) found fluorescent compounds in water samples from an area with endemic Blackfoot disease. Of the compounds discovered, tentative identifications of D-lysergic acid and/or ergometrine, ergotamine and calciferol have been made (Irgolic, 1982). These substances may have been at least contributing factors to this disease, since some of them, or similar compounds, are known vasoactive agents.

Vascular changes were also noted among persons living in Antofagasta, Chile (see Section 7.1.2.2 for discussion of study groups). Raynauds syndrome and acrocyanosis were reported to occur in 30 and 27 percent, respectively, in a group of 100 persons studied by Borgono and Greiber (1972).

Raynauds syndrome has also been reported to occur among German vintners. Butzengeiger (1940) studied 180 persons and found that 22.8 percent had evidence of vascular disorders of the extremities. Butzengeiger (1949) studied 192 vinegrowers and found that 28.7 percent had ECG changes. There was, however, no control group.

In epidemiological studies of smelters (see Section 7.1.2.1 for complete discussion of studies), peripheral vascular disease has generally not been found. However, mortality studies indicate that there might be some cardiovascular effects, although study results have been conflicting. Thus, Axelson et al. (1978) found a higher mortality in cardiovascular disease, but analysis of the data indicate that if such an effect occurred it probably needed higher

exposure levels than those causing lung cancer. A study by Ott et al. (1974) indicated, on the other hand, that the arsenic-exposed workers had less mortality than expected.

In studies on workers at the Anaconda Copper Smelter in Montana, both Lee and Fraumeni (1969) and Lee-Feldstein (1983) reported that cardiovascular mortality was significantly elevated in the workers--SMR=118 and SMR=129, respectively ($p < 0.01$)--but not related to duration of arsenic exposure. In a study cohort of these same workers, Higgins et al. (1982) reported that cardiovascular mortality increased with increasing ceiling arsenic exposure among smokers, but not among nonsmokers--at 500-4999 ug/m^3, SMR=165 for smokers ($p < 0.01$), SMR=100 for nonsmokers; at >5000 ug/m^3, SMR=182 for smokers ($p < 0.01$), SMR=166 for nonsmokers. In contrast, Lubin et al. (1981) did not find an excess in cardiovascular disease mortality (SMR=108) in their study cohort of workers from the same smelter. The cohorts in all four of these studies were slightly different.

The conflicting findings of these reports suggest that the relationship between arsenic exposure and cardiovascular disease is quite complex and in need of additional research.

5.2.3 Teratogenesis and Developmental Effects

5.2.3.1 Animal Studies--In a recent review of the toxicological effects of prenatal exposure to arsenic, Hood (1983) discussed the number of variables that influence effects on offspring of maternal arsenic exposure during pregnancy. Included in the variables are the forms of arsenic administered, species and individual differences in susceptibility, dose level and exposure route, peak level attained in the conceptus, maternal metabolism and excretion, and timing of exposure during gestation; the length of the list being indicative of the complex nature of arsenic toxicity induced during prenatal exposure.

Teratogenic effects of arsenic compounds, at least at relatively high exposure levels, have been demonstrated in a number of animal species. Studies by Ridgeway and Karnofsky (1952), for example, demonstrated no gross abnormalities in chick embryos following injection of sodium arsenate into embryonate eggs at 0.20 mg As/egg on day 4 of gestation. Retardation in body weight gain and feather growth, as well as certain other abnormalities, were, however, observed in chickens hatched from arsenic-treated eggs.

Later experimental studies on mammalian species have demonstrated teratogenic effects of arsenic in hamsters, rats and mice.

Ferm and Carpenter (1968) produced malformations in 15-day hamster fetuses via intravenous (I.V.) injections of sodium arsenate into pregnant dams on day 8 of gestation at dose levels of 15, 17.5 or 20 mg/kg body weight. The variety of malformations obtained with prenatal arsenic exposure of hamsters--including exencephaly, encephaloceles, skeletal defects and genitourinary system defects and the effects of other related experimental manipulations, e.g., protective effects of co-treatment with selenium--were reviewed in a later report by Ferm (1977).

Willhite (1981) injected arsenate (20 mg/kg) or arsenite (2-10 mg/kg) into pregnant golden hamsters at day 8 of gestation and observed axial skeletal disorders in offspring--cranioschisis aperta with exencephaly and cranioschisis occulta--while 10 hours after dosing, embryos showed a delay in neural fold elevation and neural tube closure with arsenate exposure.

Teratogenic and embryotoxic effects of prenatal arsenic exposure of mice have also been reported (Hood and Bishop, 1972; Hood and Pike, 1972; Hood et al., 1977). Increased fetal resorption, decreased fetal weights and various malformations (such as exencephaly, micrognathia, agnathia, exophthalmos, anophthalmia, hydroencephaly, cleft lip, ectrodactyly, micromelia, fused vertebrae and forked ribs) were observed following single intraperitoneal (I.P.)

injections of sodium arsenate (45 mg As/kg body weight) in Swiss-Webster mice (the single injection occurring on one day between days 6 and 12 of gestation) (Hood and Bishop, 1972). Co-treatment with 2,3-dimercaptopropanol (BAL) reduced arsenic-associated malformations (Hood and Pike, 1972; Hood et al., 1977).

Many similar embryotoxic and fetal teratogenic effects, along with other effects (renal and gonadal agenesis), have also been observed following I.P. injections of sodium arsenate in pregnant rats (Beaudoin, 1974; Burk and Beaudoin, 1977), again at relatively high dose levels (e.g., 30 mg/kg body weight).

Compared to pentavalent arsenic, trivalent arsenic as the arsenite salt appears to be proportionally more embryotoxic. For example, the fetotoxic effects seen by Baxley et al. (1981) in mice exposed to 40-45 mg/kg As as arsenite were comparable to effects observed by Hood et al. (1978), in which a much higher level of arsenate (120 mg/kg As) was administered.

The above studies are suggestive of significant effects on reproduction and development of mammalian species being induced by prenatal arsenic exposure. However, only very minimal effects, or none at all on fetal development, have been observed in studies on chronic oral exposure of pregnant rat or mice dams to relatively low levels of arsenic via drinking water (Schroeder and Mitchener, 1971). Nadeyenko et al. (1978) reported that intubation of rats with arsenic solution at a dose level of 0.0025 mg/kg for a period of 7 months, including pregnancy, produced no significant embryotoxic effects and only very infrequent slight expansion of ventricles of the cerebrum, renal pelvises and urinary bladder. Also, Hood et al. (1977) reported that very high single oral doses of arsenate solutions (120 mg/kg) to pregnant mice were necessary to cause prenatal fetal toxicity, while multiple doses of 60 mg/kg on 3 days had little effect. This report suggests that the higher doses required with oral versus

parenteral exposure relate to the more rapid methylation to less toxic forms of oral arsenic owing to its initial passage through the liver, where methylation may occur. Similar results were obtained with mice in a later study (Hood et al., 1978).

Given the presence of biomethylation in mammalian species exposed to arsenic, the question arises as to whether fetotoxicity resides only in the untransformed inorganic arsenic or is due to some of the metabolites formed in vivo. Hood et al. (1982a) have demonstrated that methylated metabolites cross the placental barrier in mice given arsenite and that these methylated forms are actually the major form of arsenic in fetuses by 12 hours post-dosing.

Recently, three groups of investigators have reported their results on the comparative teratogenicity of methylated arsenicals, administered as such, to different species.

Willhite (1981) found no teratogenic response when pregnant golden hamsters were given methylated arsenic at single doses up to a level of 100 mg As/kg. Rogers et al. (1981) administered dimethylarsenic to pregnant CD rats and CD-1 mice on days 7-16 of gestation via oral gavage. Dosing was from 7.5 to 60 mg/kg/day for rats and 200 to 600 mg/kg/day for mice. Fetal and maternal toxicity was observed in both species. A teratogenic response in mice was confined to cleft palate in the 400- and 600-mg regimens. In the rat, there was a dose-dependent incidence of irregular palatine rugae.

Hood et al. (1982b) exposed pregnant golden hamsters to either dimethyl- or monomethyl arsenic at dosages of either 900 or 1000 mg/kg of the former agent and 500 mg/kg of the latter. The levels of dimethylarsenic administered were seen to be acutely toxic to dams and were associated with significant resorption rates and malformations in survivors. In the case of the monomethyl arsenic, the overall teratogenic potency was observed to be lower.

Harrison et al. (1980) exposed CD-1 mice to monomethyl arsenic by injection (1500 mg/kg salt, i.p.) on one of gestation days 8, 9, or 10. Treatment at days 9 and 10 of gestation resulted in increased resorption and mortality rates of 37 and 43 percent, respectively, while the day 8 group showed no such effects. Skeletal malformations were also seen at the 9 and 10 gestation day exposures. While details for dimethylarsenic were not provided, it was noted that such treatment also resulted in fetotoxicity and teratogenicity, with exencephaly the primary gross malformation observed.

The available data, in summary, indicate that while the methylated arsenicals are less teratogenic and fetotoxic on an equivalent dose basis, the nature of the effects is comparable. There also appears to be a species sensitivity difference for arsenical teratogenicity and fetotoxicity, the rat being more sensitive than mice or golden hamsters.

Animal studies on the effects of early postnatal administration of arsenic compounds on growth and development have generally failed to yield any significant positive results at sublethal arsenic dose levels. Tamura (1978), for example, reported no effects on the growth and development of postnatal rats fed arsenic trioxide in their diet from the 7th to 21st day following birth at a dose level of 1.5 mg/kg/day, in comparison to a 50 percent mortality rate at a 15.0 mg/kg body weight dose. Similarly, Ferslew and Edds (1979) observed no significant effects on growth or development of young swine fed arsanilic acid at 0.01 percent concentration for 31 days commencing at 3 weeks of age, despite observations of significant alterations by organo-arsenic of white blood cell counts, serum alkaline phosphatase activity, and other blood chemistry parameters and significant increases of arsenic in various soft tissues and urine. In another study (Heywood and Sortwell, 1979), both 3.75 and 7.5 mg/kg/day doses of an arsenic compound fed to adolescent or infant rhesus monkeys resulted in mortality in most of the exposed animals, but no notable

REC 5005

effects in growth or development of animals surviving the dosing period. Unfortunately, the lack of experimental data in the above studies on the effects of exposure across a range of dose levels, besides the ones employed, greatly limits their utility in terms of determining possible dose-effect or dose-response relationships between postnatal arsenic exposure and induced effects on growth and development.

It should be noted that, whereas some of the above animal studies provide highly suggestive evidence for arsenic effects on reproduction and development, at least at high exposure levels, one cannot confidently extrapolate the results to estimate the probability of occurrence of similar or analogous effects in man. Still, some suggestions of possible arsenic effects on human reproduction and development have been derived from certain epidemiology studies discussed below.

5.2.3.2 Human Studies--Available data are mainly from studies in Sweden on male and female smelter workers. These studies were not designed specifically to study effects of arsenic but rather to study the effects, in general, of the smelter work. While data from these studies suggest a low-level effect of smelter pollutants on neighboring (proximate) populations, the diverse agents involved preclude making conclusive statements about the specific effects of arsenic.

Congenital malformations were found to occur at about the same rate, 3.0 percent among women employed at the Rönnskär smelter, as among women living in six areas belonging to the hospital serving the Rönnskär area (Nordström et al., 1978c). However, mean birthweights were lower among offspring to female Rönnskär workers (Nordström et al., 1978a, 1978b).

The number of spontaneous abortions was also increased among women working in this smelter; the highest rate (17 percent) was found among women

employed during pregnancy or who had been employed prior to pregnancy and lived close to the smelter. Women working in close connection with smelting processes had a rate of 28 percent of spontaneous abortion compared with other female employees. When both parents were employed, the abortion rate was 19.4 percent compared to 13.5 percent when the father was not employed.

Studies on spontaneous abortion among women living in the vicinity of the smelter were also conducted (Nordström et al., 1978d). In four areas, the rate varied between 7.6 and 11.0 percent. The highest rate occurred in the area closest to the smelter, but many women employed at the smelter live in that area.

5.2.4 Hematological Effects

The hematopoietic system in man has been shown to be affected by arsenic exposure in cases of acute, subacute or chronic intake, taking the form of anemia, leukopenia, granulocytopenia and eosinophilia. Such effects appear to be reversible, the system recovering in a matter of weeks after exposure ends.

Hamamoto (1955), in his report of infant poisoning by arsenic-contaminated milk in Japan, described marked anemia and leukopenia with lymphocytosis in most of a group of 59 infant patients. Erythropoiesis was disturbed in bone marrow of 19 children studied. Within a month, the hematology appeared to show normal values. Similarly, Mizuta et al. (1956) found blood disturbances, including anemia with leukopenia and lymphocytosis, in subjects surveyed for ingestion of soy sauce contaminated with arsenic.

Two recent studies dealing with acute and subacute arsenic poisoning (Feussner et al., 1979; Lerman et al., 1980) have demonstrated arsenic-induced megaloblastic anemia. Feussner et al. (1979) demonstrated that arsenic was present in bone marrow by using electron-probe microanalysis.

Chronic exposure to arsenic occasions hematological effects which resemble those seen with subacute exposure. Terada (1960), in his survey of patients exposed to arsenic in well water contaminated by industrial activity in Niigata, Japan, saw anemia as a common feature, with the anemia being either normochromic (50 percent) or hyperchromic (30 percent). In their study on individuals living in communities in Utah where arsenic was present in drinking water, Southwick et al. (1981) also reported the presence of anemia in certain individuals; however, anemia was not significantly more prevalent in exposed populations. Anemia has been reported in subjects exposed to arsenic occupationally or in medicinals (Kyle and Pease, 1965; Westhoff et al., 1975).

In animals, decreased hemoglobin production has been seen in rats fed both arsenate (Mahaffey and Fowler, 1977) and arsenite (Byron et al., 1967) and in cats given either form orally (Massmann and Opitz, 1954). The study of Woods and Fowler (1977), in which arsenate was given orally to rats and mice at 20, 40 or 85 ppm in drinking water, showed that the sites of disturbance of the heme biosynthetic pathway by arsenate mainly involved depression of ALA-synthetase and heme-synthetase activity, with elevation in the urinary levels of chiefly uroporphyrin and also coproporphyrin. The increase in uroporphyrin appears to be specific to arsenic.

5.2.5 Hepatic Effects

In the reports of Hamamoto (1955) and Mizuta et al. (1956), dealing with arsenic contamination in infant milk and soy sauce, respectively, swollen livers appeared to be a common clinical feature. Of the children exposed to milk arsenic, all subjects presented with this feature (61/61). In the autopsies of fatal outcome cases, hemorrhagic necrosis and fatty degeneration of the liver were seen. In the survivors, liver function tests were not very revealing, being within normal limits in most cases. In both of the above episodes, liver size returned to normal after exposure ceased.

Over the years, chronic intake of arsenic has been reported to be associated with hepatic damage in the form of portal hypertension, malignant liver disease and cirrhosis. In the Manchester beer poisoning episode, Reynolds (1901) noted widespread liver disease in drinkers of such beer, with the extent of the disease being related to the amount of arsenic in the beverage.

The incidence of hepatic cirrhosis among German vintners has been reviewed by Luchtrath (1972), who noted that the frequency of liver cirrhosis decreased with the banning of arsenical pesticides. The use of arsenic as an anti-syphilitic is also known to be associated with hepatic cirrhosis (Baldridge, 1934).

Non-cirrhotic portal hypertension has been infrequently noted in the literature (Morris et al., 1974; Szuler et al., 1979). Szuler described one case report of presinusoidal portal hypertension in a patient taking an arsenic antiasthmatic for 55 years. Cirrhosis was absent and liver function was not disturbed.

In the smelter study by Axelson et al. (1978) there was a tendency towards an increased mortality in liver cirrhosis among arsenic-exposed workers.

5.2.6 Renal Effects

Functional and/or biochemical impairment of the human renal system is mainly seen in acute poisoning by arsine, AsH_3 (Uldall et al., 1970; Fowler, 1977). Oligouria and anuria progressing to renal failure are common acute responses. Persistent renal sequelae in subjects surviving the acute stage of arsine poisoning include chronic renal insufficiency and hypertension. Histologically, the injury is mainly tubular and interstitial.

Acute or chronic renal effects associated with arsenate or arsenite exposure are less well characterized. Gerhardt et al. (1978) have recently described a case of acute arsenic poisoning from contaminated illicit liquor.

Acute renal bilateral cortical necrosis was diagnosed in the patient who survived the acute stage to eventually develop reduced renal size and cortical calcification.

In the clinical survey of Hamamoto (1955) of Japanese infants poisoned with arsenic-contaminated milk, possible renal injury was diagnosed by the presence of hematuria, leukocyturia and glycosuria (23.7 percent, 42.3 percent and 13.5 percent, respectively). Reversibility of these indices was apparent, with only three percent of the patients still showing pathological changes after one month. Terada (1960) also noted proteinuria in cases of arsenic poisoning in Niigata, Japan, arising from ground water contamination from an arsenic plant.

5.2.7 Respiratory Effects Other Than Cancer

Nasal septum perforation is a rapid tissue response in workers encountering high airborne arsenic levels (NAS, 1977; Hine et al., 1977; Lundgren, 1954).

In the detailed smelter worker study of Lundgren (1954), 1,276 subjects in a worksite with levels up to 7 mg As/m^3 showed two types of respiratory disturbances relating to the nature of the processing and presumably the form of the arsenic. Refined arsenic handling was associated with septal perforation and rhinopharyngolaryngitis, while workers in the roaster, furnace, and connector areas showed tracheobronchitis and signs of pulmonary insufficiency. In the latter group, exposure was mixed, including both arsenic and sulfur dioxide. A recent report has suggested, furthermore, that workplace arsenic may also be present as the sulfide (Smith et al., 1976).

Chilean children exposed to arsenic in drinking water (Borgono et al., 1977) showed a chronic cough and bronchitic history.

5.2.8 Immunosuppressant Effects

The role of inorganic arsenic as an immunosuppressant in man is mainly inferred from indirect data accumulated over the years (Arsenic. NAS, 1977).

First, the therapeutic utility of arsenicals, such as arsenite-based Fowler's solution in the treatment of steroid-responding disorders and as a lymphocytostatic agent, suggests action as an immunosuppressant.

Secondly, certain manifestations indicative of likely immune system disorders have been observed with arsenic exposure, (e.g., the occurrence of herpes simplex and chronic pulmonary infections) and suggest a role of arsenic as an immunosuppressant (Arsenic. NAS, 1977). Histories of chronic cough and bronchitis in Chilean children exposed to arsenic in drinking water (Borgono et al., 1977) would tend to support such a role.

5.3 FACTORS AFFECTING ARSENIC TOXICITY

The most widely recognized and studied arsenic interactive behavior is with selenium, and much of the early data has been reviewed by Levander (1977).

The known antagonistic relationship of arsenic and selenium in a number of animal species was first described by Moxon and co-workers (Moxon and Dubois, 1939; Dubois et al., 1940), who also demonstrated the utility of dietary arsenic supplementation in protecting livestock from the toxic levels of selenium in certain fodders. Both penta- and trivalent arsenic are equally effective in protecting against selenium toxicity, and do so regardless of the chemical form by which selenium exposure occurs.

An understanding of the *in vivo* mechanisms by which arsenic imparts a protective effect on selenium toxicity has only recently been gained.

The ability of arsenic to retard the formation of volatile selenium in the form of dimethyl selenide (Kanstra and Bonhorst, 1953) apparently involves inhibition of microsomal methyl transferase, an enzyme sensitive to arsenite (Ganther and Hsieh, 1974). An overall protective effect still exists, however, since arsenic promotes the biliary excretion of selenium (Levander and Baumann, 1966; Ganther and Baumann, 1962). According to Levander (1977), enhanced biliary

REC 5011

clearance of selenium in the presence of arsenic probably involves an excretory conjugate of both, since selenium likewise enhances the biliary excretion of arsenic.

Rössner et al. (1977) showed a protective effect for arsenite against the cytotoxicity of selenite, using suspension cultures of mouse fibroblasts exposed to these agents at 10^{-5} to 10^{-11} M. Interestingly, selenite, in turn, had only a low protective effect against arsenite cytotoxicity.

Few data exist for interactive relationships between arsenic and other elements. In one of the few pertinent studies bearing on this issue, the effects of concomitant oral exposure to cadmium, lead and arsenic versus single-agent exposure effects have been reported by Mahaffey and Fowler (1977). Cadmium and arsenic together retarded weight gain in young adult rats to a greater extent than either element alone.

6. ARSENIC MUTAGENICITY

Various inorganic compounds of arsenic have been tested for mutagenicity in a variety of test systems ranging in complexity from bacteria to peripheral lymphocytes of exposed human beings. Information on these tests has been reviewed herein and elsewhere (Flessel, 1978; NAS, 1977; Leonard and Lauwerys, 1980; WHO, 1981). The following chapter is divided into five major sections discussing studies indicative of mutagenic damage, as well as interactions of arsenic with other mutagens and possible mechanisms of mutagenic action.

6.1 GENE MUTATION STUDIES

6.1.1 Prokaryotic Test Systems (Bacteria)

Arsenic does not appear to induce gene mutations in bacteria (Table 6-1). Sodium arsenite ($NaAsO_2$) was tested for its ability to induce reverse mutations in E. coli (Nishioka, 1975). Three bacterial strains auxotrophic for tryptophan were tested for growth in the absence of tryptophan after arsenic treatment. Nishioka reported that arsenic induced mutations in wild type cells and in cells deficient in excision repair ($uvrA^-$) but not in cells deficient in recombinational repair ($recA^-$). This suggested that the rec function is necessary for arsenic-induced mutagenesis in E. coli.

The observations by Nishioka were not reproducible in subsequent studies by Rossman et al. (1980). In these latter studies, the authors examined sodium arsenite-induced mutagenesis in five strains of E. coli, all auxotrophic for tryptophan and carrying different mutations for DNA repair capacities. In addition, Rossman et al. used three protocols for quantifying the presence of mutant cells: the spot test, the plate test and the fluctuation test. Arsenite did not increase the mutation frequency in any E. coli strain using any of the

TABLE 6-1. SUMMARY OF MUTAGENICITY OF ARSENIC: GENE MUTATIONS

Reference	Test system	Chemical Information	Results	Comments
Nishioka, 1975	Reverse mutation in E. coli Strains: WP2 (trp^-) WP2 uvrA ($uvrA^-$, trp^-) CM571 ($recA^-$, trp^-)	$NaAsO_2$ 8.0×10^{-4} M in WP2 1.6×10^{-4} M in WP2 uvrA 1.6×10^{-4} M in CM571 Source: Nakarai Chemical LTD (reagent grade) Solvent: H_2O	$NaAsO_2$ positive for mutations in WP2 and WP2 uvrA but not in CM571. Increases were approximately 10x background.	1. Doses of arsenite were selected to kill 60-70% of cells. 2. Lack of mutagenesis in CM571 suggests that a rec function is required for mutagenesis in E. coli. 3. Rossman et al. (1981) were unable to reproduce these mutation studies. They claimed (a) that the induced mutation frequencies observed by Nishioka were within the normal range of background, (b) that they observed a 31-fold difference in cytotoxicity studies compared to Nishioka, and (c) that Nishioka used an incorrect method for determining mutation frequency.

REC 5014

TABLE 6-1. (continued)

Reference	Test system	Chemical Information	Results	Comments
Rossman et al., 1980	Induction of reverse mutations in *E. coli* at the trp locus. Assays: Spot test, Plate test, Fluctuation test Strains: WP2 (trp^-); $WP2_S$ (trp^-, uvrA-); WP6 (trp^-, $polA1^-$); WP10 (trp^-, $recA1^-$); $WP44_S$-NF (trp^-, $uvrA^-$, tif-1/sti^-). tif-1 mutation confers a thermally inducible SOS repair system resulting in normal mutation at 30°C and a 20-fold increase in mutation at 42°C.	$NaAsO_2$: 50 µl of 0.1 M in spot tests with $WP44_S$-NF (30°C), WP2, WP6, and WP10. $NaAsO_2$: 10 µl of 0.01 M in spot test $WP44_S$-NF, 10 µl of 0.1 M in spot test $WP44_S$-NF. $NaAsO_2$: 25 mM in plate tests WP2. $NaAsO_2$: 0.4, 1, 2, mM in fluctuation test WP2.	Arsenic did not increase the mutation frequency in any of the assays. Arsenic showed a dose-dependent decrease in mutations in $WP44_S$-NF at 42°C.	1. Results indicate that arsenic may inhibit SOS repair.
Lofroth and Ames, 1978 (abstract only)	*Salmonella* microsome assay	Arsenite and arsenate	Negative	1. No data available since information comes from an abstract.

REC 5015

TABLE 6-1. (continued)

Reference	Test system	Chemical Information	Results	Comments
Singh, 1983	Gene conversion at the trp locus and reverse mutation at the ilv locus in S. cerevisiae. Strain D7 = $\frac{\text{a ade 2-40}}{\alpha\ \text{ade 2-119}}\ \frac{\text{trp-5-12}}{\text{trp 5-27}}\ \frac{\text{ilv 1-92}}{\text{ilv 1-92}}$	$NaAsO_2$ (0.1 M added to well, volume not indicated) Solvent: H_2O	Negative for conversion. Weak positive for mutation.	1. Study lacking sufficient experimental details.
Amacher and Paillet, 1980	Forward gene mutation at the thymidine kinase (TK) locus in mouse L5178Y cells.	Na_2HAsO_4 Doses tested: (0.83×10^{-4}, 1.1×10^{-4}, 1.47×10^{-4}, 1.96×10^{-4}, 2.26×10^{-4} M) Source: Fisher Solvent: Normal saline	Negative	1. Exposed 3 hrs at 37°C. 2. Survival ranged from 66% at the low dose to 35% at the high dose. 3. Other metals such as cadmium, nickel, and trans-platinum were positive.
Rossman et al., 1980	Induction of forward mutations in Chinese hamster cells in vitro at HGPRT locus and the sodium-potassium ATPase locus.	$NaAsO_2$ (0.5×10^{-6} M, 2 days) ouabain resistance (5.0×10^{-6} M, 1 hour) ouabain resistance (20×10^{-6} M, 1.5 hours) thioguanine resistance (100×10^{-6} M, 25 min) thioguanine resistance	No increased mutation	1. UVC and MNNG used as positive controls. 2. Doses of arsenite used varied from slightly inhibitory to cell growth to fairly toxic.

REC 5016

TABLE 6-1. (continued)

Reference	Test system	Chemical Information	Results	Comments
Oberly et al., 1982	Forward gene mutation at the thymidine kinase (TK) locus in mouse L5178Y cells.	$NaAsO_2$ (3.8×10^{-6}, 7.7×10^{-6}, 11.5×10^{-6}, 15.4×10^{-6}, 19.2×10^{-6} M) Na_2HAsO_4 (7.5×10^{-5}, 9.7×10^{-5}, 11.8×10^{-5}, 14.0×10^{-5} M) Source: Mallinckrodt	$NaAsO_2$ was negative in the presence of Aroclor-induced rat S-9 mix; $NaAsO_2$ was positive for the three highest doses tested in the absence of S-9 mix; Na_2HAsO_4 was negative in the absence of an Aroclor-induced rat S-9 mix; Na_2HAsO_4 was positive at the three highest doses tested in the presence of an S-9 mix.	1. Chemical exposure was for 4 hours. 2. Only positive data were shown; negative results were only mentioned in the text. 3. The spontaneous mutation rate varied a great deal between experiments; between 2.5 and 17.9 mutants per 10^5 survivors. Most of the arsenic-induced mutant frequencies were between or just slightly above this spontaneous range. 4. The increases in mutant frequencies occurred at very low survival levels for both compounds; the highest doses caused 97% lethality. 5. At survivals above 10% none of the mutant frequencies exceeded the limits of the control mutant frequency range.

REC 5017

test protocols. Indeed, arsenic showed a dose-dependent suppression of mutations in strain $WP44_S$-NF. This strain carries a mutation (tif-1) which confers a thermally inducible SOS repair system (error-prone repair) resulting in normal spontaneous mutation at 30°C and a 20-fold increase in mutation at 42°C. The presence of sodium arsenite in the medium was sufficient to suppress this temperature-induced increase in the mutation frequency by one-half. This observation suggests that arsenic may inhibit SOS repair, a pathway which is highly important in bacterial mutagenesis. Such a repair pathway has not been detected in mammalian cells.

Rossman et al. (1980) offered explanations for the discrepancies between their results and those of Nishioka. First, they pointed out that the arsenic-induced mutation frequencies reported by Nishioka were all within the normal range of background. Second, they observed a 31-fold difference in cytotoxicity in the same bacterial strains. Third, they noted that Nishioka used an incorrect method for determining mutation frequency, basing his calculations on the initial size of the cell inoculum instead of on the final size of the plated population.

Arsenite and arsenate have also been found to be negative in the Ames Salmonella microsome assay (Lofroth and Ames, 1978). Although this work is reported only in abstract form, it may be assumed the assay was performed properly as Ames is a cited author.

Consideration of the above results alone, however, should not be taken as proof that inorganic arsenic is non-mutagenic. Bacterial systems are generally insensitive for the detection of metal mutagens because of the large amount of magnesium salts, citrate and phosphate in the minimal medium which prevent the entry of metal mutagens into bacterial cells (McCann et al., 1975).

6.1.2 Eukaryotic Microorganisms (Yeast, Fungi)

Sodium arsenite was tested for its activity in inducing reverse mutation and mitotic gene conversion in the yeast Saccharomyces cerevisiae (Singh, 1983). The diploid strain used in this study (D7) is auxotrophic for tryptophan, isoleucine, and valine, and measures gene conversion at the trp locus and reverse mutation at the ilv locus. Arsenite was inactive for gene conversion and weakly positive for mutation. This study was generally lacking in details and raw data were not shown.

6.1.3 Mammalian Cells In Vitro

Sodium arsenate was tested for the induction of forward mutations at the thymidine kinase locus in mouse L5178Y cells (Amacher and Paillet, 1980). Doses of arsenate were selected such that between 66 percent to 35 percent of cells survived a three-hour treatment. Arsenate was found not to increase the spontaneous mutation rate in these cells, while other known or suspected mutagenic metals (cadmium, nickel, and trans-platinum) were positive.

Using the same system, Oberly et al. (1982) tested sodium arsenate and sodium arsenite in the presence and in the absence of an Aroclor-induced rat S-9 mix. Sodium arsenite gave positive results at the three highest doses when tested in the absence of S-9 mix. In the presence of S-9 mix, the results were reported to be negative, although no data were presented. Sodium arsenate gave positive results at the three highest doses tested in the presence of S-9 mix. Again, without presenting data, the outcome in the absence of metabolic activation was reported to be negative. The authors concluded that these two arsenic compounds were weak mutagens. There are, however, several problems with this interpretation. First, the spontaneous mutation rate varied a great deal in these studies: between 2.5 and 17.9 mutants per 10^5 survivors. Most of the arsenic-induced mutant frequencies fell between or just slightly above

this spontaneous range. Second, the increases in mutant frequencies occurred at very low survival levels for both compounds; the highest doses used caused 97 percent lethality. Thus, at survivals exceeding 10 percent none of the mutant frequencies exceeded the limits of the range of control mutant frequencies. Taking these observations into consideration, the authors' conclusions do not seem well supported.

Sodium arsenite was also tested for the induction of forward mutations at two loci in V79 cells (Chinese hamster lung fibroblasts) (Rossman et al., 1980). The two genes studied were hypoxanthine guanine phosphoribosyl transferase (HGPRT) and membrane-bound sodium potassium ATPase. Mutations in these two enzymes were enumerated through the observation of cell clones resistant to thioguanine or ouabain, respectively. Both the concentration of the chemical as well as the incubation times were varied; there was, however, no increase in the mutation frequency at either locus. The positive controls, UVC (ultraviolet light 254 mm) and methylnitronitrosoguanidine (MNNG) were effective in elevating the mutant frequency.

6.2 CHROMOSOMAL ABERRATION STUDIES

6.2.1 Chromosomal Aberrations In Vitro

A large number of studies indicate that both trivalent and pentavalent arsenic compounds are capable of breaking chromosomes in vitro (Table 6-2). One of the earliest reports on the clastogenic potential of arsenic was from a study performed with mitogenically stimulated human peripheral lymphocytes (Petres and Hundeiker, 1968). Although the test compound was reported to be Na_2HAsO_3, it is assumed the authors meant Na_2HAsO_4. Positive results were reported, although no actual raw data were presented.

Paton and Allison (1972) tested both sodium arsenite and sodium arsenate for the induction of chromosomal aberrations in human diploid fibroblasts and

REC 5020

TABLE 6-2. SUMMARY OF MUTAGENICITY OF ARSENIC: CHROMOSOME ABERRATIONS

Reference	Test System	Chemical Information	Results	Comments
Petres and Hundeiker, 1968 (paper in German, English summary)	Chromosome aberrations induced in human peripheral lymphocytes exposed in vitro.	Na_2HAsO_3 0.5×10^{-6} and 10^{-6} g/ml of medium (assume Na_2HAsO_4 is meant) 1.6×10^{-6} M and 3.2×10^{-6} M	Positive at both doses.	1. No raw data were presented in this paper.
Paton and Allison, 1972	Chromosomal aberrations in human fibroblasts and human peripheral lymphocyte (HPL) cultures exposed in vitro.	$NaAsO_2$ (2.9×10^{-9} to 1.8×10^{-8} M) HPL. Na_2HAsO_4 (5.8×10^{-8} M) HPL. $NaAsO_2$ (2.9×10^{-9} to 5.8×10^{-8} M) fibroblasts. Source: British Drug House Chemical LTD. Solvent: H_2O	Positive for $NaAsO_2$ in HPL. Positive for $NaAsO_2$ in fibroblasts. Negative for Na_2HAsO_4 in HPL.	1. Incubation with chemical was for 48 hrs and 24 hrs for HPL and fibroblasts, respectively. 2. "Subtoxic" doses were used.
Larramendy et al., 1981	Induction of chromosomal aberrations in Syrian hamster embryo (SHE) cells and human peripheral lymphocytes (HPL) in vitro.	$NaAsO_2$ (7.7×10^{-6} M) in HPL and SHE. Na_2HAsO_4 (3.2×10^{-5} M) in HPL and SHE. Source: Chemical Services Inc. "100% pure" Solvent: Cell culture medium	Highly significant increase in the aberration frequency with both compounds in HPL and SHE.	1. Arsenite was about an order of magnitude more genotoxic than arsenate. 2. Both compounds induced mainly chromatid type aberrations. 3. Doses tested were generally non-cytotoxic. 4. Exposure to arsenic was for 24 and 48 hrs. in SHE and HPL, respectively.

REC 5021

TABLE 6-2. (continued)

Reference	Test System	Chemical Information	Results	Comments
Nakamuro and Sayato, 1981.	Chromosomal aberrations in cultured human peripheral lymphocytes (HPL) and fibroblasts.	As_2O_3 (3×10^{-7}, 12×10^{-7}, 36×10^{-7}M). $AsCl_3$ (6×10^{-7}, 24×10^{-7}, 72×10^{-7}M). $NaAsO_2$ (6×10^{-7}, 24×10^{-7}, 72×10^{-7}M). Na_2HAsO_4 (24×10^{-7}, 72×10^{-7}, 240×10^{-7}M). H_3AsO_4 (6×10^{-7}, 24×10^{-7}, 72×10^{-7}M). As_2O_5 (3×10^{-7}, 12×10^{-7}, 36×10^{-7}M). Source: Wako Pure Chemical Co. Solvent: H_2O	1. All arsenic compounds were clastogenic, all gave linear dose-response functions in lymphocytes. $NaAsO_2$ and H_3AsO_4 were positive with linear dose-response functions in fibroblasts. 2. Trivalent compounds were more potent than pentavalent compounds. The observed order for decreasing potency was: As_2O_3 > $AsCl_3$; Na AsO_2 >> Na_2HAsO_4 > H_3AsO_4; As_2O_5.	1. Treatment of lymphocytes was for the last 24 hours of culture. 2. Fibroblasts were exposed for 48 hrs. 3. All compounds induced more chromatid-type aberrations.

REC 5022

TABLE 6-2. (continued)

Reference	Test System	Chemical Information	Results	Comments
Nordenson et al., 1981	Chromosomal aberrations in peripheral lymphocytes of 3 normal volunteers - <u>in vitro</u> exposure.	$NaAsO_2$ (77×10^{-8}, 150×10^{-8}, 230×10^{-8}, 310×10^{-8} M). Na_2HAsO_4 (77×10^{-8}, 150×10^{-8}, 230×10^{-8}, 310×10^{-8} M). Source: Merck Solvent: Normal saline	$NaAsO_2$ caused a dose-related increase in gaps and chromatid breaks. Na_2HAsO_4 was negative.	1. Arsenic added 24 hours after initiation of culture, harvested at 72 hours. 2. Only scored gaps, chromatid and chromosome breaks. 3. Also examined G_0 effects: 24 hr. exposure without PHA, remove arsenic, add PHA, harvest after 48 hours; examined "$NaAsO_4$" - do not know what compound was really tested. 4. Reason for negative result with arsenate is that a sufficiently high dose was not tested. Should have increased concentration by an order of magnitude.

TABLE 6-2. (continued)

Reference	Test System	Chemical Information	Results	Comments
Wan et al., 1982	Induction of chromosome aberrations in vitro in CHO cells and human peripheral lymphocytes (HPL).	$NaAsO_2$ (10^{-6}, 5×10^{-6}, 10^{-5} M) CHO; (0.5×10^{-6}, 10^{-6}, 5×10^{-6} M) HPL Na_2HAsO_4 (5×10^{-5}, 8×10^{-5}, 10^{-4} M) CHO. Purity: Analytical grade Source: Fisher Scientific Co. Solvent: H_2O	Dose-related increase for both compounds in CHO. $NaAsO_2$ gave dose-related increase in HPL.	1. Trivalent was 5 to 10 x more potent than pentavalent. 2. All doses tested were inhibitory to CHO cell growth. 3. Arsenic present for entire culture period (22 hrs.) in CHO cells, and final 48 hrs of culture in HPL.
Poma et al., 1981b	Induction of chromosomal aberrations in mouse bone marrow and spermatogonia in vivo.	As_2O_3, single I.P. injection (4, 8 and 12 mg As/kg). Solvent: H_2O	Negative in bone marrow. Negative in spermatogonia.	1. Mouse strain: Swiss Albino 2. Sex: male. 3. Age: 12 weeks 4. Number of animals per dose group: 4-8. 5. Cells per animal: 100. 6. Sacrifice times: 12, 24, 36, 48 hrs post injection.

REC 5024

mitogenically stimulated human peripheral lymphocytes. Sodium arsenite gave positive results in both cell types while sodium arsenate was tested only in lymphocytes and was reported to be negative. Since arsenate (which most investigators find to be considerably less potent than arsenite) was tested at a lower concentration, the negative result is not surprising.

In a more recent study, the effects of sodium arsenite and sodium arsenate on chromosomal aberration frequencies were examined in cultured human peripheral lymphocytes and in Syrian hamster embryo cells (Larramendy et al., 1981). Both compounds gave highly significant increases in chromosomal aberrations in both cell types. Arsenite was more potent by approximately an order of magnitude, and both compounds induced mainly chromatid-type aberrations.

Nakamuro and Sayato (1981) tested six arsenic compounds for the induction of chromosomal aberrations in cultured human peripheral lymphocytes and in human skin fibroblasts. All arsenic compounds tested were clastogenic and all gave linear dose-response functions in lymphocytes. Trivalent compounds were more potent than pentavalent compounds. The observed order for decreasing potency was As_2O_3 > $AsCl_3$; $NaAsO_2$ >> Na_2HAsO_4 > H_3AsO_4; As_2O_5 (Figure 6-1). $NaAsO_2$ and H_3AsO_4 were positive, showing linear dose-response functions in fibroblasts. All compounds induced predominantly chromatid-type aberrations.

In another study, the effects of sodium arsenite and sodium arsenate on the induction of chromosomal aberrations in human peripheral lymphocytes exposed in vitro were examined using two protocols (Nordenson et al., 1981). In the first protocol, cells were mitogenically stimulated with PHA, arsenic was added after 24 hours and cells were harvested after 72 hours (48-hour arsenic exposure). Using this method, sodium arsenite was found to increase the frequency of chromatid breaks and gaps in a dose-dependent fashion. Sodium arsenate was reported to be negative, but these investigators employed

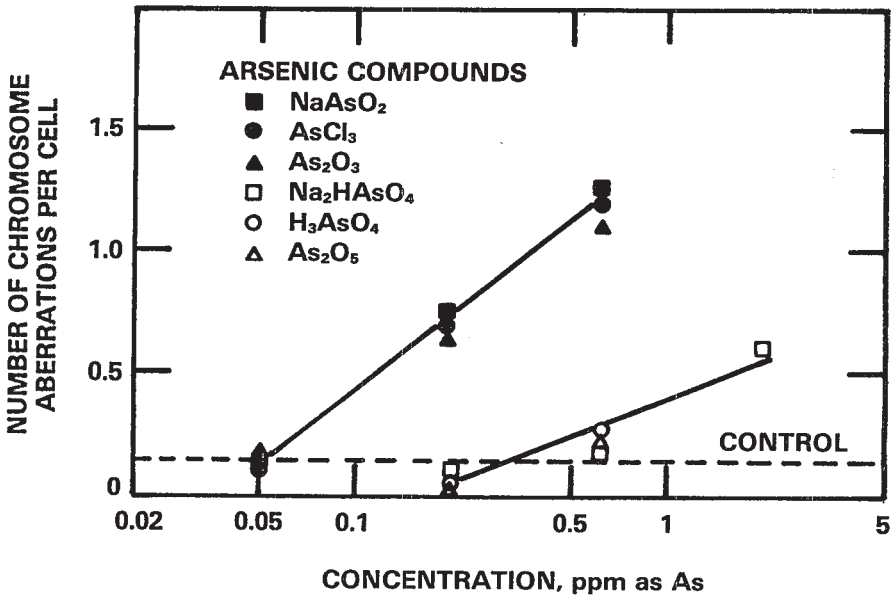


Figure 6-1. The induction of chromosome aberrations in cultured human peripheral lymphocytes by six arsenic compounds.

Source: Nakamuro and Sayato (1981).

the same concentrations of arsenate as were tested for arsenite. It is possible that higher doses of arsenate would also have yielded positive results. In the second protocol, G_0 (unstimulated) lymphocytes were exposed to arsenic for 24 hours, and the cells were washed, stimulated with PHA and harvested after 48 additional hours. Using this protocol the authors reported that "$NaAsO_4$" was negative. One may assume that the authors meant $NaAsO_2$, since having observed a lack of activity for arsenate in the first protocol, it would seem unwarranted to test it in the second. If the test compound was indeed arsenite, these observations suggest that arsenic has its effect through some influence on DNA synthesis and not by directly damaging DNA.

In the most recent study on in vitro clastogenic effects of arsenic compounds, sodium arsenite and sodium arsenate were tested in CHO cells and human peripheral lymphocytes (Wan et al., 1982). Both compounds showed dose-dependent increases in aberrations in CHO cells; arsenite was also positive in lymphocytes. Again, trivalent arsenic was 5 to 10 times more potent than pentavalent arsenic.

6.2.2 Chromosomal Aberrations In Vivo

There is only one report in the literature (excluding abstracts) in which the clastogenic effects of arsenic were tested in a mammalian species in vivo (Poma et al., 1981b). These authors examined chromosomal aberration frequencies in mouse bone marrow cells and spermatogonia after administration of As_2O_3 (4, 8 and 12 mg of arsenic/kg). This trivalent form of arsenic was previously shown to be the most potent form in vitro (Nakamuro and Sayato, 1981). Four to 8 animals were included in each dose group; animals were killed at 12, 24, 36 and 48 hours after exposure and 100 metaphase cells per animal were scored. This represents an acceptable protocol, and the study appears to have been properly performed. There was no significant increase in aberrations in either

REC 5027

bone marrow or spermatogonia following arsenic treatment. An important question in this study is whether sufficiently high doses were tested. The LD_{50} for arsenic trioxide in rats is 104 mg As/kg; thus, the highest dose used in this mouse study is only 13 percent of the rat LD_{50}. One can crudely compare the doses of arsenic trioxide which were effective in vitro to those used in this study by simply equating the test animal to an equivalent volume of water. Such a comparison indicates the mice were "1.6×10^{-4} M" effective for arsenic while the same compound was effective for inducing aberrations in vitro at approximately 0.7 to 7.0×10^{-4} M arsenic. Clearly this represents a very crude comparison since intact animals can bind, compartmentalize and excrete a toxicant while cells in culture cannot. Thus, it is not clear whether higher doses should have been tested in this study.

6.2.3 Chromosomal Aberrations and SCE in Cells of Arsenic-Exposed Human Beings

The majority of studies indicate that people exposed to arsenic due to occupation or pharmaceutical treatment display increased levels of chromosomal aberrations and SCE in peripheral lymphocytes (Table 6-3). It should be noted that most of the studies which have examined aberrations and SCE are poor in quality due either to errors in experimental protocol, misclassification of aberrations, poor choice in controls and/or not performing studies in a blind fashion.

Beckman et al. (1977) examined the frequency of chromosomal aberrations in peripheral lymphocytes of nine smelter workers who were exposed to arsenic. The levels and the forms of arsenic to which the workers were exposed were not indicated. A statistically significant increase in aberrations was found in the exposed population. There are several problems with this study. First, the authors use an incorrect definition of gaps. They state: "Gaps are commonly defined as achromatic regions exceeding the width of a chromosome." This, in

REC 5028

TABLE 6-3. SUMMARY OF MUTAGENICITY OF ARSENIC: CHROMOSOMAL ABERRATIONS AND SCE IN CELLS OF EXPOSED HUMANS

Reference	Test System	Chemical Information	Results	Comments
Beckman et al., 1977	Chromosomal aberrations in lymphocytes of 9 smelter workers exposed to arsenic.	Arsenic from smelter	Positive, six-fold increase in percent aberrant cells; eight-fold increase in aberrations per cell.	1. Authors used an incorrect definition of gaps. 2. Cells cultured too long (72 hours). 3. Cells scored per individual were unknown. 4. Number of control individuals and cells per control individual were not specified. 5. Some workers were also exposed to lead and selenium.
Nordenson et al., 1978	Chromosomal aberrations in lymphocytes of 33 smelter workers.	Arsenic from smelter	Positive	1. Divided workers into high exposure (18 individuals), medium exposure (11), low exposure (4) and new employees (6). 2. The controls were an unspecified number of apparently historical controls. 3. No dose effect. 4. Wrong definition of gaps. 5. Cell culture time too long. 6. Large difference between controls and new employees.

REC 5029

TABLE 6-3. (continued)

Reference	Test System	Chemical Information	Results	Comments
Burgdorf et al., 1977	Compared SCE and chromosomal aberrations in lymphocytes of 6 patients treated with arsenic, with results from 44 control individuals.	All treated with Fowler's solution (1% $KAsO_2$ in H_2O), for time periods between 4 and 27 years. Five of these individuals had not been treated for at least 24 years.	No difference in frequencies of chromosomal aberrations. SCE frequencies were increased more than 2-fold in arsenic-treated patients.	1. Cultured cells for 72 hours - too long for examination of aberrations. 2. No indication that study was scored blind. 3. Patients exposed to other agents (e.g. 4000 rad x-irradiation, 5000 rad x-irradiation, fluoroscopy twice weekly while receiving arsenic, 4 had asthma).
Petres et al., 1977	Chromosome aberrations in lymphocytes of 31 individuals exposed to arsenic.	Arsenic exposure related to treatment for psoriasis or associated with vine-growing.	Positive, nine-fold increase in aberrations among arsenic-exposed individuals.	1. 31 exposed individuals, 31 controls. 2. Cell culture time too long (72 hours). 3. Scored both gaps and achromatic lesions - same aberration. 4. Scored secondary constrictions - not generally considered an aberration. 5. No indication of the number of cells per person scored. 6. Saw a 5-fold increase in aneuploidy among arsenic-exposed individuals, always hypodiploidy, which suggests an artifact.

TABLE 6-3. (continued)

Reference	Test System	Chemical Information	Results	Comments
Nordenson et al., 1979	Chromosome aberrations and SCE in peripheral lymphocytes of 8 psoriatic patients treated with arsenic.	Total arsenic dose per individual varied from a low of 300 mg up to 1200 mg. Most had not been treated for 15 years.	Psoriatic patients treated with arsenic showed significantly higher (three-fold) levels of aberrations compared to control psoriatics. Psoriatic patients treated with arsenic had the same levels of SCE as controls.	1. Slides were scored blind. 2. Investigators controlled for age and sex but not for ethanol use, smoking, drug use, or infection. 3. The increases in aberrations were not dose-related. 4. Cultured cells for 72 hours: too long for aberrations. 5. Scored too few cells for SCE in control patients; provided total number of cells scored, but number of cells per individual was unknown.

REC 5031

TABLE 6-3. (continued)

Reference	Test System	Chemical Information	Results	Comments
Wen et al., 1981	SCE in peripheral lymphocytes of 13 Blackfoot disease patients (arsenic-exposed) and 13 controls.	Exposure to arsenic from well water; years of use ranged from 15 to 58. Most had not consumed contaminated water for 12 years.	Arsenic-exposed individuals showed small but statistically higher SCE level. Ranges for arsenic-exposed (9.1 to 17.5 SCE/cell) and controls (7.8 to 12.0 SCE/cell) showed considerable overlap.	1. Patients exposed to a large number of other drugs, including pantopan, scopolamine, promethazine hydrochloride, meperidine, ketamine hydrochloride, Pyrabital, Valium, ampicillin, Kanamycin, Sedes, diphenhydramine hydrochloride, Kolantyl, Complamin, Venostatin, Ulcerin, metoclopramide, Sulpyrin, chloramphenicol, reserpine, Bartropine, dextromethorphan, furosemide, and Hustazol. 2. All patients had undergone leg or foot amputation.

fact, is a definition for a break. A gap is commonly defined as an achromatic lesion not exceeding the width of a chromatid arm. Second, the total number of cells examined are given but the cells per individual worker, cells per individual control, and total number of control individuals are not listed. Third, these investigators cultured the lymphocytes for 72 hours, a duration 24 hours longer than optimum, since most chromosome aberrations are cytotoxic, and cells with such lesions generally do not survive more than a single cell cycle. After 72 hours of culture, the majority of cells have divided three times, eliminating many damaged cells. Clearly, however, this type of error tends to underestimate the frequency of aberrations. Finally, workers were also exposed to other potentially clastogenic agents such as lead and selenium.

A report one year later by the same group (Nordenson et al., 1978) extended this study to a total of 33 smelter workers. In this study individuals were grouped into high exposure (18 people), medium exposure (11), low exposure (4) and new employees (6). The groupings were based on the nature of the job; quantitative measurements of exposure were not performed. The workers were reported to have a higher level of chromosome aberrations than did the controls. However, the controls were of an unspecified number and, apparently, historical, the definition of gaps was incorrect, cells were cultured for 72 hours, and large differences were found between historical controls and new employees. Due to these problems, the positive findings reported are questionable.

Burgdorf et al. (1977) compared SCE and chromosomal aberration frequencies in lymphocytes of six patients treated with arsenic (for asthma, psoriasis or anxiety) to results from 44 control individuals. All patients had been treated with Fowler's solution (1% $KAsO_2$ in water) for time periods varying between 4 and 27 years. Five of these individuals had not been treated for at least 24 years. The authors found no difference in frequencies of chromosomal aberrations, but reported a more than 2-fold higher SCE frequency in arsenic-treated

patients. Each of the patients had an SCE level which was significantly higher than the mean level for controls. Problems with this study included a 72-hour culture period for aberrations, no indication that slides were scored "blind," and the fact that patients were exposed to other agents (4000 rad x-irradiation, 5000 rad x-irradiation, fluoroscopy twice weekly concomitant to arsenic exposure).

In a similar study, Petres et al. (1977) compared chromosome aberrations in lymphocytes of 31 arsenic-exposed people to 31 controls. Arsenic exposure resulted from treatment for psoriasis or was associated with vine-growing. The levels and forms of arsenic exposure were not indicated. A statistically significant increase in aberrations was found in the exposed group. These authors also reported a five-fold increase in aneuploidy among arsenic-exposed individuals. Problems in this study include: (1) a 72-hour cell culture period; (2) no indication of the number of cells per person scored; (3) scoring both gaps and achromatic lesions, identical endpoints; (4) scoring secondary constrictions, which are generally not considered to be aberrations; and (5) all aneuploid cells were hypodiploid, which suggests an artifact.

Nordenson et al. (1979) compared chromosome aberrations and SCE in peripheral lymphocytes of 8 arsenic-treated psoriatic patients to 8 untreated psoriatic controls. Total arsenic dose per individual varied from a low of 300 mg up to 1200 mg. Most had not been treated for 15 years. Psoriatic patients treated with arsenic showed significantly higher levels of aberrations compared to controls, but showed similar frequencies of SCE. The increase in aberrations was not related to the total arsenic dose. Although these authors controlled for age and sex, there was no apparent control for smoking, drug use or ethanol consumption. An average of 15 cells per individual were scored for SCE; generally, 20 cells per individual is considered the acceptable minimum. As in the other studies, the cells were cultured for 72 hours.

Frequencies of SCE were compared in 13 patients exposed to arsenic in drinking water to SCE frequencies in 13 control individuals (Wen et al., 1981). All patients displayed symptoms of Blackfoot disease, a peripheral vascular disease resulting from chronic arsenic intoxication. Patients had used contaminated water for 15 to 58 years; most had switched to uncontaminated tap water 12 years before this study. Arsenic-exposed individuals showed a small but statistically higher SCE level. Ranges for arsenic-exposed (9.1 to 17.5 SCE/cell) and controls (7.8 to 12.0 SCE/cell) showed considerable overlap. Sources of error in this study are large since the arsenic-exposed group had also been exposed to over 20 different pharmaceuticals.

6.3 OTHER STUDIES INDICATIVE OF MUTAGENIC DAMAGE

6.3.1 Preferential Killing of Repair-Deficient Bacterial Strains

Arsenic compounds have generally been found to preferentially kill bacteria that carry particular mutations in DNA repair pathways (Table 6-4). Both sodium arsenite and sodium arsenate gave positive results in the B. subtilus "rec assay" (Nishioka, 1975). In this assay, test chemicals are spotted onto filter discs and the discs are placed at the centers of a bacterial lawn composed of rec^+ cells (H17) or rec^- cells (M45, deficient in recombinational DNA repair). The size of the zone of growth inhibition is measured for both strains, with a differential response (more killing of M45) indicative of a DNA-damaging agent. Sodium arsenite was reported to give a moderately positive response while sodium arsenate was reported to give a weakly positive response.

The results for sodium arsenate were reproduced in the B. subtilus rec assay and positive responses for four other arsenic compounds (As_2O_5, As_2O_3, $AsCl_3$, $3AsO_5$) have been reported (Kanematsu et al., 1980). These authors indicated that all arsenic compounds gave "strongly positive" responses (greater than 6 mm growth difference).

TABLE 6-4. MUTAGENICITY OF ARSENIC: ASSAYS INDICATIVE OF DNA DAMAGE OR REPAIR

Reference	Test System	Chemical Information	Results	Comments
Nishioka, 1975	Rec assay in B. subtilus. Strains: H_{17} (rec^+, arg^-, trp^-) M45 (rec^-, arg^-, trp^-	$NaAsO_2$ (0.05 M) Na_2HAsO_4 (0.05 M) 0.05 ml aliquot spotted onto filter disc. Source: Nakarai Chemical LTD. Solvent: H_2O	$NaAsO_2$ moderate positive response in rec assay. Na_2HAsO_4 weak positive response in rec assay.	
Kanematsu et al., 1980	Implication of DNA damage through the measurement of growth of normal (rec+) and recombination-repair-deficient (rec^-) B. subtilis, "rec assay." Strains: H_{17} (rec^+, agr^-, trp^-) M45 (rec^-, arg^-, try^-).	As_2O_5 (0.05 M) As_2O_3 (0.05 M) $AsCl_3$(0.03 ml) $3AsO_5$ (0.05 M) Na_2HAsO_4 (0.1 M) 0.05-ml portions of aqueous solutions at the indicated concentration are applied to the paper disc. Source: Marvichi Chemical LTD. Solvent: H_2O	All arsenic compounds gave strong positive responses. (Greater than 6-mm difference in growth).	1. Plates kept at 4°C for 24 hrs. prior to incubation at 37°C. This "cold incubation" increases the sensitivity of the assay 20 to 50 times.

REC 5036

TABLE 6-4. (continued)

Reference	Test System	Chemical Information	Results	Comments
McCarroll et al., 1981	E. coli micro-suspension assay. Measures preferential killing of repair-deficient strains. Strains WP2 (wild type) WP2 UVRA ($uvrA^-$) CM611 ($lexA^-$, $uvrA^-$) WP67 ($polA^-$, ($uvrA^-$) WP100 ($recA^-$, $uvrA^-$) WP3110 (thy^-) P3478 ($polA^-$, thy^-)	Na_2HAsO_4 500, 250, 125, 62.5, 31.3, 15.6, 7.8, 3.9, 1.9, 0.98, 0.5, 0.2 (µg/well). $NaAsO_2$ Same	Na_2HAsO_4 was positive at 130 µg/well in strain WP100. $NaAsO_2$ was positive at 63 µg/well in strain CM 611. Results in all other strains were negative.	1. The total volume per well is not clearly stated, thus the molarity of the arsenic solutions can not be calculated 2. Strain WP100 is deficient in excision repair and in postreplicational repair (both SOS error-prone and recombinational). 3. Strain CM611 is deficient in excision repair and in post-replicational error-prone (SOS) repair.
Nordenson et al., 1981	SCE in peripheral lymphocyes, in vitro exposure.	Source: Merck Solvent: Normal saline $NaAsO_2$ (390×10^{-8} M)	Positive SCE response (1.5-fold increase).	1. Added arsenic to cultures 24 hours after initiation of culture, harvested at 72 hours.

TABLE 6-4. (continued)

Reference	Test System	Chemical Information	Results	Comments
Larramendy et al., 1981	Induction of SCE in Syrian hamster embryo (SHE) cells and human peripheral lymphocytes (HPL) in vitro.	$NaAsO_2$ (7.7×10^{-7}, 1.9×10^{-6} M) in HPL. Na_2HAsO_4 (1.6×10^{-5}, 3.2×10^{-5} M) in HPL. $NaAsO_2$ (3.8×10^{-7}, 3.8×10^{-6}, 7.7×10^{-6} M) SHE. Na_2HAsO_4 (3.2×10^{-6}, 8×10^{-6}, 1.6×10^{-5}, 3.2×10^{-5} M) SHE. Source: Chemical Services Inc. "100% pure" Solvent: Cell culture medium	Dose-related increases in SCE with both compounds in both HPL and SHE (two-fold increases).	1. Arsenite was about an order of magnitude more genotoxic than arsenate. 2. Doses tested were generally non-cytotoxic. 3. Both compounds were less efficient in inducing SCE in human whole blood cultures than in purified lymphocyte cultures. 4. Exposure to arsenic was for 24 and 48 hrs. in SHE and HPL, respectively.
Andersen, 1983	Sister chromatid exchange in cultured human lymphocytes (3 donors); and in P388D cells (continuous line of macrophage cells derived from DBA/2 mouse).	$NaAsO_2$ (10^{-6}, 10^{-7}, 10^{-8} M) P388D cells. Na_2HAsO_4 (10^{-5}, 10^{-6}, 10^{-7} M) P388D cells. $NaAsO_2$ (10^{-6} M) human lymphocytes. Solvent: H_2O	Both compounds negative in P388D cells. $NaAsO_2$ positive in lymphocytes from all three donors.	1. Chemical exposure was 48 hrs. in P388D cells. 2. Chemical exposure 24, 48, and 72 hrs. in lymphocytes. 3. Results in lymphocytes variable between donors, ranging from 30% to 117% increases in SCE frequencies for the three individuals.

REC 5038

TABLE 6-4. (continued)

Reference	Test System	Chemical Information	Results	Comments
Crossen, 1983	Sister chromatid exchange in cultured peripheral lymphocytes from 4 normal human volunteers.	Na_2HAsO_4 (1.34×10^{-5}, 2.68×10^{-5} M) $NaAsO_2$ (7.69×10^{-7}, 1.54×10^{-6} M) Source: BDH Chemicals Solvent: H_2O	Na_2HAsO_4 - 1 donor increased SCE, 2 donors unchanged SCE, 1 donor decreased SCE. $NaAsO_2$ - 2 donors increased SCE, 2 donors unchanged. Both compounds negative when cells treated during G_o and <u>not</u> present during replication.	1. Results suggest that arsenic does not damage DNA but may interfere with DNA replication. 2. Even positive responses were generally not dose-related. 3. Large variation in baseline SCE levels between individuals. 4. Both compounds present during final 48 hrs of culture.

REC 5039

TABLE 6-4. (continued)

Reference	Test System	Chemical Information	Results	Comments
Ohno et al., 1982	SCE induction in DON Chinese hamster cells <u>in vitro</u>.	$NaAsO_2$ (7.7×10^{-6} M) As_2O_5 (1.4×10^{-5} M) Na_2HAsO_4 (5.4×10^{-6} M)	All compounds gave a significant increase in the SCE frequency (1.5-fold, 1.6-fold and 1.5-fold, respectively).	1. Chemical exposure was for 28 hrs. 2. Doses tested caused a 50% inhibition in cell growth.
Wan et al., 1982	Induction of SCE in CHO cells <u>in vitro</u>.	$NaAsO_2$ (10^{-6}, 10^{-5} M) Purity: analytical grade. Source: Fisher Scientific Co. Solvent: H_2O	Dose-related increase in SCE (2.4-fold increase).	1. Arsenic present for entire culture period (24 hrs).

TABLE 6-4. (continued)

Reference	Test System	Chemical Information	Results	Comments
Tkeshelashvili et al., 1980	Fidelity of DNA synthesis components: 1. E. coli DNA polymerase. 2. Artificial DNA template poly-[d(A-T)]. 3. Radiolabeled nucleotide triphosphates	Na_2HAsO_4 (0.1, 0.5, 1.0., 5.0 mM) As_2O_5 (0.1, 0.5, 2.5, 10.0 mM) Source: Either ICN Corp. or J.T. Baker Purity: 99.9%	Neither arsenic compound affected the "natural" error rate.	1. Other metals such as chromium increase the error rate in this system. 2. This is a very artificial system, i.e., the polymerase is a bacterial-repair enzyme, the DNA is an artificial template containing only two nucleotide bases and the system is carried out entirely in vitro.
Fornace and Little, 1979	Induction of DNA-protein crosslinking and single-strand DNA breaks in mouse C3H/10T 1/2 cells (alkaline elution).	$NaAsO_2$ (1 mM) Solvent: Cell culture medium	No crosslinks detected. Positive for single-strand breaks (equivalent to 120 rad of X-ray)	1. Cells were treated for 1 hour; only 2.2% of cells survived this treatment.

REC 5041

Sodium arsenate and sodium arsenite were also found positive in the E. coli microsuspension test (McCarroll et al., 1981). In this assay, a variety of E. coli strains carrying mutations for DNA repair are incubated in multiwell microplates with a serially-diluted test compound. The highest dose at which growth is evident is compared in wild type and DNA repair-deficient strains. Again, a differential sensitivity to growth inhibition is indicative of DNA damage. Sodium arsenate was found to preferentially inhibit the growth of strain WP100 ($recA^-$, $uvrA^-$) compared to wild type cells. This strain is deficient in excision as well as recombinational repair. Sodium arsenite was positive in strains WP100 and CM611 ($lexA^-$, $uvrA^-$). This latter strain is deficient in excision repair and is not inducible for post-replicational error-prone (SOS) repair. Negative results were seen in strains which are only deficient in excision repair, implying that arsenic-induced damage is not repaired by this pathway or that arsenic has no effect on enzymes which repair spontaneous damage through excision repair.

6.3.2 DNA Damage in Mammalian Cells In Vitro

Fornace and Little (1979) examined the effects of sodium arsenite on the induction of DNA-protein crosslinks and single-strand DNA breaks in mouse C3H/10T 1/2 cells using alkaline elution (Table 6-4). This technique measures the rate at which radiolabeled DNA passes through a polyvinyl chloride filter having a defined pore size. Treatment of cells for one hour did not induce DNA-protein crosslinks but did cause a significant increase in single-strand breaks. The level of breakage observed was equivalent to treating the cells with 120 rad of x-ray. It should be noted that the treatment protocol was highly toxic with only 2.2 percent of cells surviving the treatment.

6.3.3 Fidelity of DNA Synthesis

Some metals, such as chromium, are thought to be mutagenic by interfering with a DNA polymerase-editing function. As a result they increase the rate at

REC 5042

which "errors" are made in DNA replication. Loeb and co-workers have designed an *in vitro* system that measures the rate at which particular nucleotides are inappropriately incorporated into DNA (Sirover and Loeb, 1976; Tkeshelashvili et al., 1980) (Table 6-4). In this system, the DNA template is a repeating sequence of adenine and thymidine (poly[d(A - T]) which is incubated with *E. coli* DNA polymerase I, and ^{32}P-labelled dTTP and ^{3}H-dGTP. By monitoring the ratio of the two isotopes in acid precipitable material one can quantify the frequency with which an error in incorporation is made. Neither sodium arsenate nor arsenic pentoxide (As_2O_5) affected the "natural" error rate. Chromium was shown to be positive in this assay. It should be cautioned that this is a very artificial system, i.e., the polymerase is a bacterial-repair enzyme, the DNA is an artificial template containing only two nucleotide bases, and the system is carried out entirely *in vitro*.

6.3.4. Induction of Sister Chromatid Exchanges (SCE) In Vitro

Arsenic compounds have been extensively tested for the induction of SCE in a variety of cell types *in vitro*. Almost without exception the results are positive (Table 6-4). Significant increases in SCE frequencies were shown in human peripheral lymphocytes treated with sodium arsenite (Nordenson et al, 1981; Larramendy et al., 1981; Anderson, 1983; Crossen, 1983) and sodium arsenate (Larramendy et al., 1981; Crossen, 1983). The studies by Crossen, however, suggested that individuals may vary significantly in their susceptibility to arsenic-induced SCE. Crossen noted that arsenite increased the SCE frequency in cells from two donors but had no effect in cells from two other donors. Arsenate increased the SCE frequency in one donor, had no effect in two other donors and slightly decreased the SCE frequency in a fourth donor. Crossen also used a protocol in which cells were exposed to arsenic in G_o (unstimulated), washed and then cultured for SCE analysis. The results were

similar to those seen for chromosomal aberrations (Nordenson et al., 1981), i.e., neither arsenite nor arsenate increased SCE levels when treatment occurred during a nonreplicative phase. Again, these results indicate that arsenic must be present during DNA synthesis (SCE occur during S phase) to have an effect.

Arsenic has also been tested for SCE induction in Chinese hamster lines *in vitro*. Wan et al. (1982) reported a dose-related increase in SCE in CHO cells exposed to sodium arsenite, while Ohno et al. (1982) reported significant increases in the SCE frequency in DON cells exposed to single doses of sodium arsenite, sodium arsenate, and arsenic pentoxide.

6.4 INTERACTIONS OF ARSENIC WITH OTHER MUTAGENS

6.4.1. Bacterial Studies

The effects of sodium arsenite (1 mM) on the frequencies of UVC-induced mutations were measured in *E. coli* strain WWP_2 (trp^-, $uvrA^-$), a strain deficient in excision repair (Rossman et al., 1977). Arsenite was found to reduce the number of UVC-induced mutations by 30 to 40 percent. This observation suggests that arsenic may interfere with SOS (error prone) DNA repair, and may, therefore, be a bacterial antimutagen (Table 6-5).

In a later study, Rossman (1981) further examined the effect of sodium arsenate and sodium arsenite on frequencies of UVC-induced mutations. In *E. coli* WP2, which is proficient in all repair pathways, arsenite increased UVC mutagenesis at doses up to 0.25 mM and then decreased the mutation frequency at higher doses. The increase in mutation was seen only in excision repair-proficient strains. These observations suggest that arsenic interferes with excision repair at low doses and interferes with SOS repair at higher doses.

Fong et al. (1980) examined the effect of sodium arsenate on the frequency of UVC-induced single-strand DNA breaks in *E. coli* (Table 6-5). The presence

REC 5044

TABLE 6-5. SUMMARY OF MUTAGENICITY OF ARSENIC: INTERACTIONS WITH MUTAGENS

Reference	Test System	Chemical Information	Results	Comments
Rossman et al., 1977	Interaction of UVC and arsenic in *E. coli* for mutation. Strain WWP_2 (trp^-, $uvrA^-$).	$NaAsO_2$ (1 mM) plus 1.25, 5.0, and 10 J/m^2 UVC	$NaAsO_2$ reduced the number of UVC-induced mutants by 30 to 40 %.	1. Suggests that arsenic interferes with SOS repair. 2. May not be relevant to mammals since this type of repair has not been found.
Rossman, 1981	Interaction of arsenic and UVC in the induction of mutations of *E. coli*. Strains: WP2 (trp^-) $WP2_S$ (trp^-, $uvrA^-$) WP6 (trp^-, $polA1^-$) WP5 (trp^-, $lexA^-$) WP10 (trp^-, $recA^-$)	$NaAsO_2$ (0.1, 0.25, 0.5, 0.75 mM) plus 5.6 J/m^2 in WP2. Na_2HAsO_4 (0.1, 0.3, 0.5 mM) plus 5.6 J/m^2 in WP2. $NaAsO_2$ (0.2 mM) plus 5.6 J/m^2 in WP2 0.6 J/m^2 in $WP2_s$ 1.2 J/m^2 in WP6 0.6 J/m^2 in WP5 0.6 J/m^2 in WP10 Source: Fisher Chemical Co.	Arsenite increased UVC mutagenesis in WP2 at doses up to 0.25 mM and then decreased mutation frequency at higher doses. This increase was not seen with arsenate. The effect with arsenite was seen only in excision repair-proficient strains.	1. Observations indicate that arsenic may interfere with excision repair at lower doses and with SOS repair at higher doses.

REC 5045

TABLE 6-5. (continued)

Reference	Test System	Chemical Information	Results	Comments
Fong et al., 1980	Induction of single-strand (S.S) DNA breaks in E. coli after exposure to UVC light (alkaline sucrose sedimentation). Strains used: WP2-wild type WP6-(polA), lacks DNA polymerase used in repair WP2-(uvrA), deficient in excision repair.	$NaAsO_2$ (1,2,3,4, 5 mM)	1 mM arsenic inhibited the induction of S.S. breaks in WP2 and WP6 after exposure to UVC (40 J/m^2 and 10 J/m^2, respectively). 3 mM arsenic prevented the rejoining of S.S. breaks after UVC (5 J/m^2) in WP2 (uvrA) cells.	1. Arsenic prevents enzymatic incision in DNA after exposure to ultraviolet light. 2. Authors speculate this may result from arsenic-induced depletion of cellular ATP. 3. Arsenic may inhibit post-replicational repair since it prevented rejoining of S.S. breaks in cells deficient in excision repair.
Jung et al., 1969	Inhibition of unscheduled DNA synthesis (UDS) in human epidermal cells seen in biopsies derived from seven normal volunteers after UV irradiation.	Na_2HAsO_4 (10^{-5}, 10^{-6} M)	Arsenic inhibited UVC-induced UDS.	1. Tissue biopsies were incubated with arsenic for either 1 hr or 4 hrs prior to UVC exposure. 2. There were no dose- or incubation time-related effects on inhibition of UVC-induced UDS. 3. Actual numbers were not shown.

REC 5046

TABLE 6-5. (continued)

Reference	Test System	Chemical Information	Results	Comments
Rossman, 1983 (progress report)	Mutation in V79 cells. Interaction of UVC and arsenite.	Arsenite	No interaction	1. No data provided.
Poma et al., 1981a (abstract)	Interaction between arsenic and ethyl methanesulfonate in the induction of chromosome aberrations in vivo in Swiss-albino mice: bone marrow, and spermatogonia.	Arsenic (12 mg As/kg) EMS (200 mg/kg) pre- or post-treatment.	No interaction	1. No experimental details, work described in an abstract.
Sram, 1976	Chromosomal aberrations in bone marrow cells of ICR mice. Each dose group consisted of 5 female mice. Animals sacrificed 24 hours after a single dose of TEPA, scored 250 metaphases/group (assume 50/animal).	$NaAsO_2$ in drinking water for 8 weeks. 10 mg/l (7.7×10^{-5} M) 100 mg/l (7.7×10^{-4} M) TEPA 2 mg/kg	$NaAsO_2$ alone did not appear to induce aberrations although the spontaneous rate was not clearly indicated. The lower dose of arsenic in drinking water did not affect the frequency of TEPA-induced aberrations. The higher dose of arsenic resulted in a synergistic increase in the aberration rate.	1. This study was lacking in experimental details.

TABLE 6-5. (continued)

Reference	Test System	Chemical Information	Results	Comments
Sram, 1976	Interaction of $NaAsO_2$ and TEPA for dominant lethals in ICR mice; each treated and control group consisted of 20 males and 40 females/week. Mating continued for 3 to 8 weeks after the application of TEPA.	$NaAsO_2$ in drinking water for 8 weeks/ generation, males were exposed for 4 generations prior to mating. 10 mg/l (7.7×10^{-5} M) 100 mg/l (7.7×10^{-4} M) TEPA 2 mg/kg	$NaAsO_2$ alone did not appear to induce dominant lethals, although it is not clear what the spontaneous rate was. There appeared to be a positive interaction between TEPA and the higher exposure to arsenic.	1. This study was badly lacking in experimental details. 2. It was not indicated at what time after TEPA administration the increase in dominant lethals was seen, thus it is not known which germ cell stage was affected.

REC 5048

of strand breaks in DNA was measured by alkaline sucrose sedimentation. One mM arsenite was found to inhibit the induction of strand breaks in WP2 (wild type) and WP6 polA (lacks DNA polymerase I) after exposure to UVC. The presence of 3 mM arsenate in growth medium prevented the rejoining of strand breaks after UVC exposure in WP2 uvrA cells (excision repair-deficient). The authors interpreted these observations to suggest: (1) that arsenic prevents enzymatic incision of DNA after UVC exposure (UVC alone does not cause strand breaks), and (2) that arsenic may inhibit post-replicational repair since it prevented rejoining of breaks in cells deficient in excision repair. The authors further speculated that the inhibition of enzymatic incision may result from arsenic-induced cellular depletion of ATP.

6.4.2 Mammalian Cells In Vitro

The interaction of sodium arsenate and UVC on levels of unscheduled DNA synthesis (UDS) was measured in cells from human skin biopsies taken from seven volunteers (Jung et al., 1969; Table 6-5). Arsenate was tested at two concentrations (10^{-5}, 10^{-6}M) and for two preincubation periods (1 and 4 hrs). Arsenic was reported to inhibit the level of UVC-induced UDS, although there were no dose- or time-related effects. The actual numbers were not reported in the paper.

Rossman (1983) examined the effect of arsenite on UVC-induced HGPRT mutations in V79 cells. Although no data were provided in this report, the outcome was reported to be negative.

6.4.3 Mammalian Cells In Vivo

The interaction of arsenic and ethylmethanesulfonate (EMS) on levels of chromosome aberrations in vivo was examined in bone marrow and spermatogonial cells of Swiss-albino mice (Poma et al., 1981a). The arsenic dose was 12 mg As/kg combined with either pre- or post-treatment with 200 mg/kg of EMS. No

REC 5049

interactions were reported. It should be cautioned that this information has only been reported in abstract form.

Sram (1976) examined the effects of including sodium arsenite in drinking water (7.7×10^{-5}, 7.7×10^{-4} M) on frequencies of tris (1-aziridinyl) phosphine oxide (TEPA)-induced (2 mg/kg) chromosomal aberrations in ICR mouse bone marrow cells. Animals were given arsenic-laced water for 8 weeks, were injected with TEPA, and killed after 24 hours. A total of 250 cells per dose group (5 animals per dose) were scored. Sodium arsenite alone did not appear to induce aberrations, although the spontaneous rate was not clearly indicated. The lower dose of arsenic in drinking water did not affect the frequency of TEPA-induced aberrations. The higher concentration of arsenic resulted in a synergistic increase in the aberration rate. This study was, unfortunately, lacking in experimental details.

Sram (1976) did essentially the same study for the examination of dominant lethality in ICR mice. Animals were maintained for 4 generations prior to mating on arsenic-laced drinking water (7.7×10^{-5}, 7.7×10^{-4} M). TEPA was again given as a single dose of 2 mg/kg. Each treated animal and a control group of 20 males was mated with 40 females per week. The matings continued for 3 to 8 weeks after mutagen application. Sodium arsenite alone did not appear to induce dominant lethals, although the spontaneous rate was not clearly indicated. The lower dose of arsenic in drinking water did not affect the frequency of TEPA-induced dominant lethals. The higher concentration of arsenic resulted in a synergistic increase in the dominant lethal rate. It was not indicated at what time after TEPA administration the increase in dominant lethals occurred; thus, it is not known which germ cell stage was affected. This study also failed to provide experimental details.

6.5 POSSIBLE MECHANISMS OF ACTION

Arsenic is unusual in several respects. First, unlike the overwhelming majority of clastogenic agents, arsenic does not appear to directly damage DNA. Rather, it seems to have its effect through some interference with DNA synthesis. This contention is supported by the observations that arsenic induces chromosomal aberrations and SCE only when it is present during DNA replication. Incubation and removal of arsenic before DNA synthesis has no effect (Nordenson et al., 1981; Crossen, 1983).

Second, arsenic is highly unusual in that it induces chromosomal aberrations and SCE while it fails to induce gene mutations. In this regard, it is like diethylstibesterol, which is another highly unusual carcinogen. X-irradiation, although capable of producing chromosome aberrations as well as gene mutations, is much more potent for the former endpoint. There is a small possibility, however, that the discrepancy for arsenic may be founded on an artifact. Protocols for gene mutation assays generally involve cellular incubation with the test agent for relatively short time periods (2 to 3 hours), while protocols for aberrations often involve the presence of the test agent for one or two entire cell cycles (12 to 48 hours). Thus, in the latter protocol, arsenic would be present for at least an entire S phase for all cells, whereas, when tested for gene mutations, arsenic would be present for only a small fraction of the S phase in approximately one-third to one-half of the cells. Since the evidence available suggests that arsenic has its effect only during DNA replication, this may account for the discrepancy.

Arsenic has long been known to be a sulfhydryl reagent capable of inhibiting a number of thiol-dependent enzyme systems, trivalent forms being much more potent than pentavalent forms (Leonard and Lauwerys, 1980). Thus, one possible mechanism of action for arsenic would be the inhibition of DNA repair enzymes. The work of Rossman (1981) in bacteria and Jung (1969) in human

REC 5051

skin cells *in vitro* lends support to this hypothesis. Also, the observations of Sram (1976) on the interactions of arsenic with TEPA for the induction of chromosomal aberrations and dominant lethals support such a contention. The potencies of trivalent and pentavalent arsenicals as sulfhydryl reagents are similar to their potencies as clastogens and SCE-inducing agents. Observations which counter this hypothesis are the reports by Rossman that arsenic has no effect on the frequency of UVC-induced mutations in mammalian cells *in vitro* and the fact that arsenic does not affect the frequency of EMS-induced aberrations *in vivo* (Poma et al., 1981a).

Another possible mechanism for the action of arsenic may be through its occasional incorporation into the DNA backbone in place of phosphorus. There are several lines of evidence to support this mechanism. First, for this to occur, arsenic would have to be present during DNA synthesis and would have no effect on non-dividing cells. Second, such a mechanism could explain why arsenic is clastogenic (such a bond would be weaker than the normal phosphodiester bond) but does not induce gene mutation. Third, arsenic has been shown to cause strand breaks in DNA (Fornace and Little, 1979). X-irradiation, a potent clastogen and poor inducer of gene mutations, also predominantly causes strand breaks as its major DNA lesion. An argument against such a mechanism is the observation that the trivalent forms are more potent than pentavalent forms, while pentavalent arsenic should be more likely to substitute for phosphorus in DNA. Therefore at present, there is no single, unambiguous explanation for the mechanisms by which arsenic breaks chromosomes or induces SCE.

REC 5052

7. ARSENIC CARCINOGENICITY

The case for the association of inorganic arsenic with skin and lung cancer as well as other visceral carcinomas has been extensively reviewed (Arsenic NAS, 1977; IARC, 1973 and 1980; NIOSH, 1975; Hernberg, 1977; Sunderman, 1976, Pelfrene, 1976; Kraybill, 1978; Wildenberg, 1978; Pershagen and Vahter, 1979; WHO, 1981). The following chapter is divided into three major sections discussing human studies, animal studies and quantitative carcinogenic risk estimates.

7.1 HUMAN STUDIES

The literature on arsenic carcinogenicity in humans is summarized in Table 7-1. This subsection on human studies will first focus on clinical pathophysiological aspects of arsenic carcinogenesis, followed by pertinent epidemiological studies of arsenic-induced carcinogenesis.

7.1.1 Clinical Aspects of Human Arsenic Carcinogenesis

In man, chronic exposure to arsenic induces a characteristic sequence of changes in skin epithelium, proceeding from hyperpigmentation to hyperkeratosis which may be histologically described as showing keratin proliferation of a verrucose nature with derangement of the squamous portions of the epithelium or may even be described in some cases as squamous cell carcinomas.

Late onset skin cancers, associated with arsenic exposure, appear to be of two histopathological types: squamous carcinomas in the keratotic areas and basal cell carcinomas. In one study dealing with skin cancer after prolonged use of Fowler's solution (Neubauer, 1947), the ratio of types was approximately 1:1.

Arsenic-associated skin cancers differ from those of ultraviolet light etiology by occurring on areas generally not exposed to sunlight, e.g. palms and soles, and occurring as multiple lesions (Arsenic. NAS, 1977; Pershagen

REC 5053

TABLE 7-1. SUMMARY OF CASE REPORTS AND EPIDEMIOLOGIC STUDIES OF CANCER OR PRECANCEROUS LESIONS IN PERSONS EXPOSED TO ARSENIC

Media	Study Population	Author(s)	Type of Study	Results	Highlights and Deficiencies
Air	Smelter workers-Tacoma, Washington (Analysis of deaths for 1946-1960)	Pinto and Bennett (1963)	Proportionate mortality	No difference in lung cancer proportionate mortality between exposed and unexposed workers.	Workers leaving the plant before retirement were not included. In the classification of workers by exposure, the "non-exposed" group apparently were exposed since they also had high levels of arsenic in the urine.
	Smelter workers-Tacoma, Washington (follow-up from 1950-1971)	Milham and Strong (1974)	Cohort	40 observed lung cancer deaths versus 18 expected ($P < 0.001$).	Urinary arsenic levels of persons living around the smelter decreased with distance from the smelter.
	Smelter workers-Tacoma, Washington (follow-up from 1949-1973)	Pinto et al. (1977)	Cohort	32 observed respiratory cancer deaths, versus 10.5 expected ($P < 0.05$). Dose response seen by urinary arsenic levels and by duration and intensity of exposure.	Study consisted of only pensioners.
	Smelter workers-Tacoma, Washington (Follow-up from 1941-1976)	Enterline and Marsh (1982)	Cohort	104 respiratory cancer deaths observed versus 52.5 expected ($P < 0.01$). Dose response found by intensity and duration of exposure.	Short-term high-intensity arsenic exposures appeared to have a greater effect than did long-term low-intensity exposures; SO_2 exposure was found to have little or no effect.
	Smelter workers-Anaconda, Montana (Follow-up from 1938 to 1963)	Lee and Fraumeni (1969)	Cohort	147 respiratory cancer deaths observed versus 44.7 expected ($P < 0.01$). Dose response found by intensity and duration of exposure.	A dose response was found between exposure to sulfur dioxide and respiratory cancer mortality. Exposure to sulfur dioxide could not be separated from exposure to arsenic, however.
	Smelter workers-Anaconda, Montana (Follow-up from 1964 to 1977)	Lubin et al. (1981)	Cohort	146 respiratory cancer deaths versus 88.7 expected ($P < 0.01$).	Exposure to sulfur dioxide was not found to have an independent effect on cancer risk.
	Sample of 1800 of the smelter workers-Anaconda, Montana (Follow-up from 1938-1977)	Welch et al. (1982); Higgins et al. (1982)	Cohort	24 respiratory cancer deaths versus 4.6 expected ($P < 0.01$) in the heavy exposure category. Dose response found by intensity (both time-weighted average and ceiling level categories) of exposure.	Analysis of lung cancer mortality by SO_2 exposure found that SO_2 did not play an important role in the respiratory cancer process.

REC 5054

TABLE 7-1. (continued)

Media	Study Population	Author(s)	Type of Study	Results	Highlights and Deficiencies
Air	Smelter workers-Anaconda, Montana (Follow-up from 1938 to 1977)	Lee-Feldstein (1983)	Cohort	302 respiratory cancer deaths observed versus 105.8 expected (P <0.01). Dose response found by duration and exposure.	
	Lung cancer from the parish where the Ronnskar smelter is located	Axelson et al. (1978)	Case-control	For smelter workers, the lung cancer mortality odds ratio was 4.6; there also was a significantly (P <0.02) elevated risk of leukemia and myeloma among smelter workers.	Exposure to sulfur dioxide did not appear to be associated with lung cancer.
	Lung cancer deaths in the city of Saganoseki-machi, Japan	Kuratsune et al. (1974)	Case-control	58% of lung cancer cases were found to be former smelter workers versus 15.8% in controls.	The cause of death listed on the death certificate was validated using detailed pathologic analysis.
	Copper smelters in Sagnoseki-machi, Japan	Tokudome and Kuratsune (1976)	Cohort	29 trachea, lung, and bronchus cancer deaths versus 2.44 expected (P <0.01); 3 observed colon cancer deaths versus 0.59 expected (P <0.05). A lung cancer dose response was seen by length of employment and level of exposure.	The latent period ranged from 13 to 50 years, with an average of 37.6 years.
	Smelter workers in Magna, Utah	Rencher et al. (1977)	Proportionate mortality and cohort	7 percent of the deaths were lung cancer deaths compared to 0 to 2.2 percent for other factory workers and 2.7 percent for the State; the lung cancer death rate was found to be 10.1 per 10,000 versus 2.1 and 3.3 per 10,000 for mine workers and the State, respectively.	
	Residents living near a smelter in El Paso. Texas	Rom et al. (1982)	Case-control	No association was found between lung cancer and distance from the plant.	Effects of migration, smoking and occupation were not considered.

REC 5055

TABLE 7-1. (continued)

Media	Study Population	Author(s)	Type of Study	Results	Highlights and Deficiencies
Air	Residents of Deer Lodge and Silver Bow Counties, Montana	Newman et al. (1976)	Ecological correlation	There was an increase found in the incidence of lung cancer among men. In one of the cities there was also an increase in lung cancer among women.	No adjustment was made for cancer cases which may be occupational.
	All counties in the United States with smelters	Blot and Fraumeni (1975)	Ecological correlation	Average lung cancer mortality rates were significantly elevated for both males and females in 36 counties with smelters processing copper, lead, or zinc ores.	
	Residents near a smelter in Utah	Lyon et al. (1977)	Case-control	No association between cancer and distance from the smelter was found.	Lymphoma cases which may have an association with arsenic exposure were used as controls. Effects of smoking, migration, and occupation were not considered.
	Residents near Ronnskarverken smelter in northern Sweden	Pershagen et al. (1977)	Ecological correlation	A significantly higher mortality rate for lung cancer was noted for men in the exposed area. The increase was no longer significant when occupational cases were excluded, however.	When excluding occupational cases of lung cancer from the study population, lung cancer cases for a comparable occupational group were not excluded from the comparison population.
	Population surrounding an arsenical pesticide facility	Matanoski et al. (1976, 1981)	Ecological correlation	The lung cancer mortality for males in the census tract in which the plant was located was 3-4 times higher than the control tracts ($P < 0.05$).	The difference in the lung cancer mortality rate in the index tract could not be explained by occupation.
	Arsenical sheep dip manufacturing workers	Hill and Faning (1948)	Proportionate mortality	29.3 percent of deaths were due to lung cancer versus 12.9 percent of deaths among workers in the same geographic area who were not exposed to arsenic ($P < 0.05$). The excess in cancer deaths was mainly due to an excess in lung cancer and skin cancer.	

REC 5056

TABLE 7-1. (continued)

Media	Study Population	Author(s)	Type of Study	Results	Highlights and Deficiencies
Air	Arsenical pesticide manufacturing workers	Ott et al. (1974)	Proportionate mortality and cohort	16.2% and 3.5% of deaths in the exposed group were from cancer of the respiratory system and from lymphatic and hematopoietic cancers, except leukemia, respectively, versus 5.7 and 1.4% in the controls; the cohort mortality study found 20 respiratory cancer deaths and 5 deaths of the lymphatic and hematopoietic tissues versus 5.8 and 1.3 expected, respectively (both significant at $P < 0.01$).	A respiratory cancer mortality dose response was not found below an average dosage of 3890 mg of arsenic, but above that dosage there was a good dose response. It should be noted, however, that all of the respiratory cancer at or below 3890 mg had less than one year of exposure. Thus, it is unlikely that those deaths were due to arsenic exposure.
	Retirees of an arsenical pesticide plant in Baltimore, Maryland (follow-up from 1960 to 1972)	Baetjer et al. (1975)	Proportionate mortality and cohort	The proportionate mortality ratio (PMR) was 6.58 for respiratory cancer ($P < 0.05$); for cause-specific mortality the observed-to-expected ratios were 16.67 for respiratory cancer and 50 for lymphatic cancer (both with $P < 0.05$).	The cohort study was limited to pensioners only.
	Retirees of an arsenical pesticide plant in Baltimore Maryland (follow-up 1946 to 1977)	Mabuchi et al. (1979)	Cohort	12 observed lung cancer deaths versus 3.6 expected ($P < 0.05$); a dose response by duration of employment was seen for those with exposure of high intensity.	
	Wenatchee Valley orchard workers in the state of Washington	Nelson et al. (1973)	Cohort	No difference was found between the cohort and the state of Washington for overall cancer mortality or for lung cancer mortality.	
	German vintners	Roth (1958)	Proportionate mortality	Of 47 autopsies among vintners with chronic arsenic intoxication, 64% of the deaths were due to cancer, 60% to lung cancer; 6 of the 47 and 13 of the 47 were reported to have liver and skin tumors, respectively.	No controls were used. There was no indication of how the autopsy cases were selected.

REC 5057

TABLE 7-1. (continued)

Media	Study Population	Author(s)	Type of Study	Results	Highlights and Deficiencies
Water	Residents of a section of Taiwan with high levels of arsenic in the drinking water	Tseng et al. (1968); Tseng (1977)	Cross-sectional	A skin cancer prevalence rate of 10.6/1000 for those drinking well water was found compared to 0/1000 for a control area. The skin cancer rate followed a dose response by arsenic concentration in the water.	
	Sample of inhabitants of Antofagasta, Chile	Borgono and Greiber (1972)	Cross-sectional	Abnormal skin pigmentation and hyperkeratosis were found in Antofagasta where high arsenic levels in the water were reported. No skin cancers were reported, however.	
	Residents of certain departments in the province of Cordoba, Argentina, exposed to high levels of arsenic in the water	Bergoglio (1964)	Proportionate mortality	The proportion of cancer deaths was higher than for the province as a whole (23.84% versus 15.3%, $P < 0.05$). Of the cancer deaths, respiratory cancer was reported to be 35% and skin cancer 2.3%.	The data were apparently not age-adjusted. No comparison was made of the percentage of respiratory and skin cancer deaths in the affected departments with the respective proportion for Cordoba Province.
	Patients at a dermatology clinic in eastern Argentina	Arguello et al. (1938)	Case reports	The largest proportion of cases in the clinic (82%) came from areas with the highest incidence of chronic endemic regional arsenical intoxication.	The study was not population-based.
	Residents in an area of Lane County, Oregon	Morton et al. (1976)	Cross-sectional	The prevalence of skin cancer was not found to be associated with arsenic concentrations in the water.	The sample size was relatively small.
	Residents of Hinckley and Deseret, Utah, where relatively high arsenic contamination of the drinking water supplies existed and Delta, Utah, which had very little arsenic contamination of the water supply	Southwick et al. (1981)	Cross-sectional; mortality comparison	There was no dermatological evidence of arsenic ingestion in Hinckley or Deseret. No evidence of unusual cancer mortality patterns in Hinckley was found.	Sample size was very small-only 145 in the exposed group, 105 in the controls. The town of Hinckley is rather small for a mortality analysis. The population was only 400 in 1970.

REC 5058

TABLE 7-1. (continued)

Media	Study Population	Author(s)	Type of Study	Results	Highlights and Deficiencies
Water	353 cases of Blackfoot disease and 353 controls matched for sex and age in an area of Taiwan with an endemic arsenic contamination of the water supply	Ch'i and Blackwell (1968)	Case-control	Significantly ($P < 0.01$) more cases than controls were found to consume deep well water (known to be contaminated with arsenic) and population had a low socioeconomic status.	
	Two persons living in an area of Taiwan with endemic high levels of arsenic in the water supply	Astrup (1968)	Case report	Both individuals had developed Blackfoot disease.	
Water, soil, dust	One female child	Falk et al. (1981b)	Case report	Child, with a history of pica, developed hepatic angiosarcoma with associated congenital dysplasia of the liver and an infantile benign hemangioendothelioma suggesting pre-natal as well as post-natal etiological factors.	
Milk	A group of children in Japan	Yamashita et al. (1972)	Cohort	Hyperpigmentation and depigmentation were found to be prevalent in about 15 percent of the survivors approximately 15 years after exposure.	There was no comparison group.
Arsenical medicinals	Patients being treated with arsenical medicinals	Hutchinson (1888)	Case reports	Six patients treated with arsenical medicinals exhibited the keratotic lesions associated with arsenical poisoning.	
Arsenical medicinals	Patients being treated for skin diseases and various internal disorders with arsenical medicinals.	Neubauer (1947)	Case reports	143 individuals with epitheliomas and who had taken arsenical medicinals.	

REC 5059

TABLE 7-1. (continued)

Media	Study Population	Author(s)	Type of Study	Results	Highlights and Deficiencies
Arsenical medicinal	Patients treated with Fowler's solution (an arsenical medicinal) by a private practitioner	Fierz (1965)	Cohort	106 of the 262 patients reporting for physical examination reported hyperkeratosis; 21 cases of skin cancer were also found. The response increased with increasing dose.	Less than 45% of the cohort presented themselves for physical examination, and the author himself reported that the patients reporting for examination were not a representative sample. Furthermore, no controls were used.
Arsenical medicinal	Patients treated with arsenical medicinals	Reymann et al. (1978)	Cohort	Of 389 persons treated with arsenical medicinals, 41 internal malignant neoplasms were found to occur versus 44.6 expected. No increase in internal malignant neoplasms was found by dose.	There was no control group. Internal organs presumably include the lung, and there was no control for smoking, a major confounder with regard to lung cancer.
Arsenical medicinal (Fowler's Solution)	Patients treated with Fowler's solution	Cuzick et al. (1982)	Cohort	A statistically significant association of ingestion of Fowler's solution with deaths from internal malignancies was not found. A subset of 142 of the 487 in the cohort was examined and 49% were found to show dermal signs of arsenicism including skin cancer (11%).	In the subset of 142, deaths from internal malignancies occurred only in those who had previously demonstrated dermal signs of arsenicism, leading the authors to conclude that perhaps persons who show signs of arsenicism are at a greater risk of death from internal malignancies.
Arsenical medicinal (Fowler's Solution)	Male patient	Regelson et al. (1968)	Case report	Hemangioendothelial sarcoma of the liver.	
Arsenical medicinals (Fowler's Solution)	27 cases exposed to arsenic either via arsenical drugs or via occupation	Sommers and McManus (1953)	Case reports	Skin carcinomas were reported in all cases; visceral cancers were reported for some of the cases.	
Arsenical medicinal	Male patient	Nurse (1978)	Case report	Adenocarcinoma of the kidney	Patient treated with a variety of other drugs before developing kidney cancer.

REC 5060

TABLE 7-1. (continued)

Media	Study Population	Author(s)	Type of Study	Results	Highlights and Deficiencies
Arsenical medicinal	2 male patients 1 female patient	Knoth (1966)	Case reports	Female developed mammary carcinoma and skin cancer; 1 male patient developed a reticulosarcoma of the glans penis; 1 male developed skin cancer.	
Arsenical medicinals, occupational exposure, and air (occupational) exposure	16 vintners who were arsenical pesticide users; patient who took arsenical medicinals	Braun (1958)	Case reports	Skin and visceral cancers were reported among the vintners; skin and lung cancers were reported for one patient taking an arsenical medicinal; skin cancer was reported for the other patient who took an arsenical medicinal.	
Arsenical medicinals (Fowler's Solution)	2 male patients	Morris et al. (1974)	Case reports	One patient developed skin pigmentation, skin tumors, carcinoma of the larynx, and a probable bronchial carcinoma; the other developed skin pigmentation and keratosis. Both developed noncirrhotic portal hypertension.	
Arsenical medicinal (Fowler's Solution)	Female patient	Prystowsky (1978)	Case report	Woman developed nasopharyngeal cancer; also developed palmar and plantar keratosis.	
Arsenical medicinals (Fowler's (Solution)	4 male patients and 1 female patient	Popper et al. (1978)	Case reports	The cases developed angiosarcoma of the liver.	
Arsenical medicinal (Fowler's Solution)	1 male patient	Lander et al. (1975)	Case report	The patient developed angiosarcoma.	

REC 5061

TABLE 7-1. (continued)

Media	Study Population	Author(s)	Type of Study	Results	Highlights and Deficiencies
Arsenical medicinal (Fowler's Solution)	1 male patient	Roat et al. (1982)	Case report	The patient developed both angiosarcoma and skin cancer.	
Arsenical medicinal (Fowler's Solution)	7 male patients and 1 female patient	Falk et al. (1981a)	Case reports	The cases developed angiosarcoma.	
Wood preservative	Wood treaters in Hawaii	Gilbert et al. (1983)	Cross-sectional and cohort	No association of arsenic exposure with cancer mortality or morbidity was found.	The sample size was small (only 88 in the study cohort and 61 in the controls in the cross-sectional study; 125 in the mortality study; 182 in the morbidity study).

REC 5062

and Vahter, 1979; WHO, 1981; Tseng, 1977; Sunderman, 1976). This appears to be the case for medicinal (Neubauer, 1947), environmental (Tseng et al., 1968), and occupational (Roth, 1958; Braun, 1958) exposure. The time lag between initiation of exposure and occurrence of skin cancer has been reported to range from 6 to 50 years for arsenical medicinally-induced skin cancer. The minimal latency period for skin cancer in the most reliable epidemiologic study of arsenic-contaminated drinking water was reported to be 24 years.

The amount of data on the histological classification of lung tumors associated with occupational arsenic exposure is limited. Newman et al. (1976) report that arsenic-associated lung cancers are usually the poorly differentiated type of epidermoid bronchogenic carcinoma. These investigators studied worker groups with diagnosed lung cancer in copper-mining and smelting communities in Montana. Of 25 smelter workers, 4 had well-differentiated epidermoid carcinoma, 10 poorly differentiated epidermoid carcinoma, 7 small-cell undifferentiated epidermoid carcinoma and 3 acinar-type adenocarcinoma. Copper miners and "non-copper" control individuals had lung cancer profiles which were similar to each other.

The time period between initiation of exposure and the occurrence of arsenic-associated lung cancer was found in a couple of studies to be on the order of 35-45 years (Lee and Fraumeni, 1969). Recently, a latency period of <20 years was reported by Enterline and Marsh (1980; 1982) based upon their studies of copper smelter workers in Tacoma, Washington. Tokudome and Kuratsune (1976) found that the latent period for lung cancer ranged from 13 to 50 years.

The association of other visceral cancers with arsenic exposure has been noted in a number of reports and has been reviewed elsewhere (WHO, 1981; Arsenic. NAS, 1977; NIOSH, 1976; IARC, 1973). For example, hemangiosarcoma of

REC 5063

the liver, a rare form of cancer, has been diagnosed in workers exposed to arsenic and in non-occupationally arsenic-exposed individuals (Roth, 1958; Regelson et al., 1968; Lander et al., 1975; Falk et al., 1981a and b; Roat et al., 1982). Morris et al. (1974) have postulated that the peculiar hepatic fibrosis associated with arsenic-induced portal hypertension is a precursor state for subsequent progression to hepatic angiosarcoma. Popper et al. (1978) have noted that the hepatic fibrosis and hypertension seen in humans with Thorotrast, vinyl chloride or arsenic exposure are also induced by agents which presumably also have a role in hepatic angiosarcoma.

Other cancers noted in arsenic-exposed subjects include: lymphomas and leukemia (NIOSH, 1976; Ott et al., 1974); renal adenocarcinoma (Sommers and McManus, 1953; Nurse, 1978); and nasopharyngeal carcinoma (Prystowsky et al., 1978).

Pelfrene (1976) has criticized the reports of internal malignant neoplasms associated with arsenic exposure on the basis of the relative rarity of their detection in large-scale studies of chronic arsenic exposure such as that of Tseng (1968, 1977). More recently, Reymann et al. (1978) reported on a study of a group of 389 patients who took arsenic medicinally in the 1930s. An excess of internal cancers was not observed in the total cohort when compared with the expected incidence of malignant internal neoplasms based on the Danish Cancer Registry. The size of the cohort was probably too small to have detected an increase, however.

7.1.2 Epidemiological Aspects of Human Arsenic Carcinogenesis

7.1.2.1 Cancer of the Lung--A large number of reports are available on possible associations between occupational exposure to arsenic and cancer of the respiratory system. As is common in studies of this type, exposure data are very uncertain and the arsenic exposure is not always clearly defined regarding the physicochemical properties of the arsenic compounds. The picture is often

REC 5064

confused by simultaneous exposure to other agents, especially sulfur dioxide and metals. Data on smoking are often lacking or incomplete.

An excess mortality in respiratory cancer has especially been noted among workers engaged in the production and usage of pesticides, and among smelter workers.

In 1948, Hill and Faning presented data on proportional mortality rates among British workers exposed to a mixture of ingredients--including sodium arsenite, powdered sulfur and soda ash--used in the manufacture of a sheep-dip powder. Between 1910 and 1943, 75 deaths had occurred among workers in the sodium arsenite factory and 1,216 deaths had occurred among workers in the same area but without known exposure to arsenic. Proportionate mortality analysis showed that of the deaths among factory workers, 29.3 percent had died from cancer, whereas the corresponding figure for the other workers was 12.9 percent. The excess in cancer deaths among the factory workers was mainly due to an excess in lung cancer, 31.8 percent of all cancer deaths compared with 15.9 percent; and in skin cancer, 13.6 percent compared with 1.3 percent.

Among the factory workers, chemical workers, who were the workers most closely associated with arsenite production, had a higher proportion of cancer deaths than did the factory workers as a group. Furthermore, all lung cancer deaths had occurred among the chemical workers.

Arsenic in the air of the sodium arsenite factory was determined in 1945-46 (Perry et al., 1948) and concentrations up to 4 mg As/m^3 were found by sampling for 10 minutes. No data were given on the age of the deceased, and smoking habits were not recorded. The data do not allow any conclusions about exposure before 1943. Nevertheless, this study indicated that there might be an increased risk for respiratory cancer in the manufacture of arsenic-containing pesticides, and studies in two United States plants have given further support.

REC 5065

Ott et al. (1974) studied the mortality of workers in one of these two chemical plants. From 1919 to 1956 one unit formulated and packaged insecticides containing arsenic in the form of lead arsenate, calcium arsenate, copper acetoarsenite, and magnesium arsenate. During this period, the proportions of the different compounds varied. The main product was lead arsenate. The size of the workforce was about 30 in 1928 and 100 in 1948. Turnover was high with less than 25 percent of the men remaining with the unit for more than one year. Arsenic concentrations in air in 1943 were between 0.18 and 19 mg As/m^3 in the packaging area; in 1952 concentrations were 1.7-40.8 mg As/m^3 and 0.26-7.5 mg/m^3 in the drum dryer area and packaging area, respectively. By combining job classifications and air arsenic data, four exposure classifications were obtained with estimated arsenic exposures (8-hr TWA) of 5, 3, 1, and 0.1 mg/m^3. The total dosage was then calculated for each individual by multiplying air levels with the number of days at work and assuming that 4 m^3 were inhaled during a working day.

Mortality was studied by analysis of proportionate mortality and by a retrospective cohort analysis. Nearly 2,000 employees in the factory had died between 1940 and 1972. One hundred seventy-three were identified as having worked one or more days in the arsenical production unit and who then either worked for the company until death or died after retirement.

Ott et al. (1974), after adjusting for age and year of death, compared the differences in proportionate mortality between the study group and the controls. Among the exposed, respiratory cancer accounted for 16.2 percent of the deaths compared with 5.7 percent in the controls ($p < 0.001$). There was also a significant increase ($p < 0.05$) in deaths from lymphatic and hematopoietic cancers, except for leukemia. Table 7-2 shows the observed-to-expected ratios for respiratory cancer in relation to exposure. (In the original table, dosage estimates were based on 4 m^3 inhaled per 8 hr and expressed as the natural logarithms.

REC 5066

TABLE 7-2. OBSERVED AND EXPECTED DEATHS DUE TO RESPIRATORY MALIGNANCIES, BY EXPOSURE CATEGORY

TWA Concentration x months of exposure	Average dosage mg	No. of total deaths†	Respiratory Malignancy Deaths			
			Observed*	Expected	Ratio	Observed / Expected
<1	105	26	1 (1)	1.77		.6
1-1.9	316	17	2 (2)	1.01		2.0
2-3.9	630	24	4 (4)	1.38		2.9
4-5.9	1050	22	3 (3)	1.36		2.2
6-11.9	1991	27	3 (3)	1.70		1.8
12-23.9	3890	18	2 (2)	.97		2.1
24-59.9	8833	13	3 (1)	.77		3.9
60-95.9	16257	13	5 (0)	.79		6.3
96+	74332	13	5 (0)	.72		7.0

†n = 173, 138 workers had less than one year of exposure.

*Number in brackets shows respiratory cancer deaths in workers exposed less than one year.

Source: Modified from Ott et al. (1974), and Blejer and Wagner (1976).

REC 5067

In the present table, dosage is expressed in mg and is based on 10 m^3 inhaled air.) There is no tendency towards a dose-response relationship at total exposures from 105 to 3890 mg, but a sharp increase is noted at higher dosages. Furthermore, Blejer and Wagner (1976) reported that of the 173 deaths, 138 had occurred among workers with less than one year of exposure. In that group, 16 deaths were due to respiratory cancer. As seen in Table 7-2, 15 of those deaths occurred in the six groups with average total exposures estimated to be from 105 to 3890 mg. There are no quantitative data on other compounds that these workers might have been exposed to during their total time with the company; however, it is known that in addition to the arsenic-containing insecticides, the plant processed and packaged several other products, the most important of which were powdered sulfur and dry lime sulfur.

The retrospective cohort analysis was based on a roster of 603 workers who had worked for at least one month in the actual unit between 1940 and 1973. Workers leaving the company before retirement as well as workers who had been exposed to asbestos were not included in the analysis. It was stated that virtually all men with at least one year of exposure had been identified. Person-years, by 10-year age groups, for five calendar year groups were calculated and expected number of deaths were calculated by using United States white male mortality data. Table 7-3 shows that by this analysis a significant increase ($p < 0.01$) in deaths due to respiratory cancer was found among exposed workers. There was also a significant increase ($p < 0.01$) in the number of deaths due to malignant neoplasms in lymphatic and hematopoietic tissues, except leukemia.

A chemical plant in Baltimore was the subject of two studies concerning the working environment and one study concerning the outer environment. This plant started producing arsenic acid in the early 1900s and in the early

REC 5068

TABLE 7-3. OBSERVED AND EXPECTED DEATHS FOR SELECTED CAUSES IN RETROSPECTIVE COHORT ANALYSIS (1940-1973)

	Observed deaths	Expected deaths (U.S. white males)	Ratio of observed to expected deaths
All causes	95	113.5	.84
Malignant neoplasms, total	35	19.4	1.80
Respiratory system	20	5.8	3.45†
Digestive organs & peritoneum	7	6.3	1.11
Lymphatic & hematopoietic tissues except leukemia	5	1.3	3.85†
All other sites	3	6.0	.50
Diseases of cardiovascular system	41	58.5	.70
Emphysema, chronic bronchitis, & asthma	4	2.8	1.43
All external causes	9	12.7	.71
All other causes	6	20.1	.30

† $p < 0.01$

Source: Ott et al. (1974).

REC 5069

1950s production of arsenical pesticides started. Lead arsenate, calcium arsenate and sodium arsenate were among the compounds produced. Production terminated in 1974 (Matanoski et al., 1976). The plant also produced chlorinated hydrocarbons and organic phosphates. Data on air concentrations of arsenic are lacking.

In the first study, Baetjer et al. (1975) reported on both the proportionate mortality and age-specific death rates of workers who had retired between 1960 and 1972 and generally had at least 15 years' employment. Seventeen of 22 deaths among male white workers and two of five among female workers were due to malignant neoplasms. The female deaths did not appear to be related to occupational exposure, whereas, the male deaths did. Of the 17 malignant neoplasms in males, 10 were in the respiratory tract, 3 were lymphosarcomas, and the remaining 4 were of other tissues. The proportionate mortality analysis, based on mortality data for the city of Baltimore, showed an observed/expected ratio of 6.58 for respiratory cancer ($p < .05$) and 15.79 for cancer of the lymphatic and hematopoietic system ($0.1 < p < 0.05$). The age-specific death rate analysis showed that deaths from respiratory cancer were 16.67 times the expected, and, that for lymphosarcomas, the observed number was 50 times that of the expected number. The authors reported that observed and expected rates for non-cancer deaths did not differ significantly ($p < 0.05$).

In a second study (Mabuchi et al., 1979), a follow-up was made of workers employed from 1946 to 1974. Since exposure data were lacking, an attempt was made to classify workers according to exposure to arsenicals and non-arsenicals. A roster of 3,141 workers was obtained. Since 2,189 workers had been employed for less than 4 months, a 20 percent random sample was drawn from that population and together with the remaining 952 workers constituted the study popula-

tion: 1,050 males and 343 females, mainly white. Exposure assessments were made, and the workers were categorized into one of six exposure groups.

Of the study population, 240 had died: 197 males and 43 females. Expected deaths were calculated from the city of Baltimore statistics. The observed/expected ratios for lung cancer were analyzed by exposure, year of first employment, and duration of employment. A statistically significant increase in lung cancer mortality (SMR = 336, $p < 0.05$) was found among "predominantly arsenical production" workers. There was a clear lung cancer mortality dose response among these workers by duration of exposure. Those employed 15-24 years and 25+ years both had statistically significant ($p < 0.05$) lung cancer SMRs (1365 and 2750, respectively). Interestingly, statistically significantly elevated SMRs were only found in "predominantly arsenical production" workers, but not in workers engaged entirely in arsenical production. Further analysis revealed that the proportion of workers engaged entirely in arsenical production for 5 years or more was relatively low (1 percent), while the proportion of workers exposed predominantly, but not entirely, to arsenic for 5 years or more was much higher (29 percent). This difference in duration of exposure may have accounted for the absence of excess lung cancer mortality among the workers engaged entirely in arsenical production. Data on smoking were not obtained.

Occupational exposure to arsenical pesticides has been common among vintners and agricultural workers. Exposure has mainly been to lead arsenate. In a study of orchard workers who used lead arsenate in the Wenatchee Valley in the state of Washington, Nelson et al. (1973) found a deficit of lung cancer mortality for the period 1938-68 when compared with mortality for the state of Washington.

Because the results of this study were at variance with previous evidence on the long-term effects of arsenic exposure, NIOSH reviewed data from other

sources and used alternative procedures in an attempt to verify the findings. Analysis of respiratory cancer mortality data by occupational category for the state of Washington for the period 1950-71 found that orchardists had 19 percent more deaths from respiratory cancer than expected. An analysis of cancer mortality rates for 1950-69 for the counties comprising the locale from which the orchardist sample was drawn by Nelson et al. found that males had a 7 percent higher respiratory cancer rate than expected among males. The county from which most of the orchardists were drawn had a 31 percent excess ($P < 0.01$) of lung cancer mortality. Thus, it was NIOSH's (1975) conclusion that the Nelson et al. report did not accurately depict the cancer experience of persons exposed to lead arsenate spray in the Wenatchee Valley.

Several studies in Germany indicate that workers exposed to arsenic trioxide when spraying vineyards had a high mortality in cancer, especially lung cancer. In one report (Roth, 1958), it was stated that of 47 autopsies among vintners with chronic arsenic intoxication, 30 (64 percent) were due to cancer, and 18 to lung cancer (60 percent of all cancer deaths). The author did not state how the cases were selected, nor were controls used in the study.

Gilbert et al. (1983) studied a group of 182 workers in Hawaii exposed for at least 3 months during the period 1960-1981 to the wood-treating chemicals chromated-copper-arsenate (CCA), pentachlorophenol (penta), tributyl tin oxide (TBTO) and lindane. The study was divided into two parts: (1) a cohort comparison study of 88 workers and 61 controls and (2) a historic prospective study which consisted of a morbidity and a mortality analysis of the entire cohort.

In the cohort comparison study, 61 controls were matched on the basis of age, sex, race, level of physical activity, and weight to 88 wood treatment

REC 5072

workers who were "qualified and agreed to participate in the study." Controls were recruited from among the membership of carpenters', ironworkers', masons', plumbers', and stevedores' unions and from the names of friends and relatives referred to the study by participating members of the occupational cohort. Fourteen of the controls were reported to be carpenters and 13 of them had had exposure to either CCA or penta or both. Their urine arsenic levels, however, were reported not to differ significantly from those of other controls. The exposed group and the control group were each given a comprehensive health examination consisting of a questionnaire and clinical and laboratory tests including analysis of a urine sample for penta, arsenic, copper, chromium, and tin levels. Only penta was found to be significantly elevated in the urine of the exposed group over that of the controls. The authors reported that there were no "clinically significant" differences between the exposed group and the controls. No significant differences were found between the wood treaters and controls with respect to educational level, smoking history, or alcohol consumption.

The historical prospective study identified three cases of cancer, one by means of the questionnaire in the cross-sectional study and the other two by means of the Hawaii Tumor Registry. One of the cancer cases was a bladder cancer case; the other two were colorectal cancer cases. For the mortality analysis, the vital status of 125 of the 182 workers (69 percent) was able to be determined. Of these 125, six deaths occurred, five from cardiovascular disease, the other from an unknown cause. The authors calculated that eight deaths would have been expected in this group, three of which would have been from cancer. The authors did not state the basis of the expected number of cancer deaths.

There are limitations in the study design and sample size of this study which make the results with regard to the evaluation of a cancer risk among

the wood treaters inconclusive. A cohort comparison study on the basis of a single medical examination is an inappropriate approach to determine if a cancer risk exists in the wood treater group, particularly when the group consists primarily of persons who are currently employed as wood treaters (60 of 88 were current employees). Most persons who have developed cancer will either have died or left the work force. In addition, the sample size (88 current or former wood treaters and 61 controls) would have been too small to detect an excess cancer risk. Also, it should be noted that the inclusion in the controls of 13 carpenters who had been exposed to arsenic-treated wood certainly presents a potential bias, despite the fact that the authors claimed that the levels of arsenic in the urine of these 13 were not significantly different from those in other controls. In this regard it should be noted that no effort had apparently been made to restrict the intake of seafood or other foods or liquids, which might have elevated urine arsenic levels, prior to collection of the urine samples. The mean level of urinary arsenic in both the study group and in the controls was significantly ($P < 0.01$) higher than what the authors reported would be a normal level.

The historic prospective study also had limitations. Again, the sample size was too small to adequately determine whether an excess risk of cancer existed in the study cohort. Only 125 were included in the mortality study and only 182 were included in the morbidity study. Arsenic exposure via inhalation and ingestion is known to be associated with lung and nonmelanoma skin cancer, respectively. Nonmelanoma skin cancer is rarely fatal and thus, an excess risk of skin cancer would not have been detected in such a small mortality study. The Hawaii Tumor Registry, which was one of the primary sources of information used to identify cancer cases for the morbidity study, does not even report nonmelanoma skin cancer.

REC 5074

There is also a question of whether the authors had sufficiently allowed for a cancer latency period in their study. The authors did not indicate the length of follow-up of the cohort members. Some indication is provided, however, in the data reported by the authors on the length of employment of the 88 workers in the study cohort of the cohort comparison study. These workers were part of the population in the incidence and mortality studies. Of the 88 workers, 60 had worked 10 years or less and 80 had worked 15 years or less at the time of the physical examination in 1981. Twenty-two of the study cohort in the cohort comparison study were former employees. At the minimum, assuming that the workers had had no breaks in employment, 58 of 125 (46 percent) in the mortality study would have been followed for only 15 years or less and 38 of 125 (30 percent) would have been followed for only 10 years or less. In the morbidity study, if, again, no breaks in employment of the workers are assumed, 58 of 182 (32 percent) would have been followed for only 15 years or less and 38 of 182 (21 percent) would have been followed for only 10 years or less. In conclusion, this study is inadequate to conclude whether an excess risk of cancer exists in the wood treater population in Hawaii.

Occupational exposure to arsenic also occurs in smelters where exposure is predominantly to arsenic trioxide. Several studies have been done on mortality among workers at the copper smelter in Tacoma, Washington. Pinto and Bennett (1963) reported on the proportionate mortality of 229 workers from 1946 to 1960. Workers leaving the plant before retirement were not included. The proportionate mortality of the smelter workers was compared with that of males in the state of Washington in 1958. Of all cancer deaths, the respective proportions of lung cancer were 41.9 and 23.7 percent, respectively. The authors then classified the smelter workers according to arsenic exposure and did not find any difference between exposed and non-exposed. However, the "non-exposed" had elevated arsenic levels in urine, suggesting possible exposure.

REC 5075

More extensive studies have since been published, showing an increase in lung cancer among arsenic-exposed workers (Milham and Strong, 1974; Pinto et al., 1977; Pinto et al., 1978; Enterline and Marsh, 1980; Enterline and Marsh, 1982).

Milham and Strong (1974) examined county records from 1950 to 1971 to find the number of deaths due to respiratory cancer among county residents employed at the smelter. Expected number of cases were calculated for the smelter population by using the 1960 age-cause specific mortality statistics for white males in the United States. Forty deaths were observed and 18 were expected.

The two papers by Pinto et al. (1977, 1978) refer to the same study and the following is based on the 1978 paper. The cohort studied consisted of 527 men who were living pensioners on January 1, 1949 or who became pensioners before January 1, 1973. Complete job histories were obtained for 525 men. The average duration of employment was 28 years, ranging from 7 to 54 years and beginning in 1910. Death certificates were obtained for all 324 men who had died during the observation period (1949-1973). Expected numbers of deaths were calculated from statistics of the state of Washington.

An exposure index was constructed by using data on urinary levels of arsenic obtained in 1973. Mean urinary concentrations were calculated for 32 departments, and the individual exposure index was obtained by multiplying urinary arsenic level with years of work in a department. If an individual had worked in more than one department, the index values were added. By dividing the exposure index by the total number of years in the smelter, an index of intensity of exposure was obtained, i.e., the average urinary arsenic level. These indices were created to enable interdepartmental comparisons and did not reflect past exposure since air analysis in the 1930s to 1940s indicated

that exposure might have been 5-10 times higher at that time. It may have been still higher in 1910.

Data were also obtained on smoking habits from all men still alive and from relatives of men who had died since January, 1961. Table 7-4 (Pinto et al., 1978) shows that there was a significant increase ($p < 0.05$) in deaths from all causes, in cancer deaths in general, and, specifically, in deaths from respiratory cancer. Almost all of the excess mortality could be explained by the increase in lung cancers which could not be explained by smoking.

Table 7-5 shows respiratory cancer deaths in relation to exposure index (a value which reflects both the duration and intensity of exposure). An increase in SMR with exposure is seen. Table 7-6 shows that both duration and intensity of exposure contributed to the excess in respiratory cancer. As stated above, the urine values are relative and do not reflect the actual exposure.

It was also shown that the main excess occurred in ages 65-74 years, whereas at higher ages the lung cancer rate was closer to expected rates.

More recently, Enterline and Marsh (1980, 1982) conducted additional studies on workers at this same copper smelter in Tacoma. A cohort of 2802 males who worked a year or more during the period 1940-1964 was identified. Since a one-year work exposure was required for eligibility into the cohort, actual follow-up did not start until 1941 and extended through 1976. In the cohort, the vital status of 51 could not be verified, leaving 2751 persons. In that group, 1061 deaths had occurred. There was a significant increase in total cancer mortality which wholly depended on an increase in deaths from lung cancer. Arsenic exposure was estimated for each man on the basis of a representative average urinary arsenic level for workers in a given department. Using this representative value, an individual value was calculated for each

REC 5077

TABLE 7-4. OBSERVED AND EXPECTED DEATHS AND STANDARDIZED MORTALITY RATIOS FOR SELECTED CAUSES OF DEATH OF 527 MALES OF COHORT UNDER STUDY*

Cause of death	Disease Classification†	Observed	Expected	SMR
All Causes		324	288.7	112.2‡‡
Cancer	140-205	69	46.5	148.4‡‡
Digestive	150-159	20	16.4	122.0
Respiratory	160-164	32	10.5	304.8‡‡
Lymph, etc.	200-203, 205	2	2.1	95.2
Urinary	180,181	3	3.3	90.9
All Other Cancers		12	14.2	84.5
Stroke	330-334	43	38.0	113.2
Heart Disease	400-443	144	132.3	108.8
Coronary Heart Disease	420	120	110.2	108.9
All Other Heart Disease		24	22.1	108.6
Respiratory Disease	480-493, 500-502	11	10.8	101.8
All Other Causes		57	61.8	92.2

*Cohort consisted of living male pensioners from a copper-smelting plant who were living January 1, 1949, and whose causes of death were noted through December 31, 1973.

†Numbers from rubrics of 7th Revision of International Classification of Diseases.

‡‡P<.05

Source: Pinto et al. (1978).

TABLE 7-5. OBSERVED AND EXPECTED RESPIRATORY CANCER DEATHS AND STANDARDIZED MORTALITY RATIOS BY ARSENIC EXPOSURE INDEX

Exposure index	Mean index	No. of men	Respiratory Cancer Deaths		
			Observed	Expected	SMR
Under 2,000	1,514	36	1	0.9	111.1
2,000-2,999	2,513	109	4	2.1	190.5
3,000-5,999	4,317	205	11	3.9	282.0*
6,000-8,999	7,473	109	7	2.3	304.3*
9,000-11,999	10,135	38	4	0.7	571.4*
12,000 and over	14,712	29	5	0.6	833.3*

*p <.05

Source: Pinto et al. (1978).

TABLE 7-6. OBSERVED AND EXPECTED RESPIRATORY CANCER DEATHS AND STANDARDIZED MORTALITY RATIOS BY INTENSITY AND DURATION OF EXPOSURE TO ARSENIC

Intensity of exposure (µg/liter urine)	Duration of exposure					
	less than 25 years			25 years and more		
	Observed	Expected	SMR	Observed	Expected	SMR
50-199	2	2.1	95.2	10	3.6	277.8*
200-349	4	1.5	266.7	8	2.2	363.6*
350 and over	3	0.5	600.0*	5	0.6	833.3*

*P<.05

Source: Pinto et al. (1978).

REC 5079

man for each year of employment in a given department, and a total exposure estimate per individual was made by summing values across all jobs and all years of employment.

This method of estimating exposure differed from earlier methods employed by Enterline and co-workers (Pinto et al., 1977, 1978) in that estimates of historic exposure, based upon simple linear interpolations and extrapolations of actual data from 1948-52 and 1973-75, were used to characterize exposure by department, rather than by 1973 urinary measurements. Use of this new method of analysis partially helped to eliminate exposure underestimates of workers employed in the early years of the smelter operation. However, the present method did not totally eliminate this bias because urinary arsenic levels were only determined for workers starting in 1948. For workers exposed prior to 1948 (approximately 80 percent of the present study cohort), urinary arsenic values for 1948-52 were assumed to apply. Furthermore, the average urinary arsenic level for some departments may have been based on only a few samples, thereby limiting the usefulness of the departmental average as a representative measure of any given worker's urinary arsenic level. The authors did note that in areas of the smelter where arsenic levels were reported to be high, workers tended to be measured more often for urinary arsenic. Thus, averages for those areas were, in fact, more representative.

Using this time-weighted measure of exposure, a life table method for accumulative dose, a 10-year lag period and a standard population of mortality rates in the state of Washington, the authors reported that SMRs for respiratory cancer ranged from 155 in the lowest exposure category to 246 in the highest category. Table 7-7 shows the relationship between the time-weighted estimates of arsenic exposure lagged 0 and 10 years and respiratory cancer. This relationship was much weaker than that previously reported by Pinto et al. (1977, 1978). Enterline and Marsh noted that results from the two sets of

REC 5080

TABLE 7-7. RESPIRATORY CANCER DEATHS AND SMRs BY CUMULATIVE ARSENIC EXPOSURE LAGGED 0 AND 10 YEARS, TACOMA SMELTER WORKERS

Cumulative Exposure (μg/As/1) (urine-years)	Lag			
	0 Lag		10-Year Lag	
	Observed Deaths	SMR	Observed Deaths	SMR
<500 (302)	8	202.0	10	155.4
500-1500 (866)	18	158.4	22	176.6*
1500-3000 (2173)	21	203.2**	26	226.4**
3000-5000 (4543)	26	184.1**	22	177.6*
7000+ (13457)	31	243.4**	24	246.2**

* $p<0.05$

** $p<0.01$

()Mean of class interval

Source: Enterline and Marsh (1982).

studies were not totally comparable due not only to the differences in the exposure estimates noted above, but also to differences in follow-up periods. In earlier reports, the follow-up started after exposure stopped at retirement, whereas in the present study, follow-up started at various points in the work experience of the workers, allowing for follow-up and dose accumulation to proceed concurrently. When the authors analyzed a subsample of the present study cohort, consisting of 582 workers retired at age 65 and over (paralleling the experimental design of the earlier studies), a stronger dose-response relationship was, in fact, observed.

Table 7-8 shows the respiratory cancer deaths and SMRs by duration of exposure and time since first exposure. From Table 7-8, it appears that neither duration of exposure nor long latent periods made strong contributions to excess respiratory cancer. The authors suggested that this may have been due to the high SMRs observed shortly after termination of employment but not noted thereafter; thus, for workers with less than 10 years of exposure the

REC 5081

TABLE 7-8. RESPIRATORY CANCER DEATHS AND SMRs BY DURATION OF EXPOSURE AND LATENCY, TACOMA SMELTER WORKERS

Duration (years)	Latency (Years) <10 Observed Deaths	<10 SMR	10-19 Observed Deaths	10-19 SMR	20-29 Observed Deaths	20-29 SMR	30+ Observed Deaths	30+ SMR	Total Observed Deaths	Total SMR
<10	1	55.6	10	265.4*	17	210.1**	12	137.9	40	178.9**
10-19	-	-	6	156.4	8	278.0*	4	137.9	18	187.2*
20-29	-	-	-	-	13	197.0*	13	265.3**	26**	226.1*
30+	-	-	-	-	-	-	20	221.3**	20	221.3**
Total	1	55.6	16	210.4*	38	216.3**	49	191.8**	104	198.1**

* $p < 0.05$

** $p < 0.01$

Source: Enterline and Marsh (1982).

REC 5082

SMR is highest 10-19 years after date of hire; for workers employed 10-19 years, the SMR is highest 20-29 years after date of hire, etc. This high relative risk of lung cancer mortality in the decade following termination of employment, which essentially disappears in the following 20 years, prompted the authors to suggest that arsenic may be a promoter rather than an initiator. However, when the authors reanalyzed the data according to a method which followed workers only from the point of termination or retirement, both duration of exposure and intensity of exposure contributed more strongly to respiratory cancer mortality (Table 7-9). The difference in the two analyses led the authors to suggest that the weak dose-response relationship observed in the first analysis may have resulted from a tendency for workers in high-exposure jobs to leave employment more quickly than those in low-exposure jobs.

In studying the interactive effects of sulfur dioxide, the authors did not find significant differences in respiratory cancer incidence in two departments which both had high arsenic exposures (7500 $\mu g/m^3$) but differing SO_2 exposures, one having low to moderate exposures (520 ppm) and the other having essentially none. Because the respiratory cancer SMRs were quite similar in the two departments, the authors suggested that SO_2 exposure did not play an important role in respiratory cancer excess at that particular smelter.

In discussing their overall study results, Enterline and Marsh noted that, in this particular case, a dose response was not observed when dose was measured in terms of cumulative dose. The results seen in Table 7-8 suggest that short exposures seemed to have a disproportionately greater effect than long exposures and that effects of early exposure tended to diminish with time. Table 7-9 suggests that short high-intensity exposures may have a greater effect than longer-term, more low-level exposures. The fact that different results are obtained when different exposure/follow-up methods are

REC 5083

TABLE 7-9. RESPIRATORY CANCER DEATHS AND SMRs BY DURATION AND INTENSITY OF EXPOSURES, TACOMA SMELTER WORKERS

Duration of exposure (years)	Intensity estimate: Low† No. at risk	Low† Observed deaths	Low† Expected§ deaths	Low† SMR	High†† No. at risk	High†† Observed deaths	High†† Expected§ deaths	High†† SMR
<10	687	15	8.83	169.9	824	25	12.26	203.9**
10-19	149	7	2.61	268.2*	168	11	3.42	321.6**
20-29	225	10	3.59	278.6**	171	16	2.77	577.6**
30+	159	9	2.98	302.0**	165	11	3.17	347.0**
Total	1220	41	18.01	227.7**	1328	63	21.62	291.4**

* $p < 0.05$.

** $p < 0.01$.

† low = <290 µg/As/ℓ urine (mean 163).

†† high = ≥290 µg/As/ℓ urine (mean 477).

§ Based on Washington State white males.

Source: Enterline and Marsh (1982).

REC 5084

employed suggests that choice of experimental design has a possible influence on results. The possibility that some workers may have simply been more susceptible than others may also have accounted for the dose-response relationships observed in this study.

Because the authors suggested that the role of arsenic in the carcinogenesis process may have been as a promoter rather than an initiator, the significance of cumulative exposure to arsenic as a measure of dose would be questionable in regard to the induction of respiratory cancer as observed in this study. The role of arsenic as an initiator as well as a promoter cannot be ruled out, however. Until further research is done, the authors' conclusions from this study remain speculative.

Mortality of workers in a smelter in Magna, Utah, was studied by Rencher et al. (1977). Average hourly air concentrations of arsenic in 12 work areas were between zero and 22 mg/m^3 in 1975 (NIOSH, 1975). However, exposure before 1959 had likely been higher, since a processing of ore with a relatively low arsenic content began in that year. In the period 1959 to 1969, 965 deaths had occurred among all current or former employees, and death certificates were obtained for virtually all deceased. The proportionate mortality for smelter workers was compared with that for mine workers, concentrator workers, refinery workers, and office workers, and for the population above 20 years of age for the entire state of Utah in 1968. Among the smelter workers, 7 percent of the deaths were due to respiratory cancer, whereas the percentage for the other factory employees varied from 0 to 2.2 percent and was 2.7 percent for the state. Data on smoking were obtained for all smelter workers and for subsamples of the other employee groups and indicated that nonsmoking smelter workers had the same percentage of deaths from lung cancer as mine and concentrator workers who smoked. By applying lifetable methods, age-adjusted

REC 5085

death rates were obtained. For smelter workers, a death rate for lung cancer of 10.1 per 10,000 was obtained compared with 2.1 and 3.3 per 10,000 for mine workers and the state population, respectively. Causes of death were compared with a cumulative exposure index obtained by multiplying the number of days spent in each department by the average exposure level and then summing. The average exposure to arsenic as well as sulfur dioxide, sulfates, lead, and copper was found to be higher for the lung cancer cases than for other causes of death.

In addition to these studies, a large study by Lee and Fraumeni (1969) involving 8,047 white males was conducted at the Anaconda Copper Smelter in Montana from 1938 to 1956.* Data were obtained on time, place, and duration of employment for each individual, all subjects having worked at least 12 months in the smelter during the indicated study period. Follow-up was from 1938 to 1964. Death certificates were obtained, and the lifetable method was used to compute the expected number of deaths, using mortality rates of the state of Montana. The smelter workers were classified into 5 cohorts, based on total years of smelter work and the time period in which the years were worked: (1) 15 or more years worked before 1938; (2) 15 or more years worked between 1938 and 1963; (3) 10-14 years; (4) 5-9 years; and (5) 1-4 years. An attempt was also made to classify the workers according to exposure to arsenic and sulphur dioxide. Exposure to arsenic for more than 12 months had occurred among 5,185 men. These workers were divided into three groups; heavy, medium, and light exposures. This division was based on exposure times and place at work. Arsenic concentrations in air were primarily determined from a

---

*While the original Lee and Fraumeni study reported on the mortality experience of male smelter workers in unidentified states, subsequent analyses of these workers indicate that they were employed solely at the Anaconda smelter in Montana.

REC 5086

1965 survey by Public Health Service officials (NIOSH, 1975). These air data are shown in Table 7-10.

According to a former public health official associated with this survey, actual measurements were collected during two different periods--one in 1965 and one "about five to six years earlier"--and at several locations within given departments (Archer, 1983; personal communication). It is impossible, however, to determine how the values listed in Table 7-10 are distributed over these different time periods and locations. Further, it is also impossible to determine the number of hours sampled at a given location. Therefore, the arithmetic means used by Lee and Fraumeni to characterize heavy, medium and light exposures can only be viewed as very rough estimates of arsenic exposure, their primary value being in their relative scale of measurement.

In Table 7-11 it is seen that heavy and medium exposures resulted in significant increases in SMR for respiratory cancer. The SMR was highest (800) in workers belonging to cohort 1 (more than 15 years of smelter work before 1938), and then decreased to 263 among workers with 1-14 years of smelter work. Among the workers with light exposure, the SMR was 250, 310, and 214 in cohorts 1, 2, and 3-5, respectively. Among the smelter workers with less than 12 months' exposure to arsenic, the SMR was 286.

Lee and Fraumeni also looked at factors that possibly had confounding effects on their study results. Smoking histories were not recorded; however, based upon information obtained from other studies, Lee and Fraumeni concluded that smoking alone could not have accounted for the excess respiratory cancer mortality of the magnitude observed in their study.

In contrast to smoking, the authors did note a positive relationship between exposure to sulfur dioxide and respiratory cancer mortality; however, they found it difficult to separate the relationship of arsenic from sulfur

REC 5087

TABLE 7-10. 1965 SMELTER SURVEY ATMOSPHERIC ARSENIC CONCENTRATIONS (mg As/m^3)

"Heavy exposure area" as classified by Lee and Fraumeni

Arsenic Roaster Area		Mean:	1.47
0.10	0.20	Median:	0.185
0.10	0.22		
0.10	0.25		
0.10	0.35		
0.10	1.18		
0.10	5.00		
0.17	12.66		

"Medium exposure area" as classified by Lee and Fraumeni

Reverberatory Area		Mean:	1.56
0.03	0.93	Median:	0.88
0.22	1.00		
0.23	1.27		
0.36	1.60		
0.56	1.66		
0.63	1.84		
0.66	1.94		
0.76	2.06		
0.78	2.76		
0.78	3.40		
0.80	4.14		
0.83	8.20		
Treater Building and Arsenic Loading		Mean:	1.50
0.10	0.48	Median:	0.295
0.10	0.62		
0.10	3.26		
0.11	7.20		

"Light exposure areas" as classified by Lee and Fraumeni

Copper Concentrate Transfer System		Mean:	0.70
0.25		Median:	0.65
0.65			
1.20			
Samples from Flue Station		Mean:	0.17
0.10		Median:	0.17
0.24			
Reactor Building		Mean:	0.004
0.001	0.003	Median:	0.002
0.002	0.009		
0.002	0.010		
0.002			

Source: National Institute of Occupational Safety and Health (1975).

REC 5088

TABLE 7-11. OBSERVED AND EXPECTED DEATHS FROM RESPIRATORY CANCER, WITH STANDARDIZED MORTALITY RATIOS (SMR), BY COHORT AND DEGREE OF ARSENIC EXPOSURE, 1938-63

Cohort	Respiratory cancer mortality	Maximum exposure to arsenic (12 or more months)* Heavy	Medium	Light
All cohorts combined	Observed	18	44	45
	Expected	2.7	9.2	18.8
	SMR	667†	478†	239†
1	Observed	8	22	14
	Expected	1.0	3.3	5.6
	SMR	800†	667†	250†
2	Observed	6	12	9
	Expected	0.9	2.2	2.9
	SMR	667†	545.†	310†
3-5‡	Observed	4	10	22
	Expected	0.9	3.8	10.3
	SMR	444§	263§	214†
Number of persons in arsenic category*		402	1,526	3,257

*The remaining 2,862 men in the study worked less than 12 months in their category of maximum arsenic exposure and had an SMR of 286†.

†Significant at the 1% level.

‡Cohorts 3, 4, and 5 were combined, since observed and expected deaths were small for each cohort alone.

§Significant at the 5% level.

Source: Lee and Fraumeni (1969).

REC 5089

dioxide. Most of the work areas having heavy arsenic exposure were also areas having medium sulfur dioxide exposure; conversely, all work areas with heavy sulfur dioxide exposure were areas of medium arsenic exposure. The authors did note, however, that persons with the heaviest exposure to arsenic and moderate or heavy exposure to sulfur dioxide were those most likely to die of respiratory cancer in this particular instance.

Since the Lee and Fraumeni study, additional research has been conducted on the employees of the Anaconda smelter. Lubin et al. (1981) studied 5403 of these employees. These workers had all been employed for 12 months or more between January 1, 1938, and December 31, 1956, and were known to be alive as of December 31, 1963. Essentially, this cohort was equivalent to the surviving members from the Lee and Fraumeni cohort.

Exposure was from date hired to December 31, 1963; follow-up was from 1964 to 1977. Classification of exposure categories was similar to that of Lee and Fraumeni. However, unlike the study of Lee and Fraumeni, a cumulative arsenic exposure index was calculated for each worker. This index was derived by, first, weighting the three exposure categories and then multiplying the number of years an individual worked in a given category by this weight and summing over categories. The weights were derived from mean airborne dust concentrations taken during 1943 to 1958, which averaged 11.3, 0.58 and 0.29 mg As/m^3 in the respective heavy, medium and light categories. These values differed from those used by Lee and Fraumeni to group departments (Table 7-9). It should be noted that the exposure estimates used by Lee and Fraumeni were based upon more recent monitoring data primarily collected in 1965. Lubin et al. reduced weights in the heavy category by a factor of 10 in order to account for the wearing of respirators as was observed "at least in recent years." SMRs were calculated by comparisons to U.S. white males.

The mortality experience of workers during the years 1964 to 1977 was similar to that of the workers studied by Lee and Fraumeni during the period 1938-1963. Excess deaths from respiratory cancer corresponded to areas of highest arsenic levels. The authors noted an overall strong gradient in risk associated with the indices of cumulative arsenic exposure. However, the authors also noted that this gradient was less clear when weighting of the high-exposure category was reduced ten-fold to account for respirator usage. According to Welch et al. (1982), however, respirator usage was not common prior to 1964.

Some study differences were noted by Lubin et al. between their respective study and that of Lee and Fraumeni. Differences in excess respiratory cancer--65 percent in the more recent period versus a three-fold excess in the earlier period--were partially attributed to differences in respiratory cancer rates observed between the two comparison populations. Respiratory cancer rates in the general populace have increased in recent years; therefore, comparisons to recent populations will produce lower relative risks than comparisons to past general populations in which the rates of respiratory cancer were lower. The authors also noted that the comparison populations differed in composition. Lee and Fraumeni used white males in the state of Montana as their standard population, whereas Lubin et al. used U.S. white males. As noted in this study, as well as elsewhere (Welch et al., 1982; Higgins et al., 1982), death rates for specific causes of death (inclusive of respiratory cancer) have been reported to be lower in Montana. Finally, the authors suggested the possibility that individuals most susceptible to lung cancer contracted the disease in the earlier period and were, thus, lost to the study follow-up due to death.

In looking at SO_2 exposures, the authors were unable to totally separate the possible interactive effects of SO_2 with arsenic. However, they did note

REC 5091

that after controlling for arsenic, no significant increase in mortality could be associated with heavy or medium SO_2 exposures, whereas the association with arsenic exposure persisted after controlling for SO_2. This finding is consistent with that of other researchers studying smelter populations (Enterline and Marsh, 1982; Welch et al., 1982; Higgins et al., 1982).

In an update of the earlier study co-authored with Fraumeni, Lee-Feldstein (1983) observed the mortality experience of the same Anaconda workers (with the exception of two women) from 1938 to 1977. The workers (8045) were assigned to one of five cohorts on the basis of total years of employment. Cohort 1 worked 25+ years; cohort 2, 15-24 years; cohort 3, 10-14 years; cohort 4, 5-9 years, and cohort 5, 1-4 years. SMRs were calculated by comparison to the combined white male populations in the states of Idaho, Wyoming and Montana.

Of the thirteen specific causes of death considered, tuberculosis, digestive and respiratory cancer, vascular lesions of the CNS, diseases of the heart, emphysema, and cirrhosis of the liver showed a significant excess of observed deaths over that expected; however, only excesses in respiratory cancer showed a positive gradient with length of employment when comparing cohorts 1 through 5. The ratio of observed to expected mortality from respiratory cancer was approximately 5.1, 4.5 and 2.3 in the heavy, medium and light arsenic-exposure groups, respectively. This was in accord with the earlier results of Lee and Fraumeni, except that the ratio of observed respiratory cancer deaths to that expected in the heavy exposure category in the earlier study was 7.

Brown and Chu (1983c) discussed the Lee-Feldstein (1983) data with regard to its implications on the multistage theory of cancer. They indicated that analysis of the data suggests that arsenic acts as a late-stage carcinogen

because: (1) there was an increasing excess lung cancer mortality risk with increasing age at initial exposure, and (2) the excess mortality was independent of time after exposure stopped.

Higgins et al. (1982) and Welch et al. (1982) reported on a sample of 1800 workers at the Anaconda smelter. Compared to the 8047 workers studied by Lee and Fraumeni, this cohort of 1800 workers included all the workers originally designated in Lee and Fraumeni's heavy exposure category (277) and a random sample (20 percent) of the remaining known workers. The date of entry into the study cohort ranged from 1938 to 1956, providing the individual had one year of work experience. Unlike other studies on these workers, smoking histories on the 1800 workers were obtained either by direct questioning or by proxy respondent. SMRs were based on comparisons to white males both in the state of Montana and the United States.

From industrial hygiene records for the period 1943 to 1965, estimates of airborne arsenic concentrations within 35 smelter departments were provided. A total of 818 samples were collected from 18 departments and departmental averages were calculated from these measurements. The remaining 17 departments were estimated by analogy with those that were known. The departments were then grouped into four categories in which arsenic exposure was characterized as low (<100 $\mu g/m^3$), medium (100-499 $\mu g/m^3$), high (500-4999 $\mu g/m^3$) or very high (>5000 $\mu g/m^3$).

Workers were assigned to these categories based upon estimations of both time-weighted average (TWA) arsenic exposure levels and ceiling levels. TWA values were individually calculated based upon the time that a worker spent in a given department and the average arsenic concentration estimated for that department. This quantity was summed across all departments the individual worked in and was divided by total time worked to yield a TWA. TWA arsenic

REC 5093

exposures were calculated at entry into the study cohort and at the beginning of January, 1964, corresponding to the end of the follow-up period used by Lee and Fraumeni. TWA differences between these two periods could have increased, decreased, or remained the same depending on the work history of an individual worker. In contrast, ceiling levels were defined as the highest level to which an employee was exposed for a period of 30 days or more. Ceiling levels were calculated at entry into cohort, at the beginning of 1964 and at the beginning of 1978. Unlike a TWA value, a worker's ceiling level could only increase or remain the same from point of entry into the cohort.

Data were analyzed according to five different exposure/follow-up methods which varied in the amount of overlap allowed between exposure and follow-up periods. Method I, the primary method used by the authors, included each worker's arsenic exposure up to the date he entered the cohort. Follow-up was from entry to 1978; thus, there was no overlap of the two periods. Method IV--exposure from date hired to 1964, follow-up from 1964 to 1978--also had no overlap. Methods II and V had complete overlap--exposure from date hired to 1964, follow-up from 1938 to 1964 and exposure from date hired till termination, follow-up from 1938 to 1978, respectively. Method III had partial overlap--exposure from date hired to 1964, follow-up from 1938 to 1978. Except where specifically noted, results were given according to Method I.

The results of the study supported the thesis that exposure to arsenic was strongly related to respiratory cancer mortality in workers at the Anaconda smelter. SMRs for the total cohort for all causes of death were identical when compared to either the state of Montana or U.S. white males (both SMRs = 133, significant at 0.01 level); however, SMRs for specific causes were somewhat higher when compared to Montana males than when compared to U.S. males. Exposure to arsenic appeared to be the principal factor in the observed

REC 5094

increased risk for respiratory cancer, the study cohort having 3 times the expected death rate for white men living in Montana. Exposure to other occupational contaminants, such as sulfur dioxide and asbestos, did not appear to account for respiratory cancer excess, while smoking explained only a small fraction of the excess.

Of particular note were the differing respiratory cancer results obtained under the two categories of arsenic exposure (Tables 7-12 and 7-13). The SMR for men in the lowest TWA category was elevated, although not significantly so, whereas the SMRs in the other TWA categories were significantly elevated. Mortality for respiratory cancer by ceiling arsenic exposure showed that SMRs were only signficantly elevated in the high and very high categories, whereas they were close to expectation in the two lower exposure categories. Date of hire showed a definite relationship to mortality from respiratory cancer. Workers who were employed in the early years of the smelter operation--from 1884 to 1938, but particularly prior to 1923, when a selective floatation process which markedly improved fume and dust recovery was introduced--had higher SMRs, indicating that the overall higher arsenic exposures in the early years were associated with higher death rates from respiratory cancer. Age at hire did not seem to have a confounding effect, although the authors did note that the SMRs for respiratory cancer showed more fluctuation with age than did all causes of death.

Tables 7-14 and 7-15 show comparisons of TWA and ceiling respiratory cancer mortality as analyzed by the different exposure/follow-up methods. The authors noted that, while there was some variation in the SMRs derived from the different methods, the same basic pattern of increasing respiratory cancer SMRs with increasing TWA and ceiling arsenic exposures could be seen for each method. The authors indicated that none of the exposure/follow-up methods found a significantly ($P < 0.05$) increased respiratory cancer risk for ceiling level

REC 5095

TABLE 7-12. MORTALITY FOR ALL CAUSES AND RESPIRATORY CANCER FROM 1938 TO 1978 BY TIME-WEIGHTED AVERAGE (TWA) ARSENIC EXPOSURE AS OF ENTRANCE INTO COHORT

TWA Arsenic ($\mu g/m^3$)	N	Person-Years	All Causes			Respiratory Cancer		
			Obs	Exp	SMR	Obs	Exp	SMR
<100	547	13152	219	196.7	111*	11	7.9	138
100-	542	14157	216	178.0	121**	22	7.3	303**
500-	565	13460	292	184.7	158**	29	7.7	375**
5000-	146	3552	89	56.1	159**	18	2.6	704**

* Significant at 0.05 level

** Significant at 0.01 level

Source: Higgins et al. (1982).

TABLE 7-13. MORTALITY FOR ALL CAUSES AND RESPIRATORY CANCER BY CEILING ARSENIC EXPOSURE AS OF ENTRANCE INTO COHORT

Ceiling Arsenic ($\mu g/m^3$)	N	Person-Years	All Causes			Respiratory Cancer		
			Obs	Exp	SMR	Obs	Exp	SMR
<100	445	10591	165	152.1	108	8	6.2	129
100-	276	7083	80	80.5	99	4	3.4	116
500-	833	20757	416	288.5	144**	41	11.8	348**
>5000	246	5889	155	94.4	164**	27	4.1	662**

* Significant at 0.05 level

** Significant at 0.01 level

Source: Higgins et al. (1982).

REC 5096

TABLE 7-14. RESPIRATORY CANCER MORTALITY BY METHOD OF ANALYSIS AND TWA ARSENIC CATEGORY

TWA Arsenic ($\mu g/m^3$)	METHOD OF ANALYSIS I[a]				III[b]				IV[c]			
	N	Obs	Exp	SMR	N	Obs	Exp	SMR	N	Obs	Exp	SMR
<100	547	11	7.9	138	522	5	7.9	63	354	4	4.8	84
100-	542	22	7.3	303**	580	28	7.8	359**	410	16	5.1	313**
500-	565	29	7.7	375**	515	29	7.1	408**	313	9	4.2	216*
≥5000	146	18	2.6	704**	183	18	2.7	673**	111	9	1.6	573**

*Significant at 0.05 level

**Significant at 0.01 level

[a]Exposure from date hired to cohort entry. Follow-up from cohort entry to 1978.

[b]Exposure from date hired to 1964. Follow-up from cohort entry to 1978.

[c]Exposure from date hired to 1964. Follow-up from 1964 to 1978.

Source: Higgins et al. (1982).

REC 5097

TABLE 7-15. RESPIRATORY CANCER MORTALITY BY METHOD OF ANALYSIS AND CEILING ARSENIC CATEGORY

Ceiling Arsenic ($\mu g/m^3$)	METHOD OF ANALYSIS															
	I[a]				III[b]				IV[c]				V[d]			
	N	Obs	Exp	SMR	N	Obs	Exp	SMR	N	Obs	Exp	SMR	N	Obs	Exp	SMR
<100	445	8	6.2	129	275	3	4.0	75	178	3	2.3	130	267	3	3.9	77
100-	276	4	3.4	116	218	2	2.5	79	152	0	1.6	-	210	2	2.4	83
500-	833	41	11.8	348**	970	41	13.8	298**	656	20	8.7	230**	969	41	13.7	300**
≥5000	246	27	4.1	662**	337	34	5.2	652**	202	15	3.0	496**	354	34	5.5	617**

*Significant at 0.05 level

**Significant at 0.01 level

[a]Exposure from date hired to cohort entry. Follow-up from cohort entry to 1978.

[b]Exposure from date hired to 1964. Follow-up from cohort entry to 1978.

[c]Exposure from date hired to 1964. Follow-up from 1964 to 1978.

[d]Exposure from date hired to 1978. Follow-up from cohort entry to 1978.

Source: Higgins et al. (1982).

REC 5098

categories less than 500 $\mu g/m^3$ of arsenic (Table 7-15). For the respiratory cancer SMR analysis by TWA exposure, a significantly ($P < 0.05$) elevated SMR was not found in the lowest dose category. In the 100-499 $\mu g/m^3$ TWA exposure category, there was a significantly ($P < 0.05$) elevated respiratory cancer SMR (Table 7-14). The respiratory cancer SMR in this category would not have been significant, however, if those respiratory cancer deaths with <500 $\mu g/m^3$ ceiling arsenic exposure had been excluded from the analysis. The authors concluded that if a worker in the study had not been exposed to <500 $\mu g/m^3$ ceiling level, he would have had little, if any, excess cancer risk.

A number of criticisms have been made of this study (48 FR 1864), a few of which bear mentioning at this point. The representativeness of the exposure estimates as they relate to overall exposure conditions in the smelter and specifically to the cohort's TWA and ceiling exposures has been criticized. The authors noted that individual worker exposure estimates, based upon area measurements rather than personal samples, would not likely have great precision. Furthermore, estimates of analogy--as in 17 of the departments--weaken the reliability of overall exposure estimates, although areas that were thought to be "problem" areas of high exposure were areas that were generally measured. The extent to which respirator usage was an effective protective measure is also unknown. In interviews with former workers, however, indications were that the use of respirators was not widespread or regular during the period prior to 1964. Collectively, the authors stated that exposure estimates probably tended to affect results such that exposure values were underestimated from 1884 to 1938, were reasonable for 1938 to 1964, and were overestimated for the period after 1964.

The authors found that workers who had not experienced a ceiling level of 500 $\mu g/m^3$ of arsenic did not have an elevated risk of lung cancer. However, the number of lung cancer deaths that could be predicted using a linear dose-

REC 5099

response model (see Section 7.3.1) in the group of workers with <500 $\mu g/m^3$ arsenic ceiling exposure would not be significantly different than the number of lung cancer deaths actually found. This was determined using the linear risk model (Section 7.3.1) and data obtained from Higgins and made available by Consultants in Epidemiology and Occupational Health (1982) on the cross-tabulation of the number of workers in cumulative and ceiling exposure categories. Higgins et al. are presently undertaking a study of the entire Anaconda cohort; however, results of this study will not be forthcoming until late 1984.

In foreign smelters, an excess in lung cancer mortality has also been found. The Rönnskär smelter in Sweden, which has been processing arsenic-rich ores since the 1920s, has been the subject of several studies. Axelson et al. (1978) conducted a case-control study of mortality from respiratory cancer in relation to employment at that smelter. In the parish surrounding the smelter, 369 deaths have been recorded in the registers for men aged 30-74 years during the years 1960 to 1976. Causes of death were obtained in all cases. Smoking habits were obtained from medical files. Cases were defined as subjects who died of malignant tumors of the lung, other cancers, cardiovascular disease, cerebrovascular disease, and cirrhosis of the liver. The control group was made up of persons from the same parish who died from causes other than the above, excluding 44 persons with diabetes, mental deficiency and unclear diagnoses. Attempts were made to assess exposure and four exposure groups were constructed, based on intensity and duration of exposure and time between initiation of exposure and death. It was found that occupational exposure to arsenic was associated with a significant increase in deaths from lung cancer. For the three exposure groups with at least 3 months of exposure occurring 5 years

prior to death, the lung cancer mortality ratio was 4.6. In these groups, there was an increase with exposure intensity. For the fourth group in which either persons were not exposed or the first exposure was for a period less than 3 months and/or death occurred within 5 years of this first exposure, a risk of respiratory cancer was not found.

Other agents, including sulfur dioxide, did not seem to be associated with lung cancer in this study. In 83 percent of the exposed lung cancer cases there was a history of smoking. A study of smoking habits by Pershagen (1978) showed that the excess lung cancer mortality could not be explained by smoking habits.

Because a high lung cancer mortality rate was noted among males in Saganoseki-machi, Japan, for the period 1967-69, Kuratsune et al. (1974) did a case-control study of lung cancer cases in that town. The nineteen cases of lung cancer for the period 1967-69 were compared with nineteen controls randomly selected from deaths of diseases other than cancer of the lung, skin, or bladder for the 1967-69 period. Smoking and drinking habits, residential and occupational histories, and exposure to atomic bomb radiation were the factors compared. Fifty-eight percent of lung cancer cases were found to be former smelter workers vs. 15.8 percent in the controls ($p < 0.01$). The relative risk was reported to be 9.0 (confidence limits not reported). No difference was found between the cases and controls for smoking habits, residential history, drinking habits, or atomic bomb radiation.

Tokudome and Kuratsune (1976) did a cohort study of 2765 male workers, including 839 copper smelter workers at the metal refinery in Saganoseki-machi, Japan. Deaths which occurred between 1949 and 1971 were analyzed in the

REC 5101

study. The expected number of deaths was calculated using mortality data for Japanese males. A significantly increased mortality was noted for lung cancer (SMR = 1189; observed = 29; expected = 2.44; $p < 0.01$) and colon cancer (SMR = 508; observed = 3; expected = 0.59; $p < 0.05$). A dose response was demonstrated between lung cancer mortality and the degree of exposure measured by length of employment and level of exposure. A very high excess mortality from lung cancer (SMR = 2500; 10 observed; 0.4 expected; $p < 0.01$) was found among smelter workers who had worked in the heaviest exposure category and who had been employed over 15 years before 1949. The latent period in this study ranged from 13 to 50 years.

Studies have also been performed to see if there is any increase in lung cancer among residents in areas surrounding smelters. Lyon et al. (1977) compared the incidence of lung cancer and lymphoma in Utah residents from 1970-1975 in relation to the distance of these residents from a smelter and found no association. It should be noted that distance from the smelter was based on address at the time of diagnosis; nothing regarding the length of time lived near the smelter was factored into the analysis. Furthermore, use of lymphoma cases as controls is questionable since lymphomas may also be associated with arsenic (Ott et al., 1974). Thus, the conclusion of the study that there was no association between lung cancer and distance from the smelter is questionable.

In a more recent study, Rom et al. (1982) compared lung cancer with breast and prostate cancer in residents living near a non-ferrous smelter in El Paso, Texas. The study period ranged from 1944-1973. Similar to methods used by Lyon et al. (1977), comparisons were made in relation to distance from the smelter. Breast and prostate cancer were chosen as control cancers because they have no known association with arsenic exposure. The authors reported

that the distribution of lung cancer cases (575) and control cancer cases (1490) was roughly the same for the different distances studied. No association between lung cancer and distance from the smelter was found, nor were there any associations for race, age or sex. However, the authors did note that they were unable to control for such factors as smoking, occupation and migration and were unable to obtain environmental exposure measurements over most of the years studied.

In Montana, the studies by Newman et al. (1976) showed that there was an increase in the incidence of lung cancer among men in cities where copper smelters are located. In one of the cities there was also an increased incidence of lung cancer among women. It was not stated to what extent occupational exposure had caused the increase, and there was no control for smoking.

In the Blot and Fraumeni study (1975), the cancer mortality in 71 counties with smelters and refineries was studied from 1950 to 1969. Comparisons were made with the remaining 2,985 counties in 48 states. In 36 counties with smelters processing copper, lead, or zinc ores, lung cancer mortality was significantly higher both among males ($p < 0.01$) and females ($p < 0.05$). For all 36 counties with these industries the median SMR was 112 for males and 110 for females. Although occupational cancers were included in the analyses and, therefore, contributed to some of the excess risk, the number of workers in the smelter industry generally comprised a small fraction of the total population (less than 1 to 3 percent); thus, it was unlikely that occupational exposures alone accounted for the observed excess mortality in males or the increased risk for females. Although this study is suggestive of a lung cancer effect in populations surrounding smelters, it is unknown if the lung cancer cases were even exposed to arsenic. Thus, the results, although suggestive, are inconclusive.

In the Baltimore, Maryland area, Matanoski et al. (1976, 1981) studied cancer mortality in areas near the earlier mentioned pesticide facility. They found an excess of all cancers and respiratory cancers among males in the area nearest to the factory but not among females. Soil arsenic levels generally corresponded to lung cancer and all cancer incidences, with the highest average of arsenic in the soil (63 ppm) reported in the area with the greatest cancer risk. The authors were unable to account for the differences noted between males and females, but suggested that smoking may have contributed to these differences. Other environmental factors and/or occupational exposure may have also influenced cancer mortality excess. Further environmental sampling of arsenic and conducting of community surveys were recommended to address these unknown factors.

Pershagen et al. (1977) studied cancer deaths in the area surrounding the Rönnskär smelter in Sweden. From 1961 to 1975 there was a significant excess of respiratory cancers in the male population (SMR = 250) compared to residents in an area without known emissions of arsenic but in which the same age distribution and occupational profiles applied. When the occupationally exposed cases were excluded, significant increases in respiratory cancers were no longer detected (SMR 173); however, the male population still showed a tendency to excess lung cancers. No similar occupational group was excluded from the comparison population, however. There was no tendency to an increase in lung cancer among women.

7.1.2.2 Cancer of the Skin and Precancerous Skin Lesions--An elevation in the proportionate mortality of skin cancer was reported by Hill and Faning (1948) for factory workers manufacturing sodium arsenite and by Roth (1957, 1958) for German vintners. In addition, an increased incidence of skin cancer has been reported after long-term oral exposure to arsenic.

In Taiwan a large population had long-term exposures to inorganic arsenic in drinking water. Exposure started in 1910-20 when water was obtained from deep wells, 100-200 m. below the surface. Already in the 1920s, vascular changes began to appear, and in the 1950s, the first epidemiological studies were conducted. The arsenic content of the water varied from 0.01 to 1.82 mg/l (Ch'i and Blackwell, 1968; Astrup, 1968; Tseng et al., 1968; Tseng, 1977), generally being 0.4 - 0.6 mg/l, whereas water from shallow wells or other surface waters generally contained from near zero to 0.15 mg As/l.

Tseng et al. (1968) and Tseng (1977) have reported the results from a large-scale epidemiologic survey of arsenic-related diseases in an area with high arsenic concentrations in drinking water. The population at risk was 103,514 persons. Thirty-seven villages with a population of 40,421 were surveyed house-to-house. Examinations were made with special attention to pigmentation, hyperkeratosis, and cancer of the skin. Four hundred twenty-eight cases of arsenical skin cancer were found, resulting in a rate of 10.6/1000. No cases were under 20 years of age. The prevalence rate increased markedly with age except for females >70. Over 10 percent of the people >59 were affected by skin cancer. The overall male/female ratio was 2.9:1, with males having a higher rate in all age groups >29.

The villages were divided into 4 exposure levels: <0.3, 0.3-0.6, $\geq$0.6, and undetermined, based on their water arsenic content. There was a clear cut ascending gradient of prevalence from low to high in each of 3 age groups (Table 7-16).

Hyperpigmentation (melanosis) was found in 18.4 percent of the total population: 19.2 percent for males and 17.6 percent for females. Usually the prevalence was higher for males than females. The rates increased steadily with age for males and did likewise for females until a peak was reached at 50-59, followed by a gradual decline.

REC 5105

TABLE 7-16. PREVALENCE OF SKIN CANCER (per 1000) BY AGE AND ARSENIC EXPOSURE (ppm)

Arsenic content of drinking water (ppm)	Age 20-39	40-59	>60
<.3	1.3	4.9	27.1
0.3 - 0.6	2.2	32.6	106.2
>0.6	11.5	72.0	192.0

Source: Adapted from Tseng et al. (1968).

The overall prevalence rate for keratosis was 7.1 percent - 7.5 percent for males and 6.8 percent for females. Males had higher rates in the greater than-49-year group. The prevalence increased for both males and females up to age 70 and then declined.

As was the case for skin cancer, the prevalence rates for hyperpigmentation and keratosis suggested that positive correlations existed between these conditions and the arsenic content of the water in the artesian wells; the greater the arsenic content, the higher the prevalence.

In the total survey of 40,421 people, 7418 cases of hyperpigmentation, 2868 of keratosis, 428 of skin cancer, and 360 of Blackfoot disease (see Section 5.2.2) were found. Many of these occurred in combination in the same individual.

The data were examined by comparing expected (based on overall rates) and observed rates for various combinations of the 4 end points. The obtained ratios indicated quite strongly that a common underlying cause existed for the 4 conditions, presumably chronic arsenicism.

A control population of 7500 persons from nonendemic areas was examined in the same way as the arsenic-exposed persons. Four thousand, nine hundred

REC 5106

and seventy-eight people lived on Matsu Island; its water supply was from shallow wells and no arsenic was detectable by the analytic methods used in the main series. The remaining portion of control population members came from 5 villages on Taiwan whose water source was shallow wells with arsenic levels between 0.001-0.017 mg/ℓ (ppm). No cases of melanosis, keratosis, or skin cancer were observed in the entire control population.

Although age at onset of the conditions was difficult to assess, some information on latency was obtained. "We know from the study that the youngest cancer patient was 24, the youngest with hyperpigmentation was 3, and the youngest with keratoses was 4." This meant that hyperpigmentation could occur in patients who were exposed from birth for at least 3 years, keratosis for 4 years, and cancer for 24 years (Tseng et al., 1968).

While the Taiwanese data collected in the late 1960's strongly implicated arsenic as the etiological source of the observed diseases, recent findings have called to question the hypothesis of arsenicism as sole causative source in the induction of cardiovascular effects. The discovery by Lu et al. (1977b, 1978) of fluorescent compounds identified as alkaloids--either lysergic acid, dihydrolysergic acid or a derivative of ergotamine tartfate--has opened the possibility that other toxic mechanisms may have been involved. Ergotamine-like compounds in combination with high alkalinity, characteristic of these waters, have been shown to cause gangrene (Lu et al., 1977a,b; 1978). Whether these compounds have a confounding effect on skin cancer is presently unknown.

In addition, recent analyses by Irgolic (1982) on a limited number of samples have shown the water samples to contain predominantly pentavalent arsenic and no organic arsenicals. Samples taken from two wells in the Yenshei Province of Taiwan were collected in plastic cubitainers. Two samples each of unpreserved water and water preserved either by addition of 0.1 weight percent

of ascorbic acid or by acidification of 0.1 M HNO_3 were sent to the U.S. for analysis a few days after collection. Treatment of samples by HNO_3 or ascorbic acid was done immediately upon collection (Irgolic, 1983; personal communication). Samples were analyzed during a two-week period after arrival in the U.S., the total time lapse between collection and analyses ranging from one to three weeks. The results of the analyses can be seen in Table 7-17. Additional water samples collected from other parts of Taiwan also contained pentavalent arsenic. However, these samples were less reliable in that the collection period was unknown, and, upon arrival in the U.S., these samples had a yellowish hue with some flocculated matter present (Irgolic, 1982).

Several questions still remain to be answered in regard to water-usage patterns of the Taiwanese. For instance, it is not clear how quickly the water drawn from the wells was consumed; nor is it clear how much of the water was consumed in tea or other beverages where cooking preparations, such as boiling, would have altered the chemical form of the arsenic. These questions need to be answered in light of the possible effect these answers might have on interpreting the observed skin cancer incidence.

Ch'i and Blackwell (1968) conducted a case-control study in the area of Taiwan studied by Tseng et al. The authors compared a variety of factors between 353 cases of Blackfoot disease and 353 controls matched for sex and age. Socioeconomic status, occupation, cigarette smoking, diet, and consumption of deep well water which was arsenic-contaminated were the factors compared. Two factors were found to be significantly different between the cases and controls. Significantly ($P < 0.01$) more cases than controls were found to consume deep well water and to have a lower socioeconomic status. Though the author concluded that the primary contributing cause of Blackfoot disease was consumption of deep well water, the socioeconomic differences cannot be completely discounted.

TABLE 7-17. RESULTS OF TOTAL ARSENIC ANALYSES AND ARSENITE AND ARSENATE DETERMINATIONS IN THE YENSHEI WATER SAMPLES*

Sample	Ascorbic Acid 0.1%	0.1 M HNO_3	Unpreserved	TOTAL ARSENIC, ppm HG[a]	TOTAL ARSENIC, ppm ICP[b]	Arsenite, ppm by HG	Arsenate, ppm by HG
Well I	-	+	-	0.84±0.02	0.73±0.01	-	-
	+	-	-	0.88±0.01	0.72±0.01	0.024±0.001	0.85±0.01
	-	-	+	0.85±0.01	0.73±0.01	0.022±0.001	0.83±0.08
Well II	-	+	-	1.05±0.08	0.95±0.01	-	-
	+	-	-	1.16±0.03	0.96±0.01	-	-
	-	-	+	1.11±0.02	0.98±0.01	0.024±0.01	1.08±0.02

*Average ± average deviation of at least three determinations per sample.

[a]HG = Hydride generation technique.

[b]ICP = Inductively coupled argon plasma emission spectrometry.

Source: Irgolic (1982).

REC 5109

Other studies have also explored the relationship of arsenic to skin cancer and various skin lesions. Similar chronic effects as seen in Taiwan have been reported in other countries.

In Antofagasta, Chile, a new water supply was put into service in 1958. In the 1960s, physicians began noticing dermatological manifestations and even deaths, especially among children. In an investigation of skin pigmentation in 27,088 school children from the province of Antofagasta, an overall incidence of 12 percent was reported (Borgono and Greiber, 1972). It was discovered that the drinking water contained 0.8 mg As/l. Borgono and Greiber compared 180 inhabitants of Antofagasta with a community without exposure to arsenic via drinking water. Abnormal skin pigmentation was reported to be present in 80 percent and hyperkeratosis in 36 percent of the Antofagasta inhabitants, whereas none was found in the control group ($p \leq 0.05$).

In 1970, a water treatment plant was installed and there was a considerable drop in arsenic. According to Borgono et al. (1977), there were no skin lesions in children born since the water treatment began. However, it should be noted that in this more recent study the sample size of children born since the water treatment plant began was small (306) and no comparison population was studied. Therefore, any conclusions associating the lack of dermatological manifestations with the decrease in arsenic must take into account the small sample size. In regard to skin cancer, the follow-up may not have been long enough to detect a difference.

In addition to the work of Borgono and co-workers, Zaldivar and Guillier published a series of papers on the Antofagasta situation (Zaldivar, 1974; Zaldivar, 1977; Zaldivar and Guillier, 1977). The first of these (Zaldivar, 1974) describes a study on a total of 457 patients (208 males and 249 females) bearing cutaneous lesions (leukoderma, melanoderma, hyperkeratosis, and squamous cell carcinoma). The cases were collected both by the author and the

local hospital during the period 1968 to 1971. Children 0 to 15 years of age accounted for 69.2 percent of the male cases and 77.5 percent of the female cases. The average incidence/100,000 for cases with cutaneous lesions in 1968 to 1969 were 145.5 and 168.0 for males and females, respectively. By 1971 the incidence rates had dropped to 9.1 and 10.0 for males and females, respectively. The decline in morbidity was so rapid that a conclusion that arsenic was the cause of the skin lesions would have to be considered suspect.

The existence of arsenical waters in an eastern area of the province of Cordoba, Argentina, has been known for many decades (Arguello et al., 1938; Bergoglio, 1964). Effects noted on the population from this area include hyperpigmentation, keratosis, and skin and respiratory cancer. A large area of the province, mainly in the east and somewhat to the south, is the focal point for chronic endemic regional arsenical intoxication (CERAI) (Arguello et al., 1938). This CERAI is due to the ingestion of well water coming from the uppermost sheet of underground water--the principal source of arsenic--as well as to the ingestion of arsenic from the wells, which varies among wells throughout the region. The concentration also varies with rainfall. Vanadium is also elevated in areas with high arsenic content. A later report (Bergoglio, 1964) indicates that progress had been made in improving the hygienic condition of the drinking water.

Arguello et al. (1938) summarized the early history of investigations (1913 to mid-1938) into the health outcomes associated with the ingestion of arsenic-contaminated water. They also reported the results of an investigation of a large series of epitheliomas collected from mid-1932 to September 1938 at the dermatosyphilology clinic of a medical school in the arsenic-contaminated area. The series consisted of 323 cases of epithelioma of which 39 or 12.1 percent were cases with clinical evidence of CERAI.

Patients exhibiting CERAI had characteristic cutaneous lesions, represented by the symmetrical palmo-plantar keratoderma and melanoderma, although the latter symptom was seen less frequently. Foot and hand keratoderma were seen in 100 percent of the CERAI patients. Appearance usually occurred 2 to 3 years after the onset of intoxication. A prodrome of the keratosis is the appearance of an erythema in the same location, and a subjective crawling sensation and local fever. Otherwise, it is a state of dryness which precedes the keratosis.

Arguello et al. (1938) also reported that most patients also had hyperhidrosis and abnormalities of pigmentation. The melanoderma appeared early in the process and was variable among patients. It was described as small dark spots ranging in diameter from 1 to 10 mm. They had a tendency to coalesce and appeared predominantly on the trunk in the areas not exposed to the sun. Atropy was associated with telangiectasia and loss of color, or leukoderma, between the hyperpigmented areas (the "raindrop" appearance cited by Reynolds, 1901).

Geographically, the largest proportion of cases in the clinic came from the areas with the highest incidence of CERAI. Because the authors' data are not population-based, however, it cannot be stated that the incidence of skin cancer is significantly increased in these areas. The authors reported that the hands and feet were the locations of choice for the arsenical epitheliomas (38.5 percent vs 3.9 percent) compared to the nonarsenical epitheliomas. An example of this was seen in the head where 81.6 percent of the nonarsenical epitheliomas occurred versus 15.4 percent for arsenical epitheliomas.

Bergoglio (1964) did a proportionate mortality study of residents of certain departments (counties) in the Province of Cordoba, Argentina, where endemic arsenic levels in the water supply are reported to be very high. The

proportion of cancer deaths was higher in those departments than for the province as a whole (23.84 percent versus 15.3 percent; $P < 0.05$). Of the cancer deaths, respiratory cancer constituted 35 percent and skin cancer 2.3 percent. From the description by the author, it can probably be inferred that these data are not age-adjusted. No comparison is made of the percentage of respiratory and skin cancer deaths in the affected departments with the respective proportion for Cordoba Province.

Morton et al. (1976) investigated the relationship of skin cancer morbidity and the ingestion of arsenic-contaminated drinking water in Lane County, Oregon. The southcentral region of Lane County is underlaid by an arsenic-rich stratum called the Fisher formation, which is known to produce high arsenic levels in waters from wells drilled into the land. An extensive search of the pathology records of medical providers in Lane County, Oregon, was conducted in 1972 for the occurrence of skin cancer during the years 1958 to 1971. Cases were thoroughly screened to eliminate duplications and were then coded to 1970 census tract numbers according to the residential address at the time of diagnosis. Water samples were obtained in all census tracts at selected points in all municipalities and water districts in the county, as well as from single-family water sources. The single-family water sources were neither randomly nor uniformly distributed throughout the county but instead were heavily concentrated in the regions believed to have water arsenic problems. Water samples collected during 1968 to 1974 were compiled into mean concentrations for each census tract and census tract region. The authors stated that it seemed reasonable to assume that the samples were representative of the earlier time periods as well.

The skin cancer data were expressed in four sets of rates because of the availability of 4 sets of population estimates. Overall mean annual incidence

rates for the entire 1958 to 1971 period used mean population estimates based on all four sets of denominators. Census tract regions were devised to simplify analysis and presentation. Table 7-18 presents the water arsenic level obtained. As can be readily seen, the South rural area had a much greater arsenic exposure than any of the other sections of the county. Figure 7-1 contrasts the parts of the county underlaid by the Fisher formation, and subsequent higher arsenic levels, with the parts of the county experiencing higher squamous cell skin cancer. Relatively little concordance is noted. A multiple regression analysis performed by the authors demonstrated essentially no relation between skin cancer and water arsenic. It should be noted that water arsenic levels in this study varied from 0 to 2150 ppb. The authors point out that the Lane County water arsenic levels were much lower than those reported for Taiwan and Antofagasta. In particular, only 5 percent of the Lane County samples contained 100 or more ppb of arsenic in contrast to 48 percent of the samples in that range in the Taiwan data.

Similar findings were reported by Southwick et al. (1981) in a study conducted on residents of West Millard County, Utah. As an area in which naturally occurring arsenic in public drinking water had been reported, West Millard provided an "excellent opportunity to study the effects of arsenic exposure on a homogeneous, stable population with a predominantly 'Mormon lifestyle'" (Southwick et al., 1981). The exposed communities of Hinckley and Deseret had average arsenic concentrations of 0.18 mg/l and 0.27 mg/l, respectively (based upon monthly water samples taken between May 1976 to May 1977). The control community of Delta had average arsenic concentrations of 0.02 mg/l. All drinking water in the study communities came from wells and the predominant species of arsenic was reported as the pentavalent form (85 percent).

REC 5114

TABLE 7-18. LANE COUNTY WATER ARSENIC LEVELS 1974-1978

Geographic region	Arsenic, ppb			1970 Population served by water districts	
	mean*	range	no. of samples	number	% of area residents
Rural	16.5+	0-2150	491	29,470	44
North	7.6	0-24	29	3,644	39
East	11.8	0-70	80	7,383	49
South	33.0	0-2150	186	12,713	59
Midwest	9.7	0-107	159	1,260	10
Coast	4.7	<1-13	37	4,470	54
Urban	4.8	0-860	67	135,260	91
NE Springfield	3.9	0-8	14	16,235	92
SW Springfield	6.0	0-30	4	18,460	96
S Eugene	5.3	0-750	10	29.230	88
W Eugene	6.5-	0-860	20	16,470	96
NW Eugene	3.8	<1-8	6	20,730	85
N Eugene	3.8	0-8	8	11,690	81
Core Eugene	4.0	<1-8	5	22,445	100
Lane County	8.6	0-2150	558	164,730	76

*Values with terminal digit of 5 indicate direction from which rounded, e.g., 0.51 - 0.5+, 0.49 - 0.5.

Source: Morton et al. (1976).

REC 5115

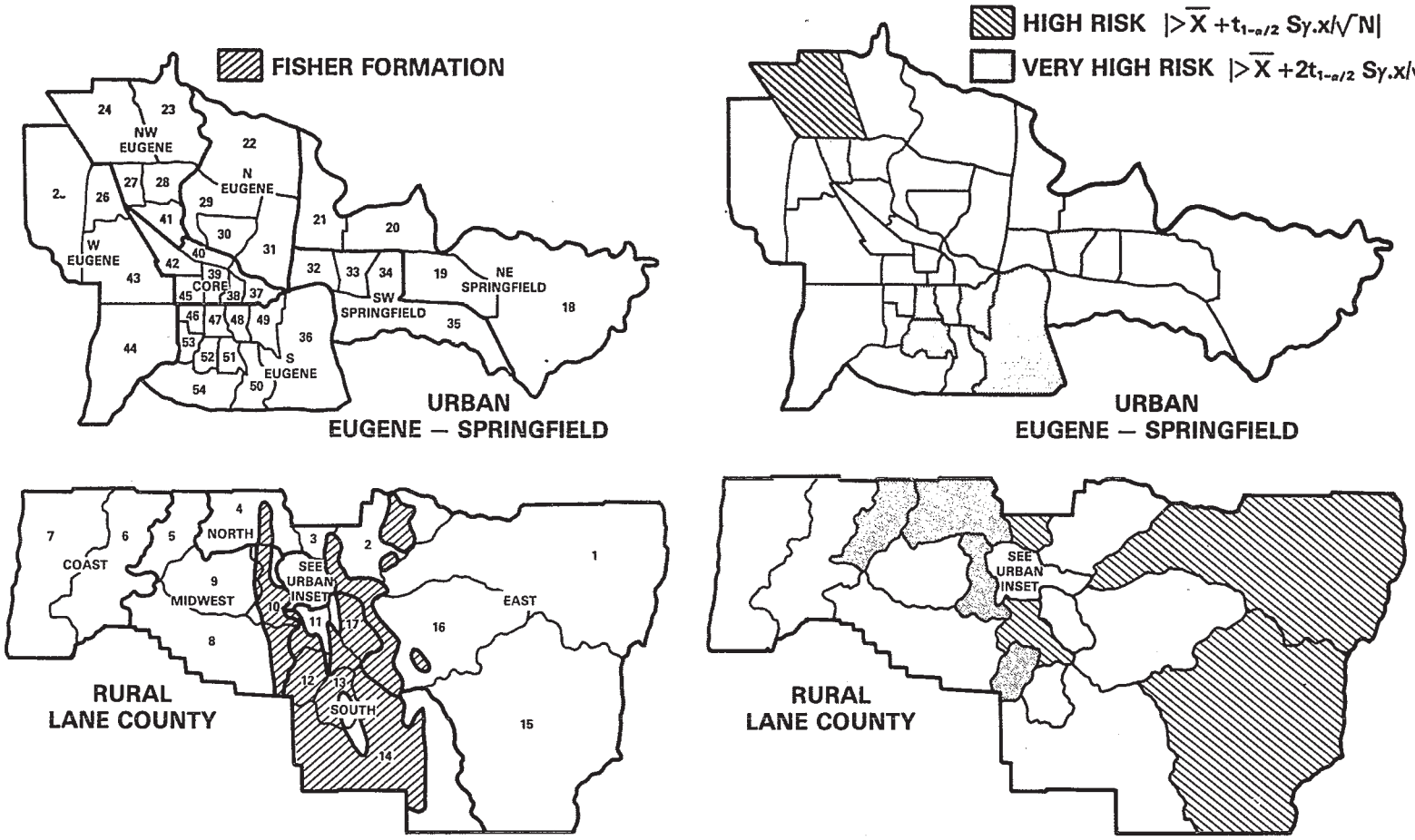


Figure 7-1. Comparison of census tracts experiencing exposure to the Fisher formation and exhibiting high skin cancer occurrence.

Source: Morton et al. (1975).

All study participants from the exposed communities were required to be five years of age or older and to have been residents of Hinckley or Deseret for at least the previous five years. Control participants were selected at random from age and sex categories matched to the exposed participants. Control participants were required to have lived their entire lives either in Delta or communities where arsenic in drinking water did not exceed the national standard of 0.05 mg/l.

Physical examinations were conducted to detect signs and symptoms associated with chronic arsenic poisoning. A total of 250 people participated in these examinations (145 exposed, 105 control); not all of these participated in each part of the examination, however. No explanation was provided by the authors as to the differences in participation rate for different parts of the examination. Urine and hair samples were collected from 94 and 74 percent of the participants, respectively. Dermatological examinations were conducted on 249 individuals. Neurological and hematological examinations were also conducted and are discussed in Sections 5.2.1 and 5.2.4, respectively. In addition, the incidence of cancer and vascular diseases in the study population was compared to other counties in the state of Utah.

The study results showed a clear relationship between the amount of arsenic consumed in drinking water and the amount measured in hair and urine. Differences between exposed and control populations were statistically significant.

Of the 249 participants examined for dermatological signs of arsenic toxicity (palmar and plantar keratosis and hyperkeratosis, tumors, diffuse pigmentation, arterial insufficiency), only 12 showed such signs and no participant had more than one sign. The 12 individuals were not clustered among the more heavily exposed, and when the dermatological signs were regressed

against annual arsenic dose and the log of the dose, no significant associations were found.

Age-adjusted cancer incidence rates showed Hinckley to have a somewhat lower cancer incidence than Delta. Cancer death rates, 1956 to 1976, showed Hinckley to have the highest rate (138 per 100,000) when compared to 42 other Utah communities. Table 7-19 shows age-specific death rates for Utah and three Millard County communities. (Fillmore is the County seat; comparisons to Deseret were not made due to the community's small population). Between 1956 and 1976, 14 cancer deaths were reported for Hinckley. All of these deaths occurred in individuals 45 years or older and the cancers were types most frequently reported for Utah: lung, breast, large intestine, prostate, stomach, leukemia, kidney, uterus, bone and connective tissue. Hinckley had generally lower death rates for cardiac and vascular diseases than did the control community of Delta. The authors noted that no unusual death patterns likely to be associated with arsenic exposure were seen in Hinckley.

Certain weaknesses exist with this study, most notably, that of a small study population from which to derive meaningful statistical analyses. Furthermore, children and adults were not treated separately. In regard to sample size, the authors felt that the small sample size was somewhat compensated by the homogeneity and stability of the predominantly nonsmoking population. Data on food consumption were also missing which might have influenced urinary arsenic levels. This, in turn, may have resulted in overstating the strength of the dose-response relationship for urinary arsenic and arsenic in drinking water. It should also be noted that some participants were reported to have an average daily water consumption greater than 8ℓ, which seems very high, even

TABLE 7-19. AGE-SPECIFIC DEATH RATES FOR UTAH AND THREE MILLARD COUNTY COMMUNITIES (DEATHS/100,000/YEAR)

Community Characteristics	Age Groups and (Number of Deaths)					
	0-4	5-14	15-24	25-44	45-64	65+
CANCER						
State	7 (158)	6 (274)	6 (223)	19 (875)	149 (4749)	558 (7680)
Fillmore	0	14 (1)	0	17 (1)	196 (13)	706 (25)
Delta	0	0	22 (1)	61 (4)	189 (11)	986 (29)
Hinckley	0	0	0	0	390 (6)	1053 (8)
CARDIOVASCULAR						
State	1 (25)	0.4 (18)	1 (34)	18 (840)	275 (8788)	2079 (28587)
Fillmore	0	0	0	17 (1)	392 (26)	1638 (58)
Delta	0	0	0	30 (2)	344 (20)	1599 (47)
Hinckley	0	0	0	0	325 (5)	1316 (10)
CEREBROVASCULAR						
State	1 (24)	0.5 (23)	1 (36)	4 (201)	52 (1651)	797 (10965)
Fillmore	0	0	0	0	60 (4)	1017 (36)
Delta	0	0	0	0	34 (2)	1088 (32)
Hinckley	0	0	0	0	0	789 (6)
ARTERIOSCLEROSIS						
State	0	0.07 (3)	0.2 (7)	0.5 (21)	13 (406)	202 (2781)
Fillmore	0	0	0	0	15 (1)	311 (11)
Delta	0	0	0	0	17 (1)	272 (8)
Hinckley	0	0	0	0	65 (1)	395 (3)
AGE GROUP SIZE						
State	119,004	224,417	175,607	227,502	159,613	68,759
Fillmore	157	347	202	293	332	177
Delta	202	400	224	330	291	147
Hinckley	40	108	57	79	77	38

Death rates from 1956-1975 for cancer, cardiovascular disease, cerebrovascular disease, and arteriosclerosis, showing numbers of deaths and the average size of the age group.

Source: Southwick et al. (1981).

REC 5119

taking into account the hot summers. In reporting on the lack of arsenic-related effects in this study population compared to others (Tseng et al., 1968; Borgono and Greiber, 1972; Borgono et al., 1977; Zaldivar, 1977; Zaldivar and Guiller, 1977), the authors did note that populations in Taiwan and Antofagasta were exposed to considerably higher concentrations of arsenic in their drinking water.

Interestingly, the importance attached to the fact that no adverse effects were seen in this group of individuals exposed to drinking water arsenic levels four times that allowed by the Interim Primary Drinking Water Regulations (0.05 mg As/l) is somewhat compromised by the very characteristics of the population that make it useful for epidemiological study. The fact that this study population is so homogeneous and stable and, therefore, lends itself to a relatively well controlled statistical analysis, also makes it less useful in terms of being representative of the overall population of the U.S. For this reason, any generalizations that might be drawn from this study population are subject to limitations.

In addition to exposures via drinking water, food exposures and therapeutic exposures have also caused skin lesions and cancers. Hyperpigmentation and depigmentation of the skin were found to be common among the survivors of the Morinaga milk poisoning in 1955. A follow-up study conducted on the exposed children when they were 17-20 years of age showed the prevalence of lesions to be 15 percent (Yamashita et al., 1972). It is not known if any skin cancers have developed.

Hutchinson (1888) first reported on a possible association of skin cancer with the use of arsenical medicines. Prior to that, the association between these arsenical agents and keratotic lesions had been recognized. In his classic paper, Hutchinson reported on 6 patients with case histories who

exhibited the keratotic lesions associated with arsenical poisoning. He felt that the clinical series supported two principal conclusions:

1. Prolonged internal use of arsenic may seriously affect the nutrition of the skin and that use may produce warty or corn-like indurations.

2. Continued use of arsenic may result in a tendency for these "arsenic corns" to grow downward and pass into epithelial cancer.

Neubauer (1947) later compiled a series of reports on 143 cases of medicinal arsenical epitheliomas. He excluded five categories of cases reported in the literature to keep the series consistent with regard to diagnosis of case and history of arsenical use. Seventy-one percent of the patients being treated with arsenical medicine were patients suffering from skin diseases, especially psoriasis (54 percent). In contrast, only a small percentage of the cases reported came from patients treated with arsenic for various internal disorders. In nearly all cases the drugs used were inorganic and almost all were trivalent. The most commonly used arsenical was potassium arsenite. No externally applied arsenic-related skin cancer case was reported in the series.

The elapsed time from the beginning of administration of the arsenical drug to the beginning of the epitheliomatous growth was variable, but averaged 18 years regardless of the type of lesion. In cases with keratosis, the latent period to the onset of keratosis was about half the latent period to the onset of the epithelioma, i.e., about 9 years. Thirty-three percent of the patients were 40 or younger. Of the 143 patients, 13 had or developed miscellaneous cancers at other sites, but such cases were not reported systematically.

Fierz (1965) reported a follow-up study of patients treated with arsenic by a private practitioner. An accurate assessment of the total arsenic intake

in terms of the amount of Fowler's Solution administered was available to the investigator from patient records. The follow-up examination was conducted under the auspices of a local polyclinic. Fourteen hundred fifty patients were identified as having received arsenic treatment, and invitations were mailed for them to come for a free follow-up medical examination. During the period March 1963 to April 1964, 262 patients presented themselves for examination. Two hundred eighty patients were not located while 100 patients actively refused to participate. Only patients under 65 years of age were invited to participate in the study. The author admits that the patients reporting for examination were not a representative sample. In fact, he categorizes them into three groups which range the spectrum of likely biases. There were patients satisfied with the results of the arsenic treatment and wishing to express thanks, patients in whom disturbing side effects were occurring, and finally patients who were still suffering from the initial disease and who were eager to get a consultation.

Arsenic treatment was prescribed for individuals suffering primarily from three main skin diseases: psoriasis (64 patients), neurodermatitis (62), and chronic eczema (72). In addition, treatment was also prescribed for 64 patients suffering from assorted skin diseases other than those listed above.

Fierz noted that the arsenic treatment showed good success. Of the 64 cases of psoriasis, 55 reported a favorable effect while taking the drops. Forty-eight of 62 patients with neurodermatitis reported a favorable effect. This effectiveness was the cause for the patients' reliance on the drug.

Upon examination, 106 of 262 patients (40.4 percent) reported hyperkeratoses, although frequently a detailed examination was necessary to find the changes. Hyperkeratoses were round, superficially verrucose papules, 1 to 3 mm in diameter. The number and the exact presentation of the hyperkeratoses varied from case to case.

In the series, 21 cases of skin cancer were found comprising 8 percent of the total subjects. As was in the case of hyperkeratosis, some variability was observed in the expression of the skin cancers. Multiple basal cell carcinoma was the most frequent histologic type observed, occurring in 48 percent of the cancer patients. The basal cell carcinomas appeared morphologically as polycyclic, sharply bounded erythemas with slight infiltration. In 13 of the 21 cancer cases, multiple carcinomas were observed, a much higher proportion than had been observed with other causes of skin cancer. Of the 21 patients with carcinomas, 16 showed distinctly developed arsenic warts on the palms and soles simultaneously with the skin tumors.

Both hyperkeratosis and skin cancer were found to vary with increasing arsenic intake. Above 400 ml of Fowler's solution, more than 50 percent of the patients studied showed hyperkeratosis. As the dose increased there was a corresponding increase in the simultaneous occurrence of hyperkeratosis of the palms and soles. Only 2/15 cases of hyperkeratosis with intakes of up to 250 ml had a simultaneous presentation, while 16/27 had a simultaneous presentation with intake of 250 to 500 ml.

As with the hyperkeratosis, skin cancer increased with increasing arsenic doses. Below 500 ml only basal cell carcinomas were found; spindle cell carcinomas were only found above that dose. The latency period for hyperkeratosis was at a minimum 2.5 years; skin cancer, however, had a minimum latency period of 6 years with a mean latency period of 14 years.

Cuzick et al. (1982) conducted a mortality analysis of a cohort of 478 patients given Fowler's solution to determine if persons taking the solution were at an increased risk of internal malignancies. The cohort consisted of 213 males (45 percent) and 265 females (55 percent) who took Fowler's solution for various lenghts of time ranging from 2 weeks to 12 years (mean duration,

8.92 months) during the period of 1945-1969. Follow-up was until January 1, 1980; the mean follow-up time for the entire cohort was 20.3 years. The median cumulative dose of arsenic was reported as 448 mg, with most patients consuming arsenic at a rate of about 250 mg/month.

Within the defined risk period, 139 patients died, 265 patients were known to be alive and at risk, 29 had passed 85 years of age, 19 had emigrated, and 26 could not be traced. Because of the unreliability of the expected values in the open-ended group beyond 85 years of age, deaths and person-years at risk after age 85 were ignored. Persons who emigrated were censored as of the date of emigration.

A subset of 142 of the cohort were physically examined during 1969-70, and the presence of arsenical keratoses, hyperpigmentation, and skin cancer was recorded. No signs of internal malignancy were clinically apparent at the time of examination. This subset was chosen because the individuals were known to be alive and were able to be traced.

The results showed that risk ratios were similar for both males and females. No signs of internal malignancy were clinically apparent in the patients given physical examinations, and mortality was not found to be significantly increased for any internal malignancies in the cohort, although it was somewhat elevated for death from bladder cancer (observed = 3, expected = 1.19, P = 0.12). The ratio of observed-to-expected deaths from all neoplasms, from cancer of the digestive organs, from cancer of the respiratory organs, and from all causes was analyzed by cumulative dose level. No trend by cumulative dose level was found; however, the risk ratios were low for deaths from all neoplasms, digestive cancers, and respiratory cancers in the lowest dose group, with the risks for deaths from all neoplasms being significantly ($p < 0.05$) lower than expected. A significant positive trend in the ratio of

observed-to-expected mortality for all neoplasms was found for dose in the period 5-9 years from first exposure, but this trend was not found in other time intervals since first exposure.

Of the subset of 142 patients examined for skin manifestation of arsenicism, their overall mortality was consistent with the remainder of the cohort. Within this group, 45 percent had keratosis, 14 percent had hyperpigmentation, and 11 percent were found to have skin cancer. The authors did not indicate what the expected proportions of patients with these signs would be. Some patients showed 2 or all 3 signs of arsenicism, and 49 percent showed at least one of the signs. The appearance of signs was dose- and age-related. Patients with signs had higher median doses (672 mg) than those without any signs (448 mg), and this was significant ($P < 0.001$) by the Wilcoxon rank-sum test. Forty percent of patients with signs had cumulative doses above 1000 mg, whereas only 22 percent of the patients without arsenical signs had cumulative doses above 1000 mg. On the average, patients with signs were 7 years older and had received their first exposure 6 calendar years earlier than those without signs. Within the group with exposures > 1000 mg, those with signs were, again, an average of 7 years older, and they had their first exposure 3 years earlier. It is interesting to note that all seven of the subsequent deaths from internal malignancy in this subgroup had been identified as showing signs of arsenicism. No deaths from cancer occurred in the group without physical signs.

In summary, this study provided little evidence that ingestion of arsenic is related to a risk of mortality from internal malignancies. Non-fatal skin cancer was found, however, to be related as a function of dose to ingestion of Fowler's solution. The authors indicated that perhaps persons who demonstrate signs of arsenicism following arsenic exposure retain arsenic longer than those

who do not show signs, which may suggest that persons who demonstrate signs of arsenicism are at a greater risk of internal malignancies. This was suggested by the fact that all of the deaths from internal malignancies in the subset of individuals that was examined for signs of arsenicism occurred in individuals who demonstrated such signs.

Knoth (1966) also reported on two patients treated with arsenical medicinals and who developed skin cancer. Roth (1958) reported that of 47 autopsy cases of vintners with chronic arsenic intoxication, 13 had skin tumors.

Gilbert et al. (1983) conducted a study on wood treaters in Hawaii who were occupationally exposed to arsenic (see Section 7.1.2.1 for complete discussion of study). The authors found no evidence of risk of skin cancer, but inadequacies in the study design and the small sample size limit the ability to draw valid conclusions from the data.

7.1.2.3 Other Cancers--Whereas there are many studies suggesting that there is an association between inhalation exposure and respiratory cancer and oral exposure and skin cancer, respectively, there are no consistent data with regai to cancer in internal organs.

Reymann et al. (1978) have investigated the relationship between the intake of arsenic for medicinal purposes and subsequent internal neoplasms. Study subjects were identified by examining the files of a dermatology clinic in Denmark for the years 1930 to 1939. Two rosters of study subjects were generated: 1) persons treated with arsenic for multiple basal cell carcinoma, Bowen's disease, psoriasis, verruca planus, and lichen planus, and 2) persons with keratoses from the first roster plus 30 other persons identified as having keratoses. The first roster of 413 persons comprised the basic study population; 24 persons were excluded for various reasons, resulting in a final study population of 389 persons. The malignancy histories of both populations

REC 5126

were traced through the years 1943-1974 in the Danish Cancer Registry. For each person a length-of-observation period was determined and an expected number of internal malignant neoplasms was determined using the former data.

In the main study population, 41 cases were observed versus 44.6 cases expected. Therefore, no increased incidence of internal malignancies was noted in the arsenic-treated patients. However, examination of the data by individual skin disease categories showed that women with multiple basal cell carcinoma had a significantly higher incidence of internal cancer. The same trend, although not significant, was observed in female patients exhibiting verruca planus. Next, an analysis was made of a possible dose-response relationship using duration of treatment as the exposure variable. The categories were low, medium and high, based on <1 month, 1-3 month, and >3 month duration of standard dose administration (6-8 mg As_2O_3). No relationship between dose and internal organ cancer was noted for the total population or by sex. In addition, the form of arsenic administered did not seem to affect the incidence of internal cancer, nor was any effect noted due to period of observation. Reymann et al. did not provide a definition of the term "internal cancer." It is presumed that the authors included lung cancer in their definition. If so, the authors did not provide any adjustment for smoking. Regardless, the sample size of 389 persons is probably too small to detect an excess in the incidence of internal cancer, even if lung cancers were excluded.

The keratosis group was not analyzed in the same way. Eight of the 19 men with keratosis died before 1974. Four of these were due to cancer of the internal organs. Expected deaths were 1.9. Similarly, 5 deaths due to cancer of the internal organs were observed in the 34 women with keratosis compared with 3.3 expected. Together there were 9 deaths due to cancer of the internal organs compared to 5.2 expected. Although the figure is almost doubled, it is

still not significant. On the average, the patients with keratosis received higher doses of arsenic than the other patients.

Hemangioendothelioma and reticulosarcoma of the liver has been reported by Roth (1958) to occur among German vintners exposed occupationally to arsenic. The same type of malignancy occurrence has also been reported in isolated cases by other authors (Pershagen and Vahter, 1979). Higgins et al. (1982) reported increased mortality for cirrhosis of the liver and urinary cancer in workers at the Anaconda Montana smelter.

More recently, Falk and coworkers (1981a) described a nationwide (U.S.) review of deaths from hepatic angiosarcoma during the years 1964-1974. Of 168 confirmed cases included for survey, a group of seven cases with a history of prolonged use of Fowler's solution was found. Taken with the data of Roth, chronic arsenic exposure, mainly via ingestion, appears to be associated with this very rare liver cancer.

In a review of four cases of hepatic angiosarcoma, Falk et al. (1981b) determined that one case, that of a child, involved environmental arsenic exposure in a copper-smelting community in Arizona. Since this child had a history of pica, the usual exposure routes were augmented by further arsenic intake.

Roat et al. (1982) reported a case of hepatic angiosarcoma in a subject who, 33 years earlier, had ingested Fowler's solution for the relatively short period of 6 months. The pre-existence of skin cancer in this subject, from age 25, of the type associated with arsenic exposure, was further support of an arsenic association.

Knoth (1966) reported on two patients who had been treated with arsenical medicinals and developed tumors at sites other than the skin or lung. One of the patients was a 61-year old woman who had been treated with an arsenical

REC 5128

medicinal and developed mammary carcinoma. The other case was that of a 53-year old male who had been treated with an arsenical medicinal for cirrhosis vulgaris and developed a reticulosarcoma of the glans penis.

In the studies by Ott et al. (1974), an increased proportionate mortality due to malignant neoplasms of lymphatic and hematopoietic tissues was found. Axelson et al. (1978) found an increased risk of leukemia and myeloma in a case-control study of workers exposed at a smelter.

7.2 ANIMAL STUDIES

While arsenic carcinogenicity in test animals has not been observed in most studies, some recent reports have noted positive results. The literature on experimental inorganic arsenic carcinogenesis, as summarized in Table 7-20 and as reviewed by scientific bodies (NAS, 1977; NIOSH, 1975; IARC, 1973 and 1980) and individuals (Sunderman, 1976; Wildenberg, 1978; Pershagen and Vahter, 1979) supports this conclusion.

In light of the presently recognized anomalous metabolizing of inorganic arsenic by rats, studies which used rats as the experimental subjects should be viewed cautiously. Studies on other animal models have generally resulted in negative findings. A few of these studies are discussed below, but most have been summarized in Table 7-20.

In a study by Baroni et al. (1963), Swiss mice were given either arsenic trioxide dissolved in drinking water (concentration of 100 mg/ℓ) ad libitum for the duration of the 70-week experiment; or, sodium arsenate in a concentration of 15.8 gm/ℓ in a 2.5 percent solution of Tween 60 in water, applied twice weekly for the duration of the experiment. Each compound was tested alone, in combination with skin applications of croton oil (to test for initiating action), and after initiation with a single skin application of 7,12-dimethylbenz(a)anthracene or with administration of urethan by stomach tube

REC 5129

TABLE 7-20. SUMMARY TABLE OF EXPERIMENTAL STUDIES OF ARSENIC CARCINOGENESIS

Route	Species (Strain)	Compound	Vehicle	Results*	Reference	Remarks
Oral	Mice (C57B16)	As_2O_3	Tap water or 12% aqueous ethanol	-	Hueper and Payne, 1962	Shortened life span of treated (aq. ethanol) vs. control.
Oral	Mice (Swiss)	As_2O_3	Drinking water	-	Baroni et al., 1963	
Oral	Mice (Swiss)	$NaAsO_2$	Drinking water	-	Kanisawa and Schroeder, 1967	Shortened life span, low dose.
Oral	Mice (NMRI)	As_2O_3	Drug (Psor-Intern) or Fowler's solution	+(?)	Knoth, 1966	Significance cannot be determined, uncomplete reporting by author.
Oral	Mice (C3H/St, female)	$NaAsO_2$	Drinking water	-	Schrauzer and Ishmael, 1974	
Oral	Rats (not specified)	$Pb_3(AsO_4)_2$ $Ca_3(AsO_4)_2$	Not specified	-	Fairhall and Miller 1941	Poor survival in treated. As reviewed by IARC (Vol. 23, 1980)
Oral	Rats (Bethesda Blacks)	As_2O_3	Tap water or aqueous ethanol (12%)	-	Hueper and Payne, 1962	
Oral	Rats (Osborne-Mendel)	$NaAsO_2$ Na_3AsO_4	Diet	-	Byron et al., 1967	Reduced survival at highest dose.
Oral	Rats (Long Evans)	$NaAsO_2$	Drinking water	-	Kanisawa and Schroeder, 1969	Low dose.
Oral	Rats (Wistar)	$Pb_3(AsO_4)_2$ Na_3AsO_4 $Pb_3(AsO_4)_2$ + NDEA Na_3AsO_4 + NDEA	Diet Diet Diet Diet	- - - -	Kroes et al., 1974	High mortality and 2 tumors (incidence not reported observed in lead arsenate group).

REC 5130

TABLE 7-20. (continued)

Route	Species (Strain)	Compound	Vehicle	Results*	Reference	Remarks
Oral	Dog	$NaAsO_2$ or Na_3AsO_4	Diet	-	Byron et al., 1967	Weight loss, early mortality, short duration of experiment.
Inhalation	Mice (not specified)	$NaAsO_2$	Aqueous aerosol	-	Berteau et al., 1978	Reported in an abstract form, high incidence in controls.
Intratracheal instillation	Rats (Wistar King) male	(1) As_2O_3 (2) Copper ore (3.95% Arsenic) (3) Flue dust	Not specified	- - -	Ishinishi et al., 1977	One tumor observed in treated, not significant.
Intratracheal instillation	Rats (Wistar King) male	As_2O_3	Aqueous solution	-	Ishinishi et al., 1976	One tumor observed in treated, not significant.
Intratracheal instillation	Rats (BDIX)	$Ca_3(AsO_4)_2$	Bordeaux mixture (contains $CuSO_4$ and $Ca(OH)_2$)	+	Ivankovic et al., 1979	Results cannot be attributed to arsenic alone.
Intratracheal instillation	Golden Hamsters (males)	As_2O_3 ± BP	Carbon carrier + dilute H_2SO_4	+	Pershagen et al., 1983	Adenomas significantly greater than controls ($p < 0.01$). Carcinomas in 3 treated animals vs. 0 in controls.
Intratracheal instillation	Golden Hamsters (female)	As_2O_3	Phosphate buffer	+	Ishinishi and Yamamoto, 1983	As_2O_3 was tumorigenic in a dose-response fashion.

REC 5131

TABLE 7-20. (continued)

Route	Species (Strain)	Compound	Vehicle	Results*	Reference	Remarks
Intratracheal instillation	Rats	Ore dust containing As at two levels of content	Not specified	+	Chung and Liu, 1982	Possible confounding effects of other elements present, unknown. No apparent differences in lung cancer with different As levels in dust.
Skin painting (application)	Mice (not specified)	$KAsO_2$ and As_2O_3	Ethanol	-	Leitch and Kennaway, 1922	Neubauer (1947) failed to confirm this observation.
Skin painting (application)	Mice (S)	$KAsO_2$ followed by croton oil in acetone	Methanol	-	Salaman and Roe, 1956	As reviewed by IARC (Vol. 23, 1980).
Skin painting (application)	Mice (Rockland all-purpose)	(1) $KAsO_2$ followed by croton oil in benzene	80% ethanol	-	Boutwell, 1963	As reviewed by IARC (Vol. 23, 1980).
Skin painting (application)	Mice (Rockland all-purpose)	(2) DMBA followed by $KAsO_2$ in 80% ethanol	acetone	Not carcinogenic	Boutwell, 1963	
Skin painting (application)	Mice (Swiss)	(1) Na_3AsO_4	Water containing Tween 60	-	Baroni et al., 1963	
		(2) Na_3AsO_4 followed by croton oil and DMBA	Water containing Tween 60	No promotional activity observed		
Subcutaneous injection	Mice (Swiss) female Progeny	Na_3AsO_4 Na_3AsO_4	Water Water	+ +	Osswald and Goerttler, 1971	

REC 5132

TABLE 7-20. (continued)

Route	Species (Strain)	Compound	Vehicle	Results*	Reference	Remarks
Subcutaneous implant	Rats (random-bred) male albino	$Ca_3(AsO_4)_2$	Paraffin pellets	-	Arkhipov, 1968	As reviewed by IARC (Vol. 23, 1980).
Subcutaneous injection	Rats (random-bred) male albino	$Ca_3(AsO_4)_2$	Sunflower oil	-	Arkhipov, 1968	
Subcutaneous injection (pre-natal + post-natal)	Mice (CFLP)	As_2O_3	Aqueous solution	+	Rudnai and Borzsony, 1981	Histological description of tumors poor.
Intravenous injection	Mice (Swiss) female	Na_3AsO_4	Water	+	Osswald and Goerttler, 1971	
Intramuscullary injection	Rats (Osborne-Mendel)	Arsenic	Metallic	-	Hueper, 1954	
Intramuscullary injection	Rabbits	Arsenic	Metallic	-	Hueper, 1954	
Oral	Mice (Swiss)	As_2O_3 and croton oil, DMBA or urethan	Drinking water	-	Baroni et al., 1963	
Oral	Mice (STS)	Arsanilic acid or $KAsO_2$ followed by DMBA (skin) then croton oil (skin) in benzene	Diet	-	Boutwell, 1963	As reviewed by IARC (Vol. 23, 1980).

(*) + statistically significant excess tumors observed over controls

\- no statistically significant excess tumors of treated vs. control or no tumors observed

REC 5133

(to test for promoting action). All tests failed to show any carcinogenic activity of the two compounds under the given experimental conditions.

Kanisawa and Schroeder (1969) treated Swiss mice with sodium arsenite (equivalent to 5 μg/ml As) in drinking water for the 30-month duration of their study. In the treated animals, the authors noted 6 malignant and 11 combined malignant and benign tumors out of 103 animals versus 15 malignant and 50 combined malignant and benign tumors out of 170 control animals; thus, the results were negative for showing any carcinogenic effect of sodium arsenite in this study.

In a study of Leitch and Kennaway (1922; as reported in IARC, 1980), 100 mice were given skin applications of a solution of potassium arsenite in ethanol containing 1.8 percent arsenic trioxide (later reduced to 0.12 percent due to a high death rate), thrice weekly for 3 months. Of the 33 mice that lived for 3 months, only one developed a metastasizing squamous cell carcinoma.

In certain animal systems, positive carcinogenic responses have been reported, however. For example, Osswald and Goerttler (1971) exposed pregnant Swiss mice to daily parenteral dosing of sodium arsenate (0.5 mg/kg, solution of 0.005 percent arsenate salt) for a total of 20 injections. Part of the offspring groups received 20 injections of the same level subcutaneously at weekly intervals. Leukemia or lymphoma was seen in 46 percent of the mothers (11/24) at the end of 2 years versus none in the controls. Of the treated offspring, 41 percent (17/41) of the males and about half of the females (24/50) developed leukemia versus only 3 of 55 male and female control offspring (approximately 6 percent). IARC (1973) has criticized this study for the absence of exposure of controls to the appropriate vehicle solution.

Knoth (1966) noted a significant frequency of tumors in 30 mice exposed to Fowler's solution orally (one drop/week, 20 weeks, approximately 5.3 mg As

total),including adenocarcinomas of the skin, lung, and lymph nodes. The absence of experimental details makes critical assessment of this study difficult.

Some recent animal studies have employed different exposure conditions than have been employed in the past. Berteau et al. (1978) have exposed a tumor-susceptible strain of female mice to a respirable aerosol of inorganic arsenic (1 percent aqueous solution of sodium meta-arsenite, 20 to 40 minutes daily, 5 days/week, 55 weeks total). The 30 exposed mice showed neither gross nor histological evidence of neoplasia.

In a two-part study, Ishinishi et al. (1977) examined the carcinogenic and co-carcinogenic effects of various arsenic compounds on male Wistar-King rats. In the first part of the study, arsenic trioxide, an arsenic-containing copper ore (containing 3.95 percent arsenic) or metal refinery flue dust (containing 10.5 percent arsenic) were administered to 51 rats via 15 weekly intratracheal instillations. The rats were observed over their lifespan. Of the 25 surviving rats, one adenocarcinoma was seen in the group receiving flue dust. One lung metastasis from osteosarcoma of the femur and one adenoma was reported in the group exposed to the copper ore. No malignant tumors were reported in the group receiving arsenic trioxide; however, one adenoma was reported for this group. All groups displayed squamous cell metaplasia in the airway and osteometaplasia in the alveolus of the lung.

In the second part of the study, 87 rats were instilled with each of the above compounds suspended in a saline solution containing benzo[a]pyrene (B[a]P) or with B[a]P, alone. Control rats (23) were instilled with the saline solution. Of the 34 surviving exposed rats, one adenocarcinoma was seen in the group receiving B[a]P plus copper ore. All exposed groups had squamous cell carcinomas of the lung. Of particular interest to the authors, was the noted co-carcinogenic effect of arsenic trioxide with B[a]P; rats in

this group exhibited a 43 percent incidence rate (3/7) for squamous cell carcinomas. This compared with a 14 percent (1/7) incidence rate in animals given B[a]P, alone. No benign or malignant tumors were seen in the 7 surviving control rats. Again, squamous cell metaplasia or osteometaplasia were seen in all groups.

The results indicated a positive interaction between arsenic trioxide and B[a]P; however, the authors noted that the numbers of surviving animals were too small to permit drawing any firm conclusions from the study.

In another study, Ishinishi et al. (1980) gave 30 male adult Wistar rats intratracheal instillations of arsenic trioxide in suspension for 15 weeks. Of the 19 rats that survived, only one malignant squamous cell carcinoma was observed over lifetime. No tumors were found in the controls.

Ivankovic and co-workers (1979) exposed rats, via intratracheal instillation, to a pesticide mixture corresponding to that used in the past for vineyard treatment and consisting of a mixture of copper (II) sulfate, calcium hydroxide and calcium arsenate. Of 25 rats exposed to approximately 0.07 mg arsenic, 10 died from lung necrosis or pneumonia. In the survivors, 9 animals (60 percent) showed multi-focal bronchogenic adenocarcinomas and bronchiolar/alveolar cell carcinomas.

This study appears to offer experimental evidence that the vineyard pesticide mixture, employed as such, could have been carcinogenic to vine dressers working with the material. One difficulty with this study is an ambiguity regarding its full significance for the general issue of arsenic-inducing carcinogenic effects by itself. Clearly, the high mortality rate, 40 percent, and the known toxicity of Bordeau mixture (copper sulfate plus calcium hydroxide) to animals (Pimentel and Marques, 1969) and man (Villar, 1974, Pimentel and Marques, 1969) suggest carcinogenesis; however, it is impossible

to clearly ascribe such activity to arsenic alone given the presence of other compounds within the mixture. In their studies, Ivankovic et al. (1979) did not include animal groups exposed to calcium arsenate alone or to Bordeau mixture alone.

Pershagen et al. (1983, in press) have studied the pulmonary carcinogenicity of arsenic trioxide alone and in combination with benzo(a)pyrene in male golden hamsters given 15 weekly intratracheal instillations of 3 mg As/kg and/or 6 mg/kg B[a]P. In this study, a carbon dust carrier with dilute sulfuric acid was employed to enhance retention of arsenic. Carcinomas of larynx, trachea, bronchi and lungs were found in 3 animals given just arsenic versus a zero response in controls. The incidence of adenomas, papillomas and adenomatoid lesions was higher in arsenic versus control groups ($p < 0.01$). While the carcinomas in the arsenic group did not reach statistical significance, the significantly higher incidence of the adenomas, papillomas, and adenomatoid lesions support the authors' conclusion that the carcinomas were not a chance finding. The use of the carrier to enhance lung retention of arsenic appears to be the key to the results in this study. By itself, the oxide of arsenic is rather rapidly cleared from the lung (see below).

Rudnai and Borzsony (1981) reported that a combination of pre- and postnatal exposure of CFLP mice to injected arsenic trioxide (1.2 µg As/g, days 15-18 of gestation; 5 µg As/animal for 3 days post-birth) resulted in a 63 percent lung tumor incidence at 1 year of age versus approximately 18 percent in controls. In this study, a detailed histological description of the tumors was not given, but it can be assumed that both adenomas and adenocarcinomas were observed.

Chung and Liu (1982) reported that the repeated intratracheal instillation of ore dust containing arsenic in rats resulted in a lung cancer incidence

REC 5137

rate of approxiamtely 15 percent (6/41) over a period of 3 years, while controls (N=18) showed no lung tumors. There was extensive metastasis in one animal. In this study, two compositions of metal content in ores were used, with the arsenic varying by 8-fold. The lung cancer rate for the two forms of ore dust were comparable, despite the 8-fold difference in arsenic, i.e., there was no simple dose response. On the other hand, the ores contained variable amounts of iron and lead, which may have affected both the dose response and, possibly, the actual incidence of the lung cancers.

Ishinishi and Yamamoto (1983) exposed female golden hamsters to arsenic trioxide by intratracheal instillation of a suspension in phosphate buffer, 15 times weekly, for 4 months, at a total dose of 5.3 mg As. A second group was given a total dose of 3.8 mg As. All animals were followed over their entire life span. The incidence of lung tumors (adenomas) for the combined exposure groups was approximately 17 percent versus no tumors in surviving controls. While the sample size was small, there was the suggestion of a dose response across the two exposure levels (3/10 for the higher dose; 1/10 for the lower dose). These data suggest that arsenic trioxide is tumorigenic in the golden hamster and may be carcinogenic.

Recently, both Inamasu et al. (1982) and Pershagen et al. (1982) have studied the effects of intratracheal instillation of calcium arsenate (see Section 4.1.1 for complete discussion of studies). Inamasu et al. gave single intratracheal instillations of arsenic trioxide or calcium arsenate to male Wistar rats. Pershagen et al. instilled male Syrian golden hamsters with four weekly suspensions of arsenic trioxide, arsenic trisulfide and calcium arsenate. The results of both studies showed that arsenic trioxide was rapidly cleared from the lungs, whereas calcium arsenate was slowly eliminated. The differences in clearance appeared to be related to solubility, with the less soluble calcium arsenate exhibiting the slowest clearance.

REC 5138

These recent findings might help to explain the differences noted above in the earlier studies of Ishinishi et al. (1977; 1980) and Ivankovic et al. (1979). In regard to the Ivankovic study, it may be that the calcium arsenate, of itself, contributed to the high mortality rate observed in the exposed rats.

Schrauzer and co-workers (Schrauzer and Ishmael, 1974; Schrauzer et al., 1977; Schrauzer et al., 1978) have reported experimental results using oral arsenic and the tumorigenic effect of the agent on spontaneous mammary adenocarcinomas in an inbred strain of mice (C_3H/St Mice). These workers noted that while arsenic retards the overall incidence of tumor formation (10 or 80 ppm As), it stimulates the growth of tumors that otherwise occur. When these animals were exposed to only 2 ppm As (arsenite) in drinking water, compared to levels of 10 or 80 ppm, there was no effect on frequency of tumors, although the same enhanced tumor growth was seen as before with levels of 10 or 80 ppm As (Schrauzer et al., 1978). Furthermore, a higher incidence of multiple tumors of the mammary gland was observed, as was the abolishing of the anticarcinogenic effect of selenium in this system when both elements were given together.

In support of the positive responses noted in the above animal studies, Dipaolo and Casto (1979) reported the transformation of cultured Syrian hamster embryo cells by direct exposure to sodium arsenate (NA_2HAsO_4). In their assay, 300 cells from secondary cultures of Syrian hamster embryo cells (HEC) were plated in complete medium with 20 percent serum in 50-mm plastic Petri dishes along with 6×10^4 HEC cells which had been irradiated as confluent monolayer cultures. Sodium arsenate at concentrations of 0 µg/ml (control), 2.5 µg/ml and 5.0 µg/ml in complete medium (with a final concentration of acetone less than 0.02 percent) were added 24 hours later. Dishes were fixed and stained nine days after seeding. Colonies were scored blind by two observers.

For the two sodium arsenate concentrations, the authors reported that the number of transformations were 1.16 and 2.08/dish, respectively, or 1.74 and 4.13 percent, respectively, on the basis of transformed colonies relative to total colonies scored. The authors also reported that typical colonies scored as transformed after direct treatment with a metal carcinogen were identical to those obtained with other chemical carcinogens. In addition, the authors claimed (data not shown) that when 2.5 µg benz(a)pyrene per ml of medium were used, the transformation frequency, on a colony basis, was 4 to 6 percent.

7.3 QUANTITATIVE CARCINOGEN RISK ESTIMATES

7.3.1 Introduction

This quantitative section deals with the unit risk for arsenic in air and water and the potency of arsenic relative to other carcinogens that the Carcinogen Assessment Group (CAG) of the U.S. Environmental Protection Agency has evaluated. The unit risk estimate for an air pollutant is defined as the lifetime cancer risk occurring in a population in which all individuals are exposed continuously from birth throughout their lifetimes to a concentration of 1 $\mu g/m^3$ of the agent in the air they breathe. The unit risk estimate for water is defined similarly, but with a water concentration of 1 µg/ℓ. Unit risk estimates are used for two purposes: (1) to compare several agents with each other in terms of carcinogenic potency, and (2) to give a crude indication of the human health risks that might be associated with exposure to these agents, if the actual exposures are known.

The data used for quantitative estimates can be of two types: (1) lifetime animal studies, and (2) human studies where cancer risk has been associated with exposure to the agent. It is assumed, unless evidence exists to the contrary, that if a carcinogenic response occurs at the dose levels used in a study, then responses at all lower doses will occur with an incidence that can be determined by an appropriate extrapolation model.

REC 5140

There is no solid scientific basis for any mathematical extrapolation model that relates carcinogen exposure to cancer risks at the extremely low concentrations which must be dealt with in evaluating environmental hazards. For practical reasons, such low levels of risk cannot be measured directly either by animal experiments or by epidemiologic studies. It is necessary, therefore, to depend on current knowledge of the mechanisms of carcinogenesis for guidance as to the correct risk model to use.

At the present time, the dominant view is that most cancer-causing agents also cause irreversible damage to DNA--a position supported by the fact that a large proportion of agents that cause cancer are also mutagenic. There is reason to expect that the quantal type of biological response, which is characteristic of mutagenesis, is associated with a linear non-threshold dose-response relationship. Indeed, there is substantial evidence from mutagenesis studies with both ionizing radiation and a wide variety of chemicals that this type of dose-response model is the appropriate one to use in estimating cancer risks from environmental exposures. This is particularly true at the lower end of the dose-response curve. At higher doses, there can be an upward curvature, probably reflecting the effects of multistage processes on the mutagenic response. The linear non-threshold dose-response relationship is also consistent with the relatively few epidemiologic studies of cancer responses to specific agents that contain enough information to make the evaluation possible (e.g., radiation-induced leukemia, breast and thyroid cancer, skin cancer induced by arsenic in drinking water, liver cancer induced by aflatoxins in the diet). There is also some evidence from animal experiments that is consistent with the linear non-threshold model (e.g., the initiation stage of the two-stage carcinogenesis model in rat liver and mouse skin).

Because of these factors, the linear non-threshold model is considered to be a viable possibility for the true dose-response relationship and, unless

REC 5141

direct evidence to the contrary is presented, it is used as the primary basis for risk extrapolation at low levels of exposure.

The quantitative aspect of carcinogen risk assessment is included here because it may be of use in setting regulatory priorities, evaluating the adequacy of technology-based controls, and other aspects of the regulatory decision-making process. However, the imprecision of presently available technology for estimating cancer risks to humans at low levels of exposure should be recognized. At best, the linear extrapolation model used here provides a rough but plausible estimate of the upper limit of risk--that is, with this model it is not likely that the true risk would be much more than the estimated risk, but it could be considerably lower. The risk estimates presented below should not be regarded, therefore, as accurate representations of true cancer risks even when the exposures involved are accurately defined. The estimates presented may, however, be factored into regulatory decisions to the extent that the concept of upper-risk limits is found to be useful.

7.3.2 Unit Risk for Air

7.3.2.1 Methodology for Quantitative Risk Estimates--The methodologies used to arrive at quantitative estimates of risk must be capable of being implemented using the data available in existing epidemiologic studies of exposure to airborne arsenic. In order to extrapolate from the exposure levels and temporal exposure patterns in these studies to those for which risk estimates are required, it will be assumed that the age-specific mortality rate of respiratory cancer per year per 100,000 persons for a particular 5-year age interval, i, can be represented using either of two models:

$$a_i(D) = a_i[1 + a'D^k] \qquad (1)$$

(a relative or multiplicative risk model), or

$$a_i(D) = a_i + 100{,}000a'D^k \qquad (2)$$

REC 5142

(an absolute or additive risk model). With either model, a_i is the age-specific mortality rate per year of respiratory cancer in a control population not exposed to arsenic, a' is a parameter representing the potential of airborne arsenic to cause respiratory cancer, and D is some measure of the exposure to arsenic up to the ith age interval. For example, D might be the cumulative dose in $\mu g/m^3$ years, the cumulative dose neglecting exposure during the last 10 years prior to the ith age interval, or the average dose in $\mu g/m^3$ over some time period prior to the ith age interval. The forms to be used for D will be constrained by the manner in which dose was treated in each individual epidemiologic study. The parameter k determines the shape of the dose-response curve. Attention will be given particularly to the values k = 1 and k = 2. If k = 1, the age-specific incidence rates vary linearly with the dose level (a linear model), and if k = 2 they vary quadratically. At low exposures the extra lifetime probability of respiratory cancer mortality will vary correspondingly (e.g., linearly for k = 1 and quadratically for k = 2).

The dose-response data available in the epidemiologic studies for estimating the parameters in these models consists primarily of a dose measure D_j for the jth exposure group, the person-years of observation Y_j, the observed number of respiratory cancer deaths O_j, and the number E_j of these deaths expected in a control population with the same sex and age distribution as the exposure group. The expected number E_j is calculated as

$$E_j = \sum_i Y_{ji} a_i / 100{,}000, \qquad (3)$$

where Y_{ji} is the number of person-years of observation in the ith age category and the jth exposure group ($Y_j = \sum_i Y_{ji}$). This is actually a simplified representation, because the calculation also takes account of the change in the

REC 5143

age-specific incidence rates with absolute time. The expected number of respiratory cancer deaths for the ith exposure group is

$$E(O_j) = \sum_i Y_{ji} a_i (1 + a' D_j^k)/100{,}000$$

$$= E_j (1 + a' D_j^k) \qquad (4)$$

under the relative risk model, and is

$$E(O_j) = \sum_i Y_{ji} (a_i + 100{,}000 a' D_j^k)/100{,}000$$

$$= E_j + a' Y_j D_j^k \qquad (5)$$

under the absolute risk model. Consequently, with either model, $E(O_j)$ can be expressed in terms of quantities typically available from the published epidemiologic studies. Note that person-years of observation are not required if the multiplicative model is used.

Making the reasonable assumption that O_j has a Poisson distribution, the parameters a' and k can be estimated from the above equations using the method of maximum likelihood. Once these parameters are estimated, the age-specific mortality rates for respiratory cancer can be estimated for any desired exposure pattern.

To estimate the corresponding additional lifetime probability of respiratory cancer mortality, let $b_1, \ldots, b_{18}$ be the mortality rates, in the absence of exposure, for all cases per year per 100,000 persons for the age intervals 0-4, 5-9,..., 80-84, and 85+, respectively; let $a_1, \ldots, a_{18}$ represent the corresponding rates for malignant neoplasms of the respiratory system. The probability of survival to the beginning of the ith 5-year age interval is estimated as

$$\prod_{j=1}^{i-1} [1 - 5b_j/100,000]. \qquad (6)$$

Given survival to the beginning of age interval i, the probability of dying of respiratory cancer during this 5-year interval is estimated as

$$5a_i/100,000. \qquad (7)$$

The probability of dying of respiratory cancer given survival to age 85 is estimated as a_{18}/b_{18}. Therefore, the probability of dying of respiratory cancer in the absence of exposure to arsenic is estimated as

$$P_0 = \sum_{i=1}^{17} [5a_i/100,000) \prod_{j=1}^{i-1} (1 - 5b_j/100,000)] \qquad (8)$$

$$+(a_{18}/b_{18}) \prod_{j=1}^{17} (1 - 5_{bj}/100,000)$$

Here the mortality rates a_i apply to the target population for which risk estimates are desired, and consequently will be different from those in (1)-(5), which applied to the epidemiologic study cohort. If the 1976 U.S. mortality rates (male, female, white, and non-white combined) are used in this expression, then $P_0 = 0.0451$.

To estimate the probability P_{EP} of respiratory cancer mortality when exposed to a particular exposure pattern EP, the formula (8) is again used, but a_i and b_i are replaced by $a_i(D_i)$ and $b_i(D_i)$, where D_i is the exposure measure calculated for the ith age interval from the exposure pattern EP. For example, if the dose measure used in (1) is cumulative dose to the beginning of the ith age interval in $\mu g/m^3$-years, and the exposure pattern EP is a

lifetime exposure to a constant level of 10 μg/m^3, then $D_i = (i-1)(5)(10)$, where the 5 accounts for the fact that each age inverval has a width of 5 years. The additional risk of respiratory cancer mortality is estimated as

$$P_{EP} - P_0. \qquad (9)$$

If the exposure pattern EP is constant exposure to μg/m^3, then $P_{EP} - P_0$ is called the "unit risk."

This approach can easily be modified to estimate the extra probability of respiratory cancer mortality by a particular age due to any specified exposure pattern. It is also clear that the applications of the approach are not limited to respiratory cancer.

7.3.2.2 Risk Estimates from Epidemiologic Studies--Prospective studies of the relationship between mortality and exposure to airborne arsenic have been conducted for the Anaconda, Montana smelter (Lee and Fraumeni, 1969; Lee-Feldstein, 1983; Higgins et al., 1982; Brown and Chu, 1983 a, b, c); and the Tacoma, Washington smelter (Pinto et al., 1977; Enterline and Marsh, 1982).

The study of Lee-Feldstein (1983) reported on an additional 14 years of follow-up of the cohort of 8047 studied by Lee and Fraumeni (1969), and used essentially the same methods of analysis as the earlier study. Therefore, it will not be necessary to consider the Lee and Fraumeni study in any detail in this report. Higgins et al. (1982) followed for an additional 14 years a sample of 1800 men from the cohort studied by Lee and Fraumeni, but used different exposure classifications and different methods of analyses.

Brown and Chu (1983 a, b, c), in a series of papers, arranged the Anaconda smelter data in such a manner that a mathematical model could be derived from it to account for the effect of the timing of exposure as predicted by the multistage model.

REC 5146

Whereas Pinto et al. (1977) studied a cohort from the Tacoma smelter consisting of 527 men followed only after retirement, the study by Enterline and Marsh (1982) involved 2802 men and included follow-up prior to retirement. Consequently, the Enterline and Marsh study appears to provide a stronger basis for quantitative risk assessment than the Pinto et al. study.

In addition to studies of copper smelter workers, there have also been studies of workers exposed to arsenicals in the production or use of pesticides. Ott et al. (1974) studied the mortality experience of workers exposed to lead arsenate and calcium arsenate.

7.3.2.2.1 The Lee-Feldstein (1983) study. This study included 8047 white males who were employed as smelter workers for 12 months or more before 1957, and whose mortality experience was observed from 1938 through 1977. Altogether, the study involved 192,476 person-years of follow-up and 3550 deaths, including 302 from respiratory cancer (Table 7-21). Expected numbers of cancer deaths were calculated on an age-adjusted basis using the combined mortality experience of the white male population of Idaho, Wyoming, and Montana. As Table 7-21 indicates, malignant neoplasms of the digestive and respiratory tracts had SMRs of 125 and 285, respectively, both of which were significant at the 1 percent level (SMR = [observed/expected][100]).

Workers were categorized both by duration of employment and level of exposure to airborne arsenic in order to determine the effect of these parameters upon mortality. For each year of the study period, workers were assigned to one of five groups on the basis of total years of smelter employment completed (Table 7-22). Work areas in the smelter were divided into heavy, medium, or light exposure areas. Based upon this division, workers were categorized into heavy, medium, or light exposure groups, as determined by their maximum exposure for 12 or more months. The results for respiratory cancer based upon these categorizations are given in Table 7-23.

REC 5147

TABLE 7-21. OBSERVED AND EXPECTED DEATHS DUE TO SELECTED CAUSES, WITH STANDARDIZED MORTALITY RATIOS (SMRs) AMONG SMELTER WORKERS, 1938-77

Cause of Death	List No.[a]	Number of deaths		SMR[b]
		Observed	Expected	
Tuberculosis	001-019	53	27.93	190[c]
Respiratory	001-008	47	25.51	184[c]
Other	010-019	6	2.42	248
Malignant neoplasms	140-199	609	370.74	164[c]
Digestive	150-159	167	133.58	125[c]
Respiratory	160-164[d]	302	105.81	285[c]
Other	140-148, 165-170, 177-181, 190-199	140	131.35	107
Vascular lesions of central nervous system	330-334	262	211.56	124[c]
Diseases of heart	400-443	1366	1056.55	129[c]
Influenza and pneumonia	480-483, 490-493	88	76.05	116
Emphysema (1963-77 only)	527	90	34.58	260[c]
Cirrhosis of liver	581	76	36.53	208[c]
Accidents	800-962	288	280.27	103
Motor vehicle	810-825, 830-835	106	115.55	92
Other	800-802, 840-862	182	164.72	110
Suicide and homicide	963-964, 970-979, 980-985	83	86.08	98
All other causes	Residual	606[e]	548.50	
Total		3522	2728.79	129[c]

[a]Seventh revision of International Lists of Diseases and Causes of Death.

[b]SMR = (observed/expected) x 100.

[c]Significant at 1% level. Bailar and Ederer (1964)

[d]Among the 302 deaths from respiratory cancer, the site was lung and bronchus (162,163) in 289 cases, larynx (163) in 9, mediastinum (164) in 3 and (160) in 1.

[e]Includes 19 emphysema deaths occurring in the years preceding 1963, for which emphysema death rates are not available from individual states.

Source: Lee-Feldstein (1983).

TABLE 7-22. DESCRIPTION OF LENGTH OF EMPLOYMENT GROUPS, WITH NUMBERS OF SMELTER WORKERS, NUMBERS OF DEATHS, PERSON-YEARS AT RISK, AND DURATION OF SMELTER EMPLOYMENT (BASED ON TOTAL WORK EXPERIENCE THROUGH SEPT. 30, 1977)

Length of employment group[a]	Number of persons[b]	Number of deaths	Number of person-years of follow-up[c]
1 (25 or more years)	1899	1169	27,053
2 (15 to 24 years)	1138	586	26,556
3 (10 to 14 years)	678	328	19,734
4 (5 to 9 years)	1082	433	30,854
5 (1 to 4 years)	3248	1006	88,279
TOTAL	8045	3522	192,476

[a]Employees in all cohorts were living on Jan. 1, 1938.

[b]Group assignment of each person here was based on his status at the termination of employment or on September 30, 1977 (whichever date was earlier).

[c]Represents cumulative follow-up experience over the study period, 1938-77, with a total of 67,569 person-years of follow-up in the period 1964-77. Individuals were initially counted at risk upon completing 1 year of employment or on Jan. 1, 1938, if employed at least a full year before that date. In each calendar year of the study period, employees were counted in the group reflecting their cumulative work experience to date.

Source: Lee-Feldstein (1983).

Exposure to airborne arsenic was estimated from 702 samples collected at 56 sampling stations during the years 1943-1958 (Morris, 1975). Morris estimated that airborne levels averaged 11.27, 0.58, and 0.27 mg/m^3 in the heavy, medium, and light exposure areas, respectively. Respirators were used with varying degrees of faithfulness in the high exposure areas; consequently, average individual exposures in these areas were probably much less than 11.27 mg/m^3. A rough estimate is that use of respirators reduces the exposure levels by a factor of 10 (OSHA, 1978).

REC 5149

TABLE 7-23. OBSERVED AND EXPECTED DEATHS FROM RESPIRATORY CANCER, WITH PERSON-YEARS OF FOLLOW-UP, BY COHORT AND DEGREE OF ARSENIC EXPOSURE

	Maximum Exposure to Arsenic (12 or more months)[a]					
	Heavy		Medium		Light	
Years of Exposure	Obs/Exp[b]	P-Y[c]	Obs/Exp	P-Y	Obs/Exp	P-Y
25 years+	13/2.5	2400	49/7	6837	51/16.3	14573
15-24	9/1.3	2629	13/4.0	6509	16/8.6	12520
Less than 15 years	11/2.4	6520	31/9.3	24594	69/31	78245

[a]The 1562 men who worked less than 12 months in their category of maximum arsenic exposure were not included in this table.

[b]Observed/Expected.

[c]Person-years of follow-up furnished by Dr. Lee-Feldstein (personal communication).

Source: Adapted from Lee-Feldstein (1983).

The Lee-Feldstein (1983) study has a number of features which support its use in making quantitative estimates of respiratory cancer risk from airborne arsenic. It was a large study that involved observations of a considerable number of respiratory cancer deaths. A substantial amount of follow-up was conducted of persons who had been exposed for 15 years or more. Estimates of exposure levels and work histories are available for estimating individual exposures and for determining dose response.

It would have been more appropriate for making quantitative estimates of risk to have categorized workers by their individual cumulative or average exposures, rather than by their maximum exposures for 1 year or more. In developing the quantitative estimates, it will be assumed that a worker's average exposure during work hours was equal to the exposure for the category to which he was assigned. However, because these assignments were based upon

maximum exposures for at least a 12-month period, this approach tends to overestimate exposures, and consequently, to underestimate the carcinogenic potency of arsenic.

Because smoking is also an important risk factor for respiratory cancer, it would have been very useful to have smoking histories for the workers. Higgins et al. (1982) collected some limited smoking data for this cohort. Higgins and co-workers suggest that the smelter workers smoked somewhat more than the average U.S. white male population, but the difference was not enough to have a major effect upon the outcome of the study.

Development of risk estimates: The data from the Lee-Feldstein (1983) study used in the risk assessment are listed in Table 7-24. The relative risk (observed/expected) from this table are graphed in Figure 7-2, and the absolute risks ([observed-expected/person-years) in Figure 7-3. It is clear from these graphs that the risk for the high-exposure group exposed for greater than 25 years is not commensurate with the risks for the other groups. Because of this, and also because the exposures in the high exposure groups are much more uncertain than those of the other groups, it was decided to estimate risk using only the low and medium exposure groups. Results of applying chi-square goodness-of-fit tests of the relative and absolute risk models with $k = 1$ and $k = 2$ are recorded in Table 7-25. The maximum likelihood estimates of the carcinogenic potency parameter a' are also listed in this table. The maximum likelihood fits of these models are graphed in Figures 7-2 and 7-3. All of the fits are poor (p less than 0.0001) with the exception of that for the absolute-risk model; this latter fit is marginally acceptable ($p = 0.025$).

The unit risk (additional risk of respiratory cancer death from lifetime exposure to 1 $\mu g/m^3$ airborne arsenic) obtained from the absolute-risk model with $k = 1$ is also listed in Table 7-25. This risk was estimated by applying (2), (8), and (9) with D_i based upon a constant exposure of 1 $\mu g/m^3$.

REC 5151

TABLE 7-24. DOSE-RESPONSE DATA FROM LEE-FELDSTEIN (1983) USED FOR RISK ASSESSMENT

Cohort	Maximum Exposure to Arsenic	Cumulative Exposure[a] ($\mu g/m^3$-years)	Person-Years of Observation[b]	Observed Deaths	Expected Deaths
1	Heavy	36064	2400	13	2.5
(25 + years	Medium	18560	6837	49	7.0
(of exposure)	Light	9280	14573	51	16.3
2					
(15-25	Heavy	22250	2629	9	1.3
years of	Medium	11600	6509	13	4.0
exposure)	Light	5800	12520	16	8.6
3					
(less than	Heavy	5973	6520	11	2.4
15 years of	Medium	3074	24594	31	9.3
exposure)	Light				

[a]Exposures are in $\mu g/m^3$-years estimated as (air concentration)(duration). For light, medium, and heavy exposures, air concentration was estimated as 290, 580, and 1127 $\mu g/m^3$, respectively (OSHA, 1978). Duration was estimated as follows (cf. Table 7-22):

Cohort 1: Persons in this cohort had at least 25 years' exposure. If all had worked continuously throughout follow-up, average duration would have been 25 + 27053/1899 = 39 years. Therefore the midpoint (39 + 25)/2 = 32 years was used.

Cohort 2: The midpoint of the employed interval, i.e., (15 + 25)/2 = 20 years was used.

Cohort 3: A weighted average of the midpoints of the employment intervals, i.e.,

$$\frac{(3)\ (88279) + (7.5)(30854) + (12.5)(19734)}{88279 + 30854 + 19734} = 5.3 \text{ years was used.}$$

[b]Furnished by Dr. Lee-Feldstein.

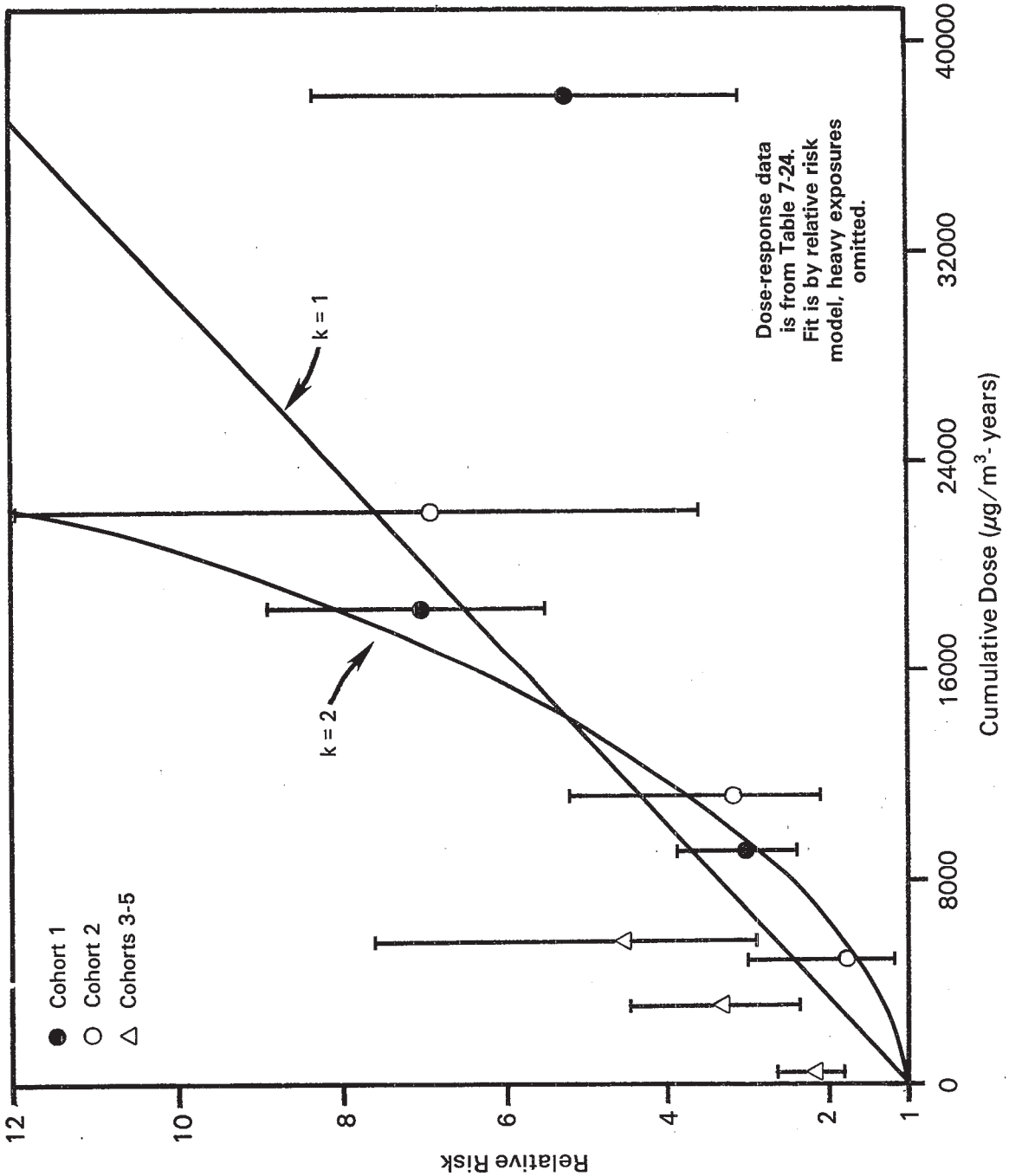


Figure 7-2. Relative risks and 90% confidence limits for data of Lee-Feldstein (1983).

REC 5153

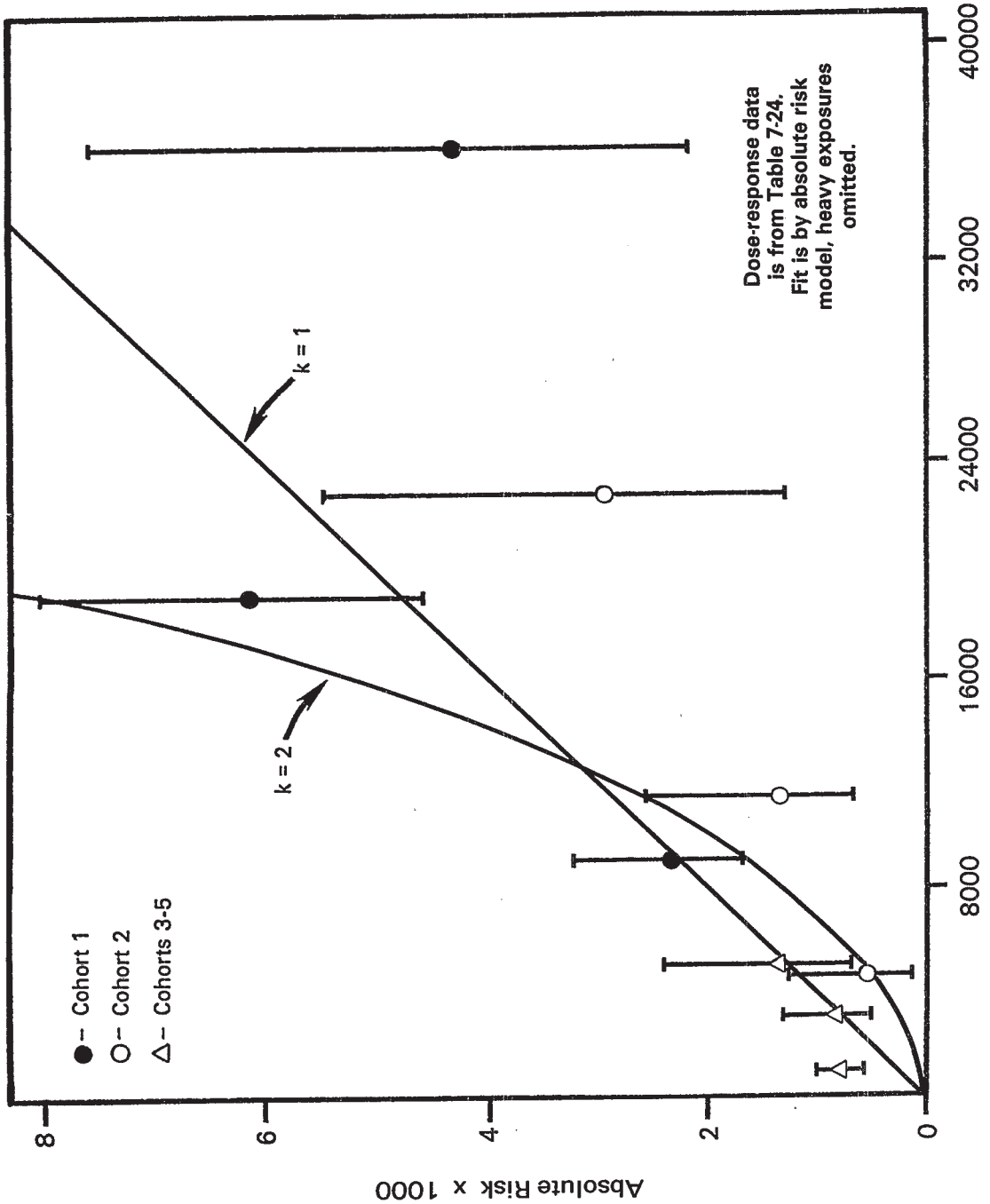


Figure 7-3. Absolute risks and 90% confidence limits for data of Lee-Feldstein (1983).

REC 5154

TABLE 7-25. SUMMARY OF QUANTITATIVE RISK ANALYSES

Exposed Population	Study and Data Source	Model	k	Results of Goodness-of-Fit Test: Carcinogenic Potency (a')[a]	x^2 (d.f.)	p-value	"unit" risk[b]
Anaconda smelter workers	Lee-Feldstein Table 7-24 (heavy exposure omitted)	absolute risk	1	2.48(-7)	12.7(5)	0.025	2.80(-3)
			2	2.09(-11)	60(5)	0.00001	lack of fit[d]
		relative risk	1	3.00(-4)	28(5)	0.00004	lack of fit
			2	2.09(-8)	79(5)	0.00001	lack of fit
	Higgins et al. Table 7-26	absolute risk	1	2.36(-7)	1.2(3)	0.75	4.90(-3)
			2	1.74(-11)	10.3(3)	0.017	1.05(-4)
		relative risk	1	3.17(-4)	2.57(3)	0.46	4.03(-3)
			2	2.18(-8)	15.4(3)	0.0015	lack of fit
	Brown & Chu Tables 7-27 and 7-29	absolute risk	1	9.45(-16)	7.01(7)	0.41	1.25(-3)
ASARCO smelter workers	Enterline & Marsh Table 7-33 (zero lag)	absolute risk	1	6.04(-7)[c]	5.5(4)	0.24	6.81(-3)
			2	1.43(-10)	20.7(4)	0.0003	lack of fit
		relative risk	1	4.6(-4)	11.6(4)	0.02	5.44(-3)
			2	1.01(-7)	23.4(4)	0.00011	lack of fit
	Enterline & Marsh Table 7-33 (10-year lag)	absolute risk	1	8.85(-7)	7.0(4)	0.14	7.60(-3)
			2	2.01(-10)	26.1(4)	0.00003	lack of fit
		relative risk	1	5.13(-4)	14.5(4)	0.006	lack of fit
			2	1.06(-4)	28.9(4)	0.00002	lack of fit
Dow pesticide manufacture workers	Ott et al. Table 7-34 (high exposure omitted)	relative risk	1	9.2(-4)	5.0(7)	0.66	1.36(-2)
			2	1.58(-7)	9.4(7)	0.23	7.68(-4)

[a] Potencies are in different units, depending upon model used (see text), and consequently are not comparable.

[b] Additional lifetime risk of respiratory cancer mortality from lifetime environmental exposure to 1 $\mu g/m^3$ arsenic.

[c] 6.04(E-7) means 6.04×10^{-7}.

[d] p-value of chi-square goodness-of-fit test is less than 0.01.

REC 5155

Specifically,

$$D_i = 4.56[(i-1) + 2.5] \qquad (10)$$

was used, which represents the cumulative exposure in $\mu g/m^3$ resulting from a constant exposure to $\mu g/m^3$ from birth to the midpoint of the ith 5-year age interval. The factor 4.56 is needed to account for the fact that the workers in the occupational study used to estimate the carcinogenic potency of arsenic were only exposed during work hours. Assuming that workers were exposed for an average of 8 hours per day, 240 days per year, an environmental exposure to 1 $\mu g/m^3$ for 1 year is equivalent to an occupational exposure to

$$(1\ \mu g/m^3)(24\ \text{hours}/8\ \text{hours})(365\ \text{days}/240\ \text{days}) = 4.56\ \mu g/m^3 \qquad (11)$$

for 1 year.

7.3.2.2.2 The Higgins et al. (1982) study. Higgins et al. conducted additional independent follow-up through 1977 of a sample of 1800 men from the Anaconda smelter cohort studied by Lee and Fraumeni (1969). The sample included all of the men classified in the heavy exposure category by Lee and Fraumeni (1969), as well as a random sample of 20 percent of the remaining cohort. There were 80 deaths from respiratory cancer in the sample. Expected numbers were based upon the mortality rates of Montana white males, except for "all respiratory diseases"; U.S. white males were the referenced population for the latter category.

Higgins et al. also reviewed the industrial hygiene data and calculated average concentrations for the period 1943-1965 for 18 departments. No measurements were available for 17 departments, and average concentrations were estimated for these. These estimates were coupled with work histories

REC 5156

updated through 1978 to obtain exposure measures for each individual in the study. Three types of individual exposure measures were considered: ceiling, time-weighted average (TWA), and cumulative. Ceiling exposures were estimates, in $\mu g/m^3$, of the highest exposure a man experienced for 30 days or more. TWA exposures were estimates, in units of $\mu g/m^3$, of the time-weighted average exposures during the period of employment. Cumulative exposures were estimates of total exposure in units of $\mu g/m^3$-years.

Higgins et al. investigated 5 combinations of follow-up and time period during which exposure was assessed: I. Exposure was assessed up to the date a worker entered the study and follow-up was from entry into the study through 1978; II. Exposure was assessed up to 1964 and follow-up was also through this date; III. Exposure was assessed through 1964 and follow-up was through 1978; IV. Exposure was assessed through 1964 and follow-up was from 1964 through 1978; V. Exposure was assessed through 1978 and follow-up was also through 1978. These different methods were considered principally because of the perceived difficulties of overlapping exposure and follow-up periods. Thus, with methods I and IV, exposure and follow-up periods were disjoint, whereas with methods II and V they coincided.

The analyses based upon ceiling exposures are not considered suitable for quantitative risk assessment because it seems extremely unlikely that respiratory cancer risk would be a function of peak exposures for any 30-day period, regardless of the other exposures that might have been experienced. This is also the case with the TWA analyses, because the exposures were averaged only over the period of employment, without regard to the duration of employment. If either of these dose measures were appropriate, it would mean, for example, that exposure to 500 $\mu g/m^3$ for 1 month would produce the same risk as exposure to 500 $\mu g/m^3$ for 30 years--which seems highly unlikely.

REC 5157

Thus, the analyses of Higgins et al. which appear to be most appropriate for developing quantitative estimates are those based upon cumulative exposure. This particular type of analysis was applied only to method V and applied only in Higgins (1982). The results of this analysis for lung cancer are listed in Table 7-26.

TABLE 7-26. RESPIRATORY CANCER MORTALITY 1938-1978 FROM CUMULATIVE EXPOSURE TO ARSENIC FOR 1800 MEN WORKING AT THE ANACONDA COPPER SMELTER[a]

Cumulative Exposure $\mu g/m^3$-years	Person-Years of Observation	Observed Deaths	Expected Deaths
0-500[b] (250)	13845.9	4	5.8
500-2000 (1250)	10713.0	9	5.7
2000-12000 (7000)	11117.8	27**	6.8
≧ 12000 (16000)	9015.5	40**	7.3

[a]From Higgins (1982), Table 6.

[b]Numbers in parenthesis indicate assumed average exposures.

**Significant at 0.01 level.

Information on the smoking habits of 80.6 percent of the 1800 men was obtained from questionnaires administered directely to those still living and to close friends or relatives of those who were deceased. Sixteen percent of the smelter workers were "non-smokers" compared with 24-36 percent of U.S. males from 1955 through 1978. Thus, it appears that the smelter workers smoked somewhat more than the average U.S. male. However, no confounding was detected between arsenic exposure and smoking; 15.1 percent of those in the "heavy" exposure group were non-smokers, versus 16.3 percent in the other

REC 5158

exposure groups. Significant increases in respiratory cancer were observed even among non-smokers exposed to high levels of arsenic.

Development of risk estimates: The relative risks (observed/expected) from Table 7-26 are graphed in Figure 7-4, and the absolute risks ([observed-expected]/person-years) in Figure 7-5. Results of applying chi-square goodness-of-fit tests of the relative- and absolute-risk models with $k = 1$ and $k = 2$ are recorded in Table 7-25. The maximum likelihood estimates of the carcinogenic potency parameter a' are also listed in Table 7-25. The maximum likelihood fits of those models are graphed in Figures 7-4 and 7-5. The fits for $k = 1$ are both excellent, with the absolute-risk model providing a slightly better fit than the relative-risk model ($p = 0.75$ vs. $p = 0.46$). The fits for $k = 2$ are much less adequate ($p = 0.017$ for the absolute-risk model and $p = 0.0015$ for the relative-risk model).

The unit risks (defined as the additional risk of respiratory cancer death from lifetime exposure to 1 $\mu g/m^3$ airborne arsenic) obtained from the absolute- and relative-risk models with $k = 1$ are also listed in Table 7-25.

These risks were estimated by applying (1) or (2), (8), and (9) with D_i based upon a constant exposure of 1 $\mu g/m^3$. Specifically,

$$D_i = (4.56)(72) \qquad (12)$$

was used, which represents the average lifetime cumulative exposure in $\mu g/m^3$ resulting from a constant exposure to 1 $\mu g/m^3$. Average lifetime exposure is used because it seems most commensurate with the treatment of exposure by Higgins et al.; in their analysis all of the person-years attributable to a single worker were placed into a single exposure category based upon total lifetime exposure, and consequently person-years of observation were placed into exposure categories according to exposures which had not yet occurred. It

REC 5159

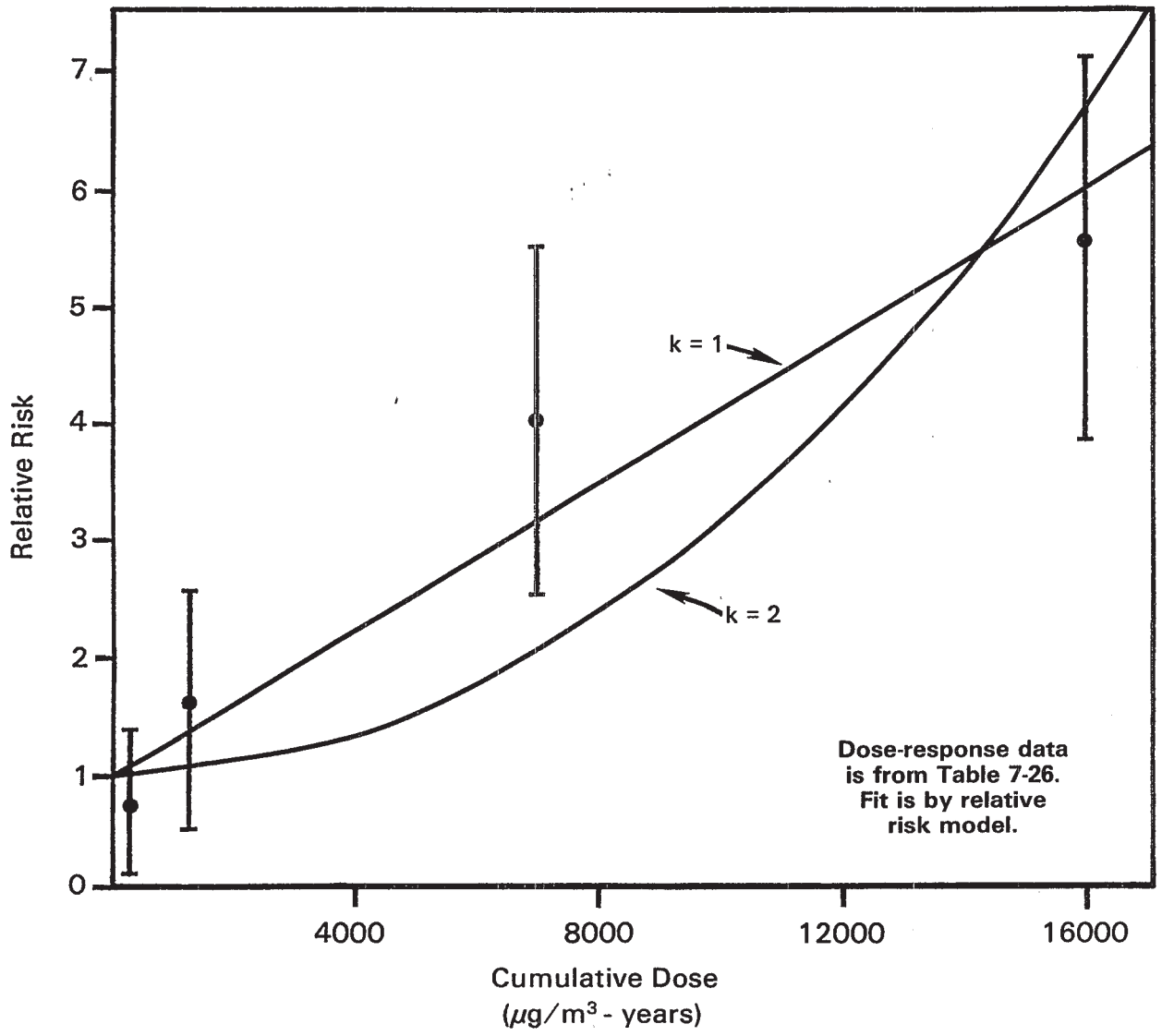


Figure 7-4. Relative risks and 90% confidence limits for data of Higgins (1982).

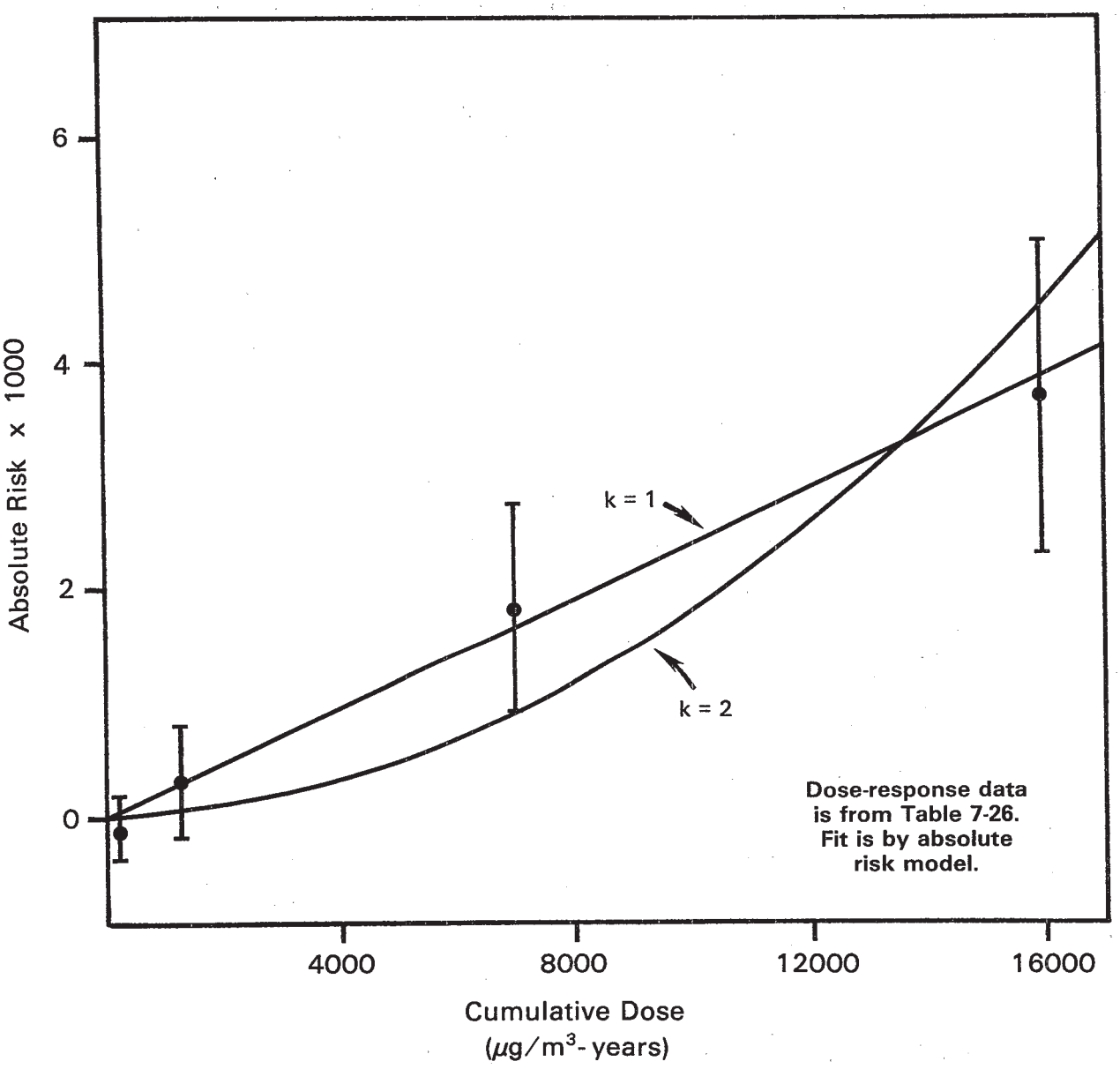


Figure 7-5. Absolute risks and 90% confidence limits for data of Higgins (1982).

would have been more appropriate for purposes of quantitative risk assessment had exposures been related to each 5-year age interval (as was done in the analysis of Enterline and Marsh, 1982) rather than to the total observation period of an individual. The factor 4.56 converts from occupational to environmental exposures and is explained at equation (11).

7.3.2.2.3 The Brown and Chu estimates from the Anaconda data. Development of Risk Estimates. As noted by Whittemore (1977) and Day and Brown (1980), the multistage theory for the carcinogenic process predicts that the carcinogenic response is a function of the following factors:

(1) exposure rate

(2) duration of exposure

(3) age at initial exposure

(4) time since cessation of exposure.

Brown and Chu (1983a) discuss in detail the ways in which these factors influence the age-specific carcinogenic rate at various stages of the carcinogenic process.

Using the updated Anaconda copper smelter workers cohort originally studied by Lee and Fraumeni (1969) and recently extended through 1977 by Lee-Feldstein (1983), Brown and Chu (1983b) concluded that airborne arsenic most probably acted on a late stage of the carcinogenic process. As a result, they hypothesized that the carcinogenic risk from arsenic exposure could be quantified by assuming a multistage model in which only the penultimate stage is affected by exposure. Under this assumption, the risk may be expressed in the form

$$r(d, t_o) = C[(d + t_o)^{k-1} - t_o^{k-1}] \qquad (13)$$

REC 5162

where d is the duration of exposure, t_o is the age at initial exposure, and C and k are unknown parameters. The parameter C depends upon the exposure rate, and the parameter k upon the time effect of exposure.

Brown and Chu (1983b) noted a deviation from this model on the part of workers who left employment at the copper smelter before the age of 55. As a result, the mortality experience of that group after leaving employment was not included in the analysis.

In order to estimate the unknown parameters C and k, the basic mortality data were arranged in the three-way table reproduced as Table 7-27. The three classifications used in this table are as follows:

(1) Level of exposure, corresponding to Lee and Fraumeni (1969)--classified into heavy, medium, and light exposure groups;

(2) Duration of employment, classified into the following five subgroups; 0-9, 10-19, 20-29, 30-39, and 40+ years;

(3) Age at initial employment, classified into the following five subgroups; 20, 20-29, 30-39, 40-49, and 50+ years.

For each of the 3 x 5 x 5 = 75 cells in the table, the following three variables were given:

Obs = observed number of respiratory cancer deaths;

Exp = expected number of respiratory cancer deaths (based upon the U.S. white male age-specific calendar-time-specific respiratory cancer mortality rates); and

Pyr = person-years of observation

A single individual could supply information for more than one cell as his duration of employment increased over the follow-up period. The person-year weighted average duration of employment, and age at initial employment, were calculated for each cell.

REC 5163

Assuming that age at initial exposure is equivalent to age at initial employment, and that duration of employment and exposure are equivalent, Brown and Chu (1983c) fitted equation 13 to the data in Table 7-27. They used the maximum likelihood method, assuming a binomial distribution where Obs is the number of positive responses, Pyr is the sample size, and the rate of response is $p = Exp/Pyr + r(\bar{d},\bar{t}_o)$, where $\bar{d},\bar{t}_o$ are the averages for each cell. Using this approach, the value for k is estimated to be 6.8, and c = .603, 1.42, 1.74×10^{-13} for the light, medium, and heavy exposure categories, respectively.

Brown and Chu (1983c) did not attempt to give an exposure rate estimate to the heavy, medium, and light exposure groups of Lee and Fraumeni, (1969). One reason for this was that "heavy" and "medium" were defined as "having worked at least one year in a heavy or medium exposure area." The "total time worked" was not necessarily an indication of the total time worked in a heavy or medium exposure area. As a result, the use of the exposure rate in the areas defined as medium or heavy would tend to overestimate the true average exposure over an individual's working history. This bias did not exist for those in the light exposure group, since almost all of their working time was spent in light exposure areas. In addition, these low environmental exposures are of greater utility in estimating risks.

As a result of these factors, only the light exposure group was used to obtain a dose-response model. In this group, Brown and Chu (1983c) estimated that the respiratory cancer rate for an individual first exposed at age t_o for a duration of d years would be

$$r(d,t_o) = .603 \times 10^{-13} [(d + t_o)^{5.8} - t_o^{5.8}]. \qquad (14)$$

Only limited information exists concerning the time-weighted exposure of workers in the light exposure areas. Arsenic concentrations in several light

REC 5164

TABLE 7-27. OBSERVED AND EXPECTED LUNG CANCER DEATHS AND PERSON-YEARS BY LEVEL OF EXPOSURE, DURATION OF EMPLOYMENT, AND AGE AT INITIAL EMPLOYMENT

Age at Initial Employment		Duration of Employment (years) 0-9	10-19	20-29	30-39	40+
High Exposure Level Group						
<20	Obs	0	0	0	3	0
	Exp	0.001	0.009	0.065	0.249	0.193
	Pyr	206	408	588	499	172
20-29	Obs	0	0	2	0	2
	Exp	0.008	0.051	0.164	0.277	0.082
	Pyr	624	637	495	308	64.4
30-39	Obs	0	0	3	0	0
	Exp	0.030	0.077	0.106	0.053	0.001
	Pyr	398	207	155	59.1	0.86
40-49	Obs	0	0	0	0	0
	Exp	0.083	0.054	0.034	0.007	0.0
	Pyr	210	80.0	49.1	6.88	0.0
50+	Obs	0	0	0	0	0
	Exp	0.066	0.027	0.0	0.0	0.0
	Pyr	78.0	23.2	0.0	0.0	0.0
Medium Exposure Level Group						
<20	Obs	0	0	1	4	1
	Exp	0.010	0.039	0.171	0.591	0.597
	Pyr	1801	1763	1500	1206	579
20-29	Obs	0	0	2	4	7
	Exp	0.035	0.118	0.331	0.717	0.514
	Pyr	2636	1622	1099	951	654
30-39	Obs	0	0	1	3	0
	Exp	0.167	0.473	0.329	0.161	0.045
	Pyr	1939	1137	438	194	68.2
40-49	Obs	0	0	1	3	0
	Exp	0.167	0.414	0.098	0.010	0.0
	Pyr	1190	448	98.9	12.1	0.0
50+	Obs	1	0	0	0	0
	Exp	0.262	0.076	0.011	0.0	0.0
	Pyr	295	71.2	14.5	0.0	0.0

TABLE 7-27. (continued)

Age at Initial Employment		Duration of Employment (years) 0-9	10-19	20-29	30-39	40+
Low Exposure Level Group						
<20	Obs	0	0	1	1	3
	Exp	0.056	0.117	0.478	1.59	1.57
	Pyr	8524	5249	4038	3175	1376
20-29	Obs	0	0	2	5	6
	Exp	0.115	0.334	0.892	1.74	0.796
	Pyr	9951	4724	2965	2117	834
30-39	Obs	0	3	1	0	1
	Exp	0.390	0.802	0.937	0.662	0.062
	Pyr	5218	2218	1364	715	74.6
40-49	Obs	2	1	1	1	0
	Exp	1.29	1.18	0.344	0.035	0.001
	Pyr	3703	1319	386	52.7	2.00
50+	Obs	3	2	0	0	0
	Exp	1.62	0.385	0.041	0.0	0.0
	Pyr	1945	371	65.4	0.0	0.0

Source: Brown and Chu (1983a).

exposure areas, as given in a NIOSH criteria document (1975), are shown in Table 7-28.

In the absence of information to the contrary, it is assumed that the person-hours spent in each area are equal. Thus an estimate of the time-weighted average for workers in the light exposure category is

$$1/3 \times .7 + 1/3 \times .17 + 1/3 \times .004 = .291 \text{ mg As/m}^3.$$

Under the linear assumption, equation 14 may be expressed in terms of mg As/m^3 working exposure by dividing by .291, which gives the result

$$r(d,t_o) = 2.07 \times 10^{-13} [(d + t_o)^{5.8} - t_o^{5.8}]. \qquad (15)$$

REC 5166

TABLE 7-28. ARSENIC EXPOSURES: 1965 SMELTER SURVEY ATMOSPHERIC ARSENIC CONCENTRATIONS ($mg/As/m^3$)

"Heavy exposure area" as classified by Lee and Fraumeni

Arsenic Roaster Area		Mean: 1.47
0.10	0.20	Median: 0.185
0.10	0.22	
0.10	0.25	
0.10	0.35	
0.10	1.18	
0.10	5.00	
0.17	12.66	

"Medium exposure areas" as classified by Lee and Fraumeni

Reverberatory Area		Mean: 1.56
0.03	0.93	Median: 0.88
0.22	1.00	
0.23	1.27	
0.36	1.60	
0.56	1.66	
0.63	1.84	
0.66	1.94	
0.76	2.06	
0.78	2.76	
0.78	3.40	
0.80	4.14	
0.83	8.20	
Treater Building and Arsenic Loading		Mean: 1.50
0.10	0.48	Median: 0.295
0.10	0.62	
0.10	3.26	
0.11	7.20	

"Light exposure areas" as classified by Lee and Fraumeni

Copper Concentrate Transfer System		Mean: 0.70
0.25		Median: 0.65
0.65		
1.20		
Samples from Flue Station		Mean: 0.17
0.10		Median: 0.17
0.24		
Reactor Building		Mean: 0.004
0.001	0.003	Median: 0.002
0.002	0.009	
0.002	0.010	
0.002		

Source: Table X-3, NIOSH Criteria Document (1975).

REC 5167

In this case, exposure is expressed in mg As/m^3 per 8-hr working day. To change the relationship so that it expresses the risk due to a lifetime of continuous exposure to 1 ug As/m^3, we assume 240 days worked per year, one mg As/m^3 on the job gives the same cumulative exposure as $10^3 \times 1/3 \times \frac{240}{365} = 219$ µg As/m^3 continuous exposure.

The age-specific rate due to a continuous 1 µg As/m^3 exposure is obtained by substituting $t_o = 0$ and $d = t$ = age into equation (15) and dividing by 219 to arrive at the correct number of exposure units. This gives the result

$$r(t) = 9.45 \times 10^{-16} \, t^{5.8}. \qquad (16)$$

The unit risk is approximately equivalent to the risk of induced respiratory cancer in the median life span. Based upon 1976 U.S. vital statistics, the median life span is 76.2 years, so that the unit risk is expressed approximately as

$$p \simeq \int_o^{76.2} 9.45 \times 10^{-16} \, t^{5.8} = \frac{9.45}{6.8} (76.2)^{6.8} \times 10^{-16} = 8.71 \times 10^{-4}. \qquad (17)$$

An additional approximation consistent with the previous unit calculations is obtained by assuming that

$$r(t) = 9.45 \times 10^{-16} \left[\frac{t_j + t_{j-1}}{2}\right]^{5.8} \quad t_{j-1} < t < t_j \qquad (18)$$

where t_j are the ages at the interval boundaries given in U.S. vital statistics records. This assumes that the age-specific death rate due to the exposure is constant throughout the interval and equal to the true value at the midpoint of the interval. Under this approximation, using 1976 vital statistics, the unit risk is estimated to be $P \simeq 1.25 \times 10^{-3}$.

REC 5168

Evaluation of Goodness-of-Fit. It is desirable to assess whether the data for the low-exposure group is consistent with the model utilized to estimate the unit risk. However, two factors tend to create a situation that would decrease this goodness-of-fit and bias the results. First, the exact values for each cell of $\bar{d}$, $\bar{t}_o$ are presently not available. Second, the value of k was determined on the basis of all three exposure groups, and does not give as good a fit as would be obtained using the low-exposure group alone.

Brown states (personal communication, 1983) that the exact values of $\bar{d}, \bar{t}_o$ are very close to the midpoint of the interval, and that the values of k appear to be statistically consistent between exposure groups. Thus, distortions of the data because of the use of midpoint values and average k, although inevitable, are not appreciable.

The expected number of cases in each cell are calculated using the relationship

$$E = Exp + Pyr \times .603 \times 10^{-13} [(d + t_o)^{5.8} - t_o^{5.8}], \qquad (19)$$

in which Exp and Pyr are taken from Table 7-27 and d, t_o are the midpoints of the intervals. These results are shown in Table 7-29. A standard chi-square goodness-of-fit test is then run, resulting in a chi-square value of $X^2_{21} = 13.85$ with 23.2 = 21 degrees of freedom and an associated p-value of .88. Unfortunately, due to the low expected number of cases in many of the cells, the X^2 approximation is of questionable validity for this situation.

To obtain a more stable approximation, cells with low frequency that are as close as possible to each other are usually combined. It is important to have some criteria for combining the data that do not depend upon inspection of the data itself. Two methods of combining the data are used here. The first is across columns (duration exposed), so that the maximum number of

TABLE 7-29. OBSERVED AND EXPECTED NUMBER OF RESPIRATORY CANCER DEATHS FOR EACH CELL IN THE LOW-EXPOSURE GROUP OF TABLE 7-27

	d				
t_o	5	15	25	35	45
18	0 .088	0 .314	1 1.20	1 3.504	3 3.836
25	0 .258	0 .858	2 2.145	5 4.358	6 3.321
35	0 .723	3 1.641	1 2.556	0 2.791	1 .497
45	2 2.023	1 2.508	1 1.428	1 .371	0 .026
55	3 2.582	2 1.234	0 .418		

$X^2_{21} = 13.85$, $p = .88$

cells are obtained, with the constraints that combined cells must have at least three expected cases, and that all cells combined are consecutive within a row. The second approach uses the same technique within a column (age first exposed). The results are shown in Tables 7-30 and 7-31 respectively, giving chi-square values of 7.01 and 7.61, with p-values of .41 and .38. Thus the assumed model is shown to be consistent with the observed low-exposure data.

7.3.2.2.4 The Enterline and Marsh (1982) study. This study included all men (2802 in all) employed at the Tacoma, Washington copper smelter for a year or more during 1940-1964. Their mortality experience was observed through 1976. The study involved over 70,000 person-years of observation, and 104 deaths from cancer of the respiratory system were recorded (Table 7-32). Respiratory cancer deaths had an SMR of 189.4, which was significantly increased at the 1 percent level. Expected deaths for Table 7-32 were based upon U.S. white

TABLE 7-30. CELLS FROM TABLE 7-29 COMBINED WITHIN ROWS TO OBTAIN CELLS WITH THREE OR MORE EXPECTED RESPIRATORY CANCER DEATHS

	d				
t_o	5	15	25	35	45
18				2 5.106	3 3.836
25			2 3.261	5 4.358	6 3.321
35			4 4.920		1 3.288
45					5 6.356
55			5 4.234		

$X^2 = 7.01$, $p = .41$

TABLE 7-31. CELLS FROM TABLE 7-29 COMBINED WITHIN COLUMNS TO OBTAIN CELLS WITH 3 OR MORE EXPECTED RESPIRATORY CANCER DEATHS

	d				
t_o	5	15	25	35	45
18				1 3.504	3 3.836
25			3 3.345	5 4.358	
35					
45				1 3.162	7 3.844
55	5 5.674	6 6.555	2 4.402		

$X^2 = 7.61$, $p = .38$

TABLE 7-32. OBSERVED DEATHS AND SMRs FOR 2802 SMELTER WORKERS WHO WORKED A YEAR OR MORE 1940-64, FOLLOWED THROUGH 1976, BY CAUSE OF DEATH

Cause of death (7th revision code)	Observed Deaths	SMR
All causes of death	1061	103.2
Tuberculosis (001-019)	4	27.6**
Malignant neoplasms (140-148)	231	123.6**
Buccal cavity and pharynx (140-148)	7	110.7
Digestive organs & peritoneum (150-159)	65	108.9
Esophagus (150)	3	66.2
Stomach (151)	17	122.1
Large intestine (153)	21	120.4
Rectum (154)	9	122.4
Biliary passages and liver (155-156)	3	64.1
Pancreas (157)	11	106.0
All other digestive organs (residual)	1	71.6
Respiratory system (160-164)	104	189.4**
Larynx (161)	2	67.7
Bronchus, trachea, and lung (162-163)	100	194.9**
All other respiratory system (residual)	2	305.0
Prostate (177)	11	79.0
Testes and other genital (178-179)	1	92.6
Kidney (180)	6	133.3
Bladder and other urinary organs (181)	4	63.0
Malignant melanoma of skin (19)	0	--
Eye (192)	1	492.7
Central nervous system (193)	3	59.8
Thyroid gland (194)	0	--
Bone (196)	2	175.0
Lymphatic & haematopoietic (200-205)	17	93.8
Lymphosarcoma and reticulosarcoma (200)	4	93.2
Hodgkins' disease (201)	2	83.9
Leukemia and aleukemia (204)	6	78.7
Other lymphopoietic tissue (202, 203, 205)	5	130.4
Other malignant neoplasms (residual)	10	82.3
Benign neoplasms (210-239)	2	78.6
Diabetes mellitus (260)	12	84.8
Stroke (333-334)	91	111.4
Heart disease (400-443)	412	92.5
Hypertension without heart disease (444-447)	1	18.8
Nonmalignant respiratory disease (470-527)	60	108.6
Influenza and pneumonia (480-493)	24	92.9
All other respiratory diseases (residual)	36	122.4
Ulcer of stomach and duodenum (540-541)	7	75.5
Cirrhosis of liver (581)	22	101.9
Chronic nephritis (592)	6	87.5
External causes of death (800-998)	81	94.2
Accidents (899-962)	61	100.6
Suicides (963, 970-979)	17	84.8
Other external causes (residual)	3	56.2
Other causes of death (residual)	85	86.1
Unknown causes	47	--

* $p < .05$, ** $p < .01$
Source: Enterline and Marsh (1982).

male mortality rates. The respiratory cancer SMR increases to 198.1 when Washington State mortality rates are applied.

Enterline and Marsh estimated individual exposures to airborne arsenic using individual work histories, urine arsenic measurements, and an estimated correlation between exposure to airborne arsenic and resulting levels of arsenic in urine. Average urine arsenic levels were available by department for the years 1948-52, 1973, 1974, and 1975. Linear interpolations were used to estimate levels between 1952 and 1973. Levels during 1949-1952 were assumed to hold prior to that time. By coupling these data with employee work histories, Enterline and Marsh estimated individual cumulative exposures for various times in units of μg-years/ℓ urinary arsenic.

Pinto et al. (1977) compared airborne concentrations of arsenic with urinary arsenic levels for 24 workers wearing personal air samplers for 5 successive days. A regression analysis of these data showed a highly significant linear correlation between airborne and urinary arsenic ($p < 0.01$). Average airborne arsenic in units of $\mu g/m^3$ was estimated to be 0.304 times average urinary arsenic levels in units of μg/ℓ.

To investigate dose-response, Enterline and Marsh divided the total person-years of observation into 5 groups by cumulative arsenic exposure (0 lag), and also by cumulative arsenic exposure up to 10 years prior to the year of observation (10-year lag). In this type of analysis, as a worker continues to be exposed to arsenic, he or she will contribute person-years to progressively higher exposure categories. The numbers of respiratory cancer deaths and corresponding expected numbers for each of these groups are given in Table 7-33. In this table, urinary arsenic levels provided by Enterline and Marsh have been converted to airborne exposures in $\mu g/m^3$-years, using the factor 0.304 estimated by Pinto et al. (1977). The observed numbers of cancers are all significantly increased at the higher exposure levels.

REC 5173

TABLE 7-33. DATA FROM TABLE 8 OF ENTERLINE AND MARSH (1982) WITH PERSON-YEARS OF OBSERVATION ADDED

Cumulative Exposure[a] $\mu g/m^3$-years	Person-Years of Observation[b]	Observed Deaths	Expected Deaths
	0 Lag		
91.8	10902	8	4.0
263	21642	18	11.0
661	14623	21	10.3
1381	13898	26	14.1
4091	9398	31	12.7
	10-Year Lag		
91.8	27802	10	6.4
263	16453	22	12.5
661	11213	26	11.5
1381	9571	22	12.4
4091	5423	24	9.7

[a]Exposures are in $\mu g/m^3$-years estimated by the formula (I $\mu g/l$-years) (0.304) where I is mean urinary exposure index from Enterline and Marsh (1982) Table 8 and 0.304 is the relation between urinary and airborne arsenic estimated by Pinto et al. (1977).

[b]Furnished by Dr. Enterline (personal communication).

Although the Enterline and Marsh (1982) study is not as large as that of Lee-Feldstein (1983), it does involve a sizable number of respiratory cancer deaths (104). Workers were followed for an extended period--an average of 25 years per individual. Several features of the analysis render it more amenable to quantitative risk estimation than the analysis used by Lee-Feldstein. Enterline and Marsh made estimates of individual exposure histories, whereas Lee-Feldstein did not. The type of dose-response analysis used by Enterline and Marsh is also more suitable for quantitative risk estimation. The exposure estimates based on a 10-year lag probably yield a more realistic dose response than those that do not utilize a lag. Because the latency period for respiratory cancer is generally greater than 10 years (cf. Doll and Peto,

REC 5174

1978), exposure during the last 10 years prior to observation would not be expected to affect respiratory cancer mortality.

By applying urinary arsenic measurements made during the years 1948-52 to earlier years, Enterline and Marsh probably underestimated exposures prior to 1948. This would result in an overestimate of the carcinogenic potency of arsenic. A calculation by Enterline and Marsh of SMRs by both year of hire and cumulative exposure indicates that workers in a given cumulative exposure category tend to have at least roughly comparable SMRs irrespective of the year of hire. This suggests that exposure estimates for earlier years are not greatly in error. However, further investigation of this problem would be useful.

Because smoking is also an important risk factor for respiratory cancer, it would have been helpful if data on smoking habits had been available for analysis. Pinto and Enterline (undated) report on smoking histories obtained in 1975 from 550 active employees at the Tacoma smelter. Of these employees, 59.6 percent were active smokers, compared to 45.4 percent in 1970 for U.S. males aged 21-64. If this excess of smokers holds in general for the smelter workers, then a small fraction of the excess in respiratory cancer could have been due to smoking.

Development of risk estimates: The data from Table 7-33 were used for quantitative risk assessment. The relative risks (observed/expected) from this table are graphed in Figures 7-6 and 7-7, and the absolute risks ([observed- expected]/person-years) in Figures 7-8 and 7-9. Although there is no clear trend of increasing SMRs with increasing exposures, such a trend is present for absolute risk. Results of applying chi-square goodness-of-fit tests of the relative- and absolute-risk models with $k = 1$ and $k = 2$ are recorded in Table 7-25. The maximum likelihood estimates of the carcinogenic

REC 5175

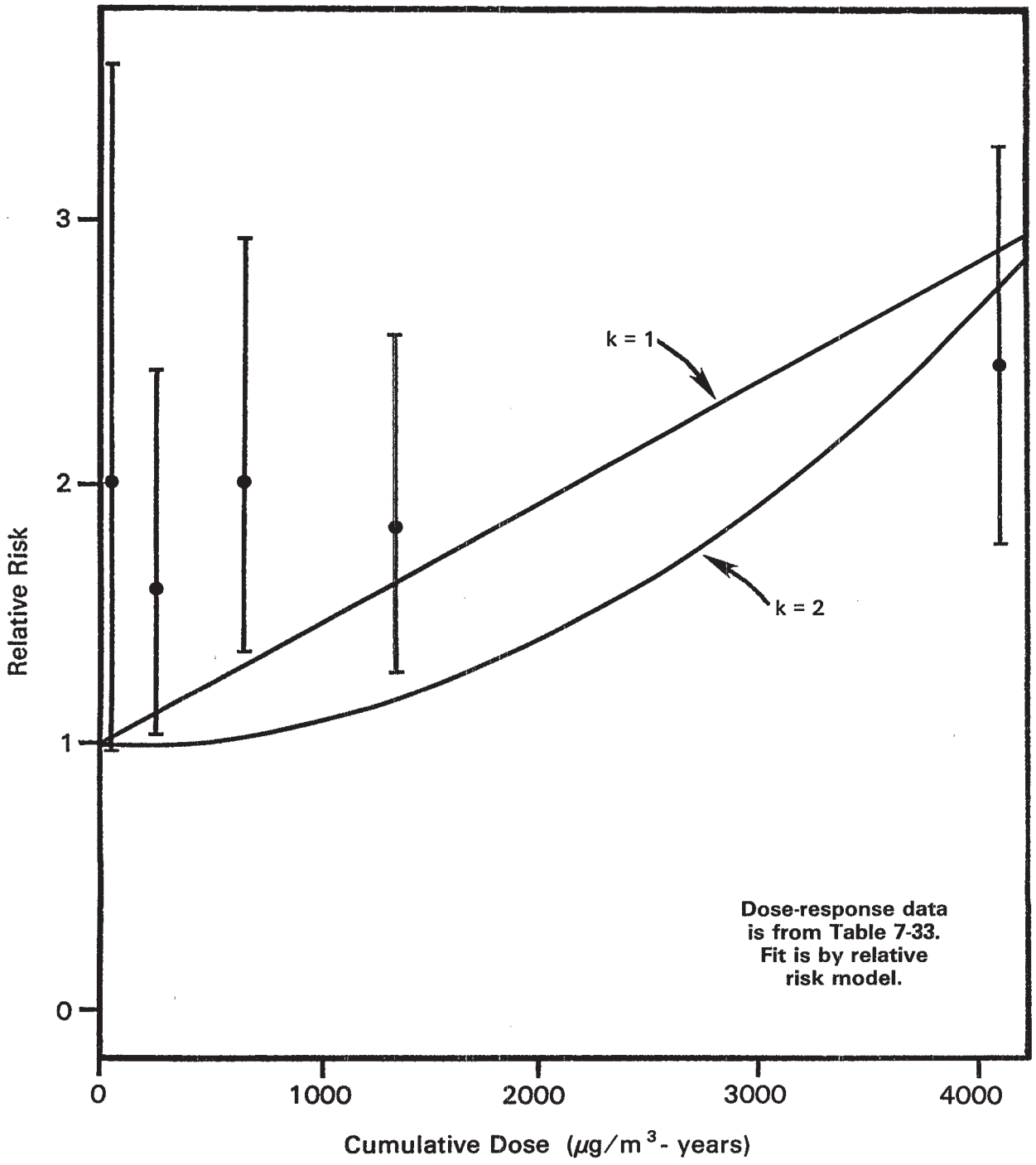


Figure 7-6. Relative risks and 90% confidence limits for zero-lag data of Enterline and Marsh (1982).

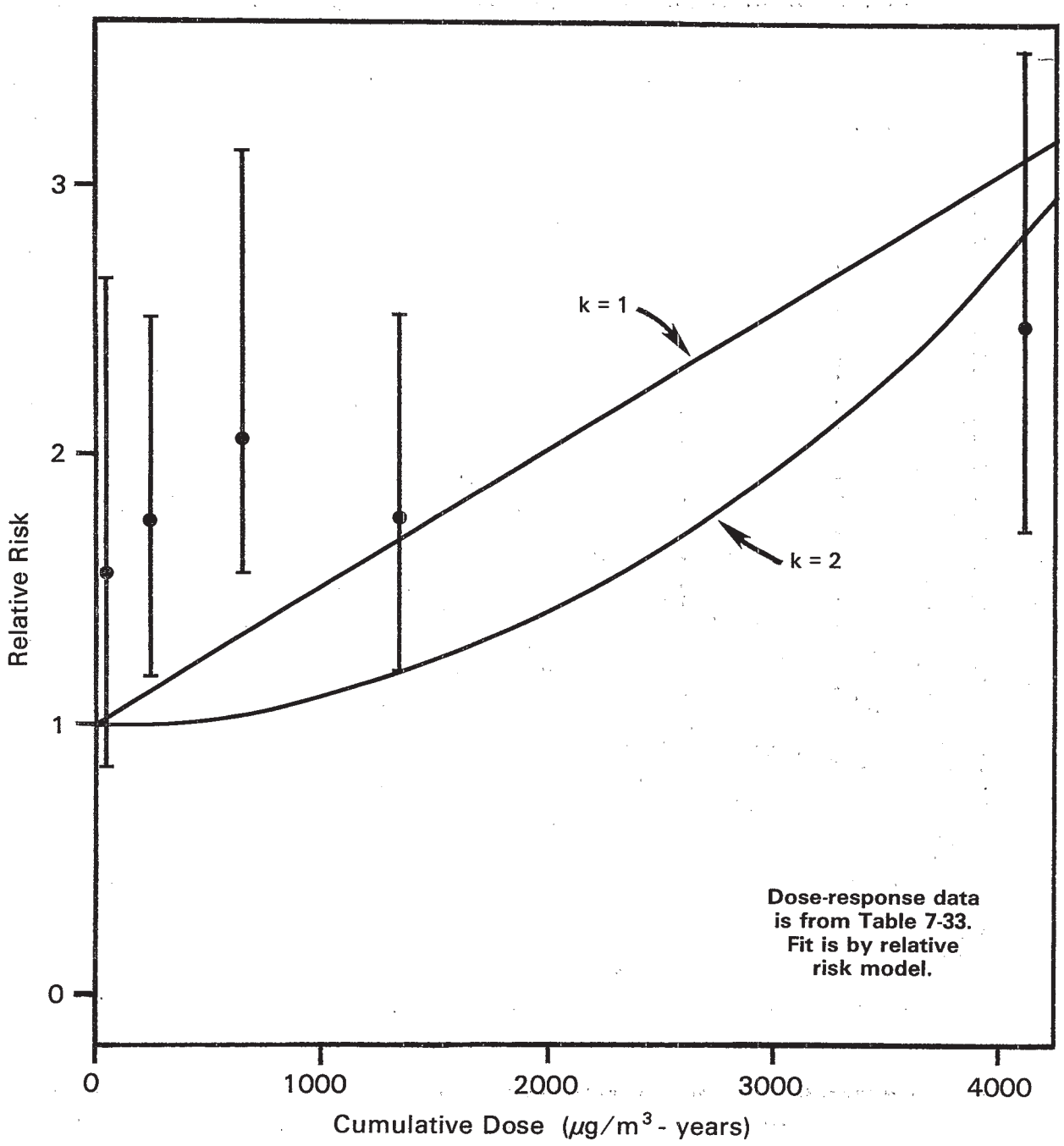


Figure 7-7. Relative risks and 90% confidence limits for 10 year lag data of Enterline and Marsh (1982).

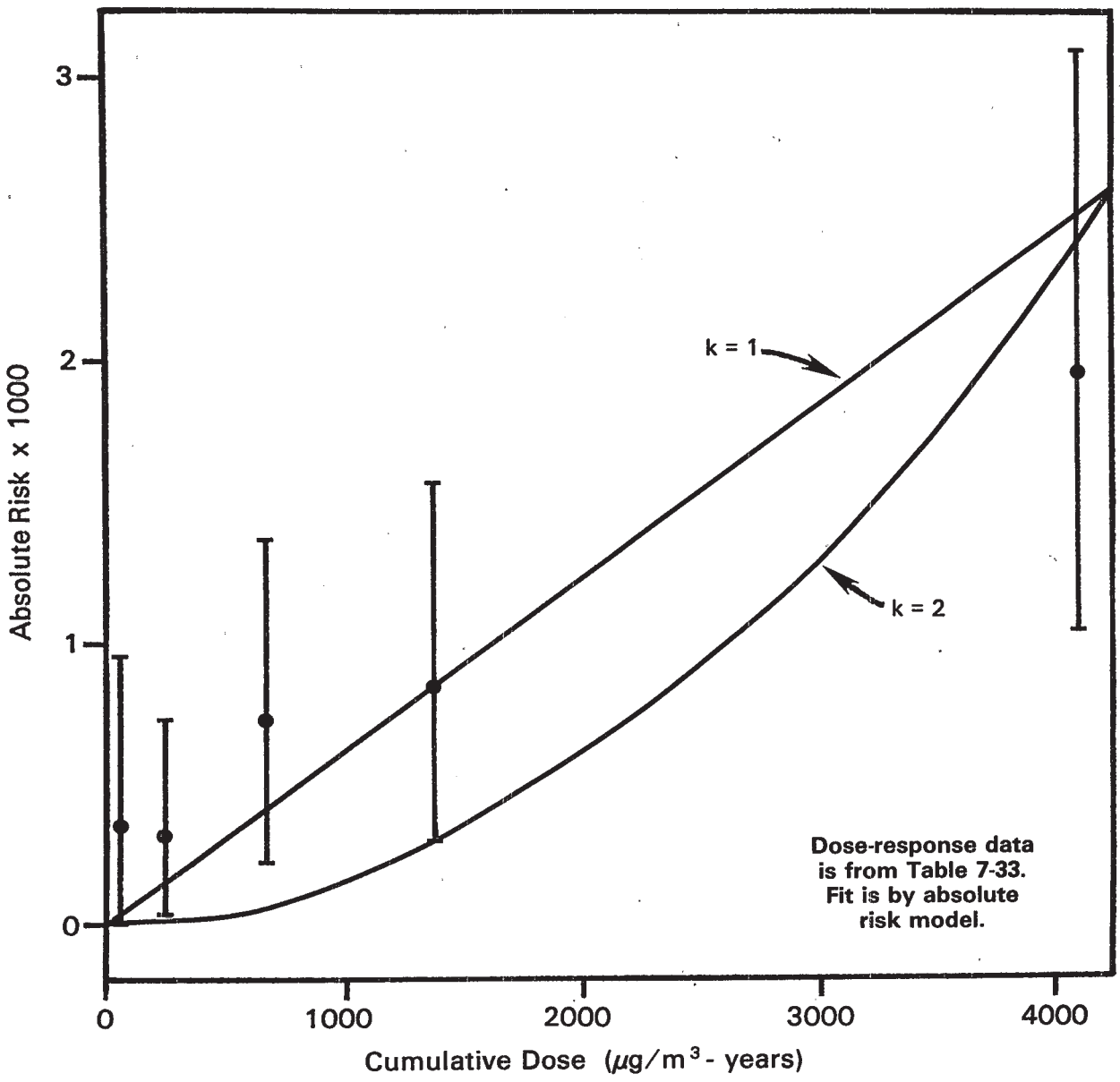


Figure 7-8. Absolute risks and 90% confidence limits for zero-lag data of Enterline and Marsh (1982).

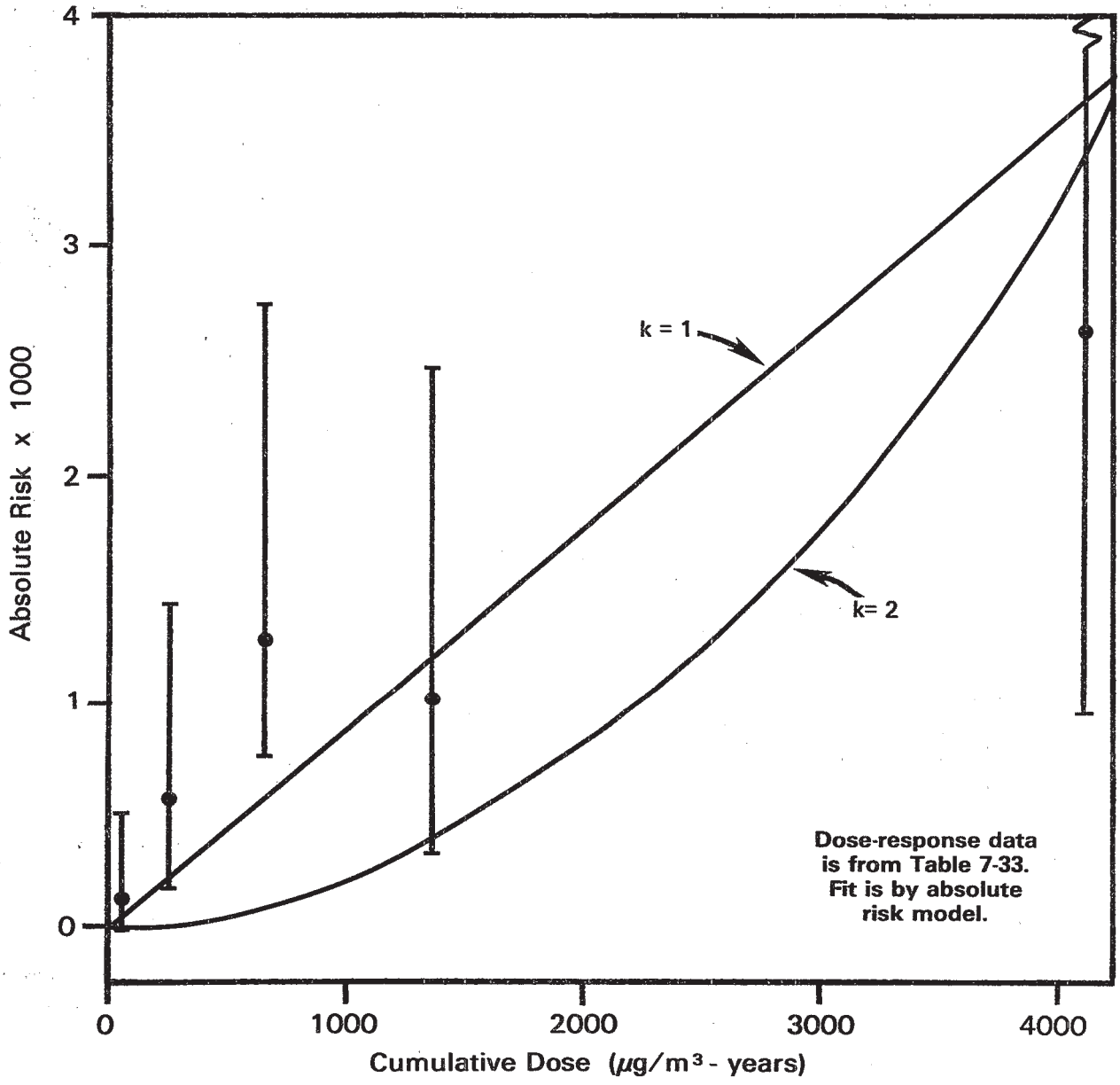


Figure 7-9. Absolute risks and 90% confidence limits for 10 year lag data of Enterline and Marsh (1982).

potency parameter a' are also listed in Table 7-25. The maximum-likelihood fits of these models are graphed in Figures 7-6 through 7-9. The quadratic fit (k = 2) is poor for both the absolute- and relative-risk models with either 0 lag or 10-year lag data (p less than 0.001 in each case). The linear fits to the relative-risk models are also relatively poor (p = 0.02 for the 0 lag data and 0.006 for the 10-year lag data). On the other hand, the linear fits of the absolute-risk model are all acceptable (p = 0.24 for 0 lag data and 0.14 for 10-year lag data).

The unit risks (additional risks of respiratory cancer death from lifetime exposure to 1 $\mu g/m^3$ airborne arsenic) obtained from each of the fits for which the chi-square p-value is 0.01 or higher, are also listed in Table 7-25. These risks were estimated by applying (1) or (2), (8), and (9) with D_i based upon a constant exposure of 1 $\mu g/m^3$. Specifically,

$$D_i = 4.56[5(i-1) + 2.5] \qquad (17)$$

was used for the 0 lag data, and

$$D_i = 4.56[5(i-1) - 7.5] \qquad (18)$$

was used for the 10-year lag data. These D_i represent the cumulative exposure in $\mu g/m^3$ resulting from a constant exposure to 1 $\mu g/m^3$ from birth to the midpoint of the ith 5-year age interval. The factor 4.56 converts from occupational to environmental exposures, and is explained at equation (11).

7.3.2.2.5 The Ott et al. (1974) study. Ott et al. (1974) compared the age-specific death patterns of 174 decedents exposed to arsenic in the production of pesticides to those of 1809 decedents who were not exposed to arsenicals. By fitting the death patterns of the unexposed decedents to a mathematical function, an estimate was obtained of the probability that a death at a parti-

REC 5180

cular age and during a particular epoch was due to respiratory cancer. This function was used to estimate expected respiratory cancer deaths in various exposure categories for the exposed decedents. Cumulative exposures were estimated for exposed decendents, using work histories and estimates of average exposures in various jobs. The exposure estimates were made by industrial hygienists familiar with the processes. Expected cancer deaths were compared with observed to obtain observed-to-expected ratios. Table 7-34 shows the results of Ott et al.'s dose-response analysis. The data in this table are all reproduced directly from Table 4 of Ott et al. (1974), except for the cumulative exposures. Average total exposures in mg provided by Ott et al. were converted to cumulative exposures in $\mu g/m^3$ years by multiplying by the factor

$$\frac{1000\ \mu g/mg}{(4\ m^3/day)(21\ days/mo)(12\ mo/year)} \qquad (19)$$

TABLE 7-34. DATA FROM TABLE 4 OF OTT ET AL. (1974)

Cumulative Exposure[a] $\mu g/m^3$-years	Observed Deaths	Expected Deaths
41.8	1	1.77
125	2	1.01
250	4	1.38
417	3	1.36
790	3	1.70
1544	2	0.97
3505	3	0.77
6451	5	0.79
29497	5	0.72

[a]Exposures are in $\mu g/m^3$-years estimated by:

$$\frac{d\ mg \times 1000\ \mu g/mg}{(4\ m^3/day)(21\ days/month)(12\ months/year)}$$

where d is average total exposure from Table 4 of Ott et al.

REC 5181

The values included in this factor are not in doubt because use of the factor simply negates the calculation of total exposure made by Ott et al.

Decedent studies such as this are more subject to bias then prospective studies such as those of Lee-Feldstein (1983) and Enterline and Marsh (1982). If, for example, in some age category arsenic exposure increased the mortality from some other disease in addition to respiratory cancer, an analyis of decedents might show an artificially low effect of arsenic upon respiratory cancer for this age group (because there might be an artificially large number of total deaths). It is also of some concern that Ott et al. did not clearly describe how the study cohort was defined.

This study involved primarily short-term exposures, as less than 25 percent of the decedents had worked with arsenicals for more than one year. Thus, this study is less appropriate for estimating risks from lifetime environmental exposure than a comparable study involving longer exposures. The study also was quite small; only 28 respiratory cancer deaths occurred among exposed decedents.

Development of risk estimates: The dose-response data in Table 7-34 were used in an assessment of risk. Because of the nature of the study, only a relative risk model could be applied to these data. The dose-response for relative risk is graphed in Figure 7-10. The response in the most highly exposed group falls far below that predicted by the lower-dose data and is omitted from Figure 7-10. This is possibly due to the fact that some of the more highly exposed workers wore respirators. Because of this shortfall in response, and also because the exposures to this group were the furthest from the low-level environmental exposures of interest, the data from the highest exposure group were omitted from the analysis.

Results of applying chi-square goodness-of-fit tests of the relative-risk model with $k = 1$ and $k = 2$ are listed in Table 7-25. The maximum-likelihood

REC 5182

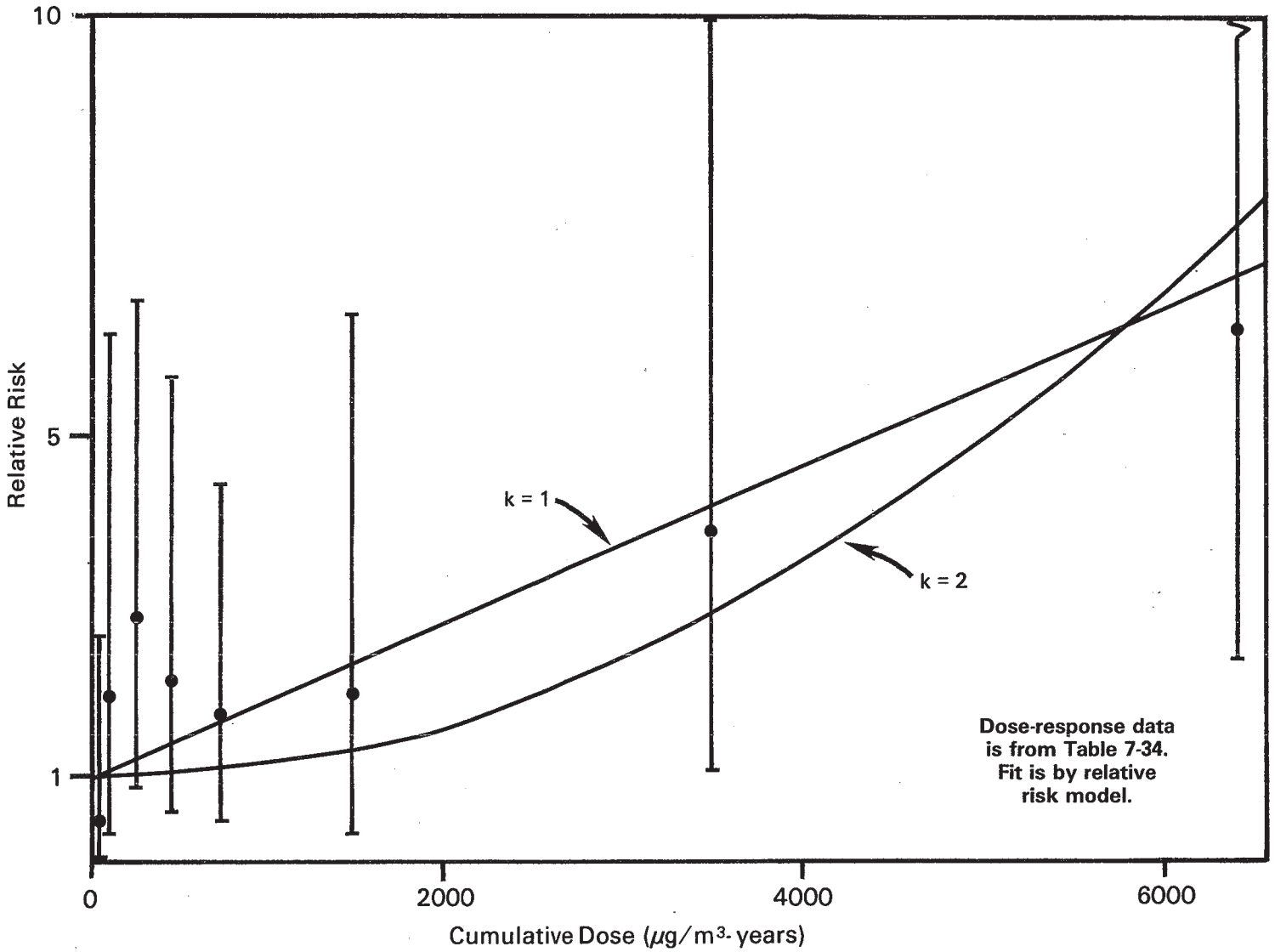


Figure 7-10. Relative risks and 90% confidence limits for data of Ott et al. (1974) with highest exposure group omitted.

estimates of the carcinogenic potency parameter a' are also listed in this table. The maximum-likelihood fits are graphed in Figure 7-10. Both of these fits are acceptable ($p = 0.66$ for $k = 1$ and $p = 0.23$ for $k = 2$), although the data appear to be more linear than quadratic. It should be kept in mind that the sample size was quite small in this study, and consequently a wide range of curve shapes would probably provide an acceptable fit.

The risk estimation method described in the previous section is based upon the life table method of analysis, and does not seem particularly appropriate for a decedent analysis. Because the method employed by Ott et al. seems to estimate a relative probability of respiratory cancer death, it was decided to estimate the extra lifetime probability of respiratory cancer death from lifetime exposure to d $\mu g/m^3$ airborne arsenic, using the expression

$$P_0(1 + a'[(72)(4.56)d]^k) - P_0 = P_0 a'[(72)(4.56)]^k. \qquad (20)$$

Here P_0 is the lifetime probability of respiratory cancer mortality given by (8), and is equal to 0.0451 if 1976 U.S. mortality rates are used. The factor 72 represents life expectancy in the U.S. in years. The factor 4.56 converts from occupational to environmental exposures, and is explained at equation (11). Thus, the term in the square brackets in (20) represents the average total exposure over a life span in $\mu g/m^3$ years, which is the same as the measure used in estimating the potency a'.

7.3.2.3 Discussion--Table 7-25 summarizes the fits of both absolute- and relative-risk models, with either $k = 1$ or $k = 2$, to dose-response data from 4 different studies. Table 7-25 also displays the carcinogenic potencies a'. It should be noted that the potencies estimated from different models are in different units, and are therefore not comparable.

In every case, a linear model ($k = 1$) fitted the data better than the corresponding quadratic model ($k = 2$). In every case but two, the fits of the

REC 5184

quadratic model could be rejected at the 0.01 level. The two exceptions involved the two smallest data sets (Higgins et al. absolute risk, and Ott et al.) and in the former case the fit was very marginal ($p = 0.017$). On the other hand, for each data set a linear model provided an adequate fit. Also, in every case, an absolute-risk linear model fit the data better than the corresponding relative-risk linear model. The p-values for the fits of the absolute-risk linear model ranged from 0.025 to 0.75.

The estimated unit risk is presented for each fit for which the chi-square goodness-of-fit p-value is greater than 0.01. The unit risks derived from linear models--8 in all--range from 0.0013 to 0.0136. The largest of these is from the Ott et al. study, which probably is the least reliable for developing quantitative estimates, and which also involved exposures to pentavalent arsenic, whereas the other studies involved trivalent arsenic. The unit risks derived from the linear ($k = 1$) absolute-risk models are considered to be the most reliable; although derived from 5 sets of data involving 4 sets of investigators and 2 distinct exposed populations, these estimates are quite consistent, ranging from 0.0013 to 0.0076.

To establish a single point estimate, the geometric mean for data sets is obtained within distinct exposed populations, and the final estimate is taken to be the geometric mean of those values. This process is illustrated in Table 7-35.

The final estimate is 4.29×10^{-3}, where exposure is in $\mu g/m^3$ of continuous exposure. Based upon an assumed 20 m^3 tidal volume of air and a 30 percent absorption rate, this amounts to a unit risk of $4.29 \times 10^{-3} \div (.3 \times 20 \times .001/70) = 50.1$ in units of mg/kg absorbed dose per day.

Although the estimates derived from the various studies are quite consistent, there are a number of uncertainties associated with them. The estimates

REC 5185

TABLE 7-35. COMBINED UNIT RISK ESTIMATES FOR ABSOLUTE-RISK LINEAR MODELS

Exposure Source	Study	Unit Risk	Geometric Mean Unit Risk	Final Estimated Unit Risk
Anaconda smelter	Brown & Chu	1.25×10^{-3}		
	Lee-Feldstein	2.80×10^{-3}	2.56×10^{-3}	
	Higgins	4.90×10^{-3}		4.29×10^{-3}
ASARCO smelter	Enterline & Marsh	6.81×10^{-3}		
		7.60×10^{-3}	7.19×10^{-3}	

were made from occupational studies that involved exposures only after employment age was reached. In estimating risks from environmental exposures throughout life, it was assumed, through either the relative-risk model (1) or the absolute-risk model (2), that the increase in the age-specific mortality rates of lung cancer was a function only of cumulative exposures, irrespective of how the exposure was accumulated. Although this assumption provides an adequate description of all of the data, it may be in error when applied to exposures that begin very early in life. Similarly, the linear models possibly are inaccurate at low exposures, even though they provide excellent descriptions of the experimental data.

The risk assessment methods employed were severely constrained by the fact that they were based only upon the analyses performed and reported by the original authors--analyses that had been performed for purposes other than quantitative risk assessment. For example, although other measures of exposure might be more appropriate, the analyses were necessarily based upon cumulative dose, since that was the only usable measure reported. Given greater access to the data from these studies, other dose measures, as well as models other than the simple relative-risk and absolute-risk models, could be

REC 5186

studied. It is possible that such wide analyses would indicate that other approaches are more appropriate than the ones applied here.

7.3.3 Unit Risk for Water

The best data available for making quantitative cancer risk estimates for ingestion of arsenic in water are the data collected by Tseng et al. (1968). They surveyed a stable population of 40,421 individuals who lived in a rural area along the southwest coast of Taiwan and who were known to have consumed drinking water containing arsenic. The occurrences of skin cancer among this population, and the arsenic concentrations in their drinking water, were measured. Since the population was stable, the study can be viewed as a lifetime feeding study, and the data may be used to predict the lifetime probability of skin cancer caused by the ingestion of arsenic.

A model estimating the cancer rate as a function of drinking water arsenic concentration was generated using information from the above study in its published form, which is a summary of data collected by the investigators. If the original data had been available, a more exact mathematical analysis would have been possible.

Doll (1971) has suggested that the relationship between the incidence of some site-specific cancers, age, and exposure level of a population may be expressed as:

$$I(x,t) = kBx^m t^{k-1} \qquad (21)$$

where x is the exposure level (which can be measured by the water concentration in ppm), t is the age of the population, and B, m, k are unknown parameters.

However, the data collected by Tseng et al. (1968) was obtained at one point in time, and since skin cancer has only a marginal effect on the death

REC 5187

rate, the obtained rates may be viewed more accurately as the probability of having contracted skin cancer by time t. The relationship between this probability, often referred to as the cumulative probability density or prevalence F(x,t), and the incidence or age-specific or hazard rate, may be expressed as:

$$F(x,t) = 1 - \exp\left[-\int_0^t I(x,s)\, ds\right]. \qquad (22)$$

Utilizing equation (21) as the form of the incidence rate, the prevalence may be expressed as

$$F(x,t) = 1 - \exp\left(-Bx^m t^k\right), \qquad (23)$$

which is a Weibull distribution.

In Table 7-36, adapted from information in Tseng, et al. (1968), estimates are given of F(x,t) for different age and water concentration groupings for males. The prevalence for females is less than for males, and therefore is not used to estimate risk.

To use this data, specific values for x and t had to be obtained for the intervals. Where the intervals were closed, the midpoint was utilized. For the greater than 0.6 ppm group, the midpoint between 0.6 and the greatest recorded value, 1.8, was taken, resulting in 1.2 ppm. For age 60 or greater, a value of 70 was utilized somewhat arbitrarily, being the same increase over the lower level as that in the other two age intervals. The values for (x,t) to relate to the prevalence estimates are shown in parentheses in Table 7-36.

From equation (23) it follows that

$$\ln(-\ln[1-F(x,t)]) = \ln(B) + m\ln(x) + k\ln(t), \qquad (24)$$

which is multiple-linear in form. Estimating the parameters by the usual least-square techniques, the following relationship is obtained:

TABLE 7-36. AGE-EXPOSURE-SPECIFIC PREVALENCE RATES FOR SKIN CANCER

Exposure in ppm[3]	AGE 20-39 (30)	AGE 40-59 (50)	AGE ≥60 (70)
0 - 0.29 (0.15)	0.0013	0.0065	0.0481
0.30 - 0.59 (0.450)	0.0043	0.0477	0.1634
≥0.6 (1.2)	0.0224	0.0983	0.2553

*Source: Tseng et al. (1968).

[a]Range given by authors. Midpoint is in parentheses.

$$\ln(- \ln[1 - F(x,t)]) = 17.548 + 1.192 \ln(x) + 3.881 \ln(t), \quad (25)$$

which is an excellent fit, having a multiple correlation coefficient of 0.986 and a standard error on the exposure regression m of .138.

Equation (25) may be expressed as

$$F(x,t) = 1\text{-}\exp\text{-}[2.429 \times 10^{-8}(X^{1.192})(t^{3.881})]$$
$$= 1\text{-}\exp\text{-}[X^{1.192} H(t)] \quad (26)$$

If the parameter m = 1.192 were in fact equal to 1, then for a given value of t, equation (26) would be "one-hit" in form.

To test this hypothesis (i.e., Ho: m = 1) the student "t" test is used, giving the result:

$$t_6 = \frac{1.192 - 1}{0.138} = 1.391,$$

which is not significant at the 0.1 level. Thus, there is insufficient evidence to reject the hypothesis that the dose-response relationship is "one-hit" even at the 0.1 level. However, a quadratic model would be rejected at the $p<.001$ level.

Fixing m = 1, the following relationship is obtained:

$$F(x,t) = 1 - \exp[-g(t)x] \qquad (27)$$

Transforming this equation to its linear form (as in equation 23) and obtaining the least-square linear estimates of B and v, it is found that:

$$g(t) = \exp(-17.5393)\, t^{3.853}, \text{ where } B = 2.41423 \times 10^{-8},\ k = 3.853.$$

The data used to obtain these estimates are shown in Table 7-37, and the goodness-of-fit is illustrated in Figure 7-11.

TABLE 7-37. DATA UTILIZED TO OBTAIN PREDICTOR EQUATION AND FIGURE 7-11

ppm Arsenic	Age at Medical Examination	Skin Cancer Prevalence Rate		Transformed Skin Cancer Prevalence Rate	
		F(x,t)		$-\ln(-\ln[1-F(x,t)])=$ $-17.5393 + 3.853\ln t + \ln x$	
x	t	Observed Rate	Expected Rate	Observed	Expected
0.15	30	0.0013	0.0031	6.64474	6.33160
	50	0.0063	0.0127	5.03269	4.36341
	70	0.0481	0.0455	3.00993	3.06695
0.45	30	0.0043	0.0053	5.44699	5.23299
	50	0.0477	0.0375	3.01849	3.26480
	70	0.1634	0.1304	1.72368	1.96834
1.20	30	0.0224	0.0141	3.78739	4.25216
	50	0.0983	0.0969	2.26844	2.28397
	70	0.2553	0.3110	1.22155	0.98751

REC 5190

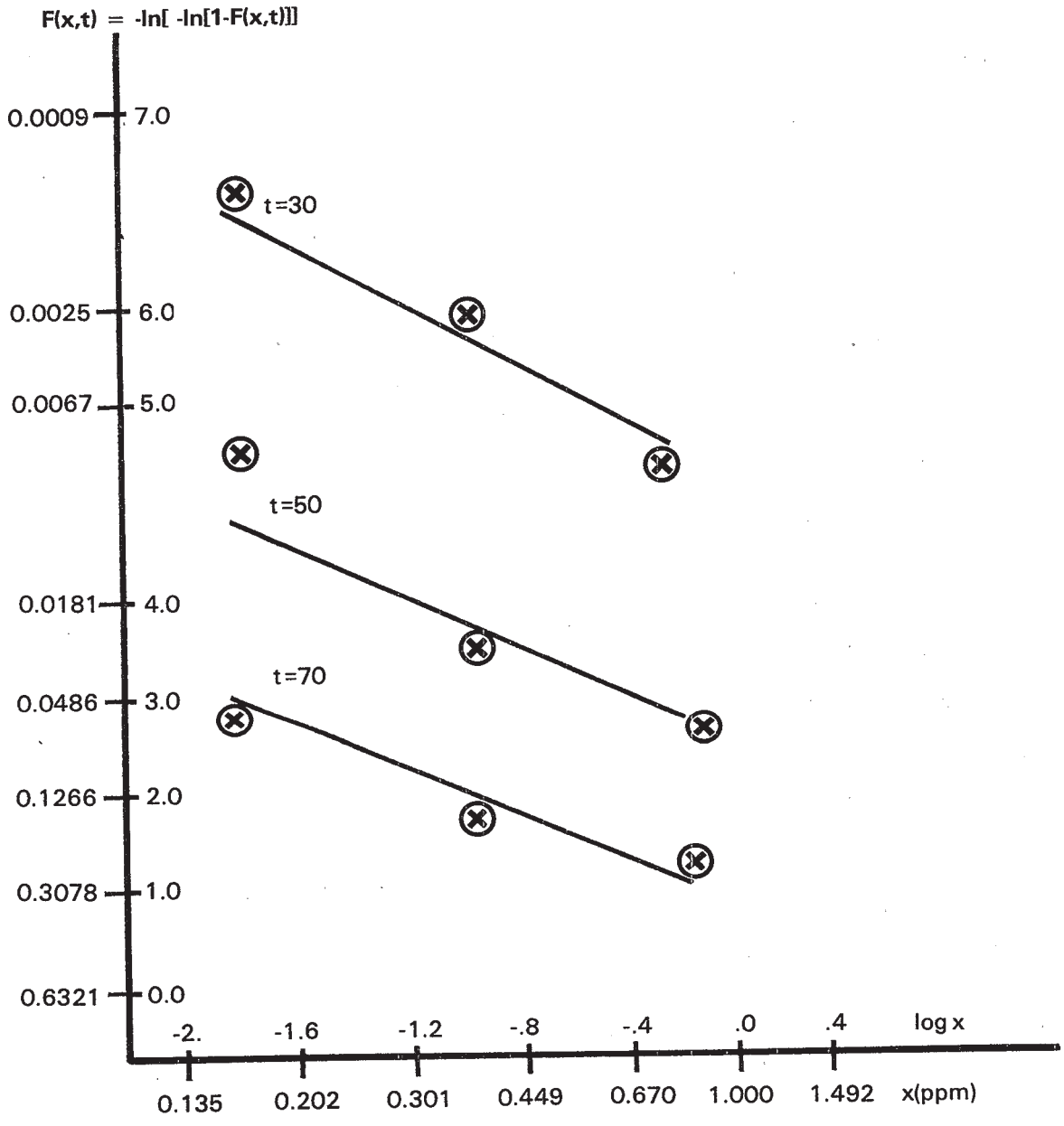


Figure 7-11. Relationship between transformed prevalence and log ppm arsenic in water, log age.

The function

$$F(x,t) = 1-\exp[-2.41423 \times 10^{-8} \times t^{3.853}], \qquad (28)$$

is the probability of contracting skin cancer by age t, given that an individual had a life-time exposure to x ppm in his drinking water (and lived until age t).

To obtain a unit risk estimate, lifetime risk is assumed to be approximately equal to the risk to the median life span in the absence of competing risk. The unit risk is thus obtained by substituting x = 1 and t = 76.2 (the median U.S. life span based upon 1976 vital statistics data) into equation (28). This gives the result

$$P(1) \tilde{=} 1-\exp[-2.414 \times 10^{-8} \times 76.2^{3.853}] = .350 \qquad (29)$$

The exponent is the slope estimate for cancer risks at low doses, so that:

$$P(x) \tilde{=} .430\ x \qquad \text{for small } x, \text{ where } x \text{ is in ppm.} \qquad (30)$$

To express the unit in mg/kg/day exposures, it is assumed that two liters of water are consumed per day by an individual weighing 70 kg. Under the assumption that 100 percent of the arsenic is absorbed through the gut, the slope in units of mg/kg/day absorbed dose is $.430 \div (.2 \div 70) = 15.8$.

A number of potential factors exist that could possibly make the Taiwanese data unsuitable as surrogate data for the U.S. population. Among them are racial, dietary, and nutritional differences. Also, exposure to ergotamine was confounded with arsenic exposure in the well water--a fact which also could have modified the results. However, there is no direct evidence demonstrating the role of these agents in the carcinogenic response to ingested arsenic. Furthermore, a recent extensive review by Andelman and Barnett (1983)

REC 5192

of the arsenic dose-response model developed here, demonstrates that presently there is no quantitative evidence that is inconsistent with the model. The Andelman and Barnett study also showed that there does not appear to be any population in the U.S. that could be studied that would have a reasonable power to contradict the hypothesis that the Taiwanese dose-response model is consistent with the U.S. dose response.

7.3.4 Relative Potency

One of the uses of the concept of unit risk is to compare the relative potencies of carcinogens. To estimate relative potency on a per-mole basis, the unit risk slope factor is multiplied by the molecular weight, and the resulting number is expressed in terms of $(mMol/kg/day)^{-1}$. This is called the relative potency index.

Figure 7-12 is a histogram representing the frequency distribution of potency indices of 52 chemicals evaluated by the CAG as suspect carcinogens. The actual data summarized by the histogram are presented in Table 7-38. Where human data were available for a compound, they were used to calculate the index. Where no human data were available, animal oral studies and animal inhalation studies were used, in that order. Animal oral studies were selected over animal inhalation studies because they have been made on most of the chemicals, thus allowing potency comparisons by route.

The potency index for arsenic, based on the Tseng et al. study, is 2.25×10^3 $(mMol/kg/day)^{-1}$. This is derived by means of the slope estimate from the Tseng et al. study, which is $15(mg/kg/day)^{-1}$.

Multiplication by the molecular weight of 149.8 gives a potency index of $2.25 \times 10^{+3}$. Rounding off to the nearest order of magnitude gives a value of 10^{+3}, which is the scale presented on the horizontal axis of Figure 7-12. The index of $2.25 \times 10^{+3}$ lies at the bottom of the first quartile of the 52 suspect carcinogens.

REC 5193

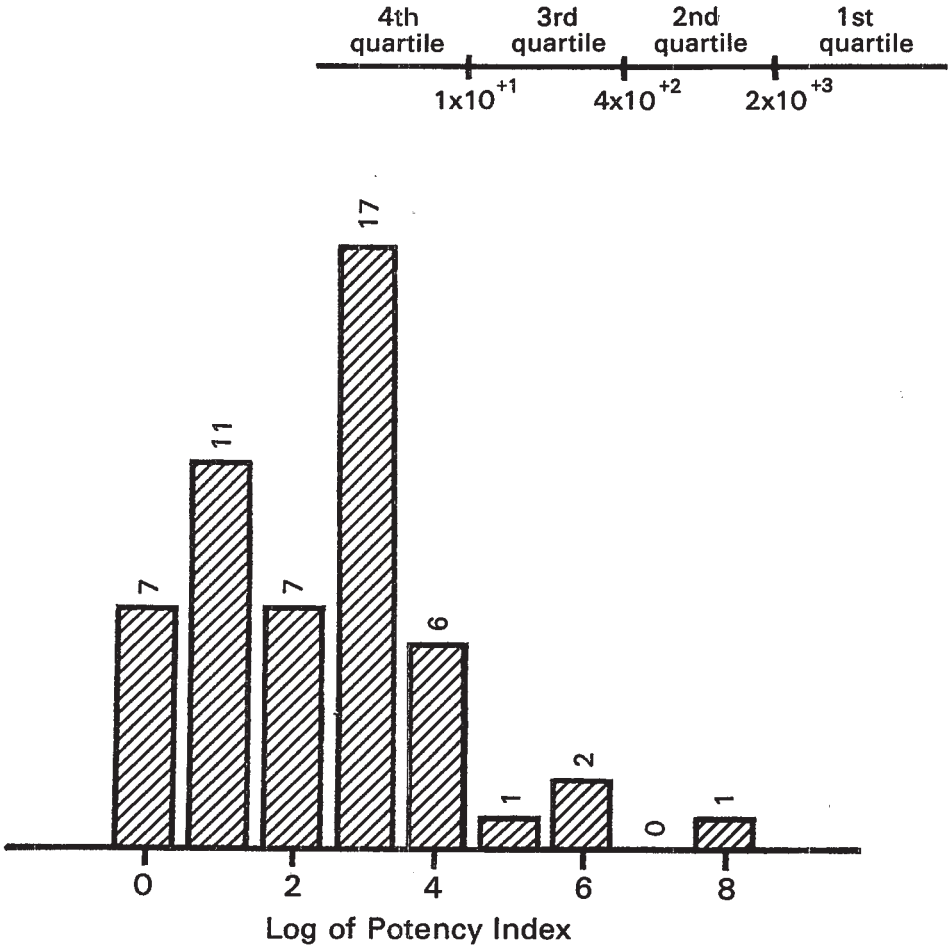


Figure 7-12. Histogram representing the frequency distribution of the potency indices of 52 suspect carcinogens evaluated by the Carcinogen Assessment Group.

TABLE 7-38. RELATIVE CARCINOGENIC POTENCIES AMONG 52 CHEMICALS EVALUATED BY THE CARCINOGEN ASSESSMENT GROUP AS SUSPECT HUMAN CARCINOGENS

Compounds	Slope (mg/kg/day)-1	Molecular Weight	Potency Index	Order of Magnitude (log_{10}) Index
Acrylonitrile	0.24(W)	53.1	$1x10^{+1}$	+1
Aflatoxin B_1	2924	312.3	$9x10^{+5}$	+6
Aldrin	11.4	369.4	$4x10^{+3}$	+4
Allyl Chloride	$1.19x10^{-2}$	76.5	$9x10^{-1}$	0
Arsenic	15(H)	149.8	$2x10^{+3}$	+3
B[a]P	11.5	252.3	$3x10^{+3}$	+3
Benzene	$5.2x10^{-2}$(W)	78	$4x10^{0}$	+1
Benzidine	234(W)	184.2	$4x10^{+4}$	+5
Beryllium	4.86	9	$4x10^{+1}$	+2
Cadmium	6.65(W)	112.4	$7x10^{+2}$	+3
Carbon Tetrachloride	$1.30x10^{-1}$	153.8	$2x10^{+1}$	+1
Chlordane	1.61	409.8	$7x10^{+2}$	+3
Chlorinated Ethanes				
1,2-dichloroethane	$6.90x10^{-2}$	98.9	$7x10^{0}$	+1
1,1,2-trichloroethane	$5.73x10^{-2}$	133.4	$8x10^{0}$	+1
1,1,2,2-tetrachloroethane	0.20	167.9	$3x10^{+1}$	+1
Hexachloroethane	$1.42x10^{-2}$	236.7	$3x10^{0}$	0
Chloroform	$7x10^{-2}$	119.4	$8x10^{0}$	+1
Chromium	41	104	$4x10^{+3}$	+4
DDT	8.42	354.5	$3x10^{+3}$	+3
Dichlorobenzidine	1.69	253.1	$4x10^{+2}$	+3
1,1-dichloroethylene	1.04(I)	97	$1x10^{+2}$	+2
Dieldrin	30.4	380.9	$1x10^{+4}$	+4

REC 5195

TABLE 7-38. (continued)

Compounds	Slope (mg/kg/day)-1	Molecular Weight	Potency Index	Order of Magnitude (log_{10}) Index
Dinitrotoluene	0.31	182	$6x10^{+1}$	+2
Diphenylhydrazine	0.77	180	$1x10^{+2}$	+2
Epichlorohydrin	$9.9x10^{-3}$	92.5	$9x10^{-1}$	0
Bis(2-chloroethyl)ether	1.14	143	$2x10^{+2}$	+2
Bis(chloromethyl)ether	9300(I)	115	$1x10^{+6}$	+6
Ethylene Dibromide (EDB)	8.51	187.9	$2x10^{+3}$	+3
Ethylene Oxide	0.63(I)	44.0	$3x10^{+1}$	+1
Formaldehyde	$2.14x10^{-2}$(I)	30	$6x10^{-1}$	0
Heptachlor	3.37	373.3	$1x10^{+3}$	+3
Hexachlorobenzene	1.67	284.4	$5x10^{+2}$	+3
Hexachlorobutadiene	$7.75x10^{-2}$	261	$2x10^{+1}$	+1
Hexachlorocyclohexane				
technical grade	4.75	290.9	$1x10^{+3}$	+3
alpha isomer	11.12	290.9	$3x10^{+3}$	+3
beta isomer	1.84	290.9	$5x10^{+2}$	+3
gamma isomer	1.33	290.9	$4x10^{+2}$	+3
Nickel	1.15(W)	58.7	$7x10^{+1}$	+2
Nitrosamines				
Dimethylnitrosamine	25.9(not by q_1^*)	74.1	$2x10^{+3}$	+3
Diethylnitrosamine	43.5(not by q_1^*)	102.1	$4x10^{+3}$	+4
Dibutylnitrosamine	5.43	158.2	$9x10^{+2}$	+3
N-nitrosopyrrolidine	2.13	100.2	$2x10^{+2}$	+2
N-nitroso-N-ethylurea	32.9	117.1	$4x10^{+3}$	+4
N-nitroso-N-methylurea	302.6	103.1	$3x10^{+4}$	+4
N-nitroso-diphenylamine	$4.92x10^{-3}$	198	$1x10^{0}$	0
PCBs	4.34	324	$1x10^{+3}$	+3
Phenols				
2,4,6-trichlorophenol	$1.99x10^{-2}$	197.4	4x10	+1

REC 5196

TABLE 7-38. (continued)

Compounds	Slope (mg/kg/day)-1	Molecular Weight	Potency Index	Order of Magnitude (log_{10}) Index
Tetrachlorodioxin	$4.25x10^{5}$	322	$1x10^{+8}$	+8
Tetrachloroethylene	$5.31x10^{-2}$	165.8	$9x10^{0}$	+1
Toxaphene	1.13	414	$5x10^{+2}$	+3
Trichloroethylene	$1.26x10^{-2}$	131.4	$2x10^{0}$	0
Vinyl Chloride	$1.75x10^{-2}$(I)	62.5	$1x10^{0}$	0

Remarks:

1. Animal slopes are 95% upperlimit slopes based on the linear multistage model. They are calculated based on animal oral studies, except for those indicated by I (animal inhalation), W (human occupational exposure), and H (human drinking water exposure). Human slopes are point estimate, based on the linear non-threshold model.

2. The potency index is a rounded-off slope in (mMol/kg/day)-1 and is calculated by multiplying the slopes in (mg/kg/day)-1 by the molecular weight of the compound.

3. Not all the carcinogenic potencies presented in this table represent the same degree of certainty. All are subject to change as new evidence becomes available.

Ranking of the relative potency indices is subject to the uncertainty involved in comparing estimates of potency for different chemicals based on different routes of exposure to different species, and using studies of different quality. Furthermore, all the indices are based on estimates of low-dose risk using linear extrapolation from the observational range. Thus, these indices are not valid for the purpose of comparing potencies in the experimental or observational range if linearity does not exist there.

7.3.5 Summary and Conclusions of the Carcinogenicity of Arsenic

7.3.5.1 Qualitative Summary--Human studies of the effects of arsenic from smelters, drinking water, pesticide manufacturing plants, and medicinals have

REC 5197

been conducted. These are summarized in Table 7-1. Studies of five independent smelter worker populations have all found an association between occupational arsenic exposure and lung cancer mortality. Several of the smelter studies have found a dose response both by intensity and by duration of exposure. The risk of lung cancer mortality in the high dose group of one study of smelter workers in Japan was found to be 10 times that expected. Some of the recent data from these smelter studies suggest that, if the multistage theory of carcinogenesis is correct, arsenic may act as a late-stage carcinogen. It is also possible to hypothesize from some of the data that arsenic may be a promoter. Either of these hypotheses, however, requires further study. In addition, some studies of communities surrounding smelters have found an association between geographic proximity to the smelter and lung cancer mortality.

Both proportionate mortality and cohort studies of pesticide manufacturing workers have demonstrated an excess of lung cancer deaths among workers in that occupation. One study of the population around a pesticide manufacturing plant found that residents of the area surrounding the plant were also at an excess risk of lung cancer. Several case reports of arsenical pesticide applicators have also shown an association between arsenical exposure and lung cancer.

A study of 40,000 persons in Taiwan exposed to arsenic in the drinking water found a significant excess prevalence of skin cancer over that of 7,500 other Taiwanese and residents of Matsu Island who drank water relatively free of arsenic. Water supplies in Chile and Argentina were also reported to be the cause of arsenic-induced skin cancers. In contrast, studies of populations in the United States exposed to relatively high levels of arsenic in the drinking water by U.S. standards did not find any excess of skin cancer.

The difference in response between the Taiwanese and the United States studies may reflect the fact that the drinking water in the study area in Taiwan

REC 5198

contained much higher levels of arsenic than did the drinking water in the United States. Furthermore, the Taiwanese waters also contained ergotamine-like compounds. Other differences between the two study areas include differences in socioeconomic status, with the Taiwanese who developed skin cancer belonging to a rather low socioeconomic strata which could have had ramifications in terms of diet, personal hygiene and medical care. Racial differences may have also contributed to the differences between the study results. In addition to these physical and cultural differences, the U.S. studies were limited by small sample sizes and would not have detected the risk from skin cancer that would have been predicted, on the basis of arsenic ingestion, from a linear model of the Taiwanese data.

Persons exposed to arsenical medicinals have also been shown to be at a risk of skin cancer.

Using the International Agency for Research on Cancer (IARC) classification scheme for evaluating carcinogens, the evidence for arsenic as a human carcinogen is considered sufficient. This is evidenced by the high relative risks, the consistency in findings in different studies, and the specificity of tumor sites (i.e., skin and lungs).

Consistent demonstration of arsenic carcinogenicity in test animals, using different chemical forms, routes of exposure, and various experimental species, has not been observed. Nevertheless, recent data indicate that tumorigenicity and possibly carcinogenicity can be demonstrated in animals if the retention of arsenic in the lung is increased. The additional observation that calcium arsenate is only slowly cleared from the lung, strongly suggests that this agent may be carcinogenic. In support of the recent animal studies, is the observation that cultured Syrian hamster embryo cells can be transformed by direct exposure to sodium arsenate.

REC 5199

7.3.5.2 Quantitative summary--Unit risks are estimated for both air and water exposures to arsenic. The air estimates were based on data obtained in five separate studies involving three independently exposed worker populations. Linear and quadratic dose-response models in both the absolute and relative form are fitted to the worker data. It was found that for the models that fit the data at the P = .01 or better level that the corresponding unit risk estimates ranged from 1.05×10^{-4} to 1.36×10^{-2}. However, linear models fit better than quadratic models and absolute better than relative models. Also it was felt that exposure to trivalent arsenic was more representive of low environmental exposure than pentavalent arsenic. Restricting unit risk estimates to those obtained from linear absolute models where exposure was to trivalent arsenic gives a range of 1.25×10^{-3} to 7.6×10^{-3}. A weighted average of the five estimates in this range gave a composite estimate of 4.29×10^{-3}.

An extensive drinking water study of the association between arsenic in well water and an examination for skin cancer of a population who lived in a rural area of Taiwan was used to estimate the unit risk for ingestion. Using the male population who appeared to be more susceptible, it was estimated that the unit risk associated with drinking water contaminated with 1 μg/ℓ of arsenic was 4.3×10^{-4}. To compare the air and water unit risks, the exposure units in both cases were converted to mg/kg/day absorbed doses, resulting in unit risk estimates of 50.1 and 15.0, respectively.

The potency of arsenic compared to other carcinogens is evaluated by noting that an arsenic potency of $2.25 \times 10^{+3}$ $(\text{mMol/kg/day})^{-1}$ lies in the first quartile of the 52 suspect carcinogens that have been evaluated by CAG.

7.3.5.3 Conclusions--Skin cancer and lung cancer have been shown by numerous epidemiologic studies to have an association with arsenic exposure. Arsenic

has not definitively been found to be a carcinogen in animal studies, however. In applying the IARC criteria for evaluating a substance as to the weight of evidence for human carcinogenicity, arsenic would be placed in group 1, which IARC characterizes as "carcinogenic to humans."

Using the linear absolute risk model, the composite estimate for cancer risk due to a lifetime exposure to 1 $\mu g/m^3$ trivalent arsenic in the air is estimated to be 4.29×10^{-3}. The unit risk due to lifetime exposure to 1 $\mu g/\ell$ of arsenic in drinking water is estimated to be 4.3×10^{-4}. On the basis of mg/kg/day absorbed dose, the unit-risk slope estimates for air and water are 50.1 and 15, respectively. While it is unlikely that the true risks would be higher than these estimates, they could be substantially lower. Compared to other compounds on a mole unit basis, the carcinogenic potency for arsenic falls towards the lower end of the first quartile.

REC 5201

8. ARSENIC AS AN ESSENTIAL ELEMENT

Mertz (1970) has set forth a set of logical criteria which trace elements should obey in order to be considered physiologically essential for man and/or animals. One of the most obvious of these, and one which should be readily demonstrable, is that the element meet a unique requirement physiologically, and, consequently, that a deficiency in that element be associated with deleterious effects.

In the case of arsenic, early reports attempting to show a nutritional requirement for the element in animals were inconclusive (Arsenic. NAS, 1977; Underwood, 1977). Part of the problem was undoubtedly technical in nature, i.e., the difficulty of carrying out such studies in an experimental environment where rigorous exclusion of a ubiquitous element from the diet is necessary. More recently, however, several carefully controlled studies have been reported to have demonstrated nutritional essentiality for arsenic in at least some mammalian species.

Nielsen et al. (1978) have noted that deprivation of pregnant rats of arsenic-supplemented diets resulted in offspring showing such post-weaning effects as slow growth, enlarged spleens, and increased red cell osmotic fragility. Greater perinatal mortality among pups from arsenic-deprived dams was also noted in a second experimental group.

In a recent review by Uthus et al. (1983), the authors reported on studies with chicks that suggest that arsenic influences arginine metabolism. It was reported that arsenic deprivation influenced the effects of dietary arginine, manganese and zinc, the fluctuations of which variously affected growth, kidney arginase, plasma alkaline phosphatase, plasma urea, plasma uric acid

and hematocrit. The authors suggested that the four components interacted to affect the conversion of arginine into urea and ornithine.

Anke et al. (1978) studied the nutritional requirements for arsenic using goats and mini-pigs and a semi-synthetic diet containing less that 50 ppb arsenic. Effects attributed to arsenic deficiency in both species were seen not only in the adult animals but in their offspring. Arsenic deficiency increased the mortality of adult goats as well as altered the mineral profiles for copper and manganese in the carcass. Significant reproductive effects for both arsenic-deficient goats and mini-pigs included reduction of the normal litter size. Furthermore, the mortality of kids and piglets from the arsenic-deficient groups was significantly higher than controls. Manganese levels were elevated in arsenic-deficient kids and piglets, but no perturbation of hematological indices (hemoglobin, hematocrit or mean corpuscular concentration) was noted. This is in contrast to the experimental observations with rats (Nielsen et al., 1974), where decreased hematocrits, elevated iron content in spleen and increased osmotic fragility of cells are seen. Given the fact that the rat is known to be an anomalous animal model for arsenic metabolism (see Chapter 4), this difference is probably peculiar to this species.

Schwartz (1977) has noted growth effects of arsenite on rats fed an arsenic-supplemented diet, with an optimal effect seen at 0.25 to 0.5 ppm. Interestingly, this worker noted that pentavalent arsenic as sodium arsenate is less effective.

Remaining to be independently demonstrated is a physiological role for arsenic, the existence of any specific carrier agent in the body, or arsenic essentiality in man.

A feature of essential element metabolism is homeostatic control of levels and movement of a particular element in vivo. From the information

considered earlier, there is no effective absorption barrier for most soluble inorganic arsenicals, but efficient excretory mechanisms (kidney, hair) and biotransformation appear to provide some control over any absorption-excretion balance.

REC 5205

9. HUMAN HEALTH RISK ASSESSMENT FOR ARSENIC

This portion of the report places the information in the earlier Chapters into a quantitative perspective with regard to non-occupational population exposure and health effects of arsenic germane to such a population.

Data for levels of arsenic encountered by humans in air, water, food and other sources, such as cigarette smoking, were set forth in Chapter 3 and are combined with data on rates of intake and rates of absorption to provide information on the total assimilation of arsenic on a daily basis. Health effects of arsenic most germane to non-occupational population exposures are then summarized. Generally, these are chronic effects associated with long-term intake of relatively low levels of arsenic. In the case of hazardous wastes, however, some health effects of concern may be associated with acute exposures; therefore, acute and sub-acute effects must also be considered.

The section dealing with dose-effect/dose-response data includes consideration of various indices of internal exposure followed by quantitative data for intake and population response.

Populations at risk, identified at least along qualitative lines, are included for discussion.

9.1 AGGREGATE EXPOSURE LEVELS TO ARSENIC IN THE U.S. POPULATION

Among individuals of the general population (not occupationally exposed to arsenic), the main routes of exposure to arsenic are typically via ingestion of food and water, with lesser exposures occurring via inhalation. Representative intake figures are presented in Table 9-1. Intake by inhalation is augmented among smokers in proportion to the level of smoking.

REC 5207

TABLE 9-1. ROUTES OF DAILY HUMAN ARSENIC INTAKE

Route/level	Rate	Total intake	Absorbed amount
Ambient air/0.006 μg/m^3[(a)]	20 m^3	0.12 μg	0.036 μg[(b)]
Drinking water/≤ 10 μg/liter	2 liters	≤ 20 μg	≤ 20 μg[(c)]
Food/50 μg daily (elemental As)	--	50 μg	40 μg[(d)]
Cigarettes/6 μg in mainstream smoke/pack[(e)]	1/2 pack	3 μg	0.9 μg[(f)]
	1 pack	6 μg	1.8 μg[(f)]
	2 pack	12 μg	2.7 μg[(f)]
Total: ≤ 60 μg nonsmokers			

(a) National average for 1981 (see Section 3.3.1)
(b) Assumes 30 percent respiratory absorption (see Chapter 4).
(c) Assumes total absorption (see Chapter 4).
(d) Assumes 80 percent absorption (see Chapter 4).
(e) Assumes 20 percent of cigarette content in inhaled smoke (see Chapter 4).
(f) Assumes 30 percent absorption of inhaled amount (see Chapter 4).

Assuming a daily ventilation rate of 20 m^3, and a national population inhalation average of 0.006 μg/m^3/As, the total daily inhalation exposure for arsenic can be projected to be approximately 0.12 μg. Assuming 30 percent absorption, approximately 0.03 μg of arsenic would be absorbed on a daily average.

Contribution of tobacco-borne arsenic to the respiratory burden would depend upon the rate of cigarette smoking. If one assumes a mass of 1 gram/cigarette and an average tobacco value of 1.5 ppm, this yields 1.5 μg arsenic/cigarette. With 20 percent of this amount in mainstream smoke, the inhaled amount for each pack of cigarettes would be approximately 6 μg arsenic, and of this amount, 40 percent would be deposited in the respiratory tract (see Chapter 4). Assuming an absorption of 75 percent of the deposited fraction, one arrives at an absorption of approximately 2 μg/pack of cigarettes or a

factor of 10 to 100 times greater than intake for nonsmokers in given ambient air settings. One may assume that the rates of absorption for trivalent and pentavalent arsenic in the respiratory tract are equivalent.

Since drinking water arsenic is mainly in a soluble form (arsenate or arsenite), virtually all of it is absorbed in the GI tract (see Chapter 4). Thus, assuming an average daily consumption of two liters of water containing at most 10 µg As/liter as an outside high figure, one can estimate that the total arsenic absorbed from drinking water would be approximately 20 µg/day. Most individuals would, in reality, take in much less than this amount, while those in the Western U.S. with well water supplies much higher in arsenic content would assimilate proportionately more.

Food arsenic values taken from the 1974 FDA survey indicate a daily total dietary intake of approximately 50 µg elemental arsenic. Based on information presented in Chapter 4, the major portion (80 percent) of food arsenic would be absorbed resulting in a net daily food arsenic absorption of 40 µg total.

Thus, a non-smoker would have a total daily absorption from all exposure media of approximately 60 µg arsenic/day or less. Of this, the diet would be the major contributor, assuming levels in water much below 10 µg/liter. For cigarette smokers, one would add 2 µg arsenic/pack of cigarettes smoked daily.

If one views aggregate intake not in terms of total arsenic intake but in terms of toxicologically significant forms of the element, then much of the dietary fraction, for reasons given earlier, such as complex organoarsenicals being present, becomes relatively less important than the forms in water and air as well as in cigarette smoke. Arsenic forms in such media include: pentavalent arsenic in most water supplies; variable mixtures of tri-and pentavalent arsenic in ambient air; and probably an arsenic oxide in cigarette smoke. From this view point, utilizing the examples already given above, non-

REC 5209

smokers would absorb 20 μg or less daily of toxicologically significant arsenic. Heavy smokers having otherwise very low air and water exposure, conceivably could receive their major exposure via cigarettes.

9.2 SIGNIFICANT HUMAN HEALTH EFFECTS ASSOCIATED WITH AMBIENT EXPOSURES

9.2.1 Acute Exposure Effects

Serious acute effects and late sequelae from exposure to arsenic will appear after single or short-term respiratory or oral exposures to large amounts of arsenic. Available data indicate that inorganic trivalent compounds of arsenic are generally more acutely toxic than inorganic pentavalent compounds, which in turn are more toxic than organic arsenic compounds. Serious effects will also appear after long-term exposure to respiratory or oral doses of arsenic.

The acute symptoms following oral exposure consist of gastrointestinal disturbances, which may be so severe that secondary cardiovascular effects and shock may result and cause death. Also, direct toxic effects on the liver, blood-forming organs, the central and peripheral nervous systems, and the cardiovascular system may appear. Some symptoms, especially those from the nervous system, may appear a long time after exposure has ceased and may not be reversible, whereas the other effects seem to be reversible. Infants and young children especially are susceptible with regard to effects on the central nervous system. The Japanese follow-up after the Morinaga milk poisoning showed that persisting damage, especially mental retardation and epilepsy, is a late sequela in children of short-term oral exposure to large doses of inorganic arsenic. Among adults, the central nervous system is not as susceptible, but peripheral neuropathy has been a common finding.

Both in adults and children, acute oral exposure has resulted in dermal changes, especially hyperpigmentation and keratosis, as a late sequela.

Acute inhalation exposures have also resulted in irritation of the upper respiratory tract, even leading to nasal perforations.

Direct dermal exposure to arsenic may lead to dermal changes; allergic reactions may also be involved.

9.2.2 Chronic Exposure Effects

Both carcinogenic and non-carcinogenic effects are associated with long-term exposures, which do not cause any obvious immediate effects. For the purpose of this document, such chronic effects will be discussed in sequence as follows:

1. Respiratory tract cancer
2. Skin cancer
3. Non-cancerous skin lesions
4. Peripheral neuropathological effects
5. Cardiovascular changes

Cancer of the respiratory system is clearly associated with exposure to arsenic via inhalation. This association has been especially noted among workers engaged in the production and usage of pesticides and among smelter workers. While it is not known to what extent exposure to other compounds in industrial atmospheres has contributed to the excess of lung cancer, the Carcinogen Assessment Group (CAG) has concluded that there is sufficient evidence that inorganic arsenic compounds are lung carcinogens in humans.

Cancer of the skin has been found as a dose-related effect in a population in Taiwan, with lifetime exposure to arsenic in well water. It has also been found among people treated with large doses of arsenite for skin disorders. Skin cancer often has a long latency period on the order of decades, the latency time decreasing with increasing intensity of exposure. The CAG has concluded that there is sufficient evidence that inorganic arsenic compounds are skin carcinogens in humans.

Hyperkeratosis and hyperpigmentation, sometimes with precancerous changes, have been a common finding in persons ingesting arsenic. These skin lesions, as well as the manifest cancer, develop on skin surfaces usually unexposed to sunlight. In studies in the United States, an association between skin lesions or skin cancer has not been demonstrated. These studies have been limited, however, by sample sizes too small to be able to detect the dose response seen in studies outside the U.S.

The effects on the peripheral nervous system range from sensory disturbances to motor weakness and even paralysis. The more severe signs have been noted in subacute poisonings, but more subtle changes after long-term low-level exposure have been found by using electromyography or measuring nerve conduction velocity. These subclinical effects are slow in recovery and may persist for years after cessation of exposure. In a study in Canada, electromyographic (EMG) changes were noted when water concentrations of arsenic exceeded 0.05 mg/l.

Cardiovascular effects have been noted especially in Taiwan, where Blackfoot disease (peripheral vasculopathy) occurred after long-term exposure to arsenic in well water. However, the presence of ergotamine-like compounds raises the possibility of vascular effects from these agents. Peripheral vascular changes were also found among German vintners who were exposed both occupationally, by spraying arsenic-containing pesticides, and orally, by drinking wine with elevated arsenic levels. Studies on occupationally-exposed persons have been inconclusive in showing that arsenic causes an increase in mortality from cardiac disease.

9.3 DOSE-EFFECT/DOSE-RESPONSE RELATIONSHIPS

9.3.1 General Considerations

This section generally attempts to define, as presently feasible, human dose-effect/dose-response relationships for health effects of likely greatest

concern at ambient environment exposure levels for arsenic in the United States. As such, the present section highlights mainly the quantitative carcinogenic risk estimates that were derived in Section 7.3.

The general question of how to define and employ a dose factor in attempts at quantitative assessments of human health risk for any toxicant is highly dependent upon: 1) the available information on the body's ability to metabolize the agent, and 2) the assessment of the relative utility of various internal indices of exposure.

The time period over which a given total intake occurs is highly important. For example, intake of one gram of arsenic over a period of years would be quite different pathophysiologically from assimilating this amount at one time, the latter probably having a lethal outcome. This time-dependent behavior is related in part to the relative ability of the body to detoxify inorganic arsenic by methylation as a function of both dose and time.

In cases of acute and sub-acute exposure, indicators of internal exposure such as blood or urine arsenic levels are probably appropriate for assessing the intensity of exposure.

With chronic, low-level exposure, however, the available data would indicate that the total amount assimilated is probably more important than an indicator concentration without knowledge of the total exposure period. An added problem is the background level of arsenic found in these indicators due to dietary habits. For example, in acute exposures, levels in blood or urine would be greatly elevated over background values while low-level chronic exposures would only result in moderate increases over background.

In regard to hair arsenic levels as an indicator of internal arsenic exposure, no reliable methods exist for distinguishing external contamination levels from those accumulated via absorption and metabolic distribution. Hair arsenic levels cannot, therefore, be employed as reliable indicators of either

REC 5213

current or cumulative long-term exposures for individual subjects, but rather may provide only a rough overall indication of group exposure situations.

Given the above considerations and limitations concerning the use of blood, urinary or hair arsenic concentrations as internal indices of cumulative, long-term low-level arsenic exposures of concern here, the dose-effect/dose-response relationships summarized below are done so mainly in terms of external arsenic exposure levels via either inhalation or ingestion.

9.3.2 Effects and Dose-Response Relationships

It is difficult to define a precise acute lethal dose of arsenic for man, because such exposure situations rarely allow accurate determination of the effective amounts. However, for trivalent arsenic, the figure is believed to range from 70 - 180 milligrams.

For subacute exposure, it appears that for children, about one gram assimilated over a period of 3-4 weeks will induce death with severe effects in survivors, while for adults, that dose will occasion significant clinical effects. In one poisoning episode, intake of approximately 50 milligrams over a period as short as two weeks resulted in clinically demonstrable effects in adults.

9.3.2.1 Respiratory Cancer--A considerable number of studies have shown associations between occupational exposure to arsenic and cancer of the respiratory system. The best information available for making quantitative risk estimates for lung cancer are derived from 5 sets of data involving 4 sets of investigators and 2 distinct exposed populations. The 4 sets of investigators are Brown and Chu (1983a,b,c), Lee-Feldstein (1983) and Higgins (1982)--who conducted studies on workers at the Anaconda smelter in Montana--and Enterline and Marsh (1982)--who conducted a study on the workers at the ASARCO smelter in Tacoma, Washington.

REC 5214

Using an absolute-risk linear model and the data from the four smelter studies, the lifetime lung cancer risk, due to continuous exposure of 1 μg/As/m^3, was estimated to range from 1.25×10^{-3} to 7.6×10^{-3}. A weighted average of the five estimates* in this range gave a composite estimate of 4.29×10^{-3} (see Section 7.3.2.3). This represents a plausible estimate of the upper limit of risk--that is, the true risk would not likely be more than the estimated risk, but it could be substantially lower.

9.3.2.2 Skin Cancer--Chronic arsenic exposure, both occupational and non-occupational, is associated with a distinctive hyperkeratosis, which is usually followed by a later onset of skin cancer. The best data available for making quantitative risk estimates for skin cancer are the data collected by Tseng et al. (1968). In this study, the authors surveyed a stable population of 40,421 individuals who lived in a rural area along the southwest coast of Taiwan and who were known to have consumed drinking water containing arsenic. The occurrences of skin cancer among this population and the arsenic concentrations in their drinking water were measured. Since the population was stable, the data obtained from the study lends itself to predictions of lifetime probability of skin cancer caused by the ingestion of arsenic.

Using an absolute-risk linear model and the data from Tseng et al., the lifetime skin cancer risk from drinking water containing 1 μg/liter of arsenic was estimated to be 4.3×10^{-4} (see Section 7.3.3). It is not likely that the true risk for skin cancer would be more than this estimated risk, but it could be considerably lower.

9.3.2.3 Non-cancerous Skin Lesions -- As noted above, in man, chronic oral exposure to arsenic induces a sequence of changes in skin epithelium, proceeding from hyperpigmentation to hyperkeratosis, characterized as keratin proliferation

---

*Two risk estimates were derived from the Enterline and Marsh study based upon exposure periods lagged 0 and 10 years. See Table 7-25.

REC 5215

of a verrucose nature and leading, in some cases, to late onset skin cancers. These effects have been noted both in populations which have ingested arsenic via drinking water and among people treated with large doses of arsenite for skin disorders. In a report by Pershagen and Vahter (1979), the authors, using the data from a patient population exposed to arsenic via Fowler's solution (Fierz, 1965), noted an increase in prevalence of hyperkeratosis with increasing dose of arsenic. The U.S. EPA is presently examining this information, along with information from other studies, in order to determine whether quantitative dose-response relationships, similar to those seen for skin cancer, can be established for these precancerous skin lesions.

9.3.2.4 Peripheral Neuropathological Effects and Cardiovascular Changes -- While the qualitative evidence for peripheral neurological effects and cardiovascular changes in arsenic-exposed populations is incontrovertible, the data are insufficient to establish quantitative dose-response relationships at the present time.

9.4 POPULATIONS AT SPECIAL RISK TO ARSENIC EXPOSURE

In reviewing the literature dealing with the acute, subacute and chronic effects of arsenic in children and adults, the evidence suggests that children may be at special risk for the effects of inorganic arsenic under conditions of acute or subacute exposure.

In earlier sections, reference was made to the outbreak of pediatric poisoning by arsenic in Japan due to the presence of arsenic in infant milk formula (Hamamoto et al., 1955). From the clinical reports published at the time of the mass poisoning as well as those from follow-up studies, a number of signs of central nervous system involvement were noted both at the time of the episode and much later, with the follow-up studies showing behavioral problems, abnormal brain wave patterns, marked cognitive deficits, and severe hearing loss in some of those children who survived the acute episode. Some

of these same tardive effects have also been noted in adults but appear to be a much less constant feature of arsenic-induced neurotoxic effects than are the peripheral neuropathies.

Because children consume more water per body weight than do adults, the daily intake of arsenic via drinking water per kilogram body weight would be greater in children. This may have implications regarding chronic exposure effects in children. Zaldivar (1977) developed a regression equation describing this relationship. It should be noted, however, that serious health effects due to chronic exposure of arsenic in drinking water have not been found at a greater frequency in children than adults.

Individuals residing in the vicinity of certain arsenic-emitting sources, e.g., certain types of smelters, may be at risk for increased arsenic intake because of both direct exposure to arsenic in air and indirect exposure via arsenic secondarily deposited from air onto soil or other human exposure media. The relative contribution of such indirect exposures to increased risk of these individuals for arsenic health effects is difficult to define due to the lack of information on this subject. However, it is most likely minimal in relation to the direct effects arising from inhalation of arsenic, including lung cancer.

As a large class of the general population at risk for increased arsenic intake, one would have to include cigarette smokers. However, it is not clear to what extent some increased arsenic intake from tobacco smoke poses a specific heightened health effect risk, although it is clear that internal indicator levels, e.g. blood arsenic, are somewhat elevated in the case of cigarette smokers relative to nonsmokers.

REC 5217

10. REFERENCES

Akland, G. [Memo to D. Sivulka]. February 23, 1983. Available from: U.S. Environmental Protection Agency, Research Triangle Park, NC; Project file no. ECAO-HA-79-5.

Amacher, D. E., and S. C. Paillet. Induction of trifluorothymidine-resistant mutants by metal in L5178Y/TK$^{+/-}$ cells. Mutat. Res. 78:279-288, 1980.

Andelman, J. B. and M. Barnett. Feasibility study to resolve questions on the relationship of arsenic in drinking water to skin cancer. Environmental Protection Agency Cooperative Agreement No. CR-806815-02-1, 1983.

Andersen, O. Effects of coal combustion products and metal compounds on sister chromatid exchange (SCE) in a macrophage cell line. Environ. Health Perspect. 47:239-253, 1983.

Andreae, M. O. Arsenic speciation in seawater and interstitial waters: the influence of biological-chemical interactions on the chemistry of a trace element. Limnol. Oceanogr. 24:440-452, 1979.

Andreae, M. O. Arsenic in rain and the atmospheric mass balance of arsenic. J. Geophys. Res. 85:4512-4518, 1980.

Andreae, M. O. Biotransformation of arsenic in the marine environment. In: Arsenic: Industrial, Biomedical and Environmental Perspectives. W. Lederer and R. Fensterheim, eds., Van Nostrand Reinhold, New York, 1983.

Andreae, M. O. Determination of arsenic species in natural waters. Anal. Chem. 49:820-823, 1977.

Andreae, M. O. Distribution and speciation of arsenic in natural waters and some marine algae. Deep-Sea Res. 25:391-402, 1978.

Andreae, M. O., and D. Klumpp. Biosynthesis and release of organo arsenic compounds by marine algae. Environ. Sci. Technol. 13:738-741, 1979.

Anke, M., M. Grun, Partschefeld, B. Grappel, and A. Hennig. Essentiality and function of arsenic: In: Trace Element Metabolism in Man and Animals, Vol. 3, M. Kirchgessner, ed., Arbeitskreses fur Tierernohrungs forschug, werhenstephen, Germany, 1978. pp. 248-252.

Archer, V. [Personal communication with D. Sivulka]. March 1, 1983. Record of communication available from: U.S. Environmental Protection Agency, Research Triangle Park, NC; Project file no. ECAO-HA-79-5.

Arguello, R. A., D. D. Cenget, and E. E. Tello. [Regional endemic cancer and arsenical intoxication in Cordoba]. Rev. Argentina Dermatosifilio. 22:461-487, 1938.

Ariyoshi, T., and T. Ikeda. On the tissue distribution and the excretion of arsenic in rats and rabbits of administration with arsenical compounds. J. Hyg. Chem. 20:290-295, 1974.

REC 5219

Astrup, P. Blackfoot disease. Ugeskr. Laeger 130:1807-1815, 1968.

Attrep, M. Jr., and M. Anirudhan. Atmospheric inorganic and organic arsenic. Trace Subst. Environ. Health 11:365-369, 1977.

Axelson, O., E. Dahlgren, C.-D. Jansson, and S. O. Rehnlund. Arsenic exposure and mortality: a case referent study from a Swedish copper smelter. Br. J. Ind. Med. 35:8-15, 1978.

Baetjer, A. M., A. M. Lilienfeld, and M. L. Levin. Cancer and occupational exposure to inorganic arsenic. In: Abstracts 18th International Congress on Occupational Health, Brighton, England, September 14-19, 1975. Organizing Committee, Brighton, England, 1975. p. 393.

Bailar, J. C. III and F. Ederer. Significance factors for the ratio of a Poisson variable to its expectation. Biometrics 20:639-643, 1964.

Baldridge, C. W. Relationship between antisyphylitic treatment and toxic cirrhoses. Am. J. Med. Sci. 188:685-690, 1934.

Baroni, C., G. J. van Esch, and U. Saffiotti. Carcinogenesis tests of two inorganic arsenicals. Arch. Environ. Health 7:668-674, 1963.

Bavon, D., I. Kunick, I. Frishmuth, and J. Petres. Further in vitro studies on the biochemistry of the inhibition of nucleic acid and protein synthesis induced by arsenic. Arch. Derm. Res. 253:15-22, 1975.

Baxley, M. N., R. D. Hood, G. C. Vedel, W. P. Harrison, and G. M. Szczech. Prenatal toxicity of orally administered sodium arsenite in mice. Bull. Environ. Contam. Toxicol. 26:749-756, 1981.

Beaudoin, A. R. Teratogenicity of sodium arsenate in rats. Teratology 10:153-158, 1974.

Beckman, G., L. Beckman, and I. Nordenson. Chromosome aberrations in workers exposed to arsenic. Environ. Health Perspect. 19:145-146, 1977.

Bencko, V., and K. Symon. Test of environmental exposure to arsenic and hearing changes in exposed children. Environ. Health Perspect. 19:95-101, 1977.

Bencko, V., and K. Symon. The cumulation dynamics in some tissue of hairless mice inhaling arsenic. Atmos. Environ. 4:157-161, 1970.

Bencko, V., B. Benes, and M. Ckirt. Biotransformation of As (III) to As (V) and arsenic tolerance. Arch. Toxicol. 36:159-162, 1976.

Bental, E., S. Lavy, and N. Amir. Electroencephalographic changes due to arsenic, thallium and strychnine poisonings. Confin. Neurol. 21(3):233-240, 1961.

Bergstrom, J. and P. O. Wester. The effect of dialysis on the arsenic content of blood and muscle tissue from uraemic patients. Excerpta Med. Int. Cong. Ser. 131:38-40, 1966.

Bergoglio, R. M. Mortality from cancer in regions of arsenical waters of the province of Cordoba Argentine Republic. Prensa Med. Argent. 51:994-998, 1964.

Berteau, P. E., J. O. Flom, R. L. Dimmick, and A. R. Boyd. Long-term study of potential carcinogenicity of inorganic arsenic aerosols to mice. Toxicol. Appl. Pharmacol. 45:323 (Abs. No. 243), 1978.

Bertolero, F., E. Marafante, J. Edel-rade, R. Pietra, and E. Sabbioni. Biotransformation and intracellular binding of arsenic in tissues of rabbits after i.p. administration of ^{74}As-labeled arsenite. Toxicology 20:35-44, 1981.

Blejer, H. P., and W. Wagner. Case study 4: inorganic arsenic-ambient level approach to the control of occupational cancerigenic exposures. In: Occupational Carcinogenesis, Proceedings of a Conference, New York Academy of Sciences, New York, New York, March 24-27, 1975. Ann. N. Y. Acad. Sci. 271:179-186, 1976.

Blot, W. J., and J. F. Fraumeni. Arsenical air pollution and cancer. Lancet II:142-144, 1975.

Borgono, J. M., and R. Greiber. Epidemiological study of arsenicism in the city of Antofagasta. In: Trace Substances in Environmental Health-V, Proceedings of the 5th Annual Conference, University of Missouri, Columbia, Missouri, June 29 - July 1, 1971. D. C. Hemphill, ed., University of Missouri, Columbia, MO, 1972. pp. 13-24.

Borgono, P. M., P. Vincent, H. Venturino, and A. Infante. Arsenic in the drinking water of the City of Antofogasta: epidemiological and clinical study before and after the installation of the treatment plant. Environ. Health Perspect. 19:103-105, 1977.

Braman, R. S., and C. C. Foreback. Methylated forms of arsenic in the environment. Science 182:1247-1249, 1973.

Braman, R. S., D. L. Johnson, C. C. Foreback, J. M. Ammons, and J. L. Bricker. Separation and determination of nanogram amounts of inorganic arsenic and methylarsenic compounds. Anal. Chem. 49:621-625, 1977.

Braun, W. Carcinoma of the skin and the internal organs caused by arsenic: delayed occupational lesions due to arsenic. German Med. Monthly 3:321-324, 1958.

Brown, C. C. and K. C. Chu. Approaches to epidemiologic analysis of prospective and retrospective studies: Example of lung cancer and exposure to arsenic. In: Proceedings of the SIMS Conference on Environmental Epidemiology: Risk assessment, June 28-July 2, 1982, Alta, Utah. SIAM Publication, 1983a.

Brown, C. C. and K. C. Chu. A new method for the analysis of cohort studies: Implications of the multistage theory of carcinogenesis applied to occupational arsenic exposure. To appear in Environmental Health Perspectives. 1983b.

REC 5221

Brown, C. C. and K. C. Chu. Implications of the multistage theory of carcinogenesis applied to occupational arsenic exposure. J. Natl. Cancer Inst. 70:455-463, 1983c.

Brune, O., G. Nordberg, and P-O. Wester. Distribution of 23 elements in kidney, liver and lung of a control group in Northern Sweden and of exposed workers from a smelter and refinery. Sci. Total Environ., 1980.

Buchet, J. P., R. Lauwerys, and H. Roels. Comparison of several methods for the determination of arsenic compounds in water and in urine. Int. Arch. Occup. Environ. Health 46:11-29, 1980.

Buchet, J. P., R. Lauwerys, and H. Roels. Comparison of the urinary excretion of arsenic metabolites after a single oral dose of sodium arsenite, monomethyl arsonate or dimethyl arsinate in man. Int. Arch. Occup. Environ. Health 48:71-79, 1981a.

Buchet, J. P., R. Lauwerys, and H. Roels. Urinary excretion of inorganic arsenic and its metabolites after repeated ingestion of sodium meta arsenite by volunteers. Int. Arch. Occup. Environ. Health 48:111-118, 1981b.

Burgdorf, W., K. Kurvink, and J. Cervenka. Elevated sister chromatid exchange rate in lymphocytes of subjects treated with arsenic. Hum. Genet. 36:69-72, 1977.

Burk, D., and A. R. Beaudoin. Arsenate-induced renal agenesis in rats. Teratology 16:247-260, 1977.

Butzengeiger, K. H. Chronic arsenic poisoning. I. EKG alterations and other symptoms observed on the heart and vascular system. II. Mucous membrane symptoms and pathogenesis. Dtsch. Arch. Klin. Med. 194: 1-16, 1949.

Butzengeiger, K. H. Peripheral circulation disturbances with chronic arsenic poisoning. Klin. Wochenschr. 19: 523-527, 1940.

Byron, W. R., Bierbower, G. W. Brauwer, and W. H. Hansen. Pathologic changes in rats and dogs from two-year feeding of sodium arsenite and sodium arsenate. Toxicol. Appl. Pharmacol. 10: 132-147, 1967.

Canadian Public Health Association Task Force on Arsenic. Electromyography, Final Report, Yellowknife and Hay River, Northwest Territories, 1978. Canadian Public Health Association, Ottawa, Canada, November 1978.

Challenger, F. Biosynthesis of organo-metallic and organo-metalloidal compounds. In: Organo-metals and organo-metalloids (F.E. Brinckman and J.M. Bellama, eds.), Symposium Series No. 82, Am. Chem. Soc., Washington, D.C., 1978, pp. 1-22.

Charbonneau, S. M., G. K. H. Tam, F. Bryce, and B. Collins. Pharmacokinetics and metabolism of inorganic arsenic in the dog. Trace Subst. Environ. Health. 12: 276-283, 1978a.

Charbonneau, S. M., G. K. H. Tam, F. Bryce, Z. Zadwidzka, and E. Sandi. Metabolism of orally administered inorganic arsenic in the dog. Toxicol. Lett. 3: 107-113, 1979.

Charbonneau, S. M., K. Spencer, F. Bryce, and E. Sandi. Arsenic excretion by monkeys dosed with arsenic-containing fish or with inorganic arsenic. Bull. Environ. Contam. Toxicol. 20: 470-477, 1978b.

Chhuttani, P. N., L. S. Chawla, and T. D. Sharma. Arsenical neuropathy. Neurology 17: 269-275, 1967.

Ch'i, I. C.,and R. Q. Blackwell. A controlled retrospective study of Blackfoot disease and epidemic peripheral gangrene disease in Taiwan. Am. J. Epidemiol. 88: 7-24, 1968.

Chung, H. C., and C. T. Liu. Induction of lung cancer in rats by intratracheal instillation of arsenic-containing ore dust. Zhonghua Zhongliu Zazhi 4:14-16, 1982.

Cikrt, M., and V. Bencko. Fate of arsenic after parenteral administration to rats, with particular reference to excretion via bile. J. Hyg. Epidemiol. Microbiol. Immunol. 18: 129-136, 1974.

Cikrt, M., V. Bencko, M. Tich, and B. Benes. Biliary excretion of ^{74}As and its distribution in the golden hamster after administration of ^{74}As (III) and ^{74}As (V). J. Hyg. Epidemiol. Microbiol. Immunol. 24:384-388, 1980.

Consultants in Epidemiology and Occupational Health. Arsenic Risk Assessment Critique and Alternative Supplemental Submission prepared for the Arsenic Program Panel Chemical Manufacturers Association, August 13, 1982. OSHA Docket No. H-037C. Standard for Inorganic Arsenic Post-hearing Evidentiary Submission of the Chemical Manufacturers Association Arsenic Panel.

Coulson, E. J., R. E. Remington, and K. M. Lynch. Metabolism in the rat of the naturally occurring arsenic of shrimp as compared with arsenic trioxide. J. Nutr. 10:255-270, 1935.

Crecelius, E. A. Changes in the chemical speciation of arsenic following ingestion by man. Environ. Health. Perspect. 19:147-150, 1977.

Crecelius, E. A. The geochemistry of arsenic and antimony in Puget Sound and Lake Washington, Washington. Thesis: University of Washington, Seattle, Washington, 1974.

Crema, A. Distribution et elimination de l'arsenic 76 chez la souris normale et cancereuse. Arch. Int. Pharmacodyn. 103:57-70, 1955.

Crossen, P. E. Arsenic and SCE in human lymphocytes. Mutat. Res. 119:415-419, 1983.

Cuzick, J., S. Evans, M. Gillman, and D. Price Evans. Medicinal arsenic and internal malignancies. Br. J. Cancer 45:904-911, 1982.

REC 5223

Damsgaard, E., K. Heydorn, N. Larsen and B. Nielsen. Simultaneous determination of arsenic, manganese and selenium in human serum by neutron activation analysis. Report No. 271. Danish Atomic Energy Commission, Roskilde, 1973.

Day, N. E., and C. C. Brown. Multistage models and primary prevention of cancer. J. Natl. Cancer Inst. 64:977-989, 1980.

Dieke, S. H., and C. P. Richter. Comparative assays of rodenticides on wild Norway Rats. I. Toxicity. Publ. Health Rep. 61:672-679, 1946.

DiPaolo, J. and B. Casto. Quantitative studies of in vitro morphological transformation of Syrian hamster cells by inorganic metal salts. Cancer Res. 39:1008-1013, 1979.

Doll, R. Weibull distribution of cancer. Implications for models of carcinogenesis. J. Roy. Stat. Soc. A 13:133-166, 1971.

Doll, R. and R. Peto. Cigarette smoking and bronchial carcinoma: dose and time relationships among regular smokers and life-long non-smokers. J. Epi. Comm. Health 32:303-113, 1978.

Done, A. K., and A. J. Peart. Acute toxicities of arsenical herbicides. Clin. Toxicol. 4:343-355, 1971.

Dubois, K. P., A. L. Moxon, and O. E. Olson. Further studies on the effectiveness of arsenic in preventing selenium poisoning. J. Nutr. 19:477-482, 1940.

Ducoff, H. S., W. B. Neal, R. L. Straube, L. D. Jacobson, and A. M. Brues. Biological studies with arsenic^{76}. II. Excretion and tissue localization. Proc. Soc. Exp. Biol. Med. 69:548-554, 1948.

Durrant, P. J., and B. Durrant. Introduction to Advanced Inorganic Chemistry. 3rd Ed., Longmans, Green and Co., Ltd., London, 1966.

Dutkiewicz, T. Experimental studies on arsenic absorption routes in rats. Environ. Health. Perspect. 19:173-177, 1977.

Edmonds, J. S., and K. A. Francesconi. Methylated arsenic from marine fauna. Nature 265:436, 1977.

Edmonds, J. S., K. A. Francesconi, J. R. Cannon, C. L. Raston, B. W. Skelton, and A. H. White. Isolation, crystal structure and synthesis of arsenobetaine, the arsenical constituent of the western rock lobster Panulirus longipes cygnus George. Tetrahedron Lett. 18:1543-1546, 1977.

Eldred, R., L. Ashbaugh, T. Cahill, R. Flocchini and M. Pitchford. Sulfate levels in the southwest during the 1980 copper smelter strike. JAPCA 33: 110-113, 1983.

Enterline, P. E. and G. M. Marsh. Mortality studies of smelter workers. Am. J. Ind. Med. 1: 251-259, 1980.

Enterline, P. E. and G. M. Marsh. Mortality among workers exposed to arsenic and other substances in a copper smelter. Am. J. Epidemiol. 116: 895-910, 1982.

Falk, H., G. G. Caldwell, K. G. Ishak, L. B. Thomas, and H. Popper. Arsenic-related hepatic angiosarcoma. Am. J. Ind. Med. 2:43-50, 1981a.

Falk, H., J. T. Herbert, L. Edmonds, C. W. Heath Jr., L. B. Thomas, and H. Popper. Review of four cases of childhood hepatic angiosarcoma--elevated environmental arsenic exposure in one case. Cancer 47:383-391, 1981b.

Feldman, C. Improvements in the arsine accumulation-helium glow detector procedure for determining traces of arsenic. Anal. Chem. 51:664-669, 1979.

Ferm, V. H. Arsenic as a teratogenic agent. Environ. Health Perspect. 19:215-217, 1977.

Ferm, V. H., and S. Carpenter. Malformations induced by sodium arsenate. J. Reprod. Fertil. 17:199-201, 1968.

Ferslew, K. E., and G. T. Edds. Effects of arsanilic acids on growth, serum enzymes, hematologic values, and residual arsenic in young swine. Am. J. Vet. Res. 40:1365-1369, 1979.

Feussner, J. R., J. D. Shelburne, S. Bredehoeft, and H. J. Cohen. Arsenic-induced bone marrow toxicity: ultrastructural and electron-probe analysis. Blood 53:820-827, 1979.

Fierz, U. Catamnestic investigations of the side effects of therapy of skin diseases with inorganic arsenic. Dermatologica 131:41-58, 1965.

Flessel, C. P. Metals as mutagens. In: Inorganic and Nutritional Aspects of Cancer, G.W. Schrauzer, ed. Plenum Press, New York, 1978, pp. 117-128.

Fong, K., F. Lee, and R. Bockrath. Effects of sodium arsenate on single-strand DNA break formation and post-replication repair in E. coli following UV irradiation. Mutat. Res. 70:151-156, 1980.

Fornace, A. J., and J. B. Little. DNA-protein cross-linking by chemical carcinogens in mammalian cells. Cancer Res. 39:704-710, 1979.

Fowler, B. Toxicology of environmental arsenic. In: Toxicology of Trace Elements. R. A. Gayer and M. A. Mehlman, eds. Halstead Press, New York. pp. 79-122, 1977.

Francis, J., B. Brower, W. Graham, O. Larson, J. McCaull, and H. Vigorita. National Statistical Assessment of Rural Water Conditions (Vol. II), Dept. of Rural Sociology, Cornell University, 1982.

Frank, G. Neurologische und psychiatrische Folgesymptome bei akuter Arsen-Wasserstoff-Vergiftung. J. Neurol. 213:59-70, 1976.

Franke, K. W., and A. L. Moxon. A comparison of the minimal fatal doses of selenium, tellurium, arsenic and vanadium. J. Pharmacol. Exp. Ther. 58:454-459, 1936.

Freeman, J. W., and J. R. Couch. Prolonged encephalopathy with arsenic poisoning. Neurology 28:853-855, 1978.

Ganther, H. E., and C. A. Baumann. Selenium metabolism. I. Effects of diet, arsenic and cadmium. J. Nutr. 77:210-216, 1962.

Ganther, H. E., and H. S. Hsieh. Mechanisms for the conversion of selenite to selenides in mammalian tissues. In: Trace Element Metabolism in Animals. 2. (W. G. Hoekstra, J. W. Suttie, H. E. Ganther and W. Mertz, Eds.). University Park Press, Baltimore, 1974. p. 339.

Garb, L. G., and C. H. Hine. Arsenical neuropathy: Residual effects following acute industrial exposure. J. Occup. Med. 19:567-568, 1977.

Gerhardt, R., J. Hudson, R. Rao and R. Sobel. Chronic renal insufficiency from cortical necrosis induced by arsenic poisoning. Arch. Intern. Med. 138:1267-1269, 1978.

Gilbert, F., R. Duncan, W. Lederer and J. Wilkinson. Effects of chemical preservatives on the health of wood treating workers in Hawaii, 1983 (unpublished).

Ginsberg, J. M. Renal mechanism for excretion and transformation of arsenic in the dog. Am. J. Physiol. 208:832-840, 1965.

Ginsberg, J. M. and W. D. Lotspeich. Interrelations of arsenate and phosphate transport in the dog kidney. Am. J. Physiol. 205:707-714, 1963.

Gurley, L. R., R. A. Walters, J. H. Jett, and R. A. Tobey. Response of CHO cell proliferation and histone phosphorylation to sodium arsenite. Toxicol. Environ. Health 6:87-105, 1980.

Hamamoto, E. [Infant arsenic poisoning by powdered milk]. Jap. Med. J. 1649:2-12, 1955.

Hanlon, D. P., and V. H. Ferm. Placental permeability of arsenate ion during early embryogenesis in the hamster. Experientia 33:1221-1222, 1977.

Hara, I., K. Hashimoto, K. Miyazaki, and K. Sunada. Case studies of polyneuritis believed to have been caused by arsenical poisoning. TR-79-0524, Labor Health Department of the Osaka Public Health Research Center, Osaka University. Sangyo Igaku 11(1):84-90, 1968.

Harrington, M., J. P. Mcdaugh, D. L. Morse, and J. Housworth. A study of a population exposed to high concentrations of arsenic in well water in Fairbanks, Alaska. Am. J. Epidemiol. 108:377-385, 1978.

Harrison, J. W. E., E. W. Packman, and D. C. Abbott. Acute oral toxicity and chemical and physical properties of arsenic trioxides. A.M.A. Arch. Ind. Health 17:118-123, 1958.

Harrison, W. P., J. C. Frazier, E. M. Mazzanti, and R. D. Hood. Teratogenicity of disodium methanarsonate and sodium dimethyl arsenate (sodium cacodylate) in mice. Teratology 21:43A, 1980.

Henry, F. T., and T. M. Thorpe. Determination of arsenic (III), arsenic (V), monomethyl arsonate and dimethyl arsinate by differential pulse polarography after separation by ion-exchange chromatography. Anal. Chem. 52:80-83, 1980.

Hernberg, S. Incidence of cancer in population with exceptional exposure to metals. In: Cold Spring Harbor Conferences on Cell Proliferation, Vol. 4, Origins of Human Cancer, Book A, Incidence of Cancer in Humans, H. H. Hiatt, J. D. Watson, and J. A. Winsten, eds., Cold Spring Harbor Laboratory, Cold Spring Harbor, New York, 1977. pp. 147-157.

Heyman, A., J. B. Pfeiffer, Jr., R. W. Willett, and H. M. Taylor. Peripheral neuropathy caused by arsenical intoxication. A study of 41 cases with observations on the effects of BAL (2,3-dimercapto-propanol). N. Engl. J. Med. 254:401-409, 1956.

Heydorn, K. Environmental variation of arsenic levels in human blood determined by neutron activation analysis. Clin. Chim. Acta. 28:344-356, 1969.

Heywood, R., and R. J. Sortwell. Arsenic intoxication in the Rhesus monkey. Toxicol. Lett. 3:137-144, 1979.

Higgins, I., K. Welch and C. Burchfiel. Mortality of Anaconda smelter workers in relation to arsenic and other exposures. Ann Arbor, MI., Dept. of Epidemiology, Univ. of Michigan. 1982.

Higgins, I. Arsenic and respiratory cancer among a sample of Anaconda Smelter Workers. Report submitted to OSHA in the comments of the Kennecott Minerals Company on the inorganic arsenic rulemaking (Exhibit 203-5), 1982.

Hill, A. B., and E. L. Faning. Studies on the incidence of cancer in a factory handling inorganic compounds of arsenic. I. Mortality experience in the factory. Br. J. Ind. Med. 5:1-6, 1948.

Hindmarsh, J. T., O. R. McLetchie, L. P. Heffernan, O. A. Haynie, H. A. Ellenberger, R. F. McCurdy, and H. J. Thiebaux. Electromyographic abnormalities in chronic environmental arsenicalism. J. Anal. Toxicol. 1:270-276, 1977.

Hine, C. H., S. S. Pinto, and K. W. Nelson. Medical problems associated with arsenic exposure. J. Occup. Med. 19:391-396, 1977.

Holden, H. E. Comparison of somatic and germ cell models for cytogenetic screening. Appl. Toxicol. 2:196-200, 1982.

Holland, J. W. Arsenic. In: A Textbook of Legal Medicine and Toxicology, Vol 2, F. Peterson and W. S. Haines, eds., Philadelphia: W. B. Saunders & Company, 1904.

Holland, R. H. and A. R. Acevedo. Current status of arsenic in American cigarettes. Cancer 19:1248-1250, 1966.

Holland, R. H., M. S. McCall, and H. C. Lanz. A study of inhaled arsenic-74 in man. Cancer Res. 19:1154-1156, 1959.

Holmqvist, I. Occupational arsenical dermatitis. A study among employees at a copper ore smelting work including investigations of skin reactions to contact with arsenic compounds. Acta. Derm. Venerol. 31:(Suppl. 26)1-214, 1951.

Hood, R. Toxicology of prenatal exposure to arsenic. In: Arsenic: Industrial, Biomedical and Environmental Perspectives. W. Lederer and R. Fensterheim, eds., Van Nostrand Reinhold, New York, 1983.

Hood, R. D., and C. T. Pike. BAL alleviation of arsenate-induced teratogenesis in mice. Teratology 6:235-238, 1972.

Hood, R. D., G. T. Thacker, and B. L. Patterson. Effects in the mouse and rat of prenatal exposure to arsenic. Environ. Health Perspect. 19:219-222, 1977.

Hood, R. D., and S. L. Bishop. Teratogenic effects of sodium arsenate in mice. Arch. Environ. Health 24:62-65, 1972.

Hood, R. D., G. C. Vedel, M. J. Zaworotko, and F. M. Tatum. Distribution of arsenite and methylated metabolites in pregnant mice. Teratology 25:50A, 1982a.

Hood, R. D., G. T. Thacker, B. L. Patterson, and G. M. Szczech. Prenatal effects of oral versus intraperitoneal sodium arsenate in mice. J. Environ. Pathol. Toxicol. 1:857-864, 1978.

Hood, R. D., W. P. Harrison, and G. C. Vedel. Evaluation of arsenic metabolites for prenatal effects in the hamster. Bull. Environ. Contam. Toxicol. 29:679-687, 1982b.

Hueper, W. A quest into the environmental causes of cancer of the lung, Public Health Monograph No. 36. U.S. Department of Health, Education, and Welfare, Public Health Service, 1955. pp. 27-29.

Hueper, W. C. Experimental studies in metal carcinogenesis. VI. Tissue reactions in rats and rabbits after parenteral introduction of suspensions of arsenic, beryllium, or asbestos in lanolin. J. Nat. Cancer Inst. 15: 113, 1954.

Hueper, W. C. and W. W. Payne. Experimental studies in metal carcinogenesis. Chromium, nickel, iron, arsenic. Arch. Environ. Health. 5: 445, 1962.

Hunter, F. T., A. F. Kip, and J. W. Irvine, Jr. Radioactive tracer studies on arsenic injected as potassium arsenite. J. Pharmacol. Exp. Ther. 76:207-220, 1942.

Hutchinson, J. On some examples of arsenic keratoses of the skin and of arsenic cancer. Trans. Pathol. Soc. (London) 39:352-363, 1888.

Inamasu, T., A. Hisanaga and N. Ishinishi. Comparison of arsenic trioxide and calcium arsenate retention in the rat lung after intratracheal instillation. Toxicol. Lett. 12: 1-5, 1982.

International Agency for Research on Cancer. IARC monographs on the evaluation of the carcinogenic risk of chemicals to man. Vol. 2. Some inorganic and organometallic compounds. World Health Organization, Lyon, France, 1973.

International Agency for Research on Cancer. IARC monographs on the evaluation of the carcinogenic risk of chemicals to man. Vol. 23. Some metals and metallic compounds. World Health Organization, Lyon, France, 1980.

Irgolic, K. J., E. A. Woolson, R. A. Stockton, R. D. Newman, N. R. Bottino, R. A. Zingaro, P. C. Kearney, R. A. Pyles, S. A. Maeda, W. J. McShane, and E. R. Cox. Characterization of arsenic compounds formed by Daphnia magna and Tetraselmis cheiri from inorganic arsenate. Environ. Health Perspect. 19:61-66, 1977.

Irgolic, K. Speciation of arsenic compounds in water supplies. U. S. Environmental Protection Agency, Health Effects Research Laboratory, Cincinnati, Ohio. EPA-600/S1-82-010, 1982.

Irgolic, K. [Personal communication with D. Sivulka]. March 10, 1983. Record of communication available from: U.S. Environmental Protection Agency, Research Triangle Park, NC; Project file no. ECAO-HA-70-5.

Ishinishi, N., Y. Kodama, E. Kunitake, K. Nobutomo, M. Urabe, T. Inamasu, Y. Suenaga, and T. Hitano. Arsenic and arsenic compounds. Nihon Rinsho 31:1991-1999, 1973.

Ishinishi, N., Y. Kodama, K. Nobutomo, and A. Hisanaga. Preliminary experimental study on carcinogenicity of arsenic trioxide in rat lung. Environ. Health Perspect. 19:191-196, 1977.

Ishinishi, N., M. Mizunoe, T. Inamasu and A. Hisanaga. Experimental study on carcinogenicity of beryllium oxide and arsenic trioxide to the lung of rats by an intratracheal instillation. Fukuoka Acta Med. 71: 19-26, 1980.

Ishinishi, N., and A. Yamamoto. Discrepancy between epidemiological evidence and animal experimental results. J. Uoeh. 5 (Suppl.):109-116, 1983.

Ivankovic, S., G. Eisenbrand, and R. Preussmann. Lung carcinoma induction in BD rats after a single intratracheal instillation of an arsenic-containing pesticide mixture formerly used in vineyards. Int. J. Cancer 24:786-788, 1979.

Japanese Pediatric Society. Summary of report of activities of the Morinaga arsenic-tainted powdered milk poisoning investigation. TR-124-74. May 26, 1973.

Jelinek, C. F., and P. E. Corneliussen. Levels of arsenic in the United States food supply. Environ. Health Perspect. 19:83-87 (1977).

REC 5229

Jenkins, R. B. Inorganic arsenic and the nervous system. Brain 89:479-498, 1966.

Johnson, D. L., and R. S. Braman. Alkyl-and inorganic arsenic in air samples. Chemosphere 6:333-338, 1975.

Johnson, R. D., D. Manske, D. New and D. Podrebarac. Pesticide, heavy metal, and other chemical residues in infant and toddler total diet samples (II). August, 1975 - July, 1976. Pesticides Monit. J. 15: 39-50, 1981b.

Johnson, R. D., D. Manske and D. Podrebarac. Pesticide, metal, and other chemical residues in adult total diet samples (XII). August, 1975 -July, 1976. Pesticides Monit. J. 15: 54-69, 1981a.

Jung, E., B. Trachsel and H. Immich. Arsenic as an inhibitor of the enzymes concerned in cellular recovery (dark repair). Ger. Med. Mon. 14:614-616, 1969.

Jung, E. and B. Trachsel. Molekularbiologische Untersuchungen zur Arsencarcinogenese. Arch. Klin. Exp. Dermatol. 237: 819-826, 1970

Kadowaki, K. Studies on the arsenic contents in organ tissues of the normal Japanese. Osaka City Med. J. 9:2083-2099, 1960. (In Japanese with English summary.)

Kagey, B. T., J. E. Bumgarner, and J. P. Creason. Arsenic levels in maternal-fetal tissue sets. Trace Subst. Environ. Health 11:252-256, 1977.

Kanematsu, N., M. Hara, and T. Kada. Rec assay and mutagenicity studies on metal compounds. Mutat. Res. 77:109-116, 1980.

Kanisawa, M., and H. A. Schroeder. Life term studies on the effects of arsenic, germanium, tin and vanadium on spontaneous tumors in mice. Cancer Res. 27: 1192-1195, 1967.

Kanisawa, M., and H. A. Schroeder. Life term studies on the effect of trace elements on spontaneous tumors in mice and rats. Cancer Res. 29:892-895, 1969.

Kanstra, L. D., and C. W. Bonhorst. Effect of arsenic on the expiration of volatile selenium compounds by rats. Proc. S. Dak. Acad. Sci. 32:72, 1953.

Kelynack, T. N., W. Kirkly, S. Delepine, and C. H. Tattersall. Arsenical poisoning from beer-drinking. Lancet 2:1600-1602, 1900.

Klaassen, C. D. Biliary excretion of arsenic in rats, rabbits, and dogs. Toxicol. Appl. Pharmacol. 29:447-457, 1974.

Knoth, W. Arsenbehandlung. Arch. Klin. Exp. Derm. 227:228-234, 1966.

Kraybill, H. F. Carcinogenesis induced by trace contaminants in potable water. Bull. N.Y. Acad. Sci. 54:413-427, 1978.

Kroes, R., M. J. van Logten, J. M. Berkvens, T. de Vries and G. J. Van Esch. Study on the carcinogenicity of lead arsenate and sodium arsenate and on the possible synergistic effect of diethylnitrosamine. Food Cosmet. Toxicol. 12: 671-679, 1974.

Kuratsune, M., S. Tokudome, T. Shirakusa, M. Yoshida, Y. Tokumitsu, T. Hayano and M. Seita. Occupational lung cancer among copper smelters. Int. J. Cancer. 13:552-558, 1974.

Kyle, P. A., and G. L. Pease. Hematologic aspects of arsenic intoxication. N. Eng. J. Med. 273:18-23, 1965.

Lakso, J. U., and S. A. Peoples. Methylation of inorganic arsenic by mammals. J. Agric. Food Chem. 23:674-676, 1975.

Lakso, J., L. Rose, S. Peoples and D. Shirachi. A colorimetric method for the determination of arsenite, arsenate, monomethylarsonic acid, and dimethylarsinic acid in biological and environmental samples. J. Agric. Food Chem. 27:1229-1233, 1979.

Landau, E., D. J. Thompson, R. G. Feldman, G. J. Goble, and W. J. Dixon. Selected non-carcinogenic effects of industrial exposure to inorganic arsenic, EPA 569/6-77-018, U.S. Environmental Protection Agency, Washington, DC, July 1977.

Lander, J. J., R. J. Stanely, H. W. Sumner, D. C. Boswell, and R. D. Aach. Angiosarcoma of the liver associated with Fowler's solution (potassium arsenate). Gastroenterology 68:1582-1586, 1975.

Lanz, H., Jr., P. C. Wallace, and J. G. Hamilton. The metabolism of arsenic in laboratory animals using As^{74} as a tracer. Univ. Calif. Publs. Pharmacol. 2:263-282, 1950.

Lao, R. C., R. S. Thomas, T. Teichman, and L. Dubois. Efficiency of collection of arsenic trioxide in high volume sampling. Sci. Total Environ. 2:373-379, 1974.

Larramendy, M. L., N. C. Popescu, and J. DiPaolo. Induction by inorganic metal salts of sister chromatid exchanges and chromosome aberrations in human and Syrian hamster strains. Environ. Mutagen. 3:597-606, 1981.

Larsen, N. A., H. Pakkenberg, E. Damsgaard, and K. Heydorn. Topographical distribution of arsenic, manganese, and selenium in the normal human brain. J. Neurolog. Sci. 42:407-416, 1979.

Le Quesne, P. M., and J. G. McLeod. Peripheral neuropathy following a single exposure to arsenic. J. Neurol. Sci. 32:437-451, 1977.

LeBlanc, P. J., and A. L. Jackson. Arsenic in marine fish and invertebrates. Mar. Pollut. Bull. 4:88-90, 1973.

Lee-Feldstein, A. Arsenic and respiratory cancer in man: follow-up of an occupational study. In: Arsenic: Industrial, Biomedical and Environmental Perspectives. W. Lederer and R. Fensterheim, eds., Van Nostrand Reinhold, New York, 1983.

Lee, A. M., and J. F. Fraumeni, Jr. Arsenic and respiratory cancer in man: an occupational study. J. Natl. Cancer Inst. 42:1045-1052, 1969.

Leitch, A., and E. L. Kennaway. Experimental production of cancer by arsenic. Brit. Med. J. 2:1107-1108, 1922. (Cited in IARC, 1980)

Leonard, A., and R. R. Lauwerys. Carcinogenicity, teratogenicity, and mutagenicity of arsenic. Mutat. Res. 75:49-62, 1980.

Lerman, B. B., N. Ali, and D. Green. Megaloblastic, dyserythropoietic anemia following arsenic ingestion. Ann. Clin. Lab. Sci. 10:515-517, 1980.

Lerman, S. A., and T. W. Clarkson. The metabolism of arsenite and arsenate by the rat. Fundam. Appl. Toxicol. (in press, 1983).

Leslie, H., and H. Smith. Self-poisoning by the abuse of arsenic-containing tonics. Med. Sci. Law 18:159-162, 1978.

Levander, O. A. Metabolic interrelationships between arsenic and selenium. Environ. Health. Perspect. 19:159-164, 1977.

Levander, O. A., and C. A. Baumann. Selenium metabolism. VI. Effect of arsenic on the excretion of selenium in the bile. Toxicol. Appl. Pharmacol. 9:106-115, 1966.

Liebscher, K., and H. Smith. Essential and nonessential trace elements. A method of determining whether an element is essential or nonessential in human tissue. Arch. Environ. Health 17:881-890, 1968.

Lindh, U., D. Brune, G. Nordberg, P. O. Wester. Levels of antimony, arsenic, cadmium, copper, lead, mercury, selenium, silver, tin and zinc in bone tissue of industrially exposed workers. Sci. Total Environ. 16:109-116, 1980.

Lofroth, G., and B. N. Ames. Mutagenicity of inorganic compounds in Salmonella typhimurium: arsenic, chromium, and selenium. Mutat. Res. 54:65-66, 1978.

Lu, F-J., M-H. Tsai, and L-H. Ling. Studies of fluorescent compounds in drinking water of Blackfoot disease indemic areas: 1. The toxic effects of fluorescent compounds on the chick embryo. J. Formosan Med. Assn. 76: 58-63, 1977a.

Lu, F-J., M-H. Tsai, and K-H Ling. Studies on fluorescent compounds in drinking water of Blackfoot endemic areas. 2. Isolation and identification of fluorescent compounds. Tai-wan I Hsuch Hui Tsa Chih 76:209-17, 1977. Chem. Abs. 87:141054d, 1977b.

Lu, F-J, M-H. Tsai, and K-H. Ling. Studies on fluorescent compounds in drinking water of areas endemic for Blackfoot disease. 3. Isolation and identification of fluorescent compounds. Tai-wan I Hsuch Hui Tsa Chih 77:68-76, 1978. Chem. Abs. 89:152,200r, 1978.

Lubin, J. H., L. M. Pottern, W. J. Blot, S. Tokudome, B. J. Stone and J. F. Fraumeni, Jr. Respiratory cancer among copper smelter workers: recent mortality statistics. JOM 23: 779-784, 1981.

Luchtrath, H. Die Leberzirrhose bei chronischer Arsen vergiftung der winzer. Dtsch. Med. Wochenschr. 97:21-22, 1972.

Lundgren, K. D. Damage to respiratory organs in workers in a smelting plant. Nord. Hyg. Tidskr. 3:66-82, 1954.

Lyon, J. L., et al. Arsenical air pollution and lung cancer. Lancet 2:869, October 22, 1977.

Mabuchi, K., A. Lilienfeld, and L. Snell. Lung cancer among pesticide workers exposed to inorganic arsenicals. Arch. Environ. Health 312-319, 1979.

Mahaffey, K. R., and B. A. Fowler. Effects of concurrent administration of lead, cadmium, and arsenic in the rat. Environ. Health Perspect. 19:165-171, 1977.

Mappes, R. [Experiments on excretion of arsenic in urine.] Versuche zur Ausscheidung von Arsen in Urin. Int. Arch. Occup. Environ. Health 40:267-272, 1977.

Marafante, E., J. Rade, R. Pietra, E. Sabbioni, and F. Bertolero. In: M. Anke, H.-J. Schneider, and C. Bruckner. Eds. Proc. 3rd Symp. on Trace Elements. Arsenic. Abteilung Wissenschaftliche Publikationen der Friedrich-Schiller Universitat, Jena, 1980. pp. 49-55.

Masahiki, O., and A. Hideyasu. Epidemiological studies on the Morinaga powdered milk poisoning incident: Final report of the joint project team from Hiroshima and Okayama Universities. Nihon eiseigaku zasshi [Jap. J. of Hyg.] 27:500-531, 1973.

Massmann, W., and H. Opitz. Experimentalle Untersuchungen uber Ekg-Veranderunger bei chronischer Arsenvergiftung. Z. Kreislaufforsch. 43:704-713, 1954.

Matanoski, G., E. Landau, and E. Elliott. Epidemiology Studies. Task I-Phase I. Pilot Study of Cancer Mortality Near an Arsenical Pesticide Plant in Baltimore. EPA-560/6-76-003, U.S. Environmental Protection Agency, Washington, DC, May 1976.

Matanoski, G., E. Landau, J. Tonascia, C. Lazar, E. Elliot, W. McEnroe and K. King. Cancer mortality in an industrial area of Baltimore. Environ. Res. 25: 8-28, 1981.

McBride, B., H. Merilees, W. Cullen and W. Pickett. Anaerobic and aerobic alkylation of arsenic. In: Organometals and Organometalloids. F. E. Brinckman and J. M. Bellama, eds. Symposium Series No. 82, Am. Chem. Soc., Washington DC, 1978. pp. 94-115. (Cited in Vahter, 1981).

McCabe, L. J., J. M. Symons, R. D. Lee, and G. G. Robeck. Survey of community water supply systems. J. Am. Water Works Assoc. 62:670-687, 1970.

McCann, J., E. Choi, E. Yamasaki, and B. Ames. Detection of carcinogens as mutagens in the Salmonella/microsome test: Assay of 300 chemicals. Proc. Natl. Acad. Sci. (U.S.) 72:5135, 1975.

McCarroll, N. E., C. E. Piper, and B. H. Keech. An E. coli microsuspension assay for the detection of DNA damage induced by direct-acting agents and promutagens. Environ. Mutagen. 3:429-444, 1981.

Mealey, J., Jr., G. L. Brownell, and W. H. Sweet. Radioarsenic in plasma, urine, normal tissues, and intracranial neoplasms. Arch. Neurol. Psychiatr. 81:310-320, 1959.

Mertz, W. Aspects of nutritional trace element research. Fed. Proc. Fed. Am. Soc. Exp. Biol. 29:1482-1488, 1970.

Milham, S., Jr. Studies of morbidity near a copper smelter. Environ. Health Perspect. 19:131-132, 1977.

Milham, S., Jr., and T. Strong. Human arsenic exposure in relation to a copper smelter. Environ. Res. 7:176-182, 1974.

Mizuta, N., M. Mizuta, F. Ita, T. Ito, H. Uchida, Y. Watanabe, H. Akama, T. Murakami, F. Hayashi, K. Nakamura, T. Yamaguchi, W. Mizuia, S. Oishi, and H. Matsumura. An outbreak of acute arsenic poisoning caused by arsenic-contaminated soy sauce (shoye). A clinical report of 220 cases. Bull. Yamaguchi Med. Sch. 4:131-50, 1956.

Morris, J. S., M. Schmid, S. Newman, P. J. Scheuer, and S. Sherlock. Arsenic and noncirrhotic portal hypertension. Gastroenterology 64:86-94, 1974.

Morton, W., G. Starr, D. Pohl, J. Stoner, S. Wagner, and P. Weswig. Skin cancer and water arsenic in Lane County, Oregon. Cancer (Philadelphia) 37:2523-2532, 1976.

Moxon, A. L., and K. P. DuBois. The influence of arsenic and certain other elements on the toxicity of seleniferous grains. J. Nutr. 18:447-457, 1939.

Munro, I. C. Naturally occurring toxicants in foods and their significance. Clin. Toxicol. 9:647-663, 1976.

Munro, I. C., S. M. Charbonneau, E. Sandi, K. Spencer, F. Bryce, and H. C. Grice. Biological availability of arsenic from fish. Toxicol. Appl. Pharmacol. 29:111, 1974. (Abstr. #92.)

Mushak, P. K. Dussauer and E. L. Walls. Flameless atomic absorption (FAA) and gas-liquid chromatographic studies in arsenic bioanalysis. Environ. Health. Persp. 19: 5-10, 1977.

Nadeyenko, V. G., V. G. Lenchenko, S. B. Genkina, and T. A. Arkhipenko. Influence of tungsten, molybdenum, copper and arsenic in intrauterine development of the fetus. TR-79-0353. Farmakologiya i Toksikologiya 41:620-623, 1978.

Nagamatsu, K., and A. Igata. Dominant and non-dominant arsenical neuropathy. TR-79-0523, Kagoshim University. Rinsho Shinkei 15:1-4, 1975.

Nakamura, I., T. Arao, K. Inoue, T. Ono, Y. Ishii, T. Sato, K. Kawakami, and H. Kuwahara. Study on the effect of arsenic on human bodies, Part I. Japanese Public Health Association (Translated for EPA by SCITRAN, Santa Barbara, Calif., EPA translation No. TR-120), 1973.

Nakamuro, M., and Y. Sayato. Comparative studies of chromosomal aberrations induced by trivalent and pentavalent arsenic. Mutat. Res. 88:73-80, 1981.

National Academy of Sciences. Arsenic. National Academy of Sciences, Washington, DC, 1977.

National Institute for Occupational Safety and Health. Criteria for a Recommended Standard.... Occupational Exposure to Inorganic Arsenic. New Criteria - 1975. HEW Publication No. (NIOSH) 75-149, U.S. Department of Health, Education, and Welfare, Washington, DC, 1975.

Natusch, D. F. S., J. R. Wallace, and C. A. Evans, Jr. Toxic trace elements: Preferential concentration in respirable particles. Science 183:202-204, 1974.

Nelson, H. A., M. R. Crane, and K. Tomson. Inorganic arsenic poisoning in pastured feeder lambs. J. Am. Vet. Med. Assoc. 158:1943-1945, 1971.

Nelson, W. C., M. H. Lykins, J. Mackey, V. A. Newill, J. F. Finklea, and D. I. Hammer. Mortality among orchard workers exposed to lead arsenate spray: a cohort study. J. Chron. Dis. 26:105-118, 1973.

Neubauer, O. Arsenical cancer: a review. Br. J. Cancer 1:192-251, 1947.

Newman, J. A., V. E. Archer, G. Saccomanno, M. Kuschner, O. Auerbach, R. D. Grondahl, and J. C. Wilson. Histological types of bronchogenic carcinoma among members of copper-mining and smelting communities. In: Occupational Carcinogenesis, Proceedings of a Conference, New York Academy of Sciences, New York, New York, March 24-27, 1975. Ann. N.Y. Acad. Sci. 271:260-268, 1976.

Nielsen, F. H., D. R. Myron, and E. O. Uthus. Newer trace elements--vanadium (V) and arsenic (As) deficiency signs and possible metabolic roles. In: Trace Element Metabolism in Man and Animals, Vol. 3, M. Kirchgessner, ed., Arbeitskreses fur Tierernahrungsforschung, Weikenstephen, Germany, 1978. pp. 244-247.

Nielsen, I. H., S. H. Givand, and D. R. Myron. Evidence of a possible requirement for arsenic by the rat. Fed. Proc. Fed. Am. Soc. Exp. Biol. 34:923, 1974.

Nishioka, H. Mutagenic activities of metal compounds in bacteria. Mutat. Res. 31: 185-189, 1975

Nordenson, I., G. Beckman, L. Beckman, and S. Nordstrom. Occupational and environmental risks in and around a smelter in northern Sweden. II. Chromosomal aberrations in workers exposed to arsenic. Hereditas 88:47-50, 1978.

REC 5235

Nordenson, I., and L. Beckman. Occupational and environmental risks in and around a smelter in northern Sweden. Hereditas 96:175-181, 1982.

Nordenson, I., S. Salmonsson, E. Brun, and G. Beckman. Chromosome aberrations in psoriatic patients treated with arsenic. Hum. Genet. 48:1-8, 1979.

Nordenson, I., A. Sweins, and L. Beckman. Chromosome aberrations in cultured human lymphocytes exposed to trivalent and pentavalent arsenic. Scand. J. Work Environ. Health 7:277-281, 1981.

Nordstrom, S., L. Beckman, and I. Nordenson. Occupational and environmental risks in and around a smelter in northern Sweden. I. Variations in birthweight. Hereditas 88:43-46, 1978a.

Nordstrom, S., L. Beckman, and I. Nordenson. Occupational and environmental risks in and around a smelter in northern Sweden. V. Spontaneous abortion among female employees and decreased birth weight in their offspring. Hereditas 90:291-296, 1978b.

Nordstrom, S., L. Beckman, and I. Nordenson. Occupational and environmental risks in and around a smelter in northern Sweden. VI. Congenital Malformations. Hereditas 90:297-302, 1978c.

Nordstrom, S., L. Beckman, and I. Nordenson. Occupational and environmental risks in and around a smelter in northern Sweden. III. Frequencies of spontaneous abortion. Hereditas 88:51-54, 1978d.

Nurse, D. S. Hazards of inorganic arsenic. Med. J. Australia 1:102, 1978.

Oberly, T. J., C. E. Piper, and D. S. McDonald. Mutagenicity of metal salts in the L5178Y mouse lymphoma assay. Toxicol. Environ. Health. 9:367-376, 1982.

Occupational Safety and Health Administration. Occupational exposure to inorganic arsenic: Final standard. (43 FR 19589, May 5, 1978; 29 CFR 1910.1018), 1978.

Odanaka, Y., O. Matano, and S. Goto. Identification of dimethylated arsenic by gas chromotography-mass spectrometry in blood, urine, and feces of rats treated with ferric methanearsonate. J. Agric. Food Chem. 26:505-507, 1978.

Ohno, H., F. Hanaoka, and M. Yamada. Inducibility of sister chromatid exchanges by heavy-metal ions. Mutat. Res. 104:141-145, 1982.

Ohta, M. Ultra-structure of sural nerve in a case of arsenical neuropathy. Acta Neuropathol. (Berl.) 16:233-242, 1970.

Okamura, K., T. Ota, K. Horiuchi, H. Hiroshima, T. Takai, Y. Sakurane, and T. Baba. Symposium on arsenic poisoning by powdered milk. (2). Diagnos. Ther. (Shinryo) 9:240-249, 1956.

Osato, K. Effects of oral administration of arsenic trioxide during the suckling stage of rats. Fukuoka Acta Med. 68:464-491, 1977.

O'Shaughnessy, E., and G. H. Kraft. Arsenic poisoning: Long-term follow-up of a nonfatal case. Arch. Phys. Med. Rehabil. 57:403-406, 1976.

Osswald, H., and K. I. Goerttler. Leukosen bei der Maus nach diaplacent arei und post natalei Arsenic-application. Verh. Dtsch. Ges. Pathol. 55:289-293, 1971.

Ott, M. G., B. B. Holder, and H. I. Gordon. Respiratory cancer and occupational exposure to arsenicals. Arch. Environ. Health 29:250-255, 1974.

Overby, L. R., and R. L. Fredrickson. Metabolic stability of radioactive arsanilic acid in chickens. J. Agric. Food Chem. 11:378-381, 1963.

Pagano, G., A. Eposito, P. Bove, M. de Angelis, A. Rota, E. Vamvakinos, and G. G. Giordana. Arsenic-induced developmental defects and mitotic abnormalities in sea urchin development. Mutat. Res. 104:351-354, 1983.

Paton, G. R. and A. C. Allison. Chromosome damage in human cell cultures induced by metal salts. Mutat. Res. 16:332-336, 1972.

Pelfrene, A. Arsenic and cancer: the still unanswered question. J. Toxicol. Environ. Health 1:1003-1016, 1976.

Penrose, W. R., H. B. S. Conacher, R. Black, J. C. Meranger, W. Miles, H. M. Cunningham, and W. R. Squires. Implications of inorganic/ organic interconversion on fluxes of arsenic in marine food webs. Environ. Health Perspect. 19:53-59, 1977.

Peoples, S. A. Arsenic toxicity in cattle. Ann. N.Y. Acad. Sci. 111:644-649, 1964.

Peoples, S. A. The metabolism of arsenic in man and animals. In: Arsenic: Industrial, Biomedical, and Environmental Perspectives. W. Lederer and R. Fensterheim, eds., Van Nostrand Reinhold, New York, 1983.

Perry, K., R. G. Bowler, H. M. Buckell, H. A. Druett, and R. S. F. Shilling. Studies in the incidence of cancer in a factory handling inorganic compounds of arsenic. II. Clinical and environmental investigations. Br. J. Ind. Med. 5:6-15, 1948.

Pershagen, G. Lung cancer mortality, occupational exposure and smoking habits in a region surrounding a smeltery. In: Proceedings from an International Symposium on the Control of Air Pollution in the Working Environment, Stockholm, 6-8 September 1977, Geneva, International Labour Office, 1978.

Pershagen, G., and M. Vahter. Arsenic. A toxicological and epidemiological appraisal. Libertryck, Stockholm, Sweden, SNV PM-1128, 1979.

Pershagen, G., C-G. Elinder, and A-M. Bolander. Mortality in a region surrounding an arsenic emitting plant. Environ. Health Perspect. 19:133-137, 1977.

Pershagen, G., B. Lind and N-E. Bjorklund. Lung retention and toxicity of some inorganic arsenic compounds. Environ. Res. 29:425-434, 1982.

Pershagen, G., G. Nordberg, and N-E. Björklund. Carcinomas of the respiratory tract in hamsters given arsenic trioxide and/or benzo(a)pyrene by the pulmonary route. Environ. Res. (in press, 1983).

Petres, J., and A. Berger. Zum einfluss anorganischen arsens auf die DNS-synthese menschlicher lymphocyten in vitro. Arch. Derm. Forsch. 242:343-352, 1972.

Petres, J., and M. Hundeiker. [Chromosome pulverization induced in vitro in cell cultures by sodium diarsonate.] Arch. Klin. Exp. Dermatol. 231:366-370, 1968.

Petres, J., D. Baron, and M. Hagedorn. Effects of arsenic cell metabolism and cell proliferation: cytogenetic and biochemical studies. Environ. Health Perspect. 19:223-227, 1977.

Petres, J., K. Schmidt-Ullrich, and U. Wolf. Chromosomenaberrationen an Menschlichen lymphozyten bei chronischen Arsenchader. Dtsch. Med. Wochenschr. 95:79, 1970.

Pimentel, J. C., and F. Marques. Vineyard sprayer's lung. A new occupational disease. Thorax 24:678-688, 1969.

Pinto, S. S., and B. M. Bennett. Effect of arsenic trioxide exposure on mortality. Arch. Environ. Health 7:583-591, 1963.

Pinto, S. S., and C. M. McGill. Arsenic trioxide exposure in industry. Ind. Med. Surg. 22:281-287, 1953.

Pinto, S. S., M. O. Varner, K. W. Nelson, A. L. Labbe, and L. D. White. Arsenic trioxide absorption and excretion in industry. J. Occup. Med. 18:677-680, 1976.

Pinto, S. S., P. E. Enterline, V. Henderson and M. O. Varner. Mortality experience in relation to a measured arsenic trioxide exposure. Environ. Health Perspect. 19:127-130, 1977.

Pinto, S. S., V. Henderson, and P. E. Enterline. Mortality experience of arsenic - exposed workers. Arch. Environ. Health 33:325-331, 1978.

Poma, K., N. Degraeve, M. Kirsch-Volders, and C. Susanne. Cytogenetic analysis of bone marrow cells and spermatogonia of male mice after in vivo treatment with arsenic. Experientia 37:129-130, 1981b.

Poma, K., N. Degraeve, and M. Kirsch-Volders. A combined action of arsenic and ethyl methanesulfonate (EMS) in somatic and germ cells of mice. Mutat. Res. 85:295, 1981a.

Poma, K., M. Kirsch-Volders, and C. Susanne. Cytogenetic investigation in mice of As, Hg, and EMS administration on their own and in combination. Mutat. Res. 97:213, 1983.

Poma, K., and C. Susanne. Influence of thiol-inhibiting substances on the cytogenetic effects of ethyl methanesulfonate (EMS) on mice treated in vivo. Mutat. Res. 97:244, 1982.

Popper, H., L. B. Thomas, N. C. Telles, H. Falk, and I. J. Selikoff. Development of hepatic angiosarcoma in man induced by vinyl chloride, thorotrast and arsenic. Am. J. Pathol. 92:349-376, 1978.

Prystowsky, S. D., G. J. Elfenbein, and S. I. Lamberg. Nasopharyngeal carcinoma associated with long-term arsenic ingestion. Arch. Dermatol. 114:602-603, 1978.

Ray-Bettley, F., and J. A. O'Shea. The absorption of arsenic and its relation to carcinoma. Br. J. Dermatol. 92:563-568, 1975.

Regelson, W., U. Kim, J. Ospina, and J. F. Holland. Hemangioendothelial sarcoma of liver from chronic arsenic intoxication by Fowler's solution. Cancer 12:514-522, 1968.

Rencher, A. C., M. W. Carter, and D. W. McKee. A retrospective epidemiological study of mortality at a large western copper smelter. J. Occup. Med. 19:754-58, 1977.

Reymann, F., R. Møller, and A. Nielsen. Relationship between arsenic intake and internal malignant neoplasms. Arch. Dermatol. 114:378-381, 1978.

Reynolds, E. S. An account of the epidemic outbreak of arsenical poisoning occurring in beer-drinkers in the north of England and Midland Counties in 1900. Lancet 1:166-170, 1901.

Ridgeway, L. P., and D. A. Karnofsky. The effects of metals on the chick embryo: Toxicity and production of abnormalities in development. Ann. N.Y. Acad. Sci. 55:203-215, 1952.

Roat, J. W., A. Wald, H. Mendelow, and K.I. Pataki. Hepatic angiosarcoma associated with short-term arsenic ingestion. Am. J. Med. 73:933-936, 1982.

Rogers, E. H., N. Chernoff, and R. J. Kavlock. The teratogenic potential of cacodylic acid in the rat and mouse. Drug Chem. Toxicol. 4:49-61, 1981.

Rom, W. N., G. Varley, J. L. Lyon and S. Shapkow. Lung cancer mortality among residents living near the El Paso smelter. Br. J. Ind. Med. 39: 269-272, 1982.

Rossman, T. G., M. S. Meyn, and W. Troll. Effects of arsenite on DNA repair in Escherichia coli. Environ. Health Perspect. 19:229-233, 1977.

Rossman, T. G., D. Stone, M. Molina and W. Troll. Absence of arsenite mutagenicity in E. coli and Chinese hamster cells. Environ. Mut. 2:371-379, 1980.

Rossman, T. G. Enhancement of UV-mutagenesis by low concentrations of arsenite in E. coli. Mutat. Res. 91:207-211, 1981.

Rossman, T. G. Progress report: EPA project no. 808482-02, pg 8, 1983.

REC 5239

Rossman, T. G., M. S. Meyn, and W. Troll. Effects of sodium arsenite on the survival of UV-irradiated Escherichia coli: Inhibition of a recA-dependent function. Mutat. Res. 30:157-162, 1975.

Rossner, P., V. Bencko, and H. Havrankova. Effect of the combined action of selenium and arsenic on suspension culture of mice fibroblasts. Environ. Health. Perspect. 19:235-237, 1977.

Rossner, P. Mutagenic effect of sodium arsenite in Chinese hamster cell line Dede. Mutat. Res. 96:65-66, 1977.

Roth, F. The sequelae of chronic arsenic poisoning in Moselle Vintners. Ger. Med. Mon. 2:172-175, 1957. Roth F. Uber den Bronchialkrebs Arsengeschodigter Winzer. Virchows Arch. 331:119-137, 1958.

Rowland, I. R., and M. J. Davies. In vitro metabolism of inorganic arsenic by the gastro-intestinal microflora of the rat. J. Appl. Toxicol. 1:278-283, 1982.

Rozenshtein, I. S. Sanitary toxicological assessment of low concentrations of arsenic trioxide in the atmosphere. Hyg. Sanit. (USSR) 34:16-22, 1970.

Rudnai, P., and M. Borzsony. Tumor-inducing effect of arsenic trioxide treatment in CFLP mice. Magy. Onkol. 25:73-77, 1981.

Sabbioni, E., E. Marafonte, F. Bertolero, and V. Foa. Inorganic arsenic: metabolic patterns and identification of arsenic-binding components in the rabbit. Proc. Int. Conf. Management Control Heavy Metals in the Environment. London, 1979. Pp. 18-21.

Schrauzer, G. N., and D. Ishmael. Effects of selenium and of arsenic on the genesis of spontaneous mammary tumors in inbred C_3H mice. Ann. Clin. Lab. Sci. 4:441-447, 1974.

Schrauzer, G. N., D. A. White, and C. J. Schneider. Cancer mortality correlation studies. IV. Associations with dietary intake and blood levels of certain trace elements, notably selenium antagonists. Bioinorg. Chem. 7:35-36, 1977.

Schrauzer, G. N., D. A. White, J. E. McGinness, and C. J. Schneider. Arsenic and cancer: effects of joint administration of arsenite and selenite on the genesis of mammary adenocarcinoma in inbred female C_3H/St mice. Bioinorg. Chem. 9:245-253, 1978.

Schroeder, H. A., M. Mitchener. Toxic effects of trace elements on the reproduction of mice and rats. Arch. Environ. Health 23:102-106, 1971.

Schwartz, K. Essentiality versus toxicity of metals. In: Clinical Chemistry and Chemical Toxicology of Metals, S. S. Brown, ed., Vol. 1, Elsevier, Amsterdam, 1977. pp. 3-22.

Selby, L. A., A. A. Case, G. D. Osweiler, and H. M. Hayes, Jr. Epidemiology and toxicology of arsenic poisoning in domestic animals. Environ. Health Perspect. 19:183-189, 1977.

Silver, A. S., and P. L. Wainman. Chronic arsenic poisoning following use of an asthma remedy. J.A.M.A. 150:584-585, 1952.

Singh, I. Induction of reverse mutation and mitotic gene conversion by some metal compounds in Saccharomyces cerevisiae. Mutat. Res. 117:149-152, 1983.

Sirover, M. A. Effects of metals in in vitro bioassays. Environ. Health. Perspect. 40:163-172, 1981.

Small, H. and C. McCants. Residual arsenic in soils and concentration in tobacco. Tobacco Sci. 6:34-36, 1962.

Smith, T. J., D. J. Eatough, L. D. Hansen, and N. F. Mangelsen. The chemistry of sulfur and arsenic in airborne copper smelter particulates. Bull. Environ. Contam. Toxicol. 15:651-659, 1976.

Smith, T. J., E. A. Crecelius, and J. C. Reading. Airborne arsenic exposure and excretion of methylated arsenic compounds. Environ. Health. Perspect. 19:89-93, 1977.

Sommers, S. C., and R. G. McManus. Multiple arsenical cancers of the skin and internal organs. Cancer 6:347-359, 1953.

Southwick, J., A. Western, M. Beck, T. Whitley, R. Isaacs, J. Petajan, and C. Hansen. Community health associated with arsenic in drinking water in Millard County, Utah. Health Effects Research Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio. EPA Report No. EPA-600/1-81-064. Available from: NTIS, Springfield, VA; PB82-108374. 1981.

Sram, R. and V. Bencko. A contribution for the evaluation of the genetic risk of exposure to arsenic. Cs. Hyg. 19: 308-315, 1974.

Sram, R. J. Relationship between acute and chronic exposures in mutagenicity studies in mice. Mutat. Res. 41:25-42, 1976.

Sunderman, F. W., Jr. A review of the carcinogenicities of nickel, chromium and arsenic compounds in man and animals. Prev. Med. 5:279-294, 1976.

Suta, B. E. Human exposure to atmospheric arsenic. Final Report. Stanford Research Institute CRESS Rpt. No. 50, EPA Contract No. 68-01-4314 and 68-02-2835, 1980.

Szuler, I. M., C. N. Williams, J. T. Hindmarsh, and P.-D. Hosoon. Massive variceal hemorrhage secondary to presinusoidal portal hypertension due to arsenic poisoning. CMA J. 120:168-171, 1979.

Talmi, Y., and D. T. Bostick. The determination of arsenic and arsenicals. J. Chromatogr. Sci. 13:231-237, 1975.

Tam, K. H., S. M. Charbonneau, F. Bryce, and G. Lacroix. Separation of arsenic metabolites in dog plasma and urine following intravenous injection of ^{74}As. Anal. Biochem. 86:505-511, 1978.

REC 5241

Tam, K. H., S. M. Charbonneau, G. Lacroix, and F. Bryce. Confirmation of inorganic arsenic and dimethylarsinic acid in urine and plasma of dog by ion-exchange and TLC. Bull. Environ. Contam. Toxicol. 21:371-374, 1979a.

Tam, K. H., S. M. Charbonneau, E. Bryce, and G. La Croix. Metabolism of inorganic arsenic (^{74}As) in humans following oral ingestion. Toxicol. Appl. Pharmacol. 50:319-322, 1979b.

Tamura, S. Study of arsenic metabolism (Report 20) - influence of arsenic agents on the brain of rats in the developmental stage. TR-79-0356. Folia Pharmacol. Japn. 74:1-14, 1978.

Tay, C-H., and C-S. Seah. Arsenic poisoning from anti-asthmatic herbal preparations. Med. J. Aust. 2:424-428, 1975.

Terada, H., K. Katsuta, T. Sasakawa, T. Saito, H. Shrota, K. Fukuchi, E. Sekiya, Y. Yokoyama, S. Hirokawa, G. Watanabe, K. Hasegawa, T. O. Shina, and E. Sekiguchi. Clinical observations of chronic toxicosis by arsenic. Nihon Rinsho 18:2394-2403 (EPA Tr. No. TR106-74), 1960.

Terada, H. Clinical observation of chronic toxicosis by arsenic. Nihon Rinsho 18:118-127, 1960.

Thomas, M. D., and T. R. Collier. The concentration of arsenic in tobacco smoke determined by a rapid titrimetric method. J. Ind. Hyg. Toxicol. 27:201-206, 1945.

Thompson, R. J. The collection and measurement of airborne arsenic. WHO Publ. Air Pollut. Meas. Tech. Part II, 126-131, 1976.

Tkeshelashvili, T. K., C. W. Shearman, R. A. Zakour, R. M. Koplitz, and L. A. Loeb. Effects of arsenic, selenium and chromium on the fidelity of DNA synthesis. Cancer Res. 40:2455-2460, 1980.

Tokanehara, S., S. Akao, and S. Tagaya. Blood findings in infantile arsenic toxicoses caused by powdered milk. Shonika Ninsho 9:1078-1084, 1956. (EPA translation No. TR 110-74).

Tokudome, S., and M. Kuratsune. A cohort study on mortality from cancer and other causes among workers at a metal refinery. Int. J. Cancer 17:310-317, 1976.

Tseng, W. P. Effects and dose-response relationships of skin cancer and Blackfoot disease with arsenic. Environ. Health Perspect. 19:109-119, 1977.

Tseng, W. P., H. M. Chu, S. W. How, J. M. Fong, C. S. Lin, and S. Yeh. Prevalence of skin cancer in an endemic area of chronic arsenalicalism in Taiwan. J. Natl. Cancer Inst. 40:453-463, 1968.

Tsutsumi, S., and K. Kato. Effects of dimercaprol or thioctic acid on the distribution and excretion of ^{74}As in rats. Bull. Tokyo Dent. Coll. 16:69-74, 1975.

REC 5242

U.S. Environmental Protection Agency. Ambient Water Quality Criteria Document for Arsenic. Cincinnati, OH. 1980.

U.S. Environmental Protection Agency. National Revised Primary Drinking Water Regulations, Advanced Notice of Proposed Rulemaking, Federal Register, Vol. 48, No. 194:45502-45521 (October 5), 1983.

Uldall, P., H. Khan, J. Ennis, R. McCallum and T. Grimson. Renal damage from industrial arsine poisoning. Br. J. Ind. Med. 27:372-377, 1970.

Underwood, E. J. Trace Elements in Human and Animal Nutrition, 4th ed. Academic Press, N.Y., 1977.

Union Carbide Corporation. Review of the Environmental Effects of Arsenic. Oak Ridge National Laboratory, Oak Ridge, Tenn. ORNL/EIS-79, 1977.

Urakabo, G., A. Hasegawa, and S. Nakaura. Studies on the fate of poisonous metals in experimental animals (V). Body retention and excretion of arsenic. J. Food Hyg. Soc. Jpn. 16:334-336, 1975. (In Japanese with English summary.)

Uthus, E., W. Cornatzer and F. Nielsen. Consequences of arsenic deprivation in laboratory animals. In: Arsenic: Industrial, Biomedical and Environmental Perspectives. W. Lederer and R. Fensterheim, eds., Van Nostrand Reinhold, New York, 1983.

Vahter, M. Biotransformation of trivalent and pentavalent inorganic arsenic in mice and rats. Environ. Res. 25:286-293, 1981.

Vahter, M., and H. Norin. Metabolism of ^{74}As-labeled trivalent and pentavalent inorganic arsenic in mice. Environ. Res. 21:446-457, 1980.

Vahter, M., and J. Envall. In vivo reduction of arsenate in mice and rabbits. Environ. Res. 32:14-24, 1983.

Vahter, M., E. Marafante, A. Lindgren, and L. Dencker. Tissue distribution and sub-cellular binding of arsenic in marmoset monkeys after ingestion of ^{74}As-arsenite. Arch. Toxicol. 51:65-77, 1982.

Vainio, H., and M. Sorsa. Chromosome aberrations and their relevance to metal carcinogenesis. Environ. Health Perspect. 40:173-180, 1981.

Valentine, J., H. Kang, and G. Spivey. Arsenic levels in human blood, urine and hair in response to exposure via drinking water. Environ. Res. 20:24-32, 1979.

Vallee, B. L., D. D. Ulmer, and W. E. C. Wacker. Arsenic toxicology and biochemistry. Arch. Ind. Health 21:132-151, 1960.

Villar, T. G. Vineyard sprayer's lung. Clinical aspects. Am. Rev. Respir. Dis. 110:545-555, 1974.

Walsh, L. M., and D. R. Keeney. Behavior and phytotoxicity of inorganic arsenicals in soils. In: Arsenic Pesticides, ACS Symp. Series 7, Am. Chem. Soc., Washington, DC, 1975. p. 35.

REC 5243

Walsh, P. R., R. A. Duce, and J. L. Fasching. A sampling technique for the determination of particulate and vapor-phase arsenic in the atmosphere. Air Pollut. Meas. Tech., Part II, Publ. World Meteorol. Org. No. 460, 140-149, 1977a.

Walsh, L. M., M. E. Sumner, and D. R. Keeney. Occurrence and distribution of arsenic in soils and plants. Environ. Health Perspect. 19:67-72, 1977b.

Wan, B., R. T. Christian, and S. W. Soukup. Studies of cytogenetic effects of sodium arsenicals on mammalian cells in vitro. Environ. Mutag. 4:493-498, 1982.

Welch, K., I. Higgins, M. Oh, and C. Burchfiel. Arsenic exposure, smoking and respiratory cancer in copper smelter workers. Arch. Env. Hlth. 37:325-335, 1982.

Wen, W. N., T-L. Lieu, H-J. Chang, S. W. Wuu, M-L. Yau, and K. Y. Jan. Baseline and sodium arsenite-inducted sister chromatid exchanges in cultured lymphocytes from patients with Blackfoot disease and healthy persons. Hum. Genet. 59:201-203, 1981.

Wentworth, W. U.S. EPA, Office of Drinking Water, State Programs Division, Compliance Monitoring Data from Federal Reporting Data System, 1983.

Westhoff, D. D., J. R. Samaha, and A. Barnes, Jr. Arsenic intoxication as a cause of megaloblastic anemia. Blood 45:241-246, 1975.

Westöö, G., and M. Rydälv. Arsenic levels in foods. Var Foda 24:21-40, 1972. (In Swedish with English summary.)

Whanger, P. D., P. H. Weswig, and J. C. Stoner. Arsenic levels in Oregon waters. Environ. Health Perspect. 19:139-143, 1977.

Whittemore, A. S. The age distribution of human cancer for carcinogenic exposures of varying intensity. Am. J. Epidemiol. 106:418-423, 1977.

Wildenberg, J. An assessment of experimental carcinogen-detecting systems with special reference to inorganic arsenicals. Environ. Res. 16:139-152, 1978.

Willhite, C. C. Arsenic-induced axial skeletal (dysraphic) disorders. Exp. Mol. Pathol. 34:145-158, 1981.

Winkler, W. O. Identification and estimation of the arsenic residue in livers of rats ingesting arsenicals. J. Assoc. Off. Anal. Chem. 45:80-91, 1962.

Wood, J. M. Biological cycles for toxic elements in the environment. Science 183:1049-1052, 1974.

Woods, J. S., and B. A. Fowler. Effects of chronic arsenic exposure on hematopoietic function in adult mammalian liver. Environ. Health Perspect. 19:209-213, 1977.

Woolson, E. A. Fate of arsenicals in different environmental substrates. Environ. Health Perspect. 19:73-81, 1977.

REC 5244

Woolson, E. A. Generation of dimethylarsine from soil. Paper presented at 16th. Meeting, Weed Science Society of America, 1976. Paper No. 218.

World Health Organization. Environmental Health Criteria 18: Arsenic. International Programme on Chemical Safety, Geneva, 1981.

Yamashita, N., D. Makoto, M. Nishio, H. Hojo, and M. Tanaka Masato. Current state of Kyoto children poisoned by arsenic-tainted Morinaga dry milk. TR-74-108. Nihon eiseigaku zasshi [Japanese J. of Hyg.] 27:364-399, 1972.

Yamauchi, H., and Y. Yamamura. Urinary inorganic arsenic and methyl arsenic excretion following arsenate-rich seaweed ingestion. Jpn. J. Ind. Health 21:47-54, 1979. (Engl. summary, Tables and Figures).

Yoshikawa, T., J. Utsumi, T. Okada, M. Moriuchi, N. Masana, K. Ozawa, and Y. Kaneko. Concerning the mass outbreak of chronic arsenic toxicosis in Niigata Prefecture. Chiryo 42:1739-1749, 1960.

Zakour, R. A., T. A. Zunkel, and L. A. Loeb. Metal-induced infidelity of DNA synthesis. Environ. Health Perspect. 40:197-205, 1981.

Zaldivar, R. Arsenic contamination of drinking water and foodstuffs causing endemic chronic poisoning. Beitr. Pathol. 151:384-400, 1974.

Zaldivar, R. Ecological investigations on arsenic dietary intake and endemic chronic poisoning in man: dose-response curve. Zentralbl. Bakteriol. Parasitenkd. Infektionskr. Hyg. Abt. 1: Orig. Reihe B. 164:481-484, 1977.

Zaldivar, R. and A. Guillier. Environmental and clinical investigation on epidemic chronic arsenic poisoning in infants and children. Zentralb. Bakteriol. Parasitenkd, Infektionskr. Hyg. Abt. 1: Orig. Reihe B. 165:226-234, 1977.

☆U.S. GOVERNMENT PRINTING OFFICE:1986 -646 -116/ 40624 REGION NO. 4

EPA-540-R-070-002
OSWER 9285.7-82
January 2009

Risk Assessment Guidance for Superfund
Volume I: Human Health Evaluation Manual
(Part F, Supplemental Guidance for Inhalation Risk Assessment)

Final

Office of Superfund Remediation and Technology Innovation
Environmental Protection Agency
Washington, D.C.

REC 5247

TABLE OF CONTENTS

1. INTRODUCTION 1
1.1 Background 1
1.2 Purpose and Scope 2
1.3 Effects on Other Office of Superfund Remediation and Technology Innovation Guidance 3

2. BACKGROUND ON DERIVATION OF INHALATION TOXICITY VALUES 4
2.1 Application of Inhalation Dosimetry 4
2.1.1 Default Approach - Extrapolation from Experimental Animal Data 5
2.1.2 Default Approach - Extrapolation from Human Occupational Data 9
2.2 Derivation of the Inhalation Unit Risk 10
2.3 Derivation of the Reference Concentration 10

3. CHARACTERIZING EXPOSURE 13
3.1 Introduction 13
3.2 Estimating Exposure Concentrations for Assessing Cancer Risks 13
3.3 Estimating Exposure Concentrations for Calculating Hazard Quotients 14
3.3.1 Step 1: Assess Duration 14
3.3.2 Step 2: Assess Exposure Pattern 15
3.3.3 Step 3: Estimate Exposure Concentration 17
3.4 Estimating Exposure Concentrations in Multiple Microenvironments 18
3.4.1 Using Microenvironments to Estimate an Average Exposure Concentration for a Specific Exposure Period 18
3.4.2 Estimating an Average Exposure Concentration Across Multiple Exposure Periods 19

4. SELECTING APPROPRIATE TOXICITY VALUES 20
4.1 Sources for Inhalation Toxicity Data 20
4.2 Recommended Procedure for Assessing Risk in the Absence of Inhalation Toxicity Values 21

5. ESTIMATING RISKS 22
5.1 Cancer Risks Characterized by an Inhalation Unit Risk 22
5.2 Hazard Quotients 24

6. EXAMPLE EXPOSURE SCENARIOS 24
6.1 Residential Receptor 24
6.2 Commercial-Industrial/Occupational Receptor 25
6.3 Construction Worker 25
6.4 Trespasser/Recreational Receptor 25

7. TARGET CONCENTRATIONS FOR SCREENING ANALYSIS OF INHALATION PATHWAYS 26
7.1 Target Contaminant Concentrations in Air 26
7.2 Screening Levels for Other Media 26
7.2.1 Soil Screening Levels 27
7.2.2 Tap Water Screening Levels 28
7.2.3 Soil Gas or Ground Water Screening Values for Vapor Intrusion 28

8. DEVELOPING AGGREGATE AND CUMULATIVE RISK ESTIMATES 28
8.1 Estimating Cumulative Risk and Hazards Across Multiple Chemicals 28
8.1.1 Cancer Risks 29
8.1.2 Hazard Quotients 29
8.2 Aggregating Risk and Hazard Quotients Across Exposure Routes 29

9. RISK CHARACTERIZATION 30
9.1 Highly Exposed or Susceptible Populations and Life Stages 30
9.1.1 Children 30
9.1.2 Workers 31
9.2 Uncertainties in Inhalation Risk Assessment 31
9.2.1 Development of Exposure Concentrations 32
9.2.2 Toxicity Assessment 32
9.2.3 Estimating Cancer Risks 33
9.2.4 Estimating Risk and Hazard from Multiple Chemicals and Exposure Pathways 33

10. REFERENCES 34

APPENDIX A A-1

APPENDIX B B-1

APPENDIX C C-1

LIST OF TABLES

Table 1: RAGS Part A Equation Describing the Estimation of Inhalation Exposure 2

Table 2: Contaminant Properties and Dosimetric Adjustment Factors 7

Table 3: The Use of Uncertainty Factors in Deriving an Inhalation Reference Concentration 12

Table 4: Recommended Procedure for Calculating Risk-Based Screening Concentrations for Contaminants in Air 27

LIST OF FIGURES

Figure 1: Human Respiratory Tract 8

Figure 2: Recommended Procedure for Deriving Exposure Concentrations and Hazard Quotients for Inhalation Exposure Scenarios 16

Figure 3: Guidance on Assessing Risk from Early-Life Exposures for Chemicals Acting by a Mutagenic Mode of Action for Carcinogenicity 23

LIST OF EQUATIONS

Equation 1: $NOAEL_{[ADJ]}$ 5

Equation 2: $NOAEL_{[HEC]}$ from Animal Data 6

Equation 3: $NOAEL_{[HEC]}$ from Human Data 10

Equation 4: Inhalation Unit Risk 10

Equation 5: Reference Concentration 11

Equation 6: Exposure Concentration for Assessing Cancer Risks 14

Equation 7: Exposure Concentration for Acute Exposure Scenarios 17

Equation 8: Exposure Concentration Chronic for Subchronic Exposure Scenarios 18

Equation 9: Exposure Concentration for a Specific Exposure Period, Microenvironments 19

LIST OF EQUATIONS (CONT.)

Equation 10: Exposure Concentration Across Multiple Exposure Periods, Microenvironments 19

Equation 11: Cancer Risk 22

Equation 12: Hazard Quotient 24

ACKNOWLEDGEMENTS

This guidance was developed by the Inhalation Risk Workgroup, which included regional and headquarters staff in EPA's Office of Superfund Remediation and Technology Innovation (OSRTI), the Office of Research and Development (ORD), the Office of Children's Health Protection (OCHP), The Office of Air and Radiation (OAR), and the Office of Solid Waste and Emergency Response (OSWER). Dave Crawford of OSRTI headquarters and Michael Sivak of EPA Region 2 provided project management and technical coordination of its development.

OSRTI would like to acknowledge the efforts of all the Inhalation Risk Workgroup members who supported the development of the guidance by providing technical input regarding its content and scope:

Marcia Bailey, Region 10
Bob Benson, Region 8
Dave Crawford, OSWER/OSRTI
Arunas Draugelis, Region 5
Brenda Foos, OCHP
Gary Foureman, ORD/NCEA
Susan Griffin, Region 8
Ofia Hodoh, Region 4
Jennifer Hubbard, Region 3
Ann Johnson, OA/OPEI
Jeremy Johnson, Region 7
Kevin Koporec, Region 4
Sarah Levinson, Region 1
Deirdre Murphy, OAR/OAQPS
Henry Schuver, OSWER/OSW
Michael Sivak, Region 2
John Stanek, ORD/NCEA
Daniel Stralka, Region 9
Timothy Taylor, OSWER/OSW
John Whalan, ORD/NCEA
Erik Winchester, ORD/OSP

Former Members:
Cheryl Overstreet, Region 6
Neil Stiber, ORD/OSP

OSRTI would also like to acknowledge the efforts of the external peer review panel members who provided input on the draft version of the document:

Sandra Baird, Massachusetts Department of Environmental Protection
Selene Chou, Agency for Toxic Substances and Disease Registry
Lynne Haber, Toxicology Excellence for Risk Assessment
Anita Meyer, US Army Corps of Engineers
Peter Valberg, Gradient Corporation

Henry Roman, Eric Ruder, and Tyra Walsh of Industrial Economics, Incorporated in Cambridge, MA provided technical assistance to EPA in the development of this guidance under Contract Number 68-W-01-05.

LIST OF ACRONYMS

µg	Microgram
µm	Micrometer
ADAF	Age Dependent Adjustment Factor
AT	Averaging Time
ATSDR	Agency for Toxic Substances and Disease Registry
BMCL	Benchmark Concentration, Lower confidence limit
BMD	Benchmark Dose
BW	Body Weight
CA	Contaminant Concentration in Air
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CSF	Cancer Slope Factor
DAF	Dosimetric Adjustment Factor
ED	Exposure Duration
EC	Exposure Concentration
EF	Exposure Frequency
EPA	Environmental Protection Agency
ER	Extra-respiratory
ET	Exposure Time
ETh	Extrathoracic
F_r	Fractional Deposition in region r
F_{total}	Total particle deposition in respiratory tract
$H_{b/g\text{-}animal}$	Animal Blood:Gas Partition Coefficient
$H_{b/g\text{-}human}$	Human Blood:Gas Partition Coefficient
HEAST	Health Effects Assessment Summary Table
HEC	Human Equivalent Concentration
HI	Hazard Index
HQ	Hazard Quotient
ICRP	International Commission for Radiological Protection
IR	Inhalation Rate
IRIS	Integrated Risk Information System
IUR	Inhalation Unit Risk
kg	Kilogram
LEC_{10}	Lower limit on Effective Concentration, using a 10 percent response level
LOAEL	Lowest Observable Adverse Effect Level
ME	Microenvironment
MF	Modifying Factor
mg	Milligram
MOA	Mode of Action
MRL	Minimal Risk Level
MW	Molecular Weight
NCEA	National Center for Environmental Assessment
NOAEL	No Observable Adverse Effect Level
ORD	Office of Research and Development
OSRTI	Office of Superfund Remediation and Technology Innovation

LIST OF ACRONYMS (CONT.)

OSWER	Office of Solid Waste and Emergency Response
PBPK	Physiologically Based Pharmacokinetic
POD	Point of Departure
ppm	Parts Per Million
PPRTV	Provisional Peer Reviewed Toxicity Value
PRG	Preliminary Remediation Goal
PU	Pulmonary
Q-alv	Alveolar ventilation rate
QSAR	Quantitative Structure-Activity Relationship
RAGS	Risk Assessment Guidance for Superfund
RBC	Risk-Based Concentration
RfC	Reference Concentration
RfD	Reference Dose
RGDR	Regional Gas Dose Ratio
RDDR	Regional Deposited Dose Ratio
RME	Reasonable Maximum Exposure
SA	Surface Area
SSL	Soil Screening Level
STSC	Superfund Health Risk Technical Support Center
TB	Tracheobronchial
TOT	Total Respiratory System
UF	Uncertainty Factor
V_e	Minute Volume

1. INTRODUCTION

The Environmental Protection Agency's (EPA's) Superfund Program has updated its approach for determining risk from inhaled chemicals to be consistent with the inhalation dosimetry methodology described in *Methods for Derivation of Inhalation Reference Concentrations and Application of Inhalation Dosimetry* (USEPA, 1994; hereafter, the *Inhalation Dosimetry Methodology*).[1] This document provides Superfund site risk assessors with guidance that should help more consistently address the *Inhalation Dosimetry Methodology*.

This document outlines recommended processes consisting of a series of steps as well as recommended equations for EPA Regions to consider when estimating inhalation exposure and risk at Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites. This guidance is intended to provide a recommended methodology for consistently addressing the inhalation pathway in risk assessments for Superfund sites.

Some of the statutory provisions described in this document contain legally binding requirements. However, this document does not substitute for those provisions or regulations, nor is it a regulation itself. Thus, it cannot impose legally binding requirements on EPA, States, or the regulated community, and may not apply to a particular situation based upon the circumstances. Any decisions regarding a particular remedy selection decision will be made based on the statute and regulations, and EPA decisionmakers retain the discretion to adopt approaches on a case-by-case basis that differ from this guidance where appropriate. EPA may change this guidance in the future.

1.1 Background

EPA's *Risk Assessment Guidance for Superfund (RAGS), Part A* (USEPA, 1989; hereafter, *RAGS, Part A*) outlined a previously recommended approach for conducting site-specific baseline risk assessments for inhaled contaminants.[2] According to the original RAGS approach, the inhalation exposure estimate was typically derived in terms of a chronic, daily "air intake" (mg/kg-day) using the following general approach. The intake of the chemical was estimated as a function of the concentration of the chemical in air (CA), inhalation rate (IR), body weight (BW), and the exposure scenario. Age-specific values for BW and IR were used when evaluating childhood exposures. Table 1 presents the *RAGS, Part A* equation for calculating intake for inhalation exposure. Inhalation toxicity values were "converted" into similar units for the risk quantification step. Cancer risk was estimated by multiplying the chronic daily intake of the chemical from the air by the "inhalation cancer slope factor" (CSF_i); the Hazard Quotient (HQ) for non-cancer effects was estimated by dividing the intake of the chemical by an "inhalation reference dose" (RfD_i).[3]

The approach outlined in *RAGS, Part A* was developed before EPA issued the *Inhalation Dosimetry Methodology*, which describes the Agency's refined recommended approach for interpreting

[1] The *Inhalation Dosimetry Methodology* can be found at the following web address: http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=71993.

[2] See sections 6.6.3, 7.2.3, 7.3.3, and 8.2 of *RAGS, Part A*.

[3] EPA defines an HQ in *RAGS, Part A* as: "The ratio of a single substance exposure level over a specified time period (e.g., subchronic) to a reference dose (RfD) for that substance derived from a similar exposure period" (USEPA, 1989).

inhalation toxicity studies in laboratory animals or studies of occupational exposures of humans to airborne chemicals. Under the *Inhalation Dosimetry Methodology*, the experimental exposures are typically extrapolated to a Human Equivalent Concentration (HEC), and a reference concentration (RfC) is typically calculated by dividing the HEC by uncertainty factors (UFs). As described in the Agency's *Guidelines for Cancer Risk Assessment* (USEPA, 2005a), the HEC developed in accordance with the *Inhalation Dosimetry Methodology* typically is also used in developing an inhalation unit risk (IUR) for cancer risk assessment (which may also be called an inhalation cancer slope factor).[4] The procedure that was used to calculate the published RfC or IUR is described in the Integrated Risk Information System (IRIS) profile or other toxicological reference document for a chemical.

TABLE 1
RAGS, PART A EQUATION DESCRIBING THE ESTIMATION OF INHALATION EXPOSURE

Equation	Location in RAGS, Part A
Intake (mg/kg-d) = CA x (IR/BW) x (ET x EF x ED)/AT	Exhibit 6-16, Page 6-44
Key: CA (mg/m^3) = contaminant concentration in air; IR (m^3/hr) = inhalation rate; BW (kg) = body weight; ET (hours/day) = exposure time; EF (days/year) = exposure frequency; ED (years) = exposure duration; and AT (days) = averaging time (period over which exposure is averaged).	

The Superfund Program has updated its inhalation risk paradigm to be compatible with the *Inhalation Dosimetry Methodology*, which represents the Agency's current methodology for inhalation dosimetry and derivation of inhalation toxicity values.[5] This document recommends that when estimating risk via inhalation, risk assessors should use the concentration of the chemical in air as the exposure metric (e.g., mg/m^3), rather than inhalation intake of a contaminant in air based on IR and BW (e.g., mg/kg-day).

1.2 Purpose and Scope

The intake equation described above (*RAGS, Part A*, Exhibit 6-16) is not consistent with the principles of EPA's *Inhalation Dosimetry Methodology* because the amount of the chemical that reaches the target site is not a simple function of IR and BW. Instead, the interaction of the inhaled contaminant with the respiratory tract is affected by factors such as species-specific relationships of exposure concentrations (ECs) to deposited/delivered doses and physiochemical characteristics of the inhaled contaminant. The *Inhalation Dosimetry Methodology* also considers the target site where the toxic effect occurs (e.g., the respiratory tract or a location in the body remote from the portal-of-entry) when applying dosimetric adjustments to experimental concentrations (USEPA, 1994). Therefore, this *RAGS, Part A* equation is not recommended for estimating exposures to inhaled contaminants.

[4] The phrase "inhalation cancer slope factor," as used in this guidance, refers generally to the risk per a measure of inhalation exposure. Inhalation exposure in cancer bioassays or occupational studies from which slope factors may be derived is most commonly expressed as an exposure concentration (e.g., µg agent/m^3 air). Please note that this differs from past use of the phrase "inhalation cancer slope factor" or "CSF_i" by the Superfund program to refer to a cancer slope expressed as an "inhalation intake" (e.g., *RAGS, Part A* (USEPA, 1989)).

[5] For additional information about the Superfund program's adoption of the *Inhalation Dosimetry Methodology*, please refer to the summary of a 2003 Superfund workshop on inhalation risk assessment: http://www.epa.gov/oswer/riskassessment/pdf/finalinhalationriskworkshop.pdf.

The purpose of this document is to provide a recommended approach for developing the information necessary to assist risk assessment and risk management decision-making at waste sites involving potential risks from inhalation exposures.[6, 7] This includes providing equations that may be used in conducting baseline risk assessments and in calculating risk-based concentrations (RBCs). It is intended that *RAGS, Part F* will replace those portions of *RAGS, Part A*, which addressed inhalation risk.

1.3 Effects on Other Office of Superfund Remediation and Technology Innovation Guidance

EPA recommends that the intake equation presented in *RAGS, Part A* (USEPA, 1989, Exhibit 6-16) should no longer be used when evaluating risk from the inhalation pathway. Implementation of a risk assessment approach consistent with the *Inhalation Dosimetry Methodology* will also affect the following guidance documents: *RAGS, Part B*, Section 3.3: Volatilization and Particulate Emission Factors (USEPA, 1991); and the Office of Solid Waste and Emergency Response's (OSWER's) *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils* (USEPA, 2002a; hereafter the *Vapor Intrusion Guidance*). EPA no longer recommends using the equations in Section 3.3 of *RAGS, Part B* nor the inhalation toxicity values generated using simple route-to-route extrapolation, such as those presented in the 2002 draft *Vapor Intrusion Guidance* and related documents.[8]

This guidance does not affect the equations pertaining to risk from inhaled chemicals in the *Soil Screening Guidance* (USEPA, 1996), Section 2.4, or the *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (USEPA, 2002b), Sections 4.2.3, 5.3.2 and Appendix B, other than to clarify that the IURs and RfCs used in the equations are based on continuous exposure (24 hours per day). If the exposure scenario of interest is less than 24 hours per day, the scenario-specific exposure time (ET) in hours per day should be used in the equations and the averaging time should be in units of hours (see Equations 6 and 8 in this document). *RAGS, Part D* (USEPA, 2001) is also not affected by *RAGS, Part F*, as it includes sufficient flexibility to accommodate the revisions described in this guidance. In addition, the screening values presented on the "Regional Screening Levels for Chemical Contaminants at Superfund Sites" screening level/preliminary remediation goal table are consistent with *RAGS, Part F* (USEPA, 2008a).[9] Readers can contact EPA headquarters with questions about the compatibility of specific Superfund documents with *RAGS, Part F*.

---

[6] Note that the assessment of risk from inhaled nanoparticles is outside the scope of this document.

[7] If a site contains asbestos contamination, risk assessors should contact EPA's Technical Review Workgroup for Metals and Asbestos for assistance.

[8] Related documents include the *Johnson and Ettinger (1991) Model for Subsurface Vapor Intrusion into Buildings* spreadsheet models (http://www.epa.gov/oswer/riskassessment/airmodel/johnson_ettinger.htm) and the accompanying *User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings* (USEPA, 2004a).

[9] This table can be found on EPA Regions 3, 6, and 9 websites (http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm; http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm; and http://www.epa.gov/region09/waste/sfund/prg/index.html).

2. BACKGROUND ON DERIVATION OF INHALATION TOXICITY VALUES

For all exposure routes, there are generally two approaches for deriving toxicity values. One involves the derivation of a reference value (e.g., RfC or RfD), while the other involves derivation of a predictive cancer risk estimate (e.g., an oral or inhalation CSF, such as an IUR). For the inhalation route, both approaches rely on EPA's *Inhalation Dosimetry Methodology* for the extrapolation of experimental concentrations to HECs. This extrapolation is described in Section 2.1 and its subsections. The approaches for deriving a toxicity value from the HEC are described in Sections 2.2 and 2.3 and differ depending on the type of toxicity value (e.g., RfC, IUR). This information is provided for background purposes only. **The procedures outlined in Section 2 are typically performed by IRIS chemical managers or by inhalation toxicologists at the National Center for Environmental Assessment's (NCEA's) Superfund Health Risk Technical Support Center (STSC) rather than as part of a baseline risk assessment.**

2.1 Application of Inhalation Dosimetry

The *Inhalation Dosimetry Methodology* recognizes a hierarchy of approaches that can be used for determining the HEC that is used to derive the RfC or IUR. Generally, the preferred approach is to use physiologically-based pharmacokinetic (PBPK) models.[10] With sufficient data, a PBPK model is capable of calculating the amount of the chemical that reaches the target organ in an animal from any exposure scenario and then estimating what human exposure would result in this same amount of chemical reaching the target organ (i.e., the HEC). PBPK models can also be used to derive continuous ECs from human and animal studies with less-than-continuous exposures. Because constructing a valid PBPK model is an information-intensive process that typically requires substantial chemical-specific data, this approach has rarely been used (USEPA, 2004b); an example can be found in the IRIS file for vinyl chloride (USEPA, 2000a). In cases where a complete PBPK model is not available, an intermediate model relying on certain chemical-specific data may be used (USEPA, 1994).[11]

If the database to support the preferred approach is inadequate, an alternative approach, called the Default Chemical Category-Specific Method can be used. This method incorporates the use of limited or categorical chemical-specific and physiological information. The default method is discussed below, followed by the procedures outlined in the *Inhalation Dosimetry Methodology* for deriving the RfC and IUR as they apply to the interpretation of animal and human data.

---

[10] EPA defines PBPK models in the IRIS glossary as a model that estimates the dose to a target tissue or organ by taking into account the rate of absorption into the body, distribution among target organs and tissues, metabolism, and excretion (USEPA, 2008b). For further information about PBPK modeling, please refer to *Approaches for the Application of Physiologically Based Pharmacokinetic Models and Supporting Data in Risk Assessment* (USEPA, 2006a).

[11] The *Inhalation Dosimetry Methodology* recognizes the existence of alternate approaches in addition to the two presented in this guidance. The PBPK approach is generally preferred. In the absence of such a model, alternate models may be more optimal than the default approach when default assumptions or parameters can be replaced by more detailed, biologically-motivated descriptions or actual data, respectively. For instance, a model may be considered more optimal if it incorporates chemical or species-specific information or if it accounts for mechanistic determinants. See Table 3-6 in the *Inhalation Dosimetry Methodology* for more details on the hierarchy of approaches (EPA, 1994, page 3-40).

2.1.1 Default Approach - Extrapolation from Experimental Animal Data

The default method involves a two-step procedure that uses limited or categorical chemical-specific and physiological information to calculate the HEC. First, the chosen point of departure (POD) from the experimental data for a chemical is adjusted to derive a concentration intended to represent an equivalent dose under conditions of continuous exposure (7 days a week, 24 hours a day).[12] In the second step, this concentration is then multiplied by a Dosimetric Adjustment Factor (DAF) to generate the HEC. Further details on each step are outlined below.

2.1.1.1 Duration Adjustment to Continuous Exposure

Most of the inhalation studies of laboratory animals used to derive RfCs and IURs involve an exposure regimen of four to six hours per day, five to seven days per week, for 13 weeks or more (equivalent to 10 percent or more of the lifetime of the animal). The POD concentration from an animal study is mathematically adjusted to reflect an equivalent dose under conditions of continuous exposure.[13] Adjustment of duration to a continuous exposure scenario is regularly applied as a default procedure to studies with repeated exposures but not to single-exposure inhalation toxicity studies in animals (USEPA, 1994). Operationally, this is accomplished by applying a *c* x *t* product (where "*c"* is concentration, and "*t"* is duration of exposure) for both the number of hours in a daily exposure period and the number of days per week that the exposure is experienced. For example, if exposure in a particular study was 6 hours per day, 5 days per week, the experimental exposure is multiplied by 6/24 x 5/7 to calculate an equivalent continuous exposure. The general equation provided in the *Inhalation Dosimetry Methodology* (USEPA, 1994, Equation 4-2) for calculating duration-adjusted exposure levels in mg/m^3 for experimental animals is presented below.

$NOAEL_{[ADJ]}$ = E x D x W **(Equation 1)**

Where:
$NOAEL_{[ADJ]}$ (mg/m^3) = the NOAEL or analogous exposure level obtained with an alternate approach (e.g., LOAEL, LEC_{10}), adjusted for duration of experimental regimen;
E (mg/m^3) = the NOAEL or analogous exposure level observed in the experimental study;
D (h/h) = number of hours exposed/24 hours; and
W (days/days) = number of days of exposure/7days.

Using the example above, the assumption is that the product of *c* x *t*, not concentration alone, is associated with the toxicity observed. This is roughly equivalent to implying that if an effect occurs from a chemical at an exposure of 6 hours per day at 40 parts per million (ppm), that same effect will

[12] Examples of PODs include the no-observed-adverse-effect level (NOAEL); the lowest-observed-adverse-effect level (LOAEL); Benchmark Concentration, Lower confidence limit (BMCL); and the Lower limit on an Effective Concentration using a 10 percent response level (LEC_{10}). For definitions of the various PODs, please refer to the IRIS glossary (http://www.epa.gov/ncea/iris/help_gloss.htm).

[13] Continuous exposure refers to 24 hours per day, 7 days per week.

occur at an exposure of 24 hours per day at 10 ppm.[14] Note that this adjustment always produces a lower concentration value than that administered to experimental animals. Thus, as stated in *A Review of the Reference Dose and Reference Concentration Processes* (hereafter, the *RfD/RfC Review*), application of this procedure results in an automatic margin of protectiveness for chemicals for which concentration alone may be the more appropriate dose metric, and it reflects the maximum dose for chemicals for which total or cumulative dose is the appropriate measure (USEPA, 2002c). If a different procedure is used to calculate the continuous exposure, it should be fully discussed in the relevant technical support document for the chemical (e.g., IRIS profile, Provisional Peer Reviewed Toxicity Values (PPRTVs) Assessment). For additional discussion, including the uncertainties associated with this approach, see Section 4.3.2 of the *Inhalation Dosimetry Methodology* and Section 4.4.2.1 of the *RfD/RfC Review* (USEPA, 2002c).

2.1.1.2 Dosimetric Adjustment to Human Equivalent Concentration

Typically, the adjusted POD concentration from the animal study is next converted to an HEC using the following equation (USEPA, 1994, Equation 4-3):

$$\mathbf{NOAEL_{[HEC]} = NOAEL_{[ADJ]} \times DAF} \qquad \textbf{(Equation 2)}$$

Where:

$NOAEL_{[HEC]}$ (mg/m^3) = the NOAEL or analogous exposure level obtained with an alternate approach, dosimetrically adjusted to an HEC;

$NOAEL_{[ADJ]}$ (mg/m^3) = the NOAEL or analogous exposure level obtained with an alternate approach, adjusted for duration of experimental regimen; and

DAF = Dosimetric Adjustment Factor for the specific site of effects (e.g., respiratory tract region or extra-respiratory).

The DAF is typically based on ratios of animal and human physiologic parameters. The specific DAF used depends on the nature of the contaminant (e.g., particle or gas) and the target site where the toxic effect occurs (e.g., respiratory tract or a location in the body remote from the portal-of-entry). For example, the DAF can be based on either the Regional Gas Dose Ratio (RGDR), for gases with respiratory effects, or the Regional Deposited Dose Ratio (RDDR) for particles.

Table 2 provides information on the site of effects for the different chemical types. It also lists the physiologic parameters considered when calculating the DAF for specific regions of the body.[15] In addition, the table provides references to the equations from the *Inhalation Dosimetry Methodology* used in deriving the DAFs. Figure 1 provides a schematic of the human respiratory tract, illustrating each of the different regions.

[14] This assumption is based on Haber's Law, which states that "the incidence and/or severity of an adverse health effect depends on the total exposure to a potentially toxic substance. Total exposure (*K*) is the concentration of the substance (*c*) times the duration time of exposure (*t*), (i.e., *c* x *t*=*K*)" (Gaylor, 2000).

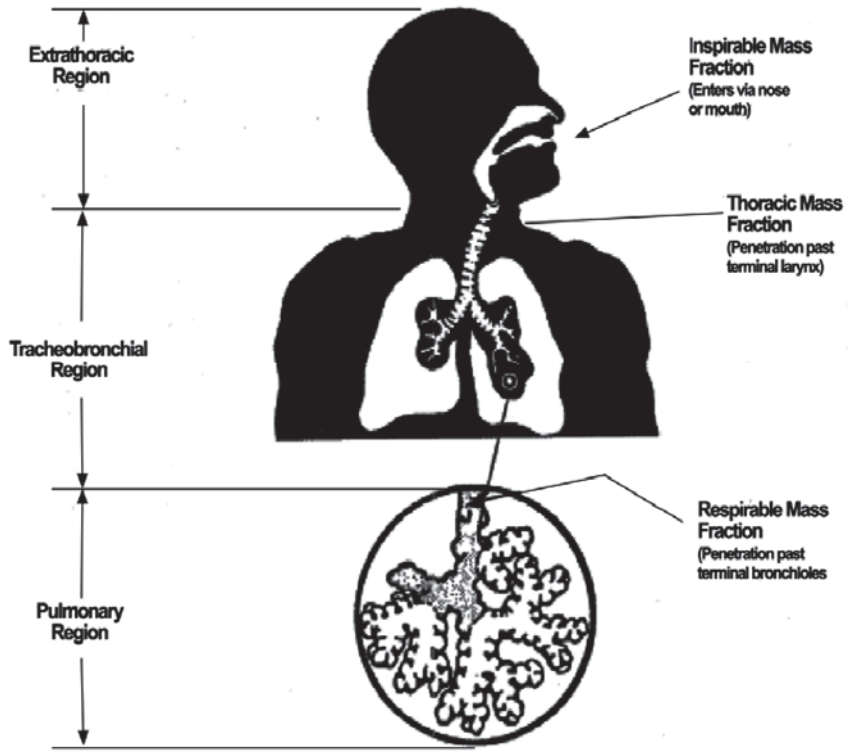
[15] The three main regions of the respiratory tract include the following: 1) Extrathoracic (includes nose, mouth, nasopharynx, oropharynx, laryngopharynx, and larynx); 2) Tracheobronchial (includes trachea, bronchi, and bronchioles); and 3) Pulmonary (includes respiratory bronchioles, alveolar ducts, alveolar sacs and the alveoli).

TABLE 2
CONTAMINANT PROPERTIES AND DOSIMETRIC ADJUSTMENT FACTORS[a]

Chemical Type	Site of Effects	Parameters Considered in Derivation of DAF for Regions of the Body[b]	DAF Equation Numbers in Inhalation Dosimetry Methodology[c]
Category 1 Gases (e.g., acrolein, hydrogen fluoride, chlorine)	Respiratory	-Minute volume (ETh, TB) -Surface area (ETh, TB, PU) -Mass transport coefficient (TB, PU) -Fraction of inhaled chemical penetrating the respiratory region (PU) -Alveolar ventilation rate (PU)	4-18 (ETh), 4-21 & 4-22 (TB), 4-28 (PU)
Category 2 Gases (e.g., acetonitrile, xylene, propanol, isoamyl alcohol)	Respiratory and Remote	-Mass transport coefficients (ETh, TB) -Blood:gas partition coefficient (ET, TB, ER) -Cardiac output (ETh, TB, ER) -Alveolar ventilation rate (PU) -Surface Area (PU) -Minute volume (ER)	4-18 (ETh), 4-21 & 4-22 (TB), 4-28 (PU), 4-48 (ER)[d,e]
Category 3 Gases (e.g., benzene, styrene)	Remote	Blood:gas partition coefficient (ER)	4-48[d]
Particles	Respiratory and Remote	-Minute volume (TOT, ER) -Surface area (TOT) -Fractional deposition of particle (TOT, ER) -Body weight (ER) -Inhaled concentration (ER)	4-14 (TOT), 4-15 (ER)

[a] Due to the complexities inherent in evaluating the health effects associated with exposure to gases, no definitive or comprehensive list of Category 1, 2, or 3 gases is available. Risk assessors should consult with an inhalation toxicologist in order to classify a specific gas as Category 1, 2, or 3, since there is overlap between the sites of effects and the parameters considered in deriving the DAF for different regions of the respiratory tract.
[b] Additional discussion of the terms used in this table can be found in the *Inhalation Dosimetry Methodology*.
[c] The *Inhalation Dosimetry Methodology* provides equations for deriving DAFs for the different contaminant categories. The equations listed in this table are the default equations for each specific region in the body.
[d] This refers to Equation 4-48 that is found on page 4-60 of the *Inhalation Dosimetry Methodology*.
[e] The equations presented for Category 2 gases in the *Inhalation Dosimetry Methodology* contain errors. Therefore, this table refers to the equations for Category 1 and 3 gases, which are expected to cover respiratory and remote effects from Category 2 gases.
Acronyms: ETh = Extrathoracic; TB = Tracheobronchial; PU = Pulmonary; ER = Extra-respiratory; TOT = Total respiratory system.

FIGURE 1
HUMAN RESPIRATORY TRACT



Source: EPA (1994), Figure 3-1, Page 3-5.

Category 1 gases are highly water-soluble and/or are rapidly irreversibly reactive in the respiratory tract (e.g., acrolein, hydrogen fluoride, chlorine). They do not significantly accumulate in the blood, and therefore their effects are usually exclusively respiratory (USEPA, 1994). The DAF for Category 1 gases consists of an RGDR and is based on the animal to human ratio of the minute volume (V_e) divided by the surface area (SA) of the region of the respiratory tract where the effect occurs.[16] See Appendix A, Sections 1, 2, and 3 of this guidance for examples of specific Category 1 DAF equations.

[16] For the purposes of this document, the V_e is defined as the total ventilation per minute and equals the product of the tidal volume (the air volume entering or leaving the lungs with a single breath) and the respiratory frequency.

Category 3 gases are relatively water-insoluble and are unreactive in the respiratory tract (e.g., benzene, styrene). Their toxicity is generally at sites remote to the respiratory tract (USEPA, 1994). The DAF for Category 3 gases is based on the ratio of the animal blood:gas partition coefficient ($H_{b/g\text{-}animal}$) and the human blood:gas partition coefficient ($H_{b/g\text{-}human}$). See Appendix A, Section 4 of this guidance for an example of a Category 3 DAF equation.

Category 2 gases are moderately water-soluble and may be rapidly reversibly reactive or moderately to slowly irreversibly reactive in respiratory tract tissue (e.g., acetonitrile, xylene, propanol, isoamyl alcohol). These gases have potential for significant accumulation in the blood, so they can exhibit both respiratory and remote toxicity (USEPA, 1994). The DAF for respiratory effects of Category 2 gases consists of an RGDR and is based on the animal to human ratio of the V_e and the SA of the region of the respiratory tract where the effect occurs, as for Category 1 gases. The DAF for extra-respiratory (ER) effects of a Category 2 gas is based on the ratio of the $H_{b/g\text{-}animal}$ and the $H_{b/g\text{-}human}$, as for Category 3 gases.

Particles also vary by solubility and reactivity. However, the default equations used to estimate the predicted regional deposition fractions for particles are based on non-soluble, non-hygroscopic particles (USEPA, 1994, Section 4.3.5.3). The DAF for a particle causing an effect in the respiratory tract is the $RDDR_r$. The $RDDR_r$ is based on the animal to human ratio of the V_e and the fractional deposition of the particle in that region (F_r), divided by the SA_r of the region where the effect occurs. This derivation, from the *Inhalation Dosimetry Methodology,* conservatively assumes that 100 percent of the deposited dose remains in the respiratory tract; clearance mechanisms are not considered. The DAF for a particle causing an ER effect, the $RDDR_{ER}$, is based on the animal to human ratio of the V_e and the total deposition of the particle in the entire respiratory tract (F_{total}), divided by BW (USEPA, 1994). The $RDDR_{ER}$ assumes that 100 percent of the deposited dose in the entire respiratory tract is available for uptake into the systemic circulation. See Appendix A, Section 5 for examples of specific particle DAF equations.

2.1.2 Default Approach - Extrapolation from Human Occupational Data

When human data are available to derive an RfC, duration adjustments are often required to account for differences in exposure scenarios (e.g., extrapolation from an 8 hour/day occupational exposure to a continuous chronic exposure). The default approach recommended by the *Inhalation Dosimetry Methodology* for adjusting the POD concentration (e.g., the no observable adverse effect level (NOAEL)) obtained from human study data is provided below in Equation 3 (USEPA, 1994, Equation 4-49).[17,18]

[17] If sufficient data are available, a PBPK model or intermediate approach using chemical-specific information may be employed in preference to the default method for extrapolating human occupational data to an HEC.

[18] EPA's IRIS glossary defines an adverse effect as the following: "A biochemical change, functional impairment, or pathologic lesion that affects the performance of the whole organism, or reduces an organism's ability to respond to an additional environmental challenge" (USEPA, 2008b).

$NOAEL_{[HEC]}$ = NOAEL x (VEho/VEh) x 5 days/7 days **(Equation 3)**

Where: $NOAEL_{[HEC]}$ (mg/m^3) = the NOAEL or analogous exposure level obtained with an alternate approach, dosimetrically adjusted to an ambient HEC;
NOAEL (mg/m^3) = occupational exposure level (time-weighted average over an 8-hour exposure period);
VEho = human occupational default minute volume over 8 hours (10 m^3); and
VEh = human ambient default minute volume over 24 hours (20 m^3).

2.2 Derivation of the Inhalation Unit Risk

The default approach for determining predictive cancer risk recommended by EPA's *Guidelines for Carcinogen Risk Assessment* (USEPA, 2005a; hereafter, *Cancer Guidelines*) is a linear extrapolation from exposures observed in the animal or human occupational study.[19] This approach involves drawing a straight line from the POD to the origin. The default linear extrapolation approach is generally considered to be conservatively protective of public health, including sensitive sub-populations (USEPA, 2005a). The slope of this line is commonly called the slope factor, and when the units are risk per $\mu g/m^3$, it is also called the IUR. EPA defines an IUR in the IRIS glossary as "the upper-bound excess lifetime cancer risk estimated to result from continuous exposure to an agent at a concentration of 1 $\mu g/m^3$ in air" (USEPA, 2008b). Equation 4 below presents a linear extrapolation from a POD of 10 percent response (LEC_{10}).[20]

$IUR = 0.1/LEC_{10[HEC]}$ **(Equation 4)**

Where: IUR $(\mu g/m^3)^{-1}$ = Inhalation Unit Risk; and
$LEC_{10[HEC]}$ ($\mu g/m^3$) = the lowest effective concentration using a 10 percent response level, dosimetrically adjusted to an HEC.

2.3 Derivation of the Reference Concentration

EPA defines an RfC in the IRIS glossary as "an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious effects during a lifetime" (USEPA, 2008b). The RfC is derived after a review of the health effects database for a chemical and identification of the most sensitive and relevant endpoint along with the principal study or studies demonstrating that endpoint. EPA Chemical Managers use UFs to account for recognized

[19] According to the *Cancer Guidelines*, "[a] nonlinear approach should be selected when there are sufficient data to ascertain the mode of action [MOA] and conclude that it is not linear at low doses and the agent does not demonstrate mutagenic or other activity consistent with linearity at low doses" (USEPA, 2005a, page 3-22). In addition, [l]inear extrapolation should be used when there are MOA data to indicate that the dose-response curve is expected to have a linear component below the POD" (USEPA, 2005a, page 3-21). This information will appear on the IRIS profile or other toxicological information source for a chemical. Chemicals with a mutagenic MOA are thought to pose a higher risk during early life. Procedures for assessing cancer risk from these chemicals are outlined in Section 5.1.

[20] The POD used in Equation 4 is an LEC_{10}, which is the lower 95 percent confidence limit on the concentration corresponding to a 10 percent response rate (i.e., the EC_{10}). Other PODs may be substituted for this value, which could be associated with alternative response levels (e.g., 1 percent, 5 percent).

uncertainties in the extrapolations from the experimental data conditions to an estimate appropriate to the assumed human scenario (USEPA, 1994). See Table 3 for a description of the standard UFs. The formula used for deriving the RfC from the HEC is provided below.

$RfC = NOAEL_{[HEC]}/(UF)$[1] **(Equation 5)**

Where: RfC (mg/m^3) = Reference Concentration
$NOAEL_{[HEC]}$ (mg/m^3) = The NOAEL or analogous exposure level obtained with an alternate approach, dosimetrically adjusted to an HEC; and
UF = Uncertainty factor(s) applied to account for the extrapolations required from the characteristics of the experimental regimen.

[1] Some toxicological information sources for RfCs will incorporate an additional factor to account for deficiencies in the available data set, called a modifying factor (MF). In 2002, however, EPA published the *RfD/RfC Review,* which recommended that the use of MFs be discontinued because their purpose is "sufficiently subsumed in the general database UF" (USEPA, 2002c, page xviii). Therefore, RfCs published subsequent to this document will not include MFs.

TABLE 3
THE USE OF UNCERTAINTY FACTORS IN DERIVING AN INHALATION REFERENCE CONCENTRATION

Standard UFs	Processes Considered in the UF Purview
H = Human to sensitive human: Extrapolation of valid experimental results from studies using prolonged exposure to average healthy humans. Intended to account for the variation in sensitivity among the members of the human population.	-Pharmacokinetics/Pharmacodynamics -Sensitivity[2] -Differences in body weight (age, obesity) -Concomitant exposures -Activity pattern -Does not account for idiosyncrasies
A = Animal to human: Extrapolation from valid results of long-term studies on laboratory animals when results of studies of human exposure are not available or are inadequate. Intended to account for the uncertainty in extrapolating laboratory animal data to the case of average healthy humans.	-Pharmacokinetics/Pharmacodynamics -Relevance of laboratory animal model -Species sensitivity
S = Subchronic to chronic: Extrapolation from less-than-chronic exposure results on laboratory animals or humans when there are no useful long-term human data. Intended to account for the uncertainty in extrapolating from less than chronic NOAELs to chronic NOAELs.	-Accumulation/Cumulative damage -Pharmacokinetics/ Pharmacodynamics -Severity of effect -Recovery -Duration of study -Consistency of effect with duration
L = LOAEL to NOAEL: Derivation from a LOAEL instead of a NOAEL. Intended to account for the uncertainty in extrapolating from LOAELs to NOAELs.	-Severity -Pharmacokinetics/Pharmacodynamics -Slope of dose-response curve -Trend, consistency of effect -Relationship of endpoints -Functional vs. histopathological evidence -Exposure uncertainties
D = Incomplete to complete data: Extrapolation from valid results in laboratory animals when the data are "incomplete." Intended to account for the inability of any single laboratory animal study to adequately address all possible adverse outcomes in humans.[1]	-Quality of critical study -Data gaps -Power of critical study/supporting studies -Exposure uncertainties

[1] The *RfD/RfC Review* indicates that this UF accounts for the potential for deriving an underprotective RfD/RfC as a result of an incomplete characterization of the chemical's toxicity or if the existing data suggest that a lower reference value might result if additional data were available (considering both the lacking and available data for particular organ systems as well as life stage) (USEPA, 2002c).

[2] The *RfD/RfC Review* also stresses that susceptible populations and life stages are accounted for with this UF (USEPA, 2002c).

Source: USEPA, 1994, Table 4-9, page 4-77.

3. CHARACTERIZING EXPOSURE

3.1 Introduction

This section describes an approach for characterizing exposure in a baseline risk assessment that is consistent with the *Inhalation Dosimetry Methodology*. The approach involves the estimation of exposure concentrations (ECs) for each receptor exposed to contaminants via inhalation in the risk assessment. ECs are time-weighted average concentrations derived from measured or modeled contaminant concentrations in air at a site, adjusted based on the characteristics of the exposure scenario being evaluated.[21,22]

Equations for estimating ECs are provided below. This document does not provide default input values for the exposure parameters referenced in these equations. EPA recommends the use of site-specific exposure values consistent with the exposure pathways and receptors at a site wherever practicable and appropriate. If a risk assessor opts to rely on default exposure input values, current Superfund-supported values may be found at the exposure assessment portion of the Superfund website: (http://www.epa.gov/oswer/riskassessment/superfund_hh_exposure.htm).

3.2 Estimating Exposure Concentrations for Assessing Cancer Risks

The estimation of an EC when assessing cancer risks characterized by an IUR involves the CA measured at an exposure point at a site as well as scenario-specific parameters, such as the exposure duration and frequency.[23] The EC typically takes the form of a CA that is time-weighted over the duration of exposure and incorporates information on activity patterns for the specific site or the use of professional judgment. The equation for estimating an EC for use with an IUR is presented below.

[21] The default method for deriving inhalation toxicity values also involves calculating time-weighted ECs, as discussed in Sections 2.1.1.1 and 2.1.2.

[22] The ECs in this document are in units of $\mu g/m^3$. Inhalation toxicity values presented on IRIS are typically expressed in units of $\mu g/m^3$ or mg/m^3, which are mass units. Some regulatory contexts require the use of volumetric units such as ppm. The conversion from mass units to volumetric units depends on the molecular weight (MW) of the material as well as the ambient temperature and atmospheric pressure. To convert from ppm to mg/m^3, the following equation can be used: $\frac{ppm \times MW}{V} = mg/m^3$; where MW is the molecular weight of the gas and V is the volume of 1 gram molecular weight of the airborne contaminant. This is derived by the formula V = RT/P; where R is the ideal gas constant, T is the temperature in Kelvin (K = 273.16 + T°C) and P is the pressure in mm Hg. The value of R is 62.4 when T is in Kelvin, (K = 273.16 + T°C), the pressure is expressed in units of mm Hg and the volume is in liters. The value of R differs if the temperature is expressed degrees Fahrenheit (°F) or if other units of pressure are used (e.g., atmospheres, kilopascals).

[23] ECs are typically based on either estimated (i.e., modeled) or measured contaminant concentrations in air.

EC = (CA x ET x EF x ED)/AT **(Equation 6)**

Where: EC ($\mu g/m^3$) = exposure concentration;
CA ($\mu g/m^3$) = contaminant concentration in air;
ET (hours/day) = exposure time;
EF (days/year) = exposure frequency;
ED (years) = exposure duration; and
AT (lifetime in years x 365 days/year x 24 hours/day) = averaging time

3.3 Estimating Exposure Concentrations for Calculating Hazard Quotients

When estimating ECs for non-cancer or cancer hazards characterized by an HQ, risk assessors should match each exposure scenario at a site to the appropriate EC equation, based on the scenario duration and frequency of exposure.[24] Figure 2 presents a flowchart to assist risk assessors with this process and provides recommended equations that can be used to estimate the EC for each type of scenario.[25] As shown in Figure 2, the recommended process for estimating ECs to be used in calculating an HQ involves the following three steps: 1) assess the duration of the exposure scenario; 2) assess the exposure pattern of the exposure scenario; and 3) estimate the scenario-specific EC.

3.3.1 Step 1: Assess Duration

The first step in the recommended process of estimating an EC for use in calculating an HQ involves assessing the duration of the exposure scenario at a site. Step 1 in Figure 2 indicates that the risk assessor first should decide whether the duration of the exposure scenario is generally acute, subchronic, or chronic. Toxicologists have long been aware that effects from a single or short-term exposure can differ markedly from effects resulting from repeated exposures. The response by the exposed person depends upon factors such as whether the chemical accumulates in the body, whether it overwhelms the body's mechanisms of detoxification or elimination, or whether it produces irreversible effects (Eaton & Klaassen, 2001). Therefore, ideally, the chemical-specific elements of metabolism and kinetics, reversibility of effects, and recovery time should be considered as part of this recommended process when defining the duration of a site-specific exposure scenario.

[24] Traditionally, the HQ approach was limited to non-cancer hazard assessment. However, the HQ approach may also be appropriate for carcinogens with a non-linear mode of action. The 2005 *Cancer Guidelines* state the following on this subject: "For cases where the tumors arise through a nonlinear mode of action, an oral reference dose or an inhalation reference concentration, or both, should be developed in accordance with EPA's established practice for developing such values … this approach expands the past focus of such reference values (previously reserved for effects other than cancer) to include carcinogenic effects determined to have a nonlinear mode of action" (USEPA, 2005a; page 3-24).

[25] Figure 2 was developed for the evaluation of inhalation exposures. While the concepts presented in this flowchart may be useful for assessing other exposure routes (e.g., oral or dermal), these other routes are beyond the scope of this document, and therefore, are not explicitly considered. Caution should be used when using Figure 2 to evaluate other exposure routes, as considerations beyond those outlined in the flowchart may apply (e.g., time to reach steady state for dermal exposures).

To the extent possible, exposure durations (EDs) evaluated in a site-specific risk assessment should be consistent with the ED represented by the toxicity value. However, frequencies or durations of human exposures often are not as clearly defined as those in animal studies with controlled exposures, particularly for intermittent exposures. For example, the emission of some volatile chemicals into the ambient air may vary with temperature and season, providing fluctuating exposures for humans living near the source. Therefore, risk assessors should use best professional judgment to determine if the ED in a given scenario is reasonably similar to the duration associated with the toxicity value. Risk assessors should describe the uncertainties associated with their choice of toxicity value in the risk characterization section of the risk assessment (see Section 9.2.2 of this document). For situations where duration-appropriate toxicity values are not available, please follow the procedures outlined in Section 4.2 and Appendix C of this document.

The specific definition for each exposure duration category may vary depending on the source of the toxicity value being used. For Tier 1 toxicity values obtained from EPA's IRIS database, acute exposures are defined as lasting 24 hours or less; subchronic exposures are defined as repeated exposures by the oral, dermal, or inhalation route for more than 30 days, up to approximately 10 percent of the human lifespan; and chronic exposures are defined as repeated exposures for more than approximately 10 percent of the human lifespan (USEPA, 2008b).[26, 27]

After deciding which duration the exposure scenario most closely matches, risk assessors should then proceed to Step 2, following the path of the selected duration. Note that if an acute duration is selected, risk assessors should proceed directly to Step 3 to estimate an acute EC for each acute exposure period.

3.3.2 Step 2: Assess Exposure Pattern

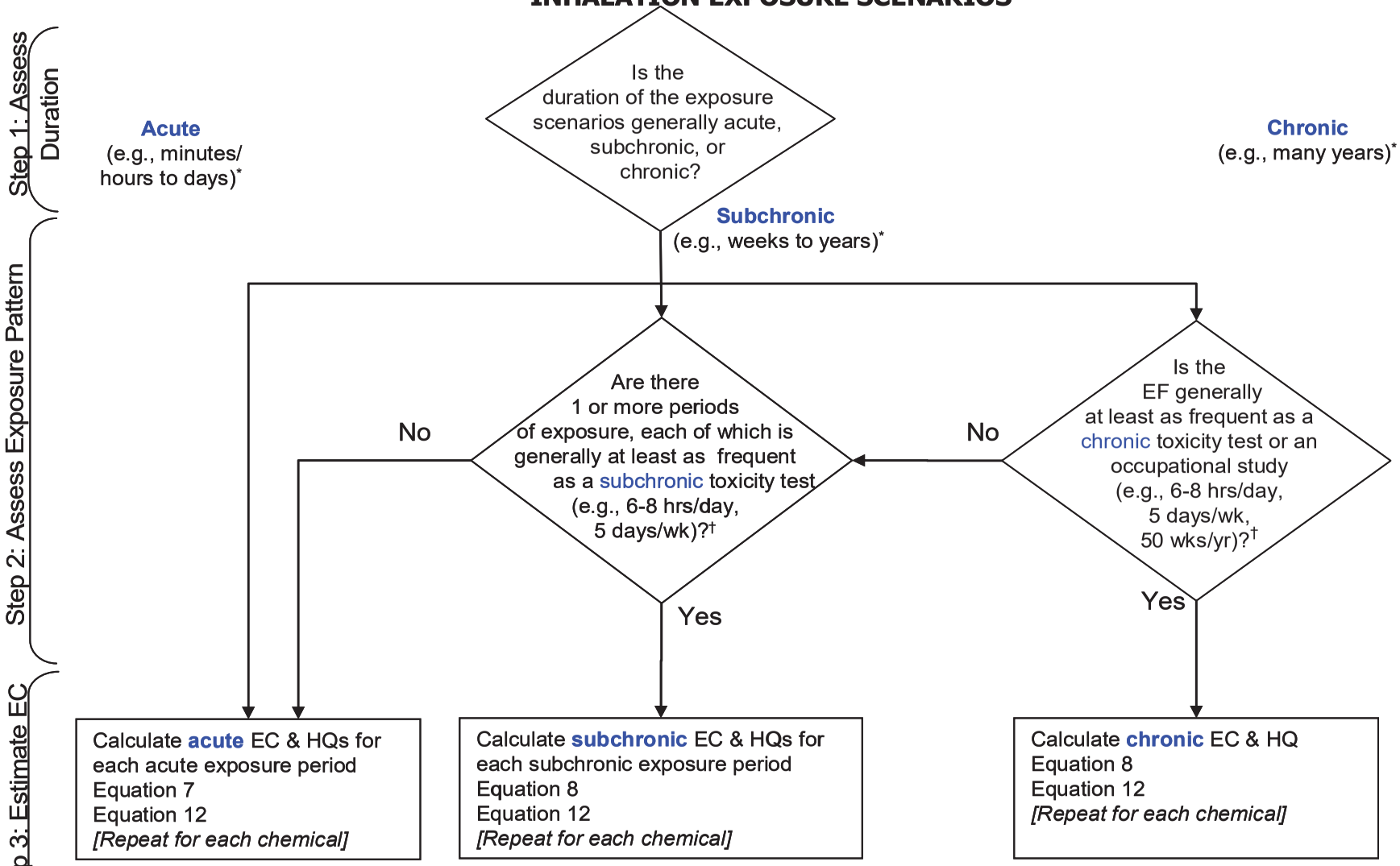
Step 2 of the recommended process for estimating an EC for use in a hazard quotient involves assessing the exposure pattern for each exposure scenario at a site. This entails comparing the exposure time and frequency at a site to that of a typical subchronic or chronic toxicity test.[28]

[26] Note that other sources of toxicity values may define exposures differently. For example, the Agency for Toxic Substances and Disease Registry (ATSDR) (which publishes Minimal Risk Levels (MRLs)) defines acute exposures as occurring from one to 14 days, intermediate exposures as greater than 14 to 364 days, and chronic exposures as 365 days or longer. However, the toxicity values are based on the same underlying toxicological concepts described in this section.

[27] Exposures with a duration lasting between 24 hours and 30 days should be treated as subchronic for the purposes of this document.

[28] Exposure regimens vary from study to study. Risk assessors should use best professional judgment to determine if the exposure pattern in a given scenario is reasonably similar to a typical regimen for a subchronic or chronic study.

FIGURE 2
RECOMMENDED PROCEDURE FOR DERIVING EXPOSURE CONCENTRATIONS AND HAZARD QUOTIENTS FOR INHALATION EXPOSURE SCENARIOS



* The specific definition for each duration category may vary depending on the source of the toxicity value being used. For Tier 1 toxicity values obtained from IRIS:
acute exposures are defined as those lasting 24 hours or less;
subchronic exposures are defined as repeated exposures for more than 30 days, up to approximately 10 percent of the life span in humans; and
chronic exposures are defined as repeated exposures for more than approximately 10 percent of the life span in humans (EPA, 2008b).
For the purposes of this document, short-term exposures, defined by the IRIS glossary as repeated exposures for more than 24 hours, up to 30 days, should be treated as subchronic.

† Exposure regimens vary from study to study. Risk assessors should use best professional judgment to determine if the exposure pattern in a given scenario is reasonably similar to a typical regimen for a chronic or subchronic study.

For exposure scenarios with a subchronic duration, risk assessors should follow the center path on the flowchart. Step 2 in this path asks whether there are one or more periods of exposure, each of which is generally as frequent as a subchronic toxicity test (e.g., 6-8 hours per day, 5 days per week). If the exposure scenario matches this description, risk assessors should proceed to Step 3 and estimate a subchronic EC for each subchronic exposure period. However, if the exposure pattern contains periods that are significantly shorter and/or involve significantly less frequent exposures than indicated in the flow chart, risk assessors should derive acute ECs for each of these exposure periods. If it is difficult to determine whether a specific exposure scenario is best modeled as a subchronic exposure or as a series of independent acute exposures, due to uncertainty in the time required to return to baseline following exposure, risk assessors may want to derive ECs using both approaches.

If the exposure scenario has a chronic duration, risk assessors should follow the right hand path on the flowchart. Step 2 in this path asks whether the exposure frequency (EF) is generally as frequent as a chronic animal toxicity test or a human occupational study (e.g., 6-8 hours per day, 5 days per week, for 50 weeks per year). If the exposure scenario matches this description, risk assessors should proceed to Step 3 and estimate a single chronic EC. However, if the scenario differs significantly from this pattern, risk assessors should proceed to the second question under the subchronic duration path and proceed as outlined above.

3.3.3 Step 3: Estimate Exposure Concentration

Step 3 of the recommended process involves estimating the EC for the specific exposure scenario based on the decisions made in Steps 1 and 2. For acute exposures, the EC is equal to the CA. Risk assessors can estimate an acute EC for each acute exposure period at a site using Equation 7. For longer-term exposures, risk assessors should take into consideration the exposure time, frequency, and duration for each receptor being evaluated as well as the period over which the exposure is averaged (i.e., the averaging time (AT)) to arrive at a time-weighted EC. If there are one or more exposure periods that are generally as frequent as a subchronic toxicity test, risk assessors should use Equation 8 to estimate a subchronic EC for each of these exposure periods. (Exposure periods with significantly less frequency should be treated as acute exposures.) If the exposure pattern is generally as frequent as a chronic toxicity test of an occupational study, risk assessors should use Equation 8 to estimate a single chronic EC for the duration of the exposure.

Acute Exposures

EC = CA **(Equation 7)**

Where: EC ($\mu g/m^3$) = exposure concentration;
CA ($\mu g/m^3$) = contaminant concentration in air;

Chronic or Subchronic Exposures

EC = (CA x ET x EF x ED)/AT **(Equation 8)**

Where: EC ($\mu g/m^3$) = exposure concentration;
CA ($\mu g/m^3$) = contaminant concentration in air;
ET (hours/day) = exposure time;
EF (days/year) = exposure frequency;
ED (years) = exposure duration; and
AT (ED in years x 365 days/year x 24 hours/day) = averaging time

Note: If the duration of the exposure period is less than one year, the units in the above equation can be changed to the following: EF (days/week); ED (weeks/exposure period); and AT (hours/exposure period).

It is important to use the EC equation that most closely matches the exposure pattern and duration at a site. For instance, if the exposure pattern at a site consists of a series of short (e.g., 4-hour) periods of high exposure separated by several days of no exposure, the approach outlined above recommends estimating an acute EC for each acute exposure period. If the chronic EC equation (Equation 8) were to be used instead, the result would be an average EC value that may lead to an underestimate of risk since the inhaled concentrations could be higher than acute toxicity values during periods of exposure.

3.4 Estimating Exposure Concentrations in Multiple Microenvironments

When detailed information on the activity patterns of a receptor at a site is available, risk assessors can use these data to estimate the EC for either non-carcinogenic or carcinogenic effects. The activity pattern data describe how much time a receptor spends, on average, in different microenvironments (MEs), each of which may have a different contaminant concentration level.[29] By combining data on the contaminant concentration level in each ME and the activity pattern data, the risk assessor can calculate a time-weighted average EC for a receptor. Because activity patterns (and hence, MEs) can vary over a receptor's lifetime, EPA recommends that risk assessors pursuing the ME approach first calculate a time-weighted average EC for each exposure period characterized by a specific activity pattern (e.g., separate ECs for a school-aged child resident and a working adult resident). These exposure period-specific ECs can then be combined into a longer term or lifetime average EC by weighting the EC by the duration of each exposure period. The following sections further explain these two steps.

3.4.1 Using Microenvironments to Estimate an Average Exposure Concentration for a Specific Exposure Period

The ME approach can be used to estimate an average EC for a particular exposure period during which a receptor has a specified activity pattern. As a simplified example, a residential receptor may

[29] EPA defines a microenvironment in *Air Quality Criteria for Particulate Matter: Volume II* as a defined space that can be treated as a well-characterized, relatively homogeneous location with respect to pollutant concentration for a specified time period (e.g., rooms in homes, restaurants, schools, offices, inside vehicles, or outdoors) (USEPA, 2004b).

be exposed to a higher concentration of a contaminant in air in the bathroom for 30 minutes per day while showering, and exposed to a lower concentration in the rest of the house for the remaining 23.5 hours per day. In this case, risk assessors can use the CA value experienced in each ME weighted by the amount of time spent in each ME to estimate an average EC for the period of residency in that house using Equation 9.[30] This approach may also be used to address exposures to contaminants in outdoor and indoor environments at sites where both indoor and outdoor samples have been collected or where the vapor intrusion pathway has been characterized.

$$EC_j = \sum_{i=1}^{n} (CA_i \times ET_i \times EF_i) \times ED_j / AT_j \qquad \textbf{(Equation 9)}$$

Where:
EC_j ($\mu g/m^3$) = average exposure concentration for exposure period j;
CA_i ($\mu g/m^3$) = contaminant concentration in air in ME i;
ET_i (hours/day) = exposure time spent in ME i;
EF_i (days/year) = exposure frequency for ME i;
ED_j (years) = exposure duration for exposure period j; and
AT_j (hours) = averaging time = ED_j x 24 hours/day x 365 days/year.

3.4.2 Estimating an Average Exposure Concentration Across Multiple Exposure Periods

To derive an average EC for a receptor over multiple exposure periods, the average EC from each period (as calculated above in Equation 9) can be weighted by the fraction of the total exposure time that each period represents, using Equation 10. For example, when estimating cancer risks, the risk assessor may calculate a lifetime average EC where the weights of the individual exposure periods are the duration of the period, ED_j, divided by the total lifetime of the receptor. Alternatively, when estimating an HQ, risk assessors can use Equation 10 to calculate less-than-lifetime average ECs across multiple exposure periods. In that case, the AT will equal the sum of the individual EDs for all of the exposure periods.

$$EC_{LT} = \sum_{i=1}^{n} (EC_j \times ED_j) / AT \qquad \textbf{(Equation 10)}$$

Where:
EC_{LT} ($\mu g/m^3$) = long-term average exposure concentration;
EC_j ($\mu g/m^3$) = average exposure concentration of a contaminant in air for exposure period j;
ED_j (years) = duration of exposure period j; and
AT (years)[1] = averaging time.

[1] When evaluating cancer risk, the AT is equal to lifetime in years. When evaluating non-cancer hazard, the AT is equal to the sum of the EDs for each exposure period.

[30] If one or more MEs involve acute exposures, risk assessors should conduct a supplemental analysis comparing the CA for each of those MEs to a corresponding acute toxicity value to ensure that receptors are protected from potential acute health effects.

4. SELECTING APPROPRIATE TOXICITY VALUES

After characterizing the exposure scenarios and estimating ECs for each receptor at a site, the risk assessor should select appropriate inhalation toxicity values for each inhaled contaminant. For estimating cancer risks, this typically involves identifying and evaluating available published cancer potency estimates. For estimating HQs, this typically involves identifying and evaluating reference values that match the characterization of the exposure scenario from Figure 2 (i.e., acute, subchronic, or chronic reference values).

This section provides guidance for the selection of toxicity values appropriate for assessing risk under inhalation exposure scenarios. It describes sources for the most current inhalation data and provides guidance for proceeding when published inhalation toxicity data are not available.

4.1 Sources for Inhalation Toxicity Data

The OSWER Directive, *Human Health Toxicity Values in Superfund Risk Assessment* (USEPA, 2003), provides a recommended hierarchy of toxicological data sources to guide risk assessors when selecting appropriate toxicity values. This document sets out a recommended three-tiered framework for selecting human toxicity values. Tier 1 consists of EPA's IRIS, Tier 2 consists of EPA's PPRTVs, and Tier 3 includes other toxicity values as recommended by NCEA, such as the California EPA toxicity values, the Agency for Toxic Substances and Disease Registry's (ATSDR's) Minimal Risk Levels (MRLs), and Health Effects Assessment Summary Table (HEAST) toxicity values. Priority in Tier 3 should be given to sources that are the most current and those that are peer reviewed. Consultation with the Superfund Headquarters office is recommended regarding the use of Tier 3 values for Superfund response decisions when the contaminant appears to be a risk driver for the site.

The most up-to-date information on Superfund-supported cancer potency estimates and chronic and subchronic cancer and non-cancer reference values for inhaled contaminants are available on the Superfund risk assessment website (www.epa.gov/oswer/riskassessment/superfund_toxicity.htm). Superfund-recommended sources for acute non-cancer toxicity values can be found at www.epa.gov/oswer/riskassessment/superfund_acute.htm.[31]

In situations where the desired reference value (e.g., acute, subchronic, chronic) is not available, risk assessors may use a reference value based on the next longer duration of exposure as a conservative estimate that would be protective for a shorter-term ED (USEPA, 2002c). For example, if a risk assessor determines that an ED at a site is subchronic, but no subchronic toxicity value is available, a chronic RfC can be used to assess hazard.

EPA recommends that toxicity values published in Superfund-supported sources should generally be used in the risk equations presented in this guidance, without modification. This includes IURs on IRIS that were calculated from oral values using a default ventilation rate and BW (see Appendix B for a list of these chemicals). It is not generally appropriate to make adjustments to these values

[31] In selecting an acute toxicity value, risk assessors should consider the duration associated with their estimate of exposure (e.g., a 1-hour versus a 24-hour air sample). Use of a toxicity value specified for a longer duration than that of the exposure estimate may overestimate hazard, while the use of a shorter duration acute reference value may underestimate hazard.

based on IR and BW using the intake equation, because the amount of the chemical that reaches the target site through the inhalation pathway is not a simple function of these parameters (see Section 1.2). Use of the toxicity values listed in Appendix B should be noted in the uncertainty section of the risk assessment (see Section 9).

4.2 Recommended Procedures for Assessing Risk in the Absence of Inhalation Toxicity Values

The following section provides guidance on recommended procedures for situations where inhalation toxicity values are not available in any of the toxicity data sources described in Section 4.1.

If RfC and IUR values are not available for an inhaled contaminant, risk assessors should first contact NCEA's STSC for guidance.[32] Risk assessors working on Superfund sites can contact STSC to determine whether a provisional peer-reviewed toxicity value (PPRTV) exists for a contaminant; if not, the risk assessor, in cooperation with the appropriate EPA Regional office may request that STSC develop a PPRTV document or that STSC develop an inhalation toxicity value as a "consult". The latter would be specific to the site in question only. Additional information on STSC's current process for developing alternative toxicity values is described in Appendix C.

If STSC indicates that no quantitative toxicity information for the inhalation route is available, the risk assessor should conduct a qualitative evaluation of this exposure route. The risk assessor should discuss in the uncertainty section of the risk assessment report the implications of not quantitatively assessing risks due to inhalation exposures to chemicals lacking inhalation toxicity data. See the section on Risk Characterization (Section 9) in this guidance for more information.

Performing simple route-to-route extrapolation without the assistance of STSC is generally not appropriate because hazard may be misrepresented when data from one route are substituted for another without any consideration of the pharmacokinetic differences between the routes (USEPA, 1998). The following circumstances, outlined in the *Inhalation Dosimetry Methodology* (page 4-6), are specific examples of situations when route-to-route extrapolation from oral toxicity values might not be appropriate, even for use during screening:

- When groups of chemicals are expected to have different toxicity by the two routes – for example, metals, irritants, and sensitizers;
- When a first-pass effect by the respiratory tract is expected;
- When a first-pass effect by the liver is expected;
- When a respiratory tract effect is established, but dosimetry comparison cannot be clearly established between the two routes;
- When the respiratory tract was not adequately studied in the oral studies; and
- When short-term inhalation studies, dermal irritation, in vitro studies, or characteristics of the chemical indicate the potential for portal-of-entry effects at the respiratory tract, but studies themselves are not adequate for inhalation toxicity value development.

[32] All contact with STSC should be performed by an EPA regional risk assessor. States and other entities should first contact their EPA regional risk assessor with questions on inhalation toxicity values. Regional risk assessors can then contact STSC on their behalf.

The *Cancer Guidelines* (USEPA, 2005a) includes the following statement regarding route-to-route extrapolation:

> "When a qualitative extrapolation can be supported, quantitative extrapolation may still be problematic due to the absence of adequate data. The differences in biological processes among routes of exposure (oral, inhalation, dermal) can be great because of, for example, first-pass effects and different results from different exposure patterns. There is no generally applicable method for accounting for these differences in uptake processes in a quantitative route-to-route extrapolation of dose-response data in the absence of good data on the agent of interest. Therefore, route-to-route extrapolation of dose data relies on a case-by-case analysis of available data" (page 3-10).

5. ESTIMATING RISKS

This section provides updated equations recommended for estimating excess cancer risks and HQs from inhaled contaminants of concern at Superfund sites. Please see Section 8.2.1 of *RAGS, Part A* for further information about how to interpret calculated excess cancer risks and HQs.

5.1 Cancer Risks Characterized by an Inhalation Unit Risk

The excess cancer risk for a receptor exposed via the inhalation pathway can be estimated with the following equation:

Risk = IUR x EC **(Equation 11)**

Where: IUR $(\mu g/m^3)^{-1}$ = Inhalation Unit Risk; and
EC $(\mu g/m^3)$ = exposure concentration (See Equation 6).

When estimated ECs are above the POD used for the low dose extrapolation described in Section 2.3, a linear concentration-response relationship may not hold.[33] In such situations, the risk assessor should not use toxicity values developed through low dose extrapolation techniques. Instead, the risk assessor may report semi-quantitative risk estimates (e.g., risks are greater than 10^{-2}) or estimate risk using the original model underlying the toxicity value, which can be found in the technical support document for the value (e.g., IRIS profile, PPRTV Assessment).

When estimating cancer risks for children, risk assessors should be aware of chemicals that pose a higher risk of cancer when exposure occurs during early life. If evidence exists suggesting differences in risk across age groups for a chemical, this typically will be considered in the derivation of the toxicity value and described in the chemical's technical support document.

[33] Reviews of chemical-specific IRIS files indicate that the risk level corresponding to the concentration level above which the IUR should not be used often falls at or near 10^{-2}. However, this risk level varies by chemical and, therefore, risk assessors should refer to the toxicity value's technical support document for information on the concentration range for which the IUR was intended to be used.

Chemicals that have been determined to cause cancer by a mutagenic mode of action (MOA) are thought to pose a higher risk during early life. An EPA-recommended procedure exists for assessing risks from these chemicals. Figure 3 summarizes the recommendations of the *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens* (USEPA, 2005b; hereafter *Supplemental Cancer Guidelines*) on how to adjust childhood risk calculations to account for chemicals with a mutagenic MOA for carcinogenicity. Please refer to the *Supplemental Cancer Guidelines* (USEPA, 2005b) for a list of chemicals with a mutagenic MOA that were used in the development of that document.

In addition, EPA's website for the "Handbook for Implementing the Supplemental Cancer Guidance at Waste and Cleanup Sites" contains an up-to-date list of chemicals that EPA has determined to have a mutagenic MOA (http://www.epa.gov/oswer/riskassessment/sghandbook/index.htm). As chemicals receive new assessments for mutagenicity, this information will appear in the IRIS profile or PPRTV assessment.

FIGURE 3
GUIDANCE ON ASSESSING RISK FROM EARLY-LIFE EXPOSURES FOR CHEMICALS ACTING BY A MUTAGENIC MODE OF ACTION FOR CARCINOGENICITY

If a chemical has been determined to cause cancer by a mutagenic MOA, it is possible that exposures to that chemical in early-life may result in higher lifetime cancer risks than a comparable duration adult exposure.

In risk assessments of exposure to chemicals for which a mutagenic MOA for carcinogenicity has been determined by EPA and a linear low-dose extrapolation performed, one of the following generally pertains:

1) If chemical-specific data on susceptibility from early-life exposures were available for derivation of CSFs, those slope factors are used for risk characterization, and Age Dependent Adjustment Factors (ADAFs) are not applied.
2) If chemical-specific data on susceptibility from early-life exposures were not available, the ADAFs are applied in calculating or estimating risks associated with early-life exposures (USEPA, 2005c).

If the latter case applies, the *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens* (USEPA, 2005b) recommends the following default ADAFs be applied in risk assessments:

- 10-fold adjustment for exposures during the first 2 years of life;
- 3-fold adjustment for exposures from ages 2 to <16 years of age; and
- No adjustment for exposures after turning 16 years of age.

In such cases, Equation 11 can be altered to include the ADAFs in the following way:

$$\text{Risk} = (\text{IUR} \times \text{EC}_{<2} \times \text{ADAF}_{<2}) + (\text{IUR} \times \text{EC}_{2\text{-}16} \times \text{ADAF}_{2\text{-}16}) + (\text{IUR} \times \text{EC}_{>16})$$

Sources: USEPA, 2005b and USEPA, 2005c.
Note: All communications and factsheets pertaining to the implementation of the 2005 *Cancer Guidelines* can be found at www.epa.gov/osa/spc/cancer_guidelines.htm.

REC 5277

5.2 Hazard Quotients

The HQ for the inhalation pathway can be calculated with the following general equation:

HQ = EC/(Toxicity Value[1] x 1000 µg/mg) **(Equation 12)**

Where: HQ (unitless) = Hazard Quotient;
EC ($\mu g/m^3$) = exposure concentration (See Equations 7 or 8);
Toxicity Value (mg/m^3) = Inhalation toxicity value (e.g., RfC) that is appropriate for the exposure scenario (acute, subchronic, or chronic).

[1] Risk assessors should refer to the flowchart (Figure 2) to select an appropriate inhalation toxicity value for the exposure scenario at a site in order to calculate the HQ.

6. EXAMPLE EXPOSURE SCENARIOS

This section of the guidance includes examples of the types of exposure scenarios risk assessors may encounter when evaluating inhalation exposures at waste sites. Each scenario includes sample values for exposure parameters and reviews the process of estimating the EC and risks for cancer and other health effects. These examples are provided for illustrative purposes only and are not representative of every exposure scenario that could be encountered at a site. Furthermore, risk assessors should use site-specific values for exposure parameters if practicable when estimating ECs and risk levels or HQs. This would typically require some information on activity patterns for the specific site or the use of professional judgment. If default values are to be used for certain exposure parameters, please consult the Superfund website for up-to-date information on Superfund-recommended default exposure parameters.[34]

6.1 Residential Receptor

An example of a residential scenario could consist of inhalation exposure for up to 24 hours per day, up to 350 days per year for 6 to 30 years. When estimating cancer risk for this type of scenario, Equation 6 is recommended to calculate an EC and Equation 11 is recommended to estimate risk. For estimating hazard quotients for cancer or non-cancer effects, this scenario can be evaluated using the steps outlined in Figure 2. The duration of this scenario ranges from 6 to 30 years, which can be considered chronic (because it consists of repeated exposures for approximately 10 percent of a receptor's lifespan). The frequency of this scenario is generally as frequent as a chronic toxicity test and therefore Equation 8 is recommended to derive a chronic EC and Equation 12 with a chronic toxicity value is recommended to calculate an HQ. If information about multiple MEs is available, risk assessors should proceed according to Section 3.4 to estimate ECs to use in estimating cancer risks or HQs.

When assessing the risk under the residential scenario for children, the risk assessor should keep in mind that exposure parameters, specifically those related to activity patterns (e.g., exposure time, frequency, and duration) may be different for children and adults at the same site. For example, due

[34] http://www.epa.gov/oswer/riskassessment/superfund_hh_exposure.htm.

to outdoor play patterns, children may spend more time near the source of contamination than adults, and thus would have higher exposure time and/or exposure frequency values than adults living in the same location.[35] For indoor vapor intrusion from the subsurface, very young children might be more highly exposed due to substantial time spent indoors.

Beyond the consideration of activity patterns, MEs, and chemicals with a mutagenic MOA for carcinogenicity (as described in Section 5.1), no additional adjustments to account for specific child receptors should be made to the default values. Appendix A of this document is intended to illustrate that the use of default values sufficiently covers age-related variation in DAF or HEC values derived using the EPA *Inhalation Dosimetry Methodology's* default approach.

6.2 Commercial-Industrial/Occupational Receptor

An example of a commercial-industrial or occupational inhalation exposure scenario could be characterized by full-time workers (e.g., 8 hours per day, 5 days per week) in an indoor setting, such as an office building, exposed via vapor intrusion of subsurface contamination on a daily basis for 5 to 25 years. When estimating cancer risk for this type of scenario, Equation 6 is recommended to calculate an EC and Equation 11 is recommended to estimate risk. Following the flowchart in Figure 2, the duration and exposure pattern of this scenario would typically be considered chronic. Therefore, Equation 8 is recommended to derive a chronic EC and Equation 12 is recommended (with a chronic RfC) when calculating an HQ for cancer or non-cancer effects. If information about multiple MEs is available, risk assessors should proceed according to Section 3.4 when deriving ECs to use in estimating cancer risks or HQs. Exposure parameters should be adjusted to consider the exposure time, frequency and duration for this scenario, which may differ from a residential scenario. Risk assessors should also use appropriate exposure parameters for outdoor workers who, similar to children, may spend more time near a source of contamination than indoor workers.

6.3 Construction Worker

One example of a construction worker scenario could involve a long-term project (1-2 years) with workers exposed regularly to contaminant vapors and fugitive dust (8 hours per day, 5 days per week). When estimating cancer risk for this type of scenario, Equations 6 and 11 are recommended to calculate an EC and the risk estimate, respectively. Following the flowchart in Figure 2, the duration of this exposure scenario would typically be considered subchronic. In addition, this exposure is generally as frequent as a subchronic toxicity test. Therefore, Equation 8 is recommended to derive a subchronic EC, and Equation 12 is recommended for use with a subchronic toxicity value to calculate the HQ. If information about multiple MEs is available, risk assessors should proceed according to Section 3.4 when deriving ECs to use in estimating cancer risks or HQs.

6.4 Trespasser/Recreational Receptor

An example trespasser/recreational scenario could consist of an exposure of 1 to 2 hours per day, for 100 days per year or less. When estimating cancer risk for this type of scenario, Equations 6 and 11

[35] For additional information about early-lifestage age groups to consider when assessing children's exposure to environmental contaminants, please consult EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (EPA, 2005d).

are recommended to calculate an EC and the risk estimate, respectively. Following the steps in Figure 2 for cancer or non-cancer effects characterized by an RfC, each exposure period should be assessed separately because this exposure lasts only one to two hours each day for an average of two days per week. Therefore, Equation 7 is recommended to derive acute ECs for each exposure period. In addition, Equation 12 is recommended for use with an acute toxicity value to calculate HQs for each exposure period.

7. TARGET CONCENTRATIONS FOR SCREENING ANALYSIS OF INHALATION PATHWAYS

For purposes of this guidance, risk-based screening levels are values that may be compared to the contaminant concentration in air to help risk assessors identify potential contaminants of concern. Screening levels can also be calculated for comparison with samples from source media at a site, such as soil. Screening levels are generally not appropriate for use as clean-up levels; they are intended to aid in initial evaluation of contaminants and exposure pathways of concern prior to proceeding with a baseline risk assessment.[36] If contaminant concentrations in air exceed the risk-based screening levels appropriate for the receptor population of interest, risk assessors should gather site-specific information to determine the need for any remedial action. The following sections outline a recommended approach for calculating screening levels in air as well as source media.

7.1 Target Contaminant Concentrations in Air

The equations recommended for estimating ECs and risk (Equations 6 through 12) can be used to calculate target contaminant concentrations in air by following the four steps outlined below in Table 4.[37]

If air samples from a site are found to be below the target concentration, the risk assessor can generally conclude that this pathway does not pose an unacceptable level of risk from the contaminant. If the concentrations are found to exceed the screening levels, the risk assessor should evaluate the inhalation pathway further by gathering additional site-specific data on contaminant levels, site conditions, and receptor characteristics.

7.2 Screening Levels for Other Media

Inhalation risk-based screening levels may also be calculated for media other than air, including soils, tap water, soil gas, and ground water. The soil gas and ground water values may be derived specifically to address concerns about vapor intrusion from subsurface contamination into indoor spaces.

---

[36] EPA regions, states, or other agencies may support unique screening levels for specific purposes that may differ from the method presented in this document. Generally, when using screening levels it is important that risk assessors understand the target risks, toxicity, and exposure assumptions as well as migration-attenuation assumptions on which they are based, and to apply them for their intended use.

[37] Target contaminant concentrations in air calculated according to the procedure outlined in this document are generally protective for direct inhalation exposures. This process should not be used to calculate concentrations in air to be protective of indirect exposures (e.g., ingestion of crops contaminated through air delivery or vapor phase transfer, ingestion of livestock or fish contaminated indirectly through air deposition or vapor phase transfer).

TABLE 4
RECOMMENDED PROCEDURE FOR CALCULATING RISK-BASED SCREENING CONCENTRATIONS FOR CONTAMINANTS IN AIR

	Cancer Risk-Based	Hazard-Based[1]
Step 1: Select Target Levels	Select target cancer risk (e.g., 1×10^{-6}).	Select target HQ (e.g., 1).
Step 2: Identify Toxicity Value[2]	Identify inhalation cancer potency value (e.g., IUR). If none exists, proceed with hazard-based screening level calculation.	Identify inhalation reference value (e.g., RfC) to match exposure scenario (acute, subchronic, or chronic). If none exist, proceed with cancer screening level calculation.
Step 3: Calculate CA	Using target cancer risk from Step 1 along with the receptor- and scenario-specific exposure parameter values, calculate CA; the following equation is recommended: CA = (AT x Target Risk)/(IUR x ET x EF x ED)	Using target HQ from Step 1 along with the receptor- and scenario-specific exposure parameter values, calculate CA; the following equation is recommended: CA = (AT x Target HQ x RfC x 1000 µg/mg)/(ET x EF x ED)
Step 4: Select Screening Concentration	Select minimum of predicted cancer risk- and hazard-based values as screening concentrations.[3] Repeat for each receptor/scenario combination of interest.	

[1] Hazard-based screening concentrations are typically derived from reference values such as RfCs. These values may be available for non-cancer effects but may include cancer, if a nonlinear MOA is thought to operate for a chemical.
[2] If no inhalation toxicity value is available for a chemical, contact STSC for further direction on how to proceed.
[3] Screening levels estimated from the equations presented in Step 3 could yield concentrations that exceed the maximum possible vapor concentration for a chemical. In such cases, it may be useful to calculate the maximum possible vapor concentration of the pure contaminant at the temperature of interest, using the following formula: $C_{max} = S \times H \times 10^3$ L/m^3, where S = solubility at 25° C (or temperature of interest) and H (unitless) = Henry's Law Constant at 25° C (or temperature of interest). This equation is based on an established relationship (see, for example, Schwartzenbach et al. 1993), that allows the Henry's Law Constant to be estimated as the ratio of a compound's vapor pressure and aqueous solubility for compounds that are slightly to moderately soluble in water. When the dimensionless Henry's Law constant, H, is used, the relationship described above can be used to calculate the vapor concentration of a saturated solution of a given compound, assuming equilibrium between the vapor and aqueous phases.

7.2.1 Soil Screening Levels

When evaluating risk in a source medium, such as soil, it is typically possible to calculate screening levels for that medium that are expected to be protective of inhalation exposures based on the expected transfer of a contaminant from the source medium to the air. Soil Screening Levels (SSLs) can be described as "risk-based soil concentrations derived for individual chemicals of concern from standardized sets of equations. These equations combine EPA chemical toxicity data with parameters defined by assumed future land uses and exposure scenarios, including receptor characteristics and potential exposure pathways" (USEPA, 2002b). These SSLs may be used for screening analyses and may serve as the basis for the development of Preliminary Remediation Goals (PRGs). Refer to the *Soil Screening Guidance* (USEPA, 1996) and the *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (USEPA, 2002b) for recommended equations that can be used to calculate SSLs for volatilization of chemicals from soil to air and for particulate emissions.

7.2.2 Tap Water Screening Values

Contaminated tap water may pose risk by the inhalation route if the contaminants present are volatile. Screening levels can be calculated for tap water that account for inhalation exposures resulting from the household use of water (e.g., showering, laundering, dishwashing). Risk assessors should consult their local EPA regional risk assessor for direction on how to calculate appropriate screening levels for tap water.

7.2.3 Soil Gas or Ground Water Screening Values for Vapor Intrusion

If there is concern at a site about the possibility of migration of vapor-forming chemicals from contaminated soil gas or ground water into the indoor air of overlying buildings ("vapor intrusion"), screening values can be calculated for these media. Risk assessors should first follow the procedure outlined in Section 7.1 and Table 4 to calculate a risk-based target concentration for the contaminant in air.

For the calculation of a soil gas screening-level concentration, the target air concentration is then divided by an assumed screening-level attenuation factor. The attenuation factor (the ratio of indoor air divided by subsurface source concentration) represents the factor by which subsurface vapor concentrations migrating into indoor air spaces are reduced due to a variety of attenuating mechanisms.

For the calculation of a ground water screening-level concentration, the target air concentration is divided by an assumed screening-level attenuation factor, and the resulting soil gas concentration is converted to a corresponding ground water concentration, assuming equilibrium between the aqueous and vapor phases at the water table.

Risk assessors should consult their local EPA regional risk assessor for direction on how to calculate appropriate screening levels for soil gas and ground water when vapor intrusion is an issue at a site.

8. DEVELOPING AGGREGATE AND CUMULATIVE RISK ESTIMATES

EPA's current approach to estimating cumulative risk or hazard at a site from multiple chemicals, set forth in *RAGS, Part A* (USEPA, 1989), is not affected by the *Inhalation Dosimetry Methodology* and therefore is not being updated at this time. In addition, the aggregation of risks and hazards across multiple exposure routes should remain unchanged. The recommended approaches for aggregating risk and hazard estimates are outlined below.

8.1 Estimating Cumulative Risks and Hazards Across Multiple Chemicals

The recommended method for estimating cumulative risk and hazard at a site from exposure to multiple chemicals is described in *RAGS, Part A*, Section 8.2.2. This method is based on the default approaches described in *Guidelines for the Health Risk Assessment of Chemical Mixtures* (USEPA, 1986). Additional information on this method was subsequently published in the *Supplementary Guidance for Conducting Health Risk Assessment of Chemical Mixtures* (USEPA, 2000b). The recommended methods to use with quantitative cancer risk estimates as well as with HQs are outlined below.

REC 5282

8.1.1 Cancer Risks

When evaluating predicted cancer risks from multiple contaminants, risk assessors should estimate the cancer risk for each substance and then sum these risks. This yields an estimate of total cancer risk, which represents the cumulative predicted cancer risk for the chemicals at a site.

Risk assessors should note, however, that this recommended method assumes "independence of action by the compounds involved (i.e., that there are no synergistic or antagonistic chemical interactions and that all chemicals produce the same effect, i.e., cancer)" (USEPA, 1989). In addition, this simple additive approach is generally most appropriate for total cancer risks less than 0.1. If these assumptions are incorrect, over- or under-estimation of actual multiple-substance risk could result (USEPA, 1989).

8.1.2 Hazard Quotients

When the evaluation involves multiple chemicals assessed via HQs, risk assessors typically first calculate the HQ for each substance, and then sum the individual HQ values. This generally yields an estimated hazard index (HI) for the multiple chemicals assessed via a hazard-based approach. Separate HIs should be calculated for each type of exposure period (i.e., chronic, subchronic, acute). If an HI is greater than 1, it is generally appropriate to derive separate HIs for each target organ of concern (for more information, see *RAGS, Part A*, page 8-14).[38] When multiple acute exposures are present at a site, risk assessors should evaluate each acute exposure event separately. Hazards from multiple chemicals generally should be summed only when the exposures to these chemicals occur simultaneously.[39]

8.2 Aggregating Risk and Hazard Quotients Across Exposure Routes

Guidance for combining the multi-chemical risk estimates and hazard quotients across exposure pathways is described in *RAGS, Part A*, Section 8.3 (USEPA, 1989). In order to determine whether risks or HIs should be combined across exposure pathways, risk assessors should first identify reasonable exposure pathway combinations. Then, risk assessors should examine whether it is likely that the same individuals would consistently face the reasonable maximum exposure (RME) by more than one pathway.

---

[38] This recommended method assumes that "the dose for each individual component is at a level at which effects are not expected to occur, be observable, or be of concern; however, when the doses are combined, effects of concern may be expected or observed in response to the higher dose level of the mixture" (EPA, 2000b, page 12). Another assumption of the HI approach is that the compounds induce the same effect by the same mechanism of action. Therefore, "application of the HI equation to a number of compounds that are not expected to induce the same type of effects or that do not act by the same mechanism, although appropriate as a screening-level approach, could overestimate the potential for effects" (EPA, 1989, page 8-14). This is generally less of a concern if one to two substances are responsible for driving the HI above 1.

[39] In cases where a single chemical is present at a site and receptors are exposed through a series of acute exposure events, the highest single EC should be compared to an acute reference value of the appropriate duration to assess hazard.

The recommended approach for estimating excess cancer risk from exposure via multiple routes is to first estimate cancer risk from each exposure pathway and then sum across the multiple routes.[40]

For the effects assessed via a reference value, risk assessors should calculate the HI for each exposure pathway and sum across the multiple routes. Separate total HIs should be calculated for each type of exposure period (i.e., chronic, subchronic or acute). If the HI exceeds one, there may be concern for potential adverse effects and risk assessors should consider deriving separate HIs for each target organ of concern.

9. RISK CHARACTERIZATION

Risk characterization is the final, summarizing step in conducting a risk assessment. Generally, the purpose of the risk characterization section of a report is to:[41]

- Describe the key findings of the risk assessment in a transparent manner, including identifying hazard, characterizing the dose-response relationship, and describing receptor exposures;
- Identify and describe the scientific and policy assumptions used in the assessment;
- Characterize uncertainties in results; and
- Provide an overall conclusion about the risks present at a site (USEPA, 2000c).

A well-crafted risk characterization section puts risk calculations into context for risk managers so that they may effectively weigh and interpret risk assessment results (i.e., it is the interface between risk assessment and risk management). A few of the key issues and uncertainties involved in calculating risks from inhalation exposures are outlined below.

9.1 Highly Exposed or Susceptible Populations and Life Stages

EPA recommends that the risk characterization portion of the risk assessment explain any particular susceptibilities to inhaled toxicants or potential for increased inhalation exposures among the various receptor groups at a site.[42] We discuss below two possible examples, children and worker receptors, though this discussion could apply to other receptor characteristics as well (e.g., age, disease, gender, genetic characteristics).

9.1.1 Children

One population group that could potentially be more highly exposed to inhalation exposures at a site is children. As discussed in Section 6.2, exposure parameters related to activity patterns (e.g., exposure time, frequency, and duration) and MEs, may vary across age groups. For example, due to outdoor play patterns, children may spend more time near the source of contamination than adults,

[40] Note that this approach is generally most appropriate for total cancer risks of less than 0.1 (EPA, 1989).

[41] For specific information on the format of risk characterizations, refer to *Elements to Consider when Drafting EPA Risk Characterizations* (EPA, 1995c).

[42] EPA's IRIS glossary defines susceptibility as the following: "Increased likelihood of an adverse effect, often discussed in terms of relationship to a factor that can be used to describe a human subpopulation (e.g., life stage, demographic feature, or genetic characteristic)" (EPA, 2008b).

REC 5284

and thus would have higher exposure time and/or exposure frequency values than adults living in the same location. Therefore, it is important to carefully describe site-specific exposures to children, and assumptions made in risk calculations.[43]

If chemical-specific data on susceptibility to the toxic effects from early life exposures are available, these data are considered when developing toxicity values that specifically address differential toxicity to the young (e.g., vinyl chloride) (USEPA, 2005c). Toxicity values derived using the default approach from the *Inhalation Dosimetry Methodology* are developed for the human population as a whole, including sensitive subgroups. Therefore, as described in Section 6 of Appendix A, no quantitative adjustment of toxicity values derived using the default approach in the *Inhalation Dosimetry Methodology* is recommended for specific age groups to account for different ventilation rates or body weights of specific age groups.

When evaluating risk to carcinogenic chemicals with a demonstrated mutagenic MOA but which lack chemical-specific information on susceptibility from early life exposures, EPA recommends a quantitative adjustment of the toxicity value to account for early life susceptibility, as described in the *Supplemental Cancer Guidelines* (see USEPA, 2005b & 2005c; and Section 5.1 of this guidance for further information).

9.1.2 Workers

Workers could have increased exposure under certain occupational scenarios. Some outdoor workers might spend more time near a source of contamination in the course of their job and this should be reflected in adjustments to the exposure parameters (e.g., ET, Exposure Frequency (EF), and ED) describing the worker exposure scenario. Toxicity values derived using the *Inhalation Dosimetry Methodology* are developed for the human population as a whole, including sensitive populations and life stages. In the default *Inhalation Dosimetry Methodology* approach, typical variation in IRs between periods of high activity and rest is considered. However, if workers have especially high levels of exertion with correspondingly high ventilation rates, these workers could be at the upper end of the risk range, particularly if they are exposed to Category 1 gases, which have direct effects in the respiratory tract. This implication should be recognized in the risk characterization section.

9.2 Uncertainties in Inhalation Risk Assessment

This guidance recommends including an assessment of the key uncertainties that may significantly impact risk estimates for inhaled chemicals. This should ensure transparency, clarity, reasonableness and consistency in risk assessments, as recommended by EPA's *Policy for Risk Characterization* (USEPA, 1995a). Other sources of uncertainty may be present and other EPA documents provide guidance on characterizing uncertainty in risk the assessment process (USEPA, 1992, 1995a, 1995b, 1995c, 1997a, 1997b). Key uncertainties related to inhalation risk assessment, which is the focus of this section, include the development of ECs, choice of toxicity value, lack of quantitative toxicity information via inhalation, and the approach to estimating and aggregating risks. According to EPA's *Guidance for Risk Characterization*, the discussion of uncertainty "should reflect the type and complexity of the risk assessment, with the level of effort for analysis and discussion of uncertainty

[43] For additional information on children's health risk assessment, please consult *A Framework for Assessing Health Risks of Environmental Exposures to Children* (EPA, 2006b).

corresponding to the level of effort for the assessment" (USEPA, 1995b). Therefore, risk assessors should provide a qualitative and/or quantitative evaluation of key uncertainties pertaining to inhalation risk, and their impact on the outcome of the assessment, consistent with the level of effort of the specific risk assessment.

9.2.1 Development of Exposure Concentrations

As described in Section 3 of this guidance, with the exception of acute exposures, time-weighted averages are typically used to represent intermittent or variable inhalation exposures to receptors at a site. This recommended approach is consistent with the duration adjustment approach (based on Haber's Law) that is generally used in deriving the toxicity values (see Section 2.1.1.1 for further information). As mentioned in Section 3, when evaluating situations in which the exposure is long-term, yet there are short periods of significantly higher exposure, those periods should also be assessed using appropriate short-term toxicity values. This ensures that periods of much higher exposure can be appropriately assessed and not "diluted out" in the assessment of longer-term exposure.

When information on multiple MEs exists at a site, risk assessors may choose to estimate ECs as outlined in Section 3.4. However, this typically requires sufficient time-activity information of receptors at a site to accurately determine the time spent in each ME. Incomplete or low quality data on time-activity pattern may introduce uncertainty into the estimation of the ECs for MEs. Risk assessors should describe the quality and completeness of these data.

The recommended method for determining the CA at a site can potentially introduce uncertainty into the EC calculations. For instance, if contaminant concentrations in air are measured, risk assessors should consider uncertainties related to how well the set of air samples available at a site represents the duration and time period being assessed as well as measurement uncertainty related to the methods and equipment used. In addition, risk assessors should describe any potential confounding of indoor air samples by other sources of contaminants (e.g., household products). If contaminant concentrations in air are modeled, (e.g., by EPA's spreadsheet models for vapor intrusion) risk assessors should address model-related uncertainties and their potential impact on the estimate of contaminant concentrations in air. Considerations of particle size at the site versus particle size used to derive the toxicity value are also important.

9.2.2 Toxicity Assessment

Section 4.1 of this document indicates that some IURs on IRIS were developed through extrapolation from oral CSFs (see Appendix B of this document). The use of toxicity values derived through simple route-to-route extrapolation introduces additional uncertainty into risk calculations. Therefore, risk assessors should indicate when extrapolated IURs are used and should characterize the potential impact of the uncertainty associated with using these values, if known.

Section 4.2 and Appendix C of this guidance recommends contacting STSC to help identify appropriate toxicity values for conducting a risk assessment at Superfund sites in the absence of published inhalation toxicity values. If STSC is unable to recommend a toxicity value, risk assessors should acknowledge the resulting uncertainty in risk associated with the chemical(s) lacking inhalation toxicity data. If STSC provides risk assessors with a toxicity value based on a PBPK

model, model uncertainty should be discussed. In addition, if STSC provides risk assessors with one or more structurally analogous chemicals, risk assessors can use toxicity data for these chemicals to help characterize the potential magnitude of the inhalation risk associated with the chemical(s) lacking data. In this case, risk assessors should acknowledge the uncertainty associated with relying on toxicity data for analogous chemicals to characterize risk at the site.

Risk assessors should also acknowledge chemicals that lack duration-appropriate toxicity values and discuss the potential impacts of substituting alternative toxicity values for HQ calculations. For instance, if the ED is determined to be subchronic but no subchronic inhalation RfC or analogous toxicity value is available for that chemical, the risk assessor should address the uncertainty associated with calculating an HQ using a toxicity value for a different duration, such as chronic, or the impact of not quantifying those risks. In addition, if risk assessors use an acute toxicity value that does not match the duration of the acute exposure being assessed, the possibility of under or overestimating hazard should be discussed.

When conducting a screening-level risk assessment using screening values such as those described in Section 7, it is important to further evaluate and clearly describe the quality and uncertainties associated with the inhalation toxicity values used in the risk assessment if measured sample contaminant concentrations at a site exceed these screening values.

9.2.3 Estimating Cancer Risks

For high exposures, for example those within the range of epidemiological studies (usually those predicted to have risks greater than 10^{-2}), the IUR derived from the linear extrapolation below the range of observation is generally not appropriate for use (see Section 5.1 of this document for further information).[44] Risk assessors should provide specific information in the risk characterization describing how these high exposures were addressed in the risk assessment. For instance, if a risk assessor chose to provide a semi-quantitative approach (e.g., indicating that risks are above 10^{-2}), this should be indicated, along with a description of the uncertainties involved in not fully quantifying risk associated with exposure to this chemical. If a risk assessor chose to use the original model in the IRIS file or other technical background document, the risk characterization section should include a description of any uncertainties in the model used and could contain examples of the risks estimated.

9.2.4 Estimating Risk and Hazard from Multiple Chemicals and Exposure Pathways

Risk assessors should also describe uncertainties involved in aggregating risk and hazard across multiple chemicals and exposure pathways. For instance, the approaches described in Section 8 of this document are associated with several assumptions (e.g., independence of action and doses for individual compounds at levels not expected to be of concern). If these assumptions are not met, aggregation may not be appropriate. This should be fully described in the risk characterization section and any uncertainties involved in the lack of quantitative information should be indicated.

[44] Also refer to Section 8.2.1 of *RAGS, Part A* for further discussion of this topic (EPA, 1989, page 8-6).

10. REFERENCES

Eaton, D.L. and Klaassen, C.D. (2001). "Principles of Toxicology" in *Casarett and Doull's Toxicology: The Basic Science of Poisons*, Klaassen, C.D., editor. McGraw-Hill Publishing Division, 6th Edition, page 14.

Gaylor, D.W. (2000). *The Use of Haber's Law in Standard Setting and Risk Assessment.* Toxicology 149:17-19. Johnson, P.C. and Ettinger, R.A. (1991). *Heuristic Model for Predicting the Intrusion Rate of Contaminant Vapors into Buildings.* Environmental Science and Technology 25: 1445-1452. http://www.epa.gov/oswer/riskassessment/airmodel/johnson_ettinger.htm

Schwarzenbach, R.P., P.M. Gschwend, and D.M. Imboden. (1993). *Environmental Organic Chemistry*. John Wiley & Sons, Inc.: New York.

U.S. EPA. (1986). *Guidelines for Health Risk Assessment of Chemical Mixtures*. Risk Assessment Forum, Washington, D.C. EPA/630/R-98/002. http://www.epa.gov/ncea/raf/pdfs/chem_mix/chemmix_1986.pdf

U.S. EPA. (1989). *Risk Assessment Guidance for Superfund, Volume 1, Part A.* Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002. http://www.epa.gov/oswer/riskassessment/ragsa/index.htm

U.S. EPA. (1991). *Risk Assessment Guidance for Superfund, Volume 1, Part B.* Office of Emergency and Remedial Response, Washington, D.C. EPA/540/R-92/003. http://www.epa.gov/oswer/riskassessment/ragsb/

U.S. EPA. (1992). *Memorandum: Guidance on Risk Characterization for Risk Managers and Risk Assessors*. From F. Henry Habicht II, Deputy Administrator, U.S. EPA, Washington, DC. http://www.epa.gov/oswer/riskassessment/pdf/habicht.pdf

U.S. EPA. (1994). *Methods of Derivation of Inhalation Reference Concentrations and Application of Inhalation Dosimetry*. Office of Research and Development, Research Triangle Park, NC. EPA/600/8-90/066F. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=71993.

U.S. EPA. (1995a). *Policy for Risk Characterization*. From Carol Browner, Administrator, U.S. EPA, Washington, DC.

U.S. EPA. (1995b) *Guidance for Risk Characterization*. Science Policy Council. February. http://www.epa.gov/osa/spc/pdfs/rcguide.pdf

U.S. EPA. (1995c). *Elements to Consider when Drafting EPA Risk Characterizations.* March. http://www.epa.gov/osa/spc/pdfs/rcelemen.pdf

U.S. EPA. (1996). *Soil Screening Guidance: User's Guide, Second Edition*. Office of Solid Waste and Emergency Response, Washington, D.C. EPA/540/R95/128. http://www.epa.gov/superfund/resources/soil/ssg496.pdf

U.S. EPA. (1997a). *Exposure Factors Handbook*. Office of Research and Development,

Washington, DC. EPA/600/P-95/002Fa. http://www.epa.gov/ncea/pdfs/efh/front.pdf

U.S. EPA. (1997b). *Policy for Use of Probabilistic Analysis in Risk Assessment*. From Fred Hansen, Deputy Administrator, Washington, DC.

U.S. EPA. (1998). *Route-to-Route Extrapolations*. Memorandum from John E. Whalan and Hugh M. Pettigrew to Margaret Stasikowski. Office of Prevention, Pesticides, and Toxic Substances. October 10, 1998.

U.S. EPA. (2000a). *Integrated Risk Information System Summaries: Vinyl Chloride*. Office of Research and Development, Washington, D.C. http://www.epa.gov/iris/subst/1001.htm

U.S. EPA. (2000b). *Supplementary Guidance for Conducting Health Risk Assessment of Chemical Mixtures*. EPA/630/R-00/002. http://www.epa.gov/ncea/raf/pdfs/chem_mix/chem_mix_08_2001.pdf

U.S. EPA. (2000c). *Risk Characterization Handbook*. Science Policy Council, Washington, D.C. EPA-100-B-00-002. http://www.epa.gov/osa/spc/pdfs/rchandbk.pdf

U.S. EPA. (2001). *Risk Assessment Guidance for Superfund, Volume 1, Part D.* Office of Emergency and Remedial Response, Washington, D.C. Publication 9285.7-47. http://www.epa.gov/oswer/riskassessment/ragsd/index.htm

U.S. EPA. (2002a). *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance).* Office of Solid Waste and Emergency Response, Washington, D.C. http://www.epa.gov/epawaste/hazard/correctiveaction/eis/vapor/complete.pdf

U.S. EPA. (2002b). *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites*. Office of Solid Waste and Emergency Response, Washington, D.C. Publication 9335.4-24. http://www.epa.gov/superfund/health/conmedia/soil/pdfs/ssg_main.pdf

U.S. EPA. (2002c). *A Review of the Reference Dose and Reference Concentration Processes*. Risk Assessment Forum, Washington, DC, EPA/630/P-02/002F. http://cfpub.epa.gov/ncea/raf/recordisplay.cfm?deid=55365

U.S. EPA. (2003). *Human Health Toxicity Values in Superfund Risk Assessment*. Office of Solid Waste and Emergency Response, Washington, D.C. Publication 9285.7-53. http://rais.ornl.gov/homepage/hhmemo.pdf.

U.S. EPA. (2004a). *User's Guide for Evaluating Subsurface Vapor Intrusion Into Buildings*. Office of Emergency and Remedial Response, Washington, D.C.

U.S. EPA. (2004b). *Air Quality Criteria for Particulate Matter: Volume II.* Office of Research and Development, Washington, D.C. EPA/600/P-95/001bF.

U.S. EPA. (2005a). *Guidelines for Carcinogen Risk Assessment*, Risk Assessment Forum, Washington, D.C. EPA/630/P-03/001F. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=116283

U.S. EPA. (2005b). *Supplemental Guidance for Assessing Cancer Susceptibility from Early-Life Exposure to Carcinogens*. Risk Assessment Forum, Washington, DC. EPA/630/R-30/003F. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=160003

U.S. EPA. (2005c). *Implementation of the Cancer Guidelines and Accompanying Supplemental Guidance – Science Policy Council Cancer Guidelines Implementation Workgroup Communication I: Application of the mode of action framework in mutagenicity determinations for carcinogenicity*. Memorandum from William H. Farland, Chair, Science Policy Council to Science Policy Council Steering Committee October 4, 2005. http://www.epa.gov/osa/spc/pdfs/canguid1.pdf

U.S. EPA. (2005d). *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants*. Risk Assessment Forum, Washington, DC. EPA/630/P-03/003F. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=146583.

U.S. EPA. (2006a). *Approaches for the Application of Physiologically Based Pharmacokinetic (PBPK) Models and Supporting Data in Risk Assessment.* National Center for Environmental Assessment, Washington, DC. EPA/600/R-05/043F. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=157668.

U.S. EPA. (2006b). *A Framework for Assessing Health Risks of Environmental Exposures to Children.* National Center for Environmental Assessment, Washington, DC. EPA/600/R-05/093F. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=158363.

U.S. EPA. (2008a). *Regional Screening Levels for Chemical Contaminants at Superfund Sites*. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm.

U.S. EPA. (2008b). *Integrated Risk Information System, Glossary of Terms*. Office of Research and Development. Searched September, 2008. http://www.epa.gov/iris/help_gloss.htm#content

APPENDICES

TABLE OF CONTENTS

APPENDIX A: ANALYSIS OF DEFAULT APPROACH FOR HEC DERIVATION AS COMPARED TO POPULATION- AND LIFE STAGE-SPECIFIC CALCULATIONS

INTRODUCTION A-1

1. EXAMPLE 1: CATEGORY 1 GAS, EXTRATHORACIC EFFECTS, ACROLEIN A-3

2. EXAMPLE 2: CATEGORY 1 GAS, TRACHEOBRONCHIAL EFFECTS, HYPOTHETICAL CHEMICAL A-4

3. EXAMPLE 3: CATEGORY 1 GAS, PULMONARY EFFECTS, HYPOTHETICAL CHEMICAL A-5

4. CATEGORY 3 GASES A-7

5. PARTICLE DEPOSITION ACROSS AGE GROUPS A-7

6. CONCLUSIONS A-10

7. REFERENCES CITED A-11

8. ADDITIONAL SOURCES OF RELATED INFORMATION A-13

APPENDIX B: CHEMICALS ON IRIS WITH EXTRAPOLATED INHALATION UNIT RISKS

APPENDIX C: STSC'S PROCESS FOR DERIVING ALTERNATIVE INHALATION TOXICITY VALUES

LIST OF TABLES

Table A-1 Calculation of $LOAEL_{[HEC]}$ Values for Humans of Different Ages and Activity Patterns for the Extrathoracic Region A-4

Table A-2 Calculation of $NOAEL_{[HEC]}$ Values for Humans of Different Ages and Activity Patterns for the Tracheobronchial Region A-5

Table A-3 Calculation of $NOAEL_{[HEC]}$ Values for Humans of Different Ages and Activity Patterns for the Pulmonary Region A-6

Table A-4 Particle Deposition Across Age Groups A-9

Table B-1 Chemicals with Extrapolated Inhalation Unit Risks on Iris B-2

LIST OF EQUATIONS

Equation A-1 $RGDR_{ETh}$ A-3

Equation A-2 $RGDR_{TB}$ A-4

Equation A-3 $RGDR_{PU}$ A-5

Equation A-4 Category 3 DAF A-7

Equation A-5 $RDDR_r$ A-7

Equation A-6 $RDDR_{ER}$ A-8

APPENDIX A

APPENDIX A

ANALYSIS OF DEFAULT APPROACH FOR HEC DERIVATION AS COMPARED TO POPULATION- AND LIFESTAGE-SPECIFIC CALCULATIONS

NOTE: The Agency's inhalation dosimetry methodology (USEPA, 1994; hereafter, "the *Inhalation Dosimetry Methodology"*) is a technical report that describes the derivation of human equivalent concentrations (HECs) from animal (or human) studies, as well as the other steps involved in developing a chronic Reference Concentration (RfC). This appendix is included to illustrate the HEC derivation using the *Inhalation Dosimetry Methodology*'s default approach (with the recommended default values for humans), and to also illustrate the impact of substituting alternate age- and activity-specific human values into the default calculations. The default approach is employed for chemicals for which more chemical-specific dosimetric and pharmacokinetic data are not available, thus precluding the use of more advanced models for deriving the HEC. The calculations in this appendix do not represent a refined or optimal model for assessing intra-human variability (e.g., age- and activity-specific risks), and are not intended to imply that risk assessors should deviate from the *Inhalation Dosimetry Methodology* by substituting alternate values into the default calculations. Age-specific data are limited. Because of these limitations, the calculations made for different ages and exposure groups in this appendix are not recommended for use in quantitative risk assessment (i.e., they are only for the purpose of illustration), but may be useful in discussions of uncertainty and variability associated with the default approach.

It is also noted that, as of this writing, the Agency is involved in a routine reevaluation of scientific advancements in the field, with consideration of the need for improvement to the *Inhalation Dosimetry Methodology*. Any revisions will consider current understanding of inhalation dosimetry and differences across and within species, as well as the Agency's risk assessment needs. In order to transparently and quantitatively address children's inhalation dosimetry and risk assessment, this guidance document will be updated (on-line) when Agency methodology updates are available that are specific to early life. Until that time, the 1994 *Inhalation Dosimetry Methodology* is the appropriate Agency methodology.

INTRODUCTION

This appendix consists of examples and discussions illustrating the current default chemical category-specific approach to inhalation dosimetry for the various categories of gases and particles as described in *Methods for Derivation of Inhalation Reference Concentrations and Application of Inhalation Dosimetry* (USEPA, 1994; hereafter, the *Inhalation Dosimetry Methodology*). This default inhalation dosimetry approach is used to convert toxicological and epidemiological study data to an HEC that can then be used to derive chronic RfCs for the human population (inclusive of susceptible populations and life stages, such as children) and also in the development of Inhalation Unit Risks (IURs) (USEPA, 2005). The default approach does not rely on age- or activity-specific values for physiological parameters when calculating HECs; however the default approach has been designed by EPA to derive reference values that are protective across the entire population.

The appendix includes six sections. Sections 1 through 3 address Category 1 gases. These sections provide example calculations for Category 1 highly reactive, high water solubility gases that are typically absorbed in the upper airways, exhibiting adverse effects in the extrathoracic (ETh), tracheobronchial (TB), and pulmonary (PU) regions of the respiratory tract, respectively. These examples include comparisons of HEC calculations based on default parameters with those derived using age- and activity-specific parameters for the respiratory region affected. Section 4 addresses Category 3 low reactivity, limited water solubility gases that exhibit systemic effects outside the respiratory tract. Section 5 addresses changes in particle deposition in the respiratory tract across age groups. The conclusions are summarized in Section 6.

When reviewing the examples, please note the following:

- An RfC derived using the *Inhalation Dosimetry Methodology* is defined as "an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime" (USEPA, 2008).

- All examples in this appendix are based on the *Inhalation Dosimetry Methodology*. EPA is committed to periodically reviewing and updating the *Inhalation Dosimetry Methodology* to ensure that it reflects the current state of the science and that it yields toxicity values that sufficiently cover potential age- and activity-related variation in inhalation exposure. A review and update is currently underway.

- The examples in this appendix are all based on calculating HECs from a point of departure (POD) for non-cancer effects (e.g., a No Observed Adverse Effect Level (NOAEL), Lowest Observed Adverse Effect Level (LOAEL), or Benchmark Concentration, Lower confidence limit (BMCL)). These calculations could also be performed in an identical manner for carcinogens using a POD for cancer risk estimate derivation (e.g., a Lower limit on the Effective Concentration (LEC) value).

- The default animal and human values for minute volume (V_e) and surface area (SA) used in these examples were obtained from *Methods for Derivation of Inhalation Reference Concentrations and Application of Inhalation Dosimetry* (USEPA, 1994).[45] The age- and activity-specific V_e values were obtained from the International Commission on Radiological Protection (ICRP) Publication 66, *Human Respiratory Tract Model for Radiological Protection* (ICRP, 1994).[46] Age-specific SA values used in Examples 1 and 2 were calculated using scaled estimates for the mass and thickness of respiratory region-specific target tissue from ICRP (1994); Values for Example 3 were calculated from an allometric scaling equation presented in a publication by Zeltner et al. (1987). EPA's Office of Research and Development (ORD) selected these data following review of the available physiological data for the age groups indicated in the examples.

- Chemical-specific data from the Integrated Risk Information System (IRIS) file for acrolein were used in the ETh example (Example 1). However, the other two examples, which focus on effects in the TB and PU regions, respectively, use hypothetical data for the POD because there are currently no chemicals on IRIS exhibiting Critical Effects (for RfC derivation) in those regions.[47] The conclusions of these two examples are unaffected by the use of hypothetical data because the results are driven by the values of parameters that are not chemical-specific (i.e., SA and V_e).

[45] The minute volume is the total ventilation per minute and equals the product of the tidal volume (the air volume entering or leaving the lungs with a single breath) and the respiratory frequency.

[46] For further information on inhalation rates in humans under different scenarios, refer to Chapter 5 of EPA's *Exposure Factors Handbook* (EPA, 1997).

[47] Hypothetical examples for the TB and PU regions were included in this appendix because currently no RfCs for gases on IRIS are calculated based on animal studies showing health effects occurring in these regions of the respiratory system

1. EXAMPLE 1: CATEGORY 1 GAS, EXTRATHORACIC EFFECTS, ACROLEIN

The Dosimetric Adjustment Factor (DAF) for a Category 1 gases, the Regional Gas Dose Ratio (RGDR), is based on the animal to human ratio of the V_e divided by the SA of the region of the respiratory tract where the effect occurs. For acrolein, the effect occurs in the ETh region. The DAF is typically calculated using the following equation (USEPA, 1994, Equation 4-18):

$$RGDR_{ETh} = \frac{\left(\frac{V_e}{SA_{ETh}}\right)_{animal}}{\left(\frac{V_e}{SA_{ETh}}\right)_{human}} = \frac{\frac{0.14\,L/min}{15\,cm^2}}{\frac{13.8\,L/min}{200\,cm^2}} = 0.14 \qquad \textbf{(Equation A-1)}$$

The default *Inhalation Dosimetry Methodology*-recommended values for the V_e and SA_{ETh} of the Wistar rat (the animal in the principal study for acrolein) are 0.14 L/min (0.20 m^3/day) and 15 cm^2, respectively (USEPA, 1994). EPA's default human values are 13.8 L/min (20 m^3/day) for V_e and 200 cm^2 for SA_{ETh} (USEPA, 1994). The RGDR for the ETh region ($RGDR_{ETh}$) was calculated using these values for the rat and the human as shown in Equation A-1. In the laboratory animal study on acrolein, the LOAEL adjusted for continuous exposure ($LOAEL_{[ADJ]}$) of 0.16 mg/m^3 (USEPA, 2003) is used as the point of departure. The $LOAEL_{[HEC]}$ is the $LOAEL_{[ADJ]}$ multiplied by the $RGDR_{ETh}$.

To illustrate any potential age- or activity-related variation in the $LOAEL_{[HEC]}$ that might result from using human parameter values other than the defaults, scaled estimates for the mass and thickness of ETh target tissue from ICRP (1994) at different ages are used to calculate the SA_{ETh} values in Table A-1. Age- and activity-related V_e reported in ICRP (1994) are based on daily time-budgeted reference values. Table A-1 shows little variation in the resultant $LOAEL_{[HEC]}$ across the groups in this example. The default procedure produces the lowest $LOAEL_{[HEC]}$ value in Table A-1 and is, therefore, sufficient to cover all of these groups.

TABLE A-1 COMPARISON OF THE HEC-DEFAULT (EPA, 1994) WITH EXAMPLE $LOAEL_{[HEC]}$ VALUES FOR HUMANS OF DIFFERENT AGES AND ACTIVITY PATTERNS FOR THE EXTRATHORACIC REGION					
	Total $V_{e\ (human)}$ (L/min)[a]	$SA_{ETh\ (human)}$ (cm^2)[b]	$(V_e/SA_{ETh})_{human}$ (L/min-cm^2)	$RGDR_{ETh}$	$LOAEL_{[HEC]}$ (mg/m^3)
Outdoor Worker, Male	17.5	470	0.037	0.25	0.04
Sedentary Worker, Male	15.4	470	0.033	0.28	0.04
Sedentary Worker, Female	12.6	407	0.031	0.30	0.05
15 Year-Old Male	14.0	439	0.032	0.29	0.05
15 Year-Old Female	10.9	397	0.027	0.35	0.06
10 Year-Old	10.6	293	0.036	0.26	0.04
5 Year-Old	6.1	198	0.031	0.30	0.05
1 Year-Old	3.6	97.1	0.037	0.25	0.04
3 Month-Old	2.0	65.8	0.030	0.31	0.05
HEC - Default	13.8	200	0.069	0.14	0.02
[a] These values are from the ICRP publication, Tables 8, 27, B.16a, B.16b and B.17 (ICRP, 1994). [b] These values are from the ICRP publication, Tables 1 and 5 (ICRP, 1994).					

2. EXAMPLE 2: CATEGORY 1 GAS, TRACHEOBRONCHIAL EFFECTS, HYPOTHETICAL CHEMICAL

The DAF for a Category 1 gas or vapor exhibiting effects in the TB region is based on the animal to human ratio of the V_e divided by the SA of the TB region for each species. The DAF is typically calculated using the following equation:

$$RGDR_{TB} = \frac{\left(\frac{V_e}{SA_{TB}}\right)_{animal}}{\left(\frac{V_e}{SA_{TB}}\right)_{human}} = \frac{\frac{0.14\ L/min}{22.5\ cm^2}}{\frac{13.8\ L/min}{3200\ cm^2}} = 1.4 \qquad \textbf{(Equation A-2)}^{48}$$

This example assumes that the hypothetical chemical has been tested on Wistar rats and therefore utilizes the EPA animal default values for that strain. The V_e value used is 0.14 L/min (0.20 m^3/day) and the default SA_{TB} is 22.5 cm^2 (USEPA, 1994). EPA's default human values are 13.8 L/min (20 m^3/day) for V_e and 3200 cm^2 for SA_{TB} (USEPA, 1994). The RGDR for the TB region ($RGDR_{TB}$) is calculated using these values for the rat and the human, as shown in Equation A-2. The example also assumes a NOAEL adjusted for continuous exposure ($NOAEL_{[ADJ]}$) of 0.16 mg/m^3 as the point of departure. The $NOAEL_{[HEC]}$ is the $NOAEL_{[ADJ]}$ multiplied by the $RGDR_{TB}$.

Table A-2 shows little variation across age and activity groups in the $NOAEL_{[HEC]}$. The variation from the default (less than a factor of 2) is less than the default value of 10 used for the uncertainty factor for intraspecies variability when deriving the RfC. Application of the normal procedure for

[48] This equation is the reduced, default version of Equation 4-19 of the *Inhalation Dosimetry Methodology*. Equation 4-19 is reduced to this form consistent with the derivation of the reduced form of the RGDR equation of extrathoracic effects described in section 4.3.6.1 and Appendix I of the *Inhalation Dosimetry Methodology*.

determining the RfC will accommodate the observed variation. In addition, RfCs and IURs are developed for chronic exposure and will generally involve an exposure for multiple years.

TABLE A-2
COMPARISON OF THE HEC-DEFAULT (EPA, 1994) WITH EXAMPLE $LOAEL_{[HEC]}$ VALUES FOR HUMANS OF DIFFERENT AGES AND ACTIVITY PATTERNS FOR THE TRACHEOBRONCHIAL REGION

	Total $V_{e\ (human)}$ (L/min)[a]	$SA_{TB\ (human)}$ (cm^2)[b]	$(V_e/SA_{TB})_{human}$ (L/min-cm^2)	$RGDR_{TB}$	$NOAEL_{[HEC]}$ (mg/m^3)
Outdoor Worker M	17.5	2660	0.0066	0.94	0.15
Sedentary Worker M	15.4	2660	0.0058	1.1	0.18
Sedentary Worker F	12.6	2640	0.0048	1.3	0.21
15 year M	14.0	2520	0.0056	1.1	0.18
15 year F	10.9	2250	0.0048	1.3	0.21
10 Year	10.6	1830	0.0058	1.1	0.18
5 Year	6.1	1340	0.0046	1.4	0.22
1 Year	3.6	857	0.0042	1.5	0.24
3 Months	2.0	712	0.0028	2.2	0.35
HEC-default	13.8	3200	0.0043	1.4	0.22

[a] These values are from the ICRP publication, Tables 8, 27, B.16a, B.16b and B.17 (ICRP, 1994).
[b] These values are from the ICRP publication, Tables 1 and 5 (ICRP, 1994).

3. EXAMPLE 3: CATEGORY 1 GAS, PULMONARY EFFECTS, HYPOTHETICAL CHEMICAL

The DAF for a Category 1 gas or vapor with an effect in the PU region is based on the animal to human ratio of the alveolar ventilation rate (Q-alv) divided by the SA of the PU region (SA_{PU}) for each species. The Q-alv is approximately equal to the V_e multiplied by 0.7. This adjustment accounts for the anatomic/physiologic deadspace in the PU region, making the Q-alv equivalent to the amount of inspired air available for gas exchange (West, 2000). The DAF for this region of the respiratory tract is typically calculated using the following equation:

$$RGDR_{PU} = \frac{\left(\frac{Q-alv}{SA_{PU}}\right)_{animal}}{\left(\frac{Q-alv}{SA_{PU}}\right)_{human}} = \frac{\frac{0.1\,L/min}{0.34\,m^2}}{\frac{9.7\,L/min}{54\,m^2}} = 1.6 \qquad \textbf{(Equation A-3)}^{49}$$

This example assumes that the hypothetical chemical has been tested on Wistar rats and therefore utilizes the EPA animal default values for that strain. The V_e valued used is 0.14 L/min (0.20 m^3/day), which when multiplied by 0.7, yields a Q-alv of 0.1 L/min. The example uses the EPA default rat SA_{PU} of 0.34 m^2 (USEPA, 1994). EPA's default human values are 13.8 L/min (20

[49] This equation is the reduced, default version of Equation 4-23 of the *Inhalation Dosimetry Methodology*. Equation 4-23 is reduced to this form consistent with the derivation of the reduced form of the RGDR equation of extrathoracic effects described in section 4.3.6.1 and Appendix I of the *Inhalation Dosimetry Methodology*.

m^3/day) for V_e (which yields a Q-alv of 9.7 L/min) and 54 m^2 for SA_{PU} (USEPA, 1994). The RGDR for the PU region ($RGDR_{PU}$) is calculated using these values for the rat and the human, as shown in Equation A-3. The example also assumes a $NOAEL_{[ADJ]}$ of 0.16 mg/m^3 as the point of departure. The $NOAEL_{[HEC]}$ is the $NOAEL_{[ADJ]}$ multiplied by the $RGDR_{PU}$.

Table A-3 below provides the Q-alv values for humans based on the daily time-budgeted V_e for different ages and activity levels from the ICRP publication (1994). SA data for the PU region in the ICRP publication are estimated using an allometric scaling model fitted to data from a morphometric analysis of SA_{PU} in a sample of seven children (ranging in age from 26 days to 5 years) and eight adults (Zeltner et al., 1987). ORD selected the Zeltner analysis for this example because these SA_{PU} data are based on empirical morphometric measurements of human lungs as opposed to scaled estimates determined from lung models (such as those done by Yu and Xu, 1987 or Yu and Yoon, 1991). In addition, the children and adult SA_{PU} values calculated in the Zeltner analysis are supported by several independent studies that measured SA_{PU} in children (Langston et al., 1984) or in adults using similar morphometric techniques (Crapo et al., 1982 & 1983; Stone et al., 1992; Mercer et al., 1994).

Table A-3 shows little variation in the resultant $NOAEL_{[HEC]}$ across the groups in this example. The default procedure produces the lowest $NOAEL_{[HEC]}$ value in Table A-3 and is, therefore, sufficient to cover all of these groups.

TABLE A-3

COMPARISON OF THE HEC-DEFAULT (EPA, 1994) WITH EXAMPLE $LOAEL_{[HEC]}$ VALUES FOR HUMANS OF DIFFERENT AGES AND ACTIVITY PATTERNS FOR THE PULMONARY REGION

	Total V_e (L/min)[a]	$Q\text{-}alv_{(human)}$ (L/min)[b]	$SA_{PU\ (human)}$ (m^2)	$(Q\text{-}alv/SA_{PU})_{human}$ (L/min-m^2)	$RGDR_{PU}$	$NOAEL_{HEC}$ (mg/m^3)
Outdoor Worker, Male	17.5	12	139	0.088	3.3	0.53
Sedentary Worker, Male	15.4	11	139	0.078	3.7	0.59
Sedentary Worker, Female	12.6	8.8	114	0.077	3.8	0.61
15 Year-Old Male	14.0	9.8	108	0.091	3.2	0.51
15 Year-Old Female	10.9	7.6	100	0.076	3.8	0.61
10 Year-Old	10.6	7.4	62.0	0.12	2.4	0.38
5 Year-Old	6.1	4.3	37.3	0.11	2.6	0.42
1 Year-Old	3.6	2.5	18.5	0.14	2.1	0.34
3 Month-Old	2.0	1.4	11.0	0.13	2.2	0.35
HEC-Default	13.8	9.7	54.0	0.18	1.6	0.26

[a] These values are from the ICRP publication, Tables 8, 27, B.16a, B.16b and B.17 (ICRP, 1994).
[b] These values are from Zeltner et al. (1987).

4. CATEGORY 3 GASES

The DAF for a Category 3 gas or vapor is based on the ratio of the animal blood:gas partition coefficient to the human blood:gas partition coefficient and is typically calculated using the following equation:

$$DAF = \frac{(H_{b/g})_{animal}}{(H_{b/g})_{human}} \qquad \textbf{(Equation A-4)}$$

The blood:gas partition coefficient is primarily determined by the solubility of the gas in an aqueous medium as well as the protein and lipid content of the blood. There is little reason to suspect that the blood:gas partition coefficient for a non-metabolized chemical will vary greatly across the human population. The limited data available indicate no difference in the blood:gas partition coefficient with age for methylene chloride in mice (Thomas et al., 1996), and for sevoflurane, isoflurane, and halothane in humans (Malviya and Lerman, 1990). Two studies examining the solubility of volatile anesthetics (isoflurane, enflurane, halothane, and methoxyflurane) in the blood and body tissues found higher blood:gas partition coefficients in adults compared with children (Lerman, et al., 1984 & 1986). Any variability in the blood:gas partition coefficient with age is expected to be less than the default value of 10 used for the uncertainty factor for intraspecies variability when deriving the RfC. Any variability in the blood:gas partition coefficient with age is also not expected to cause a large overestimate or underestimate in the calculated cancer risk.

Because of the limited data available, the *Inhalation Dosimetry Methodology* makes the science policy decision to use a value of one for the ratio of the partition coefficients when the animal to human ratio exceeds one or when the animal or human value is unknown. At this time, all chemicals on IRIS for which both human and animal data are available have an animal to human ratio of partition coefficient greater than 1.[50] Therefore, the default assumption of one is a conservative approach that is not likely to underestimate the chemical-specific DAF.

5. PARTICLE DEPOSITION ACROSS AGE GROUPS

The DAF for a particle causing an effect in the respiratory tract, the Regional Dose Deposition Ratio ($RDDR_r$), is based on the animal to human ratio of the V_e and the fractional deposition of the particle in that region (F_r), divided by the surface area of the region where the effect occurs (SA_r) (USEPA, 1994). Inherent in this derivation is the assumption that 100 percent of the deposited dose remains in the respiratory tract and any clearance mechanisms are not considered. The $RDDR_r$ is typically calculated using the following equation:

$$RDDR_r = \frac{\left(\frac{V_e}{SA_r} \times F_r\right)_{animal}}{\left(\frac{V_e}{SA_r} \times F_r\right)_{human}} \qquad \textbf{(Equation A-5)}$$

[50] While 1,4-dioxane has not yet been evaluated on IRIS, it provides an exception to this statement, in that the blood:gas partition coefficient is 2750 for mice, 1850 for rats, and 3650 for humans, yielding an animal to human ratio of 0.75 for mice and 0.51 for rats (Reitz et al., 1990).

The DAF for a particle causing an extra-respiratory (ER) effect, the $RDDR_{ER}$, is based on the animal to human ratio of the V_e and the total deposition of the particle in the entire respiratory tract (F_{total}), divided by body weight (BW) (USEPA, 1994). The $RDDR_{ER}$ assumes that 100 percent of the deposited dose in the entire respiratory tract is available for uptake into the systemic circulation. The following general equation can be used to estimate the $RDDR_{ER}$:

$$RDDR_{ER} = \frac{\left(\frac{V_e}{BW} \times F_{total}\right)_{animal}}{\left(\frac{V_e}{BW} \times F_{total}\right)_{human}} \qquad \textbf{(Equation A-6)}$$

The information on particle deposition in various age groups is quite limited. A discussion of the current state of the science can be found in the *Air Quality Criteria for Particulate Matter Volume II*, Section 6.2.3.2 (USEPA, 2004; hereafter, *PM Criteria Document*).

Experimental and modeling results are summarized in Table A-4. The results for experimental studies are mixed, some suggesting higher deposition in children and others finding no difference across age groups. Bennett and Zeman (1998) and Schiller-Scotland et al. (1994) found no difference between total deposition of particles in the respiratory tract of children (aged 7 to14 and 6 to12, respectively) and adults for 1 to 2 micrometer particles. Schiller-Scotland et al. did find two- to three-fold higher total particulate deposition in 6 to 12 year olds for particles of 2 to 3 micrometers in size. In addition, Bennett et al. (1997) found that deposition in the ETh region was 50 percent greater in children than adults. The *PM Criteria Document* concludes that "these...studies ...do not provide unequivocal evidence for significant differences in deposition between adults and children" (USEPA, 2004, page 6-29). The document notes, however, that children may have higher activity levels and higher associated minute ventilation per lung size, potentially causing a greater size-specific dose of particles to the lung.

Modeled results suggest a higher deposition of particles in the TB region of children when compared to adults, depending on the particle size (Xu and Yu (1986); Hofmann et al. (1989); Musante and Martonen (1999); Phalen and Oldham (2001); Asgharian et al. (2004); Jarabek et al. (2005); Ginsberg et al. (2005)). Mixed results again are found in modeling studies for total deposition and deposition in other respiratory regions. In general, where differences are observed in either experimental or modeled studies, variability in deposition between age groups has been reported to be most often in the range of 1- to 3-fold greater for children than for adults, but ranging from equivalency or less up to 7-fold greater.[51]

[51] A modeling analysis examining deposition fraction per unit area at various airway generations of the lung as a function of age for various particle sizes (ranging from 0.01 to 10 μm) reported comparisons between a 3-month old and 21-year old that ranged from equivalency up to a 14-fold difference in this metric for some specific airway generations (Asgharian et al., 2004).

TABLE A-4
PARTICLE DEPOSITION ACROSS AGE GROUPS

Study	Particle Size	Results
Experimental Studies		
Becquemin et al. (1991)	Various	Nasal deposition higher in adults (up to 1.8-fold higher at rest and up to 3.4-fold higher during exercise) than children – meaning that thoracic airways of children are less protected than those of adults.
Bennett et al. (1997)	4.5 µm	-ETh deposition of particles 50 percent greater in children (higher for younger ages). -No significant difference in total respiratory tract deposition.
Bennett and Zeman (1998)	1-2 µm	No difference between 7-14 year olds and adults in total deposition of particles in the respiratory tract.
Schiller-Scotland et al. (1994)	1-2 µm	No difference between 6-12 year olds and adults in total deposition of particles in the respiratory tract.
	2-3 µm	Two- to three-fold higher total deposition of particles in 6-12 year olds versus adults.
Modeled Studies		
Asgharian et al. (2004)	0.01-10 µm	-Up to 1.2-fold higher total deposition in 3 month olds compared to adults in the TB region. -Up to 1.5-fold higher total deposition in 8 year olds compared to adults in the alveolar region. Total deposition higher in adults than 3 and 23 month olds (up to 2-fold). -Estimates of deposition fraction per unit area at various airway generations of the lung and various particle sizes highest for 3 month olds compared to adults (up to 14-fold). Higher deposition also seen for 23 month olds (up to 5-fold) and 8 year olds (up to 3-fold) compared with adults. No difference in deposition in 14 year olds compared to adults.
Cheng et al. (1995)	0.0046-0.2 µm	Nasal casts of children's airways found increased deposition efficiency for ultrafine particles with decreasing age, suggesting that young children may receive a higher dose of ultrafine particles to the upper airways.
Ginsberg et al. (2005)	0.001-10 µm	-Higher deposition in 3 month olds compared with adults for coarse and fine particles in the upper TB (up to 2-fold) and PU (up to 4-fold) regions. -Higher deposition in adults in the lower TB region.
Hoffmann et al. (1989)	1-2 µm	-1.5- to 2-fold higher total deposition in the TB region for particles in resting 8 year olds versus adults. -40-50 percent lower total deposition of particles in 8 year olds under conditions of exercise.
Jarabek et al. (2005)	0.3-6 µm	-Retained mass in the TB region normalized to regional SA was compared across age groups. -Up to 2-fold lower deposition in 3 month olds compared to adults. -Up to 2-fold higher deposition in 3 year olds and 14 year olds compared to adults.
Musante and Martonen (1999)	0.25-5 µm	-Total deposition was generally higher in children (ages 7, 22, 48, and 98 months) than adults (e.g., total lung deposition in 48-month olds was 38 percent higher than adults for 1µm particles). -TB deposition monotonically decreased as a function of age (i.e., younger children had increased TB deposition). -PU deposition greatest in the 48 and 98-month children.
Musante and Martonen (2000)	2 µm	3-fold higher deposition of particles in the PU region for 7 month olds versus adults.
Oldham et al. (1997)	Various	Airway models of trachea and bronchial airways showed total deposition in children (ages 4 and 7) greater than adult (up to approximately 7-fold higher for 4 year olds compared to adults for 4.5 µm particles).
Phalen and Oldham (2001)	0.1-10 µm	-No difference in total deposition of particles in 2 year olds versus adults. -Somewhat higher (13-81 percent; depending on particle size) deposition of particles in the TB region. -Lower deposition of particles in the PU region.
Xu and Yu (1986)	Various	Increased total deposition (up to 1.5-fold higher) in children aged 6 months, 2 years, and 8 years compared with adults for particles of varying sizes.

6. CONCLUSIONS

The examples and discussions included in this appendix suggest that the *Inhalation Dosimetry Methodology's* default approaches for derivation of the HEC for Category 1 gases with effects in the ETh, TB, and PU regions and for Category 3 gases typically are sufficient to cover variation across human age- and activity-level groups. The process for deriving an RfC from the HEC includes applying an uncertainty factor (UF) to account for within-species variability, adding further protection. When deriving an IUR for a carcinogen, UFs are not used. However the procedures for estimating an IUR incorporate conservative assumptions that would likely accommodate the degree of variation observed in these examples.

Experimental and modeling results for particles suggest the potential for small differences in deposition of particles in the respiratory tract as a function of age. The assumption that 100 percent of the deposited dose is available for uptake into the systemic circulation (for remote acting toxicants), or for activity in the respiratory tract (for local toxicity) is likely to result in an overestimation of dose to the target tissue. Any small variation in deposition among age groups should be considered against the potential magnitude of such overestimation. These differences in calculated deposition are small relative to the default 10-fold UF that accounts for intra-species variability in the derivation of the RfC. In addition, RfCs and IURs are developed for chronic exposure and will generally involve an exposure for multiple years. No additional correction of the toxicity values for these age groups is needed when the RfC or IUR is used in a risk assessment. Calculations in these examples are based on empirical data from sources listed and referenced in ICRP Publication 66 (ICRP, 1994). While ORD selected the ICRP values as the best estimates for these examples, other published values for V_e and SA exist. The use of alternate values may change the $LOAEL_{[HEC]}$ calculated for the various populations and life stages and may show more or less variability in results across the age and activity groups. In addition, the examples for the TB and PU regions are based on a hypothetical chemical, since currently no RfCs for gases on IRIS are calculated based on animal studies showing health effects occurring in these regions of the respiratory system. Given the parameter values used in the default method for calculating the HEC, it is likely that the process would yield results sufficient to cover populations and life stages with varying activities and physiologic characteristics.

Note that the available data, albeit limited, generally support these conclusions. As recommended by the Reference Dose (RfD)/RfC Technical Panel (USEPA, 2002), EPA has been exploring issues involving dose to the young from inhalation exposures, both theoretically and experimentally as well as further considering the existing animal-to-human extrapolation procedures described in current methodologies (e.g., USEPA, 1994). This is especially important because of the significant developmental changes that occur in the lung from birth well into adolescence (Pinkerton and Joad, 2000). The review and updating of these methodologies will be based on the best available science.

7. REFERENCES CITED

Asgharian, B.; Ménache, M.G.; Miller, F.J. (2004). *Modeling age-related particle deposition in humans*. Journal of Aerosol Medicine 17:213-224.

Becquemin, M.H.; Swift, D.L., et al. (1991). *Particle deposition and resistance in the noses of adults and children*. The European Respiratory Journal 4:694-702.

Bennett, W. D.; Zeman, K. L., et al. (1997). *Extrathoracic deposition of inhaled, coarse particles (4.5 m) in children vs. adults*. In: Cherry, N.; Ogden, T., Eds. Inhaled particles VIII: proceedings of an international symposium on inhaled particles organized by the British Occupational Hygiene Society; August 1996; Cambridge, UK. Annals of Occupational Hygiene 41(Suppl 1): 497-502.

Bennett, W. D.; Zeman, K. L. (1998). *Deposition of fine particles in children spontaneously breathing at rest*. Inhalation Toxicology 10: 831-842.

Cheng, Y.-S.; Smith, S.M., et al. (1995). *Deposition of ultrafine aerosols and thoron progeny in replicas of nasal airways of young children*. Aerosol Science and Technology 23: 541-552.

Crapo, J.D.; Young, S.L.; et al. (1983). *Morphometric characteristics of cells in the alveolar region of mammalian lungs*. American Review of Respiratory Disease 128: S42-S46.

Crapo, J.D.; Barry, B.E.; et al. (1982). *Cell characteristics of the normal human lung.* American Review of Respiratory Disease 5: 740-745.

Ginsberg, G.L.; Foos, B.P.; et al. (2005). *Review and analysis of inhalation dosimetry methods for application of children's risk assessment*. Journal of Toxicology and Environmental Health, Part A 68: 573-615.

Hofmann, W.; Martonen, T. B.; Graham, R. C. (1989). *Predicted deposition of nonhygroscopic aerosols in the human lung as a function of subject age*. Journal of Aerosol Medicine 2: 49-68.

International Commission on Radiological Protection (1994). *ICRP Publication 66: Human Respiratory Tract Model for Radiological Protection*. Annals of the ICRP, Volume 24/1-3, Tables B-16A and B-16B.

Jarabek, A.M.; Asgharian, B.; Miller, F.J. (2005). *Dosimetric Adjustments for Interspecies Extrapolation of Inhaled Poorly Soluble Particles*. Inhalation Toxicology 17(7): 317-334.

Langston, C.; Kida, K.; et al. (1984). *Human lung growth in late gestation and in the neonate.* American Review of Respiratory Disease 129: 607-613.

Lerman, J.; Gregory, G.A.; et al. (1984). *Age and solubility of volatile anesthetics in blood*. Anesthesiology 61(2): 139-43.

Lerman, J.; Schmitt-Bantel, B.I.; et al. (1986). *Effect of age on the solubility of volatile anesthetics in human tissues.* Anesthesiology 65(3): 307-11.

Malviya, S.; Lerman, J. (1990). *The blood/gas solubilities of sevoflurane, isoflurane, halothane, and serum constituent concentrations in neonates and adults.* Anesthesiology 72(5): 793-6.

Mercer, R.R.; Russell, M.L.; Crapo, J.D. (1994). *Alveolar Septal Structure in different species*. Journal of Applied Physiology *77*: 1060-1066.

Musante, C. J.; Martonen, T. B. (2000). *Computer simulations of particle deposition in the developing human lung.* Journal of the Air and Waste Management Association 50: 1426-1432.

Musante, C. J.; Martonen, T. B. (1999). *Predicted deposition patterns of ambient particulate air pollutants in children's lungs under resting conditions*. In: Proceedings of the third colloquium on particulate air pollution and human health; June, 1999; Durham, NC. Irvine, CA: University of California, Air Pollution Health Effects Laboratory, p. 7-15 - 7-20.

Oldham, M. J.; Mannix, R. C.,; et al. (1997) *Deposition of monodisperse particles in hollow models representing adult and child-size tracheobronchial airways.* Health Physics 72: 827-834.

Phalen, R. F.; Oldham, M. J. (2001). *Methods for modeling particle deposition as a function of age.* Respiratory Physiology 128: 119-130.

Pinkerton, K.E.; Joad, J.P. (2000). *The mammalian respiratory system and critical windows of exposure for children's health.* Environmental Health Perspectives 108(Suppl 4): 457-62.

Reitz, R.H.; McCrosky, P.S., et al. (1990). *Development of a physiologically based pharmacokinetic model for risk assessment with 1,4-dioxane.* Toxicology and Applied Pharmacology 105: 37-54.

Schiller-Scotland, C.F.; Hlawa, R.; et al. (1994). *Experimental data for total deposition in the respiratory tract of children*. Toxicological Letters 72(1-3): 137-44.

Stone, K.C., Mercer, R.R. et al. (1992). *Allometric relationships of cell numbers and size in the mammalian lung.* American Journal of Respiratory Cell Molecular Biology 6: 235-243.

Thomas, R.W.; Yang, R.S.; et al. (1996). *PBPK modeling/Monte Carlo simulation of methylene chloride kinetic changes in mice in relation to age and acute, subchronic, and chronic inhalation exposure*. Environmental Health Perspectives 104(8): 858-65.

U.S. EPA. (1997). *Exposure Factors Handbook*. Office of Research and Development, Washington, DC. EPA/600/P-95/002Fa.
http://www.epa.gov/ncea/pdfs/efh/front.pdf

U.S. EPA. (1994). *Methods for Derivation of Inhalation Reference Concentrations and Application of Inhalation Dosimetry*. Office of Research and Development. Research Triangle Park, NC. EPA/600/8-90/066F. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=71993.

U.S. EPA. (2002). *A Review of the Reference Dose and Reference Concentration Processes*. Risk Assessment Forum, Washington, DC, EPA/630/P-02/002F. http://cfpub.epa.gov/ncea/raf/recordisplay.cfm?deid=55365

U.S. EPA. (2003). *Integrated Risk Information System Summaries: Acrolein*. Office of Research and Development, Washington, D.C. http://www.epa.gov/iris/subst/0364.htm

U.S. EPA. (2004). *Air Quality Criteria for Particulate Matter: Volume II.* EPA/600/P-99/002aD. http://cfpub.epa.gov/ncea/CFM/recordisplay.cfm?deid=2832

U.S. EPA. (2005). *Guidelines for Carcinogen Risk Assessment*, Risk Assessment Forum, Washington, D.C. EPA/630/P-03/001F. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=116283

U.S. EPA. (2008). Integrated Risk Information System (IRIS) Glossary of Terms. Searched September 2008. http://www.epa.gov/iris/help_gloss.htm

West, J.B. (2000). *Respiratory Physiology: The Essentials*. Lippincott, Williams & Wilkins. 6th Edition.

Xu, G.B., Yu, C.P. (1986). *Effects of age on deposition of inhaled aerosols in the human lung*. Aerosol science and Technology 5: 349-357.

Yu, C.P., Xu, G.B. (1987). *Predictive models for deposition of inhaled diesel exhaust particles in humans and laboratory species*. Research Report of the Health Effects Institute 10:3-22.

Yu, C.P., Yoon, K.J. (1991). *Retention modeling of diesel exhaust particles in rats and humans*. Research Report of the Health Effects Institute 40:1-24.

Zeltner, T.B., Caduff, J.H., et al. (1987). *The postnatal development and growth of the human lung. I. Morphometry.* Respiratory Physiology 67: 247-267.

8. ADDITIONAL SOURCES OF RELATED INFORMATION

De Winter-Sorkina. R., Cassee, F.R. (2002). *From concentration to dose: factors influencing airborne particulate matter deposition in humans and rats.* RIVM Report 650010031/2002.

Gehr et al. (1978). *The normal human lung: ultrastructure and morphometric estimation of the*

diffusion capacity. Respiration Physiology 18: 519-522.

Various Authors. (2008). *EPA Workshop on Children's Inhalation Dosimetry and Health Effects for Risk Assessment*. Journal of Toxicology and Environmental Health, Part A 71:147-248.

Zoetis, T., Hurtt, M.E. (2003). *Species comparison of lung development*. Birth Defects Research 68: 121-124.

APPENDIX B

APPENDIX B

CHEMICALS ON IRIS WITH EXTRAPOLATED INHALATION UNIT RISKS

Table B-1 contains chemicals on the Environmental Protection Agency's (EPA's) Integrated Risk Information System (IRIS) with Inhalation Unit Risk (IUR) values calculated by extrapolation using the default ventilation rate and body weight from the oral Cancer Slope Factor (CSF). These chemicals cause tumors remote from the respiratory tract. Also listed is the year EPA verified the cancer assessment. The list was compiled in September 2008.

EPA recommends that extrapolated IURs should be used with risk Equations 6 and 11 in the main document without additional modification for calculation of cancer risk by the inhalation route of exposure. It is generally not appropriate to make adjustments based on ventilation rate and body weight using the intake equation, because the amount of the chemical that reaches the target site of the chemical through the inhalation pathway is not a simple function of the inhalation rate and body weight. Risk assessors should outline the uncertainties involved in using extrapolated IURs in the risk characterization section of the risk assessment.

TABLE B-1 CHEMICALS WITH EXTRAPOLATED INHALATION UNIT RISKS ON IRIS	
Chemical	**Year of Verification**
Acrylamide[1]	1988
Aldrin	1987
Aramite	1991
Azobenzene	1988
Bromoform	1989
Chlordane	1997
Chloroform[1]	1987
DDT	1987
1,2-Dichloroethane	1986
Dieldrin	1987
1,2-Diphenylhydrazine	1986
Heptachlor	1987
Heptachlor epoxide	1987
Hexachlorobenzene	1989
Hexachlorobutadiene[1]	1986
Alpha-hexachlorocyclohexane	1986
Beta-hexachlorocyclohexane	1986
Technical-hexachlorocyclohexane	1986
Hexachlorodibenzo-p-dioxin mixture	1987
Hexachloroethane	1986
N-nitroso-di-n-butylamine	1986
N-nitrosodiethylamine	1986
N-nitrosodimethylamine	1986
N-nitrosopyrrolidine	1986
Polychlorinated biphenyls	1996
1,1,2,2-Tetrachloroethane	1986
1,1,1,2-Tetrachloroethane	1988
Toxaphene	1987
1,1,2-Trichloroethane	1986
2,4,6-Trichlorophenol	1989
[1] Note that this chemical's IUR is currently under review.	

APPENDIX C

APPENDIX C

STSC's PROCESS FOR DERIVING ALTERNATIVE INHALATION TOXICITY VALUES

If Reference Concentration (RfC) and/or Inhalation Unit Risk (IUR) values for an inhaled contaminant are not available from the sources in the Environmental Protection Agency's (EPA's) Office of Solid Waste and Emergency Response (OSWER) hierarchy, risk assessors should first contact the National Center for Environmental Assessment's (NCEA's) Superfund Health Risk Technical Support Center (STSC) for guidance.[52] Risk assessors working on Superfund sites can contact STSC to determine whether a provisional peer-reviewed toxicity value (PPRTV) exists for a contaminant; if not, the risk assessor, in cooperation with the appropriate EPA Regional office may request that STSC develop a PPRTV document or that STSC develop an inhalation toxicity value as a "consult." The latter would be specific to the site in question only.

As a first choice, if human or whole animal studies exist providing a suitable No Observable Adverse Effect Level (NOAEL)/Lowest Observable Adverse Effect Level (LOAEL) or Point of Departure (POD) from a Benchmark Dose (BMD) analysis, this data normally will be used by STSC to develop an inhalation toxicity value. If, in addition, a suitable human inhalation physiologically based pharmacokinetic (PBPK) model exists that can be utilized to refine the dose metric to the target organ, then this information generally will be included in developing an inhalation toxicity value.

If no appropriate whole animal or human studies exist, but an appropriate peer reviewed human inhalation PBPK model exists that has been validated by experimental results, then STSC usually will attempt to derive an inhalation toxicity value from this model. If none exists, but a suitable PBPK animal inhalation models exists, STSC may attempt developing a human model and deriving an inhalation value.

PBPK modeling quantitatively describes the absorption/metabolism/distribution and elimination of the chemical from a point of entry (oral, inhalation, dermal) to the target organ(s). In some cases, an oral PBPK model can be extrapolated to the inhalation pathway, but care must be taken to consider direct pulmonary effects that may not be evident by oral dosing.

As a next approach, STSC typically will evaluate development of an inhalation toxicity value using a suitable surrogate chemical based on a quantitative structure-activity relationship (QSAR) model with structural selection criteria and solubility/toxicity considerations. STSC may evaluate possible surrogate chemicals based on several available structural models and provide a comparison. Selection of the appropriate surrogate may depend on the weight of evidence of these models.

[52] All contact with STSC should be performed by an EPA regional risk assessor. States and other entities should first contact their EPA regional risk assessor with questions on inhalation toxicity values. Regional risk assessors can then contact STSC on their behalf.

If STSC uses any of the methods for developing toxicity values other than from human or whole animal data, the value normally will be presented as a "screening" value with the caveat that it should not be used as a risk driver for a site without consultation with the STSC. The uncertainties associated with using toxicity values derived through PBPK modeling or QSAR, or with using a surrogate value should be described in the risk characterization portion of the risk assessment (see Section 9). Risk assessors are discouraged from performing simplistic route-to-route extrapolations from oral data using default assumptions about Inhalation Rate (IR) and body weight (BW).[53]

[53] If STSC indicates that no quantitative toxicity information for the inhalation route is available, the risk assessor should conduct a qualitative evaluation of this exposure route. The risk assessor should discuss in the uncertainty section of the risk assessment report the implications of not quantitatively assessing risks due to inhalation exposures to chemicals lacking inhalation toxicity data. See the section on Risk Characterization (Section 9) in the main text of this guidance for more information.

An official website of the United States government

Conducting a Human Health Risk Assessment

On this page:

Planning | Hazard Identification | Dose-Response | Exposure Assessment | Risk Characterization

Planning and Scoping

Even a human health risk assessment starts with a good plan. Before anything though there is a need to make judgments early when planning major risk assessments regarding the purpose, scope, and technical approaches that will be used. To start, risk assessors will typically ask the following questions:

1. Who/What/Where is at risk?
    - Individual
    - General population
    - Lifestages such as children, teenagers, pregnant/nursing women
    - Population subgroups - highly susceptible (for example, due to asthma, genetics, etc.) and/or highly exposed (for example, based on geographic area, gender, racial or ethnic group, or economic status)

2. What is the environmental hazard of concern?

- Chemicals (single or multiple/cumulative risk)
- Radiation
- Physical (dust, heat)
- Microbiological or biological
- Nutritional (for example, diet, fitness, or metabolic state)
- Socio-Economic (for example, access to health care)

3. Where do these environmental hazards come from?

- Point sources (for example, smoke or water discharge from a factory; contamination from a Superfund site)
- Non-point sources (for example, automobile exhaust; agricultural runoff)
- Natural sources

4. How does exposure occur?

- Pathways (recognizing that one or more may be involved)
    - Air
    - Surface Water
    - Groundwater
    - Soil
    - Solid Waste
    - Food
    - Non-food consumer products, pharmaceuticals
- Routes (and related human activities that lead to exposure)
    - Ingestion (both food and water)
    - Contact with skin
    - Inhalation
    - Non-dietary ingestion (for example, "hand-to-mouth" behavior)

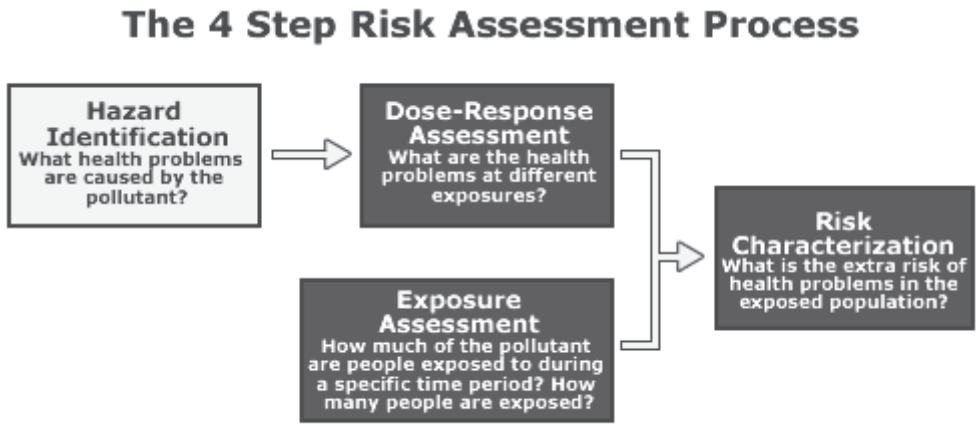
5. What does the body do with the environmental hazard and how is this impacted by factors such as age, race, sex, genetics, etc.?)
    - Absorption - does the body take up the environmental hazard
    - Distribution - does the environmental hazard travel throughout the body or does it stay in one place?
    - Metabolism - does the body break down the environmental hazard?
    - Excretion - how does the body get rid of it?

6. What are the health effects?
    - Example of some health effects include cancer, heart disease, liver disease and nerve disease.

7. How long does it take for an environmental hazard to cause a toxic effect? Does it matter when in a lifetime exposure occurs?
    - How long?
        - Acute - right away or within a few hours to a day
        - Subchronic - weeks or months (for humans generally less than 10% of their lifespan)
        - Chronic - a significant part of a lifetime or a lifetime (for humans at least seven years)
        - Intermittent
    - Timing
      Is there a critical time during a lifetime when a chemical is most toxic (e.g., fetal development, childhood, during aging)?

Step 1: Hazard Identification

The objective of Step 1 is to identify the types of adverse health effects that can be caused by exposure to some agent in question, and to characterize the quality and weight of evidence supporting this identification.



Step 1: Hazard identification is the first step of a human health risk assessment.

Hazard Identification is the process of determining whether exposure to a stressor can cause an increase in the incidence of specific adverse health effects (e.g., cancer, birth defects). It is also whether the adverse health effect is likely to occur in humans.

In the case of chemical stressors, the process examines the available scientific data for a given chemical (or group of chemicals) and develops a weight of evidence to characterize the link between the negative effects and the chemical agent.

Exposure to a stressor may generate many different adverse effects in a human: diseases, formation of tumors, reproductive defects, death, or other effects.

Sources of Data

Statistically controlled clinical studies on humans provide the best evidence linking a stressor, often a chemical, to a resulting effect. However, such studies are frequently not available since there are significant ethical concerns associated with human testing of environmental hazards.

Epidemiological studies involve a statistical evaluation of human populations to examine whether there is an association between exposure to a stressor and a human health effect. The advantage of these studies is that they involve humans while their weakness results from generally not having accurate exposure information and the difficulty of teasing out the effects of multiple stressors.

When data from human studies are unavailable, data from animal studies (rats, mice, rabbits, monkeys, dogs, etc) are relied on to draw inference about the potential hazard to humans. Animal studies can be designed, controlled, and conducted to address specific gaps in knowledge, but there are uncertainties associated with extrapolating results from animal subjects to humans.

Key Components of Hazard Identification

A wide variety of studies and analysis are used to support a hazard identification analysis.

- Toxicokinetics considers how the body absorbs, distributes, metabolizes, and eliminates specific chemicals.

- Toxicodynamics focus on the effects that chemicals have on the human body. Models based on these studies can describe mechanisms by which a chemical may impact human health, thus providing insights into the possible effects of a chemical.

When assessing a chemical for potential carcinogenic behavior, current EPA practice is to focus on analysis of a mode of action. Mode of action is a sequence of key events and processes, starting with interaction of an agent and a cell, proceeding through operational and anatomical changes, and resulting in cancer formation. A given agent may work by more than one mode of action, both at different tumor sites as well as at the same site.

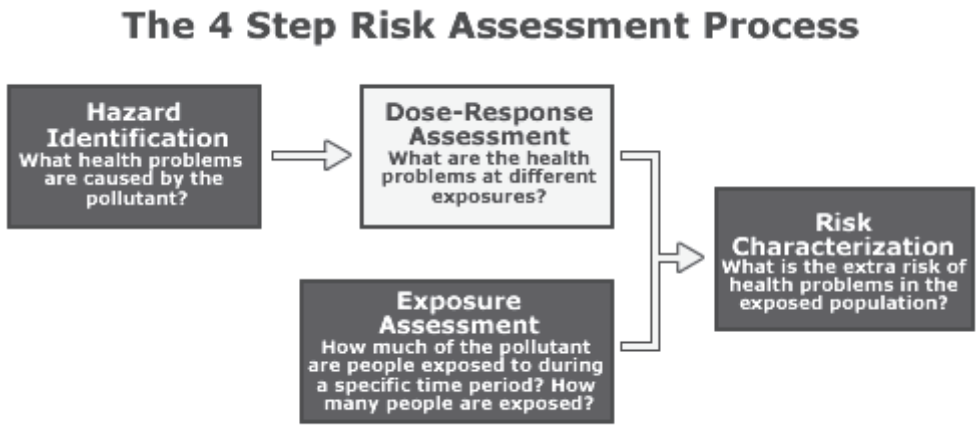
Analysis of mode of action is based on physical, chemical, and biological information that helps to explain key events in an agent's influence on tumor development.

A key component of hazard characterization involves evaluating the weight of evidence regarding a chemical’s potential to cause adverse human health effects. The weight of evidence narrative may include some standard 'descriptors' that signify certain qualitative threshold levels of evidence or confidence have been met, such as 'Carcinogenic to humans' or 'Suggestive evidence of carcinogenic potential'.

Note: More specific information on hazard assessment approaches can be found in the specific risk assessment guidelines relevant for the kind of effect being considered.

Step 2: Dose Response

The objective of Step 2 is to document the relationship between dose and toxic effect.



Step 2: Dose-response assessment is the second step of a human health risk assessment.

A dose-response relationship describes how the likelihood and severity of adverse health effects (the responses) are related to the amount and condition of exposure to an agent (the dose provided). Although this webpage refers to the "dose-response" relationship, the same principles generally apply for studies where the exposure is to a concentration of the agent (e.g., airborne concentrations applied in inhalation exposure studies), and the resulting information is referred to as the "concentration-response" relationship.

The term "exposure-response" relationship may be used to describe either a dose-response or a concentration-response, or other specific exposure conditions.

Typically, as the dose increases, the measured response also increases. At low doses there may be no response. At some level of dose the responses begin to occur in a small fraction of the study population or at a low probability rate. Both the dose at which response begin to appear and the rate at which it increases given increasing dose can be variable between different pollutants, individuals, exposure routes, etc.

The shape of the dose-response relationship depends on the agent, the kind of response (tumor, incidence of disease, death, etc), and the experimental subject (human, animal) in question. For example, there may be one relationship for a response such as 'weight loss' and a different relationship for another response such as 'death'. Since it is impractical to study all possible relationships for all possible responses, toxicity research typically focuses on testing for a limited number of adverse effects.

> Typically, as the dose increases, the measured response also increases.

Upon considering all available studies, the response (adverse effect), or a measure of response that leads to an adverse effect (known as a ‘precursor’ to the effect), that occurs at the lowest dose is selected as the critical effect for risk assessment. The underlying assumption is that if the critical effect is prevented from occurring, then no other effects of concern will occur.

As with hazard identification, there is frequently a lack of dose-response data available for human subjects. When data are available, they often cover only a portion of the possible range of the dose-response relationship, in which case some extrapolation must be done in order to extrapolate to dose levels that are lower than the range of data obtained from scientific studies. Also, as with hazard identification, animal studies are frequently done to augment the available data.

Studies using animal subjects permit the use of study design to control the number and composition (age, gender, species) of test subjects, the levels of dose tested, and the measurement of specific responses. Use of a designed study typically leads to more meaningful statistical conclusions than does an uncontrolled observational study were additional confounding factors must also be considered for their impact on the conclusions.

However, dose-response relationships observed from animal studies are often at much higher doses that would be anticipated for humans, so must be extrapolated to lower doses, and animal studies must also be extrapolated from that animal species to

humans in order to predict the relationship for humans. These extrapolations, among others, introduce uncertainty into the dose-response analysis.

Basic Dose-Response Calculations & Concepts

As a component of the first step of the process discussed below, the scientific information is evaluated for a better biological understanding of how each type of toxicity or response (adverse effect) occurs; the understanding of how the toxicity is caused is called the "mode of action" (which is defined as a sequence of key events and processes, starting with interaction of an agent with a cell, proceeding through operational and anatomical changes, and resulting in the effect, for example, cancer formation).

Based on this mode of action, the Agency determines the nature of the extrapolation used in the second step of the process discussed above, either through non-linear or linear dose-response assessment.

A two-step process...

Step 1: Take an assessment of all data that are available or can be gathered through experiments. This is in order to document the dose-response relationship(s) over the range of observed doses (i.e, the doses that are reported in the data collected).

However, frequently this range of observation may not include sufficient data to identify a dose where the adverse effect is not observed (i.e., the dose that is low enough to prevent the effect) in the human population.

Step 2: This consists of extrapolation to estimate the risk (probably of adverse effect) beyond the lower range of available observed data. This is in order to make inferences about the critical region where the dose level begins to cause the adverse effect in the human population.

Non-linear dose-response assessment

Non-linear dose response assessment has its origins in the threshold hypothesis, which holds that a range of exposures from zero to some finite value can be tolerated by the organism with essentially no chance of expression of the toxic effect, and the threshold of toxicity is where the effects (or their precursors) begin to occur. It is often prudent to focus on the most sensitive members of the population; therefore, regulatory efforts are generally made to keep exposures below the population threshold, which is defined as the lowest of the thresholds of the individuals within a population.

If the "mode of action" information (discussed above) suggests that the toxicity has a threshold, which is defined as the dose below which no deleterious effect is expected to occur, then type of assessment is referred to by the Agency as a "non-linear" dose-response assessment. The term "nonlinear" is used here in a narrower sense than its usual meaning in the field of mathematics; a nonlinear assessment uses a dose-response relationship whose slope is zero (i.e., no response) at (and perhaps above) a dose of zero.

A No-Observed-Adverse-Effect Level (NOAEL) is the highest exposure level at which no statistically or biologically significant increases are seen in the frequency or severity of adverse effect between the exposed population and its appropriate control population. In an experiment with several NOAELs, the regulatory focus is normally on the highest one, leading to the common usage of the term NOAEL as the highest experimentally determined dose without a statistically or biologically significant adverse effect. In cases in which a NOAEL has not been demonstrated experimentally, the term "lowest-observed-adverse-effect level (LOAEL)" is used, which this is the lowest dose tested.

Mathematical modeling, which can incorporate more than one effect level (i.e., evaluates more data than a single NOAEL or LOAEL), is sometimes used to develop an alternative to a NOAEL known as a Benchmark Dose (BMD) or Benchmark Dose Lower-confidence Limit (BMDL). In developing the BMDL, a predetermined change in the response rate of an adverse effect (called the benchmark response or BMR; generally in the range of 1 to 10% depending on the power of a toxicity study) is selected, and the BMDL is a statistical lower confidence limit on the dose that produces the selected response. When the non-linear approach is applied, the LOAEL, NOAEL, or BMDL is used as the point of departure for extrapolation to lower doses.

The reference dose (RfD) is an oral or dermal dose derived from the NOAEL, LOAEL or BMDL by application of generally order-of-magnitude uncertainty factors (UFs). These uncertainty factors take into account the variability and uncertainty that are reflected in possible differences between test animals and humans (generally 10-fold or 10x) and variability within the human population (generally another 10x); the UFs are multiplied together: **10 x 10 = 100x.**

If a LOAEL is used, another uncertainty factor, generally 10x, is also used. In the absence of key toxicity data (duration or key effects), an extra uncertainty factor(s) may also be employed. Sometimes a partial UF is applied instead of the default value of 10x, and this value can be less than or greater than the default. Often the partial value is ½ log unit (the square root of 10) or 3.16 (rounded to 3-fold in risk assessment). Note, that when two UFs derived from ½ log units are multiplied together (3 x 3) the result is a 10 (equal to the full UF from which the two partial factors were derived).

Thus, the RfD is determined by use of the following equation: **RfD = NOAEL (or LOAEL or BMDL) / UFs**

In general, the RfD is defined as an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive groups, such as asthmatics, or life stages, such as children or the elderly) that is likely to be without an appreciable risk of deleterious effects during a lifetime.

The **RfD is generally expressed** in **units of milligrams per kilogram of bodyweight per day: mg/kg/day**.

A similar term, know as reference concentration (RfC), is used to assess inhalation risks, where concentration refers to levels in the air (generally expressed in the units of milligrams agent per cubic meter of air: mg/m^3).

- For more information, please see A Review of the Reference Dose and Reference Concentration Processes <https://epa.gov/scientific-leadership/review-reference-dose-and-reference-concentration-processes>.

Linear dose-response assessment

If the "mode of action" information (discussed above) suggests that the toxicity does not have a threshold, then this type of assessment is referred to by the Agency as a "linear" dose-response assessment. In the case of carcinogens, if "mode of action" information is insufficient, then linear extrapolation is typically used as the default approach for dose-response assessment.

- For more detailed information, please see EPA's Guidelines for Carcinogen Risk Assessment <https://epa.gov/risk/guidelines-carcinogen-risk-assessment>.

In this type of assessment, there is theoretically no level of exposure for such a chemical that does not pose a small, but finite, probability of generating a carcinogenic response. The extrapolation phase of this type of assessment does not use UFs; rather, a straight line is drawn from the point of departure for the observed data (typically the BMDL) to the origin (where there is zero dose and zero response).

The slope of this straight line, called the slope factor or cancer slope factor, is use to estimate risk at exposure levels that fall along the line. When linear dose-response is used to assess cancer risk, EPA calculates excess lifetime cancer risk (i.e., probability that an individual will contract cancer over a lifetime) resulting from exposure to a contaminant by considering the degree to which individuals were exposed, as compared to the slope factor.

Thus, the cancer risk is determined by use of the following equation: **Cancer Risk = Exposure x Slope Factor**

Total cancer risk is calculated by adding the individual cancer risks for each pollutant in each pathway of concern (i.e., inhalation, ingestion, and dermal absorption), then summing the risk for all pathways.

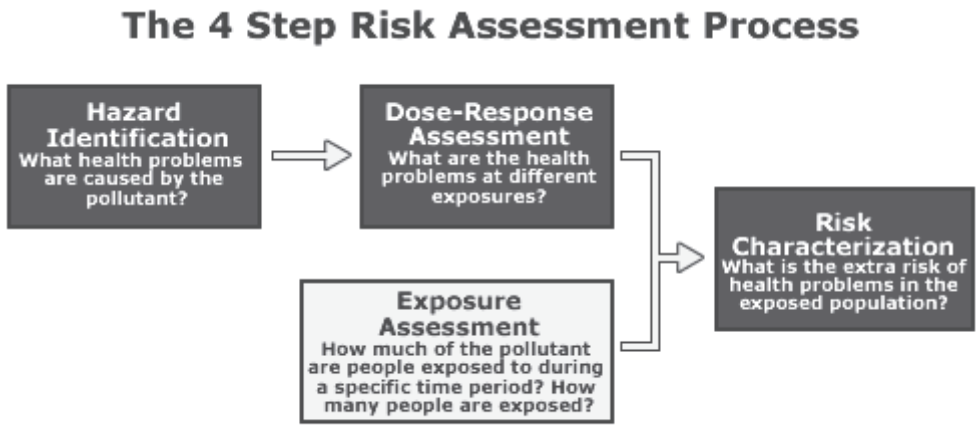
A similar term, know as inhalation unit risk (IUR), is used to assess inhalation risks, where the exposure-response relationship refers to concentrations in the air.

Note: When there are alternative procedures having significant biological support, the Agency encourages assessments to be performed using these alternative procedures, if feasible, in order to shed light on the uncertainties in the assessment, recognizing that

the Agency may decide to give greater weight to one set of procedures than another in a specific assessment or management decision.

Step 3: Exposure Assessment

The objective of Step 3 is to calculate a numerical estimate of exposure or dose.



Step 3: Exposure Assessment is the third step of a human health risk assessment.

Exposure assessment is the process of measuring or estimating the magnitude, frequency, and duration of human exposure to an agent in the environment, or estimating future exposures for an agent that has not yet been released. An exposure assessment includes some discussion of the size, nature, and types of human populations exposed to the agent, as well as discussion of the uncertainties in the above information.

Exposure can be measured directly, but more commonly is estimated indirectly through consideration of measured concentrations in the environment, consideration of models of chemical transport and fate in the environment, and estimates of human intake over time.

Different Kinds of Doses. Exposure assessment considers both the exposure pathway (the course an agent takes from its source to the person(s) being contacted) as well as the exposure route (means of entry of the agent into the body). The exposure route is

generally further described as intake (taken in through a body opening, e.g. as eating, drinking, or inhaling) or uptake (absorption through tissues, e.g. through the skin or eye).

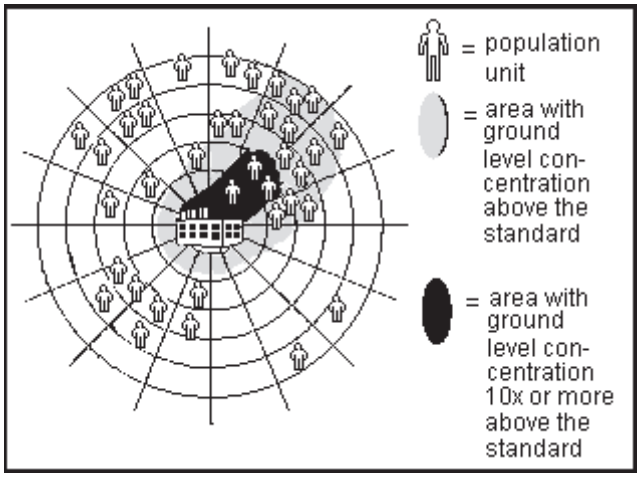
> EPA defines exposure as 'contact between an agent and the visible exterior of a person (e.g. skin and openings into the body)'.

The applied dose is the amount of agent at the absorption barrier that is available for absorption. The potential dose is the amount of agent that is ingested, inhaled, or applied to the skin. The applied dose may be less than the potential dose if the agent is only partly bioavailable.

The internal dose or absorbed dose is the amount of an agent that has been absorbed and is available for interaction with biologically significant receptors within the human body. Finally, the delivered dose is the amount of agent available for interaction with any specific organ or cell.

Range of Exposure. For any specific agent or site, there is a range of exposures actually experienced by individuals. Some individuals may have a high degree of contact for an extended period (e.g. factory workers exposed to an agent on the job). Other individuals may have a lower degree of contact for a shorter period (e.g. individuals using a recreational site downwind of the factory). EPA policy for exposure assessment requires consideration of a range of possible exposure levels.

Two common scenarios for possible exposure are "Central Tendency" and "High End". "Central Tendency" exposure is an estimate of the average experienced by the affected population, based on the amount of agent present in the environment and the frequency and duration of exposure.



"High End" exposure is the highest dose estimated to be experienced by some individuals, commonly stated as approximately equal to the 90th percentile exposure category for individuals.

Figure: Showing the "range of exposure"

Quantifying Exposure. There are three basic approaches for quantifying exposure. Each approach is based on different data, and has different strengths and weaknesses; using the approaches in combination can greatly strengthen the credibility of an exposure risk assessment.

- **Point of Contact Measurement** - The exposure can be measured at the point of contact (the outer boundary of the body) while it is taking place, measuring both exposure concentration and time of contact, then integrating them;

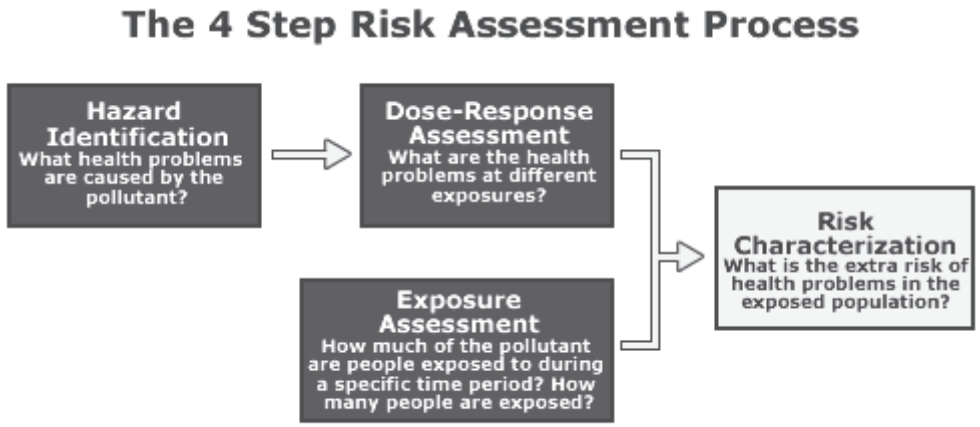
- **Scenario Evaluation** - The exposure can be estimated by separately evaluating the exposure concentration and the time of contact, then combining this information;

- **Reconstruction** - the exposure can be estimated from dose, which in turn can be reconstructed through internal indicators (biomarkers, body burden, excretion levels, etc) after the exposure has taken place (reconstruction).

- For more information on exposure assessment methods, see the Guidelines for Exposure Assessment <https://epa.gov/risk/guidelines-exposure-assessment>.

Step 4: Risk Characterization

The objective of Step 4 is to summarize and integrate information from the proceeding steps of the risk assessment to synthesize an overall conclusion about risk.



Step 4: Risk characterization is the last step of a human health risk assessment.

A risk characterization conveys the risk assessor's judgment as to the nature and presence or absence of risks, along with information about how the risk was assessed, where assumptions and uncertainties still exist, and where policy choices will need to be made. Risk characterization takes place in both human health risk assessments and ecological risk assessments.

In practice, each component of the risk assessment (e.g. hazard assessment, dose-response assessment, exposure assessment) has an individual risk characterization written to carry forward the key findings, assumptions, limitations, and uncertainties. The set of these individual risk characterizations provide the information basis to write an integrative risk characterization analysis.

The final, overall risk characterization thus consists of the individual risk characterizations plus an integrative analysis.

> The overall risk characterization informs the risk manager and others about the rationale behind EPA's approach to conducting the risk assessment.
>
> Such as: Why EPA did what it did to assess the risk?

Principles of Conducting Risk Characterizations

A good risk characterization will restate the scope of the assessment, express results clearly, articulate major assumptions and uncertainties, identify reasonable alternative interpretations, and separate scientific conclusions from policy judgments.

EPA's Risk Characterization Policy calls for conducting risk characterizations in a manner that is consistent with the following principles:

- **Transparency** - The characterization should fully and explicitly disclose the risk assessment methods, default assumptions, logic, rationale, extrapolations, uncertainties, and overall strength of each step in the assessment.

- **Clarity** - The products from the risk assessment should be readily understood by readers inside and outside of the risk assessment process. Documents should be concise, free of jargon, and should use understandable tables, graphs, and equations as needed.

- **Consistency** - The risk assessment should be conducted and presented in a manner which is consistent with EPA policy, and consistent with other risk characterizations of similar scope prepared across programs within the EPA.

- **Reasonableness** - The risk assessment should be based on sound judgment, with methods and assumptions consistent with the current state-of-the-science and conveyed in a manner that is complete and balanced, informative.

These four principles are referred to collectively as TCCR. In order to achieve TCCR in a risk characterization, the same principles need to have been applied in all of the prior steps in the risk assessment which lead up to the risk characterization.

- For more information read the Risk Characterization Handbook <https://epa.gov/risk/risk-characterization-handbook>.

Risk Assessment Home <https://epa.gov/risk>

About Risk Assessment <https://epa.gov/risk/about-risk-assessment>

Risk Recent Additions <https://epa.gov/risk/recent-additions-risk-assessment>

Human Health Risk Assessment

Conducting a Human Health Risk Assessment

Human Health Risk Models and Tools <https://epa.gov/risk/human-health-risk-models-and-tools>

Ecological Risk Assessment <https://epa.gov/risk/ecological-risk-assessment>

Risk Advanced Search <https://assessments.epa.gov/risk/advanced_search/>

Risk Assessment Guidance <https://epa.gov/risk/risk-assessment-guidance>

Risk Tools and Databases <https://epa.gov/risk/human-health-risk-models-and-tools>

Superfund Risk Assessment <https://epa.gov/risk/superfund-risk-assessment>

Where you live <https://epa.gov/risk/where-you-live-risk-assessment>

Contact Us <https://epa.gov/risk/forms/contact-us-about-risk-assessment> to ask a question, provide feedback, or report a problem.

LAST UPDATED ON JULY 23, 2024

Contracting
<https://epa.gov/contracts>

EPA www Web Snapshot
<https://epa.gov/utilities/wwwepagov-snapshots>

Grants
<https://epa.gov/grants>

No FEAR Act Data
<https://epa.gov/ocr/whistleblower-protections-epa-and-how-they-relate-non-disclosure-agreements-signed-epa>

Plain Writing
<https://epa.gov/web-policies-and-procedures/plain-writing>

Privacy
<https://epa.gov/privacy>

Privacy and Security Notice
<https://epa.gov/privacy/privacy-and-security-notice>

Newsroom
<https://epa.gov/newsroom>

Regulations.gov
<https://www.regulations.gov/>

Subscribe
<https://epa.gov/newsroom/email-subscriptions-epa-news-releases>

USA.gov
<https://www.usa.gov/>

White House
<https://www.whitehouse.gov/>

Hotlines
<https://epa.gov/aboutepa/epa-hotlines>

FOIA Requests
<https://epa.gov/foia>

Frequent Questions
<https://epa.gov/home/frequent-questions-specific-epa-programstopics>

Follow.

An official website of the United States government

Risk Assessment for Carcinogenic Effects

EPA's first carcinogen risk assessment guidelines [1], published in 1986, were the product of nearly two decades of experience and scientific consensus building. EPA has since gained considerable experience in applying cancer risk assessment approaches. Concurrently, the science of risk assessment and toxicological testing has continued to evolve, and EPA has had to address situations not explicitly discussed in the 1986 guidelines, e.g., children's risk assessment. The update of EPA's carcinogen risk assessment guidelines in 2005 consolidated the Agency's experience, providing more comprehensive and transparent guidance on topics not fully developed in the original guidelines, and providing flexibility to accommodate anticipated advances in the science.

During the time between 1996 and 2005, EPA applied the principles and procedures of the draft revised guidelines on a case-by-case basis for new hazard identifications and dose-response assessments using interim draft guidelines that represented the

Dose–Response Assessment for Assessing Health Risks Associated With Exposure to Hazardous Air Pollutants

- Summary and Tables <https://epa.gov/fera/dose-response-assessment-assessing-health-risks-associated-exposure-hazardous-air-pollutants>

evolution of risk assessment methods rather than a dramatic shift in methodology. Since 2005, EPA has applied the new 2005 guidelines which reflect EPA's accumulated experience and advances in our knowledge on cancer assessment. On the other hand, assessments for many substances that were prepared under the 1986 guidelines continue to be valid. Therefore, the dose-response assessments of carcinogens reflect a mixture of the application of 1986 guidelines and the more recent guidelines.

Hazard Identification for Carcinogenic Effects. EPA's guidelines recognize three broad categories of data: (1) human data (primarily epidemiological); (2) results of long-term experimental animal bioassays; and (3) supporting data, including a variety of short-term tests for genotoxicity and other relevant properties, pharmacokinetic and metabolic studies, and structure-activity relationships. In hazard identification of carcinogens under the guidelines, human data, animal data, and supporting evidence are combined to characterize the weight-of-evidence (WOE) regarding the agent's potential as a human carcinogen. The current guidelines <https://epa.gov/risk/guidelines-carcinogen-risk-assessment>, finalized in 2005, recommend expressing WOE by narrative statements rather than only hierarchical categories, and expressing them separately for the oral and inhalation routes. The general categories recognized by the 2005 guidelines are [2]:

- Carcinogenic to Humans
- Likely to be Carcinogenic to Humans
- Suggestive Evidence of Carcinogenic Potential

- Sources of Chronic Dose-Response Information <https://epa.gov/fera/sources-chronic-dose-response-information>
- Prioritization of Data Sources for Chronic Exposure <https://epa.gov/fera/prioritization-data-sources-chronic-exposure>
- Additional Information, Adjustments and Special Cases for Dose-Response Values in Tables 1 and 2 <https://epa.gov/fera/additional-information-adjustments-and-special-cases-dose-response-values-tables-1-and-2>
- Sources of Acute Dose-Response Information <https://epa.gov/fera/sources-acute-dose-response-information>

- Inadequate Information to Assess Carcinogenic Potential
- Not Likely to be Carcinogenic to Humans

Under the 1986 guidelines, this WOE was summarized as fitting one of several hierarchic categories [1]:

Group A - Carcinogenic to Humans: Agents with adequate human data to demonstrate the causal association of the agent with human cancer (typically epidemiologic data).

Group B - Probably Carcinogenic to Humans: Agents with sufficient evidence (i.e., indicative of a causal relationship) from animal bioassay data, but either limited human evidence (i.e., indicative of a possible causal relationship, but not exclusive of alternative explanations; Group B1), or with little or no human data (Group B2).

Group C - Possibly Carcinogenic to Humans: Agents with limited animal evidence and little or no human data.

Group D - Not Classifiable as to Human Carcinogenicity: Agents without adequate data either to support or refute human carcinogenicity.

Group E - Evidence of Non-carcinogenicity for Humans: Agents that show no evidence for carcinogenicity in at least two adequate animal tests in different species or in both adequate epidemiologic and animal studies.

For each HAP that has been assessed for carcinogenicity under either set of guidelines, Table 1 of dose-response assessments compiled by the Office of Air Quality Planning and Standards <https://epa.gov/fera/dose-response-assessment-assessing-health-risks-associated-exposure-hazardous-air-pollutants> presents the category label specified by the most recent assessment (which may be via the current or past guidelines). At some point in the future, the table may also include excerpts of narrative WOEs. These WOE categories express the relative level of certainty that these agents may cause cancer in humans.

- The NRC Risk Assessment Paradigm <https://epa.gov/fera/nrc-risk-assessment-paradigm>
- **Risk Assessment for Carcinogens**
- Risk Assessment for Noncancer Effects <https://epa.gov/fera/risk-assessment-other-effects>

The categories specifically do not connote relative levels of hazard or degree of conservatism applied in developing a dose-response assessment. For example, a substance in group C (possible human carcinogen), under the 1986 guidelines, may impart a greater cancer risk to more people than another substance in group A (known human carcinogen), yet there is a greater certainty with regard to the risk associated with the latter. EPA's WOE classifications are focused on the amount and quality of evidence regarding whether or not a substance is carcinogenic to humans, not on the level of risk a substance might present. Dose-Response Assessment for Carcinogens. Since the publication of EPA's original cancer guidelines in 1986, considerable new knowledge has been developed regarding the processes of chemical carcinogenesis and the evaluation of human cancer risk. The 2005 guidelines [2] recognize both linear and nonlinear modes of action for carcinogens. When assessing the dose-response relationship under the guidelines, cancer data in the observable range are analyzed using a common dose-response model regardless of mode of action. The method of extrapolation to lower doses from the point of departure may vary depending on whether the available data indicate a linear or nonlinear mode of action.

Under the guidelines, linear extrapolation is appropriate when the evidence supports the mode of action of gene mutation due to direct DNA reactivity or another mode of action that is thought to be linear in the low dose region. A linear mode of action will also be the approach when available evidence is not sufficient to support a nonlinear extrapolation procedure, even in the absence of evidence of DNA reactivity. Nonlinear methods (including derivation of an oral reference dose or inhalation reference concentration) are to be used if there is sufficient evidence to support a nonlinear mode of action.

For linear carcinogens, EPA's current process of estimating cancer risk is based on the unit risk estimate (URE) for inhalation, and the carcinogenic potency slope (CPS) for ingestion. The URE represents the upper-bound excess lifetime cancer risk estimated to result from continuous exposure to an agent over a lifetime at a concentration of 1 $\mu g/m^3$ in air. The interpretation of the URE would be as follows: if the URE = 1.5 x 10-6 $\mu g/m^3$, no more than 1.5 excess tumors are expected to develop per 1,000,000 people if exposed all day, every day for a lifetime to a concentration of 1 µg of the chemical per cubic meter of air. The CPS is an upper bound, usually approximating a 95% confidence limit, on the increased cancer risk from a lifetime oral exposure to an agent. This estimate, usually expressed in units of proportion (of a population) affected per

mg/kg/day, is generally reserved for use in the low-dose region of the dose-response relationship, that is, for exposures corresponding to risks less than 1 in 100. The URE and CPS are plausible upper-bound estimates of the risk (i.e., the actual risk is likely to be lower, but may be greater). However, because the URE and CPS reflect unquantifiable assumptions about effects at low doses, their upper bounds are not true statistical confidence limits. The tabulated UREs and CPSs were developed by EPA and the California EPA, and were selected for use by a priority system <https://epa.gov/fera/prioritization-data-sources-chronic-exposure>.

References

1. U.S. EPA. 1986. Guidelines for Carcinogen Risk Assessment. 51 FR 33992-34003.
2. U.S. EPA. 2005. Guidelines for Carcinogen Risk Assessment. 70 FR 17765-17817

FERA Home <https://epa.gov/fera>

Total Risk Integrated Methodology (TRIM) <https://epa.gov/fera/total-risk-integrated-methodology-trim-overview>

Multimedia Fate and Transport Modeling <https://epa.gov/fera/multimedia-fate-and-transport-modeling-overview>

Human Exposure Assessment and Modeling <https://epa.gov/fera/human-exposure-assessment-and-modeling-criteria-air-pollutant-exposure-assessment>

Risk Assessment and Modeling <https://epa.gov/fera/risk-assessment-and-modeling-overview>

Contact Us <https://epa.gov/fera/forms/contact-us-about-fera> to ask a question, provide feedback, or report a problem.

LAST UPDATED ON NOVEMBER 14, 2023

Discover

•

Accessibility Statement
<https://epa.gov/accessibility/epa-accessibility-statement>

Budget & Performance
<https://epa.gov/planandbudget>

Contracting
<https://epa.gov/contracts>

EPA www Web Snapshot
<https://epa.gov/utilities/wwwepagov-snapshots>

Grants
<https://epa.gov/grants>

No FEAR Act Data
<https://epa.gov/ocr/whistleblower-protections-epa-and-how-they-relate-non-disclosure-agreements-signed-epa>

Plain Writing
<https://epa.gov/web-policies-and-procedures/plain-writing>

Connect.

Data
<https://epa.gov/data>

Inspector General
<https://www.epaoig.gov/>

Jobs
<https://epa.gov/careers>

Newsroom
<https://epa.gov/newsroom>

Regulations.gov
<https://www.regulations.gov/>

Subscribe
<https://epa.gov/newsroom/email-subscriptions-epa-news-releases>

USA.gov
<https://www.usa.gov/>

White House
<https://www.whitehouse.gov/>

Ask.

Contact EPA
<https://epa.gov/home/forms/contact-epa>

EPA Disclaimers
<https://epa.gov/web-policies-and-procedures/epa-disclaimers>

Hotlines
<https://epa.gov/aboutepa/epa-hotlines>

FOIA Requests
<https://epa.gov/foia>

Frequent Questions
<https://epa.gov/home/frequent-questions-specific-epa-programstopics>

Follow.

Privacy

<https://epa.gov/privacy>

Privacy and Security Notice

<https://epa.gov/privacy/privacy-and-security-notice>

An official website of the United States government

Exposure Assessment Tools by Routes - Inhalation

On this page:

Overview | Methods | Calculations | Concentrations | Scenarios | Factors | Guidance | References

Overview



An exposure route is the way that a contaminant enters an individual or population after contact (IPCS, 2004). Typically, exposure occurs by one of three exposure routes—inhalation, ingestion, or dermal.

Inhalation exposure can result from breathing air that is contaminated with particulate matter (e.g., dust), vapors (e.g., volatile or semivolatile contaminants), or aerosols. Individuals can be exposed via the inhalation route during a variety of activities outdoors and indoors. Indoor receptors could also be exposed to outdoor air contaminants that infiltrate the indoor environment.

Estimating exposure from inhalation requires information on the concentrations of contaminants in the air and the timeframe over which inhalation exposure occurs. To calculate an inhaled dose, inhalation rates and receptor body weights might also be needed.

Calculations to estimate dose from inhalation are provided in this module as are various tools available for evaluating potential exposure concentrations. Exposure scenarios, exposure factors, and guidance for assessing exposure via inhalation are also provided.

Methods

When a contaminant is taken into the body via inhalation, the amount that gets into the body in a biologically available form is called the dose. There are a few different ways to measure dose (U.S. EPA, 1992):

- **Potential dose** is the amount of contaminant inhaled (i.e., amount that gets in the mouth or nose), not all of which is actually absorbed.

- **Applied dose** is the amount of contaminant at the absorption barrier (e.g., respiratory tract) that can be absorbed by the body.
- **Internal dose** is the amount of contaminant that gets past the exchange boundary (lung) and into the blood, or the amount of the contaminant that can interact with organs and tissues to cause biological effects.
- **Biologically effective dose** is the amount of contaminant that interacts with the internal target tissue or organ.

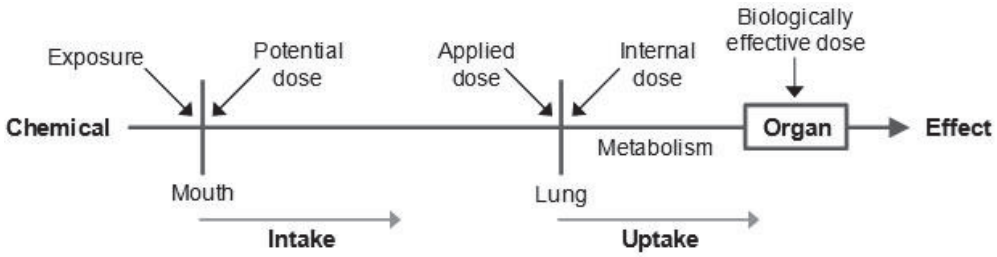


Illustration of Inhalation Route: Exposure and Dose (U.S. EPA, 1992)

The amount of chemical that is absorbed through the lung may vary from the amount of the substance that is inhaled. Thus, internal dose might differ from potential dose.

When using inhalation reference concentrations [RfCs] or inhalation unit risk [IURs] from the Integrated Risk Information System (IRIS) <https://epa.gov/iris> to characterize risk, it is not necessary to calculate the inhaled dose. This is because the IRIS methodology accounts for inhalation rates in the development of "dose-response" relationships. Instead, only an air concentration is needed to evaluate health concerns.

The methods used in developing noncancer inhalation dose-response values for IRIS are discussed in more detail in the U.S. EPA report entitled *Methods for Derivation of Inhalation Reference Concentrations and Application of Inhalation Dosimetry* <https://epa.gov/risk/methods-derivation-inhalation-reference-concentrations-and-application-inhalation-dosimetry> (U.S. EPA, 1994).

The Superfund Program has also recently updated its approach for determining inhalation risk. It has eliminated the use of inhalation rates when evaluating exposure to air contaminants. This is described in *Risk Assessment Guidance for Superfund (Part F, Supplemental Guidance for Inhalation Risk Assessment)* <https://epa.gov/risk/risk-assessment-guidance-superfund-rags-part-f> (U.S. EPA, 2009).

Inhalation - A Complicating Factor

The Agency defines exposure as the chemical concentration at the boundary of the body (U.S. EPA, 1992). In the case of inhalation, the situation is complicated by the fact that oxygen exchange with carbon dioxide takes place in the distal portion of the lung. The anatomy and physiology of the respiratory system as well as the characteristics of the inhaled agent diminishes the pollutant concentration in inspired air (potential dose) such that the amount of a pollutant that actually enters the body through the upper respiratory tract (especially

This updated methodology recommends that risk assessors use the concentration of the contaminant in air (C_{air}) as the exposure metric (e.g., mg/m^3) instead of the intake of a contaminant in air based on inhalation rate and body weight (dose; e.g., mg/kg-day).

the nasal-pharyngeal and tracheo-bronchial regions) and lung (internal dose) is less than that measured at the boundary of the body.

Calculations

Using EPA's current methodology, it is unnecessary to calculate an inhaled dose when using dose-response factors from IRIS in a risk assessment. However, inhalation risk assessments may require that an adjusted air concentration be used to represent continuous exposure.

The adjusted air concentration ($\mathbf{C_{air\text{-}adj}}$) may be estimated as shown below. As described under the Methods tab, for noncarcinogens, the air concentration is adjusted based on the time over which exposure occurs (i.e., the exposure duration). For carcinogens, the concentration is averaged over the lifetime of the exposed individual (often assumed to be 70 years).

$$Cair\text{-}adj = Cair \times ET \times 1day/24\ hours \times EF \times ED/AT$$

Where:
C_{air} = Concentration of contaminant in air (mg/m^3)
ET = Exposure time (hours/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
AT = Averaging time (days)

- The concentration in air (**C_{air}**) is either a measured or modeled value. Air concentrations may be measured in the breathing zone of individuals using personal monitoring equipment or in indoor or outdoor air using stationary or portable monitoring devices. Air measurements may represent gas phase or particulate-phase contaminants, or both.
- **Temporal parameters** in the equation include the following:
  - Exposure time (**ET**) and exposure frequency (**EF**) refer to the frequency with which the exposure occurs and might be provided in hours per day and days per year, respectively.
  - Exposure duration (**ED**) is the amount of time that an individual or population is exposed to the contaminant being evaluated and is typically given in years.
  - Averaging time (**AT**) is the amount of time over which exposure is averaged and is equal to ED for assessing non-cancer risks. For chronic assessments (e.g., cancer), potential lifetime average daily dose (LADD) is calculated in which lifetime (LT, in days) is substituted for AT.

In some cases, it may be necessary to calculate an inhalation dose using the equation below. This algorithm can be used to calculate the average daily potential dose from inhalation of a contaminant in air.

The **potential dose** of a contaminant is the product of the contaminant concentration, inhalation rate, exposure time, exposure frequency, and exposure duration divided by the product of averaging time and body weight. The equation parameters below must be defined for each inhalation exposure scenario, and all parameters must be expressed in consistent units.

In some cases, unit conversion factors may be necessary. Average Daily Dose (ADD) is generally expressed as mass of contaminant per unit body weight over time (e.g., mg/kg-day).

$$ADD = Cair \times InhR \times ET \times EF \times ED/BW \times AT$$

Where:
ADD = Average daily dose (mg/kg-day)
$\mathbf{C_{air}}$ = Concentration of contaminant in air (mg/m^3)
InhR = Inhalation rate (m^3/hour)
ET = Exposure time (hours/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (days)

See above for descriptions for many of the relevant equation parameters. The additional parameters are described below.

- Inhalation rate (**InhR**) represents the volume of air inhaled over a specified timeframe. Long-term inhalation rates are typically expressed in units of m^3/day. Short-term inhalation rates are typically indexed to activity levels and are expressed in units of m^3/hour or m^3/minute. Assessors should choose inhalation rate data that best represent the population for which exposures are being assessed. Chapter 6 of the Handbook provides inhalation rate data for various age groups (see the Factors tab in this module).
- Body weight (**BW**) of an individual, typically expressed in kilograms (kg), is also included so that the dose is normalized to that value. Sometimes the inhalation rate is already normalized to body weight (e.g., in units of m^3/kg-day). In this case, a separate term for body weight would not be necessary.

Additional information on exposure scenarios involving the inhalation route can be found in the Indirect Estimation Module in the Approaches Tool Set.

- **Key:** Information sources
- Data sources
- Models

Tool Type	Tools	Description

d	Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR Comparison Value Viewer <https://www.atsdr.cdc.gov/sites/brownfields/cvviewer.html>	ATSDR's Comparison Value Viewer is a computer program that provides users with ATSDR health comparison values for chemicals in air, soil, and water.
m	Dutch National Institute for Health and Environment (RIVM). ConsExpo <https://www.rivm.nl/en/consexpo>	ConsExpo is a set of models that can be used to estimate and assess human exposure to substances from consumer products used indoors. This model is primarily used in the European Union's assessment of industrial chemicals (REACH).
m	The Lifeline Group. LifeLine™ User Manual v1.0 (Archived) <https://archive.epa.gov/scipoly/sap/meetings/web/pdf/lifeline.pdf>	LifeLine™ software for modeling aggregate and cumulative exposure to pesticides was designed to characterize population-based risks from pesticide residues in food and tap water as well as in the home following residential uses.
m	U.S. EPA. Air Pollutants Exposure Model (APEX) <https://www.epa.gov/fera/human-exposure-modeling-air-pollutants-exposure-model>	The APEX model can be used to estimate inhalation exposures that may occur at the local level or in specific microenvironments.
m	U.S. EPA. Chemical Screening Tool For Exposures and Environmental Releases (ChemSTEER) <https://www.epa.gov/tsca-screening-tools/chemsteer-chemical-screening-tool-exposures-and-environmental-releases>	ChemSTEER is used to estimate inhalation and dermal exposures to chemicals during chemical use and manufacture. Estimates also cover the releases of a chemical into the air, water, and land associated with occupational use.

	U.S. EPA. (2016). ExpoFIRST (Exposure Factors Interactive Resource for Scenarios Tool) <https://assessments.epa.gov/risk/document/&deid=322489>	ExpoFIRST is a standalone tool that draws from data in the EPA's Exposure Factors Handbook for quick, easy, and flexible development of human exposure scenarios. The tool develops these scenarios based on the selections made by the user in terms of the route of exposure of interest, the media of interest, exposure descriptor, receptor (age groups) and other demographics.
	U.S. EPA. Exposure and Fate Assessment Screening Tool (E-FAST) <https://www.epa.gov/tsca-screening-tools/e-fast-exposure-and-fate-assessment-screening-tool-version-2014>	Exposure and Fate Assessment Screening Tool (E-FAST) provides screening-level estimates of the concentrations of chemicals released to surface water and other media from consumer products.
	U.S. EPA. Industrial Source Complex Model (ISC3) <https://www.epa.gov/scram/air-quality-dispersion-modeling-alternative-models#isc3 >	ISC3 is a steady-state Gaussian plume model which can be used to assess pollutant concentrations from a wide variety of sources associated with an industrial complex.
	U.S. EPA. Industrial Waste Air Model (IWAIR) <https://www.epa.gov/smm/industrial-waste-air-model-iwair>	IWAIR is used to evaluate inhalation risks for workers and residents in the vicinity of waste management units. It includes models to estimate emissions, dispersion, and risk.

	U.S. EPA. (1997). Johnson and Ettinger Model for Subsurface Vapor Intrusion into Buildings <https://rais.ornl.gov/epa/je/guide.pdf>	This resource includes a series of models used to evaluate vapor intrusion into buildings. Several modifications have been made to the original models including the ability to edit data for existing chemicals, add new chemicals, and default values recommended in Appendix G of the EPA OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway have been incorporated into the models. EPA has revised the models and added a series of new models.
	U.S. EPA. Multi-Chamber Concentration And Exposure Model (MCCEM) <https://www.epa.gov/tsca-screening-tools/forms/mccem-multi-chamber-concentration-and-exposure-model-download-and-install>	The MCCEM estimates average and peak indoor air concentrations of chemicals released from products or materials in residential buildings.
	U.S. EPA. Multimedia, Multipathway, and Multireceptor Exposure and Risk Assessment (3MRA) <https://www.epa.gov/ceam/3mra >	The Multimedia, Multipathway, Multireceptor Exposure and Risk Assessment (3MRA) is a screening-level tool that allows the assessment of potential human and ecological health risks resulting from long-term exposure to chemicals related to waste management.
	U.S. EPA. Swimmer Exposure Assessment Model (SWIMODEL) <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/swimmer-exposure-assessment-model-swimodel>	SWIMODEL is a screening tool to conduct exposure assessments of pesticides found in indoor swimming pools and spas.
	U.S. EPA. Wall Paint Exposure Assessment Model (WPEM) <https://www.epa.gov/tsca-screening-tools/wall-paint-exposure-assessment-model-wpem>	WPEM is used to estimate the potential exposure of consumers and workers to the chemicals emitted from wall paint applied using a roller or a brush.

Concentrations

- Measuring Concentrations
- Modeling Concentrations
- Available Data

Sources of contamination to air, water, and soil and dust are discussed in the Media Tool Set. Media-specific concentrations are needed for estimating exposure via the inhalation route. Data and tools that can be used to estimate media-specific concentrations can also be found in the Media Tool Set.

Contamination of ambient (outdoor) air can occur from anthropogenic or natural sources. Examples of anthropogenic sources include: driving cars, trucks, or buses; burning coal, oil, and other fossil fuels; manufacturing chemicals or other products; degreasing, painting, or other industrial operations; and dry cleaning. Examples of natural sources include: gases emitted by the earth's crust [e.g., radon], and smoke and carbon dioxide [CO_2] released during forest fires.

Activities such as these may add gases and/or particles to the air. Some air pollutants can remain in the environment for long periods of time and can be transported in the atmosphere (e.g., by wind) hundreds of miles from their original source.

There are many sources of indoor air contaminants. These contaminants can enter buildings from the outside or may be generated from inside sources. Examples of indoor sources include: combustion of oil, gas, kerosene, coal, wood, and tobacco products; building materials and furnishings; and consumer products).

Reductions in building ventilation may increase indoor pollutant levels because indoor emissions are not being diluted by outdoor air or carried out of the indoor environment. Temperature and humidity can also contribute to increases in contaminant concentrations indoors.

Contaminant concentrations in air can be characterized based on measurements, modeling, and/or available monitoring data.

Measuring Concentrations

Information on sampling techniques and analytical methods is available to support the measurement of contaminants in potentially inhaled media.

- **Key:** Information sources
- Data sources
- Models

Tool Type	Tools	Description
	American Society for Testing and Materials (ASTM). (2008). D6178: Standard Practice for Estimation of Short-term Inhalation Exposure to Volatile Organic Chemicals Emitted from Bedding Sets <https://www.astm.org/standards/d6178.htm>	This document describes procedures for estimating human inhalation exposure to volatile compounds emitted from bedding sets for the purpose of characterizing health risks due to short-term VOC exposures. Exposure estimates for specific raw materials and other components of different bedding sets could be evaluated and compared.

d	American Society for Testing and Materials (ASTM). Standards by Category <https://www.astm.org/products-services/standards-and-publications.html>	ASTM International (formerly known as the American Society for Testing and Materials, or ASTM) develops and provides support related to international voluntary consensus standards. Standards developed by ASTM include those relevant to occupational settings, including industrial hygiene and safety standards that specify methods for measuring the presence and amounts of chemical hazards used in the workplace. ASTM has also developed consumer product and related standards that cover methods for measuring chemicals related to a wide range of products.
d	National Institute for Occupational Safety and Health (NIOSH). (2016). NIOSH Pocket Guide to Chemical Hazards <https://www.cdc.gov/niosh/npg/>	The NIOSH Pocket Guide to Chemical Hazards informs workers, employers, and occupational health professionals about workplace chemicals and their hazards. The NPG gives general industrial hygiene information for hundreds of chemicals/classes. The NPG clearly presents key data for chemicals or substance groupings (such as cyanides, fluorides, manganese compounds) that are found in workplaces.
i	U.S. EPA. Air Modeling - Guidance for Air Toxics Modeling <https://www.epa.gov/scram/air-modeling-guidance-air-toxics-modeling>	This section provides miscellaneous guidance documents other than permit modeling or State Implementation Plan (SIP) attainment demonstrations.
i	U.S. EPA. Air Monitoring Methods <https://www.epa.gov/amtic/air-monitoring-methods>	This EPA site provides an approved method for conducting open-path remote sensing for ambient air concentrations with a Fourier transform infrared spectrometer.
i	U.S. EPA. Air Monitoring Methods – Criteria Pollutants <https://www.epa.gov/amtic/air-monitoring-methods-criteria-pollutants>	This EPA site lists designated reference or equivalent methods for monitoring and measuring ambient concentrations of criteria air pollutants—total suspended particulates (TSP), PM10, PM2.5, PM10–2.5, SO2, O3, CO, NO2, and Pb.

	U.S. EPA. Air Toxics – Monitoring Methods <https://www3.epa.gov/ttnamti1/airtox.html>	This EPA site provides descriptions and methodologies for monitoring and measuring hazardous air pollutants in ambient air.
	U.S. EPA. Compendium of Methods for the Determination of Inorganic Compounds in Ambient Air <https://www.epa.gov/amtic/compendium-methods-determination-inorganic-compounds-ambient-air>	This EPA site lists designated reference or equivalent methods for monitoring and measuring ambient concentrations of criteria air pollutants—total suspended particulates (TSP), PM10, PM2.5, PM10–2.5, SO2, O3, CO, NO2, and Pb.
	U.S. EPA. (2002). Guidance on Choosing a Sampling Design for Environmental Data Collection for Use in Developing a Quality Assurance Project Plan <https://www.epa.gov/quality/guidance-choosing-sampling-design-environmental-data-collection-use-developing-quality>	This guidance document provides information on how to develop sampling designs to collect environmental measurement data.
	U.S. EPA. (1992). Guidelines for Exposure Assessment: Table 2. Examples of Types of Measurements to Characterize Exposure-Related Media and Parameters <https://assessments.epa.gov/risk/document/&deid=15263>	This table illustrates some of the types of measurements used by exposure assessors, along with notes describing additional information often needed to use these measurements in estimating exposure or dose.
	U.S. EPA. (2004). Identification of Time-integrated Sampling and Measurement Techniques to Support Human Exposure Studies	This resource presents a literature review on the identification and evaluation of methods used to classify exposure.
	U.S. EPA. Superfund Analytical Services and Contract Laboratory Program (CLP) <https://www.epa.gov/clp>	This document is designed to offer the data reviewer guidance in determining the usability of analytical data generated through the U.S. EPA Contract Laboratory Program (CLP).

Modeling Concentrations

In the absence of measurement data, a variety of models can be used to estimate contaminant concentrations in air or dust that may be inhaled. Ambient air quality models may be used to estimate contaminant concentrations in air considering spatial-temporal characteristics (e.g., urban versus rural, geographic scale;

climate, season). Some models also account for population demographics and the time that the exposed populations spend in various microenvironments.

Indoor air models and models that evaluate air concentrations for specific exposure scenarios are also available. Examples include: inhalation of contaminants that volatilize from water while showering, and inhalation of contaminants that volatilize from pool water while swimming.

- **Key:** Information sources
- Data sources
- Models

Tool Type	Tools	Description
	American Industrial Hygiene Association (AIHA). Industrial Hygiene Model (IH Mod) <https://www.aiha.org/get-involved/volunteergroups/pages/exposure-assessment-strategies-committee.aspx >	This website for the Exposure Assessment Strategies Committee provides links to tools for the practicing Industrial Hygienist including IH-Mod which is an Excel spreadsheet containing several algorithms used for calculating airborne concentrations of chemicals. Algorithms are provided for 12 models including well-mixed room, eddy diffusion, two-zone, field plume, and estimating contamination from small spills.
	California Air Resource Board (CARB). (2002). California Population Indoor Exposure Model (CPIEM) Version 2.0 User's Guide <https://www.arb.ca.gov/research/apr/past/98-327_usera.pdf>	This user's guide is comprehensive reference document for CPIEM, a Monte Carlo simulation model for estimating inhalation exposure for several indoor microenvironments (plus outdoors). CPIEM employs a mass-balance algorithm to estimate indoor pollutant concentration distributions using airborne concentrations and location/activity profiles.

	California Department of Toxic Substances Control (DTSC). CalTOX 1.5 Multimedia Risk Assessment Model <http://www.dtsc.ca.gov/assessingrisk/ctox_model.cfm>	The CalTOX Multimedia Risk Assessment model is a spreadsheet-based model for use in health-risk assessments that address contaminated soils and the contamination of adjacent air, surface water, sediments, and ground water. It includes a multimedia and transport transformation model, exposure scenario models, and addresses uncertainty in multimedia multi-pathway models.
	Dutch National Institute for Health and Environment (RIVM). ConsExpo <https://www.rivm.nl/en/consexpo>	ConsExpo is a set of models that can be used to estimate and assess human exposure to substances from consumer products used indoors. This model is primarily used in the European Union's assessment of industrial chemicals (REACH).
	ENVIRON. Comprehensive Air Quality Model with Extensions (CAMx) <http://www.camx.com/ >	The CAMx model allows for the assessment of gaseous and particulate air pollution (i.e., ozone, PM2.5, PM10, air toxics) over many scales ranging from sub-urban to continental. It also enables examination of source attribution.
	ICF International/Systems Applications International. (2006). Regional Modeling System for Aerosols and Deposition (REMSAD) <http://remsad.icfconsulting.com/>	REMSAD is used to provide a better understanding of the distributions, sources, and removal processes related to regional haze, particulate matter and other airborne pollutants, including soluble acidic components and toxics. Air concentrations and (wet and dry) deposition values are also available.

	The Lifeline Group. LifeLine™ User Manual v1.0 (Archived) <https://archive.epa.gov/scipoly/sap/meetings/web/pdf/lifeline.pdf>	LifeLine™ software for modeling aggregate and cumulative exposure to pesticides was designed to characterize population-based risks from pesticide residues in food and tap water as well as in the home following residential uses.
	U.S. EPA. AERMOD Modeling System <https://www.epa.gov/scram/air-quality-dispersion-modeling-preferred-and-recommended-models#aermod>	AERMOD can be used to model the movement of chemicals released from one or multiple sources through air; it incorporates air dispersion based on boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain.
	U.S. EPA. Air: Fate, Exposure, and Risk Analysis (FERA) <https://www.epa.gov/fera>	This site describes multimedia fate and transport models (Total Risk Integrated Methodology [TRIM] - TRIM.FaTE); human exposure models (Air Pollutants Exposure Model [APEX/TRIM.Expo Inhalation], Hazardous Air Pollutant Exposure Model [HAPEM]); risk models (TRIM.Risk, Human Exposure Model [HEM]); as well as available documentation of methods for Fate, Exposure, and Risk Analysis as compiled by the Office of Air.
	U.S. EPA. Chemical Screening Tool For Exposures and Environmental Releases (ChemSTEER) <https://www.epa.gov/tsca-screening-tools/chemsteer-chemical-screening-tool-exposures-and-environmental-releases>	ChemSTEER is used to estimate inhalation and dermal exposures to chemicals during chemical use and manufacture. Estimates also cover the releases of a chemical into the air, water, and land associated with occupational use.

	U.S. EPA. Community Multiscale Air Quality Modeling System (CMAQ) <https://www.epa.gov/cmaq>	CMAQ is an air quality model and software suite designed to model multiple pollutants at multiple scales (from urban to regional). CMAQ can model tropospheric ozone, fine particles, toxics, acid deposition, and visibility degradation. It allows regulatory agencies to evaluate the impact of air quality management decisions and gives scientists the ability to probe, simulate, and understand chemical and physical interactions in the atmosphere.
	U.S. EPA. Estimation Program Interface (EPI) Suite <https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface >	EPI Suite is a Microsoft Windows-based collection of physical/chemical property and environmental fate estimation programs developed by EPA's Office of Pollution Prevention Toxics (OPPT) and Syracuse Research Corporation (SRC).
	U.S. EPA. Exposure and Fate Assessment Screening Tool (E-FAST) <https://www.epa.gov/tsca-screening-tools/e-fast-exposure-and-fate-assessment-screening-tool-version-2014>	Exposure and Fate Assessment Screening Tool (E-FAST) provides screening-level estimates of the concentrations of chemicals released to surface water and other media from consumer products.
	U.S. EPA. Exposure Model for Soil-Organic Fate and Transport (EMSOFT) <https://assessments.epa.gov/risk/document/&deid=241704>	EMSOFT is used to explore how chemicals in the soil can vaporize and become an inhalation exposure risk in humans. The model can predict concentrations of soil contaminants, rates of transfer into the atmosphere, and potential ingestion and dermal contact risks. EMSOFT can also estimate average contaminant concentrations at a given soil depth over time.

	U.S. EPA. (2008). Guidance for the Sampling and Analysis of Lead in Indoor Residential Dust for Use in the Integrated Exposure Uptake Biokinetic (IEUBK) Model	This document recommends "methods for collecting and analyzing indoor residential dust data to estimate the mean concentration of lead in dust for use in the IEUBK model".
	U.S. EPA. Hazardous Air Pollutant Exposure Model (HAPEM) <https://www.epa.gov/fera/human-exposure-modeling-hazardous-air-pollutant-exposure-model-hapem>	HAPEM is a screening-level exposure model designed to assess average long-term inhalation exposures of the general population or a specific sub-population to various air toxics over spatial scales ranging from urban (large city) to national; activity patterns and multiple microenvironments can be considered.
	U.S. EPA. (2005). Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities	HHRAP describes the evaluation of multi-pathway, site-specific human health risk assessments and was developed specifically for assessment of hazardous waste combustors; it is applicable to other exposure scenarios as well.
	U.S. EPA. (2001). Indoor Air Quality Building Education and Assessment Model (I-BEAM), [CD-ROM]	I-BEAM is a guidance tool designed for use by building professionals and others interested in indoor air quality in commercial buildings. I-BEAM supplements EPA's Building Air Quality guidance and was designed to provide information about managing IAQ in commercial buildings. I-BEAM contains text, animation/visual, and interactive/calculation components that can be used to perform a number of diverse tasks.

	U.S. EPA. Integrated Exposure Uptake Biokinetic (IEUBK) Model for Lead in Children <https://www.epa.gov/superfund/lead-superfund-sites-software-and-users-manuals >	The IEUBK Model is designed to model exposure from lead in air, water, soil, dust, diet, and paint and other sources with pharmacokinetic modeling to predict blood lead levels in children 6 months to 7 years old. Links to the model and supporting documentation are provided at this website. (EPA's Adult Lead Model is used to predict blood lead levels in adults.)
	U.S. EPA. Internet Geographical Exposure Modeling System (IGEMS) <https://www.epa.gov/tsca-screening-tools/igemscsm-internet-geographical-exposure-modeling-systemchemical-safety-mapper>	IGEMS incorporates models and data for ambient air, surface water, soil, and ground water in one system. Each model produces results files that can be saved and used with statistical software applications or other database programs. IGEMS can create graphics and Geographical Information System (GIS) files for displaying environmental modeling results.
	U.S. EPA. Landfill Gas Emissions Model (LandGEM) <https://www.epa.gov/catc/clean-air-technology-center-products#software >	LandGem is an automated estimation tool with a Microsoft Excel interface to estimate emission rates for total landfill gas, methane, carbon dioxide, non-methane organic compounds, and individual air pollutants from municipal solid waste landfills.

	U.S. EPA. Lead at Superfund Sites: Software and Users' Manuals <https://www.epa.gov/superfund/lead-superfund-sites-software-and-users-manuals>	EPA's Integrated Exposure Uptake Biokinetic Model for Lead in Children is used to predict blood lead levels for children aged 6 months to 7 years. The ALM Model is designed to model exposure from lead in air, water, soil, dust, diet, and paint and other sources with pharmacokinetic modeling to predict blood lead levels adults. This page provides links for downloading these lead models and supporting documentation, including technical reports, guidance documents, FAQs, short sheets related to use of the IEUBK model and the ALM, and other links with additional information related to lead and lead cleanup.
	U.S. EPA. Models for Pesticide Risk Assessment: Atmospheric Models <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/models-pesticide-risk-assessment#atmospheric >	EPA's Models for Pesticide Risk Assessment webpage provides links to aquatic, terrestrial, and atmospheric exposure models as well as health effects models used to assess the risk of a pesticide to human health or the environment. This website provides links to atmospheric models used to predict the deposition patterns of pesticides released into the atmosphere. Models include AGDISP (AGricultural DISPersal), AgDRIFT (modified version of AGDISP), PERFUM (Probabilistic Exposure and Risk Model for FUMigants), SOFEA (SOil Fumigant Exposure Assessment), and FEMS (Fumigant Exposure Modeling System).

	U.S. EPA. MOtor Vehicle Emission Simulator (MOVES) Model and Other Mobile Source Emissions Models <https://www.epa.gov/moves>	This website provides links to the MOtor Vehicle Emission Simulator (MOVES) and older models including the NONROAD model, National Mobile Inventory Model (NMIM), and MOBILE Model. MOVES is an emission modeling system that estimates emissions for mobile sources covering a broad range of pollutants. This tool allows users to perform multiple-scale analysis.
	U.S. EPA. Multimedia Models to Assess Exposures <https://www.epa.gov/ceam/multimedia-models-assess-exposures>	This site provides links to five multimedia models maintained by CEAM designed to quantify the movement and concentration of contaminants traveling through groundwater, surface water, and food chain media: Multimedia, Multi-pathway, Multi-receptor Exposure and Risk Assessment (3MRA) system; MINTEQA2 equilibrium speciation model; Multimedia Contaminant Fate, Transport, and Exposure Model (MMSOILS); Multimedia Exposure Assessment Model (MULTIMED); and Watershed Health Assessment Tools Investigating Fisheries (WHATIF) software.
	U.S. EPA. Risk Assessment and Modeling – Human Exposure Model (HEM) <https://www.epa.gov/fera/risk-assessment-and-modeling-human-exposure-model-hem>	HEM is used in performing risk assessments for major point sources of air toxics specifically for the inhalation exposure pathway. HEM provides ambient air concentrations for use with unit risk estimates and inhalation reference concentrations to estimate cancer risk and noncancer hazard, respectively, for the air toxics modeled.

	U.S. EPA. RISK, Indoor Air Quality Model	The RISK model allows calculation of individual exposure to indoor air pollutants from sources. RISK runs in the MS-Windows operating environment and allows users to calculate risk based on the calculated exposure.
	U.S. EPA. Simulation Tool Kit for Indoor Air Quality and Inhalation Exposure (IAQX), Version 1.0 User's Guide	This resource is a comprehensive guide to using IAQX version 1.
	U.S. EPA. Support Center for Regulatory Atmospheric Modeling (SCRAM) <https://www.epa.gov/scram>	This Web site is maintained by EPA's Air Quality Modeling Group (AQMG) and provides links to various air quality models, such as dispersion models, photochemical models, and receptor models. It also provides additional resources such as modeling applications and tools, and documentation and guidance for air quality models.

	U.S. EPA. Support Center for Regulatory Atmospheric Modeling – Air Quality Models <https://www.epa.gov/scram/air-quality-models>	EPA's Air Quality Modeling group maintains this site with documentation, guidance, and model code for dispersion, photochemical, and receptor models commonly used to support policy and regulatory decisions, including the assessment of control strategies and source impacts. Preferred/recommended dispersion models include the AERMOD Modeling System and the CALPUFF Modeling System. Links are provided to several photochemical models: Community Multi-scale Air Quality (CMAQ); Comprehensive Air quality Model with extensions (CAMx); Regional Modeling System for Aerosols and Deposition (REMSAD); and Urban Airshed Model Variable Grid (UAM-V®) as well as receptor models: Chemical Mass Balance (CMB); UNMIX; and Positive Matrix Factorization (PMF).
	U.S. EPA. TANKS Model <https://www3.epa.gov/ttn/chief/software/tanks/index.html>	TANKS is a Windows-based computer software program that estimates volatile organic compound (VOC) and hazardous air pollutant (HAP) emissions from fixed- and floating-roof storage tanks.
	U.S. EPA. Total Risk Integrated Methodology (TRIM) – TRIM.FaTE <https://www.epa.gov/fera/total-risk-integrated-methodology-trim-trimfate>	The TRIM.FaTE model estimates movement and transformation of pollutants over time. Outputs provide exposure estimates for environmental and human receptors that can be used in other models.

	U.S. EPA. (2007). User's Guide for the Integrated Exposure Uptake Model for Lead in Children (IEUBK)	This user's guide is a comprehensive reference for the IEUBK model, including installation, model inputs, analysis, and interpretation.
	U.S. EPA. (2000). Volatilization Rates from Water to Indoor Air Phase II <https://assessments.epa.gov/risk/document/&deid=20677>	EPA developed mass balance models for estimating chemical emissions for 5 tracer chemicals (acetone, ethyl acetate, toluene, ethylbenzene, and cyclohexane) from 4 sources (showers, dishwashers, washing machines, and bathtubs) to better characterize chemical volatilization from drinking water to indoor air. These experiments led to the development of source- and chemical-specific mass transfer coefficients, air exchange (ventilation) rates, and chemical stripping efficiencies. EPA also describes a set of protocols for estimating emission rates for chemicals other than the 5 tracer chemicals examined for this study.
	U.S. EPA. WATER9 Model <https://www3.epa.gov/ttn/chief/software/water/water9_3/index.html>	WATER9, a wastewater treatment model, estimates air emissions of individual waste constituents in wastewater collection, storage, treatment, and disposal facilities.
	U.S. EPA Region 3. Air Quality Analysis <https://www.epa.gov/air-quality-analysis >	This webpage includes information for air quality data analysts inside and outside EPA. The information provided supports EPA's NAAQS Review Process.

Available Data

Personal or stationary monitors can be used to measure air concentrations in the breathing zone of individuals who are closest to a source. Area monitors may be used to measure air concentrations that are representative of particular areas. In some cases, measurement data are used directly to estimate exposure concentrations. In other cases, measured data are used along with modeling to predict potential levels of exposure.

There are a number of information sources that provide monitoring data on contaminant concentrations in potentially inhaled media. Many of these data sources provide ambient air concentrations of contaminants at the national level and for other broad geographic areas such as cities, counties, and states. As such, they help EPA identify specific air toxics, and specific source sectors such as stationary sources or mobile sources, that generally produce the highest exposures and risks.

- **Key:** Information sources
- Data sources
- Models

Tool Type	Tools	Description

	Agency for Toxic Substances and Disease Registry (ATSDR). Toxicological Profiles for Hazardous Substances <https://www.atsdr.cdc.gov/toxprofiles/index.asp>	ATSDR has prepared approximately 300 toxicological profiles for hazardous substances found at National Priorities List (NPL) sites and other federal sites. Chemical names may be searched using the A to Z list on the ATSDR Toxic Substances Portal. Each Toxicological Profile contains a review of key studies and other data characterizing the exposure-related health effects and pertinent characteristics and processes that affect human exposures. Sections include other relevant information on releases to the environment, environmental fate, levels monitored in the environment, potential exposures, and analytical methods.
	AIRNow. AIRNow website <https://airnow.gov/ >	AirNow provides air quality information in terms of the Air Quality Index (AQI) for five criteria air pollutants; data on trends as well as real-time indices are available from this collaboration between EPA and other federal, state and local agencies.

	DeLima Associates. Consumer Product Information Database (CPID) <https://www.whatsinproducts.com/pages/index/1>	The CPID contains health effects information for nine categories of products used in the home and in some commercial/institutional settings that contain chemicals. The databases links brand names to health effects and provides label information, including brand name, ingredients and warnings, manufacturer information, health effect information, and properties and health studies for the chemical ingredients of brands.
	Health Canada. The Canadian House Dust Study <https://www.canada.ca/en/health-canada/services/environmental-workplace-health/environmental-contaminants/canadian-house-dust-study.html>	The Canadian House Dust Study sampled households between 2007 and 2010 to provide background levels of lead in Canadian homes. This web page provides links to several publications based on the results of the House Dust Study.
	Jantunen, MJ; Hanninen, O; Katsouyanni, K; Knoppel, H; Kuenzli, N; Lebret, E; Maroni, M; Saarela, K; Sram, R; Zmirou, D. (1998). Air Pollution Exposure in European Cities: The EXPOLIS STUDY <https://www.thl.fi/expolis/files/final_report.pdf>	The EXPOLIS study measured personal exposure to PM2.5, 30 VOCs, CO, and NO2 in six European cities.

	POET FP5 European project. (2006). POET Emission Inventory Documentation <http://accent.aero.jussieu.fr/documents/poet_documentation.pdf>	NASA estimated global emissions of gases (ozone precursors) from anthropogenic, natural, and biomass burning sources for the period 1990-2000. The emissions estimates are based on national activity data and emission factors.
	U.S. Department of Health and Human Services (HHS). (2010). NLM® Household Products Database <https://www.nlm.nih.gov/pubs/techbull/ja10/ja10_sis_reprint_household_prods.html>	The Household Products Database (HPD) is based on the Consumer Product Information Database (CPID). The HPD contains information on products, manufacturers, chemical ingredients, safety and handling, and potential health effects for various product categories, including auto, inside the home, landscape/yard, home maintenance, pet care, arts/crafts, personal care products, home office, and pesticides. The National Library of Medicine® (NLM) HPD has been updated and now includes 10,000 brand name products, 3,214 ingredients, and 395 manufacturers. In addition, 4,111 products are now linked to the complete Material Safety Data Sheet (MSDS).

	U.S. EPA. Air Data: Air Quality Data Collected at Outdoor Monitors Across the US <https://www.epa.gov/outdoor-air-quality-data>	The Air Data site provides access to yearly summaries of U.S. air pollution data collected at outdoor monitors across the US. This site has information about where air pollution comes from (emissions) and how much pollution is in the air outside our homes and work places (monitoring). Reports, visualization tools, and interactive maps are available on the site.
	U.S. EPA. (2018). Air Emissions Sources <https://www.epa.gov/air-emissions-inventories/national-emissions-inventory-nei>	This interactive National Emissions Inventory (NEI) Report explains how air emissions data are generated and used, and provides tools that explore emission trends and source contributions to air pollution. It highlights the most recent comprehensive and complete NEI, 2014 version 2, released in February 2018.
	U.S. EPA. Air Quality System (AQS) <https://www.epa.gov/aqs >	AQS is EPA's database of ambient air monitoring data for criteria and hazardous air pollutants collected by states and tribes at more than 10,000 monitors across the country.

d	U.S. EPA. Air Toxics – National Air Toxics Trends Stations <https://www3.epa.gov/ttn/amtic/natts.html>	The NATTS Network was developed to monitor concentrations and trends in hazardous air pollutants (air toxics) at multiple sites across the U.S. The data can also be used to assess the effectiveness of emission reduction programs, assess and verify air quality models, and can serve as a direct input to source-receptor models.
d	U.S. EPA. Analysis and Products from NHEXAS; National Human Exposure Assessment Survey	This website provides links to NHEXAS work products.
d	U.S. EPA. Building Assessment Survey and Evaluation (BASE) Study <https://www.epa.gov/indoor-air-quality-iaq/building-assessment-survey-and-evaluation-study >	During the five year Building Assessment Survey and Evaluation (BASE) study, EPA collected measurements of indoor air quality in a nationally representative sample of public and commercial office buildings. Survey information about occupant perceptions of air quality is also available along with building specifications such as age and HV/AC characteristics. This site links to the raw data from this study as well as summary statistics and reports published using the data.

	U.S. EPA. Chemical Data Reporting (CDR) <https://www.epa.gov/chemical-data-reporting >	CDR data are a collection of screening-level, exposure-related information on chemical substances. The CDR rule requires manufacturers and importers to submit information on the production and use of chemicals in commerce in large quantities. The CDR data constitute the most comprehensive source of basic screening-level, exposure-related information on chemicals available to EPA and include the following information when available: production volume, maximum concentration and physical form(s), total number of manufacturing, processing and use sites, total number of reasonably likely to be exposed manufacturing and industrial workers, and industrial processing and use and commercial and consumer use data.

	U.S. EPA. Clean Air Status and Trends Network (CASTNET) Data <https://www.epa.gov/castnet>	CASTNET provides access to measured concentrations of criteria air pollutants from various rural monitoring sites around the United States; data can be used to assess trends in air quality, ecological effects, and atmospheric deposition.
	U.S. EPA. Clearinghouse for Inventories and Emissions Factors (CHIEF) <https://www.epa.gov/chief>	This web site provides links to emissions inventories, air quality emission factors from the Emissions Factors and Policy Applications Center (EFPAC), Emissions Modeling Clearinghouse (EMCH), and monitoring techniques for air pollution control.

	U.S. EPA. CompTox Chemicals Dashboard <https://www.epa.gov/chemical-research/comptox-chemicals-dashboard>	The CompTox Chemicals Dashboard can be searched by chemical identifiers (e.g. DTXSID and CASRN), consumer product categories (i.e. view chemicals found in certain product types), and assays/genes associated with high-throughput screening data. Using high-throughput screening, living cells or proteins are exposed to chemicals and examined for subsequent changes that suggest potential biological responses. The Dashboard contains chemistry, toxicity and exposure information for over 900,000 chemicals, with over 300 chemical lists based on structure or category. Data and models within the Dashboard also help with efforts to identify chemicals of most need of further testing and reducing the use of animals in chemical testing.

	U.S. EPA. Database of Sources of Environmental Releases of Dioxin-Like Compounds in the United States <https://assessments.epa.gov/risk/document/&deid=20797>	This resource is a repository of specific CDD/CDF emissions data from all known sources in the United States. The database information can be analyzed to track emissions of CDD/CDF over time, compare specific profiles between and among source categories, and develop source specific emission factors that can then be used to develop emission estimates.
	U.S. EPA. Emission & Generation Resource Integrated Database (eGRID) < https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid>	eGRID contains data on the environmental characteristics of almost all U.S.-based generated power. Characteristics recorded include air emissions for nitrogen oxides, sulfur dioxide, and other emissions as well as net generation, emission rates, and other attributes.

d	U.S. EPA. The Facility Registry Service (FRS) Query Page <https://www.epa.gov/enviro/frs-query-page>	The FRS Query Page allows users to retrieve selected facility data from the national systems listed. Search strategies include combinations of the facility name, geographic location, facility industrial classification, affiliated organization and contact, program category, and national systems.
i	U.S. EPA. (2011). Global Anthropogenic Non-CO2 Greenhouse Gas Emissions: 1990-2030 <https://www.epa.gov/sites/production/files/2016-08/documents/epa_global_nonco2_projections_dec2012.pdf>	This 2012 report provides estimated projections to 2030 for emissions from more than twenty emissions sources. The gases included in this report are methane, nitrous oxide, and fluorinated greenhouse gases (hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride).

d	U.S. EPA. (2008). Mobile Source Observation Database (MSOD) User Guide and Reference	The MSOD database contained emission test data from in-use mobile air pollution sources such as cars, trucks, and engines from trucks and nonroad vehicles. Data are available from 1982 to present and are intended to be representative of in-use vehicle emissions in the United States. A user and reference guide is available for this database.
d	U.S. EPA. National Air Quality: Status and Trends of Key Air Pollutants <https://www.epa.gov/air-trends>	This EPA website describes the trends in ambient air pollutants as well as emissions of those pollutants from different sources across the country.
d i	U.S. EPA. National Air Toxics Assessments (NATA) <https://www.epa.gov/national-air-toxics-assessment>	NATA is EPA's ongoing comprehensive evaluation of air toxics in the U.S. It is a screening tool for state/local/tribal agencies to prioritize pollutants, emission sources, and areas of interest for further study to gain a better understanding of risks.

d	U.S. EPA. National Emission Inventory (NEI) <https://www.epa.gov/air-emissions-inventories/national-emissions-inventory-nei>	EPA's NEI database contains information about sources that emit criteria air pollutants and their precursors, and hazardous air pollutants. The database includes estimates of annual air pollutant emissions from point, nonpoint, and mobile sources in the 50 States, the District of Columbia, Puerto Rico, and the Virgin Islands. EPA collects information about sources and releases an updated version of the NEI database every three years.
d	U.S. EPA. Ozone-Depleting Substances (ODS) <https://www.epa.gov/ozone-layer-protection/ozone-depleting-substances >	This site lists ozone-depleting substances (ODS) categorized by class, number scheme, and global warming potentials for ODS substitutes.
i	U.S. EPA. The Plain English Guide to the Clean Air Act <https://www.epa.gov/clean-air-act-overview/plain-english-guide-clean-air-act>	This site provides information on pollution prevention as it relates to consumer products use. Information on the contribution of consumer products to indoor and outdoor air pollution is provided.

	U.S. EPA. RadNet <https://www.epa.gov/radnet>	RadNet, formerly Environmental Radiation Ambient Monitoring System (ERAMS), tracks radiation in the nation's air, precipitation, drinking water, and milk samples through a nationwide monitoring system.
	U.S. EPA. Source Ranking Database <https://www.epa.gov/tsca-screening-tools/srd-source-ranking-database-users-guide-and-documentation-vol-1-and-vol-2>	The Source Ranking Database includes preliminary screening-level reviews of over 12,000 potential indoor pollution sources and allows for the identification of high-priority product and material categories for further evaluation.

	U.S. EPA. SPECIATE Database <https://www.epa.gov/air-emissions-modeling/speciate-version-45-through-40>	SPECIATE is EPA's repository of total organic compound (TOC) and particulate matter (PM) speciation profiles of air pollution sources. The database can be used to create speciated emissions inventories for air quality modeling, estimate hazardous and toxic air pollutant emissions from total PM and TOC primary emissions, provide input to chemical mass balance receptor models, and verify profiles derived from ambient measurements using multivariate receptor models (e.g., factor analysis and positive matrix factorization).
	U.S. EPA. (1987). Total Exposure Assessment Methodology (TEAM) Study <https://nepis.epa.gov/adobe/pdf/2000tty7.pdf>	EPA designed this study to develop methods to measure individual total exposure (through air, food, and water) to toxic and carcinogenic chemicals, including VOCs, pesticides, and carbon monoxide. Breath, personal air, outdoor air, and water samples were collected for 30 VOCs.

Scenarios

Inhalation exposure can be relevant for ambient air, indoor air, or both depending on the source and nature of the pollutant. Inhalation exposure can be estimated by first defining the exposure scenario of interest.

Exposure scenarios typically include information on the sources and pathways of exposure, contaminants of concern, and receptor populations. They might also describe a receptor population's activities that may affect exposure and the timeframe over which exposure occurs.

Inhalation exposure could occur over short durations (e.g., more than 24 hours, up to 30 days) or longer timeframes (e.g., more than 30 days), and can be associated with various types of activities (e.g., occupational, recreational, residential) in different indoor or outdoor environments.

The table below provides some examples of inhalation scenarios. The list of examples is not meant to be exhaustive; there are numerous other inhalation scenarios that may be constructed based on the specific needs of the assessment. There are also numerous variations of the examples provided in the table.

Examples of Inhalation Exposure Scenarios and Related Exposure Factors Handbook: 2011 Edition <https://epa.gov/expobox/about-exposure-factors-handbook> **Tables**

Medium	Receptor Population	Activity/Timeframe	Inhalation Rate	Exposure Period
Ambient air	General population; adults	Routine activity; long-term; adjusted air concentration	Not applicable	Chronic
Ambient air; contaminated site	School children	Playing during time spent in elementary school; dose calculation [Table 16-17]	Short-tem, activity-specific [Table 6-2]	Sub-chronic
Ambient air; source-related contaminant	Highly-exposed local population; adults and children	Routine; long-term-dose calculation	Daily [Table 6-1]	Chronic or sub-chronic, depending on lifestage
Outdoor air; particulates from contaminated site	Occupational; adults	Site-specific construction; short-term; adjusted air concentration	Not applicable	Acute
Indoor air	Infants or home-bound elderly adults	Routine; less than lifetime; adjusted air concentration	Not applicable	Sub-chronic

Medium	Receptor Population	Activity/Timeframe	Inhalation Rate	Exposure Period
Indoor air	Occupational	Working in contaminated office building; long-term occupational; adjusted air concentration [Table 16-8]	Not applicable	Chronic
Indoor air; consumer product use	Consumers	Cleaning with same consumer product over long timeframe [Chapter 17]	Short-term, activity-specific [Table 6-2]	Chronic
Indoor air; vapor intrusion from under-foundation source	Residential adults and children	Routine over lifetime; adjusted air concentration	Not applicable	Chronic
Indoor air; volatilization from water while showering	Residential adults and children	Showering daily [Table 16-1]	Short-term, activity-specific [Table 6-2]	Chronic or sub-chronic, depending on lifestage
Outdoor or indoor air; volatilization from swimming pool water	Recreators	Swimming over less than lifetime [Table 16-1]	Short-term, activity-specific [Table 6-2]	Sub-chronic
Indoor air; contamination in vehicle	Commuters; adults	Traveling in vehicle to and from work; less than lifetime [Table 16-24]	Short-term, activity-specific [Table 6-2]	Sub-chronic

Several resources are available that illustrate inhalation exposure scenarios.

- **Key:** Information sources
- Data sources
- Models

Tool Type	Tools	Description

	U.S. EPA. (2014). Child-Specific Exposure Scenarios Examples	The Child-Specific Exposure Scenarios Examples provides common exposure pathways and tools for estimating exposure, dose, and adverse health effects in children. The scenarios provided in the document use data found in EPA's Child-Specific Exposure Factors Handbook and the Exposures Factors Handbook: 2011 Edition.
	U.S. EPA. (2004). Example Exposure Scenarios Assessment Tool <https://assessments.epa.gov/risk/document/&deid=85843>	This document presents a series of example exposure scenarios for various exposure pathways organized by route (i.e., ingestion, inhalation, or dermal) and demonstrates how data from the Exposure Factors Handbook can be applied for estimating exposures.
	U.S. EPA. (2016). ExpoFIRST (Exposure Factors Interactive Resource for Scenarios Tool) <https://assessments.epa.gov/risk/document/&deid=322489>	ExpoFIRST is a standalone tool that draws from data in the EPA's Exposure Factors Handbook for quick, easy, and flexible development of human exposure scenarios. The tool develops these scenarios based on the selections made by the user in terms of the route of exposure of interest, the media of interest, exposure descriptor, receptor (age groups) and other demographics.
	U.S. EPA. (2010). An Exposure Assessment of Polybrominated Diphenyl Ether <https://assessments.epa.gov/risk/document/&deid=210404>	EPA's exposure assessment of polybrominated diphenyl ether (PBDE) provides a comprehensive assessment of the exposure of Americans to PBDEs. The report includes information on the production, use, lifecycle, and environmental fate of these persistent organic chemicals, as well as measured environmental levels and human exposure.

	U.S. EPA. (2005). Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities	HHRAP describes the evaluation of multi-pathway, site-specific human health risk assessments and was developed specifically for assessment of hazardous waste combustors; it is applicable to other exposure scenarios as well.
	U.S. EPA. (1994). Methods for Derivation of Inhalation Reference Concentrations and Application of Inhalation Dosimetry <https://assessments.epa.gov/risk/document/&deid=71993>	This document describes EPA's methodology for estimation of inhalation reference concentrations (RfCs) as benchmark estimates of the quantitative dose-response assessment of chronic noncancer toxicity for individual inhaled chemicals. It also includes discussions of general principles of dose-response assessment for noncancer assessment process, criteria to select key studies for RfC derivation, and uncertainty and data gaps using this methodology.
	U.S. EPA. (1989). Risk Assessment Guidance for Superfund (RAGS): Volume I: Human Health Evaluation Manual (Part A) <https://www.epa.gov/risk/risk-assessment-guidance-superfund-rags-part>	The Risk Assessment Guidance for Superfund (RAGS): Volume I: Human Health Evaluation Manual (Part A) provides guidance for evaluating human health effects as part of a baseline risk assessment. This guidance document includes 10 chapters and two appendices describing topics including: planning, data collection and evaluation, exposure and toxicity assessment, and risk characterization.
	U.S. EPA. (2009). Risk Assessment Guidance for Superfund (RAGS): Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment) <https://www.epa.gov/risk/risk-assessment-guidance-superfund-rags-part-f>	This document provides guidance for conducting inhalation risk assessments for Superfund sites.

	U.S. EPA. (2012). Standard Operating Procedures (SOPs) for Residential Pesticide Exposure Assessment <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/standard-operating-procedures-residential-pesticide >	The 2012 Residential SOPs are based on the Guidelines for Exposure Assessment and present scenario-based assessments of exposure to pesticides in residential settings. New scenarios have been added to this edition for new products and uses; exposure algorithms for some existing exposure scenarios have been modified. Links to spreadsheets that can be used to perform the calculations are also available from this resource.
	U.S. EPA. (1996). Superfund Soil Screening Guidance <https://www.epa.gov/superfund/superfund-soil-screening-guidance>	The Soil Screening Guidance (SSG) is a framework proposed by U.S. EPA for developing risk-based, soil screening levels for protection of human health. The framework presents a tiered approach for site evaluation and screening-level development. The SSG is presented in three documents (fact sheet, user's guide, and technical background document) with an additional supplemental guidance. The supplemental guidance describes additional scenarios for soil screening evaluations for residential land use. It also updated the residential scenario presented in the original guidance, adding exposure pathways and incorporating new modeling data. The 2002 version includes updated dispersion modeling data for the residential air exposure model and new methods to develop SSLs for the migration of volatiles from subsurface sources into indoor air that supersede the 1996 guidance.

Factors

To estimate human exposure to contaminants in ambient or indoor air, information is needed about the exposed population(s), exposure pathways, and the concentrations of contaminants in air. When determining inhalation risk, inhalation rate and body weight

Microenvironments are the various changing spaces in which people spend their time that will influence how they will be exposed to contaminants. A

might not be needed. The Superfund Program's updated approach for determining inhalation risk eliminates use of inhalation rates when evaluating exposure to air contaminants (U.S. EPA, 2009).

However, if inhalation rates are needed, data are available in Chapter 6 of the Handbook. Inhalation rate is a volume of air inhaled per unit time. Long-term inhalation rates are reported as daily rates in units of m^3/day or m^3/kg-day. Short-term rates are described for various activities (e.g., walking, running, playing, housework, yard work) or activity levels (e.g., light, moderate, heavy) in units of m^3/minute.

Characteristics of the exposed individual and population are important to define because they determine inhalation rate. For example, inhalation rates will vary between children and adults due to differences in size, physiology, behavior, and activity levels. Individuals in an occupational setting are often assumed to be working harder than residents and so might be assumed to have a higher inhalation rate.

Personal characteristics also dictate activity patterns, which determine where a person is located (i.e., his/her microenvironments; see text box). They also pertain to the intensity of the activities in which the individual is engaged.

microenvironment can be defined as a space with a contaminant concentration that is assumed to be relatively well-mixed, homogeneous, and temporally constant while an individual is located within the microenvironment. Examples of microenvironments included in EPA assessments are automobiles, schools, work places, and other buildings. The *Exposure Factors Handbook: 2011 Edition* presents data on the amount of time that an individual is expected to spend in various microenvironments. For buildings, important factors might include size, volume, number of windows, and air exchange rates, and the Handbook provides information about these factors for both residential and nonresidential buildings (U.S. EPA, 2011).

The Exposure Factors Tab <https://epa.gov/expobox/exposure-assessment-tools-approaches-indirect-estimation-scenario-evaluation#factors> of the Indirect Estimation Module provides links to data on inhalation rates.

Activity-specific factors that may be relevant for assessing inhalation exposures associated with specific activity levels are available in Chapter 16 of the Handbook. Other exposure factors that might be needed for assessing inhalation exposures include:

Other exposure factors that might be needed for assessing inhalation exposures include:

- Body weight (**Chapter 8**)
- Consumer product use (**Chapter 17**)

- Life expectancy values, specifically when evaluating cancer risk (**Chapter 18**)
- Building characteristics when assessing indoor air exposures (**Chapter 19**)

Inhalation exposure factors should be selected to represent the age, gender (if appropriate), timeframe/activity level, and population group (e.g., resident, occupational worker) for the exposure scenario of interest.

> The Exposure Factors Tab <https://epa.gov/expobox/exposure-assessment-tools-approaches-indirect-estimation-scenario-evaluation#factors> of the Indirect Estimation Module provides links to data on other factors.

Guidance

The following sources provide helpful information for conducting exposure assessments involving the inhalation route of exposure.

- **Key:** Information sources
- Data sources
- Models

Tool Type	Tools	Description
	Australian Government Department of Health. (2012). Environmental Health Risk Assessment: Guidelines for Assessing Human Health Risks from Environmental Hazards <https://www.health.gov.au/sites/default/files/documents/2022/07/enhealth-guidance-guidelines-for-assessing-human-health-risks-from-environmental-hazards.pdf>	This guidance document provides information on basic concepts in environmental health risk assessment, including problem formulation, tiered approaches to exposure assessment. Specific guidance is provided for several topics related to exposure assessment including: assessing exposure from multiple routes and sources of exposure, probabilistic exposure modelling, and biomonitoring.

	California Air Resource Board (CARB). California Air Toxics Program <https://www.arb.ca.gov/toxics/toxics.htm>	The CARB Air Toxics Program institutes the process for identifying and controlling toxic air contaminants related to diesel activities, composite wood products, automobile coatings, residential waste burning, automotive maintenance and repair, dry cleaning, asbestos, ocean-going ship onboard incineration, and chrome plating and anodizing. The program also helps to increase public awareness regarding significant toxic exposures and methods for reducing risk.
	European Centre for Ecotoxicology and Toxicology of Chemicals (ECETOC). (2010). Guidance on Assessment Factors to Derive a Derived No-Effect Levels (DNEL) <http://www.ecetoc.org/wp-content/uploads/2014/08/ecetoc-tr-110-guidance-on-assessment-factors-to-derive-a-dnel.pdf>	This European guidance document provides a review of assessment factors (AF) used in Derived No-Effect Levels (DNEL), which are used by chemical manufacturers and importers to justify chemical safety assessments (CSA), as required by REACH. The review examined the validity of AF used in R.8 Guidance and predicts the increased difficulty of balancing DNEL with exposure predictions if the use of default AF continues.
	National Institute for Occupational Safety and Health (NIOSH). Respirator Selection Logic Guidance <https://www.cdc.gov/niosh/docs/2005-100/>	This document provides guidance to respirator program administrators on respirator selection in accordance with current respirator use and certification regulations and NIOSH policy.

	Occupational Safety and Health Administration (OSHA). Respiratory Protection eTool <https://www.osha.gov/sltc/etools/respiratory/respirator_selection.html>	This OSHA eTool provides guidance on selecting the appropriate respirator, developing a respirator change schedule, and complying with the OSHA respirator standard.
	Occupational Safety and Health Administration (OSHA). Technical Manual on Ventilation <https://www.osha.gov/otm/section-3-health-hazards/chapter-3>	This OSHA manual provides technical information and guidance on occupational safety and health issues and can be used by OSHA Compliance Safety and Health Officers to assist in hazard recognition and provide guidance in accident prevention.
	U.S. Consumer Product Safety Commission (CPSC). Carbon Monoxide <https://www.cpsc.gov/safety-education/safety-education-centers/carbon-monoxide-information-center>	This website provides links to various publications related to indoor air quality and consumer products.

	U.S. Department of Energy (DOE). (1997). Office of Scientific and Technical Information (OSTI) Case Study Comparisons of Vapor Inhalation Risk Estimates <https://www.osti.gov/scitech/biblio/641268>	This paper describes two case studies that compare exposure concentrations and estimated human health risks from the RBCA vapor transport models and actual soil vapor concentration and soil vapor flux data. The first case study examines a residential property with petroleum hydrocarbon contamination; the second case study examines chlorinated hydrocarbon contamination in soil and groundwater at a Superfund site. The two approaches compared were the American Society for Testing and Materials (ASTM) Risk-Based Corrective Action (RBCA) model predictions versus site specific soil vapor data.
	U.S. EPA. Acute Exposure Guideline Levels (AEGLs) Chemical Listing <https://www.epa.gov/aegl/access-acute-exposure-guideline-levels-aegls-values#chemicals >	AEGLs are airborne concentrations (expressed as ppm or mg/m3) that represent threshold exposure limits for the general public and are applicable to exposure periods up to 8 hours. There are three AEGL severity levels—AEGL-1, AEGL-2, and AEGL-3—with AEGL-3 being the most severe. From this website, AEGL information can be obtained using chemical name or cas. no. A compilation of AEGLs is also available for download.

	U.S. EPA. Air Modeling Guidance and Support <https://www.epa.gov/scram/modeling-guidance-and-support>	The EPA's Air Quality Modeling Group (AQMG) provides leadership to the EPA Regions and State/local/tribal agencies on the selection and use of models in regulatory settings through national modeling guidance. This website provides links to models and guidance.
	U.S. EPA. (2009). Asbestos: Protect Your Family <https://www.epa.gov/asbestos/protect-your-family>	This EPA website provides information on vermiculite consumer products that may contain asbestos.
	U.S. EPA. Consumer Products: National Volatile Organic Compound Emission Standards <https://www.epa.gov/stationary-sources-air-pollution/consumer-products-national-volatile-organic-compound-emission>	EPA promulgated national volatile organic compound (VOC) emission standards for certain categories of consumer products pursuant to section 183(e) of the Clean Air Act (Act). Information on these standards can be found at this website.
	U.S. EPA. Formaldehyde website <https://www.epa.gov/formaldehyde>	Building materials, smoking, household products, and the use of un-vented, fuel-burning appliances can be sources of formaldehyde in buildings. An important source of formaldehyde in homes may be pressed wood products made using adhesives that contain urea-formaldehyde (UF) resins. Information on formaldehyde sources may be found at this website.

	U.S. EPA. (2007). Framework for Metals Risk Assessment <https://www.epa.gov/risk/framework-metals-risk-assessment>	The Framework for Metals Risk Assessment identifies the unique properties, issues, and processes that risk assessors need to consider when evaluating metal compounds in EPA risk assessments.
	U.S. EPA. (1992). Guidelines for Exposure Assessment <https://assessments.epa.gov/risk/document/&deid=15263>	The Guidelines for Exposure Assessment is the “go to” resource for planning and conducting human exposure assessments. Guidance is also provided on general concepts of exposure, including definitions, uncertainty, suggestions for presenting results, and tools used for conducing exposure assessments. Information relevant to wildlife exposure to chemicals and human exposure to biological, radiological, and noise agents is also discussed in this resource.
	U.S. EPA. Health Effects Assessment Summary Tables (HEAST) <https://assessments.epa.gov/risk/document/&deid=2877>	HEAST was developed by EPA for the Superfund and Resource Conservation and Recovery Act (RCRA) hazardous waste programs and includes human health risk and toxicity reference values for key contaminants at hazardous waste sites.

	U.S. EPA. (2005). Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities	HHRAP describes the evaluation of multi-pathway, site-specific human health risk assessments and was developed specifically for assessment of hazardous waste combustors; it is applicable to other exposure scenarios as well.
	U.S. EPA. Indoor Air Quality (IAQ) <https://www.epa.gov/indoor-air-quality-iaq>	This resource provides links to fact sheets, reports, and other sources of information related to indoor air quality.
	U.S. EPA. Indoor Air Quality (IAQ): Volatile Organic Compounds' (VOCs) Impact on Indoor Air Quality <https://www.epa.gov/indoor-air-quality-iaq/volatile-organic-compounds-impact-indoor-air-quality >	This website provides introductory-level information VOCs, including sources, health effects, levels in homes, steps to reduce exposure, and standards/guidelines.
	U.S. EPA. (2009). Metabolically-Derived Human Ventilation Rates: A Revised Approach Based upon Oxygen Consumption Rates <https://assessments.epa.gov/risk/document/&deid=202543>	This EPA report is a companion book to the EPA Exposure Factors Handbook. It provides a revised approach for calculating individual ventilation rates directly from oxygen consumption rate. This revised approach replaces previous approaches that relied on a ventilatory equivalent based on a person’s fitness level.
	U.S. EPA. (1998). Methodology for Assessing Health Risks Associated with Multiple Pathways of Exposure to Combustor Emissions <https://assessments.epa.gov/risk/document/&deid=55525>	This guidance provides methodology on conducting indirect risk assessments for multiple pathways of exposure to combustor emissions.

	U.S. EPA. Mobile Source Pollution and Related Health Effects <https://www.epa.gov/mobile-source-pollution>	This website presents information on mobile source pollution, health effects, and strategies for reducing risk to the public from these pollutants.
	U.S. EPA. (1996). Occupational and Residential Exposure Test Guidelines for Indoor Inhalation Exposure <https://permanent.fdlp.gov/fbb/library/epa_875/875-1400.pdf>	This document is one of a series of test guidelines that have been developed by the Office of Prevention, Pesticides and Toxic Substances (OPPTS) for use in the testing of pesticides and toxic substances, and the development of test data that must be submitted to the Agency for review.
	U.S. EPA. (1996). Occupational and Residential Exposure Test Guidelines for Outdoor Inhalation Exposure <https://permanent.fdlp.gov/fbb/library/epa_875/875-1300.pdf>	This document is one of a series of test guidelines that have been developed by the Office of Prevention, Pesticides and Toxic Substances (OPPTS) for use in the testing of pesticides and toxic substances, and the development of test data that must be submitted to the Agency for review.

	U.S. EPA. (2015). OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air <https://www.epa.gov/sites/production/files/2015-09/documents/oswer-vapor-intrusion-technical-guide-final.pdf>	This OSWER guidance provides technical and policy recommendations for evaluation of subsurface vapor intrusion that may occur from subsurface soil and/or groundwater to building indoor air. It describes a recommended framework for assessing vapor intrusion to support risk management decisions. It also provides technical recommendations about monitoring and terminating building mitigation systems.
	U.S. EPA. (1989). Risk Assessment Guidance for Superfund (RAGS): Volume I: Human Health Evaluation Manual (Part A) <https://www.epa.gov/risk/risk-assessment-guidance-superfund-rags-part>	The Risk Assessment Guidance for Superfund (RAGS): Volume I: Human Health Evaluation Manual (Part A) provides guidance for evaluating human health effects as part of a baseline risk assessment. This guidance document includes 10 chapters and two appendices describing topics including: planning, data collection and evaluation, exposure and toxicity assessment, and risk characterization.
	U.S. EPA. (2009). Risk Assessment Guidance for Superfund (RAGS): Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment) <https://www.epa.gov/risk/risk-assessment-guidance-superfund-rags-part-f>	This document provides guidance for conducting inhalation risk assessments for Superfund sites.

	U.S. EPA. (2012). Standard Operating Procedures (SOPs) for Residential Pesticide Exposure Assessment <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/standard-operating-procedures-residential-pesticide >	The 2012 Residential SOPs are based on the Guidelines for Exposure Assessment and present scenario-based assessments of exposure to pesticides in residential settings. New scenarios have been added to this edition for new products and uses; exposure algorithms for some existing exposure scenarios have been modified. Links to spreadsheets that can be used to perform the calculations are also available from this resource.

	U.S. EPA. (1996). Superfund Soil Screening Guidance <https://www.epa.gov/superfund/superfund-soil-screening-guidance>	The Soil Screening Guidance (SSG) is a framework proposed by U.S. EPA for developing risk-based, soil screening levels for protection of human health. The framework presents a tiered approach for site evaluation and screening-level development. The SSG is presented in three documents (fact sheet, user's guide, and technical background document) with an additional supplemental guidance. The supplemental guidance describes additional scenarios for soil screening evaluations for residential land use. It also updated the residential scenario presented in the original guidance, adding exposure pathways and incorporating new modeling data. The 2002 version includes updated dispersion modeling data for the residential air exposure model and new methods to develop SSLs for the migration of volatiles from subsurface sources into indoor air that supersede the 1996 guidance.
	U.S. EPA. Technical Air Pollution Resources <https://www.epa.gov/technical-air-pollution-resources>	This resource provides links to various web sites related to air pollution, including resources for air quality monitoring, modeling, fate exposure and risk analysis (FERA), policy and guidance.

	U.S. EPA. Transportation, Air Pollution, and Climate Change <https://www.epa.gov/transportation-air-pollution-and-climate-change>	This website provides information on transportation-related carbon pollution and other air pollution that cause harmful health effects and climate change.
	U.S. EPA. (2004). User's Guide for the Johnson and Ettinger (1991) Model for Subsurface Vapor Intrusion into Buildings <https://www.epa.gov/sites/default/files/2015-11/documents/2004_0222_3phase_users_guide.pdf>	This resource provides guidance for the use of the Johnson and Ettinger Subsurface Vapor Intrusion Model. This revised version (Feb 2004) of the User's Guide corresponds with the release of Version 3.1 of the Johnson and Ettinger (1991) model (J&E) spreadsheets for estimating subsurface vapor intrusion into buildings. The spreadsheet tool was updated in September 2017, and is version 6.0.
	U.S. EPA. Vapor Intrusion website <https://www.epa.gov/vaporintrusion>	This web site provides basic information on vapor intrusion for the general public, homeowners, community leaders, environmental professionals, and other interested parties. Also, included at this site are links to current guidance documents, including Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air and Addressing Petroleum Vapor Intrusion At Leaking Underground Storage Tank Sites.

	U.S. EPA Region 3. Air Quality Analysis <https://www.epa.gov/air-quality-analysis >	This webpage includes information for air quality data analysts inside and outside EPA. The information provided supports EPA's NAAQS Review Process.
	U.S.EPA. Air Sensor Toolbox <https://www.epa.gov/air-sensor-toolbox>	This website provides information for citizen scientists, researchers, and developers on how to select and use low-cost, portable air sensor technology and understand results from monitoring activities. The information can help the public learn more about air quality in their communities.

References

- IPCS (International Programme on Chemical Safety). (2004). IPCS Risk Assessment Terminology: Part 2: IPCS Glossary of Key Exposure Assessment Terminology (PDF) <https://www.who.int/publications/i/item/9241562676> (122 pp, 951 K, About PDF <https://epa.gov/home/pdf-files>) . Geneva, Switzerland: World Health Organization.
- U.S. EPA. (1992). Guidelines for Exposure Assessment <https://epa.gov/risk/guidelines-exposure-assessment>. (EPA/600/Z-92/001). Washington, DC.
- U.S. EPA. (1994). Methods for Derivation of Inhalation Reference Concentrations (RfCs) and Application of Inhalation Dosimetry <https://epa.gov/risk/methods-derivation-inhalation-reference-concentrations-and-application-inhalation-dosimetry>. (EPA/600/8-90/066F). Washington, DC.
- U.S. EPA. (2009). Risk Assessment Guidance for Superfund (RAGS), Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment): Final <https://epa.gov/risk/risk-assessment-guidance-superfund-rags-part-f>. (EPA/540/-R-070/002). Washington, DC.
- U.S. EPA. (2011). Exposure Factors Handbook 2011 Edition (Final) <https://epa.gov/expobox/about-exposure-factors-handbook>. (EPA/600/R-09/052F). Washington, DC.

ExpoBox Home <https://epa.gov/expobox>

Basic Information <https://epa.gov/expobox/basic-information-about-epa-expobox>

Approaches <https://epa.gov/expobox/exposure-assessment-tools-approaches>

Media <https://epa.gov/expobox/exposure-assessment-tools-media>

Routes

- Dermal <https://epa.gov/expobox/exposure-assessment-tools-routes-dermal>

- Ingestion <https://epa.gov/expobox/exposure-assessment-tools-routes-ingestion>

- Inhalation

Tiers and Types <https://epa.gov/expobox/exposure-assessment-tools-tiers-and-types>

Lifestages and Populations <https://epa.gov/expobox/exposure-assessment-tools-lifestages-and-populations>

Chemical Classes <https://epa.gov/expobox/exposure-assessment-tools-chemical-classes>

Toolbox Search <https://epa.gov/expobox/epa-expobox-toolbox-search>

Exposure Factors <https://epa.gov/expobox/epa-expobox-and-exposure-factors>

Tutorials <https://epa.gov/expobox/exposure-assessment-tutorials>

Glossaries <https://epa.gov/expobox/exposure-assessment-glossaries>

Unit Conversion <https://epa.gov/expobox/epa-expobox-unit-conversion-table>

Uncertainty and Variability <https://epa.gov/expobox/uncertainty-and-variability>

Contact Us <https://epa.gov/expobox/forms/contact-us-about-expobox> to ask a question, provide feedback, or report a problem.

LAST UPDATED ON JANUARY 2, 2024

Grants
<https://epa.gov/grants>

No FEAR Act Data
<https://epa.gov/ocr/whistleblower-protections-epa-and-how-they-relate-non-disclosure-agreements-signed-epa>

Plain Writing
<https://epa.gov/web-policies-and-procedures/plain-writing>

Privacy
<https://epa.gov/privacy>

Privacy and Security Notice
<https://epa.gov/privacy/privacy-and-security-notice>

USA.gov
<https://www.usa.gov/>

White House
<https://www.whitehouse.gov/>

Frequent Questions
<https://epa.gov/home/frequent-questions-specific-epa-programstopics>

Follow.

Arsenic, inorganic; CASRN 7440-38-2

Human health assessment information on a chemical substance is included in the IRIS database only after a comprehensive review of toxicity data, as outlined in the IRIS assessment development process. Sections I (Health Hazard Assessments for Noncarcinogenic Effects) and II (Carcinogenicity Assessment for Lifetime Exposure) present the conclusions that were reached during the assessment development process. Supporting information and explanations of the methods used to derive the values given in IRIS are provided in the guidance documents located on the IRIS website.

STATUS OF DATA FOR Arsenic, inorganic

File First On-Line 02/10/1988

Category (section)	Assessment Available?	Last Revised
Oral RfD (I.A.)	yes	09/01/1991
Inhalation RfC (I.B.)	not evaluated	
Carcinogenicity Assessment (II.)	yes	06/01/1995

I. Chronic Health Hazard Assessments for Noncarcinogenic Effects

I.A. Reference Dose for Chronic Oral Exposure (RfD)

Substance Name — Arsenic, inorganic
CASRN — 7440-38-2
Last Revised — 09/01/1991

The oral Reference Dose (RfD) is based on the assumption that thresholds exist for certain toxic effects such as cellular necrosis. It is expressed in units of mg/kg-day. In general, the RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. Please refer to the Background Document for an elaboration of these concepts. RfDs can also be derived for the noncarcinogenic health effects of substances that are also carcinogens. Therefore, it is essential to refer to other sources of information concerning the carcinogenicity of this

substance. If the U.S. EPA has evaluated this substance for potential human carcinogenicity, a summary of that evaluation will be contained in Section II of this file.

NOTE: There was not a clear consensus among Agency scientists on the oral RfD. Applying the Agency's RfD methodology, strong scientific arguments can be made for various values within a factor of 2 or 3 of the currently recommended RfD value, i.e., 0.1 to 0.8 ug/kg/day. It should be noted, however, that the RfD methodology, by definition, yields a number with inherent uncertainty spanning perhaps an order of magnitude. New data that possibly impact on the recommended RfD for arsenic will be evaluated by the Work Group as it becomes available. Risk managers should recognize the considerable flexibility afforded them in formulating regulatory decisions when uncertainty and lack of clear consensus are taken into account.

I.A.1. Oral RfD Summary

Critical Effect	Experimental Doses*	UF	MF	RfD
Hyperpigmentation, keratosis and possible vascular complications **Human Chronic oral exposure** **Tseng, 1977; Tseng et al., 1968**	NOAEL: 0.009 mg/L converted to 0.0008 mg/kg-day LOAEL: 0.17 mg/L converted to 0.014 mg/kg-day	3	1	3E-4 mg/kg-day

*Conversion Factors -- NOAEL was based on an arithmetic mean of 0.009 mg/L in a range of arsenic concentration of 0.001 to 0.017 mg/L. This NOAEL also included estimation of arsenic from food. Since experimental data were missing, arsenic concentrations in sweet potatoes and rice were estimated as 0.002 mg/day. Other assumptions included consumption of 4.5 L water/day and 55 kg bw (Abernathy et al., 1989). NOAEL = [(0.009 mg/L x 4.5 L/day) + 0.002 mg/day] / 55 kg = 0.0008 mg/kg-day. The LOAEL dose was estimated using the same assumptions as the NOAEL starting with an arithmetic mean water concentration from Tseng (1977) of 0.17 mg/L. LOAEL = [(0.17 mg/L x 4.5 L/day) + 0.002 mg/day] / 55 kg = 0.014 mg/kg-day.

I.A.2. Principal and Supporting Studies (Oral RfD)

Tseng, W.P. 1977. Effects and dose-response relationships of skin cancer and blackfoot disease with arsenic. Environ. Health Perspect. 19: 109-119.

Tseng, W.P., H.M. Chu, S.W. How, J.M. Fong, C.S. Lin and S. Yeh. 1968. Prevalence of skin cancer in an endemic area of chronic arsenicism in Taiwan. J. Natl. Cancer Inst. 40: 453-463.

The data reported in Tseng (1977) show an increased incidence of blackfoot disease that increases with age and dose. Blackfoot disease is a significant adverse effect. The prevalences (males and females combined) at the low dose are 4.6 per 1000 for the 20-39 year group, 10.5 per 1000 for the 40-59 year group, and 20.3 per 1000 for the >60 year group. Moreover, the prevalence of blackfoot disease in each age group increases with increasing dose. However, a recent report indicates that it may not be strictly due to arsenic exposure (Lu, 1990). The data in Tseng et al. (1968) also show increased incidences of hyperpigmentation and keratosis with age. The overall prevalences of hyperpigmentation and keratosis in the exposed groups are 184 and 71 per 1000, respectively. The text states that the incidence increases with dose, but data for the individual doses are not shown. These data show that the skin lesions are the more sensitive endpoint. The low dose in the Tseng (1977) study is considered a LOAEL.

The control group described in Tseng et al. (1968; Table 3) shows no evidence of skin lesions and presumably blackfoot disease, although this latter point is not explicitly stated. This group is considered a NOAEL.

The arithmetic mean of the arsenic concentration in the wells used by the individuals in the NOAEL group is 9 ug/L (range: 1-17 ug/L) (Abernathy et al., 1989). The arithmetic mean of the arsenic concentration in the wells used by the individuals in the LOAEL group is 170 ug/L (Tseng, 1977; Figure 4). Using estimates provided by Abernathy et al. (1989), the NOAEL and LOAEL doses for both food and water are as follows: LOAEL - [170 ug/L x 4.5 L/day + 2 ug/day (contribution of food)] x (1/55 kg) = 14 ug/kg/day; NOAEL - [9 ug/L x 4.5 L/day + 2 ug/day (contribution of food)] x (1/55 kg) = 0.8 ug/kg/day.

Although the control group contained 2552 individuals, only 957 (approximately 38%) were older than 20, and only 431 (approximately 17%) were older than 40. The incidence of skin lesions increases sharply in individuals above 20; the incidence of blackfoot disease increases sharply in individuals above 40 (Tseng, 1968; Figures 5, 6 and 7). This study is less powerful than it appears at first glance. However, it is certainly the most powerful study available on arsenic exposure to people.

This study shows an increase in skin lesions, 22% (64/296) at the high dose vs. 2.2% (7/318) at the low dose. The average arsenic concentration in the wells at the high dose is 410 ug/L and at the low dose is 5 ug/L (Cebrian et al., 1983; Figure 2 and Table 1) or 7 ug/L (cited in the abstract). The average water consumption is 3.5 L/day for males and 2.5 L/day for females. There were about an equal number of males and females in the study. For the dose estimates given below we therefore assume an average of 3 L/day. No data are given on the arsenic exposure from food or the body weight of the participants (we therefore assume 55 kg). The paper states that exposure times are directly related to chronological age in 75% of the cases. Approximately 35% of the participants in the study are more than 20 years old (Figure 1).

Exposure estimates (water only) are: high dose - 410 ug/L x 3 L/day x (1/55 kg) = 22 ug/kg/day; low dose - 5-7 ug/L x 3 L/day x (1/55 kg) = 0.3-0.4 ug/kg/day.

The high-dose group shows a clear increase in skin lesions and is therefore designated a LOAEL. There is some question whether the low dose is a NOAEL or a LOAEL since there is no way of knowing what the incidence of skin lesions would be in a group where the exposure to arsenic is zero. The 2.2% incidence of skin lesions in the low-dose group is higher than that reported in the Tseng et al. (1968) control group, but the dose is lower (0.4 vs. 0.8 ug/kg/day).

The Southwick et al. (1983) study shows a marginally increased incidence of a variety of skin lesions (palmar and plantar keratosis, diffuse palmar or plantar hyperkeratosis, diffuse pigmentation, and arterial insufficiency) in the individuals exposed to arsenic. The incidences are 2.9% (3/105) in the control group and 6.3% (9/144) in the exposed group. There is a slight, but not statistically significant increase in the percent of exposed individuals that have abnormal nerve conduction (8/67 vs. 13/83, or 12% vs. 16% (Southwick et al., 1983; Table 8). The investigators excluded all individuals older than 47 from the nerve conduction portion of the study. These are the individuals most likely to have the longest exposure to arsenic.

Although neither the increased incidence of skin lesions nor the increase in abnormal nerve conduction is statistically significant, these effects may be biologically significant because the same abnormalities occur at higher doses in other studies. The number of subjects in this study was insufficient to establish statistical significance.

Table 3 (Southwick et al., 1983) shows the annual arsenic exposure from drinking water. No data are given on arsenic exposure from food or the body weight (assume 70 kg). Exposure times are not clearly defined, but are > 5 years, and dose groups are ranges of exposure.

Exposure estimates (water only) are: dosed group - 152.4 mg/year x 1 year/365 days x (1/70) kg = 6 ug/kg/day; control group - 24.2 mg/year x year/365 days x (1/70) kg = 0.9 ug/kg/day.

Again because there are no data for a group not exposed to arsenic, there is some question if the control group is a NOAEL or a LOAEL. The incidence of skin lesions in this group is about the same as in the low-dose group from the Cebrian et al. (1983) study; the incidence of abnormal nerve conduction in the control group is higher than that from the low-dose group in the Hindmarsh et al. (1977) study described below. The control dose is comparable to the dose to the control group in the Tseng et al. (1968) and Hindmarsh et al. (1977) studies. The dosed group may or may not be a LOAEL, since it is does not report statistically significant effects when compared to the control.

This study shows an increased incidence of abnormal clinical findings and abnormal electromyographic findings with increasing dose of arsenic (Hindmarsh et al., 1977; Tables III and VI). However, the sample size is extremely small. Percentages of abnormal clinical signs possibly attributed to As were 10, 16, and 40% at the low, mid and high doses, respectively. Abnormal EMG were 0, 17 and 53% in the same three groups.

The exact doses are not given in the Hindmarsh et al. (1977) paper; however, some well data are reported in Table V. The arithmetic mean of the arsenic concentration in the high-dose and mid-dose wells is 680 and 70 ug/L, respectively. Figure 1 (Hindmarsh et al., 1977) shows that the average arsenic concentration of the low-dose wells is about 25 ug/L. No data are given on arsenic exposure from food. We assume daily water consumption of 2 liters and body weight of 70 kg. Exposure times are not clearly stated.

Exposure estimates (water only) are: low - 25 ug/L x 2 L/day x (1/70) kg = 0.7 ug/kg/day; mid - 70 ug/L x 2 L/day x (1/70) kg = 2 ug/kg/day; high - 680 ug/L x 2 L/day x (1/70) kg = 19 ug/kg/day.

The low dose is a no-effect level for abnormal EMG findings. However, because there is no information on the background incidence of abnormal clinical findings in a population with zero exposure to arsenic, there is no way of knowing if the low dose is a no-effect level or another marginal effect level for abnormal clinical findings. The low dose is comparable to the dose received by the control group in the Tseng (1977) and Southwick et al. (1983) studies.

The responses at the mid dose do not show a statistically significant increase but are part of a statistically significant trend and are biologically significant. This dose is an equivocal NOAEL/LOAEL. The high dose is a clear LOAEL for both responses.

As discussed previously there is no way of knowing whether the low doses in the Cebrian et al. (1983), Southwick et al. (1983) and Hindmarsh et al. (1977) studies are NOAELs for skin lesions and/or abnormal nerve conduction. However, because the next higher dose in the

Southwick and Hindmarsh studies only shows marginal effects at doses 3-7 times higher, the Agency feels comfortable in assigning the low doses in these studies as NOAELs.

The Tseng (1977) and Tseng et al. (1968) studies are therefore considered superior for the purposes of developing an RfD and show a NOAEL for a sensitive endpoint. Even discounting the people < 20 years of age, the control group consisted of 957 people that had a lengthy exposure to arsenic with no evidence of skin lesions.

The following is a summary of the defined doses in mg/kg-day from the principal and supporting studies:

1) Tseng (1977): NOAEL = 8E-4; LOAEL = 1.4E-2

2) Cebrian et al. (1983): NOAEL = 4E-4; LOAEL = 2.2E-2

3) Southwick et al. (1983): NOAEL = 9E-4; LOAEL = none (equivocal effects at 6E-3)

4) Hindmarsh et al., 1977: NOAEL = 7E-4; LOAEL = 1.9E-2 (equivocal effects at 2E-3)

I.A.3. Uncertainty and Modifying Factors (Oral RfD)

UF — The UF of 3 is to account for both the lack of data to preclude reproductive toxicity as a critical effect and to account for some uncertainty in whether the NOAEL of the critical study accounts for all sensitive individuals.

MF — None

I.A.4. Additional Studies/Comments (Oral RfD)

Ferm and Carpenter (1968) produced malformations in 15-day hamster fetuses via intravenous injections of sodium arsenate into pregnant dams on day 8 of gestation at dose levels of 15, 17.5, or 20 mg/kg bw. Exencephaly, encephaloceles, skeletal defects and genitourinary systems defects were produced. These and other terata were produced in mice and rats all at levels around 20 mg/kg bw. Minimal effects or no effects on fetal development have been observed in studies on chronic oral exposure of pregnant rats or mice to relatively low levels of arsenic via drinking water (Schroeder and Mitchner, 1971). Nadeenko et al. (1978) reported that intubation of rats with arsenic solution at a dose level of 25 ug/kg/day for a period of 7 months, including pregnancy, produced no significant embryotoxic effects and only infrequent slight expansion of ventricles of the cerebrum, renal pelvis and urinary bladder. Hood et al. (1977) reported that very high single oral doses of arsenate solutions (120 mg/kg) to pregnant

mice were necessary to cause prenatal fetal toxicity, while multiple doses of 60 mg/kg on 3 days had little effect.

Extensive human pharmacokinetic, metabolic, enzymic and long-term information is known about arsenic and its metabolism. Valentine et al. (1987) established that human blood arsenic levels did not increase until daily water ingestion of arsenic exceeded approximately 250 ug/day (approximately 120 ug of arsenic/L. Methylated species of arsenic are successively 1 order of magnitude less toxic and less teratogenic (Marcus and Rispin, 1988). Some evidence suggests that inorganic arsenic is an essential nutrient in goats, chicks, minipigs and rats (NRC, 1989). No comparable data are available for humans.

I.A.5. Confidence in the Oral RfD

Study — Medium
Database — Medium
RfD — Medium

Confidence in the chosen study is considered medium. An extremely large number of people were included in the assessment (> 40,000) but the doses were not well-characterized and other contaminants were present. The supporting human toxicity database is extensive but somewhat flawed. Problems exist with all of the epidemiological studies. For example, the Tseng studies do not look at potential exposure from food or other source. A similar criticism can be made of the Cebrian et al. (1983) study. The U.S. studies are too small in number to resolve several issues. However, the database does support the choice of NOAEL. It garners medium confidence. Medium confidence in the RfD follows.

I.A.6. EPA Documentation and Review of the Oral RfD

Source Document — This assessment is not presented in any existing U.S. EPA document.

This analysis has been reviewed by EPA's Risk Assessment Council on 11/15/1990. This assessment was discussed by the Risk Assessment Council of EPA on 11/15/1990 and verified through a series of meetings during the 1st, 2nd and 3rd quarters of FY91.

Other EPA Documentation — U.S. EPA, 1984, 1988

Agency Work Group Review — 03/24/1988, 05/25/1988, 03/21/1989, 09/19/1989, 08/22/1990, 09/20/1990

Verification Date — 11/15/1990

Screening-Level Literature Review Findings — A screening-level review conducted by an EPA contractor of the more recent toxicology literature pertinent to the RfD for Arsenic (inorganic) conducted in September 2002 identified one or more significant new studies. IRIS users may request the references for those studies from the IRIS Hotline at hotline.iris@epa.gov or (202)566-1676.

I.A.7. EPA Contacts (Oral RfD)

Please contact the IRIS Hotline for all questions concerning this assessment or IRIS, in general, at (202)566-1676 (phone), (202)566-1749 (FAX) or hotline.iris@epa.gov (internet address).

I.B. Reference Concentration for Chronic Inhalation Exposure (RfC)

Substance Name — Arsenic, inorganic
CASRN — 7440-38-2

Not available at this time.

II. Carcinogenicity Assessment for Lifetime Exposure

Substance Name — Arsenic, inorganic
CASRN — 7440-38-2
Last Revised — 06/01/1995

Section II provides information on three aspects of the carcinogenic assessment for the substance in question; the weight-of-evidence judgment of the likelihood that the substance is a human carcinogen, and quantitative estimates of risk from oral exposure and from inhalation exposure. The quantitative risk estimates are presented in three ways. The slope factor is the result of application of a low-dose extrapolation procedure and is presented as the risk per (mg/kg)/day. The unit risk is the quantitative estimate in terms of either risk per ug/L drinking water or risk per ug/cu.m air breathed. The third form in which risk is presented is a drinking water or air concentration providing cancer risks of 1 in 10,000, 1 in 100,000 or 1 in 1,000,000. The rationale and methods used to develop the carcinogenicity information in IRIS are described in The Risk Assessment Guidelines of 1986 (EPA/600/8-87/045) and in the IRIS Background Document. IRIS summaries developed since the publication of EPA's more recent Proposed Guidelines for Carcinogen Risk Assessment also utilize those Guidelines where

indicated (Federal Register 61(79):17960-18011, April 23, 1996). Users are referred to Section I of this IRIS file for information on long-term toxic effects other than carcinogenicity.

II.A. Evidence for Human Carcinogenicity

II.A.1. Weight-of-Evidence Characterization

Classification — A; human carcinogen

Basis — based on sufficient evidence from human data. An increased lung cancer mortality was observed in multiple human populations exposed primarily through inhalation. Also, increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer were observed in populations consuming drinking water high in inorganic arsenic.

II.A.2. Human Carcinogenicity Data

Sufficient. Studies of smelter worker populations (Tacoma, WA; Magma, UT; Anaconda, MT; Ronnskar, Sweden; Saganoseki-Machii, Japan) have all found an association between occupational arsenic exposure and lung cancer mortality (Enterline and Marsh, 1982; Lee-Feldstein, 1983; Axelson et al., 1978; Tokudome and Kuratsune, 1976; Rencher et al., 1977). Both proportionate mortality and cohort studies of pesticide manufacturing workers have shown an excess of lung cancer deaths among exposed persons (Ott et al., 1974; Mabuchi et al., 1979). One study of a population residing near a pesticide manufacturing plant revealed that these residents were also at an excess risk of lung cancer (Matanoski et al., 1981). Case reports of arsenical pesticide applicators have also corroborated an association between arsenic exposure and lung cancer (Roth, 1958).

A cross-sectional study of 40,000 Taiwanese exposed to arsenic in drinking water found significant excess skin cancer prevalence by comparison to 7500 residents of Taiwan and Matsu who consumed relatively arsenic-free water (Tseng et al., 1968; Tseng, 1977). Although this study demonstrated an association between arsenic exposure and development of skin cancer, it has several weaknesses and uncertainties, including poor nutritional status of the exposed populations, their genetic susceptibility, and their exposure to inorganic arsenic from non-water sources, that limit the study's usefulness in risk estimation. Dietary inorganic arsenic was not considered nor was the potential confounding by contaminants other than arsenic in drinking water. There may have been bias of examiners in the original study since no skin cancer or preneoplastic lesions were seen in 7500 controls; prevalence rates rather than mortality rates are the endpoint; and furthermore there is concern of the applicability of extrapolating data from Taiwanese to the U.S. population because of different background

rates of cancer, possibly genetically determined, and differences in diet other than arsenic (e.g., low protein and fat and high carbohydrate) (U.S. EPA, 1988).

A prevalence study of skin lesions was conducted in two towns in Mexico, one with 296 persons exposed to drinking water with 0.4 mg/L arsenic and a similar group with exposure at 0.005 mg/L. The more exposed group had an increased incidence of palmar keratosis, skin hyperpigmentation and hypopigmentation, and four skin cancers (histologically unconfirmed) (Cebrian et al. (1983). The association between skin cancer and arsenic is weak because of the small number of cases, small cohort size, and short duration follow-up; also there was no unexposed group in either town. No excess skin cancer incidence has been observed in U.S. residents consuming relatively high levels of arsenic in drinking water but the numbers of exposed persons were low (Morton et al., 1976; Southwick et al., 1981). Therapeutic use of Fowler's solution (potassium arsenite) has also been associated with development of skin cancer and hyperkeratosis (Sommers and McManus, 1953; Fierz, 1965); several case reports implicate exposure to Fowler's solution in skin cancer development (U.S. EPA, 1988).

Several follow-up studies of the Taiwanese population exposed to inorganic arsenic in drinking water showed an increase in fatal internal organ cancers as well as an increase in skin cancer. Chen et al. (1985) found that the standard mortality ratios (SMR) and cumulative mortality rates for cancers of the bladder, kidney, skin, lung and liver were significantly greater in the Blackfoot disease endemic area of Taiwan when compared with the age adjusted rates for the general population of Taiwan. Blackfoot disease (BFD, an endemic peripheral artery disease) and these cancers were all associated with high levels of arsenic in drinking water. In the endemic area, SMRs were greater in villages that used only artesian well water (high in arsenic) compared with villages that partially or completely used surface well water (low in arsenic). However, dose-response data were not developed (Chen et al. 1985).

A retrospective case-control study showed a significant association between duration of consuming high-arsenic well water and cancers of the liver, lung and bladder (Chen et al., 1986). In this study, cancer deaths in the Blackfoot disease endemic area between January 1980 and December 1982 were chosen for the case group. About 90% of the 86 lung cancers and 95 bladder cancers in the registry were histologically or cytologically confirmed and over 70% of the liver cancers were confirmed by biopsy or à-fetoprotein presence with a positive liver x-ray image. Only confirmed cancer cases were included in the study. A control group of 400 persons living in the same area was frequency-matched with cases by age and sex. Standardized questionnaires of the cases (by proxy) and controls determined the history of artesian well water use, socioeconomic variables, disease history, dietary habits, and lifestyle. For the cancer cases, the age-sex adjusted odds ratios were increased for bladder (3.90), lung (3.39), and liver (2.67) cancer for persons who had used artesian well water for 40 or more years when compared with controls who had never used artesian well water. Similarly, in a

15-year study of a cohort of 789 patients of Blackfoot disease, an increased mortality from cancers of the liver, lung, bladder and kidney was seen among BFD patients when compared with the general population in the endemic area or when compared with the general population of Taiwan. Multiple logistic regression analysis to adjust for other risk factors including cigarette smoking did not markedly affect the exposure-response relationships or odds ratios (Chen et al., 1988).

A significant dose-response relationship was found between arsenic levels in artesian well water in 42 villages in the southwestern Taiwan and age- adjusted mortality rates from cancers at all sites, cancers of the bladder, kidney, skin, lung, liver and prostate (Wu et al., 1989). An ecological study of cancer mortality rates and arsenic levels in drinking water in 314 townships in Taiwan also corroborated the association between arsenic levels and mortality from the internal cancers (Chen and Wang, 1990).

Chen et al. (1992) conducted a recent analysis of cancer mortality data from the arsenic-exposed population to compare risk of various internal cancers and compare risk between males and females. The study area and population have been described by Wu et al. (1989). It is limited to 42 southwestern coastal villages where residents have used water high in arsenic from deep artesian wells for more than 70 years. Arsenic levels in drinking water ranged from 0.010 to 1.752 ppm. The study population had 898,806 person-years of observation and 202 liver cancer, 304 lung cancer, 202 bladder cancer and 64 kidney cancer deaths. The study population was stratified into four groups according to median arsenic level in well water (< 0.10 ppm, 0.10- 0.29 ppm, 0.30-0.59 ppm and 60+ ppm), and also stratified into four age groups (< 30 years, 30-49 years, 50-69 years and 70+ years). Mortality rates were found to increase significantly with age for all cancers and significant dose- response relationships were observed between arsenic level and mortality from cancer of the liver, lung, bladder and kidney in most age groups of both males and females. The data generated by Chen et al. (1992) provide evidence for an association of the levels of arsenic in drinking water and duration of exposure with the rate of mortality from cancers of the liver, lung, bladder, and kidney. Dose-response relationships are clearly shown by the tabulated data (Tables II-V of Chen et al., 1992). Previous studies summarized in U.S. EPA (1988) showed a similar association in the same Taiwanese population with the prevalence of skin cancers (which are often non-fatal). Bates et al. (1992) and Smith et al. (1992) have recently reviewed and evaluated the evidence for arsenic ingestion and internal cancers.

II.A.3. Animal Carcinogenicity Data

Inadequate. There has not been consistent demonstration of carcinogenicity in test animals for various chemical forms of arsenic administered by different routes to several species (IARC, 1980). Furst (1983) has cited or reviewed animal carcinogenicity testing studies of nine

inorganic arsenic compounds in over nine strains of mice, five strains of rats, in dogs, rabbits, swine and chickens. Testing was by the oral, dermal, inhalation, and parenteral routes. All oxidation states of arsenic were tested. No study demonstrated that inorganic arsenic was carcinogenic in animals. Dimethylarsonic acid (DMA), the end metabolite predominant in humans and animals, has been tested for carcinogenicity in two strains of mice and was not found positive (Innes et al., 1969); however, this was a screening study and no data were provided. The meaning of non-positive data for carcinogenicity of inorganic arsenic is uncertain, the mechanism of action in causing human cancer is not known, and rodents may not be a good model for arsenic carcinogenicity testing. There are some data to indicate that arsenic may produce animal lung tumors if retention time in the lung can be increased (Pershagen et al., 1982, 1984).

II.A.4. Supporting Data for Carcinogenicity

A retrospective cohort mortality study was conducted on 478 British patients treated between 1945-1969 with Fowler's solution (potassium arsenite). The mean duration of treatment was 8.9 months and the average total oral consumption of arsenic was about 1890 mg (daily dose x duration). In 1980, 139 deaths had occurred. No excess deaths from internal cancers were seen after this 20-year follow-up. Three bladder cancer deaths were observed (1.19 expected, SMR 2.5) (Cuzick et al., 1982). A recent follow-up (Cuzick et al., 1992) indicated no increased mortality from all cancers but a significant excess from bladder cancer (5 cases observed/1.6 expected; SMR of 3.07). A subset of the original cohort (143 persons) had been examined by a dermatologist in 1970 for signs of arsenicism (palmar keratosis). In 1990, there were 80 deaths in the subcohort and 11 deaths from internal cancers. All 11 subjects had skin signs (keratosis-10, hyperpigmentation-5 and skin cancer-3). A case-control study of the prevalence of palmar keratoses in 69 bladder cancer patients, 66 lung cancer patients and 218 hospital controls (Cuzick et al., 1984), indicated an association between skin keratosis (as an indicator of arsenic exposure) and lung and bladder cancer. Above the age of 50, 87% of bladder cancer patients and 71% of lung cancer patients but only 36% of controls had one or more keratoses. Several case reports implicate internal cancers with arsenic ingestion or specifically with use of Fowler's solution but the associations are tentative (U.S. EPA, 1988).

Sodium arsenate has been shown to transform Syrian hamster embryo cells (Dipaolo and Casto, 1979) and to produce sister chromatid-exchange in DON cells, CHO cells, and human peripheral lymphocytes exposed in vitro (Wan et al., 1982; Ohno et al., 1982; Larramendy et al., 1981; Andersen, 1983; Crossen, 1983). Jacobson-Kram and Montalbano (1985) have reviewed the mutagenicity of inorganic arsenic and concluded that inorganic arsenic is inactive or very weak for induction of gene mutations in vitro but it is clastogenic with trivalent arsenic being an order of magnitude more potent than pentavalent arsenic.

Both the pentavalent and trivalent forms of inorganic arsenic are found in drinking water. In both animals and humans, arsenate (As+5) is reduced to arsenite (As+3) and the trivalent form is methylated to give the metabolites mononomethylarsinic acid (MMA) and dimethylarsonic acid (DMA) (Vahter and Marafante, 1988). The genotoxicity of arsenate (As+5) and arsenite (As+3) and the two methylated metabolites, MMA and DMA were compared in the thymidine kinase forward mutation assay in mouse lymphoma cells (Harrington-Brock et al. 1993; Moore et al., 1995, in press). Sodium arsenite (+3) and sodium arsenate (+5) were mutagenic at concentration of 1-2 ug/mL and 10-14 ug/mL, respectively, whereas MMA and DMA were significantly less potent, requiring 2.5-5 mg/mL and 10 mg/mL, respectively, to induce a genotoxic response. Based on small colony size the mutations induced were judged chromosomal rather than point mutations. The authors have previously shown that for chemicals having clastogenic activity (i.e., cause chromosomal mutations), the mutated cells grow more slowly than cells with single gene mutations and this results in small colony size. In the mouse lymphoma assay, chromosomal abberations were seen at approximately the same arsenic levels as TK forward mutations. Arsenate, arsenite and MMA were considered clastogenic but the abberation response with DMA was insufficient to consider it a clastogen. Since arsenic exerts its genotoxicity by causing chromosomal mutations, it has been suggested by the above authors that it may act in a latter stage of carcinogenesis as a progressor, rather than as a classical initiator or promotor (Moore et al., 1994). A finding which supports this process is that arsenate (8-16 uM) and arsenite (3 uM) have been shown to induce 2-10 fold amplification of the dihydrofolate reductase gene in culture in methotrexate resistant 3T6 mouse cells (Lee et al., 1988). Although the mechanism of induction in rodent cells is not known, gene amplification of oncogenes is observed in many human tumors. Inorganic arsenic has not been shown to mutate bacterial strains, it produces preferential killing of repair deficient strains (Rossman, 1981). Sodium arsenite (As+3) induces DNA-strand breaks which are associated with DNA-protein crosslinks in cultured human fibroblasts at 3 mM but not 10 mM (Dong and Luo, 1993) and it appears that arsenite inhibits the DNA repair process by inhibiting both excision and ligation (Jha et al., 1992; Lee-Chen et al., 1993).

The inhibitory effect of arsenite on strand-break rejoining during DNA repair was found to be reduced by adding glutathione to cell cultures (Huang et al., 1993). The cytotoxic effects of sodium arsenite in Chinese hamster ovary cells also has also found to correlate with the intracellular glutathione levels (Lee et al., 1989).

In vivo studies in rodents have shown that oral exposure of rats to arsenate (As+5) for 2-3 weeks resulted in major chromosomal abnormalities in bone marrow (Datta et al., 1986) and exposure of mice to As (+3) in drinking water for 4 weeks (250 mg As/L as arsenic trioxide) caused chromosomal aberrations in bone marrow cells but not spermatogonia (Poma et al., 1987); micronuclei in bone marrow cells were also induced by intraperitoneal dosing of mice with arsenate (DeKnudt et al., 1986; Tinwell et al., 1991). Chromosomal aberrations and sister

chromatid exchange have been seen in patients exposed to arsenic from treatment with Fowler's solution (Burgdorf et al., 1977) and subjects exposed occupationally (Beckman et al., 1977) but no increase in either endpoint was seen in lymphocytes of subjects exposed to arsenic in drinking water (Vig et al., 1984).

II.B. Quantitative Estimate of Carcinogenic Risk from Oral Exposure

II.B.1. Summary of Risk Estimates

Oral Slope Factor — 1.5E+0 per (mg/kg)/day

Drinking Water Unit Risk — 5E-5 per (ug/L)

Extrapolation Method — Time- and dose-related formulation of the multistage model (U.S. EPA, 1988)

Drinking Water Concentrations at Specified Risk Levels:

Risk Level	Concentration
E-4 (1 in 10,000)	2E+0 ug/L
E-5 (1 in 100,000)	2E-1 ug/L
E-6 (1 in 1,000,000)	2E-2 ug/L

II.B.2. Dose-Response Data (Carcinogenicity, Oral Exposure)

The Risk Assessment Forum has completed a reassessment of the carcinogenicity risk associated with ingestion of inorganic arsenic (U.S. EPA, 1988). The data provided in Tseng et al., 1968 and Tseng, 1977 on about 40,000 persons exposed to arsenic in drinking water and 7500 relatively unexposed controls were used to develop dose-response data. The number of persons at risk over three dose intervals and four exposure durations, for males and females separately, were estimated from the reported prevalence rates as percentages. It was assumed that the Taiwanese persons had a constant exposure from birth, and that males consumed 3.5 L drinking water/day and females consumed 2.0 L/day. Doses were converted to equivalent

doses for U.S. males and females based on differences in body weights and differences in water consumption and it was assumed that skin cancer risk in the U.S. population would be similar to the Taiwanese population. The multistage model with time was used to predict dose-specific and age-specific skin cancer prevalence rates associated with ingestion of inorganic arsenic; both linear and quadratic model fitting of the data were conducted. The maximum likelihood estimate (MLE) of skin cancer risk for a 70 kg person drinking 2 L of water per day ranged from 1E-3 to 2E-3 for an arsenic intake of 1 ug/kg/day. Expressed as a single value, the cancer unit risk for drinking water is 5E-5 per (ug/L). Details of the assessment are in U.S. EPA (1988).

Dose response data have not been developed for internal cancers for the Taiwanese population. The data of Chen et al. (1992) are considered inadequate at present.

II.B.3. Additional Comments (Carcinogenicity, Oral Exposure)

Eastern Research Group, under contract to EPA, convened an Expert Panel on Arsenic Carcinogenicity on May 21 and 22, 1997 (Eastern Research Group, 1997). The Expert Panel believed that, "it is clear from epidemiological studies that arsenic is a human carcinogen via the oral and inhalation routes (p. 20)." They also concluded, "that one important mode of action is unlikely to be operative for arsenic". The panel agreed that arsenic and its metabolites do not appear to directly interact with DNA (pp. 30-31)." In addition, the panel agreed that, "for each of the modes of action regarded as plausible, the dose-response would either show a threshold or would be nonlinear (p. 31)". The panel agreed, however, "that the dose-response for arsenic at low doses would likely be truly nonlinear, i.e., with a decreasing slope as the dose decreased. However, at very low doses such a curve might be linear but with a very shallow slope, probably indistinguishable from a threshold (p. 31)."

II.B.4. Discussion of Confidence (Carcinogenicity, Oral Exposure)

This assessment is based on prevalence of skin cancer rather than mortality because the types of skin cancer studied are not normally fatal. However, competing mortality from Blackfoot disease in the endemic area of Taiwan would cause the risk of skin cancer to be underestimated. Other sources of inorganic arsenic, in particular those in food sources have not been considered because of lack of reliable information. There is also uncertainty on the amount of water consumed/day by Taiwanese males (3.5 L or 4.5 L) and the temporal variability of arsenic concentrations in specific wells was not known. The concentrations of arsenic in the wells was measured in the early 1960s and varied between 0.01 and 1.82 ppm. For many villages 2 to 5 analyses were conducted on well water and for other villages only one analysis was performed; ranges of values were not provided. Since tap water was supplied to many areas after 1966, the arsenic-containing wells were only used in dry periods. Because

of the study design, particular wells used by those developing skin cancer could not be identified and arsenic intake could not be assigned except by village. Several uncertainties in exposure measurement reliability existed and subsequent analysis of drinking water found fluorescent substances in water that are possible confounders or caused synergistic effects. Uncertainties have been discussed in detail in U.S. EPA (1988). Uncertainties in exposure measurement can affect the outcome of dose- response estimation.

II.C. Quantitative Estimate of Carcinogenic Risk from Inhalation Exposure

II.C.1. Summary of Risk Estimates

Inhalation Unit Risk — 4.3E-3 per (ug/cu.m)

Extrapolation Method — absolute-risk linear model

Air Concentrations at Specified Risk Levels:

Risk Level	Concentration
E-4 (1 in 10,000)	2E-2 ug/cu.m
E-5 (1 in 100,000)	2E-3 ug/cu.m
E-6 (1 in 1,000,000)	2E-4 ug/cu.m

II.C.2. Dose-Response Data for Carcinogenicity, Inhalation Exposure

Tumor Type — lung cancer
Test animals — human, male
Route — inhalation, occupational exposure
Reference — Brown and Chu, 1983a,b,c; Lee-Feldstein, 1983; Higgins, 1982; Enterline and Marsh, 1982

Ambient Unit Risk Estimates (per µg/cu.m)

Ambient Unit Risk Estimates (per µg/cu.m)				
Exposure Source	**Study**	**Unit Risk**	**Geometric Mean Unit Risk**	**Final Estimated Geometric Mean Unit Risk**
Anaconda smelter	Brown and Chu Lee-Feldstein Higgins et al.	1.25E-3 2.80E-3 4.90E-3	2.56E-3	4.29E-3
ASARCO smelter	Enterline & Marsh	6.81E-3 7.60E-3	7.19E-3	4.29E-3

II.C.3. Additional Comments (Carcinogenicity, Inhalation Exposure)

A geometric mean was obtained for data sets obtained with distinct exposed populations (U.S. EPA, 1984). The final estimate is the geometric mean of those two values. It was assumed that the increase in age-specific mortality rate of lung cancer was a function only of cumulative exposures.

The unit risk should not be used if the air concentration exceeds 2 ug/cu.m, since above this concentration the unit risk may not be appropriate.

II.C.4. Discussion of Confidence (Carcinogenicity, Inhalation Exposure)

Overall a large study population was observed. Exposure assessments included air measurements for the Anaconda smelter and both air measurements and urinary arsenic for the ASARCO smelter. Observed lung cancer incidence was significantly increased over expected values. The range of the estimates derived from data from two different exposure areas was within a factor of 6.

II.D. EPA Documentation, Review, and Contacts (Carcinogenicity Assessment)

II.D.1. EPA Documentation

U.S. EPA. 1984, 1988, 1993

A draft of the 1984 Health Assessment Document for Inorganic Arsenic was independently reviewed in public session by the Environmental Health Committee of the U.S. EPA Science Advisory Board on September 22-23, 1983. A draft of the 1988 Special Report on Ingested Inorganic Arsenic; Skin Cancer; Nutritional Essentiality was externally peer reviewed at a two-day workshop of scientific experts on December 2-3, 1986. A draft of the Drinking Water Criteria Document for Arsenic was reviewed by the Drinking Water Committee of the U.S. EPA Science Advisory Board on March 10, 1993. The comments from these reviews were evaluated and considered in the revision and finalization of these reports.

II.D.2. EPA Review (Carcinogenicity Assessment)

Agency Work Group Review — 01/13/1988, 12/07/1989, 02/03/1994

Verification Date — 02/03/1994

Screening-Level Literature Review Findings — A screening-level review conducted by an EPA contractor of the more recent toxicology literature pertinent to the cancer assessment for Arsenic (inorganic) conducted in September 2002 identified one or more significant new studies. IRIS users may request the references for those studies from the IRIS Hotline at hotline.iris@epa.gov or (202)566-1676.

II.D.3. EPA Contacts (Carcinogenicity Assessment)

Please contact the IRIS Hotline for all questions concerning this assessment or IRIS, in general, at (202)566-1676 (phone), (202)566-1749 (FAX) or hotline.iris@epa.gov (internet address).

III. [reserved]
IV. [reserved]
V. [reserved]

VI. Bibliography

Substance Name — Arsenic, inorganic
CASRN — 7440-38-2

VI.A. Oral RfD References

Abernathy, C.O., W. Marcus, C. Chen, H. Gibb and P. White. 1989. Office of Drinking Water, Office of Research and Development, U.S. EPA. Memorandum to P. Cook, Office of Drinking Water, U.S. EPA and P. Preuss, Office of Regulatory Support and Scientific Management, U.S. EPA. Report on Arsenic (As) Work Group Meetings. February 23.

Cebrian, M.E., A. Albores, M. Aguilar and E. Blakely. 1983. Chronic arsenic poisoning in the north of Mexico. Human Toxicol. 2: 121-133.

Ferm, V.H. and S.J. Carpenter. 1968. Malformations induced by sodium arsenate. J. Reprod. Fert. 17: 199-201.

Hindmarsh, J.T., O.R. McLetchie, L.P.M. Heffernan et al. 1977. Electromyographic abnormalities in chronic environmental arsenicalism. J. Analyt. Toxicol. 1: 270-276.

Hood, R.D., G.T. Thacker and B.L. Patterson. 1977. Effects in the mouse and rat of prenatal exposure to arsenic. Environ. Health Perspect. 19: 219-222.

Lu, F.J. 1990. Blackfoot disease: Arsenic or humic acid? The Lancet. 336: 115-116.

Marcus, W.L. and A.S. Rispin. 1988. Threshold carcinogenicity using arsenic as an example. In: Advances in Modern Environmental Toxicology, Vol. XV. Risk Assessment and Risk Management of Industrial and Evironmental Chemicals, C.R. Cothern, M.A. Mehlman and W.L. Marcus, Ed. Princeton Scientific Publishing Company, Princeton, NJ. p. 133-158.

Nadeenko, V.G., V. Lenchenko, S.B. Genkina and T.A. Arkhipenko. 1978. The influence of tungsten, molibdenum, copper and arsenic on the intrauterine development of the fetus. TR-79-0353. Farmakologiya i Toksikologiya. 41: 620-623.

NRC (National Research Council). 1989. Recommended Dietary Allowances, 10th ed. Report of the Food and Nutrition Board, National Academy of Sciences, Washington, National Academy Press, Washington, DC. 285 p.

Schroeder, H.A. and M. Mitchner. 1971. Toxic effects of trace elements on the reproduction of mice and rats. Arch. Environ. Health. 23(2): 102-106.

Southwick, J.W., A.E. Western, M.M. Beck, et al. 1983. An epidemiological study of arsenic in drinking water in Millard County, Utah. In: Arsenic: Industrial, Biomedical, Environmental Perspectives, W.H. Lederer and R.J. Fensterheim, Ed. Van Nostrand Reinhold Co., New York. p. 210-225.

Tseng, W.P. 1977. Effects and dose-response relationships of skin cancer and blackfoot disease with arsenic. Environ. Health Perspect. 19: 109-119.

Tseng, W.P., H.M. Chu, S.W. How, J.M. Fong, C.S. Lin and S. Yeh. 1968. Prevalence of skin cancer in an endemic area of chronic arsenicism in Taiwan. J. Natl. Can0cer. Inst. 40(3): 453-463.

Valentine, J.L., L.S. Reisbord, H.K. Kang and M.D Schluchter. 1987. Arsenic effects on population health histories. In: Trace Elements in Man and Animals - TEMA 5, C.F. Mills, I. Bremner and J.K. Chesters, eds. Commonwealth Agricultural Bureaux, Aberdeen, Scotland.

U.S. EPA. 1984. Health Assessment Document for Inorganic Arsenic. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Research Triangle Park, NC. EPA 600/8-83-021F.

U.S. EPA. 1988. Quantitative Toxicological Evaluation of Ingested Arsenic. Office of Drinking Water, Washington, DC. (Draft)

VI.B. Inhalation RfD References

None

VI.C. Carcinogenicity Assessment References

Axelson, O., E. Dahlgren, C.D. Jansson and S.O. Rehnlund. 1978. Arsenic exposure and mortality: A case referent study from a Swedish copper smelter. Br. J. Ind. Med. 35: 8-15.

Andersen, O. 1983. Effects of coal combustion products and metal compounds on sister chromatid exchange (SCE) in a macrophage like cell line. Environ. Health Perspect. 47: 239-253.

Bates, M.N., A.H. Smith and C. Hopenhayn-Rich. 1992. Arsenic ingestion and internal cancers: A review. Am. J. Epidemiol. 135(5): 462-476.

Beckman, G., L. Beckman and I. Nordenson. 1977. Chromosome aberrations in workers exposed to arsenic. Environ. Health Perspect. 19: 145-146.

Brown, C.C. and K.C. Chu. 1983a. Approaches to epidemiologic analysis of prospective and retrospective studies: Example of lung cancer and exposure to arsenic. In: Risk Assessment Proc. SIMS Conf. on Environ. Epidemiol. June 28-July 2, 1982, Alta, VT. SIAM Publications.

Brown, C.C. and K.C. Chu. 1983b. Implications of the multistage theory of carcinogenesis applied to occupational arsenic exposure. J. Natl. Cancer Inst. 70(3): 455-463.

Brown, C.C. and K.C. Chu. 1983c. A new method for the analysis of cohort studies: Implications of the multistage theory of carcinogenesis appled to occupational arsenic exposure. Environ. Health Perspect. 50: 293-308.

Burgdorf, W., K. Kurvink and J. Cervenka. 1977. Elevated sister chromatid exchange rate in lymphocytes of subjects treated with arsenic. Hum. Genet. 36(1): 69-72.

Cebrian, M.E., A. Albores, M. Aquilar and E. Blakely. 1983. Chronic arsenic poisoning in the north of Mexico. Human Toxicol. 2: 121-133.

Chen, C-J. and C-J. Wang. 1990. Ecological correlation between arsenic level in well water and age-adjusted mortality from malignant neoplasms. Cancer Res. 50(17): 5470-5474.

Chen, C-J., Y-C. Chuang, T-M. Lin and H-Y. Wu. 1985. Malignant neoplasms among residents of a Blackfoot disease-endemic area in Taiwan: High-arsenic artesian well water and cancers. Cancer Res. 45: 5895-5899.

Chen, C-J., Y-C. Chuang, S-L. You, T-M. Lin and H-Y. Wu. 1986. A retrospective study on malignant neoplasms of bladder, lung, and liver in blackfoot disease endemic area in Taiwan. Br. J. Cancer. 53: 399-405.

Chen, C-J., M-M. Wu, S-S. Lee, J-D. Wang, S-H. Cheng and H-Y. Wu. 1988. Atherogenicity and carcinogenicity of high-arsenic artesian well water. Multiple risk factors and related malignant neoplasms of Blackfoot disease. Arteriosclerosis. 8(5): 452-460.

Chen, C-J., CW. Chen, M-M. Wu and T-L. Kuo. 1992. Cancer potential in liver, lung bladder and kidney due to ingested inorganic arsenic in drinking water. Br. J. Cancer. 66(5): 888-892.

Crossen, P.E. 1983. Arsenic and SCE in human lymphocytes. Mutat. Res. 119: 415-419.

Cuzick, J., S. Evans, M. Gillman and D.A. Price Evans. 1982. Medicinal arsenic and internal malignancies. Br. J. Cancer. 45(6): 904-911.

Cuzick, J., R. Harris, P.S. Mortimer. 1984. Palmar keratoses and cancers of the bladder and lung. March 10. The Lancet. 1(8376): 530-533.

Cuzick, J., P. Sasieni and S. Evans. 1992. Ingested arsenic, keratoses, and bladder cancer. Am. J. Epidemiol. 136(4): 417-421.

Datta, S., G. Talukder and A. Sharma. 1986. Cytotoxic effects of arsenic in dietary oil primed rats. Sci. Culture. 52: 196-198.

DeKnudt, G., A. Leonard, A. Arany, G.D. Buisson and E. Delavignette. 1986. In vivo studies in male mice on the mutagenic effects of inorganic arsenic. Mutagenesis. 1(1): 33-34.

DiPaolo, J.A. and B.C. Casto. 1979. Qantitative studies of in vitro morphological transformation of Syrian hamster cells by inorganic metal salts. Cancer Res. 39: 1008-1013.

Dong, J-T., X-M. Luo. 1993. Arsenic-induced DNA-strand breaks associated with DNA-protein crosslinks in human fetal lung fibroblasts. Mutat. Res. 302(2): 97-102.

Eastern Research Group. 1997. Report on the expert panel on arsenic carcinogenicity: review and workshop. Prepared by Eastern Research Group, Lexington, MA, for the National Center for Environmental Assessment, Washington, DC, under EPA contract no. 68-C6-0041.

Enterline, P.E. and G.M. Marsh. 1982. Cancer among workers exposed to arsenic and other substances in a copper smelter. Am. J. Epidemiol. 116(6): 895-911.

Fierz, U. 1965. Catamnestic investigations of the side effects of therapy of skin diseases with inorganic arsenic. Dermatologica. 131: 41-58.

Furst, A. 1983. A new look at arsenic carcinogenesis. In: Arsenic: Industrial, Biomedical, and Environmental Perspectives, W. Lederer and R. Fensterheim, Ed. Van Nostrand Reinhold, New York. p. 151-163.

Harrington-Brock, K., T.W. Smith, C.L. Doerr, and M.M. Moore. 1993. Mutagenicity of the human carcinogen arsenic and its methylated metabolites monomethylarsonic and dimethylarsenic acids in L5178Y TK+/- mouse lymphoma cells (abstract). Environ. Mol. Mutagen. 21(Supplement 22): 27.

Higgins, I. 1982. Arsenic and respiratory cancer among a sample of Anaconda smelter workers. Report submitted to the Occupatinal Safety and Health Administration in the comments of the Kennecott Minerals Company on the inorganic arsenic rulemaking. (Exhibit 203-5)

Higgins, I., K. Welch and C. Burchfield. 1982. Mortality of Anaconda smelter workers in relation to arsenic and other exposures. University of Michigan, Dept. Epidemiology, Ann Arbor, MI.

Huang, H., C.F. Huang, D.R. Wu, C.M. Jinn and K.Y. Jan. 1993. Glutathione as a cellular defence against arsenite toxicity in cultured Chinese hamster ovary cells. Toxicology. 79(3): 195-204.

IARC (International Agency for Research on Cancer). 1980. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man, Vol. 23. Some metals and metallic compounds. World Health Organization, Lyon, France.

Innes, J.R.M., B.M. Ulland, M.G. Valerio, et al. 1969. Bioassay of pesticides and industrial chemicals for tumorigenicity in mice: A preliminary note. JNCI. 42: 1101-1114.

Jacobson-Kram, D. and D. Montalbano. 1985. The reproductive effects assessment group's report on the mutagenicity of inorganic arsenic. Environ. Mutagen. 7(5): 787-804.

Jha, A.N., M. Noditi, R. Nilsson and A.T. Natarajan. 1992. Genotoxic effects of sodium arsenite on human cells. Mutat. Res. 284(2): 215-221.

Larramendy, M.L., N.C. Popescu and J.A. DiPaolo. 1981. Induction by inorganic metal salts of sister chromatid exchanges and chromosome aberrations in human and Syrian hamster strains. Environ. Mutagen. 3: 597-606.

Lee, Te-Chang, J. Ko and K.Y. Jan. 1989. Differential cytotoxicity of sodium arsenite in human fibroblasts and chinese hamster ovary cells. Toxicology. 56(3): 289-300.

Lee, Te-Chang, N. Tanaka, P.W. Lamb, T.M. Gilmer and J.C. Barrett. 1988. Induction of gene amplification by arsenic. Science. 241(4861): 79-81.

Lee-Chen, S.F., J.R. Gurr, I.B. Lin and K.Y. Jan. 1993. Arsenite enhances DNA double-strand breaks and cell killing of methyl methanesulfonate-treated cells by inhibiting the excision of alkali-labile sites. Mutat. Res. 294(1): 21-28.

Lee-Feldstein, A. 1983. Arsenic and respiratory cancer in man: Follow-up of an occupational study. In: Arsenic: Industrial, Biomedical, and Environmental Perspectives, W. Lederer and R. Fensterheim, Ed. Van Nostrand Reinhold, New York.

Mabuchi, K., A. Lilienfeld and L. Snell. 1979. Lung cancer among pesticide workers exposed to inorganic arsenicals. Arch. Environ. Health. 34: 312-319.

Matanoski, G., E. Landau, J. Tonascia, et al. 1981. Cancer mortality in an industrial area of Baltimore. Environ. Res. 25: 8-28.

Moore, M.M., K. Harrington-Brock and C.L. Doerr. 1995. Genotoxicity of arsenic and its methylated metabolites. Mutagenesis and Cellular Toxicology Brance, Genetic Toxicology Dividion, Health Effects Research Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC. (In press).

Morton, W., G. Starr, D. Pohl, J. Stoner, S. Wagner, and P. Weswig. 1976. Skin cancer and water arsenic in Lane County, Oregon. Cancer. 37: 2523-2532.

Ohno, H., F. Hanaoka and M. Yamada. 1982. Inductibility of sister chromatid exchanges by heavy-metal ions. Mutat. Res. 104(1-3): 141-146.

Ott, M.G., B.B. Holder and H.L. Gordon. 1974. Respiratory cancer and occupational exposure to arsenicals. Arch. Environ. Health. 29: 250-255.

Pershagen, G., B. Lind and N.E. Bjorklund. 1982. Lung retention and toxicity of some inorganic arsenic compounds. Environ. Res. 29: 425-434.

Pershagen, G., G. Norberg and N.E. Bjorklund. 1984. Carcinomas of the respiratory tract in hamsters given arsenic trioxide and/or benzo(a)pyrene by the pulmonary route. Environ. Res. 34: 227-241.

Poma, K., N. Degraeve and C. Susanne. 1987. Cytogenic effects in mice after chronic exposure to arsenic followed by a single dose of ethyl methanesulfonate. Cytologia. 52(3): 445-450.

Rencher, A.C., M.W. Carter and D.W. McKee. 1977. A retrospective epidemiological study of mortality at a large western copper smelter. J. Occup. Med. 19(11): 754-758.

Rossman, T.G. 1981. Enhancement of UV-mutagenesis by low concentrations of arsenite in Escherichia coli. Mutat. Res. 91: 207-211.

Roth, F. 1958. Uber den Bronchialkrebs Arsengeschadigter Winzer. Virchows Arch. 331: 119-137.

Smith, A.H., C. Hopenhayn-Rich, M.N. Bates, et al. 1992. Cancer risks from arsenic in drinking water. Environ. Health Perspect. 97: 259-267.

Sommers, S.C. and R.G. McManus. 1953. Multiple arsenical cancers of the skin and internal organs. Cancer. 6: 347-359.

Southwick, J., A. Western, M. Beck, et al. 1981. Community health associated with arsenic in drinking water in Millard County, Utah. Health Effects Research Laboratory, Cincinnati, OH. EPA-600/1-81-064.

Tinwell, H., S.C. Stephens, J. Ashby. 1991. Arsenite as the probable active species in the human carcinogenicity of arsenic: Mouse micronucleus assays on Na and K arsenite, orpiment, and Fowler's solution. Environ. Health Perspect. 95: 205-210.

Tokudome, S. and M. Kuratsune. 1976. A cohort study on mortality from cancer and other causes among workers at a metal refinery. Int. J. Cancer. 17: 310-317.

Tseng W.P., H.M. Chu, S.W. How, J.M. Fong, C.S. Lin, and S. Yen. 1968. Prevalence of skin cancer in an endemic area of chronic arsenicism in Taiwan. J. Natl. Cancer Inst. 40(3): 453-463.

Tseng W.P. 1977. Effects and dose-response relationships of skin cancer and Blackfoot disease with arsenic. Environ. Health Perspect. 19: 109-119.

U.S. EPA. 1984. Health Assessment Document for Inorganic Arsenic. Prepared by the Office of Research and Development, Environmental Criteria and Assessment Office, Research Triangle Park, NC.

U.S. EPA. 1988. Special Report on Ingested Inorganic Arsenic; Skin Cancer; Nutritional Essentiality Risk Assessment Forum. July 1988. EPA/625/3-87/013.

U.S. EPA. 1993. Drinking Water Criteria Document for Arsenic. Office of Water, Washington, DC. Draft.

Vahter, M. and E. Marafante. 1988. In vivo methylation and detoxification of arsenic. Royal Soc. Chem. 66: 105-119.

Vig, B.K., M.L. Figueroa, M.N. Cornforth, S.H. Jenkins. 1984. Chromosome studies in human subjects chronically exposed to arsenic in drinking water. Am. J. Ind. Med. 6(5): 325-338.

Wan, B., R.T. Christian and S.W. Soukup. 1982. Studies of cytogenetic effects of sodium arsenicals on mammalian cells in vitro. Environ. Mutag. 4: 493-498.

Welch, K., I. Higgins, M. Oh and C. Burchfield. 1982. Arsenic exposure, smoking, and respiratory cancer in copper smelter workers. Arch. Environ. Health. 37(6): 325-335.

Wu, M-M., T-L. Kuo, Y-H Hwang and C-J. Chen. 1989. Dose-response relation between arsenic concentration in well water and mortality from cancers and vascular diseases. Am. J. Epidemiol. 130(6): 1123-1132.

VII. Revision History

Substance Name — Arsenic, inorganic
CASRN — 7440-38-2

Date	Section	Description
06/30/1988	II.C.1.	Inhalation slope factor changed
09/01/1991	I.A.	Oral RfD summary now on-line
06/01/1995	II.	Carcinogenicity assessment replaced

Date	Section	Description
12/03/2002	I.A.6., II.D.2.	Screening-Level Literature Review Findings message has been added.

VIII. Synonyms

Substance Name — Arsenic, inorganic
CASRN — 7440-38-2
Last Revised — 02/10/1988

- 7440-38-2
- Arsenic
- Arsenic, inorganic
- gray-arsenic

Symbol	Definition (units)	Default	Reference
Resident SLs			
$SL_{res\text{-}sol\text{-}ingnc}$	Resident Soil Noncarcinogenic Child Ingestion (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{res\text{-}sol\text{-}dernc}$	Resident Soil Noncarcinogenic Child Dermal (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{res\text{-}sol\text{-}inhnc}$	Resident Soil Noncarcinogenic Child Inhalation (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{res\text{-}sol\text{-}totnc}$	Resident Soil Noncarcinogenic Child Total (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{res\text{-}sol\text{-}ingna}$	Resident Soil Noncarcinogenic Adult Ingestion (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{res\text{-}sol\text{-}derna}$	Resident Soil Noncarcinogenic Adult Dermal (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{res\text{-}sol\text{-}inhna}$	Resident Soil Noncarcinogenic Adult Inhalation (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{res\text{-}sol\text{-}totna}$	Resident Soil Noncarcinogenic Adult Total (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{res\text{-}sol\text{-}ingc}$	Resident Soil Carcinogenic Ingestion (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{res\text{-}sol\text{-}derc}$	Resident Soil Carcinogenic Dermal (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{res\text{-}sol\text{-}inhc}$	Resident Soil Carcinogenic Inhalation (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{res\text{-}sol\text{-}totc}$	Resident Soil Carcinogenic Total (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{res\text{-}sol\text{-}ingmu}$	Resident Soil Mutagenic Ingestion (mg/kg)	Mutagen-specific	Determined in this calculator
$SL_{res\text{-}sol\text{-}dermu}$	Resident Soil Mutagenic Dermal (mg/kg)	Mutagen-specific	Determined in this calculator
$SL_{res\text{-}sol\text{-}inhmu}$	Resident Soil Mutagenic Inhalation (mg/kg)	Mutagen-specific	Determined in this calculator
$SL_{res\text{-}sol\text{-}totmu}$	Resident Soil Mutagenic Total (mg/kg)	Mutagen-specific	Determined in this calculator
$SL_{res\text{-}sol\text{-}ingvc}$	Resident Soil Carcinogenic Vinyl Chloride Ingestion (mg/kg)	Vinyl Chloride -specific	Determined in this calculator
$SL_{res\text{-}sol\text{-}dervc}$	Resident Soil Carcinogenic Vinyl Chloride Dermal (mg/kg)	Vinyl Chloride-specific	Determined in this calculator
$SL_{res\text{-}sol\text{-}inhvc}$	Resident Soil Carcinogenic Vinyl Chloride Inhalation (mg/kg)	Vinyl Chloride-specific	Determined in this calculator
$SL_{res\text{-}sol\text{-}totvc}$	Resident Soil Carcinogenic Vinyl Chloride Total (mg/kg)	Vinyl Chloride-specific	Determined in this calculator
$SL_{res\text{-}sol\text{-}ingtce}$	Resident Soil Trichloroethylene Ingestion (mg/kg)	Trichloroethylene-specific	Determined in this calculator
$SL_{res\text{-}sol\text{-}dertce}$	Resident Soil Trichloroethylene Dermal (mg/kg)	Trichloroethylene-specific	Determined in this calculator
$SL_{res\text{-}sol\text{-}inhtce}$	Resident Soil Trichloroethylene Inhalation (mg/kg)	Trichloroethylene-specific	Determined in this calculator
$SL_{res\text{-}sol\text{-}tottce}$	Resident Soil Trichloroethylene Total (mg/kg)	Trichloroethylene-specific	Determined in this calculator
$SL_{res\text{-}wat\text{-}ingnc}$	Resident Tapwater Noncarcinogenic Child Ingestion (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{res\text{-}wat\text{-}dernc}$	Resident Tapwater Noncarcinogenic Child Dermal (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{res\text{-}wat\text{-}inhnc}$	Resident Tapwater Noncarcinogenic Child Inhalation (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{res\text{-}wat\text{-}totnc}$	Resident Tapwater Noncarcinogenic Child Total (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{res\text{-}wat\text{-}ingna}$	Resident Tapwater Noncarcinogenic Adult Ingestion (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{res\text{-}wat\text{-}derna}$	Resident Tapwater Noncarcinogenic Adult Dermal (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{res\text{-}wat\text{-}inhna}$	Resident Tapwater Noncarcinogenic Adult Inhalation (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{res\text{-}wat\text{-}totna}$	Resident Tapwater Noncarcinogenic Adult Total (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{res\text{-}wat\text{-}ingc}$	Resident Tapwater Carcinogenic Ingestion (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{res\text{-}wat\text{-}derc}$	Resident Tapwater Carcinogenic Dermal (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{res\text{-}wat\text{-}inhc}$	Resident Tapwater Carcinogenic Inhalation (µg/L)	Contaminant-specific	Determined in this calculator

Symbol	Definition (units)	Default	Reference
$SL_{res\text{-}wat\text{-}totc}$	Resident Tapwater Carcinogenic Total (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{res\text{-}wat\text{-}ingmu}$	Resident Tapwater Mutagenic Ingestion (µg/L)	Mutagen-specific	Determined in this calculator
$SL_{res\text{-}wat\text{-}dermu}$	Resident Tapwater Mutagenic Dermal (µg/L)	Mutagen-specific	Determined in this calculator
$SL_{res\text{-}wat\text{-}inhmu}$	Resident Tapwater Mutagenic Inhalation (µg/L)	Mutagen-specific	Determined in this calculator
$SL_{res\text{-}wat\text{-}totmu}$	Resident Tapwater Mutagenic Total (µg/L)	Mutagen-specific	Determined in this calculator
$SL_{res\text{-}wat\text{-}ingvc}$	Resident Tapwater Carcinogenic Vinyl Chloride Ingestion (µg/L)	Vinyl Chloride-specific	Determined in this calculator
$SL_{res\text{-}wat\text{-}dervc}$	Resident Tapwater Carcinogenic Vinyl Chloride Dermal (µg/L)	Vinyl Chloride-specific	Determined in this calculator
$SL_{res\text{-}wat\text{-}inhvc}$	Resident Tapwater Carcinogenic Vinyl Chloride Inhalation (µg/L)	Vinyl Chloride-specific	Determined in this calculator
$SL_{res\text{-}wat\text{-}totvc}$	Resident Tapwater Carcinogenic Vinyl Chloride Total (µg/L)	Vinyl Chloride-specific	Determined in this calculator
$SL_{res\text{-}wat\text{-}ingtce}$	Resident Tapwater Trichloroethylene Ingestion (µg/L)	Trichloroethylene-specific	Determined in this calculator
$SL_{res\text{-}wat\text{-}dertce}$	Resident Tapwater Trichloroethylene Dermal (µg/L)	Trichloroethylene-specific	Determined in this calculator
$SL_{res\text{-}wat\text{-}inhtce}$	Resident Tapwater Trichloroethylene Inhalation (µg/L)	Trichloroethylene-specific	Determined in this calculator
$SL_{res\text{-}wat\text{-}tottce}$	Resident Tapwater Trichloroethylene Total (µg/L)	Trichloroethylene-specific	Determined in this calculator
$SL_{res\text{-}air\text{-}inhn}$	Resident Air Noncarcinogenic (µg/m^3)	Contaminant-specific	Determined in this calculator
$SL_{res\text{-}air\text{-}inhc}$	Resident Air Carcinogenic (µg/m^3)	Contaminant-specific	Determined in this calculator
$SL_{res\text{-}air\text{-}inhmu}$	Resident Air Mutagenic (µg/m^3)	Mutagen-specific	Determined in this calculator
$SL_{res\text{-}air\text{-}inhvc}$	Resident Air Carcinogenic Vinyl Chloride (µg/m^3)	Vinyl Chloride-specific	Determined in this calculator
$SL_{res\text{-}air\text{-}inhtce}$	Resident Air Trichloroethylene (µg/m^3)	Trichloroethylene-specific	Determined in this calculator
Worker SLs			
$SL_{com\text{-}sol\text{-}ingn}$	Composite Worker Soil Noncarcinogenic Ingestion (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{com\text{-}sol\text{-}dern}$	Composite Worker Soil Noncarcinogenic Dermal (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{com\text{-}sol\text{-}inhn}$	Composite Worker Soil Noncarcinogenic Inhalation (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{com\text{-}sol\text{-}totn}$	Composite Worker Soil Noncarcinogenic Total (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{com\text{-}sol\text{-}ingc}$	Composite Worker Soil Carcinogenic Ingestion (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{com\text{-}sol\text{-}derc}$	Composite Worker Soil Carcinogenic Dermal (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{com\text{-}sol\text{-}inhc}$	Composite Worker Soil Carcinogenic Inhalation (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{com\text{-}sol\text{-}totc}$	Composite Worker Soil Carcinogenic Total (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{com\text{-}air\text{-}inhn}$	Composite Worker Air Noncarcinogenic (µg/m^3)	Contaminant-specific	Determined in this calculator
$SL_{com\text{-}air\text{-}inhc}$	Composite Worker Air Carcinogenic (µg/m^3)	Contaminant-specific	Determined in this calculator
$SL_{out\text{-}sol\text{-}ingn}$	Outdoor Worker Soil Noncarcinogenic Ingestion (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{out\text{-}sol\text{-}dern}$	Outdoor Worker Soil Noncarcinogenic Dermal (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{out\text{-}sol\text{-}inhn}$	Outdoor Worker Soil Noncarcinogenic Inhalation (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{out\text{-}sol\text{-}totn}$	Outdoor Worker Soil Noncarcinogenic Total (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{out\text{-}sol\text{-}ingc}$	Outdoor Worker Soil Carcinogenic Ingestion (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{out\text{-}sol\text{-}derc}$	Outdoor Worker Soil Carcinogenic Dermal (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{out\text{-}sol\text{-}inhc}$	Outdoor Worker Soil Carcinogenic Inhalation (mg/kg)	Contaminant-specific	Determined in this calculator

Symbol	Definition (units)	Default	Reference
$SL_{out\text{-}sol\text{-}totc}$	Outdoor Worker Soil Carcinogenic Total (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{out\text{-}air\text{-}inhn}$	Outdoor Worker Air Noncarcinogenic (µg/m^3)	Contaminant-specific	Determined in this calculator
$SL_{out\text{-}air\text{-}inhc}$	Outdoor Worker Air Carcinogenic (µg/m^3)	Contaminant-specific	Determined in this calculator
$SL_{ind\text{-}sol\text{-}ingn}$	Indoor Worker Soil Noncarcinogenic Ingestion (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{ind\text{-}sol\text{-}inhn}$	Indoor Worker Soil Noncarcinogenic Inhalation (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{ind\text{-}sol\text{-}totn}$	Indoor Worker Soil Noncarcinogenic Total (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{ind\text{-}sol\text{-}ingc}$	Indoor Worker Soil Carcinogenic Ingestion (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{ind\text{-}sol\text{-}inhc}$	Indoor Worker Soil Carcinogenic Inhalation (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{ind\text{-}sol\text{-}totc}$	Indoor Worker Soil Carcinogenic Total (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{ind\text{-}air\text{-}inhn}$	Indoor Worker Air Noncarcinogenic (µg/m^3)	Contaminant-specific	Determined in this calculator
$SL_{ind\text{-}air\text{-}inhc}$	Indoor Worker Air Carcinogenic (µg/m^3)	Contaminant-specific	Determined in this calculator
$SL_{con\text{-}sol\text{-}ingn}$	Construction Worker Soil Noncarcinogenic Ingestion (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{con\text{-}sol\text{-}dern}$	Construction Worker Soil Noncarcinogenic Dermal (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{con\text{-}sol\text{-}inhn}$	Construction Worker Soil Noncarcinogenic Inhalation (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{con\text{-}sol\text{-}totn}$	Construction Worker Soil Noncarcinogenic Total (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{con\text{-}sol\text{-}ingc}$	Construction Worker Soil Carcinogenic Ingestion (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{con\text{-}sol\text{-}derc}$	Construction Worker Soil Carcinogenic Dermal (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{con\text{-}sol\text{-}inhc}$	Construction Worker Soil Carcinogenic Inhalation (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{con\text{-}sol\text{-}totc}$	Construction Worker Soil Carcinogenic Total (mg/kg)	Contaminant-specific	Determined in this calculator
Recreator SLs			
$SL_{rec\text{-}sol\text{-}ingnc}$	Recreator Soil Noncarcinogenic Child Ingestion (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{rec\text{-}sol\text{-}dernc}$	Recreator Soil Noncarcinogenic Child Dermal (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{rec\text{-}sol\text{-}inhnc}$	Recreator Soil Noncarcinogenic Child Inhalation (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{rec\text{-}sol\text{-}totnc}$	Recreator Soil Noncarcinogenic Child Total (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{rec\text{-}sol\text{-}ingna}$	Recreator Soil Noncarcinogenic Adult Ingestion (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{rec\text{-}sol\text{-}derna}$	Recreator Soil Noncarcinogenic Adult Dermal (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{rec\text{-}sol\text{-}inhna}$	Recreator Soil Noncarcinogenic Adult Inhalation (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{rec\text{-}sol\text{-}totna}$	Recreator Soil Noncarcinogenic Adult Total (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{rec\text{-}sol\text{-}ingc}$	Recreator Soil Carcinogenic Ingestion (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{rec\text{-}sol\text{-}derc}$	Recreator Soil Carcinogenic Dermal (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{rec\text{-}sol\text{-}inhc}$	Recreator Soil Carcinogenic Inhalation (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{rec\text{-}sol\text{-}totc}$	Recreator Soil Carcinogenic Total (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{rec\text{-}sol\text{-}ingmu}$	Recreator Soil Mutagenic Ingestion (mg/kg)	Mutagenic-specific	Determined in this calculator
$SL_{rec\text{-}sol\text{-}dermu}$	Recreator Soil Mutagenic Dermal (mg/kg)	Mutagenic-specific	Determined in this calculator
$SL_{rec\text{-}sol\text{-}inhmu}$	Recreator Soil Mutagenic Inhalation (mg/kg)	Mutagenic-specific	Determined in this calculator
$SL_{rec\text{-}sol\text{-}totmu}$	Recreator Soil Mutagenic Total (mg/kg)	Mutagenic-specific	Determined in this calculator

Symbol	Definition (units)	Default	Reference
$SL_{rec\text{-}sol\text{-}ingvc}$	Recreator Soil Carcinogenic Vinyl Chloride Ingestion (mg/kg)	Vinyl Chloride-specific	Determined in this calculator
$SL_{rec\text{-}sol\text{-}dervc}$	Recreator Soil Carcinogenic Vinyl Chloride Dermal (mg/kg)	Vinyl Chloride-specific	Determined in this calculator
$SL_{rec\text{-}sol\text{-}inhvc}$	Recreator Soil Carcinogenic Vinyl Chloride Inhalation (mg/kg)	Vinyl Chloride-specific	Determined in this calculator
$SL_{rec\text{-}sol\text{-}totvc}$	Recreator Soil Carcinogenic Vinyl Chloride Total (mg/kg)	Vinyl Chloride-specific	Determined in this calculator
$SL_{rec\text{-}sol\text{-}ingtce}$	Recreator Soil Trichloroethylene Ingestion (mg/kg)	Trichloroethylene-specific	Determined in this calculator
$SL_{rec\text{-}sol\text{-}dertce}$	Recreator Soil Trichloroethylene Dermal (mg/kg)	Trichloroethylene-specific	Determined in this calculator
$SL_{rec\text{-}sol\text{-}inhtce}$	Recreator Soil Trichloroethylene Inhalation (mg/kg)	Trichloroethylene-specific	Determined in this calculator
$SL_{rec\text{-}sol\text{-}tottce}$	Recreator Soil Trichloroethylene Total (mg/kg)	Trichloroethylene-specific	Determined in this calculator
$SL_{rec\text{-}wat\text{-}ingnc}$	Recreator Surface Water Noncarcinogenic Child Ingestion (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{rec\text{-}wat\text{-}dernc}$	Recreator Surface Water Noncarcinogenic Child Dermal (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{rec\text{-}wat\text{-}totnc}$	Recreator Surface Water Noncarcinogenic Child Total (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{rec\text{-}wat\text{-}ingna}$	Recreator Surface Water Noncarcinogenic Adult Ingestion (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{rec\text{-}wat\text{-}derna}$	Recreator Surface Water Noncarcinogenic Adult Dermal (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{rec\text{-}wat\text{-}totna}$	Recreator Surface Water Noncarcinogenic Adult Total (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{rec\text{-}wat\text{-}ingc}$	Recreator Surface Water Carcinogenic Ingestion (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{rec\text{-}wat\text{-}derc}$	Recreator Surface Water Carcinogenic Dermal (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{rec\text{-}wat\text{-}totc}$	Recreator Surface Water Carcinogenic Total (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{rec\text{-}wat\text{-}ingmu}$	Recreator Surface Water Mutagenic Ingestion (µg/L)	Mutagen-specific	Determined in this calculator
$SL_{rec\text{-}wat\text{-}dermu}$	Recreator Surface Water Mutagenic Dermal (µg/L)	Mutagen-specific	Determined in this calculator
$SL_{rec\text{-}wat\text{-}totmu}$	Recreator Surface Water Mutagenic Total (µg/L)	Mutagen-specific	Determined in this calculator
$SL_{rec\text{-}wat\text{-}ingvc}$	Recreator Surface Water Carcinogenic Vinyl Chloride Ingestion (µg/L)	Vinyl Chloride-specific	Determined in this calculator
$SL_{rec\text{-}wat\text{-}dervc}$	Recreator Surface Water Carcinogenic Vinyl Chloride Dermal (µg/L)	Vinyl Chloride-specific	Determined in this calculator
$SL_{rec\text{-}wat\text{-}totvc}$	Recreator Surface Water Carcinogenic Vinyl Chloride Total (µg/L)	Vinyl Chloride-specific	Determined in this calculator
$SL_{rec\text{-}wat\text{-}ingtce}$	Recreator Surface Water Trichloroethylene Ingestion (µg/L)	Trichloroethylene-specific	Determined in this calculator
$SL_{rec\text{-}wat\text{-}dertce}$	Recreator Surface Water Trichloroethylene Dermal (µg/L)	Trichloroethylene-specific	Determined in this calculator
$SL_{rec\text{-}wat\text{-}tottce}$	Recreator Surface Water Trichloroethylene Total (µg/L)	Trichloroethylene-specific	Determined in this calculator
Fish SLs			
$SL_{res\text{-}fsh\text{-}ingn}$	Resident Fish Noncarcinogenic Ingestion (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{res\text{-}fsh\text{-}ingc}$	Resident Fish Carcinogenic Ingestion (mg/kg)	Contaminant-specific	Determined in this calculator

Symbol	Definition (units)	Default	Reference
Miscellaneous Variables			
TR	target risk	1×10^{-6}	Selected by user
THQ	target hazard quotient	0.1	Selected by user
RBA	relative bioavailability factor	Arsenic = 0.6 All Others = 1	U.S. EPA 2012
K	Andelman Volatilization Factor (L/m^3)	0.5	U.S. EPA 1991b (pg. 20)
K_p	Dermal Permeability Constant (cm/hour)	Contaminant-specific Inorganic default = 0.001	U.S. EPA 2004 Exhibit 3-1 and Section 3.1.2.1
$K_{p,ve}$	Steady-state Permeability Coefficient (cm/hour)	Contaminant-specific $K_{p,ve} = K_{ew}D_e/L_e$, $K_{ew} = 1$ assuming the viable epidermis (ve) (cm/hr) behaves essentially as water; $L_e = 10^{-2}$ cm, $De = 7.1\times10^{-6}$/MW cm^2/s assuming $D_e=10^{-6}$ cm^2/s when MW = 50 (Bunge and Cleek, 1995)	U.S. EPA 2004
K_{ew}	Equilibrium Partition Coefficient between epidermis and water for the absorbing chemical (unitless)	Contaminant-specific	U.S. EPA 2004
D_{sc}	Effective diffusion coefficient for chemical transfer through the stratum corneum (cm2/hr)	Contaminant-specific	U.S. EPA 2004
B	Dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (ve) (unitless)	Contaminant-specific	U.S. EPA 2004
t^*	Time to reach steady-state (hr)	Contaminant-specific	U.S. EPA 2004
τ_{event}	Lag time per event (hr/event)	Contaminant-specific	U.S. EPA 2004
D_e	Effective Diffusivity of absorbing chemical in the epidermis (cm^2/sec)	$(7.1 \times 10^{-6}) / (\sqrt{MW})$	U.S. EPA 2004
l_{sc}	Apparent thickness of stratum corneum (cm)	0.001	U.S. EPA 2004
b,c	Correlation coefficients	Contaminant-specific see User's Guide section 4.9.8	U.S. EPA 2004
L_e	Effective Thickness of the Epidermis (cm)	0.01	U.S. EPA 2004
$AT_{res\text{-}c}$	Averaging time - resident child (days)	365 x $ED_{res\text{-}c}$ = 2190	U.S. EPA 1989 (pg. 6-23)
$AT_{res\text{-}a}$	Averaging time - resident adult (days)	365 x ED_{res} = 9490	U.S. EPA 1989 (pg. 6-23)
AT_{res}	Averaging time - resident age adjusted (days)	365 x LT = 25550	U.S. EPA 1989 (pg. 6-23)
$AT_{com\text{-}a}$	Averaging time - composite worker (days)	365 x ED_{com} = 9125 (non-carcinogenic)	U.S. EPA 1989 (pg. 6-23)
AT_{com}	Averaging time - composite worker (days)	365 x LT = 25550 (carcinogenic)	U.S. EPA 1989 (pg. 6-23)
$AT_{ind\text{-}a}$	Averaging time - indoor worker (days)	365 x ED_{ind} = 9125 (non-carcinogenic)	U.S. EPA 1989 (pg. 6-23)
AT_{ind}	Averaging time - indoor worker soil (days)	365 x LT = 25550 (carcinogenic)	U.S. EPA 1989 (pg. 6-23)
$AT_{out\text{-}a}$	Averaging time - outdoor worker (days)	365 x ED_{out} = 9125 (non-carcinogenic)	U.S. EPA 1989 (pg. 6-23)
AT_{out}	Averaging time - outdoor worker (days)	365 x LT = 25550 (carcinogenic)	U.S. EPA 1989 (pg. 6-23)
$AT_{con\text{-}a}$	Averaging time - construction worker (days)	EW_{con} x 7 (d/wk) x ED_{con} = 350 (non-carcinogenic)	U.S. EPA 1989 (pg. 6-23)
AT_{con}	Averaging time - construction worker (days)	365 x LT = 25550 (carcinogenic)	U.S. EPA 1989 (pg. 6-23)
$AT_{rec\text{-}c}$	Averaging time - recreator child (days)	365 x $ED_{rec\text{-}c}$	U.S. EPA 1989 (pg. 6-23)
$AT_{rec\text{-}a}$	Averaging time - recreator adult (days)	365 x $ED_{rec\text{-}a}$	U.S. EPA 1989 (pg. 6-23)
AT_{rec}	Averaging time - recreator (days)	365 x LT	U.S. EPA 1989 (pg. 6-23)
LT	Lifetime (years)	70	U.S. EPA 1989 (pg. 6-22)
$\Delta H_{v,b}$	Enthalpy of vaporization at the normal boiling point (cal/mol)	Contaminant-specific	See Chemical-specific hierarchy
$\Delta H_{v,gw}$	Enthalpy of vaporization at temperature of groundwater (cal/mol)	Contaminant-specific	Determined in this calculator
HLC	Henry's Law Constant at specified groundwater temperature ($atm\text{-}m^3/mol$)	Contaminant-specific	See Chemical-specific hierarchy
T_{gw}	Groundwater Temperatures (Kelvin)	Site-Specific	Site-Specific
T_C	Critical Temperatures (Kelvin)	Contaminant-specific	See Chemical-specific hierarchy
T_b	Normal Boiling Point (Kelvin)	Contaminant-specific	See Chemical-specific hierarchy
n	If (T_b/T_C < 0.57)	n = 0.3	U.S. EPA Fact Sheet
	If (T_b/T_C > 0.71)	n = 0.41	Unitless exponent values used to determine $\Delta H_{v,gw}$

Symbol	Definition (units)	Default	Reference
	Miscellaneous Variables		
	If ($0.57 < T_b/T_C \leq 0.71$)	$n = (0.74 \times T_b/T_C - 0.116)$	
VPT_{gw}	Vapor Pressure at Groundwater Temperature (mmHg)	Contaminant-specific	Determined in this calculator
VP	Vapor Pressure at 25°C (mmHg)	Contaminant-specific	Contaminant-specific

Symbol	Definition (units)	Default	Reference
Toxicity Values			
RfD_o or RFDOC	Chronic Oral Reference Dose (mg/kg-day)	Contaminant-specific	EPA Superfund hierarchy
RfC or RFCIC	Chronic Inhalation Reference Concentration (mg/m^3)	Contaminant-specific	EPA Superfund hierarchy
$SRfD_o$ or RFDOS	Subhronic Oral Reference Dose (mg/kg-day)	Contaminant-specific	EPA Superfund hierarchy
SRfC or RFCIS	Subchronic Inhalation Reference Concentration (mg/m^3)	Contaminant-specific	EPA Superfund hierarchy
CSF_o or SFO	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Contaminant-specific	EPA Superfund hierarchy
IUR	Inhalation Unit Risk $(\mu g/m^3)^{-1}$	Contaminant-specific	EPA Superfund hierarchy

Symbol	Definition (units)	Default	Reference
Ingestion and Dermal Contact Rates			
IRW_{res-c}	Resident Drinking Water Ingestion Rate - Child (L/day)	0.78	U.S. EPA 2011, Tables 3-15 and 3-33; weighted average of 90th percentile consumer-only ingestion of drinking water (birth to <6 years)
IRW_{res-a}	Resident Drinking Water Ingestion Rate - Adult (L/day)	2.5	U.S. EPA 2011, Table 3-33; 90th percentile of consumer-only ingestion of drinking water (>= 21 years)
$IFW_{res-adj}$	Resident Drinking Water Ingestion Rate - Age-adjusted (L/kg)	327.95	Calculated using the age adjusted intake factors equation
$IFWM_{res-adj}$	Resident Mutagenic Drinking Water Ingestion Rate - Age-adjusted (L/kg)	1019.9	Calculated using the age adjusted intake factors equation
IRS_{res-c}	Resident Soil Ingestion Rate - Child (mg/day)	200	U.S. EPA 1991a (pg. 15)
IRS_{res-a}	Resident Soil Ingestion Rate - Adult (mg/day)	100	U.S. EPA 1991a (pg. 15)
$IFS_{res-adj}$	Resident Soil Ingestion Rate - Age-adjusted (mg/kg)	36750	Calculated using the age adjusted intake factors equation
$IFSM_{res-adj}$	Resident Mutagenic Soil Ingestion Rate - Age-adjusted (mg/kg)	166833.33	Calculated using the age adjusted intake factors equation
IR_{ind}	Indoor Worker Soil Ingestion Rate (mg/day)	50	U.S. EPA 1991a (pg. 15)
IR_{out}	Outdoor Worker Soil Ingestion Rate (mg/day)	100	U.S. EPA 1991a (pg. 15)
IR_{con}	Construction Worker Soil Ingestion Rate (mg/day)	330	U.S. EPA 2002 Exhibit 5-1
IR_{com}	Composite Worker Soil Ingestion Rate (mg/day)	100	U.S. EPA 1991a (pg. 15)
IRW_{rec-c}	Recreator Surface Water Ingestion Rate - Child (L/hour)	0.12	U.S. EPA 2011, Table 3.5
IRW_{rec-a}	Recreator Surface Water Ingestion Rate - Adult (L/hour)	0.11	Time weighted average was calculated based on the upper percentile from U.S. EPA 2019, Table 3.7
$IFW_{rec-adj}$	Recreator Surface Water Ingestion Rate - Age-adjusted (L/kg)	Site-Specific	Calculated using the age adjusted intake factors equation
IRW_{0-2}	Surface Water Ingestion Rate - Age Segment 0-2 (L/hour)	0.12	U.S. EPA 2011, Table 3.5
IRW_{2-6}	Surface Water Ingestion Rate - Age Segment 2-6 (L/hour)	0.12	U.S. EPA 2011, Table 3.5
IRW_{6-16}	Surface Water Ingestion Rate - Age Segment 6-16 (L/hour)	0.124	Time weighted average was calculated based on the upper percentile from U.S. EPA 2019, Table 3.7
IRW_{16-26}	Surface Water Ingestion Rate - Age Segment 16-26 (L/hour)	0.0985	Time weighted average was calculated based on the upper percentile from U.S. EPA 2019, Table 3.7
$IFWM_{rec-adj}$	Recreator Mutagenic Surface Water Ingestion Rate - Age-adjusted (L/kg)	Site-Specific	Calculated using the age adjusted intake factors equation
IRS_{rec-c}	Recreator Soil Ingestion Rate - Child (mg/day)	Site-Specific	U.S. EPA 1991a (pg. 15)
IRS_{rec-a}	Recreator Soil Ingestion Rate - Adult (mg/day)	Site-Specific	U.S. EPA 1991a (pg. 15)
$IFS_{rec-adj}$	Recreator Soil Ingestion Rate - Age-adjusted (mg/kg)	Site-Specific	Calculated using the age adjusted intake factors equation
IRS_{0-2}	Soil Ingestion Rate - Age-segment 0-2 (mg/day)	200	U.S. EPA 1991a (pg. 15)
IRS_{2-6}	Soil Ingestion Rate - Age-segment 2-6 (mg/day)	200	U.S. EPA 1991a (pg. 15)
IRS_{6-16}	Soil Ingestion Rate - Age-segment 6-16 (mg/day)	100	U.S. EPA 1991a (pg. 15)
IRS_{16-26}	Soil Ingestion Rate - Age-segment 16-26 (mg/day)	100	U.S. EPA 1991a (pg. 15)

Symbol	Definition (units)	Default	Reference
Ingestion and Dermal Contact Rates			
$IFSM_{rec-adj}$	Recreator Mutagenic Soil Ingestion Rate - Age-adjusted (mg/kg)	Site-Specific	Calculated using the age adjusted intake factors equation
$DFS_{res-adj}$	Resident soil dermal contact factor- age-adjusted (mg/kg)	103390	Calculated using the age adjusted intake factors equation
$DFSM_{res-adj}$	Resident Mutagenic soil dermal contact factor- age-adjusted (mg/kg)	428260	Calculated using the age adjusted intake factors equation
$DFS_{rec-adj}$	Recreator soil dermal contact factor- age-adjusted (mg/kg)	Site-Specific	Calculated using the age adjusted intake factors equation
$DFSM_{rec-adj}$	Recreator Mutagenic soil dermal contact factor- age-adjusted (mg/kg)	Site-Specific	Calculated using the age adjusted intake factors equation
$DFW_{res-adj}$	Resident water dermal contact factor- age-adjusted (cm_2 - event/kg)	2610650	Calculated using the age adjusted intake factors equation
$DFWM_{res-adj}$	Resident Mutagenic water dermal contact factor- age-adjusted (cm_2 - event/kg)	8191633	Calculated using the age adjusted intake factors equation
$DFW_{rec-adj}$	Recreator water dermal contact factor- age-adjusted (cm_2 - event/kg)	Site-Specific	Calculated using the age adjusted intake factors equation
$DFWM_{rec-adj}$	Recreator Mutagenic water dermal contact factor- age-adjusted (cm^2 - event/kg)	Site-Specific	Calculated using the age adjusted intake factors equation
IRF_{res-a}	Fish Ingestion Rate (mg/day)	Site-Specific	Recommend using Site-Specific values
SA_{res-c}	Resident surface area soil - child (cm^2/day)	2373	U.S. EPA 2011a, Tables 7-2 and 7-8; weighted average of mean values for head, hands, forearms, lower legs, and feet (male and female, birth to < 6 years)(forearm and lower leg-specific data used when available, ratios for nearest available age group used elsewhere)
SA_{res-a}	Resident surface area soil - adult (cm^2/day)	6032	U.S. EPA 2011, Tables 7-2 and 7-12; weighted average of mean values for head, hands, forearms, lower legs, and feet (male and female, 21+ years)(forearm and lower leg-specific data used for males and female lower leg; ratio of male forearm to arm applied to female arm data.
SA_{res-c}	Resident surface area water - child (cm^2)	6365	U.S. EPA 2014, weighted average of mean values for children <6 years.
SA_{res-a}	Resident surface area water - adult (cm^2)	19652	U.S. EPA 2014, weighted average of mean values for adults, male and female 21+.
SA_{out}	Outdoor Worker soil surface area - adult (cm^2/day)	3527	US EPA 2011a, Table 7-2; weighted average of mean values for head, hands, and forearms (male and female, 21+years)
SA_{con}	Construction Worker soil surface area - adult (cm^2/day)	3527	US EPA 2011a, Table 7-2; weighted average of mean values for head, hands, and forearms (male and female, 21+years)
SA_{com}	Composite Worker soil surface area - adult (cm^2/day)	3527	US EPA 2011a, Table 7-2; weighted average of mean values for head, hands, and forearms (male and female, 21+years)

Symbol	Definition (units)	Default	Reference
Ingestion and Dermal Contact Rates			
SA_{rec-c}	Recreator surface area soil - child (cm^2/day)	Site-Specific	Site-Specific
SA_{rec-a}	Recreator surface area soil - adult (cm^2/day)	Site-Specific	Site-Specific
SA_{rec-c}	Recreator surface area water - child (cm^2)	6365	U.S. EPA 2014, weighted average of mean values for children <6 years.
SA_{rec-a}	Recreator surface area water - adult (cm^2)	19652	U.S. EPA 2014, weighted average of mean values for adults, male and female 21+.
SA_{0-2}	Resident/Recreator surface area soil - age segment 0-2 (cm2/day)	Resident 2373	U.S. EPA 2011, Tables 7-2 and 7-12; weighted average of mean values for head, hands, forearms, lower legs, and feet (male and female, 21+ years)(forearm and lower leg-specific data used for males and female lower leg; ratio of male forearm to arm applied to female arm data.
		Recreator - Site-Specific	Recreator - Site-Specific
SA_{2-6}	Resident/Recreator surface area soil - age segment 2-6 (cm^2/day)	Resident 2373	U.S. EPA 2011, Tables 7-2 and 7-12; weighted average of mean values for head, hands, forearms, lower legs, and feet (male and female, 21+ years)(forearm and lower leg-specific data used for males and female lower leg; ratio of male forearm to arm applied to female arm data.
		Recreator - Site-Specific	Recreator - Site-Specific
SA_{6-16}	Resident/Recreator surface area soil - age segment 6-16 (cm^2/day)	Resident 6032	U.S. EPA 2011, Tables 7-2 and 7-12; weighted average of mean values for head, hands, forearms, lower legs, and feet (male and female, 21+ years)(forearm and lower leg-specific data used for males and female lower leg; ratio of male forearm to arm applied to female arm data.
		Recreator - Site-Specific	Recreator - Site-Specific
SA_{16-26}	Resident/Recreator surface area soil - age segment 16-26 (cm^2/day)	Resident 6032	U.S. EPA 2011, Tables 7-2 and 7-12; weighted average of mean values for head, hands, forearms, lower legs, and feet (male and female, 21+ years)(forearm and lower leg-specific data used for males and female lower leg; ratio of male forearm to arm applied to female arm data.
		Recreator - Site-Specific	Recreator - Site-Specific
SA_{0-2}	Resident/Recreator surface area water - age segment 0-2 (cm^2)	6365	U.S. EPA 2014, weighted average of mean values for children <6 years.
SA_{2-6}	Resident/Recreator surface area water - age segment 2-6 (cm^2)	6365	U.S. EPA 2014, weighted average of mean values for children <6 years.

Symbol	Definition (units)	Default	Reference
Ingestion and Dermal Contact Rates			
SA_{6-16}	Resident/Recreator surface area water - age segment 6-16 (cm^2)	19652	U.S. EPA 2014, weighted average of mean values for adults, male and female 21+.
SA_{16-26}	Resident/Recreator surface area water - age segment 16-26 (cm^2)	19652	U.S. EPA 2014, weighted average of mean values for adults, male and female 21+.
AF_{res-c}	Resident soil adherence factor - child (mg/cm^2)	0.2	U.S. EPA 2002 (Exhibit 1-2)
AF_{res-a}	Resident soil adherence factor - adult (mg/cm^2)	0.07	U.S. EPA 2002 (Exhibit 1-2)
AF_{out}	Outdoor Worker soil adherence factor (mg/cm^2)	0.12	U.S. EPA 2011, Table 7-20 and Section 7.2.2; arithmetic mean of weighted average of body part- specific (hands, forearms, and face) mean adherence factors for adult commercial/industrial activities
AF_{com}	Composite Worker soil adherence factor (mg/cm^2)	0.12	U.S. EPA 2011, Table 7-20 and Section 7.2.2; arithmetic mean of weighted average of body part- specific (hands, forearms, and face) mean adherence factors for adult commercial/industrial activities
AF_{con}	Construction Worker soil adherence factor (mg/cm^2)	0.3	U.S. EPA 2002 (Exhibit 5-1)
AF_{rec-c}	Recreator soil adherence factor - child (mg/cm^2)	none	U.S. EPA 2004 Exhibit 3-3 presents options
AF_{rec-a}	Recreator soil adherence factor - adult (mg/cm^2)	none	U.S. EPA 2004 Exhibit 3-3 presents options
AF_{0-2}	Resident soil adherence factor - age segment 0-2 (mg/cm^2)	0.2	U.S. EPA 2002 (Exhibit 1-2)
AF_{2-6}	Resident soil adherence factor - age segment 2-6 (mg/cm^2)	0.2	U.S. EPA 2002 (Exhibit 1-2)
AF_{6-16}	Resident soil adherence factor - age segment 6-16 (mg/cm^2)	0.07	U.S. EPA 2002 (Exhibit 1-2)
AF_{16-26}	Resident soil adherence factor - age segment 16-26 (mg/cm^2)	0.07	U.S. EPA 2002 (Exhibit 1-2)
BW_{res-c}	Resident Body Weight - child (kg)	15	U.S. EPA 1991a (pg. 15)
BW_{res-a}	Resident Body Weight - adult (kg)	80	U.S. EPA 2011, Table 8-3; weighted mean values for adults 21 - 78
BW_{rec-c}	Recreator Body Weight - child (kg)	15	U.S. EPA 1991a (pg. 15)
BW_{rec-a}	Recreator Body Weight - adult (kg)	80	U.S. EPA 2011, Table 8-3; weighted mean values for adults 21 - 78
BW_{0-2}	Resident/Recreator Body Weight - age segment 0-2 (kg)	15	U.S. EPA 1991a (pg. 15)
BW_{2-6}	Resident/Recreator Body Weight - age segment 2-6 (kg)	15	U.S. EPA 1991a (pg. 15)
BW_{6-16}	Resident/Recreator Body Weight - age segment 6-16 (kg)	80	U.S. EPA 2011, Table 8-3; weighted mean values for adults 21 - 78
BW_{16-26}	Resident/Recreator Body Weight - age segment 16-26 (kg)	80	U.S. EPA 2011, Table 8-3; weighted mean values for adults 21 - 78
BW_{out}	Outdoor Worker Body Weight (kg)	80	U.S. EPA 1991a (pg. 15)
BW_{con}	Construction Worker Body Weight (kg)	80	U.S. EPA 2011, Table 8-3; weighted mean values for adults 21 - 78
BW_{ind}	Indoor Worker Body Weight (kg)	80	U.S. EPA 2011, Table 8-3; weighted mean values for adults 21 - 78
BW_{com}	Composite Worker Body Weight (kg)	80	U.S. EPA 2011, Table 8-3; weighted mean values for adults 21 - 78
ABS	Fraction of contaminant absorbed dermally from soil (unitless)	Contaminant-specific Inorganic default = none	U.S. EPA 2004 (Exhibit 3-4 and section 3.2.2.4)

Symbol	Definition (units)	Default	Reference
Ingestion and Dermal Contact Rates			
ABS_d	Fraction of contaminant absorbed dermally from soil (unitless)	VOC default = none SVOC default = 0.1	U.S. EPA 2004 (Exhibit 3-4 and section 3.2.2.4)
GIABS	Fraction of contaminant absorbed in gastrointestinal tract (unitless) Note: if the GIABS is >50% then it is set to 100% for the calculation of dermal toxicity values.	Contaminant-specific Inorganic default = 1.0 VOC default = 1.0 SVOC default = 1.0	U.S. EPA 2004 (Exhibit 4-1 and section 4.2)
DA_{event}	Absorbed dose per event ($\mu g/cm^2$ - event)	Contaminant-specific	U.S. EPA 2004 (Equation 3.2 and 3.3)

Symbol	Definition (units)	Default	Reference
Exposure Frequency, Exposure Duration, and Exposure Time Variables			
EF_{res}	Resident Exposure Frequency (days/year)	350	U.S. EPA 1991a (pg. 15)
EF_{res-a}	Resident Exposure Frequency - adult (days/year)	350	U.S. EPA 1991a (pg. 15)
EF_{res-c}	Resident Exposure Frequency - child (days/year)	350	U.S. EPA 1991a (pg. 15)
EF_{com}	Composite Worker Exposure Frequency (days/year)	250	U.S. EPA 1991a (pg. 15)
EF_{ind}	Indoor Worker Exposure Frequency (days/year)	250	U.S. EPA 1991a (pg. 15)
EF_{out}	Outdoor Worker Exposure Frequency (days/year)	225	U.S. EPA 2002 (Exhibit 1-2)
EF_{con}	Construction Worker Exposure Frequency (days/year)	250	U.S. EPA 2002 Exhibit 5-1
EF_{rec}	Recreator Exposure Frequency (days/year)	Site-Specific	Site-Specific
EF_{rec-c}	Recreator Exposure Frequency - child (days/year)	Site-Specific	Site-Specific
EF_{rec-a}	Recreator Exposure Frequency - adult (days/year)	Site-Specific	Site-Specific
EF_{0-2}	Resident/Recreator Exposure Frequency - age segment 0-2 (days/year)	Resident - 350	Resident - U.S. EPA 1991a (pg. 15)
		Recreator - Site-Specific	Recreator - Site-Specific
EF_{2-6}	Resident/Recreator Exposure Frequency - age segment 2-6 (days/year)	Resident - 350	Resident - U.S. EPA 1991a (pg. 15)
		Recreator - Site-Specific	Recreator - Site-Specific
EF_{6-16}	Resident/Recreator Exposure Frequency - age segment 6-16 (days/year)	Resident - 350	Resident - U.S. EPA 1991a (pg. 15)
		Recreator - Site-Specific	Recreator - Site-Specific
EF_{16-26}	Resident/Recreator Exposure Frequency - age segment 16-26 (days/year)	Resident - 350	Resident - U.S. EPA 1991a (pg. 15)
		Recreator - Site-Specific	Recreator - Site-Specific
ED_{res}	Resident Exposure Duration (years)	26	EPA 2011, Table 16-108; 90th percentile for current residence time.
ED_{res-c}	Resident Exposure Duration - child (years)	6	U.S. EPA 1991a (pg. 15)
ED_{res-a}	Resident Exposure Duration - adult (years)	20	ED_{res} (26 years) - ED_{res-c} (6 years)
ED_{com}	Composite Worker Exposure Duration - (years)	25	U.S. EPA 1991a (pg. 15)
ED_{ind}	Indoor Worker Exposure Duration - (years)	25	U.S. EPA 1991a (pg. 15)
ED_{out}	Outdoor Worker Exposure Duration (years)	25	U.S. EPA 1991a (pg. 15)
ED_{con}	Construction Worker Exposure Duration (years)	1	U.S. EPA 2002 Exhibit 5-1
ED_{rec}	Recreator Exposure Duration (years)	26	EPA 2011, Table 16-108; 90th percentile for current residence time.
ED_{rec-c}	Recreator Exposure Duration - child (years)	6	U.S. EPA 1991a (pg. 15)
ED_{rec-a}	Recreator Exposure Duration - adult (years)	20	ED_{rec} (26 years) - ED_{rec-c} (6 years)
ED_{0-2}	Resident/Recreator Exposure Duration - age segment 0-2 (years)	2	U.S. EPA 2005 (pg. 37)
ED_{2-6}	Resident/Recreator Exposure Duration - age segment 2-6 (years)	4	U.S. EPA 2005 (pg. 37)
ED_{6-16}	Resident/Recreator Exposure Duration - age segment 6-16 (years)	10	U.S. EPA 2005 (pg. 37)
ED_{16-26}	Resident/Recreator Exposure Duration - age segment 16-26 (years)	10	U.S. EPA 2005 (pg. 37)
ET_{res-a}	Resident Exposure Time (hours/day)	24	The whole day
ET_{res-c}	Resident Exposure Time (hours/day)	24	The whole day
ET_{res}	Resident Exposure Time (hours/day)	24	The whole day
ET_{com}	Composite Worker Exposure Time (hours/day)	8	The work day

Symbol	Definition (units)	Default	Reference
Exposure Frequency, Exposure Duration, and Exposure Time Variables			
ET_{ind}	Indoor Worker Exposure Time (hours/day)	8	The work day
ET_{out}	Outdoor Worker Exposure Time (hours/day)	8	The work day
ET_{con}	Construction Worker Exposure Time (hours/day)	8	The work day
ET_{rec}	Recreator Exposure Time (hours/day)	Site-Specific	Site-Specific
$ET_{rec\text{-}c}$	Recreator Exposure Time - child (hours/day)	Site-Specific	Site-Specific
$ET_{rec\text{-}a}$	Recreator Exposure Time - adult (hours/day)	Site-Specific	Site-Specific
$ET_{event\text{-}res\text{-}c}$	Resident Water Exposure Time - child (hours/event)	0.54	U.S. EPA 2011, Table 16-28; weighted average of 90th percentile time spent bathing (birth to <6 years)
$ET_{event\text{-}res\text{-}a}$	Resident Water Exposure Time - adult (hours/event)	0.71	U.S. EPA 2011, Tables 16-30 and 16-31; weighted average of adult (21 to 78) 90^{th} percentile of time spent bathing/ showering in a day, divided by mean number of baths/showers taken in a day.
$ET_{event\text{-}res\text{-}adj}$	Resident Water Exposure Time - age-adjusted (hours/event)	0.6708	Calculated using the age adjusted intake factors equation
$ET_{event\text{-}res\text{-}madj}$	Resident Exposure Time - age-adjusted (hours/event)	0.6708	Calculated using the age adjusted intake factors equation
$ET_{event\text{-}rec\text{-}c}$	Recreator Surface Water Exposure Time - child (hours/event)	Site-Specific	Site-Specific
$ET_{event\text{-}rec\text{-}a}$	Recreator Surface Water Exposure Time - adult (hours/event)	Site-Specific	Site-Specific
$ET_{0\text{-}2}$	Resident/Recreator Exposure Time - age segment 0-2 (hours/day)	Resident - 24	Resident - The whole day
		Recreator - Site-Specific	Recreator - Site-Specific
$ET_{2\text{-}6}$	Resident/Recreator Exposure Time - age segment 2-6 (hours/day)	Resident - 24	Resident - The whole day
		Recreator - Site-Specific	Recreator - Site-Specific
$ET_{6\text{-}16}$	Resident/Recreator Exposure Time - age segment 6-16 (hours/day)	Resident - 24	Resident - The whole day
		Recreator - Site-Specific	Recreator - Site-Specific
$ET_{16\text{-}26}$	Resident/Recreator Exposure Time - age segment 16-26 (hours/day)	Resident - 24	Resident - The whole day
		Recreator - Site-Specific	Recreator - Site-Specific
$ET_{event\text{-}rec\text{-}adj}$	Recreator Exposure Time - age-adjusted (hours/event)	Site-Specific	Calculated using the age adjusted intake factors equation
$ET_{event\text{-}rec(0\text{-}2)}$	Recreator Exposure Time - age segment 0-2 (hours/event)	Site-Specific	Site-Specific
$ET_{event\text{-}rec(2\text{-}6)}$	Recreator Exposure Time - age segment 2-6 (hours/event)	Site-Specific	Site-Specific
$ET_{event\text{-}rec(6\text{-}16)}$	Recreator Exposure Time - age segment 6-16 (hours/event)	Site-Specific	Site-Specific
$ET_{event\text{-}rec(16\text{-}26)}$	Recreator Exposure Time - age segment 16-26 (hours/event)	Site-Specific	Site-Specific
$ET_{event\text{-}res(0\text{-}2)}$	Resident Exposure Time - age segment 0-2 (hours/event)	0.54	Calculated based on the ET given for ETevent-res-c
$ET_{event\text{-}res(2\text{-}6)}$	Resident Exposure Time - age segment 2-6 (hours/event)	0.54	Calculated based on the ET given for ETevent-res-c
$ET_{event\text{-}res(6\text{-}16)}$	Resident Exposure Time - age segment 6-16 (hours/event)	0.71	Calculated based on the ET given for ETevent-res-a
$ET_{event\text{-}res(16\text{-}26)}$	Resident Exposure Time - age segment 16-26 (hours/event)	0.71	Calculated based on the ET given for ETevent-res-a
$ET_{event\text{-}rec\text{-}madj}$	Recreator Exposure Time - age-adjusted (hours/event)	Site-Specific	Calculated using the age adjusted intake factors equation
$EV_{rec\text{-}c}$	Recreator Events - child (events/day)	Site-Specific	Site-Specific

REC 14437

Symbol	Definition (units)	Default	Reference
Exposure Frequency, Exposure Duration, and Exposure Time Variables			
EV_{rec-a}	Recreator Events - adult (events/day)	Site-Specific	Site-Specific
EV_{res-c}	Resident Events - child (events/day)	1	U.S. EPA 2004; Exhibit 3-2
EV_{res-a}	Resident Events - adult (events/day)	1	U.S. EPA 2004; Exhibit 3-2
EV_{0-2}	Resident/Recreator Events - age segment 0-2 (events/day)	Resident - 1 Recreator - Site-Specific	U.S. EPA 2004; Exhibit 3-2
EV_{2-6}	Resident/Recreator Events - age segment 2-6 (events/day)	Resident - 1 Recreator - Site-Specific	U.S. EPA 2004; Exhibit 3-2
EV_{6-16}	Resident/Recreator Events - age segment 6-16 (events/day)	Resident - 1 Recreator - Site-Specific	U.S. EPA 2004; Exhibit 3-2
EV_{16-26}	Resident/Recreator Events - age segment 16-26 (events/day)	Resident - 1 Recreator - Site-Specific	U.S. EPA 2004; Exhibit 3-2

Symbol	Definition (units)	Default	Reference
Soil to Groundwater SSL Factor Variables			
C_w	Target soil leachate concentration (mg/L)	nonzero MCL or RSL × DAF	U.S. EPA. 2002 Equation 4-14
DAF	Dilution attenuation factor (unitless)	1 (or Site-Specific)	U.S. EPA. 2002 Equation 4-11
ED	Exposure duration	70	U.S. EPA. 2002 Equation 4-14
I	Infiltration Rate (m/year)	0.18	U.S. EPA. 2002 Equation 4-11
L	source length parallel to ground water flow (m)	Site-Specific	U.S. EPA. 2002 Equation 4-11
i	hydraulic gradient (m/m)	Site-Specific	U.S. EPA. 2002 Equation 4-11
K	aquifer hydraulic conductivity (m/year)	Site-Specific	U.S. EPA. 2002 Equation 4-11
θ_w	water-filled soil porosity (L_{water}/L_{soil})	0.3	U.S. EPA. 2002 Equation 4-10
θ_a	air-filled soil porosity (L_{air}/L_{soil})	= $n-\theta_w$	U.S. EPA. 2002 Equation 4-10
n	total soil porosity(L_{pore}/L_{soil})	= $1-(\rho_b/\rho_s)$	U.S. EPA. 2002 Equation 4-10
ρ_s	soil particle density (kg/L)	2.65	U.S. EPA. 2002 Equation 4-10
ρ_b	dry soil bulk density (kg/L)	1.5	U.S. EPA. 2002 Equation 4-10
H'	Dimensionless Henry Law Constant (unitless)	Contaminant-specific	See Chemical-specific hierarchy
K_d	soil-water partition coefficient (L/kg)	= $K_{oc} \times f_{oc}$ for organics	U.S. EPA. 2002 Equation 4-10
K_{oc}	soil organic carbon/water partition coefficient (L/kg)	Contaminant-specific	See Chemical-specific hierarchy
f_{oc}	fraction organic carbon in soil (g/g)	0.002	U.S. EPA. 2002 Equation 4-10
d_a	aquifer thickness (m)	Site-Specific	U.S. EPA. 2002 Equation 4-10
d_s	depth of source (m)	Site-Specific	U.S. EPA. 2002 Equation 4-10
d	mixing zone depth (m)	Site-Specific	U.S. EPA. 2002 Equation 4-12

Symbol	Definition (units)	Default	Reference
Wind Particulate Emission Factor Variables			
PEF	Particulate Emission Factor - Minneapolis (m^3/kg)	1.36 x 10^9(region-specific)	U.S. EPA 2002 Exhibit D-2
Q/C_{wind}	Inverse of the Mean Concentration at the Center of a 0.5-Acre-Square Source (g/m^2-s per kg/m^3)	93.77 (region-specific)	U.S. EPA 2002 Exhibit D-2
V	Fraction of Vegetative Cover (unitless)	0.5	U.S. EPA. 2002 Equation 4-5
U_m	Mean Annual Wind Speed (m/s)	4.69	U.S. EPA. 2002 Equation 4-5
U_t	Equivalent Threshold Value of Wind Speed at 7m (m/s)	11.32	U.S. EPA. 2002 Equation 4-5
F(x)	Function Dependent on U_m /U_t (unitless)	0.194	U.S. EPA. 2002 Equation 4-5
A	Dispersion constant unitless	PEF and region-specific	U.S. EPA 2002 Exhibit D-2
A_s	Areal extent of the site or contamination (acres)	0.5 (range 0.5 to 500)	U.S. EPA 2002 Exhibit D-2
B	Dispersion constant unitless	PEF and region-specific	U.S. EPA 2002 Exhibit D-2
C	Dispersion constant unitless	PEF and region-specific	U.S. EPA 2002 Exhibit D-2

Symbol	Definition (units)	Default	Reference
Mechanical Particulate Emission Factor Variables from Vehicle Traffic			
PEF_{sc}	Particulate Emission Factor - subchronic (m^3/kg)	Site-Specific	U.S. EPA 2002 Equation 5-5
Q/C_{sr}	Inverse of the ratio of the 1-h geometric mean concentration to the emission flux along a straight road segment bisecting a square site (g/m^2-s per kg/m^3)	23.02 (for 0.5 acre site)	U.S. EPA 2002 Equation 5-5
F_D	Dispersion correction factor (unitless)	0.185	U.S. EPA 2002 Equation E-16
T	Total time over which construction occurs (s)	Site-Specific	U.S. EPA 2002 Equation 5-5
A_R	Surface area of contaminated road segment (m^2)	($A_R = L_R \times W_R \times 0.092903 m^2/ft^2$)	U.S. EPA 2002 Equation 5-5
L_R	Length of road segment (ft)	Site-Specific	U.S. EPA 2002 Equation 5-5
W_R	Width of road segment (ft)	20	U.S. EPA 2002 Equation E-18
W	Mean vehicle weight (tons)	(number of cars x tons/car + number of trucks x tons/truck) / total vehicles)	U.S. EPA 2002 Equation 5-5
p	Number of days with at least 0.01 inches of precipitation (days/year)	Site-Specific	U.S. EPA 2002 Exhibit 5-2
∑VKT	Sum of fleet vehicle kilometers traveled during the exposure duration (km)	∑VKT = total vehicles x distance (km/day) x frequency (weeks/year) x (days/year)	U.S. EPA 2002 Equation 5-5
A	Dispersion constant unitless	12.9351	U.S. EPA 2002 Equation 5-6
A_s	Areal extent of site surface soil contamination (acres)	0.5 (range 0.5 to 500)	U.S. EPA 2002 Equation 5-6
B	Dispersion constant unitless	5.7383	U.S. EPA 2002 Equation 5-6
C	Dispersion constant unitless	71.7711	U.S. EPA 2002 Equation 5-6

Symbol	Definition (units)	Default	Reference
Mechanical Particulate Emission Factor Variables from other than Vehicle Traffic			
PEF'_{sc}	Particulate Emission Factor - subchronic (m^3/kg)	Site-Specific	U.S. EPA 2002 Equation E-26
Q/C_{sa}	Inverse of the ratio of the 1-h. geometric mean air concentration and the emission flux at the center of the square emission source (g/m^2-s per kg/m^3)	Site-Specific	U.S. EPA 2002 Equation E-15
F_D	Dispersion correction factor (unitless)	Site-Specific	U.S. EPA 2002 Equation E-16
A	Dispersion constant unitless	2.4538	U.S. EPA 2002 Equation E-15
B	Dispersion constant unitless	17.566	U.S. EPA 2002 Equation E-15
C	Dispersion constant unitless	189.0426	U.S. EPA 2002 Equation E-15
A_s	Areal extent of site surface soil contamination (acres)	(range 0.5 to 500)	U.S. EPA 2002 Equation E-15
J'_T	Total time-averaged PM_{10} unit emission flux for construction activities other than traffic on unpaved roads (g/m^2-s)	Site-Specific	U.S. EPA 2002 Equation E-25
M^{PC}_{wind}	Unit mass emitted from wind erosion (g)	Site-Specific	U.S. EPA 2002 Equation E-20
V	Fraction of Vegetative Cover (unitless)	0	U.S. EPA 2002 Equation E-20
U_m	Mean Annual Wind Speed (m/s)	4.69	U.S. EPA 2002 Equation E-20
U_t	Equivalent Threshold Value of Wind Speed at 7m (m/s)	11.32	U.S. EPA 2002 Equation E-20
F(x)	Function Dependent on U_m/U_t (unitless)	0.194	U.S. EPA 2002 Equation E-20
A_{surf}	Areal extent of site surface soil contamination ($m2$)	(range 0.5 to 500)	U.S. EPA 2002 Equation E-20
ED	Exposure duration (years)	Site-Specific	U.S. EPA 2002 Equation E-20
M_{excav}	Unit mass emitted from excavation soil dumping (g)	Site-Specific	U.S. EPA 2002 Equation E-21
0.35	PM_{10} particle size multiplier (unitless)	0.35	U.S. EPA 2002 Equation E-21
U_m	Mean annual wind speed during construction (m/s)	4.69	U.S. EPA 2002 Equation E-21
$M_{m\text{-}excav}$	Gravimetric soil moisture content (%)	12 (mean value for municipal landfill cover)	U.S. EPA 2002 Equation E-21
ρ_{soil}	In situ soil density (includes water) (mg/m^3)	1.68	U.S. EPA 2002 Equation E-21
A_{excav}	Areal extent of excavation (m^2)	(range 0.5 to 500)	U.S. EPA 2002 Equation E-21
d_{excav}	Average depth of excavation (m)	Site-Specific	U.S. EPA 2002 Equation E-21
$N_{A\text{-}dump}$	Number of times soil is dumped (unitless)	2	U.S. EPA 2002 Equation E-21
M_{doz}	Unit mass emitted from dozing operations (g)	Site-Specific	U.S. EPA 2002 Equation E-22
0.75	PM_{10} scaling factor (unitless)	0.75	U.S. EPA 2002 Equation E-22
s_{doz}	Soil silt content (%)	6.9	U.S. EPA 2002 Equation E-22
$M_{m\text{-}doz}$	Gravimetric soil moisture content (%)	7.9 (mean value for overburden)	U.S. EPA 2002 Equation E-22
$\sum VKT_{doz}$	Sum of dozing kilometers traveled (km)	Site-Specific	U.S. EPA 2002 Equation E-22
S_{doz}	Average dozing speed (kph)	11.4 (mean value for graders)	U.S. EPA 2002 Equation E-22
$N_{A\text{-}doz}$	Number of times site is dozed (unitless)	Site-Specific	U.S. EPA 2002 Equation E-22
B_d	Dozer blade length (m)	Site-Specific	U.S. EPA 2002 Page E-28
M_{grade}	Unit mass emitted from grading operations (g)	Site-Specific	U.S. EPA 2002 Equation E-23
0.6	PM10 scaling factor (unitless)	0.6	U.S. EPA 2002 Equation E-23
$\sum VKT_{grade}$	Sum of grading kilometers traveled (km)		U.S. EPA 2002 Equation E-23
S_{grade}	Average grading speed (kph)	11.4 (mean value for graders)	U.S. EPA 2002 Equation E-23
$N_{A\text{-}grade}$	Number of times site is graded (unitless)	Site-Specific	U.S. EPA 2002 Equation E-23
B_g	Grader blade length (m)	Site-Specific	U.S. EPA 2002 Page E-28
M_{till}	Unit mass emitted from tilling operations (g)	Site-Specific	U.S. EPA 2002 Equation E-24
s_{till}	Soil silt content (%)	18	U.S. EPA 2002 Equation E-24
$A_{c\text{-}till}$	Areal extent of tilling (acres)	Site-Specific	U.S. EPA 2002 Equation E-24
$A_{c\text{-}grade}$	Areal extent of grading (acres)	Site-Specific	Necessary to solve $\sum_{VKTgrade}$ in U.S. EPA 2002 Equation E-23
$A_{c\text{-}doz}$	Areal extent of dozinging (acres)	Site-Specific	Necessary to solve $\sum_{VKTgrade}$ in U.S. EPA 2002 Equation E-22
$N_{A\text{-}till}$	Number of times soil is tilled (unitless)	2	U.S. EPA 2002 Equation E-24

Symbol	Definition (units)	Default	Reference
Chronic Volatilization Factor and Soil Saturation Limit Variables			
VF_{ulim}	Volatilization Factor - Los Angeles (m^3/kg)	Contaminant-specific	U.S. EPA. 2002 Equation 4-8
C_{sat}	Soil saturation concentration (mg/kg)	Contaminant-specific	U.S. EPA. 2002 Equation 4-9
Q/C_{vol}	Inverse of the Mean Concentration at the Center of a 0.5-Acre-Square Source (g/m^2-s per kg/m^3)	68.18	U.S. EPA. 2002 Equation 4-8
A_s	Areal extent of the site contamination (acres)	0.5 (range 0.5 to 500)	U.S. EPA 2002 Equation 4-8
B	Dispersion constant unitless	18.4385 (region-specific)	U.S. EPA 2002 Exhibit D-3
C	Dispersion constant unitless	209.7845 (region-specific)	U.S. EPA 2002 Exhibit D-3
D_A	Apparent Diffusivity (cm^2/s)	Contaminant-specific	U.S. EPA. 2002 Equation 4-8
T	Exposure interval (s)	8.2×10^8 (used for unlimited source model) = 26 years	U.S. EPA. 2002 Equation 4-8
T	Exposure interval (years)	26 (used for mass-limit model)	U.S. EPA. 2002 Equation 4-13
ρ_b	Dry soil bulk density (g/cm^3)	1.5	U.S. EPA. 2002 Equation 4-8
θ_a	Air-filled soil porosity (L_{air}/L_{soil}) ($n-\theta_w$)	0.28	U.S. EPA. 2002 Equation 4-8
n	Total soil porosity (L_{pore}/L_{soil}) ($1-(\rho_b/\rho_s)$)	0.43	U.S. EPA. 2002 Equation 4-8
θ_w	Water-filled soil porosity (L_{water}/L_{soil})	0.15	U.S. EPA. 2002 Equation 4-8
ρ_s	Soil particle density (g/cm^3)	2.65	U.S. EPA. 2002 Equation 4-8
S	Water Solubility Limit (mg/L)	Contaminant-specific	See Chemical-specific hierarchy
R	Universal Gas Constant (L-atm/mole-K)	0.082057	U.S. EPAFact Sheet
R_c	Universal Gas Constant (cal/mole-K)	1.9872	U.S. EPA Fact Sheet
D_{ia}	Diffusivity in air (cm^2/s)	Contaminant-specific	U.S. EPA. 2001
H'	Dimensionless Henry's Law Constant	Contaminant-specific	See Chemical-specific hierarchy
D_{iw}	Diffusivity in water (cm^2/s)	Contaminant-specific	U.S. EPA. 2001
K_d	Soil-water partition coefficient (L/kg) (Koc×foc)	Contaminant-specific	U.S. EPA. 2002 Equation 4-8
K_{oc}	Soil organic carbon-water partition coefficient (L/kg)	$= K_{oc} \times f_{oc}$ for organics	See Chemical-specific hierarchy
f_{oc}	Organic carbon content of soil (g/g)	0.006	U.S. EPA. 2002 Equation 4-8
d_s	Average source depth (m)	Site-Specific	U.S. EPA 2002 Equation 4-13

Symbol	Definition (units)	Default	Reference
Subchronic Volatilization Factor for Unlimited Source and Mass-limit Equations			
$VF_{ulim-sc}$	Subchronic Volatilization Factor (m^3/kg)	Contaminant-specific	U.S. EPA 2002 Equation 5-14
Q/C_{sa}	Inverse of the ratio of the 1-h geometric mean air concentration to the volatilization flux at the center of a square source (g/m^2-s per kg/m^3)	14.31 (for 0.5 acre site)	U.S. EPA 2002 Equation 5-14
A	Dispersion constant unitless	2.4538	U.S. EPA 2002 Equation 5-15
A_c	Areal extent of the site soil contamination (acres)	0.5 (range 0.5 to 500)	U.S. EPA 2002 Equation 5-15
B	Dispersion constant unitless	17.566	U.S. EPA 2002 Equation 5-15
C	Dispersion constant unitless	189.0426	U.S. EPA 2002 Equation 5-15
D_A	Apparent Diffusivity (cm^2/s)	Contaminant-specific	U.S. EPA 2002 Equation 5-14
T	Total time over which construction occurs (s)	Site-Specific	U.S. EPA 2002 Equation 5-14
ρ_b	Dry soil bulk density (g/cm^3)	1.5	U.S. EPA 2002 Equation 5-14
F_D	Dispersion correction factor (unitless)	0.185	U.S. EPA 2002 Equation 5-14
θ_a	Air-filled soil porosity (L_{air}/L_{soil}) ($n-\theta_w$)	0.28	U.S. EPA 2002 Equation 5-14
n	Total soil porosity (L_{pore}/L_{soil}) ($1-(\rho_b/\rho_s)$	0.43	U.S. EPA 2002 Equation 5-14
θ_w	Water-filled soil porosity (L_{water}/L_{soil})	0.15	U.S. EPA 2002 Equation 5-14
ρ_s	Soil particle density (g/cm^3)	2.65	U.S. EPA 2002 Equation 5-14
D_{ia}	Diffusivity in air (cm^2/s)	Contaminant-specific	U.S. EPA 2001
H'	Dimensionless Henry's Law Constant	Contaminant-specific	See Chemical-specific hierarchy
D_{iw}	Diffusivity in water (cm^2/s)	Contaminant-specific	U.S. EPA 2001
K_d	Soil-water partition coefficient (L/kg) (Koc×foc)	= $K_{oc} \times f_{oc}$ for organics	See Chemical-specific hierarchy
K_{oc}	Soil organic carbon-water partition coefficient (L/kg)	Contaminant-specific	See Chemical-specific hierarchy
f_{oc}	Organic carbon content of soil (g/g)	0.006 (0.6%)	U.S. EPA 2002 Equation 5-14
T	Total time over which construction occurs (year)	Site-Specific (T=ED)	U.S. EPA 2002 Equation 5-17
d_s	Average source depth (m)	Site-Specific	U.S. EPA 2002 Equation 5-17

U.S. EPA (Environmental Protection Agency). 1987. Processes, Coefficients, and Models for Simulation Toxic Organics and Heavy Metals in Surface Waters. EPA/600/3-87/015. Office of Research and Development, Athens, GA.

U.S. EPA 1989. Risk assessment guidance for Superfund. Volume I: Human health evaluation manual (Part A)(PDF) (289 pp, 6.9 MB). Interim Final. Office of Emergency and Remedial Response. EPA/540/1-89/002.

U.S. EPA 1991a. Human health evaluation manual, supplemental guidance: "Standard default exposure factors (PDF) (28 pp, 248 K)". OSWER Directive 9285.6-03.

U.S. EPA 1991b. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals) (PDF) (68 pp, 721 K). Office of Emergency and Remedial Response. EPA/540/R-92/003. December 1991

U.S. EPA. 1996a. Soil Screening Guidance: User's Guide. Office of Emergency and Remedial Response. Washington, DC. OSWER No. 9355.4-23

U.S. EPA. 1996b. Soil Screening Guidance: Technical Background Document. Office of Emergency and Remedial Response. Washington, DC. OSWER No. 9355.4-17A

U.S. EPA. 1997a. Exposure Factors Handbook (PDF) (854 pp, 7.7 MB). Office of Research and Development, Washington, DC. EPA/600/P-95/002Fa.

U.S. EPA 2000. Exposure and Human Health Reassessment of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin (TCDD) and Related Compounds. Part I: Estimating Exposure to Dioxin-Like Compounds. Volume 3--Properties, Environmental Levels, and Background Exposures. Draft Final Report. EPA/600/P- 00/001. Office of Research and Development, Washington, DC. September.

U.S. EPA, 2000b. Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (PDF) (185 pp, 790 K).

U.S. EPA, 2001 (PDF) (38 pp, 185 K). WATER9. Version 1.0.0. Office of Air Quality Planning and Standards, Research Triangle Park, NC. Web site.

U.S. EPA 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24. December 2002.

U.S. EPA 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. OSWER 9285.7-02EP.July 2004. Document (PDF) (186 pp, 4.2 MB) and website.

U.S. EPA 2005. Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens. March 2005. Document (PDF) (166 pp, 468 K)

U.S. EPA 2009. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment) Final. OSWER 9285.7-82. January 2009. Document (PDF) (68 pp, 724 K), memo (PDF) (3 pp, 487 K) and website.

U.S. EPA 2011. Exposure Factors Handbook 2011 Edition (Final). National Center for Environmental Assessment, Office of Research and Development. Washington D.C. Currently available online at the EFH webpage or download here (PDF) (1436 pp, 21.3 MB).

U.S. EPA 2012. OSWER Directive 9200.1-113: Compilation and Review of Data on Relative Bioavailability of Arsenic in Soil . Washington, DC.

U.S. EPA 2014. OSWER Directive 9200.1-120 (PDF) (7 pp, 1.1 MB). Washington, DC.

U.S. EPA 2019. Exposure Factors Handbook Chapter 3 Updates Office of Research and Development,, Washington, DC.

TOXICOLOGICAL PROFILE FOR ARSENIC

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry

August 2007

REC 5446

DISCLAIMER

The use of company or product name(s) is for identification only and does not imply endorsement by the Agency for Toxic Substances and Disease Registry.

UPDATE STATEMENT

A Toxicological Profile for Arsenic, Draft for Public Comment was released in September 2005. This edition supersedes any previously released draft or final profile.

Toxicological profiles are revised and republished as necessary. For information regarding the update status of previously released profiles, contact ATSDR at:

Agency for Toxic Substances and Disease Registry
Division of Toxicology and Environmental Medicine/Applied Toxicology Branch
1600 Clifton Road NE
Mailstop F-32
Atlanta, Georgia 30333

This page is intentionally blank.

FOREWORD

This toxicological profile is prepared in accordance with guidelines developed by the Agency for Toxic Substances and Disease Registry (ATSDR) and the Environmental Protection Agency (EPA). The original guidelines were published in the *Federal Register* on April 17, 1987. Each profile will be revised and republished as necessary.

The ATSDR toxicological profile succinctly characterizes the toxicologic and adverse health effects information for the hazardous substance described therein. Each peer-reviewed profile identifies and reviews the key literature that describes a hazardous substance's toxicologic properties. Other pertinent literature is also presented, but is described in less detail than the key studies. The profile is not intended to be an exhaustive document; however, more comprehensive sources of specialty information are referenced.

The focus of the profiles is on health and toxicologic information; therefore, each toxicological profile begins with a public health statement that describes, in nontechnical language, a substance's relevant toxicological properties. Following the public health statement is information concerning levels of significant human exposure and, where known, significant health effects. The adequacy of information to determine a substance's health effects is described in a health effects summary. Data needs that are of significance to protection of public health are identified by ATSDR and EPA.

Each profile includes the following:

(A) The examination, summary, and interpretation of available toxicologic information and epidemiologic evaluations on a hazardous substance to ascertain the levels of significant human exposure for the substance and the associated acute, subacute, and chronic health effects;

(B) A determination of whether adequate information on the health effects of each substance is available or in the process of development to determine levels of exposure that present a significant risk to human health of acute, subacute, and chronic health effects; and

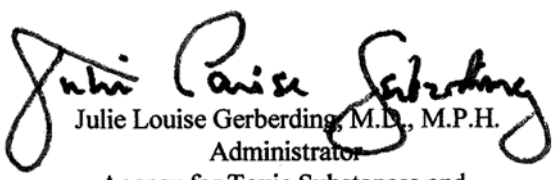
(C) Where appropriate, identification of toxicologic testing needed to identify the types or levels of exposure that may present significant risk of adverse health effects in humans.

The principal audiences for the toxicological profiles are health professionals at the Federal, State, and local levels; interested private sector organizations and groups; and members of the public.

This profile reflects ATSDR's assessment of all relevant toxicologic testing and information that has been peer-reviewed. Staff of the Centers for Disease Control and Prevention and other Federal scientists have also reviewed the profile. In addition, this profile has been peer-reviewed by a nongovernmental panel and is being made available for public review. Final responsibility for the contents and views expressed in this toxicological profile resides with ATSDR.



Howard Frumkin, M.D., Dr. P.H.
Director
National Center for Environmental Health/
Agency for Toxic Substances and
Disease Registry



Julie Louise Gerberding, M.D., M.P.H.
Administrator
Agency for Toxic Substances and
Disease Registry

The toxicological profiles are developed in response to the Superfund Amendments and Reauthorization Act (SARA) of 1986 (Public Law 99-499) which amended the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA or Superfund). This public law directed ATSDR to prepare toxicological profiles for hazardous substances most commonly found at facilities on the CERCLA National Priorities List and that pose the most significant potential threat to human health, as determined by ATSDR and the EPA. The availability of the revised priority list of 275 hazardous substances was announced in the *Federal Register* on December 7, 2005 (70 FR 72840). For prior versions of the list of substances, see *Federal Register* notices dated April 17, 1987 (52 FR 12866); October 20, 1988 (53 FR 41280); October 26, 1989 (54 FR 43619); October 17, 1990 (55 FR 42067); October 17, 1991 (56 FR 52166); October 28, 1992 (57 FR 48801); February 28, 1994 (59 FR 9486); April 29, 1996 (61 FR 18744); November 17, 1997 (62 FR 61332); October 21, 1999 (64 FR 56792); October 25, 2001 (66 FR 54014); and November 7, 2003 (68 FR 63098). Section 104(i)(3) of CERCLA, as amended, directs the Administrator of ATSDR to prepare a toxicological profile for each substance on the list.

QUICK REFERENCE FOR HEALTH CARE PROVIDERS

Toxicological Profiles are a unique compilation of toxicological information on a given hazardous substance. Each profile reflects a comprehensive and extensive evaluation, summary, and interpretation of available toxicologic and epidemiologic information on a substance. Health care providers treating patients potentially exposed to hazardous substances will find the following information helpful for fast answers to often-asked questions.

Primary Chapters/Sections of Interest

Chapter 1: Public Health Statement: The Public Health Statement can be a useful tool for educating patients about possible exposure to a hazardous substance. It explains a substance's relevant toxicologic properties in a nontechnical, question-and-answer format, and it includes a review of the general health effects observed following exposure.

Chapter 2: Relevance to Public Health: The Relevance to Public Health Section evaluates, interprets, and assesses the significance of toxicity data to human health.

Chapter 3: Health Effects: Specific health effects of a given hazardous compound are reported by type of health effect (death, systemic, immunologic, reproductive), by route of exposure, and by length of exposure (acute, intermediate, and chronic). In addition, both human and animal studies are reported in this section.
NOTE: Not all health effects reported in this section are necessarily observed in the clinical setting. Please refer to the Public Health Statement to identify general health effects observed following exposure.

Pediatrics: Four new sections have been added to each Toxicological Profile to address child health issues:

Section 1.6	**How Can (Chemical X) Affect Children?**
Section 1.7	**How Can Families Reduce the Risk of Exposure to (Chemical X)?**
Section 3.7	**Children's Susceptibility**
Section 6.6	**Exposures of Children**

Other Sections of Interest:

Section 3.8	**Biomarkers of Exposure and Effect**
Section 3.11	**Methods for Reducing Toxic Effects**

ATSDR Information Center

Phone: 1-800-CDC-INFO (800-232-4636) or 1-888-232-6348 (TTY) ***Fax:*** (770) 488-4178
E-mail: cdcinfo@cdc.gov ***Internet***: http://www.atsdr.cdc.gov

The following additional material can be ordered through the ATSDR Information Center:

Case Studies in Environmental Medicine: Taking an Exposure History—The importance of taking an exposure history and how to conduct one are described, and an example of a thorough exposure history is provided. Other case studies of interest include *Reproductive and Developmental*

Hazards; Skin Lesions and Environmental Exposures; Cholinesterase-Inhibiting Pesticide Toxicity; and numerous chemical-specific case studies.

Managing Hazardous Materials Incidents is a three-volume set of recommendations for on-scene (prehospital) and hospital medical management of patients exposed during a hazardous materials incident. Volumes I and II are planning guides to assist first responders and hospital emergency department personnel in planning for incidents that involve hazardous materials. Volume III—*Medical Management Guidelines for Acute Chemical Exposures*—is a guide for health care professionals treating patients exposed to hazardous materials.

Fact Sheets (ToxFAQs) provide answers to frequently asked questions about toxic substances.

Other Agencies and Organizations

The National Center for Environmental Health (NCEH) focuses on preventing or controlling disease, injury, and disability related to the interactions between people and their environment outside the workplace. Contact: NCEH, Mailstop F-29, 4770 Buford Highway, NE, Atlanta, GA 30341-3724 • Phone: 770-488-7000 • FAX: 770-488-7015.

The National Institute for Occupational Safety and Health (NIOSH) conducts research on occupational diseases and injuries, responds to requests for assistance by investigating problems of health and safety in the workplace, recommends standards to the Occupational Safety and Health Administration (OSHA) and the Mine Safety and Health Administration (MSHA), and trains professionals in occupational safety and health. Contact: NIOSH, 200 Independence Avenue, SW, Washington, DC 20201 • Phone: 800-356-4674 or NIOSH Technical Information Branch, Robert A. Taft Laboratory, Mailstop C-19, 4676 Columbia Parkway, Cincinnati, OH 45226-1998 • Phone: 800-35-NIOSH.

The National Institute of Environmental Health Sciences (NIEHS) is the principal federal agency for biomedical research on the effects of chemical, physical, and biologic environmental agents on human health and well-being. Contact: NIEHS, PO Box 12233, 104 T.W. Alexander Drive, Research Triangle Park, NC 27709 • Phone: 919-541-3212.

Referrals

The Association of Occupational and Environmental Clinics (AOEC) has developed a network of clinics in the United States to provide expertise in occupational and environmental issues. Contact: AOEC, 1010 Vermont Avenue, NW, #513, Washington, DC 20005 • Phone: 202-347-4976 • FAX: 202-347-4950 • e-mail: AOEC@AOEC.ORG • Web Page: http://www.aoec.org/.

The American College of Occupational and Environmental Medicine (ACOEM) is an association of physicians and other health care providers specializing in the field of occupational and environmental medicine. Contact: ACOEM, 25 Northwest Point Boulevard, Suite 700, Elk Grove Village, IL 60007-1030 • Phone: 847-818-1800 • FAX: 847-818-9266.

CONTRIBUTORS

CHEMICAL MANAGER(S)/AUTHOR(S):

Selene Chou, Ph.D.
Carolyn Harper, Ph.D.
ATSDR, Division of Toxicology and Environmental Medicine, Atlanta, GA

Lisa Ingerman, Ph.D., DABT
Fernando Llados, Ph.D.
Joan Colman, Ph.D.
Lara Chappell, Ph.D.
Mark Osier, Ph.D., DABT
Marc Odin, M.S.
Gloria Sage, Ph.D.
Syracuse Research Corporation, North Syracuse, NY

THE PROFILE HAS UNDERGONE THE FOLLOWING ATSDR INTERNAL REVIEWS:

1. Health Effects Review. The Health Effects Review Committee examines the health effects chapter of each profile for consistency and accuracy in interpreting health effects and classifying end points.

2. Minimal Risk Level Review. The Minimal Risk Level Workgroup considers issues relevant to substance-specific Minimal Risk Levels (MRLs), reviews the health effects database of each profile, and makes recommendations for derivation of MRLs.

3. Data Needs Review. The Applied Toxicology Branch reviews data needs sections to assure consistency across profiles and adherence to instructions in the Guidance.

4. Green Border Review. Green Border review assures the consistency with ATSDR policy.

This page is intentionally blank.

PEER REVIEW

A peer review panel was assembled for arsenic. The panel consisted of the following members:

1. Toby Rossman, Ph.D., Professor of Environmental Medicine, New York University School of Medicine, Nelson Institute of Environmental Medicine, Tuxedo, New York;

2. Rosalind Schoof, Ph.D., DABT, Integral Consulting, Inc., Mercer Island, Washington; and

3. Allan Smith, M.D., Ph.D., Professor of Epidemiology, School of Public Health, University of California, Berkeley, California.

Draft for Public Comment:

1. Alan Hall, M.D., Toxicology Consulting and Medical Translating Services, Inc. (TCMTS, Inc.), Elk Mountain, Wyoming;

2. Gary Pascoe, Ph.D., Pascoe Environmental Consulting, Port Townsend, Washington; and

3. Toby Rossman, Ph.D., Professor of Environmental Medicine, New York University School of Medicine, Nelson Institute of Environmental Medicine, Tuxedo, New York.

These experts collectively have knowledge of arsenic's physical and chemical properties, toxicokinetics, key health end points, mechanisms of action, human and animal exposure, and quantification of risk to humans. All reviewers were selected in conformity with the conditions for peer review specified in Section 104(I)(13) of the Comprehensive Environmental Response, Compensation, and Liability Act, as amended.

Scientists from the Agency for Toxic Substances and Disease Registry (ATSDR) have reviewed the peer reviewers' comments and determined which comments will be included in the profile. A listing of the peer reviewers' comments not incorporated in the profile, with a brief explanation of the rationale for their exclusion, exists as part of the administrative record for this compound.

The citation of the peer review panel should not be understood to imply its approval of the profile's final content. The responsibility for the content of this profile lies with the ATSDR.

This page is intentionally blank.

CONTENTS

DISCLAIMER ii
UPDATE STATEMENT iii
FOREWORD v
QUICK REFERENCE FOR HEALTH CARE PROVIDERS vii
CONTRIBUTORS ix
PEER REVIEW xi
CONTENTS xiii
LIST OF FIGURES xvii
LIST OF TABLES xix

1. PUBLIC HEALTH STATEMENT 1
1.1 WHAT IS ARSENIC? 1
1.2 WHAT HAPPENS TO ARSENIC WHEN IT ENTERS THE ENVIRONMENT? 3
1.3 HOW MIGHT I BE EXPOSED TO ARSENIC? 4
1.4 HOW CAN ARSENIC ENTER AND LEAVE MY BODY? 6
1.5 HOW CAN ARSENIC AFFECT MY HEALTH? 6
1.6 HOW CAN ARSENIC AFFECT CHILDREN? 8
1.7 HOW CAN FAMILIES REDUCE THE RISK OF EXPOSURE TO ARSENIC? 10
1.8 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO ARSENIC? 12
1.9 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH? 13
1.10 WHERE CAN I GET MORE INFORMATION? 14

2. RELEVANCE TO PUBLIC HEALTH 15
2.1 BACKGROUND AND ENVIRONMENTAL EXPOSURES TO ARSENIC IN THE UNITED STATES 15
2.2 SUMMARY OF HEALTH EFFECTS 16
2.3 MINIMAL RISK LEVELS (MRLs) 28

3. HEALTH EFFECTS 41
3.1 INTRODUCTION 41
3.2 DISCUSSION OF HEALTH EFFECTS BY ROUTE OF EXPOSURE 41
3.2.1 Inhalation Exposure 44
3.2.1.1 Death 56
3.2.1.2 Systemic Effects 56
3.2.1.3 Immunological and Lymphoreticular Effects 64
3.2.1.4 Neurological Effects 64
3.2.1.5 Reproductive Effects 66
3.2.1.6 Developmental Effects 67
3.2.1.7 Cancer 68
3.2.2 Oral Exposure 73
3.2.2.1 Death 74
3.2.2.2 Systemic Effects 162
3.2.2.3 Immunological and Lymphoreticular Effects 179
3.2.2.4 Neurological Effects 180
3.2.2.5 Reproductive Effects 183

3.2.2.6 Developmental Effects 185
3.2.2.7 Cancer 188
3.2.3 Dermal Exposure 194
3.2.3.1 Death 194
3.2.3.2 Systemic Effects 196
3.2.3.3 Immunological and Lymphoreticular Effects 198
3.2.3.4 Neurological Effects 198
3.2.3.5 Reproductive Effects 198
3.2.3.6 Developmental Effects 198
3.2.3.7 Cancer 198
3.3 GENOTOXICITY 199
3.4 TOXICOKINETICS 211
3.4.1 Absorption 211
3.4.1.1 Inhalation Exposure 211
3.4.1.2 Oral Exposure 212
3.4.1.3 Dermal Exposure 215
3.4.2 Distribution 216
3.4.2.1 Inhalation Exposure 216
3.4.2.2 Oral Exposure 216
3.4.2.3 Dermal Exposure 218
3.4.2.4 Other Routes of Exposure 218
3.4.3 Metabolism 219
3.4.4 Elimination and Excretion 225
3.4.4.1 Inhalation Exposure 225
3.4.4.2 Oral Exposure 226
3.4.4.3 Dermal Exposure 227
3.4.4.4 Other Routes of Exposure 228
3.4.5 Physiologically Based Pharmacokinetic (PBPK)/Pharmacodynamic (PD) Models 228
3.4.5.1 Summary of PBPK Models 231
3.4.5.2 Arsenic PBPK Model Comparison 231
3.4.5.3 Discussion of Models 231
3.5 MECHANISMS OF ACTION 247
3.5.1 Pharmacokinetic Mechanisms 247
3.5.2 Mechanisms of Toxicity 248
3.5.3 Animal-to-Human Extrapolations 251
3.6 TOXICITIES MEDIATED THROUGH THE NEUROENDOCRINE AXIS 252
3.7 CHILDREN'S SUSCEPTIBILITY 253
3.8 BIOMARKERS OF EXPOSURE AND EFFECT 257
3.8.1 Biomarkers Used to Identify or Quantify Exposure to Arsenic 258
3.8.2 Biomarkers Used to Characterize Effects Caused by Arsenic 261
3.9 INTERACTIONS WITH OTHER CHEMICALS 262
3.10 POPULATIONS THAT ARE UNUSUALLY SUSCEPTIBLE 264
3.11 METHODS FOR REDUCING TOXIC EFFECTS 266
3.11.1 Reducing Peak Absorption Following Exposure 267
3.11.2 Reducing Body Burden 268
3.11.3 Interfering with the Mechanism of Action for Toxic Effects 269
3.12 ADEQUACY OF THE DATABASE 269
3.12.1 Existing Information on Health Effects of Arsenic 270
3.12.2 Identification of Data Needs 273
3.12.3 Ongoing Studies 286

4. CHEMICAL AND PHYSICAL INFORMATION 291
4.1 CHEMICAL IDENTITY 291
4.2 PHYSICAL AND CHEMICAL PROPERTIES 291

5. PRODUCTION, IMPORT/EXPORT, USE, AND DISPOSAL 303
5.1 PRODUCTION 303
5.2 IMPORT/EXPORT 309
5.3 USE 309
5.4 DISPOSAL 312

6. POTENTIAL FOR HUMAN EXPOSURE 313
6.1 OVERVIEW 313
6.2 RELEASES TO THE ENVIRONMENT 316
6.2.1 Air 316
6.2.2 Water 322
6.2.3 Soil 323
6.3 ENVIRONMENTAL FATE 324
6.3.1 Transport and Partitioning 324
6.3.2 Transformation and Degradation 331
6.3.2.1 Air 331
6.3.2.2 Water 331
6.3.2.3 Sediment and Soil 333
6.3.2.4 Other Media 335
6.4 LEVELS MONITORED OR ESTIMATED IN THE ENVIRONMENT 336
6.4.1 Air 336
6.4.2 Water 337
6.4.3 Sediment and Soil 344
6.4.4 Other Environmental Media 348
6.5 GENERAL POPULATION AND OCCUPATIONAL EXPOSURE 356
6.6 EXPOSURES OF CHILDREN 367
6.7 POPULATIONS WITH POTENTIALLY HIGH EXPOSURES 374
6.8 ADEQUACY OF THE DATABASE 375
6.8.1 Identification of Data Needs 376
6.8.2 Ongoing Studies 379

7. ANALYTICAL METHODS 383
7.1 BIOLOGICAL MATERIALS 383
7.2 ENVIRONMENTAL SAMPLES 387
7.3 ADEQUACY OF THE DATABASE 388
7.3.1 Identification of Data Needs 392
7.3.2 Ongoing Studies 393

8. REGULATIONS AND ADVISORIES 395

9. REFERENCES 401

10. GLOSSARY 493

APPENDICES

A. ATSDR MINIMAL RISK LEVELS AND WORKSHEETS A-1

B. USER'S GUIDE B-1

C. ACRONYMS, ABBREVIATIONS, AND SYMBOLS C-1

D. INDEX D-1

LIST OF FIGURES

3-1. Levels of Significant Exposure to Inorganic Arsenic – Inhalation 49

3-2. Levels of Significant Exposure to Dimethylarsinic Acid – Inhalation 54

3-3. Levels of Significant Exposure to Inorganic Arsenic – Oral 117

3-4. Levels of Significant Exposure to Monomethylarsonic Acid – Oral 133

3-5. Levels of Significant Exposure to Dimethylarsinic Acid – Oral 149

3-6. Levels of Significant Exposure to Roxarsone – Oral 159

3-7. Inorganic Arsenic Biotransformation Pathway 220

3-8. Alternative Inorganic Arsenic Biotransformation Pathway 223

3-9. Conceptual Representation of a Physiologically Based Pharmacokinetic (PBPK) Model for a Hypothetical Chemical Substance 230

3-10. Parameters Used in the Mann PBPK Model for Animals 233

3-11. Parameters Used in the Mann PBPK Model for Humans 238

3-12. Parameters Used in the Yu PBPK Model for Animals 244

3-13. Existing Information on Health Effects of Inorganic Arsenic 271

3-14. Existing Information on Health Effects of Organic Arsenic 272

6-1. Frequency of NPL Sites with Arsenic Contamination 314

6-2. Counties in Which at Least 25% of Wells Exceed Different Arsenic Levels 339

This page is intentionally blank.

LIST OF TABLES

3-1. Levels of Significant Exposure to Inorganic Arsenic – Inhalation 45

3-2. Levels of Significant Exposure to Dimethylarsinic Acid – Inhalation 52

3-3. Levels of Significant Exposure to Inorganic Arsenic – Oral 75

3-4. Levels of Significant Exposure to Monomethylarsonic Acid – Oral 125

3-5. Levels of Significant Exposure to Dimethylarsinic Acid – Oral 137

3-6. Levels of Significant Exposure to Roxarsone – Oral 152

3-7. Levels of Significant Exposure to Inorganic Arsenic – Dermal 195

3-8. Genotoxicity of Inorganic Arsenic *In Vitro* 200

3-9. Genotoxicity of Inorganic Arsenic *In Vivo* 206

3-10. Genotoxicity of Organic Arsenic 209

3-11. Parameters Used in the Mann PBPK Model for Animals 234

3-12. Tissue Affinity Constants (K_{ij}) Obtained for the Mann PBPK Model for Animals by Fitting for Rabbits and Hamsters 235

3-13. Metabolic Rate Constants for the Mann PBPK Model for Animals Obtained by Fitting for Rabbits and Hamsters 236

3-14. Fitted Gastrointestinal Tract and Lung Absorption Half-time for the Hamster for the Mann PBPK Model 237

3-15. Physiological Data Used in the Mann PBPK Model for Humans 239

3-16. Tissue Affinity Constants (K_{ij}) Obtained by Fitting the Mann PBPK Animal Model for Use with Humans 240

3-17. Parameters Used in the Yu PBPK Model 245

3-18. Ongoing Studies on Health Effects of Arsenic, Federally Funded 287

4-1. Chemical Identity of Arsenic and Selected Inorganic Arsenic Compounds 292

4-2. Chemical Identity of Selected Organic Arsenic Compounds 294

4-3. Physical and Chemical Properties of Arsenic and Selected Inorganic Arsenic Compounds 297

4-4. Physical and Chemical Properties of Selected Organic Arsenic Compounds 299

5-1. Facilities that Produce, Process, or Use Arsenic 304

5-2. Facilities that Produce, Process, or Use Arsenic Compounds 306

5-3. Current U.S. Manufacturers of Selected Arsenic Compounds 308

6-1. Releases to the Environment from Facilities that Produce, Process, or Use Arsenic 317

6-2. Releases to the Environment from Facilities that Produce, Process, or Use Arsenic Compounds 319

6-3. Regional Occurrence of Arsenic in U.S. Water Sources and Finished Drinking Water 342

6-4. Levels of Arsenic in Fish and Shellfish—Recent Studies 349

6-5. Mean Daily Dietary Intake of Arsenic for Selected U.S. Population Groups 357

6-6. Levels of Arsenic in Human Tissue and Urine—Recent Studies 361

6-7. Ongoing Studies on the Environmental Fate and Exposure of Humans to Arsenic 380

7-1. Analytical Methods for Determining Arsenic in Biological Samples 385

7-2. Analytical Methods for Determining Arsenic in Environmental Samples 389

7-3. Ongoing Studies on Analytical Methods for Arsenic in Environmental and Biological Samples 394

8-1. Regulations and Guidelines Applicable to Arsenic and Arsenic Compounds 396

1. PUBLIC HEALTH STATEMENT

This public health statement tells you about arsenic and the effects of exposure to it.

The Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites in the nation. These sites are then placed on the National Priorities List (NPL) and are targeted for long-term federal clean-up activities. Arsenic has been found in at least 1,149 of the 1,684 current or former NPL sites. Although the total number of NPL sites evaluated for this substance is not known, the possibility exists that the number of sites at which arsenic is found may increase in the future as more sites are evaluated. This information is important because these sites may be sources of exposure and exposure to this substance may harm you.

When a substance is released either from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. Such a release does not always lead to exposure. You can be exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking the substance, or by skin contact.

If you are exposed to arsenic, many factors will determine whether you will be harmed. These factors include the dose (how much), the duration (how long), and how you come in contact with it. You must also consider any other chemicals you are exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

1.1 WHAT IS ARSENIC?

Arsenic is a naturally occurring element that is widely distributed in the Earth's crust. Arsenic is classified chemically as a metalloid, having both properties of a metal and a nonmetal; however, it is frequently referred to as a metal. Elemental arsenic (sometimes referred to as metallic arsenic) is a steel grey solid material. However, arsenic is usually found in the environment combined with other elements such as oxygen, chlorine, and sulfur. Arsenic combined with

these elements is called inorganic arsenic. Arsenic combined with carbon and hydrogen is referred to as organic arsenic.

Most inorganic and organic arsenic compounds are white or colorless powders that do not evaporate. They have no smell, and most have no special taste. Thus, you usually cannot tell if arsenic is present in your food, water, or air.

Inorganic arsenic occurs naturally in soil and in many kinds of rock, especially in minerals and ores that contain copper or lead. When these ores are heated in smelters, most of the arsenic goes up the stack and enters the air as a fine dust. Smelters may collect this dust and take out the arsenic as a compound called arsenic trioxide (As_2O_3). However, arsenic is no longer produced in the United States; all of the arsenic used in the United States is imported.

Presently, about 90% of all arsenic produced is used as a preservative for wood to make it resistant to rotting and decay. The preservative is copper chromated arsenate (CCA) and the treated wood is referred to as "pressure-treated." In 2003, U.S. manufacturers of wood preservatives containing arsenic began a voluntary transition from CCA to other wood preservatives that do not contain arsenic in wood products for certain residential uses, such as play structures, picnic tables, decks, fencing, and boardwalks. This phase out was completed on December 31, 2003; however, wood treated prior to this date could still be used and existing structures made with CCA-treated wood would not be affected. CCA-treated wood products continue to be used in industrial applications. It is not known whether, or to what extent, CCA-treated wood products may contribute to exposure of people to arsenic.

In the past, inorganic arsenic compounds were predominantly used as pesticides, primarily on cotton fields and in orchards. Inorganic arsenic compounds can no longer be used in agriculture. However, organic arsenic compounds, namely cacodylic acid, disodium methylarsenate (DSMA), and monosodium methylarsenate (MSMA), are still used as pesticides, principally on cotton. Some organic arsenic compounds are used as additives in animal feed. Small quantities of elemental arsenic are added to other metals to form metal mixtures or alloys with improved

properties. The greatest use of arsenic in alloys is in lead-acid batteries for automobiles. Another important use of arsenic compounds is in semiconductors and light-emitting diodes.

To learn more about the properties and uses of arsenic, see Chapters 4 and 5.

1.2 WHAT HAPPENS TO ARSENIC WHEN IT ENTERS THE ENVIRONMENT?

Arsenic occurs naturally in soil and minerals and it therefore may enter the air, water, and land from wind-blown dust and may get into water from runoff and leaching. Volcanic eruptions are another source of arsenic. Arsenic is associated with ores containing metals, such as copper and lead. Arsenic may enter the environment during the mining and smelting of these ores. Small amounts of arsenic also may be released into the atmosphere from coal-fired power plants and incinerators because coal and waste products often contain some arsenic.

Arsenic cannot be destroyed in the environment. It can only change its form, or become attached to or separated from particles. It may change its form by reacting with oxygen or other molecules present in air, water, or soil, or by the action of bacteria that live in soil or sediment. Arsenic released from power plants and other combustion processes is usually attached to very small particles. Arsenic contained in wind-borne soil is generally found in larger particles. These particles settle to the ground or are washed out of the air by rain. Arsenic that is attached to very small particles may stay in the air for many days and travel long distances. Many common arsenic compounds can dissolve in water. Thus, arsenic can get into lakes, rivers, or underground water by dissolving in rain or snow or through the discharge of industrial wastes. Some of the arsenic will stick to particles in the water or sediment on the bottom of lakes or rivers, and some will be carried along by the water. Ultimately, most arsenic ends up in the soil or sediment. Although some fish and shellfish take in arsenic, which may build up in tissues, most of this arsenic is in an organic form called arsenobetaine (commonly called "fish arsenic") that is much less harmful.

For more information on how arsenic behaves in the environment, see Chapter 6.

1.3 HOW MIGHT I BE EXPOSED TO ARSENIC?

Since arsenic is found naturally in the environment, you will be exposed to some arsenic by eating food, drinking water, or breathing air. Children may also be exposed to arsenic by eating soil. Analytical methods used by scientists to determine the levels of arsenic in the environment generally do not determine the specific form of arsenic present. Therefore, we do not always know the form of arsenic a person may be exposed to. Similarly, we often do not know what forms of arsenic are present at hazardous waste sites. Some forms of arsenic may be so tightly attached to particles or embedded in minerals that they are not taken up by plants and animals.

The concentration of arsenic in soil varies widely, generally ranging from about 1 to 40 parts of arsenic to a million parts of soil (ppm) with an average level of 3–4 ppm. However, soils in the vicinity of arsenic-rich geological deposits, some mining and smelting sites, or agricultural areas where arsenic pesticides had been applied in the past may contain much higher levels of arsenic. The concentration of arsenic in natural surface and groundwater is generally about 1 part in a billion parts of water (1 ppb), but may exceed 1,000 ppb in contaminated areas or where arsenic levels in soil are high. Groundwater is far more likely to contain high levels of arsenic than surface water. Surveys of U.S. drinking water indicate that about 80% of water supplies have less than 2 ppb of arsenic, but 2% of supplies exceed 20 ppb of arsenic. Levels of arsenic in food range from about 20 to 140 ppb. However, levels of inorganic arsenic, the form of most concern, are far lower. Levels of arsenic in the air generally range from less than 1 to about 2,000 nanograms (1 nanogram equals a billionth of a gram) of arsenic per cubic meter of air (less than 1–2,000 ng/m^3), depending on location, weather conditions, and the level of industrial activity in the area. However, urban areas generally have mean arsenic levels in air ranging from 20 to 30 ng/m^3.

You normally take in small amounts of arsenic in the air you breathe, the water you drink, and the food you eat. Of these, food is usually the largest source of arsenic. The predominant dietary source of arsenic is seafood, followed by rice/rice cereal, mushrooms, and poultry. While seafood contains the greatest amounts of arsenic, for fish and shellfish, this is mostly in an organic form of arsenic called arsenobetaine that is much less harmful. Some seaweeds may

contain arsenic in inorganic forms that may be more harmful. Children are likely to eat small amounts of dust or soil each day, so this is another way they may be exposed to arsenic. The total amount of arsenic you take in from these sources is generally about 50 micrograms (1 microgram equals one-millionth of a gram) each day. The level of inorganic arsenic (the form of most concern) you take in from these sources is generally about 3.5 microgram/day. Children may be exposed to small amounts of arsenic from hand-to-mouth activities from playing on play structures or decks constructed out of CCA-treated wood. The potential exposure that children may receive from playing in play structures constructed from CCA-treated wood is generally smaller than that they would receive from food and water. Hand washing can reduce the potential exposure of children to arsenic after playing on play structures constructed with CCA-treated wood, since most of the arsenic on the children's hands was removed with water.

In addition to the normal levels of arsenic in air, water, soil, and food, you could be exposed to higher levels in several ways, such as the following:

- Some areas of the United States contain unusually high natural levels of arsenic in rock, and this can lead to unusually high levels of arsenic in soil or water. If you live in an area like this, you could take in elevated amounts of arsenic in drinking water. Children may be taking in higher amounts of arsenic because of hand-to-mouth contact or eating soil in areas with higher than usual arsenic concentrations.

- Some hazardous waste sites contain large quantities of arsenic. If the material is not properly disposed of, it can get into surrounding water, air, or soil. If you live near such a site, you could be exposed to elevated levels of arsenic from these media.

- If you work in an occupation that involves arsenic production or use (for example, copper or lead smelting, wood treating, or pesticide application), you could be exposed to elevated levels of arsenic during your work.

- If you saw or sand arsenic-treated wood, you could inhale some of the sawdust into your nose or throat. Similarly, if you burn arsenic-treated wood, you could inhale arsenic in the smoke.

- If you live in a former agricultural area where arsenic was used on crops, the soil could contain high levels of arsenic.

- In the past, several kinds of products used in the home (rat poison, ant poison, weed killer, some types of medicines) had arsenic in them. However, most of these uses of arsenic have ended, so you are not likely to be exposed from home products any longer.

You can find more information on how you may be exposed to arsenic in Chapter 6.

1.4 HOW CAN ARSENIC ENTER AND LEAVE MY BODY?

If you swallow arsenic in water, soil, or food, most of the arsenic may quickly enter into your body. The amount that enters your body will depend on how much you swallow and the kind of arsenic that you swallow. This is the most likely way for you to be exposed near a waste site. If you breathe air that contains arsenic dusts, many of the dust particles settle onto the lining of the lungs. Most of the arsenic in these particles is then taken up from the lungs into the body. You might be exposed in this way near waste sites where arsenic-contaminated soils are allowed to blow into the air, or if you work with arsenic-containing soil or products. If you get arsenic-contaminated soil or water on your skin, only a small amount will go through your skin into your body, so this is usually not of concern.

Both inorganic and organic forms leave your body in your urine. Most of the inorganic arsenic will be gone within several days, although some will remain in your body for several months or even longer. If you are exposed to organic arsenic, most of it will leave your body within several days.

You can find more information on how arsenic enters and leaves your body in Chapter 3.

1.5 HOW CAN ARSENIC AFFECT MY HEALTH?

Scientists use many tests to protect the public from harmful effects of toxic chemicals and to find ways for treating persons who have been harmed.

One way to learn whether a chemical will harm people is to determine how the body absorbs, uses, and releases the chemical. For some chemicals, animal testing may be necessary. Animal testing may also help identify health effects such as cancer or birth defects. Without laboratory animals, scientists would lose a basic method for getting information needed to make wise decisions that protect public health. Scientists have the responsibility to treat research animals with care and compassion. Scientists must comply with strict animal care guidelines because laws today protect the welfare of research animals.

Inorganic arsenic has been recognized as a human poison since ancient times, and large oral doses (above 60,000 ppb in water which is 10,000 times higher than 80% of U.S. drinking water arsenic levels) can result in death. If you swallow lower levels of inorganic arsenic (ranging from about 300 to 30,000 ppb in water; 100–10,000 times higher than most U.S. drinking water levels), you may experience irritation of your stomach and intestines, with symptoms such as stomachache, nausea, vomiting, and diarrhea. Other effects you might experience from swallowing inorganic arsenic include decreased production of red and white blood cells, which may cause fatigue, abnormal heart rhythm, blood-vessel damage resulting in bruising, and impaired nerve function causing a "pins and needles" sensation in your hands and feet.

Perhaps the single-most characteristic effect of long-term oral exposure to inorganic arsenic is a pattern of skin changes. These include patches of darkened skin and the appearance of small "corns" or "warts" on the palms, soles, and torso, and are often associated with changes in the blood vessels of the skin. Skin cancer may also develop. Swallowing arsenic has also been reported to increase the risk of cancer in the liver, bladder, and lungs. The Department of Health and Human Services (DHHS) has determined that inorganic arsenic is known to be a human carcinogen (a chemical that causes cancer). The International Agency for Research on Cancer (IARC) has determined that inorganic arsenic is carcinogenic to humans. EPA also has classified inorganic arsenic as a known human carcinogen.

If you breathe high levels of inorganic arsenic, then you are likely to experience a sore throat and irritated lungs. You may also develop some of the skin effects mentioned above. The exposure level that produces these effects is uncertain, but it is probably above 100 micrograms of arsenic

per cubic meter ($\mu g/m^3$) for a brief exposure. Longer exposure at lower concentrations can lead to skin effects, and also to circulatory and peripheral nervous disorders. There are some data suggesting that inhalation of inorganic arsenic may also interfere with normal fetal development, although this is not certain. An important concern is the ability of inhaled inorganic arsenic to increase the risk of lung cancer. This has been seen mostly in workers exposed to arsenic at smelters, mines, and chemical factories, but also in residents living near smelters and arsenical chemical factories. People who live near waste sites with arsenic may have an increased risk of lung cancer as well.

If you have direct skin contact with high concentrations of inorganic arsenic compounds, your skin may become irritated, with some redness and swelling. However, it does not appear that skin contact is likely to lead to any serious internal effects.

Almost no information is available on the effects of organic arsenic compounds in humans. Studies in animals show that most simple organic arsenic compounds (such as methyl and dimethyl compounds) are less toxic than the inorganic forms. In animals, ingestion of methyl compounds can result in diarrhea, and lifetime exposure can damage the kidneys. Lifetime exposure to dimethyl compounds can damage the urinary bladder and the kidneys.

You can find more information on the health effects of inorganic and organic arsenic in Chapters 2 and 3.

1.6 HOW CAN ARSENIC AFFECT CHILDREN?

This section discusses potential health effects in humans from exposures during the period from conception to maturity at 18 years of age.

Children are exposed to arsenic in many of the same ways that adults are. Since arsenic is found in the soil, water, food, and air, children may take in arsenic in the air they breathe, the water they drink, and the food they eat. Since children tend to eat or drink less of a variety of foods and beverages than do adults, ingestion of contaminated food or juice or infant formula made

with arsenic-contaminated water may represent a significant source of exposure. In addition, since children often play in the soil and put their hands in their mouths and sometimes intentionally eat soil, ingestion of contaminated soil may be a more important source of arsenic exposure for children than for adults. In areas of the United States where natural levels of arsenic in the soil and water are high, or in areas in and around contaminated waste sites, exposure of children to arsenic through ingestion of soil and water may be significant. In addition, contact with adults who are wearing clothes contaminated with arsenic (e.g., with dust from copper- or lead-smelting factories, from wood-treating or pesticide application, or from arsenic-treated wood) could be a source of exposure. Because of the tendency of children to taste things that they find, accidental poisoning from ingestion of pesticides is also a possibility. Thus, although most of the exposure pathways for children are the same as those for adults, children may be at a higher risk of exposure because of normal hand-to-mouth activity.

Children who are exposed to inorganic arsenic may have many of the same effects as adults, including irritation of the stomach and intestines, blood vessel damage, skin changes, and reduced nerve function. Thus, all health effects observed in adults are of potential concern in children. There is also some evidence that suggests that long-term exposure to inorganic arsenic in children may result in lower IQ scores. We do not know if absorption of inorganic arsenic from the gut in children differs from adults. There is some evidence that exposure to arsenic in early life (including gestation and early childhood) may increase mortality in young adults.

There is some evidence that inhaled or ingested inorganic arsenic can injure pregnant women or their unborn babies, although the studies are not definitive. Studies in animals show that large doses of inorganic arsenic that cause illness in pregnant females can also cause low birth weight, fetal malformations, and even fetal death. Arsenic can cross the placenta and has been found in fetal tissues. Arsenic is found at low levels in breast milk.

In animals, exposure to organic arsenic compounds can cause low birth weight, fetal malformations, and fetal deaths. The dose levels that cause these effects also result in effects in the mothers.

You can find more information about how arsenic can affect children in Sections 3.7 and 6.6.

1.7 HOW CAN FAMILIES REDUCE THE RISK OF EXPOSURE TO ARSENIC?

If your doctor finds that you have been exposed to substantial amounts of arsenic, ask whether your children might also have been exposed. Your doctor might need to ask your state health department to investigate.

Many communities may have high levels of arsenic in their drinking water, particularly from private wells, because of contamination or as a result of the geology of the area. The north central region and the western region of the United States have the highest arsenic levels in surface water and groundwater sources, respectively. Wells used to provide water for drinking and cooking should be tested for arsenic. As of January 2006, EPA's Maximum Contaminant Level (MCL) for arsenic in drinking water is 10 ppb. If you have arsenic in your drinking water at levels higher that the EPA's MCL, an alternative source of water should be used for drinking and cooking should be considered.

If you use arsenic-treated wood in home projects, personal protection from exposure to arsenic-containing sawdust may be helpful in limiting exposure of family members. These measures may include dust masks, gloves, and protective clothing. Arsenic-treated wood should never be burned in open fires, or in stoves, residential boilers, or fire places, and should not be composted or used as mulch. EPA's Consumer Awareness Program (CAP) for CCA is a voluntary program established by the manufacturers of CCA products to inform consumers about the proper handling, use, and disposal of CCA-treated wood. You can find more information about this program in Section 6.5. Hand washing can reduce the potential exposure of children to arsenic after playing on play structures constructed with CCA-treated wood, since most of the arsenic on the children's hands was removed with water.

If you live in an area with a high level of arsenic in the water or soil, substituting cleaner sources of water and limiting contact with soil (for example, through use of a dense groundcover or thick lawn) would reduce family exposure to arsenic. By paying careful attention to dust and soil

control in the home (air filters, frequent cleaning), you can reduce family exposure to contaminated soil. Some children eat a lot of soil. You should prevent your children from eating soil. You should discourage your children from putting objects in their mouths. Make sure they wash their hands frequently and before eating. Discourage your children from putting their hands in their mouths or engaging in other hand-to-mouth activities. Since arsenic may be found in the home as a pesticide, household chemicals containing arsenic should be stored out of reach of young children to prevent accidental poisonings. Always store household chemicals in their original labeled containers; never store household chemicals in containers that children would find attractive to eat or drink from, such as old soda bottles. Keep your Poison Control Center's number by the phone.

It is sometimes possible to carry arsenic from work on your clothing, skin, hair, tools, or other objects removed from the workplace. This is particularly likely if you work in the fertilizer, pesticide, glass, or copper/lead smelting industries. You may contaminate your car, home, or other locations outside work where children might be exposed to arsenic. You should know about this possibility if you work with arsenic.

Your occupational health and safety officer at work can and should tell you whether chemicals you work with are dangerous and likely to be carried home on your clothes, body, or tools and whether you should be showering and changing clothes before you leave work, storing your street clothes in a separate area of the workplace, or laundering your work clothes at home separately from other clothes. Material safety data sheets (MSDS) for many chemicals used should be found at your place of work, as required by the Occupational Safety and Health Administration (OSHA) in the U.S. Department of Labor. MSDS information should include chemical names and hazardous ingredients, and important properties, such as fire and explosion data, potential health effects, how you get the chemical(s) in your body, how to properly handle the materials, and what to do in the case of emergencies. Your employer is legally responsible for providing a safe workplace and should freely answer your questions about hazardous chemicals. Your state OSHA-approved occupational safety and health program or OSHA can answer any further questions and help your employer identify and correct problems with hazardous substances. Your state OSHA-approved occupational safety and health program or

OSHA will listen to your formal complaints about workplace health hazards and inspect your workplace when necessary. Employees have a right to seek safety and health on the job without fear of punishment.

You can find more information about how arsenic can affect children in Sections 3.7 and 6.6.

1.8 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO ARSENIC?

Several sensitive and specific tests can measure arsenic in your blood, urine, hair, or fingernails, and these tests are often helpful in determining if you have been exposed to above-average levels of arsenic in the past. These tests are not usually performed in a doctor's office. They require sending the sample to a testing laboratory.

Measurement of arsenic in your urine is the most reliable means of detecting arsenic exposures that you experienced within the last several days. Most tests measure the total amount of arsenic present in your urine. This can sometimes be misleading, because the nonharmful forms of arsenic in fish and shellfish can give a high reading even if you have not been exposed to a toxic form of arsenic. For this reason, laboratories sometimes use a more complicated test to separate "fish arsenic" from other forms. Because most arsenic leaves your body within a few days, analysis of your urine cannot detect if you were exposed to arsenic in the past. Tests of your hair or fingernails can tell if you were exposed to high levels over the past 6–12 months, but these tests are not very useful in detecting low-level exposures. If high levels of arsenic are detected, this shows that you have been exposed, but unless more is known about when you were exposed and for how long, it is usually not possible to predict whether you will have any harmful health effects.

You can find more information on how arsenic can be measured in your hair, urine, nails, and other tissues in Chapters 3 and 7.

1.9 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The federal government develops regulations and recommendations to protect public health. Regulations *can* be enforced by law. The EPA, the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA) are some federal agencies that develop regulations for toxic substances. Recommendations provide valuable guidelines to protect public health, but *cannot* be enforced by law. The Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH) are two federal organizations that develop recommendations for toxic substances.

Regulations and recommendations can be expressed as "not-to-exceed" levels, that is, levels of a toxic substance in air, water, soil, or food that do not exceed a critical value that is usually based on levels that affect animals; they are then adjusted to levels that will help protect humans. Sometimes these not-to-exceed levels differ among federal organizations because they used different exposure times (an 8-hour workday or a 24-hour day), different animal studies, or other factors.

Recommendations and regulations are also updated periodically as more information becomes available. For the most current information, check with the federal agency or organization that provides it. Some regulations and recommendations for ARSENIC include the following:

The federal government has taken several steps to protect humans from arsenic. First, EPA has set limits on the amount of arsenic that industrial sources can release into the environment. Second, EPA has restricted or canceled many of the uses of arsenic in pesticides and is considering further restrictions. Third, in January 2001, the EPA lowered the limit for arsenic in drinking water from 50 to 10 ppb. Finally, OSHA has established a permissible exposure limit (PEL), 8-hour time-weighted average, of 10 $\mu g/m^3$ for airborne arsenic in various workplaces that use inorganic arsenic.

You can find more information on regulations and guidelines that apply to arsenic in Chapter 8.

1.10 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department, or contact ATSDR at the address and phone number below.

ATSDR can also tell you the location of occupational and environmental health clinics. These clinics specialize in recognizing, evaluating, and treating illnesses that result from exposure to hazardous substances.

Toxicological profiles are also available on-line at www.atsdr.cdc.gov and on CD-ROM. You may request a copy of the ATSDR ToxProfiles™ CD-ROM by calling the toll-free information and technical assistance number at 1-800-CDCINFO (1-800-232-4636), by e-mail at cdcinfo@cdc.gov, or by writing to:

Agency for Toxic Substances and Disease Registry
Division of Toxicology and Environmental Medicine
1600 Clifton Road NE
Mailstop F-32
Atlanta, GA 30333
Fax: 1-770-488-4178

Organizations for-profit may request copies of final Toxicological Profiles from the following:

National Technical Information Service (NTIS)
5285 Port Royal Road
Springfield, VA 22161
Phone: 1-800-553-6847 or 1-703-605-6000
Web site: http://www.ntis.gov/

2. RELEVANCE TO PUBLIC HEALTH

2.1 BACKGROUND AND ENVIRONMENTAL EXPOSURES TO ARSENIC IN THE UNITED STATES

Arsenic is widely distributed in the Earth's crust, which contains ~3.4 ppm arsenic. In nature, arsenic is mostly found in minerals and only to a small extent in its elemental form. Arsenic is mainly obtained as a byproduct of the smelting of copper, lead, cobalt, and gold ores. Arsenic trioxide is the primary form in which arsenic is marketed and consumed. There has been no domestic production of arsenic since 1985. In 2003, the world's largest producer of arsenic compounds was China, followed by Chile and Peru.

In 2003, the United States was the world's largest consumer of arsenic. Production of wood preservatives, primarily copper chromated arsenate (CCA), CrO_3•CuO•As_2O_5, accounted for >90% of domestic consumption of arsenic trioxide. In response to consumer concerns, U.S. manufacturers of arsenical wood preservative began a voluntary transition from CCA to other wood preservatives for certain residential wood products. This phase-out was completed on December 31, 2003; wood treated prior to this date could still be used and CCA-treated wood products continue to be used in industrial applications.

Other uses for arsenic compounds include the production of agricultural chemicals, as an alloying element in ammunition and solders, as an anti-friction additive to metals used for bearings, and to strengthen lead-acid storage battery grids. High-purity arsenic (99.9999%) is used by the electronics industry for gallium-arsenide semiconductors for telecommunications, solar cells, and space research. Various organic arsenicals are still used in the United States as herbicides and as antimicrobial additives for animal and poultry feed. However, the use of inorganic arsenic compounds in agriculture has virtually disappeared beginning around the 1960s. Arsenic trioxide and arsenic acid were used as a decolorizer and fining agent in the production of bottle glass and other glassware. Arsenic compounds also have a long history of use in medicine, and have shown a re-emergence of late with the recent introduction of arsenic trioxide treatment for acute promyelocytic leukemia.

The principal route of exposure to arsenic for the general population is likely to be the oral route, primarily in the food and in the drinking water. Dietary exposures to total arsenic were highly variable, with a mean of 50.6 μg/day (range of 1.01–1,081 μg/day) for females and 58.5 μg/day (range of 0.21–1,276 μg/day) for males. U.S. dietary intake of inorganic arsenic has been estimated to range from 1 to 20 μg/day, with grains and produce expected to be significant contributors to dietary inorganic arsenic

intake. Drinking water generally contains an average of 2 μg/L of arsenic, although 12% of water supplies from surface water sources in the North Central region of the country and 12% of supplies from groundwater sources in the Western region have levels exceeding 20 μg/L. Arsenic is also widely distributed in surface water, groundwater, and finished drinking water in the United States. Surveys of arsenic concentrations in rivers and lakes indicate that most values are below 10 μg/L, although individual samples may range up to 3,400 μg/L. Arsenic released to the land at hazardous waste sites is likely to be relatively immobile due to a high capacity for soil binding, particularly to iron and manganese oxides. Exposure to arsenic from other pathways is generally small, but may be significant for areas with high levels of arsenic contamination or in occupational settings. For a more complete discussion of possible exposures to arsenic, see Chapter 6 of the profile.

2.2 SUMMARY OF HEALTH EFFECTS

Arsenic is a potent toxicant that may exist in several oxidation states and in a number of inorganic and organic forms. Most cases of arsenic-induced toxicity in humans are due to exposure to inorganic arsenic, and there is an extensive database on the human health effects of the common arsenic oxides and oxyacids. Although there may be some differences in the potency of different chemical forms (e.g., arsenites tend to be somewhat more toxic than arsenates), these differences are usually minor. An exception would be arsine, which is highly toxic. However, because arsine and its methyl derivatives are gases or volatile liquids and are unlikely to be present at levels of concern at hazardous waste sites, health effect data for these compounds are not discussed in this document. Humans may be exposed to organic arsenicals (mainly methyl and phenyl derivatives of arsenic acid) that are used in agriculture and to organic arsenicals found in fish and shellfish (arsenobetaine and arsenocholine). Although the toxicity of organic arsenicals has not been as extensively investigated as inorganic arsenicals, there are sufficient animal data to evaluate the toxicity of methyl arsenates (e.g., monomethylarsonic acid [MMA] and dimethylarsinic acid [DMA]) and roxarsone. The so-called “fish arsenic” compounds (e.g., arsenobetaine) are not thought to be toxic and health effects data are not discussed in this document.

It is generally accepted that the arsenic-carbon bond is quite strong and most mammalian species do not have the capacity to break this bond; thus, inorganic arsenic is not formed during the metabolism of organic arsenicals. In most species, including humans, ingested (or exogenous) MMA(V) and DMA(V) undergo limited metabolism, do not readily enter the cell, and are primarily excreted unchanged in the urine. This is in contrast to inorganic arsenic, which undergoes sequential reduction and methylation reactions leading to the formation of MMA and DMA. Inorganic As(V) is readily reduced to inorganic

As(III), which is taken up by the cell. Within the cell (primarily in the liver), As(III) is methylated to form MMA(V), which is reduced to MMA(III); MMA(III) subsequently undergoes oxidative methylations to form DMA(V). DMA(V) is the primary excretion product in humans. Because inorganic and organic arsenicals exhibit distinct toxicokinetic characteristics, the health effects and MRLs are considered separately.

Inorganic Arsenicals. Exposures of humans near hazardous waste sites could involve inhalation of arsenic dusts in air, ingestion of arsenic in water, food, or soil, or dermal contact with contaminated soil or water. Increased risk of lung cancer, respiratory irritation, nausea, skin effects, and neurological effects have been reported following inhalation exposure. There are only a few quantitative data on noncancer effects in humans exposed to inorganic arsenic by the inhalation route. Animal data similarly identify effects on the respiratory system as the primary noncancer effect of inhaled inorganic arsenic compounds, although only a few studies are available. Only limited data on the effects of inhaled organic arsenic compounds in humans or animals are available; these studies are generally limited to high-dose, short-term exposures, which result in frank effects.

Relatively little information is available on effects due to direct dermal contact with inorganic arsenicals, but several studies indicate that the chief effect is local irritation and dermatitis, with little risk of other adverse effects.

The database for the oral toxicity of inorganic arsenic is extensive, containing a large number of studies of orally-exposed human populations. These studies have identified effects on virtually every organ or tissue evaluated, although some end points appear to be more sensitive than others. The available data from humans identify the skin as the most sensitive noncancer target following long-term oral arsenic exposure. Typical dermal effects include hyperkeratinization of the skin (especially on the palms and soles), formation of multiple hyperkeratinized corns or warts, and hyperpigmentation of the skin with interspersed spots of hypopigmentation. Oral exposure data from studies in humans indicate that these lesions typically begin to manifest at exposure levels of about 0.002–0.02 mg As/kg/day, but one study suggests that lesions may appear at even lower levels. At these exposure levels, peripheral vascular effects are also commonly noted, including cyanosis, gangrene, and, in Taiwanese populations, the condition known as “Blackfoot Disease.” Other reported cardiovascular effects of oral exposure to inorganic arsenic include increased incidences of high blood pressure and circulatory problems. The use of intravenous arsenic trioxide as therapy for acute promyelocytic leukemia has raised further concerns about the cardiovascular effects of arsenic, including alterations in cardiac QT interval and the

development of torsades de pointes. Decrements in lung function, assessed by spirometry, have been reported in subjects exposed to approximately 0.008–0.04 mg As/kg/day in the drinking water who exhibited skin lesions.

In addition to dermal, cardiovascular, and respiratory effects, oral exposure to inorganic arsenic may result in effects on other organ systems. Nausea, vomiting, and diarrhea are very common symptoms in humans following oral exposure to inorganic arsenicals, both after acute high-dose exposure and after repeated exposure to lower doses; these effects are likely due to a direct irritation of the gastrointestinal mucosa. Acute, high-dose exposure can lead to encephalopathy, with clinical signs such as confusion, hallucinations, impaired memory, and emotional lability, while long-term exposure to lower levels can lead to the development of peripheral neuropathy characterized by a numbness in the hands and feet that may progress to a painful "pins and needles" sensation. Recent studies also have reported neurobehavioral alterations in arsenic-exposed children.

Chronic exposure of humans to inorganic arsenic in the drinking water has been associated with excess incidence of miscarriages, stillbirths, preterm births, and infants with low birth weights. Animal data suggest that arsenic may cause changes to reproductive organs of both sexes, including decreased organ weight and increased inflammation of reproductive tissues, although these changes may be secondary effects. However, these changes do not result in a significant impact on reproductive ability. Animal studies of oral inorganic arsenic exposure have reported developmental effects, but generally only at concentrations that also resulted in maternal toxicity.

Arsenic is a known human carcinogen by both the inhalation and oral exposure routes. By the inhalation route, the primary tumor types are respiratory system cancers, although a few reports have noted increased incidence of tumors at other sites, including the liver, skin, and digestive tract. In humans exposed chronically by the oral route, skin tumors are the most common type of cancer. In addition to skin cancer, there are a number of case reports and epidemiological studies that indicate that ingestion of arsenic also increases the risk of internal tumors (mainly of bladder and lung, and to a lesser extent, liver, kidney, and prostate).

The Department of Health and Human Services (DHHS) has concluded that inorganic arsenic is known to be a human carcinogen. The International Agency for Research on Cancer (IARC) cites sufficient evidence of a relationship between exposure to arsenic and human cancer. The IARC classification of arsenic is Group 1. The EPA has determined that inorganic arsenic is a human carcinogen by the

inhalation and oral routes, and has assigned it the cancer classification, Group A. EPA has calculated an oral cancer slope factor of 1.5 $(mg/kg/day)^{-1}$ and a drinking water unit risk of $5x10^{-5}$ $(\mu g/L)^{-1}$ for inorganic arsenic based on human dose-response data. The inhalation unit risk for cancer is calculated to be 0.0043 $(\mu g/m^3)^{-1}$. The unit risk is the upper-bound excess lifetime cancer risk estimated to result from continuous exposure to an agent at a concentration of 1 µg/L in water or 1 $\mu g/m^3$ in air. EPA is currently revising the assessment for inorganic arsenic; a more detailed discussion of the uncertainties associated with human cancer risk levels for arsenic is presented in Section 3.2.2.7.

The following sections discuss significant effects resulting from exposure to inorganic arsenic in greater detail: dermal, cardiovascular, respiratory, gastrointestinal, neurological, and cancer. Additional information on these effects and on other effects is discussed in Section 3.2.

Dermal Effects. The most characteristic effect of long-term oral exposure to inorganic arsenic compounds is the development of skin lesions; these lesions are often used as diagnostic criteria for arsenicosis. The three lesions most often associated with chronic arsenicosis are hyperkeratinization of the skin (especially on the palms and soles), formation of multiple hyperkeratinized corns or warts, and hyperpigmentation of the skin with interspersed spots of hypopigmentation. Numerous studies of long-term, low-level exposure to inorganic arsenic in humans have reported the presence of these lesions. In general, they begin to manifest at chronic exposure levels >0.02 mg As/kg/day. Chronic oral studies of lower exposure levels, ranging from 0.0004 to 0.01 mg As/kg/day, have generally not reported dermal effects. However, in a study with detailed exposure assessment, all confirmed cases of skin lesions ingested water containing >100 µg/L arsenic (approximately 0.0037 mg As/kg/day) and the lowest known peak arsenic concentration ingested by a case was 0.115 µg/L (approximately 0.0043 mg As/kg/day). Another large study reported increased incidence of skin lesions associated with estimated doses of 0.0012 mg As/kg/day (0.023 mg As/L drinking water). The mechanism(s) by which inorganic arsenic causes dermal effects is not well-understood. Elucidating the mechanism of dermal effects has been particularly difficult because the dermal effects common in humans have not been seen in studies in animals.

Dermal effects have also been reported following inhalation exposures to inorganic arsenic, although they are not as diagnostic as for oral exposure. Several studies of arsenic-exposed workers have reported the development of dermatitis; exposure levels required to produce this condition are not well-established. Altered dermal pigmentation and hyperkeratosis have also been reported in studies of humans exposed to inorganic arsenic by inhalation, although exposure levels have varied considerably. Direct dermal contact

with inorganic arsenicals may cause irritation and contact dermatitis. Usually, the effects are mild (erythema and swelling), but may progress to papules, vesicles, or necrotic lesions in extreme cases; these conditions tend to heal without treatment if exposure ceases.

Cardiovascular Effects. A large number of studies in humans have reported cardiovascular effects following oral exposure to inorganic arsenic compounds. The cardiac effects of arsenic exposure are numerous, and include altered myocardial depolarization (prolonged QT interval, nonspecific ST segment changes), cardiac arrhythmias, and ischemic heart disease. These effects have been seen after acute and long-term exposure to inorganic arsenic in the environment, as well as side effects from intravenous therapy with arsenic trioxide for acute promyelocytic leukemia. Exposure levels for environmental exposures have not been well characterized, but intravenous doses for arsenic trioxide therapy are generally on the order of 0.15 mg As/kg/day.

Chronic exposure to inorganic arsenic has also been shown to lead to effects on the vascular system. The most dramatic of these effects is "Blackfoot Disease," a disease characterized by a progressive loss of circulation in the hands and feet, leading ultimately to necrosis and gangrene. Blackfoot Disease is endemic in an area of Taiwan where average drinking water levels of arsenic range from 0.17 to 0.80 ppm, corresponding to doses of about 0.014–0.065 mg As/kg/day. The results of a another study suggested that individuals with a lower capacity to methylate inorganic arsenic to DMA have a higher risk of developing peripheral vascular disease in the Blackfoot Disease-hyperendemic area in Taiwan. Arsenic exposure in Taiwan has also been associated with an increased incidence of cerebrovascular and microvascular diseases and ischemic heart disease. While Blackfoot Disease itself has not been reported outside of Taiwan, other vascular effects are common in areas with high arsenic exposures, and include such severe effects as increases in the incidences of Raynaud's disease and of cyanosis of fingers and toes as well as hypertension, thickening and vascular occlusion of blood vessels, and other unspecified cardiovascular conditions. However, while the majority of human studies have reported cardiovascular effects following exposure to inorganic arsenic, some have found no such effects.

Changes in cardiac rhythm and in some vascular end points have also been reported in animal studies of inorganic arsenicals, but generally only at higher exposure levels and not to the degree of severity seen in humans.

Respiratory Effects. While case reports and small cohort studies have routinely reported an increase in respiratory symptoms of humans exposed occupationally to inorganic arsenic, dose-response data for

these symptoms are generally lacking. The only study that evaluated respiratory effects (changes in chest x-ray or respiratory performance) and reported an exposure estimate did not report significant changes at an exposure level of 0.613 mg As/m^3. Exposed workers often report irritation of the mucous membranes of the nose and throat, which may lead to laryngitis, bronchitis, or rhinitis. Increased mortality due to respiratory disease has been reported in some cohort mortality studies of arsenic-exposed workers, but no conclusive evidence of an association of these diseases with arsenic exposure has been presented. It is not known whether respiratory effects following inhaled inorganic arsenic compounds are due to a direct effect of arsenic on respiratory tissues, general effects of foreign material in the lungs, or an effect of arsenic on the pulmonary vasculature. Similar responses, including rales, labored breathing, and respiratory hyperplasia, have been noted in animal studies of inhaled or instilled inorganic arsenic compounds.

Respiratory effects have also been reported following oral exposure of humans to inorganic arsenic. Acute oral exposure to ≥8 mg As/kg may result in serious respiratory effects, including respiratory distress, hemorrhagic bronchitis, and pulmonary edema; however, it is not clear whether these are primary effects or are the result of damage to the pulmonary vascular system. In general, respiratory effects have not been widely associated with long-term oral exposure to low arsenic doses. However, some studies have reported minor respiratory symptoms, such as cough, sputum, rhinorrhea, and sore throat, in people with repeated oral exposure to 0.03–0.05 mg As/kg/day. More serious respiratory effects, such as bronchitis and sequelae (bronchiectasis, bronchopneumonia) have been observed in patients chronically exposed to arsenic and at autopsy in some chronic poisoning cases. There are few animal data reporting respiratory effects of oral exposure to inorganic arsenic, and those studies generally found effects only at very high dose levels.

Gastrointestinal Effects. Both short-term and chronic oral exposures to inorganic arsenicals have been reported to result in irritant effects on gastrointestinal tissues. Numerous studies of acute, high-dose exposure to inorganic arsenicals have reported nausea, vomiting, diarrhea, and abdominal pain, although specific dose levels associated with the onset of these symptoms have not been identified. Chronic oral exposure to 0.01 mg As/kg/day generally results in similar reported symptoms. For both acute and chronic exposures, the gastrointestinal effects generally diminish or resolve with cessation of exposure. Similar gastrointestinal effects have been reported after occupational exposures to inorganic arsenicals, although it is not known if these effects were due to absorption of arsenic from the respiratory tract or from mucociliary clearance resulting in eventual oral exposure.

Neurological Effects. A common effect following both oral and inhalation exposure to inorganic is the development of peripheral neuropathy. Following occupational exposure to inorganic arsenic in pesticide plants or smelters, exposed workers have shown increased incidence of neurological changes, including altered nerve conduction velocities. One study reported that these effects were seen after 28 years of exposure to 0.31 mg As/m^3. In another study, signs and symptoms of sensory and motor polyneuropathy on both upper and lower extremities were reported in workers at a power station in Slovakia. The average length of exposure was 22.3 years (standard deviation [SD] ±8.4 years) and the average arsenic exposure in inhaled air ranged from 4.6 to 142.7 μg/m^3.

Following high-dose (>2 mg As/kg/day) acute oral exposures to inorganic arsenicals in humans, reported effects include headache, lethargy, mental confusion, hallucination, seizures, and coma. Following longer-term exposure to 0.03–0.1 mg As/kg/day, peripheral neuropathy, characterized initially by numbness of the hands and feet and a "pins and needles" sensation and progressing to muscle weakness, wrist-drop and/or ankle-drop, diminished sensitivity, and altered reflex action. Histological features of the neuropathy include a dying-back axonopathy and demyelination. Following removal from exposure, the neuropathy is only partially reversible and what recovery does occur is generally slow. Reports of neurological effects at lower arsenic levels (0.004–0.006 mg As/kg/day) have been inconsistent, with some human studies reporting fatigue, headache, depression, dizziness, insomnia, nightmare, and numbness while others reported no neurological effects. Some studies also have reported that exposure to arsenic may be associated with intellectual deficits in children. Neurological effects have also been reported in oral studies of arsenic toxicity in animals, although these were generally performed at higher doses (0.4–26.6 mg As/kg/day) than has been reported in exposed human populations. The mechanism(s) of arsenic-induced neurological changes has not been determined.

Cancer. There is clear evidence from studies in humans that exposure to inorganic arsenic by either the inhalation or oral routes increases the risk of cancer. Numerous studies of copper smelters or miners exposed to arsenic trioxide have reported an increased risk of lung cancer. Increased incidence of lung cancer has also been observed at chemical plants where exposure was primarily to arsenate. Other studies suggest that residents living near smelters or arsenical chemical plants may have increased risk of lung cancer, although the reported increases are small and are not clearly detectable in all cases. In general, studies reporting long-term exposure to 0.07 mg As/m^3 or greater have shown an increased incidence of lung cancer, while at lower exposure levels, the association has been less clear or not present.

There is convincing evidence from a large number of epidemiological studies and case reports that ingestion of inorganic arsenic increases the risk of developing skin cancer. The most common tumors seen are squamous cell carcinomas, which may develop from the hyperkeratotic warts or corns commonly seen as a dermal effect of oral inorganic arsenic exposure. Early studies of populations within the United States did not suggest an increased risk of cancer from oral inorganic arsenic exposure. Later studies have found suggestive evidence that the possibility of arsenic-induced skin cancers cannot be discounted based on an association between toenail arsenic levels and incidence of skin cancer.

There is increasing evidence that long-term exposure to arsenic can result in the development of bladder cancer, with transitional cell cancers being the most prevalent. While studies have noted statistical dose-response trends in arsenic-induced bladder cancers, reliable quantitative assessments of dose-response relationships have not been presented. Several studies have also shown that chronic oral exposure to arsenic results in the development of respiratory tumors, making lung cancer an established cause of death from exposure to arsenic in drinking water. Exposure levels in studies evaluating respiratory and bladder cancers have been comparable to those in studies evaluating skin tumors. Studies of U.S. populations have not identified an increased risk of bladder or respiratory tumors following oral exposure to inorganic arsenic.

Animal studies of both inhalation and oral exposure to inorganic arsenicals have not resulted in increased incidence of cancer formation in adult animals. However, a series of studies have shown that inorganic arsenic can induce cancer in the offspring from mice exposed to arsenic during gestation (transplacental carcinogen) and acts as a co-carcinogen with UV light and polycyclic aromatic hydrocarbons (PAHs).

Organic Arsenicals. Humans may be exposed to organic arsenicals via inhalation of dusts, ingestion of organic arsenic in water, food, soil, or dermal contact with contaminated soil, water or plants following pesticide application. There are limited data on the toxicity of organic arsenicals following inhalation exposure in humans and animals and these data do not allow for identification of critical effects. Keratosis was observed in workers exposed to 0.065 mg/m^3 arsanilic acid (i.e., 4-aminophenyl arsenic acid); no alterations in gastrointestinal symptoms or hematological alterations were observed. In animals, very high concentrations (>3,000 mg/m^3) of DMA results in respiratory distress, diarrhea, and erythematous lesions on the feet and ears. No adverse effects were observed in rats exposed to DMA concentrations as high as 100 mg DMA/m^3 for 95 days.

Similarly, the available dermal toxicity data do not allow for identification of critical effects. Contact dermatitis was observed in workers applying DMA (and its sodium salt) and mild dermal irritation was observed in a Draize test in rabbits (adverse effect level not reported). Intermediate duration (21 days) exposure studies in rabbits did not result in systemic toxicity or skin irritation following 5 day/week exposure to 1,000 mg/kg/day MMA or DMA.

The preponderance of toxicity data for organic arsenicals involves oral exposure. Human data are limited to three case reports of individuals intentionally ingesting pesticides containing organic arsenicals. Gastrointestinal irritation (vomiting, nausea, and diarrhea) were consistently reported in these cases. Animal data has primarily focused on the toxicity of MMA, DMA, and roxarsone; these data suggest that the targets of toxicity may differ between the compounds.

MMA. The gastrointestinal tract appears to be the most sensitive target of toxicity for MMA. Diarrhea and tissue damage in the large intestine have been reported in several animal species following dietary, gavage, and capsule exposure. For diarrhea, both the time of onset and incidence appear to be dose-related. In rats, diarrhea was observed in 100% of females exposed to 98.5 mg MMA/kg/day, 55% of females exposed to 33.9 mg MMA/kg/day, and 5.1% of females exposed to 3.9 mg MMA/kg/day. The increased incidence of diarrhea was observed after 3 weeks of exposure to 98.5 mg MMA/kg/day, 4 weeks at 33.9 mg MMA/kg/day, and 18 months at 3.9 mg MMA/kg/day. Histological damage consisting of squamous metaplasia of the epithelial columnar absorptive cells in the cecum, colon, and rectum was observed in rats and mice chronically exposed to 72.4 or 67.1 mg MMA/kg/day, respectively. Hemorrhagic, necrotic, ulcerated, or perforated mucosa were also observed in the large intestine of rats exposed to 67.1 mg MMA/kg/day for 2 years. In rats, the damage to the large intestine resulted in intestinal contents leaking into the abdominal cavity and the development of peritonitis. The available data provide suggestive evidence that there may be some species differences in the sensitivity to gastrointestinal damage; however, some of these differences may be due to the route of administration. The lowest adverse effect levels, regardless of duration of exposure, for gastrointestinal effects in rats, mice, rabbits, and dogs are 25.7, 67.1, 12, and 2 mg MMA/kg/day, respectively; the no adverse effect levels in rats and mice (NOAELs were not identified in rabbits and dogs) were 3.0 and 24.9 mg MMA/kg/day. However, the rabbit and dog studies involved bolus administration (gavage and capsule administration), which may have increased sensitivity; the rat and mouse studies involved dietary exposure.

The kidney also appears to be a sensitive target in rats and mice chronically exposed to MMA. An increase in the severity of progressive glomerulonephropathy was observed in female rats exposed to 33.9 mg MMA/kg/day for 2 years and an increase in the incidence of progressive glomerulonephropathy was observed in male mice exposed to 6.0 mg MMA/kg/day for 2 years. Other adverse effects that have been observed in animals exposed to MMA include hypertrophy of the thyroid follicular cells in rats exposed to 33.9 mg MMA/kg/day in the diet for 2 years, reproductive toxicity, and developmental toxicity. Decreases in pregnancy rate and male fertility index were observed in F_0 and F_1 rats exposed to 76 mg MMA/kg/day for 14 weeks prior to mating and during the mating period; the findings were not significantly different than control values but were considered treatment-related because they were outside the range found in historical controls. This study also reported a decrease in pup survival in the F_1 and F_2 offspring of rats exposed to 76 mg MMA/kg/day; as with the reproductive effects, the incidence was not statistically different from controls but was considered biologically significant because survival in the MMA pups was outside the range found in historical controls. Another study reported impaired fetal growth (decreases in fetal weights and incomplete ossification) and minor skeletal defects (an increase in the number of fetuses with supernumerary thoracic ribs and eight lumbar vertebrae) in rat and rabbit fetuses exposed to 500 or 12mg MMA/kg/day, respectively; maternal toxicity was also observed at these dose levels and the effects may be secondary to maternal stress rather than a direct effect on the developing organisms. A 2-year bioassay did not result in significant increases in the incidence of neoplastic lesions in rats and mice exposed to doses as high as 72.4 and 67.1 mg MMA/kg/day, respectively.

DMA. The most sensitive targets of DMA toxicity in rats are the urinary bladder and kidneys. In the bladder, the effects progress from cytotoxicity to cellular necrosis to regenerative proliferation and hyperplasia. At dietary doses of 11 mg DMA/kg/day, cytotoxicity is observed as early as 6 hours after exposure initiation and cellular proliferation (as evident by increased BrdU labeling) was observed after 2 weeks of exposure. After 10 weeks of exposure, necrosis and hyperplasia were also observed. The lowest adverse effect levels for urinary bladder effects following intermediate or chronic duration exposure were 5 mg DMA/kg/day for evidence of regenerative proliferation and 3.1 mg DMA/kg/day for vacuolar degeneration of urothelium and hyperplasia. Vacuolization of the superficial cells of the urothelium was observed in mice exposed to 7.8 mg DMA/kg/day and higher for 2 years. However, unlike the vacuolar degeneration observed in rats, the vacuolization observed in mice was not associated with cytotoxicity, necrosis, inflammation, or hyperplasia.

Kidney damage characterized by increased urinary calcium levels, calcification, nephrocalcinosis, and necrosis of the renal papillae have been observed in rats following intermediate- or chronic-duration exposure. Increases in urine calcium levels and corticomedullary junction calcification were observed in rats exposed to 5 or 10 mg DMA/kg/day for 10 weeks and cortical degeneration and necrosis were observed in rats exposed to 57 mg DMA/kg/day for 4 weeks. Chronic-duration exposure to 3.1 mg DMA/kg/day resulted in an increased incidence of nephrocalcinosis and necrosis of the renal papillae in rats; these lesions are typical in aged rats, although DMA exposure appeared to exacerbate them. An exacerbation of age-related kidney lesion (progressive glomerulonephropathy and nephrocalcinosis) has also been observed in male mice exposed to 37 or 94 mg DMA/kg/day, respectively, for 2 years. A consistent finding in intermediate and chronic rat studies is an increase in urine volume, which corresponds to an increase in water consumption; the toxicological significance of this finding is not known. The observed decreases in electrolyte levels and specific gravity are likely due to the higher urine volume.

Although gastrointestinal effects have been observed in animals exposed to DMA, it does not appear to be as sensitive a target compared to MMA. Diarrhea has been observed in rats exposed to a lethal dose of 190 mg DMA/kg/day for 4 weeks and in dogs administered via 16 mg DMA/kg/day. No gastrointestinal effects were observed in rats or mice chronically exposed to 7.8 or 94 mg DMA/kg/day.

Other adverse effects that have been observed in animals exposed to organic arsenicals include hypertrophy of thyroid follicular cells in rats exposed to 4.0 mg DMA/kg/day in the diet for 13 weeks and 7.8 mg DMA/kg/day in the diet for 2 years and developmental effects in rats and mice. Decreases in fetal growth and delays in ossification have been observed in rat fetuses exposed to ≥36 mg DMA/kg/day; these alterations typically occur at doses associated with decreases in maternal weight gain. Other developmental effects that have been reported include an increase in the incidences of irregular palatine rugae in rats exposed to 30 mg DMA/kg/day, diaphragmatic hernia in rats exposed to 36 mg DMA/kg/day, and cleft palate in mice exposed to 400 mg DMA/kg/day. No developmental effects were observed in rabbits exposed to 12 mg DMA/kg/day.

The available data provide strong evidence that DMA is carcinogenic in rats. A 2-year exposure to DMA resulted in significant increases in the incidence of neoplastic urinary bladder tumors in rats exposed to 7.8 mg DMA/kg/day in the diet or 3.4 mg DMA/kg/day in drinking water. No increases in neoplastic tumors were observed in mice exposed to doses as high as 94 mg DMA/kg/day for 2 years; however, a

50-week exposure to 10.4 mg DMA/kg/day did result in an increased incidence of lung tumors in A/J mice.

The available data for DMA suggest that there are species differences in terms of the critical effects and sensitivity. In rats, the urinary bladder and kidneys are the most sensitive targets with effects occurring at 5 mg DMA/kg/day following intermediate-duration exposure and 3.1 mg DMA/kg/day following chronic-duration exposure. Although the urinary bladder and kidneys are also sensitive targets in mice with LOAELs of 7.8 and 37 mg DMA/kg/day, respectively, following chronic exposure, the effects are not associated with cytotoxicity or elevated urine calcium levels. In dogs, the most sensitive effect is gastrointestinal tract irritation (diarrhea), which occurs at 16 mg DMA/kg/day.

There is concern that the rat may not be a good model to predict the human risk associated with organic arsenic exposure due to the unique toxicokinetic properties of DMA in rats. In humans and most animal species, DMA is rapidly eliminated from the body; >90% of the dose is excreted 2–3 days after dosing. In contrast, DMA is slowly eliminated in rats. One study estimated that 45% of an initial oral DMA dose was eliminated with a half-time of 13 hours; the remaining 55% of the dose DMA dose had an elimination half-time of 50 days. In rats, DMA has a strong affinity for hemoglobin resulting in an accumulation of DMA in erythrocytes. Species differences in DMA metabolism have also been found. In particular, DMA undergoes further methylation to trimethylarsine oxide (TMAO) in rats. In most animal species, almost the entire oral DMA dose is excreted in the urine unchanged; however, in rats, about half of the dose is excreted in the urine as DMA and the other half as TMAO. During the metabolism of DMA to TMAO, DMA(III) is formed as a metabolic intermediate. The formation of this highly reactive intermediate and the excretion of small amounts of DMA(III) in urine may damage the urinary bladder.

There are limited data on the mode of action of DMA for most end points. Recently, there has been considerable research on the mode of action for the development of neoplastic urinary bladder tumors in rats. Although the mechanisms have not been fully elucidated, it has been proposed that the mode of action involves cytotoxicity leading to necrosis and subsequent regeneration of the urinary bladder urothelium. There is strong evidence to suggest that DMA(III) is the causative agent for the urothelial cytotoxicity. The strongest evidence comes from the finding that urinary concentrations of DMA(III) measured in rats exhibiting urothelial cytotoxicity are equivalent to DMA(III) concentrations that are cytotoxic to urothelial cells *in vitro*. Urothelial cytotoxicity, regenerative urothelial proliferation, and urothelial tumors have not been detected in other animal species. Other animal species, including

humans, only metabolize a small percentage of ingested DMA to TMAO; thus, much lower levels of DMA(III) are produced, suggesting that rats may be very sensitive to toxicity of DMA and therefore are not an appropriate model for human risk assessment.

Roxarsone. The available data on the toxicity of roxarsone suggest that following bolus administration, the gastrointestinal tract, kidney, and nervous system are sensitive end points of roxarsone toxicity. Vomiting and gastrointestinal hemorrhage were observed in dogs receiving a single capsulized dose of 50 mg/kg roxarone; no gastrointestinal effects were observed in rats or mice administered 4 or 42 mg/kg/day roxarsone for 2 years. Kidney effects included increases in kidney weight, minimal tubular epithelial cell degeneration, and focal mineralization in rats exposed to 32 mg roxarsone/kg/day for 13 weeks; no kidney effects were observed at 16 mg/kg/day or in mice exposed to doses as high as 136 mg/kg/day for 13 weeks or 43 mg/kg/day for 2 years. Hyperexcitability, ataxia, and/or trembling were observed in rats exposed to 20 mg/kg/day for 13 weeks or 64 mg/kg/day for 13 weeks. A 14-day study in rats reported slight inactivity in rats exposed to 32 mg/kg/day, but this was not observed in longer-term studies. Neurological effects were observed in mice exposed to doses as high as 136 mg/kg/day for 13 weeks or 43 mg/kg/day for 2 years, although a slight decrease in activity at 42 mg/kg/day was reported in a 14 day study. Pigs appear to be especially sensitive to the neurotoxicity of roxarsone. Muscle tremors have been observed at doses of ≥6.3 mg roxarsone/kg/day and myelin degeneration in the spinal cord was noted at 6.3 mg/kg/day. Both the clinical signs of neuropathy and the myelin degeneration followed a time-related pattern. Mild lethargy and ataxia were observed 7 days after exposure initiation, exercise-induced muscle tremors and clonic seizures were observed at day 11, paraparesis was observed at day 22, and paraplegia was observed at day 33. At day 11, equivocal lesions were observed in the cervical spinal cord, and the severity of these lesions increased with time; myelin degeneration was observed in the peripheral nerves and optic nerve starting at day 32 (2 days after exposure termination). Equivocal evidence of carcinogenicity (a slight increase in the incidence of pancreatic tumors) was found in male rats chronically exposed to roxarsone; no increases in neoplastic tumors were observed in female rats or male and female mice.

2.3 MINIMAL RISK LEVELS (MRLs)

Estimates of exposure levels posing minimal risk to humans (MRLs) have been made for arsenic. An MRL is defined as an estimate of daily human exposure to a substance that is likely to be without an appreciable risk of adverse effects (noncarcinogenic) over a specified duration of exposure. MRLs are derived when reliable and sufficient data exist to identify the target organ(s) of effect or the most sensitive

health effect(s) for a specific duration within a given route of exposure. MRLs are based on noncancerous health effects only and do not consider carcinogenic effects. MRLs can be derived for acute, intermediate, and chronic duration exposures for inhalation and oral routes. Appropriate methodology does not exist to develop MRLs for dermal exposure.

Although methods have been established to derive these levels (Barnes and Dourson 1988; EPA 1990i), uncertainties are associated with these techniques. Furthermore, ATSDR acknowledges additional uncertainties inherent in the application of the procedures to derive less than lifetime MRLs. As an example, acute inhalation MRLs may not be protective for health effects that are delayed in development or are acquired following repeated acute insults, such as hypersensitivity reactions, asthma, or chronic bronchitis. As these kinds of health effects data become available and methods to assess levels of significant human exposure improve, these MRLs will be revised.

Inorganic Arsenicals

Inhalation MRLs. No inhalation MRLs were derived for inorganic arsenic. Human data suggest that dermal or respiratory effects may be the most prevalent (Lagerkvist et al. 1986; Mohamed 1998; Perry et al. 1948); respiratory or immunological effects appeared to be the most common following inhalation exposure to inorganic arsenic in animals (Aranyi et al. 1985; Holson et al. 1999). Adequate human studies evaluating dose-response relationships for noncancer end points were not located for inorganic arsenic, and animal data on the health effects of inorganic arsenic following inhalation exposure are limited to studies that did not evaluate a suitable range of health effects. Lacking suitable studies upon which to base the MRLs, no inhalation MRLs were derived for inorganic arsenic.

Oral MRLs

- An MRL of 0.005 mg As/kg/day has been derived for acute-duration (14 days or less) oral exposure to inorganic arsenic.

Mizuta et al. (1956) summarized findings from 220 poisoning cases associated with an episode of arsenic contamination of soy sauce in Japan. The soy sauce was contaminated with approximately 0.1 mg As/mL, probably as calcium arsenate. Arsenic intake in the cases was estimated by the researchers to be 3 mg/day (0.05 mg/kg/day, assuming 55 kg average body weight for this Asian population). The duration of exposure was 2–3 weeks in most cases. The primary symptoms were edema of the face, and gastrointestinal and upper respiratory symptoms initially, followed by skin lesions and neuropathy in

some patients. Other effects included mild anemia and leukopenia, mild degenerative liver lesions and hepatic dysfunction, abnormal electrocardiogram, and ocular lesions. For derivation of the acute oral MRL, facial edema and gastrointestinal symptoms (nausea, vomiting, diarrhea), which were characteristic of the initial poisoning and then subsided, were considered to be the critical effects. The MRL of 0.005 mg As/kg/day was calculated by applying an uncertainty factor of 10 (10 for use of a lowest-observed-adverse-effect level (LOAEL) and 1 for human variability) to the LOAEL of 0.05 mg As/kg/day (see Appendix A for MRL worksheets).

An intermediate-duration oral MRL for inorganic arsenic was not derived due to inadequacy of the database. The lowest LOAEL identified in a limited number of intermediate-duration human studies available was 0.05 mg As/kg/day in a study by Mizuta et al. (1956) (summarized above). While this study was considered appropriate to derive an acute-duration oral MRL for inorganic arsenic, there is considerable uncertainty regarding what the effects and severity might be beyond the relatively short 2–3 weeks of exposure that most subjects experienced. There are numerous studies in animals dosed for intermediate durations, but as indicated in Section 3.5.3, animals are not appropriate models for effects of inorganic arsenic in humans.

- An MRL of 0.0003 mg As/kg/day has been derived for chronic-duration (365 days or more) oral exposure to inorganic arsenic.

Tseng et al. (1968) and Tseng (1977) investigated the incidence of Blackfoot Disease and dermal lesions (hyperkeratosis and hyperpigmentation) in a large number of poor farmers (both male and female) exposed to high levels of arsenic in well water in Taiwan. A control group consisting of 17,000 people, including one group in which arsenic exposure was “undetermined” and which included those villages where arsenic-contaminated wells were no longer used or the level could not be classified, and a control population of 7,500 people who consumed water from wells almost free of arsenic (0.001–0.017 ppm) was also examined. The authors stated that the incidence of dermal lesions increased with dose, but individual doses were not provided. However, incidence data were provided based on stratification of the exposed population into low (<300 µg/L), medium (300–600 µg/L), or high (>600 µg/L) exposure levels. Doses were calculated from group mean arsenic concentrations in well water, assuming the intake parameters described by IRIS (IRIS 2007). Accordingly, the control, low-, medium-, and high-exposure levels correspond to doses of 0.0008, 0.014, 0.038, and 0.065 mg As/kg/day, respectively. The no-observed-adverse-effect level (NOAEL) identified by Tseng (1977) (0.0008 mg As/kg/day) was limited by the fact that the majority of the population was <20 years of age and the incidence of skin lesions increased as a function of age, and because the estimates of water intake and dietary arsenic intake are

highly uncertain. Schoof et al. (1998) estimated that dietary intakes of arsenic from rice and yams may have been 15–211 µg/day (mean=61 µg/day), based on arsenic analyses of foods collected in Taiwan in 1993–1995. Use of the 50 µg/day estimate would result in an approximate doubling of the NOAEL (0.0016 mg/kg/day) (see Appendix A for MRL worksheets). The MRL was derived by applying an uncertainty factor of 3 (for human variability) to the NOAEL of 0.0008 mg/kg/day.

The MRL is supported by a large number of well-conducted epidemiological studies that identify reliable NOAELs and LOAELs for dermal effects. EPA (1981b) identified a NOAEL of 0.006–0.007 mg As/kg/day for dermal lesions in several small populations in Utah. Harrington et al. (1978) identified a NOAEL of 0.003 mg As/kg/day for dermal effects in a small population in Alaska. Guha Mazumder et al. (1988) identified a NOAEL of 0.009 mg As/kg/day and a LOAEL of 0.006 mg As/kg/day for pigmentation changes and hyperkeratosis in a small population in India. Haque et al. (2003) identified a LOAEL of 0.002 mg As/kg/day for hyperpigmentation and hyperkeratosis in a case-control study in India. Cebrián et al. (1983) identified a NOAEL of 0.0004 mg As/kg/day and a LOAEL of 0.022 mg As/kg/day in two regions in Mexico. Borgoño and Greiber (1972) and Zaldívar (1974) identified a LOAEL of 0.02 mg As/kg/day for abnormal skin pigmentation in patients in Chile, and Borgoño et al. (1980) identified a LOAEL of 0.01 mg As/kg/day for the same effect in school children in Chile. Valentine et al. (1985) reported a NOAEL of 0.02 mg As/kg/day for dermal effects in several small populations in California. Collectively, these studies indicate that the threshold dose for hyper-pigmentation and hyperkeratosis is approximately 0.002 mg As/kg/day. While many of these studies also identified effects on other end points at these exposure levels, including effects on gastrointestinal (Borgoño and Greiber 1972; Cebrián et al. 1983; Guha Mazumder et al. 1988; Zaldívar 1974), cardiovascular (Tseng et al. 1995, 1996), hepatic (Hernández-Zavala et al. 1998), and neurological end points (Guha Mazumder et al. 1988; Lianfang and Jianzhong 1994; Tsai et al. 2003), the overall database for dermal effects is considerably stronger than for effects on other end points.

Organic Arsenicals

Inhalation MRLs. No inhalation MRLs were derived for organic arsenic. Human data are limited to an occupational exposure study of workers exposed to 0.065 mg/m^3 ansanilic acid (Watrous and McCaughey 1945). The exposed workers more frequently complained of keratosis than nonexposed workers. A limited number of animal studies have examined the toxicity of organic arsenicals following inhalation exposure. Respiratory distress and diarrhea were observed in rats and mice exposed to high concentrations of MMA and DMA (Stevens et al. 1979); at lower concentrations (1,540–3,150 mg DMA/m^3), respiratory irritation, as evidenced by a decrease in respiration rate, was observed in animals

exposed to MMA or DMA (Stevens et al. 1979). The acute-duration studies do not clearly identify the most sensitive targets of inorganic arsenical toxicity; the available studies are of limited scope and none included a comprehensive histological examination.

One study examined the toxicity of DMA in rats following intermediate-duration exposure. This study (Whitman 1994) found an increase in intracytoplasmic eosinophilic globules in the nasal turbinates of rats exposed to 34 or 100 mg/m^3 DMA 6 hours/day, 5 days/week for 67–68 exposures; no other adverse effects were observed in this comprehensive study. As discussed in greater detail in the oral MRL section, the toxicokinetic properties of DMA in rats differ from other species and rats do not appear to be a good model for human exposure. The half-time of DMA in the body is much longer in rats compared to other species, including humans, and DMA is more extensively methylated in rats. In the absence of data to determine whether the observed effect is due to a direct interaction of DMA, derivation of an intermediate-duration MRL using rat data is not recommended at this time.

No studies examined the chronic toxicity of organic arsenicals precluding the derivation of a chronic-duration inhalation MRL.

Oral MRLs

MMA. A limited number of animal studies have examined the acute oral toxicity of MMA. These studies consisted of LD_{50} studies in rats (Gur and Nyska 1990), mice (Kaise et al. 1989), and rabbits (Jaghabir et al. 1988) and developmental toxicity studies in rats (Irvine et al. 2006) and rabbits (Irvine et al. 2006); all studies administered MMA via gavage. Adverse effects reported in the LD_{50} studies included diarrhea in rats at 2,030 mg monosodium methane arsonate (MSMA)/kg (Gur and Nyska 1990), mice at 2,200 mg MMA/kg (Kaise et al. 1989) and rabbits at 60 mg MSMA/kg (Jaghabir et al. 1988) and respiratory arrest in mice at 1,800 mg MMA/kg/day (Kaise et al. 1989). These doses were at or near the LD_{50} levels of 2,449 mg MSMA/kg, 1,800 mg MMA/kg, 100 mg MSMA/kg for the rats, mice, and rabbits, respectively. In the developmental toxicity studies (Irvine et al. 2006), maternal effects included decreases in maternal body weight gain in rats (17% less than controls) and rabbits (70% less than controls) receiving gavage doses of 100 and 12 mg MMA/kg/day, respectively, and loose feces/diarrhea in rabbit does administered 12 mg MMA/kg/day. The NOAELs for maternal effects were 10 and 7 mg MMA/kg/day in the rats and rabbits, respectively. Minor developmental effects (decreased fetal weight, incomplete ossification, and supernumerary ribs) were also observed at the maternally toxic doses in the rats and rabbits (Irvine et al. 2006); these effects were probably secondary to the maternal stress. These

data, coupled with the results of longer-term studies (Arnold et al. 2003; Waner and Nyska 1988), suggest that the gastrointestinal tract is a sensitive target of MMA toxicity. The rabbit developmental toxicity study (Irvine et al. 2006) identified the lowest LOAEL (12 mg MMA/kg/day) for gastrointestinal irritation. However, this study is not suitable for the derivation of an acute-duration oral MRL for MMA because the MMA was administered via bolus doses. It is likely that the observed gastrointestinal effect is a concentration-dependent effect; thus, at a given dose level, effects are more likely to occur following bolus administration. A marked decrease in body weight gain was also observed at this dose level.

- An MRL of 0.1 mg MMA/kg/day has been derived for intermediate-duration (15–364 days) oral exposure to MMA.

Three studies have examined the intermediate-duration toxicity of MMA; two of these are chronic-duration studies reporting diarrhea and decreases in body weight gain after MMA exposure for <1 year. Diarrhea was observed in rats exposed to 30.2 mg MMA/kg/day in the diet (Arnold et al. 2003) and in dogs exposed via a capsule to 2 mg MMA/kg/day (Waner and Nyska 1988). Decreases in body weight were observed at the next highest doses, 106.9 mg MMA/kg/day in rats and 8 mg MMA/kg/day in dogs. In the rat study (Arnold et al. 2003), diarrhea was observed in 16.7 and 40% of the males and females, respectively, exposed to 30.2/35.9 mg MMA/kg/day during the first 52 weeks of the study; diarrhea first occurred after 4 weeks of exposure. At the highest dose level (106.9 mg MMA/kg/day), diarrhea was observed in all exposed male and female rats. In dogs, the increased incidence of diarrhea first occurred during weeks 25–28; at the highest dose tested in the study (35 mg MMA/kg/day), vomiting was also observed. A NOAEL of 3.5 mg MMA/kg/day was identified in the rat study; a NOAEL was not identified in the dog study. The remaining study in the intermediate-duration database is a 2-generation study that reported reproductive (decreased pregnancy rate and male fertility index in F_0 and F_1 generations) and developmental (decreased pup survival in F_1 and F_2 generation) effects in rats exposed to 76 mg MMA/kg/day in the diet (Schroeder 1994). The lowest LOAEL identified in the intermediate-duration database is 2 mg MMA/kg/day for diarrhea in dogs (Waner and Nyska 1988). Although dogs appear to be more sensitive to the gastrointestinal effects of MMA, a direct comparison of the two studies is not possible due to the difference in the routes of exposure. It is possible that the bolus administration of MMA, in the form of a capsule, resulted in increased sensitivity of the dogs. Because the most likely route of exposure for humans would be ingestion and the critical effect appears to be irritation of the gastrointestinal tract, studies involving bolus administration (gavage or capsule) were not considered for derivation of oral MRLs. The Arnold et al. (2003) and Schroeder (1994) studies were considered as the basis for an intermediate-duration MRL. Of these two studies, Arnold et al. (2003) identified the lowest

LOAEL, 30.2 mg MMA/kg/day, for gastrointestinal effects and was selected as the principal study for the intermediate-duration oral MRL.

Arnold et al. (2003) exposed groups of 60 male and 60 female Fischer 344 rats to 0, 50, 400, or 1,300 ppm MMA in the diet for 104 weeks. Using the average doses for weeks 1–50 reported in an unpublished version of this study (Crown et al. 1990), doses of 0, 3.5, 30.2, and 106.9 mg MMA/kg/day and 0, 4.2, 35.9, and 123.3 mg MMA/kg/day were calculated for males and females, respectively. Body weights, food consumption, and water intake were monitored regularly. Blood was taken at 3, 6, and 12 months for clinical chemistry measurements, and urine samples were collected at the same interval. Mortality was increased in high-dose males and females during the first 52 weeks of the study. Body weights were decreased in the mid- and high-dose groups of both sexes; however, at 51 weeks, only the body weight for the high-dose males was <10% of the control weight (14.5%). Food and water consumption was increased in the mid- and high-dose groups. Diarrhea was observed in 100% of the high-dose males and females and in 16.7 and 40% of the mid-dose males and females during the first 52 weeks of exposure. Diarrhea first occurred after 3 weeks of exposure to the high dose and 4 weeks of exposure to the mid-dose group; the severity of the diarrhea was dose-related. The gastrointestinal system was the primary target in animals dying early; numerous macroscopic and histological alterations were observed.

A benchmark dose (BMD) analysis of the incidence data for diarrhea was conducted; details of this analysis are presented in Appendix A. Using the female incidence data, a BMD (BMD_{10}) of 16.17 mg MMA/kg/day, which corresponds to a 10% increase in the incidence of diarrhea, was calculated; the 95% lower confidence limit on the BMD ($BMDL_{10}$) was 12.38 mg MMA/kg/day. The female incidence data were selected over the male data because the females may be more sensitive than the males. Thus, the intermediate-duration oral MRL of 0.1 mg MMA/kg/day is based on the $BMDL_{10}$ of 12.38 mg MMA/kg/day in female rats and an uncertainty factor of 100 (10 to account for animal to human extrapolation and 10 for human variability).

- An MRL of 0.01 mg MMA/kg/day has been derived for chronic-duration (365 days or longer) oral exposure to MMA.

The available data on the chronic toxicity of MMA in animals (no human data are available) suggest that the gastrointestinal tract and the kidney are the most sensitive targets. Diarrhea has been observed in rats and mice exposed to MMA in the diet for 2 years (Arnold et al. 2003). The NOAEL and LOAEL values for diarrhea are 3.0 and 25.7 mg MMA/kg/day in rats, respectively, and 24.9 and 67.1 mg MMA/kg/day

in mice, respectively. At 72.4 mg MMA/kg/day, necrotic, ulcerated, or perforated mucosa and metaplasia were observed in the cecum, colon, and rectum of rats. Squamous metaplasia was also observed in the cecum, colon, and rectum of mice exposed to 67.1 mg MMA/kg/day. Diarrhea was observed in dogs exposed via capsule to 2 mg MMA/kg/day for 52 weeks (Waner and Nyska 1988). The bolus administration used in the dog study probably increased the dog's sensitivity to MMA. In both the rats and mice, chronic administration of MMA resulted in an exacerbation of chronic progressive nephropathy. In female rats, significant increases in the severity of chronic progressive nephropathy were observed at 33.9 and 98.5 mg MMA/kg/day; the NOAEL was 3.9 mg MMA/kg/day (Arnold et al. 2003). In male mice, there was an increased incidence of slight progressive nephropathy at doses ≥6.0 mg MMA/kg/day; the NOAEL was 1.2 mg MMA/kg/day (Arnold et al. 2003; incidence data reported in Gur et al. 1991). Nephrocalcinosis was also observed in male mice exposed to ≥24.9 mg MMA/kg/day (Arnold et al. 2003). Other effects that have been observed following chronic exposure MMA include decreased weight gain in male and female rats exposed to 25.7/33.9 mg MMA/kg/day and higher (Arnold et al. 2003) and hypertrophy of the thyroid follicular epithelium in female rats exposed to ≥33.9 mg MMA/kg/day (Arnold et al. 2003). A variety of other lesions including peritonitis, pancreatitis, inflammation of the ureter, uterus, prostate, testes, epididymis, and seminal vesicles, hydronephrosis, pyelonephritis, and cortical tubular cystic dilation were also observed in rats; however, these alterations were probably secondary to the ulceration and perforation of the large intestine, which resulted in leaking of gastrointestinal contents into the abdominal cavity. Hyperplasia of the urinary bladder was also observed in rats exposed to 2.1 mg MMA/kg/day as MMA in drinking water for 2 years (Shen et al. 2003). Although hyperplasia of the urinary bladder is commonly observed in rats exposed to DMA, it was not observed in the Arnold et al. (2003) study at doses as high as 72.4 mg MMA/kg/day; thus, the significance of the results of the Shen et al. (2003) study is not known.

The lowest reliable LOAEL identified in the chronic oral MMA database was 6.0 mg MMA/kg/day for an increased incidence of progressive glomerulonephropathy in mice (Arnold et al. 2003). Although the investigators noted that the kidney lesions were consistent with the normal spectrum of spontaneous renal lesions and that there was no difference in character or severity of lesions between groups, ATSDR considers the dose-related increase in glomerulonephropathy to be treatment-related.

In the Arnold et al. (2003) study (incidence data reported in Gur et al. 1991), groups of 52 male and 52 female $B6C3F_1$ mice were exposed to 0, 10, 50, 200, or 400 ppm of MMA in the diet for 104 weeks. The average doses reported in Gur et al. (1991) were 0, 1.2, 6.0, 24.9, and 67.1 mg MMA/kg/day for males and 0, 1.4, 7.0, 31.2, and 101 mg MMA/kg/day for females. Body weights, food consumption, and

water intake were monitored regularly. Blood was taken at 3, 6, 12, 18, and 24 months for white cell counts. At sacrifice, complete necropsies were performed, including histological examination of at least 13 organs. No treatment-related increases in mortality were observed. Significant decreases in body weights were observed in males and females exposed to 67.1 or 101 mg MMA/kg/day, respectively; at week 104, the males and females weighed 17 and 23%, respectively, less than controls. Food consumption was increased in females exposed to 101 mg MMA/kg/day, and water consumption was increased in 67.1 mg MMA/kg/day males and 31.2 and 101 mg MMA/kg/day females. Loose and mucoid feces were noted in mice exposed to 67.1/101 mg MMA/kg/day. No changes were seen in white cell counts of either sex. Small decreases in the weights of heart, spleen, kidney, and liver weights were observed in some animals, but the decreases were not statistically significant. Squamous metaplasia of the cecum, colon, and rectum was observed at 67.1/101 mg MMA/kg/day. The incidence of metaplasia in the cecum, colon, and rectum were 29/49, 14/49, and 39/49 in males and 38/52, 17/52, and 42/52 in females; metaplasia was not observed in other groups of male or female mice. An increased incidence of progressive glomerulonephropathy (incidence of 25/52, 27/52, 38/52, 39/52, and 46/52 in the 0, 1.2, 6.0, 24.9, and 67.1 mg MMA/kg/day males, respectively) was observed in males; the incidence was significantly higher (Fisher Exact Test) than controls at ≥6.0 mg MMA/kg/day. Significant increases in the incidence of nephrocalcinosis was observed in the males at 24.9 and 67.1 mg MMA/kg/day (Fisher Exact Test) (incidences of 25/52, 30/52, 30/52, 45/52, and 45/51 in males and 0/52, 1/52, 1/52, 2/52, and 5/52 in females). A reduction in the incidence of cortical focal hyperplasia in the adrenal gland of male mice exposed to 67.1 mg MMA/kg/day was possibly related to MMA exposure; the toxicological significance of this effect is not known. Thus, this study identifies a NOAEL of 1.2 mg MMA/kg/day and a LOAEL of 6.0 mg MMA/kg/day for progressive glomerulonephropathy in male mice.

As described in greater detail in Appendix A, BMD was applied to the incidence data for progressive glomerulonephropathy in male mice using all available dichotomous models in EPA's Benchmark Dose Software (version 1.4.1) to calculate predicted doses associated with a 10% extra risk. As assessed by the Akaike's Information Criteria (AIC), the log-logistic model provided the best fit to the data. The predicted BMD_{10} and $BMDL_{10}$ are 2.09 and 1.09 mg MMA/kg/day. The $BMDL_{10}$ was selected as the point of departure and divided by an uncertainty factor of 100 (10 for extrapolation from animals to humans and 10 for human variability) to derive a chronic-duration oral MRL of 0.01 mg MMA/kg/day.

DMA. As discussed in greater detail in Section 2.2, urinary bladder effects characterized by cytotoxicity and regenerative proliferation and hyperplase have been observed in rats, but not in other species. The LOAELs for these effects are lower than the LOAELs for sensitive effects in other species. Additionally,

rats have a much greater capacity than other species to metabolize ingested DMA to form DMA(III) (a reactive intermediate) and TMAO (Cohen et al. 2006; Marafante et al. 1987b; Yoshida et al. 1998). It is likely that DMA(III) is the causative agent for the urothelial cytoxicity observed in rats (Cohen et al. 2006). Thus, rats were not considered a suitable model for humans and these data were not considered for derivation of MRLs for DMA.

There are limited data to assess the acute toxicity of DMA in species other than rats. Diarrhea, increased startle reflex, and ataxia were observed in mice exposed to a lethal gavage dose of 1,757 mg DMA/kg (Kaise et al. 1989); vomiting and diarrhea were also observed during the second week of a 52-week study in dogs exposed via capsule to 16 mg DMA/kg/day (Zomber et al. 1989). The remaining studies in the acute database are developmental toxicity studies in mice and rabbits. Rabbits appear to be more sensitive than mice to maternal and developmental effects. Gavage exposure to 48 mg DMA/kg/day on gestational days 7–19 resulted in maternal weight loss and abortion in approximately 75% of the does; no adverse effects were observed at 12 mg DMA/kg/day (Irvine et al. 2006). In mice, decreases in maternal body weight gain were observed at gavage doses of 200 mg DMA/kg/day on gestational days 7–16 (Rogers et al. 1981), decreases in fetal body weight, delays in ossification, and increased incidence of cleft palate were observed at 400 mg DMA/kg/day on gestational days 7–16 (Rogers et al. 1981) and fetal deaths, decreases in growth, and increased incidence of malformations were observed in mice administered 1,600 mg DMA/kg on gestational day 8 (Kavlock et al. 1985). The acute-duration database for DMA was not considered adequate for derivation of an oral MRL. The database is lacking a comprehensive toxicity study, which would be useful in establishing the critical target of toxicity. In a chronic-duration study in mice (Arnold et al. 2006), vacuolization was observed in the urinary bladder at ≥7.8 mg DMA/kg/day; it is not known if these effects would also be observed after acute-duration exposure. Thus, it is not known if systemic effects would occur at lower doses than the maternal developmental effects observed in rabbits exposed to 48 mg DMA/kg/day (Irvine et al. 2006); an acute-duration oral MRL for DMA is not recommended at this time.

Excluding rat studies, the database on the toxicity of DMA following intermediate-duration oral exposure is limited to a chronic study of dogs exposed to DMA via capsule 6 days/week for 52 weeks (Zomber et al. 1989). Diarrhea and vomiting were observed at 16 and 40 mg DMA/kg/day starting after the first week of exposure. A slight decrease in erythrocyte levels and increase in total leukocyte levels were observed in males exposed to 40 mg DMA/kg/day for 51 weeks. This dog study was not selected as the basis of an MRL because it is likely that bolus administration of DMA would increase sensitivity to the gastrointestinal effects.

- An MRL of 0.02 mg DMA/kg/day has been derived for chronic-duration (365 days or longer) oral exposure to DMA.

Two studies investigated the chronic-duration toxicity of DMA in a species other than rats. In dogs, diarrhea and vomiting were observed after 52 weeks of exposure to 16 or 40 mg As/kg/day (Zomber et al. 1989); no histological alterations were observed. In mice exposed to DMA in the diet for 2 years, vacuolization of the urothelium in the urinary bladder was observed at ≥7.8 mg DMA/kg/day and progressive glomerulonephropathy was observed at ≥37 mg DMA/kg/day (Arnold et al. 2006). As noted in Section 2.2, the vacuolization was not associated with cytotoxicity or proliferation. Because the bladder effects in mice occurred at the lowest adverse effect level for the database, it was selected as the critical effect and Arnold et al. (2006) was selected as the principal study.

In the Arnold et al. (2006) study, groups of 56 male and 56 female B6C3F_1 mice were exposed to 0, 8, 40, 200, or 500 ppm DMA in the diet for 2 years; the results of this study were also reported in an unpublished paper (Gur et al. 1989b) submitted to EPA under Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The investigators reported dietary doses of approximately 0, 1.3, 7.8, 37, and 94 mg DMA/kg/day. The following parameters were used to assess toxicity: clinical observations, body weight, food consumption, water consumption, differential leukocyte levels measured at 12, 18, and 24 months in mice in the control and 94 mg DMA/kg/day groups, organ weights (brain, kidneys, liver, and testes), and histopathological examination of major tissues and organs. No deaths or treatment-related clinical signs were observed. Decreases in body weight gain were observed in the male mice exposed to 94 mg DMA/kg/day; the difference was <10% and not considered adverse. An increase in water consumption was observed in males exposed to 94 mg DMA/kg/day during weeks 60–96. In the female mice exposed to 51 mg As/kg/day, a statistically significant decrease in lymphocytes and an increase in monocytes were observed at 24 months. Treatment related nonneoplastic alterations were observed in the urinary bladder and kidneys. In the urinary bladder, increases in the vacuolization of the superficial cells of the urothelium were observed in males exposed to 37 or 94 mg DMA/kg/day (0/44, 1/50, 0/50, 36/45, 48/48) and in females exposed to 7.8, 37, and 94 mg DMA/kg/day (1/45, 1/48, 26/43, 47/47, 43/43); incidence data reported in Gur et al. (1989b). An increased incidence of progressive glomerulonephropathy was observed in males at 37 mg DMA/kg/day (16/44, 22/50, 17/50, 34/45, 30/50) and an increased incidence of nephrocalcinosis was also observed in male mice at 94 mg DMA/kg/day (30/44, 25/50, 27/50, 29/50, 45/50). Neoplastic alterations were limited to an increased incidence of fibrosarcoma of the skin in females exposed to 94 mg DMA/kg/day (the incidence of 3/56, 0/55, 1/56,

1/56, and 6/56 in the 0, 1.3, 7.8, 37, and 94 mg DMA/kg/day groups, respectively); however, it was concluded that this lesion was not related to DMA exposure.

As described in detail in Appendix A, BMD analysis was applied to the incidence data for vacuolization of the urothelium in the urinary bladder of female mice using all available dichotomous models in EPA's Benchmark Dose Software (version 1.4.1) to calculate predicted doses associated with a 10% extra risk. As assessed by the AIC, the multi-stage model provided the best fit to the data. The predicted BMD_{10} and $BMDL_{10}$ are 2.68 and 1.80 mg DMA/kg/day. The $BMDL_{10}$ was selected as the point of departure and divided by an uncertainty factor of 100 (10 for extrapolation from animals to humans and 10 for human variability) to derive a chronic-duration oral MRL of 0.02 mg DMA/kg/day.

Roxarsone. A series of three National Toxicology Program (NTP) studies in rats and mice (NTP 1989b) and a study in dogs (Kerr et al. 1963) have examined the acute toxicity of roxarsone; adverse effects have also been reported within the first 2 weeks of a longer-term study in pigs (Rice et al. 1985; Kennedy et al. 1986). A single exposure study reported diarrhea and ataxia in rats and mice exposed to doses that exceeded the LD_{50} (NTP 1989b). In another study, no alterations in hematological parameters (only end point assessed) were found after 10 or 9 days of dietary exposure in rats and mice, respectively (NTP 1989b). In a 14-day study (NTP 1989b), a decrease in body weight gain and slight inactivity were observed in rats exposed to 32 mg roxarsone/kg/day and slight inactivity was observed in mice exposed to 42 mg roxarsone/kg/day; a decrease in body weight gain was also observed in mice exposed to 168 mg roxarsone/kg/day. The dog study was considered inadequate because a small number (n=3) of animals were tested and no control group was used. In a 30-day dietary exposure study in pigs (Rice et al. 1985; Kennedy et al. 1986), mild lethargy and ataxia were observed from day 7 forward and exercise-induced muscle tremors and clonic seizures were observed from day 11 forward in pigs exposed to 6.3 mg roxarsone/kg/day; equivocal evidence of myelin degeneration was also observed in pigs sacrificed after 11 days of exposure. These data clearly identify pigs as the most sensitive species following acute-duration oral exposure; in the absence of data to the contrary, it is assumed that pigs are a good model to predict the toxic potential of roxarsone in humans. Because the lowest dose tested in pigs was a serious LOAEL for neurotoxicity and a NOAEL for this effect was not identified, an acute-duration oral MRL cannot be derived for roxarsone.

As with the acute-duration database, pigs appear to be the most sensitive species; neurotoxicity has been observed at ≥6.3 mg roxarsone/kg/day. In a study reported by Rice et al. (1985) and Kennedy et al. (1986), exercise-induced muscle tremors and clonic convulsions were observed in pigs during the early

part of the study; when the pigs returned to a recumbent position, the seizures and tremors stopped. Paraparesis, evidenced by reluctance to rise and the pigs dragging their hindquarters on the ground, was observed at day 22; paraplegia was observed 2 days after exposure termination. In addition to these clinical signs of neuropathy, histological alterations consisting of myelin degeneration was observed in the spinal cord, peripheral nerves, and optic nerve. The lesions were first detected in the spinal cord on day 15 and in the peripheral nerves and optic nerve 2 days after exposure termination. The Rice et al. (1985) and Kennedy et al. (1986) studies did not identify a NOAEL. Muscle tremors were also observed in pigs exposed to 10 mg roxarsone/kg/day for 28 days (Edmonds and Baker 1986). This study was not designed to assess neurotoxicity and did not include histological examination of the spinal cord or nerves. Trembling, ataxia, and hyperexcitability were also observed in rats exposed to 64 mg roxarsone/kg/day for 13 weeks (NTP 1989b). Other effects that have been observed include tubular degeneration and focal regenerative hyperplasia in the kidney and decreased body weight in rats exposed to 32 mg roxarsone/kg/day for 13 weeks (NTP 1989b) and decreased body weight in mice at 136 mg roxarsone/kg/day for 13 weeks (NTP 1989b). The lowest identified adverse effect level is 6.3 mg roxarsone/kg/day for serious neurological effects in pigs (Kennedy et al. 1986; Rice et al. 1985) and is not suitable for the derivation of an intermediate-duration oral MRL.

The chronic toxicity of roxarsone has been examined in rats (NTP 1989b; Prier et al. 1963), mice (NTP 1989b; Prier et al. 1963), and dogs (Prier et al. 1963) in 2-year dietary exposure studies. None of these studies reported adverse effects at the highest doses tested; the highest NOAELs for each species are 10, 43, and 5 mg roxarsone/kg/day for rats, mice, and dogs, respectively. The results from shorter duration studies suggest that pigs are more sensitive to the neurotoxic effects of roxarsone than rats, mice, or dogs. Because no chronic duration pig studies were identified and deriving an MRL using a potentially less sensitive species may not be protective of human health, a chronic-duration oral MRL is not recommended at this time.

3. HEALTH EFFECTS

3.1 INTRODUCTION

The primary purpose of this chapter is to provide public health officials, physicians, toxicologists, and other interested individuals and groups with an overall perspective on the toxicology of arsenic. It contains descriptions and evaluations of toxicological studies and epidemiological investigations and provides conclusions, where possible, on the relevance of toxicity and toxicokinetic data to public health.

A glossary and list of acronyms, abbreviations, and symbols can be found at the end of this profile.

3.2 DISCUSSION OF HEALTH EFFECTS BY ROUTE OF EXPOSURE

To help public health professionals and others address the needs of persons living or working near hazardous waste sites, the information in this section is organized first by route of exposure (inhalation, oral, and dermal) and then by health effect (death, systemic, immunological, neurological, reproductive, developmental, genotoxic, and carcinogenic effects). These data are discussed in terms of three exposure periods: acute (14 days or less), intermediate (15–364 days), and chronic (365 days or more).

Levels of significant exposure for each route and duration are presented in tables and illustrated in figures. The points in the figures showing no-observed-adverse-effect levels (NOAELs) or lowest-observed-adverse-effect levels (LOAELs) reflect the actual doses (levels of exposure) used in the studies. LOAELs have been classified into "less serious" or "serious" effects. "Serious" effects are those that evoke failure in a biological system and can lead to morbidity or mortality (e.g., acute respiratory distress or death). "Less serious" effects are those that are not expected to cause significant dysfunction or death, or those whose significance to the organism is not entirely clear. ATSDR acknowledges that a considerable amount of judgment may be required in establishing whether an end point should be classified as a NOAEL, "less serious" LOAEL, or "serious" LOAEL, and that in some cases, there will be insufficient data to decide whether the effect is indicative of significant dysfunction. However, the Agency has established guidelines and policies that are used to classify these end points. ATSDR believes that there is sufficient merit in this approach to warrant an attempt at distinguishing between "less serious" and "serious" effects. The distinction between "less serious" effects and "serious" effects is considered to be important because it helps the users of the profiles to identify levels of exposure at which major health effects start to appear. LOAELs or NOAELs should also help in determining whether or not

the effects vary with dose and/or duration, and place into perspective the possible significance of these effects to human health.

The significance of the exposure levels shown in the Levels of Significant Exposure (LSE) tables and figures may differ depending on the user's perspective. Public health officials and others concerned with appropriate actions to take at hazardous waste sites may want information on levels of exposure associated with more subtle effects in humans or animals (LOAELs) or exposure levels below which no adverse effects (NOAELs) have been observed. Estimates of levels posing minimal risk to humans (Minimal Risk Levels or MRLs) may be of interest to health professionals and citizens alike.

Levels of exposure associated with carcinogenic effects (Cancer Effect Levels, CELs) of arsenic are indicated in Tables 3-1 and 3-3 and Figures 3-1 and 3-3. Because cancer effects could occur at lower exposure levels, Figures 3-1 and 3-3 also show a range for the upper bound of estimated excess risks, ranging from a risk of 1 in 10,000 to 1 in 10,000,000 (10^{-4} to 10^{-7}), as developed by EPA.

A User's Guide has been provided at the end of this profile (see Appendix B). This guide should aid in the interpretation of the tables and figures for Levels of Significant Exposure and the MRLs.

Chemical Forms of Concern. Analysis of the toxic effects of arsenic is complicated by the fact that arsenic can exist in several different oxidation states and many different inorganic and organic compounds. Most cases of human toxicity from arsenic have been associated with exposure to inorganic arsenic, so these compounds are the main focus of this profile.

The most common inorganic arsenical in air is arsenic trioxide (As_2O_3), while a variety of inorganic arsenates (AsO_4^{-3}) or arsenites (AsO_2^-) occur in water, soil, or food. A number of studies have noted differences in the relative toxicity of these compounds, with trivalent arsenites tending to be somewhat more toxic than pentavalent arsenates (Byron et al. 1967; Gaines 1960; Maitani et al. 1987a; Sardana et al. 1981; Willhite 1981). However, these distinctions have not been emphasized in this profile, for several reasons: (1) in most cases, the differences in the relative potency are reasonably small (about 2–3-fold), often within the bounds of uncertainty regarding NOAEL or LOAEL levels; (2) different forms of arsenic may be interconverted, both in the environment (see Section 6.3) and the body (see Section 3.4); and (3) in many cases of human exposure (especially those involving intake from water or soil, which are of greatest concern to residents near wastes sites), the precise chemical speciation is not known.

Gallium arsenide (GaAs) is another inorganic arsenic compound of potential human health concern, due to its widespread use in the microelectronics industry. Available toxicokinetic data suggest that although gallium arsenide is poorly soluble, it undergoes slow dissolution and oxidation to form gallium trioxide and arsenite (Webb et al. 1984, 1986). Therefore, the toxic effects of this compound are expected to be attributable to the arsenite that is liberated, plus the additional effects of the gallium species.

It is beyond the scope of this profile to provide detailed toxicity data on other less common inorganic arsenic compounds (e.g., As_2S_3), but these are expected to be of approximately equal or lesser toxicity than the oxycompounds, depending mainly on solubility (see Section 3.4).

Although organic arsenicals are usually viewed as being less toxic than the inorganics, several methyl and phenyl derivatives of arsenic that are widely used in agriculture are of possible human health concerns based on their toxicity in animal species (Arnold et al. 2003, 2006; NTP 1989b). Chief among these are monomethylarsonic acid (MMA) and its salts (monosodium methane arsonate [MSMA] and disodium methane arsonate [DSMA]), dimethylarsinic acid (DMA, also known as cacodylic acid) and its sodium salt (sodium dimethyl arsinite, or sodium cacodylate), and roxarsone (3-nitro-4-hydroxyphenylarsonic acid). However, it should be noted that food is the largest contributor to background intakes of organic arsenicals. Estimates on the concentration of organic arsenicals in the diet were not located; Cohen et al. (2006) estimated that the intake of DMA from food and water is <1 ng/kg/day. As with the inorganic compounds, there are toxicological differences between these various organic derivatives; because of these differences, the discussion of the health effects of MMA, DMA, and roxarsone are discussed separately. As discussed below, animals do not appear to be good quantitative models for inorganic arsenic toxicity in humans, but it is not known if this also applies to toxicity of organic arsenicals.

Several organic arsenicals are found to accumulate in fish and shellfish. These derivatives (mainly arsenobetaine and arsenocholine, also referred to as "fish arsenic") have been studied by several researchers and have been found to be essentially nontoxic (Brown et al. 1990; Cannon et al. 1983; Charbonneau et al. 1978; Kaise et al. 1985; Luten et al. 1982; Siewicki 1981; Tam et al. 1982; Yamauchi et al. 1986). Thus, these compounds are not considered further here.

Arsine (AsH_3) and its methyl derivatives, although highly toxic, are also not considered in this profile, since these compounds are either gases or volatile liquids that are unlikely to be present at levels of concern at hazardous waste sites.

Use of Animal Data. An additional complexity to the analysis of arsenic toxicity is that most laboratory animals appear to be substantially less susceptible to inorganic arsenic than humans. For example, chronic oral exposure of humans to inorganic arsenic at doses of 0.05–0.1 mg/kg/day is frequently associated with neurological (Barton et al. 1992; Goddard et al. 1992; Guha Mazumder et al. 1988; Haupert et al. 1996; Hindmarsh et al. 1977; Huang et al. 1985; Sass et al. 1993; Silver and Wainman 1952; Szuler et al. 1979; Tay and Seah 1975; Valentine et al. 1981) or hematological signs of arsenic toxicity (Glazener et al. 1968; Guha Mazumder et al. 1988; Prasad and Rossi 1995; Sass et al. 1993; Tay and Seah 1975), but no characteristic neurological or hematological signs of arsenism were detected in monkeys, dogs, or rats chronically exposed to arsenate or arsenite at doses of 0.7–2.8 mg As/kg/day (Byron et al. 1967; EPA 1980f; Heywood and Sortwell 1979). This may be because the studies were not conducted for a sufficient length of time, or because too few animals were used. Moreover, while there is good evidence that inorganic arsenic is carcinogenic in humans by both oral and inhalation routes, evidence of inorganic arsenic-induced carcinogenicity in animals is mostly negative, with the exception of studies in mice demonstrating transplacental carcinogenesis. For these reasons, quantitative dose-response data from animals are not judged to be reliable for determining levels of significant human exposure, and will be considered only briefly except when human data are lacking.

3.2.1 Inhalation Exposure

Most information on human inhalation exposure to arsenic derives from occupational settings such as smelters and chemical plants, where the predominant form of airborne arsenic is arsenic trioxide dust. One limitation to this type of study is that exposure data are usually difficult to obtain, especially from earlier time periods when exposure levels were higher than in recent years. This is further complicated by the fact that significant oral and dermal exposures are also likely to occur under these conditions and co exposure to other metals and chemicals is also common. Thus, studies of this type are, like virtually all epidemiological studies, subject to some limitations and uncertainties. Table 3-1 and Figure 3-1 summarize studies that provide the most reliable quantitative data on health effects in humans, along with several studies in animals exposed to arsenic trioxide and other inorganic arsenic compounds by the inhalation route. Data for DMA are shown in Table 3-2 and Figure 3-2. All exposure data are expressed as milligrams of arsenic (as the element) per cubic meter of air (mg As/m^3). These studies and others that provide useful qualitative information on health effects of inorganic and organic arsenicals are discussed below.

Table 3-1 Levels of Significant Exposure to Inorganic Arsenic - Inhalation

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/m³)	LOAEL Less Serious (mg/m³)		LOAEL Serious (mg/m³)		Reference Chemical Form	Comments
ACUTE EXPOSURE										
Immuno/ Lymphoret										
1	Mouse (CD-1)	3 hr		0.123 F	0.271 F	(decreased pulmonary bactericidal activity and increased susceptibility to streptococcal infection)			Aranyi et al. 1985 As(+3)	
2	Mouse (CD-1)	5 d 3 hr/d		0.259 F	0.519 F	(decreased pulmonary bactericidal activity and increased susceptibility to streptococcal infection)			Aranyi et al. 1985 As(+3)	
Developmental										
3	Mouse (CFLP)	Gd 9-12 4 hr/d		0.2	2.2	(10% decreased average fetal body weight)	21.6	(increased fetal deaths, skeletal malformations, and retarded growth)	Nagymajtenyi et al. 1985 As(+3)	
INTERMEDIATE EXPOSURE										
Death										
4	Rat (CD)	14 pmd- Gd 19 7 d/wk 6 hr/d					20 F	(5/10 dams died)	Holson et al. 1999 As(+3)	
Systemic										
5	Rat (CD)	14 pmd- Gd 19 7 d/wk 6 hr/d	Resp	2 F	8 F	(rales, dried red material around nose)			Holson et al. 1999 As(+3)	
			Bd Wt	2 F	8 F	(decreased body weight gain during gestation)				

Table 3-1 Levels of Significant Exposure to Inorganic Arsenic - Inhalation (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/m³)	LOAEL Less Serious (mg/m³)	LOAEL Serious (mg/m³)	Reference Chemical Form	Comments
6	Rat (CD)	14 pmd- Gd 19 7 d/wk 6 hr/d	Resp	0.9 F	8 F (rales)	20 F (labored breathing, gasping)	Holson et al. 1999 As(+3)	
			Gastro	8 F		20 F (gross gastrointestinal lesions)		
			Bd Wt	8 F		20 F (drastic decrease body weight)		
Immuno/ Lymphoret								
7	Mouse (CD-1)	4 wk 5 d/wk 3 hr/d		0.126 F	0.245 F (decreased pulmonary bactericidal activity)		Aranyi et al. 1985 As(+3)	
Reproductive								
8	Rat (CD)	14 pmd- Gd 19 7 d/wk 6 hr/d		8 F			Holson et al. 1999 As(+3)	
9	Rat (CD)	14 pmd- Gd 19 7 d/wk 6 hr/d		20 F			Holson et al. 1999 As(+3)	
Developmental								
10	Rat (CD)	14 pmd- Gd 19 7 d/wk 6 hr/d		8			Holson et al. 1999 As(+3)	

Table 3-1 Levels of Significant Exposure to Inorganic Arsenic - Inhalation (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/m³)	LOAEL Less Serious (mg/m³)		LOAEL Serious (mg/m³)		Reference Chemical Form	Comments
11	Rat (CD)	14 pmd- Gd 19 7 d/wk 6 hr/d		8			20	(marked increase in post-implantation loss and marked decrease in viable fetuses)	Holson et al. 1999 As(+3)	
CHRONIC EXPOSURE										
Systemic										
12	Human	23 yr (avg) (occup)	Cardio				0.36 M	(increased incidence of vasospasticity and clinical Raynaud's phenomenon)	Lagerkvist et al. 1986 As(+3)	
13	Human	0.5-50 yr (occup)	Resp	0.613					Perry et al. 1948 As(+3)	
			Dermal		0.078	(mild pigmentation keratosis of skin)	0.613	(gross pigmentation with hyperkeratinization of exposed areas, wart formation)		
Neurological										
14	Human	28 yr (avg) (occup)			0.31 M	(decreased nerve conduction velocity)			Lagerkvist and Zetterlund 1994 As(+3)	
Cancer										
15	Human	1- >30 yr (occup)					0.213 M	(CEL: lung cancer)	Enterline et al. 1987a As(+3)	
16	Human	19.5 yr (avg) (occup)					0.069 M	(CEL: lung cancer)	Enterline et al. 1987b As(+3)	

Table 3-1 Levels of Significant Exposure to Inorganic Arsenic - Inhalation (continued)

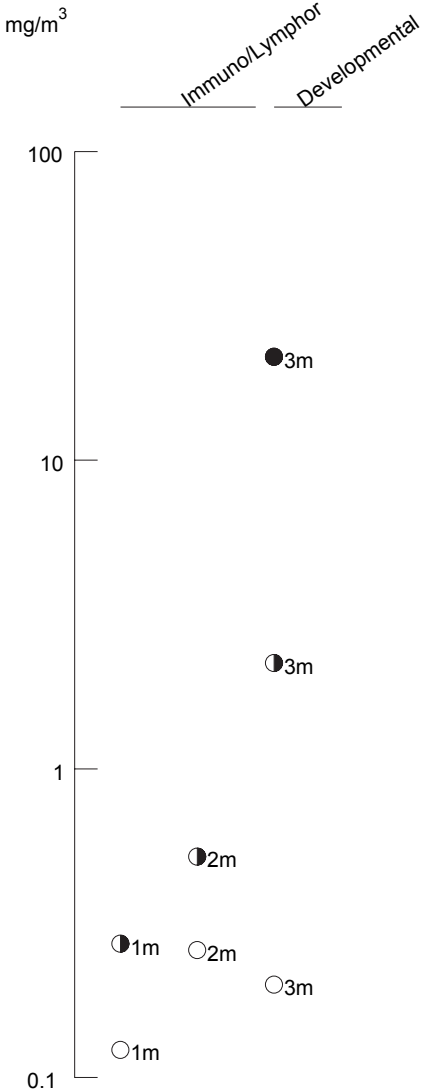
Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/m³)	LOAEL Less Serious (mg/m³)	LOAEL Serious (mg/m³)	Reference Chemical Form	Comments
17	Human	3 mo- >30 yr (occup)				0.2 M (CEL: lung cancer)	Jarup and Pershagen 1991 As(+3)	
18	Human	3 mo- >30 yr (occup)				0.05 M (CEL: lung cancer)	Jarup et al. 1989 As(+3)	
19	Human	1- >30 yr (occup)				0.38 M (CEL: lung cancer)	Lee-Feldstein 1986 As(+3)	
20	Human	>25 yr (occup)				0.29 M (CEL: lung cancer)	Lubin et al. 2000 As(+3)	
21	Human	14.8 yr (avg) (occup)				0.3 M (CEL: lung cancer)	Welch et al. 1982 As(+3)	

a The number corresponds to entries in Figure 3-1.

avg = average; Bd Wt = body weight; Cardio = cardiovascular; CEL = cancer effect level; d = day(s); F = female; Gastro = gastrointestinal; Gd = gestation day; hr = hour(s); Immuno/Lymphoret = immunological/lymphoreticular; LOAEL = lowest-observable-adverse-effect level; M = male; mo = month(s); NOAEL = no-observable-adverse-effect level; NS = not specified; occup = occupational; pmd = pre-mating day; Resp = respiratory; wk = week(s); yr = year(s)

Figure 3-1 Levels of Significant Exposure to Inorganic Arsenic - Inhalation

Acute (≤14 days)



c-Cat -Humans f-Ferret n-Mink
d-Dog k-Monkey j-Pigeon o-Other
r-Rat m-Mouse e-Gerbil
p-Pig h-Rabbit s-Hamster
q-Cow a-Sheep g-Guinea Pig

◆ Cancer Effect Level-Animals
● LOAEL, More Serious-Animals
◑ LOAEL, Less Serious-Animals
○ NOAEL - Animals

▼ Cancer Effect Level-Humans
▲ LOAEL, More Serious-Humans
◭ LOAEL, Less Serious-Humans
△ NOAEL - Humans

■ LD50/LC50
Minimal Risk Level for effects other than Cancer

Figure 3-1 Levels of Significant Exposure to Inorganic Arsenic - Inhalation *(Continued)*

Intermediate (15-364 days)

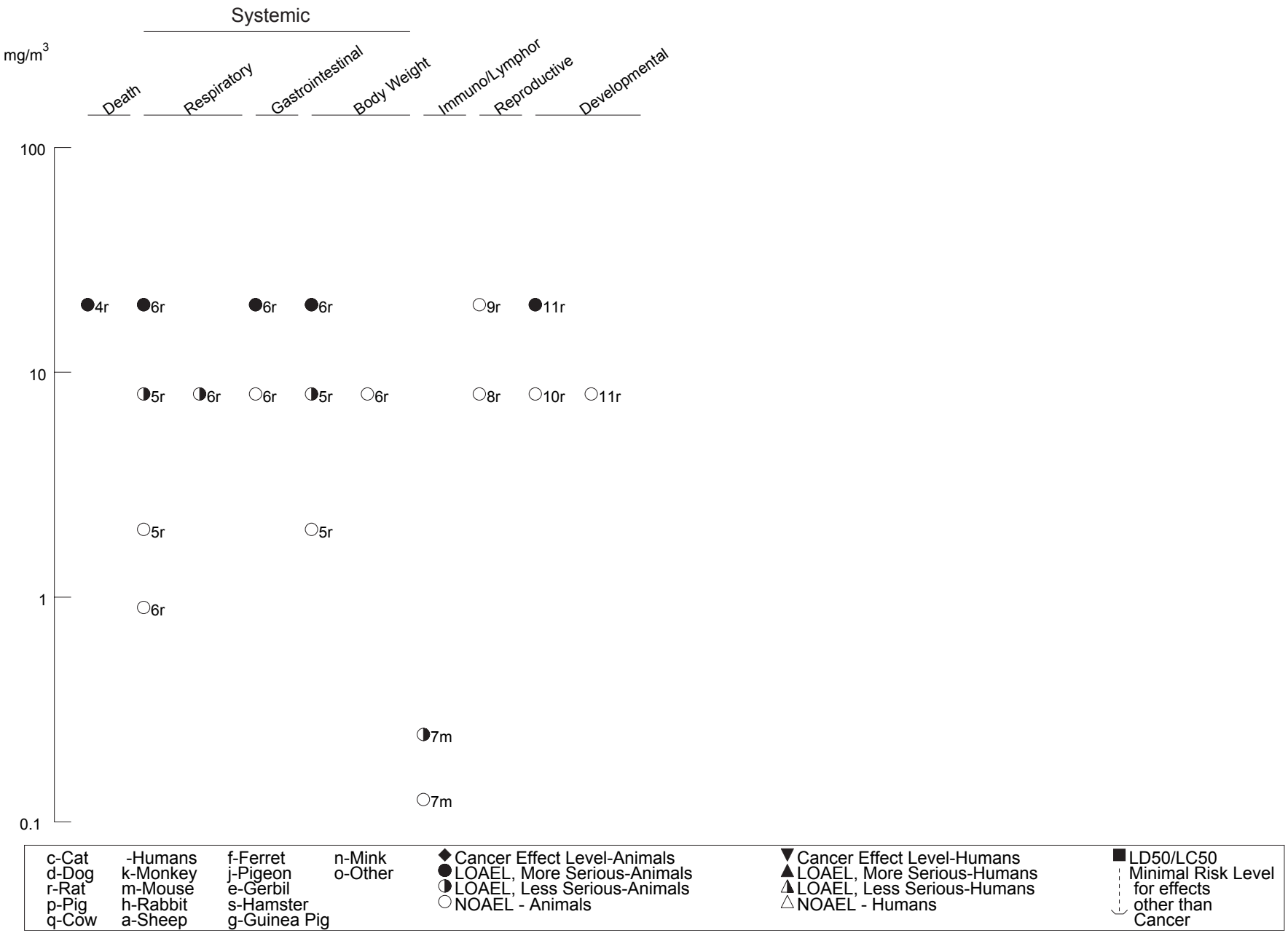


Figure 3-1 Levels of Significant Exposure to Inorganic Arsenic - Inhalation *(Continued)*

Chronic (≥365 days)

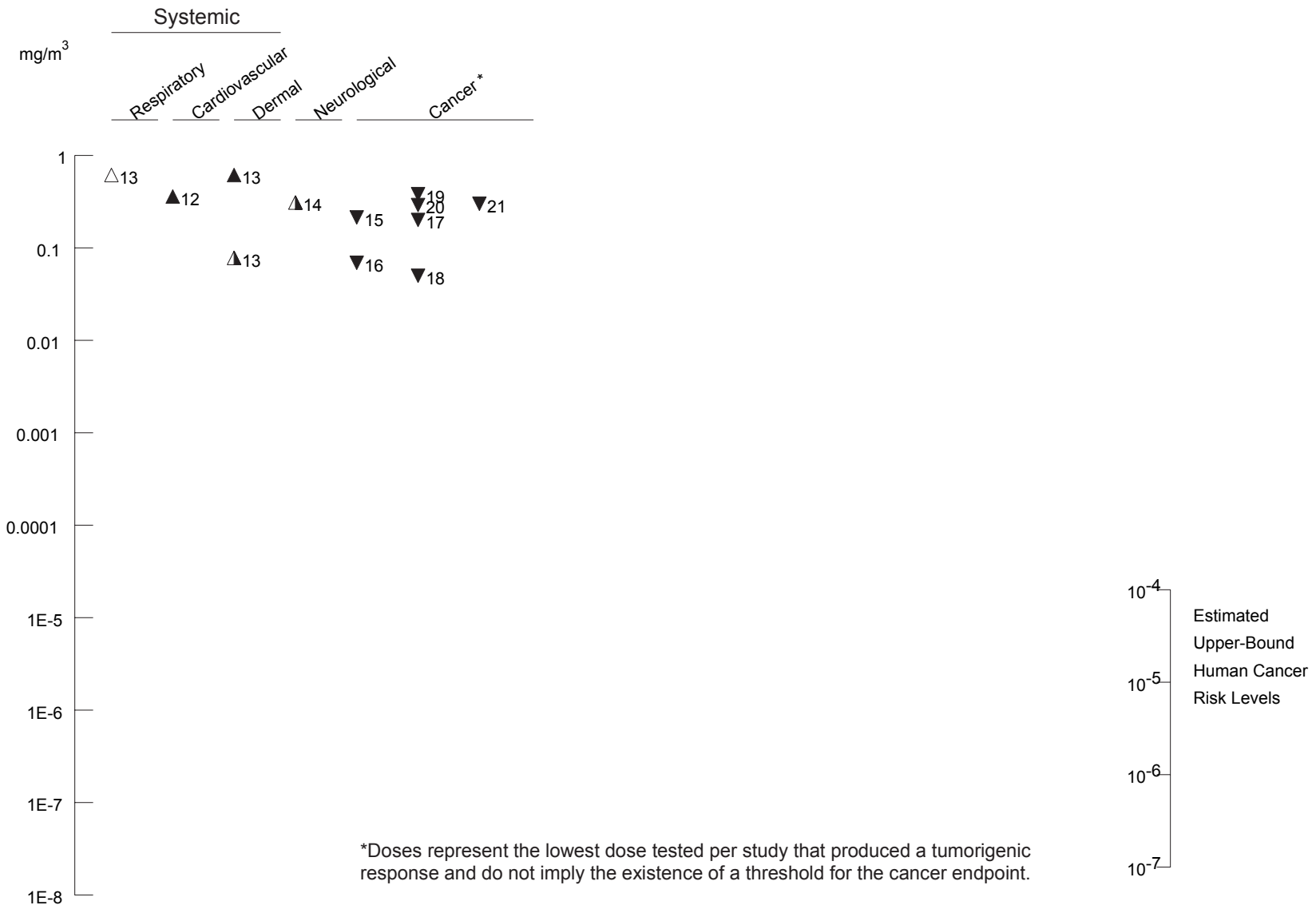


Table 3-2 Levels of Significant Exposure to Dimethylarsinic Acid - Inhalation

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/m^3)	LOAEL Less Serious (mg/m^3)	LOAEL Serious (mg/m^3)	Reference Chemical Form	Comments
ACUTE EXPOSURE								
Death								
1	Rat (Sherman)	2 hr				3900 F (LC50)	Stevens et al. 1979 DMA	
Systemic								
2	Rat (Sherman)	2 hr	Resp			4000 (respiratory distress)	Stevens et al. 1979 DMA	
			Gastro		4000 (diarrhea)			
			Dermal	4100	6900 F (erythematous lesions of ears and feet)			
			Ocular		4000 (eye encrustation)			
			Bd Wt		4000 (unspecified decrease in body weight)			
3	Mouse (Swiss-Webster)	5 min	Resp		3150 M (RD50)		Stevens et al. 1979 DMA	
INTERMEDIATE EXPOSURE								
Systemic								
4	Rat (Sprague-Dawley)	6 hr/d 5 d/wk 67-68 exposures	Resp	10	34 (intracytoplasmic eosinophilic globules in nasal turbinates)		Whitman 1994 DMA	
			Cardio	100				
			Gastro	100				
			Hemato	100				
			Hepatic	100				
			Renal	100				
			Endocr	100				
			Dermal	100				

Table 3-2 Levels of Significant Exposure to Dimethylarsinic Acid - Inhalation (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/m^3)	LOAEL		Reference Chemical Form	Comments
					Less Serious (mg/m^3)	Serious (mg/m^3)		
			Bd Wt	100				

a The number corresponds to entries in Figure 3-2.

Bd Wt = body weight; Cardio = cardiovascular; d = day(s); DMA = dimethylarsinic acid; F = female; Gastro = gastrointestinal; Hemato = hematological; hr = hour(s); LC50 = lethal concentration, 50% kill; LOAEL = lowest-observable-adverse-effect level; M = male; min = minute(s); NOAEL = no-observable-adverse-effect level; RD50 = 50% decrease in respiration rate; Resp = respiratory; wk = week(s); yr = year(s)

Figure 3-2 Levels of Significant Exposure to Dimethylarsinic Acid - Inhalation

Acute (≤14 days)

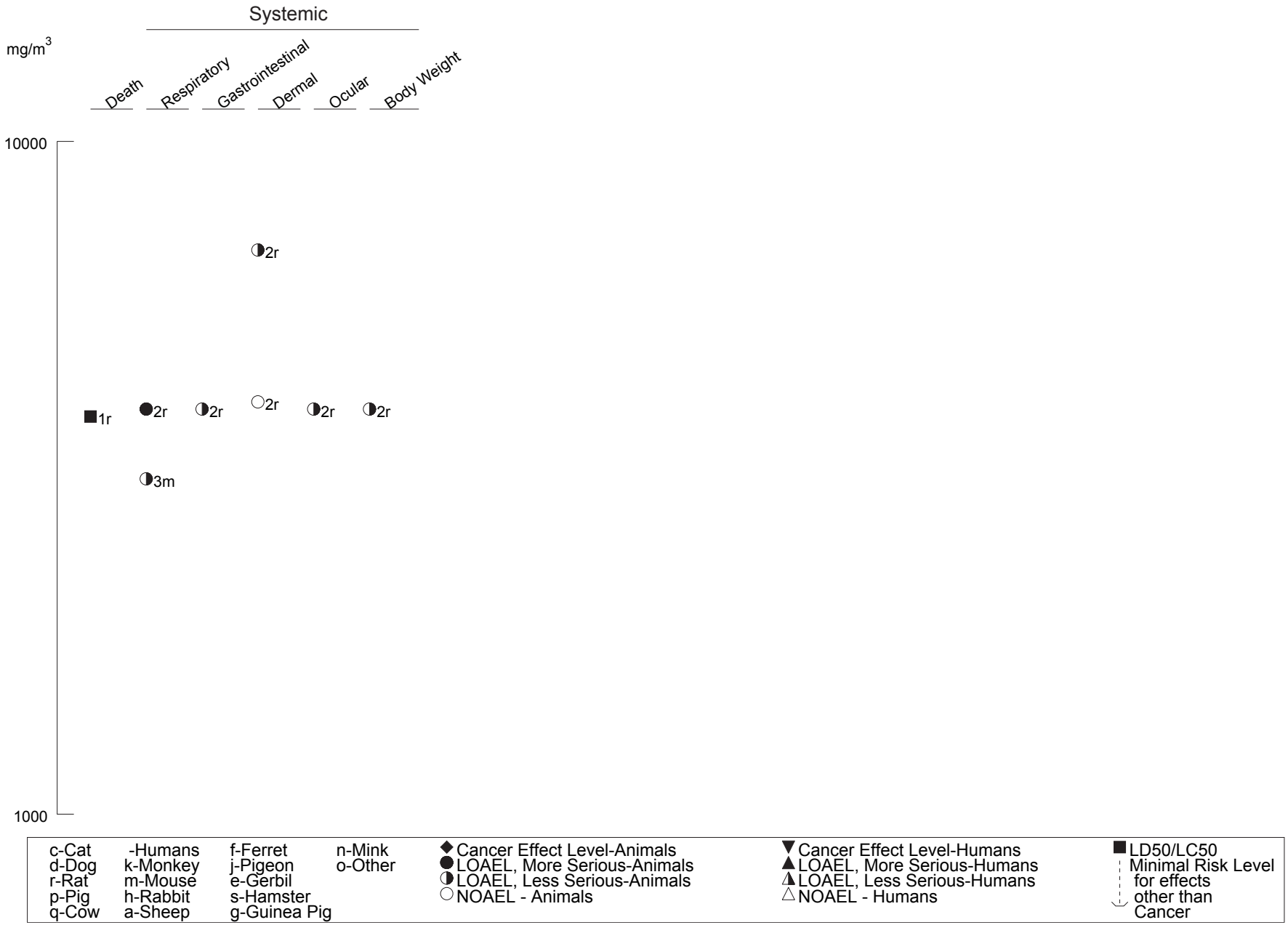
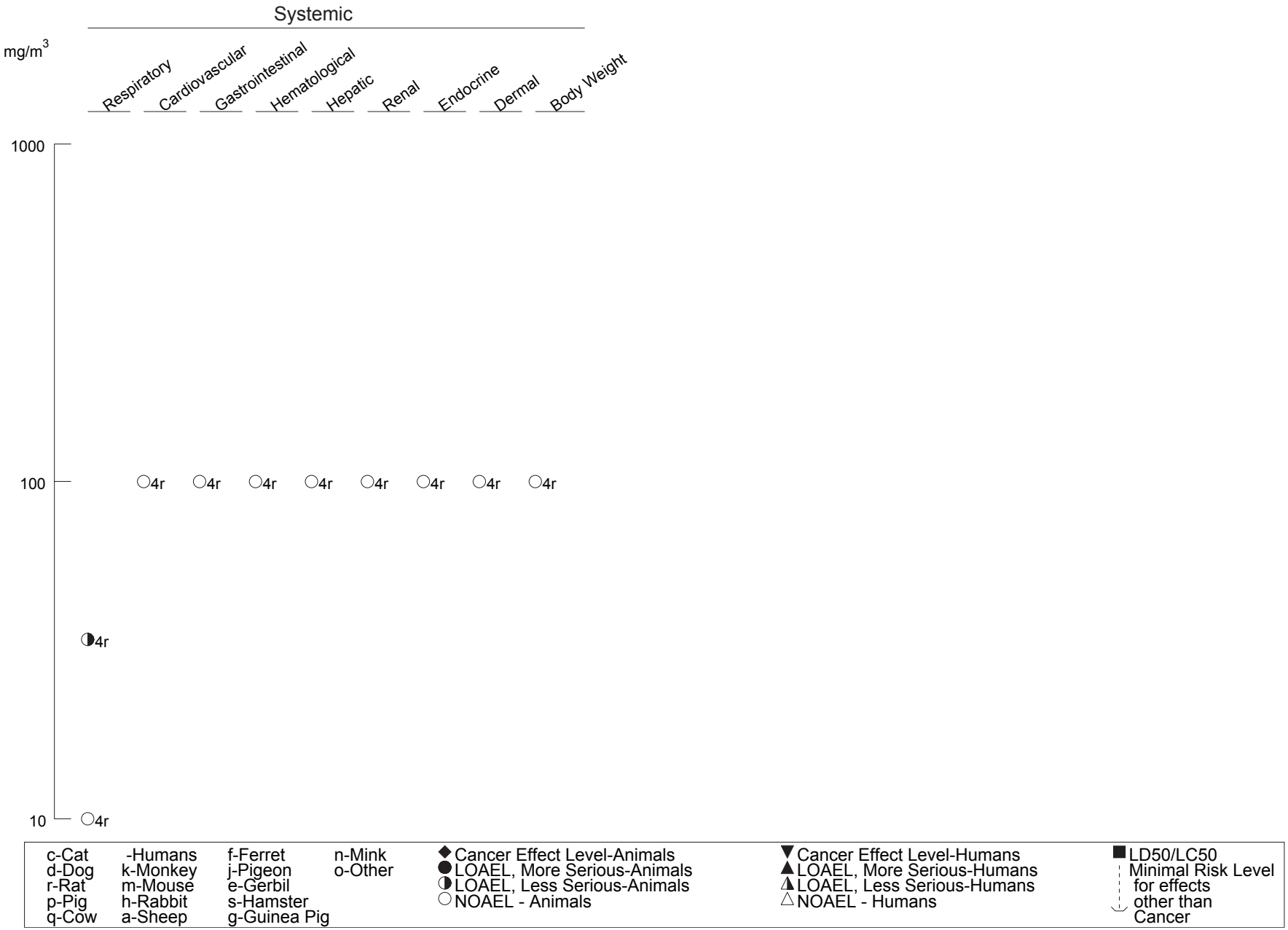


Figure 3-2 Levels of Significant Exposure to Dimethylarsinic Acid - Inhalation *(Continued)*

Intermediate (15-364 days)



3.2.1.1 Death

Inorganic Arsenicals. Although there are many studies of humans exposed to arsenic in air, no cases of lethality from short-term exposure were located. This suggests that death is not likely to be of concern following acute exposure, even at the very high exposure levels (1–100 mg As/m^3) found previously in the workplace (e.g., Enterline and Marsh 1982; Järup et al. 1989; Lee-Feldstein 1986). Delayed lethality from chronic exposure attributable to increased risk of cardiovascular disease or lung cancer is discussed below in Sections 3.2.1.2 and 3.2.1.7, respectively. The only report of a lethal effect of inhaled inorganic arsenic in animals was a developmental toxicology study in which four of nine pregnant rats died, and one rat was euthanized in extremis, between days 12 and 19 of gestation after 30–35 days of exposure to an aerosol of arsenic trioxide at an exposure concentration of 20 mg As/m^3 (Holson et al. 1999). These animals exhibited severe hyperemia and plasma discharge into the intestinal lumen at autopsy. In this same study, there was 100% mortality in groups of 10 pregnant rats after 1 day of exposure to concentrations ≥100 mg/m^3 (76 mg As/m^3).

Organic Arsenicals. No studies were located regarding death in humans after inhalation exposure to organic arsenicals. A 2-hour LC_{50} of 3,900 mg DMA/m^3 was calculated for DMA in female rats (Stevens et al. 1979). This LC_{50} is shown in Table 3-2 and Figure 3-2. Male rats and mice of both sexes were less susceptible, with only a few deaths after 2-hour exposures as high as 6,900 mg DMA/m^3 in rats and 6,400 mg DMA/m^3 in mice (Stevens et al. 1979). The cause of death was not specified, but was probably due to lung injury (see Section 3.2.1.2). No deaths were observed among rats and mice exposed to DSMA (the disodium salt of MMA) at concentrations up to 6,100 mg DSMA/m^3 in rats and 6,900 mg DSMA/m^3 in mice (Stevens et al. 1979). Chamber atmospheres at these high concentrations were so dense that it was difficult to see the animals clearly. These data indicate that there is no significant risk of acute lethality from concentrations of DMA or MMA that might be encountered in the environment or the workplace.

3.2.1.2 Systemic Effects

The highest NOAEL values and all reliable LOAEL values for systemic effects from inhalation exposure to inorganic arsenicals in each species and duration category are recorded in Table 3-1 and plotted in Figure 3-1, while the corresponding data for DMA are shown in Table 3-2 and Figure 3-2.

Respiratory Effects.

Inorganic Arsenicals. Workers exposed to arsenic dusts in air often experience irritation to the mucous membranes of the nose and throat. This may lead to laryngitis, bronchitis, or rhinitis (Dunlap 1921; Morton and Caron 1989; Pinto and McGill 1953), and very high exposures (characteristic of workplace exposures in the past) can cause perforation of the nasal septum (Dunlap 1921; Pinto and McGill 1953; Sandstrom et al. 1989). Despite the known respiratory irritant effects of arsenic, there have been few systematic investigations of respiratory effects in humans exposed to arsenic. Perry et al. (1948) found no difference in chest x-rays or respiratory performance (vital capacity and exercise-tolerance tests) between unexposed and exposed workers in a cross-sectional study at a factory where sodium arsenite was prepared. The NOAEL of 0.613 mg As/m^3 for respiratory effects in this study is shown in Table 3-1 and plotted in Figure 3-1.

Increased mortality due to respiratory disease has been reported in some cohort mortality studies of arsenic-exposed workers, but no conclusive evidence of an association with arsenic has been produced. In studies of workers exposed to arsenic trioxide at the Anaconda copper smelter in Montana, mortality due to noncancer respiratory disease (e.g., emphysema) was significantly increased compared to the general population (Lee-Feldstein 1983; Lubin et al. 2000; Welch et al. 1982). However, the data were not adjusted for smoking (a well-known confounder for respiratory disease), and analysis of the data with respect to arsenic exposure level did not show a clear dose-response. Similarly, Enterline et al. (1995) found a significant excess of nonmalignant respiratory disease mortality in workers at the ASARCO copper smelter in Tacoma, Washington, but only a slight negative relation to cumulative arsenic exposure. Xuan et al. (1993) found an increase in the relative risk of mortality from pneumoconiosis associated with arsenic exposure in a cohort of tin miners in China. However, this finding was based on a small number of observations (n=32), a clear exposure-response relationship with arsenic was not established, and the miners experienced confounding exposures to dust (a known risk factor for pneumoconiosis) and to radon. These studies were all considered to be inconclusive as to the relationship between inhaled inorganic arsenic and respiratory disease.

Respiratory symptoms were observed in a study of developmental effects in rats. Pregnant female rats exposed to arsenic trioxide dust starting 14 days prior to mating and continuing through mating and gestation exhibited rales at 8 mg As/m^3 and labored breathing and gasping at 20 mg As/m^3, with no symptoms at 2 mg As/m^3 (Holson et al. 1999). The lungs were examined by gross necropsy and no lesions were found. Intratracheal instillation of arsenic trioxide (13 mg As/kg) or gallium arsenide (1.5–

52 mg As/kg) can cause marked irritation and hyperplasia in the lungs of rats and hamsters (Goering et al. 1988; Ohyama et al. 1988; Webb et al. 1986, 1987). Since this sort of response is produced by a number of respirable particulate materials, it is likely that the inflammatory response is not specifically due to the arsenic.

Organic Arsenicals. No studies were located regarding respiratory effects in humans exposed to organic arsenicals. Short-term exposure of rats and mice to high concentrations (≥4,000 mg/m^3) of DMA caused respiratory distress, and necropsy of animals that died revealed bright red lungs with dark spots (Stevens et al. 1979). Respiratory distress was also observed in rats and mice exposed to high levels (≥6,100 mg/m^3) of the disodium salt of MMA (Stevens et al. 1979), although none of the MMA-exposed animals died. Respiratory distress appears to be associated with inhalation of very high concentrations of organic arsenicals. In 5-minute whole-body plethysmography trials, DMA and the disodium salt of MMA had RD_{50} (concentration calculated to produce a 50% decrease in respiration rate) values of 3,150 and 1,540 mg/m^3, respectively (Stevens et al. 1979). Based on these RD_{50} values, neither DMA nor MMA is considered to be a potent respiratory irritant. At low concentrations of DMA (34 or 100 mg DMA/m^3), an increase in intracytoplasmic eosinophilic globules were found in the nasal turbinates of rats exposed to DMA 6 hours/day, 5 days/week for 67–68 exposures (Whitman 1994).

Cardiovascular Effects.

Inorganic Arsenicals. There is some evidence from epidemiological studies that inhaled inorganic arsenic can produce effects on the cardiovascular system. Cardiovascular effects following oral exposure to arsenic are well known (see Section 3.2.2.2). A cross-sectional study of workers exposed to an estimated time-weighted average of 0.36 mg As/m^3 (as arsenic trioxide) at the Ronnskar copper smelter in Sweden for an average of 23 years showed that smelter workers had significantly increased incidences of Raynaud's phenomenon (a peripheral vascular disease characterized by spasm of the digital arteries and numbness of the fingers) and showed increased vasospasticity (constriction of blood vessels) in response to cold when tested in the fingers (Lagerkvist et al. 1986). A follow-up study conducted 2–3 years later found that vasospasticity measurements in exposed workers had improved concurrent with a reduction in arsenic exposure levels, although symptoms of peripheral vascular effects (cold hands or feet, white fingers, numbness in fingers or feet) were still common (Lagerkvist et al. 1988). A cross-sectional study including 46 workers in Denmark with varying, unquantified occupational exposure to arsenic in different occupations found that systolic blood pressure was significantly increased in the arsenic workers (median=125 mmHg) compared with controls (median=117 mmHg) (Jensen and Hansen 1998). Diastolic

pressure was also increased in this study (77.9 vs. 74.7 mmHg), although the difference from controls was not statistically significant.

Cohort mortality studies of arsenic-exposed workers at the ASARCO copper smelter in Tacoma, Washington (Enterline et al. 1995), Anaconda copper smelter in Montana (Lee-Feldstein 1983; Welch et al. 1982), Ronnskar copper smelter in Sweden (Wall 1980), orchard workers in Washington state (Tollestrup et al. 1995), and tin miners in China (Qiao et al. 1997; Xuan et al. 1993) have all reported increased risk of mortality from cardiovascular disease, specifically ischemic heart disease and cerebrovascular disease, in the cohorts studied. However, none of these studies provided conclusive evidence that the observed increase in risk was due to arsenic exposure. The studies in the ASARCO and Anaconda copper smelter workers failed to find a clear dose-response relationship with arsenic (Enterline et al. 1995; Welch et al. 1982), while a follow-up study of the Ronnskar smelter workers not only found lack of a dose-response, but also that the risk of cardiovascular disease was no longer elevated in the cohort (Järup et al. 1989). The studies in orchard workers and tin miners were limited by confounding exposures to copper, lead, and radon, respectively (Qiao et al. 1997; Tollestrup et al. 1995). The risk of cardiovascular disease mortality in the tin miners not only showed no dose-response relationship with arsenic exposure, but was positively associated with radon exposure, suggesting that radon may have been responsible for the increased cardiovascular risk in this cohort (Xuan et al. 1993).

The LOAEL for Raynaud's phenomenon and vasospasticity identified by Lagerkvist et al. (1986) is shown in Table 3-1 and Figure 3-1. No studies were located regarding cardiovascular effects in animals after inhalation exposure to inorganic arsenic.

Organic Arsenicals. No studies were located regarding cardiovascular effects in humans after inhalation exposure to organic arsenicals. No histological alterations were observed in the hearts of rats exposed to 100 mg DMA/m^3 for 67–68 exposures (Whitman 1994).

Gastrointestinal Effects.

Inorganic Arsenicals. Several case studies have reported nausea, vomiting, and diarrhea in workers with acute arsenic poisoning following occupational inhalation exposure (Beckett et al. 1986; Bolla-Wilson and Bleecker 1987; Ide and Bullough 1988; Morton and Caron 1989; Pinto and McGill 1953). Although gastrointestinal effects are not typically associated with arsenic poisoning by inhalation (Pinto and McGill 1953), such effects are a common feature of oral ingestion of high doses of arsenic (see Section 3.2.2.2),

and it is possible that mucociliary transport of arsenic dust from the lungs to the gut could be responsible for the effects in these cases. Exposure levels were not reliably estimated for any of these cases.

The only report of gastrointestinal effects of inhaled inorganic arsenic in animals was a developmental toxicology study in which four of nine pregnant rats died, and one rat was euthanized *in extremis*, between days 12 and 19 of gestation after 30–35 days of exposure to an aerosol of arsenic trioxide at an exposure concentration of 20 mg As/m^3 (Holson et al. 1999). These animals exhibited severe hyperemia and plasma discharge into the intestinal lumen at autopsy. Exposure to 8 mg As/m^3 did not produce gross gastrointestinal lesions.

Organic Arsenicals. Data regarding gastrointestinal effects in people exposed to organic arsenic in the air are limited. The frequency of gastrointestinal complaints was no higher than controls in workers exposed to arsanilic acid (i.e., 4-aminophenyl arsonic acid) at mean concentrations up to 0.17 mg/m^3 in a chemical factory (Watrous and McCaughey 1945). However, this sort of data might easily be biased by workers who chose not to complain about minor symptoms, so no conclusion can be reached. Rats and mice exposed to very high levels (above 3,000 mg/m^3) of MMA (disodium salt) or DMA experienced diarrhea (Stevens et al. 1979). The diarrhea could be due to transport of inhaled particulate material from the lungs to the gastrointestinal system or to direct ingestion of the compound (e.g., from grooming of the fur). No gastrointestinal effects were observed in rats repeatedly exposed to 100 mg DMA/m^3 6 hours/day, 5 days/week for 67–68 exposures (Whitman 1994).

Hematological Effects.

Inorganic Arsenicals. Although anemia is a common feature of arsenic poisoning following oral exposure in humans (see Section 3.2.2.2), case studies of workers with arsenic poisoning from occupational inhalation exposure reported no effects on red blood cell count (Beckett et al. 1986; Bolla-Wilson and Bleecker 1987; Ide and Bullough 1988; Morton and Caron 1989). The reason for this apparent route specificity is not clear, but might simply be related to dose. No studies were located regarding hematological effects in animals after inhalation exposure to inorganic arsenicals.

Organic Arsenicals. No effect on levels of hemoglobin, red cells, or white cells was detected in the blood of manufacturing workers (323 counts in 35 workers) exposed to airborne arsanilic acid dusts at a mean concentration of 0.17 mg/m^3 in the workplace (Watrous and McCaughey 1945). Controls were an unspecified number of unexposed manufacturing workers with 221 complete blood counts. No

hematological alterations were observed in rats exposed to 100 mg DMA/m^3 for an intermediate duration (Whitman 1994).

Musculoskeletal Effects.

Inorganic Arsenicals. Few data were located regarding musculoskeletal effects associated with inhalation exposure to inorganic arsenic, and none to suggest the existence of any such effects. Electromyographic examination of the calves and feet showed no differences between control and arsenic-exposed workers in a cross-sectional study of workers at the Ronnskar copper smelter in Sweden (Blom et al. 1985). No studies were located regarding musculoskeletal effects in animals after inhalation exposure to inorganic arsenicals.

Organic Arsenicals. No studies were located regarding musculoskeletal effects in humans or animals after inhalation exposure to organic arsenicals.

Hepatic Effects.

Inorganic Arsenicals. There is no evidence that inhaled inorganic arsenic produces effects on the liver, although few data are available. Case studies of workers with inhalation arsenic poisoning that included liver function tests did not find any evidence of hepatic dysfunction (Bolla-Wilson and Bleecker 1987; Ide and Bullough 1988). No studies were located regarding hepatic effects in animals after inhalation exposure to inorganic arsenicals.

Organic Arsenicals. No studies were located regarding hepatic effects in humans after inhalation exposure to organic arsenicals. No histological alterations were observed in the livers of rats exposed to 100 mg DMA/m^3 for 67–68 exposures (Whitman 1994).

Renal Effects.

Inorganic Arsenicals. The limited data available do not suggest any relationship between inhalation of inorganic arsenic and kidney effects. A cross-sectional study of renal function parameters in glass factory workers exposed to arsenic (concentrations unknown) found no meaningful differences from controls in urinary levels of several proteins (albumin, retinol binding protein, β_2-microglobulin, brush-border antigen) used as markers of glomerular damage or tubular cell exfoliation (Foà et al. 1987). Routine

clinical urinalysis was normal when included in case studies of workers with inhalation arsenic poisoning (Ide and Bullough 1988; Morton and Caron 1989). No studies were located regarding renal effects in animals after inhalation exposure to inorganic arsenicals.

Organic Arsenicals. No studies were located regarding renal effects in humans after inhalation exposure to organic arsenicals. No renal effects were reported in rats exposed to 100 mg DMA/m^3 6 hours/day, 5 days/week for 67–68 exposures (Whitman 1994).

Dermal Effects.

Inorganic Arsenicals. Dermatitis has frequently been observed in industrial workers exposed to inorganic arsenic in the air, with the highest rates occurring in the workers with the greatest arsenic exposure (Cöl et al. 1999; Dunlap 1921; Holmqvist 1951; Lagerkvist et al. 1986; Pinto and McGill 1953). Limited quantitative information is available regarding the exposure levels that produce dermatitis, and the high likelihood of co-exposure by the dermal route makes dose-response analysis difficult. A cross-sectional study of workers at a factory where sodium arsenite was prepared found that workers with the highest arsenic exposure (mean air levels ranging from 0.384 to 1.034 mg As/m^3 and estimated to average 0.613 mg As/m^3) tended to be grossly pigmented with hyperkeratinization of exposed skin and to have multiple warts (Perry et al. 1948). In the same study, workers with lower arsenic exposure (estimated to average 0.078 mg As/m^3) were much less affected, but still had a higher incidence of pigmentation keratosis than controls. LOAEL values identified by Perry et al. (1948) and Mohamed (1998) are shown in Table 3-1 and Figure 3-1. NOAEL values for dermal irritation have not been identified. Dermal effects (hyperkeratoses, hyperpigmentation) are also very common in people exposed to inorganic arsenic by the oral route (see Section 3.2.2.2). No studies were located on dermal effects in animals after inhalation exposure to inorganic arsenicals.

Organic Arsenicals. Data regarding dermal effects in people exposed to organic arsenic in the air are limited. Complaints of keratosis were roughly 2-fold higher than unexposed controls in female packaging workers exposed to arsanilic acid at an average concentration of 0.065 mg/m^3 and in male manufacturing workers exposed to an average concentration of 0.17 mg/m^3 in a chemical factory (Watrous and McCaughey 1945). Limitations in study methodology (e.g., alternate sources of effects were not investigated, workers might choose not to report minor complaints to company officials) make the reliability of this observation uncertain. Female rats exposed to DMA at 6,900 mg/m^3 developed erythematous lesions on the feet and ears (Stevens et al. 1979); these lesions did not develop in females

exposed at lower concentrations (4,100 mg/m^3) or males. It seems likely that these effects were due to direct irritation from dermal contact with the dust. No dermal effects were observed in rats repeatedly exposed to lower levels of DMA (100 mg/m^3) (Whitman 1994).

Ocular Effects.

Inorganic Arsenicals. Chemical conjunctivitis, characterized by redness, swelling, and pain, has been observed in workers exposed to arsenic dusts in air, usually accompanied by facial dermatitis (Dunlap 1921; Pinto and McGill 1953). No information was located regarding air levels of arsenic that produce this effect. No studies were located on ocular effects in animals after inhalation exposure to inorganic arsenicals.

Organic Arsenicals. No studies were located on ocular effects in humans after inhalation exposure to organic arsenicals. Rats and mice exposed to high concentrations of DMA (≥4,000 mg/m^3) developed an encrustation around the eyes (Stevens et al. 1979). It seems likely that these effects were due to direct irritation from ocular contact with the dust.

Body Weight Effects.

Inorganic Arsenicals. No studies were located on body weight effects in humans after inhalation exposure to inorganic arsenicals. Female rats exposed to arsenic trioxide dust starting 14 days before mating and continuing through mating and gestation showed a marked decrease in body weight and food consumption at 20 mg As/m^3 (preliminary study) and a smaller decrease at 8 mg As/m^3 (definitive study), with no effect at 2 mg As/m^3 (Holson et al. 1999).

Organic Arsenicals. No studies were located on body weight effects in humans after inhalation exposure to organic arsenicals. Rats and mice exposed to high concentrations of DMA (≥4,000 mg/m^3) for 2 hours had an unspecified decrease in body weight gain during the subsequent 14 days (Stevens et al. 1979). No alterations in body weight gain were observed in rats exposed to 100 mg DMA/m^3 for 67–68 exposures (Whitman 1994).

3.2.1.3 Immunological and Lymphoreticular Effects

Inorganic Arsenicals. A single study was located regarding the immunological and lymphoreticular effects of inhaled inorganic arsenic in humans. Bencko et al. (1988) detected no abnormalities in serum levels of immunoglobins in 47 workers exposed to arsenic (exposure levels not measured) in a coal-burning power plant. However, serum levels of other proteins such as transferrin, orosomucoid, and ceruloplasmin were significantly elevated compared to levels in a group of 27 workers from a different plant in which the arsenic content in the coal was 10 times lower. The investigators suggested that the increased levels of ceruloplasmin might be related to higher cancer mortality rates found among these workers.

The immune effects of inhaled arsenic in animals were studied by Aranyi et al. (1985). Female mice exposed to arsenic trioxide aerosol for 3 hours showed a concentration-related decrease in pulmonary bactericidal activity (presumably as a result of injury to alveolar macrophages) and a corresponding concentration-related increase in susceptibility to introduced respiratory bacterial pathogens. Similar results were found when the exposure was repeated over 1- and 4-week periods. The NOAEL and LOAEL values for this study are shown in Table 3-1 and Figure 3-1.

Intratracheal studies in animals offer some support for an immune effect of inhaled inorganic arsenic. Decreases in humoral response to antigens and in several complement proteins were noted in mice given an intratracheal dose of 5.7 mg As/kg as sodium arsenite (Sikorski et al. 1989), although these changes were not accompanied by any decrease in resistance to bacterial or tumor cell challenges. Animals given an intratracheal dose of GaAs (25 mg As/kg or higher) also displayed a variety of changes in numerous immunological end points (some increased, some decreased) (Burns and Munson 1993; Sikorski et al. 1989). Whether these effects were due to a direct effect on the immune system or were secondary to the inflammatory effect of GaAs on the lung (see Section 3.2.1.2, above) is uncertain.

Organic Arsenicals. No studies were located regarding immunological and lymphoreticular effects in humans or animals after inhalation exposure to organic arsenicals.

3.2.1.4 Neurological Effects

Inorganic Arsenicals. There is evidence from epidemiological studies that inhaled inorganic arsenic can produce neurological effects. A study by Gerr et al. (2000) reported an elevated incidence of peripheral neuropathy in subjects who lived near an arsenic-using pesticide plant (13/85=15.3%; odds ratio

[OR]=5.1, p=0.004), relative to subjects who lived farther from the plant (4/118=3.4%). Concentrations of arsenic in soil and house dust were elevated (~30–300 µg As/g) for residences near the plant, according to 1993–1995 monitoring data. Studies of copper smelter workers at the ASARCO smelter in Tacoma, Washington (Feldman et al. 1979), a power station in Slovakia (Buchancová et al. 1998), and the Ronnskar smelter in Sweden (Blom et al. 1985; Lagerkvist and Zetterlund 1994) have demonstrated peripheral neurological effects in workers associated with arsenic trioxide exposure. At the ASARCO smelter, the prevalence of clinically diagnosed peripheral neuropathy was markedly higher in arsenic-exposed workers (26/61=43%) than controls (4/33=12%), and although the difference in mean nerve conduction velocities (NCV) was not statistically significant, mean peroneal motor NCV was lower in arsenic-exposed workers than controls and all 12 cases of abnormally low NCV occurred in the arsenic group (Feldman et al. 1979). In the study of 70 workers in Slovakia, the investigators described 16 cases of arsenic intoxication. Among these, 13 had signs and symptoms of sensory and motor polyneuropathy on both upper and lower extremities, 10 were diagnosed with pseudoneurasthenic syndrome, and 6 suffered from toxic encephalopathy (Buchancová et al. 1998). The average length of exposure was 22.3 years (SD ±8.4 years) and the average arsenic exposure in inhaled air ranged from 4.6 to 142.7 µg/m^3. Similar results were observed at the Ronnskar smelter, where Blom et al. (1985) reported significantly increased prevalence of workers with abnormally low NCV in the exposed group, and lower, but not statistically significant, mean NCV in five peripheral nerves. A follow-up study on the Ronnskar workers 5 years later found that the prevalence of abnormally low NCV remained significantly increased in the exposed workers, but that the decrease in mean NCV was now also statistically significant in the tibial (motor) and sural (sensory) nerves (Lagerkvist and Zetterlund 1994). Blood lead was monitored in this study as a potential confounder, but levels were low and not considered likely by the researchers to have had any influence on the results. The follow-up Ronnskar study provided enough information to estimate that mean arsenic exposure was 0.31 mg As/m^3 and lasted an average of 28 years in the exposed group, and this LOAEL is shown in Table 3-1 and Figure 3-1.

The literature also contains several case studies of workers with inhalation arsenic poisoning who developed neurological symptoms. Although these studies do not provide reliable information on exposure levels or conclusive evidence that the observed effects were related to arsenic, the findings are suggestive. Symptoms in these cases included not only indicators of peripheral neuropathy (numbness, loss of reflexes, muscle weakness, tremors) (Ide and Bullough 1988; Morton and Caron 1989), but also frank encephalopathy (hallucinations, agitation, emotional lability, memory loss) (Beckett et al. 1986; Bolla-Wilson and Bleecker 1987; Morton and Caron 1989). Both peripheral neuropathy and encephalopathy are associated with oral exposure to inorganic arsenic (see Section 3.2.2.4).

The possible association between arsenic in air and neurological effects in children has also been examined. A study by Bencko et al. (1977) reported that children of approximately 10 years of age (n=56) living near a power plant burning coal of high arsenic content showed significant hearing losses (increased threshold) compared to a control group of children (n=51) living outside the polluted area (Bencko et al. 1977). The effect was most marked at low frequencies. The precise site affected within the auditory pathway was not determined and could have been in the periphery, centrally-located, or both. A small study of children in Mexico reported a significant negative correlation between tests of verbal IQ and urinary arsenic in children (n=41) living in an urban area near a smelter complex (Calderón et al. 2001). Exposure concentrations were not available in either study.

No studies were located regarding neurological effects in animals after inhalation exposure to inorganic arsenicals. Mice given a single intratracheal dose of 200 mg/kg of GaAs displayed a decrease in overall activity 6–8 hours later, but no additional neurological evaluations were conducted on these animals (Burns and Munson 1993).

Organic Arsenicals. Data regarding neurological effects in people exposed to organic arsenic in the air are limited to a single study. The frequency of central nervous system complaints was no higher than controls in workers at a chemical factory exposed to arsanilic acid at mean concentrations up to 0.17 mg/m^3 (Watrous and McCaughey 1945). Although peripheral nerve complaints were higher in arsenic packaging workers (mean exposure=0.065 mg/m^3) than in unexposed controls, this was not the case in manufacturing workers with higher arsenic exposure (mean=0.17 mg/m^3). This suggests that the effects on the peripheral nerves in the exposed packaging workers were not due to arsenic. The reliability of these data is limited by shortcomings in the study methodology (e.g., the data might easily be biased by workers who chose not to complain about minor symptoms). No studies were located regarding neurological effects in animals after inhalation exposure to organic arsenicals.

3.2.1.5 Reproductive Effects

Inorganic Arsenicals. No studies were located regarding reproductive effects in humans after inhalation exposure to inorganic arsenicals. Reproductive performance was evaluated in female rats exposed to 0.08–20 mg As/m^3 (preliminary study) or 0.2–8 mg As/m^3 (definitive study) as As_2O_3 6 hours daily from 14 days prior to mating through gestation day 19 (Holson et al. 1999). No changes occurred in the precoital interval (time to mating), mating index (percentage of rats mated), or fertility index (percentage

of matings resulting in pregnancy). The NOAEL values for this study are shown in Table 3-1 and Figure 3-1.

Organic Arsenicals. No studies were located regarding reproductive effects in humans or animals after inhalation exposure to organic arsenicals.

3.2.1.6 Developmental Effects

Inorganic Arsenicals. Developmental effects associated with occupational and environmental exposure to airborne arsenic have been investigated in a series of studies at the Ronnskar copper smelter in northern Sweden (Nordström et al. 1978a, 1978b, 1979a, 1979b). In comparison to a northern Swedish reference population, female employees of the smelter had a significantly increased incidence of spontaneous abortion (Nordström et al. 1979a), and their children had a significantly increased incidence of congenital malformations (Nordström et al. 1979b) and significantly decreased average birth weight (Nordström et al. 1978a). Increased incidence of spontaneous abortion and decreased average birth weight of children were also found in populations living in close proximity to the smelter (Nordström et al. 1978a, 1978b, 1979b). While these data are suggestive of developmental effects associated with occupational and environmental exposure from the smelter, the reported effects are not large, the analyses include only limited consideration of potential confounders (e.g., smoking), and there are no data relating the apparent effects specifically to arsenic exposure.

Ihrig et al. (1998) conducted a case-control study of stillbirths in the vicinity of a Texas arsenic pesticide factory that included estimation of environmental arsenic exposures using atmospheric dispersion modeling and multiple regression analysis considering arsenic exposure, race/ethnicity, maternal age, median income, and parity as explanatory variables. There was a statistically significant increase in the risk of stillbirth in the highest exposure category (>100 ng As/m^3, midpoint=682 ng/m^3). Further analysis showed that this increase in risk was limited to people of Hispanic descent, who the researchers speculated may be an especially sensitive population due to a genetic impairment in folate metabolism. Interpretation of this study is limited by small numbers of cases and controls in the high exposure group, lack of data on smoking, potential confounding exposures to other chemicals from the factory, and failure to take into account previous years of deposition in the exposure estimates.

Arsenic has been shown to produce developmental effects by inhalation exposure in laboratory animals, although it is unclear whether or not the effects occur only at maternally toxic doses. Mice exposed to

22 mg As/m^3 (as As_2O_3) for 4 hours on days 9–12 of gestation had serious developmental effects (significant increases in the percentage of dead fetuses, skeletal malformations, and the number of fetuses with retarded growth), while those exposed to 2.2 mg As/m^3 had only a 10% decrease in average fetal body weight, and those exposed to 0.20 mg As/m^3 had no effects (Nagymajtényi et al. 1985). The study was limited by failure to quantify malformations on a litter basis, discuss the nature and severity of the observed malformations, or report on the occurrence of maternal effects. No increases in fetal resorptions, fetal mortality, or malformations, and no decreases in fetal body weight occurred when rats were exposed to 0.2–8 mg As/m^3 (as As_2O_3), 6 hours daily from 14 days prior to mating through gestation day 19 (Holson et al. 1999). At the 8 mg/m^3 exposure level, toxicity was observed in the dams, including rales, a dried red exudate at the nose, and lower gains in net body weight than controls. In a preliminary dose-range study, there was a marked significant increase in postimplantation loss (primarily early resorptions) and consequent marked significant decrease in viable fetuses per litter at 20 mg As/m^3, a concentration that also produced severe maternal effects including mortality (Holson et al. 1999).

The NOAEL and LOAEL values for increased risk of stillbirth in humans identified by Ihrig et al. (1998) and those for developmental effects in rodents found by Nagymajtényi et al. (1985) and Holson et al. (1999) are shown in Table 3-1 and Figure 3-1.

Organic Arsenicals. No studies were located regarding developmental effects in humans or animals after inhalation exposure to organic arsenicals.

3.2.1.7 Cancer

Inorganic Arsenicals. There is convincing evidence from a large number of epidemiological studies that inhalation exposure to inorganic arsenic increases the risk of lung cancer. Most studies involved workers exposed primarily to arsenic trioxide dust in air at copper smelters (Axelson et al. 1978; Brown and Chu 1982, 1983a, 1983b; Enterline and Marsh 1982; Enterline et al. 1987a, 1987b, 1995; Ferreccio et al. 1996; Järup and Pershagen 1991; Järup et al. 1989; Lee and Fraumeni 1969; Lee-Feldstein 1983, 1986; Lubin et al. 2000; Mazumdar et al. 1989; Pinto et al. 1977, 1978; Sandstrom et al. 1989; Viren and Silvers 1999; Wall 1980; Welch et al. 1982) and mines (Liu and Chen 1996; Qiao et al. 1997; Taylor et al. 1989; Xuan et al. 1993), but increased incidence of lung cancer has also been observed at chemical plants where exposure was primarily to arsenate (Bulbulyan et al. 1996; Mabuchi et al. 1979; Ott et al. 1974; Sobel et al. 1988). In addition, several studies suggest that residents living near smelters or arsenical chemical plants may also have increased risk of lung cancer (Brown et al. 1984; Cordier et al. 1983; Matanoski et

al. 1981; Pershagen 1985), although the increases are small and are not clearly detectable in all cases (e.g., Frost et al. 1987). The strongest evidence that arsenic is responsible for the observed lung cancer comes from quantitative dose-response data relating specific arsenic exposure levels to lung cancer risk. These data are available for arsenic-exposed workers at the ASARCO copper smelter in Tacoma, Washington (Enterline and Marsh 1982; Enterline et al. 1987a, 1995; Mazumdar et al. 1989), the Anaconda copper smelter in Montana (Lee-Feldstein 1986; Welch et al. 1982), eight other U.S. copper smelters (Enterline et al. 1987b), and the Ronnskar copper smelter in Sweden (Järup and Pershagen 1991; Järup et al. 1989). A common limitation of these studies is confounding exposure to other chemicals, such as sulfur dioxide, and cigarette smoking.

Enterline and Marsh (1982) reported a significant increase in respiratory cancer mortality (standard mortality ratio [SMR]=189.4) based on 104 observed respiratory cancer deaths and only 54.9 expected over the years 1941–1976 in a cohort of 2,802 male workers employed for ≥1 year between 1940 and 1964 at the ASARCO smelter. When the cohort was separated into low and high arsenic exposure groups, with mean estimated time-weighted average arsenic exposures of 0.054 and 0.157 mg As/m^3, respectively (based on work history, historical urinary arsenic measurements, and an experimentally derived relationship between urinary and inhaled arsenic), respiratory cancer mortality was significantly increased in both groups in a concentration-related fashion (SMR=227.7 and 291.4 in the low and high groups, respectively). Enterline et al. (1987a) re-analyzed these data using improved exposure estimates that incorporated historical measurements of arsenic in the ambient air and personal breathing zone of workers. Respiratory cancer mortality was significantly increased in a concentration-related fashion in the low (SMR=213.0), medium (SMR=312.1), and high (SMR=340.9) arsenic exposure groups, which had mean estimated time-weighted average arsenic exposures of 0.213, 0.564, and 1.487 mg As/m^3, respectively. An alternative analysis of these data by Mazumdar et al. (1989) produced similar results. Enterline et al. (1995) extended the mortality follow-up from 1976 to 1986, but reported findings similar to the earlier study in a less thorough analysis. The CEL from Enterline et al. (1987a), the most complete analysis of the ASARCO cohort with the best exposure estimates, is presented in Table 3-1 and Figure 3-1.

Respiratory cancer mortality was significantly increased (SMR=285) based on 302 observed respiratory deaths between 1938 and 1977 in a cohort of 8,045 white male workers employed for at least 1 year between 1938 and 1956 at the Anaconda smelter (Lee-Feldstein 1986). When workers were categorized according to cumulative arsenic exposure and date of hire, lung cancer mortality was significantly increased in all groups hired between 1925 and 1947. Workers in the lowest cumulative exposure group

(<10 mg-mo/m^3) were reported to have had <2 years of exposure at an average arsenic concentration of 0.38 mg/m^3. An alternative analysis of a subset of the Anaconda cohort (n=1,800, including all 277 employees with heavy arsenic exposure and 20% of the others) that included information on smoking and other occupational exposures was performed by Welch et al. (1982). This analysis showed that lung cancer mortality increased with increasing time-weighted average arsenic exposure, with a small nonsignificant increase in the low group (SMR=138) exposed to 0.05 mg/m^3 and significant increases in the medium (SMR=303), high (SMR=375), and very high (SMR=704) groups exposed to 0.3, 2.75, and 5.0 mg/m^3, respectively. Cohort members were more likely to be smokers than U.S. white males, but smoking did not differ among the arsenic exposure groups. Exposure-response analysis of smokers was similar to the analysis based on the full subcohort, while analysis of nonsmokers (limited by small group sizes) also showed a similar pattern, but with lower SMRs. In a followup analysis of the same cohort, Lubin et al. (2000) re-weighted the exposure concentrations based on duration and time of exposure and re-evaluated the effects of exposure. Relative risks for respiratory cancer increased with increasing duration in each arsenic exposure area (light, medium, and heavy) after adjustment for duration in the other two exposure areas. SMRs were significantly elevated following exposure to 0.58 mg/m^3 (medium; SMR=3.01, 95% CI=2.0–4.6) or 11.3 mg/m^3 (high; SMR=3.68, 95% CI=2.1–6.4) for 10 or more years, and following exposure to 0.29 mg/m^3 (low; SMR=1.86, 95% CI=1.2–2.9) for 25 or more years. The CELs from the analyses of the Anaconda cohort are presented in Table 3-1 and Figure 3-1.

Enterline et al. (1987b) studied the mortality experience from 1949 to 1980 of a cohort of 6,078 white males who had worked for 3 years or more between 1946 and 1976 at one of eight U.S. copper smelters in Arizona, Utah, Tennessee, and Nevada. Lung cancer mortality was significantly increased only in the Utah smelter (SMR=226.7), which had the highest average arsenic exposure concentration (0.069 mg/m^3 vs. 0.007–0.013 mg/m^3 in the other smelters) and also contributed the largest number of cohort members (n=2,288 vs. 189–965 from the other smelters). A nested case-control study showed that arsenic exposure and cigarette smoking were significant risk factors for lung cancer in the smelter workers. Smoking was lower in the Utah smelter workers than in the other smelter workers, but still higher than in the referent Utah population, suggesting that the risk attributable to arsenic in this study population is somewhat lower than indicated by the SMR reported above. The CEL from this study is presented in Table 3-1 and Figure 3-1.

Järup et al. (1989) reported significantly increased lung cancer mortality (SMR=372, 95% confidence interval [CI]=304–450) based on 106 lung cancer deaths in a cohort of 3,916 male workers employed for ≥3 months between 1928 and 1967 at the Ronnskar smelter and followed for mortality through 1981.

Workers were separated into low, medium, and high arsenic exposure groups with mean time-weighted average exposure estimates of 0.05, 0.2, and 0.4 mg/m^3, respectively. Lung cancer mortality was significantly increased in all three exposure groups in a concentration-related fashion (SMR=201, 353, and 480, respectively). A nested case-control analysis of 102 lung cancer cases and 190 controls from the cohort showed that lung cancer risk increased with increasing arsenic exposure in nonsmokers, light smokers, and heavy smokers (Järup and Pershagen 1991). The results demonstrated that arsenic is a risk factor for lung cancer in the smelter workers, but also suggested a greater-than-additive interaction between smoking and arsenic exposure. In this analysis, in contrast to the cohort study, lung cancer risk due to arsenic was increased only in the higher arsenic-exposure groups. Potential explanations for this difference between the cohort and case-control analyses include a higher proportion of smokers in the smelter workers than in the regional referent population in the cohort study, and limited power to detect increased risk in the case-control study due to small group sizes in the dose-response analysis. The CELs from both the cohort and case-control studies are presented in Table 3-1 and Figure 3-1.

Several researchers have examined the histological cell types of lung cancer (epidermoid carcinoma, small cell carcinoma, adenocarcinoma) in arsenic-exposed workers (e.g., Axelson et al. 1978; Newman et al. 1976; Pershagen et al. 1987; Qiao et al. 1997; Wicks et al. 1981). Although the incidence of the various cell types varied from population to population, all studies found an increase in several tumor types. This indicates that arsenic does not specifically increase the incidence of one particular type of lung cancer.

The studies of the ASARCO cohort (Enterline and Marsh 1982; Enterline et al. 1987a, 1995) noted a supralinear exposure-response relationship (i.e., steeper at lower doses) between arsenic exposure and lung cancer mortality. Hertz-Picciotto and Smith (1993) extended this observation to several other occupationally exposed cohorts with quantitative exposure information. The authors suggest that neither toxicokinetic mechanisms nor confounding from age, smoking, or other workplace carcinogens that differ by exposure level are likely explanations for the curvilinearity. Plausible explanations offered include: (1) synergism (with smoking), which varies in magnitude according to the level of arsenic exposure, (2) long-term survivorship at higher exposures among the healthier, less susceptible individuals, and (3) exposure estimate errors that were more prominent at higher-exposure levels as a result of past industrial hygiene sampling or worker protection practices.

Quantitative risk estimates for inhaled inorganic arsenic have been derived using the exposure-response data. EPA derived a unit risk estimate (the excess risk of lung cancer associated with lifetime exposure to

1 μg/m^3) of 4.3x10^{-3} per (μg/m^3) based on the dose-response relationships between arsenic exposure and excess lung cancer mortality in workers at the Anaconda smelter in Montana (Brown and Chu 1982, 1983a, 1983b; Lee-Feldstein 1983; and an unpublished paper by Higgins and associates) and the ASARCO smelter in Tacoma, Washington (Enterline and Marsh 1982; EPA 1984a; IRIS 2007). In some cases, calculations of exposure, as well as the procedures for generating quantitative risk estimates, are quite complex and the interested reader is referred to the EPA documents (EPA 1981c, 1984a, 1987e, 1996b; IRIS 2007) for a detailed description. Viren and Silvers (1994) re-evaluated the unit risk estimate using the same methods as EPA, but incorporating updated results from the ASARCO smelter (Enterline et al. 1987a; Mazumdar et al. 1989) and the findings from the Swedish smelter (Järup et al. 1989). Their analysis yielded a revised unit risk of 1.28x10^{-3} per (μg/m^3) that, when pooled with the earlier estimate from the Montana smelter cohort, yielded a composite unit risk of 1.43x10^{-3} per (μg/m^3). This unit risk estimate is a factor of 3 smaller than the EPA's current estimate of 4.3x10^{-3} per (μg/m^3). Figure 3-1 shows the air concentrations that correspond to excess lifetime cancer risks of 10^{-4}–10^{-7} based on the EPA unit risk estimate.

There have been occasional reports of other types of cancer (i.e., nonrespiratory cancer) potentially associated with inhalation exposure to inorganic arsenic, but there is no strong evidence for any of them. For example, Enterline et al. (1995) found significantly increased mortality due to cancer of the large intestine and bone cancer in the ASARCO cohort. However, neither cancer showed any relation to cumulative arsenic exposure, and the purported increase in bone cancer risk was based on a very small number of observations. Pesch et al. (2002) reported an increase in nonmelanoma skin cancers resulting from exposure from a Slovakian coal-burning power plant, but exposure levels associated with the lesions were not presented. Bencko et al. (2005) also reported an increase in the incidence of nonmelanoma skin cancer among workers of a power plant burning coal of a high arsenic content and in the population living in the vicinity of the power plant. Bulbulyan et al. (1996) reported an increase in risk of stomach cancer among workers exposed to the highest average arsenic concentrations at a Russian fertilizer plant, but this finding, which was based on a small number of observations and was only marginally statistically significant, was confounded by exposure to nitrogen oxides, which were more convincingly associated with stomach cancer in this study. Wingren and Axelson (1993) reported an association between arsenic exposure and stomach and colon cancer in Swedish glass workers, but this result was confounded by concomitant exposure to other metals. Lee-Feldstein (1983) observed a small, marginally significant increase in digestive tract cancer (SMR=125) in one study of the Anaconda cohort, but this was not found in other studies of this cohort (Lee and Fraumeni 1969; Lee-Feldstein 1986; Welch et al. 1982). Wulff et al. (1996) observed an apparent increase in the risk of childhood cancer (all types combined) in the

population living within 20 km of the Ronnskar smelter, but the apparent increase was based on a small number of cases (13 observed vs. 6.7 expected) and was not statistically significant, and exposure to arsenic was confounded by exposure to lead, copper, cadmium, sulfur dioxide, and possibly other emissions such as nickel and selenium. A retrospective study of deaths due to unspecified types of malignancies among workers of power plants found no significant differences in death rate between two groups whose exposure levels to arsenic had a difference of one order of magnitude (Bencko et al. 1980). However, the mean age of those deceased due to cancer in the high-exposure group was 55.9 years compared to 61.2 years in the low-exposure group, and this difference was statistically significant ($p<0.05$). Also, when the workers were stratified by exposure-duration, there was a significantly higher frequency of tumors in the high-exposure group after shorter employment periods (<5 or 6–10 years) than after a longer employment period (≥11 years). No information was provided regarding specific types of cancer. Various case reports have implicated occupational arsenic exposure as a potential contributing factor in workers who developed sinonasal cancer (Battista et al. 1996), hepatic angiosarcoma (Tsai et al. 1998a), and skin cancer (Cöl et al. 1999; Tsuruta et al. 1998), but provide no proof that inhaled arsenic was involved in the etiology of the observed tumors. Wong et al. (1992) found no evidence that environmental exposure to airborne arsenic produced skin cancer in residents living near the Anaconda smelter or an open pit copper mine.

No studies were located regarding cancer in animals after inhalation exposure to inorganic arsenicals, although several intratracheal instillation studies in hamsters have provided evidence that both arsenite and arsenate can increase the incidence of lung adenomas and/or carcinomas (Ishinishi et al. 1983; Pershagen and Björklund 1985; Pershagen et al. 1984; Yamamoto et al. 1987). These data support the conclusion that inhalation of arsenic may lead to lung cancer in humans.

Organic Arsenicals. No studies were located regarding cancer effects in humans or animals after inhalation exposure to organic arsenicals.

3.2.2 Oral Exposure

There are a large number of studies in humans and animals on the toxic effects of ingested arsenic. In humans, most cases of toxicity have resulted from accidental, suicidal, homicidal, or medicinal ingestion of arsenic-containing powders or solutions or by consumption of contaminated food or drinking water. In some cases, the chemical form is known (e.g., the most common arsenic medicinal was Fowler's solution, which contained 1% potassium arsenite or arsenic trioxide), but in many cases (e.g., exposures through

drinking water), the chemical form is not known. In these cases, it is presumed that the most likely forms are either inorganic arsenate [As(+5)], inorganic arsenite [As(+3)], or a mixture. Table 3-3 and Figure 3-3 summarize a number of studies that provide reliable quantitative data on health effects in humans and animals exposed to inorganic arsenicals by the oral route. Similar data for MMA, DMA, and roxarsone are listed in Tables 3-4, 3-5, and 3-6, and shown in Figures 3-4, 3-5, and 3-6, respectively. All exposure data are expressed as milligrams of arsenic (as the element) per kilogram body weight per day (mg As/kg/day). These studies and others that provide useful qualitative information are summarized below.

3.2.2.1 Death

Inorganic Arsenicals. There are many case reports of death in humans due to ingestion of high doses of arsenic. In nearly all cases, the most immediate effects are vomiting, diarrhea, and gastrointestinal hemorrhage, and death may ensue from fluid loss and circulatory collapse (Levin-Scherz et al. 1987; Saady et al. 1989; Uede and Furukawa 2003). In other cases, death may be delayed and result from the multiple tissue injuries produced by arsenic (Campbell and Alvarez 1989). Some accounts of fatal arsenic poisoning describe both gastrointestinal effects soon after ingestion and extensive damage to multiple organ systems prior to death (Quatrehomme et al. 1992). A precise estimate of the ingested dose is usually not available in acute poisonings, so quantitative information on lethal dose in humans is sparse. The lethal doses ranged from 22 to 121 mg As/kg in four cases where known amounts were ingested as a single bolus (Civantos et al. 1995; Hantson et al. 1996; Levin-Scherz et al. 1987; Quatrehomme et al. 1992). Two people in a family of eight died from ingestion of water containing about 110 ppm of arsenic for a week (Armstrong et al. 1984). This corresponded to a dose of about 2 mg As/kg/day. Based on a review of clinical reports in the older literature, Holland (1904) estimated the minimum lethal dose to be about 130 mg (also about 2 mg/kg). A similar estimate of 70–180 mg (about 1–3 mg/kg) was provided by Vallee et al. (1960). Death due to chronic arsenic exposure has been reported at lower concentrations. Five children between the ages of 2 and 7 years died from late sequelae of chronic arsenic poisoning after drinking contaminated water throughout their lives at estimated average doses of 0.05–0.1 mg As/kg/day (Zaldívar and Guillier 1977). A 22-year-old man with chronic arsenical dermatosis died from arsenic-related effects after lifetime exposure to an estimated average dose of 0.014 mg As/kg/day in the drinking water (Zaldívar et al. 1981). Systematic studies of lethality from chronic exposure attributable to increased risk of cardiovascular disease or cancer are discussed below in Sections 3.2.2.2 and 3.2.2.7, respectively.

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
ACUTE EXPOSURE								
Death								
1	Human	1 wk (W)				2 (death)	Armstrong et al. 1984 NS	
2	Human	once (IN)				121 M (death)	Civantos et al. 1995 As(+5)	
3	Human	once (IN)				108 M (death)	Hantson et al. 1996 As(+3)	
4	Human	once (IN)				22 M (death)	Levin-Scherz et al. 1987 As(+3)	
5	Human	once (IN)				93 M (death)	Quatrehomme et al. 1992 As(+3)	
6	Rat (wild Norway)	once (G)				104 (LD50)	Dieke and Richter 1946 As(+3)	
7	Rat (Sherman)	once (G)				112 F (LD50)	Gaines 1960 As(+5) calcium arsenate	
8	Rat (Sherman)	once (G)				44 F (LD50)	Gaines 1960 As(+3)	
9	Rat (Sherman)	once (G)				175 F (LD50)	Gaines 1960 As(+5) lead arsenate	
10	Rat (Sprague-Dawley)	once (GW)				15 M (LD50)	Harrisson et al. 1958 As(+3)	

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
11	Rat (Sprague-Dawley)	once (F)				145 M (LD50)	Harrisson et al. 1958 As(+3)	
12	Rat (CD)	once Gd 9 (GW)				23 F (7/25 dams died)	Stump et al. 1999 As(+3)	
13	Mouse (Swiss-Webster)	once (GW)				39 M (LD50)	Harrisson et al. 1958 As(+3)	
14	Mouse (C57H46)	once (GW)				26 M (LD50)	Harrisson et al. 1958 As(+3)	
15	Mouse (Dba2)	once (GW)				32 M (LD50)	Harrisson et al. 1958 As(+3)	
16	Mouse (C3H)	once (GW)				26 M (LD50)	Harrisson et al. 1958 As(+3)	
17	Mouse (ddY)	once (GW)				26 M (LD50)	Kaise et al. 1985 As(+3)	
18	Rabbit (New Zealand)	Gd 6-18 1 x/d (GW)				1.49 F (7/20 dams died)	Nemec et al. 1998 As(+5)	

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
Systemic								
19	Human	1 wk (W)	Gastro		0.2 (vomiting, diarrhea, abdominal pain)	2 M (diffuse inflammation of the GI tract)	Armstrong et al. 1984 NS	
			Hemato			0.2 (pancytopenia, leukopenia)		
			Hepatic			0.4 (hepatitis)		
			Renal			0.2 (nephropathy)		
			Ocular		0.2 (periorbital swelling)			
20	Human	once (IN)	Resp			121 M (respiratory distress, lung hemmorhage and edema)	Civantos et al. 1995 As(+5)	
			Cardio			121 M (hypotension, ventricular fibrillation, cardiac arrest)		
			Gastro			121 M (ulceration of upper gastrointestinal tract)		

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
21	Human	once (IN)	Cardio			19 F (tachycardia)	Cullen et al. 1995 As (+5)	
			Gastro			19 F (profuse vomiting and diarrhea)		
			Hemato	19 F				
			Hepatic	19 F				
			Renal	19 F				
22	Human	once (NS)	Resp			8 M (hemorrhagic bronchitis, pulmonary edema)	Fincher and Koerker 1987 As(+3)	
			Cardio			8 M (hypotension, tachycardia, massive cardiomegaly)		
			Gastro			8 M (gastrointestinal bleeding)		
			Hemato			8 M (hemolysis)		
			Musc/skel			8 M (marked atrophy of distal muscle groups)		
			Renal			8 M (acute renal failure)		
			Dermal		8 M (truncal macular rash)			
23	Human	1 or 2 x (W)	Gastro		0.05 (occasional nausea, diarrhea, and abdominal cramps)		Franzblau and Lilis 1989 As(+3) As(+5)	

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
24	Human	once (W)	Gastro			120 M (vomiting and diarrhea)	Goebel et al. 1990 NS	
			Renal			120 M (anuria)		
			Dermal		120 M (hyperkeratosis)			
25	Human	once (IN)	Gastro		2 F (vomiting)		Hantson et al. 1996 As(+3)	
			Hepatic		2 F (slight increase in serum bilirubin)			
			Renal		2 F (altered renal function tests)			
26	Human	once (IN)	Gastro			13 M (frequent vomiting, diarrhea)	Kamijo et al. 1998 As(+3)	
			Hepatic			13 M (large increase in serum bilirubin, ALT, AST, LDH)		
			Dermal		13 M (erythematous eruption)			
			Ocular		13 M (constricted vision)			

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
27	Human	once (IN)	Resp			22 M (tachypnea, respiratory failure)	Levin-Scherz et al. 1987 As(+3)	
			Cardio			22 M (cyanosis, hypotension, tachycardia, ventricular fibrillation)		
			Gastro			22 M (abdominal pain, nausea, diarrhea, massive vomiting, dysphagia, hemorrhage)		
			Hepatic			22 M (large increase in serum AST and LDH)		
			Renal			22 M (large increase in serum creatinine and BUN indicating acute renal failure)		
28	Human	once pregnancy wk 30 (IN)	Cardio			6 F (hypotension, rapid pulse)	Lugo et al. 1969 As(+3)	
			Gastro			6 F (abdominal pain, vomiting)		
			Hemato		6 F (high leukocyte count, low hematocrit)			
			Renal			6 F (acute renal failure)		

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
29	Human	2-3 wk (F)	Resp		0.05 (sore throat, rhinorrhea, cough, sputum)		Mizuta et al. 1956 As(+5)	
			Cardio			0.05 (abnormal electrocardiogram)		
			Gastro			0.05[b] (nausea, vomiting, diarrhea, occult blood in feces and gastric and duodenal juice)		
			Hemato		0.05 (mild anemia, leukopenia)			
			Musc/skel		0.05 (tender calf muscle)			
			Hepatic		0.05 (mild hepatomegaly, impaired liver function, degenerative lesions)			
			Renal	0.05				
			Dermal		0.05 (pigmentation, itching, desquamation, exanthema)			
			Ocular		0.05 (edema of eyelids, conjunctivitis, central scotoma, neuro-retinitis)			

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
30	Human	once (IN)	Resp	11 M		43 M (shortness of breath, decreased oxygen saturation)	Moore et al. 1994a As(+3)	
			Cardio	11 M		43 M (hypotension, asystolic cardiac arrest)		
			Gastro			11 M (profuse diarrhea and vomiting, severe abdominal pain)		
			Hemato	43 M				
			Renal		11 M (increased serum creatinine)	43 M (acute renal failure)		
31	Human	once (IN)	Resp			93 M (pulmonary edema)	Quatrehomme et al. 1992 As(+3)	
			Gastro			93 M (ulcero-necrotic hemorrhagic gastritis)		
			Hepatic			93 M (hepatomegaly, diffuse fatty degeneration)		
			Renal			93 M (glomerular congestion)		
			Dermal			93 M (dermoepidermic separation)		

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
32	Monkey (Rhesus)	13 d 1 x/d (IN)	Gastro	3		6 (vomiting, unformed stool, "loss of condition")	Heywood and Sortwell 1979 As(+5)	
			Hepatic	3	6 (decreased liver glycogen, vacuolation of hepatocytes)			
			Renal	3	6 (dilation of proximal tubules)			
33	Rat (Wistar-Barby)	4-14 d 5 d/wk 1 x/d (G)	Cardio	2 F	11 F (decreased vasoreactivity)		Bekemeier and Hirschelmann 1989 As(+3)	
			Gastro	2 F		11 F (diarrhea, bloody stools)		
34	Rat (Sprague-Dawley)	2 x (GW)	Resp	14 F			Brown and Kitchin 1996 As(+3)	
			Hepatic		0.9 F (slight increased ornithine decarboxylase and heme oxygenase activity in liver)			
			Dermal	14 F				
35	Rat (Sprague-Dawley)	2 x (GW)	Hepatic	8 F	24 F (increased heme oxygenase activity in liver)		Brown et al. 1997c As(+5)	

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
36	Rat (Sprague-Dawley)	1 x/d 15 d (G)	Bd Wt	10 M	20 M (20-25% decreased body weight)		Rodriguez et al. 2001 As(+3)	
37	Rat (CD)	once Gd 9 (GW)	Bd Wt	15 F	23 F (decreased body weight gain)		Stump et al. 1999 As(+3)	
38	Mouse (CD-1)	Gd 6-15 1 x/d (GW)	Bd Wt	12 F	24 F (decreased body weight gain during gestation)		Nemec et al. 1998 As(+5)	
39	Mouse (B6C3F1)	1 or 4 d 1 x/d (GW)	Hemato	3 M	6 M (decreased polychromatic erythrocytes in bone marrow)		Tice et al. 1997 As(+3)	
40	Gn Pig	1 x/d 8 d (G)	Cardio		3.8 M (prolongation of QT interval)		Chiang et al. 2002 As2O3	
41	Rabbit (New Zealand)	Gd 6-18 1 x/d (GW)	Bd Wt	0.37 F	1.49 F (loss of body weight during treatment during gestation)		Nemec et al. 1998 As(+5)	
Neurological								
42	Human	1 wk (W)				2 (encephalopathy, peripheral neuropathy)	Armstrong et al. 1984 NS	

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
43	Human	once (IN)				121 M (confusion, brain edema)	Civantos et al. 1995 As(+5)	
44	Human	once (IN)				19 F (lethargy)	Cullen et al. 1995 As (+5)	
45	Human	once (NS)				8 M (severe, persistent encephalopathy and peripheral neuropathy)	Fincher and Koerker 1987 As(+3)	
46	Human	once (W)				120 M (severe polyneuropathy)	Goebel et al. 1990 NS	
47	Human	once (IN)				216 M (peripheral neuropathy)	Hantson et al. 1996 As(+3)	
48	Human	once (IN)				13 M (peripheral neuropathy)	Kamijo et al. 1998 As(+3)	
49	Human	once (IN)				22 M (agitation, disorientation, paranoia, violent reactions)	Levin-Scherz et al. 1987 As(+3)	
50	Human	2-3 wk (F)				0.05 (hypesthesia in legs, abnormal patellar reflex)	Mizuta et al. 1956 As(+5)	
51	Human	once (IN)		43 M			Moore et al. 1994a As(+3)	

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
52	Human	once (IN)				93 M (encephalopathy)	Quatrehomme et al. 1992 As(+3)	
53	Monkey (Rhesus)	13 d 1 x/d (IN)		3		6 (marked salivation, uncontrolled head shaking)	Heywood and Sortwell 1979 As(+5)	
54	Rat (Sprague-Dawley)	1 x/d 15 d (G)		10 M	20 M (altered spontaneous locomotor activity)		Rodriguez et al. 2001 As(+3)	
55	Rabbit (New Zealand)	Gd 6-18 1 x/d (GW)		0.37 F		1.49 F (prostration, ataxia)	Nemec et al. 1998 As(+5)	
Developmental								
56	Human	once pregnancy wk 30 (IN)				6 (severe pulmonary hemorrhage that may have contributed to death in premature neonate)	Lugo et al. 1969 As(+3)	
57	Rat (CD)	once Gd 9 (GW)		15		23 (increased post-implantation loss and decreased viable fetuses)	Stump et al. 1999 As(+3)	

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)		Reference Chemical Form	Comments
58	Mouse (CD-1)	once Gd 8-15 (GW)		11		23	(increased fetal mortality, exencephaly)	Baxley et al. 1981 As(+3)	
59	Mouse (CD-1)	once Gd 7-15 (GW)				48	(increased fetal death, decreased fetal weight, gross and skeletal malformations)	Hood et al. 1978 As(+5)	
60	Mouse (CD-1)	Gd 6-15 1 x/d (GW)		12		24	(increased resorptions per litter, decreased live fetuses per litter, decreased mean fetal weight)	Nemec et al. 1998 As(+5)	
61	Hamster (Lak:LVG [SYR])	once Gd 8-12 (GW)		11		14	(increased fetal mortality, decreased fetal weight)	Hood and Harrison 1982 As(+3)	
62	Rabbit (New Zealand)	Gd 6-18 1 x/d (GW)		0.37		1.49	(increased resorptions per litter, decreased live fetuses per litter)	Nemec et al. 1998 As(+5)	

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
Cancer								
63	Mouse C3H	10 d (W)				9.55 M (CEL: liver and adrenal tumors)	Waalkes et al. 2003 As(+3)	
						19.13 F (CEL: ovarian and lung tumors)		
INTERMEDIATE EXPOSURE								
Systemic								
64	Human	3 mo (W)	Gastro			0.1 (severe nausea, diarrhea, pain, cramps, vomiting, traces of blood in stool)	Franzblau and Lilis 1989 As(+3) As(+5)	
			Hemato			0.1 (anemia, leukopenia)		
			Hepatic			0.1 (large increased AST and ALT)		
			Dermal		0.1 (diffuse erythematous and scaly rash)			
			Ocular		0.1 (swelling and irritation of the eyes, impaired peripheral vision)			
65	Human	0.5-14 yr (W)	Dermal			0.05 (hyperpigmentation with keratosis, possibly pre-cancerous)	Huang et al. 1985 NS	

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
66	Human	4 mo (W)	Gastro			0.06 F (nausea, vomiting, diarrhea)	Wagner et al. 1979 NS	
			Hemato			0.06 F (anemia, leukopenia, erythroid hyperplasia of bone marrow)		
			Dermal			0.06 F (persistent extensive hyperkeratosis of palms and soles)		
			Bd Wt			0.06 F (40 lb weight loss)		
67	Rat (Wistar-Barby)	4 wk 5 d/wk 1 x/d (GW)	Cardio		11 F (decreased vasoreactivity)		Bekemeier and Hirschelmann 1989 As(+3)	
68	Rat (Sprague-Dawley)	6 wk (W)	Renal		4.7 M (increased relative kidney weight, impaired renal mitochondrial respiration, ultrastructural changes in proximal tubule)		Brown et al. 1976 As(+5)	
			Bd Wt	9.4 M	10.9 M (decreased body weight gain)			

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
69	Rat (Wistar)	1 x/d 28 d (G)	Bd Wt	0.14 F			Chattopadhyay et al. 2001 As(+3)	
70	Rat (CD)	6 wk (W)	Hepatic	3 M	6 M (ultrastructural changes in hepatocytes, impaired liver mitochondrial respiration)		Fowler et al. 1977 As(+5)	
			Bd Wt	6 M		12 M (final body weight 28% lower than controls)		
71	Rat (CD)	14 pmd- Gd 19 7 d/wk 6 hr/d (GW)	Gastro	4 F		8 F (stomach adhesions, eroded luminal epithelium in the stomach)	Holson et al. 2000 As(+3)	
			Hepatic	2 F	4 F (increased liver weight)			
			Renal	4 F	8 F (increased kidney weight)			
			Bd Wt	4 F	8 F (decreased body weight gain)			
72	Rat (NS)	16 wk (W)	Hemato		0.92 M (decreased erythrocyte and leukocyte numbers)		Kannan et al. 2001 As(+3)	
			Hepatic	2.3 M				

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
73	Rat (Sprague-Dawley)	4 wk (W)	Hemato	0.12	0.3 (increased platelet aggregation)		Lee et al. 2002 As(+3)	
74	Rat (NS)	1 x/d 30 d (G)	Endocr		2.3 M (decreased islet cells in pancreas, increased pancreatic SOD and catalase)		Mukherjee et al. 2003 As2O3	
75	Rat (Wistar)	1 x/d 5 d/wk 12 wk (G)	Resp	19 M			Schulz et al. 2002 As(+3)	
			Renal	19 M				
			Bd Wt	9.5 M	19 M (~17% decreased body weight gain)			
76	Mouse (C57BL)	6 wk (W)	Hepatic	5 M	10 M (ultrastructural changes in hepatocytes, impaired liver mitochondrial respiration)		Fowler and Woods 1979 As(+5)	
			Bd Wt	5 M	10 M (decreased body weight gain)			

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
77	Mouse (C57BL/6 B6)	14 wk (W)	Hepatic	25 M			Kerkvliet et al. 1980 As(+5)	
			Renal	25 M				
78	Gn Pig (NS)	16 wk (W)	Hemato		0.69 M (decreased erythrocyte number and leukocyte number, decreased ALAD levels)		Kannan et al. 2001 As(+3)	
			Hepatic		0.69 M (increased ALAS activity)			
79	Dog (Beagle)	26 wk ad lib (F)	Hemato	1.9 F			Neiger and Osweiler 1989 As(+3)	
			Hepatic		0.8 F (mild increased serum ALT/AST)			
			Renal	1.9 F				
			Bd Wt	0.8 F	1.5 F (decreased body weight gain)	1.9 F (25% decrease in body weight)		
Immuno/ Lymphoret								
80	Mouse (C57BL/6 B6)	14 wk (W)		25 M			Kerkvliet et al. 1980 As(+5)	
Neurological								
81	Human	3 mo (W)				0.1 (paresthesia of hands and feet; confusion, disorientation and mental sluggishness)	Franzblau and Lilis 1989 As(+3) As(+5)	

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
82	Human	4 mo (W)				0.06 F (weakness, paresthesia)	Wagner et al. 1979 NS	
83	Rat (NS)	16 wk (W)		0.92 M	2.3 M (decreased brain neurotransmitter levels)		Kannan et al. 2001 As(+3)	
84	Rat (Wistar)	1 x/d 5 d/wk 12 wk (G)		19 M			Schulz et al. 2002 As(+3)	
85	Gn Pig (NS)	16 wk (W)		0.69 M	1.7 M (changes in brain neurotransmitter levels)		Kannan et al. 2001 As(+3)	
Reproductive								
86	Rat (Wistar)	1 x/d 28 d (G)			0.14 F (changes in uterine and ovarian weights, decreased estradiol)		Chattopadhyay et al. 2001 As(+3)	
87	Rat (CD)	14 pmd- Gd 19 7 d/wk 6 hr/d (GW)		8 F			Holson et al. 2000 As(+3)	
88	Mouse (CD)	3 gen (W)				1 (decreased litter size)	Schroeder and Mitchener 1971 As(+3)	

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
Developmental								
89	Rat (CD)	14 pmd- Gd 19 7 d/wk 6 hr/d (GW)		4	8 (decreased fetal body weight, increased skeletal variations)		Holson et al. 2000 As(+3)	
90	Rat (Sprague-Dawley)	Gd 15 or pnd 1-4 mo (W)			2.93 M (impaired performance in postnatal neurobehavioral tests)		Rodriguez et al. 2002 As(+3)	
91	Mouse (CD)	3 gen (W)				1 (decreased litter size)	Schroeder and Mitchener 1971 As(+3)	
CHRONIC EXPOSURE								
Death								
92	Human	2-7 yr children (W)				0.05 (death)	Zaldivar and Guillier 1977 NS	
93	Human	22 yr (W)				0.014 M (death)	Zaldivar et al. 1981 NS	Cause of death was liver tumor.
94	Monkey (Rhesus)	1 yr (IN)				3 (2/7 died)	Heywood and Sortwell 1979 As(+5)	
95	Rat (Wistar)	27 mo (F)				30 (increased mortality)	Kroes et al. 1974 As(+5) lead arsenate	
96	Mouse (CD)	2 yr (W)				1 (increased mortality, decreased life span)	Schroeder and Balassa 1967 As(+3)	

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
97	Dog (Beagle)	2 yr (F)				2.4 (6/6 died)	Byron et al. 1967 As(+3)	
98	Dog (Beagle)	2 yr (F)				2.4 (1/6 died)	Byron et al. 1967 As(+5)	
Systemic								
99	Human	NS (W)	Resp	0.032 (cough)			Ahmad et al. 1997 NS	
			Dermal			0.032 (melanosis, keratosis, hyperkeratosis, and depigmentation)		
			Ocular			0.032 (chronic conjunctivitis)		
100	Human	>8 yr (W)	Dermal	0.0012 (increased risk of premalignant skin lesions)			Ahsan et al. 2006 (NS)	
101	Human	4 yr (IN)	Dermal			0.1 F (de-pigmentation with hyperkeratosis, possibly pre-cancerous)	Bickley and Papa 1989 As(+3)	
102	Human	NS (W)	Cardio			0.014 (gangrene of feet)	Biswas et al. 1998 NS	
			Dermal			0.014 (melanosis and keratosis of hand palms and foot soles)		

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)		LOAEL Serious (mg/kg/day)		Reference Chemical Form	Comments
103	Human	12 yr (W)	Cardio				0.02	(Raynaud's disease, gangrene of toes)	Borgono and Greiber 1972 NS	
			Gastro		0.02	(diarrhea, abdominal pain)				
			Dermal				0.02	(abnormal pigmentation with hyperkaratosis, possibly pre-cancerous)		
104	Human	11-15 yr (W)	Dermal		0.01	(hypo- and hyperpigmentation)			Borgono et al. 1980 NS	
105	Human	NS (W)	Gastro	0.0004	0.022	(gastrointestinal irritation, diarrhea, nausea)			Cebrian et al. 1983 As(+5)	
			Dermal	0.0004			0.022	(pigmentation changes with hyperkeratosis, possibly pre-cancerous)		
106	Human	1-11 yr (W)	Hepatic		0.046	(hepatomegaly)			Chakraborty and Saha 1987 NS	
			Dermal				0.046	(pigmentation changes with keratosis, possibly pre-cancerous)		

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)		Reference Chemical Form	Comments
107	Human	NS (W)	Cardio			0.064	(Blackfoot disease)	Chen et al. 1988b NS	
108	Human	>10 yr (W)	Cardio	0.0008		0.022	(increased risk of ischemic heart disease mortality)	Chen et al. 1996 NS	
109	Human	NS (W)	Cardio			0.002	(increased prevalence of cerebrovascular disease and cerebral infarction)	Chiou et al. 1997 NS	
110	Human	>5 yr (W)	Hemato	0.006[c] M 0.007 F				EPA 1981b NS	
			Dermal	0.0009[c] M 0.001 F					
111	Human	3-7 yr (W)	Cardio			0.05	(Blackfoot disease)	Foy et al. 1992 NS	
			Dermal			0.05	(melanosis with hyperkeratosis, possibly pre-cancerous)		

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
112	Human	2-6 yr (IN)	Hepatic			0.08 M (cirrhosis, ascites)	Franklin et al. 1950 As(+3)	
			Dermal			0.08 M (pigmentation with hyperkeratosis, possibly pre-cancerous)		
113	Human	1-15 yr (W)	Hepatic		0.16 (portal fibrosis of the liver)		Guha Mazumder 2005 (NS)	
114	Human	NS (W)	Hepatic	0.004		0.014 (hepatomegaly)	Guha Mazumder et al. 1988 NS	
			Dermal	0.004		0.014 (pigmentation changes with hyperkaratosis, possibly pre-cancerous)		
115	Human	1-20 yr (W)	Gastro		0.06 (abdominal pain)		Guha Mazumder et al. 1988 NS	
			Hemato		0.06 (anemia)			
			Hepatic			0.06 (hepatomegaly, fibrosis)		
			Dermal			0.06 (hyperpigmentation with hyperkeratosis, possibly pre-cancerous)		
116	Human	NS (W)	Dermal	0.0016		0.009 (hyperpigmentation with keratosis, possibly pre-cancerous)	Guha Mazumder et al. 1998a NS	

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
117	Human	(W)	Dermal		0.0014 (arsenical dermatosis)		Guo et al. 2001a (NS)	
118	Human	NS (W)	Dermal		0.0043 (hyperkeratosis, hyperpigmentation)		Haque et al. 2003 (NS)	dose listed is that associated with lowest known peak As concentration ingested by a case with complete water history
119	Human	10 yr (W)	Gastro	0.0046			Harrington et al. 1978 NS	
			Hemato	0.0046				
			Dermal	0.0046				
120	Human	NS (W)	Hepatic	0.0008	0.006 (increased serum alkaline phosphatase and bilirubin)		Hernandez-Zavala et al. 1998 NS	
121	Human	lifetime (W)	Hemato		0.002 F (anemia during pregnancy)		Hopenhayn et al. 2006 (NS)	
122	Human	NS (W)	Cardio			0.067 (ischemic heart disease)	Hsueh et al. 1998b NS	

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)		Reference Chemical Form	Comments
123	Human	0.5-14 yr (W)	Dermal			0.05	(hyperpigmentation with keratosis, possibly pre-cancerous)	Huang et al. 1985 NS	
124	Human	15 yr (IN)	Gastro			0.03 M	(hematemesis, hemoperitoneum, melena)	Lander et al. 1975 As(+3)	
			Dermal			0.03 M	(hyperkeratosis - possibly pre-cancerous)		
125	Human	NS (W)	Cardio	0.004		0.005	(cyanosis of extremities, palpitations/chest discomfort)	Lianfang and Jianzhong 1994 NS	
			Dermal	0.004		0.005	(keratosis, hyperpigmentation, depigmentation)		
126	Human	3-22 yr (IN)	Gastro			0.05 M	(gastrointestinal hemorrhages)	Morris et al. 1974 As(+3)	
			Hepatic			0.05 M	(vascular fibrosis, portal hypertension)		
			Dermal			0.05 M	(hyperpigmentation with keratoses, possibly pre-cancerous)		

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
127	Human	15 yr (IN)	Hepatic			0.05 F (central fibrosis)	Piontek et al. 1989 As(+3)	
			Dermal			0.05 F (hyperkeratosis, possibly pre-cancerous)		
128	Human	NS (W)	Endocr			0.11 (diabetes mellitus)	Rahman et al. 1998 NS	
129	Human	NS (W)	Cardio	0.018	0.055 (hypertension)		Rahman et al. 1999 NS	

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
130	Human	28 mo (IN)	Cardio	0.06 F			Silver and Wainman 1952 As(+3)	
			Gastro		0.06 F (intermittent, progressively severe nausea, cramps, and diarrhea)			
			Hemato	0.06 F				
			Hepatic		0.06 F (hepatomegaly, fatty liver)			
			Renal	0.06 F				
			Dermal			0.06 F (melanosis with hyperkeratosis, possibly pre-cancerous)		
			Ocular		0.06 F (conjunctival injection, periocular edema)			
131	Human	55 yr (IN)	Hepatic			0.03 M (portal fibrosis and hypertension, bleeding from esophageal varices)	Szuler et al. 1979 As(+3)	
			Dermal			0.03 M (hyperpigmentation with hyperkeratosis, possibly pre-cancerous)		
132	Human	45 yr (W)	Cardio			0.014 (Blackfoot disease)	Tseng 1977 NS	

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
133	Human	NS (W)	Cardio			0.014 (Blackfoot disease)	Tseng 1989 NS	
134	Human	>45 yr (W)	Dermal	0.0008[d] M	0.014 M (hyperkeratosis and hyperpigmentation)		Tseng et al. 1968 NS	
135	Human	>30 yr (W)	Cardio		0.064 M (deficits in cutaneous microcirculation of the toes)		Tseng et al. 1995 As(+3)	
136	Human	52.6 yr (avg) (W)	Cardio	0.016		0.031 (peripheral vascular disease)	Tseng et al. 1996 NS	
137	Human	16 mo (IN)	Resp	0.1 M			Wade and Frazer 1953 As(+3)	
			Cardio	0.1 M				
			Hemato	0.1 M				
			Hepatic		0.1 M (liver enlargment)			
			Dermal			0.1 M (hyperkeratosis, hyperpigmentation with hyperkeratosis, possibly pre-cancerous)		

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
138	Human	30-33 yr (W)	Dermal			0.015 M (hyperkeratosis of foot, possibly pre-cancerous)	Zaldivar 1974 NS	
139	Human	12 yr (W)	Resp		0.015[c] M (bronchitis, bronchiectasis)		Zaldivar 1974 NS	
					0.018 F (bronchitis, bronchiectasis)			
			Cardio			0.015[c] M (Raynaud's disease, thrombosis)		
						0.018 F		
			Gastro		0.015[c] M (diarrhea)			
					0.018 F (diarrhea)			
			Dermal		0.015[c] M (scaling of skin, hyperkeratosis, leukoderma, melanoderma)			
					0.018 F			
			Bd Wt		0.015[c] M (unspecified decreased body weight)			
					0.018 F (unspecified decreased body weight)			

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
140	Human	NS (W)	Dermal			0.063 (hyperpigmentation with keratoses, possibly pre-cancerous)	Zaldivar 1977 NS	
141	Human	2-7 yr children (W)	Resp			0.08 (inflammation of bronchi and larynx, bronchopneumonia)	Zaldivar and Guillier 1977 NS	
			Cardio			0.05 (vascular spasms, thrombosis, ischemia, hypotension, cardiac failure)		
			Gastro			0.05 (nause, vomiting, diarrhea, intestinal hemorrhage)		
			Hemato			0.05 (anemia)		
			Hepatic			0.08 (cirrhosis)		
			Renal		0.08 (cloudy swelling in kidneys)			
			Dermal			0.05 (hyperkeratosis of palms and soles, melanoderma, leukoderma)		
142	Human	1-39 yr (W)	Cardio			0.06 (arterial thickening, Raynaud's disease)	Zaldivar and Guillier 1977 NS	

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
143	Rat (Osborne-Mendel)	2 yr (F)	Resp	20			Byron et al. 1967 As(+3)	
			Cardio	20				
			Gastro	20				
			Hemato	9	20 (slight transient decrease in Hb and Hct values)			
			Hepatic	4		9 (enlarged bile duct, bile duct proliferation)		
			Renal	9	20 (pigmentation)			
			Bd Wt	2	4 (decreased body weight gain)			
144	Rat (Osborne-Mendel)	2 yr (F)	Resp	30			Byron et al. 1967 As(+5)	
			Cardio	30				
			Gastro	30				
			Hemato	30				
			Hepatic	9	20 (enlarged bile duct)			
			Renal	9	20 (pigmentation, cysts)			
			Bd Wt		2 (decreased body weight gain in females)			

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
145	Rat (Wistar)	27 mo (F)	Resp	7			Kroes et al. 1974 As(+5)	
			Cardio	7				
			Gastro	7				
			Hemato	7				
			Musc/skel	7				
			Hepatic	7				
			Renal	7				
			Endocr	7				
			Bd Wt		7 (decreased body weight gain)			

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
146	Rat (Wistar)	27 mo (F)	Resp	30			Kroes et al. 1974 As(+5) lead arsenate	
			Cardio	30				
			Gastro	30				
			Hemato	7	30 (slight anemia)			
			Musc/skel	30				
			Hepatic	7		30 (enlarged bile duct with extensive dilation and inflammation)		
			Renal	30				
			Endocr	30				
			Bd Wt	7	30 (decreased body weight gain)			
147	Rat (Long-Evans)	3 yr (W)	Resp	0.6			Schroeder et al. 1968 As(+3)	
			Cardio	0.6				
			Hepatic	0.6				
			Renal	0.6				
			Dermal	0.6				
			Bd Wt	0.6				

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
148	Mouse (NS)	48 wk (W)	Hepatic	11.1			Liu et al. 2000 As(+3)	
			Renal		5.6 (histological alterations of the kidney)			
			Bd Wt	11.1				
149	Mouse (NS)	48 wk (W)	Hepatic	18.5			Liu et al. 2000 As (+5)	
			Renal		18.5 (increased relative kidney weight)			
			Bd Wt	18.5				
150	Mouse (BALB/c)	15 mo (W)	Hepatic		0.7 M (increased liver weight, altered liver histopathology, decreased hepatic enzymes in serum)		Santra et al. 2000 (NS)	
			Bd Wt		0.7 M (13-17% decreased body weight)			
151	Mouse (CD)	2 yr (W)	Bd Wt		1 (decreased body weight gain after the first 6 months of the study)		Schroeder and Balassa 1967 As(+3)	

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
152	Dog (Beagle)	2 yr (F)	Resp	2.4			Byron et al. 1967 As(+3)	
			Cardio	2.4				
			Gastro	1		2.4 (bleeding in the gut)		
			Hemato	1	2.4 (slight to moderate anemia)			
			Hepatic	1	2.4 (hemosiderin deposits in hepatic macrophages)			
			Renal	2.4				
			Bd Wt	1		2.4 (44-61% weight loss)		
153	Dog (Beagle)	2 yr (F)	Resp	2.4			Byron et al. 1967 As(+5)	
			Cardio	2.4				
			Gastro	2.4				
			Hemato	1	2.4 (mild anemia)			
			Hepatic	1	2.4 (pigmentation in hepatic macrophages)			
			Renal	2.4				
			Bd Wt	1		2.4 (marked decreased weight gain)		

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
Neurological								
154	Human	>5 yr (W)		0.006[c] M 0.007 F			EPA 1981b	NS
155	Human	3-7 yr (W)				0.11 F (wrist weakness)	Foy et al. 1992	NS
156	Human	1-20 yr (W)			0.06 (tingling of hands and feet)		Guha Mazumder et al. 1988	NS
157	Human	10 yr (W)		0.0046			Harrington et al. 1978	NS
158	Human	NS (W)		0.0014		0.04 (functional denervation)	Hindmarsh et al. 1977	NS
159	Human	NS (W)		0.004	0.005 (fatigue, headache, dizziness, insomnia, nighmare, numbness)		Lianfang and Jianzhong 1994	NS
160	Human	28 mo (IN)				0.06 F (paresthesia)	Silver and Wainman 1952	As(+3)
161	Human	55 yr (IN)			0.03 M (absent ankle jerk reflex and vibration sense in legs)		Szuler et al. 1979	As(+3)

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
162	Human	NS (W)			0.0017 (decreased performance in neurobehavioral tests)		Tsai et al. 2003 (NS)	
163	Human	lifetime continuous (W)			0.005 (decreased performance in neurobehavioral tests)		Wasserman et al. 2004 (NS)	
164	Human	lifetime		0.0008	0.003 (decreased score in Performance domain of an intelligence scale)		Wasserman et al. 2007 (NS)	
Reproductive								
165	Human	NS (W)				0.008 F (increased frequencies for spontaneous abortion, stillbirth, and preterm birth rates)	Ahmad et al. 2001 (NS)	98% of the exposed group drank water containing 0.1 mg As/L or more.
166	Human	lifetime (W)				0.006 F (increased incidence of spontaneous abortion)	Milton et al. 2005 (NS)	
167	Human	lifetime (W)				0.02 F (increased risk of stilbirth)	von Ehrenstein et al. 2006 (NS)	

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
Developmental								
168	Human	continuous (W)			0.002 (reduced birth weight)		Hopenhayn et al. 2003a (NS)	
169	Human	>1 yr 1 x/d (W)				0.03 (increased SMR for malignant and non-malignant lung disease)	Smith et al. 2006 (NS)	
170	Human	lifetime (W)		0.008			von Ehrenstein et al. 2006 (NS)	NOAEL is for no increase in risk of neonatal mortality or overall infant mortality.
Cancer								
171	Human	NS (W)				0.022 (CEL: skin cancer)	Cebrian et al. 1983 As(+5)	
172	Human	NS (W)				0.064 (CEL: bladder, lung and liver cancers)	Chen et al. 1986 NS	
173	Human	NS (W)				0.064 (CEL: malignant neoplasms of the bladder, skin, lung and liver)	Chen et al. 1988b NS	
174	Human	NS (W)				0.003 (CEL: bladder cancer)	Chiou et al. 2001 (NS)	

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)		Reference Chemical Form	Comments
175	Human	2 wk- 12 yr (IN)				3.67	(CEL: bladder cancer risk)	Cuzick et al.1992 As(+3)	
176	Human	NS (W)				0.0011	(CEL: lung cancer)	Ferreccio et al. 1998 NS	
177	Human	NS (W)				0.0017	(CEL: lung cancers)	Ferreccio et al. 2000 (NS)	
178	Human	NS (W)				0.018	(CEL: lung cancer mortality)	Guo 2004 (NS)	
179	Human	NS (W)				0.018	(CEL: bladder cancer)	Guo and Tseng 2000 (NS)	
180	Human	NS (W)				0.052	(CEL: increased incidence of transitional cell carcinomas of the bladder, kidney, ureters, and all urethral cancer)	Guo et al. 1997 NS	
181	Human	NS (W)				0.0049[c] M	(CEL: squamous cell carcinoma of the skin)	Guo et al. 2001b (NS)	
						0.0094 F			

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)		Reference Chemical Form	Comments
182	Human	>1 yr (W)				0.0075	(CEL: basal or squamous skin carcinoma)	Haupert et al. 1996 NS	
183	Human	16 yr (avg) (IN)				0.04 M	(CEL: basal cell and squamous cell carcinomas of the skin, small cell and squamous cell carcinoma of the lung)	Luchtrath 1983 As(+5)	
184	Human	60 yr (W)				0.038	(CEL: intraepidermal carcinoma)	Tseng 1977 NS	
185	Human	>45 yr (W)				0.014	(CEL: squamous cell carcinoma of the skin)	Tseng et al. 1968 NS	
186	Human	~5 yr (W)				0.033	(CEL: lung, urinary tract cancer)	Tsuda et al. 1995a As(+3)	

Table 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
187	Human	12 yr (W)				0.015[c] M (CEL: squamous cell carcinoma of the skin)	Zaldivar 1974 NS	
						0.018 F (CEL: squamous cell carcinoma of the skin)		
188	Human	22-34 yr (W)				0.014 M (CEL: basal cell and squamous cell carcinomas of the skin, hemangioendothelioma of the liver)	Zaldivar et al. 1981 NS	

a The number corresponds to entries in Figure 3-3.

b Used to derive provisional acute oral minimal risk level (MRL) of 0.005 mg/kg/day; dose divided by an uncertainty factor of 10 (for extrapolation from a LOAEL to a NOAEL).

c Differences in levels of health effects and cancer effects between male and females are not indicated in Figure 3-3. Where such differences exist, only the levels of effect for the most sensitive gender are presented.

d Used to derive chronic oral minimal risk level (MRL) of 0.0003 mg/kg/day; dose divided by an uncertainty factor of 3 (for human variability).

avg = average; ALAD = delta-aminolevulinic acid dehydratase; ALAS = delta-aminolevulinic acid synthetase; ALT = alanine aminotransferase; AST = aspartate aminotransferase; Bd Wt = body weight; BUN = blood urea nitrogen; Cardio = cardiovascular; CEL = cancer effect level; d = day(s); Endocr = endocrine; (F) = feed; F = female; (G) = gavage; Gastro = gastrointestinal; Gd = gestational day; GI = gastrointestinal; (GW) = gavage in water; gen = generation; Gd = gestation day; Gn pig = guinea pig; Hemato = hematological; Hb = hemoglobin; Hct = hematocrit; Hemato = hematological; hr = hour(s); (IN) = ingestion; LD50 = lethal dose, 50% kill; LDH = lactate dehydrogenase; LOAEL = lowest-observable-adverse-effect level; M = male; Metab = metabolic; mo = month(s); Musc/skel = musculoskeletal; NOAEL = no-observable-adverse-effect level; NS = not specified; pmd = pre-mating day; pnd = post-natal day; Resp = respiratory; SMR =standardized mortality ratio; (W) = drinking water; wk = week(s); x = time(s); yr = year(s)

Figure 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral

Acute (≤14 days)

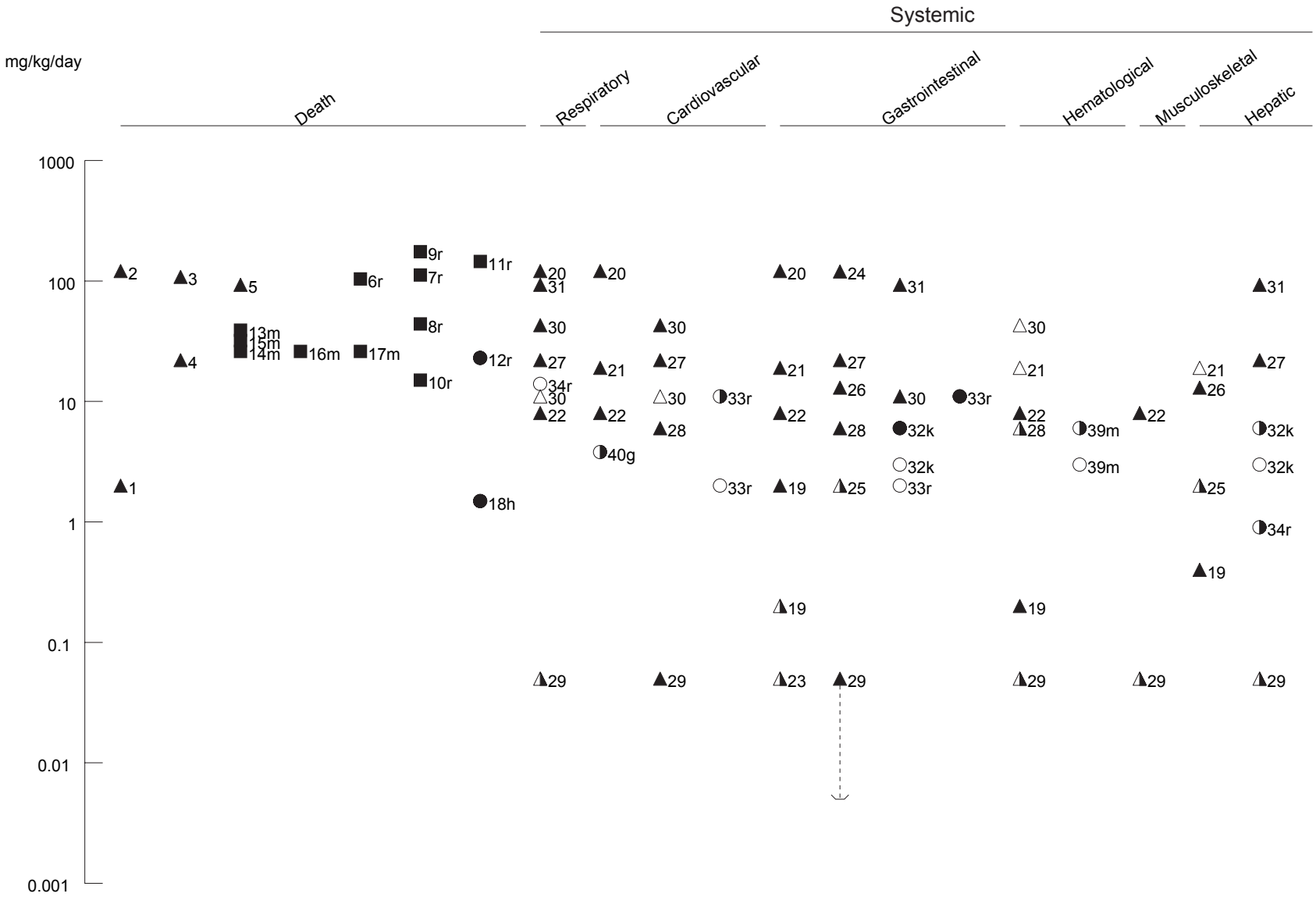


Figure 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral *(Continued)*

Acute (≤14 days)

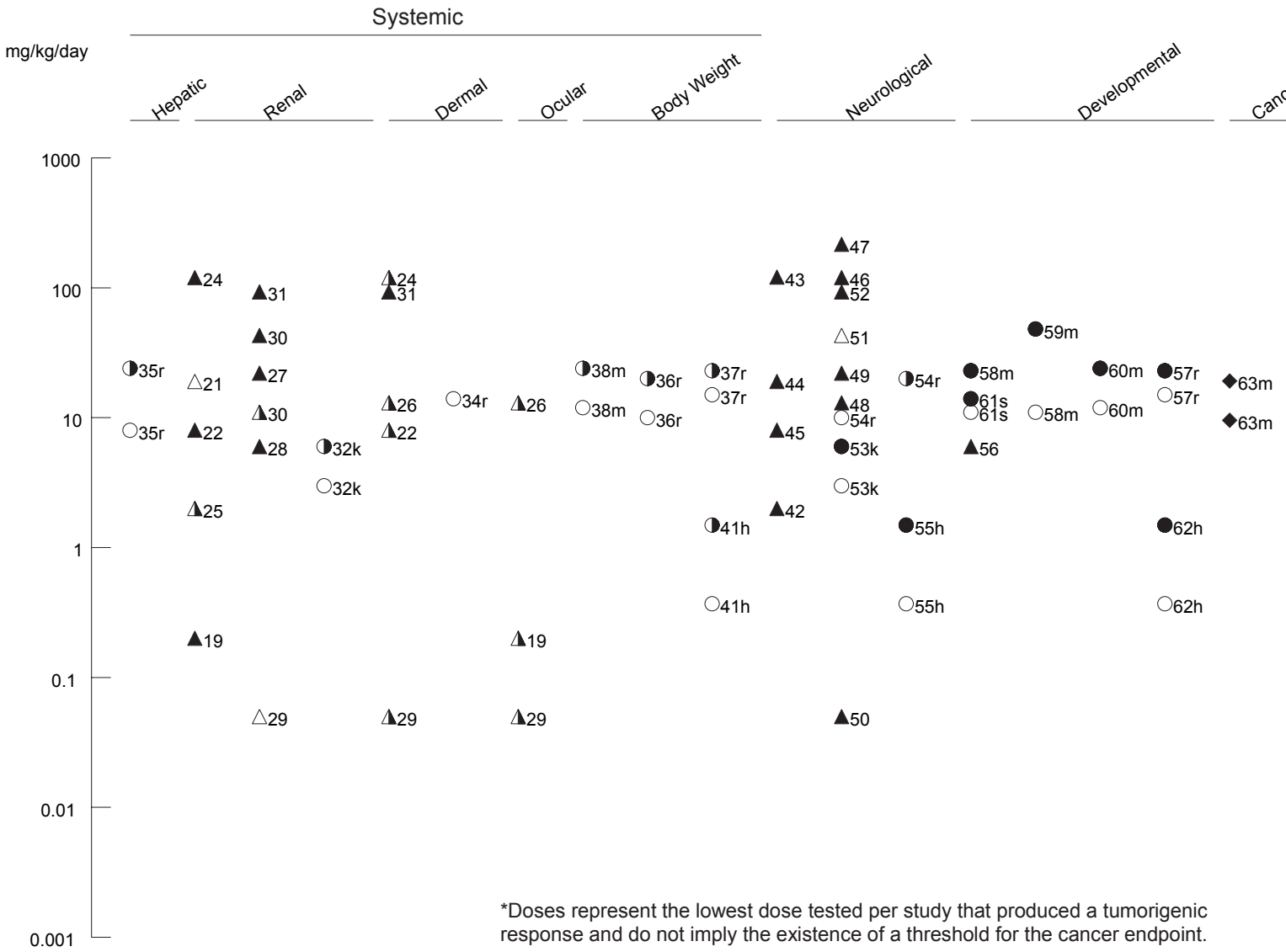


Figure 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral *(Continued)*

Intermediate (15-364 days)

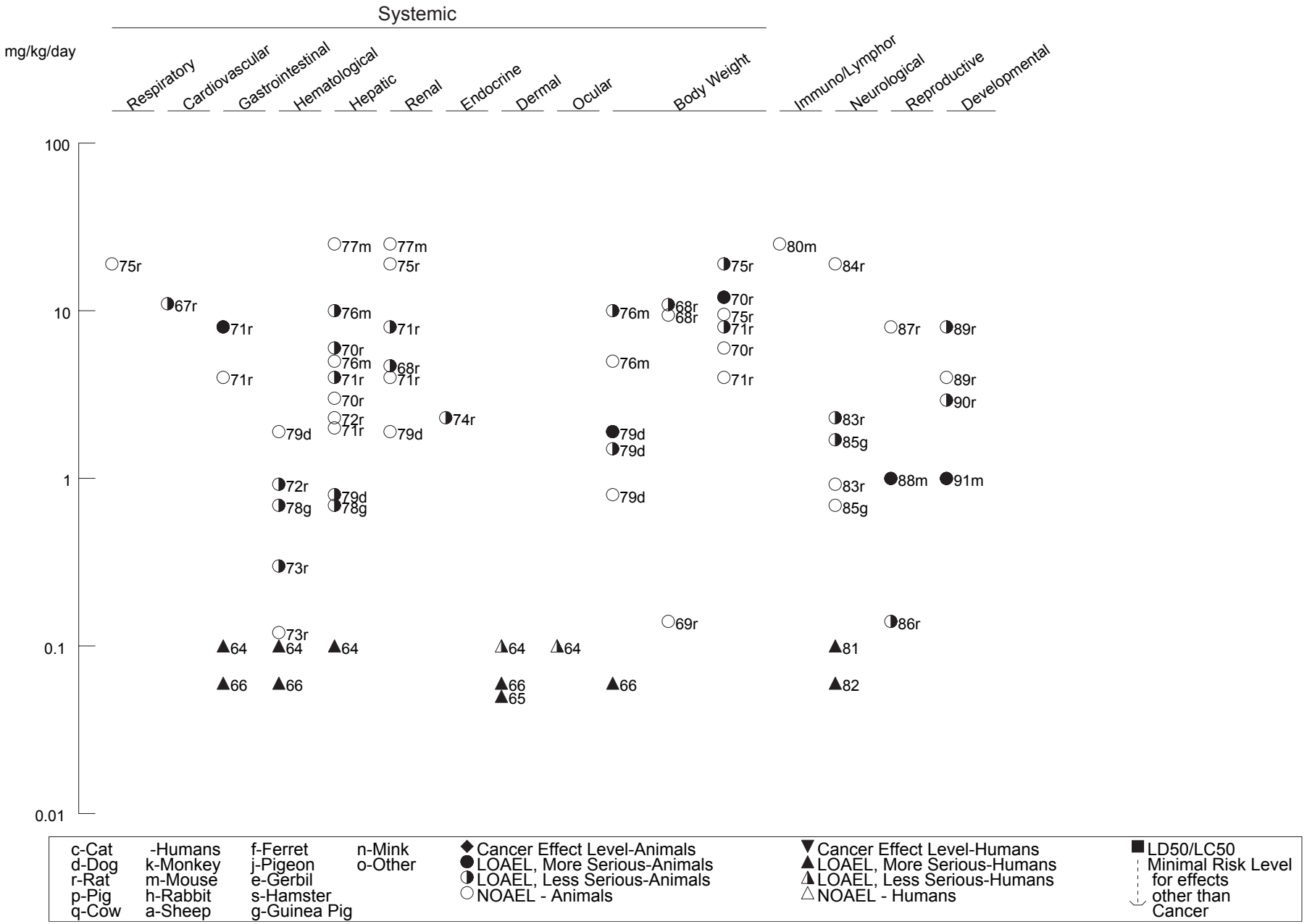


Figure 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral *(Continued)*

Chronic (≥365 days)

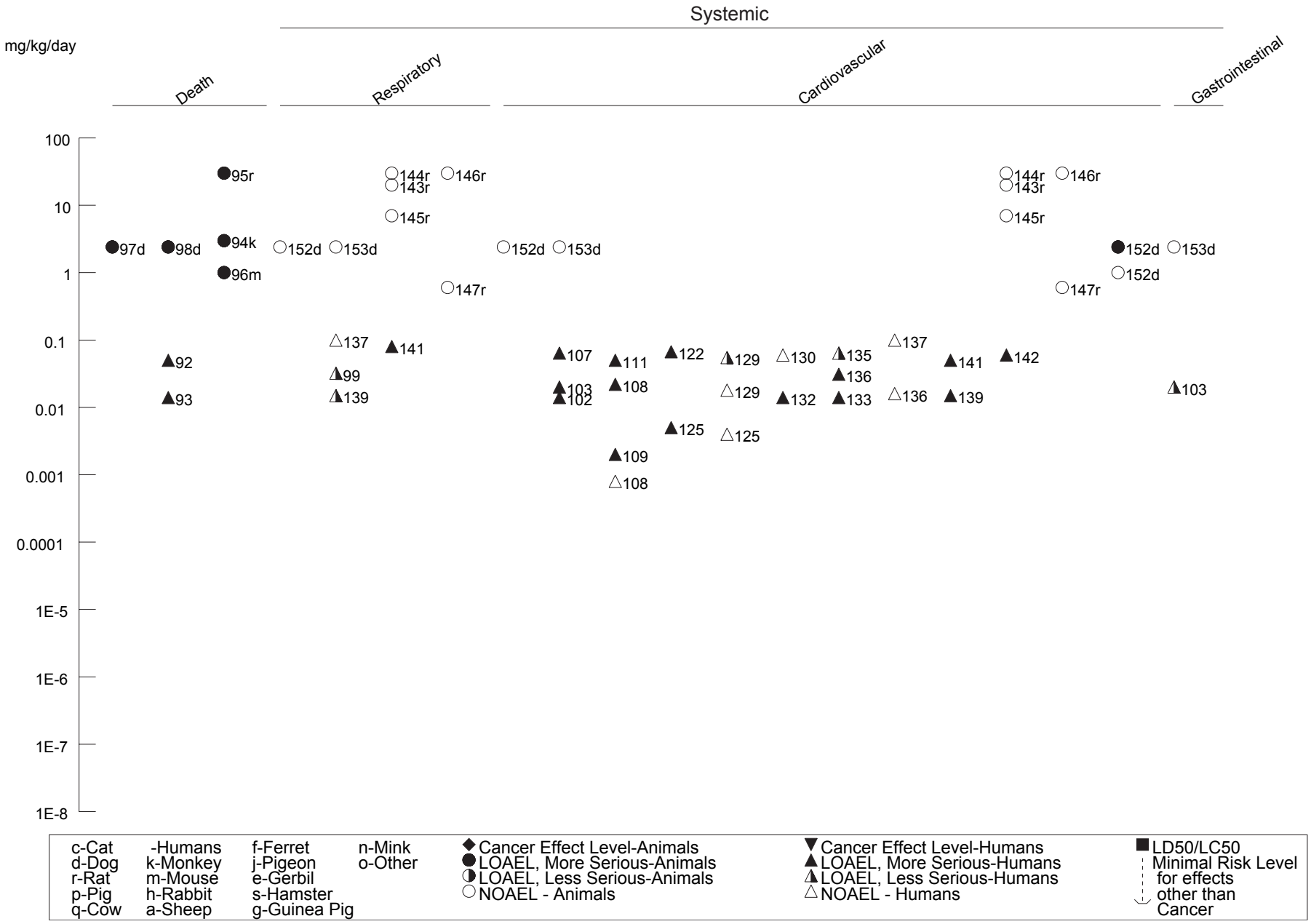


Figure 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral *(Continued)*

Chronic (≥365 days)

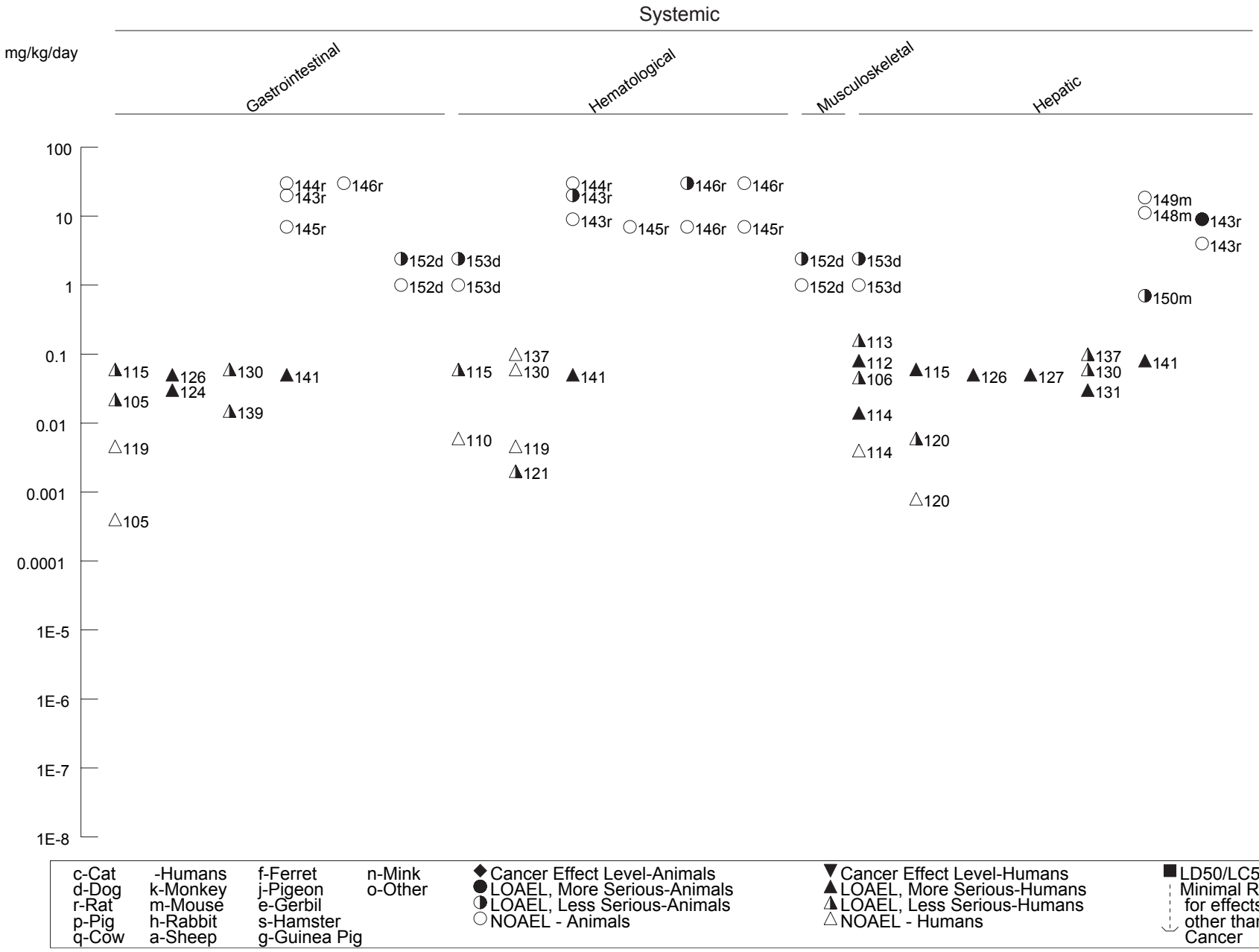


Figure 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral *(Continued)*

Chronic (≥365 days)

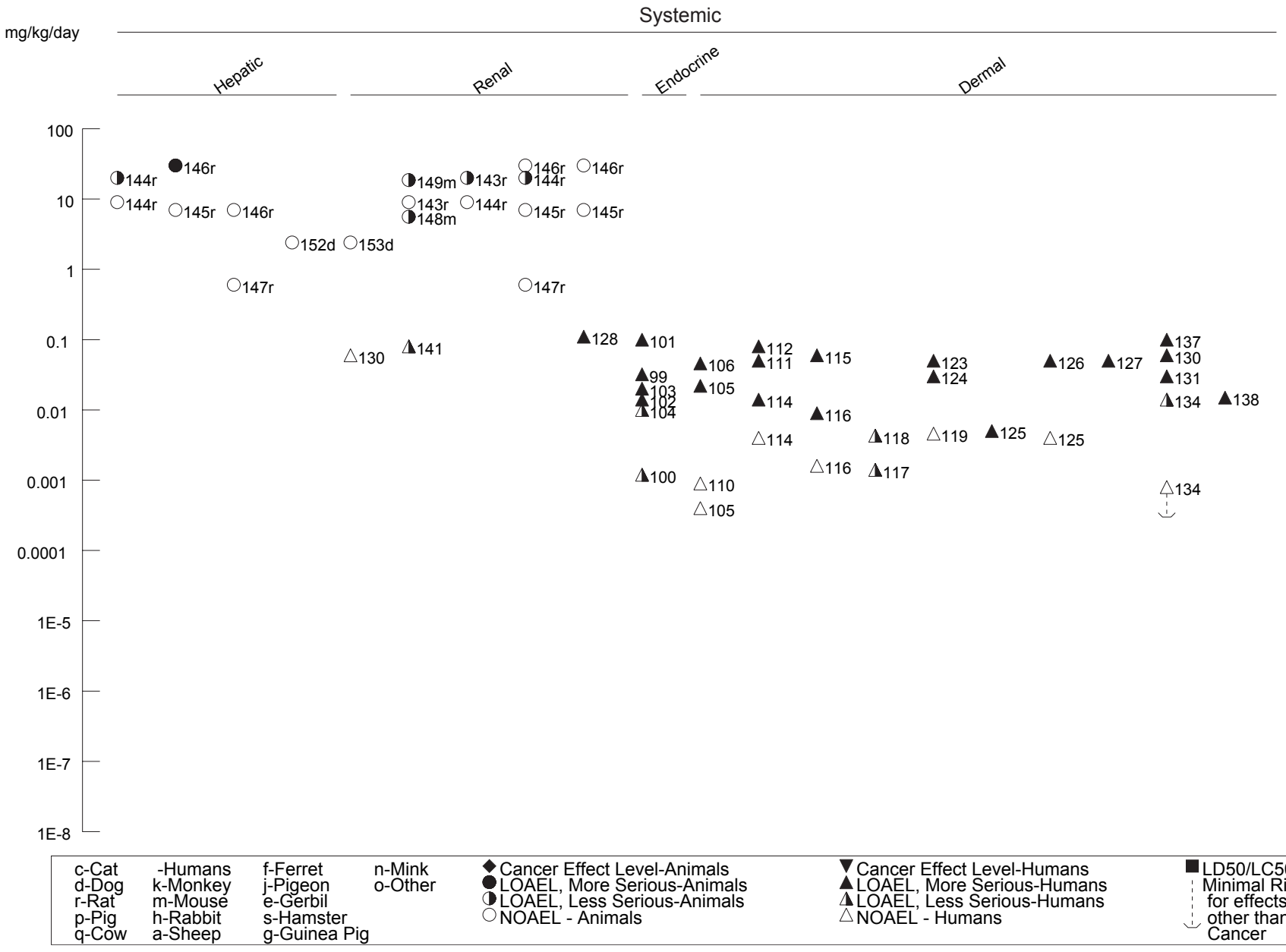


Figure 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral *(Continued)*

Chronic (≥365 days)

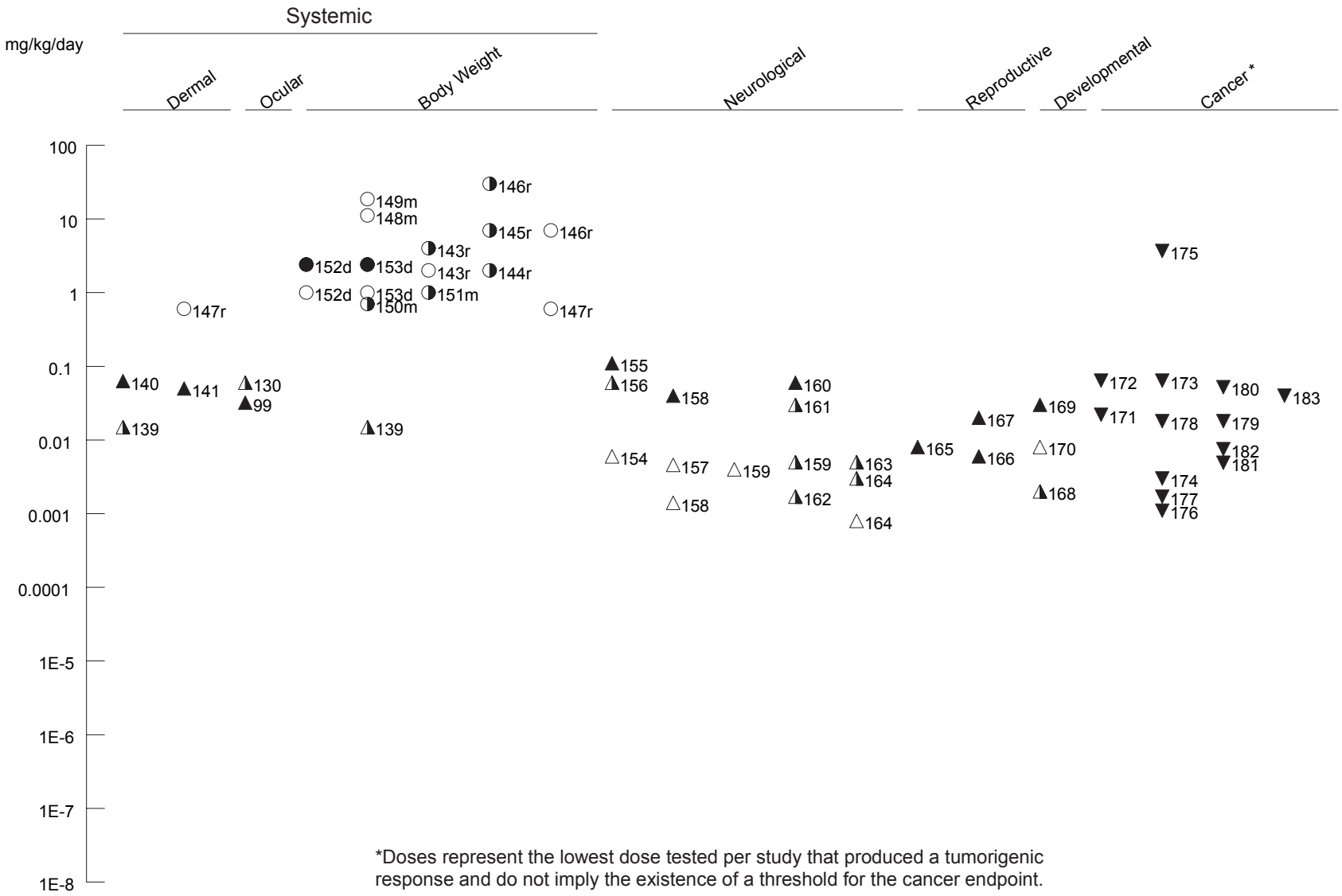


Figure 3-3 Levels of Significant Exposure to Inorganic Arsenic - Oral *(Continued)*

Chronic (≥365 days)



*Doses represent the lowest dose tested per study that produced a tumorigenic response and do not imply the existence of a threshold for the cancer endpoint.

c-Cat	-Humans	f-Ferret	n-Mink	◆ Cancer Effect Level-Animals	▼ Cancer Effect Level-Humans	■ LD50/LC50
d-Dog	k-Monkey	j-Pigeon	o-Other	● LOAEL, More Serious-Animals	▲ LOAEL, More Serious-Humans	Minimal Risk Level for effects other than Cancer
r-Rat	m-Mouse	e-Gerbil		◑ LOAEL, Less Serious-Animals	◭ LOAEL, Less Serious-Humans	
p-Pig	h-Rabbit	s-Hamster		○ NOAEL - Animals	△ NOAEL - Humans	
q-Cow	a-Sheep	g-Guinea Pig				

Table 3-4 Levels of Significant Exposure to Monomethylarsonic Acid - Oral

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
ACUTE EXPOSURE								
Death								
1	Rat (Sprague-Dawley)	once (GW)				3184 M (LD50) 2449[b] F (LD50)	Gur and Nyska 1990 MSMA	
2	Mouse (ddY)	once (GW)				1800 M (LD50)	Kaise et al. 1989 MMA	
3	Rabbit (New Zealand)	once (GW)				102 M (LD50)	Jaghabir et al. 1988 MSMA	
Systemic								
4	Rat (Sprague-Dawley)	once (GW)	Gastro		2030 (mucoid feces and diarrhea)		Gur and Nyska 1990 MSMA	
			Bd Wt	2030				
5	Rat (Sprague-Dawley)	Gd 6-15 (GW)	Bd Wt	10 F	100 F (17% decrease in maternal body weight gain)	500 F (40% decrease in maternal body weight gain)	Irvine et al. 2006 MMA	
6	Mouse (ddY)	once (GW)	Resp			1800 M (respiratory arrest)	Kaise et al. 1989 MMA	
			Gastro		2200 M (diarrhea, slight congestion of the small intestine)			

Table 3-4 Levels of Significant Exposure to Monomethylarsonic Acid - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
7	Rabbit (New Zealand)	Gd 7-19 (GW)	Gastro	7 F	12 F (loose feces/diarrhea in 7/14 pregnant rabbits)		Irvine et al. 2006 MMA	
			Bd Wt	7 F		12 F (67% decrease in maternal body weight gain)		
8	Rabbit (New Zealand)	once (GW)	Gastro		60 M (diarrhea)		Jaghabir et al. 1988 MSMA	
Developmental								
9	Rat (Sprague-Dawley)	Gd 6-15 (GW)		100	500 (decreased fetal weight and increased fetal incidence of imcomplete ossification of thoracic vertebrae)		Irvine et al. 2006 MMA	
10	Rabbit (New Zealand)	Gd 7-19 (GW)		7	12 (supernumerary thoracic ribs and eight lumbar vertebrae)		Irvine et al. 2006 MMA	
INTERMEDIATE EXPOSURE								
Death								
11	Rat (Fischer- 344)	52 wk (F)				106.9 M (increased mortality)	Arnold et al. 2003 MMA	

Table 3-4 Levels of Significant Exposure to Monomethylarsonic Acid - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
Systemic								
12	Rat (Fischer- 344)	52 wk (F)	Gastro	3.5[c] M	30.2 M (diarrhea)		Arnold et al. 2003 MMA	
			Bd Wt	30.2 M	106.9 M (14% decrease in body weight)			
13	Rat (Sprague-Dawley)	146-171 d pre-mating, mating, gestation, and lactation (F)	Bd Wt	76			Schroeder 1994 MMA	
14	Dog (Beagle)	52 wk (C)	Gastro		2 M (diarrhea)		Waner and Nyska 1988 MMA	
			Bd Wt	2 F	8 F (decrease in body weight)			
Reproductive								
15	Rat (Sprague-Dawley)	146-171 d pre-mating, mating, gestation, and lactation (F)		22	76 (decreased pregnancy rate and male fertility index in F0 and F1)		Schroeder 1994 MMA	
16	Mouse (Swiss)	19 d 3 d/wk (GW)			119 M (reduced fertility)		Prukop and Savage 1986 MSMA	

Table 3-4 Levels of Significant Exposure to Monomethylarsonic Acid - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
Developmental								
17	Rat (Sprague-Dawley)	146-171 d pre-mating, mating, gestation, and lactation (F)		22	76 (decreased pup survival F1 and F2)		Schroeder 1994 MMA	
CHRONIC EXPOSURE								
Death								
18	Rat (Fischer- 344)	104 wk (F)				72.4 M (increased mortality)	Arnold et al. 2003 MMA	

Table 3-4 Levels of Significant Exposure to Monomethylarsonic Acid - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
Systemic								
19	Rat (Fischer- 344)	104 wk (F)	Gastro	3 M	25.7 M (diarrhea)	72.4 M (necrosis, ulceration, perforation in large intestine)	Arnold et al. 2003 MMA	
			Hemato	72.4 M				
			Musc/skel	72.4 M				
			Hepatic	72.4 M				
			Renal	3.9 F	33.9 F (increased absolute kidney weight and progressive glomerulonephropathy)			
			Endocr	3.9 F	33.9 F (hypertrophy of thyroid follicular epithelium, decreased absolute thyroid weight)			
			Dermal	72.4 M				
			Ocular	72.4 M				
			Bd Wt	3 M	25.7 M (15% decrease in body weight)	33.9 F (30% decrease in body weight)		

Table 3-4 Levels of Significant Exposure to Monomethylarsonic Acid - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
20	Rat (Fischer- 344)	104 wk (W)	Hemato	8.4 M			Shen et al. 2003 MMA	
			Hepatic	2.1 M	8.4 M (increased GST-P-positive foci)			
			Renal		2.1 M (hyperplasia of the bladder)			
			Bd Wt	8.4 M				
21	Mouse (B6C3F1)	104 wk (F)	Cardio	67.1 M			Arnold et al. 2003 MMA	
			Gastro	24.9 M	67.1 M (loose and mucoid feces, metaplasia of the cecum and colon)			
			Musc/skel	67.1 M				
			Hepatic	67.1 M				
			Renal	1.2[d] M	6 M (increased incidence of progressive glomeruloephropathy)			
			Dermal	67.1 M				
			Ocular	67.1 M				
			Bd Wt	24.9 M	67.1 M (17% decrease in body weight)			

Table 3-4 Levels of Significant Exposure to Monomethylarsonic Acid - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
22	Dog (Beagle)	52 wk (C)	Resp	35			Waner and Nyska 1988 MMA	
			Gastro		2 M (diarrhea)			
			Hemato	35				
			Hepatic	35				
			Renal		8 (increased urine specific gravity; increased kidney weight)			
			Ocular	35				
			Bd Wt	2 F		8 F (42% decrease in body weight)		
Neurological								
23	Dog (Beagle)	52 wk (C)		35			Waner and Nyska 1988 MMA	
Reproductive								
24	Dog (Beagle)	52 wk (C)		35 M 8 F	35 F (decrease in estrus)		Waner and Nyska 1988 MMA	Histological examination of reproductive tissues.

Table 3-4 Levels of Significant Exposure to Monomethylarsonic Acid - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
Cancer								
25	Rat (Fischer- 344)	104 wk (W)		8.4 M			Shen et al. 2003 MMA	

a The number corresponds to entries in Figure 3-4.

b Differences in levels of health effects and cancer effects between male and females are not indicated in Figure 3-4. Where such differences exist, only the levels of effect for the most sensitive gender are presented.

c The intermediate-duration oral MRL of 0.1 mg MMA/kg/day was calculated using a benchmark dose analysis. The BMDL10 of 12.38 mg MMA/kg/day was divided by an uncertainty factor of 100 (10 to account for extrapolation from animals to humans and 10 for human variability)

d The chronic-duration oral MRL of 0.01 mg MMA/kg/day was calculated using a benchmark dose analysis. The BMDL10 of 1.09 mg MMA/kg/day was divided by an uncertainty factor of 100 (10 to account for extrapolation from animals to humans and 10 for human variability)

Bd Wt = body weight; (C) = capsule; Cardio = cardiovascular; d = day(s); Endocr = endocrine; (F) = feed; F = female; Gastro = gastrointestinal; (GO) = gavage in oil; (GW) = gavage in water; Gd = gestation day; GST-P = glutathione S-transferase placental form; Hemato = hematological; IN = ingestion; LD50 = lethal dose, 50% kill; LOAEL = lowest-observable-adverse-effect level; M = male; MMA = monomethylarsonic acid; MSMA = monosodium methane arsonate; Musc/skel = musculoskeletal; NOAEL = no-observable-adverse-effect level; Resp = respiratory; (W) = drinking water; wk = week(s); x = time(s)

Figure 3-4 Levels of Significant Exposure to Monomethylarsonic Acid - Oral

Acute (≤14 days)

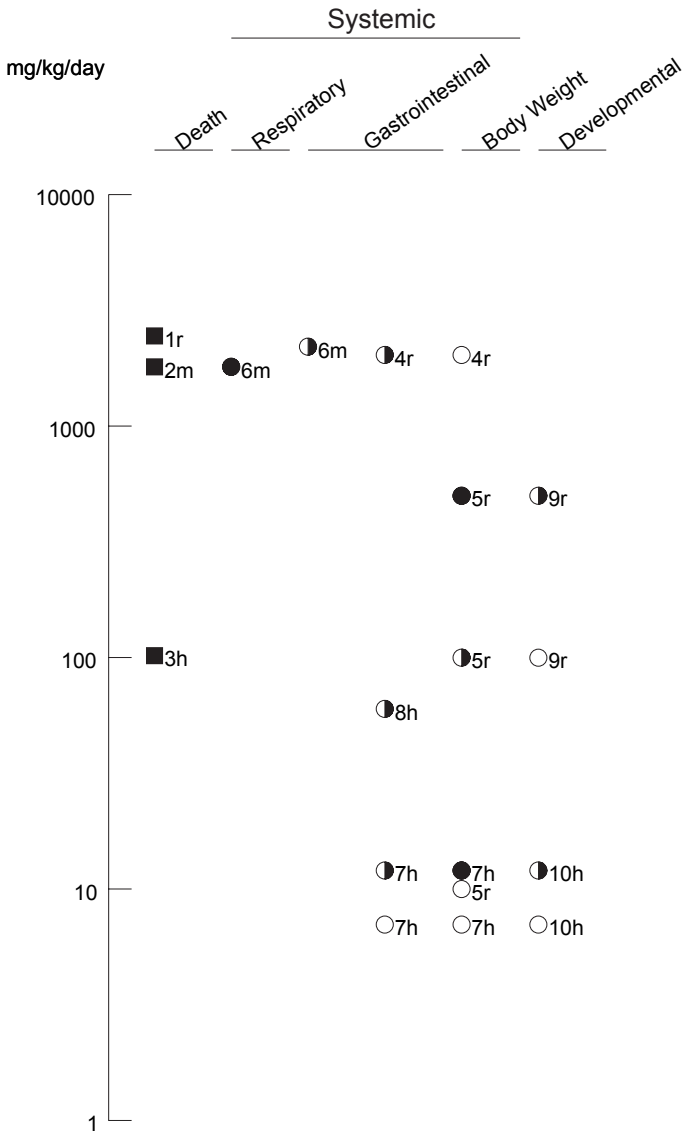


Figure 3-4 Levels of Significant Exposure to Monomethylarsonic Acid - Oral *(Continued)*

Intermediate (15-364 days)

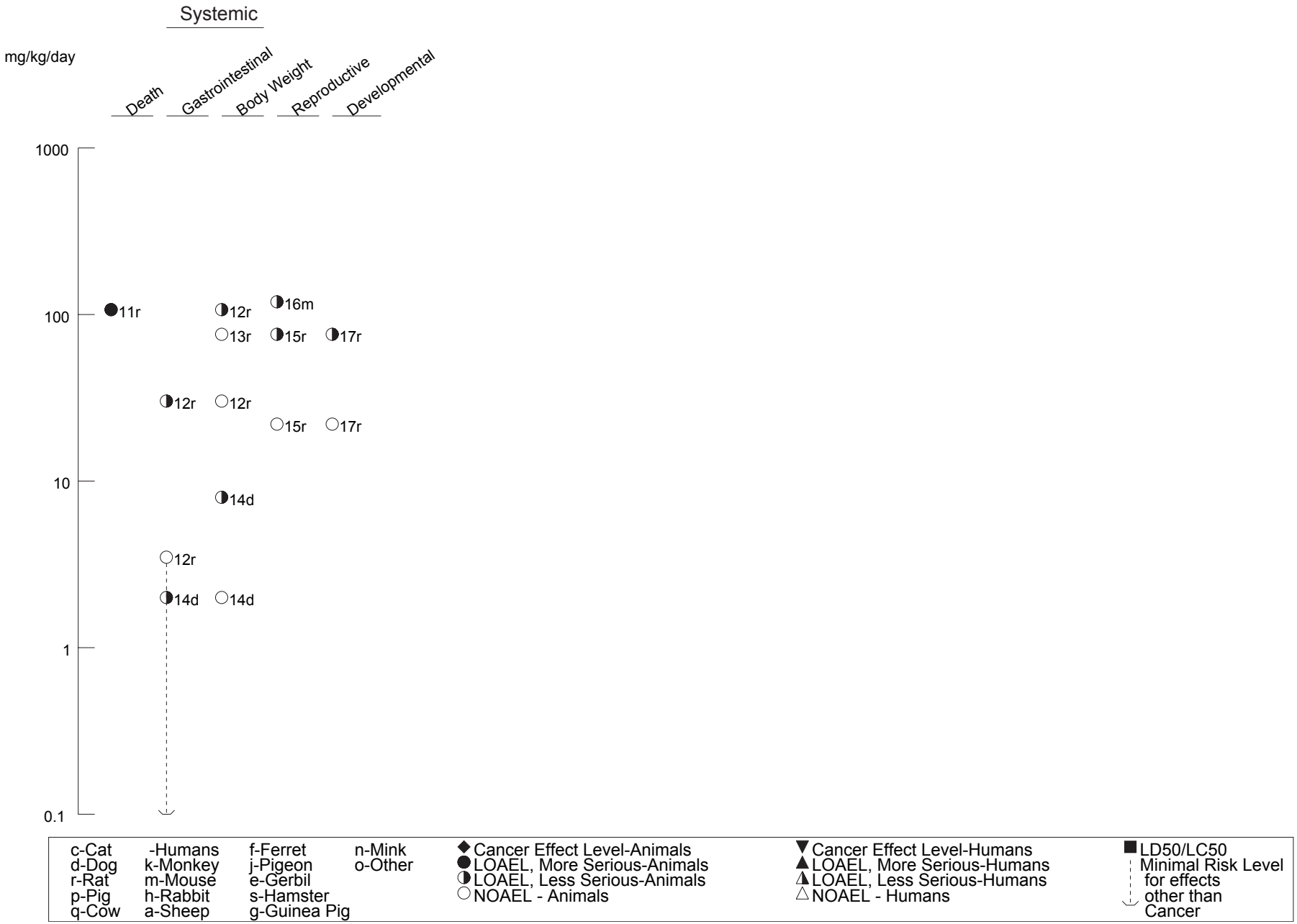


Figure 3-4 Levels of Significant Exposure to Monomethylarsonic Acid - Oral *(Continued)*

Chronic (≥365 days)

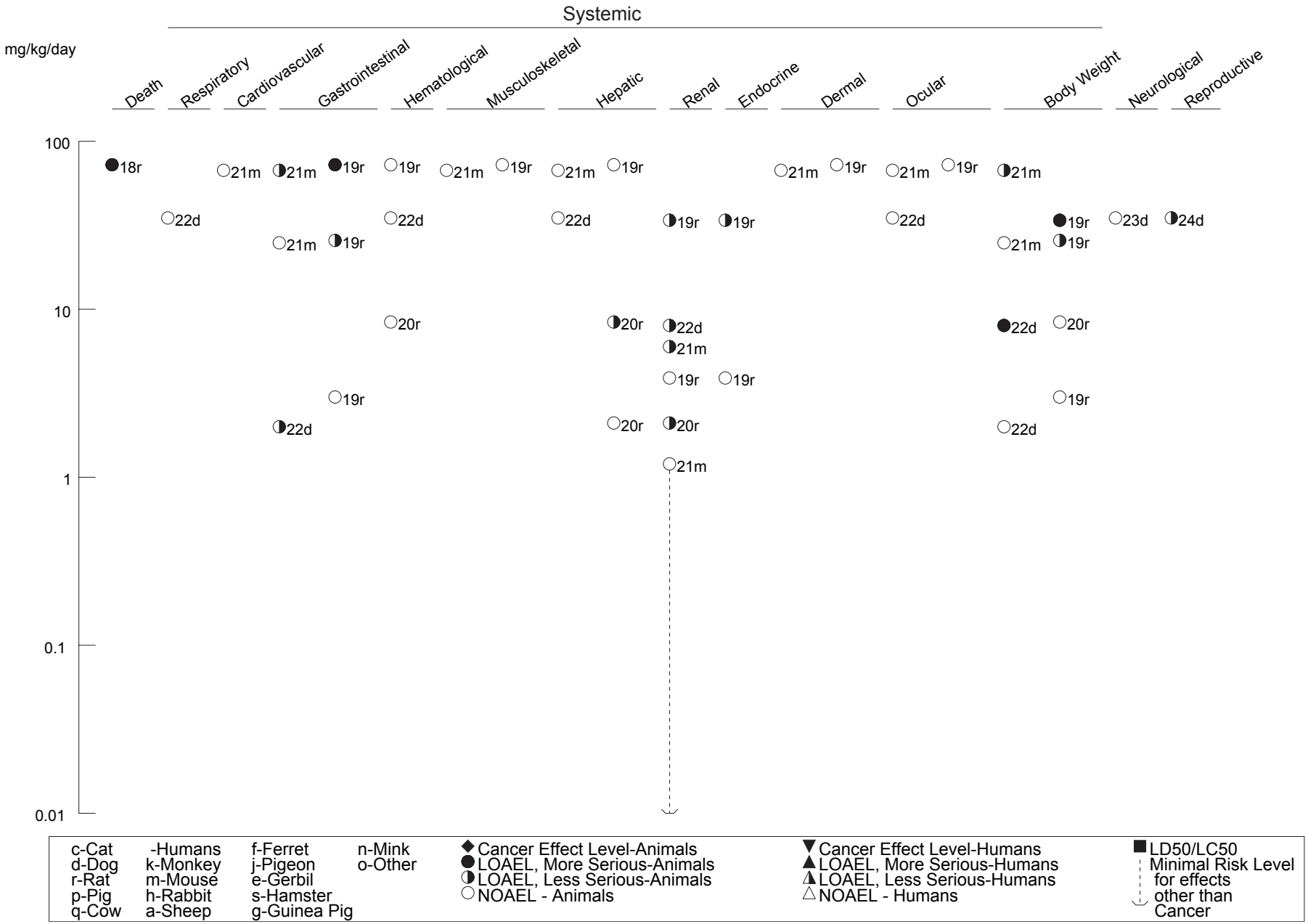


Figure 3-4 Levels of Significant Exposure to Monomethylarsonic Acid - Oral *(Continued)*

Chronic (≥365 days)

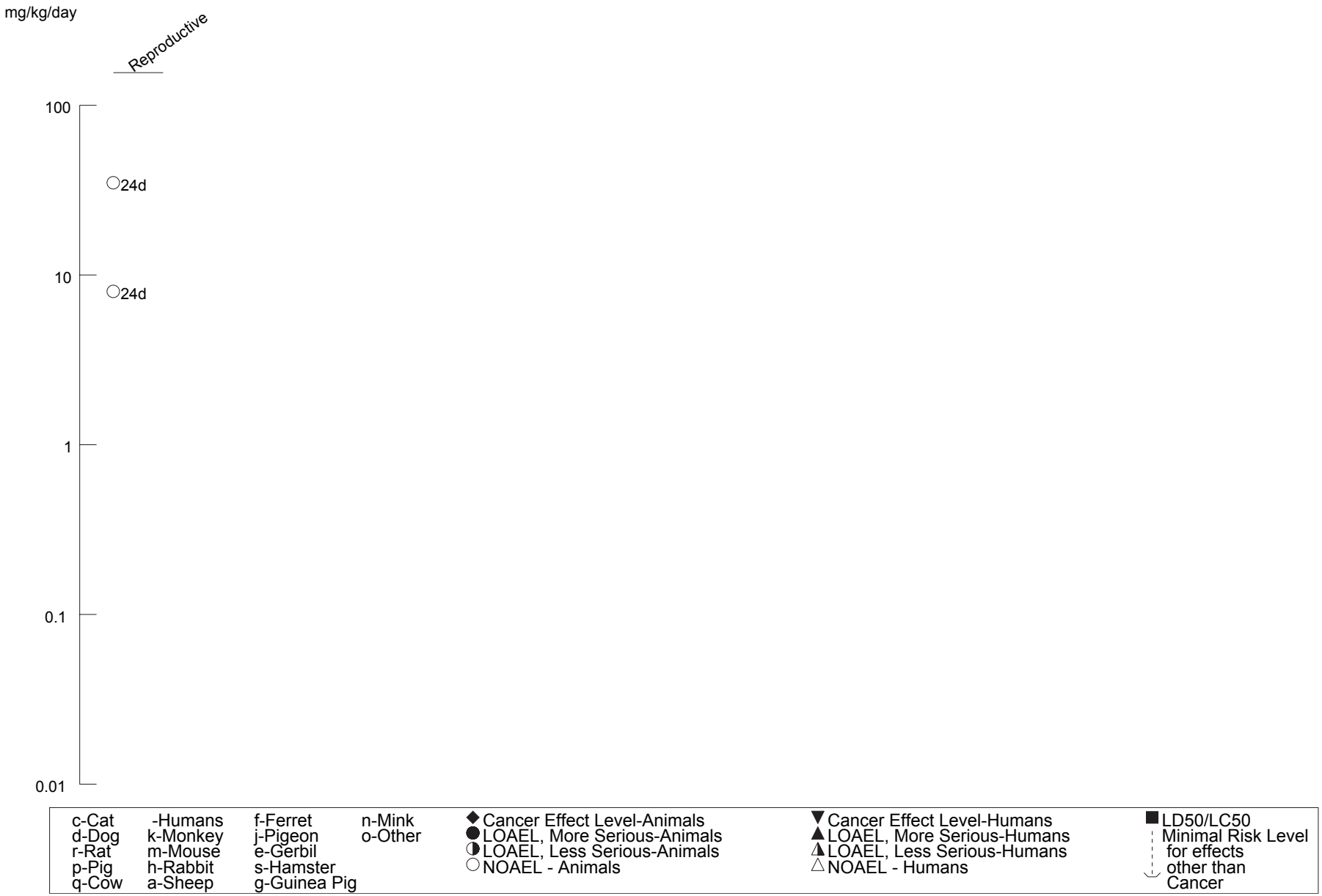


Table 3-5 Levels of Significant Exposure to Dimethylarsinic Acid - Oral

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
ACUTE EXPOSURE								
Death								
1	Rat (Fischer- 344)	13 wk (F)				475 M (100% mortality during first 2 weeks of study)	Crown et al. 1987 DMA	
2	Rat (CD)	10 d Gd 7-16 1 x/d (GW)				60 F (67% mortality)	Rogers et al. 1981 DMA	
3	Mouse (ddY)	once (GW)				1200 M (LD50)	Kaise et al. 1989 DMA	
4	Mouse (CD-1)	10 d Gd 7-16 1 x/d (GW)				600 F (59% mortality)	Rogers et al. 1981 DMA	
Systemic								
5	Rat (Fischer- 344)	2 wk (F)	Renal		11 F (altered bladder cell surface characteristics)		Cohen et al. 2001 DMA	
			Bd Wt	11 F				
6	Rat (Fischer- 344)	13 wk (F)	Gastro		475 M (diarrhea and congestion and hemorrhagic contents in gastrointestinal tract in rats dying during first 2 weeks)		Crown et al. 1987 DMA	

Table 3-5 Levels of Significant Exposure to Dimethylarsinic Acid - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
7	Rat (Sprague-Dawley)	Gd 6-15 (GW)	Bd Wt	12 F	36 F (decreased maternal body weight gain)		Irvine et al. 2006 DMA	
8	Rat (CD)	10 d Gd 7-16 1 x/d (GW)	Bd Wt			40 F (27% decreased maternal weight gain)	Rogers et al. 1981 DMA	
9	Mouse (B6C3F1)	24 hr 1 or 2 x (GW)	Resp		720 F (decreased lung ODC)		Ahmad et al. 1999a DMA	
			Hepatic		720 F (decreased liver GSH, GSSG, CYP-450 and ODC; increased serum ALT)			
10	Mouse (ddY)	once (GW)	Resp			900 M (respiratory arrest)	Kaise et al. 1989 DMA	
			Gastro		1757 M (diarrhea, slight congestion of the intestion)			
11	Mouse (CD-1)	10 d Gd 7-16 1 x/d (GW)	Bd Wt			200 F (26% decreased maternal weight gain)	Rogers et al. 1981 DMA	
12	Dog (Beagle)	52 wk (C)	Gastro	6.5	16 (vomiting and diarrhea)		Zomber et al. 1989 DMA	

Table 3-5 Levels of Significant Exposure to Dimethylarsinic Acid - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
13	Rabbit (New Zealand)	Gd 7-19 (GW)	Gastro	12 F	48 F (fluid gastrointestinal tract contents)		Irvine et al. 2006 DMA	
			Bd Wt	12 F		48 F (maternal weight loss)		
Neurological								
14	Mouse (ddY)	once (GW)				1757 M (increased startle reflex; ataxia)	Kaise et al. 1989 DMA	
Developmental								
15	Rat (Sprague-Dawley)	GD6-15 (GW)			40 F (decreased fetal body weight)		Chernoff et al. 1990 DMA	
16	Rat (Sprague-Dawley)	Gd 6-15 (GW)		12	36 (decreases in number of live fetuses and fetal weight; increases in fetuses with diaphragmatic hernia; delayed ossification)		Irvine et al. 2006 DMA	
17	Rat (CD)	10 d Gd 7-16 1 x/d (GW)		15		30 (malformed palates in 15%)	Rogers et al. 1981 DMA	

Table 3-5 Levels of Significant Exposure to Dimethylarsinic Acid - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
18	Mouse (CD-1)	Gd 8 (GW)				1600 F (fetal deaths, decreased fetal weight, delayed ossification, skeletal malformations)	Kavlock et al. 1985 DMA	
19	Mouse (CD-1)	10 d Gd 7-16 1 x/d (GW)		200		400 (18% decrease in fetal weight, delayed ossification, cleft palate in 12/28; irregular palatine rugae in 4.8%)	Rogers et al. 1981 DMA	
20	Rabbit (New Zealand)	Gd 7-19 (GW)		12			Irvine et al. 2006 DMA	
INTERMEDIATE EXPOSURE								
Death								
21	Rat (Fischer- 344)	13 wk (F)				190 M (100% mortality during first 4 weeks of study)	Crown et al. 1987 DMA	
22	Rat (Fischer- 344)	4 wk 5 d/wk 1 x/d (G)				57 (50% survival in males; 20% survival in females)	Murai et al. 1993 DMA	

Table 3-5 Levels of Significant Exposure to Dimethylarsinic Acid - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
23	Rat (Fischer- 344)	8 wk (W)				17 M (10/10 died)	Wanibuchi et al. 1996 DMA	
Systemic								
24	Rat (Fischer- 344)	10 or 20 wk (F)	Renal	1 F	10 M (necrosis in bladder epithelium)		Arnold et al. 1999 DMA	
					5 F[b] (increased kidney weight, calcification at corticomedullary junction; increased bladder weight and increased BrdU labelling in bladder epithelium)			
			Bd Wt	10				
25	Rat (Fischer- 344)	10 wk (F)	Renal		11 F (increased bladder and kidney weights, hyperplasia and necrosis of bladder epithelium)		Cohen et al. 2001 DMA	

Table 3-5 Levels of Significant Exposure to Dimethylarsinic Acid - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
26	Rat (Fischer- 344)	13 wk (F)	Resp	43.2 M			Crown et al. 1987 DMA	
			Cardio	43.2 M				
			Gastro	43.2 M	190 M (diarrhea and congestion and hemorrhagic contents in gastrointestinal tissues)			
			Hemato	0.44 F	4.5 F (decreased hemoglobin and erythrocyte levels)			
			Hepatic	23.5 M				
			Renal	0.4 M	4 M (increased urine volume and decreased specific gravity)			
			Endocr	0.4 M	4 M (hypertrophy of thyroid follicle epithelium)			
			Bd Wt	43.2 M				
27	Rat (Fischer- 344)	4 wk 5 d/wk 1 x/d (G)	Renal			57 (papillary necrosis and hyperplasia; cortical degeneration and necrosis)	Murai et al. 1993 DMA	
			Bd Wt		57 (decreased body weight)			

Table 3-5 Levels of Significant Exposure to Dimethylarsinic Acid - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
28	Rat (Sprague-Dawley)	10 wk pre-mating, gestation and lactation periods (F)	Resp	16.5			Rubin et al. 1989 DMA	
			Cardio	16.5				
			Hemato	0.34 M	2.3 M (decreased mean corpscular hemoglobin concentration)			
			Hepatic	16.5				
			Renal	16.5				
			Endocr	2.3 F	16.5 F (hypertrophy of thyroid follicle epithelium)			
			Bd Wt	16.5				
29	Rat (Sprague-Dawley)	42 d (F)	Hemato	3.7 M			Siewicki 1981 DMA	
			Hepatic	3.7 M				
			Renal	3.7 M				
			Bd Wt	3.7 M				

Table 3-5 Levels of Significant Exposure to Dimethylarsinic Acid - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
30	Dog (Beagle)	6 d/wk 52 wk (C)	Gastro	6.5	16 (vomiting and diarrhea)		Zomber et al. 1989 DMA	
			Hemato	16 M	40 M (decreased erythrocyte and increased leukocyte levels)			
Reproductive								
31	Rat (Sprague-Dawley)	10 wk pre-mating, gestation and lactation periods (F)		16.5			Rubin et al. 1989 DMA	
Cancer								
32	Mouse A/J	50 wk ad lib (W)				10.4 M (CEL: lung tumors)	Hayashi et al. 1998 DMA	

Table 3-5 Levels of Significant Exposure to Dimethylarsinic Acid - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
CHRONIC EXPOSURE								
Systemic								
33	Rat (Fischer- 344)	daily 2 yr (F)	Resp	7.8			Arnold et al. 2006 DMA	
			Cardio	7.8				
			Gastro	7.8				
			Hemato	7.8				
			Musc/skel	7.8				
			Hepatic	7.8				
			Renal	0.77 M	3.1 M (nephrocalcinosis)			
				0.77 F	3.1 F (urothelial vacular degeneration and hyperplasia of urothelial cells in urinary bladder)			
			Endocr	3.1	7.8 (hypertrophy of thyroid follicle epithelium)			
			Dermal	7.8				
			Ocular	7.8				
			Bd Wt	7.8				
34	Rat (Fischer- 344)	104 wk (W)	Renal	0.75 M	3.4 M (nodular or papillary hyperplasia in urinary bladder)		Wei et al. 1999, 2002 DMA	

Table 3-5 Levels of Significant Exposure to Dimethylarsinic Acid - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
35	Mouse (B6C3F1)	daily 2 yr (F)	Resp	94			Arnold et al. 2006 DMA	
			Cardio	94				
			Gastro	94				
			Hemato	94 F	94 F (decreased lymphocytes and increased monocytes)			
			Musc/skel	94				
			Hepatic	94				
			Renal	1.3[c] F	37 M (progressive glomerulonephropathy)			
					7.8[b] F (vacuolization of superficial cells of urotheliumin urinary bladder)			
			Dermal	94				
			Ocular	94				
			Bd Wt	94				

Table 3-5 Levels of Significant Exposure to Dimethylarsinic Acid - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
36	Dog (Beagle)	6 d/wk 52 wk (C)	Resp	40			Zomber et al. 1989 DMA	
			Cardio	40				
			Gastro	6.5	16 (vomiting and diarrhea)			
			Hepatic	40				
			Renal	40				
Reproductive								
37	Rat (Fischer- 344)	daily 2 yr (F)		7.8			Arnold et al. 2006 DMA	Histological examination of reproductive tissues.
38	Mouse (B6C3F1)	daily 2 yr (F)		94			Arnold et al. 2006 DMA	Histological examination of reproductive tissues.
Cancer								
39	Rat (Fischer- 344)	daily 2 yr (F)				7.8 (CEL: urothelial cell papillomas and carcinomas in urinary bladder)	Arnold et al. 2006 DMA	
40	Rat (Fischer- 344)	104 wk (W)				3.4 M (CEL: urinary bladder tumors)	Wei et al. 1999, 2002 DMA	

Table 3-5 Levels of Significant Exposure to Dimethylarsinic Acid - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
41	Mouse knockout	continuous 18 mo (W)				11.8 M (CEL)	Salim et al. 2003 DMA	

a The number corresponds to entries in Figure 3-5.

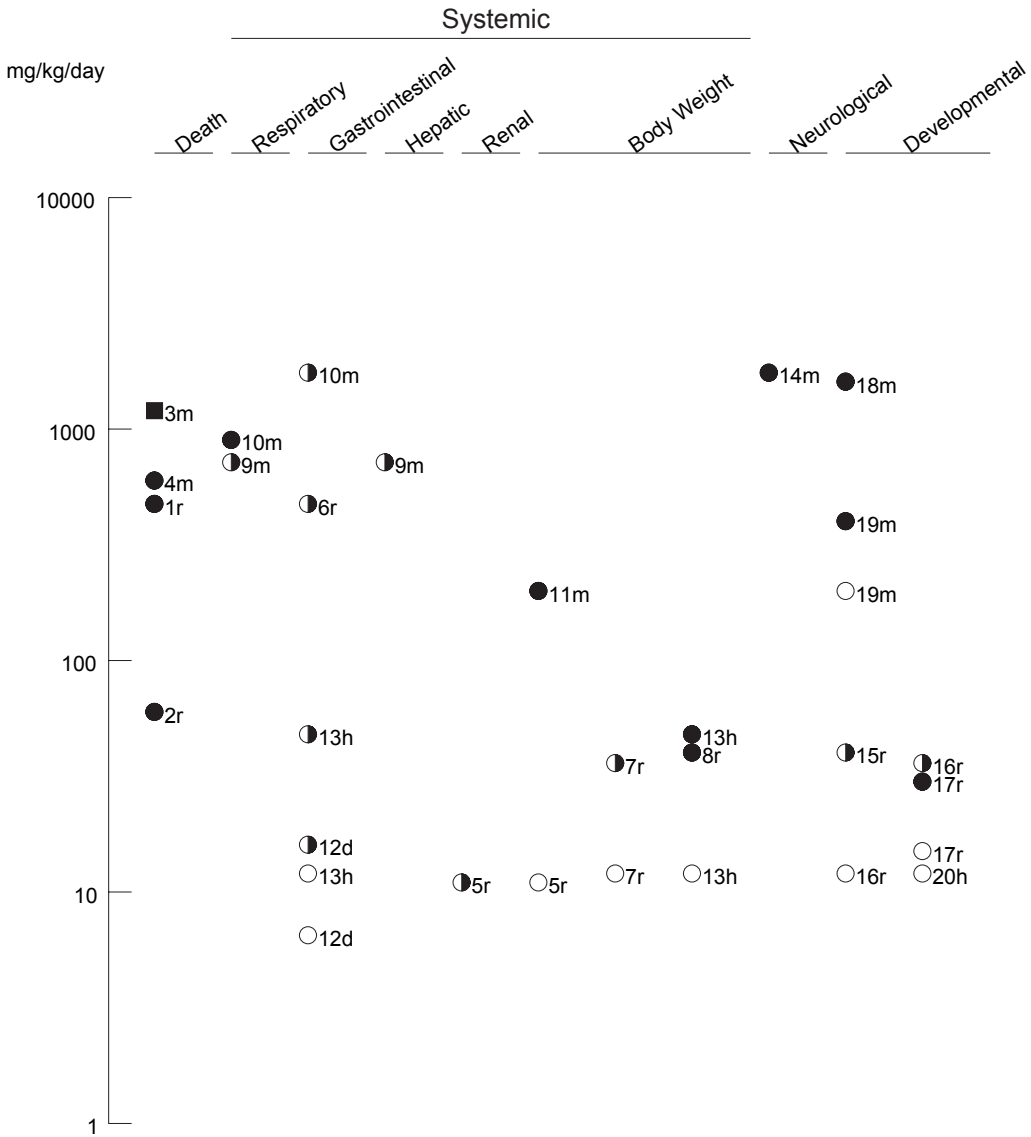
b Differences in levels of health effects and cancer effects between male and females are not indicated in Figure 3-5. Where such differences exist, only the levels of effect for the most sensitive gender are presented.

c The chronic-duration oral MRL of 0.02 mg DMA/kg/day was calculated using a benchmark dose analysis. The BMDL10 of 1.80 mg DMA/kg/day was divided by an uncertainty factor of 100 (10 to account for extrapolation from animals to humans and 10 for human variability)

ad lib = ad libitum; ALT = alanine aminotransferase; Bd Wt = body weight; BrdU = bromodeoxyuridine; (C) = capsule; Cardio = cardiovascular; CEL = cancer effect level; CYP = cytochrome p; d= day(s); DMA = dimethylarsinic acid; Endocr = endocrine; (F) = feed; F = female; (G) = gavage; Gastro = gastrointestinal; Gd = gestation day; GSH = reduced glutathione; GSSG = oxidized glutathione; (GW) = gavage in water; Hemato = hematological; hr = hour(s); LD50 = lethal dose, 50% kill; ODC = ornithine decarboxylase; LOAEL = lowest-observable-adverse-effect level; M = male; mo = month; Musc/skel = musculoskeletal; NOAEL = no-observable-adverse-effect level; Resp = respiratory; (W) = drinking water; wk = week(s); x = time(s); yr = year(s)

Figure 3-5 Levels of Significant Exposure to Dimethylarsinic Acid - Oral

Acute (≤14 days)



c-Cat, d-Dog, r-Rat, p-Pig, q-Cow, -Humans, k-Monkey, m-Mouse, h-Rabbit, a-Sheep, f-Ferret, j-Pigeon, e-Gerbil, s-Hamster, g-Guinea Pig, n-Mink, o-Other

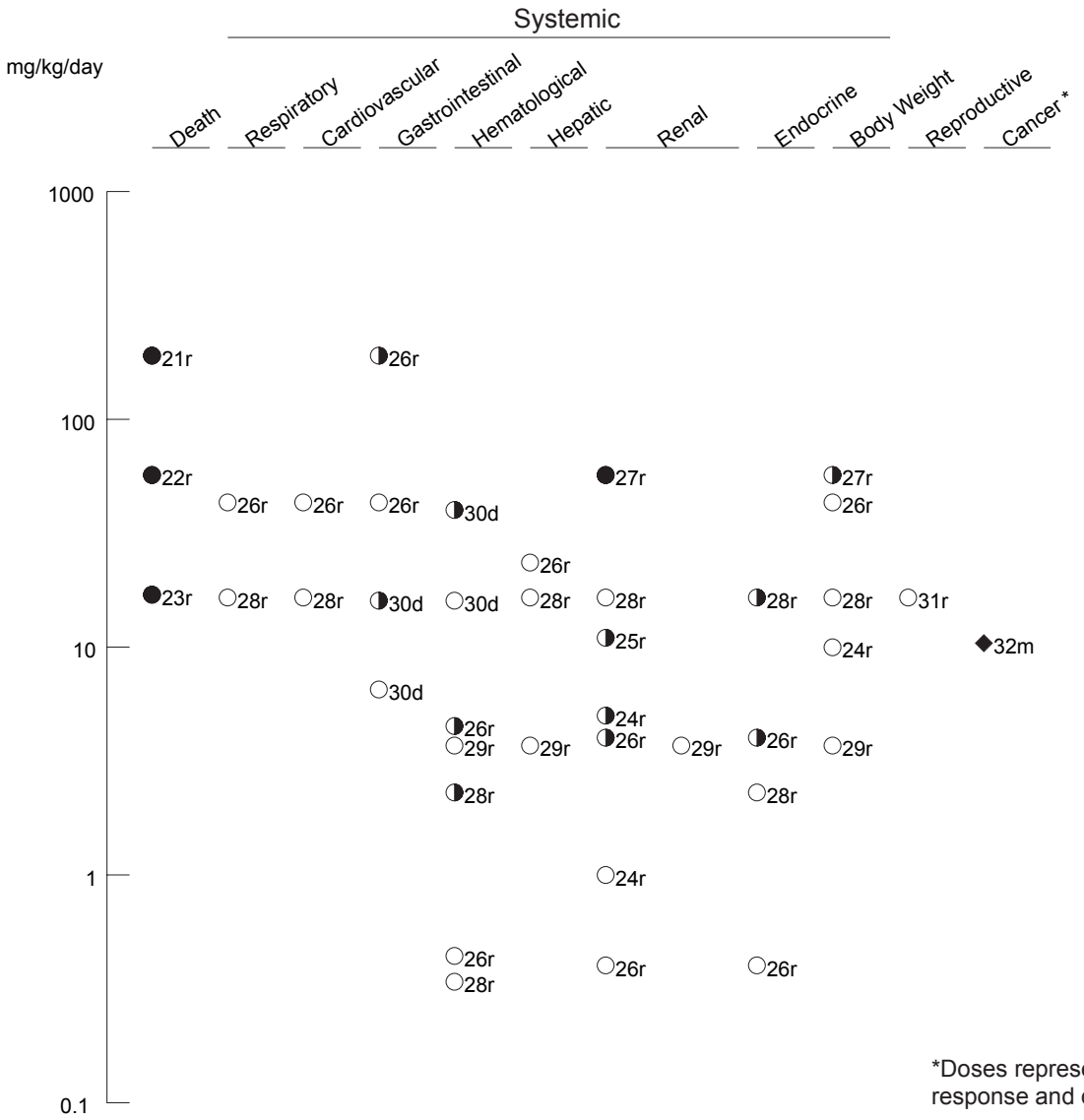
◆ Cancer Effect Level-Animals
● LOAEL, More Serious-Animals
◑ LOAEL, Less Serious-Animals
○ NOAEL - Animals

▼ Cancer Effect Level-Humans
▲ LOAEL, More Serious-Humans
◭ LOAEL, Less Serious-Humans
△ NOAEL - Humans

■ LD50/LC50
Minimal Risk Level for effects other than Cancer

Figure 3-5 Levels of Significant Exposure to Dimethylarsinic Acid - Oral *(Continued)*

Intermediate (15-364 days)



*Doses represent the lowest dose tested per study that produced a tumorigenic response and do not imply the existence of a threshold for the cancer endpoint.

c-Cat	-Humans	f-Ferret	n-Mink	◆ Cancer Effect Level-Animals	▼ Cancer Effect Level-Humans	■ LD50/LC50
d-Dog	k-Monkey	j-Pigeon	o-Other	● LOAEL, More Serious-Animals	▲ LOAEL, More Serious-Humans	Minimal Risk Level for effects other than Cancer
r-Rat	m-Mouse	e-Gerbil		◑ LOAEL, Less Serious-Animals	◭ LOAEL, Less Serious-Humans	
p-Pig	h-Rabbit	s-Hamster		○ NOAEL - Animals	△ NOAEL - Humans	
q-Cow	a-Sheep	g-Guinea Pig				

Figure 3-5 Levels of Significant Exposure to Dimethylarsinic Acid - Oral *(Continued)*

Chronic (≥365 days)

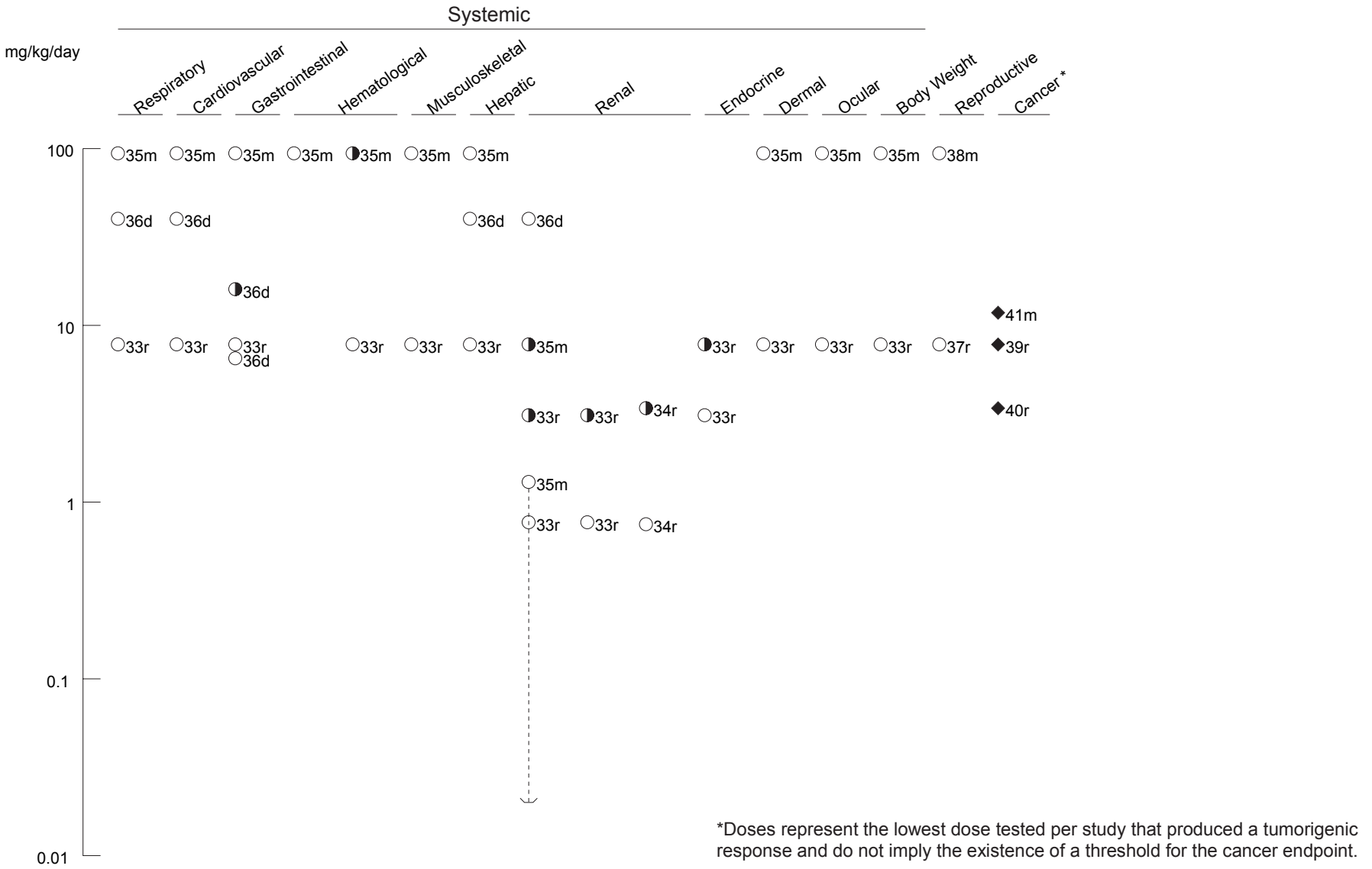


Table 3-6 Levels of Significant Exposure to Roxarsone - Oral

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
ACUTE EXPOSURE								
Death								
1	Rat (Holtzman)	once (GW)				155 (LD50)	Kerr et al. 1963 ROX	
2	Rat (Fischer- 344)	once (GO)				150 M (5/5 died) 81[b] F (LD50)	NTP 1989b ROX	
3	Rat (Fischer- 344)	14 d (F)				128[b] M (3/5 died) 144 F (5/5 died)	NTP 1989b ROX	
4	Mouse (B6C3F1)	once (GO)				300 M (5/5 died) 244[b] F (LD50)	NTP 1989b ROX	
5	Mouse (B6C3F1)	14 d (F)				168 F (5/5 died)	NTP 1989b ROX	
Systemic								
6	Rat (Fischer- 344)	14 d (F)	Bd Wt	16 M	32 M (22% reduced body weight)		NTP 1989b ROX	
7	Mouse (B6C3F1)	14 d (F)	Bd Wt	84		168 (34% decrease in body weight)	NTP 1989b ROX	
Neurological								
8	Rat (Fischer- 344)	14 d (F)		16 M	32 M (slight inactivity)		NTP 1989b ROX	

Table 3-6 Levels of Significant Exposure to Roxarsone - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
9	Mouse (B6C3F1)	14 d (F)		20	42 (slight inactivity; ruffled fur)		NTP 1989b ROX	
10	Pig (Landrace)	30 d ad lib (F)				6.3 (muscle tremors and clonic convulsions)	Rice et al. 1985; Kennedy et al. 1986 ROX	
INTERMEDIATE EXPOSURE								
Death								
11	Rat (Holtzman)	13 wk (F)				20 (10/12 died)	Kerr et al. 1963 ROX	
12	Rat (Fischer- 344)	13 wk ad lib (F)				64 M (3/10 died)	NTP 1989b ROX	
13	Mouse (B6C3F1)	13 wk ad lib (F)				136 (6/10 males and 8/10 females died)	NTP 1989b ROX	

Table 3-6 Levels of Significant Exposure to Roxarsone - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
Systemic								
14	Rat (Fischer- 344)	31 or 90 d ad lib (F)	Hemato	32 M			NTP 1989b ROX	
			Hepatic	9 F	36 F (decreased absolute and relative liver weight)			
			Renal	8 M	32 M (increased kidney weight; minimal tubular degeneration)			
			Bd Wt	8 M		32 M (27% decrease in body weight)		

Table 3-6 Levels of Significant Exposure to Roxarsone - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
15	Rat (Fischer- 344)	13 wk ad lib (F)	Resp	64 M			NTP 1989b ROX	
			Cardio	64 M				
			Gastro	64 M				
			Musc/skel	64 M				
			Hepatic	4 M	8 M (increased relative liver weight)			
			Renal	16 M	32 M (interstitial inflammation, focal regenerative hyperplasia of tubular cell epithelium and mineralization)			
			Endocr	64 M				
			Dermal	64 M				
			Bd Wt	8 M	16 M (14% decreased body weight)	32 M (26% decreased body weight)		

Table 3-6 Levels of Significant Exposure to Roxarsone - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
16	Mouse (B6C3F1)	13 wk ad lib (F)	Cardio	136			NTP 1989b ROX	
			Gastro	136				
			Musc/skel	136				
			Hepatic	136				
			Renal	136				
			Endocr	136				
			Dermal	136				
			Bd Wt		136 (18% decreased body weight in males; 11% decreased body weight in females)			
17	Mouse (B6C3F1)	29 or 91 d ad lib (F)	Hemato	68			NTP 1989b ROX	
			Hepatic	68				
			Renal	68				
Neurological								
18	Rat (Fischer- 344)	13 wk ad lib (F)		32 M		64 M (trembling, ataxia, hyperexcitability, slight inactivity, ruffled fur)	NTP 1989b ROX	

Table 3-6 Levels of Significant Exposure to Roxarsone - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)		Reference Chemical Form	Comments
19	Pig	28 d (F)				10	(muscle tremors)	Edmonds and Baker 1986 ROX	
20	Pig (Landrace)	30 d ad lib (F)				6.3	(paraplegia, myelin degeneration in spinal cord, peripheral nerves, optic nerve)	Rice et al. 1985; Kennedy et al. 1986 ROX	
CHRONIC EXPOSURE									
Systemic									
21	Rat (Fischer- 344)	103 wk ad lib (F)	Resp	4				NTP 1989b ROX	
			Cardio	4					
			Gastro	4					
			Musc/skel	4					
			Hepatic	4					
			Renal	4					
			Endocr	4					
			Dermal	4					
			Ocular	4					
			Bd Wt	4					
22	Mouse (Fischer- 344)	103 wk ad lib (F)	Resp	43 M				NTP 1989b ROX	
			Cardio	43 M					
			Gastro	43 M					
			Musc/skel	43 M					
			Hepatic	43 M					

Table 3-6 Levels of Significant Exposure to Roxarsone - Oral (continued)

Key to Figure[a]	Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL (mg/kg/day)	LOAEL Less Serious (mg/kg/day)	LOAEL Serious (mg/kg/day)	Reference Chemical Form	Comments
			Renal	43 M				
			Endocr	43 M				
			Dermal	43 M				
			Ocular	43 M				
			Bd Wt	43 F				

a The number corresponds to entries in Figure 3-6.

b Differences in levels of health effects and cancer effects between male and females are not indicated in Figure 3-6. Where such differences exist, only the levels of effect for the most sensitive gender are presented.

ad lib = ad libitum; Bd Wt = body weight; Cardio = cardiovascular; d = day(s); Endocr = endocrine; (F) = feed; F = Female; Gastro = gastrointestinal; (GO) = gavage in oil; (GW) = gavage in water; Hemato = hematological; LC50 = lethal concentration, 50% kill, LD50 = lethal dose, 50% kill; LOAEL = lowest-observed-adverse-effect level; M = male; Musc/skel = musculoskeletal; NOAEL = no-observed-adverse-effect level; occup = occupational; Resp = respiratory; wk = week(s)

Figure 3-6 Levels of Significant Exposure to Roxarsone - Oral

Acute (≤14 days)

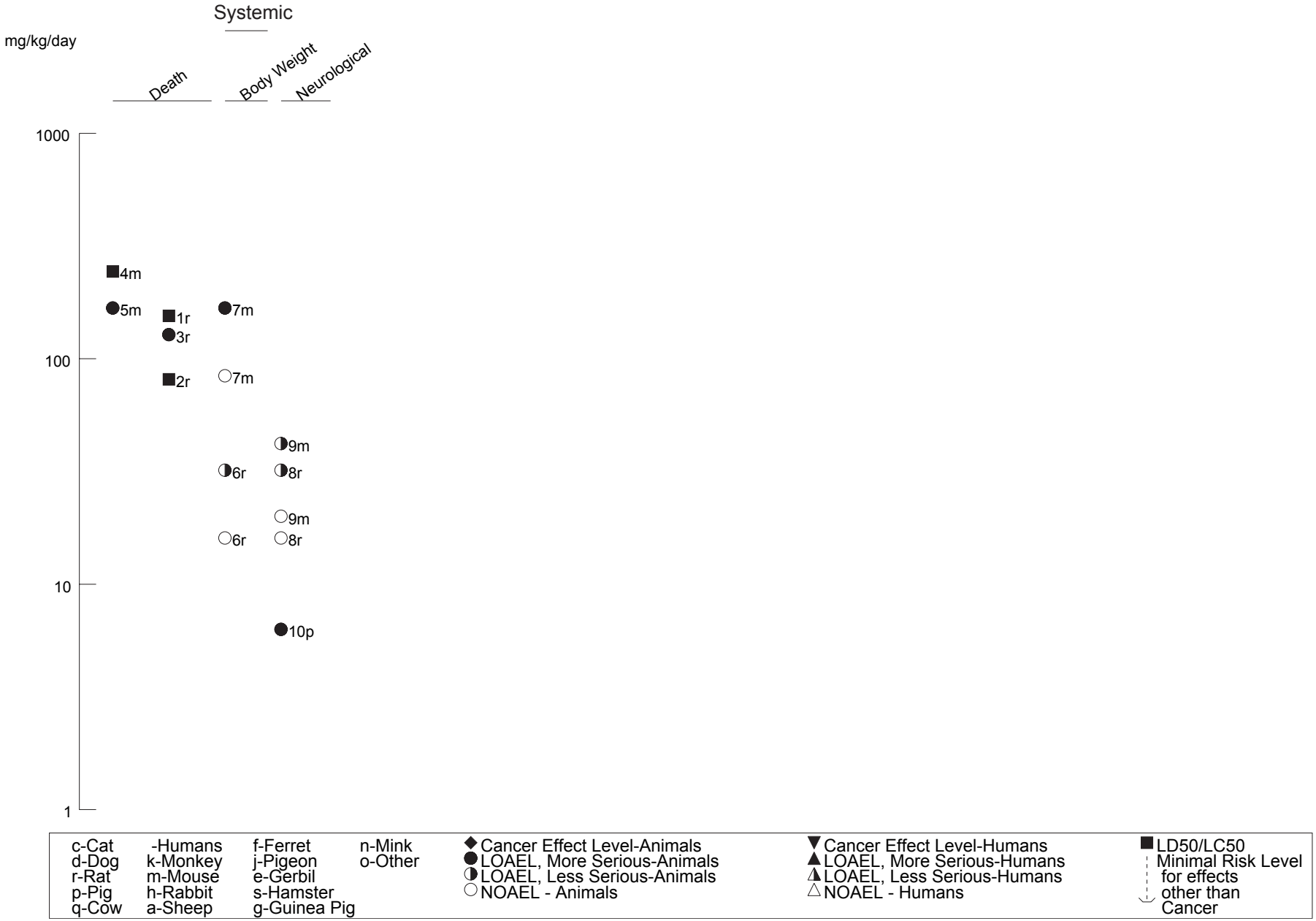
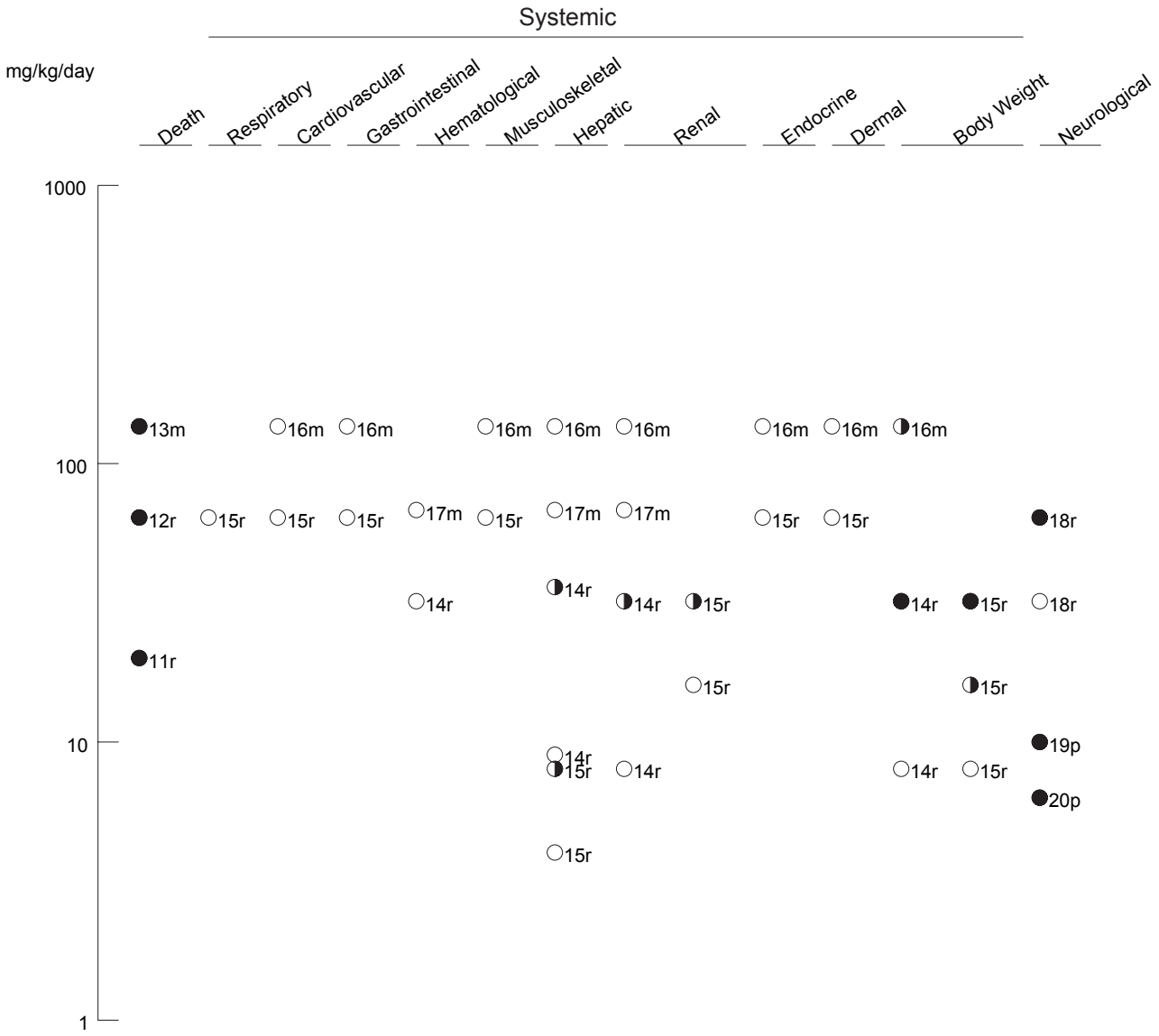


Figure 3-6 Levels of Significant Exposure to Roxarsone - Oral *(Continued)*

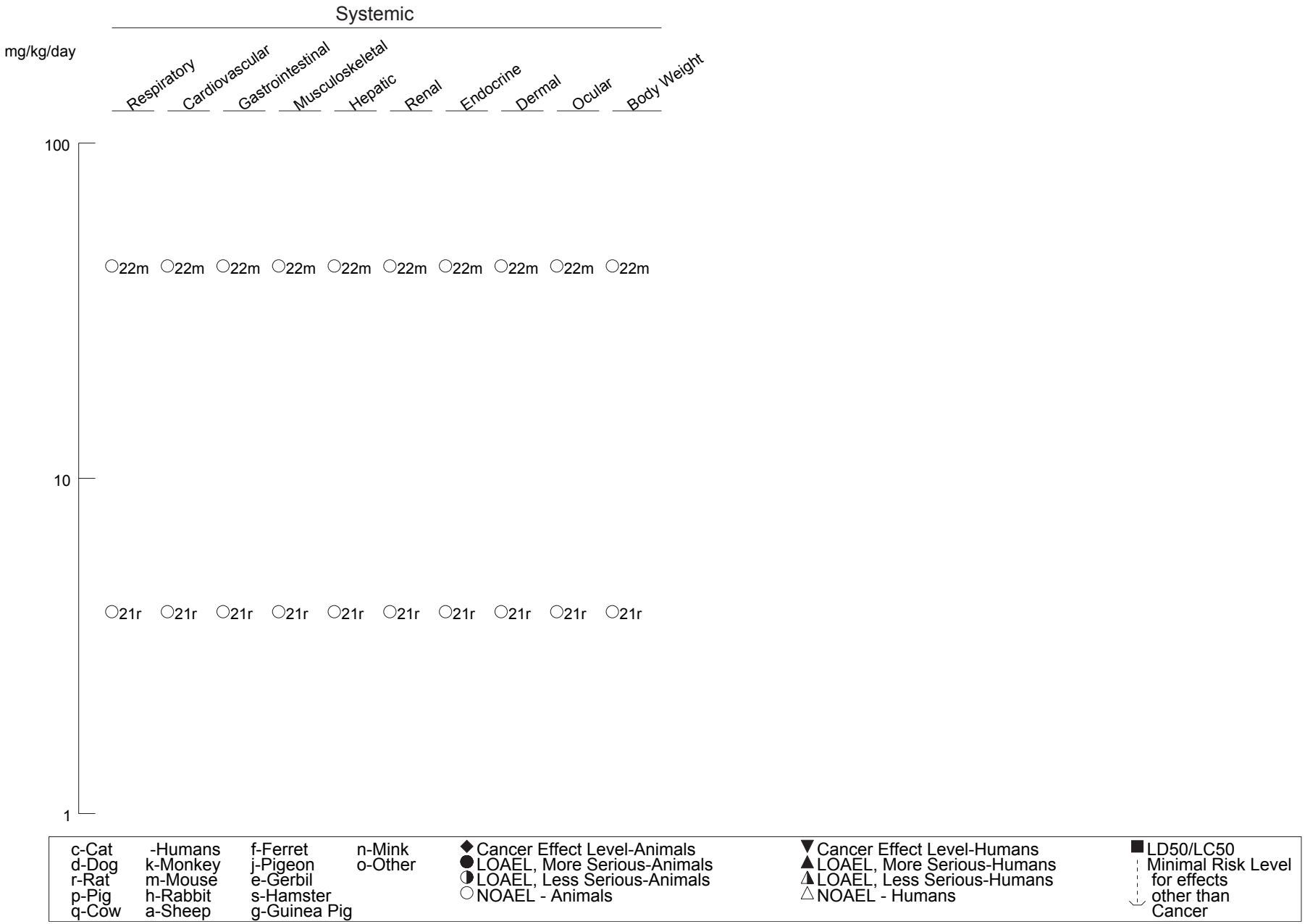
Intermediate (15-364 days)



c-Cat	-Humans	f-Ferret	n-Mink	◆ Cancer Effect Level-Animals	▼ Cancer Effect Level-Humans	■ LD50/LC50
d-Dog	k-Monkey	j-Pigeon	o-Other	● LOAEL, More Serious-Animals	▲ LOAEL, More Serious-Humans	Minimal Risk Level for effects other than Cancer
r-Rat	m-Mouse	e-Gerbil		◑ LOAEL, Less Serious-Animals	◭ LOAEL, Less Serious-Humans	
p-Pig	h-Rabbit	s-Hamster		○ NOAEL - Animals	△ NOAEL - Humans	
q-Cow	a-Sheep	g-Guinea Pig				

Figure 3-6 Levels of Significant Exposure to Roxarsone - Oral *(Continued)*

Chronic (≥365 days)



Available LD_{50} values for arsenate and arsenite in rats and mice range from 15 to 175 mg As/kg (Dieke and Richter 1946; Gaines 1960; Harrisson et al. 1958; Kaise et al. 1985). The variability can be attributed to differences based on species, strain, specific route of exposure (feed vs. gavage), specific compound tested, and testing laboratory. Most deaths occurred within 1 day of exposure, but details regarding cause of death were not generally reported. Seven of 25 pregnant rats given a single gavage dose of 23 mg As/kg as arsenic trioxide on day 9 of gestation died soon after dosing, while no deaths occurred at doses of 4–15 mg As/kg (Stump et al. 1999). Data on lethality from repeated exposure studies in animals are relatively sparse. Seven of 20 pregnant rabbits died from repeated gavage doses of 1.5 mg As/kg/day as arsenic acid during gestation, while none died at 0.1–0.4 mg As/kg/day (Nemec et al. 1998). Chronic studies observed treatment-related mortality in monkeys exposed to 3 mg As/kg/day as arsenate (Heywood and Sortwell 1979), dogs exposed to 2.4 mg As/kg/day as arsenite or arsenate (Byron et al. 1967), mice exposed to 1 mg As/kg/day as arsenite (Schroeder and Balassa 1967), and rats exposed to 30 mg As/kg/day as lead arsenate (Kroes et al. 1974).

Reliable LOAEL and LD_{50} values for lethality from oral exposure to inorganic arsenicals in each species and duration category are recorded in Table 3-3 and plotted in Figure 3-3.

Organic Arsenicals. No studies were located regarding death in humans after oral exposure to organic arsenicals, but the acute lethality of MMA, DMA, and roxarsone have been investigated in several animal studies. The LD_{50} values for MMA (including MSMA), DMA, and roxarsone are 102–3,184 mg/kg MMA or MSMA (Gur and Nyska 1990; Jaghabir et al. 1988; Kaise et al. 1989), 1,200 mg DMA/kg/day (Kaise et al. 1989), and 14.2–69.5 mg DMA/kg/day (Kerr et al. 1963; NTP 1989b), respectively. The cause of death was not investigated in any of these studies. Intermediate-duration exposure to MMA, DMA, or roxarsone resulted in increased mortality in laboratory animals exposed to 106.9 mg MMA/kg/day (Arnold et al. 2003), 17–190 mg DMA/kg/day (Crown et al. 1987; Murai et al. 1993; Wanibuchi et al. 1996) or 20–64 mg/kg/day roxarsone (Edmonds and Baker 1986; Kerr et al. 1963; NTP 1989b), respectively. Increased mortality was also observed in rats chronically exposed to 72.4 mg MMA/kg/day (Arnold et al. 2003).

3.2.2.2 Systemic Effects

The highest NOAEL values and all reliable LOAEL values for systemic effects from oral exposure in each species and duration category are recorded in Table 3-3 and plotted in Figure 3-3. Similar data for

oral exposure to MMA, DMA, and roxarsone are shown in Tables 3-4, 3-5, and 3-6, and shown in Figures 3-4, 3-5, and 3-6, respectively.

Respiratory Effects.

Inorganic Arsenicals. Serious respiratory effects, including respiratory distress, hemorrhagic bronchitis, and pulmonary edema, have been reported in some cases of acute oral arsenic poisoning at doses of 8 mg As/kg and above (e.g., Civantos et al. 1995; Fincher and Koerker 1987; Levin-Scherz et al. 1987; Moore et al. 1994b; Quatrehomme et al. 1992). These effects may be secondary to injury to the pulmonary vasculature (see Cardiovascular Effects, below). In addition, bronchitis and sequelae (bronchiectasis, bronchopneumonia) have been observed in patients and at autopsy in some chronic poisoning cases (Guha Mazumder et al. 2005; Milton and Rahman 2002; Rosenberg 1974; Tsai et al. 1999; Zaldívar 1974; Zaldívar and Guillier 1977). Bronchopneumonia secondary to arsenic-induced bronchitis was considered to be the cause of death in one young child who died after several years of exposure to an average dose of 0.08 mg As/kg/day (Zaldívar and Guillier 1977). Decrements in lung function, measured as decreased FEV_1, FVC, and $FEF_{25–75}$ have also been reported in subjects exposed to 0.1–0.5 mg As/L in the drinking water and exhibiting skin lesions (von Ehrenstein et al. 2005). In general, however, respiratory effects have not been widely associated with repeated oral ingestion of low arsenic doses. Nevertheless, a few studies have reported minor respiratory symptoms, such as cough, sputum, rhinorrhea, and sore throat, in people with repeated oral exposure to 0.03–0.05 mg As/kg/day (Ahmad et al. 1997; Mizuta et al. 1956).

There are few data regarding respiratory effects in animals following acute oral exposure to inorganic arsenic. An infant Rhesus monkey that died after 7 days of oral exposure to a complex arsenate salt at a dose of 3 mg As/kg/day exhibited bronchopneumonia with extensive pulmonary hemorrhage, edema, and necrosis (Heywood and Sortwell 1979). Two other monkeys in this treatment group survived a 1-year exposure period and had no gross or microscopic pulmonary lesions at sacrifice. Increased relative lung weights were seen in rats exposed to 6.66 mg As/kg/day as sodium arsenite 5 days/week for 12 weeks (Schulz et al. 2002). Chronic oral studies in dogs and rats treated with arsenate or arsenite failed to find respiratory lesions (Byron et al. 1967; Kroes et al. 1974; Schroeder et al. 1968).

One study utilizing gallium arsenide included limited investigation of respiratory function. Respiration rate was significantly decreased in rats following ingestion of a single dose of gallium arsenide at 1,040 mg As/kg, but was unaffected at a dose of 520 mg As/kg (Flora et al. 1997a). Respiration rate was measured 1, 7, and 15 days after dosing, but the decrease was most noticeable after 15 days.

Organic Arsenicals. No respiratory effects were noted after acute human ingestion of 1,714 mg MSMA/kg (Shum et al. 1995). Mice exhibited respiratory arrest after a single oral dose of 1,800 mg MMA/kg (Kaise et al. 1989) or 900 mg DMA/kg (Kaise et al. 1989) and lung ornithine decarboxylase activity was reduced after ingestion of one or two doses of 720 mg DMA/kg (Ahmad et al. 1999a). Localized lung hemorrhage was observed in dogs after a single oral dose of 14.2 mg/kg roxarsone in a capsule (Kerr et al. 1963). No respiratory effects were seen after intermediate or chronic exposure of rats, mice, or dogs exposed to 35 mg MMA/kg/day (Waner and Nyska 1988), 7.8–94 mg DMA/kg/day (Arnold et al. 2006; Crown et al. 1987; Rubin et al. 1989; Zomber et al. 1989), or 4–136 mg/kg/day roxarsone (NTP 1989b).

Cardiovascular Effects.

Inorganic Arsenicals. A number of studies in humans indicate that arsenic ingestion may lead to serious effects on the cardiovascular system. Characteristic effects on the heart from both acute and long-term exposure include altered myocardial depolarization (prolonged QT interval, nonspecific ST segment changes) and cardiac arrhythmias (Cullen et al. 1995; Glazener et al. 1968; Goldsmith and From 1986; Heyman et al. 1956; Little et al. 1990; Mizuta et al. 1956; Moore et al. 1994b; Mumford et al. 2007). A significant dose-related increase in the prevalence of cardiac electrophysiologic abnormalites was observed in residents of Inner Mongolia, China; the incidences of QT prolongation were observed in 3.9, 11.1, and 20.6% of the residents with drinking water levels of <21, 110–300, and 430–690 μg/L, respectively (Mumford et al. 2007). Hypertrophy of the ventricular wall was observed at autopsy after acute exposure to 93 mg of arsenic (Quatrehomme et al. 1992). Long-term, low-level exposures may also lead to damage to the vascular system. The most dramatic example of this is "Blackfoot Disease," a condition that is endemic in an area of Taiwan where average drinking water levels of arsenic range from 0.17 to 0.80 ppm (Tseng 1977), corresponding to doses of about 0.014–0.065 mg As/kg/day (IRIS 2007). The disease is characterized by a progressive loss of circulation in the hands and feet, leading ultimately to necrosis and gangrene (Chen et al. 1988b; Ch'i and Blackwell 1968; Tseng 1977, 1989; Tseng et al. 1968, 1995, 1996). Several researchers have presented evidence that other factors besides arsenic (e.g., other water contaminants, dietary deficits) may play a role in the etiology of this disease (Ko 1986; Lu et al. 1990; Yu et al. 1984). While this may be true, the clear association between the occurrence of Blackfoot Disease and the intake of elevated arsenic levels indicates that arsenic is at least a contributing factor. The results of a recent study suggested that individuals with a lower capacity to methylate

inorganic arsenic to DMA have a higher risk of developing peripheral vascular disease in the Blackfoot Disease-hyperendemic area in Taiwan (Tseng et al. 2005).

Arsenic exposure in Taiwan has also been associated with an increased incidence of cerebrovascular and microvascular diseases (Chiou et al. 1997; Wang et al. 2002, 2003) and ischemic heart disease (Chang et al. 2004; Chen et al. 1996; Hsueh et al. 1998b; Tsai et al. 1999; Tseng et al. 2003). Moreover, effects of arsenic on the vascular system have also been reported in a number of other populations. For example, hypertension, defined as a systolic blood pressure of ≥140 mm Hg in combination with a diastolic blood pressure of ≥90 mm Hg, was associated with estimated lifetime doses of approximately 0.055 mg As/kg/day (0.25 mg/L in water) in a study of people in Bangladesh (Rahman et al. 1999); no significant association was found with estimated doses of 0.018 mg As/kg/day (0.75 mg/L in water). Wang et al. (2003) found an increased incidence of microvascular and macrovascular disease among subjects in Taiwan living in an arseniasis-endemic area in which the water of artesian wells had arsenic concentrations >0.35 mg/L (estimated doses of >0.03 mg As/kg/day). An additional study of Taiwanese subjects reported a significant increase in incidence of hypertension associated with concentrations of arsenic in the water >0.7 mg/L (estimated doses of >0.06 mg As/kg/day) (Chen et al. 1995). Studies in Chile indicate that ingestion of 0.6–0.8 ppm arsenic in drinking water (corresponding to doses of 0.02–0.06 mg As/kg/day, depending on age) increases the incidence of Raynaud's disease and of cyanosis of fingers and toes (Borgoño and Greiber 1972; Zaldívar 1974, 1977; Zaldívar and Guillier 1977). Autopsy of five children from this region who died of apparent arsenic toxicity showed a marked thickening of small and medium sized arteries in tissues throughout the body, especially the heart (Rosenberg 1974). In addition, cardiac failure, arterial hypotension, myocardial necrosis, and thrombosis have been observed in children who died from chronic arsenic ingestion (Zaldívar 1974), as well as adults chronically exposed to arsenic (Dueñas et al. 1998). Likewise, thickening and vascular occlusion of blood vessels were noted in German vintners exposed to arsenical pesticides in wine and in adults who drank arsenic-contaminated drinking water (Roth 1957; Zaldívar and Guillier 1977). A survey of Wisconsin residents using private wells for their drinking water found that residents exposed for at least 20 years to water concentrations of >10 µg As/L had increased incidences of cardiac bypass surgery, high blood pressure, and circulatory problems as compared with residents exposed to lower arsenic concentrations (Zierold et al. 2004). Similarly, Lewis et al. (1999) reported increased mortality from hypertensive heart disease in both men and women among a cohort exposed to arsenic in their drinking water in Utah, as compared with the general population of Utah. Limitations in the study included lack of evaluation of smoking as a confounder and of other dietary sources of arsenic, and the lack of a dose-response for hypertensive heart disease. Another ecological study (Engel and Smith 1994) found significant increases in deaths from

arteriosclerosis, aortic aneurysm, and all other diseases of the arteries, arterioles, and capillaries among U.S. residents with arsenic drinking waters of >20 µg/L; the increase in deaths from congenital anomalies of the heart and other anomalies of the circulatory system also observed in this subpopulation limits the interpretation of the findings.

Similar alterations in vascular reactivity have been noted in rats given repeated oral doses of arsenic trioxide (11 mg As/kg/day) for several weeks (Bekemeier and Hirschelmann 1989), although no histological effects could be detected in the hearts of rats or dogs exposed to up to 30 mg As/kg/day as arsenate or arsenite for 2 years (Byron et al. 1967; Kroes et al. 1974; Schroeder et al. 1968). Acute exposure of rats to gallium arsenide at a dose of 1,040 mg As/kg resulted in an increase in blood pressure and heart rate, while 520 mg As/kg had no effect (Flora et al. 1997a). Guinea pigs exposed to arsenic trioxide for 1 day (0, 7.6, 22.7, or 37.9 mg As/kg) or 8 days (0 or 3.8 mg As/kg/day) showed prolongation of the cardiac QT interval and action potential duration (Chiang et al. 2002).

Organic Arsenicals. No adverse cardiovascular effects were noted after acute human ingestion of 1,714 mg MSMA/kg (Shum et al. 1995). However, sinus tachycardia was noted after acute ingestion of 73 mg DMA/kg (as dimethyl arsenic acid and dimethyl arsenate) (Lee et al. 1995). No cardiovascular effects were seen after intermediate or chronic exposure of laboratory animals to 35–67.1 mg MMA/kg/day (Arnold et al. 2003; Waner and Nyska 1988), 7.8–94 mg DMA/kg/day (Arnold et al. 2006; Crown et al. 1987; Rubin et al. 1989; Zomber et al. 1989), or 4–136 mg/kg/day roxarsone (NTP 1989b).

Gastrointestinal Effects.

Inorganic Arsenicals. Clinical signs of gastrointestinal irritation, including nausea, vomiting, diarrhea, and abdominal pain, are observed in essentially all cases of short-term high-dose exposures to inorganic arsenic (e.g., Armstrong et al. 1984; Bartolome et al. 1999; Campbell and Alvarez 1989; Chakraborti et al. 2003a; Cullen et al. 1995; Fincher and Koerker 1987; Goebel et al. 1990; Kingston et al. 1993; Levin-Scherz et al. 1987; Lugo et al. 1969; Moore et al. 1994b; Muzi et al. 2001; Uede and Furukawa 2003; Vantroyen et al. 2004). Similar signs are also frequently observed in groups or individuals with longer-term, lower-dose exposures (e.g., Borgoño and Greiber 1972; Cebrián et al. 1983; Franzblau and Lilis 1989; Guha Mazumder et al. 1988, 1998a; Haupert et al. 1996; Holland 1904; Huang et al. 1985; Mizuta et al. 1956; Nagai et al. 1956; Silver and Wainman 1952; Wagner et al. 1979; Zaldívar 1974), but effects are usually not detectable at exposure levels below about 0.01 mg As/kg/day (Harrington et al. 1978; Valentine et al. 1985). These symptoms generally decline within a short time after exposure ceases.

Gastrointestinal irritation symptoms form the basis (in part) for the acute oral MRL of 0.005 mg/kg/day for inorganic arsenic, as described in footnote b in Table 3-3. More severe symptoms (hematemesis, hemoperitoneum, gastrointestinal hemorrhage, and necrosis) have been reported in some cases with acute exposure to 8 mg As/kg or more (Civantos et al. 1995; Fincher and Koerker 1987; Levin-Scherz et al. 1987; Quatrehomme et al. 1992), and also in some people with long-term ingestion of 0.03–0.05 mg As/kg/day as a medicinal preparation (Lander et al. 1975; Morris et al. 1974).

Clinical signs of gastrointestinal irritation were observed in monkeys and rats given repeated oral doses of arsenic (6 and 11 mg As/kg/day, respectively) for 2 weeks (Bekemeier and Hirschelmann 1989; Heywood and Sortwell 1979). Hemorrhagic gastrointestinal lesions have also been reported in animal studies. A monkey that died after repeated oral treatment with 6 mg As/kg/day for approximately 1 month was found to have acute inflammation and hemorrhage of the small intestine upon necropsy (Heywood and Sortwell 1979). This lesion was not found in other monkeys that died in this study, or in the survivors. Two pregnant mice that died after repeated gavage treatment with 24 mg As/kg/day as arsenic acid had hemorrhagic lesions in the stomach (Nemec et al. 1998). Gross gastrointestinal lesions (stomach adhesions, eroded luminal epithelium in the stomach) were seen frequently in rats treated by gavage with 8 mg As/kg/day as arsenic trioxide starting before mating and continuing through the end of gestation (Holson et al. 2000). The lesions were not found in rats treated with 4 mg As/kg/day in this study. No histological evidence of gastrointestinal injury was detected in rats exposed to arsenate or arsenite in the feed for 2 years at doses up to 30 mg As/kg/day, but dogs fed a diet containing 2.4 mg As/kg/day as arsenite for 2 years had some bleeding in the gut (Byron et al. 1967; Kroes et al. 1974).

Organic Arsenicals. Vomiting was noted after ingestion of 793 mg/kg arsenic (as monosodium methanearsenate) in a suicide attempt (Shum et al. 1995). Ingestion of 78 mg DMA/kg (as dimethyl arsenic acid and dimethyl arsenate) induced vomiting, abdominal pain, hyperactive bowel, and diarrhea (Lee et al. 1995).

The gastrointestinal tract appears to be the critical target of toxicity following oral exposure to MMA. Diarrhea/loose feces has been reported in mice and rabbits following a single gavage dose of 2,200 mg MMA/kg or 60 mg MSMA/kg, respectively (Jaghabir et al. 1988; Kaise et al. 1989), pregnant rabbits administered 12 mg MMA/kg/day via gavage (Irvine et al. 2006), rats exposed to 30.2 mg MMA/kg/day in the diet during the first year of a 2-year study (Arnold et al. 2003), dogs administered 2 mg MMA/kg/day via capsule for 52 weeks (Waner and Nyska 1988), rats fed diets containing 25.7 mg MMA/kg/day for 2 years (Arnold et al. 2003), and mice exposed to 67.1 mg MMA/kg/day in the diet for

2 years (Arnold et al. 2003). However, the increased incidence of diarrhea is not always accompanied by macroscopic or histological alterations in the gastrointestinal tissues. For example, in the 2-year rat study (Arnold et al. 2003; incidence data reported in Crown et al. 1990), an increased incidence of diarrhea was observed at 25.7 mg MMA/kg/day; macroscopic or histological alterations were observed in some animals, but the incidence was similar to controls. At the next highest dose level (72.4 mg MMA/kg/day), thickened wall and edema and hemorrhagic, necrotic, ulcerated, or perforated mucosa were observed in the large intestine and significant increases in the incidence of squamous metaplasia of the epithelial columnar absorptive cells were found in the cecum, colon, and rectum. Squamous metaplasia was also observed in the cecum and colon of mice chronically exposed to 67.1 mg MMA/kg/day (Arnold et al. 2003; incidence data reported in Gur et al. 1991).

There are some reports of gastrointestinal effects in rats and dogs exposed to DMA; however, the LOAELs for these effects are higher than the LOAELs for MMA and most rodent studies do not report effects at nonlethal doses. Diarrhea with congestion and hemorrhagic gastrointestinal contents were observed in rats exposed to a lethal dose of 190 mg DMA/kg/day in the diet for 4 weeks (Crown et al. 1987) and diarrhea and vomiting were reported in dogs administered 16 mg DMA/kg/day via capsule 6 days/week (Zomber et al. 1989). No gastrointestinal effects were observed in rats or mice chronically exposed to 7.8 or 94 mg DMA/kg/day, respectively (Arnold et al. 2006).

Vomiting and gastrointestinal hemorrhage were observed in dogs after a single capsulized dose of 50 mg/kg roxarsone (Kerr et al. 1963), although slightly higher doses administered for 13 weeks to rats and mice had no effect (NTP 1989b). No gastrointestinal effects were seen after chronic exposure of rats (4 mg/kg/day) or mice (43 mg/kg/day) to roxarsone (NTP 1989b).

Hematological Effects.

Inorganic Arsenicals. Anemia and leukopenia are common effects of arsenic poisoning in humans, and have been reported following acute (Armstrong et al. 1984; Goldsmith and From 1986; Mizuta et al. 1956; Muzi et al. 2001; Westhoff et al. 1975), intermediate (Franzblau and Lilis 1989; Heyman et al. 1956; Nagai et al. 1956; Wagner et al. 1979), and chronic oral exposures (Chakraborti et al. 2003a; Glazener et al. 1968; Guha Mazumder et al. 1988; Hopenhayn et al. 2006; Kyle and Pease 1965; Tay and Seah 1975) at doses of 0.002 mg As/kg/day or more. These effects may be due to both a direct cytotoxic or hemolytic effect on the blood cells (Armstrong et al. 1984; Fincher and Koerker 1987; Goldsmith and From 1986; Kyle and Pease 1965; Lerman et al. 1980) and a suppression of erythropoiesis (Kyle and

Pease 1965; Lerman et al. 1980). However, hematological effects are not observed in all cases of arsenic exposure (EPA 1981b; Harrington et al. 1978; Huang et al. 1985; Silver and Wainman 1952) or even all acute poisoning cases (Cullen et al. 1995; Moore et al. 1994b).

In an acute animal study, Tice et al. (1997) found that there was a decrease in polychromatic erythrocytes in the bone marrow of mice treated with 6 mg As/kg/day for 1 or 4 days. There was no effect at 3 mg As/kg/day. Long-term studies found mild anemia in dogs fed arsenite or arsenate for 2 years at 2.4 mg As/kg/day, but no hematological effect in dogs fed 1 mg As/kg/day for 2 years or 1.9 mg As/kg/day for 26 weeks (Byron et al. 1967; Neiger and Osweiler 1989). Chronic rat studies found little or no evidence of anemia at doses up to 30 mg As/kg/day, even with co-exposure to lead (Byron et al. 1967; Kroes et al. 1974). No hematological effects were found in monkeys exposed to arsenic doses of 3–6 mg As/kg/day for 1 year (Heywood and Sortwell 1979).

Rats exposed to arsenate for 6 weeks had decreased activities of several enzymes involved in heme synthesis, but data were not provided on whether this resulted in anemia (Woods and Fowler 1977, 1978). Exposure of rats to ≥5 ppm of arsenic (0.30 mg As/kg/day as sodium arsenite) in the drinking water for 4 weeks resulted in increased platelet aggregation, while 10 or 25 ppm (0.60 or 1.5 mg As/kg/day) was associated with increased P-selectin-positive cells and decreased occlusion time (Lee et al. 2002), representing a change in platelet function. Similarly, exposure of rats or guinea pigs to 10 or 25 ppm of arsenic as arsenite (approximate doses of 0, 0.92, or 2.3 mg As/kg/day for rats and 0, 0.69, or 1.7 mg As/kg/day for guinea pigs) in the drinking water for 16 weeks (Kannan et al. 2001) resulted in decreases in erythrocyte and leukocyte numbers (rats and guinea pigs), increased blood mean corpuscular volume and corpuscular hemoglobin mass (guinea pigs only), and decreased mean corpuscular hemoglobin concentration (rats only). Gallium arsenide also disrupts heme synthesis in rats, although the evidence suggests that this effect is due primarily to the gallium moiety (Flora et al. 1997a).

Organic Arsenicals. No adverse hematological effects were noted in a man who ingested 78 mg/kg as dimethyl arsenic acid and dimethyl arsenate (Lee et al. 1995). No hematological effects were observed in rats exposed to 8.4 or 72.4 mg MMA/kg/day for 2 years (Arnold et al. 2003; Shen et al. 2003) or dogs administered 35 mg MMA/kg/day for 52 weeks (Waner and Nyska 1988); additionally, no alterations in total or differential leukocyte levels were observed in mice exposed to 67.1 mg MMA/kg/day for 2 years (Arnold et al. 2003). Although some studies have reported hematological alterations following oral exposure to DMA, this is not a consistent finding. Observed alterations include decreased mean corpuscular hemoglobin concentration in rats exposed to 2.3 mg DMA/kg/day for 10 weeks (Rubin et al.

1989), decreased hemoglobin and erythrocyte levels in rats exposed to 4.5 mg DMA/kg/day for 13 weeks (Crown et al. 1987), decreased erythrocyte levels and increased leukocyte levels in dogs administered capsules containing 40 mg DMA/kg/day for 52 weeks (Zomber et al. 1989), and decreased lymphocyte and increased monocyte levels were observed in mice chronically exposed to 94 mg DMA/kg/day (Arnold et al. 2006). No hematological alterations have been observed in rats exposed to 7.8 mg DMA/kg/day for 2 years (Arnold et al. 2006). Similarly, no hematological effects were observed in rats (Kerr et al. 1963; NTP 1989b), mice (NTP 1989b), or dogs (Prier et al. 1963) exposed to 20–32, 68, or 5 mg/kg/day roxarsone, respectively, for intermediate or chronic durations

Musculoskeletal Effects.

Inorganic Arsenicals. No studies were located regarding musculoskeletal effects in humans or animals after oral exposure to inorganic arsenicals.

Organic Arsenicals. No studies were located regarding musculoskeletal effects in humans after oral exposure to organic arsenicals. No musculoskeletal effects were seen after intermediate or chronic exposure of rats and mice to MMA (Arnold et al. 2003), DMA (Arnold et al. 2006), or roxarsone (NTP 1989b).

Hepatic Effects.

Inorganic Arsenicals. A number of studies in humans exposed to inorganic arsenic by the oral route have noted signs or symptoms of hepatic injury. Clinical examination often reveals that the liver is swollen and tender (Chakraborty and Saha 1987; Franklin et al. 1950; Guha Mazumder et al. 1988, 1998a; Liu et al. 2002; Mizuta et al. 1956; Silver and Wainman 1952; Wade and Frazer 1953; Zaldívar 1974), and analysis of blood sometimes shows elevated levels of hepatic enzymes (Armstrong et al. 1984; Franzblau and Lilis 1989; Guha Mazumder 2005; Hernández-Zavala et al. 1998). These effects are most often observed after repeated exposure to doses of 0.01–0.1 mg As/kg/day (Chakraborty and Saha 1987; Franklin et al. 1950; Franzblau and Lilis 1989; Guha Mazumder et al. 1988; Mizuta et al. 1956; Silver and Wainman 1952; Wade and Frazer 1953), although doses as low as 0.006 mg As/kg/day have been reported to have an effect following chronic exposure (Hernández-Zavala et al. 1998). Hepatic effects have also been reported in acute bolus poisoning cases at doses of 2 mg As/kg/day or more (Hantson et al. 1996; Kamijo et al. 1998; Levin-Scherz et al. 1987; Quatrehomme et al. 1992; Vantroyen et al. 2004), although acute exposure to 19 mg As/kg did not cause hepatic effects in an infant (Cullen et al. 1995).

Histological examination of the livers of persons chronically exposed to similar doses has revealed a consistent finding of portal tract fibrosis (Guha Mazumder 2005; Guha Mazumder et al. 1988; Morris et al. 1974; Piontek et al. 1989; Szuler et al. 1979), leading in some cases to portal hypertension and bleeding from esophageal varices (Szuler et al. 1979); cirrhosis has also been reported at an increased frequency in arsenic-exposed individuals (Tsai et al. 1999). Several researchers consider that these hepatic effects are secondary to damage to the hepatic blood vessels (Morris et al. 1974; Rosenberg 1974), but this is not directly established.

Acute exposure of monkeys to 6 mg As/kg/day resulted in vacuolization of the hepatocytes (Heywood and Sortwell 1979). Studies in dogs or mice have not detected clinically significant hepatic injury following exposure to either arsenite or arsenate (Byron et al. 1967; Fowler and Woods 1979; Kerkvliet et al. 1980; Neiger and Osweiler 1989; Schroeder and Balassa 1967), although enlargement of the common bile duct was noted in rats fed either arsenate or arsenite in the diet for 2 years (Byron et al. 1967; Kroes et al. 1974) and lipid vacuolation and fibrosis were seen in the livers of rats exposed to 12 mg As/kg/day as arsenate in the drinking water for 6 weeks (Fowler et al. 1977). Similarly, fatty changes and inflammatory cell infiltration were seen in the livers of both normal and metallothionein-null mice exposed to 5.6 mg arsenic/kg/day in the drinking water for 48 weeks (Liu et al. 2000). Increases in liver zinc and copper concentrations were noted in rats receiving a single oral dose of 10 mg As/kg as sodium arsenite (Flora and Tripathi 1998) and hepatic levels of malondialdehyde were increased and glutathione levels were decreased in livers of rats receiving 200 mg As/kg as GaAs (Flora et al. 1998). An increase in indices of peroxidation was reported in rats dosed with approximately 0.02 mg As/kg/day for 60 days from drinking water containing 2.5 mg sodium arsenite/L (Bashir et al. 2006); absolute liver weight was also increased at this dose level. Elevated levels of serum aspartate aminotransferase (AST) were observed in rats administered a single oral dose of 100 mg As/kg as GaAs (Flora et al. 1998). Exposure of guinea pigs to 0.69 or 1.7 mg As/kg/day in the drinking water for 16 weeks, but not in rats exposed to 0.92 or 2.3 mg As/kg/day, resulted in increases in delta-aminolevulinic acid synthetase (ALAS) levels (Kannan et al. 2001). Exposure of BALB/C mice to 0.7 mg arsenic/kg/day in the drinking water for 15 months resulted in increased liver weights, changes in liver enzymes (glutathione S-transferase, glutathione reductase, catalase, glucose-6-phosphate dehydrogenase, glutathione peroxidase), fatty liver, and fibrosis (Santra et al. 2000).

Organic Arsenicals. No adverse hepatic effects were noted after ingestion of 1,714 mg/kg MSMA or 78 mg DMA/kg (as dimethyl arsenic acid and dimethyl arsenate) in a suicide attempt (Lee et al. 1995; Shum et al. 1995). No other studies of the hepatic effects of organic arsenicals in humans were located.

Histological examination of livers from rabbits given repeated oral doses of MMA showed diffuse inflammation and hepatocellular degeneration (Jaghabir et al. 1989), but the lesions were not severe. Male rats exposed to a time-weighted average (TWA) dose of 72.4 mg MMA/kg/day for 104 weeks showed a decrease in absolute liver weight, while females exposed to 98.5 mg MMA/kg/day showed histiocytic proliferation of the liver (Arnold et al. 2003); however, these effects were probably due to a decrease in body weight and secondary complications of perforation and ulceration of the gastrointestinal effect, respectively. Shen et al. (2003) reported increases in and the number of GST-P-positive foci in the livers of rats exposed to average concentrations of 8.4 mg MMA/kg/day in the diet for 104 weeks. No effects were observed in rats exposed to DMA (Siewicki 1981), but mice exposed to one or two oral doses of 720 mg DMA/kg had decreased liver glutathione and cytochrome P-450 content and serum ornithine decarboxylase activity (Ahmad et al. 1999a). Generalized icterus was reported in dogs after acute exposure to roxarsone (Kerr et al. 1963). Some small fluctuations in liver weight have been noted in rats and mice after intermediate oral exposure to roxarsone, but the toxicological significance of this is not clear and is not observed after chronic exposure of rats and mice to lower doses (NTP 1989b).

Renal Effects.

Inorganic Arsenicals. Most case studies of acute and chronic arsenic toxicity do not report clinical signs of significant renal injury, even when other systems are severely impaired (e.g., Cullen et al. 1995; Franzblau and Lilis 1989; Jenkins 1966; Kersjes et al. 1987; Mizuta et al. 1956; Silver and Wainman 1952). In some cases, elevated serum levels of creatinine or bilirubin have been noted (Armstrong et al. 1984; Levin-Scherz et al. 1987; Moore et al. 1994b), and mild proteinuria may occur (Armstrong et al. 1984; Glazener et al. 1968; Tay and Seah 1975). Acute renal failure in some bolus poisoning episodes (e.g., Fincher and Koerker 1987; Goebel et al. 1990; Levin-Scherz et al. 1987; Lugo et al. 1969; Moore et al. 1994b) is probably a result of fluid imbalances or vascular injury (Rosenberg 1974; Zaldívar 1974). Glomerular congestion has been observed after an acute exposure to high doses (Quatrehomme et al. 1992).

Studies in animals also indicate that the kidney is not a major target organ for inorganic arsenic (Byron et al. 1967; Schroeder and Balassa 1967; Woods and Southern 1989), although some effects have been reported at high exposure levels. Mild histological changes in the renal tubules of monkeys exposed to arsenate for 2 weeks were noted by Heywood and Sortwell (1979), and some mild alterations in renal mitochondria in rats exposed to arsenate for 6 weeks were noted by Brown et al. (1976). Mild proteinuria

(Flora et al. 1998) and an increase in kidney zinc concentration (Flora and Tripathi 1998) have also been noted in rats exposed orally to a single dose of 100 mg As/kg as GaAs or 10 mg As/kg as sodium arsenite, respectively. These data suggest that the kidney is relatively less sensitive to arsenic than most other organ systems, and renal effects are unlikely to be of concern except secondary to fluid imbalances or cardiovascular injury.

Organic Arsenicals. No adverse renal effects were noted after ingestion of 1,714 mg MSMA/kg in a suicide attempt (Shum et al. 1995). Animal studies have reported renal and urinary bladder effects following oral exposure to organic arsenicals; the available data suggest that the urinary system is a more sensitive target for DMA, than for MMA or roxarsone. A decrease in urine volume was observed in rabbits following a single gavage dose of 30 mg MSMA/kg/day (Jaghabir et al. 1988) and a decrease in urine volume (35 mg MMA/kg/day) and an increase in urine specific gravity (8 mg MMA/kg/day) were observed in dogs administered MMA via capsule for 52 weeks (Waner and Nyska 1988). However, these effects may be indicative of dehydration due to diarrhea rather than a direct effect on the kidney. In a 2-year study in rats (Arnold et al. 2003), an increase in the severity of progressive glomerulonephropathy was observed in females at 33.9 mg MMA/kg/day. Hydronephrosis, pyelonephritis, cystitis, and decreases in urine volume and pH were also observed 72.4 mg MMA/kg/day; however, the investigators noted that these lesions probably resulted from urinary tract obstruction, which was secondary to peritonitis caused by gastrointestinal tract ulcerations. An increased incidence of progressive glomerulonephropathy was also observed in male mice exposed to ≥6.0 mg MMA/kg/day in the diet for 2 years (Arnold et al. 2003; incidence data reported in Gur et al. 1991); the investigators (Gur et al. 1991) noted that the kidney lesions were consistent with the normal spectrum of spontaneous lesions and that there were no differences in character or severity of the lesions between the different groups.

Exposure to DMA has resulted in kidney effects in rats and mice exposed to at least 3.1 or 37 mg DMA/kg/day, respectively; no renal effects were observed in dogs exposed to doses as high as 40 mg As/kg/day for 52 weeks (Zomber et al. 1989). In rats, the renal damage is characterized by increased urine volume and pH, decreased urine osmolarity and electrolyte (sodium, potassium, chlorine) levels, increased urinary calcium levels, and increased organ weight, nephrocalcinosis, and necrosis in the renal papillae and/or cortex; an increase in water consumption is also typically observed. The LOAELs for these effects are 5–57 mg DMA/kg/day in intermediate-duration studies (Arnold et al. 1999; Crown et al. 1987; Murai et al. 1993) and 3.1 mg DMA/kg/day in a chronic-duration study (Arnold et al. 2006). Another study did not find renal effects in rats exposed to 16.5 mg DMA/kg/day (Rubin et al. 1989). This study involved exposure to Sprague-Dawley rats compared to Fischer 344 rats used in the studies with

positive results; it is not known if this reflects a difference in strain sensitivity. In mice, progressive glomerulonephropathy was observed at 37 mg DMA/kg/day and nephrocalcinosis was observed at 94 mg DMA/kg/day (Arnold et al. 2006).

Increased kidney weights and minimal tubular epithelial cell degeneration, tubular casts, and focal mineralization were observed in rats exposed to 32 mg/kg/day roxarsone for 13 weeks (NTP 1989b). No adverse effects were observed in rats at doses as high as 20 mg/kg/day (Kerr et al. 1963; NTP 1989b) for 13 weeks or 10 mg/kg/day for 2 years (NTP 1989b; Prier et al. 1963). No adverse renal effects have been observed in mice exposed to roxarsone doses as high as 136 mg/kg/day (NTP 1989b) or 43 mg/kg/day (NTP 1989b; Prier et al. 1963) for intermediate or chronic durations, respectively, or in dogs exposed to 5 mg/kg/day for a chronic duration (Prier et al. 1963).

Damage to the urinary bladder has been observed in several studies in which rats were exposed to DMA. The observed effects include altered bladder cell surface characteristics in rats exposed to 11 mg DMA/kg/day in the diet for 2 weeks (Cohen et al. 2001), increased bladder weight and regenerative proliferation (measured as an increase in BrdU labeling) in bladder epithelium at 5 mg DMA/kg/day for 10 weeks (Arnold et al. 1999), necrosis of bladder epithelium at 10 mg DMA/kg/day for 10 weeks (Arnold et al. 1999), nodular or papillar hyperplasia at 3.4 mg DMA/kg/day for 2 years (Wei et al. 2002), and urothelial vacuolar degeneration and hyperplasia of urothelial cells at 3.1 mg DMA/kg/day for 2 years (Arnold et al. 2006). Vacuolization of the urothelium in the urinary bladder have also been observed in mice exposed to 7.8 mg DMA/kg/day in the diet for 2 years (Arnold et al. 2006). Inconsistent results were found for MMA. Hyperplasia was observed in the bladders of rats exposed to 1 mg As/kg/day as MMA in drinking water for 2 years (Shen et al. 2003), but bladder effects were not observed in another 2-year study (Arnold et al. 2003) in which rats were exposed to doses as high as 34.8 mg As/kg/day as MMA in the diet. No urinary bladder effects were found in rats and mice exposed to 64 or 136 mg/kg/day roxarsone for 13 weeks (NTP 1989b) or 4 or 43 mg/kg/day roxarsone for 2 years (NTP 1989b).

Endocrine Effects.

Inorganic Arsenicals. Very little has been written about the effects of oral exposure to arsenic on endocrine glands. In a report of the autopsies of five children who died in Chile after chronic exposure to arsenic in the drinking water, arterial thickening in the pancreas was noted (Rosenberg 1974). An association has been demonstrated between exposure to arsenic in drinking water and an increased

incidence of diabetes mellitus (Lai et al. 1994; Rahman et al. 1998; Tsai et al. 1999; Tseng et al. 2000; Wang et al. 2003), although dose-response relationships are not available.

Exposure of rats to 2.3 mg As/kg/day as arsenic trioxide for 30 days resulted in reductions in the number of islet cells in the pancreas, as well as significant reductions in pancreatic superoxide dismutase (SOD) and catalase enzyme levels and increases in the production of nitric oxide and malondialdehyde (Mukherjee et al. 2004).

Organic Arsenicals. No studies of effects of organic arsenic compounds on endocrine glands in humans were found. Hypertrophy of thyroid epithelium was observed in rats exposed to 33.9 mg MMA/kg/day in the diet for 2 years (Arnold et al. 2003), 4.0 mg DMA/kg/day in the diet for 13 weeks (Crown et al. 1987), 16.5 mg DMA/kg/day in the diet for at least 10 weeks (Rubin et al. 1989), and 7.8 mg DMA/kg/day in the diet for 2 years (Arnold et al. 2006). No other biologically significant effects were observed in other endocrine tissues following exposure to MMA or DMA. No adverse effects were seen in the adrenal or pituitary glands, thyroid, or pancreas after intermediate or chronic exposure of rats (20–64 or 4 mg/kg/day, respectively) and mice (136 or 43 mg/kg/day, respectively) to roxarsone (NTP 1989b).

Dermal Effects.

Inorganic Arsenicals. One of the most common and characteristic effects of arsenic ingestion is a pattern of skin changes that include generalized hyperkeratosis and formation of hyperkeratotic warts or corns on the palms and soles, along with areas of hyperpigmentation interspersed with small areas of hypopigmentation on the face, neck, and back. These and other dermal effects have been noted in a large majority of human studies involving repeated oral exposure (e.g., Ahmad et al. 1997, 1999b; Ahsan et al. 2000; Bickley and Papa 1989; Borgoño and Greiber 1972; Borgoño et al. 1980; Cebrián et al. 1983; Chakraborti et al. 2003a, 2003b; Chakraborty and Saha 1987; Foy et al. 1992; Franklin et al. 1950; Franzblau and Lilis 1989; Guha Mazumder et al. 1988, 1998a, 1998b, 1998c; Guo et al. 2001a; Haupert et al. 1996; Huang et al. 1985; Lander et al. 1975; Liu et al. 2002; Lüchtrath 1983; Milton et al. 2004; Mizuta et al. 1956; Morris et al. 1974; Nagai et al. 1956; Piontek et al. 1989; Rosenberg 1974; Saha and Poddar 1986; Silver and Wainman 1952; Szuler et al. 1979; Tay and Seah 1975; Tseng et al. 1968; Wade and Frazer 1953; Wagner et al. 1979; Wong et al. 1998a, 1998b; Zaldívar 1974, 1977). In cases of low-level chronic exposure (usually from water), these skin lesions appear to be the most sensitive indication of effect, so this end point is considered to be the most appropriate basis for establishing a chronic oral MRL. This is supported by the finding that other effects (hepatic injury, vascular disease, neurological

effects) also appear to have similar thresholds. As shown in Table 3-3 and Figure 3-3, numerous studies in humans have reported dermal effects at chronic dose levels generally ranging from about 0.01 to 0.1 mg As/kg/day (Ahmad et al. 1997; Bickley and Papa 1989; Borgoño and Greiber 1972; Borgoño et al. 1980; Cebrián et al. 1983; Chakraborty and Saha 1987; Foy et al. 1992; Franklin et al. 1950; Guha Mazumder et al. 1988; Huang et al. 1985; Lüchtrath 1983; Piontek et al. 1989; Silver and Wainman 1952; Tseng et al. 1968; Zaldívar 1974, 1977). However, in a study with detailed exposure assessment, all confirmed cases of skin lesions ingested water containing >100 µg/L arsenic (approximately 0.0037 mg As/kg/day) and the lowest known peak arsenic concentration ingested by a case was 0.115 µg/L (approximately 0.0043 mg As/kg/day) (Haque et al. 2003). Another large study reported increased incidence of skin lesions associated with estimated doses of 0.0012 mg As/kg/day (0.023 mg As/L drinking water) (Ahsan et al. 2006). Several epidemiological studies of moderately sized populations (20–200 people) exposed to arsenic through drinking water have detected no dermal or other effects at average chronic doses of 0.0004–0.01 mg As/kg/day (Cebrián et al. 1983; EPA 1981b; Guha Mazumder et al. 1988; Harrington et al. 1978; Valentine et al. 1985), and one very large study detected no effects in any person at an average total daily intake (from water plus food) of 0.0008 mg As/kg/day (Tseng et al. 1968). This value has been used to calculate a chronic oral MRL for inorganic arsenic of 0.0003 mg/kg/day, as described in footnote c in Table 3-3.

Another prominent dermal effect associated with chronic ingestion of inorganic arsenic is skin cancer. As discussed in greater detail in Section 3.2.2.7 (below), some of these skin cancers may evolve from the hyperkeratotic corns or warts, while the areas of altered pigmentation are not considered to be precancerous (EPA 1988d).

Dermal lesions similar to those observed in humans have not been noted in oral exposure studies in monkeys (Heywood and Sortwell 1979), dogs (Byron et al. 1967), or rodents (Schroeder et al. 1968). However, a hyperplastic response to oral arsenic exposure was reported in arsenic-exposed mice (Rossman et al. 2004).

Organic Arsenicals. No studies were located regarding dermal effects in humans after oral exposure to organic arsenicals. No gross or histological skin alterations were observed in rats or mice following intermediate- or chronic-duration exposure to MMA (Arnold et al. 2003; as reported in Crown et al. 1990; Gur et al. 1991), DMA (Arnold et al. 2006; as reported in Gur et al. 1989a, 1989b), or roxarsone (NTP 1989b)

Ocular Effects.

Inorganic Arsenicals. Periorbital swelling was reported in people drinking contaminated well water at an approximate dose of 0.2 mg As/kg for 1 week (Armstrong et al. 1984). Facial edema, generally involving the eyelids, was a prominent feature of arsenic poisoning among 220 cases associated with an episode of arsenic contamination of soy sauce in Japan (Mizuta et al. 1956). Exposure was to an estimated dose of 0.05 mg/kg/day and lasted for up to 2–3 weeks. The edema developed soon after the initial exposure and then subsided. This effect forms the basis (in part) for the acute oral MRL of 0.005 mg/kg/day for inorganic arsenic, as described in footnote b in Table 3-3. Nemec et al. (1998) noted the appearance of dried red material around the eyes of mice receiving daily oral doses of 24 mg As/kg as arsenic acid for 10 days during gestation.

Organic Arsenicals. No studies were located regarding ocular effects in humans or animals after oral exposure to organic arsenicals. No gross or histological alterations in the eye were observed in rats or mice following intermediate- or chronic-duration exposure to MMA (Arnold et al. 2003; as reported in Crown et al. 1990; Gur et al. 1991), DMA (Arnold et al. 2006; as reported in Gur et al. 1989a, 1989b), or roxarsone (NTP 1989b).

Body Weight Effects.

Inorganic Arsenicals. A 41-year old woman exposed to arsenic in the drinking water for 4 months at an approximate dose of 0.06 mg As/kg/day reported losing 40 pounds (18 kg) of body weight before seeking treatment (Wagner et al. 1979). Weight loss was also among the effects observed in a series of 475 chronic arsenism patients hospitalized in Antofagasto, Chile after receiving approximate doses of 0.02 mg As/kg/day in the drinking water for an unspecified number of years (Zaldívar 1974).

Reductions in body weight gain are commonly seen in animal studies of ingested arsenic. In pregnant rats, body weight gain was reduced by gavage treatment with 23 mg As/kg/day as arsenic trioxide on day 9 of gestation (NOAEL=15 mg As/kg/day, Stump et al. 1999), and by repeated gavage treatment with 8 mg As/kg/day as arsenic trioxide from 2 weeks prior to mating through gestation (NOAEL=4 mg As/kg/day, Holson et al. 2000). Exposure of rats by gavage to 26.6 mg As/kg/day as sodium arsenite, but not 13.3 mg As/kg/day or lower, 5 days/week for 4 weeks resulted in a significant decrease in body weight (Schulz et al. 2002). In 6-week rat studies, body weight gain was decreased at 11–12 mg As/kg/day, but not at 6–9 mg As/kg/day (Brown et al. 1976; Fowler et al. 1977). In a 12-week oral

gavage study, rats dosed with 1.5 mg/kg/day sodium arsenite had a median final body weight 18% lower than controls Dhar et al. (2005). A 60-day rat study with sodium arsenite in the drinking water reported a 13% reduction in final body weight in rats dosed with approximately 0.02 mg As/kg/day (Bashir et al. 2006). In chronic rat studies of arsenate and arsenite, body growth decreases were found at doses as low as 2 mg As/kg/day in feeding studies (Byron et al. 1967; Kroes et al. 1974), while rats exposed to lower levels of sodium arsenite in the drinking water (0.6 mg As/kg/day) throughout their lifetimes grew normally (Schroeder et al. 1968). Rats given a single oral dose of 100 mg As/kg as GaAs exhibited a 15% reduction in body weight compared to controls 7 days after exposure (Flora et al. 1998). Body weight gain was decreased in mice at 24 mg As/kg/day in a gestation exposure study (Nemec et al. 1998), 10 mg As/kg/day in a 6-week study (Fowler and Woods 1979), and 1 mg As/kg/day in a 2-year study (Schroeder and Balassa 1967). Growth was unaffected in mice that received 12 mg As/kg/day in the gestation exposure study (Nemec et al. 1998), 5 mg As/kg/day in the 6-week study (Fowler and Woods 1979), or 0.7–0.8 mg As/kg/day in 1–3 month arsenate drinking water studies (Healy et al. 1998). Dogs chronically treated with 2.4 mg As/kg/day as sodium arsenite lost 44–61% of their starting body weight and died, while lower doses had no effect on growth (Byron et al. 1967). Weight depression was also reported in dogs chronically treated with 2.4 mg As/kg/day as sodium arsenate (Byron et al. 1967). Feed consumption and body weight gain were significantly reduced in a dose-related manner in dogs fed 1.5 or 1.9 mg As/kg/day as sodium arsenite in the diet (Neiger and Osweiler 1989). Dogs in the high-dose group lost 25% of their body weight over the 17-week study period. Pair-fed controls lost weight at the same rate as high-dose dogs, showing that the effect on body weight was due to reduced feed consumption, rather than a direct effect of arsenic.

Organic Arsenicals. No studies were located regarding body weight effects in humans after oral exposure to organic arsenicals. In animal studies of organic arsenicals, decreases in body weight gain were observed in rats and mice after acute, intermediate, and chronic duration exposure to MMA (Arnold et al. 2003; Waner and Nyska 1988), DMA (Murai et al. 1993), and roxarsone (NTP 1989b); decreases in body weight gain have also been reported in pregnant rats and rabbits exposed to MMA (Irvine et al. 2006) or DMA (Irvine et al. 2006; Rogers et al. 1981). For MMA, the decreases in body weight gain were observed following intermediate-duration exposure of rats and dogs to 106.9 or 8 mg MMA/kg/day (Arnold et al. 2003; Waner and Nyska 1988), respectively, and following chronic-duration exposure of rats, mice, and dogs to 25.7, 67.1, or 8 mg MMA/kg/day, respectively (Arnold et al. 2003; Waner and Nyska 1988). The decreases in body weight gain occurred at doses that were associated with diarrhea and histological alterations in the gastrointestinal tract (Arnold et al. 2003; Waner and Nyska 1988). One DMA study in nonpregnant animals reported decreases in body weight gain in rats administered 57 mg

DMA/kg/day via gavage 5 days/week for 4 weeks (Murai et al. 1993); other DMA studies have not reported decreases in body weight gain in rats following exposure to 11 mg DMA/kg/day for acute durations (Cohen et al. 2001), 3.7–60 mg DMA/kg/day for intermediate durations (Arnold et al. 1999; Crown et al. 1987; Rubin et al. 1989; Siewicki 1981; Wanibuchi et al. 1996; Yamamoto et al. 1995), or 0.77 mg DMA/kg/day for chronic durations (Arnold et al. 2006). No alterations in body weight gain were observed in mice exposed to 94 mg DMA/kg/day for 2 years (Arnold et al. 2006). The lowest doses of roxarsone to produce a decrease in growth were 32 and 16 mg/kg/day in rats following acute- or intermediate-duration exposure, respectively, and 168 and 136 mg/kg/day in mice following acute or intermediate exposure (NTP 1989b); at the highest dose tested in chronic studies, no significant alterations in body weight gain were observed in rats at 4 mg/kg/day or in mice at 43 mg/kg/day (NTP 1989b).

3.2.2.3 Immunological and Lymphoreticular Effects

Inorganic Arsenicals. No studies were located regarding immunological and lymphoreticular effects in humans after oral exposure to inorganic arsenicals. No evidence of immunosuppression was detected in mice exposed to arsenate at levels up to 100 ppm (20 mg As/kg/day) in drinking water (Kerkvliet et al. 1980). This NOAEL is shown in Table 3-3 and Figure 3-3. Gallium arsenide at doses of 52–260 mg As/kg/day produced significant, dose-related decreases in relative spleen weight, spleen cellularity, humoral immune response (antibody forming cell response to sheep RBC), and delayed type hypersensitivity in rats (Flora et al. 1998). However, it is not clear to what extent these effects are due to the arsenic moiety.

Organic Arsenicals. No studies were located regarding immunological and lymphoreticular effects in humans or animals after oral exposure to organic arsenicals. No histological alterations were observed in immunological or lymphoreticular tissues following intermediate-duration exposure of rats to 43.2 mg DMA/kg/day in the diet (Crown et al. 1987) or rats and mice to 18.23 or 38.7 mg As/kg/day as roxarsone, respectively (NTP 1989b) or following chronic-duration exposure of rats and mice to 72.4 or 67.1 mg MMA/kg/day (Arnold et al. 2003), 7.8 or 94 mg DMA/kg/day (Arnold et al. 2006), or 4 or 43 mg/kg/day roxarsone (NTP 1989b). No studies examined immune function following oral exposure to organic arsenicals.

3.2.2.4 Neurological Effects

Inorganic Arsenicals. A large number of epidemiological studies and case reports indicate that ingestion of inorganic arsenic can cause injury to the nervous system. Acute, high-dose exposures (2 mg As/kg/day or above) often lead to encephalopathy, with signs and symptoms such as headache, lethargy, mental confusion, hallucination, seizures, and coma (Armstrong et al. 1984; Bartolome et al. 1999; Civantos et al. 1995; Cullen et al. 1995; Danan et al. 1984; Fincher and Koerker 1987; Levin-Scherz et al. 1987; Quatrehomme et al. 1992; Uede and Furukawa 2003; Vantroyen et al. 2004). Repeated exposures to lower levels (0.03–0.1 mg As/kg/day) are typically characterized by a symmetrical peripheral neuropathy (Chakraborti et al. 2003a, 2003b; Foy et al. 1992; Franzblau and Lilis 1989; Guha Mazumder et al. 1988; Hindmarsh et al. 1977; Huang et al. 1985; Lewis et al. 1999; Mizuta et al. 1956; Muzi et al. 2001; Silver and Wainman 1952; Szuler et al. 1979; Wagner et al. 1979). This neuropathy usually begins as numbness in the hands and feet, but later may develop into a painful "pins and needles" sensation. Both sensory and motor nerves are affected, and muscle weakness often develops, sometimes leading to wrist-drop or ankle-drop (Chhuttani et al. 1967; Heyman et al. 1956). Diminished sensitivity to stimulation and abnormal patellar reflexes have also been reported (Mizuta et al. 1956). Histological examination of nerves from affected individuals reveals a dying-back axonopathy with demyelination (Goebel et al. 1990; Hindmarsh and McCurdy 1986). Some recovery may occur following cessation of exposure, but this is a slow process and recovery is usually incomplete (Fincher and Koerker 1987; Le Quesne and McLeod 1977; Murphy et al. 1981). Peripheral neuropathy is also sometimes seen following acute high-dose exposures, with or without the previously described encephalopathy (Armstrong et al. 1984; Baker et al. 2005; Fincher and Koerker 1987; Goebel et al. 1990; Hantson et al. 1996; Kamijo et al. 1998). Neurological effects were not generally found in populations chronically exposed to doses of 0.006 mg As/kg/day or less (EPA 1981b; Harrington et al. 1978; Hindmarsh et al. 1977), although fatigue, headache, dizziness, insomnia, nightmare, and numbness of the extremities were among the symptoms reported at 0.005, but not 0.004 mg As/kg/day in a study of 31,141 inhabitants of 77 villages in Xinjiang, China (Lianfang and Jianzhong 1994), and depression was reported in some Wisconsin residents exposed to 2–10 µg As/L in the drinking water for 20 years or longer (Zierold et al. 2004).

There is emerging evidence suggesting that exposure to arsenic may be associated with intellectual deficits in children. For example, Wasserman et al. (2004) conducted a cross-sectional evaluation of intellectual function in 201 children 10 years of age whose parents were part of a larger cohort in Bangladesh. Intellectual function was measured using tests drawn from the Wechsler Intelligence Scale for Children; results were assessed by summing related items into Verbal, Performance, and Full-Scale

raw scores. The mean arsenic concentration in the water was 0.118 mg/L. The children were divided into four exposure groups, representing <5.5, 5.6–50, 50–176, or 177–790 µg As/L drinking water. After adjustment for confounding factors, a dose-related inverse effect of arsenic exposure was seen on both Performance and Full-Scale subset scores; for both end points, exposure to ≥50 µg/L resulted in statistically significant differences (p<0.05) relative to the lowest exposure group (<5.5 µg/L). In a later report, the same group of investigators examined 301 6-year-old children from the same area (Wasserman et al. 2007). In this case, the children were categorized into the following quartiles based on water arsenic concentration: 0.1–20.9, 21–77.9, 78–184.9, and 185–864 µg/L. After adjustment for water Mn, blood lead, and sociodemographic features known to contribute to intellectual function, water arsenic was significantly negatively associated with both Performance and Processing speed raw scores. Analyses of the dose-response showed that compared to the first quartile, those in the second and third categories had significantly lower Performance raw scores (p<0.03 and p=0.05, respectively). Those in the fourth category had marginally significantly lower Full-Scale and Processing Speed raw scores. It should be mentioned, however, that in general, arsenic in the water explained <1% of the variance in test scores. Water arsenic made no contribution to IQ outcomes. A study of 351 children age 5–15 years from West Bengal, India, found significant associations between urinary arsenic concentrations and reductions in scores of tests of vocabulary, object assembly, and picture completion; the magnitude of the reductions varied between 12 and 21% (von Ehrenstein et al. 2007). In this cohort, the average lifetime peak arsenic concentration in well water was 0.147 mg/L. However, no clear pattern was found for increasing categories of peak arsenic water concentrations since birth and children's scores in the various neurobehavioral tests conducted. Furthermore, using peak arsenic as a continuous variable in the regression models also did not support an adverse effect on the tests results. Exposure to arsenic *in utero* also did not suggest an association with the tests scores. Von Ehrestein et al. (2007) concluded that the study provided little evidence for an effect of long-term arsenic concentrations in drinking water and that the lack of findings with past exposures via drinking water may be due to incomplete assessment of past exposure, particularly exposure originating from food. Wasserman's results are consistent with those of ecological studies in children in Taiwan (Tsai et al. 2003) and in China (Wang et al. 2007). In the former, adolescents exposed to low (0.0017–0.0018 mg As/kg/day; n=20) levels of inorganic arsenic in the drinking water showed decreased performance in the switching attention task, while children in the high exposure group (0.0034–0.0042 mg As/kg/day; n=29) showed decreased performance in both the switching attention task and in tests of pattern memory, relative to unexposed controls (n=60). In the study in China (age 8– 12 years), 87 children whose mean arsenic concentration in the drinking water was 0.190 mg/L had a mean IQ score of 95 compared with 101 for children (n=253) with 0.142 mg/L arsenic in the water and 105 for control children (n=196) with 0.002 mg/L arsenic in the drinking water (Wang et

al. 2007). The differences in IQ scores between the two exposure groups and the control group were statistically significant.

Neurological effects have also been observed in animal studies. Rodriguez et al. (2001) evaluated neurobehavioral changes in male Sprague-Dawley rats exposed to 0, 5, 10, or 20 mg As/kg/day as sodium arsenite by gavage for 2 or 4 weeks; significant effects were seen in spontaneous locomotor activity and the food pellet manipulation test in the high-dose animals, while no effects were seen in the low- or mid-dose rats. Decreased performance in open field tests were also seen in rats exposed to 26.6 mg As/kg/day, but not to 13.3 mg/kg/day or less, as sodium arsenite for 4 weeks (Schulz et al. 2002); curiously, the behavioral changes were no longer present at 8 and 12 weeks of exposure, which may suggest an adaptive response. Heywood and Sortwell (1979) reported salivation and uncontrolled head shaking in two monkeys given several doses of 6 mg As/kg/day as arsenate, while no such effects were noted in monkeys given 3 mg As/kg/day for 2 weeks. Nemec et al. (1998) observed ataxia and prostration in pregnant female rabbits treated with 1.5 mg As/kg/day repeatedly during gestation, but not in rabbits treated with 0.4 mg As/kg/day. Some changes in levels of neurotransmitters (dopamine, norepinephrine, and 5-hydroxytryptamine) were seen in rats exposed to 2.3 mg As/kg/day as sodium arsenite and guinea pigs exposed to 1.7 mg As/kg/day as sodium arsenite in the drinking water for 16 weeks (Kannan et al. 2001) or in rats exposed to 0.14 mg As/kg/day as sodium arsenite by gavage for 28 days (Chattopadhyay et al. 2001), but the functional significance of these changes is not clear.

The highest NOAEL values and all reliable LOAEL values for neurological effects from inorganic arsenic in each species and duration category are recorded in Table 3-3 and plotted in Figure 3-3.

Organic Arsenicals. Numbness and tingling of the fingertips, toes, and circumoral region were reported by a women exposed to an unspecified amount of organic arsenic in bird's nest soup. Discontinuation of exposure resulted in the disappearance of symptoms (Luong and Nguyen 1999). Decreased absolute brain weights were seen in male rats exposed to 25.7 mg MMA/kg/day and female rats exposed to ≥33.9 mg MMA/kg/day, but decreased body weight also occurred at these exposure levels, and relative brain weights were increased in the males at 25.7 mg MMA/kg/day and the females at ≥33.9 mg MMA/kg/day in this study (Arnold et al. 2003). No neurological clinical signs or brain lesions were observed following chronic exposure of rats to 72.4 mg MMA/kg/day or mice to 67.1 mg MMA/kg/day (Arnold et al. 2003). Decreased spontaneous motility, increased startle response, and ataxia were observed in mice receiving a single gavage dose of 1,757 mg DMA/kg/day (Kaise et al. 1989); no other evidence (clinical signs or histological alterations) were observed in chronic studies of DMA in which

rats and mice were exposed to 7.8 or 94 mg DMA/kg/day, respectively (Arnold et al. 2006). Two studies in pigs indicate that repeated oral doses of roxarsone (6.3–20 mg/kg/day for 1 month) can cause significant neurotoxicity (Edmonds and Baker 1986; Kennedy et al. 1986; Rice et al. 1985). The main signs were time-dependent degenerations of myelin and axons (Kennedy et al. 1986; Rice et al. 1985). Evidence of neurological effects (hyperexcitability, ataxia, trembling) was noted in some rat and mouse studies (Kerr et al. 1963; NTP 1989b). Reliable NOAELs and LOAELs are presented in Tables 3-4, 3-5, and 3-6, and Figures 3-4, 3-5, and 3-6.

3.2.2.5 Reproductive Effects

Inorganic Arsenicals. Exposure to arsenic in drinking water has been associated with adverse reproductive outcomes in some studies. For example, a study of 96 women in Bangladesh who had been drinking water containing ≥0.10 mg As/L (approximately 0.008 mg As/kg/day) for 5–10 years reported a significant increase in spontaneous abortions (p=0.008), stillbirth (p=0.046), and preterm birth (p=0.018) compared to a nonexposed group (Ahmad et al. 2001). Similar results were reported by Milton et al. (2005) who found a significant association between concentrations of arsenic in the water >0.05 mg/L (approximately 0.006 mg As/kg/day) and spontaneous abortion (odds ratio [OR]=2.5; 95% CI=1.5–4.3) in a study of 533 women, also from Bangladesh. A study of 202 women from West Bengal, India, reported that exposure to arsenic concentrations of arsenic ≥0.2 mg/L in drinking water (approximately 0.02 mg As/kg/day) during pregnancy were associated with a 6-fold increased risk of stillbirth (OR=6.1; 95% CI=1.54–24.0) after adjustment for confounders (von Ehrenstein et al. 2006). No association was found between arsenic exposure and risk of spontaneous abortion (OR=1.01; 95% CI=0.73–10.8). An earlier study of 286 women in the United States also found no significant association between arsenic in the drinking water (0.0016 mg/L; approximately 0.00005 mg As/kg/day) and spontaneous abortion (OR=1.7; 95% CI=0.7–4.2) (Aschengrau et al. 1989).

Lugo et al. (1969) reported a case of a 17-year-old mother who ingested inorganic arsenic (Cowley's Rat and Mouse Poison) at week 30 of pregnancy. Twenty-four hours after ingestion of approximately 30 mL of arsenic trioxide (0.39 mg As/kg), she was admitted for treatment of acute renal failure. She went into labor and delivered a live female infant weighing 2 pounds, 7 ounces with a 1-minute Apgar score of 4. The infant's clinical condition deteriorated and she died at 11 hours of age.

Reproductive performance was not affected in female rats that received gavage doses of 8 mg As/kg/day (as As_2O_3) from 14 days prior to mating through gestation day 19 (Holson et al. 2000). Reproductive

indices that were evaluated included the precoital interval (time to mating), mating index (percentage of rats mated), and fertility index (percentage of matings resulting in pregnancy). In a 3-generation study in mice given sodium arsenite in drinking water at an average dose of 1 mg As/kg/day, there was a significant increase in the incidence of small litters and a trend toward a decreased number of pups per litter in all three generations of the treated group (Schroeder and Mitchener 1971). This finding is consistent with the results of developmental toxicity studies reported in Section 3.2.2.6. Female rats exposed to 0.24 mg As/kg/day (as arsenite) for 28 days showed changes in several reproductive system end points, including decreases in wet weights of the ovary and uterus, inhibition of steroidogenic enzymes, decreased ovarian and uterine peroxidase activities, and decreased estradiol levels relative to controls (Chattopadhyay et al. 2001). NOAEL and LOAEL values from these studies are shown in Table 3-3 and Figure 3-3.

Organic Arsenicals. No studies were located regarding reproductive effects in humans after oral exposure to organic arsenicals. No histological alterations in male or female reproductive tissues were observed in laboratory animals following exposure to MMA (Arnold et al. 2003), DMA (Arnold et al. 2006), or roxarsone (NTP 1989b) and no alterations in sperm parameters were observed in male rats exposed to 76 mg MMA/kg/day for at least 14 weeks (Schroeder 1994). However, some functional alterations have been reported in animals exposed to MMA or DMA. A decrease in estrus was observed in dogs exposed to 35 mg MMA/kg/day for 52 weeks (Waner and Nyska 1988); decreases in body weight gain (terminal body weight was 59% lower than controls) were also observed at this dose level and the effect may have been secondary to systemic toxicity. Decreases in pregnancy rate and male fertility index were observed in F_0 and F_1 rats exposed to 76 mg MMA/kg/day for 14 weeks prior to mating and during the mating, gestation, and lactation periods (Schroeder 1994). In the F_0 animals, the pregnancy rate and male fertility index were not statistically different from controls; however, the values were below historical controls and the investigators considered the effect to be treatment-related. In the F_1 animals, the male fertility index was statistically different from controls but the pregnancy rate was not; both parameters were within the range found in historical controls, but the investigators considered the effect to be treatment-related due to the consistency of the findings in the F_0 and F_1 animals. Impaired fertility, as evidenced by a decreased number of litters, was observed in male mice dosed with MSMA (119 mg/kg/day) during a 19-day mating period with unexposed females (Prukop and Savage 1986); the poor reporting of the study protocol and results precludes drawing conclusions from this study. An increase in the number of does with aborted fetuses was observed in rabbits exposed to 48 mg DMA/kg/day as DMA (Irvine et al. 2006); severe maternal toxicity (weight loss, reduced food intake, and

diarrhea) was also observed at this dose level. No reproductive effects were observed in a 2-generation rat study in which rats were exposed to 16.5 mg DMA/kg/day (Rubin et al. 1989).

3.2.2.6 Developmental Effects

Inorganic Arsenicals. Whether ingestion of inorganic arsenic may cause developmental effects in humans has not been extensively investigated. Lugo et al. (1969) reported a case of a mother who ingested inorganic arsenic (Cowley's Rat and Mouse Poison) at 30 weeks of gestation. Twenty-four hours after ingestion, she went into labor and delivered a live female infant weighing 2 pounds, 7 ounces with a 1-minute Apgar score of 4. The infant's clinical condition deteriorated with frequent episodes of apnea and bradycardia; subsequent venous blood gas determinations documented hypoxia, hypercapnea, and acidosis. The infant died at 11 hours of age. Autopsy performed 8 hours after death showed organ immaturity, generalized petechial hemorrhages, and hyaline membrane disease. Severe intra-alveolar pulmonary hemorrhage was remarkable. High arsenic levels were found in the infant's liver, kidney, and brain, demonstrating easy passage of inorganic arsenic across the placenta. The authors considered most of the findings in the neonate to be attributable to immaturity, but suggested that arsenic may have played a role in the severe intra-alveolar hemorrhaging that contributed to death.

Chronic exposure of women to arsenic in the drinking water has been associated with infants with low birth weights in Taiwan (Yang et al. 2003) and Chile (Hopenhayn et al. 2003a). Similar associations have been made between late fetal mortality, neonatal mortality, and postneonatal mortality and exposure to high levels of arsenic in the drinking water (up to 0.86 mg/L during over a decade), based on comparisons between subjects in low- and high-arsenic areas of Chile (Hopenhayn-Rich et al. 2000). More recently, von Ehrenstein et al. (2006) reported no significant association between exposure to concentrations of ≥0.1 mg/L arsenic in drinking water (approximately 0.008 mg As/kg/day) (n=117; 29 women were exposed to ≥0.5 mg/L) and increased risk for neonatal death or infant mortality during the first year of life in a study of a population in West Bengal, India. The same group of investigators reported significantly increased SMRs for lung cancer and bronchiectasis among subjects in a city in Chile who had probable exposure *in utero* (maternal exposure) or during childhood to high levels of arsenic (near 0.9 mg/L) in the drinking water (Smith et al. 2006). For those exposed in early childhood, the SMR for lung cancer was 7.0 (95% CI=5.4–8.9, $p<0.001$) and for bronchiecstasis 12.4 (95% CI=3.3–31.7, $p<0.001$). For those born during the high-exposure period, the corresponding SMRs were 6.1 (95% CI=3.5–9.9, $p<0.001$) and 46.2 (95% CI=21.1–87.7, $p<0.001$). The mortality data analyzed were for the age range 30–49 years.

No overall association between arsenic in drinking water and congenital heart defects was detected in a case-control study in Boston (Zierler et al. 1988), although an association with one specific lesion (coarctation of the aorta) was noted (OR=3.4, 95% CI=1.3–8.9). A study of 184 women with neural tube defects in the offspring living in a Texas county bordering Mexico found that exposure to levels of arsenic in the drinking water >0.010 mg/L (range or upper limit not specified) did not significantly increase the risk for neural tube defects (OR=2.0, 95% CI=0.1–3.1) (Brender et al. 2006).

Studies in animals, however, suggest that ingested inorganic arsenic may produce developmental effects at high doses that also produce overt maternal toxicity. Rats treated with a single gavage dose of 23 mg As/kg as arsenic trioxide on day 9 of gestation had a significant increase in postimplantation loss and a decrease in viable fetuses per litter, while those treated with 15 mg As/kg showed no effects (Stump et al. 1999). Rats treated by daily gavage with 8 mg As/kg/day starting 14 days before mating and continuing through gestation had significantly reduced fetal body weights and significantly increased incidences of several skeletal variations (unossified sternebrae #5 or #6, slight or moderate sternebrae malalignment, 7th cervical ribs) that the researchers considered to be consequences of developmental growth retardation (Holson et al. 2000). No developmental effects were found at 4 mg As/kg/day in this study. Exposure of rats to 2.93–4.20 mg As/kg/day throughout gestation and for 4 months postnatally resulted in alterations in neurobehavioral parameters in the offspring, including increased spontaneous locomotor activity and number of errors in a delayed alternation task; maternal behavior was not affected (Rodriguez et al. 2002). Studies in mice found increased fetal mortality, decreased fetal body weight, a low incidence of gross malformations (primarily exencephaly), and an increase in skeletal malformations in mice given single gavage doses of 23–48 mg As/kg during gestation (Baxley et al. 1981; Hood et al. 1978), with no effects at 11 mg As/kg. Similarly, in mice treated with 24 mg As/kg/day as arsenic acid on days 6–15 of gestation, there was a significant increase in the number of resorptions per litter (42% vs. 4% in controls) and significant decreases in the number of live pups per litter (6.6 vs. 12.3 in controls) and mean fetal weight (1.0 g vs. 1.3 g in controls), while no developmental effects were found at 12 mg As/kg/day (Nemec et al. 1998). Hamsters treated with a single gavage dose of 14 mg As/kg during gestation also had increased fetal mortality and decreased fetal body weight (Hood and Harrison 1982), with no effect at 11 mg As/kg. However, the most sensitive species was the rabbit, which had increased resorptions and decreased viable fetuses per litter at 1.5 mg As/kg/day and a developmental NOAEL of 0.4 mg As/kg/day, following repeated gavage dosing with arsenic acid during gestation (Nemec et al. 1998). In each of these studies (except Hood et al. 1978, which failed to report maternal effects), overt maternal toxicity, including death in some cases, was found at the same or lower doses as the developmental

effects (Baxley et al. 1981; Holson et al. 2000; Hood and Harrison 1982; Nemec et al. 1998; Stump et al. 1999).

It is noteworthy that the effect in the 3-generation reproduction study in mice by Schroeder and Mitchener (1971), decreased pups per litter (all generations), is consistent with the findings of many of these shorter-term studies (Baxley et al. 1981; Hood and Harrison 1982; Hood et al. 1978; Nemec et al. 1998; Stump et al. 1999). The dose in this long-term study was 1 mg As/kg/day; in a 2-year study by these researchers, this dose produced effects such as decreased body weight gain and increased mortality (Schroeder and Balassa 1967).

A series of studies presented evidence that inorganic arsenic may be a transplacental carcinogen in animals. Waalkes et al. (2003, 2004a, 2004b, 2004c) exposed timed-pregnant AJ mice to 0, 42.5, or 85 ppm of sodium arsenite in the drinking water from gestation day 8 through 18 and observed the offspring for 90 weeks following birth; the study authors estimated daily doses at 9.55 and 19.3 mg As/kg/day. A dose-related increase was reported in the incidence of hepatocellular carcinomas and adrenal tumors in the male offspring from both treatment levels, while male offspring from high-dose animals showed an increase in total number of tumors. In female offspring, an increase in uterine hyperplasia was seen in the offspring of both treated groups while the offspring of high-dose animals showed increased incidence of lung carcinomas. For both exposed groups, regardless of gender, the offspring showed a significant increase in the number of malignant tumors (Waalkes et al. 2003). More recent studies from the same group of investigators have suggested that aberrant estrogen signaling, potentially through inappropriate estrogen receptor-α (ER-α), may play a role in arsenic-induced liver tumors in male offspring (Waalkes et al. 2006a) and in arsenic-induced uterine and bladder carcinoma in female offspring (Waalkes et al. 2006b). The latter was based on the observation of over-expression of ER-α and *pS*2, an estrogen-regulated gene, in the respective tissues.

These studies (shown in Table 3-3 and Figure 3-3) indicate that the fetus may be affected by ingested arsenic.

Organic Arsenicals. No studies were located regarding developmental effects in humans after oral exposure to organic arsenicals. The developmental toxicity of organic arsenicals has been investigated in rats and rabbits for MMA and in rats, mice, and rabbits for DMA. Decreased fetal weights and an increased incidence of fetuses with incomplete ossification of thoracic vertebrae were observed in the offspring of rats administered via gavage 500 mg MMA/kg/day on gestational days 6–15; no

developmental effects were observed at 100 mg MMA/kg/day (Irvine et al. 2006). Decreases in maternal body weight gain were observed at 100 and 500 mg MMA/kg/day. A decrease in pup survival was observed in F_1 and F_2 offspring of rats exposed to 76 mg MMA/kg/day (Schroeder 1994); although pup survival was not statistically different from controls, the investigators considered the effect to be biologically significant because survival in the MMA pups was outside the lower range of survival in historical controls. Increases in the number of fetuses with supernumerary thoracic ribs and eight lumbar vertebrae were observed in the offspring of rabbits administered to 12 mg MMA/kg/day on gestational days 7–19 (Irvine et al. 2006); the investigators noted that these effects were probably secondary to maternal stress.

No developmental effects were observed in the offspring of rats administered via gavage 15 mg DMA/kg/day on gestational days 7–16 (Rogers et al. 1981). At 30 mg DMA/kg/day, there was an increase in the percentage of fetuses with irregular palatine rugae; no maternal effects were observed at this dose level (Rogers et al. 1981). The investigators noted that the functional significance of aberrant rugae in rats is not known. Doses of ≥36 mg DMA/kg/day resulted in decreases in fetal weights and delays in ossification (Chernoff et al. 1990; Irvine et al. 2006; Rogers et al. 1981); decreases in maternal body weight gain were often observed at the same dose levels. Irvine et al. (2006) also reported an increase in the occurrence of diaphragmatic hernia in the offspring of rats exposed to 36 mg DMA/kg/day as DMA on gestational days 6–15. Mice appear to be less sensitive than rats to the developmental toxicity of DMA. No developmental effects were observed in the offspring of mice administered 200 mg DMA/kg/day on gestational days 7–16 (Rogers et al. 1981); at higher doses, decreases in fetal body weight, delays in ossification, and cleft palate were observed (Kavlock et al. 1985; Rogers et al. 1981). In rabbits, a NOAEL of 12 mg DMA/kg/day was identified (Irvine et al. 2006); at 48 mg DMA/kg/day, there were increased maternal deaths and abortions.

3.2.2.7 Cancer

Inorganic Arsenicals. There is convincing evidence from a large number of epidemiological studies and case reports that ingestion of inorganic arsenic increases the risk of developing skin cancer (Alain et al. 1993; Beane Freeman et al. 2004; Bickley and Papa 1989; Cebrián et al. 1983; Chen et al. 2003; Guo et al. 2001a; Haupert et al. 1996; Hsueh et al. 1995; Lewis et al. 1999; Lüchtrath 1983; Mitra et al. 2004; Morris et al. 1974; Piontek et al. 1989; Sommers and McManus 1953; Tay and Seah 1975; Tsai et al. 1998a, 1999; Tseng 1977; Tseng et al. 1968; Zaldívar 1974; Zaldívar et al. 1981). Lesions commonly observed are multiple squamous cell carcinomas, some of which appear to develop from the

hyperkeratotic warts or corns described in Section 3.2.2.2. In addition, multiple basal cell carcinomas may occur, typically arising from cells not associated with hyperkeratinization. In most cases, skin cancer develops only after prolonged exposure, but one study has reported skin cancer in people exposed for <1 year (Reymann et al. 1978). Although both types of skin cancer can be removed surgically, they may develop into painful lesions that may be fatal if left untreated (Shannon and Strayer 1989).

A number of studies that identify CELs in exposed humans are summarized in Table 3-3 and shown in Figure 3-3. The EPA reviewed the studies that provided dose-response data on the risk of skin cancer (EPA 1988d) and concluded that the most useful study for the purposes of quantitative risk assessment was the ecologic epidemiology study by Tseng et al. (1968). In this study, the incidence of skin cancer was measured as a function of exposure level in over 40,000 people residing in 37 villages in Taiwan, and compared to a control group of over 7,500 people. Beyond the very large sample size, other strengths of this study include excellent case ascertainment (physical examination), inclusion of both males and females, and lifetime exposure duration. Weaknesses and uncertainties include poor nutritional status of the exposed populations, their genetic susceptibility, their exposure to inorganic arsenic from nonwater sources, and the applicability of extrapolating data from Taiwanese to the U.S. population because of different background rates of cancer, possibly genetically determined, and differences in diet other than arsenic (e.g., low protein and fat and high carbohydrate) (EPA 1988d). Because of a lack of information on the amount of individual exposure, subjects were classified into three exposure groups (i.e., high, medium, and low). Based upon pooled data for skin cancer incidence and average well concentrations for each village in the Tseng et al. (1968) study, the EPA calculated a unit risk (the upper-bound excess cancer risk from lifetime exposure to water containing 1 μg As/L) of $5x10^{-5}$ (IRIS 2007). The average daily doses (expressed as mg As/kg/day) that correspond to excess cancer risks of $1x10^{-4}$–$1x10^{-7}$ are shown in Figure 3-3.

The use of a cancer risk estimate derived from the Tseng et al. (1968) study for a U.S. population has been the source of intense debate. Some have argued and have provided data in support of the view that there is persuasive evidence that inorganic arsenic is a cause of human cancer at several sites (i.e., Smith et al. 1992, 1995, 2002). On the other hand, a number of concerns have been raised regarding the strength, or lack of strength, of the database, including: the adequacy of the model used by EPA and the accuracy and reliability of the exposure data (Brown et al. 1997a, 1997b); a number of host and environmental factors among the Taiwanese not applicable elsewhere (Carlson-Lynch et al. 1994); a possible threshold for arsenic carcinogenicity and nonlinearities in the dose-response curve (Abernathy et al. 1996; Slayton et al. 1996); differences in health and nutrition between Taiwan and the United States

that might increase cancer risk in Taiwan (Beck et al. 1995); the possibility that lower doses of arsenic may be beneficial role in some physiological processes (EPA 1988d; FNB/IOM 2001; NRC 1999, 2001); and the possibility of significant exposure to arsenic from sources other than the well water (Chappell et al. 1997). Many of these factors were recognized by EPA (1988d). A report by NRC (2001) suggested that the risks calculated based on increases in incidence of lung and bladder cancers may be greater than those calculated by the EPA based on incidences of skin cancer.

Several early epidemiological studies performed in the United States did not report an increased frequency of skin cancer in small populations consuming water containing arsenic at levels of around 0.1–0.2 ppm (EPA 1981b; Goldsmith et al. 1972; Harrington et al. 1978; Morton et al. 1976). These early data suggested that arsenic-associated skin cancer is not a common problem in this country, but these studies lacked sufficient statistical power to detect small increases in skin cancer incidence that might have occurred at these low doses (EPA 1983g). Later studies in exposed U.S. populations from Utah (Lewis et al. 1999) and Iowa (Beane Freeman et al. 2004) have suggested that arsenic-exposed individuals within the United States may have increased incidence or risk of mortality from some skin cancers, melanoma in particular; however, exposure data from these studies are generally insufficient for dose-response analysis. Another study found a suggestion of an arsenic-induced effect on the development of skin cancer, but the association did not achieve statistical significance (Karagas et al. 2001). Therefore, the risk of arsenic-induced skin cancers in U.S. populations, while it may appear to be less than in some other evaluated populations, may be the reflection that, in most studies, exposures were lower.

In addition to the risk of skin cancer, there is mounting evidence that ingestion of arsenic may increase the risks of internal cancers as well. Many case studies have noted the occurrence of internal tumors of the liver and other tissues in patients with arsenic-induced skin cancer (Falk et al. 1981b; Kasper et al. 1984; Koh et al. 1989; Lander et al. 1975; Regelson et al. 1968; Sommers and McManus 1953; Tay and Seah 1975; Zaldívar et al. 1981). These studies are supported by large-scale epidemiological studies, where associations and/or dose response trends have been detected for tumors of the bladder, kidney, liver, lung, and prostate (Chen and Wang 1990; Chen et al. 1985, 1986, 1988a, 1988b, 1992; Chiou et al. 1995; Cuzick et al. 1992; Ferreccio et al. 1998; Guo et al. 1997; Hopenhayn-Rich et al. 1998; Kurttio et al. 1999; Lewis et al. 1999; Moore et al. 2002; Rivara et al. 1997; Smith et al. 1998; Tsuda et al. 1995a; Wu et al. 1989). The EPA has not yet calculated a unit risk value or slope factor for arsenic-induced internal tumors.

There is increasingly convincing evidence that long-term exposure to arsenic can result in the development of bladder cancer (Bates et al. 2004; Chen et al. 1992, 2003; Chiou et al. 1995, 2001; Cuzick et al. 1992; Guo et al. 2001b; Karagas et al. 2004; Lamm et al. 2004; Michaud et al. 2004; Steinmaus et al. 2003), with transitional cell cancers being the most prevalent. Chiou et al. (1995) reported a dose-response relationship between long-term arsenic exposure from drinking artesian well water and the incidence of lung cancer, bladder cancer, and cancers of all sites combined (after adjustment for age, sex, and cigarette smoking) in four townships in Taiwan exposed to inorganic arsenic in drinking water (0–1.14 mg/L). In a later followup study of the same cohort, the increase in bladder cancer was found to be statistically significant only in subjects exposed for 40 years or longer (Chiou et al. 2001). Cuzick et al. (1992) evaluated a cohort treated with Fowler's solution (potassium arsenite) in Lancashire, England, during the period 1945–1969 and followed through 1991; the cohort of 478 patients showed a significant excess of bladder cancer, but no excess for other causes of death. Of a subcohort of 142 patients examined for signs of arsenicism around 1970 (Cuzick et al. 1992), all 11 subsequent cancer deaths occurred in those with signs of arsenicism (p=0.0009). Hopenhayn-Rich et al. (1996a) investigated bladder cancer mortality for the years 1986–1991 in the 26 counties of Cordoba, Argentina, and reported that bladder cancer SMRs were consistently higher in counties with documented arsenic exposure; a later case-control study by the same authors (Bates et al. 2004) did not report statistically significant increases in bladder cancers resulting from arsenic exposure, except in individuals exposed for 50 years or longer. Guo et al. (2001a) reported significantly increased rate differences for bladder cancer in men and women in Taiwan exposed to 0.64 mg arsenic/L in the drinking water, but not at lower exposure levels. The arsenic-induced bladder tumors do not appear to be histologically different than similar bladder tumor types of nonarsenic origin (Chow et al. 1997), although they tended to be more pronounced. In contrast, Michaud et al. (2004) reported no correlation between arsenic levels in toenails and the incidence of bladder cancers in Finnish workers. Among evaluated U.S. cohorts, there has generally been no association between arsenic exposure (~60–100 µg As/L) and the incidence of mortality from bladder cancers (Lamm et al. 2004; Steinmaus et al. 2003), although it is possible that smoking may render individuals more susceptible to arsenic-induced bladder tumors (Karagas et al. 2004; Steinmaus et al. 2003).

Studies have also suggested that chronic oral exposure to arsenic may result in the development of respiratory tumors and increased incidence of lung cancer (Ferreccio et al. 2000; Guo 2004; Nakadaira et al. 2002; Smith et al. 1998; Viren and Silvers 1999). A study of arsenic-exposed individuals in northern Chile reported significantly increased odds ratios for lung cancer among subjects with ≥30 µg As/L of drinking water (Ferreccio et al. 2000), although when adjusted for socioeconomic status, smoking, and

other factors, the increase was only significant at 60 µg As/L or greater. Guo (2004) reported significantly increased rates differences (RD) for lung cancer for Taiwanese men and women exposed to 0.64 mg As/L or greater, with those subjects >50 years of age being particularly at risk. Nakadaira et al. (2002) suggested that even comparatively short exposure durations (≤5 years) may be sufficient for the development of arsenic-induced lung cancer.

Studies in U.S. populations exposed to arsenic in drinking water (EPA 1981b; Lamm et al. 2004; Lewis et al. 1999; Morton et al. 1976; Steinmaus et al. 2003; Valentine et al. 1992) have not yielded the cancer incidences and health effects noted in Taiwan, Mexico, and Chile. Whether this difference is due to a smaller population of subjects compared to Taiwan, to overall lower doses in exposed U.S. populations, or to differences in nutritional or socioeconomic conditions has not been resolved. It should be noted that exposed populations in Mexico and Chile are also smaller than those in Taiwan.

Most studies of animals exposed to arsenate or arsenite by the oral route have not detected any clear evidence for an increased incidence of skin cancer or other cancers (Byron et al. 1967; Kroes et al. 1974; Schroeder et al. 1968). Arsenic has sometimes been called a "paradoxical" human carcinogen because of this lack of animal data (Jager and Ostrosky-Wegman 1997). The basis for the lack of tumorigenicity in animals is not known, but could be related to species-specific differences in arsenic distribution, and induction of cell proliferation (Byrd et al. 1996) (see Section 3.5). As discussed in Section 3.5 below, the carcinogenic effects of arsenic may partially result from its function as a cocarcinogen, which would not manifest in most animal carcinogenicity studies.

One mouse study using transgenic mice (which carry the v-Ha-ras oncogene) administered 48 mg As/kg/day as sodium arsenite in drinking water for 4 weeks followed by dermal application of 12-O-tetradecanoylphorbol-13-acetage (TPA) to shaved back skin twice a day for 2 weeks showed an increase in the incidence of skin papillomas when compared to transgenic mice receiving only TPA treatment, only arsenic, or to wild-type mice receiving both TPA and arsenic (Germolec et al. 1998); arsenic treatment alone did not result in increased papilloma incidence. Increases in mRNA transcripts for the growth factors transforming growth factor-α (TGF-α) and granulocyte/ macrophage-colony stimulating factor (GM-CSF) were detected in the epidermis of the arsenic-treated mice.

A few studies in mice have noted that arsenic ingestion may actually decrease the incidence of some tumor types. For example, arsenic exposure caused decreased incidence of urethane-induced pulmonary tumors (Blakley 1987), spontaneous mammary tumors (Schrauzer and Ishmael 1974; Schrauzer et al.

1976), and tumors resulting from injection of mouse sarcoma cells (Kerkvliet et al. 1980). However, arsenic also increased the growth rate of the tumors that did occur, resulting in a net decrease in survival time in tumor-bearing animals (Kerkvliet et al. 1980; Schrauzer and Ishmael 1974). These observations suggest that arsenic may affect different types of neoplastic cells differently, perhaps acting mainly as a tumor promoter (Schrauzer and Ishmael 1974; Shirachi et al. 1983), although some studies have suggested that arsenic's actions are not consistent with tumor promotion (Baroni et al. 1963; Boutwell 1963).

There is evidence suggesting that inorganic arsenic can induce cancer in the offspring from mice exposed to arsenic during gestation (transplacental carcinogen) (Waalkes et al. 2003, 2004a, 2004b, 2004c, 2006a, 2006b). These studies are summarized in Section 3.2.2.6, Developmental Effects.

Organic Arsenicals. No studies were located regarding cancer in humans after oral exposure to organic arsenicals. Two lifetime carcinogenicity studies with MMA did not find significant increases in tumors in rats exposed to 72.4 mg MMA/kg/day in the diet for 2 years (Arnold et al. 2003) or 8.4 mg MMA/kg/day in drinking water for 2 years (Shen et al. 2003). No significant increases in neoplastic lesions were observed in mice exposed to 67.1 mg MMA/kg/day in the diet for 2 years (Arnold et al. 2003).

In contrast, significant increases in the incidence of urinary bladder tumors have been observed in rats exposed for 2 years to 7.8 mg DMA/kg/day in the diet (Arnold et al. 2006) or 3.4 mg DMA/kg/day in drinking water (Wei et al. 1999, 2002). The incidence of bladder tumors was similar to controls in the rats exposed to 0.77 mg DMA/kg/day (Arnold et al. 2006) or 0.75 mg DMA/kg/day (Wei et al. 1999, 2002). Neither study reported significant increases in the incidence of neoplastic lesions in other tissues. Arnold et al. (2006) did not find increases in the incidence of neoplastic lesions in mice exposed to doses as high as 94 mg DMA/kg/day in the diet for 2 years. Hayashi et al. (1998) reported that exposure of A/J mice (a strain susceptible to lung tumorigenesis) to 10.4 mg DMA/kg/day (but not 1.3 or 5.2 mg DMA/kg/day) in drinking water for 50 weeks resulted in an increased incidence of papillary adenomas and/or adenocarcinomas and an increased number of lung tumors per mouse.

The incidence of basophilic foci (believed to be a precancerous lesion) in the liver of rats initiated with diethylnitrosamine was increased by subsequent 6-month drinking water exposure to 11 mg DMA/kg/day, suggesting that this compound could act as a cancer promoter (Johansen et al. 1984). Additional evidence for the possible role of DMA as a promoter comes from Yamamoto et al. (1995), who reported that 15 or 60 mg DMA/kg/day in the drinking water for 24 weeks significantly enhanced the tumor induction in the

urinary bladder, kidney, liver, and thyroid gland in male F344 rats treated with a series of initiators. Wanibuchi et al. (1996) reported that treatment of F344 rats for 32 weeks with up to 14.3 mg DMA/kg/day DMA in the drinking water did not result in increased incidences of urinary bladder papillomas or carcinomas, but that incidence of these tumors was elevated if the animals were first pretreated with an initiating compound (BBN). A later study by Li et al. (1998) reported that NBR rats (which do not synthesize $\alpha_{2\mu}$-globulin) exposed to an initiator for 4 weeks followed by DMA for 32 weeks, similar to the Wanibuchi et al. (1996) study, showed a statistically significant increase in simple hyperplasia and papillary or nodular hyperplasia of the bladder. A study by Salim et al. (2003) suggested that DMA primarily exerts its carcinogenic effects on spontaneous tumor development.

No increases in tumor incidence were observed in rats, mice, or dogs exposed to 10, 13, or 5 mg/kg/day roxarsone, respectively, in the diet for 2 years (Prier et al. 1963). Similarly, no evidence of carcinogenicity was observed in female rats or male or female mice exposed to 4 or 43 mg/kg/day as roxarsone in the diet for 2 years (NTP 1989b). However, a slight increase in pancreatic tumors was noted in male rats exposed to 4 mg/kg/day (NTP 1989b); this was considered to constitute equivocal evidence of carcinogenicity.

3.2.3 Dermal Exposure

Adverse effects from dermal exposure to inorganic or organic arsenicals have not been extensively investigated. Table 3-7 summarizes studies in animals and humans that provide quantitative data on dermal exposure-effect relationships for inorganic arsenicals. No quantitative data on dermal exposure to organic arsenicals were located. Available quantitative and qualitative data are discussed in greater detail below.

3.2.3.1 Death

Inorganic Arsenicals. No studies were located regarding death in humans after dermal exposure to inorganic arsenicals. In rats, no deaths resulted from dermal exposure to arsenate or arsenite at doses up to 1,000 mg As/kg (Gaines 1960). These data indicate that dermal exposure to inorganic arsenic compounds is very unlikely to result in death.

Organic Arsenicals. No studies were located regarding death in humans after dermal exposure to organic arsenicals. No deaths were observed in rabbits receiving daily dermal applications of 540 mg As/kg as

Table 3-7 Levels of Significant Exposure to Inorganic Arsenic - Dermal

Species (Strain)	Exposure/ Duration/ Frequency (Route)	System	NOAEL	LOAEL Less Serious	LOAEL Serious	Reference Chemical Form	Comments
ACUTE EXPOSURE							
Immuno/ Lymphoret							
Gn Pig (Hartley)	once		580 mg/L			Wahlberg and Boman 1986 As(+3)	
Gn Pig (Hartley)	once		4000 mg/L			Wahlberg and Boman 1986 As(+5)	
INTERMEDIATE EXPOSURE							
Systemic							
Mouse (Rockland)	30 wk 11 x/wk	Dermal		6 F mg/kg/day (gross hyperplasia, ulceration)		Boutwell 1963 As(+3)	

F = female; Gn pig = guinea pig; Immuno/Lymphoret = immunological/lymphoreticular; wk = week(s); x = time(s)

MMA 5 days/week for 21 days (Margitich and Ackerman 1991b) or 1,000 mg DMA/kg/day 5 days/week for 21 days (Margitich and Ackerman 1991a).

3.2.3.2 Systemic Effects

No studies were located that have associated respiratory, cardiovascular, gastrointestinal, hematological, musculoskeletal, hepatic, renal, endocrine, ocular, or body weight effects in humans or animals with dermal exposure to inorganic arsenicals.

Respiratory Effects. No studies were located regarding respiratory effects in humans after dermal exposure to organic arsenicals. No histological effects were observed in the respiratory tracts of rabbits following dermal application of 1,000 mg/kg/day MMA or DMA 5 days/week for 21 days (Margitich and Ackerman 1991a, 1991b).

Cardiovascular Effects. No studies were located regarding cardiovascular effects in humans after dermal exposure to organic arsenicals. No histological effects were observed in the hearts of rabbits following dermal application of 1,000 mg/kg/day MMA or DMA 5 days/week for 21 days (Margitich and Ackerman 1991a, 1991b).

Hematological Effects. No studies were located regarding hematological effects in humans after dermal exposure to organic arsenicals. No treatment-related hematological alterations were observed in rabbits receiving dermal applications of 1,000 mg MMA/kg/day (Margitich and Ackerman 1991a) or 1,000 mg DMA/kg/day 5 days/week for 21 days (Margitich and Ackerman 1991b).

Hepatic Effects. No studies were located regarding hepatic effects in humans after dermal exposure to organic arsenicals. No significant alterations in blood clinical chemistry, liver weights, or histopathology were observed in rabbits dermally exposed to 1,000 mg/kg/day MMA or DMA 5 days/week for 21 days (Margitich and Ackerman 1991a, 1991b).

Renal Effects. No studies were located regarding renal effects in humans after dermal exposure to organic arsenicals. No significant alterations in urinalysis, kidney weights, or histopathology were observed in rabbits following dermal exposure to 1,000 mg MMA/kg/day (Margitich and Ackerman 1991a) or 1,000 mg DMA/kg/day 5 days/week for 21 days (Margitich and Ackerman 1991b).

Endocrine Effects. No studies were located regarding endocrine effects in humans after dermal exposure to organic arsenicals. No alterations in adrenal gland weight or histopathology of the adrenal glands, pancreas, pituitary gland, thyroid gland, and parathyroid gland were observed in rabbits following dermal application of 1,000 mg/kg/day MMA or DMA 5 days/week for 21 days (Margitich and Ackerman 1991a, 1991b).

Dermal Effects.

Inorganic Arsenicals. Several studies of humans exposed to arsenic dusts in the workplace have reported that inorganic arsenic (usually arsenic trioxide) can cause contact dermatitis (Holmqvist 1951; Pinto and McGill 1953). Typical responses included erythema and swelling, with papules and vesicles in more severe cases (Holmqvist 1951). The dermal contact rates that cause these effects in humans have not been quantified, but a similar direct irritation of the skin has been noted in mice exposed to 4 mg As/kg/day as potassium arsenite for 30 weeks (Boutwell 1963). In contrast, no significant dermal irritation was noted in guinea pigs exposed to aqueous solutions containing 4,000 mg As/L as arsenate or 580 mg As/L as arsenite (Wahlberg and Boman 1986). These studies indicate that direct contact may be of concern at high exposure levels, but do not suggest that lower levels are likely to cause significant irritation.

Studies on possible dermal sensitization by inorganic arsenicals are discussed in Section 3.2.3.3 below.

Organic Arsenicals. Contact dermatitis was reported in workers involved in the application of an organic arsenical herbicide, which is a mixture of DMA and its sodium salt (Peoples et al. 1979).

Application of an unspecified amount of MMA to the skin of rabbits was reported to result in mild dermal irritation in a Draize test (Jaghabir et al. 1988). No dermal irritation was reported in rabbits repeatedly exposed to 1,000 mg MMA/kg/day (Margitich and Ackerman 1991a) or 1,000 mg DMA/kg/day 5 days/week for 21 days (Margitich and Ackerman 1991b).

Ocular Effects. No studies were located regarding ocular effects in humans or animals after dermal exposure to organic arsenicals.

Body Weight Effects. No studies were located regarding body weight effects in humans after dermal exposure to organic arsenicals. No significant alterations in body weight gain were observed in rabbits

following a 5 day/week exposure to 1,000 mg/kg/day MMA or DMA for 21 days (Margitich and Ackerman 1991a, 1991b).

3.2.3.3 Immunological and Lymphoreticular Effects

Inorganic Arsenicals. Examination of workers exposed to arsenic trioxide dusts in a copper smelter led Holmqvist (1951) to suspect that repeated dermal contact could lead to dermal sensitization. In support of this, Holmqvist (1951) found a positive patch test in 80% of the exposed workers compared to 30% in a control population. These data do suggest that workers may be sensitized to arsenic, but the high response rate in controls seems unusual. A much lower response rate (0.5%) was noted in another patch test study of dermal sensitization (Wahlberg and Boman 1986), and the few positive responses seemed to be due to a cross-reactivity with nickel. Mohamed (1998) evaluated 11 male workers at a tin smelting factory where arsenic trioxide levels ranged from 5.2 to 14.4 mg/m^3. The workers experienced symptoms of generalized itch, dry and hyperpigmented skin, folliculitis, and superficial ulcerations. The authors concluded that arsenic-containing dust collected on the sweat on the workers' skin, causing contact dermatitis. Studies in guinea pigs did not yield evidence of a sensitization reaction to inorganic arsenic (Wahlberg and Boman 1986).

Organic Arsenicals. Support for sensitization to DMA is provided in a case report of a 26-year-old woman who was occupationally exposed to DMA and experienced eczema on her face (Bourrain et al. 1998). Patch testing confirmed an allergic reaction to DMA, and avoidance of DMA resulted in disappearance of the symptoms. No studies were located regarding immunological or lymphoreticular effects in animals after dermal exposure to organic arsenicals.

No studies were located that have associated any of the following effects in humans or animals with dermal exposure to inorganic or organic arsenicals:

3.2.3.4 Neurological Effects

3.2.3.5 Reproductive Effects

3.2.3.6 Developmental Effects

3.2.3.7 Cancer

Inorganic Arsenicals. No studies were found that have associated cancer in humans with dermal exposure to arsenic. Application of arsenic acid to the skin of mice pretreated with dimethylbenz-

anthracene did not result in any skin tumors (Kurokawa et al. 1989), suggesting that arsenic does not act as a promoter in this test system.

Organic Arsenicals. No studies were located regarding cancer in humans or animals after dermal exposure to organic arsenicals.

3.3 GENOTOXICITY

Inorganic Arsenicals. There have been a large number of studies of the genotoxic effects of arsenic. Tables 3-8 and 3-9 summarize a number of reports on the *in vitro* and *in vivo* genotoxicity of inorganic arsenicals, respectively. In general, *in vitro* studies in prokaryotic organisms have been negative for gene mutations (Lantzsch and Gebel 1997; Löfroth and Ames 1978; Nishioka 1975; Rossman et al. 1980; Ulitzur and Barak 1988). Studies in human fibroblasts, lymphocytes, and leukocytes, mouse lymphoma cells, Chinese hamster ovary cells, and Syrian hamster embryo cells demonstrate that *in vitro* arsenic exposure can induce chromosomal aberrations and sister chromatid exchange (see Table 3-8 for citations). *I vitro* studies in human, mouse, and hamster cells have also been positive for DNA damage and repair and enhancement or inhibition of DNA synthesis.

Studies of humans have detected a higher-than-average incidence of chromosomal aberrations in peripheral lymphocytes, both after inhalation exposure (Beckman et al. 1977; Nordenson et al. 1978) and oral exposure (Burgdorf et al. 1977; Nordenson et al. 1979). These studies must be interpreted with caution, since in most cases, there were only a small number of subjects and a number of other chemical exposures were possible (EPA 1984a). Human and animal data are available indicating that inhaled inorganic arsenic is clastogenic. Workers exposed to unspecified concentrations of arsenic trioxide at the Ronnskar copper smelter in Sweden were found to have a significant increase in the frequency of chromosomal aberrations in peripheral lymphocytes (Beckman et al. 1977; Nordenson et al. 1978). This result is supported by an animal study that found increased chromosomal aberrations in the livers of fetuses from pregnant mice exposed to 22, but not 2.2 or 0.20, mg As/m^3 as arsenic trioxide on days 9–12 of gestation (Nagymajtényi et al. 1985). Workers in the arsenic-based glass making industry in southern India had a significantly increased frequency of micronuclei in buccal cells and increased DNA damage in leukocytes compared to a control group (Vuyyuri et al. 2006). Exposure levels were not available, but the concentration of arsenic in the blood from workers was approximately 5 times higher than in the reference group.

Table 3-8. Genotoxicity of Inorganic Arsenic *In Vitro*

Valence	Species (test system)	End point	Results		Reference
			With activation	Without activation	
Prokaryotic organisms:					
As^{+3}	*Escherichia coli*	Reverse mutation	No data	+	Nishioka 1975
As^{+3}	*E. coli* PQ37	Gene mutation	No data	–	Lantzsch and Gebel 1997
As^{+3}	*E. coli* (six strains)	Reverse mutation	No data	–	Rossman et al. 1980
As^{+3}	*Salmonella typhimurium*	Gene mutation	No data	–	Löfroth and Ames 1978
As^{+3}	*Photobacterium fischeri*	Gene mutation	No data	–	Ulitzur and Barak 1988
As^{+5}	*S. typhimurium*	Gene mutation	No data	–	Löfroth and Ames 1978
As^{+5}	*P. fischeri*	Gene mutation	No data	+	Ulitzur and Barak 1988
Eukaryotic organisms:					
	Fungi:				
As^{+3}; As^{+5}	*Saccharomyces cerevisiae*	Gene mutation	No data	–	Singh 1983
	Mammalian cells:				
As^{+3}	Human fibroblasts	DNA repair inhibition	No data	+	Okui and Fujiwara 1986
As^{+3}	Human fibroblasts	DNA repair and mutant frequencies	+	+	Wiencke et al. 1997
As^{+3}	Human fibroblasts	DNA repair inhibition	+	+	Hartwig et al. 1997
As^{+3}	Human fibroblasts (MRC5CV1)	DNA migration	No data	+	Hartmann and Speit 1996
As^{+3}	Human fibroblasts (HFW cells)	Cytotoxicity	No data	+	Lee and Ho 1994
As^{+3}	Human skin fibroblasts (HFW)	Chromosome endoreduplication	No data	+	Huang et al. 1995
As^{+3}	Human skin fibroblasts	Chromosomal aberrations	No data	+	Yih et al. 1997
As^{+3}	Human fetal lung fibroblasts	DNA strand breaks	No data	+	Dong and Luo 1993
As^{+3}	Human fetal lung fibroblasts (2BS cells)	DNA damage and repair	No data	+	Dong and Luo 1994
As^{+3}; As^{+5}	Human umbilical cord fibroblasts	Chromosomal aberrations	No data	+	Oya-Ohta et al. 1996
As^{+3}	Diploid human fibroblasts	Morphological transformation	No data	+	Landolph 1994

Table 3-8. Genotoxicity of Inorganic Arsenic *In Vitro*

Valence	Species (test system)	End point	Results		Reference
			With activation	Without activation	
As^{+3}	Human leukocytes	Chromosomal aberration	No data	+	Nakamuro and Sayato 1981
As^{+3}	Human lymphocytes	DNA protein cross-links	–	–	Costa et al. 1997
As^{+3}; As^{+5}	Human lymphocytes	Enhancement or inhibition on DNA synthesis	No data	+	Meng 1993a
As^{+3}; As^{+5}	Human lymphocytes	Enhancement or inhibition on DNA synthesis	No data	+	Meng 1993b
As^{+3}; As^{+5}	Human lymphocytes	Enhancement or inhibition on DNA synthesis	No data	+	Meng 1994
As^{+3}	Human lymphocytes	Hyperdiploidy and chromosomal breakage	No data	(+)	Rupa et al. 1997
As^{+3}	Human lymphocytes	Hyperdiploid nuclei	No data	+	Ramirez et al. 1997
As^{+3}	Human lymphocytes	Chromosomal aberration	No data	+	Beckman and Nordenson 1986
As^{+3}	Human lymphocytes	Chromosomal aberrations and sister chromatid exchange	No data	+	Nordenson et al. 1981
As^{+3}	Human lymphocytes	Chromosomal aberration	No data	+	Sweins 1983
As^{+3}	Human lymphocytes	Chromosomal aberrations	No data	+	Yager and Wiencke 1993
As^{+3}	Human lymphocytes	Chromosomal aberrations	No data	+	Vega et al. 1995
As^{+3}	Human lymphocytes	Chromosomal aberrations	No data	+	Wan et al. 1982
As^{+3}	Human lymphocytes	Chromosomal aberrations and sister chromatic exchange	No data	+	Wiencke and Yager 1992
As^{+3}	Human lymphocytes	Chromosome aberrations and sister chromatid exchanges	No data	+	Larramendy et al. 1981
As^{+3}	Human lymphocytes	Sister chromatid exchange	No data	+	Gebel et al. 1997
As^{+5}	Human lymphocytes	Sister chromatid exchange	No data	–	Gebel et al. 1997
As^{+3}	Human lymphocytes	Sister chromatid exchange	No data	+	Hartmann and Speit 1994
As^{+3}	Human lymphocytes	Sister chromatid exchange	No data	+	Jha et al. 1992
As^{+3}	Human lymphocytes	Sister chromatid exchange	No data	+	Rasmussen and Menzel 1997

Table 3-8. Genotoxicity of Inorganic Arsenic *In Vitro*

Valence	Species (test system)	End point	Results		Reference
			With activation	Without activation	
As^{+3}; As^{+5}	Human T-cell lymphoma-derived cell line (Molt-3)	PARP activity inhibition	No data	+	Yager and Wiencke 1997
As^{+3}	Human cervix carcinoma HeLa and cisplatin-resistant HeLa/CPR variant cells	DNA repair modification	+	+	Chao 1996
As^{+3}	Human cervix carcinoma cells (HeLa)	DNA damage recognition	No data	-	Hartwig et al. 1998
As^{+3}	Human osteosarcoma cells (HOS)	DNA repair	No data	+	Hu et al. 1998
As^{+3}	Human osteosarcoma cells (HOS)	Cell transformation	No data	+	Mure et al. 2003
As^{+3}	Human-hamster hybrid A_1 cells	DNA adducts	No data	+	Kessel et al. 2002
As^{+3}	Mouse lymphoma cells	Enhanced viral forward mutation	No data	(+)	Oberly et al. 1982
As^{+3}; As^{+5}	Mouse lymphoma cells [L5178Y/$TK^{+/-}$ (-3.7.2C)]	Chromosomal mutations	No data	+	Moore et al. 1997a
As^{+3}	Mouse lymphoma cells [L5178Y $tk^{+/-}$ (3.7.sc)]	Mutagenicity	No data	+	Oberly et al. 1996
As^{+3}; As^{+5}	Mouse lymphoma cells	Chromosomal aberrations	No data	+	Moore et al. 1994a
As^{+3}	Mouse lymphoma cells	Chromosomal aberrations	No data	+	Sofuni et al. 1996
As^{+3}	Mouse 3T6 cells	Gene amplification	No data	+	Lee et al. 1988
As^{+3}	Mouse embryo fibroblasts (C3H/10T/2 Cl8)	Morphological transformation	No data	+	Landolph 1994
As^{+3}	Chinese hamster V79 cells	Gene mutation	No data	–	Li and Rossman 1991
As^{+3}	Chinese hamster V79 cells	Gene mutation	No data	–	Rossman et al. 1980
As^{+3}	Chinese hamster V79 cells	DNA damage, DNA-protein cross-linking, micronucleus induction	No data	+	Gebel et al. 1998a
As^{+3}	Chinese hamster V79 cells	DNA repair and mutant frequencies	No data	+	Li and Rossman 1991
As^{+3}	Chinese hamster V79 cells	Intrachromosomal homologous recombination	No data	+	Helleday et al. 2000
As^{+3}	Chinese hamster ovary cells (CHO-AL)	Gene mutation	No data	+	Hei et al. 1998
As^{+3}	Chinese hamster ovary cells (CHO-AS52)	Mutagenicity	No data	+	Meng and Hsie 1996

Table 3-8. Genotoxicity of Inorganic Arsenic *In Vitro*

Valence	Species (test system)	End point	Results		Reference
			With activation	Without activation	
As^{+3}	Chinese hamster ovary cells	Gene mutation	No data	+	Yang et al. 1992
As^{+3}	Chinese hamster ovary cells	DNA repair inhibition	No data	+	Lee-Chen et al. 1993
As^{+3}	Chinese hamster ovary cells	DNA repair inhibition	No data	–	Lee-Chen et al. 1992
As^{+3}	Chinese hamster ovary cells (CHO-K1)	DNA strand breaks	+	+	Lee-Chen et al. 1994
As^{+3}	Chinese hamster ovary cells (CHO-K1)	DNA strand breaks	No data	+	Lynn et al. 1997
As^{+3}	Chinese hamster ovary cells	Aberrant metaphases	No data	+	Jan et al. 1986
As^{+3}	Chinese hamster ovary cells	Aberrant metaphases	No data	+	Lee et al. 1986
As^{+3}	Chinese hamster ovary cells	Chromosomal aberrations	+	+	Huang et al. 1992
As^{+3}	Chinese hamster ovary cells (CHO-K1)	Chromosomal aberrations	No data	+	Huang et al. 1993
As^{+3}, As^{+5}	Chinese hamster ovary cells (CHO-K1)	Chromosomal aberrations and sister chromatid exchange	No data	+	Kochhar et al. 1996
As^{+3}	Chinese hamster ovary cells	Chromosomal aberrations and sister chromatid exchange	+	+	Lin and Tseng 1992
As^{+3}	Chinese hamster ovary cells	Chromosomal aberrations and sister chromatid exchange	No data	+	Wan et al. 1982
As^{+3}	Chinese hamster ovary cells	Sister chromatid exchange and micronucleus induction	No data	+	Fan et al. 1996
As^{+3}	Chinese hamster ovary cells	Cell-killing and micronucleus induction	No data	+	Wang and Huang 1994
As^{+3}	Chinese hamster ovary cells	Micronuclei	No data	+	Liu and Huang 1997
As^{+3}	Chinese hamster ovary cells	Micronuclei formation	No data	+	Yee-Chien and Haimei 1996
As^{+3}	Chinese hamster ovary cells	Micronuclei induction	No data	+	Wang et al. 1997
As^{+3}	Chinese hamster ovary cells	Cytotoxicity	No data	–	Lee and Ho 1994
As^{+3}	Syrian hamster embryo cells	Gene mutation	No data	–	Lee et al. 1985

Table 3-8. Genotoxicity of Inorganic Arsenic *In Vitro*

Valence	Species (test system)	End point	Results		Reference
			With activation	Without activation	
As^{+3}	Syrian hamster embryo cells	Chromosome aberrations and sister chromatid exchanges	No data	+	Larramendy et al. 1981
As^{+3}	Syrian hamster embryo cells	Chromosomal aberration	No data	+	Lee et al. 1985
As^{+3}	Syrian hamster embryo cells	Sister chromatid exchange	No data	+	Lee et al. 1985
As^{+3}	Syrian hamster embryo cells	Micronuclei induction	No data	–	Gibson et al. 1997
As^{+3}	Syrian hamster embryo cells	Micronuclei induction	No data	–	Gibson et al. 1997
As^{+3}	Syrian hamster embryo cells	Morphological transformation	No data	+	Kerckaert et al. 1996
As^{+3}	Syrian hamster embryo cells	Morphological transformation	No data	+	Lee et al. 1985
As^{+3}	Syrian hamster embryo cells	Morphological transformation	No data	+	Casto et al. 1979
As^{+5}	Human fibroblasts	DNA repair inhibition	No data	–	Okui and Fujiwara 1986
As^{+5}	Human leukocytes	Chromosomal aberrations	No data	(+)	Nakamuro and Sayato 1981
As^{+5}	Human lymphocytes	Chromosomal aberrations	No data	–	Nordenson et al. 1981
As^{+5}	Human lymphocytes	Chromosome aberrations and sister chromatid exchanges	No data	+	Larramendy et al. 1981
As^{+5}	Human lymphocytes	Sister chromatid exchange	No data	–	Rasmussen and Menzel 1997
As^{+5}	Human peripheral lymphocytes	Sister chromatid exchange	No data	+	Zanzoni and Jung 1980
As^{+5}	Human keratinocyte line SCC-9 cells	Keratinocyte programming and transcriptional activity	No data	+	Kachinskas et al. 1997
As^{+5}	Mouse lymphoma cells	Gene mutation	No data	–	Amacher and Paillet 1980
As^{+5}	Mouse lymphoma cells	Gene mutation	No data	–	Amacher and Paillet 1980
As^{+5}	Chinese hamster ovary cells	Chromosomal aberrations	No data	+	Wan et al. 1982
As^{+5}	Syrian hamster embryo cells	Gene mutation	No data	–	Lee et al. 1985
As^{+5}	Syrian hamster embryo cells	Chromosome aberrations and sister chromatid exchanges	No data	+	Larramendy et al. 1981

Table 3-8. Genotoxicity of Inorganic Arsenic *In Vitro*

Valence	Species (test system)	End point	Results		Reference
			With activation	Without activation	
As^{+5}	Syrian hamster embryo cells	Chromosomal aberrations	No data	+	Lee et al. 1985
As^{+5}	Syrian hamster embryo cells	Sister chromatid exchange	No data	+	Lee et al. 1985
As^{+5}	Syrian hamster embryo cells	Morphological transformation	No data	+	Lee et al. 1985
As^{+5}	Syrian hamster embryo cells	Morphological transformation	No data	+	DiPaolo and Casto 1979

(+) = weakly positive or marginal result; – = negative result; + = positive result; DNA = deoxyribonucleic acid

Table 3-9. Genotoxicity of Inorganic Arsenic *In Vivo*

Valence	Exposure route	Species (test system)	End point	Results	Reference
Nonmammalian					
As^{+3} As^{+5}	Injection	*Drosophila melanogaster*	Somatic mutations and mitotic recombination	+	Ramos-Morales and Rodriguez-Arnaiz 1995
As^{+3} As^{+5}	Larval feeding	*D. melanogaster*	Somatic mutations and mitotic recombination	+	Ramos-Morales and Rodriguez-Arnaiz 1995
As^{+5}	Larvae	*D. melanogaster*	Mitotic recombinations	+	de la Rosa et al. 1994
Mammalian					
As^{+3}	Inhalation	Human (lymphocytes)	Chromosomal aberrations	–	Beckman et al. 1977
As^{+3}	Inhalation	Human (lymphocytes)	Chromosomal aberrations	+	Nordenson et al. 1978
As^{+3}	Oral	Human (lymphocytes)	Chromosomal aberrations	–	Burgdorf et al. 1977
No data	Oral	Human (lymphocytes)	Chromosomal aberrations	–	Vig et al. 1984
No data	Oral	Human (skin)	DNA adducts	+	Matsui et al. 1999
As^{+3}	Oral	Human (lymphocytes)	Sister chromatid exchange	–	Burgdorf et al. 1977
As^{+3}	Oral	Human (lymphocytes)	Sister chromatid exchange	+	Hsu et al. 1997
No data	Oral	Human (lymphocytes)	Sister chromatid exchange	+	Lerda 1994
No data	Oral	Human (lymphocytes)	Sister chromatid exchange	+	Liou et al. 1999
No data	Oral	Human (lymphocytes)	Sister chromatid exchange	+	Mahata et al. 2003
As^{+3}	Oral	Human (lymphocytes)	Sister chromatid exchange	–	Nordenson et al. 1978
No data	Oral	Human (lymphocytes)	Sister chromatid exchange	–	Vig et al. 1984
No data	Oral	Human skin carcinoma	Mutation and overexpression of p53	+	Hsu et al. 1999
As^{+3}	Oral	Exfoliated human epithelial cells	Micronuclei	+	Moore et al. 1996
As^{+3}	Oral	Exfoliated human epithelial cells	Micronuclei	+	Tian et al. 2001
No data	Oral	Human (bladder cells)	Micronuclei	+	Moore et al. 1995
No data	Oral	Human (lymphocytes)	Micronuclei	+	Martínez et al. 2004
No data	Oral	Human (lymphocytes)	Micronuclei	+	Basu et al. 2004
No data	Oral	Human (oral mucosa cells)	Micronuclei	+	Basu et al. 2004

Table 3-9. Genotoxicity of Inorganic Arsenic *In Vivo*

Valence	Exposure route	Species (test system)	End point	Results	Reference
No data	Oral	Human (urothelial cells)	Micronuclei	+	Basu et al. 2004
As^{+5}	Oral	Rat (bone marrow cells)	Chromosomal aberrations	+	Datta et al. 1986
As^{+3}	Inhalation	Mouse (fetal liver)	Chromosomal aberrations	(+)	Nagymajtényi et al. 1985
As^{+3}	Oral	Mouse (bone marrow cells)	Chromosomal aberrations	+	Das et al. 1993
As^{+3}	Oral	Mouse (bone marrow cells)	Chromosomal aberrations	+	Poddar et al. 2000
As^{+3}	Oral	Mouse (bone marrow cells)	Chromosomal breaks, exchanges	–	Poma et al. 1987
As^{+3}	Oral	Mouse (spermatogonia)	Chromosomal aberrations	–	Poma et al. 1987
As^{+3}	Oral	Mouse (leukocytes)	Chromosomal breaks	+	McDorman et al. 2002
As^{+3}	Intraperitoneal	Mouse (bone marrow cells)	Chromosomal breaks, exchanges	–	Poma et al. 1981
As^{+3}	Intraperitoneal	Mouse (bone marrow cells)	Micronuclei	+	DeKnudt et al. 1986
As^{+3}	Intraperitoneal	Mouse (spermatogonia)	Spermatongonia	–	Poma et al. 1981
As^{+3}	Intraperitoneal	Mouse (spermatogonia)	Sperm morphology	–	DeKnudt et al. 1986
As^{+3}	Intraperitoneal	Mouse (spermatogenesis)	Dominant lethal mutations	–	DeKnudt et al. 1986

(+) = weakly positive or marginal result; – = negative result; + = positive result; DNA = deoxyribonucleic acid

Investigations of genotoxic effects of ingested arsenic have yielded mixed results possibly due to the different types of cells examined and the different exposure levels experienced by the populations studied. A study of p53 mutations in arsenic-related skin cancers from patients in Taiwan exposed to arsenic from drinking water found a high rate of p53 mutations and different types of p53 mutations compared with those seen in UV-induced skin cancers (Hsu et al. 1999); similar results have been found in mice (Salim et al. 2003). In humans exposed to Fowler's solution (potassium arsenite, usually taken at a dose of about 0.3 mg As/kg/day [Holland 1904]), increased sister chromatid exchanges, but no increase in chromosomal aberrations, was reported in one study (Burgdorf et al. 1977), while just the converse (increased aberrations but no increase in sister chromatid exchange) was reported in another (Nordenson et al. 1979). Moore et al. (1997a) reported an exposure-dependent increase in the occurrence of micronucleated cells in epithelial cells from the bladder in a male population in northern Chile chronically exposed to high and low arsenic levels in their drinking water (average concentrations, 600 and 15 µg As/L, respectively), and noted that chromosome breakage was the major cause of micronucleus (MN) formation. Similar results were reported by Martínez et al. (2004) who evaluated micronuclei formation in peripheral lymphocytes from people in northern Chile exposed to up to 0.75 mg As/L in their drinking water. In contrast, Martínez et al. (2005) did not find a significant increase in micronuclei in buccal cells from subjects from the same area relative to a low exposure group. Vig et al. (1984) found no significant differences in the frequency of chromosomal aberrations or sister chromatid exchanges between two populations in Nevada with differing levels of arsenic in their drinking water (mean concentrations of 5 and 109 µg/L). In animal studies, an increased incidence of chromosomal abnormalities was detected in rats given oral doses of sodium arsenate (4 mg As/kg/day) for 2–3 weeks (Datta et al. 1986), but no consistent increase in chromosomal aberrations was detected in bone marrow cells or spermatogonia from mice given sodium arsenite (about 50 mg As/kg/day) for up to 8 weeks (Poma et al. 1987). These studies suggest that ingested arsenic may cause chromosomal effects, but these data are too limited to draw a firm conclusion.

Organic Arsenicals. The genotoxicity of the organic arsenicals has been investigated in a number of studies (see Table 3-10). Several tests indicate that DMA and roxarsone may be able to cause chromosome aberrations, mutations, and deoxyribonucleic acid (DNA) strand breaks; *in vitro* studies with MMA did not find significant increases in the occurrence of chromosome aberrations, forward or reverse mutations, unscheduled DNA synthesis (Chun and Killeen 1989a, 1989b, 1989c, 1989d). An increased number of DNA strand breaks were detected in lung and other tissues of mice and rats given oral doses of ~1,500 mg/kg DMA (Okada and Yamanaka 1994; Yamanaka et al. 1989a); this effect appeared to be related to the formation of some active oxygen species. These breaks were largely repaired within 24 hours, so the relevance with respect to health risk is uncertain.

Table 3-10. Genotoxicity of Organic Arsenic

Chemical form	Species (test system)	End point	Results: With activation	Results: Without activation	Reference
Prokaryotic organisms (*in vitro*):					
MMA	*Salmonella typhimurium*	Gene mutation	–	–	Chun and Killeen 1989c
DMA	*Escherichia coli*	Gene mutation	No data	+	Yamanaka et al. 1989b
Roxarsone	*S. typhimurium*	Gene mutation	–	–	NTP 1989b
Eukaryotic organisms (*in vitro*):					
MMA	Chinese hamster ovary cells	Chromosome aberrations	–	–	Chun and Killeen 1989a
MMA	Mouse lymphoma cells ($L5178Y/TK^{+/-}$)	Forward mutation	–	–	Chun and Killeen 1989b
MMA	Rat heptocytes	Unscheduled DNA synthesis	No data	–	Chun and Killeen 1989d
DMA	Human peripheral lymphocytes	Mitogenesis inhibited	No data	–	Endo et al. 1992
DMA	Human lymphocytes	Sister chromatid exchange	No data	–	Rasmussen and Menzel 1997
DMA	Human alveolar (L-132) cells	Lung-specific DNA damage	No data	+	Kato et al. 1994
DMA	Human alveolar type II (L-132) cells	DNA single-strand breaks	+	+	Kawaguchi et al. 1996
DMA	Human diploid L-132 epithelial cells	DNA single-strand breaks	No data	+	Rin et al. 1995
DMA	Human alveolar type II (L-132) cells	DNA strand breaks	No data	+	Tezuka et al. 1993
DMA	Human embryonic cell line of type II alveolar epithelial cells (L-132)	DNA single-strand breaks and DNA-protein crosslinks	No data	+	Yamanaka et al. 1993
DMA	Human alveolar epithelial (L-132) cells	DNA single-strand breaks and DNA-protein crosslinks	No data	+	Yamanaka et al. 1995
DMA	Human pulmonary epithelial (L-132) cells	DNA single-strand breaks	No data	+	Yamanaka et al. 1997
DMA	Human umbilical cord fibroblasts	Chromosomal aberrations	No data	+	Oya-Ohta et al. 1996
DMA	Mouse lymphoma cells ($L5178Y/TK^{+/-}$ -3.7.2C)	Chromosomal mutations	No data	+	Moore et al. 1997a
DMA	Chinese hamster lung and diploid cells (V79)	Mitotic arrest and tetraploid formation	No data	+	Endo et al. 1992

Table 3-10. Genotoxicity of Organic Arsenic

Chemical form	Species (test system)	End point	Results		Reference
			With activation	Without activation	
DMA	Chinese hamster V79 cells	Chromosomal aberrations	No data	+	Ueda et al. 1997
DMA	Chinese hamster lung and diploid cells (V79)	Chromosomal aberrations	No data	+	Kitamura et al. 2002
DMA	Chinese hamster lung and diploid cells (V79)	Chromosomal aberrations	+	+	Kuroda et al. 2004
DMA	Chinese hamster V79 cells	Tetraploids and mitotic arrest	No data	+	Eguchi et al. 1997
MMA	Human umbilical cord fibroblasts	Chromosomal aberrations	No data	+	Oya-Ohta et al. 1996
MMA	Chinese hamster V79 cells	Tetraploids and mitotic arrest	No data	+	Eguchi et al. 1997
Roxarsone	*Drosophila melanogaster*	Sex linked recessive	No data	–	NTP 1989b
Roxarsone	Rat hepatocyte	DNA double-strand breaks	No data	+	Storer et al. 1996
Roxarsone	A31-1-13 clone of BALB/c-3T3 cells	Transformation response and mutagenicity	No data	–	Matthews et al. 1993
Roxarsone	Mouse lymphoma (L5178Y) cells	Trifluorothymidine resistance	No data	+	NTP 1989b
Eukaryotic organisms (*in vivo*):					
DMA	Rat (oral exposure)	DNA single-stand breaks in lung	No data	+	Yamanaka and Okada 1994
DMA	Mouse (oral exposure)	DNA strand breaks in tissues	No data	+	Yamanaka et al. 1989b
DMA	Mouse (oral exposure)	DNA single-stand breaks in lung	No data	+	Yamanaka et al. 1993
DMA	Mouse (oral exposure)	DNA single-strand breaks in lung	No data	–	Yamanaka et al. 1989a
DMA	Mouse (oral exposure)	DNA adduct formation	No data	+	Yamanaka et al. 2001
DMA	Mouse (injection)	Aneuploidy in bone marrow cells	No data	+	Kashiwada et al. 1998

– = negative result; + = positive result; DMA = dimethylarsinic acid; DNA = deoxyribonucleic acid; MMA = monomethylarsonic acid

3.4 TOXICOKINETICS

There is an extensive database on the toxicokinetics of inorganic arsenic. Most studies have been performed in animals, but there are a number of studies in humans as well. These studies reveal the following main points:

- Both arsenate and arsenite are well absorbed by both the oral and inhalation routes. Absorption by the dermal route has not been well characterized, but is low compared to the other routes. Inorganic arsenic in soil is absorbed to a lesser extent than solutions of arsenic salts.
- The rate of absorption of arsenic in highly insoluble forms (e.g., arsenic sulfide, lead arsenate) is much lower than that of more soluble forms via both oral and inhalation routes.
- Once absorbed, arsenites are oxidized to arsenates and methylated. This process may then be repeated to result in dimethylated arsenic metabolites.
- Distribution of arsenic in the rat is quite different from other animal species, suggesting that the rat is probably not an appropriate toxicokinetic model for distribution, metabolism, or excretion of arsenic by humans.
- The As(+3) form undergoes enzymic methylation primarily in the liver to form MMA and DMA. The rate and relative proportion of methylation production varies among species. The rate of methylation varies considerably among tissues.
- Most arsenic is promptly excreted in the urine as a mixture of As(+3), As(+5), MMA, and DMA; DMA is usually the primary form in the urine. Smaller amounts are excreted in feces. Some arsenic may remain bound to tissues, depending inversely on the rate and extent of methylation.

Less information is available for the organic arsenicals. It appears that both MMA and DMA are well absorbed, but are rapidly excreted in the urine and feces. MMA may be methylated to DMA, but neither MMA nor DMA are demethylated to yield inorganic arsenic.

A review of the evidence that supports these conclusions is presented below.

3.4.1 Absorption

3.4.1.1 Inhalation Exposure

Inorganic Arsenicals. Since arsenic exists in air as particulate matter, absorption across the lung involves two processes: deposition of the particles onto the lung surface, and absorption of arsenic from the deposited material. In lung cancer patients exposed to arsenic in cigarette smoke, deposition was

estimated to be about 40% and absorption was 75–85% (Holland et al. 1959). Thus, overall absorption (expressed as a percentage of inhaled arsenic) was about 30–34%. In workers exposed to arsenic trioxide dusts in smelters, the amount of arsenic excreted in the urine (the main route of excretion; see Section 3.4.4) was about 40–60% of the estimated inhaled dose (Pinto et al. 1976; Vahter et al. 1986). Absorption of arsenic trioxide dusts and fumes (assessed by measurement of urinary metabolites) correlated with time weighted average arsenic air concentrations from personal breathing zone air samplers (Offergelt et al. 1992). Correlations were best immediately after a shift and just before the start of the next shift. Although the percent deposition was not measured in these cases, it seems likely that nearly all of the deposited arsenic was absorbed. This conclusion is supported by intratracheal instillation studies in rats and hamsters, where clearance of oxy compounds of arsenic (sodium arsenite, sodium arsenate, arsenic trioxide) from the lung was rapid and nearly complete (60–90% within 1 day) (Marafante and Vahter 1987; Rhoads and Sanders 1985). In contrast, arsenic sulfide and lead arsenate were cleared more slowly (Marafante and Vahter 1987), indicating that the rate of absorption may be lower if the inhaled arsenic is in a highly insoluble form. There are no data to suggest that absorption of inhaled arsenic in children differs from that in adults.

Organic Arsenicals. No studies were located regarding absorption of organic arsenicals in humans or animals after inhalation exposure. However, DMA instilled in the lungs of rats was absorbed very rapidly (half-time of 2.2 minutes) and nearly completely (at least 92%) (Stevens et al. 1977). This indicates that organic arsenicals are likely to be well absorbed by the inhalation route.

3.4.1.2 Oral Exposure

Inorganic Arsenicals. Several studies in humans indicate that arsenates and arsenites are well absorbed across the gastrointestinal tract. The most direct evidence is from a study that evaluated the 6-day elimination of arsenic in healthy humans who were given water from a high-arsenic sampling site (arsenic species not specified) and that reported approximately 95% absorption (Zheng et al. 2002). A similar absorption efficiency can be estimated from measurements of fecal excretion in humans given oral doses of arsenite, where <5% was recovered in the feces (Bettley and O'Shea 1975). This indicates absorption was at least 95%. These results are supported by studies in which urinary excretion in humans was found to account for 55–87% of daily oral intakes of arsenate or arsenite (Buchet et al. 1981b; Crecelius 1977; Kumana et al. 2002; Mappes 1977; Tam et al. 1979b). In contrast, ingestion of arsenic triselenide (As_2Se_3) did not lead to a measurable increase in urinary excretion (Mappes 1977), indicating that

gastrointestinal absorption may be much lower if highly insoluble forms of arsenic are ingested. There are no data to suggest that absorption of arsenic from the gut in children differs from that in adults.

These observations in humans are supported by a number of studies in animals. Fecal excretion of arsenates and arsenites ranged from 2 to 10% in monkeys and mice, with 70% or more appearing in urine (Charbonneau et al. 1978; Roberts et al. 2002; Vahter 1981; Vahter and Norin 1980). Oral absorption of [^{73}As] labeled sodium arsenate in mice was unaffected by dose (0.0005–5 mg/kg) as reflected in percentage of dose excreted in feces over 48 hours (Hughes et al. 1994). Absorption ranged from 82 to 89% at all doses. Gonzalez et al. (1995) found that the percentage of arsenate that was absorbed in rats decreased as the dose increased from 6 to 480 µg, suggesting saturable, zero-order absorption of arsenate in this species. Hamsters appear to absorb somewhat less than humans, monkeys, and mice, since fecal excretion usually ranges from 10 to 40% (Marafante and Vahter 1987; Marafante et al. 1987a; Yamauchi and Yamamura 1985). Rabbits also appear to absorb less arsenate than humans, monkeys, or mice after oral exposure (Freeman et al. 1993). After a gavage dose of 1.95 mg/kg sodium arsenate, 45% of the arsenate was recovered in feces in males and 52% in females. As in humans, when highly insoluble arsenic compounds are administered (arsenic trisulfide, lead arsenate), gastrointestinal absorption is reduced 20–30% (Marafante and Vahter 1987).

Bioavailability of arsenic was measured in rabbits ingesting doses of smelting soils that contained arsenic primarily in the form of sulfides (Freeman et al. 1993). Bioavailability was assessed by comparing the amounts of arsenic that was excreted after ingestion of the soil to that excreted after an intravenous dose of sodium arsenate. The bioavailability of the arsenic in the ingested soil was 24±3.2% and that of sodium arsenate in the gavage dose was 50±5.7%. Approximately 80% of the arsenic from ingested soil was eliminated in the feces compared with 50% of the soluble oral dose and 10% of the injected dose. In another study, rabbits dosed with sodium arsenite (0.8 mg As/kg) had 5 times greater blood arsenic concentrations than rabbits dosed with arsenic-containing soil (2.8 mg As/kg), suggesting a lower bioavailability of the arsenic in soil (Davis et al. 1992).

Studies of the bioavailability of arsenic suggest that absorption of arsenic in ingested dust or soil is likely to be considerably less than absorption of arsenic from ingested salts (Davis et al. 1992, 1996; EPA 1997g; Freeman et al. 1993, 1995; Pascoe et al. 1994; Roberts et al. 2002, 2007; Rodriguez et al. 1999). Oral absorption of arsenic in a group of three female Cynomolgus monkeys from a soluble salt, soil, and household dust was compared with absorption of an intravenous dose of sodium arsenate (Freeman et al. 1995). Mean absolute percentage bioavailability based on urine arsenic excretion was reported at

67.6±2.6% (gavage), 19.2±1.5% (oral dust), and 13.8±3.3% (oral soil). Mean absolute percentage bioavailability based on blood arsenic levels was reported at 91.3±12.4% (gavage), 9.8±4.3% (oral dust), and 10.9±5.2% (oral soil). The arsenic in the dust and soil was approximately 3.5–5-fold (based on levels in the urine) and 8–9-fold (based on levels in the blood) less bioavailable than arsenic in solution. Two other studies in monkeys reported relative bioavailability of arsenic in soil from a number of locations (electrical substation, wood preserving sites, pesticide sites, cattle-dip sites, volcanic soil, and mining sites) ranged from 5 to 31% (Roberts et al. 2002, 2007). A study in beagle dogs fed with soil containing As_2O_5 or treated with intravenous soluble arsenic found that compared to injection the bioavailability of arsenic from ingested soil was 8.3±2.0% (Groen et al. 1993). The bioavailability of arsenic in soil has been studied in juvenile swine that received daily oral doses of soil or sodium arsenate (in food or by gavage) for 15 days (EPA 1997g). The soils were obtained from various mining and smelting sites and contained, in addition to arsenic at concentrations of 100–300 µg/g, lead at concentrations of 3,000–14,000 µg/g. The arsenic doses ranged from 1 to 65.4 µg/kg/day. The fraction of the arsenic dose excreted in urine was measured on days 7 and 14 and the relative bioavailability of the soil-borne arsenic was estimated as the ratio of urinary excretion fractions, soil arsenic:sodium arsenate. The mean relative bioavailability of soil-borne arsenic ranged from 0 to 98% in soils from seven different sites (mean±SD, 45%±32). Estimates for relative bioavailability of arsenic in samples of smelter slag and mine tailings ranged from 7 to 51% (mean±SD, 35%±27). Rodriguez et al. (1999) used a similar approach to estimate the relative bioavailability of arsenic in mine and smelter wastes (soils and solid materials) in juvenile swine. Samples included iron slag deposits and calcine deposits and had arsenic concentrations that ranged from 330 to 17,500 µg/g. Relative bioavailability (waste:sodium arsenate) ranged from 3 to 43% for 13 samples (mean, 21%) and was higher in iron slag wastes (mean, 25%) than in calcine wastes (mean, 13%).

Bioavailability of arsenic from soil is reduced by low solubility and inaccessibility due to the presence of secondary reaction products or insoluble matrix components (Davis et al. 1992). This is supported by studies conducted with *in vitro* simulations of the gastric and/or intestinal fluids (Hamel et al. 1998; Pouschat and Zagury 2006; Rodriguez et al. 1999; Ruby et al. 1996, 1999; Williams et al. 1998). When soils containing arsenic are incubated in simulated gastrointestinal fluids, only a fraction of the arsenic becomes soluble. Estimates of the soluble, or bioaccessible, arsenic fraction have ranged from 3 to 50% for various soils and mining and smelter waste materials (Pouschat and Zagury 2006; Rodriguez et al. 1999; Ruby et al. 1996); these estimates are similar to *in vivo* estimates of the relative bioavailability of arsenic in these same materials (Ruby et al. 1999).

Organic Arsenicals. Based on urinary excretion studies in volunteers, it appears that both MMA and DMA are well absorbed (at least 75–85%) across the gastrointestinal tract (Buchet et al. 1981a; Marafante et al. 1987b). This is supported by studies in animals, where at least 75% absorption has been observed for DMA (Marafante et al. 1987b; Stevens et al. 1977; Vahter et al. 1984; Yamauchi and Yamamura 1984) and MMA (Hughes et al. 2005; Yamauchi et al. 1988). In mice, the relative bioavailability of MMA appears to be dose-dependent; 81% was absorbed following a single gavage dose of 0.4 mg MMA/kg/day compared to 60% following administration of 4 mg MMA/kg/day (Hughes et al. 2005).

3.4.1.3 Dermal Exposure

Inorganic Arsenicals. No quantitative studies were located on absorption of inorganic arsenicals in humans after dermal exposure. Percutaneous absorption of [^{73}As] as arsenic acid (H_3AsO_4) alone and mixed with soil has been measured in skin from cadavers (Wester et al. 1993). Labeled arsenic was applied to skin in diffusion cells and transit through the skin into receptor fluid measured. After 24 hours, 0.93% of the dose passed through the skin and 0.98% remained in the skin after washing. Absorption was lower with [^{73}As] mixed with soil: 0.43% passed through the skin over 24 hours and 0.33% remained in the skin after washing.

Dermal absorption of arsenic has been measured in Rhesus monkeys (Lowney et al. 2005; Wester et al. 1993). After 24 hours, 6.4% of [^{73}As] as arsenic acid was absorbed systemically, as was 4.5% of [^{73}As] mixed with soil (Wester et al. 1993). Similarly, 2.8% of soluble arsenic in water was detected in the urine 24 hours after exposure (Lowney et al. 2005). However, arsenic from soil was poorly absorbed; 0.12% was detected in the urine after 24 hours. Differences between the Wester et al. (1993) and Lowney et al. (2005) studies in terms of uptake from soil may be due to the differences in forms of arsenic in the soil. In the Wester et al. (1993) study, soil was mixed with radiolabelled arsenic acid in water; Lowney et al. (2005) used soil samples from a pesticide manufacturing facility that historically manufactured arsenical pesticides (the arsenic was primarily in the iron oxide and iron silicate mineral phases). Lowney et al. (2005) also measured urinary levels of arsenic following dermal application of CCA residues and found that the levels did not increase from background. Uptake of arsenic into blood or tissues was undetectable for up to 24 hours in rats whose tails were immersed in solutions of sodium arsenate for 1 hour. However, arsenic began to increase in blood, liver, and spleen over the next 5 days (Dutkiewicz 1977). The rate of uptake was estimated to be 1–33 μg/cm^2/hour. These findings suggest that dermal exposure leads initially to arsenic binding to skin, and that the bound arsenic may slowly be taken up into the blood, even after exposure ends.

Organic Arsenicals. No studies were located on absorption of organic arsenicals in humans or animals after dermal exposure.

3.4.2 Distribution

3.4.2.1 Inhalation Exposure

Inorganic Arsenicals. No studies were located on the distribution of arsenic in humans or animals after inhalation exposure, but intratracheal administration of arsenic trioxide to rats resulted in distribution of arsenic to the liver, kidney, skeleton, gastrointestinal tract, and other tissues (Rhoads and Sanders 1985). This is consistent with data from oral and parenteral studies (below), which indicate that absorbed arsenic is distributed throughout the body.

Organic Arsenicals. No studies were located regarding the distribution of organic arsenicals in humans or animals after inhalation exposure. However, DMA administered to rats by the intratracheal route was distributed throughout the body (Stevens et al. 1977), suggesting that inhalation of organic arsenicals would also lead to widespread distribution.

3.4.2.2 Oral Exposure

Inorganic Arsenicals. Analysis of tissues taken at autopsy from people who were exposed to background levels of arsenic in food and water revealed that arsenic is present in all tissues of the body (Liebscher and Smith 1968). Most tissues had about the same concentration level (0.05–0.15 ppm), while levels in hair (0.65 ppm) and nails (0.36 ppm) were somewhat higher. This indicates that there is little tendency for arsenic to accumulate preferentially in any internal organs. However, exposure levels may not have been high enough to cause elevated levels in tissues. Arsenic exposure may have been low enough that the methylation process in the body resulted in limited accumulation in internal organs. Tissue analysis of organs taken from an individual following death from ingestion of 8 g of arsenic trioxide (about 3 g of arsenic) showed a much higher concentration of arsenic in liver (147 μg/g) than in kidney (27 μg/g) or muscle, heart, spleen, pancreas, lungs, or cerebellum (11–12 μg/g) (Benramdane et al. 1999a). Small amounts were also found in other parts of the brain (8 μg/g), skin (3 μg/g), and hemolyzed blood (0.4 μg/g). Many studies have been performed where arsenic levels in hair and nails have been measured and correlations with exposure analyzed. Some of these studies are discussed in Section 3.8, Biomarkers of Exposure.

Inorganic arsenic passes easily through the placenta. High levels of arsenic were found in the liver, kidney, and brain during autopsy of an infant prematurely born to a young mother who had ingested inorganic arsenic at week 30 of gestation (Lugo et al. 1969). Arsenic was detected in human breast milk at concentrations of 0.00013–0.00082 ppm in a World Health Organization study (Somogyi and Beck 1993). Arsenic concentrations were 0.0001–0.0044 ppm in human milk sampled from 88 mothers on the Faroe Islands whose diets were predominantly seafood (Grandjean et al. 1995). Exposures to arsenic from the seafood diet in this population was most likely to organic "fish arsenic." In a population of Andean women exposed to high concentrations (about 200 ppb) of inorganic arsenic in drinking water, concentrations of arsenic in breast milk ranged from about 0.0008 to 0.008 ppm (Concha et al. 1998b).

Studies in mice and hamsters given oral doses of arsenate or arsenite have found elevated levels of arsenic in all tissues examined (Hughes et al. 2003; Vahter and Norin 1980; Yamauchi and Yamamura 1985), including the placenta and fetus of pregnant females (Hood et al. 1987, 1988). Inorganic arsenic crosses the placental barrier and selectively accumulates in the neuroepithelium of the developing animal embryo (Hanlon and Ferm 1977; Lindgren et al. 1984). In mice, radiolabel from orally administered 74-As was widely distributed to all tissues, with the highest levels in skin, kidney, and liver (Hughes et al. 2003). No obvious differences between As(+3) and As(+5) were found, although residual levels after 24 hours tended to be higher for As(+3) than As(+5) (Vahter and Norin 1980). However, *in vitro* studies have found that the cellular uptake of As(+3) was higher than that of As(+5) (Bertolero et al. 1987; Dopp et al. 2004); in mouse cells, the difference was 4-fold (Bertolero et al. 1987). In hamsters, increases in tissue levels were noted after oral treatment with As(+3) for most tissues (hair, kidney, liver, lung, skin, muscle), with the largest increases in liver and lung (Yamauchi and Yamamura 1985). Liver and kidney arsenic concentrations increased with dose in dogs fed arsenite in the diet for 6 months (Neiger and Osweiler 1992). A study examining the speciation of arsenic following a single dose exposure to sodium arsenate to mice (Kenyon et al. 2005) found that the levels of inorganic arsenic and DMA were similar in the blood, liver, and kidney; much lower levels of MMA were found in these tissues. The concentration of DMA in the lungs exceeded inorganic arsenic and the levels of inorganic arsenic and MMA were similar; the DMA concentration was about 6 times higher than that of inorganic arsenic.

Inorganic arsenic crosses the placental barrier and selectively accumulates in the neuroepithelium of the developing animal embryo (Hanlon and Ferm 1977; Lindgren et al. 1984). Following maternal exposure to arsenite or arsenate throughout gestation and lactation, inorganic arsenic and DMA were detected in the

newborn mouse brains (Jin et al. 2006). The levels of inorganic arsenic in the brain were similar to those in the newborn livers; however, the levels of DMA in the brain were about twice as high as in the liver.

Organic Arsenicals. No studies were located on the distribution of organic arsenicals in humans following oral exposure. Studies in animals found MMA and DMA distributed to all tissues after acute oral doses (Hughes et al. 2005; Stevens et al. 1977; Vahter et al. 1984; Yamauchi and Yamamura 1984; Yamauchi et al. 1988). In mice, MMA is rapidly distributed throughout the body with peak tissue concentrations occurring between 0.25 and 4 hours after administration of a single gavage dose of 0.4 or 4 mg MMA/kg (Hughes et al. 2005). The peak levels of MMA in the bladder, kidneys, and lungs were higher than blood, with the highest levels occurring in the bladder. The terminal half-lives of MMA were 4.2–4.9 hours in the liver, lung, and blood, 9.0 hours in the urinary bladder, and 15.9 hours in the kidney in mice dosed with 0.4 mg MMA/kg; similar half-lives were measured in the 4.0 mg MMA/kg mice. Two hours after dosing, most of the methylated arsenic in the tissues was in the form of MMA. In rats exposed to 100 mg/kg DMA in the diet for 72 days, high levels of arsenic was detected in the blood (Lu et al. 2004a). The arsenic was primarily found in the erythrocyte; the concentration in the erythrocyte was 150 times higher than the arsenic concentration in the plasma.

3.4.2.3 Dermal Exposure

No studies were located regarding distribution of inorganic or organic arsenicals in humans or animals after dermal exposure.

3.4.2.4 Other Routes of Exposure

Inorganic Arsenicals. Studies in mice, rabbits, and monkeys injected intravenously with solutions of arsenite or arsenate confirm that arsenic is widely distributed throughout the body (Lindgren et al. 1982; Marafante and Vahter 1986; Vahter and Marafante 1983; Vahter et al. 1982). Shortly after exposure, the concentration of arsenic tends to be somewhat higher in liver, kidney, lung, and gastrointestinal epithelium (Hughes et al. 2000; Lindgren et al. 1982; Vahter and Marafante 1983; Vahter et al. 1982), but levels tend to equilibrate over time. Arsenate shows a tendency to deposit in skeletal tissue that is not shared by arsenite (Lindgren et al. 1982, 1984), presumably because arsenate is an analog of phosphate.

The distribution of arsenic in the rat is quite different from other animal species. Following intramuscular injection of carrier-free radio-arsenate in rats, most of the injected arsenic became bound to hemoglobin in red blood cells, and very little reached other tissues (Lanz et al. 1950). However, similar experiments

in dogs, mice, guinea pigs, rabbits, and chicks found very little uptake of arsenic into the blood in these species (cats gave intermediate results).

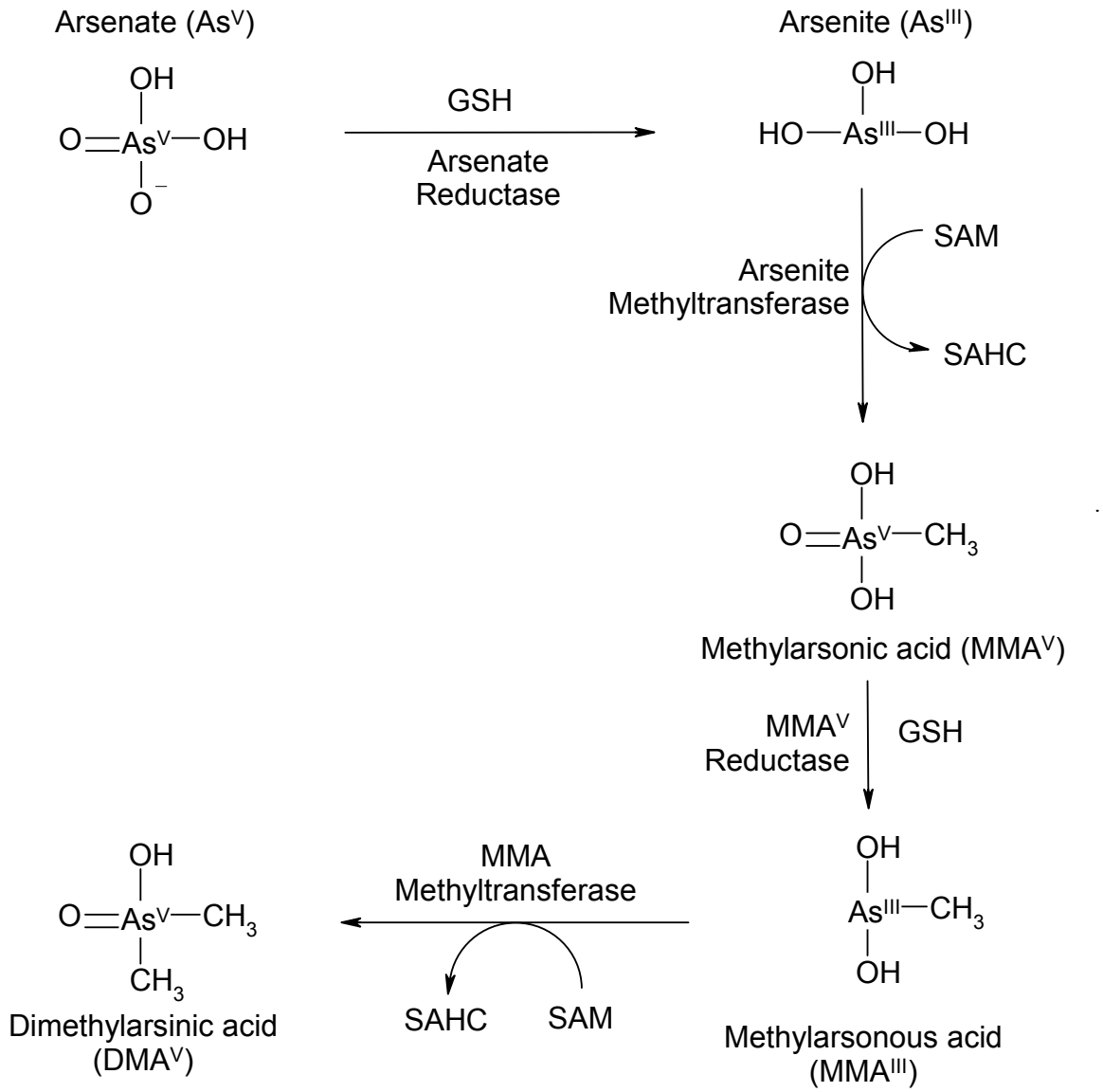
Organic Arsenicals. Following intravenous administration of DMA in mice, DMA is rapidly distributed throughout the body (Hughes et al. 2000). In the blood, the DMA was initially detected in the plasma, but fairly rapidly equilibrated between the plasma and erythrocytes. Blood, plasma, erythrocyte, liver, and kidney distribution and elimination of DMA did not differ in groups of mice administered 1.11 or 111 mg DMA/kg. However, a significant difference in DMA elimination from the lungs was observed; the elimination half-time increased from 91 minutes in the 1.11 mg DMA/kg group to 6,930 minutes in the 111 mg DMA/kg group.

3.4.3 Metabolism

Inorganic Arsenicals. The metabolism of inorganic arsenic has been extensively studied in humans and animals, and is diagrammed in Figure 3-7. Two basic processes are involved: (1) reduction/oxidation reactions that interconvert As(III) and As(V), and (2) methylation reactions, which convert arsenite to MMA and DMA. The resulting series of reactions results in the reduction of inorganic arsenate to arsenite (if necessary), methylation to MMA(V), reduction to MMA(III), and methylation to DMA(V). These processes appear to be similar whether exposure is by the inhalation, oral, or parenteral route. The human body has the ability to change inorganic arsenic to organic forms (i.e., by methylation) that are more readily excreted in urine. In addition, inorganic arsenic is also directly excreted in the urine. It is estimated that by means of these two processes, >75% of the absorbed arsenic dose is excreted in the urine (Marcus and Rispin 1988), although this may vary with the dose and exposure duration. This mechanism is thought to have an upper-dose limit which, when overwhelmed, results in a higher incidence of arsenic toxicity. This is supported by a case report of an individual who died 3 days after ingesting 8 g of arsenic trioxide (about 3 g of arsenic) (Benramdane et al. 1999a). Only 20% of the total arsenic in all tissues analyzed was methylated (14% MMA, 6% DMA), while 78% remained as arsenite and 2% as arsenate.

The majority of the evidence characterizing the metabolic pathways of arsenic is derived from analysis of urinary excretion products. Exposure of humans to either arsenates or arsenites results in increased levels of inorganic As(+3), inorganic As(+5), MMA, and DMA in urine (Aposhian et al. 2000a, 2000b; Buchet et al. 1981a, 1981b; Concha et al. 1998a, 1998b; Crecelius 1977; Kurttio et al. 1998; Lovell and Farmer

Figure 3-7. Inorganic Arsenic Biotransformation Pathway



SAHC = S-adenosylhomocysteine; SAM = S-adenosylmethionine

Source: adapted from Aposhian et al. 2000b

1985; Smith et al. 1977; Tam et al. 1979b; Vahter 1986). Similar results are obtained from studies in mice (Vahter 1981; Vahter and Envall 1983), hamsters (Hirata et al. 1988; Marafante and Vahter 1987; Takahashi et al. 1988), and rabbits (Maiorino and Aposhian 1985; Marafante et al. 1985; Vahter and Marafante 1983). Historically, little distinction was made between MMA(V) and MMA(III) in the urine in most studies, and the assumption was that the majority of MMA in the urine was MMA(V); however, Aposhian et al. (2000a, 2000b) demonstrated that the methylated arsenic atom may be in either valance state.

The relative proportions of As(+3), As(+5), MMA, and DMA in urine can vary depending upon the chemical administered, time after exposure, route of exposure, dose level, and exposed species. In general, however, DMA is the principal metabolite following long-term exposure, with lower levels of inorganic arsenic [As(+3) and As(+5)] and MMA. In humans, the relative proportions are usually about 40–75% DMA, 20–25% inorganic arsenic, and 15–25% MMA (Buchet et al. 1981a; Hopenhayn et al. 2003b; Loffredo et al. 2003; Mandal et al. 2001; Smith et al. 1977; Tam et al. 1979b; Tokunaga et al. 2002; Vahter 1986). With relatively constant exposure levels, these metabolic proportions remain similar over time (Concha et al. 2002), and appear to be similar among family members (Chung et al. 2002). One study of groups of women and children in two villages in Argentina showed that children ingesting large amounts of arsenic in their drinking water (200 µg/L) excreted about 49% inorganic arsenic and 47% DMA (Concha et al. 1998b). This compared to 32% inorganic arsenic and 66% DMA for the women in the study. This may indicate that metabolism of arsenic in children is less efficient than in adults. The rabbit has a ratio of metabolites similar to human adults (Maiorino and Aposhian 1985), suggesting that this may be a good animal model for toxicokinetics in humans. Mice may also be a good human toxicokinetic model based on the similarity of arsenic metabolism and deposition (Vahter et al. 2002). In contrast, the guinea pig, marmoset, and tamarin monkey do not methylate inorganic arsenic (Healy et al. 1998; Vahter and Marafante 1985; Vahter et al. 1982; Zakharyan et al. 1996); thus, they may be poor models for humans.

Reduction of arsenate to arsenite can be mediated by glutathione (Menzel et al. 1994). Scott et al. (1993) showed that glutathione forms complexes with both arsenate and arsenite *in vitro*, and that glutathione is oxidized (and arsenate reduced) in the glutathione-arsenate reaction. Studies *in vitro* indicate that the substrate for methylation is As(+3), and that As(+5) is not methylated unless it is first reduced to As(+3) (Buchet and Lauwerys 1985, 1988; Lerman et al. 1983). The main site of methylation appears to be the liver, where the methylation process is mediated by enzymes that utilize S-adenosylmethionine as cosubstrate (Buchet and Lauwerys 1985, 1988). Under normal conditions, the availability of methyl

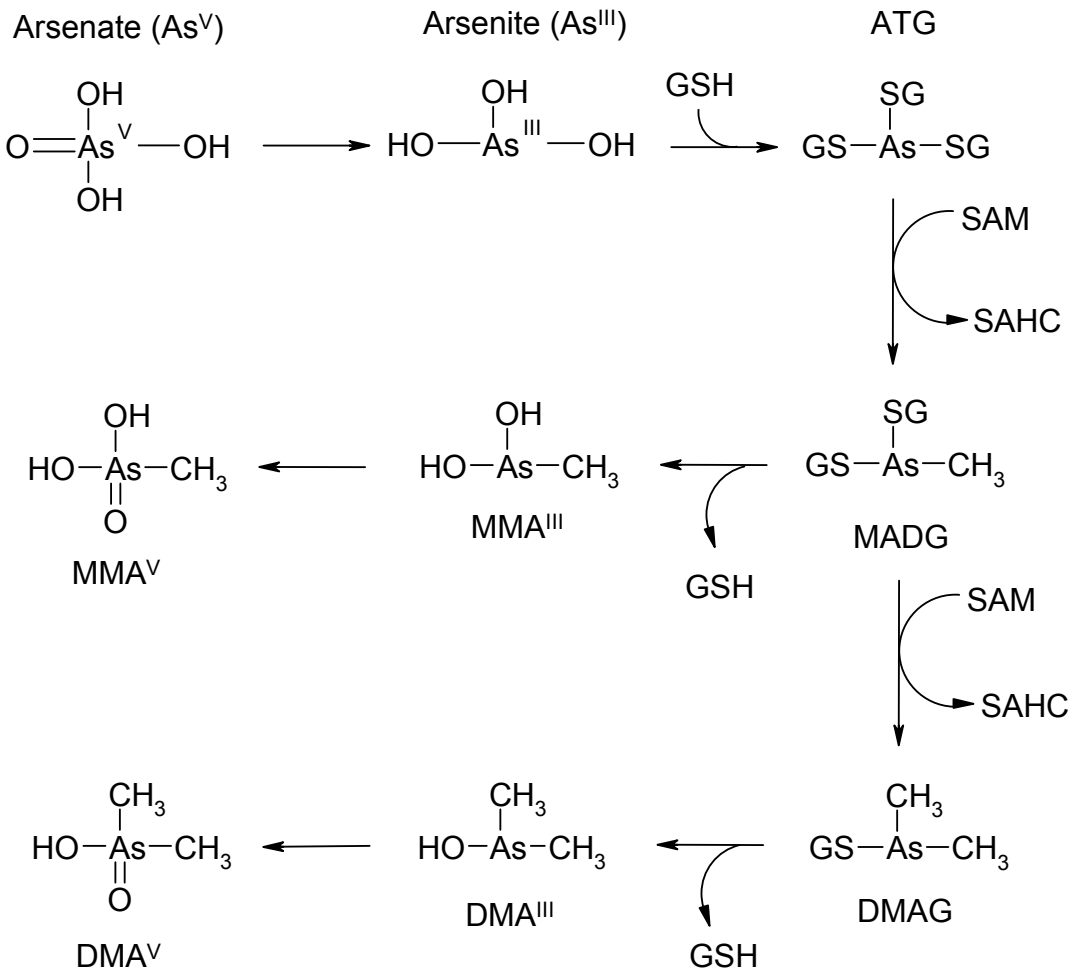
donors (e.g., methionine, choline, cysteine) does not appear to be rate limiting in methylating capacity, either in humans (Buchet et al. 1982) or in animals (Buchet and Lauwerys 1987; Buchet et al. 1981a). However, severe dietary restriction of methyl donor intake can result in significant decreases in methylating capacity (Buchet and Lauwerys 1987; Vahter and Marafante 1987).

Arsenic methyltransferase and MMA methyltransferase activities have been purified to homogeneity from cytosol of rabbit liver (Zakharyan et al. 1995), Rhesus monkey liver (Zakharyan et al. 1996), and rat liver (Thomas et al. 2004). It appears that a single protein catalyzes both activities. This activity transfers a methyl group from S-adenosylmethionine to As(+3) yielding MMA, which is then further methylated to DMA. Reduced glutathione is probably a co-factor *in vivo*, but other thiols can substitute *in vitro* (L-cysteine, dithiothreitol). The substrate saturation concentration for rabbit arsenite methyltransferase is 50 μM, for MMA methyltransferase it is 1,000 μM. The purified activity is specific for arsenite and MMA; selenite, selenate, selenide, and catechols do not serve as substrates. Thomas et al. (2004) reported cloning the gene for an S-adenosylmethionine-dependent methyltransferase from rat liver cytosol that catalyzes the conversion of arsenic to methylated and dimethylated species. It bears a high similarity to translations of *cyt19* genes in both the mouse and the human; both this gene and protein are now termed arsenic (+3 oxidation state) methyltransferase (AS3MT).

Studies in mice indicate that exposure to arsenic does not induce arsenic methylation activity (Healy et al. 1998). Mice receiving up to 0.87 mg As/kg/day as sodium arsenate in drinking water for 91 days had the same arsenic methylating activity as unexposed controls. Specific activities were highest in testis (1.45 U/mg) followed by kidney (0.70 U/mg), liver (0.40 U/mg), and lung (0.20 U/mg). None were affected by arsenic exposure.

An alternative biotransformation pathway (Figure 3-8) has recently been proposed for arsenic (Hayakawa et al. 2005) based on the nonenzymatic formation of glutathione complexes with arsenite resulting in the formation of arsenic triglutathione. The arsenic triglutathione is subsequently methylated by AS3MT to form monomethyl arsenic glutathione. At low glutathione levels (1 mM), the monomethyl arsenic glutathione is hydrolyzed to form MMA(III). At high glutathione levels (5 mM), the monomethyl arsenic glutathione is methylated to dimethylarsinic glutathione by AS3MT. Dimethylarsinic glutathione is quickly hydrolyzed to form DMA(III) (Hayakawa et al. 2005; Thomas et al. 2007). In the classical inorganic arsenic biotransformation pathway (Figure 3-7), MMA(V) is converted to the more toxic MMA(III); in contrast, in the alternative pathway, MMA(III) is converted to the less toxic MMA(V).

Figure 3-8. Alternative Inorganic Arsenic Biotransformation Pathway



ATG = arsenic triglutathione; DMAG = dimethylarsinic glutathione; GSH = glutathione; MADG = monomethyl arsenic glutathione; SAHC = S-adenosylhomocysteine; SAM = S-adenosylmethionine

Source: Hayakawa et al. 2005; Thomas et al. 2007

Since methylation tends to result in lower tissue retention of inorganic arsenic (Marafante and Vahter 1984, 1986; Marafante et al. 1985; Vahter and Marafante 1987), the methylation process is usually viewed as a detoxification mechanism. However, several studies showing an elevated toxicity of MMA(III) relative even to As(III) in cultured human liver cells (Petrick et al. 2000, 2001) have called this assumption into question. Because methylation is an enzymic process, an important issue is the dose of arsenic that saturates the methylation capacity of an organism, resulting in a possible increased level of the more toxic As(III) in tissues, or whether or not such a dose exists. Limited data from studies in humans suggest that methylation may begin to become limiting at doses of about 0.2–1 mg/day (0.003–0.015 mg/kg/day) (Buchet et al. 1981b; Marcus and Rispin 1988). However, these observations are relatively uncertain since they are based on data from only a few subjects, and the pattern of urinary excretion products in humans who ingested high (near lethal) oral doses or were exposed to elevated levels in the workplace is not much different from that in the general population (Lovell and Farmer 1985; Vahter 1986). Furthermore, the nutrient intakes reported by Engel and Receveur (1993) were sufficient to accommodate the body stores of methyl groups needed for arsenic biomethylation. At the highest arsenic level reported in the endemic area, the biomethylation process required only a few percent of the total daily methyl intake (Mushak and Crocetti 1995). Thus, the dose rate at which methylation capacity becomes saturated cannot be precisely defined with current data.

Organic Arsenicals. With the exception of arsenosugars, which may undergo extensive metabolism, organic arsenicals appear to undergo little metabolism. Humans who ingested a dose of MMA converted a small amount (about 13%) to DMA (Buchet et al. 1981a). Similarly, in mice and hamsters, DMA and MMA are primarily excreted unchanged in the urine (Hughes et al. 2005; Marafante et al. 1987b; Vahter et al. 1984). In mice, a small percentage of MMA is methylated to DMA and some is further methylated to trimethylarsine oxide (TMAO) (Hughes et al. 2005). In contrast, administration of MMA(III) to mice resulted in the excretion of mostly DMA(V) and smaller amounts of MMA(V), MMA(III), and DMA(III) (Hughes et al. 2005). As with MMA, only a small percentage (<10%) of the DMA is methylated to TMAO (Hughes et al. 2005; Marafante et al. 1987b; Yamauchi and Yamamura 1984; Yamauchi et al. 1988).

MMA and DMA are more extensively methylated in rats compared to other animal species. After 1 week of exposure to 100 mg As/kg/day as MMA in drinking water, rats excreted 50.6% of the total arsenic in urine as MMA, 19.0% as DMA, 6.9% as TMAO, and 0.4% as tetramethylarsonium (Yoshida et al. 1998). In contrast, mice exposed to a single dose of 40 mg As/kg as MMA excreted 89.6% of the dose as MMA, 6.2% as DMA, and 1.9% as TMAO (Hughes et al. 2005). Similarly, 24 hours after administration of a

single oral dose of 50 mg As/kg as MMA in hamsters, 26.9% was excreted in urine as MMA, 1.43% as DMA, and 0.07% as trimethylarsenic compound (Yamauchi et al. 1988). As with MMA, oral exposure of mice and hamsters to DMA results in most of the dose being excreted in the urine in the form of DMA (or DMA complex) (Marafante et al. 1987b); in rats, the levels of DMA and TMAO are about equal (Yoshida et al. 1998).

The available data suggest that the methylarsenates are not demethylated to inorganic arsenic either in humans (Buchet et al. 1981a; Marafante et al. 1987b) or in animals (rats and hamsters) (Stevens et al. 1977; Yamauchi and Yamamura 1984; Yoshida et al. 2001).

3.4.4 Elimination and Excretion

3.4.4.1 Inhalation Exposure

Inorganic Arsenicals. As noted previously (see Section 3.4.1.1), urinary excretion of arsenic appears to account for 30–60% of the inhaled dose (Holland et al. 1959; Pinto et al. 1976; Vahter et al. 1986). Since the deposition fraction usually ranges from about 30 to 60% for most respirable particles (EPA 1989b), this suggests that nearly all arsenic that is deposited in the lung is excreted in the urine. The time course of excretion in humans exposed by inhalation has not been thoroughly investigated, but urinary arsenic levels in workers in a smelter rose within hours after they came to work on Monday and then fell over the weekend (Vahter et al. 1986). This implies that excretion is fairly rapid, and this is supported by intratracheal studies in rats (Rhoads and Sanders 1985) and hamsters (Marafante and Vahter 1987), where whole-body clearance of administered arsenate or arsenite occurred with a half-time of 1 day or less. However, the study in rats (Rhoads and Sanders 1985) found that the clearance of arsenic trioxide was biphasic, with 95% cleared with a half-time of 29 minutes and the remaining arsenic cleared with a half-time of 75 days. For sodium arsenate and sodium arsenite, <0.1% of the dose was retained in the lung 3 days after exposure of hamsters; 1.3% of the arsenic trisulfide dose was retained after 3 days (Marafante and Vahter 1987). The Marafante and Vahter (1987) study suggested that lung clearance was influenced by compound solubility. The primary forms of arsenic found in the urine of inhalation-exposed humans are DMA and MMA, with inorganic arsenic comprising <25% of the total urinary arsenic (Apostoli et al. 1999).

Organic Arsenicals. No studies were located regarding the excretion of organic arsenicals by humans or animals after inhalation exposure. However, rats that were given a single intratracheal dose of DMA

excreted about 60% in the urine and about 8% in the feces within 24 hours (Stevens et al. 1977). This indicates that organic arsenicals are likely to be promptly excreted after inhalation exposure.

3.4.4.2 Oral Exposure

Inorganic Arsenicals. Direct measurements of arsenic excretion in humans who ingested known amounts of arsenite or arsenate indicate that very little is excreted in the feces (Bettley and O'Shea 1975), and that 45–85% is excreted in urine within 1–3 days (Apostoli et al. 1999; Buchet et al. 1981a; Crecelius 1977; Mappes 1977; Tam et al. 1979b). At low exposure levels, urinary arsenic levels generally increase linearly with increasing arsenic intake (Calderon et al. 1999). During lactation, a very small percent of ingested arsenic may also be excreted in the breast milk (Concha et al. 1998a). A similar pattern of urinary and fecal excretion is observed in hamsters (Marafante and Vahter 1987; Yamauchi and Yamamura 1985) and mice (Vahter and Norin 1980); this pattern is typically modeled as a biphasic process (e.g., Hughes et al. 2003). Generally, whole body clearance is fairly rapid, with half-times of 40–60 hours in humans (Buchet et al. 1981b; Mappes 1977). Clearance is even more rapid in mice and hamsters, with 90% removed in 2 days (Hughes et al. 2003; Marafante and Vahter 1987; Vahter 1981; Vahter and Norin 1980).

A study in pregnant women exposed to elevated levels of inorganic arsenic in drinking water found that most of the ingested arsenic was excreted in the urine as DMA (79–85%), with smaller amounts excreted as inorganic arsenic (8–16%) or MMA (5–6%) (Christian et al. 2006). Similarly, in mice, arsenate is primarily excreted in the urine as DMA, with lesser amounts of inorganic arsenic and MMA (Kenyon et al. 2005). Following a single oral dose of 10 µmol/kg sodium arsenate, 78.4% was excreted as DMA, 20.2% as inorganic arsenic, and 1.45% as MMA; at a 10-fold higher dose, the ratio of DMA to inorganic arsenic decreased (57.7% DMA, 39.8% inorganic arsenic, and 2.59% MMA).

Arsenic is also excreted in the bile via the formation of two arsenic-glutathione complexes (arsenic triglutathione and methylarsenic diglutathione) (Kala et al. 2000). In rats administered 5.0 mg/kg sodium arsenite, equal amounts of arsenic triglutathione and methylarsenic diglutathione were found in the bile 18–20 minutes after exposure. At a lower arsenic dose (0.5 mg/kg), only methylarsenic diglutathione was found. As discussed in Section 3.4.4.4, biliary excretion of arsenic has also been detected in mice, hamsters, guinea pigs, and rabbits following parenteral exposure (Csanaky and Gregus 2002).

Organic Arsenicals. Studies in humans indicate that ingested MMA and DMA are excreted mainly in the urine (75–85%), and this occurs mostly within 1 day (Buchet et al. 1981a; Marafante et al. 1987b). This is supported by studies in rats, mice, and hamsters, although in animals, excretion is more evenly distributed between urine and feces (Hughes et al. 2005; Marafante et al. 1987b; Stevens et al. 1977; Yamauchi and Yamamura 1984; Yamauchi et al. 1988). In mice administered 40 mg As/kg as DMA, 56.4% was excreted in the urine as DMA, 7.7% as a DMA complex, and 3.5% as TMAO during a 48-hour period after dosing; in the feces, 24.3% was DMA and 4.9% as DMA complex (Marafante et al. 1987b). In hamsters, 38.7% was DMA, 11.2% as DMA complex, and 6.4% as TMAO in the urine; in the feces, 37.3% as DMA and 4.9% as DMA complex. As with DMA, most MMA is excreted in the urine and feces as parent compound. In the urine of mice administered 0.4 mg As/kg as MMA, 98.2% of the urinary arsenicals was in the form of MMA(V) and 1.8% as MMA(III) (Hughes et al. 2005); at a 10-fold higher dose, 89.6% was excreted as MMA(V), 1.2% as MMA(III), 6.2% as DMA(V), 1.1% as DMA(III), and 1.9% as TMAO. As discussed previously, exposure of rats to MMA or DMA results in the excretion of a higher percentage of metabolites. After 1 week exposure to MMA, 50.6% of the dose was excreted as MMA, 19.0% as DMA, and 6.9% of TMAO (Yoshida et al. 1998). A 1-week exposure to DMA, 44.9% was excreted as DMA in the urine and 40.0% as TMAO (Yoshida et al. 1998). A longer-term exposure to DMA (>7 months) resulted in a higher percentage of the amount of parent compound excreted; 56–65% as DMA and 23–35% as TMAO (Li et al. 1998; Wanibuchi et al. 1996; Yoshida et al. 1998).

In mice and hamsters, DMA and MMA are rapidly cleared from the body (Hughes et al. 2005; Marafante et al. 1987b; Vahter et al. 1984). In mice, 85% of the initial oral dose of DMA was eliminated from the body with a half-life of 2.5 hours (Vahter et al. 1984). In contrast to the mouse data, 45% on the initial DMA dose to rats was eliminated with a half-time of 13 hours and the remaining 55% had an elimination half-time of 50 days (Vahter et al. 1984).

3.4.4.3 Dermal Exposure

Inorganic Arsenicals. No studies were located regarding excretion of inorganic arsenicals in humans or animals following dermal exposure. In rats, arsenic absorbed through the tail was excreted approximately equally in urine and feces, similar to the excretion pattern following oral exposure (Dutkiewicz 1977).

Organic Arsenicals. No studies were located regarding excretion of organic arsenicals in humans or animals following dermal exposure.

3.4.4.4 Other Routes of Exposure

Inorganic Arsenicals. Excretion of arsenate and arsenite following parenteral exposure of animals is similar to that seen following oral exposure. In rabbits and mice, urinary excretion within 8 hours usually accounts for about 50–80% of the dose (Maehashi and Murata 1986; Maiorino and Aposhian 1985; Vahter and Marafante 1983). Somewhat lower levels (30–40%) are excreted in the urine of marmoset monkeys (Vahter and Marafante 1985; Vahter et al. 1982), probably because of the absence of methylation in this species. Whole-body clearance studies in mice indicate that arsenate is over 65% removed within 24 hours, while arsenite is about 86% removed at 24 hours (Lindgren et al. 1982). A relatively small proportion of an injected dose of arsenic V (10% for rats, 4% for mice, and <2% for hamsters, guinea pigs, and rabbits) was found to be excreted into the bile within the first 2 hours postinjection (Csanaky and Gregus 2002). Following arsenic III injection, a much greater percentage (92% for guinea pigs and 75% for rats) of the arsenic was found in the bile in the first 2 hours after administration (Csanaky and Gregus 2002). Similarly, approximately 40% of an intravenous dose of sodium arsenite was excreted into the bile of rats, most of it occurring during the first hour after exposure (Kala et al. 2000). Kala et al. (2000) determined that the biliary transport of arsenic was dependent on the formation of arsenic-glutathione complexes, which were transported out of hepatocytes by multidrug resistance associated protein 2 (MRP2/cMOAT); most of the arsenic in bile was in the form of arsenic triglutathione or methylarsenic diglutathione.

3.4.5 Physiologically Based Pharmacokinetic (PBPK)/Pharmacodynamic (PD) Models

Physiologically based pharmacokinetic (PBPK) models use mathematical descriptions of the uptake and disposition of chemical substances to quantitatively describe the relationships among critical biological processes (Krishnan et al. 1994). PBPK models are also called biologically based tissue dosimetry models. PBPK models are increasingly used in risk assessments, primarily to predict the concentration of potentially toxic moieties of a chemical that will be delivered to any given target tissue following various combinations of route, dose level, and test species (Clewell and Andersen 1985). Physiologically based pharmacodynamic (PBPD) models use mathematical descriptions of the dose-response function to quantitatively describe the relationship between target tissue dose and toxic end points.

PBPK/PD models refine our understanding of complex quantitative dose behaviors by helping to delineate and characterize the relationships between: (1) the external/exposure concentration and target tissue dose of the toxic moiety, and (2) the target tissue dose and observed responses (Andersen and

Krishnan 1994; Andersen et al. 1987). These models are biologically and mechanistically based and can be used to extrapolate the pharmacokinetic behavior of chemical substances from high to low dose, from route to route, between species, and between subpopulations within a species. The biological basis of PBPK models results in more meaningful extrapolations than those generated with the more conventional use of uncertainty factors.

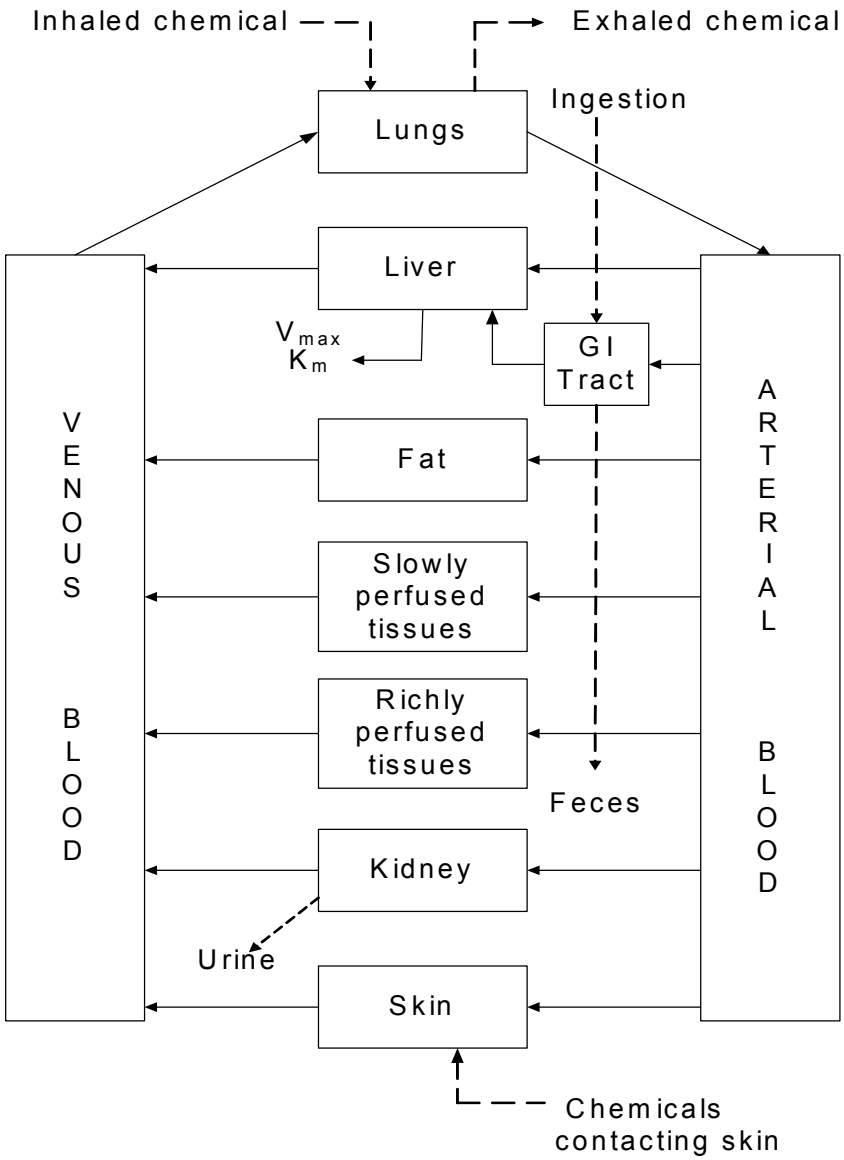
The PBPK model for a chemical substance is developed in four interconnected steps: (1) model representation, (2) model parameterization, (3) model simulation, and (4) model validation (Krishnan and Andersen 1994). In the early 1990s, validated PBPK models were developed for a number of toxicologically important chemical substances, both volatile and nonvolatile (Krishnan and Andersen 1994; Leung 1993). PBPK models for a particular substance require estimates of the chemical substance-specific physicochemical parameters, and species-specific physiological and biological parameters. The numerical estimates of these model parameters are incorporated within a set of differential and algebraic equations that describe the pharmacokinetic processes. Solving these differential and algebraic equations provides the predictions of tissue dose. Computers then provide process simulations based on these solutions.

The structure and mathematical expressions used in PBPK models significantly simplify the true complexities of biological systems. If the uptake and disposition of the chemical substance(s) are adequately described, however, this simplification is desirable because data are often unavailable for many biological processes. A simplified scheme reduces the magnitude of cumulative uncertainty. The adequacy of the model is, therefore, of great importance, and model validation is essential to the use of PBPK models in risk assessment.

PBPK models improve the pharmacokinetic extrapolations used in risk assessments that identify the maximal (i.e., the safe) levels for human exposure to chemical substances (Andersen and Krishnan 1994). PBPK models provide a scientifically sound means to predict the target tissue dose of chemicals in humans who are exposed to environmental levels (for example, levels that might occur at hazardous waste sites) based on the results of studies where doses were higher or were administered in different species. Figure 3-9 shows a conceptualized representation of a PBPK model.

If PBPK models for arsenic exist, the overall results and individual models are discussed in this section in terms of their use in risk assessment, tissue dosimetry, and dose, route, and species extrapolations.

Figure 3-9. Conceptual Representation of a Physiologically Based Pharmacokinetic (PBPK) Model for a Hypothetical Chemical Substance



Note: This is a conceptual representation of a physiologically based pharmacokinetic (PBPK) model for a hypothetical chemical substance. The chemical substance is shown to be absorbed via the skin, by inhalation, or by ingestion, metabolized in the liver, and excreted in the urine or by exhalation.

Source: adapted from Krishnan and Andersen 1994

Several PBPK models have been developed for inorganic arsenic; the Mann, Yu, and Menzel models are discussed below. A joint research effort between the Chemical Industry Institute of Toxicology (CIIT) Centers for Health Research, EPA, ENVIRON International, and the Electric Power Research Institute (EPRI) is underway to develop a biologically based dose response model of carcinogenicity. Part of this effort involves refining the existing PBPK models (Clewell et al. 2007).

3.4.5.1 Summary of PBPK Models

The Mann model (Gentry et al. 2004; Mann et al. 1996a, 1996b), Yu model (Yu 1998a, 1998b; Yu 1999a, 1999b), and Menzel model (Menzel et al. 1994) are the PBPK models for arsenic currently available. The Mann model simulates the absorption, distribution, metabolism, elimination, and excretion of As(+3), As(+5), MMA, and DMA after oral and inhalation exposure in mice, hamsters, rabbits, and humans. The Yu model simulates the absorption, distribution, metabolism, elimination, and excretion of As(+3), As(+5), MMA, and DMA after oral exposure to inorganic arsenic in mice, rats, or humans. The Menzel model is a preliminary model that predicts internal organ burden of arsenic during specific oral exposures, simulating the metabolism, distribution to organs and binding to organs in mice, rats, and humans.

3.4.5.2 Arsenic PBPK Model Comparison

The Mann model is a well-derived model, consisting of multiple compartments and metabolic processes, and modeling four chemical forms of arsenic (two organic and two inorganic), which has been validated using experimental data. The Yu model has more compartments than the Mann model, also models metabolism and fate of four forms of arsenic, and has likewise been validated using experimental data. The Menzel model is still preliminary and has not been validated.

3.4.5.3 Discussion of Models

The Mann Model

Risk assessment. The Mann model was not used for risk assessment.

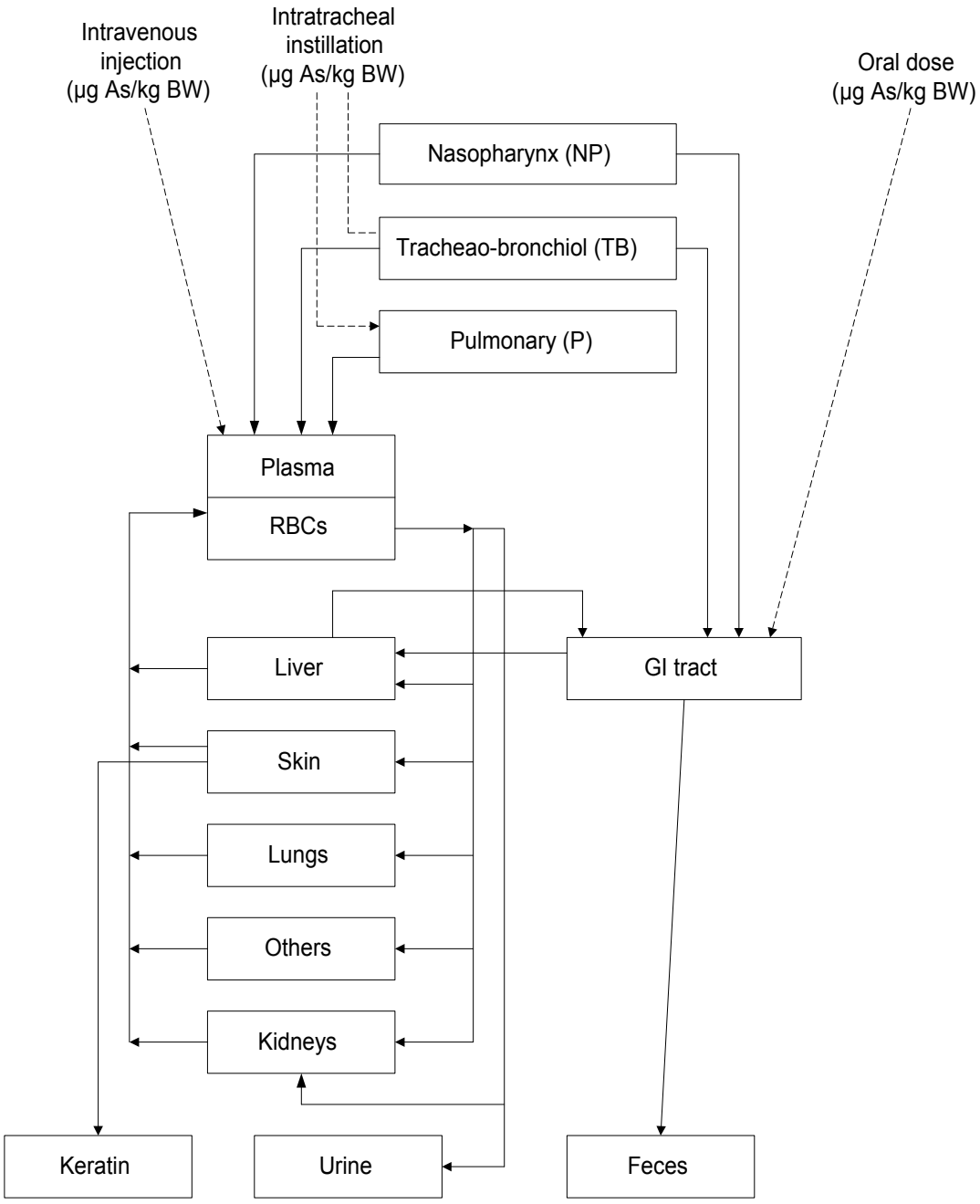
Description of the model. The Mann model was initially developed to simulate oral, intratracheal, and intravenous exposure to arsenic in rabbits and hamsters (Mann et al. 1996a). In a companion paper, the model was expanded to include inhalation exposure and extrapolated and applied to humans (Mann et al. 1996b). A subsequent paper further expanded the model to include mice (Gentry et al. 2004).

The model consists of six tissue compartments: blood, liver, kidneys, lungs, skin, and other tissues. The blood compartment is divided into plasma and red blood cell subcompartments, considered to be at equilibrium. Three routes of exposure are considered in the model. Oral exposure is considered to enter the liver from the gastrointestinal tract via first-order kinetics. Intratracheal exposure results in deposition into the pulmonary and tracheo-bronchial regions of the respiratory tract. Uptake into blood from the pulmonary region is considered to be via first order kinetics into plasma, uptake from the tracheo-bronchial region is by both transfer into plasma and transport into the gastrointestinal tract. Intravenous injection results in a single bolus dose into the plasma compartment.

Metabolism in the model consists of oxidation/reduction and two methylation reactions. The oxidation/reduction of inorganic arsenic was modeled as a first order process in the plasma, with reduction also included in the kidneys. Methylation of As(+3) was modeled as a two-step process occurring in the liver according to Michaelis-Menton kinetics.

Most physiological parameters were derived by scaling to body weight. In cases where parameters were not available (absorption rates, tissue affinity, biotransformation), estimates were obtained by fitting. This was done by duplicating the initial conditions of published experiments in the model, varying the unknown parameters and comparing the results of the simulation to the reported results. Tissue affinity constants were estimated using reported arsenic levels in tissues at various times after exposure. Metabolic rate constants and absorption rate constants were estimated using data for excretion of arsenic metabolites in urine and feces. Figure 3-10 shows the animal model and Tables 3-11, 3-12, 3-13, and 3-14 provide the parameters used in the animal model. The human model is similar to the animal models with adjustments for body weight and absorption and metabolic rates. A naso-pharynx compartment is included in the human model, which was not present in the animal models. Penetration and deposition in the respiratory tract are based on the log-normal particle size distribution of the aerosol. Metabolic and absorption rate constants were fitted using experimental data on urinary excretion of arsenic following a single oral dose of As(+3) (Buchet et al. 1981a) or As(+5) (Tam et al. 1979b) in volunteers. The lung absorption rate constant was obtained by fitting the total urinary excretion of arsenic as predicted with the model to experimental data obtained from occupational exposure to arsenic trioxide (Offergelt et al. 1992). Figure 3-11 shows the human model, and Tables 3-15 and 3-16 provide the data and constants used in the human model.

Figure 3-10. Parameters Used in the Mann PBPK Model for Animals



Source: Mann et al. 1996b

Table 3-11. Parameters Used in the Mann PBPK Model for Animals

Physiological parameter	Rabbit (body weight=3.5 kg)	Hamster (body weight=0.100 kg)
Blood volume (mL)	253	7.0
Organ weight (g)		
Liver	121	4.8
Kidneys	25	1.2
Lungs	31	1.0
Skin	420	17.1
Organ volume (mL)		
Others	2,386	62.0
Lumen volume (mL)		
Stomach	15	0.5
Small intestine	20	0.6
Blood flow (mL/minute)		
Cardiac output	556	38.3
Liver, hepatic	25	1.2
Liver, splanchic	98	6.0
Kidneys	100	7.0
Lungs	13	0.7
Skin	38	2.6
Others	282	20.8
Clearance (mL/minute)		
Glomerular Filtration Rate	10	0.6
Small intestine length (cm)	180	56.0
Total capillary surface area (cm^2)	93,835	2,681.0

PBPK = physiologically based pharmacokinetic

Source: Mann et al. 1996a

Table 3-12. Tissue Affinity Constants (K_{ij}) Obtained for the Mann PBPK Model for Animals by Fitting for Rabbits and Hamsters

	K_{ij} (unitless)			
Tissue (*i*)	As(V)	As(III)	MMA	DMA
Liver	1	200	10	1
Kidneys	40	20	100	5
Lungs	1	1	1	20
Skin	1	60	50	1
Others	10	40	1	1

DMA = dimethylarsinic acid; MMA = monomethylarsonic acid; PBPK = physiologically based pharmacokinetic

Source: Mann et al. 1996a

Table 3-13. Metabolic Rate Constants for the Mann PBPK Model for Animals Obtained by Fitting for Rabbits and Hamsters

Oxidation/reduction	First order	Rabbit	Hamster
Reduction	(1/hour)	3,000.00	100.00
Oxidation	(1/hour)	6,000.00	400.00
Kidney reduction	(1/hour)	30.00	1.00
Methylation	Michaelis–Menten		
1st step	$K_{M_{MMA}}$ (µmol/mL)	0.05	0.12
	$V_{MAX_{MMA}}$ (µmol/mL-hour)	4.00	0.12
2nd step	$K_{M_{DMA}}$ (µmol/mL)	0.90	0.08
	$V_{MAX_{DMA}}$ (µmol/mL-hour)	1.50	0.12

DMA = dimethylarsinic acid; MMA = monomethylarsonic acid; PBPK = physiologically based pharmacokinetic

Source: Mann et al. 1996a

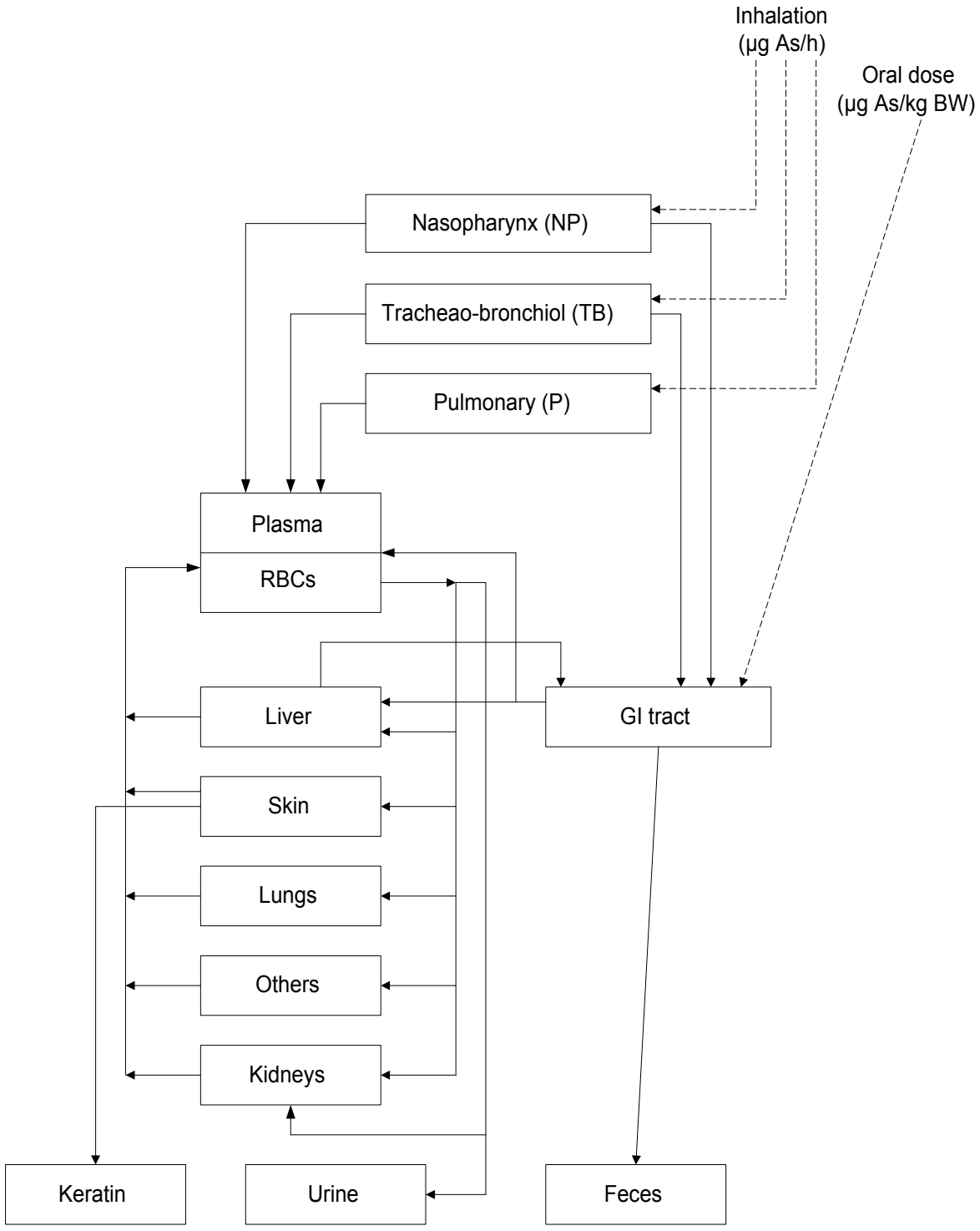
Table 3-14. Fitted Gastrointestinal Tract and Lung Absorption Half-time for the Hamster for the Mann PBPK Model

	Absorption, half-time (hour)	
Arsenic compound	Gastrointestinal tract	Lung
As(V)		
$Na_3(AsO_4)$	0.08	12
$Pb_3(AsO_4)$	0.39	690
As_2O_5	0.28	—
As(III)		
$NaAsO_2$	0.08	12
As_2S_3	0.48	12
As_2O_3	0.02	—
DMA	0.09	—

DMA = dimethylarsinic acid; PBPK = physiologically based pharmacokinetic

Source: Mann et al. 1996a

Figure 3-11. Parameters Used in the Mann PBPK Model for Humans



Source: Mann et al. 1996b

Table 3-15. Physiological Data Used in the Mann PBPK Model for Humans

Physiological parameter	Organ	Units	Human (body weight=70 kg)
Blood volume		mL	5,222
Organ weight	Liver	g	1,856
	Kidneys	g	314
	Lungs	g	584
	Skin	g	6,225
	Others	g	55,277
Lumen volume	Stomach	mL	274
	Small intestine	mL	393
Blood flow	Cardiac output	L/minute	5.29
	Liver, hepatic	L/minute	0.32
	Liver, splanchic	L/minute	1.02
	Kidneys	L/minute	0.95
	Lungs	L/minute	0.16
	Skin	L/minute	0.35
	Others	L/minute	2.49
Creatinine			
Male		g/day	1.7
Female		g/day	1.0
Clearance			
Glomerular filtration rate		mL/minute	156
Small intestine length		cm	481
Nasopharynx area		cm^2	177
Tracheobronchial area		cm^2	5,036
Pulmonary area		cm^2	712,471
Total capillary surface area		cm^2	$1,877x10^6$

DMA = dimethylarsinic acid; MMA = monomethylarsonic acid; PBPK = physiologically based pharmacokinetic

Source: Mann et al. 1996b

Table 3-16. Tissue Affinity Constants (K_{ij}) Obtained by Fitting the Mann PBPK Animal Model for Use with Humans

	K_{ij} (unitless)			
Tissue (i)	As(V)	As(III)	MMA	DMA
Liver	1	200	10	1
Kidneys	40	20	100	5
Lungs	1	1	1	20
Skin	1	60	50	1
Red blood cells	0.2	1.5	0.2	0.2
Others	10	40	1	1

DMA = dimethylarsinic acid; MMA = monomethylarsonic acid; PBPK = physiologically based pharmacokinetic

Source: Mann et al. 1996b

Validation of the model. The model was generally successful in describing the disposition of an intravenous dose of sodium arsenate in rabbits over a 24-hour period (Marafante et al. 1985). Discrepancies included a 6–7-fold overestimation of levels in skin at 24 hours and underestimation of As(+5) in plasma in the hour following injection. A statistical assessment of how well the model fit the empirical data was not presented. In hamsters, the model was also generally predictive of oral and intratracheal exposures (Marafante and Vahter 1987). Generally, predictions were better for the exposures to As(+5) than for those to As(+3).

The human model was validated using data from studies of repeated oral intake of sodium arsenite in volunteers (Buchet et al. 1981b), occupational exposure to arsenic trioxide and elemental arsenic (Vahter et al. 1986), and community exposure to As(+5) via drinking water (Harrington et al. 1978; Valentine et al. 1979). Simulations were generally in good agreement with the experimental data.

The predictions of tissue distribution, metabolism, and elimination of arsenic compounds from the mouse model were compared with experimental data, and showed generally good agreement. The model tended to overpredict the concentration of organic arsenicals in the lungs, and to a lesser extent in the kidneys and liver, while for inorganic arsenic, the model overpredicted the levels of arsenic (V) present in the urine of acutely-exposed mice.

Target tissues. Levels in skin were not well predicted by this model in animals. Results for the lung were not presented, except for the mouse model, which tended to overpredict lung levels. The human model was only used to predict urinary metabolites.

Species extrapolation. Species extrapolation was not attempted in this model. However, tissue affinities derived for the rabbit and hamster models were used in the human model.

Interroute extrapolation. Interroute extrapolation was not attempted in this model.

The Menzel Model

Risk assessment. The Menzel model was not used for risk assessment.

Description of the model. The Menzel model was developed to simulate oral exposure to arsenic from drinking water and food. Inhalation of arsenic in the particulate phase or as arsine gas is not considered. The chemical species in drinking water is assumed to be As(+5).

The model consists of two sets of compartments: those in which the pools of arsenic are not influenced by blood perfusion, and those in which blood perfusion does determine arsenic burden. The former set of compartments includes the gut, feces, hair, bladder, and urine. The latter set of compartments included lung, liver, fat, skin, kidney, and other tissues. Oral exposure is considered to enter the liver from the gastrointestinal tract.

The model followed that of Andersen and coworkers (Andersen et al. 1987; Ramsey and Andersen 1984). Data from mice were used to test predictions of absorption. Excretion is considered to be rapid and complete into the urine, with no reabsorption from the kidney. Fecal arsenic content accounts for unabsorbed arsenic excreted in the bile, and complex arsenic species from food. Metabolism includes reduction by glutathione and methylation. Arsenic accumulation in the skin, hair and nails was included by assuming that arsenic binds irreversibly to protein sulfide groups in hair and nails.

Validation of the model. The model was preliminary and has not been validated.

Target tissues. Target tissues have not yet been modeled.

Species extrapolation. Species extrapolation was not attempted in this model.

Interroute extrapolation. Interroute extrapolation was not attempted in this model.

The Yu Model

Risk assessment. The Yu model was not used for risk assessment.

Description of the model. The Yu model was developed to simulate oral exposure to arsenic in mice and rats (Yu 1998a, 1998b), and was later adapted for oral exposures in humans (Yu 1999a, 1999b). Inhalation of arsenic in the particulate phase or as arsine gas is not considered. As(+3), As(+5), MMA, and DMA were all considered in the model, though the movements of MMA and DMA were not considered.

The model consists of eight tissue compartments: intestine, skin, muscle, fat, kidney, liver, lung, and vessel-rich group (VRG, e.g., brain); in the human model, the VRG and kidney compartments were combined. Only oral exposure was considered. Absorption is based on absorption to the stomach, which then passes the arsenic to the gastrointestinal tract. From the gastrointestinal tract, arsenic is either transferred to the blood or excreted in the feces.

The physiological parameters for the model were obtained from published values in the literature. Tissue/blood partition coefficients were based on the postmortem blood and tissue concentrations from a fatal human poisoning case study (Saady et al. 1989). Tissue volumes and blood flow rates were based on published values from a number of sources (EPA 1988e; Reitz et al. 1990). Absorption and excretion rate constants were based on experimental observations of blood concentrations and urinary and fecal excretion following oral administration of inorganic arsenic (Odanaka et al. 1980; Pomroy et al. 1980). Metabolic rate constants for the methylation and dimethylation of inorganic arsenic were also based on experimental observations (Buchet et al. 1981a; Crecelius 1977). Figure 3-12 shows the model and Table 3-17 provides the parameters used for each species.

Validation of the model. The model was generally successful at predicting the urinary excretion 48 hours after administration of 5 mg/kg inorganic arsenic in both rats and mice. After 48 hours, the observed/predicted ratios associated with excreted doses ranged from 0.78 to 1.11 for the mouse and from 0.85 to 0.93 for the rat. However, the model overpredicted the amount of inorganic arsenic found in the feces of mice at 24 and 48 hours, and overpredicted the amount of DMA formed by exposed mice at 48 hours. In rats, the model overestimated the urinary and fecal excretion of inorganic arsenic at 24 hours postexposure, though at 48 hours, measured values all fell within the predicted ranges. The human model was also generally successful at predicting the urinary excretion of arsenic compounds following oral exposure, based on results of controlled human exposure studies (Buchet et al. 1981a; Vahter 1983). In general, however, the model underpredicts excretion at early time points and overpredicts at later time points, with 24 hours being the time at which its predictive capabilities agreed most strongly with available data.

The ability of the model to predict tissue burdens was not compared to actual data for any species.

Figure 3-12. Parameters Used in the Yu PBPK Model for Animals

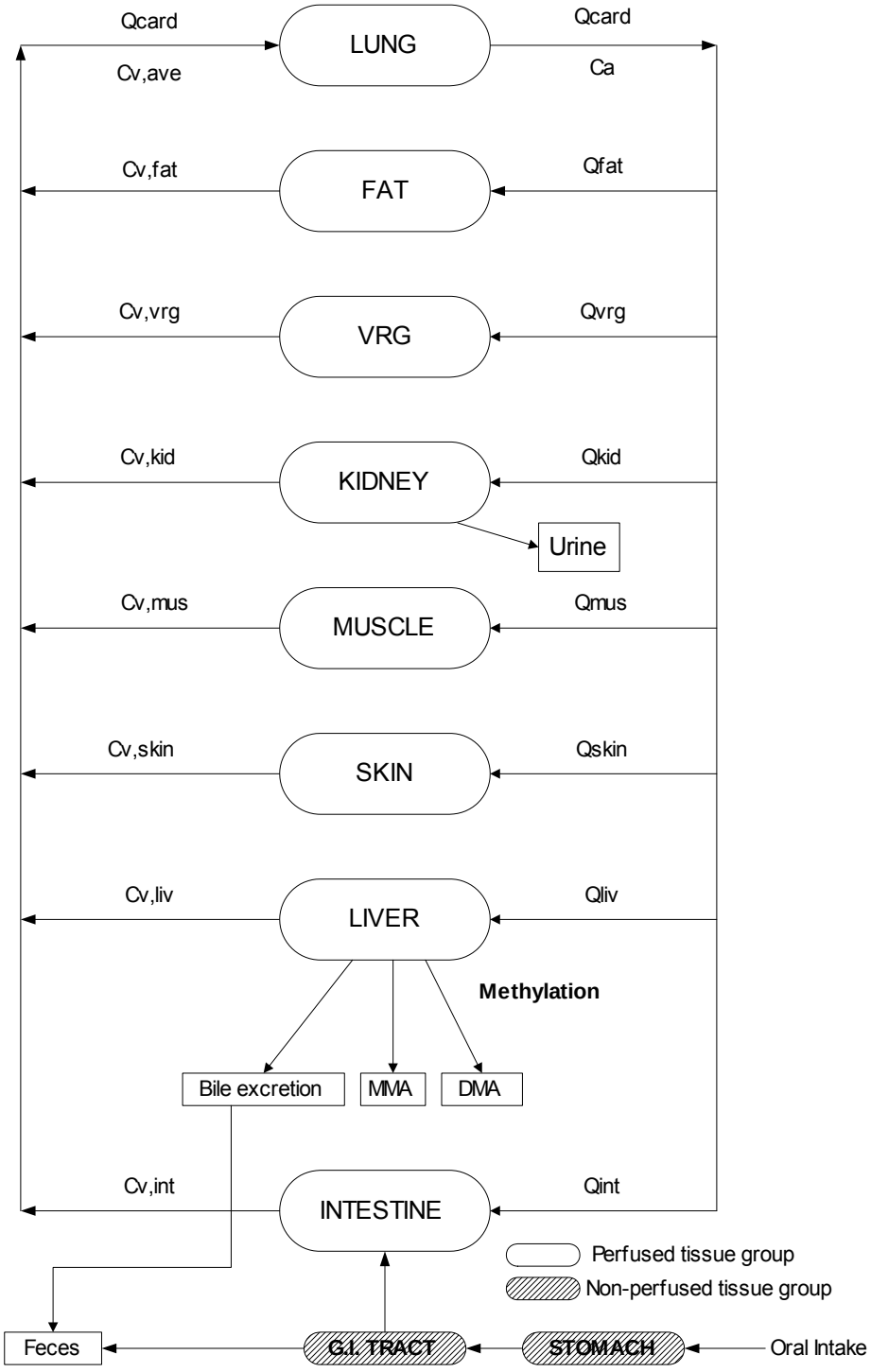


Table 3-17. Parameters Used in the Yu PBPK Model

	Mouse	Rat	Human
Partition coefficients			(As^{III}/As^{V}/MMA/DMA)
Intestine	6.0	6.0	2.8/2.8/1.2/1.4
Skin	5.0	5.0	2.5/2.5/1.25/1.25
VRG	6.0	6.0	Combined with kidney
Muscle	5.0	10.0	2.6/2.6/1.8/2.8
Fat	—	0.5	0.3/0.3/0.3/0.3
Kidney	8.5	7.5	4.15/4.15/1.8/2.075
Liver	10.0	10.0	5.5/5.3/2.35/2.65
Lung	4.0	4.0	4.15/4.15/1.8/2.075
Blood flow rate (mL/hour)			
Intestine	100	528	1,810
Skin	7.68	37.8	130
VRG	157	960	N/A
Muscle	153	1,260	25,850
Fat	—	253.2	6,467
Kidney	255	255	45,240
Liver	255	1,260	32,320
Lung	N/R	N/R	129,000
Tissue volume (mL)			
Intestine	1.94	6.9	558
Skin	1.83	15.4	606
VRG	0.81	23.0	N/A
Muscle	19.9	162	6,989
Fat	—	14.5	2,328
Kidney	0.484	1.63	248
Liver	1.67	5.82	422
Lung	0.124	1.0	400
Metabolism constants			
$Vmax_{(MMA)}$ (µmol/hour)	0.45	0.15	11.25
$Vmax_{(DMA)}$ (µmol/hour)	0.375	0.06	22.25
$Km_{(MMA)}$ (µmol/hour)	1.0	0.2	0.01
$Km_{(DMA)}$ (µmol/hour)	0.2	0.2	0.01

Table 3-17. Parameters Used in the Yu PBPK Model

	Mouse	Rat	Human
First-order rate constants			(As^{III}/As^{V}/MMA/DMA)
K_{SI} ($hour^{-1}$)	0.3	0.3	-/1.2/-/-
K_{AI} ($hour^{-1}$)	1.5	3.6	-/1.2/-/-
K_{fecal} ($hour^{-1}$)	0.33	0.048	-/0.0012/0.0/0.0
$K_{urinary}$ ($hour^{-1}$)	1.32	0.9	0.05/0.075/0.07/0.04
$K_{biliary}$ ($hour^{-1}$)	0.33	0.3	-/0.018/-/-

DMA = dimethylarsinic acid; MMA = monomethylarsonic acid; N/A = not applicable; N/R = not reported

Source: Yu 1998a, 1998b, 1999a, 1999b

Target tissues. Model predictions of tissue burdens were not compared to actual data. The model accurately predicted, with a few exceptions, the urinary and fecal excretion of inorganic arsenic and its metabolites in rats, mice, and humans.

Species extrapolation. Species extrapolation beyond rats and mice was not attempted using this model. The human model has not been compared to, or linked with, either of the rodent models.

Interroute extrapolation. Interroute extrapolation was not attempted using this model.

3.5 MECHANISMS OF ACTION

3.5.1 Pharmacokinetic Mechanisms

Arsenic absorption depends on its chemical form. In humans, As(+3), As(+5), MMA, and DMA are orally absorbed ≥75%. Arsenic is also easily absorbed via inhalation. Absorption appears to be by passive diffusion in humans and mice, although there is evidence (Gonzalez et al. 1995) for a saturable carrier-mediated cellular transport process for arsenate in rats (for review, see Rosen 2002). Dermal absorption appears to be much less than by the oral or inhalation routes. Bioavailability of arsenic from soil appears to be lower via the oral route than it is for sodium salts of arsenic. Arsenic in soil may form water insoluble compounds (e.g., sulfides), which are poorly absorbed.

Arsenic and its metabolites distribute to all organs in the body; preferential distribution has not been observed in human tissues at autopsy or in experiments with animal species other than rat (in which arsenic is concentrated in red blood cells). Since the liver is a major site for the methylation of inorganic arsenic, a "first-pass" effect is possible after gastrointestinal absorption; however, this has not been investigated in animal models.

Arsenic and its metabolites are largely excreted via the renal route. This excretion mechanism is not likely to be saturated within the dose range expected from human exposure. Excretion can also occur via feces after oral exposure; a minor excretion pathway is nails and hair. The methylation of inorganic arsenic is the major metabolism pathway. The proportion of metabolites recovered in urine (As(+3), As(+5), MMA, DMA) are roughly consistent in humans regardless of the exposure scenario. However, interindividual variation is great enough that it cannot be determined if capacity limitation may occur in some individuals.

The manifestation of arsenic toxicity depends on dose and duration of exposure. Single oral doses in the range of 2 mg As/kg and higher have caused death in humans. Doses as low as 0.05 mg As/kg/day over longer periods (weeks to months) have caused gastrointestinal, hematological, hepatic, dermal, and neurological effects. These effects appear to be a result of direct cytotoxicity. Long-term exposure (years) to drinking water at levels as low as 0.001 mg As/kg/day have been associated with skin diseases and skin, bladder, kidney, and liver cancer. Long-term inhalation exposure to arsenic has also been associated with lung cancer at air levels as low as 0.05–0.07 mg/m^3. It is not clear at this time why long-term toxicity is different between the oral and inhalation routes, given that arsenic is easily absorbed into the systemic circulation by both routes.

Studies in mice and rats have shown that arsenic compounds induce metallothionein, a metal-binding protein thought to detoxify cadmium and other heavy metals, *in vivo* (Albores et al. 1992; Hochadel and Waalkes 1997; Kreppel et al. 1993; Maitani et al. 1987a). The potency of arsenic compounds in inducing metallothionein parallels their toxicity (i.e., As(+3) > As(+5) > MMA > DMA). For cadmium, it is thought that metallothionein binds the metal, making it biologically inactive. For arsenic, however, only a small percentage of the administered arsenic is actually bound to metallothionein (Albores et al. 1992; Kreppel et al. 1994; Maitani et al. 1987a). *In vitro* studies have shown that affinity of arsenic for metallothionein is much lower than that of cadmium or zinc (Waalkes et al. 1984). It has been proposed that metallothionein might protect against arsenic toxicity by acting as an antioxidant against oxidative injury produced by arsenic (NRC 1999).

3.5.2 Mechanisms of Toxicity

Mechanisms of arsenic-induced toxicity and carcinogenicity have not been clearly identified. However, recent efforts to elucidate mechanisms of arsenic toxicity and carcinogenicity have resulted in numerous *in vitro* and *in vivo* reports. Whereas these mechanistic studies typically employed relatively high arsenic exposure levels, some of the most recent studies were performed using more environmentally-relevant exposure levels. Due to the extremely large amount of mechanistic data for arsenic, it is not feasible to include all pertinent primary studies that address issues concerning proposed mechanisms of arsenic toxicity and carcinogenicity. Therefore, the following discussion of mechanisms of arsenic toxicity represents a summary of information from several recent review articles (Chen et al. 2004, 2005; Florea et al. 2005; Hughes 2002; Kitchin 2001; Lantz and Hays 2006; Navas-Acien et al. 2005; Rossman 2003; Roy and Saha 2002; Thomas et al. 2007; Vahter 2002).

It is becoming increasingly evident that the toxicity and carcinogenicity of arsenic is likely to be closely associated with metabolic processes. Absorbed pentavalent arsenic (AsV) is rapidly reduced to trivalent arsenic (AsIII) at least partially in the blood. Much of the formed AsIII is distributed to tissues and taken up by cells (particularly hepatocytes). Many cell types appear to accumulate AsIII more rapidly than AsV. Because AsIII (as arsenite) is known to be more highly toxic than AsV (as arsenate), the reduction step may be considered bioactivation rather than detoxification. Glutathione appears to play a role in the reduction of AsV to AsIII, which is required prior to methylation. Methylation of arsenic ultimately forms relatively less toxic MMA and DMA; this process is accomplished by alternating between the reduction of AsV to AsIII and the addition of a methyl group; S-adenosylmethionine is considered to be the source of the methyl group. Both MMA and DMA are less reactive with tissue constituents than inorganic arsenic and both are readily excreted in the urine. The methylation process appears to include multiple intermediates, some of which are more reactive than inorganic arsenic. For example, reactive trivalent metabolites, MMAIII and DMAIII, have been detected in the urine of human subjects chronically exposed to arsenic in drinking water, and *in vitro* studies have demonstrated MMAIII to be more toxic than arsenite or arsenate to human hepatocytes, epidermal keratinocytes, and bronchial epithelial cells. Additional *in vitro* studies have demonstrated genotoxic and DNA damaging properties of both MMAIII and DMAIII.

AsV (as arsenate) has been demonstrated to: (1) replace phosphate in glucose-6-phosphate and 6-phosphogluconate *in vitro*, (2) replace phosphate in the sodium pump and the anion exchange transport system of human red blood cells, (3) diminish the *in vitro* formation of adenosine-t′-triphosphate (ATP) by replacing phosphate in enzymatic reactions, and (4) deplete ATP in some cellular systems, but not in human erythrocytes. However, it is becoming more apparent that the major source of arsenic toxicity and carcinogenicity is related to its reduction to arsenite.

AsIII (as arsenite) is known to react with thiol-containing molecules such as glutathione and cysteine *in vitro*. Methylated trivalent arsenics such as MMAIII are potent inhibitors of glutathione reductase and thioredoxin reductase. It has been suggested that binding of arsenite and methylated trivalent arsenicals to critical thiol groups could lead to the inhibition of essential biochemical reactions, alteration of cellular redox status, and eventual cytotoxicity. Binding of MMAIII and DMAIII to protein has also been demonstrated *in vitro*. Arsenite inhibits pyruvate dehydrogenase (PDH), a complex that oxidizes pyruvate to acetyl-CoA, a precursor to intermediates of the citric acid cycle that provides reducing equivalents to the electron transport system for ATP production. This property may explain the depletion of carbohydrates in arsenite-treated rats.

Evidence that arsenic may induce alterations in nitric oxide metabolism and endothelial function includes findings that persons exposed to high levels of arsenic in drinking water had decreased serum and urine concentrations of nitric oxide metabolites, which was reversed upon intervention with drinking water containing lower levels of arsenic. Urinary arsenic levels have been inversely associated with nitric oxide production in activated monocytes. Arsenite concentrations of 1–25 μM inhibited endothelial nitric oxide synthase activity and resulting decreased cell growth in human endothelial cells, although lower concentrations up-regulated the expression of constitutive nitric oxide synthase 3, which might serve as an explanation for observed arsenic-induced cell growth and angiogenesis.

Although epidemiological studies demonstrate the carcinogenicity of arsenic in humans, early animal cancer bioassays failed to demonstrate a carcinogenic effect following lifetime exposure to inorganic arsenic. However, more recent focus has resulted in the development of animal models that exhibit carcinogenic activity in skin, urinary bladder, liver, and lung, tissues implicated in arsenic-induced cancer in humans. This concordance in target sites among animal models and humans indicates that common mechanisms of action may be applicable to humans and laboratory animals.

Several modes of action have been proposed to explain, at least in part, the carcinogenicity of arsenic. It is likely that multiple mechanisms are involved, some of which may relate to noncancer effects as well.

Oxidative Stress. Mechanistic studies of arsenic toxicity have suggested a role of the generation of reactive oxygen species in the toxicity of inorganic arsenic. Results of both *in vivo* and *in vitro* studies of arsenic-exposed humans and animals suggest the possible involvement of increased lipid peroxidation, superoxide production, hydroxyl radical formation, blood nonprotein sulfhydrals, and/or oxidant-induced DNA damage. Reduction of cellular oxidant defense by treatment with glutathione-depleting agents results in an increased sensitivity of cells to arsenic toxicity. Support for mechanisms of toxicity that involves arsenic-induced oxidative stress includes findings that inhaled arsenic can predispose the lung to oxidative damage, chronic low-dose arsenic alters genes and proteins that are associated with oxidative stress and inflammation, and major transcriptional regulators of altered genes are redox sensitive.

Genotoxicity. Collectively, *in vitro* and *in vivo* genotoxicity assays have demonstrated that arsenics cause single strand breaks, formation of apurinic/apyrimidinic sites, DNA base and oxidative base damage, DNA-protein crosslinks, chromosomal aberrations, aneuploidy, sister chromatid exchanges, and micronuclei. Chromosomal aberrations, characterized by chromatid gaps, breaks and fragmentation,

endoreduplication, and chromosomal breaks, are dose-dependent and arsenite is more potent than arsenate. Both MMAIII and DMAIII are directly genotoxic and are many times more potent than arsenite at inducing DNA damage. Inorganic arsenic can potentiate the mutagenicity observed with other chemicals, although arsenic itself does not appear to induce point mutations. Arsenic-induced genotoxicity may involve oxidants or free radical species.

Altered Growth Factors→Cell Proliferation→Promotion of Carcinogenesis. Increased concentrations of growth factors can lead to cell proliferation and eventual promotion of carcinogenesis. Arsenic-induced cell death can also lead to compensatory cell regeneration and carcinogenesis. Altered growth factors, cell proliferation, and promotion of carcinogenesis have all been demonstrated in one or more systems exposed to arsenics. Altered growth factors and mitogenesis were noted in human keratinocytes. Cell death was observed in human hepatocytes and rat bladder epithelium. Cell proliferation was demonstrated in human keratinocytes and intact human skin and rodent bladder cells. Promotion of carcinogenesis was noted in rat bladder, kidney, liver, and thyroid, and mouse skin and lung.

Additional Mechanisms of Toxicity Data. Inorganic arsenic exposure has been shown to modify the expression of a variety of genes related to cell growth and defense, including the tumor suppressor gene p53, as well as to alter the binding of nuclear transcription factors. Carcinogenic effects of arsenic may result from a cocarcinogenic effect. Whereas arsenic exposure alone did not elicit skin tumors in mice, co-exposure to arsenic and ultraviolet light resulted in skin tumors that were greater in number and larger in size than those produced by ultraviolet light alone. Arsenate and arsenite enhanced the amplification of a gene that codes for the enzyme dihydrofolate reductase, arsenate being more potent than arsenite. Furthermore, inhibition of DNA repair has been demonstrated in arsenic-treated cells.

3.5.3 Animal-to-Human Extrapolations

The usefulness of animal models for toxicity studies with arsenic is significantly limited by two major factors. First and most importantly, no animal model exists for the health effect of greatest concern for human exposure: carcinogenicity in skin and other organs after oral exposure. Second, the pattern of metabolism in humans (significant excretion of the methylated forms of arsenic) is unlike that of most other mammalian species (the mouse and rabbit may be exceptions). The ratios of inorganic to organic arsenic excreted also vary between species. The rat sequesters arsenic in its erythrocytes and is not a suitable model for human toxicity.

3.6 TOXICITIES MEDIATED THROUGH THE NEUROENDOCRINE AXIS

Recently, attention has focused on the potential hazardous effects of certain chemicals on the endocrine system because of the ability of these chemicals to mimic or block endogenous hormones. Chemicals with this type of activity are most commonly referred to as *endocrine disruptors*. However, appropriate terminology to describe such effects remains controversial. The terminology *endocrine disruptors*, initially used by Thomas and Colborn (1992), was also used in 1996 when Congress mandated the EPA to develop a screening program for "...certain substances [which] may have an effect produced by a naturally occurring estrogen, or other such endocrine effect[s]...". To meet this mandate, EPA convened a panel called the Endocrine Disruptors Screening and Testing Advisory Committee (EDSTAC), and in 1998, the EDSTAC completed its deliberations and made recommendations to EPA concerning *endocrine disruptors*. In 1999, the National Academy of Sciences released a report that referred to these same types of chemicals as *hormonally active agents*. The terminology *endocrine modulators* has also been used to convey the fact that effects caused by such chemicals may not necessarily be adverse. Many scientists agree that chemicals with the ability to disrupt or modulate the endocrine system are a potential threat to the health of humans, aquatic animals, and wildlife. However, others think that endocrine-active chemicals do not pose a significant health risk, particularly in view of the fact that hormone mimics exist in the natural environment. Examples of natural hormone mimics are the isoflavinoid phytoestrogens (Adlercreutz 1995; Livingston 1978; Mayr et al. 1992). These chemicals are derived from plants and are similar in structure and action to endogenous estrogen. Although the public health significance and descriptive terminology of substances capable of affecting the endocrine system remains controversial, scientists agree that these chemicals may affect the synthesis, secretion, transport, binding, action, or elimination of natural hormones in the body responsible for maintaining homeostasis, reproduction, development, and/or behavior (EPA 1997h). Stated differently, such compounds may cause toxicities that are mediated through the neuroendocrine axis. As a result, these chemicals may play a role in altering, for example, metabolic, sexual, immune, and neurobehavioral function. Such chemicals are also thought to be involved in inducing breast, testicular, and prostate cancers, as well as endometriosis (Berger 1994; Giwercman et al. 1993; Hoel et al. 1992).

There is little evidence to suggest that arsenic functions as an endocrine disruptor. An association has been demonstrated between exposure to arsenic in drinking water and increased incidence of diabetes mellitus (Rahman et al. 1998; Tsai et al. 1999; Tseng et al. 2000; Wang et al. 2003), although dose-response relationships are not available and the mechanism of action for this response has not been characterized. Studies by Waalkes and coworkers (Waalkes et al. 2006a, 2006b) have suggested that in

mice, arsenic may interact with estrogens to enhance production of female urogenital cancers and male hepatocellular cancer following exposure to arsenic *in utero*. The mechanism by which this might happen has not been elucidated. No other relevant data were located in humans or animals. Data on general effects of arsenic compounds on the endocrine system are presented in Sections 3.2.1.2 and 3.2.2.2 above.

In vitro studies provide suggestive evidence that arsenic may act as an endocrine disruptor. Studies by Bodwell et al. (2004, 2006) and Davey et al. (2007) demonstrate that arsenic can alter gene regulation of steroid hormone receptors for glucocorticoids, mineralocorticoids, progesterone, and estrogen.

3.7 CHILDREN'S SUSCEPTIBILITY

This section discusses potential health effects from exposures during the period from conception to maturity at 18 years of age in humans, when all biological systems will have fully developed. Potential effects on offspring resulting from exposures of parental germ cells are considered, as well as any indirect effects on the fetus and neonate resulting from maternal exposure during gestation and lactation. Relevant animal and *in vitro* models are also discussed.

Children are not small adults. They differ from adults in their exposures and may differ in their susceptibility to hazardous chemicals. Children's unique physiology and behavior can influence the extent of their exposure. Exposures of children are discussed in Section 6.6, Exposures of Children.

Children sometimes differ from adults in their susceptibility to hazardous chemicals, but whether there is a difference depends on the chemical (Guzelian et al. 1992; NRC 1993). Children may be more or less susceptible than adults to health effects, and the relationship may change with developmental age (Guzelian et al. 1992; NRC 1993). Vulnerability often depends on developmental stage. There are critical periods of structural and functional development during both prenatal and postnatal life, and a particular structure or function will be most sensitive to disruption during its critical period(s). Damage may not be evident until a later stage of development. There are often differences in pharmacokinetics and metabolism between children and adults. For example, absorption may be different in neonates because of the immaturity of their gastrointestinal tract and their larger skin surface area in proportion to body weight (Morselli et al. 1980; NRC 1993); the gastrointestinal absorption of lead is greatest in infants and young children (Ziegler et al. 1978). Distribution of xenobiotics may be different; for example, infants have a larger proportion of their bodies as extracellular water, and their brains and livers are proportionately larger (Altman and Dittmer 1974; Fomon 1966; Fomon et al. 1982; Owen and Brozek

1966; Widdowson and Dickerson 1964). The infant also has an immature blood-brain barrier (Adinolfi 1985; Johanson 1980) and probably an immature blood-testis barrier (Setchell and Waites 1975). Many xenobiotic metabolizing enzymes have distinctive developmental patterns. At various stages of growth and development, levels of particular enzymes may be higher or lower than those of adults, and sometimes unique enzymes may exist at particular developmental stages (Komori et al. 1990; Leeder and Kearns 1997; NRC 1993; Vieira et al. 1996). Whether differences in xenobiotic metabolism make the child more or less susceptible also depends on whether the relevant enzymes are involved in activation of the parent compound to its toxic form or in detoxification. There may also be differences in excretion, particularly in newborns who all have a low glomerular filtration rate and have not developed efficient tubular secretion and resorption capacities (Altman and Dittmer 1974; NRC 1993; West et al. 1948). Children and adults may differ in their capacity to repair damage from chemical insults. Children also have a longer remaining lifetime in which to express damage from chemicals; this potential is particularly relevant to cancer.

Certain characteristics of the developing human may increase exposure or susceptibility, whereas others may decrease susceptibility to the same chemical. For example, although infants breathe more air per kilogram of body weight than adults breathe, this difference might be somewhat counterbalanced by their alveoli being less developed, which results in a disproportionately smaller surface area for alveolar absorption (NRC 1993).

Arsenic has been recognized as a human toxicant for many centuries, and the symptoms of acute poisoning are well known. Children who are exposed to high levels of arsenic exhibit symptoms similar to those seen in adults, including respiratory, cardiovascular, dermal, and neurological effects, and vomiting if the arsenic is ingested (Borgoño et al. 1980; Foy et al. 1992; Kersjes et al. 1987; Muzi et al. 2001; Rosenberg 1974; Zaldívar 1974; Zaldívar and Guillier 1977). Arterial thickening of the pancreas was observed in five children who died in Chile after chronic exposure to arsenic (Rosenberg 1974). Foy et al. (1992) described systemic effects of chronic arsenic exposure in children in a village near a tin and tungsten mining operation in Thailand. The arsenic concentration in water samples from 35 shallow wells averaged 0.82 mg As/L (range, 0.02–2.7 mg As/L). Piped water (available in some homes) had a concentration of 0.07 mg As/L. A survey of skin manifestations of arsenic poisonings was conducted in the autumn of 1987. The case reports of four children were presented. All of the children had hyperkeratosis and hyperpigmentation of the extremities, including tibia, palms, and soles. In addition, one child had developed weakness 3 years previously and had anorexia and a chronic cough for 1 year. She had been held back twice in school as a slow learner. On examination, she had a runny nose and

weakness of her wrist joints. The liver was about 4 finger-breadths below the right costal margin with a sharp but tender edge. Blood arsenic levels ranged from 0.087 to 0.46 µg/mL and the arsenic level in hair ranged from 14.4 to 20 µg/g. The authors concluded that the finding of typical skin manifestations of chronic arsenic poisoning suggests that it may take a considerably shorter period of time to develop these manifestations than previously thought. However, it is not known what effect co-exposure to tin and tungsten might have had on skin manifestations in these children. Exposure to high arsenic levels during gestation and/or during early childhood also was associated with significant increases in SMRs for lung cancer and bronchiectasis during adulthood in a study of residents in a city in Chile with high arsenic levels in the drinking water (near 0.9 mg/L) during several years (Smith et al. 2006).

As previously mentioned in Sections 3.2.1.4 and 3.2.2.4, exposure of children to arsenic also has been associated with neurological deficits in children. Studies by Wasserman et al. (2004, 2007) of 6- and 10-year-old children from Bangladesh reported small but significant decreases in some tests of cognitive function associated with levels of arsenic in the water ≥0.05 mg/L. A study of pre-school age children in West Bengal, India, reported an association between current urinary arsenic concentrations, but not long-term water arsenic, and small decrements in intellectual tests (von Ehrenstein et al. 2007). Similar results were reported in a study of children in Taiwan (Tsai et al. 2003) and in China (Wang et al. 2007). Neurological effects have also been associated with elevated levels of arsenic in the air. For example, Bencko et al. (1977) reported that children of approximately 10 years of age living near a power plant burning coal of high arsenic content showed significant hearing losses (increased threshold) compared to a control group of children living outside the polluted area (Bencko et al. 1977). Also, in a study of Mexican children, Calderón et al. (2001) reported that children living near a smelter complex had poor performance on tests evaluating verbal IQ than children who lived farther from the smelter. Thus, the limited data available suggest that exposure of children to inorganic arsenic may result in detrimental effects on neurobehavioral parameters.

Wulff et al. (1996) conducted a retrospective study of a cohort of children born between 1961 and 1990 in the municipality of Skelleftea, Sweden, where a smelter released arsenic and other pollutants including lead, copper, cadmium, and sulfur dioxide. Childhood cancer incidences among children born in the vicinity of the smelter (i.e., within 20 km) and distant from the smelter (>20 km) were compared with expected incidences based on Swedish national statistics. There appeared to be an increased risk of childhood cancer (all types combined) among children born in the vicinity of the smelter (SIR=195, 95% CI=88–300, based on 13 cases observed and 6.7 expected), but the increase was not statistically significant, and in any event, the role of arsenic in any finding from this study is confounded by the

presence of other metals. The number of cases (n=42) was very close to the expected number (n=41.8) among children born distant from the smelter. Similar results were reported in a study by Moore et al. (2002), which did not find increased incidence ratios for all childhood cancers or for childhood leukemias in children from an area of Nevada with high arsenic exposures.

Inorganic arsenic has been characterized as a developmental toxicant. It is known to cross the placental barrier and selectively accumulate in the neuroepithelium of the developing animal embryo (Hanlon and Ferm 1977; Lindgren et al. 1984). Studies in animals have also revealed that various fetal malformations occur after embryonic exposure to arsenic *in vitro*; neural tube defects are the predominant and consistent malformation in these studies (Chaineau et al. 1990; Mirkes and Cornel 1992; Morrissey and Mottet 1983; Mottet and Ferm 1983; Tabacova et al. 1996; Willhite and Ferm 1984; Wlodarczyk et al. 1996). *In vivo* studies have shown that high doses of ingested arsenic can produce developmental effects (fetal mortality, skeletal defects), but generally only at maternally toxic doses (Baxley et al. 1981; Holson et al. 1999, 2000; Hood and Harrison 1982; Hood et al. 1978; Nemec et al. 1998; Stump et al. 1999). A series of studies showed an increased incidence of tumors in the offspring of mice exposed to arsenic from gestational day 8 through day 18(Waalkes et al. 2003, 2004a, 2004b, 2004c, 2006a, 2006b) (see Section 3.2.2.6 for further details). In humans, acute prenatal exposure to high doses of inorganic arsenic can result in miscarriage and early neonatal death (Bolliger et al. 1992; Lugo et al. 1969). Although several studies have reported marginal associations between prolonged low-dose human arsenic exposure and adverse reproductive outcomes, including spontaneous abortion, stillbirth, developmental impairment, and congenital malformation (Ahmad et al. 2001; Aschengrau et al. 1989; Chakraborti et al. 2003c; Hopenhayn-Rich et al. 2000; Nordström et al. 1978a, 1979b; Yang et al. 2003; Zierler et al. 1988), none of these studies have provided convincing evidence for such effects or information concerning possible dose-response relationships.

There is no evidence for differences in absorption of arsenic in children and adults. Ingestion of arsenic in dirt may be an important route of exposure for young children. A study that used a synthetic gastric juice designed to mimic gastric conditions in a 2-year-old child found that absorption of arsenic from contaminated soil was likely to be up to 5 times lower than the total concentration of arsenic in the soil (Williams et al. 1998). As previously mentioned, arsenic crosses the placenta and preferentially accumulates in the embryonic neuroepithelium. In addition, arsenic is known to be present in breast milk at low concentrations. Arsenic concentrations were low in human milk sampled from 88 mothers in the Faroe Islands (0.0001–0.0044 ppm), where the diet is predominantly seafood (exposures were primarily to “fish arsenic” [Grandjean et al. 1995]), in a population of Andean women (0.0008–0.008 ppm) exposed

to high concentrations of inorganic arsenic in drinking water (Concha et al. 1998b), and in a World Health Organization survey (0.00013–0.00082 ppm) (Somogyi and Beck 1993). There is no information in the literature describing storage of arsenic in maternal tissues. There is some evidence that metabolism of arsenic in children is less efficient than in adults. Children in two villages in Argentina ingesting large amounts of arsenic in their drinking water (200 μg/L) excreted about 49% inorganic arsenic and 47% DMA, compared to 32% inorganic arsenic and 66% DMA for the women in the study (Concha et al. 1998b). No PBPK models specifically targeted at fetuses, infants, or children, or pregnant or lactating women were found in the literature. There are no biomarkers that have been specifically identified for children exposed to arsenic. In addition, no unique interactions of arsenic with other chemicals have been identified in children.

The mechanism of toxic action of arsenic in the mammalian cell may involve inhibition of proliferation of cells (Dong and Luo 1993; Jha et al. 1992; Petres et al. 1977). In addition, high-dose arsenic impairs assembly and disassembly of microtubules, thus interfering with mitotic spindle formation and embryonal cell division (Léonard and Lauwerys 1980; Li and Chou 1992; Mottet and Ferm 1983). Arsenic compounds also cause chromosomal aberrations (Jha et al. 1992; Léonard and Lauwerys 1980), which may disrupt cell cycling. The direct toxic effects of high levels of arsenic in the developing embryo result not from a difference in the mechanism of toxicity during development, but rather from the existence of a unique target tissue, the neuroepithelium. The process of neurulation involves cell shape changes, cytokinesis, and cell adhesion, which are dependent upon cytoskeletal elements that are functionally affected by arsenic (Dallaire and Béliveau 1992; Edelman 1992; Gunn et al. 1992; Li and Chou 1992; Moriss-Kay et al. 1994; Schoenwolf and Smith 1990; Taubeneck et al. 1994). However, since arsenic is known to affect vasculature, and since altered placental and/or embryonal vasculature has been suggested as a mechanism leading to neural tube defects, the embryo may be sensitive to this manifestation of arsenic toxicity.

3.8 BIOMARKERS OF EXPOSURE AND EFFECT

Biomarkers are broadly defined as indicators signaling events in biologic systems or samples. They have been classified as markers of exposure, markers of effect, and markers of susceptibility (NAS/NRC 1989).

Due to a nascent understanding of the use and interpretation of biomarkers, implementation of biomarkers as tools of exposure in the general population is very limited. A biomarker of exposure is a xenobiotic

substance or its metabolite(s) or the product of an interaction between a xenobiotic agent and some target molecule(s) or cell(s) that is measured within a compartment of an organism (NAS/NRC 1989). The preferred biomarkers of exposure are generally the substance itself, substance-specific metabolites in readily obtainable body fluid(s), or excreta. However, several factors can confound the use and interpretation of biomarkers of exposure. The body burden of a substance may be the result of exposures from more than one source. The substance being measured may be a metabolite of another xenobiotic substance (e.g., high urinary levels of phenol can result from exposure to several different aromatic compounds). Depending on the properties of the substance (e.g., biologic half-life) and environmental conditions (e.g., duration and route of exposure), the substance and all of its metabolites may have left the body by the time samples can be taken. It may be difficult to identify individuals exposed to hazardous substances that are commonly found in body tissues and fluids (e.g., essential mineral nutrients such as copper, zinc, and selenium). Biomarkers of exposure to arsenic are discussed in Section 3.8.1.

Biomarkers of effect are defined as any measurable biochemical, physiologic, or other alteration within an organism that, depending on magnitude, can be recognized as an established or potential health impairment or disease (NAS/NRC 1989). This definition encompasses biochemical or cellular signals of tissue dysfunction (e.g., increased liver enzyme activity or pathologic changes in female genital epithelial cells), as well as physiologic signs of dysfunction such as increased blood pressure or decreased lung capacity. Note that these markers are not often substance specific. They also may not be directly adverse, but can indicate potential health impairment (e.g., DNA adducts). Biomarkers of effects caused by arsenic are discussed in Section 3.8.2.

A biomarker of susceptibility is an indicator of an inherent or acquired limitation of an organism's ability to respond to the challenge of exposure to a specific xenobiotic substance. It can be an intrinsic genetic or other characteristic or a preexisting disease that results in an increase in absorbed dose, a decrease in the biologically effective dose, or a target tissue response. If biomarkers of susceptibility exist, they are discussed in Section 3.10, Populations That Are Unusually Susceptible.

3.8.1 Biomarkers Used to Identify or Quantify Exposure to Arsenic

Arsenic levels in blood, urine, hair, and nails have all been investigated and used as biological indicators of exposure to arsenic. Since arsenic is cleared from blood within a few hours (Tam et al. 1979b; Vahter 1983), measurements of blood arsenic reflect exposures only within the very recent past. Typical values in nonexposed individuals are <1 μg/L (Heydorn 1970; Hindmarsh and McCurdy 1986; Valentine et al.

1979). Consumption of medicines containing arsenic is associated with blood values of 100–250 µg/L, while blood levels in acutely toxic and fatal cases may be 1,000 µg/L or higher (Driesback 1980).

However, blood levels do not appear to be reliable indicators of chronic exposure to low levels of arsenic. For example, there was no correlation between the level of arsenic in blood of residents and the level of arsenic in drinking water in several U.S. communities where water levels ranged from about 6 to 125 µg/L (Valentine et al. 1979, 1981). Consequently, measurement of blood arsenic is not generally considered to be a reliable means of monitoring human populations for arsenic exposure.

As discussed in Section 3.4.4, most arsenic that is absorbed from the lungs or the gastrointestinal tract is excreted in the urine, mainly within 1–2 days. For this reason, measurement of urinary arsenic levels is generally accepted as the most reliable indicator of recent arsenic exposure, and this approach has proved useful in identifying above-average exposures in populations living near industrial point sources of arsenic (e.g., Milham and Strong 1974; Polissar et al. 1990). By the inhalation route, several researchers have found that there is a good quantitative correlation between the concentration of arsenic in workplace air (C_{air}, µg/m^3) and the concentration in the urine (C_{urine}, µg/L) of exposed workers. For example, Pinto et al. (1976) found a linear relationship for exposures ranging up to 150 µg/m^3, given by the following equation:

$$C_{air}=0.3\ C_{urine}$$

Enterline et al. (1987a) reinvestigated this relationship over a wider range of exposures (up to 3,500 µg/m^3), and found that the curve tended to be concave upward, as given by the following equation:

$$C_{air}=0.0064\ (C_{urine})^{1.94}$$

This indicates that at higher exposure levels, a higher fraction of the dose is excreted in urine, although the toxicokinetic basis for this is not certain. Numerous studies have used above-average urinary levels (i.e., higher than about 100 µg/L) as evidence of recent arsenic ingestion (e.g., Borgoño et al. 1980; Fincher and Koerker 1987; Franzblau and Lilis 1989; Goldsmith and From 1986; Kyle and Pease 1965; Valentine et al. 1981). Calderon et al. (1999) found a quantitative correlation between the log of the mean total urinary arsenic concentration/creatinine (TAs/c, µg/mg) of people living in areas with arsenic-contaminated drinking water sources and the log of the inorganic arsenic concentration in the drinking water (InAs, µg/L). The equation for the regression line is:

$$TAs/c=10^{-2.57} \times (InAs)^{0.63}$$

where -2.57 and 0.63 are the intercept and slope, respectively, for the regression of the log10-transformed data. Mixed model regression analysis showed that the log of estimated arsenic intake from drinking water (µg/day) is also a good predictor of TAs/c excretion (Calderon et al. 1999).

There is some indication that speciation of urinary arsenic may indicate the extent of past cumulative exposure to arsenic. Hsueh et al. (1998a) reported higher levels of DMA and MMA in the urine of individuals with higher cumulative past exposure to inorganic arsenic. Speciated urinary arsenic is also a recommended biomarker for recent inorganic arsenic exposure. Walker and Griffin (1998) used the EPA Exposure Assessment Model and a number of site-specific data covering environmental and biological factors to predict total and speciated urinary arsenic concentrations for children living near high levels of arsenic-contaminated soil. There was reasonable agreement between the measured and predicted speciated urinary arsenic concentrations.

An important limitation to the use of total urinary arsenic as a biomarker of exposure is that arsenobetaine is excreted (unmetabolized) in urine after ingestion of certain seafoods (Brown et al. 1990; Kalman 1987; Tam et al. 1982). Since "fish arsenic" is essentially nontoxic, analytical methods based on total urinary arsenic content may overestimate exposures to arsenic species that are of health concern. As discussed in Section 7.1, there are adequate methods for distinguishing arsenobetaine from other forms of arsenic in urine (inorganic, MMA, DMA), although these are not convenient to use as a routine screening method.

Arsenic tends to accumulate in hair and nails, and measurement of arsenic levels in these tissues may be a useful indicator of past exposures. Normal levels in hair and nails are 1 ppm or less (Choucair and Ajax 1988; Franzblau and Lilis 1989). These values may increase from several-fold to over 100-fold following arsenic exposure (Agahian et al. 1990; Bencko 2005; Bencko et al. 1986; de Peyster and Silvers 1995; EPA 1977a, 1981b; Karagas et al. 1996; Milham and Strong 1974; Valentine et al. 1979; Yamauchi et al. 1989) and remain elevated for 6–12 months (Choucair and Ajax 1988). Minimum exposure levels that produce measurable increases in arsenic levels in hair and nails have not been precisely defined. For hair, ingestion of 50–120 ppb of arsenic in drinking water produced only a marginal effect, but a clear increase was noted at 393 ppb (Valentine et al. 1979). A study of children living in a region polluted with arsenic derived from a power plant burning coal with a high arsenic content found a significant correlation between arsenic levels in hair and distance from the source of emission (Bencko and Symon 1977).

Inhalation exposure of workers to about 0.6 μg/m^3 of arsenic in air significantly increased average levels in nails (Agahian et al. 1990), although there was wide variation between individuals.

Analysis of hair may yield misleading results due to the presence of arsenic adsorbed to the external surface, but this can be minimized by collecting samples from close to the scalp or from unexposed areas and by washing the hair before analysis (e.g., Paschal et al. 1989). Similarly, extensive washing of nails is required to remove exogenous contamination (Agahian et al. 1990). The relationship between consumption of food items and levels of arsenic in toenails has been evaluated by MacIntosh et al. (1997) using standard multivariate regression models. This approach does not appear to be highly reliable, but may be sufficient for exploring associations between diet and disease. Kurttio et al. (1998) used linear regression models to show that there is a good association between arsenic concentration in hair (mg/kg) and total arsenic concentration in urine (μg/L), arsenic concentration in drinking water (μg/L) or daily intake of arsenic (μg/day). A 10 μg/L increase in the drinking water concentration or a 10–20 μg/day increase in daily arsenic intake corresponded to a 0.1 mg/kg increase in the arsenic concentration in hair. It is also important to note that the measurement of arsenic in hair and fingernails is a process not readily accessible to many clinical offices.

3.8.2 Biomarkers Used to Characterize Effects Caused by Arsenic

As discussed in Section 3.2, the characteristic pattern of skin changes caused by arsenic (hyperkeratinization, hyperpigmentation) is probably the most sensitive and diagnostic clinical indicator of chronic exposure to arsenic. However, no means has been developed for detecting these effects except by routine dermatological examination.

Peripheral neuropathy is another characteristic effect of arsenic exposure, and several researchers have investigated decreased nerve conduction velocity or amplitude as a biomarker for peripheral neuropathy. While effects can usually be detected in individuals with clinical signs of neuropathy (e.g., Goebel et al. 1990; Jenkins 1966; Le Quesne and McLeod 1977; Morton and Caron 1989; Murphy et al. 1981), effects are only marginal (EPA 1977a; Hindmarsh et al. 1977; Valentine et al. 1981) or undetectable (EPA 1981b; Kreiss et al. 1983) in exposed populations without obvious clinical signs of toxicity. This indicates that this approach is probably not sufficiently sensitive to detect neurological effects earlier than by standard neurological examination (Hindmarsh and McCurdy 1986). Also, decreases in nerve conduction velocity or amplitude are not specific for arsenic-induced neuropathy.

Arsenic is known to affect the activity of a number of enzymes, and some of these may have potential as biomarkers of effect. Most promising is the spectrum of effects caused by arsenic on the group of enzymes responsible for heme synthesis and degradation, including inhibition of coproporphyrinogen oxidase and heme synthetase (Woods and Fowler 1978; Woods and Southern 1989) and activation of heme oxygenase (Sardana et al. 1981). Menzel et al. (1998) has examined the *in vitro* induction of human lymphocyte heme oxygenase 1(HO1) as a biomarker of arsenite exposure. Arsenite did induce *de novo* synthesis of HO1 in human lymphoblastoid cells, but it has not been determined if the same response is induced *in vivo*. It has been shown in animals that these arsenic-induced enzymic changes result in increased urinary levels of uroporphyrin, coproporphyrin, and bilirubin (Albores et al. 1989; Woods and Fowler 1978), and it has been shown that these effects can be detected in the urine of arsenic-exposed humans (García-Vargas and Hernández-Zavala 1996). Therefore, altered urinary levels of these heme-related compounds could serve as a biomarker of effect. However, it is known that numerous other toxic metals also have similar effects on heme metabolism (Albores et al. 1989; Sardana et al. 1981; Woods and Southern 1989), so it is likely that these effects would not be specific for arsenic.

For more information on biomarkers for renal and hepatic effects of chemicals, see ATSDR/CDC Subcommittee Report on Biological Indicators of Organ Damage (Agency for Toxic Substances and Disease Registry 1990b) and for information on biomarkers for neurological effects, see OTA (1990).

3.9 INTERACTIONS WITH OTHER CHEMICALS

A number of researchers have found that arsenic compounds tend to reduce the effects of selenium (Hill 1975; Howell and Hill 1978; Kraus and Ganther 1989; Levander 1977; Miyazaki et al. 2003; Moxon et al. 1945; Schrauzer 1987; Schrauzer et al. 1978). Likewise, selenium can decrease the effects of arsenic, including clastogenicity (Beckman and Nordenson 1986; Biswas et al. 1999; Sweins 1983), delayed mutagenesis (Rossman and Uddin 2004), cocarcinogenesis (Uddin et al. 2005), cytotoxicity (Babich et al. 1989; Rössner et al. 1977; Styblo and Thomas 2001), and teratogenicity (Holmberg and Ferm 1969). The mechanism of this mutual inhibition of effects is not known, but may be related to the formation of a selenium-arsenic complex (seleno-bis [S-gluthionyl] arsinium ion; Gailer et al. 2002) that is excreted more rapidly than either arsenic or selenium alone (Cikrt et al. 1988; Hill 1975; Levander 1977; Levander and Baumann 1966) or due to selenium-induced changes in arsenic methylation (Styblo and Thomas 2001; Walton et al. 2003). There is little direct evidence that variations in selenium exposure in humans lead to significant increases or decreases in arsenic toxicity, although copper smelter workers who developed lung cancer had lower tissue levels of selenium than workers who did not develop lung tumors

(Gerhardsson et al. 1985, 1988). This suggests that selenium deficiency could significantly increase the risk of lung cancer following inhalation exposure to arsenic, but it is difficult to distinguish cause from effect in such a study. However, there is evidence that administration of selene can facilitate recovery from arsenic poisoning. In residents living in an area of Inner Mongolia with high levels of arsenic in drinking water, administration of 100–200 µg selenium/day in the form of selenium yeast and exposure to arsenic-free water for 14 months resulted in a greater improvement in clinical signs and symptoms, liver function, and EKG readings as compared to residents administered arsenic-free water only (Wuyi et al. 2001; Yang et al. 2002). An improvement in skin lesions was observed in 67 and 21% of the subjects in the selenium-supplemented and control groups (Yang et al. 2002). Additionally, the levels of arsenic in blood, hair, and urine were significantly lower after the 14-month period only in the selenium supplemented group.

The interaction between cigarette smoking, inhalation of arsenic, and the risk of lung cancer has not been extensively investigated. Smoking appeared to increase lung cancer risk synergistically (multiplicatively) in one study of smelter workers (Pershagen et al. 1981), although the data are not adequate to exclude a simple additive interaction (Thomas and Whittemore 1988). Cigarette smoking has been shown to increase the occurrence of lung cancer in people with high levels of arsenic in the drinking water (Chiou et al. 1995; Tsuda et al. 1995a). Suggestive evidence of a positive interaction between arsenic and benzo(a)pyrene has also been noted for induction of lung adenocarcinomas in hamsters (Pershagen et al. 1984).

Co-exposure to ethanol and arsenic may exacerbate the toxic effects of arsenic. Simultaneous exposure of rats to ethanol (10% in drinking water) and arsenic (dose not stated) for 6 weeks produced a significant increase in the concentration of arsenic in the kidney, a nonsignificant increase of arsenic in the liver and a significant increase in the concentration of glutathione in the liver, compared to rats treated with either ethanol or arsenic alone (Flora et al. 1997a, 1997b). Histological damage to the liver, but not the kidneys, was increased in rats treated with both ethanol and arsenic compared to those receiving only arsenic.

Studies of rats exposed to arsenic, lead, and cadmium, alone or in combination, have revealed mainly additive or subadditive effects on body weight, hematological parameters, and enzymes of heme synthesis (Mahaffey and Fowler 1977; Mahaffey et al. 1981). Similarly, studies of the tissue levels of arsenic in rats fed arsenic with or without lead or cadmium revealed only limited evidence of any toxicokinetic interactions (Mahaffey et al. 1981). Pretreatment of rats with a nontoxic dose of cadmium had no effect on the lethality of a high dose of arsenic and did not reduce arsenic-induced hepatotoxicity (Hochadel and

Waalkes 1997). These data do not suggest that arsenic toxicity is likely to be significantly influenced by concomitant exposure to these metals. However, supplementation with zinc or chromium may be useful in reducing chronic arsenism. Arsenic has been shown to cause an increase in total plasma cholesterol; co-administration of chromium(III) counteracts this effect (Aguilar et al. 1997). Pretreatment of mice with zinc, at least 24 hours before injection with arsenic-73, reduced arsenic retention compared to controls that did not receive the zinc pretreatment or received it only a short time before the administration of arsenic (Kreppel et al. 1994). Zinc is an inducer of metallothionein, but this induction does not appear to be the mechanism that reduces arsenic toxicity because other inducers of metallothionein did not reduce arsenic toxicity and arsenic elimination was increased by the zinc pretreatment.

Since methylation of arsenic is a detoxification mechanism, it is possible that chemicals that interfere with the methylation process could increase toxicity. This is supported by studies in animals in which reagents that inhibit methylation enzymes (e.g., periodate-oxidized adenosine) caused an increase in tissue levels of inorganic arsenic (Marafante and Vahter 1986; Marafante et al. 1985). Similarly, cellular glutathione levels appear to play a role in the methylation process, and treatment with reagents (e.g., phorone) that decrease glutathione levels increases arsenic toxicity (Buchet and Lauwerys 1987). Inadequate dietary intake of methionine, choline, or protein may also exacerbate arsenic toxicity. Rabbits pretreated with diets low in choline, methionine, or protein showed a significant increase in tissue retention of arsenic and a significant decrease in the excretion of dimethylarsinic acid (Vahter and Marafante 1987). The increased retention of arsenic in rabbits fed these deficient diets is likely to be due to a reduction in arsenic methylation. Thus, the toxic effects of chronic arsenic ingestion may be increased in populations that are also subject to malnutrition.

3.10 POPULATIONS THAT ARE UNUSUALLY SUSCEPTIBLE

A susceptible population will exhibit a different or enhanced response to arsenic than will most persons exposed to the same level of arsenic in the environment. Reasons may include genetic makeup, age, health and nutritional status, and exposure to other toxic substances (e.g., cigarette smoke). These parameters result in reduced detoxification or excretion of arsenic, or compromised function of organs affected by arsenic. Populations who are at greater risk due to their unusually high exposure to arsenic are discussed in Section 6.7, Populations with Potentially High Exposures.

No studies were located that identified an unusual susceptibility of any human subpopulation to arsenic. Several studies have evaluated possible sex-related differences in arsenic toxicity and carcinogenesis (Aposhian et al. 2000a, 2000b; Calderon et al. 1999; Loffredo et al. 2003; Mandal et al. 2001; Watanabe et al. 2001), but have not consistently identified differences. However, since the degree of arsenic toxicity may be influenced by the rate and extent of its methylation in the liver (see Section 3.4.3), it seems likely that some members of the population might be especially susceptible because of lower than normal methylating capacity. Studies of exposed humans in Taiwan suggested that subjects with lower secondary methylation indices have an increased risk of bladder cancer (Chen et al. 2003) and peripheral vascular disease (Tseng et al. 2005), particularly in subjects with high exposure levels. Reduced hepatic methylation could result from dietary deficiency of methyl donors such as choline or methionine (Buchet and Lauwerys 1987; Vahter and Marafante 1987), although this is unlikely to be a concern for most people in the United States. There is evidence that methylation capacity can vary greatly among individuals (e.g., Buchet et al. 1981a; Foà et al. 1984; Hopenhayn-Rich et al. 1996b; Tam et al. 1979b), but the basis of this variation and its impact on human susceptibility have not been fully established. There is some evidence that low dietary protein intake and possibly other nutritional deficiencies can decrease arsenic methylation (Steinmaus et al. 2005a). Recently, Heck et al. (2007) examined whether the capacity to methylate arsenic differs by nutrient intake in a cohort of 1,016 Bangladeshi adults exposed to arsenic in drinking water. The results showed that higher intakes of cysteine, methionine, calcium, protein, and vitamin B-12 were associated with lower percentages of inorganic arsenic and higher ratios of MMA to inorganic arsenic in urine. In addition, higher intakes of niacin and choline were associated with higher DMA/MMA ratios, after adjustment for sex, age, smoking, total urinary arsenic, and total energy intake. The issue of increased susceptibility to arsenic due to poor nutrition was discussed by NRC (2001), it was concluded that, with regard to skin effects, studies of cohorts from India, Bangladesh, and Taiwan suggest that nutrition plays an important role in arsenic toxicity. On the other hand, studies in other regions of the world (i.e., Chile) involving populations with much better nutrition argue against poor nutrition having a major impact on arsenic toxicity.

Various genetic polymorphisms also seem to play a role in arsenic-induced toxicity. For example, a study of 85 lung cancer patients and 108 healthy controls in northern Chile reported that there was a nonstatistically significant difference for the frequency of the GSTM1 null genotype between the healthy and lung cancer patients stratified by gender and smoking status. The same results were observed for the MspI CYP450 1A1 polymorphism (Adonis et al. 2005). Hsueh et al. (2005) examined the association of four polymorphisms: NAD(P)H oxidase, manganese superoxide dismutase (MnSOD), catalase, and endothelial nitric oxide synthase (eNOS) with arsenic related hypertension risk among 79 hypertensive

cases and 213 controls in an arseniasis-hyperendemic area in Taiwan. The results showed that MnSOD polymorphism significantly increased the risk of hypertension regardless of exposure to arsenic. NAD(P)H oxidase and eNOS polymorphisms were significantly associated with increased risk of hypertension in subjects with higher cumulative arsenic exposure (≥10.5 mg/L x year), whereas catalase polymorphism was not associated with hypertension. The results also showed that the association between MnSOD, NAD(P)H oxidase, and eNOS polymorphisms and risk of hypertension were more pronounced in subjects with high triglyceride level. A study of a population of West Bengal, India, exposed to arsenic via drinking water reported that the frequencies of null genotype in GSTT1 were 13.52 and 12.92% in skin-symptomatic and skin-asymptomatic individuals, and GSTM1 null genotype were 13.90 and 22.47% in skin-symptomatic and skin-asymptomatic individuals, respectively (Ghosh et al. 2006). Compared to those with GSTM1 null genotype, subjects with GST1-positive (at least one allele) had significantly higher risk of arsenic-induced skin lesions. Recently, Steinmaus et al. (2007) investigated urinary arsenic methylation patterns and genetic polymorphisms in methylenetetrahydrofolate reductase (MTHFR) and GST in 170 subjects (139 males) from an arsenic-exposed region in Argentina. MTHFR is a key enzyme in the metabolism of folate and has been linked to arsenic metabolism and toxicity (NRC 1999). Steinmaus et al. (2007) found that subjects with the TT/AA variant of MTHFR 677/1298 (associated with lower MTHFR activity) excreted a significantly higher proportion on ingested arsenic as inorganic arsenic and a smaller proportion as DMA(V). The study also reported that women with null genotype of GSTM1 excreted a significantly higher proportion of arsenic as monomethylarsenate than women with the active genotype. The study also found no association between polymorphisms in GSTT1 and arsenic methylation.

There is a report that described severe arsenic-induced neuropathy that developed only in a 5,10-methylenetetrahydrofolate-reductase (MTHFR) deficient member of a family that had been exposed to arsenic (Brouwer et al. 1992). The authors suggest that the MTHFR deficiency in this girl might explain the fact that of all the family members exposed to arsenic, only she developed severe clinical signs of arsenic poisoning. Liver disease does not appear to decrease methylation capacity in humans, at least at low levels of arsenic exposure (Buchet et al. 1982; Geubel et al. 1988).

3.11 METHODS FOR REDUCING TOXIC EFFECTS

This section will describe clinical practice and research concerning methods for reducing toxic effects of exposure to arsenic. However, because some of the treatments discussed may be experimental and unproven, this section should not be used as a guide for treatment of exposures to arsenic. When specific

exposures have occurred, poison control centers and medical toxicologists should be consulted for medical advice. The following texts provide specific information about treatment following exposures to arsenic:

Tintinalli JE, Ruiz E, Krone RL, eds. 1996. Emergency medicine. A comprehensive study. American College of Emergency Physicians. 4th ed. New York, NY: The McGraw-Hill Companies, Inc.

Goldfrank RL, Flomenbaum NE, Lewin NA, et al., eds. 1998. Goldfrank's toxicologic emergencies. 6th ed. Stamford, CT: Appleton and Lange.

Ellenhorn MJ. 1997. Ellenhorn's medical toxicology. Diagnosis and treatment of human poisoning. Baltimore, MD: Williams & Wilkins.

3.11.1 Reducing Peak Absorption Following Exposure

No data were located regarding the reduction of absorption after inhalation exposure to arsenic.

There are a number of methods for reducing absorption of arsenic following oral exposure. In cases of acute high-dose exposure, the removal of arsenic from the gastrointestinal tract may be facilitated by gastric lavage, stomach intubation, induced emesis, or use of cathartics (saline, sorbitol) within a few hours after ingestion (Agency for Toxic Substances and Disease Registry 1990a; Aposhian and Aposhian 1989; Campbell and Alvarez 1989; Driesback 1980; Ellenhorn and Barceloux 1988; EPA 1989e; Haddad and Winchester 1990; Kamijo et al. 1998; Stutz and Janusz 1988). However, the efficacy of several of these methods has been questioned by some authors, and in some cases, the treatments may be contraindicated. For example, vomiting and diarrhea often occur soon after ingesting arsenic, and therefore, use of an emetic or cathartic may not be necessary. Also, emesis should not be induced in obtunded, comatose, or convulsing patients (Campbell and Alvarez 1989; Ellenhorn and Barceloux 1988; EPA 1989e), and saline cathartics should be used with caution in patients with impaired renal function (Campbell and Alvarez 1989). Vantroyen et al. (2004) described a case of a massive arsenic trioxide overdose that was successfully treated by continuous gastric irrigation with sodium bicarbonate, forced diuresis, and administration of BAL and DMSA. Treatments of this sort are unlikely to be required following low-level exposures.

Another possible approach for reducing absorption following oral exposure is to administer substances that bind the arsenic in the gastrointestinal tract. For example, activated charcoal is sometimes used for this purpose (Campbell and Alvarez 1989; EPA 1989e; Stutz and Janusz 1988), although the effectiveness of this treatment is not well established. Because pentavalent arsenic is a phosphate analogue,

administration of phosphate-binding substance such as aluminum hydroxide might possibly be useful, but this has not been investigated. Sulfhydryl compounds might be given to bind trivalent arsenic, but it seems unlikely that these would be effective under the acid conditions in the stomach, and it is not clear that such complexes would have reduced gastrointestinal absorption.

Following dermal or ocular exposure to arsenic, several measures can be taken to minimize absorption. All contaminated clothing should be removed, and contacted skin should be immediately washed with soap and water. Eyes that have come in contact with arsenic should be flushed with copious amounts of clean water (EPA 1989e; Stutz and Janusz 1988).

3.11.2 Reducing Body Burden

Acute arsenic intoxication may require treatment with chelating agents such as dimercaprol (BAL) and D-penicillamine. Although body burden is not necessarily reduced, these chelators bind free arsenic and serve to reduce the body's pool of biologically active arsenic. Chelation therapy is most effective when instituted within a few hours after exposure, and efficacy decreases as time after exposure increases (Agency for Toxic Substances and Disease Registry 1990a; Kamijo et al. 1998; McFall et al. 1998; Peterson and Rumack 1977).

In general, chelating agents should be used with caution, since they may have serious side effects such as pain, fever, hypotension, and nephrotoxicity (Ellenhorn and Barceloux 1988). Some water-soluble and less toxic analogues of BAL such as dimercaptosuccinic acid (DMSA), dimercaptopropyl phthalamadic acid (DMPA), and dimercaptopropane sulfonic acid (DMPS) are currently under investigation and may prove to be promising treatments for arsenic poisoning (Agency for Toxic Substances and Disease Registry 1990a; Aposhian and Aposhian 1989; Aposhian et al. 1997; Guha Mazumder 1996; Kreppel et al. 1995). However, a randomized placebo trial of 2,3-dimercaptosuccinic acid as a therapy for chronic arsenosis due to drinking contaminated water found no significant difference between patients treated with 2,3-dimercaptosuccinic acid and those treated with a placebo (Guha Mazumder et al. 1998a). N-acetylcysteine has been used in animals to chelate arsenic (Haddad and Winchester 1990), and a human case study reported N-acetylcysteine to be successful in treating a case of arsenic poisoning that was not responding well to BAL treatment (Martin et al. 1990). Vantroyen et al. (2004) described a case of a massive arsenic trioxide overdose that was successfully treated by continuous gastric irrigation with sodium bicarbonate, forced diuresis, and administration of BAL and DMSA.

As discussed in Section 3.4.3, once arsenic has been absorbed into the blood stream, it undergoes methylation to yield MMA and DMA. These forms of arsenic are less toxic than inorganic arsenic and are cleared from the body by excretion in the urine. Therefore, if it were possible to enhance arsenic methylation, both body burden and toxicity of arsenic might be reduced. However, experimental evidence in animals and humans suggests that arsenic methylation is not enhanced to any significant degree by supplementation with methylation cofactors (Buchet and Lauwerys 1987; Buchet et al. 1982), presumably because it is enzyme level and not cofactor availability that is rate limiting in arsenic methylation.

3.11.3 Interfering with the Mechanism of Action for Toxic Effects

It is generally thought that trivalent arsenic exerts its toxic effects mainly by complexing with sulfhydryl groups in key enzymes within the body, thereby inhibiting critical functions such as gluconeogenesis and DNA repair (Aposhian and Aposhian 1989; Li and Rossman 1989). Therefore, administration of sulfhydryl-containing compounds soon after exposure could provide alternative target molecules for arsenic, and prevent inhibition of enzyme functions. In fact, many of the chelating agents discussed above (BAL, DMSA, DMPA, DMPS, N-acetylcysteine) contain sulfhydryl groups, and this may account for their efficacy.

The mechanism by which pentavalent arsenic acts is less certain. Since pentavalent arsenic is reduced in the body to the trivalent state, pentavalent arsenic may act in a similar manner as described above for trivalent arsenic. If this is the case, efforts to inhibit the reduction of pentavalent arsenic would decrease its toxicity. However, no methods are currently recognized for blocking this reduction. Pentavalent arsenic may also exert effects by acting as a phosphate analogue. As a phosphate analogue, pentavalent arsenic could potentially affect a number of biological processes, including ATP production, bone formation, and DNA synthesis. However, any effort to interfere in normal phosphate metabolism could produce serious side effects, and no method is known for selectively interfering with arsenate metabolism.

3.12 ADEQUACY OF THE DATABASE

Section 104(I)(5) of CERCLA, as amended, directs the Administrator of ATSDR (in consultation with the Administrator of EPA and agencies and programs of the Public Health Service) to assess whether adequate information on the health effects of arsenic is available. Where adequate information is not available, ATSDR, in conjunction with the National Toxicology Program (NTP), is required to assure the

initiation of a program of research designed to determine the health effects (and techniques for developing methods to determine such health effects) of arsenic.

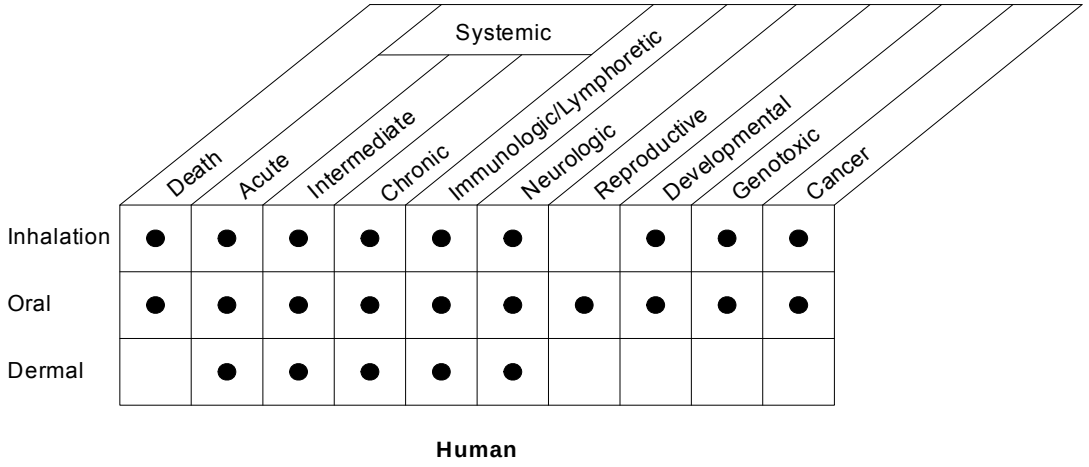
The following categories of possible data needs have been identified by a joint team of scientists from ATSDR, NTP, and EPA. They are defined as substance-specific informational needs that if met would reduce the uncertainties of human health assessment. This definition should not be interpreted to mean that all data needs discussed in this section must be filled. In the future, the identified data needs will be evaluated and prioritized, and a substance-specific research agenda will be proposed.

3.12.1 Existing Information on Health Effects of Arsenic

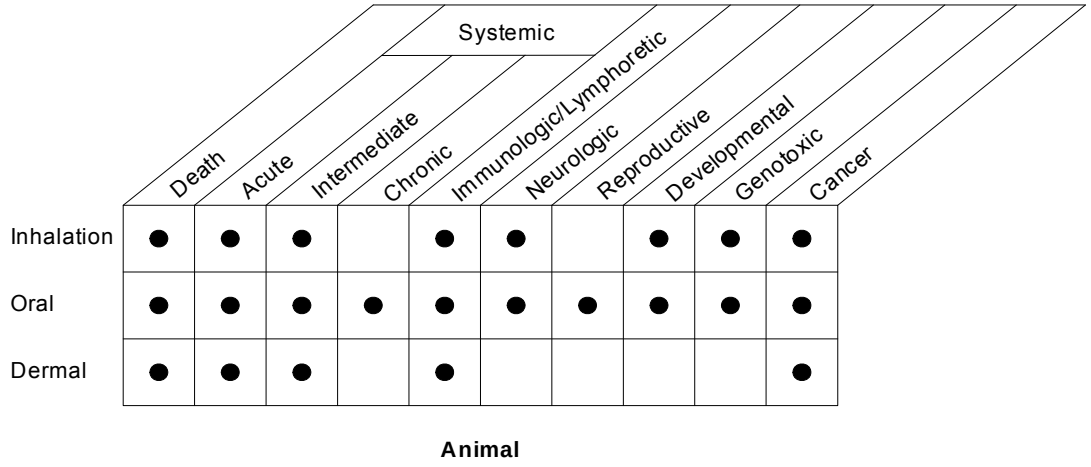
The existing data on health effects of inhalation, oral, and dermal exposure of humans and animals to inorganic and organic arsenic are summarized in Figures 3-13 and 3-14, respectively. The purpose of this figure is to illustrate the existing information concerning the health effects of arsenic. Each dot in the figure indicates that one or more studies provide information associated with that particular effect. The dot does not necessarily imply anything about the quality of the study or studies, nor should missing information in this figure be interpreted as a "data need". A data need, as defined in ATSDR's *Decision Guide for Identifying Substance-Specific Data Needs Related to Toxicological Profiles* (Agency for Toxic Substances and Disease Registry 1989), is substance-specific information necessary to conduct comprehensive public health assessments. Generally, ATSDR defines a data gap more broadly as any substance-specific information missing from the scientific literature.

As shown in Figure 3-13, there is a substantial database on the toxicity of inorganic arsenicals, both in humans and in animals. The oral route has been most thoroughly investigated, and reports are available on most end points of concern following acute, intermediate, and chronic exposure. The inhalation route has also been studied extensively, mainly in humans, with special emphasis on lung cancer. A number of noncancer end points have also been studied following inhalation exposure, but information on these effects is less extensive. Limited information on the effects of dermal exposure is also available in both humans and animals, focusing mainly on direct irritancy and dermal sensitization reactions. The absence of studies on other effects of inorganic arsenic following dermal exposure is probably not a critical data need, since dermal uptake of inorganic arsenic appears to be sufficiently limited that other routes of exposure (oral or inhalation) would almost always be expected to be of greater concern.

Figure 3-13. Existing Information on Health Effects of Inorganic Arsenic



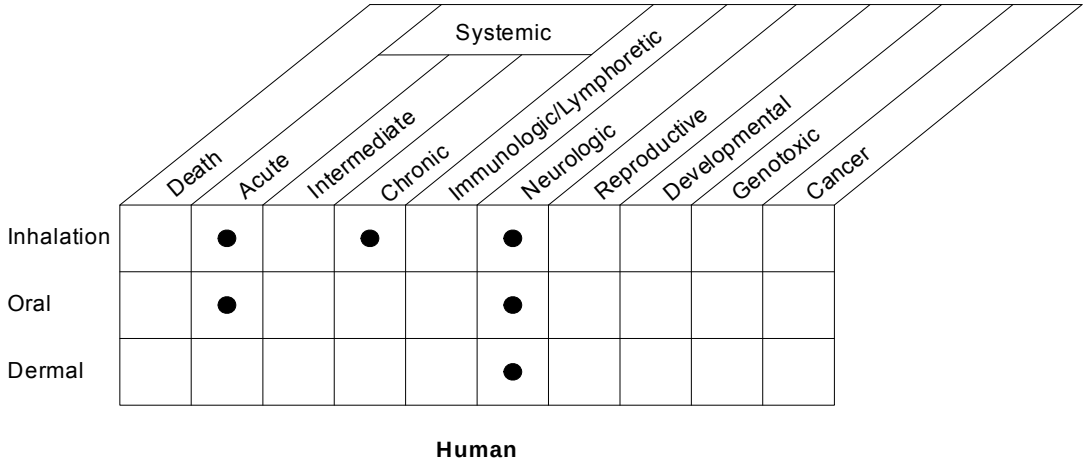
Human



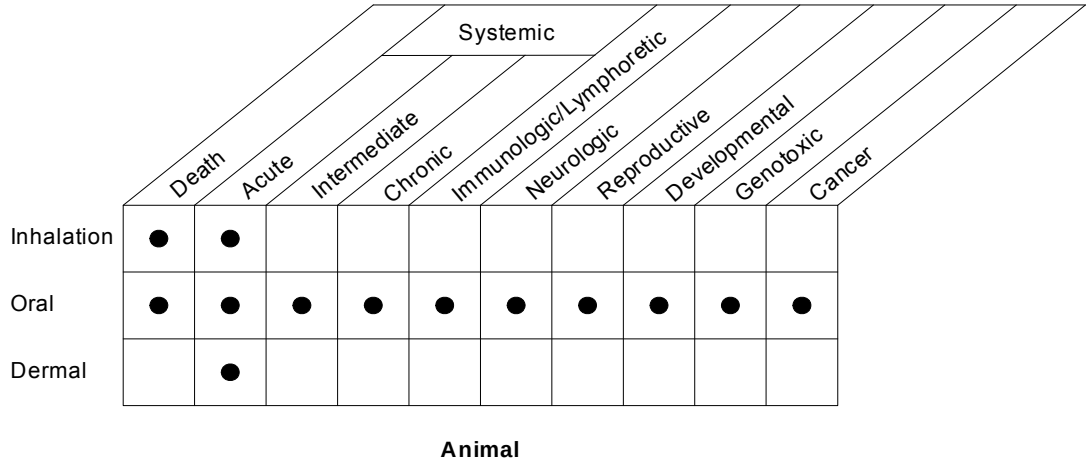
Animal

● Existing Studies

Figure 3-14. Existing Information on Health Effects of Organic Arsenic



Human



Animal

● Existing Studies

As shown in Figure 3-14, very little information is available on the effects of organic arsenic compounds in humans, although there are a number of studies in animals. These studies mainly involve the oral route, since all of these compounds are nonvolatile solids, although a few acute inhalation studies have been performed. Limited information is available on acute dermal lethality and dermal irritancy of some organic arsenicals, but data are lacking on other effects of organic arsenicals following dermal exposure. As discussed previously, in evaluating the adequacy of the database on arsenic, it is important to keep in mind that most studies in animals indicate that they are quantitatively less sensitive to arsenic than humans. For this reason, data from animal studies should be used to draw inferences about effects in humans only with caution.

3.12.2 Identification of Data Needs

Acute-Duration Exposure.

Inorganic Arsenicals. There is only limited information on the effects of acute inhalation exposure to arsenic in humans, but the chief symptoms appear to be irritation of the respiratory and gastrointestinal tracts (Beckett et al. 1986; Bolla-Wilson and Bleecker 1987; Dunlap 1921; Ide and Bullough 1988; Morton and Caron 1989; Pinto and McGill 1953). Quantitative data are lacking, but effects generally appear to be mild even at high-exposure levels. On this basis, it seems that risks of acute effects are probably low for inhalation exposures in the environment or near waste sites. Research to obtain a quantitative acute inhalation NOAEL value that could be used to derive an acute inhalation MRL would, therefore, be useful but not critical. There are numerous case studies in humans on the acute oral toxicity of arsenic, and the main end points (gastrointestinal irritation, pancytopenia, hepatic injury, neuropathy) are well characterized (Armstrong et al. 1984; Fincher and Koerker 1987). An acute oral MRL of 0.005 mg As/kg/day was derived for inorganic arsenic based on a LOAEL for gastrointestinal symptoms and facial edema reported by Mizuta et al. (1956). Additional studies to define an acute oral NOAEL would be useful to reduce uncertainty in the MRL derivation. Acute dermal exposure is unlikely to cause serious systemic injury, but it can lead to contact dermatitis and skin sensitization (Holmqvist 1951; Pinto and McGill 1953). However, available data do not permit a quantitative estimate of the concentration of arsenic on the skin or in air, dust, soil, or water that causes these effects. Further research would be valuable to obtain a quantitative NOAEL for direct dermal effects, since humans may have dermal contact with contaminated soil or water near hazardous waste sites.

Organic Arsenicals. Information on the acute toxicity of organic arsenicals in humans is limited to reports of gastrointestinal irritation in individuals ingesting pesticides containing organic arsenicals (Lee et al. 1995; Shum et al. 1995); these case reports provide limited dosing information. Acute lethality and systemic toxicity data exist for several compounds by inhalation, oral, and dermal exposure of animals. Inhalation data are limited to a lethality study of rats and mice exposed to MMA or DMA that reported respiratory and ocular irritation (Stevens et al. 1979). The oral acute studies consist of lethality studies for MMA (Gur and Nyska 1990; Jaghabir et al. 1988; Kaise et al. 1989), DMA (Kaise et al. 1989), and roxarsone (Kerr et al. 1963; NTP 1989b), systemic toxicity studies (or longer-term studies reporting effects within the first 2 weeks of exposure) for MMA (Irvine et al. 2006), DMA (Ahmad et al. 1999a; Chernoff et al. 1990; Cohen et al. 2001; Crown et al. 1987; Irvine et al. 2006; Kavlock et al. 1985; Rogers et al. 1981; Zomber et al. 1989), or roxarsone (NTP 1989b). For MMA, the available data suggest that the gastrointestinal tract may be the most sensitive target of toxicity; however, the study identifying the lowest LOAEL (Irvine et al. 2006) involved bolus administration and this is not an appropriate exposure route to estimate human risk for gastrointestinal effects following environmental exposure to MMA. The available animal studies for DMA have examined urinary bladder (Cohen et al. 2001) and developmental toxicity (Chernoff et al. 1990, Irvine et al. 2006; Kavlock et al. 1985; Rogers et al. 1981). For DMA, acute-duration studies in rats suggest that the urinary bladder is the most sensitive target of toxicity in rats (Cohen et al. 2001); however, there is evidence from longer-term studies that rats may be more sensitive than humans and other species for bladder effects. Thus, rat data were not considered as the basis of an acute-duration oral MRL for DMA. Other effects observed following acute exposure to DMA include developmental and maternal effects in mice (Kavlock et al. 1985; Rogers et al. 1981) and rabbits (Irvine et al. 2006) and diarrhea and vomiting in dogs receiving a bolus dose of DMA (Zomber et al. 1989). An acute-duration oral MRL was not derived for DMA because it is not known if systemic effects would occur at lower doses than the developmental effects. For roxarsone, the available data suggest that the most sensitive effect following acute oral exposure is neuropathy observed in pigs (Kennedy et al. 1986; Rice et al. 1985). At the only dose tested in this study, tremors, clonic convulsions, and equivocal evidence of myelin degeneration were observed; these were considered serious effects and not suitable for the derivation of an acute-duration oral MRL for roxarsone. Additional studies are needed for MMA, DMA, and roxarsone that examine a variety of end points in several species; studies for roxarsone should also include examination of neurological end points, which would be useful for identifying the critical targets of toxicity and establishing dose-response relationships.

Intermediate-Duration Exposure.

Inorganic Arsenicals. Intermediate-duration inhalation exposure of humans to arsenic appears to result in respiratory tract irritation (occasionally including perforation of the nasal septum) and mild gastrointestinal tract irritation (Ide and Bullough 1988). Quantitative data are too limited (only one study, of one individual) to derive an intermediate-duration inhalation MRL. Further studies to define the NOAEL for intermediate-duration inhalation exposure of humans would be valuable, since humans could be exposed to arsenic-containing airborne dusts near smelters, chemical plants, or waste sites. Effects of intermediate-duration oral exposure are similar to those of acute oral exposure, but may also include development of vascular injury and a characteristic group of skin changes (Franzblau and Lilis 1989; Holland 1904; Wagner et al. 1979). Most studies indicate that these effects occur at doses of about 0.05 mg As/kg/day or higher, but the data do not provide a firm basis for identifying the intermediate-duration NOAEL. For this reason, no intermediate-duration oral MRL has been derived. Further studies to establish the NOAEL would be valuable, since humans could have intermediate-duration oral exposures to arsenic through ingestion of contaminated soil or water near smelters, chemical factories, or waste sites. Since dermal effects appear to be restricted to acute irritancy, intermediate-duration dermal studies are probably not essential.

Organic Arsenicals. No information was located on the intermediate-duration toxicity of organic arsenicals in humans. Several studies have examined the intermediate-duration oral toxicity of MMA; dietary exposure studies in rats and mice (Arnold et al. 2003) identify the gastrointestinal tract as the most sensitive target. Diarrhea and lesions in the cecum, colon, and rectum have been observed. The rat 13-week study (Arnold et al. 2003) was used as the basis of the MRL. Because rats appear to be more sensitive to the toxicity of DMA, rat studies were not considered for MRL derivation. The only non-rat study was a chronic-duration dog study reporting effects during the first 51 weeks of exposure (Zomber et al. 1989); these effects included diarrhea and vomiting. However, because DMA was administered via capsule, this study was not considered adequate for derivation of an MRL. Additional studies are needed for DMA to identify critical targets of toxicity and establish dose-response relationships in non-rat species. The available data for roxarsone suggest that neurotoxicity in pigs is the most sensitive end point. One of the two available neurotoxicity studies in pigs (Edmonds and Baker 1986) did not include sensitive tests of toxicity and was not considered for MRL derivation; the other study identified a serious LOAEL at the only dose tested and thus, was not suitable for MRL derivation. Several comprehensive studies examined the toxicity of roxarsone in rats and mice (NTP 1989b). Renal tubular damage in rats was the most sensitive end point (NTP 1989b); however, the LOAEL for this effect was 9 times higher

than the dose associated with neurotoxicity in pigs. Additional studies are needed to establish a no effect level for neurotoxicity in pigs, which could be used to derive an intermediate duration MRL for roxarsone. Further studies on the intermediate-duration inhalation and dermal toxicity of these compounds would be valuable, especially in humans, since people may be exposed to organic arsenicals during their manufacture or use, or from materials deposited in waste sites.

Chronic-Duration Exposure and Cancer.

Inorganic Arsenicals. The target tissues of chronic-duration exposure of humans to inorganic arsenic are the same as for intermediate-duration exposure for both the oral and inhalation routes. Effects of dermal exposure appear to be restricted to direct irritation of exposed surfaces. Therefore, chronic-duration studies are probably not essential for the dermal route. Quantitative data from one study identify an inhalation exposure level of about 0.1 mg As/m^3 as the LOAEL for skin changes (Perry et al. 1948), but because there are no additional supporting studies and a NOAEL is not clearly established, a chronic-duration inhalation MRL has not been derived. Additional studies in humans to define the chronic inhalation NOAEL for dermal or other effects would be valuable, since humans may be chronically exposed to arsenic dusts in air near smelters, chemical factories, or waste sites. Chronic oral exposure data from studies in humans indicate that the LOAEL for skin lesions and other effects is probably about 0.01–0.02 mg As/kg/day (10–20 µg As/kg/day), and that the NOAEL is probably between 0.0004 and 0.0009 mg As/kg/day (0.4–0.9 µg As/kg/day) (Cebrián et al. 1983; EPA 1981b; Hindmarsh et al. 1977; Tseng 1977; Tseng et al. 1968). The NOAEL of 0.0008 mg As/kg/day from the study by Tseng et al. (1968) is appropriate for derivation of a chronic-duration oral MRL, but an uncertainty factor of 3 was required to account for the fact that the population that constituted the no-effect group were relatively young (possibly decreasing the ability to detect dermal or other effects that increase in prevalence with age). Another issue that needs to be acknowledged, which is common to ecological studies and contributes to uncertainty, is the fact that individual doses were not available and were calculated from group mean arsenic concentrations in well water using estimated water intake parameters. For this reason, further epidemiological studies that do not rely on an ecological-based exposure assessment that would provide additional support for the threshold dose for arsenic in humans would be valuable.

There are numerous studies in humans that support the carcinogenic effects of inorganic arsenic from inhalation exposure (Enterline et al. 1987a, 1987b, 1995; Järup and Pershagen 1991; Järup et al. 1989; Lee-Feldstein 1986; Welch et al. 1982) and oral exposure (Chen et al. 1986, 1988b, 1992; Chiou et al. 1995; Ferreccio et al. 1996; Hsueh et al. 1995; Lander et al. 1975; Liu and Chen 1996; Lüchtrath 1983;

Smith et al. 1992; Tseng 1977; Tseng et al. 1968; Yu et al. 1992; Zaldívar 1974; Zaldívar et al. 1981). Quantitative slope factors have been derived for both routes. There is a noticeable absence, however, of 2-year animal carcinogenicity studies for either the inhalation or oral route of exposure (Chan and Huff 1997). In light of the ongoing controversy over the reasons for the absence of a carcinogenic effect in animals, it seems prudent to firmly establish a negative effect in a 2-year study. The carcinogenic effects of chronic dermal exposure to inorganic arsenicals have not been studied, but dermal exposure is a relatively minor route of exposure, and these studies would not be a top priority.

The mechanism of arsenic carcinogenicity is not known, although the current view is that it functions mainly as a promoter or cocarcinogen. Further studies on the mechanism of arsenic toxicity would be particularly valuable to improve our ability to evaluate human cancer risks from inhalation or oral exposures that might occur near waste sites. Also, mechanistic studies could help in the evaluation of cancer risks from organic derivatives (see below).

Organic Arsenicals. There is very little information on the chronic toxicity of organic arsenicals in humans. One study of workers exposed to arsanilic acid did not identify any adverse effects, but no systematic, clinical, or toxicological examinations of exposed people were performed (Watrous and McCaughey 1945). Chronic toxicity studies are available for rats, mice, and dogs exposed to MMA (Arnold et al. 2003; Waner and Nyska 1988), DMA (Arnold et al. 2006; Zomber et al. 1989), and roxarsone (NTP 1989b; Prier et al. 1963). Chronic exposure to MMA results in diarrhea in rats, mice, and dogs (Arnold et al. 2003; Waner and Nyska 1988) and an increase in progressive nephropathy in rats and mice (Arnold et al. 2003). The increased incidence of progressive nephropathy was used as the basis of the chronic-duration oral MRL for MMA. For DMA, chronic exposure also resulted in an increased incidence of diarrhea and vomiting in dogs (Zomber et al. 1989) and an increased incidence of vacuolization in the urinary bladder and progressive nephropathy in mice (Arnold et al. 2006). The vacuolization in the urinary bladder was used as the basis of a chronic-duration oral MRL for DMA. The available data for chronic-exposure to roxarsone were considered inadequate for derivation of an MRL. The highest doses tested in the rat, mouse, and dog studies (NTP 1989b; Prier et al. 1963) were NOAELs. Intermediate-duration studies identify neurotoxicity in pigs as the most sensitive end point; this has not been adequately examined following chronic exposure and studies are needed.

No information was located on carcinogenic effects of organic arsenicals in humans. The carcinogenic potential of MMA (Arnold et al. 2003), DMA (Arnold et al. 2006), and roxarsone (NTP 1989b) following oral exposure has been investigated in rats and mice. No evidence of carcinogenicity was observed

following oral exposure to MMA (Arnold et al. 2003) and equivocal evidence of carcinogenicity was found in male rats, with no evidence of carcinogenicity in female rats or in male or female mice orally exposed to roxarsone (NTP 1989b). Oral exposure to DMA resulted in an increased incidence of urinary bladder tumors in rats and no evidence of carcinogenicity in mice (Arnold et al. 2006). However, there is concern that the rat is not a good model to assess the carcinogenic potential of DMA in humans due to species differences in the toxicokinetic properties of DMA. No information was located on the carcinogenicity of organic arsenicals following inhalation or dermal exposure. Studies of humans exposed in the workplace would provide valuable information on the carcinogenic potential of organic arsenicals, particularly DMA. Studies on cancer risk following inhalation and dermal exposure to organic arsenicals are would be useful since these are possible routes of exposure for humans.

Genotoxicity.

Inorganic Arsenicals. There are several studies that suggest that inorganic arsenic may cause genotoxicity (mainly chromosomal effects) in exposed humans (Burgdorf et al. 1977; Nordenson et al. 1978), and this is supported by numerous studies in animals (Datta et al. 1986; DeKnudt et al. 1986; Nagymajtényi et al. 1985) and cultured cells (Beckman and Nordenson 1986; Casto et al. 1979; DiPaolo and Casto 1979; Lee et al. 1985; Nakamuro and Sayato 1981; Nishioka 1975; Oberly et al. 1982; Okui and Fujiwara 1986; Sweins 1983; Ulitzur and Barak 1988; Zanzoni and Jung 1980). The mechanism of genotoxicity is not known, but may be due to the ability of arsenite to interfere with DNA repair (Li and Rossman 1989) or to alter apoptosis (Pi et al. 2005) or the ability of arsenate to act as a phosphate analog. Further studies to improve our understanding of the mechanism of genotoxicity would be valuable, since this could aid in the understanding of arsenic-induced cancer risk.

Organic Arsenicals. For organic arsenicals, *in vitro* genotoxicity studies are available for arsenobetaine (Eguchi et al. 1997; Oya-Ohta et al. 1996), MMA (Chun and Killeen 1989a, 1989b, 1989c, 1989d; Eguchi et al. 1997; Oya-Ohta et al. 1996), DMA (Eguchi et al. 1997; Endo et al. 1992; Kato et al. 1994; Kawaguchi et al. 1996; Kitamura et al. 2002; Kuroda et al. 2004; Moore et al. 1997a; Oya-Ohta et al. 1996; Rasmussen and Menzel 1997; Rin et al. 1995; Tezuka et al. 1993; Ueda et al. 1997; Yamanaka et al. 1989b, 1993, 1995, 1997), and roxarsone (Matthews et al. 1993; NTP 1989b; Storer et al. 1996) and *in vivo* studies are available for DMA (Kashiwada et al. 1998; Yamanaka and Okada 1994; Yamanaka et al. 1989a, 1989b, 1993, 2001). The results of these studies suggest that DMA and roxarsone are clastogenic and can cause DNA strand breaks. Additional *in vivo* studies are needed to evaluate the genotoxic potential of MMA and roxarsone.

Reproductive Toxicity.

Inorganic Arsenicals. Several studies have examined reproductive function in populations living in Bangladesh or India exposed to high levels of arsenic in drinking water and found increases in spontaneous abortions/stillbirths or preterm births (Ahmad et al. 2001; von Ehrenstein et al. 2006); another study in U.S. women did not find an increase in adverse reproductive outcomes (Aschengrau et al. 1989). Available animal studies did not find evidence for reproductive effects following inhalation or oral exposure (Holson et al. 1999, 2000), except for a trend toward decreased pups per litter in mice in a 3-generation study (Schroeder and Mitchener 1971) that is consistent with embryolethality observed in developmental studies of inorganic arsenic. Studies on spermatogenesis and reproductive success in arsenic-exposed workers would be valuable in evaluating whether there are significant reproductive risks of arsenic in humans, and this could be further strengthened by studies including histopathological examination of reproductive tissues (which was not done in the existing studies) in animals.

Organic Arsenicals. No information was located on reproductive effects of organic arsenicals in humans and no inhalation or dermal exposure animal studies were located. Intermediate- and chronic-duration oral studies for MMA (Arnold et al. 2003), DMA (Arnold et al. 2006), and roxarsone (NTP 1989b) have not reported histological damage to reproductive tissues. Decreases in pregnancy rate and male fertility index were observed in a two-generation study in rats (Schroeder 1994) and a single generation study in mice (Prukop and Savage 1986) exposed to MMA; the poor reporting in the Prukop and Savage (1986) study limits its usefulness in assessing reproductive toxicity. However, in the two-generation study, the differences between control and exposed rats were not statistically different; the effect was considered biologically significant because effects observed in the exposed rats were outside the range found in historical controls. Another reproductive performance study to confirm these results would be useful. No reproductive effects were observed in a two generation study in rats exposed to DMA (Rubin et al. 1989).

Developmental Toxicity.

Inorganic Arsenicals. There are several epidemiological studies that suggest that inhalation (Ihrig et al. 1998; Nordström et al. 1978a, 1978b, 1979a, 1979b) or oral (Hopenhayn et al. 2003a; Yang et al. 2003) exposure to inorganic arsenic might increase the risk of low birth weight, congenital defects, or abortion in exposed women. These studies do not establish that arsenic was responsible, since all involved exposures to other chemicals or risk factors, but do suggest that additional studies on developmental

parameters in humans exposed to arsenic would be valuable in determining whether this is an effect of concern. Other human studies have not found significant associations between arsenic levels in drinking water and increased neonatal deaths or infant mortality (von Ehrenstein et al. 2006) or the increase in congenital heart defects (Zierler et al. 1988) or neural tube defects (Brender et al. 2006). Studies in animals support the view that oral, inhalation, and parenteral exposure to inorganic arsenic can all increase the incidence of fetotoxicity and teratogenicity, although this appears to occur only at doses that are toxic or even lethal to the dams (Baxley et al. 1981; Beaudoin 1974; Carpenter 1987; Ferm and Carpenter 1968; Ferm et al. 1971; Hanlon and Ferm 1986; Holson et al. 1999, 2000; Hood and Bishop 1972; Hood and Harrison 1982; Hood et al. 1978; Mason et al. 1989; Nagymajtényi et al. 1985; Nemec et al. 1998; Stump et al. 1999; Willhite 1981). There are also some data to suggest that it may increase the risk of transplacental cancer in humans (Smith et al. 2006) and animals (Waalkes et al. 2003). Thus, additional studies in animals may be useful in defining the mechanisms of these developmental effects and in identifying the time of maximum susceptibility of the fetus, but such studies probably will not help identify a safe exposure level for humans.

Organic Arsenicals. No information was located regarding developmental effects in humans after oral or inhalation exposure to organic arsenicals. Animal studies conducted in rats (Chernoff et al. 1990; Irvine et al. 2006; Rogers et al. 1981), mice (Kavlock et al. 1985; Rogers et al. 1981), and rabbits (Irvine et al. 2006) have examined the developmental toxicity of organic arsenicals. Decreases in fetal body weights and delays in ossification were commonly reported at maternally toxic (decreases in body weight gain) doses of DMA (Irvine et al. 2006; Kavlock et al. 1985; Rogers et al. 1981). However, one study found increases in the percentage of fetuses with irregular palatine rugae at DMA doses not associated with maternal toxicity (Rogers et al. 1981). This effect has not been reported in other studies and additional developmental studies are needed to confirm the finding. In view of the apparent differences in susceptibility between animals and humans, it would be valuable to investigate whether there are any measurable effects on development in humans exposed to organic arsenicals in the workplace or the environment.

Immunotoxicity.

Inorganic Arsenicals. No studies were located on immunotoxic effects in humans after oral exposure to inorganic arsenic. One inhalation study in humans (Bencko et al. 1988), an inhalation study in animals (Aranyi et al. 1985), one oral study in animals (Kerkvliet et al. 1980), and one intratracheal instillation study in animals (Sikorski et al. 1989) suggest that arsenic causes little or no functional impairment of the

immune system, but one inhalation study in animals found decreased pulmonary bactericidal activity and increased susceptibility to streptococcal infection in exposed mice (Aranyi et al. 1985). Additional studies (both in humans and animals) would be valuable to investigate this end point further. Dermal exposure of humans to high levels of arsenic dusts may cause dermal sensitization (Holmqvist 1951), but the dose and time dependence of this phenomenon are not known. Studies to determine whether dermal sensitization occurs in people with low level dermal exposures to arsenic in dust or soil, such as might occur for residents near an arsenic-containing waste site, would be valuable in assessing the significance of this effect to nonoccupationally exposed populations.

Organic Arsenicals. No information was located on the effect of organic arsenicals exposure in humans or animals on immune function. Since there are suggestions that inorganic arsenic may cause some changes in the immune system, studies on possible immune effects of the common organic arsenicals might be helpful.

Neurotoxicity.

Inorganic Arsenicals. There is convincing evidence from studies in humans that inorganic arsenic can cause serious neurological effects, both after inhalation (Beckett et al. 1986; Bencko et al. 1977; Blom et al. 1985; Buchancová et al. 1998; Calderón et al. 2001; Danan et al. 1984; Feldman et al. 1979; Gerr et al. 2000; Lagerkvist and Zetterlund 1994; Morton and Caron 1989) and oral exposure (Armstrong et al. 1984; Bartolome et al. 1999; Chakraborti et al. 2003a, 2003b; Civantos et al. 1995; Cullen et al. 1995; Danan et al. 1984; EPA 1977a; Feldman et al. 1979; Fincher and Foy et al. 1992; Franzblau and Lilis 1989; Guha Mazumder et al. 1988; Hindmarsh et al. 1977; Huang et al. 1985; Fincher and Koerker 1987; Levin-Scherz et al. 1987; Lewis et al. 1999; Mizuta et al. 1956; Muzi et al. 2001; Quatrehomme et al. 1992; Silver and Wainman 1952; Szuler et al. 1979; Tsai et al. 2003; Uede and Furukawa 2003; Vantroyen et al. 2004; Wagner et al. 1979). This is based mainly on clinical observations and neurological examinations of exposed persons. Available studies provide a reasonable estimate of LOAEL and NOAEL values by the oral route, but similar data are lacking for the inhalation route. Further studies designed to identify the threshold for neurological effects in humans exposed by the inhalation route would be valuable, since humans may be exposed to arsenic dusts in air from smelters, chemical factories, or waste sites. Adult animals appear to be much less susceptible than humans to the neurological effects of inorganic arsenic, so studies in adult animals would probably not help in estimation of a safe exposure limit. However, in light of recent findings of possible associations between arsenic in drinking water and neurobehavioral alterations in children (Tsai et al. 2003; von Ehrenstein et

al. 2007; Wang et al. 2007; Wasserman et al. 2004, 2007), studies in animals, in which confounding can be eliminated, may be warranted.

Organic Arsenicals. Information on neurological effects of organic arsenicals in humans is limited to an occupational study that did not find increases in the frequency of central or peripheral nervous system complaints (Watrous and McCaughey 1945) and a case report of a women of a women reporting numbness and tingling of the fingertips, toes, and circomoral region who was exposed to organic arsenic in soup (Luong and Nguyen 1999). Neurological effects have also been observed in some animal studies. Decreases spontaneous motility, ataxia, and increased startle response were observed in mice exposed to a single high dose of DMA (Kaise et al. 1989). Degeneration of myelin and axons were observed in several studies involving oral exposure of pigs to roxarsone (Edmonds and Baker 1986; Kennedy et al. 1986; Rice et al. 1985). Hyperexcitability, ataxia, and trembling have also been observed in rats and mice orally exposed to roxarsone (Kerr et al. 1963; NTP 1989b). These findings suggest that more extensive investigations of the neurotoxic potential of roxarsone and other organic arsenicals would be valuable to determine the potential human health risk from these compounds, since humans could be exposed during the manufacture or use of these compounds, or near waste sites where they have been deposited.

Epidemiological and Human Dosimetry Studies. Numerous epidemiologic studies of humans exposed to inorganic arsenic by the oral and inhalation routes constitute the database on arsenic-related cancer and noncancer human health effects. As with virtually all epidemiologic investigations, these studies are limited by possible confounding from factors such as smoking, exposure to other chemicals, and differences in population characteristics (e.g., nutritional state, metabolism, and toxicokinetics) that inhibit extrapolation of study results to a wider population. Moreover, many of these studies lack good dose estimates for study participants. Some studies lack quantitative data altogether. For this reason, improved data on confounding factors and improved methods of human dosimetry would be valuable in any further human epidemiologic studies of arsenic, either in the workplace or in the general environment. Recent work has broadened the qualitative dose-response information beyond the highly exposed Taiwanese population, but additional studies of persons with lower exposure levels would be especially valuable for risk assessments for the U.S. population. From a public health standpoint, well designed studies of common noncancer health outcomes (e.g., cardiovascular disease and diabetes) could be more important than additional studies of cancer. Availability of methods for biomonitoring of exposure are discussed below.

Biomarkers of Exposure and Effect.

Exposure. There are sensitive and specific methods for measuring arsenic in blood, urine, hair, nails, and other tissues, and this is the approach normally employed for measuring arsenic exposure in humans. Usually total arsenic is measured, but methods are available for measuring inorganic arsenic and each of the organic derivatives separately. Urinary levels are generally considered to be the most reliable indication of recent exposures (Enterline et al. 1987a; Milham and Strong 1974; Pinto et al. 1976; Polissar et al. 1990), but if a high urinary level is present, care must be taken to account for the presence of nontoxic forms of arsenic from the diet. Blood levels are sometimes used to evaluate the status of acutely poisoned individuals (Driesback 1980; Heydorn 1970; Hindmarsh and McCurdy 1986; Valentine et al. 1979, 1981), but this approach is not generally useful for biomonitoring of long-term exposure to low levels. Hair and nails provide a valuable indication of exposures that occurred 1–10 months earlier (Agahian et al. 1990; Bencko et al. 1986; Choucair and Ajax 1988; EPA 1977a, 1981b; Milham and Strong 1974; Valentine et al. 1979; Yamauchi et al. 1989), although care must be taken to exclude external contamination of these samples. Cumulative urinary arsenic levels may be used to derive a quantitative estimate of exposure (Enterline et al. 1987a; Pinto et al. 1976), but data on the quantitative relation between exposure and arsenic levels in nails and hair were not located. Efforts to establish an algorithm for estimating past exposure levels from hair or nail levels would be valuable in quantifying average long-term exposure levels in people where repeated urinary monitoring is not feasible.

Effect. The effects of arsenic are mainly nonspecific, but the combined presence of several of the most characteristic clinical signs (e.g., nausea, diarrhea, peripheral neuropathy, anemia, vascular lesions, hyperkeratinization, hyperpigmentation) is usually adequate to suggest arsenic intoxication. Although there are standard clinical methods for detecting and evaluating each of these effects, there are no recognized methods for identifying early (preclinical) effects in exposed persons. Neurophysiological measurements of nerve conduction velocity or amplitude have been investigated (Goebel et al. 1990; Jenkins 1966; Le Quesne and McLeod 1977; Morton and Caron 1989; Murphy et al. 1981), but at present, this approach does not seem to offer much advantage over a standard neurological examination. Changes in urinary excretion levels of several heme-related metabolites appear to be a good indication of preclinical effects of arsenic toxicity in animals (Albores et al. 1989; Sardana et al. 1981; Woods and Fowler 1978; Woods and Southern 1989), but this has not been established in humans and is not specific for arsenic-induced effects. Further efforts to develop these approaches and to identify other more specific biochemical or physiological indicators of arsenic-induced effects would be very valuable in monitoring the health of persons exposed to low levels of arsenic in the environment or near waste sites.

Absorption, Distribution, Metabolism, and Excretion. Available data from toxicokinetic studies in humans reveal that arsenates and arsenites are well absorbed following both oral and inhalation exposure. Data on distribution are limited, but it appears that arsenic is transported to nearly all tissues. Metabolism involves mainly reduction-oxidation reactions that interconvert As(+5) and As(+3) and methylation of As(+3) to yield MMA and DMA. Most arsenic is rapidly excreted in the urine as a mixture of inorganic arsenics, MMA, and DMA, although some may remain bound in tissues (especially skin, hair, and fingernails). These findings are strongly supported by numerous studies in animals. Because methylation represents a detoxification pathway, an area of special interest is the capacity of the human body to methylate inorganic arsenic. Limited data suggest that the methylation system might begin to become saturated at intakes of about 0.2–1 mg As/day (Buchet et al. 1981b; Marcus and Rispin 1988), but this is uncertain. Further studies to define the rate and saturation kinetics of whole-body methylation in humans would be especially helpful in evaluating human health risk from the low levels of arsenic intake that are usually encountered in the environment. Along the same line, further studies to determine the nature and magnitude of individual variations in methylation capacity and how this depends on diet, age, and other factors would be very useful in understanding and predicting which members of a population are likely to be most susceptible.

The toxicokinetics of dermal exposure have not been studied. It is usually considered that dermal uptake of arsenates and arsenites is sufficiently slow that this route is unlikely to be of health concern (except that due to direct irritation), but studies to test the validity of this assumption would be valuable. Also, dermal uptake of organic arsenicals could be of concern, and quantitative data on the rate and extent of this would be helpful in evaluating risks from application of arsenical pesticides or exposures to organic arsenicals in waste sites.

Comparative Toxicokinetics. Available toxicity data indicate that arsenic causes many of the same effects in animals that are observed in humans, but that animals are significantly less sensitive. The basis for this difference in susceptibility is not certain but is probably mainly a result of differences in absorption, distribution, metabolism, or excretion. For example, rats strongly retain arsenic in red blood cells (Lanz et al. 1950), while humans (and most other species) do not. Similarly, marmoset monkeys do not methylate inorganic arsenic (Vahter and Marafante 1985; Vahter et al. 1982), while humans and other animal species do. Because of these clear differences in toxicity and toxicokinetics between species, further comparative toxicokinetic studies that focus on the mechanistic basis for these differences would be very valuable. At a minimum, this would help clarify which laboratory species are the most useful

models for humans and could ultimately lead to development of a PBPK model that would permit reliable extrapolation of observations across species.

Methods for Reducing Toxic Effects. There are a number of general methods for reducing the absorption of arsenic in the gastrointestinal tract and skin, but there are currently no methods for reducing the absorption of arsenic from the lungs. The removal of arsenic from the gastrointestinal tract is usually facilitated by the use of emetics, cathartics, lavages, or activated charcoal (Agency for Toxic Substances and Disease Registry 1990a; Aposhian and Aposhian 1989; Campbell and Alvarez 1989; Driesback 1980; Ellenhorn and Barceloux 1988; EPA 1989e; Haddad and Winchester 1990; Mitra et al. 2004; Stutz and Janusz 1988). Studies that investigate the effects of phosphate-binding chemicals (aluminum hydroxide) and nonabsorbable sulfhydryl compounds on the absorption of pentavalent and trivalent arsenic, respectively, may be useful in developing treatments that are more specific to arsenic intoxication. Once arsenic is in the body, treatment usually involves the use of one or more chelators, such as BAL or penicillamine. However, these agents often exhibit adverse side effects (Agency for Toxic Substances and Disease Registry 1990a; Ellenhorn and Barceloux 1988), and are generally only applied following high-dose acute exposure. Further studies investigating the efficacy of less toxic arsenic chelators, such as DMSA, DMPA, DMPS, and N-acetyl cysteine, may lead to the development of safer treatment methods. Studies on the efficacy of chelators and agents to enhance methylation and elimination in treatment of chronic arsenic exposure would also be helpful, as available treatment methods for chronic arsenic exposure are limited. Trivalent arsenic is generally believed to exert toxic effects by binding to the vicinal sulfhydryl group of key enzymes, thereby interfering with a number of biological processes, such as gluconeogenesis and DNA repair (Li and Rossman 1989; Szinicz and Forth 1988). Since pentavalent arsenic may need to be reduced in the body to the trivalent state before it can exert toxic effects, studies that investigate methods for blocking this conversion may lead to a method for interfering with the mechanism of action for pentavalent arsenic. The insufficient intake of calcium, animal protein, folate, selenium, and fiber may enhance the toxic effects of inorganic arsenic (Mitra et al. 2004), but it is not known if dietary supplementation will prove effective in patients who already show arsenic-induced symptoms.

Children's Susceptibility. Data needs relating to both prenatal and childhood exposures, and developmental effects expressed either prenatally or during childhood, are discussed in detail in the Developmental Toxicity subsection above.

A majority of the data on the effects of exposure of humans to arsenic has focused on adults. Although a few studies of acute poisoning and chronic exposure specifically describe children (Borgoño et al. 1980; Concha et al. 1998a, 1998b, 1999; Foy et al. 1992; Kersjes et al. 1987; Rosenberg 1974; Zaldívar 1974; Zaldívar and Guillier 1977), in general, data are lacking. Specifically, although there is a substantial database on the effect of arsenic on animal development, there are few data describing developmental effects in humans. Additional research in this area, using populations in areas of endemic arsenic exposure, would be useful.

Although there is no reason to suspect that the pharmacokinetics of arsenic differs in children and adults, there are few data available on this topic. Research on absorption, distribution, metabolism, and excretion in children would aid in determining if children are at an increased risk, especially in areas where chronic exposure to an environmental source occurs. With regard to exposure during development, additional research on maternal kinetics, and transfer via breast milk would be useful in obtaining a more complete picture of prenatal and neonatal development, especially with regard to neural development and the possible development of childhood cancer.

Child health data needs relating to exposure are discussed in Section 6.8.1, Identification of Data Needs: Exposures of Children.

3.12.3 Ongoing Studies

A number of researchers are continuing to investigate the toxicity and toxicokinetics of arsenic. Table 3-18 summarizes studies being sponsored by agencies of the U.S. federal government (FEDRIP 2007). Additional research is being sponsored by industry groups and other agencies, and research is also ongoing in a number of foreign countries.

Table 3-18. Ongoing Studies on Health Effects of Arsenic, Federally Funded

Investigator	Affiliation	Title	Sponsor
Ahsan, H	Columbia University, New York, New York	Chemoprevention of arsenic-induced skin cancer	NCI
Ahsan, H	Columbia University, New York, New York	Genetic susceptibility to arsenic-induced skin cancer	NCI
Andrew, A	Darmouth College, Hanover, New Hampshire	Bladder cancer prognostic indicators	NCI
Beckman, K	Children's Hospital and Research Center, Oakland, California	Fetal arsenic-nutrient interaction in adult-onset cancer	NIEHS
Bodwell, J	Darmouth College, Hanover, New Hampshire	Arsenic effects on glucocorticoid receptor action	NIEHS
Calderon, R	EPA, Research Triangle Park, North Carolina	Arsenic-induced skin conditions identified in Southwest United States	HEERL
Christiani, D	Harvard University, Boston, Massachusetts	Arsenic and health in Bangladesh	NIEHS
Dong, Z	University of Minnesota, Minneapolis, Minnesota	Molecular basis of arsenic-induced cell transformation	NCI
Finnell, R	Texas A & M University College Station, Texas	Sensitive genotypes to arsenic as a model environmental toxicant	NIEHS
Frenkel, K	New York University, New York, New York	Metal induced inflammatory factors, oxidative stress, and suppression	NIEHS
Futscher, B	University of Arizona, Tucson, Arizona	Epigenetic remodeling by environmental arsenicals	NCI
Gamble, M	Columbia University, New York, New York	Nutritional influences on arsenic toxicity	NIEHS
Germolec, D	NIH, Research Triangle Park, North Carolina	The role of growth factors and inflammatory mediators in arsenic-induced dermatotoxicity	NIEHS
Guallar, E	Johns Hopkins University, Baltimore, Maryland	Mercury, arsenic, and carotid atherosclerosis	NIEHS
He, K	Northwestern University, Chicago, Illinois	Trace elements and CVD risks factors among young adults	NHLBI
Hei, T	Columbia University, New York, New York	Mechanisms of arsenic carcinogenesis	NIEHS
Huang, C	New York University, New York, New York	Effects of arsenic on PI-3K signaling pathway	NCI
Hudgens, E	EPA, Research Triangle Park, North Carolina	Study of individuals chronically exposed to arsenic in drinking water	HEERL
Hughes, M	EPA, Research Triangle Park, North Carolina	Biomarkers of exposure: a case study with inorganic arsenic	HEERL
Hughes, M	EPA, Research Triangle Park, North Carolina	Tissue dosimetry, metabolism, and excretion of pentavalent arsenic	HEERL
Jing, Y	New York University, New York, New York	Arsenic trioxide and acute myeloid leukemia	NCI

Table 3-18. Ongoing Studies on Health Effects of Arsenic, Federally Funded

Investigator	Affiliation	Title	Sponsor
Jung, M	Georgetown University, Washington, DC	Epigenetic regulation by poly(ADP-ribose) in response to arsenite	NIEHS
Karin, M	University of California San Diego, La Jolla, California	Interaction of heavy metal ions with the human genome	NIEHS
Kelsey, K	Harvard University, Boston, Massachusetts	Arsenic mode of action in cancer—models of epigenetic mechanism	NIEHS
Liu, K	University of New Mexico, Albuquerque, New Mexico	Oxidative mechanisms of arsenic-induced carcinogenesis	NIEHS
Markowski, V	University of Southern Maine, Portland, Maine	Developmental arsenic exposure produces cognitive impairment	NIEHS
Martin, M	Georgetown University, Washington, DC	Arsenic and epigenetic regulation of gene expression	NIEHS
Muscarella, D	Cornell University Ithaca, Ithaca, New York	Arsenite effects on CD40 signaling and B-cell apoptosis	NIEHS
Nichols, R	Dartmouth College, Hanover, New Hampshire	Effect of arsenic on cytochrome P450	NIEHS
Nriagu, J	University of Michigan, Ann Harbor, Michigan	Arsenic exposure and bladder cancer in Michigan	NCI
Rosen, B	Wayne State University, Detroit, Michigan	Mechanisms of arsenical transport	NIGMS
Rosen, B	Wayne State University, Detroit, Michigan	Metal binding domains in metallo-regulatory proteins	NIAID
Rosenblatt, A	University of Miami, Coral Gables, Florida	Environmental arsenic and androgen receptor regulation	NIEHS
Rossman, T	New York University, New York, New York	Investigation and genetic analysis of the human arsenite efflux pump	NIEHS
Schwartz, J	Harvard University, Boston Massachusetts	Epigenetic effects of particles and metals on cardiac health of an aging cohort	NIEHS
Self, W	University of Central Florida, Orlando, Florida	Impact of arsenicals on selenoprotein synthesis	NIEHS
Sens, D	University of North Dakota, Grand Forks, North Dakota	Metallothionein isoform-3 urinary marker bladder cancer	NIEHS
Sheldon, L	Dartmouth College, Hanover, New Hampshire	Arsenic, histone modification, and transcription	NIEHS
Shi, X	University of Kentucky, Lexington, Kentucky	Mechanism of arsenic-induced carcinogenesis	NCI
Smith, A	University of California, Berkeley, California	Arsenic biomarker epidemiology	NIEHS
Spallholz, J	Texas Tech University, Lubbock, Texas	Selenium against arsenic toxicity and skin lesions	NCI
States, C	University of Louisville, Louisville, Kentucky	Arsenic induced miotic arrest associated apoptosis	NIEHS
Styblo, M	University of North Carolina, Chapel Hill, North Carolina	Metabolism and toxicity of arsenic in human liver	NIEHS

Table 3-18. Ongoing Studies on Health Effects of Arsenic, Federally Funded

Investigator	Affiliation	Title	Sponsor
Taylor, P	Division of Cancer Epidemiology and Genetics, NCI, Bethesda, Maryland	Biologic specimen bank for early lung cancer markers in Chinese tin miners	NCI
Taylor, B	University of Louisville, Louisville, Kentucky	Arsenite inhibition of mitotic progression	NIEHS
Vaillancourt, R	University of Arizona, Tucson, Arizona	Modulation of Prostaglandins by Arsenic	NIEHS
Willett, W	Harvard University, Boston, Massachusetts	Prospective studies of diet and cancer in men and women	NCI
Wright, R	Brigham and Women's Hospital, Boston, Massachusetts	Metal mixtures and neurondevelopment	NIEHS
Zhang, D	University of Arizona, Tucson, Arizona	The protective role of Nrf2 in arsenic-induced toxicity and carcinogenicity	NIEHS

EPA = Environmental Protection Agency; NHEERL = National Health and Environmental Effects Research Laboratory; NCI = National Cancer Institute; NHLBI = National Heart, Lung, and Blood Institute; NIEHS = National Institute of Environmental Health Sciences; NIAID= National Institute of Allergy and Infectious Diseases; NIGMS = National Institute of General Medical Sciences; NIH = National Institute of Health

Source: FEDRIP 2007

This page is intentionally blank.

4. CHEMICAL AND PHYSICAL INFORMATION

4.1 CHEMICAL IDENTITY

Information regarding the chemical identity of arsenic and some common inorganic and organic arsenic compounds are located in Tables 4-1 and 4-2, respectively.

4.2 PHYSICAL AND CHEMICAL PROPERTIES

Information regarding the physical and chemical properties of arsenic and some common inorganic and organic arsenic compounds is located in Tables 4-3 and 4-4, respectively.

Arsenic appears in Group 15 (V) of the periodic table, below nitrogen and phosphorus. Arsenic is classified chemically as a metalloid, having both properties of a metal and a nonmetal; however, it is frequently referred to as a metal. Elemental arsenic, which is also referred to as metallic arsenic, (As(0)) normally occurs as the α-crystalline metallic form, which is a steel gray and brittle solid. The β-form is a dark gray amorphous solid. Other allotropic forms of arsenic may also exist. In compounds, arsenic typically exists in one of three oxidation states, -3, +3, and +5 (Carapella 1992). Arsenic compounds can be categorized as inorganic, compounds without an arsenic-carbon bond, and organic, compounds with an arsenic-carbon bond.

Table 4-1. Chemical Identity of Arsenic and Selected Inorganic Arsenic Compounds[a]

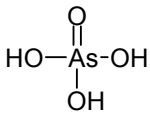
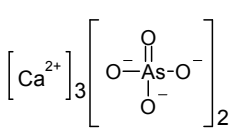
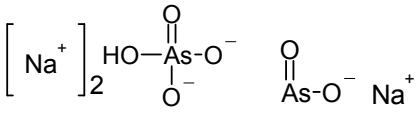
Characteristic	Arsenic	Arsenic acid	Arsenic pentoxide	Arsenic trioxide
Synonym(s)	Arsenic black; colloidal arsenic; gray arsenic, metallic arsenic	Orthoarsenic acid	Arsenic(V) oxide; arsenic acid anhydride; diarsenic pentoxide	Arsenic(III) oxide; arsenious acid; arsenious oxide; white arsenic
Registered trade name(s)	No data	Zotox; Hi-Yield Desiccant H-10; Desiccant L-10; Crab Grass Killer	No data	White Arsenic; Arsenicum Album
Chemical formula	As	H_3AsO_4	As_2O_5	As_2O_3
Chemical structure	As		$[As^{5+}]_2\,[O^{2-}]_5$	$[As^{3+}]_2\,[O^{2-}]_3$
Identification numbers:				
CAS registry	7440-38-2	7778-39-4	1303-28-2	1327-53-3
NIOSH RTECS[b]	CG0525000	CG0700000	CG2275000	CG3325000
EPA hazardous waste	D004	D004, P010	D004, P011	D004, P012
OHM/TADS	No data	No data	No data	No data
DOT/UN/NA/IMDG shipping	UN1558/IMDG 6.1	UN1553 (liquid)/ UN1554 (solid)/ IMDG 6.1 (liquid and solid)	UN1559/IMDG 6.1	UN1561/ IMDG 6.1
HSDB	509	431	429	419
EINECS	231-148-6	231-901-9	215-116-9	215-481-4
NCI	No data	No data	No data	No data

Table 4-1. Chemical Identity of Arsenic and Selected Inorganic Arsenic Compounds[a]

Characteristic	Calcium arsenate	Gallium arsenide	Sodium arsenate	Sodium arsenite
Synonym(s)	Calcium ortho-arsenate; arsenic acid, calcium salt	Gallium mono-arsenide	Disodium arsenate, dibasic; disodium hydrogen arsenate; arsenic acid, disodium salt	Arsenenous acid, sodium salt; sodium meta-arsenite
Registered trade name(s)	Pencal; Security; Turf-Cal; Chip-Cal; SPRA-Cal	No data	No data	Atlas "A"; Penite; Kill-All; Chem-Sen 56; Chem Pels C; Progalumnol Double
Chemical formula	$Ca_3(AsO_4)_2$	GaAs	Na_2HAsO_4	$NaAsO_2$
Chemical structure		Ga:As		
Identification numbers:				
CAS registry	7778-44-1	1303-00-0	7778-43-0	7784-46-5
NIOSH RTECS[b]	CG0830000	LW8800000	CG0875000	CG3675000
EPA hazardous waste	D004	D004	D004	D004
OHM/TADS	No data	No data	No data	7800057
DOT/UN/NA/IMDG shipping	UN1573/IMDG 6.1	UN 2803; Gallium/ IMDG 8.0; Gallium	UN 1685/IMDG 6.1	UN1686 (aqueous solution)/UN2027 (solid)/IMDG 6.1
HSDB	1433	4376	1675	693
EINECS	233-287-8	215-114-8	231-902-4	232-070-5
NCI	No data	No data	No data	No data

[a]All information obtained from HSDB 2007 and CHEMIDplus 2007, except where noted.
[b]RTECS 2007

CAS = Chemical Abstracts Service; DOT/UN/NA/IMDG = Department of Transportation/United Nations/North America/Intergovernmental Maritime Dangerous Goods Code; EINECS = European Inventory of Existing Chemical Substances; EPA = Environmental Protection Agency; HSDB = Hazardous Substances Data Bank; NCI = National Cancer Institute; NIOSH = National Institute for Occupational Safety and Health; OHM/TADS = Oil and Hazardous Materials/Technical Assistance Data System; RTECS = Registry of Toxic Effects of Chemical Substances

Table 4-2. Chemical Identity of Selected Organic Arsenic Compounds[a]

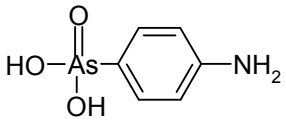
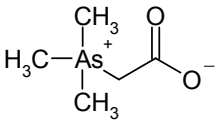
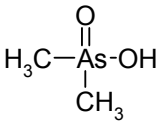
Characteristic	Arsanilic acid	Arsenobetaine	Dimethylarsinic acid
Synonym(s)	(4-Aminophenyl)arsonic acid; antoxylic acid; atoxylic acid, Pro-Gen	Arsonium, (carboxymethyl)-trimethyl-, hydroxide, inner salt	Cacodylic acid; hydroxydimethyl-arsine oxide; DMA; DMAA
Registered trade name(s)	No data	No data	510; Arsan; Phytar 560; Rad-E-Cate 35
Chemical formula	$C_6H_8AsNO_3$	$C_5H_{11}AsO_2$	$C_2H_7AsO_2$
Chemical structure			
Identification numbers:			
CAS registry	98-50-0	64436-13-1	75-60-5
NIOSH RTECS[b]	CF7875000	CH9750000	CH7525000
EPA hazardous waste	D004	No data	U136/D004
OHM/TADS	No data	No data	No data
DOT/UN/NA/IMDG shipping	No data	No data	UN1572/IMDG 6.1
HSDB	432	No data	360
EINECS	202-674-3	No data	200-883-4
NCI	No data	No data	No data

Table 4-2. Chemical Identity of Selected Organic Arsenic Compounds[a]

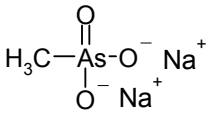
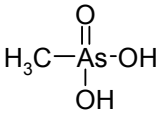
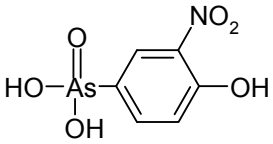
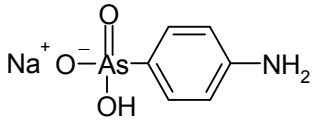
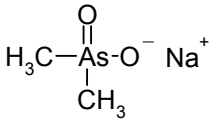
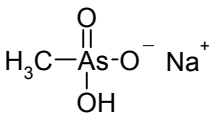
Characteristic	Disodium methane-arsonate	Methanearsonic acid	3-Nitro-4-hydroxy-phenyl-arsonic acid
Synonym(s)	DSMA; disodium monomethane arsonate	Arsonic acid, methyl-; monomethylarsonic acid	Roxarsone; 3-nitro-4-hydroxyphenylarsonic acid; 3-Nitro-10
Registered trade name(s)	Ansar 8100; Arrhenal; Ansar DSMA Liquid; Dinate; Crab-E-Rad; Chipco Crab Kleen; Arsinyl; Sodar; Methar; Drexel DSMA Liquid; Di-Tac; Ansar 184; Weed-E-Rad; Versar DSMA-LQ; Calar-E-Rad; Dal-E-Rad; Jon-Trol; Namate	No data	No data
Chemical formula	$CH_3AsO_3Na_2$	CH_5AsO_3	$C_6H_6AsNO_6$
Chemical structure			
Identification numbers:			
CAS registry	144-21-8	124-58-3	121-19-7
NIOSH RTECS[b]	PA2275000	PA1575000	CY5250000
EPA hazardous waste	D004	D004	D004
OHM/TADS	No data	No data	No data
DOT/UN/NA/IMDG shipping	No data	No data	No data
HSDB	1701	845	4296
EINECS	205-620-7	204-705-6	204-453-7
NCI	No data	No data	C5608

Table 4-2. Chemical Identity of Selected Organic Arsenic Compounds[a]

Characteristic	Sodium arsanilate	Sodium dimethylarsinate	Sodium methanearsonate
Synonym(s)	(4-Aminophenyl)arsonic acid sodium salt; arsanilic acid sodium salt; arsamin; atoxyl; soamin; trypoxyl	Sodium cacodylate; cacodylic acid, sodium salt; sodium dimethylarsonate	Arsonic acid, methyl-, monosodium salt; monosodium acid metharsonate; MSMA
Registered trade name(s)	No data	Ansar 160; Ansar 560; Bolls-Eye; Chemaid; Phytar 560, component of (with 012501); Rad-E-Cate 25.	Ansar 529; Ansar 170; Target MSMA; Phyban H.C.; Deconate; Mesamate; Bueno; Monate Merge 823; Dal-E-Rad; Weed-S-Rad; Arsanote liquid; Silvisar 550.
Chemical formula	$C_6H_7AsNO_3Na$	$C_2H_6AsO_2Na$	CH_4AsO_3Na
Chemical structure			
Identification numbers:			
CAS registry	127-85-5	124-65-2	2163-80-6
NIOSH RTECS[b]	CF9625000	CH7700000	PA2625000
EPA hazardous waste	D004	D004	D004
OHM/TADS	No data	No data	No data
DOT/UN/NA/IMDG shipping	UN2473/IMDG 6.1	UN1688/IMDG 6.1	No data
HSDB	5189	731	754
EINECS	204-869-9	204-708-2	218-495-9
NCI	C61176	No data	C60071

[a]All information obtained from HSDB 2007 and CHEMIDplus 2007, except where noted.
[b]RTECS 2007

CAS = Chemical Abstracts Service; DOT/UN/NA/IMDG = Dept. of Transportation/United Nations/North America/Intergovernmental Maritime Dangerous Goods Code; EINECS = European Inventory of Existing Chemical Substances; EPA = Environmental Protection Agency; HSDB = Hazardous Substances Data Bank; NCI = National Cancer Institute; NIOSH = National Institute for Occupational Safety and Health; OHM/TADS = Oil and Hazardous Materials/Technical Assistance Data System; RTECS = Registry of Toxic Effects of Chemical Substances

Table 4-3. Physical and Chemical Properties of Arsenic and Selected Inorganic Arsenic Compounds[a]

Property	Arsenic	Arsenic acid	Arsenic pentoxide	Arsenic trioxide
Molecular weight	74.9216	141.944	229.840	197.841
Color	Silver-gray or tin-white	White[b]	White	White
Physical state	Solid	Solid[b]	Solid	Solid
Melting point	817 °C (triple point)	35 °C	Decomposes at ~300 °C	313 °C (claudetite) 274 °C (arsenolite)
Boiling point	614 °C sublimes	Loses H_2O at 160 °C [b]	No data	460 °C
Density	5.778 g/cm^3 at 25 °C	~2.2 g/cm^3	4.32 g/cm^3	3.865 g/cm^3 (cubes) 4.15 g/cm^3 (rhombic crystals)
Odor	Odorless	No data	No data	Odorless
Odor threshold:				
Water	No data	No data	No data	No data
Air	No data	No data	No data	No data
Solubility:				
Water	Insoluble	302 g/L at 12.5 °C[b]	2,300 g/L at 20 °C	17 g/L at 16 °C
Organic solvent(s)	No data	Soluble in alcohol, glycerol[b]	Soluble in alcohol	Practically insoluble in alcohol, chloroform, ether; soluble in glycerol
Other	Insoluble in caustic and nonoxidizing acids	No data	Soluble in acid, alkali	Soluble in dilute hydrochloric acid, alkali hydroxide, carbonate solution
Partition coefficients:				
Log K_{ow}	No data	No data	No data	No data
Log K_{oc}	No data	No data	No data	No data
pK_a	No data	pK_{a1}=2.22; pK_{a2}=6.98 pK_{a3}=11.53[c]	No data	No data
Vapor pressure	7.5x10^{-3} mmHg at 280 °C	No data	No data	2.47x10^{-4} mmHg at 25 °C
Autoignition temperature	No data	No data	No data	Not flammable
Flashpoint	No data	No data	No data	No data
Flammability limits in air	No data	No data	No data	No data
Conversion factors	No data	No data	No data	No data
Explosive limits	No data	No data	No data	No data

Table 4-3. Physical and Chemical Properties of Arsenic and Selected Inorganic Arsenic Compounds[a]

Property	Calcium arsenate	Gallium arsenide	Disodium arsenate	Sodium arsenite
Molecular weight	398.072	144.64	185.91	130.92
Color	Colorless	Dark gray	Colorless[d]	White to gray-white
Physical state	Solid	Solid	Solid[d]	Solid
Melting point	Decomposes on heating	1,238 °C	57 °C[d]	No data
Boiling point	No data	No data	No data	No data
Density	3.620 g/cm^3	5.3176 g/cm^3 at 25 °C	1.87 g/cm[d]	1.87 g/cm^3
Odor	Odorless	Garlic odor	Odorless[d]	No data
Odor threshold:				
Water	No data	No data	No data	No data
Air	No data	No data	No data	No data
Solubility:				
Water	0.13 g/L at 25 °C	<1 mg/mL at 20 °C	Soluble 1:3 parts in water[d]	Freely soluble in water
Organic solvents	Insoluble	<1 mg/mg dimethyl sulfoxide, ethanol, methanol, acetone	Slightly soluble in alcohol; soluble in glycerol[d]	Slightly soluble in alcohol
Other	Soluble in dilute acids	Soluble in hydrochloric acid	Slightly soluble in alkaline solution[d]	No data
Partition coefficients:				
Log K_{ow}	No data	No data	No data	No data
Log K_{oc}	No data	No data	No data	No data
pK_a	No data	No data		
Vapor pressure	~0 mmHg at 20 °C	No data	No data	No data
Autoignition temperature	Not combustible	No data	No data	Not combustible
Flashpoint	No data	No data	No data	No data
Flammability limits in air	No data	No data	No data	No data
Conversion factors	No data	No data	No data	No data
Explosive limits	No data	No data	No data	No data

[a]All information from HSDB 2007, except where noted.
[b]Value for arsenic acid hemihydrate
[c]NRC 1999
[d]Value for disodium arsenate heptahydrate

Table 4-4. Physical and Chemical Properties of Selected Organic Arsenic Compounds[a]

Property	Arsenilic acid	Arsenobetaine	Dimethylarsinic acid
Molecular weight	217.06	196.1[b]	138.00
Color	White	No data	Colorless
Physical state	Solid	Solid[b]	Solid
Melting point	232 °C	203–210 °C (decomposes)[b]	195 °C
Boiling point		No data	>200 °C
Density	1.9571 g/cm^3 at 10 °C	No data	No data
Odor	Practically odorless	No data	Odorless
Odor threshold:			
Water	No data	No data	No data
Air	No data	No data	No data
Solubility:			
Water	Slightly soluble in cold water; soluble in hot water	No data	2,000 g/L at 25 °C
Organic solvent(s)	Slightly soluble in alcohol; soluble in amyl alcohol; insoluble in ether, acetone, benzene, chloroform	No data	Soluble in alcohol; insoluble in diethyl ether
Acids	Slightly soluble in acetic acid; soluble in alkaki carbonates; moderately soluble in concentrated mineral acids; insoluble in dilute mineral acids	No data	Soluble in acetic acid
Partition coefficients:			
Log K_{ow}	No data	No data	No data
Log K_{oc}	No data	No data	No data
pK_a	No data	2.2[c]	1.57
Vapor pressure	No data	No data	No data
Henry's law constant	No data	No data	No data
Autoignition temperature	No data	No data	No data
Flashpoint	No data	No data	No data
Flammability	No data	No data	Nonflammable
Conversion factors	No data	No data	No data
Explosive limits	No data	No data	No data

Table 4-4. Physical and Chemical Properties of Selected Organic Arsenic Compounds[a]

Property	Methanearsonic acid	3-Nitro-4-hydroxy-phenylarsonic acid	Sodium arsanilate
Molecular weight	139.97	263.03	239.04
Color	White	Pale yellow	White or creamy white
Physical state	Solid	Solid	Solid
Melting point	160.5 °C	No data	No data
Boiling point	No data	No data	No data
Density	No data	No data	No data
Odor	No data	No data	Odorless
Odor threshold:			
Water	No data	No data	No data
Air	No data	No data	No data
Solubility:			
Water	256 g/L at 20 °C	Slightly soluble in cold water; soluble in about 30 parts boiling water	Soluble 1 part in 3 parts water
Organic solvents	Soluble in ethanol	Soluble in methanol, ethanol, acetone; insoluble in ether, ethyl acetate	Soluble 1 part in 150 parts alcohol; practically insoluble in chloroform, ether
Acids	No data	Soluble in acetic acid, alkalies; sparingly soluble in dilute mineral acids	No data
Partition coefficients:			
Log K_{ow}	No data	No data	No data
Log K_{oc}	No data	No data	No data
pK_a	pK_{a1}=4.1; pK_{a2}=9.02	No data	No data
Vapor pressure at 25 °C	<7.5x10^{-8} mmHg	No data	No data
Henry's law constant	No data	No data	No data
Autoignition temperature	No data	No data	No data
Flashpoint	No data	No data	No data
Flammability	No data	No data	No data
Conversion factors	No data	No data	No data
Explosive limits	No data	No data	No data

Table 4-4. Physical and Chemical Properties of Selected Organic Arsenic Compounds[a]

Property	Disodium methanearsonate	Sodium dimethylarsinate	Sodium methanearsonate
Molecular weight	183.93	159.98	161.95
Color	White	Colorless to light yellow	White
Physical state	Solid	Solid	Solid
Melting point	>355 °C	200 °C	130–140 °C
Boiling point	No data	No data	No data
Density	1.04 g/cm^3	>1 g/cm^3 at 20 °C	1.55 g/mL[d]
Odor	No data	Odorless	Odorless
Odor threshold:			
Water	No data	No data	No data
Air	No data	No data	No data
Solubility:			
Water	432 g/L at 25 °C	200 g/L at 25 °C	580 g/L at 20 °C
Organic solvents	Soluble in methanol; practically insoluble in most organic solvents	No data	Insoluble in most organic solvents
Acids	No data	No data	No data
Partition coefficients:			
Log K_{ow}	<1	No data	-3.10
Log K_{oc}	No data	No data	No data
pK_a	pK_{a1}=4.1; pK_{a2}=8.94	6.29	pK_{a1}=4.1; pK_{a2}=9.02
Vapor pressure at 25 °C	10^{-7} mmHg	No data	$7.8x10^{-8}$ mmHg
Henry's law constant	No data	No data	No data
Autoignition temperature	No data	No data	No data
Flashpoint	No data	No data	No data
Flammability	Nonflammable	No data	Nonflammable
Conversion factors	No data	No data	No data
Explosive limits	No data	No data	No data

[a]All information from HSDB 2007, except where noted.
[b]Cannon et al. 1981 (arsenobetaine as monohydrate)
[c]Teräsahde et al. 1996
[d]Value for Ansar 6.6

This page is intentionally blank.

5. PRODUCTION, IMPORT/EXPORT, USE, AND DISPOSAL

5.1 PRODUCTION

Arsenic is presently obtained as a byproduct of the smelting of copper, lead, cobalt, and gold ores. Arsenic trioxide is volatilized during smelting and accumulates in the flue dust, which may contain up to 30% arsenic trioxide. The crude flue dust is further refined by mixing with small amounts of galena or pyrite to prevent the formation of arsensites and roasting to yield arsenic trioxide of 90–95% purity. By successive sublimations, a purity of 99% can be obtained. Elemental arsenic can be prepared by the reduction of arsenic oxide with charcoal. Demand for elemental arsenic is limited and thus, about 95% of arsenic is marketed and consumed in combined form, principally as arsenic trioxide, which is subsequently converted to arsenic acid (Carapella 1992; Hanusch et al. 1985; USGS 2006a).

Since 1985, when the ASARCO smelter in Tacoma, Washington ceased operation, there has been no domestic production of arsenic trioxide or elemental arsenic and consequently, the United States remains entirely dependent on imports (U.S. Bureau of Mines 1988, 1990; USGS 2006a). Prior to its cessation, U.S. production of arsenic trioxide had been 7,300 metric tons in 1983, 6,800 metric tons in 1984, and 2,200 metric tons in 1985 (U.S. Bureau of Mines 1988). In 2005, arsenic trioxide was obtained from the treatment of nonferrous ores or concentrates in 14 countries. In 2005, the world's largest producer of arsenic trioxide was China, followed by Chile and Peru. China is the world leader in the production of commercial-grade arsenic followed by Japan. The United States, with an apparent demand of 8,800 metric tons in 2005, is the world's leading consumer of arsenic, mainly for CCA. This is an increase over 2004 with an apparent demand of 6,800 metric tons, but far less than that of 2003, 21,600 metric tons (USGS 2006a).

Tables 5-1 and 5-2 list facilities in each state that manufacture or process arsenic and arsenic compounds, respectively, as well as the intended use and the range of maximum amounts of arsenic or arsenic compounds that are stored on site. In 2004, there were 58 and 361 reporting facilities that produced, processed, or used arsenic and arsenic compounds, respectively, in the United States. The data listed in Tables 5-1 and 5-2 are derived from the Toxics Release Inventory (TRI04 2006). Only certain types of facilities were required to report. Therefore, this is not an exhaustive list. Current U.S. manufacturers of selected arsenic compounds are given in Table 5-3.

Table 5-1. Facilities that Produce, Process, or Use Arsenic

State[a]	Number of facilities	Minimum amount on site in pounds[b]	Maximum amount on site in pounds[b]	Activities and uses[c]
AK	1	1,000,000	9,999,999	1, 13
AL	18	0	9,999,999	1, 2, 3, 5, 7, 8, 11, 12, 13, 14
AR	4	1,000	999,999	7, 8
AZ	9	0	99,999	1, 3, 4, 5, 8, 12, 13
CA	31	0	9,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13
CO	8	0	999,999	2, 7, 8, 11, 12
FL	10	1,000	999,999	1, 3, 5, 7, 8, 11, 12
GA	16	100	49,999,999	2, 3, 4, 6, 7, 8, 11, 12, 13, 14
HI	1	10,000	99,999	8
IA	4	100	99,999	6, 7, 8
ID	7	0	49,999,999	1, 2, 3, 5, 6, 7, 9, 12, 13
IL	16	0	999,999	1, 3, 4, 5, 6, 7, 8, 12, 14
IN	17	0	999,999	1, 3, 5, 6, 7, 8, 9, 12, 13
KY	9	0	999,999	1, 2, 3, 5, 6, 7, 8, 11
LA	8	0	999,999	1, 2, 3, 7, 8, 12, 13
MA	5	1,000	999,999	3, 7, 8
MD	9	0	999,999	1, 2, 4, 5, 6, 7, 8
MI	10	0	999,999	3, 7, 8, 12, 13
MN	5	100	99,999	1, 7, 8, 13
MO	6	100	999,999	1, 2, 3, 4, 5, 6, 7, 8
MS	9	1,000	49,999,999	2, 3, 4, 7, 8, 9
NC	21	0	49,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 12, 13, 14
ND	2	0	99,999	8
NE	1	0	99	8
NJ	9	0	99,999	1, 2, 3, 5, 7, 8, 9
NM	2	10,000	999,999	7, 12
NV	6	1,000	99,999,999	1, 2, 4, 5, 6, 7, 8, 11, 12, 13
NY	4	0	99,999	7, 8, 12
OH	15	0	999,999	1, 2, 3, 4, 5, 8, 9, 12, 13
OK	9	0	99,999	1, 2, 5, 6, 7, 9, 11, 12, 13
OR	6	10,000	999,999	1, 5, 7, 8, 12
PA	24	0	999,999	1, 2, 3, 5, 6, 7, 8, 10, 11, 12, 13
PR	3	1,000	99,999	8, 11
SC	9	0	9,999,999	1, 2, 3, 5, 6, 8, 12
SD	1	10,000,000	49,999,999	1, 7, 11, 13
TN	11	0	999,999	1, 2, 3, 6, 7, 8, 11, 12, 14
TX	29	0	49,999,999	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14
VA	8	0	999,999	2, 3, 7, 8, 10

Table 5-1. Facilities that Produce, Process, or Use Arsenic

State[a]	Number of facilities	Minimum amount on site in pounds[b]	Maximum amount on site in pounds[b]	Activities and uses[c]
WA	3	0	99,999	5, 7, 8
WI	9	0	99,999	1, 2, 3, 4, 5, 6, 7, 8, 12
WV	19	100	999,999	1, 2, 3, 5, 7, 8, 10, 11, 12
WY	1	100	999	1, 13

[a]Post office state abbreviations used
[b]Amounts on site reported by facilities in each state
[c]Activities/Uses:

1. Produce
2. Import
3. Onsite use/processing
4. Sale/Distribution
5. Byproduct
6. Impurity
7. Reactant
8. Formulation Component
9. Article Component
10. Repackaging
11. Chemical Processing Aid
12. Manufacturing Aid
13. Ancillary/Other Uses
14. Process Impurity

Source: TRI04 2006 (Data are from 2004)

Table 5-2. Facilities that Produce, Process, or Use Arsenic Compounds

State[a]	Number of facilities	Minimum amount on site in pounds[b]	Maximum amount on site in pounds[b]	Activities and uses[c]
AK	6	1,000	49,999,999	1, 5, 7, 12, 13, 14
AL	37	0	499,999,999	1, 2, 3, 4, 5, 7, 8, 9, 11, 12, 13
AR	20	1,000	99,999,999	1, 2, 3, 7, 8, 9, 11, 12, 13, 14
AZ	29	100	499,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
CA	40	100	99,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14
CO	9	1,000	49,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12
DE	1	10,000	99,999	1, 5, 9
FL	30	0	999,999	1, 3, 4, 5, 7, 8, 9, 11, 12, 13, 14
GA	50	0	49,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14
HI	6	1,000	99,999	7, 8, 11
IA	22	0	9,999,999	1, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13
ID	6	10,000	9,999,999	1, 3, 5, 6, 7, 8, 9, 12, 13
IL	44	0	999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
IN	54	0	9,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14
KS	14	0	999,999	1, 3, 4, 5, 6, 7, 8, 12, 13, 14
KY	29	0	999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
LA	32	0	499,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13
MA	9	0	999,999	1, 4, 5, 6, 7, 8
MD	19	0	999,999	1, 4, 5, 7, 8, 9, 11, 12, 13
ME	2	1,000	99,999	7
MI	32	0	999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14
MN	13	0	999,999	1, 3, 4, 5, 7, 8, 9, 11, 12, 13
MO	32	0	499,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14
MS	28	1,000	49,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13
MT	8	1,000	10,000,000,000	1, 2, 3, 4, 5, 6, 7, 12, 13, 14
NC	65	0	9,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
ND	11	1,000	99,999	1, 5, 8, 9, 11, 12, 13, 14
NE	6	1,000	999,999	1, 2, 3, 4, 5, 6, 8, 9, 12, 13
NH	2	1,000	99,999	8, 11
NJ	35	0	999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 12, 13
NM	11	1,000	499,999,999	1, 5, 7, 12, 13
NV	31	1,000	10,000,000,000	1, 2, 3, 5, 6, 7, 9, 11, 12, 13, 14
NY	27	0	9,999,999	1, 2, 3, 4, 5, 7, 8, 9, 12, 13
OH	50	0	999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14
OK	14	100	9,999,999	1, 2, 3, 4, 5, 6, 8, 12, 13, 14
OR	12	100	99,999	1, 2, 3, 7, 8, 12
PA	53	0	999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14
PR	8	1,000	99,999	1, 2, 3, 5, 8, 11
RI	7	100	99,999	7, 8

Table 5-2. Facilities that Produce, Process, or Use Arsenic Compounds

State[a]	Number of facilities	Minimum amount on site in pounds[b]	Maximum amount on site in pounds[b]	Activities and uses[c]
SC	34	0	49,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14
SD	6	1,000	99,999,999	1, 5, 6, 7, 8, 11, 12, 13
TN	29	0	99,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
TX	54	0	499,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14
UT	23	0	499,999,999	1, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13
VA	24	0	499,999,999	1, 2, 3, 4, 5, 7, 8, 9, 11, 12, 13, 14
WA	14	0	999,999	1, 2, 3, 4, 5, 7, 8, 9, 11, 12, 13
WI	13	100	99,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 11
WV	26	0	999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 12, 13, 14
WY	9	1,000	99,999	1, 3, 4, 5, 7, 8, 9, 12, 13

[a]Post office state abbreviations used
[b]Amounts on site reported by facilities in each state
[c]Activities/Uses:

1. Produce
2. Import
3. Onsite use/processing
4. Sale/Distribution
5. Byproduct
6. Impurity
7. Reactant
8. Formulation Component
9. Article Component
10. Repackaging
11. Chemical Processing Aid
12. Manufacturing Aid
13. Ancillary/Other Uses
14. Process Impurity

Source: TRI04 2006 (Data are from 2004)

Table 5-3. Current U.S. Manufacturers of Selected Arsenic Compounds[a]

Company	Location(s)
Arsenic acid	
Arch Wood Protection, Inc.	Conley, Georgia
Osmose Wood Preserving, Inc.	Millington, Tennessee
Arsanilic acid	
Fleming Laboratories, Inc.	Charlotte, North Carolina
Copper Chromated Arsenic (CCA)	
Arch Wood Protection, Inc.	Conley, Georgia; Kalama, Washington; Smyrna, Georgia[b]; Valparaiso, Indiana
Chemical Specialties, Inc.[b]	Charlotte, North Carolina
Osmose Wood Preserving, Inc.[b]	Buffalo, New York
Calcium acid methanearsonate (CAMA)	
Drexel Chemical Company (formulator)[c]	No information provided
Disodium methanearsonate (DSMA)	
Drexel Chemical Company	Tunica, Mississippi
Monosodium methyl arsonate (MSMA)	
Drexel Chemical Company	Tunica, Mississippi
Gallium arsenide	
Atomergic Chemetals Corporation	Farmingdale, New York

[a]Derived from Stanford Research Institute (SRI 2006), except where otherwise noted. SRI reports production of chemicals produced in commercial quantities (defined as exceeding 5,000 pounds or $10,000 in value annually) by the companies listed.
[b]USGS 2006a
[c]Meister et al. 2006

5.2 IMPORT/EXPORT

Since U.S. production ceased in 1985, all arsenic consumed in the United States is imported. Imports of arsenic (metal and compounds combined) have increased substantially since the mid-1980s, reaching 8,810 metric tons (as arsenic content) in 2005, of which 812 metric tons was as elemental arsenic. In 2005, 11,000 metric tons of arsenic trioxide was imported into the United States. China is the major import source for elemental arsenic from 2001 to 2004, supplying 81%, followed by Japan (15%) and Hong Kong (2%). China is also the major import source in 2001–2004 for arsenic trioxide, supplying 59% to the United States, followed by Morocco (22%), Chile (7%), and Mexico (5%) (USGS 2006a, 2006b).

U.S. exports of elemental arsenic were 220 metric tons in 2004 and are estimated to be 200 metric tons in 2005 (USGS 2006b). In 2005, U.S. import of arsenic was approximately 8.1×10^5 kilograms (810 metric tons) (ITA 2007a, 2007b).

5.3 USE

In 2003, the United States was the world's largest consumer of arsenic, with an apparent demand of 21,600 metric tons. In 2005, the Unites States was still the world's largest consumer of arsenic, mainly for CCA. Production of wood preservatives, primarily CCA, $CrO_3 \bullet CuO \bullet As_2O_5$, accounted for >90% of domestic consumption of arsenic trioxide prior to 2004. In 2005, about 65% of domestic consumption of arsenic trioxide was used for the production of CCA. The remainder was used for the production of agricultural chemicals, including herbicides, and insecticides. The major U.S. producers of CCA in 2005 included Arch Wood Protection, Inc., Smyrna Georgia; Chemical Specialties Inc., Charlotte, North Carolina; and Osmose Wood Preserving, Inc., Buffalo, New York (USGS 2006a). CCA is the most widely used wood preservative in the world. Wood treated with CCA is referred to as 'pressure treated' wood (American Wood Preservers Association 2007; Page and Loar 1993). In 1997, approximately 727.8 million cubic feet (20.6 million cubic meters) of wood products were pressure treated in the United States. CCA is a water-based product that protects several commercially available species of western lumber from decay and insect attack. It is widely used in treating utility poles, building lumber, and wood foundations. CCA comes in three types, A, B, and C, which contain different proportions of chromium, copper, and arsenic oxides. Type C, the most popular type, contains CrO_3, CuO, and As_2O_5 in the proportions 47.5, 18.5, and 34.0%, respectively. The retention levels are 0.25 pounds per cubic feet (pcf) for above ground use such as fencing and decking, 0.40 pcf for lumber used in ground contact such as

fence posts and deck posts, and 0.60 pcf for all weather wood foundations (Chicago Flameproof 2000; Permapost 2000). Piling used for fresh and saltwater contact should contain 0.80 and 2.5 pcf of CCA, respectively. Ammoniacal copper zinc arsenate (ACZA) is another arsenic containing preservative used to treat wood; however, it is not as widely used as CCA–C (Lebow et al. 2000).

In 2003, U.S. manufacturers of arsenical wood preservatives began a voluntary transition from CCA to other wood preservatives in wood products for certain residential uses, such as play structures, picnic tables, decks, fencing, and boardwalks. This phase out was completed on December 31, 2003; wood treated prior to this date could still be used and structures made with CCA-treated wood would not be affected. CCA-treated wood products continue to be used in industrial applications (EPA 2003a).

Elemental arsenic is used as an alloying element in ammunition and solders, as an anti-friction additive to metals used for bearings, and to strengthen lead-acid storage battery grids. In the past, the predominant use of arsenic was in agriculture. The uses of lead arsenate as a growth regulator on citrus, calcium arsenate as an herbicide on turf, sodium arsenite as a fungicide on grapes, and arsenic acid as a desiccant on okra for seed and cotton were voluntarily cancelled in the late 1980s and the early 1990s (EPA 2006). The herbicides, MSMA and DSMA, are registered for weed control on cotton, for turf grass and lawns, and under trees, vines, and shrubs; calcium acid methanearsonate (CAMA) is registered for postemergent weed control on lawns. Cacodylic acid, a defoliant and herbicide, is registered for weed control under nonbearing citrus trees, around buildings and sidewalks, and for lawn renovation (EPA 2006). Approximately 3 million pounds of MSMA or DSMA, and 100,000 pounds of cacodylic acid are applied in the U.S. annually based on EPA's Screening Level Use Analysis data. Data were not available for CAMA. Application to cotton and turf (residential and golf courses) are the major uses of organic arsenical herbicides. Currently, there are approximately 90, 25, 4, and 35 end-use products containing MSMA, DSMA, CAMA, and cacodylic acid, respectively (EPA 2006).

Other organic arsenicals used in agriculture include arsanilic acid, sodium arsanilate, and 3-nitro-4-hydroxyphenylarsonic acid (roxarsone), which are antimicrobials used in animal and poultry feeds (Beerman 1994). While the U.S. Food and Drug Administration (FDA) has authorized the used of these compounds as medicinal feed additives, only one of the arsenical compounds may be used at a time as the sole source of organic arsenic in the feed (EPA 1998k). In 1999–2000, about 70% of the broiler industry added roxarsone to broiler poultry feed; concentrations of roxarsone in feed range from 22.7 to 45.4 g/ton (Garbarino et al. 2003).

From the mid-nineteenth century to the introduction of organic pesticides in the 1940s, inorganic arsenic compounds were the dominant pesticides available to farmers and fruit growers. Calcium arsenate was formerly used to control the boll weevil and cotton worm and was used as an herbicide. Lead arsenate was used on apple and other fruit orchards as well as on potato fields. Sodium arsenite was used to control weeds on railroad right-of-ways, potato fields, and in industrial areas, as well as in baits and to debark trees. Sodium arsenate had some application in ant traps. The use of inorganic arsenic compounds in agriculture has virtually disappeared beginning around the 1960s (Azcue and Nriagu 1994; Meister 1987; Merwin et al. 1994; Sanok et al. 1995). Food uses were voluntarily cancelled in 1993 as was the use of arsenic acid as a defoliant on cotton plants; inorganic arsenic's remaining allowable uses are in ant baits and wood preservatives (EPA 1999h). In 1987, EPA issued a preliminary decision to cancel the registration of most inorganic arsenicals used as nonwood pesticides (Loebenstein 1994) (see Chapter 8). According to the California Department of Pesticide Regulation, arsenic acid, arsenic pentoxide, and arsenic trioxide are registered currently as pesticides in the United States; there are no active registrants listed for calcium arsenate, lead arsenate, or sodium arsenite (NPIRS 2007).

High-purity arsenic (99.9999%) is used by the electronics industry for gallium-arsenide semiconductors for telecommunications, solar cells, and space research (USGS 2006b). Arsenic trioxide and arsenic acid were used as a decolorizer and fining agent in the production of bottle glass and other glassware (Carapella 1992).

Arsenic compounds have a long history of use in medicine. Inorganic arsenic was used as a therapeutic agent through the mid-twentieth century, primarily for the treatment of leukemia, psoriasis, and chronic bronchial asthma; organic arsenic antibiotics were extensively used in the treatment of spirochetal and protozoal disease (NRC 1999). The availability of inorganic arsenicals in Western medicines ended in the 1970s, although they may still be encountered in non-Western traditional medicines. By the 1980s, the only remaining medicinal organic arsenical was melarsoprol for treatment of the meningoencephalitic stage of African trypanosomiasis. There has been renewed interest in arsenic as a therapeutic agent, namely the use of arsenic trioxide in the treatment of acute promyelocytic leukemia (APL) (Gallagher 1998; Kroemer and de Thé 1999; Miller 1998; Wang 2001). In 2000, the FDA approved arsenic trioxide for this use (FDA 2000).

5.4 DISPOSAL

Wastes containing arsenic are considered hazardous wastes, and as such, their treatment, storage, and disposal are regulated by law (see Chapter 8). The main route of disposal of solid wastes containing arsenic is landfilling. EPA has promulgated rules and treatment standards for landfilling liquid arsenical wastes (EPA 1990e). Arsenic-containing electronic components such as relays, switches, and circuit boards are disposed of at hazardous waste sites, and the elemental arsenic is not reclaimed. Process water at wood treatment plants that contained arsenic contained was reused. Gallium-arsenide scrap from the manufacture of semiconductor devices was reprocessed for arsenic recovery. Arsenic was not recovered from arsenical residues and dusts at domestic nonferrous smelters (USGS 2006b).

CCA-treated wood is classified as nonhazardous waste under the Federal Resource Conservation and Recovery Act (RCRA). CCA-treated wood is disposed of with regular municipal trash (i.e., municipal solid waste, not yard waste). It should not be burned in open fires, stoves, residential boilers, or fire places and should not be composted or used as mulch. Treated wood from commercial or industrial applications may only be burned in commercial or industrial incinerators in accordance with state and federal regulations (Adobe Lumber 2002; EPA 2005a).

Arsenic is listed as a toxic substance under Section 313 of the Emergency Planning and Community Right to Know Act (EPCRA) under Title III of the Superfund Amendments and Reauthorization Act (SARA) (EPA 1995c). Disposal of wastes containing arsenic is controlled by a number of federal regulations (see Chapter 8).

6. POTENTIAL FOR HUMAN EXPOSURE

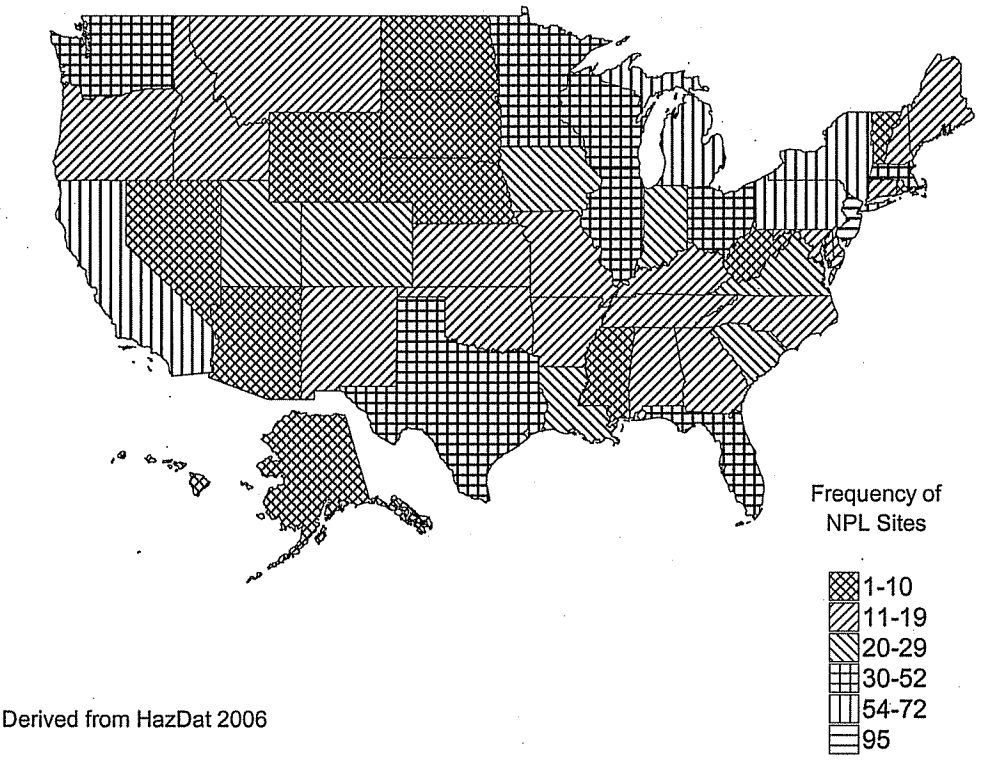
6.1 OVERVIEW

Arsenic has been identified in at least 1,149 of the 1,684 hazardous waste sites that have been proposed for inclusion on the EPA National Priorities List (NPL) (HazDat 2006). However, the number of sites evaluated for arsenic is not known. The frequency of these sites can be seen in Figure 6-1. Of these sites, 1,134 are located within the United States and 11, 2, and 2 are located in the Commonwealth of Puerto Rico, the Virgin Islands, and Guam (not shown).

Arsenic is widely distributed in the Earth's crust, which contains about 3.4 ppm arsenic (Wedepohl 1991). It is mostly found in nature in minerals, such as realgar (As_4S_4), orpiment (As_2S_3), and arsenolite (As_2O_3), and only found in its elemental form to a small extent. There are over 150 arsenic-bearing minerals (Budavari et al. 2001; Carapella 1992). While arsenic is released to the environment from natural sources such as wind-blown soil and volcanoes, releases from anthropogenic sources far exceed those from natural sources. Anthropogenic sources of arsenic include nonferrous metal mining and smelting, pesticide application, coal combustion, wood combustion, and waste incineration. Most anthropogenic releases of arsenic are to land or soil, primarily in the form of pesticides or solid wastes. However, substantial amounts are also released to air and water.

Arsenic found in soil either naturally occurring or from anthropogenic releases forms insoluble complexes with iron, aluminum, and magnesium oxides found in soil surfaces, and in this form, arsenic is relatively immobile. However, under reducing conditions, arsenic can be released from the solid phase, resulting in soluble mobile forms of arsenic, which may potentially leach into groundwater or result in runoff of arsenic into surface waters. In aquatic systems, inorganic arsenic occurs primarily in two oxidation states, As(V) and As(III). Both forms generally co-exist, although As(V) predominates under oxidizing conditions and As(III) predominates under reducing conditions. Arsenic may undergo a variety of reactions in the environment, including oxidation-reduction reactions, ligand exchange, precipitation, and biotransformation (EPA 1979, 1984a; Pongratz 1998; Welch et al. 1988). These reactions are influenced by Eh (the oxidation-reduction potential), pH, metal sulfide and sulfide ion concentrations, iron concentration, temperature, salinity, and distribution and composition of the biota (EPA 1979; Wakao et al. 1988). Much of the arsenic will adsorb to particulate matter and sediment. Arsenic released to air exists mainly in the form of particulate matter. Arsenic released from combustion processes will

Figure 6-1. Frequency of NPL Sites with Arsenic Contamination



generally occur as highly soluble oxides. These particles are dispersed by the wind and returned to the earth in wet or dry deposition. Arsines that are released to the atmosphere as a result of microbial action are oxidized to nonvolatile species that settle back to the ground.

Because arsenic is a natural component of the Earth's crust, low levels of the element are found in all environmental media. Atmospheric levels of arsenic in remote locations (away from human releases) range from 1 to 3 ng/m^3, while concentrations in urban areas may range from 20 to 100 ng/m^3. Concentrations in water are usually <10 μg/L, although higher levels may occur near natural mineral deposits or anthropogenic sources. Natural levels of arsenic in soil usually range from 1 to 40 mg/kg, with a mean of 5 mg/kg, although much higher levels may occur in mining areas, at waste sites, near high geological deposits of arsenic-rich minerals, or from pesticide application. Arsenic is also found in many foods, at concentrations that usually range from 20 to 140 μg/kg. Total arsenic concentrations may be substantially higher in certain seafoods. However, the general consensus in the literature is that about 85–>90% of the arsenic in the edible parts of marine fish and shellfish is organic arsenic (e.g., arsenobetaine, arsenochloline, dimethylarsinic acid) and that approximately 10% is inorganic arsenic (EPA 2003b). Drinking water in the United States generally contains an average of 2 μg/L of arsenic (EPA 1982c), although 12% of water supplies from surface water sources in the north Central region of the United States and 12% of supplies from groundwater sources in the western region have levels exceeding 20 μg/L (Karagas et al. 1998). In January 2001, EPA adopted a new standard that arsenic levels in drinking water were not to exceed 10 μg/L, replacing the previous standard of 50 μg/L. The date for compliance with the new MCL was January 23, 2006 (EPA 2001).

For most people, diet is the largest source of exposure to arsenic. Mean dietary intakes of total arsenic of 50.6 μg/day (range of 1.01–1,081 μg/day) and 58.5 μg/day (range of 0.21–1,276 μg/day) has been reported for females and males (MacIntosh et al. 1997). U.S. dietary intake of inorganic arsenic has been estimated to range from 1 to 20 μg/day, with grains and produce expected to be significant contributors to dietary inorganic arsenic intake (Schoof et al. 1999a, 1999b). The predominant dietary source of arsenic is generally seafood. Inorganic arsenic in seafood sampled in a market basket survey of inorganic arsenic in food ranged from <0.001 to 0.002 μg/g (Schoof et al. 1999a, 1999b). Intake of arsenic from air and soil are usually much smaller than that from food and water (Meacher et al. 2002).

People who produce or use arsenic compounds in occupations such as nonferrous metal smelting, pesticide manufacturing or application, wood preservation, semiconductor manufacturing, or glass production may be exposed to substantially higher levels of arsenic, mainly from dusts or aerosols in air.

Exposure at waste sites may occur by a variety of pathways, including inhalation of dusts in air, ingestion of contaminated soil or water, or through the food chain. The magnitude of the exposures can only be evaluated on a site-by-site basis; however, exposures generally do not exceed background intakes from food and drinking water.

Tables 4-1, 4-2, 4-3, and 4-4 summarize all of the names, abbreviations, and structures of the various arsenic compounds that are discussed in Chapter 6.

6.2 RELEASES TO THE ENVIRONMENT

The Toxics Release Inventory (TRI) data should be used with caution because only certain types of facilities are required to report (EPA 2005k). This is not an exhaustive list. Manufacturing and processing facilities are required to report information to the TRI only if they employ 10 or more full-time employees; if their facility is included in Standard Industrial Classification (SIC) Codes 10 (except 1011, 1081, and 1094), 12 (except 1241), 20–39, 4911 (limited to facilities that combust coal and/or oil for the purpose of generating electricity for distribution in commerce), 4931 (limited to facilities that combust coal and/or oil for the purpose of generating electricity for distribution in commerce), 4939 (limited to facilities that combust coal and/or oil for the purpose of generating electricity for distribution in commerce), 4953 (limited to facilities regulated under RCRA Subtitle C, 42 U.S.C. section 6921 et seq.), 5169, 5171, and 7389 (limited S.C. section 6921 et seq.), 5169, 5171, and 7389 (limited to facilities primarily engaged in solvents recovery services on a contract or fee basis); and if their facility produces, imports, or processes ≥25,000 pounds of any TRI chemical or otherwise uses >10,000 pounds of a TRI chemical in a calendar year (EPA 2005k).

6.2.1 Air

Estimated releases of 4,800 pounds (~2.2 metric tons) of arsenic to the atmosphere from 58 domestic manufacturing and processing facilities in 2004, accounted for about 0.52% of the estimated total environmental releases from facilities required to report to the TRI (TRI04 2006). Estimated releases of 0.13 million pounds (~59 metric tons) of arsenic compounds to the atmosphere from 361 domestic manufacturing and processing facilities in 2004, accounted for about 0.11% of the estimated total environmental releases from facilities required to report to the TRI (TRI04 2006). These releases for arsenic and arsenic compounds are summarized in Table 6-1 and 6-2, respectively.

Table 6-1. Releases to the Environment from Facilities that Produce, Process, or Use Arsenic[a]

		Reported amounts released in pounds per year[b]							
							Total release		
State[c]	RF[d]	Air[e]	Water[f]	UI[g]	Land[h]	Other[i]	On-site[j]	Off-site[k]	On- and off-site
AL	1	51	162	0	110,264	0	110,425	52	110,477
AR	2	0	0	No data	0	0	No data	0	0
AZ	2	10	0	0	20,717	0	20,727	0	20,727
CA	3	13	14	0	5,482	0	13	5,497	5,510
FL	2	4	0	0	0	4,950	4	4,950	4,954
GA	4	8	10	0	1,603	5	13	1,613	1,626
IA	1	0	1	0	0	0	0	1	1
ID	1	39	0	0	361,252	0	361,291	0	361,291
IL	2	250	129	0	14,087	0	379	14,087	14,466
IN	1	5	5	0	13,250	250	5	13,505	13,510
KS	1	0	0	No data	0	0	No data	0	0
KY	1	0	1	0	0	6	1	6	7
MI	2	0	5	0	0	750	5	750	755
MN	1	15	47	0	14,504	0	15	14,551	14,566
MO	1	5	0	0	0	4,040	5	4,040	4,045
MS	2	0	0	0	0	0	0	0	0
NC	4	35	8	0	1	1	43	2	45
NV	1	0	0	0	0	0	0	0	0
NY	4	0	1	0	26,525	1	26,401	126	26,527
OH	2	13	0	0	0	0	13	0	13
OR	1	0	0	0	92,606	0	92,606	0	92,606
PA	5	166	8	0	14,362	26,140	199	40,477	40,676
SC	3	10	10	0	0	1,002	15	1,007	1,022
TN	3	3,988	0	0	0	0	3,988	0	3,988
TX	5	139	376	168,563	12,600	0	181,636	42	181,678

Table 6-1. Releases to the Environment from Facilities that Produce, Process, or Use Arsenic[a]

		Reported amounts released in pounds per year[b]							
							Total release		
State[c]	RF[d]	Air[e]	Water[f]	UI[g]	Land[h]	Other[i]	On-site[j]	Off-site[k]	On- and off-site
WI	2	15	0	0	760	0	15	760	776
WV	1	0	0	0	10,135	0	10,135	0	10,135
Total	58	4,766	778	168,563	698,149	37,145	807,935	101,466	909,401

[a]The TRI data should be used with caution since only certain types of facilities are required to report. This is not an exhaustive list. Data are rounded to nearest whole number.
[b]Data in TRI are maximum amounts released by each facility.
[c]Post office state abbreviations are used.
[d]Number of reporting facilities.
[e]The sum of fugitive and point source releases are included in releases to air by a given facility.
[f]Surface water discharges, waste water treatment-(metals only), and publicly owned treatment works (POTWs) (metal and metal compounds).
[g]Class I wells, Class II-V wells, and underground injection.
[h]Resource Conservation and Recovery Act (RCRA) subtitle C landfills; other on-site landfills, land treatment, surface impoundments, other land disposal, other landfills.
[i]Storage only, solidification/stabilization (metals only), other off-site management, transfers to waste broker for disposal, unknown
[j]The sum of all releases of the chemical to air, land, water, and underground injection wells.
[k]Total amount of chemical transferred off-site, including to POTWs.

RF = reporting facilities; UI = underground injection

Source: TRI04 2006 (Data are from 2004)

Table 6-2. Releases to the Environment from Facilities that Produce, Process, or Use Arsenic Compounds[a]

		Reported amounts released in pounds per year[b]							
							Total release		
State[c]	RF[d]	Air[e]	Water[f]	UI[g]	Land[h]	Other[i]	On-site[j]	Off-site[k]	On- and off-site
AK	1	511	0	1,400,000	1,200,000	0	2,600,511	0	2,600,511
AL	19	4,299	18,127	0	853,469	7,555	875,876	7,574	883,450
AR	12	0	0	0	133	26,435	0	26,568	26,568
AZ	5	5,421	0	0	402,335	422	394,749	13,429	408,178
CA	5	65	14	0	355,660	86,396	160,673	281,461	442,134
CO	1	11	0	0	4,094	0	4,105	0	4,105
CT	1	0	0	0	0	0	No data	0	0
FL	15	3,208	503	0	343,508	4,057	346,310	4,966	351,276
GA	23	8,643	7,823	0	422,124	5,127	437,496	6,221	443,717
HI	1	0	0	0	0	0	No data	0	0
IA	4	1,291	482	0	0	35,324	1,773	35,324	37,097
ID	3	332	20	0	1,056,904	0	1,057,256	0	1,057,256
IL	11	3,960	3,110	0	96,093	21,038	71,819	52,382	124,202
IN	21	13,786	8,282	0	768,297	42,808	632,704	200,470	833,174
KS	4	924	0	0	12,082	1	13,006	1	13,007
KY	18	14,406	8,427	0	616,074	95,285	578,080	156,112	734,192
LA	7	265	23	0	25,426	0	25,563	151	25,714
MA	1	0	0	0	0	500	0	500	500
MD	8	1,870	291	0	34,130	114,115	2,661	147,745	150,406
MI	10	1,123	2,310	68,924	101,857	1,059	77,505	97,769	175,274
MN	2	10	130	0	19,270	0	19,410	0	19,410
MO	6	462	116	0	27,855	936	10,026	19,343	29,369
MS	6	61	121	0	11,676	46	11,228	676	11,904
MT	3	630	0	0	2,138,190	37	2,138,820	37	2,138,857
NC	15	5,626	4,732	0	168,030	2,429	178,388	2,429	180,818
ND	6	6,326	5	0	318,175	0	137,961	186,545	324,506
NE	2	180	0	0	11,000	0	11,180	0	11,180
NJ	2	0	1	0	0	8	0	9	9
NM	2	130	0	0	18,326	0	18,456	0	18,456
NV	10	3,041	30,017	0	98,894,564	0	98,927,328	294	98,927,622
NY	3	67	36	0	27,059	802	27,141	823	27,964
OH	17	8,595	8,352	81,024	741,730	274	668,157	171,818	839,975
OK	4	115	13	0	25,000	4,202	115	29,215	29,330
OR	4	0	5	0	0	4,012	5	4,012	4,017
PA	23	18,963	2,166	0	666,753	69,053	403,582	353,353	756,935
PR	3	0	0	0	0	0	No data	0	0
RI	1	0	8	0	0	1,006	8	1,006	1,014

Table 6-2. Releases to the Environment from Facilities that Produce, Process, or Use Arsenic Compounds[a]

		Reported amounts released in pounds per year[b]							
							Total release		
State[c]	RF[d]	Air[e]	Water[f]	UI[g]	Land[h]	Other[i]	On-site[j]	Off-site[k]	On- and off-site
SC	13	2,178	1,443	0	25,817	22,705	29,438	22,705	52,143
SD	1	0	0	0	0	0	No data	0	0
TN	13	3,379	25,878	0	292,914	17,219	258,643	80,746	339,389
TX	17	4,616	199	33,148	196,385	31,557	226,751	39,155	265,906
UT	5	6,715	4,500	0	6,368,500	3,500	6,379,715	3,500	6,383,215
VA	11	1,911	2,773	0	160,154	8,463	164,789	8,512	173,301
WA	4	0	0	0	0	0	No data	0	0
WI	4	94	21	0	1,313	9,216	223	10,421	10,644
WV	12	2,693	2,417	0	536,628	10,000	441,237	110,501	551,738
WY	2	3,300	0	0	10,800	0	14,100	0	14,100
Total	361	129,205	132,347	1,583,096	116,952,326	625,588	117,346,787	2,075,775	119,422,562

[a]The TRI data should be used with caution since only certain types of facilities are required to report. This is not an exhaustive list. Data are rounded to nearest whole number.
[b]Data in TRI are maximum amounts released by each facility.
[c]Post office state abbreviations are used.
[d]Number of reporting facilities.
[e]The sum of fugitive and point source releases are included in releases to air by a given facility.
[f]Surface water discharges, waste water treatment-(metals only), and publicly owned treatment works (POTWs) (metal and metal compounds).
[g]Class I wells, Class II-V wells, and underground injection.
[h]Resource Conservation and Recovery Act (RCRA) subtitle C landfills; other on-site landfills, land treatment, surface impoundments, other land disposal, other landfills.
[i]Storage only, solidification/stabilization (metals only), other off-site management, transfers to waste broker for disposal, unknown
[j]The sum of all releases of the chemical to air, land, water, and underground injection wells.
[k]Total amount of chemical transferred off-site, including to POTWs.

RF = reporting facilities; UI = underground injection

Source: TRI04 2006 (Data are from 2004)

Arsenic naturally occurs in soil and will be present in the atmosphere as airborne dust. It is also emitted from volcanoes and in areas of dormant volcanism (e.g., fumaroles). Gaseous alkyl arsenic compounds may be released from soil that has been treated with inorganic arsenic compounds as a result of biogenic processes (Schroeder et al. 1987; Tamaki and Frankenberger 1992). Arsenic naturally occurs in sea water and vegetation and is released into the atmosphere in sea salt spray and forest fires. Anthropogenic sources of arsenic include nonferrous metal smelting, coal, oil and wood combustion, and municipal waste incineration. Arsenic naturally occurs in coal and oil and therefore, coal- and oil-fired power plants release arsenic to the atmosphere in their emissions (Pacyna 1987). Arsenic's use in agriculture and industrial processes also contributes to its emissions. One important source of arsenic emissions is cotton ginning in which the cotton seeds are removed from the raw cotton.

The National Air Toxics Assessment reported that total anthropogenic emissions for arsenic compounds in the United States in 1996 were 355 tons/year (EPA 2005b). EPA conducted a modeling study with the Assessment System for Population Exposure Nationwide (ASPEN) in which estimates of emissions of hazardous air pollutants were used to estimate air quality (Rosenbaum et al. 1999). Using 1990 data, the total emissions of arsenic in the conterminous 48 states, excluding road dust or windblown dust from construction or agricultural tilling was estimated to be 3.0 tons/day with 90% of emissions coming from point sources and 5% each from area and mobile sources. U.S. emissions of arsenic to the atmosphere were estimated as 3,300 metric tons per year between 1979 and 1986 (Pacyna et al. 1995). There is evidence that anthropogenic emissions, at least from smelters, are lower than they had been in the early 1980s. It is likely that air releases of arsenic decreased during the 1980s due to regulations on industrial emissions (EPA 1986f), improved control technology for coal-burning facilities, and decreased use of arsenical pesticides.

Nriagu and Pacyna (1988) and Pacyna et al. (1995) estimated worldwide emissions of arsenic to the atmosphere for 1983. Estimates of yearly emissions from anthropogenic sources ranged from 12,000 to 25,600 metric tons with a median value of 18,800 metric tons. Natural sources contributed 1,100–23,500 metric tons annually. Chilvers and Peterson (1987) estimated global natural and anthropogenic arsenic emissions to the atmosphere as 73,500 and 28,100 metric tons per year, respectively. Copper smelting and coal combustion accounted for 65% of anthropogenic emissions. A U.S. Bureau of Mines study on the flow of mineral commodities estimated that global emissions of arsenic from metal smelting, coal burning, and other industrial uses ranged from 24,000 to 124,000 metric tons per year compared to natural releases, mostly from volcanoes, ranging from 2,800 to 8,000 metric tons per year (Loebenstein 1994).

Pirrone and Keeler (1996) compared trends of trace element emissions from major anthropogenic sources in the Great Lakes region with ambient concentrations observed in urban areas of the region. They found that arsenic emissions increased about 2.8% per year from 1982 to 1988 and then decreased steadily by about 1.4% per year to 1993. Coal combustion in electric utilities and in residential, commercial, and industrial facilities was an important source of arsenic in the region, accounting for about 69% of the total emissions. Iron-steel manufacturing accounted for about 13% of the region wide arsenic emissions and nonferrous metals production for 17%.

Arsenic in the particulate phase is the predominant (89–98.6%) form of arsenic in the troposphere (Matschullat 2000). Inorganic species, most commonly trivalent arsenic, is the dominant form of arsenic in the air over emission areas; methylated forms of arsenic are probably of minor significance. Arsenic-containing air samples of smelter or coal-fired power plant origin consist largely of trivalent arsenic in both vapor and particulate form (Pacyna 1987). Oxides are the primary species evolved from fossil fuel and industrial processes. Additionally, arsenic trisulfide has also been reported from coal combustion, organic arsines from oil combustion, and arsenic trichloride from refuse incineration.

Arsenic has been identified in 59 air samples collected from 1,684 current or former NPL hazardous waste sites where it was detected in some environmental media (HazDat 2006).

6.2.2 Water

Estimated releases of 780 pounds (~0.35 metric tons) of arsenic to surface water from 58 domestic manufacturing and processing facilities in 2004, accounted for about 0.09% of the estimated total environmental releases from facilities required to report to the TRI (TRI04 2006). Estimated releases of 1.3x105 pounds (~59 metric tons) of arsenic compounds to surface water from 361 domestic manufacturing and processing facilities in 2004, accounted for about 0.11% of the estimated total environmental releases from facilities required to report to the TRI (TRI04 2006). These releases for arsenic and arsenic compounds are summarized in Tables 6-1 and 6-2, respectively.

Arsenic may be released to water from the natural weathering of soil and rocks, and in areas of vulcanism. Arsenic may also leach from soil and minerals into groundwater. Anthropogenic sources of arsenic releases to water include mining, nonferrous metals, especially copper, smelting, waste water, dumping of sewage sludge, coal burning power plants, manufacturing processes, urban runoff, atmospheric deposition and poultry farms (Garbarino et al. 2003; Nriagu and Pacyna 1988; Pacyna et al. 1995). A contributory

part of mining and coal burning power plants is leaching from abandoned mine tailing and fly ash waste piles. Significant amounts of arsenic are released in liquid effluents from gold-milling operations using cyanide (Environment Canada 1993). Nriagu and Pacyna (1988) and Pacyna et al. (1995) estimated global anthropogenic inputs of arsenic into rivers, lakes, and oceans for 1983; annual estimated inputs ranged from 11,600 to 70,300 metric tons with a median value of 41,800 metric tons. Arsenic was detected in 58% of samples of urban storm water runoff from 8 of 15 cities surveyed in the National Urban Runoff Program at concentrations ranging from 1 to 50.5 µg/L (Cole et al. 1984).

Leaching of arsenic from soil, landfills, or slag deposits is a source of arsenic in groundwater (Francis and White 1987; Wadge and Hutton 1987). The arsenic in soil may be naturally-occurring or a result of the application of arsenic-containing pesticides or sludge. Wood treated with CCA is used in piers, piling and bulkheads and arsenic can leach from the treated wood (Breslin and Adler-Ivanbrook 1998; Brooks 1996; Cooper 1991; Sanders et al. 1994; Weis et al. 1998). Ammoniacal copper zinc arsenate (ACZA) is another arsenic-containing waterborne preservative; however, it is not as widely used as CCA (Lebow et al. 2000).

Arsenic has been identified in 846 groundwater and 414 surface water samples collected from 1,684 NPL hazardous waste sites, where it was detected in some environmental media (HazDat 2006).

6.2.3 Soil

Estimated releases of 0.70 million pounds (~320 metric tons) of arsenic to soils from 58 domestic manufacturing and processing facilities in 2004, accounted for about 77% of the estimated total environmental releases from facilities required to report to the TRI (TRI04 2006). An additional 0.17 million pounds (~77 metric tons), constituting about 19% of the total environmental emissions, were released via underground injection (TRI04 2006). Estimated releases of 117 million pounds (~5.3x104 metric tons) of arsenic compounds to soils from 361 domestic manufacturing and processing facilities in 2004, accounted for about 98% of the estimated total environmental releases from facilities required to report to the TRI (TRI04 2006). An additional 1.6 million pounds (~720 metric tons), constituting about 1.3% of the total environmental emissions, were released via underground injection (TRI04 2006). These releases for arsenic and arsenic compounds are summarized in Tables 6-1 and 6-2, respectively.

The soil receives arsenic from a variety of anthropogenic sources, including ash residue from power plants, smelting operations, mining wastes, and municipal, commercial, and industrial waste. Ash from

power plants is often incorporated into cement and other materials that are used for roads and construction. Arsenic may be released from such material into soil. Nriagu and Pacyna (1988) and Pacyna et al. (1995) estimated global anthropogenic inputs of arsenic into soil for 1983. Excluding mine tailings and smelter slag, annual estimated inputs ranged from 52,000 to 112,000 metric tons with a median value of 82,000 metric tons. Mine tailings and smelter slag were estimated to add an additional 7,200–11,000 and 4,500–9,000 metric tons, respectively. Old abandoned mine tailings undoubtedly contribute still more. Wood treated with CCA used in foundations or posts could potentially release arsenic into the surrounding soil. CCA preservatives have been shown to leach to varying degrees from wood, as well as through soils in both field and laboratory studies (Chirenje et al. 2003a; Hingston et al. 2001; Lebow et al. 2000; Rahman et al. 2004; Stilwell and Graetz 2001; USDA/USDT 2000). Arsenic may also be released on land through the application of pesticides and fertilizer. Senesi et al. (1999) reported the range of arsenic in 32 fertilizers as 2.2–322 ng/g. Roxarsone (3-nitro-4-hydroxyphenyl-arsonic acid), which was used to treat poultry feed in approximately 70% of the broiler poultry operations in 1999–2000, is excreted unchanged in the manure. Poultry litter (manure and bedding) is routinely used as fertilizer to cropland and pasture. In 2000, assuming 70% of the 8.3 billion broiler poultry produced in the United States were fed roxarsone-treated feed, the resulting manure would contain approximately $2.5x10^5$ kg of arsenic (Garbarino et al. 2003). Land application of sewage sludge is another source of arsenic in soil. Arsenic was detected in sewage sludge samples from 23 cities at concentrations of 0.3–53 μg/g (Mumma et al. 1984).

Arsenic has been identified in 758 soil and 515 sediment samples collected from 1,684 NPL hazardous waste sites, where it was detected in some environmental media (HazDat 2006).

6.3 ENVIRONMENTAL FATE

6.3.1 Transport and Partitioning

Arsenic in soil may be transported by wind or in runoff or may leach into the subsurface soil. However, because many arsenic compounds tend to partition to soil or sediment under oxidizing conditions, leaching usually does not transport arsenic to any great depth (EPA 1982c; Moore et al. 1988; Pantsar-Kallio and Manninen 1997; Welch et al. 1988). Arsenic is largely immobile in agricultural soils; therefore, it tends to concentrate and remain in upper soil layers indefinitely. Downward migration has been shown to be greater in a sandy soil than in a clay loam (Sanok et al. 1995). Arsenic from lead arsenate that was used for pest control did not migrate downward below 20 cm in one fruit orchard; in another orchard, 15 years after sludge amendments and deep plowing, essentially all arsenic residues

remained in the upper 40 cm of soil (Merwin et al. 1994). Leaching of arsenic in polluted wetland soil was low; leaching was correlated with the amount of dissolved organic matter in the soil (Kalbitz and Wennrich 1998). The effect of soil characteristics, namely pH, organic matter content, clay content, iron oxide content, aluminum oxide content, and cation exchange capacity (CEC), on the adsorption of various metals, including the metalloid arsenic, to 20 Dutch surface soils was assessed by regression analysis (Janssen et al. 1997). The most influential parameter affecting arsenic adsorption was the iron content of the soil.

Arsenic that is adsorbed to iron and manganese oxides may be released under reducing conditions, which may occur in sediment or flooding conditions (LaForce et al. 1998; McGeehan 1996; Mok and Wai 1994). In addition to reductive dissolution, when nutrient levels are adequate, microbial action can also result in dissolution (LaForce et al. 1998). Interestingly, drying of the previously flooded soil increases arsenic adsorption, possibly due to alterations in iron mineralogy (McGeehan et al. 1998).

Darland and Inskeep (1997) conducted a study to determine the effects of pH and phosphate competition on the transport of arsenate ($H_xAsO_4^{x-3}$) through saturated columns filled with sand containing free iron oxides. At pH 4.5 and 6.5, arsenate transport was strongly retarded, while at pH 8.5, it was rapid. The enhanced transport of arsenate at pH 8 is consistent with the pH dependence of surface complexation reactions describing arsenate sorption by metal oxide minerals that can be categorized as a ligand exchange mechanism. Phosphate was shown to compete effectively with arsenate for adsorption sites on the sand, but the competition was not sufficient to desorb all of the arsenate in batch column experiments, even when the applied phosphate exceeded the column adsorption capacity by a factor of two. The researchers concluded that arsenate desorption kinetics may play an important role in the transport of arsenate through porous media. In a study looking at the effect of competing anions on the adsorption of arsenite and arsenate on ferrihydrite, the effect of phosphate on arsenate adsorption was greater at higher pH than at low pH and the opposite trend was observed for arsenite. While sulfate did not change the affinity of arsenate for ferrihydrite, sulfate reduced the adsorption of arsenite at pHs below 7.0 (Jain and Loeppert 2000).

Smith et al. (1999) investigated the sorption properties of both As(V) and As(III) in 10 Australian soils of widely different chemistry and mineralogy at commonly found arsenic levels. Adsorption of both arsenate and arsenite was rapid (1 hour). The amount of As(V) sorbed varied widely (1.7–62.0 L/kg); soils with lower amounts of oxidic material adsorbed much less arsenic than those with higher amounts of these minerals. Arsenate sorption was highly correlated with the iron oxide content of the soil and this

factor probably accounts for much of the variation in soil adsorptivity. Considerable leaching of arsenic occurred at a separate site where cattle were treated with a dip containing arsenic (cattle dip site) and that contained similar soil properties to that studied by Smith et al. (1999). Arsenite adsorption, which was investigated in four of the Australian soils, was sorbed to a lesser extent than was arsenate. This was attributed to soil minerology and the species of As(V) (arsenate) and As(III) (arsenite) present in solution; at pH 5–7, the dominant As(V) species are $H_2AsO_4^-$ and $HAsO_4^{2-}$ and neutral H_3AsO_3 is the dominant As(III) species. For soils containing low amounts of oxidic minerals, pH had little effect on As(V) sorption, while for oxidic soils, a decrease in sorption was evident as the pH increased. In contrast, As(III) sorption increased with increasing pH (Smith et al. 1999). Jain et al. (1999) reported similar results where arsenite were both found to bind strongly to iron oxides; however, the adsorption of arsenate decreases with increasing pH, while the adsorption of arsenite increases with increasing pH (Jain et al. 1999). As(III), which exists in a neutral form as arsenous acid, H_3AsO_3 (pK_a=9.23, 12.13, 13.4), is less strongly adsorbed on mineral surfaces than the oxyanions of arsenic acid, H_3AsO_4, (pK_a=2.22, 6.98, 11.53) (NRC 1999). Based on its pK_a values, arsenic acid would exist as a mixture of arsenate anions, $H_2AsO_4^-$ and $HAsO_4^{2-}$, under most environmental conditions (pH 5–9).

The practice of liming to remediate contaminated soils and mine tailings has the potential to mobilize arsenic. Experiments performed by Jones et al. (1997) indicate that the increased mobility appears to be consistent with the pH dependence of sorption reactions of arsenic on iron oxide minerals rather than dissolution-precipitation reactions involving arsenic. They recommend that remediation of acidic mine tailings or other arsenic-contaminated soils be carefully evaluated with respect to potential arsenic mobilization, especially at contaminated sites hydraulically connected to surface or groundwaters.

Transport and partitioning of arsenic in water depends upon the chemical form (oxidation state and counter ion) of the arsenic and on interactions with other materials present. Soluble forms move with the water, and may be carried long distances through rivers (EPA 1979). However, arsenic may be adsorbed from water onto sediments or soils, especially clays, iron oxides, aluminum hydroxides, manganese compounds, and organic material (EPA 1979, 1982c; Welch et al. 1988). Under oxidizing and mildly reducing conditions, groundwater arsenic concentrations are usually controlled by adsorption rather than by mineral precipitation. The extent of arsenic adsorption under equilibrium conditions is characterized by the distribution coefficient, K_d, which measures the equilibrium partitioning ratio of adsorbed to dissolved contaminant. The value of K_d depends strongly upon the pH of the water, the arsenic oxidation state, and the temperature. In acidic and neutral waters, As(V) is extensively adsorbed, while As(III) is relatively weakly adsorbed. Trivalent inorganic arsenic exists predominantly as arsenous acid (H_3AsO_3)

at environmental pH and is not strongly adsorbed to suspended solids and sediments in the water column. Pentavalent inorganic arsenic exists predominantly as $H_2AsO_4^-$ and $HAsO_4^{2-}$ in most environmental waters, which has considerably greater adsorption characteristics than arsenous acid. While in acidic and neutral waters, As(V) is more strongly adsorbed relative to As(III), in high-pH waters (pH >9) aquifer K_d values are considerably lower for both oxidation states (Mariner et al. 1996). Sediment-bound arsenic may be released back into the water by chemical or biological interconversions of arsenic species (see Section 6.3.2).

Arsenic enters rivers from where mining operations occurred and is transported downstream, moving from water and sediment into biofilm (attached algae, bacterial, and associated fine detrital material), and then into invertebrates and fish. The source of arsenic in the water column may be resuspended sediment. While arsenic bioaccumulates in animals, it does not appear to biomagnify between tropic levels (Eisler 1994; Farag et al. 1998; Williams et al. 2006).

Most anthropogenic arsenic emitted to the atmosphere arises from high temperature processes (e.g., coal and oil combustion, smelting operations, and refuse incineration) and occurs as fine particles with a mass median diameter of about 1 μm (Coles et al. 1979; Pacyna 1987). These particles are transported by wind and air currents until they are returned to earth by wet or dry deposition. Their residence time in the atmosphere is about 7–9 days, in which time the particles may be transported thousands of kilometers (EPA 1982b; Pacyna 1987). Long-range transport was evident in analyzing deposition of arsenic in countries like Norway; there was no indication that the marine environment contributed significantly to the deposition (Steinnes et al. 1992). Atmospheric fallout can be a significant source of arsenic in coastal and inland waters near industrial areas. Scudlark et al. (1994) determined the average wet depositional flux of arsenic as 49 μg As/m^2/year for two sites in Chesapeake Bay, Maryland from June 1990 to July 1991. They found a high degree of spatial and temporal variability. The elemental fluxes derived predominantly from anthropogenic sources. Golomb et al. (1997) report average total (wet + dry) deposition rates to Massachusetts Bay of 132 μg/m^2/year, of which 21 μg/m^2/year was wet deposition during the period September 15, 1992–September 16, 1993. Hoff et al. (1996) estimated the following arsenic loadings into the Great Lakes for 1994 (lake, wet deposition, dry deposition): Superior, 11,000 kg/year, 3,600 kg/year; Michigan, 5,000 kg/year, 1,800 kg/year; Erie, 5,500 kg/year, 1,800 kg/year; and Ontario, 3,000 kg/year, 580 kg/year. The measured dry deposition fluxes of arsenic at four sampling sites around Lake Michigan ranged approximately from 0.01 to 1.5 μg As/m^2/day; estimated inputs of arsenic into Lake Michigan were reported to be $1.4x10^3$ kg/year (Shahin et al. 2000).

Terrestrial plants may accumulate arsenic by root uptake from the soil or by absorption of airborne arsenic deposited on the leaves, and certain species may accumulate substantial levels (EPA 1982b). Yet, even when grown on highly polluted soil or soil naturally high in arsenic, the arsenic level taken up by the plants is comparatively low (Gebel et al. 1998b; Pitten et al. 1999). Kale, lettuce, carrots, and potatoes were grown in experimental plots surrounding a wood preservation factory in Denmark where waste wood was incinerated to investigate the amount and pathways for arsenic uptake by plants (Larsen et al. 1992). On incineration, the arsenate in the wood preservative was partially converted to arsenite; the arsenic emitted from the stack was primarily particle bound. Elevated levels of inorganic arsenic were found in the test plants and in the soil around the factory. Statistical analyses revealed that the dominating pathway for transport of arsenic from the factory to the leafy vegetables (kale) was by direct atmospheric deposition, while arsenic in the root crops (potatoes and carrots) was a result of both soil uptake and atmospheric deposition. Arsenic accumulation by plants is affected by arsenic speciation. Uptake of four arsenic species (arsenite, arsenate, methylarsonic acid, and dimethylarsinic acid) by turnips grown under soilless culture conditions showed that while uptake increased with increasing arsenic concentration in the nutrient, the organic arsenicals showed higher upward translocation than the inorganic arsenical (Carbonell-Barrachina et al. 1999). The total amount of arsenic taken up by the turnip plants (roots and shoots) followed the trend methylarsenate (MMA)<dimethylarsinic acid (DMA) <arsenite<arsenate. In a similar experiment, conducted with tomato plants, the total amount of arsenic taken up by the tomato plants followed the trend DMA<MMA<arsenate≈arsenite, with arsenic concentrations in the plants increasing with increasing arsenic concentration in the nutrient solution. Arsenic was mainly accumulated in the root system (85%) with smaller amounts translocating to the fruit (1%). However, plants treated with MMA and DMA had higher arsenic concentrations in the shoots and fruit than those treated with arsenite or arsenate (Burlo et al. 1999). Terrestrial plants growing on land bordering arsenic-contaminated waters show relatively little arsenic content, even though the sediments have arsenic concentrations as high as 200 µg/g (Tamaki and Frankenberger 1992). Arsenic concentrations in vegetables grown in uncontaminated soils and contaminated soils containing arsenic, as well as other metals and organic contaminants, were generally <12 µg/kg wet weight. A maximum arsenic concentration of 18 µg/kg wet weight was found in unpeeled carrots grown in soil, which contained a mean arsenic concentration of 27 mg/kg dry weight (Samsøe-Petersen et al. 2002).

In a study by Rahman et al. (2004), CCA-treated lumber was used to construct raised garden beds to determine how far the components of CCA migrated in the soil and the uptake of these components by crops grown in the soil. Arsenic was found to diffuse laterally into the soil from the CCA-treated wood, with the highest concentrations found at 0–2 cm from the treated wood and a steady decline in

concentration with increased distance. The highest average arsenic concentrations found in soil closest (0–2 cm) to the CCA-treated wood were 56 and 46 μg/g in loamy sand and sandy loam soils, respectively. At a distance of 30–35 cm from the CCA-treated wood, arsenic concentrations were approximately 7 μg/g in both soils. All samples were of the top 0–15 cm of soil. Crops grown in both soil types within 0–2 cm of the CCA-treated wood contained higher concentrations of arsenic, 0.186 and 10.894 μg/g for carrots without peal and bean leaves and stems, respectively, than those grown at 1.5 m from the CCA-treated wood, 0.006 and 0.682 μg/g for bean pods and bean leaves and stems, respectively. However, based on FDA guidelines on tolerance limits, these crops would be considered approved for human consumption. Studies by Chirenje et al. (2003a) also showed that elevated arsenic concentrations were found in surface (0–5 cm) soils immediately surrounding, within the first 0.3 m, of utility poles, fences, and decks made with CCA-treated wood. Factors such as the preservative formula, fixation temperature, post treatment handling, and timber dimensions of CCA-treated wood, as well as the pH, salinity, and temperature of the leaching media can affect the leach rates from CCA-treated wood (Hingston et al. 2001). Studies of leaching of the components of CCA- and ACZA-treated wood used to construct a boardwalk in wetland environments reported elevated arsenic levels in soil and sediment below and adjacent to these structures. Generally, these levels decreased with increasing distance from the structure (Lebow et al. 2000). Increased concentrations of arsenic were also observed under CCA-treated bridges. Arsenic levels declined with distance from the bridge and were near background levels at 1.8–3 m from the bridge's perimeter (USDA/USDT 2000).

In a study by Lebow et al. (2003), the use of a water repellent finish on CCA-treated wood significantly reduces the amount of arsenic, as well as copper and chromium, in the run-off water. It was also observed the exposure to UV radiation caused a significant increase in leaching from both finished and unfinished samples of CCA-treated wood. Small amounts of arsenic can be transferred from CCA-treated wood to skin from touching CCA-treated wood surfaces (Hemond and Solo-Gabriele 2004; Kwon et al. 2004; Shalat et al. 2006; Ursitti et al. 2004; Wang et al. 2005).

Breslin and Adler-Ivanbrook (1998) examined the leaching of the copper, chromium, and arsenic from CCA-treated wood in laboratory studies using samples of treated southern yellow pine in solutions simulating estuarine waters. The tank leaching solutions were frequently sampled and replaced to approximate field conditions. Initial 12-hour fluxes ranging from $0.2x10^{-10}$ to $5.2x10^{-10}$ mol/mm^2 d was reported for arsenic. After 90 days, arsenic fluxes decreased to $0.5x10^{-11}$–$3.1x10^{-11}$ mol/mm^2 d. A study by Cooper (1991) demonstrated that the buffer system used in leaching studies of components from CCA-treated wood can significantly change the amount arsenic released from treated wood. Samples of four

species of CCA-treated wood were exposed to four acidic leaching solutions. In the samples exposed to water adjusted to pHs of 3.5, 4.5, and 5.5, losses of arsenic after 13 days were generally <7%. However, when a leaching solution of sodium hydroxide and citric acid buffer (pH 5.5) was used, the percent of arsenic leached ranged from 27.4 to 46.7% (Cooper 1991).

Arsenic bioaccumulation depends on various factors, such as environmental setting (marine, estuarine, freshwater), organism type (fish, invertebrate), trophic status within the aquatic food chain, exposure concentrations, and route of uptake (Williams et al. 2006). Bioaccumulation refers to the net accumulation of a chemical by aquatic organisms as a result of uptake from all environmental sources, such as water, food, and sediment, whereas bioconcentration refers to the uptake of a chemical by an aquatic organism through water (EPA 2003b). Biomagnification in aquatic food chains does not appear to be significant (EPA 1979, 1982b, 1983e, 2003b; Mason et al. 2000; Williams et al. 2006).

Bioconcentration of arsenic occurs in aquatic organisms, primarily in algae and lower invertebrates. Both bottom-feeding and predatory fish can accumulate contaminants found in water. Bottom-feeders are readily exposed to the greater quantities of metals, including the metalloid arsenic, which accumulate in sediments. Predators may bioaccumulate metals from the surrounding water or from feeding on other fish, including bottom-feeders, which can result in the biomagnification of the metals in their tissues. An extensive study of the factors affecting bioaccumulation of arsenic in two streams in western Maryland in 1997–1998 found no evidence of biomagnification since arsenic concentrations in organisms tend to decrease with increasing tropic level (Mason et al. 2000). Arsenic is mainly accumulated in the exoskeleton of invertebrates and in the livers of fish. No differences were found in the arsenic levels in different species of fish, which included herbivorous, insectivorous, and carnivorous species. The major bioaccumulation transfer is between water and algae, at the base of the food chain and this has a strong impact on the concentration in fish. National Contaminant Biomonitoring data produced by the Fish and Wildlife Service were used to test whether differences exist between bottom-feeders and predators in tissue levels of metals and other contaminants. No differences were found for arsenic (Kidwell et al. 1995). The bioconcentration factors (BCFs) of bryophytes, invertebrates, and fish (livers) in Swedish lakes and brooks impacted by smelter emissions were 8,700, 1,900–2,200, and 200–800, respectively (Lithner et al. 1995). EPA (2003b) assessed a large dataset of bioaccumulation data for various fish and invertebrate species. BCF values in this dataset ranged from 0.048 to 1,390.

Williams et al. (2006) reviewed 12 studies of arsenic bioaccumulation in freshwater fish, and proposed that BCF and bioaccumulation factor (BAF) values are not constant across arsenic concentrations in

water. BCF or BAF values from these 12 studies ranged from 0.1 to 3,091. Williams et al. (2006) found that BCF and BAF values appear to be the highest within the range of ambient arsenic concentrations, and decline steeply to relatively low levels as the arsenic concentrations in water increase. Based on this analysis, arsenic concentrations in tissue and BAF values may be a power function of arsenic concentrations in water. EPA (2007b) also reported that for many nonessential metals, including arsenic, accumulation is nonlinear with respect to exposure concentration.

6.3.2 Transformation and Degradation

6.3.2.1 Air

Arsenic is released into the atmosphere primarily as arsenic trioxide or, less frequently, in one of several volatile organic compounds, mainly arsines (EPA 1982b). Trivalent arsenic and methyl arsines in the atmosphere undergo oxidation to the pentavalent state (EPA 1984a), and arsenic in the atmosphere is usually a mixture of the trivalent and pentavalent forms (EPA 1984a; Scudlark and Church 1988). Photolysis is not considered an important fate process for arsenic compounds (EPA 1979).

6.3.2.2 Water

Arsenic in water can undergo a complex series of transformations, including oxidation-reduction reactions, ligand exchange, precipitation, and biotransformation (EPA 1979, 1984a; Sanders et al. 1994; Welch et al. 1988). Rate constants for these various reactions are not readily available, but the factors most strongly influencing fate processes in water include Eh, pH, metal sulfide and sulfide ion concentrations, iron concentrations, temperature, salinity, distribution and composition of the biota, season, and the nature and concentration of natural organic matter (EPA 1979; Farago 1997; Redman et al. 2002; Wakao et al. 1988). Organic arsenical pesticides, such as MSMA, DSMA, and DMA do not degrade by hydrolysis or by aquatic photolysis (EPA 2006). No formation of arsine gas from marine environments has been reported (Tamaki and Frankenberger 1992).

Inorganic species of arsenic are predominant in the aquatic environment. In the pH range of natural waters, the predominant aqueous inorganic As(V) species are the arsenate ions, $H_2AsO_4^-$ and $HAsO_4^{2-}$; the predominant inorganic As(III) species is $As(OH)_3$ (Aurillo et al. 1994; EPA 1982c). As(V) generally dominates in oxidizing environments such as surface water and As(III) dominates under reducing conditions such as may occur in groundwater containing high levels of arsenic. However, the reduction of arsenate to arsenite is slow, so arsenate can be found in reducing environments. Conversely, the oxidation of arsenite in oxidizing environments is moderately slow (half-life, 0.4–7 days in coastal

systems) and therefore, arsenite can be found in oxidizing environments (Mariner et al. 1996; Sanders et al. 1994). The main organic species in fresh water are MMA and DMA; however, these species are usually present at lower concentrations than inorganic arsenic species (Eisler 1994). (The toxicities of MMA and DMA are discussed in Chapter 3.) Aquatic microorganisms may reduce the arsenate to arsenite, as well as methylate arsenate to its mono- or dimethylated forms (Aurillo et al. 1994; Benson 1989; Braman and Foreback 1973; Edmonds and Francesconi 1987; Sanders et al. 1994). Methylated species are also produced by the biogenic reduction of more complex organoarsenic compounds like arsenocholine or arsenobetaine. Water samples from a number of lakes and estuaries, mostly in California, show measurable concentrations of methylated arsenic (equivalent to 1–59% of total arsenic) (Anderson and Bruland 1991). Within the oxic photic zone, arsenate and DMA were the dominant species. A seasonal study of one lake demonstrated that DMA was the dominant form of arsenic in surface waters during late summer and fall. Methylated species declined and arsenate species increased when the lake turned over in late fall. Mono Lake, a highly alkaline body of water, and four rivers did not have measurable concentrations of methylated arsenic. It was hypothesized that the reason why methylated forms were not detected in Mono Lake was that the extremely high inorganic arsenic concentrations in the lake, 230 µM (17 mg/L), could overwhelm the analysis of small amounts of organic forms. Other possibilities are that the high alkalinity or very high phosphate levels in the water, 260 µM (25 mg/L), are not conducive to biogenic methylation (Anderson and Bruland 1991). Both reduction and methylation of As(V) may lead to increased mobilization of arsenic, since As(III), dimethylarsinates, and monomethylarsonates are much less particle-reactive than As(V) (Aurillo et al. 1994). In the estuarial Patuxet River, Maryland, arsenate concentrations peaked during the summer, at 1.0 µg/L in 1988–1989 (Sanders et al. 1994). In contrast, winter to spring levels were around 0.1 µg/L. Arsenite concentrations were irregularly present at low levels during the year. Peaks of DMA occurred at various times, particularly in the winter and late spring and appeared to be linked with algal blooms. The DMA peak declined over several months that was followed by a rise in MMA. The MMA was thought to be occurring as a degradation product of DMA. A similar seasonal pattern of arsenic speciation was observed in Chesapeake Bay. Arsenite methylation took place during the warmer months leading to changes down the main stem of the bay; arsensite production dominated the upper reaches of the bay and methylated species dominated the more saline lower reaches. In coastal waters, reduced and methylated species are present in lower concentrations, around 10–20% of total arsenic (Sanders et al. 1994). In groundwater, arsenic generally exists as the oxyanion of arsenate ($H_xAsO_4^{3-x}$) or arsenite ($H_xAsO_3^{3-x}$), or both; however, the distribution between arsenite and arsenate is not always predictable based on oxidation-reduction potential (Robertson 1989; Welch et al. 1988).

6.3.2.3 Sediment and Soil

In soil, arsenic is found as a complex mixture of mineral phases, such as co-precipitated and sorbed species, as well as dissolved species (Roberts et al. 2007). The degree of arsenic solubility in soil will depend on the amount of arsenic distributed between these different mineral phases. The dissolution of arsenic is also affected by particle size. The distribution between these phases may reflect the arsenic source (e.g., pesticide application, wood treatment, tanning, or mining operations), and may change with weathering and associations with iron and manganese oxides and phosphate minerals in the soil (Roberts et al. 2007; Ruby et al. 1999). Davis et al. (1996) reported that in soil in Anaconda, Montana, a smelting site from 1860 to 1980, contained arsenic that is only in a sparingly soluble form, consisting of primarily arsenic oxides and phosphates.

The arsenic cycle in soils is complex, with many biotic and abiotic processes controlling its overall fate and environmental impact. Arsenic in soil exists in various oxidation states and chemical species, depending upon soil pH and oxidation-reduction potential. Under most environmental conditions, inorganic As(V) will exist as a mixture of arsenate anions, $H_2AsO_4^-$ and $HAsO_4^{2-}$, and inorganic As(III) will exist as H_3AsO_3. The arsenate and arsenite oxyanions have various degrees of protonation depending upon pH (EPA 1982b; McGeehan 1996). As(V) predominates in aerobic soils, and As(III) predominates in slightly reduced soils (e.g., temporarily flooded) or sediments (EPA 1982b; Sanders et al. 1994). As(III) commonly partitions to the aqueous phase in anoxic environments, and would be more mobile. As(V) usually remains bound to minerals, such as ferrihydrite and alumina, limiting its mobility and bioavailability (Rhine et al. 2006).

Arsenite is moderately unstable in the presence of oxygen; however, it can be found under aerobic conditions as well (Sanders et al. 1994). While arsenate is strongly sorbed by soils under aerobic conditions, it is rapidly desorbed as the system becomes anaerobic. Once it is desorbed, arsenate can be reduced to arsenite, which exhibits greater mobility in soils (McGeehan 1996). Transformations between the various oxidation states and species of arsenic occur as a result of biotic or abiotic processes (Bhumbla and Keefer 1994). While degradation of an organic compound is typically considered complete mineralization, in the case of organic arsenic compounds, the element arsenic itself cannot be degraded. However, the organic portion of the molecule can be metabolized (Woolson 1976).

Arsenicals applied to soils may be methylated by microorganisms to arsines, which are lost through volatilization, and organic forms may be mineralized to inorganic forms. Gao and Burau (1997) reported

that the overall percentage of DMA and MMA minerialized after 70 days ranged from 3 to 87% in air-dry soil and a soil near saturation, respectively. The rate of demethylation of DMA increased with soil moisture. Over the same 70-day period, arsenic losses as volatile arsines were much lower than minerialization, ranging from 0.001 to 0.4%. Arsine evolution rates followed the order: DMA>MMA>arsenite=arsenate (Gao and Burau 1997). Woolson and Kearney (1973) reported that ^{14}C-labeled DMA degraded differently in soils under aerobic and anaerobic conditions. Under anaerobic conditions, 61% of the applied DMA was converted to a volatile alkyl arsine after 24 weeks, and lost from the soil system. Under aerobic conditions, 35% was converted to a volatile organo-arsenic compound, possibly dimethyl arsine, and 41% was converted to $^{14}CO_2$ and arsenate after 24 weeks. Similar to microorganisms in soils, Reimer (1989) reported that microorganisms found in natural marine sediments and sediments contaminated with mine-tailings are also capable of methylating arsenic under aerobic and anaerobic conditions. Von Endt et al. (1968) reported that the degradation of ^{14}C-labelled monosodium methanearsonate (MSMA) was found to range from 1.7 to 10% in Dundee silty clay loam soil and Sharkey clay soil after 60 days, respectively. MSMA decomposition to CO_2 was a slow process without a lag period. Sterilized soils were found to produce essentially no $^{14}CO_2$ (0.7%) after 60 days, indicating that soil bacteria contributed to the decomposition of MSMA (Von Endt et al. 1968). Akkari et al. (1986) studied the degradation of MSMA in various soils. At 20% water content, half-lives of 144, 88, and 178 days were reported in Sharkey clay, Taloka silt loam, and Steele-Crevasse sand loam, respectively. The Sharkey soil with the highest clay content was expected to have the greatest adsorptive capacity for both water and MSMA, reducing the amount of MSMA available in the soil solution to microorganisms that degrade the MSMA. The half-lives were 25, 41, and 178 days under anaerobic (flooded) conditions in Sharkey clay, Taloka silt loam, and Steele-Crevasse sand loam, respectively. Under flooded conditions, MSMA degradation occurs by reductive methylation to form arsinite and alkylarsine gas. The authors attributed the longer half-lives for MSMA degradation in the Steele-Crevasse sand loam soil to its low organic matter content, which may have supported fewer microbial populations needed for oxidation demethylation under aerobic conditions. Under flooded conditions, anaerobiosis is expected to be slowest in low organic matter sandy loam soils (Akkari et al. 1986).

Organic arsenical pesticides, such as MSMA, DSMA, and DMA, do not degrade by hydrolysis or by soil photolysis (EPA 2006).

Roxarsone (3-nitro-4-hydroxyphenylarsonic acid) used in poultry feed is found excreted unchanged in poultry litter (bedding and manure). Roxarsone found in poultry litter, which is used to amend agricultural soil, was found to degrade to arsenate in approximately 3–4 weeks upon composting

(Garbarino et al. 2003). In addition, the arsenic in poultry litter was found to be easily mobilized by water; however, its leach rate from amended soils was slow enough that it accumulated in soils (Rutherford et al. 2003).

A sequential fractionation scheme was used to assess the chemical nature, and thus the potential bioavailability, of arsenic at cattle dip sites in Australia where sodium arsenite was used extensively in cattle dips from the turn of the century until the early 1950s (McLaren et al. 1998). Most sites contained substantial amounts, 13% on the average, of arsenic in the two most labile fractions indicating a high potential for bioaccessibility and leaching. The bulk of the arsenic appeared to be associated with amorphous iron and aluminum minerals in soil. Similarly, arsenic in soil and mine waste in the Tamar Valley in England was found to be concentrated in a fraction associated with iron and organic-iron (Kavanagh et al. 1997). Laboratory studies were performed to assess the phase partitioning of trace metals, including the metalloid arsenic, to sediment from the Coeur d'Alene River, a mining area of Idaho, and the release of metals under simulated minor and major flooding events (LaForce et al. 1998). Arsenic was primarily associated with the iron and manganese oxides as seen by its large release when these oxides were reduced. Arsenic levels were comparatively low in the organic fraction and remaining residual fraction and negligible in the extractible fractions.

6.3.2.4 Other Media

Carbonell-Barrachina et al. (2000) found the speciation and solubility of arsenic in sewage sludge suspensions to be affected by pH and Eh. Under oxidizing conditions, the solubility of arsenic was low, with a major portion of the soluble arsenic present as organic arsenic compounds, mainly dimethylarsinic acid (approximately 74% of the total arsenic in solution). Under moderately reducing conditions (0–100 mV), inorganic arsenic accounted for the majority (90%) of the total arsenic in solution, and the solubility of arsenic was increased due to dissolution of iron oxyhydroxides. Under strongly reducing conditions (-250 mV), arsenic solubility was decreased by the formation of insoluble sulfides. The pH of the solution was also found to influence the speciation and solubility of arsenic. At neutral pH, the solubility of arsenic was at its maximum, and decreased under acidic or alkaline conditions. Inorganic arsenic species were the dominant species at pH 5.0; at pH 6.5, the major soluble forms were organic arsenic species. The biomethylation of arsenic was limited at acidic pH, and was at its maximum at near neutral pH (Carbonell-Barrachina et al. 2000).

6.4 LEVELS MONITORED OR ESTIMATED IN THE ENVIRONMENT

Reliable evaluation of the potential for human exposure to arsenic depends in part on the reliability of supporting analytical data from environmental samples and biological specimens. Concentrations of arsenic in unpolluted atmospheres and in pristine surface waters are often so low as to be near the limits of current analytical methods. In reviewing data on arsenic levels monitored or estimated in the environment, it should also be noted that the amount of chemical identified analytically is not necessarily equivalent to the amount that is bioavailable. The analytical methods available for monitoring arsenic in a variety of environmental media are detailed in Chapter 7.

6.4.1 Air

Arsenic in ambient air is usually a mixture of particulate arsenite and arsenate; organic species are of negligible importance except in areas of substantial methylated arsenic pesticide application or biotic activity (EPA 1984a). Mean levels in ambient air in the United States have been reported to range from <1 to 3 ng/m^3 in remote areas and from 20 to 30 ng/m^3 in urban areas (Davidson et al. 1985; EPA 1982c; IARC 1980; NAS 1977a). EPA conducted a modeling study with the Assessment System for Population Exposure Nationwide (ASPEN) in which estimates of emissions of hazardous air pollutants were used to estimate ambient concentrations (Rosenbaum et al. 1999). Using 1990 data to estimate total emissions of arsenic in the conterminous 48 states, excluding road dust or windblown dust from construction or agricultural tilling, the 25th percentile, median, and 75th percentile arsenic concentration were estimated to be 9, 20, and 30 ng/m^3, respectively. Maps illustrating the amount of toxic air pollutant emissions, including arsenic compounds, by county in 1996 for the 48 coterminous states of the United States as well as Puerto Rico and the Virgin Islands are available on the internet at http://www.epa.gov/ttn/atw/-nata/mapemis.html, as of March 2005. Schroeder et al. (1987) listed ranges of arsenic concentrations in air of 0.007–1.9, 1.0–28, and 2–2,320 ng/m^3 in remote, rural, and urban areas, respectively. The average annual arsenic concentration in air at Nahant, Massachusetts, just north of Boston, between September 1992 and September 1993, was 1.2 ng/m^3; 75% of the arsenic was associated with fine (<2.5 μm) particles. The long-term means of the ambient concentrations of arsenic measured in urban areas of the Great Lakes region from 1982 to 1993 ranged from 4.2 to 9.6 ng/m^3 (Pirrone and Keeler 1996). Large cities generally have higher arsenic air concentrations than smaller ones due to emissions from coal-fired power plants (IARC 1980), but maximum 24-hour concentrations generally are <100 ng/m^3 (EPA 1984a). In the spring of 1990, aerosols and cloud water that were sampled by aircraft at an altitude of 1.2–3 km above the Midwestern United States had a mean mixed layer arsenic concentration of 1.6±0.9 ng/m^3 (Burkhard et al. 1994). A mean arsenic concentration of 1.0±0.5 ng/m^3 was reported at

Mayville, New York, a site 400 km to the northwest of the sampling area and directly downwind on most days.

Arsenic was monitored at an application site in the San Joaquin Valley, California and at four sites in nearby communities in 1987 where sodium arsenite was used as a fungicide on tokay grapes (Baker et al. 1996). The maximum arsenic concentration measured 15–20 meters from the edge of the field was 260 ng/m^3. The maximum arsenic concentration at four community sites in the area was 76 ng/m^3. The concentration at an urban background site was 3 ng/m^3 (Baker et al. 1996). Sodium arsenite is no longer registered in California (Baker et al. 1996). The highest historic arsenic levels detected in the atmosphere were near nonferrous metal smelters, with reported concentrations up to 2,500 ng/m^3 (IARC 1980; NAS 1977a; Schroeder et al. 1987).

Arsenic air concentrations measured in several indoor public places (e.g., cafeteria, coffee house, music club, Amtrak train, and several restaurants) with environmental tobacco smoke (ETS) ranged from <0.1 to 1 ng/m^3, with a mean of 0.4±0.3 ng/m^3. Sites that were ETS-free (university office and library) had arsenic concentrations <0.13 ng/m^3 (Landsberger and Wu 1995). The Toxic Exposure Assessment at Columbia/Harvard (TEACH) study measured levels of various toxics in New York City air in 1999. Exposures were assessed in a group of 46 high school students in West Central Harlem. Mean arsenic concentrations in summer home outdoor, home indoor, and personal air of the participants were 0.37, 0.40, and 0.45 ng/m^3, respectively (Kinney et al. 2002). Detected arsenic concentrations in indoor and outdoor air collected as part of the National Human Exposure Assessment Survey (NHEXAS) in Arizona ranged from 3.4 to 22.3 and from 3.5 to 25.7 ng/m^3, respectively, with 71 and 68% below the detection limit (1.8–14.3 ng/m^3) (O'Rourke et al. 1999).

6.4.2 Water

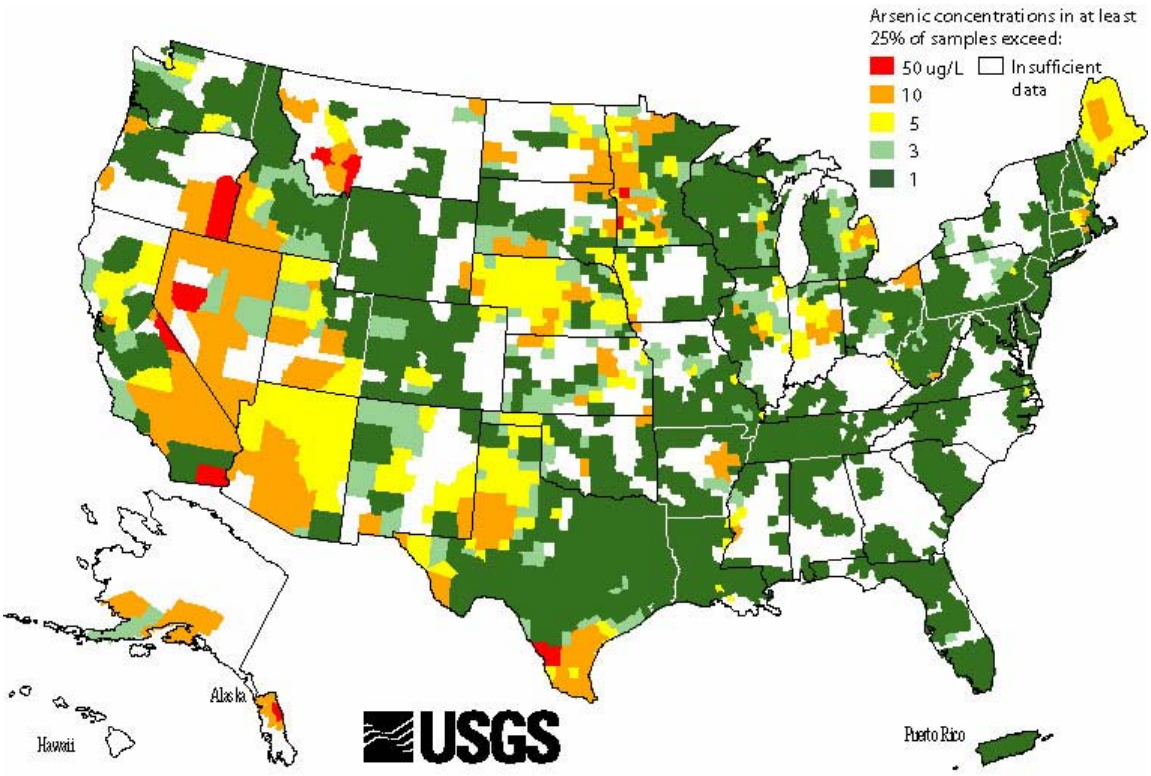
Arsenic is widely distributed in surface water, groundwater, and finished drinking water in the United States. A survey of 293 stations in two nationwide sampling networks on major U.S. rivers found median arsenic levels to be 1 µg/L; the 75th percentile level was 3 µg/L (Smith et al. 1987). Arsenic was detected in 1,298 of 3,452 surface water samples recorded in the STORET database for 2004 at concentrations ranging from 0.138 to 1,700 µg/L in samples where arsenic was detected (EPA 2005c). Two streams in western Maryland that were the focus of a major bioaccumulation study in 1997–1998 had arsenic concentrations of 0.370±0.200 and 0.670±0.460 µg/L (Mason et al. 2000). Surface water will be impacted by runoff from polluted sites. An average arsenic concentration of 5.12 µg/L was reported in

water from Moon Lake, a Mississippi River alluvial floodplain in northwest Mississippi. Intensive cultivation has occurred in this area, including cotton, soybeans, and rice (Cooper and Gillespie 2001). Hard-rock mining activities occurred in the southern part of Colorado and New Mexico north of Taos since the latter part of the 19th century until recently, which have impacted the Rio Grande and its tributaries. A mean arsenic concentration of approximately 0.8 µg/L was reported for the main stem of the Rio Grande sampled in June and September 1994. Arsenic concentrations in the Alamosa River, Colorado were 0.11 and 0.14 µg/L in June and September 1994, respectively, and 1.4 µg/L in Big Arsenic Spring, New Mexico in September 1994 (Taylor et al. 2001). Arsenic concentrations in water from watersheds in Black Hills, South Dakota, an area impacted by gold mining activities ranged from 2.5 to 55 µg/L and from 1.7 to 51 µg/L in unfiltered and filtered samples, respectively; concentrations from reference areas ranged from 1.1 to 3.4 µg/L and from 0.9 to1.9 µg/L in unfiltered and filtered samples, respectively (May et al. 2001). Arsenic concentrations ranged from 0.29 to 34.0 µg/L in water samples from Wakulla River and St. Joseph Bay North, along the Florida Panhandle; arsenic contamination in this area is likely to result from nonpoint source pollution (Philp et al. 2003).

Data on total arsenic in surface water from a number of seas and oceans show levels of <1 µg/L, except in the Antarctic Ocean and Southwest Pacific Oceans where the levels are 1.1 and 1.2 µg/L, respectively. Levels in coastal waters and estuaries are generally somewhat higher, in the range of 1–3 µg/L. However, estuarine water in Salinas, California had arsenic levels of 7.42 µg/L (Francesconi et al. 1994). The dissolved arsenic concentration in water at 40 sites in the Indian River Lagoon System in Florida ranged from 0.35 to 1.6 µg/L with a mean of 0.89±0.34 µg/L (Trocine and Trefry 1996). Thermal waters generally have arsenic levels of 20–3,800 µg/L, although levels as high as 276,000 µg/L have been recorded (Eisler 1994).

Arsenic levels in groundwater average about 1–2 µg/L, except in some western states with volcanic rock and sulfidic mineral deposits high in arsenic, where arsenic levels up to 3,400 µg/L have been observed (IARC 1980; Page 1981; Robertson 1989; Welch et al. 1988). In western mining areas, groundwater arsenic concentrations up to 48,000 µg/L have been reported (Welch et al. 1988). Arsenic concentrations in groundwater samples collected form 73 wells in 10 counties in southeast Michigan in 1997 ranged from 0.5 to 278 µg/L, with an average of 29 µg/L. Most (53–98%) of the arsenic was detected as arsenite (Kim et al. 2002). The U.S. Geological Survey mapped concentrations of arsenic in approximately 31,350 groundwater samples collected between 1973 and 2001; the counties in which at least 25% of wells exceed various levels are shown in Figure 6-2 (USGS 2007a). Most arsenic in natural waters is a

Figure 6-2. Counties in Which at Least 25% of Wells Exceed Different Arsenic Levels



Source: USGS 2007a

mixture of arsenate and arsenite, with arsenate usually predominating (Braman and Foreback 1973; EPA 1982c, 1984a). Methylated forms have also been detected in both surface water and groundwater, at levels ranging from 0.01 to 7.4 µg/L (Braman and Foreback 1973; Hood 1985), with most values below 0.3 µg/L (Hood 1985). In a survey of shallow groundwater quality in the alluvial aquifer beneath a major urban center, Denver, Colorado, arsenic levels in the 30 randomly-chosen wells sampled had median levels of <1 µg/L; the maximum level was 33 µg/L (Bruce and McMahon 1996). Arsenic levels in groundwater sometimes exceeded the EPA maximum contaminant level (MCL), which was 50 µg/L at the time, in the Willamette Valley, Oregon and a nine-county region of southeastern Michigan (USGS 1999b, 1999c).

Arsenic has also been detected in rainwater at average concentrations of 0.2–0.5 µg/L (Welch et al. 1988). This range is consistent with that found in a 1997–1998 study in western Maryland, which was the focus of a major bioaccumulation study (Mason et al. 2000). Arsenic levels in wet deposition in the watershed as well as throughfall into the two streams were 0.345±0.392, 0.400±0.400, and 0.330±0.250 µg/L, respectively. Median arsenic concentrations in 30-day rainwater composite samples collected May-September 1994 from eight arctic catchments in northern Europe at varying distances and wind directions from the emissions of a Russian nickel ore mining, roasting, and smelting industry on the Kola Peninsula ranged from 0.07 to 12.3 µg/L (Reimann et al. 1997). Rain and snow samples were collected during the fall of 1996 and winter of 1997 at eight locations in a semi-circular pattern radiating out (2–15 km) in the direction of the prevailing wind from the Claremont incinerator located in New Hampshire. This incinerator processes 200 tons of solid waste per day. Arsenic concentrations in rainwater and snow ranged from 0.020 to 0.079 µg/L and from 0.80 to 1.28 µg/L, respectively (Feng et al. 2000).

Drinking water is one of the most important sources of arsenic exposure. Surveys of drinking water in the United States have found that >99% of public water supplies have arsenic concentrations below the EPA MCL, which was 50 µg/L at the time (EPA 1984a). In an EPA study of tap water from 3,834 U.S. residences, the average value was 2.4 µg/L (EPA 1982c).

Before the MCL for arsenic in drinking water was lowered from 50 to 10 µg/L, studies were undertaken to ascertain how different standards would affect compliance. One such survey sponsored by the Water Industry Technical Action Fund was the National Arsenic Occurrence Survey (NAOS). NAOS was based on a representational survey of public water systems defined by source type, system size, and geographical location. Additionally, it included a natural occurrence factor, a stratifying variable that could qualitatively describe the likelihood of arsenic occurrence in the supply. To predict finished water

arsenic concentrations, data on the water treatment options, efficiency, and frequency of use were factored in. The results of the NAOS are presented in Table 6-3. The NAOS results are in general agreement with two older and more limited national surveys, EPA's National Inorganics and Radionuclides Survey (NIRS) and the Metropolitan Water District of Southern California Survey (MWDSC). The percentages of water systems that would be out of compliance are estimated to be 1.7, 3.6, 9.3, and 20.7% for arsenic MCLs of 20, 10, 5, and 2 μg/L, respectively. Arsenic concentrations were determined in drinking in EPA Region V (Indiana, Illinois, Michigan, Minnesota, Ohio, and Wisconsin) as part of the NHEXAS; mean arsenic concentration in flushed and standing tap water were both 1.1 μg/L (Thomas et al. 1999). A review by Frost et al. (2003) of existing data from the EPA Arsenic Occurrence and Exposure Database, as well as additional data from state health and environmental departments and water utilities found that 33 counties in 11 states had estimated mean drinking water arsenic concentrations of 10 μg/L or greater. Eleven counties had mean arsenic concentrations of ≥20 μg/L, and two counties had mean arsenic concentrations of ≥50 μg/L (Frost et al. 2003).

The north central region and the western region of the United States have the highest arsenic levels in surface water and groundwater sources, respectively. In a study of drinking water from New Hampshire, arsenic concentrations ranged from <0.01 to 180 μg/L in the 793 households tested. More than 10% of the private wells had arsenic concentrations >10 μg/L, and 2.5% had levels >50 μg/L (Karagas et al. 1998). In New Hampshire, 992 randomly selected household water samples were analyzed for arsenic levels and the results for domestic well users were compared with those for users of municipal water supplies (Peters et al. 1999). The concentrations ranged from <0.0003 to 180 μg/L, with water from domestic wells containing significantly more arsenic than water from municipal supplies; the median concentration of the former was about 0.5 μg/L and the latter was 0.2 μg/L. None of the municipal supplies exceeded an arsenic concentration of 50 μg/L, and 2% of the domestic wells were found to have arsenic concentrations that exceeded 50 μg/L. Approximately 2% of the municipal water users have water with arsenic levels exceeding 10 μg/L compared with 13% of domestic wells. Twenty-five percent of domestic wells and 5% of municipal supplies were found to have arsenic concentrations exceeding 2 μg/L. The highest arsenic levels in New Hampshire are associated with bedrock wells in the south eastern and south central part of the state (Peters et al. 1999). In a study of arsenic in well water supplies in Saskatchewan, Canada, 13% of samples were >20 μg/L and one sample exceeded 100 μg/L (Thompson et al. 1999). It was noted that the samples with high arsenic levels were derived from sites that were in near proximity to each other, indicating the presence of 'hot spots' with similar geological characteristics. As part of an epidemiological study, Engel and Smith (1994) investigated the levels of arsenic in drinking

Table 6-3. Regional Occurrence of Arsenic in U.S. Water Sources and Finished Drinking Water

	Arsenic concentration in µg/L			
Geographical region	<1	1–5	5–20	>20
Occurrence in U.S. surface water sources				
Region 1. New England	50	50	0	0
Region 2. Mid-Atlantic	84	12	4	0
Region 3. South East	93	7	0	0
Region 4. Midwest	24	76	0	0
Region 5. South Central	32	55	13	0
Region 6. North Central	33	22	33	0
Region 7. Western	42	58	0	0
Occurrence in U.S. groundwater sources				
Region 1. New England	71	21	7	0
Region 2. Mid-Atlantic	81	4	11	4
Region 3. South East	82	14	2	0
Region 4. Midwest	40	40	15	5
Region 5. South Central	68	27	15	0
Region 6. North Central	30	40	30	0
Region 7. Western	24	34	28	14
Occurrence in U.S. finished surface water supplies				
Region 1. New England	88	12	0	0
Region 2. Mid-Atlantic	92	8	0	0
Region 3. South East	100	0	0	0
Region 4. Midwest	73	27	0	0
Region 5. South Central	74	19	7	0
Region 6. North Central	44	44	0	12
Region 7. Western	42	58	0	0
Occurrence in U.S. finished groundwater supplies				
Region 1. New England	79	21	0	0
Region 2. Mid-Atlantic	81	4	11	4
Region 3. South East	94	4	2	0
Region 4. Midwest	58	27	12	3
Region 5. South Central	61	27	12	0
Region 6. North Central	40	50	10	0
Region 7. Western	20	40	22	12

Source: National Arsenic Occurrence Survey (Frey and Edwards 1997)

water throughout the United States between 1968 and 1984. They found that 30 counties in 11 states had mean arsenic levels of >5 µg/L, with a range of 5.4–91.5 µg/L; 15 counties had mean levels from 5 to 10 µg/L; 10 counties had mean levels from 10 to 20 µg/L; and 5 counties had levels >20 µg/L. The highest levels were found in Churchill County, Nevada, where 89% of the population was exposed to a mean arsenic concentration of 100 µg/L and 11% to a mean of 27 µg/L. A study by Frost et al. (2003) identified 33 counties from 11 states in which the average arsenic concentration of at least 75% of public wells was >10 µg/L. Arsenic concentrations in drinking water from these counties ranged from 10.3 to 90.0 µg/L in Pinal, Arizona and Churchill, Nevada, respectively (Frost et al. 2003).

Many communities have high levels of arsenic in their drinking water because of contamination or as a result of the geology of the area. In Millard County, Utah, seven towns had median and maximum arsenic levels of 18.1–190.7 and 125–620 µg/L, respectively, in their drinking water (Lewis et al. 1999). The mean arsenic concentration in tap water from homes in Ajo, Arizona, about 2 miles from an open pit copper mine and smelter was 90 µg/L (Morse et al. 1979). The town's water was supplied from five deep wells.

Countries such as Mexico, Bangladesh, India, Chile, Argentina, and Vietnam have highly elevated levels of arsenic in drinking water in some regions (Bagla and Kaiser 1996; Berg et al. 2001; Tondel et al. 1999; WHO 2001; Wyatt et al. 1998a, 1998b). In Bangladesh and West Bengal, the soil naturally contains high levels of arsenic, which leaches into the shallow groundwater that is tapped for drinking water. In West Bengal, India, it is estimated that more than one million Indians are drinking arsenic-laced water and tens of millions more could be at risk in areas that have not been tested for contamination. Analysis of 20,000 tube-well waters revealed that 62% have arsenic at levels above the World Health Organization (WHO) permissible exposure limit (PEL) in drinking water of 10 µg/L, with some as high as 3,700 µg/L (Bagla and Kaiser 1996). Analysis of 10,991 and 58,166 groundwater samples from 42 and 9 arsenic-affected districts in Bangladesh and West Bengal were found to have arsenic levels that were 59 and 34%, respectively, above 50 µg/L (Chowdhury et al. 2000). Berg et al. (2001), studied the arsenic contamination of the Red River alluvial tract in Hanoi, Vietnam and the surrounding rural areas. Arsenic concentrations in groundwater from private small-scale tube-wells averaged 159 µg/L, ranging from 1 to 3,050 µg/L. Arsenic concentrations ranged from 37 to 320 µg/L in raw groundwater pumped from the lower aquifer for the Hanoi water supply (Berg et al. 2001). Several investigators have noticed a correlation between high levels of arsenic and fluoride in drinking water (Wyatt et al. 1998a, 1998b). Arsenic concentrations in drinking water from four villages in Bangladesh ranged from 10 to 2,040 µg/L (Tondel et al. 1999).

6.4.3 Sediment and Soil

Arsenic is widely distributed in the Earth's crust, which contains about 3.4 ppm arsenic (Wedepohl 1991). It is mostly found in nature minerals, such as realgar (As_4S_4), orpiment (As_2S_3), and arsenolite (As_2O_3), and only found in its elemental form to a small extent. There are over 150 arsenic-bearing minerals (Budavari et al. 2001; Carapella 1992). Arsenic concentrations in soils from various countries can range from 0.1 to 50 µg/g and can vary widely among geographic regions. Typical arsenic concentrations for uncontaminated soils range from 1 to 40 µg/g, with the lowest concentrations in sandy soils and soils derived from granites. Higher arsenic concentrations are found in alluvial soils and soils with high organic content (Mandal and Suzuki 2002). Arsenic in soil may originate from the parent materials that form the soil, industrial wastes, or use of arsenical pesticides. Geological processes that may lead to high arsenic concentrations in rock and subsequently the surrounding soil include hydrothermic activity and pegmatite formation (Peters et al. 1999). In the first case, thermal activity results in the dissolution and transport of metals, including the metalloid arsenic, which are precipitated in fractures in rocks. In the second process, cooling magmas may concentrate metals that are injected into rocks, crystallizing as pegmatites. Areas of volcanic activity include large areas of California, Hawaii, Alaska, Iceland, and New Zealand.

The U.S. Geological Survey reports the mean and range of arsenic in soil and other surficial materials as 7.2 and <0.1–97 µg/g, respectively (USGS 1984). The concentrations of arsenic in 445 Florida surface soils ranged from 0.01 to 50.6 µg/g (Chen et al. 1999). The median, arithmetic mean, and geometric mean were 0.35, 1.34±3.77, and 0.42±4.10 µg/g, respectively. Chirenje et al. (2003b) reported a geometric mean arsenic concentrations of 0.40 (0.21–660) and 2.81 (0.32–110) µg/g in surface soil samples (0–20 cm) collected in May–June 2000 from Gainesville and Miami, Florida, respectively. The geometric mean arsenic concentration in 50 California soils was 2.8 µg/g (Chen et al. 1999). In the Florida surface soils, arsenic was highly correlated (α=0.0001) with the soil content of clay, organic carbon, CEC, total iron, and total aluminum. Arsenic tends to be associated with clay fractions and iron and manganese oxyhydroxides. Soils of granitic origin are generally low in arsenic, about 4 µg/g, whereas arsenic in soils derived from sedimentary rocks may be as high as 20–30 µg/g (Yan-Chu 1994). Soils overlying arsenic-rich geologic deposits, such as sulfide ores, may have soil concentrations two orders of magnitude higher (NAS 1977a).

Soils in mining areas or near smelters may contain high levels of arsenic. Arsenic concentrations up to 27,000 µg/g were reported in soils contaminated with mine or smelter wastes (EPA 1982b). Soils at an abandoned mining site in the Tamar Valley in southwest England have arsenic concentrations that may exceed 50,000 µg/g (Erry et al. 1999). The average arsenic levels in the top 2 cm of different soil types in the vicinity of a former copper smelter in Anaconda, Montana, ranged from 121 to 236 µg/g; levels were significantly related to proximity and wind direction to the smelter site (Hwang et al. 1997a). Smelter fallout can contaminate land miles from the source. Soils in mainland southern King County were studied for the presence of arsenic and lead (WSDOE 2005). Soil samples were collected in the fall of 1999 and the spring of 2001 from locations around the ASARCO smelter, which operated in Ruston from the 1890s to 1986. The study area ran roughly from the I-90 corridor south to the King-Pierce county line, from the Puget Sound shore to the Cascade foothills. Almost all of the contamination was found was in the 0–6-inch depths of the cores samples; 62 of the 75 samples were found to have arsenic levels above 20 ppm (WSDOE 2005).

Soil on agricultural lands treated with arsenical pesticides may retain substantial amounts of arsenic. One study reported an arsenic concentration of 22 µg/g in treated soil compared to 2 µg/g for nearby untreated soil (EPA 1982b). Arsenic was measured in soil samples taken from 10 potato fields in Suffolk County on Long Island, New York, where sodium arsenite had been used for vine control and fall weed control for many years. Lead arsenate also may have been used as an insecticide in certain areas. The mean arsenic levels taken at a depth of 0–18 cm from each of the 10 fields ranged from 27.8±5.44 µg/g dry weight (n=10) to 51.0±7.40 µg/g dry weight (n=10). These levels were markedly higher than the level of 2.26±0.33 µg/g (n=10) for untreated control soils (Sanok et al. 1995). A survey was conducted in 1993 to determine the concentrations of arsenic and lead in soil samples from 13 old orchards in New York State. Lead arsenate was used for pest control in fruit orchards for many years, mainly from the 1930s to 1960s, and residues remain in the soil. Concentrations of arsenic ranged from 1.60 to 141 µg/g dry weight (Merwin et al. 1994). Arsenic and lead concentrations were also measured in former orchard soils contaminated by lead arsenate from the Hanford site in Washington State. The mean arsenic concentration in surface (5–10 cm) and subsurface (10–50 cm) soils were 30 (2.9–270) and 74 (32–180) µg/g dry weight, respectively (Yokel and Delistraty 2003). Average arsenic concentration of 5.728, 5.614, and 6.746 µg/g were reported in soils, lake sediments, and wetland sediments, respectively, from Moon Lake, a Mississippi River alluvial floodplain in northwest Mississippi. Intensive cultivation has occurred in this area, including cotton, soybeans, and rice (Cooper and Gillespie 2001). A geometric mean arsenic concentration of 20.6 mg/kg (range 4.6–340 mg/kg) was reported soil collected during the

summer and fall of 2003 from 85 homes in Middleport, New York, where historical pesticide manufacturing was associated with arsenic in the soil (Tsuji et al. 2005).

The Washington State Area-wide Soil Contamination Project provides various data on arsenic contamination in soils across Washington State (Washington State 2006). Arsenic concentrations within areas affected by area-wide soil contamination are highly variable, ranging from natural background levels to >3,000 ppm in smelter areas. Generally, average arsenic concentrations in soil at developed properties are <100 ppm. Areas affected by smelter emissions in King, Pierce, Snohomish, and Stevens Counties have a higher likelihood of arsenic soil contamination than other areas of the State due to historical emissions from metal smelters located in Tacoma, Harbor Island, Everett, Northport, and Trail, British Columbia. Areas where apples and pears were historically grown, such as Chelan, Spokane, Yakima, and Okanogan Counties, also have a higher likelihood of arsenic soil contamination than other areas due to the past use of lead arsenate pesticides. Generally, arsenic contamination in soils from historical smelter emissions and historical use of lead-arsenate pesticides is found in the upper 6–18 inches of soil (Washington State 2006).

The New Jersey Department of Environmental Protection (Historic Pesticide Contamination Task Force 1999) reported on the analysis of soil samples collected from 18 sites for various pesticide residues, including arsenic, from current and former agricultural sites in New Jersey in order to assess contamination from historic pesticide use. Arsenic was detected in all 463 samples, with concentrations ranging from 1.4 to 310 ppm.

Natural concentrations of arsenic in sediments are usually <10 µg/g dry weight, but can vary widely around the world (Mandal and Suzuki 2002). Sediment arsenic concentrations reported for U.S. rivers, lakes, and streams range from about 0.1 to 4,000 µg/g (Eisler 1994; Heit et al. 1984; NAS 1977a; Welch et al. 1988). During August through November 1992 and August 1993, bed sediment in the South Platte River Basin (Colorado, Nebraska, and Wyoming) was sampled and analyzed for 45 elements, including arsenic. The range of arsenic found was 2.8–31 µg/g dry weight and the geometric mean (n=23) was 5.7 µg/g (Heiny and Tate 1997). The arsenic concentration in surface sediment (0–2 cm) at 43 sites in the Indian River Lagoon System in Florida ranged from 0.6 to 15 µg/g dry weight with a mean of 5.0±3.9 µg/g (Trocine and Trefry 1996). Arsenic levels were well correlated with those of aluminum. Correlation with aluminum levels is used to normalize sediment level concentrations to natural levels in Florida estuaries. Surficial sediments collected from 18 locations in 3 major tributaries to Newark Bay, New Jersey, were analyzed for 7 toxic metals, including arsenic (Bonnevie et al. 1994). The highest

concentrations of arsenic were found in the Rahway River adjacent to a chemical plant, 58 µg/g dry weight, and in the Hackensack River adjacent to a coal-fired power plant, 49 µg/g. The average arsenic concentration for all sediments was 17±16 µg/g. Sediments collected from seven sites in Baltimore Harbor, Maryland, at five seasonal periods between June 1987 and June 1988 had a geometric mean maximum of 7.29 µg/g dry weight and a geometric mean minimum of 1.25 µg/g (Miles and Tome 1997). This harbor is one of two sub-tributaries of the Chesapeake Bay where contaminants have been discharged on a large scale.

The upper Clark Fork River basin in western Montana is widely contaminated by metals from past mining, milling, and smelting activities. In a 1991 study, arsenic levels were determined in sediment along the river and in a reservoir 205 km downstream. Total arsenic in sediments from Clark Fork River decreased from 404 µg/g dry weight at the farthest upstream sampling station to 11 µg/g, 201 km downstream. Sediment samples from the Milltown Reservoir had arsenic concentrations ranging from 6 to 56 µg/g (Brumbaugh et al. 1994). Total recoverable arsenic in nonfiltered pore water from the Clark Fork River decreased from 1,740 µg/L at the farthest upstream sampling station to 31 µg/L at the 201 km station (Brumbaugh et al. 1994). The Coeur d'Alene river basin in northern Idaho has been contaminated with heavy metals from mining and smelting operations since 1885 (Farag et al. 1998). A 1994 study determined the metal content of sediment, biofilm, and invertebrates at 13 sites in the basin, 10 with historic mining activity and 3 reference sites. The mean arsenic levels in sediment at the mining sites ranged from 8.3 to 179.0 µg/g dry weight, compared to 2.4–13.1 µg/g dry weight at the reference sites. The mean arsenic levels in biofilm adhering to rock in the water at the mining sites ranged from 7.5 to 155.8 µg/g dry weight, compared to 7.2–27.3 µg/g dry weight at the reference sites. In Whitewood Creek, South Dakota, where as much as 100 million tons of mining and milling waste derived from gold mining activities were discharged between 1876 and 1977, mean and maximum sediment arsenic concentrations were 1,920 and 11,000 µg/g, respectively (USGS 1987). Uncontaminated sediment had mean arsenic levels of 9.2 µg/g. Arsenic concentrations in surface (0–5 cm) sediments from watersheds in Black Hills, South Dakota, an area impacted by gold mining activities, ranged from 23 to 1,951 µg/g dry weight; concentrations from reference areas ranged from 10 to 58 µg/g dry weight (May et al. 2001). Swan Lake, a sub-bay of Galveston Bay in Texas is a highly industrial area that received runoff from a tin smelter in the 1940s and 1950s. Surface sediments at 17 sites where oysters and mussels were collected ranged from 4.53 to 103 µg/g (Park and Presley 1997). A site in the channel leading from the old smelter had arsenic levels of 568 µg/g. Surface sediment was less contaminated than deeper sediment, indicating less arsenic input recently than in the past as a result of the smelter closing.

It has been suggested that the wood preservative most commonly used in dock pilings and bulkheads, CCA, can be toxic to estuarine organisms. Wendt et al. (1996) measured arsenic in surface sediments and oysters from creeks with high densities of docks and from nearby reference creeks with no docks. The average concentrations in the sediments ranged from 14 to 17 µg/g throughout the study area, which is within the range of natural background levels. Weis et al. (1998) sampled sediments along a 10-m transect from CCA-treated wood bulkheads from four Atlantic coast estuaries. Arsenic concentrations were highest in the fine-grained portion of the sediments near the CCA-treated bulkhead (0–1 m); arsenic concentrations were generally at reference levels at distances >1 m from the bulkheads (Weis et al. 1998).

Soils below and around play structures constructed from CCA-treated wood in the City of Toronto, Canada were sampled and analyzed for inorganic arsenic (Ursitti et al. 2004). A mean arsenic concentration of 2.1 µg/g (range 0.5–10 µg/g) was reported in soil samples taken within 1 m of the CCA-treated wood for all play structures. Soil samples that were collected 10 m from the play structures served as a background had arsenic concentration of 2.4 µg/g (range 0.5–13 µg/g). A mean arsenic concentration of 6.2 µg/g (range 0.5–47.5 µg/g) was reported in soil samples taken below CCA-treated wood for all play structures. Of the 217 play structures in the study, 32 had arsenic concentrations under the play structures that exceeded the Canadian federal soil guidelines with arsenic concentrations ranging from 12.4 to 47.5 µg/g. From this study, the authors concluded that arsenic does not migrate laterally, but does accumulate in soil under elevated platforms constructed from CCA-treated wood (Ursitti et al. 2004).

6.4.4 Other Environmental Media

Low levels of arsenic are commonly found in food; the highest levels are found in seafood, meats, and grains. Typical U.S. dietary levels of arsenic in these foods range from 0.02 mg/kg in grains and cereals to 0.14 mg/kg in meat, fish, and poultry (Gartrell et al. 1986). Shellfish and other marine foods contain the highest arsenic concentrations and are the largest dietary source of arsenic (Gunderson 1995a; Jelinek and Corneliussen 1977; Tao and Bolger 1999). Arsenic levels in various fish and shellfish are presented in Table 6-4. In the U.S. Food and Drug Administration (FDA) Total Diet Study, 1991–1997, seafood contained the highest levels of arsenic, followed by rice/rice cereal, mushrooms, and poultry. Concentrations in canned tuna (in oil), fish sticks, haddock (pan-cooked), and boiled shrimp were 0.609–1.470, 0.380–2.792, 0.510–10.430, and 0.290–2.681 mg/kg, respectively (Tao and Bolger 1999). Typically, arsenic levels in foods in the Total Diet Study, 1991–1996 were low, <0.03 mg/kg; only 63 of the 264 foods contained arsenic above this level. Similar results were reported in the Total Diet Study,

Table 6-4. Levels of Arsenic in Fish and Shellfish—Recent Studies

Sample type	Arsenic concentration[a] (µg/g)	Comments	Reference
Yellowtail flounder		Samples collected from Northwest Atlantic 1993	Hellou et al. 1998
Muscle (n=8)	8–37		
Liver (n=6)	7–60		
Gonad (n=6)	1.2–9.4		
Marine organisms		Belgian fish markets in 1991; inorganic arsenic ranged from 0.003 to 0.2 µg/g	Buchet and Lison 1998
Ray (n=8)	16.4		
Cod (n=8)	4.7		
Plaice (n=8)	19.8		
Sole (n=8)	5.1		
Sea-bream (n=8)	2.4		
Mussell (n=8)	3.5		
Bluefin tuna (*Thunnus thynus*) (n=14)	3.2	Virgin Rocks, Grand Banks of Newfoundland, Canada, 1990	Hellou et al. 1992
Fish		National Contaminant Biomonitoring Program, 1984–1985, 112 stations	Kidwell et al. 1995
Bottom feeding (n=2,020)	0.16±0.23 wet weight		
Predatory (n=12)	0.16±0.140 wet weight		
Oysters		South Carolina, private residential docks on tidal creeks, 1994	Wendt et al. 1996
<1 m from docks (n=10)	8.3±1.1		
>10 m from docks (n=10)	7.6±0.9		
Reference (no docks) (n=10	8.4±1.3		
Clams (n=22)	12±1.1	Indian River Lagoon, Florida, 22 sites, 1990	Trocine and Trefry 1996
Marine organisms		Swan Lake, Galveston Bay, Texas, 1993	Park and Presley 1997
Snails	13.3±17.0		
Blue crab	6.61		
Fish	0.82		
Shrimp	1.37±0.64		
Whole crab	5.35±2.51		
Oysters (n=10, pooled)	7.28±1.32		
Mussels (n=7, pooled)	7.75±2.15		
Marine organisms		GPNEP, 1992, Galveston Bay, Texas	Park and Presley 1997
Blue crab	2.31±2.15		
Fish	2.46		
Oysters, two areas		NOAA NS&T Program, 1986–1990	Park and Presley 1997
n=78, pooled	4.50±1.08	Galveston Bay	
n=874, pooled	9.67±7.00	Gulf of Mexico	

Table 6-4. Levels of Arsenic in Fish and Shellfish—Recent Studies

Sample type	Arsenic concentration[a] (µg/g)	Comments	Reference
Marine crustaceans			
Parapenaeus longirostris (pink shrimp) (n=826, 10 pools	34.84±19.21 (12.01–62.60)	Commercial crustaceans from the Mediterranean Sea (Italy)	Storelli and Marcotrigiano 2001
Aristeus antennatus (red shrimp) (n=387, 8 pool)	17.09±3.49 (10.45–20.82)		
Plesionika martia (shrimp) (n=456, 7 pools)	40.82±2.50 (36.37–44.06)		
Nephrops norvegicus (Norway lobster) (n=270, 5 pools)	43.48±14.21 (35.63–69.15)		
Freshwater fish			
Sabalo (*Brycon melanopterus)* (n=3)	0.015–0.101	Fish samples (muscle) were collected in August 1997 from the Candamo River, Peru; a pristine rainforest valley prior to the start of oil-drilling activities	Gutleb et al. 2002
Huazaco (*Hoplias malabaracus)* (n=4)	nd–0.005		
Bagre (*Pimelodus ornatus*) (n=8)	nd–0.201		
Boquichio (*Prochilodus nigricans)* (n=1)	0.063		
Doncello (*Pseudo-platystoma sp.*) (n=1)	0.055		
Freshwater fish			
Bowfin (n=59)	0.32±0.04 wet weight	Savannah River, along and below the Department of Energy's Savannah River Site (SRS); samples analyzed were edible fillets	Burger et al. 2002
Bass (n=47)	0.03±0 wet weight		
Channel catfish (n=50)	0.09±00.02 wet weight		
Chain pickerel (n=19)	0.05±0.01 wet weight		
Yellow perch (n=51)	0.05±0.01 wet weight		
Black crappie (n=52)	0.04±0.01 wet weight		
American eel (n=24)	0.04±0.01 wet weight		
Shellcracker n=52)	0.06±0 wet weight		
Bluegill (n=52)	0.05±0.02 wet weight		
Redbreast (n=43)	0.07±0.01 wet weight		
Spotted sucker (n=35)	0.03±0 wet weight		

Table 6-4. Levels of Arsenic in Fish and Shellfish—Recent Studies

Sample type	Arsenic concentration[a] (µg/g)	Comments	Reference
Horseshoe crabs			
Apodeme (n=74)	7.034±0.65 wet weight	Overall mean in tissues of crabs collected from New Jersey in 2000	Burger et al. 2003
Egg (n=63)	5.924±0.345 wet weight		
Leg (n=74)	14.482±0.685 wet weight		
Apodeme (n=40)	7.513±0.835 wet weight	Overall mean in tissues of crabs collected from Delaware in 2000	
Egg (n=35)	6.766±0.478 wet weight		
Leg (n=40)	18.102±1.489 wet weight		

[a]Concentrations are means±standard deviation, unless otherwise stated. Concentrations are in a dry weight basis, unless otherwise stated.

GM = geometric mean; GPNEP = Galveston Bay National Estuary Program; nd = not detected;
NOAA NS&T = National Oceanic and Atmospheric Administration National Status and Trends

1991–1997, where the mean arsenic concentration in all foods was 0.036 mg/kg dry weight and arsenic was not detectable in about 88% of the foods and was detected at trace levels in another 7.8% of foods. The foods with the highest mean arsenic levels were haddock, canned tuna, fish sticks, shrimp, and fish sandwiches, with arsenic concentrations ranging from 5.33 to 0.568 mg/kg dry weight (Capar and Cunningham 2000). Nriagu and Lin (1995) analyzed 26 brands of wild rice sold in the United States and found arsenic levels ranging from 0.006 to 0.142 μg/g dry weight. Arsenic concentrations ranging from 0.05 to 0.4 μg/g are typically reported for rice from North America, Europe, and Taiwan (Meharg and Rahman 2003).

During a comprehensive total diet study extending from 1985 to 1988, foods were collected in six Canadian cities and processed into 112 composite food samples (Dabeka et al. 1993). The mean, median, and range of total arsenic in all samples were 0.0732, 0.0051, and <0.0001–4.840 μg/g, respectively. Food groups containing the highest mean arsenic levels were fish (1.662 μg/g), meat and poultry (0.0243 μg/g), bakery goods and cereals (0.0245 μg/g), and fats and oils (0.0190 μg/g). Of the individual samples, marine fish had the highest arsenic levels, with a mean of 3.048 μg/g for the cooked composites and 2.466 μg/g for the raw samples. Canned fish (1.201 μg/g) and shellfish (2.041 μg/g) also contained high means. Cooked poultry, raw mushrooms, and chocolate bars contained 0.100, 0.084, and 0.105 μg/g, respectively.

National monitoring data from the Food Safety and Inspection Service National Residue Program (NRP) (1994–2000) found that the mean total arsenic concentration in livers of young chickens ranged from 0.33 to 0.43 μg/g, with an overall mean of 0.39 μg/g (Lasky et al. 2004). The mean arsenic concentrations in liver for mature chickens, turkeys, hogs, and all other species over the same time period ranged from 0.10 to 0.16 μg/g. Lasky et al. (2004) used the NRP arsenic data in livers of young chickens to estimate the concentrations of arsenic in muscle tissue, the most commonly consumed part of the chicken. Assuming that 65% of the arsenic in poultry and meat is inorganic, at a mean level of chicken consumption of 60 g/person/day, people may ingest an estimated 1.38–5.24 μg/day of inorganic arsenic from chicken.

A Danish study (Pedersen et al. 1994) reports the arsenic levels in beverages as the mean (range) in μg/L as follows: red wine, 9 (<2–25); white wine, 11 (<2–33); fortified wine, 5 (<2–11); beer, 7 (4–11); soft drinks, 3 (<2–8); miscellaneous juices, 8 (3–13); instant coffee, 4 (0.7–7); and instant cocoa, 5.6 (1.6–12.8).

In a study of dietary arsenic exposure in the Indigenous Peoples of the western Northwest Territories, Canada, fish contained the highest arsenic concentrations in foods consumed by the Dene and Métis populations with the highest concentration, 1.960 µg/g, found in smoked/dried cisco (fish). Other foods derived from land mammals, birds, and plants contained lower arsenic concentrations. A mean arsenic intake of <1.0 µg/kg/day was reported for this population (Berti et al. 1998).

The general consensus in the literature is that about 85–>90% of the arsenic in the edible parts of marine fish and shellfish is organic arsenic (e.g., arsenobetaine, arsenochloline, dimethylarsinic acid) and that approximately 10% is inorganic arsenic (EPA 2003b). However, the inorganic arsenic content in seafood may be highly variable. For example, a study in the Netherlands reported that inorganic arsenic comprised 0.1–41% of the total arsenic in seafood (Vaessen and van Ooik 1989). Buchet et al. (1994) found that, on the average, 3% of the total arsenic in mussels was inorganic in form. Some commercially available seaweeds, especially brown algae varieties, may have high percentages of the total arsenic present as inorganic arsenic (>50%) (Almela et al. 2002; Laparra et al. 2003). Arsenic concentrations ranging from 17 to 88 mg/kg dry weight were found in commercially available seaweeds (van Netten et al. 2000). Other arsenic compounds that may be found in seafood are arsenic-containing ribose derivatives called arsenosugars. Arsenosugars are the common organoarsenicals found in marine algae; they are also found in mussels, oysters, and clams (Le et al. 2004). Less information about the forms of arsenic in freshwater fish is known at this time (EPA 2003b).

Schoof et al. (1999a) reported on the analysis of 40 commodities anticipated to account for 90% of dietary inorganic arsenic intake. In this study, the amount of inorganic arsenic was measured in these foods. Consistent with earlier studies, total arsenic concentrations were highest in the seafood sampled (ranging from 160 ng/g in freshwater fish to 2,360 ng/g in marine fish). In contrast, average inorganic arsenic in seafood ranged from <1 to 2 ng/g. The highest inorganic arsenic concentrations were found in raw rice (74 ng/g), followed by flour (11 ng/g), grape juice (9 ng/g), and cooked spinach (6 ng/g).

Tobacco contains an average arsenic concentration of 1.5 ppm, or about 1.5 µg per cigarette (EPA 1998j). Before arsenical pesticides were banned, tobacco contained up to 52 mg As/kg, whereas after the ban, maximum arsenic levels were reduced to 3 µg/g (Kraus et al. 2000). An international literature survey reports arsenic yields of 0–1.4 µg/cigarette for mainstream (inhaled) cigarette smoke (Smith et al. 1997). The wide range of arsenic yields for flue-cured cigarettes suggests that the field history, soil, and fertilizer conditions under which the tobacco is grown will affect the arsenic concentration (Smith et al. 1997).

Arsenic emission factors of 0.015–0.023 µg/cigarette (mean 0.018±0.003 µg/cigarette) have been measured for sidestream smoke from a burning cigarette (Landsberger and Wu 1995).

A median arsenic concentration of 2.1 µg/g and a deposition rate of 0.008 µg/m^2/day was reported in house dust in homes evaluated as part of the German Environmental Survey in 1990–1992. A mean arsenic concentration of 7.3 µg/g was reported in house dust from 48 residences in Ottawa, Canada (Butte and Heinzow 2002). These arsenic concentrations are expected to be representative of background levels. In general high arsenic concentrations were found in household dust collected from homes in areas with known arsenic contamination. Mean arsenic concentrations of 12.6 (2.6–57) and 10.8 (1.0–49) µg/g were reported in house dust collected from the entryway and child play areas, respectively, from homes in a community in Washington State with a history of lead arsenate use (Wolz et al. 2003). Arsenic was detected in all 135 indoor floor dust samples collected as part of the NHEXAS from Arizona mining communities, ranging from 0.3–50.6 µg/g, (O'Rourke et al. 1999). A geometric mean arsenic concentration of 10.8 µg/g (range 1.0–172 µg/g) was reported in house dust from 96 homes in Middleport, New York, with historical pesticide manufacture, collected during the summer and fall of 2003 (Tsuji et al. 2005).

Arsenic has also been detected in several homeopathic medicines at concentrations up to 650 µg/g (Kerr and Saryan 1986). Some Asian proprietary medicines that are manufactured in China, Hong Kong, and other Asian countries have been reported to contain levels of inorganic arsenic ranging from 25 to 107,000 µg/g (Chan 1994). Fifty medicinally important leafy samples that were analyzed for elemental concentrations contained arsenic at levels ranging from 0.12 to 7.36 µg/g, with a mean of 2.38±1.2 µg/g (Reddy and Reddy 1997). Arsenic concentrations ranged from 0.005 to 3.77 µg/g in 95 dietary supplements purchased from retail stores in the Washington, DC area in 1999 (Dolan et al. 2003). Commercially available samples of Valarian, St. John's Wort, Passion Flower, and Echinacea were purchased in the United States and analyzed for various contaminants; arsenic concentrations were 0.0016–0.0085, 0.0065–0.017.8, 0.0024–0.0124, and 0.0021–0.0102 µg/g, respectively, in these samples (Huggett et al. 2001). Concentrations of heavy metals including the metalloid arsenic were evaluated in 54 samples of Asian remedies that were purchased in stores in Vietnam and Hong Kong that would be easily accessible to travelers, as well as in health food and Asian groceries in Florida, New York, and New Jersey. Four remedies were found to contain daily doses exceeding 0.1 mg. Two of these contained what would have been a potentially significant arsenic dose, with daily doses of 16 and 7.4 mg of arsenic (Garvey et al. 2001).

The possible presence of toxic compounds in waste materials has raised concerns about the fate of these compounds either during the composting process or when the composted product is applied to soils. Three waste compost products generated at the Connecticut Agricultural Experiment Station had arsenic levels of 12.8, 9.8, and 13 µg/g dry weight, respectively (Eitzer et al. 1997). The arsenic levels in municipal solid waste composts from 10 facilities across the United States ranged from 0.9 to 15.6 µg/g dry weight with a mean of 6.7 µg/g (He et al. 1995). These are lower than the EPA 503 regulatory limit for arsenic of 41 µg/g for agricultural use of sewage sludge (EPA 1993b). Concentrations of arsenic in U.S. sewage sludges, which are sometimes spread on soil, were <1 µg/g. Arsenic is a common impurity in minerals used in fertilizers. A comprehensive Italian study found that the arsenic content in a number of mineral and synthetic fertilizers ranged from 2.2 to 322 mg/kg with a sample of triple superphosphate having the highest level (Senesi et al. 1999). Arsenic naturally occurs in coal and crude oil at levels of 0.34–130 and 0.0024–1.63 ppm, respectively, which would account for its presence in flue gas, fly ash, and bottom ash from power plants (Pacyna 1987).

Background arsenic levels in living organisms are usually <1 µg/g wet weight (Eisler 1994). Levels are higher in areas with mining and smelting activity or where arsenical pesticides were used. Eisler (1994) has an extensive listing of arsenic levels in terrestrial and aquatic flora and fauna from literature sources to about 1990. The U.S. Fish and Wildlife Service's National Contaminant Biomonitoring Program have analyzed contaminants in fish at 116 stations (rivers and the Great Lakes) across the United States. The geometric mean concentration of arsenic for the five collection periods starting in 1976 were (period, concentration wet weight basis): 1976–1977, 0.199 µg/g; 1978–1979, 0.129 µg/g; 1980–1981, 0.119 µg/g; 1984, 0.106 µg/g; and 1986, 0.083 µg/g (Schmitt et al. 1999). In 1986, the maximum and 85th percentile arsenic levels were 1.53 and 0.24 µg/g, respectively. The highest concentrations of arsenic for all five collection periods were in bloaters from Lake Michigan at Sheboygan, Wisconsin. Arsenic levels declined by 50% at this site between 1976–1997 and 1984. The major source of arsenic into Lake Michigan was a facility at Marinette, Wisconsin, which manufactured arsenic herbicides. Table 6-4 contains arsenic levels in aquatic organisms from more recent studies. The Coeur d'Alene river basin in northern Idaho has been contaminated with heavy metals from mining and smelting operations since 1885 (Farag et al. 1998). A 1994 study determined the metal content of sediment, biofilm, and invertebrates at 13 sites in the basin, 10 with historic mining activity, and 3 reference sites. The mean arsenic levels in benthic macroinvertebrates at the mining sites ranged from 2.2 to 97.0 µg/g dry weight, compared to 2.1–2.4 µg/g dry weight at the reference sites. A study of aquatic organism in Swan Lake, a highly polluted sub-bay of Galveston Bay, Texas showed that arsenic concentrations were in the order snail>oyster>crab>shrimp>fish (Park and Presley 1997). In contrast to metals like silver, cadmium,

copper, and zinc, arsenic concentrations in oysters and mussels were less than in the sediment from which they were collected. No significant correlation was found between levels of arsenic in clams in the Indian River Lagoon in Florida with those found in sediment or water samples (Trocine and Trefry 1996). Small animals living at mining sites ingest more arsenic in their diet and have higher arsenic levels in their bodies than those living on uncontaminated sites (Erry et al. 1999). Seasonal variations in both arsenic intake and dietary composition may affect the amount of arsenic taken up by the body and transferred to predator animals. Tissue arsenic content of wood mice and bank voles living on both arsenic-contaminated mining sites and uncontaminated sites were greater in autumn than spring. The lower tissue arsenic levels in spring of rodents living on contaminated sites suggest that there is no progressive accumulation of arsenic in overwintering animals.

6.5 GENERAL POPULATION AND OCCUPATIONAL EXPOSURE

Exposure to arsenic may include exposure to the more toxic inorganic forms of arsenic, organic forms of arsenic, or both. While many studies do not indicate the forms of arsenic to which people are exposed, this information may often be inferred from the source of exposure (e.g., fish generally contain arsenic as arsenobetaine). Yost et al. (1998) reported that the estimated daily dietary intake of inorganic arsenic for various age groups ranged from 8.3 to 14 µg/day and from 4.8 to 12.7 µg/day in the United States and Canada, respectively, with 21–40% of the total dietary arsenic occurring in inorganic forms.

Drinking water may also be a significant source of arsenic exposure in areas where arsenic is naturally present in groundwater. While estimates of arsenic intake for typical adults drinking 2 L of water per day average about 5 µg/day (EPA 1982c), intake can be much higher (10–100 µg/day) in geographical areas with high levels of arsenic in soil or groundwater (see Figure 6-2). It is assumed that nearly all arsenic in drinking water is inorganic (EPA 2001).

In the United States, food intake of arsenic has been estimated to range from 2 µg/day in infants to 92 µg/day in 60–65-year-old men (see Table 6-5) (Tao and Bolger 1999). The average intake of inorganic arsenic are estimated to range from 1.34 µg/day in infants to 12.54 µg/day in 60–65-year-old men. Tao and Bolger (1999) assumed that 10% of the total arsenic in seafood was inorganic and that 100% of the arsenic in all other foods was inorganic. The greatest dietary contribution to total arsenic was seafood (76–96%) for all age groups, except infants. For infants, seafood and rice products contributed 42 and 31%, respectively. Adult dietary arsenic intakes reported for other countries range

Table 6-5. Mean Daily Dietary Intake of Arsenic for Selected U.S. Population Groups

Mean daily intake (µg/kg body weight/day)	Date of study		
	1984–1986[a]	1986–1991[b]	1991–1997[c]
Provisional tolerable daily intake (PTDI)[d]	2.1	2.1	2.1
6–11 months	0.82	0.5	0.31
2 years	1.22	0.81	1.80
14–16 years, female	0.54	0.36	0.41
14–16 years, male	0.60	0.39	0.24
25–30 years, female	0.66	0.44	0.44
25–30 years, male	0.76	0.51	0.72
60–65 years, female	0.71	0.46	1.08
60–65 years, male	0.74	0.48	1.14

[a]Gunderson 1995a
[b]Gunderson 1995b
[c]Tao and Bolger 1999
[d]No agreement has been reached on a maximum acceptable intake for total arsenic; the FAO/WHO has assigned a PTDI for inorganic arsenic of 2.1 µg/kg body weight for adults. Data from FDA studies. FDA does not recommend daily intake levels for Arsenic.

from 11.7 to 280 µg/day (Tao and Bolger 1999). Schoof et al. (1999b) estimated that intake of inorganic arsenic in the U.S. diet ranges from 1 to 20 µg/day, with a mean of 3.2 µg/day. In contrast, these estimates of inorganic arsenic intakes are based on measured inorganic arsenic concentrations from a market basket survey.

The FDA conducted earlier Total Diet Studies in 1984–1986 and 1986–1991. For the sampling period of June 1984 to April 1986, the total daily intake of arsenic from foods was 58.1 µg for a 25–30-year-old male with seafood contributing 87% of the total (Gunderson 1995a). For the sampling period from July 1986 to April 1991, the total daily intake of arsenic from foods was lower, 38.6 µg for a 25–30-year-old male. Seafood again was the major source of arsenic, contributing 88% of the total (Gunderson 1995b). Results of the two Total Diet Studies for selected population groups are shown in Table 6-5. The Total Diet Study for the sampling period from September 1991 to December 1996, shows that arsenic, at ≥0.03 µg/g, was found in 55 (21%) of the 261–264 foods/mixed dishes analyzed. The highest concentrations again were found in seafood, followed by rice/rice cereal, mushrooms, and poultry. The estimated total daily intake of arsenic from foods was 56.6 µg for a 25–30-year-old male. Seafood was the major contributor, accounting for 88–96% of the estimated total arsenic intake of adults.

Average daily dietary exposures to arsenic were estimated for approximately 120,000 U.S. adults by combining data on annual diet, as measured by a food frequency questionnaire, with residue data for table-ready foods that were collected for the annual FDA Total Diet Study. Dietary exposures to arsenic were highly variable, with a mean of 50.6 µg/day (range, 1.01–1,081 µg/day) for females and 58.5 µg/day (range, 0.21–1,276 µg/day) for males (MacIntosh et al. 1997). Inorganic arsenic intake in 969 men and women was assessed by a semi-quantitative food frequency questionnaire in combination with a database for total arsenic content in foods and by toenail concentrations of arsenic. The mean estimated average daily consumption of inorganic arsenic was 10.22 µg/day with a range of 0.93–104.89 µg/day. An assumption of 1.5% of the total arsenic in fish and 20% of the total arsenic in shellfish was inorganic arsenic was used in this assessment (MacIntosh et al. 1997).

During a comprehensive total diet study extending from 1985 to 1988, the estimated daily dietary ingestion of total arsenic by the average Canadian was 38.1 µg and varied from 14.9 µg for the 1–4 year-old-age group to 59.2 µg for 20–39-year-old males (Dabeka et al. 1993). Daily intakes of arsenic from food by women in the Shiga Prefecture, Japan, were investigated by the duplicate portion method and by the market basket method. In 1991 and 1992, the daily intakes determined by the duplicate portion

method were 206 and 210 µg, respectively. Those determined by the market basket method were 160 and 280 µg, respectively (Tsuda et al. 1995b).

Arsenic concentrations in human breast milk have been reported to range from 4 to <10 µg/L in pooled human milk samples from Scotland and Finland to 200 µg/L in samples from Antofagasta, Chile, where there is a high natural environmental concentration of arsenic (Broomhall and Kovar 1986). The arsenic concentration in the breast milk of 35 women in Ismir, Turkey, a volcanic area with high thermal activity ranged from 3.24 to 5.41 µg/L, with a median of 4.22 µg/L (Ulman et al. 1998). Sternowsky et al. (2002) analyzed breast milk from 36 women from three different regions in Germany. These regions included the city of Hamburg, a rural area, Soltau, Lower Saxony, and Munster, the potentially contaminated area. Arsenic was not detected (<0.3 µg/L) in 154 of 187 samples, with the highest concentration, 2.8 µg/L, found in a sample from the rural area. The geometric means from the three areas were comparable.

The mean arsenic levels in three groups of cows in the region that grazed on land impacted by lava and thermal activity were 4.71, 4.46, and 4.93 µg/L, compared to 5.25 µg/L for cows kept in sheds and fed commercial pellet feed and municipal water (Ulman et al. 1998). Mean arsenic concentrations in cow's milk ranging from 18.6 to 17.1 µg/L and from 16.7 to 18.0 µg/L were reported for cow's grazing in nonindustrial and an industrial regions, respectively, in Turkey (Erdogan et al. 2004).

A Danish study found that carrots grown in soil containing 30 µg/g of arsenic, which is somewhat above the 20 µg/g limit for total arsenic set by Denmark for growing produce, contained 0.014 µg/g fresh weight of arsenic, all in the form of inorganic As(III) and As(V) (Helgesen and Larsen 1998). An adult consuming 376 grams of vegetables a day (90^{th} percentile) represented solely by carrots would consume 5.3 µg of arsenic a day. The study concluded that the estimated intake of arsenic from produce grown in soil meeting regulatory limits was low compared with other food sources and water.

If vegetables are grown in planters made of wood treated with CCA, arsenic may leach out of the wood and be taken up by the vegetables. In a study by Rahman et al. (2004), arsenic was found to diffuse into the soil from the CCA-treated wood, with the highest concentrations found at 0–2 cm from the CCA-treated wood and a steady decline in concentration with increased distance from the wood. Crops grown within 0–2 cm of the CCA-treated wood contained higher concentrations of arsenic than those grown at 1.5 m from the treated wood. However, the concentrations are below U.S. FDA tolerance limits that have been set for arsenic in select food items. In addition, food grown in this manner is unlikely to constitute a significant part of a person’s diet.

In 2003, U.S. manufacturers of arsenical wood preservatives began a voluntary transition from CCA to other wood preservatives in wood products for certain residential uses, such as play structures, picnic tables, decks, fencing, and boardwalks. This phase out was completed on December 31, 2003; wood treated prior to this date could still be used and structures made with CCA-treated wood would not be affected. CCA-treated wood products continue to be used in industrial applications (EPA 2003a). EPA's Consumer Awareness Program (CAP) for CCA is a voluntary program established by the manufacturers of CCA products to inform consumers about the proper handling, use, and disposal of CCA-treated wood. Additional information about this program can be found from EPA (2007a).

The arsenic content in the human body is 3–4 mg and tends to increase with age. Arsenic concentrations in most tissues of the human body are <0.3 to 147 μg/g dry weight, excluding hair, nails, and teeth. Mammals tend to accumulate arsenic in keratin-rich tissues such as hair and nails. The normal concentrations of arsenic range from about 0.08 to 0.25 μg/g in hair, and 0.34 μg/g in nails. The normal concentration of arsenic in urine can range from 5 to 40 μg per day (total) (Mandal and Suzuki 2002). Table 6-6 contains arsenic levels in various human tissues.

A German study investigated the transfer of arsenic from the environment to humans in the northern Palatine region, a former mining area characterized by high soil levels of arsenic (<2–605 μg/g) in residential areas compared to a region in southern lower Saxony with nonelevated levels of arsenic in soil (Gebel et al. 1998a). None of the residents were occupationally exposed to arsenic and the arsenic levels in drinking water were generally below 0.015 mg/L. The mean levels of arsenic in urine and hair were lower in the reference area than in the former mining area (see Table 6-6), although within the mining area, there was a slight increase in arsenic levels in hair and arsenic excreted in urine with increasing arsenic content in soil. Children in the Palatine region did not have higher contents of arsenic in their hair or urine. The most significant factor contributing to elevated levels of arsenic in hair and urine was seafood consumption. In the combined population of people living in mining areas containing high levels of arsenic in soil and other areas, the level of arsenic in urine was positively associated with the extent of seafood consumption. However, the study also showed that seafood consumption does not lead to an extreme increase in excretion of arsenic in the urine. There are apparently other, unidentified factors affecting the urine levels. Only arsenic in urine, not in hair, was significantly correlated with age. The level of arsenic in urine was very slightly, but significantly correlated with the consumption of home-grown produce. Tobacco smoking had no correlation with the arsenic content of either hair or urine (Gebel et al. 1998a).

Table 6-6. Levels of Arsenic in Human Tissue and Urine—Recent Studies

Site population	Sample	Concentration		Units	Reference
		Mean[a]	Range		
Fort Valley, Georgia, Pesticide manufacturing facility (Superfund site)					
40 workers (samples collected at end of work week)	Urine, random	11.6	<1–57	µg/L	Hewitt et al. 1995
	Urine, 24-hour	11.0	<1–54	µg/L	
	Hair	0.78	<0.01–6.3	µg/g	
	Fingernails	0.79	<0.01–6.1	µg/g	
Hermosa, Sonora, Mexico					
Children, ages 7–11, exposed to arsenic in water (mean concentration [mean dose]):	Urine, 24-hour				Wyatt et al. 1998a, 1998b
9 µg/L [0.481 µg/kg/day]		10.26	4.05–19.68	µg/day	
15 µg/L [0.867 µg/kg/day]		10.54	2.82–20.44	µg/day	
30 µg/L [1.92 µg/kg/day]		25.18	5.44–93.28	µg/day	
Glasgow, Scotland					
Adults, normal (n=1,250)	Hair	0.650	0.20–8.17	µg/g	Raie 1996
Adults, postmortem (n=9)	Liver	0.048 [0.024]	0.011–0.152	µg/g	
Infants, postmortem (n=9)	Liver	0.0099 [0.007]	0.0034–0.019	µg/g	
Adults, postmortem (n=8)	Lung	0.044 [0.022]	0.0121–0.125	µg/g	
Infants, postmortem (n=9)	Lung	0.007 [0.0055]	0.0011–0.015	µg/g	
Adults, postmortem (n=9)	Spleen	0.015 [0.008]	0.001–0.063	µg/g	
Infants, postmortem (n=8)	Spleen	0.0049 [0.0045]	0.0011–0.0088	µg/g	
Palatinate Region, Germany (high As)[b]					
Residents (n=199)	Urine, 24-hour	3.96 [3.21]	<0.1–18.32	µg/g	Gebel et al. 1998a
Residents (n=211)	Hair	0.028 [0.016]	<0.005–0.154	µg/g	
Saxony, Germany (low As—reference)[b]					
Residents (n=75)	Urine, 24-hour	7.58 [6.20]	0.29–23.78	µg/g	Gebel et al. 1998a
Residents (n=74)	Hair	0.069 [0.053]	0.013–0.682	µg/g	
Ismir, Turkey, (volcanic area with high thermal activity)					
Nonoccupationally exposed women (n=35)	Breast milk	4.23 [4.26]	3.24–5.41	µg/L	Ulman et al. 1998
Erlangen-Nurenberg Germany 1/92–12/93					
Nonoccupationally exposed people (n=50)	Lung	5.5	<1–13.0	ng/g ww	Kraus et al. 2000
		28.4	<1–73.6	ng/g dw	

Table 6-6. Levels of Arsenic in Human Tissue and Urine—Recent Studies

Site population	Sample	Concentration		Units	Reference
		Mean[a]	Range		
Tarragona (Catalonia, Spain) 1997–1999					
Nonoccupationally exposed people (n=78)	Lung	<0.05		µg/g ww	Garcia et al. 2001
	Bone	<0.05			
	Kidney	<0.05			
	Liver	<0.05			
	Lung	<0.05			
West Bengal, India					
Residents consuming arsenic-contaminated water (n=47)	Fingernail	7.32	2.14–40.25	µg/g	Mandal et al. 2003
	Hair	4.46	0.70–16.17		
Residents consuming nonarsenic-contaminated water (n=15)	Fingernail	0.19	0.11–0.30		
	Hair	0.07	0.03–0.12		
Middleport, NY, USA					
Children <7 years (n=77)	Urine	15.1[c]	2.1–59.6	µg/L	Tsuji et al. 2005
Children <13 years (n=142)	Urine	15.7[c]	2.1–59.9		
Children ≥7 years and adults (n=362)	Urine	15.8[c]	3.9–773		
All participants	Urine	15.7[c]	2.1–773		

[a]Medians, if reported, are in brackets.
[b]The reference group (Saxony) had significantly higher levels of arsenic in urine and hair. However, data from both groups correspond to normal range reference data.
[c]Geometric mean, total arsenic

dw = dry weight; ww = wet weight

A study was performed to look at the arsenic levels, as well as the arsenic species present, in hair and nail samples from individuals in an arsenic-affected area in West Bengal, India. Mean arsenic concentrations in hair and fingernails of the chronically arsenic exposed population were 4.46 and 7.32 μg/g, respectively and were 0.07 and 0.19 μg/g in a control population. Fingernail samples were found to contain mostly inorganic arsenic (>80%) as a mixture of As(III) and As(V), as well as DMA(III) and DMA(V). Hair samples also mostly contained inorganic arsenic (>90%), as well as MMA(V) and DMA(V) (Mandal et al. 2003).

Arsenic in soil in communities surrounding former smelters is a public health concern, especially for infants and children who may consume significant quantities of soil. Since lead arsenate was used in apple and other fruit orchards, often at very high application rates, and this compound would be expected to accumulate and persist in surface soil, there are concerns to human health when these when old orchards are converted into subdivisions or when they are used to grow food crops or forage. However, arsenic in soil may be imbedded in minerals or occur as insoluble compounds such as sulfides and therefore, not be taken up by the body from the gastrointestinal tract. In addition, oxidation of mineral surfaces may result in armoring the primary mineral grain by a secondary reaction product. Arsenic-bearing solids are often encapsulated in insoluble matrices such as silica, further diminishing arsenic availability (Davis et al. 1992).

Sarkar and Datta (2004) examined the bioavailability of arsenic from two soils with different arsenic retention capacities. In this study, Immokalee (Florida) and Orelia (Texas) soils were incubated after spiking with sodium arsenate for 4 months. The Immokalee soil is a sandy spodosol with low Fe/Al, Ca/Mg, and P contents and is likely to have minimal arsenic retention capacity. The Orelia soil is a sandy clay that is expected to have strong arsenic retention capacity. Arsenic speciation and bioavailability were studied immediately after spiking and after 4 months of incubation. Approximately 85% of the total arsenic (soluble and exchangeable fractions) was considered bioavailable and phytoavailable immediately after pesticide application for the Immokalee soil; after 4 months of incubation, this decreased to approximately 46%. Immediately after pesticide application, the amounts of arsenic extracted in the soluble/exchangeable and Fe/Al-bound fractions were similar that of the Immokalee soil. After 4 months, the soluble arsenic decreased to approximately 45% and the Fe/Al-bound arsenic increased to about 40%. Experiments looking at the bioavailability of arsenic from these two soils indicated that the potentially irreversible adsorption of arsenic by the Orelia soil rendered a significant portion of the total arsenic unavailable for absorption by the human gastrointestinal system. Initially after pesticide application,

100% of the arsenic was bioavailable; after 4 months, the bioavailable fraction was found to decrease to 88 and 69% in the Immokalee and Orelia soils, respectively (Sarkar and Datta 2004).

Hamel et al. (1998) used synthetic gastric juice to estimate the bioaccessible fraction of metals in the stomach with varying liquid to solid ratios. They found that the bioaccessibility may vary in different soils and with varying liquid to solid ratios. Bioaccessibility was defined as the amount of metal that is soluble in synthetic gastric juice and therefore, potentially available for uptake across the intestinal lumen, while bioavailability was defined as the amount that was actually taken across the cell membranes. Arsenic bioaccessibility for National Institute of Standards and Technology (NIST) Montana Soil SRM 2710, with a certified arsenic concentration of 626 µg/g, was fairly consistent across the liquid-to-solid ratios and ranged from 41.8±18 to 56±21%. The extractability of a hazardous waste contaminated soil from Jersey City, New Jersey, was different than that observed for the Montana NIST soil. For the Jersey City soil, which had an arsenic concentration of 1,120 µg/g, there was an increase in the bioaccessible arsenic as the liquid-to-solid ratio increased. Bioaccessible arsenic ranged from 4.5±0.8 (at a liquid-to-solid ratio of 100:1) to 25±9% (at a ratio of 5,000:1). Similarly, smelter impacted soils from Anaconda, Montana contain metal-arsenic oxides and phosphates whose bioaccessibility is limited by solubility restraints for residence times typical of the gastrointestinal tract (Davis et al. 1992, 1996).

Inhalation of arsenic from ambient air is usually a minor exposure route for the general population. For example, the dose to a person who breathes 20 m^3/day of air containing 20–30 ng/m^3 (see Section 6.4.1) would be about 0.4–0.6 µg/day. However, smokers may be exposed to arsenic by inhalation of mainstream smoke. Assuming that 20% of the arsenic in cigarettes is present in smoke, an individual smoking two packs of cigarettes per day would inhale about 12 µg of arsenic (EPA 1984a). However, a German study of the arsenic levels in lung tissue of 50 unexposed deceased people (see Table 6-6) found no significant difference in lung arsenic concentrations of smokers versus nonsmokers, nor were there any significant age- or sex-related differences (Kraus et al. 2000). Before arsenical pesticides were banned, tobacco contained up to 52 µg As/g, whereas after the ban, maximum arsenic levels were reduced to 3 µg/g.

Occupational exposure to arsenic may be significant in several industries, mainly nonferrous smelting, arsenic production, wood preservation, glass manufacturing, and arsenical pesticide production and application. Since arsenic compounds are used as a desiccant for cotton, workers involved in harvesting and ginning cotton may be exposed to arsenic. Occupational exposure would be via inhalation and dermal contact. Should any arsenic be retained in the cotton, workers handling the fabric and the general

public would be exposed. The electronics industry is expanding the use of gallium arsenide in the production of electro-optical devices and integrated circuits, and workers in the industry where gallium arsenide is used may be exposed to hazardous substances such as arsenic, arsine, and various acids (Sheehy and Jones 1993). Occupational exposure to arsenic is generally assessed by measuring urinary excretion of arsenic. Past exposure is commonly assessed by arsenic levels in hair. Different types of occupational exposures may result in different uptakes of arsenic because of the bioavailability of the form of arsenic to which workers are exposed. For example, maintenance workers at a Slovak coal-fired power plant exposed to 8-hour TWA arsenic air concentrations of 48.3 μg/m^3 (range, 0.17–375.2) had urinary total arsenic levels of 16.9 μg As/g creatinine (range, 2.6–50.8), suggesting that bioavailability of arsenic from airborne coal fly ash is about one-third that from in copper smelters and similar settings (Yager et al. 1997). Approximately 90% of the arsenic-containing particulates were ≥3.5 μm. Apostoli et al. (1999) monitored 51 glass workers exposed to arsenic trioxide by measuring dust in the breathing zone. The mean concentration of arsenic in air was 82.9 μg/m^3 (1.5–312 μg/m^3); exposure was higher for workers involved in handling the particulate matter. The occupation exposures to principal contaminants, including arsenic, at five coal-fired power plants were evaluated during June–August 2002. Eight air samples were collected per similar exposure group at four of the five facilities; inorganic arsenic concentrations in all samples were below the limit of detection (0.37–0.72 μg/m^3), as well as being below the OSHA permissible exposure limit (PEL) of 10 μg/m^3 (Bird et al. 2004).

NIOSH researchers conducted a study of arsenic exposures and control systems for gallium arsenide operations at three microelectronics facilities during 1986–1987 (Sheehy and Jones 1993). Results at one plant showed that in all processes evaluated but one, the average arsenic exposures were at or above the OSHA action level of 5 μg/m^3, with a maximum exposure of 8.2 μg/m^3. While cleaning the Liquid Encapsulated Czochralski (LEC) pullers, the average potential arsenic exposure of the cleaning operators was 100 times the OSHA PEL of 10 μg/m^3. Area arsenic samples collected at the plant in break-rooms and offices, 20–60 feet from the process rooms, had average arsenic concentrations of 1.4 μg/m^3. At the other two plants, personal exposures to arsenic were well controlled for all processes evaluated.

A study has been conducted to examine the relationship between total arsenic levels in hair of employees in a semiconductor fabrication facility and job responsibility, a surrogate variable for arsenic exposure (de Peyster and Silvers 1995). Airborne arsenic was found in areas where equipment was cleaned but not in administrative areas. The highest airborne arsenic level found in the study, 15 μg/m^3, was collected from the breathing zone of a maintenance employee who was cleaning a source housing over a period of 2 hours in an area with local exhaust ventilation. A concentration of 2 μg/m^3 was found during the

remainder of the cleaning period (~53 minutes). Workers in maintenance who were regularly assigned to cleaning equipment, and therefore presumed to have the highest exposure potential, had a mean hair arsenic level of 0.042 μg/g. This was higher than the mean of 0.033 μg/g observed in administrative controls, but the difference was not significant. Maintenance workers who only occasionally cleaned and maintained arsenic-contaminated equipment had a mean hair arsenic level of 0.034 μg/g, which was comparable to the controls. The highest group mean hair arsenic level of 0.044 μg/g, surprisingly, was found in supervisors and engineers who were presumed to have the lowest exposure potential of all workers in the process areas. However, the highest concentrations of hair arsenic in engineers, 0.076 and 0.106 μg/g, were observed in two heavy smokers who smoked 1–2 packs of cigarettes per day. A 2-way analysis of variance indicated that smoking appeared to be a significant contributing factor whereas occupational exposure was not.

Hwang and Chen (2000) evaluated arsenic exposure in 21 maintenance engineers (exposed group) and 10 computer programmers (control group) at 3 semiconductor manufacturing facilities. Samples of air, wipe, and urine, as well as used cleaning cloths and gloves were collected to determine arsenic exposure. Arsenic was undetectable in 46 of the 93 air samples, and most samples were generally below the recommended occupational exposure limit (10 $\mu g/m^3$) in work areas during ion implanter maintenance. Arsine was detectable in 22 of the 45 area air samples and in 15 of the 35 personal air samples; however, all concentrations were well below the occupational exposure limit of 50 ppb (160 $\mu g/m^3$). Mean arsine concentrations ranged from not detected to 4.0 ppb (15 $\mu g/m^3$) in area air samples, and the mean arsine concentration of personal air for maintenance engineers was 4.3 ppb (14 $\mu g/m^3$). Arsenic concentrations in wipe samples, used cleaning cloths, and gloves, varied from not detected to 146 $\mu g/cm^2$. During ion implanter maintenance, urinary arsenic levels were found to increase (1.0–7.8 μg/g creatinine) in the maintenance engineers, from a mean baseline concentration of 3.6 μg/g creatinine. The average urinary arsenic level for the computer programmers was 3.8 μg/g creatinine (Hwang and Chen 2000). Mean arsenic concentrations in blood of 103 workers in the optoelectronic industry and 67 controls were 8.58 and 7.85 μg/L, respectively (Liao et al. 2004).

Concentrations of various metals, including arsenic, were measured in autopsy tissues (liver, lung, kidney, brain, and bone) collected from 78 nonoccupationally exposed subjects from Tarragona County, Spain between 1997 and 1999. In general, arsenic concentrations were under the analytical detection limit (0.05 μg/g wet weight) in all tissues (Garcia et al. 2001).

CCA preservatives are commonly used for treating timber used in constructions in marine and other humid environments or in contact with the ground. Exposure to CCA compounds may occur through dermal contact and inhalation of dust while working with the treated timber. Nygren et al. (1992) investigated the occupational exposure to airborne dust, chromium, copper, and arsenic in six joinery shops in Sweden where impregnated wood was used for most of their production. The mean airborne concentration of arsenic around various types of joinery machines ranged from 0.54 to 3.1 μg/m^3. No increased concentrations of arsenic were found in the workers' urine. A study was carried out in Denmark to evaluate arsenic exposure in taxidermists, workers impregnating wood with CCA solutions, fence builders, construction workers, and workers impregnating electric pylons with arsenic solution (Jensen and Olsen 1995). Airborne arsenic exposure was documented in 19 of 27 individuals working with products containing arsenic. The maximum exposure concentration was 17.3 μg/m^3, found for a single worker who was filling an impregnation container with CCA paste. Median exposures for indoor workers producing garden fences and weekend cottages were 3.7 and 0.9 μg/m^3, respectively. The maximum urine concentration reported in the study was 294.5 nanomoles arsenic per millimole creatinine (195 μg As/g creatinine) and was from the injector impregnating electric pylons. The median concentration in workers on electric pylons was 80 nanomoles arsenic per millimole creatinine (53 μg As/g creatinine), which was 6 times the concentration in reference individuals. Urine arsenic levels in workers producing garden fences and in taxidermists were 2.9 and 1.8 times the reference level, respectively.

The NIOSH National Occupational Exposure Survey (NOES) conducted in 1981–1983 estimated that about 55,000 workers were potentially exposed to arsenic (NOES 1990). The NOES was based on field surveys of 4,490 facilities that included virtually all workplace environments, except mining and agriculture, where eight or more persons are employed. The principal exposure pathway is probably inhalation of arsenic adsorbed to particulates, but ingestion and possibly dermal exposure may also be common. Since arsenic is no longer produced in the United States (see Section 5.1) and many arsenical pesticide uses have been banned (see Chapter 8), it is likely that the number of workers occupationally exposed to arsenic has decreased markedly in more recent years.

6.6 EXPOSURES OF CHILDREN

This section focuses on exposures from conception to maturity at 18 years in humans. Differences from adults in susceptibility to hazardous substances are discussed in Section 3.7, Children's Susceptibility.

Children are not small adults. A child's exposure may differ from an adult's exposure in many ways. Children drink more fluids, eat more food, breathe more air per kilogram of body weight, and have a larger skin surface in proportion to their body volume. A child's diet often differs from that of adults. The developing human's source of nutrition changes with age: from placental nourishment to breast milk or formula to the diet of older children who eat more of certain types of foods than adults. A child's behavior and lifestyle also influence exposure. Children crawl on the floor, put things in their mouths, sometimes eat inappropriate things (such as dirt or paint chips), and spend more time outdoors. Children also are closer to the ground, and they do not use the judgment of adults to avoid hazards (NRC 1993).

As with adults, most children are exposed to arsenic largely through their diet. Since the greatest dietary intake of arsenic is from fish and seafood, infants and young children for whom a substantial part of their food is milk, would not be exposed to arsenic from dietary sources as much as older children. Even when mothers consumer large amounts of seafood, there does not appear to be any major transfer of arsenobetaine, the major form of arsenic in seafood, from seafood to milk (Grandjean et al. 1995). Arsenic concentrations were very low in human milk sampled from 88 mothers in the Faroe Islands, where the seafood diet includes pilot whale meat and blubber. The total arsenic concentrations ranged from 0.1 to 4.4 µg/kg, with a median of 1.6 µg/kg (Grandjean et al. 1995). The arsenic concentration in the breast milk of 35 women in Ismir, Turkey, a volcanic area with high thermal activity ranged from 3.24 to 5.41 µg/L, with a median of 4.22 µg/L (Ulman et al. 1998). The mean arsenic levels in three groups of cows in the region that grazed on land impacted by lava and thermal activity were 4.71, 4.46, and 4.93 µg/L, compared to 5.25 µg/L for cows kept in sheds and fed commercial pellet feed and municipal water. The arsenic levels in the urine of pregnant women and the cord blood of their infants were 0.625±0.027 and 0.825±0.079 µg/L, respectively. The authors concluded that there was no harmful exposure to arsenic in volcanic areas with high arsenic levels from suckling infants or feeding them local cow's milk, nor was there harm to the newborns from their mother's diet. Sternowsky et al. (2002) analyzed breast milk from 36 women from three different regions in Germany. These regions included the city of Hamburg, a rural area, Soltau, Lower Saxony, and Munster, the potentially contaminated area. Arsenic was not detected (<0.3 µg/L) in 154 of 187 samples, with the highest concentration, 2.8 µg/L, found in a sample from the rural area. The geometric mean arsenic concentrations from the three areas were comparable. Calculated oral intakes of arsenic were between 0.12 and 0.37 µg/day for an infant at 3 months of age and weighing 6 kg.

According to the FDA study of 1986–1991, the mean daily intakes of arsenic are 0.5 and 0.81 µg/kg body weight per day for a 6–11-month-old infant and 2-year-old child, respectively (Gunderson 1995b). This

can be compared to a mean daily intake of 0.51 µg/kg-body weight per day for a 25–30-year-old male (see Table 6-5). A Total Diet Study, from September 1991 to December 1996, estimated that the average inorganic arsenic intake for children of various age/sex groups were (age-sex group, total arsenic intake in µg/day, inorganic arsenic intake in µg/day): 6–11 months, 2.15, 1.35; 2 years, 23.4, 4.41; 6 years, 30.3, 4.64; 10 years, 13.3, 4.21; and 14–16 years (females), 21.8, 5.15; 14–16 years (males), 15.4, 4.51 (Tao and Bolger 1999). The greatest dietary contribution (76–96%) of total arsenic intake for all age groups other than infants was seafood. For infants, 41 and 34% of the estimated total arsenic intakes are from seafood and rice/rice cereals, respectively (Tao and Bolger 1999). Only for toddlers does the intake approach the World Health Organization's (WHO) provisional tolerable daily intake (PTDI) for inorganic arsenic (see Table 6-5). A 1985–1988 Canadian total diet study estimated that 1–4-year-olds ingested 14.9 µg of total arsenic per day compared with 38.1 µg by the average Canadian and 59.2 µg for 20–39-year-old males (Dabeka et al. 1993). Yost et al. (2004) estimated the mean dietary intake for inorganic arsenic for children (1–6 years of age) to be 3.2 µg/day, with a range of 1.6–6.2 µg/day for the 10^{th} and 95^{th} percentiles, respectively. Inorganic arsenic intake was predominantly contributed by grain and grain products, fruits and fruit juices, rice and rice products, and milk (Yost et al. 2004). Total arsenic and arsenobentaine concentrations were measured in 16 baby food samples obtained from manufactures in Spain; total arsenic concentrations ranged from 2.042 to 0.270 µg/g in plaice with vegetables and sole with white sauce, respectively. Arsenobetaine, which is the arsenical commonly found in fish, accounted for essentially 100% of the arsenic present in the samples (Vinas et al. 2003).

Arsenic exposure from drinking water may be elevated especially in groundwater from areas where arsenic occurs naturally in soil such as the western and north central sections of the United States (see Table 6-3 and Figure 6-2).

Arsenic exposure in communities near mining and smelting facilities or where arsenic had formerly been applied to agricultural land are a public health concern, especially for infants and children. Since arsenic remains in the surface soil indefinitely and long past land uses may be forgotten, people may not realize that they are living in areas where high levels of arsenic may occur in soil. Contaminated soils pose a particular hazard to children because of both hand-to-mouth behavior and intentional ingestion of soil (pica) that contains metals and other contaminants (Hamel et al. 1998). In these communities, arsenic may contaminate carpeting or may have been tracked in from outside. Children may be exposed to this arsenic while crawling around or playing on contaminated carpeting. Exposure may also result from dermal contact with the soil, or by inhaling the dust and then swallowing it after mucociliary transport up

out of the lungs. Because much of the arsenic in soil is embedded in or adsorbed to soil particles or insoluble, it may not be in a form accessible for uptake by the body.

Hwang et al. (1997b) studied the arsenic exposure of children in Anaconda, Montana, in the vicinity of a former copper smelter from the summer of 1992 through the summer of 1993. Environmental samples and first morning voided urine samples from 414 children <72 months old were collected. Attention was focused on that fraction of the environmental source that was thought to be of the greatest risk to the child (i.e., arsenic in small particles [<250 μm]) that could most readily adhere to hands and toys and could be inadvertently ingested. Average arsenic levels in different types of soil ranged from 121 to 236 μg/g. Several studies have reported mean soil ingestion values for children ranging from 9 to 1,834 μg /day. Assuming that high arsenic exposure areas have average arsenic levels in soil from 60 to 150 μg/g, the resulting daily arsenic intake from soil could range from 1 to 275 μg/day per child. The geometric mean of speciated urinary arsenic (combined As(III), As(V), MMA and DMA) was 8.6±1.7 μg/L (n=289) in the Hwang study. A nationwide survey on arsenic exposure in the vicinity of smelter sites revealed that children without excess arsenic exposure had average total urinary arsenic levels ranging from 5 to 10 μg/L (Hwang et al. 1997a). Compared to these values, the mean total urinary arsenic values found in the Hwang study were markedly higher, but they were still well below the WHO-recommended maximum excretion level for total arsenic of 100 μg/L as an action level for intervention. The investigators hypothesized that the relatively low urinary arsenic levels found in the study were probably a reflection of the low bioavailability of some forms of arsenic in contaminated soil. Hwang et al. (1997a) stated that arsenic intake through skin contact is insignificant and may be neglected in the assessment of childhood arsenic exposure. They recommend that parents or guardians pay more attention to their children's activity, especially hand-to-mouth behavior, even though the environmental contaminants might be elevated only slightly. Children in the northern Palatine region of German study, a former mining area characterized by high levels of arsenic (<2–605 μg/g) in residential areas did not show higher arsenic levels in their hair or urine than children from a reference area of Germany (Gebel et al. 1998a).

While CCA registrants voluntarily canceled the production of CCA-treated wood for residential use in 2003, there is a potential for exposure to arsenic from existing structures (Zartarian et al. 2006). Based on a review of existing studies, Hemond and Solo-Gabriele (2004) estimated that children with contact with CCA-treated wood may be subjected to doses in the range of tens of micrograms of arsenic per day. The most important route of exposure appeared to be by hand-to-mouth activities after contact with the CCA-treated wood. Kwon et al. (2004) compared the amounts of water-soluble arsenic on hands of children in

contact with CCA-treated wood structures or sand in playgrounds. The mean amount of water-soluble arsenic on children's hands from playgrounds without CCA-treated wood was 0.095 μg (range 0.011–0.41 μg). A mean amount of water-soluble arsenic on children's hands from playgrounds with CCA-treated wood was 0.5 μg (range 0.0078–3.5 μg) (Kwon et al. 2004). Additional data from the study by Kwon et al. (2004) showed that total arsenic collected in hand-washing water (insoluble arsenic on the filter combined with the water-soluble arsenic in the filtrate) was 0.934 and 0.265 μg for the CCA playgrounds and the non-CCA playgrounds, respectively (Wang et al. 2005). Two wood surface swab samples collected from 217 play structures constructed from CCA-treated wood in the City of Toronto, Canada were sampled and analyzed for inorganic arsenic (Ursitti et al. 2004). Dislodgeable arsenic concentrations were found to vary widely from nondetectable (0.08–0.25 μg/100 cm^2) to 521 μg/100 cm^2 (mean = 41.6 μg/100 cm^2), and were found to not be a useful predictor of soil arsenic levels (Ursitti et al. 2004).

Shalat et al. (2006) evaluated postexposure hand rinses and urine for total arsenic for 11 children (13–71 months) in homes in Miami-Dade County, Florida, with and without CCA-treated playgrounds. Seven playgrounds were included in this study, and five of these contained either CCA-treated or partially CCA-treated wood. In addition, samples of wood, soil (5–8 cm from the base of the playground structure), mulch (when present), and synthetic wipes were analyzed for total arsenic. Wood and soil arsenic concentration were <2.0 and <3 mg/kg for the non-CCA-treated playgrounds, respectively. Mean arsenic concentrations of 2,380 mg/kg (range 1,440–3,270 mg/kg) and 19 mg/kg (4.0–42 mg/kg) were reported for wood and soil, respectively, in the playgrounds with CCA-treated wood. An arsenic concentration in mulch at one playground without CCA-treated wood was 0.4 mg/kg, and arsenic concentrations were 0.6 and 69 mg/kg in mulch at two of the playgrounds with CCA-treated wood. The amount of arsenic removed by synthetic wipes from the non-CCA-treated wood was <0.5 μg, while the mean amount of arsenic removed from the CCA-treated wood was 117 μg (range 1.0–313 μg). The amount of arsenic in hand rinses from children who played at the playgrounds with non-CCA-treated wood and at the playgrounds with CCA-treated wood were <0.2 and 0.6 μg (range <0.2–1.9 μg), respectively. The mean urinary total arsenic concentration was 0.0136 μg/L (range 0.0072–0.0231 μg/L) for all children. No association between assess to CCA-treated playgrounds and urinary arsenic levels was found (Shalat et al. 2006).

The potential exposure children may receive from playing in play structures constructed from CCA-treated wood is generally smaller than that they would receive from food and water. For comparison, Yost et al. (2004) estimated the mean dietary intake for inorganic arsenic for children (1–6 years of age)

to be 3.2 µg/day, with a range of 1.6–6.2 µg/day for the 10th and 95th percentiles, respectively. In a Total Diet Study, from September 1991 to December 1996, estimated average total intakes for children aged 6–11 months, 2 years, 6 years, and 10 years were 2.15, 23.4, 30.3, and 13.3 µg/day, respectively. Average inorganic arsenic intakes for the same age groups were estimated as 1.35, 4.41, 4.64, and 4.21 µg/day, respectively, based on data for total arsenic in foods and the assumption that 10% of the total arsenic in seafood was inorganic and that 100% of the arsenic in all other foods was inorganic (Tao and Bolger 1999). Hand washing after play would reduce the potential exposure to children to arsenic after playing on play structures constructed with CCA-treated wood, since most of the arsenic on the children's hands was removed with water (Kwon et al. 2004).

Concentrations of several toxic metals, including the metalloid arsenic, were measured in the placentas of 200 women in two urban cities in Ukraine, Kyiv and Dniprodzerzhinsk. Arsenic was detected in only 5% of the samples with concentrations ranging from <0.156 to 0.378 µg/g. In a study in Bulgaria, placental arsenic concentrations of 7 and 23 µg/g were reported in a control and smelter area, respectively. A placental arsenic concentration of 34 µg/g was reported in a region of Argentina with high concentrations of arsenic in drinking water (Zadorozhnaja et al. 2000).

Parents can inadvertently carry hazardous materials home from work on their clothes, skin, hair, and tools, and in their vehicles (DHHS 1995). Falk et al. (1981b) reported a case of hepatic angiosarcoma in a child that could be associated with arsenic contamination of a parent's clothing, the water supply, and the environment. The father worked in a copper mine and smelter area where his clothing was contaminated with dust containing arsenic. His daughter, who exhibited a high degree of pica, ate soil from the yard, and licked soil off her father's shoes. In a study of arsenic levels in homes in Hawaii, Klemmer et al. (1975) found higher levels in homes of employees of firms that used arsenic for pesticides or wood preservation, compared to homes where residents' work did not involve arsenic. The concentration of arsenic in dust from the homes of workers exposed to arsenic ranged from 5.2 to 1,080 µg/g, compared to concentrations of 1.1–31 µg/g in dust from control homes.

While the harmful effects of many components of tobacco smoke are well known, those due to heavy metals in the smoke have not been sufficiently emphasized. The adverse health effects of these toxic metals on the fetus through maternal smoking are of special concern (Chiba and Masironi 1992). The concentration of arsenic in tobacco is relatively low, usually below detectable limits (<1 µg/g). Although the concentrations of inorganic and organic arsenic in the urine of adults do not appear to be influenced by smoking, a positive association was found between urinary arsenic levels in children and parental

smoking habits. As detailed in a WHO report, the mean arsenic level in the urine of children of nonsmoking parents was 4.2 µg/g creatinine, in children with one smoking parent, it was 5.5 µg/g, and in children with both parents smoking, it was 13 µg/g (Chiba and Masironi 1992). Tsuji et al. (2005) reported geometric mean concentrations of total arsenic of 15.1 and 15.7 µg/L in children <7 and <13 years old, respectively, from households in Middleport, New York, where historical pesticide manufacture was associated with arsenic in soil. Geometric mean concentrations of inorganic arsenic, MMA, and DMA were 0.81, 0.54, and 2.5 µg/L, respectively, in children <7 years old and 0.83, 0.55, and 3.0 µg/L, respectively, in children <13 years old (Tsuji et al. 2005).

The use of Chinese herbal medicines (CHM) appears to be common among Chinese women. Both CHM and Chinese proprietary medicines (CPM) are used for treatment of minor ailments in babies and children. Herbal medicines are available in capsule or tablet form in drug stores, supermarkets, and by mail. The CPM "Sin Lak Pill," "Lu Shen Wan," and other anti-asthma preparations have been found to contain inorganic arsenic levels ranging from 25 to 107,000 µg/g, and cases of acute arsenic poisoning have been found in children and adults using these CPM (Chan 1994). Babies and children are particularly at risk because they may be given higher doses of these preparations per kg of body weight than adults would normally consume. They may also lack the hepatic enzymes responsible for drug biotransformation and detoxification (Chan 1994). Concentrations of heavy metals, including arsenic, were evaluated in 54 samples of Asian remedies that were purchased in stores in Vietnam and Hong Kong that would be easily accessible to travelers, as well as in health food and Asian groceries in Florida, New York, and New Jersey. One remedy that was recommended to treat children's fever would expose a 15 kg child to approximately 5.0 mg of arsenic per day (Garvey et al. 2001). A folk remedy, purchased in California, for the treatment of chicken pox, flu-like symptoms, and nasal congestion, which had been given to two children in Wisconsin, was found to contain 36% arsenic acid. One-half teaspoon of this powder (about 500 mg of arsenic) was dissolved in hot water and taken 2–3 times per day (Werner et al. 2001).

Various metallic pigments and colors in the form of salts or lakes are used in toy production. Therefore, children may be exposed to toxic metals while playing with toys, especially when they lick, suck, or swallow a toy or a piece of a toy. Toys produced in European Union Markets must conform to restrictions concerning the bioavailability of toxic metals, including arsenic. The maximum limit for bioavailability of arsenic from the accessible parts of a toy is set to 0.1 µg/day. This corresponds to an arsenic migration limit of 25 µg/g for all toy material, including modeling clay and paints (Rastogi and Pritzl 1996). A study was carried out to determine whether crayons, water colors, and water-based paints

conform with the migration limits for toxic metals (Rastogi and Pritzl 1996). For the analysis, 94 samples representing 48 products were obtained from China, Taiwan, Japan, the United States, and European countries. Fifty-two samples showed migration of arsenic, ranging from 0.01 to 3.75 μg/g.

6.7 POPULATIONS WITH POTENTIALLY HIGH EXPOSURES

In addition to individuals who are occupationally exposed to arsenic (see Section 6.5), there are several groups within the general population that have potentially high exposures (higher than background levels) to arsenic. These populations include individuals living in proximity to sites where arsenic was produced, used (e.g., as a pesticide), or disposed, and individuals living near one of the 1,684 NPL hazardous waste sites where arsenic has been found at elevated levels in some environmental media (HazDat 2006). It also includes point sources such as smelters, coal-fired power plants, and municipal incinerators. People living in areas of volcanic activity may be exposed to higher levels of arsenic since high levels are more likely to be present in the environment. Other populations at risk of potentially high levels of exposure include those whose water supply contains high levels of arsenic and those consuming large amounts of seafood or seaweed. However, as pointed out previously (see Section 6.4.4), arsenic in fish and shellfish, is largely in the form of the less harmful organic arsenical, arsenobetaine; however, some commercially available seaweeds, especially brown algae varieties, may have high percentages of the total arsenic present as inorganic arsenic (>50%) (Almela et al. 2002; Laparra et al. 2003). While elevated urinary arsenic excretion levels have been associated with the consumption of fish and seafood, in a study of 32 sport fish consumers from Lakes Erie, Huron, and Michigan, only 6 (19%) had detectable urine arsenic concentrations, >4 μg/L, and 5 of these consumed fish from Lake Huron (Anderson et al. 1998). Exposure of high levels of arsenic in drinking water is more apt to be absorbed by the body and be harmful than exposure to arsenic in seafood. For example, a group of 36 people in Zimapán, Mexico who consumed water from an aquifer with 1.0 mg As/L had hair arsenic levels of 2.6–14.1 μg/g (10 μg/g average), compared with 2.4–13.9 μg/g (6.19 μg/g average) for a reference population that consumed bottled water with <0.014 mg/L arsenic (Armienta et al. 1997).

A study was conducted to determine if significant arsenic exposure was occurring at a Superfund site in Fort Valley, Georgia (Hewitt et al. 1995). Random urine, 24-hour urine, hair, and fingernail samples were collected at the end of the workweek from 40 employees at an active pesticide manufacturing facility where arsenical pesticides had been produced for over 50 years prior to the mid-1970s. Measurement of arsenic in the urine is considered to be the best method for monitoring recent exposure in industrial populations. Hair and fingernail analyses may provide an indication of exposures that occurred

up to several months prior to testing, but both can adsorb and strongly retain arsenic from external sources. Since arsenic is rapidly cleared from the blood (half-life of 3–4 hours), blood arsenic levels are not considered suitable for monitoring populations for chronic low-level arsenic exposure. Results of the Hewitt study are summarized in Table 6-6. Urinary arsenic levels for all workers were well within the commonly accepted normal range of <100 μg/L.

As noted above, workers in a number of industries may have high exposures to arsenic, especially if proper safety procedures are not followed. For members of the general population, above-average exposure to arsenic from drinking water is possible in areas of high natural arsenic levels in groundwater or elevated arsenic levels in drinking water due to industrial discharges, pesticide applications, or leaching from hazardous waste facilities. Individuals living in the vicinity of large smelters and other industrial emitters of arsenic may be exposed to above-average arsenic levels both in the air, and as a result of atmospheric deposition, in water and soil and subsequent uptake into crops.

People sawing or drilling arsenic-treated wood without protective masks or burning this wood may be exposed to elevated levels of arsenic in air.

Recreational and subsistence fishers who consume appreciably higher amounts of locally caught fish from contaminated bodies of water may be exposed to higher levels of arsenic associated with dietary intake. Arsenic contamination has triggered the issuance of several human health advisories (EPA 1998g). As of December 1997, arsenic was identified as the causative pollutant in a restricted consumption advisory for the general population for all fish in a 7-mile area including Devil's Swamp Lake and Bayou Baton Rouge in Louisiana. A public health advisory has been issued for consumption of fish and shellfish from the Duwamish River, Seattle, Washington due to arsenic and other chemicals (WSDOE 2005).

6.8 ADEQUACY OF THE DATABASE

Section 104(i)(5) of CERCLA, as amended, directs the Administrator of ATSDR (in consultation with the Administrator of EPA and agencies and programs of the Public Health Service) to assess whether adequate information on the health effects of arsenic is available. Where adequate information is not available, ATSDR, in conjunction with NTP, is required to assure the initiation of a program of research designed to determine the health effects (and techniques for developing methods to determine such health effects) of arsenic.

The following categories of possible data needs have been identified by a joint team of scientists from ATSDR, NTP, and EPA. They are defined as substance-specific informational needs that if met would reduce the uncertainties of human health assessment. This definition should not be interpreted to mean that all data needs discussed in this section must be filled. In the future, the identified data needs will be evaluated and prioritized, and a substance-specific research agenda will be proposed.

6.8.1 Identification of Data Needs

Physical and Chemical Properties. The chemical and physical properties of the arsenic species of chief toxicological and environmental concern are sufficiently well characterized to allow estimation of the environmental fates of these compounds. However, more information regarding the K_{ow} and K_{oc} values of the organic arsenicals would help predict the fate of these compounds in the environment.

Production, Import/Export, Use, Release, and Disposal. According to the Emergency Planning and Community Right-to-Know Act of 1986, 42 U.S.C. Section 11023, industries are required to submit substance release and off-site transfer information to the EPA. The TRI, which contains this information for 2004, became available in May of 2006. This database is updated yearly and should provide a list of industrial production facilities and emissions.

While arsenic has not been produced in the United States since 1985, the United States is the largest consumer of arsenic and substantial quantities of arsenic are imported, primarily as arsenic trioxide (USGS 2006a). The agricultural use of inorganic arsenic pesticides have been discontinued in the United States. However, some organic arsenicals still may be used in agriculture. Current production and use data for individual arsenical pesticides and other arsenic compounds would help to estimate human exposure to the various arsenic species. Because arsenical pesticides are so persistent, a more complete picture of past use of these products would enable us to predict what areas may contain high levels of arsenic in soil.

Comprehensive estimates on emissions of arsenic date to the early 1980s (Nriagu and Pacyna 1988). The industrial picture has changed considerably since then and emission controls are being mandated more and more. For example, emission factors for Canadian smelters calculated in 1993 were grossly lower than those estimated in 1983 (Skeaff and Dubreuil 1997). There is a need for accurate and up-to-date measurements of atmospheric arsenic releases from both natural and anthropogenic sources to better assess human exposure to arsenic and guide environmental protection measures.

Environmental Fate. The interconversion of the various arsenic species and transport among the environmental media is complex and not all aspects are well-studied. Additional quantitative data on the rates of oxidation, reduction, and biotransformation reactions of arsenic compounds, and how these depend on environmental conditions would be useful in evaluating and predicting the fate and transport of arsenic at hazardous waste sites and other areas.

Bioavailability from Environmental Media. Toxicokinetic and toxicity studies establish that bioaccessible (e.g., soluble, not strongly adsorbed to soil or embedded in minerals) arsenic is highly absorbed following inhalation and oral exposure (see Sections 3.4.1.2 and 3.4.1.1). Some work has been done on the effect of environmental matrix (soil, food) on accessibility and absorption of arsenic (Davis et al. 1992, 1996; Hamel et al. 1998; Roberts et al. 2002, 2007), but additional data would be valuable. Limited data suggests that dermal absorption of arsenic is very low (see Section 3.4.1.3) (Lowney et al. 2005), further data would be useful to establish whether arsenic uptake occurs from contact with contaminated soil or water, since humans may be exposed by these routes near hazardous waste sites.

Food Chain Bioaccumulation. Bioconcentration factors have been measured for several freshwater and marine species. While some species (mainly marine algae and shellfish) tend to bioconcentrate arsenic (EPA 1980a; Roper et al. 1996), it is not biomagnified through the food chain (Eisler 1994; EPA 1979, 1982b, 1983e, 2003b; Williams et al. 2006).

Carrots growing on land containing somewhat more than the permissible of arsenic in crop land did not contain levels of arsenic that were harmful (Helgesen and Larsen 1998). However, further research on the uptake of arsenic by a variety of plants in a wide range of arsenic polluted sites (e.g., mining area, orchards previously treated with lead arsenate) would be valuable in assessing human exposure near such sites through the consumption of vegetables from home gardens.

Exposure Levels in Environmental Media. Additional reliable monitoring data for the levels of arsenic in contaminated media at hazardous waste sites are needed or need to be made available, so that the information obtained on levels of arsenic in the environment can be used in combination with the known body burden of arsenic to assess the potential risk of adverse health effects in populations living in the vicinity of hazardous waste sites.

Extensive monitoring data are available for total arsenic in all environmental media. Additional monitoring studies, specifically those that include identification of arsenic species, would allow more precise estimation of current exposure levels and possible human health risks.

Exposure Levels in Humans. Arsenic has been detected in human tissues, including blood, urine, hair, nails, and internal organs. Data are available for populations exposed in the workplace and for the general population (de Peyster and Silvers 1995; Jensen and Olsen 1995; Nygren et al. 1992), and some studies have been published on exposures near waste sites (Hwang et al. 1997a; Tsuji et al. 2005). Additional biomonitoring studies of residents near waste sites that contain arsenic would be helpful in evaluating the likely human health risks from these sites.

While some data are available on the speciation of arsenic in food, additional data on the particular species of arsenic, rather than just the total arsenic concentration, present in foods, especially seafood, are needed to better estimate the potential hazards to human health by the consumption of these foods (Ryan et al. 2001).

This information is necessary for assessing the need to conduct health studies on these populations.

Exposures of Children. Contaminated soils pose a particular hazard to children because of pica and hand-to-mouth activities. Some studies have been performed on exposure and body burden (Hwang et al. 1997a), but additional studies, including investigations of unique pathways for exposures of children and the amount of soil a child ingests, would provide valuable data. Small amounts of arsenic were found to be transferred to hands of children playing on play structures constructed from CCA-treated wood (Hemond and Solo-Gabriele 2004; Kwon et al. 2004; Shalat et al. 2006; Ursitti et al. 2004; Wang et al. 2005). Based on a review of existing studies, Hemond and Solo-Gabriele (2004) estimated that children with contact with CCA-treated wood may be subjected to doses in the range of tens of micrograms of arsenic per day and suggested that exposure by this route warrants further study. The PTDI assigned by the Food and Agriculture Organization of the United Nations and the World Health Organization (FAO/WHO) applies to adults. Studies are needed to assess whether children are different in their weight adjusted intake of arsenic. No childhood-specific means for reducing exposure were identified.

Child health data needs relating to susceptibility are discussed in Section 3.12.2, Identification of Data Needs: Children's Susceptibility.

Exposure Registries. No exposure registries for arsenic were located. This substance is not currently one of the compounds for which a sub-registry has been established in the National Exposure Registry. The substance will be considered in the future when chemical selection is made for sub-registries to be established. The information that is amassed in the National Exposure Registry facilitates the epidemiological research needed to assess adverse health outcomes that may be related to exposure to this substance.

6.8.2 Ongoing Studies

The Federal Research in Progress (FEDRIP 2006) database provides additional information obtainable from a few ongoing studies that may fill in some of the data needs identified in Section 6.8.1. These studies are summarized in Table 6-7.

The U.S. Geological Survey, along with other federal and state agencies, industry, and academia, is conducting the National Geochemical Survey (NGS) in order to produce a body of geochemical data for the United States based primarily on stream sediments that have been analyzed using a consistent set of analytical methods. The goal of the NGS is to analyze at least one stream sediment sample in every 289 km^2 area by a single analytical method across the entire United States (USGS 2007b).

EPA is conducting a 4-year (2000–2003) national screening-level study of contaminants in freshwater fish, referred to as the National Fish Tissue Study (EPA 2004c). This study will allow the EPA to develop national estimates of the mean concentrations of 268 chemicals in tissues of fish from lakes and reservoirs of the coterminous United States. EPA analysis of the data from this study was scheduled to begin in January 2005, with the final report scheduled to be released in 2006. Interim raw data have been released each year, and are available from EPA. Fish samples have been analyzed for total inorganic arsenic (As(III) and As(V) combined), arsenic(III), arsenic(V), MMA(V), and DMA(V). Analysis for total arsenic was not performed as part of this study.

The American Water Works Association Research Foundation (AWWARF) supports research on arsenic in drinking water.

Table 6-7. Ongoing Studies on the Environmental Fate and Exposure of Humans to Arsenic

Investigator	Affiliation	Research description	Sponsor
Basta, NT	Ohio State University, School of Natural Resources, Columbus, Ohio	Heavy metal and trace element biogeochemistry in soils; chemical speciation, bioavailability, and toxicity	USDA
Blum, CB	Columbia University Health Sciences, New York, New York	Bioavailability lead and arsenic in soil to humans	NIEHS
Hamilton, JW	Dartmouth College, Hanover, New Hampshire	Toxic metals—biological and environmental implications	NIEHS
Hoppin, J	Not specified	Monitoring of arsenic and other compounds in the blood and urine of a cohort of pregnant women in Norway	NIEHS
Kpomblekou, AK; Ankumah, RO	Tuskegee University, Agriculture and Home Economics, Tuskegee, Alabama	Biochemical processes in soils treated with trace-element-enriched broiler litter; to determine total arsenic and other metal concentrations and the distribution of their chemical forms in soils under long-term broiler litter treatments	USDA
Loeppert, RH	Texas A&M University, Soil and Crop Sciences, College Station, Texas	Inorganic chemical processes influencing soil and water quality	USDA
Peryea, FJ	Wenatchee Tree Fruit Research & Extension Center Washington State University, Pullman, Washington	Quantification of biogeochemical processes in lead arsenate-contaminated orchard soils and development of soil and plant management practices to minimize the toxicity risks that these soils impose on agricultural crops and to human and environmental health	USDA
Miller, DM; DeLaune, P; Miller, WP	University of Arkansas, Crop, Soil and Environmental Sciences, Fayetteville, Arkansas	Arsenic levels in soils of northwest Arkansas	USDA
van Geen, A	Columbia University, Lamont-Doherty Earth Observatory, Palisades, New York	Studies on arsenic in groundwater in Bangladesh	NSF

Table 6-7. Ongoing Studies on the Environmental Fate and Exposure of Humans to Arsenic

Investigator	Affiliation	Research description	Sponsor
Walker, MJ et al.	University of Nevada, Natural Resources and Environmental Sciences, Reno, Nevada	Arsenic in Churchill County, Nevada domestic water supplies	USDA
Zheng, Y	Columbia University Health Sciences, New York, New York	Arsenic mobilization in Bangladesh groundwater	NIEHS

NIEHS = National Institute of Environmental Health Sciences; NSF = National Science Foundation; USDA = U.S. Department of Agriculture

Source: FEDRIP 2006

This page is intentionally blank.

7. ANALYTICAL METHODS

The purpose of this chapter is to describe the analytical methods that are available for detecting, measuring, and/or monitoring arsenic, its metabolites, and other biomarkers of exposure and effect to arsenic. The intent is not to provide an exhaustive list of analytical methods. Rather, the intention is to identify well-established methods that are used as the standard methods of analysis. Many of the analytical methods used for environmental samples are the methods approved by federal agencies and organizations such as EPA and the National Institute for Occupational Safety and Health (NIOSH). Other methods presented in this chapter are those that are approved by groups such as the Association of Official Analytical Chemists (AOAC) and the American Public Health Association (APHA). Additionally, analytical methods are included that modify previously used methods to obtain lower detection limits and/or to improve accuracy and precision.

7.1 BIOLOGICAL MATERIALS

Atomic absorption spectrophotometry (AAS) is the most common analytical procedure for measuring arsenic in biological materials (Curatola et al. 1978; Foà et al. 1984; Johnson and Farmer 1989; Mushak et al. 1977; Norin and Vahter 1981; Sotera et al. 1988). In AAS analysis, the sample is heated in a flame or in a graphite furnace until the element atomizes. The ground-state atomic vapor absorbs mono-chromatic radiation from a source and a photoelectric detector measures the intensity of transmitted radiation (APHA 1989b). Inductively-coupled plasma atomic emission spectrometry (ICP-AES) and ICP-mass spectrometry (ICP-MS) are increasingly common techniques for the analysis of arsenic; both methods can generally provide lower detection limits than absorbance detection methods.

Samples may be prepared for AAS in a variety of ways. Most often, the gaseous hydride procedure is employed (Curatola et al. 1978; Foà et al. 1984; Johnson and Farmer 1989; Norin and Vahter 1981). In this procedure, arsenic in the sample is reduced to arsine (AsH_3), a gas that is then trapped and introduced into the flame. This approach measures total inorganic arsenic, but may not detect all organic forms unless preceded by a digestion step. Digestion or wet-ashing with nitric, sulfuric, and/or perchloric acids degrades the organic arsenic species to inorganic arsenic so that recovery of total arsenic from biological materials can be achieved (Maher 1989; Mushak et al. 1977; Versieck et al. 1983). In microwave assisted digestion, harsh oxidation conditions are used in conjunction with microwave heating (Benramdane et al. 1999b). For accurate results, it is important to check the completeness of the oxidation; however, this is seldom done (WHO 1981).

The arsenic concentration in biological fluids and tissues may also be determined by neutron activation analysis (NAA) (Landsberger and Simsons 1987; Versieck et al. 1983). In this approach, the sample is irradiated with a source of neutrons that converts a portion of the arsenic atoms to radioactive isotopes, which can be quantified after separation from radioisotopes of other chemicals. Neutron activation has limited use because of the limited number of nuclear reactors in the United States providing this service and the need to dispose of radioactive waste. X-ray fluorescence is also capable of measuring arsenic in biological materials (Bloch and Shapiro 1986; Clyne et al. 1989; Nielson and Sanders 1983) and environmental samples (see Section 7.2). This method has the advantage that no sample digestion or separation steps are required. Hydride generation combined with atomic fluorescence spectroscopy (HG-AFS) is a relatively new technique that provides freedom from interference offered by hydride generation with sensitivity better than to 20 parts per trillion and linearity up to 10 ppm (PSA 2000).

Speciation of arsenic (i.e., analysis of organic arsenic compounds or different inorganic species, rather than total arsenic) is usually accomplished by employing separation procedures prior to introduction of the sample material into a detection system. Various types of chromatography or chelation-extraction techniques are most commonly used in combination with AAS, ICP-AES, or ICP-MS detection methods (Dix et al. 1987; Foà et al. 1984; Johnson and Farmer 1989; Mushak et al. 1977; Norin et al. 1987; Thomas and Sniatecki 1995). In one method, high performance liquid chromatography (HPLC) is combined with HG-AFS to quantify As(III), dimethylarsinic acid (DMA), momomethyl arsonic acid (MMA), and As(V) (PSA 2000). Another approach involves selective reduction of arsenate and arsenite (permitting quantification of individual inorganic arsenic species), and selective distillation of methyl arsines to quantify MMA and DMA (Andreae 1977; Braman et al. 1977; Crecelius 1978). Most methods for measuring arsenic in biological samples are unable to measure arsenobetaine with any accuracy because it does not form a hydride and it gives a different response from inorganic arsenic in electrothermal AAS. Ebdon et al. (1999) successfully employed HPLC coupled with ICP-MS to determine arsenic speciation in blood plasma, which was entirely arsenobetaine. Øygard et al. (1999) developed a simple method to determine inorganic arsenic in biological samples. Their method, which involves initially distilling inorganic arsenic from the sample as $AsCl_3$ using HCl, avoids separating and quantifying all of the different arsenic species, which is both costly and time-consuming.

Table 7-1 summarizes a variety of methods for measuring total arsenic and individual arsenic species in biological materials. None of these methods have been standardized by EPA or other federal agencies.

Table 7-1. Analytical Methods for Determining Arsenic in Biological Samples

Sample matrix	Preparation method	Analytical method	Sample detection limit	Percent recovery	Reference
Methods for total arsenic:					
Blood	Digestion with nitric acid and hydrogen peroxide; dry ash with magnesium oxide/magnesium nitrate; reduction with sodium borohydride	HGAAS	0.5 µg/L	95–102	Foà et al. 1984
Blood, hair	Wet ash with nitric/perchloric acids; reduction with sodium borohydride	HGAAS	0.1 µg/L[a]	95–105	Valentine et al. 1979
Serum	Irradiation; digestion with nitric/ perchloric/sulfuric acids; extraction with toluene	NAA	0.088 ng/mL[a]	94–98	Versieck et al. 1983
Urine	Irradiate epithermally	NAA	40–100 ng/g	93–109	Landsberger and Simsons 1987
Urine	Digestion with nitric and perchloric acid; reduction with tin chloride; generation arsine by addition of zinc; reaction with SDDC	Colorimetric photometry	0.5 µg/sample	90–110	Pinto et al. 1976
Urine	Pretreatment with L-cysteine; reduction with potassium iodide/ ascorbic acid	Flow injection HGAAS	0.1 µg/L	95–100	Guo et al. 1997
Urine	Drying sample; irradiation with x-rays	XRF	0.2 µg/L[a]	92–108	Clyne et al. 1989
Hair	Wet ashing with nitric/sulfuric acids and hydrogen peroxide; reduction to arsine with sodium borohydride	HGAAS	0.06 µg/g	93	Curatola et al. 1978
Soft tissue	Digestion with nitric/sulfuric acids; complexation with DDDC in potassium iodide; extraction with chloroform	GFAAS	0.2 ppm	79.8	Mushak et al. 1977
Nails	Wet ashing with nitric/sulfuric acids and hydrogen peroxide; reduction to arsine with sodium borohydride	HGAAS	1.5 µg/g	No data	Agahian et al. 1990
Methods for arsenic speciation:					
Urine	Separation of As^{+3}, As^{+5}, MMA, and DMA on anion/cation exchange resin column; reduction to respective arsines with sodium borohydride	IEC/HGAAS	0.5 µg/L	93–106	Johnson and Farmer 1989
Urine	Reduction of As^{+3}, As^{+5}, MMA, and DMA to arsines with sodium borohydride	HGAAS	0.08 µg/L	97–104	Norin and Vahter 1981

Table 7-1. Analytical Methods for Determining Arsenic in Biological Samples

Sample matrix	Preparation method	Analytical method	Sample detection limit	Percent recovery	Reference
Urine	Reduction of As^{+3}, As^{+5}, MMA, and DMA to arsines; collection in cold trap; selective distillation by slow warming	Atomic emission (direct-current plasma)	≤1 ng for all four species	No data	Braman et al. 1977
Urine	Extraction with chloroform/ methanol; column separation with chloroform/methanol; elution on cation exchange column with ammonium hydroxide	HGAAS/TLC/ HRMS	0.34 mg/ sample[a]	No data	Tam et al. 1982
Blood/ tissue	Acidification with hydrochloric acid; complexation with TGM; extraction into cyclohexane; separation on capillary column	GLC/ECD	0.1 mg/mL	No data	Dix et al. 1987
Blood plasma	Separation by HPLC	HPLC/ICP-MS	2.5 ng As/mL	~100	Ebdon et al. 1999
Urine	Separation by anion exchange chromatography; detection by direct coupling of column to ICP-MS	IEC/ICP-MS	<0.45 µg/L for all species	No data	Inoue et al. 1994
Marine biota	Extraction with methanol-water; removal of fats by liquid-liquid extraction or solid-phase cartridge	HPLC/ICP-MS	6–25 ng/mL	94.6 (fish muscle CRM)	Sniatecki 1994
Marine biota	Separation by anion exchange coupled with HPLC; on-line microwave oxidation	HPLC/ HGAAS	0.3–0.9 ng	95–110 (recovery of spike in fish tissue)	López-Gonzálvez et al. 1994
Biological samples—Inorganic arsenic	Distill inorganic arsenic as $AsCl_3$ using HCl after prereduction of As(V) with KI/HCl	Flow-injection HGAAS	0.045 mg/kg (dry matter)	No data	Øygard et al. 1999

[a]Lowest reported concentration

CRM = certified reference material; DDDC = diethylammonium diethyldithiocarbamate; DMA = dimethylarsinate; ECD = electron capture detector; GFAAS = graphite furnace atomic absorption spectrometry; GLC = gas-liquid chromatography; HGAAS = hydride generation atomic absorption spectrometry; HRMS = high resolution mass spectrometry; ICP-MS = inductively-coupled plasma mass spectrometry; IEC = ion exchange chromatography; HPLC = high-performance liquid chromatography; MMA = monomethylarsonate; NAA = neutron activation analysis; SDDC = silver diethyldithiocarbamate; TGM = thioglycolic acid methylester; TLC = thin layer chromatography; XRF = x-ray fluorescence

Detection limits in blood and urine are about 0.1–1 ppb for most techniques; limits for hair and tissues are usually somewhat higher.

7.2 ENVIRONMENTAL SAMPLES

Arsenic in environmental samples is also measured most often by AAS techniques, with samples prepared by digestion with nitric, sulfuric, and/or perchloric acids (Dabeka and Lacroix 1987; EPA 1983b, 1994a, 1994b; Hershey et al. 1988). Other methods employed include a spectrophotometric technique in which a soluble red complex of arsine and silver diethyldithiocarbamate (SDDC) is formed (APHA 1977; EPA 1983c, 1983d), ICP-AES (EPA 2000c; NIOSH 2003), graphite furnace AAS (EPA 1983b, 1994b; NIOSH 1994b), ICP-MS (EPA 1991, 1994a, 1998j), and x-ray fluorescence (Khan et al. 1989; Nielson and Sanders 1983).

HPLC is currently the most common technique for separation of the species of arsenic found in seafood (Benramdane et al. 1999b; Guerin et al. 1999; Kumaresan and Riyazuddin 2001). An advantage of HPLC over other separation methods (e.g., gas chromatography [GC]) is that the arsenic species do not need to be derivatized prior to separation, avoiding concerns over complete conversion to the derivative for detection.

Since arsenic in air is usually associated with particulate matter, standard methods involve collection of air samples on glass fiber or membrane filters, acid extraction of the filters, arsine generation, and analysis by SDDC spectrophotometry or AAS (APHA 1977; NIOSH 1984).

Methods standardized by the EPA for measuring total arsenic in water and waste water, solid wastes, soil, and sediments include: ICP-MS (EPA 1998j, 1994a, 1991), ICP-AES (EPA 1996d), graphite furnace AAS (EPA 1994b), quartz furnace hydride generation AAS (EPA 1996h), and an electrochemical method using anodic stripping voltammetry (ASV) (EPA 1996e). A modification using cryogenic GC to EPA Method 1632 (HG/AAS) allows the technique to be adopted for the species As(III), As(V), MMA, and DMA to the 0.003 ppb level (EPA 1998l). Similar methods are recommended by APHA for water using AAS/hydride generation (APHA 1989c), AAS/graphite furnace technique (APHA 1989b), ICP (APHA 1989d), or SDDC spectrophotometry (APHA 1989a). The AAS/hydride generation method is generally resistant to matrix and chemical interferences (APHA 1989a). Techniques to compensate for these interferences have been described by EPA (1982b).

Analysis for arsenic in foods is also most frequently accomplished by AAS techniques (Arenas et al. 1988; Dabeka and Lacroix 1987; Hershey et al. 1988; Tam and Lacroix 1982). Hydride generation is the sample preparation method most often employed (Arenas et al. 1988; Hershey et al. 1988), but interferences must be evaluated and minimized.

Speciation of inorganic arsenic in environmental samples is usually accomplished by chromatographic separation, chelation-extraction or elution of As(III), and then reduction of As(V) with subsequent similar treatment (Butler 1988; López-Gonzálvez et al. 1994; Mok et al. 1988; Rabano et al. 1989).

Methods are also available for quantifying organic arsenicals in environmental media, including arsenobetaine in fish (Beauchemin et al. 1988; Cannon et al. 1983) and other organic forms of arsenic in water, soil, and foods using hyphenated methods of separation and detection (HPLC/ICP-MS, HPLC/HGAAS, IC/ICP-MS) (Andreae 1977; Braman et al. 1977; Comber and Howard 1989; Crecelius 1978; Heitkemper et al. 1994; López-Gonzálvez et al. 1994; Odanaka et al. 1983; Teräsahde et al. 1996).

Methods have been developed for extraction of arsenic species from solid seafood samples that included treatment of the sample with mixtures of organic solvents (alcohols or chloroform) and water to extract the arsenic compounds that are soluble in water or polar organic solvents. These extracts can be subsequently analyzed by HPLC. Enzymatic digestion using trypsin has also been used to extract arsenic compounds from seafood samples (Benramdane et al. 1999b). These extraction techniques are used in place of digestion when speciated data are needed.

A summary of selected methods for analysis of total arsenic and individual inorganic and organic arsenic species in environmental samples is presented in Table 7-2.

7.3 ADEQUACY OF THE DATABASE

Section 104(i)(5) of CERCLA, as amended, directs the Administrator of ATSDR (in consultation with the Administrator of EPA and agencies and programs of the Public Health Service) to assess whether adequate information on the health effects of arsenic is available. Where adequate information is not available, ATSDR, in conjunction with NTP, is required to assure the initiation of a program of research designed to determine the health effects (and techniques for developing methods to determine such health effects) of arsenic.

Table 7-2. Analytical Methods for Determining Arsenic in Environmental Samples

Sample matrix	Preparation method	Analytical method	Sample detection limit	Percent recovery	Reference
Methods for total arsenic:					
Air (particulates)	Collection on cellulose ester membrane filter; digestion with nitric acid, sulfuric acid, and perchloric acid	NIOSH Method 7900; HGAAS	0.02 µg/sample	No data	NIOSH 1994a
Air (particulate arsenic and arsenic trioxide vapor)	Collection on Na_2CO_3-impregnated cellulose ester membrane filter and H_2O_2	NIOSH Method 7901; GFAAS	0.06 µg/sample	No data	NIOSH 1994b
Air	Collection on cellulose ester membrane filter; digestion with nitric acid, sulfuric acid, and perchloric acid	NIOSH Method 7300; ICP-AES	0.140 µg/filter	No data	NIOSH 2003
Water/waste water/solid wastes	Acid digestion	EPA Method 6010C; ICP-AES	35 µg/L	86	EPA 2000c
Water/waste water/solid wastes	Digestion with nitric and hydrochloric acids	EPA Method 200.7; ICP-AES	8 µg/L	106	EPA 1994c
Water/soil/ solid waste	Digestion with nitric acid and hydrogen peroxide	EPA Methods 206.2 and 7060A; GFAAS with $Ni(NO_3)_2$ modifier	1 µg/L	85–106	EPA 1983b, 1994b
Water/waste water/solid waste	Digestion with nitric acid	EPA Methods 200.8, 6020 and 6020A ICP-MS	0.4 µg/L	97–114	EPA 1991, 1994a, 1998j
Water/soil/ solid waste	Digestion with nitric/sulfuric acid; reduction to As^{+3} with tin chloride; reduction to arsine with zinc in acid solution	EPA Method 206.3	2 µg/L	85–94	EPA 1983c
Water	Reduction to arsine in acid solution; reaction with SDDC	EPA Method 206.4; SDDC colorimetric spectrophoto-metry at 510 nm	10 µg/L	100	EPA 1983d
Water	Digestion with 6M HCl; reduction to arsine with sodium borohydride; cold trap and desorption into quartz furnace	EPA Method 1632; HGAAS	2 ng/L	No data	EPA 1998l

Table 7-2. Analytical Methods for Determining Arsenic in Environmental Samples

Sample matrix	Preparation method	Analytical method	Sample detection limit	Percent recovery	Reference
Food	Digestion with nitric acid; dry ashing with magnesium oxide; reduction with ascorbic acid; precipitation with APDC in presence of nickel carrier	GFAAS	10 ng	86–107	Dabeka and Lacroix 1987
Food	Digestion with nitric/sulfuric/ perchloric acids; reduction to trivalent arsenic with potassium iodide; reduction to arsine with sodium borohydride	HGAAS	0.1 µg/g	98–110	Hershey et al. 1988
Soil, rock, coal	Preparation of pellet	XRF (backscatter)	4 mg/kg	SRM recoveries: 110±4 in soil; 100±1in rock; 97±18 in coal	Nielson and Sanders 1983
Methods for species of arsenic:					
Air (particulate organo-arsenals)	Collection on PTFE filter	NIOSH Method 5022; ion chromatography/HGAAS	0.2 µg As/sample	No data	NIOSH 1994c
Air (arsine)	Collection on coconut shell charcoal; digestion with nitric acid	NIOSH Method 6001; GFAAS	0.004 µg/sample	No data	NIOSH 1994d
Air particulates (As^{+3} and As^{+5} only)	Collection on PFTE filter in high volume dichotomous virtual impactor; desorption with ethanolic hydrochloric acid; selective reduction of As^{+3} to arsine with zinc in acid and reduction of As^{+5} to arsine with sodium tetrahydrodiborate	HGAAS	1 ng/m^3	95±7 (As^{+3}); 100±8 (As^{+5}) on spiked materials	Rabano et al. 1989
Water	Selective elution of As^{+3} with orthophosphoric acid; elution and conversion of As^{+5} to As^{+3} with sulfur dioxide	IEC/amperometric detector (detects As^{+3} only)	0.9 µg/L	95% of converted As^{+5} recovered	Butler 1988
Water/soil	Selective complexation of As^{+5} with ammonium molybdate; extraction with isoamyl alcohol to separate from As^{+3}	Colorimetric spectrometry at 712 nm	No data	No data	Brown and Button 1979

Table 7-2. Analytical Methods for Determining Arsenic in Environmental Samples

Sample matrix	Preparation method	Analytical method	Sample detection limit	Percent recovery	Reference
Water	Selective extraction of As^{+3} with APDC into chloroform; back extraction with nitric acid; reduction of As^{+5} to As^{+3} with thiosulfate and extract	NAA	0.01 ppb	No data	Braman et al. 1977
Food (arseno-betaine in fish)	Extraction of arsenobetaine with methanol/chloroform; digestion with nitric acid/ magnesium nitrate for remainder of As species	HPLC/ICP-MS	0.3 ng as arsenobetaine	101±4 recovery of arseno-betaine	Beauchemin et al. 1988
Water/waste water/soil (inorganic species)	Acidification or digestion with hydrochloric acid	EPA Method 7063; ASV	0.1 µg/L	96–102	EPA 1996e
Water (As(III), As(V), MMA, and DMA)	Cryogenic GC, Digestion with 6M HCl; reduction to arsine with sodium boro-hydride; cold trap and desorption into quartz furnace	EPA Method 1632 appendix; HGAAS	3 ng/L	No data	EPA 1998l
Water	Reduction to arsines; cold trap and selectively warm to separate arsine species	AAS	2 ng/L	91–109	Andreae 1977
Water	Reduction of MMA, DMA and inorganic As (control pH to select As^{+3} or As^{+5}) to arsines with sodium tetra-hydroborate; cold trap and selectively warm to separate arsine species	HGAAS	0.019–0.061 ng	No data	Comber and Howard 1989
Water/soil	Extraction with sodium bicarbonate; reduction of inorganic arsenic, MMA and DMA to hydrides with sodium borohydride; cold trap arsines in n-heptane	HG-HCT/GC-MID	0.2–0.4 µg/L	97–102	Odanaka et al. 1983

AAS = atomic absorption spectrophotometry; APDC = ammonium pyrrolidine dithiocarbamate; ASV = anodic stripping voltammetry; DMA = dimethylarsinate; EPA = Environmental Protection Agency; GC-MID = gas chromatography-multiple ion detection; GFAAS = graphite furnace atomic absorption spectrometry; HGAAS=hydride generation-atomic absorption spectroscopy; HG-HCT = hydride generation-heptane cold trap; HPLC = high performance liquid chromatography; ICP-AES = inductively coupled plasma-atomic emission spectrometry; ICP-MS = inductively coupled plasma-mass spectrometry; IEC = ion exchange chromatography; MMA = monomethylarsonate; NAA = neutron activation analysis; NIOSH = National Institute of Occupational Safety and Health; PTFE = polytetrafluoroethylene; SDDC = silver diethyldithiocarbamate; SRM = standard reference material; XRF = x-ray fluorescence

The following categories of possible data needs have been identified by a joint team of scientists from ATSDR, NTP, and EPA. They are defined as substance-specific informational needs that if met would reduce the uncertainties of human health assessment. This definition should not be interpreted to mean that all data needs discussed in this section must be filled. In the future, the identified data needs will be evaluated and prioritized, and a substance-specific research agenda will be proposed.

7.3.1 Identification of Data Needs

Methods for Determining Biomarkers of Exposure and Effect. The most common biomarker for arsenic exposure is analysis of total arsenic in urine (Hughes 2006). Existing methods are sufficiently sensitive to measure background levels of arsenic in various tissues and biological fluids for average persons, and to detect increases as a result of above-average exposure (Agahian et al. 1990; Clyne et al. 1989; Curatola et al. 1978; Foà et al. 1984; Gebel et al. 1998b; Landsberger and Simsons 1987; Mushak et al. 1977; Pinto et al. 1976; Valentine et al. 1979; Versieck et al. 1983). The precision and accuracy of these methods are documented. Methods are also available that can distinguish nontoxic forms of arsenic (arsenobetaine) from inorganic and organic derivatives that are of health concern (Braman et al. 1977; Dix et al. 1987; Johnson and Farmer 1989; Norin and Vahter 1981; Tam et al. 1982). Further efforts to improve accuracy, reduce interferences, and detect multiple species using a single analysis would be valuable. Arsenic is believed to act by inhibition of numerous cellular and molecular processes. However, these effects are not specific to arsenic, and most can only be measured in tissue extracts.

Methods for Determining Parent Compounds and Degradation Products in Environmental Media. Arsenic is ubiquitous in the environment. It is found in air, water, soil, sediments, and food in several inorganic and organic forms. Analytical methods exist for the analysis of arsenic species in all of these environmental media, and these methods have the sensitivity to measure background levels and to detect elevated concentrations due to emissions from sources such as smelters, chemical plants, or hazardous waste sites (APHA 1977, 1989c; EPA 1982b, 1983b, 1983c, 1983d, 1991, 1994b, 1994c, 1996f, 1996h, 1998j, 2000c; NIOSH 1994a, 1994b, 2003). However, further research to reduce chemical and matrix interferences may improve the speed and accuracy of the analyses.

Le et al. (2004) pointed out that there is a need for the development of certified reference materials (CRMs) for speciation analysis. A shortcoming of many CRMs is that they are only certified for the total concentration of arsenic, and only limited information is available on the identity and concentrations of specific arsenic species in some CRMs.

Continued improvement of the methods for determination of the particular species of arsenic, rather than just the total arsenic concentration, present in foods, especially seafood, is needed since different arsenic species poses different hazards to individuals consuming these foods.

7.3.2 Ongoing Studies

The information in Table 7-3 was found as a result of a search of the Federal Research in Progress database (FEDRIP 2006).

Table 7-3. Ongoing Studies on Analytical Methods for Arsenic in Environmental and Biological Samples

Investigator	Affiliation	Research description	Sponsor
Styblo, M	University of North Carolina Chapel Hill, Chapel Hill, North Carolina	Optimized hydride generation system for arsenic analysis	Fogarty International Center
Dietze, WT	Tracedetect, Inc., Seattle, Washington	A continuous monitor for arsenic in drinking water	NIEHS
Dasgupta, PK	Texas Tech University, Department of Chemistry, Lubbock, Texas	A green fieldable analyzer for arsenic	NSF

NIEHS = National Institute of Environmental Health Sciences; NSF = National Science Foundation

Source: FEDRIP 2006

8. REGULATIONS AND ADVISORIES

The international and national regulations and guidelines pertaining to arsenic and its metabolites in air, water, and other media are summarized in Table 8-1.

ATSDR has not derived inhalation MRLs or an intermediate-duration oral MRL for inorganic arsenic, or any MRLs for organic arsenic, due to lack of suitable data.

ATSDR has derived an acute-duration oral MRL for inorganic arsenic of 0.005 mg As/kg/day based on a LOAEL of 0.05 mg As/kg/day for gastrointestinal effects and facial edema in Japanese people who ingested arsenic-contaminated soy sauce for 2–3 weeks (Mizuta et al. 1956). An uncertainty factor of 10 (10 for use of a LOAEL and 1 for human variability) was applied.

ATSDR has derived a chronic-duration oral MRL of 0.0003 mg/kg/day for inorganic arsenic based on a NOAEL of 0.0008 mg As/kg/day for dermal effects in a Taiwanese farming population exposed to arsenic in well water (Tseng 1977; Tseng et al. 1968). An uncertainty factor of 3 (for human variability) was applied.

EPA (IRIS 2007) has derived a chronic oral reference dose (RfD) of 0.0003 mg As/kg/day for inorganic arsenic, based on a NOAEL of 0.0008 mg As/kg/day for dermal effects and possible vascular complications in a Taiwanese farming population exposed to arsenic in well water (Tseng 1977; Tseng et al. 1968). An uncertainty factor of 3 (to account for the lack of reproductive data and uncertainty in whether the NOAEL accounts for all sensitive individuals) was applied. No reference concentration (RfC) for chronic inhalation exposures to arsenic was reported. EPA is currently revising the assessment for inorganic arsenic.

The Department of Health and Human Services (DHHS) has determined that inorganic arsenic is known to be a human carcinogen (NTP 2005). The EPA has determined that inorganic arsenic is a human carcinogen and has assigned it the cancer classification, Group A (IRIS 2007). EPA's quantitative estimates of carcinogenic risk from oral exposures include a cancer slope factor of 1.5 mg/kg/day and a drinking water unit risk of $5x10^{-5}$ µg/L. The inhalation unit risk for cancer is 0.0043 µg/m^3 (IRIS 2007).

Table 8-1. Regulations and Guidelines Applicable to Arsenic and Arsenic Compounds

Agency	Description	Information	Reference
INTERNATIONAL			
Guidelines:			
IARC	Carcinogenicity classification for arsenic and arsenic compounds	Group 1[a]	IARC 2004
WHO	Air quality guidelines	$1.5x10^{-3}$ unit risk[b]	WHO 2000
	Drinking water quality guidelines for arsenic	0.01 mg/L[c]	WHO 2004
NATIONAL			
Regulations and Guidelines:			
a. Air			
ACGIH	TLV (TWA) for arsenic and inorganic compounds	0.01 mg/m^3	ACGIH 2004
EPA	Hazardous air pollutant (arsenic and inorganic compounds, including arsine)	Yes	EPA 2004b 42 USC 7412
NIOSH	REL (15-minute ceiling limit) for arsenic and inorganic compounds[d]	0.002 mg/m^3	NIOSH 2005a
	IDLH for arsenic and inorganic compounds[d]	5 mg/m^3	
OSHA	PEL (8-hour TWA) for general industry for arsenic organic compounds	0.5 mg/m^3	OSHA 2005d 29 CFR 1910.1000
	PEL (8-hour TWA) for general industry for arsenic inorganic compounds	10 $\mu g/m^3$	OSHA 2005c 29 CFR 1910.1018
	PEL (8-hour TWA) for construction industry for arsenic organic compounds	0.5 mg/m^3	OSHA 2005b 29 CFR 1926.55
	PEL (8-hour TWA) for shipyard industry for arsenic organic compounds	0.5 mg/m^3	OSHA 2005a 29 CFR 1915.1000
b. Water			
EPA	Designated as hazardous substances in accordance with Section 311(b)(2)(A) of the Clean Water Act	Yes	EPA 2005d 40 CFR 116.4
	Arsenic pentoxide, arsenic trioxide, calcium arsenate, and sodium arsenite		
	Drinking water standards and health advisories for arsenic		EPA 2004a
	DWEL	0.01 mg/L	
	National primary drinking water standards for arsenic		EPA 2002a
	MCLG	Zero	
	MCL	0.01 mg/L[e]	
	Reportable quantities of hazardous substances designated pursuant to Section 311 of the Clean Water Act		EPA 2005e 40 CFR 117.3
	Arsenic pentoxide, arsenic trioxide, calcium arsenate, sodium arsenite	1 pound	

Table 8-1. Regulations and Guidelines Applicable to Arsenic and Arsenic Compounds

Agency	Description	Information	Reference
NATIONAL *(cont.)*			
EPA	Water quality criteria for human health consumption of arsenic:		EPA 2002b
	Water + Organism	0.018 µg/L[f]	
	Organism only	0.14 µg/L[f]	
c. Food			
EPA	Tolerances for residues		
	Dimethylarsinic acid		EPA 2005i 40 CFR 180.311
	Cotton (undelinted seed)	2.8 ppm	
	Methanearsonic acid		EPA 2005j 40 CFR 180.289
	Cotton (undelinted seed)	0.7 ppm	
	Cotton, hulls	0.9 ppm	
	Fruit, citrus	0.35 ppm	
FDA	Bottled drinking water	0.01 mg/L	FDA 2005 21 CFR 165.110
USDA	Nonsynthetic substances prohibited for use in organic crop production	Arsenic	USDA 2004 7 CFR 205.602
d. Other			
ACGIH	Carcinogenicity classification for arsenic and arsenic compounds	A1[g]	ACGIH 2004
	Biological exposure indices for inorganic arsenic plus methylated metabolites in urine at the end of the workweek	35 µg As/L	
EPA	Carcinogenicity classification	Group A[i]	IRIS 2007
	Oral slope factor	1.5 per mg/kg/day	
	Inhalation unit risk	4.3×10^{-3} per µg/m^3	
	RfC	No data	
	RfD	3×10^{-4} mg/kg/day	
	Superfund, emergency planning, and community right-to-know		
	Designated CERCLA hazardous substance		EPA 2005f 40 CFR 302.4
	Reportable quantity		
	Arsenic	Not applicable[j]	
	Arsenic acid, arsenic pentoxide, arsenic trioxide, calcium arsenate, dimethylarsinic acid, and sodium arsenite	1 pound	
	Effective date of toxic chemical release reporting for arsenic	01/01/87	EPA 2005h 40 CFR 372.65

Table 8-1. Regulations and Guidelines Applicable to Arsenic and Arsenic Compounds

Agency	Description	Information	Reference
NATIONAL *(cont.)*			
EPA	Superfund, emergency planning, and community right-to-know		
	Extremely hazardous substances		EPA 2005g 40 CFR 355, Appendix A
	Reportable quantity		
	Arsenic pentoxide, calcium arsenate, and sodium arsenite	1 pound	
	Threshold planning quantities		
	Arsenic pentoxide	100/10,000 pounds	
	Calcium arsenate and sodium arsenite	500/10,000 pounds	
NTP	Carcinogenicity classification	Known human carcinogen	NTP 2005

[a]Group 1: carcinogenic to humans
[b]Cancer risk estimates for lifetime exposure to a concentration of 1 µg/m3.
[c]Provisional guideline value: as there is evidence of a hazard, but the available information on health effects is limited.
[d]NIOSH potential occupational carcinogen
[e]MCL will become effective on 01/23/06.
[f]This criterion is based on carcinogenicity of 10^{-6} risk.
[g]A1: confirmed human carcinogen
[h]A3: confirmed animal carcinogen with unknown relevance to humans
[i]Group A: known human carcinogen
[j]Indicates that no reportable quantity is being assigned to the generic or broad class.

ACGIH = American Conference of Governmental Industrial Hygienists; CERCLA = Comprehensive Environmetnal Response, Compensation, and Liability Act; CFR = Code of Federal Regulations; DWEL = drinking water equivalent level; EPA = Environmental Protection Agency; FDA = Food and Drug Administration; IARC = International Agency for Research on Cancer; IDLH = immediately dangerous to life or health; IRIS = Integrated Risk Information System; MCL = maximum contaminant level; MCLG = maximum contaminant level goal; NAS/NRC = National Academy of Sciences/National Research Council; NIOSH = National Institute for Occupational Safety and Health; NTP = National Toxicology Program; OSHA = Occupational Safety and Health Administration; PEL = permissible exposure limit; REL = recommended exposure limit; RfC = inhalation reference concentration; RfD = oral reference dose; TLV = threshold limit values; TWA = time-weighted average; USC = United States Code; USDA = United States Department of Agriculture; WHO = World Health Organization

EPA is currently revising the assessment for inorganic arsenic. The International Agency for Research on Cancer (IARC) cites sufficient evidence of a relationship between exposure to arsenic and human cancer. IARC classification of arsenic is Group 1 (IARC 2004). The American Conference of Governmental Industrial Hygienists (ACGIH) classifies arsenic (elemental and inorganic compound) as a confirmed human carcinogen, cancer category A1 (ACGIH 2004).

ATSDR has derived an intermediate-duration oral MRL of 0.1 mg MMA/kg/day for MMA based on a $BMDL_{10}$ of 12.38 mg MMA/kg/day for diarrhea observed in rats exposed to MMA in the diet for 13 weeks (Arnold et al. 2003) and an uncertainty factor of 100 (10 for animal to human extrapolation and 10 for human variability).

ATSDR has derived a chronic-duration oral MRL of 0.01 mg MMA/kg/day for MMA based on a $BMDL_{10}$ of 1.09 mg MMA/kg/day for increased incidence of progressive nephropathy in male mice exposed to MMA in the diet for 2 years (Arnold et al. 2003) and an uncertainty factor of 100 (10 for animal to human extrapolation and 10 for human variability).

ATSDR has derived a chronic-duration oral MRL of 0.02 mg DMA/kg/day for DMA based on a $BMDL_{10}$ of 1.80 mg DMA/kg/day for increased vacuolization of the urothelium in the urinary bladder of female mice exposed to DMA in the diet for 2 years (Arnold et al. 2006) and an uncertainty factor of 100 (10 for animal to human extrapolation and 10 for human variability).

EPA has not derived RfD values for organic arsenicals (IRIS 2007).

This page is intentionally blank.

9. REFERENCES

Abernathy CO, Chappell WR, Meek ME, et al. 1996. Is ingested inorganic arsenic a "threshold" carcinogen? Fundam Appl Toxicol 29(2):168-175.

ACGIH. 2004. Arsenic. Threshold limit values for chemical substances and physical agents and biological exposure indices. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

*Ademuyiwa O, Elsenhans B, Nguyen PT, et al. 1996. Arsenic-copper interaction in the kidney of the rat: Influence of arsenic metabolites. Pharmacol Toxicol 78(3):154-160.

Adinolfi M. 1985. The development of the human blood-CSF-brain barrier. Dev Med Child Neurol 27(4):532-537.

Adlercreutz H. 1995. Phytoestrogens: Epidemiology and a possible role in cancer protection. Environ Health Perspect Suppl 103(7):103-112.

Adobe Lumber. 2002. Consumer information sheet for CCA pressure treated lumber. Adobe Lumber. http://www.adobelumber.com/ccaconsumer.shtml. August 27, 2007.

Adonis M, Martinez V, Marin P, et al. 2005. CYP1A1 and GSTM1 genetic polymorphisms in lung cancer populations exposed to arsenic in drinking water. Xenobiotica 35(5):519-530.

Agahian B, Lee JS, Nelson JH, et al. 1990. Arsenic levels in fingernails as a biological indicator of exposure to arsenic. Am Ind Hyg Assoc J 51(12):646-651.

Agency for Toxic Substances and Disease Registry. 1989. Agency for Toxic Substances and Disease Registry. Decision guide for identifying substance-specific data needs related to toxicological profiles; Notice. Federal Register 54(174):37618-37634.

Agency for Toxic Substances and Disease Registry. 1990a. Arsenic toxicity. Case studies in environmental medicine. Atlanta, GA: Agency for Toxic Substances and Disease Registry, U.S. Department of Health & Human Services, Public Health Services. HE20.7917:5 504-U.

Agency for Toxic Substances and Disease Registry. 1990b. Biomarkers of organ damage or dysfunction for the renal, hepatobiliary, and immune systems. Atlanta, GA: Subcommittee on Biomarkers of Organ Damage and Dysfunction, Agency for Toxic Substances and Disease Registry.

Aguilar MV, Martínez-Para MC, Gonzalez MJ. 1997. Effects of arsenic (V)-chromium (III) interaction on plasma glucose and cholesterol levels in growing rats. Ann Nutr Metab 41(3):189-195.

Ahmad S, Anderson WL, Kitchin KT. 1999a. Dimethylarsinic acid effects on DNA damage and oxidative stress related biochemical parameters in B6C3F_1 mice. Cancer Lett 139(2):129-135.

---

*Not cited in profile

Ahmad SA, Bandaranayake D, Khan AW, et al. 1997. Arsenic contamination in ground water and arsenicosis in Bangladesh. Int J Environ Health Res 7(4):271-276.

Ahmad SA, Sayed MH, Barua S, et al. 2001. Arsenic in drinking water and pregnancy outcomes. Environ Health Perspect 109(6):629-631.

Ahmad SKA, Sayed MHSU, Hadi SA, et al. 1999b. Arsenicosis in a village in Bangladesh. Int J Environ Health Res 9(3):187-195.

Ahsan H, Chen Y, Parvez F, et al. 2006. Arsenic exposure from drinking water and risk of premalignant skin lesions in Bangladesh: Baseline results from the health effects of arsenic longitudinal study. Am J Epidemiol 163(12):1138-1148.

Ahsan H, Perrin M, Rahman A, et al. 2000. Associations between drinking water and urinary arsenic levels and skin lesions in Bangladesh. J Occup Environ Med 42(12):1195-1205.

Akkari KH, Frans RE, Lavy TL. 1986. Factors affecting degradation of MSMA in soil. Weed Sci 34:781-787.

Alain G, Tousignant J, Rozenfarb E. 1993. Chronic arsenic toxicity. Int J Dermatol 32(12):899-901.

Albores A, Cebrian ME, Bach PH, et al. 1989. Sodium arsenite induced alterations in bilirubin excretion and heme metabolism. J Biochem Toxicol 4(2):73-78.

Albores A, Koropatnick J, Cherian MG, et al. 1992. Arsenic induces and enhances rat hepatic metallothionein production *in vivo*. Chem Biol Interact 85:127-140.

Almela C, Algora S, Benito V, et al. 2002. Heavy metal, total arsenic, and inorganic arsenic contents of algae food products. J Agric Food Chem 50:918-923.

Altman PK, Dittmer DS. 1974. In: Biological handbooks: Biology data book. Vol. III, 2nd ed. Bethesda, MD: Federation of American Societies for Experimental Biology, 1987-2008, 2041.

Amacher DE, Paillet SC. 1980. Induction of trifluorothymidine-resistant mutants by metal ions in L5178Y/TK$^{*/-}$ cells. Mutat Res 78:279-288.

American Wood Preservers Association. 2007. FAQ's: Treated wood uses. American Wood Preserver's Association. http://www.awpa.com/references/faq.asp#uses. August 28, 2007.

Andersen ME, Krishnan K. 1994. Relating *in vitro* to *in vivo* exposures with physiologically-based tissue dosimetry and tissue response models. In: Salem H, ed. Animal test alternatives: Refinement, reduction, replacement. New York: Marcel Dekker, Inc., 9-25.

Andersen ME, Clewell HJ, Gargas ML, et al. 1987. Physiologically-based pharmacokinetics and the risk assessment process for methylene chloride. Toxicol Appl Pharmacol 87:185-205.

Anderson LCD, Bruland KW. 1991. Biogeochemistry of arsenic in natural waters: The importance of methylated species. Environ Sci Technol 25:420-427.

Anderson HA, Falk C, Hanrahan L, et al. 1998. Profiles of Great Lakes critical pollutants: A sentinel analysis of human blood and urine. Environ Health Perspect 106(5):279-289.

Andreae MO. 1977. Determination of arsenic species in natural waters. Anal Chem 49(6):820-823.

APHA. 1977. Tentative method of analysis for arsenic content of atmospheric particulate matter. In: Kate M, ed. Methods of air sampling and analysis. Washington, DC: American Public Health Association, 435-438.

APHA. 1989a. Arsenic. In: Clesceri LS, Greenberg AE, Trussell RR, eds. Standard methods for the examination of water and wastewater. 17th ed. Washington, DC: American Public Health Association, 3-74-3-78.

APHA. 1989b. Metals by electrothermal atomic absorption spectrometry. In: Clesceri LS, Greenberg AE, Trussell RR, eds. Standard methods for the examination of water and wastewater. 17th ed. Washington, DC: American Public Health Association, 3-32-3-50.

APHA. 1989c. Metals by hydride generation/atomic absorption spectrometry. In: Clesceri LS, Greenberg AE, Trussell RR, eds. Standard methods for the examination of water and wastewater. 17th ed. Washington, DC: American Public Health Association, 3-43-3-50.

APHA. 1989d. Metals by plasma emission spectrometry. In: Clesceri LS, Greenberg AE, Trussell RR, eds. Standard methods for the examination of water and wastewater. 17th ed. Washington, DC: American Public Health Association, 3-53-3-78.

Aposhian HV. 1989. Biochemical toxicology of arsenic. Rev Biochem Toxicol 10:265-299.

*Aposhian HV. 1998. Mobilization of mercury and arsenic in humans by sodium 2,3-dimercapto-1-propane sulfonate (DMPS). Environ Health Perspect Suppl 106(4):1017-1025.

Aposhian HV, Arroyo A, Cebrian ME, et al. 1997. DMPS-arsenic challenge test. I: Increased urinary excretion of monomethylarsonic acid in humans given dimercaptopropane sulfonate. J Pharmacol Exp Ther 282(1):192-200.

Aposhian HV, Gurzau ES, Le XC, et al. 2000a. Occurrence of monomethylarsonous acid in urine of humans exposed to inorganic arsenic. Chem Res Toxicol 13(8):693-697.

Aposhian HV, Zheng B, Aposhian MM, et al. 2000b. DMPS-arsenic challenge test. 11. Modulation of arsenic species, including monomethylarsonous acid (MMA)(111), excreted in human urine. Toxicol Appl Pharmacol 165(1):74-83.

*Apostoli P, Alessio L, Romeo L, et al. 1997. Metabolism of arsenic after acute occupational arsine intoxication. J Toxicol Environ Health 52(4):331-342.

Apostoli P, Bartoli D, Alessio L, et al. 1999. Biological monitoring of occupational exposure to inorganic arsenic. Occup Environ Med 56(12):825-832.

Aranyi C, Bradof JN, O'Shea WJ, et al. 1985. Effects of arsenic trioxide inhalation exposure on pulmonary antibacterial defenses in mice. J Toxicol Environ Health 15:163-172.

*Arbouine MW, Wilson HK. 1992. The effect of seafood consumption on the assessment of occupational exposure to arsenic by urinary arsenic speciation measurements. J Trace Elem Electrolytes Health Dis 6(3):153-160.

Arenas V, Stoeppler M, Bergerhoff G. 1988. Arsenic determination in the ultratrace range by atomic absorption spectrometry after preconcentration of the hydride. Fresenius Z Anal Chem 332:447-452.

*Armbrust KL, Bridges DC. 2002. Dissipation of monosodium methane arsonate (MSMA) on peanuts. J Agric Food Chem 50(7):1959-1963

Armienta MA, Rodriguez R, Cruz O. 1997. Arsenic content in hair of people exposed to natural arsenic polluted groundwater at Zimapan, Mexico. Bull Environ Contam Toxicol 59:583-589.

Armstrong CW, Stroube RB, Rubio T, et al. 1984. Outbreak of fatal arsenic poisoning caused by contaminated drinking water. Arch Environ Health 39(4):276-279.

Arnold LL, Cano M, St. John M, et al. 1999. Effects of dietary dimethylarsinic acid on the urine and urothelium of rats. Carcinogenesis 20(11):2171-2179.

Arnold LL, Eldan M, Nyska A, et al. 2006. Dimethylarsinic acid: Results of chronic toxicity/oncogenicity studies in F344 rats and B6C3F1 mice. Toxicology 223(1-2):82-100.

Arnold LL, Eldan M, van Gemert M, et al. 2003. Chronic studies evaluating the carcinogenicity of monomethylarsonic acid in rats and mice. Toxicology 190:197-219.

Aschengrau A, Zierler S, Cohen A. 1989. Quality of community drinking water and the occurrence of spontaneous abortion. Arch Environ Health 44(5):283-290.

Aurillo AC, Mason RP, Hemond HF. 1994. Speciation and fate of arsenic in three lakes of the Aberjona Watershed. Environ Sci Tech 28(4):577-585.

Axelson O, Dahlgren E, Jansson C-D, et al. 1978. Arsenic exposure and mortality: A case referent study from a Swedish copper smelter. Br J Ind Med 35:8-15.

Azcue JM, Nriagu JO. 1994. Arsenic: Historical perspectives. In: Nriagu JO, ed. Arsenic in the Environment, part 1: Cycling and characterization. New York, NY: John Wiley and Sons, Inc., 1-15.

Babich H, Martin-Alguacil N, Borenfreund E. 1989. Arsenic-selenium interactions determined with cultured fish cells. Toxicol Lett 45:157-164.

Bagla P, Kaiser J. 1996. India's spreading health crisis draws global arsenic experts. Science 274(5285):174-175.

Baker BA, Topliff AR, Messing RB, et al. 2005. Persistent neuropathy and hyperkeratosis from distant arsenic exposure. J Agromedicine 10(4):43-54.

*Baker EL, Hayes CG, Landrigan PJ, et al. 1977. A nationwide survey of heavy metal absorption in children living near primary copper, lead, and zinc smelters. Am J Epidemiol 106(4):261-273.

Baker LW, Fitzell DL, Seiber JN, et al. 1996. Ambient air concentrations of pesticides in California. Environ Sci Tech 30(4):1365-1368.

*Barbaud A, Mougeolle JM, Schmutz JL. 1995. Contact hypersensitivity to arsenic in a crystal factory worker. Contact Dermatitis 33(4):272-273.

Barbey JT, Pezzullo JC, Soignet SL. 2003. Effect of arsenic trioxide on QT interval in patients with advanced malignancies. J Clin Oncol 21(19):3609-15.

Barnes DG, Dourson M. 1988. Reference dose (RfD): Description and use in health risk assessments. Regul Toxicol Pharmacol 8:471-486.

Baroni C, van Esch GJ, Saffiotti U. 1963. Carcinogenic tests of two inorganic arsenicals. Arch Environ Health 7:668-674.

Bartolome B, Cordoba S, Nieto S, et al. 1999. Acute arsenic poisoning: Clinical and histopathological features. Br J Dermatol 141:1106-1109.

Barton EN, Gilbert DT, Raju K, et al. 1992. Arsenic: The forgotten poison? West Indian Med J 41(1):36-38.

Bashir S, Sharma Y, Irshad M, et al. 2006. Arsenic induced apoptosis in rat liver following repeated 60 days exposure. Toxicology 217(1):63-70.

Basu A, Ghosh P, Das JK, et al. 2004. Micronuclei as biomarkers of carcinogen exposure in populations exposed to arsenic through drinking water in West Bengal, India: A comparative study in three cell types. Cancer Epidemiol Biomarkers Prev 13(5):820-827.

Bates MN, Rey OA, Biggs ML, et al. 2004. Case-control study of bladder cancer and exposure to arsenic in Argentina. Am J Epidemiol 159(4):381-389.

*Bates MN, Smith AH, Cantor KP. 1995. Case-control study of bladder cancer and arsenic in drinking water. Am J Epidemiol 141(6):523-530.

Battista G, Bartoli D, Iaia TE, et al. 1996. Art glassware and sinonasal cancer: Report of three cases. Am J Ind Med 30(1):31-35.

Baxley MN, Hood RD, Vedel GC, et al. 1981. Prenatal toxicity of orally administered sodium arsenite in mice. Bull Environ Contam Toxicol 26:749-756.

Beane Freeman LE, Dennis LK, Lynch CF, et al. 2004. Toenail arsenic content and cutaneous melanoma in Iowa. Am J Epidemiol 160(7):679-687.

Beauchemin D, Bednas ME, Berman SS, et al. 1988. Identification and quantitation of arsenic species in a dogfish muscle reference material for trace elements. Anal Chem 60:2209-2212.

Beaudoin AR. 1974. Teratogenicity of sodium arsenate in rats. Teratology 10:153-158.

Beck BD, Boardman PD, Hook GC, et al. 1995. Response to Smith et al. Arsenic risk assessment. Environ Health Perspect 103:15-17.

Beckett WS, Moore JL, Keogh JP, et al. 1986. Acute encephalopathy due to occupational exposure to arsenic. Br J Ind Med 43:66-67.

Beckman L, Nordenson I. 1986. Interaction between some common genotoxic agents. Hum Hered 36:397-401.

Beckman G, Beckman L, Nordenson I. 1977. Chromosome aberrations in workers exposed to arsenic. Environ Health Perspect 19(5-6):145-146.

Beerman DH. 1994. Growth regulators (animal). In: Kroschwitz JI, Howe-Grant M, eds. Kirk-Othmer encyclopedia of chemical technology. Vol. 12. New York, NY: John Wiley and Sons, 795-815.

Bekemeier H, Hirschelmann R. 1989. Reactivity of resistance blood vessels ex vivo after administration of toxic chemicals to laboratory animals: Arteriolotoxicity. Toxicol Lett 49:49-54.

Bencko V. 2005. Hair and exposure to environmental pollutants. In: Tobin DJ, eds. Hair in toxicology: An important bio-marker. Cambridge, MA: RSC Publishing, 159-174.

Bencko V, Symon K. 1977. Health aspects of burning coal with a high arsenic content 1. Arsenic in hair, urine, and blood in children residing in a polluted area. Environ Res 13:378-385.

Bencko V, Franek P, Rames J. 2005. Non-melanoma skin and lung cancer incidence in relation to arsenic exposure: 20 years of observation. In: Edler L, Kitsos CP, eds. Recent advances in quantitative methods in cancer and human health risk assessment. West Sussex, England: John Wiley & Sons, 383-394.

Bencko V, Geist T, Arbetová D, et al. 1986. Biological monitoring of environmental pollution and human exposure to some trace elements. J Hyg Epidemiol Microbiol Immunol 30(1):1-10.

Bencko V, Symon K, Chlader V, et al. 1977. Health aspects of burning coal with a high arsenic content II. Hearing changes in exposed children. Environ Res 13:386-395.

Bencko V, Symon K, Stalnik L, et al. 1980. Rate of malignant tumor mortality among coal burning power plant workers occupationally exposed to arsenic. J Hyg Epidemiol Microbiol Immunol 24(3):278-284.

Bencko V, Wagner V, Wagnerová M, et al. 1988. Immunological profiles in workers of a power plant burning coal rich in arsenic content. J Hyg Epidemiol Microbiol Immunol 32:137-146.

*Bennett BG. 1986. Exposure assessment for metals involved in carcinogenesis. IARC Sci Publ 71(8):115-127.

Benramdane L, Accominotti M, Fanton L, et al. 1999a. Arsenic speciation in human organs following fatal arsenic trioxide poisoning--a case report. Clin Chem 45(2):301-306.

Benramdane L, Bressolle F, Vallon J-J. 1999b. Arsenic speciation in humans and food products: A review. J Chromatogr Sci 37:330-344.

Benson AA. 1989. Arsonium compounds in algae. Proc Natl Acad Sci USA 86:6131-6132.

Berg M, Tran HC, Nguyen TC, et al. 2001. Arsenic contamination of groundwater and drinking water in Vietnam: A human health threat. Environ Sci Technol 35(13):2621-2626.

Berger GS. 1994. Epidemiology of endometriosis. In: Berger GS, ed. Endometriosis: Advanced management and surgical techniques. New York, NY: Springer-Verlag, 3-7.

9. REFERENCES

*Berry MR, Johnson LS, Jones JW, et al. 1997. Dietary characterizations in a study of human exposures in the lower Rio Grande Valley: I. Foods and beverages. Environ Int 23(5):675-692.

Berti PR, Receveur O, Chan HM, et al. 1998. Dietary exposure to chemical contaminants from traditional food among adult dene/métis in the western Northwest territories, Canada. Environ Res A76:131-142.

Bertolero F, Pozzi G, Sabbioni E, et al. 1987. Cellular uptake and metabolic reduction of pentavalent to trivalent arsenic as determinants of cytotoxicity and morphological transformation. Carcinogenesis 8:803-808.

Bettley FR, O'Shea JA. 1975. The absorption of arsenic and its relation to carcinoma. Br J Dermatol 92:563-568.

Bhumbla DK, Keefer RF. 1994. Arsenic mobilization and bioavailability in soils. In: Nriagu JO, ed. Arsenic in the environment, part 1: Cycling and characterization. New York, NY: John Wiley & Sons, Inc., 51-82.

Bickley LK, Papa CM. 1989. Chronic arsenicism with vitiligo, hyperthyroidism, and cancer. N J Med 86(5):377-380.

*Biggs ML, Kalman DA, Moore LE, et al. 1997. Relationship of urinary arsenic to intake estimates and a biomarker of effect, bladder cell micronuclei. Mutat Res 386(3):185-195.

*Binder S, Forney D, Kaye W, et al. 1987. Arsenic exposure in children living near a former copper smelter. Bull Environ Contam Toxicol 39:114-121.

Bird MJ, MacIntosh DL, Williams PL. 2004. Occupational exposures during routine activities in coal-fueled power plants. J Occup Environ Hyg 1:403-413.

Biswas BK, Dhar RK, Samanta G, et al. 1998. Detailed study report of Samta, one of the arsenic-affected villages of Jessore District, Bangladesh. Curr Sci 74(2):134-145.

Biswas S, Talukder G, Sharma A. 1999. Prevention of cytotoxic effects of arsenic by short-term dietary supplementation with selenium in mice *in vivo*. Mutat Res 441:155-160.

Blakley BR. 1987. Alterations in urethan-induced adenoma formation in mice exposed to selenium and arsenic. Drug Nutr Interact 5:97-102.

Bloch P, Shapiro IM. 1986. An x-ray fluorescence technique to measure in situ the heavy metal burdens of persons exposed to these elements in the workplace. J Occup Med 28(8):609-614.

Blom S, Lagerkvist B, Linderholm H. 1985. Arsenic exposure to smelter workers: Clinical and neurophysiological studies. Scand J Work Environ Health 11:265-269.

Bodwell JE, Gosse JA, Nomikos AP, et al. 2006. Arsenic disruption of steroid receptor gene activation: Complex dose-response effects are shared by several steroid receptors. Chem Res Toxicol 19:1619-1629.

Bodwell JE, Kingsley LA, Hamilton JW. 2004. Arsenic at very low concentrations alters glucocorticoid receptor (GR)-mediated gene activation but not GR-mediated gene repression: Complex dose-response effects are closely correlated with levels of activated GR and require a functional GR DNA binding domain. Chem Res Toxicol 17:1064-1076.

Bolla-Wilson K, Bleecker ML. 1987. Neuropsychological impairment following inorganic arsenic exposure. J Occup Med 29(6):500-503.

Bolliger CT, van Zijl P, Louw JA. 1992. Multiple organ failure with the adult respiratory distress syndrome in homicidal arsenic poisoning. Respiration 59(1):57-61.

Bonnevie NL, Huntley SL, Found BW, et al. 1994. Trace metal contamination in surficial sediments from Newark Bay, New Jersey. Sci Total Environ 144:1-16.

Borgoño JM, Greiber R. 1972. Epidemiological study of arsenicism in the city of Antofagasta. Trace Subst Environ Health 5:13-24.

Borgoño JM, Venturino H, Vicent P. 1980. [Clinical and epidemiological study of arsenism in northern Chile.] Rev Med Chile 108:1039-1048. (Spanish).

*Börzsönyi M, Bereczky A, Rudnai P, et al. 1992. Epidemiological studies on human subjects exposed to arsenic in drinking water in southeast Hungary [letter]. Arch Toxicol 66(1):77-78.

Bourrain JL, Morin C, Béani JC, et al. 1998. Airborne contact dermatitis from cacodylic acid. Contact Dermatitis 38(6):364-365.

Boutwell RK. 1963. A carcinogenicity evaluation of potassium arsenite and arsanilic acid. Agric Food Chem 11:381-385.

Braman RS, Foreback CC. 1973. Methylated forms of arsenic in the environment. Science 182:1247-1249.

Braman RS, Johnson DL, Foreback CC, et al. 1977. Separation and determination of nanogram amounts of inorganic arsenic and methylarsenic compounds. Anal Chem 49(4):621-625.

*Braun W. 1958. Carcinoma of the skin and the internal organs caused by arsenic. German Med Monthly 3:321-324.

*Brenard R, Laterre PF, Reynaert M, et al. 1996. Increased hepatocytic mitotic activity as a diagnostic marker of acute arsenic intoxication: A report of two cases. J Hepato 25(2):218-220.

Brender JD, Suarez L, Felkner M, et al. 2006. Maternal exposure to arsenic, cadmium, lead, and mercury and neural tube defects in offspring. Environ Res 101(1):132-139.

Breslin VT, Adler-Ivanbrook L. 1998. Release of copper, chromium and arsenic from CCA-C treated lumber in estuaries. Estuarine Coastal Shelf Sci 46:111-125.

Brooks KM. 1996. Evaluating the environmental risks associated with the use of chromated copper arsenate-treated wood products in aquatic environments. Estuaries 19(2A):296-305.

Broomhall J, Kovar IZ. 1986. Environmental pollutants in breast milk. Rev Environ Health 6(1-4):311-337.

Brouwer OF, Onkenhout W, Edelbroek PM, et al. 1992. Increased neurotoxicity of arsenic in methylenetetrahydrofolate reductase deficiency. Clin Neurol Neurosurg 94(4):307-310.

Brown CC, Chu KC. 1982. Environmental epidemiology: Risk assessment: Proceedings of a conference. In: Prentice RL, Whittemore AS, eds. Philadelphia, PA: Society for Industrial and Applied Mathematics, 94-106.

Brown CC, Chu KC. 1983a. A new method for the analysis of cohort studies: Implications of the multistage theory of carcinogenesis applied to occupational arsenic exposure. Environ Health Perspect 50:293-308.

Brown CC, Chu KC. 1983b. Implications of the multistage theory of carcinogenesis applied to occupational arsenic exposure. J Natl Cancer Inst 70(3):455-463.

Brown EJ, Button DK. 1979. A simple method of arsenic speciation. Bull Environ Contam Toxicol 21:37-42.

Brown JL, Kitchin KT. 1996. Arsenite, but not cadmium, induces ornithine decarboxylase and heme oxygenase activity in rat liver: Relevance to arsenic carcinogenesis. Cancer Lett 98:227-231.

Brown KG, Guo H-R, Greene HL. 1997a. Uncertainty in cancer risk at low doses of inorganic arsenic. Hum Ecol Risk Assess 3(3):351-362.

Brown KG, Guo H-R, Kuo T-L, et al. 1997b. Skin cancer and inorganic arsenic: Uncertainty-status of risk. Risk Anal 17(1):37-42.

Brown JL, Kitchin KT, George M. 1997c. Dimethylarsinic acid treatment alters six different rat biochemical parameters: Relevance to arsenic carcinogenesis. Teratog Carcinog Mutagen 17:71-84.

Brown LM, Pottern LM, Blot WJ. 1984. Lung cancer in relation to environmental pollutants emitted from industrial sources. Environ Res 34:250-261.

Brown MM, Rhyne BC, Goyer RA, et al. 1976. Intracellular effects of chronic arsenic administration on renal proximal tubule cells. J Toxicol Environ Health 1:505-514.

Brown RM, Newton D, Pickford CJ, et al. 1990. Human metabolism of arsenobetaine ingested with fish. Hum Exp Toxicol 9:41-46.

Bruce BW, McMahon PB. 1996. Shallow ground-water quality beneath a major urban center: Denver, Colorado, USA. J Hydrol 186:129-151.

Brumbaugh WG, Ingersoll CG, Kemble NE, et al. 1994. Chemical characterization of sediments and pore water from the upper Clark Fork River and Milltown Reservoir, Montana. Environ Toxicol Chem 13(12):1971-1983.

*Brune O, Nordberg G, Wester PO. 1980. Distribution of 23 elements in kidney, liver and lung of a control group in Northern Sweden and of exposed workers from a smelter and refinery. Sci Total Environ 16:13-35.

Buchancová J, Klimentova G, Knizkova M, et al. 1998. Health status of workers of a thermal power station exposed for prolonged periods to arsenic and other elements from fuel. Cent Eur J Public Health 6(1):29-36.

Buchet JP, Lauwerys R. 1985. Study of inorganic arsenic methylation by rat liver *in vitro*: Relevance for the interpretation of observations in man. Arch Toxicol 57:125-129.

Buchet JP, Lauwerys R. 1987. Study of factors influencing the *in vivo* methylation of inorganic arsenic in rats. Toxicol Appl Pharmacol 91:65-74.

Buchet JP, Lauwerys R. 1988. Role of thiols in the *in vitro* methylation of inorganic arsenic by rat liver cytosol. Biochem Pharmacol 37(16):3149-3153.

Buchet JP, Lison D. 1998. Mortality by cancer in groups of the Belgian population with a moderately increased intake of arsenic. Int Arch Occup Environ Health 71(2):125-130.

Buchet JP, Lauwerys R, Mahieu P, et al. 1982. Inorganic arsenic metabolism in man. Arch Toxicol Suppl 5:326-327.

Buchet JP, Lauwerys R, Roels H. 1981a. Comparison of the urinary excretion of arsenic metabolites after a single oral dose of sodium arsenite, monomethylarsonate or dimethylarsinate in man. Int Arch Occup Environ Health 48:71-79.

Buchet JP, Lauwerys R, Roels H. 1981b. Urinary excretion of inorganic arsenic and its metabolites after repeated ingestion of sodium metaarsenite by volunteers. Int Arch Occup Environ Health 48:111-118.

*Buchet JP, Lison D, Ruggeri M, et al. 1996b. Assessment of exposure to inorganic arsenic, a human carcinogen, due to the consumption of seafood. Arch Toxicol 70(11):773-778.

Buchet JP, Pauwels J, Lauwerys R. 1994. Assessment of exposure to inorganic arsenic following ingestion of marine organisms by volunteers. Environ Res 66(1):44-51.

*Buchet JP, Staessen J, Roels H, et al. 1996a. Geographical and temporal differences in the urinary excretion of inorganic arsenic: A Belgian population study. Occup Environ Med 53(5):320-327.

Budavari S, O'Neil MJ, Smith A, et al., eds. 2001. The Merck index an encyclopedia of chemicals, drugs and biologicals. 13th ed. Whitehouse Station, NJ: Merck & Co., Inc., 440, 462.

Bulbulyan MA, Jourenkova NJ, Boffetta P, et al. 1996. Mortality in a cohort of Russian fertilizer workers. Scand J Work Environ Health 22(1):27-33.

Burgdorf W, Kurvink K, Cervenka J. 1977. Elevated sister chromatid exchange rate in lymphocytes of subjects treated with arsenic. Hum Genet 36:69-72.

Burger J, Dixon C, Shukla T, et al. 2003. Metals in horseshoe crabs from Delaware Bay. Arch Environ Contam Toxicol 44:36-42.

Burger J, Gaines KF, Boring CS, et al. 2002. Metal levels in fish from the Savannah River: Potential hazards to fish and other receptors. Environ Res 89:85-97.

9. REFERENCES

*Burger J, Gochfeld M, Rooney AA, et al. 2000. Metals and metalloids in tissues of American alligators in three Florida lakes. Arch Environ Contam Toxicol 38:501-508.

Burkhard EG, Dutkiewicz VA, Husain L. 1994. A study of SO_2, SO_4^2 and trace elements in clear air and clouds above the midwestern United States. Atmos Environ 28(8):1521-1533.

Burlo F, Guijarro I, Carbonell-Barrachina AA, et al. 1999. Arsenic species: Effects on and accumulation by tomato plants. J Agric Food Chem 47:1247-1253.

Burns LA, Munson AE. 1993. Gallium arsenide selectively inhibits T cell proliferation and alters expression of CD25 (IL-2R/P55). J Pharmacol Exp Ther 265(1):178-186.

Butler ECV. 1988. Determination of inorganic arsenic species in aqueous samples by ion-exclusion chromatography with electrochemical detection. J Chromatogr 450:353-360.

Butte W, Heinzow B. 2002. Pollutants in house dust as indicators of indoor contamination. Rev Environ Contam Toxicol 175:1-46.

Byrd DM, Roegner ML, Griffiths JC, et al. 1996. Carcinogenic risks of inorganic arsenic in perspective. Int Arch Occup Environ Health 68(6):484-494.

Byron WR, Bierbower GW, Brouwer JB, et al. 1967. Pathologic changes in rats and dogs from two-year feeding of sodium arsenite or sodium arsenate. Toxicol Appl Pharmacol 10:132-147.

*Caffery-Nolan RE, McCoy KL. 1998. Direct exposure to gallium arsenide upregulates costimulatory activity of murine macrophages. Toxicol Appl Pharmacol 151:330-339.

Calderón J, Navarro ME, Jimenez-Capdeville ME, et al. 2001. Exposure to arsenic and lead an neuropsychological development in Mexican children. Environ Res 85(Section A):69-76.

Calderon RL, Hudgens E, Le CX, et al. 1999. Excretion of arsenic in urine as a function of exposure to arsenic in drinking water. Environ Health Perspect 107:663-667.

Campbell JP, Alvarez JA. 1989. Acute arsenic intoxication. Am Fam Physician 40(6):93-97.

Cannon JR, Edmonds JS, Francesconi KA, et al. 1981. Isolation, crystal structure and synthesis of arsenobetaine, a constituent of the western rock lobster, the dusty shark, and some samples of human urine. Aust J Chem 34:787-798.

Cannon JR, Saunders JB, Toia RF. 1983. Isolation and preliminary toxicological evaluation of arsenobetaine- the water-soluble arsenical constituent from the hepatopancreas of the western rock lobster. Sci Total Environ 31:181-185.

Capar SG, Cunningham WC. 2000. Element and radionuclide concentrations in food: FDA Total Diet Study 1991-1996. J AOAC Int 83:157-177.

Carapella SC. 1992. Arsenic and arsenic alloys. In: Kroschwitz JI, Howe-Grant M, eds. Kirk-Othmer encyclopedia of chemical technology. Vol. 3. New York, NY: John Wiley and Sons, 624-633.

Carbonell-Barrachina AA, Burló F, Valero D, et al. 1999. Arsenic toxicity and accumulation in turnip as affected by arsenic chemical speciation. J Agric Food Chem 47:2288-2294.

Carbonell-Barrachina AA, Jugsujinda A, Burlo F, et al. 2000. Arsenic chemistry in municipal sewage sludge as affected by redox potential and pH. Water Res 34:216-224.

Carlson-Lynch H, Beck BD, Boardman PD. 1994. Arsenic risk assessment. Environ Health Perspect 102(4):354-356.

Carpenter SJ. 1987. Developmental analysis of cephalic axial dysraphic disorders in arsenic-treated hamster embryos. Anat Embryol 176:345-365.

Casto BC, Meyers J, DiPaolo JA. 1979. Enhancement of viral transformation for evaluation of the carcinogenic or mutagenic potential of inorganic metal salts. Cancer Res 39:193-198.

Cebrián ME, Albores A, Aguilar M, et al. 1983. Chronic arsenic poisoning in the north of Mexico. Hum Toxicol 2:121-133.

Chaineau E, Binet S, Pol D, et al. 1990. Embryotoxic effects of sodium arsenite and sodium arsenate on mouse embryos in culture. Teratology 41:105-112.

Chakraborti D, Hussam A, Alauddin M. 2003b. Arsenic: Environmental health aspects with special reference to groundwater in South Asia. J Environ Sci Health Part A 38(1):xi-xv.

Chakraborti D, Mukherjee SC, Pati S, et al. 2003c. Arsenic groundwater contamination in Middle Ganga Plain, Bihar, India: A future danger? Environ Health Perspect 111:1194-1201.

Chakraborti D, Mukherjee SC, Saha KC, et al. 2003a. Arsenic toxicity from homeopathic treatment. J Toxicol Clin Toxicol 41(7):963-967.

Chakraborty AK, Saha KC. 1987. Arsenical dermatosis from tubewell water in west Bengal. Indian J Med Res 85:326-334.

Chan PC, Huff J. 1997. Arsenic carcinogenesis in animals and in humans: Mechanistic, experimental, and epidemiological evidence. J Environ Health Sci, C15(2):83-122.

Chan TYK. 1994. The prevalence use and harmful potential of some Chinese herbal medicines in babies and children. Vet Hum Toxicol 36(3):238-240.

Chang CC, Ho SC, Tsai SS, et al. 2004. Ischemic heart disease mortality reduction in an arseniasis-endemic area in southwestern Taiwan after a switch in the tap-water supply system. J Toxicol Environ Health A 67(17):1353-1361.

Chao CC. 1996. Inhibition by arsenite of anticancer drug *cis*-diamminedichloroplatinum(II) induced DNA repair and drug resistance in HeLa cells. Environ Toxicol Pharmacol 1(3):199-205.

Chappell WR, Beck BD, Brown KG, et al. 1997. Inorganic arsenic: A need and an opportunity to improve risk assessment. Environ Health Perspect 105(10):1060-1067.

Charbonneau SM, Spencer K, Bryce F, et al. 1978. Arsenic excretion by monkeys dosed with arsenic-containing fish or with inorganic arsenic. Bull Environ Contam Toxicol 20:470-477.

Chattopadhyay S, Ghosh S, Debnath J, et al. 2001. Protection of sodium arsenite-induced ovarian toxicity by coadministration of L-ascorbate (vitamin C) in mature wistar strain rat. Arch Environ Contam Toxicol 41(1):83-89.

ChemIDplus. 2007. ChemIDplus. Bethesda, MD: U.S. National Library of Medicine. http://sis.nlm.nih.gov/chemical.html. August 28, 2007.

Chen CJ, Wang CJ. 1990. Ecological correlation between arsenic level in well water and age-adjusted mortality from malignant neoplasms. Cancer Res 50:5470-5474.

*Chen CL, Whanger PD. 1994. Interaction of selenium and arsenic with metallothionein: Effect of vitamin B_{12}. J Inorg Biochem 54(4):267-276.

Chen CJ, Chen CW, Wu MM, et al. 1992. Cancer potential in liver, lung, bladder and kidney due to ingested inorganic arsenic in drinking water. Br J Cancer 66(5):888-892.

Chen CJ, Chiou HY, Chiang MH, et al. 1996. Dose-response relationship between ischemic heart disease mortality and long-term arsenic exposure. Arterioscler Thromb Vasc Biol 16(4):504-510.

Chen CJ, Chuang YC, Lin TM, et al. 1985. Malignant neoplasms among residents of a blackfoot disease-endemic area in Taiwan: High-arsenic artesian well water and cancers. Cancer Res 45:5895-5899.

Chen CJ, Chuang YC, You SL, et al. 1986. A retrospective study on malignant neoplasms of bladder, lung and liver in blackfoot disease endemic area in Taiwan. Br J Cancer 53:399-405.

Chen CJ, Hsu LI, Shih WL, et al. 2005. Biomarkers of exposure, effect, and susceptibility of arsenic-induced health hazards in Taiwan. Toxicol Appl Pharmacol 206(2):198-206.

Chen CJ, Hsueh YM, Lai MS, et al. 1995. Increased prevalence of hypertension and long-term arsenic exposure. Hypertension 25(1):53-60.

Chen CJ, Kuo T-L, Wu MM. 1988a. Arsenic and cancers [Letter]. Lancet (February 20):414-415.

Chen CJ, Wu MM, Lee SS, et al. 1988b. Atherogenicity and carcinogenicity of high-arsenic artesian well water: Multiple risk factors and related malignant neoplasms of blackfoot disease. Arteriosclerosis 8:452-460.

*Chen KS, Huang CC, Liaw CC, et al. 1988c. [Multiple primary cancers in blackfoot endemic area: Report of a case.] J Formosan Med Assoc 87:1125-1128. (Chinese)

Chen M, Ma LQ, Harris WG. 1999. Baseline concentrations of 15 trace elements in Florida surface soils. J Environ Qual 28:1173-81.

Chen Y, Ahsan H, Parvez F, et al. 2004. Validity of a food-frequency questionnaire for a large prospective cohort study in Bangladesh. Br J Nutr 92(5):851-859.

Chen YC, Guo YL, Su HJ, et al. 2003. Arsenic methylation and skin cancer risk in southwestern Taiwan. J Occup Environ Med 45(3):241-248.

Chernoff N, Setzer W, Miller DB, et al. 1990. Effects of chemically induced maternal toxicity on prenatal development in the rat. Teratology 42:651-658.

Chhuttani PN, Chawla LS, Sharma TD. 1967. Arsenical neuropathy. Neurology 17:269-274.

*Ch'i I, Blackwell RQ. 1968. A controlled retrospective study of blackfoot disease, an endemic peripheral gangrene disease in Taiwan. Am J Epidemiol 88(1):7-24.

Chiang CE, Luk HN, Wang TM, et al. 2002. Prolongation of cardiac repolarization by arsenic trioxide. Blood 100(6):2249-2252.

*Chiang HS, Hong CL, Guo HR, et al. 1988. Comparative study on the high prevalence of bladder cancer in the blackfoot disease endemic area in Taiwan. J Formosan Med Assoc 87(11):1074-1080.

Chiba M, Masironi R. 1992. Toxic and trace elements in tobacco and tobacco smoke. Bull WHO 70(2):269-275.

Chicago Flameproof. 2000. Pressure-treated Supatimber. Montgomery, IL: Chicago Flameproof. http://www.chicagoflameproof.com/supatimber.html. July 29, 2005.

Chilvers DC, Peterson PJ. 1987. Global cycling of arsenic. In: Hutchinson TC, Meema KM, eds. Lead, mercury, cadmium and arsenic in the environment. New York, NY: John Wiley & Sons, 279-301.

Chiou HY, Chiou ST, Hsu YH, et al. 2001. Incidence of transitional cell carcinoma and arsenic in drinking water: A follow-up study of 8,102 residents in an arseniasis-endemic area in northeastern Taiwan. Am J Epidemiol 153(5):411-418.

Chiou HY, Hsueh YM, Liaw KF, et al. 1995. Incidence of internal cancers and ingested inorganic arsenic: A seven-year follow-up study in Taiwan. Cancer Res 55(6):1296-1300.

Chiou HY, Huang WI, Su CL, et al. 1997. Dose-response relationship between prevalence of cerebrovascular disease and ingested inorganic arsenic. Stroke 28(9):1717-1723.

Chirenje T, Ma LQ, Clark C, et al. 2003a. Cu, Cr and As distribution in soils adjacent to pressure-treated decks, fences and poles. Environ Pollut 124(3):407-417.

Chirenje T, Ma LQ, Szulczewski M, et al. 2003b. Arsenic distribution in Florida urban soils: Comparison between Gainsville and Miami. J Environ Qual 32:109-119.

*Chiu HF, Ho SC, Wang LY, et al. 2004. Does arsenic exposure increase the risk for liver cancer? J Toxicol Environ Health A 67(19):1491-1500.

Choucair AK, Ajax ET. 1988. Hair and nails in arsenical neuropathy. Ann Neurol 23(6):628-629.

Chow NH, Guo YL, Lin JSN, et al. 1997. Clinicopathological features of bladder cancer associated with chronic exposure to arsenic. Br J Cancer 75(11):1708-1710.

Chowdhury UK, Biswas BK, Chowdhury TR, et al. 2000. Groundwater arsenic contamination in Bangladesh and West Bengel, India. Environ Health Perspect 108(5):393-397.

Christian JW, Hopenhayn C, Centeno JA, et al. 2006. Distribution of urinary selenium and arsenic among pregnant women exposed to arsenic in drinking water. Environ Res 100(1):115-122.

Chun JS, Killeen JC. 1989a. Salmonella/mammalian-microsome plate incorporation mutagenicity assay (Ames test) with and without metabolic activation with methanearsonic acid (MAA). Fermenta ASC Corporation. Submitted to the U.S. Environmental Protection Agency. MRID41651902.

Chun JS, Killeen JC. 1989b. *In vitro* chromosomal aberration assay in Chinese hamster ovary (CBO) cells with methanarsonic acid (MAA). Fermenta ASC Corporation. Submitted to the U.S. Environmental Protection Agency. MRID41651903.

Chun JS, Killeen JC. 1989c. L5178Y $TK^{*/-}$ mouse lymphoma mutagenesis assay with methanearsonic acid. Fermenta ASC Corporation. Submitted to the U.S. Environmental Protection Agency. MRID41651904.

Chun JS, Killeen JC. 1989d. Unscheduled DNA synthesis assay in rat primary hepatocytes with methanearsonic acid (MAA). Fermenta ASC Corporation. Submitted to the U.S. Environmental Protection Agency. MRID41651905.

Chung JS, Kalman DA, Moore LE, et al. 2002. Family correlations of arsenic methylation patterns in children and parents exposed to high concentrations of arsenic in drinking water. Environ Health Perspect 110(7):729-733.

Cikrt M, Mravcová A, Malátová I, et al. 1988. Distribution and excretion of ^{74}As and ^{75}Se in rats after their simultaneous administration: The effect of arsenic, selenium and combined pretreatment. J Hyg Epidemiol Microbiol Immunol 32(1):17-29.

Civantos DP, Rodríguez AL, Aguado-Borruey JM, et al. 1995. Fulminant malignant arrhythmia and multiorgan failure in acute arsenic poisoning. Chest 108(6):1774-1775.

Clewell HJ, Andersen ME. 1985. Risk assessment extrapolations and physiological modeling. Toxicol Ind Health 1(4):111-131.

Clewell HJ, Thomas RS, Gentry PR, et al. 2007. Research toward the development of a biologically based dose response assessment for inorganic arsenic carcinogenicity: A progress report. Toxicol Appl Pharmacol 222(3):388-398.

Clyne N, Ericsson F, Lins L, et al. 1989. Plasma trace elements in pre-dialytic uremic patients determined by energy dispersive X-ray fluorescence. Trace Elem Med 6(1):37-40.

Cohen SM, Arnold LL, Eldan M, et al. 2006. Methylated arsenicals: The implications of metabolism and carcinogenicity studies in rodents to human risk assessment. Crit Rev Toxicol 36(2):99-133.

Cohen SM, Yamamoto S, Cano M, et al. 2001. Urothelial cytotoxicity and regeneration induced by dimethylarsinic acid in rats. Toxicol Sci 59(1):68-74.

Cöl M, Cöl C, Soran A, et al. 1999. Arsenic-related Bowen's disease, Palmer keratosis, and skin cancer. Environ Health Perspect 107(8):687-689.

Cole RH, Frederick RE, Healy RP, et al. 1984. Preliminary findings of the priority pollutant monitoring project of the nationwide urban runoff program. J Water Pollut Control Fed 56:898-908.

Coles DG, Ragaini RC, Ondov JM, et al. 1979. Chemical studies of stack fly ash from a coal-fired power plant. Environ Sci Tech 13(4):455-459.

Comber SDW, Howard AG. 1989. Arsenic speciation by hydride generation atomic absorption spectrometry and its application to the study of biological cycling in the coastal environment. Anal Proc 26:20-22.

Concha G, Nermell B, Vahter M. 1998a. Metabolism of inorganic arsenic in children with chronic high arsenic exposure in northern Argentina. Environ Health Perspect 106(6):355-359.

Concha G, Vogler G, Lezcano D, et al. 1999. Exposure to inorganic arsenic metabolites during early human development. Toxicol Sci 44:185-190.

Concha G, Vogler G, Nermell B, et al. 1998b. Low-level arsenic excretion in breast milk of native Andean women exposed to high levels of arsenic in the drinking water. Int Arch Occup Environ Health 71(1):42-46.

Concha G, Vogler G, Nermell B, et al. 2002. Intra-individual variation in the metabolism of inorganic arsenic. Int Arch Occup Environ Health 75:576-580.

Cooper PA. 1991. Leaching of CCA from treated wood: pH effects. For Prod J 41(1):30-32.

Cooper CM, Gillespie WB. 2001. Arsenic and mercury concentrations in major landscape components of an intensively cultivated watershed. Environ Pollut 111:67-74.

Cordier S, Thériault G, Iturra H. 1983. Mortality patterns in a population living near a copper smelter. Environ Res 31:311-322.

Costa M, Zhitkovich A, Harris M, et al. 1997. DNA-protein cross-links produced by various chemicals in cultured human lymphoma cells. J Toxicol Environ Health 50(5):433-449.

Crecelius EA. 1977. Changes in the chemical speciation of arsenic following ingestion by man. Environ Health Perspect 19:147-150.

Crecelius EA. 1978. Modification of the arsenic speciation technique using hydride generation. Anal Chem 50(6):826-827.

Crown S, Kenan G, Nyska A, et al. 1987. Cacodylic acid toxicity in dietary administration to rats for 13 weeks: A preliminary study. Luxembourg Industries (Pamol) Ltd. Submitted to the U.S. Environmental Protection Agency. MRID42767701.

Crown S, Nyska A, Waner T. 1990. Methanearsonic acid combined chronic feeding and oncogenicity study in the rat. Luxembourg Industries (Pamol) Ltd. Submitted to the U.S. Environmental Protection Agency. MRID41669001.

Csanaky I, Gregus Z. 2002. Species variations in the biliary and urinary excretion of arsenate, arsenite and their metabolites. Comp Biochem Physiol C 131(3):355-365.

*Cullen WR. 1998. Arsenic in the environment. In: Bunnett JF, Mikolajczyk M, eds. Arsenic and old mustard: Chemical problems in the destruction of old arsenical and 'mustard' munitions. Netherlands: Kluwer Academic Publishers, 123-134.

Cullen NM, Wolf LR, St Clair D. 1995. Pediatric arsenic ingestion. Am J Emerg Med 13(4):432-435.

Curatola CJ, Grunder FI, Moffitt AE. 1978. Hydride generation atomic absorption spectrophotometry for determination of arsenic in hair. Am Ind Hyg Assoc Journal 39:933-938.

Cuzick J, Sasieni P, Evans S. 1992. Ingested arsenic, keratoses, and bladder cancer. Am J Epidemiol 136(4):417-421.

*Czarnecki GL, Baker DH, Garst JE. 1984. Arsenic-sulfur amino acid interactions in the chick. J Anim Sci 59:1573-1581.

Dabeka RW, Lacroix GMA. 1987. Total arsenic in foods after sequential wet digestion, dry ashing, coprecipitation with ammonium pyrrolidine dithiocarbamate, and graphite-furnace atomic absorption spectrometry. J Assoc Off Anal Chem 70(5):866-870.

Dabeka RW, McKenzie AD, Lacroix GM, et al. 1993. Survey of arsenic in total diet food composites and estimation of the dietary intake of arsenic by Canadian adults and children. J AOAC Int 76(1):14-25.

Dallaire L, Beliveau R. 1992. Phosphate transport by capillaries of the blood-brain barrier. J Biol Chem 267(31):22323-22327.

Danan M, Dally S, Conso F. 1984. Arsenic-induced encephalopathy. Neurology 34:1524.

Darland JE, Inskeep WP. 1997. Effects of pH and phosphate competition on the transport of arsenate. J Environ Qual 26(4):1133-1139.

Das T, Roychoudhury A, Sharma A, et al. 1993. Modification of clastogenicity of three known clastogens by garlic extract in mice *in vivo*. Environ Mol Mutagen 21(4):383-388.

Datta S, Talukder G, Sharma A. 1986. Cytotoxic effects of arsenic in dietary oil primed rats. Sci Cult 52(6):196-198.

Davey JC, Bodwell JE, Gosse JA, et al. 2007. Arsenic as an endocrine disruptor: Effects of arsenic on estrogen receptor-mediated gene expression *in vivo* and in cell culture. Toxicol Sci 98(1):75-86.

Davidson CI, Goold WD, Mathison TP, et al. 1985. Airborne trace elements in Great Smoky Mountains, Olympic, and Glacier National Parks. Environ Sci Technol 19:27-35.

Davis A, Ruby MV, Bergstrom PD. 1992. Bioavailability of arsenic and lead in soils from the Butte, Montana, mining district. Environ Sci Technol 26(3):461-468.

Davis A, Ruby MV, Bloom M, et al. 1996. Mineralogic constraints on the bioavailability of arsenic in smelter-impacted soils. Environ Sci Technol 30(2):392-399.

Dekundt GH, Leonard A, Arany J, et al. 1986. *In vivo* studies in male mice on the mutagenic effects of inorganic arsenic. Mutagenesis 1(1):33-34.

de la Rosa ME, Magnusson J, Ramel C, et al. 1994. Modulating influence of inorganic arsenic on the recombinogenic and mutagenic action of ionizing radiation and alkylating agents in *Drosophila melanogaster*. Mutat Res 318(1):65-71.

de Peyster A, Silvers JA. 1995. Arsenic levels in hair of workers in a semiconductor fabrication facility. Am Ind Hyg Assoc J 56(4):377-383.

Dhar P, Jaitley M, Kalaivani M, et al. 2005. Preliminary morphological and histochemical changes in rat spinal cord neurons following arsenic ingestion. Neurotoxicology 26(3):309-320.

DHHS. 1995. Report to Congress on workers' home contamination study conducted under the workers' family protection act (29 U.S.C. 671a). Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. September 1995. Pub no. 95-123. PB96192000.

*Díaz-Barriga F, Batres L, Calderón J, et al. 1997. The El Paso smelter 20 years later: Residual impact on Mexican children. Environ Res 74(1):11-16.

Dieke SH, Richter CP. 1946. Comparative assays of rodenticides on wild Norway rats. Public Health Rep 61:672-679.

DiPaolo JA, Casto BC. 1979. Quantitative studies of *in vitro* morphological transformation of Syrian hamster cells by inorganic metal salts. Cancer Res 39:1008-1013.

*Diwan A, Ward JM, Waalkes MP. 2002. Multiorgan transplacental carcinogenesis by arsenic in mice. Proc Am Assoc Cancer Res 43:1032.

Dix K, Cappon CJ, Toribara TY. 1987. Arsenic speciation by capillary gas-liquid chromatography. J Chromatogr Sci 25:164-169.

Dolan SP, Nortrup DA, Bolger PM, et al. 2003. Analysis of dietary supplements for arsenic, cadmium, mercury, and lead using inductively coupled plasma mass spectrometry. J Agric Food Chem 51(5):1307-1312.

*Domingo JL, Bosque MA, Piera V. 1991. *meso*-2,3-Dimercaptosuccinic acid and prevention of arsenite embryotoxicity and teratogenicity in the mouse. Fundam Appl Toxicol 17:314-320.

Dong JT, Luo XM. 1993. Arsenic-induced DNA-strand breaks associated with DNA-protein crosslinks in human fetal lung fibroblasts. Mutat Res 302(2):97-102.

Dong JT, Luo XM. 1994. Effects of arsenic on DNA damage and repair in human fetal lung fibroblasts. Mutat Res 315(1):11-15.

Dopp E, Hartmann LM, Florea AM, et al. 2004. Uptake of inorganic and organic derivatives of arsenic associated with induced cytotoxic and genotoxic effects in Chinese hamster ovary (CHO) cells. Toxicol Appl Pharmacol 201(2):156-165.

Driesback RH, ed. 1980. Arsenic and arsine. In: Handbook of poisoning: Prevention, diagnosis and treatment. 11th ed. Los Altos, CA: Lange Medical Publications, 241-245.

Dueñas C, Pérez-Alvarez JC, Busteros JI, et al. 1998. Idiopatic portal hypertension and angiosarcoma associated with arsenical salts therapy. J Clin Gastroenterol 26(4):303-305.

*Dulout FN, Grillo CA, Seoane AI, et al. 1996. Chromosomal aberrations in peripheral blood lymphocytes from native Andean women and children from northwestern Argentina exposed to arsenic in drinking water. Mutat Res 370(3-4):151-158.

Dunlap LG. 1921. Perforations of the nasal septum due to inhalation of arsenous oxide. JAMA 76(9):568-569.

*Durant JL, Chen J, Hemond HF, et al. 1995. Elevated incidence of childhood leukemia in Woburn, Massachusetts: NIEHS Superfund basic research program searches for causes. Environ Health Perspect 103(Suppl 6):93-98.

Dutkiewicz T. 1977. Experimental studies on arsenic absorption routes in rats. Environ Health Perspect 19:173-177.

Ebdon L, Fisher A, Roberts NB, et al. 1999. Determination of organoarsenic species in blood plasma by HPLC-ICP MS. Appl Organomet Chem 13:183-187.

Edelman GM. 1992. Morphoregulation. Dev Dynamics 193:2-10.

Edmonds JS, Francesconi KA. 1987. Transformations of arsenic in the marine environment. Experientia 43:553-557.

Edmonds MS, Baker DH. 1986. Toxic effects of supplemental copper and roxarsone when fed alone or in combination to young pigs. J Anim Sci 63:533-537.

Eguchi N, Kuroda K, Endo G. 1997. Metabolites of arsenic induced tetraploids and mitotic arrest in cultured cells. Arch Environ Contam Toxicol 32(2):141-145.

Eisler R. 1994. A review of arsenic hazards to plants and animals with emphasis on fishery and wildlife. In: Nriagu JO, ed. Arsenic in the environment: Part II: Human health and ecosystem effects. New York, NY: John Wiley & Sons, Inc, 185-259.

Eitzer BD, Iannucci-Berger WA, Mark G, et al. 1997. Fate of toxic compounds during composting. Bull Environ Contam Toxicol 58(6):953-960.

Ellenhorn MJ. 1997. Ellenhorn's medical toxicology. Diagnosis and treatment of human poisoning. Baltimore, MD: Williams & Wilkins, 1538-1542.

Ellenhorn MJ, Barceloux DG. 1988. Medical toxicology: Diagnosis and treatment of human poisoning. New York, NY: Elsevier, 1012-1048.

Endo G, Kuroda K, Okamoto A, et al. 1992. Dimethylarsenic acid induces tetraploids in Chinese hamster cells. Bull Environ Contam Toxicol 48(1):131-137.

Engel RR, Receveur O. 1993. Re: “Arsenic ingestion and internal cancers: A review”. Am J Epidemiol 138(10):896-897.

Engel RR, Smith AH. 1994. Arsenic in drinking water and mortality from vascular disease: An ecologic analysis in 30 counties in the United States. Arch Environ Health 49(5):418-427.

Enterline PE, Marsh GM. 1982. Cancer among workers exposed to arsenic and other substances in a copper smelter. Am J Epidemiol 116(6):895-911.

Enterline PE, Day R, Marsh GM. 1995. Cancers related to exposure to arsenic at a copper smelter. Occup Environ Med 52(1):28-32.

Enterline PE, Henderson VL, Marsh GM. 1987a. Exposure to arsenic and respiratory cancer: A reanalysis. Am J Epidemiol 125(6):929-938.

Enterline PE, Marsh GM, Esmen NA, et al. 1987b. Some effects of cigarette smoking, arsenic, and SO_2 on mortality among U.S. copper smelter workers. J Occup Med 29(10):831-838.

Environment Canada. 1993. Canadian environmental protection act priority substances list assessment report: Arsenic and its compounds. Ottawa, Canada: Canada Communication Group.

EPA. 1977a. Selected non-carcinogenic effects of industrial exposure to inorganic arsenic. Washington, DC: U.S. Environmental Protection Agency. PB276988. EPA560677018.

*EPA. 1977b. The evaluation of the acute inhalation toxicology of technical grade organoarsenical pesticides. Research Triangle Park, NC: U.S. Environmental Protection Agency, Health Effects Research Laboratory.

EPA. 1979. Water-related environmental fate of 129 priority pollutants: Vol. I. Introduction and technical background, metals and inorganics, pesticides and PCBs. Washington, DC: U.S. Environmental Protection Agency, Office of Water Planning and Standard. EPA440479029a.

EPA. 1980a. Ambient water quality criteria for arsenic. Washington, DC: U.S. Environmental Protection Agency, Office of Water Regulations and Standards. EPA440580021.

*EPA. 1980b. Lung cancer/mortality in proximity to a pesticide plant. Washington, DC: U.S. Environmental Protection Agency. PB80207376.

*EPA. 1980c. STORET. Washington, DC: U.S. Environmental Protection Agency, Monitoring and Data Support Division.

*EPA. 1980d. U.S. Environmental Protection Agency. Fed Regist 45:33132-33133.

*EPA. 1980e. U.S. Environmental Protection Agency: Part V. Fed Regist 45:79325-79327.

EPA. 1980f. Failure to produce arsenic neurotoxicity in the rat. An experimental study. Washington, DC: U.S. Environmental Protection Agency, Office of Toxic Substances. EPA5601180022.

*EPA. 1980g. Fate of toxic and hazardous materials in the air environment. Research Triangle Park, NC: U.S. Environmental Protection Agency, U.S. Environmental Sciences Research Lab. PB80221948.

*EPA. 1980h. Lung cancer mortality in proximity to a pesticide plant. Washington, DC: American Public Health Association and U.S. Environmental Protection Agency, Office of Toxic Substances. PB80207376.

*EPA. 1981a. Effluent guidelines and standards. Toxic pollutants. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 401.

EPA. 1981b. Community health associated with arsenic in drinking water in Millard County, Utah. Cincinnati, OH: U.S. Environmental Protection Agency, Health Effects Research Laboratory. EPA600181064. PB82108374.

EPA. 1981c. The carcinogen assessment group's final risk assessment on arsenic. Washington, DC: U.S. Environmental Protection Agency, Office of Health and Environmental Assessment. EPA600681002. PB81206013.

*EPA. 1981d. Effluent guidelines and standards. Timber products processing point source category. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 429.

*EPA. 1981e. Assessment of exposure to arsenic from CCA-treated wood: Final report. Washington, DC: U.S. Environmental Protection Agency, Office of Health and Environmental Assessment.

*EPA. 1982a. Effluent guidelines and standards. Inorganic chemicals manufacturing point source category. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 415.

EPA. 1982b. Exposure and risk assessment for arsenic. Washington, DC: U.S. Environmental Protection Agency, Office of Water Regulations and Standards. PB85221711. EPA440485005. 1.1-4.68.

EPA. 1982c. Inductively coupled plasma-atomic emission spectrometric method for trace element analysis of water and wastes - method 200.7. Cincinnati, OH: U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory.

*EPA. 1982d. Arsenic. In: Intermedia priority pollutant guidance documents. Washington, DC: U.S. Environmental Protection Agency, Office of Pesticides and Toxic Substances.

*EPA. 1982e. Speciation of arsenic compounds in water supplies. Cincinnati, OH: U.S. Environmental Protection Agency, Health Effects Research Laboratory. EPA6005182010.

*EPA. 1983a. Effluent guidelines and standards. Electrical and electronic components point source category. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 469.

EPA. 1983b. Method 206.2: atomic absorption, furnace technique. In: Methods for chemical analysis of water and wastes. Cincinnati, OH: U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory. EPA600479020.

EPA. 1983c. Method 206.3: atomic absorption-gaseous hydride. In: Methods for chemical analysis of water and wastes. Cincinnati, OH: U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory. EPA600479020.

EPA. 1983d. Method 206.4: spectrophotometric - SDDC. In: Methods for chemical analysis of water and wastes. Cincinnati, OH: U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory. EPA600479020.

EPA. 1983e. Method 206.5: sample digestion prior to total arsenic analysis by silver diethyldithiocarbamate or hydride procedures. In: Methods for chemical analysis of water and wastes. Cincinnati, OH: U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory. EPA600479020.

*EPA. 1983f. Treatability manual: Vol. I: Treatability data. Washington, DC: U.S. Environmental Protection Agency, Office of Research and Development, I.4.2.1-I.4.2.6. EPA600282001a.

EPA. 1983g. Feasibility study to resolve questions on the relationship of arsenic in drinking water to skin cancer. Washington, DC: U.S. Environmental Protection Agency, Office of Research and Development.

*EPA. 1983h. Compliance monitoring data from federal reporting data system. U.S. Environmental Protection Agency, Office of Drinking Water, State Programs Division.

EPA. 1984a. Health Assessment Document for Arsenic. Research Triangle Park, NC: U.S. Environmental Protection Agency. EPA600823021F.

*EPA. 1984b. Health assessment document for inorganic arsenic. Final report. Research Triangle Park, NC: U.S. Environmental Protection Agency, Environmental Criteria and Assessment Office. EPA600883021F. 2-1-3-22, 9-1-9-4.

*EPA. 1984c. Health effects assessment for arsenic. Washington, DC: U.S. Environmental Protection Agency, Office of Emergency and Remedial Response. EPA540186020.

*EPA. 1984d. Occurrence of arsenic in drinking water, food and air. Washington, DC: U.S. Environmental Protection Agency, Office of Water Regulations and Standards.

*EPA. 1986a. Evaluation of the potential carcinogenicity of arsenic (7940-38-2) in support of reportable quantity adjustments pursuant to CERCLA Section 102. Washington, DC: U.S. Environmental Protection Agency, Office of Health and Environmental Assessment. OHEA C-073-5.

*EPA. 1986b. Inorganic arsenic risk assessment for primary and secondary zinc smelters, primary lead smelters, zinc oxide plants, cotton gins, and arsenic chemical plants. Research Triangle Park, NC: U.S. Environmental Protection Agency, Strategies and Air Standards Division. PB86245255.

*EPA. 1986c. Method 7060 – Arsenic: atomic absorption, furnace technique. In: Test methods for evaluating solid waste. 3rd ed. SW-846. Washington, DC: U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response.

*EPA. 1986d. National emission standard for inorganic arsenic emissions from arsenic trioxide and metallic arsenic production facilities. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 61, Subpart P.

*EPA. 1986e. Creosote, pentachlorophenol, and inorganic arsenicals: Amendment of notice to cancel registrations. U.S. Environmental Protection Agency. Fed Regist 51(7):1334-1348.

EPA. 1986f. National emission standards for household air pollutants; Standards for inorganic arsenic. U.S. Environmental Protection Agency: Part II. Fed Regist 51(149):27956-27960.

*EPA. 1986g. National emission standard for inorganic arsenic emissions from primary copper smelters. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 61, Subpart O.

*EPA. 1987a. U.S. Environmental Protection Agency. Fed Regist 52:12278.

*EPA. 1987b. U.S. Environmental Protection Agency: Part II. Fed Regist 52(77):13396-13398, 13402.

*EPA. 1987c. List (phase 1) of hazardous constituents for ground-water monitoring. U.S. Environmental Protection Agency: Part II. Fed Regist 52(131):25942-25953.

*EPA. 1987d. Land disposal restrictions for certain "California list" hazardous wastes and modifications to the framework. U.S. Environmental Protection Agency: Part V. Fed Regist 52(130):25760-25763.

EPA. 1987e. The risk assessment guidelines of 1986. Washington, DC: U.S. Environmental Protection Agency. EPA600887045.

*EPA. 1987f. Carcinogenic effects of arsenic compounds in drinking water. Cincinnati, OH: U.S. Environmental Protection Agency, Health Effects Research Laboratory. PB87232542. EPA 600187007.

*EPA. 1988a. Inorganic arsenicals; Intent to cancel registrations for pesticide products registered for non-wood preservative use; conclusion of special review. U.S. Environmental Protection Agency. Fed Regist 53(126):24787-24796.

*EPA. 1988b. U.S. Environmental Protection Agency: Part II. Fed Regist 53:31138-31222.

*EPA. 1988c. U.S. Environmental Protection Agency: Part II. Fed Regist 53:4500-4501.

EPA. 1988d. Special report on ingested inorganic arsenic: Skin cancer; nutritional essentiality. Washington, DC: U.S. Environmental Protection Agency, Risk Assessment Forum. EPA625387013F. PB89125975

EPA. 1988e. Reference physiological parameters in pharmacokinetic modeling. Washington, DC: U.S. Environmental Protection Agency. EPA600688004. PB88196019.

*EPA. 1989a. Guidance for the reregistration of wood preservative pesticide products containing arsenic, chromium, and chromated arsenical compounds as the active ingredient. Washington, DC: U.S. Environmental Protection Agency, Office of Pesticide Programs. PB89102842.

EPA. 1989b. Interim methods for development of inhalation reference doses. Washington, DC: U.S. Environmental Protection Agency, Office of Health and Environmental Assessment. EPA600888066F. PB90145723.

*EPA. 1989c. U.S. Environmental Protection Agency: Part II. Fed Regist 54:35988-35992.

*EPA. 1989d. Reportable quantity adjustments; Digesting of ammonium trisulfate. U.S. Environmental Protection Agency: Part V. Fed Regist 54(155):33426, 33450, 33453-33454, 33456, 33463-33465, 33470.

EPA. 1989e. Recognition and management of pesticide poisonings. U.S. Environmental Protection Agency. EPA540988001. PB91145656, 54-62

9. REFERENCES

*EPA. 1990a. Effluent guidelines and standards. Nonferrous metals manufacturing point source category. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 421.

*EPA. 1990b. Calcium arsenate; Revocation of tolerances. U.S. Environmental Protection Agency. Fed Regist 55(158):33332-33335.

*EPA. 1990c. Land disposal restrictions for third scheduled wastes. U.S. Environmental Protection Agency: Part II. Fed Regist 55(106):22520-22536, 22683-22714.

*EPA. 1990d. Notice of intent to remove certain active ingredients from list B and to those pesticides containing those ingredients. U.S. Environmental Protection Agency: Part V. Fed Regist 55(147):31164-31174.

EPA. 1990e. Pollutant concentration estimates from the National Sewage Sludge Survey: Arsenic. U.S. Environmental Protection Agency: Part III. Fed Regist 55(218):47229.

*EPA. 1990f. Toxics in the community: 1988: National and local perspectives. Washington, DC: U.S. Environmental Protection Agency, Office of Toxic Substances.

*EPA. 1990g. National emissions standard for inorganic arsenic emissions from glass manufacturing plants. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 61. Subpart N.

*EPA. 1990h. Standards of performance for volatile organic compounds (VOC) emissions from synthetic organic chemical manufacturing industry (SOCMI) distillation operation. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 60.667.

EPA. 1990i. Interim methods for development of inhalation reference concentrations. Washington, DC: U.S. Environmental Protection Agency, Office of Health and Environmental Assessment, Office of Research and Development, Environmental Criteria and Assessment Office. EPA600890066A.

EPA. 1991. Method 200.8 - Determination of trace elements in waters and wastes by inductively coupled plasma - mass spectrometry. Cincinnati, OH: U.S. Environmental Protection Agency, EPA monitoring and support laboratory.

*EPA. 1993a. Arsenic: Supply, demand, and the environment. In: Mercury and arsenic wastes: removal, recovery, treatment, and disposal. U.S. Environmental Protection Agency Pollution Technology Review No. 214, 67-71.

EPA. 1993b. Standards for the management of hazardous waste and specific types of hazardous waste facilities. Health-based limits for exclusion of waste-dericed residues. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 266; Subpart H; Appendix VII.

EPA. 1994a. Method 6020 - Inductively coupled plasma - mass spectrometry. In: Test methods for evaluating sold waste. 3rd ed. SW-846. Washington DC: U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response.

EPA. 1994b. Method 7060A- Arsenic: atomic absorption, furnace technique. In: Test methods for evaluating sold waste. 3rd ed. SW-846. Washington DC: U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response.

EPA. 1994c. Method 200.7 - Inductively coupled plasma-atomic emission spectrometric method for trace element analysis of water and wastes. Revision 4.4, EMMC version. Cincinnati, OH: U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory. http://www.nemi.gov/. April 6, 2005.

*EPA. 1995a. Designation, reportable quantities, and notification. List of hazardous substance and reportable quantities. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 302.4.

*EPA. 1995b. Determination of reportable quantities for hazardous substances. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 117.

EPA. 1995c. Effluent guidelines and standards. Pesticide chemicals. Metallo-organic pesticide chemicals manufacturing subcategory. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 455, Subpart B.

*EPA. 1995d. Toxic chemical release reporting: Community right-to-know. Specific toxic chemical listings. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 372.65.

*EPA. 1995e. Maximum contaminant levels for inorganic chemicals. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 141, Subpart B.

*EPA. 1995f. Determination of background concentrations of inorganics in soil and sediments at hazardous waste sites. Washington, DC: U.S. Environmental Protection Agency, Office of Research and Development. EPA540S96500.

*EPA. 1996a. Effluent guidelines and standards. Pesticide chemicals. List of appropriate pollution control technologies. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 455, Table 10.

EPA. 1996b. Proposed guidelines for carcinogen risk assessment. U.S. Environmental Protection Agency. Fed Regist 61(79):17960-18011.

*EPA. 1996c. Superfund, emergency planning, and community right-to-know programs. Designation, reportable quantities, and notification. Emergency planning and notification. The list of extremely hazardous substances and their threshold planning quantities. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 355, Appendix A.

EPA. 1996d. Method 6010B- Inductively coupled plasma-atomic emission spectrometry. In: Test methods for evaluating sold waste. 3rd ed. SW-846. Washington DC: U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response.

EPA. 1996e. Method 7063- Arsenic in aqueous samples and extracts by anodic stripping voltammetry (ASV). In: Test methods for evaluating solid waste. 3rd ed. SW-846. Washington DC: U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response.

EPA. 1996f. Land disposal restrictions. Prohibitions on storage. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 268, Subpart E.

*EPA. 1996g. Land disposal restrictions. Metal bearing wastes prohibited from dilution in a combustion unit according to 40 CFR 268.3(c). U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 268, Appendix XI.

EPA. 1996h. Method 1632: Inorganic arsenic in water by hydride generation quartz furnace atomic absorption. U.S. Environmental Protection Agency, Office of Water, Engineering and Analysis Division.

*EPA. 1997a. Identification and listing of hazardous waste. Hazardous constituents. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 261.

*EPA. 1997b. Standards for owners and operators of hazardous waste treatment, storage, and disposal facilities. Ground-water monitoring list. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 264, Appendix IX.

*EPA. 1997c. National emission standards for wood furniture manufacturing operations. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 63, Subpart JJ.

*EPA. 1997d. Land disposal restrictions Phase IV: Treatment standards for wood preserving wastes, paperwork reduction and streamlining, exemptions from RCRA for certain processed materials; and miscellaneous hazardous waste provision. U.S. Environmental Protection Agency. Fed Regist 62(91)25998.

*EPA. 1997e. Fish and wildlife advisory database. U.S. Environmental Protection Agency. http://www.epa.gov/ost/fishadvice/. March 31, 2005.

*EPA. 1997f. Addition of facilities in certain industry sectors; Revised interpretation of otherwise use; Toxic release inventory reporting; Community right-to-know. U.S. Environmental Protection Agency. Fed Regist 62(84):23834.

EPA. 1997g. Relative bioavailability of arsenic in mining wastes. Denver, CO: U.S. Environmental Protection Agency. Document control no. 4500-88-AORH.

EPA. 1997h. Special report on environmental endocrine disruption: An effects assessment and analysis. Washington, DC: U.S. Environmental Protection Agency, Risk Assessment Forum. EPA630R96012.

*EPA. 1997i. Report on the expert panel on arsenic carcinogenicity: Review and workshop. Washington, DC: U.S. Environmental Protection Agency.

*EPA. 1998a. List of pesticides banned and severely restricted in the U.S. U.S. Environmental Protection Agency. http://www.epa.gov.oppfead1/international/piclist.htm. March 31, 2005.

*EPA. 1998b. Effluent limitations guidelines, pretreatment standards and new source performance standards for the industrial waste combustor subcategory of the waste combustors point source category. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 444. Fed Regist 63(25)6392.

*EPA. 1998c. National emission standards for hazardous air pollutants; proposed standards for hazardous air pollutants emissions for the Portland cement manufacturing industry. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 63. Fed Regist 63(56)14182.

*EPA. 1998d. National emissions standards for hazardous air pollutants for primary lead smelters. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 63. Fed Regist 63(74)19200.

*EPA. 1998e. National emission standards for hazardous air pollutants for source categories: national emission standards for primary copper smelters. U.S. Environmental Protection Agency. Fed Regist 63(75)19582.

*EPA. 1998f. Land disposal restrictions phase IV: final rule promulgating treatment standards for metal wastes and mineral processing wastes; mineral processing secondary materials and bevill exclusion issues; treatment standards for hazardous soils, and exclusion of recycled wood preserving wastewaters. U.S. Environmental Protection Agency. Fed Regist 63(100)28556.

EPA. 1998g. Listing of fish and wildlife advisories - 1997. Washington, DC: U.S. Environmental Protection Agency, Office of Water/Office of Science and Technology. EPA823C98001, version 3.

*EPA. 1998h. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 116.4.

*EPA. 1998i. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 401.15.

EPA. 1998j. Method 6020A- Inductively coupled plasma - mass spectrometry. In: Test methods for evaluating solid waste. 3rd ed. SW-846. Washington, DC: U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response.

EPA. 1998k. Notice of filing of pesticide petitions. U.S. Environmental Protection Agency. Fed Regist 63:40273-40279.

EPA. 1998l. Method 1632. Chemical speciation of arsenic in water and tissue by hydride generation quartz furnace atomic absorption spectrometry. Revision A. U.S. Environmental Protection Agency. http://www.epa.gov/waterscience/methods/method/files/1632.pdf. August 27, 2007.

*EPA. 1999a. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 372.65.

*EPA. 1999b. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 141.11.

*EPA. 1999c. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 302.4.

*EPA. 1999d. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 261.33.

*EPA. 1999e. National Recommended Water Quality Criteria-Correction. U.S. Environmental Protection Agency, Office of Water. EPA822Z99001.

*EPA. 1999f. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 180.180.

*EPA. 1999g. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 180.3.

EPA. 1999h. International Pesticide Notice: EPA cancels the last agricultural use of arsenic acid in the United States. U.S. Environmental Protection Agency. http://www.epa.gov/oppfead1/17b/arsenic.htm. November 3, 1999.

*EPA. 1999i. Pesticide chemicals classified as known, probable or possible human carcinogens. Environmental Protection Agency. http://www.epa.gov/pesticides/carlist/table.htm. November 3, 1999.

*EPA. 2000a. NCOD query results. Arsenic. Drinking water data. National Contaminant Occurrence Database. Public Water Systems. U.S. Environmental Protection Agency. http://www.epa.gov/ncod/. March 31, 2005.

*EPA. 2000b. National primary drinking water regulations; Arsenic and clarifications to compliance and new source contaminants monitoring; Proposed rule. U.S. Environmental Protection Agency. Fed Regist 65:38888.

EPA. 2000c. Method 6010C - Inductively coupled plasma-atomic emission spectrometry. U.S. Environmental Protection Agency, Office of Solid Waste. http://www.nemi.gov/. April 6, 2005.

EPA. 2001. National primary drinking water regulations; arsenic and clarifications to compliance and new source contaminants monitoring. U.S. Environmental Protection Agency. Fed Regist 66(14):6976-7066.

EPA. 2002a. National primary drinking water regulations. Washington, DC: Office of Ground Water and Drinking Water, U.S. Environmental Protection Agency. EPA816F02013. http://www.epa.gov/safewater/mcl.html. February 15, 2005.

EPA. 2002b. National recommended water quality criteria. Washington, DC: Office of Water, Office of Science and Technology, U.S. Environmental Protection Agency. EPA822R02047. http://www.epa.gov/waterscience/pc/revcom.pdf. February 15, 2005.

EPA. 2003a. Response to requests to cancel certain chromated copper arsenate (CCA) wood preservative products and amendments to terminate certain uses of other CCA products. Fed Regist 68 (68):17366-17372.

EPA. 2003b. Technical summary of information available on the bioaccumulation of arsenic in aquatic organisms. Washington, DC: U.S. Environmental Protection Agency. EPA822R03032. http://www.epa.gov/waterscience/criteria/arsenic/tech-sum-bioacc.pdf. August 27, 2007

EPA. 2004a. Drinking water standards and health advisories. Washington, DC: Office of Water, U.S. Environmental Protection Agency. EPA822R04005. http://www.epa.gov/waterscience/drinking/standards/dwstandards.pdf. February 15, 2005.

EPA. 2004b. Hazardous air pollutants. Washington, DC: U.S. Environmental Protection Agency. United States Code. 42 USC 7412. http://www.epa.gov/ttn/atw/orig189.html. February 15, 2005.

EPA. 2004c. National fish tissue study. Washington, DC: U.S. Environmental Protection Agency. http://www.epa.gov/waterscience/fishstudy/. April 1, 2005.

*EPA. 2004d. Risk assessment guidance for Superfund. Volume I: Human health evaluation manual. Part E: Supplemental guidance for dermal risk assessment. Washington, DC: U.S. Environmental Protection Agency. EPA540R99005. OSWER9285702EP. PB99963312, 3-16, 4-6, 6-2, R-1, R-5, B-20.

EPA. 2005b. 1996. Emissions of arsenic compounds. Technology Transfer Network. National Air Toxics Assessment. Pollutant-Specific Data Tables. U.S. Environmental Protection Agency. http://www.epa.gov/ttn/atw/nata/tablemis.html. March 31, 2005.

EPA. 2005a. Chromated copper arsenate (CCA). U.S. Environmental Protection Agency. http://www.epa.gov/oppad001/reregistration/cca/. February 25, 2005.

EPA. 2005d. Designated as hazardous substances in accordance with Section 311(b)(2)(A) of the Clean Water Act. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 116.4. http://www.epa.gov/ttn/atw/orig189.html. February 15, 2005.

EPA. 2005e. Reportable quantities of hazardous substances designated pursuant to Section 311 of the Clean Water Act. U.S. Environmental Protection Agency. Code of Federal Regulations 40 CFR 117.3. http://www.epa.gov/epacfr40/chapt-I.info/chi-toc.htm. February 16, 2005.

EPA. 2005c. STORET data warehouse. U.S. Environmental Protection Agency. http://www.epa.gov/storet/dw_home.html. April 8, 2005.

EPA. 2005f. Superfund, emergency planning, and community right-to-know programs. Designation, reportable quantities, and notifications. Code of Federal Regulations. 40 CFR 302.4. U.S. Environmental Protection Agency. http://www.epa.gov/epacfr40/chapt-I.info/chi-toc.htm. February 15, 2005.

EPA. 2005g. Superfund, emergency planning, and community right-to-know programs. Extremely hazardous substances and their threshold planning quantities. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 355, Appendix A. http://www.epa.gov/epacfr40/chapt-I.info/chi-toc.htm. February 15, 2005.

EPA. 2005h. Superfund, emergency planning, and community right-to-know programs. Toxic chemical release reporting. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 372.65. http://www.epa.gov/epacfr40/chapt-I.info/chi-toc.htm. February 16, 2005.

EPA. 2005i. Tolerances and exemptions from tolerances for pesticide chemicals in food. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 180.311. http://www.epa.gov/epacfr40/chapt-I.info/chi-toc.htm. February 15, 2005.

EPA. 2005j. Tolerances and exemptions from tolerances for pesticide chemicals in food. U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 180.289. http://www.epa.gov/epacfr40/chapt-I.info/chi-toc.htm. February 15, 2005.

EPA. 2005k. Toxic chemical release inventory reporting forms and instructions: Revised 2004 version. Section 313 of the Emergency Planning and Community Right-to-Know Act (Title III of the Superfund Amendments and Reauthorization Act of 1986). U.S. Environmental Protection Agency. Office of Environmental Information. EPA260B05001.

*EPA. 2005l. Guidelines for carcinogen risk assessment. Washington, DC: U.S. Environmental Protection Agency. EPA630P03001F.

EPA. 2006. Revised reregistration eligibility decision for MSMA, DSMA, CAMA, and cacodylic acid, August 10, 2006. Washington, DC: U.S. Environmental Protection Agency. http://www.epa.gov/oppsrrd1/REDs/organic_arsenicals_red.pdf. September 12, 2006.

EPA. 2007a. Chromated copper arsenate (CCA): Consumer awareness program (CAP). U.S. Environmental Protection Agency. http://www.epa.gov/oppad001/reregistration/cca/cap.htm. January 16, 2007.

EPA. 2007b. Framework for metals risk assessment. U.S. Environmental Protection Agency. EPA120R07001. http://www.epa.gov/osa/metalsframework/pdfs/metals-risk-assessment-final.pdf. August 30, 2007.

Erdogan S, Celik S, Erdogan Z. 2004. Comparison of selected toxic elements in cow serum and milk samples from industrial and rural regions. Bull Environ Contam Toxicol 72(5):931-936.

Erry BV, Macnair MR, Meharg AA, et al. 1999. Seasonal variation in dietary and body organ arsenic concentrations in wood mice *Apodemus sylvaticus* and bank voles *Clethrionomys glareolus*. Bull Environ Contam Toxicol 63:567-574.

*Falk H, Caldwell GG, Ishak KG, et al. 1981a. Arsenic-related hepatic angiosarcoma. Am J Ind Med 2:43-50.

Falk H, Herbert JT, Edmonds L, et al. 1981b. Review of four cases of childhood hepatic angiosarcoma–elevated environmental arsenic exposure in one case. Cancer 47:382-391.

Fan S, Ho I, Yeoh FL, et al. 1996. Squalene inhibits sodium arsenite-induced sister chromatid exchanges and micronuclei in Chinese hamster ovary-K1 cells. Mutat Res 368(3-4):165-169.

Farag AM, Woodward DF, Goldstein JN, et al. 1998. Concentrations of metal associated with mining waste in sediments, biofilm, benthic macroinvertebrates, and fish from the Coeur d'Alene River basin, Idaho. Arch Environ Contam Toxicol 34:119-127.

Farago ME. 1997. Arsenic in the marine environment. In: Gianguzza A, Pelizzetti E, Sammartano S, eds. Marine chemistry. Netherlands: Kluwer Academic Publishers, 275-291.

FDA. 2000. FDA approves arsenic trioxide for leukemia treatment in record time for a cancer drug development program. Food and Drug Administration. http://www.fda.gov/bbs/topics/ANSWERS/ANS01040.html. August 30, 2007.

FDA. 2005. Beverages. Bottled water. Final Rule. Food and Drug Administration. Code of Federal Regulations. 21 CFR 165.110. Fed Regist 70:33694-33701. http://www.fda.gov/OHRMS/DOCKETS/98fr/05-11406.pdf. September 1, 2005.

FEDRIP. 2006. Arsenic. Federal Research in Progress database. Springfield, VA: National Technical Information Service.

FEDRIP. 2007. Arsenic. Federal Research in Progress database. Springfield, VA: National Technical Information Service.

Feldman RG, Niles CA, Kelly-Hayes M, et al. 1979. Peripheral neuropathy in arsenic smelter workers. Neurology 29:939-944.

Feng X, Melander AP, Klaue B. 2000. Contribution of municipal waste incineration to trace metal deposition on the vicinity. Water Air Soil Pollut 119:295-316.

Ferm VH, Carpenter SJ. 1968. Malformations induced by sodium arsenate. J Reprod Fertil 17:199-201.

*Ferm VH, Hanlon DP. 1985. Constant rate exposure of pregnant hamsters to arsenate during early gestation. Environ Res 37:425-432.

Ferm VH, Saxon A, Smith BM. 1971. The teratogenic profile of sodium arsenate in the golden hamster. Arch Environ Health 22:557-560.

*Ferreccio CR, Gonzalez CW, Solari JS, et al. 1995. [Lung cancer in workers exposed to arsenic. A case control study.] Rev Med Chil 124:119-123. (Spanish)

Ferreccio CR, Gonzalez CW, Solari JS, et al. 1996. [Bronchopulmonary cancer in workers exposed to arsenic: A case control study.] Rev Med Chil 124(1):119-123. (Spanish)

Ferreccio C, Gonzalez Psych C, Milosavjlevic Stat V, et al. 1998. Lung cancer and arsenic exposure in drinking water: A case-control study in northern Chile. Cad Saude Publica 14(Suppl 3):193-198.

Ferreccio C, Gonzalez C, Milosavjlevic V, et al. 2000. Lung cancer and arsenic concentrations in drinking water in Chile (Erratum in: Epidemiology 12(2):283). Epidemiology 11(6):673-679.

Fincher R, Koerker RM. 1987. Long-term survival in acute arsenic encephalopathy: Follow-up using newer measures of electrophysiologic parameters. Am J Med 82:549-552.

Flora SJS, Tripathi N. 1998. Hepatic and renal metallothionein induction following single oral administration of gallium arsenide in rats. Biochem Mol Biol Int 45(6):1121-1127.

*Flora SJS, Dube SN, Pant SC, et al. 1994. Effects of multiple gallium arsenide exposure on some biochemical alterations in rat brain [letter]. Ind Health 32(4):247-252.

Flora SJS, Dube SN, Vijayaraghavan R, et al. 1997a. Changes in certain hemetological and physiological variables following single gallium arsenide exposure in rats. Biol Trace Elem Res 58:197-208.

Flora SJS, Kumar P, Kannan GM, et al. 1998. Acute oral gallium arsenide exposure and changes in certain hematological, hepatic, renal and immunological indices at different time intervals in male Wistar rats. Toxicol Lett 94:103-113.

Flora SJS, Pant SC, Malhotra PR, et al. 1997b. Biochemical and histopathological changes in arsenic-intoxicated rats coexposed to ethanol. Alcohol 14(6):563-568.

Florea AM, Yamoah EN, Dopp E. 2005. Intracellular calcium disturbances induced by arsenic and its methylated derivatives in relation to genomic damage and apoptosis induction. Environ Health Perspect 113(6):659-664.

FNB/IOM. 2001. Arsenic, boron, nickel, silicon, and vanadium. Dietary reference intakes for vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium, and zinc (2000). A Report of the Panel on Micronutrients, subcommittees on upper reference levels of nutrients and of interpretation and uses of dietary reference intakes, and the standing committee on the scientific evaluation of dietary reference intakes. Food and Nutrition Board. Institute of Medicine. Washington, DC: National Academy Press, 502-553. http://books.nap.edu/openbook.php?record_id=10026&page=R2. August 30, 2007.

Foà V, Colombi A, Maroni M, et al. 1984. The speciation of the chemical forms of arsenic in the biological monitoring of exposure to inorganic arsenic. Sci Total Environ 34:241-259.

Foà V, Colombi A, Maroni M, et al. 1987. Study of kidney function of workers with chronic low level exposure to inorganic arsenic. In: DeRosa E, Bartolucci GB, Foa V, eds. Occupational and environmental chemical hazards: Cellular and biochemical indices for monitoring toxicity. Horwood, NY: Halsted Press, 362-367.

Fomon SJ. 1966. Body composition of the infant: Part I: The male "reference infant". In: Falkner F, ed. Human development. Philadelphia, PA: WB Saunders, 239-246.

Fomon, SJ, Haschke F, Ziegler EE, et al. 1982. Body composition of reference children from birth to age 10 years. Am J Clin Nutr 35:1169-1175.

*Fowler BA, Woods JS. 1977. The transplacental toxicity of methyl mercury to fetal rat liver mitochondria: Morpho-metric and biochemical studies. Lab Invest 36:122-130.

Fowler BA, Woods JS. 1979. The effects of prolonged oral arsenate exposure on liver mitochondria of mice: Morphometric and biochemical studies. Toxicol Appl Pharmacol 50:177-187.

Fowler BA, Woods JS, Schiller CM. 1977. Ultrastructural and biochemical effects of prolonged oral arsenic exposure on liver mitochondria of rats. Environ Health Perspect 19:197-204.

Foy HM, Tarmapai S, Eamchan P, et al. 1992. Chronic arsenic poisoning from well water in a mining area in Thailand. Asia Pac J Public Health 6(3):150-152.

Francesconi KA, Edmonds JS, Morita M. 1994. Determination of arsenic and arsenic species in marine environmental samples. In: Nriagu JO, ed. Arsenic in the environment: Part II: Human health and ecosystem effects. New York, NY: John Wiley & Sons, Inc., 185-259.

Francis CW, White GH. 1987. Leaching of toxic metals from incinerator ashes. J Water Pollut Control Fed 59(11):979-986.

Franklin M, Bean WB, Harden RC. 1950. Fowler's solution as an etiologic agent in cirrhosis. Am J Med Sci 219:589-596.

Franzblau A, Lilis R. 1989. Acute arsenic intoxication from environmental arsenic exposure. Arch Environ Health 44(6):385-390.

Freeman GB, Johnson JD, Killinger JM, et al. 1993. Bioavailability of arsenic in soil impacted by smelter activities following oral administration in rabbits. Fundam Appl Toxicol 21(1):83-88.

Freeman GB, Schoof RA, Ruby MV, et al. 1995. Bioavailability of arsenic in soil and house dust impacted by smelter activities following oral administration in cynomolgus monkeys. Fundam Appl Toxicol 28(2):215-222.

Frey MM, Edwards MA. 1997. Surveying arsenic occurrence. J Am Water Works Assoc 89(3):105-117.

*Frost DV. 1987. Interrelationships of selenium and arsenic in biology. In: Combs GF, Levander OA, Spallholz JE, et al., eds. Selenium in biology and medicine: Part A: Proceedings of the Third International Symposium, Beijing, China, May 27-June 1, 1984. New York, NY: Van Nostrand Reinhold Company, 308-323.

Frost F, Harter L, Milham S, et al. 1987. Lung cancer among women residing close to an arsenic emitting copper smelter. Arch Environ Health 42(2):148-152.

Frost FJ, Muller T, Petersen HV, et al. 2003. Identifying US populations for the study of health effects related to drinking water arsenic. J Expo Anal Environ Epidemiol 13(3):231-239.

*Fujino Y, Guo X, Liu J, et al. 2004. Mental health burden amongst inhabitants of an arsenic-affected area in Inner Mongolia, China. Soc Sci Med 59(9):1963-1973.

Gailer J, George GN, Pickering IJ, et al. 2002. Biliary excretion of [(GS)2AsSe]- after intravenous injection of rabbits with arsenite and selenate. Chem Res Toxicol 15:1466-1471.

Gaines TB. 1960. The acute toxicity of pesticides to rats. Toxicol Appl Pharmacol 2:88-99.

Gallagher RE. 1998. Arsenic--new life for old potion. N Engl J Med 339(19):1389-1391.

Gao S, Burau RG. 1997. Environmental factors affecting rates of arsine evolution from and mineralization of arsenicals in soils. J Environ Qual 26(3):753-763.

Garbarino JR, Bednar AJ, Rutherford DW, et al. 2003. Environmental fate of roxarsone in poultry litter. I. Degradation of roxarsone during composting. Environ Sci Technol 37:1509-1514.

Garcia F, Ortega A, Domingo JL, et al. 2001. Accumulation of metals in autopsy tissues of subjects living in Tarragona county, Spain. J Environ Sci Health Part A 36(9):1767-1786.

García-Vargas GG, Hernández-Zavala A. 1996. Urinary porphyrins and heme biosynthetic enzyme activities measured by HPLC in arsenic toxicity. Biomed Chromatogr 10(6):278-284.

*García-Vargas GG, Del Razo LM, Cebrián ME, et al. 1994. Altered urinary porphyrin excretion in a human population chronically exposed to arsenic in Mexico. Hum Exp Toxicol 13(12):839-847.

*Garland M, Morris JS, Rosner BA, et al. 1993. Toenail trace element levels as biomarkers: Reproducibility over a 6-year period. Cancer Epidemiol Biomarkers Prev 2(5):493-497.

Gartrell MJ, Craun JC, Podrebarac DS, et al. 1986. Pesticides, selected elements, and other chemicals in adult total diet samples, October 1980-March 1982. J Assoc Off Anal Chem 69(1):146-161.

Garvey GJ, Hahn G, Lee RV, et al. 2001. Heavy metal hazards of Asian traditional remedies. Int J Environ Health Res 11(1):63-71.

*Gebel T. 1997. Arsenic and antimony: Comparative approach on mechanistic toxicology. Chem Biol Interact 107:131-144.

Gebel T, Birkenkamp P, Luthin S, et al. 1998a. Arsenic(III), but not antimony(III), induces DNA-protein crosslinks. Anticancer Res 18:4253-4258.

Gebel T, Christensen S, Dunkelberg H. 1997. Comparative and environmental genotoxicity of antimony and arsenic. Anticancer Res 17(4a):2603-2607.

Gebel TW, Suchenwirth RHR, Bolten C, et al. 1998b. Human biomonitoring of arsenic and antimony in case of an elevated geogenic exposure. Environ Health Perspect 106(1):33-39.

*Geiszinger A, Goessler W, Pedersen SN, et al. 2001. Arsenic biotransformation by the brown macroalga, *Fucus serratus*. Environ Toxicol Chem 20(10):2255-2262.

Gentry PR, Covington TR, Mann S, et al. 2004. Physiologically based pharmacokinetic modeling of arsenic in the mouse. J Toxicol Environ Health A 67(1):43-71.

Gerhardsson L, Brune D, Nordberg IGF, et al. 1985. Protective effect of selenium on lung cancer in smelter workers. Br J Ind Med 42:617-626.

Gerhardsson L, Brune D, Nordberg IGF, et al. 1988. Multielemental assay of tissues of deceased smelter workers and controls. Sci Total Environ 74:97-110.

*Gerhardt RE, Hudson JB, Rao RN, et al. 1978. Chronic renal insufficiency from cortical necrosis induced by arsenic poisoning. Arch Intern Med 138:1267-1269.

*Germolec DR, Spalding J, Boorman GA, et al. 1997. Arsenic can mediate skin neoplasia by chronic stimulation of keratinocyte-derived growth factors. Mutat Res 86(3):209-218.

Germolec DR, Spalding J, Yu H, et al. 1998. Arsenic enhancement of skin neoplasia by chronic stimulation of growth factors. Am J Pathol 153(6):1775-1785.

Gerr F, Letz R, Ryan PB, et al. 2000. Neurological effects of environmental exposure to arsenic in dust and soil among humans. Neurotoxicology 21(4):475-87.

Geubel AP, Mairlot MC, Buchet JP, et al. 1988. Abnormal methylation capacity in human liver cirrhosis. Int J Clin Pharmacol Res 8(2):117-122.

Ghosh P, Basu A, Mahata J, et al. 2006. Cytogenic damage and genetic variants in the individuals susceptible to arsenic-induced cancer through drinking water. Int J Cancer 118(10):2470-2478.

*Gianessi LP, Anderson JE. 1995a. Cacodylic acid. Pesticide use in U.S. crop production: National data report. Washington DC: National Center for Food and Agricultural Policy.

*Gianessi LP, Anderson JE. 1995b. Pesticide use in U.S. crop production. Washington, DC: National Center for Food and Agricultural Policy.

Gibson DP, Brauninger R, Shaffi HS, et al. 1997. Induction of micronuclei in Syrian hamster embryo cells: Comparison of results in the SHE cell transformation assay for national toxicology program test chemicals. Mutat Res 392(1-2):61-70.

Giwercman A, Carlsen E, Keiding N, et al. 1993. Evidence for increasing incidence of abnormalities of the human testis: A review. Environ Health Perspect Suppl 101(2):65-71.

Glazener FS, Ellis JG, Johnson PK. 1968. Electrocardiographic findings with arsenic poisoning. Calif Med 109(2):158-162.

Goddard MJ, Tanhehco JL, Dau PC. 1992. Chronic arsenic poisoning masquerading as Landry-Guillain-Barre syndrome. Electromyogr Clin Neurophysiol 32(9):419-423.

Goebel HH, Schmidt PF, Bohl J, et al. 1990. Polyneuropathy due to acute arsenic intoxication: Biopsy studies. J Neuropathol Exp Neurol 49(2):137-149.

Goering PL, Maronpot RR, Fowler BA. 1988. Effect of intratracheal gallium arsenide administration on ■-aminolevulinic acid dehydratase in rats: Relationship to urinary excretion of aminolevulinic acid. Toxicol Appl Pharmacol 92:179-193.

Goldfrank RL, Flomenbaum NE, Lewin NA, et al., eds. 1998. Goldfrank's toxicologic emergencies. 6th ed. Stamford, CT: Appleton and Lange, 1261-1273.

Goldsmith JR, Deane M, Thom J, et al. 1972. Evaluation of health implications of elevated arsenic in well water. Water Res 6:1133-1136.

Goldsmith S, From AHL. 1986. Arsenic-induced atypical ventricular tachycardia. N Engl J Med 303:1096-1097.

Golomb D, Ryan D, Eby N, et al. 1997. Atmospheric deposition of toxics onto Massachusetts Bay-I. Metals. Atmos Environ 31(9):1349-1359.

*Gonsebatt ME, Vega L, Salazar AM, et al. 1997. Cytogenetic effects in human exposure to arsenic. Mutat Res 386(3):219-228.

Gonzalez MJ, Aguilar MV, Martínez Para MC. 1995. Gastrointestinal absorption of inorganic arsenic (V): The effect of concentration and interactions with phosphate and dichromate. Vet Human Toxicol 37:131-136.

Grandjean P, Weihe P, Needham LL, et al. 1995. Relation of a seafood diet to mercury, selenium, arsenic, and polychlorinated biphenyl and other organochlorine concentrations in human milk. Environ Res 71(1):29-38.

*Greenberg SA. 1996. Acute demyelinating polyneuropathy with arsenic ingestion. Muscle Nerve 19(12):1611-1613.

Groen K, Vaessen HAMG, Kliest JJG, et al. 1993. Bioavailability of inorganic arsenic from bog ore-containing soil in the dog. Environ Health Perspect 102(2):182-184.

Guerin T, Astruc A, Astruc M. 1999. Speciation of arsenic and selenium compounds by HPLC hyphenated to specific detectors: A review of the main separation techniques. Talanta 50:1-24.

Guha Mazumder DN. 1996. Treatment of chronic arsenic toxicity as observed in West Bengal. J Indian Med Assoc 94(2):41-42.

Guha Mazumder DN. 2005. Effect of chronic intake of arsenic-contaminated water on liver. Toxicol Appl Pharmacol 206(2):169-175.

Guha Mazumder DN, Chakraborty AK, Ghose A, et al. 1988. Chronic arsenic toxicity from drinking tubewell water in rural west Bengal. Bull WHO 66(4):499-506.

Guha Mazumder DN, Das Gupta J, Santra A, et al. 1998a. Chronic arsenic toxicity in west Bengal--the worst calamity in the world. J Indian Med Assoc 96(1):4-7.

Guha Mazumder DN, Ghoshal UC, Saha J, et al. 1998b. Randomized placebo-controlled trial of 2,3-dimercaptosuccinic acid in therapy of chronic arsenicosis due to drinking arsenic-contaminated subsoil water. Clin Toxicol 36(7):683-690.

Guha Mazumder DN, Haque R, Ghosh N, et al. 1998c. Arsenic levels in drinking water and the prevalence of skin lesions in West Bengal, India. Int J Epidemiol 27:871-877.

Guha Mazumder DN, Steinmaus C, Bhattacharya P, et al. 2005. Bronchiectasis in persons with skin lesions resulting from arsenic in drinking water. Epidemiology 16(6):760-765.

Gunderson EL. 1995a. Dietary intake of pesticides, selected elements, and other chemicals: FDA total diet study, June 1984-April 1986. J AOAC Int 78(4):910-921.

Gunderson EL. 1995b. FDA total diet study, July 1986-April 1991, dietary intakes of pesticides, selected elements, and other chemicals. J AOAC Int 78(6):1353-63.

Gunn TM, Juriloff DM, Harris MJ. 1992. Further genetic studies of the cause of exancephaly in SELH mice. Teratology 45:679-686.

Guo HR. 2004. Arsenic level in drinking water and mortality of lung cancer (Taiwan). Cancer Causes Control 15:171-177.

Guo HR, Tseng YC. 2000. Arsenic in drinking water and bladder cancer: Comparison between studies based on cancer registry and death certificates. Environ Geochem Health 22: 83-91.

Guo HR, Yu HS, Hu H, et al. 2001b. Arsenic in drinking water and skin cancers: Cell-type specificity (Taiwan, R.O.C.). Cancer Causes Control 12(10):909-916.

Guo T, Baasner J, Tsalev DL. 1997. Fast automated determination of toxicologically relevant arsenic in urine by flow injection-hydride generation atomic absorption spectrometry. Analytica Chimica Acta 349(1-3):313-318.

Guo X, Fujino Y, Kaneko S, et al. 2001a. Arsenic contamination of groundwater and prevalence of arsenical dermatosis in the Hetao plain area, Inner Mongolia, China. Mol Cell Biochem 222(1-2):137-140.

Gur E, Nyska A. 1990. Acute oral toxicity study in rats. Luxembourg Industries (Pamol) Ltd. Submitted to the U.S. Environmental Protection Agency. MRID45405601.

Gur E, Nyska A, Pirak M, et al. 1989a. Cacodylic acid oncogenicity study in the mouse. Luxembourg Industries (Pamol) Ltd. Submitted to the U.S. Environmental Protection Agency. MRID41914601.

Gur E, Nyska A, Waner T, et al. 1989b. Cacodylic acid combined chronic feeding and oncogenicity study in the rat. Luxembourg Industries (Pamol) Ltd. Submitted to the U.S. Environmental Protection Agency. MRID41862101.

Gur E, Pirak M, Waner T. 1991. Methanearsonic acid oncogenicity study in the mouse. Luxembourg Industries (Pamol) Ltd. Submitted to the U.S. Environmental Protection Agency. MRID42173201.

Gutleb AC, Helsberg A, Mitchell C. 2002. Heavy metal concentrations in fish from a pristine rainforest valley in Peru: A baseline study before the start of oil-drilling activities. Bull Environ Contam Toxicol 69:523-529.

Guzelian PS, Henry CJ, Olin SS, eds. 1992. Similarities and differences between children and adults: Implications for risk assessment. Washington, DC: International Life Sciences Institute Press.

Haddad LM, Winchester JF. 1990. Clinical management of poisoning and drug overdose. 2nd ed. Philadelphia, PA: W.B. Saunders Company, 1024-1027, 18, 92, 97, 98.

*Hall JC, Harruff R. 1989. Fatal cardiac arrhythmia in a patient with interstitial myocarditis related to chronic arsenic poisoning. South Med J 82(12):1557-1560.

Hamel SC, Buckley B, Lioy PJ. 1998. Bioaccessibility of metals in soils for different liquid to solid ratios in synthetic gastric fluid. Environ Sci Tech 32(3):358-362.

Hanlon DP, Ferm VH. 1977. Placental permeability of arsenate ion during early embryogenesis in the hamster. Experientia 33(9):1221-1222.

Hanlon DP, Ferm VH. 1986. Teratogen concentration changes as the basis of the heat stress enhancement of arsenate teratogenesis in hamsters. Teratology 34:189-193.

*Hanlon DP, Ferm VH. 1987. The concentration and chemical status of arsenic in the early placentas of arsenate-dosed hamsters. Environ Res 42:546-552.

Hantson P, Verellen-Dumoulin C, Libouton JM, et al. 1996. Sister chromatid exchanges in human peripheral blood lymphocytes after ingestion of high doses of arsenicals. Int Arch Occup Environ Health 68:342-344.

Hanusch K, Grossmann H, Herbst K, et al. 1985. Arsenic and arsenic compounds. In: Gerhartz W, Yamamoto YS, Campbell FT, et al., eds. Ullman's encyclopedia of industrial chemistry. Weinham, Germany: VCH Verlagsgesellschaft, 113-141

Haque R, Mazumder DN, Samanta S, et al. 2003. Arsenic in drinking water and skin lesions: Dose-response data from West Bengal, India. Epidemiology 14(2):174-182.

Harrington JM, Middaugh JP, Morse DL, et al. 1978. A survey of a population exposed to high concentrations of arsenic in well water in Fairbanks, Alaska. Am J Epidemiol 108(5):377-385.

Harrisson JWE, Packman EW, Abbott DD. 1958. Acute oral toxicity and chemical and physical properties of arsenic trioxides. Arch Ind Health 17:118-123.

Hartmann A, Speit G. 1994. Comparative investigations of the genotoxic effects of metals in the single cell gel (SCG) assay and the sister chromatid exchange (SCE) test. Environ Mole Mutagen 23(4):299-305.

Hartmann A, Speit G. 1996. Effect of arsenic and cadmium on the persistence of mutagen-induced DNA lesions in human cells. Environ Mol Mutagen 27(2):98-104.

*Hartwell TW, Handy RW, Harris BS, et al. 1983. Heavy metal exposure in populations living around zinc and copper smelters. Arch Environ Health 38(5):284-295.

Hartwig A, Gröblinghoff UD, Beyersmann D, et al. 1997. Interaction of arsenic(III) with nucleotide excision repair in UV-irradiated human fibroblasts. Carcinogenesis 18(2):399-405.

Hartwig A, Mullenders L, Asmuá M, et al. 1998. Disruption of DNA repair process by carcinogenic metal compounds. Fresenius J Anal Chem 361:377-380.

Haupert TA, Wiersma JH, Goldring JM. 1996. Health effects of ingesting arsenic-contaminated groundwater. Wis Med J 95(2):100-104.

Hayakawa T, Kobayashi Y, Cui X, et al. 2005. A new metabolic pathway of arsenite: Arsenite-glutathione complexes are substrates for human arsenic methyltransferase Cyt19. Arch Toxicol 79:183-191.

Hayashi H, Kanisawa M, Yamanaka K, et al. 1998. Dimethylarsinic acid, a main metabolite of inorganic arsenics, has tumorigenecity and progression effects in the pulmonary tumors of A/J mice. Cancer Lett 125:83-88.

HazDat. 2006. Arsenic. ATSDR's Hazardous substance release and health effects database. Agency for Toxic Substances and Disease Registry. http://www.atsdr.cdc.gov/hazdat.html. October 16, 2006.

He X, Logan TJ, Traina SJ. 1995. Physical and chemical characteristics of selected US municipal solid waste compost. J Environ Qual 24:543-552.

Healy SM, Casarez EA, Ayala-Fierro F, et al. 1998. Enzymatic methylation of arsenic compounds. V. Arsenite methyltransferase activity in tissues of mice. Toxicol Appl Pharmacol 148(1):65-70.

Heck JE, Gamble MV, Chen Y, et al. 2007. Comsumption of folate-related nutrients and metabolism of arsenic in Bangladesh. Am J Clin Nutr 85:1367-1374.

Hei TK, Liu SX, Waldren C. 1998. Mutagenicity of arsenic in mammalian cells: Role of reactive oxygen species. Proc Natl Acad Sci U S A 95:8103-8107.

Heiny JS, Tate CM. 1997. Concentration, distribution, and comparison of selected trace elements in bed sediment and fish tissue in the South Platte River basin, USA, 1992-1993. Arch Environ Contam Toxicol 32(3):246-259.

Heit M, Klusek C, Baron J. 1984. Evidence of deposition of anthropogenic pollutants in remote Rocky Mountain lakes. Water Air Soil Pollut 22:403-416.

Heitkemper DT, Kaine LA, Jackson DS, et al. 1994. Practical applications of element-specific detection by inductively coupled plasma atomic emission spectroscopy and inductively coupled plasma mass spectrometry to ion chromatography of foods. J Chromatogr A 671(1-2):101-108.

Helgesen H, Larsen EH. 1998. Bioavailability and speciation of arsenic in carrots grown in contaminated soil. Analyst 123(5):791-796.

Helleday T, Nilsson R, Jenssen D. 2000. Arsenic [111] and heavy metal ions induce intrachromosomal homologous recombination in the hprt gene V79 Chinese hamster cells. Environ Mol Mutagen 35(2):114-122.

Hemond HF, Solo-Gabriele HM. 2004. Children's exposure to arsenic from CCA-treated wooden decks and playground structures. Risk Anal 24(1):51-64.

Hernández-Zavala A, Del Razo LM, Aguilar C, et al. 1998. Alteration in bilirubin excretion in individuals chronically exposed to arsenic in Mexico. Toxicol Lett 99:79-84.

Hershey JW, Oostdyk TS, Keliher PN. 1988. Determination of arsenic and selenium in environmental and agricultural samples by hydride generation atomic adsorption spectrometry. J Assoc Off Anal Chem 71(6):1090-1093.

Hertz-Picciotto I, Smith AH. 1993. Observations on the dose-response curve for arsenic exposure and lung cancer. Scand J Work Environ Health 19(4):217-226.

*Hessl SM, Berman E. 1982. Severe peripheral neuropathy after exposure to monosodium methyl arsonate. J Toxicol Clin Toxicol 19:281-287.

Hewitt DJ, Millner GC, Nye AC, et al. 1995. Investigation of arsenic exposure from soil at a Superfund site. Environ Res 68(2):73-81.

Heydorn K. 1970. Environmental variation of arsenic levels in human blood determined by neutron activation analysis. Clin Chim Acta 28:349-357.

Heyman A, Pfeiffer JB, Willett RW, et al. 1956. Peripheral neuropathy caused by arsenical intoxication: A study of 41 cases with observations on the effects of BAL (2,3 dimercapto-propanol). N Engl J Med 254(9):401-409.

Heywood R, Sortwell RJ. 1979. Arsenic intoxication in the Rhesus monkey. Toxicol Lett 3:137-144.

Hill CH. 1975. Interrelationships of selenium with other trace elements. Fed Proc 34(11):2096-2100.

Hindmarsh JT, McCurdy RF. 1986. Clinical and environmental aspects of arsenic toxicity. CRC Crit Rev Clin Lab Sci 23:315-347.

Hindmarsh JT, McLetchie OR, Heffernan LPM, et al. 1977. Electromyographic abnormalities in chronic environmental arsenicalism. J Anal Toxicol 1:270-276.

Hingston JA, Collins CD, Murphy RJ, et al. 2001. Leaching of chromated copper arsenate wood preservatives: A review. Environ Pollut 111(1):53-66.

Hirata M, Hisanaga A, Tanaka A, et al. 1988. Glutathione and methylation of inorganic arsenic in hamsters. Appl Organomet Chem 2:315-321.

Historic Pesticide Contamination Task Force. 1999. Findings and recommendations for the remediation of historic pesticide contamination. New Jersey Department of Environmental Protection. Historic Pesticide Contamination Task Force. http://www.state.nj.us/dep/special/hpctf/final/hpctf99.pdf. August 27, 2007.

Hochadel JF, Waalkes MP. 1997. Sequence of exposure to cadmium and arsenic determines the extent of toxic effects in male Fischer rats. Toxicology 116:89-98.

Hoel DG, Davis DL, Miller AB, et al. 1992. Trends in cancer mortality in 15 industrialized countries, 1969-1986. J Natl Cancer Inst 84(5):313-320.

Hoff RM, Strachan WMJ, Sweet CW, et al. 1996. Atmospheric deposition of toxic chemicals to the Great Lakes: A review of data through 1994. Atmos Environ 30(20):3505-3527.

Holland JW. 1904. Arsenic. In: Peterson F, Haines WS, eds. A textbook of legal medicine and toxicology. Philadelphia, PA: WB Saunders and Co., 404-433.

Holland RH, McCall MS, Lanz HC. 1959. A study of inhaled arsenic-74 in man. Cancer Res 19:1154-1156.

Holmberg RE, Ferm VH. 1969. Interrelationships of selenium, cadmium and arsenic in mammalian teratogenesis. Arch Environ Health 18:873-877.

Holmqvist I. 1951. Occupational arsenical dermatitis: A study among employees at a copper ore smelting work including investigations of skin reactions to contact with arsenic compounds. Acta Derm Venerol 31(Suppl 26):26-29, 44-45, 110-112, 195-204.

Holson JF, Stump DG, Clevidence KJ, et al. 2000. Evaluation of the prenatal developmental toxicity of orally administered arsenic trioxide in rats. Food Chem Toxicol 38:459-466.

Holson JF, Stump DG, Ulrich CE, et al. 1999. Absence of prenatal developmental toxicity from inhaled arsenic trioxide in rats. Toxicol Sci 51:87-97.

Hood RD. 1985. Cacodylic acid: Agricultural uses, biological effects and environmental fate. Washington, DC: Agent Orange Projects Office. Veterans Administration Central Office, 1-2, 22-24, 35-49, 95-106.

*Hood RD. 1998. Developmental effects of methylated arsenic metabolites in mice. Bull Environ Contam Toxicol 61:231-238.

Hood RD, Bishop SL. 1972. Teratogenic effects of sodium arsenate in mice. Arch Environ Health 24:62-65.

Hood RD, Harrison WP. 1982. Effects of prenatal arsenite exposure in the hamster. Bull Environ Contam Toxicol 29:671-678.

*Hood RD, Harrison WP, Vedel JC. 1982. Evaluation of arsenic metabolites for prenatal effects in the hamster. Bull Environ Contam Toxicol 29:679-687.

Hood RD, Thacker GT, Patterson BL, et al. 1978. Prenatal effects of oral versus intraperitoneal sodium arsenate in mice. J Environ Pathol Toxicol 1:857-864.

Hood RD, Vedel GC, Zaworotko MJ, et al. 1988. Uptake distribution and metabolism of trivalent arsenic in the pregnant mouse. J Toxicol Environ Health 25:423-434.

Hood RD, Vedel-Macrander GC, Zaworotko MJ, et al. 1987. Distribution, metabolism and fetal uptake of pentavalent arsenic in pregnant mice following oral or intraperitoneal administration. Teratology 35:19-25.

Hopenhayn C, Bush HM, Bingcang A, et al. 2006. Association between arsenic exposure from drinking water and anemia during pregnancy. J Occup Environ Hyg 48(6):635-643.

Hopenhayn C, Ferreccio C, Browning SR, et al. 2003a. Arsenic exposure from drinking water and birth weight. Epidemiology 14(5):593-602.

Hopenhayn C, Huang B, Christian J, et al. 2003b. Profile of urinary arsenic metabolites during pregnancy. Environ Health Perspect 111(16):1888-1891.

Hopenhayn-Rich C, Biggs ML, Fuchs A, et al. 1996a. Bladder cancer mortality associated with arsenic in drinking water in Argentina. Epidemiology 7(2):117-124.

Hopenhayn-Rich C, Biggs ML, Smith AH, et al. 1996b. Methylation study of a population environmentally exposed to arsenic in drinking water. Environ Health Perspect 104(6):620-628.

Hopenhayn-Rich C, Biggs ML, Smith AH. 1998. Lung and kidney cancer mortality associated with arsenic in drinking water in Córdoba, Argentina. Int J Epidemiol 27:561-569.

Hopenhayn-Rich C, Browning SR, Hertz-Picciotto I, et al. 2000. Chronic arsenic exposure and risk of infant mortality in two areas of Chile. Environ Health Perspect 108(7):667-673.

Howell GO, Hill CH. 1978. Biological interaction of selenium with other trace elements in chicks. Environ Health Perspect 25:147-150.

HSDB. 2007. Arsenic. Hazardous Substances Data Bank. National Library of Medicine. http://toxnet.nlm.nih.gov. January 16, 2007.

*Hsieh LL, Chen HJ, Hsieh JT, et al. 1994. Arsenic-related Bowen's disease and paraquat-related skin cancerous lesions show no detectable ras and p53 gene alterations. Cancer Lett 86:59-65.

Hsu CH, Yang SA, Wang JY, et al. 1999. Mutational spectrum of p53 gene in arsenic-related skin cancers from the blackfoot disease endemic area of Taiwan. Br J Cancer 80(7):1080-1086.

Hsu YH, Li SY, Chiou HY, et al. 1997. Spontaneous and induced sister chromatid exchanges and delayed cell proliferation in peripheral lymphocytes of Bowen's disease patients and matched controls of arseniasis-hyperendemic villages in Taiwan. Mutat Res 386(3):241-251.

Hsueh YM, Cheng GS, Wu MM, et al. 1995. Multiple risk factors associated with arsenic-induced skin cancer: Effects of chronic liver disease and malnutritional status. Br J Cancer 71(1):109-14.

Hsueh YM, Huang YL, Huang CC, et al. 1998a. Urinary levels of inorganic and organic arsenic metabolites among residents in an arseniasis-hyperendemic area in Taiwan. J Toxicol Environ Health 54(6):431-444.

Hsueh YM, Lin P, Chen HW, et al. 2005. Genetic polymorphisms of oxidative and antioxidant enzymes and arsenic-related hypertension. J Toxicol Environ Health A 68(17-18):1471-1484.

Hsueh YM, Wu WL, Huang YL, et al. 1998b. Low serum carotene level and increase risk of ischemic heart disease related to long-term arsenic exposure. Atherosclerosis 141:249-257.

Hu Y, Su L, Snow ET. 1998. Arsenic toxicity is enzyme specific and its effects on ligation are not caused by the direct inhibition of DNA repair enzymes. Mutat Res 408:203-218.

Huang H, Huang CF, Huang JS, et al. 1992. The transition from late G_1 to early S phase is most vulnerable to the coclastogenic effect of ultraviolet radiation plus arsenite. Int J Radiat Biol 61(1):57-62.

Huang H, Huang CF, Wu DR, et al. 1993. Glutathione as a cellular defense against arsenite toxicity in cultured Chinese hamster ovary cells. Toxicology 79(3):195-204.

Huang RN, Ho IC, Yih LH, et al. 1995. Sodium arsenite induces chromosome endoreduplication and inhibits protein phosphatase activity in human fibroblasts. Environ Mol Mutagen 25(3):188-196.

*Huang SY, Chang CS, Tang JL, et al. 1998. Acute and chronic arsenic poisoning associated with treatment of acute promyelocytic leukaemia. Br J Haematol 103:1092-1095.

Huang YZ, Qian XC, Wang GQ, et al. 1985. Endemic chronic arsenism in Xinjiang. Chin Med J 98(3):219-222.

Huggett DB, Khan IA, Allgood JC, et al. 2001. Organochlorine pesticides and metals in select botanical dietary supplements. Bull Environ Contam Toxicol 66:150-155.

Hughes MF. 2002. Arsenic toxicity and potential mechanisms of action. Toxicol Lett 133(1):1-16.

Hughes MF. 2006. Biomarkers of exposure: A case study with inorganic arsenic. Environ Health Perspect 114:1790-1796.

*Hughes MF, Kenyon EM. 1998. Dose-dependent effects on the disposition of monomethylarsonic acid and dimethylarsinic acid in the mouse after intravenous administration. J Toxicol Environ Health A53(2):95-112.

Hughes MF, Del Razo LM, Kenyon EM. 2000. Dose-dependent effects on tissue distribution and metabolism of dimethylarsinic acid in the mouse after intravenous administration. Toxicology 143(2):155-166.

Hughes MF, Devesa V, Adair BM, et al. 2005. Tissue dosimetry, metabolism and excretion of pentavalent and trivalent monomethylated arsenic in mice after oral administration. Toxicol Appl Pharmacol 208:186-197.

Hughes MF, Kenyon EM, Edwards BC, et al. 2003. Accumulation and metabolism of arsenic in mice after repeated oral administration of arsenate. Toxicol Appl Pharmacol 191(3):202-210.

Hughes MF, Menache M, Thompson DJ. 1994. Dose-dependent disposition of sodium arsenate in mice following acute oral exposure. Fundam Appl Toxicol 22(1):80-89.

*Hullinger G, Sangster L, Colvin B, et al. 1998. Bovine arsenic toxicosis from ingestion of ashed copper-chrome-arsenate treated timber. Vet Hum Toxicol 40(3):147-148.

Hwang YH, Chen SC. 2000. Monitoring of low level arsenic exposure during maintenance of ion implanters. Arch Environ Health 55(5):347-354.

Hwang YH, Bornschein RL, Grote J, et al. 1997a. Environmental arsenic exposure of children around a former copper smelter site. Environ Res 72(1):72-81.

Hwang YH, Bornschein RL, Grote J, et al. 1997b. Urinary arsenic excretion as a biomarker of arsenic exposure in children. Arch Environ Health 52(2):139-147.

IARC. 1980. Arsenic and arsenic compounds. IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans. Vol. 23. Some metals and metallic compounds. Lyon, France: International Agency for Research on Cancer, 39-141.

IARC. 2004. Overall evaluations of carcinogenicity to humans: As evaluated in IARC Monographs volumes 1-82 (at total of 900 agents, mixtures and exposures). Lyon, France: International Agency for Research on Cancer. http://www-cie.iarc.fr/monoeval/crthall.html. March 08, 2006.

Ide CW, Bullough GR. 1988. Arsenic and old glass. J Soc Occup Med 38:85-88.

Ihrig MM, Shalat SL, Baynes C. 1998. A hospital-based case-control study of stillbirths and environmental exposure to arsenic using and atmospheric dispersion model linked to a geographical information system. Epidemiology 9(3):290-294.

Inoue Y, Kawabata K, Takahashi H, et al. 1994. Determination of arsenic compounds using inductively coupled plasma mass spectrometry with ion chromatography. J Chromatog A675(1-2):149-154.

IRIS. 2007. Arsenic. Integrated Risk Information System. Washington, DC: U.S. Environmental Protection Agency. http://www.epa.gov/iris/subst/index.html. August 28, 2007.

Irvine L, Boyer IJ, DeSesso JM. 2006. Monomethylarsonic acid and dimethylarsenic acid: Developmental toxicity studies with risk assessment. Birth Defects Res B Dev Reprod Toxicol 77:53-68.

*Ishinishi N, Kodama Y, Nobutomo K, et al. 1977. Preliminary experimental study on carcinogenicity of arsenic trioxide in rat lung. Environ Health Perspect 19:191-196.

Ishinishi N, Yamamoto A, Hisanaga A, et al. 1983. Tumorigenicity of arsenic trioxide to the lung in Syrian golden hamsters by intermittent instillations. Cancer Lett 21:141-147.

ITA. 2007a. U.S. trade quick-reference tables: December 2005 imports. 280480: Arsenic. International Trade Association, U.S. Department of Commerce. http://hq-tpisweb.ita.doc.gov/portal/page/portal/rptsforms/p_hsmthly?p_year=2005&p_hs=2804800000&p_month="December"&p_flow="imports"&p_table=ita.hs_10dig_mcons_mth_Dec_2005. February 07, 2007.

ITA. 2007b. U.S. trade quick-reference tables: December 2005 imports. 281129: Arsenic trioxide. International Trade Association, U.S. Department of Commerce. http://hq-tpisweb.ita.doc.gov/portal/page/portal/rptsforms/p_hsmthly?p_year=2005&p_hs=2811291000&p_month="December"&p_flow="imports"&p_table=ita.hs_10dig_mcons_mth_Dec_2005. February 07, 2007.

*Ivankovic S, Eisenbrand G, Preussmann R. 1979. Lung carcinoma induction in BD rats after a single intratracheal instillation of an arsenic-containing pesticide mixture formerly used in vineyards. Int J Cancer 24:786-788.

*Jacobson-Kram D, Montalbano D. 1985. The reproductive effects assessment group's report on the mutagenicity of inorganic arsenic. Environ Mutagen 7:787-804.

Jager JW, Ostrosky-Wegman P. 1997. Arsenic: A paradoxical human carcinogen. Mutat Res 386(3):181-184.

Jaghabir MTW, Abdelghani A, Anderson AC. 1988. Oral and dermal toxicity of MSMA to New Zealand white rabbits, *Oryctalagus cuniculus*. Bull Environ Contam Toxicol 40:119-122.

Jaghabir MTW, Abdelghani AA, Anderson AC. 1989. Histopathological effects of monosodium methanearsonate (MSMA) on New Zealand white rabbits (*Oryctalagus cuniculus*). Bull Environ Contam Toxicol 42:289-293.

Jain A, Loeppert RH. 2000. Effect of competing anions on the adsorption of arsenate and arsenite by ferrihydrite. J Environ Qual 29:1422-1430.

Jain A, Raven KP, Loeppert RH. 1999. Arsenite and arsenate adsorption on ferrihydrite: Surface charge reduction and net OH^- release stoichiometry. Environ Sci Technol 33:1179-1184.

Jan KY, Huang RY, Lee TC. 1986. Different modes of action of sodium arsenite, 3-aminobenzamide and caffeine on the enhancement of ethyl methanesulfonate clastogenicity. Cytogenet Cell Genet 41:202-208.

Janssen RPT, Peijnenburg WJGM, Posthuma L, et al. 1997. Equilibrium partitioning of heavy metals in Dutch field soils: I. Relationship between metal partition coefficients and soil characteristics. Environ Toxicol Chem 16(12):2470-2478.

Järup L, Pershagen G. 1991. Arsenic exposure, smoking, and lung cancer in smelter workers - a case-control study. Am J Epid 134(6):545-551.

Järup L, Pershagen G, Wall S. 1989. Cumulative arsenic exposure and lung cancer in smelter workers: A dose-response study. Am J Ind Med 15:31-41.

Jelinek CF, Corneliussen PE. 1977. Levels of arsenic in the United States food supply. Environ Health Perspect 19:83-87.

Jenkins RB. 1966. Inorganic arsenic and the nervous system. Brain 89:479-498.

Jensen GE, Hansen ML. 1998. Occupational arsenic exposure and glycosylated haemoglobin. Analyst 123(1):77-80.

Jensen GE, Olsen ILB. 1995. Occupational exposure to inorganic arsenic in wood workers and taxidermists-air sampling and biological monitoring. J Environ Sci Health A30(4):921-938.

Jha AN, Noditi M, Nilsson R, et al. 1992. Genotoxic effects of sodium arsenite on human cells. Mutat Res 284(2):215-221.

*Jiang JQ. 2001. Removing arsenic from groundwater for the developing world--a review. Water Sci Technol 44(6):89-98.

*Jianhua N, Guoqiang C, Zhiziang S, et al. 1998. Pharmacokinetics of intravenous arsenic trioxide in the treatment of acute promyelocytic leukemia. Chin Med J 111(12):1107-1110.

Jin Y, Xi S, Li X, et al. 2006. Arsenic speciation transported through the placenta from mother mice to their newborn pups. Environ Res 101(3):349-355.

Johansen MG, McGowan JP, Tu SH, et al. 1984. Tumorigenic effect of dimethylarsinic acid in the rat. Proc West Pharmacol Soc 27:289-291.

Johanson CE. 1980. Permeability and vascularity of the developing brain: Cerebellum vs cerebral cortex. Brain Res 190:3-16.

Johnson LR, Farmer JG. 1989. Urinary arsenic concentrations and speciation in Cornwall residents. Environ Geochem Health 11:39-44.

Jones CA, Inskeep WP, Neuman DR. 1997. Arsenic transport in contaminated mine tailings following liming. J Environ Qual 26(2):433-439.

*Jonnalagadda SB, Nenzou G. 1996. Studies on arsenic rich mine dumps: III. Effect on the river water. J Environ Sci Health A31(10):2547-2555.

Kachinskas DJ, Qin Q, Phillips MA, et al. 1997. Arsenate suppression of human keratinocyte programming. Mutat Res 386(3):253-261.

Kaise T, Watanabe S, Itoh K. 1985. The acute toxicity of arsenobetaine. Chemosphere 14(9):1327-1332.

Kaise T, Yamauchi H, Horiguchi Y, et al. 1989. A comparative study on acute toxicity of methylarsonic acid, dimethylarsinic acid and trimethylarsine oxide in mice. Appl Organomet Chem 3:273-277.

Kala SV, Neely MW, Kala G, et al. 2000. The MRP2/cMOAT transporter and arsenic-glutathione complex formation are required for biliary excretion of arsenic. J Biol Chem 275(43):33404-33408.

Kalbitz K, Wennrich R. 1998. Mobilization of heavy metals and arsenic in polluted wetland soils and its dependence on dissolved organic matter. Sci Total Environ 209:27-39.

Kalman DA. 1987. Dietary contributions to arsenic species in urine. In: Trace elements in human health and disease: Extended abstracts from the second Nordic symposium, Odense, 17-21 August 1987. Copenhagen: World Health Organization, 136-139, 230-233.

Kamijo Y, Soma K, Asari Y, et al. 1998. Survival after massive arsenic poisoning self-treated by high fluid intake. Clin Toxicol 36(1-2):27-29.

Kannan GM, Tripathi N, Dube SN, et al. 2001. Toxic effects of arsenic (III) on some hematopoietic and central nervous system variables in rats and guinea pigs. J Toxicol Clin Toxicol 37(7):675-682.

Karagas MR, Morris JS, Weiss JE, et al. 1996. Toenail samples as an indicator of drinking water arsenic exposure. Cancer Epidemiol Biomarkers Prev 5(10):849-852.

Karagas MR, Stukel TA, Morris JS, et al. 2001. Skin cancer risk in relation to toenail arsenic concentrations in a US population-based case-control study. Am J Epidemiol 153(6):559-565.

Karagas MR, Tosteson TD, Blum J, et al. 1998. Design of an epidemiologic study of drinking water arsenic exposure and skin and bladder cancer risk in a U.S. population. Environ Health Perspect Suppl 106(4):1047-1050.

Karagas MR, Tosteson TD, Morris JS, et al. 2004. Incidence of transitional cell carcinoma of the bladder and arsenic exposure in New Hampshire. Cancer Causes Control 15:465-472.

Kashiwada E, Kuroda K, Endo G. 1998. Aneuploidy induced by dimethylarsinic acid in mouse bone marrow cells. Mutat Res 413:33-38.

Kasper ML, Schoenfield L, Strom RL, et al. 1984. Hepatic angiosarcoma and bronchioloalveolar carcinoma induced by Fowler's solution. JAMA 252(24):3407-3408.

Kato K, Hayashi H, Hasegawa A, et al. 1994. DNA damage induced in cultured human alveolar (L-132) cells by exposure to dimethylarsinic acid. Environ Health Perspect 102(Suppl 3):285-8.

*Katsnelson BA. 1998. Re: Arsenic carcinogenicity testing. Environ Health Perspect 106(12):582.

Kavanagh PJ, Farago ME, Thornton I, et al. 1997. Bioavailability of arsenic in soil and mine wastes of the Tamar Valley, SW England. Chem Speciat Bioavail 9(3):77-81.

Kavlock RJ, Chernoff N, Rogers EH. 1985. The effect of acute maternal toxicity on fetal development in the mouse. Teratog Carcinog Mutagen 5:3-13.

Kawaguchi K, Oku N, Rin K, et al. 1996. Dimethylarsenics reveal DNA damage induced by superoxide anion radicals. Biol Pharm Bull 19(4):551-553.

Kennedy S, Rice DA, Cush PF. 1986. Neuropathology of experimental 3-nitro-4-hydroxyphenylarsonic acid toxicosis in pigs. Vet Pathol 23:454-461.

*Kenyon EM, Hughes MF. 2001. A concise review of the toxicity and carcinogenicity of dimethylarsinic acid. Toxicology 160(1-3):227-236.

Kenyon EM, Del Razo LM, Hughes MF. 2005. Tissue distribution and urinary excretion of inorganic arsenic and its methylated metabolites in mice following acute oral administration of arsenate. Toxicol Sci 85(1):468-475.

*Kenyon EM, Hughes MF, Levander OA. 1997. Influence of dietary selenium on the disposition of arsenate in the female $B6C3F_1$ mouse. J Toxicol Environ Health 51(3):279-299.

Kerckaert GA, Brauninger R, LeBoeuf RA, et al. 1996. Use of the Syrian hamster embryo cell transformation assay for carcinogenicity prediction of chemicals currently being tested by the national toxicology program in rodent bioassays. Environ Health Perspect 104(Suppl. 5):1075-1084.

Kerkvliet NI, Steppan LB, Koller LD, et al. 1980. Immunotoxicology studies of sodium arsenate - effects of exposure on tumor growth and cell-mediated tumor immunity. J Environ Pathol Toxicol 4:65-79.

Kerr HD, Saryan LA. 1986. Arsenic content of homeopathic medicines. Clin Toxicol 24(5):451-459.

Kerr KB, Cavett JW, Thompson OL. 1963. The toxicity of an organic arsenical, 3-nitro-4-hydroxyl-phenylarsonic acid. I. Acute and subacute toxicity. Toxicol Appl Pharmacol 5:507-525.

Kersjes MP, Maurer JR, Trestrail JH, et al. 1987. An analysis of arsenic exposures referred to the Blodgett Regional Poison Center. Vet Hum Toxicol 29(1):75-78.

Kessel M, Liu SX, Xu A, et al. 2002. Arsenic induces oxidative DNA damage in mammalian cells. Mol Cell Biochem 234-235(1-2):301-308.

Khan AH, Tarafdar SA, Ali M, et al. 1989. The status of trace and minor elements in some Bangladeshi foodstuffs. J Radioanalyt Nuc Chem 134(2):367-381.

Kidwell JM, Phillips LJ, Birchard GF. 1995. Comparative analyses of contaminant levels in bottom feeding and predatory fish using the national contaminant biomonitoring program data. Bull Environ Contam Toxicol 54(6):919-923.

Kim MJ, Nriagu J, Haack S. 2002. Arsenic species and chemistry in groundwater of southeast Michigan. Environ Pollut 120(2):379-390.

Kingston RL, Hall S, Sioris L. 1993. Clinical observations and medical outcome in 149 cases of arsenate ant killer ingestion. J Toxicol Clin Toxicol 31(4):581-591.

Kinney PL, Chillrud SN, Ramstrom S, et al. 2002. Exposures to multiple air toxics in New York City. Environ Health Perspect 110(Suppl 4):539-546.

Kitamura M, Kuroda K, Endo Y, et al. 2002. Cysteine enhances clastogenic activity of dimethylarsinic acid. Appl Organomet Chem 16:391-396.

Kitchin KT. 2001. Recent advances in arsenic carcinogenesis: Modes of action, animal model systems, and methylated arsenic metabolites. Toxicol Appl Pharmacol 172(3):249-261.

*Kitchin KT, Ahmad S. 2003. Oxidative stress as a possible mode of action for arsenic carcinogenesis. Toxicol Lett 137(1-2):3-13.

Klemmer HW, Leitis E, Pfenninger K. 1975. Arsenic content of house dusts in Hawaii. Bull Environ Contam Toxicol 14(4):449-452.

Ko Y. 1986. A critical review of epidemiologic studies on blackfoot disease. J Voeh 8(3)339-353.

Kochhar TS, Howard W, Hoffman S, et al. 1996. Effect of trivalent and pentavalent arsenic in causing chromosome alterations in cultured Chinese hamster ovary (CHO) cells. Toxicol Lett 84(1):37-42.

Koh E, Kondoh N, Kaihara H, et al. 1989. Ureteral tumor with multiple Bowen's disease forty-two years after exposure to arsenic. Eur Urol 16:398-400.

*Kollmer WE. 1992. Arsenic in induced hair of the rat and its relation to the content in various organs during chronic exposure. J Trace Elem Electrolytes Health Dis 6(1):11-14.

Komori M, Nishio K, Kitada M et al. 1990. Fetus-specific expression of a form of cytochrome P-450 in human livers. Biochemistry 29:4430-4433.

Kraus RJ, Ganther HE. 1989. Synergistic toxicity between arsenic and methylated selenium compounds. Biol Trace Elem Res 20:105-113.

Kraus T, Quidenus G, Schaller KH. 2000. Normal values for arsenic and selenium concentrations in human lung tissue. Arch Environ Contam Toxicol 38:384-389.

Kreiss K, Zack MM, Feldman RG, et al. 1983. Neurologic evaluation of a population exposed to arsenic in Alaskan well water. Arch Environ Health 38(2):116-121.

Kreppel H, Bauman JW, Liu J, et al. 1993. Induction of metallothionein by arsenicals in mice. Fundam Appl Toxicol 20:184-189.

Kreppel H, Liu J, Liu Y, et al. 1994. Zinc induced arsenite tolerance in mice. Fundam Appl Toxicol 23:32-37.

Kreppel H, Reichl FX, Kleine A, et al. 1995. Antidotal efficacy of newly synthesized dimercaptosuccinic acid (DMSA) monoesters in experimental arsenic poisoning in mice. Fundam Appl Toxicol 26(2):239-245.

Krishnan K, Andersen ME. 1994. Physiologically-based pharmacokinetic modeling in toxicology. In: Hayes AW, ed. Principles and methods of toxicology. 3rd ed. New York, NY: Raven Press, Ltd., 149-188.

Krishnan K, Andersen ME, Clewell HJ, et al. 1994. Physiologically based pharmacokinetic modeling of chemical mixtures. In: Yang RSH, ed. Toxicology of chemical mixtures: Case studies, mechanisms, and novel approaches. San Diego, CA: Academic Press, 399-437.

Kroemer G, de Thé H. 1999. Arsenic trioxide, a novel mitochondriotoxic anticancer agent? J Natl Cancer Inst 91(9):743-745.

Kroes R, van Logten MJ, Berkvens JM, et al. 1974. Study on the carcinogenicity of lead arsenate and sodium arsenate and on the possible synergistic effect of diethylnitrosamine. Food Cosmet Toxicol 12(5-6):671-679.

Kumana CR, Au WY, Lee NSL, et al. 2002. Systemic availability of arsenic from oral arsenic-trioxide used to treat patients with hematological malignancies. Eur J Clin Pharmacol 58:521-526.

Kumaresan M, Riyazuddin P. 2001. Overview of speciation chemistry of arsenic. Curr Sci 80(7):837-846.

Kuroda K, Yoshida K, Yoshimura M, et al. 2004. Microbial metabolite of dimethylarsinic acid is highly toxic and genotoxic. Toxicol Appl Pharmacol 198(3):345-353.

Kurokawa Y, Takahashi M, Maekawa A, et al. 1989. Promoting effect of metal compounds on liver, stomach, kidney, pancreas, and skin carcinogenesis. J Am Coll Toxicol 8(7)1235-1239.

Kurttio P, Komulain H, Hakala E, et al. 1998. Urinary excretion of arsenic species after exposure to arsenic present in drinking water. Arch Environ Contam Toxicol 34:297-305.

Kurttio P, Pukkala E, Kahelin H, et al. 1999. Arsenic concentrations in well water and risk of bladder and kidney cancer in Finland. Environ Health Perspect 107(9):705-710.

Kwon E, Zhang H, Wang Z, et al. 2004. Arsenic on the hands of children after playing in playgrounds. Environ Health Perspect 112(14):1375-1380.

Kyle RA, Pease GL. 1965. Hematologic aspects of arsenic intoxication. N Engl J Med 273(1):18-23.

LaForce MJ, Fendorf SE, Li GC, et al. 1998. A laboratory evaluation of trace element mobility from flooding and nutrient loading of Coeur d'Alene River sediments. J Environ Qual 27:318-328.

Lagerkvist BJ, Zetterlund B. 1994. Assessment of exposure to arsenic among smelter workers: A five-year follow-up. Am J Ind Med 25(4):477-488.

Lagerkvist B, Linderholm H, Nordberg GF. 1986. Vasospastic tendency and Raynaud's phenomenon in smelter workers exposed to arsenic. Environ Res 39:465-474.

Lagerkvist BEA, Linderholm H, Nordberg GF. 1988. Arsenic and Raynaud's phenomenon: Vasospastic tendency and excretion of arsenic in smelter workers before and after the summer vacation. Int Arch Occup Environ Health 60:361-364.

Lai MS, Hsueh YM, Chen CJ, et al. 1994. Ingested inorganic arsenic and prevalence of diabetes mellitus. Am J Epidemiol 139(5):484-492.

*Lakso JU, Peoples SA. 1975. Methylation of inorganic arsenic by mammals. J Agric Food Chem 23:674-676.

*Lambert TW, Lane S. 2004. Lead, arsenic, and polycyclic aromatic hydrocarbons in soil and house dust in the communities surrounding the Sydney, Nova Scotia, tar ponds. Environ Health Perspect 112(1):35-41.

*Lamm SH, Kruse MB. 2004. Ingested arsenic and cancer. What's new? Presentation of the US Senate Committee on the environment and public works. http://www.ruralwater.org/arsenic/lamm1.ppt. May 09, 2007.

Lamm SH, Engel A, Kruse MB, et al. 2004. Arsenic in drinking water and bladder cancer mortality in the United States: An analysis based on 133 U.S. counties and 30 years of observation. J Occup Environ Med 46(3):298-306.

Lander JJ, Stanley RJ, Sumner HW, et al. 1975. Angiosarcoma of the liver associated with Fowler's solution (potassium arsenite). Gastroenterology 68(6):1582-1586.

Landolph JR. 1994. Molecular mechanisms of transformation of C3H/10T1/2 C1 8 mouse embryo cells and diploid human fibroblasts by carcinogenic metal compounds. Environ Health Perspect 102(Suppl3):119-125.

*Landrigan PJ. 1981. Arsenic-state of the art. Am J Ind Med 2:5-14.

Landsberger S, Simsons A. 1987. Chromium, nickel, and arsenic determinations in human samples by thermal and epithermal neutron activation analyses. Biol Trace Elem Res 13:357-362.

Landsberger S, Wu D. 1995. The impact of heavy metals from environmental tobacco smoke on indoor air quality as determined by Compton suppression neutron activation analysis. Sci Total Environ 173-174(1-6):323-337.

Lantz RC, Hays AM. 2006. Role of oxidative stress in arsenic-induced toxicity. Drug Metab Rev 38:791-804.

Lantzsch H, Gebel T. 1997. Genotoxicity of selected metal compounds in the SOS chromotest. Mutat Res 389(2-3):191-197.

Lanz H, Wallace PC, Hamilton JG. 1950. The metabolism of arsenic in laboratory animals using As^{74} as a tracer. Univ California Publ Pharmacol 2(29):263-282.

Laparra JM, Velez D, Montoro R, et al. 2003. Estimation of arsenic bioaccessibility in edible seaweed by an *in vitro* digestion method. J Agric Food Chem 51:6080-6085.

*Larochette N, Decaudin D, Jacotot E, et al. 1999. Rapid communication: Arsenite induces apoptosis via a direct effect on the mitochondrial permeability transition pore. Exp Cell Res 249:413-421.

Larramendy ML, Popescu NC, DiPaolo J. 1981. Induction by inorganic metal salts of sister chromatid exchanges and chromosome aberrations in human and Syrian hamster strains. Environ Mutagen 3:597-606.

Larsen EH, Moseholm L, Nielsen MM. 1992. Atmospheric deposition of trace elements around point sources and human health risk assessment: II. Uptake of arsenic and chromium by vegetables grown near a wood preservation factory. Sci Total Environ 126(3):263-275.

Lasky T, Sun W, Kadry A, et al. 2004. Mean total arsenic concentrations in chicken 1989-2000 and estimated exposures for consumers of chicken. Environ Health Perspect 112(1):18-21.

Le XC, Lu X, Li XF. 2004. Arsenic speciation. Anal Chem 76:27A-33A.

Lebow S, Williams RS, Lebow P. 2003. Effect of simulated rainfall and weathering on release of preservative elements from CCA treated wood. Environ Sci Technol 37:4077-4082.

Lebow ST, Lebow PT, Foster DO, et al. 2000. Environmental impact of preservative-treated wood in a wetland boardwalk. U.S. Department of Agriculture, Forest Service. FPL-RP-582.

Lee AM, Fraumeni JF. 1969. Arsenic and respiratory cancer in man: An occupational study. J Natl Cancer Inst 42:1045-1052.

Lee DC, Roberts JR, Kelly JJ, et al. 1995. Whole-bowel irrigation as an adjunct in the treatment of radiopaque arsenic [letter]. Am J Emerg Med 13(2):244-245.

Lee MY, Bae ON, Chung SM, et al. 2002. Enhancement of platelet aggregation and thrombus formation by arsenic in drinking water: A contributing factor to cardiovascular disease. Toxicol Appl Pharmacol 179(2):83-88.

Lee TC, Ho IC. 1994. Differential cytotoxic effects of arsenic on human and animal cells. Environ Health Perspect 102(Suppl 3):101-105.

Lee TC, Oshimura M, Barrett JC. 1985. Comparison of arsenic-induced cell transformation, cytotoxicity, mutation and cytogenetic effects in Syrian hamster embryo cells in culture. Carcinogenesis 6(10):1421-1426.

Lee TC, Tanaka N, Lamb PW, et al. 1988. Induction of gene amplification by arsenic. Science 241:79-81.

Lee TC, Wang-Wuu S, Huang RY, et al. 1986. Differential effects of pre- and posttreatment of sodium arsenite on the genotoxicity of methyl methanesulfonate in Chinese hamster ovary cells. Cancer Res 46:1854-1857.

Lee-Chen SF, Gurr JR, Lin IB, et al. 1993. Arsenite enhances DNA double-strand breaks and cell killing of methyl methanesulfonate-treated cells by inhibiting the excision of alkali-labile sites. Mutat Res 294(1):21-28.

Lee-Chen SF, Yu CT, Jan KY. 1992. Effect of arsenite on the DNA repair of UV-irradiated Chinese hamster ovary cells. Mutagenesis 7(1):51-55.

Lee-Chen SF, Yu CT, Wu DR, et al. 1994. Differential effects of luminol, nickel, and arsenite on the rejoining of ultraviolet light and alkylation-induced DNA breaks. Environ Mol Mutagen 23(2):116-120.

Lee-Feldstein A. 1983. Arsenic and respiratory cancer in man: Follow-up of an occupational study. In: Lederer W, Fensterheim R, eds. Arsenic: Industrial, biomedical and environmental perspectives. New York, NY: Van Nostrand Reinhold, 245-265.

Lee-Feldstein A. 1986. Cumulative exposure to arsenic and its relationship to respiratory cancer among copper smelter employees. J Occup Med 28(4):296-302.

Leeder JS, Kearns GL. 1997. Pharmacogenetics in pediatrics: Implications for practice. Pediatr Clin North Am 44:55-77.

Léonard A, Lauwerys RR. 1980. Carcinogenicity, teratogenicity and mutagenicity of arsenic. Mutat Res 75:49-62.

Le Quesne PM, McLeod JG. 1977. Peripheral neuropathy following a single exposure to arsenic. J Neurol Sci 32:437-451.

Lerda D. 1994. Sister-chromatid exchange (SCE) among individuals chronically exposed to arsenic in drinking water. Mutat Res 312(2):111-120.

Lerman BB, Ali N, Green D. 1980. Megaloblastic, dyserythropoietic anemia following arsenic ingestion. Ann Clin Lab Science 10(6):515-517.

Lerman S, Clarkson TW, Gerson RJ. 1983. Arsenic uptake and metabolism by liver cells is dependent on arsenic oxidation state. Chem Biol Interact 45:401-406.

Leung HW. 1993. Physiologically-based pharmacokinetic modelling. In: Ballantine B, Marro T, Turner P, eds. General and applied toxicology. Vol. 1. New York, NY: Stockton Press, 153-164.

*Leung PL, Huang HM. 1997. Analysis of trace elements in the hair of volunteers suffering from naso-pharyngeal cancer. Biol Trace Elem Res 57(1):19-25.

Levander OA. 1977. Metabolic interrelationships between arsenic and selenium. Environ Health Perspect 19:159-164.

Levander OA, Baumann CA. 1966. Selenium metabolism: VI. Effect of arsenic on the excretion of selenium in the bile. Toxicol Appl Pharm 9:106-115.

Levin-Scherz JK, Patrick JD, Weber FH, et al. 1987. Acute arsenic ingestion. Ann Emerg Med 16(6):702-704.

Lewis DR, Southwick JW, Ouellet-Hellstrom R, et al. 1999. Drinking water in Utah: A cohort mortality study. Environ Health Perspect 107(5):359-365.

*Lewis TA, Hartman CB, McCoy KL. 1998a. Gallium arsenide differentially affects processing of phagolysosmal targeted antigen by macrophages. J Leukoc Biol 63:321-330.

*Lewis TA, Hartmann CB, McCoy KL. 1998b. Gallium arsenide modulates proteolytic cathepsin activities and antigen processing by macrophages. J Immunol 161:2151-2157.

Li JH, Rossman TG. 1989. Inhibition of DNA ligase activity by arsenite: A possible mechanism of its comutagenesis. Mol Toxicol 2:1-9.

Li JH, Rossman TG. 1991. Comutagenesis of sodium arsenite with ultraviolet radiation in Chinese hamster V79 cells. Biol Met 4:197-200.

Li W, Chou IN. 1992. Effects of sodium arsenite on the cytoskeleton and cellular glutathione levels in cultured cells. Toxicol Appl Pharmacol 114(1):132-139.

Li W, Wanibuchi H, Salim EI, et al. 1998. Promotion of the NCI-Black-Reiter male rat bladder carcinogenesis by dimethylarsinic acid an organic arsenic compound. Cancer Lett 134(1):29-36.

*Li W, Wei C, Zhang C, et al. 2003. A survey of arsenic species in Chinese seafood. Food Chem Toxicol 41(8):1103-1110.

*Li YM, Broome JD. 1997. Apoptosis induced in premyelocytic leukemia cells by arsenic and proteasome inhibitors. Blood 90(10):203b.

*Li YM, Broome JD. 1999. Arsenic targets tubulins to induce apoptosis in myeloid leukemia cells. Cancer Res 59:776-780.

Lianfang W, Jianzhong H. 1994. Chronic arsenism from drinking water in some areas of Xinjiang, China. In: Nriagu JO, ed. Arsenic in the environment: Part II: Human health and ecosystem effects. New York, NY: John Wiley and Sons, Inc., 159-172.

Liao WT, Chang KL, Chen GS, et al. 2004. Arsenic induces human keratinocyte apoptosis by the FAS/FAS ligand pathway, which correlates with alterations in nuclear factor-κB and activator protein-1 activity. J Invest Dermatol 122(1):125-129.

Liebscher K, Smith H. 1968. Essential and nonessential trace elements: A method of determining whether an element is essential or nonessential in human tissue. Arch Environ Health 17:881-890.

Lin JK, Tseng S. 1992. Chromosomal aberrations and sister-chromatid exchanges induced by *N*-nitroso-2-acetylaminofluorene and their modifications by arsenite and selenite in Chinese hamster ovary cells. Mutat Res 265(2):203-210.

*Lin TH, Huang Y, Tseng W. 1995. Arsenic and lipid peroxidation in patients with blackfoot disease. Bull Environ Contam Toxicol 54(4):488-493.

Lindgren A, Danielsson BRG, Dencker L, et al. 1984. Embryotoxicity of arsenite and arsenate: Distribution in pregnant mice and monkeys and effects on embryonic cells *in vitro*. Acta Pharmacol Toxicol 54:311-320.

Lindgren A, Vahter M, Dencker L. 1982. Autoradiographic studies on the distribution of arsenic in mice and hamsters administered ^{74}As-arsenite or -arsenate. Acta Pharmacol Toxicol 51:253-265.

Liou SH, Lung JC, Chen YH, et al. 1999. Increased chromosome-type chromosome aberration frequencies as biomarkers of cancer risk in a blackfoot endemic area. Cancer Res 59(7):1481-1484.

Lithner G, Holm K, Borg H. 1995. Bioconcentration factors for metals in humic waters at different pH in the Röbbskär area (N. Sweden). Water, Air and Soil Pollution 85:785-790.

Little RE, Kay GN, Cavender JB, et al. 1990. Torsade de pointes and T-U wave alternans associated with arsenic poisoning. PACE 13:164-170.

Liu YC, Huang H. 1997. Involvement of calcium-dependent protein kinase C in arsenite-induced genotoxicity in Chinese hamster ovary cells. J Cell Biochem 64(3):423-433.

Liu YT, Chen Z. 1996. A retrospective lung cancer mortality study of people exposed to insoluble arsenic and radon. Lung Cancer 14(Suppl 1):137-148.

Liu J, Liu Y, Goyer RA, et al. 2000. Metallothionein-I/II null mice are more sensitive than wild-type mice to the hepatotoxic and nephrotoxic effects of chronic oral or injected inorganic arsenicals. Toxicol Sci 55(2):460-467.

*Liu J, Xie Y, Ducharme DM, et al. 2006. Global gene expression associated with hepatocarcinogenesis in adult male mice induced by in utero arsenic exposure. Environ Health Perspect 114(3):404-411.

Liu J, Zheng B, Aposhian HV, et al. 2002. Chronic arsenic poisoning from burning high-arsenic-containing coal in Guizhou, China. Environ Health Perspect 110(2):119-122.

Livingston AL. 1978. Forage plant estrogens. J Toxicol Environ Health 4:301-324.

Loebenstein JR. 1994. The materials flow of arsenic in the United States. Washington, DC: Bureau of Mines, Division of Mineral Commodities, United States Department of the Interior. BUMINES-IC-9382.

Loffredo CA, Aposhian HV, Cebrian ME, et al. 2003. Variability in human metabolism of arsenic. Environ Res 92(2):85-91.

Löfroth G, Ames BN. 1978. Mutagenicity of inorganic compounds in *Salmonella typhimurium*: arsenic, chromium, and selenium. Mutat Res 53:65-66.

López-Gonzálvez MA, Gómez MM, Cámara C, et al. 1994. On-line microwave oxidation for the determination of organoarsenic compounds by high-performance liquid chromatography-hydride generation atomic absorption spectrometry. J Anal Atom Spectrom 9(3):291-295.

Lovell MA, Farmer JG. 1985. Arsenic speciation in urine from humans intoxicated by inorganic arsenic compounds. Hum Toxicol 4:203-214.

Lowney YW, Ruby MV, Wester RC, et al. 2005. Percutaneous absorption of arsenic from environmental media. Toxicol Ind Health 21(1-2):1-14.

Lu FJ, Shih SR, Liu TM, et al. 1990. The effect of fluorescent humic substances existing in the well water of blackfoot disease endemic areas in Taiwan on prothrombin time and activated partial thromboplastin time *in vitro*. Thromb Res 57:747-753.

Lu M, Wang H, Li XF, et al. 2004a. Evidence of hemoglobin binding to arsenic as a basis for the accumulation of arsenic in rat blood. Chem Res Toxicol 17(12):1733-1742.

*Lu SN, Chow NH, Wu WC, et al. 2004b. Characteristics of hepatocellular carcinoma in a high arsenicism area in Taiwan: A case-control study. J Occup Environ Med 46(5):437-441.

*Lubin JH, Fraumeni JF. 2000. Re: "Estimates of the annual number of clinically recognized pregnancies in the United States, 1981-1991". Am J Epidemiol 152(3):297-293.

Lubin JH, Pottern LM, Stone BJ, et al. 2000. Respiratory cancer in a cohort of copper smelter workers: Results from more than 50 years of follow-up. Am J Epidemiol 151(6):554-565.

Lüchtrath H. 1983. The consequences of chronic arsenic poisoning among Moselle wine growers: Pathoanatomical investigations of post-mortem examinations performed between 1960 and 1977. J Cancer Res Clin Oncol 105:173-182.

Lugo G, Cassady G, Palmisano P. 1969. Acute maternal arsenic intoxication with neonatal death. Am J Dis Child 117:328-330.

Luong KVQ, Nguyen LTH. 1999. Organic arsenic intoxication from bird's nest soup. Am J Med Sci 317(4):269-271.

Luten JB, Riekwel-Booy G, Rauchbaar A. 1982. Occurrence of arsenic in plaice (*Pleuronectes platessa*), nature of organo-arsenic compound present and its excretion by man. Environ Health Perspect 45:165-170.

Lynn S, Lai HT, Gurr JR, et al. 1997. Arsenite retards DNA break rejoining by inhibiting DNA ligation. Mutagenesis 12(5):353-358.

Mabuchi K, Lilienfeld AM, Snell LM. 1979. Lung cancer among pesticide workers exposed to inorganic arsenicals. Arch Environ Health 34:312-320.

MacIntosh DL, Williams PL, Hunter DJ, et al. 1997. Evaluation of a food frequency questionnaire-food composition approach for estimating dietary intake of inorganic arsenic and methylmercury. Cancer Epidemiol Biomarkers Prev 6(12):1043-1050.

Maehashi H, Murata Y. 1986. Arsenic excretion after treatment of arsenic poisoning with DMSA or DMPS in mice. Jpn J Pharmacol 40:188-190.

Mahaffey KR, Fowler BA. 1977. Effects of concurrent administration of lead, cadmium, and arsenic in the rat. Environ Health Perspect 19:165-171.

Mahaffey KR, Capar SG, Gladen BC, et al. 1981. Concurrent exposure to lead, cadmium and arsenic. Effects on toxicity and tissue metal concentrations in the rat. J Lab Clin Med 98(1):463-481.

*Mahajan SK, Aggarwal HK, Wig N, et al. 1992. Arsenic induced neuropathy. J Assoc Physicians India 40(4):268-269.

Mahata J, Basu A, Ghosal S, et al. 2003. Chromosomal aberrations and sister chromatid exchanges in individuals exposed to arsenic through drinking water in West Bengel, India. Mutat Res 534(1-2):133-143.

Maher WA. 1989. Some observations on the determination of total arsenic in biological tissues. Microchem J 40:132-135.

*Mahieu P, Buchet J, Lauwerys R. 1987. Evolution clnique et biologique d'une intoxication orale aiguë par l'anhydride arsénieux et considérations sur l'attitude thérapeutique. J Toxicol Clin Exp 7:273-278.

Maiorino RM, Aposhian HV. 1985. Dimercaptan metal-binding agents influence the biotransformation of arsenite in the rabbit. Toxicol Appl Phamacol 77:240-250.

Maitani T, Saito N, Abe M, et al. 1987a. Chemical form-dependent induction of hepatic zinc-thionein by arsenic administration and effect of co-administered selenium in mice. Toxicol Lett 39:63-70.

*Maitani T, Uchiyama S, Saito Y. 1987b. Hydride generation-flame atomic-absorption spectrometry as an arsenic detector for high-performance liquid chromatography. J Chromatogr 391:161-168.

*Man ACK, Zheng YH, Mak PK. 1996. Trace elements in scalp hair of professional drivers and university teachers in Hong Kong. Biol Trace Elem Res 53(1-3):241-247.

Mandal BK, Suzuki KT. 2002. Arsenic around the world: A review. Talanta 58:201-235.

Mandal BK, Ogra Y, Suzuki KT. 2001. Identification of dimethylarsinous and monomethylarsonous. Chem Res Toxicol 14(4):371-378.

Mandal BK, Ogra Y, Suzuki KT. 2003. Speciation of arsenic in human nail and hair from arsenic-affected area by HPLC-inductively coupled argon plasma mass spectrometry. Toxicol Appl Pharmacol 189(2):73-83.

Mann S, Droz PO, Vahter M. 1996a. A physiologically based pharmacokinetic model for arsenic exposure. I. Development in hamsters and rabbits. Toxicol Appl Pharmacol 137(1):8-22.

Mann S, Droz PO, Vahter M. 1996b. A physiologically based pharmacokinetic model for arsenic exposure. II. Validation and application in humans. Toxicol Appl Pharmacol 140(2):471-486.

Mappes R. 1977. [Experiments on excretion of arsenic in urine.] Int Arch Occup Environ Health 40:267-272. (German)

Marafante E, Vahter M. 1984. The effect of methyltransferase inhibition on the metabolism of [^{74}As] arsenite in mice and rabbits. Chem Biol Interact 50:49-57.

Marafante E, Vahter M. 1986. The effect of dietary and chemically induced methylation deficiency on the metabolism of arsenate in the rabbit. Acta Pharmacol Toxicol 59(Suppl 7):35-38.

Marafante E, Vahter M. 1987. Solubility, retention and metabolism of intratracheally and orally administered inorganic arsenic compounds in the hamster. Environ Res 42:72-82.

Marafante E, Lundborg M, Vahter M, et al. 1987a. Dissolution of two arsenic compounds by rabbit alveolar macrophages *in vitro*. Fundam Appl Toxicol 8:382-388.

*Marafante E, Vahter M, Dencker L. 1984. Metabolism of arsenocholine in mice, rats and rabbits. Sci Total Environ 34:223-240.

Marafante E, Vahter M, Envall J. 1985. The role of the methylation in the detoxication of arsenate in the rabbit. Chem Biol Interact 56:225-238.

Marafante E, Vahter M, Norin H, et al. 1987b. Biotransformation of dimethylarsinic acid in mouse, hamster and man. J Appl Toxicol 7(2):111-117.

Marcus WL, Rispin AS. 1988. Threshold carcinogenicity using arsenic as an example. In: Cothern CR, Mehlman MA, Marcus WL, eds. Advances in modern environmental toxicology. Vol. XV: Risk assessment and risk management of industrial and environmental chemicals. Princeton, NJ: Princeton Scientific Publishing Co., 133-158.

Margitich DJ, Ackerman LJ. 1991a. Caccdylic acid 21 day toxicity study in rabbit. Luxembourg Industries (Pamol) Ltd. Submitted to the U.S. Environmental Protection Agency. MRID41872801.

Margitich DJ, Ackerman LJ. 1991b. Methanearsonic acid 21 day dermal toxicity study in rabbits. Luxembourg Industries (Pamol) Ltd. Submitted to the U.S. Environmental Protection Agency. MRID41872701.

Mariner PE, Holzmer FJ, Jackson RE, et al. 1996. Effects of high pH on arsenic mobility in a shallow sandy aquifer and on aquifer permeability along the adjacent shoreline, Commencement Bay Superfund Site, Tacoma, Washington. Environ Sci Tech 30(5):1645-1651.

*Marlowe M, Cossairt A, Moon C, et al. 1985. Main and interaction effects of metallic toxins on classroom behavior. J Abnorm Child Psychol 13(2):185-198.

Martin DS, Willis SE, Cline DM. 1990. N-Acetylcysteine in the treatment of human arsenic poisoning. J Am Board Fam Pract 3:293-296.

Martínez V, Creus A, Venegas W, et al. 2004. Evaluation of micronucleus induction in a Chilean population environmentally exposed to arsenic. Mutat Res 564(1):65-74.

Martínez V, Crues A, Venegas W, et al. 2005. Micronuclei assessment in buccal cells of people environmentally exposed to arsenic in northern Chile. Toxicol Lett 155:319-327.

Mason RP, Laporte JM, Andres S. 2000. Factors controlling the bioaccumulation of mercury, methylmercury, arsenic, selenium, and cadmium by freshwater invertebrates and fish. Arch Environ Contam Toxicol 38:283-97.

Mason RW, Edwards IR, Fisher LC. 1989. Teratogenicity of combinations of sodium dichromate, sodium arsenate and copper sulphate in the rat. Comp Biochem Physiol 93(2):407-411.

Matanoski G, Landau E, Tonascia J, et al. 1981. Cancer mortality in an industrial area of Baltimore. Environ Res 25:8-28.

Matschullat J. 2000. Arsenic in the geosphere - a review. Sci Total Environ 249:297-312.

Matsui M, Nishigori C, Toyokuni S, et al. 1999. The role of oxidative DNA damage in human arsenic carcinogenesis: Detection of 8-hydroxy-2'-deoxyguanosine in arsenic-related Bowen's disease. J Invest Dermatol 113:26-31.

Matthews EJ, Spalding JW, Tennant RW. 1993. Transformation of BALB/c-3T3 cells: V. Transformation responses of 168 chemicals compared with mutagenicity in Salmonella and carcinogenicity in rodent bioassays. Environ Health Perspect 101(Suppl 2):347-482.

May TW, Wiedmeyer RH, Gober J, et al. 2001. Influence of mining-related activities on concentrations of metals in water and sediment from streams of the Black Hills, South Dakota. Arch Environ Contam Toxicol 40:1-9.

Mayr U, Butsch A, Schneider S. 1992. Validation of two *in vitro* test systems for estrogenic activities with zearalenone, phytoestrogens and cereal extracts. Toxicology 74:135-149.

Mazumdar S, Redmond CK, Enterline PE, et al. 1989. Multistage modeling of lung cancer mortality among arsenic-exposed copper-smelter workers. Risk Anal 9(4):551-563.

McDorman EW, Collins BW, Allen JW. 2002. Dietary folate deficiency enhances induction of micronuclei by arsenic in mice. Environ Mol Mutagen 40(1):71-77.

McFall TL, Richards S, Matthews G. 1998. Rehabilitation in an individual with chronic arsenic poisoning: Medical, psychological, and social implications. J Spinal Cord Med 21(2):142-147.

McGeehan SL. 1996. Arsenic sorption and redox reactions: Relevance to transport and remediation. J Environ Sci Health A31(9):2319-2336.

McGeehan SL, Fendorf SE, Naylor DV. 1998. Alteration of arsenic sorption in flooded-dried soils. Soil Sci Soc Am J 62:828-833.

McLaren RG, Naidu R, Smith J, et al. 1998. Fractionation and distribution of arsenic in soils contaminated by cattle dip. J Environ Qual 27:348-354.

Meacher DM, Menzel DB, Dillencourt MD, et al. 2002. Estimation of multimedia inorganic arsenic intake in the U.S. population. Hum Ecol Risk Assess 8(7):1697-1721.

Meharg AA, Rahman M. 2003. Arsenic contamination of Bangladesh paddy field soils: Implications fro rice contribution to arsenic consumption. Environ Sci Technol 37:229-234.

Meister RT, ed. 1987. Farm chemicals handbook. Willoughby, OH: Meister Publishing. Section C:21, 46-47, 101, 177-178, 230-231.

Meister RT, ed. 1999. Farm chemicals handbook '99. Willoughby, OH: Meister Publishing Company.

Meister RT, Sine C, Sharp DT, et al. 2006. Crop protection handbook 2006. Willohughby, OH: Meister Media Worldwide, D 65.

Meng Z. 1993a. Effects of arsenic on DNA synthesis in human lymphocytes stimulated by phytohemagglutinin. Biol Trace Elem Res 39(1):73-80.

Meng Z. 1993b. Effects of arsenic on DNA synthesis in human lymphocytes. Arch Environ Contam Toxicol 25(4)525-528.

Meng Z. 1994. Effects of arsenic on DNA synthesis in human lymphocytes. In: Nraigu JO, ed. Arsenic in the environment, part II: Human health and ecosystem effects. New York, NY: John Wiley & Sons, Inc., 133-142.

Meng Z, Hsie AW. 1996. Polymerase chain reaction-based deletion analysis of spontaneous and arsenite-enhanced gpt mutants in CHO-As_{52} cells. Mutat Res 356(2)255-259.

Menzel DB, Rasmussen RE, Lee E, et al. 1998. Human lymphocyte heme oxygenase 1 as a response biomarker to inorganic arsenic. Biochem Biophys Res Commun 250:653-656.

Menzel DB, Ross M, Oddo SV, et al. 1994. A physiologically based pharmacokinetic model for ingested arsenic. Environ Geochem Health 16:209-218.

Merwin I, Pruyne PT, Ebel JG, et al. 1994. Persistence, phytotoxicity, and management of arsenic, lead and mercury residues in old orchard soils of New York State. Chemosphere 29(6):1361-1367.

*Meyer I, Heinrich J, Lippold U. 1999. Factors affecting lead, cadmium, and arsenic levels in house dust in a smelter town in eastern Germany. Environ Res 81:32-44.

Michaud DS, Wright ME, Cantor KP, et al. 2004. Arsenic concentrations in prediagnostic toenails and the risk of bladder cancer in a cohort study of male smokers. Am J Epidemiol 160(9):853-859.

Miles AK, Tome MW. 1997. Spatial and temporal heterogeneity in metallic elements in industrialized aquatic bird habitats. Environ Pollut 95(1):75-84.

Milham S, Strong T. 1974. Human arsenic exposure in relation to a copper smelter. Environ Res 7:176-182.

Miller M. 1998. Scientists explore use of arsenic in therapy. J Natl Cancer Inst 90(24):1866-1867.

Milton AH, Rahman M. 2002. Respiratory effects and arsenic contaminated well water in Bangladesh. Int J Environ Health Res 12(2):175-179.

Milton AH, Hasan Z, Shahidullah SM, et al. 2004. Association between nutritional status and aresnicosis due to chronic arsenic exposure in Bangladesh. Int J Environ Health Res 14(2):99-108.

Milton AH, Smith W, Rahman B, et al. 2005. Chronic arsenic exposure and adverse pregnancy outcomes in Bangladesh. Epidemiology 16(1):82-86.

Mirkes PE, Cornel L. 1992. A comparison of sodium arsenite- and hyperthermia-induced stress responses

*Mitra K, Kundu SN, Khuda Bukhsh AR. 1999. Efficacy of a potentized homoeopathic drug (Arsenic Album-30) in reducing toxic effects produced by arsenic trioxide in mice: II. On alterations in body weight and total protein. Complement Ther Med 7:24-34.

Mitra SR, Mazumder DN, Basu A, et al. 2004. Nutritional factors and susceptibility to arsenic-caused skin lesions in West Bengal, India. Environ Health Perspect 112(10):1104-1109.

Miyazaki K, Ushijima K, Kadono T, et al. 2003. Negative correlation between urinary selenium and arsenic levels of the residents living in an arsenic-contaminated area in Bangladesh. J Health Sci 49(3):239-242.

Mizuta N, Mizuta M, Ito F, et al. 1956. An outbreak of acute arsenic poisoning caused by arsenic-contaminated soy-sauce (shoyu): A clinical report of 220 cases. Bull Yamaguchi Med Sch 4(2-3):131-149.

Mohamed KB. 1998. Occupational contact dermatitis from arsenic in a tin-smelting factory. Contact Dermatitis 38:224-225.

Mok WM, Wai CM. 1994. Mobilization of arsenic in contaminated river waters. In: Nriagu JO, ed. Arsenic in the environment, part 1: Cycling and characterization. New York, NY: John Wiley & Sons, Inc., 99-117.

Mok WM, Riley JA, Wai CM. 1988. Arsenic speciation and quality of groundwater in a lead-zinc mine, Idaho. Water Res 22(6):769-774.

Moore DF, O'Callaghan CA, Berlyne G, et al. 1994a. Acute arsenic poisoning: Absence of polyneuropathy after treatment with 2,3-dimercaptopropanesulphonate (DMPS). J Neurol Neurosurg Psychiatry 57(9):1133-1135.

Moore JN, Ficklin WH, Johns C. 1988. Partitioning of arsenic and metals in reducing sulfidic sediments. Environ Sci Technol 22:432-437.

Moore LE, Lu M, Smith AH. 2002. Childhood cancer incidence and arsenic exposure in drinking water in Nevada. Arch Environ Health 57(3):201-206.

Moore LE, Smith AH, Hopenhayn-Rich C, et al. 1995. Increased bladder cells micronuclei in two populations environmentally exposed to arsenic in drinking water. Clin Chem 41(12 Part 2)1915-1917.

Moore LE, Smith AH, Hopenhayn-Rich C, et al. 1997a. Micronuclei in exfoliated bladder cells among individuals chronically exposed to arsenic in drinking water. Cancer Epidemiol Biomarkers Prev 6(1)31-36.

Moore LE, Warner ML, Smith AH, et al. 1996. Use of the fluorescent micronucleus assay to detect the genotoxic effects of radiation and arsenic exposure in exfoliated human epithelial cells. Environ Mol Mutagen 27(3):176-184.

Moore MM, Harrington-Brock K, Doerr CL. 1994b. Genotoxicity of arsenic and its methylated metabolites. Environ Geochem Health 16:191-198.

*Moore MM, Harrington-Brock K, Doerr CL. 1997b. Relative genotoxic potency of arsenic and its methylated metabolites. Mutat Res 386(3):279-290.

*Moreira JC. 1996. Threats by heavy metals: Human and environmental contamination in Brazil. Sci Total Environ 188(Suppl 1):S61-S71.

Morris JS, Schmid M, Newman S, et al. 1974. Arsenic and noncirrhotic portal hypertension. Gastroenterology 66(1):86-94.

Morrissey RE, Mottet NK. 1983. Arsenic-induced exencephaly in the mouse and associated lesions occurring during neurulation. Teratology 28:399-411.

Moriss-Kay GM, Wood H, Chen W. 1994. Normal neurulation in mammals. In: Ciba Foundation Symposium, neural tube defects. New York: John Wiley & Sons, 51-69.

Morse DL, Harrington JM, Housworth J, et al. 1979. Arsenic exposure in multiple environmental media in children near a smelter. Clin Toxicol 14(4):389-399.

Morselli PL, Franco-Morselli R, Bossi L. 1980. Clinical pharmacokinetics in newborns and infants: Age-related differences and therapeutic implications. Clin Pharmacokin 5:485-527.

Morton W, Starr G, Pohl D, et al. 1976. Skin cancer and water arsenic in Lane County, Oregon. Cancer 37:2523-2532.

Morton WE, Caron GA. 1989. Encephalopathy: An uncommon manifestation of workplace arsenic poisoning? Am J Ind Med 15:1-5.

Mottet NK, Ferm VH. 1983. The congenital teratogenicity and perinatal toxicity of metals. In: Clarkson TW, Nordberg GF, Sager PR, eds. Reproductive and developmental toxicity of metals. New York, NY: Plenum Press, 93-125.

Moxon AL, Paynter CR, Halverson AW. 1945. Effect of route of administration on detoxication of selenium by arsenic. J Pharmacol Exp Ther 84:115-119.

Mukherjee S, Das D, Darbar S, et al. 2003. Dietary intervention affects arsenic-generated nitric oxide and reactive oxygen intermediate toxicity in islet cells of rats. Curr Sci 85(6):786-793.

Mukherjee S, Das D, Darbar S, et al. 2004. Arsenic trioxide generates oxidative stress and islet cell toxicity in rabbit. Curr Sci 86(6):854-857.

Mumford JL, Wu K, Xia Y, et al. 2007. Chronic arsenic exposure and cardiac repolarization abnormalities with QT interval prolongation in a population-based study. Environ Health Perspect 115(5):690-694.

Mumma RO, Raupach DC, Waldman JP, et al. 1984. National survey of elements and other constituents in municipal sewage sludges. Arch Environ Contam Toxicol 13:75-83.

Murai T, Iwata H, Otoshi T, et al. 1993. Renal lesions induced in F34/DuCrj rats by 4-weeks oral administration of dimethylarsinic acid. Toxicol Lett 66:53-61.

*Murata K, Iwazawa T, Takayama T, et al. 1994. Quadruple cancer including Bowen's disease after arsenic injections 40 years earlier: Report of a case. Surg Today 24(12):1115-1118.

Mure K, Uddin AN, Lopez LC, et al. 2003. Arsenite induces delayed mutagenesis and transformation in human osteosarcoma cells at extremely low concentrations. Environ Mol Mutagen 41:322-331.

Murphy MJ, Lyon LW, Taylor JW. 1981. Subacute arsenic neuropathy: Clinical and electrophysiological observations. J Neurol Neurosurg Psychiatry 44:896-900.

Mushak P, Crocetti AF. 1995. Risk and revisionism in arsenic cancer risk assessment. Environ Health Perspect 103(7-8):684-689.

Mushak P, Dessauer K, Walls EL. 1977. Flameless atomic absorption (FAA) and gas-liquid chromatographic studies in arsenic bioanalysis. Environ Health Perspect 19:5-10.

Muzi G, dell'Omo M, Madeo G, et al. 2001. Arsenic poisoning caused by Indian ethnic remedies. J Pediatr 139(1):169.

Nagai N, Usui T, Asahi A, et al. 1956. Comparison of biochemical findings and clinical pictures on subacute or chronic arsenic poisoning of infants due to arsenic containing powdered milk. NTIS no. PB-258710-T.

Nagymajtényi L, Selypes A, Berencsi G. 1985. Chromosomal aberrations and fetotoxic effects of atmospheric arsenic exposure in mice. J Appl Toxicol 5(2):61-63.

Nakadaira H, Endoh K, Katagiri M, et al. 2002. Elevated mortality from lung cancer associated with arsenic exposure for a limited duration. J Occup Environ Med 44(3):291-299.

Nakamuro K, Sayato Y. 1981. Comparative studies of chromosomal aberrations induced by trivalent and pentavalent arsenic. Mutat Res 88:73-80.

NAS. 1977a. Medical and biologic effects of environmental pollutants: Arsenic. Washington, DC: National Academy of Sciences. http://www.nap.edu/books/0309026040/html/index.html. May 12, 2005.

NAS. 1977b. Arsenic. Drinking water and health. Washington, DC: National Academy of Sciences, 316-344, 428-430.

NAS/NRC. 1989. Report of the oversight committee. In: Biologic markers in reproductive toxicology. Washington, DC: National Academy of Sciences, National Research Council, National Academy Press.

Navas-Acien A, Sharrett AR, Silbergeld EK, et al. 2005. Arsenic exposure and cardiovascular disease: A systematic review of the epidemiologic evidence. Am J Epidemiol 162(11):1037-1049.

*Navas-Acien A, Silbergeld EK, Streeter RA, et al. 2006. Arsenic exposure and type 2 diabetes: A systematic review of the experimental and epidemiological evidence. Environ Health Perspect 114(5):641-648.

Neiger RD, Osweiler GD. 1989. Effect of subacute low level dietary sodium arsenite on dogs. Fundam Appl Toxicol 13:439-451.

Neiger RD, Osweiler GD. 1992. Arsenic concentrations in tissues and body fluids of dogs on chronic low level dietary sodium arsenite. J Vet Diagn Invest 4:334-337.

*Nelson WC, Lykins MH, Mackey J, et al. 1973. Mortality among orchard workers exposed to lead arsenate spray: A cohort study. J Chronic Dis 26:105-118.

Nemec MD, Holson JF, Farr CH, et al. 1998. Developmental toxicity assessment of arsenic acid in mice and rabbits. Reprod Toxicol 12(6):647-658.

Newman JA, Archer VE, Saccomanno G, et al. 1976. Histologic types of bronchogenic carcinoma among members of copper-mining and smelting communities. Ann N Y Acad Sci 271:260-268.

Nielson KK, Sanders RW. 1983. Multielement analysis of unweighed biological and geological samples using backscatter and fundamental parameters. Advances in X-ray Analysis 26:385-390.

NIOSH. 1984. Arsenic trioxide, as As - method 7901. In: NIOSH manual of analytical methods. 3rd ed. Vol. 1. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication no. 84-100. PB85179018.

NIOSH. 1994a. Method 7900. Arsenic and compounds, as As (except AsH_3 and As_2O_3). In: NIOSH manual of analytical methods (NMAM). 4th edition. National Institute for Occupational Safety and Health. http://www.cdc.gov/niosh/nmam/pdfs/7900.pdf. August 10, 2007.

NIOSH. 1994b. Method 7901. Arsenic trioxide, as As. In: NIOSH manual of analytical methods (NMAM). 4th edition. National Institute for Occupational Safety and Health. http://www.cdc.gov/niosh/nmam/pdfs/7901.pdf. August 10, 2007.

NIOSH. 1994c. Method 5022. Arsenic, organo-. In: NIOSH manual of analytical methods (NMAM). 4th edition. National Institute for Occupational Safety and Health. August 1994. http://www.cdc.gov/niosh/nmam/pdfs/5022.pdf. August 10, 2007.

NIOSH. 1994d. Method 6001. Arsine. In: NIOSH manual of analytical methods (NMAM). 4th edition. National Institute for Occupational Safety and Health. http://www.cdc.gov/niosh/nmam/pdfs/6001.pdf. August 10, 2007.

*NIOSH. 1994e. NIOSH Manual of Analytical Methods. 4th ed., August 15, 1994. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS. Method 7300 - Elements by ICP; Method 7900 - Arsenic; method 5022 - Arsenic, organo; Method 7901 - Arsenic trioxide.

NIOSH. 2003. Method 7300. Elements by ICP (nitric/perchloric acid ashing). NIOSH manual of analytical methods (NMAM). 4th ed. Cincinnati, OH: National Institute for Occupational Safety and Health. DHHS (NIOSH) Publication 94-113. http://www.cdc.gov/niosh/nmam/pdfs/7300.pdf. March 21, 2006.

NIOSH. 2005a. Arsenic. NIOSH pocket guide to chemical hazards. Atlanta, GA: National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention. http://www.cdc.gov/niosh/npg/npgdname.html. February 15, 2004.

*NIOSH. 2005b. International Chemical Safety Cards (ICSCs): U.S. National Version. National Institute for Occupational Safety and Health. http://www.cdc.gov/niosh/ipcs/nicstart.html. April 7, 2005.

Nishioka H. 1975. Mutagenic activities of metal compounds in bacteria. Mutat Res 31:185-189.

NOES. 1990. National Occupational Exposure Survey, National Institute for Occupational Safety and Health, Cincinnati, OH. July 16, 1990.

Nordenson I, Beckman G, Beckman L, et al. 1978. Occupational and environmental risks in and around a smelter in northern Sweden: II. Chromosomal aberrations in workers exposed to arsenic. Hereditas 88:47-50.

Nordenson I, Salmonsson S, Brun E, et al. 1979. Chromosome aberrations in psoriatic patients treated with arsenic. Hum Genet 48:1-6.

Nordenson I, Sweins A, Beckman L. 1981. Chromosome aberrations in cultured human lymphocytes exposed to trivalent and pentavalent arsenic. Scand J Work Environ Health 7:277-281.

Nordström S, Beckman L, Nordenson I. 1978a. Occupational and environmental risks in and around a smelter in northern Sweden. I. Variations in birthweight. Hereditas 88:43-46.

Nordström S, Beckman L, Nordenson I. 1978b. Occupational and environmental risks in and around a smelter in northern Sweden. III. Frequencies of spontaneous abortion. Hereditas 88:51-54.

Nordström S, Beckman L, Nordenson I. 1979a. Occupational and environmental risks in and around a smelter in northern Sweden. V. Spontaneous abortion among female employees and decreased birth weight in their offspring. Hereditas 90:291-296.

Nordström S, Beckman L, Nordenson I. 1979b. Occupational and environmental risks in and around a smelter in northern Sweden. VI. Congenital malformations. Hereditas 90:297-302.

Norin H, Vahter M. 1981. A rapid method for the selective analysis of total urinary metabolites of inorganic arsenic. Scand J Work Environ Health 7:38-44.

Norin H, Christakopoulos A, Rondahl L, et al. 1987. Identification and quantification of arsenocholine and acetylarsenocholine in trace amounts in biological material by use of pyrolysis gas chromatography/mass spectrometry. Biomed Environ Mass Spectrom 14:117-125.

NPIRS. 2007. Chemical ingredients: Arsenic. National Pesticide Information Retrieval System. http://ppis.ceris.purdue.edu/htbin/epachem.com. February 7, 2007.

NRC. 1993. Pesticides in the diets of infants and children. National Research Council. Washington, DC: National Academy Press.

NRC. 1999. Arsenic in drinking water. National Research Council. Washington, DC: National Academy Press.

NRC. 2001. Arsenic in drinking water. 2001 Update. National Research Council. Washington, DC: National Academy Press.

*Nriagu JO. 1988. A silent epidemic of environmental metal poisoning? Environ Pollut 50:139-161.

Nriagu JO, Lin T. 1995. Trace metals in wild rice sold in the United States. Sci Total Environ 172(2-3):223-228.

Nriagu JO, Pacyna JM. 1988. Quantitative assessment of worldwide contamination of air, water and soils by trace metals. Nature 333:134-139.

*NTP. 1989a. National Toxicology Program. Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service, National Toxicology Program. NTP 89-239.

NTP. 1989b. National Toxicology Program - technical report series no. 345. Toxicology and carcinogenesis studies of roxarsone (CAS No. 121-19-7) in F344/N rats and B6C3F1 mice (feed studies). Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health. NTP-TR-345. NIH pub no. 89-2800.

NTP. 2005. Report on carcinogens. 11 ed. Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service, National Toxicology Program. http://ntp-server.niehs.nih.gov/ntp/roc/toc11.html. February 15, 2004.

Nygren O, Nilsson CA, Lindahl R. 1992. Occupational exposure to chromium, copper and arsenic during work with impregnated wood in joinery shops. Ann Occup Hyg 36(5)509-517.

Oberly TJ, Hoffman WP, Garriott ML. 1996. An evaluation of the twofold rule for assessing a positive response in the L5178Y $TK^{*/-}$ mouse lymphoma assay. Mutat Res 369 (3-4):221-232.

Oberly TJ, Piper CE, McDonald DS. 1982. Mutagenicity of metal salts in the L5178Y mouse lymphoma assay. J Toxicol Environ Health 9:367-376.

Odanaka Y, Matano O, Goto S. 1980. Biomethylation of inorganic arsenic by the rat and some laboratory animals. Bull Environ Contam Toxicol 24:452-459.

Odanaka Y, Tsuchiya N, Matano O, et al. 1983. Determination of inorganic arsenic and methylarsenic compounds by gas chromatography and multiple ion detection mass spectrometry after hydride generation-heptane cold trap. Anal Chem 55:929-932.

*O'Day PA, Carroll SA, Waychunas GA. 1998. Rock-water interactions controlling zinc, cadmium, and lead concentrations in surface waters and sediments, U.S. Tri-State Mining District. 1. Molecular identification using x-ray absorption spectroscopy. Environ Sci Technol 32(7):943-955.

Offergelt JA, Roels H, Buchet JP, et al. 1992. Relation between airborne arsenic trioxide and urinary excretion of inorganic arsenic and its methylated metabolites. Br J Ind Med 49(6)387-393.

*Ohnishi Y, Murakami S, Ohtsuka H, et al. 1997. Merkel cell carcinoma and multiple Bowen's disease: Incidental association or possible relationship to inorganic arsenic exposure? J Dermatol 24(5):310-316.

Ohyama S, Ishinishi N, Hisanaga A, et al. 1988. Comparative chronic toxicity, including tumorigenicity, of gallium arsenide and arsenic trioxide intratracheally instilled into hamsters. Appl Organomet Chem 2:333-337.

Okada S, Yamanaka K. 1994. Induction of lung-specific DNA damage by methylarsenics via the production of free radials. In: Nriagu JO, ed. Arsenic in the environment. New York, NY: John Wiley & Sons, Inc., 143-157.

*O'Kamura S, Inoue N. 1999. [Hematological disturbances caused by arsenic poisoning.] Fukuoka Igaku Zasshi 90(2):33-38. (Japanese)

Okui T, Fujiwara Y. 1986. Inhibition of human excision DNA repair by inorganic arsenic and the co-mutagenic effect in V79 Chinese hamster cells. Mutat Res 172:69-76.

O'Rourke MK, Rogan SP, Jin S, et al. 1999. Spatial distributions of arsenic exposure and mining communities from NHEXAS Arizona. National Human Exposure Assessment Survey. J Expo Anal Environ Epidemiol 9(5):446-455.

OSHA. 2005a. Air contaminants. Occupational safety and health standards for shipyard employment. Occupational Safety and Health Administration. Code of Federal Regulations. 29 CFR 1915.1000. http://www.osha.gov/comp-links.html. February 15, 2005.

OSHA. 2005b. Gases, vapors, fumes, dusts, and mists. Safety and health regulations for construction. Occupational Safety and Health Administration. Code of Federal Regulations. 29 CFR 1926.55, Appendix A. http://www.osha.gov/comp-links.html. February 15, 2005.

OSHA. 2005c. Inorganic arsenic. Occupational safety and health standards. Occupational Safety and Health Administration. Code of Federal Regulations. 29 CFR 1910.1018. http://www.osha.gov/comp-links.html. March 24, 2005.

OSHA. 2005d. Limits for air contaminants. Occupational safety and health standards. Washington, DC: Occupational Safety and Health Administration. Code of Federal Regulations. 29 CFR 1910.1000. http://www.osha.gov/comp-links.html. February 15, 2005.

O'Shaughnessy E, Kraft GH. 1976. Arsenic poisoning: Long-term follow-up of a nonfatal case. Arch Phys Med Rehabil 57:403-406.

OTA. 1990. Neurotoxicity: Identifying and controlling poisons of the nervous system. Washington, DC: Office of Technology Assessment. OTA-BA-438.

Ott MG, Holder BB, Gordon HL. 1974. Respiratory cancer and occupational exposure to arsenicals. Arch Environ Health 29:250-255.

Owen GM, Brozek J. 1966. Influence of age, sex and nutrition on body composition during childhood and adolescence. In: Falkner F, ed. Human development. Philadelphia, PA: WB Saunders, 222-238.

Oya-Ohta Y, Kaise T, Ochi T. 1996. Induction of chromosomal aberrations in cultured human fibroblasts by inorganic and organic arsenic compounds and the different roles of glutathione in such induction. Mutat Res 357(1-2)123-129.

Øygard JK, Lundebye A, Julshamin K. 1999. Determination of inorganic arsenic in marine food samples by hydrochloric acid distillation and flow-injection hydride-generation atomic absorption spectrometry. J AOAC Int 82(5):1217-1223.

Pacyna JM. 1987. Atmospheric emissions of arsenic, cadmium, lead and mercury from high temperature processes in power generation and industry. In: Hutchinson TC, Meema KM, eds. Lead, mercury, cadmium and arsenic in the environment. New York: John Wiley & Sons Ltd., 69-87.

Pacyna JM, Scholtz MT, Li Y. 1995. Global budget of trace metal sources. Environ Rev 3(2):145-159.

Page BJ, Loar GW. 1993. Chromium compounds. In: Kroschwitz JI, Howe-Grant M, eds. Kirk-Othmer encyclopedia of chemical technology. Vol. 6. New York, NY: John Wiley and Sons, 297-298.

Page GW. 1981. Comparison of groundwater and surface water for patterns and levels of contamination by toxic substances. Environ Sci Technol 15(12):1475-1481.

Pantsar-Kallio M, Manninen PKG. 1997. Speciation of mobile arsenic in soil samples as a function of pH. Sci Total Environ 204(2):193-200.

Park J, Presley BJ. 1997. Trace metal contamination of sediments and organisms from the Swan Lake area of Galveston Bay. Environ Pollut 98(2):209-221.

Paschal DC, DiPietro ES, Phillips DL, et al. 1989. Age dependence of metals in hair in a selected US population. Environ Res 48:17-28.

Pascoe GA, Blanchet RJ, Linder G. 1994. Bioavailability of metals and arsenic to small mammals at a mining waste-contaminated wetland. Arch Environ Contam Toxicol 27:44-50.

Pedersen GA, Mortensen GK, Larsen EH. 1994. Beverages as a source of toxic trace element intake. Food Addit Contam 11(3):351-363.

*Pellizzari ED, Smith DJ, Clayton CA, et al. 2001. An assessment of the data quality for NHEXAS-Part I: Exposure to metals and volatile organic chemicals in Region 5. J Expo Anal Environ Epidemiol 11:140-154.

Peoples SA, Maddy KT, Peifer WR, et al. 1979. Occupational exposures to pesticides containing organoarsenicals in California. Vet Hum Toxicol 21:417-421. (Retrieval in progress)

Permapost. 2000. Chromated copper arsenate, CCA-C. Permapost Products Co., Hillsboro, Oregon. http://www.permapost.com/cca.htm. March 3, 2005.

Perry K, Bowler RG, Buckell HM, et al. 1948. Studies in the incidence of cancer in a factory handling inorganic compounds of arsenic--II: Clinical and environmental investigations. Br J Ind Med 5:6-15.

Pershagen G. 1985. Lung cancer mortality among men living near an arsenic-emitting smelter. Am J Epidemiol 122(4):684-694.

Pershagen G, Björklund NE. 1985. On the pulmonary tumorigenicity of arsenic trisulfide and calcium arsenate in hamsters. Cancer Lett 27:99-104.

Pershagen G, Bergman F, Klominek J, et al. 1987. Histological types of lung cancer among smelter workers exposed to arsenic. Br J Ind Med 44:454-458.

Pershagen G, Nordberg G, Bjorkland NE. 1984. Carcinomas of the respiratory tract in hamsters given arsenic trioxide and/or benzo[*a*]pyrene by the pulmonary route. Environ Res 34:227-241.

Pershagen G, Wall S, Taube A, et al. 1981. On the interaction between occupational arsenic exposure and smoking and its relationship to lung cancer. Scand J Work Environ Health 7:302-309.

Pesch B, Ranft U, Jakubis P, et al. 2002. Environmental arsenic exposure from a coal-burning power plant as a potential risk factor for nonmelanoma skin carcinoma: Results from a case-control study in the district of Prievidza, Slovakia. Am J Epidemiol 155(9):798-809.

*Peters RA, Thompson RH, King AJ, et al. 1944. The treatment of post-arsphenamine jaundice with sulphur-containing amino acids. Q J Med 14:35-56.

Peters SC, Blum JD, Klaue B, et al. 1999. Arsenic occurrence in New Hampshire drinking water. Environ Sci Technol 33:1328-1333.

Peterson RG, Rumack BH. 1977. D-penicillamine therapy of acute arsenic poisoning. J Pediatr 91(4):661-666.

Petres J, Baron D, Hagedorn M. 1977. Effects of arsenic cell metabolism and cell proliferation: Cytogenic and biochemical studies. Environ Health Perspect 19:223-227.

Petrick JS, Ayala-Fierro F, Cullen WR, et al. 2000. Monomethylarsenous acid (MMA III) is more toxic than arsenite in Chang human hepatocytes. Toxicol Appl Pharmacol 163:203-207.

Petrick JS, Jagadish B, Mash EA, et al. 2001. Monomethylarsenous acid (MMA^{III}) and arsenite: LD_{50} in hamsters and *in vitro* inhibition of pyruvate dehydrogenase. Chem Res Toxicol 14(6):651-656.

Philp RB, Leung FY, Bradley C. 2003. A comparison of the metal content of some benthic species from coastal waters of the Florida panhandle using high-resolution inductively coupled plasma mass spectrometry (ICP-MS) analysis. Arch Environ Contam Toxicol 44:218-223.

Pi J, He Y, Bortner C, et al. 2005. Low level, long-term inorganic arsenite exposure causes generalized resistance to apoptosis in cultured human keratinocytes: Potential role in skin co-carcinogenesis. Int J Cancer 116:20-26.

*Pi J, Yamauchi H, Kumagai Y, et al. 2002. Evidence for induction of oxidative stress caused by chronic exposure of Chinese residents to arsenic contained in drinking water. Environ Health Perspect 110:331-336.

Pinto SS, McGill CM. 1953. Arsenic trioxide exposure in industry. Ind Med Surg 22(7):281-287.

Pinto SS, Enterline PE, Henderson V, et al. 1977. Mortality experience in relation to a measured arsenic trioxide exposure. Environ Health Perspect 19:127-130.

Pinto SS, Henderson V, Enterline PE. 1978. Mortality experience of arsenic-exposed workers. Arch Environ Health 33:325-331.

Pinto SS, Varner MO, Nelson KW, et al. 1976. Arsenic trioxide absorption and excretion in industry. J Occup Med 18(10):677-680.

Piontek M, Hengels KJ, Borchard F, et al. 1989. [Noncirrhotic liver fibrosis after chronic arsenic poisoning.] Dtsch Med Wochenschr 114:1653-1657. (German)

Pirrone N, Keeler GJ. 1996. A preliminary assessment of the urban pollution in the Great Lakes region. Sci Total Environ 189/190:91-98.

Pitten F, Müller G, König P, et al. 1999. Risk assessment of former military base contaminated with organoarsenic-based warfare agents: Uptake of arsenic by terrestrial plants. Sci Total Environ 226:237-245.

Poddar S, Mukherjee P, Talukder G, et al. 2000. Dietary protection by iron against clastogenic effects of short-term exposure to arsenic in mice *in vivo*. Food Chem Toxicol 38(8):735-737.

Polissar L, Lowry-Coble K, Kalman DA, et al. 1990. Pathways of human exposure to arsenic in a community surrounding a copper smelter. Environ Res 53:29-47.

Poma K, Degraeve N, Kirsch-Volders M, et al. 1981. Cytogenetic analysis of bone marrow cells and spermatogonia of male mice after *in vivo* treatment with arsenic. Experientia 37:129-130.

Poma K, Degraeve N, Susanne C. 1987. Cytogenetic effects in mice after chronic exposure to arsenic followed by a single dose of ethylmethane sulfonate. Cytologia 52:445-449.

Pomroy C, Charbonnaeu SM, McCullough RS, et al. 1980. Human retention studies with ^{74}As. Toxicol Appl Pharm 53:550-556.

Pongratz R. 1998. Arsenic speciation in environmental samples of contaminated soil. Sci Total Environ 224:133-141.

Pouschat P, Zagury GJ. 2006. *In vitro* gastrointestinal bioavailability of arsenic in soils collected near CCA-treated utility poles. Environ Sci Technol 40(13):4317-4323.

Prasad GVR, Rossi NF. 1995. Arsenic intoxication associated with tubulointerstitial nephritis. Am J Kidney Dis 26(2)373-376.

Prier RF, Nees PO, Derse PH. 1963. The toxicity of an organic arsenical, 3-nitro-4-hydroxyphenyl-arsonic acid. II. Chronic toxicity. Toxicol Appl Pharmacol 5:526-542.

Prukop JA, Savage NL. 1986. Some effects of multiple, sublethal doses of monosodium methanearsonate (MSMA) herbicide on hematology, growth, and reproduction of laboratory mice. Bull Environ Contam Toxicol 36:337-341.

PSA. 2000. Excalibur atomic fluorescence: Measurements of arsenic, selenium, antimony, bismuth and tellurium. Orpington, England: PS Analytical Ltd. http://www.banian.com. March 31, 2005.

Qiao Y, Taylor PR, Yao S, et al. 1997. Risk factors and early detection of lung cancer in a cohort of Chinese tin miners. Ann Epidemiol 7:533-541.

Quatrehomme G, Ricq O, Lapalus P, et al. 1992. Acute arsenic intoxication: Forensic and toxicologic aspects (an observation). J Forensic Sci 37(4)1163-1171.

Rabano ES, Castillo NT, Torre KJ, et al. 1989. Speciation of arsenic in ambient aerosols collected in Los Angeles. J Air Pollut Control Assoc 39:76-80.

*Rahman M, Axelson O. 1995. Diabetes mellitus and arsenic exposure: A second look at case-control data from a Swedish copper smelter. Occup Environ Med 52(11)773-774.

Rahman FA, Allan DL, Rosen CJ, et al. 2004. Arsenic availability from chromated copper arsenate (CCA)-treated wood. J Environ Qual 33(1):173-180.

Rahman M, Tondel M, Ahmad SA, et al. 1998. Diabetes mellitus associated with arsenic exposure in Bangladesh. Am J Epidemiol 148(2):198-203.

*Rahman M, Wingren G, Axelson O. 1996. Diabetes mellitus among Swedish art glass workers–an effect of arsenic exposure? Scand J Work Environ Health 22(2):146-149.

Rahman M, Tondel M, Ahmad SA, et al. 1999. Hypertension and arsenic exposure in Bangladesh. Hypertension 33:74-78.

Raie RM. 1996. Regional variation in As, Cu, Hg, and Se and interaction between them. Ecotoxicol Environ Saf 35:248-252.

Ramirez P, Eastmond DA, Laclette JP, et al. 1997. Disruption of microtubule assembly and spindle formation as a mechanism for the induction of aneuploid cells by sodium arsenite and vanadium pentoxide. Mutat Res 386(3):291-298.

Ramos-Morales P, Rodríguez-Arnaiz R. 1995. Genotoxicity of two arsenic compounds in germ cells and somatic cells of *Drosophila melanogaster*. Environ Mol Mutagen 25(4):288-299.

Ramsey JC, Andersen ME. 1984. A physiologically based description of the inhalation pharmacokinetics of styrene in rats and humans. Toxicol Appl Pharmacol 73:159-175.

Rasmussen RE, Menzel DB. 1997. Variation in arsenic-induced sister chromatid exchange in human lymphocytes and lymphoblastoid cell lines. Mutat Res 386(3)299-306.

Rastogi SC, Pritzl G. 1996. Migration of some toxic metals from crayons and water colors. Bull Environ Contam Toxicol 56(4)527-533.

Reddy PRK, Reddy SJ. 1997. Elemental concentrations in medicinally important leafy materials. Chemosphere 34(9-10):2193-2212.

Redman AD, Macalady DL, Ahmann D. 2002. Natural organic matter affects arsenic speciation and sorption onto hematite. Environ Sci Technol 36:2889-2896.

Regelson W, Kim U, Ospina J, et al. 1968. Hemangioendothelial sarcoma of liver from chronic arsenic intoxication by Fowler's solution. Cancer 21(3):514-522.

*Reichl F, Hunder G, Liebl B, et al. 1995. Effect of DMPS and various adsorbents on the arsenic excretion in guinea-pigs after injection with As_2O_3. Arch Toxicol 69(10):712-717.

Reimann C, De Caritat P, Halleraker JH, et al. 1997. Rainwater composition in eight arctic catchments in Northern Europe (Finland, Norway and Russia). Atmos Environ 31(2):159-170.

Reimer KJ. 1989. The methylation of arsenic in marine sediments. Appl Organomet Chem 3:475-490.

Reitz RH, Mendrala AL, Corley RA, et al. 1990. Estimating the risk of liver cancer associated with human exposures to chloroform using physiologically based pharmacokinetic modeling. Toxicol Appl Pharm 105:443-459.

Reymann F, M?ller R, Nielsen A. 1978. Relationship between arsenic intake and internal malignant neoplasms. Arch Dermatol 114:378-381.

Rhine ED, Phelps CD, Young LY. 2006. Anaerobic arsenite oxidation by novel denitrifying isolates. Environ Microbiol 8(5):899-908.

Rhoads K, Sanders CL. 1985. Lung clearance, translocation and acute toxicity of arsenic, beryllium, cadmium, cobalt, lead, selenium, vanadium, and ytterbium oxides following deposition in rat lung. Environ Res 36:359-378.

Rice DA, Kennedy S, McMurray CH, et al. 1985. Experimental 3-nitro-4-hydroxyphenylarsonic acid toxicosis in pigs. Res Vet Sci 39:47-51.

Rin K, Kawaguchi K, Yamanaka K, et al. 1995. DNA-strand breaks induced by dimethylarsinic acid, a metabolite of inorganic arsenics, are strongly enhanced by superoxide anion radicals. Biol Pharm Bull 18(1):45-48.

Rivara MIZ, Cebrián MG, Corey G, et al. 1997. Cancer risk in an arsenic contaminated area of Chile. In: International congress on hazardous waste: Impact on human and ecological health. Hazardous waste, impacts on human ecological health: Proceedings of the 2nd International Congress on Hazardous Waste, Impact on Human and Ecological Health. Princeton, New Jersey: Princeton Scientific Pub. Co., 408-426.

Roberts SM, Munson JW, Lowney YW, et al. 2007. Relative oral bioavailablity of arsenic from contaminated soils measured in the cynomolgus monkey. Toxicol Sci 95(1):281-288.

Roberts SM, Weimar WR, Vinson JRT, et al. 2002. Measurement of arsenic bioavailability in soil using a primate model. Toxicol Sci 67:303-310.

Robertson FN. 1989. Arsenic in ground-water under oxidizing conditions, southwest United States. Environ Geochem Health 11:171-185.

Rodriguez RR, Basta NT, Casteel SW, et al. 1999. An *in vitro* gastrointestinal method to estimate bioavailable arsenic in contaminated soils and solid media. Environ Sci Technol 33:642-649.

Rodriguez VM, Carrizales L, Jimenez-Capdeville ME, et al. 2001. The effects of sodium arsenite exposure on behavioral parameters in the rat. Brain Res Bull 55(2):301-308.

Rodriguez VM, Carrizales L, Mendoza MS, et al. 2002. Effects of sodium arsenite exposure on development and behavior in the rat. Neurotoxicol Teratol 24(6):743-750.

*Rogers CE, Tomita AV, Trowbridge PR, et al. 1997. Hair analysis does not support hypothesized arsenic and chromium exposure from drinking water in Woburn, Massachusetts. Environ Health Perspect 105(10):1090-1097.

Rogers EH, Chernoff N, Kavlock RJ. 1981. The teratogenic potential of cacodylic acid in the rat and mouse. Drug Chem Toxicol 4(1):49-61.

Roper JM, Cherry DS, Simmers JW, et al. 1996. Bioaccumulation of toxicants in the zebra mussel, *Dreissena polymorpha*, at the Times Beach confined disposal facility, Buffalo, New York. Environ Pollut 94(2):117-129.

Rosen BP. 2002. Biochemistry of arsenic detoxification. FEBS Lett 529:86-92.

Rosenbaum AS, Axelrad DA, Woodruff TJ, et al. 1999. National estimates of outdoor air toxics concentrations. J Air Waste Manage Assoc 49:1138-1152.

Rosenberg HG. 1974. Systemic arterial disease and chronic arsenicism in infants. Arch Pathol 97:360-365.

*Rosner MH, Carter DE. 1987. Metabolism and excretion of gallium arsenide and arsenic oxides by hamsters following intratracheal instillation. Fundam Appl Toxicol 9:730-737.

Rossman TG. 2003. Mechanism of arsenic carcinogenesis: An integrated approach. Mutat Res 533:37-65.

Rossman TG, Uddin AN. 2004. Selenium prevents spontaneous and arsenite-induced mutagenesis. Int Congr Ser 1275:173-179.

Rossman TG, Stone D, Molina M, et al. 1980. Absence of arsenite mutagenicity in E coli and Chinese hamster cells. Environ Mut 2:371-379.

Rossman TG, Uddin AN, Burns FJ. 2004. Evidence that arsenite acts as a cocarcinogen in skin cancer. Toxicol Appl Pharmacol 198(3):394-404.

Rössner P, Bencko V, Havránková H. 1977. Effect of the combined action of selenium and arsenic on suspension culture of mice fibroblasts. Environ Health Perspect 19:235-237.

Roth F. 1957. The sequelae of chronic arsenic poisoning in Moselle Vintners. Ger Med Mon 2:172-175.

Roy P, Saha A. 2002. Metabolism and toxicity of arsenic: A human carcinogen. Curr Sci 82(1):38-45.

RTECS. 2007. Arsenic. Registry of Toxic Effects on Chemical Substances. National Institute of Occupational Safety and Health. MDL Information Systems, Inc. May 8, 2007

Rubin Y, Gal N, Nyska A, et al. 1989. Cacodylic acid two generation reproduction study in the rat. Luxembourg Industries (Pamol) Ltd. Submitted to the U.S. Environmental Protection Agency. MRID41059501.

Ruby MV, Davis A, Schoof R, et al. 1996. Estimation of lead and arsenic bioavailability using a physiologically based extraction test. Environ Sci Technol 30(2):422-430.

Ruby MV, Schoof R, Brattin W, et al. 1999. Advances in evaluating the oral bioavailability of inorganics in soil for use in human health risk assessment. Environ Sci Technol 33(21):3697-3705.

*Rudnai P, Borzonyi M. 1980. Carcinogenic effect of arsenic trioxide in transplacentally and neonatally treated CFLP mice. Nat Sci 2:11-18.

Rupa DS, Schuler M, Eastmond DA. 1997. Detection of hyperdiploidy and breakage affecting the 1cen-1q12 region of cultured interphase human lymphocytes treated with various genotoxic agents. Environ Mole Mutagen 29(2):161-167.

Rutherford DW, Bednar AJ, Garbarino JR, et al. 2003. Environmental fate of roxarsone in poultry litter. Part II. Mobility of arsenic in soils amended with poultry litter. Environ Sci Technol 37:1515-1520.

Ryan PB, Scanlon KA, MacIntosh DL. 2001. Analysis of dietary intake of selected metals in the NHEXAS-Maryland investigation. Environ Health Perspect 109(2):121-128.

Saady JJ, Blanke RV, Poklis A. 1989. Estimation of the body burden of arsenic in a child fatally poisoned by arsenite weedkiller. J Anal Toxicol 13:310-312.

Saha KC, Poddar D. 1986. Further studies on chronic arsenical dermatosis. Indian J Dermatol 31:29-33.

Salim EI, Wanibuchi H, Morimura K, et al. 2003. Carcinogenicity of dimethylarsinic acid in p53 heterozygous knockout and wild-type C57BL/6J mice. Carcinogenesis 24(2):335-342.

Samsøe-Petersen L, Larsen EH, Larsen PB, et al. 2002. Uptake of trace elements and PAHs by fruit and vegetables from contaminated soils. Environ Sci Technol 36:3057-3063.

Sanders JG, Riedel GF, Osmann RW. 1994. Arsenic cycling and its impact in estuarine and coastal marine ecosystems. In: Nriagu JO, ed. Arsenic in the environment, part I: Cycling and characterization. New York, NY: John Wiley & Sons, Inc., 289-308.

Sandstrom AIM, Wall SGI, Taube A. 1989. Cancer incidence and mortality among Swedish smelter workers. Br J Ind Med 46:82-89.

Sanok WJ, Ebel JG, JR, Manzell KL, et al. 1995. Residues of arsenic and lead in potato soils on long island. Chemosphere 30(4):803-806.

Santra A, Maiti A, Das S, et al. 2000. Hepatic damage caused by chronic arsenic toxicity in experimental animals. J Toxicol Clin Toxicol 38(4):395-405.

Sardana MK, Drummond GS, Sassa S, et al. 1981. The potent heme oxygenase inducing action of arsenic in parasiticidal arsenicals. Pharmacology 23:247-253.

*Sarin SK, Sharma G, Banerjee S, et al. 1999. Hepatic fibrogenesis using chronic arsenic ingestion studies in a murine model. Indian J Exp Biol 37:147-151.

Sarkar D, Datta R. 2004. Arsenic fate and bioavailability in two soils contaminated with sodium arsenate pesticide: An incubation study. Bull Environ Contam Toxicol 72(2):240-247.

Sass U, Grosshans E, Simonart JM. 1993. Chronic arsenicism: Criminal poisoning or drug-intoxication? Report of two cases. Dermatology 186(4)303-305.

Schmitt CJ, Zajicek JL, May TW, et al. 1999. Organochlorine residues and elemental contaminants in U.S. freshwater fish, 1976-1986: National contaminant biomonitoring program. Rev Environ Contam Toxicol 162:43-104.

Schoenwolf GC, Smith JL. 1990. Mechanisms of neurulation: Traditional viewpoint and recent advances. Development 109:243-270.

Schoof RA, Eickhoff J, Yost LJ, et al. 1999a. Dietary exposure to inorganic arsenic. In: Chappell WR, Abernathy CO, Calderon RL, eds. Arsenic exposure and health effects. Amsterdam: Elsevier Science, 81-88.

Schoof RA, Yost LJ, Crecelius K, et al. 1998. Dietary arsenic intake in Taiwanese districts with elevated arsenic in drinking water. Hum Ecol Risk Assess 4(1):117-135.

Schoof RA, Yost LJ, Eickhoff J, et al. 1999b. A market basket survey of inorganic arsenic in food. Food Chem Toxicol 37:839-846.

Schrauzer GN. 1987. Effects of selenium antagonists on cancer susceptibility: New aspects of chronic heavy metal toxicity. J UOEH 9(Suppl):208-215.

Schrauzer GN, Ishmael D. 1974. Effects of selenium and of arsenic on the genesis of spontaneous mammary tumors in inbred C_3H mice. Ann Clin Lab Sci 4(6):441-447.

Schrauzer GN, White DA, McGinness JE, et al. 1978. Arsenic and cancer: Effects of joint administration of arsenite and selenite on the genesis of adenocarcinoma in inbred female C_3H/St mice. Bioinorg Chem 9:245-253.

Schrauzer GN, White DA, Schneider CJ. 1976. Inhibition of the genesis of spontaneous mammary tumors in C_3H mice: Effects of selenium and of selenium-antagonistic elements and their possible role in human breast cancer. Bioinorg Chem 6:265-270.

*Schroeder HA, Balassa JJ. 1966. Abnormal trace metals in man: Arsenic. J Chron Dis 19:85-106.

Schroeder HA, Balassa JJ. 1967. Arsenic, germanium, tin and vanadium in mice: Effects on growth, survival and tissue levels. J Nutr 92:245-252.

Schroeder HA, Mitchener M. 1971. Toxic effects of trace elements on the reproduction of mice and rats. Arch Environ Health 23:102-106.

Schroeder HA, Kanisawa M, Frost DV, et al. 1968. Germanium, tin and arsenic in rats: Effects on growth, survival, pathological lesions and life span. J Nutr 96:37-45.

Schroeder RE. 1994. A two-generation reproduction study in rats with methanearsonic acid (MAA). Luxembourg Industries (Pamol) Ltd. Submitted to the U.S. Environmental Protection Agency. MRID43178301.

Schroeder WH, Dobson M, Kane DM, et al. 1987. Toxic trace elements associated with airborne particulate matter: A review. J Air Pollut Control Assoc 37(11):1267-1285.

Schulz H, Nagymajtenyi L, Institoris L, et al. 2002. A study on behavioral, neurotoxicological, and immunotoxicological effects of subchronic arsenic treatment in rats. J Toxicol Environ Health A 65(16):1181-1193.

Scott N, Hatlelid KM, MacKenzie NE, et al. 1993. Reactions of arsenic (III) and arsenic (V) species with glutathione. Chem Res Toxicol 6:102-106.

Scudlark JR, Church TM. 1988. The atmospheric deposition of arsenic and association with acid precipitation. Atmos Environ 22(5):937-943.

Scudlark JR, Conko KM, Church TM. 1994. Atmospheric wet deposition of trace elements to Chesapeake Bay: CBAD study year 1 results. Atmos Environ 28(8):1487-1498.

Senesi GS, Baldassarre G, Senesi N, et al. 1999. Trace element inputs into soils by anthropogenic activities and implications for human health. Chemosphere 39(2):343-377.

Setchell BP, Waites GMH. 1975. The blood-testis barrier. In: Creep RO, Astwood EB, Geiger SR, eds. Handbook of physiology: Endocrinology V. Washington, DC: American Physiological Society.

Shahin U, Yi SM, Paode RD, et al. 2000. Long-term elemental dry deposition fluxes measured around Lake Michigan with an automated dry deposition sampler. Environ Sci Technol 34:1887-1892.

Shalat SL, Solo-Gabriele HM, Fleming LE, et al. 2006. A pilot study of children's exposure to CCA-treated wood from playground equipment. Sci Total Environ 367(1):80-88.

Shannon RL, Strayer DS. 1989. Arsenic-induced skin toxicity. Hum Toxicol 8:99-104.

Sheehy JW, Jones JH. 1993. Assessment of arsenic exposures and controls in gallium arsenide production. Am Ind Hyg Assoc J 54(2):61-69.

Shen J, Wanibuchi H, Salim EI, et al. 2003. Induction of glutathione *S*-transferase placental form positive foci in liver and epithelial hyperplasia in urinary bladder, but no tumor development in male epithelial hyperplasia in urinary bladder, but no tumor development in male Fischer 344 rats treated with monomethylarsonic acid for 104 weeks. Toxicol Appl Pharmacol 193(3):335-345.

*Shen Z, Chen G, Ni J, et al. 1997. Use of arsenic trioxide (As_2O_3) in the treatment of acute promyelocytic leukemia (APL): II. Clinical efficacy and pharmacokinetics in relapsed patients. Blood 89(9):3354-3360.

*Shi H, Shi X, Liu KJ. 2004. Oxidative mechanism of arsenic toxicity and carcinogenesis. Mol Cell Biochem 255(1-2):67-78.

*Shibata A, Ohneseit PF, Tsai YC, et al. 1994. Mutational spectrum in the p53 gene in bladder tumors from the endemic area of blackfoot disease in Taiwan. Carcinogenesis 15(6):1085-1087.

Shirachi DY, Johansen MG, McGowan JP, et al. 1983. Tumorigenic effect of sodium arsenite in rat kidney. Proc West Pharmacol Soc 26:413-415.

Shum S, Whitehead J, Vaughn L, et al. 1995. Chelation of organoarsenate with dimercaptosuccinic acid. Vet Hum Toxicol 37(3):239-242.

Siewicki TC. 1981. Tissue retention of arsenic in rats fed witch flounder or cacodylic acid. J Nutr 111:602-609.

Sikorski EE, McCay JA, White KL Jr, et al. 1989. Immunotoxicity of the semiconductor gallium arsenide in female B6C3F1 mice. Fundam Appl Toxicol 13:843-858.

Silver AS, Wainman PL. 1952. Chronic arsenic poisoning following use of an asthma remedy. JAMA 150(6):584-585.

Singh I. 1983. Induction of reverse mutation and mitotic gene conversion by some metal compounds in *Saccharomyces cerevisiae*. Mutat Res 117:149-152.

Skeaff JM, Dubreuil AA. 1997. Calculated 1993 emission factors of trace metals for Canadian non-ferrous smelters. Atmos Environ 31(10):1449-1457.

Slayton TM, Beck BD, Reynolds KA, et al. 1996. Issues in arsenic cancer risk assessment. Environ Health Perspect 104 (10):1012-1018.

Smith AH, Biggs ML, Hopenhayn-Rich C, et al. 1995. Correspondence: Arsenic risk assessment. Environ Health Perspect 103(1): http://www.ehponline.org/docs/1995/103-1/correspondence.html. August 30, 2007.

Smith AH, Goycolea M, Haque R, et al. 1998. Marked increase in bladder and lung cancer mortality in a region of northern Chile due to arsenic in drinking water. Am J Epidemiol 147(7):660-669.

Smith AH, Hopenhayn-Rich C, Bates MN, et al. 1992. Cancer risks from arsenic in drinking water. Environ Health Perspect 97:259-267.

Smith AH, Marshall G, Yuan Y, et al. 2006. Increased mortality from lung cancer and bronchiectasis in young adults after exposure to arsenic *in utero* and in early childhood. Environ Health Perspect 114(8):1293-1296.

Smith CJ, Livingston SD, Doolittle DJ. 1997. An international literature survey of "IARC group I carcinogens" reported in mainstream cigarette smoke. Food Chem Toxicol 35(10-11):1107-1130.

Smith E, Naidu R, Alston AM. 1999. Chemistry of arsenic in soils: I. Sorption of arsenate and arsenite by four Australian soils. J Environ Qual 28:1719-1726.

Smith E, Naidu R, Alston AM. 2002. Chemistry of inorganic arsenic in soils: II. Effect of phosphorus, sodium, and calcium on arsenic sorption. J Environ Qual 31(2):557-563.

Smith RA, Alexander RB, Wolman MG. 1987. Water-quality trends in the nation's rivers. Science 235:1607-1615.

Smith TJ, Crecelius EA, Reading JC. 1977. Airborne arsenic exposure and excretion of methylated arsenic compounds. Environ Health Perspect 19:89-93.

Sobel W, Bond GG, Baldwin CL, et al. 1988. An update of respiratory cancer and occupational exposure to arsenicals. Am J Ind Med 13:263-270.

Sofuni T, Honma M, Hayashi M, et al. 1996. Detection of *in vitro* clastogens and spindle poisons by the mouse lymphoma assay using the microwell method: Interim report of an international collaborative study. Mutagenesis 11(4):349-355.

*Soignet SL, Maslak P, Wang Z, et al. 1998. Complete remission after treatment of acute promyelocytic leukemia with arsenic trioxide. N Engl J Med 339(19):1341-1348.

Sommers SC, McManus RG. 1953. Multiple arsenical cancers of the skin and internal organs. Cancer 6:347-359.

Somogyi A, Beck H. 1993. Nurturing and breast-feeding: Exposure to chemicals in breast milk. Environ Health Perspect 101(Suppl 2):45-52.

Sotera JJ, Dulude GR, Stux RL. 1988. Determination of toxic elements in biological materials by furnace atomic absorption spectrometry. Sci Total Environ 71:45-48.

SRI. 2006. Directory of chemical producers. Menlo Park, CA: SRI Consulting, 469, 533, 654, 784, 787.

Steinmaus C, Carrigan K, Kalman D, et al. 2005a. Dietary intake and arsenic methylation in a U.S. population. Environ Health Perspect 113(9):1153-1159.

Steinmaus C, Moore LE, Shipp M, et al. 2007. Genetic polymorphisms in MTHFR 677 and 1298, GSTM1 and T1, and metabolism of arsenic. J Toxicol Environ Health A 70:159-170.

Steinmaus C, Yuan Y, Bates MN, et al. 2003. Case-control study of bladder cancer and drinking water arsenic in the western United States. Am J Epidemiol 158(12):1193-1201.

*Steinmaus C, Yuan Y, Kalman D, et al. 2005b. Intraindividual variability in arsenic methylation in a U.S. population. Cancer Epidemiol Biomarkers Prev 14(4):919-924.

Steinnes E, Rambaek JP, Hanssen JK. 1992. Large scale multi-element survey of atmospheric deposition using naturally growing moss as a biomonitor. Chemosphere 25(5):735-752.

Sternowsky HJ, Moser B, Szadkowsky D. 2002. Arsenic in breast milk during the first 3 months of lactation. Int J Hyg Environ Health 205(5):405-409.

Stevens JT, DiPasquale LC, Farmer JD. 1979. The acute inhalation toxicology of the technical grade organoarsenical herbicides, cacodylic acid and disodium methanearsonic acid; a route comparison. Bull Environ Contam Toxicol 21:304-311.

Stevens JT, Hall LL, Farmer JD, et al. 1977. Disposition of ^{14}C and/or ^{74}As-cacodylic acid in rats after intravenous, intratracheal or peroral administration. Environ Health Perspect 19:151-157.

Stilwell DE, Graetz TJ. 2001. Copper, chromium, and arsenic levels in soil near highway traffic sound barriers built using CCA pressure-treated wood. Bull Environ Contam Toxicol 67:303-308.

Storelli MM, Marcotrigiano GO. 2001. Total, organic, and inorganic arsenic in some commercial species of crustaceans from the Mediterranean Sea (Italy). J Food Prot 64(11):1858-1862.

Storer RD, McKelvey TW, Kraynak AR, et al. 1996. Revalidation of the *in vitro* alkaline elution/rat hepatocyte assay for DNA damage: Improved criteria for assessment of cytotoxicity and genotoxicity and results for 81 compounds. Mutat Res 368(2):59-101.

Stump DG, Holson JF, Fleeman TL, et al. 1999. Comparative effects of single intraperitoneal or oral doses of sodium arsenate or arsenic trioxide during in utero development. Teratology 60:283-291.

Stutz DR, Janusz SJ. 1988. Hazardous materials injuries: A handbook for pre-hospital care. 2nd ed. Beltsville, MD: Bradford Communications Corporation, 208-209.

Styblo M, Thomas DJ. 2001. Selenium modifies the metabolism and toxicity of arsenic in primary rat hepatocytes. Toxicol Appl Pharmacol 172(1):52-61.

Sweins A. 1983. Protective effect of selenium against arsenic-induced chromosomal damage in cultured human lymphocytes. Hereditas 98:249-252.

Szinicz L, Forth W. 1988. Effect of As_2O_3 on gluconeogenesis. Arch Toxicol 61:444-449.

Szuler IM, Williams CN, Hindmarsh JT, et al. 1979. Massive variceal hemorrhage secondary to presinusoidal portal hypertension due to arsenic poisoning. Can Med Assoc J 120:168-171.

Tabacova S, Hunter ES, Gladen BC. 1996. Developmental toxicity of inorganic arsenic in whole embryo culture: Oxidation state, dose, time, and gestational age dependence. Toxicol Appl Pharmacol 138(2):298-307.

Takahashi K, Yamauchi H, Yamato N, et al. 1988. Methylation of arsenic trioxide in hamsters with liver damage induced by long-term administration of carbon tetrachloride. Appl Organomet Chem 2:309-314.

Tam GKH, Lacroix G. 1982. Dry ashing, hydride generation atomic absorption spectrometric determination of arsenic and selenium in foods. J Assoc Off Anal Chem 65(3):647-650.

*Tam GK, Charbonneau SM, Lacroix G, et al. 1979a. Confirmation of inorganic arsenic and dimethylarsenic acid in urine and plasma of dog by ion-exchange and TLC. Bull Environ Contam Toxicol 21:371-374.

Tam GKH, Charbonneau SM, Bryce F, et al. 1979b. Metabolism of inorganic arsenic (^{74}As) in humans following oral ingestion. Toxicol Appl Pharmacol 50:319-322.

Tam GKH, Charbonneau SM, Bryce F, et al. 1982. Excretion of a single oral dose of fish-arsenic in man. Bull Environ Contam Toxicol 28:669-673.

Tamaki S, Frankenberger WT. 1992. Environmental biochemistry of arsenic. Rev Environ Contam Toxicol 124:79-110.

Tao SS, Bolger PM. 1999. Dietary intakes of arsenic in the United States. Food Addit Contam 16:465-472.

Taubeneck MW, Daston GP, Rogers JM, et al. 1994. Altered maternal zinc metabolism following exposure to diverse developmental toxicants. Reprod Toxicol 8(1):25-40.

Tay C, Seah C. 1975. Arsenic poisoning from anti-asthmatic herbal preparations. Med J Aust 2:424-428.

Taylor HE, Antweiler RC, Roth DA, et al. 2001. The occurrence and distribution of selected trace elements in the upper Rio Grande and tributaries in Colorado and northern New Mexico. Arch Environ Contam Toxicol 41:410-426

Taylor PR, Qiao YL, Schatzkin A, et al. 1989. Relation of arsenic exposure to lung cancer among tin miners in Yunnan Province. Br J Ind Med 46:881-886.

Teräsahde P, Pantsar-Kallio M, Manninen PKG. 1996. Simultaneous determination of arsenic species by ion chromatography-inductively coupled plasma mass spectrometry. J Chromatog A750(1-2):83-88.

Tezuka M, Hanioka K, Yamanaka K, et al. 1993. Gene damage induced in human alveolar type II (L-132) cells by exposure to dimethylarsinic acid. Biochem Biophys Res Commun 191(3):1178-1183.

Thomas DC, Whittemore AS. 1988. Methods for testing interactions, with applications to occupational exposures, smoking, and lung cancer. Am J Ind Med 13:131-147.

Thomas DJ, Li J, Waters SB, et al. 2007. Arsenic (+3 oxidation state) methyltransferase and the methylation of arsenicals. Exp Biol Med 232(1):3-13.

Thomas K, Colborn T. 1992. Organochlorine endocrine disruptors in human tissue. In: Colborn T, Clement C, eds. Chemically induced alterations in sexual and functional development: The wildlife/human connection. Princeton, NJ: Princeton Scientific Publishing, 365-394.

Thomas P, Sniatecki K. 1995. Inductively coupled plasma mass spectrometry: Application to the determination of arsenic species. Fresenius J Anal Chem 351 (4-5):410-414.

Thomas DJ, Waters SB, Styblo M. 2004. Elucidating the pathway for arsenic methylation. Toxicol Appl Pharmacol 198(3):319-326.

Thomas KW, Pellizzari ED, Berry MR. 1999. Population-based dietary intakes and tap water concentrations for selected elements in the EPA Region V National Human Exposure Assessment Survey (NHEXAS). J Expo Anal Environ Epidemiol 9:402-413.

Thompson TS, Le MD, Kasick AR, et al. 1999. Arsenic in well water supplies in Saskatchewan. Bull Environ Contam Toxicol 63:478-483.

Tian D, Ma H, Feng Z, et al. 2001. Analyses of micronuclei in exfoliated epithelial cells from individuals chronically exposed to arsenic via drinking water in inner Mongolia, China. J Toxicol Environ Health A 64(6):473-484.

Tice RR, Yager JW, Andrews P, et al. 1997. Effect of hepatic methyl donor status on urinary excretion and DNA damage in B6C3F1 mice treated with sodium arsenite. Mutat Res 386(3):315-334.

Tintinalli JE, Ruiz E, Krone RL, eds. 1996. Emergency medicine. A comprehensive study. American College of Emergency Physicians. 4th ed. New York, NY: The McGraw-Hill Companies, Inc.

Tokunaga H, Roychowdhury T, Chandraskaran N, et al. 2002. Urinary arsenic species in an arsenic-affected area of West Bengal, India. Appl Organomet Chem 16:406-414.

Tollestrup K, Daling JR, Allard J. 1995. Mortality in a cohort of orchard workers exposed to lead arsenate pesticide spray. Arch Environ Health 50(3):221-229.

Tondel M, Rahman M, Magnuson A, et al. 1999. The relationship of arsenic levels in drinking water and the prevalence rate of skin lesions in Bangladesh. Environ Health Perspect 107(9):727-729.

*Trepka MJ, Heinrich J, Schulz C, et al. 1996. Arsenic burden among children in industrial areas of eastern Germany. Sci Total Environ 180(2):95-105.

TRI04. 2006. TRI explorer: Providing access to EPA's toxics release inventory data. Washington, DC: Office of Information Analysis and Access. Office of Environmental Information. U.S. Environmental Protection Agency. Toxics Release Inventory. http://www.epa.gov/triexplorer/. January 31, 2006.

Trocine RP, Trefry JH. 1996. Metal concentrations in sediment, water and clams from the Indian River Lagoon, Florida. Mar Pollut Bull 32(10):754-759.

Tsai M, Chien R, Hsieh S, et al. 1998a. Primary hepatic angiosarcoma: Report of a case involving environmental arsenic exposure. Chang Keng I Hsueh Tsa Chih 21(4):469-474.

Tsai S, Chou H, The H, et al. 2003. The effects of chronic arsenic exposure from drinking water on the neurobehavioral development in adolescence. Neurotoxicology 24:747-753.

*Tsai S, Wang T, Ko Y. 1998b. Cancer mortality trends in a blackfoot disease endemic community of Taiwan following water source replacement. J Toxicol Environ Health 55:389-404.

Tsai SM, Wang TN, Ko YC. 1999. Mortality for certain diseases in areas with high levels of arsenic in drinking water. Arch Environ Health 54(3):186-193.

Tseng W. 1977. Effects and dose-response relationships of skin cancer and blackfoot disease with arsenic. Environ Health Perspect 19:109-119.

Tseng W. 1989. Blackfoot disease in Taiwan: A 30-year follow-up study. Angiology 40(6):547-558.

Tseng CH, Chong CK, Chen CJ, et al. 1995. Abnormal peripheral microcirculation in seemingly normal subjects living in blackfoot-disease-hyperendemic villages in Taiwan. Int J Microcirc Clin Exp 15(1):21-27.

Tseng CH, Chong C, Chen CJ, et al. 1996. Dose-response relationship between peripheral vascular disease and ingested inorganic arsenic among residents in blackfoot disease endemic villages in Taiwan. Atherosclerosis 120:125-133.

Tseng CH, Chong CK, Tseng CP, et al. 2003. Long-term arsenic exposure and ischemic heart disease in arseniasis-hyperendemic villages in Taiwan. Toxicol Lett 137(1-2):15-21.

Tseng CH, Huang YK, Huang YL, et al. 2005. Arsenic exposure, urinary arsenic speciation, and peripheral vascular disease in blackfoot disease-hyperendemic villages in Taiwan. (Erratum in: Toxicol Appl Pharmacol 211(2):175). Toxicol Appl Pharmacol 206(3):299-308.

Tseng CH, Tai TY, Chong CK, et al. 2000. Long-term arsenic exposure and incidence of non-insulin dependent diabetes mellitus: A cohort study in arseniasis-hyperendemic villages in Taiwan. Environ Health Perspect 108(9):847-851.

Tseng WP, Chu HM, How SW, et al. 1968. Prevalence of skin cancer in an endemic area of chronic arsenicism in Taiwan. J Natl Cancer Inst 40:453-463.

Tsuda T, Babazono A, Yamamoto E, et al. 1995a. Ingested arsenic and internal cancer: A historical cohort study followed for 33 years. Am J Epidemiol 141(3):198-209.

Tsuda T, Indue T, Kojima M, et al. 1995b. Market basket and duplicate portion estimation of dietary intakes of cadmium, mercury, arsenic, copper, manganese, and zinc by Japanese adults. J AOAC Int 78(6):1363-1368.

Tsuda T, Kume Y, Yamamoto M, et al. 1987. An epidemiological study on cancer in certified arsenic poisoning patients in Toroku. Jpn J Ind Health 29:496-497.

Tsuji JS, Van Kerkhove MD, Kaetzel RS, et al. 2005. Evaluation of exposure to arsenic in residential soil. Environ Health Perspect 113(12):1735-1740.

Tsuruta D, Hamada T, Mochida K, et al. 1998. Merkel cell carcinoma, Bowen's disease and chronic occupational arsenic poisoning. Br J Dermatol 139:291-294.

Uddin AN, Burns FJ, Rossman TG. 2005. Vitamin E and organoselenium prevent the cocarcinogenic activity of arsenite with solar UVR in mouse skin. Carcinogenesis 26(12):2179-2186.

Ueda H, Kuroda K, Endo G. 1997. The inhibitory effect of selenium on induction of tetraploidy by dimethylarsinic acid in Chinese hamster cells. Anticancer Res 17(3c):1939-1943.

Uede K, Furukawa F. 2003. Skin manifestations in acute arsenic poisoning from the Wakayama curry-poisoning incident. Br J Dermatol 149(4):757-762.

Ulitzur S, Barak M. 1988. Detection of genotoxicity of metallic compounds by the bacterial bioluminescence test. J Biolumin Chemilumin 2:95-99.

Ulman C, Gezer S, Anal O, et al. 1998. Arsenic in human and cow's milk: A reflection of environmental pollution. Water Air Soil Pollut 101(1-4):411-416.

Unnikrishnan D, Dutcher JP, Varshneya N, et al. 2001. Torsades de pointes in 3 patients with leukemia treated with arsenic trioxide. Blood 97(5):1514-1516.

Ursitti F, Vanderlinden L, Watson R, et al. 2004. Assessing and managing exposure from arsenic in CCA-treated wood play structures. Can J Public Health 95(6):429-433.

U.S. Bureau of Mines. 1988. Mineral commodity summaries. Washington, DC: U.S. Bureau of Mines, 14-15.

U.S. Bureau of Mines. 1990. Mineral commodity summaries. Washington, DC: U.S. Bureau of Mines, 22-23.

9. REFERENCES

*U.S. Congress. 1990. Clean Air Act. Title III. Section 112. National emission standards for hazardous air pollutants. U.S. Congress. 42 USC 7412. Revised by Public Law 101-549. November 15, 1990.

USDA. 2004. Nonsynthetic substances prohibited for use in organic crop production. U.S. Department of Agriculture. Code of Federal Regulations 7 CFR 205.602. http://www.access.gpo.gov/nara/cfr/waisidx_04/7cfr205_04.html. February 15, 2005.

USDA/USDT. 2000. Assessment of the Environmental effects associated with wooden bridges preserved with creosote, pentachlorophenol, or chromated copper arsenate. U.S. Department of Agriculture. United States Department of Transportation. FPL-RP-587. http://www.fpl.fs.fed.us/documnts/fplrp/fplrp587.pdf. August 27, 2007.

USGS. 1984. Element concentrations in soils and other surficial materials on of the conterminous United States. U.S. Geological Survey. Professional Paper 1270.

USGS. 1987. Composition, distribution, and hydrologic effects of contaminated sediments resulting from the discharge of gold milling wastes to Whitewood Creek at Lead and Deadwood, South Dakota. Water-Resources Investigation Report 87-4051. U.S. Geological Survey. http://pubs.er.usgs.gov/usgspubs/wri/wri874051 August 27, 2007.

USGS. 1998. Arsenic. U.S. Geological Survey – Mineral Information – 1998. U.S. Geological Survey. http://minerals.usgs.gov/minerals/pubs/commodity/arsenic/160498.pdf.

*USGS. 1999a. Mineral Commodity Summaries 1999. Arsenic. U.S. Geological Survey. http://minerals.usgs.gov/minerals/pubs/commodity/arsenic/index.html.

USGS. 1999b. Arsenic in ground water of the Willamette Basin, Oregon. U.S. Geological Survey. http://or.water.usgs.gov/pubs_dir/Online/Pdf/98-4205.pdf. April 7, 2005.

USGS. 1999c. Arsenic-rich pyrite in the Mississippian Marshall Sandstone: Source of anomalous arsenic in southeastern Michigan ground water. U.S. Geological Survey. http://minerals.usgs.gov/east/midwest/abstract7.html. August 23,1999.

USGS. 2006a. Arsenic. 2005 Minerals yearbook. U.S. Department of the Interior, U.S. Geological Survey.:7.1-7.4, tables 1-3. http://minerals.usgs.gov/minerals/pubs/commodity/arsenic/arsenmyb05.pdf. September 12, 2006.

USGS. 2006b. Arsenic. Mineral commodity studies. U.S. Geological Survey, 26-27. http://minerals.usgs.gov/minerals/pubs/commodity/arsenic/arsenmcs06.pdf. September 12, 2006.

USGS. 2007a. Arsenic in ground water in the United States. U.S. Geological Survey. http://water.usgs.gov/nawqa/trace/pubs/geo_v46n11/fig2.html. August 29, 2007.

USGS. 2007b. The national geochemical survey-database and documentation. U.S. Geological Survey. http://tin.er.usgs.gov/geochem/doc/home.htm. August 29, 2007.

Vaessen HA, van Ooik A. 1989. Speciation of arsenic in Dutch total diets: Methodology and results. Z Lebensm Unters Forsch 189:232-235.

Vahter M. 1981. Biotransformation of trivalent and pentavalent inorganic arsenic in mice and rats. Environ Res 25:286-293.

Vahter M. 1983. Metabolism of arsenic. In: Fowler BA, ed. Biological and environmental effects of arsenic. New York, NY: Elsevier Science Publishers, 171-198.

Vahter M. 1986. Environmental and occupational exposure to inorganic arsenic. Acta Pharmacol Toxicol 59:31-34.

Vahter M. 2002. Mechanisms of arsenic biotransformation. Toxicology 181-182:211-217.

Vahter M, Envall J. 1983. *In vivo* reduction of arsenate in mice and rabbits. Environ Res 32:14-24.

Vahter M, Marafante E. 1983. Intracellular interaction and metabolic fate of arsenite and arsenate in mice and rabbits. Chem Biol Interact 47:29-44.

Vahter M, Marafante E. 1985. Reduction and binding of arsenate in Marmoset monkeys. Arch Toxicol 57:119-124.

Vahter M, Marafante E. 1987. Effects of low dietary intake of methionine, choline or proteins on the biotransformation of arsenite in the rabbit. Toxicol Lett 37:41-46.

Vahter M, Norin H. 1980. Metabolism of ^{74}As-labeled trivalent and pentavalent inorganic arsenic in mice. Environ Res 21:446-457.

*Vahter M, Concha G, Nermell B, et al. 1995. A unique metabolism of inorganic arsenic in native Andean women. Eur J Pharmacol 293(4):455-462.

Vahter M, Friberg L, Rahnster B, et al. 1986. Airborne arsenic and urinary excretion of metabolites of inorganic arsenic among smelter workers. Int Arch Occup Environ Health 57:79-91.

*Vahter M, Marafante E, Dencker L. 1983. Metabolism of arsenobetaine in mice, rats and rabbits. Sci Total Environ 30:197-211.

Vahter M, Marafante E, Dencker L. 1984. Tissue distribution and retention of ^{74}As-dimethylarsinic acid in mice and rats. Arch Environ Contam Toxicol 13:259-264.

Vahter M, Marafante E, Lindgren A, et al. 1982. Tissue distribution and subcellular binding of arsenic in Marmoset monkeys after injection of ^{74}As-arsenite. Arch Toxicol 51:65-77.

Valentine JL, Campion DS, Schluchter MD, et al. 1981. Arsenic effects on human nerve conduction. In: Howell JC, Gawthorne JM, White L, eds. Trace element metabolism in man and animals - TEMA 4. Proceedings of the Fourth International symposium on Trace Elements or Man and Animals. Canberra: Australian Academy of Science, 409-411.

Valentine JL, He S, Reisbord LS, et al. 1992. Health response by questionnaire in arsenic-exposed populations. J Clin Epidemiol 45(5):487-94.

Valentine JL, Kang HK, Spivey G. 1979. Arsenic levels in human blood, urine and hair in response to exposure via drinking water. Environ Res 20:24-32.

Valentine JL, Reisbord LS, Kang HK, et al. 1985. Arsenic effects on population health histories. In: Mills CF, Bremner I, Chesters JK, eds. Trace elements in man and animals - TEMA 5: Proceedings of the Fifth International Symposium on Trace Elements in Man and Animals. Slough, UK: Commonwealth Agricultural Bureaux, 289-294.

Vallee BL, Ulmer DD, Wacker WE. 1960. Arsenic toxicology and biochemistry. Arch Ind Health 21:132-151.

van Netten C, Cann SAH, Morley DR, et al. 2000. Elemental and radioactive analysis of commercially available seaweed. Sci Total Environ 255:169-175.

Vantroyen B, Heilier JF, Meulemans A, et al. 2004. Survival after a lethal dose of arsenic trioxide. J Toxicol Clin Toxicol 42(6):889-895.

*Vargas M, Hamadeh H, Lee E, et al. 1998. Activation of transcription factors by sodium arsenite in human lymphocytes. Toxicologist 42(1-S):323-324.

Vega L, Gonsebatt ME, Ostrosky-Wegman P. 1995. Aneugenic effect of sodium arsenite on human lymphocytes *in vitro*: An individual susceptibility effect detected. Mutat Res 334(3):365-373.

Versieck J, Hoste J, Vanballenberghe L, et al. 1983. Trace element measurements in serum by neutron activation analysis. In: Harling, OK, Clark L, Von der Hardt P, eds. Use and development of low and medium flux research reactors. Proceedings of the International Symposium on the use and development of low and medium flux research reactors, Massachusetts Institute of Technology, Cambridge, Massachusetts, U.S.A., October 16-19, 1983. Munchen: Karl Thiemig, 717-723.

Vieira I, Sonnier M, Cresteil T. 1996. Developmental expression of *CYP2E1* in the human liver: Hypermethylation control of gene expression during the neonatal period. Eur J Biochem 238:476-483.

*Vienna A, Capucci E, Wolfsperger M, et al. 1995. Heavy metal concentration in hair of students in Rome. Anthropol Anz 53(1):27-32.

Vig BK, Figueroa ML, Cornforth MN, et al. 1984. Chromosome studies in human subjects chronically exposed to arsenic in drinking water. Am J Ind Med 6:325-338.

Vinas P, Lopez-Garcia I, Merino-Merono B, et al. 2003. Stability of arsenobetaine levels in manufactured baby foods. J Food Prot 66(12):2321-2324.

Viren JR, Silvers A. 1994. Unit risk estimates for airborne arsenic exposure: An updated view based on recent data from two copper smelter cohorts. Regul Toxicol Pharmacol 20(2):125-138.

Viren J, Silvers A. 1999. Nonlinearity in the lung cancer dose-response for airborne arsenic: Apparent confounding by year of hire in evaluating lung cancer risks from arsenic exposure in Tacoma smelter workers. Regul Toxicol Pharmacol 30:117-129.

von Ehrenstein OS, Guha Mazumder DN, Hira-Smith M, et al. 2006. Pregnancy of outcomes, infant mortality, and arsenic in drinking water in West Bengal, India. Am J Epidemiol 163(7):662-669.

von Ehrenstein OS, Mazumder DN, Yuan Y, et al. 2005. Decrements in lung function related to arsenic in drinking water in West Bengal, India. Am J Epidemiol 162(6):533-541.

von Ehrenstein O, Poddar S, Yuan Y, et al. 2007. Children's intellectual function in relation to arsenic exposure. Epidemiology 18:44-51.

Von Endt DW, Kearney PC, Kaufman DD. 1968. Degradation of monosodium methanearsonic acid by soil microorganisms. J Agric Food Chem 16(1):17-20.

Vuyyuri SB, Ishaq MKuppala D, Grover P, et al. 2006. Evaluation of micronucleus frequencies and DNA damage in glass workers exposed to arsenic. Environ Mol Mutagen 47:562-570.

Waalkes MP, Harvey MJ, Klaassen CD. 1984. Relative *in vitro* affinity of hepatic metallothionein for metals. Toxicol Lett 20:33-39.

Waalkes MP, Liu J, Ward JM, et al. 2004a. Mechanisms underlying arsenic carcinogenesis: Hypersensitivity of mice exposed to inorganic arsenic during gestation. Toxicology 198(1-3):31-38.

Waalkes MP, Liu J, Ward JM, et al. 2004b. Animal models for arsenic carcinogenesis: Inorganic arsenic is a transplacental carcinogen in mice. Toxicol Appl Pharmacol 198(3):377-384.

Waalkes MP, Liu J, Ward JM, et al. 2006a. Enhanced urinary bladder and liver carcinogenesis in male CD1 mice exposed to transplancental inorganic arsenic and postnatal diethylstilbestrol or tamoxifen. Toxicol Appl Pharmacol 215(3):295-305.

Waalkes MP, Liu J, Ward JM, et al. 2006b. Urogenital carcinogenesis in female CD1 mice induced by in utero arsenic exposure is exacerbated by postnatal diethylstilbestrol treatment. Cancer Res 66(3):1337-1345.

Waalkes MP, Ward JM, Diwan BA. 2004c. Induction of tumors of the liver, lung, ovary and adrenal in adult mice after brief maternal gestational exposure to inorganic arsenic: Promotional effects of postnatal phorbol ester exposure on hepatic and pulmonary, but not dermal cancers. Carcinogenesis 25(1):133-141.

Waalkes MP, Ward JM, Liu J, et al. 2003. Transplacental carcinogenicity of inorganic arsenic in the drinking water: Induction of hepatic, ovarian, pulmonary, and adrenal tumors in mice. Toxicol Appl Pharmacol 186(1):7-17.

Wade HJ, Frazer ES. 1953. Toxipathic hepatitis due to Fowler's solution; A case treated with dimercaprol. Lancet (February):269-271.

Wadge A, Hutton M. 1987. The leachability and chemical speciation of selected trace elements in fly ash from coal combustion and refuse incineration. Environ Pollut 48:85-99.

Wagner SL, Maliner JS, Morton WE, et al. 1979. Skin cancer and arsenical intoxication from well water. Arch Dermatol 115:1205-1207.

Wahlberg JE, Boman A. 1986. Contact sensitivity to arsenical compounds: Clinical and experimental studies. Derm Beruf Umwelt 34:10-12.

Wakao N, Koyatsu H, Komai Y, et al. 1988. Microbial oxidation of arsenite and occurrence of arsenite-oxidizing bacteria in acid mine water from a sulfur-pyrite mine. Geomicrobiol J 6:11-24.

Walker S, Griffin S. 1998. Site-specific data confirm arsenic exposure predicted by the U.S. Environmental Protection Agency. Environ Health Perspect 106(3):133-139.

Wall S. 1980. Survival and mortality pattern among Swedish smelter workers. Int J Epidemiol 9(1):73-87.

Walton FS, Waters SB, Jolley SL, et al. 2003. Selenium compounds modulate the activity of recombinant rat As111-methyltransferase and the methylation of arsenite by rat and human hepatocytes. Chem Res Toxicol 16(3):261-265.

Wan B, Christian RT, Soukup SW. 1982. Studies of cytogenetic effects of sodium arsenicals on mammalian cells *in vitro*. Environ Mutagen 4:493-498.

Waner T, Nyska A. 1988. Data evaluation report: Methanearsonic acid fifty-two week chronic oral toxicity study in beagle dogs. Permenta Plant Protection Company. Submitted to the U.S. Environmental Protection Agency. MRID40546101.

Wang ZY. 2001. Arsenic compounds as anticancer agents. Cancer Chemother Pharmacol 48(Suppl 1):S72-S76.

Wang TS, Huang H. 1994. Active oxygen species are involved in the induction of micronuclei by arsenite in XRS-5 cells. Mutagenesis 9(3):253-257.

Wang CH, Jeng JS, Yip PK, et al. 2002. Biological gradient between long-term arsenic exposure and carotid atherosclerosis. Circulation 105:1804-1809.

Wang SH, Wang ZH, Cheng XT, et al. 2007. Arsenic and fluoride exposure in drinking water: Children's IQ and growth in Shanyin County, Shanxi Province, China. Environ Health Perspect 115(4):643-647.

Wang SL, Chiou JM, Chen CJ, et al. 2003. Prevalence of non-insulin-dependent diabetes mellitus and related vascular diseases in southwestern arseniasis-endemic and nonendemic areas in Taiwan. Environ Health Perspect 111(2):155-59.

Wang TS, Shu YF, Liu YC, et al. 1997. Glutathione peroxidase and catalase modulate the genotoxicity of arsenite. Toxicology 121(3):229-237.

Wang Z, Kown E, Zhang H, et al. 2005. Arsenic on the hands of children: Wang et al. Respond. Environ Health Perspect 113(6):364-365.

Wanibuchi H, Yamamoto S, Chen H, et al. 1996. Promoting effects of dimethylarsinic acid on N-butyl-N-(4-hydroxybutyl)nitrosamine-induced urinary bladder carcinogenesis in rats. Carcinogenesis 17(11):2435-2439.

*Warner ML, Moore LE, Smith MT, et al. 1994. Increased micronuclei in exfoliated bladder cells of individuals who chronically ingest arsenic-contaminated water in Nevada. Cancer Epidemiol Biomarkers Prev 3(7):583-590.

Washington State. 2006. What is area-wide soil contamination? In: Area-Wide Soil Contamination Project. Washington State. http://www.ecy.wa.gov/programs/tcp/area_wide/AW/toolbox_chap1.html. August 27, 2007.

Wasserman GA, Liu X, Parvez F, et al. 2004. Water arsenic exposure and children's intellectual function in Araihazar, Bangladesh. Environ Health Perspect 112(13):1329-1333.

Wasserman GA, Liu X, Parvez F, et al. 2007. Water arsenic exposure and intellectual function in 6-year-old children in Arailhazar, Bangladesh. Environ Health Perspect 115(2):285-289.

Watanabe C, Inaoka T, Kadono T, et al. 2001. Males in rural Bangladeshi communities are more susceptible to chronic arsenic poisoning than females: Analyses based on urinary arsenic. Environ Health Perspect 109(12):1265-1270.

Watrous RM, McCaughey MB. 1945. Occupational exposure to arsenic: In the manufacture of arsphenamine and related compounds. Ind Med 14(8):639-646.

Webb DR, Sipes IG, Carter DE. 1984. *In vitro* solubility and *in vivo* toxicity of gallium arsenide. Toxicol Appl Pharmacol 76:96-104.

Webb DR, Wilson SE, Carter DE. 1986. Comparative pulmonary toxicity of gallium arsenide, gallium (III) oxide, or arsenic (III) oxide intratracheally instilled into rats. Toxicol Appl Pharmacol 82:405-416.

Webb DR, Wilson SE, Carter DE. 1987. Pulmonary clearance and toxicity of respirable gallium arsenide particulates intratracheally instilled into rats. Am Ind Hyg Assoc J 48(7):660-667.

Wedepohl KH. 1991. The composition of the upper earth's crust and the natural cycles of selected metals. Metals in natural raw materials. Natural resources. In: Merian E, ed. Metals and their compounds in the environment. Occurrence, analysis, and biological relevance. New York, NY: VCH, 3-17.

Wei M, Wanibuchi H, Morimura K, et al. 2002. Carcinogenicity of dimethylarsinic acid in male F344 rats and genetic alterations in induced urinary bladder tumors. Carcinogenesis 23(8):1387-1397.

Wei M, Wanibuchi H, Yamamoto S, et al. 1999. Urinary bladder carcinogenicity of dimethylarsinic acid in male F344 rats. Carcinogenesis 20(9):1873-1876.

Weis JS, Weis P, Proctor T. 1998. The extent of benthic impacts of CCA-treated wood structures in Atlanic coast estuaries. Arch Environ Contam Toxicol 34(4):313-322.

*Weis P, Weis JS, Lores E. 1993. Uptake of metals from chromated-copper-arsenate (CCA)-treated lumber by Epibiota. Mar Pollut Bull 26(8):428-430.

Welch AH, Lico MS, Hughes JL. 1988. Arsenic in groundwater of the western United States. Ground Water 26(3):333-347.

Welch K, Higgins I, Oh M, et al. 1982. Arsenic exposure, smoking and respiratory cancer in copper smelter workers. Arch Environ Health 37(6):325-335.

Wendt PH, Van Dolah RF, Bobo MY, et al. 1996. Wood preservative leachates from docks in an estuarine environment. Arch Environ Contam Toxicol 31(1):24-37.

Werner MA, Knobeloch LM, Erbach T, et al. 2001. Use of imported folk remedies and medications in the Wisconsin Hmong community. Wis Med J 100(7):32-34.

West JR, Smith HW, Chasis H. 1948. Glomerular filtration rate, effective renal blood flow, and maximal tubular excretory capacity in infancy. J Pediatrics 32:10-18.

Wester RC, Maibach HI, Sedik L, et al. 1993. *In vivo* and *in vitro* percutaneous absorption and skin decontamination of arsenic from water and soil. Fundam Appl Toxicol 20(3):336-340.

Westhoff DD, Samaha RJ, Barnes A. 1975. Arsenic intoxication as a cause of megaloblastic anemia. Blood 45(2):241-246.

Whitman FT. 1994. Subchronic (90-day) inhalation toxicity study in rats with cacodylate 3.25 (MRD-92-416). Luxembourg Industries (Pamol) Ltd. Submitted to the U.S. Environmental Protection Agency. MRID44700301.

WHO. 1981. Environmental health criteria 18: Arsenic. IPCS International Programme on Chemical Safety. Geneva, Switzerland: World Health Organization.

WHO. 2000. Air quality guidelines. 2nd ed. Geneva, Switzerland: World Health Organization. http://www.euro.who.int/air/Activities/20050104_1. February 15, 2005.

WHO. 2001. Arsenic and arsenic compounds. Environmental Health Criteria 224. Geneva: United Nations Environment Programme. International Labour Organisation. World Health Organization. http://www.inchem.org/documents/ehc/ehc/ehc224.htm. August 27, 2007.

WHO. 2004. Guidelines for drinking-water quality. 3rd ed. Geneva, Switzerland: World Health Organization. http://www.who.int/water_sanitation_health/dwq/gdwq3/en/. February 15, 2005.

*Wicklund KG, Daling JR, Allard J, et al. 1988. Respiratory cancer among orchardists in Washington state, 1968-1980. J Occup Med 30:561-564.

Wicks MJ, Archer VE, Auerbach O, et al. 1981. Arsenic exposure in a copper smelter as related to histological type of lung cancer. Am J Ind Med 2:25-31.

Widdowson EM, Dickerson JWT. 1964. Chemical composition of the body. In: Comar CL, Bronner F, eds. Mineral metabolism: An advanced treatise. Volume II: The elements Part A. New York: Academic Press.

Wiencke JK, Yager JW. 1992. Specificity of arsenite in potentiating cytogenetic damage induced by the DNA crosslinking agent diepoxybutane. Environ Mol Mutagen 19(3):195-200.

Wiencke JK, Yager JW, Varkonyi A, et al. 1997. Study of arsenic mutagenesis using the plasmid shuttle vector pZ189 propagated in DNA repair proficient human cells. Mutat Res 386(3):335-344.

Willhite CC. 1981. Arsenic-induced axial skeletal (dysraphic) disorders. Exp Mol Pathol 34:145-158.

Willhite CC, Ferm VH. 1984. Prenatal and developmental toxicology of arsenicals. Adv Exp Med Biol 177:205-228.

Williams L, Schoof RA, Yager JW, et al. 2006. Arsenic bioaccumulation in freshwater fishes. Hum Ecol Risk Assess 12:904-923.

Williams TM, Rawlins BG, Smith B, et al. 1998. In-vitro determination of arsenic bioavailability in contaminated soil and mineral beneficiation waste from Ron Phibun, Southern Thailand: A basis for improved human risk assessment. Environ Geochem Health 20(4):169-177.

Wingren G, Axelson O. 1993. Epidemiologic studies of occupational cancer as related to complex mixtures of trace elements in the art glass industry. Scand J Work Environ Health 19(Suppl 1):95-100.

Wlodarczyk BJ, Bennett GD, Calvin JA, et al. 1996. Arsenic-induced neural tube defects in mice: Alterations in cell cycle gene expression. Reprod Toxicol 10(6):447-454.

Wolz S, Fenske RA, Simcox NJ, et al. 2003. Residential arsenic and lead levels in an agricultural community with a history of lead arsenate use. Environ Res 93:293-300.

Wong O, Whorton MD, Foliart DE, et al. 1992. An ecologic study of skin cancer and environmental arsenic exposure. Int Arch Occup Environ Health 64(4):235-241.

Wong SS, Tan KC, Goh CL. 1998a. Cutaneous manifestations of chronic arsenicism: Review of seventeen cases. J Am Acad Dermatol 38:179-185.

Wong ST, Chan HL, Teo SK. 1998b. The spectrum of cutaneous and internal malignancies in chronic arsenic toxicity. Singapore Med J 39(4):171-173.

Woods JS, Fowler BA. 1977. Effects of chronic arsenic exposure on hematopoietic function in adult mammalian liver. Environ Health Perspect 19:209-213.

Woods JS, Fowler BA. 1978. Altered regulation of mammalian hepatic heme biosynthesis and urinary porphyrin excretion during prolonged exposure to sodium arsenate. Toxicol Appl Pharmacol 43:361-371.

Woods JS, Southern MR. 1989. Studies on the etiology of trace metal-induced porphyria: Effects of porphyrinogenic metals on coproporphyrinogen oxidase in rat liver and kidney. Toxicol Appl Pharmacol 97:183-190.

Woolson EA, Kearney PC. 1973. Persistence and reactions of ^{14}C-cacodylic acid in soils. Environ Sci Technol 7:47-50.

*Woollons A, Russel-Jones R. 1998. Chronic endemic hydroarsenicism. Br J Dermatol 139:1092-1096.

Woolson EA. 1976. Generation of dimethyl arsine from soil. 1976 Meeting of the Weed Science Society of America. February 3-5, 1976, No. 218.

WSDOE. 2005. Tacoma Shelter Plume: South King County mainland soil study. Washington State Department of Ecology. http://www.ecy.wa.gov/programs/tcp/sites/tacoma_smelter/soil_study.htm. July 14, 2005.

*Wu MM, Chiou HY, Wang TW, et al. 2001. Association of blood arsenic levels with increased reactive oxidants and decreased antioxidant capacity in a human population of northeastern Taiwan. Environ Health Perspect 109(10):1011-1017.

Wu MM, Kuo TL, Hwang Y, et al. 1989. Dose-response relation between arsenic concentration in well water and mortality from cancers and vascular diseases. Am J Epidemiol 130(6):1123-1132.

Wulff M, Högberg U, Sandstrom A. 1996. Cancer incidence for children born in a smelting community. Acta Oncologica (Stockholm) 35(2):179-183.

Wuyi W, Linsheng Y, Shaofan H, et al. 2001. Prevention of endemic arsenism with selenium. Curr Sci 81(9):1215-1218.

Wyatt CJ, Fimbres C, Romo L, et al. 1998b. Incidence of heavy metal contamination in water supplies in Northern Mexico. Environ Res A76:114-119.

Wyatt CJ, Quiroga VL, Acosta RTO, et al. 1998a. Excretion of arsenic (As) in urine of children, 7-11 years, exposed to elevated levels of As in the city water supply in Hermosillo, Sonora, Mexico. Environ Res A78:19-24.

Xuan XZ, Lubin JH, Li JY, et al. 1993. A cohort study in southern China of tin miners exposed to radon and radon decay products. Health Phys 64(2):120-131.

Yager JW, Wiencke JK. 1993. Enhancement of chromosomal damage by arsenic: Implications for mechanism. Environ Health Perspect 101(Suppl 3):79-82.

Yager JW, Wiencke JK. 1997. Inhibition of poly(ADP-ribose) polymerase by arsenite. Mutat Res 386(3):345-351.

Yager JW, Hicks JB, Fabianova E. 1997. Airborne arsenic and urinary excretion of arsenic metabolites during boiler cleaning operations in a Slovak coal-fired power plant. Environ Health Perspect 105(8):836-842.

Yamamoto A, Hisanaga A, Ishinishi N. 1987. Tumorigenicity of inorganic arsenic compounds following intratracheal instillations to the lungs of hamsters. Int J Cancer 40:220-223.

Yamamoto S, Konishi Y, Matsuda T, et al. 1995. Cancer induction by an organic arsenic compound, dimethylarsinic acid (cacodylic acid), in F344/DuCrj rats after pretreatment with five carcinogens. Cancer Res 55(6):1271-1276.

*Yamamoto S, Wanibuchi H, Hori T, et al. 1997. Possible carcinogenic potential of dimethylarsinic acid as assessed in rat *in vivo* models: A review. Mutat Res 386(3):353-361.

Yamanaka K, Okada S. 1994. Induction of lung-specific DNA damage by metabolically methylated arsenics via the production of free radicals. Environ Health Perspect 102(Suppl 3)37-40.

Yamanaka K, Hasegawa A, Sawamura R, et al. 1989a. Dimethylated arsenics induce DNA strand breaks in lung *via* the production of active oxygen in mice. Biochem Biophys Res Commun 165(1):43-50.

Yamanaka K, Hayashi H, Kato K, et al. 1995. Involvement of preferential formation of apurinic/apyrimidinic sites in dimethylarsenic-induced DNA strand breaks and DNA-protein crosslinks in cultured alveolar epithelial cells. Biochem Biophys Res Commun 207(1):244-249.

Yamanaka K, Hayashi H, Kato K, et al. 1997. DNA single-strand breaks in L-132 cells resulting from inhibition of repair polymerization shortly after exposure to dimethylarsinic acid. Biol Pharm Bull 20(2):163-167.

Yamanaka K, Ohba H, Hasegawa A, et al. 1989b. Mutagenicity of dimethylated metabolites of inorganic arsenics. Chem Pharm Bull 37(10):2753-2756.

*Yamanaka K, Ohtsubo K, Hasegawa A, et al. 1996. Exposure to dimethylarsinic acid, a main metabolite of inorganic arsenics, strongly promotes tumorigenesis initiated by 4-nitroquinoline 1-oxide in the lungs of mice. Carcinogenesis 17(4):767-770.

Yamanaka K, Takabayashi F, Mizoi M, et al. 2001. Oral exposure of dimethylarsinic acid, a main metabolite of inorganic arsenics, in mice leads to an increase in 8-oxo-2'-deoxyguanosine level, specifically in the target organs for arsenic carcinogenesis. Biochem Biophys Res Commun 287(1):66-70.

Yamanaka K, Tezuka M, Kato K, et al. 1993. Crosslink formation between DNA and nuclear proteins by *in vivo* and *in vitro* exposure of cells to dimethylarsinic acid. Biochem Biophys Res Commun 191(3):1184-1191.

Yamauchi H, Yamamura Y. 1984. Metabolism and excretion of orally administered dimethylarsinic acid in the hamster. Toxicol Appl Pharmacol 74:134-140.

Yamauchi H, Yamamura Y. 1985. Metabolism and excretion of orally administered arsenic trioxide in the hamster. Toxicology 34:113-121.

Yamauchi H, Kaise T, Yamamura Y. 1986. Metabolism and excretion of orally administered arsenobetaine in the hamster. Bull Environ Contam Toxicol 36:350-355.

Yamauchi H, Takahashi K, Mashiko M, et al. 1989. Biological monitoring of arsenic exposure of gallium arsenide- and inorganic arsenic-exposed workers by determination of inorganic arsenic and its metabolites in urine and hair. Am Ind Hyg Assoc J 50(11):606-612.

Yamauchi H, Yamato N, Yamamura Y. 1988. Metabolism and excretion of orally and intraperitoneally administered methylarsonic acid in the hamster. Bull Environ Contam Toxicol 40:280-286.

Yan-Chu H. 1994. Arsenic distribution in soils. In: Nriagu JO, ed. Arsenic in the environment, part 1: Cycling and characterization. New York, NY: John Wiley & Sons, Inc., 17-49.

Yang CY, Chang CC, Tsai SS, et al. 2003. Arsenic in drinking water and adverse pregnancy outcome in an arseniasis-endemic area in northeastern Taiwan. Environ Res 91(1):29-34.

Yang JL, Chen MF, Wu CW, et al. 1992. Posttreatment with sodium arsenite alters the mutational spectrum induced by ultraviolet light irradiation in Chinese hamster ovary cells. Environ Mol Mutagen 20(3)156-164.

Yang L, Wang W, Hou S, et al. 2002. Effects of selenium supplementation on arsenism: An intervention trial in inner Mongolia. Environ Geochem Health 24:359-374.

Yee-Chien L, Haimei H. 1996. Lowering extracellular calcium content protects cells from arsenite-induced killing and micronuclei formation. Mutagenesis 11(1):75-78.

Yih LH, Ho IC, Lee TC. 1997. Sodium arsenite disturbs mitosis and induces chromosome loss in human fibroblasts. Cancer Res 57(22):5051-5059.

Yokel J, Delistraty DA. 2003. Arsenic, lead, and other trace elements in soils contaminated with pesticide residues at the Hanford site (USA). Environ Toxicol 18(2):104-114.

Yoshida K, Inoue Y, Kuroda K, et al. 1998. Urinary excretion of arsenic metabolites after long-term oral administration of various arsenic compounds to rats. J Toxicol Environ Health A 54:179-192.

Yoshida K, Kuroda K, Inoue Y, et al. 2001. Metabolism of dimethylarsinic acid in rats: Production of unidentified metabolites *in vivo*. Appl Organomet Chem 15:539-547.

Yost LJ, Schoof RA, Aucoin R. 1998. Intake of inorganic arsenic in the North American diet. Human Ecol Risk Assess 4(1):137-152.

Yost LJ, Tao SH, Egan SK, et al. 2004. Estimation of dietary intake of inorganic arsenic in U.S. children. Hum Ecol Risk Assess 10:473-483.

Yu D. 1998a. A realistic risk assessment of inorganic arsenic. J Environ Sci Health Part A 33(6):1149-1170.

Yu D. 1998b. Uncertainties in a pharmacokinetic modeling for inorganic arsenic. J Environ Sci Health Part A 33(7):1369-1390.

Yu D. 1999a. A physiologically based pharmacokinetic model of inorganic arsenic. Regul Toxicol Pharmacol 29:128-141.

Yu D. 1999b. A pharmacokinetic modeling of inorganic arsenic: A short-term oral exposure model for humans. Chemosphere 39(15):2737-2747.

Yu HS, Chang KL, Wang CM, et al. 1992. Alterations of mitogenic responses of mononuclear cells by arsenic in arsenical skin cancers. J Dermatol 19(11):710-714.

Yu HS, Sheu HM, Ko SS, et al. 1984. Studies on blackfoot disease and chronic arsenism in southern Taiwan: With special reference to skin lesions and fluorescent substances. J Dermatol 11:361-370.

Zadorozhnaja TD, Little RE, Miller RK, et al. 2000. Concentrations of arsenic, cadmium, copper, lead, mercury, and zinc in human placentas from two cities in Ukraine. J Toxicol Environ Health A 61:255-263.

Zakharyan R, Wu Y, Bogdan GM, et al. 1995. Enzymatic methylation of arsenic compounds: Assay, partial purification, and properties of arsenite methyltransferase and monomethylarsonic acid methyltransferase of rabbit liver. Chem Res Toxicol 8(8):1029-1038.

Zakharyan RA, Wildfang E, Aposhian HV. 1996. Enzymatic methylation of arsenic compounds. III. The marmoset and tamarin, but not the Rhesus, monkeys are deficient in methyltransferases that methylate inorganic arsenic. Toxicol Appl Pharmacol 140(1):77-84.

Zaldívar R. 1974. Arsenic contamination of drinking water and foodstuffs causing endemic chronic poisoning. Beitr Pathol 151:384-400.

Zaldívar R. 1977. Ecological investigations on arsenic dietary intake and endemic chronic poisoning in man: Dose-response curve. Zentralbl Bakteriol Hyg 164:481-484.

Zaldívar R, Guillier A. 1977. Environmental and clinical investigations on endemic chronic arsenic poisoning in infants and children. Zentralbl Bakteriol Hyg 165:226-234.

Zaldívar R, Prunés L, Ghai G. 1981. Arsenic dose in patients with cutaneous carcinomata and hepatic haemangio-endothelioma after environmental and occupational exposure. Arch Toxicol 47:145-154.

Zanzoni F, Jung EG. 1980. Arsenic elevates the sister chromatid exchange (SCE) rate in human lymphocytes *in vitro*. Arch Dermatol Res 267:91-95.

Zartarian VG, Xue J, Ozkaynak H, et al. 2006. A probabilistic arsenic exposure assessment for children who contact CCA-treated playsets and decks, Part 1: Model methodology, variability results, and model evaluation. Risk Anal 26(2):515-531.

*Zhang X, Cornelis R, De Kimpe J, et al. 1996. Accumulation of arsenic species in serum of patients with chronic renal disease. Clin Chem 42(8 Pt 1):1231-1237.

*Zhang X, Cornelis R, De Kimpe J, et al. 1997. Speciation of arsenic in serum, urine, and dialysate of patients on continuous ambulatory peritoneal dialysis. Clin Chem 43(2):406-408.

Zheng Y, Wu J, Ng JC, et al. 2002. The absorption and excretion of fluoride and arsenic in humans. Toxicol Lett 133(1):77-82.

Ziegler EE, Edwards BB, Jensen RL, et al. 1978. Absorption and retention of lead by infants. Pediatr Res 12:29-34.

Zierler S, Theodore M, Cohen A, et al. 1988. Chemical quality of maternal drinking water and congenital heart disease. Int J Epidemiol 17(3):589-594.

Zierold KM, Knobeloch L, Anderson H. 2004. Prevalence of chronic diseases in adults exposed to arsenic-contaminated drinking water. Am J Public Health 94(11):1936-1937.

Zomber G, Nyska A, Waner T, et al. 1989. Cacodylic acid 52-week oral toxicity study in beagle dogs. Luxembourg Industries (Pamol) Ltd. Submitted to the U.S. Environmental Protection Agency. MRID41490901.

10. GLOSSARY

Absorption—The taking up of liquids by solids, or of gases by solids or liquids.

Acute Exposure—Exposure to a chemical for a duration of 14 days or less, as specified in the Toxicological Profiles.

Adsorption—The adhesion in an extremely thin layer of molecules (as of gases, solutes, or liquids) to the surfaces of solid bodies or liquids with which they are in contact.

Adsorption Coefficient (K_{oc})—The ratio of the amount of a chemical adsorbed per unit weight of organic carbon in the soil or sediment to the concentration of the chemical in solution at equilibrium.

Adsorption Ratio (Kd)—The amount of a chemical adsorbed by sediment or soil (i.e., the solid phase) divided by the amount of chemical in the solution phase, which is in equilibrium with the solid phase, at a fixed solid/solution ratio. It is generally expressed in micrograms of chemical sorbed per gram of soil or sediment.

Benchmark Dose (BMD)—Usually defined as the lower confidence limit on the dose that produces a specified magnitude of changes in a specified adverse response. For example, a BMD_{10} would be the dose at the 95% lower confidence limit on a 10% response, and the benchmark response (BMR) would be 10%. The BMD is determined by modeling the dose response curve in the region of the dose response relationship where biologically observable data are feasible.

Benchmark Dose Model—A statistical dose-response model applied to either experimental toxicological or epidemiological data to calculate a BMD.

Bioconcentration Factor (BCF)—The quotient of the concentration of a chemical in aquatic organisms at a specific time or during a discrete time period of exposure divided by the concentration in the surrounding water at the same time or during the same period.

Biomarkers—Broadly defined as indicators signaling events in biologic systems or samples. They have been classified as markers of exposure, markers of effect, and markers of susceptibility.

Cancer Effect Level (CEL)—The lowest dose of chemical in a study, or group of studies, that produces significant increases in the incidence of cancer (or tumors) between the exposed population and its appropriate control.

Carcinogen—A chemical capable of inducing cancer.

Case-Control Study—A type of epidemiological study that examines the relationship between a particular outcome (disease or condition) and a variety of potential causative agents (such as toxic chemicals). In a case-controlled study, a group of people with a specified and well-defined outcome is identified and compared to a similar group of people without outcome.

Case Report—Describes a single individual with a particular disease or exposure. These may suggest some potential topics for scientific research, but are not actual research studies.

Case Series—Describes the experience of a small number of individuals with the same disease or exposure. These may suggest potential topics for scientific research, but are not actual research studies.

Ceiling Value—A concentration of a substance that should not be exceeded, even instantaneously.

Chronic Exposure—Exposure to a chemical for 365 days or more, as specified in the Toxicological Profiles.

Cohort Study—A type of epidemiological study of a specific group or groups of people who have had a common insult (e.g., exposure to an agent suspected of causing disease or a common disease) and are followed forward from exposure to outcome. At least one exposed group is compared to one unexposed group.

Cross-sectional Study—A type of epidemiological study of a group or groups of people that examines the relationship between exposure and outcome to a chemical or to chemicals at one point in time.

Data Needs—Substance-specific informational needs that if met would reduce the uncertainties of human health assessment.

Developmental Toxicity—The occurrence of adverse effects on the developing organism that may result from exposure to a chemical prior to conception (either parent), during prenatal development, or postnatally to the time of sexual maturation. Adverse developmental effects may be detected at any point in the life span of the organism.

Dose-Response Relationship—The quantitative relationship between the amount of exposure to a toxicant and the incidence of the adverse effects.

Embryotoxicity and Fetotoxicity—Any toxic effect on the conceptus as a result of prenatal exposure to a chemical; the distinguishing feature between the two terms is the stage of development during which the insult occurs. The terms, as used here, include malformations and variations, altered growth, and *in utero* death.

Environmental Protection Agency (EPA) Health Advisory—An estimate of acceptable drinking water levels for a chemical substance based on health effects information. A health advisory is not a legally enforceable federal standard, but serves as technical guidance to assist federal, state, and local officials.

Epidemiology—Refers to the investigation of factors that determine the frequency and distribution of disease or other health-related conditions within a defined human population during a specified period.

Genotoxicity—A specific adverse effect on the genome of living cells that, upon the duplication of affected cells, can be expressed as a mutagenic, clastogenic, or carcinogenic event because of specific alteration of the molecular structure of the genome.

Half-life—A measure of rate for the time required to eliminate one half of a quantity of a chemical from the body or environmental media.

Immediately Dangerous to Life or Health (IDLH)—The maximum environmental concentration of a contaminant from which one could escape within 30 minutes without any escape-impairing symptoms or irreversible health effects.

Immunologic Toxicity—The occurrence of adverse effects on the immune system that may result from exposure to environmental agents such as chemicals.

Immunological Effects—Functional changes in the immune response.

Incidence—The ratio of individuals in a population who develop a specified condition to the total number of individuals in that population who could have developed that condition in a specified time period.

Intermediate Exposure—Exposure to a chemical for a duration of 15–364 days, as specified in the Toxicological Profiles.

***In Vitro*—**Isolated from the living organism and artificially maintained, as in a test tube.

***In Vivo*—**Occurring within the living organism.

Lethal Concentration$_{(LO)}$ (LC_{LO})—The lowest concentration of a chemical in air that has been reported to have caused death in humans or animals.

Lethal Concentration$_{(50)}$ (LC_{50})—A calculated concentration of a chemical in air to which exposure for a specific length of time is expected to cause death in 50% of a defined experimental animal population.

Lethal Dose$_{(LO)}$ (LD_{Lo})—The lowest dose of a chemical introduced by a route other than inhalation that has been reported to have caused death in humans or animals.

Lethal Dose$_{(50)}$ (LD_{50})—The dose of a chemical that has been calculated to cause death in 50% of a defined experimental animal population.

Lethal Time$_{(50)}$ (LT_{50})—A calculated period of time within which a specific concentration of a chemical is expected to cause death in 50% of a defined experimental animal population.

Lowest-Observed-Adverse-Effect Level (LOAEL)—The lowest exposure level of chemical in a study, or group of studies, that produces statistically or biologically significant increases in frequency or severity of adverse effects between the exposed population and its appropriate control.

Lymphoreticular Effects—Represent morphological effects involving lymphatic tissues such as the lymph nodes, spleen, and thymus.

Malformations—Permanent structural changes that may adversely affect survival, development, or function.

Minimal Risk Level (MRL)—An estimate of daily human exposure to a hazardous substance that is likely to be without an appreciable risk of adverse noncancer health effects over a specified route and duration of exposure.

Modifying Factor (MF)—A value (greater than zero) that is applied to the derivation of a Minimal Risk Level (MRL) to reflect additional concerns about the database that are not covered by the uncertainty factors. The default value for a MF is 1.

Morbidity—State of being diseased; morbidity rate is the incidence or prevalence of disease in a specific population.

Mortality—Death; mortality rate is a measure of the number of deaths in a population during a specified interval of time.

Mutagen—A substance that causes mutations. A mutation is a change in the DNA sequence of a cell's DNA. Mutations can lead to birth defects, miscarriages, or cancer.

Necropsy—The gross examination of the organs and tissues of a dead body to determine the cause of death or pathological conditions.

Neurotoxicity—The occurrence of adverse effects on the nervous system following exposure to a chemical.

No-Observed-Adverse-Effect Level (NOAEL)—The dose of a chemical at which there were no statistically or biologically significant increases in frequency or severity of adverse effects seen between the exposed population and its appropriate control. Effects may be produced at this dose, but they are not considered to be adverse.

Octanol-Water Partition Coefficient (K_{ow})—The equilibrium ratio of the concentrations of a chemical in *n*-octanol and water, in dilute solution.

Odds Ratio (OR)—A means of measuring the association between an exposure (such as toxic substances and a disease or condition) that represents the best estimate of relative risk (risk as a ratio of the incidence among subjects exposed to a particular risk factor divided by the incidence among subjects who were not exposed to the risk factor). An OR of greater than 1 is considered to indicate greater risk of disease in the exposed group compared to the unexposed group.

Organophosphate or Organophosphorus Compound—A phosphorus-containing organic compound and especially a pesticide that acts by inhibiting cholinesterase.

Permissible Exposure Limit (PEL)—An Occupational Safety and Health Administration (OSHA) allowable exposure level in workplace air averaged over an 8-hour shift of a 40-hour workweek.

Pesticide—General classification of chemicals specifically developed and produced for use in the control of agricultural and public health pests.

Pharmacokinetics—The dynamic behavior of a material in the body, used to predict the fate (disposition) of an exogenous substance in an organism. Utilizing computational techniques, it provides the means of studying the absorption, distribution, metabolism, and excretion of chemicals by the body.

Pharmacokinetic Model—A set of equations that can be used to describe the time course of a parent chemical or metabolite in an animal system. There are two types of pharmacokinetic models: data-based and physiologically-based. A data-based model divides the animal system into a series of compartments, which, in general, do not represent real, identifiable anatomic regions of the body, whereas the physiologically-based model compartments represent real anatomic regions of the body.

Physiologically Based Pharmacodynamic (PBPD) Model—A type of physiologically based dose-response model that quantitatively describes the relationship between target tissue dose and toxic end points. These models advance the importance of physiologically based models in that they clearly describe the biological effect (response) produced by the system following exposure to an exogenous substance.

Physiologically Based Pharmacokinetic (PBPK) Model—Comprised of a series of compartments representing organs or tissue groups with realistic weights and blood flows. These models require a variety of physiological information: tissue volumes, blood flow rates to tissues, cardiac output, alveolar ventilation rates, and possibly membrane permeabilities. The models also utilize biochemical information, such as air/blood partition coefficients, and metabolic parameters. PBPK models are also called biologically based tissue dosimetry models.

Prevalence—The number of cases of a disease or condition in a population at one point in time.

Prospective Study—A type of cohort study in which the pertinent observations are made on events occurring after the start of the study. A group is followed over time.

q_1*—The upper-bound estimate of the low-dose slope of the dose-response curve as determined by the multistage procedure. The q_1* can be used to calculate an estimate of carcinogenic potency, the incremental excess cancer risk per unit of exposure (usually µg/L for water, mg/kg/day for food, and µg/m^3 for air).

Recommended Exposure Limit (REL)—A National Institute for Occupational Safety and Health (NIOSH) time-weighted average (TWA) concentration for up to a 10-hour workday during a 40-hour workweek.

Reference Concentration (RfC)—An estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious noncancer health effects during a lifetime. The inhalation reference concentration is for continuous inhalation exposures and is appropriately expressed in units of mg/m^3 or ppm.

Reference Dose (RfD)—An estimate (with uncertainty spanning perhaps an order of magnitude) of the daily exposure of the human population to a potential hazard that is likely to be without risk of deleterious effects during a lifetime. The RfD is operationally derived from the no-observed-adverse-effect level (NOAEL, from animal and human studies) by a consistent application of uncertainty factors that reflect various types of data used to estimate RfDs and an additional modifying factor, which is based on a professional judgment of the entire database on the chemical. The RfDs are not applicable to nonthreshold effects such as cancer.

Reportable Quantity (RQ)—The quantity of a hazardous substance that is considered reportable under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Reportable quantities are (1) 1 pound or greater or (2) for selected substances, an amount established by regulation either under CERCLA or under Section 311 of the Clean Water Act. Quantities are measured over a 24-hour period.

Reproductive Toxicity—The occurrence of adverse effects on the reproductive system that may result from exposure to a chemical. The toxicity may be directed to the reproductive organs and/or the related endocrine system. The manifestation of such toxicity may be noted as alterations in sexual behavior, fertility, pregnancy outcomes, or modifications in other functions that are dependent on the integrity of this system.

Retrospective Study—A type of cohort study based on a group of persons known to have been exposed at some time in the past. Data are collected from routinely recorded events, up to the time the study is undertaken. Retrospective studies are limited to causal factors that can be ascertained from existing records and/or examining survivors of the cohort.

Risk—The possibility or chance that some adverse effect will result from a given exposure to a chemical.

Risk Factor—An aspect of personal behavior or lifestyle, an environmental exposure, or an inborn or inherited characteristic that is associated with an increased occurrence of disease or other health-related event or condition.

Risk Ratio—The ratio of the risk among persons with specific risk factors compared to the risk among persons without risk factors. A risk ratio greater than 1 indicates greater risk of disease in the exposed group compared to the unexposed group.

Short-Term Exposure Limit (STEL)—The American Conference of Governmental Industrial Hygienists (ACGIH) maximum concentration to which workers can be exposed for up to 15 minutes continually. No more than four excursions are allowed per day, and there must be at least 60 minutes between exposure periods. The daily Threshold Limit Value-Time Weighted Average (TLV-TWA) may not be exceeded.

Standardized Mortality Ratio (SMR)—A ratio of the observed number of deaths and the expected number of deaths in a specific standard population.

Target Organ Toxicity—This term covers a broad range of adverse effects on target organs or physiological systems (e.g., renal, cardiovascular) extending from those arising through a single limited exposure to those assumed over a lifetime of exposure to a chemical.

Teratogen—A chemical that causes structural defects that affect the development of an organism.

Threshold Limit Value (TLV)—An American Conference of Governmental Industrial Hygienists (ACGIH) concentration of a substance to which most workers can be exposed without adverse effect. The TLV may be expressed as a Time Weighted Average (TWA), as a Short-Term Exposure Limit (STEL), or as a ceiling limit (CL).

Time-Weighted Average (TWA)—An allowable exposure concentration averaged over a normal 8-hour workday or 40-hour workweek.

Toxic Dose$_{(50)}$ (TD$_{50}$)—A calculated dose of a chemical, introduced by a route other than inhalation, which is expected to cause a specific toxic effect in 50% of a defined experimental animal population.

Toxicokinetic—The absorption, distribution, and elimination of toxic compounds in the living organism.

Uncertainty Factor (UF)—A factor used in operationally deriving the Minimal Risk Level (MRL) or Reference Dose (RfD) or Reference Concentration (RfC) from experimental data. UFs are intended to account for (1) the variation in sensitivity among the members of the human population, (2) the uncertainty in extrapolating animal data to the case of human, (3) the uncertainty in extrapolating from data obtained in a study that is of less than lifetime exposure, and (4) the uncertainty in using lowest-observed-adverse-effect level (LOAEL) data rather than no-observed-adverse-effect level (NOAEL) data. A default for each individual UF is 10; if complete certainty in data exists, a value of 1 can be used; however, a reduced UF of 3 may be used on a case-by-case basis, 3 being the approximate logarithmic average of 10 and 1.

Xenobiotic—Any chemical that is foreign to the biological system.

This page is intentionally blank.

APPENDIX A. ATSDR MINIMAL RISK LEVELS AND WORKSHEETS

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) [42 U.S.C. 9601 et seq.], as amended by the Superfund Amendments and Reauthorization Act (SARA) [Pub. L. 99–499], requires that the Agency for Toxic Substances and Disease Registry (ATSDR) develop jointly with the U.S. Environmental Protection Agency (EPA), in order of priority, a list of hazardous substances most commonly found at facilities on the CERCLA National Priorities List (NPL); prepare toxicological profiles for each substance included on the priority list of hazardous substances; and assure the initiation of a research program to fill identified data needs associated with the substances.

The toxicological profiles include an examination, summary, and interpretation of available toxicological information and epidemiologic evaluations of a hazardous substance. During the development of toxicological profiles, Minimal Risk Levels (MRLs) are derived when reliable and sufficient data exist to identify the target organ(s) of effect or the most sensitive health effect(s) for a specific duration for a given route of exposure. An MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse noncancer health effects over a specified duration of exposure. MRLs are based on noncancer health effects only and are not based on a consideration of cancer effects. These substance-specific estimates, which are intended to serve as screening levels, are used by ATSDR health assessors to identify contaminants and potential health effects that may be of concern at hazardous waste sites. It is important to note that MRLs are not intended to define clean-up or action levels.

MRLs are derived for hazardous substances using the no-observed-adverse-effect level/uncertainty factor approach. They are below levels that might cause adverse health effects in the people most sensitive to such chemical-induced effects. MRLs are derived for acute (1–14 days), intermediate (15–364 days), and chronic (365 days and longer) durations and for the oral and inhalation routes of exposure. Currently, MRLs for the dermal route of exposure are not derived because ATSDR has not yet identified a method suitable for this route of exposure. MRLs are generally based on the most sensitive chemical-induced end point considered to be of relevance to humans. Serious health effects (such as irreparable damage to the liver or kidneys, or birth defects) are not used as a basis for establishing MRLs. Exposure to a level above the MRL does not mean that adverse health effects will occur.

MRLs are intended only to serve as a screening tool to help public health professionals decide where to look more closely. They may also be viewed as a mechanism to identify those hazardous waste sites that are not expected to cause adverse health effects. Most MRLs contain a degree of uncertainty because of the lack of precise toxicological information on the people who might be most sensitive (e.g., infants, elderly, nutritionally or immunologically compromised) to the effects of hazardous substances. ATSDR uses a conservative (i.e., protective) approach to address this uncertainty consistent with the public health principle of prevention. Although human data are preferred, MRLs often must be based on animal studies because relevant human studies are lacking. In the absence of evidence to the contrary, ATSDR assumes that humans are more sensitive to the effects of hazardous substance than animals and that certain persons may be particularly sensitive. Thus, the resulting MRL may be as much as 100-fold below levels that have been shown to be nontoxic in laboratory animals.

Proposed MRLs undergo a rigorous review process: Health Effects/MRL Workgroup reviews within the Division of Toxicology and Environmental Medicine, expert panel peer reviews, and agency-wide MRL Workgroup reviews, with participation from other federal agencies and comments from the public. They are subject to change as new information becomes available concomitant with updating the toxicological profiles. Thus, MRLs in the most recent toxicological profiles supersede previously published levels. For additional information regarding MRLs, please contact the Division of Toxicology and Environmental Medicine, Agency for Toxic Substances and Disease Registry, 1600 Clifton Road NE, Mailstop F-32, Atlanta, Georgia 30333.

APPENDIX A

MINIMAL RISK LEVEL (MRL) WORKSHEET

Chemical Name: Inorganic Arsenic
CAS Number: 7440-38-2
Date: August 2007
Profile Status: Post-Public Comment, Final Draft
Route: [ ] Inhalation [X] Oral
Duration: [X] Acute [ ] Intermediate [ ] Chronic
Graph Key: 29
Species: Human

Minimal Risk Level: 0.005 [X] mg/kg/day [ ] ppm

Reference: Mizuta N, Mizuta M, Ito F, et al. 1956. An outbreak of acute arsenic poisoning caused by arsenic-contaminated soy-sauce (shōyu): A clinical report of 220 cases. Bull Yamaguchi Med Sch 4(2-3):131-149.

Experimental design: Mizuta et al. (1956) summarized findings from 220 poisoning cases associated with an episode of arsenic contamination of soy sauce in Japan. The soy sauce was contaminated with approximately 0.1 mg As/mL, probably as calcium arsenate. Arsenic intake in the cases was estimated by the researchers to be 3 mg/day (0.05 mg/kg/day, assuming 55 kg average body weight for this Asian population). Duration of exposure was 2–3 weeks in most cases. Clinical symptoms were recorded. Seventy patients were examined opthalmologically. Laboratory tests were performed on some patients and included hematology, urinalysis, fecal exam, occult blood in gastric and duodenal juice, biochemical examination of blood, liver function tests, electrocardiograph, and liver biopsy.

Effects noted in study and corresponding doses: The primary symptoms were edema of the face, and gastrointestinal and upper respiratory symptoms initially, followed in some patients by skin lesions and neuropathy. Other effects included mild anemia and leukopenia, mild degenerative liver lesions and hepatic dysfunction, abnormal electrocardiogram, and ocular lesions. For derivation of the acute oral MRL, facial edema and gastrointestinal symptoms (nausea, vomiting, diarrhea), which were characteristic of the initial poisoning and then subsided, were considered to be the critical effects.

Dose and end point used for MRL derivation: 0.05 mg As/kg/day

[ ] NOAEL [X] LOAEL

Uncertainty factors used in MRL derivation:

[ ] 1 [ ] 3 [X] 10 (for use of a LOAEL)
[ ] 1 [ ] 3 [ ] 10 (for extrapolation from animals to humans)
[X] 1 [ ] 3 [ ] 10 (for human variability)

Was a conversion factor used from ppm in food or water to a mg/body weight dose? Not applicable.

If an inhalation study in animals, list conversion factors used in determining human equivalent dose: Not applicable.

Was a conversion used from intermittent to continuous exposure? Not applicable.

Other additional studies or pertinent information that lend support to this MRL: The MRL is supported by the case of a man and wife in upstate New York who experienced gastrointestinal symptoms (nausea, diarrhea, abdominal cramps) starting almost immediately after beginning intermittent consumption of arsenic-tainted drinking water at an estimated dose of 0.05 mg As/kg/day (Franzblau and Lilis 1989). Gastrointestinal symptoms have been widely reported in other acute arsenic poisoning reports as well, although in some cases, the doses were higher and effects were severe, and in other cases, dose information was not available. The UF of 1 for intrahuman variability reflects the fact that the database includes persons of various ethnicities and age groups, including infants.

Agency Contact (Chemical Manager): Selene Chou, Ph.D and Carolyn Harper, Ph.D.

APPENDIX A

MINIMAL RISK LEVEL (MRL) WORKSHEET

Chemical Name: Inorganic Arsenic
CAS Number: 7440-38-2
Date: August 2007
Profile Status: Post-Public Comment, Final Draft
Route: [ ] Inhalation [X] Oral
Duration: [ ] Acute [ ] Intermediate [X] Chronic
Graph Key: 134
Species: Human

Minimal Risk Level: 0.0003 [X] mg/kg/day [ ] ppm

References: Tseng, WP, Chu HM, How SW, et al. 1968. Prevalence of skin cancer in an endemic area of chronic arsenicism in Taiwan. J Natl Cancer Inst 40:453-463.

Tseng, WP. 1977. Effects and dose-response relationships of cancer and Blackfoot disease with arsenic. Environ Health Perspect 19:109-119.

Experimental design: Tseng et al. (1968) and Tseng (1977) investigated the incidence of Blackfoot disease and dermal lesions (hyperkeratosis and hyperpigmentation) in a large number of poor farmers (both male and female) exposed to high levels of arsenic in well water in Taiwan. A control group consisting of 17,000 people was identified. The authors stated that the incidence of dermal lesions increased with dose, but individual doses were not provided. However, incidence data were provided based on stratification of the exposed population into low (<300 µg/L), medium (300–600 µg/L), or high (>600 µg/L) exposure levels. Doses were calculated from group mean arsenic concentrations in well water, assuming the intake parameters described by Abernathy et al. (1989). Accordingly, the control, low-, medium-, and high-exposure levels correspond to doses of 0.0008, 0.014, 0.038, and 0.065 mg As/kg/day, respectively. The NOAEL identified by Tseng (1977) (0.0008 mg As/kg/day) was limited by the fact that the majority of the population was <20 years of age and the incidence of skin lesions increased as a function of age, and because the estimates of water intake and dietary arsenic intake are highly uncertain. Schoof et al. (1998) estimated that dietary intakes of arsenic from rice and yams may have been 15–211 µg/day (mean 61 µg/day), based on arsenic analyses of foods collected in Taiwan in 1993–1995. Use of the 50 µg/day estimate would result in an approximate doubling of the NOAEL (0.0016 mg/kg/day).

Effects noted in study and corresponding doses: A clear dose-response relationship was observed for characteristic skin lesions:

0.0008 mg As/kg/day	= control group (NOAEL)
0.014 mg As/kg/day	= hyperpigmentation and keratosis of the skin (less serious LOAEL)
0.038–0.065 mg As/kg/day	= increased incidence of dermal lesions

Dose and end point used for MRL derivation: 0.0008 mg As/kg/day

[X] NOAEL [ ] LOAEL

Uncertainty factors used in MRL derivation:

[ ] 1 [ ] 3 [ ] 10 (for use of a LOAEL)
[ ] 1 [ ] 3 [ ] 10 (for extrapolation from animals to humans)

[ ] 1 [x] 3 [ ] 10 (for human variability)

Was a conversion factor used from ppm in food or water to a mg/body weight dose? The arithmetic mean concentration of arsenic in well water for the control group (0.009 mg/L) was converted to a NOAEL of 0.0008 mg As/kg/day as described below:

$$\left[\left(\frac{0.009mg}{L}\times\frac{4.5L}{day}\right)+\frac{0.002mg}{day}\right]\div 55kg = 0.0008mgAs/kg/day$$

This NOAEL conversion assumed a water intake of 4.5 L/day and a body weight of 55 kg, and includes an estimation of arsenic intake of 0.002 mg As/kg/day from food. These assumptions are detailed in Abernathy et al. (1989). This approach to deriving a chronic oral MRL is identical to EPA's approach to deriving a chronic oral RfD.

If an inhalation study in animals, list conversion factors used in determining human equivalent dose: Not applicable.

Was a conversion used from intermittent to continuous exposure? Not applicable.

Other additional studies or pertinent information that lend support to this MRL: The MRL is supported by a number of well conducted epidemiological studies that identify reliable NOAELs and LOAELs for dermal effects. EPA (1981b) identified a NOAEL of 0.006–0.007 mg As/kg/day for dermal lesions in several small populations in Utah. Harrington et al. (1978) identified a NOAEL of 0.003 mg As/kg/day for dermal effects in a small population in Alaska. Guha Mazumder et al. (1988) identified a NOAEL of 0.009 mg As/kg/day and a LOAEL of 0.006 mg As/kg/day for pigmentation changes and hyperkeratosis in a small population in India. Haque et al. (2003) identified a LOAEL of 0.0043 mg As/kg/day for hyperpigmentation and hyperkeratosis in a case-control study in India. Cebrían et al. (1983) identified a NOAEL of 0.0004 mg As/kg/day and a LOAEL of 0.022 mg As/kg/day in two regions in Mexico. Borgoño and Greiber (1972) and Zaldívar (1974) identified a LOAEL of 0.02 mg As/kg/day for abnormal skin pigmentation in patients in Chile, and Borgoño et al. (1980) identified a LOAEL of 0.01 mg As/kg/day for the same effect in school children in Chile. Valentine et al. (1985) reported a NOAEL of 0.02 mg As/kg/day for dermal effects in several small populations in California. Collectively, these studies indicate that the threshold dose for hyperpigmentation and hyperkeratosis is approximately 0.002 mg As/kg/day.

Agency Contacts (Chemical Managers): Selene Chou, Ph.D and Carolyn Harper, Ph.D.

MINIMAL RISK LEVEL (MRL) WORKSHEET

Chemical Name: Monomethylarsonic acid (MMA)
CAS Number: 124-58-3
Date: August 2007
Profile Status: Post-Public Comment, Final Draft
Route: [ ] Inhalation [X] Oral
Duration: [ ] Acute [X] Intermediate [ ] Chronic
Graph Key: 12
Species: Rat

Minimal Risk Level: 0.1 [X] mg MMA/kg/day [ ] ppm

References: Arnold LL, Eldan M, van Gemert M, et al. 2003. Chronic studies evaluating the carcinogenicity of monomethylarsonic acid in rats and mice. Toxicology 190:197-219.

Crown S, Nyska A, Waner T. 1990. Methanearsonic acid: Combined chronic feeding and oncogenicity study in the rat. Conducted by Life Science Research Israel Ltd., Ness Ziona Israel. Submitted to EPA Office of Pesticide Programs (MRID 41669001).

Experimental design: Groups of 60 male and 60 female Fischer 344 rats were exposed to 0, 50, 400, or 1,300 ppm MMA in the diet for 104 weeks. Using the average doses for weeks 1–50 reported in an unpublished version of this study (Crown et al. 1990), doses of 0, 3.5, 30.2, and 106.9 mg MMA/kg/day and 0, 4.2, 35.9, and 123.3 mg MMA/kg/day were calculated for males and females, respectively. Body weights, food consumption, and water intake were monitored regularly. Blood was taken at 3, 6, and 12 months for clinical chemistry measurements, and urine samples were collected at the same interval.

Effects noted in study and corresponding doses: Mortality was increased in high-dose males and females during the first 52 weeks of the study. Body weights were decreased in the mid- and high-dose groups of both sexes; however, at 51 weeks, only the body weight for the high-dose males was <10% of the control weight (14.5%). Food and water consumption was increased in the mid- and high-dose groups. Diarrhea was observed in 100% of the high-dose males and females and in 16.7 and 40% of the mid-dose males and females during the first 52 weeks of exposure. Diarrhea first occurred after 3 weeks of exposure to the high dose and 4 weeks of exposure to the mid-dose group; the severity of the diarrhea was dose-related. The gastrointestinal system was the primary target in animals dying early; numerous macroscopic and histological alterations were observed.

Dose and end point used for MRL derivation: Benchmark dose analysis of the dose-response data (Table A-1) for diarrhea in male and female rats exposed to MMA in the diet for 1–52 weeks (incidence data reported in Crown et al. 1990) was conducted. All available dichotomous models in EPA's Benchmark Dose Software (version 1.4.1) were fit to the data. Predicted doses associated with a 10% extra risk were calculated. As assessed by the chi-square goodness-of-fit statistic, all models, with the exception of the quantal linear model for male incidence data and the quantal linear model for female incidence data, provided an adequate fit (X^2 p>0.1) (Table A-2). Comparing across models, a better fit is generally indicated by a lower Akaike's Information Criteria (AIC). As assessed by AIC, the gamma model for the males (Figure A-1) and the 2-degree polynomial multi-stage model for the females (Figure A-2) provide the best fit to the data. The predicted BMD_{10} and $BMDL_{10}$ are 28.25 mg MMA/kg/day and 22.99 mg MMA/kg/day for the male rat incidence data and 16.17 mg MMA/kg/day, and 12.38 mg MMA/kg/day for the female rat incidence data.

Table A-1. Incidences of Diarrhea in Rats Exposed to MMA in the Diet for 1–52 Weeks

Dietary concentration (ppm)	Dose (mg MMA/kg/day)	Incidence
Male rats		
0	0	2/60
50	3.5	0/60
400	30.2	10/60
1,300	106.9	60/60
Female rats		
0	0	0/60
50	4.2	0/60
400	35.9	24/60
1,300	123.3	60/60

Sources: Arnold et al. 2003; Crown et al. 1990

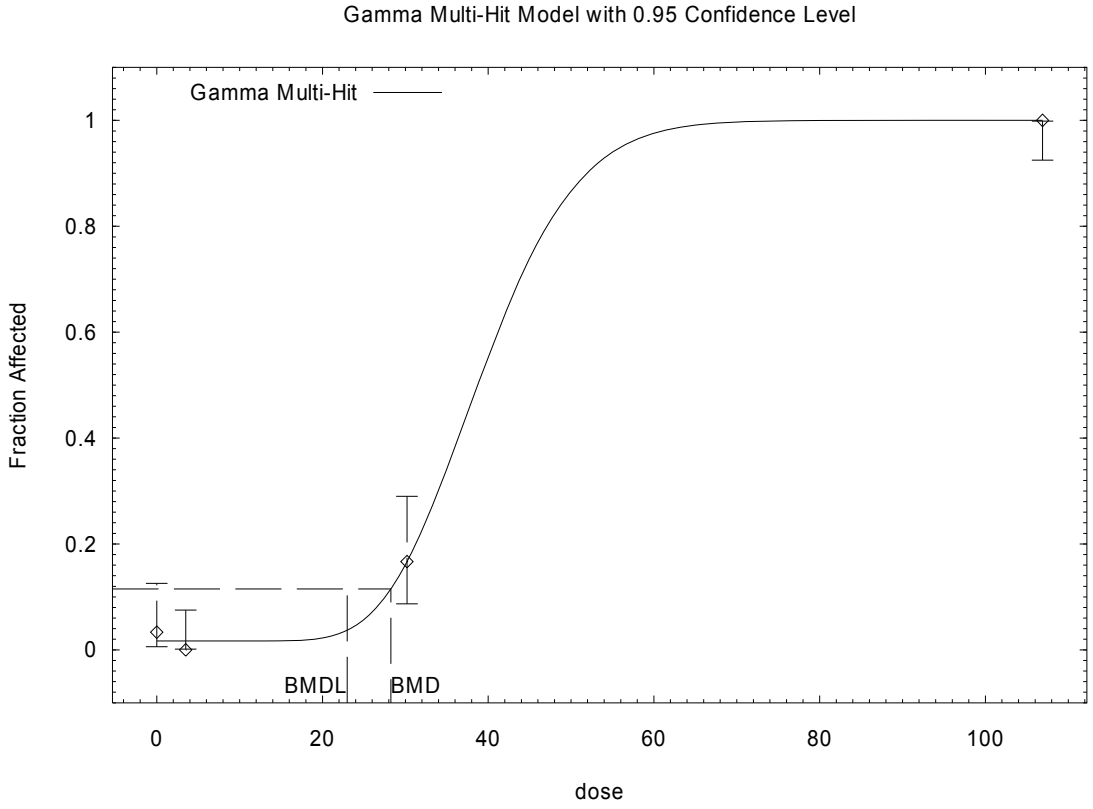
Table A-2. Modeling Predictions for the Incidence of Diarrhea in Rats Exposed to MMA in the Diet for 1–52 Weeks

Model	BMD_{10} (mg MMA/kg/day)	$BMDL_{10}$ (mg MMA/kg/day)	x^2 *p*-value	AIC
Male rats				
Gamma[a]	**28.25**	**22.99**	**0.36**	**78.41**
Logistic	24.60	20.19	0.16	79.59
Log-logistic[b]	29.32	24.73	0.15	80.41
Multi-stage[c]	25.74	19.90	0.35	78.51
Probit	23.11	18.67	0.11	80.02
Log-probit[b]	28.79	24.47	0.15	80.41
Quantal linear	6.317	5.079	0.00	123.06
Weibull[a]	27.99	20.66	0.15	80.41
Female rats				
Gamma[a]	26.81	15.18	1.00	84.76
Logistic	32.85	21.49	1.00	84.76
Log-logistic[b]	31.97	20.16	1.00	84.76
Multi-stage[c]	**16.17**	**12.38**	**0.90**	**83.88**
Probit	29.89	19.11	1.00	84.76
Log-probit[b]	28.95	18.87	1.00	84.76
Quantal linear	5.33	4.33	0.00	106.52
Weibull[a]	27.83	13.58	1.00	84.76

Sources: Arnold et al. 2003; Crown et al. 1990

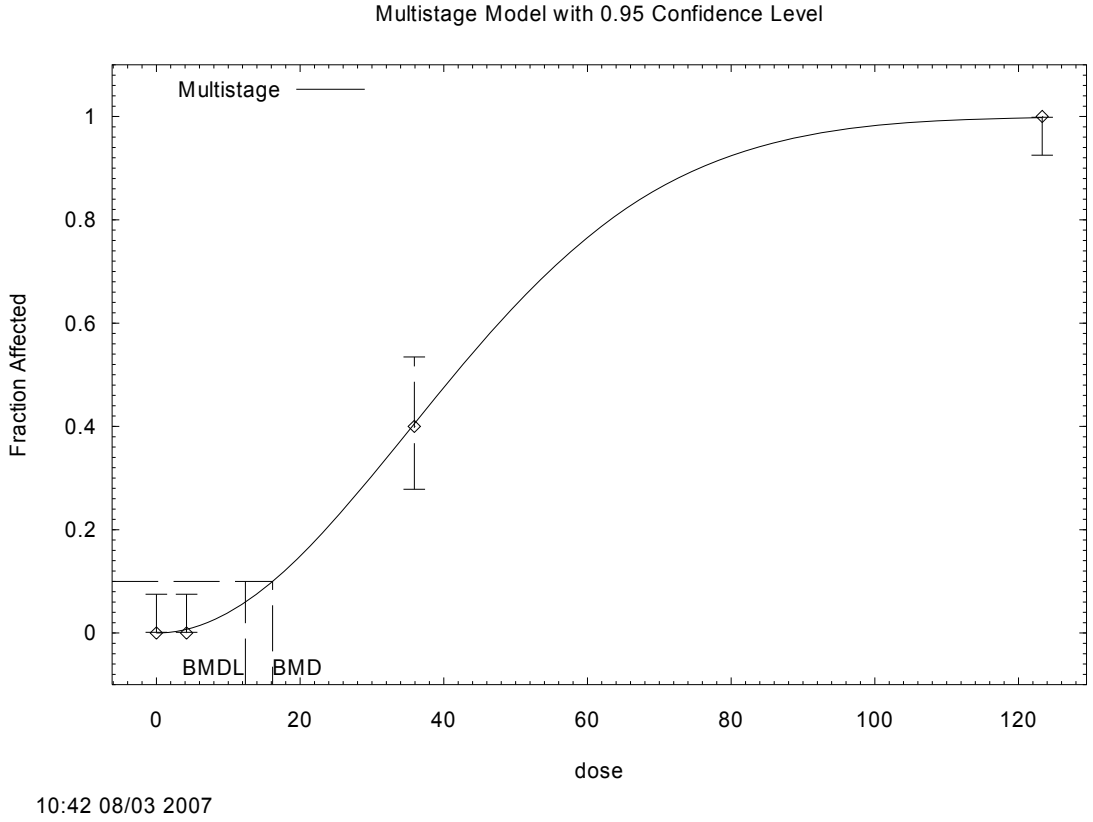
[a]Restrict power ≥1.
[b]Slope restricted to >1.
[c]Restrict betas ≥0; lowest degree polynomial with an adequate fit is reported; degree of polynomial=3.
[d]Restrict betas ≥0; lowest degree polynomial with an adequate fit is reported; degree of polynomial=2.

Figure A-1. Predicted and Observed Incidence of Diarrhea in Male Rats Exposed to MMA in the Diet for 1–52 Weeks*



*BMDs and BMDLs indicated are associated with a 10% extra risk change from the control, and are in units of mg MMA/kg/day.

Figure A-2. Predicted and Observed Incidence of Diarrhea in Female Rats Exposed to MMA in the Diet for 52 Weeks*



*BMDs and BMDLs indicated are associated with a 10% extra risk change from the control, and are in units of mg MMA/kg/day.

The $BMDL_{10}$ of 12.38 mg MMA/kg/day for female rats was selected as the point of departure for deriving the intermediate-duration oral MRL because it was lower than the $BMDL_{10}$ (22.99 mg MMA/kg/day) calculated using the male incidence data.

[ ] NOAEL [ ] LOAEL [X] BMDL

Uncertainty factors used in MRL derivation: 100

[ ] 10 for use of a LOAEL
[X] 10 for extrapolation from animals to humans
[X] 10 for human variability

Was a conversion factor used from ppm in food or water to a mg/body weight dose? Doses calculated using the average of the achieved doses for weeks 1–50 reported in Crown et al. (1990): 0, 3.5, 30.2, and 106.9 mg MMA/kg/day for males and 0, 4.2, 35.9, and 123.3 mg MMA/kg/day for females.

If an inhalation study in animals, list conversion factors used in determining human equivalent dose: Not applicable.

Was a conversion used from intermittent to continuous exposure? Not applicable.

Other additional studies or pertinent information that lend support to this MRL: Increases in the incidence of diarrhea has also been observed in dogs administered via capsule 2 mg MMA/kg/day for 52 weeks (Waner and Nyska 1988); the increased incidence of diarrhea started during weeks 25–28. At 35 mg MMA/kg/day, vomiting was also observed in the dogs. Diarrhea has also been observed in rats and mice exposed to MMA for 2 years (Arnold et al. 2003); the LOAELs are 25.7 and 67.1 mg MMA/kg/day, respectively.

Agency Contacts (Chemical Managers): Selene Chou, Ph.D and Carolyn Harper, Ph.D.

MINIMAL RISK LEVEL (MRL) WORKSHEET

Chemical Name: Monomethylarsonic acid (MMA)
CAS Number: 124-58-3
Date: August 2007
Profile Status: Post-Public Comment, Final Draft
Route: [ ] Inhalation [X] Oral
Duration: [ ] Acute [ ] Intermediate [X] Chronic
Graph Key: 21
Species: Mouse

Minimal Risk Level: 0.01 [X] mg MMA/kg/day [ ] ppm

References: Arnold LL, Eldan M, van Gemert M, et al. 2003. Chronic studies evaluating the carcinogenicity of monomethylarsonic acid in rats and mice. Toxicology 190:197-219.

Gur E, Piraic H, Waner T. 1991. Methanearsonic acid: Combined oncogenicity study in the mouse. Conducted by Life Science Research Israel Ltd., Ness Ziona Israel. Submitted to EPA Office of Pesticide Programs (MRID 42173201).

Experimental design: Groups of 52 male and 52 female $B6C3F_1$ mice were exposed to 0, 10, 50, 200, or 400 ppm of MMA in the diet for 104 weeks. The reported MMA doses were 0, 1.2, 6.0, 24.9, and 67.1 mg MMA/kg/day (males) and 0, 1.4, 7.0, 31.2, and 101 mg MMA/kg/day (females). Body weights, food consumption, and water intake were monitored regularly. Blood was taken at 3, 6, 12, 18, and 24 months for white cell counts. At sacrifice, complete necropsies were performed, including histological examination of at least 13 organs.

Effects noted in study and corresponding doses: No treatment-related increases in mortality were observed. Significant decreases in body weights were observed in males and females exposed to 32.2 or 48.5 mg As/kg/day, respectively; at week 104, the males weighed 17% less than controls and females weighed 23% less. Food consumption was increased in females exposed to 101 mg MMA/kg/day, and water consumption was increased in 67.1 mg MMA/kg/day males and 31.2 and 101 mg MMA/kg/day females. Loose and mucoid feces were noted in mice exposed to 67.1/101 mg MMA/kg/day. No changes were seen in white cell counts of either sex. Small decreases in the weights of heart, spleen, kidney, and liver were seen in some animals, but the decreases were not statistically significant. Squamous metaplasia of the cecum, colon, and rectum was observed at 67.1/101 mg MMA/kg/day. The incidences of metaplasia in the cecum, colon, and rectum were 29/49, 14/49, and 39/49 in males and 38/52, 17/52, and 42/52 in females; metaplasia was not observed in other groups of male or female mice. An increased incidence of progressive glomerulonephropathy (incidence of 25/52, 27/52, 38/52, 39/52, and 46/52 in the 0, 1.2, 6.0, 24.9, and 67.1 mg MMA/kg/day) was observed in males; the incidence was significantly higher (Fisher Exact Test) than controls at ≥6.0 mg MMA/kg/day. Significant increases in the incidence of nephrocalcinosis was observed in the males at 24.9 and 67.1 mg MMA/kg/day (Fisher Exact Test) (incidence of 25/52, 30/52, 30/52, 45/522 45/51 and 0/52, 1/52, 1/52, 2/52, and 5/52 in males and females, respectively). The investigators noted that the kidney lesions were consistent with the normal spectrum of spontaneous renal lesions and there was no difference in character or severity of the lesions between groups. A reduction in the incidence of cortical focal hyperplasia in the adrenal gland of male mice exposed to 67.1 mg MMA/kg/day was possibly related to MMA exposure; the toxicological significance of this effect is not known.

Dose and end point used for MRL derivation: Benchmark dose analysis of the dose-response data (Table A-3) for progressive glomerulonephropathy in male mice exposed to MMA in the diet for 2 years

(incidence data reported in Gur et al. 1991) was conducted. All available dichotomous models in EPA's Benchmark Dose Software (version 1.4.1) were fit to the data. Predicted doses associated with a 10% extra risk were calculated. As assessed by the chi-square goodness-of-fit statistic, all models, with the exception of the log-probit model, provided an adequate fit (X^2 p>0.1) (Table A-4). Comparing across models, a better fit is generally indicated by a lower Akaike's Information Criteria (AIC). As assessed by AIC, the log-logistic model (Figure A-3) provided the best fit to the data. The predicted BMD_{10} and $BMDL_{10}$ for the incidence data are 2.09 and 1.09 mg MMA/kg/day.

Table A-3. Incidence of Progressive Glomerulonephropathy in Male Mice Exposed to MMA in the Diet for 2 Years

Dietary Concentration (ppm)	Dose (mg MMA/kg/day)	Incidence
0	0	25/52
10	1.2	27/52
50	6.0	38/52
200	24.9	39/52
400	67.1	46/52

Sources: Arnold et al. 2003; Gur et al. 1991

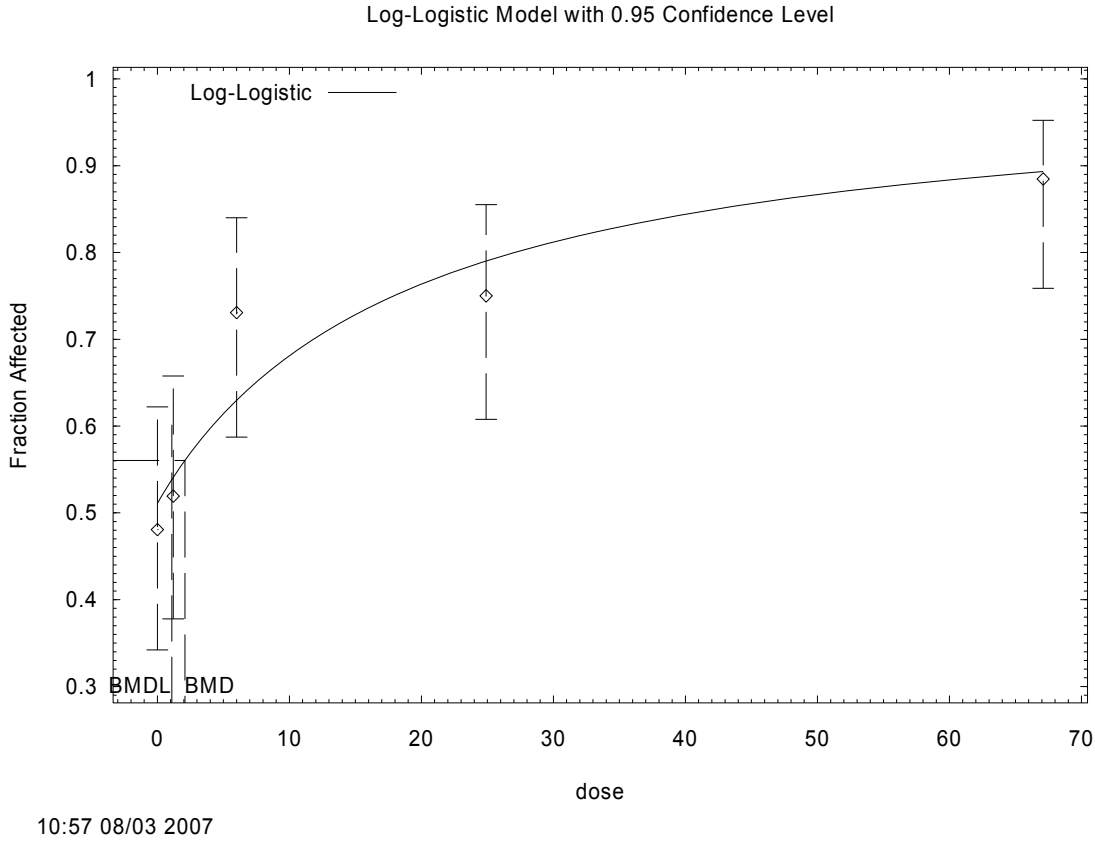
Table A-4. Modeling Predictions for the Incidence of Progressive Glomerulonephropathy in Male Mice Exposed to MMA in the Diet for 2 Years

Model	BMD_{10} (mg MMA/kg/day)	$BMDL_{10}$ (mg MMA/kg/day)	x^2 p-value	AIC
Gamma[a]	4.60	3.15	0.18	309.33
Logistic	6.09	4.45	0.13	310.15
Log-logistic[b]	**2.09**	**1.09**	**0.38**	**307.47**
Multi-stage[c]	4.60	3.15	0.18	309.33
Probit	6.62	5.00	0.11	310.43
Log-probit[b]	8.54	5.50	0.08	311.11
Quantal linear	4.60	3.15	0.18	309.33
Weibull[a]	4.60	3.15	0.18	309.33

Sources: Arnold et al. 2003; Gur et al. 1991

[a]Restrict power ≥1.
[b]Slope restricted to >1.
[c]Restrict betas ≥0; lowest degree polynomial with an adequate fit is reported; degree of polynomial=1.

Figure A-3. Predicted and Observed Incidence of Progressive Glomerulonephropathy in Male Mice Exposed to MMA*



*BMDs and BMDLs indicated are associated with a 10% extra risk change from the control, and are in units of mg MMA/kg/day.

The $BMDL_{10}$ of 1.09 mg MMA/kg/day for male mice was selected as the point of departure for deriving the chronic-duration oral MRL.

[ ] NOAEL [ ] LOAEL [X] BMDL

Uncertainty factors used in MRL derivation: 100

[ ] 10 for use of a LOAEL
[X] 10 for extrapolation from animals to humans
[X] 10 for human variability

Was a conversion factor used from ppm in food or water to a mg/body weight dose? Doses calculated using the average of the achieved doses reported in Gur et al. (1991): 0, 1.2, 6.0, 24.9, and 67.1 mg MMA/kg/day for males and 0, 1.4, 7.0, 31.2, and 101 mg MMA/kg/day for females.

If an inhalation study in animals, list conversion factors used in determining human equivalent dose: Not applicable.

Was a conversion used from intermittent to continuous exposure? Not applicable.

Other additional studies or pertinent information that lend support to this MRL: An exacerbation of chronic progressive nephropathy (an increase in the severity of the nephropathy) has also been observed in rats exposed to ≥33.9 mg MMA/kg/day for 2 years (Arnold et al. 2003).

Agency Contacts (Chemical Managers): Selene Chou, Ph.D and Carolyn Harper, Ph.D.

MINIMAL RISK LEVEL (MRL) WORKSHEET

Chemical Name: Dimethylarsinic acid (DMA)
CAS Number: 75-60-5
Date: August 2007
Profile Status: Post-Public Comment, Final Draft
Route: [ ] Inhalation [X] Oral
Duration: [ ] Acute [ ] Intermediate [X] Chronic
Graph Key: 35
Species: Mouse

Minimal Risk Level: 0.02 [X] mg DMA/kg/day [ ] ppm

References: Arnold LL, Eldan M, Nyska A, et al. 2006. Dimethylarsinic acid: Results of chronic toxicity/oncogenicity studies in F344 rats and B6C3F$_1$ mice. Toxicology 223:82-100.

Gur E, Nyska A, Pirak M, et al. 1989b. Cacodylic acid: Oncogenicity study in the mouse. Conducted by Life Science Research Israel Ltd., Ness Ziona Israel. Submitted to EPA Office of Pesticide Programs (MRID 41914601).

Experimental design: Groups of 56 male and 56 female B6C3F$_1$ mice were exposed to 0, 8, 40, 200, or 500 ppm DMA in the diet for 2 years. The investigators reported the dietary doses were equivalent to approximately 0, 1.3, 7.8, 37, and 94 mg DMA/kg/day. The following parameters were used to assess toxicity: clinical observations, body weight, food consumption, water consumption, differential leukocyte levels measured at 12, 18, and 24 months in mice in the control and 94 mg DMA/kg/day groups, organ weights (brain, kidneys, liver, and testes), and histopathological examination of major tissues and organs.

Effects noted in study and corresponding doses: No deaths were observed. Decreases in body weight gain were observed in the male mice exposed to 94 mg DMA/kg/day; the difference was <10% and was not considered adverse. An increase in water consumption was observed in males exposed to 94 mg DMA/kg/day during weeks 60–96. No treatment-related clinical signs were observed. In the female mice exposed to 94 mg DMA/kg/day, a statistically significant decrease in lymphocytes and increase in monocytes were observed at 24 months. Treatment related nonneoplastic alterations were observed in the urinary bladder and kidneys. In the urinary bladder, increases in the vacuolization of the superficial cells of the urothelium were observed in males exposed to 37 or 94 mg DMA/kg/day (0/44, 1/50, 0/50, 36/45, 48/48) and in females exposed to 7.8, 37, or 94 mg DMA/kg/day (1/45, 1/48, 26/43, 47/47, 43/43); incidence data reported in Gur et al. (1989b). An increased incidence of progressive glomerulonephropathy was observed in males at 37 mg DMA/kg/day (16/44, 22/50, 17/50, 34/45, 30/50) and an increased incidence of nephrocalcinosis was also observed in male mice at 94 mg DMA/kg/day (30/44, 25/50, 27/50, 29/50, 45/50). Neoplastic alterations were limited to an increased incidence of fibrosarcoma of the skin in females exposed to 94 mg DMA/kg/day; the incidence was 3/56, 0/55, 1/56, 1/56, and 6/56 in the 0, 1.3, 7.8, 37, and 94 mg DMA/kg/day groups, respectively; however it was concluded that this lesion was not related to DMA exposure.

Dose and end point used for MRL derivation: Benchmark dose analysis of the dose-response data (Table A-5) for vacuolization of the urothelium in the urinary bladder in female mice exposed to DMA in the diet for 2 years (incidence data reported in Gur et al. 1989b) was conducted. All available dichotomous models in EPA's Benchmark Dose Software (version 1.4.1) were fit to the data. Predicted doses associated with a 10% extra risk were calculated. As assessed by the chi-square goodness-of-fit statistic, all models, with the exception of the quantal linear model, provided an adequate fit (X^2 p>0.1) (Table A-6). Comparing across models, a better fit is generally indicated by a lower AIC. The AIC

values were similar for the logistic, multi-stage, and probit models; of these three models, the multi-stage had the lowest BMD_{10} and was selected for the analysis (see Figure A-4). The predicted BMD_{10} and $BMDL_{10}$ for the incidence data are 2.68 and 1.80 mg DMA/kg/day.

Table A-5. Incidence of Vacuolization of Urotheium in Urinary Bladder of Female Mice Exposed to DMA in the Diet for 2 Years

Dietary concentration (ppm)	Dose (mg DMA/kg/day)	Incidence
0	0	1/45
8	1.3	1/48
40	7.8	26/43
200	37	47/47
500	94	43/43

Sources: Arnold et al. 2006; Gur et al. 1989b

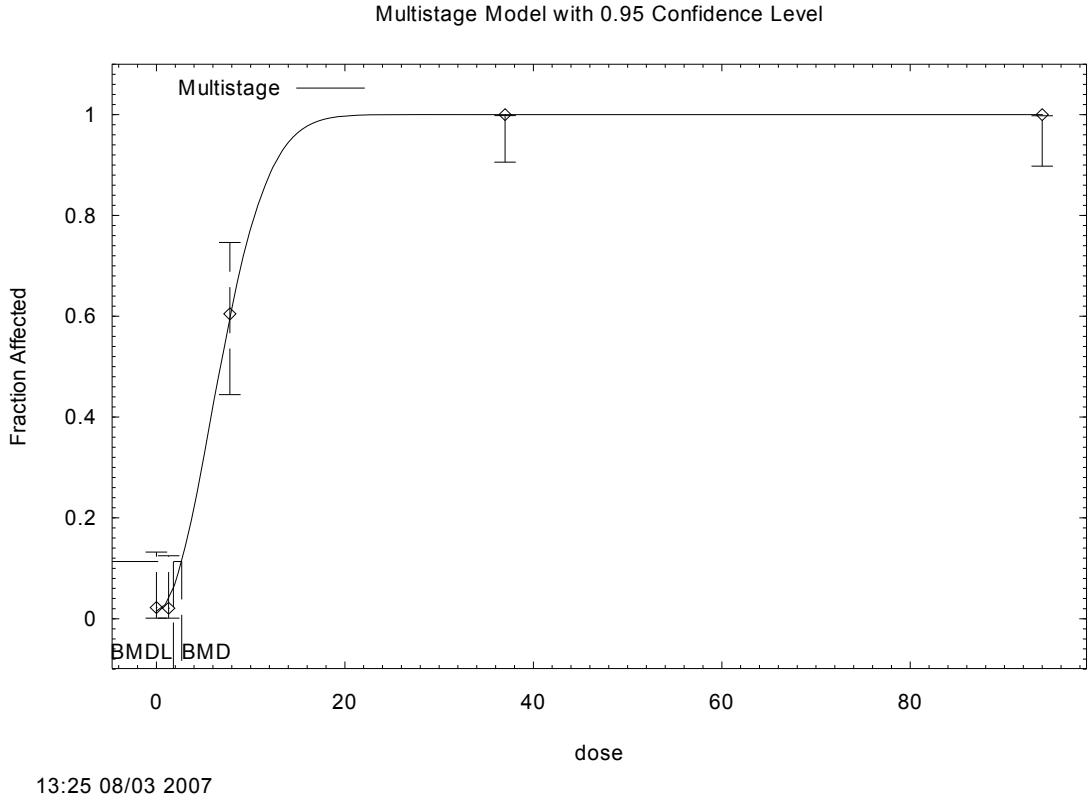
Table A-6. Modeling Predictions for the Incidence of Vacuolization in of Urothelium in Urinary Bladder of Female Mice Exposed to DMA in the Diet for 2 Years

Model	BMD_{10} (mg DMA/kg/day)	$BMDL_{10}$ (mg DMA/kg/day)	x^2 *p*-value	AIC
Gamma[a]	5.01	1.85	1.00	83.03
Logistic	3.66	2.78	0.95	81.37
Log-logistic[b]	6.23	2.34	1.00	83.03
Multi-stage[c]	**2.68**	**1.80**	**0.90**	**81.69**
Probit	3.20	2.46	0.89	81.60
Log-probit[b]	5.03	2.00	1.00	83.03
Quantal linear	0.98	0.76	0.07	91.75
Weibull[a]	4.77	1.88	1.00	83.03

Sources: Arnold et al. 2006; Gur et al. 1989b

[a]Restrict power ≥1.
[b]Slope restricted to >1.
[c]Restrict betas ≥0; lowest degree polynomial with an adequate fit is reported; degree of polynomial=2.

Figure A-4. Predicted and Observed Incidence of Vacuolization of Urothelium in Urinary Bladder of Female Mice*



Source: Arnold et al. 2006

*BMDs and BMDLs indicated are associated with a 10% extra risk change from the control, and are in units of mg DMA/kg/day.

The $BMDL_{10}$ of 1.80 mg DMA/kg/day for female mice was selected as the point of departure for deriving the chronic-duration oral MRL.

[ ] NOAEL [ ] LOAEL [X] BMDL

Uncertainty factors used in MRL derivation: 100

[ ] 10 for use of a LOAEL
[X] 10 for extrapolation from animals to humans
[X] 10 for human variability

Was a conversion factor used from ppm in food or water to a mg/body weight dose? Doses reported in Gur et al. (1989b): 0, 1.3, 7.8, 37, and 94 mg DMA/kg/day.

If an inhalation study in animals, list conversion factors used in determining human equivalent dose: Not applicable.

Was a conversion used from intermittent to continuous exposure? Not applicable.

Other additional studies or pertinent information that lend support to this MRL: One other study has investigated the chronic toxicity of DMA in species other than rats. In this study, administration of 16 mg DMA/kg/day via a capsule for 52 weeks resulted in increases in the incidence of diarrhea; no histological alterations were observed (Zomber et al. 1989).

Agency Contacts (Chemical Managers): Selene Chou, Ph.D and Carolyn Harper, Ph.D.

This page is intentionally blank.

APPENDIX B. USER'S GUIDE

Chapter 1

Public Health Statement

This chapter of the profile is a health effects summary written in nontechnical language. Its intended audience is the general public, especially people living in the vicinity of a hazardous waste site or chemical release. If the Public Health Statement were removed from the rest of the document, it would still communicate to the lay public essential information about the chemical.

The major headings in the Public Health Statement are useful to find specific topics of concern. The topics are written in a question and answer format. The answer to each question includes a sentence that will direct the reader to chapters in the profile that will provide more information on the given topic.

Chapter 2

Relevance to Public Health

This chapter provides a health effects summary based on evaluations of existing toxicologic, epidemiologic, and toxicokinetic information. This summary is designed to present interpretive, weight-of-evidence discussions for human health end points by addressing the following questions:

1. What effects are known to occur in humans?

2. What effects observed in animals are likely to be of concern to humans?

3. What exposure conditions are likely to be of concern to humans, especially around hazardous waste sites?

The chapter covers end points in the same order that they appear within the Discussion of Health Effects by Route of Exposure section, by route (inhalation, oral, and dermal) and within route by effect. Human data are presented first, then animal data. Both are organized by duration (acute, intermediate, chronic). *In vitro* data and data from parenteral routes (intramuscular, intravenous, subcutaneous, etc.) are also considered in this chapter.

The carcinogenic potential of the profiled substance is qualitatively evaluated, when appropriate, using existing toxicokinetic, genotoxic, and carcinogenic data. ATSDR does not currently assess cancer potency or perform cancer risk assessments. Minimal Risk Levels (MRLs) for noncancer end points (if derived) and the end points from which they were derived are indicated and discussed.

Limitations to existing scientific literature that prevent a satisfactory evaluation of the relevance to public health are identified in the Chapter 3 Data Needs section.

Interpretation of Minimal Risk Levels

Where sufficient toxicologic information is available, ATSDR has derived MRLs for inhalation and oral routes of entry at each duration of exposure (acute, intermediate, and chronic). These MRLs are not

meant to support regulatory action, but to acquaint health professionals with exposure levels at which adverse health effects are not expected to occur in humans.

MRLs should help physicians and public health officials determine the safety of a community living near a chemical emission, given the concentration of a contaminant in air or the estimated daily dose in water. MRLs are based largely on toxicological studies in animals and on reports of human occupational exposure.

MRL users should be familiar with the toxicologic information on which the number is based. Chapter 2, "Relevance to Public Health," contains basic information known about the substance. Other sections such as Chapter 3 Section 3.9, "Interactions with Other Substances," and Section 3.10, "Populations that are Unusually Susceptible" provide important supplemental information.

MRL users should also understand the MRL derivation methodology. MRLs are derived using a modified version of the risk assessment methodology that the Environmental Protection Agency (EPA) provides (Barnes and Dourson 1988) to determine reference doses (RfDs) for lifetime exposure.

To derive an MRL, ATSDR generally selects the most sensitive end point which, in its best judgement, represents the most sensitive human health effect for a given exposure route and duration. ATSDR cannot make this judgement or derive an MRL unless information (quantitative or qualitative) is available for all potential systemic, neurological, and developmental effects. If this information and reliable quantitative data on the chosen end point are available, ATSDR derives an MRL using the most sensitive species (when information from multiple species is available) with the highest no-observed-adverse-effect level (NOAEL) that does not exceed any adverse effect levels. When a NOAEL is not available, a lowest-observed-adverse-effect level (LOAEL) can be used to derive an MRL, and an uncertainty factor (UF) of 10 must be employed. Additional uncertainty factors of 10 must be used both for human variability to protect sensitive subpopulations (people who are most susceptible to the health effects caused by the substance) and for interspecies variability (extrapolation from animals to humans). In deriving an MRL, these individual uncertainty factors are multiplied together. The product is then divided into the inhalation concentration or oral dosage selected from the study. Uncertainty factors used in developing a substance-specific MRL are provided in the footnotes of the levels of significant exposure (LSE) tables.

Chapter 3

Health Effects

Tables and Figures for Levels of Significant Exposure (LSE)

Tables and figures are used to summarize health effects and illustrate graphically levels of exposure associated with those effects. These levels cover health effects observed at increasing dose concentrations and durations, differences in response by species, MRLs to humans for noncancer end points, and EPA's estimated range associated with an upper- bound individual lifetime cancer risk of 1 in 10,000 to 1 in 10,000,000. Use the LSE tables and figures for a quick review of the health effects and to locate data for a specific exposure scenario. The LSE tables and figures should always be used in conjunction with the text. All entries in these tables and figures represent studies that provide reliable, quantitative estimates of NOAELs, LOAELs, or Cancer Effect Levels (CELs).

The legends presented below demonstrate the application of these tables and figures. Representative examples of LSE Table 3-1 and Figure 3-1 are shown. The numbers in the left column of the legends correspond to the numbers in the example table and figure.

LEGEND

See Sample LSE Table 3-1 (page B-6)

(1) Route of Exposure. One of the first considerations when reviewing the toxicity of a substance using these tables and figures should be the relevant and appropriate route of exposure. Typically when sufficient data exist, three LSE tables and two LSE figures are presented in the document. The three LSE tables present data on the three principal routes of exposure, i.e., inhalation, oral, and dermal (LSE Tables 3-1, 3-2, and 3-3, respectively). LSE figures are limited to the inhalation (LSE Figure 3-1) and oral (LSE Figure 3-2) routes. Not all substances will have data on each route of exposure and will not, therefore, have all five of the tables and figures.

(2) Exposure Period. Three exposure periods—acute (less than 15 days), intermediate (15–364 days), and chronic (365 days or more)—are presented within each relevant route of exposure. In this example, an inhalation study of intermediate exposure duration is reported. For quick reference to health effects occurring from a known length of exposure, locate the applicable exposure period within the LSE table and figure.

(3) Health Effect. The major categories of health effects included in LSE tables and figures are death, systemic, immunological, neurological, developmental, reproductive, and cancer. NOAELs and LOAELs can be reported in the tables and figures for all effects but cancer. Systemic effects are further defined in the "System" column of the LSE table (see key number 18).

(4) Key to Figure. Each key number in the LSE table links study information to one or more data points using the same key number in the corresponding LSE figure. In this example, the study represented by key number 18 has been used to derive a NOAEL and a Less Serious LOAEL (also see the two "18r" data points in sample Figure 3-1).

(5) Species. The test species, whether animal or human, are identified in this column. Chapter 2, "Relevance to Public Health," covers the relevance of animal data to human toxicity and Section 3.4, "Toxicokinetics," contains any available information on comparative toxicokinetics. Although NOAELs and LOAELs are species specific, the levels are extrapolated to equivalent human doses to derive an MRL.

(6) Exposure Frequency/Duration. The duration of the study and the weekly and daily exposure regimens are provided in this column. This permits comparison of NOAELs and LOAELs from different studies. In this case (key number 18), rats were exposed to “Chemical x” via inhalation for 6 hours/day, 5 days/week, for 13 weeks. For a more complete review of the dosing regimen, refer to the appropriate sections of the text or the original reference paper (i.e., Nitschke et al. 1981).

(7) System. This column further defines the systemic effects. These systems include respiratory, cardiovascular, gastrointestinal, hematological, musculoskeletal, hepatic, renal, and dermal/ocular. "Other" refers to any systemic effect (e.g., a decrease in body weight) not covered in these systems. In the example of key number 18, one systemic effect (respiratory) was investigated.

(8) NOAEL. A NOAEL is the highest exposure level at which no harmful effects were seen in the organ system studied. Key number 18 reports a NOAEL of 3 ppm for the respiratory system,

which was used to derive an intermediate exposure, inhalation MRL of 0.005 ppm (see footnote "b").

(9) LOAEL. A LOAEL is the lowest dose used in the study that caused a harmful health effect. LOAELs have been classified into "Less Serious" and "Serious" effects. These distinctions help readers identify the levels of exposure at which adverse health effects first appear and the gradation of effects with increasing dose. A brief description of the specific end point used to quantify the adverse effect accompanies the LOAEL. The respiratory effect reported in key number 18 (hyperplasia) is a Less Serious LOAEL of 10 ppm. MRLs are not derived from Serious LOAELs.

(10) Reference. The complete reference citation is given in Chapter 9 of the profile.

(11) CEL. A CEL is the lowest exposure level associated with the onset of carcinogenesis in experimental or epidemiologic studies. CELs are always considered serious effects. The LSE tables and figures do not contain NOAELs for cancer, but the text may report doses not causing measurable cancer increases.

(12) Footnotes. Explanations of abbreviations or reference notes for data in the LSE tables are found in the footnotes. Footnote "b" indicates that the NOAEL of 3 ppm in key number 18 was used to derive an MRL of 0.005 ppm.

LEGEND

See Sample Figure 3-1 (page B-7)

LSE figures graphically illustrate the data presented in the corresponding LSE tables. Figures help the reader quickly compare health effects according to exposure concentrations for particular exposure periods.

(13) Exposure Period. The same exposure periods appear as in the LSE table. In this example, health effects observed within the acute and intermediate exposure periods are illustrated.

(14) Health Effect. These are the categories of health effects for which reliable quantitative data exists. The same health effects appear in the LSE table.

(15) Levels of Exposure. Concentrations or doses for each health effect in the LSE tables are graphically displayed in the LSE figures. Exposure concentration or dose is measured on the log scale "y" axis. Inhalation exposure is reported in mg/m^3 or ppm and oral exposure is reported in mg/kg/day.

(16) NOAEL. In this example, the open circle designated 18r identifies a NOAEL critical end point in the rat upon which an intermediate inhalation exposure MRL is based. The key number 18 corresponds to the entry in the LSE table. The dashed descending arrow indicates the extrapolation from the exposure level of 3 ppm (see entry 18 in the table) to the MRL of 0.005 ppm (see footnote "b" in the LSE table).

(17) CEL. Key number 38m is one of three studies for which CELs were derived. The diamond symbol refers to a CEL for the test species-mouse. The number 38 corresponds to the entry in the LSE table.

(18) Estimated Upper-Bound Human Cancer Risk Levels. This is the range associated with the upper-bound for lifetime cancer risk of 1 in 10,000 to 1 in 10,000,000. These risk levels are derived from the EPA's Human Health Assessment Group's upper-bound estimates of the slope of the cancer dose response curve at low dose levels (q_1*).

(19) Key to LSE Figure. The Key explains the abbreviations and symbols used in the figure.

SAMPLE

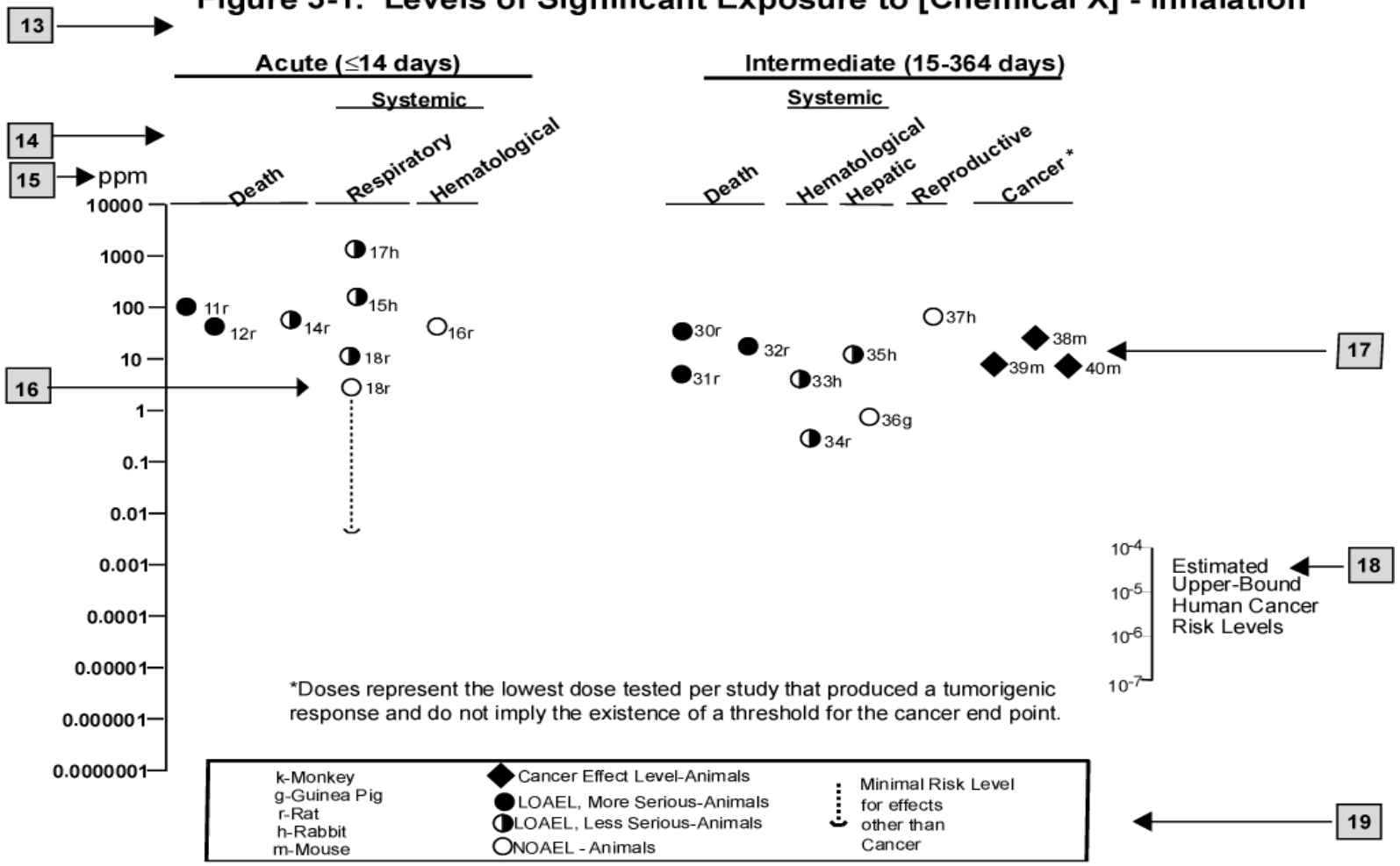
1 → **Table 3-1. Levels of Significant Exposure to [Chemical x] – Inhalation**

Key to figure[a]	Species	Exposure frequency/ duration	System	NOAEL (ppm)	LOAEL (effect) Less serious (ppm)	LOAEL (effect) Serious (ppm)	Reference
2 → INTERMEDIATE EXPOSURE							
	5	6	7	8	9		10
3 → Systemic	↓	↓	↓	↓	↓		↓
18	Rat	13 wk 5 d/wk 6 hr/d	Resp	3[b]	10 (hyperplasia)		Nitschke et al. 1981
4 → CHRONIC EXPOSURE							
Cancer					11 ↓		
38	Rat	18 mo 5 d/wk 7 hr/d			20	(CEL, multiple organs)	Wong et al. 1982
39	Rat	89–104 wk 5 d/wk 6 hr/d			10	(CEL, lung tumors, nasal tumors)	NTP 1982
40	Mouse	79–103 wk 5 d/wk 6 hr/d			10	(CEL, lung tumors, hemangiosarcomas)	NTP 1982

12 → [a] The number corresponds to entries in Figure 3-1.
[b] Used to derive an intermediate inhalation Minimal Risk Level (MRL) of $5x10^{-3}$ ppm; dose adjusted for intermittent exposure and divided by an uncertainty factor of 100 (10 for extrapolation from animal to humans, 10 for human variability).

SAMPLE

Figure 3-1. Levels of Significant Exposure to [Chemical X] - Inhalation



This page is intentionally blank.

APPENDIX C. ACRONYMS, ABBREVIATIONS, AND SYMBOLS

ACGIH	American Conference of Governmental Industrial Hygienists
ACOEM	American College of Occupational and Environmental Medicine
ADI	acceptable daily intake
ADME	absorption, distribution, metabolism, and excretion
AED	atomic emission detection
AFID	alkali flame ionization detector
AFOSH	Air Force Office of Safety and Health
ALT	alanine aminotransferase
AML	acute myeloid leukemia
AOAC	Association of Official Analytical Chemists
AOEC	Association of Occupational and Environmental Clinics
AP	alkaline phosphatase
APHA	American Public Health Association
AST	aspartate aminotransferase
atm	atmosphere
ATSDR	Agency for Toxic Substances and Disease Registry
AWQC	Ambient Water Quality Criteria
BAT	best available technology
BCF	bioconcentration factor
BEI	Biological Exposure Index
BMD	benchmark dose
BMR	benchmark response
BSC	Board of Scientific Counselors
C	centigrade
CAA	Clean Air Act
CAG	Cancer Assessment Group of the U.S. Environmental Protection Agency
CAS	Chemical Abstract Services
CDC	Centers for Disease Control and Prevention
CEL	cancer effect level
CELDS	Computer-Environmental Legislative Data System
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
Ci	curie
CI	confidence interval
CL	ceiling limit value
CLP	Contract Laboratory Program
cm	centimeter
CML	chronic myeloid leukemia
CPSC	Consumer Products Safety Commission
CWA	Clean Water Act
DHEW	Department of Health, Education, and Welfare
DHHS	Department of Health and Human Services
DNA	deoxyribonucleic acid
DOD	Department of Defense
DOE	Department of Energy
DOL	Department of Labor
DOT	Department of Transportation

DOT/UN/ NA/IMCO	Department of Transportation/United Nations/ North America/Intergovernmental Maritime Dangerous Goods Code
DWEL	drinking water exposure level
ECD	electron capture detection
ECG/EKG	electrocardiogram
EEG	electroencephalogram
EEGL	Emergency Exposure Guidance Level
EPA	Environmental Protection Agency
F	Fahrenheit
F_1	first-filial generation
FAO	Food and Agricultural Organization of the United Nations
FDA	Food and Drug Administration
FEMA	Federal Emergency Management Agency
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FPD	flame photometric detection
fpm	feet per minute
FR	Federal Register
FSH	follicle stimulating hormone
g	gram
GC	gas chromatography
gd	gestational day
GLC	gas liquid chromatography
GPC	gel permeation chromatography
HPLC	high-performance liquid chromatography
HRGC	high resolution gas chromatography
HSDB	Hazardous Substance Data Bank
IARC	International Agency for Research on Cancer
IDLH	immediately dangerous to life and health
ILO	International Labor Organization
IRIS	Integrated Risk Information System
Kd	adsorption ratio
kg	kilogram
kkg	metric ton
K_{oc}	organic carbon partition coefficient
K_{ow}	octanol-water partition coefficient
L	liter
LC	liquid chromatography
LC_{50}	lethal concentration, 50% kill
LC_{Lo}	lethal concentration, low
LD_{50}	lethal dose, 50% kill
LD_{Lo}	lethal dose, low
LDH	lactic dehydrogenase
LH	luteinizing hormone
LOAEL	lowest-observed-adverse-effect level
LSE	Levels of Significant Exposure
LT_{50}	lethal time, 50% kill
m	meter
MA	*trans*,*trans*-muconic acid
MAL	maximum allowable level
mCi	millicurie
MCL	maximum contaminant level

MCLG	maximum contaminant level goal
MF	modifying factor
MFO	mixed function oxidase
mg	milligram
mL	milliliter
mm	millimeter
mmHg	millimeters of mercury
mmol	millimole
mppcf	millions of particles per cubic foot
MRL	Minimal Risk Level
MS	mass spectrometry
NAAQS	National Ambient Air Quality Standard
NAS	National Academy of Science
NATICH	National Air Toxics Information Clearinghouse
NATO	North Atlantic Treaty Organization
NCE	normochromatic erythrocytes
NCEH	National Center for Environmental Health
NCI	National Cancer Institute
ND	not detected
NFPA	National Fire Protection Association
ng	nanogram
NHANES	National Health and Nutrition Examination Survey
NIEHS	National Institute of Environmental Health Sciences
NIOSH	National Institute for Occupational Safety and Health
NIOSHTIC	NIOSH's Computerized Information Retrieval System
NLM	National Library of Medicine
nm	nanometer
nmol	nanomole
NOAEL	no-observed-adverse-effect level
NOES	National Occupational Exposure Survey
NOHS	National Occupational Hazard Survey
NPD	nitrogen phosphorus detection
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NR	not reported
NRC	National Research Council
NS	not specified
NSPS	New Source Performance Standards
NTIS	National Technical Information Service
NTP	National Toxicology Program
ODW	Office of Drinking Water, EPA
OERR	Office of Emergency and Remedial Response, EPA
OHM/TADS	Oil and Hazardous Materials/Technical Assistance Data System
OPP	Office of Pesticide Programs, EPA
OPPT	Office of Pollution Prevention and Toxics, EPA
OPPTS	Office of Prevention, Pesticides and Toxic Substances, EPA
OR	odds ratio
OSHA	Occupational Safety and Health Administration
OSW	Office of Solid Waste, EPA
OTS	Office of Toxic Substances
OW	Office of Water

OWRS	Office of Water Regulations and Standards, EPA
PAH	polycyclic aromatic hydrocarbon
PBPD	physiologically based pharmacodynamic
PBPK	physiologically based pharmacokinetic
PCE	polychromatic erythrocytes
PEL	permissible exposure limit
pg	picogram
PHS	Public Health Service
PID	photo ionization detector
pmol	picomole
PMR	proportionate mortality ratio
ppb	parts per billion
ppm	parts per million
ppt	parts per trillion
PSNS	pretreatment standards for new sources
RBC	red blood cell
REL	recommended exposure level/limit
RfC	reference concentration
RfD	reference dose
RNA	ribonucleic acid
RQ	reportable quantity
RTECS	Registry of Toxic Effects of Chemical Substances
SARA	Superfund Amendments and Reauthorization Act
SCE	sister chromatid exchange
SGOT	serum glutamic oxaloacetic transaminase
SGPT	serum glutamic pyruvic transaminase
SIC	standard industrial classification
SIM	selected ion monitoring
SMCL	secondary maximum contaminant level
SMR	standardized mortality ratio
SNARL	suggested no adverse response level
SPEGL	Short-Term Public Emergency Guidance Level
STEL	short term exposure limit
STORET	Storage and Retrieval
TD_{50}	toxic dose, 50% specific toxic effect
TLV	threshold limit value
TOC	total organic carbon
TPQ	threshold planning quantity
TRI	Toxics Release Inventory
TSCA	Toxic Substances Control Act
TWA	time-weighted average
UF	uncertainty factor
U.S.	United States
USDA	United States Department of Agriculture
USGS	United States Geological Survey
VOC	volatile organic compound
WBC	white blood cell
WHO	World Health Organization

>	greater than
≥	greater than or equal to
=	equal to
<	less than
≤	less than or equal to
%	percent
α	alpha
β	beta
γ	gamma
δ	delta
μm	micrometer
μg	microgram
q_1^*	cancer slope factor
–	negative
+	positive
(+)	weakly positive result
(–)	weakly negative result

This page is intentionally blank.

APPENDIX D. INDEX

absorbed dose 258
adenocarcinoma 71
adenocarcinomas 193, 263
adrenal gland 36, 197
adrenal glands 197
adsorbed 261, 325, 326, 367, 370, 377
adsorption 325, 326, 363
aerobic 333, 334
ambient air 69, 336, 364
anaerobic 333, 334
androgen receptor 288
anemia 30, 60, 169, 283
aspartate aminotransferase (see AST) 171
AST (see aspartate aminotransferase) 171
bioaccumulation 330, 337, 340
bioavailability 213, 214, 215, 333, 335, 363, 364, 365, 370, 373, 380
bioconcentration factor 330
biomarker 257, 258, 260, 261, 262, 288, 392
biomarkers 257, 258, 262, 383
blood cell count 60
body weight effects 63, 177, 178, 196, 197
breast milk 9, 217, 226, 256, 286, 359, 368
cancer 7, 8, 17, 18, 19, 22, 23, 42, 56, 64, 68, 69, 70, 71, 72, 73, 74, 176, 185, 188, 189, 190, 191, 192, 193, 198, 199, 211, 248, 250, 253, 254, 255, 262, 263, 265, 270, 277, 278, 280, 282, 286, 287, 288, 289, 395, 399
carcinogen 7, 18, 23, 187, 192, 193, 395, 398, 399
carcinogenic 7, 26, 29, 41, 42, 44, 192, 194, 250, 276, 277, 395, 398
carcinogenicity 28, 44, 189, 192, 193, 194, 231, 248, 249, 250, 251, 277, 289, 398
carcinoma 71, 187, 202, 206
carcinomas 23, 73, 187, 188, 194
cardiac arrhythmia 20, 164
cardiovascular 17, 18, 19, 20, 31, 56, 58, 59, 74, 164, 166, 173, 196, 254, 282
cardiovascular effects 17, 20, 58, 59, 163, 164, 166, 196
chromosomal aberrations 199, 208, 250, 257
clearance 21, 212, 225, 226, 228
cognitive function 255
crustaceans 350
death 7, 9, 23, 41, 56, 73, 74, 162, 163, 185, 186, 191, 194, 216, 248, 251, 256
deoxyribonucleic acid (see DNA) 205, 207, 208, 210
dermal effects 17, 19, 31, 62, 175, 176, 197, 273, 275, 395
DNA (see deoxyribonucleic acid) 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 249, 250, 251, 258, 269, 278, 285
dopamine 182
elimination half-time 27, 219, 227
endocrine 174, 175, 196, 197, 252, 253
Endocrine Effects 174, 197
erythema 20, 197

estrogen receptor 187
fetal tissue 9
fetus 187, 217, 253, 280, 372
gastrointestinal effects 21, 24, 26, 28, 33, 37, 59, 60, 74, 166, 168, 274, 395
general population 15, 57, 165, 224, 257, 364, 374, 375, 378
genotoxic 41, 199, 208, 249, 251, 278
genotoxicity 199, 208, 250, 278
groundwater 4, 10, 16, 313, 315, 322, 323, 326, 331, 337, 338, 340, 341, 342, 343, 356, 369, 375, 380, 381
growth retardation 186
half-life 227, 258, 331, 375
hematological effects 60, 169, 196
hepatic effects 61, 170, 171, 196, 262
homeopathic 354
hydrolysis 331, 334
hydroxyl radical 250
immune system 64, 281
immunological 29, 41, 64, 179, 198
immunological effects 29
K_{ow} 297, 298, 299, 300, 301, 376
LD_{50} 32, 39, 162
leukemia 15, 17, 20, 287, 311
leukopenia 30, 168
lymphoreticular 64, 179, 198
melanoma 190
micronuclei 199, 208, 250
milk 217, 256, 359, 361, 368, 369
mucociliary 21, 60, 369
musculoskeletal effects 61, 170
neonatal 185, 256, 280, 286
neoplastic 25, 26, 27, 28, 193
neurobehavioral 18, 181, 182, 186, 252, 255, 281
norepinephrine 182
nuclear 251, 384
ocular effects 63, 177, 197
odds ratio 64, 183, 191
pancytopenia 273
partition coefficients 243
pharmacodynamic 228
pharmacokinetic 228, 229, 230, 234, 235, 236, 237, 239, 240
pharmacokinetics 253, 286
photolysis 331, 334
placenta 9, 185, 217, 256
placental barrier 217, 256
rate constant 232, 243, 246
renal effects 61, 62, 172, 173, 174, 196
retention 224, 264, 309, 363
salivation 182
sarcoma 193
sodium pump 249
solubility 43, 214, 225, 333, 335, 364

spermatogonia 207, 208
T3 ..... 45, 46, 47, 48, 52, 53, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 125, 126, 127, 128, 129, 130, 131, 132, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 152, 153, 154, 155, 156, 157, 158, 195
thyroid 25, 26, 35, 175, 194, 197, 251
toxicokinetic 17, 27, 32, 41, 43, 71, 211, 221, 259, 263, 278, 282, 284, 286
tremors 28, 39, 65, 274
tumors 18, 23, 26, 27, 28, 73, 187, 190, 191, 192, 193, 194, 199, 251, 256, 262, 278
volatilization 333

NIH NATIONAL CANCER INSTITUTE

Cancer Statistics

Cancer has a major impact on society in the United States and across the world. Cancer statistics describe what happens in large groups of people and provide a picture in time of the burden of cancer on society.

Statistics tell us things such as how many people are diagnosed with and die from cancer each year, the number of people who are currently living after a cancer diagnosis, the average age at diagnosis, and the numbers of people who are still alive at a given time after diagnosis. They also tell us about differences among groups defined by age, sex, racial/ethnic group, geographic location, and other categories.

Cancer statistics also help us see trends. By looking at cancer rates over time, we can track changes in the risk of developing and dying from specific cancers as well as cancer overall.

For information about chances of surviving cancer and prognosis, see Understanding Cancer Prognosis. NCI also has a collection of statistical summaries for a number of common cancer types.

Although statistical trends are usually not directly applicable to individual patients, they are essential for governments, policy makers, health professionals, and researchers to understand the impact of cancer on the population and to develop strategies to address the challenges that cancer poses to the society at large. Statistical trends are also important for measuring the success of efforts to control and manage cancer.

Statistics at a Glance: The Burden of Cancer in the United States

- In 2024, an estimated 2,001,140 new cases of cancer will be diagnosed in the United States and 611,720 people will die from the disease.
- The most common cancers (listed in descending order according to estimated new cases in 2024) are breast cancer, prostate cancer, lung and bronchus cancer, colon and rectum cancer, melanoma of the skin, bladder cancer, kidney and renal pelvis cancer, non-Hodgkin lymphoma, endometrial cancer, pancreatic cancer, leukemia, thyroid cancer, and liver cancer.

- Prostate, lung, and colorectal cancers account for an estimated 48% of all cancers diagnosed in men in 2024. For women, the three most common cancers are breast, lung, and colorectal, and they will account for an estimated 51% of all new cancer diagnoses in women in 2024.
- The rate of new cases of cancer (cancer incidence) is 440.5 per 100,000 men and women per year (based on 2017–2021 cases).
- The cancer death rate (cancer mortality) is 146.0 per 100,000 men and women per year (based on 2018–2022 deaths).
- The cancer mortality rate is higher among men than women (173.2 per 100,000 men and 126.4 per 100,000 women). When comparing groups based on race/ethnicity and sex, cancer mortality is highest in non-Hispanic Black men (208.3 per 100,000) and lowest in non-Hispanic Asian/Pacific Islander women (82.6 per 100,000).
- As of January 2022, there were an estimated 18.1 million cancer survivors in the United States. The number of cancer survivors is projected to increase to 22.5 million by 2032.
- Approximately 40.5% of men and women will be diagnosed with cancer at some point during their lifetimes (based on 2017–2019 data).
- In 2024, an estimated 14,910 children and adolescents ages 0 to 19 will be diagnosed with cancer and 1,590 will die of the disease.
- Estimated national expenditures for cancer care in the United States in 2020 were $208.9 billion. In future years, costs are likely to increase as the population ages and more people have cancer. Costs are also likely to increase as new, and often more expensive, treatments are adopted as standards of care.

Statistics at a Glance: The Burden of Cancer Worldwide

- Cancer is among the leading causes of death worldwide. In 2022, there were almost 20 million new cases and 9.7 million cancer-related deaths worldwide.
- By 2040, the number of new cancer cases per year is expected to rise to 29.9 million and the number of cancer-related deaths to 15.3 million.
- Generally, cancer rates are highest in countries whose populations have the highest life expectancy, education level, and standard of living. But for some cancer types, such as cervical cancer, the reverse is true, and the incidence rate is highest in countries in which the population ranks low on these measures.

Source: International Agency for Research on Cancer

U.S. Cancer Mortality Trends

The best indicator of progress against cancer is a change in age-adjusted mortality (death) rates, although other measures, such as quality of life, are also important. Incidence is also important, but it is not always straightforward to interpret changes in incidence. A rise in incidence can reflect a real increase in disease occurrence, such as when an increase in exposure to a risk factor causes more cases of cancer. In such a scenario the increased incidence would likely lead to a rise in deaths from the cancer. On the other hand, the incidence of cancer may rise due to a new screening test that detects many cancer cases that would not have caused a problem during someone's life (called overdiagnosis). In this example, the incidence of the cancer would increase, but death rates would not change.

Mortality trends, when compared with incidence trends, can also provide evidence of improved treatments. If death rates drop faster than incidence (or if death rates drop while incidence is rising), this may reflect the availability of better treatments. For example, statistical evidence suggests that improved treatments have likely made a substantial contribution to recent sharp declines in the lung cancer mortality rate.

In the United States, the overall cancer death rate has declined since the early 1990s. Part 1 of the most recent Annual Report to the Nation on the Status of Cancer, released in October 2022, shows that overall cancer death rates decreased by:

- 2.3% per year among men from 2015 to 2019
- 1.9% per year among women from 2015 to 2019
- 1.5% per year among children ages 0–14 from 2015 to 2019

Although death rates for many individual cancer types have also declined, rates for a few cancers have not changed or even increased.

As the overall cancer death rate has declined, the number of cancer survivors has increased. These trends show that progress is being made against the disease, but much work remains. Although rates of smoking, a major cause of cancer, have declined, the rates of other risk factors, such as obesity, have increased in the United States. Also, the U.S. population is aging, and cancer rates increase with age.

The Surveillance, Epidemiology, and End Results (SEER) Program

NCI's Surveillance, Epidemiology, and End Results (SEER) Program collects and publishes cancer incidence and survival data from population-based cancer registries that cover approximately 48% of the U.S. population. The SEER program website has more detailed cancer statistics, including population statistics for common types of cancer, customizable graphs and tables, and interactive tools.

The Annual Report to the Nation on the Status of Cancer provides an annual update of cancer incidence, mortality, and trends in the United States. This report is jointly authored by experts from NCI, the Centers for Disease Control and Prevention, American Cancer Society, and the North American Association of Central Cancer Registries.

Part 1 of the most recent report included a special section about trends in pancreatic cancer. Part 2, released in September 2023, focused on the effect of the COVID-19 pandemic on new cases and deaths from certain cancers. For example, new diagnoses of six major cancer types fell sharply from March to May of 2020, at the start of the pandemic. By July 2020, diagnoses of all of these cancer types except one (prostate cancer) had returned to pre-pandemic levels.

Related Resources

Cancer Stat Fact Sheets

SEER Did You Know? Video Series

Finding Statistics by Race/Ethnicity

State Cancer Profiles

Updated: May 9, 2024

If you would like to reproduce some or all of this content, see Reuse of NCI Information for guidance about copyright and permissions. In the case of permitted digital reproduction, please credit the National Cancer Institute as the source and link to the original NCI product using the original product's title; e.g., "Cancer Statistics was originally published by the National Cancer Institute."

How Dangerous is Lightning?

Lightning is a major cause of storm related deaths in the U.S. A lightning strike can result in a cardiac arrest (heart stopping) at the time of the injury, although some victims may appear to have a delayed death a few days later if they are resuscitated but have suffered irreversible brain damage.

According to *the NWS Storm Data*, over the last 30 years (1989-2018) the U.S. has averaged 43 *reported* lightning fatalities per year. Only about 10% of people who are struck by lightning are killed, leaving 90% with various degrees of disability. More recently, in the last 10 years (2009-2018), the U.S. has averaged 27 lightning fatalities.

Odds of Becoming a Lightning Victim (based on averages for 2009-2018)				
Estimated U.S. population as of 2019				330,000,000
Average Number of Deaths Reported	27	Estimated number of Injuries	243	270
Odds of being struck in a given year (estimated total deaths + estimated injuries)				1/1,222,000
Odds of being struck in your lifetime (Est. 80 years)				1/15,300
Odds you will be affected by someone struck (10 people for every 1 struck)				1/1,530

RAÚL R. LABRADOR
Attorney General

SCOTT L. CAMPBELL
Deputy Attorney General
Chief, Energy and Natural Resources Division

Hannah M.C. Young, ISB No. 9781
hannah.young@deq.idaho.gov
Michael A. Short, ISB No. 10554
michael.short@deq.idaho.gov
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: 208.373.0543

Attorneys for Respondent

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047

NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,

Petitioners,

v.

IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,

Respondent,

and

PERPETUA RESOURCES IDAHO, INC.,

Intervenor-Respondent.

Case Docket No. 0101-22-01
OAH Case No. 23-245-01

NOTICE RE: DECLARATION OF NORKA E. PADEN, Ph.D.

On August 13, 2024, the Idaho Department of Environmental Quality (the "Department") filed the *Expert Declaration of Norka E. Paden, Ph.D.*, ("Paden Declaration") in this matter.

On September 3, 2024, Petitioners informed the Department that two references cited in the Paden Declaration were not readily accessible. For the convenience of the parties and the Hearing Officer, true and correct copies of those scientific articles, footnotes 19[1] and 21[2] of the Paden Declaration, are attached hereto as Attachment A and Attachment B, respectively.

DATED: September 10, 2024.

DEPARTMENT OF ENVIRONMENTAL QUALITY

/s/ Michael A. Short
Michael A. Short
Deputy Attorney General

Attorneys for Respondent

[1] Zhou Q., Xi S. 2018. A review on arsenic carcinogenesis: Epidemiology, metabolism, genotoxicity and epigenetic changes. Journal of Regulatory Toxicology and Pharmacology 99: 78-88. https://www.sciencedirect.com/science/article/abs/pii/S0273230018302320?via%3Dihub

[2] Erraguntla N.K., Sielken R.L. Valdez-Flores C., Grant R.L. 2012. An updated inhalation unit risk factor for arsenic and inorganic arsenic compounds based on a combined analysis of epidemiology studies. Journal Regulatory Toxicology and Pharmacology 64(2):329-41. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0273230012001304. Accessed on July 23, 2024.

CERTIFICATE OF SERVICE

I HEREBY CERTIFY that on September 10, 2024, the foregoing was filed, served, and copied as shown below.

Bryan Hurlbutt
Laird ("Laird") J. Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701

Attorneys for Petitioner Nez Perce Tribe and Idaho Conservation League

bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638

Attorney for Petitioner
Save the South Fork Salmon

jthrower@mtntoplaw.com
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole C. Hancock
Stoel Rives LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702

Attorneys for Intervenor
Perpetua Resources of Idaho, Inc.

krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
nicole.hancock@stoel.com
via electronic service

Dylan B. Lawrence
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701

Hearing Officer

dylan@varinthomas.com
via electronic service

Paula Wilson, Hearing Coordinator
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, Idaho 83706

paula.wilson@deq.idaho.gov
via electronic service

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

/s/ DeAnne M. Chaffin
DeAnne M. Chaffin
Legal Assistant

Attachment A

Regulatory Toxicology and Pharmacology 99 (2018) 78–88

Contents lists available at ScienceDirect

Regulatory Toxicology and Pharmacology

journal homepage: www.elsevier.com/locate/yrtph

A review on arsenic carcinogenesis: Epidemiology, metabolism, genotoxicity and epigenetic changes

Qing Zhou, Shuhua Xi*

Department of Environmental and Occupational Health, Liaoning Provincial Key Laboratory of Arsenic Biological Effect and Poisoning, School of Public Health, China Medical University, No.77 Puhe Road, Shenyang North New Area, Shenyang 110122, Liaoning Province, People's Republic of China

ARTICLE INFO

Keywords:
Arsenic
Inorganic arsenic
Carcinogenesis
Epidemiology
Methylation
Signal transduction

ABSTRACT

Long-term exposure to arsenic (inorganic arsenic) is a world-wide environmental health concern. Arsenic is classified as the Group 1 human carcinogen by the International Agency for Research on Cancer (IARC). Epidemiological studies have established a strong association between inorganic arsenic (iAs) exposure in drinking water and an increased incidence of cancer including bladder, liver, lung, prostate, and skin cancer. iAs also increases the risk of other diseases such as cardiovascular disease, hypertension and diabetes. The molecular mechanisms of carcinogenesis of iAs remain poorly defined, several mechanisms have been proposed, including genotoxicity, altered cell proliferation, oxidative stress, changes to the epigenome, disturbances of signal transduction pathways, cytotoxicity and regenerative proliferation. In this article, we will summarize current knowledge on the mechanisms of arsenic carcinogenesis and focus on integrating all these issues to garner a broader perspective.

1. Introduction

Arsenic is an environmental contaminant found in soil, air, food, and water. Chronic exposure to high levels of iAs is associated with a wide range of adverse effects, such as skin lesions, peripheral vascular diseases, reproductive toxicity, and neurological effects. In addition, several epidemiological studies have linked arsenic exposure to a variety of human malignancies in skin, lungs, bladder, liver (Sankpal et al., 2012). Exposure occurs primarily via drinking water, but dietary exposure can also be substantial. Inhalation is a main route of arsenic exposure in occupational environment (Aylward et al., 2014). It is estimated that more than 100 million people worldwide are exposed to carcinogenic levels of iAs, the majority of which are caused by drinking arsenic contaminated groundwater. In some areas of the world, iAs in drinking water is still at a very high level, such as Taiwan, Bangladesh, India, China, Chile, Argentina and Mexico (Humans, 2012; Sankpal et al., 2012; Cohen et al., 2013). Lung, bladder, and kidney cancer mortality due to arsenic exposure have very long latencies, with increased risks manifesting 40 years after arsenic exposure reduction (Cohen et al., 2013).

The mechanisms by which arsenic induces carcinogenesis are unclear, in part due to lack of animal carcinogenicity studies for many years. At presents, several mechanisms of tumorigenesis induced by arsenic compounds have been proposed, including oxidative stress, genotoxic damage, chromosomal abnormalities, modification of gene expression, epigenetic mechanisms, cytotoxicity and regenerative proliferation (Zhang et al., 2007a; b; Kitchin and Wallace, 2008; Cohen et al., 2013). However, the main shortcomings in oxidative stress, genotoxicity, and chromosomal abnormalities are that most the studies supporting these modes of action being in vitro at lethal concentrations. Furthermore, some of the genotoxicity data in vivo have several deficiencies. Further understanding of the mechanisms of arsenic carcinogenesis is needed. Therefore, in this paper, we provide and discuss important information about the mechanisms of arsenic carcinogenesis.

Abbreviations: As3MT, arsenic-3-methyl transferase enzyme; BER, base excision repair; CA, chromosomal aberration; DAPK, death-associated protein kinase; DMA, dimethylarsinous acid; DNMT, DNA methyltransferase; DSBs, DNA double strand breaks; EGF, epidermal growth factor; ERCC2, excision repair; ERK1/2, extracellular signal-regulated kinase1/; GSH, glutathione; GSTO, glutathione-S-transferase omega; JNK, c-Jun N-terminal protein Kinase; MAPK, mitogen-activated protein kinase; MMA, monomethylarsonous acid; MN, micronuclei; Nrf2, nuclear factor erythroid 2-related factor 2; NF-κB, nuclear factor-kappa B; PI3K, phosphoinositide 3-kinases; ROS, reactive oxygen species; RPA1, replication protein A1; SAM, s-adenosyl-l-methionine; SCE, sister chromatid exchange; VEGF, vascular endothelial growth factor

* Corresponding author. Tel.: +86 13390587580.
E-mail address: Shxi@cmu.edu.cn (S. Xi).

https://doi.org/10.1016/j.yrtph.2018.09.010
Received 15 May 2018; Received in revised form 8 September 2018; Accepted 12 September 2018
Available online 15 September 2018
0273-2300/ © 2018 Elsevier Inc. All rights reserved.

2. Epidemiology of arsenic and cancer

To date, the International Agency for Research on Cancer (IARC) has confirmed the association of arsenic exposure with cancer of the skin, lung, and bladder, while reports on the relationship with the liver, kidney, and prostate cancer are still limited. It is noteworthy that arsenic has been only related to kidney pelvis tumors rather than the usual renal cell tumors, which are urothelial and an extension of the urinary bladder (Ferreccio et al., 2013). Key epidemiological evidence regarding the carcinogenicity of arsenic comes from studies of Taiwan, Bangladesh, Chile, and Argentina, where drinking water contains high concentrations of this metalloid (150 μg/L) (IARC, 2012). However, there are few epidemiological studies to assess the carcinogenic effects of arsenic at low to moderate levels of arsenic in drinking water and food.

2.1. Skin cancer

According to the IARC, there is sufficient human evidence of skin carcinogenicity of iAs (IARC, 2004). Skin cancer was the first documented carcinogenic effect from chronic exposure to iAs and has been studied extensively (Hughes et al., 2011). Skin lesions, including skin cancer, are characteristic of exposure to arsenic in drinking water (Cohen et al., 2013). In skin, arsenic relates to increased risk for squamous cell carcinoma (SCC) in situ, invasive SCC and basal cell carcinoma (BCC) (Naujokas et al., 2013). Several studies have reported the relationship between the chronic exposure of arsenic in drinking water and the development of skin cancer. Arsenic induced skin cancer due to high contamination of arsenic in drinking water has also been observed in West Bengal, India (Haque et al., 2003). Most studies on skin cancer have found an increased risk only at concentrations above 100 μg/L, but a case–control study by Leonardi et al. (2012) found a positive association between BCC and exposure to iAs through drinking water with concentrations < 100 μg/L. Overall, the risk of skin cancer is increased in populations with high (> 100 μg/L) exposure to iAs in drinking water.

While the toxicity of arsenic, in general, is well established, studies on the association between exposure to low arsenic concentration and the development of skin cancer are not enough. The association between the risk of skin cancer and concentrations of iAs in drinking water needs further exploration.

2.2. Lung cancer

Lung is one of the major targets for tumorigenesis due to arsenic exposure (Hubaux et al., 2013). Arsenic in drinking water has been classified as a known cause for the lung cancer by IARC. Exposure to inorganic arsenic in various mining occupations led to lung cancer also could be discovered. Various epidemiological studies have shown the link between ingestion of iAs through drinking water and development of human lung cancer. In a case-control study, a clear trend in lung cancer odds ratios (OR) and 95% confidence intervals with increasing concentration of arsenic in drinking water was observed (Ferreccio et al., 2000). Additionally, the associations between arsenic levels in drinking water and mortality of lung cancer using village as unit were assessed in ten townships in Taiwan, a significant increase in the mortality of lung cancer in both genders with arsenic levels above 0.64 mg/L was found, but no significant effect was observed at lower levels (Guo, 2004). Another study in northern Chile showed that lung and bladder cancer incidence in adults was markedly increased following exposure to arsenic in early life, even up to 40 years after high exposures ceased (Steinmaus et al., 2014). Smith et al. (2012) found that a significant increase in lung cancer mortality in a region of Chile where iAs concentrations in water ranged from 90 μg/L to nearly 1000 μg/L.

However, Ferdosi H (Ferdosi et al., 2016) did not demonstrate that an increased risk of lung cancer was associated with median drinking water arsenic levels in the range of 3–59 μg/L. A recent meta-regression by Lamm et al. (2015) indicates negative slope at low exposure levels (100–150 μg/L) with lung cancer. There is an increased risk of both bladder cancer and lung cancer only at relatively high concentrations in the drinking water (> 150 μg/L). In addition, tobacco smoking combined with arsenic exposure increases the risk of lung cancer and decreasing arsenic exposure can also decrease the risk of lung cancer in smokers (Chen et al., 2004a; b). Chen et al. (Chen et al., 2010a; b) found no significant association between ingestion of well water containing iAs at levels of 300 μg/L or less and lung cancer among never-smokers. The OR was 2.25 for iAs concentrations in drinking water that are greater than 300 μg/L (95% CI: 1.43–3.55). The threshold was found to be modified by smoking. The relative contribution of iAs vs smoking could not be assessed from the available data.

Until now, researches have focused on the association between lung cancer and exposure to high levels of arsenic, but these studies are not sufficient to evaluate the potential of iAs to induce lung cancer at low exposures. In view of the potential relevance of low arsenic concentration to arsenic exposure, it needs further investigation.

2.3. Bladder cancer

The IARC considers there to be sufficient evidence for arsenic to increase risk of urinary bladder cancer in humans, yet risks related to exposure in the 10–100 μg/L range of arsenic remain uncertain (Humans, 2004a; b; Meliker et al., 2010). An increased cancer mortality among cohorts exposed to extremely high arsenic levels has also been reported in Japan (Tsuda et al., 1995) and Chile (Marshall et al., 2007). Studies confirm that the association between exposure to iAs in drinking water and bladder cancer is found only after exposure to iAs concentrations greater than 100 μg/L. A prospective cohort study in northeastern Taiwan reported that the multivariate-adjusted relative risk of urinary tract cancer was statistically significant for residents who drank well water containing arsenic at levels > 100 μg/L (Chiou et al., 2001). Schoen et al. (2004) concluded that an increase in bladder cancer is observed only in humans who were exposed to iAs in drinking water at high concentrations, usually several hundred μg/L. A cohort study by Chen et al. (Chen et al., 2010a; b) found statistically significant increase in urinary tract carcinomas in a Taiwanese population who ingested iAs at concentrations greater than 100 μg/L. Wang et al. (Wang et al., 2013a; b) found an increased risk of bladder or upper urinary tract urothelial carcinoma only in non-smoking Taiwanese exposed to iAs in drinking water at concentrations of ≥350 μg/L for 10 years or more. Results from different geographical areas indicate a threshold for association between iAs exposure and bladder cancer at concentrations of 100 μg/L or higher (Mink et al., 2008; Chen et al., 2010a; b; Tsuji et al., 2014).

These studies have only verified the correlation between bladder cancer and high concentrations of arsenic, the studies at lower exposures have shown inconsistent results. In a lower exposure study conducted in the US, no increase in bladder cancer incidence was found in population consuming drinking water containing iAs at concentrations of 10–100 μg/L (Meliker et al., 2010). This finding was consistent with results of an earlier ecological study in Michigan (Meliker et al., 2007). In addition, an ecologic analysis in the United States found no arsenic-related increase in bladder cancer mortality was found over the exposure range of 3–60 μg/L (Lamm et al., 2004). However, an ecological study conducted by Mendez et al. supports an association between low arsenic concentrations in drinking water (1.5–15.4 μg/L) and bladder cancer incidence in the United States (Mendez et al., 2017). Mink et al. (2008) conducted a meta-analysis of data from eight studies of low levels of iAs. The meta-analysis did not find significant associations between exposures to low levels of iAs in drinking water (typically < 100–200 μg/L) and bladder cancer for never smokers. The multiple epidemiologic studies support the conclusion that low

exposure to iAs does not increase the risk of bladder cancer (Tsuji et al., 2014).

2.4. Liver cancer

The epidemiological data for the skin, lung and urinary bladder is widely accepted, whereas the association of long-term iAs exposure through drinking water with risk of liver cancer mortality remains controversial (Liu and Waalkes, 2008). IARC listes the liver as a potential organ for arsenic carcinogenesis (IARC, 2004). The increase of liver cancer mortality in population drinking water with elevated arsenic was first reported in the southwestern population of Taiwan (Chen et al., 1985). Moreover, increased liver cancer mortality associated with drinking water arsenic levels have been reported in populations from Inner Mongolia, China, Bangladesh, and Japan (Liu and Waalkes, 2008). A meta-analysis indicated that long-term iAs exposure through drinking water increased the risk of liver cancer mortality (Wang et al., 2014). In addition, an investigation in Chile revealed that exposure to arsenic in drinking water during early childhood may result in an increased in childhood liver cancer mortality (Liaw et al., 2008). Although studies conducted in Argentina, Chile, and other regions have reported a relationship of liver cancer with arsenic levels in drinking water, no consensus has been made on this relationship mostly because of a limited availability to representative data (Morales et al., 2000; Baastrup et al., 2008).

2.5. Prostate cancer

Multiple studies in humans reveal an association between environmental inorganic arsenic exposure and prostate cancer mortality or incidence, prostate is considered to be a potential target for iAs carcinogenesis (Benbrahim-Tallaa and Waalkes, 2008). A US prospective cohort study suggested that low to moderate exposure to inorganic arsenic was prospectively associated with increased mortality of prostate cancer (Garcia-Esquinas et al., 2013). Roh et al. conducted an ecologic study in Iowa, which showed a significant dose-dependent association between low-level (1.08–2.06 μg/L) arsenic exposure and prostate cancer (Roh et al., 2017). Moreover, in a US based ecologic study, counties with higher mean arsenic levels in community water systems had significantly higher prostate cancer incidence. However, an individual-level study of prostate cancer incidence and low-level arsenic exposure is needed (Bulka et al., 2016).

Overall, a reliable relationship between ingestion of iAs and cancers including skin, lung, and bladder cancer was only found in drinking water concentrations exceeding 100 μg/L (Mink et al., 2008; Tsuji et al., 2014). Lack of significant associations may result from methodological issues (e.g., inadequate statistical power and by potential misclassification of exposure) (National Research Council, 2001). In addition, exposure to inorganic and organic arsenicals via food supply, which can confound epidemiology studies considerably, especially at low exposures to arsenic in water (Aylward et al., 2014).

3. Metabolism of arsenic

The metabolism of arsenic is related to its toxicity. Inorganic arsenic is absorbed in the gastrointestinal tract when ingested through food or drinking water. Arsenic uptake is strongly dependent on its oxidation state. iAs^{V} enters cells through membrane transporters, such as the sodium/phosphate co-transporters. The methylated pentavalent organic forms of arsenic are not transported, whereas the trivalent forms (iAs^{III}) are readily transported (Rosen, 2002; Cohen et al., 2013). iAs^{III} enters the cell via aquaglyceroporin channels and transporters (Yang et al., 2012). The major transporters for the trivalent arsenicals include P-glycoproteins, ATP-binding cassette transporters (multidrug-resistant proteins), and glucose transporters (Cohen et al., 2013). The most of circulating arsenic undergoes bio-transformation in hepatocytes where arsenite undergoes a series of sequential oxidative-methylation and reduction steps (Vahter, 2002). In the human arsenic metabolic pathway, iAs^{V} is converted to iAs^{III}, with subsequent methylation to monomethylated and dimethylated arsenicals, respectively. Methylation is an important step in conversion of arsenic from inorganic to the organic form, and the process consumes both S-adenosyl-l-methionine (SAM) and glutathione (GSH) (Drobna et al., 2005). The arsenic-3-methyl transferase enzyme (As3MT) metabolizes inorganic forms to methylated forms (MMA and DMA), including both trivalent and pentavalent forms, with SAM as the methyl-donating cofactor. (Suzuki et al., 2002; Naranmandura et al., 2006). The dimethyl form also can be further methylated to trimethyl arsenic oxide (TMAO) in rodents and does not occur in humans except at extremely high exposures (Cohen et al., 2013). In the biotransformation of inorganic arsenic, glutathione-S-transferase omega (GSTO) catalyzes the reduction of arsenate, MMA^{V}, and DMA^{V} to the +3 arsenic species which are more toxic. Chowdhury et al. (2006). reported on the complete methylation of arsenate to DMA^{III} in GSTO knockout mice. There appears to be other enzyme(s) other than GSTO able to reduce arsenic(V) species but to a lesser extent. While there is evidence that GSTO can reduce pentavalent arsenicals in vitro, its in vivo relevance is lacking (Nemeti et al., 2015). The general scheme of reactions is $As^{V} + 2e \rightarrow As^{III} + Me+ \rightarrow MMA^{V} + 2e \rightarrow MMA^{III} + Me+ \rightarrow DMA^{V} + 2e \rightarrow DMA^{III}$. Since arsenic metabolism involves oxidative methylation with S-adenosyl methionine as the methyl donor, some nutrients such as folate levels affecting one carbon metabolism may influence the arsenic methylation patterns, leading difficulties in exposure analysis (Gamble et al., 2005).

In the environment, the main forms of arsenic are iAs^{V} and iAs^{III} (National Research Council, 2001). The trivalent forms of arsenic, especially organic trivalent arsenicals, are highly reactive and cytotoxic, with activity at low micromolar concentrations (Cohen et al., 2013). It has been demonstrated that the trivalent forms of arsenic are the toxic forms in a variety of cell systems. The trivalent forms of organic arsenic, MMA^{III} and DMA^{III}, have been also detected in the urine of rodents and humans that were exposed to high concentrations of iAs (Valenzuela et al., 2005). But the organic pentavalent forms of arsenic are mostly much less reactive, with activity generally at millimolar concentrations (Cohen et al., 2013).

Notably, arsenic methylation is considered to be a bioactivation and detoxification pathways. The overall toxicity of arsenic is dependent on the rate of methylation of the iAs^{III}. In vitro study has shown that MMA^{III} and DMA^{III} are much more toxic than the pentavalent forms, and trivalent methylated arsenicals are more toxic than trivalent inorganic arsenic (Mass et al., 2001). Chen et al. suggested that a higher ratio of MMA to DMA in urine is associated with an increased risk of bladder cancer development (Chen et al., 2003; Chen et al., 2004a; b). Recent studies showed that the higher percentage of methylated arsenic in urine, the more evidence of increased risk of skin and bladder cancer (Moe et al., 2016; Khairul et al., 2017). Moreover, it has been found that MMA^{III} and DMA^{III} can inhibit the activities of many enzymes and are more genotoxic than iAs^{III} (Dopp et al., 2010).

4. Genotoxicity

Genotoxicity can be produced either by direct interaction with DNA or by indirect effects that produce errors in DNA. These indirect effects can involve micronucleus (MN) formation, Sister chromatid exchange (SCE) or chromosomal aberrations (CAs). In addition, inhibition of DNA repair enzymes could also lead to an indirect genotoxic process.

4.1. Direct damage to DNA

The chromosomal effects and DNA damage were postulated to be critical events in the initiation and progression of human cancer. Nesnow et al. (2002) demonstrated that DNA reaction did not occur with arsenicals. A direct interaction of arsenicals with DNA would lead

to formation of DNA adduct, and no arsenic containing DNA adduct has been reported.

4.2. Indirect damage to DNA

The iAs-mediated chromosomal instability occurs frequently at centromeres, leading to the formation of acentric chromosomes or the fusion of centromeres between two chromosomes (Kesari et al., 2012). Fusion of two chromosomes at their centromeres can cause improper chromosome segregation, which results in aneuploidy or micronuclei formation (Xie et al., 2014). However, a fusion occurring at chromosomal ends may result in the formation of ring-like structures and/or participate in abnormal SCE (Kesari et al., 2012). At low doses, iAs does not cause DNA base pair mutations; instead, generate double-stranded breaks (Xie et al., 2014), which results in large-scale CAs (Klein et al., 2007).

Increased incidences of CAs, SCE and MN have been reported from the human populations exposed to arsenic through drinking water (Ostrosky-Wegman et al., 1991; Lerda, 1994; Dulout et al., 1996; Gonsebatt et al., 1997; Maki-Paakkanen et al., 1998; Mahata et al., 2003). MN are detected in exfoliated bladder cells, buccal cells, sputum cells, and lymphocytes from arsenic-exposed humans (Tian et al., 2001; Basu et al., 2002). In vitro studies, concentrations of arsenite are usually extremely high, frequently greater than 10 μmol/L, which would be lethal to most cell lines (Kligerman et al., 2003; Gentry et al., 2010). Such high concentrations of trivalent arsenicals usually used in vitro could not be reached in vivo at environmentally relevant concentrations of iAs. In animal studies, the positive results appear at extremely high doses of arsenic, which would be expected to produce cytotoxicity and cell death.

However, there are numerous difficulties in interpretation of these studies. To begin with, most of these studies have not shown a dose response in relation to arsenic exposure as assessing either drinking water levels or urinary arsenic. Exposure to tobacco and tobacco products affect MN formation (Reali et al., 1987; Humans, 2004a; b; Roy et al., 2016). This is particularly likely as a confounding factor given the extensive use of betel quid in some populations and the relatively high smoking rates (Humans, 2004a; b). Another possible variety among populations could be folate levels, which vary between populations and affect arsenic metabolism and toxicity (Gamble et al., 2006, 2007; Peters et al., 2015). Folate is also associated with variability in micronucleus formation (Lindberg et al., 2007; Bull et al., 2012).

4.3. Inhibition of DNA repair

Interaction with a variety of DNA repair proteins could potentially lead to an increased risk of genotoxicity (Banerjee et al., 2008; Chen et al., 2010a; b; Cohen et al., 2013). Inhibition of DNA repair has been implicated as a mechanism of arsenic contaminated drinking water induced carcinogenesis. Gentry et al. (2010) highlighted inhibition of DNA repair is a mode of action of arsenic carcinogenic effect. Arsenic can inhibit nucleotide excision repair (NER), base excision repair (BER), and mismatch repair (Hossain et al., 2012). Arsenic interfering with DNA repair is expected to promote mutation of key tumor suppressor genes such as tumor protein P53 (TP53) in patients exposed to arsenic, leading to increased risk of bladder cancer (Kelsey et al., 2005). Arsenic-mediated oxidative damage in enzymes is also reported to interfere with the DNA repair mechanisms by either inhibiting ligation or down-regulating the gene expression of DNA repair enzymes such as DNA polymerase β (Sinha and Roy, 2011). Additionally, arsenic induces formation of DNA adducts and leaves unreplicated stretches in replicating DNA followed by DNA double strand breaks (DSBs) when the adduct is excised. As arsenic impairs DNA repair mechanisms, the unrepaired DSBs can lead to chromosome or chromatid type aberrations (Wang et al., 2001).

In summary, arsenic negatively impacts DNA repair capability. Arsenite interferes with the DNA damage response at multiple levels, these effects of arsenic exposure likely contribute to its roles as a carcinogen.

5. Epigenetic changes

Recent a large body of studies on the mechanism of arsenic carcinogenesis have shown the potential involvement of altered epigenetic regulation in gene expression changes induced by arsenic exposure (Bjorklund et al., 2017). Epigenetics refers to the reversible regulation of gene expression, independent of DNA sequences. Epigenetic mechanisms allow cells to rapidly alter long-term transcriptional activity, thereby permitting coordinated changes in gene expression without permanently altering the sequence of DNA. Epigenetic alteration, which is not a genotoxic effect, leads to heritable phenomena that regulate gene expression and thus could be considered a form of potentially reversible DNA modification. Epigenetic alterations are also believed to play an important role in the complex mode of action of iAs. The main epigenetic mechanisms are DNA methylation in gene promoter regions that regulate gene expression, covalent posttranslational histone modifications, and microRNAs (miRNAs) expression changes associated with iAs exposure.

5.1. DNA methylation

DNA methylation is one of the several epigenetic mechanisms which cells use to control gene expression. DNA methylation provides sufficient control over genes regulating cell differentiation, proliferation and organism development, and these changes can be passed to daughter cells during replication (Herceg, 2007). Global genomic DNA methylation is a sign of many types of cancer. DNA methylation is the covalent addition of a methyl group to the 5th carbon (C5) position of cytosine-rich region, known as CpG islands (Bjorklund et al., 2017). In normal pathologically cells, promoter CpG islands regions are typically unmethylated.

Methylation is a major and important step in arsenic biotransformation. These methylation steps facilitate arsenic excretion but consume SAM at the same time. SAM, as the methyl donor for the majority of methyltransferases, modifies DNA, RNA, histones and other proteins, dictating replicational, transcriptional and translational fidelity, mismatch repair, chromatin modeling, epigenetic modifications and imprinting, and thus plays an important role in cancer research (Loenen, 2006). In humans, DNA methylation is initiated by the denovo DNA methyltransferase 3 (DNMT3A and B) and maintained by DNA methyltransferase 1 (DNMT1) (Bestor, 2000). Following low-dose iAs exposure, the expression of the DNMTs is reduced, which results in less methylation at target sites (Reichard et al., 2007; Cheng et al., 2012). When cells metabolize arsenic, the arsenic methyltransferase, AS3MT, transfers a methyl group from SAM to the arsenite, depleting the available methyl groups needed to the DNMTs for DNA methylation (Reichard et al., 2007).

Hypo- and hypermethylation of DNA in promoter regions are known to mediate gene expression and to suppress gene expression, respectively. Both global DNA hypomethylation and hypermethylation in the promoter region of tumor suppressor genes are often associated with carcinogenesis and cancer outcomes. Population studies have shown that individuals having relatively lower capacity to methylate arsenic to DMA^V are at greater risk for skin cancers, bladder cancer, and peripheral vascular disease (Chen et al., 2003; Tseng et al., 2005). A hospital-based case-control study performed in northern Mexico found that women with higher %MMA and/or primary methylation index (PMI) had an increased bladder cancer risk (Wei et al., 2017). Additionally, human skin exposure to iAs also led to global hypomethylation of tumor tissues (Zhang et al., 2007a; b). Arsenic exposure has been reported to induce DNA hypomethylation in vitro and in animal studies. For example, rats (Uthus and Davis, 2005) and mice (Okoji et al., 2002; Chen

et al., 2004a; b; Xie et al., 2004) exposed to iAs^{III} for several weeks displayed global DNA hypomethylation and aberrant gene expression. Studies in cell lines in vitro yielded similar results, with a reduction in global genomic DNA methylation resulting from iAs^{III} exposure (Reichard et al., 2007). Urothelial carcinoma patients with high arsenic exposure show death-associated protein kinase (DAPK) promoter hypermethylation with low expression of the DAPK gene (Chen et al., 2007). Hypermethylation and lower protein expression of DAPK were also detected in iAs treated SV40-immortalized human uroepithelial cells (Chai et al., 2007).

Conversely, some research indicates that iAs exposure leads to hypermethylation at the promoters of specific tumor-suppressor genes (Miao et al., 2015). In iAs-exposed human hepatocytes, significant hypermethylation of the promoters of genes involved in DNA repair such as excision repair cross-complementation group 2 (ERCC2) and replication protein A1 (RPA1), and of genes associated with the Wnt pathway like c-MYC (MYC) and Wnt family member 2B (WNT2B), was observed (Miao et al., 2015). Dose-dependent hypermethylation at the promoter region of several tumor suppressor genes was induced by arsenic exposure in vitro and in vivo (Stabile et al., 2005; Zhang et al., 2007a; b). Significant hypermethylation of the promoters of the tumor suppressor p16, and the DNA repair gene, mutl homolog 1 (MLH1) (Hossain et al., 2012; Lu et al., 2014), was observed in whole blood obtained from humans chronically exposed to iAs. Additionally, the promoter region of the p53 tumor suppressor gene was also found hyper methylated in arsenic-induced skin cancer patients (Chanda et al., 2006). In a population-based study of bladder cancer, a significant increase in methylation at the RASSF1A and PRSS3 promoters was found (Chai et al., 2007). This outcome was recapitulated in arsenic-induced lung cancer in A/J mice, in which the arsenic exposure reduced the expression of RASSF1A resulting from hypermethylation of its promoter region (Chai et al., 2007).

Methylation of ingested iAs to MMAs and DMAs relies on folate-dependent one-carbon metabolism. Most studies have not taken into account controlling for this confounding factor, particularly for studies from Asia, including India, Bangladesh, and China, where folate deficiency can be quite common. This can greatly influence the result of studies. In a cross-sectional study, Gamble ascertained that folate conditions are associated with lower arsenic methylation (Gamble et al., 2005). Subsequent study provides compelling evidence that folic acid supplementation to adults with low plasma concentrations of folate would result in increased arsenic methylation (Gamble et al., 2006, 2007).

Clearly, the results of various studies demonstrate that iAs can induce global levels of DNA hypomethylation and promoter specific hypermethylation of tumor suppressor genes and suggest that iAs-induced disruption of DNA methylation may be important in carcinogenesis. But the current available studies are essentially descriptive and difficult to interpret because of the complexity of the study populations and limited information provided in the reports. Studies systematically investigating DNA methylation on a genome wide level in arsenic-exposed cell lines and in target tissues are needed. Such studies would help to clarify potential effects of arsenic exposure on DNA methylation and carcinogenesis.

5.2. Histone modifications

In addition to DNA methylation, histone modifications could be potential biomarkers for the assessment of arsenic exposure and prediction of adverse health effects (Ma et al., 2016). Covalent post-translational modifications of histone proteins are known to play an important role in chromatin remodeling and thereby in regulation of gene expression, causing various cellular responses to environmental influences (Liu et al., 2015). To date, published studies on histone modifications and arsenic toxicity have focused on acetylation, methylation, and phosphorylation. These modifications modulate chromatin structure and regulate gene expression (Kouzarides, 2007). Chromatin is structured within the cell nucleus in units called nucleosomes, in which DNA is packaged within the cell. The nucleosome core particle consists of stretches of DNA wrapped in left-handed super helical turns around a histone octamer consisting of two copies each of the core histones H2A, H2B, H3, and H4 (Kouzarides, 2007).

5.3. Histone methylation

Histone methylation is also a reversible process, which occurs in both lysine and arginine residues (Wysocka et al., 2006). In mammals, histone methylation is usually found on histone H3 and H4, although it also occurs on H2A or H2B. As^{III} treatment can lead to differential effects on the methylation of H3 lysine residues, including increased H3 lysine 9 dimethylation (H3K9me2) and H3 lysine 4 trimethylation (H3K4me3) and decreased H3 lysine 27 trimethylation (H3K27me3) (Zhou et al., 2008). Elevated H3K9me2, mediated by increased levels of histone methyltransferase G9a protein, correlates with transcriptional repression (Peterson and Laniel, 2004; Zhou et al., 2008); and elevated H3K9me2 was involved in the silencing of tumor suppressors in the cancer cell lines (Esteve et al., 2007). Arsenite induces global and gene specific changes in DNA methylation and alteration in global histone methylation levels, suggesting that epigenetic mechanisms contribute to arsenite-induced aberrant gene expression. However, data on the patterns of histone methylation induced by arsenic exposure are limited, and further studies are required to decipher the relationship between altered histone methylation and gene expression, as well as its effect on arsenic-induced carcinogenesis.

5.4. Histone acetylation

Histone acetylation is a dynamic and reversible event (Glozak and Seto, 2007), which stimulates the nucleotide excision repair pathway in vivo by increasing the chromatin accessibility (Escargueil et al., 2008). More recently, changes in histone H3 acetylation have been observed in As^{III} and MMA^{III} - induced malignant transformation of human urothelial cells in vitro. These modifications are arsenic specific, suggesting that arsenicals may participate in tumorigenesis by altering the epigenetic terrain of select genes (Jensen et al., 2008). Genome-wide analysis suggests that iAs exposure during embryonic development causes global hypo-acetylation at H3K9 (Jensen et al., 2008). Recently, study showed that the global level of H4K16 acetylation in human bladder epithelial cells was reduced in a dose- and time-dependent manner by both As^{III} and MMA^{III} treatment (Liu et al., 2015). A reduction in H4K16 acetylation caused by chronic arsenic exposure could contribute to bladder carcinogenesis in bladder epithelial cells. Moreover, knockdown of MYST1, the gene responsible for H4K16 acetylation, resulted in increased cytotoxicity from arsenical exposure in human bladder epithelial cells, suggesting that H4K16 acetylation may be important for resistance to arsenic-induced toxicity (Jo et al., 2009). These studies clearly support an association of iAs/MMA^{III} exposure and altered histone acetylation, but further work is needed to understand the underlying mechanisms and to clarify the effect of altered histone acetylation on arsenic-induced toxicity and carcinogenesis.

5.5. Histone phosphorylation

Besides, phosphorylation of core histone proteins may be deeply involved in arsenic-induced carcinogenicity (Ren et al., 2011). All four core histone proteins, H2A, H2B, H3, and H4 can be post-translationally modified by phosphorylation, and are targets of protein kinases (Peterson and Laniel, 2004). Cyclin-dependent kinases are believed to be responsible for H1 phosphorylation. Several kinases can phosphorylate H2A and H2B. Phosphorylation of H3 has been specifically implicated in cell cycle progression and regulation of gene expression (Houben et al., 2007). Similarly, phosphorylation of histone H4 (serine

1) increases during the cell cycle, which is believed to be regulated by casein kinase 2 (Barber et al., 2004). Only a few studies have demonstrated a connection between histone phosphorylation and arsenic-induced carcinogenicity. Studies have suggested that arsenic induced H3 phosphorylation might be responsible for the up-regulation of the oncogenes c-fos and c-jun (Li et al., 2003). Because arsenite exposure is known to activate JNK and p38/Mpk2 kinase by inhibition of the corresponding protein phosphatases, phosphorylation of histone H3 via the JNK/SAPK pathway might be a common mechanism of metal-induced histone modification. In addition, Ray et al. reported that iAs induces a coordinated regulation of Nrf2 and histone H3S10 phosphorylation, which activates the human heme oxygenase-1gene (HMOX1) (Ray et al., 2015). These studies suggest that H3 phosphorylation may also contribute to As-induced carcinogenesis.

5.6. MicroRNAs

Several studies have shown that differential miRNA expression can be a hallmark of cancer and miRNAs can function as potential oncogenes or tumor suppressor genes influencing tumor development, progression and response to therapy (Gonzalez et al., 2015; States, 2015). miRNAs constitute another epigenetic mechanism of gene regulation affecting development, growth, and the response to stress. miRNAs are single strand small non-coding RNAs that function as negative regulators of target mRNA expression at the post-transcriptional level, which participate in diverse biological regulatory events and are transcribed mainly from non-protein-coding regions of the genome (He and Hannon, 2004). Each miRNA is thought to target several hundred genes, and as many as 30% of mammalian genes are regulated by miRNA (Lewis et al., 2005). miRNAs can modify essential cellular functions such as proliferation, differentiation and programmed death (He et al., 2005). The exact mechanisms by which expression of target mRNA is repressed are still under investigation but may include the inhibition of protein synthesis, the degradation of target mRNAs, and the translocation of target mRNAs into cytoplasmic processing bodies (Suarez et al., 2007). miRNAs bind to the 3′-UTR (untranslated regions) of target mRNAs through base pairing, stimulating mRNA degradation or inhibiting protein translation (Hei and Filipic, 2004; Flora et al., 2007).

Several in vitro and human studies demonstrate that arsenic-induced alterations in miRNA gene expression. A recently study provide strong evidence that the differential expression of miRNAs and target genes at early stage of arsenite exposure may contribute to arsenic induced carcinogenesis (Al-Eryani et al., 2018). In prostate cancer, miR-150 is upregulated, and is additionally correlated with tumor recurrence and metastasis, as well as poor overall survival; and miR-150 could serve as a novel and reliable prognostic biomarker for prostate cancer patients (Dezhong et al., 2015). miR-21 is a key oncogene, which is highly overexpressed in a wide range of cancers. miR-21 plays an important role in the initiation and progression of cancer and is implicated in multiple malignancy-related processes such as cell proliferation, apoptosis, invasion, and metastasis. Knockdown of miR-21 can reduce proliferation and tumor growth in MCF- 7 cells, and reduce invasion and metastasis in MDAMB-231 cells (Pratheeshkumar et al., 2016). Upregulation of miR-21 can enhance the transformation potential of cell by targeting programmed cell-death 4 (PDCD4) (Luo et al., 2015). Gao founded that iAs-mediated autophagy was supported by miR-21-induced PTEN-ERK signaling, and iAs-induced angiogenesis occurred through a microRNA 425-5p-regulated CCM3 (Gao et al., 2016). Furthermore, miR-155, an oncogenic miRNA, has been found to be increased in many types of cancer (Xue et al., 2016). Chen C et al. demonstrated for the first time that inhibition of miR-155 by its specific inhibitor could remarkably attenuate the malignant phenotypes and promote apoptotic cell death in arsenite-transformed cells (Chen et al., 2017). Results from clinical trials showed that overexpressed miR-155 in the serum results in low survival rate and poor prognosis of patients with lung cancer (Xue et al., 2016). Moreover, inhibition of miR-155 also decreased the cell proliferation, and triggered the apoptotic cell death in lung adenocarcinoma cells (Lv et al., 2016). These findings indicate miR-155 may be served as the specific biomarker for diagnosis and prognostic prediction of lung cancer. ROS generation resulting from arsenic exposure is thought to play a large role in arsenic-induced carcinogenesis and toxicity (Flora et al., 2007; Suarez et al., 2007) and could potentially alter these miRNAs in a similar manner (Marsit et al., 2006). The induced changes in miRNA expression were not stable, suggesting that chronic exposure may be necessary to permanently alter expression of miRNAs (Marsit et al., 2006).

Further studies are necessary to clarify whether chronic exposure to arsenic can alter miRNA expression and what biological effects are related to the altered miRNA expression. All these epigenetic marks are associated with iAs-induced carcinogenesis, additional research is required to clarify the mechanisms driving each system. More studies comparing epigenetic alterations mediated by different arsenicals are crucial, considering that toxicities and potential to cause cancer of arsenicals vary considerably. Expanded research in this area will delineate the role of iAs exposure in the initiation and development of cancer.

6. Signal transduction pathways

Signal transduction pathways transmit extracellular signals, via an intracellular series of signaling molecules into gene. Cellular processes such as proliferation, differentiation, and apoptosis are directed and managed by these pathways or cascades. Arsenic can alter signal transduction, which leads to activation or inhibition of transcription factors, regulatory proteins which bind to DNA and regulates gene transcription (Huang et al., 2004; Kumagai and Sumi, 2007; Platanias, 2009).

NF-κB is an inducible transcription factor involved in diverse sides of cellular processes, NF-κB activation in cancers has been linked to tumor cell resistance to apoptosis and necrosis, increasing proliferation, angiogenesis, and metastasis (Chen et al., 2016). NF-κB is transiently activated by a variety of signals, including cytokines, chemokines, bacterial and viral products, and free radicals. Chen et al. recently found that arsenite caused the oxidative damage by activation of Nrf2 and NF-κB-mediated pathways in cultured 16 E6/E7 transformed normal human bronchial epithelial (16-HBE) cells (Chen et al., 2017). A recently study showed that the transformation of HBE cells induced by chronic exposure to sodium arsenite is mediated by decreased Nrf2 level and its downstream NQO1 and HO-1 protein, which subsequently promote the malignant proliferation (Gu et al., 2016).

Epidermal growth factor (EGF) binds to EGF receptor (EGFR) and ultimately activates mitogen-activated protein kinase (MAPK) pathways, which plays an important role in cellular stress response, inflammation, and growth. Arsenic can stimulate c-Src activity, which can then activate EGFR by physical interaction resulting in two unique tyrosine phosphorylation events, leading to ligand-independent EGFR phosphorylation and constitutive activation (Simeonova and Luster, 2002). Arsenic can also induce activation of components of the EGFR pathway in lung epithelial cells, such as Ras, Raf, MEK and ERK through ROS (Zhang et al., 2007a; b; Miao et al., 2015). EGFR, an upstream effector of MAPK signaling, is normally inhibited by protein tyrosine phosphatases (PTPs) such as MAPK phosphatase 1. MAPK pathways include the extracellular signal-regulated kinase1/2 (ERK1/2), p38 MAPK, and stress-activated protein kinase/Jun N-terminal protein kinase (SAPK/JNK) pathways. Erk1/2 is involved in growth and differentiation while p38 MAPK and SAPK/JNK are important in stress-induced inflammation and mitochondrial-dependent apoptosis. Our previous studies found that arsenic activated p-ERK, p-P38 and p-JNK in SV-HUC-1 cells (Wang et al., 2013a; b). Arsenic-exposed hepatocellular carcinoma cells display overexpression of EGFR (Sung et al., 2012), while in leukemia cell lines, iAs^{III} is capable of activating Rac1

GTPases resulting in downstream engagement of the JNK pathway and increasing cell survival and proliferation (Herbert and Snow, 2012).

Furthermore, acute exposure to arsenite can stimulate the PI3K/AKT phosphorylation cascade, leading to cellular transformation characterized by increased proliferation and anchorage-independent growth (Liu et al., 2012). In human bronchial epithelial cells (HBECs), iAs^{III} can stimulate AKT and the consequent release of vascular endothelial growth factor (VEGF), inducing cell migration through different mechanisms (Wang et al., 2012). During malignant transformation of stem cells, arsenite has also been shown to suppress expression of PTEN, an important inhibitor of PI3K/AKT signaling (Stueckle et al., 2012). Evidence also suggests that this metalloid works through AKT to promote epithelial to mesenchymal transition (EMT), invasion, and migration of arsenic-transformed bronchial epithelial cells (Wang et al., 2012).

Endocrine disruptors (EDs) can mimic or antagonize the effects of estrogens in target tissue (Casals-Casas and Desvergne, 2011). Evidence has accumulated that estrogen receptors α and β (ERα and ERβ) are expressed in lung tumors, acting both in membrane-initiated and nuclear signaling (Siegfried and Stabile, 2014). Arsenic are EDs that activate genomic ERα, through interaction with the zinc fingers of the DNA binding domain and/or activation of protein kinase C and/or direct interaction with the ligand binding domain (Fechner et al., 2011). Several studies demonstrate that environmentally relevant concentrations of $NaAsO_2$ induces rapid activation of MAPK and cellular proliferation in human lung adenocarcinoma cells. Further, this activation is mediated through ER, Src, EGFR, and GPER, and arsenite is demonstrated as EDs in lung adenocarcinoma (Stabile et al., 2005; Marquez-Garban et al., 2007; Pietras and Marquez-Garban, 2007). Moreover, intense expression of ERα is observed in liver tumors and tumor-surrounding normal tissues after gestational arsenic exposure in mice (Waalkes et al., 2004, 2006). ERα overexpression also occurs in uterine tumors, urinary bladder carcinoma (Waalkes et al., 2006). Overexpression of ERα and ER-linked cyclin D1 was also evident in liver biopsy samples of arsenicosis patients in Guizhou, China (Marquez-Garban et al., 2007). Although aberrant ER signaling pathways may be important in carcinogenesis induced by arsenic, it may not apply to all targets of arsenic carcinogenesis.

7. Immunosuppression

The multiple effects of As on immune system tend to decrease the immune surveillance system and increase the rate of infection, autoimmune disease, cancer and other immune mediated problems (Haque et al., 2017). Recent studies found that arsenic disrupts macrophage function and exacerbate lipopolysaccharide-induced inflammation that is mediated by macrophages and monocytes (Srivastava et al., 2013). Inflammation is a well-known hallmark event for cancer progression, which plays a key role in protecting the damaged tissues after injury, but also leads to several diseases, including various cancers (Rao et al., 2017). Increased secretion of inflammatory biomarkers like IL-8, TNF-α, and TGF-β is related with iAs exposure in urothelial cells (Liu et al., 2014). Chronic low-level iAs exposure (11–50 μg/L) evoke systemic inflammation by upregulating pro-inflammatory mediators like TNF-α, IL-6, IL-8, IL-12, and CRP (Prasad and Sinha, 2017). Dutta has reported induction of various pro inflammatory and inflammatory markers in chronic low level iAs exposed population (Dutta et al., 2015). These results show that prolonged arsenic exposure can impair immune responses against inflammation. However, there are few in-depth and systematic studies to determine whether arsenic causes cancer through inflammatory diseases. It is not clear whether arsenic changes the signal of inflammation first, and then causes chronic disease. Extensive laboratory studies (both in vitro and in vivo) are warranted to elucidate the direct effects of arsenic on inflammation and cancer (Dangleben et al., 2013).

Although there is evidence that inorganic arsenic can suppress the immune system to some extent, the tumors related to arsenic, particularly skin, lung, and bladder, are not increased in individuals who are immunosuppressed (National Research Council, 1999). Essentially, immunosuppression is only related to virally associated malignancies such as lymphoma, Kaposi's sarcoma, various squamous cell carcinomas of mucous membranes, such as the cervix and oral cavity, and to a limited extent, liver cancer. (Cohen et al., 1991, 2004).

8. Cytotoxicity and regeneration

The mechanisms of cancer induced by arsenicals appear to involve cytotoxicity with consequent regeneration (Cohen et al., 2006, 2013; Dodmane et al., 2013). Most commonly hyperplasia involves not only an increase in the cell number but an increase in the replication rate (Cohen et al., 2016). The evidence is strong and accumulating that arsenic induced carcinogenesis of urinary bladder, skin and lung involves cytotoxicity and regeneration (Cohen et al., 2013; Dodmane et al., 2013; Efremenko et al., 2015). Trivalent arsenicals (iAs^{III}, MMA^{III}, and DMA^{III}) are highly toxic to cells at concentrations ranging from 0.1 μmol/L to less than 10 μmol/L. Concentrations less than 0.1 μmol/L are adaptive, and concentrations ≥10 μmol/L are lethal to all cell types (Cohen et al., 2002, 2013; Gentry et al., 2010). High doses of DMA^{V} orally administered for 10 weeks to rats increase urothelial cell proliferation and cytotoxic changes, including cellular necrosis, suggesting that administration of DMA^{V} results in cytotoxicity with necrosis, followed by regenerative hyperplasia of the bladder epithelium. Cohen et al. (2006) suggested that the toxic effects observed in the rat urinary bladder induced by DMA^{V} may be caused by DMA^{III} formation in vivo.

Cytotoxicity has also been proposed as a nonlinear mode of action for the bladder carcinogenicity of arsenic (Wei et al., 2005; Cohen et al., 2006). Epidemiologic studies also support this conclusion. For the cancer endpoint, it is not cancer that is induced by the arsenic but a variety of toxicities, such as arseniasis skin changes, bronchitis, or urothelial toxicity, which lead to regenerative proliferation and ultimately an indirect induction of cancer.

9. Conclusion

Inorganic arsenic is a human carcinogen targeting mainly urinary bladder, lung and skin. Genetic changes, inhibition of DNA repair, changes to the epigenome and signal transduction are involved in arsenic carcinogenesis. The metabolism of arsenic may also play a role in this process. The biotransformation of iAs^{V} into iAs^{III} and its methylated conjugates play a crucial role in arsenic carcinogenicity at both genetic and epigenetic levels. Compared with iAs, MMA^{III} and DMA^{III} exert several unique biological effects and are more cytotoxic and genotoxic. The methylation of iAs is considered a mechanism of activation of its toxicity and carcinogenicity. In addition, the difference in susceptibility to arsenic is related to arsenic carcinogenesis. The individual susceptibility may result from differences in metabolism genes, DNA repair, cell transport, immune response, antioxidant defenses and cell cycle control. Evidence supporting arsenic carcinogenesis comes from in vitro investigations on human cells and epidemiological studies. Further studies are still necessary for arsenic carcinogenesis.

Author contributions

Qing Zhou conceived and drafted this manuscript. Shuhua Xi revised and approved the final manuscript.

Conflicts of interest

The authors declare no conflict of interest.

Acknowledgments

This work was supported by the gs1:National Natural Science Foundation of China (81673207 and 81373023).

Transparency document

Transparency document related to this article can be found online at https://doi.org/10.1016/j.yrtph.2018.09.010.

References

Al-Eryani, L., Waigel, S., Tyagi, A., Peremarti, J., Jenkins, S.F., Damodaran, C., States, J.C., 2018. Differentially expressed mRNA targets of differentially expressed miRNAs predict changes in the TP53 Axis and carcinogenesis related pathways in human keratinocytes chronically exposed to arsenic. Toxicol. Sci. 162 (2), 645–654.

Aylward, L.L., Ramasamy, S., Hays, S.M., Schoeny, R., Kirman, C.R., 2014. Evaluation of urinary speciated arsenic in NHANES: issues in interpretation in the context of potential inorganic arsenic exposure. Regul. Toxicol. Pharmacol. 69 (1), 49–54.

Baastrup, R., Sorensen, M., Balstrom, T., Frederiksen, K., Larsen, C.L., Tjonneland, A., Overvad, K., Raaschou-Nielsen, O., 2008. Arsenic in drinking-water and risk for cancer in Denmark. Environ. Health Perspect. 116 (2), 231–237.

Banerjee, M., Sarma, N., Biswas, R., Roy, J., Mukherjee, A., Giri, A.K., 2008. DNA repair deficiency leads to susceptibility to develop arsenic-induced premalignant skin lesions. Int. J. Canc. 123 (2), 283–287.

Barber, C.M., Turner, F.B., Wang, Y., Hagstrom, K., Taverna, S.D., Mollah, S., Ueberheide, B., Meyer, B.J., Hunt, D.F., Cheung, P., Allis, C.D., 2004. The enhancement of histone H4 and H2A serine 1 phosphorylation during mitosis and S-phase is evolutionarily conserved. Chromosoma 112 (7), 360–371.

Basu, A., Mahata, J., Roy, A.K., Sarkar, J.N., Poddar, G., Nandy, A.K., Sarkar, P.K., Dutta, P.K., Banerjee, A., Das, M., Ray, K., Roychaudhury, S., Natarajan, A.T., Nilsson, R., Giri, A.K., 2002. Enhanced frequency of micronuclei in individuals exposed to arsenic through drinking water in West Bengal, India. Mutat. Res. 516 (1–2), 29–40.

Benbrahim-Tallaa, L., Waalkes, M.P., 2008. Inorganic arsenic and human prostate cancer. Environ. Health Perspect. 116 (2), 158–164.

Bestor, T.H., 2000. The DNA methyltransferases of mammals. Hum. Mol. Genet. 9 (16), 2395–2402.

Bjorklund, G., Aaseth, J., Chirumbolo, S., Urbina, M.A., Uddin, R., 2017. Effects of arsenic toxicity beyond epigenetic modifications. Environ. Geochem. Health 40 (3), 955–965.

Bulka, C.M., Jones, R.M., Turyk, M.E., Stayner, L.T., Argos, M., 2016. Arsenic in drinking water and prostate cancer in Illinois counties: an ecologic study. Environ. Res. 148, 450–456.

Bull, C.F., Mayrhofer, G., Zeegers, D., Mun, G.L., Hande, M.P., Fenech, M.F., 2012. Folate deficiency is associated with the formation of complex nuclear anomalies in the cytokinesis-block micronucleus cytome assay. Environ. Mol. Mutagen. 53 (4), 311–323.

Casals-Casas, C., Desvergne, B., 2011. Endocrine disruptors: from endocrine to metabolic disruption. Annu. Rev. Physiol. 73, 135–162.

Chai, C.Y., Huang, Y.C., Hung, W.C., Kang, W.Y., Chen, W.T., 2007. Arsenic salts induced autophagic cell death and hypermethylation of DAPK promoter in SV-40 immortalized human uroepithelial cells. Toxicol. Lett. 173 (1), 48–56.

Chanda, S., Dasgupta, U.B., Guhamazumder, D., Gupta, M., Chaudhuri, U., Lahiri, S., Das, S., Ghosh, N., Chatterjee, D., 2006. DNA hypermethylation of promoter of gene p53 and p16 in arsenic-exposed people with and without malignancy. Toxicol. Sci. 89 (2), 431–437.

Chen, C., Jiang, X., Gu, S., Zhang, Z., 2017. MicroRNA-155 regulates arsenite-induced malignant transformation by targeting Nrf2-mediated oxidative damage in human bronchial epithelial cells. Toxicol. Lett. 278, 38–47.

Chen, C.J., Chuang, Y.C., Lin, T.M., Wu, H.Y., 1985. Malignant neoplasms among residents of a Blackfoot disease-endemic area in Taiwan: high-arsenic artesian well water and cancers. Canc. Res. 45 (11 Pt 2), 5895–5899.

Chen, C.L., Chiou, H.Y., Hsu, L.I., Hsueh, Y.M., Wu, M.M., Chen, C.J., 2010a. Ingested arsenic, characteristics of well water consumption and risk of different histological types of lung cancer in northeastern Taiwan. Environ. Res. 110 (5), 455–462.

Chen, C.L., Chiou, H.Y., Hsu, L.I., Hsueh, Y.M., Wu, M.M., Wang, Y.H., Chen, C.J., 2010b. Arsenic in drinking water and risk of urinary tract cancer: a follow-up study from northeastern Taiwan. Canc. Epidemiol. Biomarkers Prev. 19 (1), 101–110.

Chen, C.L., Hsu, L.I., Chiou, H.Y., Hsueh, Y.M., Chen, S.Y., Wu, M.M., Chen, C.J., Blackfoot Disease Study, G., 2004a. Ingested arsenic, cigarette smoking, and lung cancer risk: a follow-up study in arseniasis-endemic areas in Taiwan. J. Am. Med. Assoc. 292 (24), 2984–2990.

Chen, G., Mao, J., Zhao, J., Zhang, Y., Li, T., Wang, C., Xu, L., Hu, Q., Wang, X., Jiang, S., Nie, X., Wu, Q., 2016. Arsenic trioxide mediates HAPI microglia inflammatory response and the secretion of inflammatory cytokine IL-6 via Akt/NF-kappaB signaling pathway. Regul. Toxicol. Pharmacol. 81, 480–488.

Chen, H., Li, S., Liu, J., Diwan, B.A., Barrett, J.C., Waalkes, M.P., 2004b. Chronic inorganic arsenic exposure induces hepatic global and individual gene hypomethylation: implications for arsenic hepatocarcinogenesis. Carcinogenesis 25 (9), 1779–1786.

Chen, W.T., Hung, W.C., Kang, W.Y., Huang, Y.C., Chai, C.Y., 2007. Urothelial carcinomas arising in arsenic-contaminated areas are associated with hypermethylation of the gene promoter of the death-associated protein kinase. Histopathology 51 (6), 785–792.

Chen, Y.C., Guo, Y.L., Su, H.J., Hsueh, Y.M., Smith, T.J., Ryan, L.M., Lee, M.S., Chao, S.C., Lee, J.Y., Christiani, D.C., 2003. Arsenic methylation and skin cancer risk in southwestern Taiwan. J. Occup. Environ. Med. 45 (3), 241–248.

Cheng, T.F., Choudhuri, S., Muldoon-Jacobs, K., 2012. Epigenetic targets of some toxicologically relevant metals: a review of the literature. J. Appl. Toxicol. 32 (9), 643–653.

Chiou, H.Y., Chiou, S.T., Hsu, Y.H., Chou, Y.L., Tseng, C.H., Wei, M.L., Chen, C.J., 2001. Incidence of transitional cell carcinoma and arsenic in drinking water: a follow-up study of 8,102 residents in an arseniasis-endemic area in northeastern Taiwan. Am. J. Epidemiol. 153 (5), 411–418.

Chowdhury, U.K., Zakharyan, R.A., Hernandez, A., Avram, M.D., Kopplin, M.J., Aposhian, H.V., 2006. Glutathione-S-transferase-omega [MMA(V) reductase] knockout mice: enzyme and arsenic species concentrations in tissues after arsenate administration. Toxicol. Appl. Pharmacol. 216 (3), 446–457.

Cohen, S.M., Arnold, L.L., Beck, B.D., Lewis, A.S., Eldan, M., 2013. Evaluation of the carcinogenicity of inorganic arsenic. Crit. Rev. Toxicol. 43 (9), 711–752.

Cohen, S.M., Arnold, L.L., Eldan, M., Lewis, A.S., Beck, B.D., 2006. Methylated arsenicals: the implications of metabolism and carcinogenicity studies in rodents to human risk assessment. Crit. Rev. Toxicol. 36 (2), 99–133.

Cohen, S.M., Arnold, L.L., Uzvolgyi, E., Cano, M., St John, M., Yamamoto, S., Lu, X., Le, X.C., 2002. Possible role of dimethylarsinous acid in dimethylarsinic acid-induced urothelial toxicity and regeneration in the rat. Chem. Res. Toxicol. 15 (9), 1150–1157.

Cohen, S.M., Chowdhury, A., Arnold, L.L., 2016. Inorganic arsenic: a non-genotoxic carcinogen. J. Environ. Sci. (China) 49, 28–37.

Cohen, S.M., Klaunig, J., Meek, M.E., Hill, R.N., Pastoor, T., Lehman-McKeeman, L., Bucher, J., Longfellow, D.G., Seed, J., Dellarco, V., Fenner-Crisp, P., Patton, D., 2004. Evaluating the human relevance of chemically induced animal tumors. Toxicol. Sci. 78 (2), 181–186.

Cohen, S.M., Purtilo, D.T., Ellwein, L.B., 1991. Ideas in pathology. Pivotal role of increased cell proliferation in human carcinogenesis. Mod. Pathol. 4 (3), 371–382.

Dangleben, N.L., Skibola, C.F., Smith, M.T., 2013. Arsenic immunotoxicity: a review. Environ. Health 12 (1), 73.

Dezhong, L., Xiaoyi, Z., Xianlian, L., Hongyan, Z., Guohua, Z., Bo, S., Shenglei, Z., Lian, Z., 2015. miR-150 is a factor of survival in prostate cancer patients. J BUON 20 (1), 173–179.

Dodmane, P.R., Arnold, L.L., Kakiuchi-Kiyota, S., Qiu, F., Liu, X., Rennard, S.I., Cohen, S.M., 2013. Cytotoxicity and gene expression changes induced by inorganic and organic trivalent arsenicals in human cells. Toxicology 312, 18–29.

Dopp, E., von Recklinghausen, U., Diaz-Bone, R., Hirner, A.V., Rettenmeier, A.W., 2010. Cellular uptake, subcellular distribution and toxicity of arsenic compounds in methylating and non-methylating cells. Environ. Res. 110 (5), 435–442.

Drobna, Z., Waters, S.B., Devesa, V., Harmon, A.W., Thomas, D.J., Styblo, M., 2005. Metabolism and toxicity of arsenic in human urothelial cells expressing rat arsenic (+3 oxidation state)-methyltransferase. Toxicol. Appl. Pharmacol. 207 (2), 147–159.

Dulout, F.N., Grillo, C.A., Seoane, A.I., Maderna, C.R., Nilsson, R., Vahter, M., Darroudi, F., Natarajan, A.T., 1996. Chromosomal aberrations in peripheral blood lymphocytes from native Andean women and children from northwestern Argentina exposed to arsenic in drinking water. Mutat. Res. 370 (3–4), 151–158.

Dutta, K., Prasad, P., Sinha, D., 2015. Chronic low level arsenic exposure evokes inflammatory responses and DNA damage. Int. J. Hyg Environ. Health 218 (6), 564–574.

Efremenko, A.Y., Seagrave, J., Clewell, H.J., Van Landingham, C., Gentry, P.R., Yager, J.W., 2015. Evaluation of gene expression changes in human primary lung epithelial cells following 24-hr exposures to inorganic arsenic and its methylated metabolites and to arsenic trioxide. Environ. Mol. Mutagen. 56 (5), 477–490.

Escargueil, A.E., Soares, D.G., Salvador, M., Larsen, A.K., Henriques, J.A., 2008. What histone code for DNA repair? Mutat. Res. 658 (3), 259–270.

Esteve, P.O., Chin, H.G., Pradhan, S., 2007. Molecular mechanisms of transactivation and doxorubicin-mediated repression of survivin gene in cancer cells. J. Biol. Chem. 282 (4), 2615–2625.

Fechner, P., Damdimopoulou, P., Gauglitz, G., 2011. Biosensors paving the way to understanding the interaction between cadmium and the estrogen receptor alpha. PLoS One 6 (8), e23048.

Ferdosi, H., Dissen, E.K., Afari-Dwamena, N.A., Li, J., Chen, R., Feinleib, M., Lamm, S.H., 2016. Arsenic in drinking water and lung cancer mortality in the United States: an analysis based on US counties and 30 Years of observation (1950-1979). J Environ Public Health 2016, 1602929.

Ferreccio, C., Gonzalez, C., Milosavjlevic, V., Marshall, G., Sancha, A.M., Smith, A.H., 2000. Lung cancer and arsenic concentrations in drinking water in Chile. Epidemiology 11 (6), 673–679.

Ferreccio, C., Smith, A.H., Steinmaus, C., 2013. Case-control study of arsenic in drinking water and kidney cancer in uniquely exposed Northern Chile. Am. J. Epidemiol. 178 (5), 813–818.

Flora, S.J., Bhadauria, S., Kannan, G.M., Singh, N., 2007. Arsenic induced oxidative stress and the role of antioxidant supplementation during chelation: a review. J. Environ. Biol. 28 (2 Suppl. l), 333–347.

Gamble, M.V., Liu, X., Ahsan, H., Pilsner, J.R., Ilievski, V., Slavkovich, V., Parvez, F., Chen, Y., Levy, D., Factor-Litvak, P., Graziano, J.H., 2006. Folate and arsenic metabolism: a double-blind, placebo-controlled folic acid-supplementation trial in Bangladesh. Am. J. Clin. Nutr. 84 (5), 1093–1101.

Gamble, M.V., Liu, X., Ahsan, H., Pilsner, R., Ilievski, V., Slavkovich, V., Parvez, F., Levy, D., Factor-Litvak, P., Graziano, J.H., 2005. Folate, homocysteine, and arsenic metabolism in arsenic-exposed individuals in Bangladesh. Environ. Health Perspect. 113 (12), 1683–1688.

Gamble, M.V., Liu, X., Slavkovich, V., Pilsner, J.R., Ilievski, V., Factor-Litvak, P., Levy, D.,

Alam, S., Islam, M., Parvez, F., Ahsan, H., Graziano, J.H., 2007. Folic acid supplementation lowers blood arsenic. Am. J. Clin. Nutr. 86 (4), 1202–1209.
Gao, Y., Yin, Y., Xing, X., Zhao, Z., Lu, Y., Sun, Y., Zhuang, Z., Wang, M., Ji, W., He, Y., 2016. Arsenic-induced anti-angiogenesis via miR-425-5p-regulated CCM3. Toxicol. Lett. 254, 22–31.
Garcia-Esquinas, E., Pollan, M., Umans, J.G., Francesconi, K.A., Goessler, W., Guallar, E., Howard, B., Farley, J., Best, L.G., Navas-Acien, A., 2013. Arsenic exposure and cancer mortality in a US-based prospective cohort: the strong heart study. Canc. Epidemiol. Biomarkers Prev. 22 (11), 1944–1953.
Gentry, P.R., McDonald, T.B., Sullivan, D.E., Shipp, A.M., Yager, J.W., Clewell 3rd, H.J., 2010. Analysis of genomic dose-response information on arsenic to inform key events in a mode of action for carcinogenicity. Environ. Mol. Mutagen. 51 (1), 1–14.
Glozak, M.A., Seto, E., 2007. Histone deacetylases and cancer. Oncogene 26 (37), 5420–5432.
Gonsebatt, M.E., Vega, L., Salazar, A.M., Montero, R., Guzman, P., Blas, J., Del Razo, L.M., Garcia-Vargas, G., Albores, A., Cebrian, M.E., Kelsh, M., Ostrosky-Wegman, P., 1997. Cytogenetic effects in human exposure to arsenic. Mutat. Res. 386 (3), 219–228.
Gonzalez, H., Lema, C., Kirken, R.A., Maldonado, R.A., Varela-Ramirez, A., Aguilera, R.J., 2015. Arsenic-exposed keratinocytes exhibit differential microRNAs expression profile; potential implication of miR-21, miR-200a and miR-141 in melanoma pathway. Clin Cancer Drugs 2 (2), 138–147.
Gu, S., Chen, C., Jiang, X., Zhang, Z., 2016. Role of nuclear factor E2 related factor 2 signaling pathway in malignant transformation induced by sodium arsenite. Wei Sheng Yan Jiu 45 (3), 356–361.
Guo, H.R., 2004. Arsenic level in drinking water and mortality of lung cancer (Taiwan). Cancer Causes Control 15 (2), 171–177.
Haque, R., Chaudhary, A., Sadaf, N., 2017. Immunomodulatory role of arsenic in regulatory T cells. Endocr. Metab. Immune Disord. - Drug Targets 17 (3), 176–181.
Haque, R., Mazumder, D.N., Samanta, S., Ghosh, N., Kalman, D., Smith, M.M., Mitra, S., Santra, A., Lahiri, S., Das, S., De, B.K., Smith, A.H., 2003. Arsenic in drinking water and skin lesions: dose-response data from West Bengal, India. Epidemiology 14 (2), 174–182.
He, L., Hannon, G.J., 2004. MicroRNAs: small RNAs with a big role in gene regulation. Nat. Rev. Genet. 5 (7), 522–531.
He, L., Thomson, J.M., Hemann, M.T., Hernando-Monge, E., Mu, D., Goodson, S., Powers, S., Cordon-Cardo, C., Lowe, S.W., Hannon, G.J., Hammond, S.M., 2005. A microRNA polycistron as a potential human oncogene. Nature 435 (7043), 828–833.
Hei, T.K., Filipic, M., 2004. Role of oxidative damage in the genotoxicity of arsenic. Free Radic. Biol. Med. 37 (5), 574–581.
Herbert, K.J., Snow, E.T., 2012. Modulation of arsenic-induced epidermal growth factor receptor pathway signalling by resveratrol. Chem. Biol. Interact. 198 (1–3), 38–48.
Herceg, Z., 2007. Epigenetics and cancer: towards an evaluation of the impact of environmental and dietary factors. Mutagenesis 22 (2), 91–103.
Hossain, M.B., Vahter, M., Concha, G., Broberg, K., 2012. Environmental arsenic exposure and DNA methylation of the tumor suppressor gene p16 and the DNA repair gene MLH1: effect of arsenic metabolism and genotype. Metallomics 4 (11), 1167–1175.
Houben, A., Demidov, D., Caperta, A.D., Karimi, R., Agueci, F., Vlasenko, L., 2007. Phosphorylation of histone H3 in plants–a dynamic affair. Biochim. Biophys. Acta 1769 (5–6), 308–315.
Huang, C., Ke, Q., Costa, M., Sh, X., 2004. Molecular mechanisms of arsenic carcinogenesis. Mol. Cell. Biochem. 255 (1–2), 57–66.
Hubaux, R., Becker-Santos, D.D., Enfield, K.S., Rowbotham, D., Lam, S., Lam, W.L., Martinez, V.D., 2013. Molecular features in arsenic-induced lung tumors. Mol. Canc. 12, 20.
Hughes, M.F., Beck, B.D., Chen, Y., Lewis, A.S., Thomas, D.J., 2011. Arsenic exposure and toxicology: a historical perspective. Toxicol. Sci. 123 (2), 305–332.
Humans, I. W. G. o. t. E. o. C. R. t., 2004a. Betel-quid and areca-nut chewing and some areca-nut derived nitrosamines. IARC Monogr. Eval. Carcinog. Risks Hum. 85, 1–334.
Humans, I. W. G. o. t. E. o. C. R. t., 2004b. Some drinking-water disinfectants and contaminants, including arsenic. Monographs on chloramine, chloral and chloral hydrate, dichloroacetic acid, trichloroacetic acid and 3-chloro-4-(dichloromethyl)-5-hydroxy-2(5H)-furanone. IARC Monogr. Eval. Carcinog. Risks Hum. 84, 269–477.
Humans, I. W. G. o. t. E. o. C. R. t., 2012. Arsenic, metals, fibres, and dusts. IARC Monogr. Eval. Carcinog. Risks Hum. 100 (Pt C), 11–465.
Jensen, T.J., Novak, P., Eblin, K.E., Gandolfi, A.J., Futscher, B.W., 2008. Epigenetic remodeling during arsenical-induced malignant transformation. Carcinogenesis 29 (8), 1500–1508.
International Agency for Research on Cancer, 2004. Some drinkingwater disinfectants and contaminants, including arsenic. IARC Monogr. Eval. Carcinog. Risks Hum. 84, 39–229.
International Agency for Research on Cancer, 2012. Arsenic, metals, fibres, and dusts. IARC Monogr. Eval. Carcinog. Risks Hum. 100, 41–93.
Jo, W.J., Ren, X., Chu, F., Aleshin, M., Wintz, H., Burlingame, A., Smith, M.T., Vulpe, C.D., Zhang, L., 2009. Acetylated H4K16 by MYST1 protects UROtsa cells from arsenic toxicity and is decreased following chronic arsenic exposure. Toxicol. Appl. Pharmacol. 241 (3), 294–302.
Kelsey, K.T., Hirao, T., Hirao, S., Devi-Ashok, T., Nelson, H.H., Andrew, A., Colt, J., Baris, D., Morris, J.S., Schned, A., Karagas, M., 2005. TP53 alterations and patterns of carcinogen exposure in a U.S. population-based study of bladder cancer. Int. J. Canc. 117 (3), 370–375.
Kesari, V.P., Kumar, A., Khan, P.K., 2012. Genotoxic potential of arsenic at its reference dose. Ecotoxicol. Environ. Saf. 80, 126–131.
Khairul, I., Wang, Q.Q., Jiang, Y.H., Wang, C., Naranmandura, H., 2017. Metabolism, toxicity and anticancer activities of arsenic compounds. Oncotarget 8 (14), 23905–23926.
Kitchin, K.T., Wallace, K., 2008. Evidence against the nuclear in situ binding of arsenicals–oxidative stress theory of arsenic carcinogenesis. Toxicol. Appl. Pharmacol. 232 (2), 252–257.
Klein, C.B., Leszczynska, J., Hickey, C., Rossman, T.G., 2007. Further evidence against a direct genotoxic mode of action for arsenic-induced cancer. Toxicol. Appl. Pharmacol. 222 (3), 289–297.
Kligerman, A.D., Doerr, C.L., Tennant, A.H., Harrington-Brock, K., Allen, J.W., Winkfield, E., Poorman-Allen, P., Kundu, B., Funasaka, K., Roop, B.C., Mass, M.J., DeMarini, D.M., 2003. Methylated trivalent arsenicals as candidate ultimate genotoxic forms of arsenic: induction of chromosomal mutations but not gene mutations. Environ. Mol. Mutagen. 42 (3), 192–205.
Kouzarides, T., 2007. Chromatin modifications and their function. Cell (4), 693–705.
Kumagai, Y., Sumi, D., 2007. Arsenic: signal transduction, transcription factor, and biotransformation involved in cellular response and toxicity. Annu. Rev. Pharmacol. Toxicol. 47, 243–262.
Lamm, S.H., Engel, A., Kruse, M.B., Feinleib, M., Byrd, D.M., Lai, S., Wilson, R., 2004. Arsenic in drinking water and bladder cancer mortality in the United States: an analysis based on 133 U.S. counties and 30 years of observation. J. Occup. Environ. Med. 46 (3), 298–306.
Lamm, S.H., Ferdosi, H., Dissen, E.K., Li, J., Ahn, J., 2015. A systematic review and meta-regression analysis of lung cancer risk and inorganic arsenic in drinking water. Int. J. Environ. Res. Publ. Health 12 (12), 15498–15515.
Leonardi, G., Vahter, M., Clemens, F., Goessler, W., Gurzau, E., Hemminki, K., Hough, R., Koppova, K., Kumar, R., Rudnai, P., Surdu, S., Fletcher, T., 2012. Inorganic arsenic and basal cell carcinoma in areas of Hungary, Romania, and Slovakia: a case-control study. Environ. Health Perspect. 120 (5), 721–726.
Lerda, D., 1994. Sister-chromatid exchange (SCE) among individuals chronically exposed to arsenic in drinking water. Mutat. Res. 312 (2), 111–120.
Lewis, B.P., Burge, C.B., Bartel, D.P., 2005. Conserved seed pairing, often flanked by adenosines, indicates that thousands of human genes are microRNA targets. Cell 120 (1), 15–20.
Li, J., Gorospe, M., Barnes, J., Liu, Y., 2003. Tumor promoter arsenite stimulates histone H3 phosphoacetylation of proto-oncogenes c-fos and c-jun chromatin in human diploid fibroblasts. J. Biol. Chem. 278 (15), 13183–13191.
Liaw, J., Marshall, G., Yuan, Y., Ferreccio, C., Steinmaus, C., Smith, A.H., 2008. Increased childhood liver cancer mortality and arsenic in drinking water in northern Chile. Canc. Epidemiol. Biomarkers Prev. 17 (8), 1982–1987.
Lindberg, H.K., Wang, X., Jarventaus, H., Falck, G.C., Norppa, H., Fenech, M., 2007. Origin of nuclear buds and micronuclei in normal and folate-deprived human lymphocytes. Mutat. Res. 617 (1–2), 33–45.
Liu, D., Wu, D., Zhao, L., Yang, Y., Ding, J., Dong, L., Hu, L., Wang, F., Zhao, X., Cai, Y., Jin, J., 2015. Arsenic trioxide reduces global histone H4 acetylation at lysine 16 through direct binding to histone acetyltransferase hMOF in human cells. PLoS One 10 (10), e0141014.
Liu, J., Chen, B., Lu, Y., Guan, Y., Chen, F., 2012. JNK-dependent Stat3 phosphorylation contributes to Akt activation in response to arsenic exposure. Toxicol. Sci. 129 (2), 363–371.
Liu, J., Waalkes, M.P., 2008. Liver is a target of arsenic carcinogenesis. Toxicol. Sci. 105 (1), 24–32.
Liu, S., Sun, Q., Wang, F., Zhang, L., Song, Y., Xi, S., Sun, G., 2014. Arsenic induced overexpression of inflammatory cytokines based on the human urothelial cell model in vitro and urinary secretion of individuals chronically exposed to arsenic. Chem. Res. Toxicol. 27 (11), 1934–1942.
Loenen, W.A., 2006. S-adenosylmethionine: jack of all trades and master of everything? Biochem. Soc. Trans. 34 (Pt 2), 330–333.
Lu, G., Xu, H., Chang, Wu, Z., Yao, X., Zhang, S., Li, Z., Bai, J., Cai, Q., Zhang, W., 2014. Arsenic exposure is associated with DNA hypermethylation of the tumor suppressor gene p16. J. Occup. Med. Toxicol. 9 (1), 42.
Luo, F., Ji, J., Liu, Y., Xu, Y., Zheng, G., Jing, J., Wang, B., Xu, W., Shi, L., Lu, X., Liu, Q., 2015. MicroRNA-21, up-regulated by arsenite, directs the epithelial-mesenchymal transition and enhances the invasive potential of transformed human bronchial epithelial cells by targeting PDCD4. Toxicol. Lett. 232 (1), 301–309.
Lv, L., An, X., Li, H., Ma, L., 2016. Effect of miR-155 knockdown on the reversal of doxorubicin resistance in human lung cancer A549/dox cells. Oncol Lett 11 (2), 1161–1166.
Ma, L., Li, J., Zhan, Z., Chen, L., Li, D., Bai, Q., Gao, C., Li, J., Zeng, X., He, Z., Wang, S., Xiao, Y., Chen, W., Zhang, A., 2016. Specific histone modification responds to arsenic-induced oxidative stress. Toxicol. Appl. Pharmacol. 302, 52–61.
Mahata, J., Basu, A., Ghoshal, S., Sarkar, J.N., Roy, A.K., Poddar, G., Nandy, A.K., Banerjee, A., Ray, K., Natarajan, A.T., Nilsson, R., Giri, A.K., 2003. Chromosomal aberrations and sister chromatid exchanges in individuals exposed to arsenic through drinking water in West Bengal, India. Mutat. Res. 534 (1–2), 133–143.
Maki-Paakkanen, J., Kurttio, P., Paldy, A., Pekkanen, J., 1998. Association between the clastogenic effect in peripheral lymphocytes and human exposure to arsenic through drinking water. Environ. Mol. Mutagen. 32 (4), 301–313.
Marquez-Garban, D.C., Chen, H.W., Fishbein, M.C., Goodglick, L., Pietras, R.J., 2007. Estrogen receptor signaling pathways in human non-small cell lung cancer. Steroids 72 (2), 135–143.
Marshall, G., Ferreccio, C., Yuan, Y., Bates, M.N., Steinmaus, C., Selvin, S., Liaw, J., Smith, A.H., 2007. Fifty-year study of lung and bladder cancer mortality in Chile related to arsenic in drinking water. J. Natl. Cancer Inst. 99 (12), 920–928.
Marsit, C.J., Eddy, K., Kelsey, K.T., 2006. MicroRNA responses to cellular stress. Canc. Res. 66 (22), 10843–10848.
Mass, M.J., Tennant, A., Roop, B.C., Cullen, W.R., Styblo, M., Thomas, D.J., Kligerman, A.D., 2001. Methylated trivalent arsenic species are genotoxic. Chem. Res. Toxicol. 14 (4), 355–361.
Meliker, J.R., Slotnick, M.J., AvRuskin, G.A., Schottenfeld, D., Jacquez, G.M., Wilson,

M.L., Goovaerts, P., Franzblau, A., Nriagu, J.O., 2010. Lifetime exposure to arsenic in drinking water and bladder cancer: a population-based case-control study in Michigan, USA. Cancer Causes Control 21 (5), 745–757.
Meliker, J.R., Wahl, R.L., Cameron, L.L., Nriagu, J.O., 2007. Arsenic in drinking water and cerebrovascular disease, diabetes mellitus, and kidney disease in Michigan: a standardized mortality ratio analysis. Environ. Health 6, 4.
Mendez Jr., W.M., Eftim, S., Cohen, J., Warren, I., Cowden, J., Lee, J.S., Sams, R., 2017. Relationships between arsenic concentrations in drinking water and lung and bladder cancer incidence in U.S. counties. J. Expo. Sci. Environ. Epidemiol. 27 (3), 235–243.
Miao, Z., Wu, L., Lu, M., Meng, X., Gao, B., Qiao, X., Zhang, W., Xue, D., 2015. Analysis of the transcriptional regulation of cancer-related genes by aberrant DNA methylation of the cis-regulation sites in the promoter region during hepatocyte carcinogenesis caused by arsenic. Oncotarget 6 (25), 21493–21506.
Mink, P.J., Alexander, D.D., Barraj, L.M., Kelsh, M.A., Tsuji, J.S., 2008. Low-level arsenic exposure in drinking water and bladder cancer: a review and meta-analysis. Regul. Toxicol. Pharmacol. 52 (3), 299–310.
Moe, B., Peng, H., Lu, X., Chen, B., Chen, L.W.L., Gabos, S., Li, X.F., Le, X.C., 2016. Comparative cytotoxicity of fourteen trivalent and pentavalent arsenic species determined using real-time cell sensing. J. Environ. Sci. (China) 49, 113–124.
Morales, K.H., Ryan, L., Kuo, T.L., Wu, M.M., Chen, C.J., 2000. Risk of internal cancers from arsenic in drinking water. Environ. Health Perspect. 108 (7), 655–661.
Naranmandura, H., Suzuki, N., Suzuki, K.T., 2006. Trivalent arsenicals are bound to proteins during reductive methylation. Chem. Res. Toxicol. 19 (8), 1010–1018.
National Research Council (US), 1999. Arsenic in Drinking Water. Washington (DC).
National Research Council (US), 2001. Arsenic in Drinking Water: 2001 Update. Washington (DC).
Naujokas, M.F., Anderson, B., Ahsan, H., Aposhian, H.V., Graziano, J.H., Thompson, C., Suk, W.A., 2013. The broad scope of health effects from chronic arsenic exposure: update on a worldwide public health problem. Environ. Health Perspect. 121 (3), 295–302.
Nemeti, B., Poor, M., Gregus, Z., 2015. Reduction of the pentavalent arsenical dimethylarsinic acid and the GSTO1 substrate S-(4-Nitrophenacyl)glutathione by rat liver cytosol: analyzing the role of GSTO1 in arsenic reduction. Chem. Res. Toxicol. 28 (11), 2199–2209.
Nesnow, S., Roop, B.C., Lambert, G., Kadiiska, M., Mason, R.P., Cullen, W.R., Mass, M.J., 2002. DNA damage induced by methylated trivalent arsenicals is mediated by reactive oxygen species. Chem. Res. Toxicol. 15 (12), 1627–1634.
Okoji, R.S., Yu, R.C., Maronpot, R.R., Froines, J.R., 2002. Sodium arsenite administration via drinking water increases genome-wide and Ha-ras DNA hypomethylation in methyl-deficient C57BL/6J mice. Carcinogenesis 23 (5), 777–785.
Ostrosky-Wegman, P., Gonsebatt, M.E., Montero, R., Vega, L., Barba, H., Espinosa, J., Palao, A., Cortinas, C., Garcia-Vargas, G., del Razo, L.M., et al., 1991. Lymphocyte proliferation kinetics and genotoxic findings in a pilot study on individuals chronically exposed to arsenic in Mexico. Mutat. Res. 250 (1–2), 477–482.
Peters, B.A., Hall, M.N., Liu, X., Parvez, F., Sanchez, T.R., van Geen, A., Mey, J.L., Siddique, A.B., Shahriar, H., Uddin, M.N., Islam, T., Balac, O., Ilievski, V., Factor-Litvak, P., Graziano, J.H., Gamble, M.V., 2015. Folic acid and creatine as therapeutic approaches to lower blood arsenic: a randomized controlled trial. Environ. Health Perspect. 123 (12), 1294–1301.
Peterson, C.L., Laniel, M.A., 2004. Histones and histone modifications. Curr. Biol. 14 (14), R546–R551.
Pietras, R.J., Marquez-Garban, D.C., 2007. Membrane-associated estrogen receptor signaling pathways in human cancers. Clin. Canc. Res. 13 (16), 4672–4676.
Platanias, L.C., 2009. Biological responses to arsenic compounds. J. Biol. Chem. 284 (28), 18583–18587.
Prasad, P., Sinha, D., 2017. Low-level arsenic causes chronic inflammation and suppresses expression of phagocytic receptors. Environ. Sci. Pollut. Res. Int. 24 (12), 11708–11721.
Pratheeshkumar, P., Son, Y.O., Divya, S.P., Wang, L., Zhang, Z., Shi, X., 2016. Oncogenic transformation of human lung bronchial epithelial cells induced by arsenic involves ROS-dependent activation of STAT3-miR-21-PDCD4 mechanism. Sci. Rep. 6, 37227.
Rao, C.V., Pal, S., Mohammed, A., Farooqui, M., Doescher, M.P., Asch, A.S., Yamada, H.Y., 2017. Biological effects and epidemiological consequences of arsenic exposure, and reagents that can ameliorate arsenic damage in vivo. Oncotarget 8 (34), 57605–57621.
Ray, P.D., Huang, B.W., Tsuji, Y., 2015. Coordinated regulation of Nrf2 and histone H3 serine 10 phosphorylation in arsenite-activated transcription of the human heme oxygenase-1 gene. Biochim. Biophys. Acta 1849 (10), 1277–1288.
Reali, D., Di Marino, F., Bahramandpour, S., Carducci, A., Barale, R., Loprieno, N., 1987. Micronuclei in exfoliated urothelial cells and urine mutagenicity in smokers. Mutat. Res. 192 (2), 145–149.
Reichard, J.F., Schnekenburger, M., Puga, A., 2007. Long term low-dose arsenic exposure induces loss of DNA methylation. Biochem. Biophys. Res. Commun. 352 (1), 188–192.
Ren, X., McHale, C.M., Skibola, C.F., Smith, A.H., Smith, M.T., Zhang, L., 2011. An emerging role for epigenetic dysregulation in arsenic toxicity and carcinogenesis. Environ. Health Perspect. 119 (1), 11–19.
Roh, T., Lynch, C.F., Weyer, P., Wang, K., Kelly, K.M., Ludewig, G., 2017. Low-level arsenic exposure from drinking water is associated with prostate cancer in Iowa. Environ. Res. 159, 338–343.
Rosen, B.P., 2002. Transport and detoxification systems for transition metals, heavy metals and metalloids in eukaryotic and prokaryotic microbes. Comp. Biochem. Physiol. Mol. Integr. Physiol. 133 (3), 689–693.
Roy, P., Mukherjee, A., Giri, S., 2016. Evaluation of genetic damage in tobacco and arsenic exposed population of Southern Assam, India using buccal cytome assay and comet assay. Ecotoxicol. Environ. Saf. 124, 169–176.
Sankpal, U.T., Pius, H., Khan, M., Shukoor, M.I., Maliakal, P., Lee, C.M., Abdelrahim, M., Connelly, S.F., Basha, R., 2012. Environmental factors in causing human cancers: emphasis on tumorigenesis. Tumour Biol 33 (5), 1265–1274.
Schoen, A., Beck, B., Sharma, R., Dube, E., 2004. Arsenic toxicity at low doses: epidemiological and mode of action considerations. Toxicol. Appl. Pharmacol. 198 (3), 253–267.
Siegfried, J.M., Stabile, L.P., 2014. Estrongenic steroid hormones in lung cancer. Semin. Oncol. 41 (1), 5–16.
Simeonova, P.P., Luster, M.I., 2002. Arsenic carcinogenicity: relevance of c-Src activation. Mol. Cell. Biochem. 234–235 (1–2), 277–282.
Sinha, D., Roy, M., 2011. Antagonistic role of tea against sodium arsenite-induced oxidative DNA damage and inhibition of DNA repair in Swiss albino mice. J. Environ. Pathol. Toxicol. Oncol. 30 (4), 311–322.
Smith, A.H., Marshall, G., Liaw, J., Yuan, Y., Ferreccio, C., Steinmaus, C., 2012. Mortality in young adults following in utero and childhood exposure to arsenic in drinking water. Environ. Health Perspect. 120 (11), 1527–1531.
Srivastava, R.K., Li, C., Chaudhary, S.C., Ballestas, M.E., Elmets, C.A., Robbins, D.J., Matalon, S., Deshane, J.S., Afaq, F., Bickers, D.R., Athar, M., 2013. Unfolded protein response (UPR) signaling regulates arsenic trioxide-mediated macrophage innate immune function disruption. Toxicol. Appl. Pharmacol. 272 (3), 879–887.
Stabile, L.P., Lyker, J.S., Gubish, C.T., Zhang, W., Grandis, J.R., Siegfried, J.M., 2005. Combined targeting of the estrogen receptor and the epidermal growth factor receptor in non-small cell lung cancer shows enhanced antiproliferative effects. Canc. Res. 65 (4), 1459–1470.
States, J.C., 2015. Disruption of mitotic progression by arsenic. Biol. Trace Elem. Res. 166 (1), 34–40.
Steinmaus, C., Ferreccio, C., Acevedo, J., Yuan, Y., Liaw, J., Duran, V., Cuevas, S., Garcia, J., Meza, R., Valdes, R., Valdes, G., Benitez, H., VanderLinde, V., Villagra, V., Cantor, K.P., Moore, L.E., Perez, S.G., Steinmaus, S., Smith, A.H., 2014. Increased lung and bladder cancer incidence in adults after in utero and early-life arsenic exposure. Canc. Epidemiol. Biomarkers Prev. 23 (8), 1529–1538.
Stueckle, T.A., Lu, Y., Davis, M.E., Wang, L., Jiang, B.H., Holaskova, I., Schafer, R., Barnett, J.B., Rojanasakul, Y., 2012. Chronic occupational exposure to arsenic induces carcinogenic gene signaling networks and neoplastic transformation in human lung epithelial cells. Toxicol. Appl. Pharmacol. 261 (2), 204–216.
Suarez, Y., Fernandez-Hernando, C., Pober, J.S., Sessa, W.C., 2007. Dicer dependent microRNAs regulate gene expression and functions in human endothelial cells. Circ. Res. 100 (8), 1164–1173.
Sung, T.I., Wang, Y.J., Chen, C.Y., Hung, T.L., Guo, H.R., 2012. Increased serum level of epidermal growth factor receptor in liver cancer patients and its association with exposure to arsenic. Sci. Total Environ. 424, 74–78.
Suzuki, K.T., Mandal, B.K., Ogra, Y., 2002. Speciation of arsenic in body fluids. Talanta 58 (1), 111–119.
Tian, D., Ma, H., Feng, Z., Xia, Y., Le, X.C., Ni, Z., Allen, J., Collins, B., Schreinemachers, D., Mumford, J.L., 2001. Analyses of micronuclei in exfoliated epithelial cells from individuals chronically exposed to arsenic via drinking water in inner Mongolia, China. J. Toxicol. Environ. Health 64 (6), 473–484.
Tseng, C.H., Huang, Y.K., Huang, Y.L., Chung, C.J., Yang, M.H., Chen, C.J., Hsueh, Y.M., 2005. Arsenic exposure, urinary arsenic speciation, and peripheral vascular disease in Blackfoot disease-hyperendemic villages in Taiwan. Toxicol. Appl. Pharmacol. 206 (3), 299–308.
Tsuda, T., Babazono, A., Yamamoto, E., Kurumatani, N., Mino, Y., Ogawa, T., Kishi, Y., Aoyama, H., 1995. Ingested arsenic and internal cancer: a historical cohort study followed for 33 years. Am. J. Epidemiol. 141 (3), 198–209.
Tsuji, J.S., Alexander, D.D., Perez, V., Mink, P.J., 2014. Arsenic exposure and bladder cancer: quantitative assessment of studies in human populations to detect risks at low doses. Toxicology 317, 17–30.
Uthus, E.O., Davis, C., 2005. Dietary arsenic affects dimethylhydrazine-induced aberrant crypt formation and hepatic global DNA methylation and DNA methyltransferase activity in rats. Biol. Trace Elem. Res. 103 (2), 133–145.
Vahter, M., 2002. Mechanisms of arsenic biotransformation. Toxicology 181–182, 211–217.
Valenzuela, O.L., Borja-Aburto, V.H., Garcia-Vargas, G.G., Cruz-Gonzalez, M.B., Garcia-Montalvo, E.A., Calderon-Aranda, E.S., Del Razo, L.M., 2005. Urinary trivalent methylated arsenic species in a population chronically exposed to inorganic arsenic. Environ. Health Perspect. 113 (3), 250–254.
Waalkes, M.P., Liu, J., Chen, H., Xie, Y., Achanzar, W.E., Zhou, Y.S., Cheng, M.L., Diwan, B.A., 2004. Estrogen signaling in livers of male mice with hepatocellular carcinoma induced by exposure to arsenic in utero. J. Natl. Cancer Inst. 96 (6), 466–474.
Waalkes, M.P., Liu, J., Ward, J.M., Powell, D.A., Diwan, B.A., 2006. Urogenital carcinogenesis in female CD1 mice induced by in utero arsenic exposure is exacerbated by postnatal diethylstilbestrol treatment. Canc. Res. 66 (3), 1337–1345.
Wang, F., Liu, S., Xi, S., Yan, L., Wang, H., Song, Y., Sun, G., 2013a. Arsenic induces the expressions of angiogenesis-related factors through PI3K and MAPK pathways in SV-HUC-1 human uroepithelial cells. Toxicol. Lett. 222 (3), 303–311.
Wang, T.S., Hsu, T.Y., Chung, C.H., Wang, A.S., Bau, D.T., Jan, K.Y., 2001. Arsenite induces oxidative DNA adducts and DNA-protein cross-links in mammalian cells. Free Radic. Biol. Med. 31 (3), 321–330.
Wang, W., Cheng, S., Zhang, D., 2014. Association of inorganic arsenic exposure with liver cancer mortality: a meta-analysis. Environ. Res. 135, 120–125.
Wang, Y.H., Yeh, S.D., Wu, M.M., Liu, C.T., Shen, C.H., Shen, K.H., Pu, Y.S., Hsu, L.I., Chiou, H.Y., Chen, C.J., 2013b. Comparing the joint effect of arsenic exposure, cigarette smoking and risk genotypes of vascular endothelial growth factor on upper urinary tract urothelial carcinoma and bladder cancer. J. Hazard Mater. 262, 1139–1146.
Wang, Z., Yang, J., Fisher, T., Xiao, H., Jiang, Y., Yang, C., 2012. Akt activation is

responsible for enhanced migratory and invasive behavior of arsenic-transformed human bronchial epithelial cells. Environ. Health Perspect. 120 (1), 92–97.
Wei, B., Yu, J., Kong, C., Li, H., Yang, L., Guo, Z., Cui, N., Xia, Y., Wu, K., 2017. An investigation of the health effects caused by exposure to arsenic from drinking water and coal combustion: arsenic exposure and metabolism. Environ. Sci. Pollut. Res. Int. 24 (33), 25947–25954.
Wei, M., Arnold, L., Cano, M., Cohen, S.M., 2005. Effects of co-administration of anti-oxidants and arsenicals on the rat urinary bladder epithelium. Toxicol. Sci. 83 (2), 237–245.
Wysocka, J., Allis, C.D., Coonrod, S., 2006. Histone arginine methylation and its dynamic regulation. Front. Biosci. 11, 344–355.
Xie, H., Huang, S., Martin, S., Wise Sr., J.P., 2014. Arsenic is cytotoxic and genotoxic to primary human lung cells. Mutat. Res. Genet. Toxicol. Environ. Mutagen 760, 33–41.
Xie, Y., Trouba, K.J., Liu, J., Waalkes, M.P., Germolec, D.R., 2004. Biokinetics and sub-chronic toxic effects of oral arsenite, arsenate, monomethylarsonic acid, and di-methylarsinic acid in v-Ha-ras transgenic (Tg.AC) mice. Environ. Health Perspect. 112 (12), 1255–1263.
Xue, X., Liu, Y., Wang, Y., Meng, M., Wang, K., Zang, X., Zhao, S., Sun, X., Cui, L., Pan, L., Liu, S., 2016. MiR-21 and MiR-155 promote non-small cell lung cancer progression by downregulating SOCS1, SOCS6, and PTEN. Oncotarget 7 (51), 84508–84519.
Yang, H.C., Fu, H.L., Lin, Y.F., Rosen, B.P., 2012. Pathways of arsenic uptake and efflux. Curr. Top. Membr. 69, 325–358.
Zhang, A., Feng, H., Yang, G., Pan, X., Jiang, X., Huang, X., Dong, X., Yang, D., Xie, Y., Peng, L., Jun, L., Hu, C., Jian, L., Wang, X., 2007a. Unventilated indoor coal-fired stoves in Guizhou province, China: cellular and genetic damage in villagers exposed to arsenic in food and air. Environ. Health Perspect. 115 (4), 653–658.
Zhang, A.H., Bin, H.H., Pan, X.L., Xi, X.G., 2007b. Analysis of p16 gene mutation, deletion and methylation in patients with arseniasis produced by indoor unventilated-stove coal usage in Guizhou, China. J. Toxicol. Environ. Health 70 (11), 970–975.
Zhou, X., Sun, H., Ellen, T.P., Chen, H., Costa, M., 2008. Arsenite alters global histone H3 methylation. Carcinogenesis 29 (9), 1831–1836.

Attachment B

Provided for non-commercial research and education use.
Not for reproduction, distribution or commercial use.



This article appeared in a journal published by Elsevier. The attached copy is furnished to the author for internal non-commercial research and education use, including for instruction at the authors institution and sharing with colleagues.

Other uses, including reproduction and distribution, or selling or licensing copies, or posting to personal, institutional or third party websites are prohibited.

In most cases authors are permitted to post their version of the article (e.g. in Word or Tex form) to their personal website or institutional repository. Authors requiring further information regarding Elsevier's archiving and manuscript policies are encouraged to visit:

http://www.elsevier.com/copyright

Author's personal copy

Regulatory Toxicology and Pharmacology 64 (2012) 329–341

Contents lists available at SciVerse ScienceDirect

Regulatory Toxicology and Pharmacology

journal homepage: www.elsevier.com/locate/yrtph

An updated inhalation unit risk factor for arsenic and inorganic arsenic compounds based on a combined analysis of epidemiology studies

Neeraja K. Erraguntla [a,*], Robert L. Sielken Jr. [b], Ciriaco Valdez-Flores [b], Roberta L. Grant [a]

[a] Texas Commission on Environmental Quality (TCEQ), Toxicology Division, P.O. Box 13087, MC-168, Austin, TX 78711-3087, United States
[b] Sielken & Associates Consulting, Inc., 3833 Texas Avenue, Bryan, TX 77802, United States

ARTICLE INFO

Article history:
Received 20 January 2012
Available online 17 July 2012

Keywords:
Arsenic
Cancer
Lung cancer
Meta-analysis
Toxicity
Inhalation

ABSTRACT

The United States Environmental Protection Agency (USEPA) developed an inhalation unit risk factor (URF) of 4.3E-03 per μg/m^3 for arsenic in 1984 for excess lung cancer mortality based on epidemiological studies of workers at two smelters: the Asarco smelter in Tacoma, Washington and the Anaconda smelter in Montana. Since the USEPA assessment, new studies have been published and exposure estimates were updated at the Asarco and Anaconda smelters and additional years of follow-up evaluated. The Texas Commission on Environmental Quality (TCEQ) has developed an inhalation URF for lung cancer mortality from exposures to arsenic and inorganic arsenic compounds based on a newer epidemiology study of Swedish workers and the updates of the Asarco and Anaconda epidemiology studies. Using a combined analysis approach, the TCEQ weighted the individual URFs from these three epidemiology cohort studies, to calculate a final inhalation URF of 1.5E-04 per μg/m^3. In addition, the TCEQ also conducted a sensitivity analysis, in which they calculated a URF based on a type of meta-analysis, and these results compared well with the results of the combined analysis. The no significant concentration level (i.e., air concentration at 1 in 100,000 excess lung cancer mortality) is 0.067 μg/m^3. This value will be used to evaluate ambient air monitoring data so the general public in Texas is protected against adverse health effects from chronic exposure to arsenic.

© 2012 Elsevier Inc. All rights reserved.

1. Introduction

The United States Environmental Protection Agency (USEPA) developed an inhalation unit risk factor (URF) for arsenic of 4.3E-03 per μg/m^3 in 1984 (USEPA, 1984). The last revision of URF for arsenic by USEPA's Integrated Risk Information System (IRIS) was in 1998 (USEPA, 1998) and at that time, changes to the URF value or a reassessment was not suggested. USEPA's URF was for excess lung cancer mortality based on two epidemiological studies of workers exposed to arsenic. The USEPA's final URF was the estimated geometric mean of the maximum likelihood URFs based on the workers at the Asarco smelter in Tacoma, Washington (Enterline and Marsh, 1982) and the Anaconda smelter in Montana (Brown and Chu, 1983a,b,c; Lee-Feldstein, 1983; Higgins et al., 1982).

Several epidemiological studies have been reported in arsenic-exposed smelter workers that indicate that inhalation exposure to inorganic arsenic increases the risk of lung cancer. The TCEQ conducted a comprehensive literature search of all the available epidemiology studies that reported health effects from exposure to arsenic and inorganic arsenic compounds. All these studies were evaluated for exposure information and other confounding information. From these studies, the TCEQ considered the following four epidemiology studies to contain adequate dose–response data for an updated assessment of the carcinogenic potential of arsenic and the development of a URF:

- Enterline et al. (1987a, 1995) updates of the Asarco smelter in Tacoma, Washington;
- Lubin et al. (2000, 2008) updates of the Anaconda smelter in Montana studies;
- Ronnskar Copper Smelter cohort study in Sweden (Järup et al., 1989; Viren and Silvers, 1994),
- Jones et al. (2007) updates of the UK smelter (Binks et al., 2005; Jones et al., 2007).

While, the TCEQ's arsenic peer review panel agreed that these studies were the most appropriate for deriving a URF, they additionally recommended excluding the Jones et al. (2007) study (UK study) because it used a weighted cumulative exposure to arsenic as the dose metric as opposed to the standard cumulative exposure. Other epidemiology studies without adequate dose–response data added to the weight-of-evidence that arsenic exposure is associated with lung cancer.

* Corresponding author. Fax: +1 512 239 1794.
E-mail addresses: neeraja.erraguntla@tceq.texas.gov (N.K. Erraguntla), SielkenAssoc@aol.com (R.L. Sielken Jr.), Ciriaco@SielkenAssociates.com (C. Valdez-Flores), Roberta.Grant@tceq.texas.gov (R.L. Grant).

0273-2300/$ - see front matter © 2012 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.yrtph.2012.07.001

Author's personal copy

1.1. Tacoma smelter

The Enterline and Marsh (1982) study used exposure estimates inferred from the Pinto et al. (1976) study. The Pinto et al. (1976) study reported an association between airborne arsenic concentrations and urinary arsenic concentrations. Thereafter, Enterline et al. (1987a) reported that Pinto et al. (1976) did not take into account prior arsenic exposures through diet. This resulted in high baseline levels of urinary arsenic that did not depict the true relationship between urinary arsenic measurements and workplace airborne arsenic levels. While the USEPA's URF from the Tacoma smelter based on the Enterline and Marsh (1982) study did not use the updated exposure estimates with additional years of follow-up included in Enterline et al. (1987a, 1995), the TCEQ used the updated exposure estimates to calculate an updated URF from the study because they represent more realistic estimates for cumulative exposure for workers.

1.2. Montana smelter

Similarly, for the Montana smelter, Lubin et al. (2000, 2008) updated exposure estimates that included additional years of follow-up. The exposure estimates calculated by Lubin et al. (2000) were adjusted to take into account the reduction in exposure due to the use of air filtration masks in heavy-exposure areas. This resulted in more representative arsenic cumulative exposure estimates that were lower than the exposure estimates in the Brown and Chu (1983a,b,c), Lee-Feldstein (1983) and Higgins et al. (1982) studies used in USEPA's derivation of URFs. The TCEQ used the updated exposure estimates from the Lubin (2000, 2008) studies to calculate a URF because they represent more realistic estimates for cumulative exposure for workers, especially in heavy exposure areas where respirators were used.

1.3. Sweden smelter

In addition to the Tacoma and Montana smelter studies, more recent studies based on Swedish smelter workers (Järup et al., 1989; Viren and Silvers, 1994) were included by TCEQ in the derivation of the URF. The Swedish smelter studies were not available to the USEPA when they finalized the inhalation URF in 1984 (USEPA, 1984). Järup et al. (1989) concluded that lung cancer mortality was related to the estimated average intensity of exposure to arsenic but not to duration. The TCEQ used these exposure estimates to calculate a URF because these studies accounted for the circumstances where in the workers were exposed to higher concentrations of arsenic over shorter durations as opposed to lower concentrations over longer durations and are realistic estimates of cumulative exposure for workers, especially for shorter-term workers.

1.4. UK smelter

Another study considered by the TCEQ for dose–response analyses was the Jones et al. (2007) study. Jones et al. (2007) investigated the relationships between excess lung cancer mortality at a tin smelter in Humberside, UK and inhalation exposure to lead, antimony, arsenic, cadmium and radioactivity, with the aim of identifying the cause or causes of the excess lung cancer and quantitative measures of exposures. The cohort was composed of male former employees at the tin smelter initially investigated by Binks et al. (2005). Jones et al. (2007) results indicated there were no significant associations found between lung cancer mortality and simple cumulative exposure to any of the substances studied. However, when cumulative exposures were weighted according to time since exposure and attained age, significant associations were found between lung cancer mortality and exposures to arsenic, lead and antimony. Although the TCEQ included information from the Jones et al. (2007) study in the TCEQ's arsenic Development Support Document (DSD) (TCEQ, 2012) because it had adequate dose–response information, the results were not used in the final URF calculation because of potential confounding by co-exposures and because a different dose metric than the cumulative exposure used for the other three cohorts could not be combined (i.e., the "weighted cumulative exposure") and was not was not generally accepted by the TCEQ's arsenic peer-reviewers.

1.5. Updated TCEQ arsenic inhalation URF

The main purpose of this paper is to present the procedures used in the development of an inhalation URF based on an updated inhalation carcinogenic assessment. The USEPA's inhalation URF for arsenic derived in 1984 was based on outdated epidemiological data. The TCEQ derived an inhalation URF using updated epidemiological data and updated exposure estimates of the two studies included in the USEPA (1984) assessment in addition to a recent epidemiological study based on a Swedish cohort. The TCEQ used combined analysis techniques to obtain a final URF that summarized the data from three different studies.

It is important to conduct an up-to-date toxicity assessment of arsenic based on the most recent scientific data. There is an air pollutant watch list in Texas for arsenic as well as other metals. The updated URF will be used to evaluate TCEQ's ambient air monitoring data and modeled ground-level air concentrations for the TCEQ's air permitting program.

This paper is a summary of the carcinogenic section of the TCEQ's arsenic DSD (TCEQ, 2012) that underwent an external scientific peer review organized by Toxicology Excellence for Risk Assessment and two public comment periods. The final arsenic DSD and response to comments are posted on the TCEQ website (TCEQ, 2012). Please refer to ATSDR (2007) and TCEQ (2012) for additional information on these studies as well as for a detailed discussion on the weight of evidence (WOE) from the epidemiological studies that show arsenic exposure to be associated with lung cancer.

2. Materials and methods

Several epidemiological studies of arsenic-exposed smelter workers have reported that inhalation exposure to inorganic arsenic increases the risk of lung cancer. ATSDR (2007) concluded that chronic inhalation exposure to inorganic arsenic increases the risk of lung cancer. The TCEQ considered three epidemiological studies of workers exposed to arsenic to use in a combined analysis to develop an updated URF. The three studies had adequate dose–response data and similar dose metrics so that a combined analysis approach could be used to derive a final URF. Detailed information on the studies and discussions on the inclusion of the studies are available in the arsenic DSD (TCEQ 2012). Summary information for these studies is provided in Table 1 and historical information on the three studies is discussed in the later sections.

The TCEQ guidelines for carcinogenic assessments (TCEQ 2006) employ the four-step risk assessment process formalized by the National Research Council (1983, 1994, 2001), and uses procedures recommended in the most recent USEPA cancer guidelines (2005a,b) and the scientific literature. For chronic adverse effects determined to be associated with linear dose–response relationships in the low-dose region, which is the default assumption for arsenic based on a MOA analysis, the TCEQ adopts or derives URFs. For adverse effects associated with a linear dose–response, it is assumed that an effects threshold does not exist. Therefore, a linear

Author's personal copy

Table 1
Epidemiological studies with adequate dose–response data.

Occupational location and (exposure period)	Most recent dose–response data	Last year of follow-up	Number of workers [person-years (PY)]	Cancer type SMR[a] (p value)	Cumulative arsenic exposure (mg/m^3 yr)[b]
Tacoma, WA Asarco copper smelter (1940–1964)	Enterline et al. (1995)	1986	2802 [84,916 PY]	Respiratory 210 SMR ($p < 0.01$)	<0.750 to 45+
Montana Anaconda copper smelter (1938–1958)	Lubin et al. (2000, 2008)	1989	8014 [256,850 PY[c]] (full cohort) 7887 [144,851 PY] (restricted cohort)	Respiratory 156 SMR ($p < 0.001$) (full cohort) 187 SMR ($p < 0.001$) (restricted cohort)	1 to 26.2+
Ronnskar, Sweden copper smelter (1928–1967)	Järup et al. (1989) and Viren and Silvers (1994)	1981	3916 [127,189 PY]	Lung 372 SMR ($p < 0.001$)	<0.25 to 100+

[a] SMR, standardized mortality ratio; reported results from most recent study.
[b] Milligrams of arsenic per cubic meter cumulated over years of exposure (mg/m^3 yr).
[c] For the Montana copper smelter, PY data were obtained from Table 1 of Lubin et al. (2008) because it is the most recent analysis of the data.

extrapolation from the point of departure (POD) to the origin of the inhalation dose–response curve is used to estimate excess lifetime risk at lower doses (e.g., through the use of the calculation of a POD using the BEIR IV methodology (NRC 1988) if data have been fit to a dose–response model). The slope of the line from this linear extrapolation is the inhalation URF, which is defined as the excess risk estimated to result from continuous lifetime exposure to an agent at a concentration of 1 μg/m^3 in air.

3. Results

3.1. Carcinogenic weight-of-evidence

The International Agency for Research on Cancer (IARC, 2004) has classified arsenic and arsenic compounds in Group 1, as chemicals and groups of chemicals that are causally associated with cancer in humans. USEPA (1998) has classified inorganic arsenic as a Group A, human carcinogen. Arsenic has also been classified in Group 1 (carcinogenic to humans) by Health Canada (1994, 2006). According to guidance in the new cancer guidelines (USEPA, 2005a,b), and findings from epidemiological studies, the TCEQ considers arsenic compounds, as a group, to be "Carcinogenic to Humans" via inhalation exposure.

3.2. Mode-of-action (MOA) analysis

Although inorganic arsenic has been classified as a human carcinogen, the underlying molecular mechanisms of arsenic-induced toxicity and carcinogenicity have not yet been clearly identified. Many studies have reported on multiple modes-of-action (MOAs) and the scientific community has not reached a consensus on one single carcinogenic MOA.

There is an ongoing controversy over the proposed MOA for arsenic and the two main competing hypothesis are threshold or non-linear and non-threshold or linear. The proposed MOA for arsenic has essentially been investigated mainly from studies involving arsenic exposure in drinking water (ingestion route), and not inhalation exposure. Arsenic is unique in that it causes lung cancer by two unrelated routes of exposures (i.e., inhalation and ingestion) (Chilakapati et al., 2010; Smith et al., 2009). Smith et al. (2009) explored whether the risk of developing lung cancer via exposure to arsenic via inhalation was greater than the risk of developing lung cancer via ingestion. They concluded that the increased lung cancer risks are similar whether arsenic is ingested or inhaled. For these reasons, the TCEQ is of the opinion that the findings on the MOA from the ingestion route to be supportive of the MOA for inhalation exposure to arsenic and lung cancer.

Many epidemiology studies have reported a significant dose–response relationship between arsenic concentration in water and incidence of lung cancer and other cancers, albeit, the associations occurred only at high concentrations. The available inhalation epidemiological studies have also reported an association between inhalation exposures to inorganic arsenic and lung cancer. Additionally, it is important to consider that there is evidence that arsenic that is internally absorbed first undergoes methylation to monomethylarsonic acid (MMA) and then to dimethylarsenic acid (DMA). While it was thought previously that the first step of forming MMA was a detoxification process, recent WOE for this step indicates it to be an activation step that can activate and increase the toxic and carcinogenic potential of arsenic (Smith et al., 2009). This is an important concept to because it adds WOE especially when the data on the MOA is not well-established. A linear extrapolation has therefore been the default.

The main limitation of the drinking water epidemiological studies is that the association of arsenic exposure and cancer seems to occur only at relatively high doses and not at low environmentally relevant doses. Furthermore, available data on the MOA indicates that arsenic is not a direct-acting mutagen. Therefore, these results point towards the plausibility that arsenic levels at low doses follow a non-linear threshold pattern (Schoen et al., 2004).

Lately, there has been a surge of interest to use state-of-the art molecular techniques to obtain mechanistic data to decipher the molecular mechanisms of the arsenic carcinogenic MOA and to quantify actual risks at environmentally relevant concentrations (Chilakapati et al., 2010; Suzuki et al., 2009; Gentry et al., 2010). However, in vitro studies are limited in that it is very hard to estimate the threshold dose where toxicity occurs based on in vitro dose response data and these types of studies are hard to replicate using in vivo models (Snow et al., 2005).

Other MOAs that have been proposed for arsenic include: oxidative stress, increased cellular proliferation, perturbation of DNA methylation patterns, and inhibition of DNA repair, signal transduction, and genotoxicity. There is also increasing evidence that arsenic toxicity is the result of both genetic and epigenetic events (Salnikow and Zhitkovich, 2008). The genotoxic effects of inorganic arsenic are influenced to a large extent by intracellular metabolism. These MOAs are discussed more fully in the arsenic DSD (TCEQ, 2012).

According to ATSDR (2007), it has been shown that exposure to inorganic arsenic modifies the expression of a variety of genes related to cell growth and defense, including the tumor suppressor gene p53, as well as alters the binding of nuclear transcription factors.

Regulating agencies need to consider all the WOE while developing health-protective policy decisions and before embracing

Author's personal copy

either a default linear or non-linear approach. The TCEQ (2006) guidelines recommend a linear dose–response extrapolation when definitive data on the carcinogenic MOA is lacking, and the TCEQ has chosen a default linear approach to develop an inhalation URF for arsenic as a health-protective regulatory policy. Because the main purpose of this paper is to present procedures for an updated inhalation URF and not to definitively assess/discuss the carcinogenic MOA of inorganic arsenic, only a brief summary is included in this manuscript on the different proposed MOAs that support a WOE approach for carcinogenic MOA.

3.3. Key studies

Several epidemiological studies have been reported in arsenic-exposed smelter workers that indicate that inhalation exposure to inorganic arsenic increases the risk of lung cancer. There is a sufficient WOE that chronic inhalation exposure to inorganic arsenic increases the risk of lung cancer. In addition to reviewing all the studies in the ATSDR (2007) toxicological profile, the TCEQ also conducted a comprehensive literature search and finally considered the Enterline et al. (1987a, 1995) updates of the Asarco smelter in Tacoma, Washington, the Lubin et al. (2000, 2008) updates of the Anaconda smelter in Montana studies, and the Ronnskar Copper Smelter cohort study in Sweden (Järup et al., 1989; Viren and Silvers, 1994) to contain adequate dose–response data for an updated assessment of the carcinogenic potential of arsenic and the development of URF values.

The three studies had adequate dose–response data and similar dose metrics to use in a combined analysis approach to derive a final URF and are discussed in the following sections For additional information on these studies as well as the WOE from these epidemiological studies, please refer to ATSDR (2007) and TCEQ (2012). Additionally, a brief discussion of two epidemiological studies not discussed in the ATSDR (2007) review is included in Section 3.4. These studies did not contain adequate dose–response data but add to the WOE that exposure to arsenic is associated with lung cancer.

3.3.1. Asarco copper smelter in Tacoma, Washington (Enterline and Marsh, 1982; Enterline et al., 1987a,b, 1995)

Enterline et al. (1995) investigated the risks of cumulative arsenic exposure on updated worker respiratory cancer mortality follow up through 1986 and estimated exposures through 1984. The data were an update of the earlier study (Enterline and Marsh, 1982; Enterline et al., 1987a, 1995) of 2802 men who worked at a copper smelter in Tacoma, WA for a year or more during the period of 1940–1964 and were followed up for deaths during the period 1941–1976. The updated study included 1583 total deaths and 188 respiratory cancer deaths versus 1061 total deaths and 104 respiratory cancers in the earlier study. Information on smoking was not available. Table 2 shows the summary data in Enterline et al. (1995) for the Asarco smelter used by the TCEQ to derive the inhalation URF for arsenic.

Arsenic air concentrations were estimated from departmental air arsenic and workers urinary arsenic measurements. Arsenic concentrations in air were estimated for each department starting in 1938 and urinary arsenic measurements were estimated from each department and worker starting in 1948. While the measurements of arsenic in air were confined mostly to the departments in which arsenic was thought to be a problem, arsenic in urine was measured for all workers. Enterline et al. (1995) reported that the conversion of data of urinary arsenic to air arsenic was made by the identification of departments and years for which data from both air and urinary arsenic concentrations were available and by the determination of the mathematical relation between the two. In order to estimate actual worker exposure concentrations, the average concentrations of arsenic in air were weighted by hours per shift at the sample location, number of men at the location per shift, and frequency of operation for samples. While prior to 1971 arsenic data were obtained by tape and spot samples, starting in 1971 personal air measurements were available. The authors then constructed an exposure matrix for arsenic in air by department and year from 1938 up to the time the smelter closed in 1984. The exposure estimates from 1938 were used for years before 1938. Finally, the cumulative exposure was calculated and reported as $\mu g/m^3$ yr. Enterline et al. (1995) reported significant excesses for all malignant neoplasms taken together (i.e., cancers of the large intestine, respiratory system, and bone). The SMR for respiratory cancer was 210 for the total cohort ($p < 0.01$). For <20 years since first exposure, only respiratory cancer was significant. However, for $\geqslant$20 years since first exposure SMRs were generally higher but those that were significant were the same as for the total cohort. Enterline et al. (1995) reported the relation between cumulative exposure to arsenic in air expressed as $\mu g/m^3$-yr and cancer of the respiratory system for the entire cohort, for the sub-cohort hired before 1940, and for the sub-cohort hired in 1940 or later. This stratification helped separate workers hired before 1940, who were estimated to have had relatively high exposure concentrations coupled with poor respiratory protection, from workers with relatively lower exposure concentrations coupled with better respiratory protection.

3.3.2. Anaconda copper smelter in Montana (Lubin et al., 2000, 2008)

Lubin et al. (2000, 2008) analyzed the shape of the exposure–response curve in an updated epidemiological data set of workers initially studied by Brown and Chu (1983a,b,c) and Lee-Feldstein (1983). These earlier studies followed 8047 men, who were employed at the Montana smelter for a year or more from 1938 to 1957, during the period 1938–1977. The updated study extended the follow-up period though the end of 1989. The updated study found significantly increased SMRs of 187 and 156 for respiratory cancer in the full cohort and a restricted sub-cohort, respectively.

Table 2
Observed (O), expected (E) and standard mortality rates (SMRs) from Enterline et al. (1995) for workers at the Asarco smelter in Tacoma, Washington.

Cumulative exposure interval ($\mu g/m^3$- yr)	Mean exposure (total cohort – $\mu g/m^3$- yr)	Total cohort			Hired < 1940			Hired $\geqslant$ 1940		
		O	E	SMR	O	E	SMR	O	E	SMR
<750	405	22	14.29	154.0	2	3.08	65.0	20	11.21	178.4*
750–<2000	1305	30	17.10	175.5**	5	7.33	68.2	25	9.77	256.0**
2000–<4000	2925	36	17.17	209.7**	22	8.93	246.2**	14	8.23	170.1
4000–<8000	5708	36	17.00	211.7**	15	10.01	149.9	21	7.00	300.2**
8000<20,000	12,334	39	15.48	252.0**	28	10.98	255.1**	11	4.50	244.4*
20,000–<45,000	28,336	20	7.04	284.0**	14	5.56	251.7**	6	1.48	405.5**
$\geqslant$45,000	58,957	5	1.58	315.7*	5	1.48	338.7*	0	0.11	–

* $P < 0.05$.
** $P < 0.01$.

Author's personal copy

Table 3
Observed, expected and standard mortality rates (SMRs) from Lubin et al. (2008) for the workers at the Anaconda smelter in Montana.

Cumulative exposure interval (μg/m^3-yr)	Mean Exposure (μg/m^3-yr)	Observed number of respiratory cancer deaths	Expected[a] number of respiratory cancer deaths	SMR
<750	470	62	73.81	84
750–<2000	1240	96	75.00	128
2000–<5000	3430	74	68.52	108
5000–<10,000	7270	83	74.77	111
10,000–<15,000	11,900	84	50.00	168
⩾15,000	21,900	47	20.00	235

[a] Expected = observed/SMR.

Table 3 shows the summary data in Lubin et al. (2008) for the Anaconda smelter full cohort used by the TCEQ to derive the inhalation URF for arsenic.

The restricted sub-cohort was defined to minimize the uncertainty related to possible arsenic exposures after the end of employment at the Anaconda smelter. A number of workers had stopped working at the smelter more than 5 years before 1989 or at ages less than 50 years. The restricted sub-cohort included the person-years and respiratory cancer deaths in current workers at the end of 1989, recent former workers (<5 years since last employment at the smelter), and workers with last employment at ages 50 or older. The full cohort included 8014 workers and 256,850 person-years versus 7887 workers and 144,851 person-years in the restricted sub-cohort.

Cumulative exposure estimates in mg/m^3-yr at the Anaconda smelter were based on employment records of workers in jobs with light (L), medium (M), and heavy (H) arsenic exposure and measurements of airborne arsenic concentration between 1943 and 1958 (Morris, 1978). Lubin et al. (2000, 2008) calculated the cumulative exposure to arsenic as

$$\text{Cumulative exposure} = 0.29L + 0.58M + (\gamma \times 11.3)H$$

where L, M and H are the lengths of time in years that the worker was in jobs with low, medium and high exposure concentrations, respectively, and 0.29, 0.58 and 11.3 are the arsenic air concentrations (mg/m^3) in jobs with low, medium and high exposures. The weighting factor, γ, is a fraction that measures the proportion of exposure reduction in high-concentration jobs due to the use of protective equipment.

The cumulative exposure estimates calculated by Lubin et al. (2000, 2008) based on duration in jobs with low, medium and heavy exposure concentrations were re-calculated using a weighting factor γ of 0.1 to take into account the reduction in exposure due to the use of air filtration masks in heavy-exposure jobs. This resulted in more representative arsenic cumulative exposure estimates that were lower than the estimates with a weighting factor γ of 1.0 used previously, particularly at the highest cumulative exposures. Using the weight of 0.1 on high-exposure jobs resulted in: (1) rate ratios that conformed to a linear dose–response relationship of respiratory cancer with cumulative exposure to arsenic and (2) steeper estimates of the slopes, which imply more health-protective estimates of the excess risks.

3.3.3. Smelter in Ronnskar, Sweden (Järup et al., 1989; Viren and Silvers, 1994)

Järup et al. (1989) investigated lung cancer mortality in a cohort of 3916 male Swedish smelter workers employed for at least three months from 1928 to 1967, and followed through 1981. They concluded that lung cancer mortality was related to the estimated average intensity of exposure to arsenic but not to duration. They also found that there was no evident dose–response relationship between estimated exposure to sulfur dioxide and lung cancer. The study found a statistically significant increased SMR of 372 for lung cancer in workers exposed to arsenic based on 106 lung cancer deaths. Table 4 shows the summary data in Järup et al. (1989) and Viren and Silvers (1994) for the copper smelter workers in Sweden used by the TCEQ to derive the inhalation URF for arsenic.

Exposure estimates were based on measurements of air concentrations of arsenic starting in 1945 when available. After 1950 air concentration measurements were generally available. Air concentrations for years before this period were estimated by adjusting the measurements to account for differences in production levels of raw arsenic and differences in production methods for different work sites and different calendar years. A job-exposure matrix of arsenic concentrations for different jobs and different calendar years was created. The job-exposure matrix was combined with job histories available for all workers in the cohort to calculate the cumulative exposure to arsenic for each individual. The summary data that included number of lung cancer deaths and SMR in each of several cumulative exposure categories for the total cohort, the sub-cohort of workers hired before 1940 and the sub-cohort of workers hired after 1940 were reported by Viren and Silvers (1994). Järup et al. (1989) indicate that "data suggest that arsenic

Table 4
Observed (O), Expected (E) and Standard Mortality Rates (SMRs) from Järup et al. (1989) and Viren and Silvers (1994) for the workers at the smelter in Ronnskar, Sweden.

Cumulative exposure interval (μg/m^3 yr)	Mean exposure[a] (Total cohort – μg/m^3 yr)	Total cohort[b]			Hired < 1940[b]			Hired ⩾ 1940[a]		
		O	*E*[c]	SMR[d]	*O*	*E*[c]	SMR[d]	*O*	*E*[c]	SMR[d]
<250	125	14	5.17	271	3	1.06	284	11	4.12	267
250–<1000	625	13	3.61	360	3	0.50	603	10	3.13	319
1000–<5000	3000	17	7.14	238	6	2.69	223	11	4.45	247
5000–<15,000	10,000	15	4.44	338	10	3.51	285	5	0.93	537
15,000–<50,000	32,500	29	6.29	461	27	6.03	448	2	0.26	757
50,000–<100,000	75,000	6	0.82	728	6	0.82	728	–	–	–
100,000+	125,000	12	1.06	1137	12	1.06	1137	–	–	–

[a] Data from Viren and Silvers (1994).
[b] Data from Tables IV and V (Järup et al., 1989).
[c] E was not provided, but was calculated based on $E = O/\text{SMR}$.
[d] SMR, no latency period.

Author's personal copy

concentration is more important than duration of exposure for the risk of developing lung cancer". In addition, Järup et al. (1989) indicate that they "did not find a clear dose–response relationship in the low exposure categories". These two statements in Järup et al. (1989) based on the Swedish smelter are consistent with the Lubin et al. (2008) conclusion based on the Anaconda smelter that a "direct concentration effect on the exposure–response relationship, indicating that for a fixed level of cumulative arsenic exposure, inhalation of higher concentrations of arsenic over shorter durations was more deleterious than inhalation of lower concentrations over longer durations".

3.4. Other studies

3.4.1. UK study (Binks et al., 2005; Jones et al., 2007)

Binks et al. (2005) investigated whether there was any significant excess or deficits in mortality among workers employed at a tin smelter complex in North Humberside, UK, at which employees were potentially exposed to a number of substances, including lead, arsenic, cadmium and natural series radionuclides. The cohort consisted of 1462 males employed for at least 1 year between 1967 and 1995 and followed through the end of 2001. Mortality from lung cancer showed a statistically significant excess with a SMR of 161 (CI = 124–206) ($P < 0.001$) and there was evidence of a diminution of lung cancer risk with time since exposure. Mortality from smoking-related diseases other than lung cancer showed a non-significant deficit and mortality from all causes and all cancers did not differ from that expected. Jones et al. (2007) investigated the relationship between lung cancer mortality and quantitative measures of exposure and concluded the excess of lung cancer mortality in the cohort can most plausibly be explained if arsenic is the principal occupational carcinogen. As mentioned previously, the TCEQ did not consider the Jones et al. (2007) study in the final URF calculation because the dose metric of the Jones et al. (2007) study was different than the dose metric of all the other studies. In addition, there was potential for confounding from co-exposures to other carcinogens. Refer to Appendix I of TCEQ (2012) for additional information on the cohort and findings from the Binks et al. (2005) study.

3.4.2. Chinese mine study (Tang and Zhen, 1996)

A retrospective lung cancer mortality study of Chinese miners who had been exposed to insoluble arsenic in four mines implicated arsenic to be the cause of lung cancer in the miners (Tang and Zhen, 1996). The authors were able to demonstrate a dose-dependent decrease in the incidence of lung cancer with a reduction in the concentration of insoluble arsenic in the air. The main objective of the study was to determine whether the risk of mine workers developing lung cancer was due to exposure to insoluble arsenic and/or radon exposures as both these are chemicals of concern inside the mines. While the study provided valuable WOE that indicated that lung cancer among the mine workers was because of exposure to arsenic as opposed to radon and other metals, the TCEQ did not use this study as a key study because it did not include adequate exposure data necessary to conduct a dose–response assessment and develop a URF. In addition, the values were calculated based on a case control study of a small number of miners.

3.5. Dose metric

The dose metric used for the dose–response assessments is typically cumulative arsenic exposure ($\mu g/m^3$-yr) because it is the only measure available from all cohort studies and because there are no biological/mechanistic data or statistical evidence which indicates that another dose metric is more appropriate, except for Lubin et al. (2008). Lubin et al. (2008) investigated a dose metric of cumulative arsenic exposure modified by concentration, as discussed below.

3.6. Dose–response assessments

The three epidemiological studies considered by the TCEQ in the development of the inhalation URF of lung cancer from arsenic exposures were selected because they had reliable and sufficient data for dose–response modeling. The TCEQ used a multiplicative background relative risk model and Poisson regression to fit the observed number of cancer deaths in the different studies. Poisson regression assumes that the distribution of the observed number of cancer deaths follows a Poisson distribution with unknown parameters estimated using maximum likelihood procedures. The multiplicative relative risk model uses reference population background cancer rates to fit the cohort's observed cancer rates. The model can be expressed as follows when the observed and expected number of cancer deaths are known (which is the case in the three studies considered by the TCEQ),

$$\text{Observed}_k = \text{Expected}_k \times (1 + \beta \times d_k)$$

where Observed_k is the number of deaths in the kth exposure interval predicted by the model, Expected_k is the expected number of deaths in the reference population corresponding to the person-years in the kth exposure interval, d_k is the dose (average cumulative exposure to arsenic) for the person-years in the kth exposure interval, and β is the unknown slope per unit dose to be estimated using maximum likelihood.

The multiplicative background relative risk model relates the number of observed respiratory cancer deaths in the cohort to the product of the number of respiratory cancers expected in a reference population and the effect of the dose. The underlying background respiratory cancer hazard rates of the workers in the cohort may be (and usually are) different than the underlying background respiratory hazard rates in the reference population. If no adjustment for this difference is made, the dose-dependent function (i.e., the term $1 + \beta \times d_k$ in the model) is forced to explain not only the effect of the dose in the observed respiratory cancer mortalities but also any discrepancies between the study and reference population background rates. In other words, ignoring discrepancies between the cohort's background hazards rates and the reference population hazard rates may result in biased dose–response relationships.

Crump and Allen (1985) discuss the relative risk model with a factor that accounts for the possibility of different background rates in an epidemiological cohort and its reference population. This factor adjusts for issues like the healthy worker effect, the difference between internally and externally derived background cancer rates, covariate effects not explicitly incorporated in the summary epidemiological data, etc. The multiplicative background relative risk model with no adjustment for differences in background rates can be extended to

$$\text{Observed}_k = \alpha \times \text{Expected}_k \times (1 + \beta \times d_k)$$

where the α term adjusts for any possible differences between the population's background cancer rates and the cohort's observed cancer rates in unexposed workers.

The Tacoma (Enterline et al., 1995) and the Swedish (Järup et al., 1989; Viren and Silvers, 1994) studies split the data into sub-cohorts of workers hired before 1940 and workers hired after 1940 in addition to the full cohort that included all the workers. The TCEQ extended the multiplicative relative risk model by including a multiplicative factor to account for potential differences in the background rates in the two sub-cohorts. The resulting model is as follows,

$$\text{Observed}_{k,c} = \tau_c \times \alpha \times \text{Expected}_{k,c} \times (1 + \beta \times d_{k,c})$$

where c is the index for the sub-cohort (workers hired before 1940 or workers hired after 1940), τ_c is defined as one for the sub-cohort of

Author's personal copy

workers hired before 1940 and is estimated to be a nonnegative number for the sub-cohort of workers hired after 1940. (This model is equivalent to a model that would estimate a different intercept α for each of the sub-cohorts.) A τ_c estimate of less than one for the sub-cohort hired after 1940 indicates that the adjustment for the difference between the population's background cancer rates and the sub-cohort's observed cancer rates in unexposed workers hired after 1940 ($\tau_c \times \alpha$) is less than the adjustment for the difference in the sub-cohort of workers hired before 1940 (α). A τ_c estimate of greater than one for the sub-cohort hired after 1940 indicates the opposite effect.

The TCEQ fit the summary cancer data in the three studies assuming a linear dose–response relationship, adjusting for the differences in background cancer rates and, when appropriate, for the effect of year of hire. Poisson regression models with externally derived background cancer rates (e.g., those based on SMRs) implicitly adjust for age when the reference population background rates are calculated using age-dependent background cancer rates. Estimates for the full cohort with no adjustment for the year of hire are also presented for comparison purposes. The maximum likelihood estimate (MLE), standard error (SE), and 95% upper confidence limit on the slope (95% UCL) were also calculated using the asymptotic properties of MLEs.

The TCEQ used the linear multiplicative relative risk model and Poisson regression modeling to obtain maximum likelihood estimates of β and the asymptotic variance for β (Appendix C of TCEQ, 2012) for all three cohorts. The respiratory cancer mortality data in Tables 2 and 3 and the lung cancer mortality data in Table 4 were fit using the multiplicative relative risk models described above. The data were fit using Poisson regression, external background lung cancer rates, and assuming a linear dose–response model. The MLEs of the parameters (intercept α and slope β, and when appropriate, the effect of year of hire τ_c) were obtained for the three cohorts used by TCEQ in the calculation of the final URF. The Tacoma and Sweden study cohorts made a distinction between workers hired before 1940 and those hired after 1940. Estimates for all workers adjusting for the year of hire include all the information in the cohort and, therefore, are emphasized here because they are more reliable. However, models were also fit to (i) all workers with no adjustments for year of hire, (ii) workers hired <1940, and (iii) workers hired $\geqslant$1940, for comparison purposes. The model for the Montana smelter was fit to only the full cohort with no adjustment for the year of hire because this study did not have information to split the workers by the year of hire. Although the Montana smelter study included rate ratios summary data for a sub-cohort and these data were also fit by the TCEQ and is available in the arsenic DSD (TCEQ, 2012), only the results for the full cohort are presented in Table 5. Additionally, Table 5 shows the MLEs for the effect of year of hire (τ_c, when estimated), intercept (α) and slope (β) along with the standard error of the estimated slope and the corresponding asymptotic 95% UCL on the slope.

3.7. Dosimetric adjustments

There has been concern that residents living near smelters or arsenical chemical plants may also have increased risk of lung cancer. Additionally, many of the workers live in communities in close proximity to the smelters and/or arsenical chemical plants. Therefore it may be possible that although the primary high-dose exposure occurred at work, historical smelter workers would have experienced lower but still quite elevated arsenic air (and soil and dust) concentrations at home. However, the existing community exposure studies are generally limited because they lack information on individual exposures. Additional discussion on the uncertainty involved in estimating risks for the general population from occupational worker data is provided in Section 4.3.2.

Occupational concentrations ($\text{concentration}_{OC}$) were converted to environmental concentrations for the general population ($\text{concentration}_{HEC}$) using the following equation (TCEQ, 2006):

$$\text{concentration}_{HEC} = \text{concentration}_{OC} \times (VE_{ho}/VE_h) \times (\text{days per week}_{oc}/\text{days per week}_{res})$$

where VE_{ho} is occupational ventilation rate for an 8-h day (10 m^3/day), VE_h is non-occupational ventilation rate for a 24-h day (20 m^3/day), days per week_{oc} is occupational weekly exposure frequency (default of 5 days per week) and days per week_{res} is residential weekly exposure frequency (7 days per week).

3.8. Extrapolation to lower exposures

3.8.1. Unit risk factors (URFs)

URFs express cancer potency in units of risk per air concentration (e.g., risk per $\mu g/m^3$) assuming continuous environmental lifetime exposure. They are calculated using linear low-dose extrapolation when the carcinogenic MOA is unknown or not well-established, which is the case for arsenic. Where a dose–response curve is modeled for tumor or cancer mortality data, the URF is the slope of a straight line from a specified POD to the origin, with the POD being the lowest tumor response or cancer mortality response supported by the study data.

The models used here are based on human epidemiological studies and have been fit to a linear equation (linear multiplicative relative risk model) for use with the BEIR IV methodology (NRC, 1988). Thus, extrapolated URFs using a high POD and URFs estimated using a small POD are approximately equal. Air concentrations were solved iteratively with life-table analyses using the

Table 5
Summary of all Maximum likelihood estimates (MLE), standard errors (SE) and 95% upper confidence limits (UCL) on slopes for the three different cohorts used in the final URF.

Data	Intercept MLE (α)	Slope MLE (β) $(\mu g/m^3\text{- yr})^{-1}$	Standard error slope (β)	95% UCL on slope β $(\mu g/m^3\text{- yr})^{-1}$
Tacoma, Washington (Asarco Smelter, Enterline and Marsh, 1982; Enterline et al., 1987a,b, 1995)				
All workers adjusting for year of hire (τ_c = 1.38)	*1.46*	*3.15E-05*	*1.48E-05*	*5.59E-05*
All workers with no adjustment for year of hire	1.81	2.13E-05	1.13E-05	3.99E-05
Workers hired <1940	1.43	3.44E-05	1.89E-05	6.56E-05
Workers hired 1940+	2.05	2.67E-05	2.33E-05	6.51E-05
Montana (Anaconda copper smelter, Lubin et al., 2000, 2008)				
Full Cohort	*0.94*	*5.75E-05*	*1.61E-05*	*8.40E-05*
Ronnskar, Sweden (copper smelter, Järup et al., 1989; Viren and Silvers, 1994)				
All workers adjusting for year of hire (τ_c = 1.19)	*2.37*	*2.92E-05*	*1.63E-05*	*5.61E-05*
All workers with no adjustment for year of hire	2.67	2.38E-05	9.14E-06	3.89E-05
Workers hired <1940	2.48	2.62E-05	1.35E-05	4.84E-05
Workers hired 1940+	2.60	6.17E-05	5.92E-05	1.59E-04

Preferred study-specific characterizations are noted by italic text.

Author's personal copy

BEIR IV approach (NRC, 1988). Air concentrations based on extra risk were calculated as opposed to added risk. Mortality and survival rates were used to calculate air concentrations based on a lifetime exposure of 70 years, the default used by TCEQ for exposure analysis (TCEQ, 2006). Texas-specific mortality rates for 2001–2005 for lung cancer and Texas-specific survival rates for 2005 were used in the calculation of PODs and URFs (Texas Department of State Health Services, Cancer Epidemiology and Surveillance Branch, Texas Cancer Registry) (Appendix B, TCEQ, 2012). Additionally, US specific mortality rates for 2001–2005 for lung cancer and US-specific survival rates for 2005 were used in the calculation of PODs and URFs (Table F-5 of Appendix F, TCEQ, 2012). The URFs based on the Texas and US specific rates were very similar.

3.8.2. Study specific URFs

Table 6 shows estimates of URFs based on PODs of air concentrations at 1 in 100,000 excess lung cancer mortality risk (10^{-5}-risk air concentrations) for β (MLE) and β (95% UCL) from Table 5 and using Texas mortality and survival rates. URFs and arsenic 10^{-5}-risk air concentrations were calculated using β values for all workers adjusting for year of hire, all workers with no adjustment for year of hire, and workers hired <1940 except for the Montana study. URFs were not calculated for the Tacoma smelter workers hired 1940+ because Viren and Silvers (1999) found no association for those workers, (i.e., regression did not achieve statistical significance at $P < 0.01$ based on the corresponding likelihood ratio statistic). The MLEs of URFs in Table 6 range from 9.03E-05 to 2.34E-04 per μg/m^3 while the 95% UCLs on the URFs range from 1.48E-04 to 6.03E-04 per μg/m^3. The MLE of the URFs are the preferred URFs and the preferred URFs for each of the individual study is highlighted in a gray shaded box in Table 6 and are as follows:

- Tacoma,Washington:1.19E-04 per μg/m^3;
- Anaconda, Montana: 2.18E-04 per μg/m^3;
- Ronnskar, Sweden: 1.11E-04 per μg/m^3.

Additionally, the URFs based on the US specific rates were found to be similar to the URFs based on Texas specific rates.

3.9. Combined analysis – combining URFs of all studies

3.9.1. Comparison of respiratory or lung cancer mortality to lung cancer incidence

Enterline et al. (1995) and Lubin et al. (2000, 2008) examined respiratory cancer mortality (i.e., larynx, bronchus, trachea, lung, and other residual) by cumulative arsenic exposure level whereas the Järup et al. (1989) epidemiology study investigated lung cancer mortality. Lung cancer mortality was considered the cancer endpoint of interest for all three studies for risk estimation purposes. The respiratory cancer mortality data from Enterline et al. (1995) and Lubin et al. (2000, 2008) are a reasonable surrogate for lung cancer as most (96%) of the observed deaths (i.e., 182 out of 188 and 428 out of 446, respectively) were due to lung cancer. As lung cancer mortality, and consequently respiratory cancer mortality, are reasonably predictive of lung cancer incidence (i.e., five-year survival is only about 15% (ACS, 2005)), the TCEQ considers the cancer potency estimates based on the three studies and the resulting calculations as comparable (i.e., lung cancer incidence and mortality rates are sufficiently similar to respiratory cancer mortality rates as to be comparable for purposes of this assessment).

3.9.2. Combining URFs using weighting procedures

The values of the URFs and the corresponding 95% UCLs on the URFs derived from the individual studies listed in Table 6 have a range of values. Although the range of URFs is not very large (less than a factor of three for the MLE URFs), it is advantageous for regulatory purposes to have a single URF that best describes the potential excess of lung cancers per unit of environmental concentration. The URFs based on full cohorts (adjusting for the year of hire when possible) from the Tacoma cohort, the Montana cohort and the Sweden cohort are considered appropriate estimates of the carcinogenic potency of arsenic based on their respective studies, and the three central estimates (i.e. MLE) range from 1.11E-04 to 2.18E-04 per μg/m^3 (Table 6).

The inverse of the variance of the individual URFs can be used as weights in each study to combine the individual URFs. The inverse-variance weighting combined-analyses require the estimated variance of the individual URFs. The variance of the URFs are calculated using the following formula

$$\mathrm{SE}(\mathrm{URF}_i) = (95\%\ \mathrm{UCL\ on\ URF}_i - \mathrm{MLE\ of\ URF}_i)/1.645$$

where, $i = 1, 2, 3$ is an indicator for the study, 1.645 is the 95-th percentile of the standard normal distribution and SE is the standard error of the ith-URF. The resulting standard errors for the Tacoma, Montana and Sweden studies are equal to 5.65E-05, 6.14E-05 and 6.2E-05, respectively.

The MLE of the combined URF is now given by the weighted average of the MLEs of the individual URFs. The weights are the inverse of the squared SE's of the individual URFs. That is,

Table 6
Maximum likelihood estimates (MLE) and 95% upper confidence limits (UCLs) on the URFs of lung cancer mortality for the three individual studies used in deriving the final URF.

Data	URF per μg/m^3	
	MLE	95% UCL
Tacoma, Washington (Asarco Smelter, Enterline and Marsh, 1982; Enterline et al., 1987a,b, 1995)		
All workers adjusting for year of hire	*1.19E-04*[a]	*2.12E-04*
All workers with no adjustment for year of hire	8.08E-05	1.51E-04
Workers hired <1940	1.30E-04	2.49E-04
Workers hired 1940+	n/a[b]	n/a
Montana (Anaconda copper smelter, *Lubin et al., 2000, 2008*)		
Full Cohort	*2.18E-04*[a]	*3.19E-04*
Ronnskar, Sweden (copper smelter, Järup et al., 1989; Viren and Silvers, 1994)		
All workers adjusting for year of hire	*1.11E-04*[a]	*2.13E-04*
All workers with no adjustment for year of hire	9.03E-05	1.48E-04
Workers hired <1940	1.00E-04	1.84E-04
Workers hired 1940+	2.34E-04	6.03E-04

Preferred study-specific characterizations are noted by italic text.

[a] Preferred study-specific URF.

[b] TCEQ did not calculate URFs for Tacoma workers hired 1940+ because Viren and Silvers (1999) found no association for those workers, (i.e., regression did not achieve statistical significance at $P < 0.01$ based on the corresponding likelihood ratio statistic).

Author's personal copy

$$\text{Combined URF(Risk per } \mu g/m^3) = \frac{(w_1 \times \text{URF}_1) + (w_2 \times \text{URF}_2) + (w_3 \times \text{URF}_3)}{w_1 + w_2 + w_3}$$

where $w_i = [1/\text{SE}(\text{URF}_i)]^2$ for $i = 1, 2, 3$, or

$$\text{Combined URF(Risk per } \mu g/m^3) = \frac{(3.13 \times 10^8) \times (1.19 \times 10^{-4}) + (2.65 \times 10^8) \times (2.18 \times 10^{-4}) + (2.60 \times 10^8) \times (1.11 \times 10^{-4})}{3.13 \times 10^8 + 2.65 \times 10^8 + 2.60 \times 10^8}$$
$$= 1.48\text{E-}04 \text{ per } \mu g/m^3 \text{ or } 1.5\text{E-}04 \text{ per } \mu g/m^3 \text{ (Rounding to two significant digits).}$$

The final combined best estimate of the inverse-variance-weighted URF based on Texas lung cancer mortality rates and survival probabilities is 1.5E-04 per $\mu g/m^3$ and the resulting *no significant risk level* at a 1 in 100,000 excess lung cancer risk is 0.067 $\mu g/m^3$ (rounded to two significant figures).

The 95% UCL on the combined URF can be calculated in addition to the combined central estimate of the URF. Here, the standard error of the inverse-variance-weighted URF is simply given by the square root of the inverse of the sum of the weights; that is,

$$\text{SE(Combined URF)} = \sqrt{\frac{1}{w_1 + w_2 + w_3}}$$

where, again, $w_i = [1/\text{S.E.}(\text{URF}_i)]^2$ for $i = 1, 2, 3$. The resulting standard error of the combined URF is then equal to 3.45E-05. Thus, the 95% UCL on the combined URF is given by

$$95\%\text{ UCL on combined URF (Risk per } \mu g/m^3) = \text{URF (Risk per } \mu g/m^3) + 1.645 \times \text{SE(combined URF)}$$
$$95\%\text{ UCL on combined URF (Risk per } \mu g/m^3) = 1.50 \times 10^{-4} + 1.645 \times 3.45 \times 10^{-5} = 2.05 \times 10^{-4} \text{ per } \mu g/m^3$$

The 95% UCL on the URF is only 37% greater than the final URF based on the best estimates of the individual studies.

3.10. Sensitivity analysis to various meta-analysis procedures

Analyses that combine URFs or slopes are useful when only that information is available. In some cases where the data used to derive the individual URFs and slopes are available, more robust meta-analyses can be developed. The available data of the individual studies can be combined and models fit to the combined data as a type of meta-analysis.

The TCEQ combined data from the three studies with similar dose metric and combined the individual URFs using inverse-variance weighting as recommended by the TCEQ arsenic peer review panel. As an alternate, TCEQ also calculated a URF based on the combined slopes (β) from the individual studies using inverse-variance weighting.

In addition, the TCEQ fit the linear multiplicative relative risk model to the combined summary data using Poisson regression and maximum likelihood estimation. Two alternative model parameterizations of the combined data were explored. The first model was identical to the models described before and assumed that the intercept α is identical for all the cohorts and sub-cohorts. The second model assumed that each cohort or sub-cohort could have a different intercept (i.e., each cohort or sub-cohort was allowed to have a different background respiratory or lung cancer mortality rate). The different intercepts in the second model estimated different background cancer mortality rates for the Tacoma workers hired before 1940, the Tacoma workers hired after 1940, the Montana workers, the Sweden workers hired before 1940 and the Sweden workers hired after 1940. Both, the first and second models, estimated a single slope β, its corresponding SE and the 95% UCL on β.

Table 7 shows the results of the sensitivity analysis by comparing the central estimate of the URF and the 95% UCL on the URF for the alternative three meta-analyses with the combined analysis that combined URFs using inverse variance weighting. The range of the MLE URFs (1.48E-04 to 2.07E-04 per $\mu g/m^3$) for the analyses shown in Table 7 is less than a factor of 2. The MLE of the URF for the estimate based on the combined slope is identical to the final MLE of the URF based on the combined individual URFs. The URF and 95% UCL on the URF corresponding to the second fitted model to the data are more reliable than the estimates based on the first model because the second model fits the data statistically significantly better than the first model. In addition, the first model is rejected because of lack of fit, whereas the second model is not rejected as a good fit to the data. The URF (MLE) of 1.60E-04 per $\mu g/m^3$ from the second model is very similar to the TCEQ's preferred URF (MLE) of 1.5E-04 per $\mu g/m^3$ from the combined analysis using inverse variance of the URFs to weight individual URFs.

4. Discussion

The TCEQ used the multiplicative relative risk model, as opposed to the additive risk model, to estimate URF for lung cancer. The multiplicative relative risk model is preferred over the additive risk model for lung cancer because of more plausible assumptions concerning the increase in risk with age. Lung cancer risk increases rapidly with age, which is better captured by the multiplicative relative risk model where risk increases over background rates multiplicatively. By contrast, the additive risk model assumes that cumulative exposure causes the same absolute increase in risk regardless of the age at which the risk is calculated which is less plausible relative to actual observed age-related increases in lung cancer mortality and overall mortality. Lubin et al. (2000) investigated the absolute or additive risk model but found that it provided poorer fits to the data than the multiplicative relative risk model.

Viren and Silvers (1999) fitted models to the Asarco cohort data using the same procedure as TCEQ with a slightly different model parameterization. After adjusting for the differences in model parameterizations, the TCEQ and Viren and Silvers (1999) parameters are identical. Viren and Silvers (1999), however, failed to adjust for the year of hire in their model fit to the total cohort.

Lubin et al. (2008) estimate of the slope based on the full cohort of the Anaconda smelter (4.76E-05 per $\mu g/m^3$-yr) is approximately

Author's personal copy

Table 7
Sensitivity analysis-estimated URF and 95% UCL on the URF of lung cancer mortality resulting from a type of meta-analyses that combine the Tacoma, Montana and Sweden cohorts.

Meta-analysis	URF per μg/m^3	
	MLE	95% UCL
Using *inverse-variance weighting* to estimate a common intercept α and a common slope β from the intercepts and slopes of the individual cohorts (Section 4.2.4.6.1 of TCEQ, 2012)	1.48E-04	2.04E-04
First model Estimating *one intercept* and a single slope of the multiplicative relative risk model fit to the combined data from the three cohorts (Section 4.2.4.6.2 of TCEQ, 2012)	2.07E-04	2.69E-04
Second model Estimating *an intercept for each cohort* or sub-cohort and a single slope of the multiplicative relative risk model fit to the combined data from the three cohorts (Section 4.2.4.6.2 of TCEQ, 2012)	1.60E-04	2.19E-04
Preferred URF (Combined-analysis using inverse variance of the URFs to weight individual URFs) (Section 4.2.5 of TCEQ, 2012)	1.50E-04	2.05E-04

20% less than the 5.75E-05 per μg/m^3-yr estimated by the TCEQ. Lubin et al. (2008) estimated their slope using cohort-specific estimates of background rates (which can be done only when the raw data are available), whereas the TCEQ used the available external background rates provided in summary statistics. The TCEQ slope was used because the parameter was estimated using the same model and assumptions for all the epidemiological data sets used in the assessment. Lubin et al. (2008) also provided model fits using novel weighted cumulative exposures similar to the weighted cumulative exposures used by Jones et al. (2007) in their analyses of the UK tin smelter (TCEQ 2012 offers an extensive discussion of these findings).

Viren and Silvers (1994) used summary data from Järup et al. (1989) to fit an absolute risk model. The TCEQ used the same data to fit the multiplicative background relative risk model using Poisson regression. The TCEQ used the mid-point of the exposure intervals in the summary data of Järup et al. (1989) to represent the average cumulative exposure. The TCEQ fit the data including the highest cumulative exposure interval, which only included the lower bound of the interval and the mid-point was assumed to be 25% greater than the lower bound of the interval (Viren and Silvers 1994). The TCEQ also fit the same model to the same data but excluded the highest cumulative exposure group. The TCEQ found that the likelihoods of observing the summary cohort data of the models fit with or without the highest group were essentially equal, indicating that the model fit to the data that includes all the exposure groups is as good as the model fit to the data that excludes the highest group (TCEQ, 2012).

In addition to model parameter estimation, the TCEQ also considered other issues that are relevant to this risk assessment and are discussed below. In summary, the final URF from the combined analysis (URF MLE) of 1.5E-04 per μg/m^3 is very similar to the URF calculated during the sensitivity analysis using a type of meta-analysis approach (URF (MLE) of 1.60E-04 per μg/^{3} (Table 7).

4.1. Background rates in study cohorts

The ratio between the cohort's observed cancer rate in unexposed workers and the reference population's background cancer rates (the intercept α) ranged between 1.43 and 2.05 for the Asarco smelter workers and between 2.37 and 2.67 for the Swedish workers. Viren and Silvers (1999) obtained similar results for the Asarco cohort and concluded that the model was "strictly linear with evidence of highly significant background lung cancer risk (fitted intercept), suggesting that other factors unrelated to arsenic affected the lung cancer outcome among these workers". Järup et al. (1989) also noted that the background rates in the unexposed workers of the Swedish cohort were substantially higher than the background rates in the reference population. They concluded that the differences could be due to "other occupational exposures to carcinogenic substances" or to different personal lifestyles (Doll, 1985).

4.2. Evaluating susceptibility from early-life exposures

USEPA (2005b) provides default age-dependent adjustment factors (ADAFs) to account for potential increased susceptibility in children due to early-life exposure when a chemical has been identified as acting through a mutagenic MOA for carcinogenesis. The mechanisms of arsenic carcinogenesis have not been established, although a variety of mechanisms are likely to be involved as briefly discussed above (TCEQ, 2012).

Arsenic has not been identified by USEPA as having a mutagenic MOA (USEPA, 2005b), and data are not sufficient to determine the carcinogenic MOA. As the MOA for arsenic-induced lung cancer has not been determined to be mutagenic by consensus of the scientific community, ADAFs will not be applied to the URF. This issue will be reevaluated periodically as new scientific information on arsenic's carcinogenic MOA becomes available.

There is some evidence indicating transplacental arsenic carcinogenesis in mice exposed to very high concentrations via drinking water (Waalkes et al., 2007; Ahlborn et al., 2009). However, these studies are limited for extrapolating cancer risk to humans via the inhalation route. Oral toxicity data are the most common data available as alternatives to inhalation data. However, USEPA (1994) recommends caution when using oral toxicity data for inhalation toxicity. Oral data should not be used for route-to-route extrapolation when chemicals are expected to have different toxicity by the two routes (e.g. metals, irritants, and sensitizers).

4.3. Uncertainty analysis

There are several uncertainties associated with the calculation of URFs based on epidemiological studies and specifically, calculation of URFs calculated for arsenic and arsenic compounds. The primary uncertainties are those associated with dose–response modeling and using epidemiological occupational studies to estimate risks for the general population and other potentially sensitive subpopulations. In addition, there are additional uncertainties due to occupational exposure estimation error, smoking, and co-exposures to other compounds.

4.3.1. Estimating risks for other potentially sensitive subpopulations

The relationship between lung cancer mortality and exposure to arsenic was evaluated based on healthy male workers employed in smelters. Although these workers were often healthier than the general population, the approach used by TCEQ estimates how the risk of lung cancer mortality changes with exposure to arsenic after

Author's personal copy

adjusting for the differences between the workers and the general population background lung cancer mortality rates. The estimates of excess risks based on the derived models apply to the target population (e.g., Texas all sexes and all races, Texas white males, US black females, etc.) whose background lung mortality cancer rates and survival probabilities are used in the estimation of the extra risks. The assumption being made in the calculation of the URFs is that the increase in the excess risk per a unit increase in the dose metric (i.e., cumulative exposure or weighted cumulative exposure to arsenic) is the same for the workers and for the target population. Subpopulations with higher background lung cancer mortality rates will have higher estimated URFs.

The model may underestimate excess risks for subpopulations that are particularly more sensitive than smelter workers to arsenic exposures. For example, Ihrig et al. (1998) reported that Hispanic populations have a genetic impairment in folate metabolism, an essential component to protect against arsenic toxicity. However, it is uncertain if this particular population were represented in the three smelter cohort studies. Also, smelter workers in the cohorts are often white males and therefore there is uncertainty about estimating the risk for subpopulations more sensitive to arsenic exposures than these workers.

4.3.2. Estimating risks for the general population from occupational workers

While the database of human epidemiologic studies are vast, many of the studies are limited by confounding factors such as smoking, exposure to other chemicals, and differences in population characteristics (e.g., nutritional state, metabolism, toxicokinetics) (ATSDR, 2007). These confounders can limit the extrapolation of the study results to the general population. In addition, the general population does not have the same exposure levels as occupational workers, who are generally exposed to higher concentrations. Further, workers are often healthy and there is uncertainty in extrapolating the results of epidemiology studies from occupational workers to the general population (healthy worker survivor effect). Arrighi and Hertz-Picciotto (1996) reported that for arsenic exposure, the healthy worker survivor effect was not strong enough to mask the strong effect of arsenic exposure on respiratory cancer.

While, the available epidemiology data indicates lung cancer risk in workers exposed to high concentrations of arsenic, the existing studies that report on the risk of lung cancer among residents in communities in the vicinity of a smelter are generally limited because they lack information on individual exposures and other potential confounding factors (Pershagen, 1985; Matanoski et al., 1981; Newman et al., 1976). There appears to be some disagreement among the scientific community in relating lung cancer to arsenic exposure for residents of communities in close proximity to smelters. According to an ATSDR (2007) review, several studies suggest that residents living near smelters or arsenical chemical plants may also have increased risk of lung cancer (Brown et al., 1984; Cordier et al., 1983; Matanoski et al., 1981), although the increases are small and are not clearly detectable in all cases (e.g., Frost et al., 1987). A cohort mortality study was conducted to explore lung cancer in individuals who lived near the smelter as children for at least two years between 1907 and 1932 (WSDH and ATSDR, 1994). Additionally, Tollestrup et al. (2003) conducted a retrospective cohort study to determine if long-term childhood exposures to ambient arsenic were associated with increased mortality rates. Tollestrup et al. (2003) reported elevated hazard ratios for boys in the highest exposure categories, ischemic heart disease, and external causes. However, these effects were not observed for girls in any of the categories. While, Tollestrup et al. (2003) attributed the elevated hazard ratios to chance, they also cautioned that the effects of childhood arsenic exposure might be different from that of adults. Overall, these studies do not indicate an increase in risk of lung or other cancers related to arsenic exposure in this population. Other studies have reported no associations (Rom et al., 1982; Greaves et al., 1981). In general, the available estimated exposure estimates indicated arsenic concentrations decrease as one moves farther away from the smelter. The overall evidence on communities living near historical arsenic emitting sources does not indicate cancer risk at low-level exposures, although these conclusions are limited because of poor exposure estimates.

4.3.3. Uncertainty due to co-exposures to other compounds

In addition to arsenic exposure, smelter workers can also be exposed to other potential respiratory toxicants (e.g., sulfur dioxide) and many of the workers were smokers. The risk estimates can therefore be confounded by co-exposure to other pollutants and/or smoking. Data on the interaction of smoking and arsenic exposure are available for some of the cohorts and indicate an intermediate effect that is between additive and multiplicative (Järup and Pershagen, 1991). Enterline et al. (1987b) studied the mortality experience of workers at one of eight US copper smelters in Arizona, Utah, Tennessee, and Nevada. Further, they also conducted a nested case-control study in which they showed that arsenic exposure and cigarette smoking to be significant risk factors for lung cancer in the smelter workers, albeit suggesting that the risk attributable to arsenic in this study population is somewhat lower than indicated by the SMR reported above.

Although Lubin et al. (2000) did not investigate smoking, Welch et al. (1982) and Higgins et al. (1982) found that smoking did not confound the association between inhaled arsenic exposure and respiratory cancer based on a sample of 1469 workers from the Montana cohort. The relationship between respiratory cancer and exposure to airborne arsenic and sulfur dioxide was investigated by Lubin et al. (2000). Relative risks did not increase with sulfur dioxide exposure within arsenic-exposure categories whereas relative risk increased with increasing duration of employment in work areas with heavy and medium arsenic exposure within each sulfur dioxide category. This indicates that sulfur dioxide co-exposure did not confound the arsenic dose–response. Järup et al. (1989) also found that there was no evident dose–response relationship between estimated exposure to sulfur dioxide and lung cancer.

5. Conclusions

The TCEQ has developed an arsenic inhalation URF for lung cancer of 1.50E-04 per $\mu g/m^3$ based on respiratory and lung cancer mortality in updated epidemiological studies on Asarco, Anaconda and Swedish smelter workers. The air concentrations of 0.67, 0.067, and 0.0067 $\mu g/m^3$ correspond to extra risks of 10^{-4}, 10^{-5}, and 10^{-6}, respectively. In addition, the TCEQ also conducted a sensitivity analysis, in which they calculated a URF based on a type of meta-analysis. Interestingly, the results of the combined analysis compared well with the results of the type of meta-analysis that was conducted as part of the sensitivity analysis

The main differences between the TCEQ URF of 1.5E-04 per $\mu g/m^3$ and the USEPA URF of 4.3E-03 per $\mu g/m^3$ are due to the fact that TCEQ used updated and more accurate exposure estimates for the Tacoma and the Montana cohorts in addition to including a Swedish cohort. TCEQ (2012) discusses in more detail the differences between the TCEQ and USEPA URFs. Although mortality potency factors were used to predict and protect against lung cancer incidence, the URF is considered to be sufficiently health-protective because lung cancer mortality is predictive of lung cancer incidence. These values will be used to evaluate ambient air monitoring data so that the general Texas public is protected against adverse health effects from chronic exposure to arsenic.

Author's personal copy

6. Conflict of interest statement

The authors declare that there are no conflicts of interest.

Acknowledgments

The authors would like to thank the staff from Toxicology Excellence for Risk Assessment (TERA) who organized the peer review of the arsenic DSD. The peer reviewers conducted a careful, critical review of the draft DSD and provided many useful suggestions for improvements to the final DSD. Finally, technical comments from staff of the Toxicology Division of the TCEQ and agency support at all levels significantly contributed to the development of a DSD of high scientific quality.

References

ACS, 2005. American Cancer Society. Cancer facts and figures. Available at <http://www.cancer.org/downloads/STT/CAFF2005f4PWSecured.pdf> (accessed May 2009).

Ahlborn, G.J., Nelson, G.M., Grindstaff, R.D., Waalkes, M.P., Diwan, B.A., Allen, J.W., Kitchin, K.T., Preston, R.J., Hernandez-Zavala, A., Adair, B., Thomas, D.J., Delker, D.A., 2009. Impact of life stage and duration of exposure on arsenic-induced proliferative lesions and neoplasia in C3H mice. Toxicology 262 (2), 106–113.

Arrighi, H.M., Hertz-Picciotto, I., 1996. Controlling the healthy worker survivor effect: an example of arsenic exposure and respiratory cancer. Occup. Environ. Med. 53 (7), 455–462.

ATSDR, 2007. Toxicological profile for arsenic. US Dept of Health and Human Services. Public Service.

Binks, K., Doll, R., Gillies, M., Holroyd, C., Jones, S.R., McGeoghegan, D., Scott, L., Wakeford, R., Walker, P., 2005. Mortality experience of male workers at a UK tin smelter. Occup. Med. (Lond.) 55 (3), 215–226.

Brown, C.C., Chu, K.C., 1983a. Approaches to epidemiologic analysis of prospective and retrospective studies: example of lung cancer and exposure to arsenic. In: Risk Assessment Proc. SIMS Conf. on Environ. Epidemiol. June 28–July 2, 1982. SIAM Publications, Alta, VT.

Brown, C.C., Chu, K.C., 1983b. Implications of the multistage theory of carcinogenesis applied to occupational arsenic exposure. J. Natl. Cancer Inst. 70 (3), 455–463.

Brown, C.C., Chu, K.C., 1983c. A new method for the analysis of cohort studies: Implications of the multistage theory of carcinogenesis applied to occupational arsenic exposure. Environ. Health Perspect. 50, 293–308.

Brown, L.M., Pottern, L.M., Blot, W.J., 1984. Lung cancer in relation to environmental pollutants emitted from industrial sources. Environ. Res. 34, 250–261.

Chilakapati, J., Ren, H., Wallace, K., Bailey, K., Fricke, M., Creed, J., Ward, W., Kitchin, K., 2010. Dimethylthioarsinic acid. Toxicology 268 (1–2), 31–39.

Cordier, S., Thériault, G., Iturra, H., 1983. Mortality patterns in a population living near a copper smelter. Environ. Res. 31 (2), 311–322.

Crump, K.S., Allen, B.C., 1985. Methods of quantitative risk assessment using occupational studies. Am. Stat. 39, 442–450.

Doll, R., 1985. Occupational cancer: a hazard for epidemiologists. Int. J. Epidemiol. 14, 22–31.

Enterline, P.E., Marsh, G.M., 1982. Cancer among workers exposed to arsenic and other substances in a copper smelter. Am. J. Epidemiol. 116 (6), 895–911.

Enterline, P.E., Day, R., Marsh, G.M., 1995. Cancers related to exposure to arsenic at a copper smelter. Occup. Environ. Med. 52 (1), 28–32.

Enterline, P.E., Henderson, V.L., Marsh, G.M., 1987a. Exposure to arsenic and respiratory cancer. A reanalysis. Am. J. Epidemiol. 125 (6), 929–938.

Enterline, P.E., Marsh, G.M., Esmen, N.A., Henderson, V.L., Callahan, C.M., Paik, M., 1987b. Some effects of cigarette smoking, arsenic, and SO_2 on mortality among US copper smelter workers. J. Occup. Med. 29 (10), 831–838.

Frost, F., Harter, L., Milham, S., et al., 1987. Lung cancer among women residing close to an arsenic emitting copper smelter. Arch. Environ. Health 42 (2), 148–152.

Gentry, P.R., McDonald, T.B., Sullivan, D.E., Shipp, A.M., Yager, J.W., Clewell, H.J., 2010. Analysis of genomic dose-response information on arsenic to inform key events in a mode of action for carcinogenicity. Environ. Mol. Mutagen. 51, 1–14.

Health Canada, 1994. Canadian Environmental Protection Act. Human Health Risk Assessment for Priority Substances. Catalogue No. En40-215/41E, Minister of Supply and Services Canada, Ottawa.

Health Canada, 2006. Guidelines for Canadian Drinking Water Quality: Guideline Technical Document – Arsenic. Water Quality and Health Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.

Higgins, I., Welch, K., Burchfield, C., 1982. Mortality of Anaconda Smelter Workers in Relation to Arsenic and other Exposures. University of Michigan, Dept. Epidemiology, Ann Arbor, MI.

IARC, 2004. Vol. 84. Some Drinking-Water Disinfectants and Contaminants including Arsenic. International Agency for Research on Cancer, Lyon.

Ihrig, M.M., Shalat, S.L., Baynes, C., 1998. A hospital-based case-control study of stillbirths and environmental exposure to arsenic using an atmospheric dispersion model linked to geographic information system. Epidemiology 9, 290–294.

Greaves, W.W., Rom, W.N., Lyon, J.L., Varley, G., Wright, D.D., Chiu, G., 1981. Relationship between lung cancer and distance of residence from nonferrous smelter stack effluent. Am. J. Ind. Med. 2 (1), 15–23.

Jräup, L., Pershagen, G., 1991. Arsenic exposure, smoking, and lung cancer in smelter workers– a case-control study. Am. J. Epidemiol. 134 (6), 545–551.

Järup, L., Pershagen, G., Wall, S., 1989. Cumulative arsenic exposure and lung cancer in smelter workers: a dose–response study. Am. J. Ind. Med. 15 (1), 31–41.

Jones, S.R., Atkin, P., Holroyd, C., Lutman, E., Batlle, J.V., Wakeford, R., Walker, P., 2007. Lung cancer mortality at a UK tin smelter. Occup. Med. (Lond.) 57 (4), 238–245.

Lee-Feldstein, A., 1983. Arsenic and respiratory cancer in man: follow-up of an occupational study. In: Lederer, W., Fensterheim, R. (Eds.), Arsenic: Industrial, Biomedical, and Environmental Perspectives. Van Nostrand Reinhold, New York.

Lubin, J.H., Pottern, L.M., Stone, B.J., Fraumeni, J.F., 2000. Respiratory cancer in a cohort of copper smelter workers: results from more than 50 years of follow-up. Am. J. Epidemiol. 151, 554–565.

Lubin, J.H., Moore, L.E., Fraumeni Jr., J.F., Cantor, K.P., 2008. Respiratory cancer and inhaled inorganic arsenic in copper smelters workers: a linear relationship with cumulative exposure that increases with concentration. Environ. Health Perspect. 116 (12), 1661–1665.

Matanoski, G., Landau, E., Tonascia, J., et al., 1981. Cancer mortality in an industrial area of Baltimore. Environ. Res. 25, 8–28.

Morris, H.F., 1978. Testimony on proposed standard for exposure to inorganic arsenic (exhibit 28B) in Department of Labor, Occupational Safety and Health Administration: occupational exposures to inorganic arsenic—final standard. Fed. Reg. 43, 19584–19629.

NRC, 1983. Risk Assessment in the Federal Government. National Research Council, National Academy Press, Washington, DC.

NRC, 1988. Health Risks of Radon and Other Internally Deposited Alpha-Emitters. Committee on the Biological Effects of Ionizing Radiations (BEIR IV). Board on Radiation Effects Research. Commission of Life Sciences. National Research Council. National Academy Press, Washington, DC.

NRC, 1994. Science and Judgment in Risk Assessment. National Research Council, National Academy Press, Washington, DC.

NRC, 2001. Standing Operating Procedures for Developing Acute Exposure Guideline Levels for Hazardous Chemicals. National Research Council, National Academy Press, Washington, DC.

Newman, J.A., Archer, V.E., Saccomanno, G., Kuschner, M., Auerbach, O., Grondahl, R.D., Wilson, J.C., 1976. Histological types of bronchogenic carcinoma among members of copper-mining and smelting communities. Ann. NY Acad. Sci. 271, 260–268.

Pershagen, G., 1985. Lung cancer mortality among men living near an arsenic-emitting smelter. Am. J. Epidemiol. 122 (4), 684–694.

Pinto, S.S., Varner, M.O., Nelson, K.W., Labbe, A.L., White, L.D., 1976. Arsenic trioxide absorption and excretion in industry. J. Occup. Med. 18 (10), 677–680.

Rom, W.N., Varley, G., Lyon, J.L., Shopkow, S., 1982. Lung cancer mortality among residents living near the El Paso smelter. Br. J. Ind. Med. 39, 269–272.

Salnikow, K., Zhitkovich, A., 2008. Genetic and epigenetic mechanisms in metal carcinogenesis and co carcinogenesis: nickel, arsenic, and chromium. Chem. Res. Toxicol. 21, 28–44.

Schoen, A., Beck, B., Sharma, R., Dube, E., 2004. Arsenic toxicity at low doses: epidemiological and mode of action considerations. Toxicol. Appl. Pharmacol. 198, 253–267.

Smith, A.H., Ercumen, A., Yuan, Y., Steinmaus, C.M., 2009. Increased lung cancer risks are similar whether arsenic is ingested or inhaled. J. Exposure Sci. Epidemiol. 19, 343–348.

Snow, E.T., Sykora, P., Durham, T.R., Klein, C.B., 2005. Arsenic, mode of action at biologically plausible low doses: what are the implications for low dose cancer risk? Toxicol. Appl. Pharmacol. 207 (2 Suppl), 557–564.

Suzuki, S., Arnold, L.L., Pennington, K.L., Kakiuchi-Kiyota, S., Cohen, S.M., 2009. Effects of co-administration of dietary sodium arsenite and an NADPH oxidase inhibitor on the rat bladder epithelium. Toxicology 261 (1–2), 41–46.

Tang, L.Y., Zhen, C., 1996. A retrospective lung cancer mortality study of people exposed to insoluble arsenic and radon. Lung Cancer 14, S137–S148.

TCEQ, 2006. Guidelines to Develop Effects Screening Levels, Reference Values, and Unit Risk Factors, RG-442. Texas Commission on Environmental Quality. Available at <http://www.tceq.state.tx.us/comm_exec/forms_pubs/pubs/rg/rg-442.html>.

TCEQ, 2012. Proposed Development Support Document Arsenic and Inorganic Arsenic Compounds CAS Registry Numbers: 7440-38-2 (Arsenic). Texas Commission on Environmental Quality, Toxicology Division, Chief Engineer's Office. Available at <http://www.tceq.texas.gov/toxicology/dsd/final.html>.

Tollestrup, K., Frost, F.J., Harter, L.C., McMillan, G.P., 2003. Mortality among children residing near the American Smelting and Refining Company (ASARCO) copper smelter in Ruston, Washington. Arch. Environ. Health 58 (11), 683–691.

USEPA, 1984. Health Assessment Document for Inorganic Arsenic. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Research Triangle Park, NC. EPA 600/8-83-021F.

USEPA, 1994. Methods for derivation of inhalation reference concentrations and application of inhalation dosimetry. EPA/600/8–90/066F.

USEPA, 1998. Integrated Risk Information System (IRIS): Arsenic, inorganic. <http://www.epa.gov/iris/subst/0278.htm>.

USEPA, 2005a. Guidelines for Carcinogen Risk Assessment. EPA/630/P-03/001F. Risk Assessment Forum. Washington, DC.

USEPA, 2005b. Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens. EPA/630/R-03/003F. Risk Assessment Forum. Washington, DC.

Author's personal copy

Viren, J.R., Silvers, A., 1994. Unit risk estimates for airborne arsenic exposure: an updated view based on recent data from two copper smelter cohorts. Regul. Toxicol. Pharmacol. 20 (2), 125–138.

Viren, J., Silvers, A., 1999. Nonlinearity in the lung cancer dose-response for airborne arsenic: apparent confounding by year of hire in evaluating lung cancer risks from arsenic exposure in Tacoma smelter workers. Regul. Toxicol. Pharmacol. 30 (2 Pt 1), 117–129.

Waalkes, M.P., Liu, J., Diwan, B.A., 2007. Transplacental arsenic carcinogenesis in mice. Toxicol. Appl. Pharmacol. 222, 271–280.

Welch, K., Higgins, I., Oh, M., Burchfiel, C., 1982. Arsenic exposure, smoking, and respiratory cancer in copper smelter workers. Arch. Environ. Health 37 (6), 325–335.

WSDH and ATSDR, 1994. Mortality study of children residing near Asarco copper smelter in Ruston, Washington. PB95-142022. Washington State Department of Health, Olympia, WA, and Agency for Toxic Substances and Disease Registry, Atlanta, GA.

Stoel Rives LLP

September 11, 2024

W. Christopher Pooser
101 S. Capitol Boulevard, Suite 1900
Boise, ID 83702
D. 208.387.4289
christopher.pooser@stoel.com

VIA HAND DELIVERY

Dylan Lawerence
Varin Thomas
242 N. 8th Street, Ste. 220
PO Box 1676
Boise, ID 83701

Re: Perpetua Resources Idaho, Inc's Expert Declarations

Dear Mr. Lawrence:

Enclosed please find true and correct hard copies of the following documents submitted on August 30, 2024, via email and sharepoint in the contested case of In the Matter of Air Quality Permit to Construct P-2019.0047, Case Docket No. 0101-22-01:

1. Declaration of Kevin Lewis, and the documents attached to his declaration; and

2. Declaration of Theresa Lopez, the documents attached to her declaration, and the documents identified in Attachment A to Ms. Lopez's Memorandum in Support of Declaration.

Very truly yours,



W. Christopher Pooser

Enclosures

cc (without enclosures): Michael Short (michael.short@deq.idaho.gov)
Bryan Hurlbutt (bhurlbutt@advocateswest.org)
Julia Thrower (jthrower@mtntoplaw.com)
Paula Wilson (Paula.Wilson@deq.idaho.gov)
Office of Administrative Hearings (filings@oah.idaho.gov)

DYLAN LAWRENCE
VARIN THOMAS LLC
P.O. Box 1676
Boise, ID 83701
(208) 345-6021
dylan@varinthomas.com

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	BEQ Case No. 0101-22-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	)	OAH Case No. 23-245-01 AMENDED SCHEDULING ORDER

On July 8, 2024, the hearing officer issued a Scheduling Order establishing October 17 and 18, 2024, as the dates for a hearing on the merits to address the three remaining issues identified by the Board of Environmental Quality (the "Remaining Issues"). It also established the dates for multiple filing deadlines and conferences, including a status and scheduling conference that took place on September 4, 2024. The purpose of that conference was to re-visit the remaining dates and deadlines in light of the expert witness declarations filed by DEQ and Perpetua.

At the September 4 conference, the parties agreed that there is no need to preserve or establish deadlines for further dispositive motions, motions in limine, motions to strike, or other

procedural motions. Based on the discussion and agreements reached among the parties and hearing officer at that conference, the following dates and deadlines shall govern the remainder of these administrative proceedings:

Friday, October 4, 2024: Deadline for the Petitioners to file responsive expert witness declarations.

Friday, October 11, 2024: Deadline for all parties to file pre-hearing statements, summarizing the testimony each party will adduce at the hearing on the merits and how it relates to the Remaining Issues.

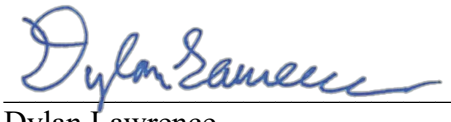
Tuesday, October 15, 2024, 10:30 a.m.: Pre-hearing conference to discuss the upcoming hearing on the merits and any related procedural matters.

Thursday, October 17, 2024, 10:30 a.m.: Day 1 of hearing on the merits, location TBD.

Friday, October 18, 2024, 10:30 a.m.: Day 2 of hearing on the merits, location TBD.

A separate Notice of Hearing will issue upon securing the hearing location. As a reminder, parties filing expert witness declarations shall provide the hearing officer with hard copies of the filings, printed double-sided and placed in a three-ring binder.

Dated this 17th day of September, 2024.



Dylan Lawrence
Hearing Officer

CERTIFICATE OF SERVICE

I hereby certify that on this 17th day of September, 2024, I caused to be served a true and correct copy of the foregoing by the following method to:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Resources Division
Office of the Attorney General
1410 N. Hilton St.
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Michael A. Short
Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
michael.short@deq.idaho.gov
hannah.young@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole Hancock
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
nicole.hancock@stoel.com
via electronic service



Dylan B. Lawrence
Hearing Officer

STATE OF IDAHO

OFFICE OF THE ATTORNEY GENERAL

RAÚL R. LABRADOR

September 24, 2024

HAND DELIVERED

Dylan Lawrence
Varin Thomas
242 N. 8th Street, Suite 220
Boise, ID 83702

Re: Department of Environmental Quality's Expert Declarations

Dear Mr. Lawrence:

Enclosed are true and correct paper copies of the following DEQ expert declarations—as well as true and correct paper copies of all documents referenced in footnotes—submitted on August 13, 2024 in the contested case, *In the Matter of Air Quality Permit to Construct P-2019.0047*, Case Docket No. 0101-22-01, OAH Case No. 23-245-01:

1. Expert Declaration of Norka E. Paden, Ph.D.; and,
2. Expert Declaration of Kevin Schilling.

Sincerely,
/s/ Michael A. Short
Michael A. Short
Deputy Attorney General
Office of the Attorney General

cc (without enclosures):	Bryan Hurlbutt	bhurlbutt@advocateswest.org
	Laird J. Lucas	llucas@advocateswest.org
	Julia Thrower	jthrower@mtntoplaw.com
	Krista K. McIntyre	krista.mcintyre@stoel.com
	W. Christopher Pooser	christopher.pooser@stoel.com
	Wade C. Foster	wade.foster@stoel.com
	Nicole C. Hancock	nicole.hancock@stoel.com
	Paula Wilson	paula.wilson@deq.idaho.gov
	Office of Administrative Hearings	filings@oah.idaho.gov

Energy and Natural Resources Division, Environmental Quality Section
1410 N. Hilton, 2nd Floor, Boise, Idaho 83706-1255
Telephone: (208) 373-0494, FAX: (208) 373-0481

DYLAN LAWRENCE
VARIN THOMAS LLC
P.O. Box 1676
Boise, ID 83701
(208) 345-6021
dylan@varinthomas.com

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	BEQ Case No. 0101-22-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,	)	OAH Case No. 23-245-01
Petitioners,	)	SECOND AMENDED SCHEDULING ORDER AND NOTICE OF HEARING
v.	)	
DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC.,	)	
Intervenor.	)	

On July 8, 2024, the hearing officer issued a Scheduling Order establishing October 17 and 18, 2024, as the dates for a hearing on the merits to address the three remaining issues identified by the Board of Environmental Quality (the "Remaining Issues"). It also established the dates for multiple filing deadlines and conferences, including a status and scheduling conference that took place on September 4, 2024. The purpose of that conference was to re-visit the remaining dates and deadlines in light of the expert witness declarations filed by DEQ and Perpetua.

At the September 4 conference, the parties agreed that there is no need to preserve or establish deadlines for further dispositive motions, motions in limine, motions to strike, or other

procedural motions. In addition, on September 23, 2024, the parties and hearing officer toured available hearing facilities. Based on the discussion and agreements reached among the parties and hearing officer, the following dates and deadlines shall govern the remainder of these administrative proceedings:

Friday, October 4, 2024: Deadline for the Petitioners to file responsive expert witness declarations.

Friday, October 11, 2024: Deadline for all parties to file pre-hearing statements, summarizing the testimony each party will adduce at the hearing on the merits and how it relates to the Remaining Issues.

Tuesday, October 15, 2024, 10:30 a.m.: Pre-hearing conference to discuss the upcoming hearing on the merits and any related procedural matters.

Thursday, October 17, 2024, 9:00 a.m.: Day 1 of hearing on the merits, Joe R. Williams Building, 700 W. State Street, 1st floor East Conference Room, Boise, Idaho 83702.

Friday, October 18, 2024, 9:00 a.m.: Day 2 of hearing on the merits, Joe R. Williams Building, 700 W. State Street, 1st floor East Conference Room, Boise, Idaho 83702.

As a reminder, parties filing expert witness declarations shall provide the hearing officer with hard copies of the filings, printed double-sided and placed in a three-ring binder.

Dated this 25th day of September, 2024.

Dylan Lawrence
Hearing Officer

CERTIFICATE OF SERVICE

I hereby certify that on this 25th day of September, 2024, I caused to be served a true and correct copy of the foregoing by the following method to:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Resources Division
Office of the Attorney General
1410 N. Hilton St.
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Michael A. Short
Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
michael.short@deq.idaho.gov
hannah.young@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole Hancock
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
nicole.hancock@stoel.com
via electronic service

Dylan B. Lawrence
Hearing Officer

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	Agency Case No. 0101-22-01
	)	OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON	)	**EXPERT DECLARATION OF WILLIAM TIEDEMANN**
Petitioners,	)	
v.	)	
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC.	)	
Intervenor-Respondent.	)	

I, WILLIAM TIEDEMANN, declare and affirm as follows:

1. I am employed by the Idaho Conservation League as a Regulatory Conservation Associate. I have been in this position since April 2022.

QUALIFICATIONS AND EXPERIENCE

2. I received my Bachelors of Science (B.S.) in Mechanical Engineering from Gonzaga University, Spokane, WA, in 2013.

3. From 2013 to 2015, I worked at Haakon Industries as a Production Engineer.w I was responsible for managing compliance with federal and State of Washington environmental regulations including Clean Air Act (CAA) permitting and hazardous waste management at Haakon's Cheney, WA, manufacturing plant. There, I was the lead engineer in completing regular CAA permit and hazardous waste reporting requirements, and as well as leading several CAA permit modifications.

4. From 2017 to 2019, I was a CAA Permitting Engineer with the Idaho Department of Environmental Quality where I developed dozens of CAA air quality permits, including Permits to Construct (PTC), Title V Permits, and permit exemption documentation for various facilities. I worked with a variety of facilities, including gravel mining/processing, food manufacturing, landfills, among others. In developing these permits for these various operations, I was responsible for analyzing compliance with Idaho's toxic air pollutant (TAP) requirements. During this time, I became deeply familiar with Idaho Rules for the Control of Air Pollutions (Air Rules) found under IDAPA 58.01.01, as well as federal air permitting regulations 40 C.F.R. 60, 61, and 63.

5. From 2019 to 2022, I worked as a Senior Environmental Engineer at Brown and Caldwell Associates where I worked with a variety of clients on a multitude of projects on permitting and compliance projects, as well as site investigation and remediation. My work involved local, state, and federal environmental regulations within many frameworks including the CAA, Clean Water Act (CWA), Emergency Planning Community Right to Know Act (EPCRA), Spill Prevention Control and Countermeasure (SPCC), National Environmental Policy Act (NEPA), and cyanidation permitting. At the state level, my work included projects that spanned from Idaho, Oregon, Washington, Texas, Minnesota, New Jersey, and Massachusetts. Within the site investigation and remediation scope, my work included groundwater and surface water baseline monitoring, abandoned mine land site characterization, petroleum impacted site remedial action and monitoring, and dioxanes impacted site characterization. Within the CAA scope, my work included assisting clients with stationary source permitting compliance for a variety of industrial facilities, primarily in New Jersey and Idaho.

6. Since April of 2022, I have been employed at the Idaho Conservation League as a Regulatory Conservation Associate. Within this role, I review and provide comments on CWA and CAA permits, participate in federal and state rulemaking, and review CWA and CAA compliance/enforcement activities.

7. Through my career with private firms, the State of Idaho, and a non-profit organization, I have reviewed and/or developed hundreds of CAA permits, participated in dozens of negotiated rulemakings, and have reviewed thousands of pages of environmental rules and regulations across a variety of disciplines.

SCOPE OF REVIEW

8. I have been asked by the Petitioners Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon to review and evaluate the issues raised in the *Final Order in the Matter of Air Quality Permit to Construct P-2019.0047*[1] (Final Order) issued by the Board of Environmental Quality (Board) on May 9, 2024. Specifically, this declaration provides evidence and expert opinion on:

a. Whether DEQ's application of the 16/70 Project-specific adjustment factor to its analysis of ambient arsenic air concentration was appropriate to demonstrate compliance with the rule for carcinogenic TAPs found in IDAPA 58.01.01.586;

b. Whether using a 5-year rolling average for compliance with the rule for carcinogenic TAPs was appropriate and properly supported by the Permit conditions; and

c. Whether there is sufficient evidence to support the T-RACT analysis limiting the non-West End pit production limit.

DOCUMENTS REVIEWED

9. In preparation of this expert declaration, I reviewed the following documents:

- The historic TAPs rulemaking record from State of Idaho historical archives. The historic record includes hundreds of separate documents, including previous draft and final TAPs rules, public hearing transcripts, response to comment documents, emails, memorandums, letters between DEQ and industry stakeholders, hand written notes, and other various documents. Generally, these documents capture the 1991 to 1995 time period in which the original DEQ TAPs policy was formalized within the Idaho Negotiated Rulemaking Process and subsequently modified several times. I reviewed the historic TAPs rulemaking record in person, at the DEQ State office on two separate occasions on August 20, and September 10, 2024.

[1] REC 3695. *Final Order in the Matter of Air Quality Permit to Construct P-2019.0047*, Case Docket No. 0101-22-01, OAH Case No. 23-245-01 (May 9, 2024) (Final Order).

- Perpetua's application for a PTC, the draft PTC (Jan. 13, 2022), final PTC (June 17, 2022), the final Statement of Basis and Response to Comments (June 17, 2022) and associated attachments.
- Idaho's Air Rules, IDAPA 58.01.01.
- The Declarations of Kevin Schilling; Norka E. Paden, Ph.D.; Kevin Lewis; and Theresa Lopez, and each declarations' attached exhibits.
- The documents referenced in this declaration, which are attached as exhibits.

SUMMARY OF OPINIONS

10. Based on my review of case materials and extensive CAA permitting and compliance experience in private practice, with the State of Idaho, and with a non-profit organization, I conclude as follows:

a. DEQ's application of the 16/70 Project-specific adjustment factor to the ambient arsenic air concentration analysis, and the use of exposure duration adjustments like the 16/70 calculations is not supported by the historic TAPs rulemaking record. It was thus inappropriate for DEQ to use such an adjustment factor to demonstrate compliance with the Air Rules.

b. DEQ's interpretation of the TAPs AACCs as averaging periods rather than enforceable "standards" is misplaced and is not supported by the historic TAPs rulemaking record;

c. DEQ use of a 5-year rolling average for TAPs emission calculations is neither supported by the TAPs rule, the historic TAPs rulemaking record, nor by limitations under the Permit conditions; and

d. There was sufficient evidence to support the T-RACT analysis limiting the non-West End pit lifetime production limit, but West End Pit production is not properly constrained below the less than life-of-mine time frame.

OPINIONS

A. Application of the 16/70 Project-specific adjustment factor for assessing compliance with the TAPs rule is inconsistent with the rulemaking history, intent, and plain language of the TAPs rule.

11. When calculating arsenic emissions from the SGP for purposes of assessing compliance with the TAPs Rule, DEQ applied a Project-specific adjustment factor that took the SGP's estimated operational boundary arsenic concentration, multiplied it by 16 (representing the 16 year life of the SGP), divided that number by 70 years (representing an average human life-time), then compared that number the arsenic Ambient Concentration for Carcinogens (AACC) in order to demonstrate TAPs compliance.

12. The Declaration of Kevin Lewis (Lewis Declaration) claims that an "apples to apples" cancer risk comparison of the project's arsenic emissions and the AACC for arsenic cannot be made without the 16/70 Project-specific adjustment factor Lewis Decl. ¶ 58.

13.The Declarations of Norka E. Paden, Ph.D. (Paden Declaration), Kevin Schilling (Schilling Declaration), and Teresa Lopez (Lopez Declaration) all opine on this issue falling into the same problematic trap by relying on the same premise.

14. Based on my review of the historical records related to the development of the TAPs Rule, it is evident that the AACCs were developed as annual emission limits, with the intent that compliance is demonstrated on a year-over-year basis. The records demonstrate that

the use of an exposure duration adjustment,[2] like the 16/70 Project-specific adjustment factor used for the SGP, was directly considered by DEQ, and ultimately rejected. If implemented, using project-specific adjustment factors would create a permitting protocol that is antithetical to the intended protections of the TAPs Rule, the AACCs, and annual, year-over-year limits. My own personal experience working as a Permitting Engineer for DEQ, the Air Rules themselves, the historical TAPs Rule rulemaking record, and greater context of U.S. Environmental Protection Agency (EPA) guidance all support this conclusion.

15. As a Permitting Engineer for DEQ, I developed dozens of permits that required a TAPs compliance analysis. Many of those permits were for sources, such as portable rock crushers and concrete batch plants, that likely had limited term operations. In other words, more than five years, but less than 70 years. In all these instances I invariably applied DEQ's standard TAPs compliance protocol – to use the AACCs as annual compliance limits that a facility must meet year-over-year. In certain select instances where a facility specifically stated they did not intend to operate for more than 5 years, a ten-fold increase in the AACC was permitted, as allowed under Air Rule 58.01.01.007.08 and 210.15, but a permit condition limiting the facility's operation to no more than 5 years was included in the permit.

16. I never applied or was asked by supervising staff or an applicant to apply an adjustment factor for a TAPs emission calculation to account for exposure duration, like the 16/70 Project-specific adjustment factor at issue here. To my knowledge, DEQ introduced this type of Project-specific adjustment factor for the first time during the development of this PTC and such adjustment factors have never been used before for the permitting of other mines or other facilities.

[2] The concept of an "exposure duration adjustment" may also be appropriately referred to as "risk amortization" or "dose-averaging" as done within the Declaration of Ian H. von Lindern, P.E., Ph.D.

17. The Air Rules themselves and the historical TAPs rulemaking record reinforce my personal experience with TAPs compliance and demonstrate that, in its original TAPs rulemaking process, DEQ directly considered, but ultimately rejected, concepts like the 16/70 Project-specific adjustment factor and exposure duration adjustments generally, except for sources expected to operate for less than 5 years.

18. In an August 13, 1992 letter from DEQ's Mr. Frank Wilkoz to Ms. Joan Cloonan, Idaho Association of Commerce and Industry,[3] Mr. Wilkoz provided a first draft of the original TAPs rules for review while adding context within a "Explanation of Additions and Changes" section. Mr. Wilkoz served as DEQ's Technical Services Bureau Chief and was heavily involved in the development of the original TAPs rulemaking and subsequent modification while Ms. Cloonan served as an industry stakeholder and provided input to the process. Mr. Wilkoz's "Explanation of Additions and Changes" section provides insight to how DEQ intended to permit remediation and short term sources. Most significantly Mr. Wilkoz writes:

> However, a remediation source cannot be allowed to produce emissions that have the potential to expose human receptors to a full lifetime dose of a TAP over a short period of time, especially a carcinogen, even in the interest of environmental clean up. Further, a single very large dose of a carcinogen, while not a full lifetime dose, has the potential to cause toxics related cancers due to the nature of dose response interaction of carcinogens at the cellular level. To allow such doses would subvert the very purpose of a clean up.

19. In an email dated August 14, 1992, Idaho Deputy Attorney General Curt Fransen emailed DEQ's Mr. Tim Teater and Mr. Frank Wilkoz directly raising these questions regarding large-dose short-term exposures.[4] During the TAPs rulemaking period, Mr. Teater served as an

[3] See Exhibit A.
[4] See Exhibit B.

Air Quality Toxicologist and was also heavily involved in the development of the original TAPs rulemaking and subsequent modifications. In his email, Mr. Fransen questions:

> 16.01.01012,13.g.iii. and iv. The standard for remediation sources raises some questions of a general nature. I don't have any answers but wonder if it makes scientific sense to directly convert risk of additional cancer based on lifetime exposure to risk of additional cancer based on less than lifetime exposure by assuming a directly proportional relationship between years of exposure and risk. Sorry that I can't properly express that but you probably get the drift. Other questions that seem to arise from simply allowing higher exposure where the length of exposure is shorter include the unknown or potential combined and synergistic effect of many short term or remediation sources or other sources in the same area and the potential of serial (one after another) short term or remediation sources. Lastly, how will the operational life of a source be determined. What if an applicant says they only intend to operate for five years (for whatever reason) so want the higher emission number to apply. There is incentive for facilities to argue they will be short-term. The spectre of serial short-term sources arises. Perhaps the definition can be clarified so there is less wiggle room.[5]

20. In a later and related email sent from Mr. Teater to Mr. Wilkosz on August, 26, 1992,[6] Mr. Teater states:

> We will need to talk about the environmental remediation source limit of five years to get a break on emissions. I am opposed to making that greater than five years. It seems that after five years most remediation sources would have emission BRC (Below Regulatory Concern) anyway. If not then they need to be treated as any other source.

21. A further review of the historical TAPs rulemaking record provides support for treating the AACC as annual, year-over-years limit rather than supporting the use of unique operational scenarios and exposure duration adjustments. The Idaho Department of Health and

[5] In my review of the historical TAPs rulemaking record, no direct reply from either Mr. Teater or Mr. Wilkoz to Mr. Fransen was found.
[6] See Exhibit C.

Welfare (IDHW) response to draft rule comments from the same Idaho DEQ 1993 TAPs rulemaking document that is cited within the Lopez Declaration[7] states:

> **Comment #108**: Section 203.05.g. Unit Risk Factors are based on a 70-year exposure. This is not appropriate for an industrial park situation that will never be a residential application. The refined analysis should be liberalized to include a different model, actual meteorological data, more appropriate risk factors, actual hours of operation, more accurate emissions factors obtained through source testing, more accurate annual potential to emit scenarios and any other justifiable refinements. New wording for this section has been suggested to reflect this.
>
> **IDHW Response:** The rules have been changed in response to this comment. IDHW agrees that for industrial areas that will never be used for residential purposes, a 70 year risk base may be conservative. However, it is hard to predict future land use patterns. Examples of unforeseen new land uses with significant environmental and human health concerns have become quite common.
> IDHW has based its emission numbers on the best available data. IDHW has strived to take a balanced approach taking into account the needs of industry to operate and the need to protect human health and the environment. Since it is not possible to account for such real life factors as lifetime exposures, additive or multiplicative effects of exposures to the large variety of industrial chemicals in use in Idaho, it is necessary to make our emissions standards generally applicable and reasonably conservative.
>
> It is not possible for IDHW to carve out special exemptions or emissions factors for potential or hypothetical new or modified industrial sources or exposure scenarios. Our rules must take a balanced approach that is generally applicable and consistently applied. IDHW can not develop special emissions factors specifically for industry dominated areas. IDHW believes that the revised Section 210. 02 Quantification of Emissions Rates and Ambient Concentrations, which allows site specific data gives adequate flexibility in compliance with toxic standards.

22. I found no additional documentation regarding additional discussions of dose-response relationships in the historical TAPs rulemaking record. Regardless, and more

[7] *See* Lopez Decl., Memo. in Supp. of Decl. at 8, 10-12.

importantly, the only less-than-lifetime exposure duration adjustment DEQ ultimately included within the original TAPs rule (or any subsequent versions) was the less than 5-year, ten-fold adjustment factor currently contained under IDAPA 58.01.01.210.15.

24. The Lopez Declaration states that the EPA's 1984 Health Assessment Document for Inorganic Arsenic guidance (EPA 1984 Guidance) concludes that arsenic has a linear dose response relationship.[8] Said another way, there is a high concentration dose of arsenic received over a short duration that is equivalent in risk to some corresponding low concentration dose of arsenic received over a longer duration. This is the underlying assumption that DEQ relies on when it applied the 16/70 Project-specific adjustment factor to assessing TAPs compliance for the SGP Permit.

25. It is important to consider the broader context of the EPA 1984 guidance and the assumption of linear dose response relationships. The EPA 1984 Guidance does not include any exposure duration adjustment equations that are presented in the Paden[9] and Lopez Declarations,[10] such as EC = [CA x ET x ET x ED]/AT, and that is the basis for the 16/70 Project-specific adjustment factor used for assessing TAPs compliance in the Permit. This equation did not appear in EPA Superfund risk assessment guidance until 2009, as the Lopez Declaration itself cites,[11] well after the original TAPs Rule was developed and promulgated.

26. Furthermore, the historical TAPs rulemaking record shows DEQ specifically rejected previously existing EPA Superfund risk assessment guidance and its use of exposure duration adjustments in consideration of risk and TAP exposure. The following documents confirm this conclusion.

[8] Lopez Decl. ¶ 12; *id.*, Memo. in Supp. of Decl. at 3-4..
[9] *See* Paden Decl. ¶ 12.
[10] *See* Lopez Decl. ¶¶ 22, 24; *id*, Memo. in Supp. of Decl. at 10-12.
[11] Lopez Decl., Memo. in Supp. of Decl. at 9.

27. A undated TAPs rulemaking concept letter[12] (herein referred to as the TAPs Concept Letter) addressed to a "Robert" (presumably Robert Wilkoz) and presumably from another DEQ staffer outlines the rationale behind changes within a modified draft TAPs rule. Within the letter it is stated:

> We also do not accept the EPA superfund risk assessment guidelines. Superfund guidelines are based on the concept that the exposures are of limited duration and do not have a large potential for multiple exposures. We can not make those assumptions for sources in Idaho, many of which involve either long term exposures or exposures to substances with a potential for multiple exposures. In Idaho, we are attempting to protect the public from the deleterious effect of multiple sources of a given pollutant or the additive effects of multiple pollutants over the course of a 70 year lifetime. If we could assure only a single exposure occupance, then accepting higher temporary risk might be justifiable.
>
> In addition we must consider the effects of the pollutant on the elderly, the very young and the infirm. By using "worse case" assumptions we are then able, under very limited conditions and when the public health would not be compromised, to deviate from the one in a million standard and apply a one in one hundred thousand as noted in the NSR policy. The use of this conservative approach allows us to be sure that actual risk is no greater than the risk figure on which we base our policy.

27. A January 23, 1992 unsigned draft letter to Mr. Charles Woods, Marketing Manager for MDT Corporation[13] (a presumed TAPs rulemaking industry stakeholder) from a DEQ staffer (presumably Mr. Wilkoz)[14] states:

> Our policy is based on a 1:1,000,000 risk at the nearest public access to the source. Risk is computed by multiplying the predicted (by the model) ambient concentration by the unit risk factor (URF) as published by the US EPA. Idaho does not accept the Superfund

[12] See Exhibit D.
[13] See Exhibit E.
[14] The draft email has handwritten mark-up addressed to a "Tim". Given the frequent emails, letters, and notes discussing TAPs concepts within the TAPs historic rulemaking documents between Tim Teater and Robert Wilkoz and the similarity in style between those documents and the January 23, 1992 draft letter, this "Tim" is presumed to be Tim Teater and the author is presumed to be Robert Wilkoz.

> risk assessment method for computing risk except for single, relatively short term exposures. Our risk assessment for continuous industrial or other large sources is based on the possibility of multiple, long term exposures.

28. A TAPs rule that allows for exposure duration adjustments and a risk assessment approach creates a problematic precedent, as is made evident by the following hypothetical scenario. If the SGP (or any subsequent source) is allowed to operate using exposure duration adjustments, an adjacent receptor (i.e., a human being) would be exposed to more than the intended annual allowable concentration of arsenic (the AACC) for 16 years. If, before the SGP operations end, the receptor moves and lives or works next to another facility or a new facility starts operations next to the SGP that applies an exposure duration adjustment for TAPs compliance (a process which could repeat indefinitely), by the end of the receptor's lifetime, it has been exposed to a TAPs concentration over the AACC for its entire life and its lifetime risk exceeds the intended 1-in-100,000 cancer risk level. In this scenario, the "spectre of serial short-term sources," as feared by Mr. Fransen in his email,[15] is apparent. Allowing the SGP to use the 16/70 Project-specific adjustment factor opens the door to a world in which the current AACCs in the TAPs Rule are effectively replaced by higher concentrations due to shorter than 70-year sources.

9. Contrast a hypothetical scenario where exposure duration adjustments are not allowed and the TAP AACCs are annual limits that must be met year-over-year by every facility in Idaho. In this case, no facility may emit TAPs at a concentration greater than the AACCs and a 1-in-100,000 excess cancer risk is preserved no matter where a receptor lives, works, or travels in Idaho during their entire life, and no matter what other facilities start operations. This scenario creates a simple and easy to implement rule that is broadly protective of human health and the

[15] *Supra,* ¶ 19.

environment and, as the Schilling Declaration itself notes, was the intent of the originally TAP rulemaking process.[16] Furthermore, this scenario is supported by the historical TAPs rulemaking record and best fits the intent of DEQ.

30. Given the full review of the above evidence and based on my experience as a Permit Engineer at DEQ, I conclude as follows:

a. During the TAPs rulemaking process, DEQ specifically considered the use of exposure duration adjustments and use of calculations akin to the 16/70 Project-specific adjustment factor, but ultimately did not incorporate their use within the TAPs rules; and

b. DEQ intended the AACCs to be annual, year-over-year concentration limits and included only a single short-term adjustment factor within the original TAPs rule for sources operating for 5-years or less; and

c. DEQ's application of the 16/70 Project-specific adjustment factor to demonstrate compliance with TAPs is not supported by the intent or language of the TAPs rule, and results in a degradation of the protection of human health and the environment that is otherwise the purpose of the TAPs rule.

B. DEQ and Perpetua incorrectly assume the 1-in-100,000 cancer risk rate, rather than the AACC, is the applicable enforceable "standard."

31. The Lopez Declaration points out that DEQ states that TAPs AACs and AACCs "are expressed in terms of ambient air concentration, but they are not ambient air quality standards"[17] and interprets this quote, and other related DEQ statements, to reach the conclusion

[16] Schilling Decl. ¶ 13.
[17] Idaho DEQ, *Idaho Department of Health and Welfare, Responses to Comments and Questions Submitted During a Public Comment Period and Public Hearings on the Proposed Repeal and Reissuance of Rules for the Control of Air Pollution in Idaho* (1993) at 10 (Comment 31).

that, "The AACCs are not one-year limits. Compliance with IDAPA 586 is not based on comparing annual air concentrations from the model to an AACC"[18]. Instead of using the AACCs as the enforceable "standard" the Lopez, Schilling and Lewis Declarations argue that remaining below the 1-in-100,000 acceptable excess cancer risk is the ultimate standard in which a facility demonstrates compliance with the TAPs rule.

32. However, Lopez, Schilling, and Lewis's understanding of increments, standards, and enforceable limits is misplaced. Labeling AACCs as "increments" versus "standards" is simply a naming convention rooted in previously existing CAA policy; the enforceable standard is the AACC as a year-over-year limit.

33. There is a distinction between the National Ambient Air Quality Standards (NAAQS) as "standards" and the TAPs as "increments." Under stationary source permitting, the NAAQS set ambient air concentration standards for seven federal Criteria Pollutants (like Particulate Matter [PM] and Sulfur Dioxide); those standards consider both the existing ambient background concentration of a given criteria pollutant, as well as the addition of the same pollutant from the stationary source that is to be permitted. For example, the current PM_{10} 24-hour NAAQS is federally set at 150 ug/m^3. This means that the public is entitled to ambient air with a PM_{10} concentration no greater than 150 ug/m^3. Thus, a facility can be permitted to emit some amount of PM_{10}, but that amount, in addition to the existing background concentration of PM_{10}, can not create a PM_{10} concentration greater than 150 ug/m^3 at the facility's property/operation boundary.[19] Additions of PM_{10} may come from a variety of stationary or

[18] Lopez Decl., Memo. in Supp. of Decl. at 12.
[19] REC 0679-80. Statement of Basis, Appx. B (Ambient Air Quality Impact Analyses Review Memorandum), Table 24.

mobile, permitted or unpermitted sources, but maintaining an ambient concentration of PM_{10} below 150 ug/m^3 is the ultimate standard.

34. The AACCs as "increments" are different in that they do not consider background concentrations of TAPs. Unlike Criteria Pollutants, DEQ does not regularly monitor the ambient concentrations of TAPs. There simply are too many TAPs (there are over 80 carcinogenic TAPs alone listed in IDAPA 58.01.01.586), they are state-specific (unlike Criteria Pollutants), and the cost to do so is generally accepted as prohibitive. Thus, during the historic TAPs rulemaking process the AACCs were implemented as "increments" versus "standards." Said another way, while it is infeasible to monitor and enforce an ultimate TAPs concentration standard, it is feasible to estimate the incremental increase in TAPs concentrations that a facility would cause.

35. The concept and naming convention of "increments" is not novel to TAPs. In 1977, Clean Air Act amendments introduced the Prevention of Significant Deterioration (PSD) program.[20] The PSD program also created "increments." As defined by the EPA, "PSD increment is the amount of pollution an area is allowed to increase. PSD increments prevent the air quality in clean areas from deteriorating to the level set by the NAAQS. The NAAQS is a maximum allowable concentration 'ceiling.' A PSD increment, on the other hand, is the maximum allowable increase in concentration that is allowed to occur above a baseline concentration for a pollutant. The baseline concentration is defined for each pollutant and, in general, is the ambient concentration existing at the time that the first complete PSD permit application affecting the area is submitted."[21]

---

[20] U.S. EPA, *Evolution of the Clean Air Act*, available at: https://www.epa.gov/clean-air-act-overview/evolution-clean-air-act (last visited Sept. 30, 2024).
[21] U.S. EPA, *Prevention of Significant Deterioration Basic Information* (Jan. 17, 2024), available at: https://www.epa.gov/nsr/prevention-significant-deterioration-basic-information (last visited Sept. 30, 2024).

36. Both the TAPs AACCs and PSD increments are maximum allowable increases from a specific source. In developing the TAPs Rules, DEQ would have certainly been aware of the concept and naming convention of "increments." The TAPs definition of increments is best viewed through the lens of a *compliance period*, rather than implying they represent an *averaging period*, as the Lewis Declaration does.[22]

37. Evidence from the historical TAPs rulemaking record reinforces this and the conclusion that the use of the term "increment" within TAPs was to differentiate them from including background concentrations as "standards" do. During the 1995 period, DEQ made revisions to the original and previously promulgated TAPs rule. As part of that process, DEQ developed a TAPs rule amendment summary document.[23] Within that document DEQ notes:

> The proposed rule will divide consideration of incremental increases of TAP emissions into individual source and facility wide categories. Net emissions is a concept that adds increases and decreases of emissions from new sources of TAP together to obtain a net amount. That net amount is then compared to acceptable ambient levels also called increments for a permitting decision. **The acceptable ambient level is referred to as an increment because TAP emissions increases are limited to an incremental increase as opposed to an absolute limited ambient concentration** (emphasis added).

38. On the other hand, if you assume DEQ intended the 1-in-100,000 cancer risk to be the enforceable standard and not the AACC as annual, year-over-year limits, it would have needed to incorporate additional variables into the TAPs Rule to guide applicants on how to assess that risk. Completing a risk assessment that analyzes a facility's excess cancer risk traditionally involves consideration of more variables and factors than just exposure duration.[24] Sensitive populations, comorbidities, and synergistic effects of combined toxic exposure all

[22] Lewis Decl. ¶ 29.
[23] See Exhibit F.
[24] *See* von Lindern Decl. ¶¶ 73-74

affect the ultimate cancer risk from a facility's airborne toxic emissions. . However, as mentioned above, the original TAPs rulemaking process rejected the risk assessment method and prioritized creating a simple and easy to implement rule that is still protective of human health and the environment. Ultimately, using the AACCs as the "enforceable standard" is a far more effective standard to use in fulfilling this goal.

39. Given the full review of the above evidence, I conclude as follows:

a. The labeling of the AACCs as "increments" versus "standards" is a naming convention rooted in previously existing CAA policy and is a distinction in the consideration of pollutant background concentrations rather than an averaging period concept.

b. DEQ intended the enforceable "standard" to be the AACC as an annual, year-over-year limit.

C. Use of a 5-year rolling average for demonstrating compliance with the TAPs ruleT-RACT is inappropriate and not supported by Permit conditions.

40. DEQ used a 5-year rolling average to calculate TAPs emissions from the SGP. However, such an approach does not comply with the intent of the original TAPs rulemaking process or with the language in the TAPs Rule stating that the AACCs are annual, year-over-year limits.

41. The Statement of Basis for the Permit partially acknowledges that the AACCs are annual limits while introducing the use of what it calls a more "refined" analysis. As stated under Section 4.2 of the TAPs Addendum Modeling Review Attachment to the Statement of Basis, "Annual average emissions of carcinogenic TAPs are typically used in the dispersion model to estimate maximum annual impacts. [Perpetua] refined the analyses by using source-specific

emission rates that are representative of a 5-year averaging period. This approach is appropriate because carcinogenic impacts are of concern from a long-term exposure basis."[25]

42. Using a 5-year rolling average on the calculated arsenic emissions from the SGP allows for some years of the SGP's TAPs emissions to be considerably higher–and above the AACC–as long as some years within the same period are comparably lower. So much so, that it would be possible for the SGP to have TAPs concentrations over the AACCs for the first four years of its operation as long as emissions from the fifth year were drastically reduced compared to the previous four.

43. This outcome creates a problematic precedent as is evident by another hypothetical scenario. Consider again the "spectre of serial short-term sources" and the scenario in which a receptor is exposed to consecutive sources that have applied an exposure duration adjustments discussed above in Paragraph 28. In a modified scenario, the receptor is adjacent to the SGP for four years of high TAPs emissions, but then relocates adjacent to a different TAPs source before a fifth year of low SGP TAP emissions occurs. The new TAPs source is also a less than 70-year source using exposure duration adjustments with TAPs concentrations above the AACCs. The receptor will be consistently exposed to TAPs concentration potentially well over the AACC, and is accruing an excess cancer risk level above 1-in-100,000. Again, the AACCs are effectively replaced by higher concentrations due to less than 70-year sources using exposure duration adjustment factors and/or emission period averaging.

44. In order to avoid such a scenario, the Air Rules and the historical TAPs rulemaking record speak for themselves. As stated within IDAPA 58.01.01.203.03, "Compliance with all applicable toxic air pollutant carcinogenic increments and toxic air pollutant

[25] REC 0698. Statement of Basis, TAPs Addendum Modeling Review Attachment.

non-carcinogenic increments demonstrates preconstruction compliance with Section 161 with regards to the pollutants listed in Sections 585 and 586." IDAPA 58.01.01.586 then simply states, "The AACC in this section are annual averages."

45. Given the full review of the above evidence, I conclude as follows:

a. Calculation of the SGP's arsenic emissions by using a 5-year rolling average is contrary to the intent of the original TAPs rulemaking process and the Air Rules stating that the AACC are an annual, year-over-year limit.

b. Using a 5-year rolling average inappropriately allows individual years of excess TAPs emissions to be masked within an averaged period.

D. There is insufficient evidence to support the T-RACT analysis limiting the non-West End pit production limit.

46. The Board in its *Final Order* questioned whether total life-of-mine ore production from non-West End pits was properly constrained by permit conditions.[26] I do not have specific concerns about whether production from non-West End pits was properly constrained over the life of the mine. However, the Board was right in questioning whether production from all pits was properly constrained.

47. The AACCs are limits for which compliance must be demonstrated on an annual, year-over-year basis. This requirement self-selects the highest maximum annual emission scenario as the emissions scenario that must be analyzed for AACC and TAPs compliance. As previously mentioned, the TAPs Addendum Modeling Review Attachment within the Statement

[26] REC 3725-27.

of Basis acknowledges this requirement: "Annual average emissions of carcinogenic TAPs are typically used in the dispersion model to estimate maximum annual impacts".[27]

48. It is unclear from the permitting record what exact emission sources and which period of time Perpetua and DEQ considered in developing the 5-year rolling averaging period for emissions. However, the von Lindern Declaration further investigates this issue, demonstrating that the likely maximum annual emissions scenario from the SGP would have considerably higher arsenic emissions than currently calculated within the Permit.[28]

49. In order to comply with the AACCs and demonstrate TAPs compliance, DEQ should have: (1) determined the worst arsenic generation scenario from any single year of the SGP (likely to include 100% production from the West End Pit); (2) compared the modeled operation boundary arsenic concentration from the worst generation scenario to the AACC to evaluate TAPs compliance; and (3) include a maximum annual ore generation permit limit from the pit(s) that correspond to the worst arsenic generation to ensure TAPs compliance.

50. Given the full review of the above evidence, I conclude as follows:

a. DEQ did not appropriately analyze the maximum annual emissions scenario from the SGP and instead diluted the SGP'd arsenic emissions through the 5-year rolling average calculation.

b. The permit does not sufficiently constrain ore production from the SGP's pit(s) on an annual basis.

[27] Analyzing the worst case scenario during permit development is a common permitting approach both at large and within DEQ specifically for fairly obvious reasons; if compliance with NAAQS, TAPs and any other applicable standards can be shown for a facility's worst case emissions/operation scenario then compliance for all other emissions/operation scenarios is inherently shown.
[28] *See* von Lindern Decl. ¶¶ 56-63

51. I declare under the penalty of perjury under the law of the State of Idaho that, to the best of my knowledge, information, and belief, the foregoing is true and correct.

DATED: October 3, 2024

William Tiedemann

Exhibit A

IDAHO DEPARTMENT
OF HEALTH AND WELFARE

DIVISION OF
ENVIRONMENTAL QUALITY

1410 North Hilton, Statehouse Mail, Boise, ID 83720-9000, (208) 334-0502 Cecil D. Andrus, Governor Richard P. Donovan, Director

August 13, 1992

Ms. Joan Cloonan,
Idaho Association of Commerce and Industry
P.O. Box 389
Boise, ID 83701

(HAND DELIVERED)

Dear Ms. Cloonan:

Enclosed per Orville Green's promise to you is:

> The First Draft of the Proposed Rules for the Control of Toxic Air Pollutants in Idaho.

> A brief explanation of the changes that have been made per our discussions at our last meeting.

This draft is to facilitate our discussions only. As I am sure you are aware, all actual regulatory proposals will have to undergo legal review and be reviewed by the U.S. EPA for compliance with the 1990 Clean Air Act Amendments.

If you have any questions on the above material please call me (334-0422). We are looking forward to continued productive discussions with you and IACI.

Sincerely,

Tim Teater
for

Robert Wilkosz
Bureau Chief
Technical Services Bureau
Division of Environmental Quality

:tt

Enclosures

cc: Dick Rush
Orville Green
Martin Bauer
Tim Teater
COF 1.1

Explanation of additions and changes.

The following is included as a brief discussion/explanation of the changes that the DEQ has made in our ideas for proposed toxic air pollutant rules. We have made every attempt to incorporate the suggestions made by IACI at the last IACI/DEQ meeting. These changes are for discussion only as they have not yet undergone legal review. The shaded portions are the changes made since our last meeting.

Environmental remediation source. This language was included for two reasons. First, we wish to encourage the rapid and effective remediation of environmental problems in other media. Remediation is a net benefit to the environment and as such, is to be encouraged when ever possible. However, we wish to reiterate that simply transferring a contaminant from one media to another is not acceptable remediation practice.

The second reason for this inclusion is that we do not think that it is reasonable to judge a source of five years or less duration by the same criteria as a permanent source. However, a remediation source cannot be allowed to produce emissions that have the potential to expose human receptors to a full lifetime dose of a TAP over a short period of time, especially a carcinogen, even in the interest of environmental clean up. Further, a single very large dose of a carcinogen, while not a full lifetime dose, has the potential to cause toxics related cancers due to the nature of dose response interaction of carcinogens at the cellular level. To allow such doses would subvert the very purpose of a clean up.

Short term source: This was included at the request of Mr. Dameworth of IACI to accommodate short term singular events. It was suggested, and we agree, that a source of five years or less should not necessarily be judged by the same criteria as permanent sources. However, as has been noted above, a short term source cannot be allowed to produce emissions that have the potential to expose human receptors to a full lifetime dose of a TAP especially a carcinogen. Again, as noted earlier, a single very large dose of a carcinogen, while not a full lifetime dose, has the potential to cause toxics related cancers due to the nature of dose response interaction of carcinogens at the cellular level. In view of the remediation adjustment factor, we consider an adjustment factor of 0.01 a reasonable compromise.

Environmental remediation or short term remediation adjustment factors. This language was included at the request of Mr. Dameworth of IACI. Mr Dameworth and others at IACI felt that language associating remediation sources with a one in ten thousand risk level (when figured in an equivalent manner as a permanent source) would inaccurately characterize the risk of these projects to the public. These draft adjustment factors are therefor added to make published risks for remediation sources seem equivalent to permanent sources. We are concerned, however, that these adjustment factors may serve to obscure the already minimal risks presented by remediation sources and compromise public confidence

in the permitting process.

The adjustment factors were arrived at in the following way. For remediation sources: five years divided by 70 years equals 0.070. This is roughly equivalent to a risk of one in ten thousand (actually a bit less). We have chosen not to make this a sliding scale calculation, ie 4/70, 3/70 etc. This was done for the reasons alluded to in the section above on environmental remediation sources.

For short term sources, it is our opinion that, since the purpose here is not necessarily to encourage operation of these sources, an adjustment factor equivalent to remediation sources is not appropriate. We do think, however, that allowing an increase in potential risk of one order of magnitude is acceptable. We believe that this factor would allow industry additional flexibility while still being adequately protective of the public health and the environment.

Approved fuels: This was deleted from the definitions at the request of IACI in order not to set precedent for other applications. This language was moved to the effected sections, 16.01.01012,02.d.vi and vii.

Section 16.01.01012,02.d.vii: This language was included to clarify the uses of laboratory equipment

Section 16.01.01012,02.d.x: This language was included to clarify the term recreational area.

Section 16.01.01012,13.g.ii,iii,&iv.: This language was included to clarify the procedures for permitting remediation and short term sources.

Section 16.01.01012,13.v: This section is included to clarify the modeling procedures. In general, we have attempted to describe the overall screening procedures from the most basic to the most sophisticated. Some of the specifics that are of interest are:

v.(a) This is a guide for the use of the TAP list in determining if further evaluation of TAP is necessary. As has been previously discussed, the TAP list with emissions screening levels is published in order that applicants have a ready reference to assist in the TAP permitting process. It has been our intent to make this list as comprehensive as possible in order that applicants have as much information at hand with out the need to do time consuming calculations and modeling when not necessary.

v.(b) Screening Modeling, first paragraph. The purpose here is not to re-approve EPA approved models, but to determine the appropriateness of the application. This is to save the applicant from doing work that ultimately will not be acceptable to the DEQ because an EPA model may have been used in an inappropriate application.

Because there are a large number of EPA approved models that can be used in the same general circumstances, DEQ review is to identify the most appropriate model for the situation. A modeling check list is available from DEQ to assist the applicant in this

process.

v.(c) This is the final step in quantification of emissions. As with screening level models, the language here is expressly to avoid the use of an inappropriate model in a given situation.

v. (d) This language is to give an explanation of how we will deal with TAP that have no OEL or URF. We looked for a more general procedure to use as opposed to a case by case method but we were unable to develop such a universal criteria. We have used the method described in the Draft Rules in the past in order not to impose a possibly unwarranted detection limit standard. By evaluating the physical and chemical properties of the substance in question, and comparing the results to chemicals for which exposure criteria are available, we were then able to propose an emissions limit that was acceptable to the applicant and DEQ.

Universal criteria that we have looked at have severe problems. Setting ELs at detection limits as has been done in the past may result in emissions limits that are unreasonably strict. A single value such as one pound an hour or one milligram per cubic meter etc. may be unreasonably strict in one instance but unreasonably liberal in another. Having no emissions or ambient criteria for TAP without an OEL or URF assumes that the lack of OEL or URF means that the compound in question is harmless. We would all agree that this assumption is unsupportable.

It is our position that the draft language represents a reasonable attempt to deal with this problem. In addition, the Division of Health is available to review the DEQ evaluation of the risk presented by a given emission level of a chemical.

Significant/significance. These terms are used throughout the Idaho Administrative Procedures Act (IDAPA). We believe that it would be difficult to remove this language entirely from the Toxics rules. We have attempted to address IACI concerns while at the same time preserving the integrity of the permitting process by adding the following language to the definitions Section 01.01003. 86, b. In reference to a net emissions increase or the potential of a source to emit a pollutant not listed in (a) above or in the New Source Review policy, any emission rate; or...

We would encourage IACI to bring specific proposals concerning the terms significant/significance to the next meeting for further discussion.

1ST DRAFT

PROPOSED RULES FOR THE CONTROL OF TOXIC AIR POLLUTION IN IDAHO

IDAPA 16.01.01003 -- DEFINITIONS.

~~*Approved Fuels. Natural gas, propane gas, liquified petroleum gas, distillate fuel oils, residual fuel oils, and diesel fuel; except that waste oil, gasoline, or refined gasoline are not approved fuels.*~~

Environmental Remediation Source. An emission source that functions to remediate or recover any release, spill, leak, discharge or disposal of any petroleum product or substance or any hazardous waste as defined by IDAPA 16.01.01003,44: from any soil or ground or surface waters. An Environmental Remediation Source shall have an operational life no greater than five (5) years from the inception of actual operations to the cessation of actual operations.

Short Term source. Any new source or major modification to an existing source, occurring one time only with an operational life no greater than five (5) years from the inception of actual operations to the cessation of actual operations. For the purposes of this act short term source includes pilot or experimental plants not covered in IDAPA 16.01.01012,02.d,x.

Pilot or Experimental Plant. An emission source that functions to test processing, mechanical, or pollution control equipment to determine full-scale feasibility.

Occupational Exposure Limit. Refers to airborne concentrations of substances and represents conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effects. Occupational exposure Limits can be found in *Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices with Intended Changes for 1991-92 or the current edition*, adopted by the American Conference of Governmental Industrial Hygienists, or the National Institute for Occupational Safety and Health (NIOSH) current Relative Exposure Limit (REL), or the Occupational Health and Safety Administration (OSHA) Air Contaminate Standards, current Permissible Exposure Limit (PEL) or current Worker Protection Standards for Agricultural Pesticides promulgated by the Environmental Protection Agency under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). The above references are listed in descending order of precedence.

Unit Risk Factor. *These factors describe the probability of developing excess cancers over a 70 year lifetime exposure to 1 ug/m^3 of a given carcinogen. Unit Risk Factors Can Be Found in the Federal Register Vol. 56 No. 35 / Thursday, February 21, 1991 / Rules and Regulations Appendix V. or listed on the Integrated Risk Information System (IRIS) of the U.S. Environmental Protection Agency or listed in the Health Effects Summary Tables promulgated by the U.S. Environmental Protection Agency Office of Health Effects Assessment and the Office of Air Quality Planning and Standards. In the absence of U.S. EPA accepted risk factors, risk factors under review by the EPA Carcinogen Risk Assessment Verification Endeavor (CRAVE) shall be used on an interim basis.*

Reasonably Available Control Technology (RACT): *Reasonably available control technology is that control technology that would achieve the lowest emissions of any toxic air pollutant applicable to a given source using reasonably available and economically feasible control equipment. This may require technology that has been applied to similar, but not necessarily identical sources.*

.01.01012, PROCEDURES AND REQUIREMENTS FOR PERMITS TO CONSTRUCT AND OPERATING PERMITS.

.01.01012,02 Permit To Construct:

No owner or operator may commence construction or modification of any stationary source, major facility, or major modification after the effective date of Section 01.01012 without first obtaining a permit to constructfrom the Department which satisfies the requirements of this Section. No exemptions shall apply to any modifications to a major facility which has not been issued a permit, except that no permit to construct is required for ~~the following classes of equipment which have actual and allowable emissions of less than one hundred (100) tons per year of any air contaminant or and would not significantly increase the emissions of a major facility~~ sources which:

a. Have actual and allowable emissions of less than one hundred (100) tons per year of any air contaminant; and

b. Would not significantly increase the emissions of a major facility; and

c. Will not have an ambient air concentration of any air contaminant that would, as demonstrated using Department-approved methods:

   i. Cause or significantly contribute to a violation of an ambient air quality standard; or

   ii. Cause an ambient concentration in excess of one percent of the Threshold Limit Value; or

   iii. Cause a cancer-risk probability in excess of one in one million.

d. Which belong to one of the following classes of equipment:

i. Air conditioning or ventilating equipment not designed to remove air contaminants generated by or released from equipment.

ii. Air contaminant detectors or recorders, combustion controllers, or combustion shutoffs.

iii. Fuel burning equipment for indirect heating and for heating and reheating furnaces using gas exclusively with a capacity of less than fifty (50) million BTU's per hour input.

iv. Other fuel burning equipment for indirect heating with a capacity of less than one million (1,000,000) BTU's per hour input.

v. Mobile internal combustion engines, marine installations and locomotives.

vi. Stationary internal combustion engines fueled by natural gas, propane gas, liquified petroleum gas, distillate fuel oils, residual fuel oils, and diesel fuel; except waste oil, gasoline, or refined gasoline shall not be used, and in accordance with the following:

100 horsepower or less -- unlimited hours of operation;
101 to 200 horsepower -- 450 hours per month;
201 to 400 horsepower -- 225 hours per month;
401 to 600 horsepower -- 150 hours per month.

vii. Stationary internal combustion engines used exclusively for emergency power generation fueled by natural gas, propane gas, liquified petroleum gas, distillate fuel oils, residual fuel oils, and diesel fuel except waste oil, gasoline, or refined gasoline shall not be used, and which operate less than 200 hours per year.

viii. Laboratory equipment used exclusively for chemical and physical analyses, research or education, including ventilating and exhaust systems for laboratory hoods.

ix. Environmental characterization activities including emplacement and operation of field instruments, drilling of sampling and monitoring wells, and any

other activities specifically exempted by the Director.

x. Pilot or experimental plants located at least 1/4 mile from any recreational area which, for the purpose of this Section, is defined as any area, available to the public used for any recreational activity such as, but not limited to, city, county, state or national parks or recreation areas, play grounds, swimming pools, stadiums or ball-game fields or residence or other structure not occupied or used solely by the owner of the facility or the owner of the property upon which the facility is located; which operate less than one year; and which also meet one of the following conditions:

(a) Use a slip stream from an existing process stream not to exceed ten percent of that existing process stream; or

(b) Have actual uncontrolled emissions which are not significant.

xi. Any emission source or sources provided that the actual uncontrolled facility-wide emissions are not significant, and the uncontrolled emissions would not significantly contribute to ambient air quality concentrations.

xii. Any other class or size of equipment specifically exempted by the Director. A list of those sources unconditionally exempted by the Director will be maintained by the Department, and made available upon request.

01.01012,13. Procedure for Issuing Permits

a. General procedures ...

b. Additional procedures ... attainment or unclassifiable area ...

c. Additional procedures ... federal Class I area ...

d. Procedures for operating permits ...

e. The Department ... fluid model ...

f. Modification of permits ...

g. *Additional procedures for demonstrating compliance with the toxic substances requirements in Section 01.01011,01.*

i. *For sources not recognized by the Department as environmental remediation or short term sources that cannot demonstrate, using Department approved methods, that emissions of carcinogens contribute an ambient air cancer risk probability of less than 1:100,000 and that emissions of non-carcinogens contribute to an ambient air concentration of less than one percent of the Threshold Limit Value, a permit cannot be issued unless the source ~~has achieved the greatest degree of emission reduction that has been adequately demonstrated~~ can demonstrate that reasonably available control technology (RACT) as defined in EPA guidelines or as approved by the Director, can be installed and properly operated. A permit may be issued without the installation and operation of RACT if the associated health risks to the public from the operation of the facility have been declared acceptable by the Department's Division of Health.*

ii. *For remediation sources that cannot demonstrate, using Department-approved methods which may include the application of a remediation adjustment factor of seventy thousandths (0.070), an emission rate or acceptable ambient level for a non-carcinogen (AAL) of one one hundredth (1/100) of the appropriate OEL, as listed on Appendix A1 of the TAP list or an acceptable ambient level for a carcinogen (AALC), as listed on Appendix A2 of the TAP list, ~~emissions of carcinogens contribute an ambient air cancer risk probability of less than 1:10,000 and or that emissions of non-carcinogens contribute to an ambient air concentration of less than ten percent of the Threshold Limit Value~~, a permit cannot be issued unless the source ~~has achieved the greatest degree of emission reduction that has been adequately demonstrated~~ can demonstrate that reasonably available control technology (RACT) as defined in EPA guidelines or as approved by the Director can be installed and properly operated. A permit may be issued without the installation and operation RACT if the associated health risks to the public from*

the operation of the facility have been reviewed and declared acceptable by the Department's Division of Health.

iii Short term sources shall be treated the same as remediation sources except that a short term adjustment factor of 0.01 instead of a remediation adjustment factor of 0.07 shall be applied.

iv. For sources that can demonstrate, using Department-approved methods, that emissions of carcinogens contribute an ambient air cancer risk probability of less than 1:1,000,000 and that emissions of non-carcinogens contribute to an ambient air concentration less than one percent of the Threshold Limit Value, no additional procedures are needed.

v. Department-approved methods will consist of the following:

(a) Emissions Screening:
Comparison of maximum potential emissions to the screening emission limits for carcinogens and non-carcinogens as documented in Appendix A1 or A2 of the Toxic Air Pollutant list ~~as promulgated by the Director~~. Maximum potential emissions can be determined by actual emissions testing using U.S. Environmental Protection Agency approved methods ~~subject to review and approval by the Division of Environmental Quality~~ or estimates of the maximum potential emissions using standard scientific and engineering principals and practices subject to review and approval by the Director. If maximum potential emissions as determined using department approved methods as described in this Section are less than or equal to the screening emissions levels as listed on Appendix A1 or A2 of the TAP list, no further procedures for demonstrating compliance with the toxic substances requirements in Section 01.01011,01 will be required.

(b) Screening Modeling:
Screening modeling, using only U.S.

Environmental Protection Agency (EPA) currently approved models, applied according to EPA's Guidelines on Air Quality Models, and as determined appropriate for the application by the Director, may be done to conservatively determine ambient concentrations of a toxic air pollutant.

To determine an acceptable ambient level for a TAP when using SCREEN, T-SCREEN or other EPA approved models which use arbitrary meteorological data and predict maximum one (1) hour concentrations, multiply the maximum hourly concentration output by the model for a distance not greater than the facility property boundary nearest the source or, with department approval, the closest point of public access by a persistence factor of 0.15 to convert the hourly average to an annual average.

For a carcinogen, no further procedures for demonstrating compliance with Section 01.01011,01 will be required if the resulting product is equal to or less than the AALC as listed on Appendix A2 of the TAP list or if the resulting product when multiplied by the unit risk factor results in an ambient air cancer risk probability less than or equal to one in a million.

For a non-carcinogen, no further procedures for demonstrating compliance with Section 01.01011,01 will be required if the resulting product is less than or equal to one one hundredth (1/100 of the appropriate occupational exposure limit as listed on Appendix A1 of the TAP list..

(c). Refined Modeling

Atmospheric dispersion modeling, using only U.S. EPA currently approved models determined appropriate for the application by the Director, applied according to EPA Guidelines on Air Quality Models may be done to determine an ambient concentrations of a TAP. The procedures will be the same as for screening modeling except that a persistence factor shall not

be used.

(d) For any TAP for which there is no OEL or screening emissions limit or AALC listed on Appendix A1 or A2, the screening emissions limit and AAL or AALC will be determined by evaluation of the physical, chemical and toxicological properties of the substance in question and by comparison to physically, chemically and toxicologically related substances if any, on a case by case basis by the Director or the Division's Department of Health.

(e) Any other method approved by the Director.

insert table 1 here

TABLE 1. SOURCE TYPE/PERMITABLE RISK LEVELS

	AJUST-MENT FACTOR	DEMINIMUS	PERMITTABLE	NOT PERMITTABLE
NEW SOURCE	N/A	≤ 1:1,000,000	≤ 1:100,000	≥ 1:100,000
REMEDIATION SOURCE	0.070	≤ 1:1,000,000	≤ 1:100,000	≥ 1:100,000
SHORT TERM SOURCE	0.010	≤ 1:1,000,000	≤ 1:100,000	≥ 1:100,000

Exhibit B

FROM: Fransen, Curt

TO: Teater, Tim
Wilkosz, Robert

DATE: 08-14-92
TIME: 11:51

CC:
SUBJECT: Toxic Air Rules
PRIORITY:
ATTACHMENTS:

My comments, briefly, are as follows:
-16.01.01.01012,02.d. By making this section an "or" section, in other words a section which categorically excludes certain classes of equipment from the permit requirement, some problems seem to arise with the less precisely defined classes from about viii onward. For instance, if a facility could jam themselves (such as INEL) into either the "laboratory equipment" or "pilot or experimental plant" class, the permit requirement would not appear to apply regardless of how large or hazardous the emission actually would be. I could see INEL argueing that everything they do is somehow for physical analyses or research (lab equipment class) or the testing of processing or mechanical stuff to determine full-scale feasibility (pilot or experimental plant class). The problem with these classes is that they are subjective and potentially broad as compared to the classes described by i through vii. Likewise, xi is vague and appears to duplicate at least some of the factors established by a, b and c.
-16.01.01012,13.g.iii. and iv. The standard for remediation sources raises some questions of a general nature. I dont have any answers but wonder if it makes scientific sense to directly convert risk of additional cancer based on lifetime exposure to risk of additional cancer based on less than lifetime exposure by assuming a directly proportional relationship between years of exposure and risk. Sorry that I cant properly express that but you probably get the drift. Other questions that seem to arise from simply allowing higher exposure where the length of exposure is shorter include the unknown or potential combined and synergistic effect of many short term or remediation sources or other sources in the same area and the potential of serial (one after another) short term or remediation sources. Lastly, how will the operational life of a source be determined. What if an applicant says they only intend to operate for five years (for whatever reason) so want the higher emission number to apply. There is incentive for facilities to argue they will be short-term. The spectre of serial short-term sources arises. Perhaps the definition can be clarified so there is less wiggle room.

Let me know if you want to discuss.

Exhibit C

FROM: Teater, Tim

TO: Wilkosz, Robert

DATE: 08-26-92
TIME: 15:28

CC:
SUBJECT: IACI toxics committee.
PRIORITY:
ATTACHMENTS:

---

1. Lori tells me that the AG's office has copies of all the state regs. Ill check on NY & NC.
2. We will need to talk about the environmental remediation source limit of five years to get a break on the emissions. I am opposed to making that greater than five years. It seems that after five years most remediation sources would have emissions BRC anyway. If not then they need to be treated as any other source.
3. The discussion on CRAVE was an increadable bunch of whining BS. Bitching for its own sake!
4. Section "d" about dealing with compounds that do not have emissions standards or URFs will be tough. As I mentioned to you, Pat and Dick Shultz supported my position on this. I can only think that we might come up with some rewording. I am totally opposed to the idea that if it has no emissions data then it should be uregulated.
5. Section "v" (a) we are asked to "prioritize emissions estimate data ie stack testing, AP-42, XWALK, etc. This is a stupid idea. I do not understand where Daimworth is coming from. Different emissions estimating techniques are appropriate for different situations. Stack testing is OK but even that depends on how much alike the processes and facilities are. Some of the stuff IACI has complained about is so self defeating.

REPLY FROM: Teater, Tim FROM: Wilkosz, Robert

TO: Teater, Tim

DATE: 08-26-92
TIME: 14:27

CC:
SUBJECT: IACI toxics committee.
PRIORITY:
ATTACHMENTS:

fyi

FORWARDED FROM: Wilkosz, Robert
FROM: Green, Orville

TO: Nagel, Joe

DATE: 08-26-92
TIME: 14:03

CC: Ledger, John
Wilkosz, Robert

SUBJECT: IACI toxics committee.
PRIORITY:
ATTACHMENTS:

We had a very good meeting. Even Mike Smith of FMC was helpful today. Joan Cloonan was on vacation. Dick Schultz and Pat McGavaran attended and helped considerably. Schultz was pleased with the meeting.

We have about a dozen items left, none unresolvable in my opinion, to work out. Wilkosz will chair the next meeting 9/14. We may schedule one more

meeting after that, but we are very close to referring the draft to the AG's office for review prior to public comment.

Afterwards, Dick Rush said that IACI was still discussing the issue, and he re-stated that they may still oppose the package once we conclude our discussions.

Exhibit D

Robert, this is a second draft - wadayathink? Please note that I'm shaky on the rational for using .15 for an annualization factor.'

This is to clarify the New Source Review Policy, as it regards its application to the construction of new sources of toxic air pollutants (TAP).

In applying the New Source Review policy to a potential source of TAP, the first aspect of the application that we look at is the screening emission limits. If the emissions out of the stack do not exceed our published emissions limits then the emissions are below regulatory concern for that process and pollutant.

If emissions are above the listed screening emissions limits then the SCREEN model is utilized to predict an ambient concentration. The DEQ, in order to have a conservative, "worse case" scenario, uses full meteorology, not just a particularly favorable stability class and or wind speed for the SCREEN model.

If predicted ambient concentrations are still above DEQ screening levels and if actual meteorological data is available, a more sophisticated model may be used to more accurately estimate dispersion data for TAP. Any model used must be EPA approved for the use and the results must be reviewed by our own meteorological staff.

When the TAP of concern are known or suspected carcinogens, the maximum hourly predicted concentrations are converted to an predicted annual concentration by multiplying the hourly concentrations by a conversion factor of .15. Derived from??

In the case of a substance of interest not being listed by DEQ or if there are no emission or ambient values listed, the substance must still be included in any emissions estimates and modeling. Potential risk associated with any unlisted substance or substance with out published values will be evaluated on a case by case basis by the DEQ.

Risk is calculated by multiplying the unit risk factor published by the EPA by the concentration obtained in the model. In general, the policy requires that risk at the facility fence line or the first point of public access from the source be equal to or less than one in a million.

We do not accept the first full time residence as the nearest point of public access except in very limited special circumstances. For instance, if a source was in an industrial area with very limited public access and the first regular public access was a nearby residence, then we may consider that residence as the first public access and analyze risk to the public accordingly.

We also do not except the EPA superfund risk assessment guidelines. Superfund guidelines are based on the concept that the exposures

are of limited duration and do not have a large potential for multiple exposures. We can not make those assumptions for sources in Idaho, many of which involve either long term exposures or exposures to substances with a potential for multiple exposures.

In Idaho, we are attempting to protect the public from the deleterious effect of multiple sources of a given pollutant or the additive effects of multiple pollutants over the course of a 70 year lifetime. If we could assure only a single exposure occupance, then accepting higher temporary risk might be justifiable.

In addition we must consider the effects of the pollutant on the elderly, the very young and the infirm. By using "worse case" assumptions we are then able, under very limited conditions and when the public health would not be compromised, to deviate from the one in a million standard and apply a one in one hundred thousand as noted in the NSR policy. The use of this conservative approach allows us to be sure that actual risk is no greater than the risk figure on which we base our policy.

For further information on the application of the New Source Review policy on TAP, please contact our office.

Exhibit E

DRAFT

January 23, 1992

Mr Charles Wood
Marketing Manager, Sterilization Equipment
MDT Corporation
P.O. Box 23077
Rochester, New York
14692-3077

Dear Mr. Wood,

Mr. Dan Heiser has asked me to respond to your recent enquiry about regulations concerning the emission of ethylene oxide (EO). The following explains the screening level review process for permits to construct new continuous industrial or other large sources.

Sources of EO emissions may be subjected to the Idaho New Source Review (NSR) policy for Toxic Air Pollutants (TAP) and may require a permit to construct (PTC). The screening level for emissions of EO into the ambient air is 6.7E-04 lb/hr. When that screening level is shown likely to be exceeded by mass balance or other acceptable engineering calculations, an Acceptable Ambient Level for a Carcinogen (AALC) is used as the next step in the screening process. The AALC was determined previously in the policy draft process. What we determine in the PTC or NSR process, is the ambient impact (concentration) of a given pollutant.

For EO the AALC is 1.0E-02 ug/m^3. In order to determine the AALC, the NSR policy requires that the source be modeled using SCREEN with full meteorology. If actual meteorological data is available, then that data should be used. If this modeling indicates that the screening AALC will be exceeded, then the applicant has the option of using a more sophisticated model to show that the AALC will meet NSR policy. Any model used must be US EPA approved for the use.

Our policy is based on a 1:1,000,000 risk at the nearest public access to the source. Risk is computed by multiplying the predicted (by the model) ambient concentration by the unit risk factor (URF) as published by the US EPA. Idaho does not accept the Superfund risk assessment method for computing risk, except for ~~single~~, relatively short term exposure. Our risk assessment for continuous industrial or other large sources is based on the possibility of multiple, long term exposures.

I have enclosed our NSR policy. That policy also outlines the decision guidelines for permitting sources of TAP based on risk or potential health impacts. If you have any further questions please feel free to contact me.

(334- ....)

Sorry Tim I meant as this tutorial sort of reminder to you

Tim my point is that we don't determine the AALC each PTC review, we determine the ambient level likely caused by the source & compare that to the AALC. right?

Exhibit F

Item No.:	Docket No.: 0101-9501	Program: Air Quality
Topic: Revision of the Toxic Air Pollutant Rules		
Status: Planned Rule	X Proposed Rule	Final Rule
Note:		
Date: Initial Publication 1/95	Board 6/95	Final Publication 8/95
Technical staff contact: Robert Wilkosz		Telephone: 334-5898

- This rule amends existing rules. The proposed rules address the permitting and exemptions from permitting, of new sources of toxic air pollution in Idaho.

- The proposed rule changes the regulatory basis on which Toxic Air Pollutants (TAP) are regulated. TAP were regulated based on the requirements to demonstrate compliance with the TAP Acceptable Ambient Concentration (AAC) increments. The proposed rule regulates TAP based upon the requirement to demonstrate compliance with section 161. This change was made to accommodate the other changes such as netting and interpollutant trading that provide for exceptions to the TAP increments.

- Below regulatory concern (BRC), Levels for TAP emissions have been established. These BRC levels have to do with record keeping, reporting, and self exemption from the requirements to obtain a permit to construct (PTC).

- The proposed rule will divide consideration of incremental increases of TAP emissions into individual source and facility wide categories. Net emissions is a concept that adds increases and decreases of emissions from new sources of TAP together to obtain a net amount. That net amount is then compared to acceptable ambient levels also called increments for a permitting decision. The acceptable ambient level is referred to as an increment because TAP emissions increases are limited to an incremental increase as opposed to an absolute limited ambient concentration.

  Source specific TAP emissions are those coming from one specific source within a whole facility under the following conditions: the emissions, without any air pollution controls must be less than the increment and with controls, the emissions must be less than or equal to the screening emissions level or the increment, which ever is greater.

- The proposed rule recalculates the way the increment for non-carcinogens is calculated. The current rules have increments based on an occupational exposure limit (OEL), divided by a total uncertainty factor of 100 with an annualized averaging time. The proposed rule will divide the OEL by 20 and decrease the averaging time to 24 hours.

- The proposed rule would eliminate remediation source factor and eliminate some TAP emissions from netting. The remediation source factor was a mathematical factor applied to the increment to allow a greater level of emissions for the short period of time (5 years) that a remediation source would operate. Remediation sources not specifically exempted from

netting requirements will be treated the same as other new sources. However, best available control technology (BACT) would be required if the TAP emissions from that source will exceed the AAC.

- The proposed rule will extend the concept of offsetting to TAP. Offsetting is allowing an increase in emissions of an air pollutant to be offset by a reduction in the same air pollutant from another source. In a circumstance that a source desires to construct a new source of TAP emissions but the new source can not meet the TAP emissions requirements, interpollutant trading provides an opportunity for that construction to go on while theoretically decreasing the over all risk from TAP emissions. The DEQ will use the EPA guidance contained in Section 112(g) of the clean air act or other EPA approved data bases or references to make all interpollutant trading determinations.

- This proposed rule is the result of numerous meeting with Idaho Association of Commerce and Industry, a number of other industrial representatives and some members of the public.

- Notification of the proposed rule will be published in the bulletin as well as various papers around the state. Public hearings are scheduled for Moscow, Pocatello and Boise. DEQ plans to submit the proposed rules the Board of Health and Welfare in June, 1995.

Item No.:	Docket No.: 01019501

CERTIFICATE OF SERVICE

I hereby certify that on October 4, 2024, a true and correct copy of the foregoing EXPERT DECLARATION OF WILL TIEDEMANN was served on the following by electronic service:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov

Dylan V. Lawrence
Hearing Officer
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com

Paula Wilson
Hearing Coordinator
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, ID 83706
paula.wilson@deq.idaho.gov

Michael A. Short
Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
michael.short@deq.idaho.gov
hannah.young@deq.idaho.gov

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
ann.yribar@ag.idaho.gov

Krista K. McINtyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd., Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com

s/ Julia Thrower
Julia S. Thrower

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	Agency Case No. 0101-22-01 OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC. Intervenor-Respondent.	**EXPERT DECLARATION OF IAN H. VON LINDERN, P.E., Ph.D.**

I, Ian H. von Lindern, P.E., Ph.D., hereby declare under penalty of perjury and pursuant to the law of the State of Idaho that the foregoing is true and correct:

QUALIFICATIONS

Name and Affiliation

1. My name is Ian von Lindern. I reside in Moscow, Idaho. I am a licensed Professional Engineer in Chemical Engineering in Idaho (License # 3044). I have practiced in the disciplines of Environmental Engineering and Risk Assessment in Idaho for the last 50 years. I was President and Principal Scientist for TerraGraphics Environmental Engineering with offices in Moscow, Kellogg, and Boise, Idaho for 30 years, retiring in 2016. TerraGraphics was the Idaho Department of Environmental Quality's (DEQ) prime consultant for the Bunker Hill Superfund Site (BHSF) and I was Project Manager and lead risk assessor for both the BHSF and the Coeur d'Alene Basin Superfund Sites from 1984 to 2014.

2. Since retiring from the consulting business, I co-founded the non-profit humanitarian organization TerraGraphics International Foundation (TIFO) and have continued to work in mining-related health and safety issues in low-income countries. TIFO's mission is to assist mining and mineral processing communities to operate as safely as practicable while maintaining essential economic activities. In that regard, we support scientifically sound and transparent analyses of the environmental and human health issues faced by mining communities, and the development of local solutions implemented within community socio-economic and cultural capabilities. Under my direction in the last ten years, TIFO has conducted and completed site characterization, risk assessment, and risk mitigation projects in

Russia, China, Peru, Dominican Republic, Senegal, Nigeria, Kyrgyzstan, Uzbekistan, and the Duck Valley Shoshone Paiute Reservation in Idaho and Nevada.

Education and Experience

3. I hold a B.S. degree in Chemical Engineering from Carnegie-Mellon University, Pittsburgh, Pennsylvania and Masters and Ph.D. degrees in Environmental Science and Engineering from Yale University, New Haven Connecticut, specializing in air pollution and public health. I have served on numerous advisory committees and the U.S. Environmental Protection Agency's (EPA) Science Advisory Board and Clean Air Science Advisory Committee on several occasions from 1975 to 2018, advising on topics relating to exposure and risk assessment in childhood heavy metal poisoning. During that tenure, I directed more than 30 major environmental health investigations at mining and smelting sites, both nationally and internationally. A current C.V. is attached.[1]

Relevant Projects and Assignments

4. I was the Regional Environmental Engineer for DEQ's predecessor agencies in both the Coeur d'Alene and Twin Falls offices. In that capacity, I processed air quality permits for the Agency for several years at the major mining and smelting operations in the State during the 1970s, and early 1980s, including the Bunker Hill Mining and Metallurgical Complex, the last U.S. operational antimony smelter at Big Creek, Idaho, and numerous mining operations in North and Central Idaho. I designed and directed the implementation of the Silver Valley Lead Health Study that investigated and provided emergency response to the childhood lead poisoning epidemic in the Coeur d'Alene mining district in the 1970-80s.

[1] Exhibit A.

5. I have particular experience with implementing EPA risk assessment guidance in Idaho. Beginning in 1984, DEQ's predecessor, Idaho Department of Health and Welfare-Division of Environment (IDHW-DOE) was the lead agency implementing the Risk Assessment and Cleanup Management Plan developed for the populated areas of the Bunker Hill Superfund Site (BHSS). The BHSS was the U.S. second largest Superfund site, and IDHW-DOE was among the first health/environmental agencies to implement the EPA Risk Assessment Guidance for Superfund (RAGS) in the late 1980s.

6. As Project Manager, I was responsible for developing and implementing the risk assessment/risk management protocols, and cleanup plan for the BHSS in collaboration with several State, federal, tribal, local governments, and industry. The project was monitored and collaboratively developed by several entities including EPA Regions VIII and X, the EPA National Center for Environmental Assessment (NCEA), EPA Headquarters, the Coeur d'Alene Tribe, the Panhandle Health District, and the States of Montana and Washington. I also served on a sub-committee of the EPA Science Advisory Board evaluating the consistency of heavy metals regulation across EPA Program Offices in the early 1990s.

7. Based on that experience, IDHW-DOE requested that I participate on the advisory committee regarding development of the toxic air pollutant (TAP) rules for the State. As a result, I had a diverse perspective in the development of the TAPS rules that afforded reasonable health protectiveness while relieving the regulators and industry of the burden of the risk assessment and risk management protocols evolving at the time. I continued as DEQ BHSS lead risk assessor until 2014.

8. In my most relevant recent experience, I am working with the international humanitarian organization Médecins Sans Frontières (MSF, or Doctors Without Borders) assisting the Kyrgyz Republic Ministry of Health in developing health protective strategies to reopen both mercury and antimony smelters in Batken, Kyrgyzstan. These facilities were among the largest mercury and antimony producers in the former Soviet Union and are essential to the regional economy.

9. TIFO is currently engaged with MSF, the U.S. Department of State, the Massachusetts College of Pharmacy and Health Sciences, and the Kyrgyz Ministry of Health in conducting risk assessment and risk mitigation activities in active and abandoned Kyrgyz antimony and mercury mining communities. Biological monitoring of the local populations indicates many children and reproductive aged women have arsenic and antimony blood and urine levels exceeding international norms. The principal source of metals contamination are mining-related fugitive dusts contaminating the community water, soil, air, and food sources.

10. I am the lead risk assessor for these projects and have produced several major reports in the last five years. The project is currently engaged in implementing medical, environmental, public health advocacy and educational interventions to reduce exposures and health risks. As such, I have considerable insight and experience with the issues associated with the proposed antimony-gold operation at Stibnite.

11. Over the past five years, I have monitored the development of the U.S. Forest Service Draft Environmental Impact Statement (DEIS) for the Stibnite Gold Project (SGP) and have reviewed and submitted comments regarding the several revisions of the Draft Permit to Construct (PTC) and associated support documents. As a result, I am familiar with the many

related issues, and particularly those related to contaminants of potential human health and environmental toxicity concerns.

ASSIGNMENT

12. My understanding is that the Board of Environmental Quality has remanded the PTC to the Hearing Officer for additional consideration of DEQ's analyses of ambient air arsenic and carcinogenic risk issues. The Petitioners in this case have requested that I provide an expert opinion regarding the Board of Environmental Quality conclusions and the Respondent's and Intervenor-Respondent's Declarations. I understand the purpose of my opinion is to assist the Hearing Officer regarding additional factual evidence on the ambient air concentration analysis performed by DEQ for the PTC analysis.

DOCUMENTS REVIEWED

13. For this assignment, I have reviewed the transcript of the May 1, 2024 special meeting of the Idaho Board of Environmental Quality in the matter of Air Quality Permit to Construct Issued to Perpetua Resources Idaho, Inc. (agency case number 11 0101-22-01)[2], the May 9, 2024 FINAL ORDER FROM THE BOARD, Case Docket No. 010-22-01 OAH Case No. 23-245-01 (Final Order in the Matter of Air Quality Permit to Construct P-2019.0045)[3], the subsequent May 23, 2024 Memorandum in Support of Joint Motion for Reconsideration and/or Clarification of Final Order,[4] the subsequent June 12, 2024, ORDER ON PETITIONS FOR RECONSIDERATION AND/OR CLARIFICATION OF FINAL ORDER[5], and the July 8, 2024 Scheduling Order.[6]

[2] TR 0156.
[3] REC 3695.
[4] REC 3731.
[5] REC 3835.
[6] REC 3867.

14. I have also reviewed the two DEQ Respondent Declarations and attached materials: EXPERT DECLARATION OF KEVIN SCHILLING and EXPERT DECLARATION OF NORKA E. PADEN, Ph.D., two Perpetua Intervenor-Respondent Declarations and attached materials: EXPERT DECLARATION OF KEVIN LEWIS and EXPERT DECLARATION OF THERESA LOPEZ, and the Petitioner Declaration and attached materials: DECLARATION OF WILL TIEDEMANN.

SUMMARY OF CONCLUSIONS

15. I have reviewed Idaho Board of Environmental Quality's Final Order and understand and agree with the Board's conclusions that:

a. DEQ Did Not Act Reasonably and in Accordance with Law When it Analyzed the Ambient Arsenic Air Concentrations for the SGP;

b. DEQ did not Act Reasonably in Using a Five-Year Rolling Average for T-RACT that was not Properly Supported by Permit Conditions;

c. There was Insufficient Evidence to Support the T-RACT Analysis Limiting the Non-West End Pit Production Limit; and

d. DEQ Did Not Act Reasonably and in Accordance with Law When it Applied the 16/70 Calculation to the Ambient Arsenic Air Concentration Analysis.

16. I have reviewed the transcript of the May 1, 2024 special meeting of the Idaho Board of Environmental Quality. I also concur with Vice Chair McMillan's testimony that:

> . . . DEQ has misinterpreted how the acceptable ambient concentration for carcinogens, the AACC, must be applied if it is to comply with our air quality rules.
>
> … DEQ's creation and application of a project-specific adjustment factor is not supported by Idaho's air quality rules.

> … the creation of a project-specific adjustment factor suggests that there is a significant ignorance about cancer, carcinogens, and carcinogenesis.
>
> … the short-sighted project-specific adjustment factor to the Stibnite Gold Project, DEQ created a misleading risk analysis that greatly underestimates the actual cancer risk.[7]

17. This report supports the Board of Environmental Quality's findings in the Final Order and concludes that:

a. DEQ's application of the 16/70 SGP Project-specific adjustment factor underestimates cancer risk and is inappropriate science and public health policy;

b. Ambient air arsenic concentrations and cancer risk are underestimated for the SGP by use of 5-year rolling average in the air quality modeling input factors;

c. Ambient air arsenic concentrations and cancer risk are underestimated for the SGP by improper application of the non-WEP emissions scenario;

d. The combined application the SGP 16/70, 5-year rolling average, and non-WEP Project-specific adjustment factors increase cancer risk and negate the health protectiveness of the TAPs rule; and

e. DEQ's SGP Project-specific adjustment factors represent a significant change in the regulation of carcinogenic risk in Idaho that increases both cancer risk and regulatory burden.

[7] TR 0159.

OPINIONS

A. DEQ's application of the 16/70 Project-specific adjustment factor is inappropriate science and public health policy.

18. DEQ has failed to properly implement Section 586 and T-RACT for the SGP PTC by introducing a 16/70 SGP Project-specific adjustment factor to allocate the full 70-year lifetime allowable cancer risk to the 16-year Life of Mine (LOM). The calculation averages the risk resulting from SGP emissions over the life of the receptor. This adjustment allows the SGP to emit as much as 70 years of allowable carcinogenic emissions in 16 years. This type of "adjustment factor," also known as risk amortization or cancer dose-averaging, undermines both the health protectiveness and the regulatory certainty of the TAPs rule. In the context of the existing TAPs rule, as applied the last 30 years, using the 16/70 Project-specific adjustment factor is an incorrect interpretation and represents unsound science and public health policy.

19. Specifically, DEQ misinterprets the purpose and function of the **maximum one-year annual average ambient air carcinogen concentration** in implementing the TAPs rule. It is important to review the development of the TAPs rule in understanding the strategy represented by this one-year annual standard. The Schilling Declaration asserts that the TAPs rule was developed nearly thirty years ago to accommodate DEQ's predecessor agency IDHW-DOE and the regulated communities' request to adopt rules that are: 1) are reasonably protective of public health, but still afford flexibility to facilities and projects; 2) are relatively easy to understand and implement; and 3) do not require excessive expenditure of time and resources by DEQ and the permittee during the permitting process.[8]

[8] Schilling Decl. ¶ 13.

20. I was invited by the IDHW-DOE Air Quality Bureau to engage in development of those rules at that time in an advisory committee role based on my previous experience outlined above. My recollection is that much of the IDHW-DOE's and regulated industries' initial experience with risk assessment analyses was in implementing Risk Assessment Guidance for Superfund at CERCLA sites.[9] Both IDHW-DOE and the regulated community were supportive of avoiding the onerous burden of incorporating similar risk assessment and risk management protocols into Idaho's TAPa rule. In short, after considerable effort, IDHW-DOE was successful in developing the Section 586[10] and T-RACT[11] rule with a strategy that simultaneously avoids requiring PTC applicants to submit risk assessment and risk management protocols, yet is protective of human health.

21. The resultant TAPs Section 586 and T-RACT rules are highly prescriptive. Strict adherence to the rules is requisite to simultaneously afford regulatory certainty and simplicity for the regulated community and provide health protectiveness to the public. The key aspects of the simple, yet protective, rules are: 1) the incremental nature of the rule relieves industry and DEQ of the burden of assessing multiple sources and exposures, and greatly simplifies the permitting process; and 2) a significant **margin of safety (MOS)** is provided to ensure surrounding communities are not subjected to industry-generated ambient air TAP concentrations exceeding health-based risk criteria.

22. The purpose and function of the MOS is to protect the community from those other sources and exposures, risk cofactors, and uncertainties that would otherwise be evaluated in comprehensive risk assessment and health impact analyses. The DEQ and the regulated

[9] Exhibit B. U.S. EPA, *The Risk Assessment Guidelines of 1986* (Aug. 1987).
[10] IDAPA 58.01.01.586.
[11] IDAPA 58.01.01.210.12.

community have successfully employed these TAPs rule in a productive and protective manner since the 1990s.

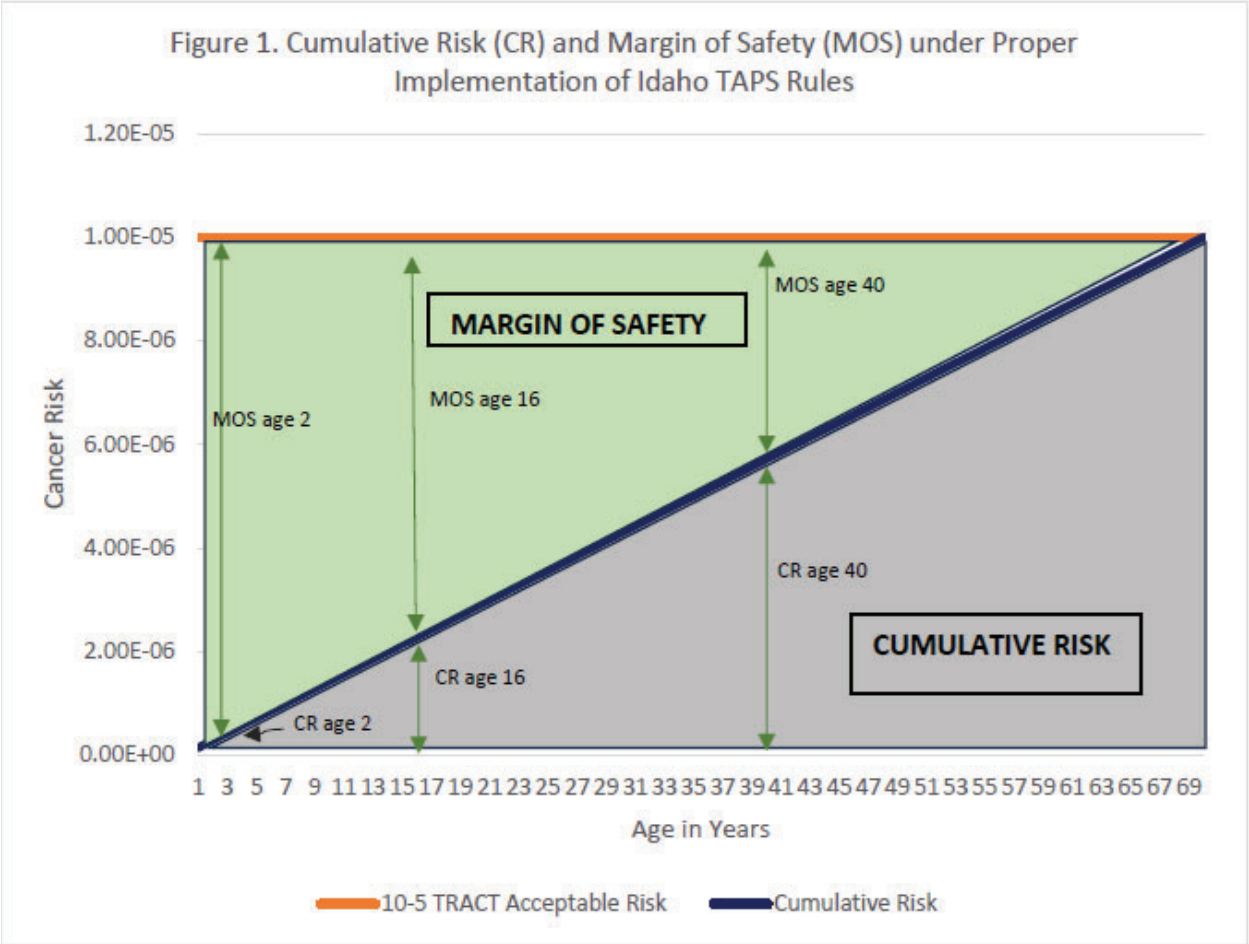
23. This prescriptive strategy specifically depends on protecting the public air space against the potential one-year annual maximum TAP emissions scenario throughout the life of the project. The one-year maximum emissions scenario is used to estimate **the maximum one-year annual average ambient air carcinogen concentration**. Ensuring that the maximum one-year annual ambient air carcinogen concentration does not exceed the acceptable ambient concentration for carcinogens (AACC) at the critical receptor location ensures that no receptor will be exposed to greater than the AACC by the incremental TAPs source for any year. The AACC is provided in Section 586 and is the ambient air concentration determined by dividing $1x10^{-5}$ lifetime risk by the Unit Risk Factor (URF). The URF is the lifetime cancer risk per 1.0 $\mu g/mg^3$ ambient air. Section 586 defines the AACC as an annual average.[12]

24. Ensuring that the criteria is achieved every year of the project guarantees the MOS will protect the individual receptors from other potential sources of the carcinogen that are not addressed in the incremental PTC analysis. Applying these criteria and MOS collectively to all individual sources assures that these health protections extend statewide.

25. Figure 1 illustrates the MOS and the cumulative lifetime risk at the critical receptor expected under the prescribed TAPS Section 586 maximum annual ambient concentration. The vertical axis is the carcinogenic risk. The horizontal axis represents the critical receptor's age commencing at the introduction of the incremental TAPs source. The

[12] *See* IDAPA 58.01.01.586 ("The AACC in this section are annual averages.").

maximum allowable lifetime risk is shown as the horizontal line at the top of the Figure ($1x10^{-5}$ T-RACT risk in this example).



26. If the TAPs rule is properly implemented, the cumulative incremental risk is shown by the diagonal line proceeding from birth to age 70 years (i.e., risk is allowed to accumulate at an annual rate of $(1x10^{-5})/70$ per year, or (AACC*URF/70) under T-RACT. The gray area below the diagonal line represents the portion of allowable lifetime risk accumulating from the incremental source. Risk increases proportional to the receptor age and the individual will have received the full allowable lifetime T-RACT exposure, and have a 10^{-5} carcinogenic risk burden at age 70-years.

27. The green area above the diagonal line represents the margin of safety (MOS) for the receptor to accommodate other contaminant exposures, risk cofactors, or uncertainties that might increase cancer risk from sources other than the incremental emissions regulated under TAPs Section 586 and T-RACT. Specifically, the large MOS safely accommodates those risk considerations that would otherwise be addressed in onerous risk and health assessment protocols. In this manner Idaho's TAPs compliance strategy purposefully, but safely, avoids requiring risk analyses.

28. The strategy also extends maximum protection to those population sub-groups most sensitive to carcinogenesis. Important life-stages of the receptor are indicated by the vertical lines at ages 0-2 years for infants and toddlers, ages 3-16 for children and adolescents, ages 17- 40 for reproductive-aged women and the fetus, and ages 41-70 years for older adults. This Idaho TAPs rule strategy affords minimal cumulative risk and maximal MOS protection during early life stages and pregnancy, acceptable risk levels during most of adulthood, with lesser protection at advanced ages when incremental cancer risk has limited effect on lifetime cumulative risk.

29. In the case of arsenic under the T-RACT criteria, the allowed annual rate of risk accumulation is a direct function of the .0023μg/m^3 T-RACT AACC multiplied by URL/70. As a result, contrary to Respondents' assertions, the AACC functions as an annual standard as historically applied in the TAPs rule. DEQ's and Perpetua's Declarations contend the Section 586 comparison of average annual ambient air arsenic concentration should utilize the average 70-year concentration, as opposed to basing health protectiveness on the worst-case **maximum one-year annual average ambient air carcinogen concentration** that is the foundation of the

MOS. Using the 70-year basis proposed by DEQ and Perpetua allows Perpetua to emit a lifetime of allowable emissions in 16 years, and undermines the health protectiveness of the rule and increases cancer risk.

30. The origin of DEQ's policy change can be found in the Lewis and Schilling Declarations. The initial Draft PTC offered by DEQ for public review exempted 99% of proposed allowable arsenic emissions from regulation and TAPs compliance because mining fugitive dust was not considered. Following subsequent public hearing testimony, DEQ required that Perpetua consider haul road dust arsenic emission under Section 586 TAPs rule.[13] As Schilling asserts, when subsequently required to consider the massive arsenic emissions, Perpetua informed DEQ that compliance with either the 10^{-6} AACC or the 10^{-5} T-RACT AACC limits were not achievable.[14] Any calculations or analyses to support these conclusions have never been disclosed.

31. According to Schilling, DEQ then suggested the ad hoc SGP 16/70 Project-specific adjustment factor, or dose-averaging approach, to avoid the annual one-year average constraints of the TAPs rule.

> Rather than revise the analytical approach to provide a less conservative assessment of impacts, I proposed that compliance with carcinogenic TAP increments could be based on cumulative cancer risk of the limited-duration project rather than the worst-case annual impact for a project of limited duration.[15]

32. The SGP 16/70 Project-specific Adjustment Factor was introduced in the TAPs Modeling Addendum, Section 4.3 AACC Adjustment for the Operational Life of the Mine.

[13] Lewis Decl. ¶ 18.
[14] Schilling Decl. ¶ 22.
[15] Schilling Decl. ¶ 22.

> [Perpetua] indicated the maximum life-of-mine will be 16 years. Life-time exposures to carcinogenic TAPs were refined by multiplying the maximum modeled annual impact by a ratio of 16/70.[16]

33. In defending this policy change, Schilling asserts that DEQ's position that the short-term factor of 10 applied to the allowable AACC when a project will have a duration of less than 5 years, shows that an adjustment in the exposure concentration is appropriate.[17] He further asserts that:

> . . . DEQ determined it would not be appropriate to subject individuals to a lifetime allowable cancer risk within a duration of less than 5 years. Therefore, the adjustment was capped at 10, rather than using a higher value or values calculated from exposure durations of 5 years of less (e.g., 70 years/5 years = 14 or 70 years/2 years = 35). These short-term projects were most commonly remediation and pilot-scale projects having a duration of up to several years.[18]

34. Schilling refers to IDHW-DOE's explicit 1992 interpretation,[19] also noted by Lopez,[20] that:

> For short term sources (usually less than five years in duration), such as remediation projects, a probability of greater than one in a million risk (over 70 years) will generally be acceptable to account for the decreased term of exposure. It is not acceptable however, for exposed individuals to receive a full 70-year exposure during the life of a short-term project. (Idaho DEQ 1992).[21]

35. In my opinion, nothing in the 1992 IDHW-DOE document suggests that an "adjustment factor" can be applied to any project with a life greater than 5 years, as the Schilling and Lopez Declarations imply is the modified DEQ policy. I am not aware of any quantitative

[16] REC 0698.
[17] Schilling Decl. ¶ 19.
[18] Schilling Decl. ¶ 19.
[19] Schilling Decl. ¶ 19.
[20] Lopez Decl., Memo. in Supp. of Decl. at 11.
[21] REC 3780.

"adjustment factor" connection between the 5-year project lifetime and the 70-year lifetime cancer risk basis. I believe that it is more accurate to describe the short-term factor of 10 as reflecting the order of magnitude increase in allowable risk from 10^{-6} to 10^{-5} criteria. This order-of-magnitude relief in allowable risk levels is commonly justified in cancer risk mitigation protocols throughout State and federal jurisdictions in various programs for various reasons, such as the Washington State protocols.[22]

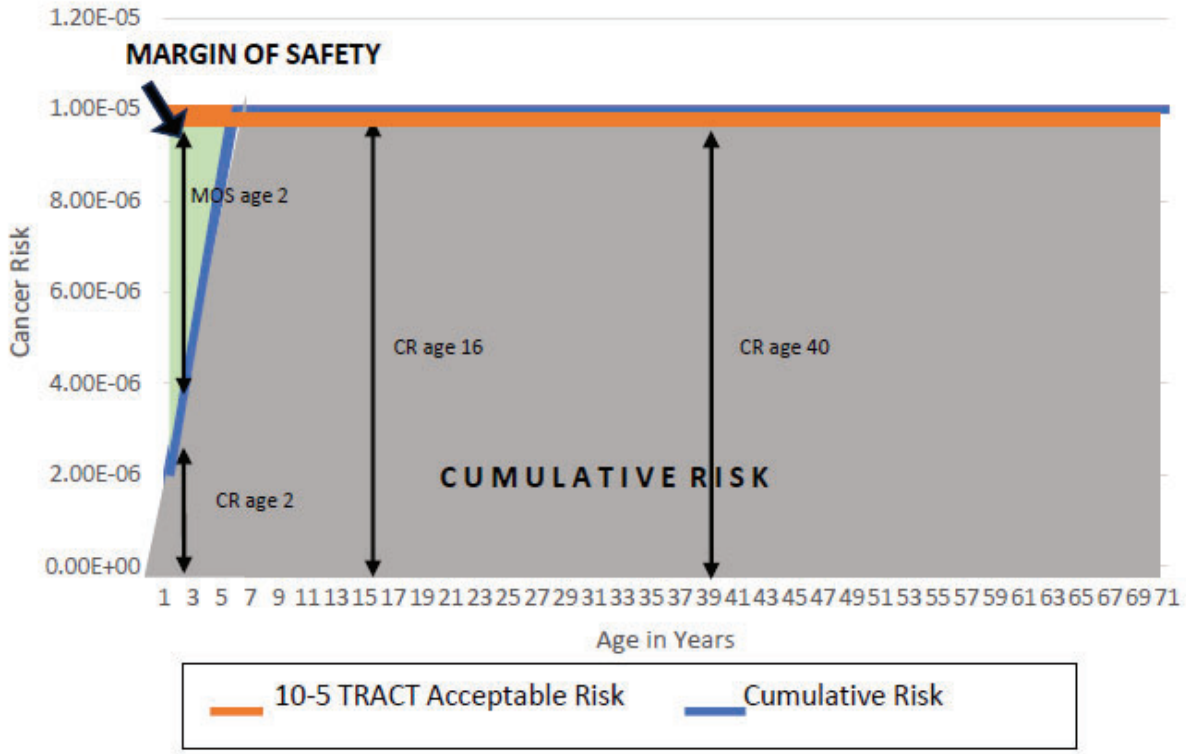
36. According to Schilling and Lopez, DEQ's modified policy implies that the SGP Project-specific adjustment factor can be applied to any carcinogenic source with a duration greater than five years. This shortsighted conclusion is incorrect, unprecedented, and not supported by EPA guidelines. The new policy is poor science and undermines the health protective strategy of regulating TAPs that has successfully been applied for the last thirty years.

37. Consider the extreme case of DEQ permitting a six-year (>5 yr.) life facility to emit sufficient carcinogens to expose individuals to the full 70-year lifetime acceptable risk in six years. The alleged allowable maximum annual ambient concentration would be 70/6 = 11.7 times the AACC, (or 117 times the AACC if T-RACT applied, (i.e. 1.17×10^{-4} cancer risk if applied for 70 years). DEQ's misinterpretation would allow emissions and consequent exposures of more than two orders of magnitude greater risk than the AACC (1.2×10^{-4} equivalent risk) for six years. At year 7 (or 10% of the receptor's assumed lifetime), the six-year-old child will have accumulated, and carry the lifetime burden, of a one-in-one hundred thousand cancer risk (10^{-5}). This risk burden will accompany the individual for the following six decades (> 90%) of the receptor's expected lifetime.

[22] Exhibit C. Washington State Department of Ecology, *Guidance Document First, Second, and Third Tier Review of Toxic Air Pollution Sources (Chapter 173-460 WAC)* (2010).

38. The effect of this dangerous scenario is illustrated in Figure 2. The MOS afforded this childhood receptor occurs briefly in the first six years of life. For the remainder of the receptor's lifetime, any additional arsenic exposure, from any source at any time, would immediately cause the cumulative lifetime exposure to exceed the unacceptable $>10^{-5}$ risk. The receptor would be challenged to avoid any additional arsenic exposures for the remainder of life.

Figure 2. Cumulative Risk (CR) and Margin of Safety (MOS) using the Project-specific (6/70) Adjustment Factor for a 6-year project



39. The ad hoc introduction of risk averaging by DEQ through a 6/70 adjustment factor, as depicted in Figure 2, would allow a six-year project to concentrate 70 years of emissions and lifetime cancer risk into both the 6-year life of the project and receptor child's first

six years of life. This scenario undermines the health protectiveness originally incorporated in Section 586, particularly with respect to neo-natal, pediatric, and adolescent cancers.

40. In justifying the use of the 16/70 Project-specific adjustment factor, the Respondents continually assert that the Unit Risk Factor (URF) is an average based on a 70-year lifetime. However, carcinogenic potency and cancer risk accumulation differ for various stages of life. The cancer dose varies based on contaminant intake and absorption rates and physiological factors such as body weight and organ development. Considering early life exposures, warrants additional examples of the inappropriateness of introducing the SGP 16/70 Project-specific adjustment factor. Pregnant women, the fetus, and pre-school children accumulate dose and risk at the highest rates and are especially vulnerable to disease due to age and developmental factors. Body weight, absorption, and hormonal considerations can make older children and adolescents more susceptible to childhood cancers.

41. DEQ's assertion that the SGP 16/70 Project-specific adjustment factor is health protective implies that it is permissible to subject these sensitive subpopulations to the equivalent $>10^{-4}$ risk levels from conceptus to school age because it will average out over the remainder of the child's life.

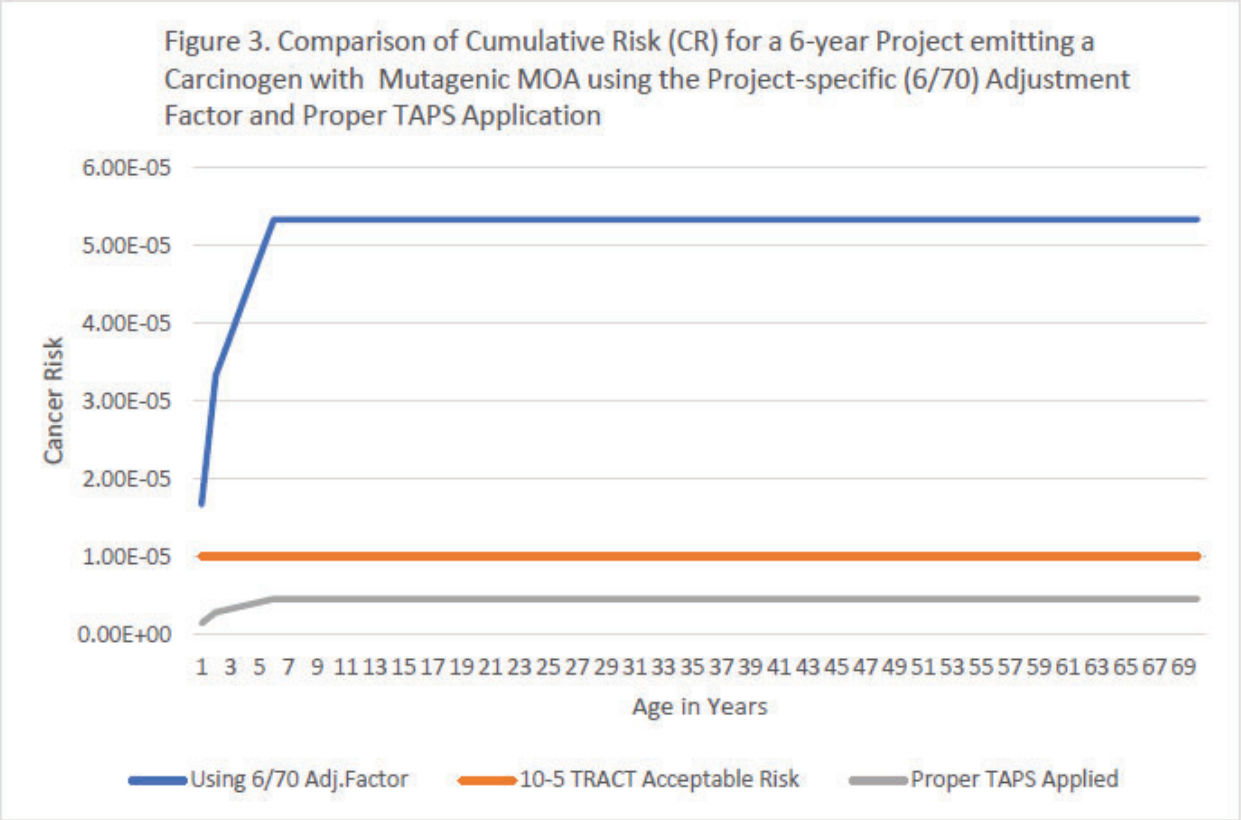
42. The SGP 16/70 Project-specific adjustment factor is a classic example of dose-averaging. The practice of averaging cancer risk over a receptor's lifetime progressively developed as an issue in the risk analyses applied to contaminated hazardous waste sites during the 1990s, and early 2000s. The EPA comprehensively considered the application of

dose-averaging or risk amortization in the Science Advisory Board (SAB) review *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens.*[23]

43. The excessive risk associated with early life-stage carcinogenic dose accumulation has long been recognized by most health authorities and specific protections were incorporated in EPA Risk Assessment Guidance for Superfund (RAGS) policy in 2009. The EPA recommends a quantitative adjustment of the toxicity value to account for early life susceptibility. This guidance recommends a 10-fold adjustment for exposures during the first 2 years of life; 3-fold adjustment for exposures from ages 2 to <16 years of age for carcinogens exhibiting mutagenic mode of action (MOA).[24]

44. Figure 3 shows lifetime cumulative risk were DEQ to apply the ad hoc 6/70 adjustment factor to a carcinogen exhibiting mutagenic MOA for the 6-year project life scenario (blue line). Applying the recommended age-specific adjustment factor shows that DEQs interpretation allowing dose-averaging over the 70-year lifetime would result in the allowable full lifetime exposure occurring by age 2 years, and the child's lifetime cumulative exposure will be $5.3x10^{-5}$ by age 6 (i.e., 53 times the one-in-one million criteria). These lifetime cumulative risks acquired by infants and toddlers, prior to adolescence far exceed EPA acceptable carcinogenic risk policy.

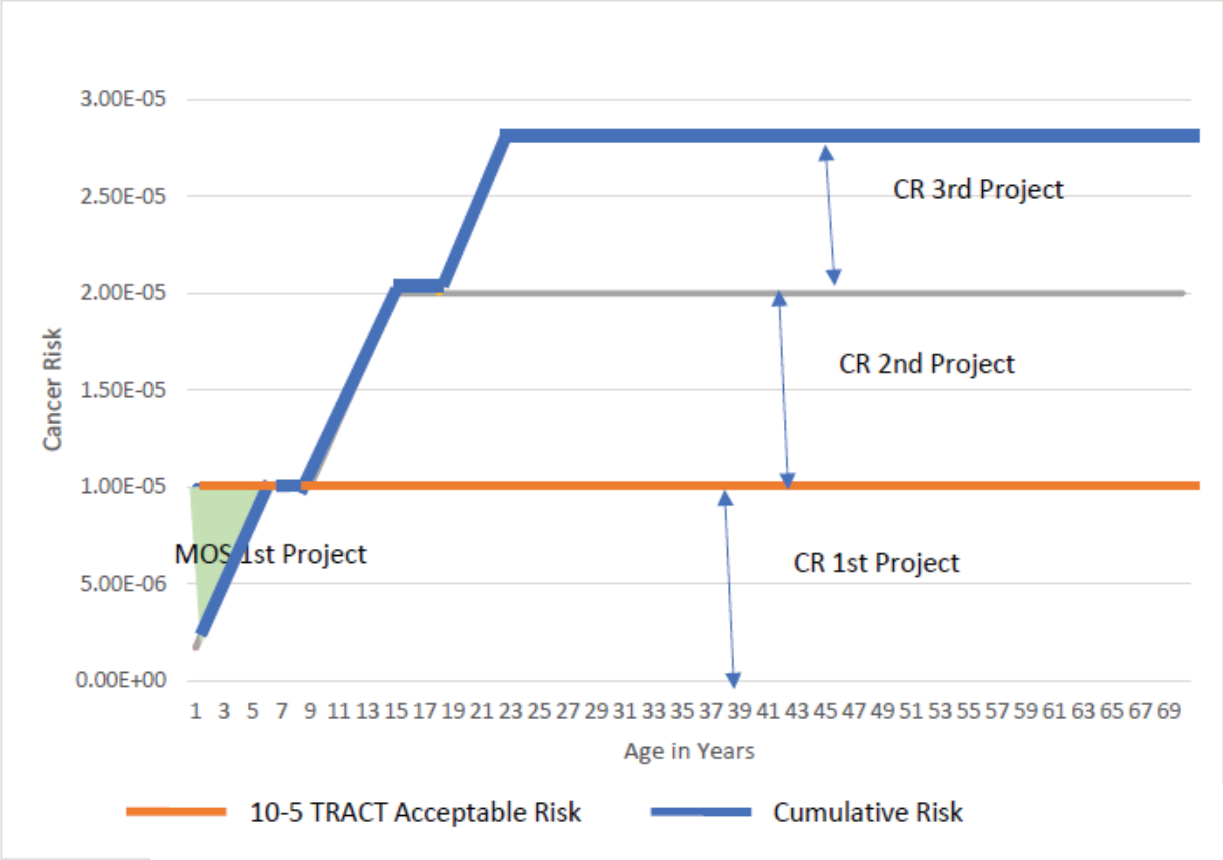
[23] Exhibit D. U.S. EPA, *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens* (2005).
[24] Exhibit E. U.S. EPA, *Risk Assessment Guidance for Superfund. Vol. I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment* (Jan. 2009).



45. Conversely, proper application of the TAPs rule using the **maximum one-year annual average ambient air carcinogen concentration** is shown by the lower cumulative risk line (gray line). Proper implementation of the TAPs rule would result in 4.6×10^{-6} cumulative cancer risk at age six years, as shown in Figure 3. These results demonstrate that application of a 6/70 adjustment factor for a six-year facility increases a six-year-old child's cancer risk by 12 times over that were the TAPs rules applied under the past policy.

46. As another example, consider the case of two additional 6-year projects being implemented near the source represented in Figure 2 at years 9 and18 in this child's life. Figure 4 shows the child already exposed to the full lifetime allowable cancer $1x10^{-5}$ risk by age 6, will have double ($2x10^{-5}$) the acceptable risk level by adolescence, and will carry three times the allowable lifetime cumulative risk burden ($3x10^{-5}$) through the reproductive stage of life.

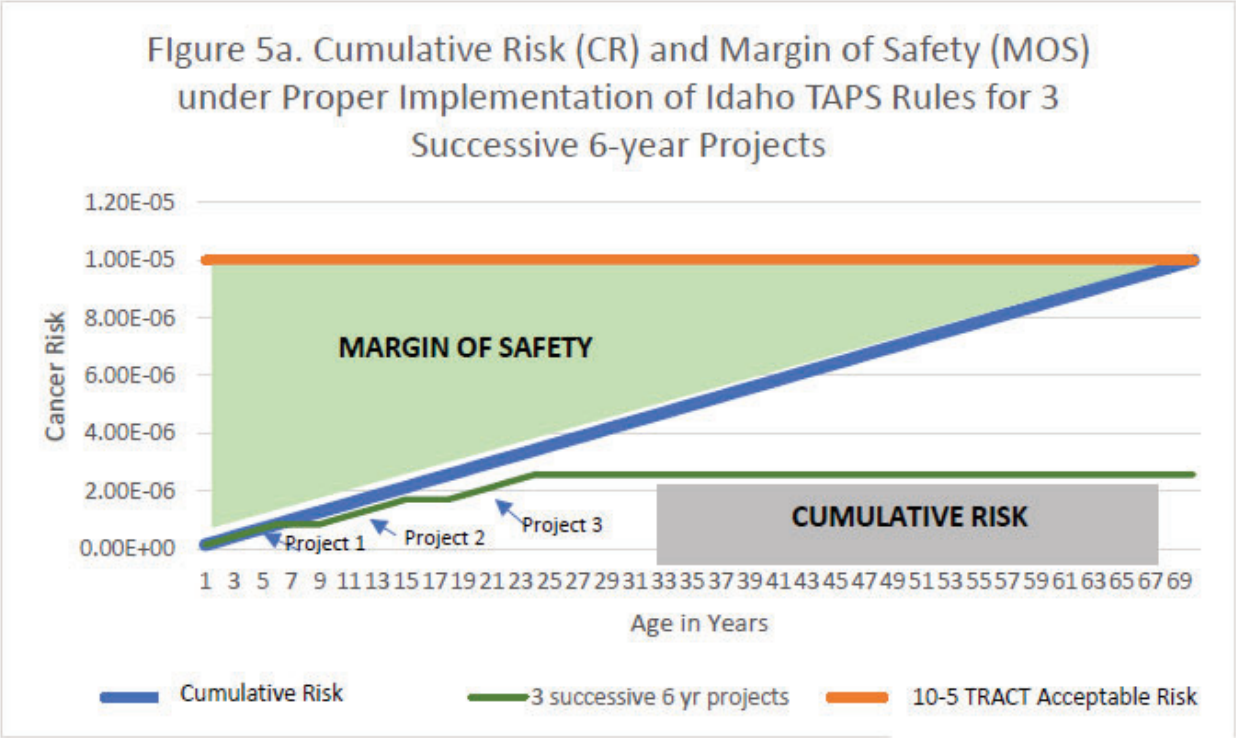
Figure 4. Cumulative Risk using the Project-specific (6/70) Adjustment Factors for 3 Successive 6-year Projects



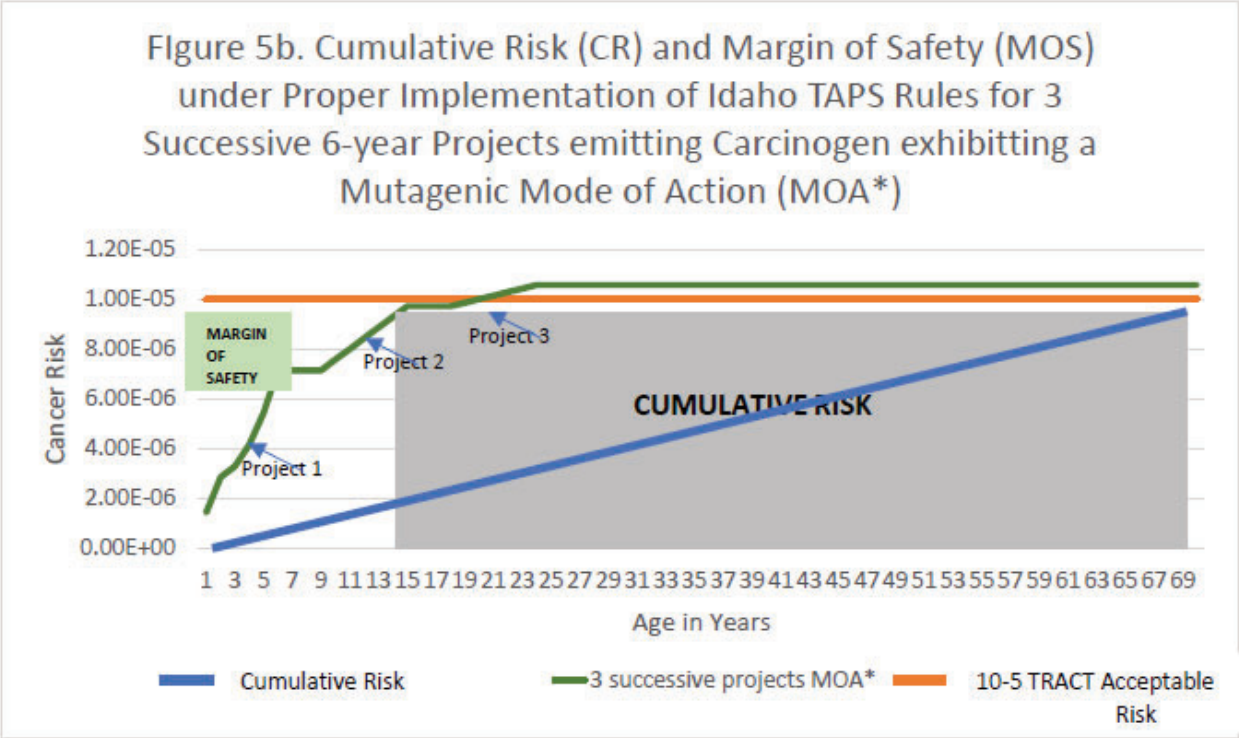
47. Consider the three sequential 6-year projects implemented under the new (6/16) adjustment factor emitting a carcinogen exhibiting mutagenic MOA. In this scenario, the three projects would increase individual cancer risk to $>1x10^{-5}$ lifetime allowable risk by age 2, to $5.3x10^{-5}$ for a 6-year-old child, $8.3x10^{-5}$ for a 16- year old adolescent, and $9.3x10^{-5}$ for a 24-year old adult. These are dangerous and unacceptable risks at vulnerable life stages.

48. Under Section 586, DEQ must consider these new projects incrementally. Thus, it would not account for the cumulative lifetime exposures associated with the earlier projects in a new source PTC application, and are not allowed to consider risk associated with those earlier projects. At Stibnite, for example, should SGP apply to open another pit at the mine, DEQ would be required to ignore the cumulative lifetime risk and cancer burden imposed by the proposed SGP 16-year LOM scenario.

49. Figures 5a and 5b demonstrate the same three sequential project scenarios under the proper implementation of the current TAPs rules using the **maximum one-year annual average ambient air carcinogen concentration** that incorporates the MOS to accommodate additional sources. Figure 5a shows the cumulative risk from all three projects for a carcinogen not exhibiting mutagenic MOA. In this case, a child growing up in the community would be protected from excess cancer risk through all life stages even though DEQ would not consider the earlier exposure in applying Section 586. The lifetime risk accrued by the individual is $2.6x10^{-6}$ as opposed to $3.0x10^{-5}$ in the earlier example. Allowing use of the 6/70 adjustment factor increases lifetime cancer risk by 12 times..



50. Figure 5b shows the cumulative risk for proper implementation of the current TAPs rule for three sequential 6-year projects emitting a carcinogen exhibiting mutagenic MOA. In this example, the MOS is successfully protective throughout childhood and adolescence, with the cumulative risk exceeding the 10^{-5} risk level at age 21. These examples illustrate the effectiveness of the MOS in accommodating additional sources and risk cofactors. The TAPs rule is health protective if properly implemented. Applying risk averaging through the use of the 16/70 Project-specific adjustment factors eliminates the MOS and substantially increases cancer risk, especially considering the incremental nature of the rule.



51. Figures 5a and 5b also demonstrate DEQ's shortsightedness in applying unprecedented cancer dose-averaging methods through the SGP 16/70 Project-specific adjustment factor. The inappropriate averaging is allegedly justified by ad hoc risk assessment calculations and risk management protocols that undermine both the simplicity and the health protectiveness of the TAPs rule. The MOS is compromised, the public is no longer secure, and the regulated industry is now obliged to include cancer risk and health impact assessments in TAPs PTC applications to support the assertions of health protectiveness.

52. There are no provisions in the Air Rules to allow manipulation of the required **maximum one-year annual average ambient air carcinogen concentration** or the **AACC,** or to submit risk calculations. The Respondents assert that because there are no specific prohibitions, using the SGP 16/70 Project-specific adjustment factor is permissible. DEQ did not

require any risk assessment justification during the PTC process, but only provided extremely limited risk analyses in post hoc declarations following the Special Board Hearing.[25]

53. In justifying the SGP Project-specific 16/70 adjustment factor, both the DEQ and Perpetua refer to the EPA Risk Assessment Guidance for Superfund (RAGS) risk assessment protocols eschewed by the agency for the last thirty years to support the ad hoc exposure averaging calculations. As noted in the Tiedeman Declaration, IDHW-DOE specifically avoided RAGS waste site remediation short-term risk protocols in developing the TAPS.[26]

54. The Board of DEQ Vice Chairman McMillan explicitly expressed concerns with this issue, indicating his belief that DEQ's creation and application of a Project-specific adjustment factor cannot be supported by Idaho's Air Rules and that DEQ has misinterpreted how the AACC must be applied if it is to comply with the those rules.

55. Vice Chairman McMillan further indicated that DEQ's application of what he called the "short-sighted" Project-specific adjustment factor to the Stibnite Gold Project created a misleading risk analysis that greatly underestimates the actual cancer risk. In his view:

> The Idaho rules are not ambiguous. There is an acceptable risk associated with the AACC standard. There is an acceptable risk associated with DEQ-approved T-RACT projects, and there is an acceptable risk associated with the short-term project that is five years or less. There are no other acceptable risks identified in Idaho's air quality rules.[27]

I agree with Dr. McMillan's statement.

[25] *See* Schilling Decl.; Paden Decl.; Lewis Decl.; Lopez Decl.
[26] Tiedemann Decl. ¶¶ 26-27.
[27] TR 0160.

B. Ambient air arsenic concentrations and cancer risk are underestimated for the SGP by using a 5-year rolling average in the air quality modeling input factors.

56. Another ad hoc SGP Project-specific adjustment factor DEQ applied to the exposure estimates (prior to implementing the 16/70 Project-specific adjustment factor) was a 5-year rolling average adjustment factor to the emissions rates used as input to the refined modeling. This disguised risk averaging technique results in the models predicting a five-year average ambient air carcinogen concentration rather than the **maximum one-year annual average ambient air carcinogen concentration** required under Section 586 and T-RACT, further undermining the health protectiveness of the TAPs rule.

57. The 5-year rolling average adjustment factor was introduced in the TAPS Modeling Addendum Section 4.2 -TAP Emission Averaging Period. In Section 4.2, DEQ asserts:

> Annual average emissions of carcinogenic TAPs are typically used in the dispersion model to estimate maximum annual impacts. PRI refined the analyses by using source-specific emission rates that are representative of a 5-year averaging period. This approach is appropriate because carcinogenic impacts are of concern from a long-term exposure basis.[28]

58. DEQ erroneously substitutes the 5-year rolling average emissions for the maximum one-year potential emissions required under Section 586 and T-RACT. Section 586 requires the prescribed maximum one-year annual average to be estimated by refined modeling of ambient concentrations based on maximum one-year potential emission rates, or PTE. The PTE should reflect the source configuration and operational scenario that would yield the maximum annual one-year ambient air arsenic concentration. This concentration is then

[28] REC 0698.

compared to the 10^{-6} AACC. If the 10^{-6} AACC is exceeded, the applicant may apply for 10-fold relief under TRACT.

59. DEQ has never disclosed this comparison. In response to public comments critical of DEQ for not calculating nor presenting the required AACC comparisons, DEQ provided the following rationale:

> The comparison offered, comparing maximum annual impacts to the T-RACT adjusted AACC, is irrelevant. Compliance with TAPs rules was demonstrated through a refined analysis, so there is no utility in focusing on results from a more conservative, less refined analysis.[29]

DEQ misinterprets the purpose the comparison and undermines the health protective strategy of the TAPS Rules as implemented in the past.

60. Instead, DEQ substituted the 5-year rolling average for the required maximum one-year emission rate. There is no provision in the TAPs rule for altering or adjusting the predicted maximum one-year annual average. This erroneous substitution significantly reduces the MOS inherent in proper allocation of the one-year maximum emission rates. To be health protective, the prescriptive Section 586 rule explicitly (not typically) requires predicting the **maximum one-year annual average contaminant concentration** using prescribed emissions estimates, and assuring that concentration is not exceeded during the life of the facility.

61. DEQ has never disclosed the required **maximum one-year ambient annual average arsenic concentration.** It is not possible from the available information provided by DEQ to determine how this 5-year rolling average compares to the maximum one-year emission rate that should have been used. I have estimated the underprediction by examining the ratio of

[29] REC 0693.

peak to mean 5-year rolling average emission rates presented in Figure 3 of Perpetua's TAP Addendum.[30] This figure shows estimated potential 5-year rolling average emissions for an alleged 16-year MODPRO2 operations plan. The estimated mean 5-year rolling average from this figure was calculated to be 0.132 lb/hr. Comparing this value to the maximum 0.232 lb/hr value suggests the peak to mean ratio for the alleged T-RACT PTE is approximately 1.8 (0.232 lb/hr / 0.132 lb/hr).

62. Because this Project-specific 5-year rolling average adjustment factor is inherently applied to the emissions input to the refined models, a 1.8 underprediction factor would translate directly to the estimated receptor point ambient air carcinogen estimates. As a result, the maximum one-year annual concentration in the model output is likely underpredicted by a factor of 1.8. The best estimate of the **maximum one-year annual ambient air arsenic concentration** for the modeled scenarios is 0.0125 $\mu g/m^3$ (1.8 x 0.00698 $\mu g/m^3$) for the WEP2.[31]

63. DEQ's application of the 5-year rolling average adjustment factor reduces the **maximum one-year annual ambient air arsenic concentration** and the associated cancer risk by 45%.

C. Ambient air arsenic concentrations and cancer risk are underestimated for the SGP by improper application of the non-WEP emissions scenarios.

64. A third SGP Project-specific adjustment, the non-WEP adjustment factor, was applied to model predicted ambient air concentrations. This is a second disguised dose-averaging step combining eight different 5-year rolling average scenarios, reducing the alleged WEP2

[30] Exhibit L. at 26.
[31] Exhibit L at PDF 224.

maximum annual average an additional 41%. DEQ averaged the maximum WEP2 scenario 5-year average arsenic concentration predicted by the model (i.e. 0.00698 μg/m^3) with the average of the seven model predicted non-WEP 5-year average concentrations (0.00134 μg/m^3). These alleged annual averages are actually an average of 5-year averages as these were predicted by the already diluted 5-year rolling average emissions input to the refined modeling. This non-WEP multi-averaging adjustment factor dilutes the ambient air carcinogenic concentration by an additional 41%, yielding the 0.00416 μg/m^3 alleged incremental annual ambient arsenic concentration. Paden and Lopez use this value to assert compliance with EPA cancer risk policies in subsequent risk calculations.[32]

65. DEQ and Perpetua assert this additional dose-averaging step is justified because no one scenario will apply throughout the 16-year LOM operation. In the context of properly applying the TAPs rule, the non-WEP adjustment factor is irrelevant. DEQ's obligation is to identify the emission scenario that produces the **maximum one-year annual average ambient air carcinogen concentration**. That value is the maximum WEP2 scenario, and would not consider non-WEP scenarios unless the non-WEP emissions sources were operating contemporaneously during the WEP2 emission maximum year. In that case, any non-WEP scenario operating in the same year as the WEP2 maximum configuration would add to, not dilute, the critical receptor maximum ambient air concentration.

66. DEQs applying the SGP Project-specific non-WEP adjustment factor effectively converts the 5-year alleged annual average value (0.00698 μg/m^3) to an arbitrary 0.00416 μg/m^3 16-year LOM average carcinogenic concentration. A variety of combinations of the different

[32] *See* Paden Decl. XXX; Lopez Decl. XXX.

modeling scenarios, based on alleged operations plans could have been combined to manipulate this multi-averaged hybrid LOM ambient air carcinogenic exposure estimate (e.g. 3-year rolling average and 70% non-WEP contribution).

67. The final effect of DEQ's application of an arbitrary multi-averaging non-WEP adjustment factor can be estimated by comparing the WEP2 and non-WEP average ambient air carcinogen estimates (i.e., (0.00698 $\mu g/m^3$ / 0.00416 $\mu g/m^3$), or by a factor of 1.7. Applying the non-WEP Project specific adjustment factor underpredicts the required **maximum one-year annual average ambient air carcinogen concentration** and associated cancer risk by an additional 41%.

D. The combined application of the SGP 16/70 Project-specific adjustment factor, the 5-year rolling average adjustment factor, and the non-WEP adjustment factor increase cancer risk and negate the health protectiveness of the TAPs rule.

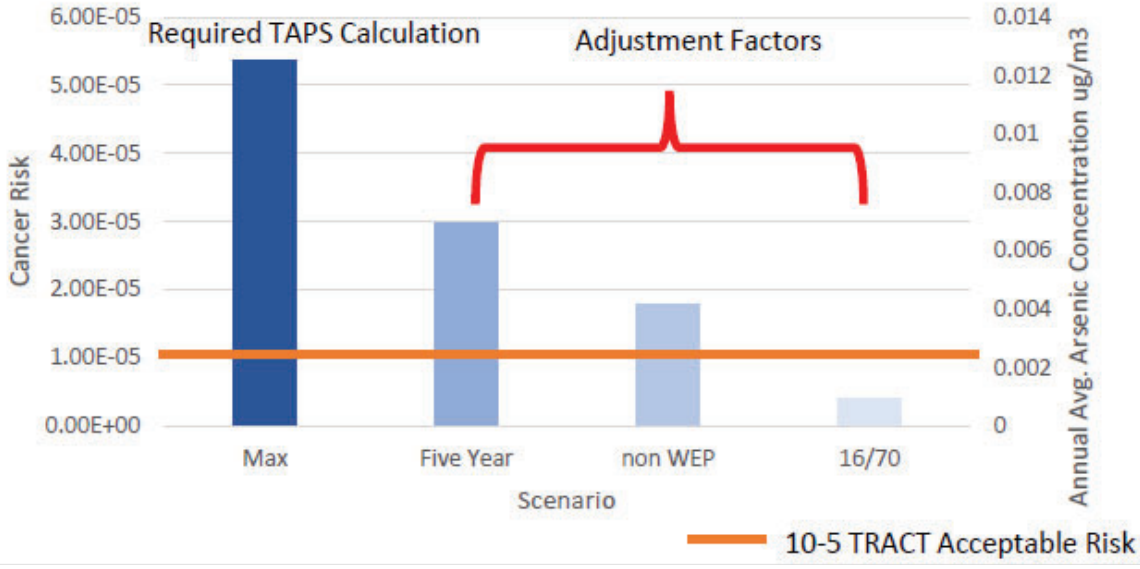
68. The conclusions in the DEQ Board's Final Order correctly identified the three Project-specific adjustment factors that undermine the health protectiveness of the TAPs rule for carcinogenic risk. The Board correctly concluded that application of these adjustment factors underestimates cancer risk. DEQ applied the: 1) 5-year rolling average; 2) non-WEP; and 3) SGP 16/70 LOM adjustment factors sequentially to the input and the output of the predictive air quality model. As a result, the dilution effects are multiplicative, rather than additive.

69. In summary, DEQ diluted the (0.0125 $\mu g/m^3$) maximum one-year annual average ambient air carcinogen concentration by 45% to 0.00698 $\mu g/m^3$ by applying the 5-year rolling average. DEQ further diluted 5-year average concentration by 41% to a value of 0.00416 $\mu g/m^3$ by applying the non-WEP adjustment factor, which is diluted an additional 78% to a value of 0.00095 $\mu g/m^3$ by applying the 16/70 SGP Project-specific adjustment factor. In total, DEQ

diluted the required **maximum one-year annual average ambient air carcinogen concentration** by 93%, or a factor of 13 times before calculating the corresponding cancer risk.

70. The risk levels associated with these exposures were similarly underpredicted as follows: the risk for estimated **maximum one-year annual average ambient air carcinogen concentration** of $5.3X10^{-5}$ was (1) diluted to $3x10^{-5}$ by applying the 5-year rolling average adjustment factor; (2) diluted to $1.8x10^{-5}$ by applying the non-WEP adjustment factor; and (3) to the alleged compliance $4x10^{-6}$ by applying the SGP 16/70 Project-specific adjustment factor. These results are shown in Figure 6. DEQs sequential application of the three SGP Project-specific adjustment factors underpredict cancer risk by 13 times, as these carcinogenic risk levels are employed in properly implementing the TAPs rule.

Figure 6. Effect of DEQs Application of the Project-specfic Adjustment Factors Compared to Required TAPS Calculation



71. These analyses confirm Vice-chairman McMillan's observation in the Special Hearing:

> The PTC proposes to allow 16 years higher daily carcinogen doses and disguises such doses using a non-rules-based mathematics.[33]

E. DEQ's SGP Project-specific adjustment factors represent a significant change in the regulation of carcinogenic risk in Idaho that increases both cancer risk and regulatory burden.

72. As DEQ admits,[34] cancer dose-averaging has seldom, if ever, been used in TAPs carcinogenic risk compliance evaluations for a stationary source under the Clean Air Act in Idaho. Although there is a history of using cancer dose-averaging in risk assessment and risk management protocols for short-term remediation projects at contaminated sites, applying it to the SGP PTC is unprecedented. In implementing the SGP 16/70 Project-specific adjustment factor, DEQ has deviated from the long-held prescribed TAPs rule protocol of guaranteeing the **maximum one-year annual average carcinogen concentration** will not exceed the AACC or T-RACT AACC for each year of the Project. This thirty-year health protective strategy has provided the public comfort that cancer risk exposures are within acceptable limits both near the source and Statewide.

73. Should application of risk averaging become precedent through acceptance of the SGP Project-specific adjustment factors, the conservative MOS inherent in the TAPs rule is significantly reduced. This major change in health protective strategy should simultaneously require PTC applications to include a comprehensive health risk assessment to consider other

[33] TR 0160.
[34] REC 1201.

potential sources otherwise inherently addressed in the MOS. Providing such evidence would be incumbent upon both the PTC applicants and DEQ.

74. These health and risk assessments would require new applicants to consider other past, present, and future sources that did, or may, expend significant portions of the critical receptor's lifetime allowable risk. A simple review of Washington State's required Health Impact Assessment (HIA) points out the numerous shortcomings in the ad hoc alleged risk analyses offered by the Respondents. The HIA requires specified emissions calculations, approved air dispersion modeling, AACC screening, risk assessment, hazard identification, exposure estimates considering other sources and exposure routes, dose-response criteria, non-carcinogenic risk characterization, uncertainty analysis, discussion of acceptability of risk, and a risk management analysis employing modified emission control strategies.[35]

75. DEQ has no history utilizing risk assessment to support TAPs rule applications, nor do the Idaho TAPs regulations offer any guidance for conducting health risk analyses. No comprehensive analyses, nor discussion related to risk and health assessment, are found in the Statement of Basis for the SGP PTC.[36] No comprehensive assessment of health and risk issues associated with application of the SGP Project-specific adjustment factors were required in Perpetua's application.

76. Additionally, from a regulatory standpoint, other Idaho air permit applicants may seek similar preferential relief. No facility plans for a 70-year life. The 70-year basis is an artifact of cancer risk analyses protocols, not a facility design criterion. Every facility ever to apply for a

[35] Exhibit C at 26.
[36] *See* REC 0410.

PTC that did not opt for short-term relief (less than 5 years) likely anticipated a project life of less than 70 years of operation. Will DEQ offer SGP-equivalent project-specific adjustment factor relief and require comprehensive Health Impact Analyses for 6/70, 10/70, 16/70, 20/70, 25/70, 30/70-year alleged project life, as Schilling Declaration suggests?[37] Will DEQ approve incremental emissions from a new source impacting the same critical receptor location that has already expended its lifetime allowable risk, as demonstrated in Figures 4 and 5, above? Will DEQ approve additional emissions from the same location after the original permit has exhausted the critical receptor lifetime allowable risk? Will DEQ require, and provide guidelines, for risk and health assessments to support the preferential relief?

77. These questions demonstrate the short-sightedness of DEQ's acquiescence to Perpetua in allowing dose-averaging concepts to be applied to the Section 586 TAPs rule. Proper application of the rule inherently precludes risk averaging to maintain health protectiveness, without requiring applicants to address the issues without guidance. The regulatory burden placed on future applicants by this modified policy is potentially immense.

78. Allowing Perpetua and the SGP to concentrate a lifetime of carcinogenic emissions and allowable risk in a shorter exposure period defined by the LOM introduces numerous issues and uncertainties that can appropriately be considered only in comprehensive risk assessment analyses.

79. There are numerous examples of inadequacies of the risk calculations offered by the Respondents. Among the more important are those related to the SGP Project-specific adjustment factors concentrating emissions and carcinogenic risk in childhood and adolescent

[37] *See* Schilling Decl. ¶ 19.

life stages. Environment Canada conducted an extensive review of the development and incorporation of life stage cumulative risk assessment, and particularly dose-averaging.[38]

80. This document provides an understandable and concise review of the several issues surrounding dose-averaging, and risk amortization in applying cumulative risk assessment to short-term exposure scenarios. The report also evaluates and describes how various U.S. and Canadian health agencies had implemented risk amortization policy in the preceding decade. Environment Canada's conclusions reflect earlier EPA's determinations that dose averaging generally underestimates risk for fetus, infant, toddler, school children and adolescents; can be appropriate for healthy adults; and overstates risk late in life.[39] Idaho's current TAPs rule MOS appropriately accommodates both these conclusions if properly implemented as illustrated in Figure 1, above.

81. Environment Canada's conclusion with regard to threshold carcinogens is most pertinent to consideration of the SGP 16/70 Project-specific adjustment factor. Environment Canada states:

> Without a sound basis for doing so (i.e. it cannot be a default assumption), **the human health risk assessor should not simply mathematically spread out a short-term dose over a long period and conclude that the short-term dose is toxicologically equivalent to a lower dose over the long period. In short, CSD recommends that the exposure be averaged over the total actual exposure period and compared with the appropriate TRV.** A scientific rationale is required to support any proposed amortization (dose averaging beyond actual exposure period) to ensure that short-term risks are not underestimated. This analysis needs to be done on a chemical-specific basis.[40] (emphasis added)

[38] Exhibit F. Environment Canada, *Interim Guidance on Human Health Risk Assessment for Short-Term Exposure to Carcinogens at Contaminated Sites* (2015).
[39] Exhibit F; Exhibit E.
[40] Exhibit F at 18.

82. TRV is the equivalent of the Idaho AACC. For the past 30 years Idaho has implemented the TAPs rule as Environment Canada recommends, providing a health-protective MOS that appropriately protects children, adolescents, and pregnancies. DEQ now proposes to endorse dose averaging through the three SGP Project-specific adjustment factors, increasing both cancer risk for these vulnerable populations and regulatory burden for PTC applicants.

83. Two examples of relevance to the SGP Project-specific adjustment factors demonstrate the inadequacy of the risk calculations offered by Paden and Lopez. A comprehensive HIA addressing arsenic at mining sites would address 1) Mode of Action (MOA); and 2) non-carcinogenic risk as these relate to critical life stages.

84. **MOA Considerations**: As the Lopez Declaration notes, arsenic is not considered a carcinogen exhibiting mutagenic MOA by the EPA at this time. Current EPA guidance does not specifically recommend applying the age-dependent adjustment factors to the arsenic inhalation URF. Current EPA policy requires life-stage adjustment for known mutagenic MOA carcinogens but leaves it to the risk assessment and risk managers' discretion whether to apply age-adjustments for carcinogens with unclear MOAs.[41] Some jurisdictions recommend applying age dependent adjustment factors to carcinogens for which the MOA is not definitive.[42] A comprehensive risk assessment would inform the risk management decision-makers that there is evidence suggesting arsenic, in combination with other co-stressors, has shown mutagenic

[41] Exhibit D.
[42] Exhibit G, California EPA, OEHHA, *Technical Support Document for Cancer Potency Factors: Methodologies for derivation, listing of available values, and adjustments to allow for early life stage exposures* (May 2009) at 3.

MOA.[43,44] A comprehensive risk assessment would inform the risk management decision-makers that there is evidence suggesting arsenic, in combination with other co-stressors, has shown mutagenic MOA.

85. **Non-carcinogenic Risk.** Environment Canada notes specific examples of non-carcinogenic arsenic health effects that can become the risk driver after applying age-specific exposure, absorption, and dose accumulation adjustments at contaminated sites where children may ingest, in addition to inhaling, arsenic laden dusts.[45]

86. Allocating a lifetime of allowable arsenic intake to children in 6 or 16 years, raises numerous non-carcinogenic concerns not mentioned in the Respondents' limited risk analyses.

87. The largest source of arsenic at the SGP are haul road fugitive dusts. Application of the SGP Project-specific adjustment factor allows the SGP to increase annual emission rates from haul roads by four to ten times more than that allowed under proper implementation of the TAPs rule.

88. This concentration of emissions in early childhood, not only increases ambient air arsenic concentrations, but more than quadruples the rate of arsenic laden dust deposition. It is well-known, in Idaho, nationally and internationally, that incidental ingestion of mining-related fugitive dusts is the major childhood exposure route for heavy metals in mining communities. Numerous DEQ risk assessments for abandoned mine sites in Idaho, including several at the

[43] Exhibit H, Environmental Health Perspectives, *Low-dose Arsenic: In Search of a Risk Threshold*, 122:5 (May 2014).
[44] Exhibit I. Speer, R.M., *et. al.*, *Arsenic and cancer: evidence and mechanisms*, Adv. Pharmacol. 96:151-202 (2023).
[45] Exhibit F at 18.

Bunker Hill and Coeur d'Alene Basin Superfund Site, have historically involved fugitive dusts from mining sites.[46, 47]

89. The EPA and DEQ Superfund regulators routinely apply age-dependent adjustment factors similar to those required for carcinogens that exhibit mutagenic MOAs.[48] There has been no consideration of non-carcinogenic risk for the SGP. Figures 3 and 5, above, demonstrate there is no need to assess other potential sources or non-carcinogenic risk if the TAPs rule is implemented properly using the **maximum one-year annual average carcinogen concentration**. Dust deposition would occur at rates anticipated under proper application of the TAPs rule. As a result, properly complying with the cancer risk criteria is also protective of non-carcinogenic risk.

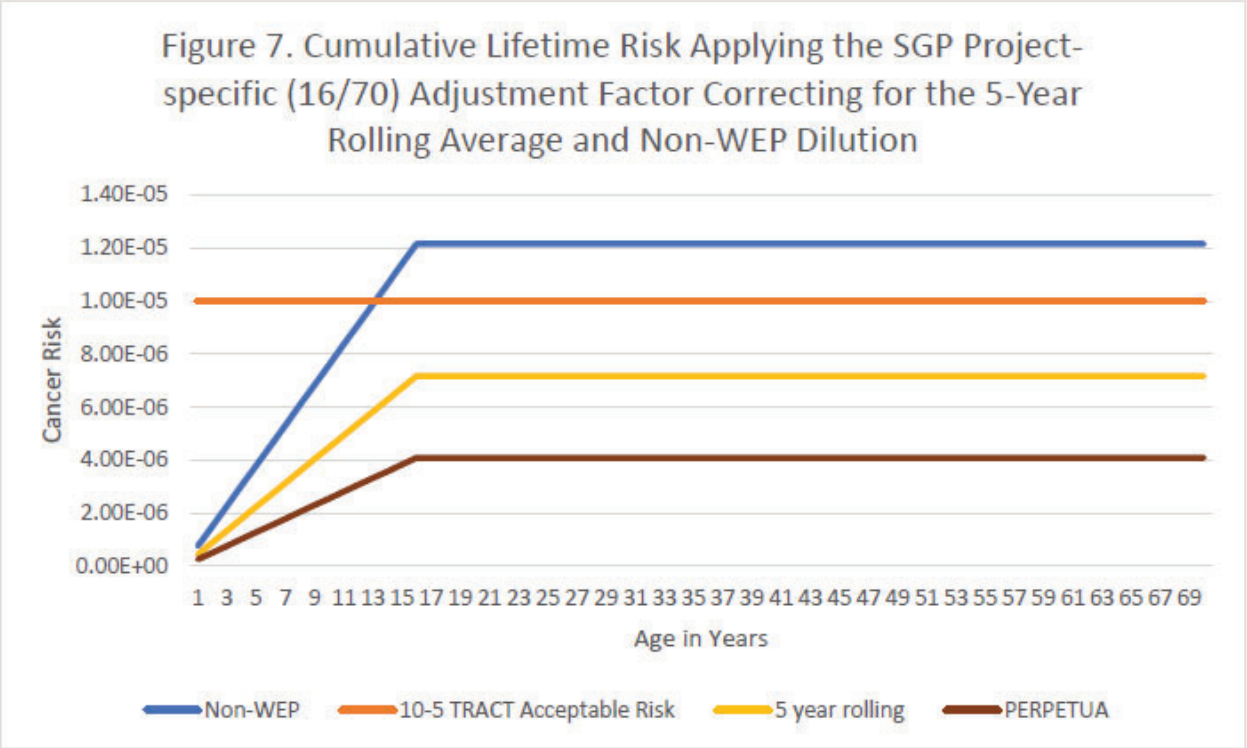
90. The Paden and Lopez Declarations contain extremely limited risk calculations. Both Respondents use the inappropriately derived dose-averaged ambient concentration of 0.00095 $\mu g/m^3$ to calculate an alleged $4x10^{-6}$ cumulative cancer risk and assert compliance with EPA risk assessment policy. Both Respondents refer to the same EPA formulae found in Superfund guidance and simply compare the same long-term 70-year average value to the same range of alleged EPA allowable risk levels. Neither considers pertinent risk co-factors, vulnerable life stages, other potential sources, or a variety of other considerations inherent in the Idaho TAPs compliance strategy or MOS noted above. Neither mentions nor indicates understanding of the incremental nature of the TAPs Rule.

---

[46] Exhibit J. von Linder, I.H., *et. al.*, *Estimating Children's Soil/Dust Ingestion Rates through Retrospective Analyses of Blood Lead Biomonitoring from the Bunker Hill Superfund Site in Idaho*, Envtl. Health Perspectives, 124:9, 1462-1470 (2016).
[47] Exhibit K. U.S. EPA, *Estimation of Age-specific Soil and Dust Ingestion Rates for U.S. Children: Update to the Default Values for the Integrated Exposure Uptake Biokinetic Model for Lead in U.S. Children* (2021).
[48] Exhibit K.

91. Were the proper TAPs analysis conducted, the cumulative risk for long-term operations would be 5.1 $x10^{-5}$, as noted above. Figure 6, above, illustrated the sequential application of the three SGP Project-specific adjustment factors applied by DEQ (i.e., 5-year rolling average,, non-WEP sources, and 16/70 lifetime adjustment). The final 16/70 exposure dilution yields a cancer risk of $4.1x10^{-6}$. DEQ and the Respondents allege that 40% of the full lifetime allowable exposure is expended by the 16 years of SGP operations.

92. The $5.1x10^{-5}$ carcinogenic risk calculated for the SGP as TAPs requires does assume a 70-year basis. Figure 7 shows the application of the proper **maximum one-year annual average ambient air carcinogen concentration** (0.0125 $\mu g/m^3$) applied to the same 16-year LOM formulae used by the Respondents. After correcting for the 5-year rolling average and non-WEP adjustment factors disguised risk averaging steps, the cumulative risk after the16-year LOM is 1.2 x 10^{-5}.



93. This cumulative risk exceeds the allowable risk criteria by 20% using DEQ and Perpetua's calculation. Figure 7 also illustrates the effect of the serial application of SGP Project-specific 5-year rolling average and non-WEP Project-specific adjustment factors on cumulative cancer risk from the critical receptor viewpoint. Removing these dilution adjustments shows the individual receptor will experience a full lifetime allowable carcinogenic $1x10^{-5}$ equivalent exposure by year 13.

94. This opinion concludes that DEQs use of the ad hoc SGP Project-specific adjustment factors undermines the health protectiveness of the TAPs rule. The TAPs rule was specifically developed to avoid requiring risk assessment analyses by providing an inherent margin of safety (MOS). These SGP Project-specific adjustment factors facilitate cancer dose-averaging risk calculations that allow the SGP to significantly increase arsenic emissions

based on short-term Life of Mine (LOM) assumptions, but to nevertheless average the risk associated with those increased emission over 70-years.

95. This transfer of risk from the mine to the receptor's lifetime significantly reduces the MOS and negates the health protectiveness of the TAPs rule. The TAPs rule simply offers 10-fold increases in allowable risk, or emissions, for either 1) short-term projects of less than 5 years, or 2) T-RACT based relief based on available technology.

96. There is neither a provision, nor a need, for risk assessment if the TAPs Rules are properly implemented based on annual compliance with **maximum one-year annual average ambient air carcinogen concentration**. This application of the TAPs rule has served Idaho well for three decades. This policy change allowing risk averaging through the SGP Project-specific adjustment factors not only undermines the health protectiveness of the individual applicant source, but also the Statewide strategy that keeps all Idahoans safe with minimal regulatory burden.

DATED: October 4, 2024



Ian H. Von Lindern, P.E., Ph.D.

Exhibit A

Ian H. von Lindern, Ph.D., P.E.

Moscow, Idaho, USA
Ian@terrafound.org |+1 208 596 8577

Education

Ph.D., Environmental Science and Engineering, Yale University, 1980
M.F.S., Biometeorology and Atmospheric Studies, Yale University, 1973
B.S., Chemical Engineering, Carnegie-Mellon University, 1971

Professional & Technical Certifications

Professional Engineer, Idaho # 3044 ChE (1975)

Professional Experience

Ian von Lindern is co-founder of TerraGraphics International Foundation (TIFO), a non-profit humanitarian environmental response organization. He served as Chief Executive Officer and Principal Scientist of TerraGraphics Environmental Engineering Inc. from 1984-2014. Under his direction, TerraGraphics developed into a one-hundred person multidisciplinary environmental firm, specializing in the design and management of complex projects including site characterization, risk assessment, hazardous waste remediation, engineering design, GIS and database, and remediation oversight. He has 46 years of national and international engineering and scientific experience that includes a variety of environmental assessments; studies in air, water, and soil pollution; toxic and hazardous materials investigations; remedial and cleanup plans; human health risk assessments; and application of statistical analysis techniques to multidisciplinary environmental problems. He has directed more than 40 major health/environmental projects including primary and secondary smelters, used battery processors, landfills, uranium mill tailings, and organic chemical waste sites in the U.S. He has designed and implemented international health risk assessment/remediation projects in countries with high levels of childhood morbidity and mortality including Russia, China, Peru, Bangladesh, Dominican Republic, Senegal, Nigeria, and Kyrgyzstan.

As a Principal Scientist at TIFO, Dr. von Lindern works with marginalized mining and recycling communities around the world to address pollution-related health and environmental issues. Projects are implemented at the local level acknowledging diverse ethnic, religious, socio-economic, and geographic backgrounds to protect future generations and maintain livelihoods in vulnerable communities. TIFO's mission focuses on building environmental health capacity in both the host countries and the next generation of US scientists by sponsoring and directing collaborative projects, pairing US and local professionals and students; and encouraging programmatic research publications summarizing project outcomes and lessons learned. Since 2010, TIFO has partnered with Médecins Sans Frontières (MSF, Doctors Without Borders) in implementing joint medical, public health and environmental responses. TIFO's recent projects are evolving into a global juxtaposition of simultaneously assisting indigenous and disadvantaged communities in both the US and poor/middle income countries responding to the exponential demand for gold and green-energy technologies in the US, central Asia and west Africa. These projects offer promise of reviving a specialty metals industry in the US and providing subsistence incomes for poor populations suffering from climate-related loss of traditional agricultural and pastoral support systems. Conversely, there is the potential for catastrophic health and environmental damages. US efforts involve rigorous technical analysis of sophisticated regulatory environmental impact and permit applications, conveying that to uninformed communities, and advocating for the highest levels of environmental responsibility. Responses in poor countries involve identifying and implementing protective measures achievable within the socio-economic, political and economic capacity of the community. International projects often involve developing practicable community, family, and individual worker level health interventions, as governments often lack the resources and capacity to effectively regulate industry in either the artisanal or formal sectors.

Dr. von Lindern has served as an EPA Science Advisory Board and Clean Air Scientific Advisory Committee (CASAC) Subcommittee Member on several occasions, including: EPA Criteria Assessment Committee for Lead in the Ambient Air (1975-1977), and subsequent CASAC NAAQS lead reviews (1982-1986, 2006-2008); Review Subcommittee Assessing the Use of the Biokinetic Model for Lead Absorption in Children at RCRA/CERCLA Sites (1988); Subcommittee Assessing the Consistency of Lead Health Regulations in U.S. EPA Programs (1992); SAB Review Subcommittee for Urban Soil Lead Abatement Demonstration Project (1993); the Ad Hoc All-Ages Lead Model (AALM) Review (2005-2007, 2019-2020); External Peer Review of EPA's Draft Report – Proposed Modeling Approaches for a Health-Based Benchmark for Lead in Drinking Water (2017).

Project Experience
Example Consulting Projects Directed by Dr. von Lindern

Bunker Hill Mining and Metallurgical Complex/Coeur d'Alene Basin Superfund Site, Idaho, 1974–2016

Dr. von Lindern has worked for the State of Idaho on various projects involving the Bunker Hill/Coeur d'Alene Basin Superfund Site for more than 40 years, both as the lead Risk Assessor and as TerraGraphics Project Manager for the State of Idaho CERCLA activities. In 1974, as an Environmental Engineer for the State of Idaho, he directed the field study of lead intoxication in children surrounding the Bunker Hill smelter. As the state oversight contractor for more than 20 years, his duties have included initial contact with local leaders, assisting IDEQ in Cooperative Agreement and PRP negotiations, legislative committee presentations, moderating Task Force meetings, reviewing PRP and EPA activities, and developing the risk management strategy and site-specific cleanup criteria. He has a number of peer-reviewed publications on the reduction of childhood blood lead levels and remedial activities at this site. He also represented the IDEQ at the National Academy of Sciences (NAS) review of this Project in Washington D.C. (Superfund and Mining Megasites Lessons Learned from the Coeur d'Alene River Basin, (NRC 2005)).

Washington State Department of Justice – Natural Resources Division Litigation Support and Expert Witness, Northeastern Washington State, December 2009– December 2012

Dr. von Lindern provided expert witness testimony and reports for numerous enforcement and civil environmental liability lawsuits and litigation at sites throughout the United States. He was Principal-in-Charge for a contract with the Washington State Attorney General Office, Natural Resources Division, regarding potential mining contamination in northeastern Washington state. He and other TerraGraphics personnel researched and visited numerous abandoned mine sites and collected samples to assess metal contamination. Dr. von Lindern provided his expert opinion to the client for litigation support.

Trail of the Coeur d'Alenes and Bayhorse Ghost Town Remediation and Idaho State Parks and Recreation (IDPR) Development

The Bayhorse Mine property is a well-known "ghost town" near Challis, Idaho with substantial historic value. After completion of an ASTM Phase I ESA and All Appropriate Inquiry standards, the IDPR was considering the site for development as a State of Idaho Park and wanted to ensure the site was suitable for such use. Dr. von Lindern led the team that completed the assessment of human health risk and water quality concerns for the purchase of the Bayhorse Mine property. After the assessment, IDPR successfully acquired the Bayhorse Mine properties for converting the "ghost town" and associated abandoned mine holdings into a cultural, historical, and adventure recreation park.

The Park design mimics innovative risk management strategies used at the Trail of the Coeur d'Alenes State Park in northern Idaho. Dr. von Lindern assisted IDEQ, IDPR, the U.S. EPA and other related agencies at both Parks by developing a risk management strategy that is protective of human health and the

environment, while allowing public access and preserving the historic and recreational value of the resource. The Park opened to the public in June 2009.

Example TIFO Humanitarian / Non-Profit Projects Directed by Dr. von Lindern

In 2005, the US National Academy of Sciences' exhaustive review of the BHSS cleanup effort determined the health response methodologies were sound and effective. Subsequently, Dr. von Lindern co-led the joint Research & Development initiative between TerraGraphics and the University of Idaho to apply environmental cleanup methodologies developed in Idaho mining districts to hazardous waste sites in low and middle-income countries. Humanitarian cleanups were undertaken in conjunction with local governments, universities, and NGOs in a variety of cultural, socio-economic and governmental venues in Russia, China, Dominican Republic, Senegal, and Nigeria. In 2012, he and Dr. Margrit von Braun sold the for-profit firm and founded TIFO as an independent non-profit organization to assist international communities in remediating hazardous waste sites. TIFO has conducted workshops and human health risk assessments in Kyrgyz Republic, Armenia, Slovenia, Bangladesh, and Mongolia in collaboration with local governments, universities, hospitals, and NGOs, including the international humanitarian organization Médecins Sans Frontières (MSF, Doctors Without Borders).

Lead Poisoning – Emergency Health Response, Haina, Dominican Republic 2007-2011.

The community of Paraiso del Dios bordered a former used lead acid battery recovery operation in the port city of Haina near Santo Domingo. In 1997, several hundred children were surveyed and found to have a mean blood lead level of 71 μg/dL (range: 9-234 μg/dL); twenty-eight percent (28%) of children required immediate medical treatment. Residents reported that several children suffered seizures during the factory's operational years and continue to exhibit learning disabilities. The factory closed in 2000 and a repository for waste materials was developed on-site. The site was then abandoned and was subject to extensive uncontrolled salvage activities. The concrete retaining wall was scavenged, releasing large amounts of buried waste into the community during rain events. The exposed wastes, exceeding 30% lead, were sold as scrap. Highly contaminated materials were recycled and used as building material and fill in the adjacent community. Children from the surrounding community accessed the industrial site on a daily basis, tracking soils from the site and exposing the rest of their families.

Dr. von Lindern designed and directed a sampling and risk assessment program in 2006-07, when the area was named one of the world's top ten most polluted sites. Extremely high lead concentrations were found on site and in adjacent residential lots. Contaminated wastes in the failed repository showed concentrations from 30% to 45% lead. Surface soil lead concentrations ranged from 4,000 to >300,000 mg/kg, orders of magnitude above the USEPA limit of 400 mg/kg. The project team then collaborated with the Ministries of Health and Environment to develop an intervention strategy recommending a blood lead monitoring and follow-up program, relocation of all high-level wastes to an off-site repository, an on-site repository for the low-level and mid-level soils, and dedication of the property as a public park with appropriate institutional controls to ensure sustainability. A blood lead monitoring program began in 2007 and found 80% of children >10 μg/dL, 24% >40 μg/dL, and 7% >70 μg/dL. In 2008, the Dominican Republic government commissioned a cleanup in which Dr. von Lindern provided technical assistance. More than 3000 cubic meters of hazardous wastes and 4000 cubic meters of contaminated soils were removed. The site was turned in to an "ecological park" with a dedication ceremony in 2010. The Ministry of Environment introduced the park as the first step in initiating a cleanup program for the entire country and dedicated an "ecological mural" to the Dominican environment and "heroes" of the cleanup effort.

Lead Poisoning – Emergency Health Response, Dakar, Senegal 2009-2011.

Thiaroye Sur Mer (TSM) was the site of Used Lead Acid Battery recovery since the 1970s. Multiple groups recovered lead from batteries to manufacture weights for local fishermen. Several thousand tons of discarded

battery sludge accumulated in the area over three decades. In 2007, dramatic increases in lead prices stimulated East Indian traders to purchase the lead oxide sludge. To minimize shipping costs, 200 local women were employed to sift out beach sand that had accumulated with the sludge. The process involved transporting, drying, sifting, and bagging the lead dust. Bags of lead product were stored in homes prior to sale. Many mothers brought their infants and toddlers with them to work. In 2007-08, 18 children died as a direct result of lead exposures. Mean blood lead levels in children were >100 μg/dL and individual levels were >350 μg/dL

Limited emergency remediation activities were undertaken in April and May of 2008. Three-hundred (300) tons of lead were removed from local homes. The World Health Organization (WHO) tested siblings of the deceased children and forty-one children were subsequently hospitalized and placed in temporary foster care. Massive flooding of the area during the rainy season delayed further action. After the flood subsided, TIFO collaborated with other partners to conduct extensive sampling and interviews of the TSM population. In collaboration with the Ministries of Health and Environment, Dr. von Lindern developed a health response and remediation strategy that was implemented in April 2009. The strategy included establishment of sentinel homes in the community where intensive interviews and sampling were conducted to determine the extent and severity of continuing exposures and to identify active lead exposure pathways. These homes and resident children were monitored to assess the effectiveness of the cleanup.

Lead Poisoning – Emergency Health Response, Zamfara and Niger State, Northern Nigeria, May 2010–Present

Beginning in 2010, Dr. von Lindern spent several months in northern Nigeria directing the characterization and remediation of the world's worst lead poisoning epidemic. The 2010-2013 epidemic in Zamfara, Nigeria was unprecedented in morbidity, mortality, and in the environmental health response. More than 400 young children died from acute lead poisoning associated with artisanal gold mining. Soil removal protocols developed at the U.S. Bunker Hill Superfund Site were adapted to local resources, labor practices, and cultural traditions. Dr. von Lindern and other TerraGraphics personnel worked cooperatively with local authorities, MSF, the Centers for Disease Control (CDC), the World Health Organization, the Blacksmith Institute, and government officials and villagers in remote areas to develop an emergency response and remove contaminated soils.

In 2011, TerraGraphics was recognized by the United Nations Environment Programme (UNEP) and Green Cross International with the Green Star Award, given to every two years in association with UN reviews of its environmental programs to recognize those who have made remarkable efforts to prevent, prepare for, and respond to environmental emergencies around the world. In 2012-13, remediation progressed from emergency response by international personnel to comprehensive cleanup implemented by the Nigerian government. TerraGraphics humanitarian successor, TIFO, partnered with MSF to provide guidance and assistance the Nigerian Federal, Zamfara State and local governments in the completion of the largest and most comprehensive cleanup implemented and funded by an African government. More than 27,000 m^3 of contaminated soils were removed from 820 residential areas and ore processing areas in eight villages, largely by hand labor, and disposed of in constructed landfills. Soil lead exposures decreased 97% for more than 17,000 villagers, allowing chelation treatment of 2349 children. Mean blood lead levels for children ≤5 years age declined from 173 μg/dL to <20 μg/dL over the four-year US $5M remedial program.

Subsequently, TIFO, MSF and other NGOs assisted local, state, and federal leadership in implementing long-term prevention and management programs in Zamfara State. In 2016, a second ASGM poisoning event killed 28 children in neighboring Niger State. The federal government requested TIFO assistance and mobilized trained technicians from Zamfara to lead the assessment and cleanup. Remediation was fully implemented with Nigerian funds, and Niger State assumed takeover of both medical and environmental operations and maintenance in 2018. This successful application was the impetus for the Nigerian Ministry of Mines and Steel/World Bank/MSF/TIFO sponsored Conference in Abuja in 2018, examining the legalization and support of ASGM as a mechanism to address poverty and population displacement in the Sahel, employing safer-mining initiatives.

Continued TIFO-Médecins Sans Frontières Collaborations: Bangladesh and Kyrgyzstan 2011-Present.

In 2014, following successful collaborations in west Africa, MSF and TIFO's partnered to assess and address pollutant-related hazards at formal and informal leather tanneries; small-scale plastic, aluminum, foundry, and textiles recycling operations; and artisanal family-scale scavenging and waste recovery and reuse operations in urban slums in Dhaka, Bangladesh. MSF has since been operating occupational health clinics employing environmental health/occupational remedies for several thousand workers and families.

Since 2016, TIFO and MSF have partnered with the Kyrgyz Ministry of Health (MOH) assessing the potential, and emergency response considerations, for seismic and climate-related catastrophic release of legacy mining and smelting hazardous wastes accumulated over 70 years of operations at the former Soviet Union's largest mercury and antimony factories. TIFO provided assistance with Staff Health and Safety planning and performing a Human Health Risk Assessment for women and children's health issues in the mercury/antimony/gold mining communities. In 2019, the joint TIFO/MSF/MOH team collected >500 soil, air, water and food samples to support health assessment and target blood, urine and hair surveys scheduled for summer 2020. These results will support establishing environmental/occupational health monitoring/intervention capacity in the local government, as Kyrgyz officials revitalize the Soviet-era mining operation to support the local economy and meet the growing demand for mercury in ASGM.

Gold and Strategic Minerals Development Impact Evaluations on Historic Tribal Lands, Intermountain West, USA, 2020 – Present.

TIFO's mission is to assist mining and mineral processing communities to operate as safely as practicable while maintaining essential economic activities. The unprecedented demand for gold and strategic metals has prompted several major exploration and mineral development proposals in western states. TIFO's international mission includes assessing and responding to health and environmental impacts of polluting activities on sovereign native and tribal lands within the US. In that regard TIFO supports scientifically-sound and transparent analyses of the environmental and human health issues faced by mining communities, and the development of solutions implemented within local socio-economic and cultural capabilities. Proposed gold, antimony, and cobalt mining in Idaho, Nevada and Washington States have the potential to adversely affect several reservations and aboriginal tribal lands. The Idaho Stibnite Gold Mine proposal, that claims it will meet 33% of the US antimony demand, is of interest because both the industry and the US regulatory arena have the capacity to implement best practices that are not available to poor communities throughout the world. Mining advocates allege these developments will be safe and secure, and are projecting unprecedented control levels for toxic contaminants. Conversely, the mining company consultants are arguing for relief from environmental regulatory requirements in these mining-friendly states. However, citizen-based interest groups and tribal authorities have limited capacity and resources to evaluate the complex environmental assessments and permit applications. Ironically, the Stibnite Gold Project is exploiting the same ores and metallurgical processes as the gold/antimony mining TIFO is assessing in Kyrgyzstan. As there are currently no smelters in the US that can process the antimony concentrates, the Idaho ores are currently projected to be exported to the same Chinese smelters processing the Kyrgyz ores. Through TIFO, Dr. von Lindern is providing independent review of these documents and submitting comments to the review agencies.

Regulatory Knowledge

Ian von Lindern has worked on projects regulated under Federal, State, local, and foreign regulations, including CERCLA, TSCA, CWA, CAA, NESHAPs, DOT, EPRCRA, SARA, NEPA, and RCRA in the U.S. He has provided litigation support and expert witness testimony in administrative and court proceedings. He has served on several U.S. government advisory panels, including the appointments pertinent to lead health and remediation as shown in the list below.

Ian H. von Lindern, Ph.D., P.E.

Special Appointments/Memberships/Affiliations

U.S. EPA Science Advisory Board. Peer Review. All Ages Lead Model (AALM). Washington, DC. October 16-20, 2019.

U.S. EPA External Peer Review. Draft Report, Proposed Modeling Approaches for a Health Based Benchmark for Lead in Drinking Water. Prepared for: U.S. Environmental Protection Agency, Office of Water, Washington, DC. June 27-28, 2017.

U.S. EPA External Peer Review. EPA's Approach for Estimating Exposures and Incremental Health Effects from Lead due to Renovation, Repair, and Painting Activities in Public and Commercial Buildings. Prepared for: U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, Washington, DC. January 2015.

U.S. EPA Science Advisory Board (CASAC). Review of the Integrated Science Assessment (ISA) for Lead in the Ambient Air. US EPA, Washington, D.C. 2012-2013

American University of Armenia, School of Public Health, Yerevan. Invited Professor, Graduate course Risk Assessment for Environmental Health Professionals for Master of Public Health (MPH) Students. 2012-present.

U.S. Centers for Disease Control and the Harvard University School of Public Health Initiative to address health effects of mining and smelting in the developing world. 2009-2013.

Affiliate Professor of Chemical Engineering, University of Idaho, Moscow, Idaho, 1981–2011

U.S. EPA Science Advisory Board. Review of the Lead National Ambient Air Quality Standard for Lead. U.S. EPA, Washington, DC. 2006-2008.

U.S. Clean Air Scientific Advisory Committee (CASAC). Review of the Air Quality Criteria Document for Lead. U.S. EPA, Washington, DC. 2010-2013, 2006-2007.

U.S. EPA Science Advisory Board. Review of EPA's Lead Renovation, Repair and Painting (LRRP) Activities. U.S. EPA, Washington, DC. 2007.

U.S. EPA Science Advisory Board. Review of EPA's Ad Hoc All-Ages Lead Model (AALM) Review Panel. U.S. EPA, Washington, DC. 2007.

U.S. EPA Science Advisory Board. Review Subcommittee for Urban Soil Lead Abatement Demonstration Project. U.S. EPA, Washington, DC, 1993-1995.

NIEHS Select Reviewer Grants Review Committee, Superfund/Hazardous Workers Training Program, NIEHS, RTP, NC. 1992.

Advisory Committee for Development of Lead Paint Abatement Guidelines for Public Housing in the United States, U.S. Dept of HUD, Washington, D.C., 1992.

U.S. EPA Science Advisory Board, Subcommittee Assessing the Consistency of Lead Health Regulations in U.S. EPA Programs, Special Report to the Administrator, Washington, D.C., 1992.

U.S. EPA Science Advisory Board, Review Subcommittee Assessing the Use of the Biokinetic Model for Lead Absorption in Children at RCRA/CERCLA sites. U.S. EPA, Washington DC, 1991.

Technical advisor and consultant to Latah County and North Central Health District Regional Solid Waste Advisory Committees, Moscow and Lewiston, ID. 1991.

Technical advisor to the National Alliance to End Lead Poisoning in Children, Washington, D.C. 1991-2001

NIEHS Select Reviewer Grants Review Committee, Superfund/Hazardous Workers Training Program, NIEHS, Research Triangle Park, NC, 1989-1993.

U.S. EPA Clean Air Scientific Advisory Committee (CASAC) Member, Subcommittee on Exposure Assessment Methodology, U.S. EPA, Washington D.C. 1988.

U.S. EPA Criteria Assessment Committee for Lead in the Ambient Air, RTP, NC. 1975-1986.

Additional Certifications/Training

PSMJ Conference for CEOs-2005

Ian H. von Lindern, Ph.D., P.E.

Publications

Tirima S, Bartrem C, von Lindern I, von Braun M, Lind D, Anka S, Abdullahi A. Food Contamination as a Pathway for Lead Exposure in Children During the 2010-2013 Lead Poisoning Epidemic in Zamfara, Nigeria. Journal of Environmental Sciences, 67:260-272, 2017.

von Lindern I, Spalinger S, Stifelman M., Stanek LW, Bartrem C. Estimating Children's Soil/Dust Ingestion Rates through Retrospective Analyses of Blood Lead Biomonitoring from the Bunker Hill Superfund Site in Idaho. Environ Health Perspect; https://doi.org/10.1289/ehp.1510144, 2016.

Tirima S, Bartrem C, von Lindern I, von Braun M, Lind D, Anka SM, Abdullahi A. Environmental Remediation to Address Childhood Lead Poisoning Epidemic due to Artisanal Gold Mining in Zamfara, Nigeria. *Environ Health Perspect*; http://dx.doi.org/10.1289/ehp.1.510145, 2016.

Bartrem C, Tirima S, von Lindern I, von Braun M, Worrell MC, Mohammad Anka S, Abdullahi A, Moller G. Unknown risk: co-exposure to lead and other heavy metals among children living in small-scale mining communities in Zamfara State, Nigeria. Int J Environ Health Res. 24(4):304-19. https://doi.org/10.1080/09603123.2013.835028, 2013.

Plumlee GS, Durant JT, Morman SA, Neri A, Wolf RE, Dooyema CA, Hageman PL, Lowers HA, Fernette GL, Meeker GP, Benzel WM, Driscoll RL, Berry CJ, Crock JG, Goldstein HL, Adams M, Bartrem CL, Tirima S, Behbod B, von Lindern I, Brown MJ. Linking Geological and Health Sciences to Assess Childhood Lead Poisoning from Artisanal Gold Mining in Nigeria. Environ Health Perspect 121:744–750; http://dx.doi.org/10.1289/ehp.1206051, 2013.

Spalinger SM, von Braun MC, Petrosyan V., von Lindern IH. Northern Idaho House Dust and Soil Lead Levels Compared to the Bunker Hill Superfund Site. Environ. Monit. Assess. 130: 57-72, 2007.

Petrosyan V, von Braun MC, Spalinger SM, von Lindern IH. Seasonal variations of lead concentration and loading rates in residential house dust in northern Idaho. Journal of Hazardous Materials 132: 68-79, 2006.

von Lindern, IH, Spalinger, SM, Bero, BN, Petrosyan, V, von Braun, MC. The influence of soil remediation on lead in house dust, Science of the Total Environment, Vol. 303/1-2, 59-78, 2003.

von Lindern, IH, Spalinger, SM, Petrosyan, V, von Braun, MC. Assessing remedial effectiveness through the blood lead: soil/dust lead relationship at the Bunker Hill Superfund Site in the Silver Valley of Idaho, Science of the Total Environment, Vol.303/1-2, 139-170, 2003.

von Braun MC, von Lindern I, Khristoforova NK, Kachur AH, Yelpatyevsky, Elpatyevskaya PV, Spalinger SM. Environmental Lead Contamination in the Rudnaya-Pristan Dalnegorsk Mining and Smelter District, Russian Far East, Environmental Research, 88, 164-173, 2002.

Bero B, von Braun MC, von Lindern IH, Hammel JE, Korus R. Evaluation of six vacuum techniques for sampling lead contaminated carpeted surfaces, Advances in Environmental Research, Vol. 1, No. 3, 333-344, 1998.

von Braun, MC, von Lindern, IH, Martyn, S, Steward K. Use of a Geographic Information System in Selecting Residential Properties for Remediation at the Bunker Hill National Priorities List Site. Proceedings of the 10th National Conference on Management of Uncontrolled Hazardous Waste Sites, Superfund, Washington, D.C. November 1989.

von Lindern, I, von Braun, MC. Reconstructive Analysis of Lead Exposures in a Smelter Community Using Geographic Information System Techniques. Proceedings of Society for Occupational and Environmental Health Conference, Washington D.C. April 1988.

Walter SD, von Lindern, IH, Yankel AJ. Age-Specific Risk Factors for Lead Absorption in Children. Archives of Environmental Health. Vol. 35, no. 1. January/February 1980.

Yankel, AJ, von Lindern, IH, Walter, SD. The Silver Valley Lead Study: The Relationship between Childhood Blood Lead Levels and Environmental Exposure, Journal of the Air Pollution Control Association, 27:8, 763-767, DOI: 10.1080/00022470.1977.10470488, 1977.

Ian H. von Lindern, Ph.D., P.E.

Reports/Presentations

Human Health Risk Assessment (HHRA) for Aidarken, Chauvay, and Surrounding Villages. Prepared for Kyrgyz Ministry of Health and Médecins Sans Frontières. 4 March 2021.

Data Summary Report: Summary of Results from Field and Laboratory Activities from August-September 2019 Environmental Assessment in Aidarken and Chauvay, Kadamjay Rayon, Kyrgyz Republic. Prepared for Kyrgyz Ministry of Health and Médecins Sans Frontières. 13 November 2020.

Mining, Climate Change, and Conflict: Lessons from Nigeria and Kyrgyzstan. Society for Mining, Metallurgy, and Exploration, Southern California Chapter (virtual). 12 November 2020.

Local and regional impacts of primary mercury production on environmental health and security in Batken, Kyrgyzstan. Ramazzini Days Conference. Carpi, Italy (virtual). 24 October 2020.

Review of Existing Information and Identification of Data Gaps for Conducting Human Health Risk Assessments (HHRA) and Biomonitoring for Heavy Metal Exposures – Khaidarken, Batken Province, Kyrgyz Republic. Prepared for Kyrgyz Ministry of Health and Médecins Sans Frontières. April 2019.

Presenter: Achievement Awardee Luncheon Presentation – International disparities in childhood lead poisoning: following metal production to the world's most vulnerable communities. Association for Environmental Health and Sciences Foundation. 29th Annual Conference on Water, Soils, Sediments, and Air. San Diego, CA, USA. 18-22 March 2019.

Eight Years, Two States, Ten Villages, and Five Thousand Children: Adapting US Superfund Methodologies to Lead Remediation in Northern Nigeria. Association for Environmental Health and Sciences Foundation. 29th Annual Conference on Water, Soils, Sediments, and Air. San Diego, CA, USA. 18-22 March 2019.

Presenter: Environmental Health and Risk Assessment: Workshop on MSF and Extractive Industries. Médecins sans Frontières, Geneva, Switzerland. 24-25 October 2018.

Instructor, Assessment and Remediation of Heavy Metal Contamination, Workshop on Extractive Industries, Médecins sans Frontières, Geneva, Switzerland, October 2018.

Presenter: Humanitarian Crisis in Pollution-Related Disease: MSF's role, response models, and discussions on the path forward. Workshop for Médecins Sans Frontières. Geneva, Switzerland. 16-17 April 2018.

Final Seismic Risk Addendum Report: Exposure Risks Related to Seismic Hazards and Risks in Batken, Kyrgyzstan. Prepared for Médecins sans Frontières. March 2019.

Coordinated Environmental Health Response to a Severe Outbreak of Lead Poisoning. International Conference on Lead Poisoning. Abuja, Nigeria. 26-27 June 2018.

Phase I & II Ungwar Magiro and Ungwar Kawo Emergency Remediation: A Summary of the Scope of Work Accomplished. Prepared for the Nigeria Federal Ministry of Environment. May 2017.

Developing and Implementing Institutional Controls Programs to Achieve Long-Term Sustainability of Interventions and Prevent Future Outbreaks. International Conference on Lead Poisoning. Abuja, Nigeria. 26-27 June 2018.

Humanitarian Crisis in Pollution-Related Disease: MSF's role, response models, and discussions on the path forward. Workshop for Médecins Sans Frontières. Geneva, Switzerland. 16-17 April 2018.

Updated Human Health Risk Assessment: Batken Province, Kyrgyz Republic. Prepared for Médecins Sans Frontières. August 2017.

Human Health Risk Assessment, Batken Province, Krygyz Republic. Prepared for Médecins Sans Frontières. July 2016.

Encephalopathy, Death, or IQ: Disparity in Environmental Remediation Response Criteria for Childhood Lead Poisoning in Low- and middle-Income Countries. 23rd Sewell Distinguished Lecture in Environmental Health Sciences Recipient. Columbia University Mailman School of Public Health. New York, NY. April 2016.

The need to address public health crises in low income countries due to global shifts in production. The Path of Least Resistance Leads to Poisoned Communities, European Public Health Conference, Milan, Italy. October 2015.

Ian H. von Lindern, Ph.D., P.E.

Escalating community metals poisoning due to changes in the global economy. Living in a Chemical World Session III, Proceedings of Ramazzini Days Conference. Carpi, Italy. October 2015.

Lessons Learned in Environmental Regulation and Remediation, Environmental Health in Mining Communities, Proceedings of the Conference on Occupational and Environmental Health in Construction and Mining. Ulaanbaatar, Mongolia. June 2015.

Remediating Polluted Worksites in Developing Countries. Safety and Health Awareness Training to Improve working Conditions in the Garment, Tannery and Construction Industries of Bangladesh, Dhaka, Bangladesh. Hosted by Dhaka Community Hospital, Harvard School of Public Health, Collegium Ramazzini. February 2014.

Integrated Remediation and Health Response to Artisanal Mining Lead Poisoning Epidemic in Zamfara, Nigeria. Conference of the International Medical Geology Association. 25 August 2013.

International Conference on Lead Poisoning: Special Focus on the Zamfara Crisis. Hosted by Centers for Disease Control and Prevention Nigeria, Nigeria Federal Ministry of Health, Médecins Sans Frontières. Abuja, Nigeria. 10 May 2012.

Artisanal Mining Lead Poisoning Epidemic, Zamfara State, Nigeria, 2010-11, Phase I and II Emergency Response Cleanup. Prepared for: Médecins Sans Frontières. Prepared by: TerraGraphics Environmental Engineering. October 2011.

Health Response to the World's Worst Lead Poisoning Epidemic - Zamfara, Nigeria 2010-11 prepared for the Zamfara Ministry of Environment, Gusau, Nigeria. October 2011.

The Life Cycle of Metals: Improving Health, Environment and Human Security, Symposium. University of Tokyo and Harvard University. Tokyo, Japan. October 2011.

Cleanup Recommendations for Bagega Village, Zamfara State, Nigeria, 2010-2011. Prepared for: Médecins Sans Frontières (MSF). Prepared by: TerraGraphics Environmental Engineering. October 2011.

Artisanal Mining Lead Poisoning Epidemic, Zamfara State, Nigeria, 2010-2011. Assessment of Remedial Effectiveness - Phase I and II Emergency Response Cleanup Summary Report Prepared for: Médecins Sans Frontières. Prepared by: TerraGraphics Environmental Engineering. August 2011.

Health Response to the World's Worst Lead Poisoning Epidemic, Zamfara, Nigeria 2010-11 Presentation to U.S. Environmental Protection Agency Headquarters, International Programs. July 2011.

A Comprehensive Approach to Remediation of the Lead Poisoning Epidemic in Zamfara, Nigeria. Joint Presentation with Médecins Sans Frontières to the Ninth meeting of the Advisory Group on Environmental Emergencies (AGEE). United Nations Environment Program, Office of Coordination of Humanitarian Affairs. Bern, Switzerland. May 2011.

Lead Poisoning -The World's Worst are Becoming Worse. More Children at More Places are More Severely Poisoned. Presentation to the U.S. Centers for Disease Control, Lead Poisoning Program. Atlanta, Georgia. April 2011.

A Comprehensive Approach to Remediation of the Lead Poisoning Epidemic in Zamfara. Presentation to the Nigerian Public Health Association, Annual Conference. Abuja, Nigeria. March 2011.

Zamfara, Nigeria Lead Poisoning Epidemic Emergency Environmental Response. May 2010-March 2011. Final Report United Nations Children's Fund (UNICEF). Programme Cooperation Agreement YW-303(01). TerraGraphics Environmental Engineering. February 2011.

Adapting U.S. Hazardous Waste Cleanup Protocols to International Mining and Smelting Sites. Consortium to Prevent and Mitigate the Environmental and Health Consequences of Metal Mining and Smelting. US Centers for Disease Control/Harvard School of Public Health. Symposium. Bozeman, Montana. May 2010.

The Cost of Legacy Toxic Waste Sites. Consortium to Prevent and Mitigate the Environmental and Health Consequences of Metal Mining and Smelting. US Centers for Disease Control/Harvard School of Public Health. Symposium. Cambridge, Massachusetts. July 2009.

Comprehensive Health Response and Cleanup Strategy for the Lead-Acid Battery Recycling Community of Thiaroye Sur Mer, Dakar, Senegal. Prepared for the Senegalese Ministry of Environment, Dakar, Senegal. February 2009.

Site Visit Report and Recommendations, Doe Run Peru (DRP) Metallurgical Facility, La Oroya, Peru. International Environmental Health and Restoration Initiative, University of Idaho, Moscow, Idaho USA. May 2008.

Comprehensive Health Response and Cleanup Strategy for the Former Metaloxa Lead-Acid Battery Recycling Site in Paraiso del Dios, Haina, Dominican Republic. Prepared for the Dominican Republic, Ministry of Environment. October 2007.

Comprehensive Health Response and Cleanup Strategy for the Rudnaya Pristan Site in Far East Russia. Prepared for the Far East Health Fund. Vladivostok, Primorye, Russia. November 2006.

Assessment of Historical Lead Exposures in the Port Richmond Area of Philadelphia. Prepared for Counsel in Wagner vs. Anzon and N.L. Industries. August 1993.

An Evaluation of Institutional Controls for the Populated Areas of Bunker Hill Superfund Site. Prepared for Panhandle Health District. January 1991.

A Modeling Technique to Evaluate Community and Occupational Airborne Lead Exposure in and Around a Primary Lead Smelter. Prepared for the National Institute of Occupational Safety and Health, R.A. Taft Laboratory, Cincinnati, Ohio. June 1982.

Exhibit B

United States
Environmental Protection
Agency

Office of Health and
Environmental Assessment
Washington DC 20460

EPA/600/8-87/045
August 1987

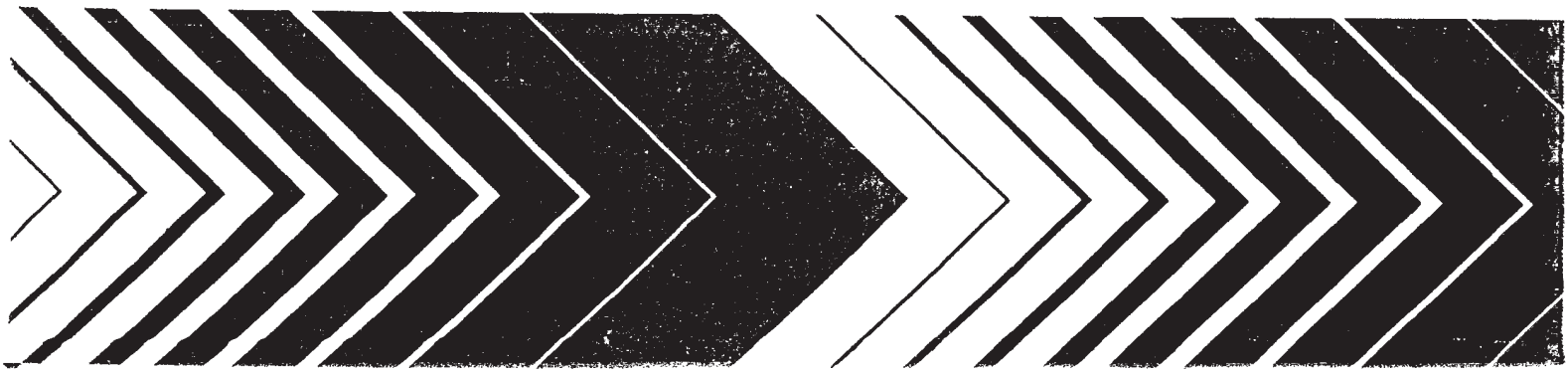
Research and Development

EPA

The Risk Assessment Guidelines of 1986

SFUND RECORDS CTR
99750

MF-0474



REC 6153

EPA/600/8-87/045
August 1987

THE RISK ASSESSMENT GUIDELINES OF 1986

U.S. Environmental Protection Agency
Washington, D.C.

REC 0134

DISCLAIMER

This document has been reviewed in accordance with U.S. Environmental Protection Agency policy and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

REC 6155

CONTENTS

Preface iv

Abstract v

GUIDELINES FOR CARCINOGEN RISK ASSESSMENT 1-1

GUIDELINES FOR MUTAGENICITY RISK ASSESSMENT 2-1

GUIDELINES FOR THE HEALTH RISK ASSESSMENT OF CHEMICAL MIXTURES 3-1

GUIDELINES FOR THE HEALTH ASSESSMENT OF SUSPECT DEVELOPMENTAL TOXICANTS 4-1

GUIDELINES FOR ESTIMATING EXPOSURES 5-1

REC 6156

PREFACE

On September 24, 1986, the U.S. Environmental Protection Agency (EPA) issued risk assessment guidelines relating to five areas: carcinogenicity, mutagenicity, chemical mixtures, suspect developmental toxicants, and estimating exposures (51 FR 33992-34054). The guidelines were developed to promote high technical quality and Agencywide consistency in the risk assessment process.

The guidelines were developed partly in response to a 1983 National Academy of Sciences publication entitled "Risk Assessment in the Federal Government: Managing the Process," which recommended that Federal regulatory agencies establish risk assessment guidelines. An EPA task force, convened by then Administrator William D. Ruckelshaus to study ways to improve the scientific foundation for Agency regulatory decisions, accepted the recommendation, and work on the guidelines began early in 1984.

The guidelines are products of a two-year Agency development and review process which included many scientists from the larger scientific community. They were developed as part of an interoffice guidelines development program under the auspices of the Office of Health and Environmental Assessment in the Agency's Office of Research and Development. The scientists involved were skilled in each topic, and early drafts were peer-reviewed by experts from academia, industry, public interest groups, and other governmental agencies. Subsequently, proposed guidelines were published in the *Federal Register*, reviewed by special panels of EPA's Science Advisory Board (SAB), and revised to take into account public and SAB comments. After final EPA review and Office of Management and Budget review, the guidelines were signed by EPA Administrator Lee M. Thomas on August 22, 1986, and published in the *Federal Register* on September 24, 1986.

Each of the five guidelines provides both technical information and science policy guidance relating to the conduct of EPA risk assessments and presentation of risk assessment information. The guidelines are sufficiently flexible to allow skilled scientists to make appropriate technical judgments on a case-by-case basis, giving full consideration to all relevant scientific information. The guidelines also stress that risk assessments should include a discussion of the strengths and weaknesses of each assessment by describing uncertainties, assumptions, and limitations, as well as the scientific basis and rationale for each assessment. They require risk assessors to inform Agency decisionmakers and the public about the assumptions used in and the implications of individual risk assessment conclusions, so that appropriate risk management decisions can be made and explained.

While these guidelines are published Agency documents, they should not be interpreted as static, but as the first step in the continuing process of identifying the best methods for assessing risk to environmental pollutants. Consequently, the risk assessment guidelines are constantly undergoing Agency scrutiny and will be revised in line with new methods and information, as appropriate.

This document presents the five guidelines as they originally appeared in the *Federal Register* but in a format that is easier to read.

REC 6157

ABSTRACT

On September 24, 1986, the U.S. Environmental Protection Agency issued risk assessment guidelines relating to five areas: carcinogenicity, mutagenicity, chemical mixtures, suspect developmental toxicants, and estimating exposures (51 FR 33992-34054). The guidelines were developed to promote high technical quality and Agencywide consistency in the risk assessment process. This document presents the five guidelines as they originally appeared in the *Federal Register* but in a format that is easier to read.

51 FR 33992

GUIDELINES FOR CARCINOGEN RISK ASSESSMENT

SUMMARY: On September 24, 1986, the U.S. Environmental Protection Agency issued the following five guidelines for assessing the health risks of environmental pollutants.

Guidelines for Carcinogen Risk Assessment

Guidelines for Estimating Exposures

Guidelines for Mutagenicity Risk Assessment

Guidelines for the Health Assessment of Suspect Developmental Toxicants

Guidelines for the Health Risk Assessment of Chemical Mixtures

This section contains the Guidelines for Carcinogen Risk Assessment.

The Guidelines for Carcinogen Risk Assessment (hereafter "Guidelines") are intended to guide Agency evaluation of suspect carcinogens in line with the policies and procedures established in the statutes administered by the EPA. These Guidelines were developed as part of an interoffice guidelines development program under the auspices of the Office of Health and Environmental Assessment (OHEA) in the Agency's Office of Research and Development. They reflect Agency consideration of public and Science Advisory Board (SAB) comments on the Proposed Guidelines for Carcinogen Risk Assessment published November 23, 1984 (49 FR 46294).

This publication completes the first round of risk assessment guidelines development. These Guidelines will be revised, and new guidelines will be developed, as appropriate.

FOR FURTHER INFORMATION CONTACT:

Dr. Robert E. McGaughy
Carcinogen Assessment Group
Office of Health and Environmental Assessment (RD-689)
401 M Street, S.W.
Washington, DC 20460
202-382-5898

SUPPLEMENTARY INFORMATION: In 1983, the National Academy of Sciences (NAS) published its book entitled *Risk Assessment in the Federal Government: Managing the Process*. In that book, the NAS recommended that Federal regulatory agencies establish "inference guidelines" to ensure consistency and technical quality in risk assessments and to ensure that the risk assessment process was maintained as a scientific effort separate from risk management. A task force within EPA accepted that recommendation and requested that Agency scientists begin to develop such guidelines.

General

The guidelines are products of a two-year Agencywide effort, which has included many scientists from the larger scientific community. These guidelines set forth principles and procedures to guide EPA scientists in the conduct of Agency risk assessments, and to inform Agency decision makers and the public about these procedures. In particular, the guidelines emphasize that risk assessments will be conducted on a case-by-case basis, giving full consideration to all relevant scientific information. This case-by-case approach means that Agency experts review the scientific information on each agent and use the most scientifically appropriate interpretation to assess risk. The guidelines also stress that this information will be fully presented in Agency risk assessment documents, and that Agency scientists will identify the strengths and weaknesses of each assessment by describing uncertainties, assumptions, and limitations, as well as the scientific basis and rationale for each assessment.

Finally, the guidelines are formulated in part to bridge gaps in risk assessment methodology and data. By identifying these gaps and the importance of the missing information to the risk assessment process, EPA wishes to encourage research and analysis that will lead to new risk assessment methods and data.

Guidelines for Carcinogen Risk Assessment

Work on the Guidelines for Carcinogen Risk Assessment began in January 1984. Draft guidelines were developed by Agency work groups composed of expert scientists from throughout the Agency. The drafts were peer-reviewed by expert scientists in the field of carcinogenesis from universities, environmental groups, industry, labor, and other governmental agencies. They were then proposed for public comment in the *FEDERAL REGISTER* (49 FR 46294). On November 9, 1984, the Administrator directed that Agency offices use the proposed guidelines in performing risk assessments until final guidelines become available.

REC 6159

After the close of the public comment period, Agency staff prepared summaries of the comments, analyses of the major issues presented by the commentors, and proposed changes in the language of the guidelines to deal with the issues raised. These analyses were presented to review panels of the SAB on March 4 and April 22-23, 1985, and to the Executive Committee of the SAB on April 25-26, 1985. The SAB meetings were announced in the *FEDERAL REGISTER* as follows: February 12, 1985 (50 FR 5811) and April 4, 1985 (50 FR 13420 and 13421).

In a letter to the Administrator dated June 19, 1985, the Executive Committee generally concurred on all five of the guidelines, but recommended certain revisions, and requested that any revised guidelines be submitted to the appropriate SAB review panel chairman for review and concurrence on behalf of the Executive Committee. As described in the responses to comments (see Part B: Response to the Public and Science Advisory Board Comments), each guidelines document was revised, where appropriate, consistent with the SAB recommendations, and revised draft guidelines were submitted to the panel chairmen. Revised draft Guidelines for Carcinogen Risk Assessment were concurred on in a letter dated February 7, 1986. Copies of the letters are available at the Public Information Reference Unit, EPA Headquarters Library, as indicated elsewhere in this section.

Following this Preamble are two parts: Part A contains the Guidelines and Part B, the Response to the Public and Science Advisory Board Comments (a summary of the major public comments, SAB comments, and Agency responses to those comments).

The Agency is continuing to study the risk assessment issues raised in the guidelines and will revise these Guidelines in line with new information as appropriate.

References, supporting documents, and comments received on the proposed guidelines, as well as copies of the final guidelines, are available for inspection and copying at the Public Information Reference Unit (202-382-5926), EPA Headquarters Library, 401 M Street, S.W., Washington, DC, between the hours of 8:00 a.m. and 4:30 p.m.

I certify that these Guidelines are not major rules as defined by Executive Order 12291, because they are nonbinding policy statements and have no direct effect on the regulated community. Therefore, they will have no effect on costs or prices, and they will

[51 FR 33993]

have no other significant adverse effects on the economy. These Guidelines were reviewed by the Office of Management and Budget under Executive Order 12291.

August 22, 1986

Lee M. Thomas,

Administrator

CONTENTS

Part A: Guidelines for Carcinogen Risk Assessment

I. Introduction

II. Hazard Identification

A. Overview
B. Elements of Hazard Identification
1. Physical-Chemical Properties and Routes and Patterns of Exposure
2. Structure-Activity Relationships
3. Metabolic and Pharmacokinetic Properties
4. Toxicologic Effects
5. Short-Term Tests
6. Long-Term Animal Studies
7. Human Studies
C. Weight of Evidence
D. Guidance for Dose-Response Assessment
E. Summary and Conclusion

III. Dose-Response Assessment, Exposure Assessment, and Risk Characterization

A. Dose-Response Assessment
1. Selection of Data
2. Choice of Mathematical Extrapolation Model
3. Equivalent Exposure Units Among Species
B. Exposure Assessment
C. Risk Characterization
1. Options for Numerical Risk Estimates
2. Concurrent Exposure
3. Summary of Risk Characterization

IV. EPA Classification System for Catagorizing Weight of Evidence for Carcinogenicity from Human and Animal Studies (Adapted from IARC)

A. Assessment of Weight of Evidence for Carcinogenicity from Studies in Humans
B. Assessment of Weight of Evidence for Carcinogenicity from Studies in Experimental Animals
C. Categorization of Overall Weight of Evidence for Human Carcinogenicity

V. References

Part B: Response to Public and Science Advisory Board Comments

I. Introduction

II. Office of Science and Technology Policy Report on Chemical Carcinogens

III. Inference Guidelines

IV. Evaluation of Benign Tumors

V. Transplacental and Multigenerational Animal Bioassays

VI. Maximum Tolerated Dose

VII. Mouse Liver Tumors

VIII. Weight-of-Evidence Categories

XI. Quantitative Estimates of Risk

REC 6160

Part A: Guidelines for Carcinogen Risk Assessment

I. Introduction

This is the first revision of the 1976 Interim Procedures and Guidelines for Health Risk Assessments of Suspected Carcinogens (U.S. EPA, 1976; Albert et al., 1977). The impetus for this revision is the need to incorporate into these Guidelines the concepts and approaches to carcinogen risk assessment that have been developed during the last ten years. The purpose of these Guidelines is to promote quality and consistency of carcinogen risk assessments within the EPA and to inform those outside the EPA about its approach to carcinogen risk assessment. These Guidelines emphasize the broad but essential aspects of risk assessment that are needed by experts in the various disciplines required (e.g., toxicology, pathology, pharmacology, and statistics) for carcinogen risk assessment. Guidance is given in general terms since the science of carcinogenesis is in a state of rapid advancement, and overly specific approaches may rapidly become obsolete.

These Guidelines describe the general framework to be followed in developing an analysis of carcinogenic risk and some salient principles to be used in evaluating the quality of data and in formulating judgments concerning the nature and magnitude of the cancer hazard from suspect carcinogens. It is the intent of these Guidelines to permit sufficient flexibility to accommodate new knowledge and new assessment methods as they emerge. It is also recognized that there is a need for new methodology that has not been addressed in this document in a number of areas, e.g., the characterization of uncertainty. As this knowledge and assessment methodology are developed, these Guidelines will be revised whenever appropriate.

A summary of the current state of knowledge in the field of carcinogenesis and a statement of broad scientific principles of carcinogen risk assessment, which was developed by the Office of Science and Technology Policy (OSTP, 1985), forms an important basis for these Guidelines; the format of these Guidelines is similar to that proposed by the National Research Council (NRC) of the National Academy of Sciences in a book entitled *Risk Assessment in the Federal Government: Managing the Process* (NRC, 1983).

These Guidelines are to be used within the policy framework already provided by applicable EPA statutes and do not alter such policies. These Guidelines provide general directions for analyzing and organizing available data. They do not imply that one kind of data or another is prerequisite for regulatory action to control, prohibit, or allow the use of a carcinogen.

Regulatory decision making involves two components: risk assessment and risk management. Risk assessment defines the adverse health consequences of exposure to toxic agents. The risk assessments will be carried out independently from considerations of the consequences of regulatory action. Risk management combines the risk assessment with the directives of regulatory legislation, together with socioeconomic, technical, political, and other considerations, to reach a decision as to whether or how much to control future exposure to the suspected toxic agents.

Risk assessment includes one or more of the following components: hazard identification, dose-response assessment, exposure assessment, and risk characterization (NRC, 1983).

Hazard identification is a qualitative risk assessment, dealing with the process of determining whether exposure to an agent has the potential to increase the incidence of cancer. For purposes of these Guidelines, both malignant and benign tumors are used in the evaluation of the carcinogenic hazard. The hazard identification component qualitatively answers the question of how likely an agent is to be a human carcinogen.

Traditionally, quantitative risk assessment has been used as an inclusive term to describe all or parts of dose-response assessment, exposure assessment, and risk characterization. Quantitative risk assessment can be a useful general term in some circumstances, but the more explicit terminology developed by the NRC (1983) is usually preferred. The dose-response assessment defines the relationship between the dose of an agent and the probability of induction of a carcinogenic effect. This component usually entails an extrapolation from the generally high doses administered to experimental animals or exposures noted in epidemiologic studies to the exposure levels expected from human contact with the agent in the environment; it also includes considerations of the validity of these extrapolations.

The exposure assessment identifies populations exposed to the agent, describes their composition and size, and presents the types, magnitudes, frequencies, and durations of exposure to the agent.

[51 FR 33994]

In risk characterization, the results of the exposure assessment and the dose-response assessment are combined to estimate quantitatively the carcinogenic risk. As part of risk characterization, a summary of the strengths and weaknesses in the hazard identification, dose-response assessment, exposure assessment, and the public health risk estimates are presented. Major assumptions, scientific judgments, and, to the extent possible, estimates of the uncertainties embodied in the assessment are also presented, distinguishing clearly between fact, assumption, and science policy.

The National Research Council (NRC, 1983) pointed out that there are many questions encountered in the risk assessment process that are unanswerable given current scientific knowledge. To bridge the uncertainty that exists in these areas where there is no scientific consensus, inferences must be made to ensure that progress continues in the assessment process. The OSTP (1985) reaffirmed this position, and generally left to the regulatory agencies the job of articulating these inferences. Accordingly, the Guidelines incorporate judgmental positions (science policies) based on evaluation of the presently available information and on the regulatory mission of the Agency. The Guidelines are consistent with the principles developed by the OSTP (1985), although in many instances are necessarily more specific.

II. Hazard Identification

A. Overview

The qualitative assessment or hazard identification part of risk assessment contains a review of the relevant biological and chemical information bearing on whether or not an agent may pose a carcinogenic hazard. Since chemical agents seldom occur in a pure state and are often transformed in the body, the review should include available information on contaminants, degradation products, and metabolites.

Studies are evaluated according to sound biological and statistical considerations and procedures. These have been described in several publications (Interagency Regulatory Liaison Group, 1979; OSTP, 1985; Peto et al., 1980; Mantel, 1980; Mantel and Haenszel, 1959; Interdisciplinary Panel on Carcinogenicity, 1984; National Center for Toxicological Research, 1981; National Toxicology Program, 1984; U.S. EPA, 1983a, 1983b, 1983c; Haseman, 1984). Results and conclusions concerning the agent, derived from different types of information, whether indicating positive or negative responses, are melded together into a weight-of-evidence determination. The strength of the evidence supporting a potential human carcinogenicity judgment is developed in a weight-of-evidence stratification scheme.

B. Elements of Hazard Identification

Hazard identification should include a review of the following information to the extent that it is available.

1. *Physical-Chemical Properties and Routes and Patterns of Exposure.* Parameters relevant to carcinogenesis, including physical state, physical-chemical properties, and exposure pathways in the environment should be described where possible.

2. *Structure-Activity Relationships.* This section should summarize relevant structure-activity correlations that support or argue against the prediction of potential carcinogenicity.

3. Meta*bolic and Pharmacokinetic Properties.* This section should summarize relevant metabolic information. Information such as whether the agent is direct-acting or requires conversion to a reactive carcinogenic (e.g., an electrophilic) species, metabolic pathways for such conversions, macromolecular interactions, and fate (e.g., transport, storage, and excretion), as well as species differences, should be discussed and critically evaluated. Pharmacokinetic properties determine the biologically effective dose and may be relevant to hazard identification and other components of risk assessment.

4. To*xicologic Effects.* Toxicologic effects other than carcinogenicity (e.g., suppression of the immune system, endocrine disturbances, organ damage) that are relevant to the evaluation of carcinogenicity should be summarized. Interactions with other chemicals or agents and with lifestyle factors should be discussed. Prechronic and chronic toxicity evaluations, as well as other test results, may yield information on target organ effects, pathophysiological reactions, and preneoplastic lesions that bear on the evaluation of carcinogenicity. Dose-response and time-to-response analyses of these reactions may also be helpful.

5. *Short-Term Tests.* Tests for point mutations, numerical and structural chromosome aberrations, DNA damage/repair, and *in vitro* transformation provide supportive evidence of carcinogenicity and may give information on potential carcinogenic mechanisms. A range of tests from each of the above end points helps to characterize an agent's response spectrum.

Short-term *in vivo* and *in vitro* tests that can give indication of initiation and promotion activity may also provide supportive evidence for carcinogenicity. Lack of positive results in short-term tests for genetic toxicity does not provide a basis for discounting positive results in long-term animal studies.

6. *Long-Term Animal Studies.* Criteria for the technical adequacy of animal carcinogenicity studies have been published (e.g., U.S. Food and Drug Administration, 1982; Interagency Regulatory Liaison Group, 1979; National Toxicology Program, 1984; OSTP, 1985; U.S. EPA, 1983a, 1983b, 1983c; Feron et al., 1980; Mantel, 1980) and should be used to judge the acceptability of individual studies. Transplacental and multigenerational carcinogenesis studies, in addition to more conventional long-term animal studies, can yield useful information about the carcinogenicity of agents.

It is recognized that chemicals that induce benign tumors frequently also induce malignant

tumors, and that benign tumors often progress to malignant tumors (Interdisciplinary Panel on Carcinogenicity, 1984). The incidence of benign and malignant tumors will be combined when scientifically defensible (OSTP, 1985; Principle 8). For example, the Agency will, in general, consider the combination of benign and malignant tumors to be scientifically defensible unless the benign tumors are not considered to have the potential to progress to the associated malignancies of the same histogenic origin. If an increased incidence of benign tumors is observed in the absence of malignant tumors, in most cases the evidence will be considered as limited evidence of carcinogenicity.

The weight of evidence that an agent is potentially carcinogenic for humans increases (1) with the increase in number of tissue sites affected by the agent; (2) with the increase in number of animal species, strains, sexes, and number of experiments and doses showing a carcinogenic response; (3) with the occurrence of clear-cut dose-response relationships as well as a high level of statistical significance of the increased tumor incidence in treated compared to control groups; (4) when there is a dose-related shortening of the time-to-tumor occurrence or time to death with tumor; and (5) when there is a dose-related increase in the proportion of tumors that are malignant.

Long-term animal studies at or near the maximum tolerated dose level (MTD) are used to ensure an adequate power for the detection of carcinogenic

[51 FR 33995]

activity (NTP, 1984; IARC, 1982). Negative long-term animal studies at exposure levels above the MTD may not be acceptable if animal survival is so impaired that the sensitivity of the study is significantly reduced below that of a conventional chronic animal study at the MTD. The OSTP (1985; Principle 4) has stated that,

> The carcinogenic effects of agents may be influenced by non-physiological responses (such as extensive organ damage, radical disruption of hormonal function, saturation of metabolic pathways, formation of stones in the urinary tract, saturation of DNA repair with a functional loss of the system) induced in the model systems. Testing regimes inducing these responses should be evaluated for their relevance to the human response to an agent and evidence from such a study, whether positive or negative, must be carefully reviewed.

Positive studies at levels above the MTD should be carefully reviewed to ensure that the responses are not due to factors which do not operate at exposure levels below the MTD. Evidence indicating that high exposures alter tumor responses by indirect mechanisms that may be unrelated to effects at lower exposures should be dealt with on an individual basis. As noted by the OSTP (1985), "Normal metabolic activation of carcinogens may possibly also be altered and carcinogenic potential reduced as a consequence [of high-dose testing]."

Carcinogenic responses under conditions of the experiment should be reviewed carefully as they relate to the relevance of the evidence to human carcinogenic risks (e.g., the occurrence of bladder tumors in the presence of bladder stones and implantation site sarcomas). Interpretation of animal studies is aided by the review of target organ toxicity and other effects (e.g., changes in the immune and endocrine systems) that may be noted in prechronic or other toxicological studies. Time and dose-related changes in the incidence of preneoplastic lesions may also be helpful in interpreting animal studies.

Agents that are positive in long-term animal experiments and also show evidence of promoting or cocarcinogenic activity in specialized tests should be considered as complete carcinogens unless there is evidence to the contrary because it is, at present, difficult to determine whether an agent is only a promoting or cocarcinogenic agent. Agents that show positive results in special tests for initiation, promotion, or cocarcinogenicity and no indication of tumor response in well-conducted and well-designed long-term animal studies should be dealt with on an individual basis.

To evaluate carcinogenicity, the primary comparison is tumor response in dosed animals as compared with that in contemporary matched control animals. Historical control data are often valuable, however, and could be used along with concurrent control data in the evaluation of carcinogenic responses (Haseman et al., 1984). For the evaluation of rare tumors, even small tumor responses may be significant compared to historical data. The review of tumor data at sites with high spontaneous background requires special consideration (OSTP, 1985; Principle 9). For instance, a response that is significant with respect to the experimental control group may become questionable if the historical control data indicate that the experimental control group had an unusually low background incidence (NTP, 1984).

For a number of reasons, there are widely diverging scientific views (OSTP, 1985; Ward et al., 1979a, b; Tomatis, 1977; Nutrition Foundation, 1983) about the validity of mouse liver tumors as an indication of potential carcinogenicity in humans when such tumors occur in strains with high spontaneous background incidence and when they constitute the only tumor response to an agent. These Guidelines take the position that when the only tumor response is in the mouse liver and when other conditions for a classification of "sufficient" evidence in animal studies are met (e.g., replicate studies, malignancy; see section IV), the data should be considered as "sufficient" evidence of carcinogenicity. It is understood that this classification could be changed on a case-by-case basis to "limited," if warranted, when factors such as the following, are observed: an increased incidence

of tumors only in the highest dose group and/or only at the end of the study; no substantial dose-related increase in the proportion of tumors that are malignant; the occurrence of tumors that are predominantly benign; no dose-related shortening of the time to the appearance of tumors; negative or inconclusive results from a spectrum of short-term tests for mutagenic activity; the occurrence of excess tumors only in a single sex.

Data from all long-term animal studies are to be considered in the evaluation of carcinogenicity. A positive carcinogenic response in one species/strain/sex is not generally negated by negative results in other species/strain/sex. Replicate negative studies that are essentially identical in all other respects to a positive study may indicate that the positive results are spurious.

Evidence for carcinogenic action should be based on the observation of statistically significant tumor responses in specific organs or tissues. Appropriate statistical analysis should be performed on data from long-term studies to help determine whether the effects are treatment-related or possibly due to chance. These should at least include a statistical test for trend, including appropriate correction for differences in survival. The weight to be given to the level of statistical significance (the p-value) and to other available pieces of information is a matter of overall scientific judgment. A statistically significant excess of tumors of all types in the aggregate, in the absence of a statistically significant increase of any individual tumor type, should be regarded as minimal evidence of carcinogenic action unless there are persuasive reasons to the contrary.

7. *Human Studies.* Epidemiologic studies provide unique information about the response of humans who have been exposed to suspect carcinogens. Descriptive epidemiologic studies are useful in generating hypotheses and providing supporting data, but can rarely be used to make a causal inference. Analytical epidemiologic studies of the case-control or cohort variety, on the other hand, are especially useful in assessing risks to exposed humans.

Criteria for the adequacy of epidemiologic studies are well recognized. They include factors such as the proper selection and characterization of exposed and control groups, the adequacy of duration and quality of follow-up, the proper identification and characterization of confounding factors and bias, the appropriate consideration of latency effects, the valid ascertainment of the causes of morbidity and death, and the ability to detect specific effects. Where it can be calculated, the statistical power to detect an appropriate outcome should be included in the assessment.

The strength of the epidemiologic evidence for carcinogenicity depends, among other things, on the type of analysis and on the magnitude and specificity of the response. The weight of evidence increases rapidly with the number of adequate studies that show comparable results on populations exposed to the same agent under different conditions.

It should be recognized that epidemiologic studies are inherently capable of detecting only comparatively large increases in the relative risk of

[51 FR 33996]

cancer. Negative results from such studies cannot prove the absence of carcinogenic action; however, negative results from a well-designed and well-conducted epidemiologic study that contains usable exposure data can serve to define upper limits of risk; these are useful if animal evidence indicates that the agent is potentially carcinogenic in humans.

C. Weight of Evidence

Evidence of possible carcinogenicity in humans comes primarily from two sources: long-term animal tests and epidemiologic investigations. Results from these studies are supplemented with available information from short-term tests, pharmacokinetic studies, comparative metabolism studies, structure-activity relationships, and other relevant toxicologic studies. The question of how likely an agent is to be a human carcinogen should be answered in the framework of a weight-of-evidence judgment. Judgments about the weight of evidence involve considerations of the quality and adequacy of the data and the kinds and consistency of responses induced by a suspect carcinogen. There are three major steps to characterizing the weight of evidence for carcinogenicity in humans: (1) characterization of the evidence from human studies and from animal studies individually, (2) combination of the characterizations of these two types of data into an indication of the overall weight of evidence for human carcinogenicity, and (3) evaluation of all supporting information to determine if the overall weight of evidence should be modified.

EPA has developed a system for stratifying the weight of evidence (see section IV). This classification is not meant to be applied rigidly or mechanically. At various points in the above discussion, EPA has emphasized the need for an overall, balanced judgment of the totality of the available evidence. Particularly for well-studied substances, the scientific data base will have a complexity that cannot be captured by any classification scheme. Therefore, the hazard identification section should include a narrative summary of the strengths and weaknesses of the evidence as well as its categorization in the EPA scheme.

The EPA classification system is, in general, an adaptation of the International Agency for Research on Cancer (IARC, 1982) approach for classifying the

REC 6164

weight of evidence for human data and animal data. The EPA classification system for the characterization of the overall weight of evidence for carcinogenicity (animal, human, and other supportive data) includes: Group A -- Carcinogenic to Humans; Group B -- Probably Carcinogenic to Humans; Group C -- Possibly Carcinogenic to Humans; Group D -- Not Classifiable as to Human Carcinogenicity; and Group E -- Evidence of Non-Carcinogenicity for Humans.

The following modifications of the IARC approach have been made for classifying human and animal studies.

For human studies:

(1) The observation of a statistically significant association between an agent and life-threatening benign tumors in humans is included in the evaluation of risks to humans.

(2) A "no data available" classification is added.

(3) A "no evidence of carcinogenicity" classification is added. This classificaton indicates that no association was found between exposure and increased risk of cancer in well-conducted, well-designed, independent analytical epidemiologic studies.

For animal studies:

(1) An increased incidence of combined benign and malignant tumors will be considered to provide sufficient evidence of carcinogenicity if the other criteria defining the "sufficient" classification of evidence are met (e.g., replicate studies, malignancy; see section IV). Benign and malignant tumors will be combined when scientifically defensible.

(2) An increased incidence of benign tumors alone generally constitutes "limited" evidence of carcinogenicity.

(3) An increased incidence of neoplasms that occur with high spontaneous background incidence (e.g., mouse liver tumors and rat pituitary tumors in certain strains) generally constitutes "sufficient" evidence of carcinogenicity, but may be changed to "limited" when warranted by the specific information available on the agent.

(4) A "no data available" classification has been added.

(5) A "no evidence of carcinogenicity" classification is also added. This operational classification would include substances for which there is no increased incidence of neoplasms in at least two well-designed and well-conducted animal studies of adequate power and dose in different species.

D. Guidance for Dose-Response Assessment

The qualitative evidence for carcinogenesis should be discussed for purposes of guiding the dose-response assessment. The guidance should be given in terms of the appropriateness and limitations of specific studies as well as pharmacokinetic considerations that should be factored into the dose-response assessment. The appropriate method of extrapolation should be factored in when the experimental route of exposure differs from that occurring in humans.

Agents that are judged to be in the EPA weight-of-evidence stratification Groups A and B would be regarded as suitable for quantitative risk assessments. Agents that are judged to be in Group C will generally be regarded as suitable for quantitative risk assessment, but judgments in this regard may be made on a case-by-case basis. Agents that are judged to be in Groups D and E would not have quantitative risk assessments.

E. Summary and Conclusion

The summary should present all of the key findings in all of the sections of the qualitative assessment and the interpretive rationale that forms the basis for the conclusion. Assumptions, uncertainties in the evidence, and other factors that may affect the relevance of the evidence to humans should be discussed. The conclusion should present both the weight-of-evidence ranking and a description that brings out the more subtle aspects of the evidence that may not be evident from the ranking alone.

III. Dose-Response Assessment, Exposure Assessment, and Risk Characterization

After data concerning the carcinogenic properties of a substance have been collected, evaluated, and categorized, it is frequently desirable to estimate the likely range of excess cancer risk associated with given levels and conditions of human exposure. The first step of the analysis needed to make such estimations is the development of the likely relationship between dose and response (cancer incidence) in the region of human exposure. This information on dose-response relationships is coupled with information on the nature and magnitude of human exposure to yield an estimate of human risk. The risk-characterization step also includes an interpretation of these estimates in light of the biological, statistical, and exposure assumptions and uncertainties that have arisen throughout the process of assessing risk.

The elements of dose-response assessment are described in section III.A. Guidance on human exposure assessment is provided in another EPA

[51 FR 33997]

document (U.S. EPA, 1986); however, section III.B. of these Guidelines includes a brief description of the specific type of exposure information that is useful for carcinogen risk assessment. Finally, in section III.C. on risk characterization, there is a description of the manner in which risk estimates should be presented so as to be most informative.

It should be emphasized that calculation of quantitative estimates of cancer risk does not

REC 6165

require that an agent be carcinogenic in humans. The likelihood that an agent is a human carcinogen is a function of the weight of evidence, as this has been described in the hazard identification section of these Guidelines. It is nevertheless important to present quantitative estimates, appropriately qualified and interpreted, in those circumstances in which there is a reasonable possibility, based on human and animal data, that the agent is carcinogenic in humans.

It should be emphasized in every quantitative risk estimation that the results are uncertain. Uncertainties due to experimental and epidemiologic variability as well as uncertainty in the exposure assessment can be important. There are major uncertainties in extrapolating both from animals to humans and from high to low doses. There are important species differences in uptake, metabolism, and organ distribution of carcinogens, as well as species and strain differences in target-site susceptibility. Human populations are variable with respect to genetic constitution, diet, occupational and home environment, activity patterns, and other cultural factors. Risk estimates should be presented together with the associated hazard assessment (section III.C.3.) to ensure that there is an appreciation of the weight of evidence for carcinogenicity that underlies the quantitative risk estimates.

A. Dose-Response Assessment

1. *Selection of Data.* As indicated in section II.D., guidance needs to be given by the individuals doing the qualitative assessment (toxicologists, pathologists, pharmacologists, etc.) to those doing the quantitative assessment as to the appropriate data to be used in the dose-response assessment. This is determined by the quality of the data, its relevance to human modes of exposure, and other technical details.

If available, estimates based on adequate human epidemiologic data are preferred over estimates based on animal data. If adequate exposure data exist in a well-designed and well-conducted negative epidemiologic study, it may be possible to obtain an upper-bound estimate of risk from that study. Animal-based estimates, if available, also should be presented.

In the absence of appropriate human studies, data from a species that responds most like humans should be used, if information to this effect exists. Where, for a given agent, several studies are available, which may involve different animal species, strains, and sexes at several doses and by different routes of exposure, the following approach to selecting the data sets is used: (1) The tumor incidence data are separated according to organ site and tumor type. (2) All biologically and statistically acceptable data sets are presented. (3) The range of the risk estimates is presented with due regard to biological relevance (particularly in the case of animal studies) and appropriateness of route of exposure. (4) Because it is possible that human sensitivity is as high as the most sensitive responding animal species, in the absence of evidence to the contrary, the biologically acceptable data set from long-term animal studies showing the greatest sensitivity should generally be given the greatest emphasis, again with due regard to biological and statistical considerations.

When the exposure route in the species from which the dose-response information is obtained differs from the route occurring in environmental exposures, the considerations used in making the route-to-route extrapolation must be carefully described. All assumptions should be presented along with a discussion of the uncertainties in the extrapolation. Whatever procedure is adopted in a given case, it must be consistent with the existing metabolic and pharmacokinetic information on the chemical (e.g., absorption efficiency via the gut and lung, target organ doses, and changes in placental transport throughout gestation for transplacental carcinogens).

Where two or more significantly elevated tumor sites or types are observed in the same study, extrapolations may be conducted on selected sites or types. These selections will be made on biological grounds. To obtain a total estimate of carcinogenic risk, animals with one or more tumor sites or types showing significantly elevated tumor incidence should be pooled and used for extrapolation. The pooled estimates will generally be used in preference to risk estimates based on single sites or types. Quantitative risk extrapolations will generally not be done on the basis of totals that include tumor sites without statistically significant elevations.

Benign tumors should generally be combined with malignant tumors for risk estimates unless the benign tumors are not considered to have the potential to progress to the associated malignancies of the same histogenic origin. The contribution of the benign tumors, however, to the total risk should be indicated.

2. *Choice of Mathematical Extrapolation Model.* Since risks at low exposure levels cannot be measured directly either by animal experiments or by epidemiologic studies, a number of mathematical models have been developed to extrapolate from high to low dose. Different extrapolation models, however, may fit the observed data reasonably well but may lead to large differences in the projected risk at low doses.

As was pointed out by OSTP (1985; Principle 26),

> No single mathematical procedure is recognized as the most appropriate for low-dose extrapolation in carcinogenesis. When relevant biological evidence on mechanism of action exists (e.g., pharmacokinetics, target organ dose), the models or procedures

employed should be consistent with the evidence. When data and information are limited, however, and when much uncertainty exists regarding the mechanism of carcinogenic action, models or procedures which incorporate low-dose linearity are preferred when compatible with the limited information.

At present, mechanisms of the carcinogenesis process are largely unknown and data are generally limited. If a carcinogenic agent acts by accelerating the same carcinogenic process that leads to the background occurrence of cancer, the added effect of the carcinogen at low doses is expected to be virtually linear (Crump et al., 1976).

The Agency will review each assessment as to the evidence on carcinogenesis mechanisms and other biological or statistical evidence that indicates the suitability of a particular extrapolation model. Goodness-of-fit to the experimental observations is not an effective means of discriminating among models (OSTP, 1985). A rationale will be included to justify the use of the chosen model. In the absence of adequate information to the contrary, the linearized multistage procedure will be employed. Where appropriate, the results of using various extrapolation models may be useful for comparison with the linearized multistage procedure. When longitudinal data on tumor development are available, time-to-tumor models may be used.

It should be emphasized that the linearized multistage procedure leads to

[51 FR 33998]

a plausible upper limit to the risk that is consistent with some proposed mechanisms of carcinogenesis. Such an estimate, however, does not necessarily give a realistic prediction of the risk. The true value of the risk is unknown, and may be as low as zero. The range of risks, defined by the upper limit given by the chosen model and the lower limit which may be as low as zero, should be explicitly stated. An established procedure does not yet exist for making "most likely" or "best" estimates of risk within the range of uncertainty defined by the upper and lower limit estimates. If data and procedures become available, the Agency will also provide "most likely" or "best" estimates of risk. This will be most feasible when human data are available and when exposures are in the dose range of the data.

In certain cases, the linearized multistage procedure cannot be used with the observed data as, for example, when the data are nonmonotonic or flatten out at high doses. In these cases, it may be necessary to make adjustments to achieve low-dose linearity.

When pharmacokinetic or metabolism data are available, or when other substantial evidence on the mechanistic aspects of the carcinogenesis process exists, a low-dose extrapolation model other than the linearized multistage procedure might be considered more appropriate on biological grounds. When a different model is chosen, the risk assessment should clearly discuss the nature and weight of evidence that led to the choice. Considerable uncertainty will remain concerning response at low doses; therefore, in most cases an upper-limit risk estimate using the linearized multistage procedure should also be presented.

3. *Equivalent Exposure Units Among Species.* Low-dose risk estimates derived from laboratory animal data extrapolated to humans are complicated by a variety of factors that differ among species and potentially affect the response to carcinogens. Included among these factors are differences between humans and experimental test animals with respect to life span, body size, genetic variability, population homogeneity, existence of concurrent disease, pharmacokinetic effects such as metabolism and excretion patterns, and the exposure regimen.

The usual approach for making interspecies comparisons has been to use standardized scaling factors. Commonly employed standardized dosage scales include mg per kg body weight per day, ppm in the diet or water, mg per m^2 body surface area per day, and mg per kg body weight per lifetime. In the absence of comparative toxicological, physiological, metabolic, and pharmacokinetic data for a given suspect carcinogen, the Agency takes the position that the extrapolation on the basis of surface area is considered to be appropriate because certain pharmacological effects commonly scale according to surface area (Dedrick, 1973; Freireich et al., 1966; Pinkel, 1958).

B. Exposure Assessment

In order to obtain a quantitative estimate of the risk, the results of the dose-response assessment must be combined with an estimate of the exposures to which the populations of interest are likely to be subject. While the reader is referred to the Guidelines for Estimating Exposures (U.S. EPA, 1986) for specific details, it is important to convey an appreciation of the impact of the strengths and weaknesses of exposure assessment on the overall cancer risk assessment process.

At present there is no single approach to exposure assessment that is appropriate for all cases. On a case-by-case basis, appropriate methods are selected to match the data on hand and the level of sophistication required. The assumptions, approximations, and uncertainties need to be clearly stated because, in some instances, these will have a major effect on the risk assessment.

In general, the magnitude, duration, and frequency of exposure provide fundamental information for estimating the concentration of the carcinogen to which the organism is exposed. These data are generated from monitoring information, modeling results, and/or reasoned estimates. An appropriate treatment of exposure should consider

REC 6167

the potential for exposure via ingestion, inhalation, and dermal penetration from relevant sources of exposures including multiple avenues of intake from the same source.

Special problems arise when the human exposure situation of concern suggests exposure regimens, e.g., route and dosing schedule that are substantially different from those used in the relevant animal studies. Unless there is evidence to the contrary in a particular case, the cumulative dose received over a lifetime, expressed as average daily exposure prorated over a lifetime, is recommended as an appropriate measure of exposure to a carcinogen. That is, the assumption is made that a high dose of a carcinogen received over a short period of time is equivalent to a corresponding low dose spread over a lifetime. This approach becomes more problematical as the exposures in question become more intense but less frequent, especially when there is evidence that the agent has shown dose-rate effects.

An attempt should be made to assess the level of uncertainty associated with the exposure assessment which is to be used in a cancer risk assessment. This measure of uncertainty should be included in the risk characterization (section III.C.) in order to provide the decision-maker with a clear understanding of the impact of this uncertainty on any final quantitative risk estimate. Subpopulations with heightened susceptibility (either because of exposure or predisposition) should, when possible, be identified.

C. Risk Characterization

Risk characterization is composed of two parts. One is a presentation of the numerical estimates of risk; the other is a framework to help judge the significance of the risk. Risk characterization includes the exposure assessment and dose-response assessment; these are used in the estimation of carcinogenic risk. It may also consist of a unit-risk estimate which can be combined elsewhere with the exposure assessment for the purposes of estimating cancer risk.

Hazard identification and dose-response assessment are covered in sections II. and III.A., and a detailed discussion of exposure assessment is contained in EPA's Guidelines for Estimating Exposures (U.S. EPA, 1986). This section deals with the numerical risk estimates and the approach to summarizing risk characterization.

1. *Options for Numerical Risk Estimates.* Depending on the needs of the individual program offices, numerical estimates can be presented in one or more of the following three ways.

a. Unit Risk -- Under an assumption of low-dose linearity, the unit cancer risk is the excess lifetime risk due to a continuous constant lifetime exposure of one unit of carcinogen concentration. Typical exposure units include ppm or ppb in food or water, mg/kg/day by ingestion, or ppm or $\mu g/m^3$ in air.

b. Dose Corresponding to a Given Level of Risk -- This approach can be useful, particularly when using nonlinear extrapolation models where the unit risk would differ at different dose levels.

c. Individual and Population Risks -- Risks may be characterized either in terms of the excess individual lifetime risks, the excess number of cancers

[51 FR 33999]

produced per year in the exposed population, or both.

Irrespective of the options chosen, the degree of precision and accuracy in the numerical risk estimates currently do not permit more than one significant figure to be presented.

2. *Concurrent Exposure.* In characterizing the risk due to concurrent exposure to several carcinogens, the risks are combined on the basis of additivity unless there is specific information to the contrary. Interactions of cocarcinogens, promoters, and inititators with known carcinogens should be considered on a case-by-case basis.

3. *Summary of Risk Characterization.* Whichever method of presentation is chosen, it is critical that the numerical estimates not be allowed to stand alone, separated from the various assumptions and uncertainties upon which they are based. The risk characterization should contain a discussion and interpretation of the numerical estimates that affords the risk manager some insight into the degree to which the quantitative estimates are likely to reflect the true magnitude of human risk, which generally cannot be known with the degree of quantitative accuracy reflected in the numerical estimates. The final risk estimate will be generally rounded to one significant figure and will be coupled with the EPA classification of the qualitative weight of evidence. For example, a lifetime individual risk of 2×10^{-4} resulting from exposure to a "probable human carcinogen" (Group B2) should be designated as 2×10^{-4} [B2] . This bracketed designation of the qualitative weight of evidence should be included with all numerical risk estimates (i.e., unit risks, which are risks at a specified concentration or concentrations corresponding to a given risk). Agency statements, such as *FEDERAL REGISTER* notices, briefings, and action memoranda, frequently include numerical estimates of carcinogenic risk. It is recommended that whenever these numerical estimates are used, the qualitative weight-of-evidence classification should also be included.

The section on risk characterization should summarize the hazard identification, dose-response assessment, exposure assessment, and the public health risk estimates. Major assumptions, scientific judgments, and, to the extent possible, estimates of

REC 6168

the uncertainties embodied in the assessment are presented.

IV. EPA Classification System for Categorizing Weight of Evidence for Carcinogenicity from Human and Animal Studies (Adapted from IARC)

A. Assessment of Weight of Evidence for Carcinogenicity from Studies in Humans

Evidence of carcinogenicity from human studies comes from three main sources:

1. Case reports of individual cancer patients who were exposed to the agent(s).
2. Descriptive epidemiologic studies in which the incidence of cancer in human populations was found to vary in space or time with exposure to the agent(s).
3. Analytical epidemiologic (case-control and cohort) studies in which individual exposure to the agent(s) was found to be associated with an increased risk of cancer.

Three criteria must be met before a causal association can be inferred between exposure and cancer in humans:

1. There is no identified bias that could explain the association.
2. The possibility of confounding has been considered and ruled out as explaining the association.
3. The association is unlikely to be due to chance.

In general, although a single study may be indicative of a cause-effect relationship, confidence in inferring a causal association is increased when several independent studies are concordant in showing the association, when the association is strong, when there is a dose-response relationship, or when a reduction in exposure is followed by a reduction in the incidence of cancer.

The weight of evidence for carcinogenicity[1] from studies in humans is classified as:

1. Sufficient evidence of carcinogenicity, which indicates that there is a causal relationship between the agent and human cancer.
2. Limited evidence of carcinogenicity, which indicates that a causal interpretation is credible, but that alternative explanations, such as chance, bias, or confounding, could not adequately be excluded.
3. Inadequate evidence, which indicates that one of two conditions prevailed: (a) there were few pertinent data, or (b) the available studies, while showing evidence of association, did not exclude chance, bias, or confounding, and therefore a causal interpretation is not credible.
4. No data, which indicates that data are not available.
5. No evidence, which indicates that no association was found between exposure and an increased risk of cancer in well-designed and well-conducted independent analytical epidemiologic studies.

B. Assessment of Weight of Evidence for Carcinogenicity from Studies in Experimental Animals

These assessments are classified into five groups:

1. Sufficient evidence[2] of carcinogenicity, which indicates that there is an increased incidence of malignant tumors or combined malignant and benign tumors:[3] (a) in multiple species or strains; or (b) in multiple experiments (e.g., with different routes of administration or using different dose levels); or (c) to an unusual degree in a single experiment with regard to high incidence, unusual site or type of tumor, or early age at onset.

Additional evidence may be provided by data on dose-response effects, as well as information from short-term tests or on chemical structure.

2. Limited evidence of carcinogenicity, which means that the data suggest a carcinogenic effect but are limited because: (a) the studies involve a single species, strain, or experiment and do not meet criteria for sufficient evidence (see section IV. B.1.c); (b) the experiments are restricted by inadequate dosage levels, inadequate duration of exposure to the agent, inadequate period of follow-up, poor survival, too few animals, or inadequate reporting; or (c) an increase in the incidence of benign tumors only.
3. Inadequate evidence, which indicates that because of major qualitative or quantitative limitations, the studies cannot be interpreted as showing either the presence or absence of a carcinogenic effect.
4. No data, which indicates that data are not available.
5. No evidence, which indicates that there is no increased incidence of neoplasms in at least two well-designed

[51 FR 34000]

and well-conducted animal studies in different species.

The classifications "sufficient evidence" and "limited evidence" refer only to the weight of the experimental evidence that these agents are carcinogenic and not to the potency of their carcinogenic action.

[1] For purposes of public health protection, agents associated with life-threatening benign tumors in humans are included in the evaluation.

[2] An increased incidence of neoplasms that occur with high spontaneous background incidence (e.g., mouse liver tumors and rat pituitary tumors in certain strains) generally constitutes "sufficient" evidence of carcinogenicity, but may be changed to "limited" when warranted by the specific information available on the agent.

[3] Benign and malignant tumors will be combined unless the benign tumors are not considered to have the potential to progress to the associated malignancies of the same histogenic origin.

C. Categorization of Overall Weight of Evidence for Human Carcinogenicity

The overall scheme for categorization of the weight of evidence of carcinogenicity of a chemical for humans uses a three-step process. (1) The weight of evidence in human studies or animal studies is summarized; (2) these lines of information are combined to yield a tentative assignment to a category (see Table 1); and (3) all relevant supportive information is evaluated to see if the designation of the overall weight of evidence needs to be modified. Relevant factors to be included along with the tumor information from human and animal studies include structure-activity relationships; short-term test findings; results of appropriate physiological, biochemical, and toxicological observations; and comparative metabolism and pharmacokinetic studies. The nature of these findings may cause one to adjust the overall categorization of the weight of evidence.

The agents are categorized into five groups as follows:

Group A -- Human Carcinogen

This group is used only when there is sufficient evidence from epidemiologic studies to support a causal association between exposure to the agents and cancer.

Group B -- Probable Human Carcinogen

This group includes agents for which the weight of evidence of human carcinogenicity based on epidemiologic studies is "limited" and also includes agents for which the weight of evidence of carcinogenicity based on animal studies is "sufficient." The group is divided into two subgroups. Usually, Group B1 is reserved for agents for which there is limited evidence of carcinogenicity from epidemiologic studies. It is reasonable, for practical purposes, to regard an agent for which there is "sufficient" evidence of carcinogenicity in animals as if it presented a carcinogenic risk to humans. Therefore, agents for which there is "sufficient" evidence from animal studies and for which there is "inadequate evidence" or "no data" from epidemiologic studies would usually be categorized under Group B2.

Group C -- Possible Human Carcinogen

This group is used for agents with limited evidence of carcinogenicity in animals in the absence of human data. It includes a wide variety of evidence, e.g., (a) a malignant tumor response in a single well-conducted experiment that does not meet conditions for sufficient evidence, (b) tumor responses of marginal statistical significance in studies having inadequate design or reporting, (c) benign but not malignant tumors with an agent showing no response in a variety of short-term tests for mutagenicity, and (d) responses of marginal statistical significance in a tissue known to have a high or variable background rate.

Group D -- Not Classifiable as to Human Carcinogenicity

This group is generally used for agents with inadequate human and animal evidence of carcinogenicity or for which no data are available.

Group E -- Evidence of Non-Carcinogenicity for Humans

This group is used for agents that show no evidence for carcinogenicity in at least two adequate animal tests in different species or in both adequate epidemiologic and animal studies.

The designation of an agent as being in Group E is based on the available evidence and should not be interpreted as a definitive conclusion that the agent will not be a carcinogen under any circumstances.

V. References

Albert, R.E., Train, R.E., and Anderson, E. 1977. Rationale developed by the Environmental Protection Agency for the assessment of carcinogenic risks. J. Natl. Cancer Inst. 58:1537-1541.

Crump, K.S., Hoel, D.G., Langley, C.H., Peto R. 1976. Fundamental carcinogenic processes and their implications for low dose risk assessment. Cancer Res. 36:2973-2979.

Dedrick, R.L. 1973. Animal Scale Up. J. Pharmacokinet. Biopharm. 1:435-461.

Feron, V.J., Grice, H.C., Griesemer, R., Peto R., Agthe, C., Althoff, J., Arnold, D.L., Blumenthal, H., Cabral, J.R.P., Della Porta, G., Ito, N., Kimmerle, G., Kroes, R., Mohr, U., Napalkov, N.P., Odashima, S., Page, N.P., Schramm, T., Steinhoff, D., Sugar, J., Tomatis, l., Uehleke, H., and Vouk, V. 1980. Basic requirements for long-term assays for carcinogenicity. In: Long-term and short-term screening assays for carcinogens: a critical appraisal. IARC Monographs, Supplement 2. Lyon, France: International Agency for Research on Cancer, pp 21-83.

Freireich, E.J., Gehan, E.A., Rall, D.P., Schmidt, L.H., and Skipper, H.E. 1966. Quantitative comparison of toxicity of anticancer agents in mouse, rat, hamster, dog, monkey and man. Cancer Chemother. Rep. 50:219-244.

Haseman, J.K. 1984. Statistical issues in the design, analysis and interpretation of animal carcinogenicity studies. Environ. Health Perspect. 58:385-392.

Haseman, J.K., Huff, J., and Boorman, G.A. 1984. Use of historical control data in carcinogenicity studies in rodents. Toxicol. Pathol. 12:126-135.

Interagency Regulatory Liaison Group (IRLG). 1979. Scientific basis for identification of potential carcinogens and estimation of risks. J. Natl. Cancer Inst. 63:245-267.

Interdisciplinary Panel on Carcinogenicity. 1984. Criteria for evidence of chemical carcinogenicity. Science 225:682-687.

International Agency for Research on Cancer (IARC). 1982. IARC Monographs on the

[51 FR 34001]

Evaluation of the Carcinogenic Risk of Chemicals to Humans, Supplement 4. Lyon, France: International Agency for Research on Cancer.

Mantel, N. 1980. Assessing laboratory evidence for neoplastic activity. Biometrics 36:381-399.

Mantel, N., and Haenszel, W. 1959. Statistical aspects of the analysis of data from retrospective studies of disease. J. Natl. Cancer Inst. 22:719-748.

National Center for Toxicological Research (NCTR). 1981. Guidelines for statistical tests for carcinogenicity in chronic bioassays. NCTR Biometry Technical Report 81-001. Available from: National Center for Toxicological Research.

REC 6170

TABLE 1.--ILLUSTRATIVE CATEGORIZATION OF EVIDENCE BASED ON ANIMAL AND HUMAN DATA[1]

Human evidence	Animal evidence				
	Sufficient	Limited	Inadequate	No data	No evidence
Sufficient	A	A	A	A	A
Limited	B1	B1	B1	B1	B1
Inadequate	B2	C	D	D	D
No data	B2	C	D	D	E
No evidence	B2	C	D	D	E

1 The above assignments are presented for illustrative purposes. There may be nuances in the classification of both animal and human data indicating that different categorizations than those given in the table should be assigned. Furthermore, these assignments are tentative and may be modified by ancillary evidence. In this regard all relevant information should be evaluated to determine if the designation of the overall weight of evidence needs to be modified. Relevant factors to be included along with the tumor data from human and animal studies include structure-activity relationships, short-term test findings, results of appropriate physiological, biochemical, and toxicological observations, and comparative metabolism and pharmacokinetic studies. The nature of these findings may cause an adjustment of the overall categorization of the weight of evidence.

National Research Council (NRC). 1983. Risk assessment in the Federal government: managing the process. Washington, D.C.: National Academy Press.

National Toxicology Program. 1984. Report of the Ad Hoc Panel on Chemical Carcinogenesis Testing and Evaluation of the National Toxicology Program, Board of Scientific Counselors. Available from: U.S. Government Printing Office, Washington, D.C. 1984-421-132:4726.

Nutrition Foundation. 1983. The relevance of mouse liver hepatoma to human carcinogenic risk: a report of the International Expert Advisory Committee to the Nutrition Foundation. Available from: Nutrition Foundation. ISBN 0-935368-37-x.

Office of Science and Technology Policy (OSTP). 1985. Chemical carcinogens: review of the science and its associated principles. Federal Register 50:10372-10442.

Peto, R., Pike, M., Day, N., Gray, R., Lee, P., Parish, S., Peto, J., Richard, S., and Wahrendorf, J. 1980. Guidelines for simple, sensitive, significant tests for carcinogenic effects in long-term animal experiments. In: Monographs on the long-term and short-term screening assays for carcinogens: a critical appraisal. IARC Monographs, Supplement 2. Lyon, France: International Agency for Research on Cancer, pp. 311-426.

Pinkel, D. 1958. The use of body surface area as a criterion of drug dosage in cancer chemotherapy. Cancer Res. 18:853-856.

Tomatis, L. 1977. The value of long-term testing for the implementation of primary prevention. In: Origins of human cancer. Hiatt, H.H., Watson, J.D., and Winstein, J.A., eds. Cold Spring Harbor Laboratory, pp. 1339-1357.

U.S. Environmental Protection Agency (U.S. EPA). 1976. Interim procedures and guidelines for health risk and economic impact assessments of suspected carcinogens. Federal Register 41:21402-21405.

U.S. Environmental Protection Agency (U.S. EPA). 1980. Water quality criteria documents; availability. Federal Register 45:79318-79379.

U.S. Environmental Protection Agency (U.S. EPA). 1983a. Good laboratory practices standards -- toxicology testing. Federal Register 48:53922.

U.S. Environmental Protection Agency (U.S. EPA). 1983b. Hazard evaluations: humans and domestic animals. Subdivision F. Available from: NTIS, Springfield, VA. PB 83-153916.

U.S. Environmental Protection Agency (U.S. EPA). 1983c. Health effects test guidelines. Available from: NTIS, Springfield, VA. PB 83-232984.

U.S. Environmental Protection Agency (U.S. EPA). 1986, Sept. 24. Guidelines for estimating exposures. Federal Register 51 (185):34042-34054

U.S. Food and Drug Administration (U.S. FDA). 1982. Toxicological principles for the safety assessment of direct food additives and color additives used in food. Available from: Bureau of Foods, U.S. Food and Drug Administration.

Ward, J.M., Griesemer, R.A., and Weisburger, E.K. 1979a. The mouse liver tumor as an endpoint in carcinogenesis tests. Toxicol. Appl. Pharmacol. 51:389-397.

Ward, J.M., Goodman, D.G., Squire, R.A. Chu, K.C., and Linhart, M.S. 1979b. Neoplastic and nonneoplastic lesions in aging ($C_{57}BL/_6N \times C_3H/HeN)F_1$ ($B_6C_3F_1$) mice. J. Natl. Cancer Inst. 63:849-854.

Part B: Response to Public and Science Advisory Board Comments

I. Introduction

This section summarizes the major issues raised during both the public comment period on the Proposed Guidelines for Carcinogen Risk Assessment published on November 23, 1984 (49 FR 46294), and also during the April 22-23, 1985, meeting of the Carcinogen Risk Assessment Guidelines Panel of the Science Advisory Board (SAB).

In order to respond to these issues the Agency modified the proposed guidelines in two stages. First, changes resulting from consideration of the public comments were made in a draft sent to the SAB review panel prior to their April meeting. Secondly, the guidelines were further modified in response to the panel's recommendations.

The Agency received 62 sets of comments during the public comment period, including 28 from corporations, 9 from professional or trade associations, and 4 from academic institutions. In general, the comments were favorable. The commentors welcomed the update of the 1976 guidelines and felt that the proposed guidelines of

REC 6171

1985 reflected some of the progress that has occurred in understanding the mechanisms of carcinogenesis. Many commentors, however, felt that additional changes were warranted.

The SAB concluded that the guidelines are "reasonably complete in their conceptual framework and are sound in their overall interpretation of the scientific issues" (Report by the SAB Carcinogenicity Guidelines Review Group, June 19, 1985). The SAB suggested various editorial changes and raised some issues regarding the content of the proposed guidelines, which are discussed below. Based on these recommendations, the Agency has modified the draft guidelines.

II. Office of Science and Technology Policy Report on Chemical Carcinogens

Many commentors requested that the final guidelines not be issued until after publication of the report of the Office of Technology and Science Policy (OSTP) on chemical carcinogens. They further requested that this report be incorporated into the final Guidelines for Carcinogen Risk Assessment.

The final OSTP report was published in 1985 (50 FR 10372). In its deliberations, the Agency reviewed the final OSTP report and feels that the Agency's guidelines are consistent with the principles established by the OSTP. In its review, the SAB agreed that the Agency guidelines are generally consistent with the OSTP report. To emphasize this consistency, the OSTP principles have been incorporated into the guidelines when controversial issues are discussed.

III. Inference Guidelines

Many commentors felt that the proposed guidelines did not provide a sufficient distinction between scientific fact and policy decisions. Others felt that EPA should not attempt to propose firm guidelines in the absence of scientific consensus. The SAB report also indicated the need to "distinguish recommendations based on scientific evidence from those based on science policy decisions."

The Agency agrees with the recommendation that policy, judgmental, or inferential decisions should be clearly identified. In its revision of the proposed guidelines, the Agency has included phrases (e.g., "the Agency takes the position that") to more clearly distinguish policy decisions.

The Agency also recognizes the need to establish procedures for action on important issues in the absence of complete scientific knowledge or consensus. This need was acknowledged in both the National Academy of Sciences book entitled *Risk Management in the Federal Government: Managing the Process* and the OSTP report on chemical carcinogens. As the NAS report states, "Risk assessment is an analytic process that is firmly based on scientific considerations, but it also requires judgments to be made when the available information is incomplete. These judgments inevitably draw on both scientific and policy considerations."

[51 FR 34002]

The judgments of the Agency have been based on current available scientific information and on the combined experience of Agency experts. These judgments, and the resulting guidance, rely on inference; however, the positions taken in these inference guidelines are felt to be reasonable and scientifically defensible. While all of the guidance is, to some degree, based on inference, the guidelines have attempted to distinguish those issues that depended more on judgment. In these cases, the Agency has stated a position but has also retained flexibility to accommodate new data or specific circumstances that demonstrate that the proposed position is inaccurate. The Agency recognizes that scientific opinion will be divided on these issues.

Knowledge about carcinogens and carcinogenesis is progressing at a rapid rate. While these guidelines are considered a best effort at the present time, the Agency has attempted to incorporate flexibility into the current guidelines and also recommends that the guidelines be revised as often as warranted by advances in the field.

IV. Evaluation of Benign Tumors

Several commentors discussed the appropriate interpretation of an increased incidence of benign tumors alone or with an increased incidence of malignant tumors as part of the evaluation of the carcinogenicity of an agent. Some comments were supportive of the position in the proposed guidelines, i.e., under certain circumstances, the incidence of benign and malignant tumors would be combined, and an increased incidence of benign tumors alone would be considered an indication, albeit limited, of carcinogenic potential. Other commentors raised concerns about the criteria that would be used to decide which tumors should be combined. Only a few commentors felt that benign tumors should never be considered in evaluating carcinogenic potential.

The Agency believes that current information supports the use of benign tumors. The guidelines have been modified to incorporate the language of the OSTP report, i.e., benign tumors will be combined with malignant tumors when scientifically defensible. This position allows flexibility in evaluating the data base for each agent. The guidelines have also been modified to indicate that, whenever benign and malignant tumors have been combined, and the agent is considered a candidate for quantitative risk extrapolation, the contribution of benign tumors to the estimation of risk will be indicated.

V. *Transplacental and Multigenerational Animal Bioassays*

REC 6172

As one of its two proposals for additions to the guidelines, the SAB recommended a discussion of transplacental and multigenerational animal bioassays for carcinogenicity.

The Agency agrees that such data, when available, can provide useful information in the evaluation of a chemical's potential carcinogenicity and has stated this in the final guidelines. The Agency has also revised the guidelines to indicate that such studies may provide additional information on the metabolic and pharmacokinetic properties of the chemical. More guidance on the specific use of these studies will be considered in future revisions of these guidelines.

VI. Maximum Tolerated Dose

The proposed guidelines discussed the implications of using a maximum tolerated dose (MTD) in bioassays for carcinogenicity. Many commentors requested that EPA define MTD. The tone of the comments suggested that the commentors were concerned about the uses and interpretations of high-dose testing.

The Agency recognizes that controversy currently surrounds these issues. The appropriate text from the OSTP report has been incorporated into the final guidelines which suggests that the consequences of high-dose testing be evaluated on a case-by-case basis.

VII. Mouse Liver Tumors

A large number of commentors expressed opinions about the assessment of bioassays in which the only increase in tumor incidence was liver tumors in the mouse. Many felt that mouse liver tumors were afforded too much credence, especially given existing information that indicates that they might arise by a different mechanism, e.g., tissue damage followed by regeneration. Others felt that mouse liver tumors were but one case of a high background incidence of one particular type of tumor and that all such tumors should be treated in the same fashion.

The Agency has reviewed these comments and the OSTP principle regarding this issue. The OSTP report does not reach conclusions as to the treatment of tumors with a high spontaneous background rate, but states, as is now included in the text of the guidelines, that these data require special consideration. Although questions have been raised regarding the validity of mouse liver tumors in general, the Agency feels that mouse liver tumors cannot be ignored as an indicator of carcinogenicity. Thus, the position in the proposed guidelines has not been changed: an increased incidence of only mouse liver tumors will be regarded as "sufficient" evidence of carcinogenicity if all other criteria, e.g., replication and malignancy, are met with the understanding that this classification could be changed to "limited" if warranted. The factors that may cause this re-evaluation are indicated in the guidelines.

VIII. Weight-of Evidence Catagories

The Agency was praised by both the public and the SAB for incorporating a weight-of-evidence scheme into its evaluation of carcinogenic risk. Certain specific aspects of the scheme, however, were criticized.

1. Several commentors noted that while the text of the proposed guidelines clearly states that EPA will use all available data in its categorization of the weight of the evidence that a chemical is a carcinogen, the classification system in Part A, section IV did not indicate the manner in which EPA will use information other than data from humans and long-term animal studies in assigning a weight-of-evidence classification.

The Agency has added a discussion to Part A, section IV.C. dealing with the characterization of overall evidence for human carcinogenicity. This discussion clarifies EPA's use of supportive information to adjust, as warranted, the designation that would have been made solely on the basis of human and long-term animal studies.

2. The Agency agrees with the SAB and those commentors who felt that a simple classification of the weight of evidence, e.g., a single letter or even a descriptive title, is inadequate to describe fully the weight of evidence for each individual chemical. The final guidelines propose that a paragraph summarizing the data should accompany the numerical estimate and weight-of-evidence classification whenever possible.

3. Several commentors objected to the descriptive title E (No Evidence of Carcinogenicity for Humans) because they felt the title would be confusing to people inexperienced with the classification system. The title for Group E, No Evidence of Carcinogenicity for Humans, was thought by these commentors to suggest the absence of data. This group, however, is intended to be reserved for agents for which there exists credible data demonstrating that the agent is not carcinogenic.

Based on these comments and further discussion, the Agency has changed the

[51 FR 34003]

title of Group E to "Evidence of Non-Carcinogenicity for Humans."

4. Several commentors felt that the title for Group C, Possible Human Carcinogen, was not sufficiently distinctive from Group B, Probable Human Carcinogen. Other commentors felt that those agents that minimally qualified for Group C would lack sufficient data for such a label.

The Agency recognizes that Group C covers a range of chemicals and has considered whether to subdivide Group C. The consensus of the Agency's

Carcinogen Risk Assessment Committee, however, is that the current groups, which are based on the IARC categories, are a reasonable stratification and should be retained at present. The structure of the groups will be reconsidered when the guidelines are reviewed in the future. The Agency also feels that the descriptive title it originally selected best conveys the meaning of the classification within the context of EPA's past and current activities.

5. Some commentors indicated a concern about the distinction between B1 and B2 on the basis of epidemiologic evidence only. This issue has been under discussion in the Agency and may be revised in future versions of the guidelines.

6. Comments were also received about the possibility of keeping the groups for animal and human data separate without reaching a combined classification. The Agency feels that a combined classification is useful; thus, the combined classification was retained in the final guidelines.

The SAB suggested that a table be added to Part A, section IV to indicate the manner in which human and animal data would be combined to obtain an overall weight-of-evidence category. The Agency realizes that a table that would present all permutations of potentially available data would be complex and possibly impossible to construct since numerous combinations of ancillary data (e.g., genetic toxicity, pharmacokinetics) could be used to raise or lower the weight-of-evidence classification. Nevertheless, the Agency decided to include a table to illustrate the most probable weight-of-evidence classification that would be assigned on the basis of standard animal and human data without consideration of the ancillary data. While it is hoped that this table will clarify the weight-of-evidence classifications, it is also important to recognize that an agent may be assigned to a final categorization different from the category which would appear appropriate from the table and still conform to the guidelines.

IX. Quantitative Estimates of Risk

The method for quantitative estimates of carcinogenic risk in the proposed guidelines received substantial comments from the public. Five issues were discussed by the Agency and have resulted in modifications of the guidelines.

1. The major criticism was the perception that EPA would use only one method for the extrapolation of carcinogenic risk and would, therefore, obtain one estimate of risk. Even commentors who concur with the procedure usually followed by EPA felt that some indication of the uncertainty of the risk estimate should be included with the risk estimate.

The Agency feels that the proposed guidelines were not intended to suggest that EPA would perform quantitative risk estimates in a rote or mechanical fashion. As indicated by the OSTP report and paraphrased in the proposed guidelines, no single mathematical procedure has been determined to be the most appropriate method for risk extrapolation. The final guidelines quote rather than paraphrase the OSTP principle. The guidelines have been revised to stress the importance of considering all available data in the risk assessment and now state, "The Agency will review each assessment as to the evidence on carcinogenic mechanisms and other biological or statistical evidence that indicates the suitability of a particular extrapolation model." Two issues are emphasized: First, the text now indicates the potential for pharmacokinetic information to contribute to the assessment of carcinogenic risk. Second, the final guidelines state that time-to-tumor risk extrapolation models may be used when longitudinal data on tumor development are available.

2. A number of commentors noted that the proposed guidelines did not indicate how the uncertainties of risk characterization would be presented. The Agency has revised the proposed guidelines to indicate that major assumptions, scientific judgments, and, to the extent possible, estimates of the uncertainties embodied in the risk assessment will be presented along with the estimation of risk.

3. The proposed guidelines stated that the appropriateness of quantifying risks for chemicals in Group C (Possible Human Carcinogen), specifically those agents that were on the boundary of Groups C and D (Not Classifiable as to Human Carcinogenicity), would be judged on a case-by-case basis. Some commentors felt that quantitative risk assessment should not be performed on any agent in Group C.

Group C includes a wide range of agents, including some for which there are positive results in one species in one good bioassay. Thus, the Agency feels that many agents in Group C will be suitable for quantitative risk assessment, but that judgments in this regard will be made on a case-by-case basis.

4. A few commentors felt that EPA intended to perform quantitative risk estimates on aggregate tumor incidence. While EPA will consider an increase in total aggregate tumors as suggestive of potential carcinogenicity, EPA does not generally intend to make quantitative estimates of carcinogenic risk based on total aggregate tumor incidence.

5. The proposed choice of body surface area as an interspecies scaling factor was criticized by several commentors who felt that body weight was also appropriate and that both methods should be used. The OSTP report recognizes that both scaling factors are in common use. The Agency feels that the choice of the body surface area scaling factor can be

REC 6174

justified from the data on effects of drugs in various species. Thus, EPA will continue to use this scaling factor unless data on a specific agent suggest that a different scaling factor is justified. The uncertainty engendered by choice of scaling factor will be included in the summary of uncertainties associated with the assessment of risk mentioned in point 1, above.

In the second of its two proposals for additions to the proposed guidelines, the SAB suggested that a sensitivity analysis be included in EPA's quantitative estimate of a chemical's carcinogenic potency. The Agency agrees that an analysis of the assumptions and uncertainties inherent in an assessment of carcinogenic risk must be accurately portrayed. Sections of the final guidelines that deal with this issue have been strengthened to reflect the concerns of the SAB and the Agency. In particular, the last paragraph of the guidelines states that "major assumptions, scientific judgments, and, to the extent possible, estimates of the uncertainties embodied in the assessment" should be presented in the summary characterizing the risk. Since the assumptions and uncertainties will vary for each assessment, the Agency feels that a formal requirement for a particular type of sensitivity analysis would be less useful than a case-by-case evaluation of the particular assumptions and uncertainties most significant for a particular risk assessment.

REC 6175

51 FR 34006

GUIDELINES FOR MUTAGENICITY RISK ASSESSMENT

SUMMARY: On September 24, 1986, the U.S. Environmental Protection Agency issued the following five guidelines for assessing the health risks of environmental pollutants.

Guidelines for Carcinogen Risk Assessment

Guidelines for Estimating Exposures

Guidelines for Mutagenicity Risk Assessment

Guidelines for the Health Assessment of Suspect Developmental Toxicants

Guidelines for the Health Risk Assessment of Chemical Mixtures

This section contains the Guidelines for Mutagenicity Risk Assessment.

The Guidelines for Mutagenicity Risk Assessment (hereafter "Guidelines") are intended to guide Agency analysis of mutagenicity data in line with the policies and procedures established in the statutes administered by the EPA. These Guidelines were developed as part of an interoffice guidelines development program under the auspices of the Office of Health and Environmental Assessment (OHEA) in the Agency's Office of Research and Development. They reflect Agency consideration of public and Science Advisory Board (SAB) comments on the Proposed Guidelines for Mutagenicity Risk Assessment published November 23, 1984 (49 FR 46314).

This publication completes the first round of risk assessment guidelines development. These Guidelines will be revised, and new guidelines will be developed, as appropriate.

FOR FURTHER INFORMATION CONTACT:

Dr. Lawrence R. Valcovic
Reproductive Effects Assessment Group
Office of Health and Environmental Assessment
(RD-689)
U. S. Environmental Protection Agency
401 M Street, S.W.
Washington, DC 20460
202-382-7303

SUPPLEMENTARY INFORMATION: In 1983, the National Academy of Sciences (NAS) published its book entitled *Risk Assessment in the Federal Government: Managing the Process.* In that book, the NAS recommended that Federal regulatory agencies establish "inference guidelines" to ensure consistency and technical quality in risk assessments and to ensure that the risk assessment process was maintained as a scientific effort separate from risk management. A task force within EPA accepted that recommendation and requested that Agency scientists begin to develop such guidelines.

General

The guidelines are products of a two-year Agencywide effort, which has included many scientists from the larger scientific community. These guidelines set forth principles and procedures to guide EPA scientists in the conduct of Agency risk assessments, and to inform Agency decision makers and the public about these procedures. In particular, the guidelines emphasize that risk assessments will be conducted on a case-by-case basis, giving full consideration to all relevant scientific information. This case-by-case approach means that Agency experts review the scientific information on each agent and use the most scientifically appropriate interpretation to assess risk. The guidelines also stress that this information will be fully presented in Agency risk assessment documents, and that Agency scientists will identify the strengths and weaknesses of each assessment by describing uncertainties, assumptions, and limitations, as well as the scientific basis and rationale for each assessment.

Finally, the guidelines are formulated in part to bridge gaps in risk assessment methodology and data. By identifying these gaps and the importance of the missing information to the risk assessment process, EPA wishes to encourage research and analysis that will lead to new risk assessment methods and data.

Guidelines for Mutagenicity Risk Assessment

Work on the Guidelines for Mutagenicity Risk Assessment began in January 1984. Draft guidelines were developed by Agency work groups composed of expert scientists from throughout the Agency. The drafts were peer-reviewed by expert scientists in the field of genetic toxicology from universities, environmental groups, industry, labor, and other governmental agencies. They were then proposed for public comment in the *FEDERAL REGISTER* (49 FR 46314). On November 9, 1984, the Administrator directed that Agency offices use the proposed guidelines in performing risk assessments until final guidelines become available.

REC 6176

After the close of the public comment period, Agency staff prepared summaries of the comments, analyses of the major issues presented by the commentors, and preliminary Agency responses to those comments. These analyses were presented to review panels of the SAB on March 4 and April 22-23, 1985, and to the Executive Committee of the SAB on April 25-26, 1985. The SAB meetings were announced in the *FEDERAL REGISTER* as follows: February 12, 1985 (50 FR 5811) and April 4, 1985 (50 FR 13420 and 13421).

In a letter to the Administrator dated June 19, 1985, the Executive Committee generally concurred on all five of the guidelines, but recommended certain revisions, and requested that any revised guidelines be submitted to the appropriate SAB review panel chairman for review and concurrence on behalf of the Executive Committee. As described in the responses to comments (see Part B: Response to the Public and Science Advisory Board Comments), each guidelines document was revised, where appropriate, consistent with the SAB recommendations, and revised draft guidelines were submitted to the panel chairmen. Revised draft Guidelines for Mutagenicity Risk Assessment were concurred on in a letter dated September 24, 1985. Copies of the letters are available at the Public Information Reference Unit, EPA Headquarters Library, as indicated elsewhere in this section.

Following this Preamble are two parts: Part A contains the Guidelines and Part B, the Response to the Public and Science Advisory Board Comments (a summary of the major public comments, SAB comments, and Agency responses to those comments).

The Agency is continuing to study the risk assessment issues raised in the guidelines and will revise these Guidelines in line with new information as appropriate.

References, supporting documents, and comments received on the proposed guidelines, as well as copies of the final guidelines, are available for inspection and copying at the Public Information Reference Unit (202-382-5926), EPA Headquarters Library, 401 M Street, S.W., Washington, DC, between the hours of 8:00 a.m. and 4:30 p.m.

I certify that these Guidelines are not major rules as defined by Executive Order 12291, because they are nonbinding policy statements and have no direct effect on the regulated community. Therefore, they will have no effect on costs or prices, and they will have no other significant adverse effects on the economy. These Guidelines were reviewed by the Office of Management

[51 FR 34007]

and Budget under Executive Order 12291.

August 22, 1986

Lee M. Thomas,

Administrator

CONTENTS

Part A: Guidelines for Mutagenicity Risk Assessment

I. Introduction

A. Concepts Relating to Heritable Mutagenic Risk
B. Test Systems

II. Qualitative Assessment (Hazard Identification)

A. Mutagenic Activity
B. Chemical Interactions in the Mammalian Gonad
C. Weight-of-Evidence Determination

III. Quantitative Assessment

A. Dose Response
B. Exposure Assessment
C. Risk Characterization

IV. References

Part B: Response to Public and Science Advisory Board Comments

Part A: Guidelines for Mutagenicity Risk Assessment

I. Introduction

This section describes the procedures that the U.S. Environmental Protection Agency will follow in evaluating the potential genetic risk associated with human exposure to chemicals. The central purpose of the health risk assessment is to provide a judgment concerning the weight of evidence that an agent is a potential human mutagen, capable of inducing transmitted genetic changes, and, if so, to provide a judgment on how great an impact this agent is likely to have on public health. Regulatory decision making involves two components: risk assessment and risk management. Risk assessment estimates the potential adverse health consequences of exposure to toxic chemicals; risk management combines the risk assessment with the directives of the enabling regulatory legislation--together with socioeconomic, technical, political, and other considerations--to reach a decision as to whether or how much to control future exposure to the chemicals. The issue of risk management will not be dealt with in these Guidelines.

Risk assessment is comprised of the following components: hazard identification, dose-response assessment, exposure assessment, and risk characterization (1). Hazard identification is the qualitative risk assessment, dealing with the inherent toxicity of a chemical substance. The qualitative mutagenicity assessment answers the question of how likely an agent is to be a human mutagen. The three remaining components

REC 6177

comprise quantitative risk assessment, which provides a numerical estimate of the public health consequences of exposure to an agent. The quantitative mutagenicity risk assessment deals with the question of how much mutational damage is likely to be produced by exposure to a given agent under particular exposure scenarios.

In a dose-response assessment, the relationship between the dose of a chemical and the probability of induction of an adverse effect is defined. The component generally entails an extrapolation from the high doses administered to experimental animals or noted in some epidemiologic studies to the low exposure levels expected from human contact with the chemical in the environment.

The exposure assessment identifies populations exposed to toxic chemicals, describes their composition and size, and presents the types, magnitudes, frequencies, and durations of exposure to the chemicals. This component is developed independently of the other components of the mutagenicity assessment and is addressed in separate Agency guidelines (2).

In risk characterization, the outputs of the exposure assessment and the dose-response assessment are combined to estimate quantitatively the mutation risk, which is expressed as either estimated increase of genetic disease per generation or per lifetime, or the fractional increase in the assumed background mutation rate of humans. In each step of the assessment, the strengths and weaknesses of the major assumptions need to be presented, and the nature and magnitude of uncertainties need to be characterized.

The procedures set forth in these Guidelines will ensure consistency in the Agency's scientific risk assessments for mutagenic effects. The necessity for a consistent approach to the evaluation of mutagenic risk from chemical substances arises from the authority conferred upon the Agency by a number of statutes to regulate potential mutagens. As appropriate, these Guidelines will apply to statutes administered by the Agency, including the Federal Insecticide, Fungicide, and Rodenticide Act; the Toxic Substances Control Act; the Clean Air Act; the Federal Water Pollution Control Act; the Safe Drinking Water Act; the Resource Conservation and Recovery Act; and the Comprehensive Environmental Response, Compensation, and Liability Act. Because each statute is administered by separate offices, a consistent Agency-wide approach for performing risk assessments is desirable.

The mutagenicity risk assessments prepared pursuant to these Guidelines will be utilized with the requirements and constraints of the applicable statutes to arrive at regulatory decisions concerning mutagenicity. The standards of the applicable statutes and regulations may dictate that additional considerations (e.g., the economic and social benefits associated with use of the chemical substance) will come into play in reaching appropriate regulatory decisions.

The Agency has not attempted to provide in the Guidelines a detailed discussion of the mechanisms of mutagenicity or of the various test systems that are currently in use to detect mutagenic potential. Background information on mutagenesis and mutagenicity test systems is available in "Identifying and Estimating the Genetic Impact of Chemical Mutagens", National Academy of Sciences (NAS) Committee on Chemical Environmental Mutagens (3), as well as in other recent publications (4, 5).

The Agency is concerned with the risk associated with both germ-cell mutations and somatic-cell mutations. Mutations carried in germ cells may be inherited by future generations and may contribute to genetic disease, whereas mutations occurring in somatic cells may be implicated in the etiology of several disease states, including cancer. These Guidelines, however, are only concerned with genetic damage as it relates to germ-cell mutations. The use of mutagenicity test results in the assessment of carcinogenic risk is described in the Guidelines for Carcinogen Risk Assessment (6).

As a result of the progress in the control of infectious diseases, increases in average human life span, and better procedures for identifying genetic disorders, a considerable heritable genetic disease burden has been recognized in the human population. It is estimated that at least 10% of all human disease is related to specific genetic abnormalities, such as abnormal composition, arrangement, or dosage of genes and chromosomes (3, 7, 8). Such genetic abnormalities can lead to structural or functional health impairments. These conditions may be expressed in *utero*; at the time of birth; or during infancy, childhood, adolescence, or adult life; they may be chronic or acute in nature. As a result, they often have a severe impact upon the affected individuals and their families in terms of physical and mental

[51 FR 34008]

suffering and economic losses, and upon society in general, which often becomes responsible for institutional care of severely affected individuals. Some examples of genetic disorders are Down and Klinefelter syndromes, cystic fibrosis, hemophilia, sickle-cell anemia, and achondroplastic dwarfism. Other commonly recognized conditions that are likely to have a genetic component include hypercholesterolemia, hypertension, pyloric stenosis, glaucoma, allergies, several types of cancer, and mental retardation. These disorders are only a few of the thousands that are at least partially genetically determined (9).

Estimation of the fraction of human genetic disorders that result from new mutations is difficult, although in certain specific cases insights are available (10). It is clear that recurring mutation is important in determining the incidence of certain genetic disorders, such as some chromosomal aberration syndromes (e.g., Down syndrome) and rare dominant and X-linked recessive diseases (e.g., achondroplasia and hemophilia A). For other single-factor disorders (e.g., sickle-cell anemia) and certain multifactorial disorders (e.g., pyloric stenosis), the contribution of new mutations to disease frequency is probably small. However, it is generally recognized that most newly-arising mutations that are phenotypically expressed are in some ways deleterious to the organism receiving them (3, 7, 8). Adverse effects may be manifested at the biochemical, cellular, or physiological levels of organization. Although mutations are the building blocks for further evolutionary change of species, it is believed that increases in the mutation rate could lead to an increased frequency of expressed genetic disorders in the first and subsequent generations.

Life in our technological society results in exposure to many natural and synthetic chemicals. Some have been shown to have mutagenic activity in mammalian and submammalian test systems, and thus may have the potential to increase genetic damage in the human population. Chemicals exhibiting mutagenic activity in various test systems have been found distributed among foods, tobacco, drugs, food additives, cosmetics, industrial compounds, pesticides, and consumer products. The extent to which exposure to natural and synthetic environmental agents may have increased the frequency of genetic disorders in the present human population and contributed to the mutational "load" that will be transmitted to future generations is unknown at this time. However, for the reasons cited above, it seems prudent to limit exposures to potential human mutagens.

A. Concepts Relating to Heritable Mutagenic Risk

These Guidelines are concerned with chemical substances or mixtures of substances that can induce alterations in the genome of either somatic or germinal cells. The mutagenicity of physical agents (e.g., radiation) is not addressed here. There are several mutagenic end points of concern to the Agency. These include point mutations (i.e., submicroscopic changes in the base sequence of DNA) and structural or numerical chromosome aberrations. Structural aberrations include deficiencies, duplications, insertions, inversions, and translocations, whereas numerical aberrations are gains or losses of whole chromosomes (e.g., trisomy, monosomy) or sets of chromosomes (haploidy, polyploidy).

Certain mutagens, such as alkylating agents, can directly induce alterations in the DNA. Mutagenic effects may also come about through mechanisms other than chemical alterations of DNA. Among these are interference with normal DNA synthesis (as caused by some metal mutagens), interference with DNA repair, abnormal DNA methylation, abnormal nuclear division processes, or lesions in non-DNA targets (e.g., protamine, tubulin).

Evidence that an agent induces heritable mutations in human beings could be derived from epidemiologic data indicating a strong association between chemical exposure and heritable effects. It is difficult to obtain such data because any specific mutation is a rare event, and only a small fraction of the estimated thousands of human genes and conditions are currently useful as markers in estimating mutation rates. Human genetic variability, small numbers of offspring per individual, and long generation times further complicate such studies. In addition, only disorders caused by dominant mutations, some sex-linked recessive mutations, and certain chromosome aberrations can be detected in the first generation after their occurrence. Conditions caused by autosomal recessive disorders (which appear to occur more frequently than dominant disorders) or by polygenic traits may go unrecognized for many generations. Therefore, in the absence of human epidemiological data, it is appropriate to rely on data from experimental animal systems as long as the limitations of using surrogate and model systems are clearly stated.

Despite species differences in metabolism, DNA repair, and other physiological processes affecting chemical mutagenesis, the virtual universality of DNA as the genetic material and of the genetic code provides a rationale for using various nonhuman test systems to predict the intrinsic mutagenicity of test chemicals. Additional support for the use of nonhuman systems is provided by the observation that chemicals causing genetic effects in one species or test system frequently cause similar effects in other species or systems. Evidence also exists that chemicals can induce genetic damage in somatic cells of exposed humans. For example, high doses of mutagenic chemotherapeutic agents have been shown to cause chromosomal abnormalities (11), sister chromatic exchange (11), and, quite probably, point mutations in human lymphocytes exposed *in vivo* (12). While these results are not in germ cells, they do indicate that it is possible to induce mutagenic events in human cells *in vivo*. Furthermore, a wide variety of different types of mutations have been observed in humans including numerical chromosome aberrations, translocations, base-pair substitutions, and frameshift mutations. Although the cause of these mutations is uncertain, it is clear from these observations that the human germ-cell DNA is subject to the same types of

REC 6179

mutational events that are observed in other species and test systems.

Certain test systems offer notable advantages: cost; anatomical, histological, and/or metabolic similarities to humans; suitability for handling large numbers of test organisms; a large data base; or a basis for characterizing genetic events.

B. Test Systems

Many test systems are currently available that can contribute information about the mutagenic potential of a test compound with respect to various genetic end points. These tests have recently been evaluated through the EPA Gene-Tox Programs and the results of Phase I have been published (5). The Agency's Office of Pesticides and Toxic Substances has published various testing guidelines for the detection of mutagenic effects (13, 14).

Test systems for detecting point mutations include those in bacteria, eukaryotic microorganisms, higher plants, insects, mammalian somatic cells in culture, and germinal cells of intact mammals. Data from heritable, mammalian germ-cell tests provide the best experimental evidence that a

[51 FR 34009]

chemical is a potential human germ-cell mutagen since these tests require that mutations occur in germinal cells and that they are transmitted to the next generation. To date, the most extensively used test for the induction of heritable mutation is the mouse specific-locus test which measures the induction of recessive mutations at seven loci concerned with coat color and ear morphology. While this test has a large data base compared to other germ-cell assays, it is difficult to extrapolate results to humans since recessive mutations may occur more frequently than dominants, and the impact of recessive mutations is not seen for many generations. Information on frequencies of induced mutations resulting in health disorders in the first generation may be obtained from mouse systems designed to detect skeletal abnormalities, cataracts, or general morphological abnormalities. However, these assays have been used to a relatively limited extent, and there is a need for additional studies with known, chemical germ-cell mutagens to further characterize the test systems. Because large numbers of offspring must usually be generated in the systems described above, it is not expected that many chemicals will be tested using these systems. To obtain data on a large number of environmental chemicals, it will be necessary to rely on other tests to identify and characterize hazards from gene mutations.

Test systems for detecting structural chromosome aberrations have been developed in a variety of organisms including higher plants, insects, fish, birds, and several mammalian species. Many of these assays can be performed *in vitro* or *in vivo*, and in either germ or somatic cells. Procedures available for detecting structural chromosome aberrations in mammalian germ cells include measurement of heritable translocations or dominant lethality, as well as direct cytogenetic analyses of germ cells and early embryos in rodents.

Some chemicals may cause numerical chromosome changes (i.e., aneuploidy) as their sole mutagenic effect. These agents may not be detected as mutagens if evaluated only in tests for DNA damage, gene mutations, or chromosome breakage and rearrangement. Therefore, it is important to consider tests for changes in chromosome number in the total assessment of mutagenic hazards. Although tests for the detection of variation in the chromosome number are still at an early stage of development, systems exist in such diverse organisms as fungi, Drosophila, mammalian cells in culture, and intact mammals (e.g., mouse X-chromosome loss assay). Aneuploidy can arise from disturbances in a number of events affecting the meiotic process (15, 16). Although the mechanisms by which nondisjunction occurs are not well understood, mitotic structures other than DNA may be the target molecules for at least some mechanisms of induced nondisjunction.

Other end points that provide information bearing on the mutagenicity of a chemical can be detected by a variety of test systems. Such tests measure DNA damage in eukaryotic or prokaryotic cells, unscheduled DNA synthesis in mammalian somatic and germ cells, mitotic recombination and gene conversion in yeast, and sister-chromatid exchange in mammalian somatic and germ cells. Results in these assays are useful because the induction of these end points often correlates positively with the potential of a chemical to induce mutations.

In general, for all three end points (i.e., point mutations and numerical and structural aberrations), the Agency will place greater weight on tests conducted in germ cells than in somatic cells, on tests performed *in vivo* rather than *in vitro*, in eukaryotes rather than prokaryotes, and in mammalian species rather than in submammalian species. Formal numerical weighting systems have been developed (17); however, the Agency has concluded that these do not readily accommodate such variables as dose range, route of exposure, and magnitude of response.

The Agency anticipates that from time to time somatic cell data from chemically exposed human beings will be available (e.g., cytogenetic markers in peripheral lymphocytes). When possible, the Agency will use such data in conjunction with somatic and germ cell comparisons from *in vivo* mammalian experimental systems as a component in performing risk assessments.

REC 6180

The test systems mentioned previously are not the only ones that will provide evidence of mutagenicity or related DNA effects. These systems are enumerated merely to demonstrate the breadth of the available techniques for characterizing mutagenic hazards, and to indicate the types of data that the Agency will consider in its evaluation of mutagenic potential of a chemical agent. Most systems possess certain limitations that must be taken into account. The selection and performance of appropriate tests for evaluating the risks associated with human exposure to any suspected mutagen will depend on sound scientific judgment and experience, and may necessitate consultation with geneticists familiar with the sensitivity and experimental design of the test system in question. In view of the rapid advances in test methodology, the Agency expects that both the number and quality of the tools for assessing genetic risk to human beings will increase with time. The Agency will closely monitor developments in mutagenicity evaluation and will refine its risk assessment scheme as better test systems become available.

II. Qualitative Assessment (Hazard Identification)

The assessment of potential human germ-cell mutagenic risk is a multistep process. The first step is an analysis of the evidence bearing on a chemical's ability to induce mutagenic events, while the second step involves an analysis of its ability to produce these events in the mammalian gonad. All relevant information is then integrated into a weight-of-evidence scheme which presents the strength of the information bearing on the chemical's potential ability to produce mutations in human germ cells. For chemicals demonstrating this potential, one may decide to proceed with an evaluation of the quantitative consequences of mutation following expected human exposure.

For hazard identification, it is clearly desirable to have data from mammalian germ-cell tests, such as the mouse specific-locus test for point mutations and the heritable translocation or germ-cell cytogenetic tests for structural chromosome aberrations. It is recognized, however, that in most instances such data will not be available, and alternative means of evaluation will be required. In such cases the Agency will evaluate the evidence bearing on the agent's mutagenic activity and the agent's ability to interact with or affect the mammalian gonadal target. When evidence exists that an agent possesses both these attributes, it is reasonable to deduce that the agent is a potential human germ-cell mutagen.

While mammalian germ-cell assays are presently primarily performed on male animals, a chemical cannot be considered to be a non-mutagen for mammalian germ cells unless it is shown to be negative in both sexes. Furthermore, because most mammalian germ-cell assays are performed in mice, it is noteworthy that the data from ionizing radiation suggest that the female mouse immature oocyte may not be an appropriate surrogate for the same stage in the human female in mutagenicity testing. However,

[51 FR 34010]

mutagenicity data on the maturing and mature oocyte of the mouse may provide a useful model for human risk assessment.

A. Mutagenic Activity

In evaluating chemicals for mutagenic activity, a number of factors will be considered: 1) genetic end points (e.g., gene mutations, structural or numerical chromosomal aberrations) detected by the test systems, 2) sensitivity and predictive value of the test systems for various classes of chemical compounds, 3) number of different test systems used for detecting each genetic end point, 4) consistency of the results obtained in different test systems and different species, 5) aspects of the dose-response relationship, and 6) whether the tests are conducted in accordance with appropriate test protocols agreed upon by experts in the field.

B. Chemical Interactions in the Mammalian Gonad

Evidence for chemical interaction in the mammalian gonad spans a range of different types of findings. Each chemical under consideration needs to be extensively reviewed since this type of evidence may be part of testing exclusive of mutagenicity per se (e.g., reproduction, metabolism, and mechanistic investigations). Although it is not possible to classify clearly each type of information that may be available on a chemical, two possible groups are illustrated.

1. *Sufficient evidence* of chemical interaction is given by the demonstration that an agent interacts with germ-cell DNA or other chromatin constituents, or that it induces such end points as unscheduled DNA synthesis, sister-chromatid exchange, or chromosomal aberrations in germinal cells.

2. *Suggestive evidence* will include the finding of adverse gonadal effects such as sperm abnormalities following acute, subchronic, or chronic toxicity testing, or findings of adverse reproductive effects such as decreased fertility, which are consistent with the chemical's interaction with germ cells.

C. Weight-of-Evidence Determination

The evidence for a chemical's ability to produce mutations and to interact with the germinal target are integrated into a weight-of-evidence judgment that the agent may pose a hazard as a potential human germ-cell mutagen. All information bearing on the subject, whether indicative of potential concern or not, must be evaluated. Whatever

REC 6181

evidence may exist from humans must also be factored into the assessment.

All germ-cell stages are important in evaluating chemicals because some chemicals have been shown to be positive in postgonial stages but not in gonia (18). When human exposures occur, effects on postgonial stages should be weighted by the relative sensitivity and the duration of the stages. Chemicals may show positive effects for some end points and in some test systems, but negative responses in others. Each review must take into account the limitations in the testing and in the types of responses that may exist.

To provide guidance as to the categorization of the weight of evidence, a classification scheme is presented to illustrate, in a simplified sense, the strength of the information bearing on the potential for human germ-cell mutagenicity. It is not possible to illustrate all potential combinations of evidence, and considerable judgment must be exercised in reaching conclusions. In addition, certain responses in tests that do not measure direct mutagenic end points (e.g., SCE induction in mammalian germ cells) may provide a basis for raising the weight of evidence from one category to another. The categories are presented in decreasing order of strength of evidence.

1. Positive data derived from human germ-cell mutagenicity studies, when available, will constitute the highest level of evidence for human mutagenicity.

2. Valid positive results from studies on heritable mutational events (of any kind) in mammalian germ cells.

3. Valid positive results from mammalian germ-cell chromosome aberration studies that do not include an intergeneration test.

4. Sufficient evidence for a chemical's interaction with mammalian germ cells, together with valid positive mutagenicity test results from two assay systems, at least one of which is mammalian (*in vitro* or *in vivo*). The positive results may both be for gene mutations or both for chromosome aberrations; if one is for gene mutations and the other for chromosome aberrations, both must be from mammalian systems.

5. Suggestive evidence for a chemical's interaction with mammalian germ cells, together with valid positive mutagenicity evidence from two assay systems as described under 4, above. Alternatively, positive mutagenicity evidence of less strength than defined under 4, above, when combined with sufficient evidence for a chemical's interaction with mammalian germ cells.

6. Positive mutagenicity test results of less strength than defined under 4, combined with suggestive evidence for a chemical's interaction with mammalian germ cells.

7. Although definitive proof of non-mutagenicity is not possible, a chemical could be classified operationally as a non-mutagen for human germ cells, if it gives valid negative test results for all end points of concern.

8. Inadequate evidence bearing on either mutagenicity or chemical interaction with mammalian germ cells.

III. Quantitative Assessment

The preceding section addressed primarily the processes of hazard identification, i.e., the determination of whether a substance is a potential germ-cell mutagen. Often, no further data will be available, and judgments will need to be based mainly on qualitative criteria. Quantitative risk assessment is a two-step process: determination of the heritable effect per unit of exposure (dose-response) and the relationship between mutation rate and disease incidence. The procedures that are presently accepted for the estimation of an increase in disease resulting from increased mutation have been described (3, 7, 8). Dose-response information is combined with anticipated levels and patterns of human exposure in order to derive a quantitative assessment (risk characterization).

A. Dose Response

Dose-response assessments can presently only be performed using data from *in vivo*, heritable mammalian germ-cell tests, until such time as other approaches can be demonstrated to have equivalent predictability. The morphological specific-locus and biochemical specific-locus assays can provide data on the frequencies of recessive mutations induced by different chemical exposure levels, and similar data can be obtained for heritable chromosomal damage using the heritable translocation test. Data on the frequencies of induced mutations resulting in health disorders in the first generation may be obtained from mouse systems designed to detect skeletal abnormalities, cataracts, or general morphological abnormalities. Assays that directly detect heritable health effects in the first generation may provide the best basis for predicting human health risks that result from mutagen exposure. The experimental data on induced mutation frequency are usually obtained at exposure levels much higher than those that will be experienced by human beings. An assessment of human risk is obtained by extrapolating the induced mutation frequency or the observed phenotypic

[51 FR 34011]

effect downward to the approximate level of anticipated human exposure. In performing these extrapolations, the Agency will place greater weight on data derived from exposures and exposure rates that most closely simulate those experienced by the human population under study.

The Agency will strive to use the most appropriate extrapolation models for risk analysis

and will be guided by the available data and mechanistic considerations in this selection. However, it is anticipated that for tests involving germ cells of whole mammals, few dose points will be available to define dose-response functions. The Agency is aware that for at least one chemical that has been tested for mutations in mammalian germ cells, there exist departures from linearity at low exposure and exposure rates in a fashion similar to that seen for ionizing radiation that has a low linear energy transfer (19). The Agency will consider all relevant models for gene and chromosomal mutations in performing low-dose extrapolations and will choose the most appropriate model. This choice will be consistent both with the experimental data available and with current knowledge of relevant mutational mechanisms.

An experimental approach for quantitative assessment of genetic risk, which may have utility in the future, uses molecular dosimetry data from intact mammals in conjunction with mutagenicity and dosimetry data from other validated test systems (20). The intact mammal is used primarily for relating the exposure level for a given route of administration of a chemical to germ-cell dose, i.e., the level of mutagen-DNA interactions. This information is then used in conjunction with results obtained from mutagenicity test systems in which the relationship between the induction of mutations and chemical interactions with DNA can be derived. With mutagen-DNA interactions as the common denominator, a relationship can be constructed between mammalian exposure and the induced mutation frequency. The amount of DNA binding induced by a particular chemical agent may often be determined at levels of anticipated human exposure.

For some mutagenic events, DNA may not necessarily be the critical target. Interaction of chemicals with other macromolecules, such as tubulin, which is involved in the separation of chromosomes during nuclear division, can lead to chromosomal nondisjunction. At present, general approaches are not available for dose-response assessments for these types of mutations. Ongoing research should provide the means to make future assessments on chemicals causing aneuploidy.

B. Exposure Asssessment

The exposure assessment identifies populations exposed to toxic chemicals; describes their composition and size; and presents the types, magnitudes, frequencies, and durations of exposure to the chemicals. This component is developed independently of the other components of the mutagenicity assessment (2).

C. Risk Characterization

In performing mutagenicity risk assessments, it is important to consider each genetic end point individually. For example, although certain chemical substances that interact with DNA may cause both point and chromosomal mutations, it is expected that the ratio of these events may differ among chemicals and between doses for a given chemical. Furthermore, transmissible chromosomal aberrations are recoverable with higher frequencies from meiotic and postmeiotic germ-cell stages, which have a brief life span, than in spermatogonial stem cells, which can accumulate genetic damage throughout the reproductive life of an individual. For these reasons, when data are available, the Agency, to the best extent possible, will assess risks associated with all genetic end points.

Any risk assessment should clearly delineate the strengths and weaknesses of the data, the assumptions made, the uncertainties in the methodology, and the rationale used in reaching the conclusions, e.g., similar or different routes of exposure and metabolic differences between humans and test animals. When possible, quantitative risk assessments should be expressed in terms of the estimated increase of genetic disease per generation, or the fractional increase in the assumed background spontaneous mutation rate of humans (7). Examples of quantitative risk estimates have been published (7, 8, 21); these examples may be of use in performing quantitative risk assessments for mutagens.

IV. References

1. Committee on the Institutional Means for Assessment of the Risks to Public Health. 1983. Risk assessment in the Federal government: managing the process. Washington, DC: National Academy Press.

2. U.S. Environmental Protection Agency. 1986, Sept. 24. Guidelines for estimating exposures. Federal Register 51(185): 34042-34054.

3. Committee on Chemical Environmental Mutagens, National Academy of Sciences. 1982. Identifying and estimating the genetic impact of chemical mutagens. Washington, DC: National Academy Press.

4. Committee I Final Report. 1983. Screening strategy for chemicals that are potential germ-cell mutagens in mammals. Mutat. Res. 114:117-177.

5. A complete reference of all Gene-Tox publications is available from the TSCA Industry Assistance Office (TS-794), Office of Toxic Substances, U.S. Environmental Protection Agency, Washington, DC 20460.

6. U.S. Environmental Protection Agency. 1986, Sept. 24. Guidelines for carcinogen risk assessment. Federal Register 51(185):33992-34003.

7. National Research Council, Advisory Committee on the Biological Effects of Ionizing Radiations. 1972. The effects on populations of exposure to low levels of ionizing radiation. (BEIR I) Washington, DC: National Academy of Sciences.

National Research Council, Advisory Committee on the Biological Effects of Ionizing Radiations. 1977. Considerations of health benefit-cost analysis for activities involving ionizing radiation exposure and alternatives. (BEIR II) Washington, DC: National Academy of Sciences.

National Research Council, Advisory Committee on the Biological Effects of Ionizing Radiations. 1980. The effects on populations of exposure to low levels of ionizing radiation. (BEIR III) Washington, DC: National Academy of Sciences.

8. United Nations General Assembly. 1958. Report of the United Nations Scientific Committee on the Effects of Atomic

REC 6183

Radiation. Official records of the General Assembly. Thirteenth Session. Supplement No. 17 (A/3838). New York: United Nations.

United Nations General Assembly. 1962. Report of the United Nations Scientific Committee on the Effects of Atomic Radiation. Official records of the General Assembly. Seventeenth Session. Supplement No. 16 (A/5216). New York: United Nations.

United Nations General Assembly. 1966. Report of the United Nations Scientific Committee on the Effects of Atomic Radiation. Official records of the General Assembly. Twenty-first Session. Supplement No. 14 (A/6314). New York: United Nations.

United Nations General Assembly. 1969. Report of the United Nations Scientific Committee on the effects of Atomic Radiation. Official records of the General Assembly. Twenty-fourth Session. Supplement No. 13 (A/7613). New York: United Nations.

United Nations General Assembly. 1972. Report of the United Nations Scientific Committee on the Effects of Atomic Radiation. Ionizing radiation: levels and effects. Vol. II. Official records of the General Assembly. Twenty-seventh Session. Supplement No. 25 (A/8725). New York: United Nations.

United Nations General Assembly. 1982. Report of the United Nations Scientific Committee on the Effects of Atomic Radiation. Sources and biological effects. New York: United Nations.

9. McKusick, V.A. 1983. Mendelian inheritance in man: catalogs of autosomal dominant, autosomal recessive and x-linked

[51 FR 34012]

phenotypes. Baltimore, MD: Johns Hopkins University Press.

10. Crow, J.F., and C. Denniston. 1981. The mutation component of genetic damage. Science 212:888-893.

11. Musilova, J., K. Michalova, and J. Urban. 1979. Sister chromatid exchanges and chromosomal breakage in patients treated with cytostatics. Mutat. Res. 67:289-294.

12. Strauss, G.H., and R.J. Albertini. 1979. Enumeration of 6- thioguanine-resistant peripheral blood lymphocytes in man as a potential test for somatic cell mutations arising *in vivo*. Mutat. Res. 61:353-379.

13. U.S. Environmental Protection Agency. 1983. OTS health effects test guidelines. EPA 560/6/82-001. Natl. Tech. Inform. Serv. PB82-232984.

14. U.S. Environmental Protection Agency. November 24, 1982. Pesticides registration; proposed data requirements. Federal Register 47:53192-53203.

15. Parker, D.R., and J.H. Williamson. 1974. Some radiation effects on segregation in Drosophila. Genetics 78:163-171.

16. Grell, R.F. 1979. Origin of meiotic nondisjunction in Drosophila females. Environ. Health Perspect. 31:33-39.

17. Russell, L.B., C.S. Aaron, F. de Serres, W.M. Generoso, K.L. Kannan, M. Shelby, J. Springer, and P. Voytek. 1984. Evaluation of existing mutagenicity bioassays for purposes of genetic risk assessment. Mutat. Res. 134:143-157.

18. Russell, L.B., R.B. Cumming, and P.R. Hunsicker. 1984. Specific locus mutation rates in the mouse following inhalation of ethylene oxide, and application of results to estimation of genetic risk. Mutat. Res. 129:381-388.

19. Russell, W.L., P.R. Hunsicker, D.A. Carpenter, C.V. Cornett, and G.M. Guin. 1982. Effect of dose fractionation on the ethylnitrosourea induction of specific-locus mutations in mouse spermatogonia. Proc. Natl. Acad. Sci. 79:3592-3593.

20. Lee, W.R. 1979. Dosimetry of chemical mutagens in eukaryote germ- cells. In. A. Hollaender and F.J. de Serres, eds. Chemical mutagens: principles and methods for their detection. Vol. 5, New York: Plenum Press, pp. 177-202.

21. Ehling, U.H., and A. Neuhauser. 1979. Procarbazine-induced specific-locus mutations in male mice. Mutat. Res. 59:245-256.

Part B: Response to Public and Science Advisory Board Comments

This section summarizes some of the issues raised in public and Science Advisory Board (SAB) comments on the Proposed Guidelines for Mutagenicity Risk Assessment published on November 23, 1984 (49 FR 46314). Unlike the other guidelines published on the same date, the Proposed Guidelines for Mutagenicity Risk Assessment contained a detailed section dealing with public comments received in response to the original proposal of 1980 (45 FR 74984). Several of the comments received in response to the proposed guidelines of 1984 were similar to those received in response to the proposed guidelines of 1980. Those comments are not addressed here because the position of the Agency on those issues has been presented in the responses included with the 1984 proposed guidelines (49 FR 46315- 46316).

A total of 44 comments were received in response to the proposed guidelines of 1984: 21 from manufacturers of regulated products, 10 from associations, 9 from government agencies, 2 from educational institutions, 1 from an individual, and 1 from a private consulting firm. The proposed guidelines and the public comments received were transmitted to the Agency's SAB prior to its public review of the proposed guidelines held April 22-23, 1985. The majority of the comments were favorable and expressed the opinion that the proposed guidelines accurately represent the existing state of knowledge in the field of mutagenesis. Several commentors offered suggestions for further clarification of particular issues, and many of the suggestions have been incorporated.

The two areas that received the most substantive comments were the sections concerning Weight-of-Evidence Determination and Dose Response. The comments on the proposed weight-of-evidence scheme ranged from suggestions for the elimination of a formal scheme to the expansion of the scheme to cover more potential data configurations. The SAB recommended an eight-level rank ordering scheme to define levels of evidence relating to human germ-cell mutagenicity. The Agency has incorporated this scheme into the Guidelines. Some commentors and the SAB suggested that the molecular dosimetry approach to dose-response data be presented as a concept that may be useful in the future rather than being available for use now. The Agency agrees that the data base at the present time is too sparse to recommend a general application of this approach to a wide range of chemical classes, and the Guidelines have been changed to reflect this. It should be noted, however, that the Agency strongly supports the development of molecular dosimetry methodologies as they relate to both an understanding of dose-response relationships and to methods for studying human exposure. A number of comments suggesting clarifications and editorial changes have been incorporated and the references have been expanded.

REC 6184

51 FR 34014

GUIDELINES FOR THE HEALTH RISK ASSESSMENT OF CHEMICAL MIXTURES

SUMMARY: On September 24, 1986, the U.S. Environmental Protection Agency issued the following five guidelines for assessing the health risks of environmental pollutants.

Guidelines for Carcinogen Risk Assessment

Guidelines for Estimating Exposures

Guidelines for Mutagenicity Risk Assessment

Guidelines for the Health Assessment of Suspect Developmental Toxicants

Guidelines for the Health Risk Assessment of Chemical Mixtures

This section contains the Guidelines for the Health Risk Assessment of Chemical Mixtures.

The Guidelines for the Health Risk Assessment of Chemical Mixtures (hereafter "Guidelines") are intended to guide Agency analysis of information relating to health effects data on chemical mixtures in line with the policies and procedures established in the statutes administered by the EPA. These Guidelines were developed as part of an interoffice guidelines development program under the auspices of the Office of Health and Environmental Assessment (OHEA) in the Agency's Office of Research and Development. They reflect Agency consideration of public and Science Advisory Board (SAB) comments on the Proposed Guidelines for the Health Risk Assessment of Chemical Mixtures published January 9, 1985 (50 FR 1170).

This publication completes the first round of risk assessment guidelines development. These Guidelines will be revised, and new guidelines will be developed, as appropriate.

FOR FURTHER INFORMATION CONTACT:

Dr. Richard Hertzberg
Methods Evaluation and Development Staff
Environmental Criteria and Assessment Office
U.S. Environmental Protection Agency
26 W. St. Clair Street
Cincinnati, OH 45268
513-569-7582

SUPPLEMENTARY INFORMATION: In 1983, the National Academy of Sciences (NAS) published its book entitled *Risk Assessment in the Federal Government: Managing the Process*. In that book, the NAS recommended that Federal regulatory agencies establish "inference guidelines" to ensure consistency and technical quality in risk assessments and to ensure that the risk assessment process was maintained as a scientific effort separate from risk management. A task force within EPA accepted that recommendation and requested that Agency scientists begin to develop such guidelines.

General

The guidelines are products of a two-year Agencywide effort, which has included many scientists from the larger scientific community. These guidelines set forth principles and procedures to guide EPA scientists in the conduct of Agency risk assessments, and to inform Agency decision makers and the public about these procedures. In particular, the guidelines emphasize that risk assessments will be conducted on a case-by-case basis, giving full consideration to all relevant scientific information. This case-by-case approach means that Agency experts review the scientific information on each agent and use the most scientifically appropriate interpretation to assess risk. The guidelines also stress that this information will be fully presented in Agency risk assessment documents, and that Agency scientists will identify the strengths and weaknesses of each assessment by describing uncertainties, assumptions, and limitations, as well as the scientific basis and rationale for each assessment.

Finally, the guidelines are formulated in part to bridge gaps in risk assessment methodology and data. By identifying these gaps and the importance of the missing information to the risk assessment process, EPA wishes to encourage research and analysis that will lead to new risk assessment methods and data.

Guidelines for the Health Risk Assessment of Chemical Mixtures

Work on the Guidelines for the Health Risk Assessment of Chemical Mixtures began in January 1984. Draft guidelines were developed by Agency work groups composed of expert scientists from throughout the Agency. The drafts were peer-reviewed by expert scientists in the fields of toxicology, pharmacokinetics, and statistics from universities, environmental groups, industry, labor, and other governmental agencies. They were then proposed for public comment in the *FEDERAL REGISTER* (50 FR 1170). On November 9, 1984, the Administrator directed that Agency offices use the

REC 6185

proposed guidelines in performing risk assessments until final guidelines become available. After the close of the public comment period, Agency staff prepared summaries of the comments, analyses of the major issues presented by the commentors, and preliminary Agency responses to those comments. These analyses were presented to review panels of the SAB on March 4 and April 22-23, 1985, and to the Executive Committee of the SAB on April 25-26, 1985. The SAB meetings were announced in the *FEDERAL REGISTER* as follows: February 12, 1985 (50 FR 5811) and April 4, 1985 (50 FR 13420 and 13421).

In a letter to the Administrator dated June 19, 1985, the Executive Committee generally concurred on all five of the guidelines, but recommended certain revisions, and requested that any revised guidelines be submitted to the appropriate SAB review panel chairman for review and concurrence on behalf of the Executive Committee. As described in the responses to comments (see Part B: Response to the Public and Science Advisory Board Comments), each guidelines document was revised, where appropriate, consistent with the SAB recommendations, and revised draft guidelines were submitted to the panel chairmen. Revised draft Guidelines for the Health Risk Assessment of Chemical Mixtures were concurred on in a letter dated August 16, 1985. Copies of the letters are available at the Public Information Reference Unit, EPA Headquarters Library, as indicated elsewhere in this section.

Following this Preamble are two parts: Part A contains the Guidelines and Part B, the Response to the Public and Science Advisory Board Comments (a summary of the major public comments, SAB comments, and Agency responses to those comments).

The SAB requested that the Agency develop a technical support document for these Guidelines. The SAB identified the need for this type of document due to the limited knowledge on interactions of chemicals in biological systems. Because of this, the SAB commented that progress in improving risk assessment will be particularly dependent upon progress in the science of interactions.

Agency staff have begun preliminary work on the technical support document and expect it to be completed by early 1987. The Agency is continuing to study the risk assessment issues raised in the guidelines and will revise these Guidelines in line with new information as appropriate.

[51 FR 34015]

References, supporting documents, and comments received on the proposed guidelines, as well as copies of the final guidelines, are available for inspection and copying at the Public Information Reference Unit (202-382-5926), EPA Headquarters Library, 401 M Street, S.W., Washington, DC, between the hours of 8:00 a.m. and 4:30 p.m.

I certify that these Guidelines are not major rules as defined by Executive Order 12291, because they are nonbinding policy statements and have no direct effect on the regulated community. Therefore, they will have no effect on costs or prices, and they will have no other significant adverse effects on the economy. These Guidelines were reviewed by the Office of Management and Budget under Executive Order 12291.

August 22, 1986

Lee M. Thomas,

Administrator

CONTENTS

Part A: Guidelines for the Health Risk Assessment of Chemical Mixtures

I. Introduction

II. Proposed Approach

A. Data Available on the Mixture of Concern
B. Data Available on Similar Mixtures
C. Data Available Only on Mixture Components
1. Systemic Toxicants
2. Carcinogens
3. Interactions
4. Uncertainties
a. Health Effects
b. Exposure Uncertainties
c. Uncertainties Regarding Composition of the Mixture

III. Assumptions and Limitations

A. Information on Interactions
B. Additivity Models

IV. Mathematical Models and the Measurement of Joint Action

A. Dose Addition
B. Response Addition
C. Interactions

V. References

Part B: Response to Public and Science Advisory Board Comments

I. Introduction

II. Recommended Procedures

A. Definitions
B. Mixtures of Carcinogens and Systemic Toxicants

III. Additivity Assumption

A. Complex Mixtures
B. Dose Additivity
C. Interpretation of the Hazard Index
D. Use of Interaction Data

IV. Uncertainties and the Sufficiency of the Data Base

V. Need for a Technical Support Document

REC 6186

Part A: Guidelines for the Health Risk Assessment of Chemical Mixtures

I. Introduction

The primary purpose of this document is to generate a consistent Agency approach for evaluating data on the chronic and subchronic effects of chemical mixtures. It is a procedural guide that emphasizes broad underlying principles of the various science disciplines (toxicology, pharmacology, statistics) necessary for assessing health risk from chemical mixture exposure. Approaches to be used with respect to the analysis and evaluation of the various data are also discussed.

It is not the intent of these Guidelines to regulate any social or economic aspects concerning risk of injury to human health or the environment caused by exposure to a chemical agent(s). All such action is addressed in specific statutes and federal legislation and is independent of these Guidelines.

While some potential environmental hazards involve significant exposure to only a single compound, most instances of environmental contamination involve concurrent or sequential exposures to a mixture of compounds that may induce similar or dissimilar effects over exposure periods ranging from short-term to lifetime. For the purposes of these Guidelines, mixtures will be defined as any combination of two or more chemical substances regardless of source or of spatial or temporal proximity. In some instances, the mixtures are highly complex consisting of scores of compounds that are generated simultaneously as by-products from a single source or process (e.g., coke oven emissions and diesel exhaust). In other cases, complex mixtures of related compounds are produced as commercial products (e.g., PCBs, gasoline and pesticide formulations) and eventually released to the environment. Another class of mixtures consists of compounds, often unrelated chemically or commercially, which are placed in the same area for disposal or storage, eventually come into contact with each other, and are released as a mixture to the environment. The quality and quantity of pertinent information available for risk assessment varies considerably for different mixtures. Occasionally, the chemical composition of a mixture is well characterized, levels of exposure to the population are known, and detailed toxicologic data on the mixture are available. Most frequently, not all components of the mixture are known, exposure data are uncertain, and toxicologic data on the known components of the mixture are limited. Nonetheless, the Agency may be required to take action because of the number of individuals at potential risk or because of the known toxicologic effects of these compounds that have been identified in the mixture.

The prediction of how specific mixtures of toxicants will interact must be based on an understanding of the mechanisms of such interactions. Most reviews and texts that discuss toxicant interactions attempt to discuss the biological or chemical bases of the interactions (e.g., Klaassen and Doull, 1980; Levine, 1973; Goldstein et al., 1974; NRC, 1980a; Veldstra, 1956; Withey, 1981). Although different authors use somewhat different classification schemes when discussing the ways in which toxicants interact, it generally is recognized that toxicant interactions may occur during any of the toxicologic processes that take place with a single compound: absorption, distribution, metabolism, excretion, and activity at the receptor site(s). Compounds may interact chemically, yielding a new toxic component or causing a change in the biological availability of the existing component. They may also interact by causing different effects at different receptor sites.

Because of the uncertainties inherent in predicting the magnitude and nature of toxicant interactions, the assessment of health risk from chemical mixtures must include a thorough discussion of all assumptions. No single approach is recommended in these Guidelines. Instead, guidance is given for the use of several approaches depending on the nature and quality of the data. Additional mathematical details are presented in section IV.

In addition to these Guidelines, a supplemental technical support document is being developed which will contain a thorough review of all available information on the toxicity of chemical mixtures and a discussion of research needs.

II. Proposed Approach

No single approach can be recommended to risk assessments for multiple chemical exposures. Nonetheless, general guidelines can be recommended depending on the type of mixture, the known toxic effects of its components, the availability of toxicity data on the mixture or similar mixtures,

[51 FR 34016]

the known or anticipated interactions among components of the mixture, and the quality of the exposure data. Given the complexity of this issue and the relative paucity of empirical data from which sound generalizations can be constructed, emphasis must be placed on flexibility, judgment, and a clear articulation of the assumptions and limitations in any risk assessment that is developed. The proposed approach is summarized in Table 1 and Figure 1 and is detailed below. An alphanumeric scheme for ranking the quality of the data used in the risk assessment is given in Table 2.

REC 6187

A. Data Available on the Mixture of Concern

For predicting the effects of subchronic or chronic exposure to mixtures, the preferred approach usually will be to use subchronic or chronic health effects data on the mixture of concern and adopt procedures similar to those used for single compounds, either systemic toxicants or carcinogens (see U.S. EPA, 1986a-1986c). The risk assessor must recognize, however, that dose-response models used for single compounds are often based on biological mechanisms of the toxicity of single compounds, and may not be as well justified when applied to the mixture as a whole. Such data are most likely to be available on highly complex mixtures, such as coke oven emissions or diesel exhaust, which are generated in large quantities and associated with or suspected of causing adverse health effects. Attention should also be given to the persistence of the mixture in the environment as well as to the variability of the mixture composition over time or from different sources of emissions. If the components of the mixture are known to partition into different environmental compartments or to degrade or transform at different rates in the environment, then those factors must also be taken into account, or the confidence in and applicability of the risk assessment is diminished.

TABLE 1.-- RISK ASSESSMENT APPROACH FOR CHEMICAL MIXTURES

1. Assess the quality of the data on interactions, health effects, and exposure (see Table 2).
   a. If adequate, proceed to Step 2.
   b. If inadequate, proceed to Step 14.

2. Health effects information is available on the chemical mixture of concern .
   a. If yes, proceed to Step 3.
   b. If no, proceed to Step 4.

3. Conduct risk assessment on the mixture of concern based on health effects data on the mixture. Use the same procedures as those for single compounds. Proceed to Step 7 (optional) and Step 12.

4. Health effects information is available on a mixture that is similar to the mixture of concern.
   a. If yes, proceed to Step 5.
   b. If no, proceed to Step 7.

5. Assess the similarity of the mixture on which health effects data are available to the mixture of concern, with emphasis on any differences in components or proportions of components, as well as the effects that such differences would have on biological activity.
   a. If sufficiently similar, proceed to Step 6.
   b. If not sufficiently similar, proceed to Step 7.

6. Conduct risk assessment on the mixture of concern based on health effects data on the similar mixture. Use the same procedures as those for single compounds. Proceed to Step 7 (optional) and Step 12.

7. Compile health effects and exposure information on the components of the mixture.

8. Derive appropriate indices of acceptable exposure and/or risk on the individual components in the mixture. Proceed to Step 9.

9. Assess data on interactions of components in the mixtures.
   a. If sufficient quantitative data are available on the interactions of two or more components in the mixture, proceed to Step 10.
   b. If sufficient quantitative data are not available, use whatever information is available to qualitatively indicate the nature of potential interactions. Proceed to Step 11.

10. Use an appropriate interaction model to combine risk assessments on compounds for which data are adequate, and use an additivity assumption for the remaining compounds. Proceed to Step 11 (optional) and Step 12.

11. Develop a risk assessment based on an additivity approach for all compounds in the mixture. Proceed to Step 12.

12. Compare risk assessments conducted in Steps 5, 8, and 9. Identify and justify the preferred assessment, and quantify uncertainty, if possible. Proceed to Step 13.

13. Develop an integrated summary of the qualitative and quantitative assessments with special emphasis on uncertainties and assumptions. Classify the overall quality of the risk assessment, as indicated in Table 2. Stop.

14. No risk assessment can be conducted because of inadequate data on interactions, health effects, or exposure. Qualitatively assess the nature of any potential hazard and detail the types of additional data necessary to support a risk assessment. Stop.

Note. -- Several decisions used here, especially those concerning adequacy of data and similarity between two mixtures, are not precisely characterized and will require considerable judgment. See text.

REC 6188

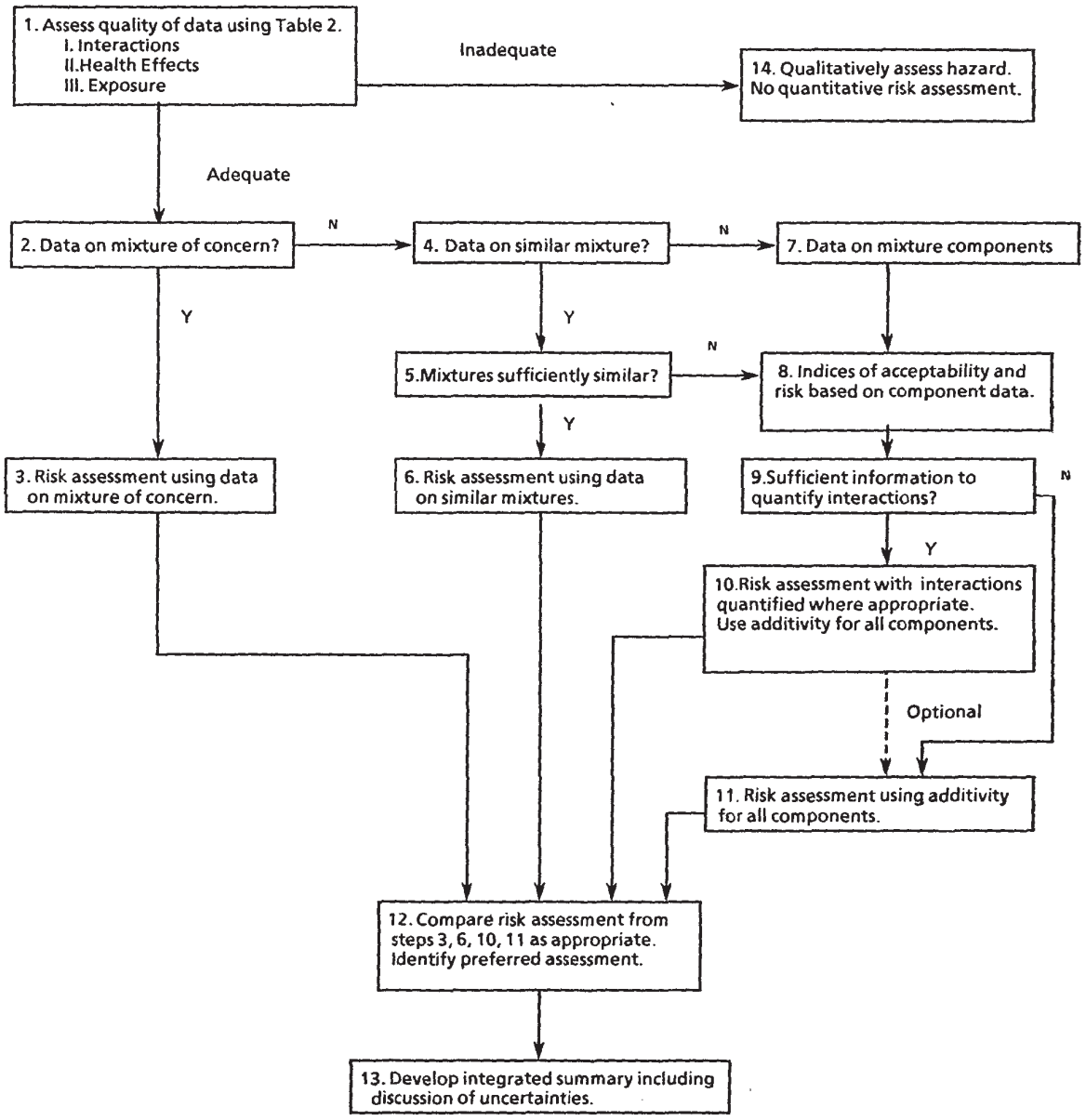


Figure 1. Flow chart of the risk assessment approach in Table 1. Note that it may be desirable to conduct all three assessments when possible (i.e., using data on the mixture, a similar mixture ,or the components) in order to make the fullest use of the available data. See text for further discussion.

TABLE 2. -- CLASSIFICATION SCHEME FOR THE QUALITY OF THE RISK ASSESSMENT OF THE MIXTURE[a]

Information on Interactions

I. Assessment is based on data on the mixture of concern.

II. Assessment is based on data on a sufficiently similar mixture.

III. Quantitative interactions of components are well characterized.

IV. The assumption of additivity is justified based on the nature of the health effects and on the number of component compounds.

V. An assumption of additivity cannot be justified, and no quantitative risk assessment can be conducted.

Health Effects Information

A. Full health effects data are available and relatively minor extrapolation is required.

B. Full health effects data are available but extensive extrapolation is required for route or duration of exposure or for species differences. These extrapolations are supported by pharmacokinetic considerations, empirical observations, or other relevant information.

C. Full health effects data are available, but extensive extrapolation is required for route or duration of exposure or for species differences. These extrapolations are not directly supported by the information available.

D. Certain important health effects data are lacking and extensive extrapolations are required for route or duration of exposure or for species differences.

E. A lack of health effects information on the mixture and its components in the mixture precludes a quantitative risk assessment.

Exposure Information[b]

1. Monitoring information either alone or in combination with modeling information is sufficient to accurately characterize human exposure to the mixture or its components.

2. Modeling information is sufficient to reasonably characterize human exposure to the mixture or its components.

3. Exposure estimates for some components are lacking, uncertain, or variable. Information on health effects or environmental chemistry suggest that this limitation is not likely to substantially affect the risk assessment.

4. Not all components in the mixture have been identified or levels of exposure are highly uncertain or variable. Information on health effects or environmental chemistry is not sufficient to assess the effect of this limitation on the risk assessment.

5. The available exposure information is insufficient for conducting a risk assessment.

B. Data Available on Similar Mixtures

If the risk assessment is based on data from a single mixture that is known to be generated with varying compositions depending on time or different emission sources, then the confidence in the applicability of the data to a risk assessment also is diminished. This can be offset to some degree if data are available on several mixtures of the same components that have different component ratios which encompass the temporal or spatial differences in composition of the mixture of concern. If such data are available, an attempt should be made to determine if significant and systematic differences exist among the chemical mixtures. If significant differences are noted, ranges of risk can be estimated based on the toxicologic data of the various mixtures. If no significant differences are noted, then a single risk assessment may be adequate, although the range of ratios of the components in the mixtures to which the risk assessment applies should also be given.

If no data are available on the mixtures of concern, but health effects data are available on a similar mixture (i.e., a mixture having the same components but in slightly different ratios, or having several common components but lacking one or more components, or having one or more additional components), a decision must be made whether the mixture on which health effects data are available is or is not "sufficiently similar" to the mixture of concern to permit a risk assessment. The determination of "sufficient similarity" must be made on a case-by-case basis, considering not only the uncertainties associated with using data on a dissimilar mixture but also the uncertainties of using other approaches such as additivity. In determining reasonable similarity, consideration should be given to any information on the components that differ or are contained in markedly different proportions between the mixture on which health effects data are available and the mixture of concern. Particular emphasis should be placed on any toxicologic or pharmacokinetic data on the components or the mixtures which would be useful in assessing the significance of any chemical difference between the similar mixture and the mixtures of concern.

Even if a risk assessment can be made using data on the mixtures of concern or a reasonably similar mixture, it may be desirable to conduct a risk assessment based on toxicity data on the

[a] See text for discussion of sufficient similarity, adequacy of data, and justification for additivity assumptions.

[b] See the Agency's Guidelines for Estimating Exposures (U.S. EPA, 1986d) for more complete information on performing exposure assessments and evaluating the quality of exposure data.

components in the mixture using the procedure outlined in section II.B. In the case of a mixture containing carcinogens and toxicants, an approach based on the mixture data alone may not be sufficiently protective in all cases. For example, this approach for a two-component mixture of one carcinogen and one toxicant would use toxicity data on the mixture of the two compounds. However, in a chronic study of such a mixture, the presence of the toxicant could mask the activity of the carcinogen. That is to say, at doses of the mixture sufficient to induce a carcinogenic effect, the toxicant could induce mortality so that at the maximum tolerated dose of the mixture, no carcinogenic effect could be observed. Since carcinogenicity is considered by the Agency to be a nonthreshold effect, it may not be prudent to construe the negative results of such a bioassay as indicating the absence of risk at lower doses. Consequently, the mixture approach should be modified to allow the risk assessor to evaluate the potential for masking, of one effect by another, on a case-by-case basis.

C. Data Available Only on Mixture Components

If data are not available on an identical or reasonably similar mixture, the risk assessment may be based on the toxic or carcinogenic properties of the components in the mixture. When little or no quantitative information is available on the potential interaction among the components, additive models (defined in the next section) are recommended for systemic toxicants. Several studies have demonstrated that dose additive models often predict reasonably well the toxicities of mixtures composed of a substantial variety of both similar and dissimilar compounds (Pozzani et al., 1959; Smyth et al., 1969, 1970; Murphy, 1980). The problem of multiple toxicant exposure has been addressed by the American Conference of Governmental Industrial Hygienists (ACGIH, 1983), the Occupational Safety and Health Administration (OSHA, 1983), the World Health Organization (WHO, 1981), and the National Research Council (NRC, 1980a, b). Although the focus and purpose of each group was somewhat different, all groups that recommended an approach elected to adopt some type of dose additive model. Nonetheless, as discussed in section IV, dose additive models are not the most biologically plausible approach if the compounds do not have the same mode of toxicologic action. Consequently, depending on the nature of the risk assessment and the available information on modes of action and patterns of joint action, the

[51 FR 34019]

most reasonable additive model should be used.

1. Systemic Toxicants. For systemic toxicants, the current risk assessment methodology used by the Agency for single compounds most often results in the derivation of an exposure level which is not anticipated to cause significant adverse effects. Depending on the route of exposure, media of concern, and the legislative mandate guiding the risk assessments, these exposure levels may be expressed in a variety of ways such as acceptable daily intakes (ADIs) or reference doses (RfDs), levels associated with various margins of safety (MOS), or acceptable concentrations in various media. For the purpose of this discussion, the term "acceptable level" (AL) will be used to indicate any such criteria or advisories derived by the Agency. Levels of exposure (E) will be estimates obtained following the most current Agency Guidelines for Estimating Exposures (U.S. EPA, 1986d). For such estimates, the "hazard index" (HI) of a mixture based on the assumption of dose addition may be defined as:

$$HI = E_1/AL_1 + E_2/AL_2 + \ldots + E_i/AL_i \qquad \text{(II-1)}$$

where:

E_i = exposure level to the i^{th} toxicant* and
AL_i = maximum acceptable level for the i^{th} toxicant.

Since the assumption of dose addition is most properly applied to compounds that induce the same effect by similar modes of action, a separate hazard index should be generated for each end point of concern. Dose addition for dissimilar effects does not have strong scientific support, and, if done, should be justified on a case-by-case basis in terms of biological plausibility.

The assumption of dose addition is most clearly justified when the mechanisms of action of the compounds under consideration are known to be the same. Since the mechanisms of action for most compounds are not well understood, the justification of the assumption of dose addition will often be limited to similarities in pharmacokinetic and toxicologic characteristics. In any event, if a hazard index is generated, the quality of the experimental evidence supporting the assumption of dose addition must be clearly articulated.

The hazard index provides a rough measure of likely toxicity and requires cautious interpretation. The hazard index is only a numerical indication of the nearness to acceptable limits of exposure or the degree to which acceptable exposure levels are exceeded. As this index approaches unity, concern for the potential hazard of the mixture increases. If the index exceeds unity, the concern is the same as if an individual chemical exposure exceeded its acceptable level by the same proportion. The hazard index does not define dose-response relationships, and its numerical value should not be construed to be a direct estimate of risk. Nonetheless, if sufficient data are available to derive individual acceptable levels for a spectrum of effects (e.g., MFO induction,

*See the Agency's guidelines (U.S. EPA, 1986d) for information on how to estimate this value.

REC 6191

variabilities of the acceptable levels are known, or if the acceptable levels are given as ranges (e.g., associated with different margins of safety), then the hazard index should be presented with corresponding estimates of variation or range. Most studies on systemic toxicity report only descriptions of the effects in each dose group. If dose-response curves are estimated for systemic toxicants, however, dose-additive or response-additive assumptions can be used, with preference given to the most biologically plausible assumption (see section IV for the mathematical details).

2. Carcinogens. For carcinogens, whenever linearity of the individual dose-response curves has been assumed (usually restricted to low doses), the increase in risk P (also called excess or incremental risk), caused by exposure d, is related to carcinogenic potency B, as:

$$P = d\,B \qquad \text{(II-2)}$$

For multiple compounds, this equation may be generalized to:

$$P = \Sigma d_i\,B_i \qquad \text{(II-3)}$$

This equation assumes independence of action by the several carcinogens and is equivalent to the assumption of dose addition as well as to response addition with completely negative correlation of tolerance, as long as $P < 1$ (see section IV). Analogous to the procedure used in equation II-1 for systemic toxicants, an index for n carcinogens can be developed by dividing exposure levels (E) by doses (DR) associated with a set level of risk:

$$HI = E_1/DR_1 + E_2/DR_2 + \ldots + E_n/DR_n \qquad \text{(II-4)}$$

Note that the less linear the dose-response curve is, the less appropriate equations II-3 and II-4 will be, perhaps even at low doses. It should be emphasized that because of the uncertainties in estimating dose-response relationships for single compounds, and the additional uncertainties in combining the individual estimate to assess response from exposure to mixtures, response rates and hazard indices may have merit in comparing risks but should not be regarded as measures of absolute risk.

3.Interactions. None of the above equations incorporates any form of synergistic or antagonistic interaction. Some types of information, however, may be available that suggest that two or more components in the mixture may interact. Such information must be assessed in terms of both its relevance to subchronic or chronic hazard and its suitability for quantitatively altering the risk assessment.

For example, if chronic or subchronic toxicity or carcinogenicity studies have been conducted that permit a quantitative estimation of interaction for two chemicals, then it may be desirable to consider using equations detailed in section IV, or modifications of these equations, to treat the two compounds as a single toxicant with greater or lesser potency than would be predicted from additivity. Other components of the mixture, on which no such interaction data are available, could then be separately treated in an additive manner. Before such a procedure is adopted, however, a discussion should be presented of the likelihood that other compounds in the mixture may interfere with the interaction of the two toxicants on which quantitative interaction data are available. If the weight of evidence suggests that interference is likely, then a quantitative alteration of the risk assessment may not be justified. In such cases, the risk assessment may only indicate the likely nature of interactions, either synergistic or antagonistic, and not quantify their magnitudes.

Other types of information, such as those relating to mechanisms of toxicant interaction, or quantitative estimates of interaction between two chemicals derived from acute studies, are even less likely to be of use in the quantitative assessment of long-term health risks. Usually it will be appropriate only to discuss these types of information, indicate the relevance of the information to subchronic or chronic exposure, and indicate, if possible, the nature of potential interactions, without attempting to quantify their magnitudes.

When the interactions are expected to have a minor influence on the mixture's toxicity, the assessment should indicate, when possible, the compounds most responsible for the predicted toxicity. This judgment should be based on predicted toxicity of each component,

[51 FR 34020]

based on exposure and toxic or carcinogenic potential. This potential alone should not be used as an indicator of the chemicals posing the most hazard.

4.Uncertainties. For each risk assessment, the uncertainties should be clearly discussed and the overall quality of the risk assessment should be characterized. The scheme outlined in Table 2 should be used to express the degree of confidence in the quality of the data on interaction, health effects, and exposure.

a. Health Effects--In some cases, when health effects data are incomplete, it may be possible to argue by analogy or quantitative structure-activity relationships that the compounds on which no health effects data are available are not likely to significantly affect the toxicity of the mixture. If a risk assessment includes such an argument, the limitations of the approach must be clearly articulated. Since a methodology has not been adopted for estimating an acceptable level (e.g., ADI) or carcinogenic potential for single compounds based either on quantitative structure-activity relationships or on the results of short-term screening tests, such methods are not at present

REC 6192

recommended as the sole basis of a risk assessment on chemical mixtures.

b. Exposure Uncertainties--The general uncertainties in exposure assessment have been addressed in the Agency's Guidelines for Estimating Exposures (U.S. EPA, 1986d). The risk assessor should discuss these exposure uncertainties in terms of the strength of the evidence used to quantify the exposure. When appropriate, the assessor should also compare monitoring and modeling data and discuss any inconsistencies as a source of uncertainty. For mixtures, these uncertainties may be increased as the number of compounds of concern increases.

If levels of exposure to certain compounds known to be in the mixture are not available, but information on health effects and environmental persistence and transport suggest that these compounds are not likely to be significant in affecting the toxicity of the mixture, then a risk assessment can be conducted based on the remaining compounds in the mixture, with appropriate caveats. If such an argument cannot be supported, no final risk assessment can be performed until adequate monitoring data are available. As an interim procedure, a risk assessment may be conducted for those components in the mixture for which adequate exposure and health effects data are available. If the interim risk assessment does not suggest a hazard, there is still concern about the risk from such a mixture because not all components in the mixture have been considered.

c. Uncertainties Regarding Composition of the Mixture--In perhaps a worst case scenario, information may be lacking not only on health effects and levels of exposure, but also on the identity of some components of the mixture. Analogous to the procedure described in the previous paragraph, an interim risk assessment can be conducted on those components of the mixture for which adequate health effects and exposure information are available. If the risk is considered unacceptable, a conservative approach is to present the quantitative estimates of risk, along with appropriate qualifications regarding the incompleteness of the data. If no hazard is indicated by this partial assessment, the risk assessment should not be quantified until better health effects and monitoring data are available to adequately characterize the mixture exposure and potential hazards.

III. Assumptions and Limitations

A. Information on Interactions

Most of the data available on toxicant interactions are derived from acute toxicity studies using experimental animals in which mixtures of two compounds were tested, often in only a single combination. Major areas of uncertainty with the use of such data involve the appropriateness of interaction data from an acute toxicity study for quantitatively altering a risk assessment for subchronic or chronic exposure, the appropriateness of interaction data on two component mixtures for quantitatively altering a risk assessment on a mixture of several compounds, and the accuracy of interaction data on experimental animals for quantitatively predicting interactions in humans.

The use of interaction data from acute toxicity studies to assess the potential interactions on chronic exposure is highly questionable unless the mechanism(s) of the interaction on acute exposure were known to apply to low-dose chronic exposure. Most known biological mechanisms for toxicant interactions, however, involve some form of competition between the chemicals or phenomena involving saturation of a receptor site or metabolic pathway. As the doses of the toxicants are decreased, it is likely that these mechanisms either no longer will exert a significant effect or will be decreased to an extent that cannot be measured or approximated.

The use of information from two-component mixtures to assess the interactions in a mixture containing more than two compounds also is questionable from a mechanistic perspective. For example, if two compounds are known to interact, either synergistically or antagonistically, because of the effects of one compound on the metabolism or excretion of the other, the addition of a third compound which either chemically alters or affects the absorption of one of the first two compounds could substantially alter the degree of the toxicologic interaction. Usually, detailed studies quantifying toxicant interactions are not available on multicomponent mixtures, and the few studies that are available on such mixtures (e.g., Gullino et al., 1956) do not provide sufficient information to assess the effects of interactive interference.

Concerns with the use of interaction data on experimental mammals to assess interactions in humans is based on the increasing appreciation for systematic differences among species in their response to individual chemicals. If systematic differences in toxic sensitivity to single chemicals exist among species, then it seems reasonable to suggest that the magnitude of toxicant interactions among species also may vary in a systematic manner. Consequently, even if excellent chronic data are available on the magnitude of toxicant interactions in a species of experimental mammal, there is uncertainty that the magnitude of the interaction will be the same in humans. Again, data are not available to properly assess the significance of this uncertainty.

Last, it should be emphasized that none of the models for toxicant interaction can predict the magnitude of toxicant interactions in the absence of extensive data. If sufficient data are available to

REC 6193

estimate interaction coefficients as described in section IV, then the magnitude of the toxicant interactions for various proportions of the same components can be predicted. The availability of an interaction ratio (observed response divided by predicted response) is useful only in assessing the magnitude of the toxicant interaction for the specific proportions of the mixture which was used to generate the interaction ratio.

The basic assumption in the recommended approach is that risk assessments on chemical mixtures are best conducted using toxicologic data on the mixture of concern or a reasonably similar mixture. While such risk

[51 FR 34021]

assessments do not formally consider toxicologic interactions as part of a mathematical model, it is assumed that responses in experimental mammals or human populations noted after exposure to the chemical mixture can be used to conduct risk assessments on human populations. In bioassays of chemical mixtures using experimental mammals, the same limitations inherent in species-to-species extrapolation for single compounds apply to mixtures. When using health effects data on chemical mixtures from studies on exposed human populations, the limitations of epidemiologic studies in the risk assessment of single compounds also apply to mixtures. Additional limitations may be involved when using health effects data on chemical mixtures if the components in the mixture are not constant or if the components partition in the environment.

B. Additivity Models

If sufficient data are not available on the effects of the chemical mixture of concern or a reasonably similar mixture, the proposed approach is to assume additivity. Dose additivity is based on the assumption that the components in the mixture have the same mode of action and elicit the same effects. This assumption will not hold true in most cases, at least for mixtures of systemic toxicants. For systemic toxicants, however, most single compound risk assessments will result in the derivation of acceptable levels, which, as currently defined, cannot be adapted to the different forms of response additivity as described in section IV.

Additivity models can be modified to incorporate quantitative data on toxicant interactions from subchronic or chronic studies using the models given in section IV or modifications of these models. If this approach is taken, however, it will be under the assumption that other components in the mixture do not interfere with the measured interaction. In practice, such subchronic or chronic interactions data seldom will be available. Consequently, most risk assessments (on mixtures) will be based on an assumption of additivity, as long as the components elicit similar effects.

Dose-additive and response-additive assumptions can lead to substantial errors in risk estimates if synergistic or antagonistic interactions occur. Although dose additivity has been shown to predict the acute toxicities of many mixtures of similar and dissimilar compounds (e.g., Pozzani et al., 1959; Smyth et al., 1969, 1970; Murphy, 1980), some marked exceptions have been noted. For example, Smyth et al. (1970) tested the interaction of 53 pairs of industrial chemicals based on acute lethality in rats. For most pairs of compounds, the ratio of the predicted LD_{50} to observed LD_{50} did not vary by more than a factor of 2. The greatest variation was seen with an equivolume mixture of morpholine and toluene, in which the observed LD_{50} was about five times less than the LD_{50} predicted by dose addition. In a study by Hammond et al. (1979), the relative risk of lung cancer attributable to smoking was 11, while the relative risk associated with asbestos exposure was 5. The relative risk of lung cancer from both smoking and asbestos exposure was 53, indicating a substantial synergistic effect. Consequently, in some cases, additivity assumptions may substantially underestimate risk. In other cases, risk may be overestimated. While this is certainly an unsatisfactory situation, the available data on mixtures are insufficient for estimating the magnitude of these errors. Based on current information, additivity assumptions are expected to yield generally neutral risk estimates (i.e., neither conservative nor lenient) and are plausible for component compounds that induce similar types of effects at the same sites of action.

IV. Mathematical Models and the Measurement of Joint Action

The simplest mathematical models for joint action assume no interaction in any mathematical sense. They describe either dose addition or response addition and are motivated by data on acute lethal effects of mixtures of two compounds.

A. Dose Addition

Dose addition assumes that the toxicants in a mixture behave as if they were dilutions or concentrations of each other, thus the true slopes of the dose-response curves for the individual compounds are identical, and the response elicited by the mixture can be predicted by summing the individual doses after adjusting for differences in potency; this is defined as the ratio of equitoxic doses. Probit transformation typically makes this ratio constant at all doses when parallel straight lines are obtained. Although this assumption can be applied to any model (e.g., the one-hit model in NRC, 1980b), it has been most often used in toxicology with the log-dose probit response model, which will be used to illustrate the assumption of dose addition.

REC 6194

Suppose that two toxicants show the following log-dose probit response equations:

$$Y_1 = 0.3 + 3 \log Z_1 \quad \text{(IV-1)}$$
$$Y_2 = 1.2 + 3 \log Z_2 \quad \text{(IV-2)}$$

where Y_i is the probit response associated with a dose of Z_i ($i=1,2$). The potency, p, of toxicant #2 with respect to toxicant #1 is defined by the quantity Z_1/Z_2 when $Y_1 = Y_2$ (that is what is meant by equitoxic doses). In this example, the potency, p, is approximately 2. Dose addition assumes that the response, Y, to any mixture of these two toxicants can be predicted by:

$$Y = 0.3 + 3 \log (Z_1 + pZ_2) \quad \text{(IV-3)}$$

Thus, since p is defined as Z_1/Z_2, equation IV-3 essentially converts Z_2 into an equivalent dose of Z by adjusting for the difference in potency. A more generalized form of this equation for any number of toxicants is:

$$Y = a_1 + b \log (f_1 + \Sigma f_i p_i) + b \log Z \quad \text{(IV-4)}$$

where:

a_1 = the y-intercept of the dose-response equation for toxicant #1
b = the slope of the dose-response lines for the toxicants
f_i = the proportion of the i^{th} toxicant in the mixture
p_i = the potency of the i^{th} toxicant with respect to toxicant #1 (i.e., Z_1/Z_i), and
Z = the sum of the individual doses in the mixture.

A more detailed discussion of the derivation of the equations for dose addition is presented by Finney (1971).

B. Response Addition

The other form of additivity is referred to as response addition. As detailed by Bliss (1939), this type of joint action assumes that the two toxicants act on different receptor systems and that the correlation of individual tolerances may range from completely negative ($r=-1$) to completely positive ($r=+1$). Response addition assumes that the response to a given concentration of a mixture of toxicants is completely determined by the responses to the components and the pairwise correlation coefficient. Taking P as the proportion of organisms responding to a mixture of two toxicants which evoke individual responses of P_1 and P_2, then

$$P = P_1 \text{ if } r = 1 \text{ and } P_1 \geq P_2 \quad \text{(IV-5)}$$
$$P = P_2 \text{ if } r = 1 \text{ and } P_1 < P_2 \quad \text{(IV-6)}$$
$$P = P_1 + P_2 (1-P_1) \text{ if } r = 0 \quad \text{(IV-7)}$$
$$P = P_1 + P_2 \text{ if } r = -1 \text{ and } P \leq 1. \quad \text{(IV-8)}$$

More generalized mathematical models for this form of joint action have been given by Plackett and Hewlett (1948).

C. Interactions

All of the above models assume no interactions and therefore do not incorporate measurements of synergistic or antagonistic effects. For measuring toxicant interactions for mixtures of two compounds, Finney (1942) proposed the

[51 FR 34022]

following modification of equation IV-4 for dose addition:

$$Y = a_1 + b \log (f_1 + pf_2 + K[pf_1f_2]^{0.5}) + b \log Z \quad \text{(IV-9)}$$

where a_1, b, f_1, f_2, p, and Z are defined as before, and K is the coefficient of interaction. A positive value of K indicates synergism, a negative value indicates antagonism, and a value of zero corresponds to dose addition as in equation IV-4. Like other proposed modifications of dose addition (Hewlett, 1969), the equation assumes a consistent interaction throughout the entire range of proportions of individual components. To account for such asymmetric patterns of interaction as those observed by Alstott et al. (1973), Durkin (1981) proposed the following modification to equation IV-9:

$$Y = a_1 + b \log (f_1 + pf_2 + K_1f_1[pf_1f_2]^{0.5} + K_2f_2[pf_1f_2]^{0.5}) + b \log Z \quad \text{(IV-10)}$$

in which $K(pf_1f_2)^{0.5}$ is divided into two components, $K_1f_1(pf_1f_2)^{0.5}$ and $K_2f_2(pf_1f_2)^{0.5}$. Since K_1 and K_2 need not have the same sign, apparent instances of antagonism at one receptor site and synergism at another receptor site can be estimated. When K_1 and K_2 are equal, equation IV-10 reduces to equation IV-9. It should be noted that to obtain a reasonable number of degrees of freedom in the estimation of K in equation IV-9 or K_1 and K_2 in equation IV-10, the toxicity of several different combinations of the two components must be assayed along with assays of the toxicity of the individual components. Since this requires experiments with large numbers of animals, such analyses have been restricted for the most part to data from acute bioassays using insects (e.g., Finney, 1971) or aquatic organisms (Durkin, 1979). Also, because of the complexity of experimental design and the need for large numbers of animals, neither equation IV-9 nor equation IV-10 has been generalized or applied to mixtures of more than two toxicants. Modifications of response-additive models to include interactive terms have also been proposed, along with appropriate statistical tests for the assumption of additivity (Korn and Liu, 1983; Wahrendorf et al., 1981).

In the epidemiologic literature, measurements of the extent of toxicant interactions, S, can be expressed as the ratio of observed relative risk to relative risk predicted by some form of additivity assumption. Analogous to the ratio of interaction in classical toxicology studies, $S = 1$ indicates no interaction, $S > 1$ indicates synergism, and $S < 1$ indicates antagonism. Several models for both

REC 6195

additive and multiplicative risks have been proposed (e.g., Hogan et al., 1978; NRC, 1980b; Walter, 1976). For instance, Rothman (1976) has discussed the use of the following measurement of toxicant interaction based on the assumption of risk additivity:

$$S = (R_{11} - 1)/(R_{10} + R_{01} - 2) \qquad \text{(IV-11)}$$

where R_{10} is the relative risk from compound #1 in the absence of compound #2, R_{01} is the relative risk from compound #2 in the absence of compound #1, and R_{11} is the relative risk from exposure to both compounds. A multiplicative risk model adapted from Walter and Holford (1978, equation 4) can be stated as:

$$S = R_{11}/(R_{10}R_{01}) \qquad \text{(IV-12)}$$

As discussed by both Walter and Holford (1978) and Rothman (1976), the risk-additive model is generally applied to agents causing diseases while the multiplicative model is more appropriate to agents that prevent disease. The relative merits of these and other indices have been the subject of considerable discussion in the epidemiologic literature (Hogan et al., 1978; Kupper and Hogan, 1978; Rothman, 1978; Rothman et al., 1980; Walter and Holford, 1978). There seems to be a consensus that for public health concerns regarding causative (toxic) agents, the additive model is more appropriate.

Both the additive and multiplicative models assume statistical independence in that the risk associated with exposure to both compounds in combination can be predicted by the risks associated with separate exposure to the individual compounds. As illustrated by Siemiatycki and Thomas (1981) for multistage carcinogenesis, the better fitting statistical model will depend not only upon actual biological interactions, but also upon the stages of the disease process which the compounds affect. Consequently, there is no *a priori* basis for selecting either type of model in a risk assessment. As discussed by Stara et al. (1983), the concepts of multistage carcinogenesis and the effects of promoters and cocarcinogens on risk are extremely complex issues. Although risk models for promoters have been proposed (e.g., Burns et al., 1983), no single approach can be recommended at this time.

V. References

ACGIH (American Conference of Governmental Industrial Hygienists). 1983. TLVs: threshold limit values for chemical substances and physical agents in the work environment with intended changes for 1983-1984. Cincinnati, OH, p.58.

Alstott, R.L., M.E. Tarrant, and R.B. Forney. 1973. The acute toxicities of 1-methylxanthine, ethanol, and 1-methylxanthine/ethanol combinations in the mouse. Toxicol. Appl. Pharmacol. 24:393-404.

Bliss, C.I. 1939. The toxicity of poisons applied jointly. Ann. Appl. Biol. 26:585-615.

Burns, F., R. Albert, E. Altschuler, and E. Morris. 1983. Approach to risk assessment for genotoxic carcinogens based on data from the mouse skin initiation-promotion model. Environ. Health Perspect. 50:309-320.

Durkin, P.R. 1979. Spent chlorination liquor and chlorophenolics: a study in detoxication and joint action using *Daphnia magna*. Ph.D. Thesis, Syracuse, NY: State University of New York College of Environmental Science and Forestry, p.145.

Durkin, P.R. 1981. An approach to the analysis of toxicant interactions in the aquatic environment. Proceedings of the 4th Annual Symposium on Aquatic Toxicology. American Society for Testing and Materials, p.388-401.

Finney, D.J. 1942. The analysis of toxicity tests on mixtures of poisons. Ann. Appl. Biol. 29:82-94.

Finney, D.J. 1971. Probit analysis, 3rd ed. Cambridge, Great Britain: Cambridge University Press, 333 p.

Goldstein, A., L. Aronow, and S.M. Kalman. 1974. Principles of drug action: the basis of pharmacology, 2nd ed. New York, NY: John Wiley and Sons, Inc., 854 p.

Gullino, P., M. Winitz, S.M. Birnbaum, J. Cornfield, M.C. Otey, and J.P. Greenstein. 1956. Studies on the metabolism of amino acids and related compounds *in vivo*. I. Toxicity of essential amino acids, individually and in mixtures, and the protective effect of L-arginine. Arch. Biochem. Biophys. 64:319-332.

Hammond, E.C., I.V. Selikoff, and H. Seidman. 1979. Asbestos exposure, cigarette smoking and death rates. Ann. NY Acad. Sci. 330:473-490.

Hewlett, P.S. 1969. Measurement of the potencies of drug mixtures. Biometrics. 25:477-487.

Hogan, M.D., L. Kupper, B. Most, and J. Haseman. 1978. Alternative approaches to Rothman's approach for assessing synergism (or antagonism) in cohort studies. Am. J. Epidemiol. 108(1):60-67.

Klaassen, C.D., and J. Doull. 1980. Evaluation of safety: toxicologic evaluation. In: J. Doull, C.D. Klaassen, and M.O. Amdur, eds. Toxicology: the basic science of poisons. New York, NY: Macmillan Publishing Co., Inc., p. 11-27.

Korn, E.L., and P-Y. Liu. 1983. Interactive effects of mixtures of stimuli in life table analysis. Biometrika. 70:103-110.

Kupper, L., and M.D. Hogan. 1978. Interaction in epidemiologic studies. Am. J. Epidemiol. 108(6):447-453.

Levine, R.E. 1973. Pharmacology: drug actions and reactions. Boston, MA: Little, Brown and Company, 412 p.

[51 FR 34023]

Murphy, S.D. 1980. Assessment of the potential for toxic interactions among environmental pollutants. In: C.L. Galli, S.D. Murphy, and R. Paoletti, eds. The principles and methods in modern toxicology. Amsterdam, The Netherlands: Elsevier/North Holland Biomedical Press.

NRC (National Research Council). 1980a. Drinking water and health, Vol.3. Washington, DC: National Academy Press, p.27-28.

NRC (National Research Council). 1980b. Principles of toxicological interactions associated with multiple chemical exposures. Washington, DC: National Academy Press, p.204.

OSHA (Occupational Safety and Health Administration). 1983. General Industry Standards, Subpart 2, Toxic and Hazardous Substances. Code of Federal Regulations. 40:1910.1000 (d)(2)(i). Chapter XVII Occupational Safety and Health Administration, p.667.

Plackett, R.L., and P.S. Hewlett. 1948. Statistical aspects of the independent joint action of poisons. Ann. Appl. Biol. 35:347-358.

Pozzani, U.C., C.S. Weil, and C.P. Carpenter. 1959. The toxicological basis of threshold values: 5. The experimental inhalation of vapor mixtures by rats, with notes upon the relationship between single dose inhalation and single dose oral data. Am. Ind. Hyg. Assoc. J. 20:364-369.

Rothman, K. 1976. The estimation of synergy or antagonism. Am. J. Epidemiol. 103(5):506-511.

Rothman, K. 1978. Estimation versus detection in the assessment of synergy. Am. J. Epidemiol. 108(1):9-11.

Rothman, K., S. Greenland, and A. Walker. 1980. Concepts of interaction. Am. J. Epidemiol. 112(4):467-470.

Siemiatycki, J., and D.C. Thomas. 1981. Biological models and statistical interactions: An example from multistage carcinogenesis. Int. J. Epidemiol. 10(4):383-387.

REC 6196

Smyth, H.F., C.S. Weil, J.S. West, and C.P. Carpenter. 1969. An exploration of joint toxic action: I. Twenty-seven industrial chemicals intubated in rats in all possible pairs. Toxicol. Appl. Pharmacol. 14:340-347.
Smyth, H.F., C.S. Weil, J.S. West, and C.P. Carpenter. 1970. An exploration of joint toxic action. II. Equitoxic versus equivolume mixtures. Toxicol. Appl. Pharmacol. 17:498-503.
Stara, J.F., D. Mukerjee, R. McGaughy, P. Durkin, and M.L. Dourson. 1983. The current use of studies on promoters and cocarcinogens in quantitative risk assessment. Environ. Health Perspect. 50:359-368.
U.S. EPA. 1986a. Guidelines for carcinogen risk assessment. Federal Register. 51(185):33992-34003.
U.S. EPA. 1986b. Guidelines for mutagenicity risk assessment. Federal Register. 51(185):34006-34012.
U.S. EPA. 1986c. Guidelines for the health assessment of suspect developmental toxicants. Federal Register 51(185): 34028-34040.
U.S. EPA. 1986d. Guidelines for estimating exposures. Federal Register 51(185):34042-34054.
Veldstra, H. 1956. Synergism and potentiation with special reference to the combination of structural analogues. Pharmacol. Rev. 8:339-387.
Wahrendorf, J., R. Zentgrof, and C.C. Brown. 1981. Optimal designs for the analysis of interactive effects of two carcinogens or other toxicants. Biometrics. 37:45-54.
Walter, S.D. 1976. The estimation and interpretation of attributable risk in health research. Biometrics. 32:829-849.
Walter, S.D., and T.R. Holford. 1978. Additive, multiplicative, and other models for disease risks. Am. J. Epidemiol. 108:341-346.
Withey, J.R. 1981. Toxicodynamics and biotransformation. In: International Workshop on the Assessment of Multichemical Contamination. Milan, Italy. (Draft copy courtesy of J.R. Withey)
WHO (World Health Organization). 1981. Health effects of combined exposures in the work environment. WHO Tech. Report Series No. 662.

Part B: Response to Public and Science Advisory Board Comments

I. Introduction

This section summarizes some of the major issues raised in public comments on the Proposed Guidelines for the Health Risk Assessment of Chemical Mixtures published on January 9, 1985 (50 FR 1170). Comments were received from 14 individuals or organizations. An issue paper reflecting public and external review comments was presented to the Chemical Mixtures Guidelines Panel of the Science Advisory Board (SAB) on March 4, 1985. At its April 22-23, 1985, meeting, the SAB Panel provided the Agency with additional suggestions and recommendations concerning the Guidelines. This section also summarizes the issues raised by the SAB.

The SAB and public commentors expressed diverse opinions and addressed issues from a variety of perspectives. In response to comments, the Agency has modified or clarified many sections of the Guidelines, and is planning to develop a technical support document in line with the SAB recommendations. The discussion that follows highlights significant issues raised in the comments, and the Agency's response to them. Also, many minor recommendations, which do not warrant discussion here, were adopted by the Agency.

II. Recommended Procedures

A. Definitions

Several comments were received concerning the lack of definitions for certain key items and the general understandability of certain sections. Definitions have been rewritten for several terms and the text has been significantly rewritten to clarify the Agency's intent and meaning.

Several commentors noted the lack of a precise definition of "mixture," even though several classes of mixtures are discussed. In the field of chemistry, the term "mixture" is usually differentiated from true solutions, with the former defined as nonhomogeneous multicomponent systems. For these Guidelines, the term "mixture" is defined as "...any combination of two or more chemicals regardless of spatial or temporal homogeneity of source" (section 1). These Guidelines are intended to cover risk assessments for any situation where the population is exposed or potentially exposed to two or more compounds of concern. Consequently, the introduction has been revised to clarify the intended breadth of application.

Several commentors expressed concern that "sufficient similarity" was difficult to define and that the Guidelines should give more details concerning similar mixtures. The Agency agrees and is planning research projects to improve on the definition. Characteristics such as composition and toxic end-effects are certainly important, but the best indicators of similarity in terms of risk assessment have yet to be determined. The discussion in the Guidelines emphasizes case-by-case judgment until the necessary research can be performed. The Agency considered but rejected adding an example, because it is not likely that any single example would be adequate to illustrate the variety in the data and types of judgments that will be required in applying this concept. Inclusion of examples is being considered for the technical support document.

B. Mixtures of Carcinogens and Systemic Toxicants

The applicability of the preferred approach for a mixture of carcinogens and systemic (noncarcinogenic) toxicants was a concern of several public commentors as well as the SAB. The Agency realizes that the preferred approach of using test data on the mixture itself may not be sufficiently protective in all cases. For example, take a simple two-component mixture of one carcinogen and one toxicant. The preferred approach would lead to using toxicity data on the mixture of the two compounds. However, it is possible to set the proportions of each component so that in a chronic bioassay of such a mixture, the presence of the toxicant could mask the activity of the carcinogen. That is to say, at doses of

REC 6197

the mixture sufficient for the carcinogen to induce tumors in the small

[51 FR 34024]

experimental group, the toxicant could induce mortality. At a lower dose in the same study, no adverse effects would be observed, including no carcinogenic effects. The data would then suggest use of a threshold approach. Since carcinogenicity is considered by the Agency to be a nonthreshold effect, it may not be prudent to construe the negative results of such a bioassay as indicating the absence of risk at lower doses. Consequently, the Agency has revised the discussion of the preferred approach to allow the risk assessor to evaluate the potential for masking of carcinogenicity or other effects on a case-by-case basis. Another difficulty occurs with such a mixture when the risk assessment needs to be based on data for the mixture components. Carcinogens and systemic toxicants are evaluated by the Agency using different approaches and generally are described by different types of data: response rates for carcinogens vs. effect descriptions for toxicants. The Agency recognizes this difficulty and recommends research to develop a new assessment model for combining these dissimilar data sets into one risk estimate. One suggestion in the interim is to present separate risk estimates for the dissimilar end points, including carcinogenic, teratogenic, mutagenic, and systemic toxicant components.

III. Additivity Assumption

Numerous comments were received concerning the assumption of additivity, including:

a. the applicability of additivity to "complex" mixtures;
b. the use of dose additivity for compounds that induce different effects;
c. the interpretation of the Hazard Index; and
d. the use of interaction data.

Parts of the discussion in the proposed guidelines concerning the use of additivity assumptions were vague and have been revised in the final Guidelines to clarify the Agency's intent and position.

A. Complex Mixtures

The issue of the applicability of an assumption of additivity to complex mixtures containing tens or hundreds of components was raised in several of the public comments. The Agency and its reviewers agree that as the number of compounds in the mixture increases, an assumption of additivity will become less reliable in estimating risk. This is based on the fact that each component estimate of risk or an acceptable level is associated with some error and uncertainty. With current knowledge, the uncertainty will increase as the number of components increases. In any event, little experimental data are available to determine the general change in the error as the mixture contains more components. The Agency has decided that a limit to the number of components should not be set in these Guidelines. However, the Guidelines do explicitly state that as the number of compounds in the mixture increases, the uncertainty associated with the risk assessment is also likely to increase.

B. Dose Additivity

Commentors were concerned about what appeared to be a recommendation of the use of dose additivity for compounds that induce different effects. The discussion following the dose additivity equation was clarified to indicate that the act of combining all compounds, even if they induce dissimilar effects, is a screening procedure and not the preferred procedure in developing a hazard index. The Guidelines were further clarified to state that dose (or response) additivity is theoretically sound, and therefore best applied for assessing mixtures of similar acting components that do not interact.

C. Interpretation of the Hazard Index

Several comments addressed the potential for misinterpretation of the hazard index, and some questioned its validity, suggesting that it mixes science and value judgments by using "acceptable" levels in the calculation. The Agency agrees with the possible confusion regarding its use and has revised the Guidelines for clarification. The hazard index is an easily derived restatement of dose additivity, and is, therefore, most accurate when used with mixture components that have similar toxic action. When used with components of unknown or dissimilar action, the hazard index is less accurate and should be interpreted only as a rough indication of concern. As with dose addition, the uncertainty associated with the hazard index increases as the number of components increases, so that it is less appropriate for evaluating the toxicity of complex mixtures.

D. Use of Interaction Data

A few commentors suggested that any interaction data should be used to quantitatively alter the risk assessment. The Agency disagrees. The current information on interactions is meager, with only a few studies comparing response to the mixture with that predicted by studies on components. Additional uncertainties include exposure variations due to changes in composition, mixture dose, and species differences in the extent of the interaction. The Agency is constructing an interaction data base in an attempt to answer some of these issues. Other comments concerned the use of different types of interaction data. The Guidelines restrict the use of interaction data to that obtained from whole animal bioassays of a duration appropriate to the risk assessment. Since such data are frequently lacking, at least for chronic or subchronic effects, the issue is whether to allow for the use of other information such as acute data, *in*

REC 6198

vitro data, or structure-activity relationships to quantitatively alter the risk assessment, perhaps by use of a safety factor. The Agency believes that sufficient scientific support does not exist for the use of such data in any but a qualitative discussion of possible synergistic or antagonistic effects.

IV. Uncertainties and the Sufficiency of the Data Base

In the last two paragraphs of section II of the Guidelines, situations are discussed in which the risk assessor is presented with incomplete toxicity, monitoring, or exposure data. The SAB, as well as several public commentors, recommended that the "risk management" tone of this section be modified and that the option of the risk assessor to decline to conduct a risk assessment be made more explicit.

This is a difficult issue that must consider not only the quality of the available data for risk assessment, but also the needs of the Agency in risk management. Given the types of poor data often available, the risk assessor may indicate that the risk assessment is based on limited information and thus contains no quantification of risk. Nonetheless, in any risk assessment, substantial uncertainties exist. It is the obligation of the risk assessor to provide an assessment, but also to ensure that all the assumptions and uncertainties are articulated clearly and quantified whenever possible.

The SAB articulated several other recommendations related to uncertainties, all of which have been followed in the revision of the Guidelines. One recommendation was that the summary procedure table also be presented as a flow chart so that all options are clearly displayed. The SAB further recommended the development of a system to express the level of confidence in the various steps of the risk assessment.

The Agency has revised the summary table to present four major options: risk assessment using data on the mixture

[51 FR 34025]

itself, data on a similar mixture, data on the mixture's components, or declining to quantify the risk when the data are inadequate. A flow chart of this table has also been added to more clearly depict the various options and to suggest the combining of the several options to indicate the variability and uncertainties in the risk assessment.

To determine the adequacy of the data, the SAB also recommended the development of a system to express the level of confidence associated with various steps in the risk assessment process. The Agency has developed a rating scheme to describe data quality in three areas: interaction, health effects, and exposure. This classification provides a range of five levels of data quality for each of the three areas. Choosing the last level in any area results in declining to perform a quantitative risk assessment due to inadequate data. These last levels are described as follows:

Interactions:

An assumption of additivity cannot be justified, and no quantitative risk assessment can be conducted.

Health effects:

A lack of health effects information on the mixture and its components precludes a quantitative risk assessment.

Exposure:

The available exposure information is insufficient for conducting a risk assessment.

Several commentors, including the SAB, emphasized the importance of not losing these classifications and uncertainties farther along in the risk management process. The discussion of uncertainties has been expanded in the final Guidelines and includes the recommendation that a discussion of uncertainties and assumptions be included at every step of the regulatory process that uses risk assessment.

Another SAB comment was that the Guidelines should include additional procedures for mixtures with more than one end point or effect. The Agency agrees that these are concerns and revised the Guidelines to emphasize these as additional uncertainties worthy of further research.

V. Need for a Technical Support Document

The third major SAB comment concerned the necessity for a separate technical support document for these Guidelines. The SAB pointed out that the scientific and technical background from which these Guidelines must draw their validity is so broad and varied that it cannot reasonably be synthesized within the framework of a brief set of guidelines. The Agency is developing a technical support document that will summarize the available information on health effects from chemical mixtures, and on interaction mechanisms, as well as identify and develop mathematical models and statistical techniques to support these Guidelines. This document will also identify critical gaps and research needs.

Several comments addressed the need for examples on the use of the Guidelines. The Agency has decided to include examples in the technical support document.

Another issue raised by the SAB concerned the identification of research needs. Because little emphasis has been placed on the toxicology of mixtures until recently, the information on mixtures is limited. The SAB pointed out that identifying research needs is critical to the risk assessment process, and the EPA should ensure that these needs are considered in the research planning process. The Agency will include a section in the

REC 6199

technical support document that identifies research needs regarding both methodology and data.

REC 6200

51 FR 34028

GUIDELINES FOR THE HEALTH ASSESSMENT OF SUSPECT DEVELOPMENTAL TOXICANTS

SUMMARY: On September 24, 1986, the U.S. Environmental Protection Agency issued the following five guidelines for assessing the health risks of environmental pollutants.

Guidelines for Carcinogen Risk Assessment

Guidelines for Estimating Exposures

Guidelines for Mutagenicity Risk Assessment

Guidelines for the Health Assessment of Suspect Developmental Toxicants

Guidelines for the Health Risk Assessment of Chemical Mixtures

This section contains the Guidelines for the Health Assessment of Suspect Developmental Toxicants.

The Guidelines for the Health Assessment of Suspect Developmental Toxicants (hereafter "Guidelines") are intended to guide Agency analysis of developmental toxicity data in line with the policies and procedures established in the statutes administered by the EPA. These Guidelines were developed as part of an interoffice guidelines development program under the auspices of the Office of Health and Environmental Assessment (OHEA) in the Agency's Office of Research and Development. They reflect Agency consideration of public and Science Advisory Board (SAB) comments on the Proposed Guidelines for the Health Assessment of Suspect Developmental Toxicants published November 23, 1984 (49 FR 46324).

This publication completes the first round of risk assessment guidelines development. These Guidelines will be revised, and new guidelines will be developed, as appropriate.

FOR FURTHER INFORMATION CONTACT:

Dr. Carole A. Kimmel
Reproductive Effects Assessment Group
Office of Health and Environmental Assessment (RD-689)
U. S. Environmental Protection Agency
401 M Street, S.W.
Washington, DC 20460
202-382-7331

SUPPLEMENTARY INFORMATION: In 1983, the National Academy of Sciences (NAS) published its book entitled *Risk Assessment in the Federal Government: Managing the Process.* In that book, the NAS recommended that Federal regulatory agencies establish "inference guidelines" to ensure consistency and technical quality in risk assessments and to ensure that the risk assessment process was maintained as a scientific effort separate from risk management. A task force within EPA accepted that recommendation and requested that Agency scientists begin to develop such guidelines.

General

The guidelines are products of a two-year Agencywide effort, which has included many scientists from the larger scientific community. These guidelines set forth principles and procedures to guide EPA scientists in the conduct of Agency risk assessments, and to inform Agency decision makers and the public about these procedures. In particular, the guidelines emphasize that risk assessments will be conducted on a case-by-case basis, giving full consideration to all relevant scientific information. This case-by-case approach means that Agency experts review the scientific information on each agent and use the most scientifically appropriate interpretation to assess risk. The guidelines also stress that this information will be fully presented in Agency risk assessment documents, and that Agency scientists will identify the strengths and weaknesses of each assessment by describing uncertainties, assumptions, and limitations, as well as the scientific basis and rationale for each assessment.

Finally, the guidelines are formulated in part to bridge gaps in risk assessment methodology and data. By identifying these gaps and the importance of the missing information to the risk assessment process, EPA wishes to encourage research and analysis that will lead to new risk assessment methods and data.

Guidelines for the Health Assessment of Suspect Developmental Toxicants

Work on the Guidelines for the Health Assessment of Suspect Developmental Toxicants began in January 1984. Draft guidelines were developed by Agency work groups composed of expert scientists from throughout the Agency. The drafts were peer-reviewed by expert scientists in the field of developmental toxicology from universities, environmental groups, industry, labor, and other governmental agencies. They were then proposed for public comment in the *FEDERAL REGISTER* (49 FR 46324). On November 9, 1984, the Administrator directed that Agency offices use the proposed guidelines in performing risk assessments until final guidelines become available.

REC 6201

After the close of the public comment period, Agency staff prepared summaries of the comments, analyses of the major issues presented by the commentors, and preliminary Agency responses to those comments. These analyses were presented to review panels of the SAB on March 4 and April 22-23, 1985, and to the Executive Committee of the SAB on April 25-26, 1985. The SAB meetings were announced in the *FEDERAL REGISTER* as follows: February 12, 1985 (50 FR 5811) and April 4, 1985 (50 FR 13420 and 13421).

In a letter to the Administrator dated June 19, 1985, the Executive Committee generally concurred on all five of the guidelines, but recommended certain revisions, and requested that any revised guidelines be submitted to the appropriate SAB review panel chairman for review and concurrence on behalf of the Executive Committee. As described in the responses to comments (see Part B: Response to the Public and Science Advisory Board Comments), each guidelines document was revised, where appropriate, consistent with the SAB recommendations, and revised draft guidelines were submitted to the panel chairmen. Revised draft Guidelines for the Health Assessment of Suspect Developmental Toxicants were concurred on in a letter dated July 26, 1985. Copies of the letters are available at the Public Information Reference Unit, EPA Headquarters Library, as indicated elsewhere in this section.

Following this Preamble are two parts: Part A contains the Guidelines and Part B, the Response to the Public and Science Advisory Board Comments (a summary of the major public comments, SAB comments, and Agency responses to those comments).

The SAB suggested that the Agency pursue additional follow-up work on quantitative risk assessment. Several efforts are currently underway within the Agency on quantitative risk assessment models and procedures, the relationship of maternal and developmental toxicity, and the evaluation and interpretation of postnatal studies. In addition, a document addressing research needs is being prepared to highlight those areas that are in need of further study.

The Agency is continuing to study the risk assessment issues raised in the guidelines and will revise these Guidelines in line with new information as appropriate.

References, supporting documents, and comments received on the proposed

[51 FR 34029]

guidelines, as well as copies of the final guidelines, are available for inspection and copying at the Public Information Reference Unit (202-382-5926), EPA Headquarters Library, 401 M Street, S.W., Washington, DC, between the hours of 8:00 a.m. and 4:30 p.m.

I certify that these Guidelines are not major rules as defined by Executive Order 12291, because they are nonbinding policy statements and have no direct effect on the regulated community. Therefore, they will have no effect on costs or prices, and they will have no other significant adverse effects on the economy. These Guidelines were reviewed by the Office of Management and Budget under Executive Order 12291.

August 22, 1986

Lee M. Thomas,

Administrator

CONTENTS

Part A: Guidelines for the Health Assessment of Suspect Developmental Toxicants

I. Introduction

II. Definitions and Terminology

III. Qualitative Assessment (Hazard Identification of Developmental Toxicants
- A. Laboratory Animal Studies of Developmental Toxicity: End Points and Their Interpretation
  - 1. End Points of Maternal Toxicity
  - 2. End Points of Developmental Toxicity
  - 3. Functional Developmental Toxicity
  - 4. Overall Evaluation of Maternal and Developmental Toxicity
  - 5. Short-term Testing in Developmental Toxicity
    - a. *In Vivo* Mammalian Developmental Toxicity Screen
    - b. *In Vitro* Developmental Toxicity Screens
  - 6. Statistical Considerations
- B. Human Studies
- C. Other Considerations
  - 1. Pharmacokinetics
  - 2. Comparisons of Molecular Structure
- D. Weight-of- Evidence Determination

IV. Quantitative Assessment
- *A. Dose-Response Assessment*
- *B. Exposure Assessment*
- *C. Risk Characterization*

V. References

Part B: Response to Public and Science Advisory Board Comments

I. Introduction

II. Coordination With Other Guidelines
- A. Other Risk Assessment Guidelines
- B. Coordination With Testing Guidelines

III. Definitions

IV. Qualitative Assessment
- A. Maternal and Developmental Toxicity
- B. Functional Developmental Toxicity
- C. Short-Term Testing
- D. Comparisons of Molecular Structure

V. Quantitative Assessment

REC 6202

Part A: Guidelines for the Health Assessment of Suspect Developmental Toxicants

I. Introduction

These Guidelines describe the procedures that the U.S. Environmental Protection Agency will follow in evaluating potential developmental toxicity associated with human exposure to environmental toxicants. In 1980, the Agency sponsored a conference that addressed issues related to such evaluations (1) and provided some of the scientific basis for these risk assessment Guidelines. The Agency's authority to regulate substances that have the potential to interfere adversely with human development is derived from a number of statutes which are implemented through multiple offices within the Agency. Because many different offices evaluate developmental toxicity, there is a need for intra-Agency consistency in the approach to assess these types of effects. The procedures described here will promote consistency in the Agency's assessment of developmental toxic effects.

The developmental toxicity assessments prepared pursuant to these Guidelines will be utilized within the requirements and constraints of the applicable statutes to arrive at regulatory decisions concerning developmental toxicity. These Guidelines provide a general format for analyzing and organizing the available data for conducting risk assessments. The Agency previously has issued testing guidelines (2, 3) that provide protocols designed to determine the potential of a test substance to induce structural and/or other abnormalities in the developing conceptus. These risk assessment Guidelines do not change any statutory or regulatory prescribed standards for the type of data necessary for regulatory action, but rather provide guidance for the interpretation of studies that follow the testing guidelines, and in addition, provide limited information for interpretation of other studies (e.g., epidemiologic data, functional developmental toxicity studies, and short-term tests) which are not routinely required, but which may be encountered when reviewing data on particular agents. Moreover, risk assessment is just one component of the regulatory process and defines the adverse health consequences of exposure to a toxic agent. The other component, risk management, combines risk assessment with the directives of the enabling regulatory legislation, together with socioeconomic, technical, political, and other considerations, to reach a decision as to whether or how much to control future exposure to the suspected toxic agent. The issue of risk management will not be addressed in these Guidelines.

The background incidence of developmental defects in the human population is quite large. For example, approximately 50% of human conceptuses fail to reach term (4); approximately 3% of newborn children are found to have one or more significant congenital malformations at birth, and by the end of the first postnatal year, about 3% more are found to have serious developmental defects (5, 6). Of these, it is estimated that 20% of human developmental defects are of known genetic transmission, 10% are attributable to known environmental factors, and the remainder result from unknown causes (7). Approximately 7.4% of children are reduced in weight at birth (i.e., below 2500 g) (8). Exposure to agents affecting development can result in multiple manifestations (malformation, functional impairment, altered growth, and/or lethality). Therefore, assessment efforts should encompass a wide array of adverse developmental end points, such as spontaneous abortions, stillbirths, malformations, early postnatal mortality, and other adverse functional or physical changes that are manifested postnatally.

Numerous agents have been shown to be developmental toxicants in animal test systems (9). Several of them have also been shown to be the cause of adverse developmental effects in humans, including alcohol, aminopterin, busulfan, chlorobiphenyls, diethylstilbestrol, isotretinoin, organic mercury, thalidomide, and valproic acid (10, 11, 12, 13). Although a number of agents found to be positive in animal studies have not shown clear evidence of hazard in humans, usually the human data available are inadequate to determine a cause and effect relationship. Comparisons of human and animal data have been made for a limited number of agents that are positive in humans (13, 14). In these comparisons, there was almost always concordance of effects between humans and at least one species tested; also, the minimally effective dose (MED) for the most sensitive animal species was approximately 0.5 to 50 times the human

[51 FR 34030]

MED, not accounting for differences in the incidence of effect at the MED. Thus, there is some limited basis for estimating the risk of exposure to human development based on data from animal studies.

The National Research Council (15) has defined risk assessment as being comprised of some or all of the following components: hazard identification, dose-response assessment, exposure assessment, and risk characterization. In general, the process of assessing the risk of human developmental toxicity may be adapted to this format. However, due to special considerations in assessing developmental toxicity, which will be discussed later in these Guidelines, it is not always possible to follow the exact standards as defined for each component.

Hazard identification is the qualitative risk assessment in which all available experimental animal and human data are used to determine if an agent is likely to cause developmental toxicity. In considering developmental toxicity, these Guidelines will address not only malformations, but

also fetal wastage, growth alteration, and functional abnormalities that may result from developmental exposure to environmental agents.

The dose-response assessment defines the relationship of the dose of an agent and the occurrence of developmental toxic effects. According to the National Research Council (15), this component would usually include the results of an extrapolation from high doses administered to experimental animals or noted in epidemiologic studies to the low exposure levels expected for human contact with the agent in the environment. Since at present there are no mathematical extrapolation models that are generally accepted for developmental toxicity, the Agency, for the most part, uses uncertainty (safety) factors and margins of safety, which will be discussed in these Guidelines. Appropriate models are being sought by the Agency for application to data in this area.

The exposure assessment identifies populations exposed to the agent, describes their composition and size, and presents the types, magnitudes, frequencies, and durations of exposure to the agent.

In risk characterization, the exposure assessment and the dose-response assessment are combined to estimate some measure of the risk of developmental toxicity. As part of risk characterization, a summary of the strengths and weaknesses in each component of the assessment are presented along with major assumptions, scientific judgments, and, to the extent possible, estimates of the uncertainties.

II. Definitions and Terminology

The Agency recognizes that there are differences in the use of terms in the field of developmental toxicology. For the purposes of these Guidelines the following definitions and terminology will be used.

Developmental Toxicology--The study of adverse effects on the developing organism that may result from exposure prior to conception (either parent), during prenatal development, or postnatally to the time of sexual maturation. Adverse developmental effects may be detected at any point in the life span of the organism. The major manifestations of developmental toxicity include: 1) death of the developing organism, 2) structural abnormality, 3) altered growth, and 4) functional deficiency.

Embryotoxicity and Fetotoxicity--Any toxic effect on the conceptus as a result of prenatal exposure; the distinguishing feature between the two terms is the stage of development during which the injury occurred. The terms, as used here, include malformations and variations, altered growth, and *in utero* death.

Altered Growth--An alteration in offspring organ or body weight or size. Changes in body weight may or may not be accompanied by a change in crown-rump length and/or in skeletal ossification. Altered growth can be induced at any stage of development, may be reversible, or may result in a permanent change.

Functional Developmental Toxicology--The study of the causes, mechanisms, and manifestations of alterations or delays in functional competence of the organism or organ system following exposure to an agent during critical periods of development pre- and/or postnatally.

Malformations and Variations--A malformation is usually defined as a permanent structural change that may adversely affect survival, development, or function. The term teratogenicity, which is used to describe these types of structural abnormalities, will be used in these Guidelines to refer only to structural defects. A variation is used to indicate a divergence beyond the usual range of structural constitution that may not adversely affect survival or health. Distinguishing between variations and malformations is difficult since there exists a continuum of responses from the normal to the extreme deviant. There is no generally accepted classification of malformations and variations. Other terminology that is often used, but no better defined, includes anomalies, deformations, and aberrations.

III. Qualitative Assessment (Hazard Identification of Developmental Toxicants)

Developmental toxicity is expressed as one or more of a number of possible end points that may be used for evaluating the potential of an agent to cause abnormal development. The four types of effects on the conceptus that may be produced by developmental exposure to toxicants include death, structural abnormality, altered growth, and functional deficits. Of these, the first three types of effects are traditionally measured in laboratory animals using the conventional developmental toxicity (also called teratogenicity or Segment II) testing protocol as well as in other study protocols, such as the multigeneration study. Functional deficits are seldom evaluated in routine studies of environmental agents. This section will discuss the end points examined in routinely used protocols as well as the evaluation of data from other types of studies, including functional studies and short-term tests. Transplacental carcinogenesis, another type of developmental effect, will not be discussed in detail here since, at present, it is considered more appropriate to use the Guidelines for Carcinogen Risk Assessment (16) for assessing the human risk for these types of effects. Also, mutational events may occur as part of developmental toxicity, and in practice, are difficult to discriminate from other possible mechanisms of developmental toxicity. The Guidelines for Mutagenicity Risk Assessment (17) should be consulted in cases where genetic damage is suspected.

A. Laboratory Animal Studies of Developmental Toxicity: End Points and Their Interpretation

The most commonly used protocol for assessing developmental toxicity in laboratory animals involves the administration of a test substance to pregnant animals (usually mice, rats, or rabbits) during the period of major organogenesis, evaluation of maternal responses throughout pregnancy, and examination of the dam and the uterine contents just prior to term (2, 3, 18, 19, 20). Other protocols may use exposure periods of one to a few days to investigate periods of particular sensitivity for induction of anomalies in specific organs or organ systems (21).In

[51 FR 34031]

addition, developmental toxicity may be evaluated in studies involving exposure of one or both parents prior to conception, of the conceptus during pregnancy and over several generations, or of offspring during the late prenatal and early postnatal periods. These Guidelines are intended to provide information for interpreting developmental effects related to any of these types of exposure. Since many of the end points evaluated also are related to effects on the parental reproductive systems, these Guidelines will be used in conjunction with those to be published in the future by EPA on male and female reproductive toxicity.

Study designs should include a high dose, which produces some maternal or adult toxicity (i.e., a level which at the least produces marginal but significantly reduced body weight, weight gain, or specific organ toxicity, and at the most produces no more than 10% mortality); a low dose, which demonstrates a no observed effect level (NOEL) for adult and offspring effects; and at least one intermediate dose level. A concurrent control group treated with the vehicle used for agent administration should be included. The route of exposure should be based on expected human exposure considerations, although data from other routes may sometimes be useful, especially if supported by pharmacokinetic information. Test animals should be selected based on considerations of species, strain, age, weight, and health status, and should be randomized to dose groups in order to reduce bias and provide a basis for performing valid statistical tests.

The next three sections discuss individual end points of maternal and developmental toxicity as measured in the conventional developmental toxicity study, the multigeneration study, and, on occasion, in postnatal studies. Other end points specifically related to reproductive toxicity will be covered in the relevant reproductive toxicity guidelines. The fourth section deals with the integrated evaluation of all data, including the relative effects of exposure on maternal animals and their offspring, which is important in assessing the level of concern about a particular agent.

1. End Points of Maternal Toxicity. A number of end points that may be observed as possible indicators of maternal toxicity are listed in Table 1. Maternal mortality is an obvious end point of toxicity; however, a number of other end points can be observed which may give an indication of the subtle effects of an agent. For example, in well-conducted studies, the fertility and gestation indices provide information on the general fertility rate of the animal stock used and are important indicators of toxic effects if treatment begins prior to mating or implantation. Changes in gestation length may indicate effects on the process of parturition.

Table 1.--End Points of Maternal Toxicity

Mortality
Fertility Index (no. with seminal plugs or sperm/no. mated)
Gestation Index (no. with implants/no. with seminal plugs or sperm)
Gestation Length (when allowed to deliver pups)
Body Weight
  Treatment days (at least first, middle, and last treatment days)
  Sacrifice day
Body Weight Change
  Throughout gestation
  During treatment (including increments of time within treatment period)
  Post-treatment to sacrifice
  Corrected maternal (body weight change throughout gestation minus gravid uterine weight or litter weight at sacrifice)
Organ Weights (in cases of suspected specific organ toxicity)
  Absolute
  Relative to body weight
Food and Water Consumption (where relevant)
Clinical Evaluations (on days of treatment and at sacrifice)
  Types and incidence of clinical signs
  Enzyme markers
  Clinical chemistries
Gross Necropsy and Histopathology

Body weight and the change in body weight are viewed collectively as indicators of maternal toxicity for most species, although these end points may not be as useful in rabbits, because body weight changes in rabbits are not good indicators of pregnancy status. Body weight changes may provide more information than a daily body weight measured during treatment or during gestation. Changes in weight during treatment could occur that would not be reflected in the total weight change throughout gestation, because of compensatory weight gain that may occur following treatment but before sacrifice. For this reason, changes in weight during treatment

REC 6205

can be examined as another indicator of maternal toxicity.

Changes in maternal body weight corrected for gravid uterine weight at sacrifice may indicate whether the effect is primarily maternal or fetal. For example, there may be a significant reduction in weight gain throughout gestation and in gravid uterine weight, but no change in corrected maternal weight gain which would indicate primarily an intrauterine effect. Conversely, a change in corrected weight gain and no change in gravid uterine weight suggests primarily maternal toxicity and little or no intrauterine effect. An alternate estimate of maternal weight change during gestation can be obtained by subtracting the sum of the weights of the fetuses. However, this weight does not include the uterine tissue, placental tissue, or the amniotic fluid.

Changes in other end points should also be determined. For example, changes in relative and absolute organ weights may be signs of a maternal effect when an agent is suspected of causing specific organ toxicity. Food and water consumption data are useful, especially if the agent is administered in the diet or drinking water. The amount ingested (total and relative to body weight) and the dose of the agent (relative to body weight) can then be calculated, and changes in food and water consumption related to treatment can be evaluated along with changes in body weight and body weight gain. Data on food and water consumption are also useful when an agent is suspected of affecting appetite, water intake, or excretory function. Clinical evaluations of toxicity may also be used as indicators of maternal toxicity. Daily clinical observations may be useful in describing the profile of maternal toxicity. Enzyme markers and clinical chemistries may be useful indicators of exposure but must be interpreted carefully as to whether or not a change constitutes toxicity. Gross necropsy and histopathology data (when specified in the protocol) may aid in determining toxic dose levels.

2. End Points of Developmental Toxicity. Because the maternal animal, and not the conceptus, is the individual treated during gestation, data generally should be calculated as incidence per litter or as number and percent of litters with particular end points.Table 2 indicates the way in which offspring and litter end points may be expressed.

Table 2.--End Points of Developmental Toxicity.

Litters with implants

No. implantation sites/dam
No. corpora lutea (CL)/dam[a]
Percent preimplantation loss

$$\frac{(\text{CL} - \text{implantations}) \times 100}{\text{CL}}$$ [a]

No. and percent live offspring/litter
No. and percent resorptions/litter
No. and percent litters with resorptions
[51 FR 34032]
No. and percent late fetal deaths/litter
No. and percent nonlive (late fetal deaths + resorptions) implants/litter
No. and percent litters with nonlive implants
No. and percent affected (nonlive + malformed) implants/litter
No. and percent litters with affected implants
No. and percent litters with total resorptions
No. and percent stillbirths/litter

Litters with live offspring[b]

No. and percent litters with live offspring
No. and percent live offspring/litter
Viability of offspring[c]
Sex ratio/litter
Mean offspring body weight/litter[c]
Mean male body weight/litter[c]
Mean female body weight/litter[c]
No. and percent externally malformed offspring/litter
No. and percent viscerally malformed offspring/litter
No. and percent skeletally malformed offspring/litter
No. and percent malformed offspring/litter
No. and percent litters with malformed offspring
No. and percent malformed males/litter
No. and percent malformed females/litter
No. and percent offspring with variations/litter
No. and percent litters having offspring with variations
Types and incidence of individual malformations
Types and incidence of individual variations
Individual offspring and their malformations and variations (grouped according to litter and dose)
Clinical signs[c]
Gross necropsy and histopathology

[a] Important when treatment begins prior to implantation. May be difficult in mice.

[b] Offspring refers both to fetuses observed prior to term or to pups following birth. The end points examined depend on the protocol used for each study.

[c] Measured at selected intervals until termination of the study.

When treatment begins prior to implantation, an increase in preimplantation loss could indicate an adverse effect either on the developing blastocyst or on the process of implantation itself. If treatment begins around the time of implantation (i.e., day 6 of gestation in the mouse, rat, or rabbit), an increase in preimplantation loss probably reflects normal variability in the animals being used, but the data should be examined carefully to determine whether or not the effect is dose related. If preimplantation

loss is related to dose in either case, further studies would be necessary to determine the mechanism and extent of such effects.

The number and percent of live offspring per litter, based on all litters, may include litters that have no live implants. The number and percent resorptions or late fetal deaths per litter gives some indication of when the conceptus died, and the number and percent nonlive implants per litter (postimplantation loss) is a combination of resorptions and late fetal deaths. The number and percent of litters showing an increased incidence for these end points is generally useful but may be less useful than incidence per litter because, in the former case, a litter is counted whether it has one or all resorbed, dead, or nonlive implants.

If a significant increase in postimplantation loss is found after exposure to an agent, the data may be compared not only with concurrent controls, but also with recent historical control data, since there is considerable interlitter variability in the incidence of postimplantation loss (22). If a given study control group exhibits an unusually high or low incidence of postimplantation loss compared to historical controls, then scientific judgment must be used to determine the adequacy of the studies for risk assessment purposes.

The end point for affected implants (i.e., the combination of nonlive and malformed conceptuses) gives an indication of the total intrauterine response to an agent and sometimes reflects a better dose-response relationship than does the incidence of nonlive or malformed offspring taken individually. This is especially true at the high end of the dose-response curve in cases when the incidence of nonlive implants per litter is greatly increased. In such cases, the malformation rate may appear to decrease because only unaffected offspring have survived. If the incidence of prenatal death or malformation is unchanged, then the incidence of affected implants will not provide any additional dose-response information. In studies where maternal animals are allowed to deliver pups normally, the number of stillbirths per litter should also be noted.

The number of live offspring per litter, based on those litters that have one or more live offspring, may be unchanged even though the incidence of nonlive in all litters is increased. This could occur either because of an increase in the number of litters with no live offspring, or an increase in the number of implants per litter. A decrease in the number of live offspring per litter should be accompanied by an increase in the incidence of nonlive implants per litter, unless the implant numbers differ among dose groups. In postnatal studies, the viability of live born offspring should be determined at selected intervals until termination of the study.

The sex ratio per litter, as well as the body weights of males and females, can be examined to determine whether or not one sex is preferentially affected by the agent. However, this is an unusual occurrence.

A change in offspring body weight is a sensitive indicator of developmental toxicity, in part because it is a continuous variable. In some cases, offspring weight reduction may be the only indicator of developmental toxicity; if so, there is always a question remaining as to whether weight reduction is a permanent or transitory effect. A permanent weight change may be considered more severe than a transitory change, although little is known about the long-term consequences of short-term fetal or neonatal weight changes. When fetal or neonatal weight reduction is the only indicator of developmental toxicity, data from the two-generation reproduction study (2), if available, may be useful for evaluating these parameters. Ideally, follow-up studies to evaluate postnatal viability, growth, and survival through weaning should be conducted. There are other factors that should be considered in the evaluation of fetal or neonatal weight changes. For example, in polytocous animals, fetal and neonatal weights are usually inversely correlated with litter size, and the upper end of the dose-response curve may be confounded by smaller litters and increased fetal or neonatal weight. Additionally, the average body weight of males is greater than that of females in the more commonly used laboratory animals.

Live offspring should be examined for external, visceral, and skeletal malformations. If only a portion of the litter is examined, then it is preferable that those examined be randomly selected from each litter. An increase in the incidence of malformed offspring may be indicated by a change in one or more of the following end points: the incidence of malformed offspring per litter, the number and percent of litters with malformed offspring, or the number of offspring or litters with a particular malformation that appears to increase with dose as indicated by the incidence of individual types of malformations.

[51 FR 34033]

Other ways of examining the data include the incidence of external, visceral, and skeletal malformations which may indicate which general systems are affected. A listing of individual offspring with their malformations and variations may give an indication of the pattern of developmental deviations. All of these methods of expressing and examining the data are valid for determining the effects of an agent on structural development. However, care must be taken to avoid counting offspring more than once in evaluating any single end point based on number or percent of offspring or litters. The incidence of individual types of malformations and variations should be examined

for significant changes which may be masked if the data on all malformations and variations are pooled. Appropriate historical control data are helpful in the interpretation of malformations and variations, especially those that normally occur at a low incidence apparently unrelated to dose in an individual study. Although a dose-related increase in malformations is interpreted as an adverse developmental effect of exposure to an agent, the significance of anatomical variations is more difficult to determine, and must take into account what is known about developmental stage (e.g., with skeletal ossification), background incidence of certain variations (e.g., 12 or 13 pairs of ribs in rabbits), or other strain - or species-specific factors. However, if variations are significantly increased in a dose-related manner, these should also be evaluated as a possible indication of developmental toxicity. The Interagency Regulatory Liaison Group noted that dose-related increases in defects, which may occur spontaneously, are as relevant as dose-related increases in any other developmental toxicity end points (23).

3. *Functional Developmental Toxicology.* Developmental effects, which are inducible by exogenous agents, are not limited to death, structural abnormalities, and altered growth. Rather, it has been demonstrated in a number of instances that subtle alterations in the functional competence of an organ or a variety of organ systems may result from exposure during critical developmental periods that may occur between conception and sexual maturation. Often, these functional defects are observed at dose levels below those at which gross malformations are evident (24). At present, such testing is not routinely required in the United States. However, data from postnatal studies, when available, are considered very useful for the assessment of the relative importance and severity of findings in the fetus and neonate. Often, the long-term consequences of adverse developmental outcomes at birth are unknown, and further data on postnatal development and function may contribute valuable information. When regulatory statutes permit, studies designed to evaluate adverse fetal or neonatal outcomes have been requested (e.g., the Office of Pesticide Programs has sometimes requested postnatal studies where the reversibility of study findings were at issue). In some cases, useful data can be derived from well-executed multigeneration studies.

Much of the early work in functional developmental toxicology was related to behavioral evaluations, and the term "behavioral teratology" became prominent in the mid 1970s. Less work has been done on other functional systems, but sufficient data have accumulated to indicate that the cardiopulmonary, immune, endocrine, digestive, urinary, nervous, and reproductive systems are subject to alterations in functional competence (25, 26). Currently, there are no standard testing procedures, although some attempts are being made to standardize and evaluate tests and protocols (27). The functional evaluation of specific systems often involves highly specialized training and equipment. The routine use of such test procedures may not always be practical, but may be extremely important in determining the nature of a suspected alteration in terms of its biological significance and dose-response relationship.

The interpretation of data from functional developmental toxicology studies is limited due to the lack of knowledge about the underlying toxicological mechanisms and their significance. However, since such data are sometimes encountered in the risk assessment of particular agents, some guidance is provided here concerning general concepts of study design and evaluation.

a. Several aspects of study design are similar to those important in standard developmental toxicity studies (e.g., a dose-response approach with the highest dose producing minimal overt maternal or perinatal toxicity, number of litters large enough for adequate statistical power, randomization of animals to dose groups, litter generally considered the statistical unit, etc.).

b. A replicate study design provides added confidence in the interpretation of data.

c. Use of a pharmacological challenge may be valuable in evaluating function and "unmasking" effects not otherwise detectable, particularly in the case of organ systems that are endowed with a reasonable degree of functional reserve capacity.

d. Use of functional tests with a moderate degree of background variability may be more sensitive to the effects of an agent than are tests with low variability that may be impossible to disrupt without being life-threatening. Butcher et al. (28) have discussed this with relation to behavioral end points.

e. A battery of functional tests usually provides a more thorough evaluation of the functional competence of an animal; tests conducted at several ages may provide more information about maturational changes.

f. Critical periods for the disruption of functional competence include both the prenatal and the postnatal periods to the time of sexual maturation, and the effect is likely to vary depending on the time and degree of exposure.

Although interpretation of functional data may be difficult at present, there are at least three ways in which the data from these studies may be useful for risk assessment purposes: 1) to help elucidate the long-term consequences of fetal and neonatal findings; 2) to indicate the potential for an agent to cause functional alterations, and the effective doses relative to those that produce other forms of toxicity;

and 3) for existing environmental agents, to focus on organ systems to be evaluated in exposed human populations.

4. *Overall Evaluation of Maternal and Developmental Toxicity.* As discussed previously, individual end points are evaluated in developmental toxicity studies, but an integrated evaluation must be done considering all maternal and developmental end points in order to interpret the data fully. Developmental toxicity is considered to be an increase in the incidence of malformed offspring, decreased viability (prenatal or postnatal), altered growth, and/or functional deficits.

The level of concern for a developmental toxic effect is related to several issues, including the relative toxicity of an agent to the offspring versus the adult animal, and the long-term consequences of findings in the fetus or neonate. Those agents which produce developmental toxicity at a dose that is not toxic to the maternal animal are of greatest concern because the developing organism appears to be selectively affected or more sensitive than the adult. However, when developmental effects are produced only

[51 FR 34034]

at maternally toxic doses, the types of developmental effects should be examined carefully, and not discounted as being secondary to maternal toxicity. Current information is inadequate to assume that developmental effects at maternally toxic doses result only from the maternal toxicity; rather, when the lowest observed effect level is the same for the adult and developing organisms, it may simply indicate that both are sensitive to that dose level. Moreover, the maternal effects may be reversible while effects on the offspring may be permanent. These are important considerations for agents to which humans may be exposed at minimally toxic levels either voluntarily or in the workplace, since several agents are known to produce adverse developmental effects at minimally toxic doses in adult humans (e.g., smoking, alcohol).

Approaches for ranking agents for their selective developmental toxicity are being developed; Schardein (10) has reviewed several of these. Of current interest are approaches that develop ratios relating an adult toxic dose to a developmental toxic dose (29, 30, 31, 32). Ratios near unity indicate that developmental toxicity occurs only at doses producing maternal toxicity; as the ratio increases, there is a greater likelihood of developmental effects occurring without maternal manifestations. Although further exploration and validation are necessary, such approaches may ultimately help in identifying those agents that pose the greatest threat and should be given higher priority for further testing (33).

5. *Short-term Testing in Developmental Toxicity.* The need for short-term tests for developmental toxicity has arisen from the large number of agents in or entering the environment, the interest in reducing the number of animals used for routine testing, and the expense of testing. Two approaches are considered here in terms of their contribution to the overall testing process: 1) an *in vivo* mammalian screen, and 2) a variety of *in vitro* systems. Currently, neither approach is considered as a replacement for routine *in vivo* developmental toxicity testing in experimental animals, and should not be used to make the final decision as to whether an agent is a positive or negative developmental toxicant; rather, such tests may be useful as tools for assigning priorities for further, more extensive testing. Although such short-term tests are not routinely required, data are sometimes encountered in the review of chemicals; the comments are provided here for guidance in the evaluation of such data.

a. *In Vivo* Mammalian Developmental Toxicity Screen. The most widely studied *in vivo* approach is that developed by Chernoff and Kavlock (34) which uses the pregnant mouse. This approach is based on the hypothesis that a prenatal injury, which results in altered development, will be manifested postnatally as reduced viability and/or impaired growth. In general, the test substance is administered over the period of major organogenesis at a single dose level that will elicit some degree of maternal toxicity. A second lower dose level may be used which potentially will reduce the chances of false positive results. The pups are counted and weighed shortly after birth, and again after 3-4 days. End points that are considered in the evaluation include: general maternal toxicity (including survival and weight gain), litter size, and viability, weight, and gross malformations in the offspring. Basic priority-setting categories for more extensive testing have been suggested: 1) agents that induce perinatal death should receive highest priority, 2) agents inducing perinatal weight changes should be ranked lower in priority, and 3) agents inducing no effect should receive the lowest priority (34). Another scheme that has been proposed applies a numerical ranking to the results as a means of prioritizing agents for further testing (35, 36).

The mouse was chosen originally for this test because of its low cost, but the procedure should be easily applicable to other species. However, the test will only predict the potential for developmental toxicity of an agent in the species utilized and does not improve the ability to extrapolate risk to other species, including humans. The Office of Toxic Substances has developed testing guidelines for this procedure (37). Although the testing guidelines are available, such procedures are not routinely

REC 6209

required, and further validation is currently being carried out (38).

b. *In Vitro* Developmental Toxicity Screens. Test systems that fall under the general heading of "*in vitro*" developmental toxicity screens include any system that employs a test subject other than the intact pregnant mammal. These systems have long been used to assess events associated with normal and abnormal development, but only recently have they been considered for their potential as screens in testing (39, 40, 41). Many of these systems are now being evaluated for their ability to predict the developmental toxicity of various agents in intact mammalian systems. This validation process requires certain considerations in study design, including defined end points for toxicity and an understanding of the system's ability to handle various test agents (40, 42). A list of agents for use in such validation studies has been developed (43).

6. *Statistical Considerations.* In the assessment of developmental toxicity data, statistical considerations require special attention. Since the litter is generally considered the experimental unit in most developmental toxicity studies, the statistical analyses should be designed to analyze the relevant data based on incidence per litter or on the number of litters with a particular end point. The analytical procedures used and the results, as well as an indication of the variance in each end point, should be clearly indicated in the presentation of data. Analysis of variance (ANOVA) techniques, with litter nested within dose in the model, take the litter variable into account but allow use of individual offspring data and an evaluation of both within and between litter variance as well as dose effects. Nonparametric and categorical procedures have also been widely used for binomial or incidence data. In addition, tests for dose-response trends can be applied. Although a single statistical approach has not been agreed upon, a number of factors important in the analysis of developmental toxicity data have been discussed (23, 44).

Studies that employ a replicate experimental design (e.g., two or three replicates with 10 litters per dose per replicate rather than a single experiment with 20-30 litters per dose group) allow for broader interpretation of study results since the variability between replicates can be accounted for using ANOVA techniques. Replication of effects due to a given agent within a study, as well as between studies or laboratories, provides added strength in the use of data for the estimation of risk.

An important factor to determine in evaluating data is the power of a study (i.e., the probability that a study will demonstrate a true effect), which is limited by the sample size used in the study, the background incidence of the end point observed, the variability in the incidence of the end point, and the analysis method. As an example, Nelson and Holson (45) have shown that the number of litters needed to detect a 5 or 10% change was dramatically lower for fetal weight (a continuous variable with low variability) than for resorptions (a binomial response with high variability). With the current recommendation in

[51 FR 34035]

testing protocols being 20 rodents per dose group (2, 3), it is possible to detect an increased incidence of malformations in the range of 5 to 12 times above control levels, an increase of 3 to 6 times the *in utero* death rate, and a decrease of 0.15 to 0.25 times the fetal weight. Thus, even within the same study, the ability to detect a change in fetal weight is much greater than for the other end points measured. Consequently, for statistical reasons only, changes in fetal weight are often observable at doses below those producing other signs of developmental toxicity. Any risk assessment should present the detection sensitivity for the study design used and for the end point(s) evaluated.

Although statistical analyses are important in determining the effects of a particular agent, the biological significance of data should not be overlooked. For example, with the number of end points that can be observed in developmental toxicity studies, a few statistically significant differences may occur by chance. On the other hand, apparent trends with dose may be biologically relevant even though statistical analyses do not indicate a significant effect. This may be true especially for the incidence of malformations or *in utero* death where a relatively large difference is required to be statistically significant. It should be apparent from this discussion that a great deal of scientific judgment based on experience with developmental toxicity data and with principles of experimental design and statistical analysis may be required to adequately evaluate such data.

B. Human Studies

Because of the ethical considerations involved, studies with deliberate dosing of humans are not done. Therefore, dose-effect developmental toxicity data from humans are limited to those available from occupational, environmental, or therapeutic exposures. While animal studies provide dose-response data that can be used in the extrapolation of risk to humans, good epidemiologic data provide the best information for assessing human risk.

The category of "human studies" includes both epidemiologic studies and other reports of cases or clusters of events. While case reports have been important in identifying several human teratogens, they are potentially of greater value in identifying topics for further investigation (46). The data from case reports are often of an anecdotal or highly selected nature, and thus are of limited usefulness for risk assessment except when a unique defect is produced, as with thalidomide, or when the agent is

so potent as to greatly increase the incidence of a particular defect(s).

As there are many different designs for epidemiologic studies, simple rules for their evaluation do not exist. The assessment of epidemiologic studies requires a sophisticated level of understanding of the appropriate epidemiologic and statistical methods and interpretation of the findings. Factors that increase a study's usefulness for risk assessment include such things as the examination of multiple end points and exposure levels, the validity of the data, and proper control of other risk factors, effect modifiers, and confounders in the study design and/or analysis. A more in-depth discussion can be found elsewhere (47).

As described earlier, a single developmental toxicant can result in multiple end points (malformations, functional impairment, altered growth, and/or lethality). These end points can be thought of as sequential competing risks. For example, a malformed fetus spontaneously aborted would not be observed in a study of births with malformations (48). Very early conceptus losses may not be identified in human populations, whereas in most laboratory animal studies, all resorption sites can be identified. Many epidemiologic studies, especially of the case-control design, have focused on one end point, possibly missing a true effect of exposure. Furthermore, some studies have selected one type or class of malformations to study. Since an agent can result in different spectra of malformations following exposure at different times in the pregnancy (49), limiting a study to one class of malformation may give misleading results. Malformations can be meaningfully grouped only if there is a logical underlying teratogenic mechanism or pathogenetic pathway. As a minimum, malformations, deformations, and disruptions should be separated.

The power, or probability of a study to detect a true effect, is dependent upon the size of the study group, the frequency of the outcome in the general population, and the level of excess risk to be identified. Rarer outcomes, such as malformations, require thousands of pregnancies to have a high probability of detecting an increase in risk. More common outcomes, such as fetal loss, require hundreds of pregnancies to have the same probability (8, 23, 50, 51, 52, 53). The confidence one has in the results of a study with negative findings is directly related to the power of the study to detect clinically meaningful differences in incidence for the end points studied.

As in animal studies, pregnancies within the same family (or litter) are not independent events. In animal studies, the litter is generally used as the unit of measure. This approach is difficult in humans since the pregnancies are sequential, with the risk factors changing for the different pregnancies (23, 51, 54). If more than one pregnancy per family is included, and this is often necessary due to small study groups, the use of non-independent observations overestimates the true size of the population at risk and artificially increases the significance level (54).

Other criteria for evaluating epidemiologic studies include the following (23, 50, 52, 55, 56, 57, 58):

1. The potential for complete or relatively complete ascertainment of events for study. This can vary by outcome and by data source; for example, if hospital records are used, early fetal losses will be underascertained, but a more complete list of pregnancies could be obtained by interviewing the women. Congenital malformations can be more completely ascertained using hospital records than birth certificates. Studies with relatively complete ascertainment of events, or at least low probability of unbiased ascertainment, should carry more weight.

2. Validity (accuracy) of the data. Recall of past events in interviews may be faulty, while hospital files contain data recorded at the time of the event (but may be incomplete). Validation of interview data with an independent source, where possible, increases confidence in the results of the study.

3. Collection of data on other risk factors, effect modifiers, and confounders. Data on smoking, alcohol consumption, drug use, and environmental and occupational exposure, etc., during pregnancy should be examined and controlled for in the study design and/or analysis where appropriate. The analytic techniques used to control for these factors require careful consideration in their application and interpretation.

C. Other Considerations

1. *Pharmacokinetics.* Extrapolation of data between species can be aided considerably by the availability of data on the pharmacokinetics of a particular agent in the species tested and, if possible, in humans. Information on half-lives, placental metabolism and transfer, and concentrations of the parent compound and metabolites in the

[51 FR 34036]

maternal animal and conceptus may be useful in predicting risk for developmental toxicity. Such data may also be helpful in defining the dose-response curve, developing a more accurate comparison of species sensitivity including that of humans (59, 60), determining dosimetry at target sites, and comparing pharmacokinetic profiles for various dosing regimens or routes of exposure. Pharmacokinetic studies in developmental toxicology are most useful if conducted in pregnant animals at the stage when developmental insults occur. The correlation of pharmacokinetic parameters and developmental toxicity data may be

REC 6211

useful in determining the contribution of specific pharmacokinetic parameters to the effects observed (61).

2. *Comparisons of Molecular Structure.* Comparisons of the chemical or physical properties of an agent with those of known developmental toxicants may provide some indication of a potential for developmental toxicity. Such information may be helpful in setting priorities for testing of agents or for evaluation of potential toxicity when only minimal data are available. Structure/activity relationships have not been well studied in developmental toxicology, although data are available that suggest structure-activity relationships for certain classes of chemicals (e.g., glycol ethers, steroids, retinoids). Under certain circumstances (e.g., in the case of new chemicals), this is one of several procedures used to evaluate the potential for toxicity when little or no data are available.

D. Weight-of-Evidence Determination

Information available from studies discussed previously, whether indicative of potential concern or not, must be evaluated and factored into the risk assessment. The types of data may vary from chemical to chemical, and certain types of data may be more relevant than other types in performing developmental toxicity assessments. The primary considerations are the human data (which are seldom available) and the experimental animal data. The qualitative assessment for developmental toxicity should include statements concerning the quality of the data, the resolving power of the studies, the number and types of end points examined, the relevance of route and timing of exposure, the appropriateness of the dose selection, the replication of the effects, the number of species examined, and the availability of human case reports, case series, and/or epidemiologic study data. In addition, pharmacokinetic data and structure-activity considerations, as well as other factors that may affect the quality, should be taken into account. Therefore, all data pertinent to developmental toxicity should be examined in the evaluation of a chemical's potential to cause developmental toxicity in humans, and sound scientific judgment should be exercised in interpreting the data in terms of the risk for adverse human developmental health effects.

IV. Quantitative Assessment

Risk assessment involves the description of the nature and often the magnitude of potential human risk, including a description of any attendant uncertainty. In the final phase of the risk assessment (risk characterization), the results of the qualitative evaluation (hazard identification), the dose-response, and the exposure assessments are combined to give qualitative and/or quantitative estimates of the developmental toxicity risk. A summary of the strengths and weaknesses of the hazard identification, dose-response assessment, and exposure assessment should be discussed. Major assumptions, scientific judgments, and, to the extent possible, estimates of the uncertainties in the assessment also should be presented.

A. Dose-Response Assessment

When quantitative human dose-effect data are available and with sufficient range of exposure, dose-response relationships may be examined. However, such data have rarely been available; thus, other methods have been used in developmental toxicology for estimating exposure levels that are unlikely to produce adverse effects in humans. The dose-response assessment is usually based on the evaluation of tests performed in laboratory animals. Evidence for a dose-response relationship is an important criterion in the assessment of developmental toxicity, although this may be based on limited data from standard three-dose studies. As mentioned earlier (section III. A. 2.), however, traditional dose-response relationships may not always be observed for some end points. For example, as the exposure level rises, embryo/fetolethal levels may be reached, resulting in an observed decrease in malformations with increasing dose (49, 51). The potential for this relationship indicates that dose-response relationships for individual end points as well as combinations of end points (e.g., dead and malformed combined) must be carefully examined and interpreted.

Although dose-response data are important in this area, the approaches frequently employed in attempts to extrapolate to humans has involved simply the use of uncertainty (safety) factors and margins of safety, which in some respects are conceptually similar. However, uncertainty factors and margins of safety are computed differently and are often used in different regulatory situations. The choice of approach is dependent upon many factors, including the statute involved, the situation being addressed, the data base used, and the needs of the decision-maker. The final uncertainty factor used and the acceptability of the margin of safety are risk management decisions, but the scientific issues that must be taken into account are addressed here.

The uncertainty factor approach results in a calculated exposure level believed to be unlikely to cause any toxic developmental response in humans. The size of the uncertainty factor will vary from agent to agent and will require the exercise of scientific judgment (10, 62), taking into account interspecies differences, the nature and extent of human exposure, the slope of the dose-response curve, the types of developmental effects observed, and the relative dose levels for maternal and developmental toxicity in the test species. The uncertainty factor selected is then divided into the NOEL for the most sensitive end point obtained from

REC 6212

the most appropriate and/or sensitive mammalian species examined to obtain an acceptable exposure level. Currently, there is no one laboratory animal species that can be considered most appropriate for predicting risk to humans (10). Each agent should be considered on a case-by-case basis.

The margin of safety approach derives a ratio of the NOEL from the most sensitive species to the estimated human exposure level from all potential sources (63). The adequacy of the margin of safety is then considered, based on the weight of evidence, including the nature and quality of the hazard and exposure data, the number of species affected, dose-response relationships, and other factors such as benefits of the agent.

Although the standard study design for a developmental toxicity study calls for a low dose that demonstrates a NOEL, there may be circumstances where a risk assessment is based on the results of a study in which a NOEL for developmental toxicity could not be identified. Rather, the lowest dose administered caused significant effect(s) and was identified as the lowest observed effect level (LOEL). In circumstances where only a LOEL is available, it may be appropriate to apply

[51 FR 34037]

an additional uncertainty factor. The magnitude of this additional factor is dependent upon scientific judgment. In some instances, additional studies may be needed to strengthen the confidence in this additional uncertainty factor.

B. Exposure Assessment

The results of the dose-response assessment are combined with an estimate of human exposure in order to obtain a quantitative estimate of risk. The Guidelines for Estimating Exposures are published separately (64) and will not be discussed in detail here. In general, the exposure assessment describes the magnitude, duration, schedule, and route of exposure. This information is developed from monitoring data and from estimates based on modeling of environmental exposures. Unique considerations relevant to developmental toxicity are duration and period of exposure as related to stage of development (i.e., critical periods), and the possibility that a single exposure may be sufficient to produce adverse developmental effects (i.e., chronic exposure is not a necessary prerequisite for developmental toxicity to be manifested). Also, it should be recognized that exposure of almost any segment of the human population (i.e., fertile men and women, the conceptus, and the child up to the age of sexual maturation) may lead to risk to the developing organism.

Data on exposure to humans may be qualitative or quantitative. The qualitative data could be surrogate data, such as employment or residence histories; quantitative or dose data are frequently not available. Exposures at different stages of the reproductive process can result in different outcomes (49). In laboratory studies, these time periods can be carefully controlled. In human studies, especially retrospective ones, linking of specific time periods and specific exposures, even on a qualitative level, may be difficult due to errors of recall or record keeping (where records are available). The increased probability of misclassification of exposure status may affect the ability of a study to recognize a true effect (8, 23, 52, 65, 66).

Exposure may be defined at a specific point in time, or the cumulative lifetime exposure up to a specific point in time. Each of these definitions carries an implicit assumption about the underlying relationship between exposure and outcome. For example, a cumulative exposure measure assumes that total lifetime exposure is important, with a greater probability of effect with greater total exposure; a dichotomous exposure measure (ever exposed versus never exposed) assumes an irreversible effect of exposure; and exposure at a specific time in the reproductive process assumes that only concurrent exposure is important. The appropriate exposure depends on the outcome(s) studied, the biologic mechanism affected by exposure, and the half-life of the exposure. Unbiased misclassification of exposure, due either to poor data or to an inappropriate exposure variable, may result in missing an effect of the agent under study.

C. Risk Characterization

Many uncertainties have been pointed out in these Guidelines which are associated with the toxicological and exposure components of risk assessments in developmental toxicology. In the past, these uncertainties have often not been readily apparent or consistently presented. The presentation of any risk assessment for developmental toxicity should be accompanied by statements concerning the strength of the hazard evaluation (see section III. D. for more detail) as well as dose-response relationships, estimates of human exposure, and any other factors that affect the quality and precision of the assessment. The dose-response and exposure data are combined to estimate risk based on a NOEL for any adverse developmental effect. The uncertainty factor selected or margin of safety calculated should be sufficiently qualified as to the assumptions used and the accuracy of the estimates.

At present, there are no mathematical models that are generally accepted for estimating developmental toxicity responses below the applied dose range. This is due primarily to a lack of understanding of the biological mechanisms underlying developmental toxicity, intra/interspecies differences in the types of developmental events, the influence of maternal effects on the dose-response curve, and whether or not a threshold exists below which no effect will be

REC 6213

produced by an agent. Many developmental toxicologists assume a threshold for most developmental effects; this assumption is based largely on the biological rationale that the embryo is known to have some capacity for repair of the damage or insult (49), and that most developmental deviations are probably multifactorial in nature (67). The existence of a NOEL in an animal study does not prove or disprove the existence or level of a true threshold; it only defines the highest level of exposure under the conditions of the test that are not associated with a significant increase in effect. The use of NOELs and uncertainty factors or margins of safety are attempts to ensure that the allowable levels are below those that will produce a significant increase in developmental effects.

Discussions of risk extrapolation procedures have noted that further work is needed to improve mathematical tools for developing estimates of potential human developmental risk (62, 68). Gaylor (69) has suggested an approach for controlling risk that combines the use of mathematical models for low-dose estimation of risk with the application of an uncertainty factor based on a preselected level of allowable risk. This approach is similar to approaches proposed for carcinogenesis, but does not preclude the possibility of a threshold, and may provide a more quantitative approach to controlling risk. Several such approaches are being examined. For the most part, the Agency will continue to use uncertainty factors and margins of safety as described above. Other appropriate methods for expressing risk are being sought and will be applied if considered acceptable.

These Guidelines summarize the procedures that the U.S. Environmental Protection Agency will follow in evaluating the potential for agents to cause developmental toxicity. These Guidelines will be reviewed and updated as advances are made in the field, since it is evident that our ability to evaluate and predict human developmental toxicity is imprecise. Further studies that 1) delineate the mechanisms of developmental toxicity and pathogenesis, 2) provide comparative pharmacokinetic data, and 3) elucidate the functional modalities that may be altered by exposure to toxic agents will aid in the interpretation of data and interspecies extrapolation. These types of studies, along with further evaluation of the relationship between maternal and fetal toxicity and the concept of a threshold in developmental toxicity, will provide for the development of improved mathematical models to more precisely assess risk.

V. References

1. U.S. Environmental Protection Agency. 1980. Assessment of risks to human reproduction and to development of the human conceptus from exposure to environmental substances, pp. 99-116. Available from: NTIS, Springfield, VA, DE82-007897.

2. U.S. Environmental Protection Agency. 1982. Pesticides assessment guidelines, subdivision F. Hazard evaluation: human and domestic animals. EPA-540/9-82-025. Available from: NTIS, Springfield, VA.

[51 FR 34038]

3. U.S. Environmental Protection Agency. 1985. Toxic Substances Control Act Test Guidelines; Final Rules. Federal Register 50:39426-39428 and 39433-39434.

4. Hertig, A.T. 1967. The overall problem in man. In: K. Benirschke, ed. Comparative aspects of reproductive failure. New York, NY: Springer-Verlag, pp. 11-41.

5. McKeown, T., and R.C. Record. 1963. Malformations in a population observed for five years after birth. In: G.E.W. Wolstenholme and C.M. O'Conner, eds. Ciba Foundation symposium on congenital malformations. Boston, MA: Little Brown, pp. 2-16.

6. Mellin, G.W., and M. Katzenstein. 1964. Increased incidence of malformations-chance or change? J. Am. Med. Assoc. 187:570-573.

7. Wilson, J.G. 1977. Embryotoxicity of drugs in man. In: J.G. Wilson and F.C. Fraser, eds. Handbook of teratology. New York, NY: Plenum Press, pp. 309-355.

8. Selevan, S.G. 1981. Design considerations in pregnancy outcome studies of occupational populations. Scand. J. Work Environ. Health 7:76-82.

9. Shepard, T.H. 1980. Catalog of teratogenic agents. Third edition. Baltimore, MD: Johns Hopkins University Press.

10. Schardein, J.L. 1983. Teratogenic risk assessment. In: H. Kalter, ed. Issues and reviews in teratology, Vol. 1. New York, NY: Plenum Press, pp. 181-214.

11. Shepard, T.H. 1984. Teratogens: an update. Hosp. Pract., Jan., pp. 191-200.

12. Brown, N.A., and S. Fabro. 1983. The value of animal teratogenicity testing for predicting human risk. Clin. Obstet. Gynecol. 26:467-477.

13. Kimmel, C.A., J.F. Holson, C.J. Hogue, and G.L. Carlo. 1984. Reliability of experimental studies for predicting hazards to human development. NCTR Technical Report for Experiment No. 6015. NCTR, Jefferson, Arkansas.

14. Nisbet, I.C.T. and N.J. Karch. 1983. Chemical hazards to human reproduction. Park Ridge: Noyes Data Corp.

15. Committee on the Institutional Means for the Assessment of Risks to Public Health. 1983. Risk assessment in the Federal government: managing the process. Commission on Life Sciences, National Research Council. Washington, DC: National Academy Press, pp. 17-83.

16. U.S. Environmental Protection Agency. 1986, Sept. 24. Guidelines for carcinogen risk assessment. Federal Register 51(185):33992-34003.

17. U.S. Environmental Protection Agency. 1986, Sept. 24. Guidelines for mutagenicity risk assessment. Federal Register 51(185):34006-34012.

18. Food and Drug Administration. 1966. Guidelines for reproduction and teratology of drugs. Bureau of Drugs.

19. Food and Drug Administration. 1970. Advisory committee on protocols for safety evaluations. Panel on reproduction report on reproduction studies in the safety evaluation of food additives and pesticide residues. Toxicol. Appl. Pharmacol. 16:264-296.

20. Organization for Economic Cooperation and Development (OECD). 1981. Guideline for testing of chemicals teratogenicity.

21. Symposium on effects of radiation and other deleterious agents on embryonic development. 1954. J. Cell. Comp. Physiol. 43 (suppl. 1).

22. Woo, D.C., and R.M. Hoar. 1979. Reproductive performance and spontaneous malformations in control Charles River rats. A joint study for MARTA. Teratology 19:54A.

23. Kimmel, C.A., G.L. Kimmel, and V. Frankos, eds. 1986. Interagency Regulatory Liaison Group workshop on reproductive toxicity risk assessment. Environ. Health Perspect. 66:193-221.

24. Rodier, P.M. 1978. Behavorial teratology. In: J.G. Wilson and F.C. Fraser, eds. Handbook of teratology, Vol. 4. New York, NY: Plenum Press, pp. 397-428.

25. Buelke-Sam, J., and C.A. Kimmel. 1979. Development and standardization of screening methods for behavorial teratology. Teratology 20:17-29.

26. Kavlock, R.J., and C.T. Grabowski, eds. 1983. Abnormal

REC 6214

functional development of the heart, lungs, and kidneys: approaches to functional teratology. Prog. Clin. Biol. Res., Vol. 140. New York, NY: Alan R. Liss, Inc.

27. Buelke-Sam, J., C.A. Kimmel, and J. Adams, eds. 1985. Design considerations in screening for behavioral teratogens: Results of the Collaborative Behavioral Teratology Study. Neurobehav. Toxicol. Teratology 7(6):537-789.

28. Butcher, R.E., V. Wootten, and C.V. Vorhees. 1980. Standards in behavorial teratology testing: test variability and sensitivity. Teratogenesis Carcinog. Mutagen. 1:49-61.

29. Johnson, E.M. 1981. Screening for teratogenic hazards: nature of the problem. Annu. Rev. Pharmacol. Toxicol. 21:417-429.

30. Johnson, E.M., and B.E.G. Gabel. 1983. An artificial embryo for detection of abnormal developmental biology. Fund. Appl. Toxicol. 3:243-249.

31. Fabro, S., G. Schull, and N.A. Brown. 1982. The relative teratogenic index and teratogenic potency: proposed components of developmental toxicity risk assessment. Teratogenesis Carcinog. Mutagen. 2:61-76.

32. Brown, N.A., and S.J. Freeman. 1984. Aternative tests for teratogenicity. Alternatives Lab. Anim. 12:7-23.

33. Johnson, E.M. 1984. A prioritization and biological decision tree for developmental toxicity safety evaluations. J. Am. Coll. Toxicol. 3:141-147.

34. Chernoff, N., and R.J. Kavlock. 1982. An *in vivo* teratology screen utilizing pregnant mice. J. Toxicol. Environ. Health 10:541-550.

35. Brown, J.M. 1984. Validation of an *in vivo* screen for the determination of embryo/fetal toxicity in mice. SRI International. EPA contract no. 68-01-5079.

36. Schuler R., B. Hardin, R. Niemeyer, G. Booth, K. Hazelden, V. Piccirillo, and K. Smith. 1984. Results of testing fifteen glycol ethers in a short-term, *in vivo* reproductive toxicity assay. Environ. Health Perspect. 57:141-146.

37. U.S. Environmental Protection Agency. 1985. Toxic Substances Control Act Test Guidelines; Final Rules. Federal Register 50: 39428-39429.

38. National Toxicology Program. 1984. Reproductive and Developmental Toxicology Program. Fiscal year 1984 annual plan, pp. 171-181.

39. Wilson, J.G. 1978. Survey of *in vitro* systems: their potential use in teratogenicity screening. In: J.G. Wilson and F.C. Fraser, eds. Handbook of teratology, Vol. 4. New York, NY: Plenum Press, pp. 135-153.

40. Kimmel, G.L., K. Smith, D.M. Kochhar, and R.M. Pratt. 1982. Overview of *in vitro* teratogenicity testing: aspects of validation and application to screening. Teratogenesis Carcinog. Mutagen. 2:221-229.

41. Brown, N.A., and S.E. Fabro. 1982. The *in vitro* approach to teratogenicity testing. In: K. Snell, ed. Developmental toxicology. London, England: Croom-Helm, pp. 31-57.

42. Kimmel, G.L. 1985. *In vitro* tests in screening teratogens: considerations to aid the validation process. In: M. Marois, ed. Prevention of physical and mental congenital defects, Part C. New York, NY: Alan R. Liss, Inc., pp. 259-263.

43. Smith, M.R., G.L. Kimmel, D.M. Kochhar, T.H. Shepard, S.P. Spielberg, and J.G. Wilson. 1983. A selection of candidate compounds for *in vitro* teratogenesis test validation. Teratogenesis Carcinog. Mutagen. 3:461-480.

44. Haseman, J.K. and L.L. Kupper. 1979. Analysis of dichotomous response data from certain toxicological experiments. Biometrics 35:281-293.

45. Nelson, C.J., and J.F. Holson. 1978. Statistical analysis of teratogenic data: problems and advancements. J. Environ. Pathol. Toxicol. 2:187-199.

46. Hogue, C.J.R. 1985. Developmental risks. Presented at Symposium: Epidemiology and health risk assessment. Columbia, MD, May 14, 1985.

47. Epidemiology Workgroup of the Interagency Regulatory Liaison Group. 1981. Guidelines for documentation of epidemiologic studies. Am. J. Epidemiol. 114(5):609-613.

48. Stein, Z., M. Susser, D. Warburton, J. Wittes, and J. Kline. 1975. Spontaneous abortion as a screening device. The effect of fetal surveillance on the incidence of birth defects. Am. J. Epidemiol. 102:275-290.

49. Wilson, J.G. 1973. Environment and birth defects. New York, NY: Academic Press, pp. 30-32.

50. Report of Panel II. 1981. Guidelines for reproductive studies in exposed human populations. In: Bloom, A.D., ed. Guidelines for studies of populations exposed to mutagenic and reproductive hazards. White Plains, NY: March of Dimes Birth Defects Foundation, pp. 37-110.

51. Selevan, S.G. 1985. Design of pregnancy outcome studies of industrial exposure. In: Hemminki, K., M. Sorsa, and H. Vainio, eds. Occupational Hazards and Reproduction. Washington, DC: Hemisphere Pub., pp. 219-229.

52. Sever, L.E., and N.A. Hessol. 1984. Overall design considerations in male and female occupational reproductive studies. In: Lockey, J.E., G.K. Lemasters, and W.R. Keye, eds. Reproduction: the new frontier in occupational and environmental research. New York, NY: Alan R. Liss, Inc. pp. 15-48.

53. Stein, Z., J. Kline, and P. Shrout. 1985. Power in surveillance. In: Hemminki, K., M. Sorsa, and H. Vainio, eds. Occupational hazards and reproduction. Washington, DC: Hemisphere Pub., pp. 203-208.

54. Kissling, G. 1981. A generalized model for analysis of nonindependent observations.

[51 FR 34039]

Ph.D. Dissertation. Ann Arbor, MI: University Microfilms.

55. Selevan, S.G. 1980. Evaluation of data sources for occupational pregnancy outcome studies. Ph.D. Dissertation. Ann Arbor, MI: University Microfilms.

56. Axelson, O. 1985. Epidemiologic methods in the study of spontaneous abortions: sources of data, methods, and sources of error. In: Hemminki, K., M. Sorsa, and H. Vainio, eds. Occupational hazards and reproduction. Washington, DC: Hemisphere Pub., pp. 231-236.

57. Tilley, B.C., A.B. Barnes, E. Bergstralh, D. Labarthe, K.L. Noller, T. Colton, and E. Adam. 1985. A comparison of pregnancy history recall and medical records: implications for retrospective studies. Am. J. Epidemiol. 121(2):269-281.

58. Wilcox, A.J. 1983. Surveillance of pregnancy loss in human populations. Am. J. Ind. Med. 4:285-291.

59. Wilson, J.G., W.J. Scott, E.J. Ritter, and R. Fradkin. 1975. Comparative distribution and embryotoxicity of hydroxyurea in pregnant rats and rhesus monkeys. Teratology 11:169-178.

60. Wilson, J.G., E.J. Ritter, W.J. Scott, and R. Fradkin. 1977. Comparative distribution and embryotoxicity of acetylsalicylic acid in pregnant rats and rhesus monkeys. Toxicol. Appl. Pharmacol. 41:67-78.

61. Kimmel, C.A., and J.F. Young. 1983. Correlating pharmacokinetics and teratogenic end points. Fund. Appl. Toxicol. 3:250-255.

62. Hogan, M.D., and D.G. Hoel. 1982. Extrapolation to man. In: A.W. Hayes, ed. Principles and methods of toxicology. New York, NY: Raven Press, pp. 711-731.

63. Chitlik, L.D., Q.Q. Bui, G.J. Burin, and S.C. Dapson. 1985. Standard evaluation procedures for teratology studies. Toxicology Branch, Hazard Evaluation Division, Office of Pesticide Programs, U.S. Environmental Protection Agency.

64. U.S. Environmental Protection Agency. 1986, Sept. 24. Guidelines for estimating exposures. Federal Register 51(185):34042-34054.

65. Lemasters, G.K., and S.G. Selevan. 1984. Use of exposure data in occupational reproductive studies. Scand. J. Work Environ. Health 10:1-6.

66. Hogue, C.J.R. 1984. Reducing misclassification errors through questionnaire design. In: Lockey, J.E., G.K. Lemasters, and W.R. Keye, eds. Reproduction: the new frontier in occupational and environmental health research. New York, NY: Alan R. Liss, Inc., pp. 81-97.

67. Fraser, F.C. 1977. Relation of animal studies to the problem in man. In: J.G. Wilson and F.C. Fraser, eds. Handbook of teratology, Vol. 1. New York, NY: Plenum Press, pp. 75-96.

68. Environmental Health Criteria 30. 1984. Principles for evaluating health risks to progeny associated with exposure to chemicals during pregnancy. World Health Organization, Geneva, Switzerland, pp. 111-114.

REC 6215

69. Gaylor, D.W. 1983. The use of safety factors for controlling risk.J. Toxicol. Environ. Health 11:329-336.

Part B: Response to Public and Science Advisory Board Comments

I. Introduction

This section summarizes some of the issues raised in public comments on the Proposed Guidelines for the Health Assessment of Suspect Developmental Toxicants published November 23, 1984 (49 FR 46324). Comments were received from 44 individuals or organizations. The Agency's initial summary of comments was presented to the Developmental Toxicity Guidelines Panel of the Science Advisory Board (SAB) at its organizational meeting on March 4, 1985. At its April 22-23, 1985, meeting, the Panel provided the Agency with its suggestions and recommendations concerning the Guidelines.

The SAB and public comments were diverse and addressed issues from a variety of perspectives. In general, the comments were favorable and in support of the Guidelines. The SAB Panel noted that the field of developmental toxicology is particularly weak with respect to quantitative assessment and recommended that further efforts be given to developing alternative methods for quantitative estimates of risk for developmental toxicity. They also indicated that further discussion of the relationship of maternal toxicity to fetal toxicity could be added. Concern was expressed that these Guidelines be coordinated with the reproductive toxicity guidelines which are currently being developed.

In response to the comments, the Agency has modified or clarified many sections of the Guidelines. For purposes of this discussion, only the most significant issues reflected by the public and SAB comments are discussed. Several minor recommendations, which do not warrant discussion here, were considered by the Agency in the revision of these Guidelines.

II. Coordination With Other Guidelines

A. Other Risk Assessment Guidelines

Several commentors raised concerns about aspects of developmental toxicity (e.g., paternally-mediated effects, effects of subchronic exposures, transplacental carcinogenesis, etc.) that were not covered in these Guidelines, and how these Guidelines will integrate with those on male and female reproductive toxicity which are still under development.

The Guidelines have been revised to indicate that developmental toxicity may result from several different types of exposure, including parental exposure prior to conception, acute or subacute exposure during organogenesis, perinatal and postnatal development to the time of sexual maturation, or subchronic exposure as would be the case in multigeneration studies. These Guidelines provide information for interpreting developmental effects related to any of the types of exposure mentioned above. End points of developmental toxicity, which are measured in multigeneration studies, have been added to Table 2 and discussed in the text. Transplacental carcinogenesis, although considered a developmental effect, will be evaluated and assessed in terms of human risk according to the Guidelines for Carcinogen Risk Assessment. Careful attention will be paid to integrating these developmental toxicity risk assessment Guidelines and the male and female reproductive toxicity risk assessment guidelines, which are currently being written, so that overlapping material is not in conflict, and no pertinent information is overlooked. Since the developmental and reproductive toxicity guidelines are being developed by Agency committees that have overlapping membership within the Agency, such integration will be ensured.

B. Coordination With Testing Guidelines

Several commentors indicated that these Guidelines did not make clear enough the fact that testing guidelines are already in place and that these guidelines were intended only for the purposes of risk assessment.

The Guidelines have been revised to indicate that they do not constitute any changes in current testing guidelines, but rather they are intended to provide guidance for the interpretation of studies that follow the testing guidelines. In addition, limited information is provided for interpretation of other studies (e.g., functional developmental toxicity studies and short-term tests) which are not routinely required or for which there are no current testing guidelines, but which may be encountered when reviewing data on particular agents.

III. Definitions

Several questions were raised about definitions of terminology, due to lack of clarity or inconsistency with other parts of these Guidelines or the testing guidelines.

As indicated in the Guidelines, there are differences in the use of terms in the field of developmental toxicology, and the terms have been defined so that the reader may understand how the terms are being used. Several minor changes in the definitions have been made

[51 FR 34040]

to make them more consistent. For example, the definition for developmental toxicology has been expanded to include the wide range of exposure situations that may result in developmental effects. The term functional teratology has been changed to functional developmental toxicology, and the term

REC 6216

teratogenicity has been discussed in the section on malformations and variations.

IV. Qualitative Assessment

A. Maternal and Developmental Toxicity

Several commentors noted the need for a better discussion of how maternal toxicity affects the evaluation of developmental toxic effects.

The Agency has taken the approach in these Guidelines of discussing in detail the individual end points of maternal and offspring toxicity, then giving guidance relating to an overall evaluation of the data in Part A, section III.A.4. This approach is consistent with the philosophy reflected in the Guidelines as follows: Those agents that cause developmental effects at doses lower than those causing maternal toxicity are of greatest concern, but developmental effects at doses that also produce maternal toxicity shoud not be discounted as secondary to maternal effects. Rather, when the lowest observed effect level (LOEL) is the same for maternal and developmental toxicity, it may indicate similar sensitivities to the agent, and maternal effects may be reversible while developmental effects may be permanent.

B. Functional Developmental Toxicity

Several commentors raised concern about the premature use of functional data in the risk assessment process. On the other hand, the SAB Panel felt that these tests were very valuable in assessing developmental toxicity.

The Agency does not routinely require such testing, and these Guidelines do not suggest requirements. However, in the review of data on existing chemicals, such data are sometimes encountered and must be evaluated by the Agency. The discussion in the Guidelines is intended to delineate the current state of the art, and to indicate to what extent the data currently may be used for risk assessment purposes.

C. Short-Term Testing

Several commentors stressed the need for further refinement, validation, and comparative testing to determine the credibility of short-term tests for developmental toxicity. The appropriateness of single dose level screens for the purpose of prioritization was endorsed by the SAB Panel with the reservation that too many false positives might occur, and that positive agents in these screens would be permanently labelled as positive developmental toxicants.

Since data from these types of test procedures may be encountered in the assessment of chemicals, the Agency felt it appropriate to give guidance as to how these should be evaluated. The Guidelines have been revised to clearly indicate that these tests are not routinely required, shoud not be considered as a replacement for routine *in vivo* developmental toxicity testing in mammals, and should not be used to make the final decision as to whether an agent is a positive or negative developmental toxicant.

D. Comparisons of Molecular Structure

Comments suggested that not much is known about structure-activity relationships for developmental toxicants, and that this procedure should not be used except in the case of hormone analogs.

A statement has been added to indicate that structure-activity relationships have not been well-studied in developmental toxicology, but under certain circumstances, e.g., in the case of the premanufacturing notice process (TSCA, section 5), the evaluation of molecular structure is one of several procedures used by the Agency to evaluate potential toxicity and to support requests for testing of new chemicals.

V. Quantitative Assessment

Most comments related to the appropriateness of using uncertainty (safety) factors, margins of safety, and no observed effect levels (NOELs). Some commentors felt that the concept of threshold was not adequately discussed in the Guidelines.

These Guidelines are intended to reflect current Agency policy and practice. Although more quantitative assessment of developmental toxicity data are desirable, and efforts are currently ongoing within the Agency to evaluate other approaches, the current practice is to use the NOEL (or the LOEL if a NOEL is not available), and to apply an uncertainty factor or to calculate the margin of safety. This practice is based in large part on the lack of understanding of the biological mechanisms involved. The uncertainty factor used or acceptability of the margin of safety are considered risk management decisions, but the scientific issues that must be taken into account are discussed in these Guidelines. An experimentally determined NOEL does not prove or disprove the existence of a threshold, although many developmental toxicologists assume a threshold for most developmental effects because of known repair capabilities in developing systems and the fact that many developmental alterations are multifactorial in nature.

REC 6217

51 FR 34042

GUIDELINES FOR ESTIMATING EXPOSURES

SUMMARY: On September 24, 1986, the U.S. Environmental Protection Agency issued the following five guidelines for assessing the health risks of environmental pollutants.

Guidelines for Carcinogen Risk Assessment

Guidelines for Estimating Exposures

Guidelines for Mutagenicity Risk Assessment

Guidelines for the Health Assessment of Suspect Developmental Toxicants

Guidelines for the Health Risk Assessment of Chemical Mixtures

This section contains the Guidelines for Estimating Exposures.

The Guidelines for Estimating Exposures (hereafter "Guidelines") are intended to guide Agency analysis of exposure assessment data in line with the policies and procedures established in the statutes administered by the EPA. These Guidelines were developed as part of an interoffice guidelines development program under the auspices of the Office of Health and Environmental Assessment (OHEA) in the Agency's Office of Research and Development. They reflect Agency consideration of public and Science Advisory Board (SAB) comments on the Proposed Guidelines for Exposure Assessment published November 23, 1984 (49 FR 46304).

This publication completes the first round of risk assessment guidelines development. These Guidelines will be revised, and new guidelines will be developed, as appropriate.

FOR FURTHER INFORMATION CONTACT:

Dr. Richard V. Moraski
Exposure Assessment Group
Office of Health and Environmental Assessment (RD-689)
U. S. Environmental Protection Agency
401 M Street, S.W.
Washington, DC 20460
202-475-8923

SUPPLEMENTARY INFORMATION: In 1983, the National Academy of Sciences (NAS) published its book entitled *Risk Assessment in the Federal Government: Managing the Process.* In that book, the NAS recommended that Federal regulatory agencies establish "inference guidelines" to ensure consistency and technical quality in risk assessments and to ensure that the risk assessment process was maintained as a scientific effort separate from risk management. A task force within EPA accepted that recommendation and requested that Agency scientists begin to develop such guidelines.

General

The guidelines are products of a two-year Agencywide effort, which has included many scientists from the larger scientific community. These guidelines set forth principles and procedures to guide EPA scientists in the conduct of Agency risk assessments, and to inform Agency decision makers and the public about these procedures. In particular, the guidelines emphasize that risk assessments will be conducted on a case-by-case basis, giving full consideration to all relevant scientific information. This case-by-case approach means that Agency experts review the scientific information on each agent and use the most scientifically appropriate interpretation to assess risk. The guidelines also stress that this information will be fully presented in Agency risk assessment documents, and that Agency scientists will identify the strengths and weaknesses of each assessment by describing uncertainties, assumptions, and limitations, as well as the scientific basis and rationale for each assessment.

Finally, the guidelines are formulated in part to bridge gaps in risk assessment methodology and data. By identifying these gaps and the importance of the missing information to the risk assessment process, EPA wishes to encourage research and analysis that will lead to new risk assessment methods and data.

Guidelines for Estimating Exposures

Work on the Guidelines for Estimating Exposures began in January 1984. Draft guidelines were developed by Agency work groups composed of expert scientists from throughout the Agency. The drafts were peer-reviewed by expert scientists in the field of exposure assessment from universities, environmental groups, industry, labor, and other governmental agencies. They were then proposed for public comment in the *FEDERAL REGISTER* (49 FR 46304). On November 9, 1984, the Administrator directed that Agency offices use the proposed guidelines in performing risk assessments until final guidelines become available.

REC 6218

After the close of the public comment period, Agency staff prepared summaries of the comments, analyses of the major issues presented by the commentors, and preliminary Agency responses to those comments. These analyses were presented to review panels of the SAB on March 4 and April 22-23, 1985, and to the Executive Committee of the SAB on April 25-26, 1985. The SAB meetings were announced in the *FEDERAL REGISTER* as follows: February 12, 1985 (50 FR 5811) and April 4, 1985 (50 FR 13420 and 13421).

In a letter to the Administrator dated June 19, 1985, the Executive Committee generally concurred on all five of the guidelines, but recommended certain revisions, and requested that any revised guidelines be submitted to the appropriate SAB review panel chairman for review and concurrence on behalf of the Executive Committee. As described in the responses to comments (see Part B: Response to the Public and Science Advisory Board Comments), each guidelines document was revised, where appropriate, consistent with the SAB recommendations, and revised draft guidelines were submitted to the panel chairmen. Revised draft Guidelines for Estimating Exposures were concurred on in a letter dated January 13, 1986. Copies of the letters are available at the Public Information Reference Unit, EPA Headquarters Library, as indicated elsewhere in this section.

Following this Preamble are two parts: Part A contains the Guidelines and Part B, the Response to the Public and Science Advisory Board Comments (a summary of the major public comments, SAB comments, and Agency responses to those comments).

The SAB requested that the Agency develop guidelines on the principles for the measurement of pollutant concentrations in the various environmental media and for the uses of environmental measurements for exposure assessment. This effort is currently underway.

The Agency also will provide technical support documents that contain detailed technical information needed to implement the Guidelines. Two of these technical reports entitled "Development of Statistical Distributions or Ranges of Standard Factors Used in Exposure Assessments" (available from the National Technical Information Service, PB85-242667) and "Methodology for Characterization of Uncertainty in Exposure Assessments" (available from the National Technical Information Service, PB85-240455) are currently available. Technical support documents will be revised periodically to reflect improvements in exposure assessment methods and new information or experience.

[51 FR 34043]

The Agency is continuing to study the risk assessment issues raised in the Guidelines and will revise these Guidelines in line with new information, as appropriate.

References, supporting documents, and comments received on the proposed guidelines, as well as copies of the final guidelines, are available for inspection and copying at the Public Information Reference Unit (202-382-5926), EPA Headquarters Library, 401 M Street, S.W., Washington, DC, between the hours of 8:00 a.m. and 4:30 p.m.

I certify that these Guidelines are not major rules as defined by Executive Order 12291, because they are nonbinding policy statements and have no direct effect on the regulated community. Therefore, they will have no effect on costs or prices, and they will have no other significant adverse effects on the economy. These Guidelines were reviewed by the Office of Management and Budget under Executive Order 12291.

August 22, 1986

Lee M. Thomas,

Administrator

CONTENTS

Part A: Guidelines for Estimating Exposure

I. Introduction

II. General Guidelines and Principles
- A. Exposure and Dose
- B. Decision Path to Determine Scope of the Assessment
- C. Uncertainty

III. Organization and Contents of an Exposure Assessment
- A. Overview
- B. Detailed Explanation of Outline
  1. Executive Summary
  2. Introduction (Purpose and Scope)
  3. General Information for Each Chemical or Mixture
  4. Sources
  5. Exposure Pathways and Environmental Fate
  6. Measured or Estimated Concentrations
  7. Exposed Populations
  8. Integrated Exposure Analysis
  9. References
  10. Appendices

Part B: Response to Public and Science Advisory Board Comments

I. Introduction

II. General Information
- A. Acceptable Latitude of Approach
- B. Technical Nature of Guidelines
- C. Measurements vs. Modeling

III. Data Availability and Uncertainty Analysis
- A. Information Uses
- B. Worst-Case Estimates

IV. Evaluation of Uncertainties
- A. Uncertainty Analysis
- B. Population Characterization

V. Clarification of Terminology
- A. Exposure vs. Dose
- B. Mixtures and Synergism
- C. Removal and Creation Steps

VI. Purpose, Philosophy, and Results

REC 6219

Part A: Guidelines for Estimating Exposures

I. Introduction

These Guidelines provide the Agency with a general approach and framework for carrying out human or nonhuman exposure assessments for specified pollutants. The Guidelines have been developed to assist future assessment activities and encourage improvement in those EPA programs that require, or could benefit from, the use of exposure assessments. The Guidelines are procedural. They should be followed to the extent possible in instances where exposure assessment is a required element in the regulatory process or where exposure assessments are carried out on a discretionary basis by EPA management to support regulatory or programmatic decisions.

This document, by laying out a set of questions to be considered in carrying out an exposure assessment, should help avoid inadvertent mistakes of omission. Ideally, exposure assessments are based on measured data. EPA recognizes that gaps in data will be common, but the Guidelines will nevertheless serve to assist in organizing the data that are available, including new data developed as part of the exposure assessment. In the absence of sufficient reliable data and the time to obtain appropriate measurements, exposure assessments may be based on validated mathematical models. Whenever possible, exposure assessments based on modeling should be complemented by reliable measurements. Furthermore, it is understood that the level of detail found in the exposure assessments depends on the scope of the assessment.

These Guidelines should also promote consistency among various exposure assessment activities that are carried out by the Agency. Consistency with respect to common physical, chemical, and biological parameters, with respect to assumptions about typical exposure situations, and with respect to the characterization of uncertainty of estimates, will enhance the comparability of results and enable the Agency to improve the state-of-the-art of exposure assessment over time through the sharing of common data and experiences.

It is recognized that the main objective of an exposure assessment is to provide reliable data and/or estimates for a risk assessment. Since a risk assessment requires the coupling of exposure information and toxicity or effects information, the exposure assessment process should be coordinated with the toxicity/effects assessment. This document provides a common approach to format, which should simplify the process of reading and evaluating exposure assessments and thereby increase their utility in assessing risk.

As the Agency performs more exposure assessments, the Guidelines will be revised to reflect the benefit of experience.

II. General Guidelines and Principles

A. Exposure and Dose

Exposure has been defined by Committee E-47, Biological Effects and Environmental Fate, of the American Society for Testing and Materials, as the contact with a chemical or physical agent. The magnitude of the exposure is determined by measuring or estimating the amount of an agent available at the exchange boundaries, i.e., lungs, gut, skin, during some specified time. Exposure assessment is the determination or estimation (qualitative or quantitative) of the magnitude, frequency, duration, and route of exposure. Exposure assessments may consider past, present, and future exposures with varying techniques for each phase, e.g., modeling of future exposures, measurements of existing exposure, and biological accumulation for past exposures. Exposure assessments are generally combined with environmental and health effects data in performing risk assessments.

In considering the exposure of a subject to a chemical agent, there are several related processes. The contact between the subject of concern and the agent may lead to the intake of some of the agent. If absorption occurs, this constitutes an uptake (or an absorbed dose). When biological tissue or fluid measurements indicate the presence of a chemical, exposures may be estimated from these data. Presence of a chemical in such biological samples is the most direct indication that an exposure has occurred. The route of exposure generally impacts the extent of absorption and should be considered in performing risk assessments.

[51 FR 34044]

B. Decision Path to Determine Scope of the Assessment

The first step in preparing an exposure assessment should be the circumscription of the problem at hand to minimize effort by use of a narrowing process. A decision path that describes this process is shown in Figure 1. As illustrated in Figure 1, the preliminary assessment and the in-depth assessment are two major phases in this logic path.

[51 FR 34046]

The preliminary assessment phase should commence by considering what risk is under study. Within this framework, a data base should be compiled from readily available scientific data and exposure information based on manufacturer, processor, and user practices. Next, the most likely areas of exposure (manufacturing, processing, consumer, distribution, disposal, water and food, etc.) should be identified. The preliminary exposure assessments should be based on data derived from environmental measurements. When a limited amount of measurement data is available, estimates may be based on modeling. Since a complete data search may not be possible, well identified

REC 6220

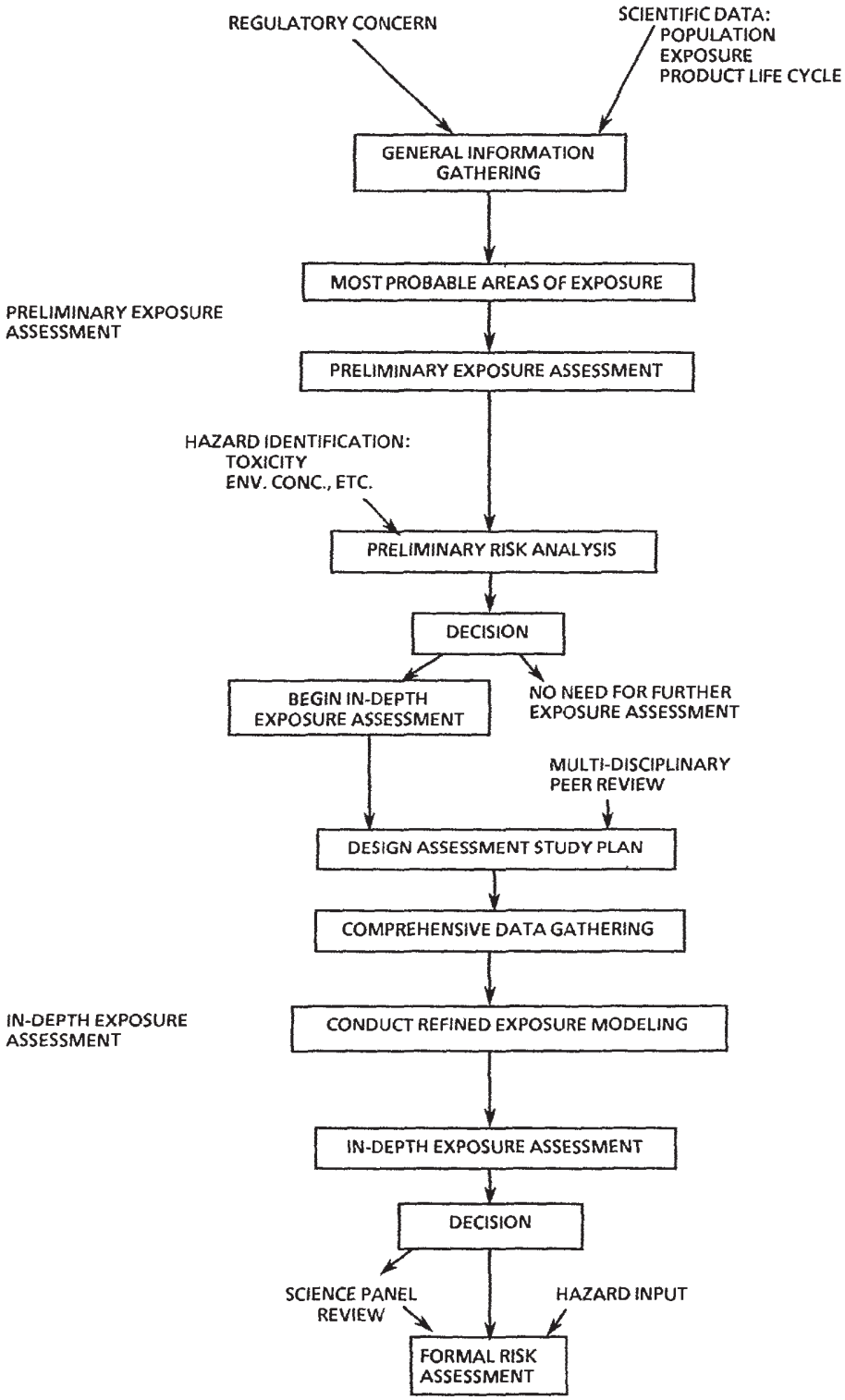


Figure 1. Decision path for exposure assessment.

assumptions and order of magnitude estimates may be used to further narrow the exposure areas of concern.

Data from this preliminary exposure assessment can then be coupled with toxicity information to perform a preliminary risk analysis. As a result of this analysis, a decision will be made that either an in-depth exposure assessment is necessary or that there is no need for further exposure information. The organization and contents of an in-depth exposure assessment are given in the following section.

In assembling the information base for either a preliminary assessment or a more detailed assessment, its adequacy should be ascertained by addressing the following considerations:

- Availability of information in every area needed for an adequate assessment;
- Quantitative and qualitative nature of the data;
- Reliability of information;
- Limitations on the ability to assess exposure.

C. Uncertainty

Exposure assessments are based on measurements, simulation model estimates, and assumptions about parameters used in approximating actual exposure conditions. Actual measurements should be used whenever possible. Both data and assumptions contain varying degrees of uncertainty which influence the accuracy of exposure assessments. Consequently, evaluation of uncertainty is an important part of all exposure assessments.

The uncertainty analyses performed will vary depending on the scope of the assessment, the quantity and quality of measurements, and the type and complexity of mathematical models used. A discussion of the types of analyses used for quantifying uncertainties in exposures is presented in the next section.

III. Organization and Contents of an Exposure Assessment

A. Overview

A suggested outline for an exposure assessment document is given in Exhibit 1. The five major topics to be addressed within most exposure assessments are as follows: Source(s), Exposure Pathways, Measured or Estimated Concentrations and Duration, Exposed Population(s), and Integrated Exposure Analysis. These five topics are appropriate for exposure assessments in general, whether the assessments are of global, national, regional, local, site specific, workplace related, or other scope. The topics are appropriate for exposure assessments on new or existing chemicals and radionuclides. They are also applicable to both single media and multimedia assessments. Since exposure assessments are performed at different levels of detail, the extent to which any assessment contains items listed in Exhibit 1 depends upon its scope. The outline is a guide to organize the data whenever they are available.

Exhibit 1.--Suggested Outline for an Exposure Assessment

1. Executive Summary
2. Introduction
   a. Purpose
   b. Scope
3. General Information for Each Chemical or Mixture
   a. Identity
      (1) Molecular formula and structure, synonyms, and Chemical Abstracts Service (CAS) number
      (2) Description of grades, contaminants, and additives
      (3) Other identifying characteristics
   b. Chemical and Physical Properties
4. Sources
   a. Characterization of Production and Distribution
   b. Uses
   c. Disposal
   d. Summary of Environmental Releases
5. Exposure Pathways and Environmental Fate
   a. Transport and Transformation
   b. Identification of Principal Pathways of Exposure
   c. Predicting Environmental Distribution
6. Measured or Estimated Concentrations
   a. Uses of Measurements
   b. Estimation of Environmental Concentrations
7. Exposed Populations
   a. Human Populations
      (1) Population size and characteristics
      (2) Population location
      (3) Population habits
   b. Nonhuman Populations (where appropriate)
      (1) Population size and characteristics
      (2) Population location
      (3) Population habits
8. Integrated Exposure Analysis
   a. Calculation of Exposure
      (1) Identification of the exposed population and critical elements of the ecosystem
      (2) Identification of pathways of exposure
   b. Human Dosimetry and Biological Measurements
   c. Development of Exposure Scenarios and Profiles
   d. Evaluation of Uncertainty
      (1) Introduction
      (2) Assessments based on limited initial data
      (3) Assessments based on subjective estimates of input variable distributions
      (4) Assessments based on data for model input variables
      (5) Assessments based on data for exposure
      (6) Summary
9. References
10. Appendices

B. Detailed Explanation of Outline

1. Executive Summary. The "Executive Summary" should be written so that it can stand on its own as a miniature report. Its main focus should be on a succinct description of the procedures used, assumptions employed, and summary tables or charts of the results. A brief discussion of the uncertainties associated with the results should be included.

2. Introduction (Purpose and Scope). This section should state the intended purpose of the exposure assessment and identify the agent being

investigated, the types of sources and exposure routes included, and the populations of concern.

3. General Information for Each Chemical or Mixture.

a. Identity.

(1) Molecular formula and structure, synonyms, and Chemical Abstracts Service number.

(2) Description of grades, contaminants, and additives.

(3) Other identifying characteristics.

b. Chemical and Physical Properties. This subsection should provide a summary description of the chemical and physical properties of the agent. Particular attention should be paid to the features that would affect its behavior in the environment.

4. Sources. The points at which a substance is believed to enter the environment should be described, along with any known rates of entry. (Points of entry may be indoors as well as outdoors; environments include indoor settings such as offices as well as outdoor environments.) A detailed exposure assessment should include a study of sources, production, uses, destruction/disposal, and environmental release of a substance. The studies

[51 FR 34047]

should include a description of human activities with respect to the substance and the environmental releases resulting from those activities. It should account for the controlled mass flow of the substance from creation to destruction and provide estimates of environmental releases at each step in this flow. Seasonal variations in environmental releases should also be examined. All sources of the substance should be accounted for with the sum of the uses, destruction, and the environmental releases. The environmental releases can be described in terms of geographic and temporal distribution and the receiving environmental media, with the form identified at the various release points.

a.Characterization of Production and Distribution. All sources of the substance's release to the environment, consistent with the scope of the assessment, should be included, such as production, extraction, processing, imports, stockpiles, transportation, accidental/ incidental production as a side reaction, and natural sources. The sources should be located, and activities involving exposure to the substance should be identified.

b. Uses. The substance should be traced from its sources through various uses (with further follow-up on the products made to determine the presence of the original material as an impurity), e.g., exports, stockpile increases, etc.

c. Disposal. This subsection should contain an evaluation of disposal sites and destruction processes, such as incineration of industrial chemical waste, incineration of the substance as part of an end-use item in municipal waste, landfilling of wastes, biological destruction, or destruction in the process of using the end product. Hazardous contaminants of the substance may be included, and products containing the substance as a contaminant may be followed from production through destruction/disposal.

d. Summary of Environmental Releases. Estimates should be made of the quantities of the substance released to the various environmental media. Sources of release to the environment include production, use, distribution/transport, natural sources, disposal, and contamination of other products. Environmental releases should be presented at a reasonable level of detail. Extremely detailed exposure estimates would attempt to specify the following information for each significant emission source: location, amount of the substance being released as a function of time to each environmental medium, physical characteristics of the emission source, and the physical and chemical form of the substance being released. Evaluation of the uncertainties associated with the emission estimates should be given. A detailed discussion of the procedures for estimating uncertainty is presented in section 8.d.

5. Exposure Pathways and Environmental Fate. The exposure pathways section should address how an agent moves from the source to the exposed population or subject. For a less detailed assessment, broad generalizations on environmental pathways and fate may be made. In the absence of data, e.g., for new substances, fate estimates may have to be predicted by analogy with data from other substances. Fate estimates may also be made by using measurements and/or models and laboratory-derived process rate coefficients. At any level of detail, certain pathways may be judged insignificant and not pursued further.

For more detailed assessments involving environmental fate, the analysis of sources described previously should provide the amount and rate of emissions to the environment, and possibly the locations and form of the emissions. The environmental pathways and fate analysis follows the substance from its point of initial environmental release, through the environment, to its ultimate fate. It may result in an estimation of the geographic and temporal distribution of concentrations of the substance in the various contaminated environmental media.

a. Transport and Transformation. The substance, once released to the environment, may be transported (e.g., convected downstream in water or on suspended sediment, through the atmosphere, etc.) or physically transformed (e.g., volatilized, melted, absorbed/desorbed, etc.); may undergo chemical transformation, such as photolysis, hydrolysis, oxidation, and reduction; may undergo biotransformation, such as biodegradation; or may accumulate in one or more media. Thus, the environmental behavior of a substance should be

evaluated before exposures are assessed. Factors that should be addressed include:

- How does the agent behave in air, water, soil, and biological media? Does it bioaccumulate or biodegrade? Is it absorbed or taken up by plants?
- What are the principal mechanisms for change or removal in each of the environmental media?
- Does the agent react with other compounds in the environment?
- Is there intermedia transfer? What are the mechanisms for intermedia transfer? What are the rates of the intermedia transfer or reaction mechanisms?
- How long might the agent remain in each environmental medium? How does its concentration change with time in each medium?
- What are the products into which the agent might degrade or change in the environment? Are any of these degradation products ecologically or biologically harmful? What is the environmental behavior of the harmful products?
- Is a steady-state concentration distribution in the environment, or in specific segments of the environment, achieved? If not, can the nonsteady-state distribution be described?
- What is the resultant distribution in the environment--for different media, different types or forms of the agent, for different geographical areas, at different times or seasons?

b. Identification of Principal Pathways of Exposure. The principal pathway analysis should evaluate the sources, locations, and types of environmental releases, together with environmental behavioral factors, to determine the significant routes of human and environmental exposure to the substance. Thus, by listing the important characteristics of the environmental release (entering media, emission rates, etc.) and the agent's behavior (intermedia transfer, persistence, etc.) after release to each of the entering media, it should be possible to follow the movement of the agent from its initial release to its subsequent fate in the environment. At any point in the environment, human or environmental exposure may occur. Pathways that result in major concentrations of the agent and high potential for human or environmental contact are the principal exposure pathways.

c. Predicting Environmental Distribution. Models may be used to predict environmental distributions of chemicals. Model estimates of environmental distribution of chemicals are based on measurements whenever feasible. In predicting environmental distributions of chemicals, available measurements must be considered.

In this section an estimation is made, using appropriate models, of representative concentrations of the agent in different environmental media, and its time-dependence in specific geographical locations (e.g., river basins, streams, etc.).

6. Measured or Estimated Concentrations.

a. Uses of Measurements. Measurements are used to identify releases (source terms) and, in the

[51 FR 34048]

exposure pathways and fate assessments, to quantitatively estimate both release rates and environmental concentrations. Some examples of uses of measurements are: sampling of stacks or discharge pipes for emissions to the environment, testing of products for chemical or radionuclide content, testing of products for chemical or radioactive releases, sampling of appropriate points within a manufacturing plant to determine releases from industrial processes or practices, sampling of potentially exposed populations using personal dosimeters, and sampling of solid waste for chemical or radionuclide content. These data should be characterized as to accuracy, precision, and representativeness. If actual environmental measurements are unavailable, concentrations can be estimated by various means, including the use of fate models (see previous section) or, in the case of new chemicals, by analogy with existing chemicals.

Measurements are a direct source of information for exposure analysis. Furthermore, reliable measurements can be used to calibrate or extrapolate models or calculations to assess environmental distributions. However, environmental pathway and fate analysis may be needed in addition to the measured data for the following reasons: for most pollutants, particularly organic and new chemicals, measurements are limited; analysis of measured data does not often yield relationships between environmental releases and environmental concentration distribution in media or geographic locations that have not been measured; analysis of measurements does not provide information on how and where biota influence the environmental distribution of a pollutant; and measured concentrations may not be traceable to individual sources.

b. Estimation of Environmental Concentrations. Concentrations of agents should be estimated for all environmental media that might contribute to significant exposures. Generally, the environmental concentrations are estimated from measurements, mathematical models, or a combination of the two. If environmental measurements are not limited by sample size or inaccuracies, then exposure assessments based on measurements have precedence over estimates based on models.

The concentrations must be estimated and presented in a format consistent with available dose-response information. In some cases an estimate of annual average concentration will be sufficient, while in other cases the temporal distribution of concentrations may be required. Future environmental concentrations resulting from current or past releases may also be projected. In some cases, both the temporal and geographic distributions of the concentration may be assessed.

REC 6224

Moreover, if the agent has natural sources, the contribution of these to environmental concentrations may be relevant. These "background" concentrations may be particularly important when the results of tests of toxic effects show a threshold or distinctly nonlinear dose-response.

The uncertainties associated with the estimated concentrations should be evaluated by an analysis of the uncertainties of the model parameters and input variables. When the estimates of the environmental concentrations are based on mathematical models, the model results must be compared to available measurements, and any significant discrepancies should be discussed. Reliable, analytically-determined values must be given precedence over estimated values whenever significant discrepancies are found.

7. Exposed Populations. Populations selected for study may be done *a priori*, but frequently the populations will be identified as a result of the sources and fate studies. From an analysis of the distribution of the agent, populations and subpopulations (i.e., collections of subjects) at potentially high exposure can be identified, which will then form the basis for the populations studied. Subpopulations of high sensitivity, such as pregnant women, infants, chronically ill, etc., may be studied separately.

Census and other survey data may be used to identify and describe the population exposed to various contaminated environmental media. Depending on the characteristics of available toxicological data, it may be appropriate to describe the exposed population by other characteristics such as species, subspecies-age-sex distribution, and health status.

In many cases, exposed populations can be described only generally. In some cases, however, more specific information may be available on matters such as the following:

a. Human Populations

(1) Population size and characteristics (e.g., trends, sex/age distribution)

(2) Population location

(3) Population habits-- transportation habits, eating habits, recreational habits, workplace habits, product use habits, etc.

b. Nonhuman Populations (where appropriate)

(1) Population size and characteristics (e.g., species, trends)

(2) Population location

(3) Population habits

8. Integrated Exposure Analysis. The integrated exposure analysis combines the estimation of environmental concentrations (sources and fate information) with the description of the exposed population to yield exposure profiles. Data should be provided on the size of the exposed populations; duration, frequency, and intensity of exposure; and routes of exposure. Exposures should be related to sources.

For more detailed assessments, the estimated environmental concentrations should be considered in conjunction with the geographic distribution of the human and environmental populations. The behavioral and biological characteristics of the exposed populations should be considered, and the exposures of populations to various concentration profiles should be estimated. The results can be presented in tabular or graphic form, and an estimate of the uncertainty associated with them should be provided.

a. Calculation of Exposure. The calculation of exposure involves two major aspects:

(1) Identification of the exposed population and critical elements of the ecosystem.

The estimate of environmental concentrations also should give the geographical areas and environmental media contaminated. The stated purpose of the assessment should have described the human and environmental subjects for which exposures are to be calculated. If the subjects are not listed, the contaminated geographical areas and environmental media can be evaluated to determine subject populations. The degree of detail to be used in defining the exposed population distribution depends on the concentration gradient over geographic areas.

(2) Identification of pathways of exposure.

(a) Identification and description of the routes by which the substances travel from production site, through uses, through environmental releases/sources, through transport and fate processes, to the target population.

(b) Quantitative estimates of the amounts of the chemical following each exposure pathway. Such estimates allow the various pathways to be put in the perspective of relative importance.

From the geographic and temporal distribution of environmental

[51 FR 34049]

concentrations, the exposed population, the behavioral characteristics, and the critical elements of the ecosystem, exposure distributions can be estimated. The results of exposure calculation should be presented in a format that is consistent with the requirements of the dose-response functions which may later be used in a risk assessment. For example, when health risks caused by exposure over extended durations are considered, average daily exposure over the duration of exposure usually is calculated. When lifetime risks are considered, average daily exposure over a lifetime usually is calculated. In contrast, when health risks caused by exposures over short durations are considered, exposure rates are calculated over short time intervals to ensure that peak risks are defined. Many exposure assessments are based on the average exposure occurring over the exposure period. The range of possible exposures is usually divided into intervals,

REC 6225

and the exposures within each interval are counted. The results can be presented in tabular form or as a histogram.

The population residing in a specific geographic area may be exposed to a substance from several exposure routes. For each exposure route, exposure of individuals in these populations may be determined by summing the contribution of all sources to the exposure route. When exposures involve more than one exposure route, the relative amounts of a substance absorbed is usually route dependent. Consequently, total absorbed dose estimates must account for these differences. Because EPA regulates sources of releases, the contribution to exposures from each type of source being considered should be displayed. Exposure estimates should be presented for each significant exposure route, and the results should be tabulated in such a way that total externally applied and absorbed dose can be determined.

b. Human Dosimetry and Biological Measurements. Biological measurements of human body fluids and tissues for substances or their metabolites can be used to estimate current or past exposure to chemicals. When analytical methods are available, chemicals that have been absorbed into the body can be measured in body tissue and fluid. Such measurements may be used to estimate human exposure if the chemical substances leave in the body reliable indicators of exposure. Furthermore, although a compound may be relatively easy to detect in body tissue, for some compounds, attributing body burdens to specific environmental releases may be difficult because of limited ability to obtain environmental measurements or appropriate metabolic data.

c. Development of Exposure Scenarios and Profiles. Depending on the scope of the exposure assessment, the total exposure may be fractionated into one or more "exposure scenarios" to facilitate quantification. As an example, Table 1 lists seven very broad scenarios: Occupational, Consumer, Transportation, Disposal, Food, Drinking Water, and Ambient. For each of the scenarios, the major topics necessary to quantify exposure include sources, pathways, measurements, and population characteristics. Investigation of only one scenario may be necessary for the scope of some assessments. For example, a pesticide application exposure assessment may consider the occupational scenario which would address the exposure to applicators and populations in the vicinity of the site. An exposure assessment around a hazardous waste site may focus on the disposal scenario. The exposure assessment

TABLE 1.--EXPOSURE ASSESSMENT INFORMATION NEEDS FOR VARIOUS EXPOSURE SCENARIOS

Exposure scenario	Sources	Fate	Population Characteristics	Measurement
Occupational (chemical production).	Site/plant locations, in-plant/on-site materials balance.	Physical and chemical properties models.	Workers, families, population around sites/plants.	In-plant/on-site releases, ambient levels surrounding site/plants; human dosimetry.
Consumer (direct use of chemical or inadvertent use).	Consumption rates, distribution pattern amounts in products.	Physical and chemical properties, shelf life release rates, models.	Consumers	Levels in products releases.
Transportation / storage/spills.	Patterns of distribution and transportation; models for spills.	Physical and chemical properties, environmental fate models.	Storage, transportation workers, general population in area.	Releases, ambient levels.
Disposal (include incineration, landfill).	Materials balance around disposal method, efficiency,releases to environment.	Fate within disposal process; environmental fate of releases; models.	Workers at site of disposal, general population around site.	Releases, levels at various points within process, ambient levels.
Food	Food chain, packaging, additives.	Food chain models, fate during preparation or processing of food.	General population, nonhuman population.	Levels in food, feedstuff; food chain sampling.
Drinking water	Groundwater, surface water, distribution system.	Leach rates from pipes, chlorination processes, fate in water; models.	General population.	Levels in drinking water, groundwater, surface water, treatment plants.
Ambient	Releases to environment; air, land, water.	Environmental fate models.	General population, nonhuman population.	Ambient air, water, soil, etc.; human dosimetry.

REC 6226

also may consider other scenarios. The more extensive and comprehensive the scope, the more scenarios are usually involved.

It will usually be advantageous in performing an exposure assessment to identify exposure scenarios, quantify the exposure in each scenario, and then integrate the scenarios to estimate total exposure. In this "integrated exposure analysis," the summation of independent exposures from different scenarios (keeping exposure routes separate) often will result in a breakout of exposure by subpopulations, since the individual scenarios usually treat exposure by subpopulation. Therefore, the integration of the scenarios, or integrated exposure analysis, will often result in an exposure profile.

For each exposed subpopulation, exposure profiles should include the size of the group, the make-up of the group (age, sex, etc.), the source of the agent, the exposure pathways, the frequency and the intensity of exposure by each route (dermal, inhalation, etc.), the duration of exposure, and the form of the agent when exposure occurs. Assumptions and uncertainties associated with each scenario and profile should be clearly discussed.

d. Evaluation of Uncertainty.

(1) Introduction. Often an exposure assessment progresses through several stages of refinement. The purpose of these Guidelines is to present methods appropriate for characterization of uncertainty for assessments at various stages of refinement, from assessments based on limited initial data to those based on extensive data.

The appropriate method for characterizing uncertainty for an exposure assessment depends upon the underlying parameters being estimated, the type and extent of data available, and the estimation procedures utilized.

[51 FR 34050]

The uncertainty of interest is always with regard to the population characteristic being estimated. For example, when the population distribution of exposures is being estimated, characterization of uncertainty addresses the possible differences between the estimated distribution of exposure and the true population distribution of exposure.

An exposure assessment quantifies contact of a substance with affected population members (human or nonhuman subjects). The measure of contact (e.g., environmental level or absorbed dose) depends upon what is needed to predict risk. An integrated exposure assessment quantifies this contact via all routes of exposure (inhalation, ingestion, and dermal) and all exposure pathways (e.g., occupational exposure, exposure from consumption of manufactured goods, etc.). The exposed population generally is partitioned into subpopulations such that the likely exposure of all members of a subpopulation is attributable to the same sources. The exposure for each member of a subpopulation is then the sum of exposures over a fixed set of sources and pathways. The measured or estimated exposures for members of a subpopulation are ideally used to estimate the subpopulation distribution of exposure or characteristics thereof. However, a lack of sufficient information sometimes precludes estimation of the subpopulation distributions of exposure and only summary measures of this distribution, such as the mean, minimum, maximum, etc., are estimated. In each case, characterization of uncertainty for the exposure assessment primarily addresses limitations of the data and the estimation procedures. The proportions of the population members in the individual subpopulations are usually estimated and can be used (by combining estimated distributions for the subpopulations) to estimate the distribution of exposure for the total population. Uncertainty concerning the sizes of the subpopulations should be addressed by discussing limitations of the data and estimation methods as well as by tabulating confidence interval estimates for the population sizes whenever possible.

(2) Assessments based on limited initial data. The initial exposure assessment for a substance may be based on limited data for exposure and/or input variables for an exposure prediction model (i.e., an equation that expresses exposure as a function of one or more input variables). These data might be either extant data or data produced by an initial small-scale study. The limited initial data frequently are insufficient to permit estimation of the entire distribution of exposure. Instead, summary measures of this distribution, such as the mean, minimum, and maximum, are usually estimated.

If the assessment is based on measured exposures, the methods used to characterize uncertainty depend mainly upon whether or not the data result from a probability sample for which the probability of inclusion is known for each sample member. Characterization of uncertainty for an assessment based on a probability sample of exposures is discussed later in section 8.d.(5). If the measured exposures are not based on a probability sample, acknowledgement that no strictly valid statistical inferences can be made beyond the units actually in the sample is one aspect of the characterization of uncertainty. If inference procedures are implemented, the assumptions upon which these inferences are based (e.g., treatment of the sample as if it were a simple random sample, or assumption of an underlying model) should be explicitly stated and justified. The data collection methods and inherent limitations of the data should also be discussed.

An initial exposure assessment also may be based on limited data, such as estimated ranges, for input variables for an exposure prediction model. The exposure prediction model would be derived from a postulated exposure scenario that describes the pathways from sources to contact with population members. If the data were only sufficient to support estimates of the ranges of the input variables, the exposure assessment might be limited

REC 6227

to a sensitivity analysis. The purpose of the sensitivity analysis would be to identify influential model input variables and develop bounds on the distribution of exposure. A sensitivity analysis would estimate the range of exposures that would result as individual model input variables were varied from their minumum to their maximum possible values with the other input variables held at fixed values, e.g., their midranges. The overall minimum and maximum possible exposures usually would be estimated also. For an exposure assessment of this type, the uncertainty would be characterized by describing the limitations of the data used to estimate possible ranges of model input variables and by discussing justification for the model. Justification of the model should include a description of the exposure scenario, choice of model input variables, and the functional form of the model. Sensitivity to the model formulation also can be investigated by replicating the sensitivity analysis for plausible alternative models.

The sensitivity analysis can be enhanced by computing the predicted exposures that result from all possible input variable combinations. If each input variable has only a finite set of possible values, the set of all possible combinations of the input variables can be formed, and the predicted exposure can be computed for each combination. These exposure predictions can be used to form a distribution of exposures by counting the number of occurrences at each exposure level or interval of exposures. This is equivalent to estimating the distribution of exposures that results from treating all input variable combinations as equally likely. This procedure can also be applied by transforming continuous input variables into discrete ones and representing them by equally spaced points. In the limit, as the equal spaces become small and the number of points becomes large, the distribution of exposure that results from counting occurrences of exposure levels is equivalent to estimating the distribution of exposures that results from statistically independent, continuous input variables with uniform distributions on the estimated ranges. This estimated distribution of exposure values can be produced by Monte Carlo simulation, one of the methods of mathematical statistics. The Monte Carlo method consists of randomly generating input variate values and using these to compute corresponding exposure levels, generating an exposure distribution via many iterations. Interpretation of statistics based on this exposure distribution would be in terms of the equally likely input variable combinations. For example, the 95th percentile of this distribution would be the exposure level exceeded by only 5% of the exposures resulting from treating all combinations of input variable values as equally likely. Although this distribution of exposures cannot be interpreted as an estimate of the population distribution (unless the input variables actually are statistically independent and uniformly distributed), it provides additional information for making regulatory decisions. Characterization of uncertainty would include a discussion of limitations of the data and justification for the model as discussed above. Sensitivity to model formulation could also be investigated by estimating the distribution of exposure that results from using the

[51 FR 34051]

same uniform input variable distributions with plausible alternative models and comparing the estimated percentiles.

(3) Assessments based on subjective estimates of input variable distributions. If a model has been formulated that expresses exposure as a function of one or more input variables, the methods of mathematical statistics, such as Monte Carlo simulation, can be used to estimate the population distribution of exposure from an estimate of the joint distribution of the model input variables. Ideally, model input variables should be represented by empirically-validated probability distributions. In some cases, it may be possible to formulate an estimate of the joint distribution of model input variables from discussions with subject matter experts (e.g., via histograms for statistically-independent input variables). The estimated population distribution of exposure will be equivalent to the distribution discussed in section 8.d.(2) for equally likely combinations of input variable values only when the input variable distributions supported are independent uniform distributions. When qualitative knowledge of input variable distributions is used to estimate the population distribution of exposure, uncertainty is characterized by discussing justification for the presumed model and input variable distributions. Alternative models and/or alternative input variable distributions also should be discussed. Sensitivity to these alternatives can be investigated by estimating the distributions of exposure that result from plausible alternatives and comparing the percentiles of the estimated exposure distributions. All available data, even if data are limited, should be used to validate the presumed input variable distributions and the predicted distribution of exposure.

(4) Assessments based on data for model input variables. The exposure assessment based on an estimate of the joint probability distribution for model input variables can be refined by collecting sample survey data for model input variables for a sample of population members. The population distribution of exposure can then be estimated by computing the expected exposure for each sample member based on the model. These expected exposures can be used to directly compute confidence interval estimates for percentiles of the exposure distribution. Alternatively, the sample survey data can be used to compute joint confidence interval estimates for percentiles of the input variable

REC 6228

distribution, which can then be used to generate confidence interval estimates for percentiles of the exposure distribution. In either case, the interval estimates for percentiles of the exposure distribution are a useful quantitative characterization of uncertainty.

Characterization of uncertainty for the exposure assessment would contain a thorough discussion of limitations of the data and justification for the model used to compute expected exposures. The design of the sample survey used to produce the data base should also be discussed. If a probability sample were not used, the lack of a probability sample would be an additional source of uncertainty. Any assumptions used in computing the confidence interval estimates, such as independence of model input variables, should be explicitly stated and justified. Sensitivity to model formulation can be investigated by estimating the distribution of exposure for plausible alternative models and comparing the estimated percentiles, if sample survey data have been collected for the input variables of the alternative models. Appropriate available data for exposure should be used to validate the predicted distribution of exposure. If specific probability distributions have been presumed for any model input variables, the data for these variables should be used to test for goodness of fit for these distributions.

(5) Assessments based on data for exposure. A major reduction in the uncertainty associated with an exposure assessment can be achieved by directly measuring the exposure for a sufficiently large sample of members of the affected population. This reduction in uncertainty is achieved by eliminating the use of a model to predict exposure. The measured exposure levels can be used to directly estimate the population distribution of exposure and confidence interval estimates for percentiles of the exposure distribution. Direct confidence interval estimates also can be computed for other characteristics of the exposure distribution, such as the mean exposure.

These confidence interval estimates are then the primary characterization of uncertainty for the exposure assessment. Limitations of the data and design of the sample survey used to collect the data also should be discussed. If the sample was not a probability sample, this would again be an additional source of uncertainty.

(6) Summary. A summary of the primary methods recommended for characterizing uncertainty in exposure assessments is presented in Table 2. Virtually all exposure assessments, except those based on measured exposure levels for a probability sample of population members, rely upon a model to predict exposure. The model may be any mathematical function, simple or complex, that expresses an individual's exposure as a function of one or more input variables. Whenever a model that has not been validated is used as the basis for an exposure assessment, the uncertainty associated with the exposure assessment may be substantial. The primary characterization of uncertainty is at least partly qualitative in this case, i.e., it includes a description of the assumptions inherent in the model and their justification. Plausible alternative models should be discussed. Sensitivity of the exposure assessment to model formulation can be investigated by replicating the assessment for plausible alternative models.

[51 FR 34052]

When an exposure assessment is based on directly measured exposure levels for a probability sample of population members, uncertainty can be greatly reduced and described quantitatively. In this case, the primary sources of uncertainty are measurement errors and sampling errors. The effects of these sources of error are measured quantitatively by confidence interval estimates of percentiles of the exposure distribution. Moreover, the sampling errors can be limited by taking a large sample.

Whenever it is not feasible to take a large sample, it is sometimes possible to obtain at least some data for exposure and model input variables. These data should be used to assess goodness of fit of the model and/or presumed distributions of input variables. This substantially reduces the amount of quantitative uncertainty for estimation of the distribution of exposure and is strongly recommended. It is recognized, however, that it may not be feasible to collect such data.

9.References. The references should contain a listing of all reports, documents, articles, memoranda, contacts, etc. that have been cited in the report.

10.Appendices. The appendices may contain such items as memoranda and letters that are not readily accessible, other tables of measurements, detailed lists of emission sources, detailed tables of exposures, process flow diagrams, mathematical model formulations, or any other item that may be needed to describe or document the exposure assessment.

Part B: Response to Public and Science Advisory Board Comments

I. Introduction

This section summarizes some of the issues raised in public comments on the Proposed Guidelines for Exposure Assessment published November 23, 1984 (49 FR 46304). Comments were received from 29 individuals or organizations. The Agency's initial summary of comments was presented to the Exposure Assessment Guidelines Review Group of the Science Advisory Board (SAB) on March 4, 1985. At its April 22-23, 1985, meeting, the panel provided the Agency with suggestions and recommendations concerning the Guidelines.

The SAB and public commentors expressed diverse opinions and addressed issues from a variety of perspectives. While most commentors supported the Guidelines, two urged withdrawal of the

REC 6229

TABLE 2.--SUMMARY OF PRIMARY METHODS FOR CHARACTERIZING UNCERTAINTY FOR ESTIMATING EXPOSURES

Type and extent of data	Population characteristic being estimated	Primary methods for characterizing uncertainty	
		Qualitative methods	Quantitative methods
Measured exposures for a large sample of population members.	Distribution of exposure.	1. Limitations of the survey design and measurement techniques.	1. Confidence interval estimates for percentiles of the exposure distribution. 2. Goodness of fit for exposure models, if any have been postulated.
Measured exposures for a small sample of population members.	Summary parameter(s) of the exposure distribution, e.g., mean or a percentile.	1. Limitations of the survey design and. measurement techniques.	1. Confidence interval estimate for the summary parameter(s). 2. Goodness of fit for exposure models,. if any have been postulated.
Measured model input variables for a large sample of population members.	Distribution of exposure.	1. Limitations of the survey.design and measurement techniques. 2. Validity of the exposure model.	1. Confidence interval estimates for percentiles of the exposure distribution. 2. Goodness of fit for input variable distribution functions, if any have been postulated. 3. Estimated distribution of exposure based on alternative models.
Estimated distributions of model input variables.	Distribution of exposure.	1. Validity of the exposure model. 2. Limitations of the data. or other basis for the input variable distributions.	1. Confidence interval estimates for percentiles of the exposure distribution. 2. Goodness of fit for input variable distributions, if input variable data are available. 3. Estimated distribution of exposure based on alternative models.
Limited data for model input variables.	Minimum, maximum, and range of the exposure distribution.	1. Limitations of the data. 2. Validity of the exposure model.	If input variable data are very limited, e.g., some extant data collected for other purposes, quantitative characterization of uncertainty may not be possible.

document. The SAB Panel recommended that supplementary guidelines be written on the use of measurements in preparing exposure assessments. In addition, the Panel wished to see a greater emphasis in the current Guidelines on the use of measured data rather than models in generating exposure assessments. The Panel recommended that the technical support document entitled "Methodology for Characterization of Uncertainty in Exposure Assessments" be expanded with additional examples.

In response to the comments, the Agency has modified or clarified many sections of the Guidelines, and is planning to develop supplementary guidance in line with the SAB recommendations. The discussion that follows highlights significant issues raised in the comments, and the Agency's response to them. Also, many minor recommendations, which do not warrant discussion here, were adopted by the Agency.

II. General Information

A. Acceptable Latitude of Approach

Some commentors believe the Guidelines are too general and allow too much latitude in choice of approach and do not assure that "all" data, sources, limitations, etc. are considered before an exposure assessment is conducted. Others suggested that the Agency specify models to be used while others thought that only measured data should be allowed.

The Guidelines were developed to provide assistance in carrying out exposure assessments. The approach suggested is deliberately general in order to accommodate the development of exposure assessments with different levels of detail depending on the scope of the assessment. The Agency does not agree with the inclusion of such restrictive terminology as "in all cases." We cannot foresee all possible cases. We believe reasonable flexibility is a necessary ingredient for the proper implementation of the Guidelines while relying on uncertainty and sensitivity analyses to put the quality of the approach in perspective.

B. Technical Nature of Guidelines

Some commentors believe the language of the document is too technical for the lay person to understand; one commentor expressed misgivings concerning the "state-of-the-art" methods available for conducting exposure assessments.

REC 6230

While the Agency recognizes that the public has an interest in the Guidelines and invites comments from the public, the Guidelines are intended for use by technical/professional people. Providing guidelines written in lay terms would result in insufficient technical specifications to the professionals in the development of scientifically acceptable exposure assessments.

The Agency believes that the suggested procedures and methods in the Guidelines are commonly accepted. The Guidelines do not suggest the use of ad hoc, untested, and unvalidated procedures, but stress the use of the best scientific methods available with maximum analysis of existing data. This is both a scientific and practical approach that reflects the level of consensus within the Agency.

[51 FR 34053]

C. Measurements vs. Modeling

Some commentors support the use of measurements alone to develop an exposure assessment. Some believed there should be no data restraints; others thought all data should be validated. Other commentors argued for the use of simulation model estimates without measurements. One commentor objected to the use of unvalidated models to perform exposure assessments. In its review, the SAB strongly encouraged the Agency to develop a supplement to the current Guidelines on the development and use of measurements for exposure assessments.

The Agency encourages the use of validated measurements when available. The Guidelines specifically state that "Reliable, analytically determined values should be given precedence over estimated values. . ." and analytically determined values ". . .can be used to calibrate. . . models. . .to assess environmental distribution." Furthermore, in practice, exposure assessments performed by the Agency use published models with varying degrees of testing and validation. It is our belief that transport process models have been adequately validated over many years in most cases.

Furthermore, the Agency has revised the Guidelines to reflect the SAB suggestions that exposure assessments based on reliable measured data are preferred over model estimates whenever feasible.

III. Data Availability and Uncertainty Analysis

A. Information Uses

Some commentors asked for guidance in the use of information that may be false and how to deal with the potential situation when different models give different results. Others asked for model selection criteria.

The Guidelines clearly state the considerations that need to be addressed when assembling information bases for exposure assessments. Two considerations are: qualitative and quantitative nature of the data and the reliability of the information. Whether the exposure assessment is based on measurements or simulation model estimates, an evaluation of uncertainties associated with the data including source data and assumptions is necessary and important.

When there is uncertainty in the scientific facts, it is Agency policy to err on the side of public safety. The Agency intends to be realistic, but will not arbitrarily select midranges of environmental distributions that may compromise human health. In addition, quality assurance is an important matter that requires detailed attention. The collection of measured data and the development of methods to collect measurements are done by another office within the EPA. These issues will be handled by the Office of Acid Deposition, Environmental Monitoring, and Quality Assurance as they develop the supplemental guidelines for measurement of exposure.

Substantial work is currently being done on the development of mathematical model selection criteria. Results of these efforts will be published as a technical support document containing detailed information to further implement the Guidelines.

B. Worst-Case Estimates

A few commentors were concerned that worst-case estimates would be used when data are nonexistent or limited. The Guidelines do not encourage the use of worst-case assessments, but rather the development of realistic assessments based on the best data available.

A technical support document and a substantial section of the Guidelines currently discuss evaluation of uncertainty in order to produce objective assessments using the best (not worst-case) estimates available either for preliminary or in-depth exposure assessments. However, the Agency will err on the side of public health when evaluating uncertainties when data are limited or nonexistent.

IV. Evaluation of Uncertainties

A. Uncertainty Analysis

Many commentors felt that the sections of the Guidelines that dealt with uncertainty needed amplification while some sections as written were confusing. Some urged that uncertainty evaluation be presented and documented for each section within a specific exposure scenario in order to judge the overall plausibility of the assessment in reaching regulatory decisions.

Since the accuracy of an exposure assessment is influenced by the degrees of uncertainty contained in both data and assumptions, the Guidelines call for the evaluation of these uncertainties. The technical support document, Methodology for

REC 6231

Characterization of Uncertainty in Exposure Assessments (available from the National Technical Information Service, PB85-240455), describes in detail how such analyses can be performed. The Guidelines suggest that the uncertainty characterization include a discussion of the limitations of the data and estimation procedures as the justification for the model chosen. A sensitivity analysis of the exposure assessment is appropriate if the data were only able to support the estimates of ranges of the input variables. By identifying model input variables that determine the bounds on the distribution of exposure, the range of exposure, which results as individual model input variables are varied from minimum to maximum possible values as other variables remain constant, constitutes the sensitivity analysis. Further sensitivity of model formulation can be examined by repeating the sensitivity analysis for plausible alternative models.

Nothing in the Guidelines precludes estimation of uncertainty for each specific exposure scenario. The Agency has encouraged the evaluation of uncertainty in each aspect of the exposure assessment, which could impact the total risk estimate. It is important to estimate the level of uncertainty in risk assessments so that decisions based on risk assessment will reflect total uncertainty. The information presented in the Guidelines or the technical support documents properly and adequately describes the extent and quality of appropriate uncertainty analysis. Recognizing that the basis for the decision to refine a preliminary exposure assessment involves risk management, the Agency, at the suggestion of many commentors, decided to strike from the Guidelines the paragraph beginning "If the maximum possible exposure. . . ." in section III.B.8.d.(2).

B. Population Characterization

The Guidelines state that identification of populations and subpopulations at potentially high exposure forms the basis of the populations to be studied. Separate studies of sensitive subpopulation can also be included. Population characteristics, such as age and/or sex distributions, can be derived from the use of geographic and activity-specific data. Uncertainty related to estimation of a population characteristic include a discussion of the data limitations and the estimation procedures. In addition, uncertainty in estimating sizes of sensitive subpopulations should include estimates of confidence intervals.

Some commentors suggested the inclusion of additional characteristics, such as occupational and life style factors, and the inclusion of additional guidance concerning potential pitfalls when conducting population exposure

[51 FR 34054]

assessments. Others expressed concern that the exposure of a particular subpopulation would be combined with other exposures to produce an average exposure level for the general population.

The section describing population characterization encompasses, in general terms, the many characteristics that may be available, including life style factors, to describe exposed populations. The Agency agrees that there are difficulties associated with epidemiologic studies. The relationship between exposure assessments and epidemiologic studies is currently being investigated and will be the subject of a future technical support document and the further refinement of the Guidelines.

V. Clarification of Terminology

A. Exposure vs. Dose

Commentors expressed concern with the American Society for Testing and Materials (ASTM) definition of exposure. Concern was also raised about the assertion that exposures can be estimated when biological tissues for fluid measurements indicate the presence of a chemical. Some commentors found difficulty in the wording of the last sentence in section II.A., specifically "The route of exposure. . .impacts. . .the overall exposure. . . ."

It is the Agency's opinion that the members who served on the ASTM Committee E-47 had expertise in exposure assessment. The scientists and engineers cumulatively possessed many years of experience in exposure assessment. In addition, no technical society has presented an alternate definition of exposure. The Agency will consider changing the definition if a reasonable alternate definition is written and agreed upon by the scientific community.

The Agency agrees with the commentors who were concerned that the wording provided in the Guidelines that the presence of a chemical in biological tissue can be used to estimate exposure is not correct in all cases. Consequently, the word "can" was changed to "may" to reflect the current level of understanding between tissue residue and exposure (II.A., 2nd paragraph, 4th sentence). The Agency agrees with several commentors' concerns that the route of exposure impacts the overall absorbed dose, not the overall exposure, and the Guidelines reflect this change (II.A., last sentence).

B. Mixtures and Synergism

Some commentors thought more discussion was necessary on the effect of chemical mixtures and potential synergistic effect on exposure. The Guidelines for the Health Risk Assessment of Chemical Mixtures includes a discussion of chemical synergism. The Agency recognizes the need to do further work in the area of exposure to mixtures. It is recommended that this be identified as an area requiring further research.

REC 6232

These Guidelines stress the need to determine the products into which the chemical might degrade or react in the environment and to determine if any of these products are ecologically or biologically harmful.

C. Removal and Creation Steps

Some commentors urged that more emphasis be placed on changes that occur once the materials have entered the ambient environment. Other commentors argued that our current understanding will not allow a comprehensive treatment, particularly for metabolic processes.

These Guidelines state the need to address how a chemical agent moves from the source to the exposed population, which may result in the estimation of geographic and temporal distributions in various environmental media. The Guidelines also state the need to know such factors as, for example, whether the chemical agent bioaccumulates or by what mechanism the agent is removed from each medium and the role of any degradation products on ecological safety. We have already stated that guidance for analysis of metabolism data is an area of ongoing research which includes consideration of metabolism data in the calculation of whole organism dose from one species to another.

VI. Purpose, Philosophy, and Results

Several commentors raised questions related to the basic style of the Guidelines. Among the issues raised were:

- the role of exposure assessment in risk assessment/risk management (many comments directed to appropriateness of Figure 1);
- statutory/regulatory authority and uses of results; and
- the need for peer review of assessments and periodic updating of Guidelines.

A deliberate effort to separate risk assessment from risk management has been made. The management of complex issues such as procedural issues, which include coordination or linkage among divisions in the Agency, are best dealt with by management and not in Guidelines.

The decision pathway (Figure 1) was included in the Guidelines at the recommendation of the SAB. It has drawn many comments. The changes suggested would include additional detail and steps that would diminish the value of the graphic. However, the figure has been truncated to remove risk management steps.

In order to remain consistent with the separation of risk assessment and risk management, any directions to consider applicable laws or regulatory decisions have been stricken from the Guidelines.

The Agency agrees that peer review is an important aspect of the assessment process. However, emergency cases may not allow peer review in preliminary assessments. All nonemergency exposure assessments have been peer reviewed and will continue to be peer reviewed. Finally, it is clearly stated in the Guidelines that periodic revision of the document will be done to reflect the benefit of experience and knowledge.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1987 - 748-121/67049

Exhibit C



Guidance Document

First, Second, and Third Tier Review of Toxic Air Pollution Sources (Chapter 173-460 WAC)

September 2010

Publication Number: 08-02-025 (revised August 2015)

Publication and Contact Information

This document is available on the Department of Ecology's website at www.ecy.wa.gov/biblio/0802025.html.

For more information, contact:

Matt Kadlec
Air Quality Program
P.O. Box 47600
Olympia, WA 98504-7600

(360) 407-6817
matt.kadlec@ecy.wa.gov

Gary Palcisko
Air Quality Program
P.O. Box 47600
Olympia, WA 98504-7600

(360) 407-7338
gary.palcisko@ecy.wa.gov

Washington State Department of Ecology - www.ecy.wa.gov

○ Headquarters, Olympia	360-407-6000
○ Northwest Regional Office, Bellevue	425-649-7000
○ Southwest Regional Office, Olympia	360-407-6300
○ Central Regional Office, Yakima	509-575-2490
○ Eastern Regional Office, Spokane	509-329-3400

To request ADA accommodation, call (360) 407-6800, 711 (relay service), or 877-833-6341 (TTY).

Table of Contents

Introduction 6

First Tier Review 7

What is first tier review? 7

How do I know if I need to do a first tier review? 7

How do I get first tier review? 7

What issues must I address before the order can be issued? 7

How can I show that emissions are below the ASIL? 7

What can I do if emissions exceed the ASIL? 8

How do I off-set the new emissions by reducing them at another emission unit? 8

Who approves a first tier analysis? 8

What happens if my first tier analysis is approved? 8

What happens if my first tier analysis is not approved? 9

Are there any exemptions from the first tier review process? 9

Second Tier Review 10

What is second tier review? 10

How do I get second tier review? 10

What is the review process for a second tier petition? 10

Pre-application conference 10

At the conference, you, your team, and Ecology staff will review the following information: 11

Second tier review petition and fees 11

After the pre-application conference, the applicant submits to Ecology a petition and applicable fees for second tier review 11

HIA protocol 11

The applicant must also submit an HIA protocol 11

HIA document 12

After Ecology approves the HIA Protocol, the applicant prepares and submits an HIA document 12

Who approves a petition for second tier review? 12

What materials should I provide, and when? 12

Is public involvement required? 13

What can I do if Ecology does not approve the second tier petition? 13

My project triggers second tier review. Are there any exemptions from the second tier review process?. 13

Third Tier Review 14

What is third tier review? 14

How do I submit a petition for third tier review? 14

What materials should I provide, and when? 14

The materials required for a third tier review are the same as for a second tier review. 14

In addition to the above documentation, you may propose voluntary measures to reduce community exposure to pollutants emitted by your project. Voluntary measures might include voluntary reduction of emissions from existing unmodified emissions units at your facility or at another facility. 14

What is the review process for a third tier petition? 15
What criteria will Ecology follow to approve or deny a petition for third tier review? 15
Before approving your third petition, Ecology's director must find that the following conditions are met: 15
- proposed emission controls represent at least tBACT; 15
- a health impact assessment addressing all of Ecology's requirements has been completed; and .. 15
- approval of the project will result in a greater environmental benefit to the state of Washington. 15

Is public involvement required? 15
What can I do if Ecology does not approve the third tier petition? 16
My project triggers third tier review. Are there any exemptions from the third tier review process? 16
Health Impact Assessment 17
What is an HIA? 17
Who needs to submit an HIA? 17
How do I submit an HIA? 17
Why do I need a pre-application conference? 17
What documentation do I submit with an HIA? 18
What do I need to submit about the TAP concentrations? 18
What materials must I include to assess exposure? 19
What issues do I need to address in the toxicity discussion? 19
What issues do I need to address in the risk/hazard assessment section? 19
What issues do I need to address in the uncertainty section? 20
The HIA mentions subpopulations. What is an example of a sensitive or understudied subpopulation? .. 20
Who reviews the HIA? 20
What can I do if Ecology does not approve the HIA? 21
Where can I get more information on the HIA? 21
Contents of the Health Impact Assessment Protocol 22
Outline of the Health Impact Assessment Report 26
Recommended Outline of an HIA 26
Project description 26
SQER and ASIL comparison 26
Hazard identification 27
Identification of places with potentially-exposed people (off-site) 27
Discussion of TAP concentrations 27
Exposure assessment 27
Toxicity (should focus on effects relevant to proposed TAP concentrations) 28
Risk/hazard characterization 28
Discussion of acceptability of risk with regard to guidelines in Chapter 173-460 WAC 28
Second and Third Tier Review Timeline 29
Second and Third Tier Review Fees 31

Introduction

Ecology and local air quality agencies use first, second and third tier review to regulate emissions of toxic air pollutants. Hundreds of potentially toxic chemicals are released into the air each year in Washington. Excess exposures to these chemicals can cause serious illnesses and premature deaths. Widespread exposure probably accounts for some of the occurrences of various types of cancers within our population.

This publication is to help toxic air pollution sources understand and use the first, second, and third tier review sections of the notice of construction application. Requirements for first, second, and third tier review are found in Chapter 173-460 Washington Administrative Code (WAC).

First Tier Review

What is first tier review?

First tier review is part of a notice of construction application for a new or modified toxic air pollutant source. It compares your project emissions to the toxic air pollutant values listed in WAC 173-460-150.

How do I know if I need to do a first tier review?

You will need to do a first tier review if potential emissions from your project exceed the de minimis emission levels specified in WAC 173-460-150. Your potential emissions are the expected worst-case emissions from your facility, considering its physical and operational design.

How do I get first tier review?

You do not need to submit a separate petition for first tier review. The notice of construction application you file with the permitting agency serves as your petition for first tier review. Typically, the permitting agency will conduct a first tier review on every notice of construction application it receives.

What issues must I address before the order can be issued?

You must show that the emission increases from all new or modified emission units are below the acceptable source impact level (ASIL):

- after application of best available control technology for air toxics (tBACT); and
- at any location outside of your property boundary.

You can find the ASILs in WAC 173-460-150.

How can I show that emissions are below the ASIL?

You can show emissions are below the ASIL by:

- demonstrating that the emissions are at or below the small quantity emission rates (SQER);
- using a screening model (such as AERSCREEN); or
- using a refined air dispersion model (such as AERMOD).

What can I do if emissions exceed the ASIL?

You have several options, including:

- revise the project and application;
- negotiate an enforceable limit;
- off-set the emissions by reducing emissions from another on-site emission unit;
- submit a second tier petition;
- submit a third tier petition; or
- withdraw the application.

How do I off-set the new emissions by reducing them at another emission unit?

You must meet several criteria in order to get this option approved:

- the emission reductions must be actual reductions;
- the reductions must be modeled against all affected receptors; and
- when the emission increases and reductions are modeled together at the receptor, the modeling must demonstrate that the off-set proposal results in emission values lower than the ASIL.

Who approves a first tier analysis?

Your permitting agency will review the first tier analysis and either approve or deny it.

What happens if my first tier analysis is approved?

If your permitting agency approves the first tier analysis, it will include the approval decision in an "Order of Approval." For permits issued by Ecology, guidelines for issuing this order and requirements for notifying the public are in WAC 173-400-110. Other permitting agencies may have their own guidelines. The order may contain the following:

- emission limits for each toxic air pollutant (TAP) subject to review;
- a method of assuring compliance with TAP limits (usually monitoring, reporting, and operation restrictions);
- a statement of the Best Available Control Technology for Air Toxics (tBACT) for each TAP; and
- enforcement criteria for voluntary emission reductions, including monitoring, record-keeping, and reporting requirements.

What happens if my first tier analysis is not approved?

If emission increases still exceed the ASIL and other options do not work, you can submit a petition for second tier review.

Are there any exemptions from the first tier review process?

Yes. A list of exemptions from new source review is in WAC 173-400-110. Also, your permitting agency might have its own list of exemptions. Exemptions for toxic air pollutants and criteria pollutants are related because the permit process procedures, definitions, and exemptions are the same for both.

Exemptions are divided into two broad categories:

- emission unit and activity exemptions; and
- exemptions based on emissions.

To see if your project is exempt, read the emission unit and activity listing in WAC 173-400-110(4 and 5), and contact your permitting agency. De minimis emission values for toxic air pollutants are in WAC 173-460-150. You must consider all of the new or modified emission units together. For the project to be exempt, emissions from all of the individual emission units added together must be below the de minimis values.

Second Tier Review

What is second tier review?

Like first tier review, second tier review is part of a notice of construction application for a new or modified toxic air pollutant source. You need to do a second tier review if any of your project's toxic air pollutant emissions exceed the ASIL after you have completed a first tier review. In this step of the notice of construction application process, the applicant submits a health impacts assessment to Ecology. Ecology will review the health risks associated with your project.

How do I get second tier review?

Submit a petition for second tier review to Ecology, with a copy to the permitting agency that has jurisdiction. The application form includes the Health Impact Assessment Checklist and is available at: http://www.ecy.wa.gov/biblio/ecy070415.html

What is the review process for a second tier petition?

Ecology's air toxics engineer, toxicologist, and air quality modeler work together on second tier petitions. The review process includes:

- pre-application conference;
- a second tier petition and payment of applicable fees;
- HIA protocol; and
- HIA document.

Pre-application conference

After Ecology is notified that a proposed project requires second tier review, Ecology recommends you have a pre-application conference with Ecology staff before you submit a second tier petition. The pre-application conference:

- helps you identify regulatory issues before you commit a significant amount of time and resources toward a specific course of action;
- lets you know early in the process what you need to address in the Health Impact Assessment, which can avoid unnecessary delays later on; and
- helps you identify the review criteria for your project, so that you can present your proposal accurately.

You and your consulting team need to attend the conference. The team typically includes an engineer, plant operations manager, and other specialists involved in your proposal. You and your team will meet with an Air Quality Program engineer, toxicologist, and air quality modeler.

The permit writer who reviewed your first tier analysis will also attend, whether they work for Ecology or a local air quality agency.

At the conference, you, your team, and Ecology staff will review the following information:

- required permits, approvals, and fees;
- protocol for the health impact analysis;
- the refined air dispersion modeling methods used to estimate TAP levels;
- typical project review timelines;
- application regulations;
- the public hearing process; and
- any other questions you might have.

The amount of information Ecology can give you at the conference depends on the level of detail you provide about the project. Because the conference takes place early in the process, Ecology will not be able to anticipate all the relevant project details. Ecology will give you a protocol to follow that tells you what to do next.

The conference **will not** provide:

- a detailed toxicology analysis or modeling review; or
- a final recommendation on a proposal.

To schedule a pre-application conference, call Matt Kadlec at (360) 407-6817 or Gary Palcisko at (360) 407-7338. They will work with you to find a time that works for everyone. The conference is typically held at Ecology's Headquarters building at:

300 Desmond Drive SE
Lacey, WA 98503

Second tier review petition and fees

After the pre-application conference, the applicant submits to Ecology a petition and applicable fees for second tier review, with a copy to the permitting agency that has jurisdiction. The application form includes the Health Impact Assessment Checklist and is available at: http://www.ecy.wa.gov/biblio/ecy070415.html. You can find more information on applicable fees starting on page 31.

HIA protocol

The applicant must also submit an HIA protocol. Ecology will review the HIA protocol after the applicant submits the $10,000 initial fee with the HIA protocol and completed second tier application. Basic information required for HIA protocol is included later in this document.

HIA document

After Ecology approves the HIA Protocol, the applicant prepares and submits an HIA document. Ecology toxicologists will review the HIA to determine if health impacts are adequately characterized. Ecology will provide substantive and non-substantive comments on the HIA document and will request the applicant revise the HIA document if necessary. This process can be repeated until the applicant prepares an acceptable final HIA document. Ecology's project engineer or delegate will review portions of the HIA that involve the project's engineering specifications. Likewise, Ecology's dispersion modeler will review portions of the HIA that involve toxic air pollutant (TAP) concentration modeling. Following confirmations by the engineer and modeler, Ecology's project toxicologist will review risk assessment portions of the HIA. The toxicologist will then communicate to all parties the results of the HIA review.

Once an acceptable HIA document has been prepared, Ecology will prepare a brief staff report which summarizes Ecology's review of the HIA and includes recommendation(s) to the local permitting authority about the petition. Ecology will:

- post the applicant's final HIA document, Ecology's staff report, and Ecology's cover letter on Ecology's air toxics review web page (http://www.ecy.wa.gov/programs/air/Tier2/Tier2_infosite.html);
- make a final recommendation for approval or denial of the project; and
- send the recommendation to you and the permitting agency, which issues the actual approval order.

Ecology's decision on the second tier petition must be included in the final decision on the notice of construction application.

Who approves a petition for second tier review?

Only Ecology staff can review, approve, or deny a second tier petition.

What materials should I provide, and when?

In the pre-application conference, you will be given a protocol for preparing the required documentation for the second tier petition. After the pre-application conference, the permitting agency (either a local air quality agency or one of Ecology's regional offices) will provide a preliminary order of approval directly to Ecology. Then, follow this protocol to provide information:

Provide to Ecology:

- the results of the refined air dispersion modeling for all pollutants that exceed the SQERs; and
- a full copy of the second tier petition (containing a Health Impacts Assessment).

Provide to the permitting agency that reviewed your first tier analysis:

- a full copy of the second tier petition.

Is public involvement required?

Yes. Public involvement is required for any project that needs a second tier review. It may be limited to a public notice and public comment period, or Ecology may determine that a public hearing is needed. If a public hearing is held, Ecology and the permitting agency will hold a joint public hearing to streamline the public review process. Ecology staff will explain the second tier recommendation at the public hearing. You and your consultants should be prepared to explain your project and answer questions at the public hearing.

What can I do if Ecology does not approve the second tier petition?

If Ecology denies the second tier petition, the permitting agency may not approve the project. At that point, you have the following options:

- revise the project and application;
- propose emission reductions from an off-site emission unit;
- submit a third tier petition; or
- withdraw the application.

My project triggers second tier review. Are there any exemptions from the second tier review process?

No. If your project triggers second tier review, you must submit a second tier petition to Ecology before your project can be approved. If you think that your project will not meet the approval criteria of a second tier review, you may opt to submit a third tier petition instead of a second tier petition.

Third Tier Review

What is third tier review?

You can submit a petition for third tier review if the health risks from your project exceed the second tier review thresholds. In third tier review, your petition requests that the director of Ecology approve the project based on a risk management analysis.

How do I submit a petition for third tier review?

Submit your petition for third tier review to Ecology, with a copy to the permitting agency that has jurisdiction.

What materials should I provide, and when?

The materials required for a third tier review are the same as for a second tier review. You may submit the third tier petition at the same time you submit the second tier petition. Prior denial of a second tier petition submitted under WAC 173-460-090 is not required. The permitting agency (either a local air quality agency or one of Ecology's regional offices) will provide a preliminary order of approval directly to Ecology. Then follow this protocol to provide information:

Provide to Ecology:

- the results of the refined air dispersion modeling for all pollutants that exceed the SQERs;
- a full copy of the third tier petition (containing a health impacts assessment); and
- a description of environmental benefits of the proposal.

Provide to the permitting authority that reviewed your first tier analysis:

- a full copy of the third tier petition.

In addition to the above documentation, you may propose voluntary measures to reduce community exposure to pollutants emitted by your project. Voluntary measures might include voluntary reduction of emissions from existing unmodified emissions units at your facility or at another facility.

What is the review process for a third tier petition?

Ecology's air toxics engineer, toxicologist, and air quality modeler work together to prepare a recommendation to the director of Ecology to either approve or deny a third tier petition. Within 30 days after you've submitted the petition, Ecology will:

- review it for completeness; and
- provide you a letter stating the petition is complete or listing needed information if it is not complete.

Within 60 days after determining that your petition is complete, Ecology will:

- write a draft technical support document and send it to you and the permitting agency for review and comment;
- address any questions or concerns brought up during review;
- together with you, initiate a minimum 30-day public notice and public comment period;
- together with you, schedule a public hearing.

After the public hearing, Ecology will review and address all comments. Ecology will then prepare the final recommendation and technical support document, and send them to you and the permitting authority, which issues the actual approval order.

Ecology's final recommendation on the third tier petition must be included in the final decision on the notice of construction application.

What criteria will Ecology follow to approve or deny a petition for third tier review?

Before approving your third petition, Ecology's director must find that the following conditions are met:

- proposed emission controls represent at least tBACT;
- a health impact assessment addressing all of Ecology's requirements has been completed; and
- approval of the project will result in a greater environmental benefit to the state of Washington.

Is public involvement required?

Yes. Public involvement is required for any project that needs a third tier review. The public involvement process must include a public notice and public comment period, as well as a public hearing. The purpose of the public hearing is to present the results of the third tier review and to

answer any questions from the public. You and your consultants should be prepared to explain your project and answer questions at the public hearing.

What can I do if Ecology does not approve the third tier petition?

If Ecology denies the third tier petition, the permitting agency may not approve the project. At that point, you have the following options:

- revise the project and application;
- propose emission reductions from an off-site emission unit; or
- withdraw the application.

My project triggers third tier review. Are there any exemptions from the third tier review process?

No. If your project triggers third tier review, you must submit a third tier petition before your project can be approved.

Health Impact Assessment

This section helps toxic air pollution sources prepare a health impact assessment (HIA) as part of second tier or third tier review, as required in Chapter 173-460 WAC. Ecology's Air Quality Program recommends that permit applicants preparing an HIA refer to the Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments, published in March 2015 by the Office of Environmental Health Hazard Assessment, California Environmental Protection Agency. (See the citation list at the end of this document.)

The guidance manual addresses the techniques used to assess health risks of airborne contaminants released by new or modified stationary sources like those permitted in Washington. Most of the techniques described in the Hot Spots Program Guidance Manual are common to other regulatory risk assessment applications. However, applicants may need additional analyses depending on their unique circumstances. Applicants should contact Ecology before beginning work on their HIA in order to assure that all WAC 173-460-090 requirements will be satisfied. In general, using the Hot Spots Program Guidance Manual risk assessment procedures and report presentation will speed up Ecology's review. It will also minimize the chance that applicants will need to revise and resubmit their HIA.

What is an HIA?

An HIA looks at how emissions of toxic air pollutants from a specific project will affect public health. It involves several steps, including hazard identification, exposure analysis, toxic response, and risk characterization.

Who needs to submit an HIA?

Second and third tier petitions always need an HIA.

How do I submit an HIA?

When you submit a petition for a second or third tier review, the HIA will be included in your pre-application conference.

Why do I need a pre-application conference?

Pre-application conferences help you learn about regulatory issues before you commit a significant amount of time and resources to a specific course of action. At the pre-application conference, Ecology will tell you what issues need to be addressed in the HIA. This will help you avoid unnecessary costs and delays.

What documentation do I submit with an HIA?

Because each HIA is tailored to fit a specific project, each one may require different documentation. Generally, you will need to include:

- A map of the site and neighborhood showing:
    - location of new or modified emission points;
    - local zoning of the affected area;
    - locations of and distances (in meters) between the sources; and
    - residences, businesses, roadways, public properties, and public or private facilities serving population subgroups such as schools, nursing homes, hospitals, and for certain TAPs, private and public drinking water wells (note the well depth).

- Hazard identification, including:
    - a list of all TAPs (as defined in Chapter 173-460 WAC) that will be emitted by the facility, and
    - a physical description of those TAPs.

For details, refer to the sections below titled "Dispersion Modeling Protocol and Report Contents," "Contents of the Health Impact Assessment," and "Outline of the Health Impact Assessment Report."

What do I need to submit about the TAP concentrations?

You must show how you derived the TAP concentration levels. Include the following:

- emission rates, in grams per unit of time, at the maximum possible rate;
- modeled concentration estimates in $\mu g/m^3$ or ppb (disclose the emissions factors used in modeling);
- any available monitoring measurement results; and
- any uncertainties and assumptions in deriving concentration levels.

You must also disclose the cross-media transport of the emissions in the environment, the environmental persistence, the degradation pathways, and the final fate of the toxic air pollutants. This means describe the movement of proposed toxic air emissions from air into water and/or soil which people may be exposed to. Generally, the inhalation pathway of exposure is the largest contributor to the total dose. However, there are situations where a non-inhalation pathway contributes substantially to total dose. You can get detailed guidance on this subject from a variety of authorities, for example EPA's Guidelines for Exposure Assessment (1992) and Exposure Factors Handbook (2011) and OEHHA's Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments (2015, chapter five). (See the citation list at the end of this document.)

What materials must I include to assess exposure?

You must identify the TAP exposure pathways, including the following:

- Disclose the total daily intake of TAPs attributable to the project source as well as the background sources. EPA has some ambient air concentration estimates in their NATA database.
- Estimate the durations of exposure, including long-term averages, short-term peaks and worst-case scenarios. Detail the exposure parameters associated with sensitive population subgroups. You can get detailed guidance on this subject from a variety of authorities, including EPA's Guidelines for Exposure Assessment (1992) and Exposure Factors Handbook (2011) and OEHHA's Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments, (2015, chapter five). (See the citation list at the end of this document.) Identify the potentially exposed populations. Give special emphasis to any subpopulations that might be unusually susceptible to any TAPs emitted by your project.
- Using the information on the location of potentially exposed populations, show the TAP concentrations at the points where people might be exposed to the pollutants in question.

What issues do I need to address in the toxicity discussion?

The toxicity discussion should focus on the effects relevant to the proposed toxic air pollutant concentrations. The following issues should be thoroughly discussed:

- toxic effects of the toxic air pollutants;
- exposure levels associated with specific effects;
- exposure patterns and duration of exposure as established by studies of the toxic effects;
- any quantitative, chronic toxicity values including:
    - inhalation reference concentration or similar hazard-based concentrations;
    - cancer unit risk factor estimates;
    - slope factor or carcinogenic potency estimates; and
- any quantitative intermediate and short-term acute toxicity values.

What issues do I need to address in the risk/hazard assessment section?

Provide a discussion of offsetting reductions in risk that might accrue to society as a result of completing the proposed facility modification. This typically includes a:

- qualitative discussion of the risks;
- quantitative discussion of the risks with appropriate toxicity measures, calculated cancer risks, and the hazard index;
- discussion of uncertainties in the risk assessment;

- discussion of acceptability of risk with regard to guidelines in Chapter 173-460 WAC; and
- discussion of the extent to which the proposed facility might affect human health.

What issues do I need to address in the uncertainty section?

There is always some level of uncertainty associated with risk assessment. While uncertainty encompasses those factors that are not known, and could be eliminated or reduced with scientific studies, we are not asking you to conduct original research. We want you to disclose your level of confidence in the data used to substantiate your conclusions.

Risk can be over or underestimated because of many factors, including:

- extrapolation of toxicity data in animals to humans;
- uncertainty in the estimation of emissions;
- uncertainty in the air dispersion models;
- interactive effects of exposure to more than one carcinogen or toxicant;
- uncertainty in the exposure estimates; and
- uncertainty about the extent of toxicant susceptibility variation within human populations.

The HIA mentions subpopulations. What is an example of a sensitive or understudied subpopulation?

Children are a subpopulation whose hematological nervous, endocrine, and immune systems are still developing. They may be more sensitive to the effects of carcinogens on their developing systems. These sensitivities are not included in the worker population and risk estimates based on occupational epidemiological data, which are based on adult populations.

Who reviews the HIA?

Ecology's Air Quality Program toxicologists review HIAs. While the toxicologists are reviewing the HIA, the engineer and dispersion modeling staff review other portions of the second or third tier petition. They determine if tBACT and refined modeling are sufficient.

Note that though Ecology's toxicologists review HIA documentation; they are not authorized to prepare the applicant's assessment.

What can I do if Ecology does not approve the HIA?

You have the following options:

- revise the project and application;
- propose emission reductions from an off-site or on-site emission unit;
- submit a third tier petition (See WAC 173-460-100); or
- withdraw the application.

Where can I get more information on the HIA?

Contact either of the Air Quality Program toxicologists:

Matt Kadlec
(360) 407-6817
matt.kadlec@ecy.wa.gov

Gary Palcisko
(360) 407-7338
gary.palcisko@ecy.wa.gov

Contents of the Health Impact Assessment Protocol

Applicants must submit a Health Impacts Assessment Protocol before submitting a draft HIA. The protocol ensures that the applicant will submit sufficient information and is intended to prevent delays caused by incomplete analyses. The protocol should contain a description of how the applicant intends to estimate the health impacts posed by TAPs subject to second tier review. Generally, an applicant will need to provide an air quality analysis that demonstrates compliance with both national ambient air quality standards and toxics review. The following items need to be included in the Health Impact Assessment Protocol:

Emissions Estimate

- Quantify short- and long-term emission rates,
  - mass per hour, day, year;
- Report emission factors and their source and justification;
- Report applicable emission standards and ASILs;
- Provide background concentrations, if known.

Source Characteristics

- Site plan showing fence line, emission units, and other structures;
- Modeling parameters.

Model and Model Assumptions

- AERMOD is to be used in most situations.

Meteorology

- Identify representative surface meteorological data.
  - 5 years of continuous quality-assured/quality-controlled meteorological data/QC'd upper air data

Receptor Grid

- Recommended receptor grid spacing to ensure that sampling error does not reduce the maximum computed concentration by more than 10%:

Distance from Source [m]	Grid Spacing [m]
0 – 150	12.5
150 – 400	25
400 – 900	50
900 - 2000	100
2000 - 4500	300
> 4500	600

Deposition

- For some TAPs, applicants may need to estimate deposition so that multi-pathway exposures can be assessed. These TAPs include:
    - 4,4'-Methylene dianiline
    - Creosotes
    - Diethylhexylphthalate
    - Hexachlorocyclohexanes
    - PAHs
    - PCBs
    - Cadmium & compounds
    - Chromium VI and compounds
    - Inorganic arsenic and compounds
    - Beryllium and compounds
    - Lead and compounds
    - Mercury and compounds
    - Nickel
    - Fluorides (including hydrogen fluoride)
    - Dioxins and furans

Model Output/Results

- Files provided to Ecology
- Modeling results to be used to demonstrate compliance or assess risk

Receptors

- Identify receptors where the ASIL is exceeded.
  - Identify maximally-exposed residential, workplace receptors and point(s) of maximum impact. (**Note**: Maximally-impacted receptors around a site can vary depending on concentration averaging time.)

Short-term and long-term risk-based exposure concentrations

Depending on which chemicals are being evaluated and the type of receptor that is impacted, short-term and/or long-term ambient concentrations are needed.

- Short-term = typically 1-hr., 8-hr., 24-hr. concentrations
- Long-term = typically annual average concentration

Acute and chronic non-cancer hazard (1-hr., 8-hr., 24-hr., annual exposure concentrations)

For all non-carcinogenic toxic air pollutants exceeding their SQERs:

- Identify relevant short-term and long-term non-cancer toxicity values for chemicals exceeding SQERs
  - For example: EPA RfCs, OEHHA RELs, ATSDR MRL

- Calculate Hazard Quotients (HQ)
  - Exposure concentration ($\mu g/m^3$) divided by risk-based concentration ($\mu g/m^3$)

- For multiple chemicals with similar toxic effects (i.e., same tissue or organ system), calculate Hazard Index
  - Sum hazard quotients with same averaging time and similar toxic effects for all toxic air pollutants that exceed the SQER

- Determine the frequency and geographic extent that short- and long-term concentrations exceed relevant toxicity values (i.e., HQs > 1)

Cancer risk (annual exposure concentrations)

For all carcinogenic toxic air pollutants exceeding their ASILs and SQERs:

- Identify existing inhalation unit risk factors or cancer potency factors
- Calculate lifetime increased cancer risk from exposure to each TAP
- Calculate the sum of cancer risks for all chemicals emitted in excess of SQER to produce the total increased cancer risk from project
- Identify population exposed in excess of one per million and estimate total population risk from project

Outline of the Health Impact Assessment Report

In general, the HIA should provide information about:

- Project description
- Emissions
- Air dispersion modeling
- ASIL screening
- Risk assessment
  - Hazard identification, exposure, dose-response (which criteria are used to estimate risk), risk characterization, uncertainty
  - Discussion of acceptability of risk

Recommended Outline of an HIA

Note: Not every item below will be required in every HIA report. Ecology staff will discuss the specific requirements of your HIA report during the pre-application meeting.

Project description

- Project overview
- Physical location
  - Address, city, county
  - Land use (zoning) in areas adjacent to project
  - Site map showing emission points, property boundary, off-site receptors (outside any limited public access boundary maintained around the facility, and the locations of any buildings and their usage (i.e., housing, business, school, etc.))

SQER and ASIL comparison

- Comparison of facility emission rates of TAPs to their respective SQER
  - Model concentrations of those that exceed their SQER
  - Compare results to their ASIL(s)
- Refined dispersion modeling to estimate off-site concentration of those TAPs to their respective ASILs
- If a chemical exceeds its ASIL at an off-site location, then a health impact assessment is performed.

Hazard identification

- Identification of the TAPs that may pose a threat to human health (those that exceed ASILs and those that exceed SQERs with similar effects).
- Physical description of the TAP (s) emitted in amounts greater than their SQER and overview of each chemical's toxicity (i.e., affected tissue/organ and the critical effect. For example, acrolein: Eyes and respiratory tract; eye irritation and respiratory epithelium lesions).
- Potential for cross-media transport in the environment, environmental persistence, degradation pathways, and final fate of the TAP(s). Provide public water solubility data, and degradation half-lives in air, water, and soil.

Identification of places with potentially-exposed people (off-site)

- For example, residences, businesses, parks, schools, hospitals within the geographic extent where estimated concentrations are greater than the ASIL.

Discussion of TAP concentrations

- Using the information on location of potentially-exposed populations, TAP concentrations that exceed ASIL(s) should be given at points where humans might come into contact with the TAP(s).
- Derivation of the concentration levels should be discussed.
- Concentration estimates, in $\mu g/m^3$ by modeling and emissions factors used in modeling.
  - Averaging times may vary depending on the project and potentially-exposed receptors, but examples are:
    - Maximum 1-hr., 8-hr., and 24-hr. exposure – for chemicals that have the potential to cause acute effects over a short time
    - Annual average exposure – for chemicals that have the potential to cause cancer or other chronic effects
    - Display results on maps

Exposure assessment

- Identification of TAP exposure pathways
- Development of total daily intake attributable to source and background sources (existing ambient air concentration estimates for some pollutants are available in EPA's NATA)
  - Durations of exposure, including long-term averages, short-term peaks, and worst-case scenarios
  - Exposures at maximally-effected residence(s), business(es), and fence line (limited public access boundary) places
  - Exposure parameters associated with sensitive population subgroups. For example, situations where children may be frequently exposed may warrant child-specific exposure parameters.

Toxicity (should focus on effects relevant to proposed TAP concentrations)

- Description of toxic effect(s)
- Exposure levels associated with effect(s)
- Exposure pattern and duration of exposure in studies of toxic effects
- Any quantitative, chronic toxicity values
  - Inhalation reference concentration or similar hazard-based concentrations
  - Cancer unit risk factor estimates
  - Oral risk based concentrations for substances evaluated through multi-pathways of exposure
- Quantitative intermediate/short-term toxicity values
- Discussion of how the site-specific toxicity value considers exposure duration and frequency at the site

Risk/hazard characterization

- Qualitative discussion of the risk(s)
- Quantitative discussion of the risk(s)
  - With appropriate measure(s) of toxicity
  - Calculated cancer risk(s)
- Hazard quotients and hazard indexes, if there are any co-acting combinations of TAPs. (Critical effect –specific hazard indexes for TAPs emitted at rates above their SQERs for any co-acting combination of such TAPs.)

Discussion of uncertainty and variability of numeric values used in the HIA

A HIA is composed of many numeric values – each with its own uncertainty and/or variability. Uncertainty is that which is not known about a factor that influences its value. Variability occurs when a quantity that is repeatedly measured exhibits values that differ. It can be quantified using descriptive statistics such as the range.

Discussion of acceptability of risk with regard to guidelines in Chapter 173-460 WAC

- Increased cancer risk is no more than 10 per million
- Non-cancer hazard quotients or indexes are less than one, or Ecology determined that non-cancer hazards are acceptable

Second and Third Tier Review Timeline

Step 1: Applicant submits to Ecology:

- full copy of the second or third tier petition (including all of the elements discussed in the HIA protocol);
- results of the refined air dispersion modeling for all pollutants that exceed the ASILs;
- preliminary order of approval issued by the permitting agency (The permitting agency will generally provide the preliminary order of approval directly to Ecology. The permitting agency is either a local air quality agency or one of Ecology's regional offices.); and
- description of environmental benefits of the proposal (for a **third tier petition**).

Step 2: Within 30 days after receiving the petition, Ecology will:

- review it for completeness; and
- issue a letter stating the petition is complete or list all information needed to complete the petition.

Step 3: Within 60 days after determining a petition is complete, Ecology will:

- write a draft technical support document and send it to the applicant and permitting agency for review and comment;
- address any questions or concerns brought up during that review;
- for a **second tier petition**, make a final decision to recommend approval or denial of the project, and send the **final second tier** recommendation to the applicant and the permitting agency;
- for a **third tier petition**, prepare a third tier review recommendation and technical support document for public comment, and send them to the applicant and the permitting agency.

Step 4: Permitting agency initiates a public comment period on the draft notice of construction approval

After receiving Ecology's recommendation on the second or third tier petition, the permitting agency and the applicant must:

- provide a minimum 30-day public notice and a public comment period before approving or denying a notice of construction application involving second or third tier review;
- include the draft notice of construction approval order and Ecology's recommendation on the second or third tier petition as part of the public review documents;

- hold a public hearing to discuss the third tier petition and to answer questions from the public; and
- in consultation with Ecology, address any questions or concerns brought up during the public comment period.

Step 5: Final approval or denial of the project by the permitting agency

- If Ecology recommends approval of the project, the permitting agency may approve the notice of construction application.
- If Ecology recommends denial of the project, the permitting agency may not approve the project.

Second and Third Tier Review Fees

Purpose

This section explains second and third tier review fees and key process changes to applicants and consultants who submit health impact assessments under Chapter 173-460 WAC. These changes were prompted by a 2011 fee rule that changes the way Ecology collects fees and charges time for work spent reviewing health impact assessment documents.

Background

Beginning July 1, 2011, Ecology changed the fee schedule for permitting activities covered under our new source review program. These fee increases, which were authorized by the 2011 legislature, must support the cost of issuing a permit. Ecology accomplishes this by collecting an initial fee with the application that will cover a set number of review hours (base hours), depending on application type and a $95 per hour fee for the hours above base needed to complete the review and issue the permit. A notice summarizing all of the changes made by Ecology to the permitting fees regulation is available at http://www.ecy.wa.gov/biblio/1102028.html.

How the 2011 Fee Structure Affects Second and Third Tier Review

Under the 2011 fee structure, each member of Ecology's toxics review team will provide approximately 2 hours of pre-application assistance to the applicant. Time spent on pre-application assistance will not be counted toward the permit fee (not toward the initial fee or any additional fee) billed to the applicant, and will be provided in the form of one meeting between the applicant and Ecology, as well as any required advanced preparation for that meeting. Our goal in this pre-application assistance is to provide you with the majority of the information you need to prepare your health impact assessment protocol for submission to Ecology.

Once Ecology has provided information in the meeting, we will still be available to offer limited guidance to you as you prepare your protocol; however, the next step is for you to submit a health impact assessment (HIA) protocol along with the initial review fee of $10,000. The fee must be submitted with the protocol to Ecology's fiscal office before Ecology will review or approve the HIA protocol.

The HIA protocol must be accompanied by a completed application for second or third tier review. The application form includes the Health Impact Assessment Checklist and is available at http://www.ecy.wa.gov/biblio/ecy070415.html.

Alternate Method for Continuing Discussions with Ecology

It is our goal that you know how to proceed to develop the HIA by the end of the pre-application meeting. If you think your project needs more than a 2-hour meeting with Ecology, you have three choices:

- Submit the Application for Second Tier Review or Third Tier Review along with your $10,000 check. Ecology will meet with you to help you prepare your HIA and we will track our time against your initial fee.
- Enter into a contract with Ecology for additional upfront work. The rate is $95 per hour. We charge the same rate for working on your project under either option.
- Request Ecology stop working on the project once the 2 hours of "free" (included in the initial review fee) pre-application assistance are used up.

The Initial Fee You Submit May Not Cover the Cost of Processing Your Petition

The $10,000 initial fee you submit covers up to 106 hours of Ecology's review time. Ecology will track the number of hours spent on your project and will notify you when we approach the 106 hours covered by the initial fee. If the total number of review hours exceeds 106 hours, Ecology will bill you $95 per hour for each additional hour worked. We will bill you at the end of the process just before we issue a final decision. You must pay the bill before Ecology will issue a decision on your petition.

Public Hearing

The applicant is responsible for costs associated with a public hearing, if one is held. This includes staff time to prepare for the public hearing, travel time to and from the public hearing, time spent conducting the public hearing, time spent responding to public comments, and publications costs for a newspaper notice.

Changes to HIA Review Procedure

Ecology's goal is to complete our review of the HIA in a timely manner so that applicants are not charged additional hourly charges. To accomplish this goal, Ecology has changed the way we review the health impact assessment. The primary changes to our review procedure include:

- Ecology will provide the minimum amount of pre-application assistance necessary to advise the applicant of the demonstrations and submittals necessary to meet permitting requirements (one meeting lasting about 2 hours).

- Ecology will review the HIA protocol after the applicant submits the $10,000 initial fee with the HIA protocol and complete second or third tier application. The HIA protocol review process can be one of continuous improvement, until an acceptable HIA protocol has been prepared.

- Based on the approved HIA protocol, the applicant will prepare and submit an HIA document for review by Ecology.
- Ecology will provide substantive and non-substantive comments on the HIA document and will request the applicant revise the HIA document, as necessary. This process can be one of continuous improvement, until an acceptable final HIA document has been prepared by the applicant. Ecology's project engineer or delegate will review portions of the HIA that involve the project's engineering specifications. Likewise, Ecology's meteorological modeler will review portions of the HIA that involve toxic air pollutant (TAP) concentration modeling. Following confirmations by the engineer and modeler, Ecology's project toxicologist will review risk assessment portions of the HIA. The toxicologist will then communicate to all parties the results of their review of the HIA.
- Once an acceptable HIA document has been prepared, Ecology will prepare a brief staff report which summarizes Ecology's review of the HIA and includes a recommendation(s) to the local permitting authority regarding the petition.
- Ecology will post the applicant's final HIA document and Ecology's staff report and cover letter on Ecology's air toxics review web page.

Who to Contact for More Information

For more information, contact:

Gary Palcisko
Washington State Department of Ecology
Air Quality Program
P.O. Box 47600
Olympia, WA 98504-7600
(360) 407-7338
gary.palcisko@ecy.wa.gov

Matt Kadlec, PhD, DABT
Washington State Department of Ecology
Air Quality Program
P.O. Box 47600
Olympia, WA 98504-7600
(360) 407-6817
matthew.kadlec@ecy.wa.gov

Citations

Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments, Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, Oakland, CA, March 2015 (http://oehha.ca.gov/air/hot_spots/hotspots2015.html)

U.S. EPA. Guidelines for Exposure Assessment. U.S. Environmental Protection Agency, Risk Assessment Forum, Washington, DC, EPA/600/Z-92/001, 1992. (http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=15263)

U.S. EPA. Exposure Factors Handbook 2011 Edition (Final). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-09/052F, 2011. (http://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=236252)

Exhibit D

EPA/630/R-03/003F
March 2005

Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens

Risk Assessment Forum
U.S. Environmental Protection Agency
Washington, DC 20460

REC 6270

DISCLAIMER

This document has been reviewed in accordance with U.S. Environmental Protection Agency policy and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

AUTHORS AND CONTRIBUTORS

This document was prepared by a Technical Panel of the Risk Assessment Forum.

AUTHORS

Hugh Barton, National Health and Environmental Effects Research Laboratory, ORD
Jim Cogliano, National Center for Environmental Assessment, ORD
Michael P. Firestone, Office of Children's Health Protection, OA
Lynn Flowers, National Center for Environmental Assessment, ORD
R. Woodrow Setzer, National Health and Environmental Effects Research Laboratory, ORD
Larry Valcovic, National Center for Environmental Assessment, ORD
Tracey Woodruff, Office of Policy, Economics, and Innovation, OA

CONTRIBUTORS

Neepa Choksi, Fellow to the Office of Solid Waste and Emergency Response
Resha M. Putzrath, Risk Assessment Forum Staff, National Center for Environmental Assessment, ORD
William P. Wood, Risk Assessment Forum Staff, National Center for Environmental, ORD

REC 6272

ACKNOWLEDGMENTS

We would especially like to thank David Bennett for his earlier work in leading the initial efforts for this work, Bill Wood for his support, and Julian Preston for his helpful review of the document. Special thanks also go to Rebecca Brown, Rosemary Castorina, Ellen Phelps, and Linda Poore for their efforts in pulling together the underlying information.

CONTENTS

PREFACE vi

1. INTRODUCTION 1
2. PROCEDURES 6
   - 2.1. DATA SOURCES FOR ANIMAL STUDIES 6
   - 2.2. EVALUATING THE MODE OF ACTION OF CARCINOGENS 8
   - 2.3. QUANTITATIVE METHODS 9
   - 2.4. IONIZING RADIATION 12
3. RESULTS 13
   - 3.1. QUALITATIVE EVALUATION OF THE DATABASE 13
   - 3.2. QUANTITATIVE EVALUATION OF THE DATABASE 15
     - 3.2.1. Carcinogens with a Mutagenic Mode of Action 16
       - 3.2.1.1. *Early Postnatal, Juvenile, and Adult Repeated Dosing Studies of Chemicals with a Mutagenic Mode of Action* 16
       - 3.2.1.2. *Acute Dosing Studies of Chemicals with a Mutagenic Mode of Action* 17
     - 3.2.2. Carcinogens with Modes of Action Other Than Mutagenicity 19
     - 3.2.3. Ionizing Radiation 21
4. DISCUSSION 23
5. GUIDANCE FOR ASSESSING CANCER RISKS FROM EARLY-LIFE EXPOSURE 30
6. COMBINING LIFESTAGE DIFFERENCES IN EXPOSURE AND DOSE-RESPONSE WHEN ASSESSING CARCINOGEN RISK - SOME EXAMPLES FOR CARCINOGENS THAT ACT THROUGH A MUTAGENIC MODE OF ACTION 36
   - 6.1 CALCULATING LIFETIME RISKS ASSOCIATED WITH LIFETIME EXPOSURES 36
   - 6.2 CALCULATING LIFETIME RISKS ASSOCIATED WITH LESS THAN LIFETIME EXPOSURES 368

APPENDIX A: TABLES A-1

Table 1a. Chemicals that have been found to have carcinogenic effects from prenatal or postnatal exposure in animals as identified in different review articles……A-1

Table 1b. List of chemicals considered in this analysis. (These are chemicals for which there are both early-life and adult exposure reported in the same animal experiment.)…… ……..A-3

Table 2. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult repeated exposures……..A-5

Table 3. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult acute exposure……A-17

Table 4. Ratio of early-life to adult cancer potencies for studies with repeated exposures of juvenile and adult animals to carcinogens with a mutagenic mode of action……..…A-44

Table 5: Ratio of early-life to adult cancer potencies for studies with repeated exposures of juvenile and adult animals to chemicals with other than mutagenic modes of action.……A-45

Table 6. Ratio of early-life to adult cancer potencies for studies with acute exposures of juveniles and adult animals to chemicals with mutagenic modes of action……A-46

Table 7. Ratio of early-life to adult cancer potencies for studies with lifetime exposures starting with juvenile and adult……..A-57

Table 8. Summary of quantitative estimates of ratio of early-life to adult cancer potencies……A-60

Table 9. Excess Relative Risk (ERR) estimates for cancer incidence from Life Span Study (Japanese survivors)……..…A-61

Table 10. Excess Relative Risk estimates for incidence of thyroid cancer from Life Span Study……..A-62

Table 11. Coefficients for the Revised Methodology mortality risk model (from U.S. EPA, 1999)……..…A-63

REFERENCES R-1

LIST OF FIGURES

Figure 1. Flow chart for early-life risk assessment using mode of action framework 42

Figure 2. Posterior, unweighted geometric means and 95% confidence intervals for the ratios of juvenile to adult cancer potency for carcinogens acting primarily through a mutagenic mode of action..... 43

Figure 3. Study designs 44

PREFACE

U.S. Environmental Protection Agency (EPA or the Agency) cancer risk assessments may be conducted differently than envisioned in this Supplemental Guidance for many reasons including, for example, new information, new scientific understanding, or different science policy judgment. The practice of risk assessment with respect to accounting for early-life exposures to toxicants continues to develop, and specific components of this Supplemental Guidance may become outdated or may otherwise require modification in individual settings. It is EPA's intent to use, to the extent practicable and consistent with Agency statutes and regulations, the best available science in its risk assessments and regulatory actions, and this Supplemental Guidance is not intended to provide any substantive or procedural obstacle in achieving that goal. Therefore, the Supplemental Guidance has no binding effect on EPA or on any regulated entity. Where EPA does use the approaches in the Supplemental Guidance in developing risk assessments, it will be because EPA has decided in the context of that risk assessment that the approaches from the Supplemental Guidance are suitable and appropriate. This judgment will be tested through peer review, and the risk assessment will be modified to use different approaches if appropriate.

This Supplemental Guidance is intended for guidance only. It does not establish any substantive "rules" under the Administrative Procedure Act or any other law and has no binding effect on EPA or any regulated entity, but instead represents a non-binding statement of policy.

The Supplemental Guidance addresses a number of issues pertaining to cancer risks associated with early-life exposures generally, but provides specific guidance on potency adjustment only for carcinogens acting through a mutagenic mode of action. This guidance recommends for such chemicals, a default approach using estimates from chronic studies (i.e., cancer slope factors) with appropriate modifications to address the potential for differential risk of early-lifestage exposure. Default adjustment factors are meant to be used only when no chemical-specific data are available to assess directly cancer susceptibility from early-life exposure to a carcinogen acting through a mutagenic mode of action.

The Agency considered both the advantages and disadvantages of extending the recommended, age dependent adjustment factors for carcinogenic potency to carcinogenic agents for which the mode of action remains unknown. EPA recommends these factors only for carcinogens acting through a mutagenic mode of action based on a combination of analysis of available data and long-standing science policy positions that set out the Agency's overall approach to carcinogen risk assessment, e.g., the use of a linear, no threshold extrapolation procedure in the absence of data in order to be health protective. In general, the Agency prefers

to rely on analyses of data rather than on general defaults. When data are available for a susceptible lifestage, they should be used directly to evaluate risks for that chemical and that lifestage on a case-by-case basis. In the case of nonmutagenic carcinogens, when the mode of action is unknown, the data were judged by EPA to be too limited and the modes of action too diverse to use this as a category for which a general default adjustment factor approach can be applied. In this situation per the Agency's *Guidelines for Carcinogen Risk Assessment*, a linear low-dose extrapolation methodology is recommended. It is the Agency's long-standing science policy position that use of the linear low-dose extrapolation approach (without further adjustment) provides adequate public health conservatism in the absence of chemical-specific data indicating differential early-life susceptibility or when the mode of action is not mutagenicity.

The Agency expects to produce additional supplemental guidance for other modes of action, as data from new research and toxicity testing indicate it is warranted. EPA intends to focus its research, and to work collaboratively with its federal partners, to improve understanding of the implications of early life exposure to carcinogens. Development of guidance for estrogenic agents and chemicals acting through other processes resulting in endocrine disruption and subsequent carcinogenesis, for example, might be a reasonable priority in light of the human experience with diethylstilbesterol and the existing early-life animal studies. It is worth noting that each mode of action for endocrine disruption will probably require separate analysis.

As the Agency examines additional carcinogenic agents, the age groupings may differ from those recommended for assessing cancer risks from early-life exposure to chemicals with a mutagenic mode of action. Puberty and its associated biological changes, for example, involve many biological processes that could lead to changes in susceptibility to the effects of some carcinogens, depending on their mode of action. The Agency is interested in identifying lifestages that may be particularly sensitive or refractory for carcinogenesis, and believes that the mode of action framework described in the Agency's *Guidelines for Carcinogen Risk Assessment* is an appropriate mechanism for elucidating these lifestages. For each additional mode of action evaluated, the various age groupings determined to be at differential risk may differ from those described in this Supplemental Guidance. For example, the age groupings selected for the age-dependent adjustments were initially selected based on the available data, i.e., for the laboratory animal age range representative of birth to < 2 years in humans. More limited data and information on human biology are being used to determine a science-informed policy regarding 2 to < 16 years. Data were not available to refine the latter age group. If more data become available regarding carcinogens with a mutagenic mode of action, consideration may be given to further refinement of these age groups.

Access to data and other information relating to the Cancer Guidelines (U.S. EPA, 2005) and this Supplemental Guidance will be through EPA's Risk Assessment Forum website, under Publications, Guidelines, Guidelines for Cancer Risk Assessment. The URL is http://www.epa.gov/cancerguidelines. The data and results of analyses are available in spreadsheets.

REC 6278

1. INTRODUCTION

Cancer risk to children in the context of the U.S. Environmental Protection Agency's cancer guidelines (U.S. EPA, 2005) includes both early-life exposures that may result in the occurrence of cancer during childhood and early-life exposures that may contribute to cancers later in life. The National Research Council (NRC, 1994) recommended that "EPA should assess risks to infants and children whenever it appears that their risks might be greater than those of adults." This document focuses on cancer risks from early-life exposure compared with those from exposures occurring later in life. Evaluating childhood cancer and childhood exposures resulting in cancer later in life are related, but separable, issues.

Historically, the focus on cancer has been as a disease associated with aging, resulting from extended exposure duration with prolonged latency periods before the cancers appear. Because much of cancer epidemiology addresses occupational exposures and because rodent cancer studies are designed to last approximately a lifetime (two years) beginning after sexual maturity, the cancer database used by EPA and other agencies for risk assessment focuses on adults. However, extensive literature demonstrates that exposures early in life (i.e., transplacental or *in utero*, early postnatal, lactational) in animals can result in the development of cancer (reviewed in Toth, 1968; Della Porta and Terracini, 1969; Druckery, 1973; Rice, 1979; Vesselinovitch et al., 1979; Rice and Ward, 1982; Vesselovitch et al., 1983; Anderson et al., 2000). Thus, one element in extending analyses to children is to evaluate the extent to which exposures early in life would alter the incidence of cancers observed later in life, compared with the incidence observed with adult-only exposures (Anderson et al., 2000; NRC, 1993).

The causes of cancer encompass a variety of possible risk factors, including genetic predisposition (Tomlinson et al., 1997), diet, lifestyle, associations with congenital malformations (Bosland, 1996), and exposure to biological and physical agents and chemicals in the environment. In some cases, tumors in adults and children have been compared (Anderson et al., 2000; Ginsberg et al., 2002). Children and adults generally develop the same spectrum of tumors when they have inherited gene and chromosomal mutations, such as Li-Fraumeni syndrome (Birch et al., 1998). With ionizing radiation, which operates through a mutagenic mode of action, both the young and the old develop many of the same tumors, with the difference being that children are more susceptible for a number of tumor types (NRC, 1990; U.S. EPA, 1994; UNSCEAR, 2000). Studies with anticancer drugs (cytotoxic and immunosuppressive) demonstrate a similar spectrum of tumors (Hale et al., 1999; Kushner et al., 1998; Larson et al., 1996; Nyandoto et al., 1998). Various viral infections, such as Epstein Barr and hepatitis B, lead to lymphoma and liver cancer, respectively, in both age groups (Lindahl et

al., 1974; Mahoney, 1999). These observations in humans indicate that the mode of action for these agents would be the same or similar for adults and children.

Although there are similarities between childhood and adult tumors, significant differences are also known to exist (Grufferman, 1998; Israel, 1995). Tumors of childhood generally consist more of embryonic cell tumors, while adults have more carcinomas. Leukemias, brain and other nervous system tumors, lymphomas (lymph node cancers), bone cancers, soft tissue sarcomas, kidney cancers, eye cancers, and adrenal gland cancers are the most common cancers of children, while skin, prostate, breast, lung, and colorectal cancers are the most common in adults (Ries et al., 1999; U. S. Cancer Statistics Working Group, 2002). Some tumors are unique to the young, including several with well established genetic bases, such as tumors of the kidney (Wilms' tumor) or eye (retinoblastoma) (Anderson et al., 2000; Israel, 1995).

The relative rarity in the incidence of childhood cancers and a lack of animal testing guidelines with perinatal[1] exposure impede a full assessment of children's cancer risks from exposure to chemicals in the environment. Unequivocal evidence of childhood cancer in humans occurring from chemical exposures is limited (Anderson et al., 2000). Established risk factors for the development of childhood cancer include radiation and certain pharmaceutical agents used in chemotherapy (Reise, 1999). There is some evidence in humans for adult tumors resulting from perinatal exposure. Pharmacological use of diethylstilbesterol (DES) during pregnancy to prevent miscarriages induced clear cell adenocarcinoma of the vagina in a few daughters exposed *in utero* though this tumor was not observed in exposed mothers (Hatch et al., 1998; Robboy et al., 1984; Vessey, 1989). In addition to the limited human data, there are examples of transplacental carcinogens in animal studies, such as recent studies with nickel and arsenic (Diwan et al., 1992; Waalkes et al., 2003), as well as studies suggesting that altered development can affect later susceptibility[2] to cancer induced by exposure to other chemicals (Anderson et al., 2000; Birnbaum and Fenton, 2003).

Infrequently, perinatal exposure in animals has been shown to induce tumors of different types than those observed with adult exposures. Studies with saccharin (Cohen et al., 1995; Whysner and Williams, 1996; IARC, 1999) and ascorbate (Cohen et al., 1998; Cohen et al., 1995; NTP, 1983) found cancer when exposures were initiated in the perinatal period. In

[1] Perinatal is defined as the time around birth and may include both prenatal (prior to birth) and postnatal (after birth) periods.

[2] Susceptibility is defined here as an increased likelihood of an adverse effect, often discussed in terms of relationship to a factor that can be used to describe a human subpopulation (e.g., lifestage, demographic feature, or genetic characteristic). The terms "susceptibility" and "sensitivity" are used with a variety of definitions in published literature making it essential that readers are aware of these differences in terminology across documents.

contrast, studies submitted to the Food and Drug Administration of approximately a dozen other food additives and colorings that were not adult carcinogens did not indicate cancer, even when perinatal exposures occurred (U.S. EPA, 1996). When observed, the differences between childhood and adult cancers suggest the importance of evaluating the impacts of maternal exposures during pregnancy as well as exposures to children (Anderson et al., 2000). The effects of maternal exposures and transplacental carcinogens require separate evaluation and are not quantitatively evaluated in the analysis presented below.

The limited human information described briefly above is supported by a number of animal bioassays that include both perinatal and adult exposures to chemicals. Standard animal bioassays generally begin dosing after the animals are 6-8 weeks old, when many organs and systems are almost fully developed, though substantial growth in body size continues thereafter (as more fully discussed in Hattis et al., 2005). The literature can be divided roughly into three types of exposure scenarios: those that include *repeated* exposures for the early postnatal to juvenile period, as compared with chronic later-life dosing; *lifetime* (i.e., combined perinatal and adult) exposure as compared with chronic later-life dosing; and those that include more *acute* exposures, such as a single intraperitoneal (ip) or subcutaneous injection, for both early-life and later-life dosing. In the early-life exposure studies that are available, perinatal exposure usually induces higher incidence of tumors later in life than the incidence seen in standard bioassays where adult animals only were exposed; some examples include diethylnitrosamine (DEN) (Peto et al., 1984), benzidine (Vesselinovitch et al., 1979), DDT (Vesselinovitch et al., 1979), and polybrominated biphenyls (PCBs) (Chhabra et al., 1993a). Reviews comparing early-life carcinogenesis bioassays with standard bioassays for a limited number of chemicals (McConnell, 1992; Miller et al., 2002; U.S. EPA, 1996) have concluded:

- The same tumor sites usually are observed following either perinatal or adult exposure.
- Perinatal exposure in conjunction with adult exposure usually increases the incidence of tumor bearing animals or reduces the latent period before tumors are observed.

There is limited evidence to inform the mode(s) of action leading to differences in tumor type and tumor incidence following early-life exposure and exposure later in life. Differences in the capacity to metabolize and clear chemicals at different ages can result in larger or smaller internal doses of the active agent(s), either increasing or decreasing risk (Ginsberg et al., 2002; Renwick, 1998). There is reason to surmise that some chemicals with a mutagenic mode of action, which would be expected to cause irreversible changes to DNA, would exhibit a greater effect in early-life versus later-life exposure. Several studies have shown increased susceptibility

of weanling animals to the formation of DNA adducts following exposure to vinyl chloride (Laib et al., 1989; Morinello et al., 2002a; Morinello et al., 2002b). Additionally, even though not used quantitatively in the analyses in this document, a recent analysis of *in vivo* transplacental micronucleus assays indicated that fetal tissues generally are more sensitive than maternal tissues for induction of micronuclei from mutagenic chemicals (Hayashi et al., 2000), providing qualitative support for the early-life susceptibility. Similarly, the neonatal mouse model for carcinogenesis, which uses two doses prior to weaning followed by observation of tumors at one year, shows carcinogenic responses for mutagenic agents (Flammang et al., 1997; McClain et al., 2001). These results are consistent with the current understanding of biological processes involved in carcinogenesis, which leads to a reasonable expectation that children can be more susceptible to carcinogenic agents than adults (Anderson et al., 2000; Birnbaum and Fenton, 2003; Ginsberg, 2003; Miller et al., 2002; Scheuplein et al., 2002). Some aspects potentially leading to childhood susceptibility include the following issues.

- More frequent cell division during development can result in enhanced fixation of mutations due to the reduced time available for repair of DNA lesions and clonal expansion of mutant cells gives a larger population of mutants (Slikker et al, 2004).
- Some embryonic cells, such as brain cells, lack key DNA repair enzymes.
- Some components of the immune system are not fully functional during development (Holladay and Smialowicz, 2000; Holsapple et al., 2003).
- Hormonal systems operate at different levels during different lifestages (Anderson et al., 2000).
- Induction of developmental abnormalities can result in a predisposition to carcinogenic effects later in life (Anderson et al., 2000; Birnbaum and Fenton, 2003; Fenton and Davis, 2002).

The methodology that has been generally used by the U.S. EPA to estimate cancer risk associated with oral exposures relies on estimation of the lifetime average daily dose, which can account for differences between adults and children with respect to exposure factors such as eating habits and body weight. However, susceptibility differences with respect to early lifestages are not taken into consideration because cancer slope factors[3] are based upon effects

[3] Cancer slope factor – An upper bound estimate of the increased cancer risk from a lifetime exposure to an agent. This estimate, usually expressed in units of proportion (of a population) affected per unit exposure (e.g., mg/kg-day or ug/m^3), is generally reserved for use in the low-dose region of the dose-response relationship. It is often the statistical upper bound on the potency and therefore the risk. "Upper bound" in this context is a plausible

observed following exposures to adult humans or sexually mature animals. Since a much larger database exists for chemicals inducing cancer in adult humans or sexually mature animals, it is necessary to determine whether adjustment of such adult-based cancer slope factors would be appropriate when assessing cancer risks associated with exposures early in life. The analysis undertaken here addresses this issue, focusing upon studies that define the potential duration and degree of increased susceptibility that may arise from childhood, defined as early-life (typically postnatal and juvenile animal) exposures. Some of these analyses, along with a more complete description of the procedures used, have been published (Barton et al., 2005). The analysis presented in this Supplemental Guidance and in the published article form the basis for developing Supplemental Guidance for evaluating cancer susceptibility associated with early-life exposures.

upper limit to the true probability.

2. PROCEDURES

This section describes the steps taken to assess potential susceptibility to early-life exposure to carcinogenic compounds compared with adult and whole-life exposure. The readily available literature was reviewed to identify animal studies that compared tumor incidence between early-life and adult-only exposures or between early-life-and-adult and adult-only exposures. Studies were categorized by length of exposure; those studies with quantitative information to estimate tumor incidence over time for early-life and adult exposures were identified. These studies provided the basis for quantitatively estimating the difference in susceptibility between early-life and adult exposures, as described below. Finally, summaries of available human data for radiation exposure were reviewed in the context of tumor incidence from early-life versus later-in-life exposure.

2.1. DATA SOURCES FOR ANIMAL STUDIES

Studies in the literature included in this analysis are those that report tumor response from experiments that included both early-life and adult exposure as separate experimental groups. Initial studies for consideration were identified through review articles and a search of the National Toxicology Program (NTP) database. Reviews of the literature regarding cancer susceptibility from early-life exposure in animals include McConnell (1992), Ginsberg (2003), Anderson et al. (2000), Miller et al. (2002) and U.S. EPA (1996). A literature search was conducted utilizing key words and MeSH headings (Medline) from studies identified in the available reviews. The list of chemicals included in this analysis for quantitative evaluation is shown in Table 1a and 1b.

Abstracts or papers were reviewed to determine if a study provided information that could be used for quantitative analysis. The criteria used to decide if a study could be included in the quantitative analysis were:

- Exposure groups at different post-natal ages in the same study or same laboratory, if not concurrent (to control for a large number of potential cross-laboratory experimental variables including pathological examinations),

- Same strain/species (to eliminate strain-specific responses confounding age-dependent responses),

- Approximately the same dose within the limits of diets and drinking water intakes that obviously can vary with age (to eliminate dose-dependent responses confounding age-dependent responses),

- Similar latency period following exposures of different ages (to control for confounding latency period for tumor expression with age-dependent responses), arising from sacrifice at >1 year for all groups exposed at different ages, where early-life exposure can occur up to about 7 weeks. Variations of around 10 to 20% in latency period are acceptable,

- Postnatal exposure for juvenile rats and mice at ages younger than the standard 6 to 8 week start for bioassays; prenatal (*in utero*) exposures are not part of the current analysis. Studies that have postnatal exposure were included (without adjustment) even if they also involved prenatal exposure,

- "Adult" rats and mice exposure beginning at approximately 6 to 8 weeks old or older, i.e. comparable to the age at initiation of a standard cancer bioassay (McConnell, 1992). Studies with animals only at young ages do not provide appropriate comparisons to evaluate age-dependency of response (e.g., the many neonatal mouse cancer studies). Studies in other species were used a supporting evidence, because they are relatively rare and the determination of the appropriate comparison ages across species is not simple, and

- Number of affected animals and total number of animals examined are available or reasonably reconstructed for control, young, and adult groups (i.e., studies reporting only percent response or not including a control group would be excluded unless a reasonable estimate of historical background for the strain was obtainable).

Tables 2 and 3 include information on the methods and results from the animal studies identified in Table 1b. Pertinent information on species, sex, dosing regimen, and tumor incidence is given. Additionally, the "Notes" column includes general information about the relationship between tumor incidence, animal age at first dosing, and sex. The data in Tables 2 and 3 were used for the calculations, described below, for estimating potentially increased cancer risk from early-life exposure.

The available literature includes a wide range of exposure scenarios. This range is due in part to the lack of a defined protocol for early-life testing and the difficulty of standardizing and administering doses preweaning. As noted previously, the literature can be divided roughly into three types of exposure scenarios: those that include repeated exposures for the early postnatal to juvenile period, as compared with chronic later-life dosing; lifetime (i.e., combined perinatal and adult) exposure as compared with chronic later-life dosing; and those that include more acute exposures, such as a single intraperitoneal (ip) or subcutaneous injection, for both early-life and later-life dosing. Table 2 includes the studies that had early postnatal to juvenile exposures, adult chronic exposures, and lifetime exposures. Table 3 includes studies with acute exposures. A discussion of the implications of the different exposure scenarios is included in Section 3.

Studies were identified for more than 50 chemicals not included in Tables 2 and 3 that demonstrated carcinogenesis following perinatal exposure, but did not directly compare exposures at different ages. A large number of studies address *in utero* exposures only. More than 100 chemicals (with both negative and positive findings) have been studied in the neonatal mouse assay, but this assay does not have a comparable adult exposure (Flammang et al., 1997; McClain et al., 2001; Fujii, 1991). Studies across laboratories often varied in their use of animal strains (e.g., for AZT studies, Diwan et al., 1999 used CD-1 mice, while NTP, 1999 used $B6C3F_1$ mice). Studies of tamoxifen use two Wistar-derived strains and had very different periods for tumor expression, i.e., sacrifice at 20 months for adult-exposed rats and natural death up to 35 months for juvenile-exposed rats, with uterine tumors observed in animals dying after 22 months (Carthew et al., 2000; Carthew et al., 1996; Carthew et al., 1995). Due to these factors, the chemicals that belong to this group were not evaluated quantitatively. In addition, there were studies assessing radiation in animals (Covelli et al., 1984; Di et al., 1990; Sasaki et al., 1978). The radiation data were not analyzed in depth, in part because there are recognized differences in toxicokinetics and toxicodynamics between radiation and chemicals with a mutagenic mode of action for carcinogenesis. Even though the data on A-bomb survivors provide information for many different cancer sites in humans with a single exposure involving all ages, a number of national and international committees of experts have analyzed and modeled these data to develop risk estimates for various specific applications. Furthermore, lack of uniformity regarding radiation doses, gestational age at exposure, and the animal strains used make it difficult to make comparisons across studies (Preston et al., 2000).

2.2. EVALUATING THE MODE OF ACTION OF CARCINOGENS

Evaluation of the mode of action of a carcinogen was based upon a weight-of-evidence approach. Multiple modes of action are associated with the chemicals in this database, but a number are associated with mutagenicity (i.e., benzo(a)pyrene, benzidine, dibenzanthracene, diethylnitrosamine, dimethylbenz(a)anthracene, dimethylnitrosamine, ethylnitrosourea, 3-methylcholanthrene, methylnitrosourea, safrole, urethane, and vinyl chloride). Determination of carcinogens that are operating by a mutagenic mode of action entails evaluation of short-term testing results for genetic endpoints, metabolic profiles, physicochemical properties, and structure-activity relationship (SAR) analyses in a weight-of-evidence approach (Dearfield et al., 1991; U.S. EPA, 1986, 1991; Waters et al., 1999), as has been done for several chemicals (e.g., Dearfield et al., 1999; McCarroll et al., 2002; U.S. EPA, 2000a). Key data for a mutagenic mode of action may be evidence that the carcinogen or a metabolite is DNA reactive and/or has the ability to bind to DNA. Also, such carcinogens usually produce positive effects in multiple test

systems for different genetic endpoints, particularly gene mutations and structural chromosome aberrations, and in tests performed *in vivo* which generally are supported by positive tests *in vitro*. Additionally, carcinogens may be identified as operating via a mutagenic mode of action if they have similar properties and SAR to established mutagenic mode of action.

2.3. QUANTITATIVE METHODS

To estimate the potential difference in susceptibility between early-life and adult exposure, we calculated the estimated ratio of the cancer potency from early-life exposure compared to the estimated cancer potency from adult exposure. The cancer potency was estimated from a one-hit model, or a restricted form of the Weibull model, which is commonly used to estimate cumulative incidence for tumor onset. The general form of the equation is:

P(dose) = 1-[1-P(0)]exp(-cancer potency*dose)

The ratio of juvenile to adult cancer potencies were calculated by fitting this model to the data for each age group. The model fit depended upon the design of the experiment that generated the data. Two designs should be handled separately: experiments in which animals are exposed either as juveniles or as adults (with either a single or multiple dose in each period), and experiments in which exposure begins either in the juvenile or in the adult period, but once begun, continues through life.

For the first case, the model equations are:

$$P_A = P_0 + (1 - P_0)(1 - e^{-m_A \delta_A}) \qquad (1)$$
$$P_J = P_0 + (1 - P_0)\left(1 - e^{-m_A e^{\lambda} \delta_J}\right)$$

where:

subscripts A and J refer to the adult and juvenile period, respectively,
λ is the natural logarithm of the juvenile:adult cancer potency ratio,
P_0 is the fraction of control animals with the particular tumor type being modeled,
P_x is the fraction of animals exposed in age period x with the tumor,
m_A is the rate of accumulation of "hits" per unit of time for adults, i.e., the cancer potency, and
δ_x is the duration or number of exposures during age period x.

For a substantial number of data sets (acute exposures), $\delta_J = \delta_A = 1$. We are interested in

determining λ, which is the logarithm of the estimated ratio of juvenile to adult cancer potencies, a measure of potential susceptibility for early-life exposure.

For the second kind of design, the model equations should take into account that exposures that were initiated in the juvenile period continue through the adult period. The model equations for the fraction of animals exposed only as adults with tumors in this design are the same as in the first design, but the fraction of animals whose first exposure occurred in the juvenile period is:

$$P_J = P_0 + (1 + P_0)\left(1 - e^{-m_A e^{\lambda}(\delta_J - \delta_A) - m_A \delta_A}\right) \tag{2}$$

All symbols in (eq. 2) have the same interpretation as their counterparts in (eq. 1), but now δ_J includes the duration of exposure during the juvenile period as well as the subsequent adult period.

Parameters in these models were estimated using Bayesian methods (see, for example, Carlin and Louis, 2000), and all inferences about the ratios were based on the marginal posterior distribution of λ. Some of these analyses, including a more complete description of the procedures (including the potential effect of alternative Bayesian priors that have been examined) have been published (Barton et al., 2005). The data for estimating each ratio were in the form of numbers of animals tested and number affected for each of control, juvenile-exposed, and adult-exposed animals, and duration of exposure for each of the juvenile-exposed and adult-exposed groups. A few data sets had separate control groups for the juvenile-exposed and adult-exposed groups, and equations 1 and 2 were modified accordingly. The likelihood for the parameters in the model was the product of three (or four, if there were two control groups) binomial probabilities: for the number of animals with tumors in the control group(s), for the juvenile-exposed group, and for the adult-exposed group. The prior for P_0 (the fraction of control animals with a particular tumor) was right triangular (right angle at the origin), based on the assumption that control incidences should be relatively low. (The base of the distribution is one, as P_0 can not exceed one. As this is a probability distribution, the area of the triangle is one. Therefore, its height at the origin must be 2.) The effect of exposure in adults is quantified by the extra risk, Q, where the probability that an animal has a tumor is $P_0 + (1 - P_0)Q$. So, from equations 1, $Q = 1 - e^{-m_A \delta_A}$, Q was given a uniform prior on the interval (0,1), reflecting total ignorance about the extra risk of adult exposure. Finally, the prior for λ was Gaussian with mean 0 (corresponding to a median or geometric mean ratio of one) and standard deviation 3. The prior for the log ratio of juvenile to adult cancer potency has some influence over the posterior estimates for the ratio of juvenile to adult potency. The magnitude of that influence depends on

the amount of support in the data for different values of the log ratio. The prior also effectively downweights extremely large or small values for the juvenile to adult potency ratio. Three priors for the standard deviation were evaluated (Barton et al., 2005, see Appendix), with the intent of finding the largest prior, i.e., one that would contain the least informative assumption for the prior. A standard deviation of 9 was tried, but some of the intervals would not converge. A standard deviation of 3 worked well, allowed ratio estimates to be derived, with all of the data of interest. An intermediate value of 6 was also examined to ascertain if a less informative prior could be used. While the intervals converged, a sensitivity analysis showed that this value for the standard deviation resulted in sufficient down-weighting of the ratios with limited information that these data would not influence the result. This was considered an unreasonable bias, so a standard deviation of 3 was used for the further analyses. A further discussion of these analyses can be found in Barton et al. (2005).

The posterior distribution for the unknown parameters in these models is the product of the likelihood from the data and the priors (the "unnormalized" prior), divided by a normalization constant that is the integral of the unnormalized prior over the ranges of all the parameters. This normalization constant was computed using numerical integration, as were posterior means and variances and marginal posterior quantiles for the log-ratio λ. All numerical computations were carried out in the R statistical programming language (version 1.8.1; R Development Core Team, 2003).

This method produced a posterior mean ratio of the early-life to adult cancer potency, which is an estimate of the potential susceptibility of early-life exposure to carcinogens. If the ratio was greater than one, this indicated that the experiment found that there was greater susceptibility from early-life exposure. If the ratio was less than one, this indicated that the experiment found that there was less susceptibility from early-life exposure. Summaries of the individual ratios from each of the dose groups from the different experiments for different groupings were also calculated (for example for all acute exposures of chemicals that are carcinogenic by a mutagenic mode of action). The summary ratios were constructed from the individual ratios within a group, by variance-weighting the means of each ratio. The individual, posterior means were weighted by using reciprocals of their posterior variance. This weighting procedure is commonly used because it gives greater weight to those studies for which the variances, i.e., the uncertainties, are smaller. Because the ratios were calculated as log ratios (see eq. 1), exponentiating the resulting inverse-variance-weighted mean yielded inverse-variance-weighted geometric means of ratios.

2.4. IONIZING RADIATION

A supporting role was assigned to the available human radiation data, where cancer incidence in adults who were children at the time of the atomic bomb (A-bomb) exposure was compared with cancer incidence in adults who were older at the time of exposure. Although there are recognized differences in toxicokinetics and toxicodynamics between radiation and chemical carcinogens with a mutagenic mode of action, the data on A-bomb survivors provide information for many different cancer sites in humans with a single exposure involving all ages. In addition to the richness of the data, a number of national and international committees of experts have analyzed and modeled these data to develop risk estimates for various specific applications.

The report of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR, 2000, with Scientific Annexes) lists more than 80 studies, in addition to the reports of the Japanese A-bomb survivors, in which at least one type of cancer was measured in humans who were exposed either intentionally or accidentally to some form of ionizing radiation. However only the A-bomb survivor reports have relevant information on incidence of early-life exposures. One of the more recent papers cited in the UNSCEAR report, by Thompson et al. (1994), contains detailed data on the incidence of 21 different cancers in 37,270 exposed A-bomb survivors (42,702 unexposed). Also, EPA has used data from the A-bomb survivors to develop age-specific relative risk coefficients using various methods for transporting the risk from the Japanese population to the U.S. population (U.S. EPA, 1994). It is beyond the scope of this effort to present all of the radiation data or a discussion of the various analyses and modeling efforts. Rather, information relevant to comparing cancer risks from juvenile versus adult exposure from UNSCEAR (2000) and U.S. EPA (1994; 1999) is presented as representative findings to determine whether the radiation data are similar qualitatively to the chemical findings. More detailed data on the A-bomb survivors can be found in Delongchamp et al. (1997) and Preston et al. (2000).

As previously noted, several studies have assessed radiation in animal studies (Covelli et al., 1984; Di et al., 1990; Sasaki et al., 1978). However, lack of uniformity regarding radiation doses, gestational age at exposure, and the animal strains used make it difficult to compare the experimental data on cancer induction after prenatal irradiation (Preston et al., 2000).

3. RESULTS

3.1. QUALITATIVE EVALUATION OF THE DATABASE

The question addressed in this analysis was whether, and how, available quantitative scientific data could inform risk assessment policy choices for adjusting cancer slope factors when they are used in the assessment of cancer risk from childhood exposure. Cancer slope factors are, with few exceptions, based on adult human epidemiology or standard chronic adult rodent bioassays, which do not address the impacts of early-life exposures. Thus, the critical data are either human epidemiological data on childhood exposures resulting in adult cancer or research studies with rodents involving early postnatal exposures. The major human data available are from radiation exposures (studies summarized in Tables 9-11), with very limited data available for humans exposed during childhood to chemicals (reviewed in Anderson et al., 2000; Miller et al., 2002).

A review of the literature identified several hundred references reporting more than 50 chemicals that have been shown to be able to cause cancer following perinatal exposure (Table 1a) (reviewed in Toth, 1968; Della Porta and Terracini, 1969; Druckery, 1973, Rice, 1979; Vesselinovitch et al., 1979; Rice and Ward, 1982; Vesselovitch et al.; 1983; Fujii, 1991; Anderson et al., 2000). Studies (or groups of studies from a single laboratory on a given chemical) that directly provided quantitative data on carcinogenesis following early postnatal exposures and adult exposures to chemicals in animals were identified for 18 chemicals, listed in Table 1b, 2, and 3. Of the identified studies, there were 11 chemicals involving repeated exposures during early postnatal and adult lifestages (Table 1b) and 8 chemicals using acute exposures (typically single doses) at different ages (Table 1b). Some of the studies evaluated single tissues or organs for tumors (e.g., only liver), while others evaluated multiple tissues and organs (Tables 2 and 3). Mice, rats, or both species and sometimes multiple strains were tested. These studies serve as the basis for the quantitative analyses presented later in the results.

In addition to the studies identified in Table 1b, studies were identified with early postnatal and early-life exposures that were evaluated qualitatively but not quantitatively. Some of these studies are notable and provide important supporting information. Two recent studies used transgenic mouse models for human tumors. Increased multiplicity of colon tumors was observed following earlier versus later azoxymethane exposures (Paulsen et al., 2003). Shortened mammary tumor latency following estradiol exposure occurred when exposures occurred between 8 and 18 weeks as opposed to earlier or later, which is generally consistent with the incidence results analyzed for DMBA (Yang et al., 2003). Several notable examples exist of developmental windows leading to cancer susceptibilities that were not observable in

adults. Several potent estrogenic chemicals including DES, tamoxifen, and genistein produce uterine tumors with early postnatal exposures of mice, though there also appear to be strain-dependent differences in the tumor sites in adult mice (Gass et al., 1964; Greenman et al., 1990; Newbold et al., 1990, 1997, 1998, 2001). Developmental susceptibilities are believed to play a key role in effects observed with saccharin (Cohen et al., 1995; Whysner and Williams, 1996) and ascorbate (Cohen et al., 1998; NTP, 1983), with bladder tumors arising when early-life exposures occurred. Studies with several species, including rat, mouse, and opossum, indicate that nervous systems tumors associated with exposures to ENU and several other chemicals appear to be highly dependent upon exposures occurring within certain windows, particularly prenatal ones (Rice, 1979; Rice and Ward, 1982; Jurgelski et al., 1979).

Analyses of the difference in cancer risk from exposures during different lifetime periods ideally should address both the period of potential susceptibility and the magnitude of the susceptibility. Available studies used a variety of study designs (see Tables 2 and 3), which can be valuable because they provide different information (Figure 1). However, variations in study design can result in a lack of comparability across chemicals, and can limit information on the consistency of effects with different chemicals acting through different modes of action. The acute dosing (largely single dose) studies (Table 3) are valuable because they involve identical exposures with explicitly defined doses and time periods demonstrating that differential tumor incidences arise exclusively from age-dependent susceptibility. These studies address both the period and magnitude of susceptibility. They were not as appropriate for quantitative adjustments for the cancer potency estimates because of their limitations, including that most used subcutaneous or ip injection that historically have not been considered quantitatively relevant routes of environmental exposure for human cancer risk assessment by EPA, and that these routes of exposure are expected to have only partial or a complete absence of first pass metabolism that is likely to affect potency estimates.

The repeated dosing studies with exposures during early postnatal or adult lifetime provide useful information on the relative impact of repeated exposures at different lifestages and may be more likely to have exposure occur during a window of susceptibility, if there is one. One notable difference in study designs was that studies with repeated early postnatal exposure were included in the analysis even if they also involved earlier maternal and/or prenatal exposure, while studies addressing only prenatal exposure were not otherwise a part of this analysis. Another notable difference among studies involved the tissues that were evaluated for tumors: some studies focused on a single tissue, particularly liver, while others evaluated multiple tissues.

Comparisons within a single repeated dosing study may have limitations for evaluating

differential susceptibility because exposures to the chemical can differ during the different lifestages, particularly when dietary or drinking water exposures are involved. A notable example is the PCB study (Chhabra et al., 1993a), in which mobilization of such lipid-soluble chemicals into mother's milk would be expected to result in infants receiving much larger exposures than other lifestages. While lactational transfer is just as relevant to human nursing offspring, this difference in exposure obscures the extent to which the early lifestage is quantitatively more susceptible (i.e., part of the increased early-life cancer risk arises from higher exposure than during the adult period). Maternal metabolism of compounds such as diphenylhydantoin (DPH) (Chhabra et al., 1993b) also may result in lower exposure during lactation, potentially underestimating the early-lifestage risk, if the parent compound is the active form of the chemical. Similar issues exist due to normal age-dependent changes in food and water consumption. Ascribing differential effects observed in animal studies solely to lifestage susceptibility must be done carefully as there may also be differences in the exposures. There are substantial and clear benefits, therefore, from experimental consistency when comparisons are made directly within a study (e.g., same species and strain, consistent pathological evaluation).

One issue to note is the rationale for the organization of the available data. It was observed that the results across a broad range of chemicals with a variety of modes of action were somewhat variable. Therefore, consistent with the approach of the EPA cancer guidelines (U.S. EPA, 2005), an approach based on mode of action appeared to be a common framework for analysis. Variability in lifestage-dependent susceptibility and susceptibility across a range of modes of action was further supported by theoretical analyses using multistage and two-stage models of carcinogenesis (Goddard and Krewski, 1995; Murdoch et al., 1992).

3.2. QUANTITATIVE EVALUATION OF THE DATABASE

As described in the Section 2.3, the potential difference in susceptibility between early-life and adult exposure was calculated as the estimated ratio of cancer potency from early-life exposure over the cancer potency from adult exposure. Tables 4-7 present the results of the quantitative analysis using the studies that were determined qualitatively to have appropriate study designs (Tables 2 and 3) containing sufficient information to analyze. Based on the studies available, the calculations were organized into four tables: (1) compounds acting through a primarily mutagenic mode of action, where the compound was administered by a chronic dosing regimen to adults and repeated dosing in the early postnatal period (Table 4); (2) compounds acting through a primarily nonmutagenic mode of action, where the compound was administered by a chronic dosing regimen to adults and repeated dosing in the early postnatal period (Table 5);

(3) compounds acting through a primarily mutagenic mode of action, where the compounds were administered by an acute dosing regimen (Table 6); and (4) compounds acting primarily through either a mutagenic or nonmutagenic mode of action with chronic adult dosing and repeated early postnatal dosing (Table 7). In these tables, the 2.5% and 97.5% are percentiles of the posterior distribution. For a Bayesian distribution, these percentiles function in a manner similar to the 95% confidence limits for other types of statistical analyses. The results are discussed below, followed by a description of results from analyses of studies of humans exposed to radiation.

3.2.1. Carcinogens with a Mutagenic Mode of Action

The most informative database on early-lifestage susceptibility exists for chemicals with a well-accepted mutagenic mode of action (e.g., diethylnitrosamine, vinyl chloride). This database includes both single-dose studies and repeated-dose studies involving periods of postnatal and/or chronic exposure. These studies help define the periods of increased vulnerability and the magnitude of the susceptibility. The acute dosing studies demonstrate that the age-dependent responses are not due to differences in exposure, because these studies explicitly control the exposure.

3.2.1.1. *Early Postnatal, Juvenile, and Adult Repeated Dosing Studies of Chemicals with a Mutagenic Mode of Action*

Studies comparing repeated dosing for early-life, adult, or lifetime exposures exist for six carcinogens with a mutagenic mode of action [benzidine, diethylnitrosamine (DEN), 3-methylcholanthrene, safrole, urethane, and vinyl chloride]; DEN also had acute dosing studies. Lifetime (i.e., combined juvenile and adult) compared to adult exposure studies were analyzed for DEN, safrole, and urethane, while studies comparing juvenile with adult exposures were analyzed for benzidine, 3-methylcholanthrene, safrole, and vinyl chloride. These chemicals all require metabolic activation to the active carcinogenic form. Analysis of the tumors arising per unit time of exposure found that juvenile exposures with each chemical could be more effective than adult exposures were at inducing tumors (Tables 4 and 7; Figure 2, a graphic representation of the posterior, unweighted geometric means and their 95% confidence intervals, for the ratios of juvenile to adult cancer potency for carcinogens acting through a mutagenic mode of action). The weighted geometric mean for repeat and lifetime exposures is 10.4; for acute exposures the weighted geometric mean value is 1.5. For benzidine and safrole, there was a notable sex difference, with high liver tumor incidence observed for early postnatal exposures of male, but not female, mice. For both the acute and the repeated/lifetime data, the 95th percentile of the individual, unweighted geometric means is above 10 (Figure 2).

This analysis focused upon the duration of exposure as a surrogate for dose, essentially assuming that the doses animals received during the different periods of these studies were similar. This assumption is a limitation of the analysis because these studies involved exposures via lactation (i.e., dosing the mother prior to weaning), drinking water, diet, or inhalation, which have the potential to deliver different doses at different lifestages. However, the range of the magnitudes of the tumor incidence ratios of juvenile to adult exposures is similar (Table 8) for the repeated dosing studies (0.12 – 111, weighted geometric mean 10.5, 42% of ratios greater than 1), lifetime dosing studies (0.18 – 79, weighted geometric mean 8.7, 67% of ratios greater than 1), and acute dosing studies (0.01 – 178, weighted geometric mean 1.5, 55% of ratios greater than 1), suggesting that these differences in dosing are not the sole determinant of the increased incidence of early tumors, i.e., uncertainty and variability remain. Because these comparisons include different chemicals with different tissue specificities, it may be informative to consider liver as a target organ affected by all of these chemicals. The range of the magnitudes of the liver tumor incidence ratios of juvenile to adult exposures is similar for the repeated dosing studies (0.12 – 111, weighted geometric mean 41.8, 86% of ratios greater than 1, Table 4), lifetime dosing studies (0.47 – 79, weighted geometric mean 14.9, 80% of ratios greater than 1, Table 7), and acute dosing studies (0.1 – 40, weighted geometric mean 8.1, 77% of ratios greater than 1, Table 8). Thus, the repeated dose studies support the concept that early-lifestage exposure to carcinogenic chemicals with a mutagenic mode of action would lead to an increased tumor incidence compared with adult exposures of a similar duration and dose.

3.2.1.2. *Acute Dosing Studies of Chemicals with a Mutagenic Mode of Action*

Acute dosing studies are available for eight carcinogens with a mutagenic mode of action that were administered to mice or rats [benzo[a]pyrene (BaP), dibenzanthracene (DBA), Diethylnitrosamine (DEN), dimethylbenzanthracene (DMBA), dimethylnitrosamine (DMN), ethylnitrosourea (ENU), methylnitrosourea (NMU), and urethane (also known as ethyl carbamate)] (Table 1b). Except for ENU and NMU, these compounds require metabolic activation to their active carcinogenic forms. These acute dosing studies generally compared a single exposure during the first few weeks of life with the identical or similar exposure in young adult animals (Tables 3 and 6). Many of these studies compared exposures during the preweaning period (i.e., approximately day 21 for rats and mice) with effects around week 6, which is approximately the age at which typical chronic bioassays begin dosing animals. These studies largely were by subcutaneous or ip injection, which historically have not been considered quantitatively relevant routes of environmental exposure for human cancer risk assessment by EPA. For purposes of comparing age-dependent susceptibilities to tumor development, these

data are highly relevant. The injection route typically alters the pharmacokinetic time courses of the parent compound and the metabolites compared with oral or other exposures due to altered kinetics of absorption and metabolism. However, for these compounds and the systemic organ effects observed, there are several pharmacokinetic reasons to believe that the age-dependent trends would be similar with other routes of exposure. These compounds are expected to be reasonably well absorbed orally, comparable with injection routes, and largely require metabolic activation, so partial or complete absence of first pass metabolism in the injection studies would be similar to or underestimate metabolic activation when compared with oral exposure.

The early exposures often resulted in higher incidence of tumors than later exposures, with increased early susceptibilities up to 178-fold (unweighted ratios in Table 6 range from 0.011 to 178, with a weighted geometric mean of 1.5, and 55% of ratios greater than 1, Figure 2, Table 8). Examples of the general age-dependent decline in susceptibility of tumor response include BaP (liver tumors), DEN (liver tumors), ENU (liver and nervous system tumors), and urethane (liver and lung tumors). While generally the Day 1 and Day 15 time points were higher than later time points, in several cases similar tumor incidence was observed at both these early times (e.g., ENU-induced kidney tumors, Tables 6 and 8).

While the degree of susceptibility generally declines during the early postnatal period through puberty into early adulthood, there are exceptions due perhaps to pubertal periods of tissue development (e.g., mammary tissues) or very early development of xenobiotic metabolizing enzymes. One such exception was the increased incidence of mammary tumors in 5-8 week old rats given DMBA, compared with older or younger rats (Meranze et al., 1969; Russo et al., 1979). Meranze et al. (1969) reported 8% mammary tumors following a single dose of DMBA at less than two weeks, 56% if given once to animals between 5 and 8 weeks old, and 15% when given once to 26 week old rats. Thus, a ratio of 7.1 is obtained when comparing susceptibilities of 5–8 week and 26-week-old rats (Table 6) compared to a ratio of 0.2 when comparing the exposure at 2 weeks versus 26 weeks. A similar effect was observed by Russo et al. (1979); see Table 3. This observation corresponds well with pubertal development of the mammary tissue, with ovarian function commencing between 3 and 4 weeks (after the < 2 week time point in the Meranze et al., 1969 study), and mammary ductal growth and branching occurring such that it is approximately two-thirds complete by week 5, consistent with the 5–8 week susceptible period of Meranze et al. (Silberstein, 2001). While this differs from the general trend previously discussed, it indicates susceptibility later in the juvenile period rather than earlier. Another example of deviation from the general trend toward an age-dependent decline is DEN-induced lung tumors that were somewhat lower in incidence following exposure on day 1 than observed for the day 15 or day 42 exposures (Vesselinovitch et al., 1975) (Tables 3 and 6).

There are substantial differences in the early-life susceptibility of different tissues observed in the acute studies (Table 8). It should be noted that the target tissues vary with chemical, so the number of chemicals for which data are available varies for each tissue. Several tissues have weighted geometric mean ratios of greater than 1 including kidney, leukemia, liver, lymph, mammary, nerve, reticular tissue, thymic lymphoma, and uterus/vagina. Some of these, such as the nerve and mammary tumors, appear to have a very specific window of susceptibility, as noted above, and the ratios were much higher if the exposure occurred during this window. Tissues with weighted mean ratios less than 1 include forestomach, harderian gland, ovaries, and thyroid. Lung has a weighted geometric mean of 1. Many of the studies produced very high lung tumor responses regardless of age, so the results are difficult to interpret, as illustrated by the dose-response data with urethane in Rogers (1951) in which the increased early susceptibility is only apparent when the dose is low. The large numbers of studies with high lung tumor responses at all ages contribute to the differences in the weighted geometric means for the acute and for the repeated dosing studies.

Overall, the acute dosing studies support the concept that early-lifestage exposure to carcinogenic chemicals with a mutagenic mode of action would lead to an increased incidence of tumors compared with adult exposures of a similar dose and duration. These studies generally use the same dose and duration at all ages, and thus do not have the type of issues discussed for the repeated dosing studies. On the other hand, the acute dosing studies have limitations that were sufficient to decide that they should not be included in the quantitative adjustment of cancer potency. First, as mentioned in the previous paragraph, the large number of studies of lung tumors with almost 100% response observed at all doses and all ages would significantly bias the median ratio toward unity for a reason based on study design rather than biology. Second, cancer potency estimates are usually derived from chronic exposures. Therefore, any adjustment to those potencies should be, if possible, from similar exposures. Third, most exposures of concern to the Agency are from repeated or chronic exposures rather than acute exposures. Finally, many of the acute studies used ip exposures, which is not the usual route of exposure for environmental chemicals. Thus, the repeated and lifetime studies are more appropriate for the purpose of this analysis.

3.2.2. Carcinogens With Modes of Action Other Than Mutagenicity

Studies comparing tumors observed at the same sites following early postnatal and chronic adult exposures in a single protocol were available for six chemicals that do not act through a mutagenic mode of action [amitrole, dichlorodiphenyltrichloroethane (DDT), dieldrin, ethylene thiourea (ETU), diphenylhydantoin (DPH), polybrominated biphenyls (PBB)] (Table 5).

These chemicals cause tumors through several different, not necessarily well defined, modes of action. For example, thyroid hormone disruption by ETU causes thyroid tumors; some PBBs act through aryl hydrocarbon (Ah) receptors, while others are phenobarbital-like pleiotrophic inducers of liver enzymes and liver tumors. Three of these studies evaluated only mouse liver tumors (amitrole, DDT, dieldrin), while the other three evaluated a large number of tissues in both mice and rats (ETU, DPH, PBB). These studies generally included a combined perinatal and adult exposure as well as the separate perinatal or adult-only groups. It should be noted that no acute perinatal dosing studies of carcinogenesis were identified for these agents; such protocols are generally considered largely non-responsive for modes of action other than mutagenicity and potent estrogenicity (e.g., DES).

For five chemicals (amitrole, DDT, dieldrin, PBB and DPH), the same tumors were observed from early and/or adult exposures, though the studies for amitrole, DDT, and dieldrin only evaluates the animals for liver tumors. With ETU, no tumors in mice or rats were observed following perinatal exposure alone (except a small, not-statistically-significant increase in male rat thyroid tumors), while thyroid tumors were observed in adult rats and thyroid, liver, and pituitary tumors in adult mice. Analysis of the incidence of tumors per time of exposure shows early-lifestage susceptibilities. The range of the magnitudes of the tumor incidence ratios of juvenile to adult exposures is similar for the repeated dosing studies (0.06–13.3, weighted geometric mean 2.2, 27% of ratios greater than 1, Tables 5 and 8) and lifetime dosing studies (0.15–36, weighted geometric mean 3.4, 21% of ratios greater than 1, Tables 7 and 8). These ranges and means are similar to those for chemicals with a mutagenic mode of action, though the means and maximums are somewhat lower. Again, liver tumors are common to these chemicals. The range of the magnitudes of liver tumor incidence ratios of juvenile to adult exposures also is similar for the repeated dosing studies (0.06–13.3, weighted geometric mean 2.6, 43% of ratios greater than 1, Tables 5 and 8) and lifetime dosing studies (0.15–36, weighted geometric mean 5.8, 33% of ratios greater than 1, Tables 7 and 8).

The major factor that complicates the interpretation of the results is that these studies, except with DDT and dieldrin, involved dietary feeding initially to the mother, which potentially could increase or decrease the dose received by the pups. Due to the maternal dosing during pregnancy and lactation, the extent to which offspring received similar doses during different early and adult lifestages is particularly uncertain for DPH, ETU, and PBBs. Oral gavage doses in young animals were selected to approximate the average daily dose in adult dietary studies based on standard estimates of feed consumption in the studies with DDT and dieldrin, while the amitrole study involved dietary feeding postnatally to the mother so the young were dosed via lactation. In addition, DDT, dieldrin, and some PBBs are more persistent in the body than are

most chemicals, leading to a prolonged exposure even following limited dosing. Thus, these studies provide evidence that early lifestages can be more susceptible to exposures to chemicals causing cancer through a variety of modes of action other than mutagenicity. However, the studies with ethylene thiourea, which acts via thyroid disruption, indicate that this is not necessarily the case for all modes of action.

3.2.3. Ionizing Radiation

As mentioned previously, the UNSCEAR, Annex I (2000) includes information derived from a wide range of both intentional (generally diagnostic or therapeutic medical) and accidental radiation exposures. Only information derived from the Japanese population (referred to as the Life Span Study in the UNSCEAR Annex I) is presented here. A statistically significant excess cancer mortality associated with radiation has been found among the bomb survivors for the following types of cancer: esophagus, stomach, colon, liver, lung, bone and connective tissue, skin, breast, urinary tract, and leukemia. Tables 9 and 10 are extracted from the tables in UNSCEAR, Annex I. The excess relative risk (ERR) is the increased cancer rate relative to an unexposed population; an ERR of 1 corresponds to a doubling of the cancer rate. Because of the low numbers of cancers in individual sites within narrow age groups, the ERRs for the various solid tumors and leukemia were presented only as less than or greater than 20 years of age at the time of exposure. The larger number of thyroid tumors enable a more detailed breakout shown in Table 10. Most sites show greater risks in the younger than in the older ages.

The U.S. EPA (1994) document presents a methodology for estimation of cancer risks in the U.S. population due to low-LET (linear energy transfer) radiation exposures using data from the Atomic Bomb Survivor Study (ABSS) as well as from selected medical exposures. The report developed mortality risk coefficients using several models that took into account age and gender dependence of dosimetry, radiogenic risk, and competing causes of death as well as transporting of risks across populations. The risk projections were updated using more recent vital statistics in a report that also included an uncertainty analysis (U.S. EPA, 1999). Details of the derivation of these coefficients are available at http://www.epa.gov/radiation/docs/rad_risk.pdf .

Table 11 contains the calculated age-specific risk coefficients derived from the application of the various models to the ABSS data. For most of the sites in the table, the risk coefficients are higher in the earlier age groups; liver, bone, skin, and kidney coefficients are age-independent and only esophageal cancer coefficients increase with increasing age. Also of note is that the coefficients generally are higher for females. Similar to the information from the UNSCEAR (2000) Annex, most sites show greater risks in the younger ages than the older ages.

However, a comparison of the two tables seems to show reversal of risks for some sites as a function of age at exposure. While the high sampling variability in the epidemiological data for some ages may contribute to this apparent reversal, the choice of risk models and associated parameters also is a factor.

4. DISCUSSION

The challenge for this analysis was how to use the existing, but limited, scientific database on early postnatal and juvenile exposures to carcinogens to inform a science policy decision on whether, and if so how, to assess the risk from childhood exposures to chemicals for which we have evidence of carcinogenicity only in adult humans or sexually mature laboratory animals. The database overall is of limited size (particularly compared with the number of chemicals that have been studied in adult occupational epidemiological studies or chronic bioassays). The majority of the human data involves exposures to ionizing radiation or DES (Anderson et al., 2000). More than 50 chemicals have been demonstrated to cause cancer following perinatal exposures in animals (without adult exposures), but only a subset of the chemicals have comparative studies across ages. The comparative experimental studies used 18 chemicals, 12 of which had mutagenic modes of action and 6 of which had data from repeated or lifetime exposures. Other analyses of similar data have found similar results (Hattis et al. 2005), but have focused on other aspects of the data, e.g., gender differences.

Previously published or internal U.S. EPA analyses have concluded that the standard animal bioassay protocols usually do not miss chemicals that would have been identified as carcinogens if perinatal exposures had been undertaken (McConnell, 1992; Miller et al., 2002; U.S. EPA, 1996). Given the increased complexity and costs of chronic bioassays with perinatal exposures, a limited number of such studies have been performed. However, these are the studies that largely constitute the available database for this analysis. In addition to the chronic bioassays with perinatal exposures, there are studies with acute dosing at different lifestages and a large number of studies with perinatal exposures without a directly comparative adult study.

Two other kinds of information can contribute toward developing a scientifically informed policy: theoretical analyses and analyses of stop studies.[4] Theoretical analyses suggest that the differential susceptibility would depend in part on the mode of action (i.e., at what step in the cancer process(s) the chemical was acting) and that the use of the average daily exposure prorated over a lifetime may underestimate or overestimate the cancer risk when exposures are time-dependent (Goddard and Krewski, 1995; Murdoch et al., 1992). Evidence for old-age-dependent promotion of basophilic foci in rats by peroxisome proliferators appears to provide a concrete example consistent with these theoretical analyses (Cattley et al., 1991; Kraupp-Grasl et al., 1991). The stop studies performed by the National Toxicology Program began exposure at the standard post-weaning age, but stopped exposure after varying periods of months. Other groups of animals were exposed for a full two years; all animals were evaluated

[4] Stop studies are studies in which exposure is halted after a predetermined period.

for tumors at the end of two years regardless of the duration of exposure (Halmes et al., 2000). Related data also are available from the stop studies with vinyl chloride (Drew et al., 1983). Analysis by Halmes et al. (2000) showed that, for six of the eleven chemicals and half the tumor sites, the assumption that the cancer risk would be equal when the product of concentration and time (i.e., C x T) was constant was incorrect, and usually underestimated risk, as more of the risk came from the beginning of the exposure rather than the end. This dependence of risk on both duration and intensity of exposure did not appear to be correlated with mutagenicity. It should be noted that these stop studies all involved exposures early in the life of the animal (as opposed to a limited number of cancer studies that looked at later periods of life; e.g., Drew et al., 1983), but the extent to which the differences in tumor outcome result from increased susceptibility in these early periods or the extended period for expression of the cancer cannot be evaluated. These stop studies also used doses as high as or higher than the highest dose used in the two-year exposure. This latter factor clearly had a significant effect for two chemicals, causing tumors at higher doses that were not observed at lower doses. These results suggest that pharmacokinetic or other dose-rate dependencies can make the effects of exposures at high doses different from those exposures at lower doses. While not directly informative about early childhood exposures, these studies provide a perspective on the common cancer risk assessment practice of averaging exposures over a lifetime, especially those that include earlier lifestages. Thus, alternative methods for estimating risks from short-term exposures during childhood should be considered.

Information on different lifestage susceptibilities to cancer risks for humans exists for ionizing radiation. The effects of chemical mutagens at different lifestages on cancer induction are derived from laboratory animal studies. While the induction of cancer by ionizing radiation and the induction of cancer by chemical mutagens are not identical processes, both involve direct damage to DNA as critical causal steps in the process. In both cases, the impacts of early exposure can be greater than the impacts of later exposures, probably due to some combination of early-lifestage susceptibility and the longer periods for observation of effects. As indicated in Tables 9 and 10, A-bomb survivors exhibited different lifestage dependencies at different tumor sites, though the total radiation-related incidence of tumors showed a general slow decline with age at exposure. However, as previously noted, there are apparent differences at some sites between the two tables. In addition to the sampling and modeling differences, the excess risk values in Table 9 are based on Japanese baselines while the coefficients in Table 10 reflect UNSCEAR's effort to transport the risks from the Japanese population to that of the United States. However, it is clear that the total radiation-related tumor incidence showed a general slow decline with age at exposure.

The studies in rodents of chemicals with mutagenic modes of action similarly support a

general decline in induced cancer risk with age at exposure and similarly show some differences for individual tumor sites. In general, the earliest two or three postnatal weeks in mice and rats appeared to be the most susceptible, though some degree of increased susceptibility through puberty in rats (beginning around 5–7 weeks) and mice (beginning around 4–6 weeks) for some types of tumors exists.

All the acute dosing studies that demonstrated carcinogenicity with animals of different ages used chemicals with a mutagenic mode of action (Tables 4 and 6). These studies provide the clearest demonstrations of periods of differential susceptibility because the exposure rate is constant at the different ages. The repeated dose studies also include several of the most informative studies for assessing perinatal carcinogenesis, notably those on vinyl chloride and DEN (Tables 2 and 4). The vinyl chloride studies by Maltoni and colleagues are part of a large series of studies on this compound that included exposures to different concentrations for varying durations, including some at early lifestages (Maltoni et al., 1984). The DEN study by Peto et al. (1984) used a unique chronic study design in which groups of rats were exposed to multiple drinking water concentrations starting at 3, 6, or 20 weeks of life. This design provides information on the susceptibility of early exposure periods within a nearly lifetime exposure.

Beyond the analysis described here, there are conceptual biological rationales that would suggest DNA-damaging agents would have greater impacts on early lifestages. Growth involves substantial levels of cell replication, even in organs that in adults are only very slowly replicating, thus increasing the likelihood that a cell will undergo division before the DNA damage caused by the mutagen has been repaired. Increased replication also can lead to a greater division of initiated cells, leading to a larger number of initiated cells per specified dose. These periods of cell replication can vary for different tissues. For example, DMBA appears to be more effective at initiating mammary tumors in 6-8 week old rats, which are undergoing development of that tissue, than during earlier or later periods (Meranze et al., 1969). While tumor promotion processes can be very dependent upon the duration of promotion, initiation processes can occur in relatively brief periods (e.g., the single-dose studies in animals or radiation exposure in humans). Most tumors take extended periods to develop, making damage that occurs earlier in life more likely to result in tumors prior to death than would exposures that occur later in life. While some of these observations may also pertain to other modes, all of them (with some differences among tumor sites) appear to be potentially relevant to a greater susceptibility to mutagenic modes of action during early-life stages (vs. later-life stages).

The information on lifestage susceptibility for chemicals inducing cancers through modes of action other than direct DNA interaction is more varied, showing an increase in tumor incidence during perinatal exposure versus exposures of mature animals (e.g., polybrominated

biphenyls induced liver tumors), no tumors from perinatal exposure (e.g., ethylene thiourea induced thyroid tumors), no effect of combined perinatal and adult exposure (e.g., DPH liver tumors in rats and female mice), and different tumors from perinatal exposure versus adult exposure (e.g., DES, ascorbate). These variations are likely a result of the modes of action of these chemicals and the pharmacokinetic differences in doses during different periods of life. No studies were evaluated that were directly comparable to the single-dose studies with mutagens, which clearly show significant differences in tumor responses after explicitly controlled doses at different lifestages.

Some evidence for an effect of early-lifestage exposures on tumor incidence was observed in studies with polybrominated biphenyls, amitrole, DDT, dieldrin, and diphenylhydantoin. These studies show increased incidence of tumors in mice from perinatal exposure, though only those for polybrominated biphenyls were statistically significant. (A nonstatistically significant increase also was observed in male rats with polybrominated biphenyls.) Combined perinatal and adult exposures generally gave statistically significant increases, though not necessarily for each sex and species (rat and mice) in the diphenylhydantoin and polybrominated biphenyl studies.

There are important demonstrations of chemicals acting through modes of action other than mutagenic to cause different tumor types with early-lifestage exposures compared with exposures for adults, e.g., tamoxifen and DES (Carthew et al., 2000; Carthew et al., 1996, Gass et al., 1964; Newbold et al., 1990, 1997, 1998). In addition, studies with *in utero* exposure to atrazine (Fenton and Davis, 2002), DES, and arsenic (Waalkes et al., 2003) indicate that early-life exposures to compounds can alter susceptibility of endocrine and reproductive organs. Three of these compounds (i.e., DES, genistein, and tamoxifen) bind to the estrogen receptor. Ongoing studies on ethinyl estradiol, nonylphenol, and genistein by the National Toxicology Program will add to this database for estrogens (Laurenzana et al., 2002; Newbold et al., 2001). These studies will evaluate cancer incidence in offspring exposed *in utero*, during lactation, and through adulthood via diet. A study with genistein found uterine tumor development to be dependent upon early-lifestage exposures (Newbold et al., 2001). Another recent study of estrogen found a shorter latency for mammary tumors in mice exposed at 8 and 12 weeks as compared to mice exposed at 4 or 18 weeks, indicating a susceptible period between 8 to 12 weeks of exposure (Yang, 2003). Thus, there is an actively growing database from which to consider issues of childhood exposure and cancer for compounds acting through the estrogen receptor or other mechanisms of endocrine disruption.

The ability to estimate with any accuracy the juvenile to adult cancer potency ratio depends very much on the experimental design used. The lifetime design has less ability to

distinguish increased susceptibility from early-life exposure than the other types of designs. Consider two different experimental designs. In the first, the "lifetime" design, a group of animals are exposed starting as juveniles, and exposure continues through adulthood. A second group are exposed only in adulthood, and the juvenile:adult ratio results from a comparison of tumor incidences in the two groups. In the second, the "repeated" design, one group of animals is exposed only during the juvenile period, and is then followed through adulthood to assess tumor incidence, and a second group of animals is exposed only through adulthood. The lifetime design turns out to be a particularly insensitive design for estimating the juvenile:adult ratio.

The following example demonstrates the magnitude of the problem: Suppose the risk per day of exposure of a chemical is ten fold greater in the juvenile period as in the adult period, and animals exposed through adulthood at a particular dose level have an extra risk of 60% for having at least one tumor, while 1% of control animals have tumors. The adult exposure period is 94 weeks, while the juvenile exposure period is 4 weeks. Thus, in the lifetime design, the group of animals exposed as juveniles will receive a total of 98 weeks of exposure, (4 in juvenile and 94 in adult), while those receiving the adult-only exposure receive 94 weeks of exposure. In the repeated design, animals exposed as juveniles receive only 4 weeks of exposure, while the adults receive 94 weeks, just as in the lifetime design. Each group starts with 50 animals. Under these assumptions, using equations (1) and (2) from Section 2.3, the expected number of animals with tumors in the three treatment groups (control, juvenile-exposed, adult-exposed groups) in the two designs is:

	Number of animals with tumors		
	Control	**Early-life exposure**	**Adult exposure**
Lifetime	1	36	30
Repeated	1	16	30

Notice that in the "lifetime" design, only six more juvenile-exposed animals have tumors than in the adult-exposed group, whereas in the "repeated" design, 16 juvenile-exposed animals have tumors. The data in the lifetime design are consistent with the hypothesis of no tumors being induced during the juvenile period: the ratios 36/50 and 30/50 are not statistically significantly different. In other words, the data from the lifetime design are statistically consistent with the hypothesis of *no risk at all* during the juvenile period, even though the real response is a 10 times greater risk from early-life exposure. The difference between the results from the two different study designs is due to the one-hit model: each additional week of a long exposure contributes less than the previous week to the total number of animals with tumors.

Note that, even if the one-hit model is not correct, chronic exposure probably results in a non-statistically significant increase for the lifetime exposure including juveniles as compared with only adult exposure.

The proper measure of relative potency of an exposure in the juvenile period relative to an exposure in the adult period is the ratio of doses in the two periods that give the same incidence of tumors. However, most of the data sets used in this report contained only one non-control dose, precluding the extensive dose-response modeling that would be required to estimate this ratio of doses. However, this document largely considered chemicals for which a mutagenic mode of action has been established and for which a linear, no-threshold dose-response function is assumed for the low-dose range being considered for risk assessment. In the case of the linear dose-response function, the analysis of the relative response from the same dose will produce the same value as ratio of doses that produces the same incidence of tumors.

For a one-hit dose-response equation, the probability of developing a tumor after the same dose and duration in the juvenile or adult period is

$$P_a = 1 - (1 - P_0)e^{-m_a x}$$
$$P_j = 1 - (1 - P_0)e^{-m_j x}$$

for dose x. Suppose we want to calculate the dose D_a or D_j that results in a given incidence of tumors after an adult or juvenile exposure. From equation 1, D_a and D_j equal:

$$D_a = \frac{-\ln\left(\frac{1-P_c}{1-P_0}\right)}{m_a}$$
$$D_j = \frac{-\ln\left(\frac{1-P_c}{1-P_0}\right)}{m_j}$$

Thus, the ratio $D_a/D_j = m_j/m_a$, the ratio calculated in this document.

In summary, this analysis supports the conclusion that there can be greater susceptibility for the development of tumors as a result of exposures to chemicals acting through a mutagenic mode of action, when the exposures occur in early lifestages as compared with later lifestages. Thus, this Supplemental Guidance recommends for chemicals with a mutagenic mode of action for carcinogenesis when chemical-specific data on early-life exposure are absent, a default

approach using estimates from chronic studies (i.e., cancer slope factors) with appropriate modifications to address the potential for differential risk of early-lifestage exposure. For chemicals acting through a non-mutagenic mode of action, e.g., hormonally mediated carcinogens, the available data suggest that other approaches may need to be developed for addressing cancer risk estimates from childhood exposures. This is a particular concern because the tumors arising from hormonally active chemicals appear to involve different sites when exposure is during early-life versus adulthood, an effect that has been observed relatively infrequently. Development of such approaches would require additional research to provide an expanded scientific basis for their support, including additional research and the possible development of new toxicity testing protocols that consider early lifestage dosing.

The current data do also not allow analysis of some issues of potential interest for risk assessment, e.g., potential increased risk of childhood cancer, from *in utero* or childhood exposures. Assessing the role of environmental exposures on childhood cancers is difficult, but additional research could include epidemiological studies or experimental studies with animals genetically designed to express cancers analogous to human childhood cancers. Rigorous quantification of exposure doses at different lifestages and in rodent pups in experimental studies would be useful for evaluating whether there is greater childhood susceptibility. Pharmacokinetic modeling could better define the internal doses to improve determination of the magnitude of increased susceptibility.

REC 6307

5. GUIDANCE FOR ASSESSING CANCER RISKS FROM EARLY-LIFE EXPOSURE

Consistent with the approach and recommendations of the U.S. EPA cancer risk assessment guidelines (U.S. EPA, 2004), any assessment of cancer susceptibility will begin with a critical analysis of the available information. Figure 3 shows the proposed steps in the process. The potential for increased susceptibility to cancer from early-life exposure, relative to comparable exposure later in life, generally warrants explicit consideration for each assessment.

When developing quantitative estimates of cancer risk, the Agency recommends integration of age-specific values for both exposure and toxicity/potency where such data are available and appropriate. Children, in general, are expected to have some exposures that differ from those of adults (either higher or lower), due to differences in size, physiology, and behavior. For example, children are generally assumed to eat more food and drink more water relative to their body weight than adults. Children's normal activities, such as putting their hands into their mouths or playing on the ground, can result in exposures to contaminants that adults do not encounter. Moreover, children and adults exposed to the same concentration of an agent in food, water, or air may receive different (higher or lower) internal doses due to differences, for example, in intake, metabolism, or absorption rates. Children are less likely than adults to be exposed to products typically used in industrial settings and often have more limited diets than adults. When assessing risks, if the data are available and relevant, it is important to include exposure that is measured or modeled for all lifestages, including exposures during childhood and during adulthood. EPA continues to develop better tools for assessing childhood exposure differences, such as the *Child-Specific Exposure Factors Handbook* (U.S. EPA, 2002a), and models, such as Stochastic Human Exposure and Dose Simulation (SHEDS) and Consolidated Human Activity Database (CHAD) (McCurdy et al., 2000; Zartarian et al., 2000)

Mode-of-action studies can be a source of data on quantitative differences between children and adults (Figure 3, Box 1). If the available information is sufficient to establish the agent's mode of action for early-life and adult exposures, then the implications for early-life exposure of that mode of action are used to develop separate risk estimates for childhood exposure. Pertinent information can be obtained both from agent-specific studies and from other

studies that investigate the general properties of the particular mode of action. All data indicating quantitative differences between children and adults are considered in developing those portion(s) of the risk estimates for exposure estimates that include childhood exposure. Some examples include the potential for children to have a different internal dose of the active agent or a change in a key precursor event (see Section 2.4.3.4 of the *Guidelines for Cancer Risk Assessment*).

When the mode of action cannot be established (Figure 3, Box 2), the policy choice would be to use linear extrapolation to lower doses such that risk estimates are based on a lifetime average daily exposure without further adjustment. No general adjustment is recommended at this time. This policy choice is consistent with past U.S. EPA practice that has been favorably evaluated over the years. The result would be expected to produce plausible upper bound risk estimates, based on the use of linear extrapolation as a default in the absence of information on the likely shape of the dose-response curve.

When a mode of action other than mutagenicity is established, if it is nonlinear (Figure 3, Box 3) or linear (Figure 3, Box 4), no general adjustment is recommended at this time. Although the available studies (discussed previously) indicates that higher or lower cancer risks may result from early-life exposure, there is insufficient information or analyses currently available to determine a general adjustment at this time. As other modes of action become better understood, this information may include data on quantitative differences between children and adults. If such data are available, an analysis of the differences could be used to adjust risk estimates for childhood exposure. EPA expects to expand this Supplemental Guidance to specifically address modes of action other than mutagenicity when sufficient data are available and analyzed.

When the data indicate a mutagenic mode of action,[5] the available studies (discussed

5 Determination of chemicals that are operating by a mutagenic mode of action entails evaluation of test results for genetic endpoints, metabolic profiles, physicochemical properties, and structure-activity analyses in a weight-of-evidence approach (Waters et al., 1999). Established protocols are used to generate the data (Cimino, 2001; OECD, 1998; U.S. EPA, 2002b); however, it is recognized that newer methods and technologies such as those arising from genomics can provide useful data and insights to a mutagenic mode of action. Carcinogens acting through a mutagenic mode of action generally interact with DNA and can produce such effects as DNA adducts and/or breakage. Carcinogens with a mutagenic mode of action often produce positive effects in multiple test systems for different genetic endpoints, particularly gene mutations and structural chromosome aberrations, and in tests performed *in vivo,* which generally are supported by those performed *in vitro*. This mode of action is addressed in more detail in Section 2.3.5 of EPA's cancer guidelines (U.S. EPA, 2005).

above) indicate higher cancer risks resulting from a given exposure occurring early in life when compared with the same amount of exposure during adulthood. However, chemical-specific data relating to mode of action (e.g., toxicokinetic or toxicodynamic information) may suggest that even though a compound has a mutagenic mode of action, higher cancer risks may not result. Such data should be considered before applying the age-dependent adjustment factors.

If the available, chemical-specific information includes an epidemiologic study of the effects of childhood exposure or an animal bioassay involving early-life exposure (Figure 3, Box 5), then these studies are analyzed to develop risk estimates (i.e., cancer slope factors) that specifically address any potential for differential potency in early lifestages. An example is the IRIS assessment of vinyl chloride (U.S. EPA, 2000b; c).

In the absence of early-life studies on a specific chemical under consideration (Figure 3, Box 6), the extrapolation from the point of departure to lower doses employs linear extrapolation (see Section 3.3.1 of the U.S. EPA [2005] cancer guidelines). This choice is based on mode-of-action data indicating that mutagens can give rise to cancers with an apparently low-dose linear response. Adjustments to the resultant risk estimates are specified with regard to childhood exposures. This approach is adopted because risk estimates based on an average daily exposure prorated over a lifetime do not consider the potential for higher cancer risks from early-life exposure.

The adjustments described below reflect the potential for early-life exposure to make a greater contribution to cancers appearing later in life. The 10-fold adjustment represents an approximation of the weighted geometric mean tumor incidence ratio from juvenile or adult exposures in the repeated dosing studies (see Table 8). This adjustment is applied for the first 2 years of life, when toxicokinetic and toxicodynamic differences between children and adults are greatest (Ginsberg et al., 2002; Renwick, 1998). Toxicokinetic differences from adults, which are greatest at birth, resolve by approximately 6 months to 1 year, while higher growth rates extend for longer periods. The 3-fold adjustment represents an intermediate level of adjustment that is applied after 2 years of age through <16 years of age. This upper age limit represents middle adolescence following the period of rapid developmental changes in puberty and the conclusion of growth in body height in NHANES data (Hattis et al., 2005). Efforts to map the approximate start of mouse and rat bioassays (i.e., 60 days) to equivalent ages in humans ranged from 10.6 to 15.1 years (Hattis et al., 2005). Data are not available to calculate a specific dose-response adjustment factor for the 2 to <16-year age range, so EPA selected the 3-fold

adjustment because it reflects a midpoint, i.e., approximately half the difference between 1 and 10 on a logarithmic scale ($10^{1/2}$), between the 10-fold adjustment for the first two years of life and no adjustment (i.e., 1-fold) for adult exposure. EPA also recognizes that exposures occurring near the end of life may have little effect on lifetime cancer risk, but lacks adequate data at present to provide an adjustment for this "wasted dose" effect. Similarly, since most of the studies involved only one latency period, the potential effect of early-life exposure on latency for the observed tumors could not be evaluated. The lack of data on effect on latency also limited the types of analyses that could be performed, e.g., more complex dose-response functions, such as multi-stage or clonal expansion models, could not be evaluated. Thus, the potential effects of early-life exposures on latency were not evaluated. Finally, as the adjustment factors are derived from a weighted geometric mean of the data evaluated, these adjustment will both over-estimate and under-estimate the potential potency for early-life exposure for chemicals with a mutagenic mode of action for carcinogenesis. An examination of the data in the tables demonstrates that some of the ratios were less than one, while others exceeded 10. For this reason, the Supplemental Guidance emphasizes that chemical-specific data should be used in preference to these default adjustment factors whenever such data are available.

The following adjustments represent a practical approach that reflects the results of the preceding analysis, which concluded that cancer risks generally are higher from early-life exposure than from similar exposure durations later in life:

- For exposures before 2 years of age (i.e., spanning a 2-year time interval from the first day of birth up until a child's second birthday), a 10-fold adjustment.

- For exposures between 2 and <16 years of age (i.e., spanning a 14-year time interval from a child's second birthday up until their sixteenth birthday), a 3-fold adjustment.

- For exposures after turning 16 years of age, no adjustment.

Clearly other age groups, such as an age group experiencing pubertal changes in physiology, or approximately ages 9 - 15, may experience changes in biological processes that could lead to modifications in the susceptibility to the effects of some carcinogens, depending on the mode of action. This Supplemental Guidance focuses on carcinogens with a mutagenic mode

of action. For any mode of action, the Agency is interested in identifying lifestages that may be particularly sensitive or refractory for carcinogenesis, and believes that the mode of action framework as described by EPA's cancer guidelines (U.S. EPA, 2005), is an appropriate mechanism for elucidating these lifestages. In general, the Agency's analyses of lifestages that may be susceptible will depend on three factors: (1) establishing the mode of action for carcinogenesis; (2) using knowledge about the biological and toxicological key events in that mode of action that are likely to be affected by lifestages; and (3) the availability, or development, of data that allow analysis of the effects of chemicals acting by that mode of action during the relevant ages. For each mode of action evaluated, therefore, the various age groupings determined to be at a differential risk, which may differ significantly from those proposed for the mutagenic mode of action, are expected to be evaluated independently of other modes of action. When data, including well established mode of action data, are available that allow specific evaluation of lifestage differences in toxicokinetics or toxicodynamics that would lead to lesser or greater susceptibility from early-life exposures to carcinogens, then those data should be used, as generally discussed in EPA's cancer guidelines (U.S. EPA, 2005), in preference to the default procedures described in this Supplemental Guidance.

The 10-fold and 3-fold adjustments in slope factor are to be combined with age-specific exposure estimates when estimating cancer risks from early life exposure to carcinogens that act through a mutagenic mode of action. It is important to emphasize that these adjustments are combined with corresponding age-specific estimates of exposure to assess cancer risk. For example, for a 70-year lifetime, where there are data showing negligible exposure to children, the estimated cancer risk from childhood exposure would be also negligible and the lifetime cancer risk would be reduced to that resulting from the relevant number of years of adult exposure (in the absence of specific information, 55 years). Where there are data (measured or modeled) for childhood exposures, the age-group specific exposure values are used along with the corresponding adjustments to the slope factor. Where there are no relevant data or models for childhood exposures and only lifetime average exposure data are available, the lifetime exposure data are used with the adjustments to the slope factor for each age segment.

It is recognized that, when the exposure is fairly uniform over a lifetime, the effect of these adjustments on estimated lifetime cancer risk are small relative to the overall uncertainty of

such estimates. These adjustments can be applied when estimating the cancer risk resulting from childhood exposure. These adjustments are applied when developing risk estimates from conventional animal bioassays or epidemiologic studies of effects of adult exposure. Some examples follow in the next section.

The Agency has also carefully considered both the advantages and disadvantages to extending the default potency adjustment factors to carcinogenic chemicals for which the mode of action remains unknown. It is the Agency's long-standing science policy position that use of the linear low-dose extrapolation approach (without further adjustment) provides adequate public health conservatism in the absence of chemical-specific data indicating differential early-life susceptibility. At the present time, therefore, EPA is recommending these age-dependent adjustment factors only for carcinogens acting through a mutagenic mode of action based on a combination of analysis of available data and the above-mentioned science policy position. In general, the Agency prefers to rely on analyses of data, rather than general defaults. When data are available for a susceptible lifestage, they should be used directly to evaluate risks for that chemical and that lifestage on a case-by-case basis. In this analysis, the data for non-mutagenic carcinogens, when the mode of action is unknown, were judged to be too limited and the modes of action too diverse to use this as a category for which a general default adjustment factor approach can be applied.

6 COMBINING LIFESTAGE DIFFERENCES IN EXPOSURE AND DOSE-RESPONSE WHEN ASSESSING CARCINOGEN RISK - SOME EXAMPLES FOR CARCINOGENS THAT ACT THROUGH A MUTAGENIC MODE OF ACTION

It is important for the risk assessor to consider lifestage differences in both exposure and dose-response when assessing cancer risk resulting from early-life exposures. As discussed in Section 5, age dependent adjustments factors (ADAFs) in dose response (i.e., slope factors) are combined with age specific exposure estimates when assessing cancer risks. This is a departure from the way cancer risks have historically been based upon the premise that risk is proportional to the daily average of lifetime dose. This Supplemental Guidance recommends an integrative approach that can be used to assess total lifetime risk resulting from lifetime or less-than-lifetime exposure during a specific portion of a lifetime.

The following examples can help demonstrate how to apply this guidance by integrating potential lifestage differences in exposure and/or dose-response (potency), and also demonstrate what the resulting impacts are on calculated risks. These hypothetical examples consider risks from both lifetime, as well as less-than-lifetime oral exposures. Risks associated with inhalation exposure to carcinogens that act via a mutagenic mode of action are calculated in similar fashion by applying the appropriate ADAF(s) along with the corresponding inhalation unit risk estimate, using pertinent estimates of exposure concentration.

Note again, ADAFs are only to be used for agents with a mutagenic mode of action for carcinogenesis when chemical-specific data are absent. For all modes of action, when chemical-specific data are available for early-life exposure, those data should be used.

6.1 CALCULATING LIFETIME RISKS ASSOCIATED WITH LIFETIME EXPOSURES

Example 1: Consider a scenario of exposure to a carcinogen with a **nonmutagenic** mode of action. Suppose the oral cancer slope factor derived from a typical animal study (i.e., where dosing begins after puberty) is estimated to be 2 per mg/kg-d, and the exposure rate remains constant throughout life at 0.0001 mg/kg-d (this is equivalent to saying the daily average of lifetime dose rate is equal to 0.0001 mg/kg-d). The risk from lifetime exposure is calculated by multiplying the slope factor and the exposure rate:

$$\text{Risk} = (2 \text{ per mg/kg-d}) \times (0.0001 \text{ mg/kg-d})$$

$= \quad 2 \times 10^{-4}$

Example 2: Now consider the same exposure scenario for a carcinogen with a **mutagenic** mode of action for which the oral cancer slope factor, derived from a typical animal study where dosing begins after puberty, is also estimated to be 2 per mg/kg-d. In this case, ADAFs are used, as follows.

a. To calculate lifetime risk for a population with average life expectancy of 70 years, sum the risk associated with each of the three relevant time periods:

- Risk during the first 2 years of life (where the ADAF = 10);
- Risk for ages 2 through < 16 (ADAF = 3); and
- Risk for ages 16 until 70 years (ADAF = 1).

Thus, risk equals the sum of:

- Risk for birth through < 2 yr $= (2 \text{ per mg/kg-d}) \times 10 \text{ (ADAF)} \times (0.0001 \text{ mg/kg-d}) \times 2\text{yr}/70\text{yr}$
  $= 0.6 \times 10^{-4}$
- Risk for ages 2 through < 16 $= (2 \text{ per mg/kg-d}) \times 3 \text{ (ADAF)} \times (0.0001 \text{ mg/kg-d}) \times (13\text{yr}/70\text{yr})$
  $= 1.1 \times 10^{-4}$
- Risk for ages 16 until 70 $= (2 \text{ per mg/kg-d}) \times 1 \text{ (ADAF)} \times (0.0001 \text{ mg/kg-d}) \times (55\text{yr}/70\text{yr})$
  $= 1.6 \times 10^{-4}$

Risk $= 0.6 \times 10^{-4} + 1.1 \times 10^{-4} + 1.6 \times 10^{-4}$
$= 3.3 \times 10^{-4}$

b. If exposure varies with age, then such differences are also included. Now suppose the same example as immediately above, except that exposure for ages 1 through <12 was twice as high as exposure for all other ages. In this case, sum the risk associated with each of the five relevant time periods in which exposure rates and/or potencies (slope

factors) vary:

Risk equals the sum of:

- Risk for birth through < 1 yr (1yr) = (2 per mg/kg-d) x 10 (ADAF) x 0.0001 mg/kg-d x 1yr/70yr
  $= 0.3 \times 10^{-4}$
- Risk for ages 1 through < 2 (1yr) = (2 per mg/kg-d) x 10 (ADAF) x 0.0002 mg/kg-d x 1yr/70 yr
  $= 0.6 \times 10^{-4}$
- Risk for ages 2 through < 12 (10yr) = (2 per mg/kg-d) x 3 (ADAF) x 0.0002 mg/kg-d x 10yr/70yr
  $= 1.7 \times 10^{-4}$
- Risk for ages 12 through < 16 (4yr) = (2 per mg/kg-d) x 3 (ADAF) x 0.0001 mg/kg-d x 4yr/70yr
  $= 0.3 \times 10^{-4}$
- Risk for ages 16 until 70 years (55yr) = (2 per mg/kg-d) x 1 (ADAF) x 0.0001 mg/kg-d x 55yr/70yr
  $= 1.6 \times 10^{-4}$

Risk $= 0.3 \times 10^{-4} + 0.6 \times 10^{-4} + 1.7 \times 10^{-4} + 0.3 \times 10^{-4} + 1.6 \times 10^{-4}$
$= 4.5 \times 10^{-4}$

6.2 CALCULATING LIFETIME RISKS ASSOCIATED WITH LESS THAN LIFETIME EXPOSURES

If exposure only occurs for a limited number of years (for example, consider a family that lives near a source of exposure for a five-year period of time before moving away), it is critical to combine lifestage differences in exposure and dose-response for the relevant time interval. The examples presented below demonstrate how adjusting potency and/or exposure can affect the assessment of cancer risk.

Example 3: If exposure to a carcinogen with a mutagenic mode of action with an oral slope factor equal to 2 per mg/kg-d occurs during adulthood for only 5 years, the daily average of lifetime dose is time weighted to apportion risk for the number of years of exposure by a factor of 5/70:

$$\text{Risk} = (2 \text{ per mg/kg-d}) \times (0.0001 \text{ mg/kg-d}) \times (5\text{yr}/70\text{yr})$$
$$= 1.4 \times 10^{-5}$$

Example 4: If this 5-year exposure occurs during childhood, the risk calculations are adjusted to consider the potential for higher potency from early-life exposure. Assessors should remember that the age dependent adjustment factors for carcinogens with a mutagenic mode of action are applied only to exposure periods occurring up to age 16.

a. For a child exposed between ages 5 and 10, only a 3-fold ADAF is applied because the exposure occurs entirely between ages 2 and <16 years:

$$\text{Risk} = 3 \text{ (ADAF)} \times (2 \text{ per mg/kg-d}) \times (0.0001 \text{ mg/kg-d}) \times (5 \text{ yr}/70 \text{ yr})$$
$$= 4.3 \times 10^{-5}$$

b. For an exposure between ages 13 and <18, a 3-fold ADAF is applied only to the 3-year portion occurring before age 16:

Risk equals the sum of:

- Risk for ages 13 through < 16 (3yr) $= 3 \text{ (ADAF)} \times (2 \text{ per mg/kg-d}) \times (0.0001 \text{ mg/kg-d}) \times (3 \text{ yr}/70 \text{ yr})$
  $= 2.6 \times 10^{-5}$
- Risk for ages 16 through < 18 (2yr) $= 1 \text{ (ADAF)} \times (2 \text{ per mg/kg-d}) \times (0.0001 \text{ mg/kg-d}) \times (2 \text{ yr}/70 \text{ yr})$
  $= 0.6 \times 10^{-5}$

$$\text{Risk} = 2.6 \times 10^{-5} + 0.6 \times 10^{-5}$$

$= 3.2 \times 10^{-5}$

c. For a child exposed from birth through age 5, different ADAFs are applied to the periods before and after age 2:

Risk equals the sum of:

- Risk for birth through < 2 (2yr) $= 10$ (ADAF) x (2 per mg/kg-d) x (0.0001 mg/kg-d) x (2 yr/70 yr)
  $= 5.7 \times 10^{-5}$
- Risk for ages 2 through < 5 (3yr) $= 3$ (ADAF) x (2 per mg/kg-d) x (0.0001 mg/kg-d) x (3 yr/70 yr)
  $= 2.6 \times 10^{-5}$

Risk $= 5.7 \times 10^{-5} + 2.6 \times 10^{-5}$
$= 8.3 \times 10^{-5}$

Example 5: Lifetime risk calculations based on less-than-lifetime exposure to a carcinogen with a mutagenic mode of action include any lifestage changes in potency as well as exposure. In this example, again consider a scenario of 5 years of exposure to a carcinogen with a mutagenic mode of action, but suppose that the exposure rate is found to vary from 0.0002 mg/kg-d during the first 2 years of life, to 0.0001 mg/kg-d during the last 3 years.

a. For a child exposed between birth and age 5, sum the risk associated with the two relevant time periods:

Risk equals the sum of:

- Risk for birth through < 2 (2yr) = 10 (ADAF) x (2 per mg/kg-d) x (0.0002 mg/kg-d) x (2 yr/70 yr)
  $= 11.4 \times 10^{-5}$
- Risk for ages 2 through < 5 (3yr) = 3 (ADAF) x (2 per mg/kg-d) x (0.0001 mg/kg-d) x (3 yr/70 yr)
  $= 2.6 \times 10^{-5}$

Risk $= 11.4 \times 10^{-5} + 2.6 \times 10^{-5}$
$= 1.4 \times 10^{-4}$

b. For comparison, a similar risk calculation for 5 years of exposure later in life (after age 16) in which the first 2 years of exposure are double that of the next 3 years are carried out without any adjustment for potency:

Risk equals the sum of:

- Risk for first 2 years of adult exposure = 1 (ADAF) x (2 per mg/kg-d) x (0.0002 mg/kg-d) x (2yr/70yr)
  $= 1.1 \times 10^{-5}$
- Risk for final 3 years of adult exposure = 1 (ADAF) x (2 per mg/kg-d) x (0.0001 mg/kg-d) x (3yr/70yr)
  $= 0.9 \times 10^{-5}$

Risk $= 1.1 \times 10^{-5} + 0.9 \times 10^{-5}$
$= 2 \times 10^{-5}$

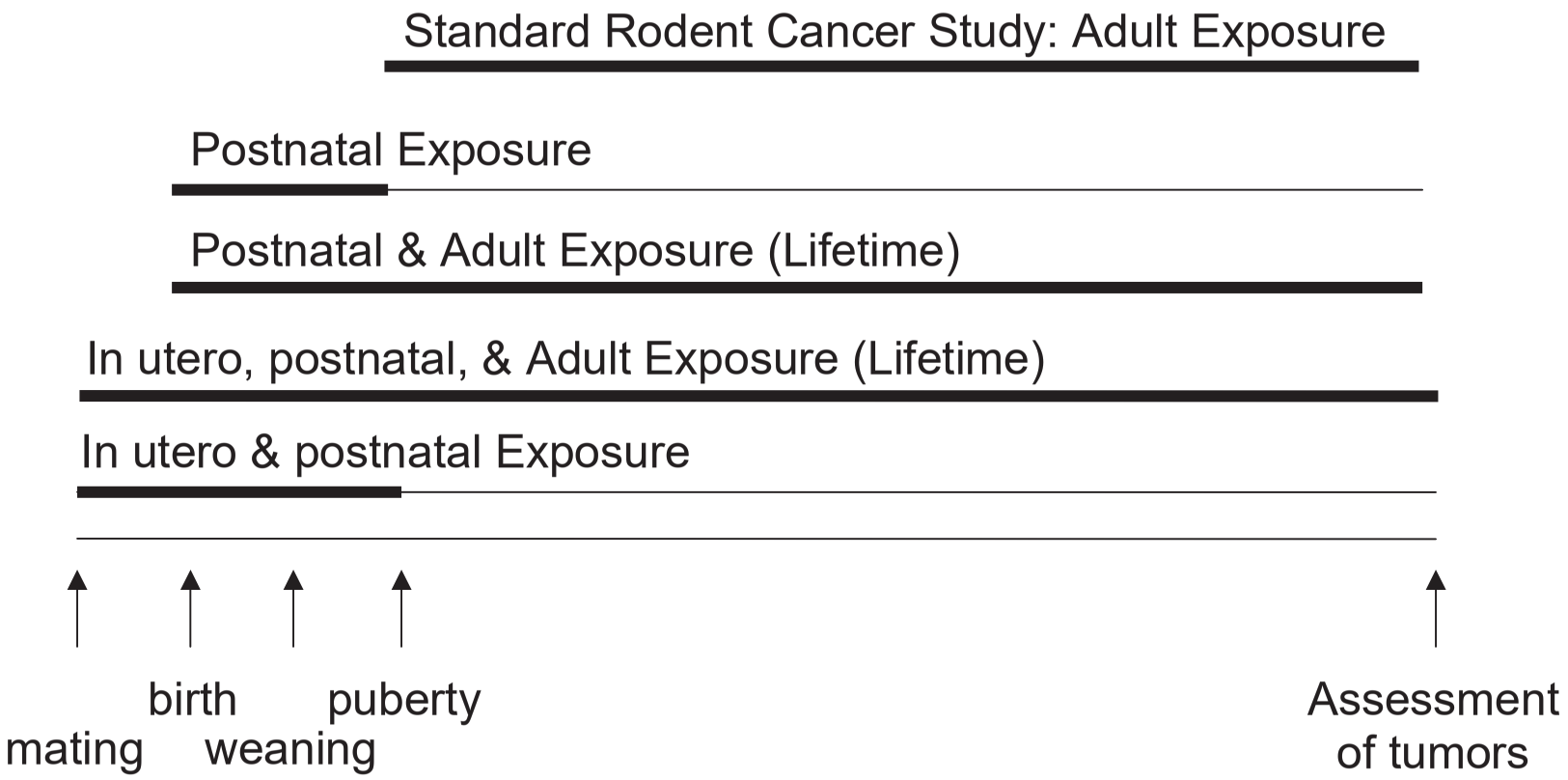


Figure 1. Study designs.

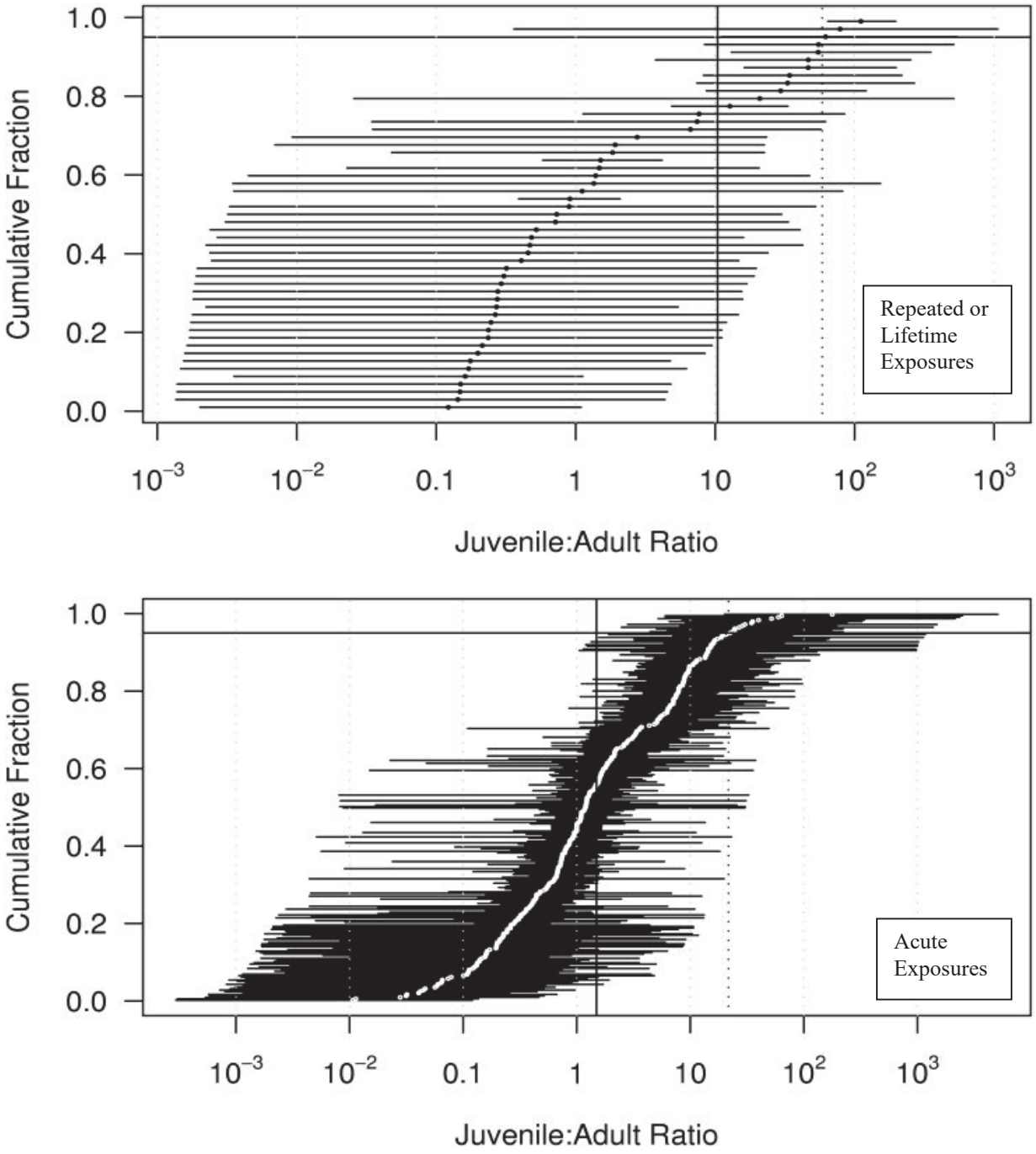


Figure 2: Posterior, unweighted geometric means and 95% confidence intervals for the ratios of juvenile to adult cancer potency for carcinogens acting primarily through a mutagenic mode of action. The top panel is for repeated and lifetime exposure studies (geometric mean in black), the bottom panel is for acute exposure studies mutagens (geometric mean in white). The horizontal lines to the left and right of each geometric mean correspond to 95% confidence limits. The vertical dark line represents the inverse-variance weighted geometric mean of the posterior geometric means. The horizontal dark line represents the 95th percentile of the unweighted distribution, with the vertical, dotted line establishing it value.

Figure 3. Flow chart for early-life risk assessment using mode of action framework

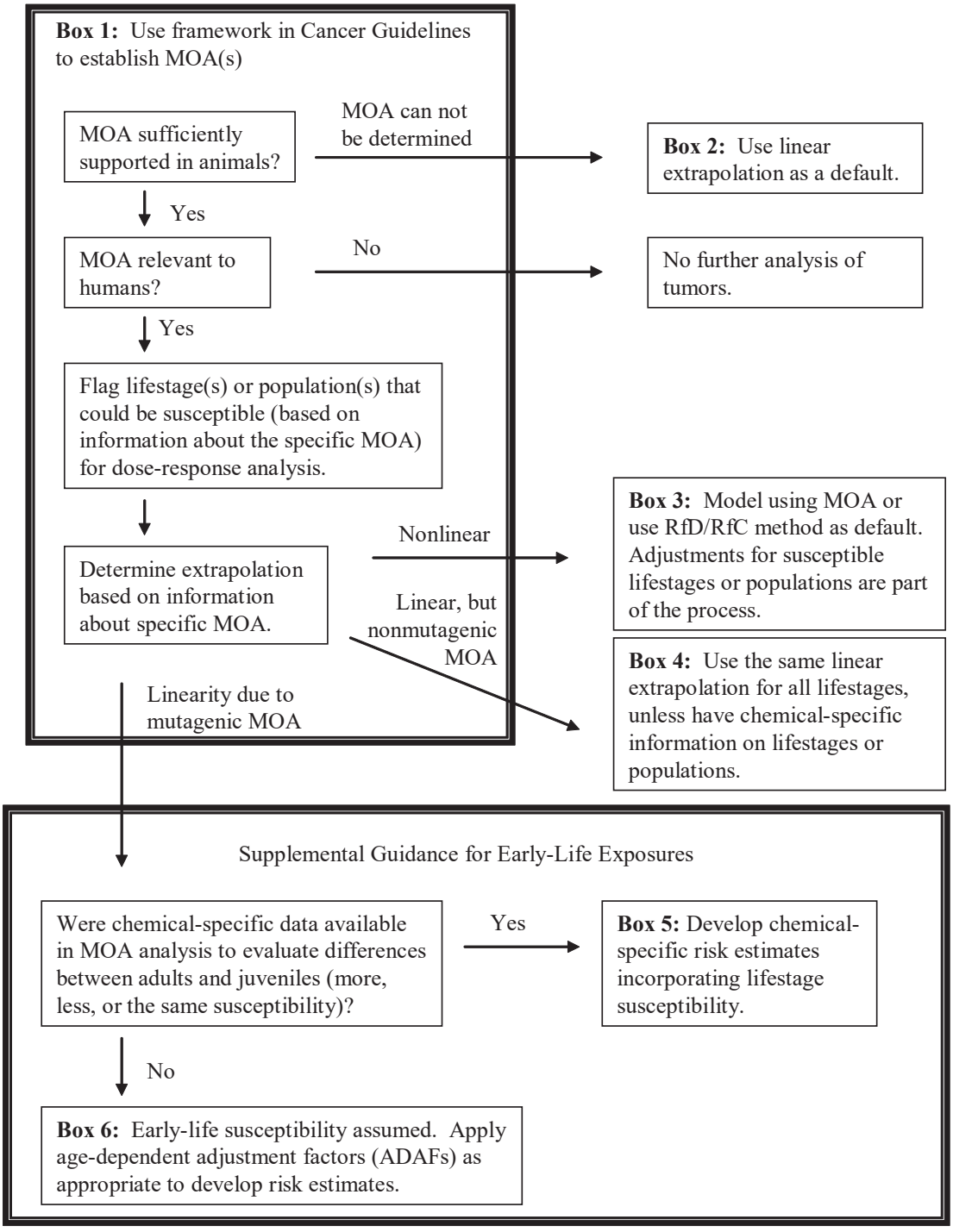


Table 1a. Chemicals that have been found to have carcinogenic effects from prenatal or postnatal exposure in animals as identified in different review articles

Chemical name	Review articles including prenatal and postnatal exposure					Chemicals selected for quantitative analysis
	Fujii (1991)	McClain et al. (2001)	Anderson et al. (2000)	Della Porta and Terracini (1969)	Other literature	
4-Acetylaminobiphenyl (AAB)	X					
4-Aminoazobenzene (AB)	X					
3-Amino-1,4,-dimethyl-5H-pyrido[4,3-b]indole (Trp-P-1)	X					
2-Aminodipyridol[1,2-a:3',2'-d]imidazole (Glu-P-2)	X					
2-Amino-6-methyldipyridol[1,2-a:3',2'-d]imidazole (Glu-P-1)	X					
3-Amino-1-methyl-5H-pyrido[4,3-b]indole (Trp-P-2)	X					
Amitrole						X
Arsenic					X	
5-Azacytidine			X			
3'-Azido-3'-deoxythymidine (AZT)			X			
Azoxymethane			X			
Benz[*a*]anthracene				X		
Benzidine			X			X
Benzo[*a*]pyrene (BaP)	X			X		X
1-(4'Bromophenylazo)-1-phenyl-1-hydroperoxymethane (BPH)	X					
N-Butyl-N-(3-carboxypropyl)nitrosamine (BCPN)	X					
N-Butyl-N-(3 hydroxbutyl)nitrosamine (BBN)	X					
Butylnitrosourea (BNU)	X					
Cyclophosphamide		X				
Dibenz[*a,h*]anthracene (DBA)				X		X
Dibutylnitrosamine (DBN)	X					
Dichlorodiphenyltrichloroethane (DDT)						X
Dieldrin						X
2-Diethylaminoethyl-2,2-dephenylvalerate hydrochloride (SKF 525A)	X					

Table 1a. Chemicals that have been found to have carcinogenic effects from prenatal or postnatal exposure in animals as identified in different review articles (continued)

Chemical name	Review articles including prenatal and postnatal exposure					Chemicals selected for quantitative analysis
	Fujii (1991)	McClain et al. (2001)	Anderson et al. (2000)	Della Porta and Terracini (1969)	Other literature	
Diethylnitrosamine (DEN)	X		X			X
Diethylstilbesterol (DES)			X			
4-Dimethylaminoazobenzene				X		
1,2-Dimethylhydrazine (DMH)	X					
7,12-Dimethylbenz[*a*]anthracene (DMBA)	X		X	X		X
Dimethylnitrosamine (DMN)	X		X	X		X
5',5'-Diphenylhydantoin (DPH)						X
Estradiol	X	X				
6-Ethoxy-2,2,4-trimethyl-1,2-dihydroquinoline (Santoquin)	X					
Ethylene thiourea (ETU)						X
Ethyl methane sulphonate				X		
Ethylnitrosobiuret			X			
Ethylnitrosourea (ENU)			X			X
N-2-Fluorenylacetamide (FAA)	X			X		
Genistein					X	
3-Hydroxyl-4-acetylaminobiphenyl (N-OH-AAB)	X					
N-2-Hydroxy-N-2-fluorenylacetamide (N-OH-FAA)	X					
2-Hydroxypropyl-propylnitrosamine			X			
9-Methylanthracene				X		
Methyl-2-benzylhydrazine			X			
Methylcholanthrene			X	X		
3-Methyl-4-dimethylaminoabenzene (3'ME-DAB)	X					
4-(Methylnitrosoamino)-1-(3-pyridyl)-1-butanone (NNK)			X			
Methylnitrosourea (NMU)			X			
Methylnitrosourethane			X			
1-Methyl-3-nitro-1-nitrosoguanidine (MNNG)	X					

Table 1a. Chemicals that have been found to have carcinogenic effects from prenatal or postnatal exposure in animals as identified in different review articles (continued)

Chemical name	Review articles including prenatal and postnatal exposure					Chemicals selected for quantitative analysis
	Fujii (1991)	McClain et al. (2001)	Anderson et al. (2000)	Della Porta and Terracini (1969)	Other literature	
2-Naphthylamine				X		
2-Naphthylhydroxyamine				X		
Nickel acetate			X			
N-Nitrosobuylamine			X			
4-Nitroquinoline-1-oxide			X	X		
N-Nitrosomethyl(2-oxopropyl)amine			X			
2-Oxopropyl-propylnitrosamine			X			
1-Phenyl-3,3',-dimethylhydrzine			X			
1-Phenyl-3,3,-dimethyltriazene			X			
Polybrominated biphenyls (PBBs)						X
Safrole (3,4-methylenedioxyally benzene)	X		X			X
Soot	X					
Sterigmatocystin	X					
Tamoxifen					X	
1,3,5-Trimethyl-2,4,6-tris[3,5-di-tert-butyl-4-hydroxybenzyl]benzene (Ionox 33)	X					
Urethane (ethyl carbamate)			X	X		X
Vinyl chloride						X

Table 1b. List of chemicals considered in this analysis. (These are chemicals for which both early-life and adult exposure are reported in the same animal experiment.)

Chemical	References	Study type	Mutagenic mode of action
Amitrole	Vesselinovitch (1983)	Repeat dosing	
Benzidine	Vesselinovitch et al. (1975b)	Repeat dosing	X
Benzo[*a*]pyrene (BaP)	Vesselinovitch et al. (1975a)	Acute exposure	X
Dibenzanthracene (DBA)	Law (1940)	Acute exposure	X
Dichlorodiphenyltrichloroethane (DDT)	Vesselinovitch et al. (1979)	Repeat dosing Lifetime exposure	
Dieldrin	Vesselinovitch et al. (1979)	Repeat dosing Lifetime exposure	
Diethylnitrosamine (DEN)	Peto et al. (1984)	Lifetime exposure	X
	Vesselinovitch et al. (1984)	Acute exposure	
Dimethylbenz[*a*]anthracene (DMBA)	Meranze et al. (1969)	Acute exposure	X
	Pietra et al. (1961)	Acute exposure	
	Walters (1966)	Acute exposure	
Dimethylnitrosamine (DMN)	Hard (1979)	Acute exposure	X
Diphenylhydantoin, 5,5- (DPH)	Chhabra et al. (1993b)	Repeat dosing Lifetime exposure	
Ethylnitrosourea (ENU)	Naito et al. (1981)	Acute exposure	X
	Vesselinovitch et al. (1974)	Acute exposure	
	Vesselinovitch (1983)	Acute exposure	
Ethylene thiourea (ETU)	Chhabra et al. (1992)	Repeat dosing Lifetime exposure	
3-Methylcholanthrene (3-MU)[a]	Klein (1959)	Repeat dosing	X
Methylnitrosourea (NMU)	Terracini and Testa (1970) Terracini et al. (1976)	Acute exposure Acute exposure	X
Polybrominated biphenyls (PBBs)	Chhabra et al. (1993a)	Repeat dosing Lifetime exposure	
Safrole	Vesselinovitch et al. (1979)	Repeat dosing Lifetime exposure	X
Urethane	Chieco-Bianchi et al. (1963) Choudari Kommineni et al. (1970) De Benedictis et al. (1962) Fiore-Donati et al. (1962)	Acute exposure Acute exposure Acute exposure Acute exposure	X
	Klein (1966)	Acute exposure Lifetime exposure	
	Liebelt et al. (1964)	Acute exposure	
	Rogers (1951)	Acute exposure	
Vinyl chloride (VC)	Maltoni et al. (1984)	Repeat dosing	X

[a] Formerly known as 20-methylcholanthrene.

Table 2. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult repeated exposures

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumors[a]		Comments	Reference
								M	F		
Amitrole	Mice ($B6C3F_1$)	liver	Control	None	Control: 0 ppm	N/A	90 weeks	1/98 (1%)	0/96 (0%)	Incidences are mice with adenomas or carcinomas.	Vesselinovitch (1983)
			Gestation day 12	Diet, to mothers	500 ppm	Gestation day 12 to delivery		6/74 (8%)[b]	0/83 (0%)[b]		
			Newborn	Diet, to mothers	500 ppm	Birth until weaning		10/45 (22%)[b]	0/55 (0%)[b]		
			At weaning	Diet, to offspring	500 ppm	From weaning to 90 weeks		20/55 (36%)[b]	9/49 (18%)[b]		
Benzidine	Mice ($B6C3F_1$)	liver	Control	None	Control: 0 ppm	N/A	90 weeks	1/98 (1%)	0/100 (0%)	Higher sensitivity in males during perinatal period, in females during adulthood. Incidences are mice with adenomas or carcinomas.	Vesselinovitch et al. (1975b) Vesselinovitch et al. (1979a)
			Gestation day 12	Diet, to mothers	150 ppm	Gestation day 12 to delivery		17/55 (31%)[c]	2/62 (3%)[d]		
			Newborn	Diet, to mothers	150 ppm	Birth until weaning		62/65 (95%)[c]	2/43 (5%)[d]		
			At weaning	Diet, to offspring	150 ppm	From weaning to 90 weeks		22/50 (44%)[c]	47/50 (94%)[c]		
			Gestation day 12	Diet, to mothers	150 ppm	Gestation day 12 until weaning		49/49 (100%)[c]	12/48 (25%)[c]		
			Gestation day 12	Diet, to mothers	150 ppm	Gestation day 12 until 90 weeks		50/50 (100%)[c]	47/50 (94%)[c]		
DDT Dichlorodiphenyl-trichloroethane	Mice ($B6C3F_1$)	liver	Control	None	Control: 0 ppm	N/A	90 weeks	1/50 (2%)	—		Vesselinovitch et al. (1979b)
			Week 1	Gavage, daily	230 µg	Weeks 1–4		5/49 (10%)[d]	—		
			Week 5	Diet, daily	150 ppm	Weeks 5–90		8/49 (16%)[d]	—		
			Week 1	Gavage, daily until 4 weeks, then in diet	230 µg 150 ppm (diet)	Weeks 1–90		10/50 (20%)[c]	—		

Table 2. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult repeated exposures (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumors[a]		Comments	Reference
								M	F		
Dieldrin	Mice ($B6C3F_1$)	liver	Control	None	Control: 0 ppm	N/A	90 weeks	1/58 (2%)	—		Vesselinovitch et al. (1979b)
			Week 1	Gavage, daily	12.5 µg	Weeks 1–4		3/46 (7%)[b]	—		
			Week 5	Diet, daily	10 ppm	Weeks 5–90		7/60 (12%)[b]	—		
			Week 1	Gavage, daily until 4 weeks, then in diet	12.5 µg 10 ppm	Weeks 1–90		21/70 (30%)[a]	—		
DEN[e] Diethylnitrosamine	Rats (Colworth)	liver	Control		Control	N/A		29/384 (8%)		Highest tumor rate when dosed at earlier ages. Incidents are rats with adenomas or carcinomas.	Peto et al. (1984)
			Week 3	Diet (in drinking water), daily	16 different doses combined[f]	From week 3 until death	6 months–3 years	105/180 (58%)[b]			
			Week 6			From week 6 until death		714/1440 (50%)[b]			
			Week 20			From week 20 until death		76/180 (42%)[b]			
		esophagus	Control		Control	N/A		0/384 (0%)			
			Week 3	Diet (in drinking water), daily	16 different doses combined[g]	From week 3 until death		77/180 (43%)[b]			
			Week 6			From week 6 until death		663/1440 (46%)[b]			
			Week 20			From week 20 until death		88/180 (49%)[b]			

Table 2. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult repeated exposures (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumors[a]		Comments	Reference
								M	F		
DPH Diphenylhydantoin, 5,5-	Rats (F344/N)	liver	Control	Control	0 ppm	N/A	2 years	0/50 (0%)	0/50 (0%)	In rats, perinatal exposure ranged from 63 to 630 ppm, and adult exposures ranged from 240 to 2,400 ppm. In mice, perinatal exposure ranged from 21 to 210 ppm. Adult exposure ranged from 30 to 300 ppm in males and 60 to 600 ppm in females. Tumor incidences are animals with adenomas or carcinomas.	Chhabra et al. (1993b)
			Perinatal	Diet, daily	630 ppm	Perinatal through 8 weeks		1/50 (2%)[d]	0/49 (0%)[d]		
			8 weeks		800 ppm	8 weeks–2 years		2/50 (4%)[d]	1/50 (2%)[d]		
			8 weeks		2,400 ppm	8 weeks–2 years		4/50 (8%)[d]	1/50 (2%)[d]		
			Perinatal		630–800	Perinatal through 2 years		1/49 (2%)[d]	0/50 (0%)[d]		
			Perinatal		630–2,400 ppm	Perinatal through 2 years		5/49 (10%)[c]	0/50 (0%)[d]		
	Mice ($B6C3F_1$)	liver	Control	Control male	0 ppm	N/A	2 years	29/50 (58%)			
			Perinatal	Diet, male	210 ppm	Perinatal through 8 weeks		33/50 (66%)[d]			
			8 weeks		100 ppm	8 weeks–2 years		29/49 (59%)[d]			
			8 weeks		300 ppm	8 weeks–2 years		26/49 (53%)[d]			
			Perinatal		210–100 ppm	Perinatal through 2 years		35/49 (71%)[d]			
			Perinatal		210–300 ppm	Perinatal through 2 years		41/50 (82%)[c]			
			Control	Control female	0 ppm	N/A	2 years		5/48 (10.4%)[d]		
			Perinatal	Diet, female	210 ppm	Perinatal through 8 weeks			12/49 (24.5%)[d]		
			8 weeks		200 ppm	8 weeks–2 years			14/49 (28%)[c]		
			8 weeks		600 ppm	8 weeks–2 years			30/50 (60%)[c]		
			Perinatal		210–200 ppm	Perinatal through 2 years			16/50 (32%)[c]		
			Perinatal		210–600 ppm	Perinatal through 2 years			34/50 (68%)[c]		

Table 2. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult repeated exposures (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumors[a]		Comments	Reference
								M	F		
ETU Ethylene thiourea	Rats (F344/N)	thyroid	Control	Control	0 ppm	N/A	2 years	1/49 (2%)	3/50 (6%)	Tumor incidences are animals with adenomas or carcinomas.	Chhabra et al. (1992)
			Perinatal	Diet, daily	90 ppm	Perinatal through 8 weeks		4/49 (8%)[d]	3/50 (6%)[d]		
			8 weeks		83 ppm	8 weeks–2 years		12/46 (26%)[c]	7/44 (16%)[d]		
			8 weeks		250 ppm	8 weeks–2 years		37/50 (74%)[c]	30/49 (61%)[c]		
			Perinatal		90–83 ppm	Perinatal through 2 years		13/50 (26%)[c]	9/47 (19%)[d]		
			Perinatal		90–250 ppm	Perinatal through 2 years		48/50 (96%)	37/50 (74%)		
	Mice ($B6C3F_1$)	liver	Control	Control	0 ppm	N/A	2 years	20/49 (41%)	4/50 (8%)		
			Perinatal	Diet, daily	330 ppm	Perinatal through 8 weeks		13/49 (26.5%)[d]	5/49 (10%)[d]		
			8 weeks		330 ppm	8 weeks–2 years		32/50 (64%)[c]	44/50 (88%)[c]		
			8 weeks		1,000 ppm	8 weeks–2 years		46/50 (92%)[c]	48/50 (96%)[c]		
			Perinatal		330–330 ppm	Perinatal through 2 years		34/49 (69%)[c]	46/50 (92%)[c]		
			Perinatal		330–1,000 ppm	Perinatal through 2 years		47/49 (6%)[c]	49/50 (98%)[c]		
		thyroid	Control	Control	0 ppm	N/A		1/50 (2%)	0/50 (0%)		
			Perinatal	Diet, daily	330 ppm	Perinatal through 8 weeks		1/46 (2%)[d]	1/49 (2%)[d]		
			8 weeks		330 ppm	8 weeks–2 years		1/49 (2%)[d]	2/50 (4%)[d]		
			8 weeks		1,000 ppm	8 weeks–2 years		29/50 (58%)[c]	38/50 (76%)[c]		

Table 2. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult repeated exposures (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumors[a]		Comments	Reference
								M	F		
ETU Ethylene thiourea (continued)			Perinatal		330–330 ppm	Perinatal through 2 years		2/48 (4%)[d]	10/49 (20%)[c]		
			Perinatal		330–1,000 ppm	Perinatal through 2 years		35/49 (71%)[c]	38/50 (76%)[c]		
		pituitary	Control	Control	0 ppm	N/A		0/44 (0%)	11/47 (23%)		
			Perinatal	Diet, daily	330 ppm	Perinatal through 8 weeks		0/42 (0%)[d]	11/48 (23%)[d]		
			8 weeks		330 ppm	8 weeks–2 years		0/42 (0%)[d]	19/49 (39%)[d]		
			8 weeks		1,000 ppm	8 weeks–2 years		8/41 (19.5%)[c]	26/49 (53%)[c]		
			Perinatal		330–330 ppm	Perinatal through 2 years		0/45 (0%)[d]	26/47 (55%)[c]		
			Perinatal		330–1,000 ppm	Perinatal through 2 years		4/39 (10%)[d]	24/47 (51%)[c]		

Table 2. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult repeated exposures (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death		Tumor incidence		Reference
							M	F	M	F	
3-Methylcholanthrene (formerly known as 20-methylcholanthrene)	Mice (Albino)	liver	Control	gavage, 3× per week	NA	NA	475 days	480 days	3/39 (7.7%)	0/36 (0%)	Klein (1959)
			8 days		0.25 mg/g	10×	311 days	321 days	21/25 (84%)[b]	7/30 (23.3%)[b]	
			90 days		0.25 mg/g	10×	330 days	366 days	1/26 (3.8%)[b]	0/29 (0%)[d]	
		lung	Control		NA	NA	475 days	480 days	17/39 (43.6%)	14/36 (38.9%)	
			8 days		0.25 mg/g	10×	311 days	321 days	25/25 (100%)[b]	28/30 (93.3%)[b]	
			90 days		0.25 mg/g	10×	330 days	366 days	25/26 (96.2%)[b]	27/29 (93.1%)[b]	
		fore-stomach	Control		NA	NA	475 days	480 days	0/39 (0%)	0/36 (0%)	
			8 days		0.25 mg/g	10×	311 days	321 days	12/25 (48%)[b]	12/30 (40%)[b]	
			90 days		0.25 mg/g	10×	330 days	366 days	13/26 (50%)[b]	8/29 (27.6%)[b]	
		skin	Control		NA	NA	475 days	480 days	0/39 (0%)	0/36 (0%)	
			8 days		0.25 mg/g	10×	311 days	321 days	4/25 (16%)[b]	4/30 (13.3%)[b]	
			90 days		0.25 mg/g	10×	330 days	366 days	1/26 (3.8%)[b]	1/25 (4%)[b]	

Table 2. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult repeated exposures (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumors[a]		Comments	Reference
								M	F		
PBBs Polybrominated biphenyls	Rats (F344/N)	liver[g]	Control	Control	0 ppm	N/A	2 years	1/50 (2%)	0/50 (0%)	Findings suggest that combined perinatal and adult exposure increases PBB-related hepatocellular carcinogenicity relative to adult-only exposure in mice and female rats. Apparent association between increasing incidences of MCL and exposure to PBB in male and female rats. Tumor incidences are animals with adenomas or carcinomas.	Chhabra et al. (1993a)
			Perinatal	Diet	10 ppm	Perinatal–8 weeks		5/50 (10%)[d]	0/50 (0%)[d]		
			8 weeks		10 ppm	8 weeks–2 years		12/49 (24%)[c]	12/50 (24%)[c]		
			8 weeks		30 ppm	8 weeks–2 years		41/50 (82%)[c]	39/50 (78%)[c]		
			Perinatal		10–10 ppm	Perinatal–2 years		16/50 (32%)[c]	39/50 (78%)[c]		
			Perinatal		10–30 ppm	Perinatal–2 years		41/50 (82%)[c]	47/50 (94%)[c]		
		Mono-nuclear cell leukemia (MCL)	Control	Control	0 ppm	N/A	2 years	25/50 (50%)	14/50 (28%)		
			Perinatal	Diet	10 ppm	Perinatal–8 weeks		31/50 (62%)[d]	13/50 (26%)[d]		
			8 weeks		10 ppm	8 weeks–2 years		33/50 (66%)[c]	22/50 (44%)[d]		
			8 weeks		30 ppm	8 weeks–2 years		31/50 (62%)[d]	23/50 (46%)[c]		
			Perinatal		10–10 ppm	Perinatal–2 years		37/50 (74%)[c]	27/50 (54%)[c]		
			Perinatal		10–30 ppm	Perinatal–2 years		37/50 (74%)[c]	25/50 (50%)[c]		
	Mice ($B6C3F_1$)	liver[g]	Control	Control	0 ppm	N/A	2 years	16/50 (32%)	5/50 (10%)		
			Perinatal	Diet	30 ppm	Perinatal–8 weeks		40/50 (80%)[c]	21/50 (42%)[c]		
			8 weeks		10 ppm	8 weeks–2 years		48/49 (98%)[c]	42/50 (84%)[c]		
			8 weeks		30 ppm	8 weeks–2 years		48/50 (96%)[c]	47/48 (98%)[c]		
			Perinatal		10 ppm	Perinatal–2 years		46/49 (94%)[c]	44/50 (88%)[c]		
			Perinatal		30–30 ppm	Perinatal–2 years		50/50 (100%)[c]	47/47 (100%)[c]		

Table 2. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult repeated exposures (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumors[a]		Comments	Reference
								M	F		
Safrole	Mice ($B6C3F_1$)	liver	Control	None	None	N/A	90 weeks	3/100 (3%)	0/100 (0%)	Highest tumor rate in males due to preweaning treatment. Highest tumor rate in females due to susceptibility in adulthood. Tumor incidences are mice with adenomas or carcinomas.	Vesselinovitch et al. (1979b)
			Day 12 of gestation	Gavage, to mothers	120 µg/g body weight	4× (days 12, 14, 16, 18)		2/61 (3%)[d]	0/65 (0%)[d]		
			Newborn	Gavage, to mothers, on alternate days	120 µg/g body weight	From birth until weaning		28/83 (34%)[c]	2/80 (3%)[d]		
			At weaning	Gavage, to offspring, 2× weekly	120 µg/g body weight	From weaning until 90 weeks		4/35 (11%)[d]	22/36 (61%)[c]		
			Day 12 of gestation	Gavage, to mothers, alternate days	120 µg/g body weight	From gestation until weaning		22/68 (32%)[b]	1/72 (1%)[b]		
			Day 12 of gestation	Gavage, to mothers, alternate days until weaning; Gavage, to offspring, 2× weekly	120 µg/g body weight	From gestation until 90 weeks		19/37 (51%)[b]	37/46 (80%)[b]		
Urethane	Mice ($B6AF_1/J$)	liver	1 week	gavage	2.5 mg/pup	1×	39–40 weeks	Tumor incidence[a]		No tumor data for controls.	Klein (1966)
								M	F		
								12/37 (33%)[b]	0/40 (0%)[b]		
			1 week		2.5 mg/pup	16× (1× at 1 week; 3× weekly for 5 weeks beginning at 4 wks of age)	39 weeks	11/33 (33%)[b]	0/31 (0%)[b]		
			4 weeks		2.5 mg/pup	15× (3× weekly for 5 weeks beginning at 4 weeks of age)	41 weeks	0/37 (0%)[b]	0/31 (0%)[b]		

Table 2. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult repeated exposures (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumors[a]		Comments	Reference
								M	F		
VC Vinyl chloride	Rats (Sprague-Dawley)	liver angio-sarcoma	Control	Control	0 ppm	N/A	135 weeks	0/22 (0%)	0/29 (0%)	Higher tumor risk when exposed at birth, higher for females.	Maltoni et al. (1984)
			Newborn	Inhalation	6,000 ppm	4 hrs/day, 5 days/wk, 5 weeks	124 weeks	5/18 (28%)[b]	12/24 (50%)[b]		
					10,000 ppm			6/24 (25%)[b]	9/20 (45%)[b]		
			Week 13		6,000 ppm	4 hrs/day, 5 days/wk, 52 weeks	135 weeks	3/17 (18%)[b]	10/25 (40%)[b]		
					10,000 ppm			3/21 (14%)[b]	4/25 (16%)[b]		
		zymbal gland	Control	Control	0 ppm	N/A	135 weeks	0/28 (0%)	0/29 (0%)		
			Newborn	Inhalation	6,000 ppm	4 hrs/day, 5 days/wk, 5 weeks	124 weeks	1/12 (8%)[b]	1/17 (6%)[b]		
					10,000 ppm			1/17 (6%)[b]	0/17 (0%)[b]		
			Week 13		6,000 ppm	4 hrs/day, 5 days/wk, 52 weeks	135 weeks	3/29 (10%)[b]	4/30 (13%)[b]		
					10,000 ppm			10/30 (33%)[b]	6/30 (20%)[b]		
		leukemia	Control	Control	0 ppm	N/A	135 weeks	0/27 (0%)	1/29 (3%)		
			Newborn	Inhalation	6,000 ppm	4 hrs/day, 5 days/wk, 5 weeks	124 weeks	N/A	1/7 (14%)[b]		
					10,000 ppm			2/6 (33%)[b]	0/15 (0%)[b]		
			Week 13		6,000 ppm	4 hrs/day, 5 days/wk, 52 weeks	135 weeks	N/A	0/29 (0%)[b]		
					10,000 ppm			0/27 (0%)[b]	2/29 (7%)[b]		
		nephro-blastoma	Control	Control	0 ppm	N/A	135 weeks	0/22 (0%)	0/29 (0%)		
			Newborn	Inhalation	6,000 ppm	4 hrs/day, 5 days/wk, 5 weeks	124 weeks	0/15 (0%)[b]	0/21 (0%)[b]		
					10,000 ppm			0/19 (0%)[b]	0/17 (0%)[b]		

Table 2. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult repeated exposures (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumors[a]		Comments	Reference
								M	F		
VC Vinyl chloride (continued)			Week 13		6,000 ppm	4 hrs/day, 5 days/wk, 52 weeks	135 weeks	4/18 (22%)[b]	1/26 (4%)[b]		
					10,000 ppm			3/21 (14%)[b]	2/25 (8%)[b]		
		angio-sarcomas: other sites	Control	Control	0 ppm	N/A	135 weeks	0/29 (0%)	0/29 (0%)		
			Newborn	Inhalation	6,000 ppm	4 hrs/day, 5 days/wk, 5 weeks	124 weeks	1/15 (7%)[b]	0/21 (0%)[b]		
					10,000 ppm			0/19 (0%)	0/17 (0%)[b]		
			Week 13		6,000 ppm	4 hrs/day, 5 days/wk, 52 weeks	135 weeks	1/29 (3%)[b]	2/30 (7%)[b]		
					10,000 ppm			2/30 (7%)[b]	1/30 (3%)[b]		
		angiomas and fibromas: other sites	Control	Control	0 ppm	N/A	135 weeks	0/28 (0%)	2/29 (7%)[b]		
			Newborn	Inhalation	6,000 ppm	4 hrs/day, 5 days/wk, 5 weeks	124 weeks	1/15 (7%)[b]	0/21 (0%)[b]		
					10,000 ppm			2/19 (11%)[b]	1/17 (6%)[b]		
			Week 13		6,000 ppm	4 hrs/day, 5 days/wk, 52 weeks	135 weeks	2/29 (7%)[b]	2/30 (7%)[b]		
					10,000 ppm			2/29 (7%)[b]	1/29 (3%)[b]		
		hepatoma	Control	Control	0 ppm	N/A	135 weeks	0/19 (0%)	0/28 (0%)		
			Newborn	Inhalation	6,000 ppm	4 hrs/day, 5 days/wk, 5 weeks	124 weeks	9/18 (50%)[b]	11/24 (46%)[b]		
					10,000 ppm			13/24 (54%)[b]	7/20 (35%)[b]		
			Week 13		6,000 ppm	4 hrs/day, 5 days/wk, 52 weeks	135 weeks	0/10 (0%)[b]	1/17 (6%)[b]		
					10,000 ppm			1/8 (13%)[b]	0/16 (0%)[b]		

Table 2. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult repeated exposures (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumors[a]		Comments	Reference
								M	F		
VC Vinyl chloride (continued)		skin carcinomas	Control	Control	0 ppm	N/A	135 weeks	0/20 (0%)	1/29 (3%)		
			Newborn	Inhalation	6,000 ppm	4 hrs/day, 5 days/wk, 5 weeks	124 weeks	1/10 (10%)[b]	1/14 (7%)[b]		
					10,000 ppm			1/16 (6%)[b]	0/15 (0%)[b]		
			Week 13		6,000 ppm	4 hrs/day, 5 days/wk, 52 weeks	135 weeks	0/15 (0%)[b]	2/19 (11%)[b]		
					10,000 ppm			2/13 (15%)[b]	1/21 (5%)[b]		
		neuro-blastoma	Control	Control	0 ppm	N/A	135 weeks	0/22 (0%)	0/29 (0%)		
			Newborn	Inhalation	6,000 ppm	4 hrs/day, 5 days/wk, 5 weeks	124 weeks	0/18 (0%)[b]	0/29 (0%)[b]		
					10,000 ppm			0/22 (0%)[b]	0/19 (0%)[b]		
			Week 13		6,000 ppm	4 hrs/day, 5 days/wk, 52 weeks	135 weeks	2/21 (10%)[b]	1/27 (4%)[b]		
					10,000 ppm			2/22 (9%)[b]	5/26 (19%)[b]		

[a] Where not delineated by gender, data combined by study authors or gender not specified. Where percentages only are given, number of subjects not specified.
[b] Not evaluated by authors.
[c] Significant compared with controls.
[d] Evaluated but not significant compared with controls.
[e] Reported as NDEA (N-nitrosodiethylamine) in the original document.
[f] Results from each dose are not available.
[g] Tumors were adenomas or carcinomas.

Table 3. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult acute exposure

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumors[a]		Comments	Reference
								M	F		
BaP Benzo[*a*]pyrene	Mice ($B6C3F_1$)	liver	Control	Control	None	N/A	142 weeks	7/100 (7%)	1/100 (1%)	In general, hepatomas developed with significantly higher incidence ($p<0.01$) in mice that were treated within 24 hours of birth or at 15 days of age than they did in similarly treated animals at 42 days of age. + higher for males.	Vesselinovitch et al. (1975a)
			Day 1	i.p.	75 µg/g body weight	1×	86 weeks (m) 129 weeks (f)	26/47 (55%)[b]	3/45 (7%)[b]		
					150 µg/g body weight	1×	81 weeks (m) 121 weeks (f)	51/63 (81%)[b]	8/45 (18%)[b]		
			Day 15	i.p.	75 µg/g body weight	1×	93 weeks (m) 116 weeks (f)	36/60 (60%)[b]	4/55 (7%)[b]		
					150 µg/g body weight	1×	81 weeks (m) 90 weeks (f)	32/55 (58%)[b]	4/55 (7%)[b]		
			Day 42	i.p.	75 µg/g body weight	1×	108 weeks(m)	7/55 (13%)[b]	0/47 (0%)[b]		
					150 µg/g body weight	1×	87 weeks (m)	4/47 (9%)[b]	0/46 (0%)[b]		
	Mice ($C3AF_1$)	liver	Control	Control	None	N/A	142 weeks	8/100 (8%)	1/100 (1%)	+ higher for males. "Age at death" is the average age at which tumors were observed.	
			Day 1	i.p.	75 µg/g body weight	1×	80 weeks (m) 91 weeks (f)	21/62 (34%)[b]	1/45 (2%)[b]		
					150 µg/g body weight	1×	69 weeks (m) 701 weeks (f)	24/52 (46%)[b]	1/56 (2%)[b]		
			Day 15	i.p.	75 µg/g body weight	1×	90 weeks (m) 102 weeks (f)	15/56 (27%)[b]	1/49 (2%)[b]		

Table 3. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult acute exposure (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumors[a]		Comments	Reference
								M	F		
BaP Benzo[*a*]pyrene (continued)					150 µg/g body weight	1×	77 weeks (m) 62 weeks (f)	12/53 (23%)[b]	1/57 (2%)[b]		
			Day 42	i.p.	75 µg/g body weight	1×		0/30 (0%)[b]	0/32 (0%)[b]		
					150 µg/g body weight	1×	79 weeks (m)	1/32 (3%)[c]	0/40 (0%)[b]		
	Mice ($B6C3F_1$)	lung	Control	Control	Control	N/A	142 weeks	13/100 (13%)	9/100 (9%)	Both sexes developed lung tumors with higher incidence when treated with BaP at birth than at 15 or 42 days of age ($p<0.05$).	
			Day 1	i.p.	75 µg/g body weight	1×	103 weeks (m) 126 weeks (f)	20/47 (43%)[b]	22/45 (49%)[b]		
					150 µg/g body weight	1×	84 weeks (m) 112 weeks (f)	37/63 (59%)[b]	28/45 (62%)[b]		
			Day 15	i.p.	75 µg/g body weight	1×	103 weeks (m) 122 weeks (f)	15/60 (25%)[b]	18/55 (33%)[b]		
					150 µg/g body weight	1×	82 weeks (m) 101 weeks (f)	20/55 (36%)[b]	18/45 (40%)[b]		
			Day 42	i.p.	75 µg/g body weight	1×	119 weeks (m) 131 weeks (f)	20/55 (36%)[b]	12/47 (26%)[b]		
					150 µg/g body weight	1×	95 weeks (m) 118 weeks (f)	18/47 (38%)[b]	8/46 (17%)[b]		

Table 3. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult acute exposure (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumors[a]		Comments	Reference
								M	F		
BaP Benzo[*a*]pyrene (continued)	Mice ($C3AF_1$)	lung	Control	Control	None	N/A	142 weeks	60/100 (60%)	50/100 (50%)	Of the two mouse strains tested, $C3AF_1$ mice developed significantly more tumors than did the $B6C3F_1$ mice ($p<0.001$).	Vesselinovitch et al. (1975a)
			Day 1	i.p.	75 µg/g body weight	1×	78 weeks (m) 82 weeks (f)	58/62 (93%)[b]	42/45 (93%)[b]		
					150 µg/g body weight	1×	70 weeks (m) 73 weeks (f)	48/52 (92%)[b]	52/56 (93%)[b]		
			Day 15	i.p.	75 µg/g body weight	1×	87 weeks (m) 98 weeks (f)	52/56 (93%)[b]	46/49 (94%)[b]		
					150 µg/g body weight	1×	75 weeks (m) 79 weeks (f)	50/53 (94%)[b]	52/57 (91%)[b]		
			Day 42	i.p.	75 µg/g body weight	1×	91 weeks (m) 93 weeks (f)	28/30 (93%)[b]	28/32 (87%)[b]		
					150 µg/g body weight	1×	85 weeks (m) 83 weeks (f)	28/32 (87%)[b]	36/40 (90%)[b]		
DBA Dibenzanthracene	Mice (Caracul × P stock)	lung	Control	Control	None	N/A	228 days	1/31 (3.2%)			Law (1940)
			Day 1	i.p.	4 mg per cm^3 vehicle	1×	181 days	24/24 (100%)[b]			
			2 months	s.c.	4 mg per cm^3 vehicle	1×	189 days	2/29 (6.9%)[b]			

Table 3. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult acute exposure (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumors[a]		Comments	Reference
								M	F		
DEN Diethylnitrosamine	Mice ($B6C3F_1$)	liver	Control	Control	Vehicle (0.01 mL trioctanoin/g body weight)	4×	142 weeks (m) 137 weeks (f)	7/98 (7%)	1/100 (1%)	Animals treated as newborns and infants developed significantly more liver tumors than animals that were treated as young adults. Newborns and infant females developed liver tumors at a later age than similarly treated males. Incidences for malignant tumors only.	Vesselinovitch et al. (1984)
			Day 1	i.p. (3-, 6- and 6-day intervals)	1.5 µg/g body weight	4×	67 weeks (m) 90 weeks (f)	37/51 (73%)[b]	45/64 (70%)[b]		
					3 µg/g body weight	4×	65 weeks (m) 80 weeks (f)	40/58 (69%)[b]	44/65 (68%)[b]		
			Day 15		1.5 µg/g body weight	4×	86 weeks (m) 117 weeks (f)	41/57 (72%)[b]	40/71 (56%)[b]		
					3 µg/g body weight	4×	76 weeks (m) 96 weeks (f)	48/69 (70%)[b]	46/62 (74%)[b]		
			Day 42		1.5 µg/g body weight	4×	117 weeks (m) 135 weeks (f)	9/49 (18%)[b]	1/47 (2%)[b]		
					3 µg/g body weight	4×	123 weeks (m) 133 weeks (f)	6/38 (16%)[b]	4/57 (7%)[b]		

Table 3. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult acute exposure (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumors[a]		Comments	Reference
								M	F		
DEN Diethylnitrosamine (continued)	Mice ($C3AF_1$)	liver	Control	Control	Vehicle (0.1 trioctanoin/g body weight)	4×	123 weeks (m) 131weeks (f)	8/99 (8%)	1/97 (1%)	Highest tumor rate when dosed at early ages. Newborns and infant females developed liver tumors at a lower incidence than similarly treated males. + higher for males.	Vesselinovitch et al. (1984)
			Day 1	i.p. (3-, 6- and 6-day intervals)	1.5 µg/g body weight	4×	64 weeks (m) 84 weeks (f)	23/32 (72%)[b]	11/39 (28%)[b]		
					3 µg/g body weight	4×	59 weeks (m) 76 weeks (f)	39/58 (67%)[b]	26/50 (52%)[b]		
			Day 15		1.5 µg/g body weight	4×	82 weeks (m) 102 weeks (f)	22/46 (48%)[b]	8/65 (12%)[b]		
					3 µg/g body weight	4×	74 weeks (m) 94 weeks (f)	35/54 (65%)[b]	22/62 (35%)[b]		
			Day 42		1.5 µg/g body weight	4×	105 weeks (m) 106 weeks (f)	12/56 (22%)[b]	0/53 (0%)[b]		
					3 µg/g body weight	4×	105 weeks (m) 103 weeks (f)	9/57 (16%)[b]	0/56 (0%)[b]		
	Mice ($B6C3F_1$)	lung	Control	Control	Vehicle (0.1 trioctanoin/g body weight)	4×	142 weeks (m) 137 weeks (f)	13/98 (13%)	9/100 (9%)	The mice treated as newborns showed lung tumors earlier than animals exposed at other times. It is not known whether this was due to actual earlier emergence of tumors or	

Table 3. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult acute exposure (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumors[a]		Comments	Reference
								M	F		
DEN Diethylnitrosamine (continued)			Day 1	i.p. (3-, 6- and 6-day intervals)	1.5 µg/g body weight	4×	70 weeks (m) 91 weeks (f)	29/51 (57%)[b]	49/64 (77%)[b]	to their earlier detection caused by shorter survival.	
					3 µg/g body weight	4×	68 weeks (m) 81 weeks (f)	34/58 (59%)[b]	42/65 (65%)[b]		
			Day 15		1.5 µg/g body weight	4×	87 weeks (m) 115 weeks (f)	51/57 (89%)[b]	61/71 (86%)[b]		
					3 µg/g body weight	4×	77 weeks (m) 97 weeks (f)	51/69 (74%)[b]	53/62 (85%)[b]		
			Day 42		1.5 µg/g body weight	4×	123 weeks (m) 129 weeks (f)	38/49 (78%)[b]	38/47 (81%)[b]		
					3 µg/g body weight	4×	121 weeks (m) 127 weeks (f)	33/38 (87%)[b]	43/57 (75%)[b]		
	Mice ($C3AF_1$)	lung	Control	Control	Vehicle (0.1 trioctanoin/g body weight)	4×	142 weeks (m) 137weeks (f)	60/99 (61%)	50/97 (52%)	Of the two strains, $C3AF_1$ mice developed lung tumors with a higher incidence and multiplicity than $B6C3F_1$ hybrids.	
			Day 1	i.p. (3-, 6- and 6-day intervals)	1.5 µg/g body weight	4×	65 weeks (m) 84 weeks (f)	30/32 (94%)[b]	38/39 (97%)[b]		
					3 µg/g body weight	4×	59 weeks (m) 76 weeks (f)	49/58 (84%)[b]	46/50 (92%)[b]		

Table 3. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult acute exposure (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumors[a]		Comments	Reference
								M	F		
DEN Diethylnitrosamine (continued)			Day 15		1.5 µg/g body weight	4×	80 weeks (m) 101 weeks (f)	42/46 (91%)[b]	61/65 (94%)[b]		
					3 µg/g body weight	4×	74 weeks (m) 92 weeks (f)	50/54 (93%)[b]	57/62 (92%)[b]		
			Day 42		1.5 µg/g body weight	4×	104 weeks (m) 110 weeks (f)	55/56 (98%)[b]	52/53 (98%)[b]		
					3 µg/g body weight	4×	101 weeks (m) 102 weeks (f)	56/57 (98%)[b]	54/56 (96%)[b]		
	Mice ($B6C3F_1$)	liver	Control	Control	None	N/A	90 weeks	1/98 (1%)	0/96 (0%)	Infant animals of both sexes (Day 15) were more sensitive than similarly exposed adults.	Vesselinovitch and Mihailovich (1983)
			Gestation day 18	i.p.	1.5 µg/g body weight	1×		2/50 (4%)[b]	1/51 (2%)[b]		
			Day 15	i.p. (3-, 6- and 6-day intervals)	1.5 µg/g body weight	4×		47/51 (92%)[b]	60/64 (94%)[b]		
			Day 42		1.5 µg/g body weight	4×		13/49 (26%)[b]	3/47 (6%)[b]		
			Day 1	i.p.	1.5 µg/g body weight	1×	73 weeks	15/59 (25%)[b]	—	At the 1.5-µg dose level, 1-day-old mice developed significantly fewer liver tumors than similarly treated infants (Day 15) ($p<0.025$). Tumor incidence in treated groups versus controls was not evaluated.	Vesselinovitch et al. (1979a)
					5 µg/g body weight	1×		29/45 (64%)[b]	—		
					10 µg/g body weight	1×		24/25 (96%)[b]	—		
			Day 15	i.p.	1.5 µg/g body weight	1×		13/24 (54%)[b]	—		
					5 µg/g body weight	1×		40/54 (74%)[b]	—		

Table 3. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult acute exposure (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumors[a]		Comments	Reference
								M	F		
DEN Diethylnitrosamine (continued)					10 µg/g body weight	1×		25/25 (100%)[b]	—		
DMBA Dimethyl-benz[*a*]anthracene	Rats (Sprague-Dawley)	mammary adeno-sarcoma	Day 20	Gavage	10 mg/100 g body weight	1×	Week 25	—	3/6 (50%)[b]	36 of 42 (86%) animals dosed at age 20 days died soon after. Highest number of tumors per animal was in the 46-day group, with decreasing numbers in the older animals. Animals were sacrificed 22 weeks after treatment.	Russo et al. (1979)
			Day 30		10 mg/100 g body weight	1×	Week 26	—	14/15 (93%)[b]		
			Day 40		10 mg/100 g body weight	1×	Week 27	—	8/9 (89%)[b]		
			Day 46		10 mg/100 g body weight	1×	Week 28	—	8/8 (100%)[b]		
			Day 55		10 mg/100 g body weight	1×	Week 29	—	33/34 (97%)[b]		
			Day 70		10 mg/100 g body weight	1×	Week 32	—	5/8 (63%)[b]		
			Day 140		10 mg/100 g body weight	1×	Week 42	—	10/15 (67%)[b]		
			Day 180		10 mg/100 g body weight	1×	Week 47	—	14/26 (54%)[b]		
	Rats (Wistar)	mammary carcinoma[d]	Control 5–8 weeks	Control	None	N/A	17 months	0/22 (0%)	0/25 (0%)	Highest tumor rate in females exposed at 5–8 weeks. Animals were observed for 16 months following treatment.	Meranze et al. (1969)
			Control 26 weeks	Control	None	N/A	20 months	0/31 (0%)	2/20 (10%)		
			< Week 2	Gavage	0.5–1.0 mg	1×	Week 40–56	0/23 (0%)[b]	4/50 (8%)[b]		
			Week 5–8		15 mg	1×	Week 14–55	0/23 (0%)[b]	14/25 (56%)[b]		
			Week 26		15 mg	1×	Week 32–73	0/34 (0%)[b]	4/26 (15%)[b]		
	Rats (Wistar, castrated)	mammary carcinoma	Week 5–8	Gavage	15 mg	1×	Week 14–55	0/21 (0%)[b]	0/22 (0%)[b]		
			Week 26		15 mg	1×	Week 32–73	0/33 (0%)[b]	0/26 (0%)[b]		

Table 3. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult acute exposure (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumors[a]		Comments	Reference
								M	F		
DMBA Dimethyl-benz[*a*]anthracene (continued)	Rats (Wistar)	Total tumors	Control 5–8 weeks	Control	None	N/A	17 months	0/22 (0%)	0/25 (0%)	Total tumors includes leukemia.	
			Control 26 weeks	Control	None	N/A	20 months	2/31 (6%)	5/20 (25%)		
			< Week 2	Gavage	0.5–1.0 mg	1×	Week 40–56	16/23 (70%)[b]	36/50 (72%)[b]		
			Week 5–8		15 mg	1×	Week 14–55	7/23 (30%)[b]	16/25 (64%)[b]		
			Week 26		15 mg	1×	Week 32–73	12/34 (35%)[b]	13/26 (50%)[b]		
	Mice (BALB/c)	lung	Control: Day 1	Control s.c.	Aqueous gelatine	1×	40 weeks	0/12 (0%)	7/23 (30%)	15 µg DMBA gave rise to a significantly greater incidence of lung tumors when administered to newborn mice than to suckling or young adults.	Walters (1966)
			Day 1	s.c.	15 µg	1×	40 weeks[f]	14/14 (100%)[b]	24/24 (100%)[b]		
			Week 2–3 (suckling)	s.c.	15 µg	1×	42–43 weeks	12/23 (52%)[b]	16/22 (73%)[b]		
				s.c.	30 µg (60 µg total)	2×	42–43 weeks	14/14 (100%)[b]	24/24 (100%)[b]		
			Adult[e]	s.c.	15 µg	1×	48-49 weeks	6/12 (50%)[b]	15/33 (45%)[b]		
				s.c.	30 µg (60 µg total)	2×	48-49 weeks	9/10 (90%)[b]	21/23 (91%)[b]		
				s.c.	30 µg (180 µg total)	6×	48-49 weeks	12/12 (100%)[b]	13/13 (100%)[b]		
	Mice (Swiss)	lymphoma	Control	Control	None	N/A	31–52 weeks	3/408 (0.7%)		Higher tumor rates at younger age of exposure. Only one treatment group was exposed i.p.; others were exposed by s.c. injection..	Pietra et al. (1961)
			Day 1	i.p.	30–40 µg	1×	13–33 weeks	6/31 (19%)[b]			
			Day 1	s.c.	30–40 µg	1×	12–27 weeks	8/27 (30%)[b]			
			Week 8	s.c.	900 µg	1×	30 weeks	1/13 (8%)[b]			

Table 3. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult acute exposure (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumors[a]		Comments	Reference
								M	F		
DMBA Dimethyl-benz[*a*]anthracene (continued)	Mice (Swiss)	lung	Control	Control	None	N/A	31–52 weeks	4/408 (0.9%)			
			Day 1	i.p.	30–40 µg	1×	13–33 weeks	24/31 (77%)[b]			
			Day 1	s.c.	30–40 µg	1×	12–27 weeks	23/27 (85%)[b]			
			Week 8	s.c.	900 µg	1×	30 weeks	2/13 (15%)[b]			
DMN Dimethyl-nitrosamine	Rats (Wistar)	kidney carcinoma	Day 1	i.p.	20 mg/kg	1×	≥5 months	1/33 (3)[b]		In the neonatal group, the dose was reduced to 20 mg/kg to achieve approximately equivalent numbers of survivors. No control group.	Hard (1979)
			Day 21		30 mg/kg	1×		5/39 (13)[b]			
			Month 1		30 mg/kg	1×		2/33 (6)[b]			
			Month 1.5		30 mg/kg	1×		1/28 (4)[b]			
			Month 2		30 mg/kg	1×		1/26 (4)[b]			
			Month 3		30 mg/kg	1×		10/27 (37)[b]			
			Month 4		30 mg/kg	1×		7/32 (22)[b]			
			Month 5		30 mg/kg	1×		0/14 (0)[b]			
	Rats (Wistar)	kidney adenoma	Day 1	i.p.	20 mg/kg	1×	≥5 months	1/33 (3)[b]			
			Day 21		30 mg/kg	1×		13/39 (33)[b]			
			Month 1		30 mg/kg	1×		11/33 (33)[b]			
			Month 1.5		30 mg/kg	1×		13/28 (48)[b]			
			Month 2		30 mg/kg	1×		11/26 (42)[b]			
			Month 3		30 mg/kg	1×		18/27 (67)[b]			
			Month 4		30 mg/kg	1×		17/32 (53)[b]			
			Month 5		30 mg/kg	1×		6/14 (43)[b]			

Table 3. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult acute exposure (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumors[a] M	Tumors[a] F	Comments	Reference
DMN Dimethyl-nitrosamine (continued)	Rats (Wistar)	kidney mesenchymal tumors	Day 1	i.p.	20 mg/kg	1×	≥5 months	8/33 (24)[b]		Mesenchymal tumors were most frequent in the three youngest age groups (z test, $p < 0.001$).	
			Day 21		30 mg/kg	1×		18/39 (46)[b]			
			Month 1		30 mg/kg	1×		23/33 (70)[b]			
			Month 1.5		30 mg/kg	1×		5/28 (19)[b]			
			Month 2		30 mg/kg	1×		2/26 (8)[b]			
			Month 3		30 mg/kg	1×		3/27 (11)[b]			
			Month 4		30 mg/kg	1×		7/32 (22)[b]			
			Month 5		30 mg/kg	1×		0/14 (0)[b]			
	Rats (Wistar)	kidney cortical epithelial tumors	Day 1	i.p.	20 mg/kg	1×	≥5 months	2/33 (6)[b]			Hard (1979)
			Day 21		30 mg/kg	1×		16/39 (41)[b]			
			Month 1		30 mg/kg	1×		12/33 (36)[b]			
			Month 1.5		30 mg/kg	1×		14/28 (52)[b]			
			Month 2		30 mg/kg	1×		11/26 (42)[b]			
			Month 3		30 mg/kg	1×		18/27 (67)[b]			
			Month 4		30 mg/kg	1×		21/32 (66)[b]			
			Month 5		30 mg/kg	1×		6/14 (43)[b]			
	Rats (Wistar)	Total tumors	Day 1	i.p.	20 mg/kg	1×	≥5 months	11/33 (33)[b]			
			Day 21		30 mg/kg	1×		25/39 (64)[b]			
			Month 1		30 mg/kg	1×		25/33 (76)[b]			
			Month 1.5		30 mg/kg	1×		17/28 (63)[b]			
			Month 2		30 mg/kg	1×		13/26 (50)[b]			
			Month 3		30 mg/kg	1×		18/27 (67)[b]			
			Month 4		30 mg/kg	1×		22/32 (69)[b]			
			Month 5		30 mg/kg	1×		7/14 (50)[b]			

Table 3. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult acute exposure (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumors[a]		Comments	Reference
								M	F		
ENU Ethylnitrosourea	Rats	nervous system	Day 1	Injection	20 mg/kg	1×		100%[b]		Susceptibility to neuro-oncogenic effect declined with increasing age.	Maekawa and Mitsumori (1990)
			Day 30	Injection	20 mg/kg	1×		61%[b]			
	Mice ($B6C3F_1$)	liver	Control	Control	None	N/A	90 weeks	1/98 (1%)	0/96 (0%)	Both male and female mice were responsive to exposure during prenatal and infant life.	Vesselinovitch (1983)
			Gestation day 18	i.p.	60 µg/g body weight	1×		28/52 (54%)[b]	18/49 (37%)[b]		
			Day 15		60 µg/g body weight	1×		41/50 (82%)[b]	28/51 (55%)[b]		
			Day 42		60 µg/g body weight	1×		10/50 (20%)[b]	5/50 (10%)[b]		
	Rats (Wistar)	nerve tissue	Control	Control	None	N/A	4–7 months	0/16 (0%)	0/10 (0%)	Highest tumor rate seen when exposed during gestation or soon after birth. Statistically significant decrease in tumor incidence with increasing age of exposure.	Naito et al. (1981)
			Gestation day 16	i.p.	40 mg/kg	1×		26/26 (100%)[b]	18/18 (100%)[b]		
			Day 1	s.c.	40 mg/kg	1×		12/12 (100%)[g]	16/16 (100%)[g]		
			Week 1		40 mg/kg	1×		12/17 (71%)[b]	18/20 (90%)[b]		
			Week 2		40 mg/kg	1×		10/14 (71%)[b]	14/18 (78%)[b]		
			Week 3		40 mg/kg	1×		6/13 (46%)[b]	5/17 (29%)[b]		
			Week 4		40 mg/kg	1×		8/15 (53%)[b]	2/10 (20%)[b]		

Table 3. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult acute exposure (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumors[a]		Comments	Reference
								M	F		
ENU Ethylnitrosourea (continued)	Mice ($B6C3F_1$)	lung	Day 1	i.p.	60 µg/g body weight	1×		49/55 (89%)[b]	49/50 (98%)[b]		Vesselinovitch et al. (1974)
			Day 15			1×		50/55 (91%)[b]	47/55 (85%)[b]		
			Day 42			1×		53/59 (90%)[b]	44/51 (86%)[b]		
			Day 1		120 µg/g body weight	1×		36/38 (95%)[b]	54/60 (90%)[b]		
			Day 15			1×		45/49 (92%)[b]	43/50 (86%)[b]		
			Day 42			1×		52/54 (96%)[b]	50/57 (88%)[b]		
	Mice ($C3AF_1$)	lung	Day 1		60 µg/g body weight	1×		46/47 (98%)[g]	51/51 (100%)[g]		
			Day 15			1×		49/49 (100%)[g]	57/59 (97%)[g]		
			Day 42			1×		59/59 (100%)[g]	57/57 (100%)[g]		
			Day 1		120 µg/g body weight	1×		63/64 (98%)[g]	53/57 (93%)[g]		
			Day 15			1×		54/56 (96%)[g]	50/56 (89%)[g]		
			Day 42			1×		59/59 (100%)[g]	48/48 (100%)[g]		
	Mice ($B6C3F_1$)	liver	Day 1	i.p.	60 µg/g body weight	1×		50/54 (93%)[g]	28/43 (65%)[g]		
			Day 15			1×		55/56 (98%)[g]	33/54 (61%)[g]		
			Day 42			1×		12/40 (30%)[b]	6/39 (15%)[b]		
			Day 1		120 µg/g body weight	1×		29/34 (85%)[g]	32/53 (60%)[g]		
			Day 15			1×		45/48 (94%)[g]	29/43 (67%)[g]		
			Day 42			1×		17/49 (35%)[g]	4/50 (8%)[g]		

Table 3. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult acute exposure (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumors[a]		Comments	Reference
								M	F		
ENU Ethylnitrosourea (continued)	Mice ($C3AF_1$)	liver	Day 1	i.p.	60 µg/g body weight	1×		42/45 (93%)[g]	19/41 (46%)[g]		
			Day 15			1×		42/50 (84%)[g]	19/48 (40%)[g]		
			Day 42			1×		7/29 (24%)[b]	4/50 (8%)[b]		
			Day 1		120 µg/g body weight	1×		55/62 (89%)[g]	19/45 (42%)[g]		
			Day 15			1×		35/45 (78%)[g]	15/35 (43%)[g]		
			Day 42			1×		8/33 (24%)[b]	3/33 (9%)[b]		
	Mice ($B6C3F_1$)	kidney	Day 1	i.p.	60 µg/g body weight	1×		11/48 (23%)[b]	5/49 (10%)[b]		
			Day 15			1×		6/41 (15%)[b]	7/31 (23%)[b]		
			Day 42			1×		4/40 (10%)[b]	3/37 (8%)[b]		
			Day 1		120 µg/g body weight	1×		10/30 (33%)[g]	14/53 (26%)[b]		
			Day 15			1×		17/37 (46%)[g]	19/49 (39%)[b]		
			Day 42			1×		8/40 (20%)[b]	11/39 (28%)[b]		
	Mice ($C3AF_1$)	kidney	Day 1	i.p.	60 µg/g body weight	1×		7/44 (16%)[b]	6/45 (13%)[b]		
			Day 15			1×		7/41 (17%)[b]	8/46 (17%)[b]		
			Day 42			1×		3/42 (42%)[b]	3/43 (7%)[b]		
			Day 1		120 µg/g body weight	1×		4/52 (7%)[b]	6/29 (21%)[g]		
			Day 15			1×		8/35 (23%)[b]	12/29 (41%)[g]		
			Day 42			1×		6/41 (71%)[b]	3/39 (8%)[b]		

Table 3. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult acute exposure (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumors[a]		Comments	Reference
								M	F		
ENU Ethylnitrosourea (continued)	Mice (B6C3F1)	Harderian	Day 1		60 µg/g body weight	1×		7/40 (17%)[b]	5/43 (12%)[b]		
			Day 15			1×		10/51 (20%)[b]	17/59 (29%)[b]		
			Day 42			1×		14/50 (28%)[b]	14/45 (31%)[b]		
			Day 1		120 µg/g body weight	1×		9/30 (30%)[g]	6/52 (12%)[b]		
			Day 15			1×		15/41 (37%)[g]	8/31 (26%)[b]		
			Day 42			1×		25/48 (52%)[g]	14/49 (29%)[b]		
	Mice ($C3AF_1$)	Harderian	Day 1		60 µg/g body weight	1×		3/25 (12%)[b]	4/35 (11%)[b]		
			Day 15			1×		1/9 (11%)[b]	6/38 (16%)[b]		
			Day 42			1×		12/48 (25%)[b]	5/33 (15%)[b]		
			Day 1		120 µg/g body weight	1×		3/52 (6%)[b]	1/25 (4%)[b]		
			Day 15			1×		6/46 (13%)[b]	2/52 (4%)[b]		
			Day 42			1×		5/29 (17%)[b]	2/11 (18%)[b]		
	Mice ($B6C3F_1$)	stomach	Day 1		60 µg/g body weight	1×		3/48 (6%)[b]	4/43 (9%)[b]		
			Day 15			1×		10/42 (24%)[g]	7/45 (16%)[b]		
			Day 42			1×		9/51 (18%)[g]	8/36 (22%)[b]		
			Day 1		120 µg/g body weight	1×		2/29 (7%)[b]	9/53 (17%)[b]		
			Day 15			1×		10/35 (29%)[g]	12/33 (36%)[b]		
			Day 42			1×		12/53 (23%)[g]	12/50 (24%)[b]		

Table 3. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult acute exposure (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumors[a]		Comments	Reference
								M	F		
ENU Ethylnitrosourea (continued)	Mice ($C3AF_1$)	stomach	Day 1		60 µg/g body weight	1×		2/39 (5%)[b]	7/45 (16%)[b]		
			Day 15			1×		7/45 (16%)[g]	7/38 (18%)[b]		
			Day 42			1×		14/55 (25%)[g]	7/49 (14%)[b]		
			Day 1		120 µg/g body weight	1×		8/60 (13%)[b]	9/44 (20%)[b]		
			Day 15			1×		16/51 (31%)[g]	11/42 (26%)[b]		
			Day 42			1×		19/48 (40%)[g]	13/37 (35%)[b]		
	Mice ($B6C3F_1$)	malignant lymphomas	Day 1		60 µg/g body weight	1×		2/55 (4%)[b]	6/52 (12%)[g]		
			Day 15			1×		3/56 (5%)[b]	14/59 (24%)[g]		
			Day 42			1×		9/59 (15%)[b]	17/59 (29%)[g]		
			Day 1		120 µg/g body weight	1×		8/39 (20%)[b]	15/65 (23%)[g]		
			Day 15			1×		14/60 (23%)[b]	17/58 (29%)[g]		
			Day 42			1×		12/59 (20%)[b]	14/60 (23%)[g]		
	Mice ($C3AF_1$)	malignant lymphomas	Day 1		60 µg/g body weight	1×		6/49 (12%)[b]	8/49 (16%)[g]		
			Day 15			1×		3/49 (6%)[b]	13/61 (21%)[g]		
			Day 42			1×		6/60 (10%)[b]	9/55 (16%)[g]		
			Day 1		120 µg/g body weight	1×		3/66 (5%)[b]	10/58 (17%)[g]		
			Day 15			1×		10/56 (18%)[b]	18/60 (30%)[g]		
			Day 42			1×		3/49 (6%)[b]	13/50 (26%)[g]		

Table 3. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult acute exposure (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumor incidence[a]		Comments	Reference
								M	F		
NMU Methylnitrosourea	Mice ($BC3F_1$)	Total tumors	Control	Control	N/A	N/A	60 weeks	1/20 (5%)	0%	Control mice did not exhibit tumors in target sites except a single hepatoma in a male control mouse.	Terracini and Testa (1970)
		lung	Day 1	i.p.	50 µg/g body weight	1×	60 weeks	12/15 (80%)[b]	16/19 (84%)[b]		
			5 weeks		50 µg/g body weight	1×	60 weeks	10/26 (39%)[b]	10/35 (29%)[b]		
		lympho-sarcoma	Day 1		50 µg/g body weight	1×	60 weeks	23/39 (59%)[b]	23/45 (51%)[b]		
			5 weeks		50 µg/g body weight	1×	60 weeks	11/35 (31%)[b]	21/45 (47%)[b]		
		liver	Day 1		50 µg/g body weight	1×	60 weeks	10/12 (83%)[b]	1/17 (6%)[b]		
			5 weeks		50 µg/g body weight	1×	60 weeks	0%[b]	0%[c]		
		kidney	Day 1		50 µg/g body weight	1×	60 weeks	3/15 (20%)[b]	3/18 (17%)[b]		
			5 weeks		50 µg/g body weight	1×	60 weeks	2/21 (10%)[b]	0%[c]		
		fore-stomach	Day 1		50 µg/g body weight	1×	60 weeks	0%[b]	4/17 (24%)[b]		
			5 weeks		50 µg/g body weight	1×	60 weeks	8/22 (36%)[b]	12/18 (67%)[b]		
	Rats (Wistar)	mammary	Day 1	i.p.	50 µg/g body weight	1×	60 weeks	0%[b]	4/14 (29%)[b]	Tumor incidence for control rats was based on previous experiments (Della Porta et al., 1968) and was not specifically reported in this paper.	Terracini and Testa (1970)
			5 weeks		50 µg/g body weight	1×	60 weeks	0%[b]	3/5 (60%)[b]		
		lympho-sarcoma	Day 1		50 µg/g body weight	1×	60 weeks	1/10 (10%)[b]	0%[b]		
			5 weeks		50 µg/g body weight	1×	60 weeks	2/8 (25%)[b]	1/11 (9%)[b]		
		kidney (ana-plastic)	Day 1		50 µg/g body weight	1×	60 weeks	14/18 (78%)[b]	9/13 (69%)[b]		
			5 weeks		50 µg/g body weight	1×	60 weeks	2/5 (40%)[b]	5/12 (42%)[b]		

Table 3. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult acute exposure (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumor incidence[a]		Comments	Reference
								M	F		
NMU Methylnitrosourea (continued)		kidney (adenoma)	Day 1		50 µg/g body weight	1×	60 weeks	3/14 (21%)[b]	2/6 (33%)[b]		
			5 weeks		50 µg/g body weight	1×	60 weeks	¼ (25%)[b]	0%[b]		
		forestomach	Day 1		50 µg/g body weight	1×	60 weeks	4/14 (29%)[b]	3/6 (50%)[b]		
			5 weeks		50 µg/g body weight	1×	60 weeks	0%[c]	0%[b]		
		intestine	Day 1		50 µg/g body weight	1×	60 weeks	3/10 (30%)[b]	2/2 (100%)[b]		
			5 weeks		50 µg/g body weight	1×	60 weeks	2/4 (50%)[b]	0%[b]		
	Mice (C3Hf/Dp)	thymus	control	i.p.	NA	NA	120 wks[**]	0/34 (0%)	0/25 (0%)	[*]Age at death from thymic lymphoma reported specifically for some, but not all, dose groups. [**]Control mice were sacrificed at 120 wks. [***]Age of death for all mice in this dose group, regardless of cancer type.	Terracini et al. (1976)
			Day 1		25 µg NMU/g body weight	1×	29 ± 8.4 wks	2/16 (13%)[b]	5/25 (20%)[b]		
			Day 70		25 µg NMU/g body weight	1×	120 wks (M)[***] 100 wks (F)	0/20 (0%)[c]	1/20 (5%)[b]		
			Day 1		50 µg NMU/g body weight	1×	16.5 ± 0.7 wks	16/24 (67%)[b]	30/44 (68%)[b]		
			Day 21		50 µg NMU/g body weight	1×	24.5 ± 2.5 wks	14/44 (32%)[b]	18/38 (47%)[b]		
			Day 70		50 µg NMU/g body weight	1×	31.4 ± 4.4 wks	9/30 (30%)[b]	6/41 (15%)[b]		

Table 3. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult acute exposure (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death		Tumor incidence		Reference
							M	F	M	F	
NMU Methylnitrosourea (continued)	Mice (C3Hf/Dp)	extra-thymic lymphoma	control	i.p.	NA	NA	120 weeks	120 weeks	1/34 (3%)	2/25 (8%)	Terracini et al. (1976)
			Day 1		25 µg NMU/g body weight	1×	100 weeks	90 weeks	2/16 (13%)[b]	1/25 (4%)[b]	
			Day 70		25 µg NMU/g body weight	1×	120 weeks	100 weeks	0/20 (0%)[b]	0/20 (0%)[b]	
			Day 1		50 µg NMU/g body weight	1×	70 weeks	80 weeks	0/24 (0%)[b]	0/44 (0%)[b]	
			Day 21		50 µg NMU/g body weight	1×	100 weeks	90 weeks	1/44 (2%)[b]	0/38 (0%)[b]	
			Day 70		50 µg NMU/g body weight	1×	110 weeks	90 weeks	1/30 (3%)[b]	0/41 (0%)[b]	
		lung	control	i.p.	NA	NA	120 weeks	120 weeks	4/34 (12%)	6/25 (24%)	
			Day 1		25 µg NMU/g body weight	1×	100 weeks	90 weeks	7/16 (44%)[b]	13/25 (52%)[b]	
			Day 70		25 µg NMU/g body weight	1×	120 weeks	100 weeks	12/20 (60%)[b]	8/20 (40%)[b]	
			Day 1		50 µg NMU/g body weight	1×	70 weeks	80 weeks	5/24 (21%)[b]	11/44 (25%)[b]	
			Day 21		50 µg NMU/g body weight	1×	100 weeks	90 weeks	23/44 (52%)[b]	15/38 (39%)[b]	
			Day 70		50 µg NMU/g body weight	1×	110 weeks	90 weeks	18/30 (60%)[b]	24/41 (59%)[b]	
		liver	control	i.p.	NA	NA	120 weeks	120 weeks	13/34 (38%)	1/25 (4%)	Terracini et al. (1976)
			Day 1		25 µg NMU/g body weight	1×	100 weeks	90 weeks	9/16 (56%)[g]	2/25 (8%)[b]	
			Day 70		25 µg NMU/g body weight	1×	120 weeks	100 weeks	12/20 (60%)[g]	2/20 (10%)[b]	
			Day 1		50 µg NMU/g body weight	1×	70 weeks	80 weeks	4/24 (17%)[g]	3/44 (7%)[b]	
			Day 21		50 µg NMU/g body weight	1×	100 weeks	90 weeks	21/44 (48%)[g]	1/38 (2.6%)[b]	

Table 3. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult acute exposure (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death		Tumor incidence		Reference
							M	F	M	F	
NMU Methylnitrosourea (continued)	Mice (C3Hf/Dp)		Day 70		50 µg NMU/g body weight	1×	110 weeks	90 weeks	8/30 (27%)[g]	2/41 (5%)[b]	
		stomach	control	i.p.	NA	NA	120 weeks	120 weeks	0/34 (0%)	5/25 (20%)	
			Day 1		25 µg NMU/g body weight	1×	100 weeks	90 weeks	2/16 (13%)[b]	10/25 (40%)[b]	
			Day 70		25 µg NMU/g body weight	1×	120 weeks	100 weeks	3/20 (15%)[b]	7/20 (35%)[b]	
			Day 1		50 µg NMU/g body weight	1×	70 weeks	80 weeks	2/24 (8%)[b]	1/44 (2%)[b]	
			Day 21		50 µg NMU/g body weight	1×	100 weeks	90 weeks	19/44 (43%)[b]	9/38 (24%)[b]	
			Day 70		50 µg NMU/g body weight	1×	110 weeks	90 weeks	8/30 (27%)[b]	21/41 (51%)[b]	
		kidney	control	i.p.	NA	NA	120 weeks	120 weeks	0/34 (0%)	0/25 (0%)	Terracini et al. (1976)
			Day 1		25 µg NMU/g body weight	1×	100 weeks	90 weeks	0/16 (0%)[b]	0/25 (0%)[b]	
			Day 70		25 µg NMU/g body weight	1×	120 weeks	100 weeks	0/20 (0%)[b]	0/20 (0%)[b]	
			Day 1		50 µg NMU/g body weight	1×	70 weeks	80 weeks	0/24 (0%)[b]	4/44 (9%)[b]	
			Day 21		50 µg NMU/g body weight	1×	100 weeks	90 weeks	1/44 (2%)[b]	4/38 (11%)[b]	
			Day 70		50 µg NMU/g body weight	1×	110 weeks	90 weeks	5/30 (17%)[b]	7/41 (17%)[b]	

Table 3. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult acute exposure (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death		Tumor incidence		Reference
							M	F	M	F	
NMU Methylnitrosourea (continued)	Mice (C3Hf/Dp)	ovary	control	i.p.	NA	NA	120 weeks	120 weeks	NA	3/25 (12%)	
			Day 1		25 µg NMU/g body weight	1×	100 weeks	90 weeks	NA	2/25 (8%)[b]	
			Day 70		25 µg NMU/g body weight	1×	120 weeks	100 weeks	NA	4/20 (20%)[b]	
			Day 1		50 µg NMU/g body weight	1×	70 weeks	80 weeks	NA	0/44 (0%)[b]	
			Day 21		50 µg NMU/g body weight	1×	100 weeks	90 weeks	NA	9/38 (24%)[b]	
			Day 70		50 µg NMU/g body weight	1×	110 weeks	90 weeks	NA	16/41 (39%)[b]	
		mammary	control	i.p.	NA	NA	120 weeks	120 weeks	NA	2/25 (8%)	Terracini et al. (1976)
			Day 1		25 µg NMU/g body weight	1×	100 weeks	90 weeks	NA	1/25 (4%)[b]	
			Day 70		25 µg NMU/g body weight	1×	120 weeks	100 weeks	NA	0/20 (0%)[b]	
			Day 1		50 µg NMU/g body weight	1×	70 weeks	80 weeks	NA	0/44 (0%)[b]	
			Day 21		50 µg NMU/g body weight	1×	100 weeks	90 weeks	1/44 (2%)[b]	0/38 (0%)[b]	
			Day 70		50 µg NMU/g body weight		110 weeks	90 weeks	NA	4/41 (9.8%)[b]	
		uterus or vagina	control	i.p.	NA	NA	120 weeks	120 weeks	NA	1/25 (4%)	
			Day 1		25 µg NMU/g body weight	1×	100 weeks	90 weeks	NA	1/25 (4%)[b]	
			Day 70		25 µg NMU/g body weight	1×	120 weeks	100 weeks	NA	6/20 (30%)[b]	
			Day 1		50 µg NMU/g body weight	1×	70 weeks	80 weeks	NA	0/44 (0%)[b]	
			Day 21		50 µg NMU/g body weight	1×	100 weeks	90 weeks	NA	1/38 (3%)[b]	
			Day 70		50 µg NMU/g body weight		110 weeks	90 weeks		7/41 (17%)[b]	

Table 3. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult acute exposure (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumors[a]		Comments	Reference
								M	F		
Urethane	Mice (SWR)	lung adenoma	Newborn	s.c.	0.18 mg/g body weight	1×	10 weeks	100%[b]		The average number of tumors per mouse increased linearly with dose.	Kaye and Trainin (1966)
			11–22 weeks	s.c.	0.25 mg/g body weight	1×	23–34 weeks	0%[b]			
	Mice (C3H/f)	liver	Control	Control	None	N/A	493 days (m) 553 days (f)	14/97 (14%)	1/77 (1%)		Liebelt et al. (1964)
			Day 1	i.p.	0.8 mg/g body weight	1×	481 days (m) 434 days (f)	27/30 (90%)[g]	18/39 (46%)[g]		
			8–10 weeks	i.p.	1 mg/g body weight	1×	321 days (m) -	6/25 (24%)[c]	0/32 (0%)[c]		
		lung	Control	Control	None	N/A	493 days (m) 553 days (f)	0/97 (0%)	0/77 (0%)	The number of lung tumors among the controls was not provided.	
			Day 1	i.p.	0.8 mg/g body weight	1×	401 days (m) 408 days (f)	14/30 (46%)[g]	19/39 (48%)[g]		
			8–10 weeks	i.p.	1 mg/g body weight	1×	506 days (m) -	2/25 (8%)[c]	0/32 (0%)[c]		
		reticular tissue	Control	Control	None	N/A	493 days (m) 553 days (f)	2/97 (2%)	6/77 (8%)		
			Day 1	i.p.	0.8 mg/g body weight	1×	285 days (m) 343 days (f)	4/30 (13%)[c]	22/39 (56%)[g]		
			8–10 weeks	i.p.	1 mg/g body weight	1×	- 453 days (f)	0/25 (25%)[c]	4/32 (13%)[c]		

Table 3. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult acute exposure (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumors[a]		Comments	Reference
								M	F		
Urethane (continued)	Mice (Swiss)	leukemia	Control	Control	None	N/A	8–10 months	1%		Highest tumor rates when dosed at birth. Exposure to newborns was followed by 21.6% leukemia, occurring at a mean age of 105 days.	Fiore-Donati et al. (1962)
			Day 1	s.c.	2 mg in 0.05 mL aqueous solution	1×		13/60 (22%)[b]			
			Day 5		4 mg in 0.05 mL aqueous solution	1×		7/39 (18%)[b]			
			Day 40		20 mg in 0.1 mL aqueous solution	1×		2/63 (3%)[b]			
	Mice (Swiss)	lung adenoma	Control 2 weeks	Control	None	N/A	9 weeks	0/15 (0%)	—	The proportion of animals with adenomas decreased steadily with age of exposure.	Rogers (1951)
			Control 4 weeks	Control	None	N/A	11 weeks	0/14 (0%)	—		
			Control 6 weeks	Control	None	N/A	13 weeks	1/15 (7%)	—		
			Control 8 weeks	Control	None	N/A	15 weeks	2/15 (13%)	—		
			Control 10 weeks	Control	None	N/A	17 weeks	0/15 (0%)	—		
			2 weeks	i.p.	1 mg/g body weight	1×	9 weeks	24/24 (100%)[b]	—		
			4 weeks	i.p.	1 mg/g body weight	1×	11 weeks	23/25 (92%)[b]	—		
			6 weeks	i.p.	1 mg/g body weight	1×	13 weeks	22/25 (88%)[b]	—		
			8 weeks	i.p.	1 mg/g body weight	1×	15 weeks	21/25 (84%)[b]	—		
			10 weeks	i.p.	1 mg/g body weight	1×	17 weeks	19/25 (76%)[b]	—		

Table 3. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult acute exposure (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumors[a]		Comments	Reference
								M	F		
Urethane (continued)	Mice (Swiss)	lung adenoma	3 weeks	i.p.	0.25 mg/g body weight	1×	12 weeks	16/19 (84%)[b]	—		
					0.5 mg/g body weight	1×	12 weeks	16/20 (80%)[b]	—		
					1 mg/g body weight	1×	12 weeks	18/20 (90%)[b]	—		
			8 weeks	i.p.	0.25 mg/g body weight	1×	17 weeks	4/17 (24%)[b]	—		
					0.5 mg/g body weight	1×	17 weeks	15/16 (94%)[b]	—		
					1 mg/g body weight	1×	17 weeks	18/18 (100%)[b]	—		

Table 3. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult acute exposure (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumor incidence[a]		Comments	Reference
								M	F		
Urethane (continued)	Mice (Swiss)	liver	Control	Control	N/A	N/A	360–720 days	10/227 (4.4%)	4/222 (8.22%)		Chieco-Bianchi et al. (1963)
			Day 1	s.c.	1 mg/g body weight	1×	180 days	1/20 (5%)[g]	0/20 (0%)[c]		
			Day 1	s.c.	1 mg/g body weight	1×	240 days	2/17 (12%)[g]	0/12 (0%)[c]		
			Day 1	s.c.	1 mg/g body weight	1×	300 days	5/18 (28%)[g]	0/16 (0%)[c]		
			Day 1	s.c.	1 mg/g body weight	1×	360 days	11/20 (55%)[g]	0/23 (0%)[c]		
			Day 1	s.c.	1 mg/g body weight	1×	420 days	13/15 (87%)[g]	2/22 (9%)[g]		
			Day 1	s.c.	1 mg/g body weight	1×	480 days	17/23 (74%)[c]	2/25 (8%)[c]		
			Day 5	s.c.	1 mg/g body weight	1×	420 days	9/13 (69.2%)[b]	2/11 (18.2%)[b]		
			Day 20	s.c.	1 mg/g body weight	1×	420 days	1/13 (8%)[b]	0/16 (0%)[b]		
			Day 40	s.c.	1 mg/g body weight	1×	420 days	0/11 (0%)[b]	0/9 (0%)[b]		
	Mice (Swiss)	skin	Control	Control	N/A	N/A	180–550 days	30/712 (4.21%)		Croton oil treatment initiated at 40 days of age.	Chieco-Bianchi et al. (1963)
			Day 1	s.c.	1 mg urethane/g body weight; 5% croton oil	single dose urethane, croton oil applied 2×/week for 10 mos	660 days	26/59 (44.1%)[g]			

Table 3. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult acute exposure (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumor incidence[a]		Comments	Reference
								M	F		
Urethane (continued)			Day 40	s.c.	1 mg urethane/g body weight; 5% croton oil	single dose urethane, croton oil applied 2×/week for 10 mos	700 days	8/41 (19.5%)[b]			
	Mice ($B6AF_1/J$)	liver	Control	gavage	N/A	N/A	71 weeks	1/25 (4%)	0/25 (0%)		Klein (1966)
			Day 1		1 mg/g body weight	1×	66 weeks	9/20 (45%)[g]	9/26 (35%)[g]		
			Day 7		1 mg/g body weight	1×	67 weeks	20/22 (91%)[g]	20/26 (77%)[g]		
			Day 14		1 mg/g body weight	1×	68 weeks	16/20 (80%)[g]	10/23 (43%)[g]		
			Day 21		1 mg/g body weight	1×	69 weeks	13/23 (57%)[g]	1/20 (5%)[g]		
			Day 28		1 mg/g body weight	1×	70 weeks	4/24 (17%)[g]	1/20 (5%)[g]		
		lung	Control	gavage	1 mg/g body weight	1×	71 weeks	9/25 (36%)	6/25 (24%)		
			Day 1		1 mg/g body weight	1×	66 weeks	20/20 (100%)[b]	25/26 (96%)[b]		
			Day 7		1 mg/g body weight	1×	67 weeks	22/22 (100%)[b]	26/26 (100%)[b]		
			Day 14		1 mg/g body weight	1×	68 weeks	19/20 (95%)[b]	19/23 (83%)[b]		
			Day 21		1 mg/g body weight	1×	69 weeks	23/23 (100%)[b]	19/20 (95%)[b]		
			Day 28		1 mg/g body weight	1×	70 weeks	24/24 (100%)[b]	20/20 (100%)[b]		
	Mice ($B6AF_1/J$)	Harderian gland	Control	gavage	1 mg/g body weight	1×	71 weeks	0/25 (0%)	0/25 (0%)		Klein (1966)
			Day 1		1 mg/g body weight	1×	66 weeks	0/20 (0%)[c]	1/26 (4%)[b]		

Table 3. Methodological information and tumor incidence for animal studies with early postnatal and juvenile and adult acute exposure (continued)

Chemical	Species (strain)	Target site	Age when first dosed	Dose route, # doses	Dose	Duration of exposure	Age at death	Tumor incidence[a]		Comments	Reference
								M	F		
Urethane (continued)			Day 7		1 mg/g body weight	1×	67 weeks	0/22 (0%)[c]	1/26 (4%)[b]		
			Day 14		1 mg/g body weight	1×	68 weeks	0/20 (0%)[c]	2/23 (9%)[b]		
			Day 21		1 mg/g body weight	1×	69 weeks	1/23 (4%)[b]	0/20 (0%)[c]		
			Day 28		1 mg/g body weight	1×	70 weeks	0/24 (0%)[c]	0/20 (0%)[c]		
		forestomach	Control	gavage	1 mg/g body weight	1×	71 weeks	0/25 (0%)	1/25 (4%)		
			Day 1		1 mg/g body weight	1×	66 weeks	0/20 (0%)[c]	3/26 (12%)[b]		
			Day 7		1 mg/g body weight	1×	67 weeks	1/22 (5%)[b]	1/26 (4%)[b]		
			Day 14		1 mg/g body weight	1×	68 weeks	1/20 (5%)[b]	4/23 (17%)[b]		
			Day 21		1 mg/g body weight	1×	69 weeks	0/23 (0%)[c]	1/20 (5%)[b]		
			Day 28		1 mg/g body weight	1×	70 weeks	2/24 (8%)[b]	1/20 (5%)[b]		

[a] Where not delineated by gender, data combined by study authors or gender not specified. Where percentages only are given, number of subjects not specified.
[b] Not evaluated by authors.
[c] Evaluated but not significant compared with controls.
[d] Study also included mammary fibroadenomas and fibromas as well as other types of cancers.
[e] 8–9 weeks old.
[f] Includes survivors up to 40 weeks only.
[g] Significant compared with controls.

i.p. = intraperitoneal injection; s.c. = subcutaneous injection

Table 4. Ratio of early-life to adult cancer potencies for studies with repeated exposures of juvenile and adult animals to carcinogens with a mutagenic mode of action*

Compound	Species (strain)	Sex	Dose	Tumor	Unweighted geometric mean	2.5%	Median	97.5%	Reference
Benzidine	Mice ($B6C3F_1$)	male		liver	111	64	**110**	198	Vesselinovitch et al. (1975b)
		female		liver	0.16	0.004	**0.22**	1.1	
3-MU 3-Methylcholanthrene (formerly known as 20-methylcholanthrene)	Mice (Albino)	male	0.25 mg/g	hepatoma	33	7.4	**30**	268	Klein (1959)
		female	0.25 mg/g	hepatoma	7.7	1.1	**7.1**	85	
		male	0.25 mg/g	forestomach	0.91	0.39	**0.91**	2.1	
		female	0.25 mg/g	forestomach	1.5	0.58	**1.5**	4.2	
		male	0.25 mg/g	skin	1.8	0.048	**2.1**	22	
		female	0.25 mg/g	skin	1.5	0.023	**1.8**	21	
Safrole	Mice ($B6C3F_1$)	male		liver	47	16	**44**	198	Vesselinovitch et al. (1979b)
		female		liver	0.12	0.002	**0.18**	1.1	
VC Vinyl chloride	Rats (Sprague-Dawley)	male	6,000 ppm	liver-angiosarcoma	6.7	0.035	**9.8**	57	Maltoni et al. (1984)
		male	10,000 ppm	liver-angiosarcoma	7.4	0.035	**11**	62	
		female	6,000 ppm	liver-angiosarcoma	13	4.9	**13**	33	
		female	10,000 ppm	liver-angiosarcoma	30	8.7	**29**	121	
		male	6,000 ppm	zymbal gland	0.73	0.0032	**1.1**	30	
		male	10,000 ppm	zymbal gland	0.27	0.0022	**0.4**	5.4	
		female	6,000 ppm	zymbal gland	0.48	0.0027	**0.7**	16	
		female	10,000 ppm	zymbal gland	0.15	0.0014	**0.19**	4.5	
		male	10,000 ppm	leukemia	21	0.026	**37**	514	
		female	6,000 ppm	leukemia	1.3	0.0035	**1.7**	153	
		female	10,000 ppm	leukemia	0.29	0.0019	**0.35**	17	
		male	6,000 ppm	nephroblastomas	0.15	0.0014	**0.19**	4.8	
		male	10,000 ppm	nephroblastomas	0.17	0.0015	**0.21**	6.2	
		female	6,000 ppm	nephroblastomas	0.28	0.0018	**0.33**	16	
		female	10,000 ppm	nephroblastomas	0.24	0.0017	**0.29**	11	
		male	6,000 ppm	angiosarcomas-other sites	0.9	0.0033	**1.26**	53	
		male	10,000 ppm	angiosarcomas-	0.25	0.0017	**0.30**	12	

Table 4. Ratio of early-life to adult cancer potencies for studies with repeated exposures of juvenile and adult animals to mutagenic chemicals (continued)

Compound	Species (strain)	Sex	Dose	Tumor	Unweighted geometric mean	2.5%	Median	97.5%	Reference
				other sites					
VC Vinyl chloride (continued)		female	6,000 ppm	angiosarcomas-other sites	0.24	0.0017	**0.29**	11	
		female	10,000 ppm	angiosarcomas-other sites	0.32	0.0019	**0.38**	20	
		male	6,000 ppm	angiomas & fibromas-other sites	0.72	0.0031	**1.0**	33	
		male	10,000 ppm	angiomas & fibromas-other sites	1.4	0.0045	**2.36**	47	
		female	6,000 ppm	angiomas & fibromas-other sites	0.27	0.0018	**0.33**	16	
		female	10,000 ppm	angiomas & fibromas-other sites	0.52	0.0024	**0.63**	41	
		male	6,000 ppm	hepatoma	62	11	**58**	543	
		male	10,000 ppm	hepatoma	34	8.2	**32**	218	
		female	6,000 ppm	hepatoma	55	13	**51**	352	
		female	10,000 ppm	hepatoma	55	8.4	**53**	513	
		male	6,000 ppm	skin carcinomas	1.1	0.0035	**1.5**	82	
		male	10,000 ppm	skin carcinomas	0.41	0.0024	**0.56**	15	
		female	6,000 ppm	skin carcinomas	0.46	0.0024	**0.59**	24	
		female	10,000 ppm	skin carcinomas	0.31	0.0019	**0.37**	19	
		male	6,000 ppm	neuroblastoma	0.21	0.0016	**0.26**	9.5	
		male	10,000 ppm	neuroblastoma	0.20	0.0016	**0.24**	8.5	
		female	6,000 ppm	neuroblastoma	0.27	0.0018	**0.32**	15	
		female	10,000 ppm	neuroblastoma	0.14	0.0014	**0.18**	4.4	

* The 2.5% and 97.5% are percentiles of the posterior distribution. For a Bayesian distribution, these percentiles function in a manner similar to the 95% confidence limits for other types of statistical analyses.

Table 5. Ratio of early-life to adult cancer potencies for studies with repeated exposures of juvenile and adult animals to chemicals with a nonmutagenic mode of action*

Compound	Species (strain)	Sex	Dose	Tumor	Ratio of juvenile to adult potency				Reference
					Unweighted geometric mean	2.5%	Median	97.5%	
Amitrole	Mice ($B6C3F_1$)	male	NA	liver	13	5.1	**14**	30	Vesselinovitch (1983)
		female	NA	liver	0.14	0.0013	**0.18**	3.9	
DDT	Mice ($B6C3F_1$)	male	NA	liver	1.3	0.0044	**2.5**	25	Vesselinovitch et al. (1979a)
Dieldrin	Mice ($B6C3F_1$)	male	NA	liver	0.75	0.0031	**1.2**	27	Vesselinovitch et al. (1979a)
DPH	Rats (F344/N)	male	630	liver	0.4	0.0024	**0.54**	16	Chhabra et al. (1993b)
		female	630	liver	0.24	0.0017	**0.29**	12	
	Mice ($B6C3F_1$)	male	210	liver	1.5	0.0040	**2.4**	71	
		female	210	liver	1.3	0.0056	**2.6**	15	
ETU	Rats (F344/N)	male	90	thyroid	0.37	0.0029	**0.61**	5.4	Chhabra et al. (1992)
		female	90	thyroid	0.23	0.0018	**0.3**	7.0	
	Mice ($B6C3F_1$)	male	330	liver	0.091	0.0011	**0.12**	1.9	
		female	330	liver	0.057	0.0010	**0.081**	0.65	
		male	330	thyroid	0.41	0.0022	**0.52**	25	
		female	330	thyroid	0.4	0.0024	**0.55**	16	
		male	330	pituitary	0.32	0.0019	**0.38**	22	
		female	330	pituitary	0.24	0.0018	**0.32**	6.9	
PBB	Rats (F344/N)	male	10	liver	0.59	0.0041	**1.1**	6.6	Chhabra et al. (1993a)
		female	10	liver	0.063	0.0009	**0.079**	1.2	
		male	10	mononuclear cell leukemia	0.79	0.0035	**1.4**	18	
		female	10	mononuclear cell leukemia	0.21	0.0017	**0.28**	6.0	
	Mice ($B6C3F_1$)	male	30	liver	3.9	1.9	**3.9**	7.5	
		female	30	liver	1.0	0.37	**1.05**	2.1	

* The 2.5% and 97.5% are percentiles of the posterior distribution. For a Bayesian distribution, these percentiles function in a manner similar to the 95% confidence limits for other types of statistical analyses.

Table 6. Ratio of early-life to adult cancer potencies for studies with acute exposures of juveniles and adult animals to carcinogens with a mutagenic mode of action*

Compound	Species (strain)	Sex	Dose	Tumor	Day	Ratio of juvenile to adult potency				Reference
						Unweighted geometric mean	2.5%	Median	97.5 %	
BaP*	Mice ($B6C3F_1$)	male	75 µg/kg	liver	1 day	9.3	2.9	**8.4**	55	Vesselinovitch et al. (1975a)
					15 days	11	3.5	**9.6**	61	
		female	75 µg/kg		1 day	1.2	0.0083	**1.6**	31	
					15 days	1.7	0.015	**2.1**	36	
		male	150 µg/kg		1 day	29	8.2	**26**	194	
					15 days	15	4.1	**13**	109	
		female	150 µg/kg		1 day	8.8	1.4	**8.1**	94	
					15 days	1.2	0.0082	**1.6**	30	
	Mice ($C3AF_1$)	male	75 µg/kg	liver	1 day	11	2.1	**10**	112	
					15 days	7.5	1.1	**7.0**	83	
		female	75 µg/kg		1 day	0.2	0.0018	**0.26**	9.1	
					15 days	0.2	0.0017	**0.24**	8.5	
		male	150 µg/kg		1 day	14	3.0	**12.8**	130	
					15 days	3.6	0.11	**3.8**	49	
		female	150 µg/kg		1 day	0.2	0.0017	**0.24**	8.8	
					15 days	0.2	0.0017	**0.24**	8.7	
	Mice ($B6C3F_1$)	Male	75 µg/kg	lung	1 day	1.2	0.45	**1.2**	3.4	
					15 days	0.2	0.0046	**0.31**	1.4	
		female	75 µg/kg	lung	1 day	2.8	1.096	**2.7**	9.5	
					15 days	1.4	0.41	**1.4**	5.1	
		Male	150 µg/kg	lung	1 day	2.2	1.0	**2.1**	5.4	
					15 days	0.8	0.2	**0.82**	2.3	
		female	150 µg/kg	lung	1 day	7.9	2.6	**7.2**	43	
					15 days	3.7	1.1	**3.4**	22	
	Mice ($C3AF_1$)	male	75 µg/kg	lung	1 day	1.2	0.47	**1.2**	3.2	
					15 days	1.1	0.43	**1.08**	3.1	

Table 6. Ratio of early-life to adult cancer potencies for studies with acute exposures of juveniles and adult animals to carcinogens with a mutagenic mode of action (continued)

Compound	Species (strain)	Sex	Dose	Tumor	Day	Ratio of juvenile to adult potency				Reference
						Unweighted geometric mean	2.5%	Median	97.5 %	
BaP* (continued)		female	75 µg/kg	lung	1 day	1.6	0.66	**1.55**	4.0	
					15 days	1.6	0.71	**1.63**	4.2	
		male	150 µg/kg	lung	1 day	1.5	0.57	**1.5**	5.0	
					15 days	1.9	0.71	**1.8**	6.0	
		female	150 µg/kg	lung	1 day	1.3	0.61	**1.3**	2.9	
					15 days	1.2	0.54	**1.1**	2.6	
DBA	Mice			lung		178	20	**143**	5100	Law (1940)
DEN**	Mice ($B6C3F_1$)	male	6 µg/kg	liver	1 day	9.0	3.5	**8.3**	37	Vesselinovitch et al. (1984)
					15 days	8.9	3.5	**8.2**	36	
		female	6 µg/kg	liver	1 day	35	9.1	**31**	239	
					15 days	25	6.3	**226**	175	
		male	12 µg/kg	liver	1 day	9.6	3.3	**8.8**	50	
					15 days	9.8	3.4	**8.9**	51	
		female	12 µg/kg	liver	1 day	16	5.9	**15**	67	
					15 days	19	7.1	**18**	79	
	Mice ($C3AF_1$)	male	6 µg/kg	liver	1 day	7.3	2.9	**6.9**	26	
					15 days	3.5	1.4	**3.3**	13	
		female	6 µg/kg	liver	1 day	17	3.2	**16**	166	
					15 days	6.4	0.86	**6.0**	73	
		male	12 µg/kg	liver	1 day	11	3.7	**9.5**	53	
					15 days	9.8	3.4	**8.9**	50	
		female	12 µg/kg	liver	1 day	40	8.5	**36**	340	
					15 days	25	5.0	**22**	221	
	Mice ($B6C3F_1$)	male	6 µg/kg	lung	1 day	0.5	0.27	**0.52**	0.93	
					15 days	1.6	0.95	**1.6**	2.7	
		female	6 µg/kg	lung	1 day	0.9	0.54	**0.89**	1.5	
					15 days	1.2	0.76	**1.2**	2.0	

Table 6. Ratio of early-life to adult cancer potencies for studies with acute exposures of juveniles and adult animals to carcinogens with a mutagenic mode of action (continued)

Compound	Species (strain)	Sex	Dose	Tumor	Day	Ratio of juvenile to adult potency				Reference
						Unweighted geometric mean	2.5%	Median	97.5 %	
DEN** (continued)		male	12 µg/kg	lung	1 day	0.4	0.21	**0.40**	0.73	
					15 days	0.7	0.39	**0.66**	1.1	
		female	12 µg/kg	lung	1 day	0.7	0.44	**0.73**	1.2	
					15 days	1.4	0.88	**1.4**	2.3	
	Mice ($C3AF_1$)	male	6 µg/kg	lung	1 day	0.7	0.22	**0.67**	1.7	
					15 days	0.5	0.21	**0.56**	1.3	
		female	6 µg/kg	lung	1 day	1.1	0.45	**1.1**	2.5	
					15 days	0.7	0.36	**0.74**	1.5	
		male	12 µg/kg	lung	1 day	0.3	0.084	**0.33**	0.76	
					15 days	0.6	0.26	**0.62**	1.4	
		female	12 µg/kg	lung	1 day	0.7	0.35	**0.75**	1.6	
					15 days	0.7	0.37	**0.75**	1.5	
DMBA#	Rats (Wistar)	male		total	2 vs 5–8 wks	3.3	1.3	**3.2**	10	Meranze et al. (1969)
					2 vs 26 wks	3.2	1.3	**3.1**	9.7	
		female		total	2 vs 5–8 wks	1.3	0.68	**1.3**	2.5	
					2 vs 26 wks	3.3	1.2	**3.0**	16	
				mammary	2 vs 5–8 wks	0.0	0.0012	**0.056**	0.26	
					2 vs 26 wks	0.2	0.0023	**0.29**	5.3	
					5 vs 26 wks	7.1	1.8	**6.4**	55	
	Mice (Balb/c)	male	15 µg	lung	1 day	30	2.8	**22**	1482	Walters (1966)
					15–19 days	1.0	0.28	**1.0**	3.5	
		male	30 µgx2	lung	15–19 days	14	1.056	**10**	978	
		female	15 µg	lung	1 day	60	6.0	**46**	2350	
					15–19 days	3.1	0.51	**3.0**	22	
		female	30 µgx2	lung	15–19 days	15	1.2	**11**	1004	
	Mice (Swiss)			lymphoma		2.7	0.60	**2.5**	19	Pietra et al. (1961)
				lung		9.1	2.9	**8.7**	40	

Table 6. Ratio of early-life to adult cancer potencies for studies with acute exposures of juveniles and adult animals to carcinogens with a mutagenic mode of action (continued)

Compound	Species (strain)	Sex	Dose	Tumor	Day	Ratio of juvenile to adult potency				Reference
						Unweighted geometric mean	2.5%	Median	97.5 %	
DMN***	Rats (Wistar)		3 wks	total	1 month	0.7	0.41	**0.73**	1.3	Hard (1979)
					1.5 months	1.1	0.58	**1.1**	2.1	
					2 months	1.5	0.75	**1.5**	3.0	
					3 months	0.9	0.50	**0.94**	1.8	
			24 hr		1 month	0.3	0.13	**0.28**	0.6	
					1.5 months	0.4	0.18	**0.42**	0.9	
					2 months	0.6	0.24	**0.56**	1.3	
					3 months	0.4	0.16	**0.36**	0.78	
			1 month		1.5 months	1.5	0.80	**1.52**	3.0	
					2 months	2.0	1.0	**2.0**	4.2	
					3 months	1.3	0.69	**1.3**	2.5	
ENU	Mice ($B6C3F_1$)	male		liver		7.8	3.9	**7.7**	18	Vesselinovitch (1983)
		female				7.1	2.9	**6.9**	21	
	Rats (Wistar)	male		nerve tissue	1 day	27	2.5	**20**	1374	Naito et al. (1981)
					1 week	1.6	0.61	**1.6**	4.6	
					2 weeks	1.6	0.58	**1.6**	4.8	
					3 weeks	0.7	0.12	**0.72**	2.3	
		female			1 day	64	6.0	**50**	2488	
					1 weeks	9.6	2.6	**8.9**	59	
					2 weeks	6.2	1.6	**5.7**	40	
					3 weeks	0.7	0.0090	**0.89**	8.9	
	Mice ($B6C3F_1$)	male	60 µg/g	lung	1	1.0	0.60	**1.0**	1.7	Vesselinovitch et al. (1974)
					15	1.1	0.66	**1.1**	1.8	
		female	60 µg/g	lung	1	2.1	1.17	**2.1**	4.1	
					15	1.0	0.60	**1.0**	1.7	
		male	120 µg/g	lung	1	1.0	0.60	**1.0**	1.7	

Table 6. Ratio of early-life to adult cancer potencies for studies with acute exposures of juveniles and adult animals to carcinogens with a mutagenic mode of action (continued)

Compound	Species (strain)	Sex	Dose	Tumor	Day	Ratio of juvenile to adult potency				Reference
						Unweighted geometric mean	2.5%	Median	97.5 %	
					15	1.1	0.66	**1.0**	1.8	
ENU (continued)		female	120 µg/g	lung	1	2.1	1.2	**2.1**	4.1	
					15	1.0	0.60	**1.0**	1.7	
	Mice ($C3AF_1$)	male	60 µg/g	lung	1	8.7	2.7	**8.0**	48	
					15	52	5.2	**39**	2141	
		female	60 µg/g	lung	15	0.7	0.32	**0.72**	1.6	
		male	120 µg/g	lung	1	0.9	0.38	**0.92**	2.2	
					15	0.7	0.28	**0.67**	1.6	
		female	120 µg/g	lung	1	0.5	0.24	**0.54**	1.2	
					15	0.4	0.18	**0.42**	0.92	
	Mice ($B6C3F_1$)	male	60 µg/g	liver	1	8.8	4.2	**8.5**	22	
					15	14	6.2	**14**	37	
		female	60 µg/g	liver	1	6.3	2.6	**6.1**	18	
					15	5.6	2.4	**5.4**	16	
		male	120 µg/g	liver	1	5.2	2.5	**5.1**	11	
					15	7.6	3.9	**7.5**	17	
		female	120 µg/g	liver	1	11	4.1	**11**	46	
					15	14	4.9	**13**	55	
	Mice ($C3AF_1$)	male	60 µg/g	liver	1	12	4.7	**11**	43	
					15	8.1	3.2	**7.6**	29	
		female	60 µg/g	liver	1	7.5	2.6	**7.0**	32	
					15	4.8	1.8	**4.6**	18	
		male	120 µg/g	liver	1	9.8	4.1	**9.3**	32	
					15	6.6	2.7	**6.3**	23	
		female	120 µg/g	liver	1	5.4	1.7	**5.0**	25	
					15	5.4	1.7	**5.1**	25	
	Mice ($B6C3F_1$)	male	60 µg/g	kidney	1	2.2	0.73	**2.1**	8.0	
					15	1.2	0.29	**1.2**	5.1	

Table 6. Ratio of early-life to adult cancer potencies for studies with acute exposures of juveniles and adult animals to carcinogens with a mutagenic mode of action (continued)

Compound	Species (strain)	Sex	Dose	Tumor	Day	Ratio of juvenile to adult potency				Reference
						Unweighted geometric mean	2.5%	Median	97.5 %	
		female	60 µg/g	kidney	1	0.7	0.024	**0.85**	5.9	
					15	2.6	0.61	**2.5**	15	
ENU (continued)		male	120 µg/g	kidney	1	1.7	0.65	**1.7**	4.4	
					15	2.6	1.14	**2.6**	6.4	
		female	120 µg/g	kidney	1	0.9	0.37	**0.87**	2.0	
					15	1.4	0.67	**1.4**	3.2	
	Mice ($C3AF_1$)	male	60 µg/g	kidney	1	1.8	0.17	**1.9**	15	
					15	2.0	0.25	**2.0**	16	
		female	60 µg/g	kidney	1	1.0	0.016	**1.3**	13	
					15	2.1	0.16	**2.2**	20	
		male	120 µg/g	kidney	1	0.2	0.0029	**0.24**	1.5	
					15	1.5	0.38	**1.5**	5.9	
		female	120 µg/g	kidney	1	2.3	0.17	**2.4**	20	
					15	7.1	1.8	**6.5**	47	
	Mice ($B6C3F_1$)	male	60 µg/g	Harderian	1	0.3	0.018	**0.41**	1.4	
					15	0.5	0.075	**0.52**	1.4	
		female	60 µg/g	Harderian	1	0.1	0.0025	**0.16**	0.74	
					15	0.8	0.35	**0.84**	2.0	
		male	120 µg/g	Harderian	1	0.4	0.13	**0.42**	0.96	
					15	0.6	0.26	**0.57**	1.2	
		female	120 µg/g	Harderian	1	0.1	0.0030	**0.18**	0.85	
					15	0.7	0.17	**0.77**	2.1	
	Mice ($C3AF_1$)	male	60 µg/g	Harderian	1	0.1	0.0023	**0.20**	1.3	
					15	0.1	0.0016	**0.18**	1.8	
		female	60 µg/g	Harderian	1	0.4	0.019	**0.52**	2.5	
					15	0.8	0.15	**0.85**	3.4	
		male	120 µg/g	Harderian	1	0.1	0.0010	**0.086**	1.0	
					15	0.3	0.0050	**0.40**	2.8	

Table 6. Ratio of early-life to adult cancer potencies for studies with acute exposures of juveniles and adult animals to carcinogens with a mutagenic mode of action (continued)

Compound	Species (strain)	Sex	Dose	Tumor	Day	Ratio of juvenile to adult potency				Reference
						Unweighted geometric mean	2.5%	Median	97.5 %	
		female	120 µg/g	Harderian	1	0.1	0.0012	**0.094**	1.2	
					15	0.1	0.0012	**0.081**	0.90	
ENU (continued)	Mice ($B6C3F_1$)	male	60 µg/g	stomach	1	0.3	0.0091	**0.34**	2.4	
					15	1.9	0.61	**1.82**	8.7	
		female	60 µg/g	stomach	1	0.2	0.0083	**0.26**	1.1	
					15	0.2	0.0072	**0.24**	1.0	
		male	120 µg/g	stomach	1	0.2	0.0059	**0.20**	0.90	
					15	1.2	0.50	**1.2**	2.9	
		female	120 µg/g	stomach	1	0.6	0.19	**0.60**	1.5	
					15	1.6	0.67	**1.6**	3.7	
	Mice ($C3AF_1$)	male	60 µg/g	stomach	1	0.0	0.0009	**0.063**	0.51	
					15	0.3	0.023	**0.41**	1.3	
		female	60 µg/g	stomach	1	0.8	0.085	**0.89**	3.5	
					15	1.1	0.19	**1.1**	4.5	
		male	120 µg/g	stomach	1	0.2	0.010	**0.19**	0.56	
					15	0.7	0.32	**0.70**	1.5	
		female	120 µg/g	stomach	1	0.4	0.14	**0.46**	1.2	
					15	0.6	0.24	**0.64**	1.5	
NMU	Mice ($BC3F_1$)	male	50 µg/g	lung adenomas	1	3.4	1.3	**3.3**	9.3	Terracini and Testa (1970)
		female	50 µg/g	lung adenomas	1	6.3	2.4	**6.0**	23	
		male	50 µg/g	lymphosarcoma	1	2.5	1.1	**2.4**	6.4	
		female	50 µg/g	lymphosarcoma	1	1.1	0.49	**1.1**	2.4	
		male	50 µg/g	hepatoma	1	35	6.5	**32**	324	
		female	50 µg/g	hepatoma	1	0.3	0.0023	**0.39**	13	
		male	50 µg/g	renal adenoma	1	0.9	0.0093	**1.2**	13	
		female	50 µg/g	renal adenoma	1	1.3	0.0081	**1.7**	33	
		male	50 µg/g	forestomach	1	0.0	0.0006	**0.039**	0.52	
		female	50 µg/g	forestomach	1	0.1	0.0027	**0.15**	0.69	

Table 6. Ratio of early-life to adult cancer potencies for studies with acute exposures of juveniles and adult animals to carcinogens with a mutagenic mode of action (continued)

Compound	Species (strain)	Sex	Dose	Tumor	Day	Ratio of juvenile to adult potency				Reference
						Unweighted geometric mean	2.5%	Median	97.5 %	
	Mice (C3Hf/Dp)	male	25 µg/g	thymic lymphoma	1	1.9	0.048	**2.1**	23	
NMU (continued)		female	25 µg/g	thymic lymphoma	1	1.2	0.0089	**1.5**	30	
		male	25 µg/g	lung adenomas	1	1.0	0.013	**1.2**	11	
		female	25 µg/g	lung adenomas	1	0.4	0.018	**0.46**	1. 7	
		male	25 µg/g	liver tumor	1	0.2	0.0016	**0.21**	4.6	
		female	25 µg/g	liver tumor	1	0.3	0.0026	**0.39**	4.4	
		male	25 µg/g	Stomach	1	0.5	0.0045	**0.67**	6.8	
		female	25 µg/g	Stomach	1	0.3	0.0046	**0.43**	3.8	
				ovarian	1	0.1	0.0014	**0.17**	3.5	
				uterine/vaginal	1	8.6	1.1	**8.1**	97	
		male	50 µg/g	thymic lymphoma	1	7.9	3.1	**7.4**	30	
		female	50 µg/g	thymic lymphoma	1	3.1	1.3	**3.0**	7.8	
		male	50 µg/g	lung adenomas	1	0.04	0.0008	**0.058**	0.45	
		female	50 µg/g	lung adenomas	1	0.1	0.0012	**0.084**	0.53	
		male	50 µg/g	liver tumor	1	0.2	0.0021	**0.33**	7.8	
		female	50 µg/g	liver tumor	1	0.1	0.0011	**0.13**	4.5	
		male	50 µg/g	Stomach	1	0.01	0.0003	**0.013**	0.12	
		female	50 µg/g	Stomach	1	0.1	0.0022	**0.15**	0.96	
				ovarian	1	0.0	0.0003	**0.014**	0.14	
				uterine/vaginal	1	0.0	0.0005	**0.034**	0.46	
		male	50 µg/g	thymic lymphoma	21	4.3	1. 6	**4.1**	17	
		female	50 µg/g	thymic lymphoma	21	1.0	0.39	**1.0**	2.6	
		male	50 µg/g	lung adenomas	21	0.1	0.0022	**0.22**	1.1	
		female	50 µg/g	lung adenomas	21	0.7	0.30	**0.75**	1.7	

Table 6. Ratio of early-life to adult cancer potencies for studies with acute exposures of juveniles and adult animals to carcinogens with a mutagenic mode of action (continued)

Compound	Species (strain)	Sex	Dose	Tumor	Day	Ratio of juvenile to adult potency				Reference
						Unweighted geometric mean	2.5%	Median	97.5 %	
		male	50 µg/g	liver tumor	21	0.1	0.0013	**0.15**	4.3	
		female	50 µg/g	liver tumor	21	0.9	0.0051	**1.4**	23	
NMU (continued)		male	50 µg/g	stomach	21	0.1	0.001	**0.08**	0.64	
		female	50 µg/g	stomach	21	1.8	0.77	**1.8**	4.7	
				ovarian	21	0.0	0.0007	**0.055**	0.97	
				uterine/vaginal	21	1.7	0.59	**1.7**	6.4	
Urethane	Mice (Swiss)	male	1 mg/g	liver	1	24	4.4	**21**	220	Chieco-Bianchi et al. (1963)
		female	1 mg/g	liver	1	0.4	0.0044	**0.54**	13	
		male	1 mg/g	liver	5	14	2.4	**13**	137	
		female	1 mg/g	liver	5	1.2	0.017	**1.4**	26	
		male	1 mg/g	liver	20	0.2	0.0018	**0.28**	10	
		female	1 mg/g	liver	20	0.1	0.0011	**0.12**	4.8	
		both	1 mg/g	skin	1	0.2	0.0027	**0.32**	5.4	
Urethane + croton oil	Mice (Swiss)	both	1 mg/g	skin	1	2.9	1.2	**2.8**	8.2	
Urethane	Rats (MRC Wistar-derived)	male/ female	16%×6	neurilemmomas	1	0.2	0.0028	**0.33**	4.5	Choudari Kommineni et al. (1970)
		male/ female	16%×6	neurilemmomas	28	0.4	0.0045	**0.51**	6.3	
		male/ female	16%×6	liver	1	7.9	1.4	**7.1**	82	
		male/ female	16%×6	liver	28	0.2	0.0026	**0.4**	11.7	
		male/ female	16%×6	thyroid	1	0.0	0.0006	**0.039**	0.67	
		male/ female	16%×6	thyroid	28	0.1	0.0011	**0.1**	1.5	
	Mice (Swiss)	male/ female	1 mg/g	lung	1	15	1.2	**11**	997	De Benedictis et al. (1962)
	Mice (Swiss)			leukemia		6.7	1.7	**6.1**	45	Fiore-Donati et al.

Table 6. Ratio of early-life to adult cancer potencies for studies with acute exposures of juveniles and adult animals to carcinogens with a mutagenic mode of action (continued)

Compound	Species (strain)	Sex	Dose	Tumor	Day	Ratio of juvenile to adult potency				Reference
						Unweighted geometric mean	2.5%	Median	97.5 %	
						5.1	1.1	**4.7**	38	(1962)
Urethane (continued)	Mice ($B6AF_1/J$)	male	1 mg/g	liver	21	5.1	1.4	**4.7**	30	Klein (1966)
		female	1 mg/g	liver	21	0.2	0.0019	**0.26**	6.0	
				Harderian gland	1	0.3	0.0021	**0.33**	11	
					7	0.3	0.0021	**0.33**	11	
					14	0.6	0.0044	**0.85**	20	
		male	1 mg/g	Harderian gland	21	0.3	0.0024	**0.41**	13	
		male	1 mg/g	forestomach	1	0.1	0.0009	**0.079**	1.9	
		female	1 mg/g	forestomach	1	0.4	0.0028	**0.49**	11	
		male	1 mg/g	forestomach	7	0.1	0.0017	**0.19**	3.5	
		female	1 mg/g	forestomach	7	0.1	0.0013	**0.16**	5.0	
		male	1 mg/g	forestomach	14	0.2	0.0018	**0.21**	3.9	
		female	1 mg/g	forestomach	14	0.8	0.0056	**1.1**	18	
		male	1 mg/g	forestomach	21	0.1	0.0008	**0.072**	1.7	
		female	1 mg/g	forestomach	21	0.2	0.0015	**0.2**	6.3	
				lung	1	1.0	0.36	**0.95**	2.5	
		male	1 mg/g	lung	14	0.8	0.26	**0.8**	2.3	
		female	1 mg/g	lung	14	0.4	0.16	**0.45**	1.1	
					21	0.9	0.31	**0.86**	2.4	
	Mice (C3H/f)	male	1 mg/g	liver	1	14	4.0	**12**	81	Liebelt et al. (1964)
		female	1 mg/g	liver	1	16	3.2	**15**	155	
		male	1 mg/g	lung	1	5.9	1.7	**5.6**	28	
		female	1 mg/g	lung	1	22	4.5	**20**	203	
		male	1 mg/g	reticular tissue	1	2.0	0.023	**2.3**	38	
		female	1 mg/g	reticular tissue	1	8.6	2.3	**7.7**	60	
	Mice (Swiss)		1 mg/g	pulmonary adenomas	2 vs 4 weeks	14	1.1	**10.1**	965	Rogers (1951)

Table 6. Ratio of early-life to adult cancer potencies for studies with acute exposures of juveniles and adult animals to carcinogens with a mutagenic mode of action (continued)

Compound	Species (strain)	Sex	Dose	Tumor	Day	Ratio of juvenile to adult potency				Reference
						Unweighted geometric mean	2.5%	Median	97.5 %	
			1 mg/g	pulmonary adenomas	2 vs 6 weeks	16	1.3	**11.3**	1025	
Urethane (continued)			1 mg/g	pulmonary adenomas	2 vs 8 weeks	19	1.6	**13.3**	1126	
			1 mg/g	pulmonary adenomas	2 vs 10 weeks	21	1.9	**14.5**	1168	
			0.25 mg/g	adenomas	3 vs 8 weeks	7.1	2.3	**6.7**	29	
			0.5 mg/g	adenomas	3 vs 8 weeks	0.7	0.29	**0.67**	1.6	
			1.0 mg/g	adenomas	3 vs 8 weeks	0.7	0.28	**0.68**	1.6	

* The 2.5% and 97.5% are percentiles of the posterior distribution. For a Bayesian distribution, these percentiles function in a manner similar to the 95% confidence limits for other types of statistical analyses.

Table 7. Ratio of early-life to adult cancer potencies for studies with lifetime exposures starting with juvenile and adult animals to carcinogens with mutagenic or nonmutagenic modes of action*

Compound	Species (strain)	Sex	Dose	Tumor	Unweightedg eometric mean	2.5%	Median	97.5%	Reference
Mutagenic compounds									
DEN	Rats (Colworth)		multiple	liver	2.8	0.0093	**5.6**	23	Peto et al. (1984)
				esophagus	0.18	0.0015	**0.23**	4.8	
Safrole	Mice ($B6C3F_1$)	male		liver	50	3.7	**50**	253	Vesselinovitch et al. (1979b)
		female		liver	4.0	0.007	**4.0**	23	
Urethane	Mice ($B6AF_1/J$)	male	2.5 mg/pup	liver	79	0.36	**102**	1,064	Klein (1966)
		female	2.5 mg/pup	liver	0.47	0.0022	**0.55**	42	
Nonmutagenic compounds									
DDT	Mice ($B6C3F_1$)			liver	23	0.0023	**0.58**	23	Vesselinovitch et al. (1979a)
Dieldrin	Mice ($B6C3F_1$)			liver	91	0.014	**14**	91	Vesselinovitch et al. (1979a)
DPH	Rats (F344/N)	male	630:800	liver	0.31	0.0019	**0.37**	18	Chhabra et al. (1993b)
			630:2,400	liver	0.36	0.0021	**0.45**	17	
		female	630:800	liver	0.33	0.0019	**0.39**	21	
			630:2,400	liver	0.33	0.0019	**0.39**	21	
	Mice ($B6C3F_1$)	male	210:100	liver	0.71	0.0028	**0.93**	49	
			210:300	liver	14	0.03	**23**	214	
		female	210:200	liver	0.32	0.002	**0.42**	13	
			210:600	liver	0.35	0.0023	**0.53**	8.8	
ETU	Rats (F344/N)	male	90:83	thyroid	0.23	0.0017	**0.3**	7.3	Chhabra et al. (1992)
			90:250	thyroid	9.1	1.1	**10.5**	27	
		female	90:83	thyroid	0.37	0.0021	**0.46**	19	
			90:250	thyroid	0.61	0.0034	**1.1**	10	

Table 7. Ratio of early-life to adult cancer potencies for studies with lifetime exposures starting with juvenile and adult animals to carcinogens with mutagenic or nonmutagenic modes of action (continued)

Compound	Species (strain)	Sex	Dose	Tumor	Unweighted geometric mean	2.5%	Median	97.5%	Reference
ETU (continued)	Mice ($B6C3F_1$)	male	330:330	liver	0.37	0.0022	**0.5**	14	
			330:1,000	liver	0.48	0.0027	**0.75**	12	
		female	330:330	liver	0.33	0.0023	**0.5**	7.8	
			330:1,000	liver	0.42	0.0025	**0.65**	11	
		male	330:330	thyroid	0.44	0.0022	**0.52**	34	
			330:1,000	thyroid	0.63	0.0035	**1.12**	10	
		female	330:330	thyroid	5.2	0.011	**10**	108	
			330:1,000	thyroid	0.18	0.0016	**0.24**	4.2	
		male	330:330	pituitary	0.40	0.0021	**0.47**	32	
			330:1,000	pituitary	0.18	0.0015	**0.22**	5.7	
		female	330:330	pituitary	0.21	0.0016	**0.26**	10	
			330:1,000	pituitary	0.27	0.0019	**0.36**	9.0	
PBB	Rats (F344/N)	male	10:10	liver	0.39	0.0023	**0.56**	13	Chhabra et al. (1993a)
			10:30	liver	0.18	0.0016	**0.25**	4.3	
		female	10:10	liver	36	15	**36**	86	
			10:30	liver	3.1	0.023	**4.6**	22	
		male	10:10	mononuclear cell leukemia	0.51	0.0025	**0.69**	23	
		male	10:30	mononuclear cell leukemia	0.77	0.0031	**1.1**	35	
		female	10:10	mononuclear cell leukemia	0.54	0.0026	**0.74**	24	
		female	10:30	mononuclear cell leukemia	0.34	0.0021	**0.45**	15	
	Mice ($B6C3F_1$)	male	30:30	liver	8.9	0.015	**12.2**	1,076	
		female	30:30	liver	4.4	0.0075	**6.2**	786	
		male	10:10	liver	0.15	0.0014	**0.2**	3.9	

Table 7. Ratio of early-life to adult cancer potencies for studies with lifetime exposures starting with juvenile and adult animals to carcinogens with mutagenic or nonmutagenic modes of action (continued)

Compound	Species (strain)	Sex	Dose	Tumor	Unweighted geometric mean	2.5%	Median	97.5%	Reference
		female	10:10	liver	0.29	0.0021	**0.43**	7.0	

* The 2.5% and 97.5% are percentiles of the posterior distribution. For a Bayesian distribution, these percentiles function in a manner similar to the 95% confidence limits for other types of statistical analyses.

Table 8. Summary of quantitative estimates of ratio of early-life to adult cancer potencies

Dose	Tissue	Number of chemicals	Inverse-weighted geometric mean ratio	Unweighted Minimum	Unweighted Maximum	Number of ratios	Percentage >1
Chemicals with mutagenic mode of action							
Repeated		4	10.5	0.12	111	45	42
Lifetime		3	8.7	0.18	79	6	67
	Combined repeated and lifetime	**6**	**10.4**	**0.12**	**111**	**51**	**45**
Acute	**Combined**	11	1.5	0.01	178	268	55
	Forestomach	3	0.076	0.01	1.9	32	16
	Harderian	2	0.48	0.06	0.8	20	0.0
	Kidney	2	1.6	0.17	7.1	18	78
	Leukemia	1	5.9	5.1	6.7	2	100
	Liver	5	8.1	0.10	40	70	77
	Lung	7	1.1	0.04	178	77	56
	Lymph	2	1.8	1.1	2.7	3	100
	Mammary (wk 5 vs wk 26)	1	7.1	NA	NA	1	100
	Mammary (wk 2 vs wk 5–8 or 26)	1	0.071	NA	NA	2	0
	Nerve	2	2.3	0.24	64	8	75
	Nerve (Day 1 comparison)	2	10	0.24	64	3	67
	Ovarian	1	0.033	0.01	0.13	3	0
	Reticular tissue	1	6.5	1.96	8.6	2	100
	Thymic lymphoma	1	2.8	1.01	7.9	6	100
	Thyroid	1	0.05	0.03	0.08	2	0
	Uterine/vaginal	1	1.6	0.03	8.6	3	67
	Day 1	7	1.7	0.01	178	127	55
	Day 15	3	1.5	0.06	52	74	65
Chemicals with nonmutagenic mode of action							
Repeated		6	2.2	0.06	13	22	27
Lifetime		5	3.4	0.15	36	38	21

Table 9. Excess Relative Risk (ERR) estimates for cancer incidence from Life Span Study (Japanese survivors)[a]

Site	Average ERR at 1 Sv	
	<20[b]	>20[b]
Stomach	0.74	0.24
Colon	0.62	0.7
Liver	1.3	0.31
Lung	0.57	1.1
Bone and connective tissue	11	0.42
Skin	5.4	0.39
Breast	3.3	0.98
Urinary bladder	0.71	0.79
Leukemia	6.1	3.7

[a] Information extracted from tables in UNSCEAR, Annex I (2000).
[b] Age at exposure.

Table 10. Excess Relative Risk (ERR) estimates for incidence of thyroid cancer from Life Span Study[a]

Age at exposure	Average ERR at 1 Sv (No. cases)
0–9 yr	10.25 (24)
10–19 yr	4.5 (35)
20–29 yr	0.10 (18)
>30 yr	0.04 (55)

[a] Information extracted from tables in UNSCEAR, Annex I (2000).

Table 11. Coefficients for the Revised Methodology mortality risk model (from U.S. EPA, 1999)[a]

Cancer type	Risk model type[b]	Age group				
		0–9	10–19	20–29	30–39	40+
Male:						
Stomach	R	1.223	1.972	2.044	0.3024	0.2745
Colon	R	2.290	2.290	0.2787	0.4395	0.08881
Liver	R	0.9877	0.9877	0.9877	0.9877	0.9877
Lung	R	0.4480	0.4480	0.0435	0.1315	0.1680
Bone	A	0.09387	0.09387	0.09387	0.09387	0.09387
Skin	A	0.06597	0.06597	0.06597	0.06597	0.06597
Breast	R	0.0	0.0	0.0	0.0	0.0
Ovary	R	0.0	0.0	0.0	0.0	0.0
Bladder	R	1.037	1.037	1.037	1.037	1.037
Kidney	R	0.2938	0.2938	0.2938	0.2938	0.2938
Thyroid	A	0.1667	0.1667	0.1667	0.1667	0.1667
Leukemia	R	982.3	311.3	416.6	264.4	143.6
Female:						
Stomach	R	3.581	4.585	4.552	0.6309	0.5424
Colon	R	3.265	3.265	0.6183	0.8921	0.1921
Liver	R	0.9877	0.9877	0.9877	0.9877	0.9877
Lung	R	1.359	1.359	0.1620	0.4396	0.6047
Bone	A	0.09387	0.09387	0.09387	0.09387	0.09387
Skin	A	0.06597	0.06597	0.06597	0.06597	0.06597
Breast	R	0.7000	0.7000	0.3000	0.3000	0.1000
Ovary	R	0.7185	0.7185	0.7185	0.7185	0.7185
Bladder	R	1.049	1.049	1.049	1.049	1.049
Kidney	R	0.2938	0.2938	0.2938	0.2938	0.2938
Thyroid	A	0.3333	0.3333	0.1667	0.1667	0.1667
Leukemia	R	1,176	284.9	370.06	178.8	157.1

[a] The coefficients were derived using several models applied to data from A-bomb survivors and selected medical exposures.

[b] A = absolute risk with coefficient units of 10^{-4} $(Gy\ y)^{-1}$; R= relative risk with coefficient units of Gy^{-1}.

REFERENCES

Anderson, LM; Diwan, BA; Fear, NT; et al. (2000) Critical windows of exposure for children's health: cancer in human epidemiological studies and neoplasms in experimental animal models. Environ Health Perspect 108(Suppl 3):573−594.

Barton, HA; Cogliano, VJ; Flowers, L; Valcovic, L; Setzer, RW; Woodruff, TJ. (2005). Assessing susceptibility from early-life exposure to carcinogens. Environ Health Perspect (in press).

Birch, JM; Blair, V; Kelsey, AM; et al. (1998) Cancer phenotype correlates with constitutional TP53 genotype in families with the Li-Fraumeni syndrome. Oncogene 17:1061−1068.

Birnbaum, LS; Fenton, SE. (2003) Cancer and developmental exposure to endocrine disruptors. Environ Health Perspect 111:389−394.

Bosland, MC. (1996) Hormonal factors in carcinogenesis of the prostate and testis in humans and in animal models. Prog Clin Biol Res 394:309−352.

Carlin, BP; Louis, TA. (2000). Bayes and empirical Bayes methods for data analysis: 2nd ed. Boca Raton, Fl: Chapman and Hall/CRC.

Carthew, P; Rich, KJ; Martin, EA; et al. (1995) DNA damage as assessed by ^{32}P-postlabelling in three rat strains exposed to dietary tamoxifen: the relationship between cell proliferation and liver tumor formation. Carcinogenesis 16:1299−1304.

Carthew, P; Edwards, RE; Nolan, BM; et al. (2000) Tamoxifen induces endometrial and vaginal cancer in rats in the absence of endometrial hyperplasia. Carcinogenesis 21:793−797.

Carthew, P; Edwards, RE; Nolan, BM; et al. (1996) Tamoxifen associated uterine pathology in rodents: relevance to women. Carcinogenesis 17:1577−1582.

Cattley, RC; Marsman, DS; Popp, JA. (1991) Age-related susceptibility to the carcinogenic effect of the peroxisome proliferator WY-14,643 in rat liver. Carcinogenesis 12:469−473.

Chhabra, RS; Eustis, S; Haseman, JK; et al. (1992) Comparative carcinogenicity of the ethylene thiourea with or without perinatal exposure in rats and mice. Fundam Appl Toxicol 18:405−417.

Chhabra, RS; Bucher, JR; Haseman, JK; et al. (1993a) Comparative carcinogenicity of polybrominated biphenyls with or without perinatal exposure in rats and mice. Fundam Appl Toxicol 21:451−460.

Chhabra, RS; Bucher, JR; Haseman, JK; et al. (1993b) Comparative carcinogenicity of 5,5-diphenylhydantoin with or without perinatal exposure in rats and mice. Fundam Appl Toxicol 21:174−186.

Chieco-Bianchi, L; De Benedictis, G; Tridente, G; et al. (1963) Influence of age on susceptibility to liver carcinogenesis and skin initiating action by urethane in Swiss mice. Br J Cancer 17:672−680.

Choudari Kommineni, VR; Greenblatt, M; Vesselinovitch, SD; et al. (1970) Urethan carcinogenesis in rats: importance of age and dose. J Natl Cancer Inst 45(4):687−696.

Cimino, MC. (2001) New OECD genetic toxicology guidelines and interpretation of results. In: Choy, WN, ed. Genetic toxicology and cancer risk assessment. New York, NY: Marcel Dekker, pp. 223−248.

Cohen, SM; Garland, EM; Cano, M; et al. (1995) Effects of sodium ascorbate, sodium saccharin and ammonium chloride on the male rat urinary bladder. Carcinogenesis 16(11):2743−2750.

Cohen, SM; Anderson, TA; de Oliveira, LM; et al. (1998) Tumorogenicity of sodium ascorbate in male rats. Cancer Res 58:2557−2561.

Covelli, V; Di, MV; Bassani, B; et al. (1984) Influence of age on life shortening and tumor induction after x-ray and neutron irradiation. Radiat Res 100:348−364.

Dearfield, KL; Auletta, AE; Cimino, MC; et al. (1991) Considerations in the U.S. Environmental Protection Agency's testing approach for mutagenicity. Mutat Res 258:259−283.

Dearfield, KL; McCarroll, NE; Protzel, A; et al. (1999) A survey of EPA/OPP and open literature on selected pesticide chemicals II. Mutagenicity and carcinogenicity of selected chloroacetanilides and related compounds. Mutat Res 443:183−221.

De Benedictis, G; Maiorano, G; Chieco-Bianchi, L., et al. (1962) Lung carcinogenesis by urethane in newborn, suckling, and adult Swiss mice. Br J Cancer 16:686−689.

Della Porta, G; Terracini, B. (1969) Chemical carcinogenesis in infant animals. Prog Exp Tumor Res 11:334−363.

Delongchamp, RR; Mabuchi, K; Yoshimoto,Y; et al. (1997) Cancer mortality among atomic bomb survivors exposed in utero or as young children: October 1950-May 1992. Radiat Res 147:385−395.

Di, MV; Coppola, M; Rebessi, S; et al. (1990) Age-related susceptibility of mouse liver to induction of tumors by neutrons. Radiat Res 124:227−234.

Diwan, BA; Kasprzak, KS; Rice, JM. (1992) Transplacental carcinogenic effects of nickel(II) acetate in the renal cortex, renal pelvis and adenohypophysis in F344/NCr rats. Carcinogenesis 13(8):1351−1357.

Diwan, BA; Riggs, CW; Logsdon, D; et al. (1999) Multiorgan transplacental and neonatal carcinogenicity of 3'azido-deoxythymidine in mice. Toxicol Appl Pharmacol 161:82−99.

Drew, RT; Boorman, GA; Haseman, JK; et al. (1983) The effect of age and exposure duration on cancer induction by a known carcinogen in rats, mice, and hamsters. Toxicol Appl Pharmacol 68:120−130.

Druckery, H. (1973) Chemical structure and action in transplacental carcinogenesis and teratogenesis. IARC Sci Pub 4:45−57.

Fenton, SE; Davis, CC. (2002) Atrazine exposure in utero increases dimethylbenz a anthracene-induced mammary tumor incidence in long evans offspring. Toxicol Sci 66(1−2):185. "The Toxicologist, Abstracts of the 41st Annual Meeting of the Society of Toxicology." (Abstract 903).

Fiore-Donati, L; De Benedictis, G; Chieco-Bianchi, L; et al. (1962) Leukaemogenic activity of Urethan in Swiss and AKR mice. Nature 190:134−139.

Flammang, TJ; Von Tungeln, LS; Kadlubar, FF; et al. (1997) Neonatal mouse assay for tumorigenicity: alternative to the chronic rodent bioassay. Regul Toxicol Pharmacol 26:230−240.

Fujii, K. (1991) Evaluations for the newborn mouse model for chemical tumorigenesis. Carcinogenesis 8:1409−1415.

Gass, GH; Coats, D; Graham, N. (1964) Carcinogenic dose-response curve to oral diethylstilbestrol. J Natl Cancer Inst 33:971−977.

Ginsberg, GL. (2003) Assessing cancer risks from short-term exposures in children. Risk Anal 23:19−34.

Ginsberg, G; Hattis, D; Sonawane, B; et al. (2002) Evaluation of child/adult pharmacokinetic differences from a database derived from the therapeutic drug literature. Toxicol Sci 66:185−200.

Goddard, MJ; Krewski, D. (1995) The future of mechanistic research in risk assessment: where are we going and can we get there from here? Toxicology 102:53−70.

Greenman, DL; Highman, B; Chen, J; et al. (1990) Estrogen-induced thyroid follicular cell adenomas in C57Bl/6 mice. J Toxicol Environ Health 29:269−278.

Grufferman, S. (1998) Methodologic approaches to studying environmental factors in childhood cancer. Environ Health Perspect 106(Suppl 3):881−886.

Hale, GA; Marina, NM; Johnes-Wallace, D; et al. (1999) Late effects of treatment for germ cell tumors during childhood and adolescence. J Pediatr Hematol Oncol 21:115−122.

Halmes, NC; Roberts, SM; Tolson, JK; et al. (2000) Reevaluating cancer risk estimates for short-term exposure scenarios. Toxicol Sci 58:32−42.

Hard, GC. (1979) Effect of age at treatment on incidence and type of renal neoplasm induced in the rat by a single dose of dimethylnitrosamine. Cancer Res 39:4965−4970.

Hartis, D; Goble, R; and Chu, M. (2005) Age-related differences in susceptibility to carcinogenesis II. Approaches for application and uncertainty analyses for individual genetically acting carcinogens. Environ Health Perspect 113:509-516..

Hatch, EE; Palmer, JR; Titus-Ernstoff, L; et al. (1998) Cancer risk in women exposed to diethylstilbestrol in utero. JAMA 280:630−634.

Hayashi, M; MacGregor, JT; Gatehouse, DG; et al. (2000) In vivo rodent erythrocyte micronucleus assay II. Some aspects of protocol design including repeated treatments, integration with toxicity testing, and automated scoring. Environ Mol Mutagen 35:234−252.

Holladay SD, Smialowicz RJ. 2000. Development of the murine and human immune system: differential effects of immunotoxicants depend on time of exposure. Environ Health Perspect 108 Suppl 3:463-473.

Holsapple MP, West LJ, Landreth KS. 2003. Species comparison of anatomical and functional immune system development. Birth Defects Res B Dev Reprod Toxicol 68(4):321-334.

Israel, MA. (1995) Molecular biology of childhood neoplasms. In: Mendelsohn, J; Howley, PM; Israel, MA; et al.; eds. The molecular basis of cancer. Saunders; Philadelphia, PA: pp. 294−316.

Jurgelski, Jr, W; Hudson, P; Falk, HL. (1979) Tissue differentiation and susceptibility to embryonal tumor induction by ethylnitrosourea in the opossum. NCI Monograph 51: 123−158.

Kaye, AM; Trainin, N. (1966) Urethan carcinogenesis and nucleic acid metabolism: Factors influencing lung adenoma induction. Cancer Res 26:2206−2212.

Klein, M. (1959) Development of hepatomas in inbred albino mice following treatment with 20-Methylcholanthrene. Cancer Res 19:1109−1113.

Klein, M. (1966) Influence of age on induction with urethan of hepatomas and other tumors in infant mice. J Natl Cancer Inst 36(6):1111−1120.

Kraupp-Grasl, B; Huber, W; Taper, H; et al. (1991) Increased susceptibility of aged rats to hepatocarcinogenesis by the peroxisome proliferator nafenopin and the possible involvement of altered liver foci occurring spontaneously. Cancer Res 51:666−671.

Kushner, BH; Heller, G; Cheung, NK; et al. (1998) High risk of leukemia after short-term dose-intensive chemotherapy in young patients with solid tumors. J Clin Oncol 16:3016−3020.

Laib, RJ; Bolt, HM; Cartier, R; et al. (1989) Increased alkylation of liver DNA and cell turnover in young versus old rats exposed to vinyl chloride correlates with cancer susceptibility. Toxicol Lett 45:231−239.

Larson, RA; LeBeau, MM; Vardiman, JW; et al. (1996) Myeloid leukemia after hematotoxins. Environ Health Perspect 104(Suppl 6):1303−1307.

Laurenzana, EM; Weis, CC; Bryant, CW; et al. (2002) Effect of dietary administration of genistein, nonylphenol or ethinyl estradiol on hepatic testosterone metabolism, cytochrome P-450 enzymes, and estrogen receptor alpha expression. Food Chem Toxicol 40:53−63.

Law, LW. (1940) The production of tumors by injection of a carcinogen into the amniotic fluid of mice. Science 91:96−97.

Liebelt, RA; Leibelt, AG; Lane, M. (1964) Hormonal influences on urethan carcinogenesis in C3H/f mice. Cancer Res 24:1869−1879.

Lindahl, T; Klein, G; Reedman, BM; et al. (1974) Relationship between Epstein-Barr virus (EBV) DNA and the EBV-determined nuclear antigen (EBNA) in Burkitt lymphoma biopsies and other lymphoproliferative malignancies. Int J Cancer 13:764-772.

Maekawa, A; Mitsumori, K. (1990) Spontaneous occurrence and chemical induction of neurogenic tumors in rats−influence of host factors and specificity of chemical structure. Crit Rev Toxicol 20(4):287−310.

Mahoney, FJ. (1999) Update on diagnosis, management, and prevention of hepatitis B virus infection. Clin Microbiol Rev 12:351−366.

Maltoni, C; Lefemine, G; Ciliberti, A; et al. (1981) Carcinogenicity bioassays of vinyl chloride monomer: a model of risk assessment on an experimental basis. Environ Health Perspect 41:3−29.

Maltoni, C; Lefemine, G; Ciliberti, A; et al. (1984) Experimental research on vinyl chloride carcinogenesis. In: Maltoni, C; Mehlaman, MA; eds. Archives of Research on Industrial Carcinogenesis. Vol. II. Princeton, NJ: Princeton Scientific Publishing.

McCarroll, NE; Protzel, A; Ioannou, Y; et al. (2002) A survey of EPA/OPP and open literature on selected pesticide chemicals. III. Mutagenicity and carcinogenicity of benomyl and carbendazim. Mutat Res 512:1−35.

McClain, R; Keller, D; Casciano, D; et al. (2001) Neonatal mouse model: review of methods and results. Toxicol Pathol 29(Suppl):128−137.

McConnell, EE. (1992) Comparative response in carcinogenesis bioassay as a function of age at first exposure. In: Guzelian, P; Henry, CJ; Olin, SS; eds. Similarities and difference between children and adults: implications for risk assessment. Washington, DC: ILSI Press; pp. 66−78.

McCurdy, T; Glen, G; Smith, L; et al. (2000) The National Exposure Research Laboratory's consolidated human activity database. J Expo Anal Environ Epidemiol 10:566−578.

Meranze, DR; Gruenstein, M; Shimkin, MB. (1969) Effect of age and sex on the development of neoplasms in Wistar rats receiving a single intragastric instillation of 7,12-dimethylbenz(a)anthracene. Int J Cancer 4:480−486.

Miller, MD; Marty, MA; Arcus, A; et al. (2002) Differences between children and adults: implications for risk assessment at California EPA. Int J Toxicol 21:403−418.

Morinello, EJ; Ham, AJL; Ranasinghe, A; et al. (2002a) Molecular dosimetry and repair of N2,3-ethenoguanine in rats exposed to vinyl chloride. Cancer Res 62:5189−5195.

Morinello, EJ; Koc, H; Ranasinghe, A; et al. (2002b) Differential induction of N(2),3-ethenoguanine in rat brain and liver after exposure to vinyl chloride. Cancer Res 62(18):5183−5188.

Murdoch, DJ; Krewski, D; Wargo, J. (1992) Cancer risk assessment with intermittent exposure. Risk Anal 12:569−577.

Naito, M.; Naito, Y; Ito, A. (1981) Effect of age at treatment on the incidence and location of neurogenic tumors induced in Wistar rats by a single dose of N-ethyl-N-nitrosourea. Gann 72(4):569−577.

Newbold, RR; Bullock, BC; McLachlan, JA. (1990) Uterine adenocarcinoma in mice following developmental treatment with estrogens: a model for hormonal carcinogenesis. Cancer Res 50:7677−7681.

Newbold, RR; Jefferson, WN; Padilla-Burgos, E; et al. (1997) Uterine carcinoma in mice treated neonatally with tamoxifen. Carcinogenesis 18:2293−2298.

Newbold, RR; Hanson, RB; Jefferson, WN; et al. (1998) Increased tumors but uncompromised fertility in the female descendants of mice exposed developmentally to diethylstilbestrol. Carcinogenesis 19:1655−1663.

Newbold, RR; Banks, EP; Bullock, B; et al. (2001) Uterine adenocarcinoma in mice treated neonatally with genistein. Cancer Res 61:4325−4328.

NRC (National Research Council). (1990) Health effects of exposure to low levels of ionizing radiation. Beir V. Committee on the Biological Effects of Ionizing Radiation. Washington, DC: National Academy Press. Available online at http://www.nap.edu/catalog/1224.html?se_side.

NRC (National Research Council). (1993). Pesticides in the diets of infants and children. Committee on Pesticides in the Diets of Infants and Children. Commission on Life Sciences. Washington, DC: National Academy Press. Available online at http://www.nap.edu/catalog/2126.html?se_side.

NRC (National Research Council). (1994). Science and judgment in risk assessment. Committee on Risk Assessment of Hazardous Air Pollutants. Commission on Life Sciences. Washington, DC: National Academy Press. Available online at http://www.nap.edu/catalog/2125.html.

NTP (National Toxicology Program). (1983) Carcinogenesis bioassay of L-ascorbic acid (Vitamin C) (CAS No. 50-81-7) in F344/N rats and B6C3F1 mice (feed study). Research Triangle Park, NC: National Toxicology Program; TR−247.

NTP (National Toxicology Program). (1999) Toxicology and carcinogenesis studies of AZT and AZT/gamma-interferon in $B6C3F_1$ mice (gavage studies). Research Triangle Park, NC: National Toxicology Program; TR−469.

Nyandoto, P; Muhonen, T; Joensuu, H. (1998) Second cancer among long-term survivors from Hodgkin's disease. Int J Radiat Oncol Biol Phys 42:373−378.

OECD (Organization for Economic Cooperation and Development). (1998) OECD guidelines for the testing of chemicals. Paris, France: Organization for Economic Cooperation and Development.

Paulsen, JE; Steffensen, IL; et al. (2003) Age-dependent susceptibility to azoxymethane-induced and spontaneous tumorigenesis in the *Min*/ + mouse. Anticancer Res 23:259−265.

Peto, R; Gray, R; Brantom, P; et al. (1984) Nitrosamine carcinogenesis in 5120 rodents: chronic administration of sixteen different concentrations of NDEA, NDMA, NPYR and NPIP in the water of 4440 inbred rats, with parallel studies on NDEA alone of the effect of age of starting (3,6, or 20 weeks) and of species (rats, mice, or hamsters). Lyon, France: IARC Sci Publ; publication no. 57:627−665.

Pietra, G; Rappaport, H; Shubik, P. (1961) The effects of carcinogenic chemicals in newborn mice. Cancer 14:308−317.

Preston, DL; Pierce, DA; Shimizu, Y. (2000) Age-time patterns for cancer and noncancer excess risks in the atomic bomb survivors. Radiat Res 154:733−734.

R Development Core Team (2003). R: a language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing; ISBN 3-900051-00-3. Available online at http://www.R−project.org.

Renwick, AG. (1998) Toxicokinetics in infants and children in relation to the ADI and TDI. Food Addit Contam 15:S17−S35.

Rice, JM; Ward, JM. (1982) Age dependence of susceptibility to carcinogenesis. Ann NY Acad Sci 381:274−289.

Ries, LA; Kosary, CL; Hanke, BF; et al. (eds.) (1999). SEER Cancer Statistics Review 1993-1998. Bethesda, MD: National Cancer Institute.

Robboy, SJ; Noller, KL; O'Brien, P; et al. (1984) Increased incidence of cervical and vaginal dysplasia in 3,980 diethylstilbestrol-exposed young women: experience of the National Collaborative Diethylstilbestrol Adenosis Project. JAMA 252:2979−2983.

Rogers, S. (1951) Age of the host and other factors affecting the production with urethane of pulmonary adenomas in mice. J Exp Med 93:426−449.

Russo, J; Wilgus, G; Russo, IH. (1979) Susceptibility of the mammary gland to carcinogenesis: I Differentiation of the mammary gland as determinant of tumor incidence and type of lesion. Am J Pathol 96(3):721−736.

Sasaki, S; Kasuga, T; Sato, F; et al. (1978) Induction of hepatocellular tumor by x-ray irradiation at perinatal stage of mice. Gann 69:451−452.

Scheuplein, R; Charnley, G; Dourson, M. (2002) Differential sensitivity of children and adults to chemical toxicity. I: biological basis. Regul Toxicol Pharmacol 35:429−447.

Silberstein, GB. (2001) Tumour-stromal interactions: role of the stroma in mammary development. Breast Cancer Res 3:218−223.

Slikker W, 3rd, Mei N, Chen T. 2004. N-ethyl-N-nitrosourea (ENU) increased brain mutations in prenatal and neonatal mice but not in the adults. Toxicol Sci 81(1):112-120.

Terracini, B; Testa, M. (1970) Carcinogenicity of a single administration of N-nitrosomethylurea: a comparison of newborn and 5-week-old mice and rats. Br J Cancer 24(3):588−598.

Terracini, B; Testa, MC; Cabral, JR; et al. (1976) The roles of age at treatment and dose in carcinogenesis in C3Hf/Dp mice with a single administration of N-nitroso-N-methylurea. Br J Cancer 33(4):427−439.

Thompson, DE; Mabuchi, K; Ron, E; et al. (1994) Cancer incidence in atomic bomb survivors, Part II: solid tumors, 1958-1987. Radiat Res 137:S17−S67.

Tomlinson, IP; Hampson, R; Karran, P; et al. (1997) DNA mismatch repair in lymphoblastoid cells from hereditary non-polyposis colorectal cancer (HNPCC) patients is normal under conditions of rapid cell division and increased mutational load. Mutat Res 383:177−182.

Toth, B. (1968) A critical review of experiments in chemical carcinogenesis using newborn animals. Cancer Research 28:727−738.

U.S. Cancer Statistics Working Group. (2002) United States cancer statistics: 1999 incidence. Atlanta, GA: Department of Health and Human Services, Centers for Disease Control and Prevention and National Cancer Institute. Available online at http://www.cdc.gov/cancer/npcr/uscs/.

U.S. EPA (Environmental Protection Agency). (1986) Guidelines for mutagenicity risk assessment. Federal Register 51:34006−34012. Available online at http://cfpub.epa.gov/ncea/raf/recordisplay.cfm?deid=55907.

U.S. EPA (Environmental Protection Agency). (1991) Pesticide assessment guidelines, subdivision F, hazard evaluation: human and domestic animals, series 84, mutagenicity, addendum 9. Office of Pesticides and Toxic Substances, Washington, DC; EPA-540/09- 91-122. Available from: National Technical Information Service, Springfield, VA PB91-158394.

U.S. EPA (Environmental Protection Agency). (1994) Estimating radiogenic cancer risks. Washington, DC; EPA/ 402/R-93/076. Available online at http://www.epa.gov/radiation/docs/rad−risk.pdf.

U.S. EPA (Environmental Protection Agency). (1996) Comparison of the effects of chemicals with combined perinatal and adult exposure vs adult only exposure in carcinogenesis bioassays. Office of Pesticide Programs, Washington, DC. Available online at http://www.epa.gov/scipoly/sap/1996/index.htm.

U.S. EPA (Environmental Protection Agency). (1999) Cancer risk coefficients for environmental exposure to radionuclides. Federal Guidance Report No. 13. Washington, DC; EPA/402-R-99-001. Available online at http://www.epa.gov/radiation/assessment/pubs.html.

U.S. EPA (Environmental Protection Agency). (2000a) Atrazine health assessment: Part B: Hazard assessment and review of available studies. Office of Pollution, Pesticides, and Toxic Substandes, Washington, DC. Available online at http://www.epa.gov/scipoly/sap/2000/june27/finalpartb_atz.pdf.

U.S. EPA (Environmental Protection Agency). (2000b) Toxicological review of vinyl chloride. Integrated Risk Information System (IRIS), National Center for Environmental Assessment, Washington, DC; EPA/635/R-00/004. Available online at http://www.epa.gov/iris/toxreviews/1001-tr.pdf.

U.S. EPA (Environmental Protection Agency). (2000c) Risk information for vinyl chloride. Integrated Risk Information System (IRIS), National Center for Environmental Assessment, Washington, DC. Available online at http://www.epa.gov/iris/subst/1001.htm.

U.S. EPA (Environmental Protection Agency). (2002a) Child-specific exposure factors handbook. National Center for Environmental Assessment, Washington, DC; EPA/600/P-00/002B. Available from National Technical Information Service, Springfield, VA, and online at http://www.epa.gov/ncea.

U.S. EPA (Environmental Protection Agency). (2002b) OPPTS harmonized test guidelines, series 870 health effects test guidelines. Office of Pollution, Pesticides and Toxic Substances, Washington, DC. Available online at http://www.epa.gov/opptsfrs/OPPTS.

U.S. EPA (Environmental Protection Agency). (2004) Guidelines for carcinogen risk assessment. Risk Assessment Forum, National Center for Environmental Assessment, Washington, DC. Available online at http://cfpub.epa.gov/ncea/raf/recordisplay.cfm?deid=55907.

UNSCEAR (United Nations Scientific Committee on the Effects of Atomic Radiation (2000). Sources and effects of ionizing radiation. 2000 Report to the General Assembly, with scientific annexes. New York, NY: United Nations Scientific Committee on the Effects of Atomic Radiation. Available online at http://www.unscear.org/reports/2000_1.html.

Vesselinovitch, SD. (1983) Perinatal hepatocarcinogenesis. Biol Res Pregnancy Perinatol 4(1):22−25.

Vesselinovitch, S. D; Mihailovich, N. (1983) Kinetics of diethylnitrosamine hepatocarcinogenesis in the infant mouse. Cancer Res 43:4253−4259.

Vesselinovitch, SD; Rao, KV; Mihailovich, N; et al. (1974) Development of broad spectrum of tumors by ethylnitrosourea in mice and the modifying role of age, sex, and strain. Cancer Res 34(10):2530−2538.

Vesselinovitch, SD; Kyriazis, AP; Milailovich, N; et al. (1975a) Conditions modifying development of tumors in mice at various sites by benzo(a)pyrene. Cancer Res 35:2948−2953.

Vesselinovitch, SD; Rao, KV; Mihailovich, N. (1975b) Factors modulating benzidine carcinogenicity bioassay. Cancer Res 35(10):2814−2819.

Vesselinovitch, SD; Rao, KV; Mihailovich, N. (1979) Neoplastic response of mouse tissues during perinatal age periods and its significance in chemical carcinogenesis. NCI Mongraph 51:239−250.

Vesselinovitch, SD; Rao, KV; Mihailovich, N. (1979a) Neoplastic response of mouse tissues during perinatal age periods. NCI Mongraph 51:239−250.

Vesselinovitch, SD; Rao, KV; Mihailovich, N. (1979b) Transplacental and lactational carcinogenesis by safrole. Cancer Res 39(11):4378−4380.

Vesselinovitch, SD; Koka, M; Mihailovich, N; et al. (1984) Carcinogenicity of diethylnitrosamine in newborn, infant, and adult mice. J Cancer Res Clin Oncol 108:60−65.

Vessey, MP. (1989) Epidemiological studies of the effects of diethylstilboestrol. Lyon, France: IARC Sci Publ; publication No 96, pp. 335−348.

Waalkes, MP; Ward, JM; Diwan, BA. (2003) Transplacental carcinogenicity of inorganic arsenic in the drinking water: induction of hepatic, ovarian, pulmonary, and adrenal tumors in mice. Toxicol Appl Pharmacol 186:7−17.

Walters, MA. (1966) The induction of lung tumours by the injection of 9,10-dimethyl-1,2-benzanthracene (DMBA) into newborn suckling and young adult mice. A dose response study. Br J Cancer 20(1):148−160.

Waters, MD; Stack, HF; Jackson, MA. (1999) Short-term tests for defining mutagenic carcinogens. In: McGregor, DB; Rice, JM; Venitt, S; eds. The use of short term tests for carcinogens and data on genetic effects in carcinogenic hazard evaluation. Lyon, France: International Agency for Research on Cancer. Publ. No. 146, pp. 499−536.

Whysner, J; Williams, GM. (1996) Saccharin mechanistic data and risk assessment: urine composition, enhanced cell proliferation, and tumor promotion. Pharmacol Ther 71:225−252.

Zartarian, VG; Özkaynak, H; Burke, JM; et al. (2000) A modeling framework for estimating children's residential exposure and dose to chlorpyrifos via dermal residue contact and non-dietary ingestion. Environ Health Perspect 108:505−514.

Exhibit E

EPA-540-R-070-002
OSWER 9285.7-82
January 2009

Risk Assessment Guidance for Superfund
Volume I: Human Health Evaluation Manual
(Part F, Supplemental Guidance for Inhalation Risk Assessment)

Final

Office of Superfund Remediation and Technology Innovation
Environmental Protection Agency
Washington, D.C.



140530

REC 6397

TABLE OF CONTENTS

1. INTRODUCTION 1
1.1 Background 1
1.2 Purpose and Scope 2
1.3 Effects on Other Office of Superfund Remediation and Technology Innovation Guidance 3

2. BACKGROUND ON DERIVATION OF INHALATION TOXICITY VALUES 4
2.1 Application of Inhalation Dosimetry 4
2.1.1 Default Approach - Extrapolation from Experimental Animal Data 5
2.1.2 Default Approach - Extrapolation from Human Occupational Data 9
2.2 Derivation of the Inhalation Unit Risk 10
2.3 Derivation of the Reference Concentration 10

3. CHARACTERIZING EXPOSURE 13
3.1 Introduction 13
3.2 Estimating Exposure Concentrations for Assessing Cancer Risks 13
3.3 Estimating Exposure Concentrations for Calculating Hazard Quotients 14
3.3.1 Step 1: Assess Duration 14
3.3.2 Step 2: Assess Exposure Pattern 15
3.3.3 Step 3: Estimate Exposure Concentration 17
3.4 Estimating Exposure Concentrations in Multiple Microenvironments 18
3.4.1 Using Microenvironments to Estimate an Average Exposure Concentration for a Specific Exposure Period 18
3.4.2 Estimating an Average Exposure Concentration Across Multiple Exposure Periods 19

4. SELECTING APPROPRIATE TOXICITY VALUES 20
4.1 Sources for Inhalation Toxicity Data 20
4.2 Recommended Procedure for Assessing Risk in the Absence of Inhalation Toxicity Values 21

5. ESTIMATING RISKS 22
5.1 Cancer Risks Characterized by an Inhalation Unit Risk 22
5.2 Hazard Quotients 24

6. EXAMPLE EXPOSURE SCENARIOS 24
6.1 Residential Receptor 24
6.2 Commercial-Industrial/Occupational Receptor 25
6.3 Construction Worker 25
6.4 Trespasser/Recreational Receptor 25

7. TARGET CONCENTRATIONS FOR SCREENING ANALYSIS OF INHALATION PATHWAYS 26
7.1 Target Contaminant Concentrations in Air 26
7.2 Screening Levels for Other Media 26
7.2.1 Soil Screening Levels 27
7.2.2 Tap Water Screening Levels 28
7.2.3 Soil Gas or Ground Water Screening Values for Vapor Intrusion 28

8. DEVELOPING AGGREGATE AND CUMULATIVE RISK ESTIMATES 28
8.1 Estimating Cumulative Risk and Hazards Across Multiple Chemicals 28
8.1.1 Cancer Risks 29
8.1.2 Hazard Quotients 29
8.2 Aggregating Risk and Hazard Quotients Across Exposure Routes 29

9. RISK CHARACTERIZATION 30
9.1 Highly Exposed or Susceptible Populations and Life Stages 30
9.1.1 Children 30
9.1.2 Workers 31
9.2 Uncertainties in Inhalation Risk Assessment 31
9.2.1 Development of Exposure Concentrations 32
9.2.2 Toxicity Assessment 32
9.2.3 Estimating Cancer Risks 33
9.2.4 Estimating Risk and Hazard from Multiple Chemicals and Exposure Pathways 33

10. REFERENCES 34

APPENDIX A A-1

APPENDIX B B-1

APPENDIX C C-1

LIST OF TABLES

Table 1: RAGS Part A Equation Describing the Estimation of Inhalation Exposure 2

Table 2: Contaminant Properties and Dosimetric Adjustment Factors 7

Table 3: The Use of Uncertainty Factors in Deriving an Inhalation Reference Concentration 12

Table 4: Recommended Procedure for Calculating Risk-Based Screening Concentrations for Contaminants in Air 27

LIST OF FIGURES

Figure 1: Human Respiratory Tract 8

Figure 2: Recommended Procedure for Deriving Exposure Concentrations and Hazard Quotients for Inhalation Exposure Scenarios 16

Figure 3: Guidance on Assessing Risk from Early-Life Exposures for Chemicals Acting by a Mutagenic Mode of Action for Carcinogenicity 23

LIST OF EQUATIONS

Equation 1: $NOAEL_{[ADJ]}$ 5

Equation 2: $NOAEL_{[HEC]}$ from Animal Data 6

Equation 3: $NOAEL_{[HEC]}$ from Human Data 10

Equation 4: Inhalation Unit Risk 10

Equation 5: Reference Concentration 11

Equation 6: Exposure Concentration for Assessing Cancer Risks 14

Equation 7: Exposure Concentration for Acute Exposure Scenarios 17

Equation 8: Exposure Concentration Chronic for Subchronic Exposure Scenarios 18

Equation 9: Exposure Concentration for a Specific Exposure Period, Microenvironments 19

LIST OF EQUATIONS (CONT.)

Equation 10: Exposure Concentration Across Multiple Exposure Periods, Microenvironments 19

Equation 11: Cancer Risk 22

Equation 12: Hazard Quotient 24

ACKNOWLEDGEMENTS

This guidance was developed by the Inhalation Risk Workgroup, which included regional and headquarters staff in EPA's Office of Superfund Remediation and Technology Innovation (OSRTI), the Office of Research and Development (ORD), the Office of Children's Health Protection (OCHP), The Office of Air and Radiation (OAR), and the Office of Solid Waste and Emergency Response (OSWER). Dave Crawford of OSRTI headquarters and Michael Sivak of EPA Region 2 provided project management and technical coordination of its development.

OSRTI would like to acknowledge the efforts of all the Inhalation Risk Workgroup members who supported the development of the guidance by providing technical input regarding its content and scope:

Marcia Bailey, Region 10
Bob Benson, Region 8
Dave Crawford, OSWER/OSRTI
Arunas Draugelis, Region 5
Brenda Foos, OCHP
Gary Foureman, ORD/NCEA
Susan Griffin, Region 8
Ofia Hodoh, Region 4
Jennifer Hubbard, Region 3
Ann Johnson, OA/OPEI
Jeremy Johnson, Region 7
Kevin Koporec, Region 4
Sarah Levinson, Region 1
Deirdre Murphy, OAR/OAQPS
Henry Schuver, OSWER/OSW
Michael Sivak, Region 2
John Stanek, ORD/NCEA
Daniel Stralka, Region 9
Timothy Taylor, OSWER/OSW
John Whalan, ORD/NCEA
Erik Winchester, ORD/OSP

Former Members:
Cheryl Overstreet, Region 6
Neil Stiber, ORD/OSP

OSRTI would also like to acknowledge the efforts of the external peer review panel members who provided input on the draft version of the document:

Sandra Baird, Massachusetts Department of Environmental Protection
Selene Chou, Agency for Toxic Substances and Disease Registry
Lynne Haber, Toxicology Excellence for Risk Assessment
Anita Meyer, US Army Corps of Engineers
Peter Valberg, Gradient Corporation

Henry Roman, Eric Ruder, and Tyra Walsh of Industrial Economics, Incorporated in Cambridge, MA provided technical assistance to EPA in the development of this guidance under Contract Number 68-W-01-05.

LIST OF ACRONYMS

µg	Microgram
µm	Micrometer
ADAF	Age Dependent Adjustment Factor
AT	Averaging Time
ATSDR	Agency for Toxic Substances and Disease Registry
BMCL	Benchmark Concentration, Lower confidence limit
BMD	Benchmark Dose
BW	Body Weight
CA	Contaminant Concentration in Air
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CSF	Cancer Slope Factor
DAF	Dosimetric Adjustment Factor
ED	Exposure Duration
EC	Exposure Concentration
EF	Exposure Frequency
EPA	Environmental Protection Agency
ER	Extra-respiratory
ET	Exposure Time
ETh	Extrathoracic
F_r	Fractional Deposition in region r
F_{total}	Total particle deposition in respiratory tract
$H_{b/g\text{-}animal}$	Animal Blood:Gas Partition Coefficient
$H_{b/g\text{-}human}$	Human Blood:Gas Partition Coefficient
HEAST	Health Effects Assessment Summary Table
HEC	Human Equivalent Concentration
HI	Hazard Index
HQ	Hazard Quotient
ICRP	International Commission for Radiological Protection
IR	Inhalation Rate
IRIS	Integrated Risk Information System
IUR	Inhalation Unit Risk
kg	Kilogram
LEC_{10}	Lower limit on Effective Concentration, using a 10 percent response level
LOAEL	Lowest Observable Adverse Effect Level
ME	Microenvironment
MF	Modifying Factor
mg	Milligram
MOA	Mode of Action
MRL	Minimal Risk Level
MW	Molecular Weight
NCEA	National Center for Environmental Assessment
NOAEL	No Observable Adverse Effect Level
ORD	Office of Research and Development
OSRTI	Office of Superfund Remediation and Technology Innovation

LIST OF ACRONYMS (CONT.)

OSWER	Office of Solid Waste and Emergency Response
PBPK	Physiologically Based Pharmacokinetic
POD	Point of Departure
ppm	Parts Per Million
PPRTV	Provisional Peer Reviewed Toxicity Value
PRG	Preliminary Remediation Goal
PU	Pulmonary
Q-alv	Alveolar ventilation rate
QSAR	Quantitative Structure-Activity Relationship
RAGS	Risk Assessment Guidance for Superfund
RBC	Risk-Based Concentration
RfC	Reference Concentration
RfD	Reference Dose
RGDR	Regional Gas Dose Ratio
RDDR	Regional Deposited Dose Ratio
RME	Reasonable Maximum Exposure
SA	Surface Area
SSL	Soil Screening Level
STSC	Superfund Health Risk Technical Support Center
TB	Tracheobronchial
TOT	Total Respiratory System
UF	Uncertainty Factor
V_e	Minute Volume

1. INTRODUCTION

The Environmental Protection Agency's (EPA's) Superfund Program has updated its approach for determining risk from inhaled chemicals to be consistent with the inhalation dosimetry methodology described in *Methods for Derivation of Inhalation Reference Concentrations and Application of Inhalation Dosimetry* (USEPA, 1994; hereafter, the *Inhalation Dosimetry Methodology*).[1] This document provides Superfund site risk assessors with guidance that should help more consistently address the *Inhalation Dosimetry Methodology*.

This document outlines recommended processes consisting of a series of steps as well as recommended equations for EPA Regions to consider when estimating inhalation exposure and risk at Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites. This guidance is intended to provide a recommended methodology for consistently addressing the inhalation pathway in risk assessments for Superfund sites.

Some of the statutory provisions described in this document contain legally binding requirements. However, this document does not substitute for those provisions or regulations, nor is it a regulation itself. Thus, it cannot impose legally binding requirements on EPA, States, or the regulated community, and may not apply to a particular situation based upon the circumstances. Any decisions regarding a particular remedy selection decision will be made based on the statute and regulations, and EPA decisionmakers retain the discretion to adopt approaches on a case-by-case basis that differ from this guidance where appropriate. EPA may change this guidance in the future.

1.1 Background

EPA's *Risk Assessment Guidance for Superfund (RAGS), Part A* (USEPA, 1989; hereafter, *RAGS, Part A*) outlined a previously recommended approach for conducting site-specific baseline risk assessments for inhaled contaminants.[2] According to the original RAGS approach, the inhalation exposure estimate was typically derived in terms of a chronic, daily "air intake" (mg/kg-day) using the following general approach. The intake of the chemical was estimated as a function of the concentration of the chemical in air (CA), inhalation rate (IR), body weight (BW), and the exposure scenario. Age-specific values for BW and IR were used when evaluating childhood exposures. Table 1 presents the *RAGS, Part A* equation for calculating intake for inhalation exposure. Inhalation toxicity values were "converted" into similar units for the risk quantification step. Cancer risk was estimated by multiplying the chronic daily intake of the chemical from the air by the "inhalation cancer slope factor" (CSF_i); the Hazard Quotient (HQ) for non-cancer effects was estimated by dividing the intake of the chemical by an "inhalation reference dose" (RfD_i).[3]

The approach outlined in *RAGS, Part A* was developed before EPA issued the *Inhalation Dosimetry Methodology*, which describes the Agency's refined recommended approach for interpreting

[1] The *Inhalation Dosimetry Methodology* can be found at the following web address: http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=71993.

[2] See sections 6.6.3, 7.2.3, 7.3.3, and 8.2 of *RAGS, Part A*.

[3] EPA defines an HQ in *RAGS, Part A* as: "The ratio of a single substance exposure level over a specified time period (e.g., subchronic) to a reference dose (RfD) for that substance derived from a similar exposure period" (USEPA, 1989).

inhalation toxicity studies in laboratory animals or studies of occupational exposures of humans to airborne chemicals. Under the *Inhalation Dosimetry Methodology*, the experimental exposures are typically extrapolated to a Human Equivalent Concentration (HEC), and a reference concentration (RfC) is typically calculated by dividing the HEC by uncertainty factors (UFs). As described in the Agency's *Guidelines for Cancer Risk Assessment* (USEPA, 2005a), the HEC developed in accordance with the *Inhalation Dosimetry Methodology* typically is also used in developing an inhalation unit risk (IUR) for cancer risk assessment (which may also be called an inhalation cancer slope factor).[4] The procedure that was used to calculate the published RfC or IUR is described in the Integrated Risk Information System (IRIS) profile or other toxicological reference document for a chemical.

TABLE 1
RAGS, PART A EQUATION DESCRIBING THE ESTIMATION OF INHALATION EXPOSURE

Equation	Location in RAGS, Part A
Intake (mg/kg-d) = CA x (IR/BW) x (ET x EF x ED)/AT	Exhibit 6-16, Page 6-44
Key: CA (mg/m^3) = contaminant concentration in air; IR (m^3/hr) = inhalation rate; BW (kg) = body weight; ET (hours/day) = exposure time; EF (days/year) = exposure frequency; ED (years) = exposure duration; and AT (days) = averaging time (period over which exposure is averaged).	

The Superfund Program has updated its inhalation risk paradigm to be compatible with the *Inhalation Dosimetry Methodology*, which represents the Agency's current methodology for inhalation dosimetry and derivation of inhalation toxicity values.[5] This document recommends that when estimating risk via inhalation, risk assessors should use the concentration of the chemical in air as the exposure metric (e.g., mg/m^3), rather than inhalation intake of a contaminant in air based on IR and BW (e.g., mg/kg-day).

1.2 Purpose and Scope

The intake equation described above (*RAGS, Part A*, Exhibit 6-16) is not consistent with the principles of EPA's *Inhalation Dosimetry Methodology* because the amount of the chemical that reaches the target site is not a simple function of IR and BW. Instead, the interaction of the inhaled contaminant with the respiratory tract is affected by factors such as species-specific relationships of exposure concentrations (ECs) to deposited/delivered doses and physiochemical characteristics of the inhaled contaminant. The *Inhalation Dosimetry Methodology* also considers the target site where the toxic effect occurs (e.g., the respiratory tract or a location in the body remote from the portal-of-entry) when applying dosimetric adjustments to experimental concentrations (USEPA, 1994). Therefore, this *RAGS, Part A* equation is not recommended for estimating exposures to inhaled contaminants.

[4] The phrase "inhalation cancer slope factor," as used in this guidance, refers generally to the risk per a measure of inhalation exposure. Inhalation exposure in cancer bioassays or occupational studies from which slope factors may be derived is most commonly expressed as an exposure concentration (e.g., µg agent/m^3 air). Please note that this differs from past use of the phrase "inhalation cancer slope factor" or "CSF_i" by the Superfund program to refer to a cancer slope expressed as an "inhalation intake" (e.g., *RAGS, Part A* (USEPA, 1989)).

[5] For additional information about the Superfund program's adoption of the *Inhalation Dosimetry Methodology*, please refer to the summary of a 2003 Superfund workshop on inhalation risk assessment: http://www.epa.gov/oswer/riskassessment/pdf/finalinhalationriskworkshop.pdf.

The purpose of this document is to provide a recommended approach for developing the information necessary to assist risk assessment and risk management decision-making at waste sites involving potential risks from inhalation exposures.[6, 7] This includes providing equations that may be used in conducting baseline risk assessments and in calculating risk-based concentrations (RBCs). It is intended that *RAGS, Part F* will replace those portions of *RAGS, Part A*, which addressed inhalation risk.

1.3 Effects on Other Office of Superfund Remediation and Technology Innovation Guidance

EPA recommends that the intake equation presented in *RAGS, Part A* (USEPA, 1989, Exhibit 6-16) should no longer be used when evaluating risk from the inhalation pathway. Implementation of a risk assessment approach consistent with the *Inhalation Dosimetry Methodology* will also affect the following guidance documents: *RAGS, Part B*, Section 3.3: Volatilization and Particulate Emission Factors (USEPA, 1991); and the Office of Solid Waste and Emergency Response's (OSWER's) *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils* (USEPA, 2002a; hereafter the *Vapor Intrusion Guidance*). EPA no longer recommends using the equations in Section 3.3 of *RAGS, Part B* nor the inhalation toxicity values generated using simple route-to-route extrapolation, such as those presented in the 2002 draft *Vapor Intrusion Guidance* and related documents.[8]

This guidance does not affect the equations pertaining to risk from inhaled chemicals in the *Soil Screening Guidance* (USEPA, 1996), Section 2.4, or the *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (USEPA, 2002b), Sections 4.2.3, 5.3.2 and Appendix B, other than to clarify that the IURs and RfCs used in the equations are based on continuous exposure (24 hours per day). If the exposure scenario of interest is less than 24 hours per day, the scenario-specific exposure time (ET) in hours per day should be used in the equations and the averaging time should be in units of hours (see Equations 6 and 8 in this document). *RAGS, Part D* (USEPA, 2001) is also not affected by *RAGS, Part F*, as it includes sufficient flexibility to accommodate the revisions described in this guidance. In addition, the screening values presented on the "Regional Screening Levels for Chemical Contaminants at Superfund Sites" screening level/preliminary remediation goal table are consistent with *RAGS, Part F* (USEPA, 2008a).[9] Readers can contact EPA headquarters with questions about the compatibility of specific Superfund documents with *RAGS, Part F*.

---

[6] Note that the assessment of risk from inhaled nanoparticles is outside the scope of this document.

[7] If a site contains asbestos contamination, risk assessors should contact EPA's Technical Review Workgroup for Metals and Asbestos for assistance.

[8] Related documents include the *Johnson and Ettinger (1991) Model for Subsurface Vapor Intrusion into Buildings* spreadsheet models (http://www.epa.gov/oswer/riskassessment/airmodel/johnson_ettinger.htm) and the accompanying *User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings* (USEPA, 2004a).

[9] This table can be found on EPA Regions 3, 6, and 9 websites (http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm; http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm; and http://www.epa.gov/region09/waste/sfund/prg/index.html).

2. BACKGROUND ON DERIVATION OF INHALATION TOXICITY VALUES

For all exposure routes, there are generally two approaches for deriving toxicity values. One involves the derivation of a reference value (e.g., RfC or RfD), while the other involves derivation of a predictive cancer risk estimate (e.g., an oral or inhalation CSF, such as an IUR). For the inhalation route, both approaches rely on EPA's *Inhalation Dosimetry Methodology* for the extrapolation of experimental concentrations to HECs. This extrapolation is described in Section 2.1 and its subsections. The approaches for deriving a toxicity value from the HEC are described in Sections 2.2 and 2.3 and differ depending on the type of toxicity value (e.g., RfC, IUR). This information is provided for background purposes only. **The procedures outlined in Section 2 are typically performed by IRIS chemical managers or by inhalation toxicologists at the National Center for Environmental Assessment's (NCEA's) Superfund Health Risk Technical Support Center (STSC) rather than as part of a baseline risk assessment.**

2.1 Application of Inhalation Dosimetry

The *Inhalation Dosimetry Methodology* recognizes a hierarchy of approaches that can be used for determining the HEC that is used to derive the RfC or IUR. Generally, the preferred approach is to use physiologically-based pharmacokinetic (PBPK) models.[10] With sufficient data, a PBPK model is capable of calculating the amount of the chemical that reaches the target organ in an animal from any exposure scenario and then estimating what human exposure would result in this same amount of chemical reaching the target organ (i.e., the HEC). PBPK models can also be used to derive continuous ECs from human and animal studies with less-than-continuous exposures. Because constructing a valid PBPK model is an information-intensive process that typically requires substantial chemical-specific data, this approach has rarely been used (USEPA, 2004b); an example can be found in the IRIS file for vinyl chloride (USEPA, 2000a). In cases where a complete PBPK model is not available, an intermediate model relying on certain chemical-specific data may be used (USEPA, 1994).[11]

If the database to support the preferred approach is inadequate, an alternative approach, called the Default Chemical Category-Specific Method can be used. This method incorporates the use of limited or categorical chemical-specific and physiological information. The default method is discussed below, followed by the procedures outlined in the *Inhalation Dosimetry Methodology* for deriving the RfC and IUR as they apply to the interpretation of animal and human data.

---

[10] EPA defines PBPK models in the IRIS glossary as a model that estimates the dose to a target tissue or organ by taking into account the rate of absorption into the body, distribution among target organs and tissues, metabolism, and excretion (USEPA, 2008b). For further information about PBPK modeling, please refer to *Approaches for the Application of Physiologically Based Pharmacokinetic Models and Supporting Data in Risk Assessment* (USEPA, 2006a).

[11] The *Inhalation Dosimetry Methodology* recognizes the existence of alternate approaches in addition to the two presented in this guidance. The PBPK approach is generally preferred. In the absence of such a model, alternate models may be more optimal than the default approach when default assumptions or parameters can be replaced by more detailed, biologically-motivated descriptions or actual data, respectively. For instance, a model may be considered more optimal if it incorporates chemical or species-specific information or if it accounts for mechanistic determinants. See Table 3-6 in the *Inhalation Dosimetry Methodology* for more details on the hierarchy of approaches (EPA, 1994, page 3-40).

2.1.1 Default Approach - Extrapolation from Experimental Animal Data

The default method involves a two-step procedure that uses limited or categorical chemical-specific and physiological information to calculate the HEC. First, the chosen point of departure (POD) from the experimental data for a chemical is adjusted to derive a concentration intended to represent an equivalent dose under conditions of continuous exposure (7 days a week, 24 hours a day).[12] In the second step, this concentration is then multiplied by a Dosimetric Adjustment Factor (DAF) to generate the HEC. Further details on each step are outlined below.

2.1.1.1 Duration Adjustment to Continuous Exposure

Most of the inhalation studies of laboratory animals used to derive RfCs and IURs involve an exposure regimen of four to six hours per day, five to seven days per week, for 13 weeks or more (equivalent to 10 percent or more of the lifetime of the animal). The POD concentration from an animal study is mathematically adjusted to reflect an equivalent dose under conditions of continuous exposure.[13] Adjustment of duration to a continuous exposure scenario is regularly applied as a default procedure to studies with repeated exposures but not to single-exposure inhalation toxicity studies in animals (USEPA, 1994). Operationally, this is accomplished by applying a *c* x *t* product (where "*c"* is concentration, and "*t"* is duration of exposure) for both the number of hours in a daily exposure period and the number of days per week that the exposure is experienced. For example, if exposure in a particular study was 6 hours per day, 5 days per week, the experimental exposure is multiplied by 6/24 x 5/7 to calculate an equivalent continuous exposure. The general equation provided in the *Inhalation Dosimetry Methodology* (USEPA, 1994, Equation 4-2) for calculating duration-adjusted exposure levels in mg/m^3 for experimental animals is presented below.

$NOAEL_{[ADJ]}$ = E x D x W **(Equation 1)**

Where:
$NOAEL_{[ADJ]}$ (mg/m^3) = the NOAEL or analogous exposure level obtained with an alternate approach (e.g., LOAEL, LEC_{10}), adjusted for duration of experimental regimen;
E (mg/m^3) = the NOAEL or analogous exposure level observed in the experimental study;
D (h/h) = number of hours exposed/24 hours; and
W (days/days) = number of days of exposure/7days.

Using the example above, the assumption is that the product of *c* x *t*, not concentration alone, is associated with the toxicity observed. This is roughly equivalent to implying that if an effect occurs from a chemical at an exposure of 6 hours per day at 40 parts per million (ppm), that same effect will

[12] Examples of PODs include the no-observed-adverse-effect level (NOAEL); the lowest-observed-adverse-effect level (LOAEL); Benchmark Concentration, Lower confidence limit (BMCL); and the Lower limit on an Effective Concentration using a 10 percent response level (LEC_{10}). For definitions of the various PODs, please refer to the IRIS glossary (http://www.epa.gov/ncea/iris/help_gloss.htm).

[13] Continuous exposure refers to 24 hours per day, 7 days per week.

occur at an exposure of 24 hours per day at 10 ppm.[14] Note that this adjustment always produces a lower concentration value than that administered to experimental animals. Thus, as stated in *A Review of the Reference Dose and Reference Concentration Processes* (hereafter, the *RfD/RfC Review*), application of this procedure results in an automatic margin of protectiveness for chemicals for which concentration alone may be the more appropriate dose metric, and it reflects the maximum dose for chemicals for which total or cumulative dose is the appropriate measure (USEPA, 2002c). If a different procedure is used to calculate the continuous exposure, it should be fully discussed in the relevant technical support document for the chemical (e.g., IRIS profile, Provisional Peer Reviewed Toxicity Values (PPRTVs) Assessment). For additional discussion, including the uncertainties associated with this approach, see Section 4.3.2 of the *Inhalation Dosimetry Methodology* and Section 4.4.2.1 of the *RfD/RfC Review* (USEPA, 2002c).

2.1.1.2 Dosimetric Adjustment to Human Equivalent Concentration

Typically, the adjusted POD concentration from the animal study is next converted to an HEC using the following equation (USEPA, 1994, Equation 4-3):

$$\mathbf{NOAEL_{[HEC]} = NOAEL_{[ADJ]} \times DAF} \qquad \textbf{(Equation 2)}$$

Where:

$NOAEL_{[HEC]}$ (mg/m^3) = the NOAEL or analogous exposure level obtained with an alternate approach, dosimetrically adjusted to an HEC;

$NOAEL_{[ADJ]}$ (mg/m^3) = the NOAEL or analogous exposure level obtained with an alternate approach, adjusted for duration of experimental regimen; and

DAF = Dosimetric Adjustment Factor for the specific site of effects (e.g., respiratory tract region or extra-respiratory).

The DAF is typically based on ratios of animal and human physiologic parameters. The specific DAF used depends on the nature of the contaminant (e.g., particle or gas) and the target site where the toxic effect occurs (e.g., respiratory tract or a location in the body remote from the portal-of-entry). For example, the DAF can be based on either the Regional Gas Dose Ratio (RGDR), for gases with respiratory effects, or the Regional Deposited Dose Ratio (RDDR) for particles.

Table 2 provides information on the site of effects for the different chemical types. It also lists the physiologic parameters considered when calculating the DAF for specific regions of the body.[15] In addition, the table provides references to the equations from the *Inhalation Dosimetry Methodology* used in deriving the DAFs. Figure 1 provides a schematic of the human respiratory tract, illustrating each of the different regions.

[14] This assumption is based on Haber's Law, which states that "the incidence and/or severity of an adverse health effect depends on the total exposure to a potentially toxic substance. Total exposure (*K*) is the concentration of the substance (*c*) times the duration time of exposure (*t*), (i.e., *c* x *t*=*K*)" (Gaylor, 2000).

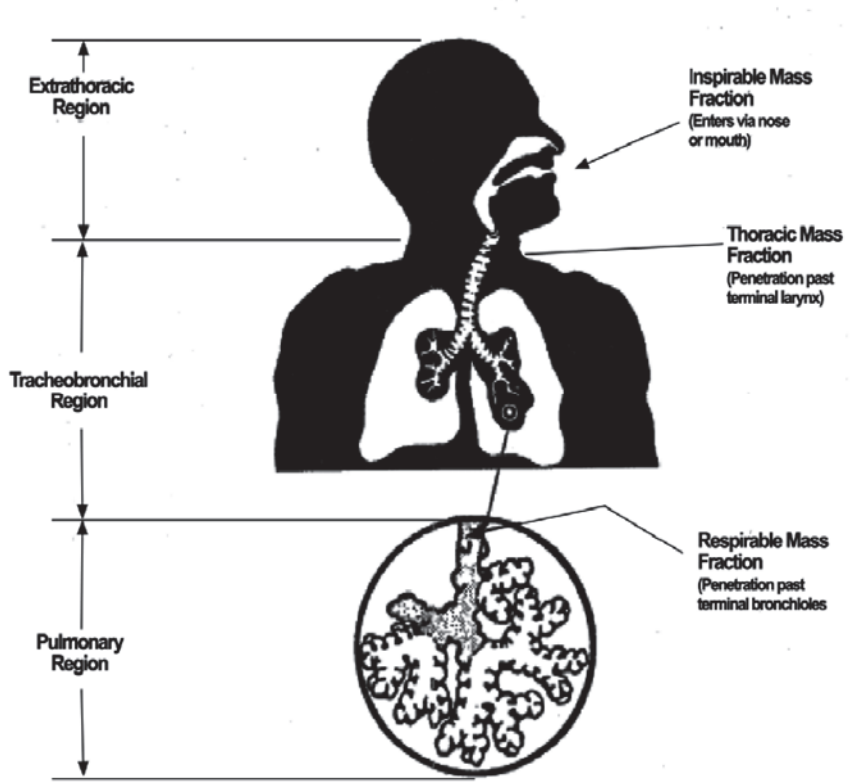
[15] The three main regions of the respiratory tract include the following: 1) Extrathoracic (includes nose, mouth, nasopharynx, oropharynx, laryngopharynx, and larynx); 2) Tracheobronchial (includes trachea, bronchi, and bronchioles); and 3) Pulmonary (includes respiratory bronchioles, alveolar ducts, alveolar sacs and the alveoli).

TABLE 2
CONTAMINANT PROPERTIES AND DOSIMETRIC ADJUSTMENT FACTORS[a]

Chemical Type	Site of Effects	Parameters Considered in Derivation of DAF for Regions of the Body[b]	DAF Equation Numbers in Inhalation Dosimetry Methodology[c]
Category 1 Gases (e.g., acrolein, hydrogen fluoride, chlorine)	Respiratory	-Minute volume (ETh, TB) -Surface area (ETh, TB, PU) -Mass transport coefficient (TB, PU) -Fraction of inhaled chemical penetrating the respiratory region (PU) -Alveolar ventilation rate (PU)	4-18 (ETh), 4-21 & 4-22 (TB), 4-28 (PU)
Category 2 Gases (e.g., acetonitrile, xylene, propanol, isoamyl alcohol)	Respiratory and Remote	-Mass transport coefficients (ETh, TB) -Blood:gas partition coefficient (ET, TB, ER) -Cardiac output (ETh, TB, ER) -Alveolar ventilation rate (PU) -Surface Area (PU) -Minute volume (ER)	4-18 (ETh), 4-21 & 4-22 (TB), 4-28 (PU), 4-48 (ER)[d,e]
Category 3 Gases (e.g., benzene, styrene)	Remote	Blood:gas partition coefficient (ER)	4-48[d]
Particles	Respiratory and Remote	-Minute volume (TOT, ER) -Surface area (TOT) -Fractional deposition of particle (TOT, ER) -Body weight (ER) -Inhaled concentration (ER)	4-14 (TOT), 4-15 (ER)

[a] Due to the complexities inherent in evaluating the health effects associated with exposure to gases, no definitive or comprehensive list of Category 1, 2, or 3 gases is available. Risk assessors should consult with an inhalation toxicologist in order to classify a specific gas as Category 1, 2, or 3, since there is overlap between the sites of effects and the parameters considered in deriving the DAF for different regions of the respiratory tract.
[b] Additional discussion of the terms used in this table can be found in the *Inhalation Dosimetry Methodology*.
[c] The *Inhalation Dosimetry Methodology* provides equations for deriving DAFs for the different contaminant categories. The equations listed in this table are the default equations for each specific region in the body.
[d] This refers to Equation 4-48 that is found on page 4-60 of the *Inhalation Dosimetry Methodology*.
[e] The equations presented for Category 2 gases in the *Inhalation Dosimetry Methodology* contain errors. Therefore, this table refers to the equations for Category 1 and 3 gases, which are expected to cover respiratory and remote effects from Category 2 gases.
Acronyms: ETh = Extrathoracic; TB = Tracheobronchial; PU = Pulmonary; ER = Extra-respiratory; TOT = Total respiratory system.

FIGURE 1
HUMAN RESPIRATORY TRACT



Source: EPA (1994), Figure 3-1, Page 3-5.

Category 1 gases are highly water-soluble and/or are rapidly irreversibly reactive in the respiratory tract (e.g., acrolein, hydrogen fluoride, chlorine). They do not significantly accumulate in the blood, and therefore their effects are usually exclusively respiratory (USEPA, 1994). The DAF for Category 1 gases consists of an RGDR and is based on the animal to human ratio of the minute volume (V_e) divided by the surface area (SA) of the region of the respiratory tract where the effect occurs.[16] See Appendix A, Sections 1, 2, and 3 of this guidance for examples of specific Category 1 DAF equations.

[16] For the purposes of this document, the V_e is defined as the total ventilation per minute and equals the product of the tidal volume (the air volume entering or leaving the lungs with a single breath) and the respiratory frequency.

Category 3 gases are relatively water-insoluble and are unreactive in the respiratory tract (e.g., benzene, styrene). Their toxicity is generally at sites remote to the respiratory tract (USEPA, 1994). The DAF for Category 3 gases is based on the ratio of the animal blood:gas partition coefficient ($H_{b/g\text{-}animal}$) and the human blood:gas partition coefficient ($H_{b/g\text{-}human}$). See Appendix A, Section 4 of this guidance for an example of a Category 3 DAF equation.

Category 2 gases are moderately water-soluble and may be rapidly reversibly reactive or moderately to slowly irreversibly reactive in respiratory tract tissue (e.g., acetonitrile, xylene, propanol, isoamyl alcohol). These gases have potential for significant accumulation in the blood, so they can exhibit both respiratory and remote toxicity (USEPA, 1994). The DAF for respiratory effects of Category 2 gases consists of an RGDR and is based on the animal to human ratio of the V_e and the SA of the region of the respiratory tract where the effect occurs, as for Category 1 gases. The DAF for extra-respiratory (ER) effects of a Category 2 gas is based on the ratio of the $H_{b/g\text{-}animal}$ and the $H_{b/g\text{-}human}$, as for Category 3 gases.

Particles also vary by solubility and reactivity. However, the default equations used to estimate the predicted regional deposition fractions for particles are based on non-soluble, non-hygroscopic particles (USEPA, 1994, Section 4.3.5.3). The DAF for a particle causing an effect in the respiratory tract is the $RDDR_r$. The $RDDR_r$ is based on the animal to human ratio of the V_e and the fractional deposition of the particle in that region (F_r), divided by the SA_r of the region where the effect occurs. This derivation, from the *Inhalation Dosimetry Methodology,* conservatively assumes that 100 percent of the deposited dose remains in the respiratory tract; clearance mechanisms are not considered. The DAF for a particle causing an ER effect, the $RDDR_{ER}$, is based on the animal to human ratio of the V_e and the total deposition of the particle in the entire respiratory tract (F_{total}), divided by BW (USEPA, 1994). The $RDDR_{ER}$ assumes that 100 percent of the deposited dose in the entire respiratory tract is available for uptake into the systemic circulation. See Appendix A, Section 5 for examples of specific particle DAF equations.

2.1.2 Default Approach - Extrapolation from Human Occupational Data

When human data are available to derive an RfC, duration adjustments are often required to account for differences in exposure scenarios (e.g., extrapolation from an 8 hour/day occupational exposure to a continuous chronic exposure). The default approach recommended by the *Inhalation Dosimetry Methodology* for adjusting the POD concentration (e.g., the no observable adverse effect level (NOAEL)) obtained from human study data is provided below in Equation 3 (USEPA, 1994, Equation 4-49).[17,18]

[17] If sufficient data are available, a PBPK model or intermediate approach using chemical-specific information may be employed in preference to the default method for extrapolating human occupational data to an HEC.

[18] EPA's IRIS glossary defines an adverse effect as the following: "A biochemical change, functional impairment, or pathologic lesion that affects the performance of the whole organism, or reduces an organism's ability to respond to an additional environmental challenge" (USEPA, 2008b).

$NOAEL_{[HEC]}$ = NOAEL x (VEho/VEh) x 5 days/7 days **(Equation 3)**

Where: $NOAEL_{[HEC]}$ (mg/m^3) = the NOAEL or analogous exposure level obtained with an alternate approach, dosimetrically adjusted to an ambient HEC;
NOAEL (mg/m^3) = occupational exposure level (time-weighted average over an 8-hour exposure period);
VEho = human occupational default minute volume over 8 hours (10 m^3); and
VEh = human ambient default minute volume over 24 hours (20 m^3).

2.2 Derivation of the Inhalation Unit Risk

The default approach for determining predictive cancer risk recommended by EPA's *Guidelines for Carcinogen Risk Assessment* (USEPA, 2005a; hereafter, *Cancer Guidelines*) is a linear extrapolation from exposures observed in the animal or human occupational study.[19] This approach involves drawing a straight line from the POD to the origin. The default linear extrapolation approach is generally considered to be conservatively protective of public health, including sensitive sub-populations (USEPA, 2005a). The slope of this line is commonly called the slope factor, and when the units are risk per $\mu g/m^3$, it is also called the IUR. EPA defines an IUR in the IRIS glossary as "the upper-bound excess lifetime cancer risk estimated to result from continuous exposure to an agent at a concentration of 1 $\mu g/m^3$ in air" (USEPA, 2008b). Equation 4 below presents a linear extrapolation from a POD of 10 percent response (LEC_{10}).[20]

$IUR = 0.1/LEC_{10[HEC]}$ **(Equation 4)**

Where: IUR $(\mu g/m^3)^{-1}$ = Inhalation Unit Risk; and
$LEC_{10[HEC]}$ ($\mu g/m^3$) = the lowest effective concentration using a 10 percent response level, dosimetrically adjusted to an HEC.

2.3 Derivation of the Reference Concentration

EPA defines an RfC in the IRIS glossary as "an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious effects during a lifetime" (USEPA, 2008b). The RfC is derived after a review of the health effects database for a chemical and identification of the most sensitive and relevant endpoint along with the principal study or studies demonstrating that endpoint. EPA Chemical Managers use UFs to account for recognized

[19] According to the *Cancer Guidelines*, "[a] nonlinear approach should be selected when there are sufficient data to ascertain the mode of action [MOA] and conclude that it is not linear at low doses and the agent does not demonstrate mutagenic or other activity consistent with linearity at low doses" (USEPA, 2005a, page 3-22). In addition, [l]inear extrapolation should be used when there are MOA data to indicate that the dose-response curve is expected to have a linear component below the POD" (USEPA, 2005a, page 3-21). This information will appear on the IRIS profile or other toxicological information source for a chemical. Chemicals with a mutagenic MOA are thought to pose a higher risk during early life. Procedures for assessing cancer risk from these chemicals are outlined in Section 5.1.

[20] The POD used in Equation 4 is an LEC_{10}, which is the lower 95 percent confidence limit on the concentration corresponding to a 10 percent response rate (i.e., the EC_{10}). Other PODs may be substituted for this value, which could be associated with alternative response levels (e.g., 1 percent, 5 percent).

uncertainties in the extrapolations from the experimental data conditions to an estimate appropriate to the assumed human scenario (USEPA, 1994). See Table 3 for a description of the standard UFs. The formula used for deriving the RfC from the HEC is provided below.

$RfC = NOAEL_{[HEC]}/(UF)$[1] **(Equation 5)**

Where: RfC (mg/m^3) = Reference Concentration
$NOAEL_{[HEC]}$ (mg/m^3) = The NOAEL or analogous exposure level obtained with an alternate approach, dosimetrically adjusted to an HEC; and
UF = Uncertainty factor(s) applied to account for the extrapolations required from the characteristics of the experimental regimen.

[1] Some toxicological information sources for RfCs will incorporate an additional factor to account for deficiencies in the available data set, called a modifying factor (MF). In 2002, however, EPA published the *RfD/RfC Review,* which recommended that the use of MFs be discontinued because their purpose is "sufficiently subsumed in the general database UF" (USEPA, 2002c, page xviii). Therefore, RfCs published subsequent to this document will not include MFs.

TABLE 3
THE USE OF UNCERTAINTY FACTORS IN DERIVING AN INHALATION REFERENCE CONCENTRATION

Standard UFs	Processes Considered in the UF Purview
H = Human to sensitive human: Extrapolation of valid experimental results from studies using prolonged exposure to average healthy humans. Intended to account for the variation in sensitivity among the members of the human population.	-Pharmacokinetics/Pharmacodynamics -Sensitivity[2] -Differences in body weight (age, obesity) -Concomitant exposures -Activity pattern -Does not account for idiosyncrasies
A = Animal to human: Extrapolation from valid results of long-term studies on laboratory animals when results of studies of human exposure are not available or are inadequate. Intended to account for the uncertainty in extrapolating laboratory animal data to the case of average healthy humans.	-Pharmacokinetics/Pharmacodynamics -Relevance of laboratory animal model -Species sensitivity
S = Subchronic to chronic: Extrapolation from less-than-chronic exposure results on laboratory animals or humans when there are no useful long-term human data. Intended to account for the uncertainty in extrapolating from less than chronic NOAELs to chronic NOAELs.	-Accumulation/Cumulative damage -Pharmacokinetics/ Pharmacodynamics -Severity of effect -Recovery -Duration of study -Consistency of effect with duration
L = LOAEL to NOAEL: Derivation from a LOAEL instead of a NOAEL. Intended to account for the uncertainty in extrapolating from LOAELs to NOAELs.	-Severity -Pharmacokinetics/Pharmacodynamics -Slope of dose-response curve -Trend, consistency of effect -Relationship of endpoints -Functional vs. histopathological evidence -Exposure uncertainties
D = Incomplete to complete data: Extrapolation from valid results in laboratory animals when the data are "incomplete." Intended to account for the inability of any single laboratory animal study to adequately address all possible adverse outcomes in humans.[1]	-Quality of critical study -Data gaps -Power of critical study/supporting studies -Exposure uncertainties

[1] The *RfD/RfC Review* indicates that this UF accounts for the potential for deriving an underprotective RfD/RfC as a result of an incomplete characterization of the chemical's toxicity or if the existing data suggest that a lower reference value might result if additional data were available (considering both the lacking and available data for particular organ systems as well as life stage) (USEPA, 2002c).

[2] The *RfD/RfC Review* also stresses that susceptible populations and life stages are accounted for with this UF (USEPA, 2002c).

Source: USEPA, 1994, Table 4-9, page 4-77.

3. CHARACTERIZING EXPOSURE

3.1 Introduction

This section describes an approach for characterizing exposure in a baseline risk assessment that is consistent with the *Inhalation Dosimetry Methodology*. The approach involves the estimation of exposure concentrations (ECs) for each receptor exposed to contaminants via inhalation in the risk assessment. ECs are time-weighted average concentrations derived from measured or modeled contaminant concentrations in air at a site, adjusted based on the characteristics of the exposure scenario being evaluated.[21,22]

Equations for estimating ECs are provided below. This document does not provide default input values for the exposure parameters referenced in these equations. EPA recommends the use of site-specific exposure values consistent with the exposure pathways and receptors at a site wherever practicable and appropriate. If a risk assessor opts to rely on default exposure input values, current Superfund-supported values may be found at the exposure assessment portion of the Superfund website: (http://www.epa.gov/oswer/riskassessment/superfund_hh_exposure.htm).

3.2 Estimating Exposure Concentrations for Assessing Cancer Risks

The estimation of an EC when assessing cancer risks characterized by an IUR involves the CA measured at an exposure point at a site as well as scenario-specific parameters, such as the exposure duration and frequency.[23] The EC typically takes the form of a CA that is time-weighted over the duration of exposure and incorporates information on activity patterns for the specific site or the use of professional judgment. The equation for estimating an EC for use with an IUR is presented below.

[21] The default method for deriving inhalation toxicity values also involves calculating time-weighted ECs, as discussed in Sections 2.1.1.1 and 2.1.2.

[22] The ECs in this document are in units of $\mu g/m^3$. Inhalation toxicity values presented on IRIS are typically expressed in units of $\mu g/m^3$ or mg/m^3, which are mass units. Some regulatory contexts require the use of volumetric units such as ppm. The conversion from mass units to volumetric units depends on the molecular weight (MW) of the material as well as the ambient temperature and atmospheric pressure. To convert from ppm to mg/m^3, the following equation can be used: $\frac{ppm \times MW}{V} = mg/m^3$; where MW is the molecular weight of the gas and V is the volume of 1 gram molecular weight of the airborne contaminant. This is derived by the formula V = RT/P; where R is the ideal gas constant, T is the temperature in Kelvin (K = 273.16 + T°C) and P is the pressure in mm Hg. The value of R is 62.4 when T is in Kelvin, (K = 273.16 + T°C), the pressure is expressed in units of mm Hg and the volume is in liters. The value of R differs if the temperature is expressed degrees Fahrenheit (°F) or if other units of pressure are used (e.g., atmospheres, kilopascals).

[23] ECs are typically based on either estimated (i.e., modeled) or measured contaminant concentrations in air.

EC = (CA x ET x EF x ED)/AT **(Equation 6)**

Where: EC ($\mu g/m^3$) = exposure concentration;
CA ($\mu g/m^3$) = contaminant concentration in air;
ET (hours/day) = exposure time;
EF (days/year) = exposure frequency;
ED (years) = exposure duration; and
AT (lifetime in years x 365 days/year x 24 hours/day) = averaging time

3.3 Estimating Exposure Concentrations for Calculating Hazard Quotients

When estimating ECs for non-cancer or cancer hazards characterized by an HQ, risk assessors should match each exposure scenario at a site to the appropriate EC equation, based on the scenario duration and frequency of exposure.[24] Figure 2 presents a flowchart to assist risk assessors with this process and provides recommended equations that can be used to estimate the EC for each type of scenario.[25] As shown in Figure 2, the recommended process for estimating ECs to be used in calculating an HQ involves the following three steps: 1) assess the duration of the exposure scenario; 2) assess the exposure pattern of the exposure scenario; and 3) estimate the scenario-specific EC.

3.3.1 Step 1: Assess Duration

The first step in the recommended process of estimating an EC for use in calculating an HQ involves assessing the duration of the exposure scenario at a site. Step 1 in Figure 2 indicates that the risk assessor first should decide whether the duration of the exposure scenario is generally acute, subchronic, or chronic. Toxicologists have long been aware that effects from a single or short-term exposure can differ markedly from effects resulting from repeated exposures. The response by the exposed person depends upon factors such as whether the chemical accumulates in the body, whether it overwhelms the body's mechanisms of detoxification or elimination, or whether it produces irreversible effects (Eaton & Klaassen, 2001). Therefore, ideally, the chemical-specific elements of metabolism and kinetics, reversibility of effects, and recovery time should be considered as part of this recommended process when defining the duration of a site-specific exposure scenario.

[24] Traditionally, the HQ approach was limited to non-cancer hazard assessment. However, the HQ approach may also be appropriate for carcinogens with a non-linear mode of action. The 2005 *Cancer Guidelines* state the following on this subject: "For cases where the tumors arise through a nonlinear mode of action, an oral reference dose or an inhalation reference concentration, or both, should be developed in accordance with EPA's established practice for developing such values … this approach expands the past focus of such reference values (previously reserved for effects other than cancer) to include carcinogenic effects determined to have a nonlinear mode of action" (USEPA, 2005a; page 3-24).

[25] Figure 2 was developed for the evaluation of inhalation exposures. While the concepts presented in this flowchart may be useful for assessing other exposure routes (e.g., oral or dermal), these other routes are beyond the scope of this document, and therefore, are not explicitly considered. Caution should be used when using Figure 2 to evaluate other exposure routes, as considerations beyond those outlined in the flowchart may apply (e.g., time to reach steady state for dermal exposures).

To the extent possible, exposure durations (EDs) evaluated in a site-specific risk assessment should be consistent with the ED represented by the toxicity value. However, frequencies or durations of human exposures often are not as clearly defined as those in animal studies with controlled exposures, particularly for intermittent exposures. For example, the emission of some volatile chemicals into the ambient air may vary with temperature and season, providing fluctuating exposures for humans living near the source. Therefore, risk assessors should use best professional judgment to determine if the ED in a given scenario is reasonably similar to the duration associated with the toxicity value. Risk assessors should describe the uncertainties associated with their choice of toxicity value in the risk characterization section of the risk assessment (see Section 9.2.2 of this document). For situations where duration-appropriate toxicity values are not available, please follow the procedures outlined in Section 4.2 and Appendix C of this document.

The specific definition for each exposure duration category may vary depending on the source of the toxicity value being used. For Tier 1 toxicity values obtained from EPA's IRIS database, acute exposures are defined as lasting 24 hours or less; subchronic exposures are defined as repeated exposures by the oral, dermal, or inhalation route for more than 30 days, up to approximately 10 percent of the human lifespan; and chronic exposures are defined as repeated exposures for more than approximately 10 percent of the human lifespan (USEPA, 2008b).[26, 27]

After deciding which duration the exposure scenario most closely matches, risk assessors should then proceed to Step 2, following the path of the selected duration. Note that if an acute duration is selected, risk assessors should proceed directly to Step 3 to estimate an acute EC for each acute exposure period.

3.3.2 Step 2: Assess Exposure Pattern

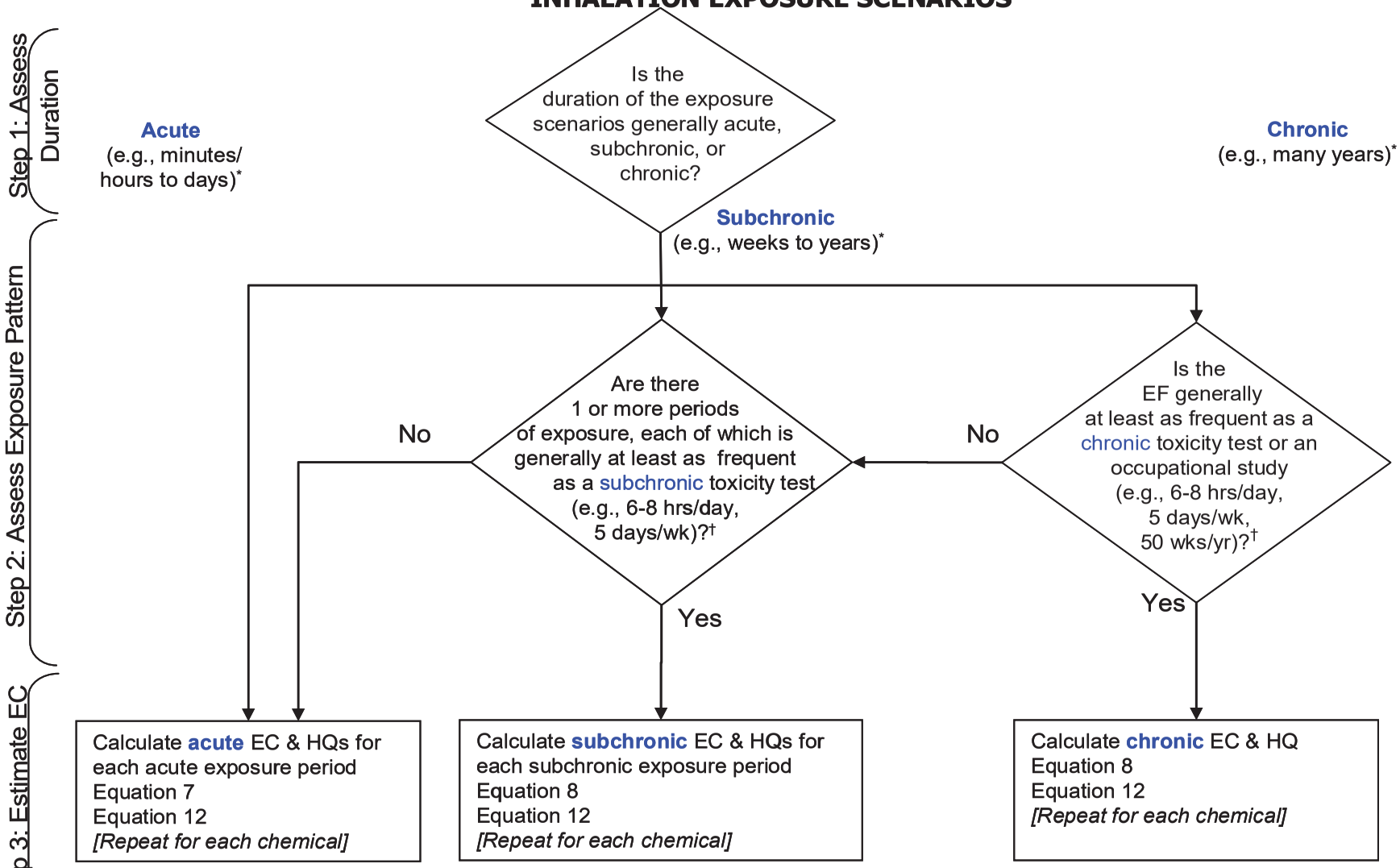
Step 2 of the recommended process for estimating an EC for use in a hazard quotient involves assessing the exposure pattern for each exposure scenario at a site. This entails comparing the exposure time and frequency at a site to that of a typical subchronic or chronic toxicity test.[28]

[26] Note that other sources of toxicity values may define exposures differently. For example, the Agency for Toxic Substances and Disease Registry (ATSDR) (which publishes Minimal Risk Levels (MRLs)) defines acute exposures as occurring from one to 14 days, intermediate exposures as greater than 14 to 364 days, and chronic exposures as 365 days or longer. However, the toxicity values are based on the same underlying toxicological concepts described in this section.

[27] Exposures with a duration lasting between 24 hours and 30 days should be treated as subchronic for the purposes of this document.

[28] Exposure regimens vary from study to study. Risk assessors should use best professional judgment to determine if the exposure pattern in a given scenario is reasonably similar to a typical regimen for a subchronic or chronic study.

FIGURE 2
RECOMMENDED PROCEDURE FOR DERIVING EXPOSURE CONCENTRATIONS AND HAZARD QUOTIENTS FOR INHALATION EXPOSURE SCENARIOS



* The specific definition for each duration category may vary depending on the source of the toxicity value being used. For Tier 1 toxicity values obtained from IRIS:
acute exposures are defined as those lasting 24 hours or less;
subchronic exposures are defined as repeated exposures for more than 30 days, up to approximately 10 percent of the life span in humans; and
chronic exposures are defined as repeated exposures for more than approximately 10 percent of the life span in humans (EPA, 2008b).
For the purposes of this document, short-term exposures, defined by the IRIS glossary as repeated exposures for more than 24 hours, up to 30 days, should be treated as subchronic.

† Exposure regimens vary from study to study. Risk assessors should use best professional judgment to determine if the exposure pattern in a given scenario is reasonably similar to a typical regimen for a chronic or subchronic study.

For exposure scenarios with a subchronic duration, risk assessors should follow the center path on the flowchart. Step 2 in this path asks whether there are one or more periods of exposure, each of which is generally as frequent as a subchronic toxicity test (e.g., 6-8 hours per day, 5 days per week). If the exposure scenario matches this description, risk assessors should proceed to Step 3 and estimate a subchronic EC for each subchronic exposure period. However, if the exposure pattern contains periods that are significantly shorter and/or involve significantly less frequent exposures than indicated in the flow chart, risk assessors should derive acute ECs for each of these exposure periods. If it is difficult to determine whether a specific exposure scenario is best modeled as a subchronic exposure or as a series of independent acute exposures, due to uncertainty in the time required to return to baseline following exposure, risk assessors may want to derive ECs using both approaches.

If the exposure scenario has a chronic duration, risk assessors should follow the right hand path on the flowchart. Step 2 in this path asks whether the exposure frequency (EF) is generally as frequent as a chronic animal toxicity test or a human occupational study (e.g., 6-8 hours per day, 5 days per week, for 50 weeks per year). If the exposure scenario matches this description, risk assessors should proceed to Step 3 and estimate a single chronic EC. However, if the scenario differs significantly from this pattern, risk assessors should proceed to the second question under the subchronic duration path and proceed as outlined above.

3.3.3 Step 3: Estimate Exposure Concentration

Step 3 of the recommended process involves estimating the EC for the specific exposure scenario based on the decisions made in Steps 1 and 2. For acute exposures, the EC is equal to the CA. Risk assessors can estimate an acute EC for each acute exposure period at a site using Equation 7. For longer-term exposures, risk assessors should take into consideration the exposure time, frequency, and duration for each receptor being evaluated as well as the period over which the exposure is averaged (i.e., the averaging time (AT)) to arrive at a time-weighted EC. If there are one or more exposure periods that are generally as frequent as a subchronic toxicity test, risk assessors should use Equation 8 to estimate a subchronic EC for each of these exposure periods. (Exposure periods with significantly less frequency should be treated as acute exposures.) If the exposure pattern is generally as frequent as a chronic toxicity test of an occupational study, risk assessors should use Equation 8 to estimate a single chronic EC for the duration of the exposure.

Acute Exposures

EC = CA **(Equation 7)**

Where: EC ($\mu g/m^3$) = exposure concentration;
CA ($\mu g/m^3$) = contaminant concentration in air;

Chronic or Subchronic Exposures

EC = (CA x ET x EF x ED)/AT **(Equation 8)**

Where: EC ($\mu g/m^3$) = exposure concentration;
CA ($\mu g/m^3$) = contaminant concentration in air;
ET (hours/day) = exposure time;
EF (days/year) = exposure frequency;
ED (years) = exposure duration; and
AT (ED in years x 365 days/year x 24 hours/day) = averaging time

Note: If the duration of the exposure period is less than one year, the units in the above equation can be changed to the following: EF (days/week); ED (weeks/exposure period); and AT (hours/exposure period).

It is important to use the EC equation that most closely matches the exposure pattern and duration at a site. For instance, if the exposure pattern at a site consists of a series of short (e.g., 4-hour) periods of high exposure separated by several days of no exposure, the approach outlined above recommends estimating an acute EC for each acute exposure period. If the chronic EC equation (Equation 8) were to be used instead, the result would be an average EC value that may lead to an underestimate of risk since the inhaled concentrations could be higher than acute toxicity values during periods of exposure.

3.4 Estimating Exposure Concentrations in Multiple Microenvironments

When detailed information on the activity patterns of a receptor at a site is available, risk assessors can use these data to estimate the EC for either non-carcinogenic or carcinogenic effects. The activity pattern data describe how much time a receptor spends, on average, in different microenvironments (MEs), each of which may have a different contaminant concentration level.[29] By combining data on the contaminant concentration level in each ME and the activity pattern data, the risk assessor can calculate a time-weighted average EC for a receptor. Because activity patterns (and hence, MEs) can vary over a receptor's lifetime, EPA recommends that risk assessors pursuing the ME approach first calculate a time-weighted average EC for each exposure period characterized by a specific activity pattern (e.g., separate ECs for a school-aged child resident and a working adult resident). These exposure period-specific ECs can then be combined into a longer term or lifetime average EC by weighting the EC by the duration of each exposure period. The following sections further explain these two steps.

3.4.1 Using Microenvironments to Estimate an Average Exposure Concentration for a Specific Exposure Period

The ME approach can be used to estimate an average EC for a particular exposure period during which a receptor has a specified activity pattern. As a simplified example, a residential receptor may

[29] EPA defines a microenvironment in *Air Quality Criteria for Particulate Matter: Volume II* as a defined space that can be treated as a well-characterized, relatively homogeneous location with respect to pollutant concentration for a specified time period (e.g., rooms in homes, restaurants, schools, offices, inside vehicles, or outdoors) (USEPA, 2004b).

be exposed to a higher concentration of a contaminant in air in the bathroom for 30 minutes per day while showering, and exposed to a lower concentration in the rest of the house for the remaining 23.5 hours per day. In this case, risk assessors can use the CA value experienced in each ME weighted by the amount of time spent in each ME to estimate an average EC for the period of residency in that house using Equation 9.[30] This approach may also be used to address exposures to contaminants in outdoor and indoor environments at sites where both indoor and outdoor samples have been collected or where the vapor intrusion pathway has been characterized.

$$EC_j = \sum_{i=1}^{n} (CA_i \times ET_i \times EF_i) \times ED_j / AT_j \qquad \textbf{(Equation 9)}$$

Where:
EC_j ($\mu g/m^3$) = average exposure concentration for exposure period j;
CA_i ($\mu g/m^3$) = contaminant concentration in air in ME i;
ET_i (hours/day) = exposure time spent in ME i;
EF_i (days/year) = exposure frequency for ME i;
ED_j (years) = exposure duration for exposure period j; and
AT_j (hours) = averaging time = ED_j x 24 hours/day x 365 days/year.

3.4.2 Estimating an Average Exposure Concentration Across Multiple Exposure Periods

To derive an average EC for a receptor over multiple exposure periods, the average EC from each period (as calculated above in Equation 9) can be weighted by the fraction of the total exposure time that each period represents, using Equation 10. For example, when estimating cancer risks, the risk assessor may calculate a lifetime average EC where the weights of the individual exposure periods are the duration of the period, ED_j, divided by the total lifetime of the receptor. Alternatively, when estimating an HQ, risk assessors can use Equation 10 to calculate less-than-lifetime average ECs across multiple exposure periods. In that case, the AT will equal the sum of the individual EDs for all of the exposure periods.

$$EC_{LT} = \sum_{i=1}^{n} (EC_j \times ED_j) / AT \qquad \textbf{(Equation 10)}$$

Where:
EC_{LT} ($\mu g/m^3$) = long-term average exposure concentration;
EC_j ($\mu g/m^3$) = average exposure concentration of a contaminant in air for exposure period j;
ED_j (years) = duration of exposure period j; and
AT (years)[1] = averaging time.

[1] When evaluating cancer risk, the AT is equal to lifetime in years. When evaluating non-cancer hazard, the AT is equal to the sum of the EDs for each exposure period.

[30] If one or more MEs involve acute exposures, risk assessors should conduct a supplemental analysis comparing the CA for each of those MEs to a corresponding acute toxicity value to ensure that receptors are protected from potential acute health effects.

4. SELECTING APPROPRIATE TOXICITY VALUES

After characterizing the exposure scenarios and estimating ECs for each receptor at a site, the risk assessor should select appropriate inhalation toxicity values for each inhaled contaminant. For estimating cancer risks, this typically involves identifying and evaluating available published cancer potency estimates. For estimating HQs, this typically involves identifying and evaluating reference values that match the characterization of the exposure scenario from Figure 2 (i.e., acute, subchronic, or chronic reference values).

This section provides guidance for the selection of toxicity values appropriate for assessing risk under inhalation exposure scenarios. It describes sources for the most current inhalation data and provides guidance for proceeding when published inhalation toxicity data are not available.

4.1 Sources for Inhalation Toxicity Data

The OSWER Directive, *Human Health Toxicity Values in Superfund Risk Assessment* (USEPA, 2003), provides a recommended hierarchy of toxicological data sources to guide risk assessors when selecting appropriate toxicity values. This document sets out a recommended three-tiered framework for selecting human toxicity values. Tier 1 consists of EPA's IRIS, Tier 2 consists of EPA's PPRTVs, and Tier 3 includes other toxicity values as recommended by NCEA, such as the California EPA toxicity values, the Agency for Toxic Substances and Disease Registry's (ATSDR's) Minimal Risk Levels (MRLs), and Health Effects Assessment Summary Table (HEAST) toxicity values. Priority in Tier 3 should be given to sources that are the most current and those that are peer reviewed. Consultation with the Superfund Headquarters office is recommended regarding the use of Tier 3 values for Superfund response decisions when the contaminant appears to be a risk driver for the site.

The most up-to-date information on Superfund-supported cancer potency estimates and chronic and subchronic cancer and non-cancer reference values for inhaled contaminants are available on the Superfund risk assessment website (www.epa.gov/oswer/riskassessment/superfund_toxicity.htm). Superfund-recommended sources for acute non-cancer toxicity values can be found at www.epa.gov/oswer/riskassessment/superfund_acute.htm.[31]

In situations where the desired reference value (e.g., acute, subchronic, chronic) is not available, risk assessors may use a reference value based on the next longer duration of exposure as a conservative estimate that would be protective for a shorter-term ED (USEPA, 2002c). For example, if a risk assessor determines that an ED at a site is subchronic, but no subchronic toxicity value is available, a chronic RfC can be used to assess hazard.

EPA recommends that toxicity values published in Superfund-supported sources should generally be used in the risk equations presented in this guidance, without modification. This includes IURs on IRIS that were calculated from oral values using a default ventilation rate and BW (see Appendix B for a list of these chemicals). It is not generally appropriate to make adjustments to these values

[31] In selecting an acute toxicity value, risk assessors should consider the duration associated with their estimate of exposure (e.g., a 1-hour versus a 24-hour air sample). Use of a toxicity value specified for a longer duration than that of the exposure estimate may overestimate hazard, while the use of a shorter duration acute reference value may underestimate hazard.

based on IR and BW using the intake equation, because the amount of the chemical that reaches the target site through the inhalation pathway is not a simple function of these parameters (see Section 1.2). Use of the toxicity values listed in Appendix B should be noted in the uncertainty section of the risk assessment (see Section 9).

4.2 Recommended Procedures for Assessing Risk in the Absence of Inhalation Toxicity Values

The following section provides guidance on recommended procedures for situations where inhalation toxicity values are not available in any of the toxicity data sources described in Section 4.1.

If RfC and IUR values are not available for an inhaled contaminant, risk assessors should first contact NCEA's STSC for guidance.[32] Risk assessors working on Superfund sites can contact STSC to determine whether a provisional peer-reviewed toxicity value (PPRTV) exists for a contaminant; if not, the risk assessor, in cooperation with the appropriate EPA Regional office may request that STSC develop a PPRTV document or that STSC develop an inhalation toxicity value as a "consult". The latter would be specific to the site in question only. Additional information on STSC's current process for developing alternative toxicity values is described in Appendix C.

If STSC indicates that no quantitative toxicity information for the inhalation route is available, the risk assessor should conduct a qualitative evaluation of this exposure route. The risk assessor should discuss in the uncertainty section of the risk assessment report the implications of not quantitatively assessing risks due to inhalation exposures to chemicals lacking inhalation toxicity data. See the section on Risk Characterization (Section 9) in this guidance for more information.

Performing simple route-to-route extrapolation without the assistance of STSC is generally not appropriate because hazard may be misrepresented when data from one route are substituted for another without any consideration of the pharmacokinetic differences between the routes (USEPA, 1998). The following circumstances, outlined in the *Inhalation Dosimetry Methodology* (page 4-6), are specific examples of situations when route-to-route extrapolation from oral toxicity values might not be appropriate, even for use during screening:

- When groups of chemicals are expected to have different toxicity by the two routes – for example, metals, irritants, and sensitizers;
- When a first-pass effect by the respiratory tract is expected;
- When a first-pass effect by the liver is expected;
- When a respiratory tract effect is established, but dosimetry comparison cannot be clearly established between the two routes;
- When the respiratory tract was not adequately studied in the oral studies; and
- When short-term inhalation studies, dermal irritation, in vitro studies, or characteristics of the chemical indicate the potential for portal-of-entry effects at the respiratory tract, but studies themselves are not adequate for inhalation toxicity value development.

[32] All contact with STSC should be performed by an EPA regional risk assessor. States and other entities should first contact their EPA regional risk assessor with questions on inhalation toxicity values. Regional risk assessors can then contact STSC on their behalf.

The *Cancer Guidelines* (USEPA, 2005a) includes the following statement regarding route-to-route extrapolation:

> "When a qualitative extrapolation can be supported, quantitative extrapolation may still be problematic due to the absence of adequate data. The differences in biological processes among routes of exposure (oral, inhalation, dermal) can be great because of, for example, first-pass effects and different results from different exposure patterns. There is no generally applicable method for accounting for these differences in uptake processes in a quantitative route-to-route extrapolation of dose-response data in the absence of good data on the agent of interest. Therefore, route-to-route extrapolation of dose data relies on a case-by-case analysis of available data" (page 3-10).

5. ESTIMATING RISKS

This section provides updated equations recommended for estimating excess cancer risks and HQs from inhaled contaminants of concern at Superfund sites. Please see Section 8.2.1 of *RAGS, Part A* for further information about how to interpret calculated excess cancer risks and HQs.

5.1 Cancer Risks Characterized by an Inhalation Unit Risk

The excess cancer risk for a receptor exposed via the inhalation pathway can be estimated with the following equation:

Risk = IUR x EC **(Equation 11)**

Where: IUR $(\mu g/m^3)^{-1}$ = Inhalation Unit Risk; and
EC $(\mu g/m^3)$ = exposure concentration (See Equation 6).

When estimated ECs are above the POD used for the low dose extrapolation described in Section 2.3, a linear concentration-response relationship may not hold.[33] In such situations, the risk assessor should not use toxicity values developed through low dose extrapolation techniques. Instead, the risk assessor may report semi-quantitative risk estimates (e.g., risks are greater than 10^{-2}) or estimate risk using the original model underlying the toxicity value, which can be found in the technical support document for the value (e.g., IRIS profile, PPRTV Assessment).

When estimating cancer risks for children, risk assessors should be aware of chemicals that pose a higher risk of cancer when exposure occurs during early life. If evidence exists suggesting differences in risk across age groups for a chemical, this typically will be considered in the derivation of the toxicity value and described in the chemical's technical support document.

[33] Reviews of chemical-specific IRIS files indicate that the risk level corresponding to the concentration level above which the IUR should not be used often falls at or near 10^{-2}. However, this risk level varies by chemical and, therefore, risk assessors should refer to the toxicity value's technical support document for information on the concentration range for which the IUR was intended to be used.

Chemicals that have been determined to cause cancer by a mutagenic mode of action (MOA) are thought to pose a higher risk during early life. An EPA-recommended procedure exists for assessing risks from these chemicals. Figure 3 summarizes the recommendations of the *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens* (USEPA, 2005b; hereafter *Supplemental Cancer Guidelines*) on how to adjust childhood risk calculations to account for chemicals with a mutagenic MOA for carcinogenicity. Please refer to the *Supplemental Cancer Guidelines* (USEPA, 2005b) for a list of chemicals with a mutagenic MOA that were used in the development of that document.

In addition, EPA's website for the "Handbook for Implementing the Supplemental Cancer Guidance at Waste and Cleanup Sites" contains an up-to-date list of chemicals that EPA has determined to have a mutagenic MOA (http://www.epa.gov/oswer/riskassessment/sghandbook/index.htm). As chemicals receive new assessments for mutagenicity, this information will appear in the IRIS profile or PPRTV assessment.

FIGURE 3
GUIDANCE ON ASSESSING RISK FROM EARLY-LIFE EXPOSURES FOR CHEMICALS ACTING BY A MUTAGENIC MODE OF ACTION FOR CARCINOGENICITY

If a chemical has been determined to cause cancer by a mutagenic MOA, it is possible that exposures to that chemical in early-life may result in higher lifetime cancer risks than a comparable duration adult exposure.

In risk assessments of exposure to chemicals for which a mutagenic MOA for carcinogenicity has been determined by EPA and a linear low-dose extrapolation performed, one of the following generally pertains:

1) If chemical-specific data on susceptibility from early-life exposures were available for derivation of CSFs, those slope factors are used for risk characterization, and Age Dependent Adjustment Factors (ADAFs) are not applied.
2) If chemical-specific data on susceptibility from early-life exposures were not available, the ADAFs are applied in calculating or estimating risks associated with early-life exposures (USEPA, 2005c).

If the latter case applies, the *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens* (USEPA, 2005b) recommends the following default ADAFs be applied in risk assessments:

- 10-fold adjustment for exposures during the first 2 years of life;
- 3-fold adjustment for exposures from ages 2 to <16 years of age; and
- No adjustment for exposures after turning 16 years of age.

In such cases, Equation 11 can be altered to include the ADAFs in the following way:

$$\text{Risk} = (\text{IUR} \times \text{EC}_{<2} \times \text{ADAF}_{<2}) + (\text{IUR} \times \text{EC}_{2\text{-}16} \times \text{ADAF}_{2\text{-}16}) + (\text{IUR} \times \text{EC}_{>16})$$

Sources: USEPA, 2005b and USEPA, 2005c.
Note: All communications and factsheets pertaining to the implementation of the 2005 *Cancer Guidelines* can be found at www.epa.gov/osa/spc/cancer_guidelines.htm.

5.2 Hazard Quotients

The HQ for the inhalation pathway can be calculated with the following general equation:

HQ = EC/(Toxicity Value[1] x 1000 µg/mg) **(Equation 12)**

Where: HQ (unitless) = Hazard Quotient;
EC ($\mu g/m^3$) = exposure concentration (See Equations 7 or 8);
Toxicity Value (mg/m^3) = Inhalation toxicity value (e.g., RfC) that is appropriate for the exposure scenario (acute, subchronic, or chronic).

[1] Risk assessors should refer to the flowchart (Figure 2) to select an appropriate inhalation toxicity value for the exposure scenario at a site in order to calculate the HQ.

6. EXAMPLE EXPOSURE SCENARIOS

This section of the guidance includes examples of the types of exposure scenarios risk assessors may encounter when evaluating inhalation exposures at waste sites. Each scenario includes sample values for exposure parameters and reviews the process of estimating the EC and risks for cancer and other health effects. These examples are provided for illustrative purposes only and are not representative of every exposure scenario that could be encountered at a site. Furthermore, risk assessors should use site-specific values for exposure parameters if practicable when estimating ECs and risk levels or HQs. This would typically require some information on activity patterns for the specific site or the use of professional judgment. If default values are to be used for certain exposure parameters, please consult the Superfund website for up-to-date information on Superfund-recommended default exposure parameters.[34]

6.1 Residential Receptor

An example of a residential scenario could consist of inhalation exposure for up to 24 hours per day, up to 350 days per year for 6 to 30 years. When estimating cancer risk for this type of scenario, Equation 6 is recommended to calculate an EC and Equation 11 is recommended to estimate risk. For estimating hazard quotients for cancer or non-cancer effects, this scenario can be evaluated using the steps outlined in Figure 2. The duration of this scenario ranges from 6 to 30 years, which can be considered chronic (because it consists of repeated exposures for approximately 10 percent of a receptor's lifespan). The frequency of this scenario is generally as frequent as a chronic toxicity test and therefore Equation 8 is recommended to derive a chronic EC and Equation 12 with a chronic toxicity value is recommended to calculate an HQ. If information about multiple MEs is available, risk assessors should proceed according to Section 3.4 to estimate ECs to use in estimating cancer risks or HQs.

When assessing the risk under the residential scenario for children, the risk assessor should keep in mind that exposure parameters, specifically those related to activity patterns (e.g., exposure time, frequency, and duration) may be different for children and adults at the same site. For example, due

[34] http://www.epa.gov/oswer/riskassessment/superfund_hh_exposure.htm.

to outdoor play patterns, children may spend more time near the source of contamination than adults, and thus would have higher exposure time and/or exposure frequency values than adults living in the same location.[35] For indoor vapor intrusion from the subsurface, very young children might be more highly exposed due to substantial time spent indoors.

Beyond the consideration of activity patterns, MEs, and chemicals with a mutagenic MOA for carcinogenicity (as described in Section 5.1), no additional adjustments to account for specific child receptors should be made to the default values. Appendix A of this document is intended to illustrate that the use of default values sufficiently covers age-related variation in DAF or HEC values derived using the EPA *Inhalation Dosimetry Methodology's* default approach.

6.2 Commercial-Industrial/Occupational Receptor

An example of a commercial-industrial or occupational inhalation exposure scenario could be characterized by full-time workers (e.g., 8 hours per day, 5 days per week) in an indoor setting, such as an office building, exposed via vapor intrusion of subsurface contamination on a daily basis for 5 to 25 years. When estimating cancer risk for this type of scenario, Equation 6 is recommended to calculate an EC and Equation 11 is recommended to estimate risk. Following the flowchart in Figure 2, the duration and exposure pattern of this scenario would typically be considered chronic. Therefore, Equation 8 is recommended to derive a chronic EC and Equation 12 is recommended (with a chronic RfC) when calculating an HQ for cancer or non-cancer effects. If information about multiple MEs is available, risk assessors should proceed according to Section 3.4 when deriving ECs to use in estimating cancer risks or HQs. Exposure parameters should be adjusted to consider the exposure time, frequency and duration for this scenario, which may differ from a residential scenario. Risk assessors should also use appropriate exposure parameters for outdoor workers who, similar to children, may spend more time near a source of contamination than indoor workers.

6.3 Construction Worker

One example of a construction worker scenario could involve a long-term project (1-2 years) with workers exposed regularly to contaminant vapors and fugitive dust (8 hours per day, 5 days per week). When estimating cancer risk for this type of scenario, Equations 6 and 11 are recommended to calculate an EC and the risk estimate, respectively. Following the flowchart in Figure 2, the duration of this exposure scenario would typically be considered subchronic. In addition, this exposure is generally as frequent as a subchronic toxicity test. Therefore, Equation 8 is recommended to derive a subchronic EC, and Equation 12 is recommended for use with a subchronic toxicity value to calculate the HQ. If information about multiple MEs is available, risk assessors should proceed according to Section 3.4 when deriving ECs to use in estimating cancer risks or HQs.

6.4 Trespasser/Recreational Receptor

An example trespasser/recreational scenario could consist of an exposure of 1 to 2 hours per day, for 100 days per year or less. When estimating cancer risk for this type of scenario, Equations 6 and 11

[35] For additional information about early-lifestage age groups to consider when assessing children's exposure to environmental contaminants, please consult EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (EPA, 2005d).

are recommended to calculate an EC and the risk estimate, respectively. Following the steps in Figure 2 for cancer or non-cancer effects characterized by an RfC, each exposure period should be assessed separately because this exposure lasts only one to two hours each day for an average of two days per week. Therefore, Equation 7 is recommended to derive acute ECs for each exposure period. In addition, Equation 12 is recommended for use with an acute toxicity value to calculate HQs for each exposure period.

7. TARGET CONCENTRATIONS FOR SCREENING ANALYSIS OF INHALATION PATHWAYS

For purposes of this guidance, risk-based screening levels are values that may be compared to the contaminant concentration in air to help risk assessors identify potential contaminants of concern. Screening levels can also be calculated for comparison with samples from source media at a site, such as soil. Screening levels are generally not appropriate for use as clean-up levels; they are intended to aid in initial evaluation of contaminants and exposure pathways of concern prior to proceeding with a baseline risk assessment.[36] If contaminant concentrations in air exceed the risk-based screening levels appropriate for the receptor population of interest, risk assessors should gather site-specific information to determine the need for any remedial action. The following sections outline a recommended approach for calculating screening levels in air as well as source media.

7.1 Target Contaminant Concentrations in Air

The equations recommended for estimating ECs and risk (Equations 6 through 12) can be used to calculate target contaminant concentrations in air by following the four steps outlined below in Table 4.[37]

If air samples from a site are found to be below the target concentration, the risk assessor can generally conclude that this pathway does not pose an unacceptable level of risk from the contaminant. If the concentrations are found to exceed the screening levels, the risk assessor should evaluate the inhalation pathway further by gathering additional site-specific data on contaminant levels, site conditions, and receptor characteristics.

7.2 Screening Levels for Other Media

Inhalation risk-based screening levels may also be calculated for media other than air, including soils, tap water, soil gas, and ground water. The soil gas and ground water values may be derived specifically to address concerns about vapor intrusion from subsurface contamination into indoor spaces.

---

[36] EPA regions, states, or other agencies may support unique screening levels for specific purposes that may differ from the method presented in this document. Generally, when using screening levels it is important that risk assessors understand the target risks, toxicity, and exposure assumptions as well as migration-attenuation assumptions on which they are based, and to apply them for their intended use.

[37] Target contaminant concentrations in air calculated according to the procedure outlined in this document are generally protective for direct inhalation exposures. This process should not be used to calculate concentrations in air to be protective of indirect exposures (e.g., ingestion of crops contaminated through air delivery or vapor phase transfer, ingestion of livestock or fish contaminated indirectly through air deposition or vapor phase transfer).

TABLE 4
RECOMMENDED PROCEDURE FOR CALCULATING RISK-BASED SCREENING CONCENTRATIONS FOR CONTAMINANTS IN AIR

	Cancer Risk-Based	Hazard-Based[1]
Step 1: Select Target Levels	Select target cancer risk (e.g., 1 x 10^{-6}).	Select target HQ (e.g., 1).
Step 2: Identify Toxicity Value[2]	Identify inhalation cancer potency value (e.g., IUR). If none exists, proceed with hazard-based screening level calculation.	Identify inhalation reference value (e.g., RfC) to match exposure scenario (acute, subchronic, or chronic). If none exist, proceed with cancer screening level calculation.
Step 3: Calculate CA	Using target cancer risk from Step 1 along with the receptor- and scenario-specific exposure parameter values, calculate CA; the following equation is recommended: CA = (AT x Target Risk)/(IUR x ET x EF x ED)	Using target HQ from Step 1 along with the receptor- and scenario-specific exposure parameter values, calculate CA; the following equation is recommended: CA = (AT x Target HQ x RfC x 1000 µg/mg)/(ET x EF x ED)
Step 4: Select Screening Concentration	Select minimum of predicted cancer risk- and hazard-based values as screening concentrations.[3] Repeat for each receptor/scenario combination of interest.	

[1] Hazard-based screening concentrations are typically derived from reference values such as RfCs. These values may be available for non-cancer effects but may include cancer, if a nonlinear MOA is thought to operate for a chemical.
[2] If no inhalation toxicity value is available for a chemical, contact STSC for further direction on how to proceed.
[3] Screening levels estimated from the equations presented in Step 3 could yield concentrations that exceed the maximum possible vapor concentration for a chemical. In such cases, it may be useful to calculate the maximum possible vapor concentration of the pure contaminant at the temperature of interest, using the following formula: C_{max} = S x H x 10^3 L/m^3, where S = solubility at 25° C (or temperature of interest) and H (unitless) = Henry's Law Constant at 25° C (or temperature of interest). This equation is based on an established relationship (see, for example, Schwartzenbach et al. 1993), that allows the Henry's Law Constant to be estimated as the ratio of a compound's vapor pressure and aqueous solubility for compounds that are slightly to moderately soluble in water. When the dimensionless Henry's Law constant, H, is used, the relationship described above can be used to calculate the vapor concentration of a saturated solution of a given compound, assuming equilibrium between the vapor and aqueous phases.

7.2.1 Soil Screening Levels

When evaluating risk in a source medium, such as soil, it is typically possible to calculate screening levels for that medium that are expected to be protective of inhalation exposures based on the expected transfer of a contaminant from the source medium to the air. Soil Screening Levels (SSLs) can be described as "risk-based soil concentrations derived for individual chemicals of concern from standardized sets of equations. These equations combine EPA chemical toxicity data with parameters defined by assumed future land uses and exposure scenarios, including receptor characteristics and potential exposure pathways" (USEPA, 2002b). These SSLs may be used for screening analyses and may serve as the basis for the development of Preliminary Remediation Goals (PRGs). Refer to the *Soil Screening Guidance* (USEPA, 1996) and the *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (USEPA, 2002b) for recommended equations that can be used to calculate SSLs for volatilization of chemicals from soil to air and for particulate emissions.

7.2.2 Tap Water Screening Values

Contaminated tap water may pose risk by the inhalation route if the contaminants present are volatile. Screening levels can be calculated for tap water that account for inhalation exposures resulting from the household use of water (e.g., showering, laundering, dishwashing). Risk assessors should consult their local EPA regional risk assessor for direction on how to calculate appropriate screening levels for tap water.

7.2.3 Soil Gas or Ground Water Screening Values for Vapor Intrusion

If there is concern at a site about the possibility of migration of vapor-forming chemicals from contaminated soil gas or ground water into the indoor air of overlying buildings ("vapor intrusion"), screening values can be calculated for these media. Risk assessors should first follow the procedure outlined in Section 7.1 and Table 4 to calculate a risk-based target concentration for the contaminant in air.

For the calculation of a soil gas screening-level concentration, the target air concentration is then divided by an assumed screening-level attenuation factor. The attenuation factor (the ratio of indoor air divided by subsurface source concentration) represents the factor by which subsurface vapor concentrations migrating into indoor air spaces are reduced due to a variety of attenuating mechanisms.

For the calculation of a ground water screening-level concentration, the target air concentration is divided by an assumed screening-level attenuation factor, and the resulting soil gas concentration is converted to a corresponding ground water concentration, assuming equilibrium between the aqueous and vapor phases at the water table.

Risk assessors should consult their local EPA regional risk assessor for direction on how to calculate appropriate screening levels for soil gas and ground water when vapor intrusion is an issue at a site.

8. DEVELOPING AGGREGATE AND CUMULATIVE RISK ESTIMATES

EPA's current approach to estimating cumulative risk or hazard at a site from multiple chemicals, set forth in *RAGS, Part A* (USEPA, 1989), is not affected by the *Inhalation Dosimetry Methodology* and therefore is not being updated at this time. In addition, the aggregation of risks and hazards across multiple exposure routes should remain unchanged. The recommended approaches for aggregating risk and hazard estimates are outlined below.

8.1 Estimating Cumulative Risks and Hazards Across Multiple Chemicals

The recommended method for estimating cumulative risk and hazard at a site from exposure to multiple chemicals is described in *RAGS, Part A*, Section 8.2.2. This method is based on the default approaches described in *Guidelines for the Health Risk Assessment of Chemical Mixtures* (USEPA, 1986). Additional information on this method was subsequently published in the *Supplementary Guidance for Conducting Health Risk Assessment of Chemical Mixtures* (USEPA, 2000b). The recommended methods to use with quantitative cancer risk estimates as well as with HQs are outlined below.

8.1.1 Cancer Risks

When evaluating predicted cancer risks from multiple contaminants, risk assessors should estimate the cancer risk for each substance and then sum these risks. This yields an estimate of total cancer risk, which represents the cumulative predicted cancer risk for the chemicals at a site.

Risk assessors should note, however, that this recommended method assumes "independence of action by the compounds involved (i.e., that there are no synergistic or antagonistic chemical interactions and that all chemicals produce the same effect, i.e., cancer)" (USEPA, 1989). In addition, this simple additive approach is generally most appropriate for total cancer risks less than 0.1. If these assumptions are incorrect, over- or under-estimation of actual multiple-substance risk could result (USEPA, 1989).

8.1.2 Hazard Quotients

When the evaluation involves multiple chemicals assessed via HQs, risk assessors typically first calculate the HQ for each substance, and then sum the individual HQ values. This generally yields an estimated hazard index (HI) for the multiple chemicals assessed via a hazard-based approach. Separate HIs should be calculated for each type of exposure period (i.e., chronic, subchronic, acute). If an HI is greater than 1, it is generally appropriate to derive separate HIs for each target organ of concern (for more information, see *RAGS, Part A*, page 8-14).[38] When multiple acute exposures are present at a site, risk assessors should evaluate each acute exposure event separately. Hazards from multiple chemicals generally should be summed only when the exposures to these chemicals occur simultaneously.[39]

8.2 Aggregating Risk and Hazard Quotients Across Exposure Routes

Guidance for combining the multi-chemical risk estimates and hazard quotients across exposure pathways is described in *RAGS, Part A*, Section 8.3 (USEPA, 1989). In order to determine whether risks or HIs should be combined across exposure pathways, risk assessors should first identify reasonable exposure pathway combinations. Then, risk assessors should examine whether it is likely that the same individuals would consistently face the reasonable maximum exposure (RME) by more than one pathway.

---

[38] This recommended method assumes that "the dose for each individual component is at a level at which effects are not expected to occur, be observable, or be of concern; however, when the doses are combined, effects of concern may be expected or observed in response to the higher dose level of the mixture" (EPA, 2000b, page 12). Another assumption of the HI approach is that the compounds induce the same effect by the same mechanism of action. Therefore, "application of the HI equation to a number of compounds that are not expected to induce the same type of effects or that do not act by the same mechanism, although appropriate as a screening-level approach, could overestimate the potential for effects" (EPA, 1989, page 8-14). This is generally less of a concern if one to two substances are responsible for driving the HI above 1.

[39] In cases where a single chemical is present at a site and receptors are exposed through a series of acute exposure events, the highest single EC should be compared to an acute reference value of the appropriate duration to assess hazard.

The recommended approach for estimating excess cancer risk from exposure via multiple routes is to first estimate cancer risk from each exposure pathway and then sum across the multiple routes.[40]

For the effects assessed via a reference value, risk assessors should calculate the HI for each exposure pathway and sum across the multiple routes. Separate total HIs should be calculated for each type of exposure period (i.e., chronic, subchronic or acute). If the HI exceeds one, there may be concern for potential adverse effects and risk assessors should consider deriving separate HIs for each target organ of concern.

9. RISK CHARACTERIZATION

Risk characterization is the final, summarizing step in conducting a risk assessment. Generally, the purpose of the risk characterization section of a report is to:[41]

- Describe the key findings of the risk assessment in a transparent manner, including identifying hazard, characterizing the dose-response relationship, and describing receptor exposures;
- Identify and describe the scientific and policy assumptions used in the assessment;
- Characterize uncertainties in results; and
- Provide an overall conclusion about the risks present at a site (USEPA, 2000c).

A well-crafted risk characterization section puts risk calculations into context for risk managers so that they may effectively weigh and interpret risk assessment results (i.e., it is the interface between risk assessment and risk management). A few of the key issues and uncertainties involved in calculating risks from inhalation exposures are outlined below.

9.1 Highly Exposed or Susceptible Populations and Life Stages

EPA recommends that the risk characterization portion of the risk assessment explain any particular susceptibilities to inhaled toxicants or potential for increased inhalation exposures among the various receptor groups at a site.[42] We discuss below two possible examples, children and worker receptors, though this discussion could apply to other receptor characteristics as well (e.g., age, disease, gender, genetic characteristics).

9.1.1 Children

One population group that could potentially be more highly exposed to inhalation exposures at a site is children. As discussed in Section 6.2, exposure parameters related to activity patterns (e.g., exposure time, frequency, and duration) and MEs, may vary across age groups. For example, due to outdoor play patterns, children may spend more time near the source of contamination than adults,

[40] Note that this approach is generally most appropriate for total cancer risks of less than 0.1 (EPA, 1989).

[41] For specific information on the format of risk characterizations, refer to *Elements to Consider when Drafting EPA Risk Characterizations* (EPA, 1995c).

[42] EPA's IRIS glossary defines susceptibility as the following: "Increased likelihood of an adverse effect, often discussed in terms of relationship to a factor that can be used to describe a human subpopulation (e.g., life stage, demographic feature, or genetic characteristic)" (EPA, 2008b).

and thus would have higher exposure time and/or exposure frequency values than adults living in the same location. Therefore, it is important to carefully describe site-specific exposures to children, and assumptions made in risk calculations.[43]

If chemical-specific data on susceptibility to the toxic effects from early life exposures are available, these data are considered when developing toxicity values that specifically address differential toxicity to the young (e.g., vinyl chloride) (USEPA, 2005c). Toxicity values derived using the default approach from the *Inhalation Dosimetry Methodology* are developed for the human population as a whole, including sensitive subgroups. Therefore, as described in Section 6 of Appendix A, no quantitative adjustment of toxicity values derived using the default approach in the *Inhalation Dosimetry Methodology* is recommended for specific age groups to account for different ventilation rates or body weights of specific age groups.

When evaluating risk to carcinogenic chemicals with a demonstrated mutagenic MOA but which lack chemical-specific information on susceptibility from early life exposures, EPA recommends a quantitative adjustment of the toxicity value to account for early life susceptibility, as described in the *Supplemental Cancer Guidelines* (see USEPA, 2005b & 2005c; and Section 5.1 of this guidance for further information).

9.1.2 Workers

Workers could have increased exposure under certain occupational scenarios. Some outdoor workers might spend more time near a source of contamination in the course of their job and this should be reflected in adjustments to the exposure parameters (e.g., ET, Exposure Frequency (EF), and ED) describing the worker exposure scenario. Toxicity values derived using the *Inhalation Dosimetry Methodology* are developed for the human population as a whole, including sensitive populations and life stages. In the default *Inhalation Dosimetry Methodology* approach, typical variation in IRs between periods of high activity and rest is considered. However, if workers have especially high levels of exertion with correspondingly high ventilation rates, these workers could be at the upper end of the risk range, particularly if they are exposed to Category 1 gases, which have direct effects in the respiratory tract. This implication should be recognized in the risk characterization section.

9.2 Uncertainties in Inhalation Risk Assessment

This guidance recommends including an assessment of the key uncertainties that may significantly impact risk estimates for inhaled chemicals. This should ensure transparency, clarity, reasonableness and consistency in risk assessments, as recommended by EPA's *Policy for Risk Characterization* (USEPA, 1995a). Other sources of uncertainty may be present and other EPA documents provide guidance on characterizing uncertainty in risk the assessment process (USEPA, 1992, 1995a, 1995b, 1995c, 1997a, 1997b). Key uncertainties related to inhalation risk assessment, which is the focus of this section, include the development of ECs, choice of toxicity value, lack of quantitative toxicity information via inhalation, and the approach to estimating and aggregating risks. According to EPA's *Guidance for Risk Characterization*, the discussion of uncertainty "should reflect the type and complexity of the risk assessment, with the level of effort for analysis and discussion of uncertainty

[43] For additional information on children's health risk assessment, please consult *A Framework for Assessing Health Risks of Environmental Exposures to Children* (EPA, 2006b).

corresponding to the level of effort for the assessment" (USEPA, 1995b). Therefore, risk assessors should provide a qualitative and/or quantitative evaluation of key uncertainties pertaining to inhalation risk, and their impact on the outcome of the assessment, consistent with the level of effort of the specific risk assessment.

9.2.1 Development of Exposure Concentrations

As described in Section 3 of this guidance, with the exception of acute exposures, time-weighted averages are typically used to represent intermittent or variable inhalation exposures to receptors at a site. This recommended approach is consistent with the duration adjustment approach (based on Haber's Law) that is generally used in deriving the toxicity values (see Section 2.1.1.1 for further information). As mentioned in Section 3, when evaluating situations in which the exposure is long-term, yet there are short periods of significantly higher exposure, those periods should also be assessed using appropriate short-term toxicity values. This ensures that periods of much higher exposure can be appropriately assessed and not "diluted out" in the assessment of longer-term exposure.

When information on multiple MEs exists at a site, risk assessors may choose to estimate ECs as outlined in Section 3.4. However, this typically requires sufficient time-activity information of receptors at a site to accurately determine the time spent in each ME. Incomplete or low quality data on time-activity pattern may introduce uncertainty into the estimation of the ECs for MEs. Risk assessors should describe the quality and completeness of these data.

The recommended method for determining the CA at a site can potentially introduce uncertainty into the EC calculations. For instance, if contaminant concentrations in air are measured, risk assessors should consider uncertainties related to how well the set of air samples available at a site represents the duration and time period being assessed as well as measurement uncertainty related to the methods and equipment used. In addition, risk assessors should describe any potential confounding of indoor air samples by other sources of contaminants (e.g., household products). If contaminant concentrations in air are modeled, (e.g., by EPA's spreadsheet models for vapor intrusion) risk assessors should address model-related uncertainties and their potential impact on the estimate of contaminant concentrations in air. Considerations of particle size at the site versus particle size used to derive the toxicity value are also important.

9.2.2 Toxicity Assessment

Section 4.1 of this document indicates that some IURs on IRIS were developed through extrapolation from oral CSFs (see Appendix B of this document). The use of toxicity values derived through simple route-to-route extrapolation introduces additional uncertainty into risk calculations. Therefore, risk assessors should indicate when extrapolated IURs are used and should characterize the potential impact of the uncertainty associated with using these values, if known.

Section 4.2 and Appendix C of this guidance recommends contacting STSC to help identify appropriate toxicity values for conducting a risk assessment at Superfund sites in the absence of published inhalation toxicity values. If STSC is unable to recommend a toxicity value, risk assessors should acknowledge the resulting uncertainty in risk associated with the chemical(s) lacking inhalation toxicity data. If STSC provides risk assessors with a toxicity value based on a PBPK

model, model uncertainty should be discussed. In addition, if STSC provides risk assessors with one or more structurally analogous chemicals, risk assessors can use toxicity data for these chemicals to help characterize the potential magnitude of the inhalation risk associated with the chemical(s) lacking data. In this case, risk assessors should acknowledge the uncertainty associated with relying on toxicity data for analogous chemicals to characterize risk at the site.

Risk assessors should also acknowledge chemicals that lack duration-appropriate toxicity values and discuss the potential impacts of substituting alternative toxicity values for HQ calculations. For instance, if the ED is determined to be subchronic but no subchronic inhalation RfC or analogous toxicity value is available for that chemical, the risk assessor should address the uncertainty associated with calculating an HQ using a toxicity value for a different duration, such as chronic, or the impact of not quantifying those risks. In addition, if risk assessors use an acute toxicity value that does not match the duration of the acute exposure being assessed, the possibility of under or overestimating hazard should be discussed.

When conducting a screening-level risk assessment using screening values such as those described in Section 7, it is important to further evaluate and clearly describe the quality and uncertainties associated with the inhalation toxicity values used in the risk assessment if measured sample contaminant concentrations at a site exceed these screening values.

9.2.3 Estimating Cancer Risks

For high exposures, for example those within the range of epidemiological studies (usually those predicted to have risks greater than 10^{-2}), the IUR derived from the linear extrapolation below the range of observation is generally not appropriate for use (see Section 5.1 of this document for further information).[44] Risk assessors should provide specific information in the risk characterization describing how these high exposures were addressed in the risk assessment. For instance, if a risk assessor chose to provide a semi-quantitative approach (e.g., indicating that risks are above 10^{-2}), this should be indicated, along with a description of the uncertainties involved in not fully quantifying risk associated with exposure to this chemical. If a risk assessor chose to use the original model in the IRIS file or other technical background document, the risk characterization section should include a description of any uncertainties in the model used and could contain examples of the risks estimated.

9.2.4 Estimating Risk and Hazard from Multiple Chemicals and Exposure Pathways

Risk assessors should also describe uncertainties involved in aggregating risk and hazard across multiple chemicals and exposure pathways. For instance, the approaches described in Section 8 of this document are associated with several assumptions (e.g., independence of action and doses for individual compounds at levels not expected to be of concern). If these assumptions are not met, aggregation may not be appropriate. This should be fully described in the risk characterization section and any uncertainties involved in the lack of quantitative information should be indicated.

[44] Also refer to Section 8.2.1 of *RAGS, Part A* for further discussion of this topic (EPA, 1989, page 8-6).

10. REFERENCES

Eaton, D.L. and Klaassen, C.D. (2001). "Principles of Toxicology" in *Casarett and Doull's Toxicology: The Basic Science of Poisons*, Klaassen, C.D., editor. McGraw-Hill Publishing Division, 6th Edition, page 14.

Gaylor, D.W. (2000). *The Use of Haber's Law in Standard Setting and Risk Assessment.* Toxicology 149:17-19. Johnson, P.C. and Ettinger, R.A. (1991). *Heuristic Model for Predicting the Intrusion Rate of Contaminant Vapors into Buildings.* Environmental Science and Technology 25: 1445-1452. http://www.epa.gov/oswer/riskassessment/airmodel/johnson_ettinger.htm

Schwarzenbach, R.P., P.M. Gschwend, and D.M. Imboden. (1993). *Environmental Organic Chemistry*. John Wiley & Sons, Inc.: New York.

U.S. EPA. (1986). *Guidelines for Health Risk Assessment of Chemical Mixtures*. Risk Assessment Forum, Washington, D.C. EPA/630/R-98/002. http://www.epa.gov/ncea/raf/pdfs/chem_mix/chemmix_1986.pdf

U.S. EPA. (1989). *Risk Assessment Guidance for Superfund, Volume 1, Part A.* Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002. http://www.epa.gov/oswer/riskassessment/ragsa/index.htm

U.S. EPA. (1991). *Risk Assessment Guidance for Superfund, Volume 1, Part B.* Office of Emergency and Remedial Response, Washington, D.C. EPA/540/R-92/003. http://www.epa.gov/oswer/riskassessment/ragsb/

U.S. EPA. (1992). *Memorandum: Guidance on Risk Characterization for Risk Managers and Risk Assessors*. From F. Henry Habicht II, Deputy Administrator, U.S. EPA, Washington, DC. http://www.epa.gov/oswer/riskassessment/pdf/habicht.pdf

U.S. EPA. (1994). *Methods of Derivation of Inhalation Reference Concentrations and Application of Inhalation Dosimetry*. Office of Research and Development, Research Triangle Park, NC. EPA/600/8-90/066F. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=71993.

U.S. EPA. (1995a). *Policy for Risk Characterization*. From Carol Browner, Administrator, U.S. EPA, Washington, DC.

U.S. EPA. (1995b) *Guidance for Risk Characterization*. Science Policy Council. February. http://www.epa.gov/osa/spc/pdfs/rcguide.pdf

U.S. EPA. (1995c). *Elements to Consider when Drafting EPA Risk Characterizations.* March. http://www.epa.gov/osa/spc/pdfs/rcelemen.pdf

U.S. EPA. (1996). *Soil Screening Guidance: User's Guide, Second Edition*. Office of Solid Waste and Emergency Response, Washington, D.C. EPA/540/R95/128. http://www.epa.gov/superfund/resources/soil/ssg496.pdf

U.S. EPA. (1997a). *Exposure Factors Handbook*. Office of Research and Development,

Washington, DC. EPA/600/P-95/002Fa. http://www.epa.gov/ncea/pdfs/efh/front.pdf

U.S. EPA. (1997b). *Policy for Use of Probabilistic Analysis in Risk Assessment*. From Fred Hansen, Deputy Administrator, Washington, DC.

U.S. EPA. (1998). *Route-to-Route Extrapolations*. Memorandum from John E. Whalan and Hugh M. Pettigrew to Margaret Stasikowski. Office of Prevention, Pesticides, and Toxic Substances. October 10, 1998.

U.S. EPA. (2000a). *Integrated Risk Information System Summaries: Vinyl Chloride*. Office of Research and Development, Washington, D.C. http://www.epa.gov/iris/subst/1001.htm

U.S. EPA. (2000b). *Supplementary Guidance for Conducting Health Risk Assessment of Chemical Mixtures*. EPA/630/R-00/002. http://www.epa.gov/ncea/raf/pdfs/chem_mix/chem_mix_08_2001.pdf

U.S. EPA. (2000c). *Risk Characterization Handbook*. Science Policy Council, Washington, D.C. EPA-100-B-00-002. http://www.epa.gov/osa/spc/pdfs/rchandbk.pdf

U.S. EPA. (2001). *Risk Assessment Guidance for Superfund, Volume 1, Part D.* Office of Emergency and Remedial Response, Washington, D.C. Publication 9285.7-47. http://www.epa.gov/oswer/riskassessment/ragsd/index.htm

U.S. EPA. (2002a). *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance).* Office of Solid Waste and Emergency Response, Washington, D.C. http://www.epa.gov/epawaste/hazard/correctiveaction/eis/vapor/complete.pdf

U.S. EPA. (2002b). *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites*. Office of Solid Waste and Emergency Response, Washington, D.C. Publication 9335.4-24. http://www.epa.gov/superfund/health/conmedia/soil/pdfs/ssg_main.pdf

U.S. EPA. (2002c). *A Review of the Reference Dose and Reference Concentration Processes*. Risk Assessment Forum, Washington, DC, EPA/630/P-02/002F. http://cfpub.epa.gov/ncea/raf/recordisplay.cfm?deid=55365

U.S. EPA. (2003). *Human Health Toxicity Values in Superfund Risk Assessment*. Office of Solid Waste and Emergency Response, Washington, D.C. Publication 9285.7-53. http://rais.ornl.gov/homepage/hhmemo.pdf.

U.S. EPA. (2004a). *User's Guide for Evaluating Subsurface Vapor Intrusion Into Buildings*. Office of Emergency and Remedial Response, Washington, D.C.

U.S. EPA. (2004b). *Air Quality Criteria for Particulate Matter: Volume II.* Office of Research and Development, Washington, D.C. EPA/600/P-95/001bF.

U.S. EPA. (2005a). *Guidelines for Carcinogen Risk Assessment*, Risk Assessment Forum, Washington, D.C. EPA/630/P-03/001F. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=116283

U.S. EPA. (2005b). *Supplemental Guidance for Assessing Cancer Susceptibility from Early-Life Exposure to Carcinogens*. Risk Assessment Forum, Washington, DC. EPA/630/R-30/003F. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=160003

U.S. EPA. (2005c). *Implementation of the Cancer Guidelines and Accompanying Supplemental Guidance – Science Policy Council Cancer Guidelines Implementation Workgroup Communication I: Application of the mode of action framework in mutagenicity determinations for carcinogenicity*. Memorandum from William H. Farland, Chair, Science Policy Council to Science Policy Council Steering Committee October 4, 2005. http://www.epa.gov/osa/spc/pdfs/canguid1.pdf

U.S. EPA. (2005d). *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants*. Risk Assessment Forum, Washington, DC. EPA/630/P-03/003F. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=146583.

U.S. EPA. (2006a). *Approaches for the Application of Physiologically Based Pharmacokinetic (PBPK) Models and Supporting Data in Risk Assessment.* National Center for Environmental Assessment, Washington, DC. EPA/600/R-05/043F. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=157668.

U.S. EPA. (2006b). *A Framework for Assessing Health Risks of Environmental Exposures to Children.* National Center for Environmental Assessment, Washington, DC. EPA/600/R-05/093F. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=158363.

U.S. EPA. (2008a). *Regional Screening Levels for Chemical Contaminants at Superfund Sites*. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm.

U.S. EPA. (2008b). *Integrated Risk Information System, Glossary of Terms*. Office of Research and Development. Searched September, 2008. http://www.epa.gov/iris/help_gloss.htm#content

APPENDICES

TABLE OF CONTENTS

APPENDIX A: ANALYSIS OF DEFAULT APPROACH FOR HEC DERIVATION AS COMPARED TO POPULATION- AND LIFE STAGE-SPECIFIC CALCULATIONS

INTRODUCTION A-1

1. EXAMPLE 1: CATEGORY 1 GAS, EXTRATHORACIC EFFECTS, ACROLEIN A-3

2. EXAMPLE 2: CATEGORY 1 GAS, TRACHEOBRONCHIAL EFFECTS, HYPOTHETICAL CHEMICAL A-4

3. EXAMPLE 3: CATEGORY 1 GAS, PULMONARY EFFECTS, HYPOTHETICAL CHEMICAL A-5

4. CATEGORY 3 GASES A-7

5. PARTICLE DEPOSITION ACROSS AGE GROUPS A-7

6. CONCLUSIONS A-10

7. REFERENCES CITED A-11

8. ADDITIONAL SOURCES OF RELATED INFORMATION A-13

APPENDIX B: CHEMICALS ON IRIS WITH EXTRAPOLATED INHALATION UNIT RISKS

APPENDIX C: STSC'S PROCESS FOR DERIVING ALTERNATIVE INHALATION TOXICITY VALUES

LIST OF TABLES

Table A-1 Calculation of $LOAEL_{[HEC]}$ Values for Humans of Different Ages and Activity Patterns for the Extrathoracic Region A-4

Table A-2 Calculation of $NOAEL_{[HEC]}$ Values for Humans of Different Ages and Activity Patterns for the Tracheobronchial Region A-5

Table A-3 Calculation of $NOAEL_{[HEC]}$ Values for Humans of Different Ages and Activity Patterns for the Pulmonary Region A-6

Table A-4 Particle Deposition Across Age Groups A-9

Table B-1 Chemicals with Extrapolated Inhalation Unit Risks on Iris B-2

LIST OF EQUATIONS

Equation A-1 $RGDR_{ETh}$ A-3

Equation A-2 $RGDR_{TB}$ A-4

Equation A-3 $RGDR_{PU}$ A-5

Equation A-4 Category 3 DAF A-7

Equation A-5 $RDDR_r$ A-7

Equation A-6 $RDDR_{ER}$ A-8

APPENDIX A

APPENDIX A

ANALYSIS OF DEFAULT APPROACH FOR HEC DERIVATION AS COMPARED TO POPULATION- AND LIFESTAGE-SPECIFIC CALCULATIONS

NOTE: The Agency's inhalation dosimetry methodology (USEPA, 1994; hereafter, "the *Inhalation Dosimetry Methodology"*) is a technical report that describes the derivation of human equivalent concentrations (HECs) from animal (or human) studies, as well as the other steps involved in developing a chronic Reference Concentration (RfC). This appendix is included to illustrate the HEC derivation using the *Inhalation Dosimetry Methodology*'s default approach (with the recommended default values for humans), and to also illustrate the impact of substituting alternate age- and activity-specific human values into the default calculations. The default approach is employed for chemicals for which more chemical-specific dosimetric and pharmacokinetic data are not available, thus precluding the use of more advanced models for deriving the HEC. The calculations in this appendix do not represent a refined or optimal model for assessing intra-human variability (e.g., age- and activity-specific risks), and are not intended to imply that risk assessors should deviate from the *Inhalation Dosimetry Methodology* by substituting alternate values into the default calculations. Age-specific data are limited. Because of these limitations, the calculations made for different ages and exposure groups in this appendix are not recommended for use in quantitative risk assessment (i.e., they are only for the purpose of illustration), but may be useful in discussions of uncertainty and variability associated with the default approach.

It is also noted that, as of this writing, the Agency is involved in a routine reevaluation of scientific advancements in the field, with consideration of the need for improvement to the *Inhalation Dosimetry Methodology*. Any revisions will consider current understanding of inhalation dosimetry and differences across and within species, as well as the Agency's risk assessment needs. In order to transparently and quantitatively address children's inhalation dosimetry and risk assessment, this guidance document will be updated (on-line) when Agency methodology updates are available that are specific to early life. Until that time, the 1994 *Inhalation Dosimetry Methodology* is the appropriate Agency methodology.

INTRODUCTION

This appendix consists of examples and discussions illustrating the current default chemical category-specific approach to inhalation dosimetry for the various categories of gases and particles as described in *Methods for Derivation of Inhalation Reference Concentrations and Application of Inhalation Dosimetry* (USEPA, 1994; hereafter, the *Inhalation Dosimetry Methodology*). This default inhalation dosimetry approach is used to convert toxicological and epidemiological study data to an HEC that can then be used to derive chronic RfCs for the human population (inclusive of susceptible populations and life stages, such as children) and also in the development of Inhalation Unit Risks (IURs) (USEPA, 2005). The default approach does not rely on age- or activity-specific values for physiological parameters when calculating HECs; however the default approach has been designed by EPA to derive reference values that are protective across the entire population.

The appendix includes six sections. Sections 1 through 3 address Category 1 gases. These sections provide example calculations for Category 1 highly reactive, high water solubility gases that are typically absorbed in the upper airways, exhibiting adverse effects in the extrathoracic (ETh), tracheobronchial (TB), and pulmonary (PU) regions of the respiratory tract, respectively. These examples include comparisons of HEC calculations based on default parameters with those derived using age- and activity-specific parameters for the respiratory region affected. Section 4 addresses Category 3 low reactivity, limited water solubility gases that exhibit systemic effects outside the respiratory tract. Section 5 addresses changes in particle deposition in the respiratory tract across age groups. The conclusions are summarized in Section 6.

When reviewing the examples, please note the following:

- An RfC derived using the *Inhalation Dosimetry Methodology* is defined as "an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime" (USEPA, 2008).

- All examples in this appendix are based on the *Inhalation Dosimetry Methodology*. EPA is committed to periodically reviewing and updating the *Inhalation Dosimetry Methodology* to ensure that it reflects the current state of the science and that it yields toxicity values that sufficiently cover potential age- and activity-related variation in inhalation exposure. A review and update is currently underway.

- The examples in this appendix are all based on calculating HECs from a point of departure (POD) for non-cancer effects (e.g., a No Observed Adverse Effect Level (NOAEL), Lowest Observed Adverse Effect Level (LOAEL), or Benchmark Concentration, Lower confidence limit (BMCL)). These calculations could also be performed in an identical manner for carcinogens using a POD for cancer risk estimate derivation (e.g., a Lower limit on the Effective Concentration (LEC) value).

- The default animal and human values for minute volume (V_e) and surface area (SA) used in these examples were obtained from *Methods for Derivation of Inhalation Reference Concentrations and Application of Inhalation Dosimetry* (USEPA, 1994).[45] The age- and activity-specific V_e values were obtained from the International Commission on Radiological Protection (ICRP) Publication 66, *Human Respiratory Tract Model for Radiological Protection* (ICRP, 1994).[46] Age-specific SA values used in Examples 1 and 2 were calculated using scaled estimates for the mass and thickness of respiratory region-specific target tissue from ICRP (1994); Values for Example 3 were calculated from an allometric scaling equation presented in a publication by Zeltner et al. (1987). EPA's Office of Research and Development (ORD) selected these data following review of the available physiological data for the age groups indicated in the examples.

- Chemical-specific data from the Integrated Risk Information System (IRIS) file for acrolein were used in the ETh example (Example 1). However, the other two examples, which focus on effects in the TB and PU regions, respectively, use hypothetical data for the POD because there are currently no chemicals on IRIS exhibiting Critical Effects (for RfC derivation) in those regions.[47] The conclusions of these two examples are unaffected by the use of hypothetical data because the results are driven by the values of parameters that are not chemical-specific (i.e., SA and V_e).

[45] The minute volume is the total ventilation per minute and equals the product of the tidal volume (the air volume entering or leaving the lungs with a single breath) and the respiratory frequency.

[46] For further information on inhalation rates in humans under different scenarios, refer to Chapter 5 of EPA's *Exposure Factors Handbook* (EPA, 1997).

[47] Hypothetical examples for the TB and PU regions were included in this appendix because currently no RfCs for gases on IRIS are calculated based on animal studies showing health effects occurring in these regions of the respiratory system

1. EXAMPLE 1: CATEGORY 1 GAS, EXTRATHORACIC EFFECTS, ACROLEIN

The Dosimetric Adjustment Factor (DAF) for a Category 1 gases, the Regional Gas Dose Ratio (RGDR), is based on the animal to human ratio of the V_e divided by the SA of the region of the respiratory tract where the effect occurs. For acrolein, the effect occurs in the ETh region. The DAF is typically calculated using the following equation (USEPA, 1994, Equation 4-18):

$$RGDR_{ETh} = \frac{\left(\frac{V_e}{SA_{ETh}}\right)_{animal}}{\left(\frac{V_e}{SA_{ETh}}\right)_{human}} = \frac{\frac{0.14\,L/min}{15\,cm^2}}{\frac{13.8\,L/min}{200\,cm^2}} = 0.14 \qquad \textbf{(Equation A-1)}$$

The default *Inhalation Dosimetry Methodology*-recommended values for the V_e and SA_{ETh} of the Wistar rat (the animal in the principal study for acrolein) are 0.14 L/min (0.20 m^3/day) and 15 cm^2, respectively (USEPA, 1994). EPA's default human values are 13.8 L/min (20 m^3/day) for V_e and 200 cm^2 for SA_{ETh} (USEPA, 1994). The RGDR for the ETh region ($RGDR_{ETh}$) was calculated using these values for the rat and the human as shown in Equation A-1. In the laboratory animal study on acrolein, the LOAEL adjusted for continuous exposure ($LOAEL_{[ADJ]}$) of 0.16 mg/m^3 (USEPA, 2003) is used as the point of departure. The $LOAEL_{[HEC]}$ is the $LOAEL_{[ADJ]}$ multiplied by the $RGDR_{ETh}$.

To illustrate any potential age- or activity-related variation in the $LOAEL_{[HEC]}$ that might result from using human parameter values other than the defaults, scaled estimates for the mass and thickness of ETh target tissue from ICRP (1994) at different ages are used to calculate the SA_{ETh} values in Table A-1. Age- and activity-related V_e reported in ICRP (1994) are based on daily time-budgeted reference values. Table A-1 shows little variation in the resultant $LOAEL_{[HEC]}$ across the groups in this example. The default procedure produces the lowest $LOAEL_{[HEC]}$ value in Table A-1 and is, therefore, sufficient to cover all of these groups.

TABLE A-1 COMPARISON OF THE HEC-DEFAULT (EPA, 1994) WITH EXAMPLE $LOAEL_{[HEC]}$ VALUES FOR HUMANS OF DIFFERENT AGES AND ACTIVITY PATTERNS FOR THE EXTRATHORACIC REGION					
	Total $V_{e\ (human)}$ (L/min)[a]	**$SA_{ETh\ (human)}$ (cm^2)[b]**	**$(V_e/SA_{ETh})_{human}$ (L/min-cm^2)**	**$RGDR_{ETh}$**	**$LOAEL_{[HEC]}$ (mg/m^3)**
Outdoor Worker, Male	17.5	470	0.037	0.25	0.04
Sedentary Worker, Male	15.4	470	0.033	0.28	0.04
Sedentary Worker, Female	12.6	407	0.031	0.30	0.05
15 Year-Old Male	14.0	439	0.032	0.29	0.05
15 Year-Old Female	10.9	397	0.027	0.35	0.06
10 Year-Old	10.6	293	0.036	0.26	0.04
5 Year-Old	6.1	198	0.031	0.30	0.05
1 Year-Old	3.6	97.1	0.037	0.25	0.04
3 Month-Old	2.0	65.8	0.030	0.31	0.05
HEC - Default	13.8	200	0.069	0.14	0.02
[a] These values are from the ICRP publication, Tables 8, 27, B.16a, B.16b and B.17 (ICRP, 1994). [b] These values are from the ICRP publication, Tables 1 and 5 (ICRP, 1994).					

2. EXAMPLE 2: CATEGORY 1 GAS, TRACHEOBRONCHIAL EFFECTS, HYPOTHETICAL CHEMICAL

The DAF for a Category 1 gas or vapor exhibiting effects in the TB region is based on the animal to human ratio of the V_e divided by the SA of the TB region for each species. The DAF is typically calculated using the following equation:

$$RGDR_{TB} = \frac{\left(\frac{V_e}{SA_{TB}}\right)_{animal}}{\left(\frac{V_e}{SA_{TB}}\right)_{human}} = \frac{\frac{0.14\ L/min}{22.5\ cm^2}}{\frac{13.8\ L/min}{3200\ cm^2}} = 1.4 \qquad \textbf{(Equation A-2)}^{48}$$

This example assumes that the hypothetical chemical has been tested on Wistar rats and therefore utilizes the EPA animal default values for that strain. The V_e value used is 0.14 L/min (0.20 m^3/day) and the default SA_{TB} is 22.5 cm^2 (USEPA, 1994). EPA's default human values are 13.8 L/min (20 m^3/day) for V_e and 3200 cm^2 for SA_{TB} (USEPA, 1994). The RGDR for the TB region ($RGDR_{TB}$) is calculated using these values for the rat and the human, as shown in Equation A-2. The example also assumes a NOAEL adjusted for continuous exposure ($NOAEL_{[ADJ]}$) of 0.16 mg/m^3 as the point of departure. The $NOAEL_{[HEC]}$ is the $NOAEL_{[ADJ]}$ multiplied by the $RGDR_{TB}$.

Table A-2 shows little variation across age and activity groups in the $NOAEL_{[HEC]}$. The variation from the default (less than a factor of 2) is less than the default value of 10 used for the uncertainty factor for intraspecies variability when deriving the RfC. Application of the normal procedure for

[48] This equation is the reduced, default version of Equation 4-19 of the *Inhalation Dosimetry Methodology*. Equation 4-19 is reduced to this form consistent with the derivation of the reduced form of the RGDR equation of extrathoracic effects described in section 4.3.6.1 and Appendix I of the *Inhalation Dosimetry Methodology*.

determining the RfC will accommodate the observed variation. In addition, RfCs and IURs are developed for chronic exposure and will generally involve an exposure for multiple years.

TABLE A-2
COMPARISON OF THE HEC-DEFAULT (EPA, 1994) WITH EXAMPLE $LOAEL_{[HEC]}$ VALUES FOR HUMANS OF DIFFERENT AGES AND ACTIVITY PATTERNS FOR THE TRACHEOBRONCHIAL REGION

	Total $V_{e\ (human)}$ (L/min)[a]	$SA_{TB\ (human)}$ (cm^2)[b]	$(V_e/SA_{TB})_{human}$ (L/min-cm^2)	$RGDR_{TB}$	$NOAEL_{[HEC]}$ (mg/m^3)
Outdoor Worker M	17.5	2660	0.0066	0.94	0.15
Sedentary Worker M	15.4	2660	0.0058	1.1	0.18
Sedentary Worker F	12.6	2640	0.0048	1.3	0.21
15 year M	14.0	2520	0.0056	1.1	0.18
15 year F	10.9	2250	0.0048	1.3	0.21
10 Year	10.6	1830	0.0058	1.1	0.18
5 Year	6.1	1340	0.0046	1.4	0.22
1 Year	3.6	857	0.0042	1.5	0.24
3 Months	2.0	712	0.0028	2.2	0.35
HEC-default	13.8	3200	0.0043	1.4	0.22

[a] These values are from the ICRP publication, Tables 8, 27, B.16a, B.16b and B.17 (ICRP, 1994).
[b] These values are from the ICRP publication, Tables 1 and 5 (ICRP, 1994).

3. EXAMPLE 3: CATEGORY 1 GAS, PULMONARY EFFECTS, HYPOTHETICAL CHEMICAL

The DAF for a Category 1 gas or vapor with an effect in the PU region is based on the animal to human ratio of the alveolar ventilation rate (Q-alv) divided by the SA of the PU region (SA_{PU}) for each species. The Q-alv is approximately equal to the V_e multiplied by 0.7. This adjustment accounts for the anatomic/physiologic deadspace in the PU region, making the Q-alv equivalent to the amount of inspired air available for gas exchange (West, 2000). The DAF for this region of the respiratory tract is typically calculated using the following equation:

$$RGDR_{PU} = \frac{\left(\frac{Q-alv}{SA_{PU}}\right)_{animal}}{\left(\frac{Q-alv}{SA_{PU}}\right)_{human}} = \frac{\frac{0.1\,L/min}{0.34\,m^2}}{\frac{9.7\,L/min}{54\,m^2}} = 1.6 \qquad \textbf{(Equation A-3)}^{49}$$

This example assumes that the hypothetical chemical has been tested on Wistar rats and therefore utilizes the EPA animal default values for that strain. The V_e valued used is 0.14 L/min (0.20 m^3/day), which when multiplied by 0.7, yields a Q-alv of 0.1 L/min. The example uses the EPA default rat SA_{PU} of 0.34 m^2 (USEPA, 1994). EPA's default human values are 13.8 L/min (20

[49] This equation is the reduced, default version of Equation 4-23 of the *Inhalation Dosimetry Methodology*. Equation 4-23 is reduced to this form consistent with the derivation of the reduced form of the RGDR equation of extrathoracic effects described in section 4.3.6.1 and Appendix I of the *Inhalation Dosimetry Methodology*.

m^3/day) for V_e (which yields a Q-alv of 9.7 L/min) and 54 m^2 for SA_{PU} (USEPA, 1994). The RGDR for the PU region ($RGDR_{PU}$) is calculated using these values for the rat and the human, as shown in Equation A-3. The example also assumes a $NOAEL_{[ADJ]}$ of 0.16 mg/m^3 as the point of departure. The $NOAEL_{[HEC]}$ is the $NOAEL_{[ADJ]}$ multiplied by the $RGDR_{PU}$.

Table A-3 below provides the Q-alv values for humans based on the daily time-budgeted V_e for different ages and activity levels from the ICRP publication (1994). SA data for the PU region in the ICRP publication are estimated using an allometric scaling model fitted to data from a morphometric analysis of SA_{PU} in a sample of seven children (ranging in age from 26 days to 5 years) and eight adults (Zeltner et al., 1987). ORD selected the Zeltner analysis for this example because these SA_{PU} data are based on empirical morphometric measurements of human lungs as opposed to scaled estimates determined from lung models (such as those done by Yu and Xu, 1987 or Yu and Yoon, 1991). In addition, the children and adult SA_{PU} values calculated in the Zeltner analysis are supported by several independent studies that measured SA_{PU} in children (Langston et al., 1984) or in adults using similar morphometric techniques (Crapo et al., 1982 & 1983; Stone et al., 1992; Mercer et al., 1994).

Table A-3 shows little variation in the resultant $NOAEL_{[HEC]}$ across the groups in this example. The default procedure produces the lowest $NOAEL_{[HEC]}$ value in Table A-3 and is, therefore, sufficient to cover all of these groups.

TABLE A-3

COMPARISON OF THE HEC-DEFAULT (EPA, 1994) WITH EXAMPLE $LOAEL_{[HEC]}$ VALUES FOR HUMANS OF DIFFERENT AGES AND ACTIVITY PATTERNS FOR THE PULMONARY REGION

	Total V_e (L/min)[a]	$Q\text{-}alv_{(human)}$ (L/min)[b]	$SA_{PU\ (human)}$ (m^2)	$(Q\text{-}alv/SA_{PU})_{human}$ (L/min-m^2)	$RGDR_{PU}$	$NOAEL_{HEC}$ (mg/m^3)
Outdoor Worker, Male	17.5	12	139	0.088	3.3	0.53
Sedentary Worker, Male	15.4	11	139	0.078	3.7	0.59
Sedentary Worker, Female	12.6	8.8	114	0.077	3.8	0.61
15 Year-Old Male	14.0	9.8	108	0.091	3.2	0.51
15 Year-Old Female	10.9	7.6	100	0.076	3.8	0.61
10 Year-Old	10.6	7.4	62.0	0.12	2.4	0.38
5 Year-Old	6.1	4.3	37.3	0.11	2.6	0.42
1 Year-Old	3.6	2.5	18.5	0.14	2.1	0.34
3 Month-Old	2.0	1.4	11.0	0.13	2.2	0.35
HEC-Default	13.8	9.7	54.0	0.18	1.6	0.26

[a] These values are from the ICRP publication, Tables 8, 27, B.16a, B.16b and B.17 (ICRP, 1994).
[b] These values are from Zeltner et al. (1987).

4. CATEGORY 3 GASES

The DAF for a Category 3 gas or vapor is based on the ratio of the animal blood:gas partition coefficient to the human blood:gas partition coefficient and is typically calculated using the following equation:

$$DAF = \frac{(H_{b/g})_{animal}}{(H_{b/g})_{human}} \qquad \textbf{(Equation A-4)}$$

The blood:gas partition coefficient is primarily determined by the solubility of the gas in an aqueous medium as well as the protein and lipid content of the blood. There is little reason to suspect that the blood:gas partition coefficient for a non-metabolized chemical will vary greatly across the human population. The limited data available indicate no difference in the blood:gas partition coefficient with age for methylene chloride in mice (Thomas et al., 1996), and for sevoflurane, isoflurane, and halothane in humans (Malviya and Lerman, 1990). Two studies examining the solubility of volatile anesthetics (isoflurane, enflurane, halothane, and methoxyflurane) in the blood and body tissues found higher blood:gas partition coefficients in adults compared with children (Lerman, et al., 1984 & 1986). Any variability in the blood:gas partition coefficient with age is expected to be less than the default value of 10 used for the uncertainty factor for intraspecies variability when deriving the RfC. Any variability in the blood:gas partition coefficient with age is also not expected to cause a large overestimate or underestimate in the calculated cancer risk.

Because of the limited data available, the *Inhalation Dosimetry Methodology* makes the science policy decision to use a value of one for the ratio of the partition coefficients when the animal to human ratio exceeds one or when the animal or human value is unknown. At this time, all chemicals on IRIS for which both human and animal data are available have an animal to human ratio of partition coefficient greater than 1.[50] Therefore, the default assumption of one is a conservative approach that is not likely to underestimate the chemical-specific DAF.

5. PARTICLE DEPOSITION ACROSS AGE GROUPS

The DAF for a particle causing an effect in the respiratory tract, the Regional Dose Deposition Ratio ($RDDR_r$), is based on the animal to human ratio of the V_e and the fractional deposition of the particle in that region (F_r), divided by the surface area of the region where the effect occurs (SA_r) (USEPA, 1994). Inherent in this derivation is the assumption that 100 percent of the deposited dose remains in the respiratory tract and any clearance mechanisms are not considered. The $RDDR_r$ is typically calculated using the following equation:

$$RDDR_r = \frac{\left(\frac{V_e}{SA_r} \times F_r\right)_{animal}}{\left(\frac{V_e}{SA_r} \times F_r\right)_{human}} \qquad \textbf{(Equation A-5)}$$

[50] While 1,4-dioxane has not yet been evaluated on IRIS, it provides an exception to this statement, in that the blood:gas partition coefficient is 2750 for mice, 1850 for rats, and 3650 for humans, yielding an animal to human ratio of 0.75 for mice and 0.51 for rats (Reitz et al., 1990).

The DAF for a particle causing an extra-respiratory (ER) effect, the $RDDR_{ER}$, is based on the animal to human ratio of the V_e and the total deposition of the particle in the entire respiratory tract (F_{total}), divided by body weight (BW) (USEPA, 1994). The $RDDR_{ER}$ assumes that 100 percent of the deposited dose in the entire respiratory tract is available for uptake into the systemic circulation. The following general equation can be used to estimate the $RDDR_{ER}$:

$$RDDR_{ER} = \frac{\left(\frac{V_e}{BW} \times F_{total}\right)_{animal}}{\left(\frac{V_e}{BW} \times F_{total}\right)_{human}} \qquad \textbf{(Equation A-6)}$$

The information on particle deposition in various age groups is quite limited. A discussion of the current state of the science can be found in the *Air Quality Criteria for Particulate Matter Volume II*, Section 6.2.3.2 (USEPA, 2004; hereafter, *PM Criteria Document*).

Experimental and modeling results are summarized in Table A-4. The results for experimental studies are mixed, some suggesting higher deposition in children and others finding no difference across age groups. Bennett and Zeman (1998) and Schiller-Scotland et al. (1994) found no difference between total deposition of particles in the respiratory tract of children (aged 7 to14 and 6 to12, respectively) and adults for 1 to 2 micrometer particles. Schiller-Scotland et al. did find two- to three-fold higher total particulate deposition in 6 to 12 year olds for particles of 2 to 3 micrometers in size. In addition, Bennett et al. (1997) found that deposition in the ETh region was 50 percent greater in children than adults. The *PM Criteria Document* concludes that "these...studies ...do not provide unequivocal evidence for significant differences in deposition between adults and children" (USEPA, 2004, page 6-29). The document notes, however, that children may have higher activity levels and higher associated minute ventilation per lung size, potentially causing a greater size-specific dose of particles to the lung.

Modeled results suggest a higher deposition of particles in the TB region of children when compared to adults, depending on the particle size (Xu and Yu (1986); Hofmann et al. (1989); Musante and Martonen (1999); Phalen and Oldham (2001); Asgharian et al. (2004); Jarabek et al. (2005); Ginsberg et al. (2005)). Mixed results again are found in modeling studies for total deposition and deposition in other respiratory regions. In general, where differences are observed in either experimental or modeled studies, variability in deposition between age groups has been reported to be most often in the range of 1- to 3-fold greater for children than for adults, but ranging from equivalency or less up to 7-fold greater.[51]

[51] A modeling analysis examining deposition fraction per unit area at various airway generations of the lung as a function of age for various particle sizes (ranging from 0.01 to 10 μm) reported comparisons between a 3-month old and 21-year old that ranged from equivalency up to a 14-fold difference in this metric for some specific airway generations (Asgharian et al., 2004).

TABLE A-4
PARTICLE DEPOSITION ACROSS AGE GROUPS

Study	Particle Size	Results
Experimental Studies		
Becquemin et al. (1991)	Various	Nasal deposition higher in adults (up to 1.8-fold higher at rest and up to 3.4-fold higher during exercise) than children – meaning that thoracic airways of children are less protected than those of adults.
Bennett et al. (1997)	4.5 µm	-ETh deposition of particles 50 percent greater in children (higher for younger ages). -No significant difference in total respiratory tract deposition.
Bennett and Zeman (1998)	1-2 µm	No difference between 7-14 year olds and adults in total deposition of particles in the respiratory tract.
Schiller-Scotland et al. (1994)	1-2 µm	No difference between 6-12 year olds and adults in total deposition of particles in the respiratory tract.
	2-3 µm	Two- to three-fold higher total deposition of particles in 6-12 year olds versus adults.
Modeled Studies		
Asgharian et al. (2004)	0.01-10 µm	-Up to 1.2-fold higher total deposition in 3 month olds compared to adults in the TB region. -Up to 1.5-fold higher total deposition in 8 year olds compared to adults in the alveolar region. Total deposition higher in adults than 3 and 23 month olds (up to 2-fold). -Estimates of deposition fraction per unit area at various airway generations of the lung and various particle sizes highest for 3 month olds compared to adults (up to 14-fold). Higher deposition also seen for 23 month olds (up to 5-fold) and 8 year olds (up to 3-fold) compared with adults. No difference in deposition in 14 year olds compared to adults.
Cheng et al. (1995)	0.0046-0.2 µm	Nasal casts of children's airways found increased deposition efficiency for ultrafine particles with decreasing age, suggesting that young children may receive a higher dose of ultrafine particles to the upper airways.
Ginsberg et al. (2005)	0.001-10 µm	-Higher deposition in 3 month olds compared with adults for coarse and fine particles in the upper TB (up to 2-fold) and PU (up to 4-fold) regions. -Higher deposition in adults in the lower TB region.
Hoffmann et al. (1989)	1-2 µm	-1.5- to 2-fold higher total deposition in the TB region for particles in resting 8 year olds versus adults. -40-50 percent lower total deposition of particles in 8 year olds under conditions of exercise.
Jarabek et al. (2005)	0.3-6 µm	-Retained mass in the TB region normalized to regional SA was compared across age groups. -Up to 2-fold lower deposition in 3 month olds compared to adults. -Up to 2-fold higher deposition in 3 year olds and 14 year olds compared to adults.
Musante and Martonen (1999)	0.25-5 µm	-Total deposition was generally higher in children (ages 7, 22, 48, and 98 months) than adults (e.g., total lung deposition in 48-month olds was 38 percent higher than adults for 1µm particles). -TB deposition monotonically decreased as a function of age (i.e., younger children had increased TB deposition). -PU deposition greatest in the 48 and 98-month children.
Musante and Martonen (2000)	2 µm	3-fold higher deposition of particles in the PU region for 7 month olds versus adults.
Oldham et al. (1997)	Various	Airway models of trachea and bronchial airways showed total deposition in children (ages 4 and 7) greater than adult (up to approximately 7-fold higher for 4 year olds compared to adults for 4.5 µm particles).
Phalen and Oldham (2001)	0.1-10 µm	-No difference in total deposition of particles in 2 year olds versus adults. -Somewhat higher (13-81 percent; depending on particle size) deposition of particles in the TB region. -Lower deposition of particles in the PU region.
Xu and Yu (1986)	Various	Increased total deposition (up to 1.5-fold higher) in children aged 6 months, 2 years, and 8 years compared with adults for particles of varying sizes.

6. CONCLUSIONS

The examples and discussions included in this appendix suggest that the *Inhalation Dosimetry Methodology's* default approaches for derivation of the HEC for Category 1 gases with effects in the ETh, TB, and PU regions and for Category 3 gases typically are sufficient to cover variation across human age- and activity-level groups. The process for deriving an RfC from the HEC includes applying an uncertainty factor (UF) to account for within-species variability, adding further protection. When deriving an IUR for a carcinogen, UFs are not used. However the procedures for estimating an IUR incorporate conservative assumptions that would likely accommodate the degree of variation observed in these examples.

Experimental and modeling results for particles suggest the potential for small differences in deposition of particles in the respiratory tract as a function of age. The assumption that 100 percent of the deposited dose is available for uptake into the systemic circulation (for remote acting toxicants), or for activity in the respiratory tract (for local toxicity) is likely to result in an overestimation of dose to the target tissue. Any small variation in deposition among age groups should be considered against the potential magnitude of such overestimation. These differences in calculated deposition are small relative to the default 10-fold UF that accounts for intra-species variability in the derivation of the RfC. In addition, RfCs and IURs are developed for chronic exposure and will generally involve an exposure for multiple years. No additional correction of the toxicity values for these age groups is needed when the RfC or IUR is used in a risk assessment. Calculations in these examples are based on empirical data from sources listed and referenced in ICRP Publication 66 (ICRP, 1994). While ORD selected the ICRP values as the best estimates for these examples, other published values for V_e and SA exist. The use of alternate values may change the $LOAEL_{[HEC]}$ calculated for the various populations and life stages and may show more or less variability in results across the age and activity groups. In addition, the examples for the TB and PU regions are based on a hypothetical chemical, since currently no RfCs for gases on IRIS are calculated based on animal studies showing health effects occurring in these regions of the respiratory system. Given the parameter values used in the default method for calculating the HEC, it is likely that the process would yield results sufficient to cover populations and life stages with varying activities and physiologic characteristics.

Note that the available data, albeit limited, generally support these conclusions. As recommended by the Reference Dose (RfD)/RfC Technical Panel (USEPA, 2002), EPA has been exploring issues involving dose to the young from inhalation exposures, both theoretically and experimentally as well as further considering the existing animal-to-human extrapolation procedures described in current methodologies (e.g., USEPA, 1994). This is especially important because of the significant developmental changes that occur in the lung from birth well into adolescence (Pinkerton and Joad, 2000). The review and updating of these methodologies will be based on the best available science.

7. REFERENCES CITED

Asgharian, B.; Ménache, M.G.; Miller, F.J. (2004). *Modeling age-related particle deposition in humans*. Journal of Aerosol Medicine 17:213-224.

Becquemin, M.H.; Swift, D.L., et al. (1991). *Particle deposition and resistance in the noses of adults and children*. The European Respiratory Journal 4:694-702.

Bennett, W. D.; Zeman, K. L., et al. (1997). *Extrathoracic deposition of inhaled, coarse particles (4.5 m) in children vs. adults*. In: Cherry, N.; Ogden, T., Eds. Inhaled particles VIII: proceedings of an international symposium on inhaled particles organized by the British Occupational Hygiene Society; August 1996; Cambridge, UK. Annals of Occupational Hygiene 41(Suppl 1): 497-502.

Bennett, W. D.; Zeman, K. L. (1998). *Deposition of fine particles in children spontaneously breathing at rest*. Inhalation Toxicology 10: 831-842.

Cheng, Y.-S.; Smith, S.M., et al. (1995). *Deposition of ultrafine aerosols and thoron progeny in replicas of nasal airways of young children*. Aerosol Science and Technology 23: 541-552.

Crapo, J.D.; Young, S.L.; et al. (1983). *Morphometric characteristics of cells in the alveolar region of mammalian lungs*. American Review of Respiratory Disease 128: S42-S46.

Crapo, J.D.; Barry, B.E.; et al. (1982). *Cell characteristics of the normal human lung.* American Review of Respiratory Disease 5: 740-745.

Ginsberg, G.L.; Foos, B.P.; et al. (2005). *Review and analysis of inhalation dosimetry methods for application of children's risk assessment*. Journal of Toxicology and Environmental Health, Part A 68: 573-615.

Hofmann, W.; Martonen, T. B.; Graham, R. C. (1989). *Predicted deposition of nonhygroscopic aerosols in the human lung as a function of subject age*. Journal of Aerosol Medicine 2: 49-68.

International Commission on Radiological Protection (1994). *ICRP Publication 66: Human Respiratory Tract Model for Radiological Protection*. Annals of the ICRP, Volume 24/1-3, Tables B-16A and B-16B.

Jarabek, A.M.; Asgharian, B.; Miller, F.J. (2005). *Dosimetric Adjustments for Interspecies Extrapolation of Inhaled Poorly Soluble Particles*. Inhalation Toxicology 17(7): 317-334.

Langston, C.; Kida, K.; et al. (1984). *Human lung growth in late gestation and in the neonate.* American Review of Respiratory Disease 129: 607-613.

Lerman, J.; Gregory, G.A.; et al. (1984). *Age and solubility of volatile anesthetics in blood*. Anesthesiology 61(2): 139-43.

Lerman, J.; Schmitt-Bantel, B.I.; et al. (1986). *Effect of age on the solubility of volatile anesthetics in human tissues.* Anesthesiology 65(3): 307-11.

Malviya, S.; Lerman, J. (1990). *The blood/gas solubilities of sevoflurane, isoflurane, halothane, and serum constituent concentrations in neonates and adults.* Anesthesiology 72(5): 793-6.

Mercer, R.R.; Russell, M.L.; Crapo, J.D. (1994). *Alveolar Septal Structure in different species*. Journal of Applied Physiology *77*: 1060-1066.

Musante, C. J.; Martonen, T. B. (2000). *Computer simulations of particle deposition in the developing human lung.* Journal of the Air and Waste Management Association 50: 1426-1432.

Musante, C. J.; Martonen, T. B. (1999). *Predicted deposition patterns of ambient particulate air pollutants in children's lungs under resting conditions*. In: Proceedings of the third colloquium on particulate air pollution and human health; June, 1999; Durham, NC. Irvine, CA: University of California, Air Pollution Health Effects Laboratory, p. 7-15 - 7-20.

Oldham, M. J.; Mannix, R. C.,; et al. (1997) *Deposition of monodisperse particles in hollow models representing adult and child-size tracheobronchial airways.* Health Physics 72: 827-834.

Phalen, R. F.; Oldham, M. J. (2001). *Methods for modeling particle deposition as a function of age.* Respiratory Physiology 128: 119-130.

Pinkerton, K.E.; Joad, J.P. (2000). *The mammalian respiratory system and critical windows of exposure for children's health.* Environmental Health Perspectives 108(Suppl 4): 457-62.

Reitz, R.H.; McCrosky, P.S., et al. (1990). *Development of a physiologically based pharmacokinetic model for risk assessment with 1,4-dioxane.* Toxicology and Applied Pharmacology 105: 37-54.

Schiller-Scotland, C.F.; Hlawa, R.; et al. (1994). *Experimental data for total deposition in the respiratory tract of children*. Toxicological Letters 72(1-3): 137-44.

Stone, K.C., Mercer, R.R. et al. (1992). *Allometric relationships of cell numbers and size in the mammalian lung.* American Journal of Respiratory Cell Molecular Biology 6: 235-243.

Thomas, R.W.; Yang, R.S.; et al. (1996). *PBPK modeling/Monte Carlo simulation of methylene chloride kinetic changes in mice in relation to age and acute, subchronic, and chronic inhalation exposure*. Environmental Health Perspectives 104(8): 858-65.

U.S. EPA. (1997). *Exposure Factors Handbook*. Office of Research and Development, Washington, DC. EPA/600/P-95/002Fa.
http://www.epa.gov/ncea/pdfs/efh/front.pdf

U.S. EPA. (1994). *Methods for Derivation of Inhalation Reference Concentrations and Application of Inhalation Dosimetry*. Office of Research and Development. Research Triangle Park, NC. EPA/600/8-90/066F. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=71993.

U.S. EPA. (2002). *A Review of the Reference Dose and Reference Concentration Processes*. Risk Assessment Forum, Washington, DC, EPA/630/P-02/002F. http://cfpub.epa.gov/ncea/raf/recordisplay.cfm?deid=55365

U.S. EPA. (2003). *Integrated Risk Information System Summaries: Acrolein*. Office of Research and Development, Washington, D.C. http://www.epa.gov/iris/subst/0364.htm

U.S. EPA. (2004). *Air Quality Criteria for Particulate Matter: Volume II.* EPA/600/P-99/002aD. http://cfpub.epa.gov/ncea/CFM/recordisplay.cfm?deid=2832

U.S. EPA. (2005). *Guidelines for Carcinogen Risk Assessment*, Risk Assessment Forum, Washington, D.C. EPA/630/P-03/001F. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=116283

U.S. EPA. (2008). Integrated Risk Information System (IRIS) Glossary of Terms. Searched September 2008. http://www.epa.gov/iris/help_gloss.htm

West, J.B. (2000). *Respiratory Physiology: The Essentials*. Lippincott, Williams & Wilkins. 6th Edition.

Xu, G.B., Yu, C.P. (1986). *Effects of age on deposition of inhaled aerosols in the human lung*. Aerosol science and Technology 5: 349-357.

Yu, C.P., Xu, G.B. (1987). *Predictive models for deposition of inhaled diesel exhaust particles in humans and laboratory species*. Research Report of the Health Effects Institute 10:3-22.

Yu, C.P., Yoon, K.J. (1991). *Retention modeling of diesel exhaust particles in rats and humans*. Research Report of the Health Effects Institute 40:1-24.

Zeltner, T.B., Caduff, J.H., et al. (1987). *The postnatal development and growth of the human lung. I. Morphometry.* Respiratory Physiology 67: 247-267.

8. ADDITIONAL SOURCES OF RELATED INFORMATION

De Winter-Sorkina. R., Cassee, F.R. (2002). *From concentration to dose: factors influencing airborne particulate matter deposition in humans and rats.* RIVM Report 650010031/2002.

Gehr et al. (1978). *The normal human lung: ultrastructure and morphometric estimation of the*

diffusion capacity. Respiration Physiology 18: 519-522.

Various Authors. (2008). *EPA Workshop on Children's Inhalation Dosimetry and Health Effects for Risk Assessment*. Journal of Toxicology and Environmental Health, Part A 71:147-248.

Zoetis, T., Hurtt, M.E. (2003). *Species comparison of lung development*. Birth Defects Research 68: 121-124.

APPENDIX B

APPENDIX B

CHEMICALS ON IRIS WITH EXTRAPOLATED INHALATION UNIT RISKS

Table B-1 contains chemicals on the Environmental Protection Agency's (EPA's) Integrated Risk Information System (IRIS) with Inhalation Unit Risk (IUR) values calculated by extrapolation using the default ventilation rate and body weight from the oral Cancer Slope Factor (CSF). These chemicals cause tumors remote from the respiratory tract. Also listed is the year EPA verified the cancer assessment. The list was compiled in September 2008.

EPA recommends that extrapolated IURs should be used with risk Equations 6 and 11 in the main document without additional modification for calculation of cancer risk by the inhalation route of exposure. It is generally not appropriate to make adjustments based on ventilation rate and body weight using the intake equation, because the amount of the chemical that reaches the target site of the chemical through the inhalation pathway is not a simple function of the inhalation rate and body weight. Risk assessors should outline the uncertainties involved in using extrapolated IURs in the risk characterization section of the risk assessment.

TABLE B-1 CHEMICALS WITH EXTRAPOLATED INHALATION UNIT RISKS ON IRIS	
Chemical	**Year of Verification**
Acrylamide[1]	1988
Aldrin	1987
Aramite	1991
Azobenzene	1988
Bromoform	1989
Chlordane	1997
Chloroform[1]	1987
DDT	1987
1,2-Dichloroethane	1986
Dieldrin	1987
1,2-Diphenylhydrazine	1986
Heptachlor	1987
Heptachlor epoxide	1987
Hexachlorobenzene	1989
Hexachlorobutadiene[1]	1986
Alpha-hexachlorocyclohexane	1986
Beta-hexachlorocyclohexane	1986
Technical-hexachlorocyclohexane	1986
Hexachlorodibenzo-p-dioxin mixture	1987
Hexachloroethane	1986
N-nitroso-di-n-butylamine	1986
N-nitrosodiethylamine	1986
N-nitrosodimethylamine	1986
N-nitrosopyrrolidine	1986
Polychlorinated biphenyls	1996
1,1,2,2-Tetrachloroethane	1986
1,1,1,2-Tetrachloroethane	1988
Toxaphene	1987
1,1,2-Trichloroethane	1986
2,4,6-Trichlorophenol	1989
[1] Note that this chemical's IUR is currently under review.	

APPENDIX C

APPENDIX C

STSC's PROCESS FOR DERIVING ALTERNATIVE INHALATION TOXICITY VALUES

If Reference Concentration (RfC) and/or Inhalation Unit Risk (IUR) values for an inhaled contaminant are not available from the sources in the Environmental Protection Agency's (EPA's) Office of Solid Waste and Emergency Response (OSWER) hierarchy, risk assessors should first contact the National Center for Environmental Assessment's (NCEA's) Superfund Health Risk Technical Support Center (STSC) for guidance.[52] Risk assessors working on Superfund sites can contact STSC to determine whether a provisional peer-reviewed toxicity value (PPRTV) exists for a contaminant; if not, the risk assessor, in cooperation with the appropriate EPA Regional office may request that STSC develop a PPRTV document or that STSC develop an inhalation toxicity value as a "consult." The latter would be specific to the site in question only.

As a first choice, if human or whole animal studies exist providing a suitable No Observable Adverse Effect Level (NOAEL)/Lowest Observable Adverse Effect Level (LOAEL) or Point of Departure (POD) from a Benchmark Dose (BMD) analysis, this data normally will be used by STSC to develop an inhalation toxicity value. If, in addition, a suitable human inhalation physiologically based pharmacokinetic (PBPK) model exists that can be utilized to refine the dose metric to the target organ, then this information generally will be included in developing an inhalation toxicity value.

If no appropriate whole animal or human studies exist, but an appropriate peer reviewed human inhalation PBPK model exists that has been validated by experimental results, then STSC usually will attempt to derive an inhalation toxicity value from this model. If none exists, but a suitable PBPK animal inhalation models exists, STSC may attempt developing a human model and deriving an inhalation value.

PBPK modeling quantitatively describes the absorption/metabolism/distribution and elimination of the chemical from a point of entry (oral, inhalation, dermal) to the target organ(s). In some cases, an oral PBPK model can be extrapolated to the inhalation pathway, but care must be taken to consider direct pulmonary effects that may not be evident by oral dosing.

As a next approach, STSC typically will evaluate development of an inhalation toxicity value using a suitable surrogate chemical based on a quantitative structure-activity relationship (QSAR) model with structural selection criteria and solubility/toxicity considerations. STSC may evaluate possible surrogate chemicals based on several available structural models and provide a comparison. Selection of the appropriate surrogate may depend on the weight of evidence of these models.

[52] All contact with STSC should be performed by an EPA regional risk assessor. States and other entities should first contact their EPA regional risk assessor with questions on inhalation toxicity values. Regional risk assessors can then contact STSC on their behalf.

If STSC uses any of the methods for developing toxicity values other than from human or whole animal data, the value normally will be presented as a "screening" value with the caveat that it should not be used as a risk driver for a site without consultation with the STSC. The uncertainties associated with using toxicity values derived through PBPK modeling or QSAR, or with using a surrogate value should be described in the risk characterization portion of the risk assessment (see Section 9). Risk assessors are discouraged from performing simplistic route-to-route extrapolations from oral data using default assumptions about Inhalation Rate (IR) and body weight (BW).[53]

[53] If STSC indicates that no quantitative toxicity information for the inhalation route is available, the risk assessor should conduct a qualitative evaluation of this exposure route. The risk assessor should discuss in the uncertainty section of the risk assessment report the implications of not quantitatively assessing risks due to inhalation exposures to chemicals lacking inhalation toxicity data. See the section on Risk Characterization (Section 9) in the main text of this guidance for more information.

Exhibit F

Health Canada Santé Canada

Your health and safety… our priority. *Votre santé et votre sécurité… notre priorité.*

Interim Guidance on

Human Health Risk Assessment for Short-Term Exposure to Carcinogens at Contaminated Sites



Federal Contaminated Sites Risk Assessment in Canada

Canada

Health Canada is the federal department responsible for helping the people of Canada maintain and improve their health. *We assess the safety of drugs and many consumer products, help improve the safety of food, and provide information to Canadians to help them make healthy decisions. We provide health services to First Nations people and to Inuit communities. We work with the provinces to ensure our health care system serves the needs of Canadians.*

Published by authority of the Minister of Health.

Federal Contaminated Sites Risk Assessment in Canada, Interim Guidance on Human Health Risk Assessment for Short-Term Exposure to Carcinogens at Contaminated Sites
is available on Internet at the following address:
www.hc-sc.gc.ca/ewh-semt/contamsite/index-eng.php

Également disponible en français sous le titre :
L'Évaluation des risques pour les sites contaminés fédéraux au Canada, Document d'orientation provisoire sur l'évaluation des risques pour la santé humaine associés à une exposition de courte durée aux substances cancérogènes présentes dans les sites contaminés

This publication can be made available on request in a variety of alternative formats.

Contact:
Publications
Health Canada
AL 0900C2
Ottawa, Ontario K1A 0K9
Tel.: 613-957-2991
Toll free: 1-866-225-0709
Fax: 613-941-5366
TTY: 1-800-267-1245 (Health Canada)
Email: publications@hc-sc.gc.ca

© Her Majesty the Queen in Right of Canada, represented by the Minister of Health, 2013

This publication may be reproduced without permission provided the source is fully acknowledged.

Cat.: H144-11/2013E-PDF
ISBN: 978-1-100-21839-7
Pub.: 120160

FEDERAL CONTAMINATED SITES RISK ASSESSMENT IN CANADA

Interim Guidance on

Human Health Risk Assessment for Short-Term Exposure to Carcinogens at Contaminated Sites

2013
Prepared by:
Contaminated Sites Division
Safe Environments Directorate

REC 6468

TABLE OF CONTENTS

PREFACE iii

ABBREVIATIONS AND ACRONYMS iv

EXECUTIVE SUMMARY 1

Cancer Risk Assessment: Non-Threshold Carcinogenic Effects 1

Cancer Risk Assessment: Threshold Carcinogenic Effects 2

Assessment of Potential Non-Cancer Health Effects from Short-Term Exposure 2

1.0 INTRODUCTION 3

1.1 Current Cancer Risk Assessment Approach 3

1.2 Issues Related to Less-Than-Lifetime Exposure to Carcinogens at Contaminated Sites 3

1.3 Practice of Dose Averaging 4

2.0 DOSE AVERAGING FOR NON-THRESHOLD CARCINOGENIC EFFECTS 4

2.1 Dose Averaging for Less-Than-Lifetime Adult-Only Exposures 6

2.1.1 Dose Averaging Implications from Adult Animal Bioassays 6

2.1.2 Dose Averaging Implications from Adult Exposures in Epidemiological Studies 10

2.1.3 Theoretical Cancer Modelling Studies of Less-Than-Lifetime Exposure 11

2.1.4 Summary for Dose Averaging for Less-Than-Lifetime Adult Exposure 13

2.2 Dose Averaging for Less-Than-Lifetime Early-Life Exposure 13

2.3 Dose Averaging for Prenatal Exposure (Transplacental Carcinogenesis) 14

2.4 Dose Averaging for Less-Than-Lifetime Exposure during Puberty 15

3.0 PROPOSED INTERIM MEASURE FOR HUMAN HEALTH RISK ASSESSMENT FOR LESS-THAN-LIFETIME EXPOSURE TO CANCER-CAUSING AGENTS AT CONTAMINATED SITES 16

3.1 Assessment of Cancer Risk for Non-Threshold Carcinogenic Effects 16

3.1.1 Carcinogenic Effects Acting Through a Mutagenic Mode of Action 16

3.1.2 Carcinogenic Effects Acting Through an Unknown Mode of Action 18

3.2 Assessment of Health Risk from Threshold Carcinogens 18

3.3 Assessment of Health Risk from Non-Cancer Health Effects 18

4.0 WORKED EXAMPLES 19

4.1 Assessment of Lifetime Risk Associated with Exposure to a Carcinogen with a Mutagenic Mode of Action 19

4.1.1 Example 1: Exposure Occurs Over a Lifetime 19

4.1.2 Example 2: Exposure Occurs at Less Than 2 Years of Age 19

5.0 REFERENCES 20

LIST OF TABLES

Table 2.1 Summary of modelling studies that compare cancer risks from short-term exposure with those from lifetime-equivalent exposure (extent of under/overestimation reported quantitatively for short-term adult exposure only).....5

Table 2.2 Summary of studies comparing cancer risks from short-term (adult-only) exposure with those from lifetime-equivalent exposure (with same total dose) 7

Table 3.1 Recommended interim adjusted age-dependent adjustment factors (ADAFs) for cancer risk assessment at contaminated sites for carcinogenic effects via a mutagenic mode of action 17

LIST OF FIGURES

Figure 2.1 Relative cancer risk estimates for various ages and durations of adult exposure calculated using a 6-stage Armitage-Doll multistage (MS) model for estimating cancer risks for time-dependent exposure patterns versus lifetime average daily dose (LADD).....12

PREFACE

The Federal Contaminated Sites Action Plan (FCSAP) is a program of the Government of Canada designed to achieve improved and continuing federal environmental stewardship as it relates to contaminated sites located on federally owned or operated properties. Guidance documents on human health risk assessment (HHRA) prepared by the Contaminated Sites Division of Health Canada in support of the FCSAP are available on our website and may also be obtained by contacting the Contaminated Sites Division at *cs-sc@hc-sc.gc.ca*.

This interim guidance document provides additional direction for custodial departments with respect to amortization of short-term exposure to carcinogens at contaminated sites. It is of particular importance at remote sites or sites that are accessed infrequently. The guidance is intended to be advisory in nature and will be updated periodically on the basis of revisions to current expertise, applicable standards and recommendations received from stakeholders. Readers are advised to consult with Health Canada, Contaminated Sites Division, to confirm that they are using the most recent version available on the Health Canada website and that the use of HHRAs is reflective of current and best practices. This document is not to be considered a substitute for the guidance of a qualified professional practitioner.

Work and opinions from various consultants, academics and governmental agencies were used to create this guidance. In particular, Angela Li-Muller, Margaret Yole, Norm Healey and Sanya Petrovic of Health Canada are recognized for their contribution.

Health Canada requests that any questions, comments, criticisms, suggested additions or revisions to the document be directed to the following: Contaminated Sites Division, Safe Environments Directorate, Health Canada, 269 Laurier Avenue West, 4th floor, Address Locator: 4904A, Ottawa, ON K1A 0K9. Email: *cs-sc@hc-sc.gc.ca*.

See also: *www.hc-sc.gc.ca/ewh-semt/contamsite/index-eng.php*.

ABBREVIATIONS AND ACRONYMS

A-D	Armitage-Doll
ADAF	age-dependent adjustment factors
AF	absorption factor
ASF	age sensitivity factor
BHT	butylated hydroxytoluene
BW	body weight
C	concentration
CalEPA	California Environmental Protection Agency
CSD	Contaminated Site Division
DES	diethylstibesterol
DMBA	dimethylbenzanthracene
DNA	deoxyribonucleic acid
DQRA	detailed quantitative risk assessment
ED	exposure duration
ED_{01}	maximum likelihood estimate of the dose corresponding to a 1% additional cancer risk
ER	exposure rate
FCSAP	Federal Contaminated Sites Action Plan
HC	Health Canada
HHRA	human health risk assessment
ILCR	incremental lifetime cancer risk
IR	intake rate
LADD	lifetime average daily dose
LMS	linearized multistage
LOAEL	lowest observed adverse effect level
MVK	Moolgavkar-Venzon-Knudson
NOAEL	no observed adverse effect level
PAHs	polycyclic aromatic hydrocarbons
PBBs	polybrominated biphenyls
PBPK	physiologically based pharmacokinetic
PQRA	preliminary quantitative risk assessment
SF	slope factor
TC	tolerable concentration
TDI	tolerable daily intake
TRV	toxicological reference value
UR	unit risk
US EPA	United States Environmental Protection Agency

EXECUTIVE SUMMARY

This document provides guidance for application at federal contaminated sites funded under the Federal Contaminated Sites Action Plan (FCSAP). It is considered to be interim and is based on an assessment of the current scientific literature. The document does not represent the opinion of Health Canada outside the application of federal contaminated sites funded under the FCSAP.

The current approach to evaluating health risks associated with human exposure to carcinogens at contaminated sites focuses on incremental lifetime cancer risks. The approach to cancer risk assessment varies according to the mode of action at the tumour site in question. Unless there is evidence to support a threshold mode of action, the current approach assumes a linear dose-response relationship at low doses (i.e. non-threshold). The incremental lifetime cancer risk (ILCR) is calculated as a product of the lifetime daily dose (or concentration) and the toxicological reference value (TRV), expressed as cancer slope factor (or inhalation unit risk).

A threshold approach can be applied when there are sufficient data to ascertain the mode of action at the tumour site in question and to conclude that the dose-response relationship is not linear at low doses. For these carcinogenic effects, the TRVs are expressed as tolerable daily intakes (TDIs) or concentrations (TCs), the intakes or concentrations to which it is believed that a person can be exposed daily over a lifetime without deleterious effects. Human exposure is compared with these TRVs, where appropriate, to determine health risks.

Characterization of human cancer risks usually makes use of TRVs that have been derived from epidemiological or toxicological studies with comparable exposure patterns. TRVs for carcinogens are often based on the results of animal studies in which the animals were exposed on a daily basis throughout their adult lifespan. Exposures at contaminated sites may mirror these exposure patterns, but in some circumstances exposures may occur over a period of time much shorter than the lifetime of the exposed individual. In a short-term exposure scenario, short-term exceedance (or excursion) above chronic average daily exposure could occur as a result of variation in intake rates or daily fluctuation in chemical concentrations in environmental media. As a result, the health risks of short-term exposure often need to be addressed.

For contaminated site risk assessments, the current practice of characterizing ILCR associated with less-than-lifetime exposures to carcinogens that act via a non-threshold mode of action involves averaging the short period of exposure over a lifetime to calculate the lifetime average daily dose (LADD). Several issues regarding this practice of averaging the exposure have been raised:

- There is a potential for underestimating cancer risks with the practice of time-averaging of exposures (LADD).
- Variability in sensitivity among different lifestages may not be fully considered.

In addition, depending on the magnitude of exposure, carcinogenic agents may elicit other, chronic and short-term non-cancer health effects as a result of short-term exposures. At present, these effects are often not evaluated.

The Contaminated Sites Division (CSD) will continue to review information related to risk assessments for carcinogenic agents, including short-term exposure and dose averaging.

Cancer Risk Assessment: Non-Threshold Carcinogenic Effects

A literature review was conducted to evaluate whether averaging short-term exposure over a lifetime would be adequate to estimate cancer risk using cancer slope factors derived from chronic animal studies. Both theoretical studies using mathematical models of carcinogenesis and empirical studies involving exposure during discrete age windows suggest that exposures in early lifestages are usually associated with a higher risk of carcinogens acting through a mutagenic mode of action. It was concluded that application of age-dependent adjustment factors to the cancer slope factor with exposure averaged over a lifetime can provide a generally conservative estimate of lifetime cancer risks. As an interim measure, the United States Environmental Protection Agency (EPA) approach has been adopted as a default recommendation for contaminated site risk assessments.

The ILCR can be estimated by summing the risk from each discrete exposure period. For non-threshold carcinogens acting through a mutagenic mode of action, it is recommended that age-dependent adjustment factors (ADAFs) be applied to the cancer slope factor (or inhalation unit risk) with exposure averaged over a lifetime to account for the sensitivity of the age-specific exposure period. We have developed default ADAFs by adjusting the US EPA's ADAFs to be consistent with the age groups recommended by CSD. These default factors can be applied when age-specific cancer slope factors (or inhalation unit risks) or chemical-specific data are not available.

When exposure periods do not match the CSD's age groupings, CSD recommends that the US EPA's ADAFs be applied. For example, if exposure occurs only between 7 months and less than 2 years of age, the adjustment factor of 10 applies. Likewise, if exposure occurs only between 12 and < 16 years of age, the ADAF of 3 applies. When chemical-specific data are available for a susceptible lifestage, these data can be used directly to evaluate risks for the chemical and the lifestage on a case-by-case basis.

Recommended interim adjusted age-dependent adjustment factors (ADAFs) for cancer risk assessment at contaminated sites for carcinogenic effects via a mutagenic mode of action

Lifestage	Age	Adjusted age-dependent adjustment factor (ADAF)[a]
Infant	0–6 months	10
Toddler	7 months–4 years	5[b]
Child	5–11 years	3
Teenager	12–19 years	2[c]
Adult	20+	1

[a] US EPA (2005 a, b), except as noted.

[b] $ADAF_{7\ mo-4\ yr} = (ADAF_{0-<2} * D_{7\ mo-1} / D_{7\ mo-4}) + (ADAF_{2-4} * D_{2-4} / D_{7\ mo-4}) = 10 * 1.5/4.5 + 3 * 3/4.5 = 5$, and D_i = exposure duration in years

[c] $ADAF_{12-19} = (ADAF_{12-<16} * D_{12-15} / D_{12-19}) + (ADAF_{16+} * D_{16-19} / D_{12-19}) = 3 * 4/8 + 1 * 4/8 = 2$, and D_i = exposure duration in years

When the mode of action is unknown or the burden of proof for a threshold mode of action has not been met, CSD recommends a non-threshold approach to cancer risk estimation. If chemical-specific data are available on quantitative differences between early lifestages and adults, an analysis of the differences could be used to adjust risk estimates for early life exposures. Otherwise, CSD does not recommend extending the default age-dependent potency adjustment factors to these carcinogenic effects. This position would be analogous to recommending a default ADAF of 1 for all lifestages.

Cancer Risk Assessment: Threshold Carcinogenic Effects

At this time, the CSD does not recommend a default age-specific adjustment for carcinogenic effects determined to have a non-linear dose-response relationship (i.e. threshold) at low doses. Adjustment can be made on a chemical-specific basis if supported by experimental data. These substances would be included in an HHRA using a TDI (or a TC in the case of inhalation exposure).

The CSD recommends that dose averaging for short-term exposure for these types of carcinogenic effects be performed in the same way as for substances with threshold non-carcinogenic effects. It is important that dose averaging should not underestimate the potential for threshold carcinogenic effects. Without a sound basis for doing so (i.e. it cannot be a default assumption), the human health risk assessor should not simply mathematically spread out a short-term dose over a longer period and conclude that the short-term dose is toxicologically equivalent to a lower dose over the long period. Instead, exposure should be averaged over the total actual exposure period and compared with the appropriate TRV. A scientific rationale is required to support any proposed amortization (dose averaging beyond actual exposure period) to ensure that short-term risks are not underestimated. This analysis needs to be done on a chemical-specific basis.

Assessment of Potential Non-Cancer Health Effects from Short-Term Exposure

For short-term exposure, carcinogenic agents may elicit other, chronic and short-term non-cancer health effects, depending on the magnitude of exposure. Short-term effects can be evaluated for potential critical receptors/lifestages[1] using short-term TRVs where available (either from other regulatory agencies or derived from literature values as per the Health Canada, 2010, detailed quantitative risk assessment [DQRA] guidance) and when applicable to the exposure scenarios. If short-term TRVs are not available, such evaluation can be conducted on the basis of relevant dose-response information from toxicity studies. It is also important to consider whether the short-term exposure might elicit early biological key events that might progress to health effects at a later date.

[1] Including relevant receptors/lifestages with the highest exposure and receptors/lifestages associated with specific sensitivity to the toxicity of the contaminants.

1.0 INTRODUCTION

1.1 Current Cancer Risk Assessment Approach

Health Canada's Contaminated Sites Division (CSD) has a current risk assessment approach for carcinogenic effects that assumes a linear dose-response relationship at low doses (non-threshold) unless there are adequate data to ascertain a mode of action that is consistent with a non-linear dose-response relationship at low doses (i.e. threshold). This approach is particularly relevant for agents that are mutagenic[2] and DNA reactive. The incremental lifetime cancer risk is calculated as a product of the lifetime daily dose and cancer slope factor.

A threshold approach can be applied when there are sufficient data to ascertain the mode of action at the tumour site in question and to conclude that the dose-response relationship is not linear at low doses. Such a carcinogenic agent usually has not been shown to demonstrate mutagenic or other properties consistent with linearity at low doses. Endocrine disruption, cell proliferation, cytotoxicity and receptor-binding are some examples of a non-linear mode of action. For these carcinogenic effects, the CSD risk assessment approach assumes a non-linear dose-response relationship at low doses. The toxicological reference value (TRV) is derived by applying an uncertainty factor to a benchmark dose or benchmark concentration (if available)—a NOAEL (no observed adverse effect level) or a LOAEL (lowest observed adverse effect level)—as appropriate to establish a tolerable daily intake (TDI) or concentration (TC), i.e. the intake or concentration to which it is believed that a person can be exposed daily over a lifetime without deleterious effects.

In many cases, non-carcinogenic effects rather than carcinogenicity may be the main determinant of health risk from long-term exposure to the threshold carcinogenic agent. For example, the developmental effects of 2,3,7,8-tetrachlorodibenzo-p-dioxin occur at lower exposure levels than those required for carcinogenicity and have been used to establish the TRV.

1.2 Issues Related to Less-Than-Lifetime Exposure to Carcinogens at Contaminated Sites

Short-term exposure to carcinogens at contaminated sites may be associated with activities that occur over a relatively short period of time, such as seasonal activities like camping, occasional visits to a remote site and certain occupational activities, e.g. construction and underground service installation. As a result, short-term health risks need to be addressed.

The significance of exposure to contaminants is best characterized by comparison with TRVs derived from epidemiological or toxicological studies with comparable exposure patterns (i.e. short-term exposure compared with TRVs derived from a short-term study). Otherwise, significant uncertainty could be introduced into risk characterization.

TRVs for carcinogens are often based on the results of animal studies in which the animals were exposed on a daily basis throughout their adult lifespan. Exposures to human receptors at a contaminated site may mirror this pattern of exposure, but more often exposure occurs for only a portion of the lifetime or may be intermittent. Exposures at a contaminated site may occur during childhood or in utero, lifestages not represented in standard cancer bioassays.

The current practice of characterizing incremental lifetime cancer risks (ILCR) associated with less-than-lifetime exposures to non-threshold carcinogens involves averaging the short period of exposure over a lifetime to calculate the lifetime average daily dose (LADD). The following issues related to dose averaging (sometimes referred to as dose amortization) have been raised when exposures occur over a short time frame:

1. There is a potential for underestimating cancer risks with the calculation of a LADD associated with a short exposure period.
2. The possibility of acute/subchronic non-cancer effects due to elevated exposures has not been considered and may be relevant when the exposure is elevated above the LADD over a subchronic period. For example, the physiological response will be different following a large short-term exposure as compared with the same exposure averaged over a longer period.
3. Variability in sensitivity among different lifestages may not have been fully considered. For example, the prenatal and neonatal periods, childhood, adolescence, and peri-menopausal and senior lifestages, as well as genetic predisposition, are currently not included in standard adult animal bioassays for deriving estimates of cancer potency.

This document provides a background discussion on each of these issues and presents interim guidance and supporting rationales.

[2] A carcinogen acts via a mutagenic mode of action if the carcinogen or its metabolite is DNA-reactive or has the ability to bind to the DNA. Mutagenicity is "the induction of permanent, transmissible changes in the amount, chemical properties or structures of the genetic material. In most cases, mutation involves changes in DNA structure that either have no effect or cause harm" (USEPA, 2005b; Schoeny, 2011).

1.3 Practice of Dose Averaging

Dose averaging refers to the practice of time averaging a short period of exposure or several intermittent short-duration exposure(s) over a longer duration. This practice is also referred to as exposure amortization. It assumes toxicity to be linearly proportional to the magnitude and duration of exposure. For example, it assumes an exposure of 365 µg/kg bw-day for 1 day, 36.5 µg/kg bw-day for 10 days and 1 µg/kg bw-day for 365 days to be toxicologically equivalent, which could be untrue. The risk for the shorter-term exposure could be underestimated. With this practice, daily exposures that exceed the maximum chronic acceptable daily dose (either a TDI or a risk-specific dose) may be incorrectly considered acceptable because they occur for only a short period of time. In the case of threshold carcinogens, this practice raises questions about the magnitude by which the TDI can be exceeded and for what duration before unacceptable chronic health risks (including carcinogenicity) are possible or expected. For non-threshold carcinogens, the practice raises the question of whether a high dose over a short period results in the same lifetime cancer risk as the same total dose over a lifetime. Also at issue is whether the short-term exposure could elicit adverse acute/subchronic non-carcinogenic health effects.

The answers to these questions, in part, depend on the following:

- when (at what lifestage) the excess exposure is expected to occur;
- whether there are any specific sensitivities associated with that lifestage; and
- whether these sensitivities have been accounted for (perhaps through application of uncertainty factors) in the TRV.

2.0 DOSE AVERAGING FOR NON-THRESHOLD CARCINOGENIC EFFECTS

The current practice of characterizing incremental cancer risks associated with less-than-lifetime exposures involves averaging the short period of exposure over a lifetime to calculate the LADD. This practice assumes that the overall incremental cancer risk is a function of the total dose received and is independent of the exposure pattern: a high dose of a carcinogen received over a short period is assumed to be equivalent to the corresponding total dose spread over a lifetime (US EPA, 1986). However, this practice is not based on firm scientific evidence or principles (Hrudey, 1998), and the US EPA (1986) has acknowledged that the approach is fraught with uncertainty; it recommends that risk assessments include a qualitative discussion of the uncertainty of this assumption.

Various groups of scientists have expressed concern that the LADD approach could underestimate cancer risk (Kodell et al., 1987, Chen et al., 1988; Murdoch et al., 1992; US EPA, 2005a; Halmes et al., 2000); the summary of some of these studies is presented in Table 2. In addition, the age at which short-term exposure occurs could influence cancer risk, as different lifestages may vary in susceptibility (Drew et al., 1983; Crump and Howe, 1984; Ginsberg, 2003; US EPA, 2005a, 2005b; Hattis et al., 2004, 2005).

The uncertainty of the practice was identified as an issue "under review" in Health Canada's (2004) guidance on Human Health Preliminary Quantitative Risk Assessment for contaminated sites. Since that publication, Health Canada's CSD has commissioned a series of contractor reports from consulting and academic experts (Brand, 2004; GlobalTox International Consultants, 2005; Wilson Scientific Consulting Inc., 2006; Orr, 2007; Al-Zoughool and Krewski, 2008) to aid in the decision-making on this issue.

Table 2.1 Summary of modelling studies that compare cancer risks from short-term exposure with those from lifetime-equivalent exposure (extent of under/overestimation reported quantitatively for short-term adult exposure only)

Reference	Study type	Qualitative assessment	Range of most likely predicted LADD underestimate to overestimate of risk	Maximum predicted underestimate (overestimate) of risk
Murdoch et al., 1992	Theoretical modelling for 30-day exposures of astronauts aged 25 to 45 to hypothetical carcinogens inside the space station. Both A-D[a] multistage and MVK[b] models were used.	LADD may underestimate or overestimate risks.	–2 to +6 fold (A-D multistage model); –2 to +7 fold (MVK model)	–2 (+33) fold (A-D multistage model); –1.4 (+63) fold (MVK model)
Kodell et al., 1987	The A-D multistage model was used to model intermittent exposure to a hypothetical carcinogen starting at age 0, 10, 20 and 50 for 1, 10 and 20 years. The ratio of excess risk for intermittent dosing relative to predicted excess risk based on LADD was calculated.	LADD underestimates risk maximally when the number of cancer stages is assumed to be 6, the 1st stage is dose-dependent and exposure occurs during years 1–10 of life.	–3 to +14 fold	–3 (> $+10^5$) fold
Chen et al., 1988	The MVK model was used to calculate the ratio of excess risk for short-term exposure to a hypothetical carcinogen to predicted excess risk associated with underlying assumptions of LADD, with various input parameters, including duration of exposure and start time of exposure.	LADD underestimates risk maximally with early-stage carcinogen and exposure early in life.	–2 to +13 fold (initiator); –4.5 to +13 fold (completer); –9 to +9 fold (promoter)	–2 (> +100) fold (initiator); –5 (> +25) fold (completer); –77 (+100) fold (promoter)

[a] Armitage-Doll

[b] Moolgavkar-Venzon-Knudson

2.1 Dose Averaging for Less-Than-Lifetime Adult-Only Exposures

The issue of dose averaging can be confounded by the potential for varied susceptibility among different lifestages. The TRV developed from studies involving adult-only exposure (e.g. occupational studies) may be inadequate to account for earlier sensitive lifestages, especially when short-duration, high-magnitude exposure is experienced during these sensitive time windows. For this reason, less-than-lifetime exposure occurring only during the adult lifestage is addressed first. In this case, the only issue leading to the potential underestimate of health risk is assumed to be the mathematical manipulation of the level of exposure. For example, daily occupational exposures occurring 5 days per week for 48–52 weeks per year are amortized to the equivalent daily dose over 7 days per week for 52 weeks per year (resulting in a lower calculated daily exposure). Amortization of this magnitude is common, as TRVs are often derived from epidemiological studies based in occupational environments. Similarly, animals are dosed 5 days per week in some toxicity studies.

Two general lines of inquiry have been explored to determine the extent to which time averaging may over or underestimate cancer risks in adult-only exposures:

1. Evidence from animal bioassays or epidemiological studies in which the cancer risks estimated from short-term exposures are compared with those derived from adult lifetime exposures.
2. Comparison of the cancer risk estimates from short-term exposures with those derived for lifetime exposures at the LADD-equivalent dose using generally accepted mathematical models of carcinogenesis.

2.1.1 Dose Averaging Implications from Adult Animal Bioassays

Standard carcinogenicity bioassays involve near-lifetime exposures; however, exposures of very limited duration may also result in tumour formation. A literature review by Calabrese and Blain (1999) found 426 chemicals from a broad range of chemical classes that could induce cancer after a single administration in a large number of animal models. Most of these chemicals, if not all, were found to be genotoxic. Thirty nine percent caused more tumours, 22% caused fewer tumours, and the remaining 39% showed similar tumourigenic responses when the carcinogen was administered as a single dose as compared with the same dose fractionated over a lifetime. However, Calabrese and Blain (1999) and others (Ginsberg, 2003) did not consider varied lifestage susceptibility when analyzing the available data, which involved a single exposure at different lifestages (i.e. fetal, neonatal).

Stop-exposure studies (summarized in Table 2.2) illustrate the influence of exposure schedule and duration on cancer risk. Exposures were stopped after only a portion of the animal's lifespan, and the animals were observed long enough to measure tumour development.

Table 2.2 Summary of studies comparing cancer risks from short-term (adult-only) exposure with those from lifetime-equivalent exposure (with same total dose)[a]

Reference	Study type	Qualitative assessment	Range of most likely predicted LADD underestimate to overestimate of risk	Maximum predicted underestimate (overestimate) of risk
	Animal experiments			
Halmes et al., 2000	Animal stop-exposure—data from 11 National Toxicology Program studies (adult animals—male rats or mice). Cancer potency was estimated using 2-year continuous bioassay data with or without inclusion of stop-exposure data.	Tumour responses in the stop-exposure experiment were underpredicted by continuous exposure data at 34/59 tumour sites for 6/11 chemicals, and overpredicted at 2/59 tumour sites for 2/11 chemicals. Prediction was accurate for 26/59 tumour sites for 9/11 chemicals.	Undefined	Undefined
		Inclusion of stop-exposure data in ED_{01}[b] estimation (as compared with using continuous bioassay data alone) led to a decrease for 63% of the chemical/tumour/site combinations and an increase for 17% of the chemical/site combinations, mostly within one order of magnitude. 15% (of all tumour sites examined) showed a greater than 10-fold decrease (greater risk or potency) in ED_{01}, implying a higher risk with shorter exposure.	Undefined	Undefined
		The "equivalent averaging times"[c] for the stop-exposures were generally longer than the actual exposure durations but less than 104 weeks for 12 of the 14 dose groups for which this comparison was made. The median "equivalent averaging time" for all the groups was 62 weeks, indicating that averaging stop-exposure duration over a lifetime (LADD) would underestimate the risk by a median factor of 2.	–5 to +2 fold	–5 (+2) fold

Table 2.2 – cont'd ➜

Reference	Study type	Qualitative assessment	Range of most likely predicted LADD underestimate to overestimate of risk	Maximum predicted underestimate (overestimate) of risk
Drew et al., 1983	Animals exposed to constant concentrations of vinyl chloride (adult animals—rats, 2 strains of mice, hamsters) by inhalation. Animal age at the start of exposure and exposure duration were varied among different exposure groups.	For most of the animal species studied, exposure from months 2–8 of life produced higher tumour frequency than exposure at later lifestages for the same duration (8–14, 14–20 or 20–26 months of age), possibly because animals died before a potential tumour could be expressed in the latter groups.	Undefined	Undefined
Hattis et al., 2004	Animals—rats and mice exposed to four types of ionizing radiation at different stages of life	On the basis of a total of 138 group tumour incidence observations, dosage delivered to older animals (6–12 or 19–21 months old) appeared to be 3 fold less effective than a similar dosage delivered to young adult animals (3–3.5 months), suggesting greater sensitivity during early adulthood.	Undefined	Undefined
	Epidemiological studies			
Hauptmann et al., 2000	Case-control study of lung cancer and smoking in adults (4300 cases). The effect of smoking pattern on lung cancer risk was examined using a linear model taking into consideration that different exposure periods vary in their contribution to the overall cancer risk.	The number of cigarettes smoked within 5–15 years prior to patient interview strongly determined lung cancer risk; the number smoked more than 20 years earlier contributed minimally to risk. The pattern corresponds to an observed decrease in risk corresponding to the time since smoking cessation. Authors concluded that use of cumulative or average dose may not be appropriate for estimating lung cancer risk.	Undefined	Undefined
Hauptmann et al., 2002	Pooled data from two German case-control studies (2652 cases) on asbestos and lung cancer were assessed in terms of various exposure metrics.	The results suggested that cancer risk increased for 5–15 years after exposure and then declined. Other studies have indicated a 20–40 year latency period for asbestos-induced lung cancer. Dose averaging over a lifetime would underestimate the risk for people whose remaining lifespan is greater than the latency period and would overestimate the risk for people whose remaining lifespan is shorter than the latency period.	Undefined	Undefined

Table 2.2 – cont'd ➜

Reference	Study type	Qualitative assessment	Range of most likely predicted LADD underestimate to overestimate of risk	Maximum predicted underestimate (overestimate) of risk
Elwood et al., 1985; Elwood, 1992	Histories of exposure to sun of 595 patients with malignant melanoma in Western Canada were examined in a case-control study.	Significant increase in risk was correlated with summer vacation and recreational activities with intense sun exposure. A moderate amount of total occupational exposure (likely from intermittent seasonal exposure) increased the risk; further increased exposure (> 200 whole body equivalent hours of exposure per season associated with long continuous exposure) had no effect or resulted in decreased risk (for men). At the same total sun exposure, the relative risk of melanoma from short-term intermittent recreational exposure exceeded long-term occupational exposure by up to 2 fold.	+1 to –2 fold	–2(+1)

[a] Adapted from Tables 4.5-1 and 4.5-2 in Orr (2007); edited to exclude studies in which juvenile exposures were compared with adult exposures.

[b] ED_{01} is the maximum likelihood estimate of the dose corresponding to a 1% additional cancer risk.

[c] Equivalent averaging time is the length of time over which stop-exposure doses have to be averaged so that the observed response falls exactly on the fitted dose-response curve developed from the continuous exposure (i.e. 104 weeks) data.

Halmes et al. (2000) evaluated cancer data from 12 similar United States National Toxicology Program animal bioassays in which both chronic lifetime and stop-exposure dosing protocols (using male rats except for 1,3-butadiene, to which male mice were exposed) were followed. The Weibull Model was fitted first to the chronic data only and then to the combined chronic and stop-exposure data adjusted to average lifetime exposure. Tumours developed following exposure to 11 chemicals (acting through different modes of action), some at multiple sites, totalling 59 chemical/site combinations. The same response rate was observed for 44% of the chemical/tumour site combinations. However, for 46% of the chemical/tumour site combinations, the response rate was higher in the stop-exposure groups than the chronic lifetime exposure groups. About 5% showed a lower response in the stop-exposure groups than the chronic lifetime exposure groups. Therefore, the assumption of equivalent cancer risk at equivalent total doses (i.e. that the product of concentration and time is constant independent of the exposure pattern) was incorrect at least half of the time. Combining stop-exposure and continuous exposure data in ED_{01}[3] estimation showed varied effect. Inclusion of responses from the stop-exposure groups led to a decrease in the ED_{01} (greater risk or potency) for 63% of the chemical/tumour/site combinations and an increase in the ED_{01} (lesser risk or potency) for 17% of the chemical/site combinations, mostly within one order of magnitude. While the overall change was less than 2-fold (in either direction) for 36% of the tumour sites examined, approximately 15% (of all tumour sites examined) showed a greater than 10-fold decrease (greater risk or potency) in ED_{01}, implying a higher risk with shorter exposure. The largest reduction was 102-fold for lymphomas following 1,3-butadiene exposure.

Halmes et al. (2000) also evaluated dose averaging by determining the "equivalent averaging time". Equivalent averaging time is the length of time over which stop-exposure doses have to be averaged so that the observed response falls exactly on the fitted dose-response curve developed from the continuous exposure (i.e. 104 weeks) data. This method of evaluation has a direct implication for cancer risk assessment. The stop-exposure studies exposed animals for varying durations that ranged from 13 weeks to 66 weeks. For most endpoints, the "equivalent averaging times" were generally longer than the actual exposure durations but less than 104 weeks for 12 of the 14 dose groups for which this comparison was made. The median "equivalent averaging time" for all the groups was 62 weeks, indicating that averaging the stop-exposure dose over a lifetime (i.e. LADD) would underestimate cancer risk by a median factor of 2 (ranging from an overestimation of 2-fold to an underestimation of 5-fold).

In addition to duration-related variability (i.e. short-term versus long-term exposures), carcinogenic sensitivity may not be constant throughout the adult period. On the basis of their analysis of animal (rats and mice) experimental data involving four different types of ionizing radiation, Hattis et al. (2004) demonstrated that the dosage delivered to older animals (6–12 months or 19–21 months old) appeared to be several-fold less effective than a similar dosage delivered to young adults (3–3.5 months old), suggesting greater sensitivity for exposures in early adulthood.

In summary, experimental data with animals suggest that averaging short-term exposure over a lifetime results in uncertainties and may overestimate or underestimate the risk when exposure occurs during adulthood. The level of underestimation or overestimation is generally within an order of magnitude for the substances studied. However, many carcinogens found at contaminated sites have not been studied in this manner.

2.1.2 Dose Averaging Implications from Adult Exposures in Epidemiological Studies

The available epidemiological data on the effect of exposure patterns on cancer risks (summarized in Table 2.2) are limited, lung and skin cancer being the most frequently studied.

A review (Wilson Scientific Consulting Inc., 2006) of the literature on cancer risk from smoking indicates a general scientific consensus that cancer risk decreases for individuals who quit smoking when compared with those who continue to smoke, the extent of the reduction lessening as the age of quitting increases. The review concluded that an appreciable amount of cancer risk is removed 10 years after smoking cessation. However, although smoking reduction may also lead to reduced lung cancer risk, the conclusion did not consider the intensity of smoking or the age of the smoker. Smoking is a unique activity that involves inhaling a high dose of a mixture of carcinogenic and non-carcinogenic chemicals, which include irritants and pharmacologically active levels of nicotine. The effects of both psychological and physical addiction as well as other socioeconomic factors may not have been accounted for in the analyses. Therefore, the exposure–risk relationship observed for smoking may not be applicable to carcinogens and exposures typical of contaminated sites. In addition, the available analysis of the smoking data lacks a quantitative comparison of the cancer risks predicted by LADD and alternative approaches with the observed cancer risks as a function of smoking intensity (dose) and duration.

Hauptmann et al. (2002) investigated lung cancer risk associated with occupational exposure to asbestos in two German case-control studies. The data suggest that an individual's lung cancer risk increased for 5–15 years after exposure and then declined. The risk declined to about one-half after more than 20 years from the final exposure. When individual risks were modelled and compared, the risk was higher and peaked earlier at high exposure rates as

[3] Maximum likelihood estimate of the dose corresponding to a 1% additional cancer risk.

compared with lower exposure rates (5 fiber-yrs/yr for 5 years versus 0.5 fiber-yrs/yr over 50 years). The result suggests that dose averaging over a lifetime would underestimate the risk, especially for people whose remaining lifespan is longer than the latency period. On the other hand, the risk would be overestimated for people whose remaining lifespan is shorter than the latency period.

Case control studies of the incidence of melanoma or basal cell carcinoma involving patients 20–79 years of age with a recent diagnosis in Western Canada (Elwood et al., 1985) found an individual's total dose alone did not determine cancer risk, as the intensity of exposure also played a role. Activities that likely involved more intense sun exposure (vacation and recreation) conferred a greater level of risk (by up to 2-fold) than if the same dose had been achieved by predominantly occupational exposure. A moderate amount of occupational sun exposure (likely from intermittent seasonal exposure) increased the risk, but further increase in exposure (typical of chronic occupational exposure) either had no effect or resulted in decreased risk (for men) (Elwood, 1992). Other major studies showed a similar pattern following intermittent exposures, although results from the northern hemisphere studies are more definitive than from Australian studies (Kricker et al., 1995), partly because the total dose received in Australia is so much greater (Elwood, 1992).

The limited human data associated with short-term or intermittent exposure support the notion that averaging short-duration or intermittent exposure over a longer time period may not be appropriate for predicting cancer risk.

2.1.3 Theoretical Cancer Modelling Studies of Less-Than-Lifetime Exposure

Mathematical models of cancer, such as the A-D multistage model and MVK model (the latter model is also known as the two stage birth-death-mutation model), are generally compatible with the current understanding of the mechanism of carcinogenesis. The A-D multistage model assumes cancer to be the end result of a normal cell going through a finite number (e.g. k) of irreversible independent transitions (stages) that must take place in a specific order (Armitage, 1985; Al-Zoughool and Krewski, 2008). The MVK model assumes that the clonal expansion of cancer involves two discrete phases: initiation (due to genetic damage) and malignant conversion with progression (Al-Zoughool and Krewski, 2008). Although these models have not been validated (United Kingdom Department of Health, 2004), they have been used to describe the age-dependent rate of cancer formation and to explore the extent to which the LADD approach could over or underestimate cancer risk resulting from less-than-lifetime exposure scenarios (Kodell et al., 1987; Murdoch and Krewski, 1988; Chen et al., 1988; Murdoch et al., 1992, Al-Zoughool and Krewski, 2008). These analyses may provide insight into the upper bound estimate of the level of over or underestimation of the risk.

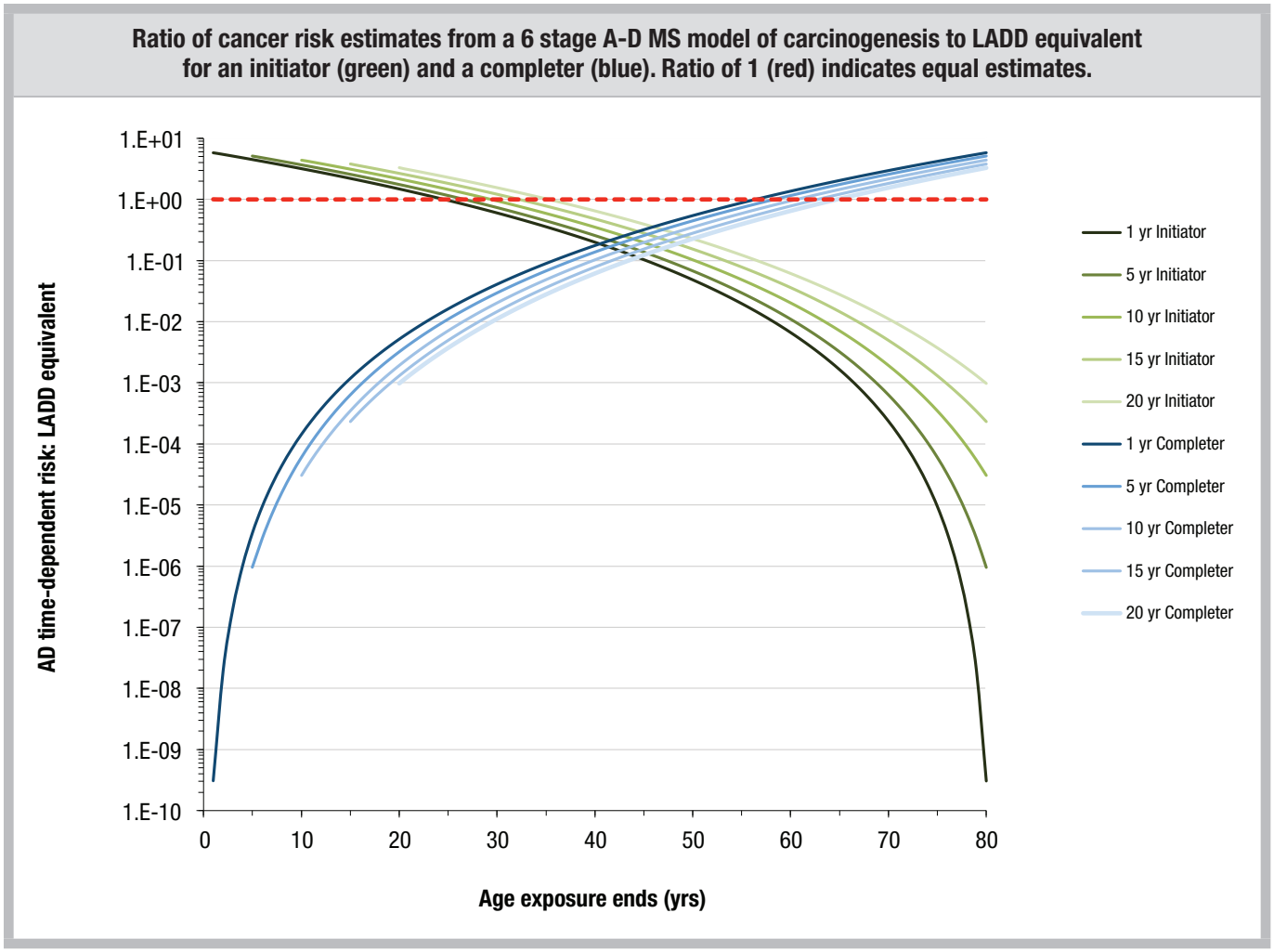
Using the A-D multistage time-to-tumour model, a number of publications (Murdoch et al., 1992; Al-Zoughool and Krewski, 2008; Kodell et al., 1987) have demonstrated the propensity of LADD to over or underestimate cancer risk under certain exposure scenarios. The theoretical upper bound of underestimation by the LADD approach was also estimated. The consensus is that the LADD approach can over or underestimate cancer risks for less-than-lifetime exposures depending on the exposure. The greatest extent of underestimation was postulated for two general scenarios: short-term exposures in early life to initiators (carcinogens that increase the rate of the first stage of carcinogenesis) and short-term exposures late in life to completers (carcinogens that increase the rate of the last stage of carcinogenesis, Chen et al., 1988). In both cases, LADD can underestimate cancer risk by up to a factor of 6. When short-duration exposure occurs in an adult's mid-life period, the extent of underestimation is less than 2- to 3-fold. Depending on the mode of action, cancer risk from short-term exposure may also be overestimated by up to several orders of magnitude.

The relationships between the prevalence and magnitude of potential under and overestimates of cancer risk using the LADD approach are illustrated in Figure 2.1. This figure compares the relative risk estimates generated using a 6-stage A-D multistage model (to estimate cancer risks for time-dependent exposure patterns) with those calculated using an "equivalent" LADD (a time-weighted average dose assuming constant lifetime exposure). The value of 1 on the Y axis represents equivalent risk estimates. Values greater than 1 represent cases in which LADD underestimates cancer risks relative to the time-dependent risk model, and values smaller than 1 represent cases in which LADD overestimates those risks. The figure illustrates that, except for the specific cases discussed above, the LADD is more likely to overestimate cancer risk, and the magnitude of potential overestimation is much greater than the magnitude of underestimation.

It is important to note that the difference in cancer risk estimates between the models is dependent on the number of stages considered in the A-D multistage model, which stage is affected and the age at first exposure. Figure 2.1 illustrates a comparison using the 6-stage A-D multistage model and an assumption that only one stage (i.e. first or last stage) is dose-related. The difference between the models in cancer risk estimates will be smaller if one uses a lower number of cancer stages in the A-D multistage model. The modelled cancer risk estimates become approximately equivalent with a 2-stage A-D model (assuming carcinogenesis has only two stages).

The results from the MVK model generally parallel those from the A-D multistage model exercises (Chen et al., 1988; Murdoch et al., 1992). The model predicts LADD may over or underestimate cancer risks depending on the cell growth rate, time of first exposure, duration of exposure and the type of carcinogen. The maximum underestimate of risk reported by Chen et al. (1988) using the LADD approach would occur with early-life, shorter exposures to an initiator (maximum 7-fold underestimate) or with longer duration, late-life exposures to a completer (maximum 4.5-fold underestimate). When exposure takes place during mid-life, the degree to which LADD can underpredict cancer risk (up to 2-fold) for initiators using the MVK model is generally quite comparable with the A-D multistage model prediction (Chen et al., 1988; Murdoch et al., 1992).

Figure 2.1 Relative cancer risk estimates for various ages and durations of adult exposure calculated using a 6-stage Armitage-Doll multistage (MS) model for estimating cancer risks for time-dependent exposure patterns versus lifetime average daily dose (LADD). Only one stage was assumed to be dose-related in the modelling, the first stage for "initiators" and the last (or kth) stage for "completers". A value of 1 on the Y axis (indicated by the red horizontal dotted line) represents equivalent risk estimates. Values greater than 1 represent cases in which LADD underestimates cancer risks, and values smaller than 1 represent cases in which LADD overestimates risks.



2.1.4 Summary for Dose Averaging for Less-Than-Lifetime Adult Exposure

Evidence from animal experiments, epidemiological studies and theoretical modelling studies supports the conclusion that exposure pattern has an effect on lifetime cancer risk. Averaging less-than-lifetime exposure over a lifetime using LADD may underestimate or overestimate cancer risks, depending on the timing of exposure and the mode of action of the carcinogen. The degree of underestimation seems generally to be confined to within an order of magnitude and is approximately 2-fold for short exposure during all but the very late stages of adulthood. Theoretical modelling predicts up to a 6-fold underestimation of risk for exposure to a completer only late in life; however, most chemicals act through multiple mechanisms, and few exclusive completers have been identified. The original multistage A-D model assumes that cancer incidence increases with age at a constant rate. The review by Al-Zoughool and Krewski (2008) indicates that this assumption does not apply to the incidence of prostate and breast cancers, which increase until age 40 and 50 and decline thereafter; the incidence of most cancer types declines after the age of 80. The multistage model may therefore overestimate cancer rates in the elderly, and LADD may not underpredict cancer risk from less-than-lifetime exposure to (theoretical) completers late in life as much as the model suggests.

Overall, the limited evidence currently available suggests dose averaging over a lifetime (LADD) overestimates as frequently as it underestimates cancer risk for short-term exposure. However, for adult exposures to mutagenic carcinogens (e.g. initiators), the underestimation of cancer risk is insignificant in most cases. Adjustment to correct for underestimation of cancer risk resulting from using the LADD approach for less-than-lifetime exposures in adults is therefore not recommended (i.e. the status quo is maintained).

2.2 Dose Averaging for Less-Than-Lifetime Early-Life Exposure

Cancer slope factors are generally derived from adult human epidemiological studies or standard chronic adult rodent bioassays. The US EPA (2005a) conducted a comprehensive review of cancer risk associated with early-life exposure to determine whether specific age-dependent adjustments of adult cancer slope factors were needed when assessing cancer risk from early-life exposure.

The review found limited cancer epidemiological data involving childhood exposure to radiation and chemotherapeutic agents. A review of available animal studies (Barton et al., 2005; Chhabra et al., 1993; Peto et al., 1984; Vesselinovitch et al., 1979) indicated that early-life exposures (i.e. perinatal) usually resulted in a higher tumour incidence later in life than standard adult-only exposures.

These findings are consistent with the current understanding of biological processes involved in carcinogenesis and are supported by other reviews (McConnell, 1992; Miller et al., 2002; US EPA, 1996), which found the following:

- Tumours usually occur at the same sites following either perinatal or adult exposure.
- Perinatal exposure followed by adult exposure usually increases the percentage of treated animals bearing tumour or reduces the latency period before tumours are observed as compared with adult-only exposures.

The US EPA (2005a) identified several factors that may contribute to increased susceptibility to carcinogens in early life:

- Differences in the capacity to metabolize and clear chemicals at different ages can result in larger or smaller internal doses of the active agent(s), either increasing or decreasing risk (Ginsberg et al., 2002; Renwick, 1998).
- More frequent cell division during development can result in enhanced fixation of mutations because of the reduced time available for repair of DNA lesions, and clonal expansion of mutant cells results in a larger population of mutants (Slikker et al., 2004).
- Some embryonic cells, such as brain cells, lack key DNA repair enzymes.
- Some components of the immune system are not fully functional during development (Holladay and Smialowicz, 2000; Holsapple et al., 2003).
- Hormonal systems operate at different levels during different lifestages (Anderson et al., 2000).
- Induction of developmental abnormalities can result in a predisposition to carcinogenic effects later in life (Anderson et al., 2000; Birnbaum and Fenton, 2003; Fenton and Davis, 2002).
- While tumour promotion processes can be very dependent upon the duration of promotion, initiation processes can occur in relatively brief periods.
- Most tumours take extended periods to develop, which means that damage occurring earlier in life is more likely to result in tumours before death than would exposures that occur later in life.

The US EPA (2005a) compared the cancer potencies from early-life exposure with the cancer potencies from adult exposure in repeated (continuous) dosing studies taken from the published literature. Studies included in the analysis involved a) exposure of animals either only during the juvenile or adult period and followed through adulthood to assess tumour incidence; or b) exposure of animals beginning either in the juvenile or adult period, but once begun continuing through life. Cancer potencies were estimated by fitting the one-hit model, or a restricted form of the Weibull model, to the data for each age group. The analysis for the six carcinogens

(benzidine, diethylnitrosamine, 3-methylcholanthrene, safrole, urethane and vinyl chloride) with a mutagenic mode of action is most informative. The results indicate that the early lifestages can be, but are not always, much more susceptible to cancer development than when exposure occurs in the adult lifestage. The ratio of tumour incidence from early life to adult exposure varies by chemical, sex and species with the weighted geometric mean ratio estimated at 10.4.

The US EPA (2005a) performed a similar analysis of acute dosing studies (which generally compared a single exposure during the juvenile period with identical or similar exposure in adult animals). The results[4] supported the concept that early-lifestage exposure to carcinogenic chemicals with a mutagenic mode of action leads to increased tumour incidence when compared with adult exposure of a similar dose and duration.

On the basis of the analysis involving repeated (continuous) dosing studies, the US EPA (2005a) recommended adjusting the adult cancer slope factor by a factor of 10 for exposures to mutagenic carcinogens occurring during the first 2 years of life. Pharmacokinetic and pharmacodynamic differences between children and adults are greatest during the first 2 years of life (World Health Organization, 2006), which corresponds to the period of birth to weaning in laboratory rodents (Hattis, 2005; WHO, 2006).

The US EPA (2005a) considered the available data insufficient to calculate a specific adjustment factor for the period from 2 through 15 years of age, which represents middle adolescence and follows the period of rapid developmental changes during puberty. The US EPA therefore selected a 3-fold adjustment as it is the geometric mean between the 10-fold adjustment for the first 2 years of life and a unity adjustment for adult exposure. The US EPA recommends that these default age-dependent adjustment factors be applied only when chemical-specific data on early-life exposure are absent.

Although the limited data for carcinogens with a non-mutagenic mode of action (e.g. hormonally mediated) suggest increased susceptibility when exposure occurs perinatally, the US EPA (2005a) considered the data inadequate to derive a generic adjustment of cancer response. More research is needed, particularly because it was observed that tumours arising from hormonally active chemicals appeared to involve different sites when exposure occurred during early life versus adulthood.

The California Environmental Protection Agency (CalEPA, 2009) released its findings on a similar study it undertook to address age-related cancer. This study compared cancer potencies (estimated by applying the linearized multistage [LMS] model to the dose-response data from animal experiments) from early-life exposures (exposed during the prenatal, postnatal or juvenile period) with exposure at an older age, preferably during adulthood. CalEPA used the full distribution of the cancer slope to derive the ratios of cancer potencies from early-life to adult exposures with adjustment for time to manifest tumour (i.e. to account for the longer available time the young animals had from exposure to tumour development). Each chemical was represented by a single distribution based on cancer potencies estimated from one or more studies and from all tumour sites.

The medians of the postnatal age sensitivity factor (ASF), estimated from data on 18 carcinogens (55 distributions), and the juvenile ASF, estimated from data on 5 carcinogens (7 distributions), were reported as 13.5 and 4.5 respectively. Because of the limited database and the broad distributions of results for different chemicals, CalEPA found no basis for specifying a default ASF with greater than half-log precision (i.e. values of 1, 3, 10, 30, etc). Further, rodents are born at a stage of maturity that approximates that of a third-trimester human foetus. Therefore, in the absence of chemical-specific data, CalEPA recommended applying a default ASF of 10 for the third trimester to age 2 years (totalling 2.25 years) and a factor of 3 for ages 2 through 15 years to account for potential higher sensitivity during early lifestages. While the same values were selected by US EPA (2005a) to be applied only to carcinogens with a mutagenic mode of action, CalEPA will apply these factors to all carcinogens. CalEPA (2009) included in its analysis three non-genotoxic carcinogens and found evidence that early life is a susceptible time for a carcinogen thought to act through a non-mutagenic mode of action, e.g. diethylstilbestrol (DES). CalEPA's rationale for not restricting ASF to chemicals acting via a mutagenic mode of action includes the potential problems of defining "mutagenic mode of action" when applied narrowly and the possibility of carcinogens with multiple modes of action that dominate at different lifestages (CalEPA, 2009).

2.3 Dose Averaging for Prenatal Exposure (Transplacental Carcinogenesis)

A number of agents are suspected to be transplacental carcinogens, i.e. in utero exposure to these agents leads to cancer development later in life, involving either a mutagenic or a non-mutagenic mode of action. Most data are from animal studies, such as those involving DES, genistein, tamoxifen, polycyclic aromatic hydrocarbons (PAHs), polybrominated biphenyls, polychlorinated dibenzo-p-dioxins (dioxin; reviewed in Birnbaum and Fenton, 2003), arsenic (Waalkes et al., 2004) and nitrosamines (Mohr et al., 1983). In humans, only radiation and DES have been shown to cause cancer following in utero exposures (Anderson et al., 2000; Barton et al., 2005; and Birnbaum and Fenton, 2003). Other chemicals suspected to be transplacental carcinogens

[4] Based on acute dosing carcinogenic data for eight chemicals with a mutagenic mode of action: benzo[a]pyrene, dibenzanthracene, diethylnitrosamine, dimethylbenzanthracene, dimethylnitrosamine, ethylnitrosourea, methylnitrosourea, urethane.

on the basis of human data include aflatoxin B1 and the hormones used for assisted reproduction (in vitro fertilization). These substances are not typically found at federal contaminated sites; moreover, for many substances that are found at contaminated sites, the data on transplacental carcinogenesis are available only from animal studies.

Some chemicals may be acting as initiators following in utero exposures or prezygotic exposure of the male parent, with cancer formed only upon subsequent postnatal promotion and/or additional exposures (i.e. in utero exposure creates altered susceptibility to cancer later in life). This effect has been seen experimentally with various chemicals, including dioxin/dimethylbenzantracene (DMBA; Brown et al., 1998), 3-methylcholanthrene/butylated hydroxytoluene (Gressani et al., 1999), genistein or atrazine/DMBA (Hilakivi-Clarke et al., 1999; Fenton and Davis, 2002) and N-methyl-N-nitrosourea or PAHs/phenobarbital (Diwan et al., 1989). In utero initiation/postnatal promotion has been demonstrated in humans only for DES and radiation (Yamasaki et al., 1992).

The prenatal to adult cancer potency ratio has not been considered in the US EPA (2005a) supplemental guidance. The CalEPA (2009) has conducted a probabilistic analysis of the prenatal to adult potency ratio. The prenatal age window showed an increased sensitivity to the majority of the 14 carcinogens (22 potency ratio distributions) analyzed. The median of the prenatal ASF distribution was 2.9. However, because of the limited database and the considerable variability in available data, no recommendation on a default adjustment factor was proposed for prenatal exposures in the first and second trimesters. As rodents are born at a stage of maturation similar to that of a third-trimester human foetus, the trimester is included in the default ASF of 10 proposed for up to 2 years of age (i.e. total duration of 2.25 years). No other major regulatory agency has a default position for adjustment of risk calculations for prenatal exposures. While CalEPA (2009) illustrated how an ASF of 10 can be applied when the daily exposure (mg/kg-d) is known, the agency has not provided sample risk calculations for human exposure from known environmental concentrations.

Physiologically based pharmacokinetic (PBPK) modeling of transplacental transfer could theoretically better define the magnitude of increased susceptibility in the foetus. However, validated PBPK models are unlikely to become available in the near future, as the necessary data for modelling and reliable markers of foetal exposure are lacking, and the models themselves require further refinement (Anderson et al., 2000). Efforts to advance knowledge on issues such as the temporal profile and gene polymorphism in enzymes involved in carcinogen activation/detoxification and DNA repair enzymes in the foetus would facilitate development of better PBPK models. More work with animal models is needed to identify transplacental carcinogens and their mechanism of action, including interaction with target genes.

2.4 Dose Averaging for Less-Than-Lifetime Exposure during Puberty

Mutagenic carcinogens are generally more effective in rapidly dividing tissues. The higher rates of cell division provide more opportunities for carcinogens to interact with DNA and less time for DNA repair prior to cell division, which results in increased probability of initiation activity. During puberty, there is dramatic growth in reproductive and other related organs, including some parts of the brain, potentially making them more susceptible to mutagenic carcinogens acting at those sites.

Changes in physiological and biological processes during puberty could also alter susceptibility to the effects of some non-mutagenic carcinogens (e.g. endocrine-disrupting chemicals). On the basis of its analysis of the limited available data, the US EPA Science Advisory Board (US EPA, 2004) concluded that altered sensitivity to the development of cancer may occur when exposure takes place during puberty as compared with other exposure time windows.

3.0 PROPOSED INTERIM MEASURE FOR HUMAN HEALTH RISK ASSESSMENT FOR LESS-THAN-LIFETIME EXPOSURE TO CANCER-CAUSING AGENTS AT CONTAMINATED SITES

The CSD provides this interim guidance with regard to HHRA of carcinogenic agents, including short-term exposure and dose averaging. Risk assessments submitted to CSD should provide a rationale taking into consideration the mode of action at the tumour site in question.

3.1 Assessment of Cancer Risk for Non-Threshold Carcinogenic Effects

3.1.1 Carcinogenic Effects Acting Through a Mutagenic Mode of Action

The US EPA (2005 a, b) provides one of the most comprehensive analyses of the available data related to increased sensitivity when exposure to a carcinogen with a mutagenic mode of action occurs at early lifestages. As an interim measure, CSD has adapted the US EPA approach for contaminated site risk assessments.

The US EPA's default adjustment factor of 10 is supported by LMS modelling studies (Al-Zoughool and Krewski, 2008) indicating that a default factor of 6 should be applied to LADD-based cancer risk estimates for mutagens (i.e. to account for potential increased effectiveness of early-life exposure to an initiator). An additional factor of 1.6 may be applied to slope factors derived from rodent bioassays in which exposure begins in early adulthood (6–8 weeks of age), to give a total adjustment of 10 (6×1.6). This additional factor (1.6) is needed to account for the neonatal/infant period (i.e. from birth to 6–8 weeks of age).

This cancer risk assessment approach takes into account the varying sensitivity of different lifestages to cancer effects. The ILCR is estimated by summing the risk from each discrete exposure period. For non-threshold carcinogens acting through a mutagenic mode of action, it is recommended that ADAFs be applied to the cancer slope factor (or inhalation unit risk) with exposure averaged over a lifetime, to account for the sensitivity of the age-dependent exposure period. This approach can be illustrated by the equations below.

ILCR from oral exposure can be estimated using the following equation:

$$ILCR = \sum_i (LADD_i * SF_i)$$

$$= \sum_i (LADD_i * SF * ADAF_i)$$

Where:
$LADD_i$ = dose received during lifestage i averaged over a lifetime
SF_i = age-specific slope factor
SF = adult cancer slope factor (per mg/kg-d)
$ADAF_i$ = age-dependent adjustment factors for lifestage i

For exposure by inhalation, the following equation applies:

$$ILCR = \sum_i (C_{ai} * TR_i * UR * ADAF_i)$$

Where:
C_{ai} = concentration in air during lifestage i (mg/m^3)
TR_i = fraction of time exposed (yr/80 yr)
UR = adult cancer unit risk (per mg/m^3)
$ADAF_i$ = age-dependent adjustment factors for lifestage i

LADD is defined by the following equation:

LADD (mg/kg-d) = [ER * ED]/Lifetime or

LADD (mg/kg-d) = [C * IR * AF * ED] / [BW* Lifetime]

Where: ER = exposure rate (mg/kg-d)
C = chemical concentration in the media (mg/m^3 or mg/kg)
IR = intake rate of medium (m^3/day or kg/day)
AF = medium-specific absorption factor
ED = exposure duration (days)
BW = body weight (kg)
Lifetime = days in a lifetime = 365 d/yr * 80 yr

$LADD_i$ is defined as the dose received during lifestage i averaged over a lifetime and can be represented by the following equation:

$LADD_i$ (mg/kg-d) = [C_i * IR_i * AF * ED_i] / [BW_i * Lifetime]

Where: C_i = chemical concentration in the media a person is exposed to during lifestagei (mg/m^3/ or mg/kg)
IR_i = intake rate of medium during lifestage$_i$ (m^3/day or kg/day)
AF = medium-specific absorption factor
ED_i = exposure duration during lifestage$_i$ (days)
BW_i = body weight during lifestage$_i$ (kg)
Lifetime = days in a lifetime = 365 d/yr * 80 yr

The US EPA's ADAFs have been adjusted to fit the age groups presented in the PQRA (Health Canada, 2004). Table 3.1 summarizes the default adjusted ADAFs that CSD recommends for contaminated site risk assessments of non-threshold carcinogens with a mutagenic mode of action. These default factors can be applied when age-specific cancer slope factors, age-specific inhalation unit risks or chemical-specific data are not available. In scenarios where exposure periods do not match the CSD's age groups, CSD recommends that the US EPA's ADAFs be applied. For example, if exposure occurs only between 7 months and less than 2 years of age, the adjustment factor of 10 would apply. Likewise, if exposure occurs only between 12 and < 16 years of age, the ADAF of 3 would apply. Worked examples are illustrated in Section 4.

When age-specific cancer slope factors, age-specific inhalation unit risks or chemical-specific data are available for a susceptible lifestage, it is preferable to use these data directly to evaluate risks for the chemical and the lifestage on a case-by-case basis. In these cases, such as vinyl chloride, application of default ADAFs would not be appropriate. The US EPA recommends twice the adult inhalation unit risk to be applied for estimating incremental cancer risk from continuous exposure to vinyl chloride from birth.

For intermittent exposures, the total cancer risk will be the sum of each discrete exposure with lifestage-specific potency and exposure averaged over a lifetime.

Table 3.1 Recommended interim adjusted age-dependent adjustment factors (ADAFs) for cancer risk assessment at contaminated sites for carcinogenic effects via a mutagenic mode of action

Lifestage	Age	Adjusted age-dependent adjustment factor (ADAF)[a]
Infant	0–6 months	10
Toddler	7 months–4 years	5[b]
Child	5–11 years	3
Teenager	12–19 years	2[c]
Adult	20+	1

[a] US EPA (2005 a, b), except as noted.

[b] $ADAF_{7\ mo-4\ yr}$ = ($ADAF_{0-<2}$ * D7 mo-1 / $D_{7\ mo-4}$) + ($ADAF_{2-4}$ * D_{2-4} / $D_{7\ mo-4}$) = 10 * 1.5/4.5 + 3 * 3/4.5 = 5, and D_i = exposure duration in years

[c] $ADAF_{12-19}$ = ($ADAF_{12-<16}$ * D_{12-15} / D_{12-19}) + ($ADAF_{16+}$ * D_{16-19} / D_{12-19}) = 3 * 4/8 + 1 * 4/8 = 2, and D_i = exposure duration in years

The prenatal period (in utero) may be a sensitive window of exposure for some cancers, and an ADAF of 3 (or 2) may not be sufficient to address increased sensitivity during puberty, but further study is needed to delineate more accurately the magnitude of increased sensitivity. CSD will continue to evaluate the issue as new research data become available and as other regulatory agencies consider this issue. In the interim, CSD recommends addressing the risks associated with mutagenic carcinogen exposure during these lifestages on a case-by-case basis.

To date, among the carcinogens for which CSD provides TRV values, the US EPA (2009, 2011a) has identified carcinogenic PAHs, trichloroethylene and vinyl chloride as acting through a mutagenic mode of action. After a toxicological review, the US EPA (2010) proposed that chromium (VI) is "likely carcinogenic to humans" via the oral route of exposure and hypothesized a mutagenic mode of action for its carcinogenicity. This US EPA report is currently undergoing review (US EPA, 2011b).

3.1.2 Carcinogenic Effects Acting Through an Unknown Mode of Action

For carcinogenic effects with an unknown mode of action or for which the burden of proof for a threshold mode of action has not been met, CSD recommends treating the effect as non-threshold. The mathematical equations used to estimate cancer risk for mutagenic carcinogens can be applied in these situations. If chemical-specific data are available on quantitative differences between early lifestages and adults, an analysis of the differences could be used to adjust risk estimates for early life exposures. Otherwise, CSD does not recommend extending the default age-dependent potency adjustment factors to these carcinogenic effects. This position would be analogous to recommending a default ADAF of 1 for all lifestages.

The non-threshold approach for carcinogenicity risk assessment arises initially from the mechanistic, one-hit model, which assumes that only one-hit is required for the cell to be altered. The role of the body's defence mechanism (e.g. repair, apoptosis), which has an influence on the health outcome, is not considered. CSD considers the use of the linear low-dose extrapolation approach (without further adjustment) to be sufficiently conservative and to provide adequate public health protection for carcinogenic effects with a mode of action that is not mutagenic.

3.2 Assessment of Health Risk from Threshold Carcinogens

The CSD does not recommend a default age-specific adjustment for carcinogenic effects found to have a non-linear dose-response relationship (i.e. threshold) at low doses at this time. An adjustment can be made on a chemical-specific basis if supported by experimental data. These substances would be included in an HHRA using a TDI (or a TC in the case of inhalation exposure).

The CSD recommends that dose averaging for short-term exposure for these types of carcinogenic effects be performed in the same way as for other substances with threshold effects. It is important that dose averaging does not underestimate the potential for threshold carcinogenic effects. Without a sound basis for doing so (i.e. it cannot be a default assumption), the human health risk assessor should not simply mathematically spread out a short-term dose over a long period and conclude that the short-term dose is toxicologically equivalent to a lower dose over the long period. In short, CSD recommends that the exposure be averaged over the total actual exposure period and compared with the appropriate TRV. A scientific rationale is required to support any proposed amortization (dose averaging beyond actual exposure period) to ensure that short-term risks are not underestimated. This analysis needs to be done on a chemical-specific basis.

3.3 Assessment of Health Risk from Non-Cancer Health Effects

For short-term exposure, carcinogenic agents may elicit other chronic and short-term non-cancer health effects, depending on the magnitude of exposure. Short-term effects can be evaluated for potential critical receptors/lifestages[5] using short-term TRVs where available (either from other regulatory agencies or derived from literature values, as per Health Canada, 2010, guidance) and applicable to the exposure scenarios. If short-term TRVs are not available, such evaluation can be conducted according to relevant dose-response information from toxicity studies. It is also important to consider whether the short-term exposure might elicit early biological key events that might progress to health effects at a later date. In many cases, both the short-term and chronic non-carcinogenic effects, rather than carcinogenicity, may be the main determinant of the risk from short-term exposure. For example, keratosis rather than carcinogenicity could drive a risk assessment for exposure to high levels of arsenic in soil (e.g. 100 mg/kg) in a less-than-lifetime exposure scenario.

[5] Including relevant receptors/lifestages with the highest exposure and receptors/lifestages associated with specific sensitivity to the toxicity of the contaminants

4.0 WORKED EXAMPLES

4.1 Assessment of Lifetime Risk Associated with Exposure to a Carcinogen with a Mutagenic Mode of Action

When assessing cancer risk, it is important to consider both the difference in exposure and the increased susceptibility for early lifestages. ADAFs in dose-response (i.e. slope factors) need to be combined with age-specific exposure estimation.

The following examples illustrate how to integrate potential lifestage differences in exposure and susceptibility in risk estimation for both lifetime and less-than-lifetime exposure during a specific period in life. The examples consider risk from oral exposure. Risks associated with inhalation exposure to mutagenic carcinogens can be calculated in a similar manner by applying the appropriate ADAFs with the corresponding inhalation unit risk estimates using appropriate estimates of exposure concentrations.

These calculations assume that the available slope factor does not specifically consider early-life exposure. In the case of carcinogens for which age-specific (and in particular early-life) slope factors are available, these factors should be used instead of adjusting the adult slope factor.

4.1.1 Example 1: Exposure Occurs Over a Lifetime

Consider a scenario of exposure to a hypothetical carcinogen with a mutagenic mode of action present in drinking water. The oral slope factor derived from a typical animal study (i.e. in which dosing begins after puberty) is estimated to be 2 $(mg/kg\text{-}d)^{-1}$. The absorption factor of the carcinogen from drinking water is 1. The carcinogen is present in drinking water at 0.001 mg/L.

To calculate lifetime risk for a population with average life expectancy of 80 years, sum the risk associated with each of the time periods, applying recommended ADAFs to the relevant time periods:

- risk for the infant—first 6 months of life (where ADAF = 10),
- risk for toddler—6 months through 4 years of life (ADAF = 5),
- risk for child—ages 5 through 11 (ADAF = 3),
- risk for teenager—ages 12 through 19 (ADAF = 2) and
- risk for adult—ages 20 to 80 (ADAF = 1)

Thus, the ILCR equals the sum of the various age groups:

- Risk for infant
  = slope factor × ADAF x $LADD_{0–6\ mo}$
  = 2 $(mg/kg\text{-}d)^{-1}$ × 10 × [(0.001 mg/L × 0.3 L/d / 8.2 kg) × 0.5 yr/80yr]
  = 5 x 10^{-6}
- Risk for toddler
  = slope factor × ADAF × $LADD_{7\ mo–4}$
  = 2 $(mg/kg\text{-}d)^{-1}$ × 5 × [(0.001 mg/L × 0.6 L/d / 16.5 kg) × 4.5 yr/80yr]
  = 2 × 10^{-5}
- Risk for children
  = slope factor × ADAF × $LADD_{5–11}$
  = 2 $(mg/kg\text{-}d)^{-1}$ × 3 × [(0.001 mg/L × 0.8 L/d / 32.9 kg) × 7 yr/80yr]
  = 1 × 10^{-5}
- Risk for teenager
  = slope factor × ADAF × $LADD_{12–19}$
  = 2 $(mg/kg\text{-}d)^{-1}$ × 2 × [(0.001 mg/L × 1 L/d / 59.7 kg) × 8 yr/80yr]
  = 8 × 10^{-6}
- Risk for adult
  = slope factor × ADAF × $LADD_{20+}$
  = 2 $(mg/kg\text{-}d)^{-1}$ x 1 × [(0.001 mg/L × 1.5 L/d / 70.7 kg) × 60 yr/80yr]
  = 3 × 10^{-5}

Total ILCR
= 5 × 10^{-6} + 2 × 10^{-5} + 1 × 10^{-5} + 8 × 10^{-6} + 3 × 10^{-5}
= 7 × 10^{-5}

4.1.2 Example 2: Exposure Occurs at Less Than 2 Years of Age

Consider a scenario in which exposure to the same hypothetical carcinogen only takes place for a limited period of time, e.g. in a family that lives near a source of contamination for a short time and then moves away. The exposure may occur with a child aged from 1 to less than 2 years of age. It is important to consider lifestage-specific differences in exposure. The carcinogen has an oral cancer slope factor of 2 $(mg/kg\text{-}d)^{-1}$ derived from a typical animal study, and the concentration in drinking water is 0.001 mg/L.

As this exposure period does not match CSD age groupings, the US EPA's ADAF applies[6].

Risk = slope factor × ADAF × $LADD_{1-<2}$
Risk = 2 $(mg/kg\text{-}d)^{-1}$ × 10 × 0.001 mg/L × 0.6 L/d/16.5 kg × 1 yr/80 yrs
= 9 × 10^{-6}

Thus, the incremental lifetime cancer risk from 1 year of exposure to a carcinogen with a mutagenic mode of action assuming initial exposure at 1 year of age is estimated at 9 × 10^{-6}.

[6] Please note that when the exposure period matches a CSD age grouping, CSD recommends that its ADAFs be used.

5.0 REFERENCES

Agency for Toxic Substances and Disease Registry, 2005. Minimal risk levels. Atlanta, GA: Agency for Toxic Substances and Disease Registry. *www.atsdr.cdc.gov/mrls/index.asp*

Al-Zoughool M and Krewski D, 2008. Cancer risk assessment with time dependent exposure patterns: An update. Ottawa, ON. Prepared for Health Canada on contract.

Anderson LM, Diwan BA, Fear NT, Roman E, 2000. Critical windows of exposure for children's health: Cancer in human epidemiological studies and neoplasms in experimental animal models. *Environ Health Perspect* 108 (Suppl. 3): 573–94.

Armitage P, 1985. Multistage models of carcinogenesis. *Environ Health Perspect* 63: 195–201.

Barton HA, Cogliano VJ, Flowers L, Valcovic L, Setzer RW, Woodruff TJ, 2005. Assessing susceptibility from early-life exposure to carcinogens. *Environ Health Perspect* 113 (9): 1125–33.

Birnbaum LS, Fenton SE, 2003. Cancer and developmental exposure to endocrine disruptors. *Environ Health Perspect* 111: 389–94.

Brand KP, 2004. A review of the theoretical justification of cumulative exposure in cancer risk assessment. Ottawa, ON. Prepared for Health Canada on contract.

Brown NM, Manzolillo PA, Zhang JX, Wang J, Lamartiniere CA, 1998. Prenatal TCDD and predisposition to mammary cancer in the rat. *Carcinogenesis* 19: 1623–29.

Calabrese EJ, Blain RB, 1999. The single exposure carcinogen database: Assessing the circumstances under which a single exposure to a carcinogen can cause cancer. *Toxicol Sci* 50: 169–85.

California EPA, 2009. Technical support document for cancer potency factors: Methodologies for derivation, listing of available values and adjustments to allow for early life stage exposures. Office of Environmental Health Hazard Assessment. May 2009. *www.oehha.ca.gov/air/hot_spots/tsd052909.html*

California Office of Environmental Health Hazard Assessment, 2005. Acute reference exposure levels (RELs). Office of Environmental Health Hazard Assessment, State of California. *http://oehha.ca.gov/air/acute_rels/allAcRELs.html*

Chen JJ, Kodell RL, Gaylor DW, 1988. Using the biological two-stage model to assess risk from short-term exposures. *Risk Anal* 8 (2): 223–30

Chhabra RS, Bucher JR, Haseman JK, Elwell MR, Kurtz PJ, Carlton BD, 1993. Comparative carcinogenicity of polybrominated biphenyls with or without perinatal exposure in rats and mice. *Fundam Appl Toxicol* 21: 451–60.

Crump KS, Howe RB, 1984. The multistage model with a time-dependent dose pattern: Applications to cancer risk assessment. *Risk Anal* 4: 163–76.

Diwan BA, Ohshima M, Rice JM, 1989. Effects of postnatal administration of tumour-promoting barbiturates on the development of tumours initiated by prenatal exposure of fetal rats and mice to N-alkylnitrosoureas. *IARC Sci Publ* 96: 75–80.

Drew RT, Boorman GA, Haseman JK, McConnell EE, Busey WM, Moore JA, 1983. The effect of age and exposure duration on cancer induction by a known carcinogen in rats, mice, and hamsters. *Toxicol Appl Pharmacol* 68: 120–30.

Elwood JM, Gallagher RP, Hill GB, Pearson JC, 1985. Cutaneous melanoma in relation to intermittent and constant sun exposure – the Western Canada Melanoma Study. *Int J Cancer* 35 (4): 427–33.

Elwood JM, 1992. Melanoma and sun exposure: Contrasts between intermittent and chronic exposure. *World J Surg* 16 (2): 157–65.

Faqs.org, 2009. Nutrition and well-being A to Z. *www.faqs.org/nutrition/Ca-De/Calcium.html*

Fenton SE, Davis CC, 2002. Atrazine increases dimethylbenz[a] anthracene-induced mammary tumor incidence in Long Evans offspring exposed in utero. *The Toxicologist,* Abstracts of the 41st Annual Meeting of the Society of Toxicology, Abstract 903.

Ginsberg G, Hattis D, Sonawane B, Russ A, Banatia P, Kozlak M, Smolenski S, Goble R, 2002. Evaluation of child/adult pharmacokinetic differences from a database derived from the therapeutic drug literature. *Toxicol Sci* 66: 185–200.

Ginsberg GL, 2003. Assessing cancer risks from short-term exposures in children. *Risk Anal* 23: 19–34.

GlobalTox International Consultants, 2005. Review of exposure amortization in cancer risk assessment. Guelph, ON. Prepared for Health Canada on contract.

Gressani KM, Leone-Kabler S, O'Sullivan MG, Case LD, Malkinson AM, Miller MS, 1999. Strain-dependent lung tumor formation in mice transplacentally exposed to 3-methylcholanthrene and post-natally exposed to butylated hydroxytoluene. *Carcinogenesis* 20 (11): 2159–65.

Halmes NC, Roberts SM, Tolson JK, Portier CJ, 2000. Reevaluating cancer risk estimates for short-term exposure scenarios. *Toxicol Sci* 58: 32–42.

Hattis D, Goble R, Russ A, Chu M, Ericson J, 2004. Age-related differences in susceptibility to carcinogenesis: A quantitative analysis of empirical animal bioassay data. *Environ Health Perspect* 112 (11): 1152–58.

Hattis D, Goble R. Chu M, 2005. Age-related differences in susceptibility to carcinogenesis. II. Approaches for application and uncertainty analyses for individual genetically acting carcinogens. *Environ Health Perspect* 113 (4): 509–16.

Hauptmann M, Wellmann J, Lubin JH, Rosenberg PS, Kreienbrock L, 2000. Analysis of exposure-time-response relationships using a spline weight function. *Biometrics* 56: 1105–8.

Hauptmann M, Pohlabein H, Lubin JH, Jockel KH, Ahrens W, Bruske-Hohlfeld I, Wichmann HE, 2002. The exposure-time-response relationship between occupational asbestos exposure and lung cancer in two German case-control studies. *Am J Ind Med* 41: 87–9.

Health Canada, 2004. Federal contaminated site risk assessment in Canada, Part I: Guidance on human health preliminary quantitative risk assessment (PQRA). Ottawa, ON: Contaminated Sites Division.

Health Canada, 2010. Federal Contaminated Site Risk Assessment in Canada, Part V: Guidance on Human Health Detailed Quantitative Risk Assessment for Chemicals ($DQRA_{Chem}$). Ottawa, ON: Contaminated Sites Division.

Hilakivi-Clarke L, Cho E, Onojafe I, Raygada M, Clarke R, 1999. Maternal exposure to genistein during pregnancy increases carcinogen-induced mammary tumorigenesis in female rat offspring. *Oncol Rep* 6(5): 1089–95.

Holladay SD, Smialowicz RJ, 2000. Development of the murine and human immune system: Differential effects of immunotoxicants depend on time of exposure. *Environ Health Perspect* 108 (Suppl. 3): 463–73.

Holsapple MP, West LJ, Landreth KS, 2003. Species comparison of anatomical and functional immune system development. *Birth Defects Res B Dev Reprod Toxicol* 68(4): 321–34.

Hrudey SE, 1998. Quantitative cancer risk assessment – pitfalls and progress. In: *Risk Assessment and Risk Management.* Hester RE, Harrison RM, eds. Cambridge, UK: Royal Society of Chemistry.

Kodell RL, Gaylor DW, Chen JJ, 1987. Using average lifetime dose rate for intermittent exposures to carcinogens. *Risk Anal* 7: 339–45.

Kricker A, Armstrong BK, English DR, Heenan PJ, 1995. Does intermittent sun exposure cause basal cell carcinoma? A case-control study in Western Australia. *Int J Cancer* 60: 489–94.

McConnell EE, 1992. Comparative response in carcinogenesis bioassays as function of age at first exposure. In: *Similarities and Differences Between Children and Adults: Implications for Risk Assessment.* Guzelain PS, Henry CJ, Olin SS, eds. Washington, DC: ILSI Press, pp. 66–78.

Miller MD, Marty MA, Arcus A, Brown J, Morry D, Sandy M, 2002. Differences between children and adults: Implications for risk assessment at California EPA. *Int J Toxicol* 21: 403–18.

Mohr U, Richter-Reichhelm HB, Emura M, Schmidt-Riese L, Tsuda H, Michiels F, et al., 1983. Assessment of nitrosamine transplacental carcinogens in the Syrian golden hamster. *Biol Res Pregnancy Perinatol* 4(1): 36–39

Murdoch DJ, Krewski D, 1988. Carcinogenic risk assessment with time-dependent exposure patterns. *Risk Anal* 8 (4): 521–30.

Murdoch DJ, Krewski D, Wellmann J, 1992. Cancer risk assessment with intermittent exposure. *Risk Anal* 12 (4): 569–77.

Orr J, 2007. Position paper: Exposure amortization for cancer risk assessment at contaminated sites. Campbellville, ON. Prepared for Health Canada on contract.

Peto R, Gray R, Brantom P, Grasso P, 1984. Nitrosamine carcinogenesis in 5120 rodents: Chronic administration of sixteen different concentrations of NDEA, NDMA, NPYR and NPIP in the water of 4440 inbred rats, with parallel studies on NDEA alone of the effect of age of starting (3, 6, or 20 weeks) and of species (rats, mice, or hamsters). *IARC Sci Publ* 57: 627–65.

Renwick AG, 1998. Toxicokinetics in infants and children in relation to the ADI and TDI. *Food Add Contam* 15: S17–S35.

Schoeny R, 2011. A framework for evaluating data in support of a mutagenic MOA. In: *Report on Workshop on Weight of Evidence for Mutagenic Modes of Action/Combined Exposures* (held March 23rd, 2011, at the University of Ottawa). McLaughlin Centre for Population Health Risk Assessment.

Slikker W 3rd, Mei N, Chen T, 2004. N-ethyl-N-nitrosourea (ENU) increased brain mutations in prenatal and neonatal mice but not in the adults. *Toxicol Sci* 81 (1): 112–120.

United Kingdom Department of Health, 2004. Guidance on a strategy for the risk assessment of chemical carcinogens. Committee on Carcinogenicity of Chemicals in Food, Consumer Products and the Environment.

US EPA, 1986. Guidelines for carcinogen risk assessment. Washington, DC: US EPA, Risk Assessment Forum.

US EPA, 1989. Risk assessment guidance for Superfund (RAGS): Volume 1 – Human health evaluation (Part A) (final report). Washington, DC: US EPA. EPA/540/1-89/002.

US EPA, 1996. Comparison of the effects of chemicals with combined perinatal and adult exposure vs adult only exposure in carcinogenesis bioassays. Washington, DC: Office of Pesticide Programs.

US EPA, 1997. National Advisory Committee for Acute Exposure Guideline Levels for Hazardous Substances. *Federal Register* 62 (210): 58839–851 (October 30, 1997).

US EPA, 2002. A review of the reference dose and reference concentration processes (final report). Washington, DC: US EPA. EPA/630/P-02/002F.

US EPA, 2004. Review of EPA's draft supplemental guidance for assessing cancer susceptibility from early-life exposure to carcinogens. A report by the Supplemental Guidance for Assessing Cancer Susceptibility Review Panel of the EPA Science Advisory Board, Washington, D.C. *www.epa.gov/sab/pdf/sab04003.pdf*

US EPA, 2005a. Supplemental guidance for assessing susceptibility from early-life exposure to carcinogens. Washington, DC: Risk Assessment Forum. EPA/630/R-03/003F.

US EPA, 2005b. Guidelines for carcinogen risk assessment. Washington, DC: Risk Assessment Forum. EPA/630/P-03/001F.

US EPA, 2008. Integrated Risk Information System (IRIS). Washington, DC: US EPA. *www.epa.gov/iriswebp/iris/index.html*

US EPA, 2009. IRIS glossary/acronyms and abbreviations. Washington, DC: US EPA. *www.epa.gov/iris/help_gloss.htm*

US EPA, 2010. IRIS toxicological review of hexavalent chromium (2010 external review draft). Washington, DC: US EPA. EPA/635/R-10/004A, September 2010.

US EPA, 2011a. Toxicological review of trichloroethylene in support of summary information on the integrated risk information system (IRIS). Washington, DC: US EPA. EPA/635/R-09/011F, September 2011.

US EPA, 2011b. IRIS toxicological review of hexavalent chromium (2011 external review draft). Retrieved April 15, 2011. *http://cfpub.epa.gov/ncea/iris_drafts/recordisplay.cfm?deid=221433*

Vesselinovitch SD, Rao KV, Mihailovich N, 1979. Neoplastic response of mouse tissues during perinatal age periods and its significance in chemical carcinogenesis. *NCI Monograph* 51: 239–250.

Waalkes MP, Liu J, Ward JM, Diwan BA, 2004. Animal models for arsenic carcinogenesis: Inorganic arsenic is a transplacental carcinogen in mice. *Toxicol Appl Pharmacol* 198 (3): 377–84.

Walker R, 1999. The significance of excursions above the ADI: Duration in relation to pivotal studies. *Regul Toxicol Pharmacol* 30 (2 Pt 2): S114–8.

Wilson Scientific Consulting Inc., 2006. Review of exposure amortization in contaminated site cancer risk assessment based on tobacco smoking data. Burnaby, BC. Prepared for Health Canada on contract.

Wilson Scientific Consulting Inc. and Meridian Environmental Inc., 2007. Guidance on issues related to acute and subchronic human health risk assessment at federal sites. Burnaby, BC. Prepared for Health Canada on contract.

World Health Organization, 2005. Acute hazard exposure assessment for pesticide residues in food. Geneva, Switzerland: WHO. *www.who.int/foodsafety/chem/acute_data/en/*

World Health Organization, 2006. Environmental health criteria 237. Principles for evaluating health risks in children associated with exposure to chemicals. Geneva: International Programme on Chemical Safety, WHO.

Yamasaki H, Loktionov A, Tomatis L, 1992. Perinatal and multigenerational effect of carcinogens: Possible contribution to determination of cancer susceptibility. *Environ Health Perspect* 98: 39–43.

Zeise L, 2007. Uncertainty associated with sources of human variation. NAS Workshop: Quantitative Approaches to Characterizing Uncertainty in Human Health Risk Assessment Based on Bioassay Results, June 5, 2007. California EPA, Office of Environmental Health Hazard Assessment.

Exhibit G

Technical Support Document for Cancer Potency Factors:

Methodologies for derivation, listing of available values, and adjustments to allow for early life stage exposures.

May 2009

California Environmental Protection Agency

Office of Environmental Health Hazard Assessment

Air Toxicology and Epidemiology Branch

REC 6497

Prepared by:

John D. Budroe, Ph.D.

Joseph P. Brown, Ph.D.

James F. Collins, Ph.D.

Melanie A. Marty, Ph.D.

Andrew G. Salmon, M.A., D.Phil.

Air Toxicology and Epidemiology Branch

and

Martha S. Sandy, Ph.D., M.P.H.

Claire D. Sherman, Ph.D.

Rajpal S. Tomar, Ph.D.

Lauren Zeise, Ph.D.

Reproductive and Cancer Hazard Assessment Branch,

Office of Environmental Health Hazard Assessment

Reviewed By

George V. Alexeeff, Ph.D., Deputy Director

Melanie A. Marty, Ph.D., Chief, Air Toxicology and Epidemiology Branch

Lauren Zeise, Ph.D., Chief, Reproductive and Cancer Hazard Assessment Branch

EXECUTIVE SUMMARY

The Air Toxics "Hot Spots" Information and Assessment Act (AB 2588, Connelly) was enacted in September 1987. Under this Act, stationary sources of air pollution are required to report the types and quantities of certain substances their facilities routinely release into the air. The goals of the Air Toxics "Hot Spots" Act are to collect emission data, identify facilities having localized impacts, ascertain health risks posed by those facilities, notify nearby residents of significant risks and reduce emissions from significant sources.

The Technical Support Document for Cancer Potency Factors (TSD) contains cancer unit risks and potency factors for 107 of the 201 carcinogenic substances or groups of substances for which emissions must be quantified in the Air Toxics Hot Spots program. These unit risks are used in the cancer risk assessment of facility emissions.

The purpose of this revision to the TSD is to provide updated calculation procedures used to derive the estimated unit risk and cancer potency factors, and to describe the procedures used to consider the increased susceptibility of infants and children compared to adults to carcinogens. This updates cancer risk assessment methods originally laid out in the California Department of Health Services' Guidelines for Chemical Carcinogen Risk Assessment (CDHS, 1985), and more recently summarized in the previous Hot Spots technical support document Part II (OEHHA, 2005a). Summaries of cancer potency factors and the underlying data are provided in Appendices A and B, which are subject to ongoing updates but were not changed as part of the revision process which created this TSD.

The procedures used to consider the increased susceptibility to carcinogens of infants and children as compared to adults include the use of age-specific weighting factors in calculating cancer risks from exposures of infants, children and adolescents, to reflect their anticipated special sensitivity to carcinogens

This document is one part of the Air Toxics Hot Spots Program Risk Assessment Guidelines. The other documents originally included in the Guidelines are Part I: Technical Support Document for the Determination of Acute Toxicity Reference Exposure Levels for Airborne Toxicants; Part III: Technical Support Document for Determination of Noncancer Chronic Reference Exposure Levels; Part IV: Technical Support Document for Exposure Assessment and Stochastic Analysis; Part V: Air Toxic Hot Spots Program Risk Assessment Guidelines. As a part of the same revision process which led to production of this revised TSD on cancer potencies, the original TSDs for Acute and Chronic Reference Exposure Levels have been replaced with a new unified TSD for Acute, 8-hour and Chronic Reference Exposure Levels.

The major changes to the TSD include the following:

- Based on the OEHHA analysis of the potency by lifestage at exposure, OEHHA proposes weighting cancer risk by a factor of 10 for exposures that occur from the third trimester of pregnancy to 2 years of age, and by a factor of 3 for exposures that occur from 2 years through 15 years of age. We intend to apply this weighting factor to all carcinogens,

REC 6499

regardless of purported mechanism of action, unless chemical-specific data exist to the contrary. In cases where there are adequate data for a specific carcinogen of potency by age, we would use the data to make any adjustments to risk.

- OEHHA proposes to use the Benchmark Dose method to compute potency factors rather than the more traditional linearized multistage model (LMS), although the LMS will still be used in some instances. The BMDL model essentially uses an empirical fit to the data (usually best with the multistage model), and then extrapolates with a straight line from the 95% lower confidence limit of the BMD (BMDL) to zero. This method is simpler and does not assume any underlying theoretical mechanisms at the low dose range. The BMDL method results in estimates of potency very similar to those obtained using the LMS method.

- OEHHA will use scaling based on body weight to the ¾ power, rather than to the ⅔ power.

- OEHHA's evaluations of the carcinogenicity of chemicals generally follow the guidelines laid out by IARC for identification and classification of potential human carcinogens, which are described in detail in the most recent revision of the *Preamble* to the IARC monographs series (IARC, 2006).

PREFACE

The Air Toxics "Hot Spots" Information and Assessment Act (AB 2588, Connelly) was enacted in September 1987. Under this Act, stationary sources are required to report the types and quantities of certain substances their facilities routinely release into the air. The goals of the Air Toxics "Hot Spots" Act are to collect emission data, identify facilities having localized impacts, ascertain health risks posed by those facilities, notify nearby residents of significant risks and reduce emissions from significant sources.

The Technical Support Document for Cancer Potency Factors (TSD) contains cancer unit risks and potency factors for 107 of the 201 carcinogenic substances or groups of substances for which emissions must be quantified in the Air Toxics Hot Spots program. These unit risks are used in risk assessment of facility emissions. The TSD provides updated calculation procedures used to derive the estimated unit risk and cancer potency factors, and procedures to consider early-life susceptibility to carcinogens. Summaries of cancer potency factors and the underlying data are provided in Appendices A and B.

In this document, OEHHA is responding to the requirements of the 1999 Children's Environmental Health Protection Act (SB25, Escutia) by revising the procedures for derivation and application of cancer potency factors to take account of general or chemical-specific information which suggests that children may be especially susceptible to certain carcinogens (OEHHA, 2001a). The revised cancer potency derivation procedures described will not be used to impose any overall revisions of the existing cancer potencies, although they do reflect updated methods of derivation. However, individual cancer potency values will be reviewed as part of the ongoing re-evaluation of health values mandated by SB 25, and revised values will be listed in updated versions of the appendices to this document as necessary. The revisions also include the use of weighting factors in calculating cancer risks from exposures of infants, children and adolescents, to reflect their anticipated special sensitivity to carcinogens. Similar legal mandates to update risk assessment methodology and cancer potencies apply to the OEHHA program for development of Public Health Goals (PHGs) for chemicals in drinking water, and Proposition 65 No Significant Risk Levels (NSRLs). The NSRLs may also be revised to reflect concerns for children's health. Revising these numbers will require the originating program to reconsider the value in an open public process. For example, OEHHA would need to release any revised potency factors for public comment and review by the Scientific Review Panel on Toxic Air Contaminants (SRP) prior to adoption under the TAC program. The procedures for outside parties to request reevaluation of cancer potency values by the programs which originated those values are listed in Appendix G.

Appendices A and B provide previously adopted Cal/EPA values which were included in the previous version of the TSD for Cancer Potency Factors (OEHHA, 2005a). Cal/EPA values were developed under the Toxic Air Contaminant (TAC) program, the PHG program, the Proposition 65 program, or in some cases specifically for the Air Toxics Hot Spots program. All the Cal/EPA values are submitted for public comments and external peer review prior to adoption by the program of origin. In the future, new values developed by the Toxic Air Contaminants or Hot Spots programs or other suitable sources will be added as these are approved.

REC 6501

Some U.S. EPA IRIS cancer unit risk values were adopted under the previous versions of these guidelines, and these values will continue to be used unless and until revised by Cal/EPA. U.S. EPA has recently revised its cancer risk assessment guidelines (U.S. EPA, 2005a). Some of the recommended changes in methodology could result in slightly different potency values compared to those calculated by the previous methodology, although in practice a number of the recommendations (for example, the use of ¾ power of the body weight ratio rather than ⅔ power for interspecies scaling) have been available in draft versions of the revised policy for some time and appear in many more recent assessments. U.S. EPA has stated that cancer potency values listed in IRIS will not be revisited solely for the purpose of incorporating changes in cancer potency value calculation methods contained in the revised cancer risk assessment guidelines. U.S. EPA has also issued supplementary guidelines on assessing cancer risk from early-life exposure (U.S. EPA, 2005b).

OEHHA uses a toxic equivalency factor procedure for dioxin-like compounds, including polychlorinated dibenzo-*p*-dioxins, dibenzofurans and polychlorinated biphenyls (PCBs). The Toxicity Equivalency Factor scheme (TEF_{WHO-97}) developed by the World Health Organization/European Center for Environmental Health (WHO-ECEH) is used for determining cancer unit risk and potency values for these chemicals where individual congener emissions are available (Appendix C).

This document is one part of the Air Toxics Hot Spots Program Risk Assessment Guidelines. The other documents originally included in the Guidelines are Part I: Technical Support Document for the Determination of Acute Toxicity Reference Exposure Levels for Airborne Toxicants; Part III: Technical Support Document for Determination of Noncancer Chronic Reference Exposure Levels; Part IV: Technical Support Document for Exposure Assessment and Stochastic Analysis; Part V: Air Toxic Hot Spots Program Risk Assessment Guidelines. As a part of the same revision process which led to production of this revised TSD on cancer potencies, the original TSDs for Acute and Chronic Reference Exposure Levels have been replaced with a new unified TSD for Acute, 8-hour and Chronic Reference Exposure Levels.

TABLE OF CONTENTS

PREFACE 5

TABLE OF CONTENTS 7

INTRODUCTION 9

SELECTION OF CANCER POTENCY VALUES 10

CANCER RISK ASSESSMENT METHODOLOGIES 11

Hazard Identification 12

Evaluation of Weight of Evidence 12

Criteria for Causality 12

Data Sources 15

Carcinogen Identification Schemes 18

Dose Response Assessment 23

Interspecies Extrapolation 24

Intraspecies Extrapolation and Inter-individual Variability 24

Toxicokinetic Models 25

Toxicodynamic Models 26

Selection of Site and Tumor Type 30

Carcinogens Inducing Tumors at Multiple Sites 31

Early-Lifestage Cancer Potency Adjustments 33

OEHHA Analysis of the Effect of Age at Exposure on Cancer Potency 35

Selection of Default Age-Sensitivity Factors (ASF) 50

Age Bins for Application of ASFs 52

U.S.EPA Analysis of the Effect of Age at Exposure on Cancer Potency 64

Other Source Documents for Cancer Risk Assessment Guidance 70

United States Environmental Protection Agency (U.S. EPA) 70

Office of Environmental Health Hazard Assessment (OEHHA), California Environmental Protection Agency 74

Chemical-specific Descriptions of Cancer Potency Value Derivations 80

REFERENCES 81

APPENDICES

Appendix A. A lookup table containing unit risk and cancer potency values.

Appendix B. Chemical-specific summaries of the information used to derive unit risk and cancer potency values.

Appendix C. A description of the use of toxicity equivalency factors for determining unit risk and cancer potency factors for polychlorinated dibenzo-*p*-dioxins, dibenzofurans and dioxin-like polychlorinated biphenyls.

Appendix D. A listing of Toxic Air Contaminants identified by the California Air Resources Board.

Appendix E. Descriptions of the International Agency for Research on Cancer (IARC) and U.S. Environmental Protection Agency (U.S. EPA) carcinogen classifications.

Appendix F. An asbestos quantity conversion factor for calculating asbestos concentrations expressed as 100 fibers/m^3 from asbestos concentrations expressed as $\mu g/m^3$.

Appendix G. Procedures for revisiting or delisting cancer potency factors by the program of origin.

Appendix H. Exposure routes and studies used to derive cancer unit risks and slope factors.

Appendix I. "Assessing susceptibility from early-life exposure to carcinogens": Barton *et al*., 2005 (from *Environmental Health Perspectives)*.

Appendix J. "In Utero and Early Life Susceptibility to Carcinogens: The Derivation of Age-at-Exposure Sensitivity Measures" – conducted by OEHHA's Reproductive and Cancer Hazard Assessment Branch.

INTRODUCTION

The Technical Support Document (TSD) for Describing Available Cancer Potency Factors provides technical information support for the Air Toxics Hot Spots Program Risk Assessment Guidelines. The TSD consists of 12 sections:

1. The TSD introduction.

2. A description of the methodologies used to derive the unit risk and cancer potency values listed in the lookup table.

3. A lookup table containing unit risk and cancer potency values. (Appendix A)

4. Chemical-specific summaries of the information used to derive unit risk and cancer potency values. (Appendix B).

5. A description of the use of toxicity equivalency factors for determining unit risk and cancer potency factors for polychlorinated dibenzo-*p*-dioxins, dibenzofurans and dioxin-like polychlorinated biphenyls (Appendix C).

6. A listing of Toxic Air Contaminants identified by the California Air Resources Board (Appendix D).

7. Descriptions of the International Agency for Research on Cancer (IARC) and U.S. Environmental Protection Agency (U.S. EPA) carcinogen classifications (Appendix E).

8. An asbestos quantity conversion factor for calculating asbestos concentrations expressed as 100 fibers/m^3 from asbestos concentrations expressed as $\mu g/m^3$ (Appendix F).

9. Procedures for revisiting or delisting cancer potency factors by the program of origin (Appendix G).

10. Exposure routes and studies used to derive cancer unit risks and slope factors (Appendix H).

11. "Assessing susceptibility from early-life exposure to carcinogens": Barton *et al*., 2005 (from *Environmental Health Perspectives)* (Appendix I).

12. "In Utero and Early Life Susceptibility to Carcinogens: The Derivation of Age-at-Exposure Sensitivity Measures" – conducted by OEHHA's Reproductive and Cancer Hazard Assessment Branch (Appendix J)

SELECTION OF CANCER POTENCY VALUES

The Office of Environmental Health Hazard Assessment (OEHHA) has developed a number of cancer potencies for use in the Toxic Air Contaminants and Air Toxics Hot Spots programs. This document also provides summaries of cancer potency factors which were originally developed for other California Environmental Protection Agency (Cal/EPA) programs, or by the U.S. EPA. These were reviewed for accuracy, reliance on up-to-date data and methodology, and applicability in the context of the Air Toxics Hot Spots program. Values found appropriate were adopted after public and peer review rather than devoting the resources necessary for a full *de novo* assessment. Thus, cancer potency values (CPF) included in the Technical Support Document (TSD) for Cancer Potency Factors were from the following sources:

1. Toxic Air Contaminant documents

2. Standard Proposition 65 documents

3. U.S.EPA Integrated Risk Information Systems (Office of Health and Environmental Assessment, U.S.EPA)

4. Expedited Proposition 65 documents

5. Other OEHHA assessments , for example for the drinking water program.

All the cancer potency value sources used generally follow the recommendations of the National Research Council on cancer risk assessment (NRC, 1983, 1994). All Cal/EPA program documents undergo a process of public comment and scientific peer review prior to adoption, although the procedures used vary according to the program. The publication procedure for Toxic Air Contaminant documents includes a public comment period and review by the Scientific Review Panel on Toxic Air Contaminants (SRP) before identification of a Toxic Air Contaminant by the Air Resources Board of the California Environmental Protection Agency (Cal/EPA). Furthermore, a petition procedure is available to initiate TAC document review and revision if appropriate because of new toxicity data. Documents developed for the Air Toxics Hot Spots program similarly undergo public comment and peer review by the SRP before adoption by the Director of OEHHA. The standard Proposition 65 document adoption procedure includes a public comment and external peer review by the Proposition 65 Carcinogen Identification Committee. The expedited Proposition 65 document adoption procedure included a public comment period. Risk assessments prepared for development of Public Health Goals (PHGs) for chemicals in drinking water are subject to two public comment periods before the final versions and responses to comments are published on the OEHHA Web site. PHG documents may also receive external peer review. Documents from U.S. EPA's Integrated Risk Information System (IRIS) receive external peer review and are posted on the Internet for public viewing during the external peer review period, and any public comments submitted are considered by the originating office. Additionally, public comment may be solicited during the document posting period. Future preference for use of developed cancer potency factors/unit risks will be done on a case by case basis. Preference will be given to those assessments most relevant to inhalation exposures of the California population, to the most recent derivations using the latest data sets and scientific methodology, and to those having undergone the most open and extensive peer review process.

CANCER RISK ASSESSMENT METHODOLOGIES

This section describes in general the methodologies used to derive the cancer unit risk and potency factors listed in this document. As noted in the Preface to this document, no new cancer unit risks or potency factors were developed for this document. All of the values contained here were previously developed in documents by Cal/EPA or U.S. EPA. Following the recommendations of the National Academy of Sciences (NRC, 1983), Cal/EPA and U.S. EPA have both used formalized cancer risk assessment guidelines, the original versions of which (California Department of Health Services, 1985; U.S. EPA, 1986) were published some time ago. Both these guidelines followed similar methodologies.

In the twenty years since these original guidelines were published there have been a number of advances in the methodology of cancer risk assessment. There have additionally been considerable advances in the quantity of data available not only from animal carcinogenesis bioassays and epidemiological studies, but also from mechanistic studies of carcinogenesis and related phenomena. Some of these advances have been incorporated into newer risk assessments by both agencies on a more or less *ad hoc* basis. There has also been an ongoing effort to provide updated risk assessment guidance documents. In 1995, U.S. EPA released for public comment the "Proposed and Interim Guidelines for Carcinogen Risk Assessment", which was the first of several drafts released for public comment. Many risk assessments appearing since then have used elements of the recommendations contained in that document, in spite of its draft status. A final version of the U.S. EPA's revised cancer risk assessment guidelines has now been released (U.S. EPA, 2005a). Although these new guidelines incorporate a number of substantial changes from their predecessors (U.S. EPA, 1986; 1995), U.S. EPA has stated that cancer potency values listed in IRIS will not be revisited solely for the purpose of incorporating changes in cancer potency value calculation methods.

Cal/EPA has not produced a revised cancer risk assessment guideline document to replace the original version (DHS, 1985). Rather, Cal/EPA has relied on incorporating new data and methodologies as these became available, and described the methods used on a case by case basis in the individual risk assessment documents where these went beyond the original guidance. However, this revision of the TSD for cancer potencies provides a convenient opportunity to summarize the current status of the methodology used by OEHHA for the air toxics programs, and also to highlight points of similarity to, and difference from, the recommendations of U.S. EPA (2005a).

In this document, OEHHA intends to follow the recommendations of the NRC (1994) in describing a set of clear and consistent principles for choosing and departing from default cancer risk assessment options. NRC identified a number of objectives that should be taken into account when considering principles for choosing and departing from default options. These include, "protecting the public health, ensuring scientific validity, minimizing serious errors in estimating risks, maximizing incentives for research, creating an orderly and predictable process, and fostering openness and trustworthiness". The OEHHA cancer risk methodologies discussed in this document are intended to generally meet those objectives cited above.

Hazard Identification

This section will describe: 1) how weight of evidence evaluations are used in hazard evaluation; 2) guidelines for inferring causality of effect; 3) the use of human and animal carcinogenicity data, as well as supporting evidence (*e.g.,* genetic toxicity and mechanistic data); 4) examples of carcinogen identification schemes.

Evaluation of Weight of Evidence

In evaluating the range of evidence on the toxicity and carcinogenicity of a compound, mixture or other agent, a "weight-of-evidence" approach is generally used to describe the body of evidence on whether or not exposure to the agent causes a particular effect. Under this approach, the number and quality of toxicological and epidemiological studies, as well as the consistency of study results and other sources of data on biological plausibility, are considered. Diverse and sometimes conflicting data need to be evaluated with respect to possible explanations of differing results. Consideration of methodological issues in the review of the toxicological and epidemiological literature is important in evaluating associations between exposure to an agent and animal or human health effects. This aspect of the evaluation process has received particular emphasis with respect to epidemiological data, where concerns as to the statistical and biological significance and reliability of the data and the impacts of confounding and misclassification are pressing. Such concerns are also relevant to some extent in the interpretation of animal bioassay data and mechanistic studies. Although the test animals, laboratory environment and characterization of the test agent are usually much better controlled than the equivalent parameters in an epidemiological study, the small sample size can be problematic. In addition, there are uncertainties associated with extrapolation of biological responses from test animal species to humans.

Criteria for Causality

There has been extensive discussion over the last two centuries on causal inference. This has particularly related to epidemiological data, but is also relevant to interpretation of animal studies. Most epidemiologists utilize causal inference guidelines based on those proposed by Bradford Hill (1971). OEHHA has relied on these and on recommendations by IARC (2006), the Institute of Medicine (2004), the Surgeon General's Reports on Smoking (U.S. DHHS, 2004) and standard epidemiologic texts (*e.g.,* Lilienfeld and Lilienfeld, 1980; Rothman and Greenland, 1998). The criteria for determination of causality used by OEHHA have been laid out in various risk assessment documents. The summary below is adapted from the Health Effects section of the document prepared to support the identification of environmental tobacco smoke (ETS) as a Toxic Air Contaminant (OEHHA, 2005b).

1. *Strength of Association*. A statistically significant strong association, which is easier to detect if there is a high relative risk, between a factor and a disease is often viewed as an important criterion for inferring causality because, all other things being equal, a strong and statistically significant association makes alternative explanations for the disease less likely. However, as discussed in Rothman and Greenland (1998), the fact that a relative risk is small in magnitude does not exclude a casual association between the risk factor and the outcome in question. Since it is more difficult to detect (*i.e.*, reach statistical

significance) a small magnitude risk, it is just as likely to indicate causality as a larger magnitude risk.

When assessing all evidence, it is important to consider the strength of the study design (particularly controlling for confounding variables, obtaining an unbiased sample, measurement error) and the level of statistical significance (*i.e.*, the ability to exclude a Type I [false positive] error). The power of the study to detect biologically meaningful effects (*i.e.*, the risk of a Type II [false negative] error) is important in considering studies that do not reach traditional (*i.e.*, $P < 0.05$) statistical significance, particularly if the biological endpoint is serious. If the outcome is serious and the study small (*i.e.*, low power), a larger P value (*e.g.*, $P < 0.10$) may be adequate evidence for identifying an effect.

There are a number of examples of statistically significant, small magnitude associations that are widely accepted as causal, such as causal links between air pollution and cardiovascular/pulmonary mortality and between second-hand smoke exposure and various cancers and heart disease. From a public health perspective, even a small magnitude increase in risk for a common disease can mean large numbers of people affected by the health outcome when exposure is frequent and widespread, as measured by the population attributable risk or attributable fraction. Small magnitude of association must not be confused with statistical significance, which is much more important.

2. *Consistency of Association.* If several investigations find an association between a factor and a disease across a range of populations, geographic locations, times, and under different circumstances, then the factor is more likely to be causal. Consistency argues against hypotheses that the association is caused by some other factor(s) that varies across studies. Unmeasured confounding is an unlikely explanation when the effect is observed consistently across a number of studies in different populations.

   Associations that are replicated in several studies of the same design or using different epidemiological approaches or considering different sources of exposure and in a number of geographical regions are more likely to represent a causal relationship than isolated observations from single studies (IARC, 2006). If there are inconsistent results among investigations, possible reasons are sought, such as adequacy of sample size or control group, methods used to assess exposure, or range in levels of exposure. The results of studies judged to be rigorous are emphasized over those of studies judged to be methodologically less rigorous. For example, studies with the best exposure assessment are more informative for assessing the association between ETS and breast cancer than studies with limited exposure assessment, all else being equal.

3. *Temporality.* Temporality means that the factor associated with causing the disease occurs in time prior to development of the disease. The adverse health effect should occur at a time following exposure that is consistent with the nature of the effect. For example, respiratory irritation immediately following exposure to an irritant vapor is temporally consistent, whereas irritation noted only years later may not be. On the other hand, tumors, noted immediately following exposure, might be temporally inconsistent with a causal relationship, but tumors arising after a latency period of months (in rodents) or years (in rodents or humans) would be temporally consistent.

4. *Coherence and Biological Plausibility.* A causal interpretation cannot conflict with what is known about the biology of the disease. The availability of experimental data or mechanistic theories consistent with epidemiological observations strengthens conclusions of causation. For example, the presence of known carcinogens in tobacco smoke supports the concept that exposure to tobacco smoke could cause increased cancer risk. Similarly, if the mechanism of action for a toxicant is consistent with development of a specific disease, then coherence and biological plausibility can be invoked. It should be noted that our understanding of the biology of disease, and therefore biological plausibility, changes in light of new information which is constantly emerging from molecular biology (including epigenetics), and from new clinical and epidemiological investigations revealing effects influenced by genetic polymorphisms, pre-existing disease, and so forth.

5. *Dose-Response.* A basic tenet of toxicology is that increasing exposure or dose generally increases the response to the toxicant. While dose-response curves vary in shape and are not necessarily always monotonic, an increased gradient of response with increased exposure makes it difficult to argue that the factor is not associated with the disease. To argue otherwise necessitates that an unknown factor varies consistently with the dose of the substance and the response under question. While increased risk with increasing levels of exposure is considered to be a strong indication of causality, absence of a graded response does not exclude a causal relationship (IARC, 2006).

   The dose-response curves for specific toxic effects may be non-monotonic. Under appropriate circumstances, where the dose response shows saturation, the effect of exposures could be nearly maximal, with any additional exposure having little or no effect. In some instances, a response is seen strongly in susceptible subpopulations, and the dose-response is masked by mixing susceptible and non-susceptible individuals in a sample. Further, there are examples of U-shaped or inverted U-shaped dose-response curves, (*e.g.*, for endocrine disrupters) (Almstrup et al., 2002; Lehmann et al., 2004). Finally, timing of exposure during development may mask an overall increase in risk with increasing dose.

6. *Specificity.* Specificity is generally interpreted to mean that a single cause is associated with a single effect. It may be useful for determining which microorganism is responsible for a particular disease, or associating a single carcinogenic chemical with a rare and characteristic tumor (*e.g.*, liver angiosarcoma and vinyl chloride, or mesothelioma and asbestos). However, the concept of specificity is not helpful when studying diseases that are multifactorial, or toxic substances that contain a number of individual constituents, each of which may have several effects and/or target sites.

7. *Experimental evidence.* While experiments are often conducted over a short period of time or under artificial conditions (compared to real-life exposures), experiments offer the opportunity to collect data under highly controlled conditions that allow strong causal conclusions to be drawn. Experimental data that are consistent with epidemiological results strongly support conclusions of causality. There are also "natural experiments" that can be studied with epidemiological methods, such as when exposure of a human population to a substance declines or ceases; if the effect attributed to that exposure decreases, then there is evidence of causality. One example of this is the drop in heart disease death and lung cancer risk after smoking cessation.

It should be noted that the causal criteria are guidelines for judging whether a causal association exists between a factor and a disease, rather than hard-and-fast rules. Lilienfeld and Lilienfeld (1980) note that "*In medicine and public health, it would appear reasonable to adopt a pragmatic concept of causality. A causal relationship would be recognized to exist whenever evidence indicates that the factors form part of the complex of circumstances that increases the probability of the occurrence of disease and that a diminution of one or more of these factors decreases the frequency of that disease. After all, the reason for determining the etiological factors of a disease is to apply this knowledge to prevent the disease.*" Rothman and Greenland (2005) discuss the complexities of causation and the use of rules and deductive methods in causal inference. They also concur with Bradford Hill and others that a determination of causality is a pragmatic conclusion rather than an absolute verdict, and advocate that these criteria should be seen as "*deductive tests of causal hypotheses".*

Data Sources

Human studies: epidemiology, ecological studies and case reports

The aim of a risk assessment for the California Air Toxics programs is to determine potential impact on human health. Ideally therefore, the hazard identification would rely on studies in humans to demonstrate the nature and extent of the hazard. However, apart from clinical trials of drugs, experimental studies of toxic effects in human subjects are rarely undertaken or justifiable. Pharmacokinetic studies using doses below the threshold for any toxic effect have been undertaken for various environmental and occupational agents, but are not usually regarded as appropriate for suspected carcinogens.

The human data on carcinogens available to the risk assessor therefore mostly consist of epidemiological studies of existing occupational or environmental exposures. It is easier to draw reliable inferences in situations where both the exposures and the population are substantial and well-defined, and accessible to direct measurement rather than recall. Thus, many important findings of carcinogenicity to humans are based on analysis of occupational exposures. Problems in interpretation of occupational epidemiological data include simultaneous exposure to several different known or suspected carcinogens, imprecise quantification of exposures and confounding exposures such as active or passive tobacco smoking. The historical database of occupational data has a bias towards healthy white adult males. Thus, the hazard analysis of these studies may not accurately characterize effects on women, infants, children or the elderly, or on members of minority ethnic groups. Nevertheless, the analysis of occupational epidemiological studies, including meta-analyses, has proved an important source for unequivocal identification of human carcinogens.

Epidemiological evidence may also be obtained where a substantial segment of a general population is exposed to the material of interest in air, drinking water or food sources. Rigorous cohort and case-control studies may sometimes be possible, in which exposed individuals are identified, their exposure and morbidity or mortality evaluated, and compared to less exposed but otherwise similar controls. More often at least the initial investigation is a cross-sectional study, where prevalence of exposures and outcomes is compared in relatively unexposed and exposed populations. Such studies are hypothesis-generating, but are important sources of information

nevertheless, and can often also justify more costly and labor-intensive follow-up cohort and/or case-control studies.

The clinical medical literature contains many case reports where a particular health outcome is reported along with unusual exposures that might have contributed to its occurrence. These reports typically describe a single patient or a small group, and have no statistical significance. They are nevertheless useful as indications of possible associations that deserve follow-up using epidemiological methods, and as supporting evidence, addressing the plausibility of associations measured in larger studies.

Animal studies

Although the observation of human disease in an exposed population can provide definitive hazard identification, adequate data of this type are not always available. More often, risk estimates have to be based on studies in experimental animals, and extrapolation of these results to predict human toxicity. The animals used are mostly rodents, typically the common laboratory strains of rat and mouse.

Rats and mice have many similarities to humans. Physiology and biochemistry are similar for all mammals, especially at the fundamental levels of xenobiotic metabolism, DNA replication and DNA repair that are of concern in identifying carcinogens. However, there are also several important differences between rodents and humans. Rodents, with a short life span, have differences in cell growth regulation compared to longer-lived species such as the human. For instance, whereas laboratory investigations have suggested that mutations in two regulatory genes (*e.g.,* H-ras and p-53) are sometimes sufficient to convert a rodent cell to a tumorigenic state, many human cancers observed clinically have seven or eight such mutations. In addition, cultured normal human cells have a very stable karyotype, whereas cultured rodent cells facilely undergo tetraploidization and then aneuploidization in cell culture. Further, cultured human cells senesce and rarely undergo spontaneous immortalization (frequency is 10^{-7} or less), whereas cultured rodent cells facilely undergo immortalization at frequencies on the order of 10^{-3}. The use of genomics to study chemical carcinogenesis is relatively new, but the differences at present appear to be a matter of degree rather than kind.

Differences in regulation of cell division are another likely reason for variation between species in the site of action of a carcinogen, or its potency at a particular site. A finding of carcinogenesis in the mouse liver, for instance, is a reasonably good indicator of potential for carcinogenesis at some site in the human, but not usually in human liver (Huff, 1999). The mouse liver (and to a lesser extent that of the rat) is a common site of spontaneous tumors. It is also relatively sensitive to chemical carcinogenesis. The human liver is apparently more resistant to carcinogenesis; human liver tumors are unusual except when associated with additional predisposing disease, such as hepatitis B or alcoholic cirrhosis, or exposure to aflatoxin B1, or simultaneous exposure to hepatitis B virus and aflatoxin B1. Conversely, other tumor sites are more sensitive in the human than in experimental animals. Interspecies variation in site and sensitivity to carcinogenesis may also arise from differences in pharmacokinetics and metabolism, especially for carcinogens where metabolic activation or detoxification is important. This variability may cause important differences in sensitivity between individuals in a diverse population such as humans. Variability

between individuals in both susceptibility and pharmacokinetics or metabolism is probably less in experimental animal strains that are bred for genetic homogeneity.

Animal carcinogenesis studies are often designed to maximize the chances of detecting a positive effect, and do not necessarily mimic realistic human exposure scenarios. Thus extrapolation from an experimentally accessible route to that of interest for a risk assessment may be necessary. Even for studies by realistic routes such as oral or inhalation, doses may be large compared to those commonly encountered in the environment, in order to counter the limitation in statistical power caused by the relatively small size of an animal experiment. Whereas the exposed population of an epidemiological study might number in the thousands, a typical animal study might have fifty individuals per exposure group. With this group size any phenomenon with an incidence of less than about 5% is likely to be undetectable. Statistically significant results may be obtained even with groups as small as ten animals per dose group, when incidence of a tumor that is rare in the controls approached 100% in a treated group. The consensus experimental design for animal carcinogenesis studies, which has evolved over the last 50 years of investigation, is represented by the protocol used by the U.S. National Toxicology Program (NTP) for studies using oral routes (diet, gavage or drinking water) or inhalation. These carcinogenesis bioassays usually involve both sexes of an experimental species, and most often two species. NTP has standardized the use of the C57BlxC3H F_1 hybrid mouse, and the Fischer 344 rat as the standard test species, although NTP has announced plans to substitute use of the Wistar Han rat for the Fischer 344 rat. There is now an extensive database of background tumor incidences, normal physiology, biochemistry, histology and anatomy for these strains, which aids in the interpretation of pathological changes observed in experiments. Nevertheless, there is enough variation in background rates of common tumors that the use of concurrent controls is essential for hazard identification or dose-response assessment. "Historical control" data are mainly used to reveal anomalous outcomes in the concurrent controls. The fact that a significantly elevated incidence of a tumor relative to the concurrent control group is within the range of historical controls at that site for the test sex and strain is not necessarily grounds for dismissing the biological significance of the finding.

Groups of fifty animals of each sex and species are used, with control groups, and several dose groups, the highest receiving the maximum tolerated dose (MTD). Recent study designs have emphasized the desirability of at least three dose levels covering a decade with "logarithmic" spacing (*i.e.* MTD, 1/2 MTD or 1/3 MTD, and 1/10 MTD). This extended design is aimed at providing better dose-response information, and may contribute important additional information, such as mechanistic insights, for the hazard identification phase.

Supporting evidence: genetic toxicity, mechanistic studies

Investigators have developed additional data sources that can support or modify the conclusions of animal carcinogenesis bioassays, and provide information on mechanisms of action of agents suspected of being carcinogenic based on epidemiological studies or animal bioassays.

Genetic damage in exposed organisms includes both gene mutations (point or frameshift), and larger scale effects such as deletions, gene amplification, sister-chromatid exchanges, translocations and loss or duplication of segments or whole chromosomes. These genetic effects of chemical exposures are deleterious in their own right. In addition, since carcinogenesis results from somatic mutations and similar genetic alterations, agents that cause genetic damage generally

have carcinogenic potential. Conversely, many known carcinogens are also known to be genotoxic, although there is also a significant class of carcinogens that are not directly genotoxic according to the usual tests. These latter agents presumably work by some other mechanism, such as methylation of tumor suppressor genes or demethylation of cellular proto-oncogenes, although recent genetic studies have shown that even tumors induced by these agents may show mutations, deletions or amplification of growth regulatory genes.

Experimental procedures to demonstrate and measure genetic toxicity may involve exposure of intact animals, and examination of genetic changes in, for example, bone marrow cells (or cells descended from these, *e.g.,* the micronucleus test, which detects remnants of chromosomal fragments in immature erythrocytes), mutations in flies (*Drosophila)*, or appearance of color spots in the coat of mice. However, many tests have employed single celled organisms or mammalian cells in culture. The best known of these tests is the *Salmonella* reverse mutation assay, popularly known as the Ames test after its inventor. This is representative of a larger class of tests for mutagenic activity in prokaryotic organisms (bacteria), which necessarily only look at gene-level mutations. Similar tests in eukaryotic microorganisms (yeasts, *Aspergillus*) and cultured mammalian cells also detect chromosomal effects. Many tests using microorganisms *in vitro* involve addition of activating enzymes (*e.g.,* liver postmitochondrial supernatant – "S9") to mimic the metabolism of promutagenic chemicals *in vivo*. Another type of test examines the induction in mammalian cells of morphological transformation or anchorage-independent growth. These two chemically induced, *in vitro* changes are considered two of the many changes that fibroblastic cells must undergo on their route to neoplastic transformation (tumorigenicity). These various genetic tests contribute different information, which may be used to amplify and confirm conclusions drawn from human studies or animal bioassays, or to draw conclusions in the absence of epidemiological or bioassay data. In the latter case they have also been used in prioritizing agents for further evaluation by means of bioassays.

Carcinogen Identification Schemes

Some regulatory programs, such as California's Safe Drinking Water and Toxics Enforcement Act ("Proposition 65") and various activities of the U.S. EPA, require that explicit lists of substances having the potential to act as human carcinogens be maintained. Other such lists are developed by non-regulatory research organizations, such as the U.S. National Toxicology Program and the International Agency for Research on Cancer (IARC), an international program of the World Health Organization. The California air toxics programs do not have any statutory requirement to "identify" carcinogens. The requirement instead is to identify hazardous substances as Toxic Air Contaminants, and to determine whether or not a threshold concentration, below which no adverse effects are expected, is likely to exist:

> ***HEALTH AND SAFETY CODE, Division 26 (Air Resources), § 39660.***
>
> *(2) The evaluation shall also contain an estimate of the levels of exposure that may cause or contribute to adverse health effects. If it can be established that a threshold of adverse health effects exists, the estimate shall include both of the following factors:*
>
> *(A) The exposure level below which no adverse health effects are anticipated.*

> *(B) An ample margin of safety that accounts for the variable effects that heterogeneous human populations exposed to the substance under evaluation may experience, the uncertainties associated with the applicability of the data to human beings, and the completeness and quality of the information available on potential human exposure to the substance. In cases in which there is no threshold of significant adverse health effects, the office shall determine the range of risk to humans resulting from current or anticipated exposure to the substance.*

In practice however this requirement amounts to the need to establish whether or not a substance is carcinogenic. Any such effects are clearly harmful. Whereas the great majority of non-cancer health effects of chemicals are regarded as having a threshold, the default assumption for carcinogens is that there is no threshold (as described below). OEHHA follows the guidelines laid out by IARC for identification and classification of potential human carcinogens, which are described in detail in the most recent revision of the *Preamble* to the IARC monographs series (IARC, 2006). The IARC Monograph series provides evaluations of the carcinogenicity of individual substances or commonly occurring mixtures. The evaluation guidelines used are similar to those used by other scientific or regulatory authorities, including U.S.EPA.

The data inputs to hazard identification for carcinogens are human epidemiological studies, animal bioassays, along with supporting evidence such as mechanistic and genotoxicity data and structure-activity comparisons. IARC also assembles data on the structure and identity of the agent. The list of agents considered includes specific chemicals and also complex mixtures, occupational and lifestyle factors, physical and biological agents, and other potentially carcinogenic exposures.

IARC evaluations determine the quality of evidence for both animal and human evidence as falling into one of four categories: sufficient evidence of carcinogenicity, limited evidence of carcinogenicity, inadequate evidence of carcinogenicity and evidence suggesting lack of carcinogenicity. Stringent requirements for data quality are imposed. In view of their crucial importance, these definitions are quoted directly from the *Preamble* (IARC 2006):

> **"(a) Carcinogenicity in humans**
>
> ***Sufficient evidence of carcinogenicity:*** The Working Group considers that a causal relationship has been established between exposure to the agent and human cancer. That is, a positive relationship has been observed between the exposure and cancer in studies in which chance, bias and confounding could be ruled out with reasonable confidence. A statement that there is *sufficient evidence* is followed by a separate sentence that identifies the target organ(s) or tissue(s) where an increased risk of cancer was observed in humans. Identification of a specific target organ or tissue does not preclude the possibility that the agent may cause cancer at other sites.
>
> ***Limited evidence of carcinogenicity*:** A positive association has been observed between exposure to the agent and cancer for which a causal interpretation is considered by the Working Group to be credible, but chance, bias or confounding could not be ruled out with reasonable confidence.
>
> ***Inadequate evidence of carcinogenicity:*** The available studies are of insufficient quality, consistency or statistical power to permit a conclusion regarding the presence or absence

of a causal association between exposure and cancer, or no data on cancer in humans are available.

Evidence suggesting lack of carcinogenicity: There are several adequate studies covering the full range of levels of exposure that humans are known to encounter, which are mutually consistent in not showing a positive association between exposure to the agent and any studied cancer at any observed level of exposure. The results from these studies alone or combined should have narrow confidence intervals with an upper limit close to the null value (*e.g.,* a relative risk of 1.0). Bias and confounding should be ruled out with reasonable confidence, and the studies should have an adequate length of follow-up. A conclusion of *evidence suggesting lack of carcinogenicity* is inevitably limited to the cancer sites, conditions and levels of exposure, and length of observation covered by the available studies. In addition, the possibility of a very small risk at the levels of exposure studied can never be excluded.

(b) Carcinogenicity in experimental animals

Carcinogenicity in experimental animals can be evaluated using conventional bioassays, bioassays that employ genetically modified animals, and other in-vivo bioassays that focus on one or more of the critical stages of carcinogenesis. In the absence of data from conventional long-term bioassays or from assays with neoplasia as the end-point, consistently positive results in several models that address several stages in the multistage process of carcinogenesis should be considered in evaluating the degree of evidence of carcinogenicity in experimental animals.

The evidence relevant to carcinogenicity in experimental animals is classified into one of the following categories:

***Sufficient evidence of carcinogenicity*:** The Working Group considers that a causal relationship has been established between the agent and an increased incidence of malignant neoplasms or of an appropriate combination of benign and malignant neoplasms in (a) two or more species of animals or (b) two or more independent studies in one species carried out at different times or in different laboratories or under different protocols. An increased incidence of tumours in both sexes of a single species in a well-conducted study, ideally conducted under Good Laboratory Practices, can also provide *sufficient evidence*.

A single study in one species and sex might be considered to provide *sufficient evidence of carcinogenicity* when malignant neoplasms occur to an unusual degree with regard to incidence, site, type of tumour or age at onset, or when there are strong findings of tumours at multiple sites.

***Limited evidence of carcinogenicity*:** The data suggest a carcinogenic effect but are limited for making a definitive evaluation because, *e.g.,* (a) the evidence of carcinogenicity is restricted to a single experiment; (b) there are unresolved questions regarding the adequacy of the design, conduct or interpretation of the studies; (c) the agent increases the incidence only of benign neoplasms or lesions of uncertain neoplastic potential; or (d) the evidence of carcinogenicity is restricted to studies that demonstrate only promoting activity in a narrow range of tissues or organs.

***Inadequate evidence of carcinogenicity*:** The studies cannot be interpreted as showing either the presence or absence of a carcinogenic effect because of major qualitative or quantitative limitations, or no data on cancer in experimental animals are available.

***Evidence suggesting lack of carcinogenicity*:** Adequate studies involving at least two species are available which show that, within the limits of the tests used, the agent is not carcinogenic. A conclusion of *evidence suggesting lack of carcinogenicity* is inevitably limited to the species, tumour sites, age at exposure, and conditions and levels of exposure studied."

IARC utilizes the evaluations of animal and human data, along with supporting evidence including genotoxicity, structure-activity relationships, and identified mechanisms, to reach an overall evaluation of the potential for carcinogenicity in humans. The revised *Preamble* (IARC, 2006) includes a description of the data evaluation criteria for this supporting evidence, and indications as to the situations where the availability of supporting evidence may be used to modify the overall conclusion from that which would be reached on the basis of bioassay and/or epidemiological evidence alone. The overall evaluation is expressed as a numerical grouping, the categories of which are described below, as before by directly quoting IARC (2006):

"Group 1: The agent is *carcinogenic to humans*.

This category is used when there is *sufficient evidence of carcinogenicity* in humans. Exceptionally, an agent may be placed in this category when evidence of carcinogenicity in humans is less than *sufficient* but there is *sufficient evidence of carcinogenicity* in experimental animals and strong evidence in exposed humans that the agent acts through a relevant mechanism of carcinogenicity.

Group 2.

This category includes agents for which, at one extreme, the degree of evidence of carcinogenicity in humans is almost *sufficient*, as well as those for which, at the other extreme, there are no human data but for which there is evidence of carcinogenicity in experimental animals. Agents are assigned to either Group 2A (*probably carcinogenic to humans*) or Group 2B (*possibly carcinogenic to humans*) on the basis of epidemiological and experimental evidence of carcinogenicity and mechanistic and other relevant data. The terms *probably carcinogenic* and *possibly carcinogenic* have no quantitative significance and are used simply as descriptors of different levels of evidence of human carcinogenicity, with *probably carcinogenic* signifying a higher level of evidence than *possibly carcinogenic*.

Group 2A: The agent is *probably carcinogenic to humans*.

This category is used when there is *limited evidence of carcinogenicity* in humans and *sufficient evidence of carcinogenicity* in experimental animals. In some cases, an agent may be classified in this category when there is *inadequate evidence of carcinogenicity* in humans and *sufficient evidence of carcinogenicity* in experimental animals and strong evidence that the carcinogenesis is mediated by a mechanism that also operates in humans. Exceptionally, an agent may be classified in this category solely on the basis of *limited*

evidence of carcinogenicity in humans. An agent may be assigned to this category if it clearly belongs, based on mechanistic considerations, to a class of agents for which one or more members have been classified in Group 1 or Group 2A.

Group 2B: The agent is *possibly carcinogenic to humans*.

This category is used for agents for which there is *limited evidence of carcinogenicity* in humans and less than *sufficient evidence of carcinogenicity* in experimental animals. It may also be used when there is *inadequate evidence of carcinogenicity* in humans but there is *sufficient evidence of carcinogenicity* in experimental animals. In some instances, an agent for which there is *inadequate evidence of carcinogenicity* in humans and less than *sufficient evidence of carcinogenicity* in experimental animals together with supporting evidence from mechanistic and other relevant data may be placed in this group. An agent may be classified in this category solely on the basis of strong evidence from mechanistic and other relevant data.

Group 3: The agent is *not classifiable as to its carcinogenicity to humans*.

This category is used most commonly for agents for which the evidence of carcinogenicity is *inadequate* in humans and *inadequate* or *limited* in experimental animals.

Exceptionally, agents for which the evidence of carcinogenicity is *inadequate* in humans but *sufficient* in experimental animals may be placed in this category when there is strong evidence that the mechanism of carcinogenicity in experimental animals does not operate in humans.

Agents that do not fall into any other group are also placed in this category.

An evaluation in Group 3 is not a determination of non-carcinogenicity or overall safety. It often means that further research is needed, especially when exposures are widespread or the cancer data are consistent with differing interpretations.

Group 4: The agent is *probably not carcinogenic to humans*.

This category is used for agents for which there is *evidence suggesting lack of carcinogenicity* in humans and in experimental animals. In some instances, agents for which there is *inadequate evidence of carcinogenicity* in humans but *evidence suggesting lack of carcinogenicity* in experimental animals, consistently and strongly supported by a broad range of mechanistic and other relevant data, may be classified in this group."

The IARC hazard evaluation system provides a detailed and generally accepted scheme to classify the strength of evidence as to the possible human carcinogenicity of chemicals and other agents. This includes careful consideration of mechanistic data and other supporting evidence, the evaluation of which is also important to inform selection of models or defaults used in dose response assessment, as is described below. The extended consideration of supporting evidence is in fact the primary difference between more recent versions of the guidance from IARC, and also by other organizations including U.S. EPA, and the original versions of that guidance. In fact, the basic criteria for hazard identification based on bioassay and epidemiological data have not

changed substantially in other respects from earlier guidance documents, including that originally published by California (DHS, 1985). Although as noted earlier the California Air Toxics programs do not categorize identified carcinogens, it has generally been the practice to regard any agent with an IARC overall classification in Group 1 or Group 2 as a known or potential human carcinogen. This implies the selection of various policy-based default options, including absence of a threshold in the dose-response curve, unless specific data are available to indicate otherwise. The same basic identification criteria are used by OEHHA scientific staff to determine the appropriate treatment of agents not evaluated by IARC, or for which newer data or revised interpretations suggest that an earlier IARC determination is no longer appropriate.

U.S. EPA has also proposed a scheme for carcinogen hazard identification and strength of evidence classification in their recently finalized Guidelines for Carcinogen Risk Assessment (U.S. EPA, 2005). These principally differ from the IARC guidance in recommending a more extensive narrative description rather than simply a numerical identifier for the identified level of evidence, and also to some degree in the weight accorded to various types of supporting evidence. However, for most purposes they may be regarded as broadly equivalent to the scheme used by IARC, and OEHHA has chosen to cite the IARC (2006) *Preamble* as representing the most up-to-date and generally accepted guidance on this issue.

Dose Response Assessment

The dose-response phase of a cancer risk assessment aims to characterize the relationship between an applied dose of a carcinogen and the risk of tumor appearance in a human. This is usually expressed as a cancer slope factor ["potency" – in units of reciprocal dose - usually $(mg/kg\text{-}body\ weight.day)^{-1}$ or "unit risk" – reciprocal air concentration – usually $(\mu g/m^3)^{-1}$] for the lifetime tumor risk associated with lifetime continuous exposure to the carcinogen at low doses. Cancer potency factors may also be referred to as "cancer slope factors". (As will be described later, additional algorithms may need to be applied to determine risk for specific age groups, or at higher doses where toxicokinetic factors have significant effect.) The basic methodologies recommended in this document are similar to those described by U.S. EPA (2005a) in their Carcinogen Risk Assessment Guidelines. This document therefore refers to U.S. EPA (2005a) for explanation of detailed procedures, and will provide only a brief summary except in cases where OEHHA recommendations are different from or more explicit than those of U.S. EPA.

The following descriptions of methods for dose response assessment, and considerations in their application, apply in principle to the analysis of both animal and human (epidemiological) cancer incidence data. Indeed, the original formulation of the multistage model (Armitage and Doll, 1954) described below was developed based on human cancer incidence. Nevertheless, the number and quality of human cancer incidence datasets are limited. The more complex analyses have usually only been possible for animal experimental data, where the interindividual variability and the exposure conditions can be both measured and controlled. Most commonly, epidemiological studies have necessarily used a form of multivariate analysis to separate the effects of several different variables relating to exposure, demographics and behaviors (*e.g.,* smoking). In these analyses it is usually assumed that the effect measure(s) vary linearly with the exposure: any more complex variance assumptions might exceed the power of the data to determine the required model parameters. However, there are exceptions, especially for occupational studies where the critical exposure is measured as a continuous variable (rather than

just categorical) and where the effect of this exposure is substantial relative to other confounding factors. For example, OEHHA (1998) used a multistage model dealing with both exposure intensity and duration in the analysis of cancer incidence in railroad workers exposure to diesel exhaust (Garshick et al., 1988)

Interspecies Extrapolation

The procedures used to extrapolate low-dose human cancer risk from epidemiological or animal carcinogenicity data are generally health-protective in that they determine an upper confidence bound on the risk experienced by an exposed population. As statistical estimates they cannot be regarded as definite predictions of the risk faced by any one specific individual, who might for a variety of reasons, including individual exposure and susceptibility, experience a risk different from the estimate. The risk assessment procedures used aim to include the majority of variability in the general human population within the confidence bounds of the estimate, although the possibility that some individuals might experience either lower or even no risk, or a considerably higher risk, cannot be excluded. Additionally, differences may exist between the characteristics of the general public and those of studied populations. For example, healthy workers, the subject of most epidemiological studies, are often found to have lower rates of morbidity and mortality than the general population (Wen et al., 1983; Monson, 1986; Rothman and Greenland, 1998). Most human data are derived from studies of largely male adult workers and risk estimates cannot take into account specific physiological factors of women, children, and older populations that may affect the potency of a carcinogen, including early age-at-exposure.

Dose-response assessment based on environmental epidemiological studies may involve evaluation of health impacts at exposure levels within the range of those measured in the study population. However, more usually the source data are studies of occupationally exposed humans or of animals, in which case the exposures in the study are likely to be much higher than those of concern for risk assessments relating to community or ambient exposures. Further, even when extrapolation from animal species to humans is not required, the general population to which the URF is applied may differ in characteristics relative to the occupational population studied. It is therefore necessary to extrapolate from the available data to the population and exposure range of concern, which is done by using a dose-response model derived from the source data. The models used fall into three main classes: mechanistically based models, empirical models and (where data are lacking to support a true data-based model) default assumptions. The factors affecting the dose-response relationships for carcinogenesis may also be divided into those relating to absorption, distribution, metabolism and excretion on the one hand (*i.e.* toxicokinetics), and those relating to the underlying dose-response characteristics of carcinogenesis at the tissue or cellular level (*i.e.* toxicodynamics). In this sense the problem of dose response assessment for carcinogens is similar to that for non-cancer toxic effects. The toxicokinetic models used may in fact be similar for both situations, but the toxicodynamic models are generally different.

Intraspecies Extrapolation and Inter-individual Variability

In estimating the impact of a particular level of exposure to a carcinogen on a target human population, it is necessary to consider the range of susceptibility in the target population. In the present case this is typically defined as the general population of the State of California, including of course women (some of whom are pregnant), infants and children, the elderly, the sick, and

those with genetic polymorphisms or acquired differences which affect their susceptibility to carcinogens. In general it has been assumed that the upper-bound risk estimates obtained from the standard toxicodynamic models described below are sufficiently health-protective to cover the intrinsic variability of the adult human target population, in spite of the fact that these models do not explicitly address this type of variability, except in the few cases where an estimate is based on epidemiological data from a large and unselected study group (U.S. EPA, 2005a). However, various analyses (Drew et al., 1983; Barton et al., 2005; Appendix J) have suggested that this assumption is inadequate to cover the expected variability within a human population that includes infants and children. Accordingly both U.S. EPA (2005b) and this document now offer guidance on the use of age-specific adjustment factors to allow for the potentially greater sensitivity of infants and children to chemical carcinogenesis.

The ability to accommodate human variability with regard to the toxicokinetic factors affecting susceptibility to carcinogens varies with the level of detail used in the particular assessment. If the generic interspecies extrapolation approach based on body weight is used without any explicit toxicokinetic model, then the assumption is made, as in the case of toxicodynamic variability, that the overall health-protective assumptions made are sufficient to cover the toxicokinetic variability. On the other hand if explicit models such as those referenced in the following paragraph are used, this variability may be more explicitly accommodated by using parameter values which are taken as point estimates from measured distributions of population values, or by using Monte Carlo techniques to include those distributions in the model (Bois et al., 1996; OEHHA, 1992; 2001b).

Toxicokinetic Models

Considerable literature exists showing the importance of understanding the toxicokinetics of carcinogens in understanding their mechanism of action, sites of impact and dose-response relationships. U.S. EPA (2005) in Section 3.1 refers to the importance of identifying an appropriate dose metric for the dose-response analysis. Early cancer risk assessments typically used applied dose as the dose metric, which is adequate in simple cases provided appropriate correction factors are applied for interspecies extrapolation. However, it is often observed that the uptake, metabolism and elimination of the carcinogenic substance (and/or a procarcinogen and metabolites) is non-linear, especially at the higher doses employed in experimental animal studies (Hoel *et al*., 1983, Gaylor *et al*., 1994). Extrapolation to lower doses where such relationships tend to linearity (Hattis, 1990) is aided by the use of toxicokinetic models. These may be relatively simple compartment models, or sophisticated "physiologically based pharmacokinetic (PBPK) models" which to a greater or lesser degree model the actual biochemical and physiological events of toxicokinetic importance. Applications of both types of model may be found in various risk assessment documents prepared for the Toxic Air Contaminants program (and other OEHHA risk assessments). Since the details vary widely according to the nature of the chemical and the availability of appropriate kinetic data these general guidelines will defer to those examples rather than attempt a fuller exposition here. Further analysis of the use of toxicokinetic modeling in extrapolation from animals to humans, and in accounting for interindividual variability among adult humans, infants and children is presented in the Air Toxics Hot Spots *Technical Support Document for the Derivation of Noncancer Reference Exposure Levels* (OEHHA, 2008). Although this refers to the use of toxicokinetic modeling in non-cancer risk assessment, the primary considerations are similar for cancer risk assessment.

Toxicodynamic Models

An early use of mechanistic analysis to support risk assessment was the development of the Armitage-Doll multistage model of dose-response for carcinogenesis. The multistage model was initially developed on theoretical grounds, and by examination of epidemiological and animal data on time to tumor incidence. Subsequent discovery of the molecular biology of proto-oncogenes has provided a basis for explaining the model in terms of actual biological events and systems (Barrett and Wiseman, 1987). This model was developed by Crump and others into the "linearized multistage model", which has been extensively used for carcinogen risk assessment. It leads to a number of partially verifiable predictions, including linearity of the dose-response relationship at low doses, which is observed for many genotoxic carcinogens. It also predicts the form of the dose-response relationship at higher doses, which generally follow a polynomial form (subject to sampling and background corrections) except where other identifiable factors such as pharmacokinetics intervene.

It has been argued that the simple linearized form of the multistage model has limitations as a description of carcinogenic mechanisms, which detract from its usefulness and generality. Cell proliferation is known to be important in the progression of cancer. It may actually be the primary mechanism of action for a few carcinogens, as opposed to the direct modification of DNA by the carcinogen or a metabolite which is assumed to cause the mutational event at each stage in the original multistage description. A cell proliferation model has been developed (Moolgavkar and Knudson, 1981), which retains the concept of an initiating mutational event (in most cases caused by interaction of the chemical with DNA, although it could also be a spontaneous mutation) as in the original multistage model, but also considers proliferation, death or terminal differentiation of both normal and initiated cells. This model is thought to better describe the biological events in carcinogenesis. However, it has not been used extensively in risk assessment because it requires many parameters that are difficult to define and measure (such as proliferation and death rates for various classes of cell). If these cannot be accurately determined, the model has too many free parameters and is not helpful in defining extrapolated values for risk assessment purposes. This highlights a general problem in using mechanistic models in carcinogen risk assessment, which is that the carcinogenesis data themselves are generally insufficient to define fully the dose response curve shape at low doses or provide much mechanistic information. The analysis is therefore supplemented with policy-based assumptions (such as the expectation of linearity at low doses) and, wherever possible, additional experimental measurements relating to the mechanism of action, in order to make meaningful prediction of risk from environmental exposures to humans.

Because of the difficulties in validating simplified mechanistic models such as the basic multistage model, and the additional difficulty of parameter estimation with more complex mechanistic models, the new U.S. EPA guidelines (U.S. EPA, 2005a) and some recent California risk assessments have chosen instead to use a less overtly mechanistic approach. This approach combines benchmark dose methodology (described below) with an explicit choice of the method for low-dose extrapolation, either assuming low-dose linearity or, for certain carcinogens where data indicate that this is appropriate, a "margin of exposure" or safety/uncertainty factor based approach. This benchmark method is now normally recommended for carcinogen dose response analysis, and the results generally differ little from those derived by the linearized multistage model. Although the linearized multistage method is no longer recommended as the default approach for cancer potency estimation it remains a plausible alternative in many cases, and still

has useful applications, such as for time-to-tumor analyses for which benchmark methods are not yet widely available. Additionally, a considerable number of existing cancer potencies in Appendices A and B, and used in the Air Toxics Hot Spots program were derived by this method. Many of these would not be significantly different if calculated by the benchmark approach, and are unlikely to be replaced soon by newly calculated values. The linearized multistage method will therefore also be briefly described here.

Benchmark Dose Methodologies

The use of benchmark dose methodology has been explored by various investigators [including Gaylor et al. (1998); van Landingham et al. (2001) and Crump (1984, 1995, 2002)] as a tool for dose response extrapolation. This has been recommended in regulatory guidelines for both carcinogenic (U.S. EPA, 2005a) and non-carcinogenic (U.S. EPA, 1995) endpoints. The basic approach is to fit an arbitrary function to the observed incidence data, and to select a "point of departure" (POD) (benchmark dose) *within the range of the observed data.* From this a low dose risk estimate or assumed safe level may be obtained by extrapolation, using an assumed function (usually linear) or by application of uncertainty factors. The critical issue here is that no assumptions are made about the nature of the underlying process in fitting the data. The assumptions about the shape of the dose response curve (linear, threshold, etc.) are explicitly confined to the second step of the estimation process, and are chosen on the basis of policy, mechanistic evidence or other supporting considerations. The benchmark chosen is a point at the low end of the observable dose-response curve. Usually a dose at which the incidence of the tumor is 10% is chosen for animal studies, although lower effect levels may be appropriate for large epidemiological data sets. Because real experimental data include variability in the response of individual subjects, and measurement errors, likelihood methodology is applied in fitting the data. A lower confidence bound (usually 95%) of the effective dose (LED_{10}), rather than its maximum likelihood estimate (MLE), is used as the point of departure. This properly reflects the uncertainty in the estimate, taking a cautious interpretation of highly variable or error-prone data. It also reflects the instability of MLE values from complex curve-fitting routines, which has been recognized as a problem also with the linearized multistage model.

For cancer dose-response estimation using the benchmark dose method, either animal bioassay data or epidemiological data provide a suitable basis. In the absence of a pharmacokinetic model (which could provide tissue-specific dose metrics), the potency would ordinarily be based on the time-weighted average exposure during the exposure or dosing period. The model used to fit the data can be chosen from a range of available alternative quantal models, depending on which provides the best fit to the data in the observable range. In practice, the multistage polynomial fit developed for the linearized multistage model works well for most tumor data sets. Here it is being used merely as a mathematical curve-fitting tool, where the model well fits the data set, without making assumptions about its validity as a biological model of carcinogenesis.

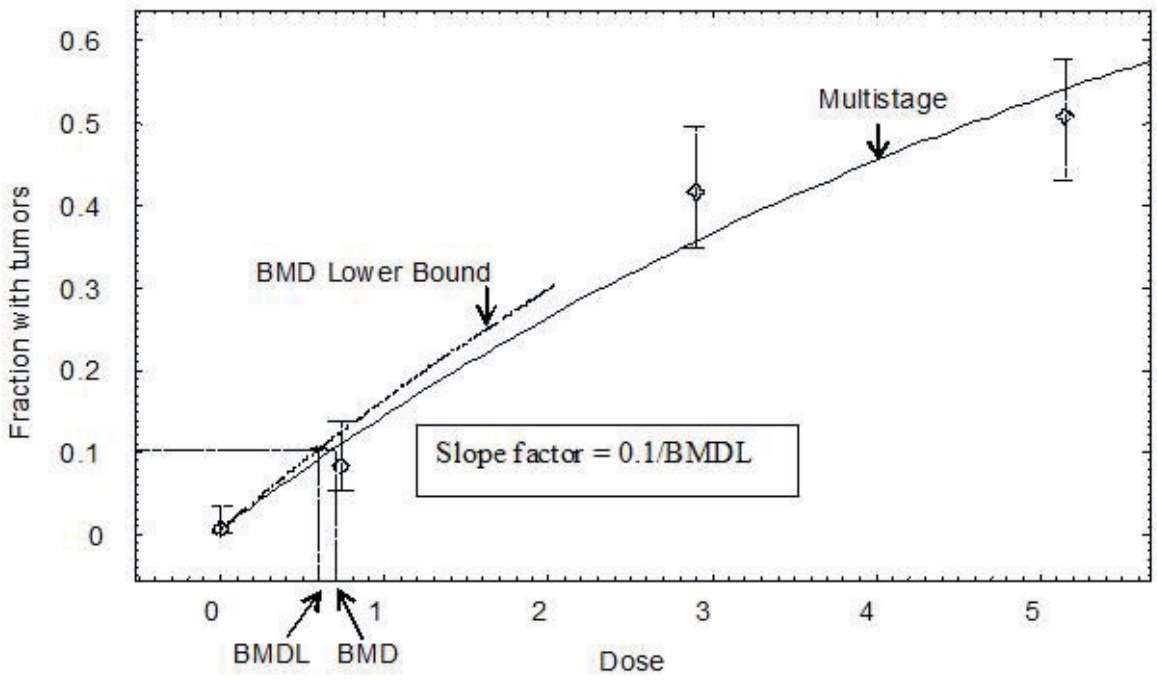
Suitable polynomial fits and estimates of the benchmark may be obtained using U.S. EPA's BMDS software. The benchmark often used is the 95% lower confidence bound on the dose producing 10% tumor incidence. However, if data are available which include a significant dose-response at less than 10% tumor incidence, then that lower benchmark should be used (*e.g.,* LED_{05} or LED_{01}). Other software such as Tox_Risk, which was used for the linearized multistage model, has been

used successfully, although the earlier GLOBAL program and its relatives are less suitable as curve-fitting tools for benchmark dose analysis.

Since it is usually assumed in cancer risk estimation that the low-dose response relationship is linear, risk estimates and a potency value (slope factor) may be obtained by linear extrapolation from an appropriate benchmark dose. The potency is the slope of that line ($0.1/LED_{10}$). The low dose linearity assumption is a general default for any carcinogen, and it is unlikely to be altered for genotoxic carcinogens.

A calculation using the benchmark dose approach (using a polynomial model with exponents restricted to zero or positive values), and linear extrapolation from the LED_{10} to obtain a potency estimate is shown in Figure 1 (the figure was generated by the U.S. EPA's BMDS program). This is based on tumor incidence data from an actual experiment with vinyl bromide in rats (Benya *et al*., 1982), with metabolized dose calculated by means of a pharmacokinetic model (Salmon *et al.,* 1992). The value of q_1* obtained by this calculation would then be corrected for the duration of the experiment if it had lasted for less than the standard rat lifetime, and for bodyweight and route-specific pharmacokinetic factors as described below. This is in addition to the correction for exposure duration that would be necessary if the study had not lasted for 105 weeks, and the interspecies correction, both of which are described below.

Figure 1. Benchmark dose calculation for tumor data in rats exposed to vinyl bromide



From Salmon *et al*. (1992), based on data from Benya *et al*. (1982)

Linearized Multistage Model

Quantal Analyses

A "multistage" polynomial (U.S. EPA, 1986, 2005a; Anderson *et al.*, 1983), based on the mechanistic insights of the original Armitage and Doll model of cancer induction and progression, has been used extensively by U.S. EPA, OEHHA and other risk assessors to model the dose response for lifetime risk of cancer. It usually is used for analysis of animal bioassay data, although related approaches have occasionally been used with epidemiological data. In mathematical terms, the probability of dying with a tumor (P) induced by an average daily dose (d) is:

$$P(d) = 1 - \exp[-(q_0 + q_1 d + q_2 d^2 + \ldots + q_j d^j)]$$

with constraints

$$q_i \geq 0 \text{ for all } i.$$

Equivalently, $$A(d) = 1 - \exp\left[- (q_1 d + q_2 d^2 + \cdots + q_k d^k)\right],$$

where $$A(d) = \frac{P(d) - P(0)}{1 - P(0)}$$ is the extra risk over background at dose d.

The q_i model parameters are constants that can be estimated by fitting the polynomial to the data from the bioassay, *i.e.* the number of tumor bearing animals (as a fraction of the total at risk) at each dose level, including the controls. The fit is optimized using likelihood methodology, assuming that the deviations from expected values follow a χ^2 distribution, with the number of degrees of freedom (and hence the maximum number of terms allowed in the polynomial) determined by the number of points in the data set. All the coefficients of the terms are constrained to be zero or positive, so the curve is required to be straight or upward curving, with no maxima, minima or other points of inflection. In addition to the maximum likelihood estimates of the parameters, the upper 95% confidence limits on these parameters are calculated.

The parameter q_0 represents the background lifetime incidence of the tumor. The 95% upper confidence limit of the slope factor q_1 (q_1^*), is termed the cancer potency. The maximum likelihood estimate (MLE) of q_1 is not usually regarded as a reliable estimate for several reasons. First, it fails to reflect the uncertainty and variability in the data which affect the value of the estimate. This is an important issue for protection of public health, which is emphasized by current regulatory guidelines. Secondly, due to the variable order of the polynomial and the effect of some terms being zero as opposed to having a small but finite value, the MLE is unstable, and may show large and unpredictable changes in response to very slight changes in the input data. It may also erratically have a zero value, even when the data imply a significant positive dose-response relationship. The MLE is not a measure of central tendency for this estimate distribution (which is always asymmetrical and often multi-peaked). For small doses, the cancer potency is the ratio of excess lifetime cancer risk to the average daily dose received. Details of the estimation procedure are given in Crump (1981) and Crump, Guess, and Deal (1977). Several software programs are available to perform the necessary calculations, including U.S. EPA's BMDS, Tox_Risk and the earlier GLOBAL programs by Crump and colleagues, and Mstage, written by Crouch (1987).

When dose is expressed in units of mg/kg-d, the potency is given in units of $(mg/kg\text{-}d)^{-1}$. Likewise, when the model input is in units of concentration ($\mu g/m^3$, ppb), the potency is given in units of $\mu g/m^3)^{-1}$ pr $(ppb)^{-1}$. As in the case of potencies obtained by the benchmark approach, the experiment-based potency value needs to be corrected for less-than lifetime or intermittent exposure, and extrapolated from the test species to humans. Risk calculations using potency value estimated using the linearized multistage model predict the cancer risk at low doses only, with the higher order terms of the fitted polynomial being ignored since their contribution is negligible at low doses.

Selection of Site and Tumor Type

In developing cancer potency estimates from animal data, standard practice has been to use dose-response data for the most sensitive tumor site as the basis of the estimate (CDHS, 1985). Where tumors of more than one histological type (*e.g.,* adenomas and carcinomas) are observed at a single

site, the combined incidence, *i.e.* proportion of animals affected with at least one tumor of any of the relevant types, is used for dose-response assessment. The same rules for combining tumor types are generally applied in determining statistical significance for carcinogen identification (IARC, 2006). Tumor types considered to represent different stages of progression following initiation of a common original normal cell type are combined, whereas tumor types having different cellular origins are generally not combined by this procedure. Other considerations that may influence choice of site for dose response estimation include the quality of the data (especially, the statistical impact of a high or variable rate of a particular tumor type and site in control animals), and biological relevance to humans. However, it is an important principle that, just as for the hazard identification phase, concordance of site or tumor type between animal models and human health effects may occur but is not assumed or required.

Carcinogens Inducing Tumors at Multiple Sites

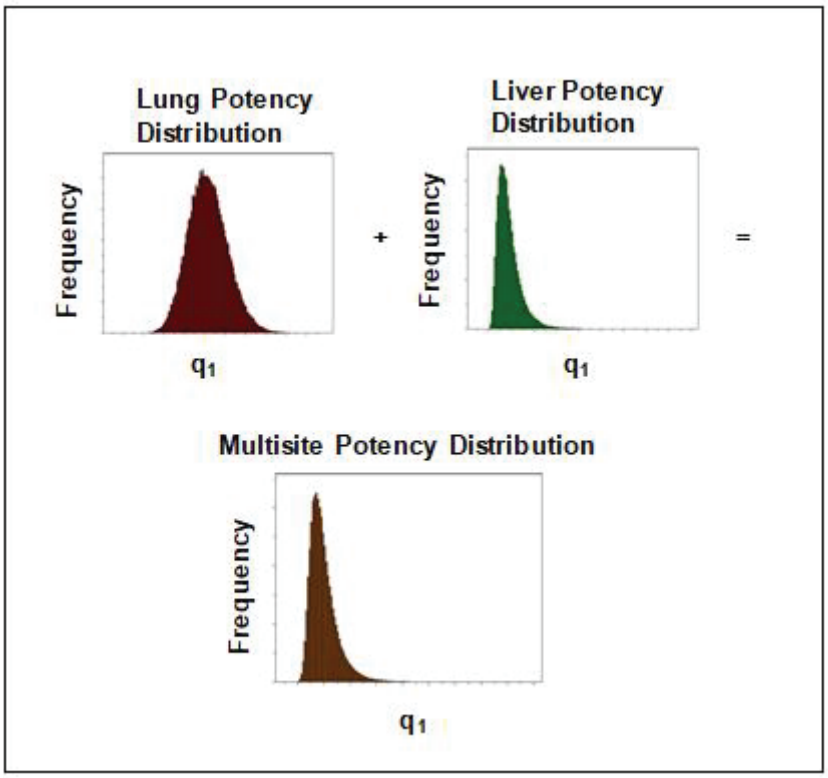
For most carcinogens, the selection of the most sensitive site in the animal studies is recognized as providing a risk estimate which is appropriate to protect human health. However, for chemicals that induce tumors at multiple sites, the single-site approach may underestimate the true carcinogenic potential. For example, the overall assessment of cancer risk from cigarette smoking (U.S. DHHS, 1982) or ionizing radiation (NRC, 1990) is not based on risk at one site, such as lung cancer. Instead, total cancer risk is estimated from all the sites at which agent-induced tumors are observed (lung, bladder, leukemia, etc), combined.

For carcinogens that induce tumors at multiple sites and/or with different cell types in a particular species and sex, OEHHA derives the animal cancer potency by probabilistically summing the potencies from the different sites and/or cell types. Using the combined potency distribution takes into account the multisite tumorigenicity and provides a basis for estimating the cumulative risk of all treatment-related tumors.

The linear term (q_1) of either the multistage model or the multistage-in-dose, Weibull-in-time model is first estimated based on the dose-response data for each of the treatment-related tumor sites. Statistical distributions, rather than point estimates, are generated at each site by tracing the profile likelihood of the linear term (q_1) (Zeise et al., 1991). The distributions of q_1 for each of the treatment-related sites are then statistically summed using a Monte Carlo approach and assuming independence (Figure 2). The sum is created by adding the linear term for each tumor site, according to its distribution, through random sampling. The upper 95 percent confidence limit on the summed distribution is taken as the multisite animal cancer potency estimate (McDonald et al., 2003, McDonald and Komulainen, 2005).

OEHHA has applied this approach in several recent dose-response analyses, including that for naphthalene presented in Appendix B of this document.

Figure 2. Addition of potency distributions for multi-site cancer potency derivations.



Early-Lifestage Cancer Potency Adjustments

In recent years, there have been growing concerns regarding the exposure of children to environmental chemicals, including the possibility that they may be more susceptible than adults to injury caused by those chemicals. The California Legislature passed the Children's Environmental Health Protection Act (Senate Bill 25, Escutia; Chapter 731, Statutes of 1999; "SB 25") to help address these concerns. Under SB25, OEHHA is mandated to consider infants and children specifically, where data permit, in evaluating the health effects of Toxic Air Contaminants (TACs).

The development of cancer is one of the adverse health effects that may occur in children as a result of exposure to environmental chemicals. The document "Prioritization of Toxic Air Contaminants under the Children's Environmental Health Protection Act" (OEHHA, 2001a) noted that risks of cancer from exposures to carcinogens occurring from conception through puberty can be different than those from exposures occurring in adulthood. Exposure to a carcinogen early in life may result in a greater lifetime risk of cancer for several reasons:

1. Cancer is a multistage process and the occurrence of the first stages in childhood increases the chance that the entire process will be completed, and a cancer produced, within an individual's lifetime.
2. Tissues undergoing rapid growth and development may be especially vulnerable to carcinogenic agents. During periods of increased cell proliferation there is rapid turnover of DNA, and more opportunity for misrepair of damage (*e.g.*, DNA breaks, crosslinks, adducts) or alterations to result in permanent changes to the DNA (*e.g.*, mutations, altered DNA methylation) that may ultimately lead to cancer.
3. During early development, a greater proportion of the body's cells are relatively undifferentiated stem cells, and as such represent a large target population of somatic cells capable of passing along permanent changes to the DNA during future cell divisions.
4. There may be greater sensitivity to hormonal carcinogens early in life since the development of many organ systems is under hormonal control (*e.g.*, male and female reproductive systems, thyroid control of CNS development).
5. Other factors that may play a role in increased cancer risk from exposures during critical developmental periods include differences in immunological activity, intestinal absorption, biliary and kidney excretion, blood and fat distribution, and expression of enzyme systems that activate or detoxify carcinogens.

Data in humans and animals for a variety of carcinogens suggest that exposures to such carcinogens early in life may result in a greater lifetime risk of cancer compared to exposures later in life. Examples of this effect in humans are carcinogenicity due to ionizing radiation, diethylstilbestrol (DES), chemotherapeutic agents, and tobacco smoke.

Ionizing radiation exposure carries an increased risk of cancer when exposures occur early in life compared to adult exposures for a number of tumor types. Children exposed to ionizing radiation (diagnostic X-rays) *in utero* demonstrate a larger excess of leukemia cases than children exposed to ionizing radiation postnatally (NRC, 1990). Exposure to radioisotopes (^{131}I, ^{137}Cs, ^{134}Cs, ^{90}Sr) as a consequence of the 1986 Chernobyl nuclear accident resulted in an elevated thyroid cancer

incidence in children but not adults (Moysich, 2002). Treatment of children for Hodgkin's lymphoma with both chemotherapeutic agents and irradiation has been shown to increase the risk of secondary tumors (Swerdlow et al., 2000; Franklin et al., 2006). Age at irradiation in Hodgkin's disease patients treated with radiotherapy strongly influenced the risk of developing breast cancer. The relative risk (RR) of developing breast cancer was 136 for women treated before 15 years of age, 19 for women 15-24 years of age, and 7 for those 24-29 years of age. In women above 30 years of age, the risk was not increased (Hancock *et al*., 1993).

DES was administered to pregnant women in the 1940s-1960s for the purpose of preventing pregnancy loss. In 1970, Herbst and Scully described 7 cases of vaginal adenocarcinoma (6 cases of the clear-cell type) in women aged 15-22 years. This type of cancer is extremely rare in that age range. A follow-up epidemiological study included an additional case, and noted the fact that the mothers of 7 of the 8 patients had been treated with DES during their pregnancy (Herbst *et al*., 1971). Reports by other investigators confirmed the association between maternal use of DES during pregnancy and the development of vaginal adenocarcinoma in their female offspring (Preston-Martin, 1989). It was observed that *in utero* DES exposure resulted in female genital tract morphological changes which correlated with both dose and duration of exposure, and those changes were not related to the maternal conditions which were the reason for the DES administration. Additionally, the risk of occurrence of those morphological changes declined with increasing gestational age at first exposure (O'Brien *et al*., 1979; Preston-Martin, 1989). In contrast, vaginal adenocarcinoma incidence did not increase in the exposed mothers themselves, indicating an increased early-life susceptibility to the carcinogenic effects of DES.

There is evidence in the epidemiological literature indicating that exposure to tobacco smoke during puberty may increase risk of breast cancer later in life, particularly among women who are NAT2 slow deacetylators (Marcus *et al*., 2000; Morabia *et al*., 2000; Lash and Aschengrau, 1999). Wiencke *et al*. (1999) report that early age at initiation of smoking is associated with a higher level of DNA adducts in lung tissue of former-smokers with lung cancer.

It has also been observed by Smith *et al*. (2006) that human *in utero* or early childhood exposure to arsenic in drinking water results in significantly increased lung cancer incidences during adult life.

Data from animal studies provide additional examples of increased sensitivity to early life (typically postnatal and juvenile) exposures. These effects span a range of target tissues, including the liver (vinyl chloride, safrole), brain (methylnitrosourea), reproductive tract (DES, tamoxifen), and lung (urethane) (OEHHA, 2001a).

In the following sections we summarize two efforts to evaluate quantitatively the effect of lifestage at exposure on carcinogenic response in experimental animal studies. The first section provides a description of OEHHA's analysis of data on the effect of age at exposure on carcinogenic potency. (Details of this analysis are in Appendix J.) The second section describes U.S. EPA's work in this area. (We also provide the published paper in Appendix I that presents the U.S. EPA analyses.) Both analyses used extant data available in the published literature. U.S. EPA used their analysis to modify the procedures they have used to estimate cancer risk by weighting risk by specific factors for childhood exposures. The weighting factors are a policy choice supported by U.S. EPA's data analysis. The results of OEHHA's analysis, summarized below and described in detail

in Appendix J, support the decision to modify policy to weight risk when exposure occurs during childhood.

OEHHA Analysis of the Effect of Age at Exposure on Cancer Potency

The analysis of animal cancer studies which include early life exposure by the Reproductive and Cancer Hazard Assessment Branch (RCHAB) of OEHHA also supports the application of lifestage-specific cancer potency factor adjustments. This analysis is provided in detail as Appendix J of this document.

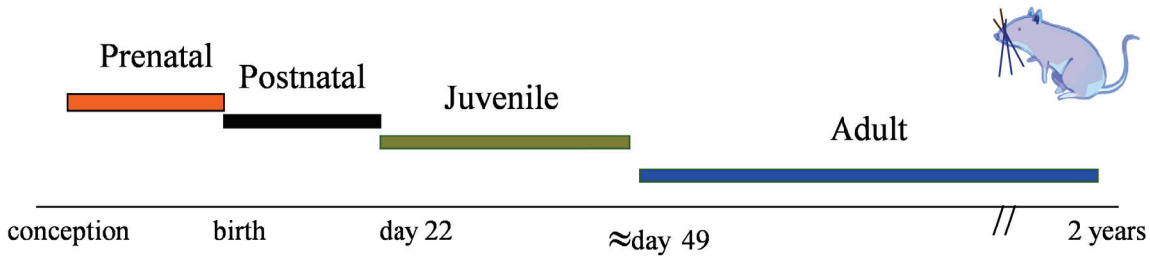
Early-in-life susceptibility to carcinogens has long been recognized by the scientific community and clinicians as a public health concern. Numerous scientific publications and symposia have addressed this issue over the years and the scientific literature contains a number of human clinical findings and epidemiological studies of early life cancer susceptibility. While there are many indications of increased human cancer susceptibility in early life, the magnitude of the impact has been difficult to gauge. Until recently risk assessment procedures have not in general addressed the issue. As described in the next section, in 2005 the U.S. EPA adopted an approach to weight carcinogens by age at exposure if they act via a mutagenic mode of action. The California legislature in 2000 directed OEHHA to assess methodologies used in addressing early-in-life risk, compile animal data to evaluate those methods, and develop methods to adequately address carcinogenic exposures to the fetus, infants, and children (Children's Environmental Health Initiative [AB 2872, Shelly]; California Health and Safety Code [HSC] section 901 [a] through [e]).

OEHHA assessed cancer risk assessment methodologies, and found that the existing risk assessment approaches did not adequately address the possibility that risk from early-in-life and adult exposures may differ. OEHHA further concluded that there was a need to address early-in-life cancer risk, and undertook studies to develop methods for doing so. Age-related cancer susceptibility data were identified from published animal cancer bioassays in which these issues were addressed. Two types of studies with early-in-life exposures were compiled. The first type are "multi-lifestage exposure studies." These studies have at least two groups exposed during different lifestages: One dose group is exposed to a chemical only during one of the following lifestages (Figure 3):

- prenatal (from conception to birth),
- postnatal (from birth to weaning),
- juvenile (from weaning to sexual maturity).

The second dose group is exposed for some period of time at an older age, preferably during the adult lifestage, that is, after sexual maturity. This group served as the reference group. In some cases where there was no adult exposure group, animals exposed as juveniles served as the reference group. Multi-lifestage exposure studies are available for many chemicals, enabling the exploration of patterns in early-life susceptibility across chemicals.

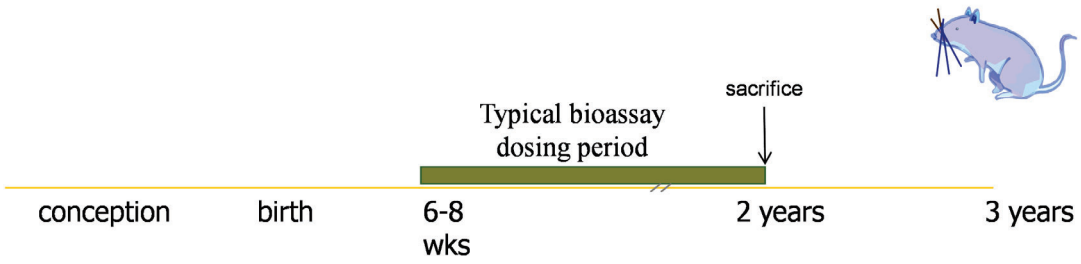
Figure 3. Definition of Rodent Lifestage Adopted in the OEHHA Analyses



OEHHA also conducted "chemical-specific case studies" of early-life sensitivity for two carcinogens, ethyl-N-nitrosoamine (DEN) and N-ethyl-N-nitrosourea (ENU) that combine data from a number of studies. These "chemical-specific case studies" were conducted to explore the feasibility of analyzing chemical-specific data on age susceptibility from single-lifestage exposure experiments. For these chemicals, OEHHA compiled from the literature a second type of study, "single-lifestage exposure experiments." In these experiments dose groups were exposed only during a particular lifestage and, unlike the "multi-lifestage exposure studies," there was no requirement that the same study also include groups exposed during a different lifestage. Thus, single-lifestage exposure experiments were identified as being either prenatal, postnatal, juvenile, or adult exposure studies. For each of the two chemicals, there were many prenatal studies conducted that were compiled, analyzed, and grouped together. Postnatal studies from different publications were similarly compiled, analyzed and grouped together, as were juvenile studies. Adult studies were not available for either DEN or ENU, thus for both chemicals juvenile exposure studies served as the referent for prenatal studies, and for postnatal studies.

Typical cancer bioassays such as those conducted in rats and mice by NTP involve exposing animals starting at six to eight weeks of age, which is the time at which these animals reach sexual maturity (late teenagers relative to humans). The experiments are run for two years, ending when the animal is in late middle age. Thus, early and very late life exposures are not included in the typical rodent bioassay (see Figure 4). If the NTP bioassay is used as a basis for estimating cancer potency, the potency and resulting risk estimates may be too low. Thus OEHHA focused on finding studies that evaluated early in life exposures.

Figure 4. Dosing Period for Typical Rodent Bioassays.



Since bioassays examining the effect of age at exposure on carcinogenesis were conducted by various investigators for different purposes, there is a great deal of variation across studies in terms of dose selection, duration of exposure, number of animals, and length of study duration. To be included in the compilation of studies with early life exposure, a study or an experimental group in a study had to meet minimum requirements.

The criteria for study inclusion are as follows:

- Treated groups were exposed to a single chemical carcinogen or a single carcinogenic chemical mixture.
- Study groups were not compromised by severe treatment-related non-cancer toxicity.
- Overall the duration of exposure period plus observation period exceeded 40 weeks, unless animals died of tumor.
- For included dose groups, the study must report age at dosing, age at sacrifice, and site-specific tumor incidence.
- Each lifestage exposure treatment group has an appropriate concurrent control group, or, for rare tumors only, an appropriate historical control.
- The studies were on mammals.
- Each treatment and control group consists of at least ten animals, unless the conduct and design of the study was well done in all other aspects (*e.g.*, the length of the study was sufficiently long to observe treatment-related tumors) and tumor incidence was high in treated groups and very low in controls.
- Site specific tumor data were reported, not only total number of tumor bearing animals.
- The test compound was administered in the diet, water, via gavage, or by intraperitoneal (i.p.), intravenous (i.v.), or subcutaneous (s.c.) injection. For dermal and subcutaneous injection studies, distal tumor findings are utilized (for dermal, other than skin tumors; for injection, non-injection site tumors).

- While studies designed to histopathologically examine tumors at multiple sites were preferred, studies that examined only a select set of organ/tissue sites were not excluded if the sites examined were known with confidence to be the only target tissues for the chemical and lifestage in question in that particular strain of animal.

Different approaches were taken to identify animal cancer studies that included groups of animals exposed during early life stages. First, MEDLINE and TOXLINE (National Library of Medicine) databases were searched using combinations of various key words for cancer (*e.g.*, tumor(s), neoplasm(s), cancer, neoplasia, cancerous, neoplasms-chemically induced) and for early-life exposure (*e.g.*, age, age-at-exposure, development (al), prenatal, *in utero*, gestation (al), postnatal, neonatal, juvenile, weaning, weanling, adolescent, adolescence, young). Second, the extensive compilation of bioassays in the *Survey of Compounds which have been Tested for Carcinogenic Activity*, was reviewed. This survey, formerly maintained by the National Cancer Institute as Public Health Service Publication Number 149, or PHS 149, is now available from a private source electronically as CancerChem, 2000. Third, from bibliographies from relevant published papers additional studies were identified. Finally the Single Dose Database developed by Calabrese and Blain (1999) was obtained and utilized to identify additional publications that appeared to contain potentially useful data. All of these publications were evaluated to determine if the study dosed separate groups of animals early in life and at or near adulthood. A total of 145 publications, providing data on 84 chemicals, were identified as meeting the criteria for study inclusion. A subset of these met the criteria for inclusion in the multi-lifestage exposure analysis.

Finally, for the OEHHA multi-lifestage analyses, we define "experiment" as a study component consisting of a control group as well as a treated group(s) exposed during the same lifestage (*i.e.*, prenatal, postnatal, juvenile or adult), and using the same experimental protocol (*e.g.*, route of exposure, strain, species, laboratory). Thus, by our definition one publication may report multiple experiments.

In the OEHHA analysis, data from studies on 23 unique carcinogens, 20 of which are considered to act via primarily genotoxic modes of action, were analyzed. Of these 20 carcinogens, 15 are thought to require metabolic activation to the ultimate carcinogenic species (Table 1). Fourteen carcinogens, including one thought to act via primarily nongenotoxic modes of action, were included in the prenatal multi-lifestage exposure studies. Eighteen carcinogens, including two thought to act via primarily nongenotoxic modes of action, were included in the postnatal multi-lifestage exposure studies. Five carcinogens were included in the juvenile multi-lifestage exposure studies. The case study chemicals, DEN and ENU, are both genotoxic. ENU is a direct acting alkylating agent, while DEN requires metabolic activation.

Table 1. Carcinogens for which studies with multi-lifestage exposures in animal studies are available

Genotoxic carcinogens requiring metabolic activation
Benzidine Benzo[a]pyrene Dibutylnitrosamine Diethylnitrosamine (DEN) 7,12-Dimethylbenz[a]anthracene (DMBA) Dimethylnitrosamine (DMN) Di-n-propylnitrosamine (DPN) 1 -Ethyl-nitrosobiuret 2-Hydroxypropylnitrosamine 3-Hydroxyxanthine 3-Methylcholanthrene (3-MC) 4-(Methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK) Safrole Urethane Vinyl chloride
Genotoxic carcinogens not requiring metabolic activation
Butylnitrosourea 1,2-Dimethylhydrazine Ethylnitrosourea (ENU) Methylnitrosourea (MNU) ß-Propiolactone
Nongenotoxic carcinogens
1,1-Bis(p-chlorophenol)-2,2,2-trichloroethane (DDT) Diethylstilbestrol (DES) 2,3,7,8-Tetrachlorodibenzodioxin (TCDD)

Cancer Potency Estimation

Statistical methods were developed and used to analyze the data and derive measures of early-life susceptibility. These are described in detail in Appendix J. In brief, a cancer potency (the slope of the dose response curve) was developed for each of the experiments selected using the linearized multistage model. This model was chosen because of widespread use in risk assessment, and its flexibility in being able to fit many different data sets needed to evaluate the effect of lifestage-at-exposure on cancer potency. The dose metric used for the potency analyses is cumulative dose normalized to body weight. The cancer potency is thus expressed as the increase in tumor probability with increasing cumulative dose in units of mg/kg body weight.

To take into account uncertainty in potency estimation, cancer potencies are depicted by a statistical distribution, rather than by a single, fixed value, using methods described in Appendix J. While these methods have typically been used to obtain and report the 95th percentile of the cancer slope parameter for cancer risk assessment purposes, here OEHHA utilized the full distribution of the cancer slope parameter to derive measures of early-life susceptibility to carcinogens. This was done to systematically take into account uncertainty in the analysis.

For experiments where treatment related tumors were observed at multiple sites or at the same site but arising from different cell types, slopes from these sites were statistically combined by summing across the potency distributions (assuming independence across the sites that were observed) to create an overall multisite cancer potency. It is not uncommon that a carcinogen causes more than one type of cancer or causes tumors at different sites depending on lifestage at exposure. For example, in humans tobacco smoke causes cancers of the lung, bladder, and certain other organs. This multi-site carcinogenicity is frequently observed in animal experiments as well. In order to account for this, all treatment-related tumors that were observed in a given lifestage were taken into account in estimating cancer potency from that particular experiment.

Addressing Early-Age Sensitivity in Estimating Cancer Risk: Age Sensitivity Factors

Inherent Sensitivity of Lifestages – Lifestage Potency Ratios

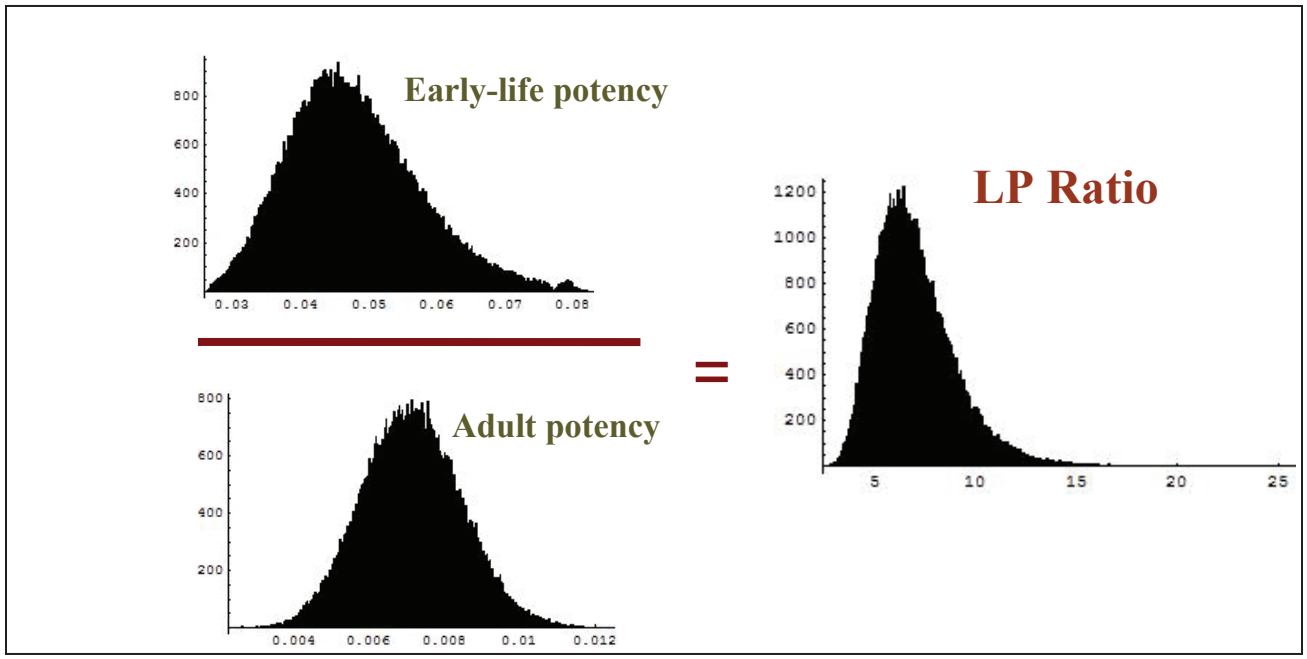
For this analysis, OEHHA calculates the ratio of cancer potency derived from an early lifestage exposure experiment(s) to that derived from an experiment(s) conducted in adult animals. OEHHA used the potency distributions for the individual lifestage exposures, rather than a point estimate, to derive the ratios. The lifestage cancer potency ratio is then described as a distribution and one can select specific percentiles from the distribution to better understand and bound the uncertainty (Figure 5). Of particular importance is the location of the ratio distribution in relation to the reference value of 1.0, which would mean no difference in risk from exposures at early versus adult lifestages. A lifestage cancer potency ratio distribution that primarily lies above the value of 1.0 indicates early life exposures to a carcinogen result in a stronger tumor response relative to adult exposure. Conversely, a lifestage cancer potency ratio distribution that mainly lies below the value of 1.0 indicates early life exposure to a carcinogen results in a weaker tumor response relative to adult exposure.

A lifestage potency (LP) ratio distribution was derived for each multi-lifestage study, resulting in 22 prenatal ratio distributions representing 14 unique carcinogens, 55 postnatal LP ratio distributions representing 18 unique carcinogens, and seven juvenile LP ratio distributions representing five unique carcinogens. The LP ratio distributions for a given early lifestage were combined into a single "LP ratio mixture distribution," in order to show the range of susceptibilities of that lifestage to the carcinogens studied.

LP ratio mixture distributions for a given early lifestage were developed by (1) obtaining a single LP ratio distribution for each chemical (when a chemical is represented by more than one study) and then (2) equally sampling across all chemicals. When a chemical is represented by more than one study, then the LP ratio distributions from all studies of that chemical were combined by equally sampling from each LP ratio distribution via Monte Carlo methods to obtain a single LP ratio distribution for that chemical. (Appendix J describes this in more detail, as well as a

sensitivity analysis that included two alternative sampling methods.) Once each chemical is represented by a single LP ratio distribution, then the LP ratio mixture distribution for each early lifestage (prenatal, postnatal, and juvenile) is obtained by equally sampling across all of the chemicals via Monte Carlo methods.

Figure 5. Lifestage Potency Ratio (LPR) distribution.

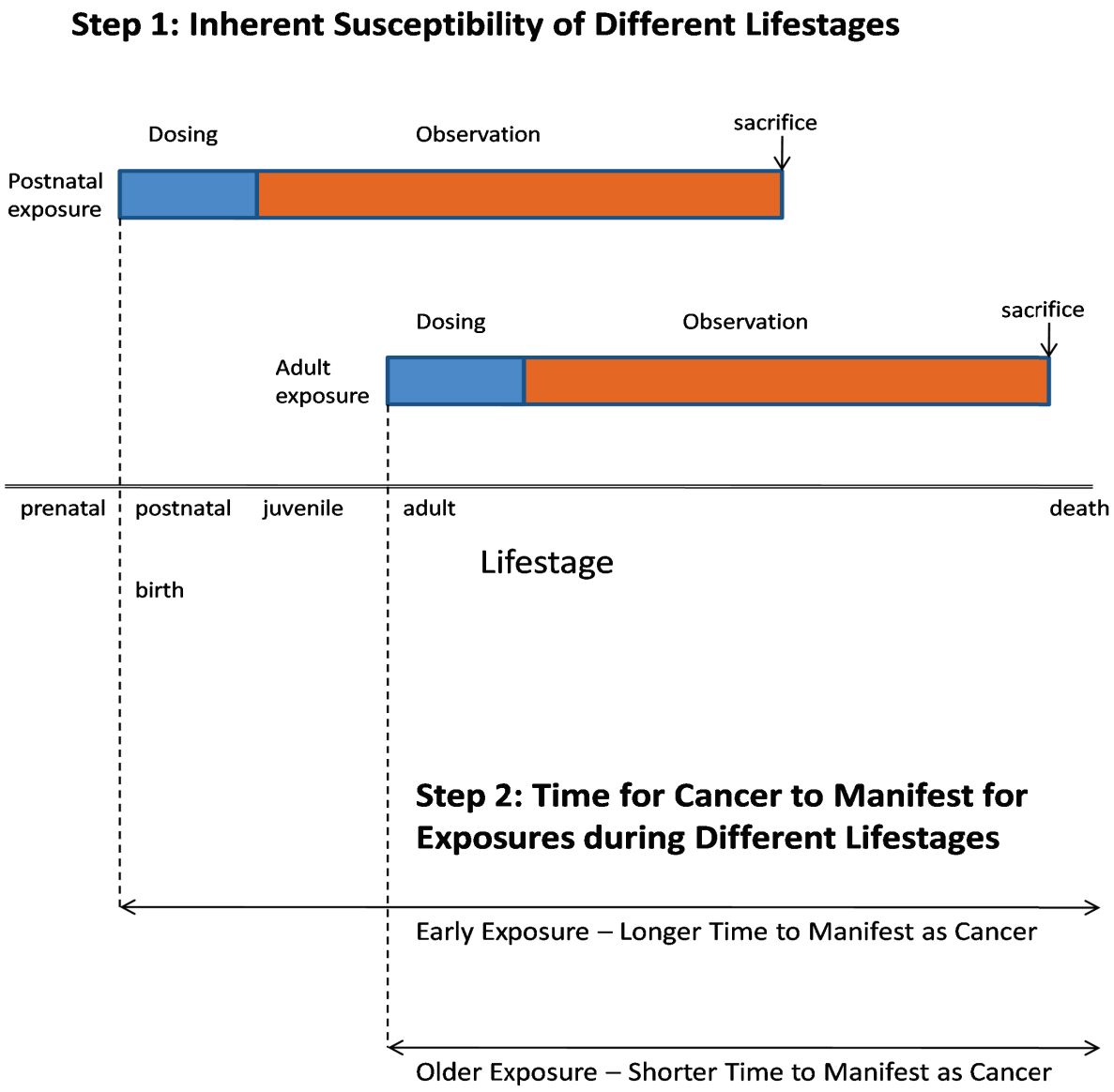


Effect of Longer Time Period for Cancer to Manifest

The LP ratios described above characterize the inherent susceptibility of early lifestages to carcinogen exposure, by comparing potencies for individuals followed for similar periods of time and similarly exposed, but exposed during different lifestages. Age-specific adjustments to the cancer potency must also take into account the longer period of time that carcinogen exposure to the young has to manifest as cancer. Empirical data from studies of both humans and animals demonstrate that, for many cancers, cancer risk increases with age, or time since first exposure. While some cancers have been seen to increase by as much as the sixth power of age, a general approach taken for example by the National Toxicology Program in analyzing tumor incidences in its chronic bioassays is to assume that cancer risk increases by the third power of age. Thus, consistent with the approach used by the NTP in analyzing rodent cancer bioassay data, the longer period of time that exposed young have to develop tumors is addressed by taking into account time-of-dosing. This was done by multiplying the LP ratio by a time-of-dosing factor, to yield an age sensitivity factor (ASF). Specifically, the prenatal LP ratio is multiplied by a factor of 3.0, the postnatal LP ratio is multiplied by a factor of 2.9, and the juvenile LP ratio is multiplied by 2.7. Thus, ASFs were developed for each experiment, by first calculating the LP ratio to address inherent susceptibility of early lifestages relative to adults, and then accounting for the effect of years available to manifest a tumor following carcinogen exposure. (see Figure 6). Note that we

are not using the term "sensitivity" in the immunologic sense (*e.g.*, sensitization), but rather are using the term more generically.

Figure 6. Issues addressed by the Age-Sensitivity Factor (ASF)



Application of this approach for risk associated with lifetime exposures would include an ASF of less than 1 for exposures during the latter part of adult life for carcinogens that act on early stages. Therefore, the addition of this adjustment to the younger lifestages but not to the later part of the adult period could overestimate the risk of whole-life exposures. On the other hand, the 70 year "lifetime" used in estimating lifetime cancer risk does not reflect the longer lifespan of the U.S. population. Further, as noted above, the animal bioassays on which potency was based typically exclude pre-weaning dosing and sacrifice animals during their late middle-age. Use of cancer potencies calculated from standard assays can therefore underestimate lifetime cancer risk. The ASF calculated for carcinogens includes both inherent sensitivity of developing animals and the available time since exposure to develop cancer.

Results of OEHHA Analysis

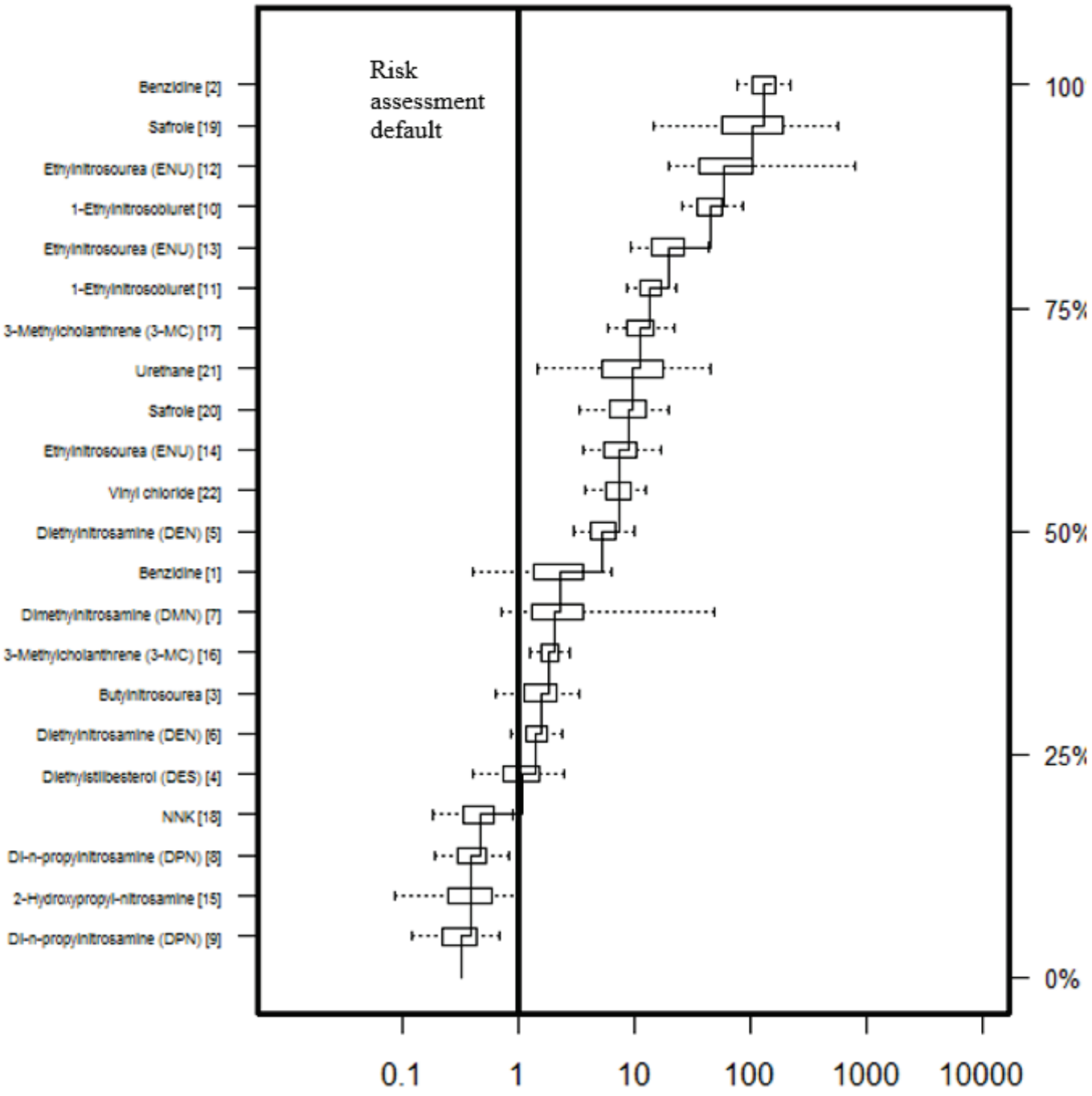
The analyses indicate that both the prenatal and postnatal lifestages can be, but are not always, much more susceptible to developing cancer than the adult lifestage. The analyses also indicated that the ASFs for these age windows vary by chemical, gender and species.

Regarding prenatal lifestage exposure, few cases were indicative of equal inherent adult and prenatal susceptibility, with an LP ratio of unity. The LP ratio distribution was roughly bimodal, with LP ratios for several studies significantly greater than unity and several others significantly less than unity. Figure 7 below shows the ASFs from each of the prenatal multi-lifestage exposure studies, displayed as a cumulative frequency profile. The median of the prenatal ASF mixture distribution was 2.9 (see also Table 6 in Appendix J),

The modality in the prenatal LP ratio distribution was reflected in the DEN and ENU case studies, with results for DEN suggesting inherently less sensitivity than older animals from exposure *in utero*, and for ENU just the opposite. For the DEN and ENU case studies, the referent groups were juvenile rather than adult animals, and the results may have underestimated the LP ratio and ASF, to the extent that some of the apparent sensitivity for DEN and ENU in the prenatal period carries through to the juvenile period. ENU is a direct acting carcinogen that does not require metabolic activation, whereas DEN can not be metabolized to any significant extent by fetal tissues until relatively late in gestation. This may explain the lower fetal susceptibility of DEN. However, prenatal metabolic status is not the sole determinant of prenatal susceptibility; *e.g.*, benzidine and safrole require metabolic activation and exhibit greater susceptibility from prenatal exposure.

The median of the postnatal ASF mixture distribution was 13.5 (see Table 7 in Appendix J). Figure 8 below shows the ASFs from each of the postnatal multi-lifestage exposure studies, displayed as a cumulative frequency profile. Thus, for the chemicals studied, there was generally greater susceptibility to carcinogens during the early postnatal compared to the adult period, particularly when the ASF accounts for the longer period cancer has to manifest when exposure occurs early in life. The DEN and ENU case studies also exhibited substantial extra susceptibility during the postnatal period. To summarize, for most of the carcinogens studied here, rodents are inherently more sensitive in the postnatal period, as indicated by Figure 8.

Figure 7. Prenatal ASF Cumulative Frequency Profile

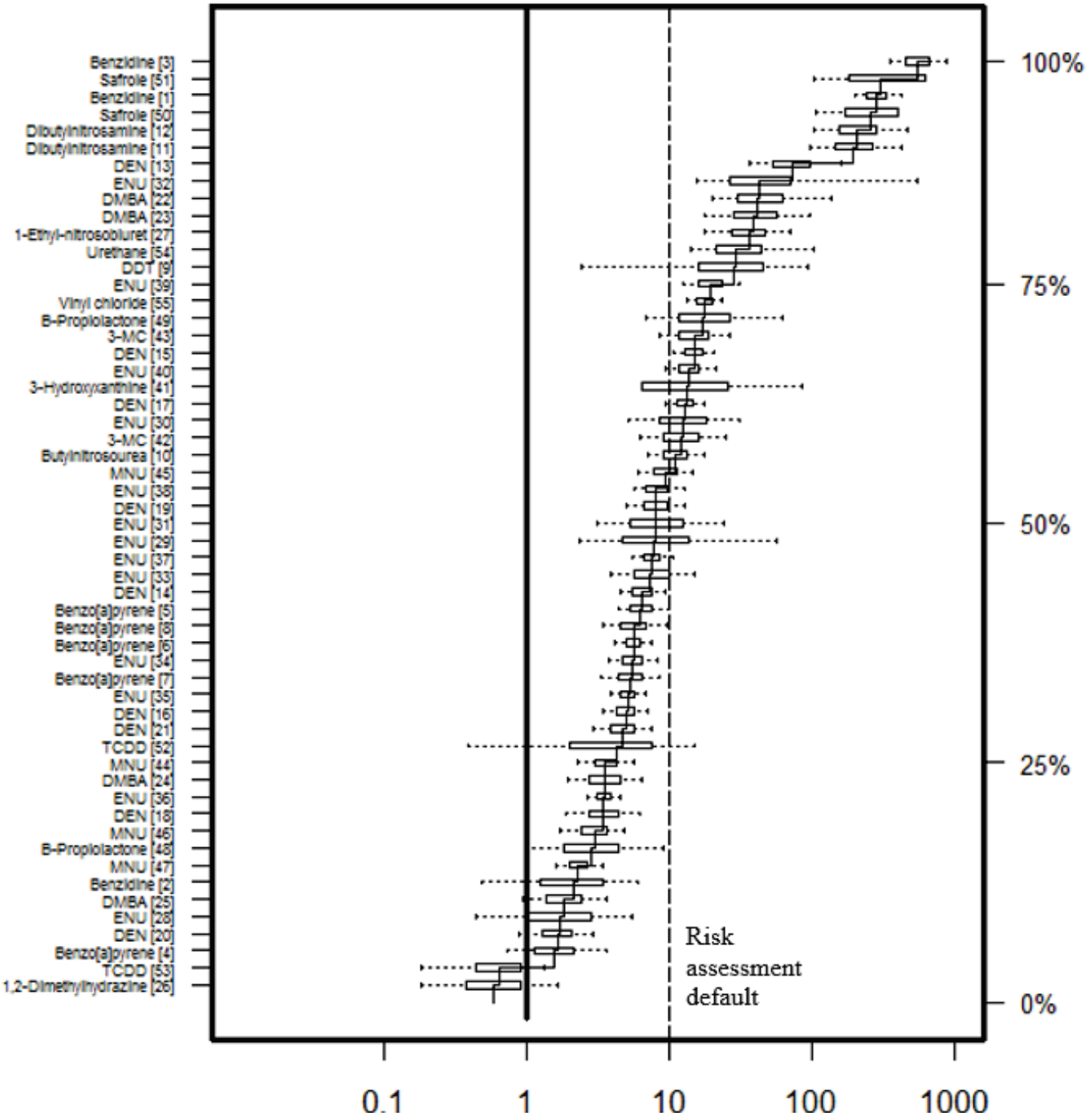


The median of the prenatal ASF mixture distribution was 2.9 (see also Table 6 in Appendix J). References are given in the legend on the next page

Figure 7 Legend (References as in Appendix J)

1. Vesselinovitch *et al*. (1979a), mouse, B6C3F$_1$, F, day -9 to 0
2. Ibid, M, day -9 to 0
3. Zeller *et al*. (1978), rat, Sprague Dawley, M/F day -2
4. Turusov *et al.* (1992), mouse, CBA, F, day -2
5. Mohr et al. (1975), hamster, Syrian Golden, day -15 to -1
6. Mohr *et al*. (1995), hamster, Syrian Golden, F, day -3
7. Althoff *et al*. (1977), hamster, Syrian Golden, M/F, day -9 to -3
8. Ibid, day -9 to -3
9. Althoff and Grandjean (1979), hamster, Syrian Golden, F, day -9 to -3
10. Druckrey and Landschutz (1971), rat, BD IX, M/F, day -10
11. Ibid, day -3
12. Naito *et al*. (1981), rat, Wistar, day -9
13. Ibid, day -9
14. Tomatis *et al*. (1977), rat, BDVi, F, day -5
15. Althoff and Grandjean (1979), hamster, Syrian Golden, M/F, day -9 to -3
16. Tomatis *et al*. (1971), mouse, CF-1, F day -4 to -1
17. Turusov *et a*l. (1973), mouse, CF-1, F, day -2
18. Anderson *et al.* (1989), mouse, C3H & B6C3 F$_1$,M/F day -8 to -4
19. Vesselnovitch *et al.* (1979a), mouse, B6C3 F$_1$, M, day -9 to -3
20. Vesselnovitch *et al.* (1979b), mouse, B6C3 F$_1$, F day -9 to -3
21. Choudari Kommineni *et al*. (1970), rat, MRC, M/F, day -4
22. Maltoni *et al.* (1981), rat, Sprague Dawley, M/F day -13 to -7

Figure 8. Postnatal ASF Cumulative Frequency Profile



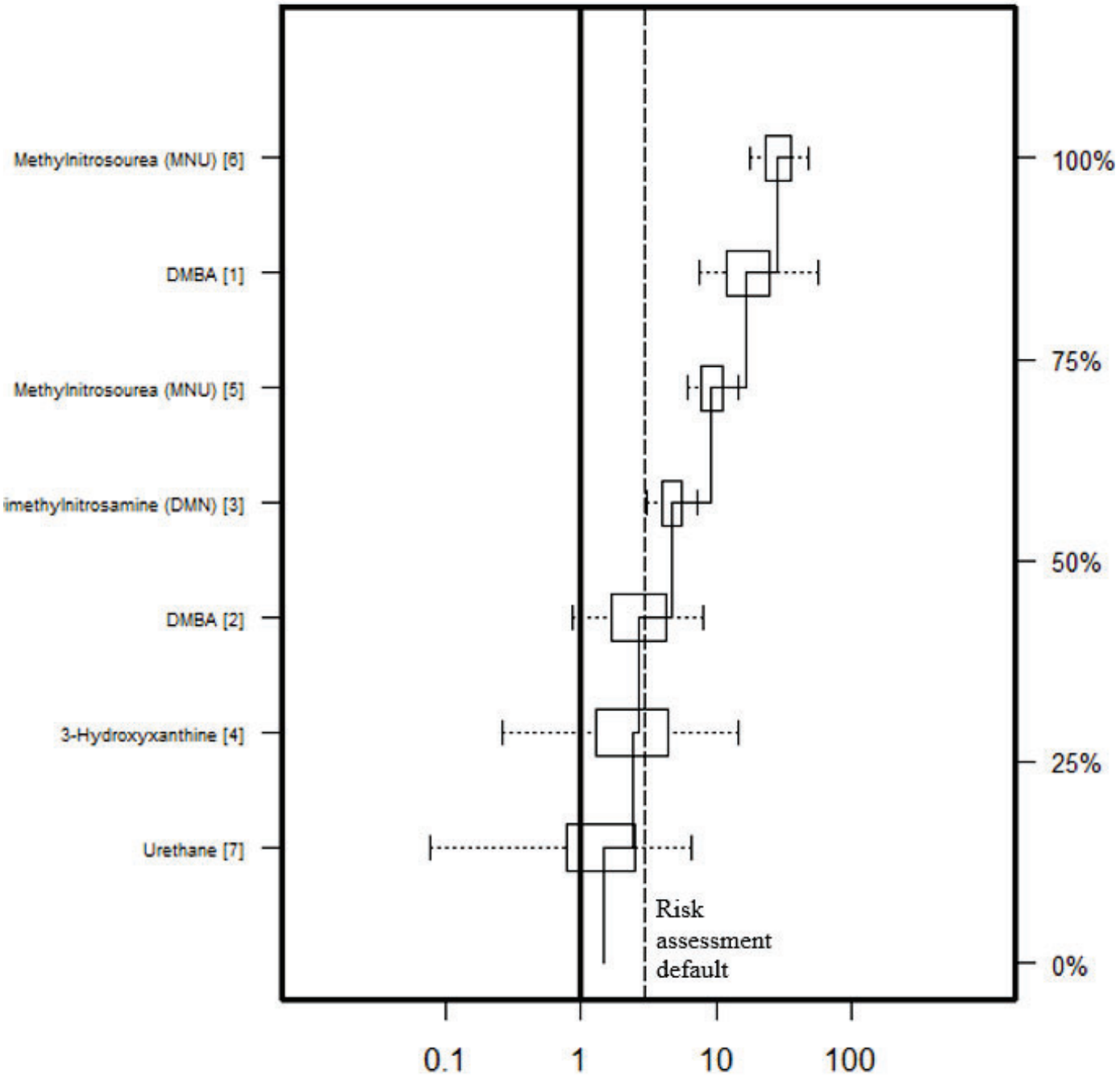
The median of the postnatal ASF mixture distribution is 13.5. The dotted line represents the default ASF for weighting risk for carcinogen exposures to humans between the third trimester and 2 years of age (see next section). References are given in the legend on the next page.

Figure 8 Legend (References as in Appendix J)

1 Vesselinovitch *et al.* (1975b), mouse, B6C3F$_1$, M, day 7-27
2 Vesselinovitch *et al.* (1979), mouse, B6C3F$_1$, F, day 1-21
3 Ibid, M, day 1-21
4 Truhaut *et al.* (1966), mouse, swiss, M/F, day 1
5 Vesselinovitch *et al.* (1975a), mouse, B6C3F$_1$, F, day 1
6 Ibid, M, day 1
7 Ibid, C3A F$_1$, F, day 1
8 Ibid, M, day 1
9 Vesselinovitch *et al.* (1979a), mouse, B6C3F$_1$, M, day 1-28
10 Zeller *et al.* (1978), rat, Sprague Dawley, M/F, day 2
11 Wood *et al.* (1970), mouse, IF x C57, F, day 1-15
12 Ibid, M, day 1-15
13 Rao and Vesselinovitch (1973), mouse, B6C3F$_1$, M, day 15
14 Vesselinovitch *et al.* (1984), mouse, B6C3F$_1$, F, day 1
15 Ibid, M, day 1
16 Ibid, F, day 15
17 Ibid, M, day 15
18 Ibid, C3A F$_1$, F, day 1
19 Ibid, M, day 1
20 Ibid, F, day 15
21 Ibid, M, day 15
22 Meranze *et al.* (1969), rat, Fels-Wistar, F, day 10
23 Ibid, M, day 10
24 Walters (1966), mouse, BALB/c, F, day 17
25 Ibid, M, day 17
26 Martin *et al.* (1974), rat, BDIX, M/F, day 10
27 Druckrey and Landschutz (1971), rat, BDIX, M/F, day 10
28 Naito *et al.* (1985), gerbil, mongolian, F, day 1
29 Ibid, M, day 1
30 Bosch (1977), rat, WAG, F, day 8
31 Ibid, M, day 8
32 Naito *et al.* (1981), rat, Wistar, F, day 7
33 Ibid, M, day 7
34 Vesselinovitch *et al.* (1974), mouse, B6C3F$_1$, F, day 1
35 Ibid, M, day 1
36 Ibid, F, day 15
37 Ibid, M, day 15
38 Ibid, C3A F$_1$, F, day 1
39 Ibid, M, day 1
40 Ibid, M, day 15
41 Anderson *et al.* (1978), rat, Wistar, F, day 9
42 Klein (1959), mouse, A/He, F, day 8-31
43 Ibid, M, day 8-31
44 Terracini and Testa (1970), mouse, B6C3F$_1$, F, day 1
45 Ibid, M, day 1
46 Terracini *et al.* (1976), mouse, C3Hf/Dp, F, day 1
47 Ibid, M, day 1
48 Chernozemski and Warwick (1970), mouse, B6A F$_1$, F, day 9
49 Ibid, M, day 9
50 Vesselinovitch *et al.* (1979a), mouse, B6C3F$_1$, M, day 1-21
51 Vesselinovitch *et al.* (1979b), mouse, B6C3F$_1$, M, day 1-21
52 Della Porta *et al.* (1987), mouse, B6C3F$_1$, F, day 10-45
53 Ibid, M, day 10-45
54 Choudari Kommineni *et al.* (1970), rat, MRC, M/F, day 1-17
55 Maltoni *et al.* (1981), rat, Sprague Dawley, M/F, day 1-35

There were only five chemicals and seven studies, two of which were not independent, available to examine susceptibility in the juvenile period. The juvenile LP ratios indicated significantly greater susceptibility in this period for three independent studies, with the remaining studies consistent with equal inherent susceptibility to adult animals (see Figure 16 in Appendix J). Figure 9 below shows the ASFs from each of the juvenile multi-lifestage exposure studies, displayed as a cumulative frequency profile. The median of the juvenile ASF mixture distribution was 4.5 (see Table 8 in Appendix J).

Figure 9. Juvenile ASF Cumulative Frequency Profile



The median of the juvenile ASF mixture distribution is 4.5. The dotted line represents the default value for weighting risk for carcinogen exposures between 2 and 15 years of age (see next section).

Figure 9 Legend (References as in Appendix J)

1. Meranze *et al.* (1969), rat, Fels-Wistar, F, day 45
2. Ibid, M, day 45
3. Noronha and Goodall (1984), rat, CRL/CDF, M, day 46
4. Anderson *et al*. (1978), rat, Wistar, F, day 28
5. Grubbs *et al*. (1983), rat, Sprague Dawley, F, day 50-57; adult comparison group dosed on days 80-87
6. Ibid, F, day 50-57; adult comparison group dosed on days 140-147
7. Choudari Kommineni *et al*. (1970), rat, MRC, M/F, day 28-43

The studies that comprise the set of multi-lifestage exposure studies available for these analyses were not homogeneous. That is, they do not represent observations from the same distribution. Sensitivity analyses were conducted to test the robustness of the findings to different procedures for analyzing data and combining results. Of the methods used to combine the LC ratio distributions for underlying studies within each lifestage, the method of equally weighting studies within a chemical appeared to best represent the available data.

In calculating the ASF, to take into account the longer period of time for early carcinogen exposures to result in tumors, the hazard function was assumed to increase with the third power of age. This assumption is standard and has been borne out by a number of observations (Bailer and Portier, 1988). If the true rate of increase with age is greater than that, then the use of these ASFs may result in underestimates of the true sensitivity of these early life stages.

As the multi-lifestage exposure and case studies show, there appears to be considerable variability in age-at-exposure related susceptibility across carcinogens. There is also variability in age-at-exposure related susceptibility among studies of the same carcinogen. The sources of variability evident in the analyzed studies include timing of exposure within a given age window, and gender, strain, and species differences in tumor response. The set of studies identified and analyzed was not sufficiently robust to fully describe the variability quantitatively. This variability raises concerns that selection of the median (the 50^{th} percentile) estimates may considerably underestimate effects for certain agents or population groups. Relatively large variability in humans in response to carcinogens is expected to be common (Finkel, 1995). On the other hand, the numbers of carcinogens represented in the available data are limited and may not be representative of the population of carcinogens to which we are exposed (*e.g.*, greater than 500 on the Proposition 65 list alone). Thus, the size of the weighting factors used to weight risk by age at exposure is a policy decision.

Several of the carcinogens studied induced tumors at multiple sites in the same experiment, and at different sites, depending upon the lifestage during which exposure occurred. For these cases the combined multisite potency distribution referred to above was the basis for the lifestage comparison. This approach differs from other researchers investigating early vs. late in life differences who focused on tumor site-specific measures of carcinogenic activity (*e.g.*, Barton *et al*., 2005; Hattis *et al*., 2004, 2005). OEHHA believes that use of combined multisite potency distributions provides a more complete approach for considering age specific differences in carcinogenic activity. However, the observation that early life is generally a period of increased

susceptibility was similarly found using the tumor site-specific approach by these other researchers.

One limitation of the approach was the focus on lifestages, without attempting to describe changes in susceptibility that occur within a lifestage. Timing of carcinogen exposure within a given age window can affect the cancer outcome. For example, experiments with 1-ethyl-1-nitroso-biuret in prenatal and adult rats showed a three-fold difference in activity between groups exposed on prenatal day -10 versus prenatal day -3. In a second example, female rats exposed early in the adult period were more than three times as sensitive to the breast cancer effects of MNU as females exposed six weeks later. In general, the adult comparison groups in the multi-lifestage exposure studies were fairly young. The extent to which this may result in an overall bias of the results presented here is unclear. Also, for several cases, juvenile animals were used as the later life exposure group. In these cases the ASFs are likely underestimates of the relative sensitivity of the prenatal and postnatal lifestages, compared to that of the adult lifestage.

Excluded from the analysis were early in life studies in which the period of exposure for a specific exposure group crossed multiple lifestages. An example of results from studies of this type is provided by mouse studies for two non-genotoxic carcinogens, diphenylhydantoin (Chhabra *et al*., 1993a) and polybrominated biphenyls (PBBs) (Chhabra *et al*., 1993b), in which exposures began prior to conception, and continued throughout the prenatal, postnatal, and post-weaning period, up to the age of eight weeks. The data demonstrate an increased sensitivity of the early life period. Some studies that crossed multiple lifestages were included in the analyses of Barton *et al*. (2005) (Appendix I), which are consistent with the general conclusions discussed above.

Selection of Default Age-Sensitivity Factors (ASF)

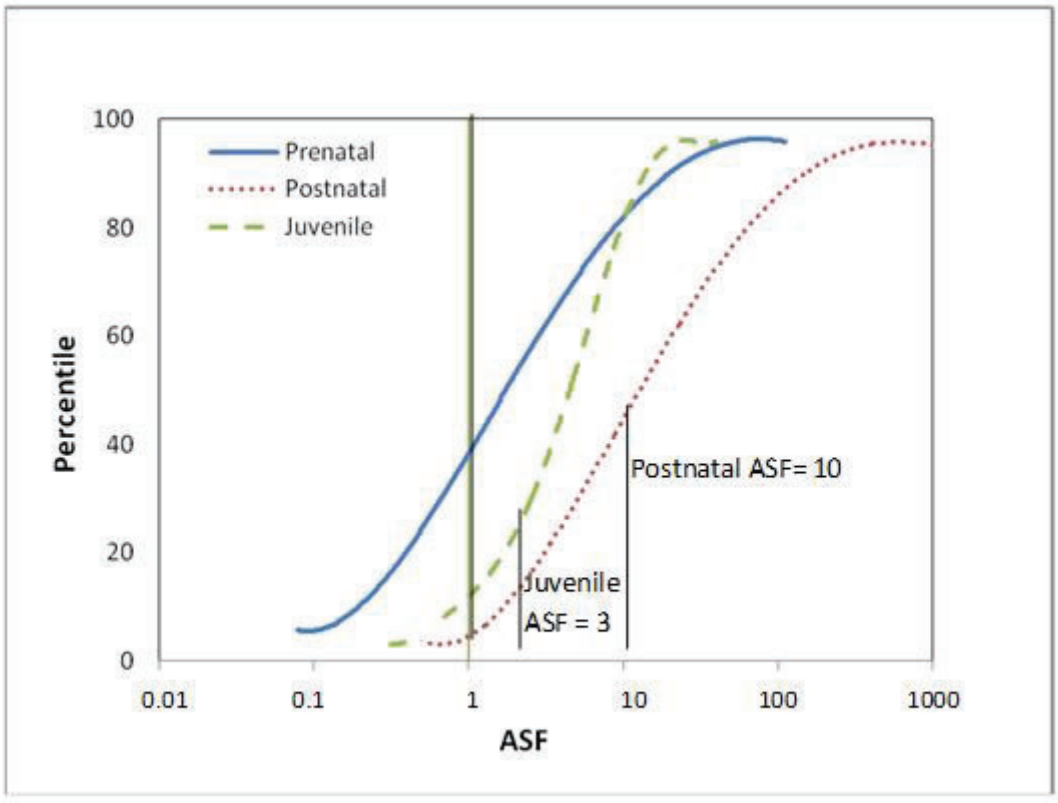
Selection of appropriate values to use to weight exposures that occur early in life using default ASFs for prenatal, postnatal and juvenile exposures is complicated by the limited database of chemicals and studies available for analysis, and the broad distribution of results for different chemicals as is shown in Figure 7, Figure 8, and Figure 9 (see also Appendix J). In view of the variability thus shown, and the considerable uncertainty in applying conclusions from this relatively small set of chemicals to the much larger number of chemicals of concern, it is probably unreasonable to specify a default ASF with greater than half-log precision (*i.e.* values of 1, 3, 10, 30 etc.). Further, rodents are born at a stage of maturity that approximates a third trimester human. Therefore, in the absence of chemical-specific data, OEHHA proposes to apply a default ASF of 10 for the third trimester to age 2 years, and a factor of 3 for ages 2 through 15 years to account for potential increased sensitivity to carcinogens during childhood. A factor of 10 falls just below the median estimate of the ASF for postnatal studies. This is also the value selected by U.S. EPA; while it is consistent with the OEHHA analysis, it may underestimate risk for some chemicals. The broad distribution of observed chemical-specific sensitivity ratios clearly indicates that there are some chemicals for which the sensitivity ratio is much larger than 10. Further research is needed to develop criteria for identifying these cases. Similarly, a factor of 3 for juvenile exposures is consistent with the range of estimates derived from the multi-lifestage exposure studies, and falls close to the median juvenile ASF estimate. It is acknowledged that there are few data available on which to base an estimate for the juvenile period. A factor of 3 adjusts for the longer time available for cancer to manifest, but may not fully account for some inherent differences in susceptibility to cancer, for example the observed susceptibility of breast tissue of

pubescent girls exposed to radiation. For specific carcinogens where data indicate enhanced sensitivity during lifestages other than the immediate postnatal and juvenile periods, or demonstrate ASFs different from the default ASFs, the chemical-specific data should be used in order to adequately protect public health.

The ASFs will be applied to all carcinogens, regardless of the theorized mode of action. While U.S. EPA currently intends to apply weighting factors only to those carcinogens with "a mutagenic mode of action" (U.S.EPA, 2005), OEHHA notes that there is evidence that early life is a susceptible time for carcinogens that are thought to act via non-mutagenic mode of action (DES is a prime example). Defining a mutagenic mode of action may be problematic if approached narrowly (ERG, 2008). Further, carcinogens may have multiple modes of action and one mode may predominate over other modes at different lifestages. The complexity of carcinogenesis argues against restricting the ASF to chemicals acting via a mutagenic mode of action.

Figure 10 provides a visual comparison of the ASF mixture distributions for the three early-life stages, prenatal, postnatal, and juvenile. In this figure, which is in log space, the policy choice of an ASF of 10 for exposures during the third trimester to age 2 years and 3 for the period of life from 2 to 15 years of age are indicated as vertical lines. It is apparent from this figure that weighting risk from exposures to carcinogens early in life is well-supported.

Figure 10. Prenatal, Postnatal, and Juvenile ASF Mixture Distributions and relation to default ASFs



OEHHA recognizes the limitations in the data and analyses presented, as discussed above. However, the analyses do provide some guidance on the extent to which risk may be over or underestimated by current approaches. While there is a great deal of variability across chemicals in the prenatal ASFs, the data indicate that the potency associated with prenatal carcinogen exposure is not zero. A factor of 3 is close to the median ASF, while a factor of 10 falls roughly at the 70th percentile of the prenatal ASF estimate. An ASF could be applied as a default when calculating lifetime cancer risk in humans arising from carcinogen exposures that occur *in utero*. In view of the considerable variability in the data for different carcinogens and the limited database available for analysis, OEHHA is not proposing the application of a specific factor to cancer potency estimates for prenatal exposures in the first and second trimesters as a default position in these Guidelines. However, given that the rodent is born at a stage of maturation similar to a third trimester fetus, it is reasonable to include the third trimester in the 10X potency weighting proposed up to age 2 years. The applicability of a cancer potency adjustment factor for first and second trimester prenatal exposure will be evaluated on a case-by-case basis, and may be used as evidence develops that supports such use. The consideration of prenatal exposures, including application of an appropriate susceptibility factor, would not make a large difference for risk estimates based on continuous lifetime exposures, due to the relatively short duration of gestation. However, risk estimates for short-term or intermittent exposures would be slightly increased by inclusion of the risks to the fetus during the prenatal period. Thus, risk may be underestimated when the first and second trimesters are excluded from the analysis.

Age Bins for Application of ASFs

The choice of human ages to which the ASFs apply is based on toxicodynamic and toxicokinetic considerations. Important toxicodynamic factors related to susceptibility to carcinogens include the rate of cellular proliferation and differentiation, which is quite high during organ maturation. In addition, toxicokinetic differences by age are important, due to impacts on detoxification and clearance of carcinogens (see following section). OEHHA's analysis of the influence of age-at-exposure on carcinogenesis broke the experimental rodent data into age bins that we termed "lifestages" including prenatal, "postnatal" (birth to weaning, about day 21) and "juvenile" (weaning to sexual maturation, or about day 22 to about day 49). Experiments were placed into the lifestage bins if exposure occurred at some time during the experimental rodent age bin.

There is no simple way to compare the rodent age groups used in the OEHHA analysis of available data to equivalent age groups in humans. Complicating factors include variations in organ system structural and functional maturation both within and between species. Further, the rodent age bins were chosen by gross indicators of development namely birth, weaning and sexual maturation, not on the basis of known susceptibility to carcinogenesis. Thus, critical factors relating to carcinogen susceptibility by age are the focus of the choice of human age bins to which the ASFs of 10 and 3 apply, rather than an attempt at exact correlation of rodent lifestage bin with human age.

The investigations used by OEHHA to evaluate the relationship between age at exposure and cancer potency were not conducted by standardized protocol. Further, the windows of susceptibility are quite varied by chemical and organ system, even within the lifestages defined in the OEHHA analysis. This complicates choosing a default ASF and the human age bin to which it applies. Examples from animal studies provided in Appendix J include the chemical diethylnitrosamine (DEN). The cancer potency varied over several orders of magnitude depending

on when during gestation and postnatal life the exposure occurred. A three-fold difference in potency between exposure on prenatal day -3 and prenatal day -10 is noted for 1-ethyl-1-nitrosobiuret in rats. There are also human examples of extensive variation of potency by age at exposure, including radiation, DES, and chemotherapeutic agents. The diversity of responses to different agents obviously underscores uncertainty in the choice of age bins to apply the default ASFs. However, the ASFs are a ***default*** to use when you have no chemical-specific data on influence of age-at-exposure on potency in order to protect public health. There will always be specific chemical examples where the ASF for either the third trimester-<2 yrs or 2-<16 yrs age bin is quite a bit larger or quite a bit smaller than the default.

In the following sections, we discuss our logic in proposing age bins of third trimester to age 2 years, and 2 to age <16 years to which the ASFs of 10 and 3 apply, respectively, and indicate the impact on risk estimates of these age bins.

Toxicokinetic Factors Relevant to Age Bins

Choice of the age-bins to which the default ASFs are applied is based on our understanding of the two primary drivers of age-related sensitivity to carcinogens, namely age-related toxicokinetic factors and toxicodynamic factors. In the case of toxicokinetics, the largest postnatal differences in xenobiotic metabolic capability occur between infants and adults. As noted in OEHHA (2001) and reviewed in detail elsewhere (*e.g.*, Cresteil et al., 1998; Ginsberg et al., 2004), hepatic drug metabolism by the cytochrome P-450 family of enzymes and the Phase II conjugating enzymes undergoes a maturation process during the first few years of life. The hepatic cytochrome P-450 enzymes exist in fetal isoforms at birth, and progressively change to adult isoforms at a relatively early stage of postnatal development. Thus, in humans the metabolic capability towards prototypical substrates develops over the first year of life towards adult levels. Similarly, the largest differences in metabolic capability of Phase II enzymes (conjugation of xenobiotic metabolites prior to excretion) tend to be between infants and adults. Other factors such as renal capability also are most different between neonates and adults. Thus, the first 2 years of life would encompass the increased sensitivity of early life stages due to toxicokinetic differences between early life and adulthood.

Ontogeny of Cytochrome P-450 Enzymes in Humans.

Cresteil (1998) describes three groups of neonatal cytochrome P-450: Cyp3A7 and Cyp4A1 present in fetal liver and active on endogenous substrates; an early neonatal group including Cyp2D6 and 2E1 which surge within hours of birth; and a later developing group, Cyp3A4, Cyp2Cs, and Cyp1A2. Total Cyp 3A protein, a major cytochrome P-450 enzyme responsible for biotransformation of many xenobiotics, is relatively constant in neonates and adults. However, Cyp3A7 is the primary fetal form (Hakkola et al., 1998), while Cyp3A4 is the primary adult hepatic form of the 3A series. At one month Cyp3A4 activity is about one-third of that in the adult liver (Lacroix et al., 1997; Hakkola et al., 1998). Allegaert *et al*. (2007) stated that Cyp3A4 (testosterone-6ß-hydroxylase) activity equaled or exceeded adult activity after 1 year of age. Cyp2E1, which metabolizes benzene, trichloroethylene and toluene, among others, increases gradually postnatally, reaching about one-third of adult levels by one year of age and attains adult levels by 10 years of age (Vieira et al., 1996; Cresteil, 1998). Cyp1A2, and Cyp2C9 and 2C19, the most abundant Cyp2 enzymes in adult human liver, appear in the weeks after birth, and reach

30% to 50% of adult levels at about 1 year of age (Treluyer et al., 1997; Hines and McCarver, 2002). Cyp1A1 is expressed in fetal liver where it can activate such xenobiotics as benzo[a]pyrene and aflatoxin B1 (Shimada et al., 1996), but is less important in adult liver (Hakkola et al., 1998).

Ontogeny of Cytochrome P-450 Enzymes in Rodents.

Hart et al. (2009) report developmental profiles of a number of cytochrome P-450 enzymes (measured as levels of mRNA transcripts of the specific genes) in mice. They identified three groups of isoforms. Group 1 (Cyp3A16 in both sexes; Cyp3A41b in males) appeared rapidly after birth but declined to essentially zero at 15-20 days, which is the period of weaning in mice. A second group (Cyp2E1, Cyp3A11 and Cyp4A10 in both sexes; Cyp3A41b in females) also increased rapidly after birth, but reached a stable maximal level by postnatal day 5. The third group (Cyp1A2, Cyp2A4, Cyp2B10, Cyp2C29, Cyp2D22, Cyp2F2, Cyp3A13 and Cyp3A25) were expressed only at low levels until days 10 to 15, but reached high stable levels by day 20.

ElBarbry et al. (2007) examined the developmental profiles of two toxicologically significant cytochrome P-450 enzymes, Cyp1A2 and Cyp2E1 in rats. mRNA transcripts of these genes were very low postnatally, but thereafter increased to reach a peak at or shortly after weaning (postnatal day 21 - 28 for rats). Immunoreactive Cyp1A2 and Cyp2E1 proteins were first detectable at postnatal day 3 and reached 50% of adult levels at weaning and adult levels at puberty. Differences in profiles between gene expression as mRNA and appearance of specific proteins as determined by immunoassay may reflect changes in the relative importance of transcription and translation control processes at various phases in development. Enzyme activities characteristic of Cyp1A2 and Cyp2E1 were found to parallel gene expression levels (ElBarbry et al., 2007) rather than immunodetectable protein levels, so there may also be issues of cross-reactivity between these two isoenzymes and others for which gene expression was not measured in these experiments.

In summary, the gene expression data in rats and mice show differences in details, but broadly resemble one another in that the main changes occur in the early postnatal period, with the major adjustments completed at or around the time of weaning, although the adult pattern may not be completely established until puberty. There do not appear to be substantive data for experimental species other than rats and mice, although the situation in humans appears similar in general outline and one may conclude that this pattern or some variant of it is characteristic of mammalian species in general.

Ontogeny of Phase II Enzymes

Phase II conjugating enzymes are generally less active in the neonate than the adult (Milsap and Jusko, 1994). Hence, there is concern that detoxification and elimination of chemicals is slower in infants. In humans, expression of some of the UGT enzymes matures to adult levels in two months after birth, although glucuronidation of some drugs by the UGT1A subfamily does not reach adult levels until puberty (Levy et al., 1975; Snodgrass, 1992; McCarver and Hines, 2002). Reduced glucuronidation in neonates slows the clearance of *N*-hydroxyarylamines, phenol, and benzene metabolites. Acetylation by the N-acetyltransferases and sulfation by sulfotransferases are generally somewhat comparable to adult levels, although it varies by tissue and by specific sulfotransferase (McCarver and Hines, 2002). Human glutathione sulfotransferase (GST) is present as a fetal isoform which decreases postnatally, while GST-alpha and GST-mu increase

over the first few years of life to adult levels (McCarver and Hines, 2002). Epoxide hydrolase, important in detoxifying reactive epoxide metabolites, is present in neonatal liver although at much reduced activity relative to adults (McCarver and Hines, 2002).

Clearances of Drugs in Infants and Children vs. Adults

Several investigators have evaluated age-related drug disposition (Renwick, 1998; Renwick et al., 2000; Ginsberg et al., 2002; Hattis et al., 2003). Renwick et al. (2000) noted higher internal doses in neonates and young infants versus adults for seven drugs that are substrates for glucuronidation, one with substrate specificity for CYP1A2, and four with substrate specificity for CYP3A4 metabolism. Ginsberg et al (2002) evaluated toxicokinetic information on 45 drugs in children and adults metabolized by different cytochrome P-450 pathways, by Phase II conjugations, or eliminated unchanged by the kidney. These authors noted half-lives 3-9-fold longer in infants than those in adults. It was also shown that the bulk of the elevated child/adult half-life ratios occurred primarily in the 0 to 6 month age range, and that for some compounds the clearance is actually higher in the 6 month to 2 year age grouping. In evaluating the interindividual variability by age, Hattis et al (2003) note that the largest interindividual variability occurs in the youngest children, apparently due to variability in development of critical metabolism and elimination pathways. Anderson and Holford (2008) noted that a comparison of three early-life drug clearance models (surface area, allometric ¾ power and per kilogram scaling) all demonstrated an increase in clearance over the first year of life due to the maturation of metabolic capacity.

Renal elimination depends on maturity of processes related to tubular reabsorption and secretion, and glomerular filtration rates. At birth, the glomerular filtration rate (GFR) is low (2-4 ml/min), increases in the first few days (8-20 ml/min) and slowly increases to adult values in 8-12 month old infants (Plunkett et al., 1992; Kearns et al, 2003).

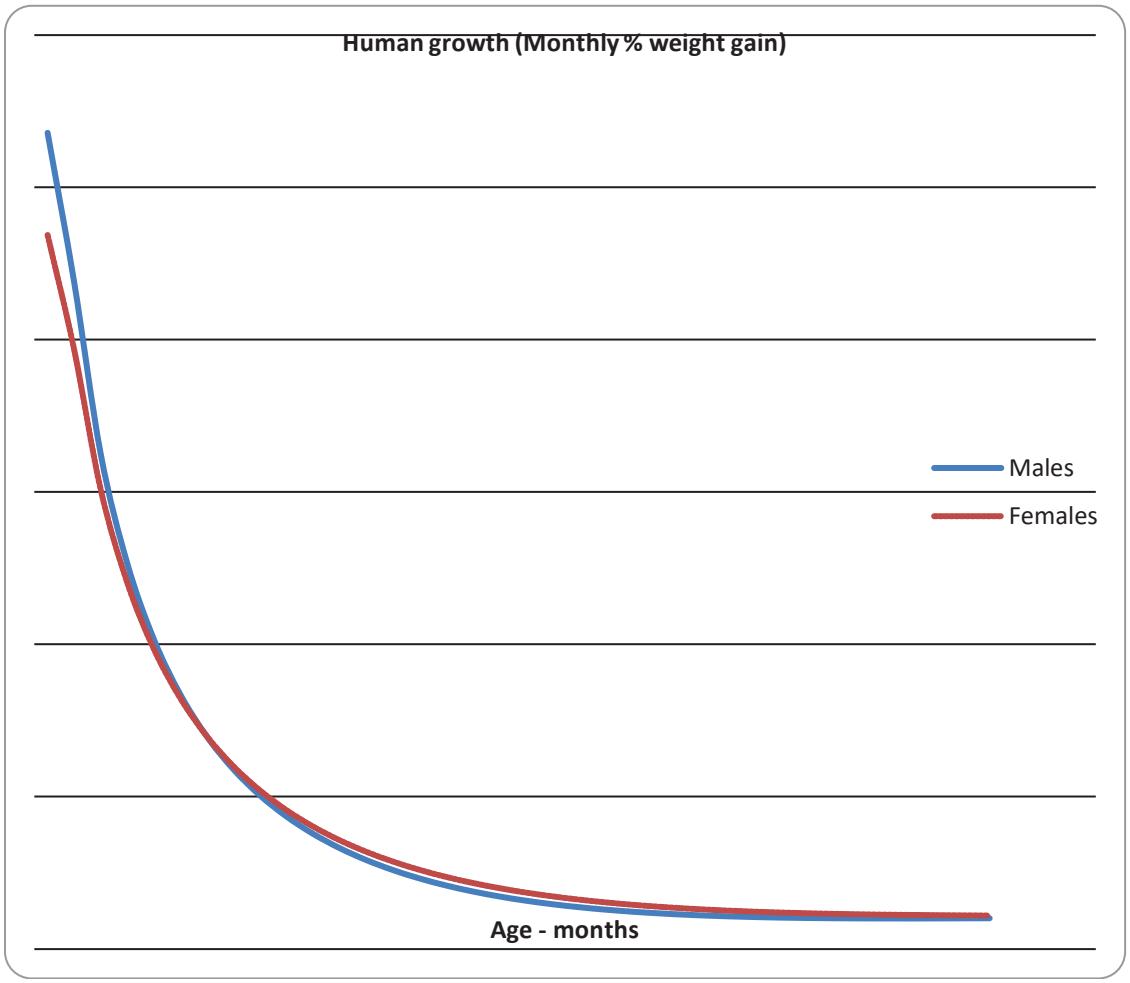
Newborn and young animals have less capacity to excrete chemicals into the bile than do adult animals. A number of chemicals are excreted more slowly via bile in neonates than adult rats, including ouabain, the glucuronide conjugate of sulfobromophthalein (Klaassen, 1973), and methyl mercury (Ballatori and Clarkson, 1982), resulting in a longer half-life in neonates.

Toxicodynamic Factors Relevant to Age Bins

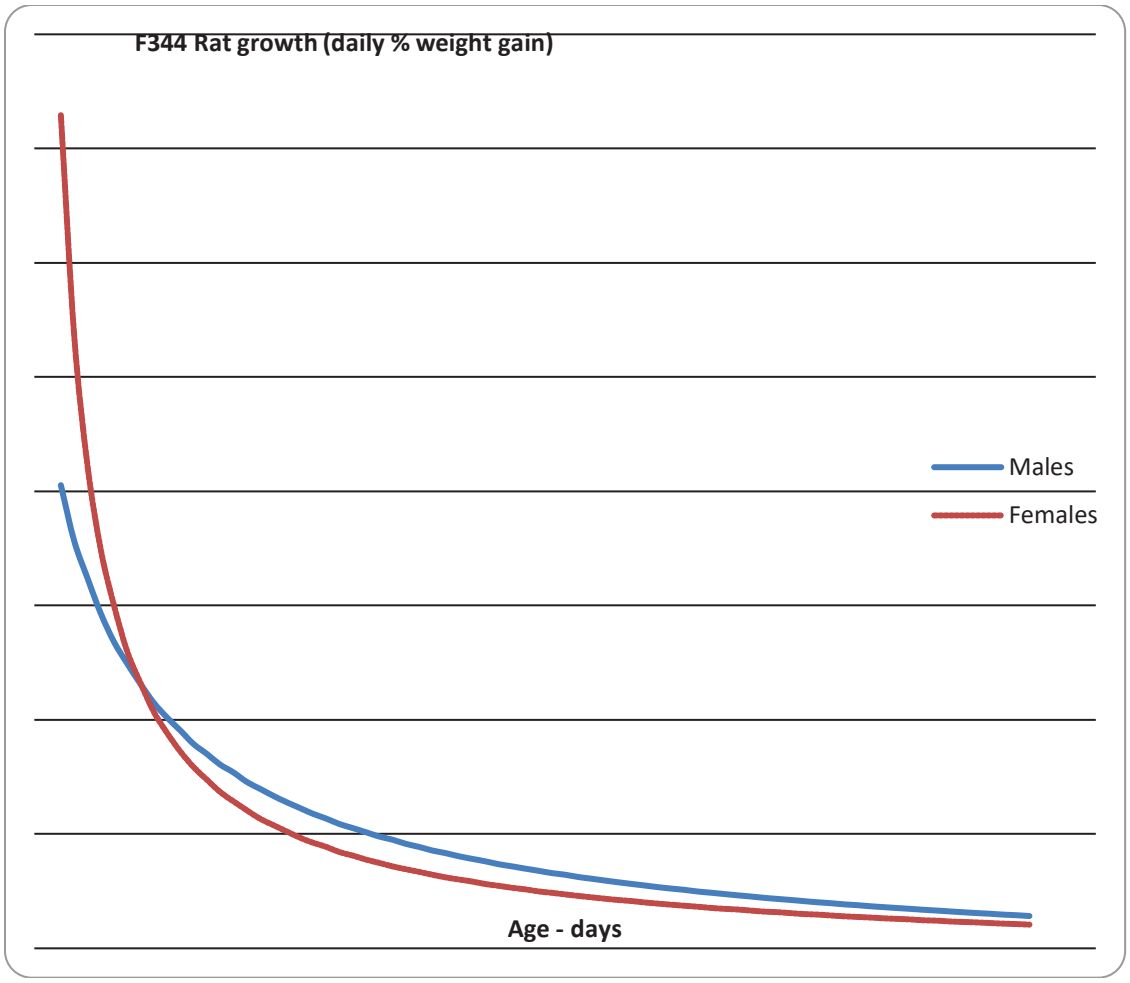
Important as the developmental changes in toxicokinetics are in determining sensitivity to carcinogens and other toxicants, it is likely that the toxicodynamic differences, *i.e.* intrinsic differences in susceptibility to carcinogenesis at the tissue or cellular level, are even more influential. Changes in cell division rates and differentiation, which are thought to be important toxicodynamic determinants of susceptibility to carcinogenesis, peak in the first 2 years of life for most major organ systems. Cell division continues to accommodate growth throughout childhood and adolescence, extending in some cases even into the young adult period in both humans and experimental animals. Adolescence is an important period for organ cell division and differentiation for the mammary gland and reproductive organs.

As noted above, one of the key factors influencing susceptibility to carcinogenesis is believed to be cell division rate, which acts both by forcing error-prone repair which fixes DNA damage as mutated gene sequences (McLean et al, 1982) and by promoting expansion of mutated clones

(Moolgavkar and Knudson, 1981). Actual cell division rates as a function of age are hard to determine for practical and (in the human case) ethical reasons. However, growth curves expressed as the proportional increment in body weight with time may be regarded as a reasonable although not perfect surrogate since for most tissues of the body cell size does not change markedly during growth. Both humans and rodents show remarkably high growth rates in infancy, which then drop steeply to a lower but still significant rate during childhood. A growth spurt at the beginning of adolescence is noticeable in its absolute magnitude, especially in males, but does not approach the proportional growth rate seen in infancy. The time intervals proposed to reflect the period of highest sensitivity to carcinogenesis (up to about 21 days in rodents, up to 24 months in humans) encompass the period of highest growth rate and thus it is assumed the highest cell division rates, as show in the following charts:



Data from CDC NHANES 2000:
http://www.cdc.gov/nchs/about/major/nhanes/growthcharts/datafiles.htm



Data from Tables A3 and A4 of Appendix J

Cell division rates in adult rodents and humans are harder to relate to growth curves since at least some tissues retain active cell division as part of their ongoing functionality and repair. In humans growth in body weight slows to essentially zero at the end of adolescence (and any later increments represent tissue specific changes such as increase in muscle or adipose tissue mass rather than overall growth). On the other hand, rodents continue to increase in body size (at a modest rate compared to that seen in earlier lifestages) throughout the adult period. However, it appears reasonable to conclude from the body weight data that an essentially adult pattern of overall cell division is established by the late adolescent period (age six weeks in rodents; 16 years in humans). However, increased cell division and cell differentiation are seen in the reproductive system and its accessories during puberty.

Organ Development

The age intervals chosen for the ASFs are generally supported by human organ system development data. Examples of supporting data are available for the lung, brain, immune system and liver. Zeltner and Burri (1987) stated that postnatal lung development consists of an alveolar stage, which lasts to about 1-1.5 years of age, and a stage of microvascular maturation, which exists from the first months after birth to the age of 2-3 years. Pinkerton and Joad (2006) describe

alveolar proliferation as occurring most prominently in the 0-2 year age range, with alveolar expansion continuing in the 2-8 year age range. Ballinoti et al. (2008) demonstrated that addition of alveoli rather than expansion is a major mode of lung growth in infants and toddlers by measuring a constant carbon monoxide diffusion capacity to lung volume from 3 through 23 months of age. Kajekar (2007) also considered the 0-2 age range to be the primary period of alveolar development, although there is continued cellular proliferation resulting in lung growth and expansion up to approximately 18 years of age.

Rice and Barone (2000) note that most of the cell proliferation phase of human radial glia and neuronal growth is finished by 2 years of age, based on evidence in Bayer et al. (1993). They note further that numerous studies have shown actively proliferating brain regions are more susceptible to anti-mitotic agents than the same structures after active proliferation ceases. Peak brain growth as a percentage of body weight occurs at birth and around post-natal day (PND) 7-8 in humans and rats, respectively (Watson *et al*., 2006). De Graaf-Peters and Hadders-Algra (2006) reviewed the ontogeny of the human central nervous system and found that a large amount of axon and dendrite sprouting and synapse formation and the major part of telencephalic myelination take place during the first year after birth. While the brain continues to remodel itself throughout life, cellular proliferation in the whole brain peaks by about one year of age and is relatively complete by age 2. Development of the blood-brain barrier (BBB) appears to continue in humans until approximately 6 months of age. Rat BBB functionality is essentially complete by approximately two weeks after birth (Watson *et al*., 2006).

The immune system development occurs in stages, primarily prenatally in primates and both pre- and post-natally in rodents (Dietert et al., 2000). Formation and expansion of hematopoetic stem cells is followed by expansion of lineage-specific stem cells, colonization of bone marrow and thymus, and maturation of cells to immunocompetence. In the primate, this is largely complete by 1 to 2 years of age (Holsapple et al., 2003), although establishment of immune memory develops throughout childhood and beyond. In the rodent, maturation to immunocompetence occurs postnatally from birth to about 30 days of age. In terms of carcinogenesis, perhaps one of the more important immune cells is the NK cell, thought to be responsible for immune surveillance and killing of circulating transformed cells. Based on immunohistochemistry, the principal cell lines including NK cells are present at gestation day 100 in the monkey and are at about 60% of adult values at birth (Holladay and Smialowicz, 2000).

As noted above, renal and hepatic clearance are both lower in humans at birth than in adults. Nephrogenesis is complete by 35 weeks gestation in humans and before birth in the mouse (but after birth in the rat). The ability to concentrate urine and the development of acid-base equilibrium appear in the first few months after birth (Zoetis and Hurtt, 2003). Renal clearance of drugs, a function of a number of processes in the kidney, appears to be comparable to adults within the first few months of life (Hattis et al., 2003; Ginsberg et al., 2002), while glomerular filtration, which rises rapidly over the first few postnatal months, is at adult values by two years of age (Zoetis and Hurtt, 2003). While complete anatomic maturity of the human liver is noted by 5 years of age (Walthall et al, 2005), liver function also appears to mature within the first year of life as seen by drug clearance studies cited above.

Critical Windows of Susceptibility to Carcinogens

It has been shown that there are critical windows during development both pre-and postnatally where enhanced susceptibility to carcinogenesis occurs (Anderson et al, 2000). Some of these observations relate to factors affecting the incidence of cancers in childhood, resulting from prenatal or preconception mutational events. For example, prenatal exposure to ionizing radiation and DES can result in leukemia and vaginal carcinoma, respectively, in childhood. Although obviously a source of great concern, these cancers appearing during childhood are relatively rare compared to cancers appearing later in life. Thus the concern in risk assessment for early in life exposures is to address the lifetime cancer incidence as a result of these exposures, including both cancers appearing during childhood and those appearing later.

OEHHA (see Appendix J) and other investigators (U.S. EPA, 2005; Barton et al, 2005; Hattis et al., 2004) have examined the available rodent data on sensitivity to carcinogenic exposures early in life. All these investigators found substantial increases in sensitivity to carcinogens in animal studies where exposures to young animals were compared to similar exposures to adults. Hattis et al. (2004) reported maximum likelihood estimates for the ratio of carcinogenic potency during the period from birth to weaning to the adult potency of between 8.7 and 10.5, whereas Barton et al (2005) reported a weighted geometric mean of 10.4 for the ratio of juvenile (less than 6-8 weeks) to adult potency in rodents. However, the number of experiments which provide information of this type, and the carcinogenic agents which have been studied, are relatively limited. Hattis examined several different datasets and study designs, but these covered only 13 different chemicals, while the mean value reported by Barton et al. was based on only six of the 18 chemicals which they examined. OEHHA's analysis included data in rodents on 23 chemicals, and found median potency ratios of 13.5 for the postnatal period (birth to day 22) and 4.5 for the juvenile period (postnatal days 22 to ~49) relative to adults (day ~49 to 2 years). These potency ratios include the adjustment for time to manifest tumor (*e.g.*, age to the power of three), unlike the earlier investigations. All these investigations identified variations in the observed lifetime potency ratio depending on the type of experimental design, the sex of the animals, the time of exposure and especially between chemicals. Nevertheless these analyses, although falling far short of a comprehensive evaluation of the age dependence of carcinogenic potency for all the chemicals of interest, do show a consistent overall trend of increasing potency for exposures early in life, especially soon after birth.

An evaluation of cancer induction by ionizing radiation also provides support for the concept of enhanced sensitivity to carcinogenesis at younger ages. Various studies of this phenomenon have been undertaken in animal models, but the important point for the present discussion is that epidemiological data exist which indicate age-dependent sensitivity in humans (U.S. EPA, 1994; 1999). The most extensive data set showing age-dependent effects is that for Japanese survivors of the atomic bomb explosions at Hiroshima and Nagasaki. Analysis of these data shows linear increases in tumor incidence at a number of sites with increasing radiation dose and younger age at exposure. There are other data suggesting humans are more susceptible to chemical carcinogens when exposure occurs in childhood. These data exist for tobacco smoke (Marcus et al., 2000; Wiencke et al., 1999) and chemotherapy and radiation (Mauch et al., 1996; Swerdlow et al., 2000; Franklin et al., 2006).

Proposed Age Bins for Application of Default Age Sensitivity Factors

In developing a default science-based risk assessment policy to address this general conclusion, one key variable to define is the age interval or intervals over which age-dependent sensitivity factors should be applied. Different investigators have considered different age ranges, but in general the more sensitive period has at least been defined as including the time from birth up to mid-adolescence when the major phases of growth and hormonal change are complete. It is also recognized that, apart from the dramatic prenatal developmental events, the earliest postnatal stages represent the greatest differences in physiology and biochemistry from the adult. This reflects the immaturity of many organ systems, extremely rapid growth, and the incomplete maturation of various metabolic capabilities. As noted earlier, the rodent age bins in OEHHA's analysis were based on gross developmental milestones (birth, weaning, sexual maturity). OEHHA's analysis of studies that included exposure sometime between birth and weaning indicated this period as having the highest sensitivity to carcinogenesis. The data for the later juvenile period (postnatal days 22 to ~ 49) are somewhat sparse, covering only three carcinogens and only one where there are corresponding data for both postnatal and juvenile lifestages. However, it appears based on the overall range of potency ratios observed for the juvenile period that sensitivity to many carcinogens is elevated in this period also, but to a lesser extent than during the first 22 days. [Hattis et al. (2005) and Barton et al. (2005) report analyses for exposures at any time during the juvenile period, i.e. up to 6-8 weeks, and do not separate by additional age bins].

Weaning is not such an obvious or consistently timed transition for humans, being subject to a wide range of cultural and economic variables. However, it is generally considered that the human infant period encompasses the first two years of life. This period includes the most rapid periods of cellular division and differentiation for the major organ systems (excluding the breast and reproductive organs). Although there is linear growth between 2 and 8 years of age, the organ development is largely although not entirely complete.

Thus, considering both the development of major organ systems and the associated differences in toxicodynamic and toxicokinetic factors, OEHHA initially proposed to apply the postnatal ASF derived from rodent studies (birth to 21 days) to the human age intervals of birth - < 2 years. Similarly, OEHHA chose to apply the "juvenile" ASF derived from rodent studies (22 - ~49 days) to the human ages 2 - < 16 years. This timetable was also selected by U.S. EPA (2005) in their supplemental guidance for assessing early-life susceptibility to carcinogens. They describe their choice of critical periods as follows:

> "The adjustments described below reflect the potential for early-life exposure to make a greater contribution to cancers appearing later in life. The 10-fold adjustment represents an approximation of the weighted geometric mean tumor incidence ratio from juvenile or adult exposures in the repeated dosing studies (see Table 8). This adjustment is applied for the first 2 years of life, when toxicokinetic and toxicodynamic differences between children and adults are greatest (Ginsberg et al., 2002; Renwick, 1998). Toxicokinetic differences from adults, which are greatest at birth, resolve by approximately 6 months to 1 year, while higher growth rates extend for longer periods. The 3-fold adjustment represents an intermediate level of adjustment that is applied after 2 years of age through <16 years of age. This upper age limit represents middle adolescence following the period of rapid developmental changes in puberty and the conclusion of growth in body height in

NHANES data (Hattis et al., 2005). Efforts to map the approximate start of mouse and rat bioassays (i.e., 60 days) to equivalent ages in humans ranged from 10.6 to 15.1 years (Hattis et al., 2005)."

There is general agreement that rodents are born at a maturational stage approximately equivalent to a third trimester human fetus. Thus, there is good rationale to include the third trimester of pregnancy in the age bin for application of the ASF of 10. Therefore, OEHHA is applying the ASF of 10 for exposures during the third trimester of pregnancy to age 2. The default ASF values used by OEHHA are summarized in Table 2.

While there is strong evidence that growth and therefore cell proliferation rates and cell differentiation are extremely high prior to age 2, and lower (although still elevated relative to the adult) thereafter, there is still residual uncertainty with respect to the cut point for application of the ASFs of 10 and 3. Thus, another possible approach would be to move the cut point for the application of the ASF of 10 to a later age to account for this uncertainty. We present the effect on risk estimates of varying cut points in Table 3 and Table 4.

Table 2. Default Age Sensitivity Factors to be used to estimate cancer risks to infants and children

R (third trimester to age 2yrs)	10
R (age 2 to age 16 yrs)	3
R (age 16 to 70 yrs)	1

Application of ASFs in Risk Assessment

The effect of using the proposed default ASFs in calculating cancer risk over a 70 year lifetime, and for a 9 year exposure common in the Hot Spots program risk assessments is demonstrated in Table 3 and Table 4 below. Ignoring for the moment the increased exposures to carcinogens that children experience, the effect of the weighting factors is to increase the lifetime cancer risk by about 2. For risks from shorter exposures, such as the commonly used 9 year exposure scenario, OEHHA proposes to evaluate risk from exposures starting at the third trimester in the surrounding general population. The weighting factors in this case increase the risk to a larger extent. Depending on the exposure scenario, the use of age-specific distributions for uptake rates for air, food and water would also increase the risk estimates significantly independent of any application of ASFs. This is because the uptake rates for all these media per unit of body weight are higher in children and, especially, infants.

Assessing risks to short-term exposures to carcinogens involves additional uncertainties. The cancer potency factors are generally based on long-term exposures. However, in reality, the local air districts in California are frequently assessing risk from short term activities related to construction, mitigation of contaminated soils, and so forth. OEHHA recommends that when assessing such shorter term projects, the districts assume a minimum of 2 years of exposure and apply the slope factors and the 10 fold ASF to such assessments. Exposure durations longer than 2 years would use the method for the remaining years as noted above.

Table 3. Example of default ASF use for a lifetime exposure (not adjusted for age-specific exposure)

Carcinogen Potency = 1 $(mg/kg\text{-}d)^{-1}$
Exposure = 0.0001 mg/kg-d
No consideration of differences of exposure

No adjustment: Lifetime Risk = potency × dose	Risk
70 year Lifetime risk = 1 × 0.0001	**1.0×10^{-4}**

With proposed default ASF of 10 for third trimester to age 2, and 3 for ages 2 to 16 years: LR = Σ (potency x dose x ASF x fraction of lifetime)	ASF	Duration	Risk
R (third trimester to age 2yrs)	10	2.25/70	0.321×10^{-4}
R (age 2 to age 16 yrs)	3	14/70	0.600×10^{-4}
R (age 16 to 70 yrs)	1	54/70	0.771×10^{-4}
70 year Lifetime Risk			**1.7×10^{-4}**

For comparison, if ASF of 10 were applied to age 5, and ASF of 3 for the ages 5 to 16 years: LR = Σ (potency x dose x ASF x fraction of lifetime)	ASF	Duration	Risk
R (birth to age 5)	10	5.25/70	0.750×10^{-4}
R (age 5 to 16 yrs)	3	11/70	0.471×10^{-4}
R (age 16 to 70 yrs)	1	54/70	0.771×10^{-4}
70 year Lifetime Risk			**2.0×10^{-4}**

Table 4. Example of default ASF use for a 9-year exposure

Carcinogen Potency = 1 $(mg/kg\text{-}d)^{-1}$
Exposure = 0.0001 mg/kg-d
No consideration of differences of exposure

No adjustment: Total Risk = potency × dose x fraction of lifetime		Duration	Risk
9-year Total Risk		9/70	**0.13×10^{-4}**
With default ASF of 10 for third trimester to age 2 and 3 thereafter: LR = Σ (potency x dose x ASF x fraction of lifetime)	ASF	Duration	Risk
R (third trimester to age 2yrs)	10	2.25/70	0.321×10^{-4}
R (age 2 to 9 yrs)	3	7/70	0.300×10^{-4}
9 year Total Risk			**0.62×10^{-4}**
For comparison, if ASF of 10 applied to age 5, and ASF of 3 thereafter: LR = Σ (potency x dose x ASF x fraction of lifetime)	ASF	Duration	Risk
R (birth to age 5 yrs)	10	5/70	0.750×10^{-4}
R (age 5 to 9 yrs)	3	4/70	0.171×10^{-4}
9 year Total Risk			**0.92×10^{-4}**

Special Consideration of Puberty

In addition to the general concerns over increased sensitivity to carcinogenesis during infancy and childhood, there are specific concerns for exposure during the period when hormonal and developmental changes associated with puberty are in process, especially for carcinogens with hormonal modes of action or with impacts on the reproductive system and its accessory organs. At puberty, there is increased development of breast and reproductive organs that clearly involves rapid cellular division and differentiation. Thus, for carcinogens that induce mammary and reproductive organ cancers, puberty represents a time of increased sensitivity. As noted in the section on Selection of Default Age-Sensitivity Factors (page 50), if the risk assessor is evaluating a chemical with the potential for more than usually enhanced potency during this period, such as those which induce mammary or reproductive organ tumors (*e.g.*, a polycyclic aromatic hydrocarbon), then the risk assessment may use a larger ASF to calculate risk from exposure during puberty. OEHHA may recommend chemical-specific ASFs for puberty to the local air quality management districts for use in the Air Toxics Hot Spots program.

U.S.EPA Analysis of the Effect of Age at Exposure on Cancer Potency

U.S. EPA addressed the potential for increased susceptibility to cancer caused by environmental chemicals when the exposure occurs during an early lifestage in "Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens" (U.S. EPA, 2005b) (referred to henceforth as the Supplemental Guidance). This document is intended to be a companion to the revised "Guidelines for Carcinogen Risk Assessment" (U.S. EPA, 2005a). We present a summary of their analysis, which supports the policy decision to weight cancer potency and therefore risk by age-at-exposure. As previously noted, there are several methodological differences between the U.S. EPA analysis and the OEHHA analysis. Of note, in the OEHHA analysis all treatment-related tumors that were observed in a given lifestage exposure experiment were taken into account in estimating cancer potency. Thus in comparing cancer potencies associated with early life vs. adult exposure, OEHHA compared the total cancer risk associated with exposure during a given lifestage, rather than comparing the risk for cancers at one single site in each lifestage, as the U.S. EPA did. In addition, the age groupings are somewhat different in the U.S. EPA analysis from those used by OEHHA in their analysis (described above). For example, prenatal (*in utero*) exposures were not part of the analysis performed by U.S. EPA, and that Agency's analyses did not distinguish between postnatal and juvenile exposures.

U.S. EPA oral exposure cancer risk methodology relies on estimation of the lifetime average daily dose, which can account for exposure factor differences between adults and children (*e.g.*, eating habits and body weight). However, early lifestage susceptibility differences have not been taken into consideration when cancer potency factors were calculated. The Supplemental Guidance document focused on studies that define the potential duration and degree of increased susceptibility that may arise from early-life exposures. An analysis of those studies including a detailed description of the procedures used was published in Barton *et al*. (2005) (included as Appendix I). The criteria used to decide if a study could be included in the quantitative analysis are as follows (excerpted from U.S. EPA, 2005b):

1. Exposure groups at different post-natal ages in the same study or same laboratory, if not concurrent (to control for a large number of potential cross-laboratory experimental variables including pathological examinations),
2. Same strain/species (to eliminate strain-specific responses confounding age-dependent responses),
3. Approximately the same dose within the limits of diets and drinking water intakes that obviously can vary with age (to eliminate dose-dependent responses confounding age-dependent responses),
4. Similar latency period following exposures of different ages (to control for confounding latency period for tumor expression with age-dependent responses), arising from sacrifice at >1 year for all groups exposed at different ages, where early-life exposure can occur up to about 7 weeks. Variations of around 10 to 20% in latency period are acceptable,
5. Postnatal exposure for juvenile rats and mice at ages younger than the standard 6 to 8 week start for bioassays; prenatal (*in utero*) exposures are not part of the current analysis. Studies that have postnatal exposure were included (without adjustment) even if they also involved prenatal exposure,

6. "Adult" rats and mice exposure beginning at approximately 6 to 8 weeks old or older, *i.e.* comparable to the age at initiation of a standard cancer bioassay (McConnell, 1992). Studies with animals only at young ages do not provide appropriate comparisons to evaluate age-dependency of response (*e.g.*, the many neonatal mouse cancer studies). Studies in other species were used as supporting evidence, because they are relatively rare and the determination of the appropriate comparison ages across species is not simple, and
7. Number of affected animals and total number of animals examined are available or reasonably reconstructed for control, young, and adult groups (i.e., studies reporting only percent response or not including a control group would be excluded unless a reasonable estimate of historical background for the strain was obtainable).

Cancer potencies were estimated from a one-hit model (a restricted form of the Weibull time-to-tumor model), which estimates cumulative incidence for tumor onset. U.S. EPA (2005b) compared the estimated ratio of the cancer potency from early-life exposure to the estimated cancer potency from adult exposure. The general form of the equation for the tumor incidence at a particular dose, [P(dose)] is:

$$P(dose) = 1-[1-P(0)]\exp(-\text{cancer potency}*\text{dose})$$

where P(0) is the incidence of the tumor in controls. The ratio of juvenile to adult cancer potencies at a single site were calculated by fitting this model to the data for each age group. The model fit depended upon the design of the experiment that generated the data. Studies evaluated by U.S. EPA had two basic design types: experiments in which animals were exposed either as juveniles or as adults (with either a single or multiple dose in each period), and experiments in which exposure began either in the juvenile or in the adult period, but once started, continued through life.

The model equations for the first study type are:

$$P_A = P_0 + (1-P_0)\,(1-e^{-m_A \delta_A})$$

$$P_J = P_0 + (1-P_0)\,(1-e^{-m_A e^{\lambda} \delta_J})$$

where A and J refer to the adult and juvenile period, respectively, λ is the natural logarithm of the juvenile:adult cancer potency ratio, P_0 is the fraction of control animals with the particular tumor type being modeled, P_x is the fraction of animals exposed in age period x with the tumor, m_A is the cancer potency, and δ_x is the duration or number of exposures during age period x.

The goal of the model is to determine λ, which is the logarithm of the estimated ratio of juvenile to adult cancer potencies. This serves as a measure of potential susceptibility for early-life exposure.

For the second study type, the model equations take into account that exposures that were initiated in the juvenile period continue through the adult period. The model equations for the fraction of animals exposed only as adults with tumors in this design are the same as in the first study type, but the fraction of animals whose first exposure occurred in the juvenile period is:

$$P_J = P_0 + (1\text{-}P_0)\,(1\text{-}e^{-m_A\, e^{\lambda\cdot(\delta_J - \delta_A)} - m_A\,\delta_A})$$

δ_J includes the duration of exposure during the juvenile period and the subsequent adult period.

Parameters in these models were estimated using Bayesian methods and all inferences about the ratios were based on the marginal posterior distribution of λ. A complete description of these procedures (including the potential effect of alternative Bayesian priors that were examined) was published in Barton *et al.* (2005) (Appendix I). This method produced a posterior mean ratio of the early-life to adult cancer potency, which is an estimate of the potential susceptibility of early-life exposure to carcinogens. Ratios of greater or less than one indicate greater or less susceptibility from early-life exposure, respectively.

U.S. EPA reviewed several hundred studies reporting information on 67 chemicals or complex mixtures that are carcinogenic via perinatal exposure. Eighteen chemicals were identified which had animal study designs involving early-life and adult exposures in the same experiment. Of those 18 chemicals, there were overlapping subsets of 11 chemicals involving repeated exposures during early postnatal and adult lifestages and 8 chemicals using acute exposures (usually single doses) at different ages. Those chemicals are listed in Table 5.

Table 5 Chemicals having animal cancer study data available with early-life and adult exposures in the same experiment.

Chemical	Study Type
Amitrole	repeat dosing
Benzidine	repeat dosing
Benzo[a]pyrene (BaP)	acute exposure
Dibenzanthracene (DBA)	acute exposure
Dichlorodiphenyltrichloroethane (DDT)	lifetime exposure, repeat dosing
Dieldrin	lifetime exposure, repeat dosing
Diethylnitrosamine (DEN)	acute exposure, lifetime exposure
Dimethylbenz[a]anthracene (DMBA)	acute exposure
Dimethylnitrosamine (DMN)	acute exposure
Diphenylhydantoin, 5,5-(DPH)	lifetime exposure, repeat dosing
Ethylnitrosourea (ENU)	acute exposure
Ethylene thiourea (ETU)	lifetime exposure, repeat dosing
3-Methylcholanthrene (3-MC)	repeat dosing
Methylnitrosourea (NMU)	acute exposure
Polybrominated biphenyls (PBBs)	lifetime exposure, repeat dosing
Safrole	lifetime exposure, repeat dosing
Urethane	acute exposure, lifetime exposure
Vinyl chloride (VC)	repeat dosing

U.S. EPA calculated the difference in susceptibility between early-life and adult exposure as the estimated ratio of cancer potency at specific sites from early-life exposure over the cancer potency from adult exposure for each of the studies that were determined qualitatively to have appropriate study designs and adequate data. The results were grouped into four categories: 1) mutagenic chemicals administered by a chronic dosing regimen to adults and repeated dosing in the early postnatal period (benzidine, diethylnitrosamine, 3-methylcholanthrene, safrole, urethane and vinyl chloride); 2) chemicals without positive mutagenicity data administered by a chronic dosing regimen to adults and repeated dosing in the early postnatal period (amitrole, dichlorodiphenyltrichloroethane (DDT), dieldrin, ethylene thiourea, diphenylhydantoin, polybrominated biphenyls); 3) mutagenic chemicals administered by an acute dosing regimen (benzo[*a*]pyrene, dibenzanthracene, diethylnitrosamine, dimethylbenzanthracene, dimethyl-nitrosamine, ethylnitrosourea, methylnitrosourea and urethane); 4) chemicals with or without positive mutagenicity data with chronic adult dosing and repeated early postnatal dosing.

The acute dosing animal cancer studies were considered qualitatively useful by U.S. EPA because they involve identical exposures with defined doses and time periods demonstrating that differential tumor incidences arise exclusively from age-dependent susceptibility. However, they

were not used to derive a quantitative cancer potency factor age adjustment, primarily because most of the studies used subcutaneous or intraperitoneal injection as a route of exposure. These methods have not been considered quantitatively relevant routes of environmental exposure for human cancer risk assessment by U.S. EPA, for reasons including the fact that these routes of exposure are expected to have a partial or complete absence of first pass metabolism which could affect potency estimates. Additionally, U.S. EPA decided that cancer potency estimates are usually derived from chronic exposures, and therefore, any adjustment to those potencies should be from similar exposures.

The repeated dosing studies with mutagenic chemicals using exposures during early postnatal and adult lifestages were used to develop a quantitative cancer potency factor age adjustment. Studies with repeated early postnatal exposure were included in the analysis even if they also involved earlier maternal and/or prenatal exposure, while studies addressing only prenatal exposure were not used in the analysis. The weighted geometric mean susceptibility ratio (juvenile to adult) for repeated and lifetime exposures in this case was 10.4 (range 0.12 – 111, 42% of ratios greater than 1).

USEPA suggests the use of age-dependent-adjustment factors (ADAF) for chemicals acting through a mutagenic mode of action., based on the results of the preceding analysis, which concluded that cancer risks generally are higher from early-life exposure than from similar exposure doses and durations later in life:

1. For exposures before 2 years of age (i.e., spanning a 2-year time interval from the first day of birth until a child's second birthday), a 10-fold ADAF.

2. For exposures between 2 and <16 years of age (i.e., spanning a 14-year time interval from a child's second birthday until their sixteenth birthday), a 3-fold ADAF.

3. For exposures after turning 16 years of age, no adjustment (ADAF=1).

The ADAF of 10 used for the 0 – 2 years of age range is approximately the weighted geometric mean cancer potency ratio from juvenile versus adult exposures in the repeated dosing studies. U.S. EPA considered this period to display the greatest toxicokinetic and toxicodynamic differences between children and adults. Data were not available to calculate a specific dose-response adjustment factor for the 2 to <16-year age range, so EPA selected an ADAF of 3 because it was half the logarithmic scale difference between the 10-fold adjustment for the first two years of life and no adjustment (*i.e.*, 1-fold) for adult exposure. The ADAF of 3 represents an intermediate level of adjustment applied after 2 years of age through <16 years of age. The upper age limit (16 years of age) reflects the end of puberty and the attainment of a final body height. U.S. EPA recognizes that the use of a weighted geometric mean of the available study data to develop an ADAF for cancer potencies may either overestimate or underestimate the actual early-life cancer potency for specific chemicals, and therefore emphasizes in the Supplemental Guidance that chemical-specific data should be used in preference to these default adjustment factors whenever such data are available.

U.S. EPA is recommending the ADAFs described above only for mutagenic carcinogens, because the data for non-mutagenic carcinogens were considered to be too limited and the modes of action

too diverse to use this as a category for which a general default adjustment factor approach can be applied. OEHHA considers this approach to be insufficiently health protective. There is no obvious reason to suppose that the toxicokinetics of non-mutagens would be systematically different from those of mutagens. It would also be inappropriate to assume by default that non-mutagenic carcinogens are assumed to need a toxicodynamic correction factor of 1. Most if not all of the factors that make individuals exposed to carcinogens during an early-lifestage potentially more susceptible than those individuals exposed during adulthood also apply to non-mutagenic carcinogen exposures (*e.g.*, rapid growth and development of target tissues, potentially greater sensitivity to hormonal carcinogens, differences in metabolism). It should also be noted that carcinogens that do not cause gene mutations may still be genotoxic by virtue of causing chromosomal damage. Additionally, many carcinogens do not have adequate data available for deciding on a specific mode of action, or do not necessarily have a single mode of action. For these reasons, OEHHA will apply the default cancer potency factor age adjustments described above to all carcinogens unless data are available which allow for the development of chemical-specific cancer potency factor age adjustments. In those cases, an agent-specific model of age dependence (based on observational or experimental data) might be used, or alternative (larger or smaller) adjustment factors and age ranges may be applied where understanding of the mechanism of action and target tissues makes this appropriate.

Other Source Documents for Cancer Risk Assessment Guidance

As noted previously, the cancer potencies and unit risks tabulated in this technical support document have been developed by various programs over a number of years. The methods used therefore necessarily varied according to the date of the assessment and the program responsible. The following section summarizes the sources and procedures most commonly applied, and their historical context where this is apposite.

United States Environmental Protection Agency (U.S. EPA)

The U.S. EPA was one of the first regulatory agencies to develop and apply cancer risk assessment methodology. Their guidance documents and technical publications have been influential for many programs, including the California Air Toxics (Toxic Air Contaminants and Hot Spots) programs.

Guidelines for Carcinogen Risk Assessment (U.S. EPA, 1986)

Prior to the more recent guidelines updating project which, after nearly ten years of internal and public review drafts culminated in the 2005 final revision (see below), U.S. EPA carcinogen risk assessment procedures were generally as described in Anderson *et al*. (1983) and "Guidelines for Carcinogen Risk Assessment" (U.S. EPA, 1986). These methods, which are outlined below, were used to calculate the Integrated Risk Information System (IRIS) cancer potency values, some of which are cited in this document. U.S. EPA has always indicated that cancer risk estimates based on adequate human epidemiologic data are preferred if available over estimates based on animal data. Although the newer guidelines offer alternative methods for dose-response analysis of animal bioassays, and updated consideration of specific topics such as lifestage-related differences in sensitivity, and mechanism of action for some types of carcinogen, the underlying principles and many of the specific procedures developed in these original guidelines are still applicable and in use.

U.S. EPA Calculation of Carcinogenic Potency Based on Animal Data

In extrapolating low-dose human cancer risk from animal carcinogenicity data, it is generally assumed that most agents that cause cancer also damage DNA, and that the quantal type of biological response characteristic of mutagenesis is associated with a linear non-threshold dose-response relationship. U.S. EPA stated that the risk assessments made with this model should be regarded as conservative, representing the most plausible upper limit for the risk. The mathematical expression used by U.S. EPA in the 1986 guidelines to describe the linear non-threshold dose-response relationship at low doses is the linearized multistage procedure developed by Crump (1980). This model is capable of fitting almost any monotonically increasing dose-response data, and incorporates a procedure for estimating the largest possible linear slope at low extrapolated doses that is consistent with the data at all experimental dose levels. A description of the linearized multistage procedure has been provided above (page 29). U.S. EPA used an updated version (GLOBAL86, Howe *et al*., 1986) of the computer program GLOBAL79 developed by Crump and Watson (1979) to calculate the point estimate and the 95% upper confidence limit of the extra risk $A(d)$.

U.S. EPA separated tumor incidence data according to organ sites or tumor types. The incidence of benign and malignant tumors was combined whenever scientifically defensible. U.S. EPA considered this incidence combination scientifically defensible unless the benign tumors are not considered to have the potential to progress to the associated malignancies of the same histogenic origin. The primary comparison in carcinogenicity evaluation is tumor response in dosed animals as compared to contemporary matched control animals. However, U.S. EPA stated that historical control data could be used along with concurrent control data in the evaluation of carcinogenic responses, and notes that for the evaluation of rare tumors, even small tumor responses may be significant compared to historical data. If several data sets (dose and tumor incidence) are available (different animal species, strains, sexes, exposure levels, exposure routes) for a particular chemical, the data set used in the model was the set where the incidence is statistically significantly higher than the control for at least one test dose level and/or where the tumor incidence rate shows a statistically significant trend with respect to dose level. The data set generating the highest lifetime cancer risk estimate (q_1^*) was chosen where appropriate. An example of an inappropriate data set would be a set which generates an artifactually high risk estimate because of a very small number of animals used. If there are 2 or more data sets of comparable size for a particular chemical that are identical with respect to species, strain, sex and tumor sites, the geometric mean of q_1^* estimated from each of those data sets was used for risk estimation. U.S. EPA assumed that mg/surface area/day is an equivalent dose between species. Surface area was further assumed to be proportional to the 2/3 power of the weight of the animal in question. Equivalent dose was therefore computed using the following relationship:

$$d = \frac{l_e * m}{L_e * W^{2/3}}$$

where L_e = experimental duration, l_e = exposure duration, m = average dose (mg/day) and W = average animal weight. Default average body weights for humans, rats and mice are 70, 0.35 and 0.03 kg, respectively.

Exposure data expressed as ppm in the diet were generally converted to mg/day using the relationship m = ppm * F * r, where ppm is parts per million of the chemical in the diet, F is the weight of the food consumed per day in kg, and r is the absorption fraction (assumed to be 1 in the absence of data indicating otherwise). The weight of food consumed, calories required, and animal surface area were generally all considered to be proportional to the 2/3 power of the animal weight, so:

$$m \propto \text{ppm} * W^{2/3} * r, \text{ or } \quad \frac{m}{r W^{2/3}} \propto \text{ppm}$$

The relationship could lead to the assumption that dietary ppm is an equivalent exposure between species. However, U.S. EPA did not believe that this assumption is justified, since the calories/kg food consumed by humans is significantly different from that consumed by laboratory animals (primarily due to differences in moisture content). An empirically derived food factor, $f = F/W$

was used, which is the fraction of a species' body weight consumed per day as food. U.S. EPA (1986) gave the *f* values for humans, rats and mice as 0.028, 0.05 and 0.13, respectively.

Dietary exposures expressed as concentrations in ppm were converted to mg/surface area using the following relationship:

$$\frac{m}{r * W^{2/3}} = \frac{\text{ppm} * F}{W^{2/3}} = \frac{\text{ppm} * f * W}{W^{2/3}} = \text{ppm} * f * W^{2/3}$$

Exposures expressed as mg/kg/day ($m/Wr = s$) were converted to mg/surface area using the relationship:

$$\frac{m}{rW^{2/3}} = s * W^{2/3}$$

The calculation of dose when exposure is via inhalation was performed for cases where 1) the chemical is either a completely water-soluble gas or aerosol and is absorbed proportionally to the amount of inspired air, or 2) where the chemical is a partly water-soluble gas which reaches an equilibrium between the inspired air and body compartments. After equilibrium is attained, the rate of absorption is proportional to metabolic rate, which is proportional to the rate of oxygen consumption, which is related to surface area.

Exposure expressed as mg/day to completely water-soluble gas or aerosols can be calculated using the expression $m = I * v * r$, where I is the inspiration rate/day in m^3, v is the concentration of the chemical in air (mg/m^3), and r is the absorption fraction (assumed to be the same for all species in the absence of data to the contrary; usually 1). For humans, the default inspiration rate of 20 m^3 has been adopted. Inspiration rates for 113 g rats and 25 g mice have been reported to be 105 and 34.5 liters/day, respectively. Surface area proportionality can be used to determine inspiration rate for rats and mice of other weights; for mice, $I = 0.0345\ (W / 0.025)^{2/3}$ m^3/day; for rats, $I = 0.105\ (W / 0.113)^{2/3}$ m^3/day. The empirical factors for air intake/kg/day (i) for humans, rats and mice are 0.29, 0.64 and 1.3, respectively. Equivalent exposures in mg/surface area can be calculated using the relationship:

$$\frac{m}{W^{2/3}} = \frac{Ivr}{W^{2/3}} = \frac{iWvr}{W^{2/3}} = iW^{1/3}vr$$

Exposure expressed as mg/day to partly water-soluble gases is proportional to surface area and to the solubility of the gas in body fluids (expressed as an absorption coefficient r for that gas). Equivalent exposures in mg/surface area can be calculated using the relationships $m = kW^{2/3} * v * r$, and $d = m/W^{2/3} = kvr$. The further assumption is made that in the case of route-to-route extrapolations (*e.g.*, where animal exposure is via the oral route, and human exposure is via inhalation, or vice versa), unless pharmacokinetic data to the contrary exist, absorption is equal by either exposure route.

Adjustments were made for experimental exposure durations shorter than the lifetime of the test animal; the slope q_1^* was increased by the factor $(L/L_e)^3$, where L is the normal lifespan of the experimental animal and L_e is the duration of the experiment. This assumed that if the average dose d is continued, the age-specific rate of cancer will continue to increase as a constant function of the background rate. Since age-specific rates for humans increase by at least the 2nd power of the age, and often by a considerably higher power (Doll, 1971), there is an expectation that the cumulative tumor rate, and therefore q_1^*, will increase by at least the 3rd power of age. If the slope q_1^* is calculated at age L_e, it would be expected that if the experiment was continued for the full lifespan L at the same average dose, the slope q_1^* would have been increased by at least $(L/L_e)^3$.

U.S. EPA Calculation of Carcinogenic Potency Based on Human Data

U.S. EPA stated that existing human epidemiologic studies with sufficiently valid exposure characterization are always used in evaluating the cancer potency of a chemical. If they showed a carcinogenic effect, the data were analyzed to provide an estimate of the linear dependence of cancer rates on lifetime cancer dose (equivalent to the factor q_1^*). If no carcinogenic effect was demonstrated and carcinogenicity had been demonstrated in animals, then it was assumed that a risk does exist, but it is smaller than could have been observed in the epidemiologic study. An upper limit of cancer incidence was calculated assuming that the true incidence is just below the level of detection in the cohort studied, which is largely determined by the cohort size. Whenever possible, human data are used in preference to animal data. In human epidemiologic studies, the response is measured as the relative risk of the exposed cohort of individuals compared to the control group. The excess risk ($R(X)$ - 1, where $R(X)$ is relative risk) was assumed to be proportional to the lifetime average exposure X, and to be the same for all ages. The carcinogenic potency is then equal to $[R(X) - 1]/X$ multiplied by the lifetime risk at that site in the general population. According to this original procedure, the confidence limit for the excess risk was not usually calculated. This decision was ascribed to the difficulty in accounting for inherent uncertainty in the exposure and cancer response data. More recent assessments have taken the opposite view and attempted to calculate and characterize this uncertainty by determining confidence limits, *inter alia*.

Guidelines for Carcinogen Risk Assessment (U.S. EPA, 2005a)

U.S. EPA revised its "Guidelines for Carcinogen Risk Assessment" (referred to henceforth as the "U.S. EPA Guidelines") in 2005. Compared to the 1986 version of this document, more emphasis is placed on establishing a "mode of action" (MOA). The following excerpt provides a definition of this term:

> "The term "mode of action" is defined as a sequence of key events and processes, starting with interaction of an agent with a cell, proceeding through operational and anatomical changes, and resulting in cancer formation. A "key event" is an empirically observable precursor step that is itself a necessary element of the mode of action or is a biologically based marker for such an element. Mode of action is contrasted with "mechanism of action," which implies a more detailed understanding and description of events, often at the molecular level, than is meant by mode of action".

Cancer risk assessments performed under the prior U.S. EPA Guidelines sometimes included a MOA description. However, the 1986 U.S. EPA Guidelines did not explicitly mandate the development of a MOA description in cancer risk assessments.

The MOA information is then used to govern how a cancer risk assessment shall proceed. Tumor incidence data sets arising from a MOA judged to be not relevant to humans are not used to extrapolate a cancer potency factor. If an MOA cannot be determined or is determined to have a low-dose linear dose-response and a nonmutagenic MOA, then a linear extrapolation method is used to develop a cancer potency factor. The same linear extrapolation is used for all lifestages, unless chemical specific information on lifestage or population sensitivity is available. Carcinogens that act via an MOA judged to have a nonlinear low-dose dose response are modeled using MOA data, or the RfD/RfC risk assessment method is used as a default. Adjustments for susceptible lifestages or populations are to be performed as part of the risk assessment process.

If a carcinogen is deemed to act via a mutagenic MOA, then the data from the MOA analysis is evaluated to determine if chemical-specific differences between adults and juveniles exist and can be used to develop a chemical-specific risk estimate incorporating lifestage susceptibility. If this cannot be done, then early-life susceptibility is assumed, and age-dependent adjustment factors (ADAFs) are applied as appropriate to develop risk estimates. In cases where it is not possible to develop a toxicokinetic model to perform cross-species scaling of animal tumor data sets which arise from oral exposures, the U.S. EPA Guidelines state that administered doses should be scaled from animals to humans on the basis of equivalence of $mg/kg^{3/4}$-d (milligrams of the agent normalized by the 3/4 power of body weight per day). This is a departure from the 1986 U.S. EPA guidelines, which used a 2/3 power of body weight normalization factor. Other adjustments for dose timing, duration and route are generally assumed to be handled in similar fashion to that described for the 1986 guidelines, although of course updated parameter values would be used where available.

The 2005 U.S. EPA Guidelines also use benchmark dose methodology (described above, page 27) to develop a "point-of departure" (POD) from tumor incidence data. For linear extrapolation, the POD is used to calculate a cancer potency factor, and for nonlinear extrapolation the POD is used in the calculation of a reference dose (RfD) or reference concentration (RfC).

It should be noted that none of the cancer potency factors listed in this document were obtained from U.S. EPA risk assessments performed under the 2005 U.S. EPA Guidelines. All U.S. EPA IRIS cancer potency values contained in this document were obtained from risk assessments using the 1986 U.S. EPA Guidelines.

Office of Environmental Health Hazard Assessment (OEHHA), California Environmental Protection Agency

The cancer risk assessment procedures originally used by the Office of Environmental Health Hazard Assessment (OEHHA) are outlined in "Guidelines for Chemical Carcinogen Risk Assessments and their Scientific Rationale" (referred to below as the Guidelines) (CDHS, 1985). These procedures were generally used in generating Toxic Air Contaminant (TAC) cancer potency values, standard Proposition 65 cancer potency values and Public Health Goal (PHG) cancer

potency values. Expedited Proposition 65 cancer potency values depart somewhat from those procedures and are discussed separately below.

OEHHA cancer risk assessment methodology as described by CDHS (1985) generally resembled that used at that time by U.S. EPA (Anderson *et al*., 1983; U.S. EPA, 1986). OEHHA risk assessment practice similarly reflects the evolution of the technical methodology (*e.g.*, as described in U.S. EPA, 2005a) since the original guidelines were published. The basic principles and procedures described below are still considered applicable. More recent additions to OEHHA cancer risk assessment methods such as the use of benchmark dose methodologies and early-lifestage cancer potency adjustments are discussed above. The Guidelines state that both animal and human data, when available, should be part of the dose-response assessment.

OEHHA Calculation of Carcinogenic Potency Based on Animal Data

The procedures used to extrapolate low-dose human cancer risk from animal carcinogenicity data assumed that a carcinogenic change induced in a cell is transmitted to successive generations of cell descendants, and that the initial change in the cell is an alteration (*e.g.*, mutation, rearrangement, etc.) in the cellular DNA. Non-threshold models are used to extrapolate to low-dose human cancer risk from animal carcinogenicity data.

Several models were proposed for extrapolating low-dose human cancer risk from animal carcinogenicity data in the original Guidelines. These models include the Mantel-Bryan method (log-probit model), the one-hit model, the linearized multistage procedure, the gamma multihit model, and a number of time-to-tumor models. The Guidelines stated that time-to-tumor models (i.e., a Weibull-in-time model) should be used for low-dose extrapolation in all cases where supporting data are available, particularly when survival is poor due to competing toxicity. However, the Guidelines also noted the difficulty of determining the actual response times in an experiment. Internal tumors are generally difficult to detect in live animals and their presence is usually detected only at necropsy. Additionally, use of these models often requires making the determination of whether a tumor was the cause of death, or was found only coincidentally at necropsy when death was due to other causes. Further, competing causes of death, such as chemical toxicity, may decrease the observed time-to-tumor for nonlethal cancers by allowing earlier necropsy of animals in higher dose groups. The linearized multistage (LMS) procedure was noted as being an appropriate method for dose extrapolation in most cases, with the primary exception being a situation in which sufficient empirical data are available to indicate a dose-response curve of a "quasi-threshold" type (*e.g.*, flat for two or three dose levels, then curving sharply upwards). In this case, the LMS procedure may underestimate the number of stages and overestimate the low-dose risks. In this case, the gamma multihit model was suggested as being a potential alternative. The Mantel-Bryan model was described as having little biological basis as applied to carcinogenesis, and being likely to underestimate risks at low doses. The Guidelines stated that this model should not be used for low dose extrapolation. More recent practice has departed from these original guidelines in some respects, for instance by experimenting with cell-proliferation based models in a few cases. However, the LMS model remained the preferred extrapolation model for most purposes. Some of the difficulties in achieving a satisfactory fit to tumor incidence data were found to be alleviated by application of toxicokinetic models and use of an internal rather than applied dose metric with the LMS model. This has resulted in the alternative models originally advocated (Gamma multihit, Mantel-Bryan) being mostly

abandoned. As noted above (Dose-Response Assessment, page 23), the use of allegedly biologically based statistical models such as LMS has fallen from favor in recent years, and benchmark dose methodology has become the preferred method for extrapolating cancer potency values from animal cancer incidence data. However, it should also be noted that results generated by the LMS model and benchmark dose methodology from the same data set are often quite similar.

The 1985 Guidelines stated that both animal and human data, when available, should be part of the dose-response assessment. Although preference was given to human data when these were of adequate quality, animal studies may provide important supporting evidence. Low-dose extrapolation of human cancer risk from animal carcinogenicity data was generally based on the most sensitive site, species and study demonstrating carcinogenicity of a particular chemical, unless other evidence indicates that the data set in question is not appropriate for use. Where both benign and malignant tumors are induced at the same site and the benign tumors are considered to have the potential to progress to malignant tumors, the incidence data for both types of tumors could be combined to form the basis for risk assessment. Pharmacokinetic data on chemical metabolism, effective dose at target site, or species differences between laboratory test animals and humans were considered in dose-response assessments when available. In performing exposure scaling from animals to humans, the "surface area" correction (correcting by the 2/3 power of body weight) was used unless specific data indicate that this should not be done. The Guidelines assumed that in the absence of evidence to the contrary, chemicals that cause cancer after exposure by ingestion will also cause cancer after exposure by inhalation, and vice versa. These original proposals have continued in use with little change except that currently, TAC and PHG cancer potency factor calculations use a 3/4 power of body weight correction for interspecies scaling, in line with current U.S. EPA practice. The standard Proposition 65 cancer potency factor calculations still use a 2/3 power correction because the cancer potency calculation method is specified in regulation (California Health and Safety Code 25249.5 *et seq*.).

Cancer unit risk factors [in units of $(\mu g/m^3)^{-1}$] have been calculated from cancer potency factors [in units of $(mg/kg\text{-}day)^{-1}$] using the following relationship:

$$UR = \frac{CPF * 20\ m^3}{70\ kg\ *\ CV}$$

where UR is the cancer unit risk, CPF is the cancer potency factor, 70 kg is the reference human body weight, 20 m^3 is the reference human inspiration rate/day, and CV is the conversion factor from mg to µg (= 1000). The cancer unit risk describes the excess cancer risk associated with an inhalation exposure to a concentration of 1 $\mu g/m^3$ of a given chemical; the cancer potency factor describes the excess cancer risk associated with exposure to 1 mg of a given chemical per kilogram of body weight.

It should be noted that although this default method is still used in deriving published cancer unit risk values, for site-specific risk assessments age-appropriate distributions and percentile values are used in the current version of the Hot Spots exposure assessment document. Where exposure to children occurs (as it does in most exposures to the general population surrounding a source

site) it is also necessary to apply the age-specific adjustment factors for the appropriate durations in accordance with the guidance offered above (Page 30 *et seq.*).

OEHHA Calculation of Carcinogenic Potency Based on Human Data

Human epidemiologic studies with adequate exposure characterization are used to evaluate the cancer potency of a chemical. If they show a carcinogenic effect, the data are analyzed to provide an estimate of the linear dependence of cancer rates on lifetime cancer dose. The 1985 Guidelines stated that with continuous exposure, age-specific incidence continues to increase as a power function (*e.g.*, t^3 or t^4) of the elapsed time since initial exposure. Lifetime risks can be estimated by applying such a power function to the observed data and extrapolating beyond the actual followup period. OEHHA has generally undertaken the calculation of study power and confidence bounds on the potency estimate as important tools to establish the credibility of the estimate obtained and in comparing this with other estimates (from other human studies or from animal data). Due to the diversity in quality and type of epidemiological data, the specific approaches used in OEHHA risk assessments based on human epidemiologic studies vary on a case by case basis rather than following explicit general guidelines. Examples of the methods used can be observed in the Toxic Air Contaminant documents (these documents are listed in Appendix D: the methods used are described in the compound summaries provided in Appendix B).

Expedited Proposition 65 Cancer Risk Assessment Methodology

Expedited cancer potency values developed for several agents listed as carcinogens under Proposition 65 (California Health and Safety Code 25249.5 *et seq*.) were derived from selected animal carcinogenicity data sets of the Carcinogenic Potency Database (CPDB) of Gold *et al.* (1984, 1986, 1987, 1989, 1990, 1997) using default procedures specified in the administrative regulations for Proposition 65 (Title 22 California Code of Regulations [CCR] 12703). OEHHA hazard assessments usually describe all relevant data on the carcinogenicity (including dose-response characteristics) of the chemical under examination, followed by an evaluation of any pharmacokinetic and mechanistic (*e.g.*, genotoxicity) data. An evaluation of the data set for the chemical may indicate that adjustments in target dose estimates or use of a dose response model different from the default are appropriate. The procedure used to derive expedited Proposition 65 cancer potency values differs from the usual methodology in two ways. First, it relies on cancer dose response data evaluated and extracted from the original literature by Gold *et al.* Second, the choice of a linearized multistage procedure for generating cancer potency values is automatic, and pharmacokinetic adjustments are not performed. The methods used to develop expedited cancer potency values incorporate the following assumptions:

1. The dose response relationship for carcinogenic effects in the most sensitive species tested is representative of that in humans.
2. Observed experimental results can be extrapolated across species by use of the interspecies factor based on "surface area scaling."
3. The dose to the tissue giving rise to a tumor is assumed to be proportional to the administered dose.
4. The linearized multistage polynomial procedure can be used to extrapolate potency outside the range of experimental observations to yield estimates of "low" dose potency.

5. Cancer risk increases with the third power of age.

The Carcinogenic Potency Database of Gold *et al.* (1984, 1986, 1987, 1989, 1990) contains the results of more than 4000 chronic laboratory animal experiments on 1050 chemicals by combining published literature with the results of Federal chemical testing programs (Technical Reports from the Carcinogenesis Bioassay Program of the National Cancer Institute (NCI)/National Toxicology Program (NTP) published prior to June 1987). The published literature was searched (Gold *et al*., 1984) through the period December 1986 for carcinogenicity bioassays; the search included the Public Health Service publication "Survey of Compounds Which Have Been Tested for Carcinogenic Activity" (1948-1973 and 1978), monographs on chemical carcinogens prepared by the International Agency for Research on Cancer (IARC) and Current Contents. Also searched were Carcinogenesis Abstracts and the following journals: British Journal of Cancer, Cancer Letters, Cancer Research, Carcinogenesis, Chemosphere, Environmental Health Perspectives, European Journal of Cancer, Food and Chemical Toxicology, Gann, International Journal of Cancer, Journal of Cancer Research and Clinical Oncology (formerly Zeitschrift fur Krebsforschung und Klinische Onkologie), Journal of Environmental Pathology and Toxicology, Journal of Toxicology and Environmental Health, Journal of the National Cancer Institute, and Toxicology and Applied Pharmacology. Studies were included in the database if they met the following conditions:

1. The test animals were mammals.
2. Chemical exposure was started early in life (100 days of age or less for hamsters, mice and rats).
3. Route of administration was via the diet, drinking water, gavage, inhalation, intravenous injection or intraperitoneal injection.
4. The test chemical was administered alone (not in combination with other chemicals).
5. Chemical exposure was chronic (*i.e*. duration of exposure was at least one-fourth the standard lifespan for that species), with not more than 7 days between exposures.
6. The experiment duration was at least half the standard lifespan for the species used.
7. The study design included a control group and at least 5 animals/exposure group.
8. No surgical interventions were performed.
9. Pathology data were reported for the number of animals with tumors (not total number of tumors).
10. All results reported were original data (not analysis of data reported by other authors).

Included in their data set tabulations are estimates of average doses used in the bioassay, resulting tumor incidences for each of the dose levels employed for sites where significant responses were observed, dosing period, length of study and histopathology. Average daily dose levels were calculated assuming 100% absorption. Dose calculations follow procedures similar to those of Cal/EPA and U.S. EPA; details on methods used and standard values for animal lifespans, body weights, and diet, water and air intake are listed in Gold *et al.* (1984). OEHHA (1992) reviewed the quality assurance, literature review, and control procedures used in compiling the data and found them to be sufficient for use in an expedited procedure. Cancer potency estimates were

derived by applying the mathematical approach described in the section below to dose response data in the Gold *et al.* database.

The following criteria were used for data selection:

1. Data sets with statistically significant increases in cancer incidence with dose ($p \leq 0.05$) were used. (If the authors of the bioassay report considered a statistically significant result to be unrelated to the exposure to the carcinogen, the associated data set was not used.)
2. Data sets were not selected if the endpoint was specified as "all tumor-bearing animals" or results were from a combination of unrelated tissues and tumors.
3. When several studies were available, and one study stood out as being of higher quality due to numbers of dose groups, magnitude of the dose applied, duration of study, or other factors, the higher quality study was chosen as the basis for potency calculation if study results were consistent with those of the other bioassays listed.
4. When there were multiple studies of similar quality in the sensitive species, the geometric mean of potencies derived from these studies was taken. If the same experimentalists tested two sexes of the same species/strain under the same laboratory conditions, and no other adequate studies were available for that species, the data set for the more sensitive sex was selected.
5. Potency was derived from data sets that tabulate malignant tumors, combined malignant and benign tumors, or tumors that would have likely progressed to malignancy.

Cancer potency was defined as the slope of the dose response curve at low doses. Following the default approach, this slope was estimated from the dose response data collected at high doses and assumed to hold at very low doses. The Crump linearized multistage polynomial (Crump *et al.*, 1977) was fit to animal bioassay data:

$$\text{Probability of cancer} = 1 - \exp[-(q_0 + q_1 d + q_2 d^2 + ...)]$$

Cancer potency was estimated from the upper 95% confidence bound on the linear coefficient q_1, which is termed q_1^*.

For a given chemical, the model was fit to a number of data sets. As discussed in the section above, the default was to select the data for the most sensitive target organ in the most sensitive species and sex, unless data indicated that this was inappropriate. Deviations from this default occur, for example, when there are several bioassays or large differences exist between potency values calculated from available data sets.

Carcinogenicity bioassays using mice and/or rats will often use an exposure duration of approximately two years. For standard risk assessments, this is the assumed lifespan for these species. Animals in experiments of shorter duration are at a lower risk of developing tumors than those in the standard bioassay; thus potency is underestimated unless an adjustment for experimental duration is made. In estimating potency, short duration of an experiment was taken into account by multiplying q_1^* by a correction factor equal to the cube of the ratio of the assumed standard lifespan of the animal to the duration of the experiment (T_e). This assumes that the cancer hazard would have increased with the third power of the age of the animals had they lived longer:

$$q_{animal} = q_1^* * (104 \text{ weeks}/T_e)^3$$

In some cases excess mortality may occur during a bioassay, and the number of initial animals subject to late occurring tumors may be significantly reduced. In such situations, the above described procedure can, at times, significantly underestimate potency. A time-dependent model fit to individual animal data (i.e., the data set with the tumor status and time of death for each animal under study) may provide better potency estimates. When Gold *et al.* indicated that survival was poor for a selected data set, a time-dependent analysis was attempted if the required data were available in the Tox Risk (Crump *et al.*, 1991) data base. The Weibull multistage model (Weibull-in-time; multistage-in-dose) was fit to the individual animal data.

To estimate human cancer potency, q_{animal} values derived from bioassay data were multiplied by an interspecies scaling factor (K; the ratio of human body weight (bw_h) to test animal body weight (bw_a), taken to the 1/3 power (Anderson *et al.*, 1983)):

$$K = (bw_h/bw_a)^{1/3}$$

Thus, cancer potency = $q_{human} = K * q_{animal}$

Chemical-specific Descriptions of Cancer Potency Value Derivations

Unit Risk and potency values for chemicals whose cancer potency values were obtained from Toxic Air Contaminant documents, standard or expedited Proposition 65 documents, U.S. EPA's Integrated Risk Information System (IRIS) documents and Health Effects Assessment Summary Table (HEAST) entries, or from other documents prepared by OEHHA's Air Toxicology and Epidemiology Branch or Pesticide and Environmental Toxicology Branch are presented in Appendix A. Information summaries for these chemicals are presented in Appendix B.

REFERENCES

Allegaert K, Verbesselt R, Rayyan M, Debeer A, de Hoon J (2007). Urinary metabolites to assess in vivo ontogeny of hepatic drug metabolism in early neonatal life. Methods Find Exp Clin Pharmacol 29(4):251-6.

Anderson EL and the Carcinogen Assessment Group of the U.S. Environmental Protection Agency (1983). Quantitative approaches in use to assess cancer risk. Risk Anal 3:277-295.

Anderson LM, Diwan BA, Fear NT, Roman E. (2000). Critical windows of exposure for children's health: Cancer in human epidemiological studies and neoplasms in animal models. Environ Health Perspect 108 (Suppl3):573-94.

Armitage P, Doll R. (1954). The age distribution of cancer and a multistage theory of carcinogenesis. Br J Cancer 8(1): 1-12.

Barone S Jr, Das KP, Lassiter LT, White LD. (2000). Vulnerable processes of nervous system development: a review of markers and methods. NeuroTox 21:15-36.

Barrett JC, Wiseman RW (1987). Cellular and molecular mechanisms of multistep carcinogenesis: relevance to carcinogen risk assessment. Environ Health Perspect 76:65-70.

Barton HA, Cogliano VJ, Flowers L, Valcovic L, Setzer RW, Woodruff TJ (2005). Assessing susceptibility from early-life exposure to carcinogens. Environ Health Perspect 113:1125-1133.

Bayer SA, Altman J, Russo RJ, Zhang X (1993) Timetables of neurogenesis in the human brain based on experimentally determined patterns in the rat. Neurotoxicology 14:83-144.

Benya TJ, Busey WM, Dorato MA, Berteau PE (1982). Inhalation carcinogenicity bioassay of vinyl bromide in rats. Toxicol Appl Pharmacol 64:367-379.

Bogen KT, Spear RC (1987). Integrating uncertainty and inter-individual variability in environmental risk assessment. Risk Anal 7:427-436.

Bogen KT, Witschi HP (2002). Lung tumors in A/J mice exposed to environmental tobacco smoke: estimated potency and implied human risk. Carcinogenesis 23:511-519.

Bogen KT (1994). Cancer potencies of heterocyclic amines found in cooked foods. Food Chem Toxicol 32: 505-515.

Bois FY, Gelman A, Jiang J, Maszle DR, Zeise L, Alexeeff G (1996). Population toxicokinetics of tetrachloroethylene. Arch Toxicol 70:347-55.

Bradford Hill A. 1971. Statistical evidence and inference. In: Principles of Medical Statistics, 9th ed., pp. 309-323. Oxford University Press, New York, NY.

California Department of Health Services (CDHS) (1985). Guidelines for Chemical Carcinogen Risk Assessments and Their Scientific Rationale. CDHS, Health and Welfare Agency, Sacramento, CA.

California Environmental Protection Agency (Cal/EPA) (1992). Expedited Cancer Potency Values and Proposed Regulatory Levels for Certain Proposition 65 Carcinogens. Office of Environmental Health Hazard Assessment, Reproductive and Cancer Hazard Assessment Section, Berkeley, CA.

Cresteil T (1998). Onset of xenobiotic metabolism in children: toxicological implications. Food Addit Contam 15 Suppl:45-51.

Crouch E, Wilson R (1979). Interspecies comparison of carcinogenic potency. J Toxicol Environ Health 5:1095-1118.

Crouch E (1992). MSTAGE (Version 1.1). E.A.C. Crouch, Cambridge Environmental Inc., 58 Buena Vista Road, Arlington, Massachusetts 02141.

Crump KS, Watson WW (1979). GLOBAL79: A FORTRAN program to extrapolate dichotomous animal carcinogenicity data to low doses. National Institute of Environmental Health Sciences, Contract No. 1-ES-2123.

Crump KS, Guess HA, Deal LL (1987). Confidence intervals and test of hypotheses concerning dose response relations inferred from animal carcinogenicity data. Biometrics 33:437-451.

Crump KS, Howe RB, Van Landingham C, Fuller WG (1991). TOXRISK Version 3. TOXicology RISK Assessment Program. KS Crump Division, Clement International Division, 1201 Gaines Street, Ruston LA 71270.

Crump KS (1980). An improved procedure for low-dose carcinogenic risk assessment from animal data. J Environ Pathol Toxicol 5:675-684.

Crump KS (1984). A new method for determining allowable daily intakes. Fundam Appl Toxicol 4:854-871.

Crump KS (1995). Calculation of benchmark doses from continuous data. Risk Anal 15:78-89.

Crump KS (2002). Critical issues in benchmark calculations from continuous data. Crit Rev Toxicol 32:133-153.

Dietert RR, Etzel RA, Chen D, Halonen M, Holladay SD, Jarabek AM, Landreth K, Peden DB, Pinkerton K, Smialowicz RJ, Zoetis T (2000). Workshop to identify critical windows of exposure for children's health: immune and respiratory systems work group summary. Environ Health Perspect (Suppl 3):483-90.

Doll R (1971). Weibull distribution of cancer: implications for models of carcinogenesis. J Royal Stat Soc A 13:133-166.

Drew RT, Boorman GA, Haseman JK, McConnell EE, Busey WM, Moore JA (1983). The effect of age and exposure duration on cancer induction by a known carcinogen in rats, mice, and hamsters. Toxicol Appl Pharmacol 68:120-130.

Elbarbry FA, McNamara PJ, Alcorn J (2007). Ontogeny of hepatic Cyp1A2 and Cyp2E1 expression in rat. J Biochem Mol Toxicol 21(1):41-50.

ERG (2008) Summary Report of the Peer Review Meeting: EPA's Draft Framework for Determining a Mutagenic Mode of Action for Carcinogenicity. Final Report. Submitted to Risk Assessment Forum, Office of the Science Advisor, U.S. Environmental Protection Agency, Washington D.C., by Eastern Research Group. May 23, 2008.

Finkel AM (1995). Toward less misleading comparisons of uncertain risks: the example of aflatoxin and alar. Environ Health Perspect 103:376-385

Franklin J, Pluetschow A, Paus M, et al. (2006). Secondary malignancy risk associated with treatment of Hodgkin's lymphoma: meta-analysis of the randomized trials. Annals of Oncology 17:1749-60.

Freireich EJ, Gehan EA, Rall DP, Schmidt LH, Skipper HE (1966). Quantitative comparison of toxicity of anticancer agents in mouse, rat, hamster, dog, monkey, and man. Cancer Chemother Rep 50:219-244.

Garshick E, Schenker MB, Munoz A, Segal M, Smith TJ, Woskie SR, Hammond SK, Speizer FE. (1988). A retrospective cohort study of lung cancer and diesel exhaust exposure in railroad workers. Am Rev Respir Dis 137: 820-825.

Gaylor D, Ryan L, Krewski D, Zhu Y (1998). Procedures for calculating benchmark doses for health risk assessment. Regul Toxicol Pharmacol 28:150-164.

Gaylor DW, Gold LS (1994). Quick estimate of the regulatory virtually safe dose based on the maximum tolerated dose for rodent bioassays. Regul Toxicol Pharmacol 22:57-63.

Gold L, de Veciana M, Backman G, Magaw R, Lopipero P, Smith M, Blumenthal M, Levinson R, Bernstein L, Ames B (1986). Chronological supplement to the Carcinogenic Potency Database: Standardized results of animal bioassays published through December 1984 and by the National Toxicology Program through May 1986. Environ Health Perspect 74:237-329.

Gold L, Sawyer C, Magaw R, Backman G, de Veciana M, Levinson R, Hooper N, Havender W, Bernstein L, Peto R, Pike M, Ames B (1984). A Carcinogenic Potency Database of the standardized results of animal bioassays. Environ Health Perspect 58:9-319.

Gold L, Slone T, Bernstein L (1989). Summary of carcinogenic potency and positivity for 492 rodent carcinogens in the Carcinogenic Potency Database. Environ Health Perspect 79:259-272.

Gold L, Slone T, Backman G, Eisenberg S, Da Costa M, Wong M, Manley N, Ames B (1990). Third chronological supplement to the Carcinogenic Potency Database; Standardized results of animal bioassays published through December 1986 and by the National Toxicology Program through June 1987. Environ Health Perspect 84:215-285.

Gold L, Slone T, Backman G, Magaw R, Da Costa M, Ames B (1987). Second chronological supplement to the Carcinogenic Potency Database; Standardized results of animal bioassays published through December 1984 and by the National Toxicology Program through May 1986. Environ Health Perspect 74:237-329.

Gold LS, Slone TH, Manley NB, Garfinkel GB, Rohrbach L, Ames BN (1997). Carcinogenic Potency Database. In: Handbook of Carcinogenic Potency and Genotoxicity Databases, Gold LS and Zeiger E, eds. CRC Press, Boca Raton, FL, pp. 1-605.

Hakkola J, Tanaka E, Pelkonen O (1998). Developmental expression of cytochrome P450 enzymes in human liver. Pharmacol Toxicol 82(5):209-17.

Hancock SL, Tucker MA, Hoppe RT (1993). Breast cancer after treatment of Hodgkin's disease. J Natl Cancer Inst 85:25-31.

Hattis D, Goble R, Chu M (2005). Age-related differences in susceptibility to carcinogenesis. II. Approaches for application and uncerta1inty analyses for individual genetically acting carcinogens. Environ Health Perspect 113:509-16.

Hattis D, Goble R, Russ A, Chu M, Ericson J (2004). Age-related differences in susceptibility to carcinogenesis: a quantitative analysis of empirical animal bioassay data. Environ Health Perspect 112:1152-1158.

Hattis D (1990). Pharmacokinetic principles for dose-rate extrapolation of carcinogenic risk from genetically active agents. Risk Anal 10:303-16.

Herbst AL, Scully RE (1970). Adenocarcinoma of the vagina in adolescence. A report of 7 cases including 6 clear-cell carcinomas (so-called mesonephromas). Cancer 25:745-757.

Herbst AL, Ulfelder H, Poskanzer DC (1971). Adenocarcinoma of the vagina. Association of maternal stilbestrol therapy with tumor appearance in young women. N Engl J Med 284:878-881.

Hines RN, McCarver DG (2002). The ontogeny of human drug-metabolizing enzymes: Phase I oxidative enzymes. J Pharmacol Exp Ther 300(2):355-60.

Hoel DG, Kaplan NL, Anderson MW (1983). Implication of nonlinear kinetics on risk estimation in carcinogenesis. Science 219:1032-1037.

Holsapple MP, West LJ, Landreth KS (2003). Species comparison of anatomical and functional immune system development. Birth Defects Research (Part B) 68:321-34.

Howe RB, Crump KS, Van Landingham C (1986). GLOBAL86: A computer program to extrapolate quantal animal toxicity data to low doses. Clement Associates, Inc., Ruston, LA.

Huff J (1999). Long-term chemical carcinogenesis bioassays predict human cancer hazards. Issues, controversies, and uncertainties. Ann N Y Acad Sci 895:56-79.

IARC (2006). Monographs on the Evaluation of Carcinogenic Risks to Humans: Preamble. International Agency for Research on Cancer, Lyon, France. Available at: http://monographs.iarc.fr/ENG/Preamble/CurrentPreamble.pdf

Institute of Medicine (2004). Gulf War and Health: Updated literature review of Sarin. The National Academy of Sciences, National Academy Press, Washington, DC, pp 20-22. www.nap.edu

Lacroix D, Sonnier M, Moncion A, Cheron G, Cresteil T (1997). Expression of Cyp3A in the human liver - evidence that the shift between Cyp3A7 and Cyp3A4 occurs immediately after birth. Eur J Biochem. 247(2):625-34.

Lash TL, Aschengrau A (1999). Active and passive cigarette smoking and the occurrence of breast cancer. Am J Epidemiol 149:5-12.

Lilienfeld AM, Lilienfeld DE (1980). Foundations of Epidemiology. Oxford University Press, Oxford, England.

Marcus PM, Newman B, Millikan RC, Moorman PG, Baird DD, Oaguish B (2000). The association of adolescent cigarette smoking, alcoholic beverage consumption, environmental tobacco smoke, and ionizing radiation with subsequent breast cancer (United States). Cancer Causes Control 11:271-8.

Mauch PM, Kalish LA, Marcus KC, Coleman CN, Shulman LN, Krill E, Come S, Silver B, Canellos GP, Tarbell NJ (1996). Second malignancies after treatment for laporotomy staged IA-IIIB Hodgkin's disease: long-term analysis of risk factors and outcome. Blood 87:3625-32.

McConnell EE (1992). Comparative response in carcinogenesis bioassay as a function of age at first exposure. In: Guzelian P, Henry CJ, Olin SS, eds. Similarities and difference between children and adults: implications for risk assessment. ILSI Press, Washington, DC, pp. 66−67.

McDonald T, Komulainen H (2005). Carcinogenicity of the chlorination disinfection by-product MX. J Environ Sci Health Part C, 23:163–214.

McDonald T, Hoover S, Faust J, Rabovsky J, MacGregor MK, Sherman C, Sandy M, Zeise L (2003). Development of cancer potency estimates for California's Proposition 65. Poster at Society of Toxicology Annual Meeting. March 2003, Salt Lake City, UT. Abstract No. 687, Toxicol Sci 72, S-1, 142.

Monson RR (1986). Observations on the healthy worker effect. J Occup Med 28: 425-433.

Moolgavkar SH, Knudson AG Jr. (1981). Mutation and cancer: a model for human carcinogenesis. J Natl Cancer Inst 66:1037-1052.

Morabia A, Bernstein MS, Bouchardy I, Kurtz J, Morris MA (2000). Breast cancer and active and passive smoking: the role of the N-acetyltransferase 2 genotype. Am J Epidemiol 152:226-232.

Moysich KB, Menezes RJ, Michalek AM (2002). Chernobyl-related ionising radiation exposure and cancer risk: an epidemiological review. Lancet Oncol 3:269-279.

National Research Council (NRC) (1983). Risk Assessment in the Federal Government: Managing the Process. Committee on the Institutional Means for Assessment of Risks to Public Health. National Academy Press, Washington, DC.

National Research Council (NRC) (1990). Health Effects of exposure to low levels of ionizing radiation. BEIR V. Committee on the Biological Effects of Ionizing Radiation. National Academy Press, Washington, DC

National Research Council (NRC) (1994). Science and Judgment in Risk Assessment. Committee on Risk Assessment of Hazardous Air Pollutants, Board on Environmental Studies and Toxicology, Commission on Life Sciences. National Academy Press, Washington, DC.

O'Brien PC, Noller KL, Robboy SJ, Barnes AB, Kaufman RH, Tilley BC, Townsend DE (1979). Vaginal epithelial changes in young women enrolled in the National Cooperative Diethylstilbestrol Adenosis (DESAD) project. Obstet Gynecol 53:300-308.

Office of Environmental Health Hazard Assessment (OEHHA) (2001a). Prioritization of Toxic Air Contaminants Under the Children's Environmental Health Protection Act. California Environmental Protection Agency, Sacramento, CA.

Office of Environmental Health Hazard Assessment (OEHHA) (2001b). Public Health Goals for chemicals in drinking water: Tetrachloroethylene. California Environmental Protection Agency, Sacramento, CA.

Office of Environmental Health Hazard Assessment (OEHHA) (1998). Proposed Identification of Diesel Exhaust as a Toxic Air Contaminant. Part B: Health Effects. (Approved by the Scientific Review Panel April 22, 1998). California Environmental Protection Agency, Sacramento, CA.

Office of Environmental Health Hazard Assessment (OEHHA) (1992). Proposed Identification of Perchloroethylene as a Toxic Air Contaminant. Part B: Health Effects. (Approved by the Scientific Review Panel, 1991: revised 1992). California Environmental Protection Agency, Sacramento, CA.

Office of Environmental Health Hazard Assessment (OEHHA) (2005a). Air Toxics Hot Spots Program Risk Assessment Guidelines. Part II: Technical Support Document for Describing Available Cancer Potency Factors. California Environmental Protection Agency, Sacramento, CA.

Office of Environmental Health Hazard Assessment (OEHHA) (2005b). Proposed Identification of Environmental Tobacco Smoke as a Toxic Air Contaminant. Part B: Health Effects. As approved by the Scientific Review Panel, June 24, 2005. California Environmental Protection Agency, Sacramento, CA.

Pinkerton KE, Joad JP (2000). The mammalian respiratory system and critical windows of exposure for children's health. Environ Health Perspect 108 (Suppl3):457-62.

Preston-Martin S (1989). Epidemiological studies of perinatal carcinogenesis. IARC Sci Publ 96:289-314.

Rice D, Barone S Jr. (2000). Critical periods of vulnerability for the developing nervous system: evidence from humans and animal models. Environ Health Perspect 108 (suppl3):511-33.

Rothman K, Greenland S (1998). Modern Epidemiology. 2nd edition. Lippincott–Raven, Philadelphia, PA, pp. 133-134.

Rothman KJ, Greenland S (2005). Causation and causal inference in epidemiology. Am J Public Health 95 Suppl1:S144-S150.

Salmon AG, Monserrat L, Brown JP (1992). Use of a pharmacokinetic model in cancer risk assessment for vinyl bromide. Presented at the Society of Toxicology Annual Meeting, Seattle, WA, February 1992. Abstract: The Toxicologist 12(1): 96.

Shimada T, Yamazaki H, Mimura M, Wakamiya N, Ueng YF, Guengerich FP, Inui Y (1996). Characterization of microsomal cytochrome P-450 enzymes involved in the oxidation of xenobiotic chemicals in human fetal liver and adult lungs. Drug Metab Dispos 24(5):515-22.

Smith AH, Marshall G, Yuan Y, Ferreccio C, Liaw J, von Ehrenstein O, Steinmaus C, Bates MN, Selvin S (2006). Increased mortality from lung cancer and bronchiectasis in young adults after exposure to arsenic in utero and in early childhood. Environ Health Perspect 114:1293-1296.

Swerdlow AJ, Barber JA, Vaughan Hudson G, Cunningham D, Gupta RK, Hancock BW, Horwich A, Lister TA, Linch DC (2000). Risk of second malignancy after Hodgkin's disease in a collaborative British cohort: the relation to age at treatment. J Clin Oncology 18:498-509.

Travis CC,White RK (1988). Interspecific scaling of toxicity data. Risk Anal 8:119-125.

Treluyer JM, Gueret G, Cheron G, Sonnier M, Cresteil T (1997). Developmental expression of Cyp2C and Cyp2C-dependent activities in the human liver: in-vivo/in-vitro correlation and inducibility. Pharmacogenetics 7(6):441-52.

U.S. Dept. of Health and Human Services (U.S. DHHS) (1982). The health consequences of smoking: Cancer. A Report of the Surgeon General. United States Department of Health and Human Services. Pub No (PHS) 82-50179. Washington DC.

U.S. Dept. of Health and Human Services (U.S. DHHS) (1994). The health consequences of smoking: a report of the Surgeon General. Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, Washington, DC.

U.S. Environmental Protection Agency (U.S. EPA) (1986). Guidelines for Carcinogen Risk Assessment. Federal Register 51:33992-34003.

U.S. Environmental Protection Agency (U.S. EPA) (1994). Estimating Radiogenic Cancer Risks. EPA 402-R-93-076. U.S. Environmental Protection Agency Washington, DC, June 1994.

U.S. Environmental Protection Agency (U.S. EPA) (1999). Cancer Risk Coefficients for Environmental Exposure to Radionuclides. Federal Guidance Report No. 13. EPA 402-R-99-001. Environmental Protection Agency, Office of Radiation and Indoor Air. Washington, DC, September 1999.

U.S. Environmental Protection Agency (U.S. EPA) (2002). A review of the reference dose and reference concentration process. Risk Assessment Forum, Washington, DC. EPA/630/P-02/002F. Available from: http://cfpub.epa.gov/ncea/raf/recordisplay.cfm?deid=55365.

U.S. Environmental Protection Agency (U.S. EPA) (2005a). Guidelines for Carcinogen Risk Assessment. Risk Assessment Forum, Washington, DC. EPA/630/P-03/001F.

U.S. Environmental Protection Agency (U.S. EPA) (2005b). Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens. EPA/630/R-03/003F. Available from: http://www.epa.gov/iris/children032505.pdf.

Van Landingham CB, Allen BC, Shipp AM, Crump KS (2001). Comparison of the EU T25 single point estimate method with benchmark dose response modeling for estimating potency of carcinogens. Risk Anal 21:641-56.

Vieira I, Sonnier M, Cresteil T (1996). Developmental expression of Cyp2E1 in the human liver. Hypermethylation control of gene expression during the neonatal period. Eur J Biochem. 238(2):476-83.

Walthall K, Cappon GD, Hurtt ME, Zoetis T (2005). Postnatal development of the gastrointestinal system: a species comparison. Birth Defects Res Part B 74:132-56.

Watson RE, DeSesso JM, Hurtt ME, Cappon GD (2006). Postnatal growth and morphological development of the brain: a species comparison. Birth Defects Res Part B. 77:471-484.

Wen CP, Tsai SP, Gibson RL (1983). Anatomy of the healthy worker effect: A critical review. J Occup Med 25: 283-289.

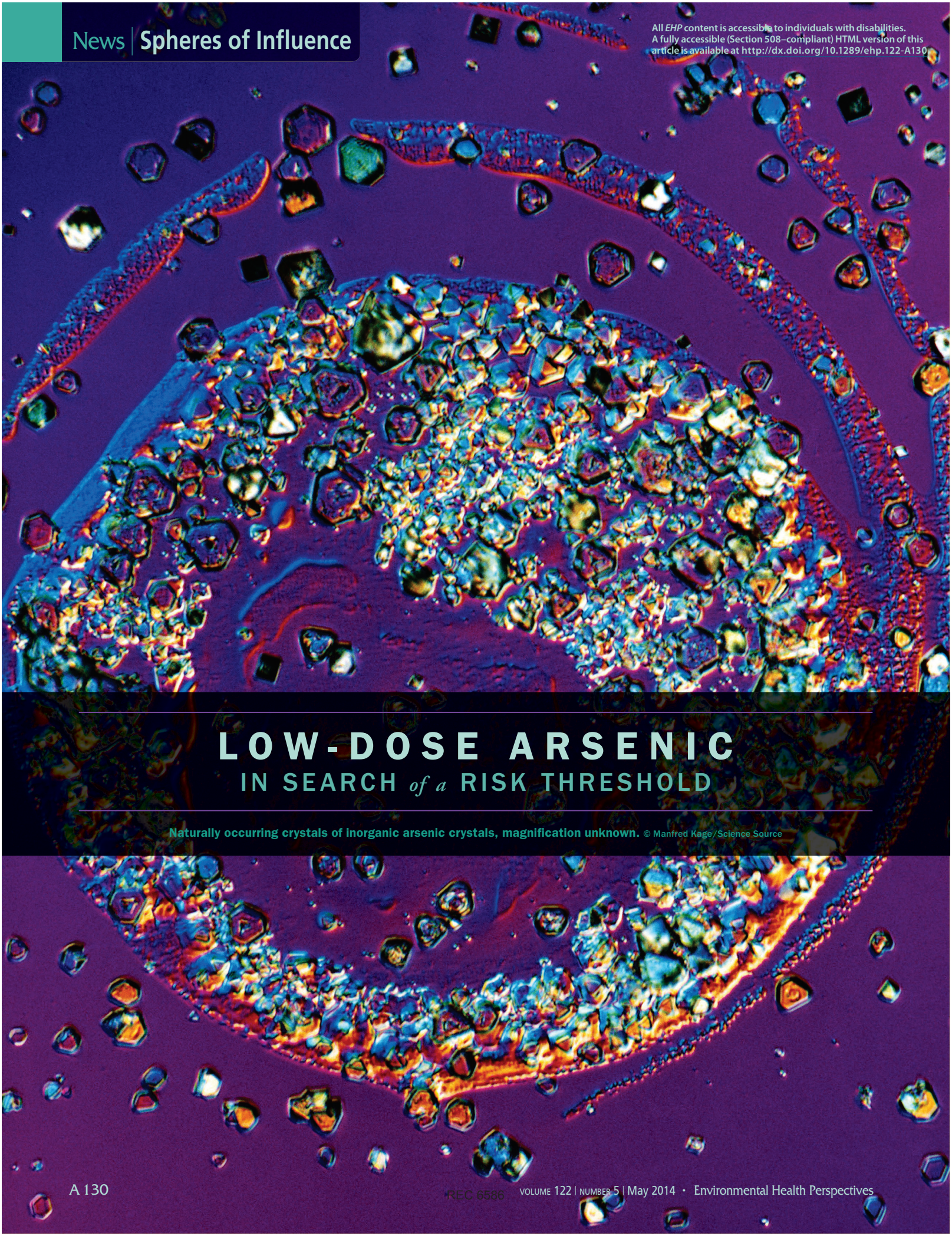
Wiencke JK, Thurston SW, Kelsey KT, Varkonyi A, Wain JC, Mark EJ, Christiani DC (1999). Early age at smoking and tobacco carcinogen DNA damage in the lung. J Natl Cancer Inst 91:614-9.

Zeise L, Salmon AG, McDonald T, Painter P (1991). Cancer potency estimation. In: Risks of carcinogenesis from urethane exposure. Salmon AG and Zeise L, eds, CRC Press, Boca Raton, FL, pp 97-112.

Zoetis T, Hurtt ME (2003). Species comparison of anatomical and functional renal development. Birth Defects Res PartB 68:111-120.

Exhibit H

All *EHP* content is accessible to individuals with disabilities.
A fully accessible (Section 508–compliant) HTML version of this article is available at http://dx.doi.org/10.1289/ehp.122-A130.



LOW-DOSE ARSENIC
IN SEARCH *of a* RISK THRESHOLD

Naturally occurring crystals of inorganic arsenic crystals, magnification unknown. © Manfred Kage/Science Source

REC 6586

Scientists long ago linked high levels of arsenic in groundwater to cancer and other environmental illnesses, particularly in Taiwan, Bangladesh, and South America, where the contamination can often reach extraordinarily high levels of 1,000 ppb or more. Now concerns are shifting to the health effects of much lower doses such as those that many Americans live with every day.

Margaret Karagas, who directs the Children's Environmental Health and Disease Prevention Research Center at Dartmouth College, says researchers increasingly believe that arsenic risks are more widespread than previously recognized, particularly during vulnerable periods such as pregnancy and childhood. Protecting against low-level exposure is challenging, however, given that arsenic is a natural element in the Earth's crust and ubiquitous throughout the environment.

Moreover, the evidence for low-dose effects is controversial. One view holds that arsenic has a dose threshold below which exposures aren't harmful. But controversial studies in the peer-reviewed literature increasingly suggest this threshold may not exist, so that any exposure—no matter how small—could boost risks for diabetes, heart disease, immunological problems, and cancer.[1,2,3,4,5,6]

The disagreement is a problem for regulators who face mounting pressure to set or reduce standards for arsenic. The U.S. Environmental Protection Agency (EPA) is grappling with a revised estimate of arsenic carcinogenicity that, if enacted, would result in unattainable clean-up standards, according to Susan Griffin, a senior toxicologist with the EPA's Region 8 office in Denver, Colorado. The U.S. Food and Drug Administration (FDA) is also under pressure to regulate arsenic in foods, especially rice, which readily absorbs the metal as it grows, making it a top source of dietary exposure.

The focus on rice comes on the heels of a new "action level" of 10 ppb for arsenic in apple juice that was proposed by the FDA in July 2013.[7] This new value, which tightens the agency's previous "level of concern" of 23 ppb (and which has yet to be formally adopted), was motivated in part by mounting publicity over low doses of arsenic in the diet, including media-directed efforts by the public-interest group Consumers Union (CU) to raise awareness on the issue. Growing public scrutiny has put a spotlight on the complex question of how very low arsenic exposures may affect human health.

A Historical View

That arsenic can be lethal has been known since antiquity. But lethal doses of arsenic are difficult to quantify, and they depend on solubility, valence states, and other factors. The Agency for Toxic Substances and Disease Registry suggests that the minimal lethal exposure in humans ranges from 1 to 3 ppm, with death resulting from cardiovascular collapse and hypovolemic shock.[8]

Researchers didn't perceive arsenic as an environmental health threat until studies in Taiwan, and later in Chile, linked levels in groundwater with skin cancers such as squamous cell carcinoma (which is rarely fatal) and a condition called black foot disease (which affects blood vessels, leading to gangrene). Villagers were exposed to the arsenic beginning in the early twentieth century after artesian wells were drilled throughout southwestern Taiwan to avoid saltwater intrusion from shallower wells.[9] The U.S. Public Health Service aimed to protect against the arsenic-related skin problems seen in Taiwan when it set a 50-ppb standard for arsenic in drinking water in 1942, which was then adopted by the EPA in 1975.[10]

The levels deemed "low" in early environmental health research on arsenic were much higher than what's considered low today. Studies from Taiwan up to the 1980s described groundwater levels of up to 300 ppb as low, of up to 600 ppb as moderate, and values beyond that as high.[10,11] These delineations were based on a view that consuming arsenic in groundwater, while harmful, wasn't fatal in the long run.

Two pivotal studies led researchers to reconsider that point. Chien-Jen Chen, who was then a teaching assistant at the National Taiwan University College of Medicine, and colleagues showed that arsenic could, in fact, boost risks for fatal malignancies at groundwater concentrations far less than 600 ppb. Published in 1985, the first study reported statistically significant associations between chronic exposure to artesian well water in Southwestern Taiwan and elevated mortality from cancers of the lung, bladder, and other internal organs.[12,13] And in their follow-up study, Chen and colleagues reported that this relationship was dose-dependent—i.e., that cancer rates grew with higher arsenic exposure—and that mortality rates were especially high in areas where blackfoot disease also was endemic.[11]

Joseph Graziano, a professor of environmental health sciences and pharmacology at Columbia University, says Chen's data had far-reaching consequences that scientists are still grappling with today. Without evidence to the contrary, the EPA defaulted to what is still a standard regulatory assumption: namely that any exposure to a carcinogen, no matter how small, increases cancer risk to some degree. Therefore, the National Research Council (NRC) now describes arsenic levels beyond 150 ppb as high, between 150 ppb and 50 ppb as moderate, and below 50 ppb as low.[14]

But linear assumptions drive considerable risk even at low exposures. Extrapolating from high-dose human data, the NRC predicted in 1999 that the 50-ppb water standard could induce cancer in as many as 1 in 100 people.[15]

By that time, the EPA had already been engaged in technical review on arsenic for years. The agency ultimately evaluated more than 300 studies and drew on expert opinions from the NRC, the National Drinking Water Council, and its own Science Advisory Board (SAB) before it finally dropped the standard from 50 to 10 ppb in 2001[16]—a level the NRC estimated might lead to a cancer risk of approximately 1 in 300 for people exposed over a lifetime.[17] According to Craig Steinmaus, an associate adjunct professor in epidemiology at the University of California, Berkeley, School of Public Health, the EPA by necessity had to factor cost and technical feasibility as well as health into the 10-ppb drinking water standard.

Debating the Standard

The EPA's risk assumptions on arsenic were criticized by researchers who felt it was inappropriate to extrapolate low-dose effects from the high-dose Taiwanese studies. Samuel Cohen, a professor of pathology and microbiology at the University of Nebraska Medical Center, has long maintained that arsenic has a dose threshold below which exposures are not harmful. According to Cohen's own research with rodents (in addition to *in vitro* and *in vivo* studies by other researchers), arsenic is carcinogenic only at doses high enough to induce cytotoxicity followed by regenerative cell proliferation. If prolonged, he says, that mechanism can spawn tumors in the bladder, lungs, and skin.

But Cohen insists this whole process depends on the generation of reactive arsenic metabolites that, in turn, interact with sulfhydryl groups in critical cell proteins. And at minimal doses (below 10 ppb in drinking water given to experimental animals or 100 ppb in well water consumed by humans, he says), arsenic exposure doesn't generate enough reactive metabolites to induce tumor growth, suggesting that arsenic has a dose threshold. Moreover, Cohen claims that only direct reactions with DNA produce linear, nonthreshold dose responses for cancer, but according to the evidence, he says, inorganic arsenic is not DNA-reactive.[18]

"A linear dose–response line goes against what we know about arsenic's basic biology," Cohen says. "What we show in the lab shows there must be a threshold phenomenon."

Other scientists disagree. Steinmaus, for instance, counters that rodents may not be good models for human arsenic metabolism given that "they don't get cancer at doses that clearly cause cancer in humans." He says, "You need to interpret those data cautiously."

Moreover, high-dose human data from Taiwan are valuable because they remove some of the uncertainty associated with

Arsenic in U.S. Private Wells

Despite the 10-ppb upper limit on inorganic arsenic in municipal water, neither the EPA nor state governments regulate arsenic in private wells. However, a 2001 EPA study found that 13 million U.S. residents get their drinking water from private wells that exceed the federal arsenic standard.[35,36,37] Similarly, in 2009 the U.S. Geological Survey (USGS) tested 1,774 private wells nationwide and found that 6.8% of them exceeded the EPA standard (these are the most recent national data available on arsenic in private wells).[38]

According to Leslie DeSimone, a water quality specialist with the USGS, 90% of the exceedances were below 50 ppb, but measured concentrations ranged as high as 242 ppb, with the highest levels detected in the West, Midwest, parts of Texas, and New England. During a survey of Maine wells conducted in the mid to late 2000s, USGS scientists measured a concentration of 3,100 ppb in the coastal town of Danforth.[39] Maine resides within a belt of arsenic-laden bedrock that extends north from New York.

Bill Wilber, chief of the USGS National Water Quality Assessment Program, says in some cases simply drilling a well introduces oxygen and other elements that alter the chemistry of the underlying geology, liberating arsenic from bedrock and allowing it to seep into the water column. "So you can find a big exceedance in one well and not in another that's just fifty feet away," Wilber says.

According to Andy Smith, state toxicologist with the Maine Division of Environmental Health, the cost of a home-based system to remove arsenic from well water ranges from $300 for a point-of-use system (i.e., at the faucet) to as much as $9,000 for point-of-entry systems that treat water for the whole household. Federal or state assistance to purchase these systems generally isn't available, Smith says.

exposure, Steinmaus claims. Villagers in Taiwan often spend much of their lives in one general location, so the arsenic measured in local well water likely reflects their actual long-term intake. By contrast, populations in the United States and other developed countries with lower arsenic levels in groundwater are more mobile, leading to a strong likelihood of exposure misclassification. This statistical bias occurs when individual subjects in epidemiology studies are classified as having consumed more—or less—of a substance over a given duration than they actually ingested, making it difficult to accurately estimate disease associations.

Thus, the EPA SAB concluded in 2010 that—given the size and stability of the population, as well as the inclusion of long-term exposure patterns—the Taiwanese data were "still the most appropriate source for estimating bladder and lung cancer risk to humans."[10] But the SAB also stated that published studies from countries with low levels of arsenic in drinking water (which the SAB defined as up to 160 ppb) should be critically evaluated.[10]

Evidence for Low-Dose Impacts

Low-dose studies are now ongoing in a number of countries, including various locations throughout the United States. For instance, in 2013 Ana Navas-Acien, an associate professor of environmental sciences and epidemiology at the Johns Hopkins Bloomberg School of Public Health, published results from a prospective study showing that urinary arsenic concentrations reflecting low and moderate drinking water exposures were associated with lung, prostate, and pancreatic cancer,[5] as well as with cardiovascular disease,[2] among Native Americans living in Arizona, Oklahoma, and the Dakotas.

Navas-Acien's team measured arsenic in urine samples that had been collected and frozen between 1989 and 1991. The cohort of nearly 4,000 individuals had originally been assembled for the Strong Heart Study (SHS), an evaluation of cardiovascular health in Native Americans launched by the National Heart, Lung and Blood Institute in 1988. According to Navas-Acien, Native Americans included in the SHS tend to be more geographically stable than the general U.S. population, limiting the potential for exposure misclassification.[5] "They get the same exposure to arsenic year after year that they got at birth," she explains.

By matching local well water data collected by the EPA and urinary arsenic measures from the SHS samples with information from death certificates up through 2008, Navas-Acien could study the relationship between arsenic exposure and cancer mortality. Her team's results suggested that arsenic had a linear dose response with lung cancer in particular, although Navas-Acien points out that confidence intervals were wide at doses below 5 ppb in well water, indicating uncertainty at the lowest exposure levels.

A similar linear response was also estimated for prostate and pancreatic cancer, but with even wider confidence intervals at the lowest doses. However, the excess relative risks estimated for prostate and pancreatic cancer in Navas-Acien's study are much greater than they are for lung cancer; this is inconsistent with findings from other areas such as Taiwan, and therefore raises questions among some researchers about the validity of the findings. Navas-Acien's team didn't evaluate bladder cancer or skin cancer because of the small number of cases.

In a separate study of the same SHS cohort, Navas-Acien reported an association between low-dose arsenic exposures and higher rates of cardiovascular disease.[2] That study is one of the first prospective cohort studies to evaluate arsenic-related cardiovascular risk, including both incidence and mortality, in a population from the United States.

These findings add to a wealth of data emerging from what could be the largest evaluation of arsenic toxicity yet undertaken: the Health Effects of Arsenic Longitudinal Study (HEALS), which launched in Bangladesh in 2000.[19] Coordinated by Graziano and Habibul Ahsan, a professor of epidemiology, medicine, and human genetics at the University of Chicago, HEALS has over time assembled a cohort of tens of thousands of individuals living in the district of Araihazar, where arsenic levels measured in well water have ranged from nondetectible to more than 900 ppb.

The HEALS team first reported an association between arsenic and high blood pressure in 2007 at well water concentrations of 10–40 ppb. Since then, HEALS has yielded dozens of papers associating arsenic at levels below 50 ppb with health conditions including heart disease, hematuria (blood in the urine), and impaired lung function.[20,21,22] Studies also showed that increased total urinary arsenic was associated with skin lesions such as melanosis and keratosis, which are known precursors to skin cancer.[23,24] "HEALS is an ongoing effort, and we are expanding the design and questions that we can answer with longer follow-up," Ahsan says.

The Regulatory Landscape

Confronted with mounting evidence of arsenic's low-dose effects, its commercial uses are being phased out. Of particular concern are uses in agriculture, which can result in potentially significant human exposures. According to a November 2013 NRC report, foods dominate human arsenic exposures when the levels in drinking water drop below 50 ppb (drinking water drives the exposures when its arsenic content exceeds that amount).[14]

In some cases, agricultural soils are naturally high in arsenic, but arsenical herbicides also can leave residues that accumulate in crops. Most of these herbicides have now been phased out (with some exceptions made for turfgrass and cotton),[25,26] but what remains in soil from past applications has been especially problematic in apple orchards, where these herbicides were routinely used, and in rice grown on old cotton fields that were treated with the chemicals.

Arsenical feed additives used to promote growth and prevent disease in poultry and swine may also be problematic for human consumers. However, these additives are also being phased out. Production of the feed additive roxarsone ceased voluntarily in 2011 after the FDA detected inorganic arsenic in the livers of chickens that ate it.[27] The manufacturers of roxarsone and two other arsenical feed additives have requested that the FDA withdraw approval of these products.[28] The agency is currently considering a request to ban a fourth additive, nitarsone.[28]

Now the FDA is weighing how to impose standards for arsenic in foods. The proposed standard of 10 ppb in apple juice was a first step in this direction, but advocates with CU say the agency should go further by imposing a 120-ppb standard for inorganic arsenic in rice.[29] In November 2012 CU published the results of a study showing that 223 samples of rice and rice-based products sold in the United States contained inorganic arsenic at concentrations ranging from 29.4 to 210 ppb.[30] In addition, Dartmouth investigators reported that brown rice syrup, a sweetener, might expose consumers to "significant concentrations" of inorganic arsenic.[31] (Arsenic tends to accumulate in the aleurone layer of the rice grain, which gives brown rice its color. This layer is removed to produce white rice.[31])

The FDA followed up with its own report on 1,300 samples of rice and rice products, which found that concentrations of inorganic arsenic ranged from an average 0.1 µg per serving in infant formula to an average 7.2 µg per serving in brown rice.[32] For perspective, Aaron Barchowsky, a professor of environmental and occupational health at the University of Pittsburgh School of Public Health, says that daily consumption of 3 liters of water at the 10-ppb standard amounts to a 30-µg dose of inorganic arsenic.

In a 6 September 2013 statement, the FDA said the amount of detectable arsenic in the sampled rice and rice products was too low to cause "any immediate or short-term adverse health effects."[33] FDA spokesperson Shelly Burgess says the statement referred to short-term effects only, and not skin, bladder, or lung cancer.

But Michael Crupain, director of *Consumer Reports*' Food Safety and Sustainability Center, insists that chronic low-level exposures over time are still a concern, especially for infants fed formula made with brown rice syrup, which had the highest levels detected in CU's survey. The FDA is now performing a draft risk assessment for arsenic in rice, which agency officials say could guide further actions.

Also on the regulatory front, the EPA is grappling with its numerical estimate of arsenic's cancer potency. This value, known as a cancer slope factor (CSF), guides important regulatory policies, including clean-up standards at contaminated waste sites. Set in 1998, the original CSF for arsenic was based on nonmelanoma skin cancers observed in the early Taiwanese studies.

In 2010 the EPA proposed a revised CSF as part of an arsenic reassessment under the agency's Integrated Risk Information System (IRIS).[10] The proposed CSF, which was based on newer reports of associations with more dangerous lung and bladder cancers, was 17 times greater than the older value. But that new value was protested by industry and other affected stakeholders, even some of the agency's own scientists. Griffin, of EPA Region 8, says that with the revised CSF, arsenic clean-up levels would drop 100-fold, which is below natural background levels of arsenic in western states.

The proposal was subsequently dropped by the EPA, and under a congressional mandate the agency is now revising its arsenic reassessment with a focus on both cancer and noncancer end points. On 7 November 2013 the NRC presented a report that the EPA will use for guidance in drafting a new IRIS document.[14] Graziano, who chairs the NRC committee, says the EPA will submit the revised document by 2015. And at that point, he says, NRC scientists will review it to ensure that dose–response relationships between inorganic arsenic and its effects are "appropriately estimated and characterized."

Continued Debate

Meanwhile the debate over low-dose health risks from arsenic will likely continue on two fronts: how to apply mechanistic findings from animal and *in vitro* research to human responses, and how to address fundamental uncertainties in the human data.

A key question is whether the recent epidemiological literature supports estimates of cancer risk predicted from linear dose–response models. Dozens of studies over the last 15 years have investigated human cancer risk from arsenic exposure at sites around the world. According to a 2011 review published by Herman Gibb, president of environmental consulting firm Tetra Tech Sciences, these studies provide conflicting evidence, in part because the sample sizes needed to quantify risks at drinking water doses less than 100 ppb are larger than what's ordinarily achievable.[34]

Steinmaus argues that the high-dose epidemiology data may ultimately be most suitable for risk assessment, "but when you extrapolate down from those doses, the risks are huge." He adds, "This raises the question of whether linear extrapolations are suitable, and herein lies the big controversy."

Charles W. Schmidt, MS, an award-winning science writer from Portland, ME, has written for *Discover Magazine*, *Science*, and *Nature Medicine*.

REFERENCES

1. Navas-Acien A, et al. Arsenic exposure and prevalence of type 2 diabetes in US adults. JAMA 300(7):814–822 (2008); http://dx.doi.org/10.1001/jama.300.7.814.
2. Moon KA, et al. Association between exposure to low to moderate arsenic levels and incident cardiovascular disease. A prospective cohort study. Ann Intern Med 159(10):649–659 (2013); http://dx.doi.org/10.7326/0003-4819-159-10-201311190-00719.
3. Dangleben NL, et al. Arsenic immunotoxicity: a review. Environ Health 12(1):73 (2013); http://dx.doi.org/10.1186/1476-069X-12-73.
4. Gilbert-Diamond D, et al. A population-based case–control study of urinary arsenic species and squamous cell carcinoma in New Hampshire, USA. Environ Health Perspect 121(10):1154–1160 (2013); http://dx.doi.org/10.1289/ehp.1206178.
5. García-Esquinas E, et al. Arsenic exposure and cancer mortality in a US-based prospective cohort: the Strong Heart Study. Cancer Epidemiol Biomarkers Prev 22(11):1944–1953 (2013); http://dx.doi.org/10.1158/1055-9965.EPI-13-0234-T.
6. Mostafa MG, Cherry N. Arsenic in drinking water and renal cancers in rural Bangladesh. Occup Environ Med 70(11):768–773 (2013); http://dx.doi.org/10.1136/oemed-2013-101443.
7. FDA. FDA Proposes "Action Level" for Arsenic in Apple Juice [press release]. Silver Spring, MD:U.S. Food and Drug Administration (12 July 2013). Available: http://goo.gl/bMgW5L [accessed 24 April 2014].
8. ATSDR. Arsenic Toxicity Clinical Assessment [e-course]. Atlanta, GA:Agency for Toxic Substances Disease Registry, U.S. Centers for Disease Control and Prevention (updated 15 January 2010). Available: http://www.atsdr.cdc.gov/csem/csem.asp?csem=1&po=12 [accessed 24 April 2014].
9. Jean J-S, et al. The Taiwan Crisis: A Showcase of the Global Arsenic Problem. Boca Raton, FL:CRC Press (2010).
10. EPA. IRIS Toxicological Review of Inorganic Arsenic (Cancer) (2010 External Review Draft) [website]. Washington, DC:U.S. Environmental Protection Agency (updated 20 June 2013). Available: http://cfpub.epa.gov/ncea/iris_drafts/recordisplay.cfm?deid=219111 [accessed 24 April 2014].
11. Chen CJ, et al. Arsenic and cancers. Lancet 331(8582):414–415 (1988); http://dx.doi.org/10.1016/S0140-6736(88)91207-X.
12. Chen CJ, et al. Malignant neoplasms among residents of a blackfoot disease-endemic area in Taiwan: high-arsenic artesian well water and cancers. Cancer Res 45(11 pt 2):5895–5899 (1985); http://www.ncbi.nlm.nih.gov/pubmed/4053060.
13. Chen CJ, et al. A retrospective study on malignant neoplasms of bladder, lung and liver in blackfoot disease endemic area in Taiwan. Br J Cancer 53(3):399–405 (1986); http://www.ncbi.nlm.nih.gov/pubmed/3964542.
14. National Research Council. Critical Aspects of EPA's IRIS Assessment of Inorganic Arsenic: Interim Report. Washington, DC: The National Academies Press (2014). Available: http://www.nap.edu/catalog.php?record_id=18594 [accessed 24 April 2014].
15. National Research Council. Arsenic in Drinking Water. Washington, DC:The National Academies Press (1999). Available: http://www.nap.edu/openbook.php?isbn=0309063337 [accessed 24 April 2014].
16. EPA. Arsenic: Rule-Making History [website]. Washington, DC:Office of Water, U.S. Environmental Protection Agency (updated 6 March 2012). Available: http://water.epa.gov/lawsregs/rulesregs/sdwa/arsenic/history.cfm [accessed 24 April 2014].
17. National Research Council. Arsenic in Drinking Water: 2001 Update. Washington, DC:The National Academies Press (2001). Available: http://www.nap.edu/openbook.php?isbn=0309076293 [accessed 24 April 2014].
18. Nesnow S, et al. DNA damage induced by methylated trivalent arsenicals is mediated by reactive oxygen species. Chem Res Toxicol 15(12):1627–1634 (2002); http://dx.doi.org/10.1021/tx025598y.
19. Chen Y, et al. A prospective study of arsenic exposure, arsenic methylation capacity, and risk of cardiovascular disease in Bangladesh. Environ Health Perspect 121(7):832–838 (2013); http://dx.doi.org/10.1289/ehp.1205797.
20. Parvez F, et al. Arsenic exposure and impaired lung function. Findings from a large population-based prospective cohort study. Am J Respir Crit Care Med 188(7):813–819 (2013); http://dx.doi.org/10.1164/rccm.201212-2282OC.
21. Melkonian S, et al. Urinary and dietary analysis of 18,470 Bangladeshis reveal a correlation of rice consumption with arsenic exposure and toxicity. PLoS ONE 8(11):e80691 (2013); http://dx.doi.org/10.1371/journal.pone.0080691.
22. McClintock TR, et al. Association between arsenic exposure from drinking water and hematuria: results from the Health Effects of Arsenic Longitudinal Study. Toxicol Appl Pharmacol 276(1):21–27 (2014); http://dx.doi.org/10.1016/j.taap.2014.01.015.
23. Sober AJ, Burstein JM. Precursors to skin cancer. Cancer 75(suppl S2):645–650 (1995); http://goo.gl/0q2Lya.
24. Woolgar JA, Triantafyllou A. Squamous cell carcinoma and precursor lesions: clinical pathology. Periodontol 2000 57(1):51–72 (2011); http://dx.doi.org/10.1111/j.1600-0757.2011.00389.x.
25. EPA. Chromated Copper Arsenate (CCA): CCA Guidance—Questions and Answers [website]. Washington, DC:Office of Pesticide Programs, U.S. Environmental Protection Agency (updated 7 February 2014). Available: http://www.epa.gov/oppad001/reregistration/cca/cca_guidance_q_a.htm [accessed 24 April 2014].
26. EPA. Organic Arsenicals [website]. Washington, DC:Office of Pesticide Programs, U.S. Environmental Protection Agency (updated 2 April 2013). Available: http://www.epa.gov/pesticides/reregistration/organic_arsenicals_fs.html [acccessed 24 April 2014].
27. FDA. Questions and Answers Regarding 3-Nitro (Roxarsone) [website]. Silver Spring, MD:U.S. Food and Drug Administration (updated 8 June 2011). Available: http://goo.gl/hM15jz [accessed 24 April 2014].
28. Taylor MR. Re: Docket No. FDA-2009-P-0594, Citizen Petition on Behalf of the Center for Food Safety and the Institute for Agriculture and Trade Policy. Silver Spring, MD:U.S. Food and Drug Administration (30 September 2013). Available: http://goo.gl/SFOYCJ [accessed 24 April 2014].
29. Consumers Union. CU Letter to the FDA Regarding Arsenic in Rice. Yonkers, NY:Consumers Union (20 September 2012). Available: http://consumersunion.org/news/cu-letter-to-the-fda-regarding-arsenic-in-rice/ [accessed 24 April 2014].
30. Arsenic in your food: our findings show a real need for federal standards for this toxin. Consumer Reports (November 2012). Available: http://www.consumerreports.org/cro/magazine/2012/11/arsenic-in-your-food/index.htm [accessed 24 April 2014].
31. Jackson BP, et al. Arsenic, organic foods, and brown rice syrup. Environ Health Perspect 120(5):623–626 (2012); http://dx.doi.org/10.1289/ehp.1104619.
32. FDA. Arsenic in Rice and Rice Products [website]. Silver Spring, MD:U.S. Food and Drug Administration (updated 12 September 2013). Available: http://www.fda.gov/food/foodborneillnesscontaminants/metals/ucm319870.htm [accessed 24 April 2014].
33. FDA. FDA Statement on Testing and Analysis of Arsenic in Rice and Rice Products [press release]. Silver Spring, MD:Center for Food Safety and Applied Nutrition, U.S. Food and Drug Administration (6 September 2013). Available: http://goo.gl/gQgzCr [accessed 24 April 2014].
34. Gibb H, et al. Utility of recent studies to assess the National Research Council 2001 estimates of cancer risk from ingested arsenic. Environ Health Perspect 119(3):284–290 (2011); http://dx.doi.org/10.1289/ehp.1002427.
35. EPA. Arsenic in Drinking Water [website]. Washington, DC:Office of Water, U.S. Environmental Protection Agency (updated 17 September 2013). Available: http://water.epa.gov/lawsregs/rulesregs/sdwa/arsenic/index.cfm [accessed 24 April 2014].
36. Blum D. The arsenic in our drinking water [weblog entry]. The New York Times, Well section, Poison Pen Blog, online edition (20 September 2013). Available: http://goo.gl/8IXwau [accessed 24 April 2014].
37. EPA. Fact Sheet: Drinking Water Standard for Arsenic. EPA 815-F-00-015. Washington, DC:Office of Water, U.S. Environmental Protection Agency (January 2001). Available: http://water.epa.gov/lawsregs/rulesregs/sdwa/arsenic/regulations_factsheet.cfm [accessed 24 April 2014].
38. DeSimone LA, et al. Quality of Ground Water from Private Domestic Wells [website]. Reston, VA:U.S. Geological Survey (4 March 2014). Available: http://goo.gl/zGmf3Y [accessed 24 April 2014].
39. Nielsen MG, et al. Assessment of Arsenic Concentrations in Domestic Well Water, by Town, in Maine, 2005–09. U.S. Geological Survey Scientific Investigations Report 2010–5199. Augusta, ME:National Water Quality Assessment Program, U.S. Geological Survey (2010). Available: http://pubs.usgs.gov/sir/2010/5199/ [accessed 24 April 2014].

Exhibit I

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

HHS Public Access

Author manuscript

Adv Pharmacol. Author manuscript; available in PMC 2024 February 12.

Published in final edited form as:

Adv Pharmacol. 2023 ; 96: 151–202. doi:10.1016/bs.apha.2022.08.001.

Arsenic and cancer: evidence and mechanisms

Rachel M. Speer[1], **Xixi Zhou**[1], **Lindsay B. Volk**[1], **Ke Jian Liu**[1,2,*], **Laurie G. Hudson**[1]

[1]Department of Pharmaceutical Sciences, College of Pharmacy, University of New Mexico, Albuquerque, New Mexico, USA

[2]Stony Brook Cancer Center, Renaissance School of Medicine, State University of New York Stony Brook, Stony Brook, NY 11794, USA

Abstract

Arsenic is a potent carcinogen and poses a significant health concern worldwide. Exposure occurs through ingestion of drinking water and contaminated foods and through inhalation due to pollution. Epidemiological evidence shows arsenic induces cancers of the skin, lung, liver, and bladder among other tissues. While studies in animal and cell culture models support arsenic as a carcinogen, the mechanisms of arsenic carcinogenesis are not fully understood. Arsenic carcinogenesis is a complex process due its ability to be metabolized and because of the many cellular pathways it targets in the cell. Arsenic metabolism and the multiple forms of arsenic play distinct roles in its toxicity and contribute differently to carcinogenic endpoints, and thus must be considered. Arsenic generates reactive oxygen species increasing oxidative stress and damaging DNA and other macromolecules. Concurrently, arsenic inhibits DNA repair, modifies epigenetic regulation of gene expression, and targets protein function due its ability to replace zinc in select proteins. While these mechanisms contribute to arsenic carcinogenesis, there remain significant gaps in understanding the complex nature of arsenic cancers. In the future improving models available for arsenic cancer research and the use of arsenic induced human tumors will bridge some of these gaps in understanding arsenic driven cancers.

Keywords

arsenic; cancer; carcinogenesis; DNA damage; mechanism

INTRODUCTION

Over millennia, humans have harnessed the unique properties of arsenic for medicinal, agricultural, commercial, and decorative purposes. At the same time, humans have been subject to the stealthy toxicity of arsenic as an odorless and tasteless, intentional or unintentional, poison. Our complicated relationship with arsenic continues to this day.

Therapeutic uses of arsenic have been documented for thousands of years in traditional Chinese medicine and early western medicine. Two forms of arsenic were included in the

*Corresponding author: kliu@salud.unm.edu.

Conflict of interest: the authors declare no conflict of interest.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Shennong Materia Medica in 200 BCE and Hippocrates is believed to use arsenic pastes to treat skin disorders (Au, 2011; Hughes et al., 2011; Paul et al., 2022; Chen & Costa, 2021). In 1786 Thomas Fowler reported on the medicinal effects of his arsenic solution for a broad range of infectious diseases and skin and blood disorders, in addition to other health conditions. The noted antimicrobial properties of arsenic led to the development of Salvarsan in the early 1900s as an effective treatment of syphilis garnering a Nobel prize for Paul Ehrlich in 1908. In the past, various forms of arsenic, including those used in traditional Chinese medicine and Fowler's solution, were employed as cancer therapeutics especially for cancers of the blood and skin (Au, 2011; Hughes et al., 2011; Paul et al., 2022; Chen & Costa, 2021). The FDA approved arsenic trioxide as a chemotherapeutic for leukemia in 2000 bringing an ancient drug into the modern era.

Other arsenic compounds have been beneficial as rodenticides, pesticides for agricultural crops and wood preservatives (Hughes et al., 2011; Bencko and Foong, 2017). Arsenic-based pigments were used in paints, fabrics and wallpapers based on a coveted emerald green color (Hughes et al., 2011). However, the medicinal and non-medicinal uses of arsenic revealed human toxicities based on unintended exposures. Widespread use of lead arsenate as a pesticide in apple and cherry orchards ultimately led to an official ban in the United States in 1988 (Hughes et al., 2011). The lasting legacy of this use is evident in millions of acres of land contaminated with lead arsenate. Chromated copper arsenate continues to be used as a wood preservative for non-residential purposes and organic arsenicals remain in restricted use as broad-spectrum herbicides. The potential for further contamination of soils and water by inorganic and organic arsenic compounds is under periodic review by the US Environmental Protection Agency (EPA).

Arsenic toxicity has been exploited for political gains through strategic poisonings leading to the often quoted statement labeling arsenic as the "king of poisons and poison of kings". Modern toxicological focus largely centers on the human health consequences of medicinal, occupational and environmental exposures to arsenic. Studies on health effects of human exposures through natural or anthropogenic arsenic contamination in soils and water led to adoption of drinking water standards worldwide currently at 10 ppb. Despite efforts to limit arsenic exposures, it is estimated that 200 million people or more are exposed to toxic levels of arsenic worldwide (Costa 2021). This chapter will focus on arsenic carcinogenicity and cover human population evidence for arsenic as a carcinogen, mechanisms of arsenic carcinogenicity, the carcinogenic potential of different forms of arsenic and conclude with a brief discussion of areas for future research.

SECTION 1: HUMAN STUDIES

Arsenic is a worldwide health concern due to prevalence in the environment and established human toxicity (Podgorski, 2020; Agency for Toxic Substances and Disease Registry (ATSDR), 2007; ATSDR, 2016; Naujokas et al., 2013). Arsenic is present in rocks, soil and water, and background environmental levels may be increased by mining, burning of fossil fuels, and application of agricultural pesticides and herbicides (Gundert-Remy et al., 2015). In recognition of its toxic potential, arsenic is at the top of the ASTDR Priority List (https://www.atsdr.cdc.gov/spl/index.html). Occupational exposures are limited by the US

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Occupational Safety and Health Administration to 10 μg/m^3, and recommended drinking water exposure limits of 10 μg/L (10 ppb) have been established by the EPA and the World Health Organization (WHO) (WHO, 2011; EPA, 2014).

The majority of human population studies focus on chronic arsenic ingestion through drinking water as the predominant exposure route (Andrew et al., 2003; Banerjee et al., 2007; Podgorski, 2020, ATSDR, 2007, ATSDR, 2016; WHO, 2011). Many parts of the world have high levels of arsenic in groundwater and aquifers with populations that use these water sources for household needs. One arsenic prediction model based on household groundwater-usage statistics estimates that between 94 and 220 million people may be exposed to high arsenic concentrations (Podgorski, 2020). Indeed, many seminal health studies have focused on populations in areas of the world with high levels of arsenic in water sources including, but not limited to, Bangladesh, India, Taiwan and Chile (ATSDR, 2007; ATSDR, 2016; Banerjee et al., 2017; Farzan et al., 2021; Moore et al., 2002). Some studies have established the relationship between arsenic levels in water and arsenic in biological specimens such as urine, hair and nails (Mahata et al., 2003; Maki-Paakkanen et al., 1998; Ruíz-Vera et al., 2019).

More recently, greater attention has been paid to food as a source of arsenic exposure (Oberoi 2014; Gundert-Remy 2015; Arslan et al., 2017; Wong et al., 2022). Food crops may contain elevated arsenic levels through irrigation with arsenic-containing water, cultivation in arsenic contaminated fields, or use of agricultural products containing arsenic (Gundert-Remy et al., 2015; Wong et al., 2022). Rice has become a notable concern due to arsenic's uptake and accumulation in this plant compared to other common grains such as wheat (Karagas et al., 2019). There is evidence of greater urinary arsenic in individuals reporting higher rice consumption compared to those with low rice consumption even in areas of low arsenic drinking water exposure (Gossai et al., 2017).

The relationships between arsenic exposure and cancer are clear. Cancer is one of the health effects of concern; arsenic is classified as a Class I human carcinogen by the International Agency for Research on Cancer (IARC) with strong experimental and human population evidence to support arsenic carcinogenicity (IARC, 2004; Moore et al., 2002; Srinivas et al., 2019; Tam et al., 2020). The strongest evidence for organ-specific arsenic carcinogenicity is in skin, lung, bladder and kidney with evidence for arsenic contributions to other cancers (WHO, ATSDR, 2007, ATSDR, 2016; Palma-Lara et al., 2020) (Figure 1).

Skin Cancer

Various non-cancerous skin lesions are associated with long term exposure to inorganic arsenic including changes in pigmentation, plantar-palmar hyperkeratinization and hyperkeratotic warts and corns (ASTDR, 2007; Hunt et al., 2014). These skin changes are most common in areas with high arsenic levels in drinking water and are viewed as sensitive indicators of chronic arsenic exposure (ASTDR, 2007; Hunt et al., 2014; Cheng et al., 2016). Skin lesions and cancer appear to be more prevalent at exposures to drinking water levels in excess of 50 μg/L and evidence linking arsenic to skin cancer is less conclusive at lower arsenic levels (Boffetta et al., 2020, Lamm et al., 2021; Karagas et al., 2015). Recent

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

findings suggest that ingestion of arsenic containing foods in the diet such as rice may also contribute to skin cancer risk (Karagas et al., 2019; Gossai et al., 2017).

The most common tumors associated with arsenic exposure are keratinocytic tumors including squamous cell carcinomas, which may develop from hyperkeratotic warts or corns, and basal cell carcinomas (ASTDR, 2007; Karagas et al., 2015; Palma-Lara et al., 2020). There is less consistent evidence for arsenic-associated melanoma although it has been reported in Bangladesh (Choudhury et al., 2018), but not in the United States (Langston et al., 2022; Bedaiwi et al., 2021; Yager et al., 2016) or there are too few studies to draw firm conclusions (Matthews et al., 2019).

Lung Cancer

Epidemiological evidence indicates increased incidence of lung cancer in workers exposed to arsenic in the copper mining and smelting industry and ingestion through contaminated water (ASTDR 2007; Smith et al., 2012; Steinmaus et al., 2014; Palma-Lara et al., 2020). Studies conducted in Chilean cohorts born during periods of low versus high arsenic exposure from water reveal increased incidence of several cancers, including lung cancer, associated with the high exposure period (ASTDR, 2010; Smith et al., 2006). Similarly, mitigation efforts to decrease arsenic ingestion from contaminated water in Taiwan led to reduction in lung cancer rates (Su et al., 2011). No associations were identified for lung cancer and arsenic in soil in Taiwan despite reported associations between lung cancer and other metals in the same soils (Huang et al., 2013). These findings and others support the conclusion that lung cancer is increased upon chronic exposure to arsenic in drinking water (ASTDR, 2007; Kuo et al., 2017a; Su et al., 2011; Chen et al., 2010; Heck et al., 2009). There is evidence for dose dependence (Chen et al., 2010); however, the associations are less strong at low arsenic exposures (Shao et al., 2021; Tsuij et al., 2019)

The most common type of lung cancer associated with arsenic exposure is squamous cell carcinoma (Kuo et al., 2017; Heck et al., 2009; Taeger et al., 2009). The correlation between arsenic and squamous cell carcinoma was more pronounced at higher exposure levels; adenocarcinoma and small cell carcinoma of the lung were not associated with arsenic level in the drinking water in a Taiwan population (Kuo et al., 2017) although other investigators reported increased adenocarcinoma and small cell carcinomas of the lung with arsenic exposure (Chen et al., 2010; Guo et al., 2004). A study of former German uranium miners exposed to arsenic found that the arsenic-related type of lung cancer differed in miners based on evidence of silicosis. Arsenic was associated with increased squamous cell carcinoma in miners without silicosis. In contrast non-small cell lung cancer was related to arsenic exposure in miners with silicosis (Taeger et al., 2009) suggesting that other underlying factors may influence the specific lung cancer arising because of arsenic exposure.

Bladder Cancer

Population studies identify a clear relationship between elevated arsenic levels in drinking water and bladder cancer (IARC, 2004; ASTDR, 2007; Smith et al., 2012; Krajewski et al., 2021). A recent study found evidence for oxidative DNA damage in residents exposed to arsenic from artesian well-water in Taiwan and concluded that arsenic exposure and

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

DNA damage predicted the risk of bladder cancer (Tsai et al., 2021). In the US, arsenic concentrations in drinking water were positively associated with bladder cancer in both men and women (Mendez et al., 2017; Baris et al., 2016) and a spatial cluster analysis of bladder cancer mortality identified significant hot spots. Further study concluded that there was a significant association between bladder cancer mortality and arsenic intake from well water (Amin et al., 2019; Baris et al., 2016). Notably, well water is not subject to federal regulation and may exceed the EPA recommended maximum contaminant level. As with other arsenic-associated cancers, there is not uniform agreement on risks linked to lower exposures (Kayajanian, 2003) although a meta-analysis suggested that exposure to 10 μg/L of arsenic in drinking water may double the risk of bladder cancer (Saint-Jacques et al., 2014). Arsenic ingestion through food is also considered a potentially important source of exposure that may contribute to bladder and other cancers (Gundert-Remy et al., 2015; Oberoi et al., 2014; Karagas et al., 2019).

There are several studies that indicate arsenic exposure may influence bladder cancer progression and clinical outcomes. Comparisons of clinicopathological characteristics in bladder cancer patients from an arsenic contaminated region versus two reference areas found significantly greater proportions of locally advanced and high-grade tumors in the arsenic-exposed patients (Fernandez et al., 2020). Patients from areas of high arsenic exposure in Taiwan versus low arsenic exposure found worse prognosis in the patients from areas of high arsenic and this was most pronounced in the disease-free survival of early-stage disease (Chang et al., 2021). Similar findings were reported for patients in West Bengal, India where measured arsenic accumulation in bladder tumor tissue was associated with advanced tumors, poor prognosis and disease recurrence after treatment (Ghosh et al., 2021). These observations may be related to distinct mechanisms of arsenic carcinogenesis (Zhou et al., 2021; Palma-Lara et al., 2020) as described in Section 2.

Additional Cancers and Cancer Risk Due to Prenatal and Early Life Exposure

Although the evidence for arsenic-associated cancers is strongest for skin, lung and bladder tumors, there are other cancers that are linked to arsenic exposure. There is significant evidence for arsenic induced kidney cancer (Smith et al., 2012; Krajewski et al., 2021; Saint-Jacques et al., 2014; Ferreccio et al., 2013a; Naujokas et al., 2013; Palma-Lara et al., 2020; Chen and Costa, 2021) and liver cancer (Naujokas et al., 2013; Palma-Lara et al., 2020; Chen & Costa, 2021; ASTDR, 2010). There is more limited evidence for increased gastrointestinal tract (Krajewski et al., 2021; ASTDR, 2010), laryngeal (Smith et al., 2012), prostate (Lamm et al., 2021) and breast cancer (Moslehi et al., 2020) risk with elevated arsenic exposure (Abuawad et al., 2021). In the case of breast cancer, it appears that genetic factors may play an important modifying role in arsenic-associated risk (Moslehi et al., 2020).

Gestational and early life exposure to arsenic is associated with a variety of long-term health effects including increased risk of cancer in humans (Smeester and Fry, 2018; Martinez and Lam, 2021). Studies conducted in Northern Chile provide strong evidence for the cancer consequences of prenatal and early life arsenic exposures. In 1958, the levels of arsenic in drinking water increased nearly 10-fold to 870 ppb and remediation efforts in the 1970s

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

reduced arsenic in drinking water to near pre-1958 levels. This led to human cohorts with different levels and timing of arsenic exposure (Smith et al., 2012). Increased mortality rates were observed for bladder, laryngeal, lung, kidney, liver and other cancers (Smith et al., 2012; Ferreccio et al., 2013b; Steinmaus et al., 2014). Long latency patterns of 25 years or more after early life exposure have been reported for liver, kidney and bladder cancers, often accompanied by evidence for higher incidence and cancer mortality in children and young adults (Yuan et al., 2010; Marshall et al., 2007; Liaw et al., 2008). These findings point to arsenic cancer risks that can persist decades after exposure in early life stages. Given evidence from experimental animal models that prenatal arsenic exposure elevates cancer development (Martinez and Lam, 2021; Waalkes et al., 2007), arsenic exposures across the entire lifespan are a concern.

Modifying Factors of Arsenic Carcinogenesis

Arsenic is one of a limited number of metals or metalloids that is metabolized to methylated forms (Roy et al., 2020). Biotransformation of inorganic arsenic to mono and dimethyl forms (MMA and DMA, respectively) occurs through the enzyme arsenic methyltransferase (AS3MT) and arsenic is excreted as a mixture of inorganic and methylated forms (Roy et al., 2020, see also Section 3). Population studies suggest that the different forms of arsenic are not equivalent in carcinogenic potential. Studies of the proportion of inorganic and methylated arsenic species found that individuals with high urinary inorganic percent or low DMA present were more likely to develop bladder cancer (Chung et al., 2013) and a meta-analysis found that bladder and lung cancer were increased significantly with increasing MMA percent in the urine (Melak et al., 2014). Positive associations between percent urinary MMA and cancers of the breast and skin in addition to lung and bladder also have been reported (Abuawad 2021; Gamboa-Loira et al., 2017; Huang et al., 2018). There is increasing evidence that polymorphisms and expression levels of AS3MT may lead to differences in arsenic metabolism (Delgado et al., 2021) and are important factors in arsenic-related cancer risk and outcomes (Song et al., 2020; Huang et al., 2018; Lin et al., 2018; De la Rosa et al., 2017).

Co-exposures of arsenic and DNA damaging agents can amplify carcinogenesis with the greatest evidence in human populations for skin, lung and bladder cancers. The risk of arsenic-associated skin lesions that can be precursors to cancer was greater with sun exposure (Chen et al., 2006). Furthermore, arsenic exposure and smoking increase risk of lung and bladder cancers with evidence for significant arsenic dose effect (Tsuda et al., 1995; Karagas et al., 2004; Chen et al., 2010; Chen et al., 2004; Koutros et al., 2018; Ferreccio et al., 2013b). These population-based findings are consistent with experimental findings of arsenic co-carcinogenesis (Zhou et al., 2021). Cumulatively, the evidence derived from studies of human populations exposed to arsenic indicate that arsenic is a human carcinogen both as a single agent and the carcinogenic effects can be modified by multiple factors including genetic polymorphisms and toxic co-exposures.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

SECTION 2: MECHANISMS OF ARSENIC CARCINOGENESIS

The diverse range of cellular effects of arsenic exposure create a complex landscape for studying arsenic carcinogenesis. Many processes affected by arsenic exposure are interconnected further complicating our understanding of arsenic's effects. This section will discuss key mechanisms of arsenic carcinogenesis focusing on oxidative stress, the role of DNA damage and repair in genotoxicity, epigenetic changes, and how arsenic interacts with proteins to affect major pathways of carcinogenesis.

Oxidative Stress

Oxidative stress is a cornerstone of arsenic toxicity and carcinogenesis. It plays a role in DNA damage, repair inhibition and cellular mechanisms related to cell stress and cell death. Arsenic induces elevated levels of reactive oxygen species (ROS) and reactive nitrogen species (RNS) that are damaging to macromolecules in the cell including DNA and protein (Ding et al., 2005; Wang et al., 2013) (Figure 2). Oxidative stress due to arsenic exposure is initiated by intracellular metabolism of arsenic, which involves glutathione (GSH) as a necessary mediator. GSH depletion during arsenic metabolism may result in reduced ability to ameliorate damaging ROS, both endogenous and those produced by the direct effects of arsenic in the cell. Arsenic metabolism also produces additional reactive intermediates. For example, the dimethylarsenic peroxyl radical, which is formed in the metabolism of dimethylarsenic acid, a methylated form of inorganic arsenic, further requires antioxidant remediation, and this intermediate has been shown to induce DNA damage (Flora et al., 2007; Yamanaka, 1994; Yamanaka et al., 1995). Specific forms of arsenic and their effects on oxidative stress are discussed in Section 3.

In general, reactive species arise due to the reduction of molecular oxygen to form superoxide radical anions ($O_2^{\cdot -}$), hydrogen peroxide (H_2O_2), hydroxyl radicals (•OH), hydroperoxyl radicals (HOO•), singlet oxygen (O_2), and peroxyl radicals (ROO•) (Wiseman and Halliwell, 1996). Arsenic facilitates the formation of these species by targeting several different processes. The role of arsenic in production of ROS is observed in the mitochondria where it causes dysregulation of the electron transport chain (Hosseini et al., 2013). Arsenic inhibits succinate dehydrogenase activity responsible and altering the balance of oxidative phosphorylation and O_2 production which perpetuates formation of additional ROS while also altering mitochondrial membrane potential (Hosseini et al., 2013; Yen et al., 2012). Mitochondria also contain elevated levels of sulfhydryl containing enzymes due to their redox-prominent role making many enzymes in the mitochondria molecular targets of arsenic exposure (Netto et al., 2002). Arsenic induced ROS also leads to formation of oxidative DNA damage, which can be measured as 8-hydroxy-2'-deoxyguanosine (8-OHdG) (Chayapong et al., 2017; Ding et al., 2005; Kessel et al., 2002). NADPH oxidase (NOX), which is activated by arsenic and stimulates increased generation of ROS, is one mechanism of increase DNA damage through oxidative stress (Cooper et al., 2022).

Arsenic causes various forms of cellular damage, which enhances the formation of radicals in the cell, adding to oxidative stress. For example, arsenic exposure leads to the formation of oxidized lipids, which can be used as a biomarker for arsenic-induced oxidative

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

stress. Lipid peroxidation contributes to protein damage and compromised mitochondrial permeability forming a cycle of increased damage to macromolecules and ROS (Li et al., 2020; Mahajan et al., 2018; Nutt et al., 2005).

Arsenic generates RNS including nitric oxide (NO•), which further interacts with another product of arsenic exposure, $O_2^{\cdot -}$, to produce peroxynitrite ($ONOO^-$), which can affect DNA and proteins (Pace et al., 2017). $ONOO^-$ induces the nitration of tyrosine in proteins potentially altering their function. $ONOO^-$ also can cause S-nitrosation of cysteine residues in proteins, which was demonstrated in a study on the DNA repair protein, PARP-1 and was inhibited by the production of ROS and RNS after exposure to arsenic (Zhou et al., 2019). Additionally, $ONOO^-$ interacts with guanine forming 8-nitroguanine, which is used as a biomarker for RNS production (Kawanishi and Hiraku, 2006). Levels of arsenic exposure have been correlated with increased levels of 8-nitroguanine in epidemiology studies (Navasumrit et al., 2019; Phookphen et al., 2017). Arsenic-induced ROS and RNS increase oxidative stress leading to direct and indirect damage to DNA, proteins, and signaling pathways involved in maintaining genomic integrity. These effects are further discussed in the following sections.

Genotoxicity

Arsenic carcinogenesis is a complex process. However, the current body of research suggests genotoxicity arising as damage to genetic information is a key driver of arsenic-induced cancers and is a result of combined induction of DNA damage, inhibited DNA repair, and aberrant cell division. Genotoxicity begins with damage to genetic material. There is sufficient data showing arsenic exposure results in various forms of DNA damage including DNA double- and single-strand breaks and other lesions such as 8-nitroguanine and 8-OHdG as discussed above (Ding et al., 2005; Dong and Luo, 1993; Dutta et al., 2015; Okayasu et al., 2003). However, arsenic does not directly interact with DNA to cause damage, and there is a lack of strong evidence of arsenic forming adducts with DNA. Instead, studies show arsenic induced oxidative stress is responsible for the majority of DNA damage after arsenic exposure (Kumar et al., 2016). Studies show RNS and ROS inhibitors and pre-treatment with antioxidants attenuate DNA damage after arsenic exposure suggesting oxidative stress is a major contributor in arsenic-induced DNA damage (Ding et al., 2005; Lynn et al., 1998; Nesnow et al., 2002). This effect was also observed in arsenic-exposed human populations (Biswas et al., 2010) and animal studies (Balakumar et al., 2012; Kadirvel et al., 2007)

DNA double strand breaks are a particularly lethal form of DNA damage and if left unrepaired result in cell death. Arsenic-induced DNA double strand breaks have been identified in a number of studies (Guillamet et al., 2004; Mouron et al., 2006; Okayasu et al., 2003; Xie et al., 2014). If mis-repaired, these DNA double strand breaks in sites of key tumor suppressor genes may lead to changes to the genetic material and carcinogenesis. This result is also true of single-strand breaks and the formation of intra-DNA adducts and crosslinks with proteins and other cellular molecules (Bau et al., 2002; Dong et al., 1993; Mouron et al., 2001; Wang et al., 2001). DNA adducts and DNA-protein adducts may also contribute to the formation of DNA double strand breaks if mis-repaired (Bau et al., 2002, Wang et al., 2001). Several studies show arsenic exposure results in crosslinking of

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

proteins, including DNA repair proteins, with DNA potentially inhibiting repair processes and contributing to genomic instability (Garman et al., 1997; Gebel et al., 1998; Mustra et al., 2007). In another study arsenic-induced DNA-protein crosslinks were observed with gross chromosomal changes including sister chromatid exchanges, a hallmark of genomic instability (Mouron et al., 2005).

Genomic instability is a common driver of cancers and is associated with exposure to many metals including arsenic (Mitkovska et al., 2020; Wu et al., 2019; Wise and Wise, 2012). DNA damage and dysregulation of cell division induced by arsenic ultimately leads to gross changes to genetic material including formation of micronuclei (Basu et al., 2004; Navasumrit et al., 2019), both numerical and structural chromosome instability (States, 2015), and microsatellite instability (Wu et al., 2017). Numerical chromosome instability associated with arsenic exposure has been observed in both human populations (Dulout et al., 1996), cell culture models (Eguchi et al., 1997; Salazar et al., 2010; Sciandrello et al., 2002), and animal studies (Kashiwada et al., 1998). Numerical chromosome instability can arise due to uncoupling mechanisms involved in cell division, such as changes in mitotic checkpoints and centrosome dysregulation, and is considered a driving force of carcinogenesis (Sansregret and Swanton, 2017). Arsenic induces prolonged mitotic arrest resulting in aneuploidy (Eguchi et al., 1997; Yih et al., 1997). Other studies have shown arsenic disrupts centrosome function (States et al., 2002; Suzuki et al., 2009), which can be carried down through cell populations even after removal of arsenic suggesting these changes may be permanent and heritable (Sciandrello et al., 2002). Another endpoint of altered cell division is the formation of micronuclei, which form as a result of lagging chromosomes and chromosome fragments, and these events have been observed in arsenic-exposed cells (Moore et al., 1996), workers (Lewińska et al., 2007; Vuyyuri et al., 2006), and in populations exposed to arsenic in drinking water (Tian et al., 2001; Warner et al., 1994).

Structural chromosomal changes including chromatid exchanges, ring structures, and dicentric chromosomes have been identified in arsenic-exposed human populations (Banerjee et al., 2007; Ghosh et al., 2006; Mahata et al., 2003). Other studies have identified chromatid gaps associated with arsenic exposure and urine levels (Maki-Paakkanen et al., 1998). Importantly for carcinogenesis, increases in chromosomal aberrations have been associated with arsenic-induced cancers and pre-cancerous lesions. For example, chromosome aberrations were found in patients with arsenic-induced Bowen's disease (Ghosh et al., 2007), arsenic-induced stomach cancer (Boffetta et al., 2007), and were higher in bladder cancer patients with arsenic exposure than those without (Moore et al., 2002).

Telomere maintenance and stability is closely tied to maintaining genomic stability. Several recent studies in an arsenic exposed human population found exposure was associated with altered telomere length, which is also attributed to enhanced chromosomal instability and cancer (Chatterjee et al., 2018; Villarreal et al., 2019). Guanine bases are a target of arsenic-induced oxidative damage. Thus, telomeres, rich in guanine, are a target of arsenic exposure. For example, Coluzzie et al., 2014 showed telomeric changes, included enriched DNA damage and shortening, occurred because of arsenic-induced oxidative stress. These telomeric changes may contribute to compromised protection provided by telomeres in

REC 6600

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

maintaining chromosomal integrity. Other studies have identified arsenic-induced oxidative stress as a source of telomere attrition and structural chromosome instability arising as end-to-end fusions, and these effects were reduced by the addition of antioxidants (Liu et al., 2003). Epidemiology studies have confirmed arsenic exposure is associated with decreased telomere length and increased risk of skin carcinomas (Farzan et al., 2021; Grau-Perez et al., 2019; Srinivas et al., 2019) while other studies have shown the opposite (Gao et al., 2015).

The literature supports genomic instability represented as structural and numerical chromosome instability and alterations to chromosome maintenance (telomeres) as a prominent mechanism of arsenic-induced carcinogenesis. While these changes are evident the mechanisms of how they arise are important in understanding arsenic carcinogenesis. Changes in cell division were discussed above in association with numerical chromosome instability. However, structural chromosome instability is most associated with DNA damage (discussed above) and failure of robust DNA repair pathways as discussed below.

DNA repair

Arsenic induces a variety of DNA lesions, each with distinct repair pathways (Figure 3). Inhibited DNA repair after arsenic exposure is considered a driving mechanism of genomic instability and arsenic-induced cancers and research in this area has uncovered detailed cellular mechanisms of arsenic carcinogenesis. Mechanistic studies show arsenic affects critical repair factors in pathways of DNA repair including excision repair pathways, nucleotide excision repair (NER), base excision repair (BER) and strand break repair pathways, homologous recombination (HR), and non-homologous end joining (NHEJ).

Excision repair mechanisms are used to remove oxidative damage to nucleotides. Non-bulky damage to DNA bases, such as arsenic-induced 8-oxoguanine and apurinic and apyrimidinic sites, are repaired by BER. BER has been shown to be essential in repairing oxidative damage after arsenic exposure (Lai et al., 2011). Meanwhile BER genes were found to have decreased expression in HaCaT cells exposed to arsenic exposure (Ding et al., 2021). Specifically, human 8-oxoguanine DNA glycosylase I (Ebert et al., 2011), DNA polymerase β, and APE1 (Sykora and Snow, 2008) were found to have suppressed or altered expression and activity in human lung cells after arsenic exposure contributing to repressed BER function.

NER is responsible for repairing bulky type DNA lesions and is particularly important when considering arsenic as a co-carcinogen. NER repairs bulky lesions such as cyclobutane DNA photoproducts induced by ultraviolet radiation (UVR) and DNA adducts as a result of polyaromatic hydrocarbon (PAH) exposure. Arsenic alters NER through several mechanism. Individuals exposed to arsenic in drinking water were found to have decreased expression of DNA repair genes across in cell culture and human populations (Andrew et al., 2003; Andrew et al., 2006). Studies focused on NER after arsenic exposure have identified specific protein targets of arsenic including XPC, XPA, and ERCC1 (Holcomb et al., 2017; Huestis et al., 2016; Muenyi et al., 2011; Nollen et al., 2009; Zhou et al., 2014). Other mechanisms of arsenic-inhibited NER include inhibited protein function. Arsenic inhibits the activity of DNA ligase III and DNA ligase I (Hu et al., 1998). Extensive studies have also found zinc finger proteins in the NER pathway, including XPA are targeted by arsenic exposure altering

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

their function and are further discussed in Section 3 below (Huestis et al., 2016; Zhou et al., 2014). In addition to direct protein effects, polymorphisms in NER genes were found to be associated with non-melanoma skin cancer and arsenic exposure (Applebaum et al., 2007).

If NER or BER fail to repair DNA damage, double strand breaks can arise. These breaks are repaired by NHEJ or HR as a final attempt to repair the damage and maintain genomic integrity. However, studies show that both NHEJ and HR are impaired by arsenic exposure. Notably Morales et al., 2016 found arsenic shifted repair to the more error-prone alt-NHEJ pathway from the high-fidelity HR repair pathway potentially resulting in mis-repaired DNA double strand breaks and increased genomic instability. Arsenic has been shown to affect HR repair by altering recruitment of HR repair factors including BRCA1 and RAD51 (Zhang et al., 2014). Arsenic increased sumoylation of Mus18, an endonuclease involved in cyclobutane pyrimidine dimers (CPDs) and 6,4'PP HR repair, resulting in compromised DNA damage response (Hu et al., 2017). PARP-1 may play a role in double strand break repair due to changes to PARylation and therefore recruitment of DNA double strand break repair factors. PARP-1 also plays a role in BER, NHEJ, single strand break repair, and as a zinc finger protein has been shown to be a primary target of arsenic exposure, which will be discussed in Section 3.

Epigenetic changes

While studies have identified DNA repair deficiency as a mechanism of arsenic carcinogenesis, epigenetic regulation contributes to changes in DNA repair after arsenic exposure. Decreased gene expression is an established effect of arsenic exposure and studies show arsenic alters DNA methylation patterns across the genome with some sex differences (Bailey et al., 2013; Broberg et al., 2014; Nohara et al., 2011). Increased methylation of promotors involved in DNA repair has been associated with modified expression after arsenic exposure and was observed across different repair pathways. For example, BRCA1, ERCC2, MLH1, and OGG1 all had increased promoter methylation after arsenic exposure often associated with decreased expression (Hossain et al., 2012; Paul et al., 2014; Selmin et al., 2019; Wang et al., 2021). These studies support the finding that DNA methylation is associated with persistent genomic instability (Mauro et al., 2015). Confirming the importance of these finding are studies showing altered methylation patterns in populations exposed to arsenic (Bhattacharjee et al., 2018; Intarasunanont et al., 2012).

DNA methylation may be affected by the metabolism of arsenic, which involved methylation steps. Long term arsenic exposure has been associated with DNA hypomethylation as a result of depleted S-adenosylmethionine (SAM) (Reichard et al., 2007). While the mechanisms are not fully understood, SAM depletion results in decreased DNA methyltransferase activity, which may contribute to this effect (Du et al., 2018). Depletion of SAM and methylation activity may also affect histone methylation.

Posttranslational histone modifications, including methylation and acetylation, play an important role in gene expression. Arsenic has been shown to affect each of these posttranslational modifications creating a complicated landscape for understanding how they alter gene expression and accessibility and recruitment of DNA repair factors to sites of DNA damage. One study found the altered balance of H3K9me2, H3K36me3

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

and H4K20me2 after arsenic exposure may lead to decreased repair ability at sites of DNA damage (Li et al., 2016). Directly related to expression of DNA repair genes, arsenic increased H3K9me2 was found to reduced expression of genes involved in BER (Ding et al., 2021). Other studies show global histone methylation patterns after arsenic exposure are a contributing factor in malignant transformation (Ge et al., 2018) and cell transformation (Qiu et al., 2021). Zhang et al., 2020 found histone demethylase JDHM2A is responsible for regulating H3K9 dimethylation after arsenic exposure as a potential mechanism.

Arsenic altered levels of histone acetylases may also contribute to changes in gene expression, especially of DNA repair genes. H3K18ac was downregulated after arsenic exposure and this effect was notable in the promoter regions of NER protein genes (Zhang et al., 2020). Arsenic may also inhibit accessibility to repair sites of DNA damage through decreased histone acetylation. For example, arsenic decreased global H4K16Ac, notable for its role in relaxing chromatin, with concentration and time (Jo et al., 2009). Mechanisms of altered histone acetylation, including the effect of arsenic on histone acetyltransferases following arsenic exposure has been linked to zinc finger protein interactions (Tam et al., 2017).

Epigenetic alteration of gene expression is also affected by arsenic-induced changes in microRNAs, which have been linked to inhibited DNA repair, increased sensitivity to oxidative stress, and cellular transformation, and have been proposed to be used as biomarkers of arsenic exposure (Sturchio et al., 2014). Various cohorts of arsenic exposed people around the world have been evaluated for changes in microRNA expression to understand which microRNAs may be playing a role in disease progression (Al-Eryani et al., 2018a; Banerjee et al., 2019; Beck et al., 2018; Ruiz-Vera et al., 2019). Specific microRNAs have been linked with arsenic-induced skin lesions and cancers. For example, Banerjee et al., 2017 found miR-21 contributes to skin lesion and cancer in chronically exposed individuals.

Cell culture studies have looked closely at the role of specific microRNAs altered by arsenic exposure in targeted pathways of cancers. A study of prolonged exposure to arsenic used HaCaT cells as a model for skin cancer and identified dynamic changes in microRNA expression at different stages of exposure and transformation (Banerjee et al., 2022). Looking at specific microRNAs, Gonzalez et al., 2015 found arsenic upregulated miR-21, miR-200a, and miR-141 expression, and determined a likely association with pathways of melanoma progression. Another cell culture study found miR-200b was associated with malignant transformation of bronchial epithelial cells (Wang et al., 2011). These studies have investigated associations between microRNAs and cellular transformation and carcinogenesis. Others have focused on earlier processes in arsenic carcinogenesis. For example, arsenic altered microRNAs were implicated in targeting specific pathways such as the TP53 pathway, implicated to have early effects contributing to carcinogenesis (Al-Eryani et al., 2018b). An *in vivo* study in rats found arsenic-responsive microRNAs are likely involved in pathways of oxidative stress, specifically related to genes that regulate GSH levels (Ren et al., 2015).

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

MicroRNA studies in human populations and in experimental models have been used to understand how they may affect DNA repair. For example, Wei et al., 2018 found miR-145 was upregulated in individuals exposed to toxic levels of arsenic, and this effect was replicated in a cell culture model where it was found to target expression of ERCC2, potentially having a negative impact on DNA repair. From these studies it is likely microRNAs play a role in pathways of arsenic-induced carcinogenesis and modulating expression DNA repair genes.

Protein Effects

Arsenic-dependent changes to protein expression were discussed above. However, arsenic also affects protein directly. Recent studies have focused on how arsenic affects protein folding signaling pathways and protein function. For example, arsenic induced endoplasmic reticulum protein folding stress, which contributed to autophagy defects but not oxidative stress suggesting this effect is independent of ROS (Dodson et al., 2018). Endoplasmic reticulum protein folding effects have been observed in other arsenic studies as well and is associated with autophagy (Wadgaonkar and Chen, 2021).

While arsenic-altered protein expression and processing contribute to carcinogenic mechanisms, studies show arsenic can interact with zinc finger proteins causing inhibited function, and as briefly mentioned in Section 1, has a significant effect on zinc finger protein interactions. Zinc finger proteins are highly sensitive to oxidation due to thiol groups that play a central role in their function (Krishna et al., 2003). This structure is protected and maintained by a zinc ion, which coordinates a combination of 4 cysteine and histidine residues within the zinc finger domain. Zinc fingers can be found in several arrangements of cysteine and histidine including C2H2, C3H1, C4 and more complex structures like C4C4 ring domains (Klug et al., 2010; Razin et al., 2012). These structures are largely responsible for protein binding nucleic acids and with other proteins (Eom et al., 2016; Fu and Blackshear, 2017).

The mechanisms of arsenic disruption of zinc finger proteins involves the direct displacement of zinc by arsenic within the zinc finger domain. However, different forms of arsenic bind the specific zinc finger orientations depending on the ratio of cysteine and histidine. In general, arsenic has a lower binding affinity for protein with one or two cysteines compared to those with three or four (Asmuss et al., 2000; Kitchin and Wallace, 2006a; Kitchen and Wallace, 2006b). However, while arsenite and arsenic trioxide show a preference to bind to C3H1 and C4 zing finger domains methylated arsenic can bind to all three C2H2, C3H1, and C4 types (Zhou et al., 2014). Details of specific forms of arsenic in carcinogenic mechanisms is discussed in Section 3. Arsenic is similar enough to zinc to competitively displace it from the zinc finger, but in doing so induces a conformational shift within the domain altering how the protein functions (Quintal et al., 2011). The selectivity of different forms of arsenic to bind zinc finger domains with specific combinations of cysteine and histidine also suggests binding selectivity and may impact specific carcinogenic mechanisms differently.

Arsenic displacement of zinc has significant implications for protein in many cell regulatory pathways affecting DNA repair and gene expression (Huestis et al., 2016; Zhou et al.,

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

2020a). Many studies have focused on the impact of arsenic on zinc finger proteins involved in DNA repair (Cooper et al., 2014; Ding et al., 2017; Tam et al., 2020; Zhou et al., 2011; Zhou et al., 2015). After DNA damage, repair proteins must form complexes around the damage site, which requires binding to the damaged DNA. DNA-binding proteins use zinc fingers for this purpose, and therefore if disrupted, can destabilize DNA repair complexes at sites of damage and inhibit repair. The DNA repair protein PARP-1 is a C3H1 zinc finger DNA binding protein shown to be a sensitive target of arsenic exposure inhibiting its function (Ding et al., 2009; Walter et al., 2007). This disruption interferes with DNA binding and recruitment of other DNA repair factors involved in different pathways of repair including NER and BER (Chaudhuri et al., 2017). Arsenic was also found to bind and displace zinc in XPA, a critical DNA repair factor in NER (Huestis et al., 2016).

Arsenic may impact DNA repair by modulating access to sites of DNA damage. Zhang et al., 2014 found arsenic was able to bind to RNF20 and RNF40 RING finger domains causing a conformational shift in these proteins. The RNF20 and RNF40 RING fingers are responsible for the monoubiquitinating histone H2B and promoting access of DNA double strand break repair factors to sights of DNA damage (Zhang et al., 2014). Indeed, Recruitment of DNA repair factors including the HR repair protein, RAD51, to sites of double strand breaks was impaired after arsenic exposure. Similarly, arsenic was found to bind the FANCL E3 ubiquitin ligase and RING finger protein, altering recruitment of DNA repair factors to sites of DNA interstrand crosslinks (Jiang et al., 2017). These studies demonstrate arsenic can impact the function of different types of zinc finger proteins. Additionally, this interference affects different mechanisms of DNA damage repair and recruitment highlighting the dynamic and vast effect arsenic can have on cellular processes.

Signaling Pathways

Altered signaling after arsenic exposure contributes to checkpoint control, DNA repair response, and cell survival changes linking them together. Many pathways altered by arsenic exposure are interconnected and likely affect multiple mechanisms of arsenic carcinogenesis. One study using arsenic as a case study predicted top pathways associated with arsenic exposure include stress response, apoptosis, cell cycle, and protein signaling pathways such as MAPK, Jak-STAT, and p53 (Davis et al., 2008). MAPK signaling disruption has been observed in cell culture studies to increase cell invasiveness (Tingting et al., 2010). Predictions on arsenic's effect in signaling pathways including JNK, EGFR, AKT, PI3L, mTOR, and Nrf2-Keap1 have been extensively validated in other studies as well (Chen et al., 2013; Kang and Lee, 2008; Fu et al., 2021; Wang et al., 2017). These pathways are interconnected but are largely related to cell survival and escape from cell death and transformation.

The EGFR pathway has been closely linked with alterations of DNA repair and cell proliferation after arsenic exposure. Tong et al., 2015 found DNA mismatch repair was inhibited after arsenic exposure by promoting EGFR expression. Another study found EGFR and HB-EGF were activated in arsenic-transformed cells to promote cell proliferation (Wang et al., 2020). Recently a study in lung epithelial cells found EGFR expression was enhanced

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

after acute and chronic arsenic exposure, but the mechanism responsible for these changes was different depending on the exposure time (Kim et al., 2020).

The balance of cell survival and cell death pathways are shifted after arsenic exposure (Dreval et al., 2018; Watcharasit et al., 2012). The Nrf2-Keap1 signaling pathway is a cellular mechanism implicated in promoting cell survival and when dysregulated is considered to have cancer-promoting functions. Specifically, constitutively active Nrf2 leads to a variety of downstream implications including altered expression of growth factors, antioxidant proteins, transcription factors, and protein processing due to its activity in binding antioxidant response elements (AREs) in the promoter of genes (Hayes et al., 2010). Studies show arsenic constitutively activates Nrf2 is closely tied to the alteration of the autophagy pathway (Lau et al., 2013; Zhou et al., 2020b). Indeed, studies show arsenic increases autophagy activity (Bolt et al., 2010; Pucer et al., 2010).

Many studies have investigated the PI3K AKT, and mTOR pathways in arsenic cellular transformation and malignancy (Chen and Costa, 2018). When these pathways are unregulated normal cell growth becomes aberrant. Chronic arsenic exposure alters the PI3K/AKT pathway and is associated with anchorage-independent growth and cell migration (Carpenter and Jiang, 2013). Other studies have found autophagy dysfunction is tied to PI3K and mTOR signaling (Liang et al., 2020). Evidence shows in arsenic-transformed cells the AKT pathway is implicated in enhancing invasiveness (Wang et al., 2012) while being regulated upstream by JNK to promote alterations in phosphorylation of proteins involved in altering expression of tumor suppressors and oncogenes (Chen et al., 2013).

SECTION 3: CHEMICAL FORMS OF ARSENIC AND CARCINOGENESIS

Inorganic and Organic Arsenic Forms, Exposure, and Metabolism

Arsenic exists in several different oxidation states and various chemical forms (Carlin at al., 2016; Bolt and Henglestler, 2018). There are two major oxidation states of arsenicals, trivalent and pentavalent. Both oxidation states exist naturally (Carlin at al., 2016; Zhu et al., 2014). Arsenic occurs naturally in many minerals, usually in combination with sulfur and metals. Humans can be exposed to arsenic through different forms and oxidation states, and metabolism of arsenic also converts one form or oxidation state to another (Watanabe and Hirano, 2013). Each form/oxidation state may have different exposure routes, organ/tissue distribution, toxicity, and carcinogenic effects (Watanabe and Hirano, 2013; Sattar et al., 2016). There are two major forms of arsenicals, inorganic and organic. Inorganic arsenicals are the major form of arsenic exposure, occupationally and environmentally. Organic arsenicals are mainly acknowledged as metabolites of arsenic, specifically, in methylated forms (Negro Silva et al., 2017; Cohen et al. 2006).

Trivalent arsenicals are found in the form of sodium/potassium arsenite and arsenic trioxide (Dopp et al., 2005). Pentavalent arsenicals are mainly found as sodium arsenate. The environmental existence of inorganic arsenicals is in two major phases, solid and a liquid. Inorganic arsenicals in ground water can be found in both trivalent and pentavalent forms (Zheng et al., 2017). The trivalent and pentavalent forms mainly exist in oxic and anoxic

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

waters, respectively, due to their chemical properties. Drinking water is a major source of environmental exposure of inorganic arsenicals (Carlin at al., 2016; Zhu et al., 2014; Mantha et al., 2017). As mentioned in Section 1 arsenicals may also be accumulated in plants through irrigation (Zhu et al., 2014; Mantha et al., 2017; Dominguez-Gonzales et al., 2020), such as rice and vegetables, which also serve as a significant source of inorganic arsenic exposures. Trivalent and pentavalent arsenicals also exist in soil which leads to inhalation exposure from dust (Liu et al., 2016, Alamdar et al., 2016). Occupational exposure of arsenic can occur in facilities that manufacture pesticides, herbicides, and other agricultural products (Baker et al., 2018). Mine smelters and woodworking facilities are also major sources of occupational inorganic arsenic exposures.

Organic arsenicals are not commonly found naturally in the environment. Organic arsenicals include arsanilic acid, arsenosugars, and methylated arsenicals. Methylated arsenicals are produced as a consequence of inorganic arsenic biotransformation in various organisms. Humans may be exposed to methylated arsenicals from ingestion of seafood and meat (Yoshinaga and Narukawa, 2021; Naess et al., 2020).

Trivalent arsenic uptake into eukaryotes is mediated mainly by proteins in the aquaporin superfamily (AQPs) (Agre et al., 2002). Mammalian AQPs were first identified to transport trivalent arsenic in rat and mice as AQP9 and AQP7, respectively (Liu et al., 2002). Meanwhile, trivalent arsenic has also been shown to be taken up by glucose transporters such as GLUT1 (Liu et al., 2006) and hexose permeases (Liu et al., 2004). Both aquaglyceroporins and glucose permeases are bidirectional routes of trivalent arsenic into and out of cells.

Organic arsenic forms contribute to arsenic toxicity mainly through metabolic pathways. The metabolism of arsenic after absorption consists of two major types of reactions; oxidative methylation and reduction (Li et al., 2017; Hughes et al., 2011) (Figure 4). First, arsenite is oxidatively methylated into monomethylarsonic acid (MMA^V). MMA^V is thus reduced into monomethylarsonous acid (MMA^{III}). Second, MMA^{III} is oxidatively methylated into dimethylarsonic acid (DMA^V), then reduced into dimethylarsonous acid (DMA^{III}). The metabolism of arsenic plays a critical role in toxicity and carcinogenesis. The exact mechanisms of action of different arsenic forms is still unclear, but various hypotheses have been proposed.

Under drinking water exposure, an animal study of organ distribution of arsenicals suggested that kidney, lung and liver contain highest levels of arsenic (Li et al., 2013). In lung, the major form is DMA^{III} at almost all time points (Kenyon et al., 2005). At early stages of exposure, liver and kidney contain all forms of arsenicals, such as MMA^{III}, MMA^V, DMA^{III}, DMA^V, and inorganic arsenic. At later stages, both liver and kidney show an increase in the percentage of DMA^{III} in arsenicals (Kenyon et al., 2005). In contrast, blood and brain contains the lowest level of all arsenic forms compared to other organs across all time points. Inorganic and organic arsenicals were also reported to be strongly accumulated in reproductive organs (Pant et al., 2004).

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

The subcellular distribution of arsenicals largely depends on the cell type. According to the characteristics of arsenic metabolism, there are two different types of cells, methylating (such as hepatocytes) and non-methylating (such as urothelial cells) (Dopp et al., 2010). The membrane permeability and the efficacy of arsenic uptake depend upon both the arsenic species and the cell type (Dopp et al., 2005). Uptake rates of MMA^{III} and DMA^{III} were highest and exceeded those of their pentavalent counterparts by several orders of magnitude. Non-methylating cells accumulate higher amounts of arsenic within the cell than the methylating cells, and cellular uptake and efflux seem to be faster in methylating cells. Elevated concentrations of arsenic are present in the ribosomal fraction of non-methylating cells and in nucleic and mitochondrial fractions of methylating cells. However, cytotoxic and genotoxic effects are more pronounced in methylating cells (Dopp et al. 2008), which also suggests that methylated forms of arsenic may have greater cytotoxic effects than inorganic arsenic forms.

Carcinogenesis of Arsenic Forms

Arsenic exposure is mainly in the form of trivalent inorganic arsenic through gastrointestinal absorption. Different forms and oxidation state of arsenicals play various roles in carcinogenesis (Wadgaonkar and Chen, 2021). Some research indicates that organic arsenic forms such as MMA and DMA are most relevant to skin and bladder cancers (Gamboa-Loira et al., 2017). MMA and DMA are both positively related to almost all types of cancers (Gamboa-Loira et al., 2017; Di Giovanni et al., 2020; Kuo et al., 2017; Jomova et al., 2011). However, DMA level was found to be negatively correlated to lung cancer only (Gamboa-Loira et al., 2017).

MMA^{III} induces malignant transformation in a human bladder urothelial cell line (Bredfeldt et al., 2006), and this kind of transformation is irreversible (Wnek et al., 2010). Acute and chronic MMA^{III} exposure induces MAPK and COX-2, which may be a mechanism of bladder carcinogenesis (Eblin et al., 2007). Also, MMA^{III} alters histone modification patterns in human bladder cells (Ge et al., 2018). There are still gaps in research progress on organic arsenic forms and liver and lung cancers.

The molecular mechanisms of arsenic induction of various cancers can be summarized into two major categories: a) the trivalent arsenicals activate or inhibit signaling proteins or alter protein structure by reacting with proteinaceous thiol groups and b) inorganic or organic arsenicals activate ROS signaling or ROS-related signaling pathways. Carcinogenesis of inorganic arsenicals is related to both mechanisms. However, organic arsenicals are predominantly reported to correspond to ROS-dependent mechanisms at present (Huang et al., 2017). Current literature suggests that both inorganic and organic arsenicals contribute to arsenic carcinogenesis. It remains to be determined which specific form of arsenic is the most carcinogenic, although the answer may likely depend on the chemical properties of arsenical and the target organ.

Forms of Arsenic and Reactive Oxygen Species

Almost all forms and oxidation states of arsenicals can induce ROS and relevant signaling pathways (Lee et al., 2016). For example, for arsenic trioxide, superoxide induction occurs

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

through HO-1, hydrogen peroxide and also RNS such as nitric oxide and peroxynitrite (Zhou et al., 2019; Chen et al., 2008; Gurr et al., 2003). In murine embryonic maxillary mesenchymal cells, pentavalent arsenic leads to oxidative injury initiating cell death cascade, triggering cytotoxicity, mitochondrial dysfunction, and activation of caspase-9 (Singh et al., 2010). Specifically, the antioxidant N-acetylcysteine attenuates the effect of pentavalent arsenic, suggesting that ROS production may contribute to the mechanism of pentavalent arsenic cytotoxicity.

In human bladder urothelial cells, MMA^{III} is known to produce ROS (Wnek et al., 2011). In smooth muscle cells, MMA^{III} has been reported as a mitochondria toxicant that elevates ROS through mitochondrial and non-mitochondrial pathways (Pace et al., 2016). In rat liver cells, MMA^{III} has the highest potential of ROS generation, followed by DMA^{III}, then arsenic trioxide (Naranmandura et al., 2011). In human bladder urothelial cells, MMA^{III} was also observed to generate higher ROS than the same concentration of arsenic trioxide (Eblin et al., 2006). In human myeloid leukemic HL-60 cells, MMA^{III} and DMA^{III} cause apoptosis through inhibition to mitochondrial membrane potential and oxidative stress (Rehman et al., 2014). Caspase-9 and caspase-3 were significantly activated by MMA^{III} and DMA^{III} exposure. Similarly, antioxidant N-acetylcysteine is also able to reverse these effects (Rehman et al., 2014).

In HepG2 cells, MMA^{V}, DMA^{V}, or trimethylarsine (TMA^{V}) significantly induced CYP1A1 and NQO1 through an Hsp90 pathway (Anwar-Mohamed et al., 2014). ROS production by MMA^{V} exposure is also significantly higher than arsenic trioxide. Overall, MMA^{V} and DMA^{V} have moderate effect when compared to MMA^{III} and DMA^{III}, but the effects become stronger in a reductive environment, for example when there is a low ROS/GSH ratio (Sakurai et al., 2005).

In total, inorganic and organic arsenicals both contribute to ROS generation and ROS-dependent signaling pathways. However, there are still debates on which arsenic form generates higher ROS *in vivo*. It is still largely unclear whether metabolism of arsenic could enhance or reduce the strength of ROS effect. In addition, there is still limited knowledge on the differences of ROS type generated from different arsenicals, which should be of importance to ROS-related mechanisms.

Forms of Arsenic and DNA Damage/Repair

As mentioned in Section 2, trivalent arsenic inhibits DNA repair through direct interaction with zinc finger DNA repair proteins such as PARP-1 and XPA. For pentavalent arsenicals, there is no evidence currently demonstrating direct interaction with zinc fingers. However, pentavalent arsenicals are able to generate ROS which are not only able to induce DNA damage but also impair DNA repair pathways (Flora, 2011; Schwerdtle et al., 2003). Therefore, in contrast to trivalent arsenicals, which inhibit DNA repair through both direct and ROS pathways, pentavalent arsenicals inhibit DNA repair only through ROS-dependent signaling pathways.

In natural killer cells, at low concentration, MMA^{III} induces oxidative stress, DNA damage, and inhibits cell growth. DNA damage positively correlates with oxidative stress, indicating

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

that at environmentally relevant concentrations, MMA^{III} has a genotoxic effect (Xu and Wang, 2018). In human bladder urothelial cells, low-level chronic exposure to MMA^{III} elevates DNA damage, which remains at a high level after removal of MMA^{III}, and elevated levels of ROS also play a role in MMA^{III} induced-DNA damage (Wnek et al., 2009). While pentavalent arsenicals only act through ROS-dependent pathways, MMA^{III} has two potential interdependent mechanisms for human bladder urothelial cell transformation; elevated levels of MMA^{III}-induced DNA damage through the production of ROS and the direct MMA^{III}-induced inhibition of PARP-1 (Wnek et al., 2011), which has been confirmed *in vitro* (Zhou et al., 2014).

In T cells, MMA^{III} induces strong genotoxicity in the early developing T cells in the thymus. In terms of MMA^{III} induced genotoxicity and apoptosis, double negative ($CD4^{-}$ $CD8^{-}$) T cells were much more sensitive than double positive cells (Xu et al., 2017). ROS-dependent mechanisms are particularly important. For example, superoxide is involved either directly or indirectly in producing DNA damage in cells exposed to trivalent methylated arsenicals. DMA^{III} and MMA^{III} produced significantly more DNA damage in the homozygous knockout mouse splenocytes than in the splenocytes from the wild-type or heterozygous mice (Tennant and Kligerman, 2011).

Overall, the DNA damage effect and DNA repair inhibition capabilities of various arsenic forms and oxidative states largely depend on the tissue or cell type. Intriguingly, in bladder or human urothelial cells, DMA^{III} and MMA^{III} are the most hazardous arsenicals when considering cytotoxicity and genotoxicity (Bailey et al., 2012; Wang et al., 2007). However, in lung and skin cells, trivalent arsenicals show higher potency for DNA damage (Bolt and Hengstler, 2018; Sattar et al., 2016). This may be because of a difference in metabolism or cellular arsenic uptake.

Conclusion

There is extensive and strong epidemiological evidence that links arsenic exposure with increased risk of developing various types of cancer. Arsenic is ranked number one by the Agency for Toxic Substances and Disease Registry (ATSDR) on their priority list of substances that are determined to pose the most significant potential threat to human health. The most effective and efficient strategy to decrease arsenic-induced cancer risk is to reduce arsenic exposure. Based on convincing research findings, in 2001, U.S. EPA adopted a new standard for arsenic in drinking water of 0.01 mg/l or 10 parts per billion (ppb), replacing the old standard of 50 ppb. The same standard has since been used by most countries around the world. However, it is estimated that over 200 million people world-wide remain exposed to arsenic above this level (Li and Costa 2022).

Over the last several decades, extensive research has been carried out to investigate and identify various molecular and cellular changes caused by arsenic that are associated with known carcinogenic processes. Despite tremendous progress to date, we still do not fully understand exactly how arsenic causes cancer development, and what are the key cancer-driving events that play critical roles in arsenic-induced cancer. One of the significant barriers in research is the lack of relevant and appropriate animal models that mimic the

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

development of arsenic-induced cancer in humans, probably due to differences in genetics and arsenic metabolism between rodents and humans. Recent development in humanized mice could potentially provide an important tool to help resolve these critical questions (Koller et al., 2020).

Another major issue is that while current research has identified many individual molecular targets of arsenic involved in carcinogenic processes, it is difficult to assess which of these altered processes are predominantly responsible for arsenic-induced cancer in humans. The recent advances in whole genome sequencing and the associated informatics technology could help identify, using unbiased approaches, target molecules and processes that drive the mutation and tumorigenesis at the whole genome level.

Abbreviations

8-OHdG	8-hydroxy-2'-deoxyguanosine
AQP	aquaporin
AS3MT	arsenic methyltransferase
ATSDR	Agency for Toxic Substances and Disease Registry
BER	base excision repair
CPD	cyclobutene pyrimidine dimer
DMA	Dimethylated arsenic
DMA^{III}	dimethylarsonous acid
DMA^{V}	dimethylarsonic acid
EPA	US Environmental Protection Agency
GSH	glutathione
HR	homologous recombination
IARC	International Agency for Research on Cancer
MMA	Monomethylated arsenic
MMA^{III}	monomethylarsonous acid
MMA^{V}	monomethylarsonic acid
NER	nucleotide excision repair
NHEJ	non-homologous end joining
NOX	NADPH oxidase
PAH	polyaromatic hydrocarbons

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

RNS	Reactive nitrogen species
ROS	Reactive oxygen species
TMA(V)	trimethylarsine
UVR	ultraviolet radiation
WHO	World Health Organization

References

Abuawad A, Bozack AK, Saxena R, Gamble MV, 2021. Nutrition, one-carbon metabolism and arsenic methylation. Toxicology. 10.1016/i.tox.2021.152803.

Agency for Toxic Substances and Disease Registry (ATSDR). 2007. Toxicological profile for Arsenic. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. Available at: http://www.atsdr.cdc.gov/ToxProfiles/tp2.pdf.

Agency for Toxic Substances and Disease Registry (ATSDR). 2016. Addendum to Toxicological profile for Arsenic. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. Available at: https://www.atsdr.cdc.gov/toxprofiles/Arsenic_addendum.pdf.

Agency for Toxic Substances and Disease Registry (ATSDR) Substance Priority List, https://www.atsdr.cdc.gov/spl/index.html

Agre P, 2002. Aquaporin water channels–from atomic structure to clinical medicine. J Physiol 542, 3–16,. 10.1113/iphvsiol.2002.020818 [PubMed: 12096044]

Alamdar A, 2016. Human Arsenic exposure via dust across the different ecological zones of Pakistan. Ecotoxicol Environ Saf 126, 219–227,. 10.1016/i.ecoenv.2015.12.044 [PubMed: 26773831]

Al-Eryani L, Jenkins SF, States VA, Pan J, Malone JC, Rai SN, Galandiuk S, Giri AK, States JC, 2018a. miRNA expression profiles of premalignant and malignant arsenic-induced skin lesions. PLOS ONE 13, 0202579. 10.1371/iournal.pone.0202579e

Al-Eryani L, Waigel S, Tyagi A, Peremarti J, Jenkins SF, Damodaran C, States JC, 2018b. Differentially Expressed mRNA Targets of Differentially Expressed miRNAs Predict Changes in the TP53 Axis and Carcinogenesis-Related Pathways in Human Keratinocytes Chronically Exposed to Arsenic. Toxicological Sciences 162, 645–654. 10.1093/toxsci/kfx292 [PubMed: 29319823]

Amin RW, Stafford B, Guttmann RP, 2019. A spatial study of bladder cancer mortality and incidence in the contiguous US: 2000–2014. Sci Total Environ. 10.1016/i.scitotenv.2019.03.290.

Andrew AS, Burgess JL, Meza MM, Demidenko E, Waugh MG, Hamilton JW, Karagas MR, 2006. Arsenic Exposure Is Associated with Decreased DNA Repair in Vitro and in Individuals Exposed to Drinking Water Arsenic. Environmental Health Perspectives 114, 1193–1198. 10.1289/ehp.9008 [PubMed: 16882524]

Andrew AS, Karagas MR, Hamilton JW, 2003. Decreased DNA repair gene expression among individuals exposed to arsenic in United States drinking water. International Journal of Cancer 104, 263–268. 10.1002/iic.10968 [PubMed: 12569548]

Anwar-Mohamed A, 2014. Methylated pentavalent arsenic metabolites are bifunctional inducers, as they induce cytochrome P450 1A1 and NAD(P)H:quinone oxidoreductase through AhR- and Nrf2-dependent mechanisms. Free Radic Biol Med 67, 171–187,. 10.1016/i.freeradbiomed.2013.10.810 [PubMed: 24161444]

Applebaum KM, Karagas MR, Hunter DJ, Catalano PJ, Byler SH, Morris S, Nelson HH, 2007. Polymorphisms in Nucleotide Excision Repair Genes, Arsenic Exposure, and Non-Melanoma Skin Cancer in New Hampshire. Environmental Health Perspectives 115, 1231–1236. 10.1289/ehp.10096 [PubMed: 17687452]

Asmuss M, Mullenders LHF, Eker A, Hartwig A, 2000. Differential effects of toxic metal compounds on the activities of Fpg and XPA, two zinc finger proteins involved in DNA repair. Carcinogenesis 21, 2097–2104. 10.1093/carcin/21.11.2097 [PubMed: 11062174]

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Arslan B, Djamgoz MBA, Akün E, 2017. ARSENIC: A Review on Exposure Pathways, Accumulation, Mobility and Transmission into the Human Food Chain. Rev Environ Contam Toxicol 243, 27–51. 10.1007/398201618 [PubMed: 28005215]

Au WY, 2011. A biography of arsenic and medicine in Hong Kong and China. Hong Kong Med J 17, 507–513. [PubMed: 22147326]

Bailey KA, 2012. Transcriptional Modulation of the ERK1/2 MAPK and NF-kappaB Pathways in Human Urothelial Cells After Trivalent Arsenical Exposure: Implications for Urinary Bladder Cancer. J Can Res Updates 1, 57–68. [PubMed: 23487506]

Bailey KA, Wu MC, Ward WO, Smeester L, Rager JE, García-Vargas G, Del Razo L-M, Drobná Z, Stýblo M, Fry RC, 2013. Arsenic and the Epigenome: Interindividual Differences in Arsenic Metabolism Related to Distinct Patterns of DNA Methylation. Journal of Biochemical and Molecular Toxicology 27, 106–115. 10.1002/ibt.21462 [PubMed: 23315758]

Baker BA, Cassano VA, Murray C, Exposure, A.T.F. o A., 2018. Arsenic Exposure, Assessment, Toxicity, Diagnosis, and Management: Guidance for Occupational and Environmental Physicians. J Occup Environ Med 60, 634–639,. 10.1097/J0M.0000000000001485

Balakumar BS, Ramanathan K, Kumaresan S, Suresh R, 2012. DNA damage by sodium arsenite in experimental rats: ameliorative effects of antioxidant vitamins. C and E. Ind J Sci Tech 322–327.

Banerjee M, Al-Eryani L, Srivastava S, Rai SN, Pan J, Kalbfleisch TS, States JC, 2022. Delineating the Effects of Passaging and Exposure in a Longitudinal Study of Arsenic-Induced Squamous Cell Carcinoma in a HaCaT Cell Line Model. Toxicological Sciences 185, 184–196. 10.1093/toxsci/kfab129 [PubMed: 34730829]

Banerjee M, Sarkar J, Das JK, Mukherjee A, Sarkar AK, Mondal L, Giri AK, 2007. Polymorphism in the ERCC2 codon 751 is associated with arsenic-induced premalignant hyperkeratosis and significant chromosome aberrations. Carcinogenesis 28, 672–676. 10.1093/carcin/bgl181 [PubMed: 17050553]

Banerjee N, Bandyopadhyay AK, Dutta S, Das JK, Roy Chowdhury T, Bandyopadhyay A, Giri AK, 2017. Increased microRNA 21 expression contributes to arsenic induced skin lesions, skin cancers and respiratory distress in chronically exposed individuals. Toxicology 378, 10–16. 10.1016/i.tox.2017.01.006 [PubMed: 28069514]

Banerjee N, Das S, Tripathy S, Bandyopadhyay AK, Sarma N, Bandyopadhyay A, Giri AK, 2019. MicroRNAs play an important role in contributing to arsenic susceptibility in the chronically exposed individuals of West Bengal, India. Environ Sci Pollut Res 26, 28052–28061. 10.1007/s11356-019-05980-8

Baris D, Waddell R, Beane Freeman LE, Schwenn M, Colt JS, Ayotte JD, Ward MH, Nuckols J, Schned A, Jackson B, Clerkin C, Rothman N, Moore LE, Taylor A, Robinson G, Hosain GM, Armenti KR, McCoy R, Samanic C, Hoover RN, JF F Jr, Johnson A, Karagas MR, Silverman DT, 2016. Elevated Bladder Cancer in Northern New England: The Role of Drinking Water and Arsenic. J Natl Cancer Inst. 10.1093/^^^099.

Basu A, Ghosh P, Das JK, Banerjee A, Ray K, Giri AK, 2004. Micronuclei as Biomarkers of Carcinogen Exposure in Populations Exposed to Arsenic Through Drinking Water in West Bengal, India: A Comparative Study in Three Cell Types. Cancer Epidemiol Biomarkers Prev 13, 820–827. [PubMed: 15159315]

Bau D-T, Wang T-S, Chung C-H, Wang ASS, Wang ASS, Jan K-Y, 2002. Oxidative DNA adducts and DNA-protein cross-links are the major DNA lesions induced by arsenite. Environmental Health Perspectives 110, 753–756. 10.1289/ehp.02110s5753 [PubMed: 12426126]

Beck R, Bommarito P, Douillet C, Kanke M, Del Razo LM, García-Vargas G, Fry RC, Sethupathy P, Stýblo M, 2018. Circulating miRNAs Associated with Arsenic Exposure. Environ. Sci. Technol 52, 14487–14495. 10.1021/acs.est.8b06457 [PubMed: 30457847]

Bedaiwi A, Wysong A, Rogan EG, Clarey D, Arcari CM, 2021. Arsenic Exposure and Melanoma Among US Adults Aged 20 or Older, 2003-2016. Public Health Rep. 10.1177/00333549211008886.

Bencko V, Yan Li Foong F, 2017. The history of arsenical pesticides and health risks related to the use of Agent Blue. Ann Agric Environ Med 24, 312–316. 10.26444/aaem/74715. [PubMed: 28664715]

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Bhattacharjee P, Sanyal T, Bhattacharjee S, Bhattacharjee P, 2018. Epigenetic alteration of mismatch repair genes in the population chronically exposed to arsenic in West Bengal, India. Environmental Research 163, 289–296. 10.1016/i.envres.2018.01.002 [PubMed: 29499398]

Biswas J, Sinha D, Mukherjee S, Roy S, Siddiqi M, Roy M, 2010. Curcumin protects DNA damage in a chronically arsenic-exposed population of West Bengal. Hum Exp Toxicol 29, 513–524. 10.1177/0960327109359020 [PubMed: 20056736]

Boffetta P, Hel O, Norppa H, Fabianova E, Fucic A, Gundy S, Lazutka J, Cebulska-Wasilewska A, Puskailerova D, Znaor A, Kelecsenyi Z, Kurtinaitis J, Rachtan J, Forni A, Vermeulen R, Bonassi S, 2007. Chromosomal Aberrations and Cancer Risk: Results of a Cohort Study from Central Europe. American Journal of Epidemiology 165, 36–43. 10.1093/aie/kwi367 [PubMed: 17071846]

Boffetta P, Zunarelli C, Borron C, 2020. Dose-Response Analysis of Exposure to Arsenic in Drinking Water and Risk of Skin Lesions: A Systematic Review of the Literature. Dose Response 21;18(4):1559325820957823. 10.1177/1559325820957823.

Bolt AM, Byrd RM, Klimecki WT, 2010. Autophagy is the predominant process induced by arsenite in human lymphoblastoid cell lines. Toxicology and Applied Pharmacology 244, 366–373. 10.1016/i.taap.2010.01.019 [PubMed: 20153345]

Bolt HM, Hengstler JG, 2018. Contemporary trends in toxicological research on arsenic. Arch Toxicol 92, 3251–3253,. 10.1007/s00204-018-2311-z [PubMed: 30244273]

Bredfeldt TG, Jagadish B, Eblin KE, Mash EA, Gandolfi AJ, 2006. Monomethylarsonous acid induces transformation of human bladder cells. Toxicol Appl Pharmacol 216, 69–79,. 10.1016/i.taap.2006.04.011 [PubMed: 16806342]

Broberg K, Ahmed S, Engström K, Hossain MB, Mlakar SJ, Bottai M, Grandér M, Raqib R, Vahter M, 2014. Arsenic exposure in early pregnancy alters genome-wide DNA methylation in cord blood, particularly in boys. Journal of Developmental Origins of Health and Disease 5, 288–298. 10.1017/S2040174414000221 [PubMed: 24965135]

Carlin DJ, 2016. Arsenic and Environmental Health: State of the Science and Future Research Opportunities. Environ Health Perspect 124, 890–899,. 10.1289/ehp.1510209 [PubMed: 26587579]

Carpenter L, R. J,B-H, 2013. Roles of EGFR, PI3K, AKT, and mTOR in Heavy Metal-Induced Cancer. Current Cancer Drug Targets 13, 252–266. [PubMed: 23297824]

Chang CW, Ou CH, Yu CC, Lo CW, Tsai CY, Cheng PY, Chen YT, Huang HC, Wu CC, Li CC, Lee HY, 2021. Comparative analysis of patients with upper urinary tract urothelial carcinoma in black-foot disease endemic and non-endemic area. BMC Cancer 10.1186/s12885-021-07799-4.

Chatterjee D, Adak S, Banerjee N, Bhattacharjee P, Bandyopadhyay AK, Giri AK, 2018. Evaluation of health effects, genetic damage and telomere length in children exposed to arsenic in West Bengal, India, in: Mutation Research/Genetic Toxicology and Environmental Mutagenesis, In Memory of Professor Adayapalam T Natarajan. pp. 82–88. 10.1016/j.mrgentox.2018.06.012

Chayapong J, Madhyastha H, Madhyastha R, Nurrahmah QI, Nakajima Y, Choijookhuu N, Hishikawa Y, Maruyama M, 2017. Arsenic trioxide induces ROS activity and DNA damage, leading to G0/G1 extension in skin fibroblasts through the ATM-ATR-associated Chk pathway. Environ Sci Pollut Res 24, 5316–5325. 10.1007/s11356-016-8215-7

Chen B, Liu J, Chang Q, Beezhold K, Lu Y, Chen F, 2013. JNK and STAT3 signaling pathways converge on Akt-mediated phosphorylation of EZH2 in bronchial epithelial cells induced by arsenic. Cell Cycle 12, 112–121. 10.4161/cc.23030 [PubMed: 23255093]

Chen CL, Chiou HY, Hsu LI, Hsueh YM, Wu MM, Chen CJ, 2010. Ingested arsenic, characteristics of well water consumption and risk of different histological types of lung cancer in northeastern Taiwan. Environ Res. 10.1016/i.envres.2009.08.010.

Chen CL, Hsu LI, Chiou HY, Hsueh YM, Chen SY, Wu MM, Chen CJ, 2004. Blackfoot Disease Study Group. Ingested arsenic, cigarette smoking, and lung cancer risk: a follow-up study in arseniasis-endemic areas in Taiwan. JAMA. 10.1001/jama.292.24.2984.

Chen QY, & Costa M (2021). Arsenic: A Global Environmental Challenge. Annual Review of Pharmacology and Toxicology, 61(1), 47–63. 10.1146/annurev-pharmtox-030220-013418.

Chen QY, Costa M, 2018. PI3K/Akt/mTOR Signaling Pathway and the Biphasic Effect of Arsenic in Carcinogenesis. Mol Pharmacol 94, 784–792. 10.1124/mol.118.112268. [PubMed: 29769245]

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Chen SC, Chen WC, 2008. Vascular leakage induced by exposure to arsenic via increased production of NO, hydroxyl radical and peroxynitrite. Microvasc Res 75, 373–380,. 10.1016/i.mvr.2007.12.004. [PubMed: 18243249]

Chen Y, Graziano JH, Parvez F, Hussain I, Momotaj H, Geen A, Howe GR, Ahsan H, 2006. Modification of risk of arsenic-induced skin lesions by sunlight exposure, smoking, and occupational exposures in Bangladesh. Epidemiology. 10.1097/01.ede.0000220554.50837.7f.

Cheng PS, Weng SF, Chiang CH, Lai FJ, 2016. Relationship between arsenic-containing drinking water and skin cancers in the arseniasis endemic areas in Taiwan. J Dermatol. 10.1111/1346-8138.13058.

Choudhury MIM, Shabnam N, Ahsan T, Ahsan SMA, Kabir MS, Khan RM, Miah MA, Uddin MK, Liton MAR, 2018. Cutaneous Malignancy due to Arsenicosis in Bangladesh: 12-Year Study in Tertiary Level Hospital. Biomed Res Int. 10.1155/2018/4678362.

Chung CJ, Huang YL, Huang YK, Wu MM, Chen SY, Hsueh YM, Chen CJ, 2013. Urinary arsenic profiles and the risks of cancer mortality: a population-based 20-year follow-up study in arseniasis-endemic areas in Taiwan. Environ Res. 10.1016/i.envres.2012.11.007.

Cohen SM, Arnold LL, Eldan M, Lewis AS, Beck BD, 2006. Methylated arsenicals: the implications of metabolism and carcinogenicity studies in rodents to human risk assessment. Crit Rev Toxicol 36, 99–133,. 10.1080/10408440500534230 [PubMed: 16736939]

Coluzzi E, Colamartino M, Cozzi R, Leone S, Meneghini C, O'Callaghan N, Sgura A, 2014. Oxidative Stress Induces Persistent Telomeric DNA Damage Responsible for Nuclear Morphology Change in Mammalian Cells. PLOS ONE 9, 110963. 10.1371/iournal.pone.0110963

Cooper KL, Volk LB, Dominguez DR, Duran AD, Ke Jian Liu KJ, Hudson LG, 2022. Contribution of NADPH oxidase to the retention of UVR-induced DNA damage by arsenic. Toxicol Appl Pharmacol 434, 115799. 10.1016/i.taap.2021.115799 [PubMed: 34798142]

Cooper KL, Yager JW, Hudson LG, 2014. Melanocytes and keratinocytes have distinct and shared responses to ultraviolet radiation and arsenic. Toxicology Letters 224, 407–415. 10.1016/i.toxlet.2013.11.010 [PubMed: 24270004]

Critical Aspects of Environmental Protection Agency's (EPA's) IRIS Assessment of Inorganic Arsenic: Interim Report, 2014.The National Academies Press.

Davis AP, Murphy CG, Rosenstein MC, Wiegers TC, Mattingly CJ, 2008. The Comparative Toxicogenomics Database facilitates identification and understanding of chemical-gene-disease associations: arsenic as a case study. BMC Medical Genomics 1, 48. 10.1186/1755-8794-1-48 [PubMed: 18845002]

Delgado DA, Chernoff M, Huang L, Tong L, Chen L, Jasmine F, Shinkle J, Cole SA, Haack K, Kent J, Umans J, Best LG, Nelson H, Griend DV, Graziano J, Kibriya MG, Navas-Acien A, Karagas MR, Ahsan H, Pierce BL, 2021. Rare, Protein-Altering Variants in AS3MT and Arsenic Metabolism Efficiency: A Multi-Population Association Study. Environ Health Perspect. 10.1289/EHP8152.

Ding W, Hudson LG, Liu KJ, 2005. Inorganic arsenic compounds cause oxidative damage to DNA and protein by inducing ROS and RNS generation in human keratinocytes. Mol Cell Biochem 279, 105–112. 10.1007/s11010-005-8227-y [PubMed: 16283519]

Ding W, Liu W, Cooper KL, Qin X-J, Bergo P.L. de S., Hudson LG, Liu KJ, 2009. Inhibition of Poly(ADP-ribose) Polymerase-1 by Arsenite Interferes with Repair of Oxidative DNA Damage *. Journal of Biological Chemistry 284, 6809–6817. 10.1074/ibc.M805566200 [PubMed: 19056730]

Ding X, Zhang A, Li C, Ma L, Tang S, Wang Q, Yang G, Li J, 2021. The role of H3K9me2-regulated base excision repair genes in the repair of DNA damage induced by arsenic in HaCaT cells and the effects of Ginkgo biloba extract intervention. Environmental Toxicology 36, 850–860. 10.1002/tox.23088 [PubMed: 33378118]

Ding X, Zhou X, Cooper KL, Huestis J, Hudson LG, Liu KJ, 2017. Differential sensitivities of cellular XPA and PARP-1 to arsenite inhibition and zinc rescue. Toxicology and Applied Pharmacology, Recent advances in metal toxicity and carcinogenesis research 331, 108–115. 10.1016/i.taap.2017.05.031

Dodson M, Vega MR, Harder B, Castro-Portuguez R, Rodrigues SD, Wong PK, Chapman E, Zhang DD, 2018. Low-level arsenic causes proteotoxic stress and not oxidative stress. Toxicology and Applied Pharmacology 341, 106–113. 10.1016/i.taap.2018.01.014 [PubMed: 29408041]

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Dominguez-Gonzalez MR, Barciela-Alonso MC, Calvo-Millan VG, Herbello-Hermelo P, Bermejo-Barrera P, 2020. The bioavailability of arsenic species in rice. Anal Bioanal Chem 412, 3253–3259,. 10.1007/s00216-020-02589-6 [PubMed: 32270245]

Dong J-T, Luo X-M, 1993. Arsenic-induced DNA-strand breaks associated with DNA—protein crosslinks in human fetal lung fibroblasts. Mutation Research Letters 302, 97–102. 10.1016/0165-7992(93)90010-S

Dopp E, von Recklinghausen U, Diaz-Bone R, Hirner AV, Rettenmeier AW, 2010. Cellular uptake, subcellular distribution and toxicity of arsenic compounds in methylating and non-methylating cells. Environmental Research, 2nd International Congress, As 2008: Arsenic from Nature to Humans (Valencia, Spain, May 21-23) 110, 435–442. 10.1016/i.envres.2009.08.012 [PubMed: 19758587]

Dopp E, 2008. Subcellular distribution of inorganic and methylated arsenic compounds in human urothelial cells and human hepatocytes. Drug Metab Dispos 36, 971–979,. 10.1124/dmd.107.019034 [PubMed: 18256204]

Dopp E, 2005. Forced uptake of trivalent and pentavalent methylated and inorganic arsenic and its cyto-/genotoxicity in fibroblasts and hepatoma cells. Toxicol Sci 87, 46–56,. 10.1093/toxsci/kfi218 [PubMed: 15947026]

Dreval K, Tryndyak V, Kindrat I, Twaddle NC, 2018. Cellular and Molecular Effects of Prolonged Low-Level Sodium Arsenite Exposure on Human Hepatic HepaRG Cells. Toxicological Sciences 162, 676–687. 10.1093/toxsci/kfx290 [PubMed: 29301061]

Du X, Tian M, Wang X, Zhang J, Huang Q, Liu L, Shen H, 2018. Cortex and hippocampus DNA epigenetic response to a long-term arsenic exposure via drinking water. Environmental Pollution 234, 590–600. 10.1016/j.envpol.2017.11.083 [PubMed: 29223816]

Dulout FN, Grillo CA, Seoane AI, Maderna CR, Nilsson R, Vahter M, Darroudi F, Natarajan AT, 1996. Chromosomal aberrations in peripheral blood lymphocytes from native Andean women and children from Northwestern Argentina exposed to arsenic in drinking water. Mutation Research/Genetic Toxicology 370, 151–158. 10.1016/S0165-1218(96)00060-2

Dutta K, Prasad P, Sinha D, 2015. Chronic low level arsenic exposure evokes inflammatory responses and DNA damage. International Journal of Hygiene and Environmental Health 218, 564–574. 10.1016/i.iiheh.2015.06.003 [PubMed: 26118750]

Dutta PK, Pehkonen SO, Sharma VK, Ray AK, 2005. Photocatalytic Oxidation of Arsenic(III): Evidence of Hydroxyl Radicals. Environ. Sci. Technol 39, 1827–1834. 10.1021/es0489238 [PubMed: 15819243]

Ebert F, Weiss A, Bültemeyer M, Hamann I, Hartwig A, Schwerdtle T, 2011. Arsenicals affect base excision repair by several mechanisms. Mutation Research/Fundamental and Molecular Mechanisms of Mutagenesis 715, 32–41. 10.1016/i.mrfmmm.2011.07.004 [PubMed: 21782832]

Eblin KE, 2006. Arsenite and monomethylarsonous acid generate oxidative stress response in human bladder cell culture. Toxicol Appl Pharmacol 217, 7–14,. 10.1016/i.taap.2006.07.004 [PubMed: 16930658]

Eblin KE, Bredfeldt TG, Buffington S, Gandolfi AJ, 2007. Mitogenic signal transduction caused by monomethylarsonous acid in human bladder cells: role in arsenic-induced carcinogenesis. Toxicol Sci 95, 321–330,. 10.1093/toxsci/kfl160 [PubMed: 17093206]

Eguchi N, Kuroda K, Endo G, 1997. Metabolites of Arsenic Induced Tetraploids and Mitotic Arrest in Cultured Cells. Arch. Environ. Contam. Toxicol 32, 141–145. 10.1007/s002449900166 [PubMed: 9069188]

Eom KS, Cheong JS, Lee SJ, 2016. Structural Analyses of Zinc Finger Domains for Specific Interactions with DNA. Journal of Microbiology and Biotechnology 26, 2019–2029. 10.4014/imb.1609.09021 [PubMed: 27713215]

Farzan SF, Shahriar M, Kibriya MG, Jasmine F, Sarwar G, Slavkovic V, Graziano JH, Ahsan H, Argos M, 2021. Urinary arsenic and relative telomere length in 5–7 year old children in Bangladesh. Environment International 156, 106765. 10.1016/i.envint.2021.106765 [PubMed: 34273872]

Fernández MI, Valdebenito P, Delgado I, Segebre J, Chaparro E, Fuentealba D, Castillo M, Vial C, Barroso JP, Ziegler A, Bustamante A, 2020. Impact of arsenic exposure on clinicopathological

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

characteristics of bladder cancer: A comparative study between patients from an arsenic-exposed region and nonexposed reference sites. Urol Oncol. 10.1016/i.urolonc.2019.09.013.

Ferreccio C, Smith AH, Durán V, Barlaro T, Benítez H, Valdés R, Aguirre JJ, Moore LE, Acevedo J, Vásquez MI, Pérez L, Yuan Y, Liaw J, Cantor KP, Steinmaus C, 2013a. Case-control study of arsenic in drinking water and kidney cancer in uniquely exposed Northern Chile. Am J Epidemiol 1;178(5):813–8. 10.1093/aje/kwt059. [PubMed: 23764934]

Ferreccio C, Yuan Y, Calle J, Benítez H, Parra RL, Acevedo J, Smith AH, Liaw J, Steinmaus C, 2013b. Arsenic, tobacco smoke, and occupation: associations of multiple agents with lung and bladder cancer. Epidemiology. 10.1097/EDE.0b013e31829e3e03.

Flora SJ, 2011. Arsenic-induced oxidative stress and its reversibility. Free Radic Biol Med 51, 257–281,. 10.1016/i.freeradbiomed.2011.04.008 [PubMed: 21554949]

Flora SJS, Bhadauria S, Kannan GM, Singh N, 2007. Arsenic induced oxidative stress and the role of antioxidant supplementation during chelation: a review. J Environ Biol 28, 333–347. [PubMed: 17929749]

Fu M, Blackshear PJ, 2017. RNA-binding proteins in immune regulation: a focus on CCCH zinc finger proteins. Nat Rev Immunol 17, 130–143. 10.1038/nri.2016.129 [PubMed: 27990022]

Fu S-C, Lin J-W, Liu J-M, Liu S-H, Fang K-M, Su C-C, Hsu R-J, Wu C-C, Huang C-F, Lee K-I, Chen Y-W, 2021. Arsenic induces autophagy-dependent apoptosis via Akt inactivation and AMPK activation signaling pathways leading to neuronal cell death. NeuroToxicology 85, 133–144. 10.1016/i.neuro.2021.05.008 [PubMed: 34038756]

Gamboa-Loira B, Cebrián ME, Franco-Marina F, Lñpez-Carrillo L, 2017. Arsenic metabolism and cancer risk: A meta-analysis. Environ Res. 10.1016/i.envres.2017.04.016.

Gao J, Roy S, Tong L, Argos M, Jasmine F, Rahaman R, Rakibuz-Zaman M, Parvez F, Ahmed A, Hore SK, Sarwar G, Slavkovich V, Yunus M, Rahman M, Baron JA, Graziano JH, Ahsan H, Pierce BL, 2015. Arsenic exposure, telomere length, and expression of telomere-related genes among Bangladeshi individuals. Environmental Research 136, 462–469. 10.1016/i.envres.2014.09.040 [PubMed: 25460668]

Garman GD, Anderson SL, Cherr GN, 1997. Developmental abnormalities and DNA-protein crosslinks in sea urchin embryos exposed to three metals. Aquatic Toxicology 39, 247–265. 10.1016/S0166-445X(97)00033-7

Ge Y, 2018. Mapping dynamic histone modification patterns during arsenic-induced malignant transformation of human bladder cells. Toxicol Appl Pharmacol 355, 164–173,. 10.1016/i.taap.2018.06.029 [PubMed: 29966674]

Ge Y, Zhu J, Wang X, Zheng N, Tu C, Qu J, Ren X, 2018. Mapping dynamic histone modification patterns during arsenic-induced malignant transformation of human bladder cells. Toxicology and Applied Pharmacology 355, 164–173. 10.1016/i.taap.2018.06.029 [PubMed: 29966674]

Gebel T, Birkenkamp P, Luthin S, Dunkelberg H, 1998. Arsenic(III), but not antimony(III), induces DNA-protein crosslinks. Anticancer Res 18, 4253–4257. [PubMed: 9891475]

Ghosh P, Banerjee M, Chaudhuri S, Das JK, Sarma N, Basu A, Giri AK, 2007. Increased chromosome aberration frequencies in the Bowen's patients compared to non-cancerous skin lesions individuals exposed to arsenic. Mutation Research/Genetic Toxicology and Environmental Mutagenesis 632, 104–110. 10.1016/i.mrgentox.2007.05.005

Ghosh P, Basu A, Mahata J, Basu S, Sengupta M, Das JK, Mukherjee A, Sarkar AK, Mondal L, Ray K, Giri AK, 2006. Cytogenetic damage and genetic variants in the individuals susceptible to arsenic-induced cancer through drinking water. International Journal of Cancer 118, 2470–2478. 10.1002/iic.21640 [PubMed: 16353154]

Ghosh S, Basu M, Banerjee K, Chaudhury SP, Paul T, Bera DK, Pal DK, Sk UH, Panda CK, Ghosh A, 2021. Arsenic level in bladder tumor of patients from an exposed population: association with progression and prognosis. Future Oncol. 10.2217/fon-2020-0154.

Giovanni P, 2020. Arsenic Exposure and Risk of Urothelial Cancer: Systematic Review and Meta-Analysis. Int J Environ Res Public Health 17. 10.3390/iierph17093105 [PubMed: 33375123]

Gonzalez H, Lema C, Kirken A,R, R. AM, V.-R. A, J.A. R, 2015. Arsenic-exposed Keratinocytes Exhibit Differential microRNAs Expression Profile; Potential Implication of miR-21, miR-200a and miR-141 in Melanoma Pathway. Clinical Cancer Drugs 2, 138–147. [PubMed: 27054085]

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Gossai A, Zens MS, Punshon T, Jackson BP, Perry AE, Karagas MR, 2017. Rice Consumption and Squamous Cell Carcinoma of the Skin in a United States Population. Environ Health Perspect 7;125(9):097005. 10.1289/EHP1065.

Grau-Perez M, Zhao J, Pierce B, Francesconi KA, Goessler W, Zhu Y, An Q, Umans J, Best L, Cole SA, Navas-Acien A, Tellez-Plaza M, 2019. Urinary metals and leukocyte telomere length in American Indian communities: The Strong Heart and the Strong Heart Family Study. Environmental Pollution 246, 311–318. 10.1016/i.envpol.2018.12.010 [PubMed: 30557805]

Guillamet E, Creus A, Ponti J, Sabbioni E, Fortaner S, Marcos R, 2004. In vitro DNA damage by arsenic compounds in a human lymphoblastoid cell line (TK6) assessed by the alkaline Comet assay. Mutagenesis 19, 129–135. 10.1093/mutage/geh005 [PubMed: 14981159]

Gundert-Remy U, Damm G, Foth H, Freyberger A, Gebel T, Golka K, Röhl C, Schupp T, Wollin KM, Hengstler JG, 2015. High exposure to inorganic arsenic by food: the need for risk reduction. Arch Toxicol. 10.1007/s00204-015-1627-1.

Guo HR, Wang NS, Hu H, Monson RR, 2004. Cell type specificity of lung cancer associated with arsenic ingestion. Cancer Epidemiol Biomarkers Prev Apr;13(4):638–43.

Gurr JR, 2003. Nitric oxide production by arsenite. Mutat Res 533, 173–182,. 10.1016/i.mrfmmm.2003.08.024 [PubMed: 14643419]

Hayes John D., McMahon M, Chowdhry S, Dinkova-Kostova AT, 2010. Cancer Chemoprevention Mechanisms Mediated Through the Keap1–Nrf2 Pathway. Antioxidants & Redox Signaling 13, 1713–1748. 10.1089/ars.2010.3221 [PubMed: 20446772]

Hayes JD, McMahon M, Chowdhry S, Dinkova-Kostova AT, 2010. Cancer chemoprevention mechanisms mediated through the Keap1–Nrf2 pathway. Antioxid Redox Signal 13, 1713–1748. 10.1089/ars.2010.3221 [PubMed: 20446772]

Heck JE, Andrew AS, Onega T, Rigas J, JR BP, K. MR, D. EJ, 2009. Lung cancer in a U.S. population with low to moderate arsenic exposure. Environ Health Perspect. 10.1289/ehp.0900566.

Holcomb N, Goswami M, Han SG, Scott T, D'Orazio J, Orren DK, Gairola CG, Mellon I, 2017. Inorganic arsenic inhibits the nucleotide excision repair pathway and reduces the expression of XPC. DNA Repair 52, 70–80. 10.1016/i.dnarep.2017.02.009 [PubMed: 28237621]

Hossain MB, Vahter M, Concha G, Broberg K, 2012. Environmental arsenic exposure and DNA methylation of the tumor suppressor gene p16 and the DNA repair gene MLH1: effect of arsenic metabolism and genotype. Metallomics 4, 1167–1175. 10.1039/c2mt20120h [PubMed: 23073540]

Hosseini M-J, Shaki F, Ghazi-Khansari M, Pourahmad J, 2013. Toxicity of Arsenic (III) on Isolated Liver Mitochondria: A New Mechanistic Approach. Iran J Pharm Res 12, 121–138. [PubMed: 24250680]

Hu L, Yang F, Lu L, Dai W, 2017. Arsenic-induced sumoylation of Mus81 is involved in regulating genomic stability. Cell Cycle 16, 802–811. 10.1080/15384101.2017.1302628 [PubMed: 28318385]

Hu Y, Su L, Snow ET, 1998. Arsenic toxicity is enzyme specific and its affects on ligation are not caused by the direct inhibition of DNA repair enzymes1Supported by: the Electric Power Research Institute, Agreement No. WO3370-22, in: Additional Support Was Provided by the NYU/NIEHS Center Grant (ES00260), the NYU Medical Center Kaplan Comprehensive Cancer Center (CA13343), and the American Cancer Society, Minnesota Division. 1. Mutation Research/DNA Repair 408. pp. 203–218. 10.1016/S0921-8777(98)00035-4 [PubMed: 9806419]

Huang CY, Lin YC, Shiue HS, Chen WJ, Su CT, Pu YS, Ao PL, Hsueh YM, 2018. Comparison of arsenic methylation capacity and polymorphisms of arsenic methylation genes between bladder cancer and upper tract urothelial carcinoma. Toxicol Lett. 10.1016/i.toxlet.2018.05.035.

Huang HH, Huang JY, Lung CC, Wu CL, Ho CC, Sun YH, Ko PC, Su SY, Chen SC, Liaw YP, 2013. Cell-type specificity of lung cancer associated with low-dose soil heavy metal contamination in Taiwan: an ecological study. BMC Public Health. 10.1186/1471-2458-13-330.

Huang P, Zhang YH, Zheng XW, Liu YJ, Zhang H, Fang L, Zhang YW, Yang C, Islam K, Wang C, Naranmandura H, 2017. Phenylarsine oxide (PAO) induces apoptosis in HepG2 cells via ROS-mediated mitochondria and ER-stress dependent signaling pathways. Metallomics 9, 1756–1764. 10.1039/c7mt00179g [PubMed: 28831476]

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Huang Q, Zhan L, Cao H, Li J, Lyu Y, Guo X, Zhang J, Ji L, Ren T, An J, Liu B, Nie Y, Xing J, 2016. Increased mitochondrial fission promotes autophagy and hepatocellular carcinoma cell survival through the ROS-modulated coordinated regulation of the NFKB and TP53 pathways. Autophagy 12, 999–1014. 10.1080/15548627.2016.1166318 [PubMed: 27124102]

Huestis J, Zhou X, Chen L, Feng C, Hudson LG, Liu KJ, 2016. Kinetics and thermodynamics of zinc(II) and arsenic(III) binding to XPA and PARP-1 zinc finger peptides. Journal of Inorganic Biochemistry 163, 45–52. 10.1016/i.iinorgbio.2016.08.0Q3 [PubMed: 27521476]

Hughes MF, Beck BD, Chen Y, Lewis AS, Thomas DJ, 2011. Arsenic exposure and toxicology: a historical perspective. Toxicol Sci 123, 305–332,. 10.1093/toxsci/kfr184 [PubMed: 21750349]

Hunt KM, Srivastava RK, Elmets CA, Athar M, 2014. The mechanistic basis of arsenicosis: pathogenesis of skin cancer. Cancer Lett 28;354(2):211–9. 10.1016/i.canlet.2014.08.016. [PubMed: 25173797]

Intarasunanont P, Navasumrit P, Waraprasit S, Chaisatra K, Suk WA, Mahidol C, Ruchirawat M, 2012. Effects of arsenic exposure on DNA methylation in cord blood samples from newborn babies and in a human lymphoblast cell line. Environmental Health 11, 31. 10.1186/1476-069X-11-31 [PubMed: 22551203]

Jiang J, Bellani M, Li L, Wang P, Seidman MM, Wang Y, 2017. Arsenite Binds to the RING Finger Domain of FANCL E3 Ubiquitin Ligase and Inhibits DNA Interstrand Crosslink Repair. ACS Chem. Biol 12, 1858–1866. 10.1021/acschembio.6b01135 [PubMed: 28535027]

Jimenez Villarreal J, Murillo Ortiz B, Martinez Garza S, Rivas Armendáriz DI, Boone Villa VD, Carranza Rosales P, Betancourt Martínez ND, Delgado Aguirre H, Morán Martínez J, 2019. Telomere length analysis in residents of a community exposed to arsenic. Journal of Biochemical and Molecular Toxicology 33, 22230. 10.1002/ibt.22230

Jo WJ, Ren X, Chu F, Aleshin M, Wintz H, Burlingame A, Smith MT, Vulpe CD, Zhang L, 2009. Acetylated H4K16 by MYST1 protects UROtsa cells from arsenic toxicity and is decreased following chronic arsenic exposure. Toxicology and Applied Pharmacology 241, 294–302. 10.1016/j.taap.2009.08.027 [PubMed: 19732783]

John PJ, Kumar N, 2022. Mechanistic Basis of Arsenic Induced Carcinogenesis: Differential miRNA Expression (preprint. Review. 10.21203/rs.3.rs-1141158/v1

Jomova K, 2011. Arsenic: toxicity, oxidative stress and human disease. J Appl Toxicol 31, 95–107,. 10.10Q2/iat.1649 [PubMed: 21321970]

Kadirvel R, Sundaram K, Mani S, Samuel S, Elango N, Panneerselvam C, 2007. Supplementation of ascorbic acid and α-tocopherol prevents arsenic-induced protein oxidation and DNA damage induced by arsenic in rats. Hum Exp Toxicol 26, 939–946. 10.1177/09603271070879Q9 [PubMed: 18375637]

Kang Y-H, Lee S-J, 2008. The role of p38 MAPK and JNK in Arsenic trioxide-induced mitochondrial cell death in human cervical cancer cells. Journal of Cellular Physiology 217, 23–33. 10.1002/icp.21470 [PubMed: 18412143]

Karagas MR, Gossai A, Pierce B, Ahsan H, 2015. Drinking Water Arsenic Contamination, Skin Lesions, and Malignancies: A Systematic Review of the Global Evidence. Curr Environ Health Rep. 10.1007/s40572-014-004Q-x.

Karagas MR, Punshon T, Davis M, Bulka CM, Slaughter F, Karalis D, Argos M, Ahsan H, 2019. Rice Intake and Emerging Concerns on Arsenic in Rice: a Review of the Human Evidence and Methodologic Challenges. Curr Environ Health Rep. 10.1007/s40572-019-00249-1.

Karagas MR, Tosteson TD, Morris JS, Demidenko E, Mott LA, Heaney J, Schned A, 2004. Incidence of transitional cell carcinoma of the bladder and arsenic exposure in New Hampshire. Cancer Causes Control. 10.1023/B:CACQ.0000036452.55199.a3.

Kashiwada E, Kuroda K, Endo G, 1998. Aneuploidy induced by dimethylarsinic acid in mouse bone marrow cells. Mutation Research/Genetic Toxicology and Environmental Mutagenesis 413, 33–38. 10.1016/S1383-5718(98)00011-4

Kawanishi S, Hiraku Y, 2006. Oxidative and Nitrative DNA Damage as Biomarker for Carcinogenesis with Special Reference to Inflammation. Antioxidants & Redox Signaling 8, 1047–1058. 10.1089/ars.2006.8.1047 [PubMed: 16771694]

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Kayajanian G, 2003. Arsenic, cancer, and thoughtless policy. Ecotoxicology and Environmental Safety 55, 139–142. 10.1016/S0147-6513(02)00042-8 [PubMed: 12742359]

Kenyon EM, Del Razo LM, Hughes MF, 2005. Tissue distribution and urinary excretion of inorganic arsenic and its methylated metabolites in mice following acute oral administration of arsenate. Toxicol Sci 85, 468–475,. 10.1093/toxsci/kfi107 [PubMed: 15703264]

Kessel M, Liu SX, Xu A, Santella R, Heil TK, 2002. Arsenic induces oxidative DNA damage in mammalian cells, in: Vallyathan V, Shi X, Castranova V. (Eds.), Oxygen/Nitrogen Radicals: Cell Injury and Disease, Developments in Molecular and Cellular Biochemistry. Springer US, Boston, MA, pp. 301–308. 10.1007/978-1-4615-1087-134

Kim C, States JC, Ceresa BP, 2020. Chronic and acute arsenic exposure enhance EGFR expression via distinct molecular mechanisms. Toxicology in Vitro 67, 104925. 10.1016/i.tiv.2020.104925 [PubMed: 32599262]

Kitchin KT, Wallace K, 2006a. Dissociation of arsenite-peptide complexes: Triphasic nature, rate constants, half-lives, and biological importance. Journal of Biochemical and Molecular Toxicology 20, 48–56. 10.1002/ibt.20108 [PubMed: 16498640]

Kitchin KT, Wallace K, 2006b. Arsenite binding to synthetic peptides: The effect of increasing length between two cysteines. Journal of Biochemical and Molecular Toxicology 20, 35–38. 10.1002/ibt.20112 [PubMed: 16498636]

Klionsky DJ, 2007. Autophagy: from phenomenology to molecular understanding in less than a decade. Nat Rev Mol Cell Biol 8, 931–937. 10.1038/nrm2245 [PubMed: 17712358]

Klug A, 2010. The discovery of zinc fingers and their development for practical applications in gene regulation and genome manipulation. Quarterly Reviews of Biophysics 43, 1–21. 10.1017/S0033583510000089 [PubMed: 20478078]

Koller BH, Snouwaert JN, Douillet C, Jania LA, El-Masri H, Thomas DJ, Stýblo M, 2020. Arsenic Metabolism in Mice Carrying a *BORCS7/AS3MT* Locus Humanized by Syntenic Replacement. Environ Health Perspect. 128(8):87003. 10.1289/EHP6943. [PubMed: 32779937]

Koutros S, Baris D, Waddell R, Beane Freeman LE, Colt JS, Schwenn M, Johnson A, Ward MH, Hosain GM, Moore LE, Stolzenberg-Solomon R, Rothman N, Karagas MR, Silverman DT, 2018. Potential effect modifiers of the arsenic-bladder cancer risk relationship. Int J Cancer 1;143(11):2640–2646. 10.1002/iic.31720. [PubMed: 29981168]

Krajewski AK, Jimenez MP, Rappazzo KM, Lobdell DT, Jagai JS, 2021. Aggregated cumulative county arsenic in drinking water and associations with bladder, colorectal, and kidney cancers, accounting for population served. J Expo Sci Environ Epidemiol. 10.1038/s41370-021-00314-8.

Krishna SS, Majumdar I, Grishin NV, 2003. Structural classification of zinc fingers: SURVEY AND SUMMARY. Nucleic Acids Research 31, 532–550. 10.1093/nar/gkg161 [PubMed: 12527760]

Kumar M, Lalit M, Thakur R, 2016. Natural Antioxidants Against Arsenic-Induced Genotoxicity. Biol Trace Elem Res 170, 84–93. 10.1007/s12011-015-04487 [PubMed: 26242483]

Kuo CC, Moon KA, Wang SL, Silbergeld E, Navas-Acien A, 2017b. The Association of Arsenic Metabolism with Cancer, Cardiovascular Disease, and Diabetes: A Systematic Review of the Epidemiological Evidence. Environ Health Perspect 125, 087001. 10.1289/EHP577 [PubMed: 28796632]

Kuo YC, Lo YS, Guo HR, 2017a. Lung Cancer Associated with Arsenic Ingestion: Cell-type Specificity and Dose Response. Epidemiology 2017a Oct;28 Suppl 1:S106–S112. 10.1097/EDE.0000000000000743.

Lai Y, Zhao W, Chen C, Wu M, Zhang Z, 2011. Role of DNA polymerase beta in the genotoxicity of arsenic. Environmental and Molecular Mutagenesis 52, 460–468. 10.1002/em.20643 [PubMed: 21370284]

Lamm SH, Boroje IJ, Ferdosi H, Ahn J, 2021. A review of low-dose arsenic risks and human cancers. Toxicology. 10.1016/i.tox.2021.152768.

Langston ME, Brown HE, Lynch CF, Roe DJ, Dennis LK, 2022. Ambient UVR and Environmental Arsenic Exposure in Relation to Cutaneous Melanoma in Iowa. International Journal of Environmental Research and Public Health. 10.3390/iierph19031742

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Lau A, Zheng Y, Tao S, Wang H, Whitman SA, White E, Zhang DD, 2013. Arsenic Inhibits Autophagic Flux, Activating the Nrf2-Keap1 Pathway in a p62-Dependent Manner. Molecular and Cellular Biology 33, 2436–2446. 10.1128/MCB.01748-12 [PubMed: 23589329]

Lee CH, Yu HS, 2016. Role of mitochondria, ROS, and DNA damage in arsenic induced carcinogenesis. 10.2741/s465

Lewińska D, Palus J, Stępnik M, Dziubałtowska E, Beck J, Rydzyński K, Natarajan AT, Nilsson R, 2007. Micronucleus frequency in peripheral blood lymphocytes and buccal mucosa cells of copper smelter workers, with special regard to arsenic exposure. Int Arch Occup Environ Health 80, 371–380. 10.1007/s00420-006-0130-7 [PubMed: 17277946]

Li AH, Costa M, 2022. Chapter 11 - Selected molecular mechanisms of metal toxicity and carcinogenicity, in: Nordberg GF, Costa M (Eds.), Handbook on the Toxicology of Metals (Fifth Edition). Academic Press, pp. 253–278. 10.1016/B978-Q-12-823292-7.00008-5

Li H, 2013. Distribution of arsenic species and its DNA damage in subchronic arsenite-exposed mice. Wei Sheng Yan Jiu 42, 764–769, 776. [PubMed: 24218882]

Li J, Ma L, Wang X, Li D, Zeng Q, Xing X, Li C, Xie L, Chen L, Chen W, Zhang A, 2016. Modifications of H3K9me2, H3K36me3 and H4K20me2 may be involved in arsenic-induced genetic damage. Toxicology Research 5, 1380–1387. 10.1039/c6tx00117c [PubMed: 30090442]

Li J, Packianathan C, Rossman TG, Rosen BP, 2017. Nonsynonymous Polymorphisms in the Human AS3MT Arsenic Methylation Gene: Implications for Arsenic Toxicity. Chem Res Toxicol 30, 1481–1491,. 10.1021/acs.chemrestox.7b00113 [PubMed: 28537708]

Li X, Sun D, Zhao T, Zhang Z, 2020. Long non-coding RNA ROR confers arsenic trioxide resistance to HepG2 cells by inhibiting p53 expression. European Journal of Pharmacology 872, 172982. 10.1016/i.eiphar.2020.172982 [PubMed: 32017938]

Liang C, Feng Z, Manthari RK, Wang C, Han Y, Fu W, Wang J, Zhang J, 2020. Arsenic induces dysfunctional autophagy via dual regulation of mTOR pathway and Beclin1-Vps34/PI3K complex in MLTC-1 cells. Journal of Hazardous Materials 391, 122227. 10.1016/i.ihazmat.2020.122227 [PubMed: 32044640]

Liaw J, Marshall G, Yuan Y, Ferreccio C, Steinmaus C, Smith AH, 2008. Increased childhood liver cancer mortality and arsenic in drinking water in northern Chile. Cancer Epidemiol Biomarkers Prev. 10.1158/1055-9965.EPI-07-2816.

Lin YC, Chen WJ, Huang CY, Shiue HS, Su CT, Ao PL, Pu YS, Hsueh YM, 2018. Polymorphisms of Arsenic (+3 Oxidation State) Methyltransferase and Arsenic Methylation Capacity Affect the Risk of Bladder Cancer. Toxicol Sci. 10.1093/toxsci/kfy087.

Liu L, Trimarchi JR, Navarro P, Blasco MA, Keefe DL, 2003. Oxidative Stress Contributes to Arsenic-induced Telomere Attrition, Chromosome Instability, and Apoptosis*. Journal of Biological Chemistry 278, 31998–32004. 10.1074/ibc.M303553200 [PubMed: 12767976]

Liu Y, 2016. Bioaccessibility and health risk assessment of arsenic in soil and indoor dust in rural and urban areas of Hubei province, China. Ecotoxicol Environ Saf 126, 14–22,. 10.1016/i.ecoenv.2015.11.037 [PubMed: 26707184]

Liu Z, 2006. Mammalian glucose permease GLUT1 facilitates transport of arsenic trioxide and methylarsonous acid. Biochem Biophys Res Commun 351, 424–430,. 10.1016/i.bbrc.2006.10.054 [PubMed: 17064664]

Liu Z, 2002. Arsenite transport by mammalian aquaglyceroporins AQP7 and AQP9. Proc Natl Acad Sci U S A 99, 6053–6058,. 10.1073/pnas.092131899 [PubMed: 11972053]

Liu Z, Boles E, Rosen BP, 2004. Arsenic trioxide uptake by hexose permeases in Saccharomyces cerevisiae. J Biol Chem 279, 17312–17318,.10.1074/ibc.M314006200 [PubMed: 14966117]

Lynn S, Shiung J-N, Gurr J-R, Jan KY, 1998. Arsenite Stimulates Poly(ADP-Ribosylation) by Generation of Nitric Oxide. Free Radical Biology and Medicine 24, 442–449. 10.1016/S0891-5849(97)00279-7 [PubMed: 9438557]

Lyon, 2004. International Agency for Research on Cancer: IARC Working Group on the Evaluation of Carcinogenic Risk to Humans. Some Drinking-water Disinfectants and Contaminants, including Arsenic In: IARC Monographs on the Evaluation of Carcinogenic Risks to Humans.

Mahajan L, Verma PK, Raina R, Pankaj NK, Sood S, Singh M, 2018. Alteration in thiols homeostasis, protein and lipid peroxidation in renal tissue following subacute oral exposure of imidacloprid

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

and arsenic in Wistar rats. Toxicology Reports 5, 1114–1119. 10.1016/i.toxrep.2018.11.003 [PubMed: 30456172]

Mahata J, Basu A, Ghoshal S, Sarkar JN, Roy AK, Poddar G, Nandy AK, Banerjee A, Ray K, Natarajan AT, Nilsson R, Giri AK, 2003. Chromosomal aberrations and sister chromatid exchanges in individuals exposed to arsenic through drinking water in West Bengal, India. Mutation Research/Genetic Toxicology and Environmental Mutagenesis 534, 133–143. 10.1016/S1383-5718(02)00255-3

MÄki-Paakkanen J, Kurttio P, Paldy A, Pekkanen J, 1998. Association between the clastogenic effect in peripheral lymphocytes and human exposure to arsenic through drinking water. Environmental and Molecular Mutagenesis 32, 301–313. 10.1002/(SICI)1098-2280(1998)32:4 [PubMed: 9882004]

Mantha M, 2017. Estimating Inorganic Arsenic Exposure from U.S. Rice and Total Water Intakes. Environ Health Perspect 125, 057005. 10.1289/EHP418 [PubMed: 28572075]

Marshall G, Ferreccio C, Yuan Y, Bates MN, Steinmaus C, Selvin S, Liaw J, Smith AH, 2007. Fifty-year study of lung and bladder cancer mortality in Chile related to arsenic in drinking water. J Natl Cancer Inst. 10.1093/inci/dim004.

Martinez VD, Lam WL, 2021. Health Effects Associated With Pre- and Perinatal Exposure to Arsenic. Front Genet. 10.3389/fgene.2021.664717.

Matthews NH, Fitch K, Li WQ, Morris JS, Christiani DC, Qureshi AA, Cho E, 2019. Exposure to Trace Elements and Risk of Skin Cancer: A Systematic Review of Epidemiologic Studies. Cancer Epidemiol Biomarkers Prev. 10.1158/1055-9965.EPI-18-0286.

Mauro M, Caradonna F, Klein CB, 2016. Dysregulation of DNA methylation induced by past arsenic treatment causes persistent genomic instability in mammalian cells. Environmental and Molecular Mutagenesis 57, 137–150. 10.1002/em.21987 [PubMed: 26581878]

Melak D, Ferreccio C, Kalman D, Parra R, Acevedo J, Pérez L, Cortés S, Smith AH, Yuan Y, Liaw J, Steinmaus C, 2014. Arsenic methylation and lung and bladder cancer in a case-control study in northern Chile. Toxicol Appl Pharmacol. 10.1016/i.taap.2013.11.014.

Mitkovska VI, Dimitrov HA, Chassovnikarova TG, 2020. Chronic exposure to lead and cadmium pollution results in genomic instability in a model biomonitor species (Apodemus flavicollis Melchior, 1834. Ecotoxicology and Environmental Safety 194, 110413. 10.1016/i.ecoenv.2020.110413 [PubMed: 32163775]

Moore LE, Smith AH, Eng C, Kalman D, DeVries S, Bhargava V, Chew K, Moore II D, Ferreccio C, Rey OA, Waldman FM, 2002. Arsenic-Related Chromosomal Alterations in Bladder Cancer. JNCI: Journal of the National Cancer Institute 94, 1688–1696. 10.1093/inci/94.22.1688 [PubMed: 12441324]

Moore Lee E., Warner ML, Smith AH, Kalman D, Smith MT, 1996. Use of the fluorescent micronucleus assay to detect the genotoxic effects of radiation and arsenic exposure in exfoliated human epithelial cells. Environmental and Molecular Mutagenesis 27, 176–184. 10.1002/(SICI)1098-2280(1996)27:3<176::AID-EM2>3.0.C0;2-D [PubMed: 8625953]

Moore LE, Warner ML, Smith AH, Kalman D, Smith MT, 1996. Use of the fluorescent micronucleus assay to detect the genotoxic effects of radiation and arsenic exposure in exfoliated human epithelial cells. Environmental and Molecular Mutagenesis 27, 176–184. 10.1002/(SICI)1098-2280(1996)27:3 [PubMed: 8625953]

Morales Maria E., Derbes RS, Ade CM, Ortego JC, Stark J, Deininger PL, Roy-Engel AM., 2016. Heavy Metal Exposure Influences Double Strand Break DNA Repair Outcomes. PLOS ONE 11, e0151367. 10.1371/iournal.pone.0151367 [PubMed: 26966913]

Morales ME, Derbes RS, Ade CM, Ortego JC, Stark J, Deininger PL, Roy-Engel AM, 2016. Heavy Metal Exposure Influences Double Strand Break DNA Repair Outcomes. PLOS ONE 11, 0151367. 10.1371/iournal.pone.0151367

Moslehi R, Stagnar C, Srinivasan S, Radziszowski P, Carpenter DO, 2020. The possible role of arsenic and gene-arsenic interactions in susceptibility to breast cancer: a systematic review. Rev Environ Health 10.1515/reveh-2020-0080.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Mourón SA, Golijow CD, Dulout FN, 2001. DNA damage by cadmium and arsenic salts assessed by the single cell gel electrophoresis assay. Mutation Research/Genetic Toxicology and Environmental Mutagenesis 498, 47–55. 10.1016/S1383-5718(01)00266-2

Mourón SA, Grillo CA, Dulout FN, Golijow CD, 2006. Induction of DNA strand breaks, DNA-protein crosslinks and sister chromatid exchanges by arsenite in a human lung cell line. Toxicology in Vitro 20, 279–285. 10.1016/i.tiv.2005.07.005 [PubMed: 16143491]

Mourón SA, Grillo CA, Dulout FN, Golijow CD, 2005. DNA–protein cross-links and sister chromatid exchanges induced by dimethylarsinic acid in human fibroblasts cells. Mutation Research/Genetic Toxicology and Environmental Mutagenesis 581, 83–90. 10.1016/i.mrgentox.2004.11.001

Muenyi CS, States VA, Masters JH, Fan TW, Helm CW, States JC, 2011. Sodium arsenite and hyperthermia modulate cisplatin-DNA damage responses and enhance platinum accumulation in murine metastatic ovarian cancer xenograft after hyperthermic intraperitoneal chemotherapy (HIPEC. J Ovarian Res 4, 9. 10.1186/1757-2215-4-9 [PubMed: 21696631]

Mustra DJ, Warren AJ, Wilcox DE, Hamilton JW, 2007. Preferential binding of human XPA to the mitomycin C-DNA interstrand crosslink and modulation by arsenic and cadmium. Chemico-Biological Interactions 168, 159–168. 10.1016/i.cbi.2007.04.004 [PubMed: 17512921]

Naess S, 2020. Mercury, lead, arsenic, and cadmium in Norwegian seafood products and consumer exposure. Food Addit Contam Part B Surveill 13, 99–106,. 10.1080/19393210.2020.1735533 [PubMed: 32207381]

Naranmandura H, 2011. Mitochondria are the main target organelle for trivalent monomethylarsonous acid (MMA(III))-induced cytotoxicity. Chem Res Toxicol 24, 1094–1103 10.1021/tx200156k [PubMed: 21648415]

Naujokas MF, Anderson B, Ahsan H, Aposhian HV, Graziano JH, Thompson C, Suk WA, 2013. The broad scope of health effects from chronic arsenic exposure: update on a worldwide public health problem. Environ Health Perspect. 10.1289/ehp.1205875.

Navasumrit P, Chaisatra K, Promvijit J, Parnlob V, Waraprasit S, Chompoobut C, Binh TT, Hai DN, Bao ND, Hai NK, Kim K-W, Samson LD, Graziano JH, Mahidol C, Ruchirawat M, 2019. Exposure to arsenic in utero is associated with various types of DNA damage and micronuclei in newborns: a birth cohort study. Environ Health 18, 51. 10.1186/s12940-019-0481-7 [PubMed: 31174534]

Negro Silva LF, 2017. Effects of Inorganic Arsenic, Methylated Arsenicals, and Arsenobetaine on Atherosclerosis in the Mouse Model and the Role of As3mt-Mediated Methylation. Environ Health Perspect 125, 077001. 10.1289/EHP806 [PubMed: 28728140]

Nesnow S, Roop BC, Lambert G, Kadiiska M, Mason RP, Cullen WR, Mass MJ, 2002. DNA damage induced by methylated trivalent arsenicals is mediated by reactive oxygen species. Chem Res Toxicol 15, 1627–1634. 10.1021/tx025598y [PubMed: 12482246]

Netto LES, Kowaltowski AJ, Castilho RF, Vercesi AE, 2002. 25] Thiol enzymes protecting mitochondria against oxidative damage, in: Sies H, Packer L. (Eds.), Methods in Enzymology, Protein Sensors and Reactive Oxygen Species - Part B: Thiol Enzymes and Proteins. Academic Press, pp. 260–270. 10.1016/S0076-6879(02)48644-2

Nohara K, Baba T, Murai H, Kobayashi Y, Suzuki T, Tateishi Y, Matsumoto M, Nishimura N, Sano T, 2011. Global DNA methylation in the mouse liver is affected by methyl deficiency and arsenic in a sex-dependent manner. Arch Toxicol 85, 653–661. 10.1007/s00204-010-0611-z [PubMed: 20978746]

Nollen M, Ebert F, Moser J, Mullenders LHF, Hartwig A, Schwerdtle T, 2009. Impact of arsenic on nucleotide excision repair: XPC function, protein level, and gene expression. Molecular Nutrition & Food Research 53, 572–582. 10.1002/mnfr.200800480 [PubMed: 19382146]

Nutt L, Gogvadze V, Uthaisang-Tanechpongtamb W, Mirnikjoo B, Mcconkey D, Orrenius S, 2005. Indirect effects of Bax and Bak initiate the mitochondrial alterations that lead to cytochrome c release during arsenic trioxide-induced apoptosis. Cancer biology & therapy 4, 459–67. [PubMed: 15846091]

Oberoi S, Barchowsky A, Wu F, 2014. The global burden of disease for skin, lung, and bladder cancer caused by arsenic in food. Cancer Epidemiol Biomarkers Prev. 10.1158/1055-9965.EPI-13-1317.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Okayasu R, Takahashi S, Sato H, Kubota Y, Scolavino S, Bedford JS, 2003. Induction of DNA double strand breaks by arsenite: comparative studies with DNA breaks induced by X-rays. DNA Repair 2, 309–314. 10.1016/S1568-7864(02)00220-3 [PubMed: 12547393]

Pace C, 2016. Monomethylarsonous acid, but not inorganic arsenic, is a mitochondria-specific toxicant in vascular smooth muscle cells. Toxicol In Vitro 35, 188–201,.10.1016/i.tiv.2016.06.006 [PubMed: 27327130]

Pace C, Dagda R, Angermann J, 2017. Antioxidants Protect against Arsenic Induced Mitochondrial Cardio-Toxicity. Toxics 5, 38. 10.3390/toxics5040038 [PubMed: 29206204]

Palma-Lara I, Martinez-Castillo M, Quintana-Peréz JC, Arellano-Mendoza MG, Tamay-Cach F, Valenzuela-Limón OL, García-Montalvo EA, Hernández-Zavala A, 2020. Arsenic exposure: A public health problem leading to several cancers. Regul Toxicol Pharmacol. 10.1016/i.yrtph.2019.104539.

Pant N, Murthy RC, Srivastava SP, 2004. Male reproductive toxicity of sodium arsenite in mice. Hum Exp Toxicol 23, 399–403,. 10.1191/0960327104ht467oa [PubMed: 15346721]

Paul NP, Galván AE, Yoshinaga-Sakurai K, Rosen BP, & Yoshinaga M (2022). Arsenic in medicine: Past, present and future. BioMetals. 10.1007/s10534-022-00371-y

Paul S, Banerjee N, Chatterjee A, Sau TJ, Das JK, Mishra PK, Chakrabarti P, Bandyopadhyay A, Giri AK, 2014. Arsenic-induced promoter hypomethylation and over-expression of ERCC2 reduces DNA repair capacity in humans by non-disjunction of the ERCC2-Cdk7 complex†. Metallomics 6, 864–873. 10.1039/c3mt00328k [PubMed: 24473091]

Phookphan P, Navasumrit P, Waraprasit S, Promvijit J, Chaisatra K, Ngaotepprutaram T, Ruchirawat M, 2017. Hypomethylation of inflammatory genes (COX2, EGR1, and SOCS3) and increased urinary 8-nitroguanine in arsenic-exposed newborns and children. Toxicology and Applied Pharmacology 316, 36–47. 10.1016/i.taap.2016.12.015 [PubMed: 28025110]

Podgorski J, Berg M, 2020. Global threat of arsenic in groundwater. Science. 10.1126/science.aba1510.

Porta C, Paglino C, Mosca A, 2014. Targeting PI3K/Akt/mTOR Signaling in Cancer. Frontiers in Oncology 4. [PubMed: 24551591]

Pucer Anja, Castino R, Mirković B, Falnoga I, Šlejkovec Z, Isidoro C, Lah TT, 2010. Differential role of cathepsins B and L in autophagy-associated cell death induced by arsenic trioxide in U87 human glioblastoma cells. Biological Chemistry 391, 519–531. 10.1515/bc.2010.050 [PubMed: 20302512]

Pucer A, Castino R, Mirković B, Falnoga I, Šlejkovec Z, Isidoro C, Lah TT, 2010. Differential role of cathepsins B and L in autophagy-associated cell death induced by arsenic trioxide in U87 human glioblastoma cells. Biological Chemistry 391, 519–531. 10.1515/bc.2010.050 [PubMed: 20302512]

Qiu Y, Bi Z, Fu Y, Li L, Wadgaonkar P, Almutairy B, Zhang W, Thakur C, Chen F, 2021. Profiling of histone H3 trimethylation and distinct epigenetic pattern of chromosome Y in the transformed bronchial epithelial cells induced by consecutive arsenic treatment. Genes & Diseases. 10.1016/i.qendis.2021.11.005

Quintal SM, dePaula QA, Farrell NP, 2011. Zinc finger proteins as templates for metal ion exchange and ligand reactivity. Chemical and biological consequences. Metallomics 3, 121–139. 10.1039/c0mt00070a [PubMed: 21253649]

de la Rosa R, Steinmaus C, Akers NK, Conde L, Ferreccio C, Kalman D, Zhang KR, Skibola CF, Smith AH, Zhang L, Smith MT, 2017. Associations between arsenic (+3 oxidation state) methyltransferase (AS3MT) and N-6 adenine-specific DNA methyltransferase 1 (N6AMT1) polymorphisms, arsenic metabolism, and cancer risk in a Chilean population. Environ Mol Mutagen 58, 411–422. 10.1002/em.22104 [PubMed: 28640505]

Ramírez P, Del Razo LM, Gutierrez-Ruíz MC, Gonsebatt ME, 2000. Arsenite induces DNA–protein crosslinks and cytokeratin expression in the WRL-68 human hepatic cell line. Carcinogenesis 21, 701–706. 10.1093/carcin/21.4.701 [PubMed: 10753206]

Ray Chaudhuri A, Nussenzweig A, 2017. The multifaceted roles of PARP1 in DNA repair and chromatin remodelling. Nat Rev Mol Cell Biol 18, 610–621. 10.1038/nrm.2017.53 [PubMed: 28676700]

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Razin SV, Borunova VV, Maksimenko OG, Kantidze OL, 2012. Cys2His2 zinc finger protein family: Classification, functions, and major members. Biochemistry Moscow 77, 217–226. 10.1134/S0006297912030017 [PubMed: 22803940]

Rehman K, 2014. Trivalent methylated arsenic metabolites induce apoptosis in human myeloid leukemic HL-60 cells through generation of reactive oxygen species. Metallomics 6, 1502–1512, 10.1039/c4mt00119b [PubMed: 24870979]

Rehman MYA, Briedé JJ, Herwijnen M, Krauskopf J, Jennen DGJ, Malik RN, Kleinjans JCS, 2022. Integrating SNPs-based genetic risk factor with blood epigenomic response of differentially arsenic-exposed rural subjects reveals disease-associated signaling pathways. Environmental Pollution 292, 118279. 10.1016/i.envpol.2021.118279 [PubMed: 34619179]

Reichard JF, Schnekenburger M, Puga A, 2007. Long term low-dose arsenic exposure induces loss of DNA methylation. Biochemical and Biophysical Research Communications 352, 188–192. 10.1016/i.bbrc.2006.11.001 [PubMed: 17107663]

Ren X, Gaile DP, Gong Z, Qiu W, Ge Y, Zhang C, Huang C, Yan H, Olson JR, Kavanagh TJ, Wu H, 2015. Arsenic responsive microRNAs in vivo and their potential involvement in arsenic-induced oxidative stress. Toxicology and Applied Pharmacology 283, 198–209. 10.1016/i.taap.2015.01.014 [PubMed: 25625412]

Roy NK, Murphy A, Costa M, 2020. Arsenic Methyltransferase and Methylation of Inorganic Arsenic. Biomolecules 22;10(9):1351. 10.3390/biom10091351. [PubMed: 32971865]

Ruíz-Vera T, Ochoa-Martínez ÁC, Zarazúa S, Carrizales-Yáñez L, Pérez-Maldonado IN, 2019. Circulating miRNA-126, −145 and −155 levels in Mexican women exposed to inorganic arsenic via drinking water. Environmental Toxicology and Pharmacology 67, 79–86. 10.1016/i.etap.2019.02.004 [PubMed: 30769280]

Saint-Jacques N, Parker L, Brown P, Dummer TJ, 2014. Arsenic in drinking water and urinary tract cancers: a systematic review of 30 years of epidemiological evidence. Environ Health. 10.1186/1476-069X-13-44.

Sakurai T, 2005. Preventive mechanism of cellular glutathione in monomethylarsonic acid-induced cytolethality. Toxicol Appl Pharmacol 206, 54–65,. 10.1016/i.taap.2004.11.008 [PubMed: 15963344]

Salazar AM, Miller HL, McNeely SC, Sordo M, Ostrosky-Wegman P, States JC, 2010. Suppression of p53 and p21CIP1/WAF1 Reduces Arsenite-Induced Aneuploidy. Chem. Res. Toxicol 23, 357–364. 10.1021/tx900353v [PubMed: 20000476]

Sansregret L, Swanton C, 2017. The Role of Aneuploidy in Cancer Evolution. Cold Spring Harb Perspect Med 7, 028373. 10.1101/cshperspect.a028373

Sattar A, 2016. Metabolism and toxicity of arsenicals in mammals. Environ Toxicol Pharmacol 48, 214–224,. 10.1016/i.etap.2016.10.020 [PubMed: 27829199]

Schwerdtle T, Walter I, Mackiw I, Hartwig A, 2003. Induction of oxidative DNA damage by arsenite and its trivalent and pentavalent methylated metabolites in cultured human cells and isolated DNA. Carcinogenesis 24, 967–974,. 10.1093/carcin/bgg018 [PubMed: 12771042]

Sciandrello G, Barbaro R, Caradonna F, Barbata G, 2002. Early induction of genetic instability and apoptosis by arsenic in cultured Chinese hamster cells. Mutagenesis 17, 99–103. 10.1093/mutage/17.2.99 [PubMed: 11880537]

Selmin OI, Donovan MG, Skovan B, Paine Murieta GD, Romagnolo DF, 2019. Arsenic induced BRCA1 CpG promoter methylation is associated with the downregulation of ERα and resistance to tamoxifen in MCF7 breast cancer cells and mouse mammary tumor xenografts. International Journal of Oncology 54, 869–878. 10.3892/iio.2019.4687 [PubMed: 30664189]

Selmin Ornella I., Donovan MG, Skovan B, Paine-Murieta GD, Romagnolo DF, 2019. Arsenic-induced BRCA1 CpG promoter methylation is associated with the downregulation of ERα and resistance to tamoxifen in MCF7 breast cancer cells and mouse mammary tumor xenografts. International Journal of Oncology 54, 869–878. 10.3892/iio.2019.4687 [PubMed: 30664189]

Shao K, Zhou Z, Xun P, Cohen SM, 2021. Bayesian benchmark dose analysis for inorganic arsenic in drinking water associated with bladder and lung cancer using epidemiological data. Toxicology. 10.1016/j.tox.2021.152752.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Shi H, Hudson LG, Ding W, Wang S, Cooper KL, Liu S, Chen Y, Shi X, Liu KJ, 2004. Arsenite Causes DNA Damage in Keratinocytes Via Generation of Hydroxyl Radicals. Chem. Res. Toxicol 17, 871–878. 10.1021/tx049939e [PubMed: 15257611]

Singh S, Greene RM, Pisano MM, 2010. Arsenate-induced apoptosis in murine embryonic maxillary mesenchymal cells via mitochondrial-mediated oxidative injury. Birth Defects Res A Clin Mol Teratol 88, 25–34,. 10.1002/bdra.20623 [PubMed: 19739150]

Smeester L, Fry RC, 2018. Long-Term Health Effects and Underlying Biological Mechanisms of Developmental Exposure to Arsenic. Curr Environ Health Rep. 10.1007/S40572-018-0184-1.

Smith AH, Marshall G, Liaw J, Yuan Y, Ferreccio C, Steinmaus C, 2012. Mortality in young adults following in utero and childhood exposure to arsenic in drinking water. Environ Health Perspect. 10.1289/ehp.1104867.

Smith AH, Marshall G, Yuan Y, Ferreccio C, Liaw J, von EO, Steinmaus C, Bates MN, Selvin S, 2006. Increased Mortality from Lung Cancer and Bronchiectasis in Young Adults after Exposure to Arsenic in Utero and in Early Childhood. Environmental Health Perspectives 114, 1293–1296. 10.1289/ehp.8832 [PubMed: 16882542]

Song Y, Jin D, Chen J, Liang W, Liu X, 2020. Effects of Arsenic (+3 Oxidation State) Methyltransferase Gene Polymorphisms and Expression on Bladder Cancer: Evidence from a Systematic Review, Meta-analysis and TCGA Dataset. Toxicol Sci. 10.1093/toxsci/kfaa087.

Srinivas N, Rachakonda S, Hielscher T, Calderazzo S, Rudnai P, Gurzau E, Koppova K, Fletcher T, Kumar R, 2019. Telomere length, arsenic exposure and risk of basal cell carcinoma of skin. Carcinogenesis 40, 715–723. 10.1093/carcin/bgz059 [PubMed: 30874287]

States JC, 2015. Disruption of Mitotic Progression by Arsenic. Biol Trace Elem Res 166, 34–40. 10.1007/s12011-015-0306-7 [PubMed: 25796515]

States JC, Reiners JJ, Pounds JG, Kaplan DJ, Beauerle BD, McNeely SC, Mathieu P, McCabe MJ, 2002. Arsenite Disrupts Mitosis and Induces Apoptosis in SV40-Transformed Human Skin Fibroblasts. Toxicology and Applied Pharmacology 180, 83–91. 10.1006/taap.2002.9376 [PubMed: 11969375]

Steinmaus C, Ferreccio C, Acevedo J, Yuan Y, Liaw J, Durán V, Cuevas S, Garcia J, Meza R, Valdás R, Valdás G, Benítez H, VanderLinde V, Villagra V, Cantor KP, Moore LE, Perez SG, Steinmaus S, Smith AH, 2014. Increased lung and bladder cancer incidence in adults after in utero and early-life arsenic exposure. Cancer Epidemiol Biomarkers Prev. 10.1158/1055-9965.EPI-14-0059.

Sturchio E, Colombo T, Boccia P, Carucci N, Meconi C, Minoia C, Macino G, 2014. Arsenic exposure triggers a shift in microRNA expression. Science of The Total Environment 472, 672–680. 10.1016/i.scitotenv.2013.11.092 [PubMed: 24317173]

Su CC, Lu JL, Tsai KY, IeB L, 2011. Reduction in arsenic intake from water has different impacts on lung cancer and bladder cancer in an arseniasis endemic area in Taiwan. Cancer Causes Control. 10.1007/s10552-010-9679-2.

Suzuki T, Miyazaki K, Kita K, Ochi T, 2009. Trivalent dimethylarsenic compound induces histone H3 phosphorylation and abnormal localization of Aurora B kinase in HepG2 cells. Toxicology and Applied Pharmacology 241, 275–282. 10.1016/i.taap.2009.08.017 [PubMed: 19716834]

Sykora P, Snow ET, 2008. Modulation of DNA polymerase beta-dependent base excision repair in cultured human cells after low dose exposure to arsenite. Toxicology and Applied Pharmacology 228, 385–394. 10.1016/i.taap.2007.12.019 [PubMed: 18252256]

Taeger D, Johnen G, Wiethege T, Tapio S, Möhner M, Wesch H, Tannapfel A, Müller KM, Brüning T, Pesch B, 2009. Major histopathological patterns of lung cancer related to arsenic exposure in German uranium miners. Int Arch Occup Environ Health. 10.1007/s00420-008-0386-1.

Tam LM, Jiang J, Wang P, Li L, Miao W, Dong X, Wang Y, 2017. Arsenite Binds to the Zinc Finger Motif of TIP60 Histone Acetyltransferase and Induces Its Degradation via the 26S Proteasome. Chem. Res. Toxicol 30, 1685–1693. 10.1021/acs.chemrestox.7b00146 [PubMed: 28837777]

Tam LM, Price NE, Wang Y, 2020. Molecular Mechanisms of Arsenic-Induced Disruption of DNA Repair.Chem. Res. Toxicol 33, 709–726. 10.1021/acs.chemrestox.9b00464 [PubMed: 31986875]

Tennant AH, Kligerman AD, 2011. Superoxide dismutase protects cells from DNA damage induced by trivalent methylated arsenicals. Environ Mol Mutagen 52, 238–243,. 10.1002/em.20609 [PubMed: 20740636]

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Tian Defa, MA H, Feng Z, Xia Y, Le XC, Ni Z, Allen J, Collins B, Schreinemachers D, Mumford JL., 2001. Analyses of Micronuclei in Exfoliated Epithelial Cells from Individuals Chronically Exposed to Arsenic Via Drinking Water in Inner Mongolia, China. Journal of Toxicology and Environmental Health, Part A 64, 473–484. 10.1080/152873901753215939 [PubMed: 11732698]

Tian D, MA H, Feng Z, Xia Y, Le XC, Ni Z, Allen J, Collins B, Schreinemachers D, Mumford JL, 2001. Analyses of Micronuclei in Exfoliated Epithelial Cells from Individuals Chronically Exposed to Arsenic Via Drinking Water in Inner Mongolia, China. Journal of Toxicology and Environmental Health, Part A 64, 473–484. 10.1080/152873901753215939 [PubMed: 11732698]

Tingting R, Wei G, Changliang P, Xinchang L, Yi Y, 2010. Arsenic trioxide inhibits osteosarcoma cell invasiveness via MAPK signaling pathway. Cancer Biology & Therapy 10, 251–257. 10.4161/cbt.10.3.12349 [PubMed: 20592496]

Tong D, Ortega J, Kim C, Huang J, Gu L, Li G-M, 2015. Arsenic Inhibits DNA Mismatch Repair by Promoting EGFR Expression and PCNA Phosphorylation *. Journal of Biological Chemistry 290, 14536–14541. 10.1074/jbcM115.641399 [PubMed: 25907674]

Tsai TL, Kuo CC, Hsu LI, Tsai SF, Chiou HY, Chen CJ, Hsu KH, Wang SL, 2021. Association between arsenic exposure, DNA damage, and urological cancers incidence: A long-term follow-up study of residents in an arseniasis endemic area of northeastern Taiwan. Chemosphere. 10.1016/i.chemosphere.2020.129094.

Tsuda T, Babazono A, Yamamoto E, Kurumatani N, Mino Y, Ogawa T, Kishi Y, Aoyama H, 1995. Ingested arsenic and internal cancer: a historical cohort study followed for 33 years. Am J Epidemiol. 10.1093/oxfordiournals.aie.a117421.

Tsuji JS, Chang ET, Gentry PR, Clewell HJ, Boffetta P, Cohen SM, 2019. Dose-response for assessing the cancer risk of inorganic arsenic in drinking water: the scientific basis for use of a threshold approach. Critical Reviews in Toxicology 49, 36–84. 10.1080/10408444.2019.1573804 [PubMed: 30932726]

Vuyyuri SB, Ishaq M, Kuppala D, Grover P, Ahuja Y r, 2006. Evaluation of micronucleus frequencies and DNA damage in glass workers exposed to arsenic. Environmental and Molecular Mutagenesis 47, 562–570. 10.1002/em.20229 [PubMed: 16795086]

Waalkes MP, Liu J, Diwan BA, 2007. Transplacental arsenic carcinogenesis in mice. Toxicology and Applied Pharmacology, Research and Risk Assessment for Arsenic 222, 271–280. 10.1016/i.taap.2006.12.034

Wadgaonkar P, Chen F, 2021. Connections between endoplasmic reticulum stress-associated unfolded protein response, mitochondria, and autophagy in arsenic-induced carcinogenesis. Seminars in Cancer Biology, Metal Carcinogenesis 76, 258–266. 10.1016/i.semcancer.2021.04.004

Walter I, Schwerdtle T, Thuy C, Parsons JL, Dianov GL, Hartwig A, 2007. Impact of arsenite and its methylated metabolites on PARP-1 activity, PARP-1 gene expression and poly(ADP-ribosyl)ation in cultured human cells. DNA Repair 6, 61–70. 10.1016/i.dnarep.2006.08.008 [PubMed: 17011244]

Wang F, Zhou X, Liu W, Sun X, Chen C, Hudson LG, Jian Liu K, 2013. Arsenite-induced ROS/RNS generation causes zinc loss and inhibits the activity of poly(ADP-ribose) polymerase-1. Free Radical Biology and Medicine 61, 249–256. 10.1016/i.freeradbiomed.2013.04.019 [PubMed: 23602911]

Wang G, Zhang T, Sun W, Wang H, Yin F, Wang Z, Zuo D, Sun M, Zhou Z, Lin B, Xu J, Hua Y, Li H, Cai Z, 2017. Arsenic sulfide induces apoptosis and autophagy through the activation of ROS/JNK and suppression of Akt/mTOR signaling pathways in osteosarcoma. Free Radical Biology and Medicine 106, 24–37. 10.1016/i.freeradbiomed.2017.02.015 [PubMed: 28188923]

Wang L, Lu Y-F, Wang C-S, Xie Y-X, Zhao Y-Q, Qian Y-C, Liu W-T, Wang M, Jiang B-H, 2020. HB-EGF Activates the EGFR/HIF-1α Pathway to Induce Proliferation of Arsenic-Transformed Cells and Tumor Growth. Frontiers in Oncology 10. [PubMed: 32047721]

Wang Q, Wang W, Zhang A, 2021. TET-mediated DNA demethylation plays an important role in arsenic-induced HBE cells oxidative stress via regulating promoter methylation of OGG1 and GSTP1. Toxicology in Vitro 72, 105075. 10.1016/j.tiv.2020.105075 [PubMed: 33388378]

Wang TC, Jan KY, Wang AS, Gurr JR, 2007. Trivalent arsenicals induce lipid peroxidation, protein carbonylation, and oxidative DNA damage in human urothelial cells. Mutat Res 615, 75–86,. 10.1016/j.mrfmmm.2006.10.003 [PubMed: 17134727]

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Wang T-S, Hsu T-Y, Chung C-H, Wang ASS, Bau D-T, Jan K-Y, 2001. Arsenite induces oxidative DNA adducts and DNA-protein cross-links in mammalian cells. Free Radical Biology and Medicine 31, 321–330. 10.1016/SQ891-5849(01100581-0 [PubMed: 11461769]

Wang Z, Yang J, Fisher T, Xiao H, Jiang Y, Yang C, 2012. Akt Activation Is Responsible for Enhanced Migratory and Invasive Behavior of Arsenic-Transformed Human Bronchial Epithelial Cells. Environmental Health Perspectives 120, 92–97. 10.1289/ehp.1104061 [PubMed: 21954225]

Wang Z, Zhao Y, Smith E, Goodall GJ, Drew PA, Brabletz T, Yang C, 2011. Reversal and Prevention of Arsenic-Induced Human Bronchial Epithelial Cell Malignant Transformation by microRNA-200b. Toxicological Sciences 121, 110–122. 10.1093/toxsci/kfr029 [PubMed: 21292642]

Warner ML, Moore LE, Smith MT, Kalman DA, Fanning E, Smith AH, 1994. Increased micronuclei in exfoliated bladder cells of individuals who chronically ingest arsenic-contaminated water in Nevada. Cancer Epidemiology, Biomarkers & Prevention 3, 583–590.

Watanabe T, Hirano S, 2013. Metabolism of arsenic and its toxicological relevance. Arch Toxicol 87, 969–979,. 10.1007/s00204-012-0904-5 [PubMed: 22811022]

Watcharasit P, Visitnonthachai D, Suntararuks S, Thiantanawat A, Satayavivad J, 2012. Low arsenite concentrations induce cell proliferation via activation of VEGF signaling in human neuroblastoma SH-SY5Y cells. Environmental Toxicology and Pharmacology 33, 53–59. 10.1016/i.etap.2011.10.005 [PubMed: 22120617]

Wei S, Xue J, Sun B, Zou Z, Chen C, Liu Q, Zhang A, 2018. miR-145 via targeting ERCC2 is involved in arsenite-induced DNA damage in human hepatic cells. Toxicology Letters 295, 220–228. 10.1016/i.toxlet.2018.04.028 [PubMed: 29705342]

Wise SS, Wise JP, 2012. Chromium and genomic stability. Mutation Research/Fundamental and Molecular Mechanisms of Mutagenesis, Micronutrients and genomic stability 733, 78–82. 10.1016/i.mrfmmm.2011.12.002

Wiseman H, Halliwell B, 1996. Damage to DNA by reactive oxygen and nitrogen species: role in inflammatory disease and progression to cancer. Biochem J 313, 17–29. [PubMed: 8546679]

WM M Jr, S E, J Cohen, I W, Cowden J, JS L, R S, 2017. Relationships between arsenic concentrations in drinking water and lung and bladder cancer incidence in U.S. counties. J Expo Sci Environ Epidemiol. 10.1038/ies.2016.58.

Wnek SM, 2011. Interdependent genotoxic mechanisms of monomethylarsonous acid: role of ROS-induced DNA damage and poly(ADP-ribose) polymerase-1 inhibition in the malignant transformation of urothelial cells. Toxicol Appl Pharmacol 257, 1–13,. 10.1016/i.taap.2011.08.029 [PubMed: 21925530]

Wnek SM, Jensen TJ, Severson PL, Futscher BW, Gandolfi AJ, 2010. Monomethylarsonous acid produces irreversible events resulting in malignant transformation of a human bladder cell line following 12 weeks of low-level exposure. Toxicol Sci 116, 44–57,. 10.1093/toxsci/kfq106 [PubMed: 20375083]

Wnek SM, Medeiros MK, Eblin KE, Gandolfi AJ, 2009. Persistence of DNA damage following exposure of human bladder cells to chronic monomethylarsonous acid. Toxicol Appl Pharmacol 241, 202–209,. 10.1016/i.taap.2009.08.016 [PubMed: 19699219]

Wong C, Roberts SM, Saab IN, 2022. Review of regulatory reference values and background levels for heavy metals in the human diet. Regul Toxicol Pharmacol. 10.1016/i.yrtph.2022.105122.

World Health Organization: Guidelines for drinking-water quality, http://apps.who.int/iris/bitstream/10665/44584/1/9789241548151_eng, (2011)

Wu C-L, Huang L-Y, Chang CL, 2017. Linking arsenite- and cadmium-generated oxidative stress to microsatellite instability in vitro and in vivo. Free Radical Biology and Medicine 112, 12–23. 10.1016/i.freeradbiomed.2017.07.006 [PubMed: 28690196]

Wu J, Ferragut Cardoso AP, States VAR, Al-Eryani L, Doll M, Wise SS, Rai SN, States JC, 2019. Overexpression of hsa-miR-186 induces chromosomal instability in arsenic-exposed human keratinocytes. Toxicology and Applied Pharmacology 378, 114614. 10.1016/j.taap.2019.114614 [PubMed: 31176655]

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Xie H, Huang S, Martin S, Wise JP, 2014. Arsenic is cytotoxic and genotoxic to primary human lung cells. Mutation Research/Genetic Toxicology and Environmental Mutagenesis 760, 33–41. 10.1016/i.mrgentox.2013.11.001 [PubMed: 24291234]

Xu H, 2017. Genotoxicity induced by monomethylarsonous acid (MMA(+3)) in mouse thymic developing T cells. Toxicol Lett 279, 60–66,. 10.1016/i.toxlet.2017.07.897 [PubMed: 28760575]

Xu H, Wang X, Wang W, 2018. Monomethylarsonous acid: Induction of DNA damage and oxidative stress in mouse natural killer cells at environmentally-relevant concentrations. Mutat Res Genet Toxicol Environ Mutagen 832–833, 1-6,. 10.1016/i.mrgentox.2018.05.017

Yager JW, Erdei E, Myers O, Siegel M, Berwick M, 2016. Arsenic and ultraviolet radiation exposure: melanoma in a New Mexico non-Hispanic white population. Environ Geochem Health 38, 897–910. 10.1007/s10653-015-9770-4 [PubMed: 26445994]

Yamanaka K, Hayashi H, Kato K, Hasegawa A, Okada S, 1995. Involvement of Preferential Formation of Apurinic/Apyrimidinic Sites in Dimethylarsenic-Induced DNA Strand Breaks and DNA-Protein Crosslinks in Cultured Alveolar Epithelial Cells. Biochemical and Biophysical Research Communications 207, 244–249. 10.1006/bbrc.1995.1179 [PubMed: 7857272]

Yamanaka K, Okada S, 1994. Induction of lung-specific DNA damage by metabolically methylated arsenics via the production of free radicals. Environ Health Perspect 102 Suppl 3, 37–40. 10.1289/ehp.94102s337

Yen Y-P, Tsai K-S, Chen Y-W, Huang C-F, Yang R-S, Liu S-H, 2012. Arsenic induces apoptosis in myoblasts through a reactive oxygen species-induced endoplasmic reticulum stress and mitochondrial dysfunction pathway. Arch Toxicol 86, 923–933. 10.1007/s00204-012-0864-9 [PubMed: 22622864]

Yih L-H, Ho I-C, Lee T-C, 1997. Sodium Arsenite Disturbs Mitosis and Induces Chromosome Loss in Human Fibroblasts. Cancer Research 57, 5051–5059. [PubMed: 9371502]

Yoshinaga J, Narukawa T, 2021. Dietary intake and urinary excretion of methylated arsenicals of Japanese adults consuming marine foods and rice. Food Addit Contam Part A Chem Anal Control Expo Risk Assess 38, 622–629,. 10.1080/19440049.2021.1877836 [PubMed: 33625959]

Yuan Y, Marshall G, Ferreccio C, Steinmaus C, Liaw J, Bates M, Smith AH, 2010. Kidney cancer mortality: fifty-year latency patterns related to arsenic exposure. Epidemiology. 10.1097/EDE.0b013e3181c21e46.

Zhang A, Tang S, Yang Y, Li C, Ding X, Zhao H, Wang J, Yang G, Li J, 2020. Histone demethylase JHDM2A regulates H3K9 dimethylation in response to arsenic-induced DNA damage and repair in normal human liver cells. Journal of Applied Toxicology 40, 1661–1672. 10.1002/iat.4026 [PubMed: 32608101]

Zhang AL, Chen L, Ma L, Ding X, Tang S, Zhang AH, Li J, 2020. Role of H3K18ac-regulated nucleotide excision repair-related genes in arsenic-induced DNA damage and repair of HaCaT cells. Hum Exp Toxicol 39, 1168–1177. 10.1177/0960327120903482 [PubMed: 32031413]

Zhang F, Paramasivam M, Cai Q, Dai X, Wang P, Lin K, Song J, Seidman MM, Wang Y, 2014. Arsenite Binds to the RING Finger Domains of RNF20-RNF40 Histone E3 Ubiquitin Ligase and Inhibits DNA Double-Strand Break Repair. J. Am. Chem. Soc 136, 12884–12887. 10.1021/ja507863d [PubMed: 25170678]

Zheng L, 2017. Deriving water quality criteria for trivalent and pentavalent arsenic. Sci Total Environ 587–588, 68–74,. 10.1016/i.scitotenv.2017.02.004

Zhou J, Zhang X, Tang H, Yu J, Zu X, Xie Z, Yang X, Hu J, Tan F, Li Q, Lei X, 2020. . Clinica Chimica Acta 506, 1–8. 10.1016/i.cca.2020.02.028

Zhou X, 2019. Peroxynitrite contributes to arsenic-induced PARP-1 inhibition through ROS/RNS generation. Toxicol Appl Pharmacol 378, 114602. 10.1016/i.taap.2019.114602 [PubMed: 31152818]

Zhou X, 2014. Differential binding of monomethylarsonous acid compared to arsenite and arsenic trioxide with zinc finger peptides and proteins. Chem Res Toxicol 27, 690–698,. 10.1021/tx500022i [PubMed: 24611629]

Zhou X, Cooper KL, Sun X, Liu KJ, Hudson LG, 2015. Selective Sensitization of Zinc Finger Protein Oxidation by Reactive Oxygen Species through Arsenic Binding *. Journal of Biological Chemistry 290, 18361–18369. 10.1074/ibc.M115.663906 [PubMed: 26063799]

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Zhou X, Ding X, Shen J, Yang D, Hudson LG, Liu KJ, 2019. Peroxynitrite contributes to arsenic-induced PARP-1 inhibition through ROS/RNS generation. Toxicology and Applied Pharmacology 378, 114602. 10.1016/i.taap.2019.114602 [PubMed: 31152818]

Zhou X, Medina S, Bolt AM, Zhang H, Wan G, Xu H, Lauer FT, Wang SC, Burchiel SW, Liu KJ, 2020. Inhibition of red blood cell development by arsenic-induced disruption of GATA-1. Sci Rep 10, 19055. 10.1038/s41598-020-76118-x [PubMed: 33149232]

Zhou X, Sun X, Cooper KL, Wang F, Liu KJ, Hudson LG, 2011. Arsenite Interacts Selectively with Zinc Finger Proteins Containing C3H1 or C4 Motifs *. Journal of Biological Chemistry 286, 22855–22863. 10.1074/jbcM111.232926 [PubMed: 21550982]

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

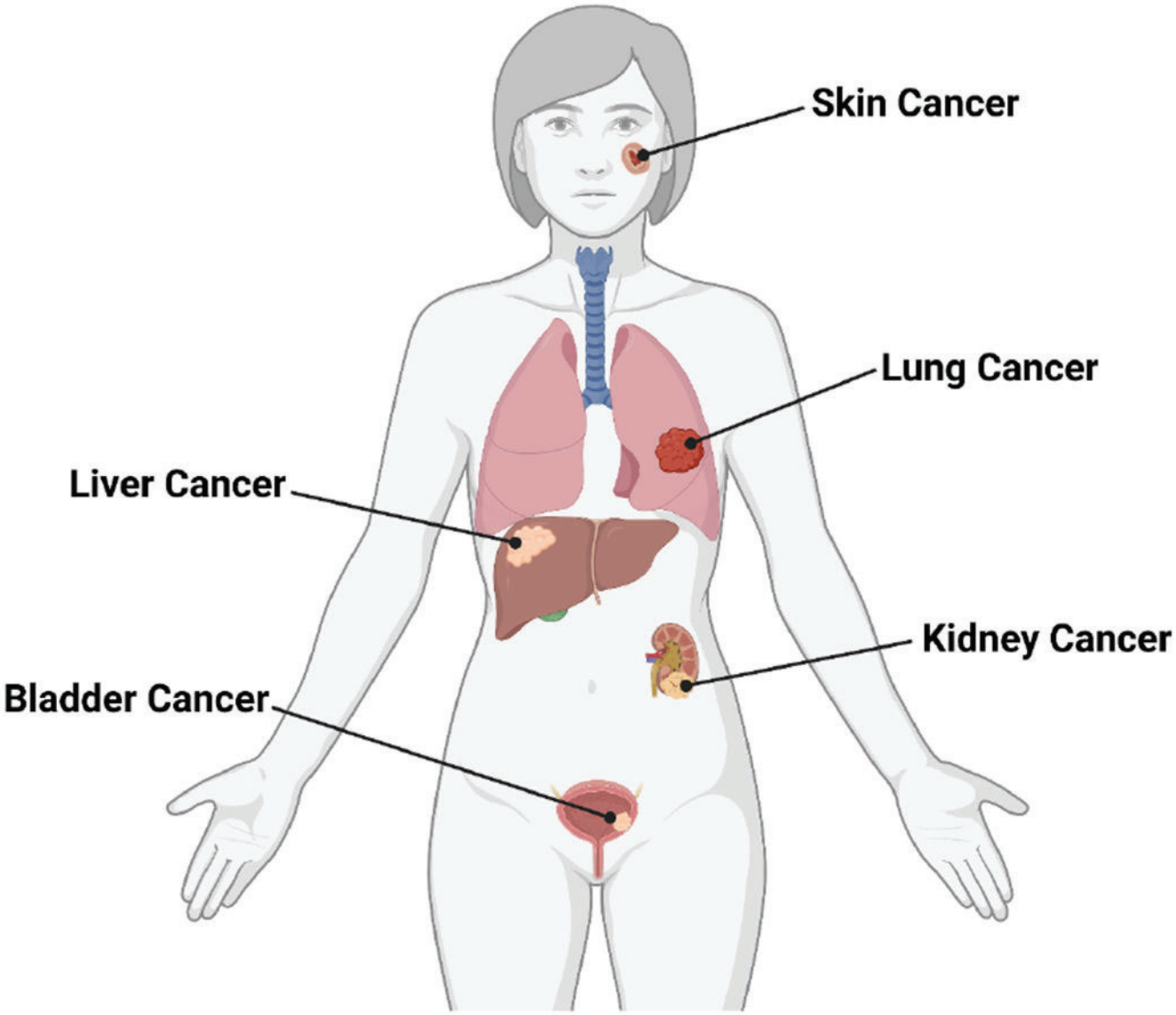


Figure 1.

Cancers associated with arsenic exposure. Epidemiology studies support the association of arsenic exposure through drinking water with increased risk of developing skin, lung, bladder, kidney, and liver cancers.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

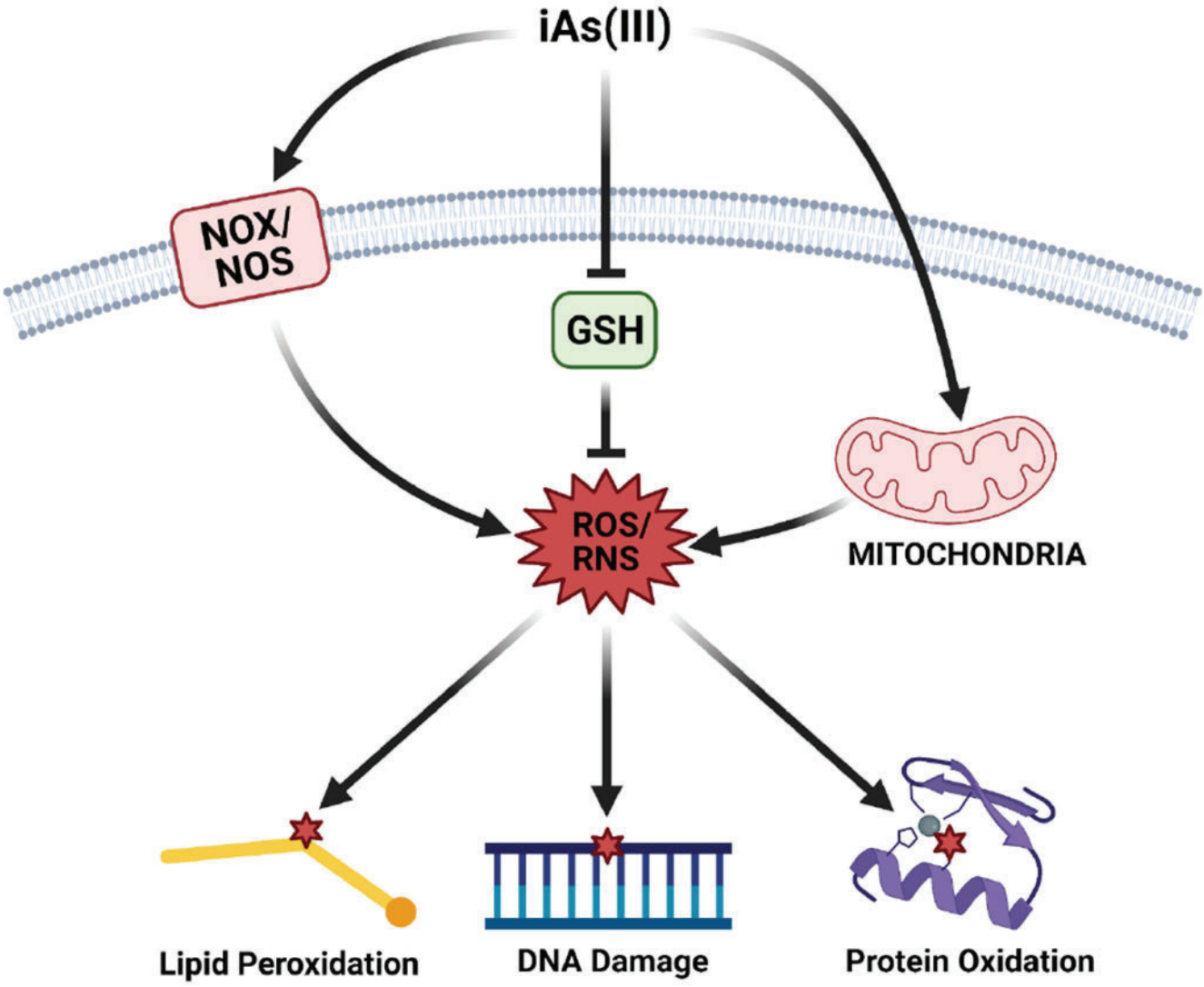


Figure 2. Mechanism of arsenic-induced ROS and oxidative damage to macromolecules.

Arsenic exposure stimulates the production of ROS and RNS through mechanisms such as the dysregulation of the electron transport chain and stimulation of enzymes such as NADPH oxidase and nitric oxide synthase. The depletion of GSH through the metabolism of arsenic further promotes redox imbalance. Consequently, macromolecules such as DNA, protein, and lipids are damaged by arsenic-induced ROS and RNS.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

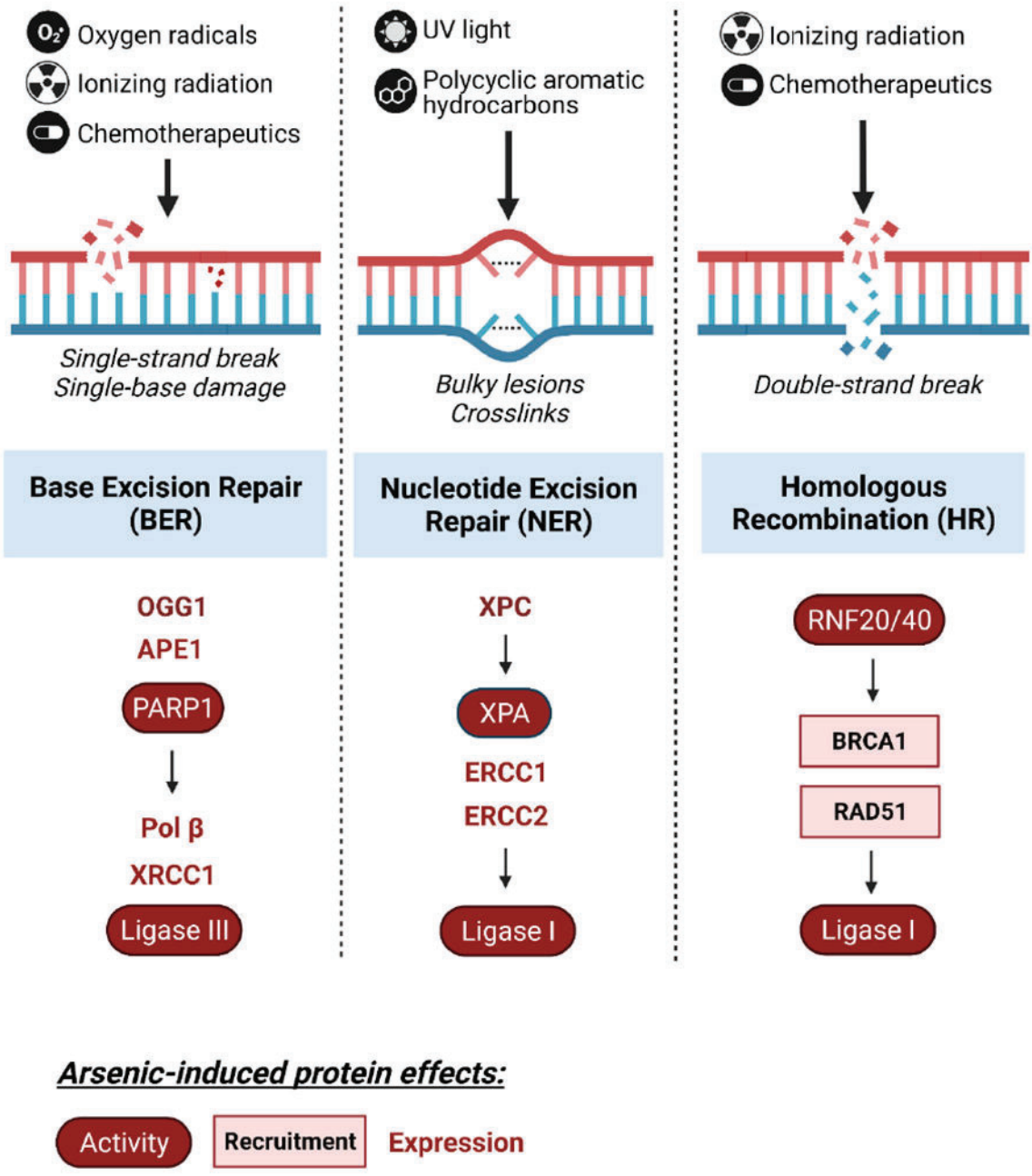


Figure 3. Arsenic inhibits DNA repair.

Exposure to DNA damaging agents such as ROS, UV light, and ionizing radiation can generate single-base damage, bulky lesions, and double-strand breaks, respectively. These types of damage are remediated by repair pathways which contain critical DNA repair proteins that facilitate the recruitment of repair proteins, removal of damage, and the synthesis and sealing of undamaged DNA. Arsenic alters the function of key DNA repair proteins through several means: zinc finger domain inhibition leading to loss of activity,

disruption in recruitment to DNA damage, and the suppression of expression by altering transcription and protein turnover.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

REC 6634

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

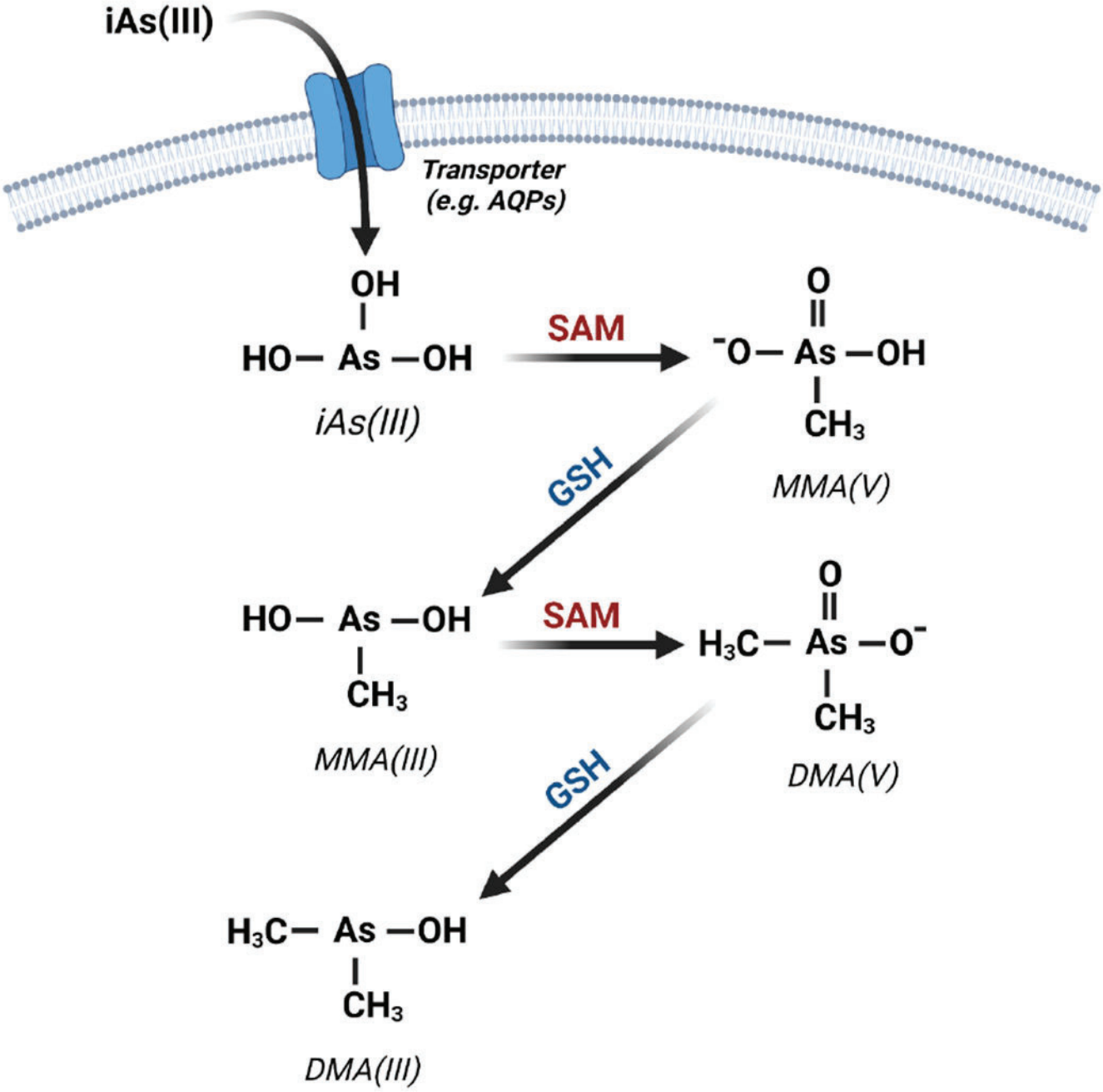


Figure 4.

The metabolism of arsenic. The uptake of trivalent arsenic into eukaryotes is mediated through several transporters such as AQPs. Trivalent arsenic is metabolized by successive oxidative methylation and reduction reactions. First, iAs(III) is oxidatively methylated into MMA(V) by S-adenosyl methionine (SAM), then reduced into MMA(III) by GSH. Second, MMA(III) is oxidatively methylated into DMA(V), then reduced into DMA(III)

Exhibit J

A Section 508–conformant HTML version of this article is available at http://dx.doi.org/10.1289/ehp.1510144.

Estimating Children's Soil/Dust Ingestion Rates through Retrospective Analyses of Blood Lead Biomonitoring from the Bunker Hill Superfund Site in Idaho

Ian von Lindern,[1] Susan Spalinger,[1] Marc L. Stifelman,[2] Lindsay Wichers Stanek,[3] and Casey Bartrem[1]

[1]TerraGraphics Environmental Engineering, Inc., Moscow, Idaho, USA; [2]U.S. Environmental Protection Agency (EPA), Region 10, Seattle, Washington, USA; [3]U.S. EPA, Office of Research and Development, Research Triangle Park, North Carolina, USA

Background: Soil/dust ingestion rates are important variables in assessing children's health risks in contaminated environments. Current estimates are based largely on soil tracer methodology, which is limited by analytical uncertainty, small sample size, and short study duration.

Objectives: The objective was to estimate site-specific soil/dust ingestion rates through reevaluation of the lead absorption dose–response relationship using new bioavailability data from the Bunker Hill Mining and Metallurgical Complex Superfund Site (BHSS) in Idaho, USA.

Methods: The U.S. Environmental Protection Agency (EPA) *in vitro* bioavailability methodology was applied to archived BHSS soil and dust samples. Using age-specific biokinetic slope factors, we related bioavailable lead from these sources to children's blood lead levels (BLLs) monitored during cleanup from 1988 through 2002. Quantitative regression analyses and exposure assessment guidance were used to develop candidate soil/dust source partition scenarios estimating lead intake, allowing estimation of age-specific soil/dust ingestion rates. These ingestion rate and bioavailability estimates were simultaneously applied to the U.S. EPA Integrated Exposure Uptake Biokinetic Model for Lead in Children to determine those combinations best approximating observed BLLs.

Results: Absolute soil and house dust bioavailability averaged 33% (SD ± 4%) and 28% (SD ± 6%), respectively. Estimated BHSS age-specific soil/dust ingestion rates are 86–94 mg/day for 6-month- to 2-year-old children and 51–67 mg/day for 2- to 9-year-old children.

Conclusions: Soil/dust ingestion rate estimates for 1- to 9-year-old children at the BHSS are lower than those commonly used in human health risk assessment. A substantial component of children's exposure comes from sources beyond the immediate home environment.

Citation: von Lindern I, Spalinger S, Stifelman ML, Stanek LW, Bartrem C. 2016. Estimating children's soil/dust ingestion rates through retrospective analyses of blood lead biomonitoring from the Bunker Hill Superfund Site in Idaho. Environ Health Perspect 124:1462–1470; http://dx.doi.org/10.1289/ehp.1510144

Introduction

Ingestion Rate Background

Consumption of fine soil and dust particulates, especially by young children, is the dominant route of exposure for lead and other contaminants (Laidlaw et al. 2014; Landrigan et al. 1975; Lanphear et al. 1998, 2003). Childhood soil and dust ingestion occurs via multiple pathways, including hand-to-mouth transfer, mouthing of objects, and contaminated food. These pathways are dependent on individual behaviors, exposure time, and environmental conditions (Zahran et al. 2013a). Accurate estimates of the soil and household dust ingestion rate (IR) pathway are needed to assess children's exposures and health risks associated with trace metals and persistent organic chemical residues in the home or play environment, and to make informed cleanup decisions.

Early estimates of soil/dust IRs in children were based on studies of trace elements in soil and feces, yielding uncertain estimates due to analytical uncertainty, limited sample size, and short study duration (Batelle 2005; Doyle et al. 2010; Sedman and Mahmood 1994; Stanek et al. 2012; U.S. EPA 2011, 2012). Currently, national U.S. Environmental Protection Agency (EPA) central tendency soil/dust IRs of 60 mg/day (children 6 weeks to < 12 months of age) and 100 mg/day (children 1 to < 6 years of age) are based on these tracer studies (U.S. EPA 2011). More recent studies have used dermal transfer to estimate soil and dust IRs. Ozkaynak et al. (2011) modeled the frequency of hand and object mouthing in children 3 years to < 6 years of age, resulting in a mean total soil/dust IR of 68 mg/day (95th percentile: 224 mg/day). Similarly, Wilson et al. (2013) used a mechanistic model including parameters for particle loading on skin, transfer to hands, hand surface area, mouthing surface area, hand-to-mouth frequency, saliva dissolution, and exposure time, to estimate an average combined soil/dust IR of 61 mg/day for children 7 months to 4 years of age. Meta-analysis of four major studies using stochastic modeling of the most reliable tracers resulted in an average soil ingestion estimate of 26 mg/day (95th percentile: 79 mg/day) for children 1–8 years of age (Stanek et al. 2012). Findings from large-scale reviews and integration of data from tracer, mechanistic, validation modeling/measurement, and empirical relation (biomonitoring/environmental concentration) studies suggest that mean IRs in children are < 100 mg/day and may be as low as 40–80 mg/day (Bierkens et al. 2011; Moya and Phillips 2014).

Soil/dust IR and bioavailability are sensitive parameters in the U.S. EPA Integrated Exposure Uptake Biokinetic (IEUBK) Model for Lead in Children. The IEUBK model currently uses default IRs ranging from 85 to 135 mg/day for 6-month- to 6-year-old children and 30% absolute bioavailability for ingested soil and indoor dust (U.S. EPA 2013). The first use of the IEUBK model to develop site-specific cleanup levels was at the Bunker Hill Mining and Metallurgical Complex Superfund Site (BHSS) in northern Idaho (CH2M Hill 1991; TerraGraphics 1990; U.S. EPA and IDHW 1991, 1992). The dose–response relationship observed between soil, dust, and blood lead levels (BLLs) was consistently lower at the BHSS than IEUBK model predictions using the default parameters (TerraGraphics 1990; von Lindern et al. 2003b). This was nominally attributed to lower soil/dust bioavailability (18%), although it was acknowledged that the reduced

Address correspondence to S. Spalinger, TerraGraphics Environmental Engineering, 121 S. Jackson St., Moscow, ID 83843 USA. Telephone: (208) 882-7858. E-mail: susan.spalinger@terragraphics.com

Supplemental Material is available online (http://dx.doi.org/10.1289/ehp.1510144).

We thank J. Brown, G. Diamond, and R. Hanson for thoughtful review of this manuscript, and we also thank M. Thorhaug, S. Weppner, and J. Williams of TerraGraphics, and Manchester Environmental Laboratory. We dedicate this manuscript to R. Elias, longtime U.S. EPA lead health scientist, for his persistence, scholarship, and guidance.

Funding for this work was provided by the U.S. EPA, by the Idaho Department of Environmental Quality (IDEQ), and by TerraGraphics.

This manuscript was reviewed by the U.S. EPA and approved for publication. Views expressed by the authors do not necessarily represent the U.S. EPA or agency policy.

I.v.L., S.S., and C.B. are employees of TerraGraphics Environmental Engineering, Inc., which is a consultant to the Idaho Department of Environmental Quality, and held two contracts at the time of this project for scientific and engineering support services for the Bunker Hill Superfund Site. TerraGraphics was also a consultant to U.S. EPA to conduct analyses for this research project. I.v.L. served on the U.S. Clean Air Science Advisory Committee for the Integrated Science Assessment for Lead in the Ambient Air and the Review of the Air Quality Criteria Document for Lead. C.B. and I.v.L. are also employed by TerraGraphics International Foundation, a nonprofit organization. The other authors declare they have no actual or potential competing financial interests.

Received: 28 April 2015; Accepted: 21 December 2015; Advance Publication: 8 January 2016; Final Publication: 1 September 2016.

dose response was likely a combination of lower bioavailability and IRs (von Lindern et al. 2003b).

BHSS Background

In 1974, soon after the lead smelter operators bypassed emission controls destroyed by a baghouse fire, > 95% of children 1–9 years of age living within 3 mi of the smelter had BLLs exceeding 40 µg/dL (Yankel et al. 1977). Lead health interventions have been ongoing since that time. The smelter closed in 1981 and remediation began in 1986, representing one of the world's largest, most comprehensive, and well-documented lead health response cleanups (U.S. EPA 2005, 2010; von Lindern et al. 2003a, 2003b). From 1988 through 2002, soil from > 3,500 properties within the 21-mi^2 area surrounding the smelter was removed and replaced with up to 1 ft of clean fill averaging ≤ 50 mg/kg. Hundreds of families with children received lead health education and in-home follow-up investigations through a local Lead Health Intervention Program (LHIP). The LHIP tested children's BLLs, achieving participation rates > 50% among 0- to 9-year-old children for 15 consecutive years through door-to-door recruitment and incentive payments. Annual blood lead survey results were used to prioritize soil cleanup until the Remedial Action Objective (RAO) of < 5% of children with BLLs ≥ 10 µg/dL was achieved. From 1988 through 2002, homes of young children (0–6 years), pregnant women, and older children with BLLs ≥ 10 µg/dL were remediated first, regardless of location within the site. Beginning in 1994, all soils in contiguous neighborhoods with lead levels ≥ 1,000 mg/kg were removed and replaced, regardless of BLLs. This cleanup prioritization coupled with families moving within the affected communities resulted in a dynamic, complex combination of soil/dust exposures affecting individual children.

Blood lead data, collected during the seasonal peak in late summer, were matched to dust lead concentrations (from samples collected from household vacuum cleaners) and soil lead data to monitor the relationship between children's BLLs and environmental exposures to ensure cleanup was effective. Four variables were used to quantify soil and dust exposures throughout the cleanup: house dust, yard soil, neighborhood soil, and community soil lead concentrations. The neighborhood soil variable is the mean of all yard soils within a specific radius of the home, excluding the home's yard soil lead concentration. This was calculated for 200-ft, 500-ft, and 1,000-ft radii. The community soil variable is the mean of all yard soils within the community, excluding the home and neighborhood radius soil lead concentrations. The prioritized cleanup rapidly reduced the number of children residing in homes with soil lead concentrations ≥ 1,000 mg/kg and markedly decreased yard soil exposures for those families. Neighborhood soil lead concentrations progressively declined until the block-by-block cleanup strategy was implemented in 1994, and then decreased faster as contiguous neighborhoods were remediated. Community soil lead mean concentrations declined steadily until 2002 when yard soil replacement was mostly complete. House dust lead exposures (dust lead concentrations from homes of children with BLL measurements) decreased following the yard, neighborhood, community, and industrial complex cleanups but lagged the community soil means by a decade or more (von Lindern et al. 2003a).

By 2002, children's mean BLLs decreased to 2.2 µg/dL. In 2013, the health district conducted the first comprehensive blood lead survey since 2002, recruiting an estimated 50% of children 6 months to 9 years of age living within the 21-mi^2 area using incentive payments and door-to-door solicitation. The geometric mean BLL among 1- to 5-year-old children tested was 2.2 µg/dL (SD ± 1.8) compared with the most recent U.S. mean of 1.3 µg/dL (CDC 2013), with 2 of 276 children having levels ≥ 10 µg/dL, indicating that the cleanup continues to meet the RAO of 95% of children < 10 µg/dL (TerraGraphics 2015). Over the 15 years of active cleanup (1988–2002), education, and intervention, the LHIP amassed approximately 5,400 blood lead observations (referred to as the parent database) from nearly 2,340 individuals, yielding 2,176 records of blood/soil/dust lead concentrations (TerraGraphics 2004; von Lindern et al. 2003b, 2003a).

Subsequent to the cleanup at the BHSS, the U.S. EPA adopted an *in vitro* methodology to estimate site-specific bioavailability of lead in soil and dust (U.S. EPA 2012). This methodology was applied to a subset of archived soil and dust samples from the BHSS, and results were applied to the parent database. The objective of this study was to estimate age-specific soil/dust IRs through reanalysis of the dose–response relationship using new soil and house dust lead bioavailability data. In light of uncertainties and limitations of fecal tracer soil ingestion studies, these site-specific estimates likely have broader application to the IEUBK model and to human health risk assessment.

Methods

Blood lead samples collected from children participating in the LHIP were obtained through written informed consent from parents as well as child assent. The annual LHIP surveys are public health actions undertaken by state and local health authorities. TerraGraphics secured approval from the University of Idaho's Institutional Review Board for this project. No additional survey data or samples were collected from human subjects for this analysis.

Sample Analyses

In total, 271 samples (193 house dust samples, 73 yard soil samples, and 5 quality control samples) sieved to 80 mesh (or < 0.177 mm) were analyzed for total lead (Method 6010B) and *in vitro* bioaccessibility (TerraGraphics 2012; U.S. EPA 2007, 2012). U.S. EPA's *in vitro* assay measures the solubility, or bioaccessibility, of lead in soil and dust samples to estimate (*in vivo*) bioavailability. The 80 mesh sieve for both soil and dust was initiated at the BHSS in 1974 and focuses analyses on particle sizes more likely to adhere to hands and other surfaces and be ingested by children (Panhandle District Health Department et al. 1986; Ruby and Lowney 2012). Archived soil and dust samples collected between 1986 and 2002 were retrieved from storage. Those with intact seals, legible identification numbers, and sufficient mass for analysis were then checked to ensure that blood lead data and information on child age and sex, home location, and property remediation status were available. A temporal and geographic subset of samples meeting these criteria was randomly selected and analyzed at the laboratory. Reanalyzed soil and dust lead concentrations were compared to historical values using linear regression. *In vitro* bioaccessibility results were converted to *in vivo* relative bioavailability and absolute bioavailability (ABS) following U.S. EPA methods using comparison to a lead acetate reference (0.5) following Equation 1 (U.S. EPA 2007, 2009, 2012):

$$\mathrm{ABS} = (0.878 \times \mathrm{IVBA} - 0.028) \times 0.5, \quad [1]$$

where IVBA = *in vitro* bioaccessibility.

Community mean ABS values for unremediated yard soils and house dust, and site-wide ABS means for postremediation soils were integrated into the parent database. Annual site-wide ABS means were calculated using a weighted average of bioavailable lead (product of concentration and bioavailability) from remediated and unremediated yards.

Quantitative Analyses

Soil and dust partitions, age-specific IRs, and lead uptake from sources other than soil and dust were determined through structural equations modeling (SEM). SEM is a statistical multivariate methodology appropriate for pathways analysis, defined as a network of linear relations between variables. SEM was applied by von Lindern et al. (2003b) to reflect the exposure pathways of yard, community, and neighborhood soils (Ullman and Bentlar 2003). The 2003 SEM was

repeated using absorbed and bioavailable lead (instead of blood and total soil and dust lead levels), using SAS® software version 8 (SAS Institute Inc.). Several combinations of variables, including neighborhood soil means using radii of 200 ft, 500 ft, and 1,000 ft and age- and year-specific soil and dust categorical variables (i.e., grouped by both age and calendar year), were alternatively added, and model fit was evaluated by five criteria: *a*) convergence, *b*) chi-square probability test ($p > 0.05$), *c*) goodness of fit index (GFI) (> 0.90), *d*) parameters with significant t-statistics ($p < 0.05$), and *e*) parameter performance in subsequent IEUBK model analyses, described below (Carey 1998; SAS Institute Inc. 2008; Suhr 2006; Wothke 2010). Both the chi-square and GFI measure the difference between the expected and observed covariance matrices. Higher chi-square probability indicates better fit. The GFI ranges from 0 to 1.0, with higher values indicating better fit (Jöreskog and Sörbom 1988; SAS Institute Inc. 2008). SEM equations were solved using mean values for the independent variables and model parameters to estimate: *a*) soil and dust lead pathway parameters, *b*) neighborhood and community soil effects on lead uptake, *c*) age-specific and temporal effects in lead intake and uptake, and *d*) source partition scenarios for use in subsequent IEUBK modeling.

Ingestion Rate Estimates

Total lead uptake (µg/day) was calculated by dividing the measured BLLs (µg/dL) by the age-specific biokinetic slope factors, referred to as CR^{-1} (day/dL), used in the original IEUBK model (Harley and Kneip 1985; Jacobs Engineering et al. 1989; Kneip et al. 1983; TerraGraphics 1990, 2012; U.S. EPA 1994). Total lead uptake was partitioned into components used in the IEUBK model: air, diet, water, and soil/dust. Lead uptake from soil and dust was estimated by partitioned dust, yard soil, neighborhood soil (used only in the SEM), and community soil subcomponents by subtracting air, dietary, and drinking-water uptakes estimated from the IEUBK model default values (U.S. EPA 2001), as shown in Equation 2:

$$\begin{aligned} UP_{sd} = &[(C_d \times IR_d \times ABS_d) \\ &+ (C_{ys} \times IR_{ys} \times ABS_{ys}) \\ &+ (C_{cs} \times IR_{cs} \times ABS_{cs}) \\ &+ (C_{ns} \times IR_{ns} \times ABS_{ns})] \\ = &\, UP_{tot} - [UP_{air} + UP_{diet} + UP_{water}], \end{aligned} \quad [2]$$

where UP = lead uptake (µg/day); C = concentration (mg/kg); IR = ingestion rate (mg/day); ABS = absolute bioavailability (unitless); and (subscripts): *sd* = combined soil/dust sources; *d* = house dust; *ys* = yard soil; *cs* = community soil; *ns* = neighborhood soil (SEM); *tot* = total sources; *air* = airborne source; *diet* = dietary source; *water* = water source.

Equation 2 can be rearranged to calculate total soil/dust IRs [IR_{sd} (mg/day) is the sum of IR_d, IR_{ys}, IR_{cs}, and IR_{ns}] by assigning partition coefficients, i.e., fractional contributions to total soil/dust ingestion by each source, as follows in Equation 3:

$$\begin{aligned} IR_{sd} = 1{,}000 \times \{UP_{sd}/[&(C_d \times PT_d \times ABS_d) \\ &+ (C_{ys} \times PT_{ys} \times ABS_{ys}) \\ &+ (C_{cs} \times PT_{cs} \times ABS_{cs}) \\ &+ (C_{ns} \times PT_{ns} \times ABS_{ns})]\}, \end{aligned} \quad [3]$$

where PT = partition coefficient.

Partition coefficients used in these analyses included the IEUBK model default, those originally developed to support BHSS cleanup criteria, and values derived from SEM. Partition coefficients, resulting age-specific soil/dust IRs (using Equation 3), and bioavailability were input to the IEUBK model batch-mode analyses (IEUBKwin v1.1 build 11) to compare predicted and observed BLLs. The combined IR and partition scenarios showing best-predicted BLLs were evaluated by linear regression and sums of squared error (SSE). The slope nearest to 1.0 coupled with the highest r^2, highest F-statistic, and lowest sum of squared residuals from linear regression, as well as the SSE (squared difference between observed and predicted geometric mean BLLs), were used to determine the scenario(s) that best represent observed BLLs. The age-specific soil and dust IR estimates were then determined based on these scenario(s).

Results

Sample Analysis

The selected subset of historical data was considered generally representative of the parent database (e.g., lead concentration and child's age) (Table 1). The reanalyzed soil and dust lead concentrations were not significantly different

Table 1. Comparison of the parent BHSS database with the subset of records selected for reanalysis (historical data).

	Parent data set						Selected subset					
City	Minimum	Maximum	Average	SD	Geometric mean	Geometric SD	Minimum	Maximum	Average	SD	Geometric mean	Geometric SD
Kellogg	Parent data set $n = 3{,}054$						Selected subset $n = 118$					
Age (years)	0	9	5.1	2.7	—	—	1	9	5.5	2.6	—	—
Blood lead (µg/dL)	1	54	6.4	4.7	5.1	2.0	2	41	7.6	5.7	6.3	1.8
Soil lead (mg/kg)	100	13,400	954	1,625	274	4.4	100	6,930	1,407	1,849	435	5.2
Dust lead (mg/kg)	32	52,700	1,213	2,839	733	2.4	88	5,530	1,373	1,093	985	2.3
Page	Parent data set $n = 161$						Selected subset $n = 15$					
Age (years)	0	9	5.1	2.6	—	—	1	9	4.3	2.8	—	—
Blood lead (µg/dL)	1	26	7.0	4.7	5.7	1.9	3	12	5.6	2.4	5.2	1.5
Soil lead (mg/kg)	53	3,480	557	668	287	3.2	100	1,670	541	420	387	2.5
Dust lead (mg/kg)	69	2,070	678	496	478	2.6	86	1,680	706	567	467	2.9
Pinehurst	Parent data set $n = 1{,}369$						Selected subset $n = 117$					
Age (years)	0	9	5.1	2.6	—	—	1	9	5.2	2.4	—	—
Blood lead (µg/dL)	1	26	4.6	3.1	3.8	1.9	1	17	4.3	2.6	3.7	1.7
Soil lead (mg/kg)	31	3,060	438	424	312	2.3	37	1,700	469	356	369	2.0
Dust lead (mg/kg)	22	15,000	639	1,053	417	2.4	45	15,000	625	1,427	383	2.3
Smelterville	Parent data set $n = 642$						Selected subset $n = 57$					
Age (years)	0	9	4.9	2.7	—	—	1	9	4.5	2.6	—	—
Blood lead (µg/dL)	1	55	7.0	5.4	5.6	2.0	2	30	7.5	4.9	6.4	1.7
Soil lead (mg/kg)	100	10,700	953	1,921	245	4.3	100	8,170	1,037	1,821	242	4.8
Dust lead (mg/kg)	54	11,300	1,127	1,257	757	2.5	393	4,210	1,387	807	1,190	1.8
Wardner	Parent data set $n = 173$						Selected subset $n = 5$					
Age (years)	0	9	5.2	2.7	—	—	1	8	4.8	3.1	—	—
Blood lead (µg/dL)	1	20	6.6	3.8	5.5	1.9	2	8	4.6	2.2	4.2	1.6
Soil lead (mg/kg)	100	34,800	759	2,925	224	3.5	100	13,200	3,104	5,705	484	9.6
Dust lead (mg/kg)	130	6,000	1,005	1,112	700	2.3	307	2,220	1,147	697	959	2.1

from historical results (r^2 = 0.99, p < 0.01, n = 73; and r^2 = 0.91, p < 0.01, n = 193, respectively), indicating that samples were not compromised during storage. The reanalyzed sample results are summarized in Table 2. Mean soil bioavailability ranged from 30% to 39% by community, averaging 33% (SD ± 4%); dust bioavailability ranged from 27% to 30%, averaging 28% (SD ± 6%). Three "clean" soil samples were obtained in 2011 from borrow piles used to replace contaminated property soils. No clean yard soil samples were previously collected and archived. Consequently, these three samples represent postremediation replacement clean soils, and bioavailability results averaged 15% (SD ± 0.6%; data not shown). Linear regression relating soil and dust bioavailability to lead concentration showed a weak relationship (r^2 = 0.15, p = 0.0006 and r^2 = 0.045, p = 0.0028, respectively).

SEM Analyses

Several plausible SEM combinations met the model acceptance criteria. In each accepted model, bioavailable lead in dust and soils from the home yard, neighborhood, and community were all significant independent predictors of total blood lead uptake. Based on experience with the BHSS cleanup and development of the parent database, numerous combinations of spatial, temporal, and age-specific variable constructs and database time periods were explored (data not shown). Of the three neighborhood radii, 500 ft showed the best fit by combined chi-square test and parameter t-values. Age-specific coefficients for dust concentration among the youngest children (6 to < 24 months old) were significant (p < 0.01), implying different IRs, with a significant intercept representing uptake from other sources. Coefficients for age-specific and year-specific soil concentration variables were not significant (p > 0.05). The SEM with temporal variables showed marginally significant (p = 0.05) positive dust coefficients for 6- to 23-month-old children in 1994–1998, suggesting higher dust IRs during those years.

Source partitions using three SEM combinations were evaluated in subsequent IEUBK model analyses: Model 1 (1989–2002 database) included a term allowing calculation of year-specific IRs, and model 2 (1989–1998 database) and model 3 (1989–2002 database) assumed constant source contributions and IRs throughout each respective time period (Tables 3 and 4). Soil/dust IRs and source partitions were estimated by substitution of mean soil and dust lead concentrations in the model equations.

Model 2, shown in Equations 4 and 5 (chi-square test: p = 0.7416, n = 1,571; Table 3), was selected based on performance in subsequent IEUBK modeling:

$$\begin{aligned}\ln(UP_{tot}) = {} & [0.1466 \times \ln(C_d \times ABS_d)] \\ & + [0.0516 \times \ln(C_{ys} \times ABS_{ys})] \\ & + [0.0440 \times \ln(C_d \times ABS_d \times \text{age0–1})] \\ & + [0.0613 \times \ln(C_d \times ABS_d \times \text{age1–2})] \\ & + [0.0661 \times \ln(C_{ns} \times ABS_{cs})] \\ & + [0.0954 \times \ln(C_{cs} \times ABS_{cs})] \\ & + 0.7666 \end{aligned} \quad [4]$$

Table 2. Community averages of reanalyzed archived soil and house dust samples.

	Soil			Dust		
City	n	Soil lead (mg/kg) (mean ± SD)	Soil ABS (%) (mean ± SD)	n	Dust lead (mean ± SD) (mg/kg)	Dust ABS (%) (mean ± SD)
Kellogg	24	2,656 ± 1,624	34 ± 3	66	1,179 ± 934	28 ± 6
Page	7	778 ± 417	33 ± 4	12	753 ± 529	27 ± 5
Pinehurst	33	569 ± 463	32 ± 4	75	762 ± 2,131	28 ± 6
Smelterville	8	4,136 ± 2,192	39 ± 2	36	1,239 ± 550	30 ± 4
Wardner	1	2,030	30	4	892 ± 415	27 ± 5
Overall	73	1,686 ± 1,748	33 ± 4	193	996 ± 1,472	28 ± 6

ABS, absolute bioavailability.

Table 3. Structural equations modeling (SEM) results.

	Model 1 (1989–2002)			Model 2 (1989–1998)			Model 3 (1989–2002)		
Variables	Slope coefficient	t-Value[a]	Standardized coefficient	Slope coefficient	t-Value[a]	Standardized coefficient	Slope coefficient	t-Value[a]	Standardized coefficient
UP_{tot} (Equation 4)									
$\ln(UP_d)$	0.1347	8.43	0.2575	0.1466	7.95	0.2762	0.1360	8.50	0.2598
ln(DUSTage0–1)	0.0450	2.80	0.0132	0.0440	2.24	0.0116	0.0450	2.79	0.0132
ln(DUSTage1–2)	0.0501	4.06	0.0273	0.0613	6.23	0.0333	0.0667	7.45	0.0363
ln(DUST1994–1998)	0.0336	1.95	0.0128	—	—	—	—	—	—
$\ln(UP_{ys})$	0.0611	6.09	0.1027	0.0516	4.82	0.0866	0.0601	5.99	0.1010
$\ln(UP_{ns})$	0.0647	3.30	0.1364	0.0661	2.41	0.1396	0.0636	3.24	0.1341
$\ln(UP_{cs})$	0.1594	6.03	0.3439	0.0954	2.75	0.2050	0.1571	5.94	0.3389
Intercept	0.3639	3.34	0.1316	0.7666	5.55	0.2670	0.3820	3.52	0.1382
Error	—	—	0.2098	—	—	0.2021	—	—	0.2100
Bioavailable dust lead (Equation 5)									
$\ln(UP_{ys})$	0.1039	7.57	0.0914	0.1054	7.31	0.0938	0.1039	7.57	0.0914
$\ln(UP_{ns})$	0.0751	2.77	0.0828	0.1126	3.01	0.1262	0.0751	2.77	0.0828
$\ln(UP_{cs})$	0.3350	9.35	0.3782	0.2582	5.50	0.2944	0.3350	9.35	0.3782
Intercept	2.3390	16.52	0.4418	2.5994	14.67	0.4804	2.3339	16.52	0.4418
Error	—	—	0.1523	—	—	0.1468	—	—	0.1523
Baseline bioavailable lead (µg/dL)	1.4			2.2			1.5		
Baseline bioavailable dust lead (mg/kg)	37.0			48.1			36.9		
n		2,034			1,571			2,034	
Goodness of fit index		0.9995			0.9999			0.9998	
χ^2		4.7284			0.598			1.5347	
Degrees of freedom		3			2			2	
Pr > χ^2		0.1928			0.7416			0.4642	
r^2 Total uptake		0.9560			0.9591			0.9559	
r^2 Bioavailable dust lead		0.9768			0.9785			0.9768	

Abbreviations: χ^2, chi-square; cs, community soil; d, dust; DUSTage0–1, bioavailable dust lead if the child was 6–11 months; DUSTage1–2, bioavailable dust lead if the child was 12–23 months; DUST1994–1998, bioavailable dust lead if the year was 1994, 1995, 1996, 1997, or 1998. ln, natural log; ns, neighborhood soil; Pr, probability; r^2, r-squared; tot, total; UP, uptake; ys, yard soil.
[a]t-Values ≥ 1.96 are equivalent to p-values < 0.05.

$$\ln(C_d \times ABS_d) = [0.1054 \times \ln(C_{ys} \times ABS_{ys})] + [0.1126 \times \ln(C_{ns} \times ABC_{cs})] + [0.2582 \times \ln(C_{cs} \times ABS_{cs})] + 2.5994, \quad [5]$$

where ln = natural log; C_{ns} = neighborhood soil arithmetic mean using 500-ft radius (mg/kg); age0–1 = 1 for 6–11 months, otherwise 0; age1–2 = 1 for 12–23 months, otherwise 0; ABS_{cs} applies to both C_{ns} and C_{cs} values.

The SEM standardized regression coefficients (Table 3) yielded partition coefficients of 50% house dust/25% yard soil/10% arithmetic mean neighborhood soil/15% arithmetic mean community soil (50/25/10/15) (Table 4) used in subsequent calculation of age-specific IRs.

Ingestion Rate Estimates

Figure 1 summarizes arithmetic and geometric mean soil/dust IRs calculated for four source partition scenarios: *a*) the IEUBK model default 55% dust/45% yard soil (55/45), *b*) the original BHSS model applying 40% dust/30% yard soil/30% geometric mean community soil (40/30/30G) (Panhandle District Health Department 1986), *c*) the same partition using arithmetic average community soil (40/30/30A), and *d*) the SEM (50/25/10/15). Calculated IRs were observed in three general ranges. The highest IR estimates were arithmetic means for the 55/45 partition and are near the IEUBK model recommended values (also shown in Figure 1). Mid- and low-range IR estimates are approximately one-third and one-half lower, respectively [corresponding numeric data with 95% confidence interval (CI) and percentiles are provided in Table S1].

IEUBK Model Results

The four IR and partition scenarios with the best agreement are from the mid-range IRs shown in Figure 1 (i.e., 40/30/30G-geometric mean IR (geoIR), 55/45-geoIR, 50/25/10/15-arithmetic mean IR (aveIR), 40/30/30A-aveIR; the high- and low-range IRs, respectively, over- and underpredicted observed BLLs (data not shown). Figure 2 shows the results of the SSE and linear regression analyses for annual observed and predicted geometric mean BLLs for the four scenarios with the best agreement. Observed geometric mean BLLs ranged from > 8 µg/dL in the late 1980s to near 2 µg/dL in 2002, and observed geometric standard deviations (GSDs) ranged from 1.52 to 2.12 (n = 2,176). GSDs calculated from the IEUBK batch runs for these four scenarios ranged from 1.42 to 2.10, with medians around 1.7 (see Table S2), consistent with the IEUBK model default GSD of 1.6.

Each of the four scenarios represents a plausible source partition and estimated lead intake scenario, produces similar IR estimates (Table 5), and shows temporal variability in the SSE, with the largest SSEs in 1988 (see Table S3). The scenarios with the smallest total SSE for 1989–2002 were 40/30/30G-geoIR, 55/45-geoIR, and 50/25/10/15-aveIR. The 40/30/30A-geoIR was similar to the 50/25/10/15-aveIR and had the next smallest SSE for those same years. Although all four scenarios showed temporal variation in predicting observed BLLs, the 50/25/10/15-aveIR had the lowest SSEs in the early and later years of the cleanup (1989–1990 and 1996–2002, respectively), whereas the 40/30/30G-geoIR had the lowest SSE in the middle years of the cleanup (1991–1995). Additionally, linear regression indicated that the 50/25/10/15-aveIR and the 40/30/30A-aveIR scenarios were best-fit models due to a slope coefficient nearest 1.0, in combination with highest r^2, largest F-statistic, and smallest sum of squared residuals (see

Table 4. Structural equations modeling (SEM) results for soil/dust contributions (%).

	Model 1 (1989–2002)			Model 2 (1989–1998)			Model 3 (1989–2002)		
Variables	0–2 years	2–9 years	Value[a]	0–2 years	2–9 years	Value[a]	0–2 years	2–9 years	Value[a]
Contribution of dust/soil ingestion									
House dust	40	37	40	48	45	50	41	38	40
Yard	30	30	30	28	30	25	30	31	30
Neighborhood	11	11	10	9	10	10	11	11	10
Community	19	23	20	15	15	15	18	20	20
Contribution to lead in blood									
House dust			17			22			16
Yard			35			34			33
Neighborhood			14			15			14
Community			34			29			37

[a]Values are rounded to total 100%.

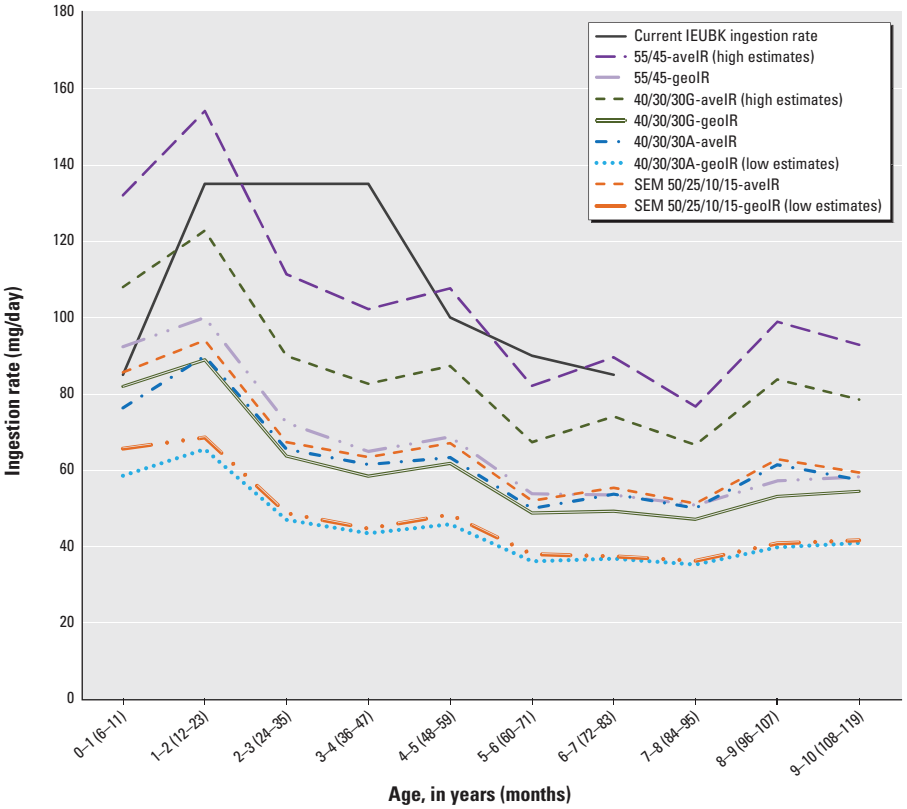


Figure 1. Arithmetic and geometric mean age-specific soil/dust ingestion rates (IRs) for four soil/dust partition scenarios. Included are current Integrated Exposure Uptake Biokinetic (IEUBK) model IRs and calculated age-specific mean soil/dust IRs for the four partition scenarios. For each age (6 months–9 years), arithmetic mean IRs (aveIR) and geometric mean IRs (geoIR) are shown. 55/45 is the partition of dust/yard soil, 40/30/30 is the partition of dust/yard/community soil, and SEM 50/25/10/15 is the partition of dust/yard/neighborhood/community soil. Corresponding numeric data, with 95% CI and percentile distributions for each model and age, are provided in Table S1.

Table S4). The age-specific IRs and 95% CIs for the 50/25/10/15-aveIR scenario are shown in Figure 3 because this scenario had the lowest SSEs in multiple years and was one of the best-fit linear regressions. Figure 3 also shows age-specific IRs recommended by U.S. EPA risk assessment guidance (U.S. EPA 1994, 2011).

Discussion

At the BHSS, children's soil/dust exposures have been investigated since the 1970s, and the IEUBK model has been used to evaluate the dose–response relationship since 1986. Use of the IEUBK model default IRs, bioavailability and soil/dust partition failed to account for soil sources beyond the immediate home yard and consistently overpredicted observed BLLs. In 1990, the BHSS cleanup criteria were developed using the 40/30/30G partition accounting for community soils and reduced soil/dust lead uptake (compared with the IEUBK model default). The overprediction of BLLs using default IEUBK model values was resolved by lowering soil and dust lead bioavailability, although it could have been explained by several combinations of reduced IRs or bioavailability. However at the time, it was not possible to determine which was predominant. In this study, we used a newly available laboratory method to estimate soil and house dust ABS. The soil and house dust bioavailability results of 33% and 28%, respectively, are similar to the recommended 30% IEUBK model default values and those found in other BHSS studies (Maddaloni et al. 1998). These findings suggest that IRs, not ABS, should be reduced by about 40% from the IEUBK default values to best represent the dose–response relationship observed at the BHSS.

In this study, the more rigorous SEM pathways analyses resulted in several plausible models, all suggesting that community and neighborhood soil sources, in addition to the yard soil source, are independent contributors to total lead uptake and bioavailable lead in house dust. Others have recently confirmed the importance of soil beyond the immediate home yard (Laidlaw et al. 2014; Zahran et al. 2013a, 2013b). The 50/25/10/15-aveIRs were derived from the only partition including neighborhood soils and exhibited the lowest SSEs in multiple years. These IRs were calculated using arithmetic-mean neighborhood and community soil exposures. The central tendency statistic that better approximates geographic area exposures has been the subject of debate and remains unresolved; the arithmetic mean represents an aggregate biased by high or low concentrations, and the geometric mean is the most likely concentration in the prescribed area. Two of the four select models employed arithmetic means, one used the geometric mean, and the IEUBK model default scenario uses individual observations and assumes the effect of soils beyond the home yard is included in house dust. However, all four models produced similar IRs with the average nearly identical to the 50/25/10/15-aveIRs, indicating the source partition is critical in describing lead intake.

Age-specific and temporal effects, also examined with SEM, suggested children 6–23 months of age exhibited greater lead intake rates from house dust than older children, consistent with the study by Wilson et al. (2013). Additionally, SEM analyses including year-specific variables suggested dust intake rates for younger children may have been lower early in the cleanup (1989–1993) and higher during the middle years of the cleanup (1994–1998). However, only age- and year-specific intake rates of interior dust were statistically significant predictors (Table 3); consequently, age- and year-specific IRs for soil intake (yard, neighborhood, or community) were not included in our final model (data not shown). Several factors may have caused temporal variations in IRs, or partition coefficients. Aggressive LHIP education and intervention programs may have resulted in a temporary reduction in soil/dust intake by children. Alternatively, elevated dust loadings caused by flooding and

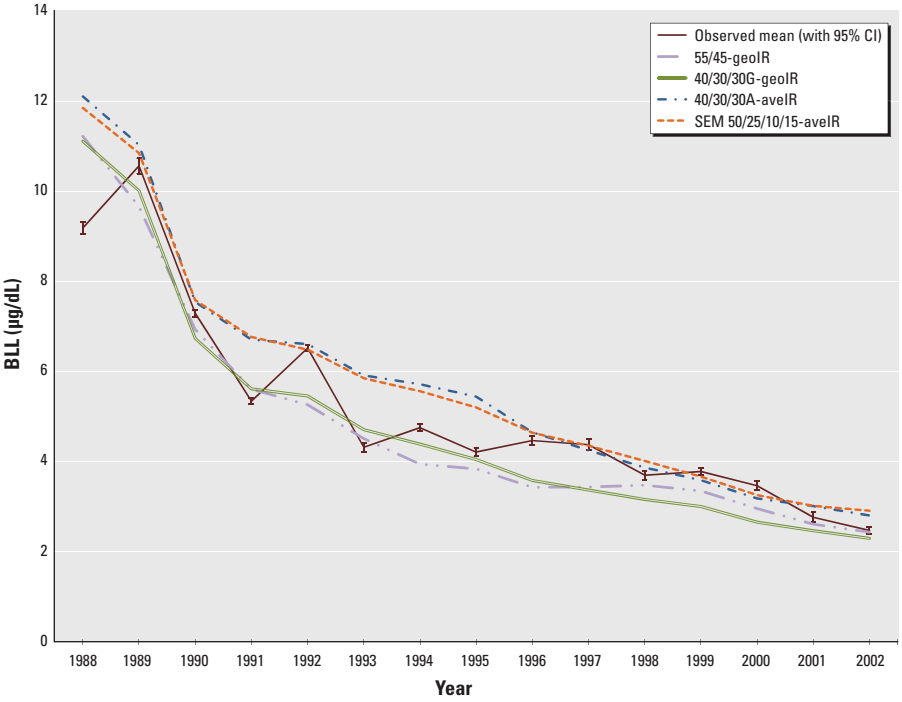


Figure 2. Observed and predicted geometric mean blood lead levels (BLLs) by year for four scenarios that best predict observed BLLs. Predicted geometric mean BLLs for the four scenarios are compared with observed BLLs from 1988 through 2002. Observed BLLs include error bars for the 95% confidence interval (CI). Abbreviations: aveIR, arithmetic mean ingestion rate; geoIR, geometric mean ingestion rate. 55/45 is the partition of dust/yard soil, 40/30/30 is the partition of dust/yard/community soil, and SEM 50/25/10/15 is the partition of dust/yard/neighborhood/community soil. Corresponding numeric data, with 95% CI and percentile distributions for each model and age, are provided in Table S1.

Table 5. Mean age-specific soil/dust ingestion rates (mg/day) for four scenarios that best predict observed blood lead levels.

Age[a] (years)	55/45[b]-geoIR	40/30/30G[c]-geoIR	40/30/30A[c]-aveIR	50/25/10/15[d]-aveIR	Average all models
0–1	92	82	76	86	84
1–2	100	89	90	94	93
2–3	72	64	66	67	67
3–4	65	58	62	63	62
4–5	69	62	63	67	65
5–6	54	49	50	52	51
6–7	54	49	54	55	53
7–8	51	47	50	51	50
8–9	57	53	61	63	59
9–10	58	54	57	59	57

Abbreviations: aveIR, arithmetic mean ingestion rate; geoIR, geometric mean ingestion rate.
[a]0–1 = 6–11 months, 1–2 = 12–23 months, 2–3 = 24–35 months, etc. [b]Dust/yard soil. [c]Dust/yard/community soil; G = geometric mean; A = arithmetic mean. [d]Dust/yard/neighborhood/community soil.

construction activities may have exacerbated ingestion in the middle years of the cleanup. However, SEM and IEUBK model sensitivity analyses investigating alternate time period (years) variable constructs suggested that variation in calculated IRs may be an artifact of the source partitions, nature of the data, or progression of the cleanup. At the beginning of the cleanup, there was little difference between community soil and neighborhood soil concentrations. As area-wide cleanups predominated, these variable concentrations diverged between 1994 and 1998 and returned to similar concentrations by 2000 (TerraGraphics 2004). The 50/25/10/15 SEM is the only partition scenario that captures spatial differentiation in soil outside the home yard through the neighborhood soil variable. It is also possible that various periods of the cleanup exhibited different partition ratios from landscape changes or LHIP activities.

The truncated 1989–1998 database was used to derive the select SEM partition because from 1999 forward, the yard, neighborhood, and community soil variables were dominated by remediated homes. Lead concentrations were not measured in remediated yards. Instead, a nominal value of 100 mg/kg was assigned to represent the maximum allowable recontamination level. Replacement soils, and presumably yard soil concentrations immediately following remediation, averaged ≤ 50 mg/kg (LFR Inc. 2008; McCulley, Frick & Gilman Inc. 1997). Consequently, remediated soil lead concentrations were likely biased high and reflected less variation in the final years of the cleanup. Including 1999–2002 in the SEM analyses could bias the standardized coefficients for soil lead parameters used to estimate source effects.

Additionally, SEM coefficients were based on 1,571 of 4,019 observations in the 1989–1998 database. Most missing variable measurements for the SEM subset were house dust lead levels, implying the home lacked a vacuum cleaner, and were associated with likely dustier homes and higher BLLs (TerraGraphics 2004; U.S. EPA 2000; von Lindern et al. 2003a, 2003b). As a result of the missing house dust levels, mean values for key variables in the SEM subset differ from those in the parent database; particularly, mean absorbed lead was about 11% greater for children with no dust lead observation. Because total absorbed lead was allocated to source variables, higher absorbed blood lead implies potentially higher soil/dust IRs, absorption rates, or dust lead concentrations, or a combination thereof among these underrepresented children. The LHIP provides free loaner high-efficiency particulate arresting vacuum cleaners to residents to address this need.

This study is part of larger cleanup and public health response. It was not a designed experiment. The LHIP paid participants a modest fee for blood and house dust samples specifically to identify and provide follow-up services to children at risk. Factors such as self-selection, repeat blood leads, uncontrolled vacuum dust samples, lack of a home vacuum cleaner, intervention responses, other lead sources, community awareness, and assumed clean soil values could bias the IRs higher or lower. Many of these factors were discussed in detail by von Lindern et al. (2003b).

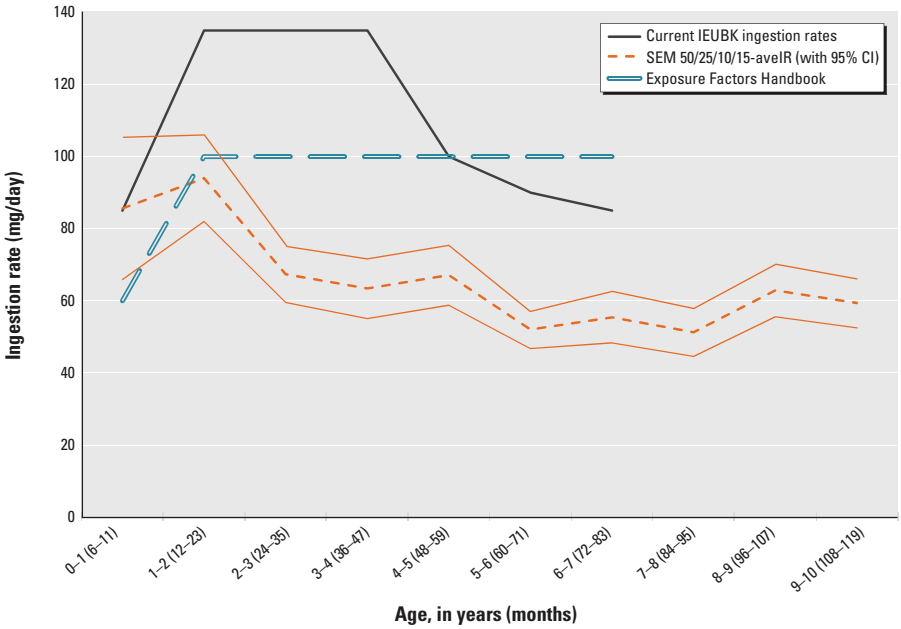


Figure 3. Mean age-specific ingestion rates (IRs) with 95% confidence intervals (CI) for the structural equations modeling (SEM) partition scenario. SEM 50/25/10/15 partition scenario (of dust/yard/neighborhood/community soil) with arithmetic mean IRs (aveIR) for ages 6 months–9 years, including 95% CI, are compared with current Integrated Exposure Uptake Biokinetic (IEUBK) model IRs and *Exposure Factors Handbook* IRs (ages 6 months–6 years only) (U.S. EPA 1994, 2011).

Conclusions

The addition of *in vitro* soil and house dust bioavailability estimates to the BHSS lead health database facilitated analysis of absorbed and bioavailable soil/dust lead, which improves understanding of the dose–response relationship and supports improved estimates of total soil/dust IRs. Bioavailability was substantially underestimated in the original BHSS risk assessment. The IEUBK model, using default bioavailability and default soil/dust IRs, consistently overpredicted BLLs collected from > 50% of resident children, and this was likely attributable to overestimating IRs. Although remediation activities were based on an inaccurate combination of IRs and bioavailability estimates, remediation was nonetheless effective in achieving the objective of < 5% of children with BLLs ≥ 10 µg/dL.

Soil and dust IRs at the BHSS from 1988 through 2002 averaged 66 mg/day (95% CI: 57, 75 mg/day) for children 6 months–9 years of age, and peaked at 94 mg/day (95% CI: 82, 106 mg/day) at age 12–23 months. The estimated IRs were lower than both IEUBK default and the U.S. EPA *Exposure Factors Handbook* recommended values for all ages except the youngest age group (< 12 months) (U.S. EPA 2001, 2011). The average IRs are 40% less than IEUBK default recommendations and 30% lower than estimates in the *Exposure Factors Handbook* (shown in Figure 3), and are consistent with recent studies and reviews suggesting values < 100 mg/day (Bierkens et al. 2011; Moya and Phillips 2014; Ozkaynak et al. 2011; Wilson et al. 2013).

Soil/dust IRs are among the most sensitive variables in the IEUBK and other risk assessment models used at hazardous waste sites (Griffin et al. 1999; TRW Lead Committee 2014). Accurately estimating lead intake requires simultaneously quantifying both soil/dust IRs and the soil/dust source partition. Inclusion of neighborhood and community soil exposures is essential to estimating soil/dust lead intake. These findings suggest that approximately half of the lead intake is from house dust and half is from soil, equally attributed to the immediate home yard and surrounding neighborhood/community. Additionally, the importance of soil outside the home environment varies with distance, not property boundaries, and intake estimates should account for soil sources in the immediate neighborhood and greater community.

References

Batelle. 2005. Summary Report of the U.S. EPA Colloquium on Soil/Dust Ingestion Rates and Mouthing Behavior for Children and Adults. Available: http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=146585#Download [accessed 13 January 2015].

Bierkens J, Van Holderbeke M, Cornelis C, Torfs R. 2011. Exposure through soil and dust ingestion. In: Dealing with Contaminated Sites: from Theory towards Practical Application. (Swartjes FA, ed). Dordrecht, the Netherlands:Springer Science+Business Media B.V., 261–286.

Carey G. 1998. Path Analysis Using PROC CALIS. Available: http://psych.colorado.edu/~carey/courses/psyc7291/handouts/pathcalis.pdf [accessed 13 January 2015].

CDC (Centers for Disease Control and Prevention). 2013. Blood lead levels in children aged 1–5 years — United States, 1999–2010. MMWR Morb Mortal Wkly Rep 62:245–248.

CH2M Hill. 1991. Residential Soil Feasibility Study for the Bunker Hill CERCLA Site Populated Areas. Prepared for the Idaho Division of Environmental Quality, Boise, ID. Document Number BHPA-RSFS-F-RO-041991. Seattle, WA:U.S. EPA Region 10 Office.

Doyle JR, Blais JM, White PA. 2010. Mass balance soil ingestion estimating methods and their application to inhabitants of rural and wilderness areas: a critical review. Sci Total Environ 408:2181–2188.

Griffin S, Goodrum PE, Diamond GL, Meylan W, Brattin WJ, Hassett JM. 1999. Application of a probabilistic risk assessment methodology to a lead smelter site. Hum Ecol Risk Assess 5:845–868, doi:10.1080/10807039.1999.9657763.

Harley NH, Kneip TH. 1985. An Integrated Metabolic Model for Lead in Humans of All Ages. EPA report, Contract B44899. Washington, DC:U.S. Environment Protection Agency.

Jacobs Engineering, ICAIR Life Systems, TerraGraphics. 1989. Human Health Risk Assessment: Protocol for the Populated Areas of the Bunker Hill Superfund Site. Contract Number 68-01-7351. Seattle, WA:U.S. EPA Region 10 Office.

Jöreskog KG, Sörbom D. 1988. LISREL 7: A Guide to the Program and Applications, Chicago, IL:SPSS.

Kneip TJ, Mallon RP, Harley NH. 1983. Biokinetic modeling for mammalian lead metabolism. Neurotoxicology 4:189–192.

Laidlaw MA, Zahran S, Pingitore N, Clague J, Devlin G, Taylor MP. 2014. Identification of lead sources in residential environments: Sydney Australia. Environ Pollut 184:238–246, doi:10.1016/j.envpol.2013.09.003.

Landrigan PJ, Gehlbach SH, Rosenblum BF, Shoults JM, Candelaria RM, Barthel WF, et al. 1975. Epidemic lead absorption near an ore smelter. The role of particulate lead. N Engl J Med 292:123–129, doi:10.1056/NEJM197501162920302.

Lanphear BP, Matte TD, Rogers J, Clickner RP, Dietz B, Bornschein RL, et al. 1998. The contribution of lead-contaminated house dust and residential soil to children's blood lead levels. A pooled analysis of 12 epidemiologic studies. Environ Res 79:51–68, doi:10.1006/enrs.1998.3859.

Lanphear BP, Succop P, Roda S, Henningsen G. 2003. The effect of soil abatement on blood lead levels in children living near a former smelting and milling operation. Public Health Rep 118:83–91.

LFR Inc. 2008. Final Completion of Remedial Action Certification Report for Pinehurst Reasonably Segregable Area. Seattle, WA:U.S. EPA Region 10 Office.

Maddaloni M, Lolacono N, Manton W, Blum C, Drexler J, Graziano J. 1998. Bioavailability of soil-borne lead in adults, by stable isotope dilution. Environ Health Perspect 106:1589–1594.

McCulley, Frick & Gilman Inc. 1997. Completion of Remedial Action–Certification Report for Smelterville Reasonable Segregable Area. Seattle, WA:U.S. EPA Region 10 Office.

Moya J, Phillips L. 2014. A review of soil and dust ingestion studies for children. J Expo Sci Environ Epidemiol 24:545–554, doi:10.1038/jes.2014.17.

Ozkaynak H, Xue J, Zartarian VG, Glen G, Smith L. 2011. Modeled estimates of soil and dust ingestion rates for children. Risk Anal 31:592–608.

Panhandle District Health Department; Idaho Department of Health and Welfare; Center for Environmental Health, Centers for Disease Control; U.S. Environmental Protection Agency. 1986. Kellogg Revisited – 1983: Childhood Blood Lead and Environmental Status Report. Available: http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=9101OTYB.TXT [accessed 13 January 2015].

Ruby MV, Lowney YW. 2012. Selective soil particle adherence to hands: implications for understanding oral exposure to soil contaminants. Environ Sci Technol 46:12759–12771, doi:10.1021/es302473q.

SAS Institute Inc. 2008. SAS/STAT® 9.2 User's Guide Introduction to Structural Equation Modeling with Latent Variables (Book Excerpt). Cary, NC:SAS Institute Inc. Available: https://support.sas.com/documentation/cdl/en/statugstructequmodel/61765/PDF/default/statugstructequmodel.pdf [accessed 13 January 2015].

Sedman RM, Mahmood RJ. 1994. Soil ingestion by children and adults reconsidered using the results of recent tracer studies. Air Waste 44:141–144.

Stanek EJ III, Calabrese EJ, Xu B. 2012. Meta-analysis of mass-balance studies of soil ingestion in children. Risk Anal 32:433–447, doi:10.1111/j.1539-6924.2011.01673.x.

Suhr D. 2006. The Basics of Structural Equation Modeling. Available: http://jansenlex.readyhosting.com/wuss/2006/tutorials/TUT-Suhr.pdf [accessed 13 January 2015].

TerraGraphics (TerraGraphics Environmental Engineering, Inc.). 1990. Risk Assessment Data Evaluation Report (RADER) for the Populated Areas of the Bunker Hill Superfund Site. TES Contract No. 68-W9-0008, WA_C10012. Prepared for U.S. Environmental Protection Agency, Region X. Seattle, WA:U.S. EPA Region 10 Office.

TerraGraphics. 2004. Final Bunker Hill Box Human Health Remedial Evaluation Report. Prepared for U.S. Environmental Protection Agency Region X and Idaho Division of Environmental Quality. Moscow, Idaho:TerraGraphics. Seattle, WA:U.S. EPA Region 10 Office.

TerraGraphics. 2012. Work Plan for: "Estimating Soil Ingestion Through the Blood Lead:Soil/Dust Lead Relationship at the Bunker Hill Superfund Site in the Silver Valley of Idaho." Contract Number EP-11-H-001529. Prepared for U.S. Environmental Protection Agency, Region X.

TerraGraphics. 2015. Bunker Hill Mining and Metallurgical Complex Superfund Site OU1 2013 House Dust and Blood Lead Data and Risk Management Evaluation. Prepared for Idaho Division of Environmental Quality. Seattle, WA:U.S. EPA Region 10 Office.

TRW Lead Committee. 2014. Training on the IEUBK Model, Adult Lead Methodology, and Recent Lead Risk Assessment Updates. Available: https://semspub.epa.gov/work/11/176285.pdf [accessed 1 March 2014].

Ullman JB, Bentler PM. 2003. Structural equation modeling. Part Four. Data analysis methods. In: Handbook of Psychology. Hoboken, NJ:Wiley, Four:24:607–634.

U.S. EPA (U.S. Environmental Protection Agency). 1994. Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children. EPA/540/R-93/081. Available: http://nepis.epa.gov/Exe/ZyNET.exe/2000WN4R.TXT?ZyActionD=ZyDocument&Client=EPA&Index=1991+Thru+1994&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C91thru94%5CTxt%5C00000016%5C2000WN4R.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=p%7Cf&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPUR [accessed 9 January 2015].

U.S. EPA. 2000. Bunker Hill Populated Areas Operable Unit First Five Year Review Report. 910-R-05-006. Available: http://www.epa.gov/region10/pdf/sites/bunker_hill/bh_populated_fyr_2000.pdf [accessed 13 January 2015].

U.S. EPA. 2001. Integrated Exposure Uptake Biokinetic Model (IEUBKwin v1.0) Software and Users Manual. Available: https://www.epa.gov/superfund/lead-superfund-sites-software-and-users-manuals [accessed 2 September 2012].

U.S. EPA. 2005. Five-Year Review Report: Second Five-Year Review for the Bunker Hill Mining and Metallurgical Complex Superfund Site, Operable Units 1, 2, and 3, Idaho and Washington. 910-R-05-006. Available: http://www.epa.gov/region10/pdf/sites/bunker_hill/bh_2nd_fyr_102505.pdf [accessed 7 December 2014].

U.S. EPA. 2007. Technical Support Document: Estimation of Relative Bioavailability of Lead in Soil and Soil-Like Materials Using *in Vivo* and *in Vitro* Methods. OSWER 9285.7-77. Available: http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=93001C2U.TXT [accessed 7 December 2014].

U.S. EPA. 2009. Validation Assessment of *in Vitro* Lead Bioaccessibility Assay for Predicting Relative Bioavailability of Lead in Soils and Soil-like Materials at Superfund Sites. OSWER 9200.3-51. Available: http://nepis.epa.gov/Exe/ZyNET.exe/P100GELG.TXT?ZyActionD=ZyDocument&Client=EPA&Index=2006+Thru+2010&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C06thru10%5CTxt%5C00000033%5CP100GELG.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=p%7Cf&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL [accessed 26 January 2015].

U.S. EPA. 2010. 2010 Five-Year Review Report for the Bunker Hill Mining and Metallurgical Complex Superfund Site, Operable Units 1, 2, and 3, Idaho and Washington. Available: http://www.epa.gov/region10/pdf/sites/bunker_hill/bunkerhill_final_2010five-yearreview_tagged.pdf [accessed 7 December 2014].

U.S. EPA. 2011. U.S. EPA. Exposure Factors Handbook 2011 Edition (Final). EPA/600/R-09/052F. Available: https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=236252 [accessed 7 December 2014].

U.S. EPA. 2012. Standard Operating Procedure for an *in Vitro* Bioaccessibility Assay for Lead in Soil. EPA 9200.2-86. Available: http://nepis.epa.gov/Exe/ZyNET.exe/P100GESL.TXT?ZyActionD=ZyDocument&Client=EPA&Index=2011+Thru+2015&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C11thru15%5CTxt%5C00000007%5CP100GESL.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=p%7Cf&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL [accessed 20 January 2015].

U.S. EPA. 2013. Integrated Science Assessment for Lead (Final Report). EPA/600/R-10/075F. Available: https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=255721 [accessed 1 December 2014].

U.S. EPA, IDHW (Idaho Department of Health and Welfare). 1991. Record of Decision. Bunker Hill Mining and Metallurgical Complex. Residential Soils Operable Unit. EPA/ROD/R10-91/028. Available: http://www.epa.gov/superfund/sites/rods/fulltext/r1091028.pdf [accessed 31 January 2014].

U.S. EPA, IDHW. 1992. Record of Decision. Bunker Hill Mining and Metallurgical Complex. Shoshone County, Idaho. EPA/ROD/R10-92/041.

von Lindern IH, Spalinger SM, Bero BN, Petrosyan V, von Braun MC. 2003a. The influence of soil remediation on lead in house dust. Sci Total Environ 303:59–78, doi:10.1016/S0048-9697(02)00356-X.

von Lindern I, Spalinger S, Petroysan V, von Braun M. 2003b. Assessing remedial effectiveness through the blood lead:soil/dust lead relationship at the Bunker Hill Superfund Site in the Silver Valley of Idaho. Sci Total Environ 303:139–170, doi:10.1016/S0048-9697(02)00352-2.

Wilson R, Jones-Otazo H, Petrovic S, Mitchell I, Bonvalot Y, Williams D, et al. 2013. Revisiting dust and soil ingestion rates based on hand-to-mouth transfer. Hum Ecol Risk Assess 19:158–188, doi:10.1080/10807039.2012.685807.

Wothke W. 2010. Introduction to Structural Equations Modeling. Course Notes. Available: http://www.smallwaters.com/Courses%20and%20Presentations/Structural%20Equation%20Modeling/Introduction%20to%20SEM%20with%20Proc%20Calis/Introduction%20to%20SEM%20%28Webinar%20Slides%29.pdf [accessed 13 January 2015].

Yankel AJ, von Lindern IH, Walter SD. 1977. The Silver Valley lead study: the relationship between childhood blood lead levels and environmental exposure. J Air Pollut Control Assoc 27:763–767.

Zahran S, Laidlaw MA, McElmurry SP, Filippelli GM, Taylor M. 2013a. Linking source and effect: resuspended soil lead, air lead, and children's blood lead levels in Detroit, Michigan. Environ Sci Technol 47:2839–2845, doi:10.1021/es303854c.

Zahran S, Mielke HW, McElmurry SP, Filippelli GM, Laidlaw MA, Taylor MP. 2013b. Determining the relative importance of soil sample locations to predict risk of child lead exposure. Environ Int 60:7–14, doi:10.1016/j.envint.2013.07.004.

Exhibit K

ESTIMATION OF AGE-SPECIFIC SOIL AND DUST INGESTION RATES FOR U.S. CHILDREN: UPDATE TO THE DEFAULT VALUES FOR THE INTEGRATED EXPOSURE UPTAKE BIOKINETIC MODEL FOR LEAD IN U.S. CHILDREN

OVERVIEW

Since 1994, the Office of Land and Emergency Management (OLEM), formerly known as the Office of Solid Waste and Emergency Response (OSWER), has recommended the Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK model) as a risk assessment tool to support environmental cleanup decisions at current or future anticipated residential sites (U.S. EPA, 1994a, b). The IEUBK model predicts blood lead levels (PbB) in young children (birth to 7 years of age) exposed to lead from several sources and routes. The IEUBK model uses more than 100 input parameters that are initially set to default values. Of these, there are 46 parameters that may be input, or modified, by the user; the remainder are internal variables that are unavailable for modification (U.S. EPA, 1994a).

The IEUBK model uses empirical data from numerous studies of lead uptake and biokinetics, contact and intake rates of children with contaminated media, and data on the presence and behavior of environmental lead to predict a plausible distribution centered on the geometric mean (GM) of PbB for a hypothetical child or population of children (U.S. EPA, 2020).[1] The relative variability of PbB concentrations around the GM is defined as the geometric standard deviation (GSD). The GSD encompasses biological and behavioral differences, measurement variability from repeat sampling, variability as a result of sample locations and analytical variability.[2] From the distribution, the IEUBK model estimates the risk (*i.e.*, probability) that a child's or a population of children's PbB concentration will not exceed a certain PbB concentration (U.S. EPA, 1998, 1994a; White et al., 1998).

Ingestion of fine soil and dust particulates, especially by young children, is the dominant route of exposure for lead. (Laidlaw et al., 2014; Landrigan et al., 1975; Lanphear et al., 1998, 2003). Childhood soil and dust ingestion occurs via multiple pathways, including hand-to-mouth transfer, mouthing of objects, and contaminated food. The rate at which soil and dust is ingested are dependent on a child's age, individual behaviors, exposure time, total dust and soil accessible and environmental conditions (Zahran et al., 2013a,b). Age-specific estimates of the soil and dust ingestion rate pathway are needed to assess children's exposures in the home or play environment, and to make informed cleanup decisions.

---

[1] The GM represents the central tendency estimate (*e.g.*, mean, 50th percentile) of PbB concentration of children from a hypothetical population (Hogan et al., 1998). If an arithmetic mean (or average) is used, the model provides a central point estimate for risk of an elevated PbB level. By definition a central tendency estimate is equally likely to over- or under-estimate the lead-intake at a contaminated site. Upper confidence limits (UCLs) can be used in the IEUBK model; however, the IEUBK model results could be interpreted as a more conservative estimate of the risk of an elevated PbB level. See U.S. EPA (1994a) for further information.

[2] The IEUBK model uses a log-normal probability distribution to characterize this variability (U.S. EPA, 1994a). The biokinetic component of the IEUBK model output provides a central estimate of blood lead concentration along with the distribution of possible blood lead concentrations in a population of similarly exposed children. In the IEUBK model, the GSD encompasses biological and behavioral differences, measurement variability from repeat sampling, variability as a result of sample locations, and analytical variability. The GSD is **not** intended to reflect variability in blood lead concentrations where different individuals are exposed to substantially **different** media concentrations of lead. The recommended default value for GSD (1.6) was derived from empirical studies with young children where both blood and environmental lead concentrations were measured (White et al., 1998).

The soil and dust ingestion rate is one of the most influential variables in the IEUBK model for lead in children (U.S. EPA, 1994a).

Early estimates of soil and dust ingestion rate in children were based on studies of trace elements in soil and feces (Battelle, 2005; Doyle et al., 2010; Sedman and Mahmood, 1994; U.S. EPA, 2011, 2012). The default values for the *Age-Dependent Soil and Dust Ingestion Rate* variable in the IEUBK model (v. 1.1, build 11) represent age-specific central tendency estimates for lead intake from soil and dust for children (6 to 84 months of age). The default values (v.1.1, build 11) are based on these tracer studies from a literature review and analysis performed during a review of the National Ambient Air Quality Standards (NAAQS) for lead (U.S. EPA, 1989, pp. A-16). The default soil and dust ingestion rate values are based on a study of soil ingestion in children (Sedman et al., 1989). This study utilized trace elements to quantify soil ingestion rates. The initial calibration of the IEUBK model employed these default values, and the results of a validation study performed in the early 1990s showed reasonably close agreement between model estimates using these intake values and empirical blood lead measurements (Hogan et al., 1998). The study that formed the basis for the existing default values did not, however, account for several factors that should be considered when designing a soil dust ingestion study (e.g., sieve to the currently recommended size fraction[3], sample household dust, soil outside of individual yards or the bioavailability of the lead in ingested soil or dust).

The purpose of this document is to provide the technical basis for an analysis of the currently available published literature to support an updated *Age-Dependent Soil and Dust Ingestion Rate (IRsd)* variable in the IEUBK model (Table 1). The updated age-specific soil and dust ingestion rate estimates for the *Age-Dependent Soil and Dust Ingestion Rate* variable in the IEUBK are based on soil and dust ingestion rates from scenario 3 of von Lindern et al. (2016). As described below in the Technical Analysis Section, this study was selected because it was determined that the approach employed by the authors provides the best central tendency estimate of age-specific soil and dust ingestion rates for use in the IEUBK to support risk assessments conducted under CERCLA or RCRA corrective action authority. The soil-dust ingestion rates from Scenario 3 results in soil-dust ingestion rates that are supported by other independent analyses that use dermal transfer to estimate soil and dust ingestion rate, specifically the modeled estimates from Ozkaynak et al. (2011) and Wilson et al. (2013) (see Table 2).

Soil/dust ingestion studies reviewed for this effort are not intended to specifically represent soil-dust ingestion for children who engage in pica behavior. The intake estimates for soil pica behavior would be greater than intake estimates for incidental ingestion of soil-dust, but reliable data for pica ingestion rates or frequency are not available[4].
The intended audience for this document is human health risk assessors familiar with using the IEUBK model in support of CERCLA and RCRA corrective action risk assessments. For further background information on both this variable and the use of the IEUBK model in Superfund lead risk assessment, refer to U.S. EPA (1994a) or the Technical Review Workgroup for Lead (TRW) website (https://www.epa.gov/superfund/lead-superfund-sites-guidance).

[3] Particle size should be similar to the fraction that adheres to skin to reflect the particles that are incidentally ingested during hand-to-mouth activity.
[4] See Chapter 5 of US EPA Exposure Factors Handbook for more information on pica.

Table 1. Recommended revision to default age-specific soil/ dust ingestion rates (mg/day) in the IEUBK model

Source	Age Category (months)							Basis for Age-Specific Value
	0<12	12<24	24<36	36<48	48<60	60<72	72<84	
IEUBK Model Default[a]	85	135	135	135	100	90	85	Methodology U.S. EPA, 1989 Data Source Sedman et al., 1989
Revised Soil/Dust Ingestion Rate	86	94	67	63	67	52	55	Methodology von Lindern et al., 2016 Ozkaynak et al., 2011 Wilson et al., 2013 Data Source von Lindern et al., 2016

[a]IEUBK model v. 1.1, build 11.

INTRODUCTION

The IEUBK model predicts PbB in young children (birth to 7 years of age) exposed to lead from several sources of exposure and routes. The IEUBK model uses more than 100 input parameters that are initially set to default values. Of these, there are 46 parameters that may be input, or modified, by the user; the remainder are locked (U.S. EPA, 1994a). Default values represent national averages or other central tendency values derived from empirical data in the open literature. Default values include a) lead concentrations in exposure media (*e.g.*, diet representative of national food sources); b) contact and intake rates (*e.g.*, soil/dust ingestion); and c) exposure durations (White et al., 1998). The representativeness of IEUBK model output is wholly dependent on the representativeness of the data (often assessed in terms of completeness, comparability, precision, and accuracy [U.S. EPA, 1994a]).

Representative site-specific data are essential for developing a risk assessment (as well as cleanup goals) that reflect the current or potential future conditions. The most common type of site-specific data is media-specific lead concentration information (air, water, soil, dust). Until recently, an inexpensive, validated method to estimate bioavailability of lead in soil or dust was not available. Receptor data (*e.g.*, age, body weight, breathing rate, or soil ingestion rate) does not typically vary from site to site.

To promote defensible and reproducible risk assessments and cleanup plans, while maintaining flexibility needed to respond to different site conditions, U.S. EPA recommends the Data Quality Objectives process (U.S. EPA, 2006). Data Quality Objectives provide a structured approach to collecting environmental data that will be sufficient to support decision-making (http://www.epa.gov/QUALITY/dqos.html).

TECHNICAL ANALYSIS

The initial default IEUBK total soil and dust ingestion rates were used in the development of the NAAQS (U.S. EPA, 1989). Rather than adding new data, many of the published studies since the initial default values were adopted in 1994 were reanalyzed data from previous studies. Moreover, the TRW identified a number of limitations of the re-analyses of the data that were published after 1994. For example, Stanek and Calabrese (2000) included estimates of daily soil ingestion that were significantly negative, biased by large negative values in the data. The decision to include the negative values and their consequent impact on the results was never addressed by the authors (Stifelman 2006). We have identified several newer and relevant studies on soil/dust ingestion from seven sources: Arnot et al., 2010; Bierkens and Cornelis, 2006; Jang et al., 2014; Ozkaynak et al., 2011; Stanek et al., 2012a,b; von Lindern et al., 2016; Wilson et al., 2013.

To evaluate these studies, the TRW Lead Committee used a data quality objective (DQO) approach (see Attachment 1). This approach (working through the first four steps of the DQO process) allowed the Committee to focus on identifying studies that provided information that would support a revision of the default age-specific soil-dust ingestion rates for use in the IEUBK model for assessing lead exposure at CERCLA and RCRA corrective action sites. Table 2 provides a summary of these literature sources.

The following studies were evaluated to support a revision to the soil and dust ingestion rate default parameter in the IEUBK. Arnot et al. (2010) described the Farfel Exposure Model (FHX) employed by Health Canada, which uses a soil/dust ingestion rate of 65 mg/day for children age 5-11 years, and 100 mg/day for toddlers (age 6-60 months). Bierkens and Cornelis (2006) derived a range of soil/dust ingestion values (23.2 to 116 mg/day assuming an 8-hour waking and outdoor period [alternate values for 12-hour waking and outdoor period shown in Table 2]) based on probabilistic modeling of other mouthing frequency and hand loading publications. A 4-day fecal study of Korean children age 0 to 84 months, using the limiting tracer method, calculated an arithmetic mean soil/dust ingestion rate of 118 mg/day and a geometric mean of 29.3 mg/day (Jang et al., 2014; tracer-specific data not provided in study). Ozkaynak et al. (2011) estimated a mean soil/dust ingestion rate for children 3 to 6 years of age (as compared to the age range of the IEUBK model which is children <72 months old) using stochastic human exposure and dose simulation (SHEDS) modeling, using activity diaries to estimate hand-to-mouth, and object-to-mouth contact rates. Stanek et al. (2012a,b) conducted a meta-analysis of their earlier four mass balance studies using stochastic modeling of the most reliable tracers of children from Amherst, Massachusetts; Anaconda, Montana; and Washington State. Soil pica data were excluded from their analysis. Soil/dust ingestion rates for children in specific age classes are shown in Table 2; an overall mean soil/dust ingestion rate of 25.5 mg/day (95^{th} percentile 79.4 mg/day) was estimated. Similar to Ozkaynak et al. (2011), Wilson et al. (2013) calculated soil and dust ingestion rates using a mechanistic model including parameters for particle loading on skin, transfer to hands, hand surface area, mouthing surface area, hand-to-mouth frequency, saliva dissolution, and exposure time using deterministic and probabilistic methods. Results, which are dependent on exposure time, were calculated separately for soil and dust, then summed for a daily soil/dust ingestion rate.

In addition, the information available on soil and dust ingestion rate values in EPA's Exposure Factors Handbook (U.S. EPA, 2017) was also considered as part of this effort but was not included in the peer review of this document (which preceded the release of the Exposure Factors Handbook update). The difference between the soil and dust ingestion rate values in the

Exposure Factors Handbook (U.S. EPA, 2017) and those proposed herein was addressed by the Office of Research and Development evaluation of the IEUBK model. (U.S. EPA, 2020).

The study by von Lindern et al. (2016) satisfies many of the evaluation criteria described in the TRW Lead Committee's DQOs (see Attachment 1). The authors of that study used environmental information collected at the Bunker Hill Mining and Metallurgical Complex Superfund Site (BHSS) site in Idaho to compare archived soil and dust samples from the BHSS to children's blood lead levels monitored from 1989 through 2002 to calculate soil/dust ingestion rates using the IEUBK model. Over 15 years of active cleanup, the Lead Health Intervention Program amassed approximately 5,400 blood lead observations (referred to as the parent database) from nearly 2,340 children (ages 0–9 and with a >50% participation rate) and yielding 2,176 records of blood/soil/dust lead concentrations. The study by von Lindern et al. (2016) used measured peak blood leads, community soil, neighborhood soil, yard soil concentration, house dust concentration and bioavailability information with IEUBK model defaults for Air, Water, and Diet to estimate soil-dust ingestion rates (IRs_D) under different Structural Equations Modeling (SEM) scenarios.

In the Bunker Hill study, four variables were used to quantify soil and dust exposures: house dust, yard soil, neighborhood soil (the mean of all yard soils within 200, 500, and 1000 feet of the home, excluding the home's yard), and community soil (the mean of all yard soils within the community, excluding the home's yard and neighborhood). The 271 samples (193 house dust samples, 73 yard soil samples and 5 quality control samples) were sieved to 80 mesh (to account for the particle size that would likely adhere to a child's hands) and analyzed for total lead and bioavailability.

The default assumption for the IEUBK model is that the source of soil ingested is 55% dust and 45% yard soil (U.S. EPA, 1994b). Structural Equations Modeling (SEM) was used to evaluate three different scenarios of yard soil to dust, neighborhood soil, and community soil:

1. 55% house dust/45% yard soil (as currently in the IEUBK model),
2. 40% house dust/30% yard soil/30% community soil, (alternatively using arithmetic or geometric means for community soil) and
3. 50% house dust/25% yard soil/10% neighborhood soil/15% community soil (alternatively using arithmetic or geometric means for neighborhood and community soil).

Table 2. Data summary of average soil/dust ingestion rates in children from selected studies.

Source	Soil/Dust Ingestion Rate (mg/day)	Age Range	n	Summary of Evaluation
IEUBK Model Default Values[a]	85-135	Children 0-84 months (yearly values)	77	Existing IEUBK model soil-dust ingestion rates Based on technical analysis to support the NAAQS for Lead (U.S. EPA, 1989).
Arnot et al., 2010	100	Children 6 60 months (age range)	n/a[b]	Is not considered a support document for revising the soil/dust ingestion rate because these are assumed input parameters for an exposure model using exposure factors for the general population of Canada. They are based on Health Canada 1998, which is based on Binder et al., (1986), Clausing et al. (1987), Calabrese et al. (1989), and Van Wijnen et al. (1990). Farfel Exposure Model (FHX) and Health Canada. 1998.[b]
	65	Children age 5 to 144 months (age range)		
Bierkens and Cornelis, 2006[c]	23.2-116	Children 12-84 months (age range) 8-hr awake and outdoors	5,000 (model runs)	Supportive study based on the limited number of observations.. Ranges of ingestion rates derived from probabilistic modeling of data from other publications reporting mouthing frequency and hand loading (Holmes et al., 1999; AuYeung et al., 2003; and U.S. EPA exposure factors, 2017).
	34.8-174	Children 12-84 months (age range) 12-hr awake and outdoors		
Ozkaynak et al., 2011	68	Children 36-72 months (age range) Mean value	1,000 (model runs)	Supportive study based on lack of new observation data. The estimates are based on modeling using SHEDS and hand-to-mouth and object-to-mouth contacts.
Jang et al., 2014	118	Children 0-96 months Arithmetic mean	58 samples	New tracer data based on Korean children. Estimates based on aluminum. The publication lacked details of the study. Only feces and soil-dust collected. 5 children were used as control group to compensate for exposure from other sources.
	29.3	Children 0-96 months Geometric mean	58 samples	

Source	Soil/Dust Ingestion Rate (mg/day)	Age Range	n	Summary of Evaluation
Stanek et al., 2012a,b	3.8	Children 12 to 36 months old	39 samples	Meta-analysis of four existing mass balance studies. The reanalysis of existing data is not a direct measurement and is not considered a candidate for supporting a revised default age-specific soil-dust ingestion rate
	20.6	Children 24 to 36 months old	55 samples	
	32.2	Children 36 to 60 months old	47 samples	
	40.9	Children 48 to 108 months old	75 samples	
U.S EPA Exposure Factors Handbook (2017)	40 - 90	Children < 6 months, 6 months to < 1, 1 to <2 years, 2 to <6 years, 1 to <6 years , 6 to < 12 years	241 in key tracer studies, 2,599 biokinetic modeling studies, modeled estimates of 1,000 simulated individuals and 200,000 trials.	The overall rating was low based on criteria of Soundness, Applicability and Utility, Clarity and Completeness, Variability and Uncertainty, and Evaluation and Review.
von Lindern et al., 2016	52-94[d]	Children 12 to 72 months old (yearly values)	985[f] (measured PbB and environmental values used for model runs)	Reanalysis of archived soil and dust data from Bunker Hill Superfund Site, available information includes bioavailability data, particle size and children's blood lead levels monitored (in some cases longitudinal data) from 1988-2002. Evaluated various combinations of dust, yard soil, neighborhood soil, and community soil. Accurately predicted peak annual blood lead from children representing greater than 50% of all resident children for 15 consecutive years.
Wilson et al., 2013	61	Toddlers 7 to 60 months	200,000 (model runs)	The study is considered a supportive study due to new modeled data. This study models soil/dust ingestion rates in Canada using hand-to-mouth transfer.
	55	Children 60 to 144 months		

[a]IEUBK model v. 1.1, build 11.
[b]Health Canada values based on data from Binder et al., 1986; Clausing et al., 1987; Calabrese et al., 1989; and Van Wijnen et al., 1990.
[c]Study reports values in units of mg/hr. The range (2.9-14.5 mg/hour) was converted to mg/d assuming both an 8-hour and a 12-hour waking and outdoor period.
[d]Results of Structural Equations Modeling (SEM) assuming 50% dust, 25% yard soil, 10% neighborhood soil, and 15% community soil.
[e] von Lindern et al. (2016) employed a hybrid approach that measured peak blood leads, particle size, community soil concentration, neighborhood soil concentration, yard soil concentration, as well as house dust concentration, and used IEUBK Modeled defaults for Air, Water, and Diet to estimate IRs under different SEM scenarios to select the model which best fit the empirical distribution of blood leads, representative of over 50% of the community for 15 consecutive years.
[f] 985 is the sum of 12-72 month old children in the 50/25/10/15 partition from Table S-1 of Supplemental Material to von Lindern et al. (2016).

The authors selected the model that provided the best fit to the empirical distribution of blood leads, which represented over 50% of the community for 15 consecutive years. Though ingestion rates for all three scenarios were similar, scenario 3 above had the lowest sum of squared error (SSE) in the statistical evaluation[5]. For this scenario, the authors derived age-specific, arithmetic mean soil/dust ingestion rates ranging from 52 to 94 mg/day for children age 1 to 6 years, with 95% confidence intervals ranging from 47 to 106 mg/day (Table 3). The other two scenarios were less acceptable because they did not fit the data as well.

Table 3. Soil/dust ingestion rates for the 50% house dust/25% yard soil/10% neighborhood soil/15% community soil scenario for the 12-71 month age range that is used in the IEUBK model (von Lindern et al., 2016).

Age[a]	n	AvgIR (95% CI)[b]	Percentiles						
			5	10	25	50	75	90	95
0-12	54	86 (66, 105)	17	27	38	72	94	165	221
13-24	174	94 (82, 106)	16	22	42	69	123	188	250
25-36	202	67 (59, 75)	10	19	28	53	82	140	178
37-48	209	63 (55, 72)	10	14	26	47	76	130	156
49-60	192	67 (59, 75)	11	15	32	53	86	122	182
61-72	208	52 (47, 57)	10	12	23	41	74	102	126
73-84	218	55 (48,62)	7	11	21	41	68	116	171

[a] Months
[b] AvgIR (95% CI) = arithmetic mean ingestion rate (95% confidence intervals)

After evaluating the available literature using the DQOs (see Attachment 1), the TRW Lead Committee recommends the age-specific soil-dust ingestion rates from scenario 3 of von Lindern et al. (2016) as the basis for revising the default age-specific soil-dust ingestion rates in the IEUBK model for CERCLA and RCRA corrective action risk assessments. As described above, this study was selected because it was determined that the approach employed by the authors most closely fits the DQOs established by the TRW Lead Committee for this effort; the study by von Lindern et al. (2016) provides the best estimate of age-specific soil and dust ingestion rates for use in the IEUBK model at CERCLA and RCRA 5,400 blood lead observations from nearly 2,340 individuals, yielding 2,176 records of blood/soil/dust lead concentrations over a 15 year timeframe with a >50% participation rate. In total, 271 samples (193 house dust samples, 73 yard soil samples and 5 quality control samples) sieved to 80 mesh (the particle size that adheres to a child's hand and most likely to be ingested by children) were analyzed for total lead and *in vitro* bioaccessibility. Community mean absolute bioavailability values (ABS) for unremediated yards soils and house dust, and site-wide ABS means for post-remediation soils were integrated into the database. Annual site-wide ABS means were calculated using a weighted average of bioavailable lead from remediated and unremediated yards. Aggressive LHIP education and intervention programs may have resulted in a temporary reduction in soil-dust intake rates by children, although this conclusion is not supported by multiple systematic reviews (Nussbaumer-Streit, Yeoh *et al.* 2016). Alternatively, elevated dust loadings caused by flooding and construction activities may have exacerbated soil-dust ingestion rates in the middle years of the BHSS cleanup. However, SEM and IEUBK model sensitivity analysis suggested that variation in calculated ingestion rates may be an artifact of the source partitions, nature of the data, or progression of the cleanup. The data collected at the BHSS best represents conditions at most CERCLA and RCRA corrective action sites during the Remedial

[5] Sum of Squared Error (SSE) is a statistical measure of the discrepancy between empirical values and the estimation model results. Lower SSE means better model prediction

Investigation and Feasibility Study phase of the remedial process. The soil-dust ingestion rates from Scenario 3 of von Lindern et al. (2016) results in soil-dust ingestion rates for the IEUBK model that are supported by other independent analyses, specifically the modeled estimates from Ozkaynak et al. (2011) and Wilson et al. (2013) (see Table 2).

UNCERTAINTY

Several studies published since 1994 were not applicable to this variable; for example, they contained only adult data, evaluated sediment ingestion rates rather than soil ingestion rates, or were review papers summarizing or reanalyzing other studies. Among recent publications that provide new data for young children (see Table 2), the TRW Lead Committee considered the study by von Lindern et al. (2016) to provide the relevant age-specific estimates of soil-dust ingestion rates for young children because it satisfied the most evaluation criteria (see Attachment 1) compared with the other studies. The TRW Lead Committee acknowledges that the data used by von Lindern et al. (2016) are site-specific and consideration was given to whether the Bunker Hill site was representative of other hazardous waste sites in the US. The data collected for that study were from an area of known lead contamination and could represent higher levels of lead than found in some areas. Also, as these data were collected from a site where EPA and other authorities were actively engaged in public outreach to reduce exposure, the soil-dust ingestion rates could be lower than in communities lacking public education efforts to limit exposure to soil and dust and thus may not necessarily be appropriate as an estimate for the general population, although the effectiveness of education has not been demonstrated in any of the Cochrane systematic reviews (Nussbaumer-Streit et al., 2016). Alternatively, elevated dust loadings caused by flooding and construction activities may have exacerbated soil-dust ingestion rates in the middle years of the BHSS cleanup. However, SEM and IEUBK model sensitivity analysis suggested that variation in calculated ingestion rates may be an artifact of the source partitions, nature of the data, or progression of the cleanup. The TRW Lead Committee notes that these conditions would likely occur at any CERCLA or RCRA corrective action site where USEPA was engaged in a risk assessment and therefore this limitation may be considered a strength (in that the data are possibly a better fit for the intended purpose than soil-dust ingestion rates collected from a naïve population would be). Furthermore, the information from this study is supported by two independent studies (Ozkaynak et al., 2011; Wilson et al., 2013). Thus, in the absence of other high-quality information the estimates from von Lindern et al. (2016) shown in table 3 are likely to be most representative of soil dust ingestion rates for young children at CERCLA and RCRA corrective action sites. The TRW Lead Committee did not, as part of this review process, define study acceptance criteria (aside from using the DQOs to guide the evaluation), conduct a systematic review, or conduct quality assurance activities on the published data to identify anomalies such as incorrect units, duplicate samples, etc. Consideration of additional studies published in the future could inform further refinement of age-specific soil and dust ingestion rates.

RECOMMENDATIONS FOR THE IEUBK MODEL

Results from several new studies provide information on average soil dust ingestion rates from children 0-84 months old. In general, these studies support an average combined soil/dust ingestion rate from 50 to 100 mg/day for children younger than 84 months old that could be applied to children residing near a CERCLA or RCRA corrective action site. For example, the two supporting studies Ozkaynak et al. (2011) and Wilson et al. (2013) result in values of 68 mg/day and 55-61 mg/day, respectively. These values are consistent with the recommended age-specific soil-dust ingestion rates for some of the similar age groupings from von Lindern et al.

(2016). The age-specific soil/dust ingestion recommended as the default soil/dust ingestion rates in the IEUBK model are shown in Table 4.

Table 4. Recommended change to soil/dust ingestion rates for use in the IEUBK model.

Age (years)	Age-specific, Average Soil/Dust Ingestion Rate (mg/day)	Basis for Age-Specific Value
0-1	86	Age-specific arithmetic mean ingestion rates based on the best fit model from von Lindern et al., 2016 and supported by modeled estimates from Ozkaynak et al., 2011; Wilson et al., 2013
1-2	94	
2-3	67	
3-4	63	
4-5	67	
5-6	52	
6-7	55	

Based on the evaluation described in this document and many factors specific to CERCLA and RCRA corrective action sites, these soil-dust ingestion rates are appropriate for assessing exposure at contaminated areas where the IEUBK model is frequently used. The TRW Lead Committee recommends updating the default *Age-Dependent Soil and Dust Ingestion Rate* variable in the IEUBK model to the age-specific average soil/dust ingestion rates based on von Lindern et al. (2016) (Table 3). These default values are considered appropriate for all applications of the IEUBK model where current and future residential scenarios are being assessed for CERCLA and RCRA corrective action risk assessment. The updated age-specific soil-dust ingestion rates are incorporated into the IEUBK model as shown in Figure 1.

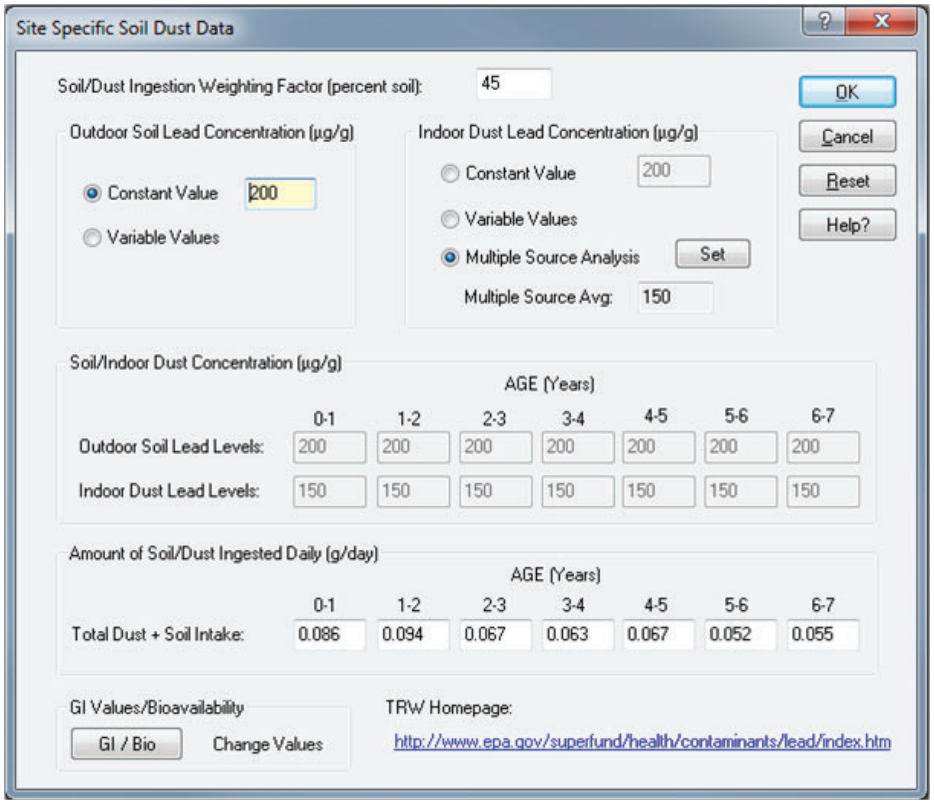


Figure 1. IEUBK Model Site Specific Soil Dust Data Entry Window with the Updated Soil/Dust Ingestion Rates.

IMPACT ON THE IEUBK MODEL PREDICTIONS

Using current IEUBK model (v.2) defaults for all parameters while implementing the proposed soil-dust rates will increase the preliminary remediation goal (PRG). Table 5 presents the updated estimates as well as the estimates from the previous analyses.

The PRGs in Table 5 are used to illustrate the impact when developing a screening level for lead in soil. As examples, the PRGs corresponding to PbBs of 10 µg/dL and 5 µg/dL are presented for illustrative purposes.

Table 5. Effects of changing the Soil-Dust Ingestion Rate (mg/day) in the IEUBK model

Study	Age Range	IRsd	P10 PRG[†]	P5 PRG[‡]
IEUBK Model (v1.1 build 11) default values	0-1 yr 1-2 yrs 2-3 yrs 3-4 yrs 4-5 yrs 5-6 yrs 6-7 yrs	85 mg/d 135 mg/d 135 mg/d 135 mg/d 100 mg/d 90 mg/d 85 mg/d	418 ppm	153 ppm
Proposed Update (based on von Lindern et al.	0-1 yr 1-2 yrs 2-3 yrs	86 mg/d 94 mg/d 67 mg/d	605 ppm	200 ppm

Study	Age Range	IRsd	P10 PRG[†]	P5 PRG[‡]
[2016]) using IEUBK v.2 default values	3-4 yrs 4-5 yrs 5-6 yrs 6-7 yrs	63 mg/d 67 mg/d 52 mg/d 55 mg/d		

[†] P10 PRG is the preliminary remediation goal for soil lead based on no more than 5% probability of exceeding a blood lead concentration of 10 µg/dL using IEUBK (v1.1. build 11) with default values for the 0-84 month age range.

[‡] P5 PRG is the preliminary remediation goal for soil lead based on no more than 5% probability of exceeding a blood lead concentration of 5 µg/dL using IEUBK (v1.1. build 11) with default values for the 0-84 month age range.

REFERENCES

Arnot, J.A., D. Mackay, R. Sutcliffe, and B. Lo. 2010. Estimating farfield organic chemical exposures, intake rates and intake fractions to human age classes. Environmental Modelling and Software 25: 1166-1175.

AuYeung et al., 2003. 13th Annual Conference of the International Society of Exposure Assessment, Stresa, Italy. Abstract book. P. 428.

Battelle. 2005. Summary report of the U.S. EPA colloquium on soil/dust ingestion rates and mouthing behavior for children and adults. Prepared under U.S. EPA Contract Number EP-C-04-027 for Jacqueline Moya, U.S. EPA National Center for Environmental Assessment.

Bierkens, J. and C. Cornelis. 2006. Probabilistic estimates of hourly ingestion rates for children and adults based on field measured soil hand loading data. Epidemiology: 17: p. S469. ISEE/ISEA Conference Abstracts Supplement: Symposium Abstracts.

Binder, S., D. Sokal, and D. Maughan. 1986. Estimating soil ingestion: the use of tracer elements in estimating the amount of soil ingested by young children. Arch Environ Health 41: 341-345.

Calabrese, E., R.M. Barnes, E.J. Stanek, H. Pastides, E. Gilbert, P. Veneman, et al. 1989. How much soil do young children ingest: an epidemiologic study. Regul Toxicol Pharmacol, 10: 123–137.

Clausing, P., B. Brunekreef, and J.H. Van Wijnen. 1987. A method for estimating soil ingestion by children. Int Arch Occup Environ Health 59: 73-82.

Doyle, J.R., Blais, J.M., and White, P.A. 2010. Mass balance soil ingestion estimating methods and their application to inhabitants of rural and wilderness areas: A Critical Review.Health Canada. 1998. Exposure Factors for Assessing Total Daily Intake of Priority Substances by the General Population of Canada. Priority Substances, Bureau of Chemical Hazards, Environmental Health Directorate, Ottawa, ON, p.42.

Hogan, K., A. Marcus, R. Smith, and P. White. 1998. Integrated Exposure, Uptake, Biokinetic Model for Lead in Children: Empirical Comparison with Epidemiologic Data. Environ. Health Perspect. 106 (S6): 1557–67. Available online at: http://www.ncbi.nlm.nih.gov/sites/entrez?db=pubmed

Holmes, K.K.; Shirai, J.H.; Richter, K.Y.; and Kissel, J.C. 1999. Field measurements of dermal loadings in occupational and recreational activities. Environ. Res. 80:148-157.

Jang, J-Y., S-Y Kim, S-J Kim, K-E Lee, H-K Cheong, E-H Kim, K-H Choi, and Y-H Kim. 2014. General factors of the Korean Exposure Factors Handbook. Journal of Preventive Medicine and Public Health 47: 7-17.

Laidlaw, MA, Zharan S, Pingitore N, Clague J, Devlin G, Taylor MP. 2014. Identification of lead sources in residential environments: Sydney, Australia. Environ Pollut 184:238-246.

Landrigan, PJ, Gehlbach SH, Rosenblum BF, Shoults JM, Candelaria RM, Barthel WF et al., 1975. Epidemic lead absorption near an ore smelter. The role of particulate lead. N Engl J Med 292:123-129.

Lanphear BP, Matte TD, Rogers J, Clickner RP, Dietz B, Bornschein RL et al., 1998. The contribution of lead-contaminated house dust and residential soil to children's blood lead levels. A pooled analysis of 12 epidemiological studies. Environ Res 79:51-68.

Lanphear BP, Succop P, Roda S, Henningsen G. 2003. The effect of soil abatement on blood lead levels in children living near a former smelting and milling operation. Public Health Rep 118:83-91.

Lin, C et al. 2017. Estimates of Soil Ingestion in a Population of Chinese Children. Environmental Health Perspectives. https://doi.org/10.1289/EHP930.

Ma J, P.L. 2016. Estimation of the daily soil/dust (SD) ingestion rate of children from Gansu Province, China via hand-to-mouth contact using tracer elements. Environmental Geochemistry and Health.

Nussbaumer-Streit, B., B. Yeoh, U. Griebler, L. M. Pfadenhauer, L. K. Busert, S. K. Lhachimi, S. Lohner and G. Gartlehner (2016). "Household interventions for preventing domestic lead exposure in children." Cochrane Database of Systematic Reviews (10). http://dx.doi.org/10.1002/14651858.CD006047.pub5

Ozkaynak, H., J. Xue, V.G. Zartarian, G. Glen, and L. Smith. 2011. Modeled estimates of soil and dust ingestion rates for children. Risk Analysis 31: 592-608.

Sedman, R.M. 1989. The development of applied action levels for soil contact: A scenario for the exposure of humans to soil in a residential setting. Env. Health Perspect. 79: 291-313.

Sedman RM and Mahmood RJ. 1994. Soil ingestion by children and adults reconsidering using the results of recent tracer studies. Air Waste 44:141-144.

Stanek, E.J. III, and E.J. Calabrese. 2000. Daily Soil Ingestion Estimates for Children at a Superfund Site. Risk Analysis 20: 627-635.

Stanek, E.J. III, E.J. Calabrese, and B. Xu. 2012a. Meta-analysis of mass-balance studies of soil ingestion in children. Risk Analysis 32: 433-447.

Stanek, E.J. III, B. Xu, and E.J. Calabrese. 2012b. Equation reliability of soil ingestion estimates in mass-balance soil ingestion studies. Risk Analysis 32: 448-463.

Stifelman, M. 2006. Daily soil ingestion estimates for children at a Superfund site. Risk Anal 26(4): 863; author reply 865. http://www.ncbi.nlm.nih.gov/pubmed/16948680

U.S. Environmental Protection Agency. 1989. Review of the National Ambient Air Quality Standards for Lead: Exposure Analysis Methodology and Validation, Report No. EPA-450/2-89/011. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC.

U.S. Environmental Protection Agency. 1994a. Technical Support Document: Parameters and Equations Used in the Integrated Exposure Uptake Biokinetic Model for Lead in Children (v0.99d). Office of Solid Waste and Emergency Response, Washington, DC. EPA 540/R-94/040, PB94-963505, OSWER #9285.7-22. December.

U.S. Environmental Protection Agency. 1994b. Guidance Manual for the IEUBK Model for Lead in Children. Office of Solid Waste and Emergency Response, Washington, DC. PB93-963510, OSWER #9285.7-15-1.

U.S. Environmental Protection Agency. 2005. Five-Year Review Report: Second Five-Year Review for the Bunker Hill Mining and Metallurgical Complex Superfund Site, Operable Units 1, 2, and 3 Idaho and Washington. USEPA Report no. 910-R-05-006. Available: http://www.epa.gov/region10/pdf/sites/bunker_hill/bh_2nd_fyr_102505.pdf

U.S. Environmental Protection Agency. 2007. Lead Human Exposure and Health Risk Assessments for Selected Areas. Volume II: Appendices – Draft Report. Appendix H: Blood Lead (PbB) Prediction Methods, Models, and Inputs.

U.S. Environmental Protection Agency. 2008. Child-Specific Exposure Factors Handbook. U.S. Environmental Protection Agency, Office of Research and Development, National Center for Environmental Assessment, Washington Office, Washington, DC, EPA/600/R-06/096F.

U.S. Environmental Protection Agency. 2010. 2010 Five-Year Review Report for the Bunker Hill Mining and Metallurgical Complex Superfund Site, Operable Units1, 2, and 3, Idaho and Washington. Available: http://www.epa.gov/region10/pdf/sites/bunker_hill/bunkerhill_final_2010fiveyearreview_tagged.pdf

U.S. Environmental Protection Agency. 2011. Exposure Factors Handbook: 2011 Edition. Office of Research and Development, National Center for Environmental Assessment, Washington, DC. EPA/600/R-090/052F.

U.S. Environmental Protection Agency. 2017. Update for Chapter 5 of the Exposure Factors Handbook, *Soil and Dust Ingestion*, Washington, DC. EPA/600/R-17/384F.

U.S. Environmental Protection Agency (U.S. EPA). 2020. Memorandum from John Vandenberg, Director Health and Environmental Effects Assessment Division OSRTI, OLEM To Brigit Lowery, Director Assessment and Remediation Division, OSRTI, OLEM. Subject: Evaluation of IEUBK version 2.0 model performance. September 23.

Van Wijnen, J.H., P. Clausing, and B. Brunekreef. 1990 Estimating soil ingestion by children. Environ Res 51: 147-162.

von Lindern, I., S. Spalinger, M.L. Stifelman, L.W. Stanek, and C. Bartrem. 2016. Estimating Children's Soil/Dust Ingestion Rates through Retrospective Analyses of Blood Lead Biomonitoring from the Bunker Hill Superfund Site in Idaho. Environ Health Perspect 124(9):1462-1470. Available at: http://dx.doi.org/10.1289/ehp.1510144

White, P. D., P. Van Leeuwen, B. D. Davis, M. Maddaloni, K. A. Hogan, A. H. Marcus and R. W. Elias. 1998. The conceptual structure of the integrated exposure uptake biokinetic model for lead in children. Environ Health Perspect 106 Suppl 6: 1513-1530. Available online at: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1533456/

Wilson, R., H. Jones-Otazo, S. Petrovic, I. Mitchell, Y. Bonvalot, D. Williams, and G.M. Richardson. 2013. Revisiting dust and soil ingestion rates based on hand-to-mouth transfer. Human and Ecological Risk Assessment 19:158-188.

Zahran, S., M. Laidlaw, S. P. McElmurry, G. M. Filippelli and M. P. Taylor. 2013a. "Linking Source and Effect: Resuspended Soil Lead, Air Lead, and Children's Blood Lead Levels in Detroit, Michigan." Environmental Science & Technology. http://dx.doi.org/10.1021/es303854c

Zahran, S., H. W. Mielke, S. P. McElmurry, G. M. Filippelli, M. A. Laidlaw and M. P. Taylor 2013b. "Determining the relative importance of soil sample locations to predict risk of child lead exposure." Environ Int 60: 7-14. http://www.ncbi.nlm.nih.gov/pubmed/23973618

Zhang T, C. X. 2015. Perchlorate in indoor dust and human urine in China: contribution of indoor dust to total daily intake. Environmental Science and Technology.

ATTACHMENT 1. DATA QUALITY OBJECTIVES FOR THE SOIL-DUST INGESTION RATE LITERATURE EVALUATION

1. State the Problem
    a. Current IEUBK Model soil-dust ingestion rates do not reflect recent studies, which have addressed many of the problems of previous studies
        i. Age-specific rates
        ii. Dust rates
        iii. Confidence limits
        iv. Analytical uncertainty
            1. CV
            2. Negative values
        v. Study duration
            1. 5-20 days
        vi. Untested tracer bioavailability assumptions
        vii. Biomarkers
        viii. Sampling uncertainty
            1. Particle size
            2. Dust
            3. Exposure area
        ix. Number of subjects
        x. Transparency
            1. Stanek & Calabrese Data was not shared, despite requests & assurances
        xi. Consistency with other studies
            1. Multiple analyses of single datasets produce multiple estimates
        xii. Potential Conflict (or appearance) of interest
            1. PRP funding

2. Identify the Decisions
    a. IEUBK default
        i. Age-specific values
        ii. CTE values

3. Identify Inputs to the Decision
    a. Literature search
    b. Evaluation criteria
    c. Peer review

4. Define the Study Boundaries
    a. Timing
    b. Schedule
    c. Review process
    d. Impacts to programs & agencies

FMI see https://www.epa.gov/fedfac/guidance-systematic-planning-using-data-quality-objectives-process

References

Nussbaumer-Streit, B., B. Yeoh, U. Griebler, L. M. Pfadenhauer, L. K. Busert, S. K. Lhachimi, S. Lohner and G. Gartlehner (2016). "Household interventions for preventing domestic lead exposure in children." Cochrane Database of Systematic Reviews(10). http://dx.doi.org/10.1002/14651858.CD006047.pub5

Exhibit L

Perpetua Resources Corp.
405 S. 8th Street, Ste 201
Boise, ID 83702
Tel: 208.901.3060
www.perpetuaresources.com

October 6, 2021

Kelli Wetzel
Permit Writer, Air Quality Division
Idaho Department of Environmental Quality
1410 North Hilton
Boise, ID 83706

Subject: **Facility ID No. 085-00011, Perpetua Resources Idaho, Inc., Stibnite Gold Project –TAP Addendum Report**

Dear Ms. Wetzel:

Perpetual Resources, Inc. is providing the enclosed TAP Addendum report (Addendum) for the Stibnite Gold Project. The Addendum contains the hazardous air pollutant (HAP) and toxic air pollutant (TAP) emissions calculations provided in the PTC application and as requested by IDEQ, supplements that information to support IDEQ's responses to comments.

If you have any questions regarding this submittal, please contact me at 208-901-3053 or alan.haslam@perpetua.us.

Thank you for reviewing this information.

Sincerely,
Perpetua Resources

Alan Haslam
Vice President – Permitting

Enclosure: TAP Addendum Report

AIR SCIENCES INC.

DENVER • PORTLAND • LOS ANGELES

Stibnite Gold Project Permit to Construct Application

TAP Addendum

Prepared For:
PERPETUA RESOURCES IDAHO, INC.

PROJECT NO. 335-21-404
OCTOBER 5, 2021

REC 6666

TABLE OF CONTENTS

1.0 Introduction 1
2.0 HAP/TAP Emissions 2
2.1 Description of HAP Source Status 3
2.1.1 Controlled HAP Emissions 3
2.1.2 Uncontrolled HAP Emissions 3
2.2 Description of HAP/TAP Emission Calculations 3
2.2.1 Metal Emissions from Mining Fugitive Dust 3
2.2.2 Metal Emissions from Ore Processing and Lime/Aggregate Production 4
2.2.2.1 Crushing, Screening, and Material Handling 4
2.2.2.2 Lime Kiln 5
2.2.2.3 Autoclave 5
2.2.2.4 EW Cells, Pregnant Solution Tank, Retort, Furnace, and Carbon Kiln 5
2.2.2.5 Antimony Dryer and Dry Bagging 6
2.2.3 Metal Emissions from Concrete Production 6
2.2.4 H_2SO_4 and H_2S Emissions from the Autoclave 6
2.2.5 HCl Emissions from the Lime Kiln 6
2.2.6 HCN Emissions from Cyanide Leaching and Tailings Storage Facility 6
2.2.7 HAP/TAP Emissions from Fuel Storage and Fuel Combustion 6
2.2.8 Carbon Disulfide Emissions from Xanthate 7
2.2.9 Evaporative Mercury Emissions from Mining Surfaces 7
3.0 TAP Analysis 8
3.1 Equipment or Activities Covered or Addressed by NESHAP or NSPS 8
3.1.1 NESHAP Subpart ZZZZ 8
3.1.2 NESHAP Subpart AAAAA 9
3.1.3 NESHAP Subpart CCCCCC 9
3.1.4 NESHAP Subpart EEEEEEE 9
3.1.5 NSPS Subpart LL 10
3.1.6 NSPS Subpart OOO 10
3.2 Metals Review for TAP Provisions Applicability 10
3.3 Screening Level Analysis of TAP Emissions 12
3.4 Modeling of TAP Emissions 13

3.4.1 Meteorological Data and Deposition 13
3.4.2 Modeling for Non-Carcinogenic TAPs 16
3.4.3 Modeling Carcinogenic TAPs 19
3.4.4 Carcinogenic TAP Modeling Lifetime Exposure Adjustment 22
3.4.5 Arsenic Compliance Demonstration for Modeling Scenarios W1–W5 22
4.0 Comparison of Actual Arsenic Modeling to Potential Arsenic Modeling 24
5.0 Emission Inventory for Carcinogenic TAPs 27
5.1 Drilling Dust Control System 27
5.2 Haul Road Capping 27
5.3 Long-Term Mining Production Limits 27
5.4 Burntlog Access Road Refinement 28
5.5 Bulldozing Refinement 28
6.0 T-RACT Analysis 29
6.1 Drilling Dust Control System 29
6.2 Haul Road Dust and Arsenic Control 30
6.2.1 Dust Control Technologies 30
6.2.2 Arsenic Control Technologies 33
7.0 Proposed Permit Conditions for Carcinogenic TAP Compliance 34
7.1 Conditions per IDAPA 58.01.01.210.12(d) 34
7.2 Conditions per IDAPA 58.01.01.210.14(e) 34
8.0 Mercury Emissions Analysis 36
9.0 References 38

Tables

Table 1. Metal TAP Concentrations for Limestone and Lime 4
Table 2. Metals Comparison to IDAPA 58.01.01.585-586 TAPs 10
Table 3. TAPs Exceeding the Screening Emission Level 13
Table 4. PM Deposition Parameters by Source Category 14
Table 5. Pit-Specific Ore and DR Densities for Deposition 16
Table 6. Compliance Demonstration for Non-Carcinogenic TAPs 17
Table 7. Comparison of 180,000 T/day and T-RACT Emissions 19
Table 8. Compliance Demonstration for Carcinogenic TAPs 20

Table 9. Actual Analysis vs. Potential Analysis for Arsenic Lifetime Exposure 24
Table 10. EPA RBLC Determinations for 90% or Greater Control Efficiency of Unpaved Roads 32
Table 11. Mercury Source and Emissions Summary 37

Figures

Figure 1. Non-Carcinogenic Maximum TAP Concentration (µg/m^3) Locations 18
Figure 2. Carcinogenic Maximum TAP Concentration (µg/m^3) Locations 21
Figure 3. Actual Arsenic Mining Emissions vs. Potential Arsenic Mining Emissions 26
Figure 4. Actual Arsenic Concentrations (µg/m^3) and Maximum Location 26
Figure 5. Potential Arsenic Concentrations (µg/m^3) and Maximum Location 26
Figure 6. Quartzite Rock Areas 33

Appendices

Appendix A – HAP/TAP Emission Calculations
Appendix B – Modeled Emissions per Modeling Scenario and Source
Appendix C – TAP Modeling Results
Appendix D – Electronic Files

1.0 INTRODUCTION

On September 10, 2020 and February 18, 2021, the Idaho Department of Environmental Quality (IDEQ) provided notices for public comment on the Perpetua Resources Idaho, Inc. (hereafter referred to as Perpetua Resources) Stibnite Gold Project (SGP) complete application materials (Application), draft permit to construct (Draft PTC), and statement of basis (SOB). The public comments received included requests for additional information regarding hazardous air pollutant (HAP) and toxic air pollutant (TAP) emission estimates and modeling.

The purpose of this TAP Addendum (Addendum) is to provide that additional information to support IDEQ's responses to comments. The information provided in this Addendum confirms the following determinations made by Perpetua Resources and IDEQ at the time of the public notices:

1. The SGP is an area source for HAP emissions.

2. The SGP complies with the Idaho TAP provisions (IDAPA 58.01.01.210).

3. The SGP complies with the Idaho mercury rule (IDAPA 58.01.01.215).

This Addendum supplements information in the complete Application and supports those determinations highlighted during the public comment. Section 2.0 provides a description of the HAP/TAP emission calculations and source status. Section 3.0 provides a TAP emissions evaluation and modeling analysis, including TAP emission sources covered by IDAPA 58.01.01.210.20. Section 4.0 compares arsenic modeling analyses for actual and potential arsenic emissions. Section 5.0 provides a discussion of the emission reductions that demonstrate compliance with carcinogenic TAPs. Section 6.0 provides a Toxic Air Pollutant Reasonably Available Control Technology (T-RACT) analysis. Section 7.0 provides proposed permit conditions for demonstrating compliance with carcinogenic TAPs, and Section 8.0 provides a discussion of mercury emissions, including mercury emission sources covered by IDAPA 58.01.01.215.01.

IDAPA 58.01.01.210 and 215 reduce the information required from a PTC applicant and streamline the PTC review required by IDEQ in those circumstances where the HAP/TAP emissions are covered or addressed by federal regulations (IDAPA 58.01.01.210) or the mercury emissions are below a specific exemption threshold (IDAPA 58.01.01.215). Perpetua Resources referenced these rules in the Application and relied on these provisions to present a complete HAP/TAP emissions inventory that aligned with these rules. To support IDEQ's responses to public comments, IDEQ requested that Perpetua Resources expand its HAP/TAP analyses beyond the requirements of these rules and reconfirm compliance with TAP thresholds. This additional work reconfirms IDEQ's earlier findings that the SGP is an area source, and the proposed HAP/TAP emissions comply with IDAPA 58.01.01.210 and 215.

2.0 HAP/TAP EMISSIONS

During the two IDEQ public comment periods, IDEQ received comments regarding the following:

1. SGP source status for HAPs
2. Metal HAP/TAP emissions from fugitive dust
3. Metal HAP/TAP emissions from the autoclave and lime kiln processes
4. Fugitive emissions of hydrogen cyanide (HCN)

To support IDEQ's responses to comments and confirm the SGP area source status, the potential-to-emit (PTE)[1] HAP/TAP emission inventory in Appendix A of this Addendum contains emission calculations for all HAPs and TAPs emitted from all the SGP processes, including:

- Metals from mining fugitive dust emissions
- Metals from ore processing, ore concentration and refining, and lime, aggregate, and concrete production
- Antimony (Sb) emissions from the Sb drying and bagging circuit
- Sulfuric acid (H_2SO_4) and hydrogen sulfide (H_2S) from the autoclave, and hydrochloric acid (HCl) emissions and lime kiln
- Evaporative HCN from cyanide leaching and the tailings storage facility
- Various HAPs/TAPs from fuel storage and combustion
- Carbon disulfide emissions from the use of xanthate
- Evaporative mercury from mining surfaces

This HAP/TAP emission inventory was conducted for all 14 modeling scenarios evaluated in the Application. The emissions provided in Appendix A reflect the highest emissions scenario (HAP/TAP Emission Calculations – Scenario W3, 180,000 T/day).[2]

---

[1] PTE in this Addendum refers to the potential emissions after applying all proposed *air pollution control equipment and restrictions on hours of operation or on the type or amount of material combusted, stored or processed* per IDAPA 58.01.01.006.88 (i.e., PTE is the proposed permitted emissions).

[2] HAP/TAP Emission Calculations – Scenario W3, 180,000 T/day: HAP/TAP emissions based on the potential mining production rate of 180,000 tons per day (T/day) and the highest emissions scenario (Modeling Scenario W3).

2.1 Description of HAP Source Status

2.1.1 Controlled HAP Emissions

The controlled HAP emissions (PTE) from the SGP are below the major source thresholds; therefore, the SOB classified the SGP as an area source for HAP emissions. This is consistent with EPA's determination that all U.S. gold mine ore processing and production facilities are area sources.[3] The emissions inventory provided in Appendix A shows the total HAP emissions are 3.67 tons per year (ton/yr) for a single HAP and 12.56 ton/yr for all the HAPs combined for the highest emissions scenario (Modeling Scenario W3). The major source levels are 10 ton/yr for a single HAP and/or 25 ton/yr for all the HAPs combined.

2.1.2 Uncontrolled HAP Emissions

Uncontrolled HAP emissions are estimated to exceed 25 ton/yr, combined; therefore, to support the area source designation, Perpetua Resources committed to operational limitations and emission controls in the Application that achieve area source status.

2.2 Description of HAP/TAP Emission Calculations

This section provides a brief description of the methods used to calculate the HAP/TAP emissions provided in Appendix A. The references used for the HAP/TAP calculations were presented in the Application. Any new references are provided in this section.

2.2.1 Metal Emissions from Mining Fugitive Dust

The metal HAP/TAP emissions from fugitive dust generated by mining activities (drilling, blasting, excavating, hauling, etc.) were calculated by multiplying the HAP/TAP-specific median metal concentration in the ore[4] by the activity-specific total particulate matter (PM) emissions. The median metal concentrations were derived from over 55,000 core samples taken primarily from the more mineralized zones of the SGP pits (i.e., in and around gold ore deposits).

This emissions inventory does not reflect any of the emission reductions described in Section 5.0 for carcinogenic TAP compliance.

[3] *EPA recently gathered data and evaluated emissions of other HAP, including cyanide and non-mercury metals. The data indicate that the gold mining processing and production category consists of only area sources (i.e., facilities that emit less than ten tons per year of any one HAP and less than 25 tons per year of any combination of HAP)* (EPA 2010).

[4] Iron (Fe) and selenium (Se) were not included in the Application because the concentrations of these metals were similar to typical crustal abundance levels. In response to comments on HAPs/TAPs emissions, the concentrations of these metals (18,200 ppm of Fe and 0.4 ppm of Se) are provided (Midas Gold 2020).

2.2.2 Metal Emissions from Ore Processing and Lime/Aggregate Production

2.2.2.1 Crushing, Screening, and Material Handling

The metal HAP/TAP emissions generated by process and production sources (the crushing, screening, and handling of ore, limestone, lime, and aggregate) were calculated by multiplying the PM emissions from these sources by the median concentration of metals in the ore, limestone, lime, or aggregate. The ore median metal concentrations are discussed in Section 2.2.1. The limestone, lime, and aggregate metal concentrations are provided in Table 1.

The limestone metal concentrations were measured from core hole samples through the middle marble formation in the proposed limestone quarry's footprint. These rock samples were specifically analyzed to assess the formation as a viable limestone source. As a conservative estimate, the limestone metal profile was also used for aggregate production.

Table 1. Metal TAP Concentrations for Limestone and Lime

CAS	TAP Name	Concentration (ppm) [1]
7440-38-2	Arsenic	23
7440-41-7	Beryllium	0.8
7440-43-9	Cadmium	0.25
7440-48-4	Cobalt	4
7440-47-3	Chromium	15
7439-97-6	Mercury	0.02
7439-96-5	Manganese	236.5
7440-02-0	Nickel	5
7439-92-1	Lead	3
7440-36-0	Antimony	2.5
7723-14-0	Phosphorus	130
7440-22-4	Silver	0
7429-90-5	Aluminum	22,600
7440-39-3	Barium	145
1317-65-3	Calcium Carbonate [2]	274,500
1305-78-8	Calcium Oxide [3]	740,000
7440-50-8	Copper	5
7439-89-6	Iron	10,350
7439-98-7	Molybdenum	0.5
7440-28-0	Thallium	5
7440-61-1	Uranium	5

CAS	TAP Name	Concentration (ppm) [1]
7440-62-2	Vanadium	15.5
7440-33-7	Tungsten	5
7440-66-6	Zinc	18

[1] Median of 98 samples of the SGP limestone material (M3 2018).
[2] Calcium carbonate ($CaCO_3$) is used for limestone processing.
[3] Calcium oxide (CaO) is used for lime processing. 40% to 74% CaO (NLA 2007).

2.2.2.2 Lime Kiln

The non-mercury metal HAP/TAP emissions from the lime kiln were calculated by multiplying the PM emissions by the median concentration of metals in the limestone shown in Table 1. The mercury emissions from the lime kiln were conservatively estimated by assuming all mercury in the limestone feed is volatilized and emitted.

2.2.2.3 Autoclave

Mercury emissions from the SGP autoclave were based on the SysCAD modeling of the SGP autoclave performed by Perpetua Resources' engineering contractor: M3 Engineering. This modeling predicted 0.0105 grams per second of mercury emissions exiting the autoclave mercury control system, which is comprised of a venturi scrubber, a vent gas cleaning tower, a vent gas steam condensation tower, and one or more sulfur-impregnated activated carbon filters.

The non-mercury metal HAP/TAP emissions from the autoclave mercury control system are expected to be less than the mercury emissions because non-mercury HAP/TAP emissions are only particulates and more easily controlled by the emissions control system. Mercury emissions move through the control system as both particulate and gas. For this review, the non-mercury HAP/TAP emissions were conservatively assumed to be equal to the mercury emissions.

2.2.2.4 EW Cells, Pregnant Solution Tank, Retort, Furnace, and Carbon Kiln

Mercury emissions from the SGP electrowinning (EW) cells, pregnant solution tank, mercury retort, induction melting furnace, and carbon regeneration kiln were calculated based on stack test data from similar sources utilizing similar mercury control systems at Nevada gold mines.

The non-mercury metal HAP/TAP emissions exiting these mercury control systems are expected to be less than the mercury emissions because non-mercury HAP/TAP emissions are only particulates and more easily controlled by the emissions control system. Mercury emissions move through the control system as both particulate and gas. For this review, the non-mercury HAP/TAP emissions were conservatively assumed to be equal to the respective mercury emissions.

2.2.2.5 Antimony Dryer and Dry Bagging

The Sb circuit proposed in the Application was replaced with a new dewatering/packaging circuit. The new circuit eliminates the potential for metal emissions from dust and mercury evaporation emissions from concentrate heating. Instead, the Sb concentrate will be dewatered using a filter press and then bagged as a wet (damp) product. There are no HAP/TAP emissions associated with this new circuit.

2.2.3 Metal Emissions from Concrete Production

The metal HAP/TAP emissions from concrete production were calculated using EPA emission factors from AP-42 Section 11.12, Concrete Batching. This section provides controlled emission factors for cement silo filling and central mix batching. There are no emission factors for cement silo unloading. Therefore, the cement silo filling factors were used for cement silo unloading as a conservative estimate.

Chromium (VI) percentages of the total chromium were provided by IDEQ for cement silo filling and central mix batching. These percentages were used to calculate chromium (VI) emissions from cement silo filling and unloading and central mix batching.

There are no HAP/TAP emission factors for the dust generated from aggregate handling in the concrete production process. As a conservative estimate, the limestone metals profile provided in Table 1 of Section 2.2.2.1 was used to estimate the HAP/TAP emissions from aggregate handling.

2.2.4 H_2SO_4 and H_2S Emissions from the Autoclave

H_2SO_4 and H_2S emissions from the SGP autoclave were calculated based on source test data from similar autoclaves at gold mines in Nevada.

2.2.5 HCl Emissions from the Lime Kiln

The HCl emissions from the lime kiln were calculated using the HCl emission factor obtained from EPA's EPCRA Section 313 Guidance for Reporting Hydrochloric Acid (EPA 1999b).

2.2.6 HCN Emissions from Cyanide Leaching and Tailings Storage Facility

The evaporative HCN emissions from cyanide leaching and the tailings storage facility were calculated using the flux methodology developed by EPA and the Nevada Mining Association as part of the 40 CFR 63 rule-making process. The methodology is based on empirical measurements at several gold mines in Nevada taken under the direction of EPA. Numerous gold mines in several states have used this method since its development in 2010.

2.2.7 HAP/TAP Emissions from Fuel Storage and Fuel Combustion

HAP/TAP emissions from fuel combustion (propane and diesel) were calculated using fuel combustion rates and the applicable EPA AP-42 emission factors.

HAP/TAP emissions from fuel storage (gasoline) were calculated from the tank volatile organic compound (VOC) emissions multiplied by the weight percentages of HAP/TAP in the fuel. The percentages were obtained from EPA's EPCRA Section 313 Industry Guidance Metal Mining Facilities, Table 3-8 for gasoline (EPA 1999a).

2.2.8 Carbon Disulfide Emissions from Xanthate

Carbon disulfide (CS_2) emissions from potassium amyl xanthate (PAX) use were calculated based on the decomposition of xanthate to CS_2 gas. The decomposition rate was determined from published experimental data.

2.2.9 Evaporative Mercury Emissions from Mining Surfaces

Mercury can evaporate from rock surfaces in pits, tailings facilities, development rock storage facilities, and stockpiles. The rate of mercury evaporation (or flux) is a function of the mercury concentration in the material. Mercury flux rates and concentration measurements taken at a gold mine in Nevada were adjusted for the SGP mercury concentrations to estimate mercury flux emissions from the SGP pits, tailings facility, development rock storage facilities, and ore stockpiles.

3.0 TAP ANALYSIS

A complete inventory of the PTE TAP emissions is provided in Appendix A, as discussed in Section 2.0. Appendix A also identifies the applicability of IDAPA 58.01.01.210.20. According to IDAPA 58.01.01.210.20, no further demonstration of compliance with the TAP provisions is required to obtain a PTC for new source emissions, such as the SGP, from:

a. The equipment or activities covered by a New Source Performance Standards (NSPS) or National Emissions Standards for Hazardous Air Pollutants (NESHAP); or

b. The source category of equipment or activities addressed by a NSPS or NESHAP even if the specific equipment or activity is not subject to compliance requirements under the federal rule.

After applying IDAPA 58.01.01.210.20 as described in Section 3.1, the remaining TAP emissions are subject to further compliance demonstration and are compared to the screening emission levels (EL) described in Section 3.3. TAP emissions that below the screening EL, require no further demonstration of compliance with the TAP provisions. TAP emissions above the screening EL require modeling, as described in Section 3.4. To identify the TAPs subject to review, Section 3.2 provides a comparison of the metals analyzed in the SGP ore, development rock, and limestone to the TAPs listed in IDAPA 58.01.01.585 and IDAPA 58.01.01.586.

3.1 Equipment or Activities Covered or Addressed by NESHAP or NSPS

In accordance with IDAPA 58.01.01.210.20, the equipment and activities at the SGP that are either covered or addressed by NESHAP or NSPS are discussed in the following subsections. TAPs emitted from these sources that are also HAPs require no further evaluation to demonstrate compliance with the TAP provisions. TAP emissions from these sources that are not HAPs require additional review to demonstrate compliance with the TAP provisions.

3.1.1 NESHAP Subpart ZZZZ

40 CFR 63, Subpart ZZZZ, NESHAP for Stationary Reciprocating Internal Combustion Engines covers HAP emissions from the SGP emergency generators and fire pump (Source ID No. EDG1, EDG2, EDG3, and EDFP). IDAPA 58.01.01.210.20(a) applies to Source ID No. EDG1, EDG2, EDG3, and EDFP.

3.1.2 NESHAP Subpart AAAAA

40 CFR 63, Subpart AAAAA, NESHAP for Lime Manufacturing Plants addresses HAP emissions from the SGP lime manufacturing sources (Source ID No. LS12, LK, LS-L/U, LCR, and LKC).[5] IDAPA 58.01.01.210.20(b) applies to Source ID No. LS12, LK, LS-L/U, LCR, and LKC.

3.1.3 NESHAP Subpart CCCCCC

40 CFR 63, Subpart CCCCCC, NESHAP for Source Category: Gasoline Dispensing Facilities covers the SGP gasoline storage tanks (Source ID No. TG1 and TG2). IDAPA 58.01.01.210.20(a) applies to Source ID No. TG1 and TG2.

3.1.4 NESHAP Subpart EEEEEEE

40 CFR 63, Subpart EEEEEEE, NESHAP: Gold Mine Ore Processing and Production Area Source Category covers HAP emissions from the SGP autoclave (Source ID No. AC) and the EW cells, pregnant solution tank, mercury retort, induction melting furnace, and carbon regeneration kiln (Source ID No. EW, MR, MF, and CKD). IDAPA 58.01.01.210.20(a) applies to Source ID No. AC, EW, MR, MF, and CKD.

The NESHAP source category addresses HAP emissions from mining activities, specifically fugitive dust-generating activities (drilling, blasting, excavating, hauling, etc.), explosives use and storage (Source ID No. PS), cyanide leaching (Source ID No. CIP Leach 1-4, CIL 1-6, CIP 1-6, and CN Detox 1-2), tailings storage, ore processing (Source ID No. OC1-13), ore processing heating (Source ID No. ACB, CKB, PV, and HS), and the ore processing reagent use of PAX and sodium cyanide (NaCN). The NESHAP source category is defined as "*Gold Ore Mining ..., NAICS code 212221, Establishments primarily engaged in developing the mine site, mining, and/or beneficiating (i.e., preparing) ores valued chiefly for their gold content. Establishments primarily engaged in transformation of the gold into bullion or doré bar in combination with mining activities are included in this industry*" (EPA 2011b). EPA's rule-making docket (Docket ID EPA-HQ-OAR-2010-0239) provides documents evaluating HAP metal emissions from mining fugitive dust, HCN emissions from cyanide leaching, and downwind HCN ambient concentrations.[6]

---

[5] NESHAP Subpart AAAAA defines the affected source as follows: *each lime kiln and its associated cooler, each individual PSH [processed stone handling] system. The individual types of emission units in a PSH system are conveying system transfer points, bulk loading or unloading systems, screening operations, bucket elevators, and belt conveyors-if they follow the processed stone storage bin or storage pile in the sequence of PSH operations. The materials processing operations (MPO) associated with lime products (such as quicklime and hydrated lime), lime kiln dust handling, quarry or mining operations, limestone sizing operations, and fuels are not subject to today's final NESHAP. Processed stone handling operations are further distinguished in the final NESHAP as follows: (1) whether their emissions are vented through a stack, (2) whether their emissions are fugitive emissions, (3) whether their emissions are vented through a stack with some fugitive emissions from the partial enclosure, and/or (4) whether the source is enclosed in a building* (69 Fed. Reg. 394, 397 (January 5, 2004)).

[6] EPA-HQ-OAR-2010-0239-0132, *Profile of the Metal Mining Industry;* EPA-HQ-OAR-2010-0239-0157, *Recommended Methodology for Quantification of Fugitive Dust Metals Emissions from Mining Activities for Title V Applicability;* EPA-HQ-OAR-2010-0239-0102, *QAPP Comprehensive Air Emissions Testing for Hydrogen Cyanide;* EPA-HQ-OAR-2010-0239-0134, -0135 -0136 -0137 -0161 -0162 -0378, *Meteorological and Hydrogen Cyanide (HCN) Fence Line Monitoring* reports.

In response to public comments, this Addendum applies IDAPA 58.01.01.210.20(a) to those sources of HAP emissions at the SGP that are covered by Subpart EEEEEEE. This Addendum provides further evaluation of the sources of HAP emissions that are addressed by the NESHAP per IDAPA 58.01.01.210.20(b) – the mining emissions.[7]

3.1.5 NSPS Subpart LL

40 CFR 60, Subpart LL, Standards of Performance for Metallic Mineral Processing Plant covers the SGP ore processing (Source ID No. OC1-13). IDAPA 58.01.01.210.20(a) applies to Source ID No. OC1-13.

3.1.6 NSPS Subpart OOO

40 CFR 60, Subpart OOO, Standards of Performance for Nonmetallic Mineral Processing Plants covers the SGP limestone processing sources (Source ID LS1-11 and LSBM), aggregate production (Source ID No. PCSP1 and PCSP2), and aggregate handling in the concrete production process (Source ID No. CA-L/U). IDAPA 58.01.01.210.20(a) applies to Source ID No. LS1-11, LSBM, PCSP1, PCSP2, CA-L/U.

3.2 Metals Review for TAP Provisions Applicability

Table 2 provides a comparison of the metals analyzed in the SGP ore, development rock, and limestone to the TAPs listed in IDAPA 58.01.01.585 and IDAPA 58.01.01.586.

Table 2. Metals Comparison to IDAPA 58.01.01.585-586 TAPs

Metal			TAP		
CAS	**Name**	**HAP?**	**CAS**	**Name**	**Is the Metal a TAP?**
7440-57-5	Gold	No	7440-57-5	Not listed	No
7440-22-4	Silver	No	7440-22-4	Silver - Including metal soluble compounds, as Ag	Yes, same CAS Yes, similar form No
7429-90-5	Aluminum	No	7429-90-5	Aluminum, including: Metal & Oxide Pyro powders Soluble salts	Yes, same CAS Yes, similar form No No
7440-36-0	Antimony	Yes	7440-36-0	Antimony & compounds, as Sb (handling & use)	Yes, same CAS
7440-38-2	Arsenic	Yes	7440-38-2	Arsenic compounds	Yes, same CAS
7440-39-3	Barium	No	7440-39-3	Barium, soluble compounds, as Ba	Yes, same CAS
7440-41-7	Beryllium	Yes	7440-41-7	Beryllium & compounds	Yes, same CAS

[7] A demonstration of compliance that applied IDAPA 58.01.01.210.20(a) and (b) to the sources of HAP emissions covered and addressed by the NESHAP is presented in the SOB (February 18, 2021).

Metal			TAP		
CAS	**Name**	**HAP?**	**CAS**	**Name**	**Is the Metal a TAP?**
7440-69-9	Bismuth	No	1304-82-1	Bismuth telluride undoped Bismuth telluride if selenium doped	No, Bi compounds are expected to be bismuthinite ($Bi2S_3$) and bismite (Bi_2O_3) [1]
7440-43-9	Cadmium	Yes	7440-43-9	Cadmium and compounds	Yes, same CAS
7440-70-2	Calcium	No	1317-65-3 156-62-7 1305-62-0 1305-78-8 1344-95-2 13397-24-5	Calcium carbonate Calcium cyanamide Calcium hydroxide Calcium oxide Calcium silicate (synthetic) Calcium sulfate	Yes [2] No, different CAS No, different CAS Yes [2] No, different CAS No, different CAS
7440-47-3	Chromium	Yes	7440-47-3 7440-47-3 16065-83-1 18540-29-9	Chromium metal, including: Chromium (II) compounds, as Cr Chromium (III) compounds, as Cr Chromium (VI) & compounds, as Cr+6	Yes, same CAS Yes, same CAS No, different CAS No, different CAS
7440-48-4	Cobalt	Yes	10210-68-1 16842-03-8 7440-48-4	Cobalt carbonyl, as Co Cobalt hydro carbonyl, as Co Cobalt metal, dust, and fume	No, different CAS No, different CAS Yes, same CAS
7440-50-8	Copper	No	7440-50-8	Copper: Fume Dusts & mists, as Cu	Yes, same CAS No Yes, similar form
7440-55-3	Gallium	No		Not listed	No
7439-89-6	Iron	No	1309-37-1 13463-40-6 7439-89-6	Iron oxide fume (Fe2O3), as Fe Iron pentacarbonyl, as Fe Iron salts, soluble, as Fe	No, different CAS No, different CAS Yes, same CAS
7439-91-0	Lanthanum	No		Not listed	No
7440-09-7	Potassium	No	1310-58-3	Potassium hydroxide	No, different CAS
7439-92-1	Lead	Yes		Not listed	No, criteria pollutant
7439-95-4	Magnesium	No	1309-48-4	Magnesium oxide fume	No, different CAS
7439-96-5	Manganese	Yes	7439-96-5	Manganese, as Mn, including: Dust & compounds Fume	Yes, same CAS Yes, similar form No
7439-97-6	Mercury	Yes		Not listed	No, regulated by mercury rules
7439-98-7	Molybdenum	No	7439-98-7	Molybdenum, as Mo, including: Soluble compounds Insoluble compounds	Yes, same CAS No Yes, similar form
7440-02-0	Nickel	Yes	7440-02-0 12035-72-2 7440-02-0	Nickel Nickel Subsulfide Nickel Refinery Dust	No, see Ni refinery dust No, different CAS Yes, same CAS and form

Metal			TAP		
CAS	Name	HAP?	CAS	Name	Is the Metal a TAP?
7723-14-0	Phosphorus	Yes	7723-14-0	Phosphorus	Yes, same CAS
			10025-87-3	Phosphorus oxychloride	No, different CAS
			10026-13-8	Phosphorus penta-chloride	No, different CAS
			1313-80-3	Phosphorus penta-sulfide	No, different CAS
			1314-56-3	Phosphorus pentoxide (ID)	No, different CAS
			7719-12-2	Phosphorus trichloride	No, different CAS
7782-49-2	Selenium	Yes	7782-49-2	Selenium and compounds, as Se	Yes, same CAS
7440-23-5	Sodium	No	26628-22-8	Sodium azide (CL)	No, different CAS
			7631-90-5	Sodium bisulfite	No, different CAS
			136-78-7	Sodium 2,4-dichloro-phenoxyethyl sulfate; see Sesone	No, different CAS
			62-74-8	Sodium fluoroacetate	No, different CAS
			1310-73-2	Sodium hydroxide	No, different CAS
			7681-57-4	Sodium metabisulfite	No, different CAS
7440-20-2	Scandium	No		Not listed	No
7440-24-6	Strontium	No		Not listed	No
7440-28-0	Thallium	No	7440-28-0	Thallium, soluble compounds, as Tl	Yes, same CAS
7440-29-1	Thorium	No		Not listed	No
7440-32-6	Titanium	No		Not listed	No
7440-33-7	Tungsten	No	7440-33-7	Tungsten, including: Insoluble compounds Soluble compounds	Yes, same CAS Yes, similar form No
7440-61-1	Uranium	No	7440-61-1	Uranium (natural) soluble & insoluble compounds, as U	Yes, same CAS
7440-62-2	Vanadium	No	1314-62-1	Vanadium, as V_2O_5 Respirable dust & fume	No, different CAS [3]
			12604-58-9	Ferrovanadium dust	No, different CAS
7440-66-6	Zinc	No	7440-66-6	Zinc metal (ID)	Yes, same CAS
			7646-85-7	Zinc chloride fume	No, different CAS
			1314-13-2	Zinc oxide fume	No, different CAS
			1314-13-2	Zinc oxide dust	No, different CAS

[1] Over 95% of the samples were at or below the detection limit for Bismuth of 2 ppm. Limited sampling for tellurium indicates 90% of the samples are below 0.5 ppm. Mineralogical studies have not identified telluride minerals as a significant phase in the deposits. Based on these low levels and deposit mineralogy, no significant bismuth telluride is expected to be found in the ore body or development rock.

[2] Although the CAS numbers do not match, the calcium in the ore, limestone, and aggregate is expected to be in the form of calcium carbonate ($CaCO_3$). For lime, the calcium will be in the form of calcium oxide (CaO).

[3] The principal vanadium mineral in Idaho shale-hosted vanadium deposits is metahewettite ($CaV_6O_{162} \bullet H2O$) (USGS n.d.). Although not a TAP, vanadium in the ore, limestone, and aggregate is conservatively assumed to be V_2O_5 for the purpose of the TAP evaluation included in this HAP/TAP Addendum.

3.3 Screening Level Analysis of TAP Emissions

As discussed in Section 2.0, the highest TAP emissions scenario is Model Scenario W3, that estimates emissions from a potential throughput of 180,000 T/day. Table A in Appendix A

provides a summary of the TAP emissions for Model Scenario W3, identifies whether the sources are covered or addressed by IDAPA 58.01.01.210.20(a) or (b) (Section 3.1), and notes the TAP screening EL. TAPs that exceed the screening EL are highlighted in Table A. These TAPs require further demonstrations of compliance with the applicable ambient air concentration (AAC) and are listed in Table 3 below.

Table 3. TAPs Exceeding the Screening Emission Level

CAS	TAP Name	Carcinogenic	SGP PTE (lb/hr) [1]	Screening EL (lb/hr)
7429-90-5	Aluminum	No	58.50	0.667
7440-38-2	Arsenic	Yes	0.544	0.0000015
7440-39-3	Barium	No	0.659	0.033
7440-41-7	Beryllium	Yes	0.00261	0.000028
7440-43-9	Cadmium	Yes	0.000435	0.0000037
1317-65-3	Calcium Carbonate	No	13.65	0.667
1305-78-8	Calcium Oxide	No	0.696	0.133
592-01-8	Cyanide	No	0.453	0.333
50-00-0	Formaldehyde	Yes	0.00189	0.00051
7439-89-6	Iron	No	15.04	0.067
7439-96-5	Manganese	No	0.244	0.067
7440-02-0	Nickel	Yes	0.00169	0.000027
7723-14-0	Phosphorus	No	0.530	0.007
7664-93-9	Sulfuric Acid	No	2.03	0.067
7440-28-0	Thallium	No	0.00867	0.007
7440-62-2	Vanadium	No	0.0237	0.003

[1] Model Scenario W3, 180,000 T/day Emissions

3.4 Modeling of TAP Emissions

To maintain consistency with the National Ambient Air Quality Standards (NAAQS) compliance analyses reviewed by IDEQ, the TAP modeling was performed using the same IDEQ-approved datasets and model versions described in the SOB from February 18, 2021. TAP modeling was conducted for the 14 modeling scenarios consistent with the NAAQS analyses. Scenario W5 was eliminated from the arsenic modeling, as discussed in Section 3.4.5.

3.4.1 Meteorological Data and Deposition

The meteorological dataset used for the TAP modeling was processed using EPA's Qian and Venkatram (Q&V) meteorological processing method. This method, which does not use the BULKRN keyword, is approved by EPA as a default method.

As discussed in the PTC application, EPA evaluated the performance of the model with the Q&V processed meteorological dataset as part of its model approval determination. This evaluation quantified the bias between the modeled concentrations and the actual observed concentrations. The results of EPA's evaluation showed a conservative bias of the model to overpredict concentrations by a factor of 1.41 to 3.21 (Air Sciences 2020, A-8 of Attachment A). Therefore, the meteorological dataset used in the TAP modeling is expected to predict conservatively high concentrations.

The particulate deposition parameters used in the NAAQS compliance analysis were derived for PM_{10} and $PM_{2.5}$. See Tables 24 and 25 in the SOB from February 18, 2021. Dust-related metal TAP emissions include total particulates (all size fractions of PM up to PM_{30}). Therefore, the deposition parameters for PM were calculated using the same methodology and EPA references used for PM_{10} and $PM_{2.5}$ in the NAAQS compliance analysis. The PM deposition parameters are provided in Table 4.

Table 4. PM Deposition Parameters by Source Category

Source Category	Parameter	PM				
		Bin 1	Bin 2	Bin 3	Bin 4	Bin5
Haul Roads	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.02	0.23	0.75	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3) (DR average of YP, HF, WE)	2.46	2.46	2.46	--	--
Material Handling (Ore, DR, Limestone)	Bin Upper Diameter (µm)	2.50	5.00	10.00	30.00	--
	Mass Fraction	0.07	0.20	0.20	0.53	--
	Mass Mean Diameter (µm)	2.50	5.00	10.00	30.00	--
	Density (g/cm^3) (Ore)	Pit-specific, see Table 5				
	Density (g/cm^3) (DR)	Pit-specific, see Table 5				
	Density (g/cm^3) (Limestone)	1.09	1.09	1.09	1.09	--
Baghouses	Bin Upper Diameter (µm)	2.50	6.00	10.00	30.00	--
	Mass Fraction	0.25	0.45	0.20	0.10	--
	Mass Mean Diameter (µm)	2.50	6.00	10.00	30.00	--
	Density (g/cm^3) (Ore)	Pit-specific, see Table 5				
Diesel Engines	Bin Upper Diameter (µm)	1.00	2.50	6.00	10.00	30.00
	Mass Fraction	0.82	0.08	0.03	0.03	0.04
	Mass Mean Diameter (µm)	1.00	2.50	6.00	10.00	30.00
	Density (g/cm^3) (Diesel Combustion)	1.00	1.00	1.00	1.00	1.00
Heaters and Boilers	Bin Upper Diameter (µm)	1.00	2.50	6.00	10.00	30.00
	Mass Fraction	0.23	0.22	0.25	0.09	0.21
	Mass Mean Diameter (µm)	1.00	2.50	6.00	10.00	30.00
	Density (g/cm^3) (Propane Combustion)	1.24	1.24	1.24	1.24	1.24
	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--

Source Category	Parameter	PM				
		Bin 1	Bin 2	Bin 3	Bin 4	Bin5
Lime Loading and Unloading (Quick, Pebble)	Mass Fraction	0.05	0.29	0.66	--	--
	Mass Mean Diameter	2.50	10.00	30.00	--	--
	Density (g/cm^3) (Quick)	0.44	0.44	0.44	--	--
	Density (g/cm^3) (Pebble)	0.96	0.96	0.96	--	--
Lime Unloading (Quick, Pebble)	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.09	0.49	0.42	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3) (Quick)	0.44	0.44	0.44	--	--
	Density (g/cm^3) (Pebble)	0.96	0.96	0.96	--	--
Cement and Aggregate Loading and Unloading	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.05	0.29	0.66	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3) (Cement)	1.44	1.44	1.44	--	--
	Density (g/cm^3) (Aggregate)	1.28	1.28	1.28	--	--
Prill Loading and Unloading	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.05	0.30	0.65	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3) (Prill)	0.84	0.84	0.84	--	--
Refining Processes	Bin Upper Diameter (µm)	1.00	2.50	6.00	10.00	30.00
	Mass Fraction	0.72	0.10	0.07	0.03	0.08
	Mass Mean Diameter (µm)	1.00	2.50	6.00	10.00	30.00
	Density (g/cm^3) (Diesel Combustion)	1.00	1.00	1.00	1.00	1.00
Portable Crushing and Screening Plant	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.05	0.32	0.63	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3) (DR average of YP, HF, WE)	2.46	2.46	2.46	--	--
Lime Kiln and Ball Mill	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction (Kiln)	0.27	0.28	0.45	--	--
	Mass Fraction (Ball Mill)	0.30	0.54	0.16	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3)	1.09	1.09	1.09	--	--
Blasting and Drilling	Bin Upper Diameter (µm)	2.50	10.00	30.00	--	--
	Mass Fraction	0.03	0.49	0.48	--	--
	Mass Mean Diameter (µm)	2.50	10.00	30.00	--	--
	Density (g/cm^3) (Ore or DR)	Pit-specific, see Table 5				
Dozing	Bin Upper Diameter (µm)	2.50	10.00	15.00	30.00	--
	Mass Fraction	0.11	0.08	0.06	0.75	--
	Mass Mean Diameter (µm)	2.50	10.00	15.00	30.00	--
	Density (g/cm^3) (Waste)	Pit-specific, see Table 5				

Table 5. Pit-Specific Ore and DR Densities for Deposition

Pit	Material	Density (g/cm^3)
YP	Ore	2.59
BT	Ore	2.00
HF	Ore	2.59
WE	Ore	2.68
YP	DR	2.48
BT	DR	2.00
HF	DR	2.34
WE	DR	2.57
Average (YP, HF, WE)	DR	2.46

3.4.2 Modeling for Non-Carcinogenic TAPs

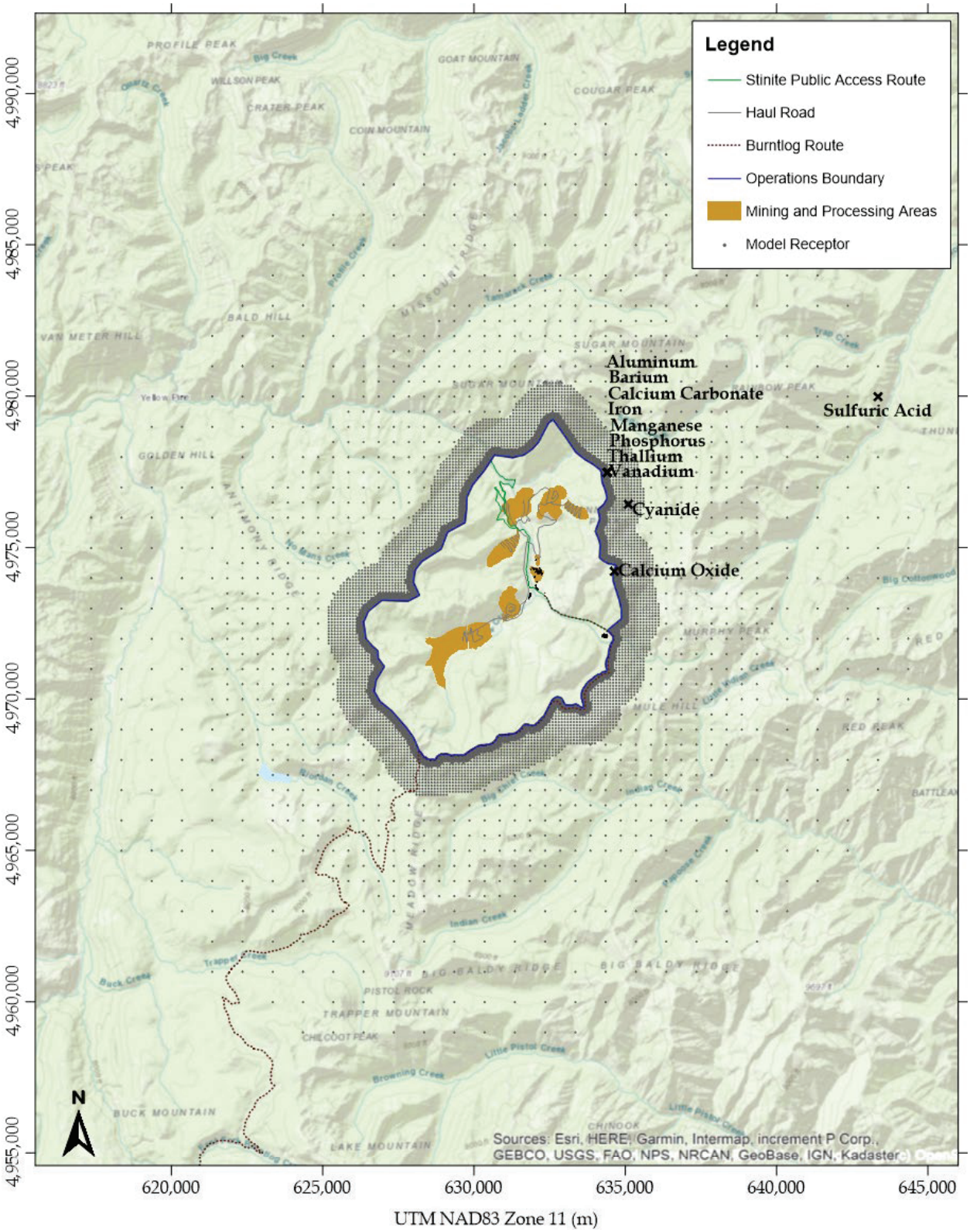
The non-carcinogenic TAPs subject to the AACs per IDAPA 58.01.01.585 were modeled at the emission levels shown in Table 3 above. The maximum 24-hour modeled concentration for each of the 14 modeling scenarios demonstrates compliance with the applicable AAC, as summarized in Table 6.

Table 6. Compliance Demonstration for Non-Carcinogenic TAPs

CAS	TAP Name	Highest Model Scenario	SGP Maximum 24-hr Concentration (μg/m³)	AAC (μg/m³)	TAP Compliance
7429-90-5	Aluminum	W5	6.17	500	Yes
7440-39-3	Barium	W5	0.07	25	Yes
1317-65-3	Calcium Carbonate	W5	1.22	500	Yes
1305-78-8	Calcium Oxide	ALL	0.15	100	Yes
592-01-8	Cyanide	ALL	0.20	250	Yes
7439-89-6	Iron	W5	1.58	50	Yes
7439-96-5	Manganese	W5	0.03	250	Yes
7723-14-0	Phosphorus	W5	0.06	5	Yes
7664-93-9	Sulfuric Acid	ALL	0.41	50	Yes
7440-28-0	Thallium	W5	0.001	5	Yes
7440-62-2	Vanadium	W5	0.002	2.5	Yes

The modeled emissions for each modeling scenario and source are provided in Appendix B. The modeled concentration per modeling scenario is provided in Appendix C. The predicted locations of the maximum concentrations for each non-carcinogenic TAP are presented in Figure 1.

Figure 1. Non-Carcinogenic Maximum TAP Concentration (µg/m³) Locations



3.4.3 Modeling Carcinogenic TAPs

The carcinogenic TAPs subject to the acceptable ambient concentrations for carcinogens (AACC) per IDAPA 58.01.01.586 were modeled using an emission inventory that includes the following T-RACT controls, long-term mining production limits, and other emission inventory refinements, as described below:

- Installing and operating dust collection systems on drilling rigs (T-RACT)
- Capping the haul roads that are outside of the pits and development rock storage facilities (DRSFs) with clean development rock (T-RACT)
- Limiting long-term mining production to 135,000 T/day (5-year rolling total)
- Constructing the Burntlog access road with offsite materials containing background level arsenic concentrations
- Updating the bulldozing emission factor using the SGP site-specific silt content.

The above emission inventory reductions are discussed in more detail in Section 5.0. The T-RACT analysis is provided in Section 6.0. A comparison of the 180,000 T/day TAP emissions shown in Table 3 and the T-RACT TAP emissions is shown in Table 7.

Table 7. Comparison of 180,000 T/day and T-RACT Emissions

CAS	TAP Name	Carcinogenic	180,000 T/day Emissions (lb/hr) [1]	T-RACT Emissions (lb/hr) [2]
7440-38-2	Arsenic	Yes	0.544	0.232
7440-41-7	Beryllium	Yes	0.00261	0.00185
7440-43-9	Cadmium	Yes	0.000435	0.000317
50-00-0	Formaldehyde	Yes	0.00189	0.00189
7440-02-0	Nickel	Yes	0.00169	0.00121

[1] Model Scenario W3 emissions from Table 3
[2] T-RACT emission levels for the demonstration of carcinogenic TAP compliance. See Table A-W3, T-RACT Emissions in Appendix A, pp. A-45 to A-49.

The maximum modeled concentration for each of the 14 modeling scenarios demonstrated compliance with the applicable AACC, as summarized in Table 8. The AACCs listed in Table 8 were increased by a factor of ten (10) per IDAPA 58.01.01.210.12(b); T-RACT adjustment. The SGP maximum concentrations were adjusted to account for the life-of-mine (LOM) production limits, which affect the lifetime exposure, and to account for the elimination of Modeling Scenario W5. See Sections 3.4.4 and 3.4.5 for more detail.

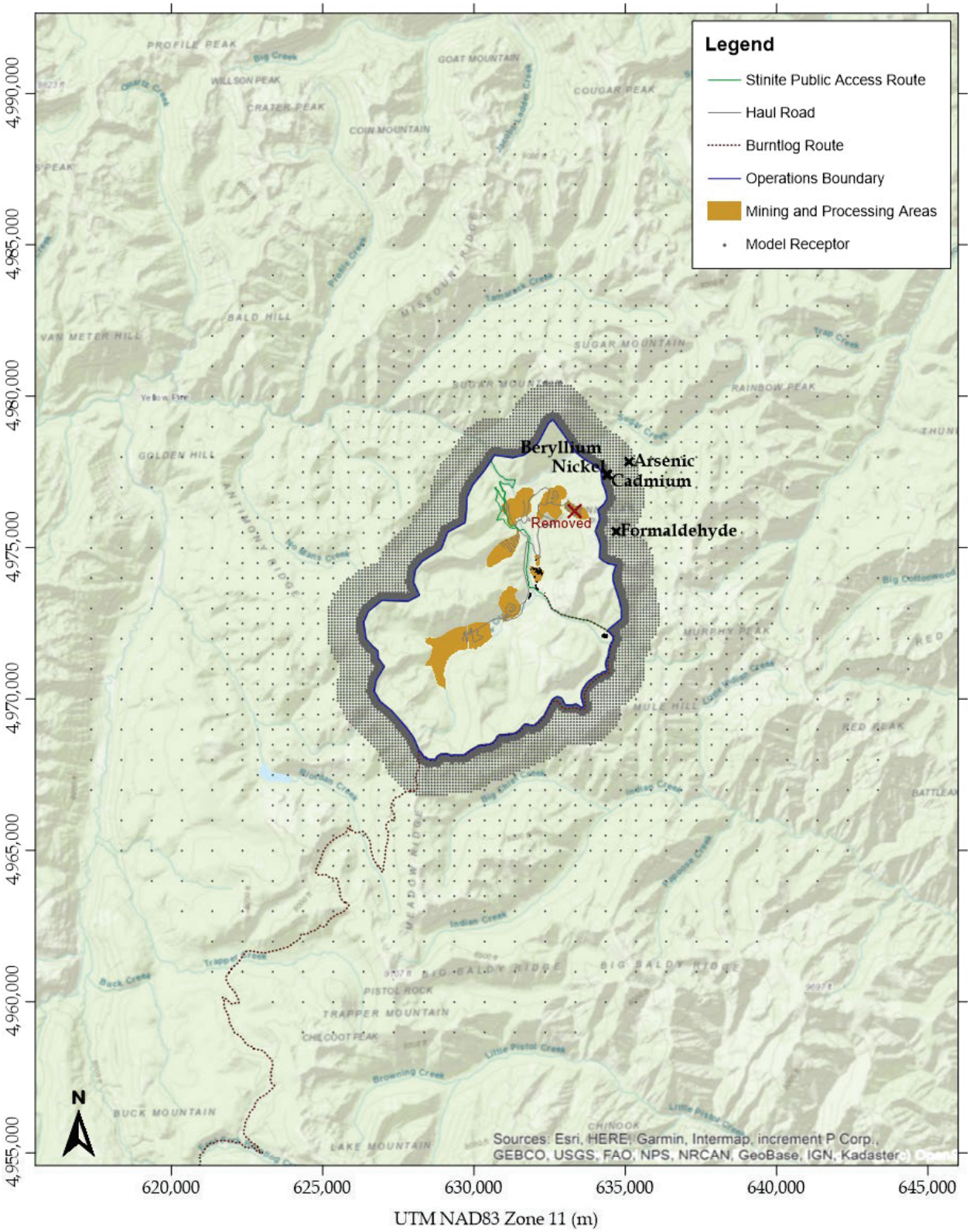
Table 8. Compliance Demonstration for Carcinogenic TAPs

CAS	TAP Name	Model Scenario	SGP Maximum Lifetime Exposure Concentration (µg/m³) [1]	AACC (µg/m³) [2]	TAP Compliance
7440-38-2	Arsenic	W2	0.00095	0.0023	Yes
7440-41-7	Beryllium	W1	0.00001	0.042	Yes
7440-43-9	Cadmium	W1	0.000002	0.0056	Yes
50-00-0	Formaldehyde	ALL	0.00007	0.77	Yes
7440-02-0	Nickel	W1	0.00001	0.42	Yes

[1] The lifetime exposure concentrations are based on the proposed restrictions discussed in Sections 3.4.4 and 3.4.5.
[2] The AACCs are increased by a factor of ten per IDAPA 58.01.01.210.12(b); T-RACT adjustment.

The modeled emissions for each modeling scenario and source are provided in Appendix B. The modeled concentration per modeling scenario is provided in Appendix C. The locations of the maximum concentrations for each carcinogenic TAP are presented in Figure 2.

Figure 2. Carcinogenic Maximum TAP Concentration (µg/m³) Locations



3.4.4 Carcinogenic TAP Modeling Lifetime Exposure Adjustment

The AACCs provided in IDAPA 58.01.01.586 were developed *based on the probability of developing excess cancers over a seventy (70) year lifetime exposure to one (1) microgram per cubic meter (1 ug/m3) of a given carcinogen and expressed in terms of a screening emission level or an acceptable ambient concentration for a carcinogenic toxic air pollutant* (IDAPA 58.01.01.006.125). Therefore, the highest modeled annual carcinogenic TAP concentration from each of the 14 modeling scenarios was evaluated for lifetime exposure as follows:

$$Lifetime\ expsoure\ \left(\frac{\mu g}{m^3}\right) = \frac{Highest\ annual\ concentration\ \left(\frac{\mu g}{m^3}\right) \times 16\ (mine\ operation\ years)}{70\ (years, lifetime\ exposure)}$$

This equation conservatively assumes that the highest annual concentration from the 14 modeling scenarios is repeated for 16 years of mining operation. This is then averaged over 70 years to calculate the 70-year lifetime exposure.

Calculating lifetime exposure based on 16 years of mining operation is also conservative. The annual emissions for carcinogenic TAP modeling are based on 135,000 T/day (see Section 3.4.3) and 365 days per year. Over 16 years, this equates to a potential mining production of 788.4 million tons:

$$\frac{135{,}000\left(\frac{ton}{day}\right) \times 365\left(\frac{day}{year}\right) \times 16\ years}{1{,}000{,}000\left(\frac{ton}{million\ ton}\right)} = 788.4\ million\ tons$$

The actual LOM total production as described in the SGP Refined Proposed Action (ModPRO2) mine plan is only 402.86 million tons (Perpetua 2021a), which is 51.1% of the potential LOM production represented in the above equation and related emissions evaluations.

3.4.5 Arsenic Compliance Demonstration for Modeling Scenarios W1–W5

To demonstrate compliance with the AACC for arsenic, two addition operating limitations were applied:

- The removal of Modeling Scenario W5 as a potential operating scenario
- Limiting the West End pit's LOM potential mining production to 50% of the total LOM potential mining production of 788.4 million tons: 50% * 788.4 = 394.2 million tons

Perpetua Resources has determined that the West End DRSF will not be constructed. This change eliminated Modeling Scenario W5 from the arsenic modeling evaluation. The remaining four West End pit modeling scenarios (W1–W4) are evaluated using the 70-year lifetime exposure equation from Section 3.4.4 and adjusting for the proposed West End pit LOM production limit of 50% of the total production as follows:

$$lifetime\ expsoure\ \left(\frac{\mu g}{m^3}\right) = \left(\frac{\left[Wi\left(\frac{\mu g}{m^3}\right)(50\%) + nonW\left(\frac{\mu g}{m^3}\right)(50\%)\right] \times 16\ (mine\ operation\ years)}{70\ (years, lifetime\ exposure)}\right)$$

Where:

$Wi = the\ modeled\ annual\ arsenic\ concentration\ from\ Scenario\ Wi;\ i = 1\ to\ 4$

$nonW = the\ modeled\ annual\ arsenic\ concentration\ of\ the\ highest\ nonW\ scenario;$

B1, B2, H1, H2, H3, H4, Y1, Y2, or Y3

The above equation was used to calculate the lifetime arsenic exposure from the West End pit scenarios (W1–W4) on a receptor-by-receptor basis. Combining the concentrations from Modeling Scenarios W1–W4 with the highest concentration from the remaining non-West End pit scenarios (B1, B2, H1, H2, H3, H4, Y1, Y2, or Y3) ensures that the maximum concentration is evaluated.

Calculating lifetime arsenic exposure based on the proposed West End pit LOM production limit of 50% of the total production is conservative. The actual LOM total production from the West End pit as described in the ModPRO2 mine plan is only 198.26 million tons (Perpetua 2021a), which is 50.3% of the proposed West End pit LOM production limit of 394.2 million tons.

4.0 COMPARISON OF ACTUAL ARSENIC MODELING TO POTENTIAL ARSENIC MODELING

Additional analyses of arsenic emissions were prompted by public comments on the draft PTC. IDEQ requested that Perpetua Resources conduct an arsenic modeling analysis based on the actual mining operation and production described in the ModPRO2 mine plan. Those modeling results were submitted to IDEQ in a report on July 8, 2021, titled "Stibnite Gold Project Permit to Construct Application Arsenic Modeling Addendum" (Air Sciences 2021).

While that report provided an assessment of the actual arsenic concentrations expected from the actual mining operation and production over the life of the SGP ("actual analysis"), the analysis described in Section 3.0 above is based on potential operating scenarios ("potential analysis"). These analyses ensure that public health is protected under all operating conditions.

A comparison between the actual analysis and the potential analysis for the lifetime exposure of arsenic is summarized in Table 9.

Table 9. Actual Analysis vs. Potential Analysis for Arsenic Lifetime Exposure

Model Parameter	Actual Data	Potential Data	Actual Data Basis	Potential Data Basis
Process emissions (lb/hr)	0.004514	0.004514	Equipment design rate	Equipment design rate
Mining emissions (lb/hr); varies	Max: 0.0854 Min: 0.0058 Avg: 0.0451	Max: 0.232 Min: 0.061	ModPRO2 – 16 years of operation	14 potential worst-case scenarios
Emissions included in modeling (lb/yr)	100%	98%	Actual analysis of all emissions	Includes IDAPA 58.01.01.210.20
LOM production (million tons)	402.86	788.4	ModPRO2	135,000 ton/day * 365 day/yr * 16 years
Lifetime exposure modeling	Average concentration over 16 years of operation	Highest scenario concentration assumed for 16 years	Actual analysis	Potential worst-case analysis
Maximum modeled concentration ($\mu g/m^3$)	0.00015	0.00095	Actual analysis	Potential worst-case analysis
Applicable AACC ($\mu g/m^3$)	0.0023	0.0023	IDAPA 58.01.01. 210.12(b) and .586	IDAPA 58.01.01. 210.12(b) and .586

A brief discussion of Table 9 is provided below:

- AACC Results: In both the actual and potential analyses, the maximum modeled arsenic concentrations are below the AACC, demonstrating compliance with IDAPA 58.01.01.210.

- Process emissions: The process arsenic emissions in both analyses are identical. This is because both emission inventories were based on the maximum design rates of the process equipment.

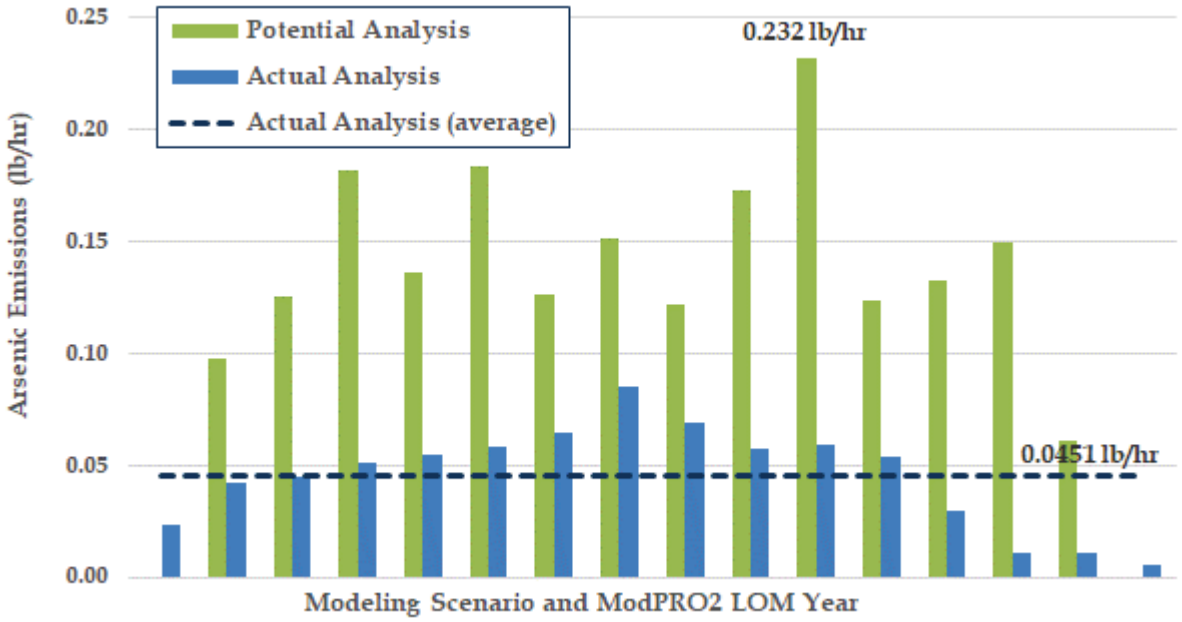
- Mining emissions: The arsenic emissions in the actual analysis (0.0451 lb/hr average) are only 19% of the arsenic emissions in the potential analysis (0.232 lb/hr highest scenario). This is because the actual mining operation and production activities (e.g., drilling, blasting, material product, hauling miles, etc.) in ModPRO2 are far less than the potential mining (PTC) operating scenarios. Figure 3 compares the ModPRO2 arsenic emissions from mining for each year of operation (actual analysis) to the PTC arsenic emissions from mining for each worst-case operating scenario (potential analysis).

- In both analyses, all the arsenic emissions are included in the modeling, except emissions from covered or addressed sources, IDAPA 58.01.01210.20(a) and (b). See Section 3.1.

- The actual analysis LOM production of 402.86 million tons is 51.1% of the potential analysis production of 788.4 million tons.

- When modeling the lifetime arsenic exposure, the actual analysis is based on modeling each year of the ModPRO2 mine plan and then averaging the yearly results on a receptor-by-receptor basis. In addition to the lower actual arsenic emissions, the mining activity locations vary, which reduced the average arsenic concentration at any given location outside the operations boundary. In contrast, the potential analysis is based on higher (potential) emissions and the highest modeling scenario, which are assumed to occur for 16 consecutive years. This potential approach resulted in significantly higher and more conservative arsenic hot-spot concentrations.

Figure 3. Actual Arsenic Mining Emissions vs. Potential Arsenic Mining Emissions



The concentrations and maximum locations of the arsenic lifetime exposure (70 years) are presented in Figure 4 for the actual analysis and Figure 5 for the potential analysis. As shown in these figures, the maximum arsenic concentrations are below the applicable AACC per IDAPA 58.01.01.210.12(b) and 586.

Figure 4. Actual Arsenic Concentrations (µg/m³) and Maximum Location

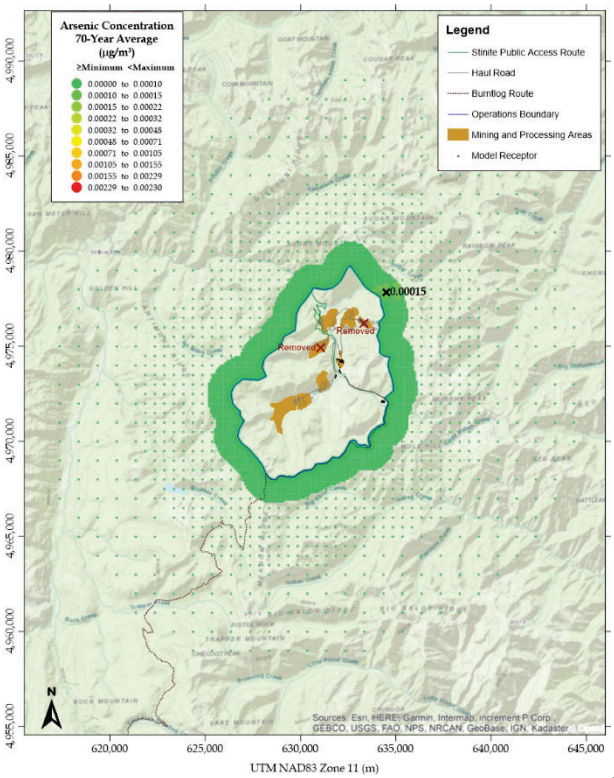
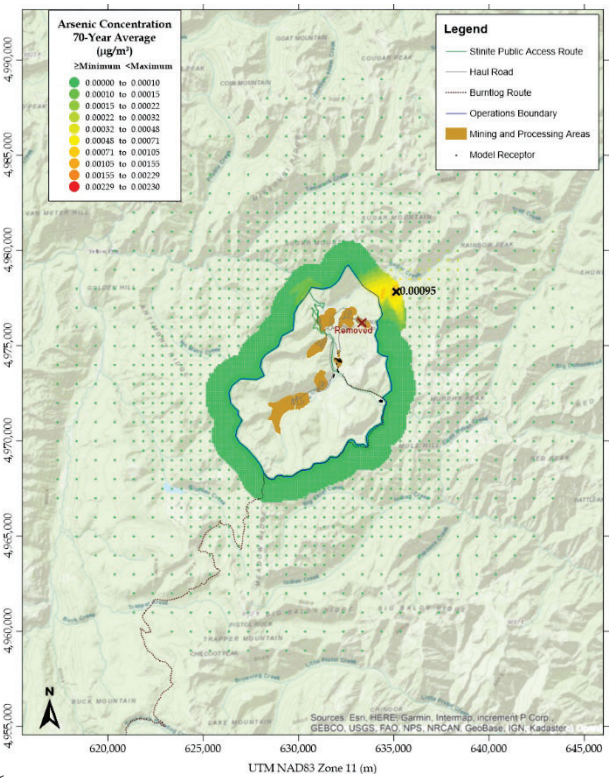


Figure 5. Potential Arsenic Concentrations (µg/m³) and Maximum Location



5.0 EMISSION INVENTORY FOR CARCINOGENIC TAPS

As discussed in Section 3.4.3, carcinogenic TAPs were modeled using an emission inventory adjusted for T-RACT controls, long-term mining production limits, and other refinements. These emission inventory changes are described in the following sections. The detailed emission calculations for the T-RACT emission inventory are provided in Appendix A (HAP/TAP Emission Calculations – Scenario W3, T-RACT Emissions).[8] The changes to these emission inventory inputs are highlighted on page A-41 of Appendix A.

5.1 Drilling Dust Control System

To reduce dust-related metal TAP emissions from drilling, Perpetua Resources will install and operate drilling rigs mounted with dust collection systems. *These systems have the ability to operate in various climates, i.e., they are not subject to freezing at lower temperatures as with the use of water, and they can be up to 99 percent efficient if properly maintained* (CDC 2012). The arsenic emissions inventory in Appendix A conservatively assumes a dust control efficiency of 90% for these systems.

5.2 Haul Road Capping

To reduce dust-related arsenic emissions from haul roads, Perpetua Resources will cap the haul roads that are outside of the pits and DRSFs with clean (low arsenic) development rock. Haul roads within the pits and DRSFs cannot be capped with this material because of steep grades and periodic road rerouting as mining areas develop. The median arsenic concentration of the clean development rock is 90 parts per million (ppm) (Perpetua 2021g).

5.3 Long-Term Mining Production Limits

To limit long-term dust-related metal TAP emissions, Perpetua Resources proposes limiting mining production to 135,000 T/day based on a 5-year rolling averaging period. This long-term mining production limit will be in addition to the current short-term daily limit of 180,000 T/day.

Limiting the long-term mining production limit to 135,000 T/day (5-year rolling average) is conservative. The highest 5-year rolling average mining production rate as described in ModPRO2 is only 95,700 T/day (Perpetua 2021a), which is 70.9% of the proposed limit.

[8] HAP/TAP Emission Calculations – Scenario W3, T-RACT: The HAP and TAP emissions based on T-RACT controls, a long-term mining production limit of 135,000 T/day (5-year rolling average), other refinements, and the highest emissions scenario (Modeling Scenario W3).

5.4 Burntlog Access Road Refinement

To reduce dust-related arsenic emissions from vehicle travel on the Burntlog access road, Perpetua Resources will construct this road with borrow material located outside of the mine site ambient air boundary. Analyses of the borrow sites show low arsenic levels of 2.5 ppm (ALS 2018), which are consistent with the background soil levels (DHHS 2007).

5.5 Bulldozing Refinement

Perpetua Resources and Air Sciences conducted a thorough review of the SGP emissions inventory to identify any potential dust-related metal TAP emission control measures (as discussed in the previous sections) and emission factor refinements. The only emission factor refinement identified was changing the bulldozing emission factor silt content from the EPA default of 6.9% to the SGP site-specific silt content of 4.0% (Midas Gold 2015). EPA recommends the use of site-specific data when available.[9]

[9] *In using the equations to estimate emissions from sources found in a specific western surface mine, it is necessary that reliable values for correction parameters be determined for the specific sources of interest if the assigned quality ratings of the equations are to be applicable. For example, actual silt content of coal or overburden measured at a facility should be used instead of estimated values. In the event that site-specific values for correction parameters cannot be obtained, the appropriate geometric mean values from Table 11.9-3 may be used, but the assigned quality rating of each emission factor equation should be reduced by 1 level (e.g., A to B)* (EPA 1998).

6.0 T-RACT ANALYSIS

Per IDAPA 58.01.01.210.14(a), this section documents the T-RACT control technologies.

6.1 Drilling Dust Control System

As discussed in Section 5.1, Perpetua Resources will install and operate drilling rigs mounted with dust collection systems. The following paragraphs evaluate this control as T-RACT:

Identification of all possible control technologies

Drilling operations create dust-related metal TAP emissions. The possible control technologies for these emissions are as follows:

- Applying best management practices
- Wet drilling with water injection
- Dry drilling with dust collectors

Best management practices include: (1) avoiding drilling operations during high dust conditions, and (2) shrouding drill areas to limit dust emissions.

Wet drilling includes injected water flows through the center of the drill and out though the drill bit to reduce dust emissions by 96% to 98%.[10]

Dry drilling includes rigs equipped with dust collection systems that shroud dust generated from the drilling area, capture, and remove dust through a dust collection system composed of an exhaust fan and filters that can achieve up to 99% control efficiency (CDC 2012).

Elimination of technologically infeasible or unreasonable technologies

Wet drilling at the SGP has the following disadvantages:

- It is subject to freezing at the low temperatures expected for the SGP location.
- It can result in drill bit plugging, drill rotation binding, and drill bit degradation.
- A wet drill hole can interfere with the blasting agent.

Based on the above disadvantages of wet drilling, it is considered an infeasible or unreasonable technology for the SGP.

[10] *Testing has demonstrated that dust control efficiencies of up to 98 percent can be obtained using the water separator sub while dust control efficiencies of wet drilling without the water separator sub were 96 percent* (CDC 2012).

Ranking the remaining technologies by control effectiveness

The ranking of the possible control technologies for drilling by control effectiveness is as follows (highest to lowest):

1. Dry drilling with dust collectors – up to 99% control efficiency
2. Best management practices

Evaluation of the most effective control technology and selection of T-RACT

Perpetua Resources selects the top (most effective) control technology of dry drilling with dust collectors as T-RACT. Selecting the top control negates the need for considering economic, energy, and environmental impacts regarding the other control technologies.

6.2 Haul Road Dust and Arsenic Control

Dust emissions from unpaved roads are caused by vehicle traffic on these roads. Particles are lifted and dropped from the rolling wheels, and the turbulent wake behind the vehicles causes these particulates to become air borne. Dust control options include surface improvement (paving) or surface treatment (chemical suppressant application or watering).

As discussed in the SOB from February 18, 2021, Perpetua Resources will control dust emissions from haul roads by treating the surface with frequent watering and the periodic application of a chemical suppressant. Reducing dust emissions reduces dust-related metal TAP emissions. In addition, Perpetua Resources will reduce arsenic emissions by capping the haul roads outside of the pits and DRSFs with clean (low arsenic) development rock, as discussed in Section 5.2. The following sections evaluate these control measures as T-RACT.

6.2.1 Dust Control Technologies

Identification of all possible control technologies

Vehicle traffic on unpaved haul roads creates dust-related metal TAP emissions. The possible control technologies for these emissions are as follows:

- Paving
- Application of a chemical dust suppressant
- Watering

Paving: *The control efficiencies achievable by paving can be estimated by comparing emission factors for unpaved and paved road conditions* (EPA 2006). The particulate emission factor for a paved road with a silt loading of 0.2 g/m^2 (based on the EPA default value for the SGP average daily traffic of 500–5,000 trips per day) (EPA 2011a) and the SGP average vehicle weight of 182.6 tons is

0.515 lb/VMT. The SGP unpaved road particulate emission factor is 14.43 lb/VMT (uncontrolled). Based on these emission factors, the estimated control efficiency of paving the haul roads is 96%.

Dust suppressant and watering: The SGP dust emissions from unpaved haul roads are calculated based on a surface treatment control efficiency of 90% (annual basis) for the application of a chemical dust suppressant supplemented with frequent watering. As discussed in the SGP Application, this control efficiency is supported by EPA's AP-42 13.2.2 referenced test reports, which show that a chemical dust suppressant alone can achieve 90% to 99% control efficiency and 98% for magnesium chloride in particular (Air Sciences 2020, Appendix A to Attachment A). A control efficiency of 90% is also supported by the control efficiency limits established under Reasonable Achievable Control Technology (RACT), Best Available Control Technology (BACT), and Lowest Achievable Emission Rate (LAER) determinations under EPA's New Source Review permitting program.

The EPA RACT/BACT/LAER Clearinghouse (RBLC) database contains case-specific information on the air pollution technologies required by major stationary sources seeking a permit under EPA's New Source Review (NSR) program. This database was queried for all listings of air pollution technologies for unpaved roads using chemical dust suppressants or a combination of chemical dust suppressants and watering. The results of the query identified 10 projects containing a control efficiency of 90% or greater for unpaved roads. These determinations are listed in Table 10.

Table 10. EPA RBLC Determinations for 90% or Greater Control Efficiency of Unpaved Roads

State	Facility Name	RBLC-ID	Dust Control	Dust Control Efficiency
AK	Donlin Gold Project	AK-0084	water/chem	90%
AR	Turk Power Plant	AR-0094	water/chem	90%
CO	Rio Grande Portland Cement Corp.	CO-0043	water/chem	90%
IN	Nucor Steel	IN-0034	chem	90%
LA	Nucor Steel Louisiana	LA-0239	water/chem	90%
MO	Lafarge Corp.	MO-0048	chem	90%
NV	Sloan Quarry	NV-0045	chem	98%
NV	Nellis Air Force Base	NV-0047	water/chem	90%
OH	Unlimited Concrete	OH-0126	water/chem	90%
OH	Unlimited Concrete	OH-0131	water/chem	90%

(EPA 2021)

Elimination of technologically infeasible or unreasonable technologies

Paving haul roads at the SGP has the following disadvantages:

- The paving of haul roads is not conventional practice at mining operations.
- Paved highway weight limits are only approximately 20,000 pounds (10 tons).
- Paving is costly.

The conventional practice for mining operations is to utilize unpaved haul roads with treated surfaces to control fugitive dust. Haul trucks are single axle vehicles with a gross loaded weight of 60 tons to 685 tons. The loaded weight range for the SGP haul trucks is 60 to 260 tons. These weights significantly exceed regulatory weight limits for paved highways of 10 tons. Furthermore, the SGP mining activity locations move as mining progresses. This requires haul roads to be rerouted as necessary. Due to the temporary nature of hauling routes and the heavy weight of haul trucks, paving is considered an infeasible or unreasonable technology for the SGP.

Ranking the remaining technologies by control effectiveness

The ranking of the possible control technologies for drilling by control effectiveness is as follows (highest to lowest):

1. Application of a chemical dust suppressant – 90% to 99% control efficiency

2. Watering – 75% to 95% control efficiency (EPA 2006, Figure 13.2.2-2)

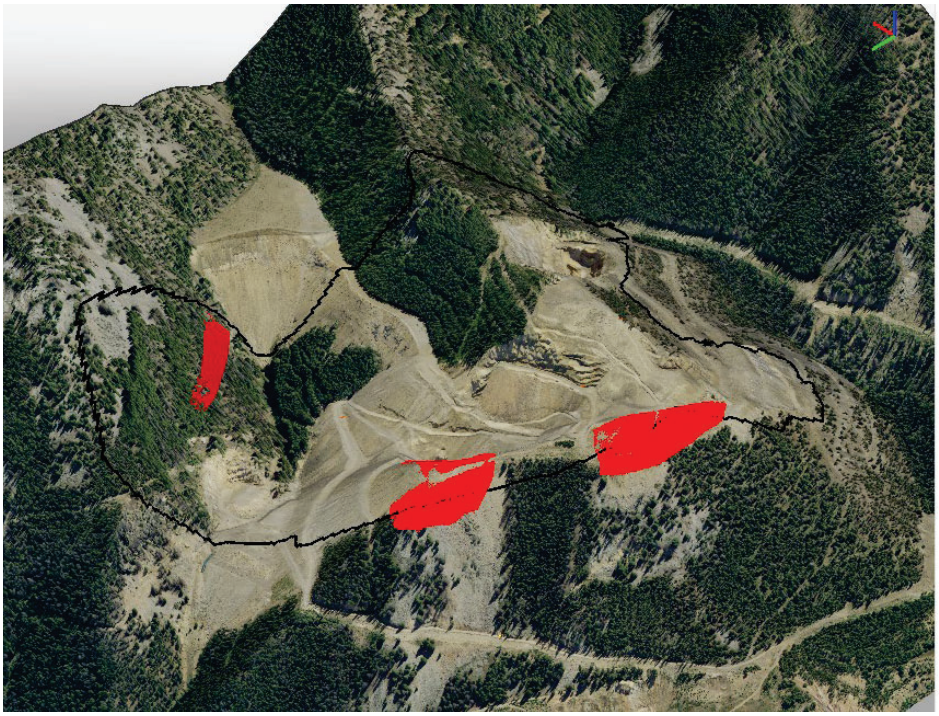
Evaluation of the most effective control technology and selection of T-RACT

After eliminating paving as a viable control option, Perpetua Resources selects the next most effective control technologies of the application of a chemical dust suppressant supplemented with frequent watering as T-RACT.

6.2.2 Arsenic Control Technologies

After applying T-RACT for dust control, as discussed in Section 6.2.1, dust-related arsenic emissions can only be further reduced by capping the haul roads with clean (low-arsenic) development rock. The median arsenic concentration of the SPG onsite material is 667 ppm (Midas Gold 2017c). However, there are quartzite rock deposits at the West End pit that have significantly lower mineralization and, thus, lower arsenic levels. The median arsenic concentration of this quartzite rock is 90 ppm (Perpetua 2021g), and there is approximately 3 million tons of this material available. Figure 6 shows the locations of the quartzite rock deposits.

Figure 6. Quartzite Rock Areas



Perpetua Resources proposes capping the haul roads that are outside of the pits and DRSFs with clean (low-arsenic) development rock as a T-RACT work practice, in addition to the T-RACT dust control measures discussed in Section 6.2.1. Haul roads within the pits and DRSFs cannot be capped with this material because of steep grades and periodic road rerouting as mining areas develop.

7.0 PROPOSED PERMIT CONDITIONS FOR CARCINOGENIC TAP COMPLIANCE

IDEQ is required to establish limits and standards as part of the permit to construct to ensure compliance with the TAP provisions in accordance with IDAPA 58.01.01.210.12(d) and 14(e). Per these two rules, Perpetua Resources proposes the following permit conditions:

7.1 Conditions per IDAPA 58.01.01.210.12(d)

Per IDAPA 58.01.01.210.12(d), *[t]he Department shall include emission limits and other permit terms for the toxic air pollutant in the permit to construct that assure that the facility will be operated in the manner described in the preconstruction compliance demonstration*. As discussed in Section 5.2, Perpetua Resources is proposing long-term mining production limits to demonstrate compliance with carcinogenic TAPs. The following are proposed permit conditions to address this TAP provision:

- The permittee shall haul no more than 135,000 tons per day (T/day) of ore and rock, based on a 5-year rolling average.
    - Each year, the permittee shall monitor and record the amount of ore and rock transported on haul trucks in tons per year (T/yr), and calculate the 5-year rolling average (T/day) based on 365 days per year.
- The permittee shall haul no more than 788.4 million tons (MT) of ore and rock from all deposits over the life of the mine.
- The permittee shall haul no more than 394.2 MT of ore and rock from the West End deposit over the life of the mine.
    - Each year, the permittee shall monitor and record the amount of ore and rock transported on haul trucks (T/yr) from all deposits and the amount of ore and rock transported on haul trucks (T/yr) from the West End deposit, and calculate the life-of-mine rolling total (MT) for each.

7.2 Conditions per IDAPA 58.01.01.210.14(e)

Per IDAPA 58.01.01.210.14(e), *[i]f the Department determines that the applicant has proposed T-RACT, the Department shall determine which of the options, or combination of options, will result in the lowest emission of toxic air pollutants, develop the emission standards constituting T-RACT and incorporate the emission standards into the permit to construct.* As discussed in Section 6.2, Perpetua Resources is proposing T-RACT controls to demonstrate compliance with carcinogenic TAPs. The following are proposed permit conditions to address this TAP provision:

- The permittee shall use drilling rigs equipped with dust collection systems. Control efficiency: 90%.
    - Within 60 days after startup, the permittee shall develop and maintain an Operation and Maintenance (O&M) manual. The O&M manual shall be a permittee-developed document based upon, but independent from, manufacturer-supplied operating manuals. The permittee shall operate the dust collection systems in accordance with the O&M manual at all times. The requirements in the O&M manual shall be incorporated by reference to this permit and shall be enforceable permit conditions. The O&M manual shall be submitted to DEQ within 60 days after initial startup.
- The permittee shall cap haul roads that are outside of the pits and DRSFs with low-arsenic material.
    - The permittee shall develop and maintain a plan that:
        - identifies the low-arsenic quartzite rock deposits in the West End pit based on core sample analyses,
        - requires periodic inspections (at least quarterly) of the capped haul roads and recapping as needed, and
        - includes record keeping of the inspections and any recapping of roads, noting the date and road section.
    - The permittee shall use the low-arsenic quartzite rock deposits from the West End pit, or other material with equal or lower arsenic concentration, as capping material.
        - If other material is used, it must be analyzed for arsenic concentration and a record of the median arsenic concentration shall be maintained.

The Draft PTC currently includes conditions for treating haul road surfaces with a chemical suppressant and water to control 90% of the dust (on an annual basis). See Conditions 1.2, 2.1–2.6, 2.8, 3.2, and 3.9. Therefore, no new conditions are needed or proposed for this dust control practice.

8.0 MERCURY EMISSIONS ANALYSIS

A complete inventory of mercury emissions is provided in Appendix A, as discussed in Section 2.0. This section categorizes these emissions into mercury emissions covered or not covered by IDAPA 58.01.01.215. According to IDAPA 58.01.01.215:

No owner or operator may commence construction or modification of a stationary source or facility that results in an increase in annual potential emissions of mercury of twenty-five (25) pounds or more unless the owner or operator has obtained a permit to construct under Sections 200 through 228 of these rules. The permit to construct application shall include an MBACT analysis for the new source or sources for review and approval by the Department. A determination of applicability under Section 215 shall be based upon the best available information. Fugitive emissions shall not be included in a determination of applicability under Section 215.

01. Exemptions. New or modified stationary sources within a source category subject to 40 CFR Part 63 are exempt from the requirements of Section 215.

Table 11 summarizes the SGP mercury sources and potential emissions for the highest emissions year (Model Scenario W3, 180,000 T/day Emissions). This table also provides the mercury emissions without considering the above exemptions, the exemption criteria, and the non-exempt mercury emissions for each source. As shown in this table, under IDAPA 58.01.01.215.01, the total potential non-exempt mercury emissions are 5.40E-5 ton/yr (0.108 lb/yr), which is well below the 25 lb/yr emission threshold.

Table 11. Mercury Source and Emissions Summary

Source	All Emissions ton/yr	Fugitive/ NESHAP Exemption	Non-Exempt Emissions ton/yr
Mining			
Fugitive Dust (drilling, blasting, excavating, hauling, etc.)	0.0021	Fugitive	0
Fugitive Evaporative (pits, tailings, DRSFs, stockpiles)	0.0036	Fugitive	0
Ore Processing			
Crushing, Screening, and Transfers	2.47E-05		2.47E-05
Prill Silos	0		0
Ore Concentration and Refining			
Autoclave	0.00010	7E	0
EW, Pregnant Tank, Retort, Furnace, Carbon Kiln	0.0017	7E	0
Process Heating			
POX, Carbon Kiln, Propane Vaporizers, Solution Heater	8.28E-06		8.28E-06
Lime Production			
Lime Kiln Combustion	2.09E-05	5A	0
Limestone Crushers, Screens, Mill, and Transfers	3.86E-07		3.86E-07
Lime Kiln, Kiln Feed, Lime Mill, and Pebble Lime Silo	0.0010	5A	0
Lime Silos and Lime Mill Crushing	4.05E-09		4.05E-09
Aggregate Production			
Portable Crushers, Screens, and Transfers	1.10E-07		1.10E-07
Concrete Production			
Central Mixer	0		0
Cement Silo Loading and Unloading	0		0
Aggregate Bin	6.90E-08		6.90E-08
HVAC			
Heaters	2.04E-05		2.04E-05
Emergency Power			
Emergency Generators and Fire Pump	0	4Z	0
Fuel Storage			
Gasoline Fuel Tanks	0	6C	0
Total	**0.00863**		**5.40E-05**

9.0 REFERENCES

Air Sciences. 2020. "Stibnite Gold Project Permit to Construct Application." *Prepared for: Midas Gold Idaho, Inc.* June 23.

—. 2021. "Stibnite Gold Project Permit to Construct Application Arsenic Modeling Addendum." *Prepared For: Perpetua Resources, Inc. (Formerly Midas Gold Idaho, Inc.* July 8.

ALS. 2018. "Project: Midas Gold - Burntlog Route." 8 rock samples submitted to the ALS USA Inc. Reno, NV lab on September 4, 2018, September 26.

CDC. 2012. "Dust Control Handbook for Industrial Minerals Mining and Processing." *RI 9689. Report of Investigations/2012.* Department of Health and Human Services, Centers for Disease Control and Prevention (CDC), January. Accessed June 28, 2021. https://www.cdc.gov/niosh/mining/UserFiles/works/pdfs/2012-112.pdf.

DHHS. 2007. "Toxicological Profile for Arsenic." U.S. Department of Health and Human Services (DHHS), August.

EPA. 1998. "AP-42 Section 11.9 Western Surface Coal Mining." U.S. Environmental Protection Agency (EPA), October.

—. 1999a. "EPCRA Section 313 Industry Guidance, Metal Mining Facilities." *EPA 745-B-99-001.* Section 313 of the Emergency Planning and Community Right-to-Know Act, Toxic Chemical Release Inventory, Table 3-8 (Gasoline). Environmental Protection Agency, January.

—. 1999b. "Guidance for Reporting Hydrochloric Acid (acid aerosols including mists, vapors, gas, fog, and other airborne forms of any particle size)." *EPA-745-B-99-014.* Emergency Planning and Community Right-to-Know Act - Section 313. Environmental Protection Agency, December.

—. 2006. "AP-42 Section 13.2.2 Unpaved Roads." U.S. Environmental Protection Agency (EPA), November. Accessed October 12, 2020. https://www3.epa.gov/ttn/chief/ap42/ch13/related/c13s02-2.html.

—. 2010. "Part III, 40 CFR Parts 9 and 63, National Emission Standards for Hazardous Air Pollutants: Gold Mine Ore Processing and Production Area Source Category and Addition to Source Category List for Standards; Proposed Rule." *Federal Register / Vol. 75, No. 81 / Wednesday, April 28, 2010 / Proposed Rules 22479.* Environmental Protection Agency, April 28.

—. 2011a. "AP-42 Section 13.2.1 Paved Roads." U.S. Environmental Protection Agency (EPA), January.

—. 2011b. "Part III, 40 CFR Parts 9 and 63, National Emission Standards for Hazardous Air Pollutants: Gold Mine Ore Processing and Production Area Source Category; and Addition to Source Category List for Standards; Final Rule." *9450 Federal Register / Vol. 76, No. 33 / Thursday, February 17, 2011 / Rules and Regulations.* Environmental Protection Agency, February 17.

—. 2021. "RACT/BACT/LAER Clearinghouse (RBLC)." United States Environmental Protection Agency (EPA). Accessed April 2021. https://cfpub.epa.gov/rblc/index.cfm?action=Home.Home&lang=en.

M3. 2018. "M3-PN170045 Stibnite Gold Feasibility Study RE: M3-MGI-029E Lime Kiln Analysis Memo." *File: Copy of MGI-17-431-FullGeochem - MB.XLSX.* Email from L. Becker, M3, to D. Kerner, Midas Gold, June 14.

Midas Gold. 2015. "Soil Resources Baseline Study, Stibnite Gold Project." Reid, Samuel B., Assistant Geology Supervisor, Midas Gold, Inc., April.

—. 2017c. "Geochemistry Statistics." Email from R. McCluskey, Midas Gold Idaho, to E. Memon, Air Sciences, September 26.
—. 2020. "Te-2." *File: 2020-12-09_Fe and Se data.xlsx.* Email from A. Zinsser, Midas Gold Idaho, Inc., to K. Lewis, Air Sciences Inc., December 9.
NLA. 2007. "FACT SHEET: Lime, The Versatile Chemical, Lime Terminology, Standards & Properties." National Lime Association (NLA), January. Accessed December 10, 2020. https://www.lime.org/documents/publications/free_downloads/fact-properties2007rev.pdf.
Perpetua. 2021a. "ModPRO2 Mine Plan." *File: Midas Stibnite Mine Plan and Equipment Schedule (10Feb21).xlsx.* Email from R. McCluskey, Perpetua Resources Inc., to E. Memon, Air Sciences Inc., February 11.
—. 2021g. "RE: As values feeding Haul Road Geochem runoff calculations." *Attachment: Upper Quartzite_DH_ICP data_Medians.xlsx.* Email from A. Zinsser, Perpetua Resources, to D. Kerner, Perpetua Resources, June 7.
USGS. n.d. "Vanadium, Chapter U of Critical Mineral Resources of the United States—Economic and Environmental Geology and Prospects for Future Supply." *Professional Paper 1802–U.* U.S. Department of the Interior, U.S. Geological Survey. Accessed December 5, 2020. https://pubs.usgs.gov/pp/1802/u/pp1802u.pdf.

Appendix A – HAP/TAP Emission Calculations

Appendix A Table of Contents

HAP/TAP Emission Calculations – Scenario W3, 180,000 T/day Emissions.....A-2

Table A-W3. HAP/TAP Emissions and Exemptions – Scenario W3, 180,000 T/day Emissions .A-21

HAP/TAP Emission Calculations – Scenario W3, T-RACT Emissions.....A-26

Table A-W3. HAP/TAP Emissions and Exemptions – Scenario W3, T-RACT Emissions.....A-45

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 1 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021

Model Scenario W3 180,000 T/day Emissions

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**HAP/TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
106-99-0	1,3-Butadiene	8.4E-07	3.7E-06	0	0	0	0	8.4E-07	3.7E-06	Y	Y
91-57-6	2-Methylnaphthalene	1.1E-06	4.6E-06	0	0	0	0	1.1E-06	4.6E-06	Y	N
56-49-5	3-Methylchloranthrene	7.8E-08	3.4E-07	0	0	0	0	7.8E-08	3.4E-07	Y	Y
57-97-6	7,12-Dimethylbenz(a)anthracene	7.6E-07	3.0E-06	0	0	0	0	7.6E-07	3.0E-06	Y	N
83-32-9	Acenaphthene	5.7E-06	7.1E-06	0	0	0	0	5.7E-06	7.1E-06	Y	N
208-96-8	Acenaphthylene	1.1E-05	1.4E-05	0	0	0	0	1.1E-05	1.4E-05	Y	N
75-07-0	Acetaldehyde	2.5E-05	1.1E-04	0	0	0	0	2.5E-05	1.1E-04	Y	Y
107-02-8	Acrolein	1.6E-05	2.0E-05	0	0	0	0	1.6E-05	2.0E-05	Y	Y
120-12-7	Anthracene	1.7E-06	2.4E-06	0	0	0	0	1.7E-06	2.4E-06	Y	N
7440-36-0	Antimony	0	0	5.7E-04	2.5E-03	1.9E-02	8.2E-02	1.9E-02	8.5E-02	Y	Y
7440-38-2	Arsenic	8.7E-06	3.8E-05	4.5E-03	2.0E-02	0.54	2.38	0.55	2.40	Y	Y
56-55-3	Benz(a)anthracene	3.1E-07	1.4E-06	0	0	0	0	3.1E-07	1.4E-06	Y	Y
71-43-2	Benzene	3.6E-04	1.6E-03	7.0E-03	3.1E-02	0	0	7.4E-03	3.2E-02	Y	Y
50-32-8	Benzo(a)pyrene	1.4E-07	6.1E-07	0	0	0	0	1.4E-07	6.1E-07	Y	Y
205-99-2	Benzo(b)fluoranthene	4.4E-07	1.9E-06	0	0	0	0	4.4E-07	1.9E-06	Y	Y
191-24-2	Benzo(g,h,i)perylene	7.5E-07	1.1E-06	0	0	0	0	7.5E-07	1.1E-06	Y	N
207-08-9	Benzo(k)fluoranthene	1.5E-07	6.6E-07	0	0	0	0	1.5E-07	6.6E-07	Y	Y
7440-41-7	Beryllium	5.2E-07	2.3E-06	4.3E-04	1.9E-03	2.6E-03	1.1E-02	3.0E-03	1.3E-02	Y	Y
92-52-4	Biphenyl	0	0	4.4E-05	1.9E-04	0	0	4.4E-05	1.9E-04	Y	Y
7440-43-9	Cadmium	4.8E-05	2.1E-04	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.7E-04	3.8E-03	Y	Y
75-15-0	Carbon Disulfide	0	0	1.4E-02	6.3E-02	0	0	1.4E-02	6.3E-02	Y	Y
7440-47-3	Chromium	6.6E-05	2.7E-04	6.1E-04	2.5E-03	7.3E-03	3.2E-02	8.0E-03	3.5E-02	Y	Y
18540-29-9	Cr (VI)	0	0	3.4E-07	1.5E-06	0	0	3.4E-07	1.5E-06	Y	Y
218-01-9	Chrysene	5.8E-07	2.5E-06	0	0	0	0	5.8E-07	2.5E-06	Y	Y
7440-48-4	Cobalt	4.0E-06	1.6E-05	4.7E-04	2.0E-03	3.3E-03	1.4E-02	3.7E-03	1.6E-02	Y	Y
592-01-8	Cyanide	0	0	0.45	1.99	0	0	0.45	1.99	Y	Y
53-70-3	Dibenzo(a,h)anthracene	1.8E-07	7.7E-07	0	0	0	0	1.8E-07	7.7E-07	Y	Y
106-46-7	Dichlorobenzene	5.7E-05	2.3E-04	0	0	0	0	5.7E-05	2.3E-04	Y	Y
206-44-0	Fluoranthene	5.5E-06	7.0E-06	0	0	0	0	5.5E-06	7.0E-06	Y	N
86-73-7	Fluorene	1.7E-05	2.1E-05	0	0	0	0	1.7E-05	2.1E-05	Y	N
50-00-0	Formaldehyde	3.3E-03	1.5E-02	0	0	0	0	3.3E-03	1.5E-02	Y	Y
110-54-3	Hexane	8.5E-02	0.34	3.1E-02	0.14	0	0	0.12	0.48	Y	Y
7647-01-0	Hydrogen Chloride	0	0	0.99	3.67	0	0	0.99	**3.67**	Y	Y
193-39-5	Indeno(1,2,3-cd)pyrene	2.2E-07	9.6E-07	0	0	0	0	2.2E-07	9.6E-07	Y	Y
7439-92-1	Lead	0	0	4.8E-04	2.1E-03	6.5E-03	2.9E-02	7.0E-03	3.1E-02	Y	N
7439-96-5	Manganese	1.8E-05	7.2E-05	4.6E-03	1.7E-02	0.24	1.07	0.25	1.08	Y	Y
7439-97-6	Mercury	1.2E-05	5.0E-05	6.9E-04	2.9E-03	1.3E-03	5.7E-03	2.0E-03	8.6E-03	Y	N
91-20-3	Naphthalene	1.9E-04	3.1E-04	1.9E-03	8.5E-03	0	0	2.1E-03	8.8E-03	Y	Y
7440-02-0	Nickel	9.1E-05	4.0E-04	4.6E-04	2.0E-03	1.6E-03	7.1E-03	2.2E-03	9.5E-03	Y	Y
85-01-8	Phenanthrene	5.1E-05	6.3E-05	0	0	0	0	5.1E-05	6.3E-05	Y	N
108-95-2	Phenol	0	0	2.4E-04	1.1E-03	0	0	2.4E-04	1.1E-03	Y	Y
7723-14-0	Phosphorus	0	0	5.6E-03	2.3E-02	0.53	2.32	0.54	2.34	Y	Y
129-00-0	Pyrene	5.0E-06	6.6E-06	0	0	0	0	5.0E-06	6.6E-06	Y	N
7782-49-2	Selenium	1.1E-06	4.6E-06	4.1E-04	1.8E-03	3.3E-04	1.4E-03	7.4E-04	3.2E-03	Y	Y
108-88-3	Toluene	5.2E-04	1.1E-03	3.2E-02	0.14	0	0	3.2E-02	0.14	Y	Y
1330-20-7	Xylene	2.5E-04	3.0E-04	3.1E-02	0.14	0	0	3.2E-02	0.14	Y	Y
Total HAP		9.0E-02	0.36	1.58	6.25	1.36	5.95	3.03	12.56		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
TRUE	0.2155	0.8650	8.3307	31.6474	86.1858	377.4936	94.7319	410.0060
	chk	chk	chk-15	chk	chk	chk	chk	chk

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary - continued

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**Non-HAP TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
7429-90-5	Aluminum	0	0	0.65	2.58	57.86	253.41	58.50	255.98	N	Y
7440-39-3	Barium	2.1E-04	8.4E-04	6.6E-03	2.7E-02	0.65	2.86	0.66	2.88	N	Y
1317-65-3	Calcium Carbonate	0	0	2.24	8.12	11.41	49.97	13.65	58.09	N	Y
1305-78-8	Calcium Oxide	0	0	0.70	0.95	0	0	0.70	0.95	N	Y
7440-50-8	Copper	4.0E-05	1.6E-04	4.9E-04	2.1E-03	4.1E-03	1.8E-02	4.6E-03	2.0E-02	N	Y
110-82-7	Cyclohexane	0	0	1.0E-03	4.6E-03	0	0	1.0E-03	4.6E-03	N	Y
7783-06-4	Hydrogen Sulfide	0	0	0.90	3.94	0	0	0.90	3.94	N	Y
7439-89-6	Iron	0	0	0.21	0.81	14.83	64.96	15.04	65.77	N	Y
7439-98-7	Molybdenum	5.2E-05	2.1E-04	4.2E-04	1.8E-03	8.1E-04	3.6E-03	1.3E-03	5.6E-03	N	Y
109-66-0	Pentane	0.12	0.50	0	0	0	0	0.12	0.50	N	Y
7440-22-4	Silver	0	0	4.1E-04	1.8E-03	4.1E-04	1.8E-03	8.2E-04	3.6E-03	N	Y
7664-93-9	Sulfuric Acid	0	0	2.03	8.89	0	0	2.03	8.89	N	Y
7440-28-0	Thallium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-61-1	Uranium	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-62-2	Vanadium	1.1E-04	4.4E-04	7.3E-04	3.0E-03	2.3E-02	1.0E-01	2.4E-02	0.10	N	Y
25551-13-7	Trimethyl benzene	0	0	1.1E-02	4.8E-02	0	0	1.1E-02	4.8E-02	N	Y
7440-33-7	Tungsten	0	0	5.2E-04	2.2E-03	8.1E-03	3.6E-02	8.7E-03	3.8E-02	N	Y
7440-66-6	Zinc	1.4E-03	5.5E-03	8.0E-04	3.3E-03	2.9E-02	0.12	3.1E-02	0.13	N	Y
Total Non-HAP TAP		0.13	0.50	6.75	25.40	84.83	371.54	91.71	397.44		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

Conversions

2,000 lb/ton
8,760 hr/yr
24 hr/day

PROPANE COMBUSTION

Source Data

Source ID	Description	MMBtu/day	MMBtu/yr
Lime Process Heating			
LKC	PFR Shaft Lime Kiln Combustion	529.0	163,935
Ore Process Heating			
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	17.0	510
CKB	Carbon Regeneration Kiln (Burners)	54.1	19,754
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	2.4	876
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	120.0	43,800
Subtotal		193.5	64,940
HVAC			
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	96.0	35,040
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	96.0	35,040
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	96.0	35,040
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	12.0	4,380
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	48.0	17,520
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	72.0	26,280
Subtotal		438.0	159,870

PROPANE COMBUSTION - CONTINUED

HAP/TAP Emission Factors and Emissions

O.Heat_pph O.Heat_tpy L.Heat_pph L.Heat_tpy HVAC_pph HVAC_tpy lb/hr ton/yr

		Emission Factor[2]		Emissions[1] Ore Proc Heat		Lime Proc Heat		HVAC		Total			
CAS	Pollutant	lb/MMscf	lb/MMBtu[3]	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	TAP	A/C
91-57-6	2-Methylnaphthalene	2.4E-05	2.35E-8	1.9E-07	7.6E-07	5.2E-07	1.9E-06	4.3E-07	1.9E-06	1.1E-06	4.6E-06	N	
56-49-5	3-Methylchloranthrene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
57-97-6	7,12-Dimethylbenz(a)ant	< 1.6E-05	1.57E-8	1.3E-07	5.1E-07	3.5E-07	1.3E-06	2.9E-07	1.3E-06	7.6E-07	3.0E-06	N	
83-32-9	Acenaphthene	< 1.8E-06	1.76E-9	1.4E-08	5.7E-08	3.9E-08	1.4E-07	3.2E-08	1.4E-07	8.5E-08	3.4E-07	N	
208-96-8	Acenaphthylene	< 1.8E-06	1.76E-9	1.4E-08	5.7E-08	3.9E-08	1.4E-07	3.2E-08	1.4E-07	8.5E-08	3.4E-07	N	
120-12-7	Anthracene	< 2.4E-06	2.35E-9	1.9E-08	7.6E-08	5.2E-08	1.9E-07	4.3E-08	1.9E-07	1.1E-07	4.6E-07	N	
7440-38-2	Arsenic	2.0E-04	1.96E-7	1.5E-06	6.4E-06	3.7E-06	1.6E-05	3.6E-06	1.6E-05	8.7E-06	3.8E-05	Y	C
56-55-3	Benz(a)anthracene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
71-43-2	Benzene	2.1E-03	2.06E-6	1.5E-05	6.7E-05	3.9E-05	1.7E-04	3.8E-05	1.6E-04	9.1E-05	4.0E-04	Y	C
50-32-8	Benzo(a)pyrene	< 1.2E-06	1.18E-9	8.7E-09	3.8E-08	2.2E-08	9.6E-08	2.1E-08	9.4E-08	5.2E-08	2.3E-07	Y	C
205-99-2	Benzo(b)fluoranthene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
191-24-2	Benzo(g,h,i)perylene	< 1.2E-06	1.18E-9	9.5E-09	3.8E-08	2.6E-08	9.6E-08	2.1E-08	9.4E-08	5.7E-08	2.3E-07	N	
207-08-9	Benzo(k)fluoranthene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
7440-41-7	Beryllium	< 1.2E-05	1.18E-8	8.7E-08	3.8E-07	2.2E-07	9.6E-07	2.1E-07	9.4E-07	5.2E-07	2.3E-06	Y	C
7440-43-9	Cadmium	1.1E-03	1.08E-6	8.0E-06	3.5E-05	2.0E-05	8.8E-05	2.0E-05	8.6E-05	4.8E-05	2.1E-04	Y	C
7440-47-3	Chromium	1.4E-03	1.37E-6	1.1E-05	4.5E-05	3.0E-05	1.1E-04	2.5E-05	1.1E-04	6.6E-05	2.7E-04	Y	A
218-01-9	Chrysene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
7440-48-4	Cobalt	8.4E-05	8.24E-8	6.6E-07	2.7E-06	1.8E-06	6.8E-06	1.5E-06	6.6E-06	4.0E-06	1.6E-05	Y	A
53-70-3	Dibenzo(a,h)anthracene	< 1.2E-06	1.18E-9	8.7E-09	3.8E-08	2.2E-08	9.6E-08	2.1E-08	9.4E-08	5.2E-08	2.3E-07	Y	C
106-46-7	Dichlorobenzene	1.2E-03	1.18E-6	9.5E-06	3.8E-05	2.6E-05	9.6E-05	2.1E-05	9.4E-05	5.7E-05	2.3E-04	Y	A
206-44-0	Fluoranthene	3.0E-06	2.94E-9	2.4E-08	9.5E-08	6.5E-08	2.4E-07	5.4E-08	2.4E-07	1.4E-07	5.7E-07	N	
86-73-7	Fluorene	2.8E-06	2.75E-9	2.2E-08	8.9E-08	6.1E-08	2.3E-07	5.0E-08	2.2E-07	1.3E-07	5.3E-07	N	
50-00-0	Formaldehyde	7.5E-02	7.35E-5	5.5E-04	2.4E-03	1.4E-03	6.0E-03	1.3E-03	5.9E-03	3.3E-03	1.4E-02	Y	C
110-54-3	Hexane	1.8E+00	1.76E-3	1.4E-02	5.7E-02	3.9E-02	1.4E-01	3.2E-02	1.4E-01	8.5E-02	3.4E-01	Y	A
193-39-5	Indeno(1,2,3-cd)pyrene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
7439-96-5	Manganese	3.8E-04	3.73E-7	3.0E-06	1.2E-05	8.2E-06	3.1E-05	6.8E-06	3.0E-05	1.8E-05	7.2E-05	Y	A
7439-97-6	Mercury	2.6E-04	2.55E-7	2.1E-06	8.3E-06	5.6E-06	2.1E-05	4.7E-06	2.0E-05	1.2E-05	5.0E-05	N	
91-20-3	Naphthalene	6.1E-04	5.98E-7	4.8E-06	1.9E-05	1.3E-05	4.9E-05	1.1E-05	4.8E-05	2.9E-05	1.2E-04	Y	A
7440-02-0	Nickel	2.1E-03	2.06E-6	1.5E-05	6.7E-05	3.9E-05	1.7E-04	3.8E-05	1.6E-04	9.1E-05	4.0E-04	Y	C
85-01-8	Phenanthrene	1.7E-05	1.67E-8	1.3E-07	5.4E-07	3.7E-07	1.4E-06	3.0E-07	1.3E-06	8.1E-07	3.2E-06	N	
129-00-0	Pyrene	5.0E-06	4.90E-9	4.0E-08	1.6E-07	1.1E-07	4.0E-07	8.9E-08	3.9E-07	2.4E-07	9.5E-07	N	
7782-49-2	Selenium	< 2.4E-05	2.35E-8	1.9E-07	7.6E-07	5.2E-07	1.9E-06	4.3E-07	1.9E-06	1.1E-06	4.6E-06	Y	A
108-88-3	Toluene	3.4E-03	3.33E-6	2.7E-05	1.1E-04	7.3E-05	2.7E-04	6.1E-05	2.7E-04	1.6E-04	6.5E-04	Y	A
109-66-0	Pentane	2.6E+00	2.55E-3	2.1E-02	8.3E-02	5.6E-02	2.1E-01	4.7E-02	2.0E-01	1.2E-01	5.0E-01	Y	A
7440-39-3	Barium	4.4E-03	4.31E-6	3.5E-05	1.4E-04	9.5E-05	3.5E-04	7.9E-05	3.4E-04	2.1E-04	8.4E-04	Y	A
7440-50-8	Copper	8.5E-04	8.33E-7	6.7E-06	2.7E-05	1.8E-05	6.8E-05	1.5E-05	6.7E-05	4.0E-05	1.6E-04	Y	A
7439-98-7	Molybdenum	1.1E-03	1.08E-6	8.7E-06	3.5E-05	2.4E-05	8.8E-05	2.0E-05	8.6E-05	5.2E-05	2.1E-04	Y	A
7440-62-2	Vanadium	2.3E-03	2.25E-6	1.8E-05	7.3E-05	5.0E-05	1.8E-04	4.1E-05	1.8E-04	1.1E-04	4.4E-04	Y	A
7440-66-6	Zinc	2.9E-02	2.84E-5	2.3E-04	9.2E-04	6.3E-04	2.3E-03	5.2E-04	2.3E-03	1.4E-03	5.5E-03	Y	A
Total				3.6E-02	1.4E-01	9.8E-02	3.6E-01	8.1E-02	3.5E-01	2.1E-01	8.6E-01		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *AP-42, Table 1.4-3 & 1.4-4 (7/98) Natural Gas Combustion* 1.0766 1.0766

(3) *Natural Gas Higher Heating Value* 1,020 *MMBtu/MMscf* chk

DIESEL COMBUSTION

Source Data

Source ID	Description	Power Rating kW	Power Rating hp	Operation hr/day	Operation hr/yr	Fuel Consumption[1] & [2] MMBtu/day	Fuel Consumption[1] & [2] MMBtu/yr
EDG1	Camp Emergency Generator	1,000	1,341	1	100	9.39	938.70
EDG2	Plant Emergency Generator #1	1,000	1,341	1	100	9.39	938.7
EDG3	Plant Emergency Generator #2	1,000	1,341	1	100	9.39	938.7
EDFP	Mill Fire Pump	200	268	1	100	1.88	187.7
Total						30.0	3,003.8

(1) *Based on brake specific fuel consumption for diesel generators* 7,000 *Btu/hp-hr* *AP-42 Tbl 3.3-1*

(2) *Heat Content of* 0.137 *MMBtu/gal* *1E+6 Btu/MMBtu* *1.341 hp/kW*

HAP/TAP Emission Factors and Emissions

lb/hr ton/yr

	Pollutant	Factor (lb/MMBtu) ≤600 hp[2]	Factor (lb/MMBtu) >600hp[3]	Emissions (≤600 hp) lb/hr	Emissions (≤600 hp) ton/yr	Emissions (>600 hp) lb/hr	Emissions (>600 hp) ton/yr	Total Emissions[1] lb/hr	Total Emissions[1] ton/yr	TAP	A/C
106-99-0	1,3-Butadiene	< 3.9E-05		8.4E-07	3.7E-06	0.0E+00	0.0E+00	8.4E-07	3.7E-06	Y	C
83-32-9	Acenaphthene	< 1.4E-06	4.7E-06	1.1E-07	1.3E-07	5.5E-06	6.6E-06	5.6E-06	6.7E-06	N	
208-96-8	Acenaphthylene	< 5.1E-06	9.2E-06	4.0E-07	4.7E-07	1.1E-05	1.3E-05	1.1E-05	1.3E-05	N	
75-07-0	Acetaldehyde	7.7E-04	2.5E-05	1.6E-05	7.2E-05	8.1E-06	3.5E-05	2.5E-05	1.1E-04	Y	C
107-02-8	Acrolein	< 9.3E-05	7.9E-06	7.2E-06	8.7E-06	9.2E-06	1.1E-05	1.6E-05	2.0E-05	Y	A
120-12-7	Anthracene	1.9E-06	1.2E-06	1.5E-07	1.8E-07	1.4E-06	1.7E-06	1.6E-06	1.9E-06	N	
56-55-3	Benz(a)anthracene	1.7E-06	6.2E-07	3.6E-08	1.6E-07	2.0E-07	8.8E-07	2.4E-07	1.0E-06	Y	C
71-43-2	Benzene	9.3E-04	7.8E-04	2.0E-05	8.8E-05	2.5E-04	1.1E-03	2.7E-04	1.2E-03	Y	C
50-32-8	Benzo(a)pyrene	< 1.9E-07	< 2.6E-07	4.0E-09	1.8E-08	8.3E-08	3.6E-07	8.7E-08	3.8E-07	Y	C
205-99-2	Benzo(b)fluoranthene	< 9.9E-08	< 1.1E-06	2.1E-09	9.3E-09	3.6E-07	1.6E-06	3.6E-07	1.6E-06	Y	C
191-24-2	Benzo(g,h,i)perylene	< 4.9E-07	< 5.6E-07	3.8E-08	4.6E-08	6.5E-07	7.8E-07	6.9E-07	8.3E-07	N	
207-08-9	Benzo(k)fluoranthene	< 1.6E-07	< 2.2E-07	3.3E-09	1.5E-08	7.0E-08	3.1E-07	7.3E-08	3.2E-07	Y	C
218-01-9	Chrysene	3.5E-07	1.5E-06	7.6E-09	3.3E-08	4.9E-07	2.2E-06	5.0E-07	2.2E-06	Y	C
53-70-3	Dibenzo(a,h)anthracene	< 5.8E-07	< 3.5E-07	1.2E-08	5.5E-08	1.1E-07	4.9E-07	1.2E-07	5.4E-07	Y	C
206-44-0	Fluoranthene	7.6E-06	4.0E-06	6.0E-07	7.1E-07	4.7E-06	5.7E-06	5.3E-06	6.4E-06	N	
86-73-7	Fluorene	2.9E-05	1.3E-05	2.3E-06	2.7E-06	1.5E-05	1.8E-05	1.7E-05	2.1E-05	N	
50-00-0	Formaldehyde	1.2E-03	7.9E-05	2.5E-05	1.1E-04	2.5E-05	1.1E-04	5.1E-05	2.2E-04	Y	C
193-39-5	Indeno(1,2,3-cd)pyrene	< 3.8E-07	< 4.1E-07	8.0E-09	3.5E-08	1.3E-07	5.8E-07	1.4E-07	6.2E-07	Y	C
91-20-3	Naphthalene	8.5E-05	1.3E-04	6.6E-06	8.0E-06	1.5E-04	1.8E-04	1.6E-04	1.9E-04	Y	A
85-01-8	Phenanthrene	2.9E-05	4.1E-05	2.3E-06	2.8E-06	4.8E-05	5.7E-05	5.0E-05	6.0E-05	N	
129-00-0	Pyrene	4.8E-06	3.7E-06	3.7E-07	4.5E-07	4.4E-06	5.2E-06	4.7E-06	5.7E-06	N	
108-88-3	Toluene	4.1E-04	2.8E-04	3.2E-05	3.8E-05	3.3E-04	4.0E-04	3.6E-04	4.3E-04	Y	A
1330-20-7	Xylene	2.9E-04	1.9E-04	2.2E-05	2.7E-05	2.3E-04	2.7E-04	2.5E-04	3.0E-04	Y	A
Total				1.4E-04	3.6E-04	1.1E-03	2.2E-03	1.2E-03	2.6E-03		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *AP-42, Tab. 3.3-2, 10/96, diesel engines (≤ 600 hp)* chk chk

(3) *AP-42, Tabs. 3.4-3 & 3.4-4, 10/96, large diesel engines (> 600 hp)*

ORE PROCESSING

Source Data

Source ID	Description	PM Emissions lb/day	PM Emissions ton/yr
OC1	Loader Transfer of Ore to Grizzly	3.500	0.639
OC2	Grizzly to Apron Feeder	3.500	0.639
OC3	Apron Feeder to Dribble Conveyor	3.500	0.639
OC4	Apron Feeder to Vibrating Grizzly	3.500	0.639
OC5	Dribble Conveyor to Vibrating Grizzly	3.500	0.639
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	3.500	0.639
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	30.000	5.475
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	3.500	0.639
OC9	Stockpile Transfers to Reclaim Conveyors	16.560	3.022
OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	16.560	3.022
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	16.560	3.022
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge C	33.120	6.044
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	3.864	0.705
Total		141.164	25.762

HAP/TAP Emission Factors and Emissions

CAS No.	Pollutant	Concentration ppm[2]	Emissions[1] lb/hr	Emissions[1] ton/yr	TAP	A/C
7440-38-2	Arsenic	667	3.9E-03	1.7E-02	Y	C
7440-41-7	Beryllium	3.2	1.9E-05	8.2E-05	Y	C
7440-43-9	Cadmium	0.50	2.9E-06	1.3E-05	Y	C
7440-48-4	Cobalt	4	2.4E-05	1.0E-04	Y	A
7440-47-3	Chromium	9	5.3E-05	2.3E-04	Y	A
7439-97-6	Mercury [3]	0.96	5.6E-06	2.5E-05	N	
7439-96-5	Manganese	299	1.8E-03	7.7E-03	Y	A
7440-02-0	Nickel	2	1.2E-05	5.2E-05	Y	C
7439-92-1	Lead	8	4.7E-05	2.1E-04	N	
7440-36-0	Antimony	23	1.4E-04	5.9E-04	Y	A
7723-14-0	Phosphorus	650	3.8E-03	1.7E-02	Y	A
7782-49-2	Selenium [4]	0.40	2.4E-06	1.0E-05	Y	A
7440-22-4	Silver	0.50	2.9E-06	1.3E-05	Y	A
7429-90-5	Aluminum	71,000	4.2E-01	1.8E+00	Y	A
7440-39-3	Barium	800	4.7E-03	2.1E-02	Y	A
1317-65-3	Calcium Carbonate	14,000	8.2E-02	3.6E-01	Y	A
7440-50-8	Copper	5	2.9E-05	1.3E-04	Y	A
7439-89-6	Iron [4]	18,200	1.1E-01	4.7E-01	Y	A
7439-98-7	Molybdenum	1	5.9E-06	2.6E-05	Y	A
7440-28-0	Thallium	10	5.9E-05	2.6E-04	Y	A
7440-61-1	Uranium	10	5.9E-05	2.6E-04	Y	A
7440-62-2	Vanadium	28	1.6E-04	7.2E-04	Y	A
7440-33-7	Tungsten	10	5.9E-05	2.6E-04	Y	A
7440-66-6	Zinc	35	2.1E-04	9.0E-04	Y	A
Total			6.2E-01	2.7E+00		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *(Midas Gold 2017c) Median concentration of 55,000 SGP samples.*

[3] *(Midas Gold 2018e) Median ore concentration of 151,000 SGP samples; resource block model.*

[4] *(Midas Gold 2020) Median concentration of 56,000 SGP samples for Fe and 1,500 SGP samples for Se.*

1E+6 parts/ppm

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis	
	PROJECT NO: 335-20-3	PAGE: 7	OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021	

ORE CONCETRATION AND REFINING

Source Data

Source ID	Description	Subpart 7E Allowable Limit lb/yr[1]	Oper. hr/yr	% of Subpart 7E for Controlled Systems %		Controlled Hg Emissions lb/hr	ton/yr	lb/yr
AC	Autoclave	213.4	8,760	[2]		0.000023	0.00010	0.20
EW,MR,MF,CKD	Refinery Sources (C. Kiln, EW, Retort, Furn	16.8		20%	[3]	0.000384	0.00168	3.36
7439-97-6 Mercury	Total	230.2				0.000407	0.00178	3.56

[1] *Subpart 7E Limit - Ore Pretreatment Processes (CFR 2018b)*

$$\frac{84\ lb}{MMton} \times \frac{2{,}540{,}400\ ton}{yr} \times \frac{MMton}{1.0E+6\ ton} = \frac{213.4\ lb}{yr}$$

[1] *Subpart 7E Limit - Carbon Processes with Mercury Retorts*

$$\frac{0.8\ lb}{ton} \times \frac{21\ ton}{yr} = \frac{16.8\ lb}{yr}$$

[2] *Controlled SysCAD modeled emissions from Autoclave:* 0.0105 g/hr 2.3E-05 lb/hr 0.20 lb/yr (M3 2019)

[3] *Based on similar source (but with much higher ore Hg content) Hg reporting levels provided below:*

Goldstrike Refinery (2015 & 2016 Hg Reports) (NDEP 2015a) (NDEP 2016)

$$\frac{28.79\ lb}{yr} \times \frac{yr}{251.00\ ton} = \frac{0.11\ lb}{MMton} \times \frac{ton}{0.8\ lb} = 14.3\%$$

Twin Creeks Refinery (2015 & 2016 Hg Reports) (NDEP 2015a) (NDEP 2016)

$$\frac{31.27\ lb}{yr} \times \frac{yr}{142.77\ ton} = \frac{0.22\ lb}{MMton} \times \frac{ton}{0.8\ lb} = 27.4\%$$

HAP/TAP Emission Factors and Emission

AC_pph AC_tpy Refin_pph Refin_tpy lb/hr ton/yr

CAS No.	Pollutant	Emission Factor[1]	Autoclave lb/hr	Autoclave ton/yr	Refinery lb/hr	Refinery ton/yr	Total Emissions lb/hr	Total Emissions ton/yr	TAP	A/C
7440-38-2	Arsenic	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	C
7440-41-7	Beryllium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	C
7440-43-9	Cadmium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	C
7440-48-4	Cobalt	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-47-3	Chromium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7439-97-6	Mercury	see above	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	N	
7439-96-5	Manganese	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-02-0	Nickel	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	C
7439-92-1	Lead	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	N	
7440-36-0	Antimony	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7723-14-0	Phosphorus	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7782-49-2	Selenium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-22-4	Silver	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7429-90-5	Aluminum	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-39-3	Barium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
1317-65-3	Calcium Carbonate	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-50-8	Copper	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7439-89-6	Iron	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7439-98-7	Molybdenum	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-28-0	Thallium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-61-1	Uranium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-62-2	Vanadium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-33-7	Tungsten	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-66-6	Zinc	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
Total			5.5E-04	2.4E-03	9.2E-03	4.0E-02	9.8E-03	4.3E-02		

[1] *Hg is the most difficult metal to control due to it existing in both particulate and gaseous form. Therefore, all other metals are conservatively estimated to be equal to or less than the Hg emissions.*

0.0525 0.0525 chk

7664-93-9	Sulfuric Acid	Autoclave	2.03	8.89			2.03	8.89
7783-06-4	Hydrogen Sulfid	Autoclave	0.90	3.94			0.90	3.94
592-01-8	Cyanide	Point Sources - 5 EW Cells			0.0012	0.0053	0.00	0.01
Total			2.93	12.84	0.01	0.05	2.94	12.88

ORE CONCETRATION AND REFINING - CONTINUED

Source Data

Source ID	Description	Throughput ton/day	Throughput ton/yr	Operation hr/day	Operation hr/yr
AC	Autoclave	6,960	2,540,400	24	8,760

Autoclave HAP/TAP Emission Factors and Emission lb/hr ton/yr

CAS No.	Pollutant	Emission Factor		Emissions[1] lb/hr	Emissions[1] ton/yr
7664-93-9	Sulfuric Acid	0.007	lb/ton[2]	2.03	8.89
7783-06-4	Hydrogen Sulfide	0.9	lb/hr[3]	0.90	3.94

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *H2SO4 is based on Acidic Autoclave test data (APT 2010)*

[3] *H2S is based on Acidic Autoclave test data (APT 2013)*

LEACHING OPERATION

Cyanide (HCN) Source Data, Emission Factors, and Emissions

Source ID	Description	Dia. ft[1]	pH[1]	Free CN- g/m3[1]	T C[1]	pKa	a0	H	kG[2] m/s	Fa*Fw	g/s	lb/hr	ton/yr
												lb/hr	ton/yr
TSF	***Fugitive Sources***												
TSF	Tailings Maint. Pond	76	7.75	1	3.74	9.803	0.9912	0.0025	1.89E-05	0.641	1.27E-05	0.0001	0.0004
MILLTA	CN Detox Tank 1	40	8.5	25	25	9.250	0.8490	0.0055	0.000311	0.688	0.002891	0.0229	0.101
MILLTA	CN Detox Tank 2	40	8.5	25	25	9.250	0.8490	0.0055	0.000311	0.688	0.002891	0.0229	0.101
MILLTA	CIP Leach Tank 1	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	0.0114	0.050
MILLTA	CIP Leach Tank 2	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	0.0114	0.050
MILLTA	CIP Leach Tank 3	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	0.0114	0.050
MILLTA	CIP Leach Tank 4	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	0.0114	0.050
MILLTA	CIL Tank 1	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIL Tank 2	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIL Tank 3	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIL Tank 4	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIL Tank 5	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIL Tank 6	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIP Tank 1	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA	CIP Tank 2	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA	CIP Tank 3	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA	CIP Tank 4	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA	CIP Tank 5	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA	CIP Tank 6	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
		Acres[1]											
TSF	Tails, Aqueous Surface	110.222	7.75	1	3.74	9.803	0.9912	0.0025	1.89E-05	0.421	0.008845	0.0702	0.307
TSF	Tails, Wet Sediment	110.222							5.31E-08	0.421	0.009961	0.0791	0.346
TSF	Tails, Dry Sediment	110.222							2.33E-08	1	0.010375	0.0823	0.361
		330.666											
592-01-8	Cyanide Fugitive Sources - Subtotal											0.4527	1.983
75-15-0	Carbon Disulfide											0.01446	0.06332
	Point Sources												
EW	EW Cells	[3]										0.0006	0.003
EW	Preg/Barren Tanks	[3]										0.0006	0.003
592-01-8	Cyanide Point Sources - Subtotal											0.0012	0.0053
	Total											0.454	1.988

[1] *(Midas Gold 2016)(M3 2017c)(M3 2017d)*

[2] *The emission factors and caculation methodology are from the EPA directed HCN study: (Card, T. 2009)(EPA 2009)(Schmidt 2010)*

[3] *(APT 2009)*

Carbon Disulfide Emissions from Xanthate Decomposition

CAS No.	Pollutant	Xanthate[1] ton/yr	Molar Decomp.[2]	CS_2 MW Ratio	Temperature Adj. Factor[3]	Emissions lb/hr	Emissions ton/yr
						lb/hr	ton/yr
75-15-0	Carbon Disulfide	1,700	0.99%	0.376	1%	0.0145	0.063

	MW	
Xanthate (PAX)	202.37	$C6H11KOS_2$
Carbon disulfide	76.139	CS_2

[1] *(Midas Gold 2016) p. 12-11*

[2] *(Air Sciences 2020) molar decomposition of xanthate in solution to CS2 gas*

[3] *(Air Sciences 2020) based on the comparison of CS2 generation at 25C and 70C*

Conversions

8,760	hr/yr	453.5929	g/lb	Wind adjustment factor Fw	1
2,000	lb/ton	3.28084	ft/m		
4,046.86	m2/acre	3,600	s/hr		

LIME PRODUCTION

Source Data

Source ID	Description	Throughput ton/day	Throughput ton/yr	PM Emissions lb/day	PM Emissions ton/yr
LS1	Limestone transfer to Primary Crusher Hopper			3.39	0.48
LS2	Primary Crushing and Associated Transfers In and Out			6.10	0.86
LS3	Primary Screening and Associated Transfers In and Out			28.25	3.97
LS4	Secondary Crushing and Associated Transfers In and Out			6.10	0.86
LS5	Secondary Screening and Associated Transfers In and Out			28.25	3.97
LS6	Limestone transfer to Ball Mill Feed Bin			3.39	0.48
LS7	Limestone transfer to Ball Mill Feed Conveyor			3.39	0.48
LS8	Ball Mill Feed transfer to Ball Mill			3.39	0.48
LSBM	Limestone Ball Mill			45.65	6.42
LS9	Limestone transfer to Kiln Feed Bin			0.80	0.12
LS10	Limestone transfer to Lime Kiln Feed Conveyor			0.80	0.12
LS11	Fines Screening and Associated Transfers In and Out			6.68	1.03
Subtotal LS1-11				136.18	19.28
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln			0.80	0.12
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	169	52,377	21.97	3.40
Subtotal LS12,LK				22.77	3.53
Total				158.95	22.80

HAP/TAP Emission Factors and Emissions

LS_pph LS_tpy LS12_pph LS12_tpy LK_pph LK_tpy lb/hr ton/yr

CAS No.	Pollutant	Concentration ppm[2]	LS1-11,LSBM lb/hr	LS1-11,LSBM ton/yr	LS12 lb/hr	LS12 ton/yr	Lime Kiln lb/hr	Lime Kiln ton/yr	Emissions[1] lb/hr	Emissions[1] ton/yr	TAP	A/C
7440-38-2	Arsenic	23	1.01E-04	4.43E-04	6.51E-07	2.85E-06	1.79E-05	7.83E-05	1.20E-04	5.24E-04	Y	C
7440-41-7	Beryllium	0.8	3.52E-06	1.54E-05	2.27E-08	9.92E-08	6.22E-07	2.72E-06	4.17E-06	1.82E-05	Y	C
7440-43-9	Cadmium	0.25	1.10E-06	4.82E-06	7.08E-09	3.10E-08	1.94E-07	8.51E-07	1.30E-06	5.70E-06	Y	C
7440-48-4	Cobalt	4	2.27E-05	7.71E-05	1.34E-07	4.96E-07	3.66E-06	1.36E-05	2.65E-05	9.12E-05	Y	A
7440-47-3	Chromium	15	8.51E-05	2.89E-04	5.01E-07	1.86E-06	1.37E-05	5.11E-05	9.93E-05	3.42E-04	Y	A
7439-97-6	Mercury [3]	0.02	1.13E-07	3.86E-07	6.68E-10	2.48E-09	2.82E-04	1.05E-03	2.82E-04	1.05E-03	N	
7439-96-5	Manganese	236.5	1.34E-03	4.56E-03	7.89E-06	2.93E-05	2.16E-04	8.05E-04	1.57E-03	5.39E-03	Y	A
7440-02-0	Nickel	5	2.20E-05	9.64E-05	1.42E-07	6.20E-07	3.89E-06	1.70E-05	2.60E-05	1.14E-04	Y	C
7439-92-1	Lead	3	1.70E-05	5.78E-05	1.00E-07	3.72E-07	2.75E-06	1.02E-05	1.99E-05	6.84E-05	N	
7440-36-0	Antimony	2.5	1.42E-05	4.82E-05	8.34E-08	3.10E-07	2.29E-06	8.51E-06	1.66E-05	5.70E-05	Y	A
7723-14-0	Phosphorus	130	7.38E-04	2.51E-03	4.34E-06	1.61E-05	1.19E-04	4.43E-04	8.61E-04	2.96E-03	Y	A
7440-22-4	Silver	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	Y	A
7429-90-5	Aluminum	22600	1.28E-01	4.36E-01	7.54E-04	2.80E-03	2.07E-02	7.69E-02	1.50E-01	5.15E-01	Y	A
7440-39-3	Barium	145	8.23E-04	2.79E-03	4.84E-06	1.80E-05	1.33E-04	4.94E-04	9.60E-04	3.31E-03	Y	A
1317-65-3	Calcium Carbonate	274500	1.56E+00	5.29E+00	9.16E-03	3.40E-02	2.51E-01	9.35E-01	1.82E+00	6.26E+00	Y	A
7440-50-8	Copper	5	2.84E-05	9.64E-05	1.67E-07	6.20E-07	4.58E-06	1.70E-05	3.31E-05	1.14E-04	Y	A
7439-89-6	Iron	10350	5.87E-02	1.99E-01	3.45E-04	1.28E-03	9.47E-03	3.52E-02	6.85E-02	2.36E-01	Y	A
7439-98-7	Molybdenum	0.5	2.84E-06	9.64E-06	1.67E-08	6.20E-08	4.58E-07	1.70E-06	3.31E-06	1.14E-05	Y	A
7440-28-0	Thallium	5	2.84E-05	9.64E-05	1.67E-07	6.20E-07	4.58E-06	1.70E-05	3.31E-05	1.14E-04	Y	A
7440-61-1	Uranium	5	2.84E-05	9.64E-05	1.67E-07	6.20E-07	4.58E-06	1.70E-05	3.31E-05	1.14E-04	Y	A
7440-62-2	Vanadium	15.5	8.79E-05	2.99E-04	5.17E-07	1.92E-06	1.42E-05	5.28E-05	1.03E-04	3.53E-04	Y	A
7440-33-7	Tungsten	5	2.84E-05	9.64E-05	1.67E-07	6.20E-07	4.58E-06	1.70E-05	3.31E-05	1.14E-04	Y	A
7440-66-6	Zinc	18	1.02E-04	3.47E-04	6.01E-07	2.23E-06	1.65E-05	6.13E-05	1.19E-04	4.10E-04	Y	A
Subtotal			1.75E+00	5.94E+00	1.03E-02	3.82E-02	2.82E-01	1.05E+00	2.04E+00	7.03E+00	9.0667	9.0667
7647-01-0	Hydrogen Chloride	0.14 lb/ton product[4]					0.99	3.67	0.99	3.67		chk

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *(M3 2018) Median concentrations of SGP limestone material. Metals with medians below the detection limit (DL) are set to 1/2DL.*

[3] *Hg emissions from the Lime Kiln are conservatively estimated assuming 100% volatilization of all Hg in the limestone*

[4] *(EPA 1999b)*

1E+6 parts/ppm

LIME PRODUCTION - CONTINUED

Source Data

Source ID	Description	PM Emissions lb/day	PM Emissions ton/yr
LS1L	Mill Lime Silo #1 Loading	0.248	0.002
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	1.200	0.011
MillS2L	Mill Lime Silo #2 Loading	0.248	0.002
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	1.200	0.011
ACS1L	AC Lime Silo #1 Loading	0.990	0.009
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.304	0.042
ACS2L	AC Lime Silo #2 Loading	0.990	0.009
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.304	0.042
ACS3L	AC Lime Silo #3 Loading	0.990	0.009
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.304	0.042
ACS4L	AC Lime Silo #4 Loading	0.495	0.004
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	2.304	0.021
Subtotal - Mill & AC Lime Silos		15.576	0.203
LCR	Lime Mill Crushing and associated transfers In and Out	6.828	1.058
LSL	Pebble Lime Silo Loading via Bucket Elevator	0.149	0.023
LSU	Pebble Lime Silo discharge to Lime Slaker	0.015	0.002
Subtotal - Lime Mfg		6.991	1.083
Total		22.567	1.286

HAP/TAP Emission Factors and Emissions

CAS No.	Pollutant	Concentration ppm[2]	Mill and AC lb/hr	Mill and AC ton/yr	Lime Mfg lb/hr	Lime Mfg ton/yr	Emissions[1] lb/hr	Emissions[1] ton/yr	TAP	A/C
7440-38-2	Arsenic	23	1.06E-06	4.66E-06	5.69E-06	2.49E-05	6.75E-06	2.96E-05	Y	C
7440-41-7	Beryllium	0.8	3.70E-08	1.62E-07	1.98E-07	8.67E-07	2.35E-07	1.03E-06	Y	C
7440-43-9	Cadmium	0.25	1.16E-08	5.07E-08	6.18E-08	2.71E-07	7.34E-08	3.22E-07	Y	C
7440-48-4	Cobalt	4	2.60E-06	8.11E-07	1.17E-06	4.33E-06	3.76E-06	5.14E-06	Y	A
7440-47-3	Chromium	15	9.74E-06	3.04E-06	4.37E-06	1.63E-05	1.41E-05	1.93E-05	Y	A
7439-97-6	Mercury	0.02	1.30E-08	4.05E-09	5.83E-09	2.17E-08	1.88E-08	2.57E-08	N	
7439-96-5	Manganese	236.5	1.53E-04	4.79E-05	6.89E-05	2.56E-04	2.22E-04	3.04E-04	Y	A
7440-02-0	Nickel	5	2.31E-07	1.01E-06	1.24E-06	5.42E-06	1.47E-06	6.43E-06	Y	C
7439-92-1	Lead	3	1.95E-06	6.08E-07	8.74E-07	3.25E-06	2.82E-06	3.86E-06	N	
7440-36-0	Antimony	2.5	1.62E-06	5.07E-07	7.28E-07	2.71E-06	2.35E-06	3.22E-06	Y	A
7723-14-0	Phosphorus	130	8.44E-05	2.63E-05	3.79E-05	1.41E-04	1.22E-04	1.67E-04	Y	A
7440-22-4	Silver	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	Y	A
7429-90-5	Aluminum	22,600	1.47E-02	4.58E-03	6.58E-03	2.45E-02	2.13E-02	2.91E-02	Y	A
7440-39-3	Barium	145	9.41E-05	2.94E-05	4.22E-05	1.57E-04	1.36E-04	1.86E-04	Y	A
1305-78-8	Calcium Oxide	740,000 [3]	4.80E-01	1.50E-01	2.16E-01	8.02E-01	6.96E-01	9.52E-01	Y	A
7440-50-8	Copper	5	3.25E-06	1.01E-06	1.46E-06	5.42E-06	4.70E-06	6.43E-06	Y	A
7439-89-6	Iron	10350	6.72E-03	2.10E-03	3.01E-03	1.12E-02	9.73E-03	1.33E-02	Y	A
7439-98-7	Molybdenum	0.5	3.25E-07	1.01E-07	1.46E-07	5.42E-07	4.70E-07	6.43E-07	Y	A
7440-28-0	Thallium	5	3.25E-06	1.01E-06	1.46E-06	5.42E-06	4.70E-06	6.43E-06	Y	A
7440-61-1	Uranium	5	3.25E-06	1.01E-06	1.46E-06	5.42E-06	4.70E-06	6.43E-06	Y	A
7440-62-2	Vanadium	15.5	1.01E-05	3.14E-06	4.52E-06	1.68E-05	1.46E-05	1.99E-05	Y	A
7440-33-7	Tungsten	5	3.25E-06	1.01E-06	1.46E-06	5.42E-06	4.70E-06	6.43E-06	Y	A
7440-66-6	Zinc	18	1.17E-05	3.65E-06	5.24E-06	1.95E-05	1.69E-05	2.31E-05	Y	A
Total			5.02E-01	1.57E-01	2.25E-01	8.38E-01	7.27E-01	9.95E-01		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *See LIME PRODUCTION, page 10*

[3] *(NLA 2007) 40% to 74% CaO in lime*

1E+6 parts/ppm

AGGREGATE PRODUCTION

Source Data

Source ID	Description	PM Emissions lb/day	PM Emissions ton/yr
PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conve	15.00	2.74
PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conve	15.00	2.74
Total		30.00	5.48

HAP/TAP Emission Factors and Emissions

CAS No.	Pollutant	Concentration ppm[2]	Emissions[1] lb/hr	Emissions[1] ton/yr	TAP	A/C
7440-38-2	Arsenic	23	2.88E-05	1.26E-04	Y	C
7440-41-7	Beryllium	0.8	1.00E-06	4.38E-06	Y	C
7440-43-9	Cadmium	0.25	3.13E-07	1.37E-06	Y	C
7440-48-4	Cobalt	4	5.00E-06	2.19E-05	Y	A
7440-47-3	Chromium	15	1.88E-05	8.21E-05	Y	A
7439-97-6	Mercury	0.02	2.50E-08	1.10E-07	N	
7439-96-5	Manganese	236.5	2.96E-04	1.29E-03	Y	A
7440-02-0	Nickel	5	6.25E-06	2.74E-05	Y	C
7439-92-1	Lead	3	3.75E-06	1.64E-05	N	
7440-36-0	Antimony	2.5	3.13E-06	1.37E-05	Y	A
7723-14-0	Phosphorus	130	1.63E-04	7.12E-04	Y	A
7440-22-4	Silver	0	0.00E+00	0.00E+00	Y	A
7429-90-5	Aluminum	22600	2.83E-02	1.24E-01	Y	A
7440-39-3	Barium	145	1.81E-04	7.94E-04	Y	A
1317-65-3	Calcium Carbonate	274500	3.43E-01	1.50E+00	Y	A
7440-50-8	Copper	5	6.25E-06	2.74E-05	Y	A
7439-89-6	Iron	10350	1.29E-02	5.67E-02	Y	A
7439-98-7	Molybdenum	0.5	6.25E-07	2.74E-06	Y	A
7440-28-0	Thallium	5	6.25E-06	2.74E-05	Y	A
7440-61-1	Uranium	5	6.25E-06	2.74E-05	Y	A
7440-62-2	Vanadium	15.5	1.94E-05	8.49E-05	Y	A
7440-33-7	Tungsten	5	6.25E-06	2.74E-05	Y	A
7440-66-6	Zinc	18	2.25E-05	9.86E-05	Y	A
Total			3.85E-01	1.69E+00		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *See LIME PRODUCTION, page 10*

1E+6 parts/ppm

CONCRETE PRODUCTION

Source Data

TP_unit/day TP_unit/yr

description

Source ID	Description	Throughput ton/day	Throughput ton/yr
CS1L	Cement/Shotcrete Silo #1 Loading	164	60,000
CS1U	Cement/Shotcrete Silo #1 Unloading	164	60,000
CS2L	Cement/Shotcrete Silo #2 Loading	164	60,000
CS2U	Cement/Shotcrete Silo #2 Unloading	164	60,000
CM	Central Mixer Loading	164	60,000
	Subtotal Cement Silo Filling	658	240,000
	Subtotal Central Mix Batching	164	60,000

HAP/TAP Emission Factors and Emissions

CF_pph CF_tpy CM_pph CM_tpy lb/hr ton/yr

CAS No.	HAP/TAP	Silo Fill lb/ton[2]	Central Mixer lb/ton[3]	Cement Silo L/U lb/hr	Cement Silo L/U ton/yr	Central Mix Batching lb/hr	Central Mix Batching ton/yr	Total Emissions[3] lb/hr	Total Emissions[3] ton/yr	TAP	A/C
7440-38-2	Arsenic	4.24E-09	2.96E-07	1.16E-7	5.09E-7	2.03E-6	8.88E-6	2.14E-6	9.39E-6	Y	C
7440-41-7	Beryllium	4.86E-10		1.33E-8	5.83E-8	--	--	1.33E-8	5.83E-8	Y	C
7440-43-9	Cadmium		7.10E-10	--	--	4.86E-9	2.13E-8	4.86E-9	2.13E-8	Y	C
7440-47-3	Chromium	2.90E-08	1.27E-07	7.95E-7	3.48E-6	8.70E-7	3.81E-6	1.66E-6	7.29E-6	Y	A
18540-29-9	Cr (VI)	5.80E-09	2.70E-08	1.59E-7	6.96E-7	1.85E-7	8.11E-7	3.44E-7	1.51E-6	Y	C
7439-92-1	Lead	1.09E-08	3.66E-08	2.99E-7	1.31E-6	2.51E-7	1.10E-6	5.49E-7	2.41E-6	N	
7439-96-5	Manganese	1.17E-07	3.78E-06	3.21E-6	1.40E-5	2.59E-5	1.13E-4	2.91E-5	1.27E-4	Y	A
7440-02-0	Nickel	4.18E-08	2.48E-07	1.15E-6	5.02E-6	1.70E-6	7.44E-6	2.84E-6	1.25E-5	Y	C
7723-14-0	Phosphorus		1.20E-06	--	--	8.22E-6	3.60E-5	8.22E-6	3.60E-5	Y	A
Total				5.73E-6	2.51E-5	3.91E-5	1.71E-4	4.49E-5	1.97E-4		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *AP-42, Table 11.12-8, (06/06) Cement Silo Filing, Controlled.* 20% *Cr (VI), IDEQ email on 11/23/2020* 0.0002 0.0002

(3) *AP-42, Table 11.12-8, (06/06) Central Mix Batching, Controlled.* 21.29% *Cr (VI), IDEQ email on 11/23/2020* chk

Conversions

24 hr/day

CONCRETE PRODUCTION - CONTINUED

Source Data

Source ID	description Description	PM_ppd PM Emissions lb/day	PM_tpy PM Emissions ton/yr
CAL	Aggregate Bin Loading	16.56	1.73
CAU	Aggregate Bin Unloading	16.56	1.73
Total		33.12	3.45

HAP/TAP Emission Factors and Emissions

CAS No.	Pollutant	Concentration ppm[2]	lb/hr Emissions[1]	ton/yr Emissions[1]	TAP	A/C
7440-38-2	Arsenic	23	1.81E-05	7.94E-05	Y	C
7440-41-7	Beryllium	0.8	6.30E-07	2.76E-06	Y	C
7440-43-9	Cadmium	0.25	1.97E-07	8.63E-07	Y	C
7440-48-4	Cobalt	4	5.52E-06	1.38E-05	Y	A
7440-47-3	Chromium	15	2.07E-05	5.18E-05	Y	A
7439-97-6	Mercury	0.02	2.76E-08	6.90E-08	N	
7439-96-5	Manganese	236.5	3.26E-04	8.16E-04	Y	A
7440-02-0	Nickel	5	3.94E-06	1.73E-05	Y	C
7439-92-1	Lead	3	4.14E-06	1.04E-05	N	
7440-36-0	Antimony	2.5	3.45E-06	8.63E-06	Y	A
7723-14-0	Phosphorus	130	1.79E-04	4.49E-04	Y	A
7440-22-4	Silver	0	0.00E+00	0.00E+00	Y	A
7429-90-5	Aluminum	22600	3.12E-02	7.80E-02	Y	A
7440-39-3	Barium	145	2.00E-04	5.00E-04	Y	A
7440-50-8	Copper	5	6.90E-06	1.73E-05	Y	A
7439-89-6	Iron	10350	1.43E-02	3.57E-02	Y	A
7439-98-7	Molybdenum	0.5	6.90E-07	1.73E-06	Y	A
7440-28-0	Thallium	5	6.90E-06	1.73E-05	Y	A
7440-61-1	Uranium	5	6.90E-06	1.73E-05	Y	A
7440-62-2	Vanadium	15.5	2.14E-05	5.35E-05	Y	A
7440-33-7	Tungsten	5	6.90E-06	1.73E-05	Y	A
7440-66-6	Zinc	18	2.48E-05	6.21E-05	Y	A
Total			4.63E-02	1.16E-01		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *See LIME PRODUCTION, page 10*

1E+6 parts/ppm

FUEL STORAGE - GASOLINE

Source Data

	description	VOC_ppd	VOC_tpy
		VOC Emissions	
Source ID	Description	lb/day	ton/yr
TG1	Mine Site Gasoline Tank #1	5.25	0.96
TG2	Mine Site Gasoline Tank #2	5.25	0.96
Total		10.49	1.91

HAP/TAP Emission Factors and Emissions

			lb/hr	ton/yr		
		Concentration	Emissions[1]			
CAS No.	Pollutant	wt. %[2]	lb/hr	ton/yr	TAP	A/C
71-43-2	Benzene	1.608%	7.03E-03	3.08E-02	Y	C
92-52-4	Biphenyl	0.010%	4.37E-05	1.91E-04	Y	A
110-82-7	Cyclohexane	0.240%	1.05E-03	4.60E-03	Y	A
110-54-3	Hexane	7.138%	3.12E-02	1.37E-01	Y	A
91-20-3	Naphthalene	0.444%	1.94E-03	8.50E-03	Y	A
108-95-2	Phenol	0.055%	2.40E-04	1.05E-03	Y	A
108-88-3	Toluene	7.212%	3.15E-02	1.38E-01	Y	A
25551-13-7	Trimethyl benzene	2.500%	1.09E-02	4.79E-02	Y	A
1330-20-7	Xylene	7.170%	3.13E-02	1.37E-01	Y	A
Total			1.15E-01	5.05E-01		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *(EPA 1999a)*

MINING FUGITIVE EMISSIONS

Dust Emissions

Source Data **Model Scenario** **W3** **180,000 T/day Emissions**

Operating schedule 365 day/yr

Clean rock cap (CR >0% [1]

[1] *(Perpetua 2021h) Percent of VMTs on haul roads capped with CR*
Roads outside of the pits and DRSFs are capped with CR

Source ID	Description	PM Emissions lb/day	PM Emissions ton/yr
YPP	Yellow Pine Pit	--	--
HFP	Hangar Flats Pit	--	--
WEP	West End Pit	1,887.91	344.54
BT	Bradley Tailings	--	--
YPPBL	Yellow Pine Pit Blasting	--	--
HFPBL	Hangar Flats Pit Blasting	--	--
WEPBL	West End Pit Blasting	643.03	117.35
BTBL	Bradley Tailings Blasting	--	--
STKP	PC Stockpile	--	--
FDRSF	Fiddle DRSF	--	--
HFDRSF	Hangar Flats DRSF	289.91	52.91
YPDRSF	Yellow Pine DRSF	--	--
WEDRSF	West End DRSF	--	--
HR000	Haul Roads	16,697.74	3,047.34
TSF	Tailing Storage Facility	--	--
ACCRD	Access Roads	38.10	6.95
UGEXP	Scout Portal	0.008	0.002
Total		19,556.71	3,569.10

TSF, ACCRD, UGEXP 38.11 6.95 chk 3569.10

HAP/TAP Emission Factors		ORE	DR	CR	HRD	Borrow	AR
		Concentration					
CAS No.	Pollutant	ppm[1]	ppm[1]	ppm[3]	ppm[4]	ppm[5]	ppm
7440-38-2	Arsenic	667	667	90	667	2.5	667
7440-41-7	Beryllium	3.2	3.2		3.2		3.2
7440-43-9	Cadmium	0.5	0.5		0.5		0.5
7440-48-4	Cobalt	4	4		4		4
7440-47-3	Chromium	9	9		9		9
7439-97-6	Mercury [2]	0.96	0.6		0.6		0.6
7439-96-5	Manganese	299	299		299		299
7440-02-0	Nickel	2	2		2		2
7439-92-1	Lead	8	8		8		8
7440-36-0	Antimony	23	23		23		23
7723-14-0	Phosphorus	650	650		650		650
7782-49-2	Selenium	0.4	0.4		0.4		0.4
7440-22-4	Silver	0.5	0.5		0.5		0.5
7429-90-5	Aluminum	71000	71000		71000		71000
7440-39-3	Barium	800	800		800		800
1317-65-3	Calcium Carbonate	14000	14000		14000		14000
7440-50-8	Copper	5	5		5		5
7439-89-6	Iron	18200	18200		18200		18200
7439-98-7	Molybdenum	1	1		1		1
7440-28-0	Thallium	10	10		10		10
7440-61-1	Uranium	10	10		10		10
7440-62-2	Vanadium	28	28		28		28
7440-33-7	Tungsten	10	10		10		10
7440-66-6	Zinc	35	35		35		35

[1] *(Midas Gold 2017c)* *Median concentration of 55,000 SGP samples.* *1E+6 parts/ppm*

[2] *(Midas Gold 2018e)* *Median ore and development rock (DR) concentrations of 151,000 samples; resource block model.*

[3] *(Perpetua 2021g)* *Median concentration of 265 SGP samples.*

[4] *HRD: haul road - emissions calculated based on 0% of the total VMT occuring on CR*

[5] *(ALS 2018)* *Median concentration of 8 SGP samples.*

DR DR DR DR DR DR DR DR ORE DR DR DR DR HRD DR/AR

MINING FUGITIVE EMISSIONS - CONTINUED **Model Scenario W3** DR **180,000 T/day Emissions**

HAP/TAP Emissions

Hourly [1] YPP_pph HFP_pph WEP_pph BT_pph YPPBL_pph HFPBL_pph WEPBL_pph BTBL_pph STKP_pph FDRSF_pph HFDRSF_pph YPDRSF_pph WEDRSF_pph HR000_pph CCRD, UGE lb/hr

CAS No.	Pollutant	YPP lb/hr	HFP lb/hr	WEP lb/hr	BT lb/hr	YPPBL lb/hr	HFPBL lb/hr	WEPBL lb/hr	BTBL lb/hr	STKP lb/hr	FDRSF lb/hr	HFDRSF lb/hr	YPDRSF lb/hr	WEDRSF lb/hr	HR000 lb/hr	TSF, ACCRD, UGEXP lb/hr	Total lb/hr
7440-38-2	Arsenic	0	0	0.052	0	0	0	0.018	0	0	0	8.1E-3	0	0	0.464	1.1E-3	0.544
7440-41-7	Beryllium	0	0	2.5E-4	0	0	0	8.6E-5	0	0	0	3.9E-5	0	0	2.2E-3	5.1E-6	2.6E-3
7440-43-9	Cadmium	0	0	3.9E-5	0	0	0	1.3E-5	0	0	0	6.0E-6	0	0	3.5E-4	7.9E-7	4.1E-4
7440-48-4	Cobalt	0	0	3.1E-4	0	0	0	1.1E-4	0	0	0	4.8E-5	0	0	2.8E-3	6.4E-6	3.3E-3
7440-47-3	Chromium	0	0	7.1E-4	0	0	0	2.4E-4	0	0	0	1.1E-4	0	0	6.3E-3	1.4E-5	7.3E-3
7439-97-6	Mercury	0	0	4.7E-5	0	0	0	1.6E-5	0	0	0	7.2E-6	0	0	4.2E-4	9.5E-7	4.9E-4
7439-96-5	Manganese	0	0	0.024	0	0	0	8.0E-3	0	0	0	3.6E-3	0	0	0.208	4.7E-4	0.244
7440-02-0	Nickel	0	0	1.6E-4	0	0	0	5.4E-5	0	0	0	2.4E-5	0	0	1.4E-3	3.2E-6	1.6E-3
7439-92-1	Lead	0	0	6.3E-4	0	0	0	2.1E-4	0	0	0	9.7E-5	0	0	5.6E-3	1.3E-5	6.5E-3
7440-36-0	Antimony	0	0	1.8E-3	0	0	0	6.2E-4	0	0	0	2.8E-4	0	0	0.016	3.7E-5	0.019
7723-14-0	Phosphorus	0	0	0.051	0	0	0	0.017	0	0	0	7.9E-3	0	0	0.452	1.0E-3	0.530
7782-49-2	Selenium	0	0	3.1E-5	0	0	0	1.1E-5	0	0	0	4.8E-6	0	0	2.8E-4	6.4E-7	3.3E-4
7440-22-4	Silver	0	0	3.9E-5	0	0	0	1.3E-5	0	0	0	6.0E-6	0	0	3.5E-4	7.9E-7	4.1E-4
7429-90-5	Aluminum	0	0	5.585	0	0	0	1.902	0	0	0	0.858	0	0	49.397	0.113	57.855
7440-39-3	Barium	0	0	0.063	0	0	0	0.021	0	0	0	9.7E-3	0	0	0.557	1.3E-3	0.652
1317-65-3	Calcium Ca	0	0	1.101	0	0	0	0.375	0	0	0	0.169	0	0	9.740	0.022	11.408
7440-50-8	Copper	0	0	3.9E-4	0	0	0	1.3E-4	0	0	0	6.0E-5	0	0	3.5E-3	7.9E-6	4.1E-3
7439-89-6	Iron	0	0	1.432	0	0	0	0.488	0	0	0	0.220	0	0	12.662	0.029	14.831
7439-98-7	Molybdenu	0	0	7.9E-5	0	0	0	2.7E-5	0	0	0	1.2E-5	0	0	7.0E-4	1.6E-6	8.1E-4
7440-28-0	Thallium	0	0	7.9E-4	0	0	0	2.7E-4	0	0	0	1.2E-4	0	0	7.0E-3	1.6E-5	8.1E-3
7440-61-1	Uranium	0	0	7.9E-4	0	0	0	2.7E-4	0	0	0	1.2E-4	0	0	7.0E-3	1.6E-5	8.1E-3
7440-62-2	Vanadium	0	0	2.2E-3	0	0	0	7.5E-4	0	0	0	3.4E-4	0	0	0.019	4.4E-5	0.023
7440-33-7	Tungsten	0	0	7.9E-4	0	0	0	2.7E-4	0	0	0	1.2E-4	0	0	7.0E-3	1.6E-5	8.1E-3
7440-66-6	Zinc	0	0	2.8E-3	0	0	0	9.4E-4	0	0	0	4.2E-4	0	0	0.024	5.6E-5	0.029
Total		0	0	8.320	0	0	0	2.834	0	0	0	1.278	0	0	73.586	0.168	86.185

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.* chk 86.1849 86.1849

DR DR DR DR DR DR DR DR ORE DR DR DR DR HRD DR/AR

MINING FUGITIVE EMISSIONS - CONTINUED **Model Scenario W3** DR **180,000 T/day Emissions**

HAP/TAP Emissions

Annual

		YPP_tpy	HFP_tpy	WEP_tpy	BT_tpy	YPPBL_tpy	HFPBL_tpy	WEPBL_tpy	BTBL_tpy	STKP_tpy	FDRSF_tpy	HFDRSF_tpy	YPDRSF_tpy	WEDRSF_tpy	HR000_tpy	CCRD, UGE	ton/yr
		YPP	HFP	WEP	BT	YPPBL	HFPBL	WEPBL	BTBL	STKP	FDRSF	HFDRSF	YPDRSF	WEDRSF	HR000	TSF, ACCRD, UGEXP	Total
CAS No.	Pollutant	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr
7440-38-2	Arsenic	0	0	0.230	0	0	0	0.078	0	0	0	0.035	0	0	2.033	4.6E-3	2.381
7440-41-7	Beryllium	0	0	1.1E-3	0	0	0	3.8E-4	0	0	0	1.7E-4	0	0	9.8E-3	2.2E-5	0.011
7440-43-9	Cadmium	0	0	1.7E-4	0	0	0	5.9E-5	0	0	0	2.6E-5	0	0	1.5E-3	3.5E-6	1.8E-3
7440-48-4	Cobalt	0	0	1.4E-3	0	0	0	4.7E-4	0	0	0	2.1E-4	0	0	0.012	2.8E-5	0.014
7440-47-3	Chromium	0	0	3.1E-3	0	0	0	1.1E-3	0	0	0	4.8E-4	0	0	0.027	6.3E-5	0.032
7439-97-6	Mercury	0	0	2.1E-4	0	0	0	7.0E-5	0	0	0	3.2E-5	0	0	1.8E-3	4.2E-6	2.1E-3
7439-96-5	Manganese	0	0	0.103	0	0	0	0.035	0	0	0	0.016	0	0	0.911	2.1E-3	1.067
7440-02-0	Nickel	0	0	6.9E-4	0	0	0	2.3E-4	0	0	0	1.1E-4	0	0	6.1E-3	1.4E-5	7.1E-3
7439-92-1	Lead	0	0	2.8E-3	0	0	0	9.4E-4	0	0	0	4.2E-4	0	0	0.024	5.6E-5	0.029
7440-36-0	Antimony	0	0	7.9E-3	0	0	0	2.7E-3	0	0	0	1.2E-3	0	0	0.070	1.6E-4	0.082
7723-14-0	Phosphorus	0	0	0.224	0	0	0	0.076	0	0	0	0.034	0	0	1.981	4.5E-3	2.320
7782-49-2	Selenium	0	0	1.4E-4	0	0	0	4.7E-5	0	0	0	2.1E-5	0	0	1.2E-3	2.8E-6	1.4E-3
7440-22-4	Silver	0	0	1.7E-4	0	0	0	5.9E-5	0	0	0	2.6E-5	0	0	1.5E-3	3.5E-6	1.8E-3
7429-90-5	Aluminum	0	0	24.463	0	0	0	8.332	0	0	0	3.756	0	0	216	0.494	253
7440-39-3	Barium	0	0	0.276	0	0	0	0.094	0	0	0	0.042	0	0	2.438	5.6E-3	2.855
1317-65-3	Calcium Ca	0	0	4.824	0	0	0	1.643	0	0	0	0.741	0	0	42.663	0.097	49.967
7440-50-8	Copper	0	0	1.7E-3	0	0	0	5.9E-4	0	0	0	2.6E-4	0	0	0.015	3.5E-5	0.018
7439-89-6	Iron	0	0	6.271	0	0	0	2.136	0	0	0	0.963	0	0	55.462	0.127	64.958
7439-98-7	Molybdenu	0	0	3.4E-4	0	0	0	1.2E-4	0	0	0	5.3E-5	0	0	3.0E-3	7.0E-6	3.6E-3
7440-28-0	Thallium	0	0	3.4E-3	0	0	0	1.2E-3	0	0	0	5.3E-4	0	0	0.030	7.0E-5	0.036
7440-61-1	Uranium	0	0	3.4E-3	0	0	0	1.2E-3	0	0	0	5.3E-4	0	0	0.030	7.0E-5	0.036
7440-62-2	Vanadium	0	0	9.6E-3	0	0	0	3.3E-3	0	0	0	1.5E-3	0	0	0.085	1.9E-4	0.100
7440-33-7	Tungsten	0	0	3.4E-3	0	0	0	1.2E-3	0	0	0	5.3E-4	0	0	0.030	7.0E-5	0.036
7440-66-6	Zinc	0	0	0.012	0	0	0	4.1E-3	0	0	0	1.9E-3	0	0	0.107	2.4E-4	0.125
Total		0	0	36.441	0	0	0	12.412	0	0	0	5.596	0	0	322	0.736	377
															chk	377.4900	377.4900

MINING FUGITIVE EMISSIONS - CONTINUED

Mercury Evaporative Flux Emissions

Fugitive Mercury Flux and Emissions

			Area		Hg Flux	Emissions[1] lb/hr	ton/yr	lb/yr
CAS No.	Pollutant	Source	m^2	ha	µg/m^2-yr			
		Stockpiles	52,623	5.3	556	7.37E-6	3.2E-5	6.5E-2
		Rock Dumps	2,063,990	206.4	76.2	3.96E-5	1.7E-4	0.35
		Tailings	1,338,158	133.8	2,144	7.22E-4	3.2E-3	6.32
		Pits	1,504,919	150.5	132.3	5.01E-5	2.2E-4	0.44
7439-97-6	Mercury					8.2E-4	3.6E-3	7.17

[1] *Hourly emissions based on:* 8,760 *hours per year of operation*

Fugitive Mercury Emission Factors

	Twin Creeks (TC)		Ore Hg Adjusted	Stibnite	
	Hg Flux [1]	Hg [2]	µg/m^2/yr	Hg Flux [3]	Hg [4]
Source	µg/m^2-yr	µg/g	TC	µg/m^2-yr	µg/g
Stockpiles	5,609	33	556	556	0.96
Rock Dumps	768	3.5	76.2	76.2	0.60
Tailings	21,621	33	2,144	2,144	0.96
Pits	1,334	9.5	132	132.3	0.60

[1] *(Eckley 2010)* *Table 1: Hg flux µg/m^2-yr*

[2] *(Eckley 2010)* *Table 1: Average Hg flux mg/g: " Stockpiles - high-grade stockpiles, Rock Dumps - waste rock dumps, Tailings - high-grade stockpiles as a surrogate; Pits - pit"*

[3] *(Eckley 2010)* *Figure 2: log(y) = m*log(x) + b*

y = Hg Flux (ng/m^2-d)
x = material Hg concentration (µg/g)]

Slope =	*Solar*	*TC*
	Low	*0.59*
	Medium	*0.6*
	High	*0.77*
	Average	*0.65*

[4] *(Midas Gold 2018e)*

Sample Calculation: m = log (y1/y2) / log(x1/x2)

m=	0.65	unitless
y1=	5,609	µg/m^2-yr
x1=	33	µg/m^2-yr
x2=	0.96	µg/m^2-yr
log(x1/x2)=	1.536243	unitless
log(y1/y2)=	1.003679	unitless
y1/y2=	10.08506	unitless
y2=	556.2	µg/m^2-yr

Conversions

2,000	lb/ton
10,000	m2/ha
453.593	g/lb

TABLE A-W3. HAP/TAP Emissions and Exemptions

180,000 T/day Emissions						MINING										LEACHING	
chk						*Mining*	*Model Scenario W3*									*CN Leach/PAX*	
						YPP,HFP,WEP,BT	YPPBL,HFPBL,WEPBL,BTBL		HR000		STKP, FDRSF, HFDRSF, YPDRSF, WEDRSF		TSF,ACCRD,UGEXP				
CAS	HAP/TAP	HAP	TAP			Pits		Blasting		Haul Roads		Stockpiles and DRFS		Tails, Access Road, Exploration		CN Leach and PAX	
	NSPS or NESHAP HAP/TAP -->	*Y*															
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				A/C	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
106-99-0	1,3-Butadiene	Y	Y	Y	C				0	0	0		0				
91-57-6	2-Methylnaphthalene	Y	N	n/a								0					
56-49-5	3-Methylchloranthrene	Y	Y	Y	C												
57-97-6	7,12-Dimethylbenz(a)anthracene	Y	N	n/a													
83-32-9	Acenaphthene	Y	N	n/a													
208-96-8	Acenaphthylene	Y	N	n/a													
75-07-0	Acetaldehyde	Y	Y	Y	C												
107-02-8	Acrolein	Y	Y	Y	A												
120-12-7	Anthracene	Y	N	n/a													
7440-36-0	Antimony	Y	Y	Y	A	1.8E-3	7.9E-3	6.2E-4	2.7E-3	0.016	0.070	2.8E-4	1.2E-3	3.7E-5	1.6E-4		
7440-38-2	Arsenic	Y	Y	Y	C	0.052	0.230	0.018	0.078	0.464	2.033	8.1E-3	0.035	1.1E-3	4.6E-3		
71-43-2	Benzene	Y	Y	Y	C												
50-32-8	Benzo(a)pyrene	Y	Y	Y	C												
56-55-3	Benz(a)anthracene	Y	Y	Y	C												
205-99-2	Benzo(b)fluoranthene	Y	Y	Y	C												
207-08-9	Benzo(k)fluoranthene	Y	Y	Y	C												
218-01-9	Chrysene	Y	Y	Y	C												
53-70-3	Dibenzo(a,h)anthracene	Y	Y	Y	C												
193-39-5	Indeno(1,2,3-cd)pyrene	Y	Y	Y	C												
191-24-2	Benzo(g,h,i)perylene	Y	N	n/a													
7440-41-7	Beryllium	Y	Y	Y	C	2.5E-4	1.1E-3	8.6E-5	3.8E-4	2.2E-3	9.8E-3	3.9E-5	1.7E-4	5.1E-6	2.2E-5		
92-52-4	Biphenyl	Y	Y	Y	A												
7440-43-9	Cadmium	Y	Y	Y	C	3.9E-5	1.7E-4	1.3E-5	5.9E-5	3.5E-4	1.5E-3	6.0E-6	2.6E-5	7.9E-7	3.5E-6		
75-15-0	Carbon Disulfide	Y	Y	Y	A											0.014	0.063
7440-47-3	Chromium	Y	Y	Y	A	7.1E-4	3.1E-3	2.4E-4	1.1E-3	6.3E-3	0.027	1.1E-4	4.8E-4	1.4E-5	6.3E-5		
18540-29-9	Cr (VI)	Y	Y	Y	C												
7440-48-4	Cobalt	Y	Y	Y	A	3.1E-4	1.4E-3	1.1E-4	4.7E-4	2.8E-3	0.012	4.8E-5	2.1E-4	6.4E-6	2.8E-5		
592-01-8	Cyanide	Y	Y	Y	A											0.453	1.983
106-46-7	Dichlorobenzene	Y	Y	Y	A												
206-44-0	Fluoranthene	Y	N	n/a													
86-73-7	Fluorene	Y	N	n/a													
50-00-0	Formaldehyde	Y	Y	Y	C												
110-54-3	Hexane	Y	Y	Y	A												
7647-01-0	Hydrogen Chloride	Y	Y	Y	A												
7439-92-1	Lead	Y	N	n/a		6.3E-4	2.8E-3	2.1E-4	9.4E-4	5.6E-3	0.024	9.7E-5	4.2E-4	1.3E-5	5.6E-5		
7439-96-5	Manganese	Y	Y	Y	A	0.024	0.103	8.0E-3	0.035	0.208	0.911	3.6E-3	0.016	4.7E-4	2.1E-3		
7439-97-6	Mercury	Y	N	n/a		9.7E-5	4.3E-4	1.6E-5	7.0E-5	4.2E-4	1.8E-3	5.4E-5	2.4E-4	7.2E-4	3.2E-3		
91-20-3	Naphthalene	Y	Y	Y	A												
7440-02-0	Nickel	Y	Y	Y	C	1.6E-4	6.9E-4	5.4E-5	2.3E-4	1.4E-3	6.1E-3	2.4E-5	1.1E-4	3.2E-6	1.4E-5		
85-01-8	Phenanthrene	Y	N	n/a													
108-95-2	Phenol	Y	Y	Y	A												
7723-14-0	Phosphorus	Y	Y	Y	A	0.051	0.224	0.017	0.076	0.452	1.981	7.9E-3	0.034	1.0E-3	4.5E-3		
129-00-0	Pyrene	Y	N	n/a													
7782-49-2	Selenium	Y	Y	Y	A	3.1E-5	1.4E-4	1.1E-5	4.7E-5	2.8E-4	1.2E-3	4.8E-6	2.1E-5	6.4E-7	2.8E-6		
108-88-3	Toluene	Y	Y	Y	A												
1330-20-7	Xylene	Y	Y	Y	A												
7429-90-5	Aluminum	N	Y	N	A	5.585	24.463	1.902	8.332	49.397	216	0.858	3.756	0.113	0.494		
7440-39-3	Barium	N	Y	N	A	0.063	0.276	0.021	0.094	0.557	2.438	9.7E-3	0.042	1.3E-3	5.6E-3		
1317-65-3	Calcium Carbonate	N	Y	N	A	1.101	4.824	0.375	1.643	9.740	42.663	0.169	0.741	0.022	0.097		
1305-78-8	Calcium Oxide	N	Y	N	A												
7440-50-8	Copper	N	Y	N	A	3.9E-4	1.7E-3	1.3E-4	5.9E-4	3.5E-3	0.015	6.0E-5	2.6E-4	7.9E-6	3.5E-5		
110-82-7	Cyclohexane	N	Y	N	A												
7783-06-4	Hydrogen Sulfide	N	Y	N	A												
7439-89-6	Iron	N	Y	N	A	1.432	6.271	0.488	2.136	12.662	55.462	0.220	0.963	0.029	0.127		
7439-98-7	Molybdenum	N	Y	N	A	7.9E-5	3.4E-4	2.7E-5	1.2E-4	7.0E-4	3.0E-3	1.2E-5	5.3E-5	1.6E-6	7.0E-6		
109-66-0	Pentane	N	Y	N	A												
7440-22-4	Silver	N	Y	N	A	3.9E-5	1.7E-4	1.3E-5	5.9E-5	3.5E-4	1.5E-3	6.0E-6	2.6E-5	7.9E-7	3.5E-6		
7664-93-9	Sulfuric Acid	N	Y	N	A												
7440-28-0	Thallium	N	Y	N	A	7.9E-4	3.4E-3	2.7E-4	1.2E-3	7.0E-3	0.030	1.2E-4	5.3E-4	1.6E-5	7.0E-5		
7440-61-1	Uranium	N	Y	N	A	7.9E-4	3.4E-3	2.7E-4	1.2E-3	7.0E-3	0.030	1.2E-4	5.3E-4	1.6E-5	7.0E-5		
7440-62-2	Vanadium	N	Y	N	A	2.2E-3	9.6E-3	7.5E-4	3.3E-3	0.019	0.085	3.4E-4	1.5E-3	4.4E-5	1.9E-4		
25551-13-7	Trimethyl benzene	N	Y	N	A												
7440-33-7	Tungsten	N	Y	N	A	7.9E-4	3.4E-3	2.7E-4	1.2E-3	7.0E-3	0.030	1.2E-4	5.3E-4	1.6E-5	7.0E-5		
7440-66-6	Zinc	N	Y	N	A	2.8E-3	0.012	9.4E-4	4.1E-3	0.024	0.107	4.2E-4	1.9E-3	5.6E-5	2.4E-4		
HAP TOTAL						***0.131***	***0.574***	***0.045***	***0.196***	***1.160***	***5.079***	***0.020***	***0.088***	***3.4E-3***	***0.015***	***0.467***	***2.046***
MERCURY TOTAL (exempt)						***9.7E-5***	***4.3E-4***	***1.6E-5***	***7.0E-5***	***4.2E-4***	***1.8E-3***	***5.4E-5***	***2.4E-4***	***7.2E-4***	***3.2E-3***		
MERCURY TOTAL (non-exempt)																	
TAP TOTAL (HAP-TAP addressed by NSPS/NESHAP)																	
TAP TOTAL (For EL Evaluation)						***8.319***	***36.438***	***2.834***	***12.411***	***73.580***	***322***	***1.278***	***5.595***	***0.168***	***0.735***	***0.467***	***2.046***

TABLE A-W3. HAP/TAP Emissions and Exemptions

180,000 T/day Emissions

chk

						0	0	0	0	1	1	1	1	0	0	1	1
						PROCESSING AND PRODUCTION											
						Ore Processing				*Ore Concentration and Refining*				*Process Heating*			
						OC1-13		PS		AC		EW,MR,MF,CKD		ACB, CKB, PV, HS		LKC	
CAS	HAP/TAP	HAP	TAP			Crushers & Xfers		Prill Silos		Autoclave		EW, Preg Tank, Retort, Furnace, Carbon Kiln		POX Boiler, C. Kiln Comb., Prop. Vap., Sol'n Heater		Lime Kiln Combustion	
	NSPS or NESHAP HAP/TAP -->			*Y*		*LL*	*LL*			*7E*	*7E*	*7E*	*7E*			*5A*	*5A*
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				*A/C*	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
106-99-0	1,3-Butadiene	Y	Y	Y	C												
91-57-6	2-Methylnaphthalene	Y	N	n/a										1.9E-7	7.6E-7	5.2E-7	1.9E-6
56-49-5	3-Methylchloranthrene	Y	Y	Y	C									1.3E-8	5.7E-8	3.3E-8	1.4E-7
57-97-6	7,12-Dimethylbenz(a)anthracene	Y	N	n/a										1.3E-7	5.1E-7	3.5E-7	1.3E-6
83-32-9	Acenaphthene	Y	N	n/a										1.4E-8	5.7E-8	3.9E-8	1.4E-7
208-96-8	Acenaphthylene	Y	N	n/a										1.4E-8	5.7E-8	3.9E-8	1.4E-7
75-07-0	Acetaldehyde	Y	Y	Y	C												
107-02-8	Acrolein	Y	Y	Y	A												
120-12-7	Anthracene	Y	N	n/a										1.9E-8	7.6E-8	5.2E-8	1.9E-7
7440-36-0	Antimony	Y	Y	Y	A	1.4E-4	5.9E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7440-38-2	Arsenic	Y	Y	Y	C	3.9E-3	0.017			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.5E-6	6.4E-6	3.7E-6	1.6E-5
71-43-2	Benzene	Y	Y	Y	C									1.5E-5	6.7E-5	3.9E-5	1.7E-4
50-32-8	Benzo(a)pyrene	Y	Y	Y	C									8.7E-9	3.8E-8	2.2E-8	9.6E-8
56-55-3	Benz(a)anthracene	Y	Y	Y	C									1.3E-8	5.7E-8	3.3E-8	1.4E-7
205-99-2	Benzo(b)fluoranthene	Y	Y	Y	C									1.3E-8	5.7E-8	3.3E-8	1.4E-7
207-08-9	Benzo(k)fluoranthene	Y	Y	Y	C									1.3E-8	5.7E-8	3.3E-8	1.4E-7
218-01-9	Chrysene	Y	Y	Y	C									1.3E-8	5.7E-8	3.3E-8	1.4E-7
53-70-3	Dibenzo(a,h)anthracene	Y	Y	Y	C									8.7E-9	3.8E-8	2.2E-8	9.6E-8
193-39-5	Indeno(1,2,3-cd)pyrene	Y	Y	Y	C									1.3E-8	5.7E-8	3.3E-8	1.4E-7
191-24-2	Benzo(g,h,i)perylene	Y	N	n/a										9.5E-9	3.8E-8	2.6E-8	9.6E-8
7440-41-7	Beryllium	Y	Y	Y	C	1.9E-5	8.2E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	8.7E-8	3.8E-7	2.2E-7	9.6E-7
92-52-4	Biphenyl	Y	Y	Y	A												
7440-43-9	Cadmium	Y	Y	Y	C	2.9E-6	1.3E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	8.0E-6	3.5E-5	2.0E-5	8.8E-5
75-15-0	Carbon Disulfide	Y	Y	Y	A												
7440-47-3	Chromium	Y	Y	Y	A	5.3E-5	2.3E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.1E-5	4.5E-5	3.0E-5	1.1E-4
18540-29-9	Cr (VI)	Y	Y	Y	C												
7440-48-4	Cobalt	Y	Y	Y	A	2.4E-5	1.0E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3	6.6E-7	2.7E-6	1.8E-6	6.8E-6
592-01-8	Cyanide	Y	Y	Y	A							1.2E-3	5.3E-3				
106-46-7	Dichlorobenzene	Y	Y	Y	A									9.5E-6	3.8E-5	2.6E-5	9.6E-5
206-44-0	Fluoranthene	Y	N	n/a										2.4E-8	9.5E-8	6.5E-8	2.4E-7
86-73-7	Fluorene	Y	N	n/a										2.2E-8	8.9E-8	6.1E-8	2.3E-7
50-00-0	Formaldehyde	Y	Y	Y	C									5.5E-4	2.4E-3	1.4E-3	6.0E-3
110-54-3	Hexane	Y	Y	Y	A									0.014	0.057	0.039	0.145
7647-01-0	Hydrogen Chloride	Y	Y	Y	A												
7439-92-1	Lead	Y	N	n/a		4.7E-5	2.1E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7439-96-5	Manganese	Y	Y	Y	A	1.8E-3	7.7E-3			2.3E-5	1.0E-4	3.8E-4	1.7E-3	3.0E-6	1.2E-5	8.2E-6	3.1E-5
7439-97-6	Mercury	Y	N	n/a		5.6E-6	2.5E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	2.1E-6	8.3E-6	5.6E-6	2.1E-5
91-20-3	Naphthalene	Y	Y	Y	A									4.8E-6	1.9E-5	1.3E-5	4.9E-5
7440-02-0	Nickel	Y	Y	Y	C	1.2E-5	5.2E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.5E-5	6.7E-5	3.9E-5	1.7E-4
85-01-8	Phenanthrene	Y	N	n/a										1.3E-7	5.4E-7	3.7E-7	1.4E-6
108-95-2	Phenol	Y	Y	Y	A												
7723-14-0	Phosphorus	Y	Y	Y	A	3.8E-3	0.017			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
129-00-0	Pyrene	Y	N	n/a										4.0E-8	1.6E-7	1.1E-7	4.0E-7
7782-49-2	Selenium	Y	Y	Y	A	2.4E-6	1.0E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.9E-7	7.6E-7	5.2E-7	1.9E-6
108-88-3	Toluene	Y	Y	Y	A									2.7E-5	1.1E-4	7.3E-5	2.7E-4
1330-20-7	Xylene	Y	Y	Y	A												
7429-90-5	Aluminum	N	Y	N	A	0.418	1.829			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7440-39-3	Barium	N	Y	N	A	4.7E-3	0.021			2.3E-5	1.0E-4	3.8E-4	1.7E-3	3.5E-5	1.4E-4	9.5E-5	3.5E-4
1317-65-3	Calcium Carbonate	N	Y	N	A	0.082	0.361			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
1305-78-8	Calcium Oxide	N	Y	N	A												
7440-50-8	Copper	N	Y	N	A	2.9E-5	1.3E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3	6.7E-6	2.7E-5	1.8E-5	6.8E-5
110-82-7	Cyclohexane	N	Y	N	A												
7783-06-4	Hydrogen Sulfide	N	Y	N	A					0.900	3.942						
7439-89-6	Iron	N	Y	N	A	0.107	0.469			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7439-98-7	Molybdenum	N	Y	N	A	5.9E-6	2.6E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	8.7E-6	3.5E-5	2.4E-5	8.8E-5
109-66-0	Pentane	N	Y	N	A									0.021	0.083	0.056	0.209
7440-22-4	Silver	N	Y	N	A	2.9E-6	1.3E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7664-93-9	Sulfuric Acid	N	Y	N	A					2.030	8.891						
7440-28-0	Thallium	N	Y	N	A	5.9E-5	2.6E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7440-61-1	Uranium	N	Y	N	A	5.9E-5	2.6E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7440-62-2	Vanadium	N	Y	N	A	1.6E-4	7.2E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.8E-5	7.3E-5	5.0E-5	1.8E-4
25551-13-7	Trimethyl benzene	N	Y	N	A												
7440-33-7	Tungsten	N	Y	N	A	5.9E-5	2.6E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3				
7440-66-6	Zinc	N	Y	N	A	2.1E-4	9.0E-4			2.3E-5	1.0E-4	3.8E-4	1.7E-3	2.3E-4	9.2E-4	6.3E-4	2.3E-3
HAP TOTAL						***9.8E-3***	***0.043***			***2.8E-4***	***1.2E-3***	***5.8E-3***	***0.025***	***0.015***	***0.060***	***0.041***	***0.152***
MERCURY TOTAL (exempt)										***2.3E-5***	***1.0E-4***	***3.8E-4***	***1.7E-3***			***5.6E-6***	***2.1E-5***
MERCURY TOTAL (non-exempt)						***5.6E-6***	***2.5E-5***							***2.1E-6***	***8.3E-6***		
TAP TOTAL (HAP-TAP addressed by NSPS/NESHAP)						***9.8E-3***	***0.043***			***2.3E-4***	***1.0E-3***	***5.0E-3***	***0.022***			***0.041***	***0.152***
TAP TOTAL (For EL Evaluation)						***0.612***	***2.682***			***2.930***	***12.835***	***4.6E-3***	***0.020***	***0.036***	***0.144***	***0.057***	***0.212***

TABLE A-W3. HAP/TAP Emissions and Exemptions

180,000 T/day Emissions

chk

						0	0	1	1	0	0	0	0	0	0	0	0	0	0
						PROCESSING AND PRODUCTION - Continued													
						Lime Production						*Aggregate Prod.*		*Concrete Production*					
						LS1-11,LSBM		LK,LS12,LCR,LS-L/U		LS1-L/U,MillS2-L/U,ACS1-4		PCSP1,PCSP2		CM		CS1L,CS1U,CS2L, CS2U		CA-L/U	
CAS	HAP/TAP	HAP	TAP			Limestone Crushers, Screens, Mill, Xfers		Lime Kiln, Kiln Feed, Lime Mill, Pebble Lime Silo		Lime Silos and Lime Mill Crushing		Portable Crushers, Screens, Xfers		Central Mixer		Cement Silo #1 and #2 L/U		Aggregate Bin	
	NSPS or NESHAP HAP/TAP -->			*Y*		*OOO*	*OOO*	*5A*	*5A*			*OOO*	*OOO*					*OOO*	*OOO*
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				*A/C*	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
106-99-0	1,3-Butadiene	Y	Y	Y	C														
91-57-6	2-Methylnaphthalene	Y	N	n/a															
56-49-5	3-Methylchloranthrene	Y	Y	Y	C														
57-97-6	7,12-Dimethylbenz(a)anthracene	Y	N	n/a															
83-32-9	Acenaphthene	Y	N	n/a															
208-96-8	Acenaphthylene	Y	N	n/a															
75-07-0	Acetaldehyde	Y	Y	Y	C														
107-02-8	Acrolein	Y	Y	Y	A														
120-12-7	Anthracene	Y	N	n/a															
7440-36-0	Antimony	Y	Y	Y	A	1.4E-5	4.8E-5	3.1E-6	1.2E-5	1.6E-6	5.1E-7	3.1E-6	1.4E-5					3.5E-6	8.6E-6
7440-38-2	Arsenic	Y	Y	Y	C	1.0E-4	4.4E-4	2.4E-5	1.1E-4	1.1E-6	4.7E-6	2.9E-5	1.3E-4	2.0E-6	8.9E-6	1.2E-7	5.1E-7	1.8E-5	7.9E-5
71-43-2	Benzene	Y	Y	Y	C														
50-32-8	Benzo(a)pyrene	Y	Y	Y	C														
56-55-3	Benz(a)anthracene	Y	Y	Y	C														
205-99-2	Benzo(b)fluoranthene	Y	Y	Y	C														
207-08-9	Benzo(k)fluoranthene	Y	Y	Y	C														
218-01-9	Chrysene	Y	Y	Y	C														
53-70-3	Dibenzo(a,h)anthracene	Y	Y	Y	C														
193-39-5	Indeno(1,2,3-cd)pyrene	Y	Y	Y	C														
191-24-2	Benzo(g,h,i)perylene	Y	N	n/a															
7440-41-7	Beryllium	Y	Y	Y	C	3.5E-6	1.5E-5	8.4E-7	3.7E-6	3.7E-8	1.6E-7	1.0E-6	4.4E-6			1.3E-8	5.8E-8	6.3E-7	2.8E-6
92-52-4	Biphenyl	Y	Y	Y	A														
7440-43-9	Cadmium	Y	Y	Y	C	1.1E-6	4.8E-6	2.6E-7	1.2E-6	1.2E-8	5.1E-8	3.1E-7	1.4E-6	4.9E-9	2.1E-8			2.0E-7	8.6E-7
75-15-0	Carbon Disulfide	Y	Y	Y	A														
7440-47-3	Chromium	Y	Y	Y	A	8.5E-5	2.9E-4	1.9E-5	6.9E-5	9.7E-6	3.0E-6	1.9E-5	8.2E-5	8.7E-7	3.8E-6	7.9E-7	3.5E-6	2.1E-5	5.2E-5
18540-29-9	Cr (VI)	Y	Y	Y	C									1.9E-7	8.1E-7	1.6E-7	7.0E-7		
7440-48-4	Cobalt	Y	Y	Y	A	2.3E-5	7.7E-5	5.0E-6	1.8E-5	2.6E-6	8.1E-7	5.0E-6	2.2E-5					5.5E-6	1.4E-5
592-01-8	Cyanide	Y	Y	Y	A														
106-46-7	Dichlorobenzene	Y	Y	Y	A														
206-44-0	Fluoranthene	Y	N	n/a															
86-73-7	Fluorene	Y	N	n/a															
50-00-0	Formaldehyde	Y	Y	Y	C														
110-54-3	Hexane	Y	Y	Y	A														
7647-01-0	Hydrogen Chloride	Y	Y	Y	A	0	0	0.986	3.666										
7439-92-1	Lead	Y	N	n/a		1.7E-5	5.8E-5	3.7E-6	1.4E-5	1.9E-6	6.1E-7	3.8E-6	1.6E-5	2.5E-7	1.1E-6	3.0E-7	1.3E-6	4.1E-6	1.0E-5
7439-96-5	Manganese	Y	Y	Y	A	1.3E-3	4.6E-3	2.9E-4	1.1E-3	1.5E-4	4.8E-5	3.0E-4	1.3E-3	2.6E-5	1.1E-4	3.2E-6	1.4E-5	3.3E-4	8.2E-4
7439-97-6	Mercury	Y	N	n/a		1.1E-7	3.9E-7	2.8E-4	1.0E-3	1.3E-8	4.1E-9	2.5E-8	1.1E-7					2.8E-8	6.9E-8
91-20-3	Naphthalene	Y	Y	Y	A														
7440-02-0	Nickel	Y	Y	Y	C	2.2E-5	9.6E-5	5.3E-6	2.3E-5	2.3E-7	1.0E-6	6.3E-6	2.7E-5	1.7E-6	7.4E-6	1.1E-6	5.0E-6	3.9E-6	1.7E-5
85-01-8	Phenanthrene	Y	N	n/a															
108-95-2	Phenol	Y	Y	Y	A														
7723-14-0	Phosphorus	Y	Y	Y	A	7.4E-4	2.5E-3	1.6E-4	6.0E-4	8.4E-5	2.6E-5	1.6E-4	7.1E-4	8.2E-6	3.6E-5			1.8E-4	4.5E-4
129-00-0	Pyrene	Y	N	n/a															
7782-49-2	Selenium	Y	Y	Y	A														
108-88-3	Toluene	Y	Y	Y	A														
1330-20-7	Xylene	Y	Y	Y	A														
7429-90-5	Aluminum	N	Y	N	A	0.128	0.436	0.028	0.104	0.015	4.6E-3	0.028	0.124					0.031	0.078
7440-39-3	Barium	N	Y	N	A	8.2E-4	2.8E-3	1.8E-4	6.7E-4	9.4E-5	2.9E-5	1.8E-4	7.9E-4					2.0E-4	5.0E-4
1317-65-3	Calcium Carbonate	N	Y	N	A	1.558	5.291	0.260	0.969			0.343	1.503						
1305-78-8	Calcium Oxide	N	Y	N	A			0.216	0.802	0.480	0.150								
7440-50-8	Copper	N	Y	N	A	2.8E-5	9.6E-5	6.2E-6	2.3E-5	3.2E-6	1.0E-6	6.3E-6	2.7E-5					6.9E-6	1.7E-5
110-82-7	Cyclohexane	N	Y	N	A														
7783-06-4	Hydrogen Sulfide	N	Y	N	A														
7439-89-6	Iron	N	Y	N	A	0.059	0.199	0.013	0.048	6.7E-3	2.1E-3	0.013	0.057					0.014	0.036
7439-98-7	Molybdenum	N	Y	N	A	2.8E-6	9.6E-6	6.2E-7	2.3E-6	3.2E-7	1.0E-7	6.3E-7	2.7E-6					6.9E-7	1.7E-6
109-66-0	Pentane	N	Y	N	A														
7440-22-4	Silver	N	Y	N	A	0	0												
7664-93-9	Sulfuric Acid	N	Y	N	A														
7440-28-0	Thallium	N	Y	N	A	2.8E-5	9.6E-5	6.2E-6	2.3E-5	3.2E-6	1.0E-6	6.3E-6	2.7E-5					6.9E-6	1.7E-5
7440-61-1	Uranium	N	Y	N	A	2.8E-5	9.6E-5	6.2E-6	2.3E-5	3.2E-6	1.0E-6	6.3E-6	2.7E-5					6.9E-6	1.7E-5
7440-62-2	Vanadium	N	Y	N	A	8.8E-5	3.0E-4	1.9E-5	7.1E-5	1.0E-5	3.1E-6	1.9E-5	8.5E-5					2.1E-5	5.3E-5
25551-13-7	Trimethyl benzene	N	Y	N	A														
7440-33-7	Tungsten	N	Y	N	A	2.8E-5	9.6E-5	6.2E-6	2.3E-5	3.2E-6	1.0E-6	6.3E-6	2.7E-5					6.9E-6	1.7E-5
7440-66-6	Zinc	N	Y	N	A	1.0E-4	3.5E-4	2.2E-5	8.3E-5	1.2E-5	3.6E-6	2.3E-5	9.9E-5					2.5E-5	6.2E-5
HAP TOTAL						***2.3E-3***	***8.1E-3***	***0.987***	***3.669***	***2.6E-4***	***8.5E-5***	***5.3E-4***	***2.3E-3***	***3.9E-5***	***1.7E-4***	***5.7E-6***	***2.5E-5***	***5.6E-4***	***1.4E-3***
MERCURY TOTAL (exempt)						***0***	***0***	***2.8E-4***	***1.0E-3***										
MERCURY TOTAL (non-exempt)						***1.1E-7***	***3.9E-7***			***1.3E-8***	***4.1E-9***	***2.5E-8***	***1.1E-7***					***2.8E-8***	***6.9E-8***
TAP TOTAL (HAP-TAP addressed by NSPS/NESHAP)						***2.3E-3***	***8.0E-3***	***0.986***	***3.668***			***5.2E-4***	***2.3E-3***					***5.6E-4***	***1.4E-3***
TAP TOTAL (For EL Evaluation)						***1.746***	***5.930***	***0.517***	***1.923***	***0.502***	***0.157***	***0.385***	***1.684***	***3.9E-5***	***1.7E-4***	***5.4E-6***	***2.4E-5***	***0.046***	***0.114***

TABLE A-W3. HAP/TAP Emissions and Exemptions

180,000 T/day Emissions						PROCESSING AND PRODUCTION - Continued						MINING and LEACHING - Totals									
chk						*HVAC*		*Emer. Power/Fire*		*Fuel Storage*		*HAP Total*		*Mercury Total*		*Mercury Total*		*TAP Total*		*TAP Total*	
CAS	HAP/TAP	HAP	TAP			H1M,H2M,HM,HAC,HR,HA,HMO,HTS,HW		EDG1,EDG2,EDG3,EDFP		TG1,TG2				*Exempt*		*Non-Exempt*		*HAP-TAP addressed by NSPS/NESHAP*		*For EL Evaluation*	
						Heaters		Emergency Generators and Fire Pump		Gasoline Fuel Tanks											
	NSPS or NESHAP HAP/TAP -->		*Y*					*4Z*	*4Z*	*6C*	*6C*										
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				*A/C*	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
106-99-0	1,3-Butadiene	Y	Y	Y	C			8.4E-7	3.7E-6			0	0					0	0	0	0
91-57-6	2-Methylnaphthalene	Y	N	n/a		4.3E-7	1.9E-6														
56-49-5	3-Methylchloranthrene	Y	Y	Y	C	3.2E-8	1.4E-7														
57-97-6	7,12-Dimethylbenz(a)anthracene	Y	N	n/a		2.9E-7	1.3E-6														
83-32-9	Acenaphthene	Y	N	n/a		3.2E-8	1.4E-7	5.6E-6	6.7E-6												
208-96-8	Acenaphthylene	Y	N	n/a		3.2E-8	1.4E-7	1.1E-5	1.3E-5												
75-07-0	Acetaldehyde	Y	Y	Y	C			2.5E-5	1.1E-4												
107-02-8	Acrolein	Y	Y	Y	A			1.6E-5	2.0E-5												
120-12-7	Anthracene	Y	N	n/a		4.3E-8	1.9E-7	1.6E-6	1.9E-6												
7440-36-0	Antimony	Y	Y	Y	A							0.019	0.082							0.019	0.082
7440-38-2	Arsenic	Y	Y	Y	C	3.6E-6	1.6E-5					0.544	2.381							0.544	2.381
71-43-2	Benzene	Y	Y	Y	C	3.8E-5	1.6E-4	2.7E-4	1.2E-3	7.0E-3	0.031										
50-32-8	Benzo(a)pyrene	Y	Y	Y	C	2.1E-8	9.4E-8	8.7E-8	3.8E-7												
56-55-3	Benz(a)anthracene	Y	Y	Y	C	3.2E-8	1.4E-7	2.4E-7	1.0E-6												
205-99-2	Benzo(b)fluoranthene	Y	Y	Y	C	3.2E-8	1.4E-7	3.6E-7	1.6E-6												
207-08-9	Benzo(k)fluoranthene	Y	Y	Y	C	3.2E-8	1.4E-7	7.3E-8	3.2E-7												
218-01-9	Chrysene	Y	Y	Y	C	3.2E-8	1.4E-7	5.0E-7	2.2E-6												
53-70-3	Dibenzo(a,h)anthracene	Y	Y	Y	C	2.1E-8	9.4E-8	1.2E-7	5.4E-7												
193-39-5	Indeno(1,2,3-cd)pyrene	Y	Y	Y	C	3.2E-8	1.4E-7	1.4E-7	6.2E-7												
191-24-2	Benzo(g,h,i)perylene	Y	N	n/a		2.1E-8	9.4E-8	6.9E-7	8.3E-7												
7440-41-7	Beryllium	Y	Y	Y	C	2.1E-7	9.4E-7					2.6E-3	0.011							2.6E-3	0.011
92-52-4	Biphenyl	Y	Y	Y	A					4.4E-5	1.9E-4										
7440-43-9	Cadmium	Y	Y	Y	C	2.0E-5	8.6E-5					4.1E-4	1.8E-3							4.1E-4	1.8E-3
75-15-0	Carbon Disulfide	Y	Y	Y	A							0.014	0.063							0.014	0.063
7440-47-3	Chromium	Y	Y	Y	A	2.5E-5	1.1E-4					7.3E-3	0.032							7.3E-3	0.032
18540-29-9	Cr (VI)	Y	Y	Y	C																
7440-48-4	Cobalt	Y	Y	Y	A	1.5E-6	6.6E-6					3.3E-3	0.014							3.3E-3	0.014
592-01-8	Cyanide	Y	Y	Y	A							0.453	1.983							0.453	1.983
106-46-7	Dichlorobenzene	Y	Y	Y	A	2.1E-5	9.4E-5														
206-44-0	Fluoranthene	Y	N	n/a		5.4E-8	2.4E-7	5.3E-6	6.4E-6												
86-73-7	Fluorene	Y	N	n/a		5.0E-8	2.2E-7	1.7E-5	2.1E-5												
50-00-0	Formaldehyde	Y	Y	Y	C	1.3E-3	5.9E-3	5.1E-5	2.2E-4												
110-54-3	Hexane	Y	Y	Y	A	0.032	0.141			0.031	0.137										
7647-01-0	Hydrogen Chloride	Y	Y	Y	A																
7439-92-1	Lead	Y	N	n/a								6.5E-3	0.029								
7439-96-5	Manganese	Y	Y	Y	A	6.8E-6	3.0E-5					0.244	1.067							0.244	1.067
7439-97-6	Mercury	Y	N	n/a		4.7E-6	2.0E-5					1.3E-3	5.7E-3	1.3E-3	5.7E-3	0	0	0	0	0	0
91-20-3	Naphthalene	Y	Y	Y	A	1.1E-5	4.8E-5	1.6E-4	1.9E-4	1.9E-3	8.5E-3	0	0					0	0	0	0
7440-02-0	Nickel	Y	Y	Y	C	3.8E-5	1.6E-4					1.6E-3	7.1E-3					0	0	1.6E-3	7.1E-3
85-01-8	Phenanthrene	Y	N	n/a		3.0E-7	1.3E-6	5.0E-5	6.0E-5			0	0					0	0	0	0
108-95-2	Phenol	Y	Y	Y	A					2.4E-4	1.1E-3	0	0					0	0	0	0
7723-14-0	Phosphorus	Y	Y	Y	A							0.530	2.320					0	0	0.530	2.320
129-00-0	Pyrene	Y	N	n/a		8.9E-8	3.9E-7	4.7E-6	5.7E-6			0	0					0	0	0	0
7782-49-2	Selenium	Y	Y	Y	A	4.3E-7	1.9E-6					3.3E-4	1.4E-3					0	0	3.3E-4	1.4E-3
108-88-3	Toluene	Y	Y	Y	A	6.1E-5	2.7E-4	3.6E-4	4.3E-4	0.032	0.138	0	0					0	0	0	0
1330-20-7	Xylene	Y	Y	Y	A			2.5E-4	3.0E-4	0.031	0.137	0	0					0	0	0	0
7429-90-5	Aluminum	N	Y	N	A							0	0					0	0	57.855	253
7440-39-3	Barium	N	Y	N	A	7.9E-5	3.4E-4					0	0					0	0	0.652	2.855
1317-65-3	Calcium Carbonate	N	Y	N	A							0	0					0	0	11.408	49.967
1305-78-8	Calcium Oxide	N	Y	N	A							0	0					0	0	0	0
7440-50-8	Copper	N	Y	N	A	1.5E-5	6.7E-5					0	0					0	0	4.1E-3	0.018
110-82-7	Cyclohexane	N	Y	N	A					1.0E-3	4.6E-3	0	0					0	0	0	0
7783-06-4	Hydrogen Sulfide	N	Y	N	A							0	0					0	0	0	0
7439-89-6	Iron	N	Y	N	A							0	0					0	0	14.831	64.958
7439-98-7	Molybdenum	N	Y	N	A	2.0E-5	8.6E-5					0	0					0	0	8.1E-4	3.6E-3
109-66-0	Pentane	N	Y	N	A	0.047	0.204					0	0					0	0	0	0
7440-22-4	Silver	N	Y	N	A							0	0					0	0	4.1E-4	1.8E-3
7664-93-9	Sulfuric Acid	N	Y	N	A							0	0					0	0	0	0
7440-28-0	Thallium	N	Y	N	A							0	0					0	0	8.1E-3	0.036
7440-61-1	Uranium	N	Y	N	A							0	0					0	0	8.1E-3	0.036
7440-62-2	Vanadium	N	Y	N	A	4.1E-5	1.8E-4					0	0					0	0	0.023	0.100
25551-13-7	Trimethyl benzene	N	Y	N	A					0.011	0.048	0	0					0	0	0	0
7440-33-7	Tungsten	N	Y	N	A							0	0					0	0	8.1E-3	0.036
7440-66-6	Zinc	N	Y	N	A	5.2E-4	2.3E-3					0	0					0	0	0.029	0.125
HAP TOTAL						***0.034***	***0.148***	***1.2E-3***	***2.6E-3***	***0.103***	***0.453***	***1.826***	***7.998***								
MERCURY TOTAL (exempt)														***1.3E-3***	***5.7E-3***						
MERCURY TOTAL (non-exempt)						***4.7E-6***	***2.0E-5***									***0***	***0***				
TAP TOTAL (HAP-TAP addressed by NSPS/NESHAP)								***1.1E-3***	***2.5E-3***	***0.103***	***0.453***							***0***	***0***		
TAP TOTAL (For EL Evaluation)						***0.081***	***0.355***			***0.012***	***0.052***									***86.645***	***380***

TABLE A-W3. HAP/TAP Emissions and Exemptions

180,000 T/day Emissions						PROCESSING AND PRODUCTION - Totals										ALL	ALL	ALL	TAP EL	
chk						*HAP Total*		*Mercury Total Exempt*		*Mercury Total Non-Exempt*		*TAP Total HAP-TAP addressed by NSPS/NESHAP*		*TAP Total For EL Evaluation*		*HAP*	*Hg Non-Exempt*	*TAP For EL Evaluation*	*TAP Emission Screening Level (EL)*	
CAS	HAP/TAP	HAP	TAP																	
	NSPS or NESHAP HAP/TAP -->		*Y*																Non-car	Carcin
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				*A/C*	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr	ton/yr	lb/hr	lb/hr	lb/hr
106-99-0	1,3-Butadiene	Y	Y	Y	C	8.4E-7	3.7E-6					8.4E-7	3.7E-6			3.7E-6		0	--	2.4E-5
91-57-6	2-Methylnaphthalene	Y	N	n/a		1.1E-6	4.6E-6									4.6E-6			--	--
56-49-5	3-Methylchloranthrene	Y	Y	Y	C	7.8E-8	3.4E-7					3.3E-8	1.4E-7	4.5E-8	2.0E-7	3.4E-7		4.5E-8	--	2.5E-6
57-97-6	7,12-Dimethylbenz(a)anthracene	Y	N	n/a		7.6E-7	3.0E-6									3.0E-6			--	--
83-32-9	Acenaphthene	Y	N	n/a		5.7E-6	7.1E-6									7.1E-6			--	--
208-96-8	Acenaphthylene	Y	N	n/a		1.1E-5	1.4E-5									1.4E-5			--	--
75-07-0	Acetaldehyde	Y	Y	Y	C	2.5E-5	1.1E-4					2.5E-5	1.1E-4			1.1E-4			--	3.0E-3
107-02-8	Acrolein	Y	Y	Y	A	1.6E-5	2.0E-5					1.6E-5	2.0E-5			2.0E-5			0.017	--
120-12-7	Anthracene	Y	N	n/a		1.7E-6	2.4E-6									2.4E-6			--	--
7440-36-0	Antimony	Y	Y	Y	A	5.7E-4	2.5E-3					5.7E-4	2.5E-3	1.6E-6	5.1E-7	0.085		0.019	0.033	--
7440-38-2	Arsenic	Y	Y	Y	C	4.5E-3	0.020					4.5E-3	0.020	8.2E-6	3.6E-5	2.400		0.544	--	1.5E-6
71-43-2	Benzene	Y	Y	Y	C	7.4E-3	0.032					7.3E-3	0.032	5.3E-5	2.3E-4	0.032		5.3E-5	--	8.0E-4
50-32-8	Benzo(a)pyrene	Y	Y	Y	C	1.4E-7	6.1E-7					1.1E-7	4.8E-7	3.0E-8	1.3E-7	6.1E-7				
56-55-3	Benz(a)anthracene	Y	Y	Y	C	3.1E-7	1.4E-6					2.7E-7	1.2E-6	4.5E-8	2.0E-7	1.4E-6				
205-99-2	Benzo(b)fluoranthene	Y	Y	Y	C	4.4E-7	1.9E-6					3.9E-7	1.7E-6	4.5E-8	2.0E-7	1.9E-6				
207-08-9	Benzo(k)fluoranthene	Y	Y	Y	C	1.5E-7	6.6E-7					1.1E-7	4.7E-7	4.5E-8	2.0E-7	6.6E-7		2.9E-7	--	2.0E-6
218-01-9	Chrysene	Y	Y	Y	C	5.8E-7	2.5E-6					5.3E-7	2.3E-6	4.5E-8	2.0E-7	2.5E-6				
53-70-3	Dibenzo(a,h)anthracene	Y	Y	Y	C	1.8E-7	7.7E-7					1.5E-7	6.4E-7	3.0E-8	1.3E-7	7.7E-7				
193-39-5	Indeno(1,2,3-cd)pyrene	Y	Y	Y	C	2.2E-7	9.6E-7					1.7E-7	7.6E-7	4.5E-8	2.0E-7	9.6E-7				
191-24-2	Benzo(g,h,i)perylene	Y	N	n/a		7.5E-7	1.1E-6									1.1E-6			--	--
7440-41-7	Beryllium	Y	Y	Y	C	4.3E-4	1.9E-3					4.3E-4	1.9E-3	3.5E-7	1.5E-6	0.013		2.6E-3	--	2.8E-5
92-52-4	Biphenyl	Y	Y	Y	A	4.4E-5	1.9E-4					4.4E-5	1.9E-4			1.9E-4			0.100	--
7440-43-9	Cadmium	Y	Y	Y	C	4.6E-4	2.0E-3					4.3E-4	1.9E-3	2.8E-5	1.2E-4	3.8E-3		4.4E-4	--	3.7E-6
75-15-0	Carbon Disulfide	Y	Y	Y	A											0.063		0.014	2.000	--
7440-47-3	Chromium	Y	Y	Y	A	6.8E-4	2.8E-3					6.3E-4	2.6E-3	4.8E-5	1.6E-4	0.035		7.4E-3	0.033	--
18540-29-9	Cr (VI)	Y	Y	Y	C	3.4E-7	1.5E-6							3.4E-7	1.5E-6	1.5E-6		3.4E-7	--	5.6E-7
7440-48-4	Cobalt	Y	Y	Y	A	4.7E-4	2.0E-3					4.7E-4	2.0E-3	4.8E-6	1.0E-5	0.016		3.3E-3	3.3E-3	--
592-01-8	Cyanide	Y	Y	Y	A	1.2E-3	5.3E-3					1.2E-3	5.3E-3			1.988		0.453	0.333	--
106-46-7	Dichlorobenzene	Y	Y	Y	A	5.7E-5	2.3E-4					2.6E-5	9.6E-5	3.1E-5	1.3E-4	2.3E-4		3.1E-5	30.000	--
206-44-0	Fluoranthene	Y	N	n/a		5.5E-6	7.0E-6									7.0E-6			--	--
86-73-7	Fluorene	Y	N	n/a		1.7E-5	2.1E-5									2.1E-5			--	--
50-00-0	Formaldehyde	Y	Y	Y	C	3.3E-3	0.015					1.4E-3	6.2E-3	1.9E-3	8.3E-3	0.015		1.9E-3	--	5.1E-4
110-54-3	Hexane	Y	Y	Y	A	0.117	0.480					0.070	0.281	0.046	0.198	0.480		0.046	12.000	--
7647-01-0	Hydrogen Chloride	Y	Y	Y	A	0.986	3.666					0.986	3.666			3.666			0.050	--
7439-92-1	Lead	Y	N	n/a		4.8E-4	2.1E-3									0.031			--	--
7439-96-5	Manganese	Y	Y	Y	A	4.6E-3	0.017					4.4E-3	0.017	1.9E-4	2.2E-4	1.085		0.244	0.067	--
7439-97-6	Mercury	Y	N	n/a		7.1E-4	2.9E-3	6.9E-4	2.8E-3	1.3E-5	5.4E-5					8.6E-3	5.4E-5		--	--
91-20-3	Naphthalene	Y	Y	Y	A	2.1E-3	8.8E-3					2.1E-3	8.7E-3	1.6E-5	6.7E-5	8.8E-3		1.6E-5	3.330	--
7440-02-0	Nickel	Y	Y	Y	C	5.5E-4	2.4E-3					4.9E-4	2.2E-3	5.6E-5	2.4E-4	9.5E-3		1.7E-3	--	2.7E-5
85-01-8	Phenanthrene	Y	N	n/a		5.1E-5	6.3E-5									6.3E-5			--	--
108-95-2	Phenol	Y	Y	Y	A	2.4E-4	1.1E-3					2.4E-4	1.1E-3			1.1E-3			1.270	--
7723-14-0	Phosphorus	Y	Y	Y	A	5.6E-3	0.023					5.5E-3	0.023	9.3E-5	6.2E-5	2.343		0.530	7.0E-3	--
129-00-0	Pyrene	Y	N	n/a		5.0E-6	6.6E-6									6.6E-6			--	--
7782-49-2	Selenium	Y	Y	Y	A	4.1E-4	1.8E-3					4.1E-4	1.8E-3	6.2E-7	2.6E-6	3.2E-3		3.3E-4	0.013	--
108-88-3	Toluene	Y	Y	Y	A	0.032	0.139					0.032	0.139	8.8E-5	3.7E-4	0.139		8.8E-5	25.000	--
1330-20-7	Xylene	Y	Y	Y	A	0.032	0.138					0.032	0.138			0.138			29.000	--
7429-90-5	Aluminum	N	Y	N	A									0.648	2.577			58.504	0.667	--
7440-39-3	Barium	N	Y	N	A									6.8E-3	0.028			0.659	0.033	--
1317-65-3	Calcium Carbonate	N	Y	N	A									2.244	8.125			13.652	0.667	--
1305-78-8	Calcium Oxide	N	Y	N	A									0.696	0.952			0.696	0.133	--
7440-50-8	Copper	N	Y	N	A									5.3E-4	2.2E-3			4.6E-3	0.067	--
110-82-7	Cyclohexane	N	Y	N	A									1.0E-3	4.6E-3			1.0E-3	70.000	--
7783-06-4	Hydrogen Sulfide	N	Y	N	A									0.900	3.942			0.900	0.933	--
7439-89-6	Iron	N	Y	N	A									0.213	0.812			15.043	0.067	--
7439-98-7	Molybdenum	N	Y	N	A									4.7E-4	2.0E-3			1.3E-3	0.333	--
109-66-0	Pentane	N	Y	N	A									0.123	0.495			0.123	118	--
7440-22-4	Silver	N	Y	N	A									4.1E-4	1.8E-3			8.2E-4	7.0E-3	--
7664-93-9	Sulfuric Acid	N	Y	N	A									2.030	8.891			2.030	0.067	--
7440-28-0	Thallium	N	Y	N	A									5.2E-4	2.2E-3			8.7E-3	7.0E-3	--
7440-61-1	Uranium	N	Y	N	A									5.2E-4	2.2E-3			8.7E-3	0.013	--
7440-62-2	Vanadium	N	Y	N	A									8.4E-4	3.5E-3			0.024	3.0E-3	--
25551-13-7	Trimethyl benzene	N	Y	N	A									0.011	0.048			0.011	8.200	--
7440-33-7	Tungsten	N	Y	N	A									5.2E-4	2.2E-3	0		8.7E-3	0.333	--
7440-66-6	Zinc	N	Y	N	A									2.2E-3	8.8E-3	0		0.031	0.667	--
HAP TOTAL						*1.200*	*4.566*									*12.564*				
MERCURY TOTAL (exempt)								*6.9E-4*	*2.8E-3*											
MERCURY TOTAL (non-exempt)										*1.3E-5*	*5.4E-5*						*5.4E-5*			
TAP TOTAL (HAP-TAP addressed by NSPS/NESHAP)												*1.150*	*4.353*							
TAP TOTAL (For EL Evaluation)														*6.928*	*26.109*			*93.573*		

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 1 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021

Model Scenario W3 T-RACT Emissions

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	HAP/TAP	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
106-99-0	1,3-Butadiene	8.4E-07	3.7E-06	0	0	0	0	8.4E-07	3.7E-06	Y	Y
91-57-6	2-Methylnaphthalene	1.1E-06	4.6E-06	0	0	0	0	1.1E-06	4.6E-06	Y	N
56-49-5	3-Methylchloranthrene	7.8E-08	3.4E-07	0	0	0	0	7.8E-08	3.4E-07	Y	Y
57-97-6	7,12-Dimethylbenz(a)anthracene	7.6E-07	3.0E-06	0	0	0	0	7.6E-07	3.0E-06	Y	N
83-32-9	Acenaphthene	5.7E-06	7.1E-06	0	0	0	0	5.7E-06	7.1E-06	Y	N
208-96-8	Acenaphthylene	1.1E-05	1.4E-05	0	0	0	0	1.1E-05	1.4E-05	Y	N
75-07-0	Acetaldehyde	2.5E-05	1.1E-04	0	0	0	0	2.5E-05	1.1E-04	Y	Y
107-02-8	Acrolein	1.6E-05	2.0E-05	0	0	0	0	1.6E-05	2.0E-05	Y	Y
120-12-7	Anthracene	1.7E-06	2.4E-06	0	0	0	0	1.7E-06	2.4E-06	Y	N
7440-36-0	Antimony	0	0	5.7E-04	2.5E-03	1.3E-02	5.8E-02	1.4E-02	6.1E-02	Y	Y
7440-38-2	Arsenic	8.7E-06	3.8E-05	4.5E-03	2.0E-02	0.23	1.02	0.24	1.04	Y	Y
56-55-3	Benz(a)anthracene	3.1E-07	1.4E-06	0	0	0	0	3.1E-07	1.4E-06	Y	Y
71-43-2	Benzene	3.6E-04	1.6E-03	7.0E-03	3.1E-02	0	0	7.4E-03	3.2E-02	Y	Y
50-32-8	Benzo(a)pyrene	1.4E-07	6.1E-07	0	0	0	0	1.4E-07	6.1E-07	Y	Y
205-99-2	Benzo(b)fluoranthene	4.4E-07	1.9E-06	0	0	0	0	4.4E-07	1.9E-06	Y	Y
191-24-2	Benzo(g,h,i)perylene	7.5E-07	1.1E-06	0	0	0	0	7.5E-07	1.1E-06	Y	N
207-08-9	Benzo(k)fluoranthene	1.5E-07	6.6E-07	0	0	0	0	1.5E-07	6.6E-07	Y	Y
7440-41-7	Beryllium	5.2E-07	2.3E-06	4.3E-04	1.9E-03	1.9E-03	8.1E-03	2.3E-03	1.0E-02	Y	Y
92-52-4	Biphenyl	0	0	4.4E-05	1.9E-04	0	0	4.4E-05	1.9E-04	Y	Y
7440-43-9	Cadmium	4.8E-05	2.1E-04	4.1E-04	1.8E-03	2.9E-04	1.3E-03	7.5E-04	3.3E-03	Y	Y
75-15-0	Carbon Disulfide	0	0	1.4E-02	6.3E-02	0	0	1.4E-02	6.3E-02	Y	Y
7440-47-3	Chromium	6.6E-05	2.7E-04	6.1E-04	2.5E-03	5.2E-03	2.3E-02	5.9E-03	2.6E-02	Y	Y
18540-29-9	Cr (VI)	0	0	3.4E-07	1.5E-06	0	0	3.4E-07	1.5E-06	Y	Y
218-01-9	Chrysene	5.8E-07	2.5E-06	0	0	0	0	5.8E-07	2.5E-06	Y	Y
7440-48-4	Cobalt	4.0E-06	1.6E-05	4.7E-04	2.0E-03	2.3E-03	1.0E-02	2.8E-03	1.2E-02	Y	Y
592-01-8	Cyanide	0	0	0.45	1.99	0	0	0.45	1.99	Y	Y
53-70-3	Dibenzo(a,h)anthracene	1.8E-07	7.7E-07	0	0	0	0	1.8E-07	7.7E-07	Y	Y
106-46-7	Dichlorobenzene	5.7E-05	2.3E-04	0	0	0	0	5.7E-05	2.3E-04	Y	Y
206-44-0	Fluoranthene	5.5E-06	7.0E-06	0	0	0	0	5.5E-06	7.0E-06	Y	N
86-73-7	Fluorene	1.7E-05	2.1E-05	0	0	0	0	1.7E-05	2.1E-05	Y	N
50-00-0	Formaldehyde	3.3E-03	1.5E-02	0	0	0	0	3.3E-03	1.5E-02	Y	Y
110-54-3	Hexane	8.5E-02	0.34	3.1E-02	0.14	0	0	0.12	0.48	Y	Y
7647-01-0	Hydrogen Chloride	0	0	0.99	3.67	0	0	0.99	**3.67**	Y	Y
193-39-5	Indeno(1,2,3-cd)pyrene	2.2E-07	9.6E-07	0	0	0	0	2.2E-07	9.6E-07	Y	Y
7439-92-1	Lead	0	0	4.8E-04	2.1E-03	4.6E-03	2.0E-02	5.1E-03	2.2E-02	Y	N
7439-96-5	Manganese	1.8E-05	7.2E-05	4.6E-03	1.7E-02	0.17	0.76	0.18	0.78	Y	Y
7439-97-6	Mercury	1.2E-05	5.0E-05	6.9E-04	2.9E-03	1.2E-03	5.1E-03	1.9E-03	8.0E-03	Y	N
91-20-3	Naphthalene	1.9E-04	3.1E-04	1.9E-03	8.5E-03	0	0	2.1E-03	8.8E-03	Y	Y
7440-02-0	Nickel	9.1E-05	4.0E-04	4.6E-04	2.0E-03	1.2E-03	5.1E-03	1.7E-03	7.5E-03	Y	Y
85-01-8	Phenanthrene	5.1E-05	6.3E-05	0	0	0	0	5.1E-05	6.3E-05	Y	N
108-95-2	Phenol	0	0	2.4E-04	1.1E-03	0	0	2.4E-04	1.1E-03	Y	Y
7723-14-0	Phosphorus	0	0	5.6E-03	2.3E-02	0.38	1.65	0.38	1.67	Y	Y
129-00-0	Pyrene	5.0E-06	6.6E-06	0	0	0	0	5.0E-06	6.6E-06	Y	N
7782-49-2	Selenium	1.1E-06	4.6E-06	4.1E-04	1.8E-03	2.3E-04	1.0E-03	6.4E-04	2.8E-03	Y	Y
108-88-3	Toluene	5.2E-04	1.1E-03	3.2E-02	0.14	0	0	3.2E-02	0.14	Y	Y
1330-20-7	Xylene	2.5E-04	3.0E-04	3.1E-02	0.14	0	0	3.2E-02	0.14	Y	Y
Total HAP		9.0E-02	0.36	1.58	6.25	0.81	3.56	2.48	10.17		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

	0.2155	0.8650	8.3307	31.6474	61.0803	267.5316	69.6264	300.0439
TRUE	0.2155	0.8650	8.3307	31.6474	61.0803	267.5316	69.6264	300.0439
	chk	chk	chk-15	chk	chk	chk	chk-14	chk

Hazardous Air Pollutants (HAP)/Toxic Air Pollutants (TAP) Emissions Summary - continued

		Emissions[1]									
		Fuel Combustion		Process/Prod/Leach		Mining		Total			
CAS	**Non-HAP TAP**	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	HAP	TAP
7429-90-5	Aluminum	0	0	0.65	2.58	41.11	180.04	41.75	182.62	N	Y
7440-39-3	Barium	2.1E-04	8.4E-04	6.6E-03	2.7E-02	0.46	2.03	0.47	2.06	N	Y
1317-65-3	Calcium Carbonate	0	0	2.24	8.12	8.11	35.50	10.35	43.63	N	Y
1305-78-8	Calcium Oxide	0	0	0.70	0.95	0	0	0.70	0.95	N	Y
7440-50-8	Copper	4.0E-05	1.6E-04	4.9E-04	2.1E-03	2.9E-03	1.3E-02	3.4E-03	1.5E-02	N	Y
110-82-7	Cyclohexane	0	0	1.0E-03	4.6E-03	0	0	1.0E-03	4.6E-03	N	Y
7783-06-4	Hydrogen Sulfide	0	0	0.90	3.94	0	0	0.90	3.94	N	Y
7439-89-6	Iron	0	0	0.21	0.81	10.54	46.15	10.75	46.96	N	Y
7439-98-7	Molybdenum	5.2E-05	2.1E-04	4.2E-04	1.8E-03	5.8E-04	2.5E-03	1.0E-03	4.6E-03	N	Y
109-66-0	Pentane	0.12	0.50	0	0	0	0	0.12	0.50	N	Y
7440-22-4	Silver	0	0	4.1E-04	1.8E-03	2.9E-04	1.3E-03	7.0E-04	3.1E-03	N	Y
7664-93-9	Sulfuric Acid	0	0	2.03	8.89	0	0	2.03	8.89	N	Y
7440-28-0	Thallium	0	0	5.2E-04	2.2E-03	5.8E-03	2.5E-02	6.3E-03	2.8E-02	N	Y
7440-61-1	Uranium	0	0	5.2E-04	2.2E-03	5.8E-03	2.5E-02	6.3E-03	2.8E-02	N	Y
7440-62-2	Vanadium	1.1E-04	4.4E-04	7.3E-04	3.0E-03	1.6E-02	7.1E-02	1.7E-02	7.4E-02	N	Y
25551-13-7	Trimethyl benzene	0	0	1.1E-02	4.8E-02	0	0	1.1E-02	4.8E-02	N	Y
7440-33-7	Tungsten	0	0	5.2E-04	2.2E-03	5.8E-03	2.5E-02	6.3E-03	2.8E-02	N	Y
7440-66-6	Zinc	1.4E-03	5.5E-03	8.0E-04	3.3E-03	2.0E-02	8.9E-02	2.2E-02	9.8E-02	N	Y
Total Non-HAP TAP		0.13	0.50	6.75	25.40	60.27	263.98	67.15	289.88		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

Conversions

2,000 lb/ton
8,760 hr/yr
24 hr/day

PROPANE COMBUSTION

Source Data

Source ID	Description	MMBtu/day	MMBtu/yr
Lime Process Heating			
LKC	PFR Shaft Lime Kiln Combustion	529.0	163,935
Ore Process Heating			
ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	17.0	510
CKB	Carbon Regeneration Kiln (Burners)	54.1	19,754
PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	2.4	876
HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	120.0	43,800
Subtotal		193.5	64,940
HVAC			
H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	96.0	35,040
H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	96.0	35,040
HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	96.0	35,040
HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	6.0	2,190
HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	12.0	4,380
HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	48.0	17,520
HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	72.0	26,280
Subtotal		438.0	159,870

PROPANE COMBUSTION - CONTINUED

HAP/TAP Emission Factors and Emissions

O.Heat_pph O.Heat_tpy L.Heat_pph L.Heat_tpy HVAC_pph HVAC_tpy lb/hr ton/yr

		Emission Factor[2]		Emissions[1] Ore Proc Heat		Lime Proc Heat		HVAC		Total			
CAS	Pollutant	lb/MMscf	lb/MMBtu[3]	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	TAP	A/C
91-57-6	2-Methylnaphthalene	2.4E-05	2.35E-8	1.9E-07	7.6E-07	5.2E-07	1.9E-06	4.3E-07	1.9E-06	1.1E-06	4.6E-06	N	
56-49-5	3-Methylchloranthrene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
57-97-6	7,12-Dimethylbenz(a)ant	< 1.6E-05	1.57E-8	1.3E-07	5.1E-07	3.5E-07	1.3E-06	2.9E-07	1.3E-06	7.6E-07	3.0E-06	N	
83-32-9	Acenaphthene	< 1.8E-06	1.76E-9	1.4E-08	5.7E-08	3.9E-08	1.4E-07	3.2E-08	1.4E-07	8.5E-08	3.4E-07	N	
208-96-8	Acenaphthylene	< 1.8E-06	1.76E-9	1.4E-08	5.7E-08	3.9E-08	1.4E-07	3.2E-08	1.4E-07	8.5E-08	3.4E-07	N	
120-12-7	Anthracene	< 2.4E-06	2.35E-9	1.9E-08	7.6E-08	5.2E-08	1.9E-07	4.3E-08	1.9E-07	1.1E-07	4.6E-07	N	
7440-38-2	Arsenic	2.0E-04	1.96E-7	1.5E-06	6.4E-06	3.7E-06	1.6E-05	3.6E-06	1.6E-05	8.7E-06	3.8E-05	Y	C
56-55-3	Benz(a)anthracene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
71-43-2	Benzene	2.1E-03	2.06E-6	1.5E-05	6.7E-05	3.9E-05	1.7E-04	3.8E-05	1.6E-04	9.1E-05	4.0E-04	Y	C
50-32-8	Benzo(a)pyrene	< 1.2E-06	1.18E-9	8.7E-09	3.8E-08	2.2E-08	9.6E-08	2.1E-08	9.4E-08	5.2E-08	2.3E-07	Y	C
205-99-2	Benzo(b)fluoranthene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
191-24-2	Benzo(g,h,i)perylene	< 1.2E-06	1.18E-9	9.5E-09	3.8E-08	2.6E-08	9.6E-08	2.1E-08	9.4E-08	5.7E-08	2.3E-07	N	
207-08-9	Benzo(k)fluoranthene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
7440-41-7	Beryllium	< 1.2E-05	1.18E-8	8.7E-08	3.8E-07	2.2E-07	9.6E-07	2.1E-07	9.4E-07	5.2E-07	2.3E-06	Y	C
7440-43-9	Cadmium	1.1E-03	1.08E-6	8.0E-06	3.5E-05	2.0E-05	8.8E-05	2.0E-05	8.6E-05	4.8E-05	2.1E-04	Y	C
7440-47-3	Chromium	1.4E-03	1.37E-6	1.1E-05	4.5E-05	3.0E-05	1.1E-04	2.5E-05	1.1E-04	6.6E-05	2.7E-04	Y	A
218-01-9	Chrysene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
7440-48-4	Cobalt	8.4E-05	8.24E-8	6.6E-07	2.7E-06	1.8E-06	6.8E-06	1.5E-06	6.6E-06	4.0E-06	1.6E-05	Y	A
53-70-3	Dibenzo(a,h)anthracene	< 1.2E-06	1.18E-9	8.7E-09	3.8E-08	2.2E-08	9.6E-08	2.1E-08	9.4E-08	5.2E-08	2.3E-07	Y	C
106-46-7	Dichlorobenzene	1.2E-03	1.18E-6	9.5E-06	3.8E-05	2.6E-05	9.6E-05	2.1E-05	9.4E-05	5.7E-05	2.3E-04	Y	A
206-44-0	Fluoranthene	3.0E-06	2.94E-9	2.4E-08	9.5E-08	6.5E-08	2.4E-07	5.4E-08	2.4E-07	1.4E-07	5.7E-07	N	
86-73-7	Fluorene	2.8E-06	2.75E-9	2.2E-08	8.9E-08	6.1E-08	2.3E-07	5.0E-08	2.2E-07	1.3E-07	5.3E-07	N	
50-00-0	Formaldehyde	7.5E-02	7.35E-5	5.5E-04	2.4E-03	1.4E-03	6.0E-03	1.3E-03	5.9E-03	3.3E-03	1.4E-02	Y	C
110-54-3	Hexane	1.8E+00	1.76E-3	1.4E-02	5.7E-02	3.9E-02	1.4E-01	3.2E-02	1.4E-01	8.5E-02	3.4E-01	Y	A
193-39-5	Indeno(1,2,3-cd)pyrene	< 1.8E-06	1.76E-9	1.3E-08	5.7E-08	3.3E-08	1.4E-07	3.2E-08	1.4E-07	7.8E-08	3.4E-07	Y	C
7439-96-5	Manganese	3.8E-04	3.73E-7	3.0E-06	1.2E-05	8.2E-06	3.1E-05	6.8E-06	3.0E-05	1.8E-05	7.2E-05	Y	A
7439-97-6	Mercury	2.6E-04	2.55E-7	2.1E-06	8.3E-06	5.6E-06	2.1E-05	4.7E-06	2.0E-05	1.2E-05	5.0E-05	N	
91-20-3	Naphthalene	6.1E-04	5.98E-7	4.8E-06	1.9E-05	1.3E-05	4.9E-05	1.1E-05	4.8E-05	2.9E-05	1.2E-04	Y	A
7440-02-0	Nickel	2.1E-03	2.06E-6	1.5E-05	6.7E-05	3.9E-05	1.7E-04	3.8E-05	1.6E-04	9.1E-05	4.0E-04	Y	C
85-01-8	Phenanthrene	1.7E-05	1.67E-8	1.3E-07	5.4E-07	3.7E-07	1.4E-06	3.0E-07	1.3E-06	8.1E-07	3.2E-06	N	
129-00-0	Pyrene	5.0E-06	4.90E-9	4.0E-08	1.6E-07	1.1E-07	4.0E-07	8.9E-08	3.9E-07	2.4E-07	9.5E-07	N	
7782-49-2	Selenium	< 2.4E-05	2.35E-8	1.9E-07	7.6E-07	5.2E-07	1.9E-06	4.3E-07	1.9E-06	1.1E-06	4.6E-06	Y	A
108-88-3	Toluene	3.4E-03	3.33E-6	2.7E-05	1.1E-04	7.3E-05	2.7E-04	6.1E-05	2.7E-04	1.6E-04	6.5E-04	Y	A
109-66-0	Pentane	2.6E+00	2.55E-3	2.1E-02	8.3E-02	5.6E-02	2.1E-01	4.7E-02	2.0E-01	1.2E-01	5.0E-01	Y	A
7440-39-3	Barium	4.4E-03	4.31E-6	3.5E-05	1.4E-04	9.5E-05	3.5E-04	7.9E-05	3.4E-04	2.1E-04	8.4E-04	Y	A
7440-50-8	Copper	8.5E-04	8.33E-7	6.7E-06	2.7E-05	1.8E-05	6.8E-05	1.5E-05	6.7E-05	4.0E-05	1.6E-04	Y	A
7439-98-7	Molybdenum	1.1E-03	1.08E-6	8.7E-06	3.5E-05	2.4E-05	8.8E-05	2.0E-05	8.6E-05	5.2E-05	2.1E-04	Y	A
7440-62-2	Vanadium	2.3E-03	2.25E-6	1.8E-05	7.3E-05	5.0E-05	1.8E-04	4.1E-05	1.8E-04	1.1E-04	4.4E-04	Y	A
7440-66-6	Zinc	2.9E-02	2.84E-5	2.3E-04	9.2E-04	6.3E-04	2.3E-03	5.2E-04	2.3E-03	1.4E-03	5.5E-03	Y	A
Total				3.6E-02	1.4E-01	9.8E-02	3.6E-01	8.1E-02	3.5E-01	2.1E-01	8.6E-01		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *AP-42, Table 1.4-3 & 1.4-4 (7/98) Natural Gas Combustion* 1.0766 1.0766

(3) *Natural Gas Higher Heating Value* 1,020 *MMBtu/MMscf* chk

DIESEL COMBUSTION

Source Data

Source ID	Description	Power Rating kW	Power Rating hp	Operation hr/day	Operation hr/yr	Fuel Consumption[1] & [2] MMBtu/day	Fuel Consumption[1] & [2] MMBtu/yr
EDG1	Camp Emergency Generator	1,000	1,341	1	100	9.39	938.70
EDG2	Plant Emergency Generator #1	1,000	1,341	1	100	9.39	938.7
EDG3	Plant Emergency Generator #2	1,000	1,341	1	100	9.39	938.7
EDFP	Mill Fire Pump	200	268	1	100	1.88	187.7
Total						30.0	3,003.8

[1] *Based on brake specific fuel consumption for diesel generators* 7,000 *Btu/hp-hr* *AP-42 Tbl 3.3-1*

[2] *Heat Content of* 0.137 *MMBtu/gal* 1E+6 *Btu/MMBtu* 1.341 *hp/kW*

HAP/TAP Emission Factors and Emissions

	Pollutant	Factor (lb/MMBtu) ≤600 hp[2]	Factor (lb/MMBtu) >600hp[3]	Emissions (≤600 hp) lb/hr	Emissions (≤600 hp) ton/yr	Emissions (>600 hp) lb/hr	Emissions (>600 hp) ton/yr	Total Emissions[1] lb/hr	Total Emissions[1] ton/yr	TAP	A/C
106-99-0	1,3-Butadiene	< 3.9E-05		8.4E-07	3.7E-06	0.0E+00	0.0E+00	8.4E-07	3.7E-06	Y	C
83-32-9	Acenaphthene	< 1.4E-06	4.7E-06	1.1E-07	1.3E-07	5.5E-06	6.6E-06	5.6E-06	6.7E-06	N	
208-96-8	Acenaphthylene	< 5.1E-06	9.2E-06	4.0E-07	4.7E-07	1.1E-05	1.3E-05	1.1E-05	1.3E-05	N	
75-07-0	Acetaldehyde	7.7E-04	2.5E-05	1.6E-05	7.2E-05	8.1E-06	3.5E-05	2.5E-05	1.1E-04	Y	C
107-02-8	Acrolein	< 9.3E-05	7.9E-06	7.2E-06	8.7E-06	9.2E-06	1.1E-05	1.6E-05	2.0E-05	Y	A
120-12-7	Anthracene	1.9E-06	1.2E-06	1.5E-07	1.8E-07	1.4E-06	1.7E-06	1.6E-06	1.9E-06	N	
56-55-3	Benz(a)anthracene	1.7E-06	6.2E-07	3.6E-08	1.6E-07	2.0E-07	8.8E-07	2.4E-07	1.0E-06	Y	C
71-43-2	Benzene	9.3E-04	7.8E-04	2.0E-05	8.8E-05	2.5E-04	1.1E-03	2.7E-04	1.2E-03	Y	C
50-32-8	Benzo(a)pyrene	< 1.9E-07	< 2.6E-07	4.0E-09	1.8E-08	8.3E-08	3.6E-07	8.7E-08	3.8E-07	Y	C
205-99-2	Benzo(b)fluoranthene	< 9.9E-08	< 1.1E-06	2.1E-09	9.3E-09	3.6E-07	1.6E-06	3.6E-07	1.6E-06	Y	C
191-24-2	Benzo(g,h,i)perylene	< 4.9E-07	< 5.6E-07	3.8E-08	4.6E-08	6.5E-07	7.8E-07	6.9E-07	8.3E-07	N	
207-08-9	Benzo(k)fluoranthene	< 1.6E-07	< 2.2E-07	3.3E-09	1.5E-08	7.0E-08	3.1E-07	7.3E-08	3.2E-07	Y	C
218-01-9	Chrysene	3.5E-07	1.5E-06	7.6E-09	3.3E-08	4.9E-07	2.2E-06	5.0E-07	2.2E-06	Y	C
53-70-3	Dibenzo(a,h)anthracene	< 5.8E-07	< 3.5E-07	1.2E-08	5.5E-08	1.1E-07	4.9E-07	1.2E-07	5.4E-07	Y	C
206-44-0	Fluoranthene	7.6E-06	4.0E-06	6.0E-07	7.1E-07	4.7E-06	5.7E-06	5.3E-06	6.4E-06	N	
86-73-7	Fluorene	2.9E-05	1.3E-05	2.3E-06	2.7E-06	1.5E-05	1.8E-05	1.7E-05	2.1E-05	N	
50-00-0	Formaldehyde	1.2E-03	7.9E-05	2.5E-05	1.1E-04	2.5E-05	1.1E-04	5.1E-05	2.2E-04	Y	C
193-39-5	Indeno(1,2,3-cd)pyrene	< 3.8E-07	< 4.1E-07	8.0E-09	3.5E-08	1.3E-07	5.8E-07	1.4E-07	6.2E-07	Y	C
91-20-3	Naphthalene	8.5E-05	1.3E-04	6.6E-06	8.0E-06	1.5E-04	1.8E-04	1.6E-04	1.9E-04	Y	A
85-01-8	Phenanthrene	2.9E-05	4.1E-05	2.3E-06	2.8E-06	4.8E-05	5.7E-05	5.0E-05	6.0E-05	N	
129-00-0	Pyrene	4.8E-06	3.7E-06	3.7E-07	4.5E-07	4.4E-06	5.2E-06	4.7E-06	5.7E-06	N	
108-88-3	Toluene	4.1E-04	2.8E-04	3.2E-05	3.8E-05	3.3E-04	4.0E-04	3.6E-04	4.3E-04	Y	A
1330-20-7	Xylene	2.9E-04	1.9E-04	2.2E-05	2.7E-05	2.3E-04	2.7E-04	2.5E-04	3.0E-04	Y	A
Total				1.4E-04	3.6E-04	1.1E-03	2.2E-03	1.2E-03	2.6E-03		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *AP-42, Tab. 3.3-2, 10/96, diesel engines (≤ 600 hp)*

[3] *AP-42, Tabs. 3.4-3 & 3.4-4, 10/96, large diesel engines (> 600 hp)*

ORE PROCESSING

Source Data

Source ID	Description	PM Emissions lb/day	PM Emissions ton/yr
OC1	Loader Transfer of Ore to Grizzly	3.500	0.639
OC2	Grizzly to Apron Feeder	3.500	0.639
OC3	Apron Feeder to Dribble Conveyor	3.500	0.639
OC4	Apron Feeder to Vibrating Grizzly	3.500	0.639
OC5	Dribble Conveyor to Vibrating Grizzly	3.500	0.639
OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	3.500	0.639
OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	30.000	5.475
OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	3.500	0.639
OC9	Stockpile Transfers to Reclaim Conveyors	16.560	3.022
OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	16.560	3.022
OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	16.560	3.022
OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge C	33.120	6.044
OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	3.864	0.705
Total		141.164	25.762

HAP/TAP Emission Factors and Emissions

CAS No.	Pollutant	Concentration ppm[2]	Emissions[1] lb/hr	Emissions[1] ton/yr	TAP	A/C
7440-38-2	Arsenic	667	3.9E-03	1.7E-02	Y	C
7440-41-7	Beryllium	3.2	1.9E-05	8.2E-05	Y	C
7440-43-9	Cadmium	0.50	2.9E-06	1.3E-05	Y	C
7440-48-4	Cobalt	4	2.4E-05	1.0E-04	Y	A
7440-47-3	Chromium	9	5.3E-05	2.3E-04	Y	A
7439-97-6	Mercury [3]	0.96	5.6E-06	2.5E-05	N	
7439-96-5	Manganese	299	1.8E-03	7.7E-03	Y	A
7440-02-0	Nickel	2	1.2E-05	5.2E-05	Y	C
7439-92-1	Lead	8	4.7E-05	2.1E-04	N	
7440-36-0	Antimony	23	1.4E-04	5.9E-04	Y	A
7723-14-0	Phosphorus	650	3.8E-03	1.7E-02	Y	A
7782-49-2	Selenium [4]	0.40	2.4E-06	1.0E-05	Y	A
7440-22-4	Silver	0.50	2.9E-06	1.3E-05	Y	A
7429-90-5	Aluminum	71,000	4.2E-01	1.8E+00	Y	A
7440-39-3	Barium	800	4.7E-03	2.1E-02	Y	A
1317-65-3	Calcium Carbonate	14,000	8.2E-02	3.6E-01	Y	A
7440-50-8	Copper	5	2.9E-05	1.3E-04	Y	A
7439-89-6	Iron [4]	18,200	1.1E-01	4.7E-01	Y	A
7439-98-7	Molybdenum	1	5.9E-06	2.6E-05	Y	A
7440-28-0	Thallium	10	5.9E-05	2.6E-04	Y	A
7440-61-1	Uranium	10	5.9E-05	2.6E-04	Y	A
7440-62-2	Vanadium	28	1.6E-04	7.2E-04	Y	A
7440-33-7	Tungsten	10	5.9E-05	2.6E-04	Y	A
7440-66-6	Zinc	35	2.1E-04	9.0E-04	Y	A
Total			6.2E-01	2.7E+00		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *(Midas Gold 2017c) Median concentration of 55,000 SGP samples.*

(3) *(Midas Gold 2018e) Median ore concentration of 151,000 SGP samples; resource block model.*

(4) *(Midas Gold 2020) Median concentration of 56,000 SGP samples for Fe and 1,500 SGP samples for Se.*

1E+6 parts/ppm

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis
	PROJECT NO: 335-20-3	PAGE: 7 OF: 19 SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021

ORE CONCETRATION AND REFINING

Source Data

Source ID	Description	Subpart 7E Allowable Limit lb/yr[1]	Oper. hr/yr	% of Subpart 7E for Controlled Systems %	Controlled Hg Emissions lb/hr	ton/yr	lb/yr
AC	Autoclave	213.4	8,760	[2]	0.000023	0.00010	0.20
EW,MR,MF,CKD	Refinery Sources (C. Kiln, EW, Retort, Furn	16.8		20% [3]	0.000384	0.00168	3.36
7439-97-6 Mercury	Total	230.2			0.000407	0.00178	3.56

[1] *Subpart 7E Limit - Ore Pretreatment Processes (CFR 2018b)*

$$\frac{84\ lb}{MMton} \times \frac{2{,}540{,}400\ ton}{yr} \times \frac{MMton}{1.0E{+}6\ ton} = \frac{213.4\ lb}{yr}$$

[1] *Subpart 7E Limit - Carbon Processes with Mercury Retorts*

$$\frac{0.8\ lb}{ton} \times \frac{21\ ton}{yr} = \frac{16.8\ lb}{yr}$$

[2] *Controlled SysCAD modeled emissions from Autoclave:* 0.0105 g/hr 2.3E-05 lb/hr 0.20 lb/yr (M3 2019)

[3] *Based on similar source (but with much higher ore Hg content) Hg reporting levels provided below:*

Goldstrike Refinery (2015 & 2016 Hg Reports) *(NDEP 2015a) (NDEP 2016)*

$$\frac{28.79\ lb}{yr} \times \frac{yr}{251.00\ ton} = \frac{0.11\ lb}{MMton} \times \frac{ton}{0.8\ lb} = 14.3\%$$

Twin Creeks Refinery (2015 & 2016 Hg Reports) *(NDEP 2015a) (NDEP 2016)*

$$\frac{31.27\ lb}{yr} \times \frac{yr}{142.77\ ton} = \frac{0.22\ lb}{MMton} \times \frac{ton}{0.8\ lb} = 27.4\%$$

HAP/TAP Emission Factors and Emission

AC_pph AC_tpy Refin_pph Refin_tpy lb/hr ton/yr

CAS No.	Pollutant	Emission Factor[1]	Autoclave lb/hr	Autoclave ton/yr	Refinery lb/hr	Refinery ton/yr	Total Emissions lb/hr	Total Emissions ton/yr	TAP	A/C
7440-38-2	Arsenic	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	C
7440-41-7	Beryllium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	C
7440-43-9	Cadmium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	C
7440-48-4	Cobalt	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-47-3	Chromium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7439-97-6	Mercury	see above	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	N	
7439-96-5	Manganese	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-02-0	Nickel	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	C
7439-92-1	Lead	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	N	
7440-36-0	Antimony	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7723-14-0	Phosphorus	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7782-49-2	Selenium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-22-4	Silver	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7429-90-5	Aluminum	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-39-3	Barium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
1317-65-3	Calcium Carbonate	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-50-8	Copper	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7439-89-6	Iron	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7439-98-7	Molybdenum	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-28-0	Thallium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-61-1	Uranium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-62-2	Vanadium	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-33-7	Tungsten	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
7440-66-6	Zinc	same as Hg	2.3E-05	1.0E-04	3.8E-04	1.7E-03	4.1E-04	1.8E-03	Y	A
Total			5.5E-04	2.4E-03	9.2E-03	4.0E-02	9.8E-03	4.3E-02		

[1] *Hg is the most difficult metal to control due to it existing in both particulate and gaseous form. Therefore, all other metals are conservatively estimated to be equal to or less than the Hg emissions.*

0.0525 0.0525 chk

7664-93-9	Sulfuric Acid	Autoclave	2.03	8.89			2.03	8.89
7783-06-4	Hydrogen Sulfid	Autoclave	0.90	3.94			0.90	3.94
592-01-8	Cyanide	Point Sources - 5 EW Cells			0.0012	0.0053	0.00	0.01
Total			2.93	12.84	0.01	0.05	2.94	12.88

ORE CONCETRATION AND REFINING - CONTINUED

Source Data

Source ID	Description	Throughput ton/day	Throughput ton/yr	Operation hr/day	Operation hr/yr
AC	Autoclave	6,960	2,540,400	24	8,760

Autoclave HAP/TAP Emission Factors and Emission lb/hr ton/yr

CAS No.	Pollutant	Emission Factor		Emissions[1] lb/hr	Emissions[1] ton/yr
7664-93-9	Sulfuric Acid	0.007	lb/ton[2]	2.03	8.89
7783-06-4	Hydrogen Sulfide	0.9	lb/hr[3]	0.90	3.94

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *H2SO4 is based on Acidic Autoclave test data (APT 2010)*

[3] *H2S is based on Acidic Autoclave test data (APT 2013)*

LEACHING OPERATION

Cyanide (HCN) Source Data, Emission Factors, and Emissions

Source ID	Description	Dia. ft[1]	pH[1]	Free CN- g/m3[1]	T C[1]	pKa	a0	H	kG[2] m/s	Fa*Fw	g/s	lb/hr	ton/yr
												lb/hr	ton/yr
TSF	***Fugitive Sources***												
TSF	Tailings Maint. Pond	76	7.75	1	3.74	9.803	0.9912	0.0025	1.89E-05	0.641	1.27E-05	0.0001	0.0004
MILLTA	CN Detox Tank 1	40	8.5	25	25	9.250	0.8490	0.0055	0.000311	0.688	0.002891	0.0229	0.101
MILLTA	CN Detox Tank 2	40	8.5	25	25	9.250	0.8490	0.0055	0.000311	0.688	0.002891	0.0229	0.101
MILLTA	CIP Leach Tank 1	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	0.0114	0.050
MILLTA	CIP Leach Tank 2	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	0.0114	0.050
MILLTA	CIP Leach Tank 3	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	0.0114	0.050
MILLTA	CIP Leach Tank 4	52	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.668	0.001435	0.0114	0.050
MILLTA	CIL Tank 1	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIL Tank 2	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIL Tank 3	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIL Tank 4	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIL Tank 5	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIL Tank 6	54	10.25	125	30	9.120	0.0690	0.0065	0.000311	0.666	0.002485	0.0197	0.086
MILLTA	CIP Tank 1	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA	CIP Tank 2	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA	CIP Tank 3	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA	CIP Tank 4	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA	CIP Tank 5	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
MILLTA	CIP Tank 6	20	10.25	125	52.5	8.535	0.0189	0.0148	0.000311	0.742	0.000236	0.0019	0.008
		Acres[1]											
TSF	Tails, Aqueous Surface	110.222	7.75	1	3.74	9.803	0.9912	0.0025	1.89E-05	0.421	0.008845	0.0702	0.307
TSF	Tails, Wet Sediment	110.222							5.31E-08	0.421	0.009961	0.0791	0.346
TSF	Tails, Dry Sediment	110.222							2.33E-08	1	0.010375	0.0823	0.361
		330.666											
592-01-8	Cyanide Fugitive Sources - Subtotal											0.4527	1.983
75-15-0	Carbon Disulfide											0.01446	0.06332
	Point Sources												
EW	EW Cells	[3]										0.0006	0.003
EW	Preg/Barren Tanks	[3]										0.0006	0.003
592-01-8	Cyanide Point Sources - Subtotal											0.0012	0.0053
	Total											0.454	1.988

[1] *(Midas Gold 2016)(M3 2017c)(M3 2017d)*

[2] *The emission factors and caculation methodology are from the EPA directed HCN study: (Card, T. 2009)(EPA 2009)(Schmidt 2010)*

[3] *(APT 2009)*

Carbon Disulfide Emissions from Xanthate Decomposition

CAS No.	Pollutant	Xanthate[1] ton/yr	Molar Decomp.[2]	CS_2 MW Ratio	Temperature Adj. Factor[3]	Emissions lb/hr	Emissions ton/yr
						lb/hr	ton/yr
75-15-0	Carbon Disulfide	1,700	0.99%	0.376	1%	0.0145	0.063

	MW	
Xanthate (PAX)	202.37	$C6H11KOS_2$
Carbon disulfide	76.139	CS_2

[1] *(Midas Gold 2016) p. 12-11*

[2] *(Air Sciences 2020) molar decomposition of xanthate in solution to CS2 gas*

[3] *(Air Sciences 2020) based on the comparison of CS2 generation at 25C and 70C*

Conversions

8,760	hr/yr	453.5929	g/lb
2,000	lb/ton	3.28084	ft/m
4,046.86	m2/acre	3,600	s/hr

Wind adjustment factor Fw 1

Air Sciences Inc.	PROJECT TITLE: Stibnite Gold Project	BY: K. Lewis		
	PROJECT NO: 335-20-3	PAGE: 10	OF: 19	SHEET: Calcs
AIR EMISSION CALCULATIONS	SUBJECT: HAP/TAP Emission Calculations	DATE: October 4, 2021		

LIME PRODUCTION

Source Data

Source ID	Description	Throughput ton/day	Throughput ton/yr	PM Emissions lb/day	PM Emissions ton/yr
LS1	Limestone transfer to Primary Crusher Hopper			3.39	0.48
LS2	Primary Crushing and Associated Transfers In and Out			6.10	0.86
LS3	Primary Screening and Associated Transfers In and Out			28.25	3.97
LS4	Secondary Crushing and Associated Transfers In and Out			6.10	0.86
LS5	Secondary Screening and Associated Transfers In and Out			28.25	3.97
LS6	Limestone transfer to Ball Mill Feed Bin			3.39	0.48
LS7	Limestone transfer to Ball Mill Feed Conveyor			3.39	0.48
LS8	Ball Mill Feed transfer to Ball Mill			3.39	0.48
LSBM	Limestone Ball Mill			45.65	6.42
LS9	Limestone transfer to Kiln Feed Bin			0.80	0.12
LS10	Limestone transfer to Lime Kiln Feed Conveyor			0.80	0.12
LS11	Fines Screening and Associated Transfers In and Out			6.68	1.03
Subtotal LS1-11				136.18	19.28
LS12	Kiln Feed transfer to PFR Shaft Lime Kiln			0.80	0.12
LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	169	52,377	21.97	3.40
Subtotal LS12,LK				22.77	3.53
Total				158.95	22.80

HAP/TAP Emission Factors and Emissions

			LS_pph	LS_tpy	LS12_pph	LS12_tpy	LK_pph	LK_tpy	lb/hr	ton/yr		
		Concentration	LS1-11,LSBM		LS12		Lime Kiln		Emissions[1]			
CAS No.	Pollutant	ppm[2]	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	TAP	A/C
7440-38-2	Arsenic	23	1.01E-04	4.43E-04	6.51E-07	2.85E-06	1.79E-05	7.83E-05	1.20E-04	5.24E-04	Y	C
7440-41-7	Beryllium	0.8	3.52E-06	1.54E-05	2.27E-08	9.92E-08	6.22E-07	2.72E-06	4.17E-06	1.82E-05	Y	C
7440-43-9	Cadmium	0.25	1.10E-06	4.82E-06	7.08E-09	3.10E-08	1.94E-07	8.51E-07	1.30E-06	5.70E-06	Y	C
7440-48-4	Cobalt	4	2.27E-05	7.71E-05	1.34E-07	4.96E-07	3.66E-06	1.36E-05	2.65E-05	9.12E-05	Y	A
7440-47-3	Chromium	15	8.51E-05	2.89E-04	5.01E-07	1.86E-06	1.37E-05	5.11E-05	9.93E-05	3.42E-04	Y	A
7439-97-6	Mercury [3]	0.02	1.13E-07	3.86E-07	6.68E-10	2.48E-09	2.82E-04	1.05E-03	2.82E-04	1.05E-03	N	
7439-96-5	Manganese	236.5	1.34E-03	4.56E-03	7.89E-06	2.93E-05	2.16E-04	8.05E-04	1.57E-03	5.39E-03	Y	A
7440-02-0	Nickel	5	2.20E-05	9.64E-05	1.42E-07	6.20E-07	3.89E-06	1.70E-05	2.60E-05	1.14E-04	Y	C
7439-92-1	Lead	3	1.70E-05	5.78E-05	1.00E-07	3.72E-07	2.75E-06	1.02E-05	1.99E-05	6.84E-05	N	
7440-36-0	Antimony	2.5	1.42E-05	4.82E-05	8.34E-08	3.10E-07	2.29E-06	8.51E-06	1.66E-05	5.70E-05	Y	A
7723-14-0	Phosphorus	130	7.38E-04	2.51E-03	4.34E-06	1.61E-05	1.19E-04	4.43E-04	8.61E-04	2.96E-03	Y	A
7440-22-4	Silver	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	Y	A
7429-90-5	Aluminum	22600	1.28E-01	4.36E-01	7.54E-04	2.80E-03	2.07E-02	7.69E-02	1.50E-01	5.15E-01	Y	A
7440-39-3	Barium	145	8.23E-04	2.79E-03	4.84E-06	1.80E-05	1.33E-04	4.94E-04	9.60E-04	3.31E-03	Y	A
1317-65-3	Calcium Carbonate	274500	1.56E+00	5.29E+00	9.16E-03	3.40E-02	2.51E-01	9.35E-01	1.82E+00	6.26E+00	Y	A
7440-50-8	Copper	5	2.84E-05	9.64E-05	1.67E-07	6.20E-07	4.58E-06	1.70E-05	3.31E-05	1.14E-04	Y	A
7439-89-6	Iron	10350	5.87E-02	1.99E-01	3.45E-04	1.28E-03	9.47E-03	3.52E-02	6.85E-02	2.36E-01	Y	A
7439-98-7	Molybdenum	0.5	2.84E-06	9.64E-06	1.67E-08	6.20E-08	4.58E-07	1.70E-06	3.31E-06	1.14E-05	Y	A
7440-28-0	Thallium	5	2.84E-05	9.64E-05	1.67E-07	6.20E-07	4.58E-06	1.70E-05	3.31E-05	1.14E-04	Y	A
7440-61-1	Uranium	5	2.84E-05	9.64E-05	1.67E-07	6.20E-07	4.58E-06	1.70E-05	3.31E-05	1.14E-04	Y	A
7440-62-2	Vanadium	15.5	8.79E-05	2.99E-04	5.17E-07	1.92E-06	1.42E-05	5.28E-05	1.03E-04	3.53E-04	Y	A
7440-33-7	Tungsten	5	2.84E-05	9.64E-05	1.67E-07	6.20E-07	4.58E-06	1.70E-05	3.31E-05	1.14E-04	Y	A
7440-66-6	Zinc	18	1.02E-04	3.47E-04	6.01E-07	2.23E-06	1.65E-05	6.13E-05	1.19E-04	4.10E-04	Y	A
Subtotal			1.75E+00	5.94E+00	1.03E-02	3.82E-02	2.82E-01	1.05E+00	2.04E+00	7.03E+00	9.0667	9.0667
7647-01-0	Hydrogen Chloride	0.14 lb/ton product[4]					0.99	3.67	0.99	3.67		chk

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *(M3 2018) Median concentrations of SGP limestone material. Metals with medians below the detection limit (DL) are set to 1/2DL.*

[3] *Hg emissions from the Lime Kiln are conservatively estimated assuming 100% volatilization of all Hg in the limestone*

[4] *(EPA 1999b)*

1E+6 parts/ppm

LIME PRODUCTION - CONTINUED

Source Data

Source ID	Description	PM Emissions lb/day	PM Emissions ton/yr
LS1L	Mill Lime Silo #1 Loading	0.248	0.002
LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	1.200	0.011
MillS2L	Mill Lime Silo #2 Loading	0.248	0.002
MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	1.200	0.011
ACS1L	AC Lime Silo #1 Loading	0.990	0.009
ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.304	0.042
ACS2L	AC Lime Silo #2 Loading	0.990	0.009
ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.304	0.042
ACS3L	AC Lime Silo #3 Loading	0.990	0.009
ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.304	0.042
ACS4L	AC Lime Silo #4 Loading	0.495	0.004
ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	2.304	0.021
Subtotal - Mill & AC Lime Silos		15.576	0.203
LCR	Lime Mill Crushing and associated transfers In and Out	6.828	1.058
LSL	Pebble Lime Silo Loading via Bucket Elevator	0.149	0.023
LSU	Pebble Lime Silo discharge to Lime Slaker	0.015	0.002
Subtotal - Lime Mfg		6.991	1.083
Total		22.567	1.286

HAP/TAP Emission Factors and Emissions

CAS No.	Pollutant	Concentration ppm[2]	Mill and AC lb/hr	Mill and AC ton/yr	Lime Mfg lb/hr	Lime Mfg ton/yr	Emissions[1] lb/hr	Emissions[1] ton/yr	TAP	A/C
7440-38-2	Arsenic	23	1.06E-06	4.66E-06	5.69E-06	2.49E-05	6.75E-06	2.96E-05	Y	C
7440-41-7	Beryllium	0.8	3.70E-08	1.62E-07	1.98E-07	8.67E-07	2.35E-07	1.03E-06	Y	C
7440-43-9	Cadmium	0.25	1.16E-08	5.07E-08	6.18E-08	2.71E-07	7.34E-08	3.22E-07	Y	C
7440-48-4	Cobalt	4	2.60E-06	8.11E-07	1.17E-06	4.33E-06	3.76E-06	5.14E-06	Y	A
7440-47-3	Chromium	15	9.74E-06	3.04E-06	4.37E-06	1.63E-05	1.41E-05	1.93E-05	Y	A
7439-97-6	Mercury	0.02	1.30E-08	4.05E-09	5.83E-09	2.17E-08	1.88E-08	2.57E-08	N	
7439-96-5	Manganese	236.5	1.53E-04	4.79E-05	6.89E-05	2.56E-04	2.22E-04	3.04E-04	Y	A
7440-02-0	Nickel	5	2.31E-07	1.01E-06	1.24E-06	5.42E-06	1.47E-06	6.43E-06	Y	C
7439-92-1	Lead	3	1.95E-06	6.08E-07	8.74E-07	3.25E-06	2.82E-06	3.86E-06	N	
7440-36-0	Antimony	2.5	1.62E-06	5.07E-07	7.28E-07	2.71E-06	2.35E-06	3.22E-06	Y	A
7723-14-0	Phosphorus	130	8.44E-05	2.63E-05	3.79E-05	1.41E-04	1.22E-04	1.67E-04	Y	A
7440-22-4	Silver	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	Y	A
7429-90-5	Aluminum	22,600	1.47E-02	4.58E-03	6.58E-03	2.45E-02	2.13E-02	2.91E-02	Y	A
7440-39-3	Barium	145	9.41E-05	2.94E-05	4.22E-05	1.57E-04	1.36E-04	1.86E-04	Y	A
1305-78-8	Calcium Oxide	740,000 [3]	4.80E-01	1.50E-01	2.16E-01	8.02E-01	6.96E-01	9.52E-01	Y	A
7440-50-8	Copper	5	3.25E-06	1.01E-06	1.46E-06	5.42E-06	4.70E-06	6.43E-06	Y	A
7439-89-6	Iron	10350	6.72E-03	2.10E-03	3.01E-03	1.12E-02	9.73E-03	1.33E-02	Y	A
7439-98-7	Molybdenum	0.5	3.25E-07	1.01E-07	1.46E-07	5.42E-07	4.70E-07	6.43E-07	Y	A
7440-28-0	Thallium	5	3.25E-06	1.01E-06	1.46E-06	5.42E-06	4.70E-06	6.43E-06	Y	A
7440-61-1	Uranium	5	3.25E-06	1.01E-06	1.46E-06	5.42E-06	4.70E-06	6.43E-06	Y	A
7440-62-2	Vanadium	15.5	1.01E-05	3.14E-06	4.52E-06	1.68E-05	1.46E-05	1.99E-05	Y	A
7440-33-7	Tungsten	5	3.25E-06	1.01E-06	1.46E-06	5.42E-06	4.70E-06	6.43E-06	Y	A
7440-66-6	Zinc	18	1.17E-05	3.65E-06	5.24E-06	1.95E-05	1.69E-05	2.31E-05	Y	A
Total			5.02E-01	1.57E-01	2.25E-01	8.38E-01	7.27E-01	9.95E-01		

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

[2] *See LIME PRODUCTION, page 10*

[3] *(NLA 2007) 40% to 74% CaO in lime*

1E+6 parts/ppm

AGGREGATE PRODUCTION

Source Data

PM_ppd PM_tpy

Source ID	description Description	PM Emissions lb/day	ton/yr
PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conve	15.00	2.74
PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conve	15.00	2.74
Total		30.00	5.48

HAP/TAP Emission Factors and Emissions

lb/hr ton/yr

CAS No.	Pollutant	Concentration ppm[2]	Emissions[1] lb/hr	ton/yr	TAP	A/C
7440-38-2	Arsenic	23	2.88E-05	1.26E-04	Y	C
7440-41-7	Beryllium	0.8	1.00E-06	4.38E-06	Y	C
7440-43-9	Cadmium	0.25	3.13E-07	1.37E-06	Y	C
7440-48-4	Cobalt	4	5.00E-06	2.19E-05	Y	A
7440-47-3	Chromium	15	1.88E-05	8.21E-05	Y	A
7439-97-6	Mercury	0.02	2.50E-08	1.10E-07	N	
7439-96-5	Manganese	236.5	2.96E-04	1.29E-03	Y	A
7440-02-0	Nickel	5	6.25E-06	2.74E-05	Y	C
7439-92-1	Lead	3	3.75E-06	1.64E-05	N	
7440-36-0	Antimony	2.5	3.13E-06	1.37E-05	Y	A
7723-14-0	Phosphorus	130	1.63E-04	7.12E-04	Y	A
7440-22-4	Silver	0	0.00E+00	0.00E+00	Y	A
7429-90-5	Aluminum	22600	2.83E-02	1.24E-01	Y	A
7440-39-3	Barium	145	1.81E-04	7.94E-04	Y	A
1317-65-3	Calcium Carbonate	274500	3.43E-01	1.50E+00	Y	A
7440-50-8	Copper	5	6.25E-06	2.74E-05	Y	A
7439-89-6	Iron	10350	1.29E-02	5.67E-02	Y	A
7439-98-7	Molybdenum	0.5	6.25E-07	2.74E-06	Y	A
7440-28-0	Thallium	5	6.25E-06	2.74E-05	Y	A
7440-61-1	Uranium	5	6.25E-06	2.74E-05	Y	A
7440-62-2	Vanadium	15.5	1.94E-05	8.49E-05	Y	A
7440-33-7	Tungsten	5	6.25E-06	2.74E-05	Y	A
7440-66-6	Zinc	18	2.25E-05	9.86E-05	Y	A
Total			3.85E-01	1.69E+00		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *See LIME PRODUCTION, page 10*

1E+6 parts/ppm

CONCRETE PRODUCTION

Source Data

TP_unit/day TP_unit/yr

Source ID	description Description	Throughput ton/day	ton/yr
CS1L	Cement/Shotcrete Silo #1 Loading	164	60,000
CS1U	Cement/Shotcrete Silo #1 Unloading	164	60,000
CS2L	Cement/Shotcrete Silo #2 Loading	164	60,000
CS2U	Cement/Shotcrete Silo #2 Unloading	164	60,000
CM	Central Mixer Loading	164	60,000
	Subtotal Cement Silo Filling	658	240,000
	Subtotal Central Mix Batching	164	60,000

HAP/TAP Emission Factors and Emissions

CF_pph CF_tpy CM_pph CM_tpy lb/hr ton/yr

CAS No.	HAP/TAP	Silo Fill lb/ton[2]	Central Mixer lb/ton[3]	Cement Silo L/U lb/hr	Cement Silo L/U ton/yr	Central Mix Batching lb/hr	Central Mix Batching ton/yr	Total Emissions[3] lb/hr	Total Emissions[3] ton/yr	TAP	A/C
7440-38-2	Arsenic	4.24E-09	2.96E-07	1.16E-7	5.09E-7	2.03E-6	8.88E-6	2.14E-6	9.39E-6	Y	C
7440-41-7	Beryllium	4.86E-10		1.33E-8	5.83E-8	--	--	1.33E-8	5.83E-8	Y	C
7440-43-9	Cadmium		7.10E-10	--	--	4.86E-9	2.13E-8	4.86E-9	2.13E-8	Y	C
7440-47-3	Chromium	2.90E-08	1.27E-07	7.95E-7	3.48E-6	8.70E-7	3.81E-6	1.66E-6	7.29E-6	Y	A
18540-29-9	Cr (VI)	5.80E-09	2.70E-08	1.59E-7	6.96E-7	1.85E-7	8.11E-7	3.44E-7	1.51E-6	Y	C
7439-92-1	Lead	1.09E-08	3.66E-08	2.99E-7	1.31E-6	2.51E-7	1.10E-6	5.49E-7	2.41E-6	N	
7439-96-5	Manganese	1.17E-07	3.78E-06	3.21E-6	1.40E-5	2.59E-5	1.13E-4	2.91E-5	1.27E-4	Y	A
7440-02-0	Nickel	4.18E-08	2.48E-07	1.15E-6	5.02E-6	1.70E-6	7.44E-6	2.84E-6	1.25E-5	Y	C
7723-14-0	Phosphorus		1.20E-06	--	--	8.22E-6	3.60E-5	8.22E-6	3.60E-5	Y	A
Total				5.73E-6	2.51E-5	3.91E-5	1.71E-4	4.49E-5	1.97E-4		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *AP-42, Table 11.12-8, (06/06) Cement Silo Filing, Controlled.* 20% *Cr (VI), IDEQ email on 11/23/2020* 0.0002 0.0002

(3) *AP-42, Table 11.12-8, (06/06) Central Mix Batching, Controlled.* 21.29% *Cr (VI), IDEQ email on 11/23/2020* chk

Conversions

24 hr/day

CONCRETE PRODUCTION - CONTINUED

Source Data

PM_ppd PM_tpy

description

Source ID	Description	PM Emissions lb/day	PM Emissions ton/yr
CAL	Aggregate Bin Loading	16.56	1.73
CAU	Aggregate Bin Unloading	16.56	1.73
Total		33.12	3.45

HAP/TAP Emission Factors and Emissions

lb/hr ton/yr

CAS No.	Pollutant	Concentration ppm[2]	Emissions[1] lb/hr	Emissions[1] ton/yr	TAP	A/C
7440-38-2	Arsenic	23	1.81E-05	7.94E-05	Y	C
7440-41-7	Beryllium	0.8	6.30E-07	2.76E-06	Y	C
7440-43-9	Cadmium	0.25	1.97E-07	8.63E-07	Y	C
7440-48-4	Cobalt	4	5.52E-06	1.38E-05	Y	A
7440-47-3	Chromium	15	2.07E-05	5.18E-05	Y	A
7439-97-6	Mercury	0.02	2.76E-08	6.90E-08	N	
7439-96-5	Manganese	236.5	3.26E-04	8.16E-04	Y	A
7440-02-0	Nickel	5	3.94E-06	1.73E-05	Y	C
7439-92-1	Lead	3	4.14E-06	1.04E-05	N	
7440-36-0	Antimony	2.5	3.45E-06	8.63E-06	Y	A
7723-14-0	Phosphorus	130	1.79E-04	4.49E-04	Y	A
7440-22-4	Silver	0	0.00E+00	0.00E+00	Y	A
7429-90-5	Aluminum	22600	3.12E-02	7.80E-02	Y	A
7440-39-3	Barium	145	2.00E-04	5.00E-04	Y	A
7440-50-8	Copper	5	6.90E-06	1.73E-05	Y	A
7439-89-6	Iron	10350	1.43E-02	3.57E-02	Y	A
7439-98-7	Molybdenum	0.5	6.90E-07	1.73E-06	Y	A
7440-28-0	Thallium	5	6.90E-06	1.73E-05	Y	A
7440-61-1	Uranium	5	6.90E-06	1.73E-05	Y	A
7440-62-2	Vanadium	15.5	2.14E-05	5.35E-05	Y	A
7440-33-7	Tungsten	5	6.90E-06	1.73E-05	Y	A
7440-66-6	Zinc	18	2.48E-05	6.21E-05	Y	A
Total			4.63E-02	1.16E-01		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *See LIME PRODUCTION, page 10*

1E+6 parts/ppm

FUEL STORAGE - GASOLINE

Source Data

Source ID	Description	VOC Emissions lb/day	VOC Emissions ton/yr
TG1	Mine Site Gasoline Tank #1	5.25	0.96
TG2	Mine Site Gasoline Tank #2	5.25	0.96
Total		10.49	1.91

HAP/TAP Emission Factors and Emissions

CAS No.	Pollutant	Concentration wt. %[2]	Emissions[1] lb/hr	Emissions[1] ton/yr	TAP	A/C
71-43-2	Benzene	1.608%	7.03E-03	3.08E-02	Y	C
92-52-4	Biphenyl	0.010%	4.37E-05	1.91E-04	Y	A
110-82-7	Cyclohexane	0.240%	1.05E-03	4.60E-03	Y	A
110-54-3	Hexane	7.138%	3.12E-02	1.37E-01	Y	A
91-20-3	Naphthalene	0.444%	1.94E-03	8.50E-03	Y	A
108-95-2	Phenol	0.055%	2.40E-04	1.05E-03	Y	A
108-88-3	Toluene	7.212%	3.15E-02	1.38E-01	Y	A
25551-13-7	Trimethyl benzene	2.500%	1.09E-02	4.79E-02	Y	A
1330-20-7	Xylene	7.170%	3.13E-02	1.37E-01	Y	A
Total			1.15E-01	5.05E-01		

(1) *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.*

(2) *(EPA 1999a)*

MINING FUGITIVE EMISSIONS

Dust Emissions

Source Data **Model Scenario** **W3** **T-RACT Emissions**

Operating schedule 365 day/yr

Clean rock cap (CR) >50% [1]

[1] *(Perpetua 2021h) Percent of VMTs on haul roads capped with CR*

Roads outside of the pits and DRSFs are capped with CR

Source ID	Description	PM Emissions lb/day	PM Emissions ton/yr
YPP	Yellow Pine Pit	--	--
HFP	Hangar Flats Pit	--	--
WEP	West End Pit	338.16	61.71
BT	Bradley Tailings	--	--
YPPBL	Yellow Pine Pit Blasting	--	--
HFPBL	Hangar Flats Pit Blasting	--	--
WEPBL	West End Pit Blasting	643.03	117.35
BTBL	Bradley Tailings Blasting	--	--
STKP	PC Stockpile	--	--
FDRSF	Fiddle DRSF	--	--
HFDRSF	Hangar Flats DRSF	152.12	27.76
YPDRSF	Yellow Pine DRSF	--	--
WEDRSF	West End DRSF	--	--
HR000	Haul Roads	12,723.41	2,322.02
TSF	Tailing Storage Facility	--	--
ACCRD	Access Roads	38.10	6.95
UGEXP	Scout Portal	0.008	0.002
Total		13,894.82	2,535.81

TSF, ACCRD, UGEXP 38.11 6.95 chk 2535.81

HAP/TAP Emission Factors

CAS No.	Pollutant	ORE ppm[1]	DR ppm[1]	CR ppm[3]	HRD ppm[4]	Borrow ppm[5]	AR ppm
		Concentration					
7440-38-2	Arsenic	667	667	90	378.5	2.5	2.5
7440-41-7	Beryllium	3.2	3.2		3.2		3.2
7440-43-9	Cadmium	0.5	0.5		0.5		0.5
7440-48-4	Cobalt	4	4		4		4
7440-47-3	Chromium	9	9		9		9
7439-97-6	Mercury [2]	0.96	0.6		0.6		0.6
7439-96-5	Manganese	299	299		299		299
7440-02-0	Nickel	2	2		2		2
7439-92-1	Lead	8	8		8		8
7440-36-0	Antimony	23	23		23		23
7723-14-0	Phosphorus	650	650		650		650
7782-49-2	Selenium	0.4	0.4		0.4		0.4
7440-22-4	Silver	0.5	0.5		0.5		0.5
7429-90-5	Aluminum	71000	71000		71000		71000
7440-39-3	Barium	800	800		800		800
1317-65-3	Calcium Carbonate	14000	14000		14000		14000
7440-50-8	Copper	5	5		5		5
7439-89-6	Iron	18200	18200		18200		18200
7439-98-7	Molybdenum	1	1		1		1
7440-28-0	Thallium	10	10		10		10
7440-61-1	Uranium	10	10		10		10
7440-62-2	Vanadium	28	28		28		28
7440-33-7	Tungsten	10	10		10		10
7440-66-6	Zinc	35	35		35		35

[1] *(Midas Gold 2017c)* *Median concentration of 55,000 SGP samples.* *1E+6 parts/ppm*

[2] *(Midas Gold 2018e)* *Median ore and development rock (DR) concentrations of 151,000 samples; resource block model.*

[3] *(Perpetua 2021g)* *Median concentration of 265 SGP samples.*

[4] *HRD: haul road - emissions calculated based on 50% of the total VMT occuring on CR*

[5] *(ALS 2018)* *Median concentration of 8 SGP samples.*

DR DR DR DR DR DR DR DR ORE DR DR DR DR HRD DR/AR

MINING FUGITIVE EMISSIONS - CONTINUED **Model Scenario W3** DR **T-RACT Emissions**

HAP/TAP Emissions

Hourly [1] YPP_pph HFP_pph WEP_pph BT_pph YPPBL_pph HFPBL_pph WEPBL_pph BTBL_pph STKP_pph FDRSF_pph HFDRSF_pph YPDRSF_pph WEDRSF_pph HR000_pph CCRD, UGE lb/hr

CAS No.	Pollutant	YPP lb/hr	HFP lb/hr	WEP lb/hr	BT lb/hr	YPPBL lb/hr	HFPBL lb/hr	WEPBL lb/hr	BTBL lb/hr	STKP lb/hr	FDRSF lb/hr	HFDRSF lb/hr	YPDRSF lb/hr	WEDRSF lb/hr	HR000 lb/hr	TSF, ACCRD, UGEXP lb/hr	Total lb/hr
7440-38-2	Arsenic	0	0	9.4E-3	0	0	0	0.018	0	0	0	4.2E-3	0	0	0.201	4.2E-6	0.232
7440-41-7	Beryllium	0	0	4.5E-5	0	0	0	8.6E-5	0	0	0	2.0E-5	0	0	1.7E-3	5.1E-6	1.9E-3
7440-43-9	Cadmium	0	0	7.0E-6	0	0	0	1.3E-5	0	0	0	3.2E-6	0	0	2.7E-4	7.9E-7	2.9E-4
7440-48-4	Cobalt	0	0	5.6E-5	0	0	0	1.1E-4	0	0	0	2.5E-5	0	0	2.1E-3	6.4E-6	2.3E-3
7440-47-3	Chromium	0	0	1.3E-4	0	0	0	2.4E-4	0	0	0	5.7E-5	0	0	4.8E-3	1.4E-5	5.2E-3
7439-97-6	Mercury	0	0	8.5E-6	0	0	0	1.6E-5	0	0	0	3.8E-6	0	0	3.2E-4	9.5E-7	3.5E-4
7439-96-5	Manganese	0	0	4.2E-3	0	0	0	8.0E-3	0	0	0	1.9E-3	0	0	0.159	4.7E-4	0.173
7440-02-0	Nickel	0	0	2.8E-5	0	0	0	5.4E-5	0	0	0	1.3E-5	0	0	1.1E-3	3.2E-6	1.2E-3
7439-92-1	Lead	0	0	1.1E-4	0	0	0	2.1E-4	0	0	0	5.1E-5	0	0	4.2E-3	1.3E-5	4.6E-3
7440-36-0	Antimony	0	0	3.2E-4	0	0	0	6.2E-4	0	0	0	1.5E-4	0	0	0.012	3.7E-5	0.013
7723-14-0	Phosphorus	0	0	9.2E-3	0	0	0	0.017	0	0	0	4.1E-3	0	0	0.345	1.0E-3	0.376
7782-49-2	Selenium	0	0	5.6E-6	0	0	0	1.1E-5	0	0	0	2.5E-6	0	0	2.1E-4	6.4E-7	2.3E-4
7440-22-4	Silver	0	0	7.0E-6	0	0	0	1.3E-5	0	0	0	3.2E-6	0	0	2.7E-4	7.9E-7	2.9E-4
7429-90-5	Aluminum	0	0	1.000	0	0	0	1.902	0	0	0	0.450	0	0	37.640	0.113	41.106
7440-39-3	Barium	0	0	0.011	0	0	0	0.021	0	0	0	5.1E-3	0	0	0.424	1.3E-3	0.463
1317-65-3	Calcium Ca	0	0	0.197	0	0	0	0.375	0	0	0	0.089	0	0	7.422	0.022	8.105
7440-50-8	Copper	0	0	7.0E-5	0	0	0	1.3E-4	0	0	0	3.2E-5	0	0	2.7E-3	7.9E-6	2.9E-3
7439-89-6	Iron	0	0	0.256	0	0	0	0.488	0	0	0	0.115	0	0	9.649	0.029	10.537
7439-98-7	Molybdenu	0	0	1.4E-5	0	0	0	2.7E-5	0	0	0	6.3E-6	0	0	5.3E-4	1.6E-6	5.8E-4
7440-28-0	Thallium	0	0	1.4E-4	0	0	0	2.7E-4	0	0	0	6.3E-5	0	0	5.3E-3	1.6E-5	5.8E-3
7440-61-1	Uranium	0	0	1.4E-4	0	0	0	2.7E-4	0	0	0	6.3E-5	0	0	5.3E-3	1.6E-5	5.8E-3
7440-62-2	Vanadium	0	0	3.9E-4	0	0	0	7.5E-4	0	0	0	1.8E-4	0	0	0.015	4.4E-5	0.016
7440-33-7	Tungsten	0	0	1.4E-4	0	0	0	2.7E-4	0	0	0	6.3E-5	0	0	5.3E-3	1.6E-5	5.8E-3
7440-66-6	Zinc	0	0	4.9E-4	0	0	0	9.4E-4	0	0	0	2.2E-4	0	0	0.019	5.6E-5	0.020
Total		0	0	1.490	0	0	0	2.834	0	0	0	0.670	0	0	55.918	0.167	61.079

[1] *Hourly emissions are based on annual throughput for the carcinogenic annual risk TAPs and daily throughput for the non-carcinogenic 24-hr TAPs.* chk 61.0794 61.0794

DR DR DR DR DR DR DR DR ORE DR DR DR DR HRD DR/AR

MINING FUGITIVE EMISSIONS - CONTINUED **Model Scenario W3** DR **T-RACT Emissions**

HAP/TAP Emissions

Annual

		YPP_tpy	HFP_tpy	WEP_tpy	BT_tpy	YPPBL_tpy	HFPBL_tpy	WEPBL_tpy	BTBL_tpy	STKP_tpy	FDRSF_tpy	HFDRSF_tpy	YPDRSF_tpy	WEDRSF_tpy	HR000_tpy	CCRD, UGE	ton/yr
		YPP	HFP	WEP	BT	YPPBL	HFPBL	WEPBL	BTBL	STKP	FDRSF	HFDRSF	YPDRSF	WEDRSF	HR000	TSF, ACCRD, UGEXP	Total
CAS No.	Pollutant	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr
7440-38-2	Arsenic	0	0	0.041	0	0	0	0.078	0	0	0	0.019	0	0	0.879	1.8E-5	1.017
7440-41-7	Beryllium	0	0	2.0E-4	0	0	0	3.8E-4	0	0	0	8.9E-5	0	0	7.4E-3	2.2E-5	8.1E-3
7440-43-9	Cadmium	0	0	3.1E-5	0	0	0	5.9E-5	0	0	0	1.4E-5	0	0	1.2E-3	3.5E-6	1.3E-3
7440-48-4	Cobalt	0	0	2.5E-4	0	0	0	4.7E-4	0	0	0	1.1E-4	0	0	9.3E-3	2.8E-5	0.010
7440-47-3	Chromium	0	0	5.6E-4	0	0	0	1.1E-3	0	0	0	2.5E-4	0	0	0.021	6.3E-5	0.023
7439-97-6	Mercury	0	0	3.7E-5	0	0	0	7.0E-5	0	0	0	1.7E-5	0	0	1.4E-3	4.2E-6	1.5E-3
7439-96-5	Manganese	0	0	0.018	0	0	0	0.035	0	0	0	8.3E-3	0	0	0.694	2.1E-3	0.758
7440-02-0	Nickel	0	0	1.2E-4	0	0	0	2.3E-4	0	0	0	5.6E-5	0	0	4.6E-3	1.4E-5	5.1E-3
7439-92-1	Lead	0	0	4.9E-4	0	0	0	9.4E-4	0	0	0	2.2E-4	0	0	0.019	5.6E-5	0.020
7440-36-0	Antimony	0	0	1.4E-3	0	0	0	2.7E-3	0	0	0	6.4E-4	0	0	0.053	1.6E-4	0.058
7723-14-0	Phosphorus	0	0	0.040	0	0	0	0.076	0	0	0	0.018	0	0	1.509	4.5E-3	1.648
7782-49-2	Selenium	0	0	2.5E-5	0	0	0	4.7E-5	0	0	0	1.1E-5	0	0	9.3E-4	2.8E-6	1.0E-3
7440-22-4	Silver	0	0	3.1E-5	0	0	0	5.9E-5	0	0	0	1.4E-5	0	0	1.2E-3	3.5E-6	1.3E-3
7429-90-5	Aluminum	0	0	4.382	0	0	0	8.332	0	0	0	1.971	0	0	165	0.494	180
7440-39-3	Barium	0	0	0.049	0	0	0	0.094	0	0	0	0.022	0	0	1.858	5.6E-3	2.029
1317-65-3	Calcium Ca	0	0	0.864	0	0	0	1.643	0	0	0	0.389	0	0	32.508	0.097	35.501
7440-50-8	Copper	0	0	3.1E-4	0	0	0	5.9E-4	0	0	0	1.4E-4	0	0	0.012	3.5E-5	0.013
7439-89-6	Iron	0	0	1.123	0	0	0	2.136	0	0	0	0.505	0	0	42.261	0.127	46.152
7439-98-7	Molybdenu	0	0	6.2E-5	0	0	0	1.2E-4	0	0	0	2.8E-5	0	0	2.3E-3	7.0E-6	2.5E-3
7440-28-0	Thallium	0	0	6.2E-4	0	0	0	1.2E-3	0	0	0	2.8E-4	0	0	0.023	7.0E-5	0.025
7440-61-1	Uranium	0	0	6.2E-4	0	0	0	1.2E-3	0	0	0	2.8E-4	0	0	0.023	7.0E-5	0.025
7440-62-2	Vanadium	0	0	1.7E-3	0	0	0	3.3E-3	0	0	0	7.8E-4	0	0	0.065	1.9E-4	0.071
7440-33-7	Tungsten	0	0	6.2E-4	0	0	0	1.2E-3	0	0	0	2.8E-4	0	0	0.023	7.0E-5	0.025
7440-66-6	Zinc	0	0	2.2E-3	0	0	0	4.1E-3	0	0	0	9.7E-4	0	0	0.081	2.4E-4	0.089
Total		0	0	6.527	0	0	0	12.412	0	0	0	2.936	0	0	245	0.731	268
															chk	267.5280	267.5280

MINING FUGITIVE EMISSIONS - CONTINUED

Mercury Evaporative Flux Emissions

Fugitive Mercury Flux and Emissions

			Area		Hg Flux	Emissions[1] lb/hr	ton/yr	lb/yr
CAS No.	Pollutant	Source	m^2	ha	µg/m^2-yr			
		Stockpiles	52,623	5.3	556	7.37E-6	3.2E-5	6.5E-2
		Rock Dumps	2,063,990	206.4	76.2	3.96E-5	1.7E-4	0.35
		Tailings	1,338,158	133.8	2,144	7.22E-4	3.2E-3	6.32
		Pits	1,504,919	150.5	132.3	5.01E-5	2.2E-4	0.44
7439-97-6	Mercury					8.2E-4	3.6E-3	7.17

[1] *Hourly emissions based on:* 8,760 *hours per year of operation*

Fugitive Mercury Emission Factors

	Twin Creeks (TC)		Ore Hg Adjusted	Stibnite	
	Hg Flux [1]	Hg [2]	µg/m^2/yr	Hg Flux [3]	Hg [4]
Source	µg/m^2-yr	µg/g	TC	µg/m^2-yr	µg/g
Stockpiles	5,609	33	556	556	0.96
Rock Dumps	768	3.5	76.2	76.2	0.60
Tailings	21,621	33	2,144	2,144	0.96
Pits	1,334	9.5	132	132.3	0.60

[1] *(Eckley 2010)* *Table 1: Hg flux µg/m^2-yr*

[2] *(Eckley 2010)* *Table 1: Average Hg flux mg/g: " Stockpiles - high-grade stockpiles, Rock Dumps - waste rock dumps, Tailings - high-grade stockpiles as a surrogate; Pits - pit"*

[3] *(Eckley 2010)* *Figure 2: log(y) = m*log(x) + b*

y = Hg Flux (ng/m^2-d)
x = material Hg concentration (µg/g)]

Slope =	*Solar*	*TC*
	Low	*0.59*
	Medium	*0.6*
	High	*0.77*
	Average	*0.65*

[4] *(Midas Gold 2018e)*

Sample Calculation: m = log (y1/y2) / log(x1/x2)

m=	0.65	unitless
y1=	5,609	µg/m^2-yr
x1=	33	µg/m^2-yr
x2=	0.96	µg/m^2-yr
log(x1/x2)=	1.536243	unitless
log(y1/y2)=	1.003679	unitless
y1/y2=	10.08506	unitless
y2=	556.2	µg/m^2-yr

Conversions

2,000	lb/ton
10,000	m2/ha
453.593	g/lb

TABLE A-W3. HAP/TAP Emissions and Exemptions

T-RACT Emissions						MINING										LEACHING	
chk						*Mining*		*Model Scenario*	*W3*							*CN Leach/PAX*	
						YPP,HFP,WEP,BT		YPPBL,HFPBL,WEPBL,BTBL		HR000		STKP, FDRSF, HFDRSF, YPDRSF, WEDRSF		TSF,ACCRD,UGEXP			
CAS	HAP/TAP	HAP	TAP			Pits		Blasting		Haul Roads		Stockpiles and DRFS		Tails, Access Road, Exploration		CN Leach and PAX	
	NSPS or NESHAP HAP/TAP -->			*Y*													
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				A/C	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
7440-38-2	Arsenic	Y	Y	Y	C	9.4E-3	0.041	0.018	0.078	0.201	0.879	4.2E-3	0.019	4.2E-6	1.8E-5		
7440-41-7	Beryllium	Y	Y	Y	C	4.5E-5	2.0E-4	8.6E-5	3.8E-4	1.7E-3	7.4E-3	2.0E-5	8.9E-5	5.1E-6	2.2E-5		
7440-43-9	Cadmium	Y	Y	Y	C	7.0E-6	3.1E-5	1.3E-5	5.9E-5	2.7E-4	1.2E-3	3.2E-6	1.4E-5	7.9E-7	3.5E-6		
50-00-0	Formaldehyde	Y	Y	Y	C												
7440-02-0	Nickel	Y	Y	Y	C	2.8E-5	1.2E-4	5.4E-5	2.3E-4	1.1E-3	4.6E-3	1.3E-5	5.6E-5	3.2E-6	1.4E-5		

TABLE A-W3. HAP/TAP Emissions and Exemptions

T-RACT Emissions						PROCESSING AND PRODUCTION											
chk						*Ore Processing*				*Ore Concentration and Refining*				*Process Heating*			
						OC1-13		PS		AC		EW,MR,MF,CKD		ACB, CKB, PV, HS		LKC	
CAS	HAP/TAP	HAP	TAP			Crushers & Xfers		Prill Silos		Autoclave		EW, Preg Tank, Retort, Furnace, Carbon Kiln		POX Boiler, C. Kiln Comb., Prop. Vap., Sol'n Heater		Lime Kiln Combustion	
	NSPS or NESHAP HAP/TAP -->			*Y*		*LL*	*LL*			*7E*	*7E*	*7E*	*7E*			*5A*	*5A*
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				*A/C*	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
7440-38-2	Arsenic	Y	Y	Y	C	3.9E-3	0.017			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.5E-6	6.4E-6	3.7E-6	1.6E-5
7440-41-7	Beryllium	Y	Y	Y	C	1.9E-5	8.2E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	8.7E-8	3.8E-7	2.2E-7	9.6E-7
7440-43-9	Cadmium	Y	Y	Y	C	2.9E-6	1.3E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	8.0E-6	3.5E-5	2.0E-5	8.8E-5
50-00-0	Formaldehyde	Y	Y	Y	C									5.5E-4	2.4E-3	1.4E-3	6.0E-3
7440-02-0	Nickel	Y	Y	Y	C	1.2E-5	5.2E-5			2.3E-5	1.0E-4	3.8E-4	1.7E-3	1.5E-5	6.7E-5	3.9E-5	1.7E-4

TABLE A-W3. HAP/TAP Emissions and Exemptions

T-RACT Emissions						PROCESSING AND PRODUCTION - Continued													
chk						*Lime Production*						*Aggregate Prod.*		*Concrete Production*					
						LS1-11,LSBM		LK,LS12,LCR,LS-L/U		LS1-L/U,MillS2-L/U,ACS1-4		PCSP1,PCSP2		CM		CS1L,CS1U,CS2L, CS2U		CA-L/U	
CAS	HAP/TAP	HAP	TAP			Limestone Crushers, Screens, Mill, Xfers		Lime Kiln, Kiln Feed, Lime Mill, Pebble Lime Silo		Lime Silos and Lime Mill Crushing		Portable Crushers, Screens, Xfers		Central Mixer		Cement Silo #1 and #2 L/U		Aggregate Bin	
	NSPS or NESHAP HAP/TAP -->			*Y*		*OOO*	*OOO*	*5A*	*5A*			*OOO*	*OOO*					*OOO*	*OOO*
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				A/C	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
7440-38-2	Arsenic	Y	Y	Y	C	1.0E-4	4.4E-4	2.4E-5	1.1E-4	1.1E-6	4.7E-6	2.9E-5	1.3E-4	2.0E-6	8.9E-6	1.2E-7	5.1E-7	1.8E-5	7.9E-5
7440-41-7	Beryllium	Y	Y	Y	C	3.5E-6	1.5E-5	8.4E-7	3.7E-6	3.7E-8	1.6E-7	1.0E-6	4.4E-6			1.3E-8	5.8E-8	6.3E-7	2.8E-6
7440-43-9	Cadmium	Y	Y	Y	C	1.1E-6	4.8E-6	2.6E-7	1.2E-6	1.2E-8	5.1E-8	3.1E-7	1.4E-6	4.9E-9	2.1E-8			2.0E-7	8.6E-7
50-00-0	Formaldehyde	Y	Y	Y	C														
7440-02-0	Nickel	Y	Y	Y	C	2.2E-5	9.6E-5	5.3E-6	2.3E-5	2.3E-7	1.0E-6	6.3E-6	2.7E-5	1.7E-6	7.4E-6	1.1E-6	5.0E-6	3.9E-6	1.7E-5

TABLE A-W3. HAP/TAP Emissions and Exemptions

T-RACT Emissions						PROCESSING AND PRODUCTION - Continued						MINING and LEACHING - Totals									
chk						*HVAC*		*Emer. Power/Fire*		*Fuel Storage*		*HAP Total*		*Mercury Total*		*Mercury Total*		*TAP Total*		*TAP Total*	
						H1M,H2M,HM,HAC,HR,HA,HMO,HTS,HW		EDG1,EDG2,EDG3,EDFP		TG1,TG2				*Exempt*		*Non-Exempt*		*HAP-TAP addressed by NSPS/NESHAP*		*For EL Evaluation*	
CAS	HAP/TAP	HAP	TAP			Heaters		Emergency Generators and Fire Pump		Gasoline Fuel Tanks											
	NSPS or NESHAP HAP/TAP -->			*Y*				*4Z*	*4Z*	*6C*	*6C*										
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				*A/C*	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
7440-38-2	Arsenic	Y	Y	Y	C	3.6E-6	1.6E-5					0.232	1.017							0.232	1.017
7440-41-7	Beryllium	Y	Y	Y	C	2.1E-7	9.4E-7					1.9E-3	8.1E-3							1.9E-3	8.1E-3
7440-43-9	Cadmium	Y	Y	Y	C	2.0E-5	8.6E-5					2.9E-4	1.3E-3							2.9E-4	1.3E-3
50-00-0	Formaldehyde	Y	Y	Y	C	1.3E-3	5.9E-3	5.1E-5	2.2E-4												
7440-02-0	Nickel	Y	Y	Y	C	3.8E-5	1.6E-4					1.2E-3	5.1E-3					0	0	1.2E-3	5.1E-3

TABLE A-W3. HAP/TAP Emissions and Exemptions

T-RACT Emissions						PROCESSING AND PRODUCTION - Totals										ALL	ALL	ALL	TAP EL	
chk						*HAP Total*		*Mercury Total Exempt*		*Mercury Total Non-Exempt*		*TAP Total HAP-TAP addressed by NSPS/NESHAP*		*TAP Total For EL Evaluation*		*HAP*	*Hg Non-Exempt*	*TAP For EL Evaluation*	*TAP Emission Screening Level (EL)*	
CAS	HAP/TAP	HAP	TAP																	
	NSPS or NESHAP HAP/TAP -->	*Y*																	Non-car	Carcin
	Non-Carcinogenic Acute (A) or Carcinogenic (C) -->				*A/C*	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr	ton/yr	lb/hr	lb/hr	lb/hr
7440-38-2	Arsenic	Y	Y	Y	C	4.5E-3	0.020					4.5E-3	0.020	8.2E-6	3.6E-5	1.037		0.232	--	1.5E-6
7440-41-7	Beryllium	Y	Y	Y	C	4.3E-4	1.9E-3					4.3E-4	1.9E-3	3.5E-7	1.5E-6	0.010		1.9E-3	--	2.8E-5
7440-43-9	Cadmium	Y	Y	Y	C	4.6E-4	2.0E-3					4.3E-4	1.9E-3	2.8E-5	1.2E-4	3.3E-3		3.2E-4	--	3.7E-6
50-00-0	Formaldehyde	Y	Y	Y	C	3.3E-3	0.015					1.4E-3	6.2E-3	1.9E-3	8.3E-3	0.015		1.9E-3	--	5.1E-4
7440-02-0	Nickel	Y	Y	Y	C	5.5E-4	2.4E-3					4.9E-4	2.2E-3	5.6E-5	2.4E-4	7.5E-3		1.2E-3	--	2.7E-5

Appendix B – Modeled Emissions per Modeling Scenario and Source

Appendix B Table of Contents

Non-Carcinogenic TAP Modeling

Table B-Y1, 180,000 T/day Emissions B-2
Table B-Y2, 180,000 T/day Emissions B-8
Table B-Y3, 180,000 T/day Emissions B-14
Table B-H1, 180,000 T/day Emissions B-20
Table B-H2, 180,000 T/day Emissions B-26
Table B-H3, 180,000 T/day Emissions B-32
Table B-H4, 180,000 T/day Emissions B-38
Table B-W1, 180,000 T/day Emissions B-44
Table B-W2, 180,000 T/day Emissions B-50
Table B-W3, 180,000 T/day Emissions B-56
Table B-W4, 180,000 T/day Emissions B-62
Table B-W5, 180,000 T/day Emissions B-68
Table B-B1, 180,000 T/day Emissions B-74
Table B-B2, 180,000 T/day Emissions B-80

Carcinogenic TAP Modeling

Table B-Y1, T-RACT Emissions B-86
Table B-Y2, T-RACT Emissions B-89
Table B-Y3, T-RACT Emissions B-92
Table B-H1, T-RACT Emissions B-95
Table B-H2, T-RACT Emissions B-98
Table B-H3, T-RACT Emissions B-101
Table B-H4, T-RACT Emissions B-104
Table B-W1, T-RACT Emissions B-107
Table B-W2, T-RACT Emissions B-110
Table B-W3, T-RACT Emissions B-113
Table B-W4, T-RACT Emissions B-116
Table B-W5, T-RACT Emissions B-119
Table B-B1, T-RACT Emissions B-122
Table B-B2, T-RACT Emissions B-125

TABLE B-Y1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to		LL	LL	0.010	1.2E-4	2.0E-3
	OC2	Grizzly to Apron Feeder		LL	LL	0.010	1.2E-4	2.0E-3
	OC3	Apron Feeder to Dribble Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC4	Apron Feeder to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC5	Dribble Conveyor to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor		LL	LL	0.089	1.0E-3	0.018
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile		LL	LL	0.010	1.2E-4	2.0E-3
	OC9	Stockpile Transfers to Reclaim Conveyors		LL	LL	0.049	5.5E-4	9.7E-3
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor		LL	LL	0.049	5.5E-4	9.7E-3
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	LL	LL	0.049	5.5E-4	9.7E-3
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	LL	LL	0.098	1.1E-3	0.019
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	LL	LL	0.011	1.3E-4	2.3E-3
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0.221	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	7E	7E	2.3E-5	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MR	Mercury Retort	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	2.6E-7	0	0	3.1E-6	0
	CKB	Carbon Regeneration Kiln (Burners)	0	8.4E-7	0	0	9.7E-6	0
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	3.7E-8	0	0	4.3E-7	0
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	1.9E-6	0	0	2.2E-5	0
	LKC	PFR Shaft Lime Kiln Combustion	0	5A	5A	0	9.5E-5	0
	LS1	Limestone transfer to Primary Crusher Hopper	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS2	Primary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS3	Primary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323
	LS4	Secondary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS5	Secondary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323

TABLE B-Y1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS8	Ball Mill Feed transfer to Ball	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LSBM	Limestone Ball Mill	0	OOO	OOO	0.043	2.8E-4	0.522
	LS9	Limestone transfer to Kiln Feed Bin	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS11	Fines Screening and Associated Transfers In and Out	0	OOO	OOO	6.3E-3	4.0E-5	0.076
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	5A	5A	7.5E-4	4.8E-6	9.2E-3
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	5A	5A	0.021	1.3E-4	0.251
	LCR	Lime Mill Crushing and associated transfers In and Out	0	5A	5A	6.4E-3	4.1E-5	0
	LSL	Pebble Lime Silo Loading via Bucket Elevator	0	5A	5A	1.4E-4	9.0E-7	0
	LSU	Pebble Lime Silo discharge to Lime Slaker	0	5A	5A	1.4E-5	9.0E-8	0
	LS1L	Mill Lime Silo #1 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	MillS2L	Mill Lime Silo #2 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	ACS1L	AC Lime Silo #1 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS2L	AC Lime Silo #2 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS3L	AC Lime Silo #3 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS4L	AC Lime Silo #4 Loading	0	4.9E-6	2.7E-6	4.7E-4	3.0E-6	0
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
Concrete Production	CM	Central Mixer Loading	0	2.6E-5	8.2E-6	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	8.0E-7	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	8.0E-7	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	8.0E-7	0	0	0	0

TABLE B-Y1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	8.0E-7	0	0	0	0
	CAL	Aggregate Bin Loading	0	OOO	OOO	0.016	1.0E-4	0
	CAU	Aggregate Bin Unloading	0	OOO	OOO	0.016	1.0E-4	0
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	1.9E-7	0	0	2.2E-6	0
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	7.5E-7	0	0	8.6E-6	0
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	1.1E-6	0	0	1.3E-5	0
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	4Z	4Z	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	6C	6C	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	6C	6C	0	0	0
Mining - Modeling Scenario: Y1	YPP	Yellow Pine Pit	0	0.024	0.051	5.585	0.063	1.101
	HFP	Hangar Flats Pit	0	0	0	0	0	0
	WEP	West End Pit	0	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	8.0E-3	0.017	1.902	0.021	0.375
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0	0
	STKP	PC Stockpile	0	4.5E-3	9.7E-3	1.063	0.012	0.210
	FDRSF	Fiddle DRSF	0	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0	0
	HR000	Haul Roads	0	0.065	0.141	15.394	0.173	3.035
	TSF	Tailing Storage Facility	0.232	0	0	0	0	0
	ACCRD	Access Roads	0	4.7E-4	1.0E-3	0.113	1.3E-3	0.022
	UGEXP	Scout Portal	0	1.0E-7	2.3E-7	2.5E-5	2.8E-7	4.9E-6
		Total	**0.453**	**0.102**	**0.220**	**24.705**	**0.278**	**6.987**

TABLE B-Y1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	2.9E-3	0	1.6E-6	4.5E-6
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	0	0	0	0	5.0E-5
	LS1	Limestone transfer to Primary Crusher Hopper	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5

TABLE B-Y1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	0	0	0	0

TABLE B-Y1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	0	0	0	0
	CAL	Aggregate Bin Loading	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	0	0	0	6.8E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	0	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	0	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	0	0	0	0
Mining - Modeling Scenario: Y1	YPP	Yellow Pine Pit	0	1.432	0	7.9E-4	2.2E-3
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0.488	0	2.7E-4	7.5E-4
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0.272	0	1.5E-4	4.2E-4
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0	3.946	0	2.2E-3	6.1E-3
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**0.696**	**6.380**	**2.030**	**3.9E-3**	**0.010**

TABLE B-Y2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to		LL	LL	0.010	1.2E-4	2.0E-3
	OC2	Grizzly to Apron Feeder		LL	LL	0.010	1.2E-4	2.0E-3
	OC3	Apron Feeder to Dribble Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC4	Apron Feeder to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC5	Dribble Conveyor to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor		LL	LL	0.089	1.0E-3	0.018
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile		LL	LL	0.010	1.2E-4	2.0E-3
	OC9	Stockpile Transfers to Reclaim Conveyors		LL	LL	0.049	5.5E-4	9.7E-3
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor		LL	LL	0.049	5.5E-4	9.7E-3
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	LL	LL	0.049	5.5E-4	9.7E-3
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	LL	LL	0.098	1.1E-3	0.019
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	LL	LL	0.011	1.3E-4	2.3E-3
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0.221	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	7E	7E	2.3E-5	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MR	Mercury Retort	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	2.6E-7	0	0	3.1E-6	0
	CKB	Carbon Regeneration Kiln (Burners)	0	8.4E-7	0	0	9.7E-6	0
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	3.7E-8	0	0	4.3E-7	0
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	1.9E-6	0	0	2.2E-5	0
	LKC	PFR Shaft Lime Kiln Combustion	0	5A	5A	0	9.5E-5	0
	LS1	Limestone transfer to Primary Crusher Hopper	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS2	Primary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS3	Primary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323
	LS4	Secondary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS5	Secondary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323

TABLE B-Y2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS8	Ball Mill Feed transfer to Ball	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LSBM	Limestone Ball Mill	0	OOO	OOO	0.043	2.8E-4	0.522
	LS9	Limestone transfer to Kiln Feed Bin	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS11	Fines Screening and Associated Transfers In and Out	0	OOO	OOO	6.3E-3	4.0E-5	0.076
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	5A	5A	7.5E-4	4.8E-6	9.2E-3
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	5A	5A	0.021	1.3E-4	0.251
	LCR	Lime Mill Crushing and associated transfers In and Out	0	5A	5A	6.4E-3	4.1E-5	0
	LSL	Pebble Lime Silo Loading via Bucket Elevator	0	5A	5A	1.4E-4	9.0E-7	0
	LSU	Pebble Lime Silo discharge to Lime Slaker	0	5A	5A	1.4E-5	9.0E-8	0
	LS1L	Mill Lime Silo #1 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	MillS2L	Mill Lime Silo #2 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	ACS1L	AC Lime Silo #1 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS2L	AC Lime Silo #2 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS3L	AC Lime Silo #3 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS4L	AC Lime Silo #4 Loading	0	4.9E-6	2.7E-6	4.7E-4	3.0E-6	0
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
Concrete Production	CM	Central Mixer Loading	0	2.6E-5	8.2E-6	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	8.0E-7	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	8.0E-7	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	8.0E-7	0	0	0	0

TABLE B-Y2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	8.0E-7	0	0	0	0
	CAL	Aggregate Bin Loading	0	OOO	OOO	0.016	1.0E-4	0
	CAU	Aggregate Bin Unloading	0	OOO	OOO	0.016	1.0E-4	0
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	1.9E-7	0	0	2.2E-6	0
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	7.5E-7	0	0	8.6E-6	0
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	1.1E-6	0	0	1.3E-5	0
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	4Z	4Z	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	6C	6C	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	6C	6C	0	0	0
Mining - Modeling Scenario: Y2	YPP	Yellow Pine Pit	0	0.024	0.051	5.585	0.063	1.101
	HFP	Hangar Flats Pit	0	0	0	0	0	0
	WEP	West End Pit	0	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	8.0E-3	0.017	1.902	0.021	0.375
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	3.6E-3	7.9E-3	0.858	9.7E-3	0.169
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0	0
	HR000	Haul Roads	0	0.096	0.208	22.711	0.256	4.478
	TSF	Tailing Storage Facility	0.232	0	0	0	0	0
	ACCRD	Access Roads	0	4.7E-4	1.0E-3	0.113	1.3E-3	0.022
	UGEXP	Scout Portal	0	1.0E-7	2.3E-7	2.5E-5	2.8E-7	4.9E-6
		Total	**0.453**	**0.131**	**0.285**	**31.817**	**0.358**	**8.390**

TABLE B-Y2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	2.9E-3	0	1.6E-6	4.5E-6
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	0	0	0	0	5.0E-5
	LS1	Limestone transfer to Primary Crusher Hopper	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5

TABLE B-Y2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	0	0	0	0

TABLE B-Y2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	0	0	0	0
	CAL	Aggregate Bin Loading	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	0	0	0	6.8E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	0	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	0	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	0	0	0	0
Mining - Modeling Scenario: Y2	YPP	Yellow Pine Pit	0	1.432	0	7.9E-4	2.2E-3
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0.488	0	2.7E-4	7.5E-4
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0.220	0	1.2E-4	3.4E-4
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0	5.822	0	3.2E-3	9.0E-3
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**0.696**	**8.203**	**2.030**	**4.9E-3**	**0.013**

TABLE B-Y3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to		LL	LL	0.010	1.2E-4	2.0E-3
	OC2	Grizzly to Apron Feeder		LL	LL	0.010	1.2E-4	2.0E-3
	OC3	Apron Feeder to Dribble Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC4	Apron Feeder to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC5	Dribble Conveyor to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor		LL	LL	0.089	1.0E-3	0.018
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile		LL	LL	0.010	1.2E-4	2.0E-3
	OC9	Stockpile Transfers to Reclaim Conveyors		LL	LL	0.049	5.5E-4	9.7E-3
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor		LL	LL	0.049	5.5E-4	9.7E-3
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	LL	LL	0.049	5.5E-4	9.7E-3
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	LL	LL	0.098	1.1E-3	0.019
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	LL	LL	0.011	1.3E-4	2.3E-3
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0.221	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	7E	7E	2.3E-5	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MR	Mercury Retort	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	2.6E-7	0	0	3.1E-6	0
	CKB	Carbon Regeneration Kiln (Burners)	0	8.4E-7	0	0	9.7E-6	0
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	3.7E-8	0	0	4.3E-7	0
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	1.9E-6	0	0	2.2E-5	0
	LKC	PFR Shaft Lime Kiln Combustion	0	5A	5A	0	9.5E-5	0
	LS1	Limestone transfer to Primary Crusher Hopper	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS2	Primary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS3	Primary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323
	LS4	Secondary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS5	Secondary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323

TABLE B-Y3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS8	Ball Mill Feed transfer to Ball	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LSBM	Limestone Ball Mill	0	OOO	OOO	0.043	2.8E-4	0.522
	LS9	Limestone transfer to Kiln Feed Bin	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS11	Fines Screening and Associated Transfers In and Out	0	OOO	OOO	6.3E-3	4.0E-5	0.076
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	5A	5A	7.5E-4	4.8E-6	9.2E-3
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	5A	5A	0.021	1.3E-4	0.251
	LCR	Lime Mill Crushing and associated transfers In and Out	0	5A	5A	6.4E-3	4.1E-5	0
	LSL	Pebble Lime Silo Loading via Bucket Elevator	0	5A	5A	1.4E-4	9.0E-7	0
	LSU	Pebble Lime Silo discharge to Lime Slaker	0	5A	5A	1.4E-5	9.0E-8	0
	LS1L	Mill Lime Silo #1 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	MillS2L	Mill Lime Silo #2 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	ACS1L	AC Lime Silo #1 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS2L	AC Lime Silo #2 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS3L	AC Lime Silo #3 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS4L	AC Lime Silo #4 Loading	0	4.9E-6	2.7E-6	4.7E-4	3.0E-6	0
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
Concrete Production	CM	Central Mixer Loading	0	2.6E-5	8.2E-6	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	8.0E-7	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	8.0E-7	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	8.0E-7	0	0	0	0

TABLE B-Y3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	8.0E-7	0	0	0	0
	CAL	Aggregate Bin Loading	0	OOO	OOO	0.016	1.0E-4	0
	CAU	Aggregate Bin Unloading	0	OOO	OOO	0.016	1.0E-4	0
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	1.9E-7	0	0	2.2E-6	0
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	7.5E-7	0	0	8.6E-6	0
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	1.1E-6	0	0	1.3E-5	0
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	4Z	4Z	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	6C	6C	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	6C	6C	0	0	0
Mining - Modeling Scenario: Y3	YPP	Yellow Pine Pit	0	0.024	0.051	5.585	0.063	1.101
	HFP	Hangar Flats Pit	0	0	0	0	0	0
	WEP	West End Pit	0	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	8.0E-3	0.017	1.902	0.021	0.375
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	3.6E-3	7.9E-3	0.858	9.7E-3	0.169
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0	0
	HR000	Haul Roads	0	0.155	0.337	36.835	0.415	7.263
	TSF	Tailing Storage Facility	0.232	0	0	0	0	0
	ACCRD	Access Roads	0	4.7E-4	1.0E-3	0.113	1.3E-3	0.022
	UGEXP	Scout Portal	0	1.0E-7	2.3E-7	2.5E-5	2.8E-7	4.9E-6
		Total	**0.453**	**0.191**	**0.415**	**45.941**	**0.517**	**11.175**

TABLE B-Y3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	2.9E-3	0	1.6E-6	4.5E-6
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	0	0	0	0	5.0E-5
	LS1	Limestone transfer to Primary Crusher Hopper	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5

TABLE B-Y3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	0	0	0	0

TABLE B-Y3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	0	0	0	0
	CAL	Aggregate Bin Loading	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	0	0	0	6.8E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	0	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	0	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	0	0	0	0
Mining - Modeling Scenario: Y3	YPP	Yellow Pine Pit	0	1.432	0	7.9E-4	2.2E-3
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0.488	0	2.7E-4	7.5E-4
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0.220	0	1.2E-4	3.4E-4
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0	9.442	0	5.2E-3	0.015
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**0.696**	**11.823**	**2.030**	**6.9E-3**	**0.019**

TABLE B-H1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to		LL	LL	0.010	1.2E-4	2.0E-3
	OC2	Grizzly to Apron Feeder		LL	LL	0.010	1.2E-4	2.0E-3
	OC3	Apron Feeder to Dribble Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC4	Apron Feeder to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC5	Dribble Conveyor to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor		LL	LL	0.089	1.0E-3	0.018
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile		LL	LL	0.010	1.2E-4	2.0E-3
	OC9	Stockpile Transfers to Reclaim Conveyors		LL	LL	0.049	5.5E-4	9.7E-3
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor		LL	LL	0.049	5.5E-4	9.7E-3
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	LL	LL	0.049	5.5E-4	9.7E-3
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	LL	LL	0.098	1.1E-3	0.019
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	LL	LL	0.011	1.3E-4	2.3E-3
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0.221	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	7E	7E	2.3E-5	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MR	Mercury Retort	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	2.6E-7	0	0	3.1E-6	0
	CKB	Carbon Regeneration Kiln (Burners)	0	8.4E-7	0	0	9.7E-6	0
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	3.7E-8	0	0	4.3E-7	0
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	1.9E-6	0	0	2.2E-5	0
	LKC	PFR Shaft Lime Kiln Combustion	0	5A	5A	0	9.5E-5	0
	LS1	Limestone transfer to Primary Crusher Hopper	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS2	Primary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS3	Primary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323
	LS4	Secondary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS5	Secondary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323

TABLE B-H1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS8	Ball Mill Feed transfer to Ball	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LSBM	Limestone Ball Mill	0	OOO	OOO	0.043	2.8E-4	0.522
	LS9	Limestone transfer to Kiln Feed Bin	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS11	Fines Screening and Associated Transfers In and Out	0	OOO	OOO	6.3E-3	4.0E-5	0.076
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	5A	5A	7.5E-4	4.8E-6	9.2E-3
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	5A	5A	0.021	1.3E-4	0.251
	LCR	Lime Mill Crushing and associated transfers In and Out	0	5A	5A	6.4E-3	4.1E-5	0
	LSL	Pebble Lime Silo Loading via Bucket Elevator	0	5A	5A	1.4E-4	9.0E-7	0
	LSU	Pebble Lime Silo discharge to Lime Slaker	0	5A	5A	1.4E-5	9.0E-8	0
	LS1L	Mill Lime Silo #1 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	MillS2L	Mill Lime Silo #2 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	ACS1L	AC Lime Silo #1 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS2L	AC Lime Silo #2 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS3L	AC Lime Silo #3 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS4L	AC Lime Silo #4 Loading	0	4.9E-6	2.7E-6	4.7E-4	3.0E-6	0
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
Concrete Production	CM	Central Mixer Loading	0	2.6E-5	8.2E-6	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	8.0E-7	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	8.0E-7	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	8.0E-7	0	0	0	0

TABLE B-H1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	8.0E-7	0	0	0	0
	CAL	Aggregate Bin Loading	0	OOO	OOO	0.016	1.0E-4	0
	CAU	Aggregate Bin Unloading	0	OOO	OOO	0.016	1.0E-4	0
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	1.9E-7	0	0	2.2E-6	0
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	7.5E-7	0	0	8.6E-6	0
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	1.1E-6	0	0	1.3E-5	0
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	4Z	4Z	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	6C	6C	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	6C	6C	0	0	0
Mining - Modeling Scenario: H1	YPP	Yellow Pine Pit	0	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0.024	0.051	5.585	0.063	1.101
	WEP	West End Pit	0	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	8.0E-3	0.017	1.902	0.021	0.375
	WEPBL	West End Pit Blasting	0	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0	0
	STKP	PC Stockpile	0	4.5E-3	9.7E-3	1.063	0.012	0.210
	FDRSF	Fiddle DRSF	0	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0	0
	HR000	Haul Roads	0	0.105	0.228	24.940	0.281	4.918
	TSF	Tailing Storage Facility	0.232	0	0	0	0	0
	ACCRD	Access Roads	0	4.7E-4	1.0E-3	0.113	1.3E-3	0.022
	UGEXP	Scout Portal	0	1.0E-7	2.3E-7	2.5E-5	2.8E-7	4.9E-6
		Total	**0.453**	**0.142**	**0.308**	**34.252**	**0.385**	**8.870**

TABLE B-H1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	2.9E-3	0	1.6E-6	4.5E-6
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	0	0	0	0	5.0E-5
	LS1	Limestone transfer to Primary Crusher Hopper	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5

TABLE B-H1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	0	0	0	0

TABLE B-H1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	0	0	0	0
	CAL	Aggregate Bin Loading	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	0	0	0	6.8E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	0	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	0	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	0	0	0	0
Mining - Modeling Scenario: H1	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	1.432	0	7.9E-4	2.2E-3
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0.488	0	2.7E-4	7.5E-4
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0.272	0	1.5E-4	4.2E-4
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0	6.393	0	3.5E-3	9.8E-3
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**0.696**	**8.827**	**2.030**	**5.2E-3**	**0.014**

TABLE B-H2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to		LL	LL	0.010	1.2E-4	2.0E-3
	OC2	Grizzly to Apron Feeder		LL	LL	0.010	1.2E-4	2.0E-3
	OC3	Apron Feeder to Dribble Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC4	Apron Feeder to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC5	Dribble Conveyor to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor		LL	LL	0.089	1.0E-3	0.018
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile		LL	LL	0.010	1.2E-4	2.0E-3
	OC9	Stockpile Transfers to Reclaim Conveyors		LL	LL	0.049	5.5E-4	9.7E-3
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor		LL	LL	0.049	5.5E-4	9.7E-3
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	LL	LL	0.049	5.5E-4	9.7E-3
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	LL	LL	0.098	1.1E-3	0.019
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	LL	LL	0.011	1.3E-4	2.3E-3
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0.221	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	7E	7E	2.3E-5	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MR	Mercury Retort	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	2.6E-7	0	0	3.1E-6	0
	CKB	Carbon Regeneration Kiln (Burners)	0	8.4E-7	0	0	9.7E-6	0
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	3.7E-8	0	0	4.3E-7	0
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	1.9E-6	0	0	2.2E-5	0
	LKC	PFR Shaft Lime Kiln Combustion	0	5A	5A	0	9.5E-5	0
	LS1	Limestone transfer to Primary Crusher Hopper	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS2	Primary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS3	Primary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323
	LS4	Secondary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS5	Secondary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323

TABLE B-H2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS8	Ball Mill Feed transfer to Ball	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LSBM	Limestone Ball Mill	0	OOO	OOO	0.043	2.8E-4	0.522
	LS9	Limestone transfer to Kiln Feed Bin	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS11	Fines Screening and Associated Transfers In and Out	0	OOO	OOO	6.3E-3	4.0E-5	0.076
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	5A	5A	7.5E-4	4.8E-6	9.2E-3
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	5A	5A	0.021	1.3E-4	0.251
	LCR	Lime Mill Crushing and associated transfers In and Out	0	5A	5A	6.4E-3	4.1E-5	0
	LSL	Pebble Lime Silo Loading via Bucket Elevator	0	5A	5A	1.4E-4	9.0E-7	0
	LSU	Pebble Lime Silo discharge to Lime Slaker	0	5A	5A	1.4E-5	9.0E-8	0
	LS1L	Mill Lime Silo #1 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	MillS2L	Mill Lime Silo #2 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	ACS1L	AC Lime Silo #1 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS2L	AC Lime Silo #2 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS3L	AC Lime Silo #3 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS4L	AC Lime Silo #4 Loading	0	4.9E-6	2.7E-6	4.7E-4	3.0E-6	0
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
Concrete Production	CM	Central Mixer Loading	0	2.6E-5	8.2E-6	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	8.0E-7	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	8.0E-7	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	8.0E-7	0	0	0	0

TABLE B-H2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	8.0E-7	0	0	0	0
	CAL	Aggregate Bin Loading	0	OOO	OOO	0.016	1.0E-4	0
	CAU	Aggregate Bin Unloading	0	OOO	OOO	0.016	1.0E-4	0
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	1.9E-7	0	0	2.2E-6	0
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	7.5E-7	0	0	8.6E-6	0
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	1.1E-6	0	0	1.3E-5	0
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	4Z	4Z	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	6C	6C	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	6C	6C	0	0	0
Mining - Modeling Scenario: H2	YPP	Yellow Pine Pit	0	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0.024	0.051	5.585	0.063	1.101
	WEP	West End Pit	0	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	8.0E-3	0.017	1.902	0.021	0.375
	WEPBL	West End Pit Blasting	0	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	3.6E-3	7.9E-3	0.858	9.7E-3	0.169
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0	0
	HR000	Haul Roads	0	0.157	0.342	37.334	0.421	7.362
	TSF	Tailing Storage Facility	0.232	0	0	0	0	0
	ACCRD	Access Roads	0	4.7E-4	1.0E-3	0.113	1.3E-3	0.022
	UGEXP	Scout Portal	0	1.0E-7	2.3E-7	2.5E-5	2.8E-7	4.9E-6
		Total	**0.453**	**0.193**	**0.419**	**46.440**	**0.523**	**11.273**

TABLE B-H2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	2.9E-3	0	1.6E-6	4.5E-6
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	0	0	0	0	5.0E-5
	LS1	Limestone transfer to Primary Crusher Hopper	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5

TABLE B-H2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	0	0	0	0

TABLE B-H2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	0	0	0	0
	CAL	Aggregate Bin Loading	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	0	0	0	6.8E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	0	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	0	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	0	0	0	0
Mining - Modeling Scenario: H2	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	1.432	0	7.9E-4	2.2E-3
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0.488	0	2.7E-4	7.5E-4
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0.220	0	1.2E-4	3.4E-4
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0	9.570	0	5.3E-3	0.015
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**0.696**	**11.951**	**2.030**	**7.0E-3**	**0.019**

TABLE B-H3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to		LL	LL	0.010	1.2E-4	2.0E-3
	OC2	Grizzly to Apron Feeder		LL	LL	0.010	1.2E-4	2.0E-3
	OC3	Apron Feeder to Dribble Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC4	Apron Feeder to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC5	Dribble Conveyor to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor		LL	LL	0.089	1.0E-3	0.018
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile		LL	LL	0.010	1.2E-4	2.0E-3
	OC9	Stockpile Transfers to Reclaim Conveyors		LL	LL	0.049	5.5E-4	9.7E-3
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor		LL	LL	0.049	5.5E-4	9.7E-3
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	LL	LL	0.049	5.5E-4	9.7E-3
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	LL	LL	0.098	1.1E-3	0.019
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	LL	LL	0.011	1.3E-4	2.3E-3
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0.221	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	7E	7E	2.3E-5	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MR	Mercury Retort	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	2.6E-7	0	0	3.1E-6	0
	CKB	Carbon Regeneration Kiln (Burners)	0	8.4E-7	0	0	9.7E-6	0
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	3.7E-8	0	0	4.3E-7	0
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	1.9E-6	0	0	2.2E-5	0
	LKC	PFR Shaft Lime Kiln Combustion	0	5A	5A	0	9.5E-5	0
	LS1	Limestone transfer to Primary Crusher Hopper	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS2	Primary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS3	Primary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323
	LS4	Secondary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS5	Secondary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323

TABLE B-H3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS8	Ball Mill Feed transfer to Ball	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LSBM	Limestone Ball Mill	0	OOO	OOO	0.043	2.8E-4	0.522
	LS9	Limestone transfer to Kiln Feed Bin	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS11	Fines Screening and Associated Transfers In and Out	0	OOO	OOO	6.3E-3	4.0E-5	0.076
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	5A	5A	7.5E-4	4.8E-6	9.2E-3
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	5A	5A	0.021	1.3E-4	0.251
	LCR	Lime Mill Crushing and associated transfers In and Out	0	5A	5A	6.4E-3	4.1E-5	0
	LSL	Pebble Lime Silo Loading via Bucket Elevator	0	5A	5A	1.4E-4	9.0E-7	0
	LSU	Pebble Lime Silo discharge to Lime Slaker	0	5A	5A	1.4E-5	9.0E-8	0
	LS1L	Mill Lime Silo #1 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	MillS2L	Mill Lime Silo #2 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	ACS1L	AC Lime Silo #1 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS2L	AC Lime Silo #2 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS3L	AC Lime Silo #3 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS4L	AC Lime Silo #4 Loading	0	4.9E-6	2.7E-6	4.7E-4	3.0E-6	0
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
Concrete Production	CM	Central Mixer Loading	0	2.6E-5	8.2E-6	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	8.0E-7	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	8.0E-7	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	8.0E-7	0	0	0	0

TABLE B-H3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	8.0E-7	0	0	0	0
	CAL	Aggregate Bin Loading	0	OOO	OOO	0.016	1.0E-4	0
	CAU	Aggregate Bin Unloading	0	OOO	OOO	0.016	1.0E-4	0
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	1.9E-7	0	0	2.2E-6	0
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	7.5E-7	0	0	8.6E-6	0
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	1.1E-6	0	0	1.3E-5	0
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	4Z	4Z	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	6C	6C	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	6C	6C	0	0	0
Mining - Modeling Scenario: H3	YPP	Yellow Pine Pit	0	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0.024	0.051	5.585	0.063	1.101
	WEP	West End Pit	0	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	8.0E-3	0.017	1.902	0.021	0.375
	WEPBL	West End Pit Blasting	0	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	3.6E-3	7.9E-3	0.858	9.7E-3	0.169
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0	0
	HR000	Haul Roads	0	0.096	0.209	22.854	0.258	4.506
	TSF	Tailing Storage Facility	0.232	0	0	0	0	0
	ACCRD	Access Roads	0	4.7E-4	1.0E-3	0.113	1.3E-3	0.022
	UGEXP	Scout Portal	0	1.0E-7	2.3E-7	2.5E-5	2.8E-7	4.9E-6
		Total	**0.453**	**0.132**	**0.287**	**31.960**	**0.360**	**8.418**

TABLE B-H3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	2.9E-3	0	1.6E-6	4.5E-6
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	0	0	0	0	5.0E-5
	LS1	Limestone transfer to Primary Crusher Hopper	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5

TABLE B-H3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	0	0	0	0

TABLE B-H3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	0	0	0	0
	CAL	Aggregate Bin Loading	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	0	0	0	6.8E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	0	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	0	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	0	0	0	0
Mining - Modeling Scenario: H3	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	1.432	0	7.9E-4	2.2E-3
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0.488	0	2.7E-4	7.5E-4
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0.220	0	1.2E-4	3.4E-4
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0	5.858	0	3.2E-3	9.0E-3
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**0.696**	**8.239**	**2.030**	**4.9E-3**	**0.013**

TABLE B-H4. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to		LL	LL	0.010	1.2E-4	2.0E-3
	OC2	Grizzly to Apron Feeder		LL	LL	0.010	1.2E-4	2.0E-3
	OC3	Apron Feeder to Dribble Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC4	Apron Feeder to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC5	Dribble Conveyor to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor		LL	LL	0.089	1.0E-3	0.018
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile		LL	LL	0.010	1.2E-4	2.0E-3
	OC9	Stockpile Transfers to Reclaim Conveyors		LL	LL	0.049	5.5E-4	9.7E-3
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor		LL	LL	0.049	5.5E-4	9.7E-3
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	LL	LL	0.049	5.5E-4	9.7E-3
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	LL	LL	0.098	1.1E-3	0.019
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	LL	LL	0.011	1.3E-4	2.3E-3
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0.221	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	7E	7E	2.3E-5	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MR	Mercury Retort	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	2.6E-7	0	0	3.1E-6	0
	CKB	Carbon Regeneration Kiln (Burners)	0	8.4E-7	0	0	9.7E-6	0
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	3.7E-8	0	0	4.3E-7	0
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	1.9E-6	0	0	2.2E-5	0
	LKC	PFR Shaft Lime Kiln Combustion	0	5A	5A	0	9.5E-5	0
	LS1	Limestone transfer to Primary Crusher Hopper	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS2	Primary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS3	Primary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323
	LS4	Secondary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS5	Secondary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323

TABLE B-H4. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS8	Ball Mill Feed transfer to Ball	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LSBM	Limestone Ball Mill	0	OOO	OOO	0.043	2.8E-4	0.522
	LS9	Limestone transfer to Kiln Feed Bin	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS11	Fines Screening and Associated Transfers In and Out	0	OOO	OOO	6.3E-3	4.0E-5	0.076
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	5A	5A	7.5E-4	4.8E-6	9.2E-3
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	5A	5A	0.021	1.3E-4	0.251
	LCR	Lime Mill Crushing and associated transfers In and Out	0	5A	5A	6.4E-3	4.1E-5	0
	LSL	Pebble Lime Silo Loading via Bucket Elevator	0	5A	5A	1.4E-4	9.0E-7	0
	LSU	Pebble Lime Silo discharge to Lime Slaker	0	5A	5A	1.4E-5	9.0E-8	0
	LS1L	Mill Lime Silo #1 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	MillS2L	Mill Lime Silo #2 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	ACS1L	AC Lime Silo #1 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS2L	AC Lime Silo #2 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS3L	AC Lime Silo #3 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS4L	AC Lime Silo #4 Loading	0	4.9E-6	2.7E-6	4.7E-4	3.0E-6	0
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
Concrete Production	CM	Central Mixer Loading	0	2.6E-5	8.2E-6	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	8.0E-7	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	8.0E-7	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	8.0E-7	0	0	0	0

TABLE B-H4. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	8.0E-7	0	0	0	0
	CAL	Aggregate Bin Loading	0	OOO	OOO	0.016	1.0E-4	0
	CAU	Aggregate Bin Unloading	0	OOO	OOO	0.016	1.0E-4	0
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	1.9E-7	0	0	2.2E-6	0
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	7.5E-7	0	0	8.6E-6	0
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	1.1E-6	0	0	1.3E-5	0
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	4Z	4Z	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	6C	6C	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	6C	6C	0	0	0
Mining - Modeling Scenario: H4	YPP	Yellow Pine Pit	0	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0.024	0.051	5.585	0.063	1.101
	WEP	West End Pit	0	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	8.0E-3	0.017	1.902	0.021	0.375
	WEPBL	West End Pit Blasting	0	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	3.6E-3	7.9E-3	0.858	9.7E-3	0.169
	WEDRSF	West End DRSF	0	0	0	0	0	0
	HR000	Haul Roads	0	0.123	0.268	29.277	0.330	5.773
	TSF	Tailing Storage Facility	0.232	0	0	0	0	0
	ACCRD	Access Roads	0	4.7E-4	1.0E-3	0.113	1.3E-3	0.022
	UGEXP	Scout Portal	0	1.0E-7	2.3E-7	2.5E-5	2.8E-7	4.9E-6
		Total	**0.453**	**0.159**	**0.346**	**38.383**	**0.432**	**9.685**

TABLE B-H4. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	2.9E-3	0	1.6E-6	4.5E-6
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	0	0	0	0	5.0E-5
	LS1	Limestone transfer to Primary Crusher Hopper	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5

TABLE B-H4. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	0	0	0	0

TABLE B-H4. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	0	0	0	0
	CAL	Aggregate Bin Loading	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	0	0	0	6.8E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	0	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	0	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	0	0	0	0
Mining - Modeling Scenario: H4	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	1.432	0	7.9E-4	2.2E-3
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0.488	0	2.7E-4	7.5E-4
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0.220	0	1.2E-4	3.4E-4
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0	7.505	0	4.1E-3	0.012
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**0.696**	**9.886**	**2.030**	**5.8E-3**	**0.016**

TABLE B-W1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to		LL	LL	0.010	1.2E-4	2.0E-3
	OC2	Grizzly to Apron Feeder		LL	LL	0.010	1.2E-4	2.0E-3
	OC3	Apron Feeder to Dribble Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC4	Apron Feeder to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC5	Dribble Conveyor to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor		LL	LL	0.089	1.0E-3	0.018
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile		LL	LL	0.010	1.2E-4	2.0E-3
	OC9	Stockpile Transfers to Reclaim Conveyors		LL	LL	0.049	5.5E-4	9.7E-3
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor		LL	LL	0.049	5.5E-4	9.7E-3
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	LL	LL	0.049	5.5E-4	9.7E-3
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	LL	LL	0.098	1.1E-3	0.019
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	LL	LL	0.011	1.3E-4	2.3E-3
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0.221	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	7E	7E	2.3E-5	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MR	Mercury Retort	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	2.6E-7	0	0	3.1E-6	0
	CKB	Carbon Regeneration Kiln (Burners)	0	8.4E-7	0	0	9.7E-6	0
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	3.7E-8	0	0	4.3E-7	0
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	1.9E-6	0	0	2.2E-5	0
	LKC	PFR Shaft Lime Kiln Combustion	0	5A	5A	0	9.5E-5	0
	LS1	Limestone transfer to Primary Crusher Hopper	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS2	Primary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS3	Primary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323
	LS4	Secondary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS5	Secondary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323

TABLE B-W1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS8	Ball Mill Feed transfer to Ball	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LSBM	Limestone Ball Mill	0	OOO	OOO	0.043	2.8E-4	0.522
	LS9	Limestone transfer to Kiln Feed Bin	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS11	Fines Screening and Associated Transfers In and Out	0	OOO	OOO	6.3E-3	4.0E-5	0.076
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	5A	5A	7.5E-4	4.8E-6	9.2E-3
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	5A	5A	0.021	1.3E-4	0.251
	LCR	Lime Mill Crushing and associated transfers In and Out	0	5A	5A	6.4E-3	4.1E-5	0
	LSL	Pebble Lime Silo Loading via Bucket Elevator	0	5A	5A	1.4E-4	9.0E-7	0
	LSU	Pebble Lime Silo discharge to Lime Slaker	0	5A	5A	1.4E-5	9.0E-8	0
	LS1L	Mill Lime Silo #1 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	MillS2L	Mill Lime Silo #2 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	ACS1L	AC Lime Silo #1 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS2L	AC Lime Silo #2 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS3L	AC Lime Silo #3 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS4L	AC Lime Silo #4 Loading	0	4.9E-6	2.7E-6	4.7E-4	3.0E-6	0
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
Concrete Production	CM	Central Mixer Loading	0	2.6E-5	8.2E-6	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	8.0E-7	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	8.0E-7	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	8.0E-7	0	0	0	0

TABLE B-W1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	8.0E-7	0	0	0	0
	CAL	Aggregate Bin Loading	0	OOO	OOO	0.016	1.0E-4	0
	CAU	Aggregate Bin Unloading	0	OOO	OOO	0.016	1.0E-4	0
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	1.9E-7	0	0	2.2E-6	0
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	7.5E-7	0	0	8.6E-6	0
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	1.1E-6	0	0	1.3E-5	0
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	4Z	4Z	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	6C	6C	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	6C	6C	0	0	0
Mining - Modeling Scenario: W1	YPP	Yellow Pine Pit	0	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0	0
	WEP	West End Pit	0	0.024	0.051	5.585	0.063	1.101
	BT	Bradley Tailings	0	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	8.0E-3	0.017	1.902	0.021	0.375
	BTBL	Bradley Tailings Blasting	0	0	0	0	0	0
	STKP	PC Stockpile	0	4.5E-3	9.7E-3	1.063	0.012	0.210
	FDRSF	Fiddle DRSF	0	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0	0
	HR000	Haul Roads	0	0.090	0.196	21.435	0.242	4.227
	TSF	Tailing Storage Facility	0.232	0	0	0	0	0
	ACCRD	Access Roads	0	4.7E-4	1.0E-3	0.113	1.3E-3	0.022
	UGEXP	Scout Portal	0	1.0E-7	2.3E-7	2.5E-5	2.8E-7	4.9E-6
		Total	**0.453**	**0.127**	**0.276**	**30.746**	**0.346**	**8.179**

TABLE B-W1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	2.9E-3	0	1.6E-6	4.5E-6
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	0	0	0	0	5.0E-5
	LS1	Limestone transfer to Primary Crusher Hopper	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5

TABLE B-W1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	0	0	0	0

TABLE B-W1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	0	0	0	0
	CAL	Aggregate Bin Loading	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	0	0	0	6.8E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	0	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	0	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	0	0	0	0
Mining - Modeling Scenario: W1	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	0	1.432	0	7.9E-4	2.2E-3
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0.488	0	2.7E-4	7.5E-4
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0.272	0	1.5E-4	4.2E-4
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0	5.495	0	3.0E-3	8.5E-3
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**0.696**	**7.928**	**2.030**	**4.8E-3**	**0.013**

TABLE B-W2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to		LL	LL	0.010	1.2E-4	2.0E-3
	OC2	Grizzly to Apron Feeder		LL	LL	0.010	1.2E-4	2.0E-3
	OC3	Apron Feeder to Dribble Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC4	Apron Feeder to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC5	Dribble Conveyor to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor		LL	LL	0.089	1.0E-3	0.018
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile		LL	LL	0.010	1.2E-4	2.0E-3
	OC9	Stockpile Transfers to Reclaim Conveyors		LL	LL	0.049	5.5E-4	9.7E-3
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor		LL	LL	0.049	5.5E-4	9.7E-3
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	LL	LL	0.049	5.5E-4	9.7E-3
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	LL	LL	0.098	1.1E-3	0.019
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	LL	LL	0.011	1.3E-4	2.3E-3
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0.221	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	7E	7E	2.3E-5	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MR	Mercury Retort	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	2.6E-7	0	0	3.1E-6	0
	CKB	Carbon Regeneration Kiln (Burners)	0	8.4E-7	0	0	9.7E-6	0
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	3.7E-8	0	0	4.3E-7	0
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	1.9E-6	0	0	2.2E-5	0
	LKC	PFR Shaft Lime Kiln Combustion	0	5A	5A	0	9.5E-5	0
	LS1	Limestone transfer to Primary Crusher Hopper	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS2	Primary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS3	Primary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323
	LS4	Secondary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS5	Secondary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323

TABLE B-W2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS8	Ball Mill Feed transfer to Ball	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LSBM	Limestone Ball Mill	0	OOO	OOO	0.043	2.8E-4	0.522
	LS9	Limestone transfer to Kiln Feed Bin	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS11	Fines Screening and Associated Transfers In and Out	0	OOO	OOO	6.3E-3	4.0E-5	0.076
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	5A	5A	7.5E-4	4.8E-6	9.2E-3
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	5A	5A	0.021	1.3E-4	0.251
	LCR	Lime Mill Crushing and associated transfers In and Out	0	5A	5A	6.4E-3	4.1E-5	0
	LSL	Pebble Lime Silo Loading via Bucket Elevator	0	5A	5A	1.4E-4	9.0E-7	0
	LSU	Pebble Lime Silo discharge to Lime Slaker	0	5A	5A	1.4E-5	9.0E-8	0
	LS1L	Mill Lime Silo #1 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	MillS2L	Mill Lime Silo #2 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	ACS1L	AC Lime Silo #1 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS2L	AC Lime Silo #2 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS3L	AC Lime Silo #3 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS4L	AC Lime Silo #4 Loading	0	4.9E-6	2.7E-6	4.7E-4	3.0E-6	0
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
Concrete Production	CM	Central Mixer Loading	0	2.6E-5	8.2E-6	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	8.0E-7	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	8.0E-7	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	8.0E-7	0	0	0	0

TABLE B-W2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	8.0E-7	0	0	0	0
	CAL	Aggregate Bin Loading	0	OOO	OOO	0.016	1.0E-4	0
	CAU	Aggregate Bin Unloading	0	OOO	OOO	0.016	1.0E-4	0
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	1.9E-7	0	0	2.2E-6	0
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	7.5E-7	0	0	8.6E-6	0
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	1.1E-6	0	0	1.3E-5	0
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	4Z	4Z	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	6C	6C	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	6C	6C	0	0	0
Mining - Modeling Scenario: W2	YPP	Yellow Pine Pit	0	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0	0
	WEP	West End Pit	0	0.024	0.051	5.585	0.063	1.101
	BT	Bradley Tailings	0	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	8.0E-3	0.017	1.902	0.021	0.375
	BTBL	Bradley Tailings Blasting	0	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	3.6E-3	7.9E-3	0.858	9.7E-3	0.169
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0	0
	HR000	Haul Roads	0	0.145	0.316	34.484	0.389	6.800
	TSF	Tailing Storage Facility	0.232	0	0	0	0	0
	ACCRD	Access Roads	0	4.7E-4	1.0E-3	0.113	1.3E-3	0.022
	UGEXP	Scout Portal	0	1.0E-7	2.3E-7	2.5E-5	2.8E-7	4.9E-6
		Total	**0.453**	**0.181**	**0.393**	**43.590**	**0.491**	**10.711**

TABLE B-W2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	2.9E-3	0	1.6E-6	4.5E-6
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	0	0	0	0	5.0E-5
	LS1	Limestone transfer to Primary Crusher Hopper	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5

TABLE B-W2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	0	0	0	0

TABLE B-W2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	0	0	0	0
	CAL	Aggregate Bin Loading	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	0	0	0	6.8E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	0	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	0	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	0	0	0	0
Mining - Modeling Scenario: W2	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	0	1.432	0	7.9E-4	2.2E-3
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0.488	0	2.7E-4	7.5E-4
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0.220	0	1.2E-4	3.4E-4
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0	8.840	0	4.9E-3	0.014
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**0.696**	**11.221**	**2.030**	**6.6E-3**	**0.018**

TABLE B-W3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to		LL	LL	0.010	1.2E-4	2.0E-3
	OC2	Grizzly to Apron Feeder		LL	LL	0.010	1.2E-4	2.0E-3
	OC3	Apron Feeder to Dribble Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC4	Apron Feeder to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC5	Dribble Conveyor to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor		LL	LL	0.089	1.0E-3	0.018
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile		LL	LL	0.010	1.2E-4	2.0E-3
	OC9	Stockpile Transfers to Reclaim Conveyors		LL	LL	0.049	5.5E-4	9.7E-3
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor		LL	LL	0.049	5.5E-4	9.7E-3
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	LL	LL	0.049	5.5E-4	9.7E-3
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	LL	LL	0.098	1.1E-3	0.019
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	LL	LL	0.011	1.3E-4	2.3E-3
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0.221	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	7E	7E	2.3E-5	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MR	Mercury Retort	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	2.6E-7	0	0	3.1E-6	0
	CKB	Carbon Regeneration Kiln (Burners)	0	8.4E-7	0	0	9.7E-6	0
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	3.7E-8	0	0	4.3E-7	0
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	1.9E-6	0	0	2.2E-5	0
	LKC	PFR Shaft Lime Kiln Combustion	0	5A	5A	0	9.5E-5	0
	LS1	Limestone transfer to Primary Crusher Hopper	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS2	Primary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS3	Primary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323
	LS4	Secondary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS5	Secondary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323

TABLE B-W3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS8	Ball Mill Feed transfer to Ball	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LSBM	Limestone Ball Mill	0	OOO	OOO	0.043	2.8E-4	0.522
	LS9	Limestone transfer to Kiln Feed Bin	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS11	Fines Screening and Associated Transfers In and Out	0	OOO	OOO	6.3E-3	4.0E-5	0.076
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	5A	5A	7.5E-4	4.8E-6	9.2E-3
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	5A	5A	0.021	1.3E-4	0.251
	LCR	Lime Mill Crushing and associated transfers In and Out	0	5A	5A	6.4E-3	4.1E-5	0
	LSL	Pebble Lime Silo Loading via Bucket Elevator	0	5A	5A	1.4E-4	9.0E-7	0
	LSU	Pebble Lime Silo discharge to Lime Slaker	0	5A	5A	1.4E-5	9.0E-8	0
	LS1L	Mill Lime Silo #1 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	MillS2L	Mill Lime Silo #2 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	ACS1L	AC Lime Silo #1 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS2L	AC Lime Silo #2 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS3L	AC Lime Silo #3 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS4L	AC Lime Silo #4 Loading	0	4.9E-6	2.7E-6	4.7E-4	3.0E-6	0
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
Concrete Production	CM	Central Mixer Loading	0	2.6E-5	8.2E-6	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	8.0E-7	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	8.0E-7	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	8.0E-7	0	0	0	0

TABLE B-W3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8 (24-hr) lb/hr	Manganese 7439-96-5 (24-hr) lb/hr	Phosphorus 7723-14-0 (24-hr) lb/hr	Aluminum 7429-90-5 (24-hr) lb/hr	Barium 7440-39-3 (24-hr) lb/hr	Calcium Carbonate 1317-65-3 (24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	8.0E-7	0	0	0	0
	CAL	Aggregate Bin Loading	0	OOO	OOO	0.016	1.0E-4	0
	CAU	Aggregate Bin Unloading	0	OOO	OOO	0.016	1.0E-4	0
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	1.9E-7	0	0	2.2E-6	0
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	7.5E-7	0	0	8.6E-6	0
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	1.1E-6	0	0	1.3E-5	0
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	4Z	4Z	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	6C	6C	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	6C	6C	0	0	0
Mining - Modeling Scenario: W3	YPP	Yellow Pine Pit	0	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0	0
	WEP	West End Pit	0	0.024	0.051	5.585	0.063	1.101
	BT	Bradley Tailings	0	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	8.0E-3	0.017	1.902	0.021	0.375
	BTBL	Bradley Tailings Blasting	0	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	3.6E-3	7.9E-3	0.858	9.7E-3	0.169
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0	0
	HR000	Haul Roads	0	0.208	0.452	49.397	0.557	9.740
	TSF	Tailing Storage Facility	0.232	0	0	0	0	0
	ACCRD	Access Roads	0	4.7E-4	1.0E-3	0.113	1.3E-3	0.022
	UGEXP	Scout Portal	0	1.0E-7	2.3E-7	2.5E-5	2.8E-7	4.9E-6
		Total	**0.453**	**0.244**	**0.530**	**58.504**	**0.659**	**13.652**

TABLE B-W3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	2.9E-3	0	1.6E-6	4.5E-6
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	0	0	0	0	5.0E-5
	LS1	Limestone transfer to Primary Crusher Hopper	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5

TABLE B-W3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	0	0	0	0

TABLE B-W3. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	0	0	0	0
	CAL	Aggregate Bin Loading	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	0	0	0	6.8E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	0	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	0	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	0	0	0	0
Mining - Modeling Scenario: W3	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	0	1.432	0	7.9E-4	2.2E-3
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0.488	0	2.7E-4	7.5E-4
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0.220	0	1.2E-4	3.4E-4
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0	12.662	0	7.0E-3	0.019
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**0.696**	**15.043**	**2.030**	**8.7E-3**	**0.024**

TABLE B-W4. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to		LL	LL	0.010	1.2E-4	2.0E-3
	OC2	Grizzly to Apron Feeder		LL	LL	0.010	1.2E-4	2.0E-3
	OC3	Apron Feeder to Dribble Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC4	Apron Feeder to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC5	Dribble Conveyor to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor		LL	LL	0.089	1.0E-3	0.018
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile		LL	LL	0.010	1.2E-4	2.0E-3
	OC9	Stockpile Transfers to Reclaim Conveyors		LL	LL	0.049	5.5E-4	9.7E-3
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor		LL	LL	0.049	5.5E-4	9.7E-3
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	LL	LL	0.049	5.5E-4	9.7E-3
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	LL	LL	0.098	1.1E-3	0.019
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	LL	LL	0.011	1.3E-4	2.3E-3
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0.221	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	7E	7E	2.3E-5	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MR	Mercury Retort	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	2.6E-7	0	0	3.1E-6	0
	CKB	Carbon Regeneration Kiln (Burners)	0	8.4E-7	0	0	9.7E-6	0
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	3.7E-8	0	0	4.3E-7	0
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	1.9E-6	0	0	2.2E-5	0
	LKC	PFR Shaft Lime Kiln Combustion	0	5A	5A	0	9.5E-5	0
	LS1	Limestone transfer to Primary Crusher Hopper	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS2	Primary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS3	Primary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323
	LS4	Secondary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS5	Secondary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323

TABLE B-W4. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS8	Ball Mill Feed transfer to Ball	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LSBM	Limestone Ball Mill	0	OOO	OOO	0.043	2.8E-4	0.522
	LS9	Limestone transfer to Kiln Feed Bin	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS11	Fines Screening and Associated Transfers In and Out	0	OOO	OOO	6.3E-3	4.0E-5	0.076
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	5A	5A	7.5E-4	4.8E-6	9.2E-3
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	5A	5A	0.021	1.3E-4	0.251
	LCR	Lime Mill Crushing and associated transfers In and Out	0	5A	5A	6.4E-3	4.1E-5	0
	LSL	Pebble Lime Silo Loading via Bucket Elevator	0	5A	5A	1.4E-4	9.0E-7	0
	LSU	Pebble Lime Silo discharge to Lime Slaker	0	5A	5A	1.4E-5	9.0E-8	0
	LS1L	Mill Lime Silo #1 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	MillS2L	Mill Lime Silo #2 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	ACS1L	AC Lime Silo #1 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS2L	AC Lime Silo #2 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS3L	AC Lime Silo #3 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS4L	AC Lime Silo #4 Loading	0	4.9E-6	2.7E-6	4.7E-4	3.0E-6	0
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
Concrete Production	CM	Central Mixer Loading	0	2.6E-5	8.2E-6	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	8.0E-7	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	8.0E-7	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	8.0E-7	0	0	0	0

TABLE B-W4. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	8.0E-7	0	0	0	0
	CAL	Aggregate Bin Loading	0	OOO	OOO	0.016	1.0E-4	0
	CAU	Aggregate Bin Unloading	0	OOO	OOO	0.016	1.0E-4	0
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	1.9E-7	0	0	2.2E-6	0
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	7.5E-7	0	0	8.6E-6	0
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	1.1E-6	0	0	1.3E-5	0
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	4Z	4Z	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	6C	6C	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	6C	6C	0	0	0
Mining - Modeling Scenario: W4	YPP	Yellow Pine Pit	0	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0	0
	WEP	West End Pit	0	0.024	0.051	5.585	0.063	1.101
	BT	Bradley Tailings	0	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	8.0E-3	0.017	1.902	0.021	0.375
	BTBL	Bradley Tailings Blasting	0	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	3.6E-3	7.9E-3	0.858	9.7E-3	0.169
	WEDRSF	West End DRSF	0	0	0	0	0	0
	HR000	Haul Roads	0	0.094	0.204	22.281	0.251	4.393
	TSF	Tailing Storage Facility	0.232	0	0	0	0	0
	ACCRD	Access Roads	0	4.7E-4	1.0E-3	0.113	1.3E-3	0.022
	UGEXP	Scout Portal	0	1.0E-7	2.3E-7	2.5E-5	2.8E-7	4.9E-6
		Total	**0.453**	**0.130**	**0.282**	**31.387**	**0.353**	**8.305**

TABLE B-W4. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	2.9E-3	0	1.6E-6	4.5E-6
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	0	0	0	0	5.0E-5
	LS1	Limestone transfer to Primary Crusher Hopper	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5

TABLE B-W4. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	0	0	0	0

TABLE B-W4. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	0	0	0	0
	CAL	Aggregate Bin Loading	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	0	0	0	6.8E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	0	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	0	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	0	0	0	0
Mining - Modeling Scenario: W4	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	0	1.432	0	7.9E-4	2.2E-3
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0.488	0	2.7E-4	7.5E-4
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0.220	0	1.2E-4	3.4E-4
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0	5.711	0	3.1E-3	8.8E-3
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**0.696**	**8.092**	**2.030**	**4.8E-3**	**0.013**

TABLE B-W5. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to		LL	LL	0.010	1.2E-4	2.0E-3
	OC2	Grizzly to Apron Feeder		LL	LL	0.010	1.2E-4	2.0E-3
	OC3	Apron Feeder to Dribble Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC4	Apron Feeder to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC5	Dribble Conveyor to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor		LL	LL	0.089	1.0E-3	0.018
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile		LL	LL	0.010	1.2E-4	2.0E-3
	OC9	Stockpile Transfers to Reclaim Conveyors		LL	LL	0.049	5.5E-4	9.7E-3
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor		LL	LL	0.049	5.5E-4	9.7E-3
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	LL	LL	0.049	5.5E-4	9.7E-3
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	LL	LL	0.098	1.1E-3	0.019
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	LL	LL	0.011	1.3E-4	2.3E-3
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0.221	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	7E	7E	2.3E-5	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MR	Mercury Retort	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	2.6E-7	0	0	3.1E-6	0
	CKB	Carbon Regeneration Kiln (Burners)	0	8.4E-7	0	0	9.7E-6	0
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	3.7E-8	0	0	4.3E-7	0
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	1.9E-6	0	0	2.2E-5	0
	LKC	PFR Shaft Lime Kiln Combustion	0	5A	5A	0	9.5E-5	0
	LS1	Limestone transfer to Primary Crusher Hopper	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS2	Primary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS3	Primary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323
	LS4	Secondary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS5	Secondary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323

TABLE B-W5. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS8	Ball Mill Feed transfer to Ball	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LSBM	Limestone Ball Mill	0	OOO	OOO	0.043	2.8E-4	0.522
	LS9	Limestone transfer to Kiln Feed Bin	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS11	Fines Screening and Associated Transfers In and Out	0	OOO	OOO	6.3E-3	4.0E-5	0.076
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	5A	5A	7.5E-4	4.8E-6	9.2E-3
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	5A	5A	0.021	1.3E-4	0.251
	LCR	Lime Mill Crushing and associated transfers In and Out	0	5A	5A	6.4E-3	4.1E-5	0
	LSL	Pebble Lime Silo Loading via Bucket Elevator	0	5A	5A	1.4E-4	9.0E-7	0
	LSU	Pebble Lime Silo discharge to Lime Slaker	0	5A	5A	1.4E-5	9.0E-8	0
	LS1L	Mill Lime Silo #1 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	MillS2L	Mill Lime Silo #2 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	ACS1L	AC Lime Silo #1 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS2L	AC Lime Silo #2 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS3L	AC Lime Silo #3 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS4L	AC Lime Silo #4 Loading	0	4.9E-6	2.7E-6	4.7E-4	3.0E-6	0
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
Concrete Production	CM	Central Mixer Loading	0	2.6E-5	8.2E-6	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	8.0E-7	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	8.0E-7	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	8.0E-7	0	0	0	0

TABLE B-W5. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	8.0E-7	0	0	0	0
	CAL	Aggregate Bin Loading	0	OOO	OOO	0.016	1.0E-4	0
	CAU	Aggregate Bin Unloading	0	OOO	OOO	0.016	1.0E-4	0
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	1.9E-7	0	0	2.2E-6	0
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	7.5E-7	0	0	8.6E-6	0
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	1.1E-6	0	0	1.3E-5	0
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	4Z	4Z	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	6C	6C	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	6C	6C	0	0	0
Mining - Modeling Scenario: W5	YPP	Yellow Pine Pit	0	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0	0
	WEP	West End Pit	0	0.024	0.051	5.585	0.063	1.101
	BT	Bradley Tailings	0	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	8.0E-3	0.017	1.902	0.021	0.375
	BTBL	Bradley Tailings Blasting	0	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0	0
	WEDRSF	West End DRSF	0	3.6E-3	7.9E-3	0.858	9.7E-3	0.169
	HR000	Haul Roads	0	0.104	0.225	24.595	0.277	4.850
	TSF	Tailing Storage Facility	0.232	0	0	0	0	0
	ACCRD	Access Roads	0	4.7E-4	1.0E-3	0.113	1.3E-3	0.022
	UGEXP	Scout Portal	0	1.0E-7	2.3E-7	2.5E-5	2.8E-7	4.9E-6
		Total	**0.453**	**0.139**	**0.303**	**33.702**	**0.379**	**8.761**

TABLE B-W5. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	2.9E-3	0	1.6E-6	4.5E-6
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	0	0	0	0	5.0E-5
	LS1	Limestone transfer to Primary Crusher Hopper	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5

TABLE B-W5. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	0	0	0	0

TABLE B-W5. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	0	0	0	0
	CAL	Aggregate Bin Loading	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	0	0	0	6.8E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	0	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	0	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	0	0	0	0
Mining - Modeling Scenario: W5	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	0	1.432	0	7.9E-4	2.2E-3
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0.488	0	2.7E-4	7.5E-4
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0.220	0	1.2E-4	3.4E-4
	HR000	Haul Roads	0	6.305	0	3.5E-3	9.7E-3
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**0.696**	**8.686**	**2.030**	**5.2E-3**	**0.014**

TABLE B-B1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to		LL	LL	0.010	1.2E-4	2.0E-3
	OC2	Grizzly to Apron Feeder		LL	LL	0.010	1.2E-4	2.0E-3
	OC3	Apron Feeder to Dribble Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC4	Apron Feeder to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC5	Dribble Conveyor to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor		LL	LL	0.089	1.0E-3	0.018
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile		LL	LL	0.010	1.2E-4	2.0E-3
	OC9	Stockpile Transfers to Reclaim Conveyors		LL	LL	0.049	5.5E-4	9.7E-3
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor		LL	LL	0.049	5.5E-4	9.7E-3
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	LL	LL	0.049	5.5E-4	9.7E-3
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	LL	LL	0.098	1.1E-3	0.019
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	LL	LL	0.011	1.3E-4	2.3E-3
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0.221	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	7E	7E	2.3E-5	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MR	Mercury Retort	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	2.6E-7	0	0	3.1E-6	0
	CKB	Carbon Regeneration Kiln (Burners)	0	8.4E-7	0	0	9.7E-6	0
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	3.7E-8	0	0	4.3E-7	0
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	1.9E-6	0	0	2.2E-5	0
	LKC	PFR Shaft Lime Kiln Combustion	0	5A	5A	0	9.5E-5	0
	LS1	Limestone transfer to Primary Crusher Hopper	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS2	Primary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS3	Primary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323
	LS4	Secondary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS5	Secondary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323

TABLE B-B1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS8	Ball Mill Feed transfer to Ball	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LSBM	Limestone Ball Mill	0	OOO	OOO	0.043	2.8E-4	0.522
	LS9	Limestone transfer to Kiln Feed Bin	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS11	Fines Screening and Associated Transfers In and Out	0	OOO	OOO	6.3E-3	4.0E-5	0.076
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	5A	5A	7.5E-4	4.8E-6	9.2E-3
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	5A	5A	0.021	1.3E-4	0.251
	LCR	Lime Mill Crushing and associated transfers In and Out	0	5A	5A	6.4E-3	4.1E-5	0
	LSL	Pebble Lime Silo Loading via Bucket Elevator	0	5A	5A	1.4E-4	9.0E-7	0
	LSU	Pebble Lime Silo discharge to Lime Slaker	0	5A	5A	1.4E-5	9.0E-8	0
	LS1L	Mill Lime Silo #1 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	MillS2L	Mill Lime Silo #2 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	ACS1L	AC Lime Silo #1 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS2L	AC Lime Silo #2 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS3L	AC Lime Silo #3 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS4L	AC Lime Silo #4 Loading	0	4.9E-6	2.7E-6	4.7E-4	3.0E-6	0
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
Concrete Production	CM	Central Mixer Loading	0	2.6E-5	8.2E-6	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	8.0E-7	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	8.0E-7	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	8.0E-7	0	0	0	0

TABLE B-B1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	8.0E-7	0	0	0	0
	CAL	Aggregate Bin Loading	0	OOO	OOO	0.016	1.0E-4	0
	CAU	Aggregate Bin Unloading	0	OOO	OOO	0.016	1.0E-4	0
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	1.9E-7	0	0	2.2E-6	0
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	7.5E-7	0	0	8.6E-6	0
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	1.1E-6	0	0	1.3E-5	0
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	4Z	4Z	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	6C	6C	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	6C	6C	0	0	0
Mining - Modeling Scenario: B1	YPP	Yellow Pine Pit	0	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0	0
	WEP	West End Pit	0	0	0	0	0	0
	BT	Bradley Tailings	0	0.023	0.051	5.567	0.063	1.098
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	8.0E-3	0.017	1.902	0.021	0.375
	STKP	PC Stockpile	0	4.5E-3	9.7E-3	1.063	0.012	0.210
	FDRSF	Fiddle DRSF	0	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0	0
	HR000	Haul Roads	0	0.120	0.260	28.394	0.320	5.599
	TSF	Tailing Storage Facility	0.232	0	0	0	0	0
	ACCRD	Access Roads	0	4.7E-4	1.0E-3	0.113	1.3E-3	0.022
	UGEXP	Scout Portal	0	1.0E-7	2.3E-7	2.5E-5	2.8E-7	4.9E-6
		Total	**0.453**	**0.156**	**0.339**	**37.687**	**0.424**	**9.547**

TABLE B-B1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	2.9E-3	0	1.6E-6	4.5E-6
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	0	0	0	0	5.0E-5
	LS1	Limestone transfer to Primary Crusher Hopper	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5

TABLE B-B1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	0	0	0	0

TABLE B-B1. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	0	0	0	0
	CAL	Aggregate Bin Loading	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	0	0	0	6.8E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	0	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	0	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	0	0	0	0
Mining - Modeling Scenario: B1	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	0	1.427	0	7.8E-4	2.2E-3
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0.488	0	2.7E-4	7.5E-4
	STKP	PC Stockpile	0	0.272	0	1.5E-4	4.2E-4
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0	7.278	0	4.0E-3	0.011
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**0.696**	**9.707**	**2.030**	**5.7E-3**	**0.015**

TABLE B-B2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to		LL	LL	0.010	1.2E-4	2.0E-3
	OC2	Grizzly to Apron Feeder		LL	LL	0.010	1.2E-4	2.0E-3
	OC3	Apron Feeder to Dribble Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC4	Apron Feeder to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC5	Dribble Conveyor to Vibrating Grizzly		LL	LL	0.010	1.2E-4	2.0E-3
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor		LL	LL	0.010	1.2E-4	2.0E-3
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor		LL	LL	0.089	1.0E-3	0.018
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile		LL	LL	0.010	1.2E-4	2.0E-3
	OC9	Stockpile Transfers to Reclaim Conveyors		LL	LL	0.049	5.5E-4	9.7E-3
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor		LL	LL	0.049	5.5E-4	9.7E-3
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	LL	LL	0.049	5.5E-4	9.7E-3
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	LL	LL	0.098	1.1E-3	0.019
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	LL	LL	0.011	1.3E-4	2.3E-3
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0.221	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	7E	7E	2.3E-5	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MR	Mercury Retort	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	7E	7E	9.6E-5	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	2.6E-7	0	0	3.1E-6	0
	CKB	Carbon Regeneration Kiln (Burners)	0	8.4E-7	0	0	9.7E-6	0
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	3.7E-8	0	0	4.3E-7	0
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	1.9E-6	0	0	2.2E-5	0
	LKC	PFR Shaft Lime Kiln Combustion	0	5A	5A	0	9.5E-5	0
	LS1	Limestone transfer to Primary Crusher Hopper	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS2	Primary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS3	Primary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323
	LS4	Secondary Crushing and Associated Transfers In and Out	0	OOO	OOO	5.7E-3	3.7E-5	0.070
	LS5	Secondary Screening and Associated Transfers In and Out	0	OOO	OOO	0.027	1.7E-4	0.323

TABLE B-B2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LS8	Ball Mill Feed transfer to Ball	0	OOO	OOO	3.2E-3	2.0E-5	0.039
	LSBM	Limestone Ball Mill	0	OOO	OOO	0.043	2.8E-4	0.522
	LS9	Limestone transfer to Kiln Feed Bin	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	OOO	OOO	7.5E-4	4.8E-6	9.2E-3
	LS11	Fines Screening and Associated Transfers In and Out	0	OOO	OOO	6.3E-3	4.0E-5	0.076
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	5A	5A	7.5E-4	4.8E-6	9.2E-3
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	5A	5A	0.021	1.3E-4	0.251
	LCR	Lime Mill Crushing and associated transfers In and Out	0	5A	5A	6.4E-3	4.1E-5	0
	LSL	Pebble Lime Silo Loading via Bucket Elevator	0	5A	5A	1.4E-4	9.0E-7	0
	LSU	Pebble Lime Silo discharge to Lime Slaker	0	5A	5A	1.4E-5	9.0E-8	0
	LS1L	Mill Lime Silo #1 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	MillS2L	Mill Lime Silo #2 Loading	0	2.4E-6	1.3E-6	2.3E-4	1.5E-6	0
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0	1.2E-5	6.5E-6	1.1E-3	7.3E-6	0
	ACS1L	AC Lime Silo #1 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS2L	AC Lime Silo #2 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS3L	AC Lime Silo #3 Loading	0	9.8E-6	5.4E-6	9.3E-4	6.0E-6	0
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
	ACS4L	AC Lime Silo #4 Loading	0	4.9E-6	2.7E-6	4.7E-4	3.0E-6	0
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0	2.3E-5	1.2E-5	2.2E-3	1.4E-5	0
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	OOO	OOO	0.014	9.1E-5	0.172
Concrete Production	CM	Central Mixer Loading	0	2.6E-5	8.2E-6	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	8.0E-7	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	8.0E-7	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	8.0E-7	0	0	0	0

TABLE B-B2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Cyanide 592-01-8	Manganese 7439-96-5	Phosphorus 7723-14-0	Aluminum 7429-90-5	Barium 7440-39-3	Calcium Carbonate 1317-65-3
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	8.0E-7	0	0	0	0
	CAL	Aggregate Bin Loading	0	OOO	OOO	0.016	1.0E-4	0
	CAU	Aggregate Bin Unloading	0	OOO	OOO	0.016	1.0E-4	0
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	1.5E-6	0	0	1.7E-5	0
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	9.3E-8	0	0	1.1E-6	0
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	1.9E-7	0	0	2.2E-6	0
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	7.5E-7	0	0	8.6E-6	0
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	1.1E-6	0	0	1.3E-5	0
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	4Z	4Z	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	4Z	4Z	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	6C	6C	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	6C	6C	0	0	0
Mining - Modeling Scenario: B2	YPP	Yellow Pine Pit	0	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0	0
	WEP	West End Pit	0	0	0	0	0	0
	BT	Bradley Tailings	0	0.023	0.051	5.567	0.063	1.098
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	8.0E-3	0.017	1.902	0.021	0.375
	STKP	PC Stockpile	0	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	3.6E-3	7.9E-3	0.858	9.7E-3	0.169
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0	0
	HR000	Haul Roads	0	0.028	0.061	6.713	0.076	1.324
	TSF	Tailing Storage Facility	0.232	0	0	0	0	0
	ACCRD	Access Roads	0	4.7E-4	1.0E-3	0.113	1.3E-3	0.022
	UGEXP	Scout Portal	0	1.0E-7	2.3E-7	2.5E-5	2.8E-7	4.9E-6
		Total	**0.453**	**0.064**	**0.139**	**15.801**	**0.178**	**5.232**

TABLE B-B2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	0	2.7E-3	0	1.5E-6	4.1E-6
	OC2	Grizzly to Apron Feeder	0	2.7E-3	0	1.5E-6	4.1E-6
	OC3	Apron Feeder to Dribble Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC4	Apron Feeder to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC5	Dribble Conveyor to Vibrating Grizzly	0	2.7E-3	0	1.5E-6	4.1E-6
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	0	2.7E-3	0	1.5E-6	4.1E-6
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	0	0.023	0	1.3E-5	3.5E-5
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	0	2.7E-3	0	1.5E-6	4.1E-6
	OC9	Stockpile Transfers to Reclaim Conveyors	0	0.013	0	6.9E-6	1.9E-5
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	0	0.013	0	6.9E-6	1.9E-5
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	0	0.013	0	6.9E-6	1.9E-5
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	0	0.025	0	1.4E-5	3.9E-5
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	0	2.9E-3	0	1.6E-6	4.5E-6
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	0	2.3E-5	2.030	2.3E-5	2.3E-5
	EW	Electrowinning Cells and Pregnant Solution Tank	0	9.6E-5	0	9.6E-5	9.6E-5
	MR	Mercury Retort	0	9.6E-5	0	9.6E-5	9.6E-5
	MF	Induction Melting Furnace	0	9.6E-5	0	9.6E-5	9.6E-5
	CKD	Carbon Regeneration Kiln (Drum)	0	9.6E-5	0	9.6E-5	9.6E-5
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	0	0	0	0	1.6E-6
	CKB	Carbon Regeneration Kiln (Burners)	0	0	0	0	5.1E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	0	0	0	0	2.3E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	0	0	0	0	1.1E-5
	LKC	PFR Shaft Lime Kiln Combustion	0	0	0	0	5.0E-5
	LS1	Limestone transfer to Primary Crusher Hopper	0	1.5E-3	0	7.1E-7	2.2E-6
	LS2	Primary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS3	Primary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5
	LS4	Secondary Crushing and Associated Transfers In and Out	0	2.6E-3	0	1.3E-6	3.9E-6
	LS5	Secondary Screening and Associated Transfers In and Out	0	0.012	0	5.9E-6	1.8E-5

TABLE B-B2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	0	1.5E-3	0	7.1E-7	2.2E-6
	LS7	Limestone transfer to Ball Mill Feed Conveyor	0	1.5E-3	0	7.1E-7	2.2E-6
	LS8	Ball Mill Feed transfer to Ball	0	1.5E-3	0	7.1E-7	2.2E-6
	LSBM	Limestone Ball Mill	0	0.020	0	9.5E-6	2.9E-5
	LS9	Limestone transfer to Kiln Feed Bin	0	3.5E-4	0	1.7E-7	5.2E-7
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	0	3.5E-4	0	1.7E-7	5.2E-7
	LS11	Fines Screening and Associated Transfers In and Out	0	2.9E-3	0	1.4E-6	4.3E-6
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	0	3.5E-4	0	1.7E-7	5.2E-7
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	0	9.5E-3	0	4.6E-6	1.4E-5
	LCR	Lime Mill Crushing and associated transfers In and Out	0.211	2.9E-3	0	1.4E-6	4.4E-6
	LSL	Pebble Lime Silo Loading via Bucket Elevator	4.6E-3	6.4E-5	0	3.1E-8	9.6E-8
	LSU	Pebble Lime Silo discharge to Lime Slaker	4.6E-4	6.4E-6	0	3.1E-9	9.6E-9
	LS1L	Mill Lime Silo #1 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	MillS2L	Mill Lime Silo #2 Loading	7.6E-3	1.1E-4	0	5.2E-8	1.6E-7
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	0.037	5.2E-4	0	2.5E-7	7.8E-7
	ACS1L	AC Lime Silo #1 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS2L	AC Lime Silo #2 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS3L	AC Lime Silo #3 Loading	0.031	4.3E-4	0	2.1E-7	6.4E-7
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
	ACS4L	AC Lime Silo #4 Loading	0.015	2.1E-4	0	1.0E-7	3.2E-7
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	0.071	9.9E-4	0	4.8E-7	1.5E-6
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	0	6.5E-3	0	3.1E-6	9.7E-6
Concrete Production	CM	Central Mixer Loading	0	0	0	0	0
	CS1L	Cement/Shotcrete Silo #1 Loading	0	0	0	0	0
	CS1U	Cement/Shotcrete Silo #1 Unloading	0	0	0	0	0
	CS2L	Cement/Shotcrete Silo #2 Loading	0	0	0	0	0

TABLE B-B2. TAPs that Exceed the EL by Source chk **180,000 T/day Emissions**

	Source ID	Source Description	Calcium Oxide 1305-78-8	Iron 7439-89-6	Sulfuric Acid 7664-93-9	Thallium 7440-28-0	Vanadium 7440-62-2
			(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr	(24-hr) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	0	0	0	0	0
	CAL	Aggregate Bin Loading	0	7.1E-3	0	3.5E-6	1.1E-5
	CAU	Aggregate Bin Unloading	0	7.1E-3	0	3.5E-6	1.1E-5
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	0	0	0	0	9.0E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	0	0	0	0	9.0E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	0	0	0	0	5.6E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	0	0	0	0	1.1E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	0	0	0	0	4.5E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	0	0	0	0	6.8E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	0	0	0	0	0
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	0	0	0	0	0
Fuel Storage	TG1	Mine Site Gasoline Tank #1	0	0	0	0	0
	TG2	Mine Site Gasoline Tank #2	0	0	0	0	0
Mining - Modeling Scenario: B2	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	0	1.427	0	7.8E-4	2.2E-3
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0.488	0	2.7E-4	7.5E-4
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0.220	0	1.2E-4	3.4E-4
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0	1.721	0	9.5E-4	2.6E-3
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	0	0.029	0	1.6E-5	4.4E-5
	UGEXP	Scout Portal	0	6.4E-6	0	3.5E-9	9.8E-9
		Total	**0.696**	**4.097**	**2.030**	**2.7E-3**	**6.8E-3**

TABLE B-Y1. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	LL	LL	LL	LL	LL
	OC2	Grizzly to Apron Feeder	LL	LL	LL	LL	LL
	OC3	Apron Feeder to Dribble Conveyor	LL	LL	LL	LL	LL
	OC4	Apron Feeder to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC5	Dribble Conveyor to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	LL	LL	LL	LL	LL
	OC9	Stockpile Transfers to Reclaim Conveyors	LL	LL	LL	LL	LL
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	LL	LL	LL	LL	LL
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	LL	LL	LL	LL	LL
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	7E
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	7E
	MR	Mercury Retort	7E	7E	7E	7E	7E
	MF	Induction Melting Furnace	7E	7E	7E	7E	7E
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	7E
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	1.3E-7	7.7E-9	7.0E-7	4.8E-5	1.3E-6
	CKB	Carbon Regeneration Kiln (Burners)	4.1E-7	2.4E-8	2.2E-6	1.5E-4	4.3E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	1.8E-8	1.1E-9	9.9E-8	6.8E-6	1.9E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	9.0E-7	5.4E-8	5.0E-6	3.4E-4	9.5E-6
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	5A
	LS1	Limestone transfer to Primary Crusher Hopper	OOO	OOO	OOO	OOO	OOO
	LS2	Primary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS3	Primary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS4	Secondary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS5	Secondary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO

TABLE B-Y1. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS7	Limestone transfer to Ball Mill Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS8	Ball Mill Feed transfer to Ball	OOO	OOO	OOO	OOO	OOO
	LSBM	Limestone Ball Mill	OOO	OOO	OOO	OOO	OOO
	LS9	Limestone transfer to Kiln Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS11	Fines Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	5A
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	5A
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	5A
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	5A
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	5A
	LS1L	Mill Lime Silo #1 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	MillS2L	Mill Lime Silo #2 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	ACS1L	AC Lime Silo #1 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS2L	AC Lime Silo #2 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS3L	AC Lime Silo #3 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS4L	AC Lime Silo #4 Loading	2.3E-8	7.9E-10	2.5E-10	0	4.9E-9
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	1.1E-7	3.8E-9	1.2E-9	0	2.4E-8
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
Concrete Production	CM	Central Mixer Loading	2.0E-6	0	4.9E-9	0	1.7E-6
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	3.3E-9	0	0	2.9E-7

TABLE B-Y1. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	OOO
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	OOO
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.9E-9	5.4E-7	3.7E-5	1.0E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.4E-8	2.2E-6	1.5E-4	4.1E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.5E-8	3.2E-6	2.2E-4	6.2E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	4Z	4Z	4Z	4Z	4Z
Fuel Storage	TG1	Mine Site Gasoline Tank #1	6C	6C	6C	6C	6C
	TG2	Mine Site Gasoline Tank #2	6C	6C	6C	6C	6C
Mining - Modeling Scenario: Y1	YPP	Yellow Pine Pit	9.4E-3	4.5E-5	7.0E-6	0	2.8E-5
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0.018	8.6E-5	1.3E-5	0	5.4E-5
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	5.7E-3	2.7E-5	4.3E-6	0	1.7E-5
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0.065	5.5E-4	8.5E-5	0	3.4E-4
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	4.0E-6	5.1E-6	7.9E-7	0	3.2E-6
	UGEXP	Scout Portal	2.3E-7	1.1E-9	1.7E-10	0	7.0E-10
		Total	**0.098**	**7.1E-4**	**1.4E-4**	**1.9E-3**	**5.0E-4**

TABLE B-Y2. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	LL	LL	LL	LL	LL
	OC2	Grizzly to Apron Feeder	LL	LL	LL	LL	LL
	OC3	Apron Feeder to Dribble Conveyor	LL	LL	LL	LL	LL
	OC4	Apron Feeder to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC5	Dribble Conveyor to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	LL	LL	LL	LL	LL
	OC9	Stockpile Transfers to Reclaim Conveyors	LL	LL	LL	LL	LL
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	LL	LL	LL	LL	LL
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	LL	LL	LL	LL	LL
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	7E
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	7E
	MR	Mercury Retort	7E	7E	7E	7E	7E
	MF	Induction Melting Furnace	7E	7E	7E	7E	7E
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	7E
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	1.3E-7	7.7E-9	7.0E-7	4.8E-5	1.3E-6
	CKB	Carbon Regeneration Kiln (Burners)	4.1E-7	2.4E-8	2.2E-6	1.5E-4	4.3E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	1.8E-8	1.1E-9	9.9E-8	6.8E-6	1.9E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	9.0E-7	5.4E-8	5.0E-6	3.4E-4	9.5E-6
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	5A
	LS1	Limestone transfer to Primary Crusher Hopper	OOO	OOO	OOO	OOO	OOO
	LS2	Primary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS3	Primary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS4	Secondary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS5	Secondary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO

TABLE B-Y2. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS7	Limestone transfer to Ball Mill Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS8	Ball Mill Feed transfer to Ball	OOO	OOO	OOO	OOO	OOO
	LSBM	Limestone Ball Mill	OOO	OOO	OOO	OOO	OOO
	LS9	Limestone transfer to Kiln Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS11	Fines Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	5A
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	5A
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	5A
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	5A
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	5A
	LS1L	Mill Lime Silo #1 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	MillS2L	Mill Lime Silo #2 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	ACS1L	AC Lime Silo #1 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS2L	AC Lime Silo #2 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS3L	AC Lime Silo #3 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS4L	AC Lime Silo #4 Loading	2.3E-8	7.9E-10	2.5E-10	0	4.9E-9
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	1.1E-7	3.8E-9	1.2E-9	0	2.4E-8
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
Concrete Production	CM	Central Mixer Loading	2.0E-6	0	4.9E-9	0	1.7E-6
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	3.3E-9	0	0	2.9E-7

TABLE B-Y2. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	OOO
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	OOO
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.9E-9	5.4E-7	3.7E-5	1.0E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.4E-8	2.2E-6	1.5E-4	4.1E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.5E-8	3.2E-6	2.2E-4	6.2E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	4Z	4Z	4Z	4Z	4Z
Fuel Storage	TG1	Mine Site Gasoline Tank #1	6C	6C	6C	6C	6C
	TG2	Mine Site Gasoline Tank #2	6C	6C	6C	6C	6C
Mining - Modeling Scenario: Y2	YPP	Yellow Pine Pit	9.4E-3	4.5E-5	7.0E-6	0	2.8E-5
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0.018	8.6E-5	1.3E-5	0	5.4E-5
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	4.2E-3	2.0E-5	3.2E-6	0	1.3E-5
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0.094	7.9E-4	1.2E-4	0	5.0E-4
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	4.0E-6	5.1E-6	7.9E-7	0	3.2E-6
	UGEXP	Scout Portal	2.3E-7	1.1E-9	1.7E-10	0	7.0E-10
		Total	**0.125**	**9.5E-4**	**1.8E-4**	**1.9E-3**	**6.5E-4**

TABLE B-Y3. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	LL	LL	LL	LL	LL
	OC2	Grizzly to Apron Feeder	LL	LL	LL	LL	LL
	OC3	Apron Feeder to Dribble Conveyor	LL	LL	LL	LL	LL
	OC4	Apron Feeder to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC5	Dribble Conveyor to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	LL	LL	LL	LL	LL
	OC9	Stockpile Transfers to Reclaim Conveyors	LL	LL	LL	LL	LL
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	LL	LL	LL	LL	LL
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	LL	LL	LL	LL	LL
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	7E
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	7E
	MR	Mercury Retort	7E	7E	7E	7E	7E
	MF	Induction Melting Furnace	7E	7E	7E	7E	7E
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	7E
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	1.3E-7	7.7E-9	7.0E-7	4.8E-5	1.3E-6
	CKB	Carbon Regeneration Kiln (Burners)	4.1E-7	2.4E-8	2.2E-6	1.5E-4	4.3E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	1.8E-8	1.1E-9	9.9E-8	6.8E-6	1.9E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	9.0E-7	5.4E-8	5.0E-6	3.4E-4	9.5E-6
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	5A
	LS1	Limestone transfer to Primary Crusher Hopper	OOO	OOO	OOO	OOO	OOO
	LS2	Primary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS3	Primary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS4	Secondary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS5	Secondary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO

TABLE B-Y3. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS7	Limestone transfer to Ball Mill Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS8	Ball Mill Feed transfer to Ball	OOO	OOO	OOO	OOO	OOO
	LSBM	Limestone Ball Mill	OOO	OOO	OOO	OOO	OOO
	LS9	Limestone transfer to Kiln Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS11	Fines Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	5A
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	5A
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	5A
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	5A
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	5A
	LS1L	Mill Lime Silo #1 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	MillS2L	Mill Lime Silo #2 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	ACS1L	AC Lime Silo #1 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS2L	AC Lime Silo #2 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS3L	AC Lime Silo #3 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS4L	AC Lime Silo #4 Loading	2.3E-8	7.9E-10	2.5E-10	0	4.9E-9
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	1.1E-7	3.8E-9	1.2E-9	0	2.4E-8
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
Concrete Production	CM	Central Mixer Loading	2.0E-6	0	4.9E-9	0	1.7E-6
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	3.3E-9	0	0	2.9E-7

TABLE B-Y3. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	OOO
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	OOO
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.9E-9	5.4E-7	3.7E-5	1.0E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.4E-8	2.2E-6	1.5E-4	4.1E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.5E-8	3.2E-6	2.2E-4	6.2E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	4Z	4Z	4Z	4Z	4Z
Fuel Storage	TG1	Mine Site Gasoline Tank #1	6C	6C	6C	6C	6C
	TG2	Mine Site Gasoline Tank #2	6C	6C	6C	6C	6C
Mining - Modeling Scenario: Y3	YPP	Yellow Pine Pit	9.4E-3	4.5E-5	7.0E-6	0	2.8E-5
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0.018	8.6E-5	1.3E-5	0	5.4E-5
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	4.2E-3	2.0E-5	3.2E-6	0	1.3E-5
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0.150	1.3E-3	2.0E-4	0	7.9E-4
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	4.0E-6	5.1E-6	7.9E-7	0	3.2E-6
	UGEXP	Scout Portal	2.3E-7	1.1E-9	1.7E-10	0	7.0E-10
		Total	**0.182**	**1.4E-3**	**2.5E-4**	**1.9E-3**	**9.5E-4**

TABLE B-H1. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	LL	LL	LL	LL	LL
	OC2	Grizzly to Apron Feeder	LL	LL	LL	LL	LL
	OC3	Apron Feeder to Dribble Conveyor	LL	LL	LL	LL	LL
	OC4	Apron Feeder to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC5	Dribble Conveyor to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	LL	LL	LL	LL	LL
	OC9	Stockpile Transfers to Reclaim Conveyors	LL	LL	LL	LL	LL
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	LL	LL	LL	LL	LL
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	LL	LL	LL	LL	LL
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	7E
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	7E
	MR	Mercury Retort	7E	7E	7E	7E	7E
	MF	Induction Melting Furnace	7E	7E	7E	7E	7E
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	7E
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	1.3E-7	7.7E-9	7.0E-7	4.8E-5	1.3E-6
	CKB	Carbon Regeneration Kiln (Burners)	4.1E-7	2.4E-8	2.2E-6	1.5E-4	4.3E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	1.8E-8	1.1E-9	9.9E-8	6.8E-6	1.9E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	9.0E-7	5.4E-8	5.0E-6	3.4E-4	9.5E-6
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	5A
	LS1	Limestone transfer to Primary Crusher Hopper	OOO	OOO	OOO	OOO	OOO
	LS2	Primary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS3	Primary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS4	Secondary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS5	Secondary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO

TABLE B-H1. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS7	Limestone transfer to Ball Mill Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS8	Ball Mill Feed transfer to Ball	OOO	OOO	OOO	OOO	OOO
	LSBM	Limestone Ball Mill	OOO	OOO	OOO	OOO	OOO
	LS9	Limestone transfer to Kiln Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS11	Fines Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	5A
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	5A
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	5A
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	5A
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	5A
	LS1L	Mill Lime Silo #1 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	MillS2L	Mill Lime Silo #2 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	ACS1L	AC Lime Silo #1 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS2L	AC Lime Silo #2 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS3L	AC Lime Silo #3 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS4L	AC Lime Silo #4 Loading	2.3E-8	7.9E-10	2.5E-10	0	4.9E-9
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	1.1E-7	3.8E-9	1.2E-9	0	2.4E-8
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
Concrete Production	CM	Central Mixer Loading	2.0E-6	0	4.9E-9	0	1.7E-6
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	3.3E-9	0	0	2.9E-7

TABLE B-H1. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	OOO
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	OOO
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.9E-9	5.4E-7	3.7E-5	1.0E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.4E-8	2.2E-6	1.5E-4	4.1E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.5E-8	3.2E-6	2.2E-4	6.2E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	4Z	4Z	4Z	4Z	4Z
Fuel Storage	TG1	Mine Site Gasoline Tank #1	6C	6C	6C	6C	6C
	TG2	Mine Site Gasoline Tank #2	6C	6C	6C	6C	6C
Mining - Modeling Scenario: H1	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	9.4E-3	4.5E-5	7.0E-6	0	2.8E-5
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0.018	8.6E-5	1.3E-5	0	5.4E-5
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	5.7E-3	2.7E-5	4.3E-6	0	1.7E-5
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0.103	8.7E-4	1.4E-4	0	5.4E-4
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	4.0E-6	5.1E-6	7.9E-7	0	3.2E-6
	UGEXP	Scout Portal	2.3E-7	1.1E-9	1.7E-10	0	7.0E-10
		Total	**0.136**	**1.0E-3**	**1.9E-4**	**1.9E-3**	**7.0E-4**

TABLE B-H2. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	LL	LL	LL	LL	LL
	OC2	Grizzly to Apron Feeder	LL	LL	LL	LL	LL
	OC3	Apron Feeder to Dribble Conveyor	LL	LL	LL	LL	LL
	OC4	Apron Feeder to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC5	Dribble Conveyor to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	LL	LL	LL	LL	LL
	OC9	Stockpile Transfers to Reclaim Conveyors	LL	LL	LL	LL	LL
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	LL	LL	LL	LL	LL
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	LL	LL	LL	LL	LL
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	7E
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	7E
	MR	Mercury Retort	7E	7E	7E	7E	7E
	MF	Induction Melting Furnace	7E	7E	7E	7E	7E
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	7E
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	1.3E-7	7.7E-9	7.0E-7	4.8E-5	1.3E-6
	CKB	Carbon Regeneration Kiln (Burners)	4.1E-7	2.4E-8	2.2E-6	1.5E-4	4.3E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	1.8E-8	1.1E-9	9.9E-8	6.8E-6	1.9E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	9.0E-7	5.4E-8	5.0E-6	3.4E-4	9.5E-6
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	5A
	LS1	Limestone transfer to Primary Crusher Hopper	OOO	OOO	OOO	OOO	OOO
	LS2	Primary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS3	Primary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS4	Secondary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS5	Secondary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO

TABLE B-H2. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS7	Limestone transfer to Ball Mill Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS8	Ball Mill Feed transfer to Ball	OOO	OOO	OOO	OOO	OOO
	LSBM	Limestone Ball Mill	OOO	OOO	OOO	OOO	OOO
	LS9	Limestone transfer to Kiln Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS11	Fines Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	5A
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	5A
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	5A
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	5A
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	5A
	LS1L	Mill Lime Silo #1 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	MillS2L	Mill Lime Silo #2 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	ACS1L	AC Lime Silo #1 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS2L	AC Lime Silo #2 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS3L	AC Lime Silo #3 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS4L	AC Lime Silo #4 Loading	2.3E-8	7.9E-10	2.5E-10	0	4.9E-9
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	1.1E-7	3.8E-9	1.2E-9	0	2.4E-8
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
Concrete Production	CM	Central Mixer Loading	2.0E-6	0	4.9E-9	0	1.7E-6
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	3.3E-9	0	0	2.9E-7

TABLE B-H2. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	OOO
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	OOO
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.9E-9	5.4E-7	3.7E-5	1.0E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.4E-8	2.2E-6	1.5E-4	4.1E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.5E-8	3.2E-6	2.2E-4	6.2E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	4Z	4Z	4Z	4Z	4Z
Fuel Storage	TG1	Mine Site Gasoline Tank #1	6C	6C	6C	6C	6C
	TG2	Mine Site Gasoline Tank #2	6C	6C	6C	6C	6C
Mining - Modeling Scenario: H2	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	9.4E-3	4.5E-5	7.0E-6	0	2.8E-5
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0.018	8.6E-5	1.3E-5	0	5.4E-5
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	4.2E-3	2.0E-5	3.2E-6	0	1.3E-5
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0.152	1.3E-3	2.0E-4	0	8.1E-4
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	4.0E-6	5.1E-6	7.9E-7	0	3.2E-6
	UGEXP	Scout Portal	2.3E-7	1.1E-9	1.7E-10	0	7.0E-10
		Total	**0.184**	**1.4E-3**	**2.5E-4**	**1.9E-3**	**9.6E-4**

TABLE B-H3. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	LL	LL	LL	LL	LL
	OC2	Grizzly to Apron Feeder	LL	LL	LL	LL	LL
	OC3	Apron Feeder to Dribble Conveyor	LL	LL	LL	LL	LL
	OC4	Apron Feeder to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC5	Dribble Conveyor to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	LL	LL	LL	LL	LL
	OC9	Stockpile Transfers to Reclaim Conveyors	LL	LL	LL	LL	LL
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	LL	LL	LL	LL	LL
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	LL	LL	LL	LL	LL
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	7E
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	7E
	MR	Mercury Retort	7E	7E	7E	7E	7E
	MF	Induction Melting Furnace	7E	7E	7E	7E	7E
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	7E
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	1.3E-7	7.7E-9	7.0E-7	4.8E-5	1.3E-6
	CKB	Carbon Regeneration Kiln (Burners)	4.1E-7	2.4E-8	2.2E-6	1.5E-4	4.3E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	1.8E-8	1.1E-9	9.9E-8	6.8E-6	1.9E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	9.0E-7	5.4E-8	5.0E-6	3.4E-4	9.5E-6
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	5A
	LS1	Limestone transfer to Primary Crusher Hopper	OOO	OOO	OOO	OOO	OOO
	LS2	Primary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS3	Primary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS4	Secondary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS5	Secondary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO

TABLE B-H3. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS7	Limestone transfer to Ball Mill Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS8	Ball Mill Feed transfer to Ball	OOO	OOO	OOO	OOO	OOO
	LSBM	Limestone Ball Mill	OOO	OOO	OOO	OOO	OOO
	LS9	Limestone transfer to Kiln Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS11	Fines Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	5A
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	5A
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	5A
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	5A
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	5A
	LS1L	Mill Lime Silo #1 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	MillS2L	Mill Lime Silo #2 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	ACS1L	AC Lime Silo #1 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS2L	AC Lime Silo #2 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS3L	AC Lime Silo #3 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS4L	AC Lime Silo #4 Loading	2.3E-8	7.9E-10	2.5E-10	0	4.9E-9
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	1.1E-7	3.8E-9	1.2E-9	0	2.4E-8
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
Concrete Production	CM	Central Mixer Loading	2.0E-6	0	4.9E-9	0	1.7E-6
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	3.3E-9	0	0	2.9E-7

TABLE B-H3. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	OOO
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	OOO
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.9E-9	5.4E-7	3.7E-5	1.0E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.4E-8	2.2E-6	1.5E-4	4.1E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.5E-8	3.2E-6	2.2E-4	6.2E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	4Z	4Z	4Z	4Z	4Z
Fuel Storage	TG1	Mine Site Gasoline Tank #1	6C	6C	6C	6C	6C
	TG2	Mine Site Gasoline Tank #2	6C	6C	6C	6C	6C
Mining - Modeling Scenario: H3	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	9.4E-3	4.5E-5	7.0E-6	0	2.8E-5
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0.018	8.6E-5	1.3E-5	0	5.4E-5
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	4.2E-3	2.0E-5	3.2E-6	0	1.3E-5
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0.095	8.0E-4	1.2E-4	0	5.0E-4
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	4.0E-6	5.1E-6	7.9E-7	0	3.2E-6
	UGEXP	Scout Portal	2.3E-7	1.1E-9	1.7E-10	0	7.0E-10
		Total	**0.126**	**9.6E-4**	**1.8E-4**	**1.9E-3**	**6.5E-4**

TABLE B-H4. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	LL	LL	LL	LL	LL
	OC2	Grizzly to Apron Feeder	LL	LL	LL	LL	LL
	OC3	Apron Feeder to Dribble Conveyor	LL	LL	LL	LL	LL
	OC4	Apron Feeder to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC5	Dribble Conveyor to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	LL	LL	LL	LL	LL
	OC9	Stockpile Transfers to Reclaim Conveyors	LL	LL	LL	LL	LL
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	LL	LL	LL	LL	LL
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	LL	LL	LL	LL	LL
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	7E
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	7E
	MR	Mercury Retort	7E	7E	7E	7E	7E
	MF	Induction Melting Furnace	7E	7E	7E	7E	7E
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	7E
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	1.3E-7	7.7E-9	7.0E-7	4.8E-5	1.3E-6
	CKB	Carbon Regeneration Kiln (Burners)	4.1E-7	2.4E-8	2.2E-6	1.5E-4	4.3E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	1.8E-8	1.1E-9	9.9E-8	6.8E-6	1.9E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	9.0E-7	5.4E-8	5.0E-6	3.4E-4	9.5E-6
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	5A
	LS1	Limestone transfer to Primary Crusher Hopper	OOO	OOO	OOO	OOO	OOO
	LS2	Primary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS3	Primary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS4	Secondary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS5	Secondary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO

TABLE B-H4. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS7	Limestone transfer to Ball Mill Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS8	Ball Mill Feed transfer to Ball	OOO	OOO	OOO	OOO	OOO
	LSBM	Limestone Ball Mill	OOO	OOO	OOO	OOO	OOO
	LS9	Limestone transfer to Kiln Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS11	Fines Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	5A
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	5A
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	5A
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	5A
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	5A
	LS1L	Mill Lime Silo #1 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	MillS2L	Mill Lime Silo #2 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	ACS1L	AC Lime Silo #1 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS2L	AC Lime Silo #2 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS3L	AC Lime Silo #3 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS4L	AC Lime Silo #4 Loading	2.3E-8	7.9E-10	2.5E-10	0	4.9E-9
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	1.1E-7	3.8E-9	1.2E-9	0	2.4E-8
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
Concrete Production	CM	Central Mixer Loading	2.0E-6	0	4.9E-9	0	1.7E-6
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	3.3E-9	0	0	2.9E-7

TABLE B-H4. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	OOO
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	OOO
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.9E-9	5.4E-7	3.7E-5	1.0E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.4E-8	2.2E-6	1.5E-4	4.1E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.5E-8	3.2E-6	2.2E-4	6.2E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	4Z	4Z	4Z	4Z	4Z
Fuel Storage	TG1	Mine Site Gasoline Tank #1	6C	6C	6C	6C	6C
	TG2	Mine Site Gasoline Tank #2	6C	6C	6C	6C	6C
Mining - Modeling Scenario: H4	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	9.4E-3	4.5E-5	7.0E-6	0	2.8E-5
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0.018	8.6E-5	1.3E-5	0	5.4E-5
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	4.2E-3	2.0E-5	3.2E-6	0	1.3E-5
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0.120	1.0E-3	1.6E-4	0	6.4E-4
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	4.0E-6	5.1E-6	7.9E-7	0	3.2E-6
	UGEXP	Scout Portal	2.3E-7	1.1E-9	1.7E-10	0	7.0E-10
		Total	**0.152**	**1.2E-3**	**2.1E-4**	**1.9E-3**	**7.9E-4**

TABLE B-W1. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	LL	LL	LL	LL	LL
	OC2	Grizzly to Apron Feeder	LL	LL	LL	LL	LL
	OC3	Apron Feeder to Dribble Conveyor	LL	LL	LL	LL	LL
	OC4	Apron Feeder to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC5	Dribble Conveyor to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	LL	LL	LL	LL	LL
	OC9	Stockpile Transfers to Reclaim Conveyors	LL	LL	LL	LL	LL
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	LL	LL	LL	LL	LL
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	LL	LL	LL	LL	LL
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	7E
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	7E
	MR	Mercury Retort	7E	7E	7E	7E	7E
	MF	Induction Melting Furnace	7E	7E	7E	7E	7E
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	7E
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	1.3E-7	7.7E-9	7.0E-7	4.8E-5	1.3E-6
	CKB	Carbon Regeneration Kiln (Burners)	4.1E-7	2.4E-8	2.2E-6	1.5E-4	4.3E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	1.8E-8	1.1E-9	9.9E-8	6.8E-6	1.9E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	9.0E-7	5.4E-8	5.0E-6	3.4E-4	9.5E-6
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	5A
	LS1	Limestone transfer to Primary Crusher Hopper	OOO	OOO	OOO	OOO	OOO
	LS2	Primary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS3	Primary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS4	Secondary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS5	Secondary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO

TABLE B-W1. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS7	Limestone transfer to Ball Mill Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS8	Ball Mill Feed transfer to Ball	OOO	OOO	OOO	OOO	OOO
	LSBM	Limestone Ball Mill	OOO	OOO	OOO	OOO	OOO
	LS9	Limestone transfer to Kiln Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS11	Fines Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	5A
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	5A
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	5A
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	5A
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	5A
	LS1L	Mill Lime Silo #1 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	MillS2L	Mill Lime Silo #2 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	ACS1L	AC Lime Silo #1 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS2L	AC Lime Silo #2 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS3L	AC Lime Silo #3 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS4L	AC Lime Silo #4 Loading	2.3E-8	7.9E-10	2.5E-10	0	4.9E-9
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	1.1E-7	3.8E-9	1.2E-9	0	2.4E-8
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
Concrete Production	CM	Central Mixer Loading	2.0E-6	0	4.9E-9	0	1.7E-6
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	3.3E-9	0	0	2.9E-7

TABLE B-W1. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	OOO
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	OOO
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.9E-9	5.4E-7	3.7E-5	1.0E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.4E-8	2.2E-6	1.5E-4	4.1E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.5E-8	3.2E-6	2.2E-4	6.2E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	4Z	4Z	4Z	4Z	4Z
Fuel Storage	TG1	Mine Site Gasoline Tank #1	6C	6C	6C	6C	6C
	TG2	Mine Site Gasoline Tank #2	6C	6C	6C	6C	6C
Mining - Modeling Scenario: W1	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	9.4E-3	4.5E-5	7.0E-6	0	2.8E-5
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0.018	8.6E-5	1.3E-5	0	5.4E-5
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	5.7E-3	2.7E-5	4.3E-6	0	1.7E-5
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0.089	7.5E-4	1.2E-4	0	4.7E-4
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	4.0E-6	5.1E-6	7.9E-7	0	3.2E-6
	UGEXP	Scout Portal	2.3E-7	1.1E-9	1.7E-10	0	7.0E-10
		Total	**0.122**	**9.1E-4**	**1.7E-4**	**1.9E-3**	**6.3E-4**

TABLE B-W2. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	LL	LL	LL	LL	LL
	OC2	Grizzly to Apron Feeder	LL	LL	LL	LL	LL
	OC3	Apron Feeder to Dribble Conveyor	LL	LL	LL	LL	LL
	OC4	Apron Feeder to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC5	Dribble Conveyor to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	LL	LL	LL	LL	LL
	OC9	Stockpile Transfers to Reclaim Conveyors	LL	LL	LL	LL	LL
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	LL	LL	LL	LL	LL
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	LL	LL	LL	LL	LL
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	7E
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	7E
	MR	Mercury Retort	7E	7E	7E	7E	7E
	MF	Induction Melting Furnace	7E	7E	7E	7E	7E
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	7E
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	1.3E-7	7.7E-9	7.0E-7	4.8E-5	1.3E-6
	CKB	Carbon Regeneration Kiln (Burners)	4.1E-7	2.4E-8	2.2E-6	1.5E-4	4.3E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	1.8E-8	1.1E-9	9.9E-8	6.8E-6	1.9E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	9.0E-7	5.4E-8	5.0E-6	3.4E-4	9.5E-6
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	5A
	LS1	Limestone transfer to Primary Crusher Hopper	OOO	OOO	OOO	OOO	OOO
	LS2	Primary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS3	Primary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS4	Secondary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS5	Secondary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO

TABLE B-W2. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS7	Limestone transfer to Ball Mill Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS8	Ball Mill Feed transfer to Ball	OOO	OOO	OOO	OOO	OOO
	LSBM	Limestone Ball Mill	OOO	OOO	OOO	OOO	OOO
	LS9	Limestone transfer to Kiln Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS11	Fines Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	5A
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	5A
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	5A
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	5A
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	5A
	LS1L	Mill Lime Silo #1 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	MillS2L	Mill Lime Silo #2 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	ACS1L	AC Lime Silo #1 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS2L	AC Lime Silo #2 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS3L	AC Lime Silo #3 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS4L	AC Lime Silo #4 Loading	2.3E-8	7.9E-10	2.5E-10	0	4.9E-9
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	1.1E-7	3.8E-9	1.2E-9	0	2.4E-8
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
Concrete Production	CM	Central Mixer Loading	2.0E-6	0	4.9E-9	0	1.7E-6
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	3.3E-9	0	0	2.9E-7

TABLE B-W2. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	OOO
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	OOO
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.9E-9	5.4E-7	3.7E-5	1.0E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.4E-8	2.2E-6	1.5E-4	4.1E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.5E-8	3.2E-6	2.2E-4	6.2E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	4Z	4Z	4Z	4Z	4Z
Fuel Storage	TG1	Mine Site Gasoline Tank #1	6C	6C	6C	6C	6C
	TG2	Mine Site Gasoline Tank #2	6C	6C	6C	6C	6C
Mining - Modeling Scenario: W2	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	9.4E-3	4.5E-5	7.0E-6	0	2.8E-5
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0.018	8.6E-5	1.3E-5	0	5.4E-5
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	4.2E-3	2.0E-5	3.2E-6	0	1.3E-5
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0.141	1.2E-3	1.9E-4	0	7.5E-4
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	4.0E-6	5.1E-6	7.9E-7	0	3.2E-6
	UGEXP	Scout Portal	2.3E-7	1.1E-9	1.7E-10	0	7.0E-10
		Total	**0.173**	**1.3E-3**	**2.4E-4**	**1.9E-3**	**9.0E-4**

TABLE B-W3. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	LL	LL	LL	LL	LL
	OC2	Grizzly to Apron Feeder	LL	LL	LL	LL	LL
	OC3	Apron Feeder to Dribble Conveyor	LL	LL	LL	LL	LL
	OC4	Apron Feeder to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC5	Dribble Conveyor to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	LL	LL	LL	LL	LL
	OC9	Stockpile Transfers to Reclaim Conveyors	LL	LL	LL	LL	LL
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	LL	LL	LL	LL	LL
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	LL	LL	LL	LL	LL
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	7E
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	7E
	MR	Mercury Retort	7E	7E	7E	7E	7E
	MF	Induction Melting Furnace	7E	7E	7E	7E	7E
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	7E
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	1.3E-7	7.7E-9	7.0E-7	4.8E-5	1.3E-6
	CKB	Carbon Regeneration Kiln (Burners)	4.1E-7	2.4E-8	2.2E-6	1.5E-4	4.3E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	1.8E-8	1.1E-9	9.9E-8	6.8E-6	1.9E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	9.0E-7	5.4E-8	5.0E-6	3.4E-4	9.5E-6
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	5A
	LS1	Limestone transfer to Primary Crusher Hopper	OOO	OOO	OOO	OOO	OOO
	LS2	Primary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS3	Primary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS4	Secondary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS5	Secondary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO

TABLE B-W3. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS7	Limestone transfer to Ball Mill Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS8	Ball Mill Feed transfer to Ball	OOO	OOO	OOO	OOO	OOO
	LSBM	Limestone Ball Mill	OOO	OOO	OOO	OOO	OOO
	LS9	Limestone transfer to Kiln Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS11	Fines Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	5A
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	5A
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	5A
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	5A
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	5A
	LS1L	Mill Lime Silo #1 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	MillS2L	Mill Lime Silo #2 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	ACS1L	AC Lime Silo #1 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS2L	AC Lime Silo #2 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS3L	AC Lime Silo #3 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS4L	AC Lime Silo #4 Loading	2.3E-8	7.9E-10	2.5E-10	0	4.9E-9
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	1.1E-7	3.8E-9	1.2E-9	0	2.4E-8
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
Concrete Production	CM	Central Mixer Loading	2.0E-6	0	4.9E-9	0	1.7E-6
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	3.3E-9	0	0	2.9E-7

TABLE B-W3. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	OOO
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	OOO
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.9E-9	5.4E-7	3.7E-5	1.0E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.4E-8	2.2E-6	1.5E-4	4.1E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.5E-8	3.2E-6	2.2E-4	6.2E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	4Z	4Z	4Z	4Z	4Z
Fuel Storage	TG1	Mine Site Gasoline Tank #1	6C	6C	6C	6C	6C
	TG2	Mine Site Gasoline Tank #2	6C	6C	6C	6C	6C
Mining - Modeling Scenario: W3	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	9.4E-3	4.5E-5	7.0E-6	0	2.8E-5
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0.018	8.6E-5	1.3E-5	0	5.4E-5
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	4.2E-3	2.0E-5	3.2E-6	0	1.3E-5
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0.201	1.7E-3	2.7E-4	0	1.1E-3
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	4.0E-6	5.1E-6	7.9E-7	0	3.2E-6
	UGEXP	Scout Portal	2.3E-7	1.1E-9	1.7E-10	0	7.0E-10
		Total	**0.232**	**1.9E-3**	**3.2E-4**	**1.9E-3**	**1.2E-3**

TABLE B-W4. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	LL	LL	LL	LL	LL
	OC2	Grizzly to Apron Feeder	LL	LL	LL	LL	LL
	OC3	Apron Feeder to Dribble Conveyor	LL	LL	LL	LL	LL
	OC4	Apron Feeder to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC5	Dribble Conveyor to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	LL	LL	LL	LL	LL
	OC9	Stockpile Transfers to Reclaim Conveyors	LL	LL	LL	LL	LL
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	LL	LL	LL	LL	LL
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	LL	LL	LL	LL	LL
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	7E
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	7E
	MR	Mercury Retort	7E	7E	7E	7E	7E
	MF	Induction Melting Furnace	7E	7E	7E	7E	7E
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	7E
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	1.3E-7	7.7E-9	7.0E-7	4.8E-5	1.3E-6
	CKB	Carbon Regeneration Kiln (Burners)	4.1E-7	2.4E-8	2.2E-6	1.5E-4	4.3E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	1.8E-8	1.1E-9	9.9E-8	6.8E-6	1.9E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	9.0E-7	5.4E-8	5.0E-6	3.4E-4	9.5E-6
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	5A
	LS1	Limestone transfer to Primary Crusher Hopper	OOO	OOO	OOO	OOO	OOO
	LS2	Primary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS3	Primary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS4	Secondary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS5	Secondary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO

TABLE B-W4. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS7	Limestone transfer to Ball Mill Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS8	Ball Mill Feed transfer to Ball	OOO	OOO	OOO	OOO	OOO
	LSBM	Limestone Ball Mill	OOO	OOO	OOO	OOO	OOO
	LS9	Limestone transfer to Kiln Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS11	Fines Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	5A
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	5A
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	5A
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	5A
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	5A
	LS1L	Mill Lime Silo #1 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	MillS2L	Mill Lime Silo #2 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	ACS1L	AC Lime Silo #1 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS2L	AC Lime Silo #2 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS3L	AC Lime Silo #3 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS4L	AC Lime Silo #4 Loading	2.3E-8	7.9E-10	2.5E-10	0	4.9E-9
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	1.1E-7	3.8E-9	1.2E-9	0	2.4E-8
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
Concrete Production	CM	Central Mixer Loading	2.0E-6	0	4.9E-9	0	1.7E-6
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	3.3E-9	0	0	2.9E-7

TABLE B-W4. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	OOO
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	OOO
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.9E-9	5.4E-7	3.7E-5	1.0E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.4E-8	2.2E-6	1.5E-4	4.1E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.5E-8	3.2E-6	2.2E-4	6.2E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	4Z	4Z	4Z	4Z	4Z
Fuel Storage	TG1	Mine Site Gasoline Tank #1	6C	6C	6C	6C	6C
	TG2	Mine Site Gasoline Tank #2	6C	6C	6C	6C	6C
Mining - Modeling Scenario: W4	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	9.4E-3	4.5E-5	7.0E-6	0	2.8E-5
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0.018	8.6E-5	1.3E-5	0	5.4E-5
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	4.2E-3	2.0E-5	3.2E-6	0	1.3E-5
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0.092	7.8E-4	1.2E-4	0	4.9E-4
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	4.0E-6	5.1E-6	7.9E-7	0	3.2E-6
	UGEXP	Scout Portal	2.3E-7	1.1E-9	1.7E-10	0	7.0E-10
		Total	**0.124**	**9.4E-4**	**1.7E-4**	**1.9E-3**	**6.4E-4**

TABLE B-W5. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	LL	LL	LL	LL	LL
	OC2	Grizzly to Apron Feeder	LL	LL	LL	LL	LL
	OC3	Apron Feeder to Dribble Conveyor	LL	LL	LL	LL	LL
	OC4	Apron Feeder to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC5	Dribble Conveyor to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	LL	LL	LL	LL	LL
	OC9	Stockpile Transfers to Reclaim Conveyors	LL	LL	LL	LL	LL
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	LL	LL	LL	LL	LL
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	LL	LL	LL	LL	LL
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	7E
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	7E
	MR	Mercury Retort	7E	7E	7E	7E	7E
	MF	Induction Melting Furnace	7E	7E	7E	7E	7E
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	7E
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	1.3E-7	7.7E-9	7.0E-7	4.8E-5	1.3E-6
	CKB	Carbon Regeneration Kiln (Burners)	4.1E-7	2.4E-8	2.2E-6	1.5E-4	4.3E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	1.8E-8	1.1E-9	9.9E-8	6.8E-6	1.9E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	9.0E-7	5.4E-8	5.0E-6	3.4E-4	9.5E-6
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	5A
	LS1	Limestone transfer to Primary Crusher Hopper	OOO	OOO	OOO	OOO	OOO
	LS2	Primary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS3	Primary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS4	Secondary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS5	Secondary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO

TABLE B-W5. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS7	Limestone transfer to Ball Mill Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS8	Ball Mill Feed transfer to Ball	OOO	OOO	OOO	OOO	OOO
	LSBM	Limestone Ball Mill	OOO	OOO	OOO	OOO	OOO
	LS9	Limestone transfer to Kiln Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS11	Fines Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	5A
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	5A
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	5A
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	5A
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	5A
	LS1L	Mill Lime Silo #1 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	MillS2L	Mill Lime Silo #2 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	ACS1L	AC Lime Silo #1 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS2L	AC Lime Silo #2 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS3L	AC Lime Silo #3 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS4L	AC Lime Silo #4 Loading	2.3E-8	7.9E-10	2.5E-10	0	4.9E-9
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	1.1E-7	3.8E-9	1.2E-9	0	2.4E-8
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
Concrete Production	CM	Central Mixer Loading	2.0E-6	0	4.9E-9	0	1.7E-6
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	3.3E-9	0	0	2.9E-7

TABLE B-W5. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	OOO
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	OOO
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.9E-9	5.4E-7	3.7E-5	1.0E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.4E-8	2.2E-6	1.5E-4	4.1E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.5E-8	3.2E-6	2.2E-4	6.2E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	4Z	4Z	4Z	4Z	4Z
Fuel Storage	TG1	Mine Site Gasoline Tank #1	6C	6C	6C	6C	6C
	TG2	Mine Site Gasoline Tank #2	6C	6C	6C	6C	6C
Mining - Modeling Scenario: W5	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	9.4E-3	4.5E-5	7.0E-6	0	2.8E-5
	BT	Bradley Tailings	0	0	0	0	0
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0.018	8.6E-5	1.3E-5	0	5.4E-5
	BTBL	Bradley Tailings Blasting	0	0	0	0	0
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	4.2E-3	2.0E-5	3.2E-6	0	1.3E-5
	HR000	Haul Roads	0.101	8.6E-4	1.3E-4	0	5.4E-4
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	4.0E-6	5.1E-6	7.9E-7	0	3.2E-6
	UGEXP	Scout Portal	2.3E-7	1.1E-9	1.7E-10	0	7.0E-10
		Total	**0.133**	**1.0E-3**	**1.9E-4**	**1.9E-3**	**6.9E-4**

TABLE B-B1. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	LL	LL	LL	LL	LL
	OC2	Grizzly to Apron Feeder	LL	LL	LL	LL	LL
	OC3	Apron Feeder to Dribble Conveyor	LL	LL	LL	LL	LL
	OC4	Apron Feeder to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC5	Dribble Conveyor to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	LL	LL	LL	LL	LL
	OC9	Stockpile Transfers to Reclaim Conveyors	LL	LL	LL	LL	LL
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	LL	LL	LL	LL	LL
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	LL	LL	LL	LL	LL
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	7E
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	7E
	MR	Mercury Retort	7E	7E	7E	7E	7E
	MF	Induction Melting Furnace	7E	7E	7E	7E	7E
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	7E
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	1.3E-7	7.7E-9	7.0E-7	4.8E-5	1.3E-6
	CKB	Carbon Regeneration Kiln (Burners)	4.1E-7	2.4E-8	2.2E-6	1.5E-4	4.3E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	1.8E-8	1.1E-9	9.9E-8	6.8E-6	1.9E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	9.0E-7	5.4E-8	5.0E-6	3.4E-4	9.5E-6
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	5A
	LS1	Limestone transfer to Primary Crusher Hopper	OOO	OOO	OOO	OOO	OOO
	LS2	Primary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS3	Primary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS4	Secondary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS5	Secondary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO

TABLE B-B1. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS7	Limestone transfer to Ball Mill Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS8	Ball Mill Feed transfer to Ball	OOO	OOO	OOO	OOO	OOO
	LSBM	Limestone Ball Mill	OOO	OOO	OOO	OOO	OOO
	LS9	Limestone transfer to Kiln Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS11	Fines Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	5A
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	5A
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	5A
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	5A
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	5A
	LS1L	Mill Lime Silo #1 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	MillS2L	Mill Lime Silo #2 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	ACS1L	AC Lime Silo #1 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS2L	AC Lime Silo #2 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS3L	AC Lime Silo #3 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS4L	AC Lime Silo #4 Loading	2.3E-8	7.9E-10	2.5E-10	0	4.9E-9
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	1.1E-7	3.8E-9	1.2E-9	0	2.4E-8
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
Concrete Production	CM	Central Mixer Loading	2.0E-6	0	4.9E-9	0	1.7E-6
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	3.3E-9	0	0	2.9E-7

TABLE B-B1. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	OOO
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	OOO
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.9E-9	5.4E-7	3.7E-5	1.0E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.4E-8	2.2E-6	1.5E-4	4.1E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.5E-8	3.2E-6	2.2E-4	6.2E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	4Z	4Z	4Z	4Z	4Z
Fuel Storage	TG1	Mine Site Gasoline Tank #1	6C	6C	6C	6C	6C
	TG2	Mine Site Gasoline Tank #2	6C	6C	6C	6C	6C
Mining - Modeling Scenario: B1	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	9.2E-3	4.4E-5	6.9E-6	0	2.8E-5
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0.018	8.6E-5	1.3E-5	0	5.4E-5
	STKP	PC Stockpile	5.7E-3	2.7E-5	4.3E-6	0	1.7E-5
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	0	0	0	0	0
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0.117	9.9E-4	1.5E-4	0	6.2E-4
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	4.0E-6	5.1E-6	7.9E-7	0	3.2E-6
	UGEXP	Scout Portal	2.3E-7	1.1E-9	1.7E-10	0	7.0E-10
		Total	**0.149**	**1.1E-3**	**2.1E-4**	**1.9E-3**	**7.7E-4**

TABLE B-B2. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Ore Processing	OC1	Loader Transfer of Ore to	LL	LL	LL	LL	LL
	OC2	Grizzly to Apron Feeder	LL	LL	LL	LL	LL
	OC3	Apron Feeder to Dribble Conveyor	LL	LL	LL	LL	LL
	OC4	Apron Feeder to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC5	Dribble Conveyor to Vibrating Grizzly	LL	LL	LL	LL	LL
	OC6	Vibrating Grizzly to Primary Crusher or Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC7	Primary Crusher and Associated Transfers out to Coarse Ore Stockpile Feed Conveyor	LL	LL	LL	LL	LL
	OC8	Coarse Ore Stockpile Feed Conveyor Transfer to Stockpile	LL	LL	LL	LL	LL
	OC9	Stockpile Transfers to Reclaim Conveyors	LL	LL	LL	LL	LL
	OC10	Reclaim Conveyors to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	OC11	SAG Mill Feed Conveyor Transfer to SAG Mill	LL	LL	LL	LL	LL
	OC12	Pebble Crusher and Associated Transfers in (from SAG Mill) and out (to Pebble Discharge Conveyor)	LL	LL	LL	LL	LL
	OC13	Pebble Discharge Conveyor to SAG Mill Feed Conveyor	LL	LL	LL	LL	LL
	PSL	Prill Silos Loading (2 x 100 ton)	0	0	0	0	0
	PSU	Prill Silos Unloading (2 x 100	0	0	0	0	0
Mill Leaching	MILLTAN	Mill Leaching	0	0	0	0	0
Ore Concentration and Refining	AC	Autoclave	7E	7E	7E	7E	7E
	EW	Electrowinning Cells and Pregnant Solution Tank	7E	7E	7E	7E	7E
	MR	Mercury Retort	7E	7E	7E	7E	7E
	MF	Induction Melting Furnace	7E	7E	7E	7E	7E
	CKD	Carbon Regeneration Kiln (Drum)	7E	7E	7E	7E	7E
Process Heating	ACB	POX Boiler (17 MMBtu/hr Propane-Fired)	1.3E-7	7.7E-9	7.0E-7	4.8E-5	1.3E-6
	CKB	Carbon Regeneration Kiln (Burners)	4.1E-7	2.4E-8	2.2E-6	1.5E-4	4.3E-6
	PV	Propane Vaporizer (0.1 MMBtu/hr Propane-Fired)	1.8E-8	1.1E-9	9.9E-8	6.8E-6	1.9E-7
	HS	Strip Circuit Solution Heater (5 MMBtu, Propane-Fired)	9.0E-7	5.4E-8	5.0E-6	3.4E-4	9.5E-6
	LKC	PFR Shaft Lime Kiln Combustion	5A	5A	5A	5A	5A
	LS1	Limestone transfer to Primary Crusher Hopper	OOO	OOO	OOO	OOO	OOO
	LS2	Primary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS3	Primary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS4	Secondary Crushing and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS5	Secondary Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO

TABLE B-B2. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
Lime Production	LS6	Limestone transfer to Ball Mill Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS7	Limestone transfer to Ball Mill Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS8	Ball Mill Feed transfer to Ball	OOO	OOO	OOO	OOO	OOO
	LSBM	Limestone Ball Mill	OOO	OOO	OOO	OOO	OOO
	LS9	Limestone transfer to Kiln Feed Bin	OOO	OOO	OOO	OOO	OOO
	LS10	Limestone transfer to Lime Kiln Feed Conveyor	OOO	OOO	OOO	OOO	OOO
	LS11	Fines Screening and Associated Transfers In and Out	OOO	OOO	OOO	OOO	OOO
	LS12	Kiln Feed transfer to PFR Shaft Lime Kiln	5A	5A	5A	5A	5A
	LK	Parallel Flow Regenerative (PFR) Shaft Lime Kiln	5A	5A	5A	5A	5A
	LCR	Lime Mill Crushing and associated transfers In and Out	5A	5A	5A	5A	5A
	LSL	Pebble Lime Silo Loading via Bucket Elevator	5A	5A	5A	5A	5A
	LSU	Pebble Lime Silo discharge to Lime Slaker	5A	5A	5A	5A	5A
	LS1L	Mill Lime Silo #1 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	LS1U	Mill Lime Silo #1 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	MillS2L	Mill Lime Silo #2 Loading	1.1E-8	4.0E-10	1.2E-10	0	2.5E-9
	MillS2U	Mill Lime Silo #2 Unloading to SAG Mill Conveyor	5.5E-8	1.9E-9	6.0E-10	0	1.2E-8
	ACS1L	AC Lime Silo #1 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS1U	AC Lime Silo #1 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS2L	AC Lime Silo #2 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS2U	AC Lime Silo #2 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS3L	AC Lime Silo #3 Loading	4.5E-8	1.6E-9	4.9E-10	0	9.9E-9
	ACS3U	AC Lime Silo #3 Unloading to Lime Slaker	2.2E-7	7.7E-9	2.4E-9	0	4.8E-8
	ACS4L	AC Lime Silo #4 Loading	2.3E-8	7.9E-10	2.5E-10	0	4.9E-9
	ACS42U	AC Lime Silo #4 Unloading to Lime Slaker	1.1E-7	3.8E-9	1.2E-9	0	2.4E-8
Aggregate Prod.	PCSP1	Portable Crushing and Screening Plant 1 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
	PCSP2	Portable Crushing and Screening Plant 2 (2 crushers (primary and secondary), 2 screens (primary and secondary), and 5 conveyor transfers)	OOO	OOO	OOO	OOO	OOO
Concrete Production	CM	Central Mixer Loading	2.0E-6	0	4.9E-9	0	1.7E-6
	CS1L	Cement/Shotcrete Silo #1 Loading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS1U	Cement/Shotcrete Silo #1 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CS2L	Cement/Shotcrete Silo #2 Loading	2.9E-8	3.3E-9	0	0	2.9E-7

TABLE B-B2. TAPs that Exceed the EL by Source chk **T-RACT Emissions**

	Source ID	Source Description	Arsenic 7440-38-2	Beryllium 7440-41-7	Cadmium 7440-43-9	Formaldehyde 50-00-0	Nickel 7440-02-0
			(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr	(annual) lb/hr
	CS2U	Cement/Shotcrete Silo #2 Unloading	2.9E-8	3.3E-9	0	0	2.9E-7
	CAL	Aggregate Bin Loading	OOO	OOO	OOO	OOO	OOO
	CAU	Aggregate Bin Unloading	OOO	OOO	OOO	OOO	OOO
HVAC	H1M	Mine Air Heater #1 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	H2M	Mine Air Heater #2 (4 MMBtu/hr Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HM	Mill HVAC Heaters (4 x 1.0 MMBtu Propane-Fired)	7.8E-7	4.7E-8	4.3E-6	2.9E-4	8.2E-6
	HAC	Autoclave HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HR	Refinery HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HA	Admin HVAC Heater (0.25 MMBtu Propane-Fired)	4.9E-8	2.9E-9	2.7E-7	1.8E-5	5.1E-7
	HMO	Mine Ops. HVAC Heaters (2 x 0.25 MMBtu Propane-Fired)	9.8E-8	5.9E-9	5.4E-7	3.7E-5	1.0E-6
	HTS	Truck Shop HVAC Heaters (2 x 1.0 MMBtu Propane-Fired)	3.9E-7	2.4E-8	2.2E-6	1.5E-4	4.1E-6
	HW	Warehouse HVAC Heaters (3 x 1.0 MMBtu Propane-Fired)	5.9E-7	3.5E-8	3.2E-6	2.2E-4	6.2E-6
Emer. Power/Fire	EDG1	Camp Emergency Generator (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG2	Plant Emergency Generator #1 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDG3	Plant Emergency Generator #2 (Mfr. Yr. >2007; diesel)	4Z	4Z	4Z	4Z	4Z
	EDFP	Mill Fire Pump (Mfr. Yr. >2009; diesel)	4Z	4Z	4Z	4Z	4Z
Fuel Storage	TG1	Mine Site Gasoline Tank #1	6C	6C	6C	6C	6C
	TG2	Mine Site Gasoline Tank #2	6C	6C	6C	6C	6C
Mining - Modeling Scenario: B2	YPP	Yellow Pine Pit	0	0	0	0	0
	HFP	Hangar Flats Pit	0	0	0	0	0
	WEP	West End Pit	0	0	0	0	0
	BT	Bradley Tailings	9.2E-3	4.4E-5	6.9E-6	0	2.8E-5
	YPPBL	Yellow Pine Pit Blasting	0	0	0	0	0
	HFPBL	Hangar Flats Pit Blasting	0	0	0	0	0
	WEPBL	West End Pit Blasting	0	0	0	0	0
	BTBL	Bradley Tailings Blasting	0.018	8.6E-5	1.3E-5	0	5.4E-5
	STKP	PC Stockpile	0	0	0	0	0
	FDRSF	Fiddle DRSF	0	0	0	0	0
	HFDRSF	Hangar Flats DRSF	4.2E-3	2.0E-5	3.2E-6	0	1.3E-5
	YPDRSF	Yellow Pine DRSF	0	0	0	0	0
	WEDRSF	West End DRSF	0	0	0	0	0
	HR000	Haul Roads	0.030	2.5E-4	4.0E-5	0	1.6E-4
	TSF	Tailing Storage Facility	0	0	0	0	0
	ACCRD	Access Roads	4.0E-6	5.1E-6	7.9E-7	0	3.2E-6
	UGEXP	Scout Portal	2.3E-7	1.1E-9	1.7E-10	0	7.0E-10
		Total	**0.061**	**4.1E-4**	**9.2E-5**	**1.9E-3**	**3.1E-4**

Appendix C – TAP Modeling Results

TABLE C. TAP Maximum Modeled Concentrations and AACs

	TAP Maximum Modeled Concentrations by Model Scenario																	
	Y1	Y2	Y3	H1	H2	H3	H4	W1 [2]	W2 [2]	W3 [2]	W4 [2]	W5 [3]	B1	B2	Max Scenario			Compl-
Pollutant	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	ID	AAC [4]	iance
Aluminum	1.13561	1.41646	1.13855	1.19028	1.28403	1.09010	1.17371	6.01079	5.27252	6.00999	4.97175	6.17075	1.17437	0.97352	6.17075	W5	500	Yes
Arsenic [1]	0.00030	0.00049	0.00029	0.00023	0.00053	0.00020	0.00021	0.00091	0.00095	0.00090	0.00087	N/A	0.00024	0.00012	0.00095	W2	0.0023	Yes
Barium	0.01279	0.01595	0.01282	0.01341	0.01446	0.01228	0.01322	0.06773	0.05941	0.06772	0.05602	0.06953	0.01323	0.01097	0.06953	W5	25	Yes
Beryllium [1]	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00001	0.00001	0.00001	0.00001	N/A	0.00000	0.00000	0.00001	W1	0.042	Yes
Cadmium [1]	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000002	0.000002	0.000002	0.000002	N/A	0.000000	0.000000	0.000002	W1	0.0056	Yes
Calcium Carbonate	0.34375	0.33431	0.37347	0.39124	0.38168	0.37132	0.38141	1.18652	1.04095	1.18637	0.98165	1.21807	0.39107	0.34851	1.21807	W5	500	Yes
Calcium Oxide	0.14837	0.14837	0.14837	0.14837	0.14837	0.14837	0.14837	0.14837	0.14837	0.14837	0.14837	0.14837	0.14837	0.14837	0.14837	ALL	100	Yes
Cyanide	0.19651	0.19651	0.19651	0.19651	0.19651	0.19651	0.19651	0.19651	0.19651	0.19651	0.19651	0.19651	0.19651	0.19651	0.19651	ALL	250	Yes
Formaldehyde [1]	0.00007	0.00007	0.00007	0.00007	0.00007	0.00007	0.00007	0.00007	0.00007	0.00007	0.00007	N/A	0.00007	0.00007	0.00007	ALL	0.77	Yes
Iron	0.29143	0.36343	0.29219	0.30525	0.32952	0.27957	0.30100	1.54079	1.35154	1.54058	1.27445	1.58179	0.30110	0.24962	1.58179	W5	50	Yes
Manganese	0.00477	0.00595	0.00478	0.00500	0.00538	0.00458	0.00493	0.02531	0.02220	0.02531	0.02094	0.02599	0.00494	0.00410	0.02599	W5	250	Yes
Nickel [1]	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00001	0.00001	0.00001	0.00001	N/A	0.00000	0.00000	0.00001	W1	0.42	Yes
Phosphorus	0.01036	0.01293	0.01039	0.01088	0.01169	0.00996	0.01073	0.05502	0.04827	0.05502	0.04551	0.05649	0.01074	0.00891	0.05649	W5	5	Yes
Sulfuric Acid	0.41149	0.41149	0.41149	0.41149	0.41149	0.41149	0.41149	0.41149	0.41149	0.41149	0.41149	0.41149	0.41149	0.41149	0.41149	ALL	50	Yes
Thallium	0.00016	0.00020	0.00016	0.00017	0.00018	0.00016	0.00017	0.00085	0.00074	0.00085	0.00070	0.00087	0.00017	0.00014	0.00087	W5	5	Yes
Vanadium	0.00045	0.00056	0.00045	0.00047	0.00051	0.00043	0.00046	0.00237	0.00208	0.00237	0.00196	0.00243	0.00046	0.00039	0.00243	W5	2.5	Yes

[1] Carcinogenic TAP concentrations adjusted for 70-year exposure, as discussed in Section 3.4.4.
[2] Carcinogenic TAP concentrations adjusted for the West End pit LOM production limit, as discussed in Section 3.4.5.
[3] Modeling Scenario W5 is eliminated for carcinogenic TAP compliance, as discussed in Section 3.4.5.
[4] The AACs for carcinogenic pollutants are increased by a factor of ten per IDAPA 58.01.01.210.12(b); T-RACT adjustment.

Appendix D – Electronic Files

The electronic modeling files, emission inventory file, and Addendum references can be accessed via the following link:

https://drive.google.com/drive/folders/1o0-uNIu5DRds8hLShaD_0nPEBnlEJFCQ?usp=sharing

CERTIFICATE OF SERVICE

I hereby certify that on October 4, 2024, a true and correct copy of the foregoing EXPERT DECLARATION OF IAN H. VON LINDERN, P.E., Ph.D. was served on the following by electronic service:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov

Dylan V. Lawrence
Hearing Officer
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com

Paula Wilson
Hearing Coordinator
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, ID 83706
paula.wilson@deq.idaho.gov

Michael A. Short
Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
michael.short@deq.idaho.gov
hannah.young@deq.idaho.gov

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
ann.yribar@ag.idaho.gov

Krista K. McINtyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd., Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com

s/ Julia Thrower
Julia S. Thrower

RAÚL R. LABRADOR
Attorney General

SCOTT L. CAMPBELL
Deputy Attorney General
Chief, Energy and Natural Resources Division

Hannah M.C. Young, ISB No. 9781
hannah.young@deq.idaho.gov
Michael A. Short, ISB No. 10554
michael.short@deq.idaho.gov
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: 208.373.0422

Attorneys for Respondent

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047

NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,

Petitioners,

v.

IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,

Respondent,

and

PERPETUA RESOURCES IDAHO, INC.,

Intervenor-Respondent.

Case Docket No. 0101-22-01
OAH Case No. 23-245-01

DEPARTMENT OF ENVIRONMENTAL QUALITY'S PREHEARING STATEMENT

I. REMAINING ISSUES UPON REMAND

Petitioners initiated the instant contested case, challenging the Department of Environmental Quality's ("DEQ") issuance of an air quality permit to construct ("PTC") to Perpetua Resources, Inc. ("Perpetua") on July 22, 2022. REC 0001-0028. After the Hearing Officer found in DEQ and Perpetua's favor on summary judgment, Petitioners appealed to the Board of Environmental Quality (the "Board"). REC 3280-3328, REC 3372-3425, REC 3426-3441. Petitioners appealed five of the issues decided by the Hearing Officer. REC 3426-3441. On May 9, 2024, the Board issued its "Final Order," affirming the Hearing Officer's decision on four of the five issues. REC 3695-3720. Regarding the fifth issue, the Board found "there was insufficient evidence to support DEQ's analysis of the ambient air concentrations." REC 3706. Thus, the Board remanded the matter to the Hearing Officer "for the development of further evidence regarding the ambient air concentrations of arsenic that will be produced by the [Stibnite Gold Project] and whether those levels comply with the Air Rules." REC 3717.

Regarding this issue, the Board specifically found as follows:

(1) "DEQ did not act reasonably and in accordance with law when it applied the 16/70 calculation to the ambient arsenic air concentration analysis;"

(2) "DEQ did not act reasonably in using a five-year rolling average for T-RACT that was not properly supported by permit conditions;" and

(3) "there was insufficient evidence to support the T-RACT analysis limiting the non-West End Pit production limit."

REC 3712-3715. These three sub-issues, referred to as the "Remaining Issues," are now before the Hearing Officer upon remand.

II. STANDARD OF REVIEW

The Board "must determine whether DEQ 'has acted reasonably and in accordance with law' when issuing the Permit…" REC 3697. As to the Remaining Issues, the Board found DEQ did not act reasonably and in accordance with law because it lacked sufficient evidence to support DEQ's analysis. REC 3706, 3714-3715. Upon remand, Petitioners still bear the burden of proof as the party challenging DEQ's issuance of the PTC. IDAPA 62.01.01.477. Thus, the Hearing Officer must now determine whether there is sufficient evidence establishing that DEQ was reasonable and acted in accordance with the law when it issued the PTC, and specifically in DEQ's analysis of the arsenic ambient air concentrations. The Hearing Officer, and the Board, are only considering whether DEQ was reasonable and acted in accordance with the law; the question is not whether a person may disagree with DEQ's reasonable and lawful approach.

Throughout this contested case, and including in the current remand, it has been clear that expert opinions and testimony are necessary. *See* REC 3375 (in the Amended Memorandum Decision on Motions for Summary Judgment and Preliminary Order, the Hearing Officer discussed the technical nature of the air permit matters and determined that DEQ staff were expert witnesses); REC 3716 (the Board seeks expert testimony from a toxicologist or other qualified expert). Because the PTC being challenged is technical and complex, expert testimony has been essential. *See* REC 3375. And DEQ's "experience, technical competence, and specialized knowledge may be utilized in the evaluation of the evidence." I.C. § 67-5251(5).

III. REGULATORY SCHEME

The Remaining Issues concern Perpetua's emissions of arsenic, a toxic air pollutant ("TAP"). The Rules for the Control of Air Pollution in Idaho, IDAPA 58.01.01 ("the Air Rules") contain several relevant provisions related to the control of TAPs. First, Section 161 provides an

overarching requirement wherein DEQ must determine that TAP emissions will not "injure or unreasonably affect human or animal life or vegetation." IDAPA 58.01.01.161. In issuing a permit, DEQ must find that a new or modified stationary source will comply with Section 161. IDAPA 58.01.01.203.03. Compliance with Section 161, with regards to the TAPs listed in Sections 585 (non-carcinogenic TAPs) and 586 (carcinogenic TAPs), is determined using the methods provided in Section 210 of the Air Rules. IDAPA 58.01.01.203.03.

Section 210 begins: "In accordance with Subsection 203.03, the applicant must demonstrate preconstruction compliance with Section 161 to the satisfaction of the Department." IDAPA 58.01.01.210. Section 210 goes on at length to provide the methods by which DEQ and the permit applicant analyze the TAP emissions from a new source or modification of an existing source and demonstrate compliance. *Id.* Compliance with Section 210 can first be established by demonstrating that the emissions from TAPs will not exceed the acceptable ambient concentrations ("AACCs") set forth in Sections 585 and 586. IDAPA 58.01.01.210.05. The AACCs are expressed as annual averages and use the Environmental Protection Agency's ("EPA") unit risk factors ("URF") for the listed TAPs. IDAPA 58.01.01.106.19. A URF is a particular TAPs inhalation unit risk ("IUR"). "All IURs (including for arsenic) are based on an incremental lifetime risk of 1 in one million from exposure to 1 $\mu g/m^3$ of a substance continuously (24 hours day and 365 days/ year) over a lifetime of exposure (assumed to be 70 years)." REC 4282.

Relevant here, Section 210.12 also allows a permit applicant to "use [Toxic Air Pollutant-Reasonably Available Control Technology ("T-RACT")] to demonstrate preconstruction compliance for toxic air pollutants listed in Section 586." IDAPA 58.01.01.210.12. T-RACT "is an emission standard based on the lowest emission of toxic air pollutants that a particular source

is capable of meeting by the application of control technology that is reasonably available, as determined by the Department…" IDAPA 58.01.01.210. When an applicant uses T-RACT, the allowable cancer risk shifts from 1-in-1,000,000 to 1-in-100,000.

IV. EXPERT TESTIMONY ON THE REMAINING ISSUES

The expert testimony of Kevin Schilling, Dr. Norka Paden, Kevin Lewis, and Theresa Lopez demonstrates that DEQ acted reasonably and in accordance with the law when it issued the PTC, including in its analysis of the ambient air concentrations. Although DEQ maintains that the record was already sufficient to support DEQ's analysis, the expert testimony provided by DEQ and Perpetua contains the additional evidence sought by the Board. None of the testimony provided by the Petitioners in their submitted declarations refute the expert testimony provided by DEQ and Perpetua or prove that DEQ failed to act reasonably or in accordance with the law. Thus, the testimony establishes that Petitioners again fail to meet their burden.

A. The Expert Declarations Demonstrate that DEQ Acted Reasonably and In Accordance With Law In Using the Project Specific 16/70 Adjustment.

First, the Board found "DEQ did not provide sufficient evidence in the form of an expert opinion from a toxicologist or other qualified expert regarding the cancer risk associated with the 16/70 adjustment." REC 3716. The Board also determined that it could "not find sufficient evidence in the record to support the proposition that a higher exposure to arsenic for a shorter period of time is equally or more protective than a lower annual lifetime average exposure." REC 3717. The testimony of Mr. Schilling, Mr. Lewis, Dr. Paden, and Ms. Lopez demonstrate that not only was this adjustment supported by the Air Rules, but it did not create an unacceptable increased cancer risk.

The cornerstone of the carcinogenic TAP rules is limiting *project caused* cancer risk to less than 1-in-1,000,000, or 1-in-100,000 when T-RACT is used. As DEQ and Perpetua's experts

explained, where project-caused cancer risk is the metric, it is appropriate to account for the exposure duration, as DEQ did here. REC 3929, 4142, 4283. As Ms. Lopez stated: "Comparing unadjusted emissions to the AACC would result in an over-estimation of cancer risk because the dose will not continue for the 70-year lifetime exposure assumed in the development of the AACC." REC 4283.Thus, an over-estimation would be inappropriate, as it misrepresents the nature of the project and its effects.

The Air Rules, specifically the AACCs, rely upon and incorporate EPA's science and methodologies. *See* REC 3876, REC 4284. Dr. Paden explained: "Under EPA's methodology for human health risk assessments, cancer risk calculations are done using a lifetime exposure set at 70 years." REC 3877. But, according to Mr. Schilling, when a project has "an enforceable operational life of less than 70 years, an adjustment for reduced exposure duration is appropriate." REC 3929. The testimony of Dr. Paden, Mr. Lewis, and Ms. Lopez all concur. Ms. Lopez specifically testified that "[a]djusting exposure duration is necessary and proper from a scientific and toxicological standpoint to apply the AACCs accurately." REC 4286. Dr. Paden also explained that "DEQ used EPA's methodology for adjusting exposure duration given the known exposure duration (lifetime of the mine)." REC 3878. Thus, the testimony demonstrates that this adjustment is consistent with the Air Rules, specifically the AACCs.

Further, Dr. Paden concluded:

> DEQ's analysis followed EPA's guidelines and that results from a shorter duration exposure (i.e., 16 years) is within EPA's target risk range of 1 in 1,000,000 to 1 in 10,000 (i.e., one in one million to one in ten thousand) and is not likely to increase cancer risk by the arsenic air emissions calculated by the analyses of the air permit application (maximum arsenic-modeled concentrations).

REC 3881. Simply put, DEQ did not underestimate the cancer risk caused by the project. Ms. Lopez agreed, concluding "the incremental increase in cancer risk caused by arsenic emissions

from the [Stibnite Gold Project] is 1 in 240,000, which is less than the acceptable risk of 1 in 100,000." REC 4280-4281.

The expert testimony demonstrates that the project specific adjustment was reasonable – calculating cancer risk naturally requires one to consider the exposure duration. REC 3877, REC 4286. The adjustment has also been shown to be lawful – the AACCs are based on EPA's methodologies and adjusting the exposure length is consistent with EPA methodology. REC 3876-3877, REC 4286. Finally, the testimony of Dr. Paden and Ms. Lopez establish that "the highest air concentration of arsenic from the project is below the acceptable lifetime risk established by the T-RACT AACC." REC 4285.

B. The Expert Declarations Demonstrate That DEQ Acted Reasonably and In Accordance With Law In Using a Five-Year Rolling Average.

Next, the Board found "there was insufficient evidence to support use of the five-year rolling average in the ambient arsenic air concentration analysis." REC 3713. Because the AACCs are listed as annual average in the Air Rules, the Board reasoned that DEQ could not use a "5-year rolling average when performing its arsenic ambient air concentration calculations." REC 3712. The Board is referring to the fact that DEQ limited mine production to 135,000 tons per day of ore, based on a five-year rolling average. REC 3712.

The testimony of Mr. Schilling and Mr. Lewis establish that while the AACCs are expressed as annual averages, the ultimate requirement of the Air Rules, including the AACCs, is that the project not exceed the *lifetime* risk. REC 3919, REC 4134-4135. Stated another way, the AACCs describe the annual average concentration that will result in a 1-in-1,000,000, or 1-in-100,000 for T-RACT, excess cancer risk assuming a lifetime exposure of 70 years; however, the averaging period of the AACCs themselves are not the compliance period. REC 4134. The five-year rolling average compliance period is in fact sufficient to assure that

operations, arsenic emissions, long-term impacts, and resulting airborne arsenic *lifetime cancer risk* associated with the project is less than the T-RACT allowable 1-in-100,000 cancer risk. REC 4134-4135.

According to Dr. Paden's testimony, the AACCs are calculated using EPA's standard methodology for estimating cancer risk in health assessments. REC 3876. Relying on EPA's methodology, Dr. Paden explains that AACCs for carcinogens are based on the cancer unit risk values from EPA and correspond to a 1-in-1,000,000 cancer risk (or 1-in-100,000 for T-RACT). REC 3876. And, in general, hourly, daily, and annual variabilities in exposure, even when such values exceed the value of the AACC, do not necessarily mean non-compliance with the 1-in-1,000,000 or 1-in-100,000 cancer risk increment. REC 3926.

C. The Expert Declarations Demonstrate that DEQ Acted Reasonably and In Accordance With Law as there was Sufficient Evidence to Support the T-RACT Analysis Limiting the Non-West End Pit Production Limit.

Finally, the Board concluded "there was insufficient evidence in the record to demonstrate exactly how or whether the non-West End Pit production was limited and, if it was, the Board of Environmental Quality could not find any PTC conditions able to enforce that reduction." REC 3714. According to the testimony of Mr. Schilling and Mr. Lewis, the PTC appropriately and effectively limited both West End Pit and non-West End Pit production. REC 3927, REC 4139. Further PTC condition 3.6 "limits total hauling and excavation from the mine to 788.4 million tons." REC 3927; *see also* REC 4139. Condition 3.6 then "limits hauling and excavation from the West End Pit to 394.2 million tons, which is equal to 50% of total allowable production." REC 3927. Thus, a limit to the non-West End Pit was not necessary based on the following relationship:

$$\text{Production}_{\text{Non-WEP}} = \text{Production}_{\text{total}} - \text{Production}_{\text{WEP}}$$

REC 3928. As explained by Mr. Schilling and Mr. Lewis, when production is assumed from West End Pit sources, compliance with the T-RACT AACC may not be established, which is why production was limited to 50%. REC 3928, REC 4140. But if all 788.4 million tons came from non-West End Pit deposits, ambient arsenic concentrations would be well below the T-RACT adjusted AACC. REC 3927-3928, REC 4140. Therefore, a limit on non-West End Pit sources is not required and would not make sense in the context of the existing limit on total production and West End Pit production.

V. CONCLUSION

The testimony described above demonstrates that DEQ acted reasonably and lawfully when it issued the PTC, and specifically in its analysis of arsenic emissions. As to each of the Remaining Issues, Petitioners have failed to meet their burden, and the Hearing Officer should find in DEQ's and Perpetua's favor.

DATED this 11th day of October, 2024.

STATE OF IDAHO
OFFICE OF THE ATTORNEY GENERAL

/s/ Hannah M.C. Young

HANNAH M.C. YOUNG
Deputy Attorney General
Attorneys for the Idaho Department of Environmental Quality

CERTIFICATE OF SERVICE

I hereby certify that on October 11, 2024, a true and correct copy of the foregoing ***DEQ'S PREHEARING STATEMENT*** was served on the following:

Bryan Hurlbutt
Laurence ("Laird") J. Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701

Attorneys for Petitioner Nez Perce Tribe and Idaho Conservation League

bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638

Attorney for Petitioner Save the South Fork Salmon

jthrower@mtntoplaw.com
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole C. Hancock
Stoel Rives LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702

Attorneys for Intervenor Perpetua Resources of Idaho, Inc.

krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
nicole.hancock@stoel.com
via electronic service

Dylan B. Lawrence
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701

Hearing Officer

dylan@varinthomas.com
via electronic service

Paula Wilson, Hearing Coordinator
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, Idaho 83706

paula.wilson@deq.idaho.gov
via electronic service

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

/s/ DeAnne M. Chaffin
DeAnne M. Chaffin
Legal Assistant

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
Nicole C. Hancock, ISB No. 6899
nicole.hancock@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 _____ NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioner, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC. Intervenor-Respondent.	Case Docket No. 0101-22-01 OAH Case No. 23-245-01 PERPETUA'S PREHEARING STATEMENT

TABLE OF CONTENTS

KEY TO TERMS AND ABBREVIATIONS iii
I. CONTESTED CASE REMAND AND STATEMENT OF ISSUES 1
II. STANDARD OF REVIEW 2
III. RELEVANT REGULATORY BACKGROUND: IDAHO TAP RULES 3
IV. QUALIFIED EXPERTS ON BEHALF OF PERPETUA WILL PRESENT ADDITIONAL EXPLANATION AT THE HEARING 4
A. The evidence will show that DEQ properly adjusted the exposure duration for the arsenic exposure concentration to reflect the 16-year life of the Project. 5
B. The evidence will show that DEQ properly used a five-year rolling average production limit for T-RACT. 8
C. The evidence will show that the PTC already limits production from the non-West-End Pits, and no separate limit is necessary. 9
V. CONCLUSION 10

KEY TO TERMS AND ABBREVIATIONS

AACC	Acceptable Ambient Concentration for a Carcinogen
DEQ	Respondent Idaho Department of Environmental Quality
EPA	United States Environmental Protection Agency
IUR	Inhalation Unit Risk, developed by EPA
Idaho Air Rules	Rules for the Control of Air Pollution in Idaho, IDAPA 58.01.01, *et seq*.
Perpetua	Intervenor-Respondent Perpetua Resources Idaho, Inc.
Petitioners	Petitioners Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon
Project	Stibnite Gold Project
PTC	Air Quality Permit to Construct No. P-2019.0047, issued to Perpetua on June 17, 2022
TAP	Toxic air pollutant
T-RACT	Toxic air pollutant reasonably available control technology
URF	Unit Risk Factor, based on EPA's IUR

I. CONTESTED CASE REMAND AND STATEMENT OF ISSUES

The Board of Environmental Quality (the "Board") issued a Final Order regarding Perpetua Resources Idaho, Inc.'s ("Perpetua") Permit to Construct (the "PTC") for the Stibnite Gold Project (the "Project"). REC 3695-3720. The Board affirmed the Idaho Department of Environmental Quality ("DEQ") on four of the five claims presented. REC 3698-3706. On the fifth claim, the Board held there was insufficient evidence to determine whether DEQ acted reasonably and according to the Rules for the Control of Air Pollution in Idaho, IDAPA 58.01.01 *et seq.* (2022) (the "Idaho Air Rules"),[1] in analyzing ambient air concentrations of arsenic emissions and in finding those concentrations were less than the amount of arsenic that would contribute to an excess cancer risk probability of 1-in-100,000. *See* REC 3706-3717.

The Board found that DEQ "did not provide sufficient evidence in the form of an expert opinion from a toxicologist or other qualified expert regarding the cancer risk associated with the 16/70 adjustment." REC 3716. The Board remanded to the Hearing Officer "for the development of further evidence regarding the ambient air concentrations of arsenic that will be produced by the [Project] and whether those levels comply with the Air Rules." REC 3717. On remand, the parties "must focus only on the development of additional factual evidence on the ambient arsenic air concentration analysis performed by DEQ for the PTC." REC 3841-3842.

Specifically, the evidentiary hearing is limited to three issues:

(1) whether the "16/70 analysis performed by DEQ was equally or more protective of human and animal life and vegetation as what is provided for by the Air Rules" and whether ambient air concentrations of arsenic from the Project comply with the Idaho Air Rules, REC 3715-3717.

[1] All citations are to the 2022 version of the Idaho Air Rules.

(2) whether DEQ acted reasonably in using a five-year rolling average in analyzing arsenic ambient air concentrations, REC 3712-3713; and

(3) whether non-West End Pit production was limited, and what effect non-West End Pit production has on arsenic emissions, REC 3713-3714.

Analyzing ambient air concentrations of arsenic and the cancer risk probability associated with arsenic emissions are issues beyond the ordinary knowledge of a layperson. An expert witness's scientific, technical, or other specialized knowledge is necessary to help the Board understand the evidence. *See* IDAPA 62.01.01.485; *see also* REC 3375-3376. Perpetua will introduce qualified expert testimony at the hearing to provide the explanation and justification the Board seeks and will show that Petitioners' objections are simply opinions and unsupported speculation that provide no basis to conclude DEQ acted unreasonably or contrary to the Idaho Air Rules.

II. STANDARD OF REVIEW

The Board "must determine whether DEQ 'has acted reasonably and in accordance with the law.'" REC 3697 (quoting *In the Matter of Sunnyside Park Utilities' Application for Sewage Disposal Permit*, Final Order on Petition for Review of Preliminary Order, at p. 10 (BEQ Dkt. 0103-07-02, Apr. 7, 2009). This analysis appropriately considers DEQ's "experience, technical competence, and specialized knowledge" to evaluate evidence.[2] *See* Idaho Code § 67-5251(5); *see also* Idaho Code § 67-5251(4)(b) (authorizing the Board to take official notice of "generally recognized technical or scientific facts within the agency's specialized knowledge."); Michael S. Gilmore & Dale D. Goble, The Idaho Administrative Procedure Act: A Primer for the

[2] The Idaho Legislature recently amended the standard for judicial review under the Idaho Administrative Procedure Act to prohibit deference to agency interpretations, Idaho Code § 67-5279(5), but the standard for judicial review does not apply to the Hearing Officer or the Board's review of the PTC. *See* REC 3377 (explaining that the statute's standards "are not directly applicable").

Practitioner, 30 Idaho L. Rev. 273, 319 (1994) ("[T]he agency's repeated exposure to a specialized subject matter is a source of specialized knowledge that is useful in evaluating evidence."). The burden of establishing that DEQ acted unreasonably or inconsistently with the law falls on Petitioners, who must prove their allegations by a preponderance of the evidence. IDAPA 62.01.01.477.

III. RELEVANT REGULATORY BACKGROUND: IDAHO TAP RULES

The evaluation of arsenic emissions from the Project starts with IDAPA 58.01.01.161. *See* IDAPA 58.01.01.203.03. Section 161 requires DEQ to evaluate emissions of carcinogenic toxic air pollutants ("TAPs") and determine that the emissions will not injure or unreasonably affect human or animal life or vegetation. Preconstruction compliance with Section 161 can be shown using the methods provided in IDAPA 58.01.01.210. *See id*.

Compliance with Section 210 is shown when the modeled maximum ambient air impact is less than or equal to the applicable acceptable ambient concentration ("AACC") for carcinogens provided in IDAPA 58.01.01.586. *See* IDAPA 58.01.01.210. AACCs are based on Unit Risk Factors ("URFs") developed by the United States Environmental Protection Agency ("EPA"). *See* IDAPA 58.01.01.106.19, .586. AACCs and URFs are listed in Section 586 and assure that the excess cancer risk is no more than 1-in-1,000,000 over a 70-year lifetime of constant exposure to the listed carcinogen. This is made clear by the definition of "Toxic Air Pollutant Carcinogenic Increments" in the Idaho Air Rules:

> Those ambient air quality increments based on the probability of developing excess cancers over a seventy (70) year lifetime exposure to one (1) microgram per cubic meter (1 ug/m3) of a given carcinogen and expressed in terms of a screening emission level or an acceptable ambient concentration for a carcinogenic toxic air pollutant. They are listed in Section 586.

See IDAPA 58.01.01.006.125. AACCs are expressed as annual average concentrations. *See* IDAPA 58.01.01.586. The AACC for arsenic is 0.00023 $\mu g/m^3$. *Id*.

Here, DEQ found Perpetua demonstrated preconstruction compliance for arsenic emissions using the method set forth in Section 210.12.[3] Section 210.12 allows an applicant to use reasonable achievable control technology for TAPs ("T-RACT") to demonstrate compliance with Section 161. IDAPA 58.01.01.210.12.a. If T-RACT is used to control emissions, then the allowable excess cancer risk over a 70-year lifetime of constant exposure is 1-in-100,000, or 10 times the AACC. IDAPA 58.01.01.210.12.b. The T-RACT AACC for arsenic is 0.0023 $\mu g/m^3$.

The plain language of Section 210.12.b requires DEQ to *compare* the modeled T-RACT ambient concentration from the Project to the cancer risk of the T-RACT AACC:

> Compare the source's or modification's approved T-RACT ambient concentration at the point of compliance for the toxic air pollutant to the amount of the toxic air pollutant that would contribute an ambient air cancer risk probability of less than one to one hundred thousand (1:100,000) (which amount is equivalent to ten (10) times the applicable acceptable ambient concentration listed in Section 586).

IDAPA 58.01.01.210.12.b. Toxicologists refer to the modeled T-RACT ambient concentration as the "exposure concentration." If the exposure concentration is less than or equal to the T-RACT AACC, then "no further procedures for demonstrating preconstruction compliance will be required for that toxic air pollutant as part of the application process." IDAPA 58.01.01.210.12.c.

IV. QUALIFIED EXPERTS ON BEHALF OF PERPETUA WILL PRESENT ADDITIONAL EXPLANATION AT THE HEARING

Perpetua's qualified expert witnesses will present testimony that DEQ's analysis of arsenic emissions from the Project complied with the Idaho Air Rules and the toxicological and other scientific principles on which they are based. Theresa Lopez (a Principal Toxicologist at Tetra Tech, Inc.) and Kevin Lewis (a Principal Air Quality Engineer at Air Sciences Inc.) will

[3] Normally, fugitive dust emissions of arsenic from gold mining would be excluded from TAP compliance demonstrations because the emissions are "addressed" by National Emission Standards for Hazardous Air Pollutants (NESHAP), 40 C.F.R. Part 63, Subpart EEEEEEE. *See* IDAPA 58.01.01.210.20.b.

explain why DEQ acted reasonably and in accordance with the law when comparing the Project's modeled arsenic exposure concentration to the T-RACT AACC and finding the emissions do not present an unacceptable risk to human health or the environment. Ms. Lopez and Mr. Lewis's testimony will be consistent with the expert declarations of Kevin Schilling (DEQ's Stationary Source Air Modeling Supervisor) and Dr. Norka Paden (a DEQ Environmental Toxicologist).

A. The evidence will show that DEQ properly adjusted the exposure duration for the arsenic exposure concentration to reflect the 16-year life of the Project.

Cancer risk cannot be evaluated without considering the length of time a potential receptor will be exposed to a carcinogen—referred to as "exposure duration." When comparing the Project's modeled arsenic exposure concentration to the T-RACT AACC pursuant to Section 210.12, DEQ properly adjusted the exposure concentration to account for the 16-year exposure duration of the Project. In other words, to ensure an "apples to apples" comparison between the arsenic exposure concentration and the T-RACT AACC, DEQ calculated the Project's exposure concentration using the 16-year exposure duration to ensure that concentration was comparable to the assumption of the 70-year exposure duration found in the AACC. The adjustment is illustrated in the following formula utilized by DEQ:

$$Lifetime\ exposure\ \left(\frac{\mu g}{m^3}\right) = \frac{Highest\ annual\ concentration\ \left(\frac{\mu g}{m^3}\right) \times 16\ (mine\ operation\ years)}{70\ (years, lifetime\ exposure)}$$

REC 710. The lifetime exposure in the formula is the Project's arsenic exposure concentration.

Based on the maximum modelled annual concentration, the lifetime exposure concentration of arsenic for the Project is 0.00095 µg/m^3. REC 714. Compared to the T-RACT AACC (0.0023 µg/m^3), the Project's lifetime exposure of arsenic is less than a 1-in-100,000 cancer risk and demonstrates that the Project's arsenic emissions will not injure or unreasonably affect human, animal life, or vegetation. The Board, however, did not find sufficient evidence to

support the 16/70 adjustment and called for a toxicologist or other qualified expert to cure perceived evidentiary gaps. *See* REC 3715-3717.

The expert testimony of Ms. Lopez and Mr. Lewis will explain that DEQ followed Sections 210.12 and 586 when adjusting the Project's arsenic exposure concentration to compare against the arsenic T-RACT AACC. Their collective expert testimony will be that:

- AACCs are calculated from URFs listed in Section 586, which are based on Inhalation Unit Risks ("IURs") for carcinogens developed by EPA;
- EPA developed IURs assuming the dose of a carcinogen is cumulative over the duration of exposure and that cancer risk increases linearly as the cumulative total dose increases over a 70-year lifetime (i.e., where the cancer risk is dependent on exposure duration);
- IURs/URFs are substantially conservative and based on a cumulative lifetime excess cancer risk of 1-in-1,000,000 from exposure to 1 $\mu g/m^3$ of a substance continuously (24 hours/day and 365 days/year) over a lifetime exposure of 70 years;
- the concepts of margin of safety and mode of action are not appropriately applied in toxicological risk assessment, and another margin of safety on top of IURs/URFs is absent from the Idaho Air Rules;
- AACCs are derived by dividing a 1-in-1,000,000 cancer risk by the URF and thus represent the excess cancer risk probability averaged over a 70-year lifetime;
- being based on URFs, AACCs are not annual emission limits but are excess cancer risk probability values expressed in terms of exposure concentrations for a lifetime;
- interpreting AACCs as annual emission limits ignores the definitions of IUR/URF and AACC and conflates incremental concentrations with incremental cancer risk;

- adjusting the arsenic exposure concentration for the 16-year life of the mine is consistent with toxicology guidance and practices, follows the method EPA developed for the correct use of IURs/URFs and AACCs, and does not underestimate excess cancer risk from the Project;
- the URF for arsenic is 0.0043 $\mu g/m^3$, which results in an AACC of 0.00023 $\mu g/m^3$ and a T-RACT AACC of 0.0023 $\mu g/m^3$;
- for a project with an operational life of less than 70 years, it is appropriate to adjust for actual exposure duration;
- the short-term project adjustment factor recognized in Section 210.15 is an example of an adjustment for exposure duration that is consistent with DEQ and EPA's methods for risk assessment and reliance on IURs/URFs and AACCs;
- DEQ and EPA use a formula to compare the exposure concentration ($C_{air\text{-}adj}$) from a project that operates for less than 70 years to the AACC, which considers the contaminant concentration in air (C_{air}), exposure time (ET) of 24 hours /day, exposure frequency (EF) of 365 days/year, exposure duration (ED) of years of exposure to the C_{air}, and an averaging time (AT) of 70 years x 365 days/year x 24 hours/day;
- the formula is $\mathbf{C_{air\text{-}adj} = C_{air} \times ET \times 1day/24\ hours \times EF \times ED/AT}$;
- using the maximum modelled annual concentration of arsenic and an ED of 16 years (the longest period the mine will operate), the arsenic exposure concentration is 0.00095 $\mu g/m^3$, which is less than the arsenic T-RACT AACC of 0.0023 $\mu g/m^3$; and
- based on the exposure concentration of 0.00095 $\mu g/m^3$, the incremental increase in cancer risk from the Project's arsenic emissions is 1-in-240,000, which is below the acceptable lifetime risk of 1-in-100,000 established by the T-RACT AACC.

The expert testimony at the hearing will demonstrate that comparing the Project's arsenic exposure concentration to the T-RACT AACC under Section 210.12 requires the exposure concentration to be adjusted from a lifetime exposure to the Project's actual exposure duration to provide an "apples to apples" comparison to the T-RACT AACC. The evidence will support the underlying rule-based mathematics that DEQ used to calculate the arsenic exposure concentration from a 16-year project and to properly compare the exposure concentration to the T-RACT AACC. Perpetua's expert testimony will also explain the flaws and misunderstandings in Petitioners' declarations, which simply reflect disagreements with the professional judgments of DEQ staff and advocacy positions that do not align with the Idaho Air Rules.

B. The evidence will show that DEQ properly used a five-year rolling average production limit for T-RACT.

Established as a T-RACT control, Condition 3.5 of the PTC limits mine production to 135,000 tons per day based on a five-year rolling average. REC 385. This production limit ensures that arsenic emissions from the Project are consistent with assumptions used to model maximum annual concentrations against the T-RACT AACC. The Board, however, found "no evidence in the record explaining how the five-year rolling average comports with the annual AACC limits." REC 3713. The expert testimony of Ms. Lopez and Mr. Lewis will explain that a five-year rolling average production limit will not change lifetime incremental cancer risk and is protective and consistent with Section 586 and AACCs. Collectively they will testify that:

- because AACCs are developed based on cumulative, lifetime exposure of 70-years, the values are based on a 70-year compliance period, do not require annual compliance, and are not annual limits;
- a five-year rolling average compliance period represents a shorter and more conservative timeframe than the 16-year life of the mine and ensures that cumulative

exposure over that duration will remain below the T-RACT AACC; and

- any averaging period that is less than an exposure duration of 16 years is consistent with the arsenic AACC and Sections 210.12 and 586 and will not increase or decrease the excess cancer risk estimated using maximum modelled annual concentrations.

The expert testimony at the hearing will show that AACCs are not based on annual exposure and that DEQ acted reasonably in determining that a production limit based on a five-year rolling average ensures the Project is operated as described in the compliance demonstration under Sections 210.12 and 586.

C. The evidence will show that the PTC already limits production from the non-West-End Pits, and no separate limit is necessary.

The PTC establishes two life-of-mine production limits in Condition 3.6: (1) a limit on total mine production of 788.4 million tons and (2) a limit on West End Pit production of 394.2 million tons, which is 50% of total mine production. REC 385. Condition 3.6 does not expressly address or limit non-West End Pit production. While so, in calculating the highest arsenic ambient concentrations from the Project, DEQ limited production by 50% from both the West End Pit and the non-West End Pits. The Board was uncertain why non-West End Pit production was adjusted and limited by 50%. REC 3714. In particular, the Board inquired why DEQ limited production from the non-West End Pits when Condition 3.6 includes no such limit. *Id*.

The expert testimony of Mr. Lewis will explain that a separate production limit on the non-West End Pits was not necessary. He will testify that:

- modeling scenarios based on full production from the non-West End Pits (*i.e.*, the entirety of mine production or 788.4 million tons) for the 16-year life of the mine demonstrated compliance with the T-RACT AACC;

- modeling scenarios based on 50% production from the West End Pits and the remaining 50% from the non-West End Pits (*i.e.*, 394.2 + 392.4 = 788.4 million tons) for the 16-year life of the mine also demonstrated compliance with the T-RACT AACC;
- since Condition 3.6 limits West End Pit production to 394.2 million tons and total production to 788.4 million tons, an additional production limit on the non-West End Pits is unnecessary and would be redundant (i.e., the non-West End Pits are already limited by the total production limit and demonstrate compliance with the T-RACT AACC at full production).

The expert testimony at the hearing will show that an additional production limit on the non-West End Pits offers no further protection to the public health or the environment.

V. CONCLUSION

At the evidentiary hearing, Perpetua will demonstrate that DEQ acted reasonably and in compliance with Sections 161, 203, 210.12, and 586 of the Idaho Air Rules when permitting the Project's arsenic emissions. Based on the expert testimony, the Hearing Officer should enter findings of fact and conclusions of law that DEQ properly adjusted the Project's arsenic T-RACT ambient concentration based on an exposure duration of 16 years, that a five-year rolling average production limit is consistent with the arsenic AACC, and that no additional production limit is necessary to limit emissions from the non-West End Pits.

DATED: October 11, 2024.

STOEL RIVES LLP

W. Christopher Pooser

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole C. Hancock

Attorneys for Perpetua Resources Idaho, Inc.

CERTIFICATE OF SERVICE

I hereby certify that on October 11, 2024, a true and correct copy of the **PERPETUA'S PREHEARING STATEMENT** was served on the following:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Dylan B. Lawrence
Hearing Officer
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Bryan Hurlbutt
Laurence ("Laird") J. Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Michael A. Short
Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
michael.short@deq.idaho.gov
hannah.young@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
ann.yribar@ag.idaho.gov
via electronic service

Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, Idaho 83706
paula.wilson@deq.idaho.gov
via electronic service

W. Christopher Pooser
W. Christopher Pooser
Attorneys for Perpetua Resources Idaho, Inc.

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	Agency Case No. 0101-22-01 OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC. Intervenor-Respondent.	**PETITIONERS' PRE-HEARING STATEMENT**

Pursuant to the Second Amended Scheduling Order, REC 6045-47, Petitioners Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon submit this pre-hearing statement summarizing the testimony Petitioners will adduce at the hearing on the merits and how it relates to the three remaining issues (the "Remaining Issues") identified by the Board of Environmental Quality (the "Board"). Those issues all relate to the Idaho Department of Environmental Quality's ("DEQ") evaluation of arsenic dust emissions from the proposed Stibnite Gold Project, including DEQ's decision to create a never-before-used "Project-specific adjustment factor" for Perpetua, and whether that approach complies with the Rules for the Control of Air Pollution in Idaho, IDAPA 58.01.01 (the "Air Rules"), specifically, the provisions for controlling toxic air pollutants ("TAPs").

BACKGROUND

Petitioners originally filed the Petition to Initiate Contested Case on July 22, 2022, seeking review of DEQ's issuance on June 17, 2022, of Air Quality Permit to Construct P-2019.0047 ("PTC") to mining company Perpetua Resources Idaho, Inc. ("Perpetua") for its proposed Stibnite Gold Project. REC 0001-28. The Hearing Officer granted Perpetua's motion to intervene, denied Perpetua's motion to dismiss, and granted Petitioners' motion to file the Amended Petition to Initiate Contested Case. *See* REC 0044–45; REC 0160–86; REC 0255–57 (Am. Petition). After discovery, briefing, and a hearing, the Hearing Officer issued a Preliminary Order and then an Amended Preliminary Order granting summary judgment in favor DEQ and Perpetua (collectively "Respondents") and against Petitioners on all issues in the Amended Petition, including the arsenic issues that make up the Remaining Issues. *See* REC 3280–3328; REC 3372–3425 (Am. Prelim. Order).

Petitioners filed with the Board a Petition for Review and then an Amended Petition for Review of the Preliminary Orders, seeking review on five issues. *See* REC 3425–41 (Am. Petition for Review). After briefing and a hearing, the Board issued a preliminary oral decision on May 1, 2024. *See* TR 0156–174. The Board denied four of the issues Petitioners raised, but ruled in Petitioners' favor on the arsenic issue, remanding on that issue, and directing legal counsel to draft a written decision. TR 0158–59.

In the oral decision, Board Member MacMillan summarized the Board's concerns with the way DEQ assessed the Stibnite Gold Project arsenic emissions as follows:

> [M]ost germane in this contested case are carcinogen dose and duration. The greater the dose of carcinogen exposure, the greater is the chance of cancer initiation; the longer the duration of carcinogen exposure, the greater is the risk of developing cancer.
>
> Low dose exposure, as embodied in the AACC and applied daily for up to 70 years, would be expected to limit cancer to only a one in million chance.
>
> The higher dose, such as associated with this short-term project in a T-RACT acceptable concentrations, would be expected to limit cancer to one in 100,000 chances, even after 70 years.
>
> DEQ concluded that the Stibnite gold project cancer risk exceeds the AACC associated risk and exceeds the T-RACT associated risk.
>
> The Idaho rules are not ambiguous. There is an acceptable risk associated with the AACC standard. There is an acceptable risk associated with DEQ-approved T-RACT projects, and there is an acceptable risk associated with the short-term project that is five years or less. There are no other acceptable risks identified in Idaho's air quality rules.
>
> DEQ's project-specific adjustment factor creates a new, higher level of cancer risk for 16 years. DEQ assumes 70 years is required for cancer to develop. That is an incorrect assumption.
>
> The AACC, the T-RACT, and short-term AACC emission exposure limits are actually daily limits that apply over a person's entire lifetime, regardless of how long they live. The acceptable cancer risk remains one in one million or one in 100,000. Higher carcinogen doses increase the cancer risk every day of a person's life. A higher daily dose for 16 years elevates the cancer risk even more.

> Application of the project-specific adjustment factor allows DEQ to ignore 16 years of higher cancer initiation risk. The PTC proposes to allow 16 years higher daily carcinogen doses, and disguises such doses using non-rules-based mathematics. Use of the project-specific adjustment factor ignores 16 years of cancer initiation due to higher carcinogenic arsenic dose that is otherwise allowed by rule. The AACC, the T-RACT and short-term project AACCs dictate an annual average compliance.
>
> DEQ further violates this compliance point by instituting a five-year rolling average compliance. Such a creative compliance point allows even further departure from our air quality goals, and specifically compliance with Section 161 of our air quality rules.
>
> * * *
>
> In my opinion, DEQ has misapplied the Idaho air quality rule, and they do not have authority to create new cancer risks.

TR 0159–60.

The Board's May 9, 2024 Final Order remanded this case, finding "DEQ did not act reasonably and in accordance with the law when it analyzed the ambient arsenic air concentrations for the [Stibnite Gold Project]." REC 3717. Specifically, the Board found that DEQ erred in three ways:

1. DEQ failed to show how the "five-year rolling average [for calculating the ambient arsenic concentrations resulting from the Stibnite Gold Project] comports with the annual AACC limits" set forth in Section 586 of the Air Rules. REC 3713;

2. DEQ failed to provide sufficient evidence to demonstrate whether non-West End Pit production was limited and enforceable under the PTC conditions. REC 3714; and

3. The Air Rules do not provide for adjusting a project's emissions "in proportion to the amount of time it will operate," and DEQ failed to demonstrate that the 16/70 Project-specific adjustment factor "was equally or more protective of human and animal life and vegetation as what is provided for by the Air Rules." REC 3716–17.

The Board remanded the case to the Hearing Officer "for the development of further evidence regarding the ambient air concentrations of arsenic . . . and whether those levels comply with the Air Rules." REC 3717.

On July 8, 2024, the Hearing Officer entered a pre-hearing order setting the hearing for this matter, which will address the issues identified by the Board regarding DEQ's analysis of the ambient arsenic air concentrations for the Stibnite Gold Project, for commencement on October 17, 2024. REC 3867.

TESTIMONY ON REMAINING ISSUES

I. THE 16/70 PROJECT-SPECIFIC ADJUSTMENT FACTOR IS CONTRARY TO THE IDAHO AIR RULES AND THREATENS PUBLIC HEALTH.

A. The Air Rules, Their Rulemaking History, and DEQ's Normal Practice Do Not Allow Use of the 16/70 Dose Averaging Approach.

As the Board found in the Final Order, the Air Rules require meeting the AACC, allow for T-RACT and short-term source adjustments to the AACC, and provide no other exceptions, such as the 16/70 project-specific adjustment used here. REC 3708–10.

Mr. William Tiedemann will testify to his experience working as an environmental engineer, including working as a Clean Air Act Permitting Engineer at DEQ. Tiedemann Decl. ¶¶ 3–5. In his experience, he never worked on a PTC or other air permit that utilized, or even considered, a project-specific adjustment factor or other dose averaging adjustment for sources lasting less than 70 years. *Id.* ¶¶ 15–16. He will testify that in his experience, he and his colleagues treated the AACCs as annual limits that a source must meet every year. *Id.*

Mr. Tiedemann will also testify to gathering and reviewing historical documents from the 1993 TAPs rulemaking. *Id.* ¶ 17. He will testify that those documents show that DEQ contemplated but rejected the use of exposure duration adjustments, like the 16/70

Project-specific adjustment factor used here. *Id.* ¶¶ 18–20. He will also testify that the use of EPA's superfund risk assessment guidelines developed for short-term sources were considered and rejected during the TAPs rulemaking. *Id.* ¶ 25–27. Furthermore, Mr. Tiedemann will testify that the records and the language of the TAPs rule itself demonstrate that DEQ developed the AACCs as annual limits an emissions source must show it will comply with each and every year of operation. *Id.* ¶¶ 22–23. Finally, Mr. Tiedemann will testify that the AACCs are enforceable limits under the Air Rules, and the fact that they are "increments" does not somehow make them unenforceable, as DEQ and Perpetua argue. *Id.* ¶ 37.

Dr. Ian H. von Lindern participated on the advisory committee involved with the TAPs rulemaking in the 1990s, and will testify that his recollection is that the TAPs were intended to be easy to apply while still being proscriptive and strict enough to protect public health. von Lindern Decl. ¶¶ 7, 20, He will testify that DEQ chose not to include the use of risk assessments to demonstrate compliance for individual sources in the Air Rules, in part because industry considered risk assessments an onerous burden. *Id.* ¶ 20. The result of the rulemaking process was a simple, yet protective rule found in Section 586 that simplifies the permitting process while providing a margin of safety for protecting human health. *Id.* ¶ 21. Dr. von Lindern will also testify that review of other states that use risk assessments as part of demonstrating compliance with toxic pollutant rules, like Washington, specifically call for risk assessments and provide direction for when and how to perform them in their rules, unlike the Idaho Air Rules, which do not call for risk assessments or provide direction for their use. *Id.* ¶¶ 35, 74–75.

Both Mr. Tiedemann's and Dr. von Lindern's testimony will support the Board's conclusion that the Air Rules do not provide for adjusting a project's emissions or risk "in proportion to the amount of time it will operate." REC 3715.

B. The 16/70 Dose Averaging Adjustment Threatens Public Health And Exceeds Allowable Cancer Risk Under the Air Rules.

The Board found that DEQ failed to demonstrate that the 16/70 Project-specific adjustment factor "was equally or more protective of human and animal life and vegetation as what is provided for by the Air Rules." REC 3716–17.

Dr. von Lindern and Mr. Tiedemann will testify that treating the AACC as an annual average that must be complied with by all sources year-after-year protects public health. von Lindern Decl. ¶¶ 19–29; Tiedemann Decl. ¶¶ 14, 17–21. They will testify that no matter where someone lives in Idaho, no matter how many sources operate, and no matter whether someone is in a sensitive life-stage, if the AACC is an annual average that must be complied with every year by all sources, then that person should not experience a risk greater than that intended by the Air Rules from industrial permitted sources; or stated differently, cancer risk will accumulate over their expected 70-year lifetime without exceeding the Air Rule's maximum allowable lifetime risk under all circumstances.

Dr. von Lindern and Mr. Tiedemann will testify that dose averaging for one source, like the Stibnite Gold Project, ignores the additive cancer risk from additional sources that someone has already been exposed to in the past and additional sources they are be exposed to in the future. von Lindern Decl. ¶¶ 46–50; Tiedemann Decl. ¶¶ 28–29. They will also testify that DEQ's and Perpetua's experts did not address this problem.

Dr. von Lindern will testify that dose averaging over a 70-year lifetime, as was done for the Stibnite Gold Project, does not account for variable carcinogenic potency and cancer risk accumulation for different stages of life, including pregnant women, fetuses, and pre-school children, who accumulate dose and risk at the highest rates and are particularly vulnerable. *Id.* ¶¶ 37–45.

Dr. von Lindern will testify that the dose averaging used for the Stibnite Gold Project fails to account for carcinogens exhibiting mutagenic mode of action (MOA). *Id.* at 43–45. He will testify that using DEQ's dose averaging approach can increase a six-year-old child's cancer risk by 12 times over the risk allowed by treating the TAPs as a maximum one-year average. *Id.* at 46-50.

In sum, this testimony will show that strict yearly compliance with the AACCs achieves the Air Rules public health protections. By contrast, using dose averaging and relying on overly simple risk assessments that fail to consider the spectre of multiple sources, fail to consider sensitive life stages, and fail to consider mutagenic MOAs is not "equally or more protective of human and animal life and vegetation as what is provided for by the Air Rules," as the Board asked. DEQ's approach allows for greater cancer risk and sets a dangerous new precedent.

II. THE 5-YEAR ROLLING AVERAGE DILUTES THE ANNUAL ARSENIC EMISSIONS AND IS NOT AN ANNUAL AVERAGE.

The Board found that DEQ failed to show how the "five-year rolling average [for calculating the ambient arsenic concentrations] comports with the annual AACC limits" set forth in Section 586 of the Air Rules. REC 3713.

Mr. Tiedemann and Dr. von Lindern will testify that DEQ and Perpetua's use of a 5-year rolling average to calculate the ambient arsenic concentrations to apply the TAPs rule is inconsistent with the rulemaking history and intent of the rule, which plainly states that AACC's are annual, year-over-year limits. Tiedemann Decl. ¶ 40; von Lindern Decl. ¶ 58. This is consistent with the Board's determination that the Section 586 AACC limits are based on annual averages and that the rule specifies compliance on an annual basis. REC 3713. Mr. Tiedemann will further testify that applying a 5-year rolling average could allow some years of considerably higher arsenic emissions, potentially above that of the AACC, which would allow the source to

emit emissions that create an excess cancer risk level above the T-RACT adjusted risk level of 1:100,000. Tiedemann Decl. ¶¶ 41–44.

Mr. Tiedmann's testimony will be confirmed by Dr. von Lindern, who found no evidence in the record that DEQ ever calculated the *maximum* annual average arsenic concentration from the Stibnite Gold Project. Dr. von Linder will testify that he used available information in the record to estimate that the maximum annual average arsenic concentration was approximately 1.8 times larger than the 5-year rolling average DEQ used. von Lindern Decl. ¶ 61. He will also testify that because use of the 5-year rolling average reduces the arsenic concentrations from the maximum annual average, it also masks the excess cancer risk by 45%. *Id.* ¶¶ 59-61, 63, 70.

In sum, the testimony will show that DEQ's use of a five-year rolling average masks individual years during which the Stibnite Gold Project will cause arsenic concentrations to exceed the AACC, and this allows dangerous high-dose, short-duration exposures to occur and does not comport with the Air Rules.

III. AVERAGING WEST END PIT AND NON-WEST END PIT EMISSIONS SCENARIOS FURTHER MASKS THE TRUE RISK FROM ARSENIC.

The Board found that there was insufficient evidence to demonstrate whether non-West End Pit production was limited and enforceable under the PTC conditions. REC 3714.

Mr. Tiedemann will testify that the Board was correct in questioning whether production from all pits was properly constrained. Tiedemann Decl. ¶ 46. Mr. Tiedemann found that the permitting record does not provide sufficient evidence as to exactly what emission sources and which time period Respondents considered in developing the 5-year rolling average. *Id.* ¶ 48. He will further testify, that in his experience, to comply with the AACCs and demonstrate TAPs compliance, a worst case scenario for arsenic emissions in any one year should have been calculated, modeled at the operation boundary, and compared to the AACC. *Id.* ¶ 49. Only then,

could permit conditions be included that include a true maximum annual ore generation limit. *Id.* Mr. Tiedemann will testify that the worst case year is likely when 100% of mine production is from the West End Pit. *Id.* Mr. Tiedemann will conclude his testimony finding that the PTC as written does not sufficiently constrain ore production on an annual basis such that it can be demonstrated that it complies with the AACC in the TAPs rule. *Id.* ¶ 50.

Dr. von Lindern will testify that he further investigated this issue, finding that the likely maximum annual emissions scenario has considerably higher arsenic emissions than currently calculated. von Lindern Decl. ¶¶ 56–63. Dr. von Lindern will testify that his review of the record showed the "WEP2" scenario was the worst case scenario considered by Respondents for the Stibnite Gold Project, but that Respondents reduced the true maximum annual average arsenic concentration in their "WEP2" scenario by 41% by combining 8 different 5-year rolling average scenarios: Respondents combined the 5-year rolling average of the WEP2 scenario with 7 non-WEP 5-year rolling averages. *Id.* ¶ 64. Those non-WEP scenarios have lower arsenic emissions than the WEP2 scenario, and the effect of this adjustment is to further dilute the apparent arsenic concentration and excess cancer risk by an additional 41%, which is inconsistent with calculation of the maximum annual average required by the TAPs rule. *Id.* ¶¶ 64-67.

IV. CONSIDERED TOGETHER, THE THREE ADJUSTMENT FACTORS ARE A SIGNIFICANT DEPARTURE FROM THE AIR RULES AND GREATLY UNDERESTIMATE CANCER RISK FROM THE STIBNITE GOLD PROJECT.

Dr. von Lindern will testify regarding the effect of the three adjustment factors and how together the dilution effects are multiplicative and function to undermine the health protectiveness of the TAPs rule for carcinogenic risk. von Linder Decl. ¶ 68. For example, Dr. von Lindern will explain how the 5-year rolling average functions to dilute arsenic concentration

by 45%; the non-WEP adjustment factor dilutes the arsenic concentration further by another 41%; and finally, the 16/70 Project-specific adjustment factor dilutes this number by an additional 78% to result in a arsenic concentration value in the permit record. *Id.* ¶ 69. Dr. von Linder will testify that it is only by these successive dilutions or "dose averaging" of the arsenic emissions that Respondents were able to push the corresponding cancer risk factor below the T-RACT acceptable excess cancer risk of 1:100,000. *Id.* ¶ 70.

Finally, Dr. von Lindern will testify that DEQ's approach in applying these adjustment factors to dose average, and thus lower the true ambient air arsenic concentration, for longer term projects such as the Stibnite Gold Project is unprecedented in Idaho, and has significant implications for and undermines the protection of human health statewide. *Id.* ¶¶ 73–74.

CONCLUSION

Petitioners' expert testimony will show that for each of the Remaining Issues, DEQ employed a technique that deviates from what the Air Rules require, and that using each technique results in a greater health risk than the Air Rules intended.

DATED: October 11, 2024

Respectfully submitted,

s/ *Julia S. Thrower*
Julia S. Thrower
Attorney for Save the South Fork Salmon

s/ *Bryan Hurlbutt*
Bryan Hulbutt
Attorney for the Nez Perce Tribe and the Idaho Conservation League

CERTIFICATE OF SERVICE

I hereby certify that on October 11, 2024, a true and correct copy of the foregoing PETITIONERS' PRE-HEARING STATEMENT was served on the following by electronic service:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov

Dylan V. Lawrence
Hearing Officer
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com

Paula Wilson
Hearing Coordinator
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, ID 83706
paula.wilson@deq.idaho.gov

Michael A. Short
Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
michael.short@deq.idaho.gov
hannah.young@deq.idaho.gov

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
ann.yribar@ag.idaho.gov

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd., Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com

s/ *Julia Thrower*
Julia S. Thrower

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
Nicole C. Hancock, ISB No. 6899
nicole.hancock@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Intervenor-Respondent Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047, NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent. and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	AGENCY CASE No. 0101-22-01 OAH Case No. 23-245-01 **MOTION TO STRIKE EXPERT DECLARATIONS OF WILLIAM TIEDEMANN AND IAN H. VON LINDERN**

INTRODUCTION

Intervenor-Respondent Perpetua Resources Idaho, Inc. ("Perpetua") moves to strike paragraphs and sentences from the Declaration of William Tiedemann ("Tiedemann Declaration") and the Declaration of Ian H. von Lindern ("von Lindern Declaration"), and the related exhibits attached thereto. The specific language Perpetua seeks to strike is identified in the tables attached to this motion as Exhibits A and B.

Perpetua moves to strike these paragraphs, sentences, and exhibits because (I) they constitute conclusory statements and legal opinions and (II) they present and rely on evidence that is irrelevant, unauthenticated, and constitutes hearsay. As a result, nearly all of the Tiedemann Declaration and significant sections of the von Lindern Declaration are inadmissible under the Idaho Rules of Administrative Procedure ("IDAPA Rules"). The Hearing Officer must strike the identified sentences, paragraphs, and corresponding exhibits from the record. Perpetua makes this motion on the grounds and authorities below.

Perpetua files this motion to preserve, for the record, its objections to the Tiedemann Declaration and von Lindern Declaration. Perpetua does not oppose the Hearing Officer taking this motion under advisement and allowing Petitioners to respond to the motion on the same schedule already set for post-hearing statements, if the Hearing Officer deems it necessary.

To the extent that the Hearing Officer does not strike the identified testimony, the Hearing Officer should provide Perpetua with the opportunity to file an overlength post-hearing statement, if necessary, to address the many conclusions and legal opinions in the Tiedemann and von Lindern Declarations which constitute legal arguments that cannot be appropriately addressed at a hearing.

ARGUMENT

I. The Tiedemann and von Lindern Declarations are Replete with Conclusions and Legal Opinions that are Inadmissible.

Under IDAPA Rule 485, "[e]xpert testimony that is conclusory, offers legal opinions, or which is based solely upon hearsay, is inadmissible." IDAPA 62.01.01.485. Idaho courts similarly exclude expert opinions that are "speculative, conclusory, or unsubstantiated by facts in the record." *Ryan v. Beisner*, 123 Idaho 42, 46 (Ct. App. 1992) (applying the Idaho Rules of Evidence or "I.R.E."). An expert witness's testimony offers an impermissible legal conclusion when it invades the role of the reviewing authority—here, the Hearing Officer—to determine the applicable law. *See Ybarra v. Legis. of Idaho*, 166 Idaho 902, 908 (2020).

While factual materials from a non-attorney witness may be helpful, "the legal analysis of a non-lawyer, expert witness is not." *Id.* Indeed, "the problem with testimony containing a legal conclusion is in conveying the witness's unexpressed, and perhaps erroneous, legal standards to the [factfinder]" which "invades the [Hearing Officer's] province…to determine the applicable law." *Ballard v. Kerr*, 160 Idaho 674, 694 (2016) (internal punctuation omitted) (citing *Torres v. Cty. of Oakland*, 758 F.2d 147, 150 (6th Cir. 1985)).

Despite this clear prohibition on conclusions and legal opinions in expert testimony, the Tiedemann and von Lindern Declarations are replete with both. Mr. Tiedemann repeatedly provides his own legal interpretations of the Idaho air permitting rules, expressly provides "conclusions" on legal questions before the Hearing Officer,[1] and attempts to support his conclusions by interpreting the legal significance of unsubstantiated documents that preceded the

[1] *See, e.g.,* Tiedemann Dec. at 4, ¶ 10 (Mr. Tiedemann states that "[b]ased on my review of case materials and extensive CAA permitting and compliance experience in private practice, with the State of Idaho, and with a non-profit organization, I conclude as follows" before providing legal conclusions on the issues before the Hearing Officer).

promulgation of the regulations at issue. Indeed, the Tiedemann Declaration reads more like a legal brief than an expert declaration.

Similarly, the von Lindern Declaration includes Mr. von Lindern's statements that he agrees with specific legal conclusions made the Idaho Board of Environmental Quality ("BEQ") as well as legal conclusions in testimony made by a BEQ member. *See, e.g.,* von Lindern Dec. at 6, ¶¶ 15-16. Additionally, the von Lindern Declaration repeatedly characterizes DEQ's application of the Idaho air permitting rules as "misinterpretation" and "arbitrary," *see, e.g., id.* at 8, ¶ 19; *id.* at 28, ¶ 66, while referring to Petitioners' preferred interpretation of the rules as the "proper implementation" and "proper application," *see, e.g., id.* at 19, ¶ 45; *id.* at 33, ¶ 77.

Such content is wholly inappropriate for expert declarations and is inadmissible in this case under IDAPA Rule 485. Mr. Tiedemann and Mr. von Lindern are not attorneys or legal experts, yet they present erroneous legal interpretations throughout their Declarations that invade the Hearing Officer's role to make conclusions of law. *See* IDAPA 62.01.01.252.01(d) (authorizing presiding officers to make "findings of fact" and "conclusions of law"). As a result, the Hearing Officer should strike the paragraphs, sentences, and language of the Tiedemann and von Lindern Declarations identified in Exhibits A and B, respectively.

II. The Tiedemann Declaration Inappropriately Presents and Relies on Evidence that is Irrelevant, Unauthenticated, and Constitutes Hearsay.

The Hearing Officer may exclude evidence that is "irrelevant, unduly repetitious, or excludable on constitutional or statutory grounds." Idaho Code § 67-5251; IDAPA 62.01.01.475. Additionally, IDAPA Rule 476 provides that the Hearing Officer is "entitled to weigh the quality of the evidence presented, including the credibility of witnesses." IDAPA 62.01.01.476. While the Hearing Officer is not bound by the I.R.E., the Hearing Officer "may

assign less weight to evidence that would otherwise be inadmissible under the Idaho Rules of Evidence." *Id.* Thus, the I.R.E. inform the Hearing Officer's decisions on this motion.

Under the I.R.E., evidence is admissible only if it is relevant and authenticated. I.R.E. 401, 901; *Med. Recovery Servs., Ltd. Liab. Co. v. Eddins*, No. 47848, 2021 Ida. LEXIS 126, at *18 (July 9, 2021). Evidence is relevant when "it has any tendency to make a fact more or less probable than it would be without the evidence" and "the fact is of consequence in determining the action." I.R.E. 401. However, to authenticate evidence, "the proponent must produce evidence sufficient to support a finding that the item is what the proponent claims it is." I.R.E. 901(a); *see Eddins*, 2021 Ida. LEXIS 126, at *18 (quoting I.R.E. 901(b)(1) and explaining that authentication of a writing may be made by a witness with knowledge that "an item is what it is claimed to be"). The Hearing Officer may give less credence to evidence that does not meet the above I.R.E. criteria. IDAPA 62.01.01.476.

Additionally, "hearsay" is inadmissible under the I.R.E. unless it qualifies for an exception. I.R.E. 802. "Hearsay" is an out of court statement offered as evidence to "prove the truth of the matter asserted." I.R.E. 801(c). Although the Hearing Officer is not bound by hearsay rules of evidence generally, when expert testimony is based solely on hearsay statements, it is inadmissible. IDAPA 62.01.01.485.

The Tiedemann Declaration presents and relies heavily on irrelevant evidence that Mr. Tiedemann fails to authenticate. *See Eddins*, 2021 Ida. LEXIS 126, at *18. Mr. Tiedemann cherry-picks thirty-year-old informal emails, stakeholder letters, and draft documents from Idaho Department of Environmental Quality ("DEQ") archives and labels them as definitive evidence of the BEQ's rulemaking intent. Mr. Tiedemann claims that these documents are part of the historical rulemaking record for regulatory provisions at issue in this case and repeatedly relies

on these documents to support his erroneous, unreliable, and inadmissible legal conclusions. *See, e.g.*, Tiedemann Dec. at 6-9, ¶ 14.

These documents are irrelevant because Mr. Tiedemann did not establish that they were part of the actual rulemaking record that is appropriate for the Hearing Officer to consider when interpreting the BEQ's intent in adopting the rules at issue.[2] Indeed, Mr. Tiedemann and the Petitioners fail to offer any evidence to authenticate these documents as part of the rulemaking record. Although the documents might be included in state archives, draft documents and informal emails regarding internal DEQ deliberations do not illustrate either DEQ's or BEQ's final policy or intent concerning how the rules should be applied or interpreted.[3]

---

[2] If the meaning of a statute or regulation is ambiguous after analyzing its plain language and employing traditional methods of interpretation, courts review administrative history but do not consider draft documents and unpublished, informal communications that fail to illustrate the final intent of the statute or regulation. For instance, Idaho courts have held that the opinions and beliefs of one legislator, even one who drafted a bill, cannot establish the entire Legislature's intent. *Gillihan v. Gump*, 140 Idaho 264, 268, 92 P.3d 514, 518 (2004) *abrogated on other grounds by Gonzalez v. Thacker*, 148 Idaho 879, 231 P.3d 524 (2009). The same is true here—the communications of individual DEQ employees and a Deputy Attorney General, employed by the Office of the Attorney General, do not represent the intent of DEQ and BEQ.

Federal courts counsel against "considering wide ranging materials associated with the development of regulations" and give little to no weight to unpublished items that constitute a "hodgepodge of meeting minutes, staffers' notes, draft regulations, reports hearings and technical papers, many of which are anonymous." *Sikorsky Aircraft Corp. v. United States*, 102 Fed. Cl. 38, 55 (2011); *Perry v. Martin Marietta Corp.*, 47 F.3d 1134 (Fed. Cir. 1995)). This approach is consistent with the U.S. Supreme Court's explanation of the types of documents that represent an agency's policy positions and interpretations for purposes of deference. *Kisor v. Wilkie*, 588 U.S. 558, 577, 139 S. Ct. 2400, 2416-17 (2019) ("In other words, [an interpretation] must be the agency's 'authoritative' or 'official position,' rather than any more ad hoc statement not reflecting the agency's views. . . Not everything the agency does comes from, or is even in the name of, [the agency head]. So, for example, we have deferred to 'official staff memoranda' that were 'published in the Federal Register,' even though never approved by the agency head. But there are limits. The interpretation must at the least emanate from those actors, using those vehicles, understood to make authoritative policy in the relevant context.") (internal citations omitted).

[3] The petitioners have offered no certification or authentication confirming that the source of these materials is from the state archives.

Notably, the Tiedemann Declaration includes a long block quotation of an email from an Idaho Deputy Attorney General to DEQ without providing any response from DEQ. Tiedemann Dec. at 8, ¶ 19. The content of this email is irrelevant on its face because, without a response from DEQ, it provides no insight into DEQ's rulemaking process or the correct interpretation of the regulations at issue. Even with the response, it would be inadmissible. However, this highlights the prejudice that would result from considering such incomplete and unreliable information.

Additionally, the Tiedemann Declaration quotes and heavily relies on an "undated" draft letter for which Mr. Tiedemann merely *presumes* the identity of the author and the recipient. Tiedemann Dec. at 11, ¶ 27 (quoting "[a] undated TAPs rulemaking concept letter" which Mr. Tiedemann claims is "addressed to a 'Robert' (presumably Robert Wilkoz) and presumably from another DEQ staffer"). By failing to identify the date of the letter and merely assuming the identity of the involved parties, Mr. Tiedemann failed to produce evidence sufficient to support a finding that the letter is what Mr. Tiedemann claims it is. Accordingly, Mr. Tiedemann and the Petitioners have failed to authenticate this letter.

Moreover, the statements that Mr. Tiedemann references from this undated draft letter constitute hearsay because the statements were not made by Mr. Tiedemann and are offered to "prove the truth of the matter asserted." *See* I.R.E. 801. While the I.R.E. includes a hearsay exception for certain types of public records, the exception does not apply when an opponent shows "that the source of information or other circumstances indicate a lack of trustworthiness." I.R.E. 801(8). Without any information to confirm the date of this draft letter or the parties involved, or full context of the comment in light of responses and other information that was available at the time, the draft letter is not trustworthy and constitutes hearsay.

As the draft documents and informal communications that the Tiedemann Declaration relies upon constitute irrelevant, unauthenticated, and hearsay evidence under the I.R.E., the Hearing Officer should strike these documents or, at a minimum, afford them no weight under IDAPA Rule 476. Perpetua reserves the right to raise further objections to Mr. Tiedemann's testimony, including whether he is qualified to provide expert opinion on the Idaho air permitting rules or related rulemaking history.

CONCLUSION

The Hearing Officer should strike from the Tiedemann Declaration the following: paragraphs 10.a, 10.b., 10.c., 10.d.; 14; paragraphs 17 through 24[4]; 26 through 30[5]; 32; 34; 36 through 39; 40; 43 through 47; 49 through 50; section headers A, B, C, and D; and all referenced exhibits (Exhibits A, B, C, D, E, and F). The Hearing Officer should strike from the von Lindern Declaration the following: paragraphs 15.a through 15.d, 16, 18, 19, 51, 52, 60, 68, 71, and 96; certain language in paragraphs 26, 29, 36, 37, 45, 50, 55, 58, 61, 65, 66, 67, 72, 77, and 80; section headers A, C, E; and the titles of Figures 1, 3, 5a, 5b. If the Hearing Officer decides that portions of the declaration or exhibits should not be stricken, Perpetua respectfully requests that, where applicable, the Hearing Officer consider this evidence with less weight and provide Perpetua with an opportunity to brief these matters as a matter of due process.[6]

[4] The Tiedemann Declaration does not contain a Paragraph 23.

[5] The Tiedemann Declaration includes two Paragraph 27s. Perpetua seeks to strike both. Also, the Tiedemann Declaration includes paragraph A.9. after paragraph A.28. Perpetua assumes that Petitioners intended this to be paragraph "29."

[6] *Cf. Cowan v. Bd. of Comm'rs*, 143 Idaho 501, 512 (2006) (discussing procedural due process requirement that a defendant be given an opportunity respond and be heard).

DATED: October 14, 2024

STOEL RIVES LLP

By: /s/ Nicole Hancock
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole C. Hancock

Attorneys for Intervenor-Respondent Perpetua Resources Idaho, Inc.

CERTIFICATE OF SERVICE

I HEREBY CERTIFY that on the 14th day of October 2024, I caused a true and correct copy of this Motion to Strike to be served on the following persons:

Via Email to:

Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, Idaho 83706-1255
paula.wilson@deq.idaho.gov

Hannah M.C. Young
Michael Short
Deputy Attorney General
Idaho Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
michael.short@deq.idaho.gov

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, Idaho 83720-0010
Ann.yribar@ag.idaho.gov

Dylan Lawrence, Hearing Officer
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
Located at 350 N 9th St., Ste. 300
Filings@oah.idaho.gov

Bryan Hurlbutt
Laird J. Lucas
Advocates for the West
P.O. Box 1612
Boise, Idaho 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for the Nez Perce Tribe and Idaho Conservation League

Julia Thrower
Mountain Top Law, PLLC
614 Thompson Ave.
McCall, Idaho 83638
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

/s/ Wade C. Foster
Wade C. Foster

EXHIBIT A

Language to Strike in the Tiedemann Declaration

Paragraph or Section Header	Language to Strike	Justification to Strike
¶ 10.a	Based on my review of case materials and extensive CAA permitting and compliance experience in private practice, with the State of Idaho, and with a non-profit organization, I conclude as follows: DEQ's application of the 16/70 Project-specific adjustment factor to the ambient arsenic air concentration analysis, and the use of exposure duration adjustments like the 16/70 calculations is not supported by the historic TAPs rulemaking record. It was thus inappropriate for DEQ to use such an adjustment factor to demonstrate compliance with the Air Rules.	Presents legal opinion and conclusory statement in violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis in violation of Rule 485. Testimony relies solely on unreliable, unauthenticated hearsay evidence in violation of Rule 485.
¶ 10.b	Based on my review of case materials and extensive CAA permitting and compliance experience in private practice, with the State of Idaho, and with a non-profit organization, I conclude as follows: DEQ's interpretation of the TAPs AACCs as averaging periods rather than enforceable "standards" is misplaced and is not supported by the historic TAPs rulemaking record;	Presents legal opinion in violation and conclusory statement of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis in violation of Rule 485.

Paragraph or Section Header	Language to Strike	Justification to Strike
		Testimony relies solely on unreliable, unauthenticated hearsay evidence in violation of Rule 485.
¶ 10.c	Based on my review of case materials and extensive CAA permitting and compliance experience in private practice, with the State of Idaho, and with a non-profit organization, I conclude as follows: DEQ use of a 5-year rolling average for TAPs emission calculations is neither supported by the TAPs rule, the historic TAPs rulemaking record, nor by limitations under the Permit conditions;	Presents legal opinion and conclusory statement in violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis in violation of Rule 485. Testimony relies solely on unreliable, unauthenticated hearsay evidence in violation of Rule 485.
¶ 10.d	Based on my review of case materials and extensive CAA permitting and compliance experience in private practice, with the State of Idaho, and with a non-profit organization, I conclude as follows: There was sufficient evidence to support the T-RACT analysis limiting the non-West End pit lifetime production limit, but West End Pit production is not properly constrained below the less than life-of-mine time frame.	Presents legal opinion in violation of Rule 485.

Paragraph or Section Header	Language to Strike	Justification to Strike
Section Header A	Application of the 16/70 Project-specific adjustment factor for assessing compliance with the TAPs rule is inconsistent with the rulemaking history, intent, and plain language of the TAPs rule.	Presents legal opinion in violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis in violation of Rule 485. Testimony relies solely on unreliable, unauthenticated hearsay evidence in violation of Rule 485.
¶ 14	Based on my review of the historical records related to the development of the TAPs Rule, it is evident that the AACCs were developed as annual emission limits, with the intent that compliance is demonstrated on a year-over-year basis. The records demonstrate that the use of an exposure duration adjustment, like the 16/70 Project-specific adjustment factor used for the SGP, was directly considered by DEQ, and ultimately rejected. If implemented, using project-specific adjustment factors would create a permitting protocol that is antithetical to the intended protections of the TAPs Rule, the AACCs, and annual, year-over-year limits. My own personal experience working as a Permitting Engineer for DEQ, the Air Rules themselves, the historical TAPs Rule rulemaking record, and greater context of U.S. Environmental Protection Agency (EPA) guidance all support this conclusion.	Presents legal opinion in violation of Rule 485. Provides legal opinion or analysis in violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis in violation of Rule 485. Testimony relies solely on unreliable, unauthenticated hearsay evidence in

Paragraph or Section Header	Language to Strike	Justification to Strike
		violation of Rule 485.
¶ 17	The Air Rules themselves and the historical TAPs rulemaking record reinforce my personal experience with TAPs compliance and demonstrate that, in its original TAPs rulemaking process, DEQ directly considered, but ultimately rejected, concepts like the 16/70 Project-specific adjustment factor and exposure duration adjustments generally, except for sources expected to operate for less than 5 years.	Presents legal opinion in violation of Rule 485.
¶ 18	In an August 13, 1992 letter from DEQ's Mr. Frank Wilkoz to Ms. Joan Cloonan, Idaho Association of Commerce and Industry, Mr. Wilkoz provided a first draft of the original TAPs rules for review while adding context within a "Explanation of Additions and Changes" section. Mr. Wilkoz served as DEQ's Technical Services Bureau Chief and was heavily involved in the development of the original TAPs rulemaking and subsequent modification while Ms. Cloonan served as an industry stakeholder and provided input to the process. Mr. Wilkoz's "Explanation of Additions and Changes" section provides insight to how DEQ intended to permit remediation and short term sources. Most significantly Mr. Wilkoz writes: However, a remediation source cannot be allowed to produce emissions that have the potential to expose human receptors to a full lifetime dose of a TAP over a short period of time, especially a carcinogen, even in the interest of environmental clean up. Further, a single very large dose of a carcinogen, while not a full lifetime dose, has the potential to cause toxics related cancers due to the nature of dose response interaction of carcinogens at the cellular level. To allow such doses would subvert the very purpose of a clean up. **Corresponds to Exhibit A.**	Petitioners have not demonstrated reliability of historical records, therefore testimony relies on unreliable, unauthenticated information. 1992 email is hearsay. Remainder of paragraph A.18 after the first sentence relies solely on hearsay in violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis in violation of Rule 485.
¶ 19	In an email dated August 14, 1992, Idaho Deputy Attorney General Curt Fransen emailed DEQ's Mr. Tim Teater and Mr. Frank Wilkoz directly raising these questions regarding large-dose short-term exposures.4 During the TAPs rulemaking period, Mr. Teater served as an Air Quality	Petitioners have not demonstrated reliability of historical records, therefore testimony

Paragraph or Section Header	Language to Strike	Justification to Strike
	Toxicologist and was also heavily involved in the development of the original TAPs rulemaking and subsequent modifications. In his email, Mr. Fransen questions: 16.01.01012,13.g.iii. and iv. The standard for remediation sources raises some questions of a general nature. I don't have any answers but wonder if it makes scientific sense to directly convert risk of additional cancer based on lifetime exposure to risk of additional cancer based on less than lifetime exposure by assuming a directly proportional relationship between years of exposure and risk. Sorry that I can't properly express that but you probably get the drift. Other questions that seem to arise from simply allowing higher exposure where the length of exposure is shorter include the unknown or potential combined and synergistic effect of many short term or remediation sources or other sources in the same area and the potential of serial (one after another) short term or remediation sources. Lastly, how will the operational life of a source be determined. What if an applicant says they only intend to operate for five years (for whatever reason) so want the higher emission number to apply. There is incentive for facilities to argue they will be short-term. The spectre of serial short-term sources arises. Perhaps the definition can be clarified so there is less wiggle room. **Corresponds to Exhibit B.**	relies on unreliable, unauthenticated information. 1992 email is hearsay. Testimony in paragraph A.19 relies solely on hearsay in violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis in violation of Rule 485.
¶ 20	In a later and related email sent from Mr. Teater to Mr. Wilkosz on August, 26, 1992,6 Mr. Teater states: We will need to talk about the environmental remediation source limit of five years to get a break on emissions. I am opposed to making that greater than five years. It seems that after five years most remediation sources would have emission BRC (Below Regulatory Concern) anyway. If not then they need to be treated as any other source. **Corresponds to Exhibit C.**	Petitioners have not demonstrated reliability of historical records, therefore testimony relies on unreliable, unauthenticated information. 1992 email is hearsay and relies solely on hearsay in violation of Rule 485.

Paragraph or Section Header	Language to Strike	Justification to Strike
		Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis in violation of Rule 485. Testimony relies solely hearsay evidence in violation of Rule 485.
¶ 21	A further review of the historical TAPs rulemaking record provides support for treating the AACC as annual, year-over-years limit rather than supporting the use of unique operational scenarios and exposure duration adjustments.	Presents legal opinion in violation of Rule 485. Petitioners have not demonstrated reliability of historical records, therefore testimony relies on unreliable, unauthenticated information.
¶ 22	Regardless, and more importantly, the only less-than-lifetime exposure duration adjustment DEQ ultimately included within the original TAPs rule (or any subsequent versions) was the less than 5-yaer, ten-fold adjustment factor currently contained under IDAPA 58.01.01.210.15.	Presents legal opinion in violation of Rule 485.
¶ 24	Said another way, there is a high concentration dose of arsenic received over a short duration that is equivalent in risk to some corresponding low concentration dose of arsenic received over a longer duration. This is the underlying assumption that DEQ relies on when it applied the 16/70 Project-specific adjustment factor to assessing TAPs compliance for the SGP Permit.	Presents legal opinion and conclusory statement in violation of Rule 485.

Paragraph or Section Header	Language to Strike	Justification to Strike
¶ 26	Furthermore, the historical TAPs rulemaking record shows DEQ specifically rejected previously existing EPA Superfund risk assessment guidance and its use of exposure duration adjustments in consideration of risk and TAP exposure. The following documents confirm this conclusion.	Presents legal opinion and conclusory statement in violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis in violation of Rule 485.
¶ 27	A undated TAPs rulemaking concept letter(herein referred to as the TAPs Concept Letter) addressed to a "Robert" (presumably Robert Wilkoz) and presumably from another DEQ staffer outlines the rationale behind changes within a modified draft TAPs rule. Within the letter it is stated: We also do not accept the EPA superfund risk assessment guidelines. Superfund guidelines are based on the concept that the exposures are of limited duration and do not have a large potential for multiple exposures. We can not make those assumptions for sources in Idaho, many of which involve either long term exposures or exposures to substances with a potential for multiple exposures. In Idaho, we are attempting to protect the public from the deleterious effect of multiple sources of a given pollutant or the additive effects of multiple pollutants over the course of a 70 year lifetime. If we could assure only a single exposure occupance, then accepting higher temporary risk might be justifiable. In addition we must consider the effects of the pollutant on the elderly, the very young and the infirm. By using "worse case" assumptions we are then able, under very limited conditions and when the public health would not be compromised, to deviate from the one in a million standard and apply a one in one hundred thousand as noted in the NSR policy. The use of this conservative approach allows us	Petitioners have not demonstrated reliability of historical records, therefore testimony relies on unreliable, unauthenticated information. Undated concept letter is hearsay and this testimony relies solely on hearsay in violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis in violation of Rule 485.

Paragraph or Section Header	Language to Strike	Justification to Strike
	to be sure that actual risk is no greater than the risk figure on which we base our policy. **Corresponds to Exhibit D.**	
¶ 27	A January 23, 1992 unsigned draft letter to Mr. Charles Woods, Marketing Manager for MDT Corporation13 (a presumed TAPs rulemaking industry stakeholder) from a DEQ staffer (presumably Mr. Wilkoz) states: Our policy is based on a 1:1,000,000 risk at the nearest public access to the source. Risk is computed by multiplying the predicted (by the model) ambient concentration by the unit risk factor (URF) as published by the US EPA. Idaho does not accept the Superfund risk assessment method for computing risk except for single, relatively short term exposures. Our risk assessment for continuous industrial or other large sources is based on the possibility of multiple, long term exposures. **Corresponds to Exhibit E.**	Petitioners have not demonstrated reliability of historical records, therefore testimony relies on unreliable, unauthenticated information. Undated concept letter is hearsay and this testimony relies solely on hearsay in violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis in violation of Rule 485.
¶ 28	A TAPs rule that allows for exposure duration adjustments and a risk assessment approach creates a problematic precedent, as is made evident by the following hypothetical scenario. If the SGP (or any subsequent source) is allowed to operate using exposure duration adjustments, an adjacent receptor (i.e., a human being) would be exposed to more than the intended annual allowable concentration of arsenic (the AACC) for 16 years. If, before the SGP operations end, the receptor moves and lives or works next to another facility or a new facility starts operations next to the SGP that applies an exposure duration adjustment for TAPs compliance (a process which could repeat indefinitely), by the end of the receptor's lifetime, it has been exposed to a TAPs concentration over the AACC for its entire life and its lifetime risk exceeds the intended 1-in-100,000 cancer risk	Presents legal opinion in violation of Rule 485. Third sentence is testimony made relying solely on hearsay email which must be excluded under Rule 485.

Paragraph or Section Header	Language to Strike	Justification to Strike
	level. In this scenario, the "spectre of serial short-term sources," as feared by Mr. Fransen in his email is apparent. Allowing the SGP to use the 16/70 Project-specific adjustment factor opens the door to a world in which the current AACCs in the TAPs Rule are effectively replaced by higher concentrations due to shorter than 70-year sources.	
¶ 9	Contrast a hypothetical scenario where exposure duration adjustments are not allowed and the TAP AACCs are annual limits that must be met year-over-year by every facility in Idaho. In this case, no facility may emit TAPs at a concentration greater than the AACCs and a 1-in-100,000 excess cancer risk is preserved no matter where a receptor lives, works, or travels in Idaho during their entire life, and no matter what other facilities start operations. This scenario creates a simple and easy to implement rule that is broadly protective of human health and the environment and, as the Schilling Declaration itself notes, was the intent of the originally TAP rulemaking process. Furthermore, this scenario is supported by the historical TAPs rulemaking record and best fits the intent of DEQ.	Presents legal opinion in violation of Rule 485. For last sentence specifically, Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis.
¶ 30.a	Given the full review of the above evidence and based on my experience as a Permit Engineer at DEQ, I conclude as follows: During the TAPs rulemaking process, DEQ specifically considered the use of exposure duration adjustments and use of calculations akin to the 16/70 Project-specific adjustment factor, but ultimately did not incorporate their use within the TAPs rules;	Presents legal opinion and conclusory statement in violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis.
¶ 30.b	Given the full review of the above evidence and based on my experience as a Permit Engineer at DEQ, I conclude as follows: DEQ intended the AACCs to be annual, year-over-year concentration limits and included only a single short-term adjustment factor within the original TAPs rule for sources operating for 5-years or less;	Presents legal opinion and conclusory statement in violation of Rule 485.

Paragraph or Section Header	Language to Strike	Justification to Strike
		Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis.
¶ 30.c	Given the full review of the above evidence and based on my experience as a Permit Engineer at DEQ, I conclude as follows: DEQ's application of the 16/70 Project-specific adjustment factor to demonstrate compliance with TAPs is not supported by the intent or language of the TAPs rule, and results in a degradation of the protection of human health and the environment that is otherwise the purpose of the TAPs rule.	Presents legal opinion and conclusory statement in violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis.
Section Header B	DEQ and Perpetua incorrectly assume the 1-in-100,000 cancer risk rate, rather than the AACC, is the applicable enforceable "standard."	Presents legal opinion in violation of Rule 485.
¶ 32	Labeling AACCs as "increments" versus "standards" is simply a naming convention rooted in previously existing CAA policy; the enforceable standard is the AACC as a year-over-year limit.	Presents legal opinion in violation of Rule 485.
¶ 34	The AACCs as "increments" are different in that they do not consider background concentrations of TAPs. Unlike Criteria Pollutants, DEQ does not regularly monitor the ambient concentrations of TAPs. There simply are too many TAPs (there are over 80 carcinogenic TAPs alone listed in IDAPA 58.01.01.586), they are state-specific (unlike Criteria Pollutants), and the cost to do so is generally accepted as prohibitive. Thus, during the historic TAPs rulemaking process the AACCs were implemented as "increments" versus "standards." Said another way, while it is infeasible to monitor and enforce an ultimate TAPs concentration standard, it is feasible to estimate the incremental increase in TAPs concentrations that a facility would cause.	Presents legal opinion in violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis.

Paragraph or Section Header	Language to Strike	Justification to Strike
¶ 36	Both the TAPs AACCs and PSD increments are maximum allowable increases from a specific source. In developing the TAPs Rules, DEQ would have certainly been aware of the concept and naming convention of "increments." The TAPs definition of increments is best viewed through the lens of a compliance period, rather than implying they represent an averaging period, as the Lewis Declaration does.	Presents legal opinion in violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis.
¶ 37	Evidence from the historical TAPs rulemaking record reinforces this and the conclusion that the use of the term "increment" within TAPs was to differentiate them from including background concentrations as "standards" do. During the 1995 period, DEQ made revisions to the original and previously promulgated TAPs rule. As part of that process, DEQ developed a TAPs rule amendment summary document.23 Within that document DEQ notes: The proposed rule will divide consideration of incremental increases of TAP emissions into individual source and facility wide categories. Net emissions is a concept that adds increases and decreases of emissions from new sources of TAP together to obtain a net amount. That net amount is then compared to acceptable ambient levels also called increments for a permitting decision. The acceptable ambient level is referred to as an increment because TAP emissions increases are limited to an incremental increase as opposed to an absolute limited ambient concentration. **Corresponds to Exhibit F.**	Presents legal opinion and conclusory statement violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis. Petitioners have not demonstrated reliability of historical records, therefore testimony relies on unreliable, unauthenticated information.
¶ 38	On the other hand, if you assume DEQ intended the 1-in-100,000 cancer risk to be the enforceable standard and not the AACC as annual, year-over-year limits, it would have needed to incorporate additional variables into the TAPs Rule to guide applicants on how to assess that risk. Completing a risk assessment that analyzes a facility's excess cancer risk traditionally involves consideration of more variables and factors than just exposure duration.	Presents legal opinion in violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the

Paragraph or Section Header	Language to Strike	Justification to Strike
	Sensitive populations, comorbidities, and synergistic effects of combined toxic exposure all affect the ultimate cancer risk from a facility's airborne toxic emissions. However, as mentioned above, the original TAPs rulemaking process rejected the risk assessment method and prioritized creating a simple and easy to implement rule that is still protective of human health and the environment. Ultimately, using the AACCs as the "enforceable standard" is a far more effective standard to use in fulfilling this goal.	rulemaking analysis. Petitioners have not demonstrated reliability of historical records, therefore testimony relies on unreliable, unauthenticated information.
¶ 39.a	Given the full review of the above evidence, I conclude as follows: The labeling of the AACCs as "increments" versus "standards" is a naming convention rooted in previously existing CAA policy and is a distinction in the consideration of pollutant background concentrations rather than an averaging period concept.	Presents legal opinion and conclusory statement in violation of Rule 485.
¶ 39.b	Given the full review of the above evidence, I conclude as follows: DEQ intended the enforceable "standard" to be the AACC as an annual, year-over-year limit.	Presents legal opinion and conclusory statement in violation of Rule 485.
Section Header C	Use of a 5-year rolling average for demonstrating compliance with the TAPs ruleT-RACT is inappropriate and not supported by Permit conditions.	Presents legal opinion in violation of Rule 485.
¶ 40	Use of a 5-year rolling average for demonstrating compliance with the TAPs ruleT-RACT is inappropriate and not supported by Permit conditions.	Presents legal opinion in violation of Rule 485.
¶ 43	This outcome creates a problematic precedent as is evident by another hypothetical scenario. Consider again the "spectre of serial short-term sources" and the scenario in which a receptor is exposed to consecutive sources that have applied an exposure duration adjustments discussed above in Paragraph 28. In a modified scenario, the receptor is adjacent to the SGP for four years of high TAPs emissions, but then relocates adjacent to a different TAPs source before a fifth year of low SGP TAP emissions occurs. The new	Presents legal and analysis opinion in violation of Rule 485. Second sentence relies solely on hearsay in violation of Rule 485.

Paragraph or Section Header	Language to Strike	Justification to Strike
	TAPs source is also a less than 70-year source using exposure duration adjustments with TAPs concentrations above the AACCs. The receptor will be consistently exposed to TAPs concentration potentially well over the AACC, and is accruing an excess cancer risk level above 1-in-100,000. Again, the AACCs are effectively replaced by higher concentrations due to less than 70-year sources using exposure duration adjustment factors and/or emission period averaging.	
¶ 44	In order to avoid such a scenario, the Air Rules and the historical TAPs rulemaking record speak for themselves.	Presents legal opinion in violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis.
¶ 45.a	Given the full review of the above evidence, I conclude as follows: Calculation of the SGP's arsenic emissions by using a 5-year rolling average is contrary to the intent of the original TAPs rulemaking process and the Air Rules stating that the AACC are an annual, year-over-year limit	Presents legal opinion and conclusory statement in violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis.
¶ 45.b	Given the full review of the above evidence, I conclude as follows: Using a 5-year rolling average inappropriately allows individual years of excess TAPs emissions to be masked within an averaged period.	Presents legal opinion and conclusory statement in violation of Rule 485.

Paragraph or Section Header	Language to Strike	Justification to Strike
		Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis.
Section Header D	There is insufficient evidence to support the T-RACT analysis limiting the non-West End pit production limit.	Presents legal opinion in violation of Rule 485.
¶ 46	However, Board was right in question whether the production from all pits was properly constrained.	Presents conclusory statement and legal opinion in violation of Rule 485.
¶ 47	The AACCs are limits for which compliance must be demonstrate on an annual year-over-year basis.	Presents legal opinion in violation of Rule 485.
¶ 49	In order to comply with the AACCs and demonstrate TAPs compliance, DEQ should have: (1) determined the worst arsenic generation scenario from any single year of the SGP (likely to include 100% production from the West End Pit); (2) compared the modeled operation boundary arsenic concentration from the worst generation scenario to the AACC to evaluate TAPs compliance; and (3) include a maximum annual ore generation permit limit from the pit(s) that correspond to the worst arsenic generation to ensure TAPs compliance.	Presents legal analysis and opinion in violation of Rule 485.
¶ 50.a	Given the full review of the above evidence, I conclude as follows: a. DEQ did not appropriately analyze the maximum annual emissions scenario from the SGP and instead diluted the SGP'd arsenic emissions through the 5-year rolling average calculation.	Presents legal opinion and conclusory statement in violation of Rule 485.
¶ 50.b	Given the full review of the above evidence, I conclude as follows: The permit does not sufficiently constrain ore production from the SGP's pit(s) on an annual basis.	Presents legal opinion and conclusory statement in violation of Rule 485.

EXHIBIT B

Language to Strike in the von Lindern Declaration

Paragraph or Section Header	Language to Strike	Justification to Strike
¶ 15.a	I have reviewed Idaho Board of Environmental Quality's Final Order and understand and agree with the Board's conclusions that: DEQ Did Not Act Reasonably and in Accordance with Law When it Analyzed the Ambient Arsenic Air Concentrations for the SGP;	Presents legal opinion and conclusory statement in violation of Rule 485.
¶ 15.b	I have reviewed Idaho Board of Environmental Quality's Final Order and understand and agree with the Board's conclusions that: DEQ did not Act Reasonably in Using a Five-Year Rolling Average for T-RACT that was not Properly Supported by Permit Conditions;	Presents legal opinion and conclusory statement in violation of Rule 485.
¶ 15.c	I have reviewed Idaho Board of Environmental Quality's Final Order and understand and agree with the Board's conclusions that: There was Insufficient Evidence to Support the T-RACT Analysis Limiting the Non-West End Pit Production Limit;	Presents legal opinion and conclusory statement in violation of Rule 485.
¶ 15.d	I have reviewed Idaho Board of Environmental Quality's Final Order and understand and agree with the Board's conclusions that: DEQ Did Not Act Reasonably and in Accordance with Law When it Applied the 16/70 Calculation to the Ambient Arsenic Air Concentration Analysis.	Presents legal opinion and conclusory statement in violation of Rule 485.
¶ 16	I have reviewed the transcript of the May 1, 2024 special meeting of the Idaho Board of Environmental Quality. I also concur with Vice Chair McMillan's testimony that: . . . DEQ has misinterpreted how the acceptable ambient concentration for carcinogens, the AACC, must be applied if it is to comply with our air quality rules. … DEQ's creation and application of a project-specific adjustment factor is not supported by Idaho's air quality rules.	Presents legal opinion and conclusory statement in violation of Rule 485.

Paragraph or Section Header	Language to Strike	Justification to Strike
	… the creation of a project-specific adjustment factor suggests that there is a significant ignorance about cancer, carcinogens, and carcinogenesis. … the short-sighted project-specific adjustment factor to the Stibnite Gold Project, DEQ created a misleading risk analysis that greatly underestimates the actual cancer risk	
Section Header A	DEQ's application of the 16/70 Project-specific adjustment factor is inappropriate science and public health policy.	Presents legal opinion and conclusory statement in violation of Rule 485.
¶ 18	DEQ has failed to properly implement Section 586 and T-RACT for the SGP PTC by introducing a 16/70 SGP Project-specific adjustment factor to allocate the full 70-year lifetime allowable cancer risk to the 16-year Life of Mine (LOM). The calculation averages the risk resulting from SGP emissions over the life of the receptor. This adjustment allows the SGP to emit as much as 70 years of allowable carcinogenic emissions in 16 years. This type of "adjustment factor," also known as risk amortization or cancer dose-averaging, undermines both the health protectiveness and the regulatory certainty of the TAPs rule. In the context of the existing TAPs rule, as applied the last 30 years, using the 16/70 Project-specific adjustment factor is an incorrect interpretation and represents unsound science and public health policy.	Presents legal opinion in violation and conclusory statement of Rule 485.
¶ 19	Specifically, DEQ misinterprets the purpose and function of the **maximum one-year annual average ambient air carcinogen concentration** in implementing the TAPs rule. It is important to review the development of the TAPs rule in understanding the strategy represented by this one-year annual standard. The Schilling Declaration asserts that the TAPs rule was developed nearly thirty years ago to accommodate DEQ's predecessor agency IDHW-DOE and the regulated communities' request to adopt rules that are: 1) are reasonably protective of public health, but still afford flexibility to facilities and projects; 2) are relatively easy to understand and implement; and 3) do not require excessive expenditure of time and	Presents legal opinion and conclusory statement in violation of Rule 485.

Paragraph or Section Header	Language to Strike	Justification to Strike
	resources by DEQ and the permittee during the permitting process.	
Title of Figure 1	Cumulative Risk (CR) and Margin of Safety (MOS) under Properr Implementation of TAPS Rules	Presents legal opinion and conclusory statement in violation of Rule 485.
¶ 26	If the TAPs rule is properly implemented, the cumulative incremental risk is shown by the diagonal line proceeding from birth to age 70 years (i.e., risk is allowed to accumulate at an annual rate of (1x10-5)/70 per year, or (AACC*URF/70) under T-RACT. The gray area below the diagonal line represents the portion of allowable lifetime risk accumulating from the incremental source.	Presents legal opinion in violation of Rule 485.
¶ 29	Using the 70-year basis proposed by DEQ and Perpetua allows Perpetua to emit a lifetime of allowable emissions in 16 years, and undermines the health protectiveness of the rule and increases cancer risk.	Presents legal opinion in violation of Rule 485.
¶ 36	This shortsighted conclusion is incorrect, unprecedented, and not supported by EPA guidelines.	Presents legal opinion statement in violation of Rule 485.
¶ 37	DEQ's misinterpretation would allow emissions and consequent exposures of more than two orders of magnitude greater risk than the AACC (1.2 X 10-4 equivalent risk) for six years.	Presents legal opinion in violation of Rule 485.
Title of Figure 3	Comparison of Cumulative Risk (CR) for 6-year Project emitting a Carcinogen with a Mutagenic MOA using the Project-specific (16/70) Adjustment Factor and Proper TAPS Application	Presents legal opinion and conclusory statement in violation of Rule 485.
¶ 45	Conversely, proper application of the TAPs rule using the maximum one-year annual average ambient air carcinogen concentration is shown by the lower cumulative risk line (gray line). Proper implementation of the TAPs rule would result in 4.6x10-6 cumulative cancer risk at age six years, as shown in Figure 3.	Presents legal opinion in violation of Rule 485.

Paragraph or Section Header	Language to Strike	Justification to Strike
Title of Figure 5a	Cumulative Risk (CR) and Margin of Safety (MOS) under Proper Implementation of Idaho TAPS Rules for 3 Successive 6-year Projects	Presents legal opinion in violation of Rule 485.
¶ 50	The TAPs rule is health protective if properly implemented.	Presents legal opinion in violation of Rule 485.
Title of Figure 5b	Cumulative Risk (CR) and Margin of Safety (MOS) under Proper Implementation of Idaho TAPS Rules for 3 Successive 6-yea Projects emitting Carcinogen Exhibiting a Mutagenic Mod of Action (MOA*)	Presents legal opinion in violation of Rule 485.
¶ 51	The inappropriate averaging is allegedly justified by ad hoc risk assessment calculations and risk management protocols that undermine both the simplicity and the health protectiveness of the TAPs rule. The MOS is compromised, the public is no longer secure, and the regulated industry is now obliged to include cancer risk and health impact assessments in TAPs PTC applications to support the assertions of health protectiveness.	Presents legal opinion in violation of Rule 485.
¶ 52	There are no provisions in the Air Rules to allow manipulation of the required maximum one-year annual average ambient air carcinogen concentration or the AACC, or to submit risk calculations.	Presents legal opinion in violation of Rule 485.
¶ 55	Vice Chairman McMillan further indicated that DEQ's application of what he called the "short-sighted" Project-specific adjustment factor to the Stibnite Gold Project created a misleading risk analysis that greatly underestimates the actual cancer risk. In his view: *The Idaho rules are not ambiguous*. There is an acceptable risk associated with the AACC standard. There is an acceptable risk associated with DEQ-approved T-RACT projects, and there is an acceptable risk associated with the short-term project that is five years or less. There are no other acceptable risks identified in Idaho's air quality rules. I agree with Dr. McMillan's statement. (emphasis added)	Highlighted language offers legal opinion in violation.
¶ 58	DEQ erroneously substitutes the 5-year rolling average emissions for the maximum one-year potential emissions required under Section 586 and T-RACT.	Presents legal opinion in violation of Rule 485.
¶ 60	Instead, DEQ substituted the 5-year rolling average for the required maximum one-year emission rate. There is no provision in the TAPs rule for altering or adjusting the	Presents legal opinion in violation of Rule 485.

Paragraph or Section Header	Language to Strike	Justification to Strike
	predicted maximum one-year annual average. This erroneous substitution significantly reduces the MOS inherent in proper allocation of the one-year maximum emission rates. To be health protective, the prescriptive Section 586 rule explicitly (not typically) requires predicting the **maximum one-year annual average contaminant concentration** using prescribed emissions estimates, and assuring that concentration is not exceeded during the life of the facility.	
¶ 61	It is not possible from the available information provided by DEQ to determine how this 5-year rolling average compares to the maximum one-year emission rate that should have been used.	Presents legal opinion and conclusory statement in violation of Rule 485.
Section Header C	Ambient air arsenic concentrations and cancer risk are underestimated for the SGP by improper application of the non-WEP emissions scenarios.	Presents legal opinion in violation of Rule 485.
¶ 65	In the context of properly applying the TAPs rule, the non-WEP adjustment factor is irrelevant. DEQ's obligation is to identify the emission scenario that produces the maximum one-year annual average ambient air carcinogen concentration. That value is the maximum WEP2 scenario, and would not consider non-WEP scenarios unless the non-WEP emissions sources were operating contemporaneously during the WEP2 emission maximum year. In that case, any non-WEP scenario operating in the same year as the WEP2 maximum configuration would add to, not dilute, the critical receptor maximum ambient air concentration.	Presents legal opinion in violation of Rule 485.
¶ 66	DEQs applying the SGP Project-specific non-WEP adjustment factor effectively converts the 5-year alleged annual average value (0.00698 $\mu g/m^3$) to an arbitrary 0.00416 $\mu g/m^3$ 16-year LOM average carcinogenic concentration.	Presents legal opinion in violation of Rule 485.
¶ 67	The final effect of DEQ's application of an arbitrary multi-averaging non-WEP adjustment factor can be estimated by comparing the WEP2 and non-WEP average ambient air carcinogen estimates (i.e., (0.00698 µg/m3 / 0.00416 µg/m3), or by a factor of 1.7.	Presents legal opinion in violation of Rule 485.

Paragraph or Section Header	Language to Strike	Justification to Strike
Section Header D	The combined application of the SGP 16/70 Project-specific adjustment factor, the 5-year rolling average adjustment factor, and the non-WEP adjustment factor increase cancer risk and negate the health protectiveness of the TAPs rule.	Presents legal opinion in violation of Rule 485.
¶ 68	The conclusions in the DEQ Board's Final Order correctly identified the three Project-specific adjustment factors that undermine the health protectiveness of the TAPs rule for carcinogenic risk. The Board correctly concluded that application of these adjustment factors underestimates cancer risk. DEQ applied the: 1) 5-year rolling average; 2) non-WEP; and 3) SGP 16/70 LOM adjustment factors sequentially to the input and the output of the predictive air quality model. As a result, the dilution effects are multiplicative, rather than additive.	Presents legal opinion in violation of Rule 485.
¶ 70	DEQs sequential application of the three SGP Project-specific adjustment factors underpredict cancer risk by 13 times, as these carcinogenic risk levels are employed in properly implementing the TAPs rule.	Presents legal opinion in violation of Rule 485.
¶ 72	As DEQ admits,34 cancer dose-averaging has seldom, if ever, been used in TAPs carcinogenic risk compliance evaluations for a stationary source under the Clean Air Act in Idaho. Although there is a history of using cancer dose-averaging in risk assessment and risk management protocols for short-term remediation projects at contaminated sites, applying it to the SGP PTC is unprecedented. In implementing the SGP 16/70 Project-specific adjustment factor, DEQ has deviated from the long-held prescribed TAPs rule protocol of guaranteeing the **maximum one-year annual average carcinogen concentration** will not exceed the AACC or T-RACT AACC for each year of the Project. This thirty-year health protective strategy has provided the public comfort that cancer risk exposures are within acceptable limits both near the source and Statewide.	Presents legal opinion in violation of Rule 485.
Section Header E	DEQ's SGP Project-specific adjustment factors represent a significant change in the regulation of carcinogenic risk in Idaho that increases both cancer risk and regulatory burden.	Presents legal opinion in violation of Rule 485.
¶ 77	These questions demonstrate the short-sightedness of DEQ's acquiescence to Perpetua in allowing dose-averaging concepts to be applied to the Section 586 TAPs rule. Proper application of the rule inherently precludes risk averaging to maintain health protectiveness, without requiring applicants	Presents legal opinion in violation of Rule 485.

Paragraph or Section Header	Language to Strike	Justification to Strike
	to address the issues without guidance. The regulatory burden placed on future applicants by this modified policy is potentially immense.	
¶ 80	Idaho's current TAPs rule MOS appropriately accommodates both these conclusions if properly implemented as illustrated in Figure 1, above.	Presents legal opinion in violation of Rule 485.
¶ 94	This opinion concludes that DEQs use of the ad hoc SGP Project-specific adjustment factors undermines the health protectiveness of the TAPs rule. The TAPs rule was specifically developed to avoid requiring risk assessment analyses by providing an inherent margin of safety (MOS). These SGP Project-specific adjustment factors facilitate cancer dose-averaging risk calculations that allow the SGP to significantly increase arsenic emissions based on short-term Life of Mine (LOM) assumptions, but to nevertheless average the risk associated with those increased emission over 70-years.	Presents legal opinion in violation of Rule 485.
¶ 96	There is neither a provision, nor a need, for risk assessment if the TAPs Rules are properly implemented based on annual compliance with **maximum one-year annual average ambient air carcinogen concentration**. This application of the TAPs rule has served Idaho well for three decades. This policy change allowing risk averaging through the SGP Project-specific adjustment factors not only undermines the health protectiveness of the individual applicant source, but also the Statewide strategy that keeps all Idahoans safe with minimal regulatory burden.	Presents legal opinion in violation of Rule 485.

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
Nicole C. Hancock, ISB No. 6899
nicole.hancock@stoel.com

STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Intervenor-Respondent Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY

STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047, NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent. PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	AGENCY CASE No. 0101-22-01 OAH Case No. 23-245-01 **AMENDED MOTION TO STRIKE EXPERT DECLARATIONS OF WILLIAM TIEDEMANN AND IAN H. VON LINDERN**

INTRODUCTION

Intervenor-Respondent Perpetua Resources Idaho, Inc. ("Perpetua") moves to strike paragraphs and sentences from the Declaration of William Tiedemann ("Tiedemann Declaration") and the Declaration of Ian H. von Lindern ("von Lindern Declaration"), and the related exhibits attached thereto. The specific language Perpetua seeks to strike is identified in the tables attached to this motion as Exhibits A and B.

Perpetua moves to strike these paragraphs, sentences, and exhibits because (I) they constitute conclusory statements and legal opinions and (II) they present and rely on evidence that is irrelevant, unauthenticated, and constitutes hearsay. As a result, nearly all of the Tiedemann Declaration and significant sections of the von Lindern Declaration are inadmissible under the Idaho Rules of Administrative Procedure ("IDAPA Rules"). The Hearing Officer must strike the identified sentences, paragraphs, and corresponding exhibits from the record. Perpetua makes this motion on the grounds and authorities below.

Perpetua files this motion to preserve, for the record, its objections to the Tiedemann Declaration and von Lindern Declaration. Perpetua does not oppose the Hearing Officer taking this motion under advisement and allowing Petitioners to respond to the motion on the same schedule already set for post-hearing statements, if the Hearing Officer deems it necessary.

To the extent that the Hearing Officer does not strike the identified testimony, the Hearing Officer should provide Perpetua with the opportunity to file an overlength post-hearing statement, if necessary, to address the many conclusions and legal opinions in the Tiedemann and von Lindern Declarations which constitute legal arguments that cannot be appropriately addressed at a hearing.

ARGUMENT

I. The Tiedemann and von Lindern Declarations are Replete with Conclusions and Legal Opinions that are Inadmissible.

Under IDAPA Rule 485, "[e]xpert testimony that is conclusory, offers legal opinions, or which is based solely upon hearsay, is inadmissible." IDAPA 62.01.01.485. Idaho courts similarly exclude expert opinions that are "speculative, conclusory, or unsubstantiated by facts in the record." *Ryan v. Beisner*, 123 Idaho 42, 46 (Ct. App. 1992) (applying the Idaho Rules of Evidence or "I.R.E."). An expert witness's testimony offers an impermissible legal conclusion when it invades the role of the reviewing authority—here, the Hearing Officer—to determine the applicable law. *See Ybarra v. Legis. of Idaho*, 166 Idaho 902, 908 (2020).

While factual materials from a non-attorney witness may be helpful, "the legal analysis of a non-lawyer, expert witness is not." *Id.* Indeed, "the problem with testimony containing a legal conclusion is in conveying the witness's unexpressed, and perhaps erroneous, legal standards to the [factfinder]" which "invades the [Hearing Officer's] province…to determine the applicable law." *Ballard v. Kerr*, 160 Idaho 674, 694 (2016) (internal punctuation omitted) (citing *Torres v. Cty. of Oakland*, 758 F.2d 147, 150 (6th Cir. 1985)).

Despite this clear prohibition on conclusions and legal opinions in expert testimony, the Tiedemann and von Lindern Declarations are replete with both. Mr. Tiedemann repeatedly provides his own legal interpretations of the Idaho air permitting rules, expressly provides "conclusions" on legal questions before the Hearing Officer,[1] and attempts to support his conclusions by interpreting the legal significance of unsubstantiated documents that preceded the

[1] *See, e.g.,* Tiedemann Dec. at 4, ¶ 10 (Mr. Tiedemann states that "[b]ased on my review of case materials and extensive CAA permitting and compliance experience in private practice, with the State of Idaho, and with a non-profit organization, I conclude as follows" before providing legal conclusions on the issues before the Hearing Officer).

promulgation of the regulations at issue. Indeed, the Tiedemann Declaration reads more like a legal brief than an expert declaration.

Similarly, the von Lindern Declaration includes Mr. von Lindern's statements that he agrees with specific legal conclusions made the Idaho Board of Environmental Quality ("BEQ") as well as legal conclusions in testimony made by a BEQ member. *See, e.g.,* von Lindern Dec. at 6, ¶¶ 15-16. Additionally, the von Lindern Declaration repeatedly characterizes DEQ's application of the Idaho air permitting rules as "misinterpretation" and "arbitrary," *see, e.g., id.* at 8, ¶ 19; *id.* at 28, ¶ 66, while referring to Petitioners' preferred interpretation of the rules as the "proper implementation" and "proper application," *see, e.g., id.* at 19, ¶ 45; *id.* at 33, ¶ 77.

Such content is wholly inappropriate for expert declarations and is inadmissible in this case under IDAPA Rule 485. Mr. Tiedemann and Mr. von Lindern are not attorneys or legal experts, yet they present erroneous legal interpretations throughout their Declarations that invade the Hearing Officer's role to make conclusions of law. *See* IDAPA 62.01.01.252.01(d) (authorizing presiding officers to make "findings of fact" and "conclusions of law"). As a result, the Hearing Officer should strike the paragraphs, sentences, and language of the Tiedemann and von Lindern Declarations identified in Exhibits A and B, respectively.

II. The Tiedemann and von Lindern Declarations Inappropriately Present and Rely on Evidence that is Irrelevant, Unauthenticated, and Constitutes Hearsay.

The Hearing Officer may exclude evidence that is "irrelevant, unduly repetitious, or excludable on constitutional or statutory grounds." Idaho Code § 67-5251; IDAPA 62.01.01.475. Additionally, IDAPA Rule 476 provides that the Hearing Officer is "entitled to weigh the quality of the evidence presented, including the credibility of witnesses." IDAPA 62.01.01.476. While the Hearing Officer is not bound by the I.R.E., the Hearing Officer "may

assign less weight to evidence that would otherwise be inadmissible under the Idaho Rules of Evidence." *Id.* Thus, the I.R.E. inform the Hearing Officer's decisions on this motion.

Under the I.R.E., evidence is admissible only if it is relevant and authenticated. I.R.E. 401, 901; *Med. Recovery Servs., Ltd. Liab. Co. v. Eddins*, No. 47848, 2021 Ida. LEXIS 126, at *18 (July 9, 2021). Evidence is relevant when "it has any tendency to make a fact more or less probable than it would be without the evidence" and "the fact is of consequence in determining the action." I.R.E. 401. However, to authenticate evidence, "the proponent must produce evidence sufficient to support a finding that the item is what the proponent claims it is." I.R.E. 901(a); *see Eddins*, 2021 Ida. LEXIS 126, at *18 (quoting I.R.E. 901(b)(1) and explaining that authentication of a writing may be made by a witness with knowledge that "an item is what it is claimed to be"). The Hearing Officer may give less credence to evidence that does not meet the above I.R.E. criteria. IDAPA 62.01.01.476.

Additionally, "hearsay" is inadmissible under the I.R.E. unless it qualifies for an exception. I.R.E. 802. "Hearsay" is an out of court statement offered as evidence to "prove the truth of the matter asserted." I.R.E. 801(c). Although the Hearing Officer is not bound by hearsay rules of evidence generally, when expert testimony is based solely on hearsay statements, it is inadmissible. IDAPA 62.01.01.485.

The Tiedemann Declaration presents and relies heavily on irrelevant evidence that Mr. Tiedemann fails to authenticate. *See Eddins*, 2021 Ida. LEXIS 126, at *18. Mr. Tiedemann cherry-picks thirty-year-old informal emails, stakeholder letters, and draft documents from Idaho Department of Environmental Quality ("DEQ") archives and labels them as definitive evidence of the BEQ's rulemaking intent. Mr. Tiedemann claims that these documents are part of the historical rulemaking record for regulatory provisions at issue in this case and repeatedly relies

on these documents to support his erroneous, unreliable, and inadmissible legal conclusions. *See, e.g.*, Tiedemann Dec. at 6-9, ¶ 14.

These documents are irrelevant because Mr. Tiedemann did not establish that they were part of the actual rulemaking record that is appropriate for the Hearing Officer to consider when interpreting the BEQ's intent in adopting the rules at issue.[2] Indeed, Mr. Tiedemann and the Petitioners fail to offer any evidence to authenticate these documents as part of the rulemaking record. Although the documents might be included in state archives, draft documents and informal emails regarding internal DEQ deliberations do not illustrate either DEQ's or BEQ's final policy or intent concerning how the rules should be applied or interpreted.[3]

---

[2] If the meaning of a statute or regulation is ambiguous after analyzing its plain language and employing traditional methods of interpretation, courts review administrative history but do not consider draft documents and unpublished, informal communications that fail to illustrate the final intent of the statute or regulation. For instance, Idaho courts have held that the opinions and beliefs of one legislator, even one who drafted a bill, cannot establish the entire Legislature's intent. *Gillihan v. Gump*, 140 Idaho 264, 268, 92 P.3d 514, 518 (2004) *abrogated on other grounds by Gonzalez v. Thacker*, 148 Idaho 879, 231 P.3d 524 (2009). The same is true here—the communications of individual DEQ employees and a Deputy Attorney General, employed by the Office of the Attorney General, do not represent the intent of DEQ and BEQ.

Federal courts counsel against "considering wide ranging materials associated with the development of regulations" and give little to no weight to unpublished items that constitute a "hodgepodge of meeting minutes, staffers' notes, draft regulations, reports hearings and technical papers, many of which are anonymous." *Sikorsky Aircraft Corp. v. United States*, 102 Fed. Cl. 38, 55 (2011); *Perry v. Martin Marietta Corp.*, 47 F.3d 1134 (Fed. Cir. 1995)). This approach is consistent with the U.S. Supreme Court's explanation of the types of documents that represent an agency's policy positions and interpretations for purposes of deference. *Kisor v. Wilkie*, 588 U.S. 558, 577, 139 S. Ct. 2400, 2416-17 (2019) ("In other words, [an interpretation] must be the agency's 'authoritative' or 'official position,' rather than any more ad hoc statement not reflecting the agency's views. . . Not everything the agency does comes from, or is even in the name of, [the agency head]. So, for example, we have deferred to 'official staff memoranda' that were 'published in the Federal Register,' even though never approved by the agency head. But there are limits. The interpretation must at the least emanate from those actors, using those vehicles, understood to make authoritative policy in the relevant context.") (internal citations omitted).

[3] The petitioners have offered no certification or authentication confirming that the source of these materials is from the state archives.

Notably, the Tiedemann Declaration includes a long block quotation of an email from an Idaho Deputy Attorney General to DEQ without providing any response from DEQ. Tiedemann Dec. at 8, ¶ 19. The content of this email is irrelevant on its face because, without a response from DEQ, it provides no insight into DEQ's rulemaking process or the correct interpretation of the regulations at issue. Even with the response, it would be inadmissible. However, this highlights the prejudice that would result from considering such incomplete and unreliable information.

Additionally, the Tiedemann Declaration quotes and heavily relies on an "undated" draft letter for which Mr. Tiedemann merely *presumes* the identity of the author and the recipient. Tiedemann Dec. at 11, ¶ 27 (quoting "[a] undated TAPs rulemaking concept letter" which Mr. Tiedemann claims is "addressed to a 'Robert' (presumably Robert Wilkoz) and presumably from another DEQ staffer"). By failing to identify the date of the letter and merely assuming the identity of the involved parties, Mr. Tiedemann failed to produce evidence sufficient to support a finding that the letter is what Mr. Tiedemann claims it is. Accordingly, Mr. Tiedemann and the Petitioners have failed to authenticate this letter.

Moreover, the statements that Mr. Tiedemann references from this undated draft letter constitute hearsay because the statements were not made by Mr. Tiedemann and are offered to "prove the truth of the matter asserted." *See* I.R.E. 801. While the I.R.E. includes a hearsay exception for certain types of public records, the exception does not apply when an opponent shows "that the source of information or other circumstances indicate a lack of trustworthiness." I.R.E. 801(8). Without any information to confirm the date of this draft letter or the parties involved, or full context of the comment in light of responses and other information that was available at the time, the draft letter is not trustworthy and constitutes hearsay.

Similarly, the von Lindern Declaration includes testimony regarding his participation in "an advisory committee role" in DEQ meetings regarding the development of the Idaho air permitting rules at issue, including his rendition of the experience and perspectives of those involved, von Lindern Dec. at 9, ¶ 20. While Mr. von Lindern does not quote individual statements from such meetings, he provides unreliable, irrelevant information about what he perceived to be the objectives of the agency and industry. In addition to being irrelevant because whatever he believes to have been the purpose does not allow him to substitute his own judgment for that of the Hearing Officer, these statements are conclusory and suffer the same unreliability issues as hearsay and other references to unauthenticated documents: Mr. von Lindern provides no underlying authenticated documentation or support to confirm the trustworthiness of his reported observations.[4] While he does not specify what others *may* have said to support his conclusions (and doing so would be impermissible under hearsay rules) the same unreliability concerns apply.

As the draft documents,informal communications, and unsupported recollections that the Tiedemann and von Lindern Declaration rely upon constitute irrelevant, unauthenticated, and hearsay evidence under the I.R.E., the Hearing Officer should strike these documents or, at a minimum, afford them no weight under IDAPA Rule 476. Perpetua reserves the right to raise further objections to Mr. Tiedemann's testimony, including whether he is qualified to provide expert opinion on the Idaho air permitting rules or related rulemaking history.

[4] Furthermore, the opinions and beliefs of one participant in a rulemaking process does not establish the intent of the DEQ and BEQ in promulgating the rules. *See Gillihan v. Gump*, 140 Idaho 264, 268, 92 P.3d 514, 518 (2004), *supra* note 2.

CONCLUSION

The Hearing Officer should strike from the Tiedemann Declaration the following: paragraphs 10.a, 10.b., 10.c., 10.d.; 14; paragraphs 17 through 24[5]; 26 through 30[6]; 32; 34; 36 through 39; 40; 43 through 47; 49 through 50; section headers A, B, C, and D; and all referenced exhibits (Exhibits A, B, C, D, E, and F). The Hearing Officer should strike from the von Lindern Declaration the following: paragraphs 15.a through 15.d, 16, 18, 19, 20, 51, 52, 60, 68, 71, and 96; certain language in paragraphs 26, 29, 36, 37, 45, 50, 55, 58, 61, 65, 66, 67, 72, 77, and 80; section headers A, C, E; and the titles of Figures 1, 3, 5a, 5b. If the Hearing Officer decides that portions of the declaration or exhibits should not be stricken, Perpetua respectfully requests that, where applicable, the Hearing Officer consider this evidence with less weight and provide Perpetua with an opportunity to brief these matters as a matter of due process.[7]

DATED: October 15, 2024

STOEL RIVES LLP

By: /s/ Nicole Hancock
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole C. Hancock

Attorneys for Intervenor-Respondent Perpetua Resources Idaho, Inc.

[5] The Tiedemann Declaration does not contain a Paragraph 23.

[6] The Tiedemann Declaration includes two Paragraph 27s. Perpetua seeks to strike both. Also, the Tiedemann Declaration includes paragraph A.9. after paragraph A.28. Perpetua assumes that Petitioners intended this to be paragraph "29."

[7] *Cf. Cowan v. Bd. of Comm'rs*, 143 Idaho 501, 512 (2006) (discussing procedural due process requirement that a defendant be given an opportunity respond and be heard).

CERTIFICATE OF SERVICE

I HEREBY CERTIFY that on the 15th day of October 2024, I caused a true and correct copy of this Motion to Strike to be served on the following persons:

Via Email to:

Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton
Boise, Idaho 83706-1255
paula.wilson@deq.idaho.gov

Hannah M.C. Young
Michael Short
Deputy Attorney General
Idaho Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
michael.short@deq.idaho.gov

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, Idaho 83720-0010
Ann.yribar@ag.idaho.gov

Dylan Lawrence, Hearing Officer
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
Located at 350 N 9th St., Ste. 300
Filings@oah.idaho.gov

Bryan Hurlbutt
Laird J. Lucas
Advocates for the West
P.O. Box 1612
Boise, Idaho 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for the Nez Perce Tribe and Idaho Conservation League

Julia Thrower
Mountain Top Law, PLLC
614 Thompson Ave.
McCall, Idaho 83638
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

/s/ Wade C. Foster
Wade C. Foster

EXHIBIT A

Language to Strike in the Tiedemann Declaration

Paragraph or Section Header	Language to Strike	Justification to Strike
¶ 10.a	Based on my review of case materials and extensive CAA permitting and compliance experience in private practice, with the State of Idaho, and with a non-profit organization, I conclude as follows: DEQ's application of the 16/70 Project-specific adjustment factor to the ambient arsenic air concentration analysis, and the use of exposure duration adjustments like the 16/70 calculations is not supported by the historic TAPs rulemaking record. It was thus inappropriate for DEQ to use such an adjustment factor to demonstrate compliance with the Air Rules.	Presents legal opinion and conclusory statement in violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis in violation of Rule 485. Testimony relies solely on unreliable, unauthenticated hearsay evidence in violation of Rule 485.
¶ 10.b	Based on my review of case materials and extensive CAA permitting and compliance experience in private practice, with the State of Idaho, and with a non-profit organization, I conclude as follows: DEQ's interpretation of the TAPs AACCs as averaging periods rather than enforceable "standards" is misplaced and is not supported by the historic TAPs rulemaking record;	Presents legal opinion in violation and conclusory statement of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis in violation of Rule 485.

Paragraph or Section Header	Language to Strike	Justification to Strike
		Testimony relies solely on unreliable, unauthenticated hearsay evidence in violation of Rule 485.
¶ 10.c	Based on my review of case materials and extensive CAA permitting and compliance experience in private practice, with the State of Idaho, and with a non-profit organization, I conclude as follows: DEQ use of a 5-year rolling average for TAPs emission calculations is neither supported by the TAPs rule, the historic TAPs rulemaking record, nor by limitations under the Permit conditions;	Presents legal opinion and conclusory statement in violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis in violation of Rule 485. Testimony relies solely on unreliable, unauthenticated hearsay evidence in violation of Rule 485.
¶ 10.d	Based on my review of case materials and extensive CAA permitting and compliance experience in private practice, with the State of Idaho, and with a non-profit organization, I conclude as follows: There was sufficient evidence to support the T-RACT analysis limiting the non-West End pit lifetime production limit, but West End Pit production is not properly constrained below the less than life-of-mine time frame.	Presents legal opinion in violation of Rule 485.

Paragraph or Section Header	Language to Strike	Justification to Strike
Section Header A	Application of the 16/70 Project-specific adjustment factor for assessing compliance with the TAPs rule is inconsistent with the rulemaking history, intent, and plain language of the TAPs rule.	Presents legal opinion in violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis in violation of Rule 485. Testimony relies solely on unreliable, unauthenticated hearsay evidence in violation of Rule 485.
¶ 14	Based on my review of the historical records related to the development of the TAPs Rule, it is evident that the AACCs were developed as annual emission limits, with the intent that compliance is demonstrated on a year-over-year basis. The records demonstrate that the use of an exposure duration adjustment, like the 16/70 Project-specific adjustment factor used for the SGP, was directly considered by DEQ, and ultimately rejected. If implemented, using project-specific adjustment factors would create a permitting protocol that is antithetical to the intended protections of the TAPs Rule, the AACCs, and annual, year-over-year limits. My own personal experience working as a Permitting Engineer for DEQ, the Air Rules themselves, the historical TAPs Rule rulemaking record, and greater context of U.S. Environmental Protection Agency (EPA) guidance all support this conclusion.	Presents legal opinion in violation of Rule 485. Provides legal opinion or analysis in violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis in violation of Rule 485. Testimony relies solely on unreliable, unauthenticated hearsay evidence in

Paragraph or Section Header	Language to Strike	Justification to Strike
		violation of Rule 485.
¶ 17	The Air Rules themselves and the historical TAPs rulemaking record reinforce my personal experience with TAPs compliance and demonstrate that, in its original TAPs rulemaking process, DEQ directly considered, but ultimately rejected, concepts like the 16/70 Project-specific adjustment factor and exposure duration adjustments generally, except for sources expected to operate for less than 5 years.	Presents legal opinion in violation of Rule 485.
¶ 18	In an August 13, 1992 letter from DEQ's Mr. Frank Wilkoz to Ms. Joan Cloonan, Idaho Association of Commerce and Industry, Mr. Wilkoz provided a first draft of the original TAPs rules for review while adding context within a "Explanation of Additions and Changes" section. Mr. Wilkoz served as DEQ's Technical Services Bureau Chief and was heavily involved in the development of the original TAPs rulemaking and subsequent modification while Ms. Cloonan served as an industry stakeholder and provided input to the process. Mr. Wilkoz's "Explanation of Additions and Changes" section provides insight to how DEQ intended to permit remediation and short term sources. Most significantly Mr. Wilkoz writes: However, a remediation source cannot be allowed to produce emissions that have the potential to expose human receptors to a full lifetime dose of a TAP over a short period of time, especially a carcinogen, even in the interest of environmental clean up. Further, a single very large dose of a carcinogen, while not a full lifetime dose, has the potential to cause toxics related cancers due to the nature of dose response interaction of carcinogens at the cellular level. To allow such doses would subvert the very purpose of a clean up. **Corresponds to Exhibit A.**	Petitioners have not demonstrated reliability of historical records, therefore testimony relies on unreliable, unauthenticated information. 1992 email is hearsay. Remainder of paragraph A.18 after the first sentence relies solely on hearsay in violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis in violation of Rule 485.
¶ 19	In an email dated August 14, 1992, Idaho Deputy Attorney General Curt Fransen emailed DEQ's Mr. Tim Teater and Mr. Frank Wilkoz directly raising these questions regarding large-dose short-term exposures.4 During the TAPs rulemaking period, Mr. Teater served as an Air Quality	Petitioners have not demonstrated reliability of historical records, therefore testimony

Paragraph or Section Header	Language to Strike	Justification to Strike
	Toxicologist and was also heavily involved in the development of the original TAPs rulemaking and subsequent modifications. In his email, Mr. Fransen questions: 16.01.01012,13.g.iii. and iv. The standard for remediation sources raises some questions of a general nature. I don't have any answers but wonder if it makes scientific sense to directly convert risk of additional cancer based on lifetime exposure to risk of additional cancer based on less than lifetime exposure by assuming a directly proportional relationship between years of exposure and risk. Sorry that I can't properly express that but you probably get the drift. Other questions that seem to arise from simply allowing higher exposure where the length of exposure is shorter include the unknown or potential combined and synergistic effect of many short term or remediation sources or other sources in the same area and the potential of serial (one after another) short term or remediation sources. Lastly, how will the operational life of a source be determined. What if an applicant says they only intend to operate for five years (for whatever reason) so want the higher emission number to apply. There is incentive for facilities to argue they will be short-term. The spectre of serial short-term sources arises. Perhaps the definition can be clarified so there is less wiggle room. **Corresponds to Exhibit B.**	relies on unreliable, unauthenticated information. 1992 email is hearsay. Testimony in paragraph A.19 relies solely on hearsay in violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis in violation of Rule 485.
¶ 20	In a later and related email sent from Mr. Teater to Mr. Wilkosz on August, 26, 1992,6 Mr. Teater states: We will need to talk about the environmental remediation source limit of five years to get a break on emissions. I am opposed to making that greater than five years. It seems that after five years most remediation sources would have emission BRC (Below Regulatory Concern) anyway. If not then they need to be treated as any other source. **Corresponds to Exhibit C.**	Petitioners have not demonstrated reliability of historical records, therefore testimony relies on unreliable, unauthenticated information. 1992 email is hearsay and relies solely on hearsay in violation of Rule 485.

Paragraph or Section Header	Language to Strike	Justification to Strike
		Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis in violation of Rule 485. Testimony relies solely hearsay evidence in violation of Rule 485.
¶ 21	A further review of the historical TAPs rulemaking record provides support for treating the AACC as annual, year-over-years limit rather than supporting the use of unique operational scenarios and exposure duration adjustments.	Presents legal opinion in violation of Rule 485. Petitioners have not demonstrated reliability of historical records, therefore testimony relies on unreliable, unauthenticated information.
¶ 22	Regardless, and more importantly, the only less-than-lifetime exposure duration adjustment DEQ ultimately included within the original TAPs rule (or any subsequent versions) was the less than 5-yaer, ten-fold adjustment factor currently contained under IDAPA 58.01.01.210.15.	Presents legal opinion in violation of Rule 485.
¶ 24	Said another way, there is a high concentration dose of arsenic received over a short duration that is equivalent in risk to some corresponding low concentration dose of arsenic received over a longer duration. This is the underlying assumption that DEQ relies on when it applied the 16/70 Project-specific adjustment factor to assessing TAPs compliance for the SGP Permit.	Presents legal opinion and conclusory statement in violation of Rule 485.

Paragraph or Section Header	Language to Strike	Justification to Strike
¶ 26	Furthermore, the historical TAPs rulemaking record shows DEQ specifically rejected previously existing EPA Superfund risk assessment guidance and its use of exposure duration adjustments in consideration of risk and TAP exposure. The following documents confirm this conclusion.	Presents legal opinion and conclusory statement in violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis in violation of Rule 485.
¶ 27	A undated TAPs rulemaking concept letter(herein referred to as the TAPs Concept Letter) addressed to a "Robert" (presumably Robert Wilkoz) and presumably from another DEQ staffer outlines the rationale behind changes within a modified draft TAPs rule. Within the letter it is stated: We also do not accept the EPA superfund risk assessment guidelines. Superfund guidelines are based on the concept that the exposures are of limited duration and do not have a large potential for multiple exposures. We can not make those assumptions for sources in Idaho, many of which involve either long term exposures or exposures to substances with a potential for multiple exposures. In Idaho, we are attempting to protect the public from the deleterious effect of multiple sources of a given pollutant or the additive effects of multiple pollutants over the course of a 70 year lifetime. If we could assure only a single exposure occupance, then accepting higher temporary risk might be justifiable. In addition we must consider the effects of the pollutant on the elderly, the very young and the infirm. By using "worse case" assumptions we are then able, under very limited conditions and when the public health would not be compromised, to deviate from the one in a million standard and apply a one in one hundred thousand as noted in the NSR policy. The use of this conservative approach allows us	Petitioners have not demonstrated reliability of historical records, therefore testimony relies on unreliable, unauthenticated information. Undated concept letter is hearsay and this testimony relies solely on hearsay in violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis in violation of Rule 485.

Paragraph or Section Header	Language to Strike	Justification to Strike
	to be sure that actual risk is no greater than the risk figure on which we base our policy. **Corresponds to Exhibit D.**	
¶ 27	A January 23, 1992 unsigned draft letter to Mr. Charles Woods, Marketing Manager for MDT Corporation13 (a presumed TAPs rulemaking industry stakeholder) from a DEQ staffer (presumably Mr. Wilkoz) states: Our policy is based on a 1:1,000,000 risk at the nearest public access to the source. Risk is computed by multiplying the predicted (by the model) ambient concentration by the unit risk factor (URF) as published by the US EPA. Idaho does not accept the Superfund risk assessment method for computing risk except for single, relatively short term exposures. Our risk assessment for continuous industrial or other large sources is based on the possibility of multiple, long term exposures. **Corresponds to Exhibit E.**	Petitioners have not demonstrated reliability of historical records, therefore testimony relies on unreliable, unauthenticated information. Undated concept letter is hearsay and this testimony relies solely on hearsay in violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis in violation of Rule 485.
¶ 28	A TAPs rule that allows for exposure duration adjustments and a risk assessment approach creates a problematic precedent, as is made evident by the following hypothetical scenario. If the SGP (or any subsequent source) is allowed to operate using exposure duration adjustments, an adjacent receptor (i.e., a human being) would be exposed to more than the intended annual allowable concentration of arsenic (the AACC) for 16 years. If, before the SGP operations end, the receptor moves and lives or works next to another facility or a new facility starts operations next to the SGP that applies an exposure duration adjustment for TAPs compliance (a process which could repeat indefinitely), by the end of the receptor's lifetime, it has been exposed to a TAPs concentration over the AACC for its entire life and its lifetime risk exceeds the intended 1-in-100,000 cancer risk	Presents legal opinion in violation of Rule 485. Third sentence is testimony made relying solely on hearsay email which must be excluded under Rule 485.

Paragraph or Section Header	Language to Strike	Justification to Strike
	level. In this scenario, the "spectre of serial short-term sources," as feared by Mr. Fransen in his email is apparent. Allowing the SGP to use the 16/70 Project-specific adjustment factor opens the door to a world in which the current AACCs in the TAPs Rule are effectively replaced by higher concentrations due to shorter than 70-year sources.	
¶ 9	Contrast a hypothetical scenario where exposure duration adjustments are not allowed and the TAP AACCs are annual limits that must be met year-over-year by every facility in Idaho. In this case, no facility may emit TAPs at a concentration greater than the AACCs and a 1-in-100,000 excess cancer risk is preserved no matter where a receptor lives, works, or travels in Idaho during their entire life, and no matter what other facilities start operations. This scenario creates a simple and easy to implement rule that is broadly protective of human health and the environment and, as the Schilling Declaration itself notes, was the intent of the originally TAP rulemaking process. Furthermore, this scenario is supported by the historical TAPs rulemaking record and best fits the intent of DEQ.	Presents legal opinion in violation of Rule 485. For last sentence specifically, Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis.
¶ 30.a	Given the full review of the above evidence and based on my experience as a Permit Engineer at DEQ, I conclude as follows: During the TAPs rulemaking process, DEQ specifically considered the use of exposure duration adjustments and use of calculations akin to the 16/70 Project-specific adjustment factor, but ultimately did not incorporate their use within the TAPs rules;	Presents legal opinion and conclusory statement in violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis.
¶ 30.b	Given the full review of the above evidence and based on my experience as a Permit Engineer at DEQ, I conclude as follows: DEQ intended the AACCs to be annual, year-over-year concentration limits and included only a single short-term adjustment factor within the original TAPs rule for sources operating for 5-years or less;	Presents legal opinion and conclusory statement in violation of Rule 485.

Paragraph or Section Header	Language to Strike	Justification to Strike
		Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis.
¶ 30.c	Given the full review of the above evidence and based on my experience as a Permit Engineer at DEQ, I conclude as follows: DEQ's application of the 16/70 Project-specific adjustment factor to demonstrate compliance with TAPs is not supported by the intent or language of the TAPs rule, and results in a degradation of the protection of human health and the environment that is otherwise the purpose of the TAPs rule.	Presents legal opinion and conclusory statement in violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis.
Section Header B	DEQ and Perpetua incorrectly assume the 1-in-100,000 cancer risk rate, rather than the AACC, is the applicable enforceable "standard."	Presents legal opinion in violation of Rule 485.
¶ 32	Labeling AACCs as "increments" versus "standards" is simply a naming convention rooted in previously existing CAA policy; the enforceable standard is the AACC as a year-over-year limit.	Presents legal opinion in violation of Rule 485.
¶ 34	The AACCs as "increments" are different in that they do not consider background concentrations of TAPs. Unlike Criteria Pollutants, DEQ does not regularly monitor the ambient concentrations of TAPs. There simply are too many TAPs (there are over 80 carcinogenic TAPs alone listed in IDAPA 58.01.01.586), they are state-specific (unlike Criteria Pollutants), and the cost to do so is generally accepted as prohibitive. Thus, during the historic TAPs rulemaking process the AACCs were implemented as "increments" versus "standards." Said another way, while it is infeasible to monitor and enforce an ultimate TAPs concentration standard, it is feasible to estimate the incremental increase in TAPs concentrations that a facility would cause.	Presents legal opinion in violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis.

Paragraph or Section Header	Language to Strike	Justification to Strike
¶ 36	Both the TAPs AACCs and PSD increments are maximum allowable increases from a specific source. In developing the TAPs Rules, DEQ would have certainly been aware of the concept and naming convention of "increments." The TAPs definition of increments is best viewed through the lens of a compliance period, rather than implying they represent an averaging period, as the Lewis Declaration does.	Presents legal opinion in violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis.
¶ 37	Evidence from the historical TAPs rulemaking record reinforces this and the conclusion that the use of the term "increment" within TAPs was to differentiate them from including background concentrations as "standards" do. During the 1995 period, DEQ made revisions to the original and previously promulgated TAPs rule. As part of that process, DEQ developed a TAPs rule amendment summary document.23 Within that document DEQ notes: The proposed rule will divide consideration of incremental increases of TAP emissions into individual source and facility wide categories. Net emissions is a concept that adds increases and decreases of emissions from new sources of TAP together to obtain a net amount. That net amount is then compared to acceptable ambient levels also called increments for a permitting decision. The acceptable ambient level is referred to as an increment because TAP emissions increases are limited to an incremental increase as opposed to an absolute limited ambient concentration. **Corresponds to Exhibit F.**	Presents legal opinion and conclusory statement violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis. Petitioners have not demonstrated reliability of historical records, therefore testimony relies on unreliable, unauthenticated information.
¶ 38	On the other hand, if you assume DEQ intended the 1-in-100,000 cancer risk to be the enforceable standard and not the AACC as annual, year-over-year limits, it would have needed to incorporate additional variables into the TAPs Rule to guide applicants on how to assess that risk. Completing a risk assessment that analyzes a facility's excess cancer risk traditionally involves consideration of more variables and factors than just exposure duration.	Presents legal opinion in violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the

Paragraph or Section Header	Language to Strike	Justification to Strike
	Sensitive populations, comorbidities, and synergistic effects of combined toxic exposure all affect the ultimate cancer risk from a facility's airborne toxic emissions. However, as mentioned above, the original TAPs rulemaking process rejected the risk assessment method and prioritized creating a simple and easy to implement rule that is still protective of human health and the environment. Ultimately, using the AACCs as the "enforceable standard" is a far more effective standard to use in fulfilling this goal.	rulemaking analysis. Petitioners have not demonstrated reliability of historical records, therefore testimony relies on unreliable, unauthenticated information.
¶ 39.a	Given the full review of the above evidence, I conclude as follows: The labeling of the AACCs as "increments" versus "standards" is a naming convention rooted in previously existing CAA policy and is a distinction in the consideration of pollutant background concentrations rather than an averaging period concept.	Presents legal opinion and conclusory statement in violation of Rule 485.
¶ 39.b	Given the full review of the above evidence, I conclude as follows: DEQ intended the enforceable "standard" to be the AACC as an annual, year-over-year limit.	Presents legal opinion and conclusory statement in violation of Rule 485.
Section Header C	Use of a 5-year rolling average for demonstrating compliance with the TAPs ruleT-RACT is inappropriate and not supported by Permit conditions.	Presents legal opinion in violation of Rule 485.
¶ 40	Use of a 5-year rolling average for demonstrating compliance with the TAPs ruleT-RACT is inappropriate and not supported by Permit conditions.	Presents legal opinion in violation of Rule 485.
¶ 43	This outcome creates a problematic precedent as is evident by another hypothetical scenario. Consider again the "spectre of serial short-term sources" and the scenario in which a receptor is exposed to consecutive sources that have applied an exposure duration adjustments discussed above in Paragraph 28. In a modified scenario, the receptor is adjacent to the SGP for four years of high TAPs emissions, but then relocates adjacent to a different TAPs source before a fifth year of low SGP TAP emissions occurs. The new	Presents legal and analysis opinion in violation of Rule 485. Second sentence relies solely on hearsay in violation of Rule 485.

Paragraph or Section Header	Language to Strike	Justification to Strike
	TAPs source is also a less than 70-year source using exposure duration adjustments with TAPs concentrations above the AACCs. The receptor will be consistently exposed to TAPs concentration potentially well over the AACC, and is accruing an excess cancer risk level above 1-in-100,000. Again, the AACCs are effectively replaced by higher concentrations due to less than 70-year sources using exposure duration adjustment factors and/or emission period averaging.	
¶ 44	In order to avoid such a scenario, the Air Rules and the historical TAPs rulemaking record speak for themselves.	Presents legal opinion in violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis.
¶ 45.a	Given the full review of the above evidence, I conclude as follows: Calculation of the SGP's arsenic emissions by using a 5-year rolling average is contrary to the intent of the original TAPs rulemaking process and the Air Rules stating that the AACC are an annual, year-over-year limit	Presents legal opinion and conclusory statement in violation of Rule 485. Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis.
¶ 45.b	Given the full review of the above evidence, I conclude as follows: Using a 5-year rolling average inappropriately allows individual years of excess TAPs emissions to be masked within an averaged period.	Presents legal opinion and conclusory statement in violation of Rule 485.

Paragraph or Section Header	Language to Strike	Justification to Strike
		Petitioners have not demonstrated qualification of expert to testify regarding the rulemaking analysis.
Section Header D	There is insufficient evidence to support the T-RACT analysis limiting the non-West End pit production limit.	Presents legal opinion in violation of Rule 485.
¶ 46	However, Board was right in question whether the production from all pits was properly constrained.	Presents conclusory statement and legal opinion in violation of Rule 485.
¶ 47	The AACCs are limits for which compliance must be demonstrate on an annual year-over-year basis.	Presents legal opinion in violation of Rule 485.
¶ 49	In order to comply with the AACCs and demonstrate TAPs compliance, DEQ should have: (1) determined the worst arsenic generation scenario from any single year of the SGP (likely to include 100% production from the West End Pit); (2) compared the modeled operation boundary arsenic concentration from the worst generation scenario to the AACC to evaluate TAPs compliance; and (3) include a maximum annual ore generation permit limit from the pit(s) that correspond to the worst arsenic generation to ensure TAPs compliance.	Presents legal analysis and opinion in violation of Rule 485.
¶ 50.a	Given the full review of the above evidence, I conclude as follows: a. DEQ did not appropriately analyze the maximum annual emissions scenario from the SGP and instead diluted the SGP'd arsenic emissions through the 5-year rolling average calculation.	Presents legal opinion and conclusory statement in violation of Rule 485.
¶ 50.b	Given the full review of the above evidence, I conclude as follows: The permit does not sufficiently constrain ore production from the SGP's pit(s) on an annual basis.	Presents legal opinion and conclusory statement in violation of Rule 485.

EXHIBIT B

Language to Strike in the von Lindern Declaration

Paragraph or Section Header	Language to Strike	Justification to Strike
¶ 15.a	I have reviewed Idaho Board of Environmental Quality's Final Order and understand and agree with the Board's conclusions that: DEQ Did Not Act Reasonably and in Accordance with Law When it Analyzed the Ambient Arsenic Air Concentrations for the SGP;	Presents legal opinion and conclusory statement in violation of Rule 485.
¶ 15.b	I have reviewed Idaho Board of Environmental Quality's Final Order and understand and agree with the Board's conclusions that: DEQ did not Act Reasonably in Using a Five-Year Rolling Average for T-RACT that was not Properly Supported by Permit Conditions;	Presents legal opinion and conclusory statement in violation of Rule 485.
¶ 15.c	I have reviewed Idaho Board of Environmental Quality's Final Order and understand and agree with the Board's conclusions that: There was Insufficient Evidence to Support the T-RACT Analysis Limiting the Non-West End Pit Production Limit;	Presents legal opinion and conclusory statement in violation of Rule 485.
¶ 15.d	I have reviewed Idaho Board of Environmental Quality's Final Order and understand and agree with the Board's conclusions that: DEQ Did Not Act Reasonably and in Accordance with Law When it Applied the 16/70 Calculation to the Ambient Arsenic Air Concentration Analysis.	Presents legal opinion and conclusory statement in violation of Rule 485.
¶ 16	I have reviewed the transcript of the May 1, 2024 special meeting of the Idaho Board of Environmental Quality. I also concur with Vice Chair McMillan's testimony that: . . . DEQ has misinterpreted how the acceptable ambient concentration for carcinogens, the AACC, must be applied if it is to comply with our air quality rules. … DEQ's creation and application of a project-specific adjustment factor is not supported by Idaho's air quality rules.	Presents legal opinion and conclusory statement in violation of Rule 485.

Paragraph or Section Header	Language to Strike	Justification to Strike
	… the creation of a project-specific adjustment factor suggests that there is a significant ignorance about cancer, carcinogens, and carcinogenesis. … the short-sighted project-specific adjustment factor to the Stibnite Gold Project, DEQ created a misleading risk analysis that greatly underestimates the actual cancer risk	
Section Header A	DEQ's application of the 16/70 Project-specific adjustment factor is inappropriate science and public health policy.	Presents legal opinion and conclusory statement in violation of Rule 485.
¶ 18	DEQ has failed to properly implement Section 586 and T-RACT for the SGP PTC by introducing a 16/70 SGP Project-specific adjustment factor to allocate the full 70-year lifetime allowable cancer risk to the 16-year Life of Mine (LOM). The calculation averages the risk resulting from SGP emissions over the life of the receptor. This adjustment allows the SGP to emit as much as 70 years of allowable carcinogenic emissions in 16 years. This type of "adjustment factor," also known as risk amortization or cancer dose-averaging, undermines both the health protectiveness and the regulatory certainty of the TAPs rule. In the context of the existing TAPs rule, as applied the last 30 years, using the 16/70 Project-specific adjustment factor is an incorrect interpretation and represents unsound science and public health policy.	Presents legal opinion in violation and conclusory statement of Rule 485.
¶ 19	Specifically, DEQ misinterprets the purpose and function of the **maximum one-year annual average ambient air carcinogen concentration** in implementing the TAPs rule. It is important to review the development of the TAPs rule in understanding the strategy represented by this one-year annual standard. The Schilling Declaration asserts that the TAPs rule was developed nearly thirty years ago to accommodate DEQ's predecessor agency IDHW-DOE and the regulated communities' request to adopt rules that are: 1) are reasonably protective of public health, but still afford flexibility to facilities and projects; 2) are relatively easy to understand and implement; and 3) do not require excessive expenditure of time and	Presents legal opinion and conclusory statement in violation of Rule 485.

Paragraph or Section Header	Language to Strike	Justification to Strike
	resources by DEQ and the permittee during the permitting process.	
¶ 20	I was invited by the IDHW-DOE Air Quality Bureau to engage in development of those rules at that time in an advisory committee role based on my previous experience outlined above. My recollection is that much of the IDHW-DOE's and regulated industries' initial experience with risk assessment analyses was in implementing Risk Assessment Guidance for Superfund at CERCLA sites. Both IDHW-DOE and the regulated community were supportive of avoiding the onerous burden of incorporating similar risk assessment and risk management protocols into Idaho's TAPa rule. In short, after considerable effort, IDHW-DOE was successful in developing the Section 58610 and T-RACT11 rule with a strategy that simultaneously avoids requiring PTC applicants to submit risk assessment and risk management protocols, yet is protective of human health.	Testimony relies solely on unreliable, unauthenticated hearsay evidence in violation of Rule 485.
Title of Figure 1	Cumulative Risk (CR) and Margin of Safety (MOS) under Properr Implementation of TAPS Rules	Presents legal opinion and conclusory statement in violation of Rule 485.
¶ 26	If the TAPs rule is properly implemented, the cumulative incremental risk is shown by the diagonal line proceeding from birth to age 70 years (i.e., risk is allowed to accumulate at an annual rate of (1x10-5)/70 per year, or (AACC*URF/70) under T-RACT. The gray area below the diagonal line represents the portion of allowable lifetime risk accumulating from the incremental source.	Presents legal opinion in violation of Rule 485.
¶ 29	Using the 70-year basis proposed by DEQ and Perpetua allows Perpetua to emit a lifetime of allowable emissions in 16 years, and undermines the health protectiveness of the rule and increases cancer risk.	Presents legal opinion in violation of Rule 485.
¶ 36	This shortsighted conclusion is incorrect, unprecedented, and not supported by EPA guidelines.	Presents legal opinion statement in violation of Rule 485.
¶ 37	DEQ's misinterpretation would allow emissions and consequent exposures of more than two orders of magnitude greater risk than the AACC (1.2 X 10-4 equivalent risk) for six years.	Presents legal opinion in violation of Rule 485.

Paragraph or Section Header	Language to Strike	Justification to Strike
Title of Figure 3	Comparison of Cumulative Risk (CR) for 6-year Project emitting a Carcinogen with a Mutagenic MOA using the Project-specific (16/70) Adjustment Factor and Proper TAPS Application	Presents legal opinion and conclusory statement in violation of Rule 485.
¶ 45	Conversely, proper application of the TAPs rule using the maximum one-year annual average ambient air carcinogen concentration is shown by the lower cumulative risk line (gray line). Proper implementation of the TAPs rule would result in 4.6x10-6 cumulative cancer risk at age six years, as shown in Figure 3.	Presents legal opinion in violation of Rule 485.
Title of Figure 5a	Cumulative Risk (CR) and Margin of Safety (MOS) under Proper Implementation of Idaho TAPS Rules for 3 Successive 6-year Projects	Presents legal opinion in violation of Rule 485.
¶ 50	The TAPs rule is health protective if properly implemented.	Presents legal opinion in violation of Rule 485.
Title of Figure 5b	Cumulative Risk (CR) and Margin of Safety (MOS) under Proper Implementation of Idaho TAPS Rules for 3 Successive 6-yea Projects emitting Carcinogen Exhibiting a Mutagenic Mod of Action (MOA*)	Presents legal opinion in violation of Rule 485.
¶ 51	The inappropriate averaging is allegedly justified by ad hoc risk assessment calculations and risk management protocols that undermine both the simplicity and the health protectiveness of the TAPs rule. The MOS is compromised, the public is no longer secure, and the regulated industry is now obliged to include cancer risk and health impact assessments in TAPs PTC applications to support the assertions of health protectiveness.	Presents legal opinion in violation of Rule 485.
¶ 52	There are no provisions in the Air Rules to allow manipulation of the required maximum one-year annual average ambient air carcinogen concentration or the AACC, or to submit risk calculations.	Presents legal opinion in violation of Rule 485.
¶ 55	Vice Chairman McMillan further indicated that DEQ's application of what he called the "short-sighted" Project-specific adjustment factor to the Stibnite Gold Project created a misleading risk analysis that greatly underestimates the actual cancer risk. In his view:	Highlighted language offers legal opinion in violation.

Paragraph or Section Header	Language to Strike	Justification to Strike
	The Idaho rules are not ambiguous. There is an acceptable risk associated with the AACC standard. There is an acceptable risk associated with DEQ-approved T-RACT projects, and there is an acceptable risk associated with the short-term project that is five years or less. There are no other acceptable risks identified in Idaho's air quality rules. I agree with Dr. McMillan's statement. (emphasis added)	
¶ 58	DEQ erroneously substitutes the 5-year rolling average emissions for the maximum one-year potential emissions required under Section 586 and T-RACT.	Presents legal opinion in violation of Rule 485.
¶ 60	Instead, DEQ substituted the 5-year rolling average for the required maximum one-year emission rate. There is no provision in the TAPs rule for altering or adjusting the predicted maximum one-year annual average. This erroneous substitution significantly reduces the MOS inherent in proper allocation of the one-year maximum emission rates. To be health protective, the prescriptive Section 586 rule explicitly (not typically) requires predicting the **maximum one-year annual average contaminant concentration** using prescribed emissions estimates, and assuring that concentration is not exceeded during the life of the facility.	Presents legal opinion in violation of Rule 485.
¶ 61	It is not possible from the available information provided by DEQ to determine how this 5-year rolling average compares to the maximum one-year emission rate that should have been used.	Presents legal opinion and conclusory statement in violation of Rule 485.
Section Header C	Ambient air arsenic concentrations and cancer risk are underestimated for the SGP by improper application of the non-WEP emissions scenarios.	Presents legal opinion in violation of Rule 485.
¶ 65	In the context of properly applying the TAPs rule, the non-WEP adjustment factor is irrelevant. DEQ's obligation is to identify the emission scenario that produces the maximum one-year annual average ambient air carcinogen concentration. That value is the maximum WEP2 scenario, and would not consider non-WEP scenarios unless the non-WEP emissions sources were operating contemporaneously during the WEP2 emission maximum year. In that case, any non-WEP	Presents legal opinion in violation of Rule 485.

Paragraph or Section Header	Language to Strike	Justification to Strike
	scenario operating in the same year as the WEP2 maximum configuration would add to, not dilute, the critical receptor maximum ambient air concentration.	
¶ 66	DEQs applying the SGP Project-specific non-WEP adjustment factor effectively converts the 5-year alleged annual average value (0.00698 µg/m^3) to an arbitrary 0.00416 µg/m^3 16-year LOM average carcinogenic concentration.	Presents legal opinion in violation of Rule 485.
¶ 67	The final effect of DEQ's application of an arbitrary multi-averaging non-WEP adjustment factor can be estimated by comparing the WEP2 and non-WEP average ambient air carcinogen estimates (i.e., (0.00698 µg/m3 / 0.00416 µg/m3), or by a factor of 1.7.	Presents legal opinion in violation of Rule 485.
Section Header D	The combined application of the SGP 16/70 Project-specific adjustment factor, the 5-year rolling average adjustment factor, and the non-WEP adjustment factor increase cancer risk and negate the health protectiveness of the TAPs rule.	Presents legal opinion in violation of Rule 485.
¶ 68	The conclusions in the DEQ Board's Final Order correctly identified the three Project-specific adjustment factors that undermine the health protectiveness of the TAPs rule for carcinogenic risk. The Board correctly concluded that application of these adjustment factors underestimates cancer risk. DEQ applied the: 1) 5-year rolling average; 2) non-WEP; and 3) SGP 16/70 LOM adjustment factors sequentially to the input and the output of the predictive air quality model. As a result, the dilution effects are multiplicative, rather than additive.	Presents legal opinion in violation of Rule 485.
¶ 70	DEQs sequential application of the three SGP Project-specific adjustment factors underpredict cancer risk by 13 times, as these carcinogenic risk levels are employed in properly implementing the TAPs rule.	Presents legal opinion in violation of Rule 485.
¶ 72	As DEQ admits,34 cancer dose-averaging has seldom, if ever, been used in TAPs carcinogenic risk compliance evaluations for a stationary source under the Clean Air Act in Idaho. Although there is a history of using cancer dose-averaging in risk assessment and risk management protocols for short-term remediation projects at contaminated sites, applying it to the SGP PTC is unprecedented. In implementing the SGP 16/70 Project-specific adjustment factor, DEQ has deviated from the long-held prescribed TAPs rule protocol of guaranteeing the **maximum one-year annual average carcinogen concentration** will not exceed the AACC or T-RACT	Presents legal opinion in violation of Rule 485.

Paragraph or Section Header	Language to Strike	Justification to Strike
	AACC for each year of the Project. This thirty-year health protective strategy has provided the public comfort that cancer risk exposures are within acceptable limits both near the source and Statewide.	
Section Header E	DEQ's SGP Project-specific adjustment factors represent a significant change in the regulation of carcinogenic risk in Idaho that increases both cancer risk and regulatory burden.	Presents legal opinion in violation of Rule 485.
¶ 77	These questions demonstrate the short-sightedness of DEQ's acquiescence to Perpetua in allowing dose-averaging concepts to be applied to the Section 586 TAPs rule. Proper application of the rule inherently precludes risk averaging to maintain health protectiveness, without requiring applicants to address the issues without guidance. The regulatory burden placed on future applicants by this modified policy is potentially immense.	Presents legal opinion in violation of Rule 485.
¶ 80	Idaho's current TAPs rule MOS appropriately accommodates both these conclusions if properly implemented as illustrated in Figure 1, above.	Presents legal opinion in violation of Rule 485.
¶ 94	This opinion concludes that DEQs use of the ad hoc SGP Project-specific adjustment factors undermines the health protectiveness of the TAPs rule. The TAPs rule was specifically developed to avoid requiring risk assessment analyses by providing an inherent margin of safety (MOS). These SGP Project-specific adjustment factors facilitate cancer dose-averaging risk calculations that allow the SGP to significantly increase arsenic emissions based on short-term Life of Mine (LOM) assumptions, but to nevertheless average the risk associated with those increased emission over 70-years.	Presents legal opinion in violation of Rule 485.
¶ 96	There is neither a provision, nor a need, for risk assessment if the TAPs Rules are properly implemented based on annual compliance with **maximum one-year annual average ambient air carcinogen concentration**. This application of the TAPs rule has served Idaho well for three decades. This policy change allowing risk averaging through the SGP Project-specific adjustment factors not only undermines the health protectiveness of the individual applicant source, but also the Statewide strategy that keeps all Idahoans safe with minimal regulatory burden.	Presents legal opinion in violation of Rule 485.

DYLAN LAWRENCE
VARIN THOMAS LLC
P.O. Box 1676
Boise, ID 83701
(208) 345-6021
dylan@varinthomas.com

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	BEQ Case No. 0101-22-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	OAH Case No. 23-245-01 THIRD AMENDED SCHEDULING ORDER, NOTICE OF HEARING, AND PREHEARING ORDER

On October 15, 2024, the parties and hearing officer convened for a prehearing conference via Zoom. Based on the discussion and agreements reached among the parties and hearing officer at the conference and in subsequent email exchanges, the following dates, deadlines, and procedures shall govern the remainder of these administrative proceedings:

Thursday, October 17, 2024, 9:00 a.m.: Day 1 of hearing on the merits, Joe R. Williams Building, 700 W. State Street, 1st floor East Conference Room, Boise, Idaho 83702.

Friday, October 18, 2024, 9:00 a.m.: Day 2 of hearing on the merits, Joe R. Williams Building, 700 W. State Street, 1st floor East Conference Room, Boise, Idaho 83702.

Friday, November 8, 2024: Deadline for all parties to file post-hearing briefs. Post-hearing briefs shall be limited to 25 pages of content, excluding first page and certificate of service.

Friday, November 8, 2024: Deadline for Petitioners to file response to Perpetua's Amended Motion to Strike of October 15, 2024. Petitioners' response shall be limited to 8 pages of content excluding first page, certificate of service, and attachments, which is effectively the same page count as the Amended Motion.

Wednesday, November 13, 2024: Deadline for Perpetua to file a reply brief in support of its Amended Motion to Strike, limited to 5 pages of content, excluding first page and certificate of service.

In addition to the above dates and deadlines, the parties and hearing officer agreed to the following procedures with respect to the hearing-on-the-merits:

Because the parties are filing pre-hearing briefs and post-hearing briefs, opening and closing statements are not necessary.

The order of presentation at hearing shall be: DEQ, Perpetua, Petitioners.

Generally speaking, the parties and hearing officer believe it is reasonable to allocate approximately 4 hours of hearing time each for DEQ, Perpetua, and Petitioners, including time for cross-examination and questions from the hearing officer. For example, DEQ filed expert witness declarations of Kevin Schilling and Norka Paden. The goal and expectation is that direct examination, cross-examination, and hearing officer questioning of Mr. Schilling and Ms. Paden will be completed in roughly 4 hours of hearing time, excluding breaks, *etc*.

For the most part, the parties are already aware of the other parties' likely hearing exhibits because the expert witness declarations included the majority of the exhibits that will be used at hearing. In addition, the parties expressed a preference for minimizing the service and receipt of

additional hard copies of exhibits and instead prefer to rely on the electronic versions in the record to the maximum extent possible. Therefore, the parties and hearing officer agreed that if an exhibit to be proffered at hearing is an existing exhibit to an expert witness declaration, the proffering party only needs to produce one hard copy of the exhibit at the hearing. If a party intends to proffer an exhibit that is not an existing exhibit to an expert witness declaration, it should produce four hard copies of the exhibit at the hearing.

Labeling of exhibits shall be as follows: DEQ, 100-199; Perpetua, 200-299; Petitioners, 300-399.

Finally, because the prehearing conference and this order/notice have occurred within a relatively truncated period of time, the hearing officer intends to begin the hearing on October 17 by confirming it accurately reflects the understandings of the parties.

Dated this 16th day of October, 2024.

Dylan Lawrence
Hearing Officer

CERTIFICATE OF SERVICE

I hereby certify that on this 16th day of October, 2024, I caused to be served a true and correct copy of the foregoing by the following method to:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Paula Wilson, Hearing Coordinator
Division of Environmental Quality
Energy and Resources Division
Office of the Attorney General
1410 N. Hilton St.
Boise, ID 83706
paula.wilson@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Michael A. Short
Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
michael.short@deq.idaho.gov
hannah.young@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole Hancock
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
nicole.hancock@stoel.com
via electronic service



Dylan B. Lawrence
Hearing Officer

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 _____ NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	Agency Case No. 0101-22-01 OAH Case No. 23-245-01 NOTICE OF REPLACEMENT OF DEQ HEARING COORDINATOR

NOTICE IS HEREBY GIVEN that Diane Cutler has replaced Paula Wilson as the Department of Environmental Quality (DEQ) Hearing Coordinator. It is hereby requested that, as of this date, all documents filed in this matter be served by email upon Diane Cutler as the DEQ Hearing Coordinator in lieu of Paula Wilson.

Contact information for Diane Cutler is as follows:

Diane Cutler, Hearing Coordinator
Rules and Planning Analyst
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
(208)373-0165
diane.cutler@deq.idaho.gov

Dated this 4th day of November, 2024.

/s/ Paula J. Wilson
Paula J. Wilson, Paralegal
Energy and Natural Resources Division
Office of the Attorney General
1410 N. Hilton, Boise, Idaho 83706
paula.wilson@deq.idaho.gov

CERTIFICATION OF SERVICE

I HEREBY CERTIFY that on this 4th day of November, 2024, the foregoing was filed, served, and copied as shown below.

Dylan B. Lawrence
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
electronic service

Hearing Officer

Diane Cutler, Hearing Coordinator
Rules and Planning Analyst
Department of Environmental Quality
1410 N. Hilton
Boise, ID 8306
diane.cutler@deq.idaho.gov
electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
electronic service

Counsel for Petitioner Save the Southfork Salmon

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
electronic service

Counsel for Petitioners Nez Perce Tribe and Idaho Conservation League

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole C. Hancock
Stoel Rives LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
nicole.hancock@stoel.com
electronic service

Counsel for Intervenor Perpetua

Hannah M.C. Young
Michael A. Short
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
hannah.young@deq.idaho.gov
michael.short@deq.idaho.gov
electronic service

Counsel for Respondent DEQ

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
electronic service

/s/ Paula J. Wilson
Paula J. Wilson

RAÚL R. LABRADOR
Attorney General

SCOTT L. CAMPBELL
Deputy Attorney General
Chief, Energy and Natural Resources Division

Hannah M.C. Young, ISB No. 9781
hannah.young@deq.idaho.gov
Michael A. Short, ISB No. 10554
michael.short@deq.idaho.gov
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: 208.373.0422

Attorneys for Respondent

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047

NEZ PERCE TRIIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,

Petitioners,

v.

IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,

Respondent,

and

PERPETUA RESOURCES IDAHO, INC.,

Intervenor.

Case Docket No. 0101-22-01
OAH Case No. 23-245-01

DEPARTMENT OF ENVIRONMENTAL QUALITY'S POST-HEARING BRIEF

I. INTRODUCTION

On October 17 and 18, 2024, the Department of Environmental Quality ("DEQ"), Perpetua Resources, Inc. ("Perpetua"), and Petitioners Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon (collectively, "Petitioners") participated in an evidentiary hearing in the above captioned matter. The hearing was conducted in accordance with the Board of Environmental Quality's (the "Board") May 9, 2024 *Final Order*, REC 3695-3720, and June 12, 2024 *Order on Petitions for Reconsideration and/or Clarification of Final Order*, REC 3835-43. In the Board's Final Order, the Board "remand[ed] this matter back for the development of further evidence regarding the ambient air concentrations of arsenic that will be produced by the Stibnite Gold Project ("SGP") and whether those levels comply with the Air Rules." REC 3717. In particular, the Board remanded the matter to the Hearing Officer for further evidence because it found as follows:

> (1) DEQ did not act reasonably and in accordance with law when it applied the 16/70 calculation to the ambient arsenic air concentration analysis;
>
> (2) DEQ did not act reasonably in using a five-year rolling average for T-RACT that was not properly supported by permit conditions; and,
>
> (3) there was insufficient evidence to support the T-RACT analysis limiting the non-West End Pit production limit.

See REC 3712-15. The Board's remand asked DEQ to provide the necessary evidence on these sub-issues (hereinafter the "Remaining Issues") to demonstrate that DEQ acted reasonably and in accordance with the law. *See* REC 3842 (the parties "must focus only on the development of additional factual evidence on the ambient arsenic air concentration analysis performed by DEQ for the PTC"). The additional evidence presented on remand—through both written expert declarations and oral testimony—does in fact clearly demonstrate that DEQ acted reasonably and in accordance with law when it issued the Permit to Construct ("PTC").

II. PERPETUA'S MOTION TO STRIKE

Prior to the hearing, Perpetua filed its *Motion to Strike Expert Declarations Of William Tiedemann and Ian H. von Lindern* on October 14, 2024, and an *Amended Motion to Strike Expert Declarations Of William Tiedemann and Ian H. von Lindern* on October 15, 2024 ("Amended Motion"). REC 6929-6990. The Amended Motion moves to strike specific paragraphs and exhibits of the declarations of William Tiedemann and Dr. Ian H. von Lindern, Petitioners' two witnesses. As explained in the Amended Motion, the declarations contain statements that are merely legal opinions expressed as conclusory statements. In addition, they provide and rely upon evidence that is irrelevant, hearsay, and cannot be authenticated.

In addition to striking the declarations, as argued in the Amended Motion, the Hearing Officer should strike documentary evidence used by Mr. Tiedemann at the hearing, as well as testimony of Mr. Tiedemann given at the hearing. At the hearing, DEQ asked Mr. Tiedemann questions related to the authenticity and relevance of the documents attached to his declaration. *See* Tr. 364-373.[1] Mr. Tiedemann was unable to authenticate his attached exhibits and continued to express only his own assumptions related to the documents. *Id*. These unauthenticated documents, and the conclusions derived from them, should be struck.

Additionally, and significantly, both DEQ and Perpetua objected to Mr. Tiedemann's testimony as an expert witness. Mr. Tiedemann's written and oral testimony covered a variety of topics, including legal interpretation of the Rules for the Control of Air Pollution in Idaho, IDAPA 58.01.01, *et seq.* (the "Air Rules") and speculation on toxicological and scientific modelling issues. Mr. Tiedemann does not possess the requisite experience or knowledge to opine on these topics as an expert.

[1] All transcript citations herein reference the transcript from the hearing held on October 17 and 18, 2024.

As to interpretation of the Air Rules, his legal conclusions relate to the substantive legal issues before the Hearing Officer and are improper topics for expert testimony. *See Ybarra v. Legislature by Bedke*, 166 Idaho 902, 908, 466 P.3d 421, 427 (2020) (The Idaho Supreme Court has "previously held that testimony containing conclusions of law by an expert witness is generally inadmissible"). When an expert witness offers a legal conclusion it "invade[s] the province of the court to determine the applicable law." *Ballad v. Kerr*, 160 Idaho 674, 694, 378 P.3d 464, 484 (2016). Thus, as to an expert's scientific, technical, or other specialized knowledge that may help the trier of fact to understand the evidence or to determine a fact in issue, the legal analysis of a non-lawyer, expert witness is not helpful. *See Ybarra, supra* (striking numerous legal conclusions contained in the expert's declaration).

Moreover, as clarified by the Board, the development of additional factual evidence "must focus only" on "the ambient arsenic air concentration analysis performed by DEQ for the PTC." REC 3842 (emphasis added). Mr. Tiedemann's testimony ventures far afield from this narrow topic. The development of the TAPs rules over 30 years ago is less important than the analysis DEQ actually conducted in 2022—and, Mr. Tiedemann did not personally participate in the development of those rules, nor is he a qualified legal expert able to opine on regulatory history and interpretation. For these reasons, and those further presented in Perpetua's Amended Motion, Mr. Tiedemann's analysis and legal conclusions related to the Air Rules are an improper evidentiary basis for the fact finder to consider. The Hearing Officer should strike it from the record and afford it no weight.

Additionally, DEQ disagrees that Mr. Tiedemann has the requisite scientific, technical, or other specialized knowledge to provide the Hearing Officer expert testimony that assists in the development of the record. In this remand, the Board was explicit that the matter would return to the Hearing Officer for the "development of further evidence regarding the ambient air

concentrations of arsenic that will be produced by the SGP." REC 3717. Specifically, the Board indicated that the additional factual record should derive from "a toxicologist or other qualified expert regarding the cancer risk." REC 3716.

Mr. Tiedemann was tendered as an expert witness "in mechanical engineering, air permitting, and environmental compliance." Tr. 324:6-7. None of these topics relate to toxicology, nor cancer risk assessment. Consequently, even if Mr. Tiedemann has the requisite knowledge to be considered an expert in these fields—a claim DEQ strongly debates—his expertise is not relevant to the narrow and specific issues on remand. Consequently, Mr. Tiedemann's testimony is irrelevant and should be excluded. *See* IDAPA 62.01.01.475 (evidence is excludable under Idaho Code § 67-5251); I.C. § 67-5251(1) ("[T]he presiding officer may exclude evidence that is irrelevant"). Given the significant technical expertise required to analyze this matter and Mr. Tiedemann's lack of relevant experience in toxicology or cancer risk assessment, his scientific testimony—as well as his foray into legal conclusions and regulatory interpretation—has no probative value, confuses the issues, and poses a risk of unfair prejudice. Such evidence should be excluded. *See* I.R.E. 403.

DEQ joins in the Amended Motion and asks the Hearing Officer to strike those enumerated paragraphs and exhibits of the declarations of both Mr. Tiedemann and Dr. von Lindern, as outlined in the motions. Additionally, DEQ herein asks that the Hearing Officer strike the oral testimony of Mr. Tiedemann concerning legal conclusions and topics outside his proffered expertise of mechanical engineering, air permitting, and environmental compliance. DEQ understands that the Hearing Officer is not bound by the Idaho Rules of Evidence, except as provided in OAH Rule 475. To the extent the Amended Motion and DEQ's present request to strike is denied, DEQ encourages the Hearing Officer to assign little weight, if any, to the

testimony that would be inadmissible under the Idaho Rules of Evidence. *See* IDAPA 62.01.01.476.

III. STANDARD OF REVIEW & BURDEN OF PROOF

The Board "must determine whether DEQ 'has acted reasonably and in accordance with law' when issuing the Permit . . ." REC 3697. As to the Remaining Issues, the Board found DEQ did not act reasonably and in accordance with law because it lacked sufficient evidence to support DEQ's analysis. REC 3706; *see also* REC 3714-15 ("the other four issues brought before the Board have been finally decided and cannot be reopened on remand").

Upon remand, Petitioners still bear the burden of proof as the party challenging DEQ's issuance of the PTC. IDAPA 62.01.01.477 ("the burden of proof is on the party requesting or challenging an agency action or order"). The Petitioners' must meet their burden by a preponderance of the evidence. *Id*. Thus, the Hearing Officer must determine whether Petitioners presented competent evidence establishing that DEQ was not reasonable and did not act in accordance with the law when it issued the PTC; and specifically, whether DEQ's analysis of the arsenic ambient air concentrations was unreasonable and unlawful. The Hearing Officer, and the Board, must only consider whether DEQ was reasonable and acted in accordance with the law—not whether a person disagrees with DEQ's reasonable and lawful approach.

Throughout this contested case, and including the current remand, it has been clear that expert opinions and testimony are necessary. *See* REC 3375 (in the December 5, 2023 *Amended Memorandum Decision on Motions for Summary Judgment and Preliminary Order*, the Hearing Officer discussed the technical nature of the air permit matters and determined that DEQ staff were expert witnesses); REC 3716 (the Board seeks expert testimony from a toxicologist or other qualified expert). Because the PTC at issue, as well as the questions of cancer risk and arsenic concentrations, are technical and complex, expert testimony has been essential. *See* REC 3375.

Importantly, DEQ's "experience, technical competence, and specialized knowledge may be utilized in the evaluation of the evidence." I.C. § 67-5251(5).

Prior to the hearing, DEQ, Perpetua, and Petitioners each provided two expert declarations. At the hearing, the parties presented those same witnesses to testify as experts. The expert witness testimony was meant to provide the "further evidence" requested by the Board. That testimony proves that DEQ both acted reasonably and lawfully. Specifically, the written and oral testimony of DEQ and Perpetua's expert witnesses establish that the SGP permit DEQ issued to Perpetua meets all requirements of the Air Rules and that DEQ acted reasonably and in accordance with law when it performed its analysis and created PTC conditions related to the arsenic emissions from the SGP. Thus, Petitioners are unable to prove, and have been unable to prove, that their assertion—DEQ acted unreasonably and unlawfully—is "more probably true than not true." *See* I.C.J.I. 1.20.1 (providing civil jury instructions for the preponderance of the evidence burden of proof).

IV. REGULATORY SCHEME

The testimony from DEQ and Perpetua's expert witnesses demonstrate that the Air Rules support DEQ's arsenic emissions analysis, air impact analysis, and the related permit conditions DEQ imposed for the SGP. For the Remaining Issues, the applicable sections of the Air Rules have been outlined several times in this proceeding, which include: Sections 203, 161, 210, 586, and the definition of "toxic air pollutant carcinogenic increments" in Section 006.125 of the Air Rules.[2] *See* REC 3416-17, 3707-10, 6894-96. In general terms, the parties appear to agree on the relevance and applicability of these specific rule sections listed above. However, the Board primarily questioned whether DEQ had authority to factor in the project duration for the SGP's arsenic

[2] DEQ issued the PTC to Perpetua on June 17, 2022. Thus, the 2022 version of the Air Rules are cited and relied upon.

emissions and the resulting impact to air. This questioning was based on a fundamental misunderstanding of the Air Rules.

Section 203 of the Air Rules states that DEQ cannot issue a permit to construct unless the permit applicant can demonstrate to the satisfaction of the Department, "using the methods provided in Section 210," that "the emissions of toxic air pollutants from the stationary source . . . would not injure or unreasonably affect human health or animal life or vegetation as required by Section 161." IDAPA 58.01.01.203.03. An applicant has demonstrated compliance with Section 210 when the modeled maximum ambient air impact is less or equal to the applicable acceptable ambient concentration ("AACC") for carcinogens as provided in IDAPA 58.01.01.586. *See* IDAPA 58.01.01.210. The AACC in IDAPA 58.01.01.586 "is calculated by dividing the acceptable lifetime risk (1 in 1,000,000) by the [unit risk factor ("URF")]," which is "4.3E-03µg/m3 for arsenic." REC 4282. The URF, which is developed by the Environmental Protection Agency (EPA) is the risk probability from exposure to 1 $\mu g/m^3$ of a substance continuously (24 hours/day and 365 days/year) over a lifetime of exposure (assumed to be 70 years). REC 3922.

Section 210.12 then allows a permit applicant to "use [Toxic Air Pollutant Reasonably Available Control Technology ("T-RACT")] to demonstrate preconstruction compliance for toxic air pollutants listed in Section 586." IDAPA 58.01.01.210.12. T-RACT "is an emission standard based on the lowest emission of toxic air pollutants that a particular source is capable of meeting by the application of control technology that is reasonably available, as determined by the Department…" IDAPA 58.01.01.210. When an applicant uses T-RACT, the allowable cancer risk changes from 1-in-1,000,000 to 1-in-100,000.

DEQ used the methods in Section 210 to determine the SGP's compliance with Section 161. Because Perpetua proposed to use T-RACT, the arsenic emissions from SGP could not create a lifetime cancer risk of greater than 1-in-100,000. Tr. 62:16-21. Perpetua then modeled the

emissions from the SGP, based on its "maximum design rate." Tr. 266:23-25. The modeling relied upon many conservative assumptions, using worst case scenarios. *See* Tr. 269:23-272:3. Mr. Schilling explained the next steps in the process, stating:

> During development of final SGP permitting analyses, [Perpetua] expressed concern that compliance with AACCs could not be demonstrated with the conservative assumptions used in previous analyses, including the assumption that the SGP was a permanent source rather than one of 16-year duration. Rather than revise the analytical approach to provide a less conservative assessment of impacts, I proposed that compliance with carcinogenic TAP increments could be based on cumulative cancer risk of the limited-duration project rather than the worst-case annual impact for a project of limited duration. Since the AACC annual average is an expression of a 1- in-1,000,000 cancer risk limit for permitting projects, modeled impacts (annual contaminant concentration) must be adjusted to an exposure concentration that is appropriately comparable to the annual average AACC. Therefore, annual impacts for a project with a 16-year duration could be multiplied by a 16/70 factor to more appropriately compare to the AACC, which is based on a 70-year exposure duration.

REC 3924-25. "So, in Perpetua's case, in order to develop an appropriate factor to compare or an appropriate concentration to compare to the AACC, [DEQ] needed to account for the exposure duration." Tr. 35:1-4.

DEQ's application of the project specific adjustment is consistent with the purpose and intent of the TAPs rules. Mr. Schilling stated that, in his experience based on personally participating in the development of the TAPs rules, the "carcinogenic TAP AACCs were established to ensure that impacts of any carcinogenic TAPs from a project or facility would not cause a lifetime cancer risk over 1-in-1,000,000 or 1-in-100,000 when using T-RACT." REC 3926. He explained:

> Going all the way back to the toxics policy that was used in permitting, the cornerstone of that was focused on project risk. In other words, any particular project, whether it is a new facility or a modification, not causing a risk to exceed one in a million or one in 100,000, some things changed with T-RACT going from policy to regulation.

Tr. 18:5-12. Thus, "DEQ continually asserted that carcinogenic TAPs resulting from a permitting project should be regulated to prevent an unacceptable excess cancer risk based on a 70-year lifetime." REC 3922. In simple terms, from the beginning of their development, the cornerstone of the TAPs rules is that total increased pollutant-specific cancer risk from a project over the project's life cannot exceed the lifetime cancer risk limit imposed by the rules.

This approach, as described by Mr. Schilling, makes sense given the Air Rules' reference to and reliance upon EPA's URFs. Section 586 specifically lists the URF for each pollutant. Thus, "DEQ adopted EPA's cancer risk values and risk assessment methodology when it promulgated the Air Rules for toxic air pollutants from stationary sources." REC 4282. Stated another way, "[c]ancer risks used to establish AACCs were based on EPA's cancer risk model (using established EPA URFs)." REC 3926. When asked if the Air Rules rely upon the URFs, Mr. Schilling responded by stating: "I believe it is really the cornerstone of the whole TAPs program for regulating carcinogenic compounds." Tr. 20:8-10. According to Mr. Schilling, inclusion of the URF demonstrates that "it's a project cancer risk that is the focus rather than an annual strict increment." Tr. 38:7-8. And, as Dr. Paden explained: "Under EPA's methodology for human health risk assessments, cancer risk calculations are done using a lifetime exposure set at 70 years," meaning the risk calculations use a lifetime of 70 years. REC 3877.

Further, Petitioners wrongly argue that a permittee must comply with the AACCs on an annual basis. That assertion is simply not supported by the rule language or the rule history. The Air Rules define "toxic air pollutant carcinogenic increments" as:

> Those ambient air quality increments based on the probability of developing excess cancers over a seventy (70) year lifetime exposure to one (1) microgram per cubic meter (1 ug/m3) of a given carcinogen and expressed in terms of a screening emission level or an acceptable ambient concentration for a carcinogenic toxic air pollutant. They are listed in Section 586.

IDAPA 58.01.01.006.125. All the parties appear to agree that the TAPs rules are incremental, meaning the rules are "just a base-allowed impact for that project" and "it doesn't concern itself with what goes on at the whole rest of the facility or what goes at the neighboring facility or what is already there for background." Tr. 36:16-20. Significantly, the rules were not intended to be annual limits. *See* Tr. 277-278, Tr. 416; Tr. 450. Instead, the rules create an increment that is "one in 1 million over a lifetime of exposure," Tr. 36:25-37:1. The lifetime increment is what the permittee must comply with, not an annual limit.

In summary, the TAPs rules require that a project not exceed the lifetime allowable risk from a project. That risk is a 1-in-1,000,000, or 1-in-100,000 if T-RACT is used, increased risk. Again, the AACCs are not annual limits, but an annual average "expression of a 1-in-1,000,000 cancer risk limit for permitting projects." *See* REC 3924-25. This requires DEQ to adjust exposure duration to "to an exposure concentration that is appropriately comparable to the annual average AACC." REC 3925. A permanently operating project is the underlying assumption for using a 70-year lifetime and exposure duration. Where a project will not operate permanently, however, a specific adjustment for the actual life of the project is reasonable. Consequently, DEQ's use of a project specific adjustment factor is supported by the regulations outlined above.

V. EXPERT TESTIMONY ON THE REMAINING ISSUES

Before reviewing the expert testimony provided on remand, a review of the applicable standard of review for technical agency decisions is appropriate.[3] When analysis "requires a high level of technical expertise," a court must defer to "the informed discretion of the responsible [] agencies." *Kleppe v. Sierra Club*, 427 U.S. 390, 412 (1976). "When specialists express conflicting

[3] The discussion hereinbelow outlines appropriate customary tools of interpretation utilized before the deferential rule of agency interpretation in *Chevron, U.S.A., Inc. v. Nat. Res. Def. Council, Inc.*, 467 U.S. 837 (1984) and after its overruling by *Loper Bright Enterprises v. Raimondo*, 144 S. Ct. 2244 (2024). *See* I.C. § 67-5279(5) (requiring application of customary tools of interpretation when interpretating statute).

views, an agency must have discretion to rely on the reasonable opinions of its own qualified experts even if, as an original matter, a court might find contrary views more persuasive." *Marsh v. Oregon Nat. Res. Council*, 490 U.S. 360, 378 (1989). A court "will uphold a decision of less than ideal clarity if the agency's path may reasonably be discerned." *Bowman Transp., Inc.*, 419 U.S. at 286 (citing *Colorado Interstate Gas Co. v. FPC*, 324 U.S. 581, 595 (1945)) (emphasis added).

"When examining this kind of scientific determination, as opposed to simple findings of fact, a reviewing court must generally be at its most deferential") *Baltimore Gas & Electric Co. v. Natural Resources Defense Council, Inc.*, 462 U.S. 87, 103 (1983) (emphasis added). This is particularly true for statistical and modeling analysis. *See Appalachian Power Co. v. EPA*, 135 F.3d 791, 802 (D.C. Cir. 1998) (per curiam) (identifying statistics as "the prime example of those areas of technical wilderness into which judicial expeditions are best limited to ascertaining the lay of the land"). The court "will examine each step of [the agency's] analysis to satisfy ourselves that the agency has not departed from a rational course, and only when the model bears no rational relationship to the characteristics of the data to which it is applied will we conclude the use of the model was arbitrary and capricious." *Huntsman Petrochemical LLC v. Env't Prot. Agency*, 114 F.4th 727, 735 (D.C. Cir. 2024) (emphasis added) (cleaned up).

A. The Expert Testimony Demonstrates that DEQ Acted Reasonably and in Accordance with Law in Using the Project Specific 16/70 Adjustment.

i. The applicable standard for compliance with the TAPs rules is the cancer risk in ambient air resulting from allowable emissions of the proposed project for the life of the project.

The cornerstone of the carcinogenic TAP rules is limiting project-caused cancer risk to less than 1-in-1,000,000, or 1-in-100,000 when T-RACT is used. The Board misunderstood the Air Rules, finding that "nowhere in the Air Rules does it provide that a project that will operate more than 5 years, but less than 70 years may be adjusted in proportion to the amount of time it will

operate." REC 3715. This conclusion is based on the improper assumption that the Air Rules require compliance with the AACCs on an annual basis, and not compliance with the lifetime cancer risk increment. Based on the testimony provided at the hearing and in the declarations, the Air Rules support DEQ implementing the TAPs rules as it did.

First, the definition of "Toxic Air Pollutant Carcinogenic Increments" supports DEQ's analysis. The definition, provided above, "references the [one] in a million cancer risk being the criteria, and that the AACCs are an expression of that for a continuation exposure over the lifetime." Tr. 20:15-18; *see* IDAPA 58.01.01.006.125. The definition is also "expressed in terms of the screening emission limit or the acceptable ambient concentration of a carcinogen," and the use of the word "expressed," in Mr. Schilling's opinion, "makes it clear that it focuses on a total project-imposed cancer risk rather than a specific year by year." Tr. 32:9-14.

Further, Section 586, which contains the AACCs, also provides the URFs, which were created by EPA. The URF[4] is "the toxicity value that you compare an exposure concentration to to estimate risk from that exposure." Tr. 182:24-183:1. As Dr. Paden explained, "DEQ has in the rules that [A]ACC uses the inhalation unit risk which comes from EPA," and that Section 586 contains "a footnote there that indicates that value is taken from EPA." Tr. 137:5-8. Thus, the inclusion of the URF in Section 586 demonstrates that "it's a project cancer risk that is the focus rather than an annual strict increment." Tr. 38:7-8. When Mr. Schilling was asked what the impact would be to the TAPs rules if the URFs were not included in Section 586, he stated:

> It would be less clear that it's project risk we're concerned about. I wouldn't say it would be clear that the intent would be just an annual standard because through the rulemaking process and that entire thing and background, project risk was always sort of the cornerstone focus.

[4] Ms. Lopez testified that the unit risk factors are the same as the inhalation unit risk. *See* Tr. 182:9-13.

Tr. 37:22-38:3. In simple terms, the rules are focused on the overall risk of the project based on exposure over a lifetime.

Dr. von Lindern testified that the "annual compliance with [the AACC] is the cornerstone of the rule, as opposed to some of the opinions that we've had here previously." Tr. 416:22-25. He also continually referred to the AACC as a *maximum annual* or *maximum one year* concentration. *See, e.g.,* REC 6108, 6110, 6112. However, when asked where the term "maximum one-year annual average ambient air carcinogen concentration" came from, he responded by stating that it is "how you should interpret [section] 586, which says 'annual averages.'" Tr. 484:24-25 (emphasis added). He also admitted that the terminology was not actually in the rules. Tr. 485:2.

This was not the only instance where Dr. von Lindern's expressed his desire for the Air Rules to operate differently than they actually do. For example, Dr. von Lindern continually discussed a "margin of safety" and the impacts to sensitive populations. *See* Tr. 417:9-15; REC 6112. But as he again admitted, the margin of safety is not in the Air Rules, Tr. 478:11-12 ("that's my term to help explain this"), and that the URFs already take into account sub-susceptible groups, Tr. 484:6. Finally, even though EPA does not list arsenic as having a mutagenic mode of action, he continually stated it *should be* and instead noted it was "one of the most controversial things going on in EPA." Tr. 483:2-3; *see also* Tr. 479:25-480:2.

DEQ acted reasonably and lawfully when it used a project specific exposure adjustment factor in determining Perpetua's compliance with the Air Rules. For the reasons discussed above, the Air Rules support using the adjustment factor because compliance is based on the *life of the project.* "[T]o develop an appropriate factor to compare or an appropriate concentration to compare to the AACC, [DEQ] needed to account for the exposure duration." Tr. 35:1-4. Mr. Schilling aptly described DEQ's implementation of the rules as follows:

> I believe we take a stance with the rules that implements the rules to our best understanding and reasonable understanding of what they are. We have a case where a lot of different stakeholders wish the rules were either more stringent or less stringent and would like to see them account for co-contributing sources, additive carcinogenic effects, other things that may have just come out in the last 30 years since the rules have been promulgated that deal with new toxicological concepts and whatever else. But we are dealing with the rules we have and we implement them to what we believe is a reasonable and fair assessment to our regulated community. And sometimes we face challenging things that don't completely fit in the box we anticipated them to fit in. And we look at the rules and interpret them accordingly. We firmly believe that making this assessment based on what's in the rules as defining project risk as the cornerstone. We feel it is appropriate to make that exposure duration adjustment.

Tr. 56:23-57:19. Although Petitioners clearly feel differently, their opinions are not supported by rule language. Petitioners cannot demonstrate by a preponderance of the evidence that DEQ acted unreasonably or unlawfully.

ii. The PTC does not need a specific condition limiting the mine operations to 16 years.

As already discussed, DEQ used a 16-year life of mine in calculating the risk, ultimately creating a 16 over 70-year project adjustment for exposure duration. But because the PTC contains production limits, a 16-year limit in the PTC is unnecessary. Mr. Schilling explained that the production limits cap Perpetua's production so that, "in the absence of a time limit in there, they could actually extend operations longer." Tr. 120:15-16. And, if Perpetua "went at a slower pace they would need to extend it longer." Tr. 120:17-18. However, "by extending it longer, since our emissions are proportional on production and concentrations are proportional on emissions and risk is dependent upon the total exposure, you're going to arrive at the same risk whether it would be 16 years or 70 years." Tr. 120:19-24. Ms. Lopez agreed with this assertion, stating: "Exposure to a higher concentration for a shorter amount of time is the risk equivalent of a higher -- lower concentration for a longer period of time." Tr. 208:14-17. Thus, the 16-years is simply a worst-case scenario for annual impacts, wherein Perpetua would be operating at the maximum capacity, as allowed by the PTC conditions.

iii. DEQ's analysis of arsenic emissions, and the corresponding PTC conditions, are protective of public health.

The arsenic analysis performed by DEQ, which included the project specific adjustment factor, is protective of public health. In its Final Order, the Board stated that it "has not found sufficient evidence in the record to convince it that the 16/70 analysis performed by DEQ was equally or more protective of human and animal life and vegetation as what is provided for by the Air Rules." REC 3717. The testimony from DEQ and Perpetua's expert witnesses clearly provides sufficient evidence demonstrating that DEQ's arsenic analysis was equally or more protective.

As has been discussed herein, the Air Rules, specifically the AACCs, rely upon and incorporate EPA's science and methodologies. *See* REC 3876, REC 4284. The URFs in Section 586 were developed by EPA and "reflect[] many years of research and evaluation. . ." REC 4282. Using EPA's methodology for calculating cancer risk, both Dr. Paden and Ms. Lopez concluded that the use of the project specific adjustment factor did not unreasonably increase the risk and was in fact in compliance with the T-RACT 1-in-100,000 increment. *See* Tr. 134:23, 201:2.

Both Dr. Paden and Ms. Lopez calculated the cancer risk from the SGP using EPA's formula for human health risk assessments where cancer risk calculations are done using a variable exposure duration and an assumed 70-year lifetime. REC 3877. That formula is as follows:

EC = (CA x ET x EF x ED)/AT

Where: EC ($\mu g/m^3$) = exposure concentration;
CA ($\mu g/m^3$) = contaminant concentration in air;
ET (hours/day) = exposure time;
EF (days/year) = exposure frequency;
ED (years) = exposure duration; and
AT (lifetime in years 70 x 365 days/year x 24 hours/day) = averaging time

Id.

And Ms. Lopez testified:

> Using the highest modelled annual average arsenic concentration from the project of 0.00414 µg/m^3 (REC 716) the calculation of the air concentration adjusted for exposure from the SGP is as follows:

$$\left[0.00414\,\frac{\mu g}{m3}\,x\,24\,\frac{hours}{day}\,x\,\frac{1\,day}{24\,hours}\,x\,365\,\frac{days}{year}\,x\,16\,years\right] / \left[365\,\frac{days}{year}\,x\,70\,years\right] = 0.00095\,\frac{\mu g}{m3}$$

REC 4284. As Ms. Lopez explained:

> This calculation took the exposure, the CA, contaminate concentration in air, which was the emissions from the mine, multiplied it by 24 hours a day, 365 days a year, for 16 years, and then divided by the averaging time in years to develop an exposure concentration that is equal to .00095.

Tr. 197:13-19.

Simply put, the result of these calculations demonstrated that the arsenic emissions from the SGP resulted in a .00095 µg/m3 arsenic concentration averaged over a lifetime. Thus, Ms. Lopez concluded that "[t]he actual risk is four in a million or approximately one in 240,000." Tr. 200:18-19; *see also* Tr. 136:1-5 (Dr. Paden similarly concluded: "But most importantly, the 16 years that we are discussing in this hearing, and that four in 1 million cancer risk. So that is the below the T-RACT which is below our rule standard for cancer risk. This is less than the T-RACT adjusted risk increment of 1-in-100,000.").

Clearly, the formulas above account for exposure duration. Dr. Paden testified that it is common practice when performing a risk assessment to adjust the exposure duration. Tr. 144:22. She explained, stating:

> In fact, usually when we are talking about residential exposures you can use different values from EPA, 26 [years]. Or when you are valuating a receptor that could be -- a receptor who is going to be exposed, a recreational person who is going to go to the site only for a short amount of time, you can use that exposure duration, that way you don't overestimate the risk. So if you have information that is provided to me as a risk assessor and they tell me I am going to look at the risk here, to be more accurate I can use that information and put the 26, the 16, 15, whatever number the person is going to get exposed to get an accurate calculation of the cancer risk.

Tr. 143:24-144:13. Ms. Lopez agreed, stating "[c]omparing unadjusted emissions to the AACC would result in an over-estimation of cancer risk because the dose will not continue for the 70-year lifetime exposure assumed in the development of the AACC." REC 4283.

The expert testimony demonstrates that DEQ did not underestimate the cancer risk caused by the project. The expert testimony also demonstrates that the project specific adjustment was reasonable – calculating cancer risk naturally requires one to consider the exposure duration. REC 3877, REC 4286. The adjustment has also been shown to be lawful – the AACCs are based on EPA's methodologies and adjusting the exposure length is consistent with EPA methodology. *See* REC 3876-77, 4286. And the testimony of Dr. Paden and Ms. Lopez establish that "the highest air concentration of arsenic from the project is below the acceptable lifetime risk established by the T-RACT AACC." REC 4285.

iv. DEQ did not depart from any agency precedent in performing its analysis regarding arsenic emissions.

DEQ did not break from any established agency precedent when it factored in the duration of the project, both in terms of a 16-year lifetime and an overall production limit. Mr. Schilling testified that, in his experience, "we have not encountered applications that were over five years, but less than 70." Tr. 67:1-2. He also indicated that a permittee only has to indicate how long it will operate "if they want to take credit for a shorter than permanent duration in their permitting -- in their permit itself." Tr. 68:8-10. This is not a situation where DEQ had previously considered and rejected a project specific adjustment. This is also not a situation where DEQ has an explicit mandate preventing it from doing so. In fact, the Air Rules support DEQ's decision.

Petitioners' witnesses claimed that DEQ did in fact depart from agency practice. *See, e.g.,* Tr. 466:8-10; Tr. 340:5-9. But neither witness described a situation where DEQ was confronted with a project-specific duration adjustment but denied it based upon some agency position or

practice. When asked, Mr. Tiedemann stated that, in his time at DEQ, no permit applicant asked for a project specific adjustment (of less than 70 years but greater than 5). *See* Tr. 363:7-8. Mr. Schilling explained that when Perpetua did in fact make this request of DEQ, DEQ considered it, focusing on ultimate compliance with lifetime cancer risk, ensured it was a "reasonable approach to our interpretation," and then ultimately moved forward. Tr. 124:20-125:3. Thus, in reality, DEQ followed its typical permitting process where "you start with an application and the analysis gets refined over time." Tr. 30:11-13.

B. The Expert Testimony Demonstrates that DEQ Acted Reasonably and in Accordance with Law in Using a Five-Year Rolling Average.

Next, the testimony demonstrated that the five-year rolling average production limit for assessing compliance with the AACC is both reasonable and lawful. Again, the Board wrongly assumes that the AACCs provide annual compliance limits. But "long-term exposure to a given concentration over the life of the project is the critical parameter for the risk-based AACCs." REC 3919. Mr. Schilling explained:

> It goes back to the same cornerstone of the rules being project-imposed risk. As long as project-imposed risk is the criteria and we have a duration of the project of 16 years, what really matters for demonstrating, whether it complies or not, is where are we at after 16 years.

Tr. 39:14-19. Thus, the "[u]se of a 5-year averaging period for limiting processing rates easily accomplishes this requirement for a project with a 16-year duration, and it provides for reasonable periodic assurance of compliance with the long-term limit." REC 3926. Again, DEQ does not simply determine if the SGP complied with the lifetime AACC at the end of the project. Instead, DEQ uses "something less than 16 years as a responsible vehicle to identify when things might… be going wrong at an earlier time." *Id.*

The PTC also contains "sideboards" on production. Mr. Lewis and Mr. Schilling described these sideboards stating, "there are shorter-term processing limits in [the PTC]," Tr. 43:20-21, and

"[i]t's the 135,000 tons per day has sideboards and, you know, other short-term limits that you have to demonstrate compliance with," Tr. 291:12-14. But because Perpetua also has year to year operational variability given its operations, the five-year rolling average is actually more representative of emissions – not simply capturing one year that may be much different from any other year, operation-wise. *See* Tr. 291:21-24. Dr. Paden confirmed that "if a five-year rolling average was actually more representative because of the variability of the project, [that] would . . . actually be the best number to use as the representative number." Tr. 174:22-175:2.

Because DEQ demonstrated that the use of project adjustment factor was protective of public health, it follows that the five-year rolling average is also protective. When Perpetua's counsel asked Mr. Lewis, if "the five-year rolling average is a way to disguise whether or not this permit is going to allow Perpetua to exceed the T-RACT limits," Mr. Lewis stated: "That's just a complete mischaracterization of what's going on." Tr. 292:5-12. And, in fact, Perpetua's counsel confirmed that, "even at its peak mining production, on any one given day, even if you strung it together every day for an entire year… [the SGP] still wouldn't exceed the T-RACT control limit." Tr. 292:19-22. If Perpetua can demonstrate that it will comply with the AACCs, understanding that it is a lifetime risk for the 16-year project, then a five-year rolling average is a reasonable method for measuring compliance.

C. The Expert Testimony Demonstrates that DEQ Acted Reasonably and in Accordance with Law as there was Sufficient Evidence to Support the T-RACT Analysis Limiting the Non-West End Pit Production Limit.

Finally, the Board concluded "there was insufficient evidence in the record to demonstrate exactly how or whether the non-West End Pit production was limited and, if it was, the Board of Environmental Quality could not find any PTC conditions able to enforce that reduction." REC 3714. According to the testimony of Mr. Schilling and Mr. Lewis, the PTC appropriately and effectively limited both West End Pit and non-West End Pit production. *See* REC 3927; REC

4139; Tr. 45; Tr. 281. Mr. Schilling explained: "There's sort of two main limits. There's a total mine limit in there of 788.4 million tons. And then there is a west end pit-specific limit of 50 percent of that, which is 394.2 million tons." Tr. 45:11-15. Further, a "limit to the non-west end pit production sources was not needed because even if 100 percent of the production is from non-west end pit sources, we're still in compliance." Tr. 45:18-21. This was important because, as Mr. Lewis explained, "pound for pound, the West End Pit resulted in higher ambient air impacts." Tr. 307:14-16.

These limits are contained in the PTC as condition 3.6, which "limits total hauling and excavation from the mine to 788.4 million tons" and it "limits hauling and excavation from the West End Pit to 394.2 million tons, which is equal to 50% of total allowable production." REC 3927; *see also* REC 4139. Thus, a limit to the non-West End Pit was not necessary based on the following relationship:

$$\text{Production}_{\text{Non-WEP}} = \text{Production}_{\text{total}} - \text{Production}_{\text{WEP}}$$

See REC 3928. Therefore, DEQ acted both reasonably and lawfully, as a limit on non-West End Pit sources is not required and would not make sense in the context of the existing limit on total production and West End Pit production.

VI. CONCLUSION

As discussed above, the expert witness testimony demonstrates that DEQ acted reasonably and lawfully when it issued the PTC, and specifically in its analysis of arsenic emissions. When DEQ performed the arsenic emissions analysis, and in particular when it applied the project specific adjustment, DEQ both followed the Air Rules and was protective of public health. Thus, as to each of the Remaining Issues, Petitioners have failed to meet their burden, and the Hearing Officer must find in DEQ's and Perpetua's favor.

DATED this 8th day of November, 2024.

STATE OF IDAHO
OFFICE OF THE ATTORNEY GENERAL

/s/ Hannah M.C. Young

HANNAH M.C. YOUNG
Deputy Attorney General
Attorneys for the Idaho Department of Environmental Quality

CERTIFICATE OF SERVICE

I hereby certify that on November 8, 2024, a true and correct copy of the foregoing was filed, served, and copied as shown below.

Bryan Hurlbutt
Laurence ("Laird") J. Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701

Attorneys for Petitioner Nez Perce Tribe and Idaho Conservation League

bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638

Attorney for Petitioner Save the South Fork Salmon

jthrower@mtntoplaw.com
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole C. Hancock
Stoel Rives LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702

Attorneys for Intervenor Perpetua Resources of Idaho, Inc.

krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
nicole.hancock@stoel.com
via electronic service

Dylan B. Lawrence
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701

Hearing Officer

dylan@varinthomas.com
via electronic service

Diane Cutler
Hearing Coordinator
Rules and Planning Analyst
Department of Environmental Quality
1410 N Hilton
Boise ID 83706

diane.cutler@deq.idaho.gov
via electronic service

Office of Administrative Hearings
filings@oah.idaho.gov
via electronic service

/s/ DeAnne M. Chaffin
DeAnne M. Chaffin
Legal Assistant

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
Nicole C. Hancock, ISB No. 6899
nicole.hancock@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 _____ NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioner, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC. Intervenor-Respondent.	Case Docket No. 0101-22-01 OAH Case No. 23-245-01 PERPETUA'S POSTHEARING STATEMENT

TABLE OF CONTENTS

KEY TO TERMS AND ABBREVIATIONS iii
I. INTRODUCTION 1
II. STANDARD OF REVIEW 2
III. DEQ'S ASSESSMENT OF THE PROJECT'S IMPACT ON INCREMENTAL CANCER RISK UNDER THE IDAHO TAP RULES 4
A. DEQ's assessment of preconstruction compliance with the TAPs rules relies on cancer risk values and risk assessment methodology established by EPA. 4
B. DEQ compared the Project's arsenic exposure concentration to the T-RACT AACC and accounted for the enforceable maximum production limits. 7
IV. ARGUMENT 9
A. DEQ and Perpetua presented expert evidence demonstrating that DEQ properly adjusted for exposure duration to derive the Project's maximum arsenic exposure concentration based on the PTC's enforceable production limits. 10
1. The T-RACT AACC is not an annual limit but represents an ambient concentration that aligns with an acceptable incremental cancer risk of no more than 1-in-100,000 over a 70-year lifetime of continuous exposure. 10
2. Adjusting the exposure concentration to reflect exposure duration is consistent with the Air Rules. 13
3. DEQ's PTC conditions properly restrict production and emissions and a further limit on years of operation is not necessary. 17
B. DEQ and Perpetua's expert evidence showed that DEQ properly used a five-year rolling average production limit as a T-RACT long-term limit. 20
C. DEQ and Perpetua's expert evidence showed that the PTC already limits production from the non-West-End Pits, and no separate limit is necessary. 22
V. CONCLUSION 23

KEY TO TERMS AND ABBREVIATIONS

AACC	Acceptable Ambient Concentration for a Carcinogen
DEQ	Respondent Idaho Department of Environmental Quality
EPA	United States Environmental Protection Agency
IUR	Inhalation Unit Risk, developed by EPA
Idaho Air Rules	Rules for the Control of Air Pollution in Idaho, IDAPA 58.01.01, *et seq*.
Perpetua	Intervenor-Respondent Perpetua Resources Idaho, Inc.
Petitioners	Petitioners Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon
Project	Stibnite Gold Project
PTC	Air Quality Permit to Construct No. P-2019.0047, issued to Perpetua on June 17, 2022
TAP	Toxic air pollutant
T-RACT	Toxic air pollutant reasonably available control technology
URF	Unit Risk Factor, based on EPA's IUR

I. INTRODUCTION

The scope of the Board of Environmental Quality (the "Board") remand in this matter is limited to the development of factual evidence "regarding the ambient air concentrations of arsenic that will be produced by the Stibnite Gold Project [the "Project"] and whether those levels comply with the Air Rules."[1] REC 3717; *see also* REC 3841-3842. On remand, to address the Board's questions, the Idaho Department of Environmental Quality ("DEQ") and Perpetua Resources Idaho, Inc. ("Perpetua") presented the expert testimony of Kevin Schilling (DEQ's Stationary Source Modeling Supervisor), two toxicologists—Dr. Norka Paden (a DEQ Toxicological Risk Assessor) and Theresa Lopez (a Principal Toxicologist with Tetra Tech, Inc.)—and Kevin Lewis (an expert in air quality modeling and permitting for mining projects).

DEQ and Perpetua's expert witnesses demonstrated that DEQ properly assessed ambient concentrations of arsenic from the Project in compliance with the Rules for the Control of Air Pollution in Idaho, IDAPA 58.01.01 *et seq.* (2022) (the "Idaho Air Rules").[2] They explained that DEQ adopted cancer risk values and assessment methodology established by the United States Environmental Protection Agency ("EPA"). They explained that EPA evaluates incremental excess cancer risk from continuous exposure over a 70-year lifetime, not one year. They explained how ambient arsenic concentrations from the Project will be 41% of the acceptable cancer risk of 1-in-100,000, adjusted to reflect an enforceable maximum production scenario based on the Permit to Construct ("PTC"). They explained how the duration of the Project under this maximum production scenario would be 16 years and that a longer duration does not change arsenic emissions or the acceptable cancer risk.

[1] For a review of the issues on remand and discussion of procedural history, see Perpetua's Prehearing Statement (submitted Oct. 11, 2024). REC 6902-6915.

[2] All citations are to the 2022 version of the Idaho Air Rules.

Petitioners' witnesses—William Tiedemann (a regulatory conservation associate with the Idaho Conservation League) and Dr. Ian von Lindern (a chemical engineer)—are not qualified to opine on complex areas of air quality modeling and risk assessment of ambient concentrations of arsenic. They offered nothing more than conclusory statements and policy preferences as alternatives to DEQ's science-based decision making. Their views cannot be substituted for the agency's technical competence and specialized knowledge. Petitioners have not met their burden to establish, by a preponderance of the evidence, that DEQ acted unreasonably or contrary to the Idaho Air Rules. The Hearing Officer should find that DEQ and Perpetua's expert testimony supports the reasonableness of DEQ's analyses and compliance with the Idaho Air Rules and the sufficiency of the PTC conditions. DEQ's permit decision should be affirmed.

II. STANDARD OF REVIEW

The Board "must determine whether DEQ 'has acted reasonably and in accordance with the law.'" REC 3697 (quoting *In the Matter of Sunnyside Park Utilities' Application for Sewage Disposal Permit*, Final Order on Petition for Review of Preliminary Order, at p. 10 (BEQ Dkt. 0103-07-02, Apr. 7, 2009)). The burden of establishing that DEQ acted unreasonably or inconsistently with the law falls on Petitioners, who must prove their allegations by a preponderance of the evidence. IDAPA 62.01.01.477. A "preponderance of the evidence" is evidence that, when weighed with that opposed to it, has more convincing force and from which results a greater probability of truth. *Harris v. Elec. Wholesale*, 141 Idaho 1, 3, 105 P.3d 267, 269 (2004) (citation omitted).

The Board's analysis appropriately considers DEQ's "experience, technical competence, and specialized knowledge" to evaluate evidence.[3] *See* Idaho Code § 67-5251(5); *see also* Idaho

[3] The Idaho Legislature recently amended the standard for judicial review under the Idaho Administrative Procedure Act to prohibit deference to agency interpretations, Idaho Code

Code § 67-5251(4)(b) (authorizing the Board to take official notice of "generally recognized technical or scientific facts within the agency's specialized knowledge"); Michael S. Gilmore & Dale D. Goble, *The Idaho Administrative Procedure Act: A Primer for the Practitioner*, 30 Idaho L. Rev. 273, 319 (1994) ("[T]he agency's repeated exposure to a specialized subject matter is a source of specialized knowledge that is useful in evaluating evidence."). A decision rooted in an agency's technical competence and specialized knowledge is generally accorded great weight. *See Appalachian Power Co. v. EPA*, 135 F.3d 791, 802 (D.C. Cir. 1998) ("Statistical analysis is perhaps the prime example of those areas of technical wilderness into which judicial expeditions are best limited to ascertaining the lay of the land"); *Earth Island Inst. v. U.S. Forest Serv.*, 351 F.3d 1291, 1301 (9th Cir. 2003) ("an agency is entitled to wide discretion in assessing the scientific evidence").

This is particularly persuasive when an agency is performing emissions assessments and modeling, including in the context of risk assessments. *See Huntsman Petrochemical LLC v. EPA*, 114 F.4th 727, 735 (D.C. Cir. 2024). In *Huntsman*, the D.C. Circuit rejected a challenge to the EPA cancer risk assessment of ethylene oxide under the hazardous air pollutant standards in the Clean Air Act. *Id*. The court held that while the petitioners' proposed alternative "approach

---

§ 67-5279(5), but the standard for judicial review does not apply to the Hearing Officer or the Board's review of the PTC. *See* REC 3377 (explaining that the statute's standards "are not directly applicable"). Nor does the amendment change the appropriate recognition of an agency's "experience, technical competence, and specialized knowledge" involving complex technical matters and scientific data, whether on administrative or judicial review. In a similar vein, while the U.S. Supreme Court recently eliminated judicial deference to agency interpretations of law under the federal Administrative Procedure Act, the Court reiterated that the Act "does mandate that judicial review of agency policymaking and factfinding be deferential." *Loper Bright Enters. v. Raimondo*, 144 S. Ct. 2244, 2261 (2024). Furthermore, in the context of legal interpretations, the Court explained that "although an agency's interpretation of a statute 'cannot bind a court,' it may be especially informative 'to the extent it rests on factual premises within [the agency's] expertise.'" *Id*. at 2267 (quoting *Bureau of Alcohol, Tobacco & Firearms v. FLRA*, 464 U.S. 89, 98 n. 8 (1983)).

to statistical modeling … may have advantages," *id*. at 742, EPA's action was "reasonable" because EPA "adequately explained its modeling approach and decisions" in light of the technical nature of the evidence before it, *id*. at 737.

III. DEQ'S ASSESSMENT OF THE PROJECT'S IMPACT ON INCREMENTAL CANCER RISK UNDER THE IDAHO TAP RULES

DEQ evaluated the Project's ambient arsenic concentration and associated incremental excess cancer risk under Idaho's toxic air pollutants ("TAPs") rules, which are based on EPA cancer risk values and assessment methodologies. Following EPA's approach, DEQ analyzed the health impacts of carcinogens based on long-term chronic exposure rather than short-term or acute exposure. *See* Tr. 145:6-146:13 (Paden); *see also* REC 4293-4294.

A. DEQ's assessment of preconstruction compliance with the TAPs rules relies on cancer risk values and risk assessment methodology established by EPA.

Based on the official rulemaking record and as explained by Mr. Schilling, the TAPs rules offer a simplified project-specific, risk-based approach to evaluate arsenic emissions. *See* Tr. 17:7-22:9 (Schilling); REC 3921-3924 (¶¶ 12-19). DEQ's evaluation starts with IDAPA 58.01.01.161. *See* IDAPA 58.01.01.203.03. Section 161 requires DEQ to assess arsenic emissions and determine that the emissions will not injure or unreasonably affect human or animal life or vegetation. Preconstruction compliance with Section 161 can be shown using the methods provided in IDAPA 58.01.01.210. *See id*.; Tr. 25:7-26:3 (Schilling). Under Section 210, preconstruction compliance is determined on a project basis and based on project-specific conditions. *See* IDAPA 58.01.01.210; *see also* Tr. 18:1-13, 20:6-12, 37:10-38:22 (Schilling).

Compliance with Section 210 is shown when a source's modeled maximum annual average ambient concentration of the carcinogenic TAP is less than or equal to the acceptable ambient concentration for a carcinogen ("AACC") established in IDAPA 58.01.01.586. *See* IDAPA 58.01.01.210. AACCs for each carcinogen are derived from a Unit Risk Factor ("URF")

developed and published by EPA. *See* IDAPA 58.01.01.106.19 (identifying "URF" as "Unit Risk Factor from the US Environmental Protection Agency"); *see also* Tr. 20:6-18 (explaining that URFs are the "cornerstone of the whole TAPs program for regulating carcinogenic compounds"), 21:5-10 (Schilling); Tr. 138:15-139:5 (Paden); Tr. 181:15-182:19 (Lopez); REC 4282 (¶ 16). EPA refers to the URF as the Inhalation Unit Risk factor ("IUR").[4] Tr. 181:15-182:19, 188:10-22 (Lopez); REC 4282 (¶¶ 12-14), 4295; *see also* REC 3878 (¶ 14).

URFs/IURs represent a chemical-specific risk based on exposure to 1 µg/m3 of that substance continuously (24 hours/day and 365 days/year) over a lifetime (assumed to be 70 years).[5] Tr. 19:11-20:18 (Schilling); REC 3922 (¶ 15); Tr. 135:2-13, 138:18-13 (Paden); REC 3876-3877 (¶¶ 11-12); Tr. 181:15-182:1 (Lopez); REC 4282 (¶¶ 12-13), 4295; *see also* Ex. 210. EPA develops URFs/IURs based on years of scientific study, taking into account the exposure of sensitive subpopulations and measuring excess cancer risk above the background risk a person faces in their everyday lives. Tr. 138:6-139:5, 146:15-24, 147:16-148:5, 153:13-154:12, 171:20-172:21 (Paden); Tr. 181:23-182:1, 185:6-12, 188:2-22, 190:8-191:6 (Lopez); REC 4293-4295. Because URFs/IURs align with continuous exposure over a 70-year lifetime, the value does not represent the lifetime risk of developing cancer after a single exposure. REC 4287 (¶ 42), 4295-4296, 4303.

The AACC represents the ambient concentration that a person could be exposed to continuously for a 70-year lifetime before the cancer risk exceeds 1-in-1,000,000. Tr. 20:6-18,

[4] During the hearing, URFs and IURs were referred to interchangeably.

[5] A lifetime cancer risk of 1-in-1,000,000 means that if 1 million people are continuously exposed to a specific concentration of a substance (as established by the URF/IUR) for 70 years, one person may develop cancer. To put this risk in perspective, the National Oceanic and Atmospheric Administration estimates that the chances of getting struck by lightning are much higher—1-in-15,300 in a lifetime. REC 4295 n. 1.

31:21-32:14 (Schilling); REC 3922-3923 (¶¶ 15, 17); Tr. 126:9-14 (Paden) (the AACCs "are an expression of the one in a million cancer risk for a 70-year exposure"); REC 3876-3877 (¶¶ 11-12); Tr. 194:18-195:8 (Lopez); REC 4282-4283 (¶¶ 16-18), 4295-4296. The AACC is calculated by dividing the acceptable lifetime cancer risk of 1-in-1,000,000 by the URF/IUR. REC 3876-3877 (¶ 11); Tr. 194:18-195:8 (Lopez); REC 4282-4283 (¶¶ 16-17), 4295-4296; *see also* Tr. 21:5-10 (Schilling); REC 3922 (¶ 15).

Relevant here, the URF/IUR for arsenic is 4.3E-3 per $\mu g/m^3$ ($0.0043/\mu g/m^3$), which converts to an AACC of 2.3E-4 $\mu g/m^3$ ($0.00023\ \mu g/m^3$) at an incremental lifetime cancer risk of 1-in-1,000,000. *See* IDAPA 58.01.01.586. Because both the numerator (the cancer risk) and denominator (the URF/IUR) assume a 24-hour, per day exposure for 365 days per year for 70 years, the calculation of the arsenic AACC is simply the risk divided by the URF/IUR:

0.000001 / 0.0043 per µg/m3 = 0.00023 µg/m3.

Tr. 136:6-137:10 (Paden); REC 3876-3877 (¶ 11); Tr. 194:18-195:8 (Lopez); REC 4282 (¶ 16), 4296; *see also* REC 3922 (¶ 15).

Thus, the arsenic AACC represents the ambient concentration that aligns with an acceptable incremental cancer risk probability of no more than 1-in-1,000,000 assuming 70 years of constant exposure. This is made clear by the definition of "Toxic Air Pollutant Carcinogenic Increments" in the Idaho Air Rules:

> Those ambient air quality increments based on the probability of developing excess cancers over a seventy (70) year lifetime exposure to one (1) microgram per cubic meter (1 ug/m^3) of a given carcinogen and expressed in terms of a screening emission level or an acceptable ambient concentration for a carcinogenic toxic air pollutant. They are listed in Section 586.

IDAPA 58.01.01.006.125; *see also* Tr. 31:19-32:14 (Schilling) (explaining the definition is important to identify a 1-in-1,000,000 cancer risk and the link to the AACC and to "make[] it

clear that it focuses on a total project-imposed cancer risk rather than a specific year by year.").

While the AACCs are expressed as annual average ambient concentrations in Section 586, this reference does not mean that the AACCs are annual limits (as explained in Section IV.A.1 below). Rather, the AACCs are ambient concentrations that align with the incremental cancer risk assuming an exposure duration over a 70-year lifetime. Interpreting the AACCs as an annual limit is contrary to the development of URF/IUR values and EPA's determination of risk-based acceptable exposures over a 70-year lifetime. Tr. 48:18-21, 56:2-5 (Schilling); REC 3923 (¶ 17); Tr. 509:2-19 (Lopez); 4286-4287 (¶¶ 37-41), 4302-4303. In other words, there is *no toxicological basis* to treat the AACC as an annual limit because that would improperly assume a single annual exposure would result in incremental lifetime cancer risk. *See* Tr. 145:6-24 (Paden) ("We do not evaluate cancer risk for an acute exposure, but for chronic exposure.").

B. DEQ compared the Project's arsenic exposure concentration to the T-RACT AACC and accounted for the enforceable maximum production limits.

In this case, DEQ found Perpetua demonstrated preconstruction compliance for arsenic emissions using the method set forth in Section 210.12. Section 210.12 allows an applicant to use reasonable achievable control technology for TAPs ("T-RACT") to demonstrate compliance with Section 161. IDAPA 58.01.01.210.12.a. The Idaho Air Rules define T-RACT as an "emission standard" based on the lowest emission of TAPs. IDAPA 58.01.01.007.12. T-RACT may be based on the application of an operational requirement incorporated into the permit—*e.g.*, PTC Conditions 3.5 and 3.6 establish production limits to control fugitive dust emissions from the Project.[6] *See* IDAPA 58.01.010.210.14.e. Where T-RACT is used to control emissions, the

[6] Fugitive dust emissions are the primary source of arsenic from the Project. Because these emissions are "addressed" by National Emission Standards for Hazardous Air Pollutants (NESHAP), 40 C.F.R. Part 63, Subpart EEEEEEE, they normally would be excluded from TAP compliance demonstrations. *See* IDAPA 58.01.01.210.20.b. In response to public comments,

allowable incremental cancer risk probability over a 70-year lifetime of constant exposure is 1-in-100,000, or 10 times the AACC. IDAPA 58.01.01.210.12.b. This is called the T-RACT AACC, which for arsenic is 0.0023 $\mu g/m^3$.

The plain language of Section 210.12.b requires DEQ to *compare* the "approved T-RACT ambient concentration" from the source to the cancer risk increment reflected by the T-RACT AACC:

> Compare the source's or modification's approved T-RACT ambient concentration at the point of compliance for the toxic air pollutant to the amount of the toxic air pollutant that would contribute an ambient air cancer risk probability of less than one to one hundred thousand (1:100,000) (which amount is equivalent to ten (10) times the applicable acceptable ambient concentration listed in Section 586).

Id.; *see also* Tr. 20:8:18 (Schilling). Toxicologists refer to the approved T-RACT ambient concentration from the source as the "exposure concentration." *See*, *e.g.*, Tr. 141:17-143:1 (Paden); Tr. 191:12-193:2, 197:9-19 (Lopez).

As explained in more detail below, the exposure concentration is calculated from the modeled maximum annual average ambient concentration, which accounts for T-RACT—*e.g.*, here, the maximum production limits under PTC Conditions 3.5 and 3.6 would effectively limit the Project's exposure duration to 16 years if Perpetua operated at the maximum allowed levels without interruption. If under this scenario the exposure concentration is less than or equal to the T-RACT AACC, "no further procedures for demonstrating preconstruction compliance will be required for that toxic air pollutant as part of the application process." *See* IDAPA 58.01.01.210.12.c; *see also* Tr. 65:4-18 (Schilling).

DEQ determined that the Project's arsenic exposure concentration, adjusted to reflect the

---

DEQ took a conservative approach and included these fugitive emissions in assessing TAP emissions under Section 210. *See* REC 4133-4134 (¶ 18).

PTC's maximum production limits and related exposure duration, is 0.00095 µg/m^3, which is less than the T-RACT AACC of 0.0023 µg/m^3. REC 3877 (¶¶ 12-14); Tr. 197:9-19, 200:2-201:25 (Lopez); REC 4284-4285 (¶¶ 24-25), 4300-4301. This reflects an incremental lifetime cancer risk of 1-in-240,000, which is well below the acceptable cancer risk probability of 1-in-100,000. Tr. 200:2-201:25 (Lopez); REC 4284-4285 (¶¶ 24-30), 4300-4301.

IV. ARGUMENT

Over the two-day hearing, DEQ and Perpetua provided comprehensive expert testimony in support of DEQ's evaluation of arsenic emissions from the Project and compliance with the TAPs rules. Specifically, the testimony established:

(1) the Project's modeled arsenic exposure concentration must be adjusted for exposure duration, based on the production limits in the PTC, for an apples-to-apples comparison to the T-RACT AACC to demonstrate compliance with the Idaho Air Rules;

(2) the 135,000 ton per day five-year rolling average for daily production does not increase cancer risk because total production (and therefore emissions) is limited and cumulative arsenic exposure over the life of the Project does not change; and

(3) the total life-of-mine production limit and the 50% production limit on the West End Pit necessarily limit production from the non-West End Pits and are designed to ensure incremental lifetime cancer risk remains below the T-RACT AACC.

Petitioners' arguments that the AACCs are annual limits that cannot be adjusted for exposure duration are unavailing. As set forth in Perpetua's Motion to Strike and consistent with objections made by DEQ and Perpetua during the hearing, Mr. Tiedemann and Dr. von Lindern are not qualified as experts in the fields of air quality modeling, permitting, or toxicology. Furthermore, their testimony in many instances is factually incorrect, articulates nothing more

than their policy preferences and uninformed interpretation of the TAPs rules, and fails to account for DEQ's expertise in implementing complex rules within its technical expertise.

A. DEQ and Perpetua presented expert evidence demonstrating that DEQ properly adjusted for exposure duration to derive the Project's maximum arsenic exposure concentration based on the PTC's enforceable production limits.

When comparing the Project's arsenic exposure concentration to the T-RACT AACC pursuant to Section 210.12.b, DEQ adjusted the exposure concentration to account for enforceable operational conditions. REC 698, 710. DEQ and Perpetua presented expert toxicological and other scientific evidence demonstrating that DEQ acted consistent with scientific principles governing cancer risk assessment and the Idaho Air Rules. When adjusted for maximum production and finite production levels under the PTC —and thus maximum arsenic emissions—the Project's duration is 16 years and the incremental cancer risk associated with the Project is 1-in-240,000, which is below a cancer risk probability of 1-in-100,000.

1. The T-RACT AACC is not an annual limit but represents an ambient concentration that aligns with an acceptable incremental cancer risk of no more than 1-in-100,000 over a 70-year lifetime of continuous exposure.

Section 586 states that "[t]he AACC in this section are annual averages." IDAPA 58.01.01.586. To treat the AACCs as annual limits would ignore the plain language of Section 586 and conflict with the cumulative, long-term nature of the cancer risk that is the foundation of the TAPS rules. Tr. 48:18-21 ("the important criteria is project imposed risk rather than treating the AACC as an annual limit"), 56:2-5 (Schilling); REC 3923 (¶ 17); Tr. 509:2-19 (Lopez); 4286-4287 (¶¶ 37-41), 4302-4303. *See also United Sav. Ass'n of Tex. v. Timbers of Inwood Forest Assoc*., 484 U.S. 365, 371 (1988) (interpretation of regulations, like statutes, is a "holistic endeavor" and must ensure that "the permissible meanings produce[] a substantive effect that is compatible with the rest of the law."); *see also Mason v. Donnelly Club*, 135 Idaho 581, 586, 21 P.3d 903, 908 (2001).

The AACCs are expressed as annual averages in Section 586, but they are not annual limits. Section 586 does not use the term annual limit and does not specify compliance on an annual basis. Nor does Section 210.12. *See* IDAPA 58.01.01.210.12. If IDEQ had intended to treat an annual average as an annual limit, it would have done so. *See United States v. Bucher*, 375 F.3d 929, 932 (9th Cir. 2004) ("To interpret a regulation, we look first to its plain language. As with legislation, we presume the drafters said what they meant and meant what they said."). Rather, the reference to an annual average is appropriately viewed in the context of the project-specific concentrations that are modeled as annual averages as opposed to maximum concentrations. Tr. 52:5-17 (Schilling).

The use of a maximum *annual average* in modeling reflects a long-term averaging period. Tr. 301:17-20 (Lewis). But the model output from any single year cannot be compared against the AACC as an annual limit because the AACC is based on 70 years of exposure—not one year of exposure. Tr. 73:12-15 (Schilling) (comparing the AACC to the annual average concentration modeled is "not appropriate . . . [b]ecause we still center on the fact that what matters is project-imposed cancer risk and not a year-by-year evaluation."); Tr. 237:16-25, 238:1-6, Tr. 311:7-14 (noting that the model produces an "annual average concentration" and that "is not on a 70-year lifetime basis.") (Lewis). For that reason, the annual average concentration must be adjusted "to the same basis as the AACC lifetime exposure concentration" or 70 years. Tr. 304:22-25 (Lewis); *see also* Tr. 301:6-8, 305:1-2 (Lewis); Tr. 507:5-15 ("If a one-year exposure is to be used to compare to the AACC, he's ignoring the fact that there's still a 70-year lifetime that needs to be accounted for in that one-year average.") (Lopez).

This approach is consistent with the science underpinning carcinogenic risk, which reflects the cumulative dose over a lifetime. Tr. 135:10-13 (Paden); Tr. 507:5-15 (Lopez). DEQ

and Perpetua's expert toxicologists established that incremental cancer risk is based on cumulative exposure and the AACC reflects an ambient concentration to which a person may be exposed for 24 hours per day, 365 days a year, for 70 years at a resulting incremental cancer risk of 1-in-1,000,000 or in the case of the T-RACT AACC 1-in-100,000. Tr. 135:2-137:10 (Paden); REC 3876-3839 (¶¶ 11-15); Tr. 204:15-24 (Lopez); REC 4283 (¶ 17). The AACC values adopted by DEQ in Section 586 align with incremental cancer risk over the default exposure duration of a 70-year lifetime—not any single year—and therefore compliance is appropriately assessed on this long-term basis and not on an annual basis.[7] Tr. 73:12-15 (Schilling); Tr. 237:18-25, 238:1-6, 509:2-19 (Lopez); REC 4283 (¶ 18), 4286-4287 (¶¶ 38-39), 4302-4303. Otherwise, if the AACC were treated as an annual limit, it "significantly lowers acceptable risk" and would translate into a risk of 1-in-7 million. Tr. 217:6-18 (Lopez); REC 4287 (¶ 39).

Petitioners do not dispute that the incremental cancer risk at the heart of the AACCs is based on 70-year cumulative exposure. But in the declaration and testimony of Dr. von Lindern, he repeatedly refers to the AACCs as the "maximum one-year-annual average ambient air carcinogen concentration." *See*, *e.g.*, Tr. 436:14-15, 452:5-7 (von Lindern); REC 6108, 6110. Dr. von Lindern conceded that this phrase does not exist in the TAPs rules but is his own interpretive gloss on the reference to "annual average" in Section 586. Tr. 484:18-485:2 (von Lindern). Dr. von Lindern is not a toxicologist, Tr. 406:11-13 (von Lindern), and his testimony about risk

[7] Use of an averaging period greater than one year is an accepted feature of air regulations and permitting, particularly where the health risk being addressed results from long-term chronic exposure, rather than acute exposure. REC 4136 (¶ 30). For example, the $PM_{2.5}$ National Ambient Air Quality Standard of 9.0 μg/m³ addresses health risks associated with long-term exposure, but while the standard is based on an annual average, determinations of compliance are not limited to a single year—rather, compliance is based on a three-year average. 40 CFR § 50.20(a); 40 C.F.R. Part 50, Appendix N; *see* 89 Fed. Reg. 16202, 16203 (Mar. 6, 2024).

assessments was inaccurate, *see* Tr. 499:2-509:19 (Lopez).[8]

Indeed, as Ms. Lopez pointed out in her rebuttal testimony, using a "maximum one-year annual average ambient air carcinogen concentration" ignores the 70-year lifetime that underpins the AACCs. Tr. 509:2-19 (Lopez). While Dr. von Lindern might prefer that the TAPs rules reflect his interpretation, he offered no evidence to refute the scientific testimony and judgment of toxicologists Dr. Paden and Ms. Lopez. *See Huntsman*, 114 F.4th at 735 (agency "evaluation of scientific data within its area of expertise" should be afforded "an extreme degree" of reliance, and particularly so for "statistical and modeling analysis." (internal quotation marks and citation omitted)).

2. Adjusting the exposure concentration to reflect exposure duration is consistent with the Air Rules.

DEQ and Perpetua's expert toxicologists provided extensive testimony demonstrating that if a source operates less than the 70-year lifetime on which the AACCs are based, the exposure duration must be adjusted in proportion to the amount of time the source will operate. REC 3923-3925 (¶¶ 16-19, 22-23), 3929 (¶¶ 31-33); REC 3876-3878 (¶¶ 8-9, 12-15); REC 4283-4285 (¶¶ 20-30), 4292-4293, 4296, 4298-4300). Cancer risk cannot be evaluated without considering the length of time a potential receptor will be exposed to a carcinogen—referred to as "exposure duration." Tr. 34:10-35:8, 56:18-57:19 (Schilling); Tr. 140:1-145:15 (Paden); Tr. 189:15-190:5, 192:6-194:15, 197:9-198:5, 215:1-218:3, 229:11-232:19 (Lopez). By adopting

[8] Mr. Tiedeman's testimony regarding the TAPs rules was not credible either. During the hearing, he revealed that his air quality permitting experience while employed at DEQ was very limited and that he had little to do with TAPs permitting or compliance; what experience he had was supervised by more senior colleagues. Tr. 352:2-363:8 (Tiedemann). In addition, Mr. Tiedeman acknowledged that during his former employment at Brown and Caldwell, he was asked to review the Project, voiced no objections to it, and later requested to be reassigned away from the Project based on his personal views about the mining industry. Tr. 386:11-392:2 (Tiedemann).

EPA's IURs, DEQ adopted EPA's cancer risk methodology for analyzing TAP ambient concentrations. Tr. 135:2-137:10 (Paden); Tr. 213:11:3-214:14, 231:13-232:19 (Lopez). That includes EPA's recognition that inhalation risk assessments require the timeframe over which inhalation exposure occurs and that exposure duration is not always 70 years. *See id*.

EPA uses an equation that explicitly adjusts an estimated ambient concentration based on site-specific information, including an assumption that exposure will occur for less than 70 years:

EC = (CA x ET x EF x ED) / AT

Where: EC (µg/m3) = exposure concentration;
CA (µg/m3) = contaminant concentration in air;
ET (hours/day) = exposure time;
EF (days/year) = exposure frequency;
ED (years) = exposure duration; and
AT (lifetime in years 70 x 365 days/year x 24 hours/day) = averaging time

REC 3923 (¶ 16); REC 3877 (¶ 12); 4284 (¶ 22). In the equation, the exposure concentration (EC) is calculated from the modeled maximum annual average ambient concentration, referred to as the "contaminant concentration in air" (CA), and the temporal parameters. REC 3877 (¶ 12); 4284 (¶ 22). The temporal parameters in the equation include the exposure time (ET) in hours per day, the exposure frequency (EF) in days per year, the exposure duration (ED) in years, and the averaging time (AT), which is the amount of time over which exposure is averaged for chronic assessments. REC 3877 (¶ 12); 4284 (¶ 22). The averaging time (the denominator) is the only constant. The other temporal inputs are variable based on site or project specifics.

Since EPA's IUR values are adopted at Section 586 as URFs and AACCs with an expected 70-year lifetime exposure, DEQ must adjust the exposure concentration to reflect the exposure duration to ensure the comparison to the AACC is proper. Tr. 34:10-35:8, 56:18-57:19 (Schilling); Tr. 140:1-145:15 (Paden); Tr. 189:15-190:5, 192:6-194:15, 197:20-198:5, 215:1-218:3, 229:11-232:19 (Lopez). If not, as the Hearing Officer previously recognized, the

"comparison of emissions that will only take place for 16 years to a standard that is based on an assumed 70-year exposure period is an 'apples to oranges' comparison." REC 3418. Thus, when comparing the Project's arsenic exposure concentration to the arsenic T-RACT AACC pursuant to Section 210.12.b, DEQ properly adjusted the exposure concentration to account for a 16-year exposure duration of the Project. REC 3875-3879 (¶¶ 4-17); REC 4280-4281 (¶ 10), 4283-4287 (¶¶ 20-42).

Consistent with EPA's toxicity values, DEQ calculated the Project's exposure concentration using the highest annual modeled concentrations based on a 16-year exposure duration to ensure the exposure concentration was comparable to the assumption of the 70-year exposure duration found in the AACC. REC 3926-3927 (¶ 27), 3929 (¶ 32); REC 3876 (¶¶ 9-10). The adjustment is illustrated in the following formula utilized by DEQ:

$$Lifetime\ exposure\ \left(\frac{\mu g}{m^3}\right) = \frac{Highest\ annual\ concentration\ \left(\frac{\mu g}{m^3}\right) \times 16\ (mine\ operation\ years)}{70\ (years, lifetime\ exposure)}$$

REC 710; *see also* REC 3876 (¶ 10). The lifetime exposure in the formula is the Project's arsenic exposure concentration. DEQ's formula is equivalent to EPA's formula, as both account for exposure duration. *See* Tr. 139:15-145:24 (Paden); Tr. 191:12-194:15, 197:9-198:5 (Lopez).

The highest annual modeled concentration of arsenic from the Project, operating under the maximum production scenario allowed by the PTC, was 0.00416 µg/m^3. *See* REC 714; Tr. 302:3-303:10 (Lewis).[9] Using EPA's equation for proper implementation of the URF to reflect exposure duration, DEQ adjusted the duration to reflect the highest allowable maximum production scenario and corresponding exposure duration of 16 years of operation to determine the annual average exposure concentration of arsenic for the Project is 0.00095 µg/m^3:

[9] REC 2144 shows an adjusted ambient concertation of 0.00095 µg/m3, which is 0.00416 µg/m^3 * 16/70.

EC = 0.00416 µg/m^3 x 16 years / 70 years = 0.00095 µg/m^3

See REC 714; *see also* REC 3923 (¶ 18); REC 3877-3878 (¶¶ 13-14); REC 4284-4285 (¶¶ 22-25), 4300-4301. Compared to the T-RACT AACC (0.0023 µg/m^3) as required by Section 210.12, the Project's annual average exposure concentration of arsenic is far less, and thus the lifetime exposure of arsenic is less than a 1-in-100,000 cancer risk, which demonstrates that the Project's arsenic emissions will not injure or unreasonably affect human health and the environment. REC 3877 (¶¶ 12-14); Tr. 197:9-19, 200:2-201:25 (Lopez); REC 4284-4285 (¶¶ 24-25), 4300-4301. Based on the annual average exposure concentration of 0.00095 µg/m3, the incremental increase in cancer risk from the Project's arsenic emissions over the life of the Project is 1-in-240,000, which is below the acceptable T-RACT incremental lifetime cancer risk of 1-in-100,000. Tr. 200:2-201:25 (Lopez); REC 4284-4285 (¶¶ 24-30), 4300-4301.

The expert testimony at the hearing demonstrated that comparing the Project's arsenic exposure concentration to the T-RACT AACC under Section 210.12 requires the exposure concentration to be adjusted from a lifetime exposure to the Project's exposure duration for the highest maximum production scenario to provide an "apples-to-apples" comparison to the T-RACT AACC. IDAPA 58.01.01.210.15, which addresses project durations shorter than five years, is an example of adjusting the TAPs analysis for exposure duration. While Petitioners argue DEQ can adjust for exposure duration only under Section 210.15, the rule proves DEQ's scientific understanding of EPA's equation that applies project-specific T-RACT limits to adjust the cancer risk evaluation for a source with an operational life of less than 70 years. *See* REC 3923-3924 (¶ 19); Tr. 229:11-230:8 (Lopez); REC 4286 (¶¶ 32-35), 4301-4302. And nowhere in the Idaho Air Rules is DEQ prohibited from following proper scientific method.

As addressed in the next subsection, the PTC's T-RACT production limits translate to an

exposure duration shorter than 70 years. A shorter exposure duration means the Project's highest arsenic exposure concentration was shown to be less than the T-RACT AACC, the same scientific justification that underlies Section 210.15. In the end, the evidence supported the underlying rule-based mathematics that DEQ used to calculate the highest arsenic exposure concentration from a 16-year exposure duration and to properly compare that exposure concentration to the T-RACT AACC.

3. DEQ's PTC conditions properly restrict production and emissions and a further limit on years of operation is not necessary.

The largest source of arsenic emissions from the Project is haul road dust. REC 62, 226. Because higher production and more activity on the haul roads generate more emissions, the PTC imposes production limits as T-RACT—and not a limit on years of operation—to ensure that emissions are controlled and the resulting incremental lifetime cancer risk does not exceed the T-RACT AACC. Tr. 116:13-23, 117:24-119:6, 119:25-121:3 (Schilling); Tr. 202:1-203:17, Tr. 212:11-213:21 (Lopez); Tr. 315:16-19 ("Years don't equal emissions. Production equals emissions. That's why it's permitted that way.") (Lewis). The production limits serve as surrogate emission limits on fugitive dust sources. REC 722, 923, 939-940. That means that the Project's arsenic emissions—and cancer risk from those emissions—are directly tied to the production limits DEQ established in the PTC. *See* Tr. 314:12-317:2 (Lewis).

Condition 3.5 of the PTC includes two limits on daily production: 180,000 tons per day and 135,000 tons per day based on a five-year rolling average. REC 385. Condition 3.6 establishes a life-of-mine production limit of 788.4 million tons and a total production limit on the West End Pits of 394.2 million tons. REC 385. If Perpetua produces at the highest daily allowable levels without interruption, Perpetua will reach the total production limit in the PTC in 16 years (788.4 million tons total / 135,000 tons per day x 365 days per year = 16 years). *See*

REC 710; Tr. 317:3-14 (Lewis) (noting that the calculation appropriately "limit[s] the parameter that was directly used to calculate the emissions."). This scenario equates to the highest modeled ambient concentrations of arsenic, using the most conservative emissions and modeling assumptions that resulted in predicted arsenic impacts between one and two orders of magnitude higher than actual impacts.[10] REC 4134-4135 (¶ 20-25); *see also* Tr. 269:23-277:5 (Lewis).

Because arsenic emissions are a function of production and not years of operation, the exposure concentration and incremental cancer risk do not change if it takes longer than 16 years to exhaust the 788.4 million ton life-of-mine production. Tr. 202:1-203:17 (Lopez). Because "emissions are proportional on production and concentrations are proportional on emissions and risk is dependent upon the total exposure, you're going to arrive at the same risk whether it would be 16 years or 70 years." Tr. 120:19-24 (Schilling). Therefore, adding a 16-year permit limit is unnecessary—and would unnecessarily limit operational flexibility with no additional protection for public health and the environment—as it would not alter the Project's incremental lifetime cancer risk probability. Tr. 202:11-22 (Lopez).

To illustrate that testimony, Attachment A sets out the year-by-year calculations of the Project's lifetime modeled arsenic exposure concentration for two scenarios: (1) 16 years of operation, and (2) 70 years of operation, both at the life-of-mine production limit of 788.4

[10] Dr. von Lindern's testimony regarding the emissions calculations and modeling performed by DEQ and Perpetua are inaccurate and reveal a misunderstanding of the record. First, even Petitioners concede that Dr. von Lindern is not an expert in the area of emissions estimations or modeling. Tr. 405:19-406:1 (von Lindern). Second, he did not understand the record basis for his assertions. *See* Tr. 467:18-24, 468:12-472:21 (von Lindern). Third, assertions made in his declaration regarding modeling adjustments, which culminate in Figure 6, REC 6695 (¶¶ 68-70), are inaccurate as described in testimony by Mr. Lewis, *see* Tr. 488:19-494:12. In a complex area within the agency's technical expertise, it is DEQ approach that is properly granted deference, *see Huntsman*, 114 F.4th at 735, and Dr. von Lindern's testimony should be afforded no weight.

million tons. REC 385. For 16 years of operation, the modeled maximum annual average ambient concentration is 0.00416 µg/m3. *See* REC 714; Tr. 302:3-303:10 (Lewis). This annual average concentration is applied to each year of operations through 16 years (788.4 million tons total / 135,000 tons per day x 365 days per year = 16 years). REC 710. The resulting annual average arsenic exposure concentration (adjusted for exposure duration) is 0.00095 µg/m3, which is below the T-RACT AACC of 0.0023 µg/m3.

For 70 years of operation, the production is lowered to 30,857 tons per day in order to comply with the life-of-mine production limit (788.4 million tons total / 30,857 tons per day x 365 days per year = 70 years). Because ambient concentration is proportional to emissions and emissions are proportional to production, the lower production rate still results in a lower modeled maximum annual average ambient concentration of 0.00095 µg/m3 (0.00416 µg/m3 * 30,857 ton/day / 135,000 tons per day = 0.00095 µg/m3). Tr. 120:19-24 (Schilling). In both cases, Attachment A illustrates the expert testimony establishing that with the total lifetime mine production limit of 788.4 million tons, the lifetime modeled arsenic exposure concentrations (the annual average concentration averaged over 70 years) in both the 16-year and 70-year cases are the same at 0.00095 µg/m3, which is 41% of the T-RACT AACC of 0.0023 µg/m3, as required by Section 210.12.

In sum, whether the Project is mined in 16 years or 70 years, or anywhere in between, annual production will necessarily be limited by the PTC's total life-of-mine production limits, total emissions and cumulative exposure will remain the same, and the Project cancer risk will remain at only 41% of the allowable T-RACT AACC. Tr. 116:15-23, 120:12-25, 121:1-3 (Schilling); Tr. 202:11-22, 203:15-18 (Lopez).

B. DEQ and Perpetua's expert evidence showed that DEQ properly used a five-year rolling average production limit as a T-RACT long-term limit.

The PTC's life-of-mine production limit, as further constrained by the 135,000 ton per day production limit on a five-year rolling average, are the T-RACT long-term limits. These permit limits ensure the mine will be operated in a manner required by the compliance demonstration under Section 210.12.d and that the Project's maximum arsenic concentrations will be below the acceptable T-RACT incremental cancer risk. Tr. 114:17-115:6 (Schilling); Tr. 280:20-25, 283:15-19 (Lewis). As explained by DEQ and Perpetua's experts, the 180,000 ton per day short-term limit addresses short-term National Ambient Air Quality Standards, while the 135,000 ton per day limit on a five-year rolling average is a long-term T-RACT limit designed to match the lifetime (long-term) exposure risk reflected by the AACC. Tr. 284:4-22 (Lewis).

As discussed, the AACCs are not annual limits and do not require an annual compliance demonstration. Based on from EPA's URFs/IURs, they represent the ambient concentration that aligns with an acceptable incremental cancer risk probability of no more than 1-in-1,000,000 assuming 70 years of constant exposure. Therefore, it is the total production and associated cumulative arsenic exposure that drive compliance with the T-RACT AACC. It follows that a five-year rolling average compliance period represents a shorter and more conservative compliance demonstration period than 70 years and ensures that cumulative exposure will remain below the T-RACT AACC. Tr. 39:11-40:25 (Schilling); Tr. 219:25-220:12 (Lopez); Tr. 318:1-13 (Lewis) ("[T]he simplest way to characterize it is that we have a lifetime exposure increment. And so five years is certainly less than a lifetime"); *see also* REC 3926 (¶ 26); REC 4288 (¶¶ 46-47), 4303; REC 4138 (¶ 43).

As a result, even if annual production were to occur at the maximum daily rate of 180,000 tons for any one year (or even two or three years), the PTC's life-of-mine production

limit, combined with the 135,000 ton per day production limit on a five-year rolling average, would require Perpetua to substantially reduce production during the applicable rolling-average period to ensure permit compliance. Tr. 61:1-16 (Schilling); Tr. 282:13-18 (Lewis). Thus, under the PTC production limits, a period of operations at 180,000 tons per day, followed by the mandated reduction in other years to meet the five-year rolling average, will not increase or decrease the incremental cancer risk estimated using maximum modelled annual concentrations over a 70-year lifetime—because the ultimate exposure concentration remains the cumulative emissions over the years of operation, divided by the 70-year lifetime. Tr. 118:3-6 (Schilling); REC 3926 (¶ 26); Tr. 208:14-209:2 (Lopez); REC 4287-4288 (¶¶ 43-47); Tr. 291:9-24 (Lewis). This does not constitute "dose averaging" as asserted by Dr. von Lindern, and it does not affect total production. *See* Tr. 457:1-4 (von Lindern). As long as total production complies with the five-year rolling average of 135,000 tons per day and the life-of-mine limit, total production and therefore emissions remain at or below the T-RACT production limits that were used to demonstrate compliance with the incremental cancer risk probability of 1-in-240,000.

Use of a rolling average is common in air permits to provide operational flexibility and assure compliance. REC 3925 (¶ 24); Tr. 294:11-17 (Lewis). Expert testimony confirmed that the 135,000 ton per day five- year rolling average production limit limits arsenic emissions, protects the incremental excess cancer risk, conforms with the TAPs rules, and is protective of human health and the environment. Tr. 39:14-19 (Schilling); Tr. 174:22-175:2 (Paden); Tr. 284:14-285:1 (Lewis). Along with the life-of-mine production limit, the rolling average allows flexibility, acknowledges operational variability, and achieves DEQ's permitting objective in ensuring compliance with the TAPs rules. Tr. 80:19-81:6 (Schilling); Tr. 260:2-17 (Lewis).

Because the AACCs are not based on exposure in any single year, and because the highest exposure concentration for the shortest possible exposure duration (16 years) demonstrated compliance with the T-RACT AACC, DEQ acted reasonably in determining that a production limit based on a five-year rolling average is protective of public health and the environment and ensures the Project is operated as described in the compliance demonstration under Sections 210.12 and 586.

C. DEQ and Perpetua's expert evidence showed that the PTC already limits production from the non-West-End Pits, and no separate limit is necessary.

The final issue raised by the Board concerns the two life-of-mine production limits in Condition 3.6: (1) a limit on total mine production of 788.4 million tons and (2) a limit on West End Pit production of 394.2 million tons, which is 50% of total production. REC 385. While Condition 3.6 does not expressly limit non-West End Pit production, DEQ limited production by 50% from both the West End Pit and the non-West End Pits in calculating the highest arsenic ambient concentrations from the Project. REC 710. The Board found "there was insufficient evidence in the record to demonstrate exactly how or whether the non-West End Pit production was limited" and if it was, "could not find any PTC conditions able to enforce that reduction." REC 3714.

The expert testimony of Mr. Schilling and Mr. Lewis explained that a separate production limit on the non-West End Pits was not necessary. They testified that modeling scenarios based on full production from the non-West End Pits (*i.e.*, the entirety of mine production or 788.4 million tons) for the shortest possible exposure duration (16 years) demonstrated compliance with the T-RACT AACC. Tr. 45:16-21 (Schilling); REC 3927-3928 (¶¶ 28, 30); REC 4140 (¶49). Modeling scenarios based on 50% production from the West End Pit and the remaining 50% from the non-West End Pits (*i.e.*, 394.2 million tons + 392.4 million tons = 788.4 million

tons) for the shortest duration of the mine (16 years) also demonstrated compliance with the T-RACT AACC. Tr. 116:13-23 (Schilling); Tr. 277:3-278:9 (Lewis).

If the West End Pit is mined to its maximum allowed production of 394.2 million tons (which results in the maximum modeled annual average ambient concentration), then total production from the non-West End Pits is inherently limited to the remaining 50%. Tr. 47:22-48:18 (Schilling); Tr. 281:1-282:7 (Lewis). Because Condition 3.6 limits West End Pit production to 394.2 million tons and total production to 788.4 million tons, an additional production limit on the non-West End Pits is unnecessary and would be redundant. Tr. 45:11-21 (Schilling); REC 3927 (¶ 28); Tr. 281:1-282:7 (Lewis); REC 4140-4141 (¶¶ 52-53).

Thus, the non-West End Pits are already limited by the total production limit and demonstrate compliance with the T-RACT AACC at total production limit of 788.4 million tons. Tr. 45:16-21 (Schilling); Tr. 281:1-282:7 (Lewis); REC 4140 (¶49). An additional production limit on the non-West End Pits offers no further protection to the public health or the environment. Tr. 281:1-282:7 (Lewis); REC 4140-4141 (¶ 53).

V. CONCLUSION

At the evidentiary hearing, DEQ and Perpetua demonstrated that DEQ acted reasonably and in compliance with Sections 161, 203, 210.12, and 586 of the Idaho Air Rules when permitting the Project's arsenic emissions. Based on DEQ and Perpetua's expert testimony, the Hearing Officer should enter findings of fact and conclusions of law that DEQ properly adjusted the Project's arsenic T-RACT ambient concentration based on an exposure duration tied to the T-RACT production limits equating to a 16-year duration, that a five-year rolling average production limit is consistent with the arsenic T-RACT AACC, and that no additional production limit is necessary to limit emissions from the non-West End Pits.

DATED: November 8, 2024.

STOEL RIVES LLP

Christopher Pooser
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole C. Hancock

Attorneys for Perpetua Resources Idaho, Inc.

CERTIFICATE OF SERVICE

I hereby certify that on November 8, 2024, a true and correct copy of the **PERPETUA'S POSTHEARING STATEMENT** was served on the following:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Dylan B. Lawrence
Hearing Officer
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Bryan Hurlbutt
Laurence ("Laird") J. Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Michael A. Short
Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
michael.short@deq.idaho.gov
hannah.young@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
ann.yribar@ag.idaho.gov
via electronic service

Diane Cutler, Hearing Coordinator
Rules and Planning Analyst
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
(208)373-0165
diane.cutler@deq.idaho.gov
via electronic service

Christopher Pooser
Attorneys for Perpetua Resources Idaho, Inc.

ATTACHMENT A

	16 Years of Operation at a Production Rate of 135,000 tons per day			70 Years of Operation at a Lower Production Rate		
Year	Daily Production ton/day	Annual Production (daily*365) MMton/yr	Maximum Modeled Annual Average Ambient Concentration $\mu g/m^3$	Daily Production ton/day	Annual Production (daily*365) MMton	Maximum Modeled Annual Average Ambient Concentration $\mu g/m^3$
1	135,000	49.28	0.00416	30,857	11.26	0.00095
2	135,000	49.28	0.00416	30,857	11.26	0.00095
3	135,000	49.28	0.00416	30,857	11.26	0.00095
4	135,000	49.28	0.00416	30,857	11.26	0.00095
5	135,000	49.28	0.00416	30,857	11.26	0.00095
6	135,000	49.28	0.00416	30,857	11.26	0.00095
7	135,000	49.28	0.00416	30,857	11.26	0.00095
8	135,000	49.28	0.00416	30,857	11.26	0.00095
9	135,000	49.28	0.00416	30,857	11.26	0.00095
10	135,000	49.28	0.00416	30,857	11.26	0.00095
11	135,000	49.28	0.00416	30,857	11.26	0.00095
12	135,000	49.28	0.00416	30,857	11.26	0.00095
13	135,000	49.28	0.00416	30,857	11.26	0.00095
14	135,000	49.28	0.00416	30,857	11.26	0.00095
15	135,000	49.28	0.00416	30,857	11.26	0.00095
16	135,000	49.28	0.00416	30,857	11.26	0.00095
17	0	0	0	30,857	11.26	0.00095
18	0	0	0	30,857	11.26	0.00095
19	0	0	0	30,857	11.26	0.00095
20	0	0	0	30,857	11.26	0.00095
21	0	0	0	30,857	11.26	0.00095
22	0	0	0	30,857	11.26	0.00095
23	0	0	0	30,857	11.26	0.00095
24	0	0	0	30,857	11.26	0.00095
25	0	0	0	30,857	11.26	0.00095
26	0	0	0	30,857	11.26	0.00095
27	0	0	0	30,857	11.26	0.00095
28	0	0	0	30,857	11.26	0.00095
29	0	0	0	30,857	11.26	0.00095
30	0	0	0	30,857	11.26	0.00095
31	0	0	0	30,857	11.26	0.00095
32	0	0	0	30,857	11.26	0.00095
33	0	0	0	30,857	11.26	0.00095
34	0	0	0	30,857	11.26	0.00095
35	0	0	0	30,857	11.26	0.00095
36	0	0	0	30,857	11.26	0.00095
37	0	0	0	30,857	11.26	0.00095
38	0	0	0	30,857	11.26	0.00095
39	0	0	0	30,857	11.26	0.00095
40	0	0	0	30,857	11.26	0.00095
41	0	0	0	30,857	11.26	0.00095
42	0	0	0	30,857	11.26	0.00095
43	0	0	0	30,857	11.26	0.00095
44	0	0	0	30,857	11.26	0.00095
45	0	0	0	30,857	11.26	0.00095
46	0	0	0	30,857	11.26	0.00095
47	0	0	0	30,857	11.26	0.00095
48	0	0	0	30,857	11.26	0.00095
49	0	0	0	30,857	11.26	0.00095
50	0	0	0	30,857	11.26	0.00095
51	0	0	0	30,857	11.26	0.00095
52	0	0	0	30,857	11.26	0.00095
53	0	0	0	30,857	11.26	0.00095
54	0	0	0	30,857	11.26	0.00095
55	0	0	0	30,857	11.26	0.00095
56	0	0	0	30,857	11.26	0.00095
57	0	0	0	30,857	11.26	0.00095
58	0	0	0	30,857	11.26	0.00095
59	0	0	0	30,857	11.26	0.00095
60	0	0	0	30,857	11.26	0.00095
61	0	0	0	30,857	11.26	0.00095
62	0	0	0	30,857	11.26	0.00095
63	0	0	0	30,857	11.26	0.00095
64	0	0	0	30,857	11.26	0.00095
65	0	0	0	30,857	11.26	0.00095
66	0	0	0	30,857	11.26	0.00095
67	0	0	0	30,857	11.26	0.00095
68	0	0	0	30,857	11.26	0.00095
69	0	0	0	30,857	11.26	0.00095
70	0	0	0	30,857	11.26	0.00095
Total Lifetime Production:		**788.4**			**788.4**	
Lifetime Modeled Arsenic Exposure Concentration:			**0.00095**			**0.00095**
Percent of T-RACT AACC of 0.0023 mg/m3:			41%			41%

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	Agency Case No. 0101-22-01
	)	OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON	)	**PETITIONERS' POST-HEARING STATEMENT**
Petitioners,	)	
v.	)	
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC.	)	
Intervenor-Respondent.	)	

INTRODUCTION

Over the course of the hearing in the above-captioned case, held on October 17-18, 2024, Petitioners Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon presented compelling evidence that the Permit to Construct ("Permit" or "PTC") issued by the Idaho Department of Environmental Quality ("DEQ") to Perpetua Resources Idaho, Inc. ("Perpetua") for the proposed Stibnite Gold Project ("SGP" or "Project") does not demonstrate compliance with the Rules for Control of Air Pollution in Idaho, ("Air Rules"), IDAPA 58.01.01, and if allowed to proceed, will create a significant threat to public health and cause a dangerous precedent of applying project-specific adjustments to carcinogenic toxic air pollutant assessments found nowhere in the Air Rules. DEQ and Perpetua (collectively, "Respondents") failed to provide the Hearing Officer with evidence to support their contention that their calculation of ambient arsenic concentration in their T-RACT analysis complies with the Air Rules, or that using the 16/70 Project-specific adjustment factor to assess excess cancer risk was in accordance with the Air Rules or scientifically justified.

Petitioners detail their argent below with the aid of the hearing transcript (hereinafter referred to as "Tr.") for the hearing held on October 17-18, 2024.

LEGAL STANDARDS

Petitioners brought this contested case to challenge DEQ's action in issuing the Permit for the Stibnite Gold Project. Under the Idaho Administrative Procedures Act, an agency action like DEQ issuing the Permit will be overturned where its findings, inferences, conclusions, or decisions are: "(a) in violation of constitutional or statutory provisions; (b) in excess of the statutory authority of the agency; (c) made upon unlawful procedure; (d) not supported by substantial evidence on the record as a whole; or (e) arbitrary, capricious, or an abuse of

discretion." Idaho Code ("I.C.") § 67-5279(3); *see 917 Lusk v. City of Boise*, 158 Idaho 12, 14 (2015). "An action is capricious if it was done without a rational basis. It is arbitrary if it was done in disregard to the facts and circumstances presented or without adequate determining principles." *Am. Lung Ass'n of Idaho/Nev. v. Idaho State Dep't of Agric.*, 142 Idaho 544, 547 (2006) (citations omitted).

APPLICABLE AIR RULES

The Air Rules' requirements for controlling the emission of toxic air pollutants ("TAPs") begin with IDAPA 58.01.01.161. Section 161 is the overarching policy or qualitative standard that should be applied to the emission of toxic contaminants, such as arsenic. It provides:

> Any contaminant that is by its nature toxic to human or animal life or vegetation ***must not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human life or vegetation.***

(emphasis added). To obtain a permit to construct an applicant must demonstrate, to the satisfaction of the Department that:

> ***Using the methods provided in Section 210***, the emissions of toxic air pollutants from the stationary source or modification would not injure or unreasonably affect human or animal life or vegetation ***as required by Section 161***. Compliance with all applicable toxic air pollutant carcinogenic increments and toxic air pollutant non- carcinogenic increments demonstrates preconstruction compliance with Section 161 ***with regard to the pollutants listed in Section 585 and 586.***

IDAPA 58.01.01.203.03 (emphasis added). Thus, if a TAP is listed in IDAPA 58.01.01.585 or 586 ("Section 586"), it must be evaluated under the methods provided in Section 210.

Section 586 of the Air Rules consists of a table that lists each carcinogenic TAP that is covered by the rules–including arsenic. Section 586 includes "the screening emissions levels (EL) and acceptable ambient concentrations (AACC)" for each toxic carcinogenic pollutant listed. The EL listed for arsenic is "1.5E-06 lb/hr" and the AACC for arsenic is "2.3E-04 $\mu g/m^3$."

The AACC is the carcinogen concentration in air in which daily exposure would limit the risk of cancer to 1 in 1 million over a lifetime, which is identified as 70 years. The AACCs listed in the table in Section 586 are based on "annual averages." IDAPA 58.01.01.586.

Section 210.01 provides that the applicant must first identify what TAPs will be emitted by the project. IDAPA 58.01.01.210.01. Then the applicant must use "standard scientific and engineering principles and practices to estimate the emission rate" of the pollutant. IDAPA 58.01.01.210.02.a. If the EL exceeds the levels listed in Section 586, then the applicant must continue with further analysis under Section 210.

The applicant must then use "the modeling methods provided in Subsection 202.02 to estimate the ambient concentrations at specific receptor sites for any toxic air pollutant emitted from the point(s) of emission." IDAPA 58.01.01.210.03.a.5. The "point of compliance is the receptor site that is estimated to have the highest ambient concentration of the toxic air pollutant of all the receptor sites . . .." IDAPA 58.01.01.210.03.b. Preconstruction compliance for toxic pollutants can be demonstrated using any of the methods "described in Subsection 210.05 through 210.08 and may use any applicable specialized method described in Subsection 210.09 through 210.12." IDAPA 58.01.01.210.04.

Applicable here are the compliance methods described in Section 210.12, which provides for the use of "T-RACT" to demonstrate preconstruction compliance for toxic pollutants listed in Section 586. T-RACT stands for "Toxic Air Pollutant Reasonably Available Control Technology" and "is an emission standard based on the lowest emission of toxic air pollutants that a particular source is capable of meeting by the application of control technology that is reasonably available, as determined by the Department, considering technological and economic feasibility." IDAPA 58.01.01.210. The applicant must comply with IDAPA 58.01.01.210.13 and

210.14 to first get approval by DEQ to proceed under the T-RACT provisions before it can be used in the modeling. If T- RACT is used, it allows for a comparison of:

> [T]he source's . . . approved T-RACT ambient concentration at the point of compliance for the toxic air pollutant to the amount of the toxic air pollutant that would contribute an ambient air cancer risk probability of less than one to one hundred thousand (1:100,000) (which amount is equivalent to ten (10) times the applicable acceptable ambient concentration listed in Section 586).

IDAPA 58.01.01.210.12.b. Thus, if the source's approved T-RACT ambient concentration meets the AACC listed in Section 586 times 10, then "no further procedures for demonstrating preconstruction compliance will be required for that toxic air pollutant as part of the application process." IDAPA 58.01.01.210.12.c. DEQ must then include appropriate conditions in the permit to ensure that the T-RACT is implemented so that the 10-times ambient concentrations can be met. IDAPA 58.01.01.210.12.d.

Section 210 provides one further analysis that has bearing in this case. Section 210.15 provides that "short term" projects "may utilize a short-term adjustment factor of ten (10). "For a carcinogen, multiply either the applicable acceptable ambient concentration (AACC) or the screening emission rate, but not both, by ten (10), to demonstrate preconstruction compliance." IDAPA 58.01.01.210.15. "Short Term Source" is defined as any new stationary source "with an operational life no greater than five (5) years from the inception of any operations to the cessation of actual operations." IDAPA 58.01.01.007.08. Thus, short term sources are also allowed 10 times the AACC, which would represent a 1 in 100,000 cancer risk, as long as the operational source life is no greater than five (5) years.

As noted above, the AACC levels found in Section 586 "conservatively represents a long-term exposure (70 years) that would result in a 1 in 1,000,000 cancer risk." REC 1242. Neither the AACC limit, nor the 10-fold higher T-RACT limit could not be met for the Stibnite

Gold Project. Thus, Respondents applied two adjustments to the arsenic calculations to reduce calculated emissions: (1) decreasing maximum potential annual mine production from 180,000 tons per day ("T/day") to 135,000 T/day based on a five-year rolling average limit; and (2) decreasing maximum potential annual production from the West End Pit by applying a 50% annual limit. The T-RACT amount allowed for in Section 210.12 represents a 1 in 100,000 lifetime excess cancer risk. IDAPA 58.01.01.210.12.b. But even using T-RACT, the AACC levels, as adjusted to 10-times higher by IDAPA 58.01.01.210.12.b, still could not be met. REC 1243–1244. It was at that point that Respondents decided to focus on excess cancer risk rather than the AACC limits as the applicable standard, and apply the 16/70 Project-specific adjustment to the calculation of arsenic emissions. REC 1243–1244, *see also* REC 698–706. Using this final of three adjustments to the arsenic concentration–which Respondents now claim is a "cancer risk assessment"–is found nowhere in the Air Rules, and as discussed further below, is not supported by applicable science.

ARGUMENT

I. The 16/70 Adjustment Is Unlawful, Not Supported by the Evidence, and Should be Rejected.

A. The Plain Language of the Air Rules Does Not Allow Using a Project-specific Adjustment Factor.

Based on the the Air Rules provisions above, the Board correctly concluded that the 16/70 Project-specific adjustment factor DEQ used here is "nowhere" found in the rules:

> The Air Rules clearly provide an AACC standard in Section 586. They then clearly provide an adjustment to that AACC standard when T-RACT can be used to control emissions. IDAPA 58.01.01.210.12.b. The Air Rules also clearly allow for a 10-times adjustment to the AACC when a project is going to operate for 5 years or less. IDAPA 58.01.01.210.15. But nowhere in the Air Rules does it provide that a project that will operate more than 5

> years but less than 70 years may be adjusted in proportion to the amount of time it will operate.

REC 3715. This should be the end of the story on the 16/70 Project-specific adjustment factor issue.

DEQ is not free to disregard the plain language of the Air Rules, even if it has some rationale for doing so. Agency rules (like the Air Rules) have the full force and effect of law. *See Mead v. Arnell*, 117 Idaho 660, 664–65 (1990). As the Idaho Supreme Court has explained: "We must follow the law as written. If it is socially or economically unsound, the power to correct it is legislative, not judicial." *Herndon v. West*, 87 Idaho 335, 339 (1964). "Regulations, like statutes, are interpreted according to canons of construction." Black & Decker Corp. v. C.I.R., 986 F.2d 60, 65 (4th Cir. 1993).

Under the canon of *generalia specialibus non derogant*, when there is a conflict between a general provision and a specific provision, the specific provision prevails. "The canon provides that a 'narrow, precise, and specific' statutory provision is not overridden by another provision 'covering a more generalized spectrum' of issues." *Perez-Guzman v. Lynch*, 835 F.3d 1066, 1075 (9th Cir. 2016) (quoting *Radzanower v. Tourche Ross & Co.*, 426 U.S. 148, 153–54 (1976)). "[T]he assumption being that the more specific of two conflicting provisions 'comes closer to addressing the very problem posed by the case at hand and is thus more deserving of credence.'" *Perez-Guzman*, 835 F.3d at 1075 (quoting Antonin Scalia & Bryan A. Garner, Reading Law: The Interpretation of Legal Texts 183 (2012)). The Idaho Supreme Court applies this cannon. *See Tomich v. City of Pocatello*, 127 Idaho 394, 400 (1995); *Mickelsen v. City of Rexburg*, 101 Idaho 305, 307 (1980).

Again here, Air Rules Section 203.03 requires "no permit to construct shall be granted" unless DEQ determines that the applicant has shown: "Using the methods provided in

Section 210, the emissions of toxic air pollutants from the . . . source . . . would not injure or unreasonably affect human health or animal life or vegetation as required by Section 161." (emphasis added). To protect human health, Section 586 sets a numeric arsenic AACC limit at an annual average of 0.00023 $\mu g/m^3$. Section 210 creates two specific exceptions to meeting the AACC (which is an annual emissions factor), allowing a 10-fold higher AACC where the applicant makes a T-RACT demonstration (Section 210.12) and/or where a project is short-term (5 years or less) (Section 210.15). These specific, numerical provisions in Sections 586 and 210 cannot be disregarded to fall back on a more general, qualitative standard in Air Rule Section 161, which provides that a toxic air pollutant "shall not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation." REC 3419.

Nor can the explicit AACC annual average value listed in Section 586 be ignored by reverse engineering using the URFs and cancer risk calculations, as DEQ now says it is doing. This method is nowhere found in the "methods in Section 210" and has never been used by DEQ before. *See* REC 1194 (Schilling memo admitting this is "a complete change in the regulatory approach used to demonstrate compliance with toxics," and it "abandons the Section 210 approach"). Section 210 sets forth clear and straightforward methods for checking a source's annual arsenic concentration against the annual arsenic value listed in Section 586 (or 10 times that value for T-RACT, like for the SGP, and short-term sources). Instead of using these methods in Section 210, DEQ abandoned this approach, and has come up with a new method, which instead of using the actual annual arsenic concentration DEQ and Perpetua modeled to occur due to the SGP's arsenic emissions, averages 16 years of emissions over 70 years, to compare them to 10 times the AACC. This is a fabrication. This is not a cancer risk assessment. von Lindern

Test., Tr. 434-435, 465. And Respondents during the three years of permit development and two years of this contested case proceeding never, until now, consulted a toxicologist on whether spreading out the Project's arsenic emissions and cancer risk over 70 years was appropriate. Paden Test., Tr. 154; Lopez Test., Tr. 234. DEQ must follow Section 210 and compare the annual average arsenic concentrations from the SGP to the T-RACT adjusted AACC listed Section 586. *See* IDAPA58.01.01.210.12.

Another cannon of construction requires interpreting regulations to avoid rendering provisions superfluous—which is what DEQ's approach here does to the Air Rules explicit short-term source adjustment for projects that last 5 years or less. "A statute should be construed so that effect is given to all its provisions, so that no part will be rendered superfluous or insignificant." *Brown v. Caldwell Sch. Dist. No. 132*, 127 Idaho 112, 117 (1995). Again, Section 210 specifically provides for AACC adjustments for in two situations: projects that have demonstrated T-RACT; and short-term five-year-or-less projects. DEQ cannot just make up a third adjustment found nowhere in the Rules. This is especially so since there is already an adjustment in the Air Rules for short-term sources for which everyone agrees the SGP does not qualify. If DEQ can adjust AACCs based on project duration, as it has done here, then the short-term adjustment in Section 215 is superfluous. DEQ's interpretation cannot stand.

Thus, the 16/70 adjustment is not allowed by the plain language of the Air Rules and must be rejected, whether or not DEQ or Perpetua can offer any rationale for using it.

B. The 16/70 Approach Undermines the Air Rules, Creates a Dangerous Precedent for Idahoans, and Allows Higher Cancer Risk.

Not only does the plain language of the Air Rules foreclose DEQ's approach, but this approach is contrary to the intent of the Air Rules and would create a dangerous precedent allowing Idahoans to be exposed to *higher* cancer risks than under DEQ's longstanding pre-SGP

interpretation of the Air Rules: where TAPs values listed in Section 586 are annual limits that must be met by a source every year of emissions.

Around the time of the TAPs rulemaking, a number of concerns were raised about creating exceptions for short term sources, even for remediation projects being undertaken to clean up the environment. *See* REC 6055-6056 (Tiedemman Decl. ¶¶ 18–21). Health concerns were raised about exposing people to a large dose of carcinogen during short periods. REC 6071-6084 (*Id.* at Exh. A). Health concerns were raised about the risk of "combined and synergistic effect of many short term . . . or other sources . . . and the potential of serial (one after another) short term . . . sources," the risk of creating an "incentive for facilities to argue they will be short-term," and the risk of a "spectre of serial short-term sources." REC 6086 (*Id.* at Exh. B).

IDHW echoed these concerns in response to comments, stating that for the TAPs it "strived to take a balanced approach taking into account the needs of industry to operate and the need to protect human health and the environment." REC 6056-6057 (Tiedemann Decl. ¶ 21); *see also* REC 4298, 4300-4302 (Lopez Decl., Memo in Supp. at 8, 10–12) (citing to same IDHW response to comments). IDHW added: "Since it is not possible to account for such real life factors as lifetime exposures, additive or multiplicative effects of exposures to the large variety of industrial chemicals in use in Idaho, it is necessary to make our emissions standards generally applicable and reasonably conservative." REC 6057 (Tiedemann Decl. ¶ 21). This was reflected in Dr. von Lindern's testimony, who was involved during TAPs Rule rulemaking, testified as to his recollection from those hearings confirmed that "one of the main objectives of developing the TAPs – these rules was to avoid risk assessment." von Lindern Test., Tr. 416. This is also reflected in the Air Rules, which include specific adjustments for T-RACT and short-term sources but are otherwise generally applicable to all sources—including the SGP.

Under DEQ's longstanding, pre-SGP precedent in applying the TAPs Rule, Idahoans are better protected from these risks. As Dr. von Lindern and Mr. Tiedemann showed, where the AACC values are treated as limits that must be met by sources in Idaho every year, no single source nor any combination of sources will expose an Idahoan to more than the AACC concentration (or 10 times the AACC concentration for T-RACT or short-term sources) at any time over their 70-year life, no matter how many sources they might encounter or where they might encounter them in the state; and accordingly, the cancer risk over that entire 70 years will not exceed the applicable cancer risk (1 in 1 million, or 1 in 100,000 for T-RACT or short-term sources). *See* REC 6109-6113 (Dr. von Lindern Decl. ¶¶ 21–29); REC 6060-60621 (Tiedemman Decl. ¶¶ 28–29). "That's the way TAPs has been implemented [on] every other project that's been done in Idaho to date." von Lindern Test., Tr. 421.

By contrast, under DEQ's approach, Dr. von Lindern explained that it:

> would concentrate 70 years of cumulative risk . . . into . . . however many years you're adjusting that project, whether it be six years or 16 years or something like that. * * * I understand from their interpretation that you could apply this risk factor to as low as 6 over 70. * * * [For a 16-year project,] [t]hey would they completely used their entire lifetime exposure by the end of adolescence.

von Lindern Test., Tr. 421-423.

Furthermore, Idahoans could be exposed to one source (like the SGP) at levels higher than the listed AACC values, and then be exposed to additional sources during the rest of their life such that the cancer risk over their life exceeds the Air Rules risk levels. *See* REC 6120 (Figure 4 of von Lindern Decl.). Dr. von Lindern testified that because the AACC is an "incremental standard," "DEQ is not allowed to consider past exposures. The next project gets another full boat of lifetime exposure. [in the 6 year] example, by age 12, you're twice the

amount. By age 18, you're three times your total cumulative lifetime exposure." von Lindern Test., Tr. 443. For example, DEQ and Perpetua have modeled the SGP to result in 0.00416 $\mu g/m^3$ average annual arsenic concentration. REC 0361 (brief explaining how to reverse the 16/70 adjustment); REC 3876 (Paden Decl. ¶ 9). This is *181 percent* of the T-RACT adjusted AACC for arsenic of 0.0023 $\mu g/m^3$. REC 0361. If a person were exposed to 0.00416 $\mu g/m^3$ of arsenic for 16 years, and then were exposed to another arsenic source(s)—even if that source complied with but was close to the T-RACT adjusted AACC value—then that person will have more than a full allowable 70-year exposure to arsenic and corresponding cancer risk.

> The TAPs rule is health protective if properly implemented. Applying risk averaging through the use of the 16/70 Project-specific adjustment factors eliminates the [margin of safety] and substantially increases cancer risk, especially considering the incremental nature of the rule.

REC 6122 (von Lindern Decl. ¶ 50). As the Board stated:

> There is an acceptable risk associated with the AACC standard. There is an acceptable risk associated with DEQ-approved T-RACT projects, and there is an acceptable risk associated with the short-term project that is five years or less. There are no other acceptable risks identified in Idaho's air quality rules.

TR 0160. The 16/70 Project-specific adjustment factor creates a misleading risk analysis that greatly underestimates actual cancer risk.

C. DEQ's & Perpetua's Cancer Risk Assessment is Not Scientifically Valid and Fails to Show that the SGP Is Equally or More Protective of Human and Animal Life and Vegetation

The Board not only faulted DEQ for using the 16/70 Project-specific adjustment factor because that approach is nowhere found in the Air Rules, but it also faulted DEQ for failing to show that the 16/70 adjustment factor was sufficiently protective of human health and the environment:

> The arsenic analysis performed by DEQ must be viewed within the wider lens of IDAPA 58.01.01.161 and 203 which require that toxic pollutants must "not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation." see also IDAPA 58.01.01.203.03. The Board of Environmental Quality has not found sufficient evidence in the record to convince it that the 16/70 analysis performed by DEQ was equally or more protective of human and animal life and vegetation as what is provided for by the Air Rules. Therefore, the Board of Environmental Quality remands this matter back for the development of further evidence regarding the ambient air concentrations of arsenic that will be produced by the SGP and whether those levels comply with the Air Rules.

REC 3716-3717. Even if the Hearing Officer determines that compliance with the TAPs rule can be accomplished through a risk assessment assessing excess cancer risk, Respondents have failed to show that the 16/70 Project-specific adjustment factor is a scientifically valid risk assessment, that they followed any scientifically valid risk assessment protocol, and that application of their simple equation to the SGP emissions accounts for total health risk the Project will create.

1. Respondents 16/70 Project-specific adjustment factor is not scientifically valid and it does not follow any standard risk assessment protocol.

Testimony from Respondents' toxicologists, Dr. Paden and Ms. Lopez, failed to establish that application of the 16/70 Project-specific adjustment factor to arsenic emissions is a scientifically valid method for assessing excess cancer risk for this Project. Ms. Lopez's testimony relied on one statement from Appendix A, titled "Major Default Options," from EPA's 2005 Guidelines for Carcinogen Risk Assessment (Ex. 221) to justify applying the 16/70 Project-specific adjustment factor. Lopez Test., Tr. 221-22. However, reading from several areas of the document, Dr. von Lindern testified that the document as a whole does not support applying an exposure duration adjustment to assess cancer risk for this project. Von Lindern Test., Tr. 424-429.

A true risk assessment is comprehensive and multi-variable. For example, the State of Washington requires "health impact assessments" (HIA) for some sources of toxic air emissions. REC 6251-6262 (von Lindern Decl., Exh. C (DEC Guidance)). According to the Washington Department of Ecology, the techniques in its guidance manual "are common to other regulatory risk assessment applications." REC 6251 (*Id.5).*. "An HIA looks at how emissions of toxic air pollutants from a specific project will affect public health. It involves several steps, including hazard identification, exposure analysis, toxic response, and risk characterization." *Id.*

For an HIA, the applicant must disclose the total daily intake of TAPs attributable to the source "as well as the background sources." REC 6253 (*Id.* at 19). The applicant must estimate exposure durations, "[d]etail the exposure parameters associated with sensitive population subgroups," "[i]dentify the potentially exposed populations," and "[g]ive special emphasis to any subpopulations that might be unusually susceptible to any TAPs emitted by your project." *Id.* In the risk/hazard assessment section, the applicant must also include a toxicity discussion, which should discuss: toxic effects of the TAPs; exposure levels associated with specific effects; exposure patterns and duration of exposure; any quantitative, chronic toxicity values (including hazard-based concentrations, cancer unit risk factor estimates, and slope factor or carcinogenic potency estimates); and any quantitative intermediate and short-term acute toxicity values. *Id.*

For an HIA, the applicant must also provide risk/hazard information, including a qualitative discussion of the risks; quantitative discussion of the risks with toxicity measures, calculated cancer risks, and the hazard index; discussion of uncertainties in the risk assessment; discussion of acceptability of risk; and discussion of extent to which the proposed facility might affect human health.. REC 6253-6254 (*Id.* at 19–20). Applicants are to disclose uncertainties of their risk assessment, including: uncertainty in emission estimates; uncertainty in air dispersion

models; interactive effects of exposure to more than one carcinogen or toxicant; uncertainty in exposure estimates; and uncertainty about the extent of toxicant susceptibility variation within populations. REC 6254 (*Id.* at 20).

DEQ's and Perpetua's toxicologist declarations lack most of these common risk assessment techniques, including uncertainties in emissions and modeling, and interactive effects of exposure to more than one carcinogen, among others identified above. *See* Paden Decl; Lopez Decl.

2. DEQ and Perpetua Fail to Account for Combined Effects of Other Carcinogens as Required by Air Rule Section 161

Air Rule Section 161 requires protection from toxic pollutants like arsenic from a source both alone and "in combination with other contaminants." But neither DEQ nor Perpetua factored in exposure to other contaminants, either during the 16-year SGP, or any other time during someone's lifetime. They only consider arsenic from the SGP. The SPG will itself emit other toxic and hazardous air pollutants. REC 433-44 (table of TAP/HAP emissions). Idahoans may already be exposed to background concentrations of other contaminants. And as already explained, someone exposed to the SGP might be exposed to other sources of arsenic and other contaminants throughout the other 54 years of their 70 year life. But these exposures are not accounted for in the risk assessments. *See* Lopez Decl.; Paden Decl; REC 6137 (von Lindern Decl. ¶ 90).

3. DEQ and Perpetua Fail to Account for Sensitive Populations, Mutagenic MOA, and Non-carcinogenic Risk

The cancer risks DEQ and Perpetua calculated fail to account for the health risks of short-duration, high exposure to arsenic for sensitive populations, including pregnant women, the

fetus, and pre-school children, who accumulate dose and risk at high rates. REC 6117-6118 (von Lindern Decl. ¶¶ 40–44).

DEQ and Perpetua also failed to consider mutagenic modes of action (MOA). While this is not definitively settled, and current EPA policy does not require accounting for this, there is evidence suggesting that arsenic in combination with other co-stressors has shown mutagenic MOA. REC 6135-6136 (*Id.* ¶ 84). As such, a comprehensive risk assessment would use age dependent adjustment factors, *id.*, which neither DEQ nor Perpetua has done.

DEQ and Perpetua also failed to consider non-carcinogenic arsenic health effects, especially to children. *See* REC 6136-6137 (*Id.* ¶¶ 85–88). Non-carcinogenic arsenic health effects can become the risk driver at sites where children may ingest, in addition to inhaling, arsenic laden dusts. REC 6136 (*Id.* ¶ 85. Incidental ingestion of mining-related fugitive dusts is the major exposure route for heavy metals in mining communities in Idaho. REC 6136-6137 (*Id.* ¶ 88.)

In summary, each of the problems above would be avoided by treating the AACCs limits that must be met by source each year of operations, as DEQ had always done prior to the SGP. These problems—the disregard for the Air Rules as written, the dangerous precedent, and the underestimation of cancer risk from the SGP—are all amplified by DEQ's use of the five-year rolling average and its treatment of production from the different mining pits, discussed in the next section.

II. DEQ and Perpetua's calculated ambient arsenic concentration is not consistent with and is less protective than the annual average AACC limit specified in Section 586 of the Air Rules.

The Board of Environmental Quality held that the "AACC limits set forth in Section 586 are based on annual averages." REC 3713; *see also* REC 3707. Furthermore, calculations of the

annual average emission rate of a source is based on "the maximum capacity of the source . . . with the effect of any physical or operational limitations that [have] been specifically described . . ." REC 3708 (citing IDAPA 58.01.01.210.02.c). Calculation of the maximum capacity of the source is also required if an applicant is proceeding under the T-RACT provisions of the Air Rules. REC 3708 (citing IDAPA 58.01.01.210.02.d). Specifically, Air Rule 210.2.d provides:

> The T-RACT emissions rate of a toxic air pollutant from a source . . is calculated using the *maximum* capacity of the source or modification under its physical and operational design with the effect of:
>
> i. Any physical or operational limitation other than control equipment that has been specifically described in a written and certified submission to the Department; and
>
> ii. An emission standard that is T-RACT.

(emphasis added).[1] Thus, demonstrating compliance with the AACC limits set forth in Section 586 must be based on the calculation of the maximum annual average ambient TAP concentration that a source, given physical and operational limitations, can potentially emit. "You don't permit on actual emissions. You permit on, you know, maximum potential emissions." Lewis Test. Tr. 491.

Here, record and expert witness testimonial evidence demonstrate that the five-year rolling average and the West End pit production adjustments serve to significantly reduce the maximum potential emissions the Project is capable of producing under the PTC. Using less than

[1] In addition to Section 210 of the Air Rules, there are several other provisions that explicitly state that *maximum* emissions are the relevant measure for calculating emissions. *See*, *e.g.*, Air Rules 006.36 (defining "allowable emissions" as "calculated using the *maximum* rated capacity of the source or facility") (emphasis added); *id.* 006.36 (definition the "potential to emit" as the "*maximum* capacity of a facility or stationary source to emit an air pollutant under its physical and operational design") (emphasis added); *id.* 007.05.a ("for the purposes of Sections 200 through 228" of the Air Rules, defining "projected actual emissions" as the "*maximum* annual rate . . . at which an existing emissions unit is projected to emit a regulated air pollutant . . .") (emphasis added).

maximum potential emissions also undermines and underestimates Respondents' cancer "risk assessment."

A. The five-year rolling average does not "comport[ ] with the annual AACC limits." Rather, it underestimates the maximum annual average arsenic concentration and thus, underestimates the excess cancer risk.

Testimony from Mr. Lewis demonstrates that using the five-year rolling average to calculate the annual average ambient arsenic concentration underestimates the potential maximum annual average that could be emitted under the permit's operational limitations, and thus is not synonymous with the AACC limit and undermines Respondents' cancer risk calculations. Table C of the TAP Addendum, as confirmed by Mr. Lewis's testimony, shows that the annual average ambient arsenic concentration calculated for the five-year rolling average (after application of the 16/70 Project-specific adjustment factor) is 0.00095 $\mu g/m^3$. REC 6888; Lewis Test., Tr. 285. Although the maximum annual average arsenic concentration were the mine to operate at the full potential of 180,000 T/day was never calculated during the permit's development, Mr. Lewis testified that hypothetically using the 180,000 T/day production limit would increase the annual average arsenic concentration to 0.00126 $\mu g/m^3$, or 33 percent higher. Lewis Test., Tr. 285, 289. In other words, Perpetua's calculation of the annual arsenic emissions using the five-year rolling average is at least 1.3 times lower than the maximum permissible emissions under permit conditions.[2]

Dr. von Lindern testified that, using Perpetua's own data in the TAP Addendum, he estimated that the annual average arsenic concentration using the five-year rolling average may underestimate the maximum annual arsenic concentration by as much as 1.8 times. von Lindern Test., Tr. 455.

[2] 0.00126 $\mu g/m^3$) / (0.00095 $\mu g/m^3$) = 1.33.

Mr. Lewis confirmed that using a five-year rolling average based on 135,000 T/day is inappropriate for calculating the maximum annual average arsenic concentration because permit conditions do not restrict Perpetua from having several years of maximum production of 180,000 T/day as long as the five-year average is at or below 135,000 T/day:

> Q. Okay. And tell me what those conditions are as you understand them.
>
> A. . . . So in condition 3.5 of the permit, there's two limits in there. I characterize one of them as a short-term limit, and that is 180,000 tons per day. . . . In that same condition, there's another limit that's 135,000 tons per day, but that's over a five-hear rolling average, so that's considered a long-term limit.

von Lindern Test., Tr. 280. Mr. Schilling confirmed this to be the case:

> Q. . . . [I]f we just round off at 180,000 [tons] as the daily limit and 135,000 [tons] as the five-year rolling average daily limit . . ., [Perpetua] could produce up to 180,000 tons per day out of the mine, but they would have to operate in a manner that would allow them to average no more than 135,000 tons per day on that five-year rolling average basis; is that right?
>
> A. Yes. Yes.

Schilling Test., Tr. 61. Thus, it is possible that in any given five-year period, Perpetua could have up to three years of emissions that correspond to a maximum operations rate of 180,000 T/day, followed by two years of less production, as depicted below for three successive five-year rolling average periods covering eight years of mining operations:[3]

Tons/day	**60,000**	**75,000**	**180,000**	**180,000**	**180,000**	**60,000**	**75,000**	**180,000**
Years 1-5	1	2	3	4	5			
Years 2-6		2	3	4	5	6		
Years 3-7			3	4	5	6	7	
Years 4-8				4	5	6	7	8

[3] Mr. Schilling testified that for calculating the five-year rolling average"each year [the rolling average] shifts and drops off the later year and adds on the newer year." Schilling Test., Tr. 44.

Using the five-year rolling average of 135,000 T/day allows Perpetua to hide up to nine years of annual arsenic emissions at the maximum allowed 180,000 T/day production rate during the total 16 years of the life of mine. Mr. Schilling confirmed as much:

> *Idaho Air Rules* Section 586 state that AACCs are annual averages. The implication of the stated issue is that when a standard or increment is specified for a certain averaging-period, then any limits imposed on operations should be for the same averaging period or a shorter averaging period. For example, an operational limit designed to limit emissions that is based on a 5-year averaging period would not be adequate for assuring compliance with the annual average standard. ***This is because variability in operational rates within the 5-year operational period could result in a violation of the annual standard*** while still complying with the five-year operational limit in the period.

Schilling Decl. ¶ 24 (emphasis added).

The evidence presented at the hearing confirms that Board's findings that "the five-year rolling average allows for a smoothing out of the peak concentrations of ambient arsenic," and "allows considerable daily and annual increases in exposures which are contrary to limits set forth in the Air Rules." REC 3713.

B. DEQ and Perpetua's calculation of the ambient arsenic concentration incorrectly applies Permit Condition 3.5 that limits WEP production to 50 % of total life-of-mine production.

The Board found that there was insufficient evidence to support Respondents' T-RACT analysis that limited the non-West End pit production limit. REC 3713-14. However, it is the Respondents' misapplication of the West End pit life-of-mine production limit that allows the maximum annual average arsenic concentration to go unanalyzed, and thus does not meet the Air Rule's requirement to calculate the maximum annual potential emissions and directly compare it to the T-RACT AACC limit.

Permit Condition 3.6 limits West End pit production to a total life-of-mine production of 394.2 million tons. REC (PTC citation); Schilling Test., Tr. 45, 48. Mr. Lewis's testimony

confirms that this limit is a life-of-mine, or total, production limit, and does not limit West End pit production on an annual basis except to the extent that production from any pit is limited to 180,000 T/day and a 135,000 T/day five-year rolling average. Lewis Test., Tr. 282.

Mr. Lewis also confirmed that, based on the permit conditions, a scenario of more than 50% production from the West End pit in any given year is a possibility:

> Q. Okay. And then the 180,000 tons per day, that's the maximum in a 24-hour period that can be taken out of all the mines in total; is that right?
>
> A. That's correct.
>
> Q. So regardless of which location you're in in the moment, you cannot take more than 180,000 tons a day out, . . .
>
> * * *
>
> "You just don't mine from all of [the pits] the same amount at the same time. . . . [A]s the mine develops, . . . you might start out at the Yellow Pine Pit and then, you know, move over to the West End Pit."

Lewis Test., Tr. 261. Because the permit does not limit annual West End pit mine production to 50%, Perpetua's maximum potential emissions would actually be 100% West End pit production at a maximum of 180,000 T/day. While this 180,000 T/day production can not happen every day over the 16-year life of the mine due to the five-year rolling average limit of 135,000 T/day, Perpetua could certainly mine 180,000 T/day from the West End pit every day for multiple years over, far exceeding the annual compliance period for the AACC. According to Mr. Lewis's testimony, having 180,000 T/day production from the West End pit in any given year(s) while still meeting the 394.2 million tons life of mine production limit is a real potential.

A theoretical mining scenario applying permit limitations (180,000 T/day maximum production; 135,000 T/day five-year rolling average; and maximum total life-of-mine West End

pit production of 394.2 million tons) where production occurs only from the West End pit is depicted below:

Mine Year	1	2	3	4	5	6	7	8
Thousand Tons/day	180	180	180	60	75	180	180	45
Million tons mined/year (running total)	65.7	131.4	197.1	219.0	246.375	312.075	377.775	394.2

Therefore, Perpetua could mine the entire 394.2 million tons from the West End pit for eight years, with five of those years up to the 180,000 T/day limit.

Correct application of the West End pit production permit limits is critical to calculating the maximum annual potential emission required under the Air Rules because West End pit production is the most problematic for arsenic concentration at the point of compliance because of its location and prevailing wind patterns. Schilling Test., Tr. 48-49; Lewis Test., Tr. 261, 270, 307 ([P]ound for pound, the West End Pit resulted in higher ambient air impacts.").

Mr. Lewis testified that Perpetua initially calculated the arsenic concentration of the worst-case scenario (100% West End pit production):

> Q. Do you recall, though, if W2 includes production from other pits or is it just accounting for a scenario where it would be a hundred percent West End Pit production?
>
> A. No, it's 50 percent West End Pit production combined with the worst-case modeling from the non-West End [ ] Pit production.
>
> * * *

> Q. Okay. So for the record, [the number in Exhibit 304] is 0.00698 . . . . So what is the – what does this table represent? . . .
>
> A. Yeah, sure. This table represents, again, modeling at 135,000 tons per day, and in this case, it's – it's the annual average concentration that the model spits out. And it is not on a 70-year lifetime basis. And for this W2 scenario, the number I just mentioned, that is not including the permit condition that limits the West End Pit to 50 percent of the total.
>
> * * *
>
> Q. . . . And so as far as comparing the W2 in the chart in Table C above [in Exhibit 304] and the W2 in the spreadsheet below, the difference there is that the W2 above contains a 50 percent production limit [from the West End pit] and W2 below is a hundred percent –
>
> A. Correct.

Lewis Test. Tr. 309, 311-12. However, rather than using the arsenic emissions calculations that would more closely represent the maximum annual potential emissions,[4] Perpetua focused on "project imposed risk rather than treating the AACC as an annual limit in itself." Schilling Test. Tr. 48.

The dilution–or dose averaging, as Dr. von Lindern stated, is seen in the equation in the TAP Addendum, and was recognized by the Board in its final order. REC 3712 (citing REC 710). Dr. von Lindern testified that the arsenic concentration that Perpetua finally derived and that was used by the Respondents' toxicologists to assess excess cancer risk was a series of averaging techniques that resulted in an underestimation of maximum potential emissions by 41 percent.

> A. So W2 was the – as far as I understand, is the maximum, and it would be that W2 year that would – that should be reflected as the maxim to calculate the one-year standard. You can't do it because they use the five-year standard for the input. But this identifies the maximum year that should have been used in the calculation.

[4] The calculations are based on the five-year rolling average of 135,000 T/day production average, and thus do not represent the maximum potential scenario within any given year of 180,000 T/day production.

> This step was then to take – this gets hard because it's an average of the average of the average of the average. But it's the average of Y1 through H4, which each are five-year rolling averages, as I understand, to begin with, and it averages that with W2. And that's where that .00416, whatever that number was that [Dr. Paden and Ms. Lopez] used.

von Lindern Test., Tr. 458-459. Dr. von Lindern's testimony was confirmed by Mr. Lewis, Lewis Test. Tr. 309 ([I]t's 50 percent West End Pit production combined with the worst-case modeling from the non-West End [ ] Pit production."), and is depicted using the numbers from the lower table in Exhibit 304 in the equation below:

$$\frac{\frac{(0.00124 + 0.00206 + 0.00123 + 0.00102 + 0.00228 + 0.00082 + 0.00090)}{7} + 0.00698}{2} = 0.00416^{5}$$

The above equation, using ambient arsenic concentrations from the lower table in Exhibit 304, shows that Respondents' arsenic calculations were not developed using the worst-case annual emissions scenario–the annual emissions scenario results when 180,000 T/day are mined from the West End pit for several consecutive years–a scenario the PTC currently does not preclude. Instead Respondents, using the above equation, averaged arsenic emissions from a West End pit scenario with an average of seven non-West-End pit scenarios, and all using the five-year rolling average to start. To date, Perpetua/DEQ have never publicly demonstrated what

[5] 0.00416 was the number to which both Dr. Paden and Ms. Lopez applied the 16/70 Project-specific adjustment factor in their alleged risk assessment analysis. *See* REC 3876 (Paden Decl.); REC 4284 (Lopez Decl).

ambient arsenic concentrations would result on an annual basis if 180,000 T/day is mined from the West End pit for a full year.

CONCLUSION

Figures 6 and 7 of Dr. von Lindern's Declaration depict the effects of each of Respondents' mathematical tricks used to reduce the apparent maximum annual average arsenic concentration. REC 6130, 6139; *see also* von Lindern Test., Tr. 460-462. "[T]he effect of the serial application of SGP Project-specific five-year rolling average and non-WEP Project-specific adjustment factors on cumulative cancer risk" is that it allows an "individual receptor [to] experience a full lifetime allowable carcinogenic 1x10-5 equivalent exposure by year 13." REC 6139. The 16/70 "Project-specific adjustment factor is what allegedly gets them into compliance by diluting it another 78 percent." von Lindern Test., Tr. 460-61.

Petitioners have demonstrated not only that this after-the-fact, alleged Project-specific adjustment factor "risk assessment" by Respondents' toxicologists is not supported by any scientific evidence, but also it is nowhere in the Air Rules. DEQ's approval of the use of these adjustment factors to bring a project into compliance with the TAPs rule creates dangerous future precedent, undermines the administration of Idaho's air quality program, and erodes the health protections that are the basis of the Air Rules. The Board recognized this at the hearing on the parties motions for summary judgment:

> Application of the project-specific adjustment factor allows DEQ to ignore 16 years of higher cancer initiation risk. The PTC proposes to allow 16 years higher daily carcinogen doses, and disguises such doses using a non-rules-based mathematics. Use of the project-specific adjustment factor ignores 16 years of cancer initiation due to higher carcinogenic arsenic dose that is otherwise allowed by rule. The AACC, the T-RACT, and short-term project AACCs dictate an annual average compliance.

> DEQ further violates this compliance point by instituting a five-year rolling average compliance. Such a creative compliance point allows even further departure from our air quality goals, and specifically compliance with Section 161 of our air quality rules.

TR 0160. The Hearing Officer should therefore find that DEQ did not act reasonably and in accordance with the law when demonstrating compliance with the TAPs rule for arsenic emissions, and should remand the permit back to DEQ to correct the errors.

DATED: November 8, 2024

Respectfully submitted,

s/ *Julia Thrower*
Julia S. Thrower
Attorney for Save the South Fork Salmon

s/ *Bryan Hurlbutt*
Bryan Hulbutt
Attorney for the Nez Perce Tribe and the Idaho Conservation League

CERTIFICATE OF SERVICE

I hereby certify that on November 8, 2024, a true and correct copy of the foregoing PETITIONERS' POST-HEARING BRIEF was served on the following by electronic service:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov

Dylan V. Lawrence
Hearing Officer
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com

Diane Cutler, Hearing Coordinator
Rules and Planning Analyst
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
(208)373-0165
diane.cutler@deq.idaho.gov

Michael A. Short
Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
michael.short@deq.idaho.gov
hannah.young@deq.idaho.gov

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
ann.yribar@ag.idaho.gov

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole Hancock
Stoel Rives LLP
101 S. Capitol Blvd., Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
nicole.hancock@stoel.com

s/*Julia Thrower*
Julia S. Thrower

Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	Agency Case No. 0101-22-01
	)	OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON	)	**PETITIONERS' RESPONSE OPPOSING PERPETUA'S MOTION TO STRIKE EXPERT DECLARATIONS**
Petitioners,	)	
v.	)	
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC.	)	
Intervenor-Respondent.	)	

Petitioners Nez Perce Tribe, Idaho Conservation League, and Save the Fork Salmon file this response opposing the Motion to Strike filed on October 15, 2024, by Intervenor-Respondent Perpetua Resources Idaho, Inc. ("Perpetua") asking the Hearing Officer to strike specific sentences, paragraphs, and exhibits from the Expert Declaration of William Tiedemann and the Expert Declaration of Dr. Ian von Lindern. For the same, the Hearing Officer denied the objections Perpetua made when Mr. Tiedemman and Dr. von Lindern testified at the hearing on October 18, 2024, so too should Perpetua's Motion to Strike be denied.

ARGUMENT

I. Procedural Rules 475 and 476, and the Board's Remand Order Encourage Taking Evidence, Not Excluding It.

This contested case is governed by the Office of Administrative Hearing's Idaho Rules of Administrative Procedure, IDAPA 62.01.01 *et seq*. *See* IDAPA 62.01.01.001.02. Rule 475 provides that the Hearing Officer is "not bound by the Idaho Rules of Evidence," with some exceptions. IDAPA 62.01.01.475. Rule 475 also directs: "*Evidence should be taken* by the presiding officer to assist the parties' development of the record, *not excluded* to frustrate that development." *Id.* (emphases added). Relatedly, Rule 476 provides that the Hearing Officer is entitled to "weigh the quality of evidence presented" and "may assign less weight to evidence that would otherwise be inadmissible under the Idaho Rules of Evidence." IDAPA 62.01.01.476.

Here, in both the initial Order and the Order on Reconsideration, the Board of Environmental Quality remanded to the Hearing Officer to develop the record. REC 3717 (The Board "remands this matter back for the development of further evidence regarding the ambient air concentrations of arsenic that will be produced by the SGP and whether those levels comply with the Air Rules."); REC 3841 ("The parties will have an opportunity to develop a full factual record on the arsenic issue before the Hearing Officer on remand."). Moreover, the Board

emphasized that it "will not limit the scope of the proceedings on remand or the types of evidence that may be presented, other than to restate that they must focus only on the development of additional factual evidence on the ambient arsenic air concentration analysis performed by DEQ for the PTC." REC 3841-42. Under Rule 475 and 476, and the Board's orders, the Hearing Officer should deny Perpetua's Motion to Strike, should admit Petitioners' expert declarations and the documents attached to them in full, and can weigh the quality of the evidence.

II. Procedural Rule 485 Similarly Allows Admitting Expert Opinions.

Rule 485 allows the Hearing Officer to "admit, weigh, and consider expert opinions," which are "generally admissible if the the proffering party demonstrates the relevancy of the expert opinions, as well as demonstrates the general reliability of the expert opinions, both as to methodology and qualifications of the expert." IDAPA 62.01.01.485. Mr. Tiedemman and Dr. von Lindern's declarations themselves demonstrate the relevance and reliability of their opinions, and can be weighed and considered by the Hearing Officer.

Perpetua seeks to strike specific isolated sentences based on this part of Rule 485: "Expert testimony that is conclusory, offers legal opinions, or which is based solely upon hearsay is inadmissible." *Id.* However, each of the "conclusions" in Mr. Tiedemman's and Dr. von Lindern's declarations Perpetua complains about is not "conclusory"; rather, each conclusion is based on supporting facts and expert opinion. Moreover, none of the statements Perpetua complains about are based "solely" upon hearsay (or any hearsay). And each statement Perpetua says is a "legal conclusion" is the expert's opinion, based on their relevant experience and is supported factually. Perpetua's and DEQ's expert declarations are full of similar supposed "legal conclusion" types of statements, including statements in section headings, in summaries of

expert opinions, in conclusions, and elsewhere. *See*, *e.g.* Lewis Decl. ¶¶ 12, 18, 28–38, 39–44, 55, 57–60, 62; Lopez Decl. ¶¶ 10.b, 26, 37, 38; Schilling Decl. ¶¶ 6, 20, 26, 31, 34. The Hearing Officer is fully capable of considering these statements and weighing them without being duped into accepting any legal conclusions proffered by any of the experts.

III. Exhibits to the Tiedemann Declaration Are Admissible.

Perpetua argues the exhibits to the Tiedemann Declaration are unauthenticated, hearsay, and irrelevant. Perpetua is wrong.

Mr. Tiedemann authenticated the exhibits by stating that they are true and correct copies of public records obtained from DEQ. Tiedemann Test., Tr. 327–29. For "Evidence about public records," the Idaho Rule of Evidence 901(b)(7) provides that all that is required to authenticate is evidence that (A) a document was recorded or filed in a public office as authorized by law; or (B) a public record or statement is from the office where items of this kind are normally kept. Mr. Tiedemann obtained through a public records request to DEQ under the Idaho Public Records Act, which defines "public record" to include, but not be limited to:

> any writing containing information relating to the conduct or administration of the public's business prepared, owned, used or retained by any state agency, independent public body corporate and politic or local agency regardless of physical form or characteristics. Provided, however, that personal notes created by a public official solely for his own use shall not be a public record as long as such personal notes are not shared with any other person or entity.

Idaho Code § 74-101(13).

Mr. Tiedemann's exhibits and his statements about those documents are not based on hearsay. First, the hearsay exemption for public records in Idaho Rule of Evidence 803 applies. Second, Procedural Rule 478 allows the Hearing Officer to admit, weigh, and consider hearsay evidence. IDAPA 62.01.01.478. Third, the documents are not being relied on for the truth of the

matters asserted in them, meaning they are not hearsay. The documents show various officials and other people involved in the toxic air pollutant ("TAP") rulemaking raised concerns about using the Environmental Protection Agency's risk assessments and about granting exceptions for short-term sources. Mr. Tiedemann (and Petitioners) do not rely on the documents to prove the truth of those concerns; just the fact that these concerns were raised.

Finally, the documents are relevant. Petitioners acknowledge that the language of the Rules for the Control of Air Pollution in Idaho ("Air Rules"), IDAPA 58.01.01, themselves are most relevant, and as the Board already held in this matter:

> The Air Rules clearly provide an AACC standard in Section 586. They then clearly provide an adjustment to that AACC standard when T-RACT can be used to control emissions. IDAPA 58.01.01.210.12.b. The Air Rules also clearly allow for a 10-times adjustment to the AACC when a project is going to operate for 5 years or less. IDAPA 58.01.01.210.15. But nowhere in the Air Rules does it provide that a project that will operate more than 5 years but less than 70 years may be adjusted in proportion to the amount of time it will operate.

REC 3715. The documents attached to the Tiedemman Declaration are relevant though, too, as they help confirm the Board's conclusion above about what the plain language of the Air Rules show.

CONCLUSION

Based on the foregoing, the Hearing Officer should deny Perpetua's motion to strike and allow and consider all evidence submitted or presented by Petitioners in this matter.

//

//

//

//

DATED: November 8, 2024

Respectfully submitted,

s/*Julia Thrower*
Julia S. Thrower
Attorney for Save the South Fork Salmon

s/*Bryann Hurlbutt*
Bryan Hulbutt
Attorney for the Nez Perce Tribe and the Idaho Conservation League

CERTIFICATE OF SERVICE

I hereby certify that on November 8, 2024, a true and correct copy of the foregoing PETITIONERS' RESPONSE OPPOSING PERPETUA'S MOTION TO STRIKE EXPERT DECLARATIONS was served on the following by electronic service:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov

Dylan V. Lawrence
Hearing Officer
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com

Diane Cutler, Hearing Coordinator
Rules and Planning Analyst
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
(208)373-0165
diane.cutler@deq.idaho.gov

Michael A. Short
Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
michael.short@deq.idaho.gov
hannah.young@deq.idaho.gov

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
ann.yribar@ag.idaho.gov

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole Hancock
Stoel Rives LLP
101 S. Capitol Blvd., Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
nicole.hancock@stoel.com

s/*Julia Thrower*
Julia S. Thrower

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
Nicole C. Hancock, ISB No. 6899
nicole.hancock@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Intervenor-Respondent Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY

STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047, NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent. PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	AGENCY CASE No. 0101-22-01 OAH Case No. 23-245-01 **REPLY IN SUPPORT OF MOTION TO STRIKE EXPERT DECLARATIONS OF WILLIAM TIEDEMANN AND IAN H. VON LINDERN**

Intervenor-Respondent Perpetua Resources Idaho, Inc. ("Perpetua") files this Reply in support of its Motion to Strike sentences and paragraphs from the Declaration of William Tiedemann ("Tiedemann Declaration") and the Declaration of Ian H. von Lindern ("von Lindern Declaration") (collectively, "the Declarations"). Petitioners' Response in Opposition fails to justify why these conclusory statements and expressions of improper and erroneous legal opinion that are based on irrelevant, unauthenticated, and hearsay evidence should be admitted under the Idaho Rules of Administrative Procedure for contested cases ("IDAPA Rules"). Moreover, significant sections of the Tiedemann and von Lindern Declarations are inadmissible because they offer unqualified opinions beyond the witness' expertise and experience.[1]

ARGUMENT

Contrary to assertions made by Petitioners, the Tiedemann and von Lindern Declarations include numerous statements that are conclusory and offer legal opinions and therefore are properly excluded under IDAPA 62.01.01.485. *See* Mot. to Strike, Exhibits A and B. Furthermore, Petitioners offer no basis for consideration by the Hearing Officer of irrelevant statements based on hearsay and unauthenticated documents.

Perpetua does not dispute that the Hearing Officer should take evidence to develop the factual record consistent with the Board's Order. Pet. Opp. at 1 (citing IDAPA 62.01.01.475). But Rule 485 is clear that "[e]xpert testimony that is conclusory, offers legal opinions, or which is based solely upon hearsay, is inadmissible." IDAPA 62.01.01.485. Additionally, evidence is "excludable" under Rule 475 if it is "irrelevant." IDAPA 62.01.01.475 (incorporating Idaho Code § 67-5251(1)). For these reasons, the Hearing Officer should exclude from the record those

[1] During the Hearing, Perpetua objected to Mr. Tiedemann's status as an expert on DEQ rulemaking and the TAPs rule, Tr. 324:10-17, 325:9-25 (Tiedemann), as well as Dr. von Lindern's status as an expert on toxicology, Tr. 406:8-25, 407:1-2 (von Lindern).

portions of the Tiedemann and von Lindern Declarations referenced in Perpetua's Motion to Strike or, at a minimum, afford these statements no weight under IDAPA 62.01.01.476.

I. The Declarations Provide Inadmissible Legal Opinions.

Rather than applying their expertise to opine on DEQ's application of the Toxic Air Pollutants ("TAPs") rules, the Tiedemann and von Lindern Declarations attempt to interpret the rulemaking history of the TAPs rules and directly answer legal questions that are properly assessed by the Hearing Officer. Mot. to Strike at 2-3. Such legal analysis is the sole responsibility of the Hearing Officer, not a witness. *Id.* Petitioners do not refute that these statements constitute legal opinions but simply argue that each statement "is the expert's opinion." Pet. Opp. at 2. However, Mr. Tiedemann and Dr. von Lindern are not attorneys and have no expertise in the area of regulatory interpretation. *See* Tr. 320-321 (Tiedemann) (reviewing education and expertise); Tr. 393-408 (von Lindern) (same). Rather, their proffered testimony is a biased opinion based on what they wish the rules said and how they hope that they will be interpreted. And even if they did have pertinent experience to offer legal conclusions, Rule 485 expressly prohibits the admission of legal opinions. IDAPA 62.01.01.485.

Unlike the identified sections of the Tiedemann and von Lindern Declarations, the expert declarations filed by DEQ and Perpetua stay within the bounds of the respective witness' areas of expertise. REC 3921-3929 (Schilling Dec.) (explaining the technical requirements of the TAPs rules and reviewing DEQ's determinations for consistency); REC 4135-4143 (Lewis Dec) (same); REC 3876-3881 (Paden Dec.) (explaining the risk assessment methodology under the TAPs rules and reviewing DEQ's toxicological determinations); REC 4280-4288 (Lopez Dec.) (same). These expert declarations provide opinions on technical issues that aid the Hearing

Officer in addressing the legal questions before him but refrain from explicitly answering those questions or making legal conclusions based on the rulemaking history of the TAPs rules.

II. Petitioners Fail to Justify the Admission of Irrelevant, Unauthenticated, and Hearsay Evidence Relied on in the Declarations.

Perpetua's Motion to Strike identified significant portions of the Tiedemann Declaration that relied on unauthenticated documents, which Mr. Tiedemann incorrectly claimed were part of "the historic TAPs rulemaking record." REC 6051 (¶ 9) (Tiedemann Dec.). Petitioners argue that Mr. Tiedemann authenticated these documents by stating that they are copies of public records. Pet. Opp. at 3. Petitioners mischaracterize the relevant law.

The documents relied on by Mr. Tiedemann are not part of the official rulemaking record. As the State clarified during the hearing, documents must be "stamped with essentially a Bates number or record number" to be part of the official rulemaking record, and Mr. Tiedemann confirmed that the documents he relied on did not include such numbering. Tr. 365:21-24, 366:1-4 (Tiedemann). Accordingly, these documents are neither authenticated, *see* I.R.E. 901(a), nor relevant in interpreting DEQ intent and the TAPs rules [2] and should be excluded under Rule 475.

Despite Petitioners' arguments, they also constitute hearsay. The public documents exception does not apply here, where "the source of information or other circumstances indicate a lack of trustworthiness." Mot. to Strike at 6 (quoting I.R.E. 801(8) and explaining that the documents include draft and unsigned letters, two of which Mr. Tiedemann could only presume the authors and recipients); REC 6058-6060 (¶¶ 26-27) (Tiedemann Dec.). Additionally, Petitioners' claim that Mr. Tiedemann only relies on these documents to indicate that "concerns were raised" regarding DEQ's application of the TAPs rules, not to "prove the truth of those

[2] *See* Mot. to Strike at 5 n.3 (citing caselaw explaining that such unpublished, informal documents are not considered in regulatory interpretation).

concerns," Pet. Opp. at 3-4, is as unpersuasive as it is inaccurate. Indeed, Mr. Tiedemann relies on the content of these documents to support his interpretation of the TAPs rules. *See, e.g.*, REC 6058-6059 (¶¶ 26-27) (Tiedemann Dec.).

Petitioners do not even attempt to refute the unreliability and irrelevance of statements made by Dr. von Lindern regarding his perception of the TAPs rulemaking process. *See* Mot. to Strike at 7. Additionally, Dr. von Lindern repeatedly provided his opinion on which policies he believes should drive DEQ's application of the TAPs rules. *See, e.g.*, REC 6108 (¶ 18) (von Lindern Dec.) (claiming that DEQ's interpretation represents unsound policy); Tr. 450:14 (von Lindern) (stating that DEQ's analysis is "unacceptable" and "is not good policy"). Such commentary on which policies the TAPs rules *should* embody are irrelevant to this proceeding, which concerns only whether DEQ's determinations are consistent with the current TAPs rules.

III. The Declarations Offer Unqualified and Irrelevant Opinions.

Despite lacking the requisite expertise on DEQ rulemaking, toxicology, and air quality modeling,[3] Mr. Tiedemann and Dr. von Lindern opine on these topics. REC 6053-6061 (Tiedemann Dec.); Tr. 348-349, 367-374 (Tiedemann); REC 6125-6140 (von Lindern Dec.); Tr. 406-409, 457-478 (von Lindern).

As Mr. Tiedemann spent only two years at DEQ, where he had very limited experience with air quality permitting and had little to do with TAPs compliance, REC 6049-6050 (¶¶ 2-7) (Tiedemann Dec.); Tr. 352:2-363:8 (Tiedemann), he is not an expert on DEQ rulemakings or the TAPs rules, *see* Tr. 255:12-256:7 (Lewis) (explaining that two years at DEQ does not qualify someone as an expert). Dr. von Lindern is not a toxicologist, Tr. 406:11-14 (von Lindern), and

[3] Expert opinions are only admissible in a contested case "if the proffering party. . . demonstrates the general reliability of the expert opinions, both as to methodology and qualifications of the expert." IDAPA 62.01.01.485.

the Hearing Officer specifically did not approve Dr. von Lindern as an expert on toxicology, Tr. 408:13-22 (von Lindern). Highlighting his lack of toxicology expertise, Dr. von Lindern incorrectly concluded that DEQ's use of the 16/70 adjustment factor was an inappropriate use of "dose-averaging" that will expose children to dangerous levels of emissions based on the level of "carcinogenic potency" in early life stages. Tr. 431:24-25, 432:1-15, 432-435 (von Lindern); REC 6108 (¶18), REC 6115-6118. Indeed, expert toxicologist, Theresa Lopez, explained why this testimony "indicates that [Dr. von Lindern] does not understand toxicology." Tr. 499:12-16 (Lopez). Petitioners also do not assert that Dr. von Lindern is an expert on emissions estimates or modeling. *See* Tr. 405:19-406:1 (von Lindern). This was reflected in his reliance on the expertise of other witnesses to understand DEQ's modeling work. *See* Tr. 458:2-24, 459:1-2, 471:2-24 (von Lindern) (explaining that he struggled to understand DEQ's technical calculations and relied on Kevin Schilling's expertise).

Mr. Tiedemann and Dr. von Lindern's lack of expertise led to incorrect and irrelevant conclusions. Upon Perpetua's reservation of its objections to the testimony of Mr. Tiedemann and Dr. von Lindern, the Hearing Officer emphasized that he has the discretion to afford it the appropriate weight and credibility. Tr. 326:10-13 (Tiedemann); Tr. 409:8-12 (von Lindern). To the extent that the Hearing Officer does not exclude the testimony subject to Perpetua's objections, Perpetua asserts that the proper remedy is to afford the testimony no weight.

CONCLUSION

For the reasons explained above, Petitioners' Response fails to justify admission of the many conclusory statements, legal opinions, and otherwise irrelevant, unauthenticated, and hearsay evidence presented in the Tiedemann and von Lindern Declarations.

DATED: November 13, 2024

Stoel Rives

By: /s/ Nicole Hancock
Nicole Hancock

Attorneys for Intervenor-Respondent Perpetua Resources Idaho, Inc.

CERTIFICATE OF SERVICE

I HEREBY CERTIFY that on the 13th day of November 2024, I caused a true and correct copy of this REPLY IN SUPPORT OF MOTION TO STRIKE EXPERT DECLARATIONS to be served on the following persons via email:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Dylan B. Lawrence
Hearing Officer
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Bryan Hurlbutt
Laurence ("Laird") J. Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Michael A. Short
Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
michael.short@deq.idaho.gov
hannah.young@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
ann.yribar@ag.idaho.gov
via electronic service

Diane Cutler, Hearing Coordinator
Rules and Planning Analyst
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
(208)373-0165
diane.cutler@deq.idaho.gov
via electronic service

/s/ Christopher Pooser
Christopher Pooser

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor.	BEQ Case No. 0101-22-01 OAH Case No. 23-245-01 FINDINGS OF FACT, CONCLUSIONS OF LAW, AND PRELIMINARY ORDER

I. FACTUAL AND PROCEDURAL BACKGROUND

Perpetua Resources Idaho, Inc. is in the process of applying for a variety of permits for its proposed Stibnite Gold Project ("SGP") in Valley County, Idaho. The SGP would consist of conventional open-pit mining, ore preparation, and gold extraction operations. In August 2019, Perpetua applied to the Idaho Department of Environmental Quality ("DEQ") for an air quality permit for the construction and operation of the SGP, pursuant to the Rules for the Control of Air Pollution in Idaho in IDAPA 58.01.01 (the "Air Rules"). DEQ issued the final version of air quality permit-to-construct P-2019.0047 (the "Permit") on June 17, 2022.

On July 22, 2022, the Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon ("Petitioners") filed a joint petition to initiate a contested case (the "Petition") regarding the Permit, which they subsequently amended on January 11, 2023 (the "Petition"). The Petition alleges DEQ committed several errors in its development of the Permit and asks the Board of Environmental

Quality ("Board" or "BEQ") to vacate and withdraw the Permit and remand it to DEQ to correct such errors. On August 12, 2022, Perpetua filed a petition to intervene in the contested case proceeding, which the hearing officer granted on August 22, 2022.

Most relevant to this order are Paragraphs 55 and 56 of the Petition. They allege DEQ's evaluation of the toxic air pollutant ("TAP") arsenic underestimated emissions in three specific ways: (a) averaging emissions over a 5-year period; (b) averaging the estimated annual ambient modeling impacts across two multi-year scenarios; and (c) averaging the resultant 16-year total emissions over the 70-year human lifetime to assert compliance. (*See* Am. Pet. of 1/11/23, ¶¶ 55, 56.) Effectively, these allegations constituted three "sub-issues" of Claim No. 9 identified in the order on Perpetua's motion to dismiss. (*See* Order of 11/15/22, at p. 9.)

On September 6, 2022, Perpetua filed a motion to dismiss the Petition. The hearing officer ruled on that motion on November 15, 2022. In doing so, the hearing officer identified 13 individual claims of error in the Petition. Pursuant to a stipulated scheduling order, the Petitioners filed a motion for summary judgment on April 14, 2023, and DEQ and Perpetua filed motions for summary judgment on May 12, 2023. As a result of the motion to dismiss and the motions for summary judgment, the Hearing Officer ruled in favor of DEQ and Perpetua on all 13 individual claims of error. (*See* Orders of 1/15/22 and 10/31/23.)

After the summary judgment decision, the Petitioners filed a petition for review of the hearing officer's preliminary order with the Board, alleging: (1) the hearing officer erred, factually and legally, in upholding DEQ's determination that Perpetua has legal control of the Stibnite Road Access Route such that the Route need not comply with ambient air quality standards; (2) in finding that Perpetua will preclude the general public from accessing locations within the ambient air boundary, the hearing officer lacked a reasonable factual basis and misapplied applicable

regulations, policy, and guidance; (3) the hearing officer failed to decide Petitioners' claim that DEQ violated the Clean Air Act and applicable state and federal rules and regulations by allowing Perpetua to submit plans with important project details in the future–after Permit issuance and without public comment; or to the extent that this claim was decided, the hearing officer erred; (4) the hearing officer erroneously determined that the Permit includes enforceable conditions that will achieve 93.3% dust control; and (5) the hearing officer misinterpreted and misapplied applicable rules to uphold DEQ's decision to artificially dilute the ambient arsenic concentrations attributable to the SGP by 16/70. (*See* Pet. for Rev. of Prelim. Order of 11/14/23, at p. 1.)

After briefing and motion practice before the Board, the Board issued orders on May 9 and June 12, 2024. Collectively, these two orders affirmed the hearing officer's summary judgment rulings on the first four of the above issues, but found that the hearing officer erred in ruling in favor of DEQ and Perpetua on the fifth issue regarding arsenic emissions. Specifically, the Board concluded that "DEQ did not act reasonably and in accordance with law when it analyzed the ambient arsenic air concentrations for the SGP." (Order of 5/9/24, at pp. 12-23.)

Therefore, the Board remanded the matter back to the hearing officer in order to address the following issues: (a) whether DEQ acted reasonably in using a 5-year rolling average for T-RACT that was not supported by permit conditions (*see* Order of 5/9/23, at p. 18); (b) whether there was sufficient evidence to support DEQ's T-RACT analysis regarding non-West End Pit production (*see* Order of 5/9/23, at p. 19); and (c) whether DEQ acted reasonably and in accordance with law when it applied the 16/70 adjustment to the acceptable ambient concentration ("AACC") for arsenic. (*See* Order of 5/9/23, at p. 21.)

The Board's remand includes instructions to provide the parties with "an opportunity to develop a full factual record on the arsenic issue…." (*See* Order of 6/12/24, at pp. 6-7.) However,

the Board denied requests from DEQ and Perpetua to provide "clarification and instructions to the Hearing Officer regarding the proceedings on remand…." (*See* Order of 6/12/24, at pp. 7-8.) So, while the Board articulated three narrow substantive issues to address on remand, it provided wide discretion regarding the procedures.

On remand, the parties agreed expert witness testimony would be necessary to address the issues identified by the Board, and they expressed a preference to forgo traditional written discovery and depositions of expert witnesses to explore the issues. Instead, the parties chose to disclose their expert witness opinions through the filing of declarations. Therefore, from August to October 2024, the parties filed a total of six expert witness declarations. These declarations put the parties and hearing officer on notice of the proffering party's positions and opinions in advance of the hearing on the merits.

The hearing on the merits took place on October 17 and 18, 2024. All of the parties filed post-hearing statements on November 8, 2024, and Perpetua filed a reply brief in support of a previously filed motion to strike on November 13, 2024. Therefore, as of November 13, 2024, this matter has been fully submitted for decision by the hearing officer.

II. PRELIMINARY EVIDENTIARY RULINGS AND DISPOSITION OF PERPETUA'S MOTION TO STRIKE

The admissibility of exhibits was addressed during the hearing. The hearing officer did not deny any requests to admit an exhibit. The hearing officer admitted the following exhibits:

- Ex. 100 (Schilling (DEQ) decl.)
- Ex. 101 (Paden (DEQ) decl.)
- Ex. 200 (Lewis (Perpetua) decl.)
- Ex. 201 (Lopez (Perpetua) decl.)
- Ex. 203 (EPA Health Assessment guidance document)

- Ex. 205 (3/7/91 mem. from Wilkosz and Teater to Green)
- Ex. 208 (EPA Risk Assessment Guidance for Superfund, Vol. I: Human Health Evaluation Manual (Part 7 F, Supplemental Guidance for Inhalation Risk Assessment)
- Ex. 220 (demonstrative exhibit)
- Ex. 222 (poster with caluclations)
- Ex. 221 (EPA guidelines for carcinogen risk assessment)
- Ex. 300 (DEQ Position on the Arsenic Modeling Addendum to the Perpetua Resources Stibnite Gold Project Permit to Construct Application)
- Ex. 301 (TAPs Modeling Addendum; Statement of Basis)
- Ex. 302 (von Lindern decl.)
- Ex. 303, 304 (Table C; TAP Maximum Modeled Concentrations and AACs)
- Ex. 305 (Tiedemann decl.)

In advance of the hearing on the merits, Perpetua filed a motion to strike particular references within the expert witness declarations filed by the Petitioners. (*See* Mot. to Strike of 10/14/24; Am. Mot. to Strike of 10/15/24.) In addition, during the hearing, Perpetua and DEQ lodged multiple objections to testimony offered by the Petitioners' witnesses pursuant to OAH Rule of Procedure[1] 482. Pursuant to Procedural Rule 512, and for the reasons below, the hearing officer denies the request to formally "strike" references from the record. However, pursuant to Procedural Rule 476, the hearing officer has taken the motion and objections under advisement in the evaluation of the credibility and testimony of the witnesses.

The judicial Idaho Rules of Evidence do not strictly apply to administrative hearings. *See*

[1] Office of Administrative Hearings, Idaho Rules of Administrative Procedure, IDAPA 62.01.01.

IDA. ADMIN. PROC.R. 475, 476; *see also* IDAHO CODE § 67-5251. According to the procedural rules for administrative hearings, "[e]vidence should be taken by the presiding officer to assist the parties' development of the record, not excluded to frustrate that development." IDA. ADMIN. PROC.R. 475. In addition, "[a] presiding officer is entitled to weigh the quality of evidence presented, including the credibility of witnesses," and "may assign less weight to evidence that would otherwise be inadmissible under the Idaho Rules of Evidence." IDA. ADMIN. PROC.R. 476. Moreover, as previously referenced, when the Board remanded this matter to the hearing officer, it did so with instructions to provide the parties with "an opportunity to develop a full factual record on the arsenic issue…." (*See* Order of 6/12/24, at pp. 6-7.)

Overall, the testimony offered by the Petitioners' witnesses was relevant to the narrow arsenic issues identified by the Board for further deliberation. Had the Petitioners failed to comply with the Board's directive to "focus only on the development of additional factual evidence on the ambient arsenic air concentration analysis," *see* Order of 6/12/24, at pp. 7-8, formally striking testimony and sustaining objections would be appropriate. In light of the general relevance of the Petitioners' testimony and the relaxed rules of evidence, the hearing officer does not find a compelling reason to formally strike testimony from the record and therefore denies the motion and overrules reserved objections from the hearing pursuant to Rule of Procedure 482.

Subject to that ruling, the hearing officer notes for the record that he has taken the motion and objections under advisement in evaluating the evidence pursuant to Procedural Rule 476. In general, the hearing officer agrees that, often, the Protestants' witnesses Mr. Tiedemann and Dr. von Lindern testified regarding what they wished the Air Rules said, rather than what they actually say. The hearing officer also agrees that many of the exhibits offered by the Petitioners' witnesses consisted of isolated references from prior rulemakings that lacked explanation of their context or

relevance to the interpretation of the plain language of the existing Air Rules. The Findings of Fact below reflect the hearing officer's evaluation of the evidence pursuant to Procedural Rule 476.

III. FINDINGS OF FACT AND CONCLUSIONS OF LAW

A. Legal Background

1. Perpetua filed its air Permit application on August 20, 2019. (*See* R., at REC0418 (Statement of Basis).)

2. DEQ issued the Permit on June 17, 2022.

3. At the time Perpetua filed its Permit application and DEQ issued the Permit, a prior version of the Air Rules was in effect, which this Order will cite as the "2022 Air Rules."

4. In 2023, DEQ updated the Air Rules in connection with Governor Little's "zero-based regulation" effort, which this Order will cite as the "2023 Air Rules."[2] (*See* Tr. of 10/17/24, 34:2-4 (Schilling/DEQ).)

5. A "toxic air pollutant" ("TAP") is defined as, "[a]n air pollutant that has been determined by the Department to be by its nature, toxic to human or animal life or vegetation and listed in Section 585 or 586." *See* 2022 Air Rule 006.124, 2023 Air Rule 006.50.

6. Section 586 of the Air Rules identifies "arsenic compounds" as a TAP.

7. The TAPs program in Air Rule 586 is specific to the State of Idaho and is not part of Idaho's approved state implementation plan overseen by EPA pursuant to the federal Clean Air Act. (*See* Tr. of 10/17/24, 91:12-92:1 (Schilling/DEQ).)

8. Based on the plain language of Air Rules 161, 210, and 586, the evaluation of toxic air pollutant emissions under those rules is inherently project-specific and is focused on the increased

[2] The 2023 rulemaking renumbered some of the 2022 Air Rules. When references to both sets of rules are the same, this Order simply cites to the "Air Rules." When the same rule was renumbered in 2023, this Order will provide citations to both the 2022 Air Rules and the 2023 Air Rules.

cancer risk posed by the specific project proposed by the air permit application.

9. In other words, and by contrast, the TAPs evaluation is different than the evaluation of national ambient air quality standards ("NAAQs"), which is focused on the overall risk to the general public taking into account all sources of air pollution.

10. In a contested administrative proceeding, "[t]he agency's experience, technical competence, and specialized knowledge may be utilized in the evaluation of the evidence." IDAHO CODE § 67-5251(5).

B. As Long As the 16-Year Assumption Is Reasonable, DEQ Did Not Err in Adjusting Arsenic Exposure Concentration to Reflect an Exposure Duration of Less Than 70 Years, Because Doing So Is Standard Practice by EPA and Toxicologists

11. In order to obtain a permit to construct, the applicant must demonstrate preconstruction compliance with Air Rule 161. *See* Air Rule 203.03.

12. According to Air Rule 161, TAPs "shall not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation."

13. A permit applicant may demonstrate preconstruction compliance with Air Rule 161 "[u]sing the methods provided in Section 210." *See* Air Rule 203.03.

14. A permit applicant may demonstrate preconstruction compliance with Air Rule 161 by demonstrating "[c]ompliance with all applicable [TAP] carcinogen increments and toxic air pollutant non-carcinogenic increments….with regards to the pollutants listed in Sections 585 and 586."

15. The Air Rules define "T-RACT" as "[a]n emission standard based on the lowest emission of toxic air pollutants that a particular source is capable of meeting by the application of control technology that is reasonably available, as determined by the Department, considering technological and economic feasibility. If control technology is not feasible, the emission standard may be based

on the application of a design, equipment, work practice or operational requirement, or combination thereof." *See* 2022 Air Rule 007.12; 2023 Air Rule 210.

16. A permit applicant "may use T-RACT to demonstrate preconstruction compliance for [TAPs] listed in Section 586." *See* 2022 Air Rule 210.12; 2023 Air Rule 210.12(a).

17. For the SGP, T-RACT for arsenic consists of the use of chemicals and water to suppress emissions from the disturbance of unpaved mine haul roads. (*See generally* Mem. Dec. and Prelim. Order of 10/31/23, at pp. 34-46.)

18. In order to use T-RACT to demonstrate preconstruction compliance for TAPs under Section 586, it is first necessary to identify the source's "approved T-RACT ambient concentration at the point of compliance" for the relevant TAP (hereinafter, the "Approved Concentration"). *See* Air Rule 210.12(b).

19. Next, it is necessary to compare the Approved Concentration to "the amount of the [TAP] that would contribute an ambient air cancer risk probability of less than one to one hundred thousand (1:100,000)" (hereinafter, the "AACC" or "Acceptable Concentration.") *See* Air Rule 210.12(b).

20. The amount of the [TAP] that would contribute an ambient air cancer risk probability of less than one to one hundred thousand (1:100,000) is "equivalent to ten (10) times the applicable acceptable ambient concentration listed in Section 586." *See* Air Rule 210.12(b).

21. If the source's Approved Concentration is "less than or equal to" the Acceptable Concentration, then "no further procedures for demonstrating preconstruction compliance will be required for that toxic air pollutant as part of the application process." *See* 2022 Air Rule 210.12(c); *see also* 2023 Air Rule 210.12(c).

22. Under Section 586, the acceptable ambient concentration of arsenic is an annual average of $2.3E^{-04}$ $\mu g/m^3$.

23. Ten (10) times $2.3E^{-04}$ $\mu g/m^3$ equals $2.3E^{-03}$ $\mu g/m^3$.

24. Therefore, when T-RACT is utilized, the Acceptable Concentration for arsenic is an annual average of $2.3E^{-03}$ $\mu g/m^3$, *i.e.*, 0.0023 $\mu g/m^3$.

25. For more traditional emissions sources such as a factory, the predictability of the amount and location of emissions typically means that it is necessary to model only one emissions scenario. (*See* Tr. of 10/18/24, 268:23-269:1 (Lewis/Perpetua).)

26. Because the SGP has a complex emissions profile, in this case, Perpetua modeled fourteen "worst case" emissions scenarios. (*See* Tr. of 10/18/24, 268:19-269:8, 270:3-8 (Lewis/Perpetua).)

27. These modeling scenarios overestimate emissions by approximately 1.5 times to 3 times actual emissions. (*See* Tr. of 10/18/24, 273:14-19 (Lewis/Perpetua).)

28. For the SGP, the highest modeled annual average arsenic concentration was 0.00414 $\mu g/m^3$. (*See* Tr. of 10/18/24, 277:3-13 (Lewis/Perpetua).)

29. However, for projects such as the SGP in which exposure is known to be for less than 70 years, it is inappropriate to compare this concentration to the Acceptable Concentration in order to determine compliance with Section 586.

30. For projects such as the SGP in which exposure is known to be for less than 70 years, failure to account for the true exposure period results in overstating emissions from the project. (*See* Tr. of 10/17/24, 39:2-7 (Schilling/DEQ).)

31. The table of Acceptable Concentrations in Section 586 contains a column labeled "URF."

32. "URF" is a reference to "unit risk factors" developed by EPA. *See* 2022 Air Rule 106.19; 2023 Air Rule 586 (note below table). (*See also* Tr. of 10/17/24, 137:2-6 (Paden/DEQ).)

33. For air emissions, the URF is also described as inhalation unit risk ("IUR"). (*See* Tr. of 10/17/24, 182:16-19 (Lopez/Perpetua).)

REC 7100

34. The URFs/IURs developed by EPA are an estimate of the excess cancer risk resulting from continuous inhalation of a concentration of 1 microgram per cubic meter of a pollutant in the air over the course of an assumed 70-year lifetime. (*See* Tr. of 10/17/24, 135:10-13 (Paden/DEQ).)

35. Excess cancer risk is also described as an "increment." (*See* Tr. of 10/17/24, 35:10-37:5 (Schilling/DEQ).)

36. The URFs/IURs are developed by EPA after extensive research by scientists, public health officials, and industry representatives, and represent a consensus of the best science regarding the potency of a given carcinogen. (*See* Tr. of 10/17/24, 188:2-16 (Lopez/Perpetua).)

37. The URFs/IURs adopted by EPA take into account, and are protective of, sensitive populations that are at increased cancer risk, such as pregnant women and young children. (*See* Tr. of 10/17/24, 138:18-23, 147:24-148:5, 172:5-21 (Paden/DEQ); 188:17-22 (Lopez/Perpetua).)

38. The Acceptable Concentrations listed in the last column of the table in Section 586 are calculated based upon the URFs in the same table. (*See* Tr. of 10/17/24, 126:9-14 (Schilling/DEQ).)

39. Because Air Rule 586 incorporates the URFs/IURs adopted by EPA, its Acceptable Concentrations (*i.e.*, AACCs) are inherently expressed as the annual average concentration over the course of an assumed 70-year lifetime.

40. The 2022 Air Rules, which were in effect at the time Perpetua filed its Permit application and the time DEQ issued the Permit, expressly reference the assumed 70-year lifetime for evaluating increased cancer risk from TAPs exposure. (*See* 2022 Air Rule 006.125.)

41. While that specific reference was eliminated from the 2023 Air Rules as a result of the zero-based regulation initiative, the result is the same, because Air Rule 586 incorporates EPA's URFs, which are based on an assumed 70-year lifetime of exposure.

42. For the vast majority of projects for which an air permit is sought, the applicant and DEQ

assume the project will have an indefinite project life that exceeds the assumed 70-year lifetime on which the IURs/URFs are based. (*See* Tr. of 10/17/24, 21:12-25 (Schilling/DEQ).)

43. For projects with a project life of 70 years or more, direct comparison of the highest modeled annual average concentration to the Acceptable Concentration is appropriate for determining compliance with Section 586.

44. For projects with a known project life of less than 70 years, EPA adjusts the highest modeled annual average concentration to account for the different exposure durations in order to accurately calculate cancer risk with an Approved Concentration that is capable of comparison to the Acceptable Concentrations in Section 586. (*See* Tr. of 10/17/24, 143:21-144:1, 144:17-145:2 (Paden/DEQ); 190:1-5, 192:6-193:2 (Lopez/Perpetua).)

45. The Air Rules contain an adjustment factor for "short term" projects with an operational life of no more than five (5) years. *See* 2022 Air Rules 007.11, 210.15; 2023 Air Rules 007.08, 210.15.

46. For these short term projects, the Acceptable Concentration for carcinogens such as arsenic may be multiplied by 10. *See* Air Rule 210.15.

47. The adjustment factor in Section 210.15 was adopted primarily to address projects that are inherently short-term by nature, such as contamination remediation projects and pilot projects. (*See* Tr. of 10/17/24, 23:7-12 (Schilling/DEQ).)

48. The Air Rules do not expressly preclude adjusting exposure concentrations to account for projects with an operational life of more than 5 years and less than 70 years.

49. To the contrary, as previously referenced, Air Rule 586 contains an express reference to the URFs/IURs adopted by EPA, which are based on an assumed 70-year lifetime exposure.

50. EPA commonly utilizes the following formula to compare the exposure concentration from a project that operates for less than 70 years to the lifetime exposure concentration that would cause a

specified cancer risk: EC = (CA x ET x (1 day/24 hours) x EF x ED) / AT. (*See* Tr. of 10/17/24, 137:2-6, 139:15-21, 140:1-143:20 (Paden/DEQ); 191:14-20, 213:11-214:14 (Lopez/Perpetua); Ex. 101, ¶¶ 10-12 (Paden decl.).)

51. EC represents the adjusted exposure concentration, expressed in $\mu g/m^3$.

52. CA represents the modeled contaminant concentration in air, expressed in $\mu g/m^3$.

53. For the SGP, CA equals 0.00414 $\mu g/m^3$ for arsenic.

54. ET represents the exposure time and is assumed to be 24 hours/day.

55. EF represents the exposure frequency and is assumed to be 365 days/year.

56. ED represents the exposure duration in years.

57. DEQ assumed an exposure duration of 16 years for the SGP. The appropriateness of this assumption will be addressed in the next section of this order.

58. AT represents the averaging time expressed in number of days. As previously referenced, EPA assumes a continuous 70-year lifetime of exposure. Therefore, this variable is 365 days/year x 70 years = 25,550 days.

59. To account for an exposure duration of less than 70 years, the adjusted Acceptable Concentration is calculated as follows: (0.00414 $\mu g/m^3$ x 24 hours/day x 1 day/24 hours x 365 days/year x 16 years) / 25,550 days = 0.00095 $\mu g/m^3$. (*See* Tr. of 10/17/24, 197:9-19 (Lopez/Perpetua); Tr. of 10/18/24, 278:21-279:6 (Lewis/Perpetua).)

60. An arsenic concentration of 0.00095 ug/m^3 is less than the T-RACT-based Acceptable Concentration for arsenic of 0.0023 $\mu g/m^3$.

61. Stated another way, the excess cancer risk from arsenic emissions at the SGP is 1 in 240,000, which is a smaller excess cancer risk than the T-RACT-based standard of 1 in 100,000. (*See* Tr. of 10/17/24, 200:13-19 (Lopez/Perpetua).)

62. Therefore, as long as DEQ's assumption of a 16-year project life is reasonable, DEQ did not err in concluding that arsenic emissions from the SGP comply with Section 586.

C. Assuming a 16-Year Period of Exposure Without a Corresponding Permit Condition Was Reasonable Because Even if the SGP Operates for More Than 16 Years, the Cancer Risk Does Not Change As Long as the Permit's Production Limits Are Satisfied

63. For emissions modeling, Perpetua and DEQ assumed the SGP would have an operating lifetime of 16 years.

64. This assumption is based on the calculation of how long it would take Perpetua to deplete the mined resource at the maximum authorized production rates under the Permit. (See Tr. of 10/17/24, 197:20-198:5 (Lopez/Perpetua).)

65. In issuing an air permit, DEQ "may impose any reasonable conditions…." Air Rule 211.01.

66. When it issued the Permit, DEQ did not include a condition expressly limiting the SGP to 16 years of operation.

67. The importance of the assumed 16-year project life to the Section 586 analysis above raises the issue of whether the lack of a Permit condition limiting the SGP to 16 years of operation was error.

68. Generally speaking, in toxicology, there are three broad categories of exposures to contaminants based on the duration of exposure—acute, sub-chronic, and chronic. (Tr. of 10/17/24, 145:8-146:13 (Paden/DEQ).)

69. The analysis of acute exposure generally focuses on exposure to contaminants lasting 24 to 48 hours. (*Id*.)

70. The analysis of sub-chronic exposure generally focuses on exposure to contaminants lasting 30 to 90 days. (*Id*.)

71. The analysis of chronic exposure generally focuses on exposure to contaminants lasting for

several months or more than one year. (*Id*.)

72. The calculation of cancer risk is inherently an evaluation of chronic exposure. (*Id*.)

73. The calculation of cancer risk pursuant to EPA's IURs/URFs and Section 586 is linear, in that it is a function of only two variables—exposure concentration and exposure duration. (Tr. of 10/17/24 at 190:12-17, 202:11-203:17, 208:3-209:9, 211:12-212:1, 223:15-23 (Lopez/Perpetua); Ex. 208, p. 18 (EPA 2009, Risk Assessment Guidance); Ex. 221, app. A, p. A-10 (EPA 2005, Guidelines for Carcinogen Risk Assessment.)

74. This linear approach is generally considered to be conservatively protective of public health, including sensitive subpopulations. (*See* Tr. of 10/17/24, 190:12-17 (Lopez/Perpetua).)

75. Permit Condition No. 3.6 states: "The permittee shall haul no more than 788.4 million tons (MT) of ore and DR [development rock] from all deposits over the life of the mine and no more than 394.2 MT of ore and DR from the West End deposit over the life of the mine." (R., at REC0385.)

76. Even if the SGP operates for more than 16 years, the cancer risk from arsenic exposure calculated pursuant to EPA's IURs/URFs and Section 586 does not change as long as Perpetua complies with the production limits in Condition No. 3.6. (Tr. of 10/17/24, 169:18-170:5 (Paden/DEQ); 203:8-17, 208:3-209:2 (Lopez/Perpetua).)

77. Because the specific issues articulated by the Board on remand are limited to analysis of cancer risk from arsenic exposure, and because that risk does not change with a project life longer than 16 years if compliance with Condition No. 3.6 is achieved, DEQ's decision not to including a Permit condition specifically limiting the life of the SGP to 16 years was not error.

D. Using a 5-Year Rolling Average to Evaluate Arsenic Emissions from the SGP Was Reasonable, Given DEQ's Broad Discretion Regarding Monitoring Requirements Under the Air Rules, the Highly Variable Nature of SGP Emissions Over Time, and Section 586's Focus on Project-Based Excess Cancer Risk

78. Condition 3.5 of the Permit states: "The permittee shall haul no more than 180,000 tons per

day (T/day) of ore and DR. The permittee shall haul no more than 135,000 T/day of ore and DR, based on a 5-year rolling average."

79. As previously described, the Board remanded the matter back to the hearing officer to evaluate whether DEQ acted reasonably in using the above 5-year rolling average without further related permit conditions. (*See* Order of 5/9/23, at p. 18.)

80. When issuing a permit to construct, the Air Rules provide DEQ with authority to "impose any reasonable conditions upon an approval," including a variety of conditions relating to ensuring compliance. *See* Air Rule 211.01.

81. The Acceptable Concentrations listed in Section 586 are exposure concentrations for calculating cancer risk that are expressed as "annual averages." *See* Air Rule 586.

82. More specifically, the Acceptable Concentrations listed in Section 586 provide the basis for calculating the excess cancer risk created when humans are exposed to one (1) microgram per cubic meter of a given carcinogen at a specified concentration continuously for an assumed 70-year lifetime. (*See* 2022 Air Rule 006.125; *see also* Tr. of 10/17/24, 137:2-10 (Paden/DEQ), 195:4-8 (Lopez/Perpetua).)

83. In other words, if humans are exposed to the T-RACT-based Acceptable Concentration of arsenic continuously for 70 years, the probability that excess cancers will develop as a result of such exposure is 1 in 100,000, or 0.00001%. (*Id*.)

84. The Acceptable Concentrations are expressed as annual "averages," not annual "limitations." *See* Air Rule 586.

85. Because Section 586 and its Acceptable Concentrations are focused on calculating a cumulative cancer risk that accumulates over a continuous 70-year exposure period, it is not necessarily the case that monitoring emissions on an annual basis is necessary to achieve compliance

with those standards.

86. Aside from Section 211.01's statement that DEQ may impose "reasonable" conditions to achieve compliance, the hearing officer is not aware of any specific, applicable legal authorities governing the frequency and timing of any such monitoring requirements for the TAPs listed in Section 586.

87. On one end of the spectrum, in the short term, arsenic emissions at the SGP will be limited on a daily basis through Condition 3.5, which limits daily haulage of ore and DR to 180,000 tons. This short-term limit is primarily intended to ensure the SGP maintains compliance with NAAQS, rather than the TAPs program. (*See* Tr. of 10/17/24, 43:20-24 (Schilling/DEQ); Tr. of 10/18/24, 284:4-13 (Lewis/Perpetua).)

88. On the other end of the spectrum, in the long term, total arsenic emissions at the SGP will be limited through Condition 3.6, which limits total haulage of ore and DR for the life of the mine to 788.4 million tons facility-wide and to 394.2 million tons of ore and DR from the West End Pit.

89. Accordingly, even if Perpetua frontloads its daily haulage such that it is hauling 180,000 tons per day for as long as possible while maintaining compliance with the Permit, the overall cancer risk calculated pursuant to EPA and toxicological standards does not change because Condition 3.6 limits total exposure for the life of the SGP, however long that is.

90. In fact, even without limiting the five-year rolling average production to 135,000 tons per day as Condition 3.5 presently does, if Perpetua hauled up to 180,000 tons per day pursuant to the remainder of Condition 3.5, it would still not exceed the Acceptable Concentration.

91. This is because 180,000 tpd is 33.3% greater than 135,000 tpd. If the adjusted Acceptable Concentration of 0.00095 $\mu g/m^3$ is correspondingly increased by 33.3%, the result is 0.001267$\mu g/m^3$, which is still less than the Acceptable Concentration of 0.0023 $\mu g/m^3$ for arsenic.

(*See* Tr. of 10/18/24, 285:17-290:5, 296:25-297:10 (Lewis/Perpetua).)

92. For the vast majority of projects permitted by DEQ, the expected emissions over time are stable and predictable.

93. By contrast, levels of emissions of air pollutants from mining operations like the SGP can change greatly over time due to multiple factors, such as the mine's stage of development and the location of the specific deposit being mined at any given time. (*See* Tr. of 10/17/24, 41:2-19 (Schilling/DEQ); Tr. of 10/18/24, 259:23-260:24 (Lewis/Perpetua).)

94. For projects with highly variable emissions over time, assessing compliance strictly on an annual basis is not always appropriate. (*See* Tr. of 10/17/24, 40:2-7 (Schilling/DEQ).)

95. For projects like the SGP with highly variable emissions over time, a five-year rolling average of emissions is more representative of actual emissions from the project than evaluating emissions on an annual basis. (*See* Tr. of 10/17/24, 174:22-175:2 (Paden/DEQ); Tr. of 10/18/24, 291:21-24 (Lewis/Perpetua).)

96. Given all of these factors, pursuant to Air Rule 211.01, DEQ was reasonable and did not err in using the five-year rolling average to monitor and control emission from the SGP, and it is not necessary for the 135,000 tpd average production limit to be reduced to a daily limit in order to achieve compliance with Air Rule 586.

97. In fact, because Section 586 is focused on excess cancer risk posed by a project over the course of an assumed 70-year lifetime or the lifetime of a project that will last less than 70 years, the five-year rolling average approach in Condition 3.5 is stricter and more protective than Section 586 requires. (*See* Tr. of 10/17/24, 40:12-18 (Schilling/DEQ); 294:11-23 (Lewis/Perpetua).)

E. Because Production from the West End Pit Cannot Legally Exceed 50% of Total Production from the SGP, a Separate Permit Condition Limiting Production From Non-West End Pit Sources Is Not Necessary

98. As previously referenced, Condition 3.6 limits total haulage of ore and DR for the life of the

SGP to 788.4 million tons facility-wide and to 394.2 million tons of ore and DR from the West End Pit.

99. On remand, the Board expressed concern that it "could not identify a PTC condition that would limit the non-West End Pit production by 50%," even though it observed in the record the use of an equation that "shows that the non-West End Pit production was also limited by 50%." (Order of 5/9/24, at p. 20.)

100. Therefore, according to the Board, "there was insufficient evidence in the record to demonstrate exactly how or whether the non-West End Pit production was limited and, if it was, the Board of Environmental Quality could not find any PTC conditions able to enforce that reduction." (*Id*.)

101. A map of the SGP is attached hereto as Attachment A. (*See* Ex. 200, Figure 1; R. at REC4145 (Lewis Decl.).)

102. As the map depicts, the West End Pit ("WEP") is located close to the northeast boundary of the SGP.

103. As the map also depicts, the prevailing wind vector at the SGP is generally from the southwest to the northeast.

104. As a result of these factors (geography and wind), the highest modeled impacts to receptors at the SGP boundary came from emissions from the WEP area. (*See* Tr. of 10/18/24, 270:3-23 (Lewis/Perpetua).)

105. As previously referenced, Condition 3.6 limits total facility life-of-mine haulage to 788.4 million tons.

106. If 0% of the production occurs from the WEP and 100% occurs from non-WEP sources, then maximum modeled arsenic impacts remain well below the Acceptable Concentration.

107. As the production mix changes to introduce more production from the WEP and correspondingly less from non-WEP sources, there is a disproportionate increase in arsenic impacts.

108. The modeling demonstrates that when 50% of the production is from the WEP and 50% is from non-WEP sources, that is the point at which modeled impacts for arsenic equal the T-RACT-based AACC in Section 586.

109. In other words, if more than 50% of total production were to occur from the WEP, then the maximum modeled impact would exceed the Acceptable Concentration, and the SGP would be out of compliance with Section 586.

110. Therefore, under the Permit, production from the WEP cannot exceed 50% of total SGP-wide production.

111. A helpful visual depiction of this relationship is attached hereto as Attachment B. (*See* Ex. 100, p. 12, Figure 1 (Schilling Decl.).)

112. Because Condition 3.6 limits WEP production to 394.2 million tons, and because 394.2 million equals 50% of 788.4 million tons, Condition 3.6 limits WEP production to 50% of total authorized production.

113. If 50% of total production from the SGP occurs from the WEP, then production from non-WEP sources is automatically limited to 50% of total production under the plain language of Condition 3.6.

114. If non-WEP sources account for more than 50% of total production at the SGP, then the SGP must correspondingly reduce production from the WEP below 50%.

115. As haulage from the WEP decreases and haulage from non-WEP sources increases, the modeled arsenic impacts decrease further and further below the Acceptable Concentration.

116. Therefore, it was reasonable for DEQ not to include a specific Permit condition

limiting non-WEP haulage to 50% of total mine haulage for the life of the SGP.

IV. PRELIMINARY ORDER

Based on the foregoing findings of fact and conclusions of law, the Hearing Officer hereby concludes: (a) DEQ acted reasonably in using a 5-year rolling average for T-RACT that was not supported by further permit conditions; (b) there was sufficient evidence to support DEQ's T-RACT analysis regarding non-West End Pit production; and (c) DEQ acted reasonably and in accordance with law when it applied the 16/70 adjustment to the AACC for arsenic.

All of the individual claims of error asserted in the Petitioners' Petition have now been resolved. Subject to the rights of the parties to seek further relief pursuant to the procedures below, the hearing officer concludes that DEQ did not commit reversible error in issuing the Permit to Perpetua. It is so ordered.

V. RULE 626 NOTICE

Pursuant to Idaho Code Sections 67-5243 and 67-5245, BEQ Rule of Procedure 003, and OAH Rule of Procedure 626:

This is a preliminary order of the hearing officer. It can and will become final without further action of BEQ, and without any further notice to you, unless any party requests that either the hearing officer or the BEQ review it. If no such request is made within fourteen (14) days of the service of this preliminary order, the order will become final, and you will then have twenty-eight (28) days to file a petition for judicial review with a district court, pursuant to Idaho Code Sections 67-5270 through 67-5279.

If you disagree with this preliminary order, you may file a "motion for reconsideration" with the hearing officer, or you may file "exceptions" and/or a "petition for review" with BEQ. You are allowed to file all of these.

If you would like to file a motion for reconsideration of this preliminary order with the hearing officer, you must do so within fourteen (14) days of the service date of this order. After the hearing officer receives your motion for reconsideration, he has twenty-one (21) days to rule upon it. If he does not issue a ruling within twenty-one (21) days, your motion will be considered denied.

If another party has filed a motion for reconsideration of this preliminary order, you must file any opposition brief within fourteen (14) days from the service date of the motion for reconsideration. No further briefing by any party will be permitted unless the hearing officer, in his discretion, requests it.

You may also file any exceptions you may have to this preliminary order, with a supporting brief, directly with BEQ within fourteen (14) days of the service date of this order, unless BEQ sets a different deadline.

If another party has filed exceptions to this preliminary order with BEQ, you must file any opposition brief within fourteen (14) days from the service date of the exceptions. No further briefing by any party will be permitted unless BEQ, in its discretion, requests it.

You may also file a petition for review regarding this preliminary order, with a supporting brief which sets forth the basis for review, directly with BEQ within fourteen (14) days of the service date of this order, unless BEQ sets a different deadline. BEQ may also notify the parties within fourteen (14) days of the service date of this order, that they, by their own choice, are reviewing this preliminary order, which notice will identify the issues BEQ will review. If a motion for reconsideration has been filed with the hearing officer, your petition for review, or BEQ's notice, does not have to be filed until fourteen (14) days after the motion for reconsideration process with the hearing officer is complete.

If another party has filed a petition for review of this preliminary order with BEQ, you

must file any opposition brief within fourteen (14) days from the service date of the petition for review. No further briefing by any party will be permitted unless BEQ, in its discretion, requests it.

If you would like to request oral argument regarding any motion for reconsideration, exceptions, or petition for review, you must state so in your filings. The decision whether to have oral argument is a decision for the hearing officer or BEQ to make, and they may decide to not have oral argument, even if you or any other party has requested it.

If BEQ reviews a preliminary order, its has the option of either issuing a final order, remanding the matter back to the hearing officer, or holding additional hearings. You will be notified of BEQ's choice if the preliminary order is reviewed.

Dated this 7th day of January 2025.



Dylan Lawrence
Hearing Officer

CERTIFICATE OF SERVICE

I hereby certify that on this 7th day of January 2025, I caused to be served a true and correct copy of the foregoing by the following method to:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Diane Cutler, Hearing Coordinator
Rules and Planning Analyst
Department of Environmental Quality
1410 N. Hilton St.
Boise, ID 83706
diane.cutler@deq.idaho.gov
via electronic service

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Michael A. Short
Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
michael.short@deq.idaho.gov
hannah.young@deq.idaho.gov
via electronic service

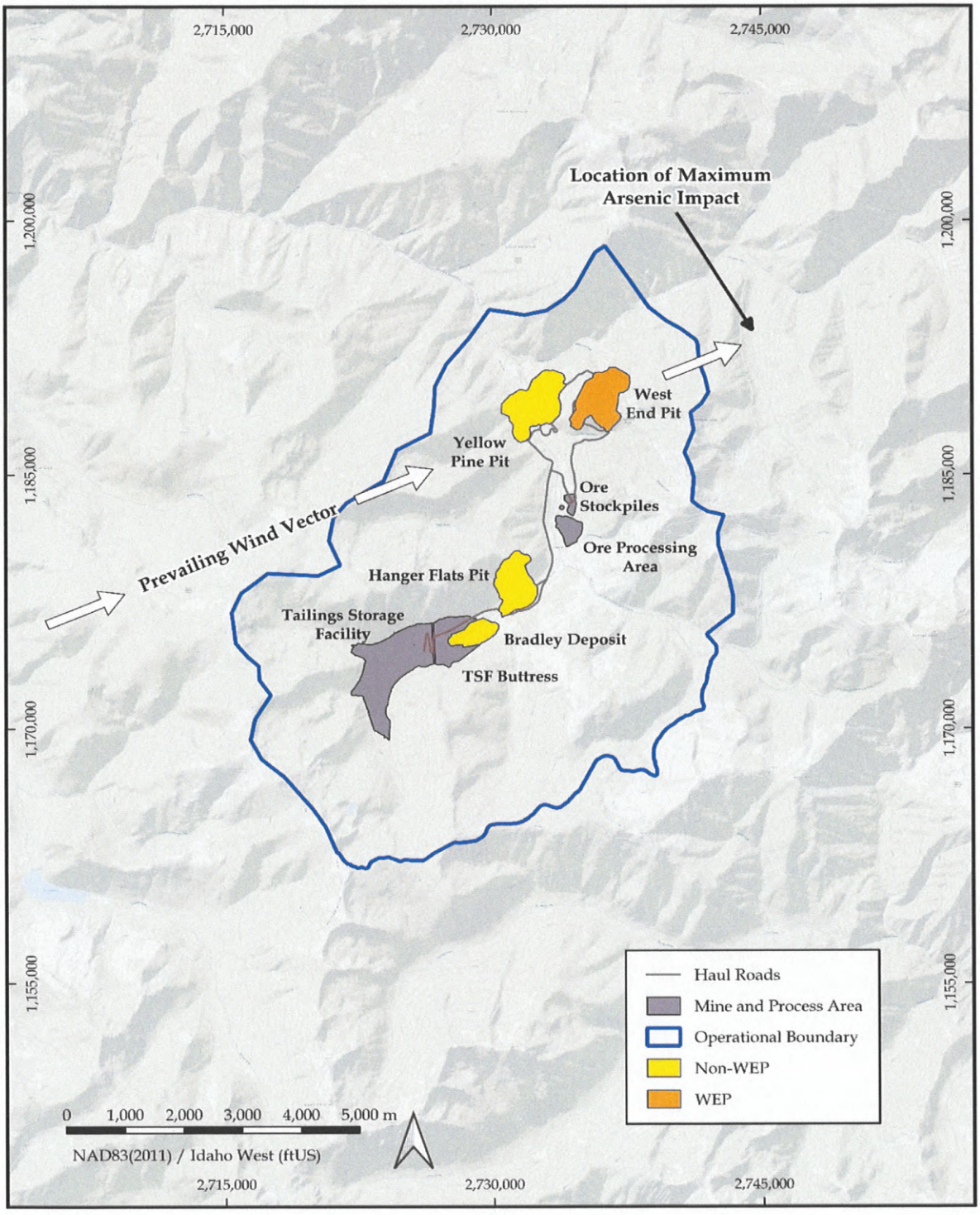
Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole Hancock
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
nicole.hancock@stoel.com
via electronic service

Dylan B. Lawrence
Hearing Officer

Attachment A

EXHIBIT A
Figure 1. Location of Maximum Arsenic Impacts



Attachment B

assure that applicable emissions do not exceed the arsenic T-RACT AACC. Non-West End Pit production is limited to the facility-wide 788.4-million-ton limit for total hauling and excavation at the mine if there were no West End Pit production.

29. Production is effectively limited from non-West End Pit sources because of the following relationship:

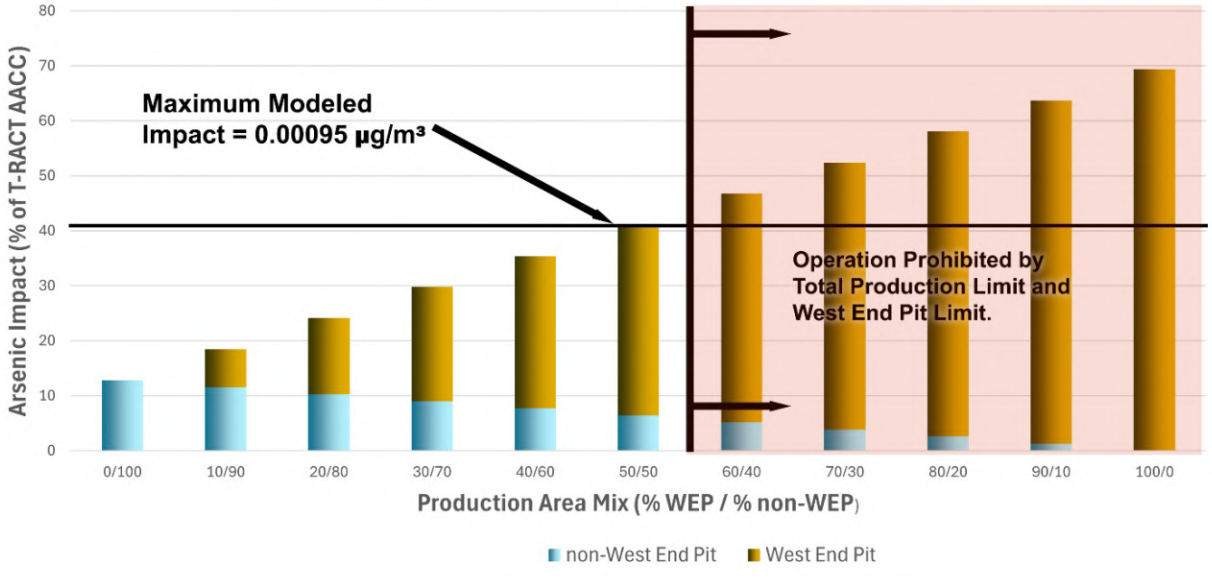
$$Production_{Non\text{-}WEP} = Production_{total} - Production_{WEP}$$

Where:

$Production_{Non\text{-}WEP}$ = production from non-West End Pit Sources
$Production_{total}$ = Total allowable production.
$Production_{WEP}$ = production from West End Pit Sources (not to exceed 50% of $Production_{total}$)

30. The effect of a limit on total production and West End Pit production can be observed by showing how maximum arsenic impacts change with changes in the fraction of total allowable production that occurs from the West End Pit. This was done for the single receptor that had the highest overall exposure concentration. Figure 1 shows how the total adjusted impact is affected by changes in the West End Pit production. The Figure shows how total impacts increase as West End Pit production increases and non-West End Pit production decreases. Figure 1 also shows how impacts would increase above the adjusted combined impact of 0.00095 µg/m^3 for West End Pit allowable production above 50% of the total allowable production from combined West End Pit and non-West End Pit sources.

Figure 1: Maximum Arsenic Impacts as a Function of the Percentage of Total Allowable Production that may Occur from West End Pit Sources



Bryan Hurlbutt (ISB # 8501)
Laurence ("Laird") J. Lucas (ISB # 4733)
Advocates for the West
P.O. Box 1612
Boise, ID 83701
208.342.7024
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Attorneys for Nez Perce Tribe and Idaho Conservation League

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	Agency Case No. 0101-22-01
	)	OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON	)	**PETITIONERS' PETITION FOR REVIEW OF JANUARY 7, 2025 PRELIMINARY ORDER, MEMORANDUM IN SUPPORT, AND REQUEST FOR HEARING**
Petitioners,	)	
v.	)	
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC.	)	
Intervenor-Respondent.	)	

Petitioners Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon hereby petition the Idaho Board of Environmental Quality (the "Board") for review of the Findings of Fact Conclusions of Law, and Preliminary Order ("Preliminary Order") issued on January 7, 2025, by the Hearing Officer in this matter. This Petition for Review is brought under Idaho Code §67-5245, IDAPA 62.01.01.626, and IDAPA 58.01.23.003.

PROCEDURAL BACKGROUND

In this contested case, Petitioners challenge the Idaho Department of Environmental Quality's ("DEQ" or "Department") approval of a permit to construct issued to Perpetua Resources Idaho, Inc. ("Perpetua") for the proposed Stibnite Gold Project (the "Project")—a massive open-pit mine in Valley County, Idaho.

On June 17, 2022, DEQ issued Permit to Construct P-2019.0047 (the "Permit"), which is the Permit at issue in this contested case. *See* REC 0367. On July 22, 2022, Petitioners timely filed the original Petition to Initiate Contested Case. REC 0001. On July 28, 2022, the Hearing Officer Dylan Lawrence was assigned to preside over this matter. On August 12, 2022, Perpetua filed a Petition to Intervene, which was granted on August 22, 2022.[1] REC 005; REC 006.

After the Parties engaged in limited discovery, the Parties filed cross-motions for summary judgment. REC 0323; REC 1204, 1207; REC 1276, 1279. On September 21, 2023, the Hearing Officer held a hearing on the cross motions for summary judgment. TR 0001. On October 31, 2023, the Hearing Officer issued a Memorandum Decision on Motions for Summary Judgment and Preliminary Order (the "2023 Preliminary Order"). *See* REC 3280.

In the 2023 Preliminary Order, the Hearing Officer rejected Respondents' arguments that Petitioners lacked standing to pursue this contested case, finding each Petitioner had standing to challenge the Permit. But the Hearing Officer ruled against Petitioners on all claims addressed in

[1] DEQ and Perpetua are collectively referred to as "Respondents" in this Petition.

the 2023 Preliminary Order and granted Summary Judgment to DEQ and Perpetua. REC 3280. On November 14, 2024, Petitioners sought the Board's review of the 2023 Preliminary Order. *See* REC 3342.

After briefing on the petition for review and a hearing held on April 8, 2024, before the Board, TR 0058, the Board issued a Final Order ("2024 Final Order") on May 9, 2024. *See* REC 3695. The Final Order affirmed the findings and conclusions of the October 2023 Preliminary Order with respect to issues regarding Perpetua's legal and physical control of the Stibnite Road Access Route; that DEQ acted reasonably when it allowed Perpetua to defer submitting detailed plans until after the Permit was issued; and that the Permit included enforceable conditions achieving a 93.3% dust control efficiency. REC 3717. The Board, however, concluded that "DEQ did not act reasonably and in accordance with law when it analyzed the ambient arsenic air concentrations" and remanded this issue "to the Hearing Officer for further factual development in accordance with the terms of this order." REC 3717.

More specifically, the Board held that DEQ: did not act reasonably in using a five-year rolling average for T-RACT that was not properly supported by permit conditions; there was insufficient evidence to support the T-RACT analysis limiting the non-West End Pit production limit; and DEQ did not act reasonably and in accordance with law when it applied the 16/70 calculation to the ambient arsenic air concentration analysis. REC 3712-15.

On remand, the parties submitted expert reports and pre- and post-hearing briefs. The Hearing Officer held a two-day hearing on October 17-18, 2024, where the Parties presented expert testimony. And on January 7, 2025, the Hearing Officer issued the Findings of Fact, Conclusions of Law, and Preliminary Order ("2025 Preliminary Order"). In the 2025 Preliminary Order, the Hearing Officer ruled against Petitioners on all claims related to the analysis of arsenic

emissions from the Stibnite Gold Project, and held that DEQ did not commit reversible error in issuing the Permit for the Stibnite Gold Project. 2025 Prelim. Or. at 21.

Petitioners hereby seek review of the 2025 Preliminary Order.

BASES FOR PETITION

The Hearing Officer erred in the 2025 Preliminary Order, which should be modified, amended, or revoked, and the Permit should be set aside, vacated, and remanded to DEQ, based on the following:

1. The 16/70 adjustment for arsenic is unlawful, sets a dangerous new precedent, and is not supported by the evidence; and

2. Using a five-year rolling average is not reasonable to assess compliance with arsenic limits; and the Permit's conditions are not sufficient to limit production from West End Pit and/or non-West End Pit sources to meet arsenic limits.

Each of these bases are explained in detail in the Memorandum in Support found below.

LEGAL STANDARDS

Petitioners brought this contested case to challenge DEQ's action in issuing the Permit for the Stibnite Gold Project. Under the Idaho Administrative Procedures Act, an agency action like DEQ issuing the Permit will be overturned where its findings, inferences, conclusions, or decisions are: "(a) in violation of constitutional or statutory provisions; (b) in excess of the statutory authority of the agency; (c) made upon unlawful procedure; (d) not supported by substantial evidence on the record as a whole; or (e) arbitrary, capricious, or an abuse of discretion." Idaho Code ("I.C.") § 67-5279(3); *see 917 Lusk v. City of Boise*, 158 Idaho 12, 14 (2015). "An action is capricious if it was done without a rational basis. It is arbitrary if it was done in disregard to the facts and circumstances presented or without adequate determining

principles." *Am. Lung Ass'n of Idaho/Nev. v. Idaho State Dep't of Agric.*, 142 Idaho 544, 547 (2006) (citations omitted).

APPLICABLE AIR RULES & THE STIBNITE GOLD PROJECT

The Air Rules' requirements for controlling the emission of toxic air pollutants ("TAPs") begin with IDAPA 58.01.01.161. Section 161 is the overarching policy or qualitative standard that should be applied to the emission of toxic contaminants, such as arsenic. It provides:

> Any contaminant that is by its nature toxic to human or animal life or vegetation ***must not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation.***

(emphasis added). To obtain a permit to construct an applicant must demonstrate, to the satisfaction of the Department that:

> ***Using the methods provided in Section 210***, the emissions of toxic air pollutants from the stationary source or modification would not injure or unreasonably affect human or animal life or vegetation ***as required by Section 161***. Compliance with all applicable toxic air pollutant carcinogenic increments and toxic air pollutant non- carcinogenic increments demonstrates preconstruction compliance with Section 161 ***with regard to the pollutants listed in Section 585 and 586.***

IDAPA 58.01.01.203.03 (emphasis added). Thus, if a TAP is listed in IDAPA 58.01.01.585 or 586 ("Section 586"), it must be evaluated under the methods provided in Section 210.

Section 586 of the Air Rules consists of a table that lists each carcinogenic TAP that is covered by the rules–including arsenic. Section 586 includes "the screening emissions levels (EL) and acceptable ambient concentrations (AACC)" for each toxic carcinogenic pollutant listed. The EL listed for arsenic is "1.5E-06 lb/hr" and the AACC for arsenic is "2.3E-04 $\mu g/m^3$." The AACC is the carcinogen concentration in air in which daily exposure would limit the risk of cancer to 1 in 1 million over a lifetime, which is identified as 70 years. The AACCs listed in the table in Section 586 are based on "annual averages." IDAPA 58.01.01.586.

Section 210.01 provides that the applicant must first identify what TAPs will be emitted by the project. IDAPA 58.01.01.210.01. Then the applicant must use "standard scientific and engineering principles and practices to estimate the emission rate" of the pollutant. IDAPA 58.01.01.210.02.a. If the EL exceeds the levels listed in Section 586, then the applicant must continue with further analysis under Section 210.

The applicant must then use "the modeling methods provided in Subsection 202.02 to estimate the ambient concentrations at specific receptor sites for any toxic air pollutant emitted from the point(s) of emission." IDAPA 58.01.01.210.03.a. The "point of compliance is the receptor site that is estimated to have the highest ambient concentration of the toxic air pollutant of all the receptor sites . . .." IDAPA 58.01.01.210.03.b. Preconstruction compliance for toxic pollutants can be demonstrated using any of the methods "described in Subsection 210.05 through 210.08 and may use any applicable specialized method described in Subsection 210.09 through 210.12." IDAPA 58.01.01.210.04.

Applicable here are the compliance methods described in Section 210.12, which provides for the use of "T-RACT" to demonstrate preconstruction compliance for toxic pollutants listed in Section 586. T-RACT stands for "Toxic Air Pollutant Reasonably Available Control Technology" and "is an emission standard based on the lowest emission of toxic air pollutants that a particular source is capable of meeting by the application of control technology that is reasonably available, as determined by the Department, considering technological and economic feasibility." IDAPA 58.01.01.210. The applicant must comply with IDAPA 58.01.01.210.13 and 210.14 to first get approval by DEQ to proceed under the T-RACT provisions before it can be used in the modeling. If T- RACT is used, it allows for a comparison of:

> [T]he source's . . . approved T-RACT ambient concentration at the point of compliance for the toxic air pollutant to the amount of the

> toxic air pollutant that would contribute an ambient air cancer risk probability of less than one to one hundred thousand (1:100,000) (which amount is equivalent to ten (10) times the applicable acceptable ambient concentration listed in Section 586).

IDAPA 58.01.01.210.12.b. Thus, if the source's approved T-RACT ambient concentration meets the AACC listed in Section 586 times 10, then "no further procedures for demonstrating preconstruction compliance will be required for that toxic air pollutant as part of the application process." IDAPA 58.01.01.210.12.c. DEQ must then include appropriate conditions in the permit to ensure that the T-RACT is implemented so that the 10-times ambient concentrations can be met. IDAPA 58.01.01.210.12.d.

Section 210 provides one further analysis that has bearing in this case. Section 210.15 provides that "short term" projects "may utilize a short-term adjustment factor of ten (10). "For a carcinogen, multiply either the applicable acceptable ambient concentration (AACC) or the screening emission rate, but not both, by ten (10), to demonstrate preconstruction compliance." IDAPA 58.01.01.210.15. "Short Term Source" is defined as any new stationary source "with an operational life no greater than five (5) years from the inception of any operations to the cessation of actual operations." IDAPA 58.01.01.007.08. Thus, short term sources are also allowed 10 times the AACC, which would represent a 1 in 100,000 cancer risk, as long as the operational source life is no greater than five (5) years.

Neither the AACC arsenic limit, nor the 10-fold higher T-RACT arsenic limit of 0.0023 $\mu g/m^3$, could be met for the Stibnite Gold Project. *See* REC 3710-12. Thus, Respondents adjusted the calculated arsenic emissions by (1) decreasing maximum potential annual mine production from 180,000 tons per day ("T/day") to 135,000 T/day based on a five-year rolling average limit; and (2) decreasing maximum potential annual production from the West End Pit by applying a 50% annual limit. *See id.* Even then, the Project's highest annual average arsenic

concentration of 0.00416 µg/m^3 exceeded the T-RACT limit of 0.0023 µg/m^3. So Respondents came up with and applied the novel 16/70 Project-specific adjustment to the calculated arsenic concentrations: multiplying the calculated highest annual average arsenic concentration of 0.00416 µg/m^3 by 16 and dividing by 70. *See id. See also* REC 1243–44, REC 698–706. This 16/70 adjustment reduced the supposed arsenic concentration to .00095 µg/m^3.

MEMORANDUM IN SUPPORT OF PETITION

I. The 16/70 Adjustment for Arsenic Is Unlawful, Sets a Dangerous New Precedent, and Is Not Supported by the Evidence.

A. The Plain Language of the Air Rules Does Not Allow Using a Project-specific Adjustment Factor.

The Board correctly concluded that the 16/70 Project-specific adjustment factor DEQ used here is "nowhere" found in the rules:

> The Air Rules clearly provide an [acceptable ambient concentration ("AACC")] standard in Section 586. They then clearly provide an adjustment to that AACC standard when T-RACT can be used to control emissions. IDAPA 58.01.01.210.12.b. The Air Rules also clearly allow for a 10-times adjustment to the AACC when a project is going to operate for 5 years or less. IDAPA 58.01.01.210.15. But nowhere in the Air Rules does it provide that a project that will operate more than 5 years but less than 70 years may be adjusted in proportion to the amount of time it will operate.

REC 3715.[2] This should be the end of the story on the 16/70 Project-specific adjustment factor issue.

Ignoring the Board's interpretation of the Air Rules, the Hearing Officer rationalized that adjusting the Stibnite Gold Project based on the 16 years it will operate is appropriate, because the "Air Rules do not expressly preclude" it. 2025 Prelim. Or. at 12 (¶ 48). This was an error.

Neither the Hearing Officer nor DEQ are free to disregard the plain language of the Air Rules, even if they have a supposed rationale for doing so. Agency rules (like the Air Rules) have the full force and effect of law. *See Mead v. Arnell*, 117 Idaho 660, 664–65 (1990). As the Idaho Supreme Court has explained: "We must follow the law as written. If it is socially or economically unsound, the power to correct it is legislative, not judicial." *Herndon v. West*, 87 Idaho 335, 339 (1964).

"Regulations, like statutes, are interpreted according to canons of construction." *Black & Decker Corp. v. C.I.R.*, 986 F.2d 60, 65 (4th Cir. 1993); *see also United States v. Korotkiy*, 118 F.4th 1202, 1209-10 (9th Cir. 2024).

Under the canon of *generalia specialibus non derogant*, when there is a conflict between a general provision and a specific provision, the specific provision prevails. "The canon provides that a 'narrow, precise, and specific' statutory provision is not overridden by another provision 'covering a more generalized spectrum' of issues." *Perez-Guzman v. Lynch*, 835 F.3d 1066, 1075

[2] The Board emphasized this point at its Special Meeting:

> Idaho rules are not ambiguous. There is an acceptable risk associated with the AACC standard. There is an acceptable risk associated with DEQ-approved T-RACT projects, and there is an acceptable risk associated with the short-term project that is five years or less. There are no other acceptable risks identified in Idaho's air quality rules.

May 1, 2024 BEQ Special Meeting, TR 0160.

(9th Cir. 2016) (quoting *Radzanower v. Tourche Ross & Co.*, 426 U.S. 148, 153–54 (1976)). "[T]he assumption being that the more specific of two conflicting provisions 'comes closer to addressing the very problem posed by the case at hand and is thus more deserving of credence.'" *Perez-Guzman*, 835 F.3d at 1075 (quoting Antonin Scalia & Bryan A. Garner, Reading Law: The Interpretation of Legal Texts 183 (2012)). The Idaho Supreme Court applies this canon. *See Tomich v. City of Pocatello*, 127 Idaho 394, 400 (1995); *Mickelsen v. City of Rexburg*, 101 Idaho 305, 307 (1980).

Again here, Air Rules Section 203.03 requires "no permit to construct shall be granted" unless DEQ determines that the applicant has shown: "Using the methods provided in Section 210, the emissions of toxic air pollutants from the . . . source . . . would not injure or unreasonably affect human health or animal life or vegetation as required by Section 161." (emphasis added). To protect human health, Section 586 sets a numeric arsenic AACC limit at an annual average of 0.00023 $\mu g/m^3$. Section 210 creates two specific exceptions to meeting the AACC (which is an annual emissions factor), allowing a 10-fold higher AACC where the applicant makes a T-RACT demonstration (Section 210.12) and/or where a project is short-term (5 years or less) (Section 210.15). These specific, numerical provisions in Sections 586 and 210 cannot be disregarded to fall back on a more general, qualitative standard in Air Rule Section 161, which provides that a toxic air pollutant "shall not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation." REC 3419.

Nor can the explicit AACC annual average value listed in Section 586 be ignored by reverse engineering cancer risk calculations, as DEQ and Perpetua now say they are doing. This method is nowhere found in the "methods in Section 210" and has never been used by DEQ

before. *See* REC 1194 (Schilling memo admitting this is "a complete change in the regulatory approach used to demonstrate compliance with toxics," and it "abandons the Section 210 approach"). Section 210 sets forth clear and straightforward methods for checking a source's annual arsenic concentration against the annual arsenic value listed in Section 586 (or 10 times that value for T-RACT, like for the Stibnite Gold Project, and short-term sources).

Instead of using these methods in Section 210, DEQ abandoned this approach and came up with a new method that does not use the highest modeled annual arsenic concentration, but averages 16 years of emissions over 70 years, to compare them to 10 times the AACC. This is a fabrication. This is not a cancer risk assessment. von Lindern Test., TR. 434-35, 465. And Respondents–during the three years of permit development and two years of this contested case proceeding–never, until now, consulted a toxicologist on whether spreading out the Project's arsenic emissions and cancer risk over 70 years was appropriate. Paden Test., TR 154; Lopez Test., TR 234. DEQ must follow Section 210 and compare the annual average arsenic concentrations from the Stibnite Gold Project to the T-RACT adjusted AACC listed Section 586. *See* IDAPA58.01.01.210.12.

Another canon of construction requires interpreting regulations to avoid rendering provisions superfluous—which is what DEQ's approach here does to the Air Rules's explicit short-term source adjustment for projects that last 5 years or less. "A statute should be construed so that effect is given to all its provisions, so that no part will be rendered superfluous or insignificant." *Brown v. Caldwell Sch. Dist. No. 132*, 127 Idaho 112, 117 (1995). Again, Section 210 specifically provides for AACC adjustments for in two situations: projects that have demonstrated T-RACT; and short-term five-year-or-less projects. DEQ cannot just make up a third adjustment found nowhere in the Rules. This is especially so since there is already an

adjustment in the Air Rules for short-term sources for which everyone agrees the Stibnite Gold Project does not qualify. If DEQ can adjust AACCs based on project duration, as it has done here, then the short-term adjustment in Section 215 is superfluous. DEQ's interpretation cannot stand.

Thus, the 16/70 adjustment is not allowed by the plain language of the Air Rules and must be rejected, whether or not DEQ or Perpetua can offer any rationale for using it.

B. The 16/70 Approach Undermines the Air Rules, Creates a Dangerous Precedent for Idahoans, and Allows Higher Cancer Risk.

Not only does the plain language of the Air Rules foreclose DEQ's approach, but this approach is contrary to the intent of the Air Rules and would create a dangerous precedent allowing Idahoans to be exposed to *higher* cancer risks than under DEQ's longstanding pre-Stibnite Gold Project interpretation of the Air Rules: where TAPs values listed in Section 586 are annual limits, or increments, that must be met by a source every year of emissions. The Hearing Officer completely ignored this regulatory framework and erred in finding that Respondent's ad-hoc approach to assessing compliance with Section 586 was valid.

Around the time of the TAPs rulemaking, a number of concerns were raised about creating exceptions for short term sources, even for remediation projects being undertaken to clean up the environment. *See* REC 6055-56 (Tiedemman Decl. ¶¶ 18–21). Health concerns were raised about exposing people to a large dose of carcinogen during short periods. REC 6071-84 (*Id.* at Exh. A). Health concerns were raised about the risk of "combined and synergistic effect of many short term . . . or other sources . . . and the potential of serial (one after another) short term . . . sources," the risk of creating an "incentive for facilities to argue they will be short-term," and the risk of a "spectre of serial short-term sources." REC 6086 (*Id.* at Exh. B).

The Idaho Department of Health and Welfare ("IDHW"), DEQ's predecessor agency, echoed these concerns in response to comments, stating that for the TAPs it "strived to take a balanced approach taking into account the needs of industry to operate and the need to protect human health and the environment." REC 6056-57 (Tiedemann Decl. 21); *see also* REC 4298, 4300-02 (Lopez Decl., Memo in Supp. at 8, 10–12) (citing the same IDHW response to comments). IDHW added: "Since it is not possible to account for such real life factors as lifetime exposures, additive or multiplicative effects of exposures to the large variety of industrial chemicals in use in Idaho, it is necessary to make our emissions standards generally applicable and reasonably conservative." REC 6057 (Tiedemann Decl. 21). This was reflected in Dr. von Lindern's testimony, who was involved during TAPs Rule rulemaking, testified as to his recollection from those hearings confirmed that "one of the main objectives of developing the TAPs – these rules was to avoid risk assessment." von Lindern Test., TR 416. This is also reflected in the Air Rules, which include specific adjustments for T-RACT and short-term sources but are otherwise generally applicable to all sources—including the Stibnite Gold Project.

Under DEQ's longstanding, pre-Stibnite Gold Project precedent in applying the TAPs Rule, Idahoans are better protected from these risks. Because the AACCs are increments (as opposed to ambient air quality standards), Section 586 "would not account for the cumulative lifetime exposures associated with the earlier projects in a new source [permit to construct] application, and are not allowed to consider risk associated with those earlier projects. At Stibnite, for example, should [Perpetua] apply to open another pit at the mine, DEQ would be required to ignore the cumulative lifetime risk and cancer burden imposted by the proposed

[Stibnite Gold Mine] 16-year [life of mine] scenario." REC 6121 (von Lindern Decl. 48); *see also* REC 6121-24 (*Id.* at ¶¶49-52).

As Dr. von Lindern and Mr. Tiedemann showed, where the AACC values are treated as limits, or increments, that must be met by sources in Idaho every year, no single source nor any combination of sources will expose an Idahoan to more than the AACC concentration (or 10 times the AACC concentration for T-RACT or short-term sources) at any time over their 70-year life, no matter how many sources they might encounter or where they might encounter them in the state; and accordingly, the cancer risk over that entire 70 years will not exceed the applicable cancer risk (1 in 1 million, or 1 in 100,000 for T-RACT or short-term sources). *See* REC 6109-13 (Dr. von Lindern Decl. ¶¶ 21–29); REC 6060-62 (Tiedemman Decl. ¶¶ 28–29).

"That's the way TAPs has been implemented [on] every other project that's been done in Idaho to date." von Lindern Test., TR 421.

By contrast, under DEQ's approach, Dr. von Lindern explained that it:

> would concentrate 70 years of cumulative risk . . . into . . . however many years you're adjusting that project, whether it be six years or 16 years or something like that. * * * I understand from their interpretation that you could apply this risk factor to as low as 6 over 70. * * * [For a 16-year project,] [t]hey would they completely used their entire lifetime exposure by the end of adolescence.

von Lindern Test., TR 421-423.

Furthermore, Idahoans could be exposed to one source (like the Stibnite Gold Project) at levels higher than the listed AACC values, and then be exposed to additional sources during the rest of their life such that the cancer risk over their life exceeds the Air Rules risk levels. *See* REC 6120 (Figure 4 of von Lindern Decl.). Dr. von Lindern testified that because the AACC is an "incremental standard," "DEQ is not allowed to consider past exposures. The next project gets

another full boat of lifetime exposure. [in the 6 year] example, by age 12, you're twice the amount. By age 18, you're three times your total cumulative lifetime exposure." von Lindern Test., TR 443. For example, DEQ and Perpetua have modeled the Stibnite Gold Project to result in 0.00416 μg/m^3 average annual arsenic concentration. REC 0361 (Pet'rs' Mot. Summ. J.) (explaining how to reverse the 16/70 adjustment); REC 3876 (Paden Decl. 9). This is *181 percent* of the T-RACT adjusted AACC for arsenic of 0.0023 μg/m^3. REC 0361 (Pet'rs' Mot. Summ. J.). If a person were exposed to 0.00416 μg/m^3 of arsenic for 16 years, and then were exposed to another arsenic source(s)—even if that source complied with but was close to the T-RACT adjusted AACC value—then that person will have more than a full allowable 70-year exposure to arsenic and corresponding cancer risk.

> The TAPs rule is health protective if properly implemented. Applying risk averaging through the use of the 16/70 Project-specific adjustment factors eliminates the [margin of safety] and substantially increases cancer risk, especially considering the incremental nature of the rule.

REC 6122 (von Lindern Decl. 50). As the Board stated:

> There is an acceptable risk associated with the AACC standard. There is an acceptable risk associated with DEQ-approved T-RACT projects, and there is an acceptable risk associated with the short-term project that is five years or less. There are no other acceptable risks identified in Idaho's air quality rules.

TR 0160. The 16/70 Project-specific adjustment factor creates a misleading risk analysis that greatly underestimates actual cancer risk.

C. DEQ's & Perpetua's Cancer Risk Assessment is Not Scientifically Valid and Fails to Show that the Stibnite Gold Project Is Equally or More Protective of Human and Animal Life and Vegetation

The Board not only faulted DEQ for using the 16/70 Project-specific adjustment factor because that approach is nowhere found in the Air Rules, but it also faulted DEQ for failing to

show that the 16/70 adjustment factor was sufficiently protective of human health and the environment:

> The arsenic analysis performed by DEQ must be viewed within the wider lens of IDAPA 58.01.01.161 and 203 which require that toxic pollutants must "not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation." see also IDAPA 58.01.01.203.03. The Board of Environmental Quality has not found sufficient evidence in the record to convince it that the 16/70 analysis performed by DEQ was equally or more protective of human and animal life and vegetation as what is provided for by the Air Rules. Therefore, the Board of Environmental Quality remands this matter back for the development of further evidence regarding the ambient air concentrations of arsenic that will be produced by the [Stibnite Gold Project] and whether those levels comply with the Air Rules.

REC 3716-17. Even if the Hearing Officer determines that compliance with the TAPs rule can be accomplished through an excess cancer risk assessment, Respondents have failed to show that the 16/70 Project-specific adjustment factor is a scientifically valid risk assessment, that they followed any scientifically valid risk assessment protocol, and that application of their simple equation to the Stibnite Gold Project emissions accounts for the total health risk the Project will create.

1. Respondents 16/70 Project-specific adjustment factor is not scientifically valid and it does not follow any standard risk assessment protocol.

The Hearing Officer found that using a project-specific adjustment factor was reasonable "because doing so is standard EPA practice." 2025 Prelim. Or. at 9. Testimony from Respondents' toxicologists, Dr. Paden and Ms. Lopez, failed to establish that application of the 16/70 Project-specific adjustment factor to arsenic emissions is a scientifically valid method for assessing excess cancer risk for this Project.

Both Dr. Paden and Ms. Lopez relied on EPA guidance for their cancer risk assessments that was specifically developed "to provide a recommended approach for developing the information necessary to assist risk assessment and risk management decision-making at waste sites . . . .". REC 5257 (EPA's Risk Assessment Guidance for Superfund); *see* REC 3876-79 (Paden Decl. ¶¶ 11-15); REC 4305-08 (Lopez Decl., Memo. in Supp., Attach. B) (providing calculations of risk associated with air concentration using equations from EPA's superfund guidance). The 16/70 Project-specific adjustment factor is "a classic example of dose-averaging in risk analyses applied to contaminated hazardous waste sites," but an inappropriate technique to use when the Air Rules provide for increments. REC 6117 (von Lindern Decl. 42). There are no provisions in the Air Rules and no evidence was presented from federal Clean Air Act guidance or otherwise that provides for adjusting toxic air pollutant exposure concentration in assessing compliance with increments, as DEQ has done.

Ms. Lopez's testimony relied on one statement from Appendix A, titled "Major Default Options," from EPA's 2005 Guidelines for Carcinogen Risk Assessment[3] to justify applying the 16/70 Project-specific adjustment factor. Lopez Test., TR 221-22. However, reading from several areas of the document, Dr. von Lindern testified that the document as a whole demonstrates that dose-averaging is not a standard practice, and does not support applying an exposure duration adjustment to assess cancer risk for this project. von Lindern Test., TR 424-429.

A true risk assessment is comprehensive and multi-variable. For states that require a cancer risk assessment for evaluating the emissions of toxic air pollutants, considering the total daily intake of a toxic air pollutant attributable to the source as well as the background sources is standard practice. REC 6132 (von Lindern Decl. ¶¶ 74); *see* REC 6235-68 (*Id.*, Exh. C (State of Washington Department of Ecology Guidance Document)); Pet'r's Post-Hearing Brief at 13.

[3] This document was offered into evidence at the October 17-18, 2024 OAH Hearing at Ex. 221.

Other standard practices include considering uncertainties in emissions and modeling, interactive effects of exposure to more than one carcinogen, and others.

For example, the State of Washington requires "health impact assessments" (HIA) for some sources of toxic air emissions. REC 6251-6262 (von Lindern Decl., Exh. C (DEC Guidance)). According to the Washington Department of Ecology, the techniques in its guidance manual "are common to other regulatory risk assessment applications." REC 6251 (von Lindern Decl., Exh. C*)*. "An HIA looks at how emissions of toxic air pollutants from a specific project will affect public health. It involves several steps, including hazard identification, exposure analysis, toxic response, and risk characterization." *Id.*

For an HIA, the applicant must disclose the total daily intake of TAPs attributable to the source "as well as the background sources." REC 6253 (*Id.* at 19). The applicant must estimate exposure durations, "[d]etail the exposure parameters associated with sensitive population subgroups," "[i]dentify the potentially exposed populations," and "[g]ive special emphasis to any subpopulations that might be unusually susceptible to any TAPs emitted by your project." *Id.* In the risk/hazard assessment section, the applicant must also include a toxicity discussion, which should discuss: toxic effects of the TAPs; exposure levels associated with specific effects; exposure patterns and duration of exposure; any quantitative, chronic toxicity values (including hazard-based concentrations, cancer unit risk factor estimates, and slope factor or carcinogenic potency estimates); and any quantitative intermediate and short-term acute toxicity values. *Id.*

For an HIA, the applicant must also provide risk/hazard information, including a qualitative discussion of the risks; quantitative discussion of the risks with toxicity measures, calculated cancer risks, and the hazard index; discussion of uncertainties in the risk assessment; discussion of acceptability of risk; and discussion of extent to which the proposed facility might

affect human health. REC 6253-54 (*Id.* at 19–20). Applicants are to disclose uncertainties of their risk assessment, including: uncertainty in emission estimates; uncertainty in air dispersion models; interactive effects of exposure to more than one carcinogen or toxicant; uncertainty in exposure estimates; and uncertainty about the extent of toxicant susceptibility variation within populations. REC 6254 (*Id.* at 20).

Respondents' toxicologists' assessments were based on a single emissions calculation, not performed by either toxicologist but provided to them by Respondents, and without a full understanding, how the emissions calculation were derived. *See generally* REC 3873-3916 (Paden Decl.); REC 4277-4318 (Lopez Decl.); *see also* Paden Test., TR 156; Lopez Test., TR 234. Furthermore, their declarations lack most of these common risk assessment techniques, including uncertainties in emissions and modeling, and interactive effects of exposure to more than one carcinogen, among others identified above. *See generally* REC 3873-3916 (Paden Decl.); REC 4277-4318 (Lopez Decl.). The Hearing Officer's finding that Respondents' cancer risk assessments followed standard EPA practice and were scientifically valid and complied with the Air Rules was wrong.

2. DEQ and Perpetua Fail to Account for Combined Effects of Other Carcinogens as Required by Air Rule Section 161

Air Rule Section 161 requires protection from toxic pollutants like arsenic from a source both alone and "in combination with other contaminants." But neither DEQ nor Perpetua factored in exposure to other contaminants, either during the 16-year Stibnite Gold Project, or any other time during someone's lifetime. They only consider arsenic from the Stibnite Gold Project. The Stibnite Gold Project will itself emit other toxic and hazardous air pollutants. REC 433-44 (table of TAP/HAP emissions). Idahoans may already be exposed to background concentrations of other contaminants. And as already explained, someone exposed to the Stibnite

Gold Project might be exposed to other sources of arsenic and other contaminants throughout the other 54 years of their 70 year life. But these exposures are not accounted for in the risk assessments. *See* REC 3873-3916 (Paden Decl.); REC 4277-4318 (Lopez Decl); REC 6137 (von Lindern Decl. 90).

3. DEQ and Perpetua Fail to Account for Sensitive Populations, Mutagenic MOA, and Non-carcinogenic Risk

The cancer risks DEQ and Perpetua calculated fail to account for the health risks of short-duration, high exposure to arsenic for sensitive populations, including pregnant women, the fetus, and pre-school children, who accumulate dose and risk at high rates. REC 6117-18 (von Lindern Decl. ¶¶ 40–44).

DEQ and Perpetua also failed to consider mutagenic modes of action (MOA). While this is not definitively settled, and current EPA policy does not require accounting for this, there is evidence suggesting that arsenic in combination with other co-stressors has shown mutagenic MOA. REC 6135-36 (*Id.* 84). As such, a comprehensive risk assessment would use age dependent adjustment factors, *id.*, which neither DEQ nor Perpetua has done.

DEQ and Perpetua also failed to consider non-carcinogenic arsenic health effects, especially to children. *See* REC 6136-37 (*Id.* ¶¶ 85–88). Non-carcinogenic arsenic health effects can become the risk driver at sites where children may ingest, in addition to inhaling, arsenic laden dusts. REC 6136 (*Id.* 85. Incidental ingestion of mining-related fugitive dusts is the major exposure route for heavy metals in mining communities in Idaho. REC 6136-37 (*Id.* ¶ 88.)

In summary, each of the problems above would be avoided by treating the AACCs limits that must be met by source each year of operations, as DEQ had always done prior to the Stibnite Gold Project. These problems—the disregard for the Air Rules as written, the dangerous precedent, and the underestimation of cancer risk from the Stibnite Gold Project—are all

amplified by DEQ's use of the five-year rolling average and its treatment of production from the different mining pits, discussed in the next section.

II. The Hearing Officer erred in finding that using a five-year rolling average was reasonable to assess compliance with Section 586, and that Permit conditions were sufficient to limit production from West End Pit and/or non-West End Pit sources.

The Board unequivocally determined that the Section 586 AACCs were "limits;" those limits were "based on annual averages;" and that Section 586 required compliance on an annual basis. REC 3717. The Board held that the Permit "conditions were inadequate to ensure that the 135,000 T/day used in the ambient arsenic air concentration analysis would not be exceeded for some portion of the five-year rolling period." REC 3713. The Hearing Officer disregarded the Board's findings, and made a fatal error in his analysis that the total emissions over the 16 years the mine would operate spread out for 70 years. 2025 Prelim. Or. at 16-17 (¶¶ 84-89). This error was propagated in the Hearing Officer's finding that the Permit conditions limiting total life-of-mine production and total West End Pit production effectively decreased modeled arsenic impacts "further and further below the [AACC]." *Id.* at 19-20 (¶¶ 107-115).

Permit Condition 3.5 limits daily production to a total of 180,000 T/day, with a five-year rolling average of 135,000 T/day. REC 385. DEQ's permit writer, Mr. Schilling, confirmed that using a five-year rolling average was inappropriate for calculating the annual average arsenic concentration because the permit conditions do not restrict Perptua from having several years of maximum production of 180,000 T/day when the five-year average is at or below 135,000 T/day:

> *Idaho Air Rules* Section 586 state that AACCs are annual averages. The implication of the stated issue is that when a standard or increment is specified for a certain averaging-period, then any limits imposed on operations should be for the same averaging period or a shorter averaging period. For example, an operational limit designed to limit emissions that is based on a 5-year averaging period would not be adequate for assuring compliance with the annual average standard. ***This is because variability in***

> ***operational rates within the 5-year operational period could result in a violation of the annual standard*** while still complying with the five-year operational limit in the period.

REC 3925 (Schilling Decl. ¶24 (emphasis added)); *see also* Schilling Test., TR 61; Pet'rs' Post-hearing Statement at 18-19. This should have been the end of the inquiry and confirms the Board's finding that there is "no evidence in the record explaining how the five-year rolling average comports with the annual AACC limits." REC 3713.

In an attempt to demonstrate that even with 180,000 T/day annual average production, the Project will not exceed the arsenic AACC, Respondents' expert, Mr. Lewis used the wrong starting numbers. Mr. Lewis's back-of-the-envelope calculation indicated that 180,000 T/day production was approximately 33.3% higher than 135,000 T/day production, and therefore emissions would be correspondingly higher (0.00095 μg/m^3 versus 0.00126 μg/m^3), but still be below the 0.0023 μg/m^3 AACC in Section 586. Lewis Test., TR 287-89[4]. However, Mr. Lewis used the wrong starting numbers by using 0.00095 μg/m^3–the emissions calculations that had been adjusted by the 16/70 adjustment factor, which is for purposes of assessing excess cancer risk, and not compliance with Section 586. The Hearing Officer continued this error in his decision. *See* 2025 Prelim. Or. at 17 (¶ 91).

"[N]owhere in the Air Rules does it provide that [emission calculations for a project] may be adjusted in proportion to the amount of time it operates." REC 3715. Therefore, the appropriate number to compare to the AACC is 0.00095 μg/m^3 with the adjustment factor backed out of it:

[4] *See also* Exhibit 222, which was admitted as evidence at the October 17-18, 2024 OAH Hearing.

$$0.00095\ \mu g/m^3\ (70/16) = 0.00416\ \mu g/m^3$$ [5]

The emissions calculation for the five-year rolling average with the Project-specific adjustment factor thus is and always was above the AACC limit, as will be the arsenic emissions at 180,000 T/day production, just 33.3% higher (0.0055 $\mu g/m^3$). The Hearing Officer's holding, then, that neither the 135,000 T/day five-year rolling average nor the 180,000 T/day production limit exceed the AACC is wrong.

Moreover, the Hearing Officer's erred in his analysis of the West End Pit production issue. First, he erred in finding that "the highest modeled annual average arsenic concentration was 0.00414 $\mu g/m^3$." *See* 2025 Prelim. Or. at 10 (¶ 28). The highest modeled emission scenario (or, using the language of Section 586, the maximum annual average) is based on the highest amount of production given conditions or limitations in the Permit. Lewis Test., TR 266-67. The Permit conditions relevant to emissions calculations in this case are (1) Permit Condition 3.5, which provides for a maximum production of 180,000 T/day, with a five year rolling average of 135,000 T/day, and (2) Permit Condition 3.6, which limits the life of mine maximum production to 788.4 million tons, with a maximum of 50%, or 394.2 million tons from the West End Pit. REC 385. Notably, the Board already found that Permit Condition 3.6 does not limit the annual production from the West End Pit to 50% production (e.g., 90,000 T/day with a five-year rolling average of 67,500 T/day), but just the total life of mine production to 50%. REC 3713 n.7 (stating that Condition 3.6 "does not provide a limitation on the daily amount of hauling that could occur [from the West End Pit].").

Consideration of the total possible production from the West End Pit in determining the maximum annual arsenic concentration is important because its geography and prevailing wind

[5] This is the number that both Respondents' experts used in their excess cancer risk assessment. REC 4284 (Lopez Decl. 24); REC 3876 (Paden Decl. 9).

resulted in "the highest modeled impacts to receptors at the [Project] boundary came from emissions for the [West End Pit] area." 2025 Prelim. Or. at 19 (¶¶ P101-04). There is no theoretical limit, i.e., permit condition, that limits West End Pit production, and DEQ's own expert witness confirmed that there is no practical limit. In other words, 100% West End Pit production is a realistic possibility:

> You just don't mine from all of [the pits] the same amount at the same time. . . . [A]s the mine develops, . . . you might start out at the Yellow Pine Pit and then, you know, move over to the West End Pit.

Lewis Test., TR 261. Therefore, under Permit Condition 3.6 that limits West End Pit production to half the total ore production–to 384.2 million total tons–at a maximum five-year rolling average of 135,000 T/day, Perpetua could produce and haul ore exclusively from the West End Pit for eight years, with five of those years possibly reaching up to 180,000 T/day. *See* Pet'rs' Post-hearing Statement at 20-21.

But that is not the scenario considered when emissions were calculated to be 0.00416 μg/m^3. Dr. von Lindern testified that the 0.00416 μg/m^3 is calculated by averaging the average of seven non-West End Pit emissions scenarios with the one West End Pit emission scenario,[6] and this averaging technique worked to reduce the apparent emissions by a factor of 1.7. REC 6129 (von Lindern Decl. 67).

---

[6] $\dfrac{\dfrac{(0.00124 + 0.00206 + 0.00123 + 0.00102 + 0.00228 + 0.00082 + 0.00090)}{7} + 0.00698}{2} = 0.00416$

The emissions calculations for the different production scenarios are represented as five-year rolling averages, and are found in Table C: TAP Maximum Modeled Concentrations and Applicable AACs. This document was admitted into evidence at the October 17-18, 2024 OAH Hearing as Exhibit 304.. The first seven emissions calculations are for different scenarios of 100% non-West End Pit production. The 0.00698 μg/m^3 value is for a 100% West End Pit production scenario. von Lindern Test., TR 458-459; Lewis Test., TR 311-12.

The record documents and testimony show that the annual average arsenic concentration based on a 135,000 T/day five year rolling average is 0.00698 μg/m^3. October 17-18, 2024 Hearing, Exh. 304; *see* Petr's Post Hearing Statement at 21-23. Using Respondents' back-of-the-envelope calculation that emissions from 180,000 T/day will be 33.3% higher than from 135,000 T/day, Lewis Test., TR 287-89, the highest annual average arsenic emissions are estimated to be 0.0093 μg/m^3–significantly higher than Section 586's AACC for arsenic of 0.0023 μg/m^3. Neither Perpetua nor DEQ has yet to date calculated the highest annual average arsenic emissions. Lewis Test., TR 283-84.

Because Respondents' dose-averaging excess cancer risk assessment (if accepted as a valid method) is based on 0.00414 μg/m^3–emissions that do not represent the highest maximum modeled emissions[7]–Respondents' conclusion that the Project will not increase cancer risk above 1 in 100,000 are not reliable. The Board should eschew Respondents' mathematical tricks that only serve to hide the true threat to public health, reject the Hearing Officer's conclusions that DEQ acted reasonably in determining the Project's maximum annual average arsenic emissions, and send the Permit back to DEQ for re-evaluation.

CONCLUSION

Respondents' post-hoc excess cancer risk "assessment," concocted after comments from Petitioners' on three draft permits over three years, and after an additional two years of contested case proceedings, and hidden from public scrutiny, is a farce. The Hearing Officer's Preliminary Order flies in the face of findings made by this Board in its May 9, 2024 Final Order, creates ad-hoc rules found nowhere in DEQ regulations, is unreasonable and ignores much of the scientific evidence before it, and is dangerous for public health and damaging precedent for clean air. The Board should therefore hold unlawful and set aside the Permit and should remand to

[7] *See* REC 4284 (Lopez Decl. 24); REC 3876 (Paden Decl. 9).

DEQ to either deny the Permit or to issue a Permit that complies with the Air Rules and the Board's orders.

Petitioners' request the Board hold a hearing on this Petition.

DATED: January 21, 2025

Respectfully submitted,

s/ *Julia Thrower*
Julia S. Thrower
Attorney for Save the South Fork Salmon

s/ *Bryan Hurlbutt*
Bryan Hulbutt
Attorney for the Nez Perce Tribe and the Idaho Conservation League

CERTIFICATE OF SERVICE

I hereby certify that I have this 21st day of January 2025, served a true and correct copy of the foregoing PETITIONERS' PETITION FOR REVIEW OF JANUARY 7, 2025 PRELIMINARY ORDER, MEMORANDUM IN SUPPORT, AND REQUEST FOR HEARING upon all parties of record in this proceeding by delivering a copy by e-mail to the following:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov

Dylan V. Lawrence
Hearing Officer
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com

Diane Cutler, Hearing Coordinator
Rules and Planning Analyst
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
(208)373-0165
diane.cutler@deq.idaho.gov

Michael A. Short
Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
michael.short@deq.idaho.gov
hannah.young@deq.idaho.gov

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole Hancock
Stoel Rives LLP
101 S. Capitol Blvd., Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
nicole.hancock@stoel.com

s/*Julia Thrower*
Julia S. Thrower

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	Agency Case No. 0101-22-01
	)	OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON	)	**PETITIONER SAVE THE SOUTH FORK SALMON'S MOTION FOR RECONSIDERATION BASED ON NEW EVIDENCE**
Petitioners,	)	
v.	)	
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC.	)	
Intervenor-Respondent.	)	

Petitioner Save the South Fork Salmon ("SSFS") hereby moves the Idaho Board of Environmental Quality (the "Board") for reconsideration of the Board's May 9, 2024 Final Order regarding the issue of whether the Stibnite Road Access Route was appropriately excluded from ambient air protections in the permit to construct the Department of Environmental Quality ("DEQ") issued to Perpetua Resources Idaho ("Perpetua"). Specifically, the U.S. Forest Service's January 3, 2025 Final Record of Decision for the Stibnite Gold Project, and supporting documents, provide relevant new information that address the issue of whether Perpetua has legal control to preclude public access from the Stibnite Road Access Route.

On June 12, 2024, the Board issued an Order on petitions for Reconsideration and/or Clarification of Final Order, which stayed the statutory deadlines under Idaho Code ("I.C.") § 67-5246 for the May 9, 2024 Final Order until other issues (ambient arsenic concentration) remanded back to the Hearing Officer were resolved. REC 3840 (stating the Board "will stay issuance of a final order on all five issues until the remand before the Hearing Officer is complete and all statutory deadlines for review of the Hearing Officer's Orders have run."). This Motion for Reconsideration is timely brought under Idaho Code §§ 67-5246, 67-5276 and IDAPA 04.11.01.740.

BACKGROUND

In this contested case, Petitioners Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon challenge the Idaho Department of Environmental Quality's ("DEQ" or "Department") approval of a permit to construct issued to Perpetua Resources Idaho, Inc. ("Perpetua") for the proposed Stibnite Gold Project (the "Project"): a massive open-pit mine in Valley County, Idaho.

On June 17, 2022, DEQ issued permit to construct P-2019.0047 (the "Permit"), which is the Permit at issue in this contested case. On July 22, 2022, Petitioners timely filed the original Petition to Initiate Contested Case. One of the claims Petitioners raised was that DEQ acted unreasonably and not in accordance with the law when it determined, without specific evidence, that Perpetua would have legal control of the Stibnite Road Access Route (the "Route") such that it could exclude the Route from ambient air.

After briefing and a hearing on cross-motions for summary judgment in front of the Board, on May 9, 2024, the Board issued a Final Order, ruling in Petitioners' favor on one issue, and ruling against Petitioners on four other issues, including the ambient air boundary issue. *See* REC 3695-3719. Specifically, the Board held that in assessing whether to include the Stibnite Road Access Route within the ambient air boundary, it was reasonable–in the absence of other evidence in the record–for DEQ to rely on Perpetua's representations in its application form that it would have legal control over the Route's access. REC 3701.

The Board recognized that the absence of evidence in the record as to whether the Forest Service would require continuing public access over the Route was due to the federal environmental review process under the National Environmental Policy Act not being completed, and no final decision by the Forest Service had been made. REC 3700. At the hearing, DEQ recognized that "should the [Forest Service] ultimately require public access through the [Stibnite Gold Project], the ambient air boundary analysis will have to be reevaluated." REC 3700 (citing TR 0080 (March 14, 2024 Board Hearing at 88-89)).

On June 12, 2024, the Board issued an Order on Petitions for Reconsideration and/or Clarification of Final Order, ruling it "will stay issuance of a final order on all five issues until

the remand before the Hearing Officer is complete and all statutory deadlines for review of the Hearing Officer's Orders have run." REC 3840.

MEMORANDUM IN SUPPORT

1. The Forest Service's decision leaves the Stibnite Road Access Route open to public use; it does not allow Pereptua to preclude public access.

On January 3, 2025, the Forest Service completed the environmental review process and issued a Final Environmental Impact Statement ("FEIS") and Record of Decision ("ROD"). The Forest Service's final decision documents unequivocally establish that the Stibnite Road Access Route is for public use and that Perpetua does not have absolute legal authority to preclude such use:

- Stibnite Road connects to Thunder Mountain Road on the southeastern portion of the Stibnite mine site and currently provides public access through the mine area. Thrower Decl., Exh. 2 at 3-423.

- A new 12-foot-wide gravel road will be constructed **to provide public access from Stibnite Road (FR50412) to Thunder Mountain Road (FR 50375) through the Stibnite Gold Project.** During operations, the public access road will be used to travel through the Stibnite Gold Project and will provide seasonal use, open to all vehicles. Thrower Decl., Exh. 1 at 74 (Table 6) (emphasis added).

- During operations, the public access road through the Operations Area Boundary[1] would provide seasonal use, open to all vehicles; access would not be provided in winter when impassable (current county maintenance standards) and signs would inform the public of seasonal and temporary closures. Public vehicles passing through would be required to check-in with mine personnel at the North or South SGP entry points and would receive a safety briefing and would also be required to check-out with the SGP personnel upon exhibiting the SGP. For safety purposes, public access would be separated from other SGP roads by berms, security fencing, and the underpass to allow the public road to pass beneath the mine haul road. Thrower Decl., Exh. 2 at 2-20.

[1] The Operations Area Boundary is identical to the ambient air boundary defined in the Permit. REC 0415 (Statement of Basis Permit to Construct No. P-2019.0047, June 17, 2022).

These documents establish that: (1) the Stibnite Road Access Route will be constructed primarily to provide public access through the mine site; (2) the road will be open to "all vehicles" seasonally in a similar manner to current county maintenance standards; (3) the Route for public access will be separated from other mine roads and features where the public will not be allowed to access; and (4) although Perpetua has control to impose safety restrictions on the Route, the Route is open for public use. Consequently, although Perpetua has control to restrict public access for safety purposes, it does not have control to preclude public access completely.

2. Without legal control to preclude public access, and consistent with EPA policy, DEQ guidance, and the Clean Air Act, DEQ cannot exclude the Stibnite Road Access Route from ambient air.

As discussed in Petitioners' briefs before the Board on the Parties' cross-motions for summary judgment, REC 339-43; REC 2336-40, the Clean Air Act's regulatory definition of ambient air, 40 C.F.R. 50.1(e), EPA's long-standing policy on ambient air, REC 1138-49, and DEQ's guidance, REC 1096, 1109-10, establish that air within a facility's boundaries is ambient air unless the facility can demonstrate that *public access is precluded*. In its final decision, the Forest Service has decided that public access is granted--*not precluded*. The Forest Service's decision requires Perpetua to leave the Stibnite Road Access Route open to public access through the mine site and only authorizes Perpetua to restrict or control access based on safety reasons. [cite]. Because public access is not precluded,the Stibnite Road Access Route must receive ambient air protections. Petitioners refer the Board to their briefs on cross-motions for summary judgment on the issue. REC 339-43; REC 2336-40.

CONCLUSION

Based on new information in the Forest Service's decision documents for the Stibnite Gold Project, the Board should remand the Permit back to DEQ for reconsideration of the ambient air boundary analysis.

Dated January 24, 2025

Respectfully submitted,

/s/ Julia Thrower
Julia Thrower
Attorney for Save the South Fork Salmon

CERTIFICATE OF SERVICE

I hereby certify that I have this 24th day of January 2025, served a true and correct copy of the foregoing PETITIONER SAVE THE SOUTH FORK SALMON MOTION FOR RECONSIDERATION BASED ON NEW EVIDENCE upon all parties of record in this proceeding by delivering a copy by e-mail to the following:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov

Dylan V. Lawrence
Hearing Officer
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com

Diane Cutler, Hearing Coordinator
Rules and Planning Analyst
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
(208)373-0165
diane.cutler@deq.idaho.gov

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Michael A. Short
Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
michael.short@deq.idaho.gov
hannah.young@deq.idaho.gov

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole Hancock
Stoel Rives LLP
101 S. Capitol Blvd., Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
nicole.hancock@stoel.com

s/*Julia Thrower*
Julia S. Thrower

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	Agency Case No. 0101-22-01 OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC. Intervenor-Respondent.	)	**DECLARATION OF JULIA THROWER**

I, JULIA THROWER, hereby declare as follows:

1. The following facts are personally known to me, and if called as a witness, I could and would competently testify thereto. I am over eighteen years of age.

2. I am counsel of record representing Petitioner Save the South Fork Salmon in this matter.

3. The attached Exhibits 1-2 are true and correct copies of the following documents, which were obtained online from the Payette National Forest Stibnit Gold Project EIS website: https://www.fs.usda.gov/project/?project=50516.

4. Exhibit 1 contains an excerpt of the U.S. Forest Service, Payette and Boise National Forests, Final Record of Decision, Stibnite Gold Project, Valley County, Idaho (January 2025).

5. Exhibit 2 contains excerpts from the U.S. Forest Service, Stibnite Bold Project Final Environmental Impact Statement (January 2025).

I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge, information and belief, and based on my personal experiences.

Signed this 24th day of January 2025, in McCall, Idaho.

/s/ Julia Thrower
Julia S. Thrower

Exhibit 1

Stibnite Gold Project
Record of Decision
(excerpt)

United States Department of Agriculture
Forest Service

Stibnite Gold Project

Final

Environmental Impact Statement

Forest Service, Region 4, Payette and Boise National Forests, Valley County, Idaho



REC 7156

2.4.4.4 Public Access

During construction of the SGP and completion of the Burntlog Route, to the degree practicable, the public would continue to have access on forest roads currently available to the public (**Figure 2.4-1**). However, public access through the Operations Area Boundary on Stibnite Road would be restricted for a period of approximately one year while a new through-site public access road is constructed. A new 4-mile long, 12-foot-wide gravel road would be constructed to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road through the SGP (**Figure 2.4-2**). The road would be constructed on a widened bench on the west side within the Yellow Pine pit, then head south of the Yellow Pine pit, where this road would utilize an underpass to cross under a SGP haul road and continue southward, parallel to and on the east side of the mine haul road on a partially revegetated portion of a former haul road (**Figure 2.4-2**). Southwest of the ore processing area, the public access road would connect with Thunder Mountain Road and continue toward the worker housing facility, exiting the SGP to the southeast.

During operations, the public access road through the Operations Area Boundary would provide seasonal use, open to all vehicles; access would not be provided in winter when impassable (current county maintenance standards) and signs would inform the public of seasonal and temporary closures. Public vehicles passing through would be required to check-in with mine personnel at the North or South SGP entry points and would receive a safety briefing and would also be required to check-out with SGP personnel upon exiting the SGP. For safety purposes, public access would be separated from other SGP roads by berms, security fencing, and the underpass to allow the public road to pass beneath the mine haul road. No stopping or deviating from the public access road would be allowed. Perpetua could restrict access to any vehicles due to concerns related to public or employee health and safety, such as during road construction and maintenance, blasting, highwall scaling, mining in the immediate area of the road, and similar operations.

Public access along Johnson Creek Road during the life of the SGP would be unchanged; however, closures spanning from a half-day to multiple days could occur due to construction activities. Total closures of half-day to multiple days could occur during construction work on Stibnite Road between the village of Yellow Pine and the SGP, part of Thunder Mountain Road, and Burnt Log Road.

Public access on existing segments of the Burnt Log Road would be restricted for limited periods of time to upgrade road segments during construction of the Burntlog Route. Other routes available for public use are shown on **Figure 2.4-1**.

Public access by foot via existing trails or on roads would be restricted within the Operations Area Boundary shown on **Figure 2.4-2**. Security personnel, fencing (including wildlife exclusion fencing), and signs would restrict public access to vehicular traffic on the designated public access roadway inside the Operations Area Boundary.

Johnson Creek Road

During non-winter conditions (roads clear of snow), the Operations Area Boundary can be accessed from the City of Cascade by traveling northeast on Warm Lake Road for about 34 miles to Landmark, then north on Johnson Creek Road for approximately 25 miles to the village of Yellow Pine, and approximately 14 miles east on the Stibnite Road portion of McCall-Stibnite Road (Stibnite Road). Johnson Creek Road and the Stibnite Road portion of McCall-Stibnite Road is currently used to access the Operations Area Boundary during the summer.

The Johnson Creek Road is a county maintained, native surface road that is open to vehicles with seasonal restrictions due to snow. During the winter, Valley County plows approximately 10 miles of Johnson Creek Road from Yellow Pine to Wapiti Meadow Ranch and Perpetua (under agreement with Valley County) plows along Stibnite Road. Valley County grooms the remaining 17 miles of Johnson Creek Road from Wapiti Meadow Ranch to Warm Lake Road at Landmark for OSV use. Valley County does not plow Warm Lake Road from Warm Lake to Landmark. This section is a designated groomed OSV route.

McCall-Stibnite Road

The Stibnite Road from the intersection with Johnson Creek Road then east to the mine is also a county-maintained native surface road, open to all vehicles with seasonal restrictions due to snow. This road is plowed in the winter by Perpetua through an agreement with Valley County. Stibnite Road connects to Thunder Mountain Road on the southeastern portion of the Stibnite mine site and currently provides public access through the mine area.

The analysis area can be accessed from McCall during non-winter conditions by traveling east on the Lick Creek Road portion of McCall-Stibnite Road for approximately 37 miles to the East Fork Road portion of McCall-Stibnite Road, then approximately 16 miles to the village of Yellow Pine, and approximately 14 miles east on Stibnite Road. Lick Creek Road is not maintained during the winter; however, East Fork Road and Stibnite Road are plowed from the intersection with SFSR Road to Yellow Pine by Valley County and from Yellow Pine to the Operations Area Boundary by Perpetua to access their private land inholdings in the area. Although the Lick Creek and East Fork roads are not proposed to be used by the SGP, they provide access for other users of the analysis area.

South Fork Salmon River Road

The SFSR Road can be accessed year-round from Cascade by traveling approximately 24 miles northeast on Warm Lake Road to the intersection with SFSR Road. It then travels north for approximately 30 miles to intersect with the East Fork Road portion of the McCall-Stibnite Road. Some segments along SFSR Road have sharp curves which can be challenging for heavy vehicle travel. Although this route currently provides the only access to the Operations Area Boundary during winter months, it is not proposed to be used by the SGP.

3.16.4.3 Existing Stream Crossings

Existing stream crossings along the existing Johnson Creek, Stibnite, and Burnt Log roads are shown on **Figure 3.13-7**. There are 213 existing stream crossings along existing main access roads in the analysis

Exhibit 2

Stibnite Gold Project
Final Environmental Impact Statement
(excerpts)

United States Department of Agriculture

U.S. Forest Service

Payette and Boise National Forests

Final Record of Decision

Stibnite Gold Project

Valley County, Idaho

January 2025

Table 5 Prominent Regulatory and Land and Resource Management Plan Requirements

Description	Type	Reference	Resources Affected
The proponent will prepare a dust mitigation plan with appropriate schedule or triggers for control deemed adequate by Idaho Department of Environmental Quality to achieve the level of control of 93.3 percent of dust (as required in conditions 2.1-2.8 of the Permit to Construct from Idaho Department of Environmental Quality). Additionally, the proponent will employ particulate matter or opacity monitors deemed adequate by the Forest Service and immediately apply water or chemical dust control when PM or opacity monitors reach levels within 10 percent of the threshold determined by Idaho Department of Environmental Quality.	Idaho Department of Environmental Quality Permit	Idaho Department of Environmental Quality Permit to Construct	Air Quality Visibility, Wildlife, Vegetation, Wilderness
During project planning, affected tribe(s) shall be consulted regarding opportunities for restoration, enhancement, and maintenance of native plant communities that are of interest to tribe(s) when proposed activities may affect those plant communities.	FP Component	BNF and PNF: TRST04	Cultural Resources, Vegetation
When taking water from fish-bearing waters for road and facility construction and maintenance activities, intake hoses shall be screened with the most appropriate mesh size (generally 3/32 of an inch), or as determined through coordination with National Oceanic and Atmospheric Administration Fisheries and/or U.S. Fish and Wildlife Service.	FP Component	BNF and PNF: FRST01 TEST32	Fish
Fish passage shall be provided at all proposed and reconstructed stream crossings of existing and potential fish-bearing streams.	FP Component	BNF and PNF: SWST08	Fish
Surface water withdrawal intake hoses will be situated so as to prevent generation of turbidity in bottom sediments during pumping.	Design Feature		Fish, Water Resources
Where settlement ponds, tailing dams, or impoundments are planned, each will be located, designed, constructed, and inspected under the supervision of a professional engineer.	FP Component	BNF and PNF: MIGU03	Geology and Geotechnical
Prohibit solid and sanitary waste facilities in Riparian Conservation Areas. If no alternative to locating mine waste (waste rock, spent ore, tailings) facilities in Riparian Conservation Areas exists, then: Analyze waste material using the best conventional methods and analytic techniques to determine its chemical and physical stability characteristics. Locate and design waste facilities using the best conventional geochemical and geotechnical predictive tools to ensure mass stability and prevent the release of acid or toxic materials. If the best conventional technology is not sufficient to prevent such releases and ensure stability over the long term, and such releases or instability would result in exceedance of established water quality standards or would degrade surface resources, prohibit such facilities in RCAs. Monitor waste and waste facilities to confirm predictions of chemical and physical stability and make adjustments to operations as needed to avoid degrading effects to beneficial uses and native and desired non-native fish and their habitats.	FP Component	BNF and PNF: MIST09	Geology and Geotechnical, Wetlands and Water Resources, Wildlife, Fish

Description	Type	Reference	Resources Affected
Reclaim and monitor waste facilities to ensure chemical and physical stability and revegetation to avoid degrading effects to beneficial uses and native and desired non-native fish and their habitats. Require reclamation bonds adequate to ensure long-term chemical and physical stability and successful revegetation of mine waste facilities.			
Transport hazardous materials on the Forest in accordance with 49 CFR 171 in order to reduce the risk of spills of toxic materials and fuels during transport through RCAs.	FP Component	BNF and PNF: SWGU11	Hazardous Materials, Fish, Health and Safety
A Spill Prevention, Control, and Countermeasure (SPCC) Plan shall be prepared in accordance with 49 CFR parts 171 through 180, including packaging, transportation, incident reporting, and incident response. Include the following items within the SPCC Plan: • During off-loading of fuel from fuel vehicles or during refueling operations have a standard marine-type fuel containment boom (which would be of sufficient length for a worst-case discharge), spill prevention kit, and fire kit readily available on site. • Store two or more spill containment and response caches along each of the fuel delivery routes. • Spill response team will carry sufficient containment equipment for one full fuel tanker. • Include the Forest Service as a party to be notified in the event of a hazardous materials spill. • Intake pumps, engines, fuel storage, fuel containment site, and other equipment with fuel or lubricants will be inspected at each refueling and periodically between refueling for leakage or spillage. • Pilot and emergency spill response vehicles will carry appropriate containment and first aid equipment. • All fuel containers will be marked with contents, owner's name and contact information. • Material Safety and Data Sheets for all products will be posted and available on site with the SPCC plan. • Intake pumps will not be situated within the active stream and ditch channel and will be placed within containment vessels capable of holding 120 percent of the pump engine's fuel, engine oil and hydraulic fluid. The smallest practical pump and intake hose will be used. • Following large storm events, the intake pumps will be inspected to determine if stream flow has encroached into the pump area and if the pump needs to be moved so it remains above flowing water. • A spill prevention and clean-up kit will be placed at the intake pump site and will consist of absorbent pads and/or boom (which will be sufficient length for a worst-case discharge), drip pan, a shovel, and a fire extinguisher. • Spare fuel for the water intake pump will be stored in approved [29 CFR 1926.152(a)(1)] fuel storage containers	Regulatory Requirement and Design Features	49 CFR 171	Hazardous Materials, Health and Safety, Water Resources, Wetlands, Fish, Wildlife, Soils,

Description	Type	Reference	Resources Affected
placed into a secondary containment vessel capable of holding at least 120 percent of the volume of the fuel in the fuel container. • A copy of the SPCC plan will be kept at an appropriate on-site facility.			
Unless otherwise authorized, all garbage or refuse should be removed from National Forest System lands. This includes, but is not limited to, empty fuel and lubricant containers. Food and garbage will be stored either indoors, in vehicles, or if outside, in wildlife-proof containers. No garbage will be burned.	FP Component and Design Features	Design Feature developed for compliance with BNF and PNF: MIGU04	Hazardous Materials, Water Resources, Fish, Health and Safety, Wildlife
The operator shall comply with all applicable Federal and State fire laws and regulations and shall take all reasonable measures to prevent and suppress fires on the area of operations and shall require their employees, contractors and subcontractors to do likewise.	Regulatory Requirement	36 CFR 228.11	
The operator shall comply with State of Idaho fire protection procedures (as outlined in IDAPA 20.04.01) and any local Valley County Fire District regulations and shall require their employees, contractors and subcontractors to do likewise.	Regulatory Requirement	IDAPA 20.04.01	Health and Safety, Vegetation
Several fire-response kits will be spaced strategically around the project area and be inspected annually.	Design Feature		Health and Safety, Vegetation
On-site staff will maintain contact with Krassel District Ranger to ensure appropriate procedures are followed in the event of implementation of fire restrictions or woodland use restrictions (e.g., “Red Flag Warnings”).	Design Feature		Health and Safety, Vegetation
Damage to or loss of Forest System trails from mining activities should be repaired or mitigated by the Project Operator.	FP Component	BNF: REGU22, REGU24 PNF: REGU23, REGU26	Recreation
When new recreation facilities and trails must be located in RCAs, they shall be developed such that degrading effects to Riparian Conservation Areas are mitigated. Where reasonable and practical location alternatives exist, new recreation facilities and trails should be located outside of RCAs.	FP Component	BNF: REST02 PNF: REST02	Recreation

Description	Type	Reference	Resources Affected
Architectural designs will follow principles and concepts outlined in the Built Environment Image Guide. Facilities identified as necessary should blend with the surrounding landscape character and the ROS setting. ROS descriptions in the Boise National Forest and Payette National Forest Land and Resource Management Plans Appendix F should be used to help guide facility development and recreation activity management within each ROS class. When a structure or facility is created for other than public use, the materials, color, and location should be chosen to reduce visual contrast of the structure. Natural or neutral colors should be used in to help structures blend with the landscape. The use of natural or neutral colors and non-reflective surfaces will be considered for structures. An exception to this will be when the function of the structure is to be seen.	FP Component	BNF and PNF: FRGU13, SCGU13, SCGU14, SCGU15 BNF: REGU12, REGU15 PNF: REGU13, REGU16	Scenic Resources, Tribal Resources
Reclamation cover material (e.g., growth media) used in places including but not limited to the tailings storage facility and tailings storage facility buttress will be evaluated for contaminants prior to use during reclamation. Acceptable metal and contaminant concentrations and sampling and testing methodology will be documented in a sampling and analysis plan developed prior to reclamation.	Design Feature		Soil, Water, Public Safety
Topsoil and any brush removed will be stockpiled separate from fill material and used in reclamation.	Design Feature		Soils
Measures such as, but not limited to, segregating and stockpiling topsoil, implementing stormwater and sediment best management practices (BMPs), backfilling, revegetation, and concurrent reclamation will be conducted, where possible and practical, for areas where the soil has been exposed by ground-disturbing activities. These areas and sites include but are not limited to borrow sites, utility corridors, skid trails, firebreaks, temporary roads, cut and fill slopes, and areas where construction activities have occurred.	Design Feature	Design Feature developed to lessen impacts under BNF and PNF: SWST03, SWGU05	Soils, Vegetation, Timber, Transportation and Access, Water, Wetlands, Fish
Applicable road obliteration for all roads proposed for obliteration including temporary roads and applicable sections of the Burntlog route (if selected) will be fully recontoured, including full bench constructed road segments. Road obliteration through recontouring is the reclamation of a road template through the following: • Deep decompaction (36”) of the inside half of the road surface; • excavate road fill down to the natural ground level and then place on top of the decompacted inside half of the road surface on the cut slope side of road; • Reestablish the natural slope profile; and • Vegetation clump planting. Decompaction**:** All compacted road surfaces that will be covered with excavated material, for example the inside half of the road surface, shall be decompacted to a depth of 36 inches or to a restrictive layer (bedrock). This is to promote water infiltration, breakup any potential landslide slip surface between	Design Feature		Soils, Vegetation, Transportation and Access

Description	Type	Reference	Resources Affected
the road surface and excavated and placed fill material and allow deep root vegetation establishment. Excavation: After decompaction of the roadway, the outside road fill material shall be excavated and placed on roadbed between the top of cut and natural ground, forming a slope approximating natural contours. No ditches, water traps, or berms shall remain. Finished product should blend in with the surrounding terrain. Soil-Vegetation Plug Transplanting: Excavate soil-vegetation plugs from adjacent natural and undisturbed ground having a minimum surface area of 9 square feet to a depth beyond the vegetation rooting zone (plug size is dictated by excavator bucket size). The plug transplant shall be of sufficient depth that will maintain the root system and contain adequate soil to enhance favorable growth. Soil-vegetation plug transplanting will be done at a minimum rate of 15 plantings per 100 lineal feet evenly distributed along the width and length of the recontoured surface. The plugs will be transplanted to a depth even with the surrounding recontoured ground level. This work will be accomplished with an excavator. Surface Ground Cover: Ground cover across the entire recontoured or disturbed surface (this will include all scarified ground, de-compacted roads and skid trials), by order of priority, shall be achieved using a combination of clump planting, native mulch, coarse woody debris and certified weed free agriculture straw to reach a minimum of 50 percent to the maximum 80 percent coverage of the recontoured surface or disturbed area. Apply native seed mix, hydromulch or organic fertilizer. This order or priority shall be given to vegetation plug planting, native mulch, coarse woody debris, and straw. When applying coarse woody debris, use various size classes at levels similar to surrounding undisturbed ground and placed at various orientations. The desired result of road obliteration through recontouring is to restore slope contours the natural slope profile, improve soil productivity, improve soil-water infiltration, and reestablish ground water flow paths and hydrologic function.			
Road rutting from operations, outside the mine site, will be minimized by construction and maintenance of surface drainage structures, application of surfacing material, and by restricting road use when conditions are unacceptable due to moisture that is leading to the onset of rutting and concentrated turbid flow. (Note typical guidance is 'no use' if ruts deeper than 4" are created.) This design feature does not apply to the mine site.	Design Feature	Design Feature developed to lessen impacts under BNF and PNF: SWST02 SWST03	Soils, Vegetation, Timber, Transportation and Access, Water, Wetlands, Fish

Description	Type	Reference	Resources Affected
Handling of road waste material (e.g., slough, rocks) will avoid or minimize delivery of waste material to streams that will result in degradation of soil, water, riparian, and aquatic resources.	Design Feature	Design Feature developed for compliance with BNF and PNF: FRST05	Transportation and Access, Fish, Soils, Water Resources, Wildlife,
Commercial transport vehicles will be inspected at Knox or Landmark by the driver prior to accessing the Johnson Creek area.	Design Feature		Transportation and Access, Health and Safety
Road clearing and maintenance activities for roads under Forest Roads and Trail Act easement agreements will be coordinated with Valley County, as necessary.	Design Feature		Transportation and Access, Health and Safety
Mitigate degrading effects from locatable mine operations situated within Riparian Conservation Areas by identifying reasonable locations for access, processing, and disposal facilities outside of RCAs, wherever possible.	FP Component	BNF and PNF: MIST04, LSST07, MIST08, FRGU06	Transportation and Access, Water Resources, Fish, Wetlands.
To minimize the degradation of watershed resource conditions, prior to expected water runoff, water management features will be constructed, installed, and/or maintained. Activities and features include, but are not limited to, water bars, rolling dips, seeding, grading, slump removal, barriers and berms, distribution of slash, and culvert and ditch cleaning in all applicable areas.	Design Feature	Design Feature developed for compliance with BNF and PNF: SWST01 and SWST04	Transportation and Access, Water Resources, Soils, Wetlands
To accommodate floods, including associated bedload and debris, new culverts, replacement culverts, and other stream crossings will be designed to accommodate a 100-year flood recurrence interval unless site-specific analysis using calculated risk tools or another method, determines a more appropriate recurrence interval.	FP Component	BNF and PNF: FRST02	Transportation and Access, Water Resources, Soils, Wetlands, Fish
To minimize sediment runoff from the temporary roads and roadbeds, water management features will be constructed, installed, and/or maintained on authorized temporary roads and roadbeds, on completion of use, before expected water runoff, or before seasonal shutdown. Activities and features could include, but will not be limited to, water bars, silt fencing, certified weed-free wattles, and/or weed-free straw bales, rolling dips, seeding, grading, slump removal, barriers and berms, distribution of slash, and culvert and ditch cleaning. These features will be installed in strategic downslope areas and in RCAs, where and when appropriate.	Design Feature	Design Feature developed for compliance with BNF and PNF: SWGU06	Transportation and Access, Water Resources, Wetlands, Soils

Description	Type	Reference	Resources Affected
Snow removal will be accomplished in accordance with the following standards of performance: • All debris, except snow and ice, that is removed from the road surface and ditches will be deposited away from stream channels at approved locations. • During snow removal operations, banks will not be undercut, and gravel or other surfacing material will not be bladed off the roadway surface. • Ditches and culverts will be kept functioning during and following plowing. Berms left on the shoulder of the road will be removed and/or drainage openings will be created and maintained. Drainage openings will be spaced to maintain satisfactory surface drainage without discharge on erodible fills. • Dozers will be used on an as-needed basis for plowing snow. The dozer operator will maintain an adequate snow floor over the gravel road surface. • Snow will not be totally removed to the gravel road surface. Appropriate snow floor depth will be maintained to protect the roadway. • Damage of roads from, or as a result of, snow removal will be repaired in a timely manner. • Culverts and stream crossings will be clearly marked before snow removal begins to avoid placing berm openings in locations that will allow runoff to enter drainages directly at the culverts or stream crossings. Excessive snow will not be plowed into locations that will impact operation of the culverts or prevent positive drainage from drainage areas. Some snow is necessary around culvert openings and in the bar ditches as this will insulate the ditch and culvert and will prevent the water in the ditch and culvert from freezing. • No ice and snow removal chemicals will be used on roads. • Traction material will be 3/8-inch diameter gravel or greater.	Design Feature		Transportation and Access, Water Resources, Wetlands, Fish
If sensitive plants or their propagules are required to be collected, collection methods and other information will be under the direction of the Forest or Regional Botanist.	Design Feature	Design Feature developed for compliance with BNF and PNF: BTST02	Vegetation
For projects or activities that include application of insecticides, herbicides, fungicides, or rodenticides, degrading effects on sensitive plant species will be mitigated.	FP Component	BNF and PNF: BTST04	Vegetation
In revegetation and seeding projects in occupied Threatened, Endangered, Proposed, or Candidate (TEPC) plant habitat, a Forest botanist shall be consulted to ensure appropriate species are used.	FP Component	BNF and PNF: TEST09	Vegetation

Description	Type	Reference	Resources Affected
When available and not cost-prohibitive, seeds and plants used for seedings and plantings in revegetation projects should originate from genetically local sources of native species. When project objectives justify the use of non-native plant materials, documentation explaining why non-natives are preferred should be part of the project planning process.	FP Component	BNF and PNF: BTGU03	Vegetation
Noxious weeds and undesirable non-native plants will be eradicated in the Operations Area boundary, within permitted use areas, and the cut and fill slopes of roads and trails used by mine and mine facility related traffic. Where it is not practical to eradicate existing infestations, infestations will be managed to prevent seed production and spread. In areas of existing extensive infestation, mitigation for noxious weed prevention will be incorporated into road layout, design, and project alternative evaluation.	Design Feature	Design Feature developed for compliance with BNF and PNF: FRGU02, TEST10	Vegetation
Clean borrow and gravel sources on Forest should be maintained as noxious weed free through an inspection and treatment program. Off-Forest inspections and treatments should be coordinated with county weed agents.	FP Component	BNF and PNF: NPGU02	Vegetation
All seed used on National Forest System lands will be certified to be free of seeds from noxious weeds listed on the current All States Noxious Weeds List.	FP Component	BNF and PNF: NPST02	Vegetation
Materials such as hay, straw, or mulch that are used for rehabilitation and reclamation activities shall be free of noxious weed seed and shall comply with the 1995 weed-free forage special order against use of non-certified hay, straw, or mulch. Materials that are not covered under a weed seed free certification, and that have the potential to contain noxious weed seed, shall be inspected and determined to be free of weed seed before purchase and use.	FP Component	BNF and PNF: NPST01 NPST06	Vegetation
Source sites for gravel and borrow materials shall be inspected for noxious weeds before materials are processed, used, or transported from the source site into the project area or onto the National Forest.	FP Component	BNF and PNF: NPST07	Vegetation
Gravel or borrow material source sites with noxious weed species present shall not be used unless effective treatment or other mitigation measures are implemented.	FP Component	BNF and PNF: NPST08	Vegetation
To prevent invasion and expansion of noxious weeds, the following provisions will be included in the plan of operating where land-disturbing activities are associated with the authorized land use): a) Re-vegetate areas, as designated by the Forest Service, where the soil has been exposed by ground-disturbing activity. Implement other measures, as designated by the Forest Service, to supplement the influence of re-vegetation in preventing the invasion or expansion of noxious weeds. Potential areas will include: construction and development sites, underground utility corridors, skid trails, landings, firebreaks, slides, slumps, temporary roads, cut and fill slopes, and travel ways of specified roads.	FP Component	BNF and PNF: NPST03	Vegetation

Description	Type	Reference	Resources Affected
b) Earth-disturbing equipment used on National Forest System lands--such as cats, graders, and front-loaders--shall be cleaned to remove all visible plant parts, soil, and material that may carry noxious weed seeds. Cleaning shall occur prior to entry onto the project area and again upon leaving the project area if the project area has noxious weed infestations. This also applies to fire suppression earth-disturbing equipment contracted after a Wildland Fire Situation Analysis and Wildland Fire Implementation Plan has been completed.			
Integrated weed management shall be used to maintain or restore habitats for sensitive plants and other native species of concern where they are threatened by noxious weeds or non-native invasive plants. Specific measures to reduce the potential for spread and establishment of noxious weed infestations could include, but are not limited to, determining the presence, location, and amount of noxious weed infestations in the Operations Area, developing management strategies such as, methods and frequency for treating infestations, treatment procedures and restrictions, reporting requirements, and follow-up or monitoring requirements. Herbicide applications will be by or under the direct supervision of licensed Idaho professional herbicide applicators with Aquatic Pest Control certifications and will be consistent with the Boise National Forest Invasive Species Management Plan and Payette National Forest guidance.	FP Component and Design Features	Design Feature developed for compliance with BNF and PNF: NPST11	Vegetation
New facilities for storage of fuels and other toxicants will be located outside of occupied Regional Forest Sensitive, Forest Watch, and TEPC plant habitat.	FP Component	BNF and PNF: TEST11	Hazardous Materials, Water Resources, Fish, Health and Safety, Vegetation
Public firewood cutting and gathering along the Burntlog route, if the route is open to the public, will not be allowed.	Design Feature		Vegetation
Mitigate, through avoidance or minimization, management actions within known winter roosting sites of TEPC species if those actions would adversely affect the survival of wintering or roosting populations. During project planning, determine sites, periods, and appropriate mitigation measures to avoid or minimize effects.	FP Component	BNF and PNF: TEST13 WIST03	Wildlife
Section 6 of Idaho Department of Land's Best Management Practices for Mining in Idaho (IDL 1992) will be observed, including if water is encountered in exploration holes, water zones will be sealed off during abandonment to prevent crossflow.	Regulatory Requirement	Section 6 of Idaho Department of Land's Best Management Practices for Mining in Idaho (IDL 1992)	Water Resources

Description	Type	Reference	Resources Affected
The proponent will implement surface water quality baseline turbidity monitoring, as defined in the Idaho Department of Environmental Quality permit clauses.	Design Feature		Water Resources, Fish
Do not authorize storage of fuels and other toxicants or refueling within Riparian Conservation Areas unless there are no other alternatives. Storage of fuels and other toxicants or refueling sites within Riparian Conservation Areas shall be approved by the responsible official and have an approved spill containment plan commensurate with the amount of fuel.	FP Component	BNF and PNF: SWST11	Water Resources, Fish, Wetlands, Hazardous Materials, Health and Safety
Dust abatement chemicals will be used in accordance with the applicable road maintenance Biological Assessment. Apply dust- abatement additives and stabilization chemicals (typically $MgCl_2$, $CaCl_2$, or lignin sulphonates) to avoid run-off of applied dust abatement solutions to streams. Spill containment equipment will be available during chemical dust abatement application. Where the road surface is within 25 feet (slope distance) of surface water, dust abatement will only be applied to a 10-foot swath down the centerline of the road. The rate and quantity of application will be regulated to insure all of the chemical is absorbed before leaving the road surface.	Design Feature		Water Resources, Fish, Wetlands, Air Quality, Transportation and Access
Drilling mud and hole plug products, if utilized, will conform to American Petroleum Institute guidelines for ensuring groundwater integrity.	Design Feature	American Petroleum Institute guidelines	Water Resources, Health and Safety, Hazardous Materials
Trees or snags that are felled in Riparian Conservation Areas will be left unless determined not to be necessary for achieving soil, water, riparian, and aquatic desired conditions. Felled trees or snags left in Riparian Conservation Areas will be left intact unless resource protection (e.g., the risk of insect infestation is unacceptable) or public safety requires bucking them into smaller pieces.	FP Component	BNF and PNF: SWST10	Water Resources, Soil, Fish, Vegetation
The proponent will monitor stormwater runoff and stormwater BMPs as per the Stormwater Pollution Prevention Plan (SWPPP). Stormwater monitoring, inspections, and reporting will be conducted in accordance with the Idaho Pollutant Discharge Elimination System Multi-Sector General Permit and the SWPPP.	Permitting Requirement	Idaho Pollutant Discharge Elimination System Multi-Sector General Permit and the SWPPP	Water Resources, Soils
All activities will be conducted in accordance with Idaho environmental anti-degradation policies, including Idaho Department of Environmental Quality water quality regulations at IDAPA 58.01.02 and applicable federal regulations.	IDAPA 58.01.02		Water Resources, Wetlands, Fish
If additional water rights are applied for, the Forest Service will be informed to determine if additional analysis or consultation is necessary prior to use.	Design Feature		Water Rights

Description	Type	Reference	Resources Affected
Road reconstruction and/or upgrades to NFR 51290 (Meadow Creek Lookout Road) on the ridgeline dividing Meadow Creek from the Indian Creek drainage will be restricted to 30 feet either side of the centerline of the existing alignment to prevent potential for direct impacts to the Frank Church River of No Return Wilderness.	Design Feature	Design Feature developed for compliance with BNF and PNF: LSST03, LSST05	Wilderness
Mitigate management actions within known winter roosting sites or hibernacula (bats) of Sensitive species if those actions would measurably reduce the survival of wintering or roosting populations. Sites, periods, and mitigation measures will be determined during project planning.	FP Component	BNF and PNF: WIST04	Wildlife
To mitigate impacts to known nesting or denning sites of Management Indicator Species or Sensitive species, land clearing activities in areas where complete vegetation removal is necessary greater than 0.5 acres will not occur, to the extent possible, until after the bird breeding season (April 1 through July 30th) for migratory and resident birds. This design feature does not apply to the mine site, road construction or maintenance, hazard tree felling, or the power line upgrades and construction.	Design Feature	Design Feature developed for compliance with BNF and PNF: WIST03	Wildlife
To the extent possible, trees and snags found to contain nesting cavities would not be disturbed or cut. No trees with active nests would be cut. Exceptions: Mine Site and New Road Construction: Land clearing activities in areas where complete vegetation removal (greater than 0.5 acres) is necessary; these activities will not occur until after the bird breeding season (March 1 through July 30th) for migratory and resident birds. Power line construction and upgrades: Land clearing activities in areas where complete vegetation removal is necessary will not occur until after the bird breeding season (March 1 through July 30th) for migratory and resident birds.	Design Feature	BNF and PNF: Developed in response to WIST03; EO 13186	Wildlife
Potential water sources will be surveyed by the proponent, in coordination with the Forest Service, for Columbia spotted frog egg masses and other amphibians after ice melt and avoid disturbing any water sources with identified egg masses or other species. Exceptions: If egg masses are found at a water source essential for proposed activities, the egg masses will be relocated in coordination with the Forest Service wildlife biologist.	Design Feature	Design Feature developed for compliance with BNF and PNF: WIST03, TEST12	Wildlife
The Forest Service wildlife biologist will be notified of any sightings of TEPC or Sensitive wildlife species, including, occupied sensitive species nests or dens encountered during implementation. If necessary to maintain key features of nesting and denning habitat or to avoid disruption of nesting and denning activities, prescribed activities will be modified in accordance with the Forest Service wildlife biologist.	Design Feature	Design Feature developed for compliance with BNF and PNF: WIST03, TEST12	Wildlife

Description	Type	Reference	Resources Affected
Where practicable, monitoring of high elevation habitats characteristic of wolverine denning habitat will be done in cooperation with State fish and game agencies.	Design Feature	Design Feature developed for compliance with BNF: WIGU17	Wildlife
To minimize adverse effects of lighting to TEPC, Management Indicator Species, or Sensitive species, where necessary and in accordance with Mine Safety and Health Administration and the Occupational Safety and Health Administration, the proponent could utilize actions in line with, but not limited to, the below: • To the extent practicable, limit construction activities to the time between dawn and dusk. • Utilize, where possible, use down shielding or directional lighting such as 'Cobra' style lights rather than an omnidirectional light system. • While allowing for public and worker safety, utilize low intensity energy saving lighting (e.g., low pressure sodium lamps). • If possible, minimize illumination of lighting on associated construction or operation structures by using motion sensors or heat sensors. • If possible, place light shields over outside lights, confining light to the immediate area. • Whisper Quiet light plants could be utilized used to mitigate visual impacts from night operations.	Design Feature	Design Feature developed for compliance with BNF and PNF: WIST03, WIST04 TEST29	Wildlife
Communication towers should not be sited in or near wetlands, or other known bird concentration or high use areas (e.g., riparian corridors), in known migratory or daily movement flyways. Towers should not be sited in areas with a high incidence of fog, mist, and low ceilings.	Design Feature		Wildlife
If fawning and calving activity is encountered during project activities, the activity will cease and/or be modified in coordination with the Forest Service.	FP Component	BNF: WIGU12 PNF: WIGU12	Wildlife
In goshawk territories with known active nest stands, identify alternate and replacement nest stands during project-level planning when it is determined that the proposed activity is likely to degrade nest stand habitat.	FP Component	BNF and PNF: WIST06	Wildlife
To minimize adverse effects of noise to TEPC, Management Indicator Species, or Sensitive species, where necessary and in accordance with Mine Safety and Health Administration and Occupational Safety and Health Administration, the proponent could utilize actions in line with, but not limited to, the below: • Construction equipment engines will be equipped with adequate mufflers, intake silencers, and engine enclosures when feasible. • When practicable, pumps, generators, and engines will be turned off when not in use.	Design Feature	Design Feature developed for compliance with BNF and PNF: WIST03, WIST04 TEST29	Wildlife, Scenic Resources, Noise, Wilderness

Description	Type	Reference	Resources Affected
• Temporary wooden structure could be erected around portions of the drill, pumps, and heaters, with acoustic absorbent panels. These temporary structures will not be put in place if they created safety issues related to exhaust vapor build-up. • When feasible, activities such as helicopter use and blasting, could be scheduled at the same time.			
In revegetation and seeding projects in occupied sensitive plant habitat, a Forest botanist shall be consulted to ensure appropriate species are used.	FP Component	BNF and PNF: BTST05	Vegetation
Design and implement projects within occupied habitats of Sensitive species to help prevent them from becoming listed. Use Forest Service-approved portions of Conservation Strategies and Agreements, as appropriate, in the management of Sensitive species habitat to keep management actions from contributing to a trend toward listing for these species.	FP Component	BNF and PNF: WIST02	Wildlife, Vegetation

Table 6 Proponent Proposed Environmental Design Features

Description	Resources Affected
Following crushing, the crushed ore will report via conveyor to a dome-shaped, covered stockpile.	Air Quality
Dust emission controls, such as water sprays and/or bag house dust collectors, will reduce dust from crushing, conveying, and stockpiling.	Air Quality
Dust will be controlled in a similar manner to the ore crushing and conveying process using water sprays and/or bag house dust collectors.	Air Quality
Air emissions from the leaching facility will be captured in a series of air pollution controls, and the material collected will be disposed of as a solid waste or a hazardous waste depending on characterization of the waste.	Air Quality
Air emissions from the induction furnace will be captured in a series of emission controls. Mercury from the induction furnace will be converted to a liquid metallic state, and then securely stored prior to shipment to a certified hazardous waste disposal facility.	Air Quality
Silos will be equipped with air emission controls except for Prill Silo.	Air Quality
All off-highway diesel engines will be Environmental Protection Agency Tier IV or better.	Air Quality, Climate Change
The Project Operator will encourage employees to use company provided shuttle buses as transport to the Stibnite Gold Logistics Facility from towns along SH 55.	Air Quality, Health and Safety, Transportation and Access
Busing and/or vanpooling will be provided for the Project Operator and contractor employees. The associated parking area will accommodate approximately 300 vehicles. To the degree practicable, the Project Operator will mandate the use of busing and vans for employee and contractor transportation to the Stibnite Gold Project and the worker housing facility.	Air Quality, Health and Safety, Transportation and Access
Proper dust control will be employed along transportation corridors and active mining areas using aquatic safe dust suppression chemicals and methods.	Air Quality, Water Resources, Fish, Wildlife

Description	Resources Affected
The Project Operator will utilize “smart grid” technology to reduce energy consumption, such as auto dimming lights in offices.	Climate Change
The Project Operator employees and contractors will be informed about relevant governmental regulations intended to protect cultural and historic resources.	Heritage
To protect fish residing in, using, or potentially using the Yellow Pine Pit lake (Chinook salmon, steelhead trout, bull trout, Westslope cutthroat trout, mountain whitefish), the Project Operator has developed a Fish Salvage and Release Plan to isolate the lake from upstream movement into the lake and salvage and release fish. The Fish Salvage and Release Plan will be refined in coordination with federal, state, and tribal agencies. The Project Operator will, in consultation with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service, design, install, and operate a fish trap and one or two weirs designed to allow fish to leave the Yellow Pine pit lake but not allow fish to migrate upstream past the trap to ensure that the fewest number of individual Endangered Species Act -listed fish species are present in the pit lake when the draining process begins. The timing for providing the upstream barrier to fish movement will be designed to minimize the number of fish in the Yellow Pine pit lake, particularly larger bull trout. Fish captured in the Yellow Pine pit lake will be immediately released downstream of the upstream fish movement barrier or in another location determined by the appropriate regulatory agencies. The Yellow Pine pit lake will be partially drained to recover the remaining fish and relocate them prior to final draining of the pit lake.	Fish
A fishway has been designed and will be operated within the East Fork South Fork Salmon River diversion tunnel to provide upstream and downstream volitional fish passage throughout mine operations. The East Fork South Fork Salmon River diversion tunnel will be approximately 0.9 miles long and 15 feet high by 15 feet wide. The tunnel will include a parallel accessway to allow equipment and personnel access for monitoring, inspection, and maintenance. The accessway will function as a floodway for high flows, limiting the operating flow range within the fishway while river and thus total tunnel flows vary more widely.	Fish
As an alternative to the fishway in the East Fork South Fork Salmon River diversion tunnel the Project Operator will provide adult passage by trap and haul if needed. Criteria may be put in place so that if any unusual or unexpected events occur that result in adverse impacts to fish during operations, fish passage through the fishway will be switched to trap and haul operations.	Fish
Low-energy lighting will be provided in the fishway to determine if it aids in fish passage and to provide light for tunnel and fishway inspections. The system will be configured so that it mimics the photoperiod of the region, run manually on a dimming system, or be completely turned off at the option of the operator.	Fish
Fish salvage and relocation operations will be conducted any time the facility needs repair within the fishway, potentially during sediment removal, and potentially when streamflows recede from the accessway.	Fish
Post mining, the East Fork South Fork Salmon River stream channel will be reestablished across the backfilled Yellow Pine pit with a channel design that will provide for upstream and downstream fish passage.	Fish
the Project Operator will reestablish fish passage at the location of the existing box culvert on the East Fork South Fork Salmon River just downstream of the confluence with Meadow Creek at the McCall-Stibnite Road (CR 50-412) crossing.	Fish
The Project Operator will improve fish passage along the Burntlog Route within the Stibnite Gold Project area by identifying and replacing existing collapsed, undersized, or otherwise degraded or poorly designed culverts at road crossings and committing appropriate resources to fix and improve these structures.	Fish

Description	Resources Affected
The Project Operator will install side-ditching, culverts, guardrails, and bridges, where necessary along the Burntlog Route, with design features to provide fish passage and limit potential sediment delivery to streams.	Fish
The Project Operator will employ blasting setback distances and other controlled blasting techniques following industry best management practices (modifying blasting variables including charge size, and vibration and overpressure monitoring) to minimize impacts to fish from blasting. the Project Operator will follow up with monitoring in early stages of operation to evaluate effectiveness and refine blasting protocols in coordination with federal, state, and tribal agencies, if needed.	Fish
Dewatering of the Yellow Pine pit lake or stream segments will generally be conducted during low-flow periods to facilitate stream segment isolation and fish salvage. When practicable, dewatering also will be timed to avoid or minimize impacts during known spawning periods for Chinook salmon, steelhead, and bull trout.	Fish
To protect fish, the Project Operator will develop a standard procedure for channel segment isolation, dewatering, fish salvage, and fish relocation to appropriate receiving streams during dewatering or maintenance of natural stream and diversion channels, based on the U.S. Fish and Wildlife Service Recommended Fish Exclusion, Capture, Handling, and Electroshocking Protocols and Standards (U.S. Fish and Wildlife Service 2012) and refined in coordination with federal, state, and tribal agencies.	Fish
The fishway operations and management plan defines the monitoring and evaluation plan elements and describes how the hydraulic conditions, fish use, and performance of the tunnel fishway will be measured and evaluated, and the design of the adaptive management component of the plan including the option of using trap and haul.	Fish
Access and Stibnite Gold Project haul road crossings of fish bearing streams will be designed such that structures installed or constructed allow fish passage.	Fish and Wildlife
The Project Operator will implement measures to limit stream baseflow effects during active operations, including a combination of lining key reaches of streams potentially impacted by pit dewatering, and treating and discharging pit dewatering water that is not used for ore processing or other industrial uses. Maintain instream flows for fish species and other aquatic resources: flows within natural stream channels affected by Stibnite Gold Project operations will be maintained to meet seasonally appropriate and stream-specific low-flow needs to the maximum extent practicable. the Project Operator will continue to evaluate options and measures to further avoid and minimize the magnitude and duration of effects of the Stibnite Gold Project through other measures in consultation with federal, state, and tribal agencies.	Fish, Water Resources
Following permanent cessation of mining activities at the Yellow Pine pit, the Project Operator will backfill the pit and route the East Fork South Fork Salmon River over the backfilled pit with a longer, lower-gradient channel with higher intrinsic potential for Chinook salmon and steelhead spawning and rearing than the channel that exists presently. The floodplain area along the constructed channel will include side-channels and other off-channel features and will be revegetated to restore wetland and riparian habitat providing long-term shade and cover favorable to fish.	Fish, Wetlands
The Meadow Creek channel will be routed over the final tailings storage facility and tailings storage facility embankment and buttress, resulting in a long, relatively flat surface and a short, steep face. On top of the tailings storage facility surface, Meadow Creek will be contained within a broad floodplain corridor bound laterally by erosion-resistant terraces and vertically by a subsurface armor layer over a low-permeability geosynthetic stream liner. Design thicknesses of the reclamation material and armor layer were selected to be protective of the geosynthetic stream liner under post-closure weather, vegetation, and flow conditions.	Fish, Wetlands

Description	Resources Affected
The Project Operator will stabilize and restore Blowout Creek. Blowout Creek wetland restoration will consist of restoring and enhancing palustrine aquatic bed (PAB), palustrine emergent (PEM), Palustrine scrub-scrub (PSS) wetlands that were impacted when a historical dam failed on Blowout Creek. Headcutting and shallow aquifer dewatering have impaired and reduced functions of the wetland vegetation classes. A grade control and groundwater cutoff structure is proposed to raise the water level in Blowout Creek as well as recharge the shallow groundwater system and reduce stream headcutting. A coarse rock drain will be constructed within the chute downstream of the failed dam to isolate the flow of Blowout Creek from the actively eroding chute side slopes and to prevent further erosion of the gully bottom, facilitating subsequent restoration of a surface channel on top of the drain. The Project Operator will stabilize the steep, confined, erosive middle reach to address the significant fine sediment load currently produced from this reach and restore the downstream, relatively low-gradient reach.	Fish, Wetlands, Water Resources
The Project Operator will lead annual site visits for U.S. Army Corps of Engineers, Environmental Protection Agency, Idaho Department of Fish and Game, and other interested agency personnel as needed to facilitate agency review of mitigation areas if desired. Final reporting and data archival requirements will be subject to permit conditions; however, it is anticipated that until the U.S. Army Corps of Engineers concurs that mitigation sites meet success criteria, monitoring reports will be prepared by the Project Operator annually and submitted to U.S. Army Corps of Engineers Walla Walla District, Environmental Protection Agency, Idaho Department of Fish and Game, IDL, National Oceanic and Atmospheric Administration Fisheries, U.S. Fish and Wildlife Service, the Forest Service, affected Tribes, and other interested agencies, Stibnite Gold Project partners, and stakeholders. After success criteria are met, permit conditions will set the frequency for long-term monitoring and reporting.	Fish, Wetlands, Water Resources
The Project Operator will repair and rehabilitate habitats adversely affected by historical mining impacts in the Stibnite Gold Project area within the disturbance footprint of the modified mine plan.	Fish, Wetlands, Water Resources
Minor surface improvements (e.g., ditch and culvert repair, adding gravel, winter snow removal, and summer dust suppression) will occur on the Yellow Pine Route to reduce sediment runoff and dust generation.	Fish, Wildlife, Water Resources
Implementation of an avalanche hazard management program that "could" include avalanche control and/or road closure. Also proposed are daily region-scale assessments; daily weather observations including snowpack and avalanches; notifying Stibnite Gold Project staff of highly unstable conditions; closing roads during periods of elevated hazard or blocked roads; and mitigating the avalanche hazard with explosives. Section 7.2 of Dynamic Avalanche Consulting (2021) provides a description of an active avalanche monitoring and mitigation program that has more specific descriptions of the components that could be included in a Stibnite Gold Project -specific plan. Section 8.0 of Dynamic Avalanche Consulting (2021) includes a discussion of avalanche mitigation likely to be necessary for the avalanche paths identified and this should be included in the program discussed above. the Project Operator will provide for Forest Service review of a written avalanche monitoring and mitigation program that could be implemented for the Stibnite Gold Project.	Geotechnical Hazards
Construction and operation of snow catchment areas for smaller avalanche paths. Section 7.3 of Dynamic Avalanche Consulting (2021) includes a more detailed discussion of specific locations and design characteristics for ditches and catchment areas to reduce avalanche impacts to roads. the Project Operator will review this information and current road designs to provide for Forest Service review of specific designs and maintenance and operating plans for said ditches and catchment areas along the selected access route.	Geotechnical Hazards

Description	Resources Affected
Avalanche structural defense options that could be beneficial in the Stibnite Gold Project mine site to protect high-value, stationary facilities from avalanche hazards. The Project Operator will review this information and provide the Forest Service with any recommendations for implementing structural avalanche defenses in at the Stibnite Gold Project mine site.	Geotechnical Hazards
The Project Operator will increase the ground limestone dosage to the pre-oxidized concentrate as it is fed into the autoclave to address the potential for creation of soluble arsenic. By decreasing the free acid levels (increasing the pH) in the autoclave by increasing the ground limestone dosage in the autoclave feed increases the quantity of crystalline (stable) arsenic compounds in the resultant slurry with a proportional decrease in the quantity of amorphous (unstable) arsenic compounds.	Hazardous Materials
The Project Operator will monitor levels of soluble arsenic in the tailings. If soluble arsenic levels are higher than anticipated, the Project Operator will treat the oxidized concentrate with hot arsenic cure prior to neutralization.	Hazardous Materials
The ore processing area will be designed to provide for containment of ore processing materials, chemicals, wastes, and surface runoff. Potentially hazardous chemicals and wastes will be stored within buildings or areas with both primary and secondary containment. Surface runoff within the ore processing area will be directed to a contact water pond for collection. Leaks or spills escaping primary and secondary containment will flow to the contact water pond for collection and will not discharge off site.	Hazardous Materials
The processing circuit will be housed in a steel frame building set on concrete foundations with interior curbing to provide secondary containment; the interior curbing will be high enough to contain 110 percent of the volume of the largest tank.	Hazardous Materials
The gold and silver leaching circuit will be designed and operated consistent with the International Cyanide Management Institute Code (https://www.cyanidecode.org) and the Initiative for Responsible Mining Assurance Standard for Responsible Mining (https://responsiblemining.net/resources/). Accordingly, impermeable secondary containment for cyanide unloading, storage, mixing and process tanks shall be sized to hold a volume at least 110 percent of the largest tank within the containment and any piping draining back to the tank, with additional capacity for the design storm event, if applicable. Pipelines containing process water or process solution shall also use secondary containment in combination with audible alarms, interlock systems, and/or sumps as spill control measures.	Hazardous Materials
Cyanide-bearing solutions used in ore processing will be neutralized to approximately 10 milligrams per liter weak acid dissociable cyanide before the material is pumped to the tailings storage facility. Residual cyanide will be treated using a sodium metabisulfite and air system to detoxify the cyanide by oxidation to form cyanate.	Hazardous Materials
Cyanide will be neutralized to levels protective of wildlife, and the tailings storage facility will be surrounded by an 8-foot high, chain-link fence designed to keep wildlife, such as deer and elk, from entering the impoundment area, to prevent either liner damage or wildlife drowning.	Hazardous Materials
Oils, solvents, and lubricants will be stored in approved containers located within, or directly adjacent to, the maintenance shop and contained within secondary containments to prevent spills into the environment. All used petroleum products, waste antifreeze, and used solvents will be collected in approved containers, transported off site, and disposed or recycled.	Hazardous Materials
Nitric and sulfuric acid will be transported in tanks designed to prevent spills even in the event of rollovers.	Hazardous Materials
Nitric and sulfuric acids will be stored in specialized non-corrosive, polyethylene-lined tanks located within the ore processing facility and will have secondary containment.	Hazardous Materials
Liquids will be shipped to the Stibnite Gold Project in tank trucks designed for spill prevention and escorted to the Stibnite Gold Project by pilot cars manned and equipped to handle spills.	Hazardous Materials

Description	Resources Affected
Other legacy materials may be encountered during construction and operations. If encountered, these materials will be characterized to determine potential for reprocessing, reuse, or disposal.	Hazardous Materials
Small scale composting associated with organic materials generated at the worker housing facility may be incorporated within the centralized growth media stockpile in the Fiddle valley.	Hazardous Materials
An Explosives and Blasting Management Plan will be prepared for the Stibnite Gold Project. Explosives storage, transport, handling, and use will comply with applicable Department of Homeland Security, Bureau of Alcohol, Tobacco, Firearms and Explosives, and Mine Safety and Health Administration regulations.	Health and Safety
For safety and security reasons, no alcohol, firearms, or illegal drugs will be permitted on site.	Health and Safety
For safety and security reasons, public access into the mine area will be prevented by using fencing, gate locking, security personnel, and/or notice postings that prohibit unauthorized entry; no unauthorized vehicles or personnel will be permitted on the Stibnite Gold Project.	Health and Safety
Personnel transporting, handling, or using any hazardous chemicals (including sodium cyanide) will be trained to ensure the safe use of such materials. The Project Operator will design, construct, and manage facilities to conform to International Cyanide Management Code.	Health and Safety, Fish, Wildlife, Hazardous Materials
Fuel and other petroleum products at the site will be stored in above ground containment structures, with appropriate secondary containment measures.	Health and Safety, Fish, Wildlife, Hazardous Materials
Air emissions, groundwater, surface water, and aquatic parameters will be monitored during mine construction, operation, closure, and post-closure as specified in the final authorizations from the regulating agencies.	Monitoring
Monitoring will be conducted following the completion of closure and reclamation of all facilities and disturbance areas to demonstrate compliance with permit requirements and to measure the success of reclamation and mitigation.	Monitoring
The draft EMMP includes the following plans for monitoring aquatic resources: Stream and Wetlands Monitoring and Management Plan and Fisheries and Aquatic Habitat Monitoring and Management Plan.	Monitoring
The ore processing facility building will be enclosed.	Noise, Wildlife, Health and Safety
Appropriate sound dampening and muffling equipment will be utilized to minimize noise excursion from equipment and facilities. When possible, schedule high noise activities at the same time. Monitor and maintain equipment to reduce noise related impacts.	Noise, Wildlife, Health and Safety
When practicable, pumps, generators, and engines will be turned off when not in use to avoid unnecessary noise generation and reduce energy consumption.	Noise, Wildlife, Health and Safety
Electric line power will be utilized during operations to eliminate diesel generator noise, except in emergency situations when grid power is down or temporary use in remote areas where it is not practical to run power lines.	Noise, Wildlife, Health and Safety
An 8-mile temporary 16-foot-wide groomed over-snow vehicle trail will be created adjacent to Johnson Creek Road between Landmark and Trout Creek Campground during construction of the Burntlog Route.	Recreation

Description	Resources Affected
A 16-foot-wide groomed over-snow vehicle trail will be created south of Warm Lake Road to connect the southern end of Johnson Creek Road to the Landmark-Stanley Road. This 0.3-mile route will be used throughout construction and operations.	Recreation
During construction, approximately 11 miles of groomed over-snow vehicle trail will be maintained along Cabin Creek Road (FR 467).	Recreation
Suitable surface coatings or exterior design features will be used on Stibnite Gold Project buildings and other structures to reduce visual impacts.	Scenic Resources
Lighting will be managed within active mining areas to avoid unintended lighting of natural, wildlife usage areas. External lighting will be kept to the minimum required for safety and security purposes. Lights will be directed down toward the interior of the Stibnite Gold Project and shielded, where appropriate.	Scenic Resources, Wildlife
Approximately 37 percent of the reclamation will be done concurrent to mining and ore processing; the remaining 63 percent will be accomplished during closure.	Soils, Reclamation
The Yellow Pine pit will be backfilled with West End pit development rock during operations.	Soils, Reclamation
A sinuous channel will be constructed through the backfilled area for the reconstructed East Fork South Fork Salmon River with an average valley gradient approximating the historical, pre-disturbance river gradient.	Soils, Reclamation
The backfill will be placed to achieve a mounded final reclamation surface to promote drainage away from the West End pit and prevent formation of a pit lake within Midnight pit.	Soils, Reclamation
The floor of the sidehill pit southwest of the main West End pit will be graded to drain, covered with growth media, and revegetated.	Soils, Reclamation
The Project Operator will begin with placement of soil and rock cover material, then construct wetlands and restore Meadow Creek and its tributaries within appropriately sized lined floodplain corridors, place growth media, and revegetate the area.	Soils, Reclamation
Hangar Flats pit will be fully backfilled with development rock to the valley bottom elevation or slightly higher during mine operations. There will be no Hangar Flats pit lake.	Soils, Reclamation
Once all final mine closure and reclamation work has been completed, the Project Operator will reduce the 21-foot-wide travel way of 19.8 miles of Burntlog Road (FR 447), 1.3 mile of Meadow Creek Lookout Road (FR 51290), and 2.0 miles along Thunder Mountain Road (FR 375) of Burntlog Route to their approximate pre-mining width.	Soils, Reclamation
The approximately 15 miles of Burntlog Route connecting to Meadow Creek Lookout Road (FR 51290) and Thunder Mountain Road (FR 50375) will be decommissioned.	Soils, Reclamation
Following mining and ore processing operations, unless they are taken over by a third-party for ongoing use and maintenance, the Burntlog Maintenance Facility buildings will be removed. The sewer system and septic tanks for the facility will be decommissioned. Soil and rock beneath fuel storage areas and chemical storage buildings will be tested for contamination. All petroleum products, solvents, and other hazardous or toxic materials will be removed from the site and disposed of according to applicable state and federal regulations. After demolition of the buildings and facilities, the site will be graded, and drainage restored.	Soils, Reclamation
The Project Operator will manufacture growth media material using fines from glacial till sources mined from the Yellow Pine pit, available mulched vegetation, and off-site composted material.	Soils, Reclamation
Planting, seeding, and mulching will be conducted in the fall and early winter to take advantage of snowpack and springtime moisture. Where cover crops are used in lieu of mulch, seeding will occur in the spring or fall followed by seeding of the permanent mixture.	Soils, Reclamation
Reclamation monitoring will begin during concurrent reclamation at Stibnite Gold Project facilities. Quantitative and qualitative monitoring of reclamation success will begin the first growing season after final reclamation is completed and will continue until success criteria are satisfied.	Soils, Reclamation

Description	Resources Affected
Soil stability will be estimated for all reclaimed areas using qualitative descriptors.	Soils, Reclamation
Slope stability will be monitored during the erosion inspections.	Soils, Reclamation
If the performance of reclaimed areas is not satisfactory, appropriate maintenance activities will be implemented. Maintenance activities may include one or more of the following: • Sediment removal from sediment basins, stormwater drainage channels, and diversions as necessary to maintain their design capacity; • Diverting surface water away from reclaimed areas where erosion jeopardizes attainment of reclamation standards; • Stabilizing rills, gullies, and other erosion features or slope failures that have exposed development rock; • Noxious weed and invasive plant species control; and, • Re-seeding or re-applying reclamation treatments in areas where it is determined through monitoring and agency consultation that reclamation will not meet standards.	Soils, Reclamation
The Project Operator will submit an annual report to the Forest Service and the other federal and state agencies that are responsible for issuing authorizations applicable to reclamation for the preceding calendar year. The annual report will contain descriptions of the reclamation activities completed during the previous year, a summary of areas reclaimed, a discussion of the results of the reclamation monitoring conducted, and corrective actions implemented.	Soils, Reclamation
A new 12-foot-wide gravel road will be constructed to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375) through the Stibnite Gold Project. During operations, the public access road will be used to travel through the Stibnite Gold Project and will provide seasonal use, open to all vehicles. Vehicles passing through the Stibnite Gold Project will be required to check-in with mine personnel at the North or South Stibnite Gold Project entry points.	Transportation and Access, Health and Safety
Post reclamation, a road will be established over the backfilled Yellow Pine pit to allow public access through the reclaimed site and connect Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375). This will replace the operational phase public access route.	Transportation and Access
Prior to site preparation and construction of surface facilities, vegetation will be removed from operating areas. Trees and deadwood, shrubs, and slash not needed to construct windrows at the edge of Burntlog Route disturbance (to function as sediment barriers), will be chipped, and suitable soil will be separately salvaged and stockpiled (except for a small portion that will be 'live handled') for use as part of site reclamation and restoration. Portions of the salvaged soil will be blended with the chipped wood to create growth media. All growth media placed in stockpiles will be stabilized, seeded, and mulched to protect the stockpiles from wind and water erosion.	Vegetation
The Project Operator will inspect and remove vegetation material (including noxious weeds) from mechanical equipment and properly dispose to minimize the spread of unwanted vegetation.	Vegetation
Wood wastes and wood mulch are the two primary sources of compost. Food waste produced from on-site meal preparation and wastes may provide another source. Combined and properly managed during composting, these materials will provide a source of organic matter to be blended into substrate materials suitable for mitigation.	Vegetation
The Project Operator will be responsible for noxious weed control within areas disturbed by Stibnite Gold Project activities.	Vegetation, Wildlife
Develop and employ planting plans for wildlife benefits (cover, forage, etc.) using approved seed mixes.	Vegetation, Wildlife

Description	Resources Affected
The Project Operator will use aquatic safe herbicides during vegetation management activities and noxious weed control. Adhere to chemical label restrictions, Federal and State rules on usage. Use proper equipment for chemical application by trained personnel.	Vegetation, Fish
The Project Operator or its designated contractor(s) will perform long-term maintenance as necessary, including maintaining and monitoring the Mitigation Area (including stream and wetlands) in perpetuity once the final performance standards are met or until such responsibility is relinquished to an appropriate third party (Forest Service, etc.) as approved by the U.S. Army Corps of Engineers.	Vegetation, Wetlands
The Project Operator will plant stream reclamation reaches and wetland reclamation areas with native plant species that are present in PAB, PEM, PSS, and palustrine forested wetlands and riparian areas along streams throughout the Mitigation Area.	Vegetation, Wetlands
To address stream temperature, riparian planting widths along restored and enhanced stream reaches will be 18 feet wide on each stream bank where possible. Taller and denser vegetation such as spruce trees will be planted. Further, the creation of the lined Stibnite Lake, a feature similar in size to the present Yellow Pine pit lake, will replace the function of the existing Yellow Pine pit lake in buffering stream temperature extremes and reduce maximum stream temperatures in East Fork South Fork Salmon River in and downstream of the Stibnite Gold Project.	Vegetation, Wetlands, Surface Water, Reclamation
Pre-construction water management activities will include the installation of surface water management features and implementation of best management practices to reduce erosion and sediment delivery to streams. These water management features and best management practices could include sedimentation ponds; run-on water diversion ditches, trenches, and/or berms; runoff water collection ditches; silt fence; water bars; culverts; energy dissipation structures; terraces; and other features specified in construction permits.	Water Resources
Stormwater runoff from undisturbed areas upslope of mine features in the major drainages will be captured in the stream diversion channels described above or in other channels that will direct runoff away from disturbed areas. Smaller-scale diversion channels or earthen berms will be used, where necessary, to divert stormwater around other mine infrastructure.	Water Resources
Stormwater drains, ditches, and stream channels will be protected against erosion through a combination of adequate dimension, appropriate gradient, riprap, fabric- encapsulated soil lifts, or other stabilization materials. Diversions will be sized for a peak flow recurrence interval appropriate to the risk level of the facility, in recognition of other water management measures and fail-safes in place (excess flood storage and freeboard in the tailings storage facility, etc.), and in accordance with regulatory standards.	Water Resources
Existing streams that run through areas proposed for mining related disturbance will be diverted to prevent generation of contact water or commingling of contact and non-contact water, keeping clean water clean; and to prevent flooding of mine facilities by runoff generated off site.	Water Resources
Groundwater pumped from the dewatering wells will be considered to be contact water and will be managed through forced evaporation or active water treatment when the volume of pumped water exceeds the ore processing facility demand.	Water Resources
Channel segments constructed over fill or excavated in permeable materials will be constructed over a geosynthetic liner to reduce seepage. A transition layer of sand and gravel followed by riprap or similar will be placed over the liner for erosion protection.	Water Resources
Secondary containment for pipelines will consist of an open geosynthetic-lined trench, pipe-in-pipe, or backfilled geomembrane-wrapped trench, depending on location, and the pipeline corridor will drain to one of two pipeline maintenance ponds – one at the truck shop and one at the ore processing facility.	Water Resources

Description	Resources Affected
A lined tailings pipeline maintenance pond will be located at the ore processing facility, to which tailings and process water in the tailings distribution or water reclaim pipelines will drain by gravity during maintenance shutdowns or if there is a leak in either pipeline. The pond will typically be empty except during maintenance or unforeseen problems with the tailings pipeline, pumping system, or tailings storage facility. The pond is designed to contain the contents of the pipelines and the runoff from the pond and lined pipeline corridor from a 100-year, 24-hour storm event plus snowmelt.	Water Resources
Underdrain collection sumps and downgradient monitoring wells will be used for tailings storage facility leak detection.	Water Resources
Water treatment will continue until metal concentrations from each source have stabilized at levels that meet water quality standards for discharge.	Water Resources
A truck wash facility will include an oil-water separation system and water treatment facilities to enable reuse of the wash water.	Water Resources
During mine operations, summer low flows in perennial diversion channels around the tailings storage facility impoundment and buttress (Meadow Creek), Yellow Pine pit (Hennessy Creek and East Fork South Fork Salmon River diversion tunnel), and West End pit (West End Creek) will be piped underground as a mitigation measure to maintain cold stream temperatures.	Water Resources
Hennessy Creek flow will be disconnected from the current unlined ditch passing alongside the Northwest Bradley dumps.	Water Resources
A liner will be installed under the Meadow Creek stream and floodplain corridor to minimize water seepage into the Hangar Flats pit or the pit dewatering well system, and to avoid potential pit wall instability or loss of stream habitat as a result of stream dewatering.	Water Resources
The underdrain system will convey spring and seep flows beneath both facilities to a collection sump at the buttress toe where the flows will be monitored for water quality prior to release into the stream system or capture for use in the processing circuit or treatment prior to discharge, depending on water quality.	Water Resources
Crushed rock will be placed on Stibnite Gold Project access roads as needed to provide a durable surface and limit sediment transport.	Water Resources, Fish, Soils
Road surfaces throughout the Stibnite Gold Project will be stabilized and managed to minimize transport of sediment, dust, and other materials, especially near watercourses through appropriate road engineering, surface drainage, watering, and application of dust control binding agents (magnesium chloride, lignin sulfonate, etc.), roadside ditching, road-cut stabilization, road surface maintenance, appropriate speed limits, and by limiting traffic.	Water Resources, Fish, Soils
During operations, runoff generated from direct precipitation on the tailings storage facility will be retained in the tailings storage facility water pool for reclaim to the ore processing circuit.	Water Resources, Fish, Wildlife, Wetlands
Riparian fringe and floodplain wetlands will be established on the broad, gently sloping floodplains on both sides of the reclaimed stream channels.	Wetlands
Valley margin wetlands will only be established where there is an upgradient water source sufficient to produce enough saturation and near surface water tables for wetland conditions.	Wetlands
Wetland reclamation will begin after the end of mine construction, with the first reclaimed wetlands occurring in the Blowout Creek drainage. Additional reclamation will occur in and after operational year 3 and continue through operations to closure year 25.	Wetlands
Salvaged O and A horizon soils from wetland or hydric soils (seed bank materials over or in combination with mineral soils uplands and wetland subsoils (growth media) will be used to create wetland soil conditions.	Wetlands

Description	Resources Affected
During Burntlog Route and Stibnite Gold Project haul road construction and use, the Project Operator will install and maintain sediment control measures and devices, such as culverts, culvert inlet protection devices, ditching, silt fencing, straw wattles, straw bales, and sediment catch basins.	Wetlands, Fish, Wildlife
Erodible cut and fill slopes along roads will be mulched, hydro-seeded or have durable rock inlay material to minimize the potential for sediment generation.	Wetlands, Fish, Wildlife
During winter road maintenance, the Project Operator will remove snow from the Burntlog Route and haul roads at the Stibnite Gold Project and the temporary construction access Yellow Pine Route. The Project Operator will avoid disposal of snow in riparian areas, wetlands, or areas where snowmelt might cause road damage or erosion during spring melt. Care will also be taken to dispose of collected snow, which may contain sand or gravel, in a manner that avoids impacts to nearby streams and rivers.	Wetlands, Fish, Wildlife
The Project Operator will use coarse sand (with less than 20 percent fines) for winter sanding of the main access road and Stibnite Gold Project haul roads in combination with a fine to medium gravel as needed, (approximately 1/4 - 5/8-inch sizing).	Wetlands, Fish, Wildlife
The Project Operator will salvage and preserve the growth media and seedbank materials of wetlands and riparian areas that will be impacted by the Stibnite Gold Project. These salvaged soils, containing native seed banks, will be used to aid in establishment of wetland and riparian vegetation in the stream and wetland reclamation areas.	Wetlands, Vegetation
Soil will be amended with additional compost and other sources of organic matter necessary to successfully reclaim wetlands at the Stibnite Gold Project.	Wetlands, Vegetation
The Project Operator will maintain a recycling program at the Stibnite Gold Project.	Wildlife
In order to reduce attractants, during construction and operations, trash and other miscellaneous inert (non-hazardous) garbage will be contained in on-site wildlife-resistant containers and hauled to the Valley County waste transfer station for disposal. Used oils, solvents, grease, and antifreeze will be handled separately from normal trash and garbage. Good housekeeping practices will include minimizing loose trash, odors, and access for wildlife to trash storage or disposal areas and prompt removal of trash.	Wildlife
Implement an Avian Protection Plan at the Stibnite Gold Project for transmission lines, including designing power lines and poles to minimize potential bird mortalities due to electrocution. Develop procedures for managing nests of protected species on utility structures (if nests are built).	Wildlife
Construct and operate all overhead powerlines and transmission lines and related facilities in accordance with Avian Power Line Interaction Committee suggested practices (Avian Power Line Interaction Committee 2012) as described in Idaho Power's Avian Protection Plan.	Wildlife
Electric power structures to serve the Stibnite Gold Project facilities will be designed and constructed to avoid raptor perching on structures for predation purposes and minimize the risk of their being electrocuted.	Wildlife
The Project Operator will install a wildlife exclusion fence around the tailings storage facility, process facility areas, and related process ponds in order to reduce the potential for mortalities.	Wildlife
The Project Operator will plan routine inspections of tailings storage facility facilities for wildlife use. If needed, the Project Operator will implement measures to remove wildlife and install additional BMPs to reduce wildlife exposure to these areas.	Wildlife
If critical wildlife zones or corridors are identified, restricted or seasonal access will be established prior to construction or expansion activities to the extent practicable. Physical barriers and/or signage will be added identifying these areas and site-specific measures will be implemented to minimize impacts.	Wildlife

Description	Resources Affected
The Project Operator will implement an animal trapping and relocation plan, as necessary, for nuisance species for safety of staff, visitors, and animals.	Wildlife
The Project Operator will install fences along and around the ore processing facilities, tailings storage facility, explosive storage areas, and composting/landfill, excluding pit perimeters and high walls.	Wildlife
The Project Operator will install signs of known wildlife crossing and usage areas along access and Stibnite Gold Project haul road corridors and all active facility areas. Locations are yet to be determined but signs will be installed to state the road name and mile markers where these corridors are known to exist. These will also be referenced in the training materials.	Wildlife
The Project Operator will provide tiered training for awareness, sighting, operations and maintenance, and restoration. Cross training to include noxious weeds, maintenance needs, unsafe conditions, etc., as well as reporting mechanisms. All mine personnel and visitors will receive some level of training tiered appropriately based on where they are working, type of work activities, and reason for mine visit. Forms will be developed to document training and identify how often training needs to be refreshed. Fact sheets will be developed on known wildlife in the area including pictures, warnings, and what to do if encountered.	Wildlife
The Project Operator will design and manage the tailings storage facility and associated facilities to reduce wildlife attraction. These include the following: • Surface area of the supernatant pond will be minimized to the extent practical. • Install an 8-foot fence around the tailings storage facility to exclude wildlife from the facility. • Implement an avian mortality reporting system for the tailings storage facility and contact water ponds. • Use skirting to enclose open spaces as necessary beneath raised structures as practical. • Follow the International Cyanide Management Code to avoid features possibly attractive to wildlife, as feasible.	Wildlife
Erosion control techniques at the Stibnite Gold Project will include mulching, wetland sodding; planting of vegetation to stabilize slopes; and use of silt fences, biofilters, brush mats, erosion control fabric, and/or fiber rolls along temporary swales, perimeter dikes, and stream banks. In addition, to minimize human disturbance, permanent signage will be posted around the perimeter of individual project sites to prohibit unauthorized foot traffic and the use of all-terrain vehicles and motorbikes, dumping, draining, and cutting and/or removal of plant materials.	Wildlife
Sumps will be constructed with at least one side having a shallow grade for wildlife egress. Sumps will be backfilled and reclaimed when no longer needed for drilling.	Wildlife
Mine site facilities will be monitored in accordance with the draft EMMP for the presence and potential mortality of birds, mammals, reptiles, and amphibians. Sightings of rare or sensitive wildlife, along with any wildlife mortalities, will be recorded and provided in periodic reports to the Forest Service, U.S. Fish and Wildlife Service, and Idaho Department of Fish and Game.	Wildlife
The Project Operator will provide mine personnel with mobile deterrents to avoid conflicts with wildlife – sprays, air horns, etc.	Wildlife
The Project Operator will establish and post speed limits for the Burntlog Route, Stibnite Gold Project haul roads, and light vehicle access roads on the Stibnite Gold Project site. Slower speed limits will be posted at known wildlife crossings and along defined migratory corridors during migration season.	Wildlife, Health and Safety

Description	Resources Affected
There will be no hunting or discharge of firearms during construction and operations within the Stibnite Gold Project area. The Stibnite Gold Project site will be posted to prohibit hunting, and employees will be prohibited from carrying firearms on the Stibnite Gold Project.	Wildlife, Health and Safety
The Project Operator will employ vegetation maintenance for safety along roads, removal of hazard trees, and riparian conservation areas, etc. – coordinate such that wildlife protection and restoration are incorporated during maintenance.	Wildlife, Health and Safety

In addition to these project environmental design features and Forest Service requirements, the Project incorporates elements specifically designed to be protective of Endangered Species Act - listed species that are presented in Part 10.3 and made conditions of this decision.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	Agency Case No. 0101-22-01 OAH Case No. 23-245-01 **CERTIFICATION AND TRANSMITTAL OF AGENCY RECORD AND TRANSCRIPTS**

I, Diane Cutler, certify and state as follows:

1. My name is Diane Cutler. I am the Rules and Planning Analyst with the Department of Environmental Quality (DEQ).

2. My duties include assisting DEQ with contested cases by organizing and managing the documents filed into the agency record.

3. In this capacity and for the purpose of contested cases, I am referred to as the hearing coordinator.

4. As hearing coordinator, I am custodian of the record compiled under Idaho Code § 67-5249.

5. A true and correct copy of the *Corrected Agency Record and Transcripts* for Agency Case No. 0101-22-01/OAH Case No. 23-245-01, In the Matter of Air Quality Permit to Construct P-2019.0047, is provided here via hyperlink and transmitted to the Idaho Board of Environmental Quality. This record is also available on DEQ's Petitions for Review website. This record is current as of January 27, 2025, and will be updated as documents are filed in this case.

I certify under penalty of perjury pursuant to the law of the State of Idaho that the foregoing is true and correct.

Dated this 27 day of January, 2025.

/s/ Diane Cutler

Diane Cutler, Hearing Coordinator
Rules and Planning Analyst
Department of Environmental Quality
1410 N. Hilton, Boise, ID 83706
(208)373-0165
diane.cutler@deq.idaho.gov

CERTIFICATE OF SERVICE

I HEREBY CERTIFY that on this 27 day of January, 2025, the foregoing was filed, served, and copied as shown below.

Dylan B. Lawrence
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov

Hannah M.C. Young
Michael A. Short
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
hannah.young@deq.idaho.gov
michael.short@deq.idaho.gov

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole C. Hancock
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
nicole.hancock@stoel.com

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
Counsel for the Idaho
Board of Environmental Quality
ann.yribar@ag.idaho.gov

/s/ Diane Cutler
Diane Cutler

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	Agency Case No. 0101-22-01 OAH Case No. 23-245-01 **NOTICE OF SPECIAL MEETING OF THE BOARD OF ENVIRONMENTAL QUALITY | FEBRUARY 13, 2025**

NOTICE IS HEREBY GIVEN that the Board of Environmental Quality (DEQ Board) has scheduled a Special Meeting to take action in the above-captioned matter. The DEQ Board will hold an executive session pursuant to Idaho Code § 74-206(1)(f) to communicate with legal counsel to discuss the ramifications of and legal options regarding this pending contested case. The Board will also consider Petitioners' request that the Board hold a hearing on *Petitioners' Petition for Review of January 7, 2025 Preliminary Order, Memorandum in Support, and Request for Hearing* filed on January 21, 2025. The DEQ Board will further take action to consider the *Petitioner Save the South Fork Salmon's Motion for Reconsideration Based on New Evidence* filed January 24, 2025.

The Special Board Meeting will be held on February 13, 2025, at 10:30 a.m. Mountain Time in conference rooms C and D at the Department of Environmental Quality State Office, 1410 N. Hilton, Boise, Idaho. The public may attend the meeting in person or via Microsoft Teams. The Teams link will be available in the Meeting Notice posted at https://www.deq.idaho.gov/board-of-environmental-quality/ at least 24 hours prior to the meeting date.

Dated this 4th day of February, 2025.

/s/ Diane Cutler
Diane Cutler, Hearing Coordinator
Rules and Planning Analyst
Department of Environmental Quality
1410 N. Hilton, Boise, ID 83706
(208)373-0165
diane.cutler@deq.idaho.gov

CERTIFICATE OF SERVICE

I HEREBY CERTIFY that on this 4th day of February, 2025, the foregoing was filed, served, and copied as shown below.

Dylan B. Lawrence
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov

Hannah M.C. Young
Michael A. Short
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
hannah.young@deq.idaho.gov
michael.short@deq.idaho.gov

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole C. Hancock
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
nicole.hancock@stoel.com

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
Counsel for the Idaho
Board of Environmental Quality
ann.yribar@ag.idaho.gov

/s/ Diane Cutler
Diane Cutler

RAÚL R. LABRADOR
Attorney General

SCOTT L. CAMPBELL
Deputy Attorney General
Chief, Energy and Natural Resources Division

HANNAH M.C. YOUNG, ISB #9781
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: (208) 373-0422
Facsimile: (208) 373-0481
Email: hannah.young@deq.idaho.gov

Attorneys for Respondent

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047

NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,

Petitioners,

v.

IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,

Respondent,

and

PERPETUA RESOURCES IDAHO, INC.,

Intervenor.

Case Docket No. 0101-22-01
OAH Case No. 23-245-01

RESPONDENT, IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY'S RESPONSE TO PETITIONERS' PETITION FOR REVIEW OF JANUARY 7, 2025 PRELIMINARY ORDER

TABLE OF CONTENTS

INTRODUCTION 1
PROCEDURAL HISTORY 2
STATEMENT OF FACTS 4
LEGAL STANDARD 5
REGULATORY SCHEME 8
ARGUMENT 12
I. The Hearing Officer Properly Concluded that DEQ Acted Reasonably and in Accordance with Law in Using the Project Specific 16/70 Adjustment 12
II. The Hearing Officer Properly Concluded that DEQ Acted Reasonably and in Accordance with Law in Using the Five-Year Rolling Average 21
III. The Hearing Officer Properly Concluded that DEQ Acted Reasonably and in Accordance with Law as there was Sufficient Evidence to Support the T-RACT Analysis Limiting the Non-West End Pit Production Limit 23
CONCLUSION 27

Respondent, the Idaho Department of Environmental Quality ("DEQ"), by and through the Office of the Attorney General, hereby submits this *Response to Petitioners' Petition for Review of January 7, 2025 Preliminary Order*.

INTRODUCTION

On June 17, 2022, DEQ issued an air quality permit, a Permit to Construct ("PTC"), to Perpetua Resources Idaho, Inc. ("Perpetua") for the Stibnite Gold Project ("SGP"). REC 1274. The PTC, which is the subject of this contested case, was issued after DEQ's nearly three-year permitting effort. *Id.* This effort included three extended public comment periods, two public informational meetings, frequent meetings with Perpetua, numerous requests for additional information, and four permit iterations. *Id*. Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon ("Petitioners") brought their challenge of the PTC on July 22, 2022. This matter has been in the contested case process since. Now, Petitioners bring their Second Petition to the Board of Environmental Quality (the "Board"), again challenging the permitted dust emissions covered by the PTC.

The contested case first came directly before the Board in April of 2024, when Petitioners first appealed the Hearing Officer's decision in DEQ's favor. After considering the matter and hearing oral argument, the Board remanded this case back to the Hearing Officer for further consideration of one discrete issue, the arsenic ambient air emissions. In particular, the Board remanded the matter to the Hearing Officer for further evidence because it found as follows:

> (1) DEQ did not act reasonably and in accordance with law when it applied the 16/70 calculation to the ambient arsenic air concentration analysis;
>
> (2) DEQ did not act reasonably in using a five-year rolling average for T-RACT that was not properly supported by permit conditions; and,
>
> (3) There was insufficient evidence to support the T-RACT analysis limiting the non-West End Pit production limit.

See REC 3712-15. The Board's remand asked DEQ to provide the necessary evidence on these three sub-issues (hereinafter the "Remaining Issues") to demonstrate that DEQ acted reasonably and in accordance with the law. *See* REC 3842. The Hearing Office carefully and thoroughly considered the Remaining Issues, hearing and considering testimony from several expert witnesses. Ultimately, as to this issue, the Hearing Officer determined that DEQ acted reasonably and lawfully, finding specifically:

> (a) DEQ acted reasonably in using a 5-year rolling average for T-RACT that was not supported by further permit conditions;
>
> (b) there was sufficient evidence to support DEQ's T-RACT analysis regarding non-West End Pit production; and
>
> (c) DEQ acted reasonably and in accordance with law when it applied the 16/70 adjustment to the AACC for arsenic.

REC 7111. DEQ now urges the Board to do the same and find that DEQ acted reasonably and in accordance with the law and to uphold the Hearing Officer's January 7, 2025 decision.

PROCEDURAL HISTORY

On July 22, 2022, Petitioners initiated a contested case, challenging DEQ's issuance of the PTC to Perpetua for the SGP. REC 0001-0028. Thereafter, the Board appointed a Hearing Officer to oversee and decide the contested case. REC 0031-0032. On August 12, 2022, DEQ responded to the Petition, denying it committed any error in issuing the PTC. REC 0033-0039. Perpetua then moved to intervene in the contested case, which the Hearing Officer granted. REC 0040-0045.

On September 6, 2022, Perpetua filed a Motion to Dismiss the Petition, which DEQ joined. REC 0052-0124. In ruling on the Motion to Dismiss, the Hearing Officer dismissed three of Petitioners' claims and partially dismissed a fourth. REC 0160-0186. Petitioners were given leave to amend their Petition, and an Amended Petition was filed in January 2023. REC 0263-0292.

Petitioners filed a Motion for Summary Judgment on April 14, 2023, and DEQ and Perpetua filed their own Motions for Summary Judgment on May 12, 2023. REC 0319-0363; REC 1204-1232; REC 1276-1336. After hearing oral argument, the Hearing Officer issued his *Memorandum Decision on Motions for Summary Judgment and Preliminary Order* on October 31, 2023, appearing to dismiss all of Petitioners' claims. REC 3280-3328. Seeking clarity on his decision, DEQ and Perpetua filed a *Joint Motion for Reconsideration and/or Clarification* on November 10, 2023. REC 3332-3341. On December 5, 2023, the Hearing Officer issued his *Amended Memorandum Decision on Motions for Summary Judgment and Preliminary Order*. REC 3372-3425. The Hearing Officer made it clear he dismissed all of Petitioners' claims. *Id*.

On December 15, 2023, Petitioners filed their *Amended Petition for Review of Preliminary Orders*, initiating its first appeal to the Board. REC 3426-3441. After briefing and oral argument, the Board issued its *Final Order* on May 9, 2024 ("Final Order"). In the Final Order, the Board found that DEQ acted reasonably and in accordance with the law on four of the five issues before the Board. As to the fifth issue, the Board concluded: "DEQ Did Not Act Reasonably or in Accordance with Law When it Analyzed the Ambient Arsenic Air Concentrations for the SGP." REC 3717. Therefore, the Board "remand[ed] this matter back for the development of further evidence regarding the ambient air concentrations of arsenic that will be produced by the SGP and whether those levels comply with the Air Rules." *Id*.

After the Board issued the Final Order, DEQ and Perpetua filed a *Joint Motion for Reconsideration and/or Clarification of Final Order.* REC 3721-3727. In the Joint Motion, DEQ and Perpetua asked the Board to either reconsider its decision, hold additional hearings on the arsenic emissions analysis, or provide clarification as to the Board's instructions to the Hearing

Officer. *Id.* The Board denied the request for reconsideration, and also denied the request to hold additional hearings or provide additional clarification for the Hearing Officer. REC 3838.

Thus, the matter was remanded to the Hearing Officer for the development of additional evidence. On remand, "the parties agreed expert witness testimony would be necessary to address the issues identified by the Board," and "from August to October 2024, the parties filed a total of six expert witness declarations." REC 7094. Then on October 17 and 18, 2024, the Hearing Officer held an evidentiary hearing wherein he heard from all six proffered witnesses. *Id.* On January 7, 2025, the Hearing Officer issued his *Findings of Fact, Conclusions of Law, and Preliminary Order* ("Second Preliminary Order"). REC 7091-7118. In the Second Preliminary Order, he found DEQ acted both reasonably and lawfully in its analysis of the ambient arsenic emissions. REC 7111.

On January 21, 2025, Petitioners filed their *Petition for Review of January 7, 2025 Preliminary Order, Memorandum In Support, and Request for Hearing* ("Second Petition"), once again asking the Board to review the Hearing Officer's decision. REC 7119-7145. Specifically, the Petitioners claim:

(1) The 16/70 adjustment for arsenic is unlawful, sets a dangerous new precedent, and is not supported by the evidence; and

(2) Using a five-year rolling average is not reasonable to assess compliance with arsenic limits; and the Permit's conditions are not sufficient to limit production from West End Pit and/or non-West End Pit sources to meet arsenic limits.

REC 7122. Thus, Petitioners continue to raise the same three issues addressed on remand.

STATEMENT OF FACTS

The Clean Air Act ("CAA") is the federal law that regulates air emissions from stationary and mobile sources. 42 U.S.C. § 7401, *et seq*. The Environmental Protection Agency ("EPA") has delegated the authority to implement the CAA in Idaho to DEQ. REC 1272. To implement the CAA, DEQ promulgated the Rules for the Control of Air Pollution in Idaho, IDAPA 58.01.01 (the

"Air Rules"). DEQ has received delegated authority from EPA for decades, and EPA has approved DEQ's program year after year. REC 1272. This delegation includes the authority to issue permits to qualifying facilities. *Id.* DEQ's air quality permit program issues more than 100 permits a year. REC 1258. In writing permits, DEQ staff use federal and state regulations and internal operating procedures. REC 1273. When DEQ receives a permit application for a "permit to construct," DEQ strives to issue the permit within 150 days, which includes time for a public comment period. *Id.*

Perpetua submitted an application for a permit to construct for the SGP on August 20, 2019. REC 0418. The SGP will consist of conventional open-pit mining, ore preparation, and gold extraction. REC 0415. DEQ expended extraordinary efforts to evaluate the application, consider public comments, and engage in highly technical decision-making to arrive at an environmentally and legally sound permit. *See* REC 1273-1274. DEQ held three extended public comment periods, two informational meetings, frequent meetings with Perpetua, and made many requests for additional information. REC 0418. DEQ found Perpetua's application incomplete three times. *Id.* DEQ's relentless pursuit for necessary information, and Perpetua's willingness to provide it, demonstrate the parties' desire to prepare only a defensible, environmentally protective permit.

On June 17, 2022, DEQ issued the 43-page PTC and accompanying 505-page Statement of Basis for the SGP. *See* REC 0367-0914. Petitioners then initiated the contested case on July 22, 2022, challenging DEQ's issuance of the PTC. REC 0001-0028.

LEGAL STANDARD

In a contested case proceeding, "the Board must determine whether DEQ has acted reasonably and in accordance with law." *In the Matter of Sunnyside Park Utilities' Application for Sewage Disposal Permit*, Final Order on Petition for Review of Preliminary Order, at 10 (BEQ

Dkt. 0103-07-02, Apr. 7, 2009).[1] A court will affirm the Board's decision, should it be appealed, unless the court finds that DEQ and the Board's decision is in violation of constitutional or statutory provisions, is in excess of statutory authority, is made on unlawful procedure, or is arbitrary, capricious, or an abuse of discretion. *See* I.C. § 67-5279(3).[2] Petitioners bear the burden of proof as the party challenging DEQ's issuance of the PTC. IDAPA 62.01.01.477 ("the burden of proof is on the party requesting or challenging an agency action or order"). The Petitioners' must meet their burden by a preponderance of the evidence. *Id*.

The Hearing Officer was tasked with determining whether Petitioners presented competent evidence establishing that DEQ was not reasonable and did not act in accordance with the law when it issued the PTC; and specifically, whether DEQ's analysis of the arsenic ambient air concentrations was unreasonable and unlawful. The Hearing Officer, and now the Board, must only consider whether DEQ was reasonable and acted in accordance with the law— not whether a person disagrees with DEQ's reasonable and lawful approach.

When reviewing the Second Preliminary Order, the Board has the authority to "exercise all of the decision-making power that [the Board] would have if [the Board] had presided over the hearing." I.C. § 67-5245(7). "This means that, in reviewing the Preliminary Order, the Board may review all of the evidence *de novo*…" *In the Matter of Sunnyside Park Utilities' Application for Sewage Disposal Permit*, at 2. "A de novo standard of review permits an appellate court to review all legal issues raised in the lower court, even if one of the issues was not addressed in the first

[1] Publicly available at https://www2.deq.idaho.gov/admin/LEIA/api/document/download/5566.

[2] The Hearing Officer recognized the helpfulness of using the judicial standard of review in I.C. § 67-5279, "[b]ecause those are the standards that ultimately govern the disposition of this matter…" REC 3377. Further, and importantly, Petitioners use the judicial standard of review set out in I.C. § 67-5279 in asking for relief. REC 3474.

instance, so long as there is a sufficient factual basis." *State v. Jay*, 167 Idaho 592, 598, 473 P.3d 861, 867 (Ct. App. 2020).

Throughout this contested case, it has been clear that expert opinions are necessary. *See* REC 3375 (in the December 5, 2023 *Amended Memorandum Decision on Motions for Summary Judgment and Preliminary Order*, the Hearing Officer discussed the technical nature of the air permit matters and determined DEQ staff were expert witnesses); REC 3716 (the Board seeks expert testimony from a toxicologist or other qualified expert). Because the PTC at issue, as well as the questions of cancer risk and arsenic concentrations, are technical and complex, expert testimony is essential. *See* REC 3375. Importantly, DEQ's "experience, technical competence, and specialized knowledge may be utilized in the evaluation of the evidence." I.C. § 67-5251(5).

When analysis "requires a high level of technical expertise," a court must defer to "the informed discretion of the responsible... agencies." *Kleppe v. Sierra Club*, 427 U.S. 390, 412 (1976). "When specialists express conflicting views, an agency must have discretion to rely on the reasonable opinions of its own qualified experts even if, as an original matter, a court might find contrary views more persuasive." *Marsh v. Oregon Nat. Res. Council*, 490 U.S. 360, 378 (1989). A court "will uphold a decision of less than ideal clarity if the agency's path may reasonably be discerned." *Bowman Transp., Inc.*, 419 U.S. at 286 (citing *Colorado Interstate Gas Co. v. FPC*, 324 U.S. 581, 595 (1945)).

"When examining this kind of scientific determination, as opposed to simple findings of fact, a reviewing court must generally be at its most deferential." *Baltimore Gas & Electric Co. v. Natural Resources Defense Council, Inc.*, 462 U.S. 87, 103 (1983). This is particularly true for statistical and modeling analysis. *See Appalachian Power Co. v. EPA*, 135 F.3d 791, 802 (D.C. Cir. 1998) (per curiam) (identifying statistics as "the prime example of those areas of technical

wilderness into which judicial expeditions are best limited to ascertaining the lay of the land"). The court "will examine each step of [the agency's] analysis to satisfy ourselves that the agency has not departed from a rational course, and only when the model bears no rational relationship to the characteristics of the data to which it is applied will we conclude the use of the model was arbitrary and capricious." *Huntsman Petrochemical LLC v. Env't Prot. Agency*, 114 F.4th 727, 735 (D.C. Cir. 2024) (emphasis added) (cleaned up).

REGULATORY SCHEME

For the Remaining Issues and issues subject to this Petition, the applicable sections of the Air Rules have been outlined several times, which include: Sections 203, 161, 210, 586, and the definition of "toxic air pollutant carcinogenic increments" in Section 006.125 of the Air Rules.[3] *See* REC 3416-17, 3707-10, 6894-96. In general terms, the parties appear to agree on the relevance and applicability of these specific rule sections listed above. However, Petitioners continue to question whether DEQ had authority to factor in the project duration for the SGP's arsenic emissions. Through its expert witnesses, DEQ explained why factoring in project duration was in fact supported by the Air Rules.

Section 203 of the Air Rules states that DEQ cannot issue a permit to construct unless the permit applicant can demonstrate to the satisfaction of the Department, "using the methods provided in Section 210," that "the emissions of toxic air pollutants from the stationary source… would not injure or unreasonably affect human health or animal life or vegetation as required by Section 161." IDAPA 58.01.01.203.03. An applicant has demonstrated compliance with Section 210 when the estimated ambient air impacts are less or equal to the applicable acceptable ambient concentration ("AACC") for carcinogens as provided in IDAPA 58.01.01.586. *See* IDAPA

[3] DEQ issued the PTC to Perpetua on June 17, 2022. Thus, the 2022 version of the Air Rules are relied upon.

58.01.01.210. The AACC in IDAPA 58.01.01.586 "is calculated by dividing the acceptable lifetime risk (1 in 1,000,000) by the [unit risk factor ("URF")]," which is "4.3E-3µg/m3 for arsenic." REC 4282. The URF, which is developed by the Environmental Protection Agency (EPA) is the risk probability from exposure to 1 µg/m3 of a substance continuously (24 hours/day and 365 days/year) over a lifetime of exposure (assumed to be 70 years). REC 3922.

Section 210.12 then allows a permit applicant to "use [Toxic Air Pollutant Reasonably Available Control Technology ("T-RACT")] to demonstrate preconstruction compliance for toxic air pollutants listed in Section 586." IDAPA 58.01.01.210.12. T-RACT "is an emission standard based on the lowest emission of toxic air pollutants that a particular source is capable of meeting by the application of control technology that is reasonably available, as determined by the Department…" IDAPA 58.01.01.210. When an applicant uses T-RACT, the allowable cancer risk changes from 1-in-1,000,000 to 1-in-100,000.

DEQ used the methods in Section 210 to determine the SGP's compliance with Section 161. Because Perpetua proposed to use T-RACT, the arsenic emissions from SGP could not create a lifetime cancer risk of greater than 1-in-100,000. TR 0244:16-21. Perpetua then modeled the emissions from the SGP, based on its "maximum design rate," as limited by the PTC. TR 0524:23-25. The modeling relied upon many conservative assumptions, using worst case scenarios. *See* TR 0527:23-272:3. Kevin Schilling, DEQ's Stationary Source Air Modeling Supervisor and one of DEQ's expert witnesses during the remand, explained the next steps in the process, stating:

> During development of final SGP permitting analyses, [Perpetua] expressed concern that compliance with AACCs could not be demonstrated with the conservative assumptions used in previous analyses, including the assumption that the SGP was a permanent source rather than one of 16-year duration. Rather than revise the analytical approach to provide a less conservative assessment of impacts, I proposed that compliance with carcinogenic [Toxic Air Pollutant] increments could be based on cumulative cancer risk of the limited-duration project rather than the worst-case annual impact for a project of limited duration. Since the AACC

> annual average is an expression of a 1- in-1,000,000 cancer risk limit for permitting projects, modeled impacts (annual contaminant concentration) must be adjusted to an exposure concentration that is appropriately comparable to the annual average AACC. Therefore, annual impacts for a project with a 16-year duration could be multiplied by a 16/70 factor to more appropriately compare to the AACC, which is based on a 70-year exposure duration.

REC 3924-25. "So, in Perpetua's case, in order to develop an appropriate factor to compare or an appropriate concentration to compare to the AACC, [DEQ] needed to account for the exposure duration." TR 0217:1-4.

DEQ's application of the project specific adjustment is consistent with the purpose and intent of the Toxic Air Pollutant ("TAP") Rules within the Air Rules. During the evidentiary hearing, Mr. Schilling stated that, in his experience based on personally participating in the development of the TAPs Rules, the "carcinogenic TAP AACCs were established to ensure that impacts of any carcinogenic TAPs from a project or facility would not cause a lifetime cancer risk over 1-in-1,000,000 or 1-in-100,000 when using T-RACT." REC 3926. He explained:

> Going all the way back to the toxics policy that was used in permitting, the cornerstone of that was focused on project risk. In other words, any particular project, whether it is a new facility or a modification, not causing a risk to exceed one in a million or one in 100,000, some things changed with T-RACT going from policy to regulation.

TR 0200:5-12. Thus, "DEQ continually asserted that carcinogenic TAPs resulting from a permitting project should be regulated to prevent an unacceptable excess cancer risk based on a 70-year lifetime." REC 3922. In simple terms, from the beginning of their development, the cornerstone of the TAPs Rules is that total increased pollutant-specific cancer risk from a project over the project's life cannot exceed the lifetime cancer risk limit imposed by the rules.

This approach, as described by Mr. Schilling, makes sense given the Air Rules' reference to and reliance upon EPA's URFs. Section 586 specifically lists the URF for each pollutant. Thus, "DEQ adopted EPA's cancer risk values and risk assessment methodology when it promulgated

the Air Rules for toxic air pollutants from stationary sources." REC 4282. Stated another way, "[c]ancer risks used to establish AACCs were based on EPA's cancer risk model (using established EPA URFs)." REC 3926. When asked during the evidentiary hearing if the Air Rules rely upon the URFs, Mr. Schilling responded by stating: "I believe it is really the cornerstone of the whole TAPs program for regulating carcinogenic compounds." TR 0202:8-10. According to Mr. Schilling, inclusion of the URF demonstrates that "it's a project cancer risk that is the focus rather than an annual strict increment." TR 0220:7-8. This is further supported by the definition of "Toxic Air Pollutant Carcinogenic Increments" in the Air Rules, which is as follows:

> Those ambient air quality increments based on the probability of developing excess cancers over a seventy (70) year lifetime exposure to one (1) microgram per cubic meter (1 ug/m3) of a given carcinogen and expressed in terms of a screening emission level or an acceptable ambient concentration for a carcinogenic toxic air pollutant. They are listed in Section 586.

IDAPA 58.01.01.006.125. And, as DEQ's Toxicologist and expert witness Dr. Norka Paden explained: "Under EPA's methodology for human health risk assessments, cancer risk calculations are done using a lifetime exposure set at 70 years," meaning the risk calculations use a lifetime of 70 years. REC 3877.

Thus, the TAPs Rules require that a project not exceed the lifetime allowable risk from a project. That is an increased risk of a 1-in-1,000,000, or 1-in-100,000 if T-RACT is used. Again, the AACCs are not annual limits, but an annual average "expression of a 1-in-1,000,000 cancer risk limit for permitting projects." See REC 3924-25. This requires DEQ to adjust exposure duration to "to an exposure concentration that is appropriately comparable to the annual average AACC." REC 3925. A permanently operating project is the underlying assumption for using a 70-year lifetime and exposure duration. Where a project will not operate permanently, however, a

specific adjustment for the actual life of the project is reasonable. Consequently, DEQ used a project specific adjustment factor, as supported by the regulations outlined above.

ARGUMENT

As stated above, the Board remanded this matter back to the Hearing Officer for further consideration of the three Remaining Issues. *See* REC 3712-3715. These are the same three issues Petitioners bring in their Second Petition. DEQ asked the Board to hear additional evidence on these issues when it filed its *Motion for Reconsideration and/or Clarification*, stating "DEQ and Perpetua ask the Board to reconsider its decision regarding DEQ's analysis of arsenic ambient concentrations and reopen the proceedings before the Board and hold an additional hearing on the analysis before issuing a final order." REC 3735. The Board denied the motion; instead, the Board entrusted the Hearing Officer to hear additional evidence and render a decision. REC 3835-3843.

During the remand, the parties spent several months working with their experts to provide written declarations. Subsequently, the Hearing Officer held a two-day evidentiary hearing. During the hearing, the Hearing Officer listened to expert witness testimony during examination and cross-examination, making his own credibility determinations. The Hearing Officer also asked his own questions of the witnesses. Thereafter, the Hearing Officer issued his decision, finding that, based on all the evidence presented, DEQ's analysis was reasonable and lawful.

I. The Hearing Officer Properly Concluded that DEQ Acted Reasonably and in Accordance with Law in Using the Project Specific 16/70 Adjustment

A. The project specific adjustment is supported by the Air Rules.

The Board remanded this matter to the Hearing Officer to determine whether DEQ acted reasonably and in accordance with law when it applied the 16/70 adjustment factor to the ambient arsenic emissions from the SGP. During the remand, DEQ and Perpetua's experts explained how

the Air Rules fully support using the project specific adjustment factor, and how it was protective of public health. Through the expert testimony, it became clear the cornerstone of the carcinogenic TAP Rules is limiting *project-caused* cancer risk to less than 1-in-1,000,000, or 1-in-100,000 when T-RACT is used. After careful consideration of the declarations and testimony, the Hearing Officer concurred the Air Rules support DEQ's approach. Still, Petitioners assert this was error. Petitioners claim the Hearing Officer ignored the Board's interpretation, REC 7127, but the Hearing Officer had the benefit of the expert witness testimony that was specifically requested by the Board.

Ignoring the Hearing Officer's thoughtful analysis, Petitioners instead state, "the Hearing Officer rationalized that adjusting the Stibnite Gold Project based on the 16 years it will operate is appropriate, because the 'Air Rules do not expressly preclude' it." REC 7127. As described above, it is not that the Air Rules simply do not "expressly preclude" the approach, but they expressly support it. First, the definition of "Toxic Air Pollutant Carcinogenic Increments" plainly supports DEQ's analysis. Again, the definition is as follows:

> Those ambient air quality increments based on the probability of developing excess cancers over a seventy (70) year lifetime exposure to one (1) microgram per cubic meter (1 ug/m3) of a given carcinogen and expressed in terms of a screening emission level or an acceptable ambient concentration for a carcinogenic toxic air pollutant. They are listed in Section 586.

IDAPA 58.01.01.006.125. Mr. Schilling highlighted that the definition "references the [one] in a million cancer risk being the criteria, and that the AACCs are an expression of that for a continuation exposure over the lifetime." TR 0202:15-18; *see* IDAPA 58.01.01.006.125. The definition is also "expressed in terms of the screening emission limit or the acceptable ambient concentration of a carcinogen," and the use of the word "expressed," in Mr. Schilling's opinion, "makes it clear that it focuses on a total project-imposed cancer risk rather than a specific year by year." TR 0214:9-14. The Hearing Officer also found the definition persuasive, stating the

definition "expressly reference the assumed 70-year lifetime for evaluating increased cancer risk from TAPs exposure." REC 7101.

Further, Section 586 of the Air Rules, which contains the AACCs, also provides the URFs, which were created by EPA. The URF[4] is "the toxicity value that you compare an exposure concentration to estimate risk from that exposure." TR 0364:24-0365:1. As Dr. Paden explained, "DEQ has in the rules that [A]ACC uses the inhalation unit risk which comes from EPA," and that Section 586 contains "a footnote there that indicates that value is taken from EPA." TR 0319:5-8. Thus, the inclusion of the URF in Section 586 demonstrates that "it's a project cancer risk that is the focus rather than an annual strict increment." TR 0220:7-8. When Mr. Schilling was asked what the impact would be to the TAP Rules if the URFs were not included in Section 586, he stated:

> It would be less clear that it's project risk we're concerned about. I wouldn't say it would be clear that the intent would be just an annual standard because through the rulemaking process and that entire thing and background, project risk was always sort of the cornerstone focus.

TR 0219:22-0220:3. In simple terms, the TAP Rules are focused on the overall risk of the project based on exposure over a lifetime. The Hearing Officer concurred stating: "Because Air Rule 586 incorporates the URFs/IURs adopted by EPA, its Acceptable Concentrations (i.e., AACCs) are inherently expressed as the annual average concentration over the course of an assumed 70-year lifetime." REC 7101.

The Hearing Officer did note that the "Air Rules do not expressly preclude adjusting exposure concentrations to account for projects with an operational life of more than 5 years and

[4] Perpetua's toxicologist and expert witness Theresa Lopez testified that the unit risk factors are the same as the inhalation unit risk. *See* TR 0364:9-13.

less than 70 years."[5] REC 7102. But he also stated that, "[t]o the contrary, as previously referenced, Air Rule 586 contains an express reference to the URFs/IURs adopted by EPA, which are based on an assumed 70-year lifetime exposure." *Id*. Understanding the AACCs necessarily requires a person to understand the impact of including the URFs. Once this is understood, it is clear that "it's a project cancer risk that is the focus rather than an annual strict increment." TR 0220:7-8.

Petitioners' expert witnesses, Dr. Ian von Lindern and William Tiedemann, offered a different reading of the Air Rules. However, the Hearing Officer found that "often, the Protestants' witnesses Mr. Tiedemann and Dr. von Lindern testified regarding what they wished the Air Rules said, rather than what they actually say." REC 7096 (emphasis added). For example, Dr. von Lindern testified the "annual compliance with [the AACC] is the cornerstone of the rule…" TR 0674:22-25. He also continually referred to the AACC as a maximum annual or maximum one year concentration. *See*, e.g., REC 6108, 6110, 6112. When asked where the term "maximum one-year annual average ambient air carcinogen concentration" came from, he responded by stating that it is "how you should interpret [section] 586, which says 'annual averages.'" TR 0742:24-25 (emphasis added). But he admitted the terminology was not from the Air Rules. TR 0743:2. Dr. von Lindern also continually discussed a "margin of safety" and the impacts to sensitive populations. *See* TR 0675:9-15; REC 6112. He also admitted that the margin of safety is not in the Air Rules, TR 0736:11-12 ("that's my term to help explain this"), and that the URFs already take into account susceptible groups, TR 0742:6. And even though EPA does not list arsenic as having a mutagenic mode of action, he continually stated it should be and instead noted it was "one of the

[5] Petitioners also claim that DEQ's approach renders the short-term adjustment for projects that last five years or less superfluous. REC 7129. The Hearing Officer specifically discusses the short-term source adjustment factor. Clearly, that provision in IDAPA 58.01.01.210.15 is still available and relevant for projects that will exist for less than five years. But that is not the case with the SGP.

most controversial things going on in EPA." TR 0741:2-3; *see also* TR 0737:25-0738:2. Petitioners continue to make these same arguments, only expressing what they *wish* the Air Rules said.

B. DEQ's approach is protective of public health.

In its Final Order, the Board stated it "has not found sufficient evidence in the record to convince it that the 16/70 analysis performed by DEQ was equally or more protective of human and animal life and vegetation as what is provided for by the Air Rules." REC 3717. During the remand, both DEQ and Perpetua's experts explained in great detail how DEQ was protective of public health. Still, Petitioners assert that DEQ's analysis is "allowing Idahoans to be exposed to higher cancer risk." REC 7130. As discussed herein, the expert witness testimony clearly provides sufficient evidence demonstrating that DEQ's analysis was equally or more protective and is in fact provided for by the Air Rules.

As has been discussed, the Air Rules, specifically the AACCs, rely upon and incorporate EPA's science and methodologies. *See* REC 3876, REC 4284. The URFs in Section 586 were developed by EPA and "reflect[] many years of research and evaluation…" REC 4282. Using EPA's methodology for calculating cancer risk, both Dr. Paden and Theresa Lopez, Perpetua's Toxicologist and expert witness, concluded that the use of the project specific adjustment factor did not unreasonably increase the risk and was in compliance with the T-RACT 1-in-100,000 project-allowable increased cancer risk increment. *See* TR 0316:23, 0383:2.

Shockingly, Petitioners assert that "Dr. Paden and Ms. Lopez[] failed to establish that application of the 16/70 Project-specific adjustment factor to arsenic emissions is a scientifically valid method for assessing excess cancer risk…" REC 7134. Although Petitioners did not provide their own toxicologist, they still attack the two toxicologists who clearly opined that including

project duration was done in accordance with human health risk assessments.[6] Both Dr. Paden and Ms. Lopez calculated the cancer risk from the SGP using EPA's formula for human health risk assessments where cancer risk calculations are done using a variable exposure duration and an assumed 70-year lifetime. REC 3877. That formula is as follows:

EC = (CA x ET x EF x ED)/AT

Where: EC (µg/m3) = exposure concentration;
CA (µg/m3) = contaminant concentration in air;
ET (hours/day) = exposure time;
EF (days/year) = exposure frequency;
ED (years) = exposure duration; and
AT (lifetime in years 70 x 365 days/year x 24 hours/day) = averaging time

Id. And Ms. Lopez testified:

> Using the highest modelled annual average arsenic concentration from the project of 0.00414 µg/m3 (REC 716) the calculation of the air concentration adjusted for exposure from the SGP is as follows:

$$\left[0.00414\,\frac{\mu g}{m3}\,x\,24\,\frac{hours}{day}\,x\,\frac{1\,day}{24\,hours}\,x\,365\,\frac{days}{year}\,x\,16\,years\right] / \left[365\,\frac{days}{year}\,x\,70\,years\right] = 0.00095\,\frac{\mu g}{m3}$$

REC 4284. As Ms. Lopez explained:

> This calculation took the exposure, the CA, contaminate concentration in air, which was the emissions from the mine, multiplied it by 24 hours a day, 365 days a year, for 16 years, and then divided by the averaging time in years to develop an exposure concentration that is equal to .00095.

TR 0379:13-19.

Simply put, the result of these calculations demonstrated that the arsenic emissions from the SGP resulted in a 0.00095 µg/m3 arsenic concentration averaged over a lifetime. Thus, Ms. Lopez concluded "[t]he actual risk is four in a million or approximately one in 240,000." TR 0382:18-19; *see also* TR 0318:1-5 (Dr. Paden similarly concluded: "But most importantly, the 16

[6] Petitioners also discuss at length the "health impact assessments" from the State of Washington. Once again, Petitioners are just discussing what they wish the Air Rules prescribe.

years that we are discussing in this hearing, and that four in 1 million cancer risk. So that is the below the T-RACT which is below our rule standard for cancer risk. This is less than the T-RACT adjusted risk increment of 1-in-100,000."). Clearly, the formulas above account for exposure duration. Dr. Paden testified it is common practice when performing a risk assessment to adjust the exposure duration. TR 0326:22. She explained, stating:

> In fact, usually when we are talking about residential exposures you can use different values from EPA, 26 [years]. Or when you are valuating a receptor that could be -- a receptor who is going to be exposed, a recreational person who is going to go to the site only for a short amount of time, you can use that exposure duration, that way you don't overestimate the risk. So if you have information that is provided to me as a risk assessor and they tell me I am going to look at the risk here, to be more accurate I can use that information and put the 26, the 16, 15, whatever number the person is going to get exposed to get an accurate calculation of the cancer risk.

TR 0325:24-0326:13. Ms. Lopez agreed, stating "[c]omparing unadjusted emissions to the AACC would result in an over-estimation of cancer risk because the dose will not continue for the 70-year lifetime exposure assumed in the development of the AACC." REC 4283 (emphasis added).

C. DEQ's arsenic analysis is not an "ad hoc" approach but is consistent with DEQ practice.

Lacking a true legal basis, Petitioners instead argue that DEQ has engaged in an "ad hoc approach" and is creating a new, dangerous precedent. REC 7130. Petitioners imply that only now, under the scrutiny of a contested case, has DEQ considered the impact of its analysis on public health and whether it complies with the Air Rules. Nothing could be further from the truth. As was discussed at length during the evidentiary hearing, DEQ did not break from any established agency precedent when it factored in the duration of the project, both in terms of a 16-year lifetime and having an overall production limit.

Mr. Schilling testified that, in his experience, "we have not encountered applications that were over five years, but less than 70." TR 0249:1-2. He also stated a permittee must only indicate

how long it will operate "if they want to take credit for a shorter than permanent duration in their permitting -- in their permit itself." TR 0250:8-10. This is not a situation where DEQ previously considered and rejected a project specific adjustment. And this is also not a situation where DEQ has an explicit mandate preventing it from doing so. In fact, the Air Rules support its decision.

Petitioners continue to claim DEQ departed from agency practice. REC 7130. But neither Petitioners nor their witnesses could describe a situation where DEQ was confronted with a project-specific duration adjustment but denied it based upon some agency position or practice. When asked, Mr. Tiedemann stated that, in his time at DEQ, no permit applicant asked for a project specific adjustment (of less than 70 years but greater than 5). *See* TR 0621:7-8. It is difficult to understand how DEQ could have been departing from a "long-standing, pre-Stibnite Gold Project Precedent," REC 7131, when it was encountering a situation for the first time. Mr. Schilling explained that when Perpetua did make this request, DEQ considered and vetted it, focusing on ultimate compliance with lifetime cancer risk, ensured it was a "reasonable approach to our interpretation," and then ultimately moved forward. TR 0306:20-0307:3. Thus, in reality, DEQ followed its typical permitting process where "you start with an application and the analysis gets refined over time." TR 0212:11-13.

The Hearing Officer concurred, stating that where a project has a "life of 70 years or more, direct comparison of the highest modeled annual average concentration to the Acceptable Concentration is appropriate for determining compliance with Section 586." REC 7102. But when a project has "a known project life of less than 70 years, EPA adjusts the highest modeled annual average concentration to account for the different exposure durations in order to accurately calculate cancer risk with an Approved Concentration that is capable of comparison to the Acceptable Concentrations in Section 586." *Id.* Thus, "for projects such as the SGP in which

exposure is known to be for less than 70 years, it is inappropriate to compare this concentration to the Acceptable Concentration in order to determine compliance with Section 586." REC 7100.

Petitioners then argue the TAP Rule rulemaking history supports their contention that DEQ's approach strays from agency practice. REC 7130. Again, DEQ's application of the project specific adjustment is consistent with the purpose and intent of the TAP Rules. Mr. Schilling stated that, in his experience based on personally participating in the development of the rules, the "carcinogenic TAP AACCs were established to ensure that impacts of any carcinogenic TAPs from a project or facility would not cause a lifetime cancer risk over 1-in-1,000,000 or 1-in-100,000 when using T-RACT." REC 3926. He explained:

> Going all the way back to the toxics policy that was used in permitting, the cornerstone of that was focused on project risk. In other words, any particular project, whether it is a new facility or a modification, not causing a risk to exceed one in a million or one in 100,000, some things changed with T-RACT going from policy to regulation.

TR 200:5-12. Thus, "DEQ continually asserted that carcinogenic TAPs resulting from a permitting project should be regulated to prevent an unacceptable excess cancer risk based on a 70-year lifetime." REC 3922. In simple terms, from the beginning, the cornerstone of the TAP Rules is that total increased pollutant-specific cancer risk from a project over the project's life cannot exceed the lifetime cancer risk limit imposed by the rules.

Petitioners discuss the "intent of the Air Rules," but continue to rely on the random assortment of unofficial rulemaking documents provided during the evidentiary hearing. REC 7130. In doing so, Petitioners ignore the Hearing Officer's Second Preliminary Order, wherein he "agrees that many of the exhibits offered by the Petitioners' witnesses consisted of isolated references from prior rulemakings that lacked explanation of their context or relevance to the interpretation of the plain language of the existing Air Rules." REC 7096-7097. Thus, the opinions

of witnesses who were not participants in the rulemaking and the assortment of unexplained documents should have no bearing.

Based on the above, the expert testimony demonstrates that the project specific adjustment was reasonable – calculating cancer risk naturally requires one to consider the exposure duration. REC 3877, REC 4286. The adjustment has also been shown to be lawful – the AACCs are based on EPA's methodologies and adjusting the exposure length is consistent with EPA methodologies. See REC 3876-77, 4286. Ultimately, the testimony of Dr. Paden and Ms. Lopez establish "the highest air concentration of arsenic from the project is below the acceptable lifetime risk established by the T-RACT AACC." REC 4285.

II. The Hearing Officer Properly Concluded that DEQ Acted Reasonably and in Accordance with Law in Using the Five-Year Rolling Average

Next, the Board asked the Hearing Officer to consider DEQ's use of a five-year rolling average for determining compliance. The testimony presented demonstrated that the five-year rolling average production limit for assessing compliance with the AACC is both reasonable and lawful. But since Petitioners continue to wrongly assert that the AACCs provide annual compliance limits, they also continue to assert that a five-year rolling average is insufficient. REC 7139. But "long-term exposure to a given concentration over the life of the project is the critical parameter for the risk-based AACCs." REC 3919. Mr. Schilling explained:

> It goes back to the same cornerstone of the rules being project-imposed risk. As long as project-imposed risk is the criteria and we have a duration of the project of 16 years, what really matters for demonstrating, whether it complies or not, is where are we at after 16 years.

TR 0221:14-19. Thus, the "[u]se of a 5-year averaging period for limiting processing rates easily accomplishes this requirement for a project with a 16-year duration, and it provides for reasonable periodic assurance of compliance with the long-term limit." REC 3926. Again, DEQ does not

simply determine if the SGP complied with the lifetime AACC at the end of the project. Instead, DEQ uses "something less than 16 years as a responsible vehicle to identify when things might… be going wrong at an earlier time." *Id*.

The PTC also contains "sideboards" on production. Mr. Schilling and Kevin Lewis, Perpetua's expert witness and air quality engineer, described these sideboards stating, "there are shorter-term processing limits in [the PTC]," TR 0225:20-21, and "[i]t's the 135,000 tons per day has sideboards and, you know, other short-term limits that you have to demonstrate compliance with…" TR 0549:12-14. But because Perpetua also has year to year operational variability given its operations, the five-year rolling average is actually more representative of emissions – not simply capturing one year that may be much different from any other year, operation-wise. *See* TR 0549:21-24. Dr. Paden confirmed that "if a five-year rolling average was actually more representative because of the variability of the project, [that] would… actually be the best number to use as the representative number." TR 0356:22-175:2. The Hearing Officer concurred, stating: "For projects like the SGP with highly variable emissions over time, a five-year rolling average of emissions is more representative of actual emissions from the project than evaluating emissions on an annual basis." REC 7108.

Because DEQ demonstrated the project adjustment factor was protective of public health, it follows that the five-year rolling average is also protective. When Perpetua's counsel asked Mr. Lewis, if "the five-year rolling average is a way to disguise whether or not this permit is going to allow Perpetua to exceed the T-RACT limits," Mr. Lewis stated: "That's just a complete mischaracterization of what's going on." TR 0550:5-12. And, in fact, Perpetua's counsel confirmed that, "even at its peak mining production, on any one given day, even if you strung it together every day for an entire year… [the SGP] still wouldn't exceed the T-RACT control limit."

TR 0550:19-22. If Perpetua can demonstrate that it will comply with the AACCs, understanding that it is a lifetime risk for the 16-year project, then a five-year rolling average is a reasonable method for measuring compliance. Again, the Hearing Officer agreed, finding:

> In fact, because Section 586 is focused on excess cancer risk posed by a project over the course of an assumed 70-year lifetime or the lifetime of a project that will last less than 70 years, the five-year rolling average approach in Condition 3.5 is stricter and more protective than Section 586 requires.

REC 7108. Again, for the reasons set forth herein, DEQ was both reasonable and lawful in using a five-year rolling average.

III. The Hearing Officer Properly Concluded that DEQ Acted Reasonably and in Accordance with Law as there was Sufficient Evidence to Support the T-RACT Analysis Limiting the Non-West End Pit Production Limit

Finally, the Board had concluded "there was insufficient evidence in the record to demonstrate exactly how or whether the non-West End Pit production was limited and, if it was, the Board of Environmental Quality could not find any PTC conditions able to enforce that reduction." REC 3714. Petitioners continue to assert that the PTC does not effectively limit production from the West End Pit or Non-West End Pit. REC 7141. According to the testimony of Mr. Schilling and Mr. Lewis, the PTC appropriately and effectively limited both West End Pit and non-West End Pit production. *See* REC 3927; REC 4139; TR 0227; TR 0539. Mr. Schilling explained: "There's sort of two main limits. There's a total mine limit in there of 788.4 million tons. And then there is a west end pit-specific limit of 50 percent of that, which is 394.2 million tons."[7] TR 0227:11-15. Thus, a "limit to the non-west end pit production sources was not needed because even if 100 percent of the production is from non-west end pit sources, we're still in

[7] Petitioners state: "100% West End Pit production is a realistic possibility." REC 7142. This is incorrect. As Mr. Schilling testified, PTC Condition 3.6 limits West End Pit production to 50% of the total ore. TR 0227:11-15.

compliance." TR 0227:18-21. This was important because, as Mr. Lewis explained, "pound for pound, the West End Pit resulted in higher ambient air impacts." TR 0565:14-16.

These limits are contained in the PTC as Condition 3.6, which "limits total hauling and excavation from the mine to 788.4 million tons" and it "limits hauling and excavation from the West End Pit to 394.2 million tons, which is equal to 50% of total allowable production." REC 3927; *see also* REC 4139. Thus, a limit to the non-West End Pit was not necessary based on the following relationship:

$$\text{Production}_{\text{Non-WEP}} = \text{Production}_{\text{total}} - \text{Production}_{\text{WEP}}$$

See REC 3928.

As the Hearing Officer explained, "Because Condition 3.6 limits [West End Pit] production to 394.2 million tons, and because 394.2 million equals 50% of 788.4 million tons, Condition 3.6 limits [West End Pit] production to 50% of total authorized production." REC 7110. Accordingly: "If 50% of total production from the SGP occurs from the West End Pit, then production from non-[West End Pit] sources is automatically limited to 50% of total production under the plain language of Condition 3.6." REC 7110. Again, this is important because, as the Hearing Officer explained: "As haulage from the WEP decreases and haulage from non-WEP sources increases, the modeled arsenic impacts decrease further and further below the Acceptable Concentration." REC 7110. Based on the relationship between West End Pit and Non-West End Pit production, and the overall limits in the permit, the Hearing Officer concluded that "it was reasonable for DEQ not to include a specific Permit condition limiting non-[West End Pit] haulage to 50% of total mine haulage for the life of the SGP." REC 7110-7111. Therefore, DEQ acted both reasonably and lawfully, as a limit on non-West End Pit sources is not required and would not make sense in the context of the existing limit on total production and West End Pit production.

Petitioners also discuss Dr. von Lindern's testimony "that the .00416 µg/m3 is calculated by averaging the average of seven non-West End Pit emissions scenarios with the one West End Pit emission scenario, and this averaging technique worked to reduce the apparent emissions by a factor of 1.7." REC 7142. This methodology—averaging across the different scenarios—is simply not the methodology used by Perpetua, is not the methodology presented and described in the SGP PTC application, and is not the methodology approved by DEQ and used for permit issuance. The Petitioners continue to use Dr. von Lindern's fabricated methodology to falsely claim DEQ inappropriately diluted maximum predicted impacts.

When Dr. von Lindern discussed this alleged averaging during the hearing, he claimed DEQ does "another dose-averaging exercise where they take the worst-case scenario and they dilute it by combining it with other scenarios…" TR 0715:6-8. The amounts referenced by Petitioners in their Second Petition, and used by Dr. von Lindern, come from "Table C. TAP Maximum Modeled Concentrations and Applicable AACs." TR, Exhibit 304. Mr. Lewis explained that "[t]his table represents, again, modeling at 135,000 tons per day, and in this case, it's -- it's the annual average concentration that the model spits out." TR 0569:9-10. Mr. Lewis also testified that the numbers used from Table C do not reflect DEQ's permit conditions, such as limits to the West End Pit, and, therefore, are not representative. TR 0569:12-14. Importantly, Perpetua did not propose and DEQ did not accept any averaging for the impacts. Instead, the methodology described in Section 5.8 of DEQ's TAPs Addendum Modeling Review Attachment of the Ambient Air Quality Impact Analysis Review Memorandum was used to evaluate maximum impacts on a receptor-by-receptor basis for all potential scenario combinations, as follows:

$$LifeExpose_{Wi,j,n} = \left[\left(WEPExpose_{Wi,n}\right)(50\%) + \left(nonWEPExpose_{Sj,n}\right)(50\%)\right]\left[\frac{16\ year\ LOM}{70\ year\ exposure}\right]$$

Where:

W*i*	=	West End Pit scenario, where *i* = 1 to 4.
S*j*	=	non West End Pit scenario, where *j* = B1, B2, H1, H2, H3, H4, Y1, Y2, and Y3.
n	=	specific receptor.
$LifeExpose_{Wi,j,n}$	=	lifetime exposure in µg/m^3 for West End Pit scenario *i*, non West End Pit scenario *j*, at receptor *n*.
$WEPExpose_{Wi,n}$	=	annual maximum impact in µg/m^3 for West End Pit scenario *i* at receptor *n*.
$nonWEPExpose_{Sj,n}$	=	annual maximum impact in µg/m^3 for non West End Pit scenario *j* at receptor *n*.
16 year LOM	=	maximum life-of-mine.
70 year exposure	=	Lifetime exposure used for development of AACCs in *Idaho Air Rules*.

See REC 3946-3947. From results calculated at specific receptors and for all scenarios (given by the above equation), the maximum impact at each receptor is determined by selecting the West End Pit/non-West End Pit scenario combination that provides the largest impact. *Id.* That is obtained by using the maximum impact of all West End Pit scenarios and the maximum impact of all non-West End Pit scenarios at that receptor. *Id.* From the population of maximum impacts at specific receptors, the overall maximum impact is selected as the value for comparison to the arsenic AACC. *Id.*

Considering the receptor that had the highest overall adjusted maximum impact of 0.00095 µg/m3, the unadjusted impacts from non-West End Pit scenarios ranged from 0.00010 µg/m3 to 0.00129 µg/m3 and West End Pit scenarios ranged from 0.00581 µg/m3 to 0.00698 µg/m3. *See* REC 3928; REC 3946-3947. By using the worst-case permit-allowable condition of 50% of production from the West End Pit sources and the remaining 50% from non-West End Pit sources, DEQ arrived at a combined maximum impact of 0.00414 µg/m3. *See* REC 3923. When this is adjusted using the 16/70 factor to account for limited exposure duration, DEQ arrived at 0.000945 µg/m3, which was rounded up to 0.00095 µg/m3. *Id.* There was no averaging among scenarios or

among receptors that could inappropriately dilute estimated impacts. The method calculated impacts from each scenario at each receptor, then selected the maximum potential impact at each receptor, and finally selected the receptor with the highest impact. *See* REC 3946-3947.

CONCLUSION

DEQ takes very seriously its mission to protect public health and the environment. After an enormous effort, which included much stakeholder involvement, DEQ issued a permit that is legally and technically defensible. REC 1273. Petitioners have failed to prove that DEQ committed any errors in its thorough and diligent PTC analysis, including in its analysis of the ambient arsenic air emissions. The expert witness testimony requested by the Board clearly demonstrates that DEQ acted reasonably and lawfully. The Hearing Officer agreed, after considering the testimony proffered by the parties. Thus, as to each of the Remaining Issues, Petitioners continue to fail to meet their burden, and the Board must uphold the Hearing Officer's Second Preliminary Order.

DATED: February 4, 2025

STATE OF IDAHO
OFFICE OF THE ATTORNEY GENERAL

/s/ Hannah M.C.Young

HANNAH M.C. YOUNG
Deputy Attorney General
Attorneys for the Idaho Department of Environmental Quality

CERTIFICATION OF SERVICE

I HEREBY CERTIFY that on this 4th day of February, 2025, a true and correct copy of the foregoing **RESPONDENT IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY'S RESPONSE TO PETITIONERS' PETITION FOR REVIEW OF JANUARY 7, 2025 PRELIMINARY ORDER** was served on the following via electronic mail to the indicated address:

Bryan Hurlbutt
Laurence ("Laird") J. Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701

Attorneys for Petitioner Nez Perce Tribe and Idaho Conservation League

bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638

Attorney for Petitioner
Save the South Fork Salmon

jthrower@mtntoplaw.com
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole C. Hancock
Stoel Rives LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702

Attorneys for Intervenor
Perpetua Resources of Idaho, Inc.

krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
nicole.hancock@stoel.com
via electronic service

Dylan B. Lawrence
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701

Hearing Officer

dylan@varinthomas.com
via electronic service

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010

ann.yribar@ag.idaho.gov
via electronic service

Diane Cutler
Hearing Coordinator
Rules and Planning Analyst
Department of Environmental Quality
1410 N Hilton
Boise ID 83706

diane.cutler@deq.idaho.gov
via electronic service

Office of Administrative Hearings

filings@oah.idaho.gov
via electronic service

/s/ DeAnne M. Chaffin
DeAnne M. Chaffin
Legal Assistant

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
Nicole C. Hancock, ISB No. 6899
nicole.hancock@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 _____ NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	Case Docket No. 0101-22-01 OAH Case No. 23-245-01 PERPETUA'S OPPOSITION TO PETITION FOR REVIEW OF JANUARY 7, 2025 PRELIMINARY ORDER

TABLE OF CONTENTS

TABLE OF AUTHORITIES ii

KEY TO TERMS AND ABBREVIATIONS iii

I. INTRODUCTION AND BACKGROUND 1

II. STANDARD OF REVIEW 3

III. DEQ'S ASSESSMENT OF THE PROJECT'S IMPACT ON INCREMENTAL LIFETIME CANCER RISK UNDER THE TAPs RULES 5

A. DEQ's assessment of preconstruction compliance with the TAPs rules relies on cancer risk values and risk assessment methodology established by EPA. 5

B. The AACCs are derived from EPA's URFs/IURs, which represent continuous exposure over an assumed 70-year lifetime. 6

C. DEQ compared the Project's modeled arsenic exposure concentration to the T-RACT AACC accounting for maximum production limits. 7

IV. ARGUMENT 9

A. The evidence supports the Hearing Officer's conclusion that DEQ properly adjusted for exposure duration to derive the Project's modeled arsenic exposure concentration based on the PTC's production limits. 10

1. DEQ and Perpetua's expert evidence supports the Hearing Officer's conclusion that the T-RACT AACC is not an annual limit but represents an ambient concentration that aligns with the lifetime incremental cancer risk 10

2. DEQ and Perpetua's expert evidence supports the Hearing Officer's conclusion that adjusting the modeled exposure concentration to reflect exposure duration is consistent with the TAPs rules. 13

3. Petitioners present a range of irrelevant references and misinformation that fails to change the Hearing Officer's findings of fact and conclusions of law. 17

4. DEQ and Perpetua's expert evidence supports the Hearing Officer's conclusion that a limit on years of operation is not necessary. 18

B. The evidence supports the Hearing Officer's conclusion that DEQ reasonably used a five-year rolling average production limit as a T-RACT long-term limit. 20

C. The evidence supports the Hearing Officer's conclusion that PTC conditions were sufficient to limit production from the non-West End Pits. 22

1. DEQ and Perpetua's expert evidence showed how the PTC limits production from the non-West End Pits and that no separate limit is necessary. 22

2. Petitioners' contention that the maximum modeled annual average arsenic concentration was 0.00698 $\mu g/m^3$ is not supported by the evidence. 23

V. CONCLUSION 25

TABLE OF AUTHORITIES

Cases

Earth Island Inst. v. U.S. Forest Serv.,
351 F.3d 1291 (9th Cir. 2003) 4

Harris v. Elec. Wholesale,
141 Idaho 1, 105 P.3d 267 (2004)....4

Huntsman Petrochemical LLC v. EPA,
114 F.4th 727 (D.C. Cir. 2024)....4, 12, 17

Loper Bright Enters. v. Raimondo,
603 U.S. 369 (2024)....4

Statutes

Idaho Code § 67-5251(4)(b) 4

Idaho Code § 67-5251(5)....4

Idaho Code § 67-5279(5)....4

Regulations

Idaho Air Rule 006.125....5, 7

Idaho Air Rule 007.12....7

Idaho Air Rule 106.02....5

Idaho Air Rule 106.19....6

Idaho Air Rule 161....5, 7, 18, 25

Idaho Air Rule 203....5, 25

Idaho Air Rule 210....5, 25

Idaho Air Rule 210.12.... passim

Idaho Air Rule 210.15....16

Idaho Air Rule 586.... passim

IDAPA 62.01.01.485 1

IDAPA 62.01.01.477 ....3, 4

KEY TO TERMS AND ABBREVIATIONS

AACC	Acceptable Ambient Concentration for a Carcinogen
Board	Board of Environmental Quality
DEQ	Respondent Idaho Department of Environmental Quality
EPA	United States Environmental Protection Agency
Idaho Air Rules	Rules for the Control of Air Pollution in Idaho, IDAPA 58.01.01. *et seq*. (2022)
IUR	Inhalation Unit Risk, developed by EPA
Perpetua	Intervenor-Respondent Perpetua Resources Idaho, Inc.
Petition for Review	Petitioners' Petition for Review of January 7, 2025 Preliminary Order, Memorandum in Support, and Request for Hearing (REC 7119-45)
Petitioners	Petitioners Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon
Preliminary Order	Findings of Fact, Conclusions of Law, and Preliminary Order, dated January 7, 2025 (*REC 7091-7118*)
Project	Stibnite Gold Project
PTC	Air Quality Permit to Construct No. P-2019.0047, issued to Perpetua on June 17, 2022 (REC 367-409)
TAPs	Toxic air pollutants
T-RACT	Toxic air pollutant reasonably available control technology
URF	Unit Risk Factor, based on EPA's IUR

Perpetua opposes Petitioners' Petition for Review. The Board should affirm and accept the Hearing Officer's Preliminary Order and dismiss Petitioners' contested case challenging the PTC issued by DEQ for the Project.

I. INTRODUCTION AND BACKGROUND

The Board remanded this matter to seek the development of a "full factual record" regarding "the ambient air concentrations of arsenic that will be produced by the Stibnite Gold Project and whether those levels comply with the Air Rules." REC 3717; *see also* REC 3841-42. Specifically, the Board's remand was limited to three narrow issues:

(1) whether the "16/70 analysis performed by DEQ was equally or more protective of human and animal life and vegetation as what is provided for by the Air Rules" and whether ambient air concentrations of arsenic from the Project comply with the Idaho Air Rules, REC 3715-17;

(2) whether DEQ acted reasonably in using a five-year rolling average in analyzing arsenic ambient air concentrations, REC 3712-13; and

(3) whether non-West End Pit production was limited, and what effect non-West End Pit production has on arsenic emissions, REC 3713-14.

The Board observed that those issues involve cancer risk probability associated with arsenic emissions beyond the ordinary knowledge of a layperson. *See* REC 3716. An expert witness's scientific, technical, or other specialized knowledge was necessary to help the Board understand the complex relationship between arsenic exposure, incremental lifetime cancer risk, and the Idaho Air Rules. *See id.*; IDAPA 62.01.01.485.

On remand, the Hearing Officer took extensive evidence on the three issues. DEQ presented the expert testimony of Dr. Norka Paden (a DEQ Toxicological Risk Assessor) and Kevin Schilling (DEQ's Stationary Source Modeling Supervisor). Perpetua presented the expert

testimony of Theresa Lopez (a Principal Toxicologist with Tetra Tech, Inc.) and Kevin Lewis (an expert in air quality modeling and permitting for mining projects). Petitioners presented witnesses Dr. Ian von Lindern (a chemical engineer) and William Tiedemann (a regulatory conservation associate with the Idaho Conservation League).

After hearing the evidence, the Hearing Officer issued the Preliminary Order (*REC 7091-7118*) and concluded that DEQ assessed ambient concentrations of arsenic from the Project reasonably and in compliance with the Idaho Air Rules.[1] The Hearing Officer determined that:

- in the Idaho Air Rules, DEQ adopted incremental cancer risk values and assessment procedures established by EPA;
- EPA and DEQ methodologies are intended to evaluate incremental excess cancer risk from continuous exposure over a 70-year lifetime, not one year;
- according to standard EPA cancer risk assessment procedures, modeled arsenic exposure concentrations from the Project must be adjusted to reflect the PTC's maximum production limits and the Project's 16-year exposure duration;
- the incremental lifetime cancer risk associated with the Project's finite emissions is 1-in-240,000, which is below the applicable cancer risk probability of 1-in-100,000; and
- the Project's duration under the PTC's maximum production limits would be 16 years and a longer duration does not change arsenic emissions or the acceptable cancer risk.

The Hearing Officer's findings and conclusions are correct and fully supported by the record on remand. Petitioners had the opportunity to prove that DEQ and Perpetua were wrong on the science and the law, and they failed to meet their burden of proof.

Petitioners repeat the same arguments in the Petition for Review and criticize DEQ for

[1] All citations are to the 2022 version of the Idaho Air Rules.

not consulting a toxicologist until the Board's remand order. REC 7129, 7143. Petitioners claim DEQ and Perpetua "concocted" a "post-hoc excess cancer risk 'assessment'" and have used "mathematical tricks" to justify evaluating the Project's arsenic emissions and cancer risk over 70 years. REC 7129, 7143. The record shows that DEQ maintained the same reasonable approach all along. At the Board's direction, DEQ and Perpetua offered the toxicological framework and standard cancer risk assessment procedures that support and reinforce DEQ's review of the Project's arsenic emissions in compliance with the Idaho Air Rules.

The Hearing Officer concluded that the testimony of Dr. von Lindern and Mr. Tiedemann was unconvincing and only of "general relevance" on the complex areas of air quality modeling and cancer risk assessment of ambient concentrations of arsenic. *REC 7096*. "Often," as the Hearing Officer observed, "Mr. Tiedemann and Dr. von Lindern testified regarding what they wished the Air Rules said, rather than what they actually say." *Id*. The record confirms the Hearing Officer's statement. Petitioners' witnesses offered nothing more than "isolated references from prior rulemakings" and policy preferences that cannot overcome DEQ's reasonable and science-based decision making under the Idaho Air Rules. *See id*.

The Board must affirm and adopt the Hearing Officer's Preliminary Order and deny the Petition for Review. Petitioners' views cannot be substituted for DEQ's technical competence and specialized knowledge. Yet they ask the Board to accept their preferences and reject not only the choices made by DEQ, but the judgment of the Hearing Officer who carefully considered the evidence, including extensive toxicological evidence, requested by the Board.

II. STANDARD OF REVIEW

The Board "must determine whether DEQ 'has acted reasonably and in accordance with the law.'" REC 3697 (citations omitted). The Petitioners carry the burden to establish that DEQ acted unreasonably or inconsistent with the law and must prove their allegations by a

preponderance of the evidence. IDAPA 62.01.01.477. "A 'preponderance of the evidence' is evidence that, when weighed with that opposed to it, has more convincing force and from which results a greater probability of truth." *Harris v. Elec. Wholesale*, 141 Idaho 1, 3, 105 P.3d 267, 269 (2004); Idaho Civil Jury Instruction 1.20.1 (describing preponderance of the evidence as "the proposition is more probably true than not true").

Petitioners ignore the Board's standard of review and their burden of proof. *See* REC 7122-23. They also fail to acknowledge that the Board may consider DEQ's "experience, technical competence, and specialized knowledge" to evaluate evidence.[2] Idaho Code § 67-5251(5); *see also* Idaho Code § 67-5251(4)(b) (allowing official notice of "generally recognized technical or scientific facts within the agency's specialized knowledge"); Michael S. Gilmore & Dale D. Goble, *The Idaho Administrative Procedure Act: A Primer for the Practitioner*, 30 Idaho L. Rev. 273, 319 (1994) ("[T]he agency's repeated exposure to a specialized subject matter is a source of specialized knowledge that is useful in evaluating evidence.").

A decision rooted in an agency's technical competence and specialized knowledge is generally accorded great weight. *Earth Island Inst. v. U.S. Forest Serv.*, 351 F.3d 1291, 1301 (9th Cir. 2003). This is particularly persuasive when an agency is performing emissions assessments and modeling, including in the context of risk assessments. *See Huntsman*

[2] The Idaho Legislature recently amended the standard for judicial review under the Idaho Administrative Procedure Act to prohibit deference to agency interpretations, Idaho Code § 67-5279(5), but the standard for judicial review does not apply to the Board's review of the PTC, *see* REC 3377 (explaining that the statute's standards "are not directly applicable"). Nor does the amendment change the recognition of an agency's "experience, technical competence, and specialized knowledge" involving complex technical matters under Idaho Code § 67-5251(5). In a similar vein, while the United States Supreme Court recently eliminated judicial deference to agency interpretations of law under the federal Administrative Procedure Act, the Court explained that "although an agency's interpretation of a statute 'cannot bind a court,' it may be especially informative 'to the extent it rests on factual premises within [the agency's] expertise.'" *Loper Bright Enters. v. Raimondo*, 603 U.S. 369, 402 (2024) (citation omitted).

Petrochemical LLC v. EPA, 114 F.4th 727, 735 (D.C. Cir. 2024) (rejecting a challenge to EPA cancer risk assessment of ethylene oxide under Clean Air Act hazardous air pollutant standards).

III. DEQ'S ASSESSMENT OF THE PROJECT'S IMPACT ON INCREMENTAL LIFETIME CANCER RISK UNDER THE TAPS RULES

As the Preliminary Order outlines, DEQ evaluated the Project's arsenic emissions under Idaho's TAPs rules. The Hearing Officer's findings emphasize two key elements of the TAPs rules' risk-based approach to evaluate arsenic emissions: (1) the TAPs rules are project-specific and based on EPA cancer risk values and assessment methodologies that assume 70-year lifetime exposure; and (2) following EPA's standard cancer risk assessment procedures, DEQ compared the Project's modeled arsenic exposure concentration to the arsenic cancer risk increment established in the TAPs rules.

A. DEQ's assessment of preconstruction compliance with the TAPs rules relies on cancer risk values and risk assessment methodology established by EPA.

The TAPs rules are an Idaho specific program. *REC 7097 (¶ 7)*; Tr. 91:12-92:1 (Schilling). DEQ's evaluation of TAPs starts with Idaho Air Rule 161. *REC 7098 (¶ 11)*; Idaho Air Rule 203. Section 161 requires DEQ to determine that TAP emissions will not injure or unreasonably affect human, animal life, or vegetation. *REC 7098 (¶¶ 11-12)*. Preconstruction compliance with Section 161 can be shown using the methods provided in Idaho Air Rule 210. *See REC 7098 (¶ 13)*; Idaho Air Rule 203.03; Tr. 25:7-26:3 (Schilling). Under Section 210, compliance is determined on a project basis and based on project-specific conditions. *See REC 7097-98 (¶¶ 8-9)*; Tr. 17:7-22:9, 37:10-38:22, 84:4-22 (Schilling); REC 3921-24 (¶¶ 12-19).

Preconstruction compliance may be demonstrated by comparing emissions with the applicable TAP carcinogenic increment expressed as an "AACC" (or "acceptable ambient concentration for a carcinogen") in Idaho Air Rule 586. *See REC 7098 (¶ 14)*; Idaho Air Rules 006.125, 106.02, 203, 210, 586. TAP carcinogenic increments are different than standards, which

are emission limits. Tr. 35:10-36:21 (Schilling). As Mr. Schilling explained, "An increment is just a base-allowed impact for that project. So it doesn't concern itself with what goes on at the whole rest of the facility or what goes at the neighboring facility or what is already there for background. It says you can do this no matter what." Tr. 36:16-21 (Schilling).

B. The AACCs are derived from EPA's URFs/IURs, which represent continuous exposure over an assumed 70-year lifetime.

The table of AACCs in Section 586 contains a column labeled "URF." *REC 7100 (¶ 31)*; Idaho Air Rule 586. URF is a reference to a Unit Risk Factor developed and published by EPA. *See REC 7100 (¶ 32)*; Idaho Air Rule 106.19 ("URF. Unit Risk Factor from the US Environmental Protection Agency"). EPA refers to URFs as "IURs" or inhalation unit risk factors. *REC 7100 (¶ 33)*; Tr. 181:15-182:19, 188:10-22 (Lopez); REC 4282 (¶¶ 12-14). As explained below, the allowable increments provided in the AACCs are derived from URFs/IURs.

URFs/IURs represent a chemical-specific excess cancer risk based on exposure to 1 $\mu g/m^3$ of that substance continuously (24 hours/day and 365 days/year) over an assumed 70 year lifetime.[3] *REC 7101 (¶ 34)*; Tr. 19:11-20:18 (Schilling); REC 3922 (¶ 15); Tr. 135:2-13, 138:18-13 (Paden); REC 3876-77 (¶¶ 11-12); Tr. 181:15-182:1 (Lopez); REC 4282 (¶¶ 12-13); *see also* Ex. 210. EPA develops URFs/IURs based on years of scientific study, taking into account the exposure of sensitive subpopulations (e.g., children and pregnant women) and measuring excess cancer risk above the background risk. *REC 7101 (¶¶ 36-37)*; Tr. 138:6-139:5, 147:16-148:5, 153:13-154:12, 171:20-172:21 (Paden); Tr. 181:23-182:19, 188:2-22, 190:8-191:6 (Lopez).

The AACCs in Section 586 are derived from URFs/IURs. *REC 7101 (¶ 38)*; Tr. 20:6-21:10 (Schilling) (explaining that URFs are the "cornerstone of the whole TAPs program for

[3] A lifetime cancer risk of 1-in-1,000,000 means that if 1 million people are continuously exposed to a specific concentration of a substance (as established by the URF/IUR) for 70 years, one person may develop cancer.

regulating carcinogenic compounds"); Tr. 138:15-139:5 (Paden); Tr. 181:15-182:19 (Lopez); REC 4282 (¶ 16). Relevant here, the URF/IUR for arsenic is 0.0043/μg/m^3, which converts to an AACC of 0.00023 μg/m^3. *See* Idaho Air Rule 586. The calculation of the AACC is simply the incremental lifetime cancer risk of 1-in-1,000,000 divided by the URF/IUR.[4] *See* Tr. 136:6-137:10 (Paden); REC 3876-77 (¶ 11); Tr. 194:18-195:8 (Lopez); REC 4282-83 (¶¶ 16-17).

Derived from URFs/IURs, the AACCs represent the ambient concentration that a person could be exposed to continuously for a 70-year lifetime before the cancer risk exceeds 1-in-1,000,000. *REC 7101 (¶¶ 39, 82)*; Tr. 20:6-18, 30:21-32:3, 126:9-14 (Schilling); Tr. 135:2-13 (Paden); REC 3876-77 (¶¶ 11-12); Tr. 194:18-195:8 (Lopez); REC 4282-83 (¶¶ 16-18). This is made clear by Idaho Air Rule 006.125, the definition of "Toxic Air Pollutant Carcinogenic Increments." *See* REC 7101 (¶ 40). Section 006.125 reads:

> Those ambient air quality increments based on the probability of developing excess cancers over a seventy (70) year lifetime exposure to one (1) microgram per cubic meter (1 ug/m^3) of a given carcinogen and expressed in terms of a screening emission level or an acceptable ambient concentration for a carcinogenic toxic air pollutant. They are listed in Section 586.

See also Tr. 31:19-32:14 (Schilling) (explaining that the definition "makes it clear that it focuses on a total project-imposed cancer risk rather than a specific year by year").

C. DEQ compared the Project's modeled arsenic exposure concentration to the T-RACT AACC accounting for maximum production limits.

Section 210.12 allows a source to use "T-RACT" to demonstrate preconstruction compliance with Section 161. *REC 7098 (¶¶ 14-16)*. T-RACT is defined as an "emission standard based on the lowest emission of [TAPs] that a particular source is capable of meeting by the application of control technology that is reasonably available." *REC 7098-99 (¶ 15)* (quoting Idaho Air Rule 007.12). Where T-RACT operational limits are used to control emissions, the

[4] 0.000001 / 0.0043 per μg/m^3 = 0.00023 μg/m^3.

allowable incremental cancer risk probability over a 70-year lifetime of exposure is 1-in-100,000, or 10 times the AACC. *REC 7099 (¶ 19)*; Idaho Air Rule 210.12.b. This is called the T-RACT AACC, which for arsenic is 0.0023 μg/m^3. *REC 7099-7100 (¶¶ 22-24)*.

To show compliance with the T-RACT AACC, the plain language of Section 210.12.b requires DEQ to *compare* the source's "approved T-RACT ambient concentration" to the cancer risk probability reflected by the T-RACT AACC:

> *Compare* the source's or modification's approved T-RACT ambient concentration at the point of compliance for the toxic air pollutant to the amount of the toxic air pollutant that would contribute an ambient air cancer risk probability of less than one to one hundred thousand (1:100,000) (which amount is equivalent to ten (10) times the applicable acceptable ambient concentration listed in Section 586).

Idaho Air Rule 210.12.b (emphasis added). During the hearing, the "approved T-RACT ambient concentration" was referred to in various ways. DEQ and Perpetua's toxicologists referred to it as the "exposure concentration." *See*, *e.g.*, Tr. 141:17-143:1 (Paden); Tr. 191:12-193:2 (Lopez). In the Preliminary Order, the Hearing Officer refers to it as the "Approved Concentration." REC *7099 (¶¶ 18-19)*. For clarity, this brief refers to it as the "modeled exposure concentration," or in the case of arsenic, the "modeled arsenic exposure concentration."

The modeled exposure concentration is the source's modeled maximum annual average ambient concentration of the TAP based on the T-RACT operational limits. Operational limits for the Project are the maximum production limits under PTC Conditions 3.5 and 3.6. If Perpetua were to operate without interruption at those production limits, the Project's exposure duration would be 16 years. If under this worst-case scenario the modeled arsenic exposure concentration is less than or equal to the T-RACT AACC, then "no further procedures for demonstrating preconstruction compliance will be required for that toxic air pollutant as part of the application process." *See REC 7099 (¶ 21)* (quoting Idaho Air Rule 210.12.c); Tr. 65:4-18 (Schilling).

DEQ determined that the Project's modeled arsenic exposure concentration, adjusted to reflect the PTC's maximum production limits and related 16-year exposure duration, is 0.00095 µg/m^3, *which is less than the T-RACT AACC of 0.0023 µg/m^3*. REC 3877 (¶¶ 12-14); Tr. 197:9-19, 200:2-201:25 (Lopez); REC 4284-85 (¶¶ 24-25). DEQ used the following equation, based on standard EPA cancer risk assessment procedures:

EC = 0.00414 µg/m^3 x 16 years / 70 years = 0.00095 µg/m^3

See REC 7103 (¶ 59); REC 714. The modeled arsenic exposure concentration of 0.00095 µg/m^3 reflects an incremental lifetime cancer risk of 1-in-240,000, which is well below the acceptable cancer risk probability of 1-in-100,000 of the arsenic T-RACT AACC. *REC 7103 (¶¶ 60, 61)*; Tr. 136:1-5 (Paden); Tr. 200:2-201:25 (Lopez); REC 4284-85 (¶¶ 24-30).

IV. ARGUMENT

On remand, expert evidence from DEQ and Perpetua established the following to reinforce DEQ's evaluation of arsenic emissions and compliance with the TAPs rules:

(1) scientific principles and standard cancer risk assessment procedures require (a) the adjustment of the modeled arsenic exposure concentration for the Project's exposure duration for a true comparison to the T-RACT AACC, and (b) the adjustment for exposure duration does not increase cancer risk because cumulative exposure over the Project's life does not change;

(2) the 135,000 ton per day five-year rolling average for daily production established by the PTC does not increase cancer risk because the AACCs are based on 70 years of constant exposure, not exposure in any single year; and

(3) the PTC's total life-of-mine production limit and the 50% production limit on the West End Pit restrict production from the non-West End Pits and are designed to ensure the incremental lifetime cancer risk remains below the T-RACT AACC.

Petitioners' arguments that the AACCs are annual limits that cannot be adjusted for exposure duration are unavailing and contrary to standard cancer risk assessment and good science. Dr. von Lindern and Mr. Tiedemann's testimony in many instances articulated nothing more than their policy preferences and uninformed interpretation of the TAPs rules. *See REC 7096-97*. Petitioners failed to satisfy their burden to show DEQ acted unreasonably or unlawfully.

A. The evidence supports the Hearing Officer's conclusion that DEQ properly adjusted for the exposure duration to derive the Project's modeled arsenic exposure concentration based on the PTC's production limits.

Petitioners contend the Hearing Officer ignored the Board's interpretation that the TAPs rules do not allow adjustment of the Project's maximum arsenic concentration for exposure duration. REC 7126-27, 7133-34. Petitioners misconstrue the Board's remand order. The Board remanded on three issues to the Hearing Officer to develop a "full factual record," REC 3840-41, including evidence from toxicologists or other experts regarding "the ambient air concentrations of arsenic that will be produced by the Stibnite Gold Project and whether those levels comply with the Air Rules," REC 3716-17. On remand, the Hearing Officer concluded that DEQ and Perpetua's expert evidence demonstrated DEQ acted consistent with the scientific principles governing cancer risk assessment and the TAPs rules. *REC 7098-7105*.

1. DEQ and Perpetua's expert evidence supports the Hearing Officer's conclusion that the T-RACT AACC is not an annual limit but represents an ambient concentration that aligns with the lifetime incremental cancer risk.

Petitioners maintain the AACCs are "annual limits" and that the failure to treat the AACCs as "annual limits" allows greater cancer risk. *See* REC 7130-33, 7139. For this view, Petitioners largely rely on Dr. von Lindern's testimony that the AACCs are the "maximum one-year-annual average ambient air carcinogen concentration." *See*, *e.g.*, Tr. 436:14-15, 452:5-7 (von Lindern); REC 6108, 6110. Dr. von Lindern, however, conceded that his proffered terminology does not exist in the TAPs rules but is his own interpretation of "annual average" in

Section 586. Tr. 484:18-485:2 (von Lindern). Dr. von Lindern is not a toxicologist, Tr. 406:11-13 (von Lindern), and his testimony was scientifically inaccurate, *see* Tr. 499:2-509:19 (Lopez).[5]

The Hearing Officer correctly concluded that the AACCs are not annual limitations. *REC 7106-07 (¶¶ 84-85)*. The AACCs are ambient concentrations that align with incremental cancer risk assuming exposure over 70-years. *REC 7101 (¶ 39), 7102 (¶ 49), 7106 (¶¶ 82-83)*. While the AACCs are expressed as "annual averages," Section 586 does not use the term "annual limit" or specify compliance on an annual basis. *REC 7106 (¶¶ 81, 84)*. Nor does Section 210.12. Since the AACCs "are focused on calculating a cumulative cancer risk that accumulates over a continuous 70-year exposure period, it is not necessarily the case that monitoring emissions on an annual basis is necessary to achieve compliance with those standards." *REC 7106-07 (¶ 85)*.

As explained by DEQ and Perpetua's experts, to treat the AACCs as annual limits would ignore the plain language of Section 586 and conflict with the cumulative, long-term nature of the cancer risk that is the foundation of the TAPS rules. Tr. 509:2-19 (Lopez); 4286-4287 (¶¶ 37-41), 4302-4303; *see also* Tr. 48:18-21; 56:2-5 (Schilling); REC 3923 (¶ 17). Interpreting the AACCs as annual limits has *no toxicological basis* because that assumes a single annual exposure would result in incremental lifetime cancer risk. *See* Tr. 145:6-24 (Paden) ("We do not evaluate cancer risk for an acute exposure, but for chronic exposure."); Tr. 509:2-19 (Lopez); REC 4286-87 (¶¶ 37-42). Cancer risk assessment is an evaluation of chronic exposure, not acute or sub-chronic exposure. *REC 7104-7105 (¶¶ 68-72)*; Tr. 145:6-146:13 (Paden).

DEQ and Perpetua's toxicologists established that incremental cancer risk is based on cumulative exposure and that the AACC is an ambient concentration to which a person may be

[5] Mr. Tiedemann's testimony regarding the TAPs rules was not credible either. He revealed that his air quality permitting experience while employed at DEQ was very limited and that he had little to do with TAPs permitting or compliance. Tr. 352:2-363:8 (Tiedemann).

exposed for 24 hours per day, 365 days a year, for 70 years with an incremental cancer risk of 1-in-1,000,000 or 1-in-100,000 in the case of the T-RACT AACC. *REC 7106 (¶¶ 82-83)*; Tr. 135:2-137:10 (Paden); REC 3876-39 (¶¶ 11-15); Tr. 204:15-24 (Lopez); REC 4283 (¶ 17). The AACC values in Section 586 align with lifetime incremental cancer risk—not exposure in any single year—and compliance is assessed on a 70-year basis, not on an annual basis or following a single exposure. *REC 7106-07 (¶ 85)*; Tr. 237:18-238:6, 509:2-19 (Lopez); REC 4286-87 (¶¶ 38-42). This approach is consistent with the science of cancer risk assessment, which reflects the cumulative dose over a 70-year lifetime. Tr. 135:10-13 (Paden); Tr. 507:5-15 (Lopez). Indeed, using a "maximum one-year annual average ambient air carcinogen concentration" would ignore the assumed 70-year lifetime exposure that underpins the AACCs. Tr. 509:2-19 (Lopez).

Rather than establishing an "annual limit," the reference to an "annual average" is appropriately viewed in the context of the project-specific concentrations that are *modeled* as an "annual average." Tr. 52:5-17 (Schilling); Tr. 301:17-20 (Lewis). The model output from any single year cannot be compared against the AACC as an annual limit because the AACC is based on 70 years of exposure. Tr. 72:22-73:15 (Schilling) (comparing the AACC to an annual average concentration is "not appropriate . . . [b]ecause we still center on the fact that what matters is project-imposed cancer risk and not a year-by-year evaluation"); Tr. 237:16-25, 238:1-6, Tr. 311:7-14 (Lewis). For that reason, the modeled exposure concentration must be adjusted "to the same basis as the AACC lifetime exposure concentration" or 70 years. Tr. 304:22-25 (Lewis); *see also* Tr. 301:6-8, 305:1-2 (Lewis); Tr. 507:5-15 (Lopez).

While Petitioners want the TAPs rules to fit Dr. von Lindern's reading of Section 586, the rules do not. His commentary failed to refute the scientific testimony and judgment of DEQ and Perpetua's experts. *See Huntsman*, 114 F.4th at 735 (agency "evaluation of scientific data

within its area of expertise" should be afforded "an extreme degree" of reliance, and particularly so for "statistical and modeling analysis" (citation omitted)). Even Dr. von Lindern conceded the language in Section 586 does not match his interpretation. Convincing science-based evidence from DEQ and Perpetua's experts fully supports the Hearing Officer's holding that the AACCs are not annual limits because the concentrations reflect "cumulative cancer risk that accumulates over a continuous 70-year exposure period." *REC 7016-17 (¶¶ 81-85)*.

2. DEQ and Perpetua's expert evidence supports the Hearing Officer's conclusion that adjusting the modeled exposure concentration to reflect exposure duration is consistent with the TAPs rules.

Petitioners contend the TAPs rules do not allow adjustment of the maximum modeled annual average arsenic concentration for exposure duration. The Hearing Officer disagreed, stating: "[f]or projects with a known project life of less than 70 years, EPA adjusts the highest modeled annual average concentration to account for the different exposure durations in order to accurately calculate cancer risk with an Approved Concentration that is capable of comparison to the Acceptable Concentrations in Section 586." *REC 7102 (¶ 44)*. The "failure to account for the true exposure period results in overstating emissions from the project." *REC 7100 (¶ 30)*.

The expert evidence confirms the Hearing Officer's conclusions. DEQ and Perpetua's expert toxicologists provided extensive testimony showing that if a source operates less than the 70-year lifetime on which the AACCs are based, the exposure duration must be adjusted. REC 3923-25 (¶¶ 16-19, 22-23), 3929 (¶¶ 31-33); REC 3876-78 (¶¶ 8-9, 12-15); REC 4283-85 (¶¶ 20-30), 4292-4293, 4296, 4298-4300). Cancer risk cannot be evaluated without considering the length of time a potential receptor will be exposed to a carcinogen—referred to as "exposure duration." Tr. 140:1-145:15 (Paden); Tr. 189:15-190:5, 192:6-194:15, 197:9-198:5, 215:1-218:3, 229:11-232:19 (Lopez); Tr. 34:10-35:8, 56:18-57:19 (Schilling).

By adopting EPA's URFs/IURs, DEQ adopted EPA's cancer risk methodology for

analyzing TAP ambient concentrations. *See REC 7101 (¶¶ 39, 41)*; Tr. 135:2-137:10 (Paden); Tr. 213:11:3-214:14, 231:13-232:19 (Lopez). That includes EPA's recognition that inhalation risk assessments require the timeframe over which exposure occurs and that exposure duration is not always 70 years. *See REC 7102 (¶ 44)*; Tr. 135:2-137:10, 143:21-145:2 (Paden); Tr. 189:15-190:5, 192:6-194:15, 213:11-215:5, 231:13-232:19 (Lopez). EPA expresses this as an equation that explicitly adjusts the estimated concentration of the contaminant in the air based on project-specific information, including for exposure duration that could occur for less than 70 years:

EC = (CA x ET x EF x ED) / AT

Where: EC ($\mu g/m^3$) = exposure concentration;
CA ($\mu g/m^3$) = contaminant concentration in air;
ET (hours/day) = exposure time;
EF (days/year) = exposure frequency;
ED (years) = exposure duration; and
AT (lifetime in years 70 x 365 days/year x 24 hours/day) = averaging time.

REC 7102-7103 (¶¶ 50-56); REC 3923 (¶ 16); Tr. 136:19-137:13, 140:1-143:20 (Paden); REC 3876-77 (¶¶ 10-12); Tr. 191:12-194:15, 213:11-214:14 (Lopez); REC 4284 (¶ 22).

In the equation, the exposure concentration (EC) is calculated using the modeled maximum annual average ambient concentration, referred to as the "contaminant concentration in air" (CA), and temporal parameters. *REC 7103 (¶¶ 51-52)*; REC 3877 (¶ 12); 4284 (¶ 22). The temporal inputs in the equation are variable and include the exposure time (ET) in hours per day, the exposure frequency (EF) in days per year, and the exposure duration (ED) in years. The averaging time (AT) (the denominator) is the time over which exposure is averaged for chronic assessments and is the only constant. *REC 7103 (¶ 54-56, 58)*; REC 3877 (¶ 12); 4284 (¶ 22).

For the exposure concentration (EC) to be expressed in the same manner as EPA's URF/IUR and the AACCs in Section 586, with an assumed 70-year exposure, DEQ must adjust the numerator of the equation to reflect the project-specific exposure duration (ED). *REC 7101-*

02 (¶¶ 43-44); Tr. 140:1-145:15 (Paden); Tr. 189:15-190:5, 192:6-194:15, 197:20-198:5, 215:1-218:3, 229:11-232:19 (Lopez); REC 3924-25; Tr. 34:10-35:8, 56:18-57:19 (Schilling). Thus, when comparing the Project's highest modeled annual arsenic concentration to the arsenic T-RACT AACC pursuant to Section 210.12.b, DEQ properly adjusted the exposure concentration (EC) to account for a 16-year exposure duration (ED) of the Project. REC 3875-79 (¶¶ 4-17); REC 4280-81 (¶ 10), 4283-4287 (¶¶ 20-42). All other project-specific factors—such as exposure time (ET) and exposure frequency (EF)—remain the same.

DEQ calculated the Project's modeled arsenic exposure concentration using same approach, using the highest modeled annual arsenic concentration multiplied by the 16-year exposure duration to ensure the exposure concentration was comparable to the assumption of the 70-year exposure duration found in the AACC. REC 3926-27 (¶ 27), 3929 (¶ 32); REC 3876 (¶¶ 9-10). The adjustment is illustrated in the following formula utilized by DEQ:

$$Lifetime\ exposure\ \left(\frac{\mu g}{m^3}\right) = \frac{Highest\ annual\ concentration\ \left(\frac{\mu g}{m^3}\right) \times 16\ (mine\ operation\ years)}{70\ (years, lifetime\ exposure)}$$

REC 710; REC 3876 (¶ 10). The lifetime exposure in the formula is the exposure concentration. DEQ's formula matches EPA's formula and accounts for exposure duration. *See* Tr. 139:15-145:24 (Paden); Tr. 191:12-194:15, 197:9-198:5 (Lopez).

The highest modeled annual arsenic concentration from the Project, operating under the PTC's maximum production limits, was 0.00414 µg/m^3. *See REC 7100 (¶ 28), 7103 (¶ 53)*; Tr. 302:3-303:10 (Lewis). Using EPA's equation, DEQ adjusted the Project duration to reflect the highest allowable maximum production scenario and related exposure duration (16 years) to determine the modeled arsenic exposure concentration for the Project is 0.00095 µg/m^3:

EC = 0.00414 µg/m^3 x 16 years / 70 years = 0.00095 µg/m^3

See REC 7103 (¶ 59); REC 714; *see also* REC 3923 (¶ 18); REC 3877-78 (¶¶ 13-14); Tr. 197:9-

198:5 (Lopez); REC 4284-85 (¶¶ 22-25), 4300-01; Tr. 298:23-299:12 (Lewis).

Compared to the T-RACT AACC (0.0023 μg/m^3), the Project's modeled arsenic exposure concentration is far less, and thus the lifetime exposure of arsenic is less than a 1-in-100,000 cancer risk, which demonstrates the Project's arsenic emissions will not injure or unreasonably affect human health and the environment. *REC 7103 (¶ 60)*; REC 3877 (¶¶ 12-14); Tr. 197:9-19, 200:2-201:25 (Lopez); REC 4284-85 (¶¶ 24-25), 4300-4301. Based on the modeled arsenic exposure concentration of 0.00095 μg/m^3, the incremental increase in cancer risk from the Project's arsenic emissions over the life of the Project is 1-in-240,000, which is below the acceptable T-RACT incremental lifetime cancer risk of 1-in-100,000. *REC 7103 (¶¶ 60-61)*; Tr. 200:2-201:25 (Lopez); REC 4284-85 (¶¶ 24-30), 4300-01.

Thus, the expert testimony demonstrated that comparing the Project's modeled arsenic exposure concentration to the T-RACT AACC under Section 210.12 requires the exposure concentration to be adjusted to a lifetime exposure to compare to the T-RACT AACC. Idaho Air Rule 210.15, which addresses project durations shorter than five years, is an example of the toxicological principle that duration is relevant when evaluating project-specific cancer risk for a source with an operational life of less than 70 years. *See* REC 3923-24 (¶ 19); Tr. 229:11-230:8 (Lopez); REC 4286 (¶¶ 32-35), 4301-4302. The TAPs rules do not prohibit DEQ from following proper scientific method and "adjusting exposure concentrations to account for projects with an operational life of more than 5 years and less than 70 years."[6] *See REC 7102 (¶ 48)*.

On remand, DEQ and Perpetua's experts directly addressed the questions posed by the

[6] Nor does the rulemaking record support such a rule. Petitioners relied on a rulemaking record that was not the official rulemaking record, Tr. 365:9-366:4 (Tiedemann), and that "consisted of isolated references from prior rulemakings that lacked explanation of their context or relevance to the interpretation of the plain language of the existing Air Rules." REC 7096-97.

Board and unpacked the underlying rule-based mathematics that DEQ used to calculate the modeled arsenic exposure concentration from a 16-year exposure duration and to compare properly the exposure concentration to the T-RACT AACC. The Hearing Officer's conclusions are fully supported by the expert evidence presented and the TAPs rules; Petitioners did not satisfy their burden to show otherwise.

3. Petitioners present a range of irrelevant references and misinformation that fails to change the Hearing Officer's findings of fact and conclusions of law.

Petitioners raise several other arguments in support of their contention that adjusting the modeled arsenic exposure concentration to reflect the Project's exposure duration is not scientifically valid. *See* REC 7133-39. First, Petitioners argue that DEQ and Perpetua's reliance on EPA guidance, such as risk assessment at superfund sites, was inappropriate to assess cancer risk when the TAPs rules provide for TAP carcinogenic increments. REC 7135. Dr. Paden and Ms. Lopez, however, explained that the EPA guidance is not specific only to superfund sites and represents standard EPA cancer risk assessment methodology and procedures to calculate the concentration that corresponds to a risk level for a specified exposure duration over a 70-year lifetime. Tr. 159:25-62:17 (Paden); Tr. 233:23-234:6 (Lopez); REC 4306.

Second, Petitioners present the State of Washington's TAP program to argue DEQ should have assessed excess cancer risk as Washington does. Petitioners might prefer the approach taken by Washington, but Washington law and the state's distinct program does not control here. Following the Idaho TAPs rules, the expert evidence supports the Hearing Officer's conclusion that comparing the Project's modeled arsenic exposure concentration to the T-RACT AACC under Section 210.12 requires the adjustment of the exposure concentration for exposure duration to compare to the T-RACT AACC. *See Huntsman*, 114 F.4th at 737, 742 (holding while the petitioners' proposed alternative "approach to statistical modeling … may have advantages,"

EPA's action was "reasonable" because EPA "adequately explained its modeling approach and decisions" in light of the technical nature of the evidence before it).

Third, Petitioners claim that DEQ's analysis failed to consider mutagenic modes of action and sensitive populations. REC 7138-39. None of those claims are supported by the evidence. One reason is that EPA does not consider arsenic mutagenic, Tr. 499:8-508:4 (Lopez), as even Dr. von Lindern acknowledged, Tr. 439:14-16 (von Lindern). Another reason, as the Hearing Officer found, is that URFs/IURs are developed taking into account the exposure of sensitive subpopulations (e.g., children and pregnant women). *REC 7101 (¶¶ 36-37)*; Tr. 138:6-139:5, 146:15-24, 147:16-148:5, 153:13-154:12, 171:20-172:21 (Paden); Tr. 181:23-182:1, 185:6-12, 188:2-22, 190:6-191:6 (Lopez); REC 4293-95.

Fourth, Petitioners raise the irrelevant argument that DEQ only considered the impact of arsenic emissions and failed to account for the effects of other carcinogens under Section 161. REC 7137-38. Petitioners' argument is outside the scope of remand, and it is simply false. DEQ and Perpetua quantified the emissions of all TAPs from the Project and evaluated any TAP that exceeded the screening emission level in Section 586. REC 432-34, 699-701. Each carcinogenic TAP that exceeded the screening emission level was modeled and confirmed to be well below the T-RACT AACC. REC 697-716. The evidence does not support Petitioners' claim.

4. DEQ and Perpetua's expert evidence supports the Hearing Officer's conclusion that a limit on years of operation is not necessary.

The Hearing Officer also concluded that "[e]ven if the SGP operates for more than 16 years, the cancer risk from arsenic exposure calculated pursuant to EPA's IURs/URFs and Section 586 does not change as long as Perpetua complies with the production limits in Condition No. 3.6." *REC 7105 (¶ 76)*. And because incremental cancer risk from arsenic exposure "does not change with a project life longer than 16 years if compliance with Condition

No. 3.6 is achieved, DEQ's decision not to includ[e] a Permit condition specifically limiting the life of the SGP to 16 years was not error." *Id. (¶ 77)*. DEQ and Perpetua's expert evidence supports the Hearing Officer's conclusion that a permit limit on Project duration is not necessary.

A limit on the Project's years of operation is unnecessary because it is the production limits on emissions, not years of operation, that control the exposure. The largest source of arsenic emissions from the Project is haul road dust. REC 62, 226. Higher production and more activity on the haul roads generate more emissions, so PTC Conditions 3.5 and 3.6 impose production limits as T-RACT to ensure that emissions are controlled and do not exceed the T-RACT AACC. Tr. 117:24-119:6, 119:25-121:3 (Schilling); Tr. 202:1-203:17, Tr. 212:11-213:21 (Lopez); Tr. 315:16-19 (Lewis). As such, the Project's arsenic emissions, and cancer risk from those emissions, are directly tied to the PTC's production limits. *See* Tr. 314:12-317:2 (Lewis).

Condition 3.5 of the PTC includes two limits on daily production: 180,000 tons per day and 135,000 tons per day based on a five-year rolling average. *REC 7105-06 (¶ 78)*; REC 385. The 180,000 ton per day short-term limit addresses short-term 24-hour National Ambient Air Quality Standards. *REC 7107 at ¶ 87*; Tr. 284:4-22 (Lewis). Condition 3.6 establishes a total, life-of-mine production limit of 788.4 million tons, as well as a total production limit on the West End Pits of 394.2 million tons. *REC 7105 (¶ 75)*; REC 385. The PTC's total production limits, as restrained by the 135,000 ton per day five-year rolling average limit, are long-term T-RACT limits. These permit limits ensure that the Project's arsenic emissions are consistent with assumptions used to model the arsenic exposure concentrations against the T-RACT AACC. Tr. 114:17-115:6 (Schilling); Tr. 280:20-25, 283:15-19 (Lewis).

The Hearing Officer understood that arsenic emissions are a function of production, not years of operation, and that the modeled exposure concentration and incremental cancer risk do

not change if it takes longer than 16 years to exhaust the 788.4 million ton total production. *REC 7105 (¶ 76)*; Tr. 116:7-23, 117:24-118:6, 119:24-121:3 (Schilling); Tr. 169:10-170:5 (Paden); Tr. 202:1-203:17, 208:3-209:2 (Lopez); Tr. 314:12-317:2 (Lewis). Because "emissions are proportional on production and concentrations are proportional on emissions and risk is dependent upon the total exposure, you're going to arrive at the same risk whether it would be 16 years or 70 years." Tr. 120:19-24 (Schilling). Adding a 16-year permit limit is unnecessary; incremental lifetime cancer risk will not change and remains below the T-RACT AACC. *See REC 7105 (¶¶ 76-77)*; Tr. 202:11-22, 203:15-17 (Lopez); Tr. 314:12-317:2 (Lewis).

B. The evidence supports the Hearing Officer's conclusion that DEQ reasonably used a five-year rolling average production limit as a T-RACT long-term limit.

As noted, PTC Condition 3.5 limits mine production to 135,000 tons per day based on a five-year rolling average and ensures that arsenic emissions from the Project are consistent with assumptions used to model the exposure concentration against the T-RACT AACC. Petitioners' claim that a five-year rolling average is inappropriate is grounded on their belief that the AACCs are annual limits. *See* REC 7139-40. They contend the PTC improperly spreads out 16 years of emissions over 70 years and the five-year operational period could result in a violation of the "annual average arsenic concentration." *Id*.

On remand, the Hearing Officer concluded that DEQ acted reasonably and did not err in using the 135,000 ton per day five-year rolling average limit. *REC 7107 (¶ 96)*. Again, he found that the AACCs "are expressed as annual 'averages,' not annual 'limitations.'" *REC 7106 (¶ 84)*. And: "because Section 586 is focused on excess cancer risk posed by a project over the course of an assumed 70-year lifetime or the lifetime of a project that will last less than 70 years, the five-year rolling average approach in Condition 3.5 is stricter and more protective than Section 586 requires." *REC 7108 (¶ 97)* (citing Tr. 40:12-18 (Schilling); Tr. 294:11-23 (Lewis)).

The evidence supports the Hearing Officer's conclusion. As explained earlier (at pp. 10-13), Petitioners did not prove the AACCs are annual limits. *See* REC 7139-41. The AACCs reflect incremental cancer risk over a 70-year lifetime, and not risk over one year, so there is no need to monitor emissions annually. REC 7106-07 (¶ 85). It follows that a five-year rolling average compliance period represents a shorter and more conservative compliance demonstration period than 70 years and ensures that cumulative exposure is below the T-RACT AACC. *REC 7108 (¶ 97)*; *see also* Tr. 39:11-40:25 (Schilling); Tr. 219:25-220:12 (Lopez); Tr. 293:16-294:23, 318:1-13 (Lewis); *see also* REC 3926 (¶ 26); REC 4288 (¶¶ 46-47), 4303; REC 4138 (¶ 43).

In addition, Petitioners misconstrue Mr. Schilling's testimony, claiming he "confirmed that using a five-year rolling average was inappropriate for calculating the annual average arsenic concentration." REC 7139-40 (quoting REC 3925 (¶ 24)). But in Mr. Schilling's words, he was explaining the "implication of the stated issue." Had Petitioners read on, they would have learned why the five-year rolling average is proper and his conclusion that "[s]ince the exposure concentration (a resulting project caused concentration averaged over a lifetime) is a measure of compliance with AACC, the five-year rolling average is consistent with limits in Idaho Air Rules for carcinogenic TAPs." REC 3926 (¶¶ 25-26).

Finally, the Hearing Officer recognized that even if annual production occurred at the 180,000 tons daily rate for any one year, the incremental cancer risk will not change because the PTC's life-of-mine production limit, combined with the 135,000 ton per day five-year rolling average limit, restricts total exposure from the Project. *REC 7107 (¶ 89)*; *see also* Tr. 118:3-6 (Schilling); REC 3926 (¶ 26); Tr. 208:14-209:2 (Lopez); REC 4287-88 (¶¶ 43-47). Even without the five-year rolling average limit, production up to 180,000 tons per day would still not exceed the T-RACT AACC. *REC 7107 (¶ 90)*. As Mr. Lewis explained, 180,000 tons per day is 33.3%

greater than 135,000 tons per day, and if the maximum arsenic concentration of 0.00095 μg/m^3 is correspondingly increased by 33.3%, the result is 0.001267 μg/m^3, still less than the arsenic T-RACT AACC of 0.0023 μg/m^3. *Id. (¶¶ 90- 91)*; Tr. 285:17-290:5, 292:2-293:1 (Lewis); Ex. 222.

Because the AACCs are not based on exposure in a single year, and because the highest modeled arsenic exposure concentration for the shortest possible exposure duration (16 years) demonstrated compliance with the T-RACT AACC, the Hearing Officer correctly held that DEQ acted reasonably in determining that a five-year rolling average production limit is protective and ensures the Project is operated to align with the T-RACT AACC under Section 586.

C. The evidence supports the Hearing Officer's conclusion that PTC conditions were sufficient to limit production from the non-West End Pits.

1. DEQ and Perpetua's expert evidence showed how the PTC limits production from the non-West End Pits and that no separate limit is necessary.

The final issue on remand concerns the relationship between the two life-of-mine production limits in Condition 3.6: (1) the total, life-of-mine limit of 788.4 million tons and (2) the West End Pit limit of 394.2 million tons or 50% of total production. *See* REC 385; REC 7109 (¶¶ 98-100). Condition 3.6 does not expressly limit non-West End Pit production, and the Board found "there was insufficient evidence in the record to demonstrate exactly how or whether the non-West End Pit production was limited." REC 3714.

DEQ and Perpetua's expert evidence directly addressed the Board's inquiry. Based on that evidence, the Hearing Officer correctly held that "it was reasonable for DEQ not to include a specific permit condition limiting non-WEP haulage to 50% of total mine haulage for the life of the SGP." *REC 7110-7111 (¶ 116)*. The greatest arsenic impacts from the Project originate from the West End Pit due to its location and the prevailing winds. *REC 7109 (¶¶ 101-104)*; Tr. 48:25-50:3 (Schilling); Tr. 270:3-23 (Lewis). That led DEQ to limit production from the West End Pit to 50% of total production.

The most conservative modeling scenarios based on 50% production from the West End Pit and the remaining 50% from the non-West End Pits demonstrated compliance with the T-RACT AACC. Tr. 116:13-23 (Schilling); Tr. 277:3-278:9 (Lewis). Modeling scenarios based on 100% production from the non-West End Pits (and 0% production from the West End Pit) were also below and demonstrated compliance with the T-RACT AACC. *REC 7109 (¶ 106)*; Tr. 45:9-21 (Schilling); REC 4140 (¶ 49). An additional production limit on the non-West End Pits offers no further protection to the public health or the environment. Tr. 45:23-48:21 (Schilling); REC 3927-28 (¶¶ 28-30); Tr. 281:1-282:7 (Lewis); REC 4140-41 (¶¶ 49-53).

That is because if 50% of the total production occurs from the West End Pit, then production from the non-West End Pits is "automatically limited" to the remaining 50% of the total production allowed. *REC 7110 (¶¶ 112-113)*; *see also* Tr. 47:22-48:18 (Schilling); Tr. 281:1-282:7 (Lewis). And if non-West End Pits account for more than 50% of the total production from the Project, then production from the West End Pit must be correspondingly reduced below 50%. *REC 7110 (¶¶ 114-115).* Thus, the non-West End Pits are already limited by the total production limit and demonstrate compliance with the T-RACT AACC. *REC 7110-11 (¶ 116)*. The evidence supports the Hearing Officer's conclusion that an additional production limit on the non-West End Pits is unnecessary.

2. Petitioners' contention that the maximum modeled annual average arsenic concentration was 0.00698 µg/m^3 is not supported by the evidence.

Petitioners do not directly take issue with the Hearing Officer's conclusion that a separate production limit on the non-West End Pits is not necessary. *See* REC 7141-43. Rather, relying on Dr. von Lindern's testimony, they argue the Hearing Officer erred in finding the highest modeled annual average arsenic concentration based on production of 135,000 tons per day was 0.00414 µg/m^3 and that it should have been 0.00698 µg/m^3. REC 7141 (citing REC 7100 (¶ 28). From

there, taking Mr. Lewis's observation that production of 180,000 tons per day is 33.3% higher than production of 135,000 tons per day, Petitioners extrapolate that the highest annual average arsenic concentration should be 0.0093 $\mu g/m^3$, which is above the arsenic T-RACT AACC of 0.0023 $\mu g/m^3$. REC 7143.

Petitioners mischaracterize the evidence, and their inferences are incorrect. Dr. von Lindern was not offered as an expert in emissions estimations or modeling, *see* Tr. 405:19-406:1 (von Lindern), as his testimony confirmed. Dr. von Lindern testified that the Project's maximum modeled arsenic concentration was 0.00698 $\mu g/m^3$ based on the results from the W2 modeling scenario identified in the bottom table of Exhibit 304. *See* Tr. 457:11-458:12 (von Lindern). He relied on the 0.00689 $\mu g/m^3$ concentration assuming it included the PTC's production limits, but he did not know what the concentration represented. *See* Tr. 457:11-458:12, 467:8-472:21 (von Lindern). In fact, the concentration does not include the PTC's production limits and is not the Project's maximum modeled arsenic concentration. Tr. 310:14-312:13, 314:3-11 (Lewis). Dr. von Lindern should have used, as DEQ and Perpetua did, the modeled arsenic exposure concentration of 0.00095 $\mu g/m^3$ from the W2 modeling scenario identified at the top of Exhibit 304. Dr. von Lindern's testimony was inaccurate, misleading, and is not reliable.[7]

Petitioners' misunderstandings of the technical aspects of DEQ's work and the relevant model outputs and their failure to account for the PTC's production limits in their calculations demonstrates why there is no basis for their allegations that DEQ used "mathematical tricks" and

[7] Dr. von Lindern also did not understand how DEQ and Perpetua derived the maximum modeled annual arsenic concentration of 0.00414 $\mu g/m^3$. He understood the value was "an average of the average of the average of the average," specifically the average of modeling scenarios Y1 through H4 on the bottom table of Ex. 304. Tr. 457:16-458:22 (von Lindern); REC 7142 n.6. Dr. von Lindern's calculation adds and averages modeling outputs from different receptor locations, which is as erroneous as assuming a single person can be in two places at the same time. His calculation does not represent any math performed by DEQ or Perpetua.

"post-hoc" assessments to "hide the true threat to public health." *See* REC 7143. In all cases where they claim the Project's modeled arsenic exposure concentration exceeds the T-RACT AACC of 0.0023 $\mu g/m^3$—stating a variety of numbers such as 0.0055 (*see* REC 7128) and 0.00689 and 0.0093 (*see* REC 7143)—Petitioners fail to account for the PTC's production limits.

V. CONCLUSION

After two years of administrative challenges by Petitioners and multiple reviews by the Hearing Officer and the Board, Petitioners attempt again to substitute their preferences for the science-based, technical work of DEQ. The evidentiary record on remand demonstrates that Petitioners failed to carry their burden to prove, by a preponderance of the evidence, that DEQ acted unreasonably and inconsistent with the TAPs rules. Their evidence and commentary were unconvincing and improbable when weighed against DEQ and Perpetua's extensive expert evidence. Supported by that evidence, the Hearing Officer correctly concluded that DEQ properly adjusted the Project's modeled arsenic exposure concentration based on an exposure duration tied to the PTC's production limits, that a five-year rolling average production limit is consistent with the T-RACT AACC, and that no additional production limit is necessary to limit emissions from the non-West End Pits. The Board can now issue a final order affirming and accepting the Hearing Officer's Preliminary Order and deny Petitioners' Petition for Review.

DATED: February 4, 2025.

STOEL RIVES LLP

Christopher Pooser

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole C. Hancock

Attorneys for Perpetua Resources Idaho, Inc.

CERTIFICATE OF SERVICE

I hereby certify that on February 4, 2025, a true and correct copy of the PERPETUA'S OPPOSITION TO PETITION FOR REVIEW OF JANUARY 7, 2025 PRELIMINARY ORDER was served on the following:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Dylan B. Lawrence
Hearing Officer
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Bryan Hurlbutt
Laurence ("Laird") J. Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Michael A. Short
Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
michael.short@deq.idaho.gov
hannah.young@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
ann.yribar@ag.idaho.gov
via electronic service

Diane Cutler, Hearing Coordinator
Rules and Planning Analyst
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
(208)373-0165
diane.cutler@deq.idaho.gov
via electronic service

Christopher Pooser
Attorneys for Perpetua Resources Idaho, Inc.

RAÚL R. LABRADOR
Attorney General

SCOTT L. CAMPBELL
Deputy Attorney General
Chief, Energy and Natural Resources Division

HANNAH M.C. YOUNG, ISB #9781
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: (208) 373-0422
Facsimile: (208) 373-0481
Email: hannah.young@deq.idaho.gov

Attorneys for Respondent

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047

NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,

Petitioners,

v.

IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,

Respondent,

and

PERPETUA RESOURCES IDAHO, INC.,

Intervenor.

Case Docket No. 0101-22-01
OAH Case No. 23-245-01

RESPONDENT IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY'S RESPONSE TO PETITIONER SAVE THE SOUTH FORK SALMON'S MOTION FOR RECONSIDERATION BASED ON NEW EVIDENCE

Respondent, the Idaho Department of Environmental Quality ("DEQ"), by and through the Office of the Attorney General, hereby submits this Response to Petitioner Save the South Fork Salmon's ("SSFS") Motion for Reconsideration Based on New Evidence.

INTRODUCTION

On June 17, 2022, DEQ issued an air quality permit, a Permit to Construct ("PTC"), to Perpetua Resources Idaho, Inc. ("Perpetua") for the Stibnite Gold Project ("SGP"). REC 1274. In the PTC, DEQ determined that the Stibnite Access Route ("the Route"), an access road that runs through the SGP, was not accessible by the general public and was, therefore, not "ambient air," as that term is defined in the applicable rules. REC 3475. The Hearing Officer and then the Board of Environmental Quality ("the Board") ultimately agreed with DEQ's determination that the Route was not ambient air. *See* REC 3297, REC 3701. SSFS now appeals that decision due to "new evidence." REC 7147. Based on SSFS's Motion for Reconsideration and the supporting affidavit of counsel, there is no new evidence that should change the Board's decision. Thus, the Board should continue to find that DEQ acted both reasonably and lawfully.

PROCEDURAL HISTORY

On July 22, 2022, SSFS, the Nez Perce Tribe, and the Idaho Conservation League (collectively, "Petitioners") initiated a contested case, challenging DEQ's issuance of the PTC to Perpetua for the SGP. REC 0001-0028. Thereafter, the Board appointed a Hearing Officer to oversee and decide the contested case. REC 0031-0032. On August 12, 2022, DEQ responded to the Petition, denying it committed any error in issuing the PTC. REC 0033-0039. Perpetua then moved to intervene in the contested case, which the Hearing Officer granted. REC 0040-0045.

On September 6, 2022, Perpetua filed a Motion to Dismiss the Petition, which DEQ joined. REC 0052-0124. In ruling on the Motion to Dismiss, the Hearing Officer dismissed three of

Petitioners' claims and partially dismissed a fourth. REC 0160-0186. Petitioners were given leave to amend their Petition, and an Amended Petition was filed in January 2023. REC 0263-0292.

Petitioners filed a Motion for Summary Judgment on April 14, 2023, and DEQ and Perpetua filed their own Motions for Summary Judgment on May 12, 2023. REC 0319-0363; REC 1204-1232; REC 1276-1336. After hearing oral argument, the Hearing Officer issued his *Memorandum Decision on Motions for Summary Judgment and Preliminary Order* on October 31, 2023, appearing to dismiss all of Petitioners' claims. REC 3280-3328. Seeking clarity on his decision, DEQ and Perpetua filed a *Joint Motion for Reconsideration and/or Clarification* on November 10, 2023. REC 3332-3341. On December 5, 2023, the Hearing Officer issued his *Amended Memorandum Decision on Motions for Summary Judgment and Preliminary Order*. REC 3372-3425. The Hearing Officer made it clear he dismissed all of Petitioners' claims. *Id*.

On December 15, 2023, Petitioners filed their *Amended Petition for Review of Preliminary Orders*, initiating its first appeal to the Board. REC 3426-3441. After briefing and oral argument, the Board issued its *Final Order* on May 9, 2024 ("Final Order"). In the Final Order, the Board found that DEQ acted reasonably and in accordance with the law on four of the five issues before the Board.[1] Relevant to this Motion for Reconsideration, the Board found that DEQ acted reasonably and in accordance with law when it found that Perpetua has both legal and practical control of the Stibnite Access Route and properly excluded it from the ambient air boundary.

[1] As to the fifth issue, the Board found that DEQ did not act reasonably or in accordance with law when it analyzed the ambient arsenic air concentrations for the SGP and remanded the matter back to the Hearing Officer for the development of further evidence. REC 3717. The Hearing Officer issued his *Findings of Fact, Conclusions of Law, and Preliminary Order* on January 7, 2025. REC 7091-7118. The Hearing Officer found that DEQ acted both reasonably and lawfully in its analysis of the ambient air arsenic emissions. On January 21, 2025, Petitioners filed their *Petition for Review of January 7, 2025 Preliminary Order, Memorandum In Support, and Request for Hearing*, once again asking the Board to review the Hearing Officer's decision. REC 7119-7145. That appeal to the Board is progressing concurrently with this Motion for Reconsideration.

On January 24, 2025, SSFS filed its *Motion for Reconsideration Based on New Evidence* ("Motion for Reconsideration"). In its Motion for Reconsideration, SSFS claims "the U.S. Forest Service's January 3, 2025 Final Record of Decision for the Stibnite Gold Project, and supporting documents, provide relevant new information that address the issue of whether Perpetua has legal control to preclude public access from the Stibnite Road Access Route." REC 7147. Thus, SSFS asks the Board to "remand the Permit back to DEQ for reconsideration of the ambient air boundary analysis." REC 7151.

LEGAL STANDARD

In a contested case proceeding, "the Board must determine whether DEQ has acted reasonably and in accordance with law." *In the Matter of Sunnyside Park Utilities' Application for Sewage Disposal Permit*, Final Order on Petition for Review of Preliminary Order, at 10 (BEQ Dkt. 0103-07-02, Apr. 7, 2009).[2] A court will affirm the Board's decision, should it be appealed, unless the court finds that DEQ and the Board's decision is in violation of constitutional or statutory provisions, is in excess of statutory authority, is made on unlawful procedure, or is arbitrary, capricious, or an abuse of discretion. *See* I.C. § 67-5279(3).[3] But, it is the Petitioners who have "the burden of proving by a preponderance of the evidence, the allegations in the petition." IDAPA 58.01.23.062. Thus, the Board must uphold DEQ's decision to issue the PTC unless it determines that Petitioners have in fact proven, by a preponderance of the evidence, that DEQ's decision was (1) unreasonable, (2) not in accordance with law, (3) issued upon unlawful procedure, and (4) was arbitrary, capricious, or an abuse of discretion.

[2] Publicly available at https://www2.deq.idaho.gov/admin/LEIA/api/document/download/5566.

[3] The Hearing Officer recognized the helpfulness of using the judicial standard of review in I.C. § 67-5279, "[b]ecause those are the standards that ultimately govern the disposition of this matter…" REC 3377. Further, and importantly, Petitioners use the judicial standard of review set out in I.C. § 67-5279 in asking for relief. REC 3474.

ARGUMENT

In its Final Order, the Board found "that there is sufficient evidence in the record to support DEQ's conclusion that Perpetua has practical and legal control over the Stibnite Road Access Route such that it may be excluded from consideration as ambient air." REC 3703. The evidence has not changed. The Board's analysis should also remain unchanged. For the reasons discussed below, DEQ's decision to exclude the Route from ambient air remains reasonable and lawful.

I. The PTC Still Requires Perpetua to Have the Ability to Restrict the General Public from the Route.

SSFS does not assert that any condition of the PTC has changed or that Perpetua will be unable to comply with the terms of the PTC. The PTC requires that the "general public" be precluded from accessing the Route and requires that access for all guests be carefully managed. REC 0376. For example, Permit Condition 2.7 requires a combination of security escort vehicles, manned guardhouses, locked gates, barriers, warning signs, and registration of all guests to the mine site. *Id*. Condition 2.7 also requires Perpetua to submit an Access Management Plan, which must include the specific measures Perpetua will use to discourage public access, including those included in Condition 2.7. *Id.* These conditions will be more than sufficient to notify a reasonable person that his or her presence is not permitted unless specifically granted by Perpetua and therefore punishable under I.C. § 18-7008 for criminal trespass and actionable under I.C. § 6-202 for civil trespass.

In its initial review, the Board agreed, finding "there are substantial conditions in the PTC that require Perpetua to implement practical and physical restrictions on access to the SGP by the general public." REC 3701. None of the language cited by SSFS from the Forest Service's Final Environmental Impact Statement ("FEIS") prevents Perpetua from complying with the

conditions of the PTC. For example, SSFS points to the following language:

> A new 12-foot-wide gravel road will be constructed to provide public access from Stibnite Road (FR50412) to Thunder Mountain Road (FR 50375) through the Stibnite Gold Project. During operations, the public access road will be used to travel through the Stibnite Gold Project and will provide seasonal use, open to all vehicles.

REC 7149. The Forest Service has always referred to this as a public access road – Perpetua agreed to include the road to benefit the public and to provide members of the public with access. *See* REC 3295. However, that does not change the fact that Perpetua must be able to preclude the public from using the road at any time, for any reason, or discontinue access at its discretion. REC 1238. That also does not change the fact that the members of the public become "invitees" of Perpetua once they enter the mine boundary, for purposes of an ambient air analysis. *See* REC 1145 (EPA's Revised Policy on Exclusions from "Ambient Air"). Nothing in the FEIS or other related documents prevents Perpetua having or asserting this level of control. And SSFS does not allege that the Forest Service's interpretation or assessment of the road has changed throughout its review. Thus, there is no new evidence demonstrating that Perpetua will now be unable to meet the PTC requirements.

II. DEQ Reasonably Relies on Perpetua's Assertions Regarding Control of the Stibnite Access Route.

DEQ excluded the Route from ambient air because, in part, Perpetua represented during the permitting process that it would have legal authority to prohibit access by the "general public" and the practical ability to do so. REC 1260; REC 1236-1240. Under the Rules for the Control of Air Pollution in Idaho, IDAPA 58.01.01 ("Air Rules"), a permit applicant is required to certify that the information and statements provided in a permit application are "true, accurate, and complete." IDAPA 58.01.01.123. In its permit application, Perpetua (then Midas Gold)

stated that it "will legally control the SGP, an active industrial site where mining activities will occur, such as heavy equipment operation," and that it "has established an operations boundary to identify the area where public access will be excluded." REC 1807. DEQ's reliance on these assertions was completely reasonable and supported by the Air Rules. The Board agreed, finding: "It was reasonable for DEQ to rely on Perpetua's representations in its application form that it would have legal control over access to the Stibnite Road Access Route." REC 3700.

The Board went on to state that "DEQ recognized at oral argument that, should the [Forest Service] ultimately require public access through the SGP, the ambient air boundary analysis will have to be reevaluated." REC 3700, TR 0080. According to the information provided by SSFS, the Forest Service is not *requiring* public access through the SGP. The information presented by SSFS does not conflict with the information provided to DEQ, and SSFS does not allege that Perpetua has in any way changed the assertions made to DEQ. Therefore, there is no evidence in the record that would make DEQ's reliance on Perpetua's statements related to the Route unreasonable or unlawful.

III. DEQ and EPA Guidance Continue to Support DEQ's Determination.

Finally, DEQ's determination that the Route is not ambient air is still supported by both DEQ and EPA guidance. The Hearing Officer summarized the Environmental Protection Agency ("EPA") guidance well when he stated:

> According to EPA's 2019 ambient air policy: (1) it is appropriate to exclude areas from ambient air where measures are employed that are "effective in precluding access to the land by the general public;" (2) such measures can include physical barriers, but physical barriers are not required; (3) determinations by the agency are discretionary on a case-by-case basis; (4) the permit applicant must have the legal ability to preclude access by the general public and must employ measures that actually preclude the general public as a practical matter; (5) in evaluating the adequacy of the preclusion measures, the agency applies a "rule of reason" as to whether the general public will have access "under reasonably anticipated circumstances.

REC 3392. Similarly, DEQ's guidance focuses on the ways in which the permittee will discourage public access. REC 3392. The nature or remote location of the facility may discourage public access, or the permittee may take steps to prevent access. *Id.* If the general public is sufficiently precluded, it is reasonable to consider that the facility or specific area would not qualify as ambient air. *Id.* This is different from a "right-of-way easement" or "common service road." As one example, PTC condition 2.7 requires registration of all guests of a mine—surely no easement or common service road requires such registration.[4]

The Board has already reviewed both EPA and DEQ guidance and determined that the Route was properly excluded from ambient air. REC 3698. Again, the guidance continues to support DEQ's decision. The general public will be sufficiently excluded due to the measures Perpetua must take to comply with the PTC. And while the general public *may* be given access on Perpetua's terms, that is not the same as Perpetua relinquishing legal or practical control. Accordingly, nothing in the FEIS or related documents changes the analysis.

CONCLUSION

The PTC requires Perpetua to have legal and practical control of the Stibnite Access Route. Perpetua continues to assert, and the evidence continues to demonstrate, that Petitioners have the necessary control over the Stibnite Access Route. Thus, DEQ's decision to exclude the Route from ambient air is reasonable and lawful. The Board should confirm its Final Order and deny SSFS's Motion to Reconsider.

[4] The FEIS discusses the need for users of the Route to check-in with Perpetua. The language from the FEIS, and quoted by SSFS, states: "Public vehicles passing through would be required to check-in with mine personnel at the North or South SGP entry points and would receive a safety briefing and would also be required to check-out with the SGP personnel upon exhibiting the SGP." REC 7149.

DATED: February 7, 2025

STATE OF IDAHO
OFFICE OF THE ATTORNEY GENERAL

/s/ Hannah M.C. Young
HANNAH M.C. YOUNG
Deputy Attorney General
Attorneys for the Idaho Department of Environmental Quality

CERTIFICATION OF SERVICE

I HEREBY CERTIFY that on this 7th day of February, 2024, a true and correct copy of the foregoing RESPONDENT IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY'S RESPONSE TO PETITIONER SAVE THE SOUTH FORK SALMON'S MOTION FOR RECONSIDERATION BASED ON NEW EVIDENCE was served on the following via electronic mail to the indicated address:

Bryan Hurlbutt
Laurence ("Laird") J. Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701

Attorneys for Petitioner Nez Perce Tribe and Idaho Conservation League

bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638

Attorney for Petitioner
Save the South Fork Salmon

jthrower@mtntoplaw.com
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole C. Hancock
Stoel Rives LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702

Attorneys for Intervenor
Perpetua Resources of Idaho, Inc.

krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
nicole.hancock@stoel.com
via electronic service

Dylan B. Lawrence
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701

Hearing Officer

dylan@varinthomas.com
via electronic service

Office of Administrative Hearings

filings@oah.idaho.gov
via electronic service

Diane Cutler
Hearing Coordinator
Rules and Planning Analyst
Department of Environmental Quality
1410 N Hilton
Boise ID 83706

diane.cutler@deq.idaho.gov
via electronic service

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010

ann.yribar@ag.idaho.gov
via electronic service

/s/ DeAnne M. Chaffin
DeAnne M. Chaffin
Legal Assistant

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
Nicole C. Hancock, ISB No. 6899
nicole.hancock@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	Case Docket No. 0101-22-01 OAH Case No. 23-245-01 PERPETUA'S BRIEF IN OPPOSITION TO PETITIONER'S MOTION FOR RECONSIDERATION BASED ON NEW EVIDENCE

Intervenor-Respondent Perpetua Resources Idaho, Inc. ("Perpetua") submits this opposition to the Motion for Reconsideration Based on New Evidence submitted by Petitioner Save the South Fork Salmon ("Petitioner"). Petitioner claims that the Final Environmental Impact Statement ("FEIS") and Record of Decision ("ROD") issued by the United States Forest Service ("Forest Service") for the Stibnite Gold Project (the "Project") constitute new evidence that Perpetua does not have legal control over the Stibnite Access Route. Petitioner's claim fails on its face—Perpetua maintains the same control over public access to the Stibnite Access Route as has been described by the Forest Service throughout the National Environmental Policy Act ("NEPA") process and the Idaho Department of Environmental Quality ("DEQ") in development of the Permit to Construct ("PTC"). The Board should reject Petitioner's claims and dismiss the Motion.

INTRODUCTION

I. Procedural History

The Project is a mining and mineral processing operation that will be constructed and operated on state, private, and federal land in Valley County, Idaho. In addition to gold and silver, Perpetua will produce antimony essential to military applications critical for national security.

Before commencing construction on the Project, Perpetua must obtain various regulatory approvals, including a PTC from DEQ, as well as a separate NEPA authorization that provides Perpetua with the legal right to conduct operations on Forest Service lands. This comprehensive NEPA review required the Forest Service to develop an Environmental Impact Statement

("EIS") prior to issuing a ROD to authorize Perpetua's Mine Plan.[1] 42 U.S.C. § 4332(2)(C); 40 C.F.R. § 1502.1. The Forest Service issued a Draft EIS ("DEIS") on August 14, 2020, and a Supplemental DEIS on October 28, 2022.

In 2017, during the initial scoping phase of the NEPA process, Perpetua modified its original Mine Plan to include the Stibnite Access Route after receiving feedback that the Project would lengthen travel time for those who use the existing Stibnite Road to access Thunder Mountain Road. *See* REC 676, 893–895, 1758. Under the Mine Plan, Perpetua will control the Stibnite Access Route and will allow registered visitors restricted and limited use for the sole purpose of accessing other National Forest areas on the north side of the Project. This has not changed throughout the PTC and NEPA processes. *See* Pooser Decl., Exh. 1 at REC 376, Exh. 2 at REC 415, 676–677, 893–897, Exh. 3, Exh. 4, Exh. 5, Exh. 6, Exh. 7. The PTC, issued by DEQ on June 17, 2022, reflects the same ambient air boundary as set forth in the DEIS, including Perpetua's plan to control public access to the Stibnite Access Route. *See id.*, Exh. 1 at REC 376, Exh. 2 at REC 676–677.

On May 9, 2024, the Idaho Board of Environmental Quality (the "Board") issued a Final Order finding that "DEQ acted reasonably and in accordance with law when it found Perpetua has legal and practical control of the Stibnite Access Route such that it could be excluded from the ambient air boundary." REC 3698–3703. The Board found that (1) there was sufficient evidence to demonstrate that Perpetua will have legal control over access to the ambient air

[1] An EIS includes a comprehensive environmental analysis of the proposed activity and its potential impacts, as well as possible alternatives. 40 C.F.R. § 1502.1. The ROD completes the NEPA process by documenting the responsible federal agency's decision on the proposed activity—or an alternative—subject to mitigation measures. 40 C.F.R. § 1505.2.

boundary and (2) the PTC contains enforceable conditions that will preclude practical access by the general public. *Id.*

However, at the time of the issuance of the PTC and the Board's Final Order, the Forest Service had not issued the FEIS and ROD. The Board stated that it would not speculate as to the outcome of the NEPA process but found that there was sufficient evidence in the record to support DEQ's conclusion that Perpetua will have legal authority to control access. *Id.* The Board acknowledged DEQ's statement during oral argument that "should the [Forest Service] ultimately require public access through the [Project], the ambient air boundary analysis will have to be reevaluated." REC 3700.

On September 6, 2024, the Forest Service issued the FEIS. On January 3, 2025, the Forest Service issued the ROD. The ROD gives Perpetua legal authority to control the Project's boundary, including access to the Stibnite Access Route. Along with the ROD, the Forest Service also issued an Errata to the FEIS to provide clarifications in response to objections. The Errata states that the Stibnite Access Route is not a public road. Pooser Decl., Exh. 6 at PRI 1012. The FEIS, Errata, and ROD are all consistent with the DEIS and Supplemental DEIS—each of these documents reflect Perpetua's legal control over the Stibnite Access Route, and the conditions for practical control over the Route mirror the conditions originally set forth in the DEIS and the Supplemental DEIS. *Compare id.*, Exh. 5, 6, 7 *with* Exh. 3, 4.

Petitioner now seeks reconsideration of the Board's Final Order based on their assertion of "new evidence" in the FEIS and the ROD—there is none—and requests remand of the PTC to DEQ for reconsideration of the ambient air boundary analysis. Pet. Mot. at 5.

II. EPA Guidance on Ambient Air and the Board's Conclusion that the Stibnite Access Route is Not Ambient Air

Idaho regulations define "ambient air" consistent with EPA regulations as "that portion of the atmosphere, external to buildings, to which the general public has access." IDAPA 58.01.01.006.05. *See also* 40 C.F.R. § 50.1(e) (same definition). EPA and DEQ have long recognized that an applicant need not demonstrate the impact of a source's emissions on air within areas where general public access is restricted. *See* REC 1138, 1341, 1805.

EPA has consistently exempted from "ambient air" "the atmosphere over land [1] owned *or controlled* by the source and [2] to which the public access is precluded by a fence or other physical barriers." REC 1138 (emphasis added). In 2019, EPA broadened the "fence or other physical barriers" element and recognized that physical boundaries are not the only way in which to preclude public access. REC 1146. Specifically, EPA recognized that other measures (such as video surveillance, monitoring, clear signage, and routine security patrols) may be effective in deterring or precluding general public access to the land. *Id*. EPA gives the example that clearly visible "No Trespassing" signs in conjunction with some degree of fencing or other physical and/or non-physical barriers may be effective to preclude access by the general public. REC 1147.

Also important, EPA recognizes a source's "ambient air" is reviewed based on an individual, case-by-case basis. REC 1147–1148. As EPA explains in the 2019 guidance:

> The EPA will apply a rule of reason in evaluating the effectiveness of any measure proposed by a source … this evaluation should address relevant factors, such as the nature of the measure used (e.g., physical or non-physical), source location, type and size of source and property to be excluded, surrounding area (including the proximity, nature, and size of the population in the area), and other factors affecting whether members of the general public would readily be able to trespass upon or otherwise have access to the source's properties.

REC 1147. Air agencies "should consider all relevant information provided by the source or other interested parties, or otherwise available regarding the effectiveness of the measures to prevent public access." *Id*. Thus, air agencies exercise discretion in determining whether a permit condition is appropriate to ensure that the source administers selected measures in a manner that maintains continued public health protection. *Id*.

Only the first element—legal control—is raised by Petitioner's Motion. Petitioner did not request reconsideration of the Board's determination in the Final Order that Perpetua will preclude practical access by the general public.

ARGUMENT

The Forest Service's FEIS and ROD do not warrant remand of the PTC to DEQ for reconsideration of its ambient air boundary analysis because (I) the FEIS and ROD provide no new evidence; (II) the FEIS and ROD support the Board's conclusion that Perpetua will have legal (and practical) control over the Stibnite Access Route; and (III) the Errata expressly confirms that the Stibnite Access Route is not a public road.

I. The FEIS and ROD Provide No New Evidence

Petitioner's argument hinges on the claim that the FEIS and ROD provide new evidence demonstrating that Perpetua will not have legal control over access to the Project site. Petitioner argues that these documents "unequivocally establish that the Stibnite Road Access Route is for public use and that Perpetua does not have *absolute legal authority* to preclude such use."[2] Pet.

[2] As established in the EPA guidance discussed above, the applicable legal standard is not "absolute" control; it is whether Perpetua will (1) exercise "legal control" of the Project site and (2) preclude "practical access" by the general public, as DEQ and Forest Service have properly recognized.

Mot. at 3 (emphasis added). Petitioner's claim of alleged "new" evidence is simply wrong as a factual matter. Petitioner's Motion should be denied for this reason alone.

The FEIS and ROD clearly provide descriptions of Perpetua's control of access and nothing in the FEIS or ROD changes either the Forest Service's analysis of the control question in the DEIS and the Supplemental DEIS, or the DEQ's analysis of the question when it first issued the PTC in June 2022. To be crystal clear, the characterization of Perpetua's legal control over the Stibnite Access Route has not changed throughout DEQ's development of the PTC, the Board's review of Petitioner's challenge, or the Forest Service's NEPA review.

DEQ's June 2022 Statement of Basis for the PTC recognized that Perpetua "will legally control the [Project site]" and provide limited public access through the Stibnite Access Route, subject to restrictions in Perpetua's Access Management Plan:

> [Perpetua] has the legal authority to control access to the Stibnite Road access route and would provide seasonal (non-winter conditions) access only. At the discretion of [Perpetua], additional access controls may occur during various phases of construction, during mine operations that present potential safely hazards such as blasting, due to inclement weather, or under any other circumstances that may present a threat to the protection of public or employee health and safety. [Perpetua] has the legal and practical ability to enforce its control over roadway access and to monitor traffic passing through the [Project] site.

Pooser Decl., Exh. 2 at REC 676–677.

The PTC then provides the following minimum control measures that Perpetua will implement in its Access Management Plan relative to the Stibnite Access Route:

- Preclude unauthorized access at primary access points through the use of security escort vehicles, manned guardhouses, locked gates, barriers, or equivalent measures;
- Post warning signs and place boulders at secondary access points;
- Use trained security personnel to patrol the Project site and escort trespassers off the site;

- Provide access only to "registered guests" for the sole purpose of passing through the Project site to another destination; and

- Require guests to complete a registration sheet that explains Perpetua's requirements for accessing the site and identifies potential hazards.

See id., Exh. 1 at REC 376.

The relevant analysis and conditions have not changed since DEQ made its initial decisions. Nonetheless, Petitioner erroneously claims that the following excerpts from the FEIS and ROD now establish that Perpetua will not legally control the Stibnite Access Route:

- Stibnite Road connects to Thunder Mountain Road on the southeastern portion of the Stibnite mine site and currently provides public access through the mine area.

- A new 12-foot-wide gravel road will be constructed to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375) through the Stibnite Gold Project. During operations, the public access road will be used to travel through the Stibnite Gold Project and will provide seasonal use, open to all vehicles.

- During operations, the public access road through the Operations Area Boundary would provide seasonal use, open to all vehicles; access would not be provided in winter when impassable (current county maintenance standards) and signs would inform the public of seasonal and temporary closures. Public vehicles passing through would be required to check-in with mine personnel at the North or South SGP entry points and would receive a safety briefing and would also be required to check-out with the SGP personnel upon exhibiting the SGP. For safety purposes, public access would be separated from other SGP roads by berms, security fencing, and the underpass to allow the public road to pass beneath the mine haul road.

Pet. Mot. at 3.

But these excerpts are also found in the DEIS and Supplemental DEIS. Indeed, the Forest Service used *nearly the exact same language* in the Supplemental DEIS, which was available at the time of DEQ's decision, with only a few grammatical differences:

- Stibnite Road connects to Thunder Mountain Road on the southeastern portion of the Stibnite site and currently provides public access through the site. Pooser Decl., Exh. 4, Excerpts from Supplemental DEIS at PRI 993.

- A new 12-foot-wide gravel road would be constructed to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375) through the SGP. During operations, the public access road would be used to travel through the SGP and would provide seasonal use, open to all vehicles. *Id.*, Exh. 4, Excerpts from Supplemental DEIS at PRI 991. *See also id.*, Exh. 3, Excerpts from DEIS at PRI 979–980.

- During operations, the public access road through the SGP would provide seasonal use, open to all vehicles; access would not be provided in winter when impassable (current county maintenance standards) and signs would inform the public of seasonal and temporary closures. Vehicles passing through the SGP would be required to check-in with mine personnel at the North or South SGP entry points and would receive a safety briefing and would also be required to check-out with SGP personnel upon exiting the SGP. For safety purposes, public access would be separated from other SGP roads by berms, security fencing, and the underpass to allow the public road to pass beneath the mine haul road. *Id.,* Exh. 4, Excerpts from Supplemental DEIS at PRI 989. *See also id.*, Exh. 3, Excerpts from DEIS at PRI 979–980.

The attached Exhibits—which include Forest Service determinations that Perpetua requests be administratively noticed by the Board[3]—include portions of the DEQ permitting record and additional NEPA documents that further demonstrate this consistency. *See id.*, Exh. 1, Excerpts from Permit to Construct, Exh. 2, Excerpts from Statement of Basis, Exh. 3, Excerpts from DEIS, Exh. 4, Excerpts from Supplemental DEIS, Exh. 5, Excerpts from FEIS, Exh. 6, Excerpts from Errata, Exh. 7, Excerpts from ROD.

Nor do the FEIS and ROD require public access (in fact the agency explicitly stated the opposite). The Stibnite Access Route is an element of the approved Mine Plan for the Project that is in the ultimate control of Perpetua—as illustrated by the measures Perpetua will

[3] Pursuant to IDAPA § 62.01.01.479, Idaho Code § 67-5251(4)(a), Idaho Code § 9-101(3), and I.R.E. Rule 201(b)(2), Perpetua requests that the Board take judicial notice that the Forest Service made the determinations in the highlighted portions of the NEPA documents. These highlighted portions provide adjudicative facts that are "not subject to reasonable dispute because" they are part of "official acts" of the Forest Service. *See Hastings v. Idaho Dep't of Water Res.*, 173 Idaho 630, 547 P.3d 1190, 1200-01 (2024) (affirming the district court's decision to take judicial notice of a conditional permit issued by the Idaho Department of Water Resources under Idaho Code § 9-101(3) and I.R.E. Rule 201(b)(2)).

implement to limit access and to manage use. The DEIS, Supplemental EIS, and FEIS analyzed the environmental impacts of Perpetua's Mine Plan, including the restricted public access (controlled and limited by Perpetua) through the Stibnite Access Route. *See* Pooser Decl., Exh. 3, Exh. 4, Exh. 5. In the ROD, the Forest Service then approved Perpetua's Mine Plan and authorizes Perpetua to control use of the Route and preclude public access pursuant to the Access Management Plan. Therefore, nothing has changed from the DEIS or SDEIS, and there is nothing for DEQ to reevaluate**.**

II. The FEIS and ROD Support the Board's Conclusion that Perpetua Will Have Legal Control Over the Stibnite Access Route

In its May 2024 Final Order, the Board concluded that there was sufficient evidence to demonstrate that Perpetua will have legal control over the Stibnite Access Route. REC 3698–3703. Additionally, the Board explained that Perpetua's measures to control practical access "make[] clear that access. . . will only be available under a very limited basis and not to the 'general public.'" REC 3702. Because the characterization of Perpetua's legal control over the Stibnite Access Route in the FEIS and ROD are consistent with the PTC, Statement of Basis, DEIS, and Supplemental DEIS, nothing in these final NEPA documents alters the Board's conclusions. The FEIS and ROD authorize Perpetua to restrict and control when and under what conditions vehicles use the Stibnite Access Route as DEQ authorized in the PTC. *See* Pooser Decl., Exh. 5 at PRI 1001–1002, Exh. 7 at PRI 1018–1019. Accordingly, the FEIS and ROD support the Board's Final Order.

III. The Forest Service's Errata Expressly Confirms that the Stibnite Access Route is Not a Public Road

Petitioner ignores the Forest Service's Errata to the FEIS, which flatly contradicts Petitioner's argument and further confirms that Perpetua has legal control over the Stibnite

Access Route. *See* Pooser Decl., Exhibit 6 at PRI 1012. The Errata added the following statement to the end of a paragraph in the FEIS reviewing the many measures that Perpetua will take to restrict access to the Project site:

> Because public use of the road would be subject to Perpetua's control measures on general use, *the public access road is not considered a public road*.

Id. (emphasis added). The Forest Service explained that "[t]he addition clarifies the status of the access road through the site with regard to whether it will be operated as a public road." *Id.*

The characterization of the Stibnite Access Route is consistent with Forest Service guidance, which limits a "public road" to one that is "(1) Available, except during scheduled periods, extreme weather, or emergency conditions; (2) Passable by four-wheel standard passenger cars; and open to the general public for use without restrictive gates, prohibitive signs or regulation other than restrictions based on size, weight, or class of registration." *See Pub. Lands for the People, Inc. v. United States Dep't of Agric.*, 2010 U.S. Dist. LEXIS 132748, at *34–35 (E.D. Cal. Dec. 14, 2010). Indeed, the Stibnite Access Route will be controlled by restrictive gates, prohibitive signs, and other control measures set out in the PTC, FEIS, and ROD. Pooser Decl., Exh. 1 at REC 376, Exh. 5 at PRI 1001–1002, Exh. 7 at PRI 1018–1019.

The Forest Service's Errata explicitly contradicts Petitioner's claim that the FEIS and ROD "unequivocally establish" that the Stibnite Access Route is for public use. Instead, the Errata further reconfirms what the PTC, Statement of Basis, DEIS, Supplemental EIS, FEIS, and ROD consistently establish—Perpetua will have legal control over access through the Stibnite Access Route.

CONCLUSION

As the FEIS and the ROD fail to provide any new information that would change DEQ's conclusion, remand to DEQ is neither appropriate nor necessary. Remand would be a waste of agency resources and time, particularly in light of the years of review that DEQ has already spent scrutinizing the PTC.

DATED: February 7, 2025.

STOEL RIVES LLP

/s/ Christopher Pooser
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole C. Hancock

Attorneys for Perpetua Resources Idaho, Inc.

CERTIFICATE OF SERVICE

I hereby certify that on this 7th day of February 2025, a true and correct copy of the foregoing PERPETUA'S BRIEF IN OPPOSITION TO PETITIONER'S MOTION FOR RECONSIDERATION BASED ON NEW EVIDENCE was served on the following:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Dylan B. Lawrence
Hearing Officer
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Bryan Hurlbutt
Laurence ("Laird") J. Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Michael A. Short
Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
michael.short@deq.idaho.gov
hannah.young@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
ann.yribar@ag.idaho.gov
via electronic service

Diane Cutler, Hearing Coordinator
Rules and Planning Analyst
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
(208)373-0165
diane.cutler@deq.idaho.gov
via electronic service

/s/ *Christopher Pooser*
W. Christopher Pooser
Attorneys for Perpetua Resources Idaho, Inc.

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
Nicole C. Hancock, ISB No. 6899
nicole.hancock@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	Case Docket No. 0101-22-01 OAH Case No. 23-245-01 DECLARATION OF W. CHRISTOPHER POOSER IN SUPPORT OF PERPETUA'S OPPOSITION TO RECONSIDERATION

I, W. CHRISTOPHER POOSER, declare as follows:

1. I am a partner at Stoel Rives LLP and an attorney of record for Intervenor-Respondent Perpetua Resources Idaho, Inc. ("Perpetua") in the above-entitled matter. As such, I

have personal knowledge of the facts and statements contained in this Declaration. I submit this Declaration in support of Perpetua's Opposition to Petitioner's Motion for Reconsideration Based on New Evidence.

2. Exhibits 1 through 2 are true and correct excerpts from Idaho Department of Environmental Quality permitting documents regarding the Stibnite Gold Project that are currently in the record and labeled with REC numbers. Portions of the documents relevant to Perpetua's Opposition have been highlighted for ease of reading.

3. Exhibits 3 through 7 are true and correct excerpts from the United States Forest Service's review of the Stibnite Gold Project under the National Environmental Policy Act, obtained online from the Payette National Forest Stibnite Gold Project EIS website: https://www.fs.usda.gov/project/?project=50516. These documents are not yet part of the administrative record. For purposes of the record, these documents have been Bates-stamped with "PRI" numbers consistent with previous declarations. Portions of the documents relevant to Perpetua's Opposition have been highlighted for ease of reading.

Ex. No.	REC or Bates No.	Document Description
1	REC 367, 376	Excerpts from Permit to Construct (June 17, 2022)
2	REC 410, 415, 676–677, 893–897	Excerpts from Statement of Basis (June 17, 2022)
3	PRI 977–985	Excerpts from Draft Environmental Impact Statement (August 2020)
4	PRI 986–997	Excerpts from Supplemental Draft Environmental Impact Statement (October 28, 2022)
5	PRI 998–1010	Excerpts from Final Environmental Impact Statement (September 6, 2024)
6	PRI 1011–1012	Excerpts from Errata to Final Environmental Impact Statement (January 3, 2025)

7	PRI 1013–1020	Excerpts from Record of Decision (January 3, 2025)

I declare under penalty of perjury under the laws of the state of Idaho that the foregoing is true and correct.

DATED: February 7, 2025.

STOEL RIVES LLP

/s/ Christopher Pooser
W. Christopher Pooser

CERTIFICATE OF SERVICE

I hereby certify that on this 7th day of February 2025, a true and correct copy of the foregoing DECLARATION OF W. CHRISTOPHER POOSER IN SUPPORT OF PERPETUA'S OPPOSITION TO RECONSIDERATION was served on the following:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Dylan B. Lawrence
Hearing Officer
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Bryan Hurlbutt
Laurence ("Laird") J. Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Michael A. Short
Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
michael.short@deq.idaho.gov
hannah.young@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
ann.yribar@ag.idaho.gov
via electronic service

Diane Cutler, Hearing Coordinator
Rules and Planning Analyst
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
(208)373-0165
diane.cutler@deq.idaho.gov
via electronic service

/s/ *Christopher Pooser*
W. Christopher Pooser
Attorneys for Perpetua Resources Idaho, Inc.

EXHIBIT 1
Excerpts from Permit to Construct

Air Quality

PERMIT TO CONSTRUCT

Permittee	Perpetua Resources Idaho, Inc.
Permit Number	P-2019.0047
Project ID	62288
Facility ID	085-00011
Facility Location	Forest Service Roads NF-374 and NF-412 Stibnite, Idaho 83611

Permit Authority

This permit (a) is issued according to the "Rules for the Control of Air Pollution in Idaho" (Rules), IDAPA 58.01.01.200–228; (b) pertains only to emissions of air contaminants regulated by the State of Idaho and to the sources specifically allowed to be constructed or modified by this permit; (c) has been granted on the basis of design information presented with the application; (d) does not affect the title of the premises upon which the equipment is to be located; (e) does not release the permittee from any liability for any loss due to damage to person or property caused by, resulting from, or arising out of the design, installation, maintenance, or operation of the proposed equipment; (f) does not release the permittee from compliance with other applicable federal, state, tribal, or local laws, regulations, or ordinances; and (g) in no manner implies or suggests that the Idaho Department of Environmental Quality (DEQ) or its officers, agents, or employees assume any liability, directly or indirectly, for any loss due to damage to person or property caused by, resulting from, or arising out of design, installation, maintenance, or operation of the proposed equipment. Changes in design, equipment, or operations may be considered a modification subject to DEQ review in accordance with IDAPA 58.01.01.200–228.

Date Issued June 17, 2022

Kelli Wetzel

Kelli Wetzel, Permit Writer

Mike Simon

Mike Simon, Stationary Source Bureau Chief

the Stockpile Transfer to Reclaim Conveyors (OC9), Reclaim Conveyors to SAG Mill Feed Conveyor (OC10), and SAG Mill Feed Transfer to SAG Mill conveyor (OC11).

- Develop specific criteria to determine what frequency and type (water and/or chemical) of dust suppressant must be applied, and appropriate suppressant application rates. Chemical dust suppressants shall be applied consistent with manufacturer's instructions and recommendations.
- Develop and implement precautionary measures to address high-wind events, such as when average (sustained) wind speed is forecast to exceed 25 miles per hour.
- Provide training/orientation to all relevant employees regarding FDCP requirements, including the necessity of restricting public access as specified in the Access Management Plan (AMP). Visible emissions evaluations shall be conducted by the permittee's employees who are certified visible emission observers.
- At least once each year, evaluate FDCP requirements to identify additional requirements and evaluate effectiveness of practices, including dust suppressant application rates, as appropriate.

2.7 The permittee shall develop and maintain an AMP that identifies the facility boundary and all primary and secondary access points, and clearly specifies measures used to discourage public access to the facility. The permittee shall comply with the measures identified in the AMP at all times. The measures specified in the AMP shall be incorporated by reference to this permit and shall be enforceable permit conditions. At a minimum, the AMP shall include requirements to:

- Observe all primary access points to preclude unauthorized public access. Onsite personnel shall be available for this purpose during active mining and mineral processing operations. Public access to the facility may be monitored by the use of security escort vehicles or manned guardhouses, or sufficiently precluded by the use of locked gates, barriers, or equivalent measures. Primary access points include the North and South Security Gates.
- Post warning signs and periodically patrol secondary access points to the facility to preclude public access. Onsite personnel shall be available for this purpose. Plans shall be described in the AMP, including identifying the access points monitored, the frequency of patrol, and measures employed to discourage access (e.g., locked gates, barriers, natural features, etc.). Secondary access points include secondary roadways and trails traversing the facility.
- Only registered guests of the facility will be allowed access to or through the facility. Those seeking to be a guest for the sole purpose of passing through the facility to another destination shall be provided a registration sheet that explains Perpetua's requirements for accessing the site and identifies potential hazards of the site.

2.8 Copies of the FDCP and AMP shall be submitted to DEQ for approval 30 days prior to startup at the address provided (Permit Condition 2.26), and shall remain onsite at all times. Any changes to the FDCP or the AMP shall be submitted to DEQ for review, comment, and approval 30 days prior to the change.

EXHIBIT 2
Excerpts from Statement of Basis

Statement of Basis

Permit to Construct No. P-2019.0047
Project ID 62288

Perpetua Resources Idaho, Inc.
Stibnite, Idaho

Facility ID 085-00011

Final

June 17, 2022

Kelli Wetzel KW
Permit Writer

The purpose of this Statement of Basis is to satisfy the requirements of IDAPA 58.01.01.et seq, Rules for the Control of Air Pollution in Idaho, for issuing air permits.

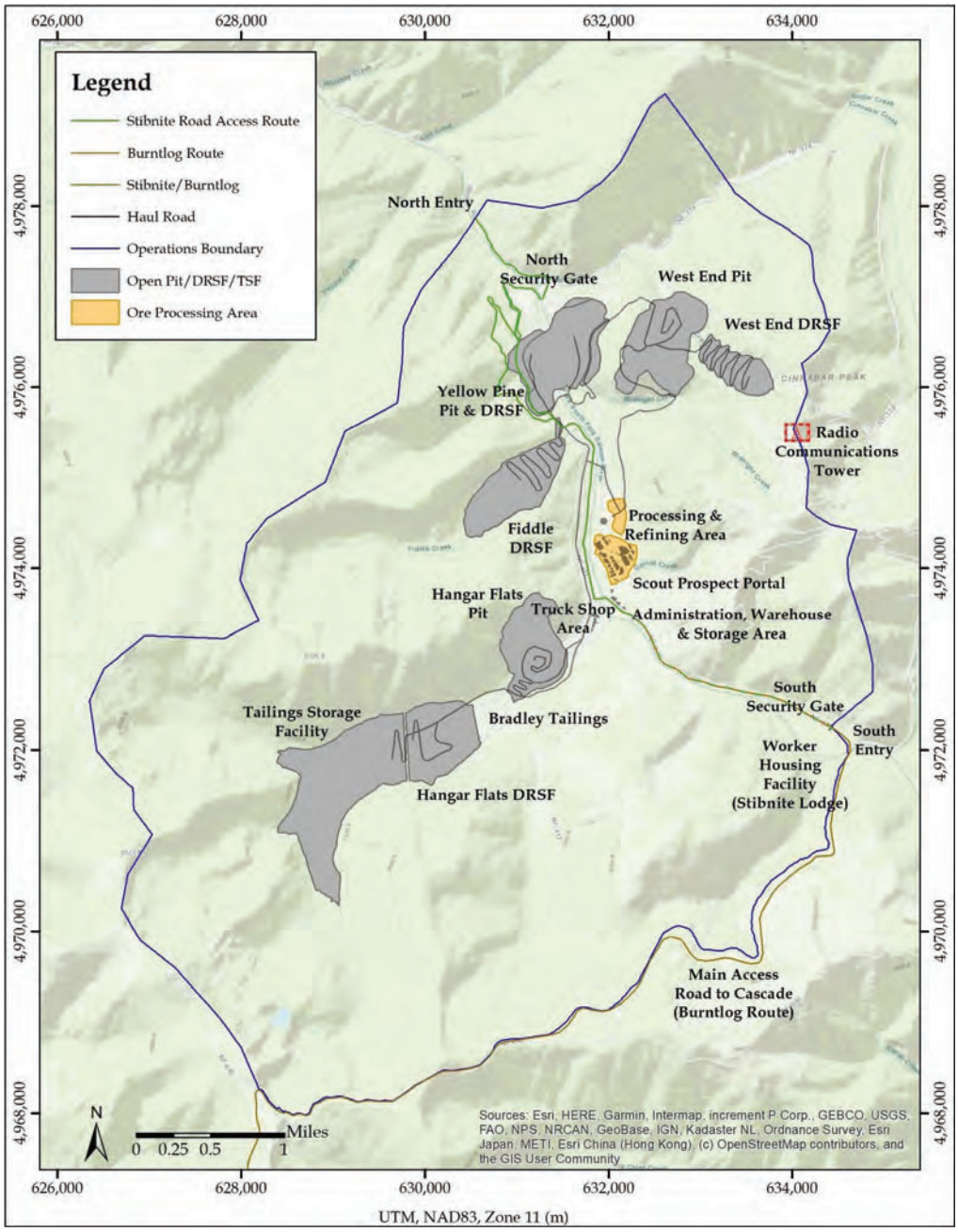
FACILITY INFORMATION

Description

Perpetua Resources Idaho, Inc. (PRI) proposes to construct and operate the Stibnite Gold Project (SGP), consisting of conventional open-pit mining, ore preparation, and gold extraction operations.

SGP is to be located in Valley County at the intersection Forest Service roads NF-374 and NF-412 (Stibnite Road), approximately 10 miles east of Yellow Pine. The proposed Burntlog Route access road will provide year-round access to the site. The project comprises a combination of public national forest and private lands. The mining operations boundary within which public access will be excluded is defined in Figure 1. This operations boundary also defines the ambient air boundary used in all ambient air quality impact analyses.

Fi ure 1 PRO ECT RE OF OPER TIO S



3.3.10 Ambient Air Boundary

Ambient air is defined in Section 006 of the Idaho Air Rules as "that portion of the atmosphere, external to buildings, to which the general public has access."

PRI will legally control the SGP, an active industrial site where mining activities will occur, such as heavy equipment operation. Most areas of the mine will require strict safety protocols and controlled access. PRI has established an operations boundary to identify the area where public access will be excluded. Public access inside the operations boundary will be restricted for the life of the mine by physical barriers at points of potential access, including the current Stibnite Road point of entry and proposed site access via the Burntlog Route, as well as natural features of the landscape that prevent access. Consistent with the guidance provided in the EPA's draft revised policy on ambient air (EPA 2018b), public access control will include the following measures:

- Primary Access Points: The Stibnite Road (north) and Burntlog Route (south) access points will include locked gates. Guard shacks will be located at each gate to monitor all vehicle ingress/egress. Each gate also will include appropriate adjacent barriers (i.e., fencing, bollards, boulders, or other barriers) to prevent any vehicle from circumventing the gate and gaining site access. These primary access points are also controlled by adjacent natural features, such as streams and creeks, steep topography, and areas of thick vegetation and undergrowth that serve as natural barriers or impediments to access.

- Secondary Access Points: Other potential access points, such as secondary roadways and trails, will include posted signs warning the public against entry into the site. At these locations, boulders will be placed across the trail and at an appropriate width adjacent to the trail to prevent any vehicle from circumventing the barrier. These secondary access points also incorporate adjacent natural features, such as streams and creeks, steep topography, and areas of thick vegetation and undergrowth that serve as natural barriers or impediments to access. Some mine features, such as the TSF and process plant areas, will include perimeter fencing.

- Surveillance: PRI security personnel will routinely patrol mine facilities and roadways for unauthorized individuals. In addition, all onsite personnel will be trained on the necessity of restricting public access to areas within the operations boundary. Any suspected trespassing by unauthorized individuals will be reported immediately to security, and trespassers will be escorted off the site.

In response to comments from local community citizens, PRI will manage an access route to provide the general public with limited access through the SGP site between Stibnite Road at Sugar Creek and Thunder Mountain Road at Meadow Creek (shown in Figure 2). This route will be managed in accordance with the Stibnite Road Access Management Plan which is summarized as follows:

The proposed Stibnite Road access route through the SGP site is meant to provide controlled through-site access that is safe, provides travel-time comparable to current conditions and is consistent with the United States Forest Service travel management plan. The Stibnite Road access route extends from the north entry point southward to the Administration, Warehouse and Storage Area. Continuing southward, the Stibnite Road access route incorporates the Burntlog access road segment that occurs within the operations area and extends to the south entry point as shown on Figure 2. PRI has the legal authority to control access to the Stibnite Road access route and would provide seasonal (non-winter conditions) access only. At the discretion of PRI, additional access controls may occur during various phases of construction, during mine operations that present potential safely hazards such as blasting, due to

REC 7287
0676
PET 310

inclement weather, or under any other circumstances that may present a threat to the protection of public or employee health and safety. PRI has the legal and practical ability to enforce its control over roadway access and to monitor traffic passing through the SGP site. Signage will be placed at the North Security Gate (near the bridge over Sugar Creek) and the South Security Gate (near the Stibnite Lodge) to provide information to travelers, and guard shacks will be located at each gate to monitor all vehicle ingress/egress. Persons wishing to traverse the SGP site on the Stibnite Road access route will be required to check in at the security gate to receive a safety briefing and to alert mine staff of their presence. Travelers will be required to check out upon exiting the site to ensure passage through the site in a safe and timely manner. Travelers will not be allowed to stop or loiter while traveling though the operations area. Along its full length, the Stibnite Road access route would have appropriate signage to direct travelers and would be separated from mine haul roads and areas of mine operations by fencing, berms, or gates to prevent travelers from straying from the route. When possible and to the degree practicable, anticipated public access restrictions will be communicated to the public in a timely manner so that they may plan appropriately. Receptors on the Stibnite Road access route were not included in the SGP air quality analyses as this road is not considered ambient air.

The worker housing facility will be located within the project operations boundary, near the south access security gate. This housing facility will be used strictly for accommodating employees, contractors, and official visitors, and it will not be accessible to the general public. Therefore, the atmosphere over the land occupied by the worker housing facility is not considered ambient air, and receptors were not placed at this location for the air quality analyses.

The operations boundary, shown in Figure 2 above and Figure 9 below, was used to define the ambient air boundary for air dispersion modeling purposes.

3.3.11 Nearby Co-Contributing Sources

If impacts of neighboring emission sources on receptors showing a significant impact from the sources subject to the permitting action are not adequately accounted for by the background concentration used, then emissions from those sources must be modeled. The nearest significant permitted facility to SGP is Tamarack Mill, located more than 75 kilometers (km) west. This facility is located too far away to cause a significant concentration gradient along the periphery of the SGP and was therefore not included in the cumulative impact analyses for SGP.

3.3.12 Receptor Network

DEQ determined that the receptor grid used in the submitted modeling analyses was adequate to resolve maximum modeled impacts.

The SGP air quality analyses were performed using the following receptor spacing and extents (Table 18):

- 25-m-spaced receptors placed along the ambient air boundary;
- 50-m-spaced receptors extending 250 m beyond the ambient air boundary;
- 100-m-spaced receptors extending 1 km beyond the 50-m-spaced receptors;
- 500-m-spaced receptors extending 5 km beyond the ambient air boundary; and
- 1-km-spaced receptors extending 10 km beyond the ambient air boundary.

In addition, each highest modeled impact was evaluated further by performing a hot-spot analysis using a finer 25-m-spacing receptor grid. The modeling receptor grid is shown below in Figure 9. The full grid,

REC 7288
0677
PET 311

405 S. 8th Street #201
Boise, ID USA 83702
info@midasgoldidaho.com

MAX.TSX
MDRPF.OTCQX

www.midasgoldidaho.com

Midas Gold Idaho, Inc. - Stibnite Gold Project
Stibnite Road Access Management Plan – Version 1

April 15, 2020

1 Purpose and Objectives

This Stibnite Road Access Management Plan (Plan) describes the methods whereby Midas Gold Idaho, Inc. (Midas Gold), an Idaho corporation, would manage access on designated roads that traverse the proposed Stibnite Gold Project (SGP) mine site. The SGP is described in Midas Gold's Plan of Restoration and Operations (PRO).

The SGP is a proposed open pit mine that will be located at Stibnite, in central Idaho (see inset, Figure 1). The United States Forest Service (USFS) Forest System Road (FR) that passes through Stibnite (Stibnite Road; FR 50412) extends from the village of Yellow Pine eastward along the East Fork of the South Fork of the Salmon River for approximately 14 miles. Stibnite Road then continues south through the historic Stibnite mine site and connects with Thunder Mountain Road (FR 50375) on the southeastern portion of the proposed SGP. This route also allows for access to Meadow Creek Lookout Road (FR 51290; see Figure 1). As initially proposed, construction and operations at the SGP would prohibit access through the mine site for the life of the mine (approximately 20 to 25 years). During this period, alternative access to Thunder Mountain Road and Meadow Creek Lookout Road would be provided via the newly constructed Burntlog Route; a proposed mine access route that would connect the existing Burnt Log Road to Thunder Mountain Road with a new section of roadway and an upgraded section of Meadow Creek Lookout Road. Additionally, as proposed in the PRO, an off-highway vehicle (OHV) Trail would be upgraded to connect Horse Heaven/Powerline Road to Meadow Creek Lookout Road. Public access routes proposed in the PRO are illustrated in Figure 1. As part of reclamation of the SGP and closure of the mine site, Stibnite Road would be re-established in an alignment similar to its current location and would become the primary access route to Thunder Mountain Road. The Burntlog Route would be reclaimed to its previous condition and would no longer be connected to Thunder Mountain Road.

Following the presentation of the proposed public access routes described above in Midas Gold's PRO, an alternative public access route has been proposed by Midas Gold and would pass through the SGP mine site (Stibnite Road access route). This alternative route is under evaluation as part of the USFS's obligation to review the SGP in accordance with the National Environmental Policy Act (NEPA). One of the alternatives currently being evaluated in the Draft environmental impact statement (EIS), Alternative 2, would provide continued access through the SGP site on a realigned Stibnite Road during mine operations. The implementation of this Plan is contingent upon the selection of the applicable alternative by the USFS as the preferred alternative for the SGP and inclusion of the proposed Stibnite Road access route as a component of the approved SGP.

The health and safety of the public and the employees of the SGP is Midas Gold's priority. The procedures included in this Plan would be implemented by Midas Gold over the course of the life of the mine to ensure that the use of the Stibnite Road access route is conducted safely and responsibly.

2 Project Information

2.1 Introduction

Midas Gold has proposed to redevelop portions of the Stibnite Mining District (District) as described in the SGP PRO, submitted to the United States Forest Service (USFS) in September 2016. The SGP will be located at Stibnite in Valley County, approximately 92 miles by air and 144 miles by road northeast of Boise, Idaho; 44 air miles northeast of Cascade, Idaho; and 10 air miles east of Yellow Pine, Idaho. Current access to the site is from State Highway 55 to the SGP area via Warm Lake, Johnson Creek, and Stibnite Roads as shown in Figure 1. The proposed layout of the SGP mine features is illustrated in Figure 2.

Mining operations in the District first began in the 1920s and continued episodically through 1996. Proposed SGP mine operations described in Section 9 of the PRO would include open-pit mining in the three previously mined areas:

- The Yellow Pine open pit will encompass the area of the former Yellow Pine pit, Homestake pit, and portions of the Bradley Mining Company rock dumps.
- The West End open pit will encompass the former Stibnite Mines, Inc., open pits.
- The Hangar Flats open pit will encompass the former underground Meadow Creek Mine area, Hecla heap, and adjacent former mill and smelter area.

Other features and facilities that would be part of SGP mine operations include development rock storage facilities (DRSF), a tailings storage facility (TSF) and tailings pipeline, surface water management features (diversions, collection ditches, stormwater collection ponds), an ore processing facility, a water treatment facility, equipment maintenance and storage buildings, a worker housing facility, and all associated haul roads and access roads. The north and south points of entry to the SGP would have security gates and guard shacks that would be occupied on a continual basis. Features related to SGP mine but located off-site are illustrated in Figure 1 and include the Landmark Road Maintenance Facility, Stibnite Gold Logistics Facility, and features associated with powerline upgrades and extension.

The general timeline for constructing, operating, restoring, and mitigating the SGP is approximately 20 to 25 years, including 3 years of site preparation, construction, and early restoration activities; 12 to 15 years of operations; and 5 to 7 years of final closure and reclamation work. The SGP will produce gold, silver, and antimony over the 12- to 15-year mining period.

2.2 The SGP and NEPA

The proposed SGP occurs on patented mining claims (private land) and land administered by the United States Forest Service (USFS) within both the Boise National Forest (BNF) and Payette National Forest (PNF). The Big Creek/Stibnite Management Area 13, which includes the District, is administered by the Krassel Ranger District of the PNF. Proposed actions that occur on Federally managed lands require environmental review and analysis in compliance with NEPA. The NEPA analysis for the SGP was initiated

in mid-2017 with the USFS as the lead agency. The USFS is preparing an EIS to evaluate the environmental effects of the proposed SGP as well as a range of alternatives to the proposed action.

Public comments received for the SGP indicated that the change in access through the SGP for 20 to 25 years was of significant concern, particularly for those in the Johnson Creek and Yellow Pine area who use Stibnite Road to access Thunder Mountain Road and points beyond. At the direction of the USFS, Midas Gold evaluated numerous additional access options for the SGP that provided access similar to existing conditions and travel times. Midas Gold identified a suitable access route through the SGP site that would provide through-site access during operations. The road was designed to be separated from mine operations and to provide access similar to that provided by the existing Stibnite Road. The alternative access route through the SGP was included for consideration in the Draft EIS document as a component of Alternative 2.

2.3 Proposed Stibnite Road Access Route Through the SGP

The proposed SGP Stibnite Road access route that is currently under evaluation in the SGP Draft EIS is illustrated in Figure 2 and would include one of the two optional routes described below. During mine site construction, a new 12-foot-wide gravel road would be constructed to provide public access from Stibnite Road on the northern end of the SGP to Thunder Mountain Road on the southeastern end of the site. Along its full length, the Stibnite Road access route would have appropriate signage to direct travelers and would be separated from mine haul roads and areas of mine operations by fencing, berms, or gates to prevent travelers from straying from the route.

Two optional routes were identified and include variations in alignment in the vicinity of the Yellow Pine pit:

- **Stibnite Road Access Route: Option 1** – The access road would begin at the North Security Gate and would be constructed along a widened bench of the western portion of Yellow Pine pit during an early operational phase of the mine. South of the Yellow Pine pit this road would pass beneath the mine haul leading to the Fiddle Creek DRSF and would then parallel a mine haul road along a partially revegetated portion of the former Bradley mine haul road. In the central portion of the SGP site near the Mine Administration Building, the road would connect with the Burntlog Route and continue southeast toward the Worker Housing Facility and the South (Main) Security Gate. From the north end (North Security Gate) of the SGP to the south end (South Security Gate), this road would be approximately 3 miles in length.

- **Stibnite Road Access Route: Option 2** – The access road would begin at the North Security Gate and would be constructed west of the Yellow Pine pit. South of the Yellow Pine pit this road would pass beneath the mine haul leading to the Fiddle Creek DRSF and would then parallel a mine haul road along a partially revegetated portion of the former Bradley mine haul road. In the central portion of the SGP site near the Mine Administration Building, the road would connect with the Burntlog Route and continue southeast toward the Worker Housing Facility and the South (Main) Security Gate. From the north end (North Security Gate) of the SGP to the south end (South Security Gate), this road would be approximately 4 miles in length.

Based on assessment of impacts and public and agency feedback, one of these two options would be selected if Alternative 2 is identified as the Preferred Alternative for the Midas Gold SGP.

2.4 Access Controls

The proposed Stibnite Road access route through the SGP site is meant to provide controlled, through-site access that is safe, and provides travel-time comparable to current conditions. Additionally, the Stibnite Road access route would provide access that is consistent with the USFS travel management plan. Whereas Stibnite Road between Yellow Pine and Stibnite is not plowed in winter, Midas Gold would operate the Stibnite Road access route on a seasonal basis, i.e. access would not be provided in winter. Public access to the road would begin when Stibnite Road becomes passable in the Spring.

For either of the two route options described above, the northern extent of the Stibnite Road access route would begin at the North Security Gate, would continue southward traversing the SGP mine site, would connect with the Burntlog Route and would continue southeastward out of the mine operations area. The access route would exit South Security Gate near the employee housing facility.

Midas Gold has the legal authority to control access to the Stibnite Road access route and would provide seasonal (non-winter conditions) access only. At the discretion of Midas Gold, additional access controls may occur during various phases of construction, during mine operations that present potential safety hazards such as blasting or pit expansion, due to inclement weather, or under any other circumstances that may present a threat to the protection of public health and safety. Midas Gold has the legal and practical ability to enforce its control over roadway access and to monitor traffic passing through the SGP site. Signage would be placed at the North Security Gate (near the bridge over Sugar Creek) and the Main (South) Security Gate (near the Stibnite Lodge) entry points to provide information to travelers, and guard shacks would be located at each SGP Site entry gate to monitor all vehicle ingress/egress. To ensure passage through the site in a safe and timely manner, persons wishing to traverse the SGP site on the Stibnite Road access route would be required to check in at the security gate upon entry to receive a safety briefing and to alert mine staff as to their presence. After passing through the SGP site, travelers would also be required to stop at the guard shack upon exiting to check out. Travelers would not be allowed to stop or loiter while traveling though the operations area. Along its full length, the Stibnite Road access route would have appropriate signage to direct travelers and would be separated from mine haul roads and areas of mine operations by fencing, berms, or gates to prevent travelers from straying from the route.

Midas Gold would have the ability to temporarily restrict travel along the Stibnite Road access route for the protection of public health and safety. When possible and to the degree practicable, anticipated public access restrictions would be communicated to the public in a timely manner so that they may plan appropriately.

3 Conclusion

Midas Gold's SGP is under evaluation by the USFS and is proceeding through environmental analysis under NEPA. Midas Gold's proposed action and several alternatives to the proposed action will be included in the forthcoming Draft EIS. Alternative 2 in the Draft EIS includes an access alternative that would route a roadway, the Stibnite Road access route, through the mine site.

Maintaining and protecting SGP mine employee and public health and safety is Midas Gold's priority. This Stibnite Road Access Management Plan has been prepared to demonstrate that appropriate best practices, roadway construction features, and Midas Gold SGP site security measures would be in place over the life of the SGP mine and would effectively control access to the Stibnite Road access route.

This Plan will be updated and revised as appropriate.

List of Figures

Figure 1 – Site Vicinity Map
Figure 2 – Mine Site Layout

EXHIBIT 3
Excerpts from Draft EIS

United States Department of Agriculture
Forest Service

Stibnite Gold Project

Draft Environmental Impact Statement

Forest Service, Region 4, Payette and Boise National Forests, Valley County, Idaho

August 2020



REC 7295

PRI-00000977

2.4.3 Timeline

Timelines for construction, operations, and closure and reclamation for Alternative 2 would be the same as for Alternative 1.

2.4.4 Construction Phase

Construction activities and timing under Alternative 2 would be essentially the same as under Alternative 1. However, the modifications described in **Table 2.4-1** above would eliminate, relocate or modify interrelated construction activities.

2.4.4.1 Access Roads

BURNTLOG ROUTE – RIORDAN CREEK SEGMENT

Under Alternative 2, a section of new road construction along Burntlog Route (**Figure 2.4-3**) would be located on the south side of the Riordan Creek drainage and cross Riordan Creek north of Black Lake. The approximately 5.3-mile road segment would have 12 stream crossings, 3 of which cross perennial streams. The elevation of this road segment is approximately 8,000 to 8,600 feet and the average grade of this road segment would be 5 to 6 percent. The new construction portion of Burntlog Route under Alternative 2 would be approximately 13.5 miles and under Alternative 1 would be approximately 15 miles.

2.4.4.2 Public Access

STIBNITE ROAD TO THUNDER MOUNTAIN ROAD LINK

During mine site construction, a new 12-foot-wide gravel road would be constructed to provide public access from Stibnite Road (CR 50-412) to Thunder Mountain Road (FR 50375). The public access road would be constructed prior to the removal of development rock from Yellow Pine pit.

There are two options for a public access road through the mine site:

- Option 1 (**Figure 2.4-4**) – Constructed along a widened bench of the western portion of Yellow Pine pit (**Figure 2.4-5**). South of Yellow Pine pit this road would parallel a mine haul road and use a partially revegetated portion of the former Bradley mine haul road (**Figure 2.4-6**). The public access road portion through Yellow Pine pit would include a rockfall catchment area. This road would be approximately 3 miles in length.
- Option 2 (**Figure 2.4-7**) – Constructed west of the Yellow Pine pit. South of Yellow Pine pit, this road would parallel a mine haul road and use a partially revegetated portion of the former Bradley mine haul road (**Figure 2.4-8**). This road would be approximately 4 miles in length.

Based on assessment of impacts and public and agency feedback, one of these two options would be selected.

When the volume of water needing treatment in the Centralized WTP exceeds 4,000 gpm, such as during spring runoff, contact water ponds would be used to equalize the flows through the Centralized WTP. For high water years, mine pits also could be temporarily used to hold water for treatment.

During mine operation, the Centralized WTP is expected to require the following chemicals and reagents on an annual basis.

Sodium Hypochlorite – 15,000 gallons

Ferric Sulfate – 125,000 gallons/year

Hydrated Lime – 250 tons

Organic Flocculant (polymer) – 1,900 gallons

Sulfuric Acid – 2,400 gallons

Sodium Bisulfite – 2,000 gallons

Organic sulfide precipitant, if needed

Transport of these chemicals and reagents would add approximately 40 round trips for delivery to the operational AADT presented in **Table 2.4-3**. An estimated 2 to 4 employees would be required to operate the Centralized WTP.

The resulting solids from the Centralized WTP are not expected to be classified as a hazardous waste, and would be disposed in the TSF. Treated water would be discharged through the RIBs and/or direct discharge to the EFSFSR through an IPDES permitted outfall.

2.4.5.7 Access Roads

Access during operations would be the same as described in Alternative 1, except that a portion of the Burntlog Route would be relocated as described in Section 2.4.3.1, Access Roads.

2.4.5.8 Public Access

STIBNITE ROAD TO THUNDER MOUNTAIN ROAD LINK

Public Access during operations would be the same as described in Alternative 1, except that a new 12-foot-wide gravel road would be constructed to provide public access from Stibnite Road (CR 50-412) to Thunder Mountain Road (FR 50375) as described in Section 2.4.4.2, Public Access. The public access road would be used to travel through the mine site and would provide seasonal use, open to all vehicles. Vehicles passing through the mine site would be required to check-in with mine personnel at the Main or North Gates guard shacks upon entering the mine site and would receive a safety briefing. Vehicles on the public access road would be required to pass through the mine site without stopping or deviating from the public access road and would be required to check-out with mine site personnel upon exiting the mine site, to ensure they are clear of the site for safety purposes. Midas Gold would have the option to restrict mine site access to any vehicles due to concerns related to public or employee health

REC 7297
PRI-00000979

and safety, such as during blasting, mining in the immediate area of the road and other similar operations.

Berms, security fencing, and two underpasses, to allow the public road to pass beneath the mine haul road, would separate the public access road from other mine site roads. One underpass would be located north of the Fiddle DRSF and a second underpass would be located near the ore processing facility area. The public access road would be temporarily closed during construction and maintenance, and during other mining activities that would be considered public safety hazards (e.g., highwall scaling, blasting). Signs would be placed to inform the public of temporary closures and the public access road would not be plowed in the winter.

2.4.5.9 Off-site Facilities

Under Alternative 2, a maintenance facility (Burntlog Maintenance Facility) would be constructed within a borrow source site 4.4 miles east of the junction of Johnson Creek Road and Warm Lake Road (**Figure 2.4-1**). The relocated maintenance facility would include the same components as described in Alternative 1.

2.4.5.10 Traffic

The production of lime on-site would reduce lime deliveries to the site by 2,032 trips per year and would require an average of 133 additional propane deliveries per year (Midas Gold 2018b).

Table 2.4-3 shows the expected operational supply and haulage traffic under Alternative 2. The AADT for Alternative 2 is 50 vehicles.

2.4.6 Closure and Reclamation

Closure and Reclamation activities under Alternative 2 would be the same as under Alternative 1, except as described below.

2.4.6.1 Hangar Flats DRSF

Upon completion of final grading of the Hangar Flats DRSF, a low permeability geosynthetic cover would be placed on the top of the DRSF, which would be designed to limit infiltration through the DRSF. The geosynthetic liner would be overlain by placement of an inert soil/rock layer and growth media and revegetated.

2.4.6.2 Fiddle DRSF

Upon completion of final grading of the Fiddle DRSF, a low permeability geosynthetic cover would be placed on the top and outslopes of the DRSF that is designed to limit infiltration through the DRSF. The geosynthetic liner would be overlain by placement of an inert soil/rock layer and growth media and revegetated.

REC-7298
PRI-00000980

4 ENVIRONMENTAL CONSEQUENCES

4.1 INTRODUCTION

Chapter 4 describes the potential environmental consequences of implementing each of the alternatives presented in Chapter 2. Pursuant to 40 Code of Federal Regulations (CFR) 1500.1(b) and 1500.4, this section summarizes the completed analysis and forms the scientific and analytical basis for the comparison of alternatives. The alternatives described in Chapter 2 may cause, either directly or indirectly, changes in the human and natural environment. This Environmental Impact Statement (EIS) analyzes these potential changes and discloses the effects to the decision-makers and the public. Disclosure is a fundamental goal of the National Environmental Policy Act (NEPA). In addition, cumulative effects along with applicable mitigation measures and irreversible and irretrievable effects also are discussed. Effects of each action can be neutral, beneficial, and/or adverse. Effects are quantified whenever possible, and/or are qualitatively discussed.

The individual resource discussions are generally presented by issue(s) and organized with the presentation of the effects analysis issues and indicators for the resource; a brief methodology for the analysis of impacts; an evaluation of the alternatives' impacts to the resource; a discussion of cumulative effects, irreversible and irretrievable commitments, and short-term uses versus long-term productivity; followed by a summary of impacts by issues and indicators. The final subsection provides a table summarizing and comparing quantitative and qualitative impacts to each resource by alternative.

Section 4.1, Introduction, provides a brief explanation of what each resource section will address, including a summary of incomplete and unavailable information relevant to evaluating significant adverse impacts; the presentation of past, present, and reasonably foreseeable future actions (RFFAs) used for the direct, indirect, and cumulative impact analyses; and a discussion of Forest Plan Consistency and Potential Forest Plan Amendments.

4.1.1 Effects Analysis Indicators and Methodology of Analysis

An issue is defined as a point of disagreement, debate, or dispute with a proposed activity based on some anticipated effect. Issues are described in terms of cause and effect; that is, if an action occurs, an impact could result. Issues are addressed by describing comparative factors that provide a way to define, compare, and contrast the effects of the alternatives, including No Action.

REC 7299

PRI-00000981

Table 4.3-21 Maximum Annual HAP and Air Toxics Emissions Summary – Alternative 2 NSR Inventory [1]

Source Category	HCN (tpy)	H_2SO_4 (tpy)	HAP (tpy)	Hg (lbs/yr)
Ore Processing and Refining	0.97	8.9	1.8	24.9
Mining Fugitive	0.0	0.0	.0004	7.1
Total	**0.97**	**8.9**	**5.3**	**32.0**

Table Source: Air Sciences 2020

Table Notes:

1 - The HAP and Air Toxics emissions conform to the accepted PTC application to IDEQ.

H_2SO_4 = sulfuric acid, mist form. HCN = hydrogen cyanide.

HAP = Hazardous Air Pollutants. Hg = mercury (all forms).

tpy. = Tons per year. VOCs = Volatile Organic Compounds.

4.3.2.2.3 OPERATIONS PHASE – CONTROLLED ACCESS ROADWAY

The controlled access road for Alternative 2 is shown in **Figure 4.3-2** as it was included in a supplemental dispersion modeling analysis for this alternative. Although the route would be hypothetically open to all vehicles year-round, the level of usage is expected to vary seasonally because the destination areas are generally inaccessible except to over-snow vehicles between December and March. Roadway dust emissions would be reduced or eliminated during the wet months and periods of snow cover. In consideration of this, the modeling of the roadway impacts was only performed for the period of April through November. In addition, the IDEQ determination that the road is not within the regulated ambient air means that NAAQS do not apply for protection of individuals using the road.

To assess possible risk due to use of the controlled access roadway, supplemental dispersion modeling for this alternative treated the path of the public access road as “ambient air.” This requires that model receptors be positioned along the route as illustrated in **Figure 4.3-2** to predict pollutant concentrations. Treatment of the access road as ambient air could be considered a conservative approach, because several measures would be in place, consistent with EPA policy regarding sufficient measures to restrict or control public access (EPA 2019a). All public traffic on the proposed road would be required to check in and out of the mine site, and therefore they could be considered guests of the mine. Public vehicles would need to be checked in at security checkpoints at either end of the route through the Operations Area Boundary. Because the roadway would be fenced off, and on a separate ROW, no public access to the mine site or other operational areas would be allowed. Taken together, these practices allowed IDEQ to determine that the controlled access roadway can be excluded from ambient air analyses.

4.16.2.2.2.2 Public Access

Under Alternative 2, public access would be the same as Alternative 1 (e.g., the newly constructed Burntlog Route connecting to Meadow Creek Lookout Road [FR 51290]), except public access also would be provided through the mine site from Stibnite Road to Thunder Mountain Road (FR 50375) during mining operations. The newly constructed Burntlog Route connecting to Meadow Creek Lookout Road and then Thunder Mountain Road would allow public access when other routes are not available (i.e., the public access route through the mine site). The newly constructed roadway portion of the Burntlog Route would be a temporary road that is necessary for mining purposes and would meet 36 CFR 228A requirements for environmental protection. Public motor vehicle use would be allowed on the newly constructed, private mining road when other public access roads are blocked by mine operations. Approximately 13.5 miles of new roads managed by Midas Gold, but open to public access when needed, would be created.

After mine construction is complete, a 12-foot-wide, approximately 3- to 4-mile gravel road connecting Stibnite Road to Thunder Mountain Road would be open to all vehicles year-round. Midas Gold would maintain the public access road under Valley County's FRTA easement; however, it would not be plowed. There are two options for public access through the mine site (refer to Section 2.4.4.2, Public Access). Under Option 1, an approximately 3-mile public access road through a widened portion of the western side of Yellow Pine pit and paralleling a mine haul road would be constructed. Under Option 2, an approximately 4-mile public access road west of the Yellow Pine pit and paralleling the same mine haul road as Option 1 would be constructed. The selected public access road option would be separated from the mine site roads by berms, security fencing, and underpasses. For added safety, the public access road would be temporarily closed during construction and maintenance activities of the public access road, and during other mining activities that would be considered public safety hazards (e.g., high wall scaling and blasting). Signs would be placed to inform the public of the closure. During closures on the road through the mine site, public use of the Burntlog Route would be allowed.

4.16.2.2.3 Closure and Reclamation

Impacts to traffic volume and public access under Alternative 2 would be similar to those described under Alternative 1 for closure and reclamation; however, Alternative 2 would require an additional 40 truck trips per year to deliver chemicals for water treatment in perpetuity. Like operations, 40 truck trips for water treatment would provide an increase of 0.1 AADT for closure and reclamation and post-closure traffic. Post-closure, traffic to the mine site (i.e., the additional 40 truck trips per year required to deliver chemicals for water treatment in perpetuity) would no longer utilize the Burntlog Route, but would use the Yellow Pine Route to access the mine site which would be plowed to provide year-round access for treatment plant workers. Water treatment-related deliveries would not occur during the winter; supplies and waste would be stockpiled on site. Public access to and through the mine site would remain post reclamation and would require revision to the existing FRTA easement with Valley County.

relates to noise is “low” and the possibility is rated as “low,” with an overall public health rating of “negligible.”

4.18.2.1.4.3 Nutrition

Activities in the SGP area related to nutrition include fishing, hunting, or gathering of berries (or other edible vegetation). Contaminants in surface water could potentially bioaccumulate in the edible tissues of fish in impacted surface water or in wildlife that drink impacted surface water. Likewise, contaminants in soil could potentially bioaccumulate in plants growing in impacted soils. As discussed above, implementation of controls and surface water management during mine operations and the closure and reclamation activities would likely decrease concentrations of contaminants in soil and surface water relative to existing conditions. In addition, recreational exposures are expected to be of limited frequency and short duration (the Payette National Forest camping stay limit for individual campground sites is 16 days). For these reasons, the magnitude of impact on public health as it relates to nutrition is “low” and the possibility is rated as “low,” with an overall public health rating of “negligible.” There are no differences in impact findings among the construction, operation, and closure and reclamation phases of Alternative 1.

4.18.2.2 Alternative 2

Alternative 2 is similar to Alternative 1 with the main differences consisting of re-routing of a segment of the Burntlog Route, allowing public access through the mine site during operations, change in the location of the maintenance facility, re-routing a portion of the transmission line to be upgraded around the Thunder Mountain Estates, generating lime at the mine site, and establishment of a Centralized Water Treatment Plant. These changes are intended to reduce potential effects on surface water quality, reduce potential traffic related issues by providing public access through the mine site and potentially decreasing incidental public use of Burntlog Route, reduce SGP-related annual average daily traffic to the mine site during operations (through on-site lime generation) and reduce overall disturbance in the SGP area. However, Alternative 2 also would include an on-site propane-fired lime kiln and has higher air emissions than Alternative 1.

As discussed in Section 4.3.2, Direct and Indirect Effects on Air Quality, the $PM_{2.5}$ “annual” average (computed as the mean values from April through November) and PM_{10} 24-hour average concentrations (12.8 µg/m^3 and 179.7 µg/m^3, respectively) are predicted to be slightly over the respective NAAQS criteria at receptors along the public access road through the mine site (12 µg/m^3 and 150 µg/m^3, respectively). NAAQS are set at a level expected to protect public health with an adequate margin of safety, taking into consideration effects on susceptible populations. Signage and security checkpoints would alert the public to requirements for driving through the mine site, including check in and out at the checkpoints, no stopping or loitering while traversing the operations area, and restrictions would be enforced by signage, fencing, berms and/or gates to restrict travel to the designated route. The amount of time spent within the mine site on the public access road would be of limited duration. In addition, it is anticipated that people would only occasionally use the route through the mine site, such that the frequency

of exposure would be limited. While air modeling results exceeded the NAAQS criteria during the operations phase along the public access road through the mine site, the limited duration and frequency of exposure to PM at modeled air concentrations would likely be minimal, which would significantly reduce the public health impact associated with air quality, even for sensitive subpopulations. The slight exceedances of the NAAQS criteria along the public access road are expected to have little to no effect on the health of the general population, however, sensitive susceptible populations are at greater risk of health effects associated with air quality conditions.

Overall, impacts to public health and safety under Alternative 2 would therefore be slightly improved compared to Alternative 1 for traffic-related issues and surface water quality impacts. However, on-site lime generation could lead to slightly greater air quality impacts along the public access route through the mine site, that could affect sensitive subpopulations.

4.18.2.3 Alternative 3

Alternative 3 is similar to Alternative 1 with the main differences being no construction of the Meadow Creek off-highway-vehicle Connector Trail, the tailings storage facility (TSF) constructed in the EFSFSR, and different access through the mine site after mine closure/reclamation. Impacts to public health and safety would be essentially the same as those described under Alternative 1.

4.18.2.4 Alternative 4

Alternative 4 is similar to Alternative 1 with the main differences being the use of the Yellow Pine Route for access to the mine for all phases, and public road access through the mine during operations (similar to Alternative 2). These changes would result in different impacts than Alternative 1, particularly the use of the Yellow Pine Route.

Under Alternative 4, the Yellow Pine Route would be used from construction through operations and closure and reclamation and the Burntlog Route would not be constructed. Use of Johnson Creek (CR 10-413) and Stibnite (CR 50-412) roads as the primary route to the mine site during construction, operations, and closure and reclamation would result in increased noise, traffic, and safety-related issues from mine-related traffic along the Yellow Pine Route. The Yellow Pine Route would route all mine-related traffic through the Village of Yellow Pine and public traffic and mine traffic would share the same road from Landmark to the mine site. Additionally, the Yellow Pine Route would result in one point of entry to the SGP, effectively combining public access with mining traffic for the life of the mine. This limited ingress/egress to the SGP site also will impact emergency vehicle access during periods of road blockage.

The steep terrain along the Yellow Pine Route would likely be a greater risk to public safety under Alternative 4, because it would be the only route used for the life of the SGP and would require safety considerations for geotechnical hazards, landslides, and avalanche zones (see Section 4.2, Geologic Resources and Geotechnical Hazards). Overall, Alternative 4 could lead to greater public health and safety impacts compared to Alternative 1 through use of the Yellow Pine Route (increase traffic-related issues and increased geotechnical, landslide, and

EXHIBIT 4
Excerpts from Supplemental DEIS

United States Department of Agriculture
Forest Service

Stibnite Gold Project

Supplemental Draft Environmental Impact Statement

Forest Service, Region 4, Payette and Boise National Forests, Valley County, Idaho



REC 7305

PRI-00000986

During operations, mine-related traffic would include transport of employees to and from the SGP, delivery of supplies, and activities associated with road maintenance such as snowplowing and sanding. Under the 2021 MMP and the Johnson Creek Route Alternative, operational AADT would be 50 vehicles (33 heavy vehicles and 17 light vehicles), resulting in approximately four mine-related vehicles per hour traveling outside the SGP.

The upgraded Burnt Log Road and the newly constructed Burntlog Route would experience an increase in traffic of over 71 percent under the 2021 MMP, with 27.5 percent of the traffic comprised of heavy vehicles. Although heavy vehicles currently use Johnson Creek Route to access the SGP, the Johnson Creek Route Alternative traffic would result in a noticeable change in baseline driver experience and slower drive times due to the substantial increase in mine-related heavy vehicles along the Johnson Creek Route during the life of the SGP. Even though upgrades to Johnson Creek Road and Stibnite Road would be made, these roads would still have many curves and slopes.

During closure and reclamation, activities including slope recontouring, facility removal, seeding and planting, and post-closure environmental monitoring would require approximately 7 years. Closure and reclamation would generate a total estimated AADT of 27 vehicles (15 heavy vehicles and 12 light vehicles). Post-closure monitoring activities would generate a total estimated AADT of six light vehicles.

Local roads experience a seasonal effect which results in noticeable differences in traffic. Valley County has many summer recreational areas that attract visitors from May through October with peak AADT levels in June, July, and August. Mine access via the Johnson Creek Route would be more impactful on summer recreational traffic because it would utilize established roads rather than new road development. Winter driving conditions influence the amount of traffic and result in lower AADT levels during the winter months. Therefore, the effect of SGP traffic on these roads would show a noticeably greater increase in mine-related winter traffic during winter. Post-closure winter traffic would not be as noticeable as heavy vehicle deliveries would not occur and approximately six mine-related light vehicles per day would utilize the accessible roadways in the analysis area for monitoring and maintenance purposes.

Public Access

Under the 2021 MMP, public access to the SGP area would be enhanced by the development of a new access road (Burntlog Route) compliant with current road standards. Under both action alternatives, there would also be a controlled public access route through the SGP during the operations, and closure and reclamation phases; however, public access would be intermittently interrupted during the construction phase. Under the Johnson Creek Route Alternative, the Burntlog Route would not be constructed, and the Johnson Creek Route would be used for both public and SGP-related access. To continue providing OSV access to Landmark, a 10.4-mile groomed OSV route between Warm Lake and Trout Creek Campground on Cabin Creek Road would be created as part of the 2021 MMP along with a parking area, resulting in a new winter access facility that would be maintained by Valley County.

Safety and Emergency Access

For the duration of the SGP, the increase in total volume of mine-related vehicles, specifically heavy vehicles or trucks, on the Yellow Pine and Burntlog routes would result in an increased risk for accidents occurring between public and SGP-related traffic due to the one-lane constraints during construction, for

Development of the mineral resource would include construction of access and haul roads; construction of supporting infrastructure; open pit mining; ore processing; placement of tailings in a TSF; and placement of development rock. New access to the SGP would be provided by the proposed Burntlog Route, which would be a combination of widening the existing Burnt Log Road (FR 447), Thunder Mountain Road (FR 50375), and Meadow Creek Lookout Road (FR 51290) and constructing new connecting road segments of approximately 15 miles (**Figure 2.4-1**). Development of the Burntlog Route would entail 340.9 acres of new cut and fill activity (including borrow sources) along existing and newly constructed roadways.

To provide electric power for the SGP, an existing powerline would be upgraded and a new transmission line from a new Johnson Creek substation to the mine would be constructed. Additional off-site support facilities to be constructed along access corridors include the SGLF and the Burntlog Access Route Maintenance Facility. The SGLF would house administrative offices, the assay laboratory, and a warehouse while the maintenance facility would be the headquarters for road maintenance and snow removal (**Section 2.4.4.9**). The proposed facilities and access roads are shown on **Figure 2.4-1** and **Figure 2.4-2**. The Operations Area Boundary shown on **Figures 2.4-1** and **2.4-2** is the boundary within which Perpetua would control public access.

The components of the 2021 MMP are described in the following sections in terms of overall land management and affected areas, and project phases: construction; operations; exploration; and closure and reclamation, including post-closure monitoring.

2.4.2 Land Management and Affected Areas

Table 2.4-1 provides a summary of land management or ownership by estimated SGP component for the maximum affected area proposed and also includes acreages of new disturbance and re-disturbance by SGP component and ownership.

2.4.3 Phases and Timeline

The actions proposed under the 2021 MMP would take place over a period of approximately 20 to 25 years, not including the long-term, post-closure environmental monitoring or potential long-term water treatment. The phases of the SGP are described in subsequent sections and include: (1) Construction (approximately 3 years; Mine Years -3 through -1); (2) Mining and Ore Processing Operations (approximately 15 years; Mine Years 1 through 15)); (3) Surface and Underground Exploration (approximately 17 years, beginning during construction and continuing concurrent with operations; Mine Years -2 through 15); and (4) Closure and Reclamation (Mine Year 16+). Most activities in the Closure and Reclamation period would be completed within five years. However, closure water management and water treatment are expected to continue for as long as 25 years (Mine Years 16 through 40). The environmental monitoring phase would continue for as long as needed to demonstrate that the site has been fully reclaimed. **Figure 2.4-3** provides an illustration of the timing of construction and operations activities and the initiation of the closure phase.

REC 7307

PRI-00000988

2.4.4.4 Public Access

During construction of the SGP and completion of the Burntlog Route, to the degree practicable, the public would continue to have access on forest roads currently available to the public (**Figure 2.4-1**). However, current public access through the SGP on Stibnite Road would be restricted for a period of approximately one year while a new through-site public access road is constructed. A new 4-mile long, 12-foot-wide gravel road would be constructed to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road through the SGP (**Figure 2.4-2**). The road would be constructed on a widened bench on the west side within the Yellow Pine pit, then head south of the Yellow Pine pit, where this road would utilize an underpass to cross under a SGP haul road and continue southward, parallel to and on the east side of the mine haul road on a partially revegetated portion of a former haul road (**Figure 2.4-2**). Southwest of the ore processing area, the public access road would connect with Thunder Mountain Road and continue toward the worker housing facility, exiting the SGP to the southeast.

During operations, the public access road through the SGP would provide seasonal use, open to all vehicles; access would not be provided in winter when impassable (current county maintenance standards) and signs would inform the public of seasonal and temporary closures. Vehicles passing through the SGP would be required to check-in with mine personnel at the North or South SGP entry points and would receive a safety briefing and would also be required to check-out with SGP personnel upon exiting the SGP. For safety purposes, public access would be separated from other SGP roads by berms, security fencing, and the underpass to allow the public road to pass beneath the mine haul road. No stopping or deviating from the public access road would be allowed. Perpetua would restrict SGP access to any vehicles due to concerns related to public or employee health and safety, such as during road construction and maintenance, blasting, highwall scaling, mining in the immediate area of the road, and similar operations.

Public access would continue along Johnson Creek Road and Burnt Log Road. Total closures of half-day to multiple days could occur during construction work on Stibnite Road between the village of Yellow Pine and the SGP, part of Thunder Mountain Road, and Burnt Log Road.

Public use of the Burntlog Route would provide motorized access to Meadow Creek Lookout Road (FR 51290) and Monumental Summit. Other routes available for public use are shown on **Figure 2.4-1**.

Public access by foot via existing trails or on roads would be restricted within the Operations Area Boundary shown on **Figure 2.4-2**. Security personnel, fencing (including wildlife exclusion fencing), and signs would restrict public access to vehicular traffic on the designated public access roadway inside the Operations Area Boundary.

Warm Lake to Landmark Groomed OSV Trail

Due to year-round access to the SGP along the Burntlog Route, an existing, approximately 8.5-mile-long groomed OSV trail from Warm Lake to Landmark would be closed for the life of the SGP. To replace this recreational use, a dedicated alternative OSV route would be established from Warm Lake area to Landmark via the Cabin Creek/Trout Creek drainages and Johnson Creek Road (**Figure 2.4-4**).

REC 7308

PRI-00000989

Description	Resources Affected
Cyanide-bearing solutions used in ore processing would be neutralized to approximately 10 milligrams per liter weak acid dissociable (WAD) cyanide before the material is pumped to the TSF. Residual cyanide would be treated using a sodium metabisulfite and air system to detoxify the cyanide by oxidation to form cyanate.	Hazardous Materials
Cyanide would be neutralized to levels protective of wildlife, and the TSF would be surrounded by an 8-foot high, chain-link fence designed to keep wildlife, such as deer and elk, from entering the impoundment area, to prevent either liner damage or wildlife drowning.	Hazardous Materials
Oils, solvents, and lubricants would be stored in approved containers located within, or directly adjacent to, the maintenance shop and contained within secondary containments to prevent spills into the environment. All used petroleum products, waste antifreeze, and used solvents would be collected in approved containers, transported off site, and disposed or recycled.	Hazardous Materials
Nitric and sulfuric acid would be transported in tanks designed to prevent spills even in the event of rollovers.	Hazardous Materials
Nitric and sulfuric acids would be stored in specialized non-corrosive, polyethylene-lined tanks located within the ore processing facility and would have secondary containment.	Hazardous Materials
Liquids would be shipped to the SGP in tank trucks designed for spill prevention and escorted to the SGP by pilot cars manned and equipped to handle spills.	Hazardous Materials
Other legacy materials may be encountered during construction and operations. If encountered, these materials would be characterized to determine potential for reprocessing, reuse, or disposal.	Hazardous Materials
Small scale composting associated with organic materials generated at the worker housing facility may be incorporated within the centralized GMS in the Fiddle valley.	Hazardous Materials
An Explosives and Blasting Management Plan would be prepared for the SGP. Explosives storage, transport, handling, and use would comply with applicable Department of Homeland Security, Bureau of Alcohol, Tobacco, Firearms and Explosives, and MSHA regulations.	Health and Safety
For safety and security reasons, no alcohol, firearms, or illegal drugs would be permitted on site.	Health and Safety
For safety and security reasons, public access into the mine area would be prevented by using fencing, gate locking, security personnel, and/or notice postings that prohibit unauthorized entry; no unauthorized vehicles or personnel would be permitted on the SGP.	Health and Safety
Personnel transporting, handling, or using any hazardous chemicals (including sodium cyanide) would be trained to ensure the safe use of such materials. Perpetua would design, construct, and manage facilities to conform to ICMC.	Health and Safety, Fish, Wildlife, Hazardous Materials
Fuel and other petroleum products at the site would be stored in above ground containment structures, with appropriate secondary containment measures.	Health and Safety, Fish, Wildlife, Hazardous Materials
Air emissions, groundwater, surface water, and aquatic parameters would be monitored during mine construction, operation, closure, and post-closure as specified in the final authorizations from the regulating agencies.	Monitoring

REC 7309

PRI-00000990

Description	Resources Affected
A new 12-foot-wide gravel road would be constructed to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375) through the SGP. During operations, the public access road would be used to travel through the SGP and would provide seasonal use, open to all vehicles. Vehicles passing through the SGP would be required to check-in with mine personnel at the North or South SGP entry points.	Transportation and Access, Health and Safety
Post reclamation, a road would be established over the backfilled Yellow Pine pit to allow public access through the reclaimed site and connect Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375). This would replace the operational phase public access route.	Transportation and Access
Prior to site preparation and construction of surface facilities, vegetation would be removed from operating areas. Merchantable timber on NFS surface lands could be purchased from the USFS. Non-merchantable trees, deadwood, shrubs, and slash would be removed, and any remaining vegetation would be grubbed using a bulldozer. The resulting material would be saved for future use in reclamation activities. Specifically, the organic matter would be chipped and stockpiled for use as mulch or blended to create a growth media additive. After vegetation removal, growth media would be salvaged and stockpiled. Stockpiles would be stabilized, seeded, and mulched to protect the stockpiles from wind and water erosion.	Vegetation
Perpetua would inspect and remove vegetation material (including noxious weeds) from mechanical equipment and properly dispose to minimize the spread of unwanted vegetation.	Vegetation
Wood wastes and wood mulch are the two primary sources of compost. Food waste produced from on-site meal preparation and wastes may provide another source. Combined and properly managed during composting, these materials would provide a source of organic matter to be blended into substrate materials suitable for mitigation.	Vegetation
Perpetua would be responsible for noxious weed control within areas disturbed by SGP activities.	Vegetation, Wildlife
Develop and employ planting plans for wildlife benefits (cover, forage, etc.) using approved seed mixes.	Vegetation, Wildlife
Perpetua would use aquatic safe herbicides during vegetation management activities and noxious weed control. Adhere to chemical label restrictions, federal/state rules on usage. Use proper equipment for chemical application by trained personnel.	Vegetation, Fish
Perpetua or its designated contractor(s) would perform long-term maintenance as necessary, including maintaining and monitoring the Mitigation Area (including stream and wetlands) in perpetuity once the final performance standards are met or until such responsibility is relinquished to an appropriate third party (Forest Service, etc.) as approved by the USACE.	Vegetation, Wetlands
Perpetua would plant stream reclamation reaches and wetland reclamation areas with native plant species that are present in PAB, PEM, PSS, and palustrine forested wetlands and riparian areas along streams throughout the Mitigation Area.	Vegetation, Wetlands
To address stream temperature, riparian planting widths along restored and enhanced stream reaches would be 18 feet wide on each stream bank where possible. Taller and denser vegetation such as spruce trees would be planted. Further, the creation of the lined Stibnite Lake, a feature similar in size to the present Yellow Pine pit lake, would replace the function of the existing Yellow Pine pit lake in buffering stream temperature extremes and reduce maximum stream temperatures in East Fork SFSR in and downstream of the SGP.	Vegetation, Wetlands, Surface Water, Reclamation
Pre-construction water management activities would include the installation of surface water management features and implementation of best management practices to reduce erosion and sediment delivery to streams. These water management features and best management practices could include sedimentation ponds; run-on water diversion ditches, trenches, and/or berms; runoff water collection ditches; silt fence; water bars; culverts; energy dissipation structures; terraces; and other features specified in construction permits.	Water Resources

REC 7310

PRI-00000991

confirmed that the 10-km domain size was adequate to characterize near-field air quality impacts. Air quality effects would typically decrease at distances beyond the modeled 10 km range.

The refined model uses a "grid" of defined receptor points at which air pollutant concentrations are predicted by the model calculations. Receptor tiers were used starting at 25 m along the Operations Area Boundary and transitioning to 1 km spacing out to the 10-km extent of the modeled domain to follow accepted regulatory modeling practice. Tighter spaced receptors were used closer to the Operations Area Boundary to allow the model to map in more detail the predicted close-in concentrations that are generally the highest.

Second, a much larger "far-field" region was defined within an area up to 300 km-radius from the SGP that encompassed more-distant Class I areas, wilderness areas, Tribal reservations, and other areas requested by Tribes were considered in the analysis. For the SGP, this region is shown in **Figure 3.3-2**, with the Class I areas identified.

A key concept in air quality analysis is the definition of "ambient air" as a defined area in which air pollutant effects to air are to be compared to the national and state ambient air quality standards because that area is accessible to the general public (EPA 2019a). For purposes of the SGP, the area outside the area of Operations Boundary is defined as ambient air for modeling analyses is the Operations Area Boundary. This area is illustrated in **Figure 3.3-1** and is understood to be the limit of the operations area that would be closed to unrestricted public access. In this area, public access would be prohibited, or restricted through such measures that are accepted as means to control public access (EPA 2019a) such as security checkpoints, physical barriers at points of potential access road and trail entry, and security surveillance patrols.

A May 12, 2021, memorandum developed for the Forest Service by Stantec Consulting Services Inc. (Stantec) outlines the rationale to exclude a portion of the proposed seasonal through-site controlled public access road through the mine operations from the public as approved by both the IDEQ and the accepted by the EPA from ambient air for dispersion modeling purposes (Stantec 2021). This stretch of road is from Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375). The EPA Region X has indicated that the access road could possibly be excluded from ambient air if sufficient enforceable measures are taken to comply with the 2019 revised policy (EPA 2019a). To comply with this measure, Perpetua has developed an access and transportation management plan that is included as Appendix D in the Air Quality Specialist Report (Forest Service 2022a). The Stantec memorandum provides details that IDEQ, who is responsible for issuing air permits in the state, have excluded the road because of access restriction measures put in place consistent with their rules and requirements in the permit. Lastly, DEQ issued a final Permit to Construct (PTC) on June 17, 2022, that requires an Access Management Plan to be developed outing specific requirements relating to access control. Further information regarding IDEQ's ambient air interpretation is available in the PTC, condition 2.7, and the Response to Comments document, Comment 16.

REC 7311

PRI-00000992

The maintenance of certain NFS roads is coordinated between the Forest Service and Valley County through Schedule A agreements. Typically, NFS road maintenance activities (including dust control, removal of debris from roadway and rights-of-way, road repair, and snow removal) are coordinated with the Valley County Roads and Bridge Department. Most Valley County backcountry roads are closed through the winter and melt off in the spring (Valley County 2017). Similarly, NFS roads are closed by snow in the winter and re-open once the snow melts off in the spring. Therefore, roads do not open for through-traffic until at least mid-June and often close to public use as early as October 15.

3.16.4.2 Primary Routes

There are three existing primary routes within the analysis area to access the Operations Area Boundary from Cascade or McCall: Johnson Creek, Lick Creek, and SFSR routes as shown on **Figure 3.16-1**. All of the routes require the use of Idaho SH 55.

Johnson Creek Route

During non-winter conditions (roads clear of snow), the Operations Area Boundary can be accessed from the City of Cascade by traveling northeast on Warm Lake Road for about 34 miles to Landmark, then north on Johnson Creek Road for approximately 25 miles to the village of Yellow Pine, and approximately 14 miles east on the Stibnite Road portion of McCall-Stibnite Road (Stibnite Road). The Johnson Creek Route, which only includes Johnson Creek Road and the Stibnite Road portion of McCall-Stibnite Road, is currently used to access the Operations Area Boundary during the summer.

The Johnson Creek Road is a county maintained, native surface road that is open to vehicles with seasonal restrictions due to snow. During the winter, Valley County plows approximately 10 miles of Johnson Creek Road from Yellow Pine to Wapiti Meadow Ranch and Perpetua (under agreement with Valley County) plows along Stibnite Road. Valley County grooms the remaining 17 miles of Johnson Creek Road from Wapiti Meadow Ranch to Warm Lake Road at Landmark for OSV use. Valley County does not plow Warm Lake Road from Warm Lake to Landmark. This section is a designated groomed OSV route.

The Stibnite Road portion of the route is also a county-maintained native surface road, open to all vehicles with seasonal restrictions due to snow. This road is plowed in the winter by Perpetua through an agreement with Valley County. Stibnite Road connects to Thunder Mountain Road on the southeastern portion of the Stibnite site and currently provides public access through the site.

Lick Creek Route

The SGP also can be accessed from McCall during non-winter conditions by traveling east on the Lick Creek portion of McCall-Stibnite Road (Lick Creek Road) for approximately 37 miles to the East Fork South Fork portion of McCall-Stibnite Road (East Fork Road), then approximately 16 miles to the village of Yellow Pine, and approximately 14 miles east on Stibnite Road. Lick Creek Road is not maintained during the winter; however, East Fork Road and Stibnite Road are plowed from SFSR Road to Yellow Pine by Valley County and from Yellow Pine to the Operations Area Boundary by Perpetua to access their private land inholdings in the area.

REC 7312

PRI-00000993

existing conditions. If the results from this computation are below the NAAQS, then impacts at other locations in the domain would be below the NAAQS as well.

For NAAQS modeling inputs, the highest emissions of each pollutant during any LOM year were determined and provided in **Table 4.3-6**. For the 2021 MMP, the highest criteria pollutant emissions occur during two different years, LOM 6 (CO, NO_X, and SO_2) and LOM 10 ($PM_{2.5}$ and PM_{10}). Therefore, to capture the highest modeled concentration for each pollutant, separate modeling was performed for LOM 6 and 10 (i.e., two models). Note that VOC emission maximums from LOM 3 were not modeled because there is no specific NAAQS for these emissions, however VOCs are addressed as part of the secondary $PM_{2.5}$ analysis.

Table 4.3-6 LOM Years for Pollutant-Specific Maximum Annual Emissions

Pollutant	LOM Year	SGP Total Annual Emissions (tpy)
CO	6	535.5
NO_2	6	335.2
PM_{10}	10	320.1
$PM_{2.5}$	10	69.2
SO_2	6	7.3
VOC	3	27.4
HAPs	10	8.5
Hg	10	13.3 (lb/yr)

The 2021 MMP would include a 12-foot wide gravel road to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375) through the SGP. Perpetua received a final PTC from IDEQ on June 17, 2022. This application proposed to exclude the public road on the basis of restricted access and maintaining full control, and that people traveling on the road would be considered "guests of the mine." IDEQ accepted the private road concept proposed by Perpetua (see PTC Condition 2.7, Response to Comments #16 and Statement of Basis on the IDEQ website) and in response to comments on February 18, 2021, also states that the roadway between Stibnite Road at Sugar Creek and Thunder Mountain Road at Meadow Creek was appropriately excluded from ambient air. Additionally, the EPA Region X has indicated that the access road could possibly be excluded from ambient air if sufficient enforceable measures are taken to comply with the 2019 revised policy (EPA 2019a). To comply with this measure, Perpetua has developed a transportation management plan and is included as Appendix D of the Air Quality Specialist Report (Forest Service 2022a).

The AERMOD dispersion modeling results for the 2021 MMP analysis emissions and comparison with the applicable NAAQS are provided in **Table 4.3-7**. The geographic location of the maximum impacts amongst the criteria pollutants and averaging periods between LOM 6 and 10 are provided in Figure 4 of the Air Quality Analysis Addendum ModPro2 (Air Sciences 2021a). The results demonstrate compliance with all NAAQS and would be considered to have a moderate impact locally and minor impact regionally. Additionally, **Table 4.3-8** provides geographic locations of the NAAQS maximums.

REC 7313

PRI-00000994

portion of the Johnson Creek Route. The Stibnite Road portion of the Johnson Creek Route would be improved by straightening curves, retaining walls, and installing culverts. The Johnson Creek Route would require 183 acres of cut and fill in addition to the existing roadways to address traffic safety, geotechnical hazards, landslides, and avalanche zones and may result in periods of road closure, while the Burntlog Route would require 246 acres of cut and fill primarily along a new route. While more acreage would be required for the Burntlog Route in comparison with the Johnson Creek Route, the activity along the Johnson Creek Route would be in proximity to Johnson Creek and the East Fork SFSR, whereas the Burntlog Route location avoids these surface flows. In addition to cut and fill in proximity to these surface flows, any traffic-related spills along the Johnson Creek Route would also occur closer to the streams compared to the Burntlog Route.

The public access route through the Operations Area Boundary would separate public traffic from mine traffic on the road through the Operations Area Boundary thereby reducing potential safety issues. Safety and emergency access impacts from the SGP would be localized, long-term, and minor to major.

4.16.3 Mitigation Measures

Mitigation measures required by the Forest Service would represent reasonable and effective means to reduce the impacts identified in the previous section or to reduce uncertainty regarding the forecasting of impacts into the future. These mitigation measures would be in addition to the Forest Service requirements and EDFs (**Section 2.4.9**) accounted for in the preceding impact analysis. At this time, no mitigation measures have been identified for Access and Transportation.

4.16.4 Irreversible and Irretrievable Commitments of Public Resources

4.16.4.1 No Action Alternative

Under the No Action Alternative, there would be no irreversible and irretrievable commitment of public resources as it relates to access and transportation.

4.16.4.2 Action Alternatives

The SGP would alter the roadway system, transportation and public access within the analysis area under both the 2021 MMP and the Johnson Creek Route Alternative. This would constitute an irretrievable commitment of the public resource as the baseline transportation and public access conditions would be restored when the SGP reclamation is completed.

Consumption of renewable and non-renewable resources would be required for infrastructure development, including metals, aggregate, cement, wood, fuel and other materials, which would be an irreversible commitment of these resources. Funds and labor would be irretrievably committed for project permitting and development.

4.16.5 Short-term Uses versus Long-term Productivity

4.16.5.1 No Action Alternative

Under the No Action Alternative, the public access roads developed for the action alternatives would not create any short-term uses that would affect long-term access and transportation productivity.

REC 7314

PRI-00000995

Soil Quality

Legacy soil impacts from historical mining plus significant soil disturbance is expected under the 2021 MMP (Soils Specialist Report, Forest Service 2022c). Thus, additional soil contaminants may be exposed during the construction and operation phases of the SGP. However, these soil impacts would be limited to the active mining areas, with restricted public access.

Releases of hazardous materials could range from a minor to large spills within the Operations Area Boundary or the off-site facilities, or along access routes. Depending on the nature of the spill and the effectiveness of spill responses, a release could potentially lead to exposures to contaminants in soil. The direct and indirect effects of a spill may range from negligible to major depending on the spill incident but based on the planned infrastructure specifically designed for the storage and management of hazardous materials, a large release to the environment within the Operations Area Boundary or off-site facilities would not likely occur. In the event a release was to occur, it would likely be relatively small in volume based on estimated container volumes and would be addressed promptly as per the SPCC Plan and Spill Response Plan. The SPCC Plan would address site-specific spill prevention measures, fuel haul guidelines, fuel unloading procedures, inspections, secondary containment of all on-site fuel storage tanks, and staff training. The Solid and Hazardous Materials Handling and Emergency Response Plan would address response and cleanup for any spill of hazardous materials, including concentrate, on all transport routes. The plan would include a sampling plan to assure that all spilled material is cleaned up and would include contingency plans for remediation of potential impacts to soil, wetlands/riparian, and water resources.

In the event that large quantities of hazardous materials are spilled into the environment from a transportation incident, or in the event that a spill is not immediately discovered or addressed, the impact could be more substantial. For these reasons, the magnitude of the health impact related to soil quality is rated as "medium" on **Table 4.18-3**, because some exposure of legacy contamination and/or a release of hazardous materials (ranging from small to large quantities) is possible. However, the possibility of the impacts on public health is rated as "low," because the public access is restricted in the active mining area, public access would be limited during response actions along access routes, and the probability of a large spill is low.

During closure and reclamation, RCM would be used as surface material to support vegetation growth and slope stability. The Reclamation and Closure Plan includes appropriate types and concentrations of material that would be protective of human receptors when identifying suitable RCM. The reclamation process is expected to lead to an overall reduction in chemical impacts to surface soil by removing potential sources of metals leaching into the soils, removing sources of erosion and sedimentation, reducing erosion of soils and sedimentation, and reducing downstream sediment transport. Thus, potential negative impacts to soil due to mining disturbance would be largely offset by positive impacts from reclamation of legacy contamination. Therefore, the evaluation of the potential public health and safety impacts associated with exposure to contaminants in soil during the closure and reclamation phase would be negligible (**Table 4.18-3**).

Idaho Department of Health and Welfare (IDHW) reviewed available information from the proposed Reclamation and Closure Plan for the SGP to consider whether potential health risks from metals in soils

REC 7315

PRI-00000996

along Thunder Mountain Road would begin during construction and continue until a new public access road through the SGP was constructed.

Secure areas within the Operations Area Boundary would be restricted from general public access and would be off limits to hunting by employees, thereby closing some areas to hunting and recreational shooting; however, the area is currently rarely used by hunters and recreational shooters. Impacts would be negligible, long term, and localized within the Operations Area Boundary.

After construction of the Burntlog Route and as part of public access control within and in the vicinity of the Operations Area Boundary, about 4.7 miles of Stibnite Road and 5.4 miles of Thunder Mountain Road would be closed to public use, but a new public access road through the Operations Area Boundary would be constructed. However, the public would not be able to reach the Stibnite Mining District Interpretive Site within the Operations Area Boundary, effectively closing this site to the public throughout operations. Impacts would be localized to just the interpretive site and would begin with the completion of Burntlog Route and conclude after closure and reclamation. These impacts are anticipated to be minor, long term, and localized.

During periodic closures of the road through the Operations Area Boundary, recreation areas and sites beyond the Operations Area Boundary accessed from Stibnite and Thunder Mountain roads would be available via the new Burntlog Route. Using the Burntlog Route would result in a long detour for recreationists traveling from Yellow Pine to Monumental Summit, Thunder Mountain Road, and Meadow Creek lookout. There could be a decrease in summer and winter use of the impacted sites/areas, even with the Burntlog Route, if displaced recreationists decide to forego visiting these destinations due to added travel time. Impacts are anticipated to be moderate, long term, and localized.

During mine operations, public access would be allowed through the Operations Area Boundary via a 12-foot gravel road that connects Stibnite Road to Thunder Mountain Road. This road would be open to all vehicles year-round but would not be plowed during the winter. Because the road would be within the Operations Area Boundary, there would be no public use allowed off the road; the road would be for public access to the recreation sites/areas accessed via Thunder Mountain Road. The public access road through the Operations Area Boundary would return access to these recreation sites/areas after Stibnite Road is no longer available. In addition, the public access road would allow visitors from Yellow Pine to reach the Thunder Mountain Road sites/areas substantially faster than taking the Burntlog Route, which may result in less displacement of use at these sites/areas during operations. For visitors that pass through the Operations Area Boundary on the public access road, the recreation setting would be very developed and substantially modified; however, this would likely be expected, because the road would be passing through the active Operations Area Boundary. Although the public access road would return access to recreation sites/areas accessed via Thunder Mountain Road, there would be temporary closures of this route during some mining activities that would be considered public safety hazards (e.g., highwall scaling, blasting). When such road closures would occur, the closures would result in reduced access to recreation sites/areas off Thunder Mountain Road; reduced recreation opportunities and use due to a lack of access; and impacts to recreation experiences due to visitor expectations regarding site/area availability. Impacts from road closures would affect recreation sites/areas off Thunder Mountain Road and may ultimately lead to continued displacement of visitors from the Thunder Mountain Road sites/areas. Impacts would persist throughout operations and closure and reclamation until a relocated Stibnite Road was available to

REC 7316

PRI-00000997

EXHIBIT 5
Excerpts from Final EIS

United States Department of Agriculture
Forest Service

Stibnite Gold Project

Final

Environmental Impact Statement

Forest Service, Region 4, Payette and Boise National Forests, Valley County, Idaho



REC 7318

PRI-00000998

in slower travel times for non-mine-related traffic and may deter other travelers from using these roadways. Travelers may use alternative roadways including McCall-Stibnite Road to South Fork Salmon River Road.

During operations, mine-related traffic would include transport of employees to and from the SGP, delivery of supplies, and activities associated with road maintenance such as snowplowing and sanding. Under the 2021 MMP and the Johnson Creek Route Alternative, operational AADT would be 50 vehicles (33 heavy vehicles and 17 light vehicles), resulting in approximately four mine-related vehicles per hour traveling outside the SGP.

The upgraded Burnt Log Road and the newly constructed Burntlog Route would experience an increase in traffic of over 71 percent under the 2021 MMP, with 27.5 percent of the traffic comprised of heavy vehicles. Under the Johnson Creek Route Alternative, traffic on Johnson Creek Road and Stibnite Road would increase approximately 71 percent as well, also with 27.5 percent of the traffic comprised of heavy vehicles. Although heavy vehicles currently use Johnson Creek Route to access the SGP, the Johnson Creek Route Alternative traffic would result in a noticeable change in baseline driver experience and slower drive times due to the substantial increase in mine-related heavy vehicles along the Johnson Creek Route during the life of the SGP. Even though upgrades to Johnson Creek Road and Stibnite Road would be made, these roads would still have many curves and slopes.

During closure and reclamation, activities including slope recontouring, facility removal, seeding and planting, and post-closure environmental monitoring would require approximately 7 years. Closure and reclamation would generate a total estimated AADT of 27 vehicles (15 heavy vehicles and 12 light vehicles). Post-closure monitoring activities would generate a total estimated AADT of six light vehicles.

Local roads experience a seasonal effect which results in noticeable differences in traffic. Valley County has many summer recreational areas that attract visitors from May through October with peak AADT levels in June, July, and August. Mine access via the Johnson Creek Route would be more impactful on summer recreational traffic because it would utilize established roads rather than new road development. Winter driving conditions influence the amount of traffic and result in lower AADT levels during the winter months. Therefore, the effect of SGP traffic on these roads would show a noticeably greater increase in mine-related winter traffic during winter. Post-closure winter traffic would not be as noticeable as heavy vehicle deliveries would not occur and approximately six mine-related light vehicles per day would utilize the accessible roadways in the analysis area for monitoring and maintenance purposes.

Public Access

Under the 2021 MMP, public access to the SGP area would be enhanced by the development of a new access road (Burntlog Route) compliant with current road standards. Under both action alternatives, there would also be a controlled public access route through the SGP during the operations, and closure and reclamation phases; however, public access would be intermittently interrupted during the construction phase. Under the Johnson Creek Route Alternative, the Burntlog Route would not be constructed, and the Johnson Creek Route would be used for both public and SGP-related access. To continue providing OSV access to Landmark, a groomed OSV route between Warm Lake and Trout Creek Campground on Cabin Creek Road would be established as part of the 2021 MMP to connect to Landmark from Trout Creek

REC 7319

PRI-00000999

2.4.4.4 Public Access

During construction of the SGP and completion of the Burntlog Route, to the degree practicable, the public would continue to have access on forest roads currently available to the public (**Figure 2.4-1**). However, public access through the Operations Area Boundary on Stibnite Road would be restricted for a period of approximately one year while a new through-site public access road is constructed. A new 4-mile long, 12-foot-wide gravel road would be constructed to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road through the SGP (**Figure 2.4-2**). The road would be constructed on a widened bench on the west side within the Yellow Pine pit, then head south of the Yellow Pine pit, where this road would utilize an underpass to cross under a SGP haul road and continue southward, parallel to and on the east side of the mine haul road on a partially revegetated portion of a former haul road (**Figure 2.4-2**). Southwest of the ore processing area, the public access road would connect with Thunder Mountain Road and continue toward the worker housing facility, exiting the SGP to the southeast.

During operations, the public access road through the Operations Area Boundary would provide seasonal use, open to all vehicles; access would not be provided in winter when impassable (current county maintenance standards) and signs would inform the public of seasonal and temporary closures. Public vehicles passing through would be required to check-in with mine personnel at the North or South SGP entry points and would receive a safety briefing and would also be required to check-out with SGP personnel upon exiting the SGP. For safety purposes, public access would be separated from other SGP roads by berms, security fencing, and the underpass to allow the public road to pass beneath the mine haul road. No stopping or deviating from the public access road would be allowed. Perpetua could restrict access to any vehicles due to concerns related to public or employee health and safety, such as during road construction and maintenance, blasting, highwall scaling, mining in the immediate area of the road, and similar operations.

Public access along Johnson Creek Road during the life of the SGP would be unchanged; however, closures spanning from a half-day to multiple days could occur due to construction activities. Total closures of half-day to multiple days could occur during construction work on Stibnite Road between the village of Yellow Pine and the SGP, part of Thunder Mountain Road, and Burnt Log Road.

Public access on existing segments of the Burnt Log Road would be restricted for limited periods of time to upgrade road segments during construction of the Burntlog Route. Other routes available for public use are shown on **Figure 2.4-1**.

Public access by foot via existing trails or on roads would be restricted within the Operations Area Boundary shown on **Figure 2.4-2**. Security personnel, fencing (including wildlife exclusion fencing), and signs would restrict public access to vehicular traffic on the designated public access roadway inside the Operations Area Boundary.

REC 7320

PRI-00001000

Description	Resources Affected
The gold and silver leaching circuit would be designed and operated consistent with the International Cyanide Management Institute Code (ICMC) (https://www.cyanidecode.org) and the Initiative for Responsible Mining Assurance (IRMA) Standard for Responsible Mining (https://responsiblemining.net/resources/). Accordingly, impermeable secondary containment for cyanide unloading, storage, mixing and process tanks shall be sized to hold a volume at least 110 percent of the largest tank within the containment and any piping draining back to the tank, with additional capacity for the design storm event, if applicable. Pipelines containing process water or process solution shall also use secondary containment in combination with audible alarms, interlock systems, and/or sumps as spill control measures.	Hazardous Materials
Cyanide-bearing solutions used in ore processing would be neutralized to approximately 10 milligrams per liter weak acid dissociable (WAD) cyanide before the material is pumped to the TSF. Residual cyanide would be treated using a sodium metabisulfite and air system to detoxify the cyanide by oxidation to form cyanate.	Hazardous Materials
Cyanide would be neutralized to levels protective of wildlife, and the TSF would be surrounded by an 8-foot high, chain-link fence designed to keep wildlife, such as deer and elk, from entering the impoundment area, to prevent either liner damage or wildlife drowning.	Hazardous Materials
Oils, solvents, and lubricants would be stored in approved containers located within, or directly adjacent to, the maintenance shop and contained within secondary containments to prevent spills into the environment. All used petroleum products, waste antifreeze, and used solvents would be collected in approved containers, transported off site, and disposed or recycled.	Hazardous Materials
Nitric and sulfuric acid would be transported in tanks designed to prevent spills even in the event of rollovers.	Hazardous Materials
Nitric and sulfuric acids would be stored in specialized non-corrosive, polyethylene-lined tanks located within the ore processing facility and would have secondary containment.	Hazardous Materials
Liquids would be shipped to the SGP in tank trucks designed for spill prevention and escorted to the SGP by pilot cars manned and equipped to handle spills.	Hazardous Materials
Other legacy materials may be encountered during construction and operations. If encountered, these materials would be characterized to determine potential for reprocessing, reuse, or disposal.	Hazardous Materials
Small scale composting associated with organic materials generated at the worker housing facility may be incorporated within the centralized GMS in the Fiddle valley.	Hazardous Materials
An Explosives and Blasting Management Plan would be prepared for the SGP. Explosives storage, transport, handling, and use would comply with applicable Department of Homeland Security, Bureau of Alcohol, Tobacco, Firearms and Explosives, and MSHA regulations.	Health and Safety
For safety and security reasons, no alcohol, firearms, or illegal drugs would be permitted on site.	Health and Safety
For safety and security reasons, public access into the mine area would be prevented by using fencing, gate locking, security personnel, and/or notice postings that prohibit unauthorized entry; no unauthorized vehicles or personnel would be permitted on the SGP.	Health and Safety
Personnel transporting, handling, or using any hazardous chemicals (including sodium cyanide) would be trained to ensure the safe use of such materials. Perpetua would design, construct, and manage facilities to conform to ICMC.	Health and Safety, Fish, Wildlife, Hazardous Materials

REC 7321
PRI-00001001

Description	Resources Affected
Perpetua would submit an annual report to the USFS and the other federal and state agencies that are responsible for issuing authorizations applicable to reclamation for the preceding calendar year. The annual report would contain descriptions of the reclamation activities completed during the previous year, a summary of areas reclaimed, a discussion of the results of the reclamation monitoring conducted, and corrective actions implemented.	Soils, Reclamation
A new 12-foot-wide gravel road would be constructed to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375) through the SGP. During operations, the public access road would be used to travel through the SGP and would provide seasonal use, open to all vehicles. Vehicles passing through the SGP would be required to check-in with mine personnel at the North or South SGP entry points.	Transportation and Access, Health and Safety
Post reclamation, a road would be established over the backfilled Yellow Pine pit to allow public access through the reclaimed site and connect Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375). This would replace the operational phase public access route.	Transportation and Access
Prior to site preparation and construction of surface facilities, vegetation would be removed from operating areas. Trees and deadwood, shrubs, and slash not needed to construct windrows at the edge of Burntlog Route disturbance (to function as sediment barriers), would be chipped, and suitable soil would be separately salvaged and stockpiled (except for a small portion that would be 'live handled') for use as part of site reclamation and restoration. Portions of the salvaged soil would be blended with the chipped wood to create growth media. All growth media placed in stockpiles would be stabilized, seeded, and mulched to protect the stockpiles from wind and water erosion.	Vegetation
Perpetua would inspect and remove vegetation material (including noxious weeds) from mechanical equipment and properly dispose to minimize the spread of unwanted vegetation.	Vegetation
Wood wastes and wood mulch are the two primary sources of compost. Food waste produced from on-site meal preparation and wastes may provide another source. Combined and properly managed during composting, these materials would provide a source of organic matter to be blended into substrate materials suitable for mitigation.	Vegetation
Perpetua would be responsible for noxious weed control within areas disturbed by SGP activities.	Vegetation, Wildlife
Develop and employ planting plans for wildlife benefits (cover, forage, etc.) using approved seed mixes.	Vegetation, Wildlife
Perpetua would use aquatic safe herbicides during vegetation management activities and noxious weed control. Adhere to chemical label restrictions, Federal and State rules on usage. Use proper equipment for chemical application by trained personnel.	Vegetation, Fish
Perpetua or its designated contractor(s) would perform long-term maintenance as necessary, including maintaining and monitoring the Mitigation Area (including stream and wetlands) in perpetuity once the final performance standards are met or until such responsibility is relinquished to an appropriate third party (Forest Service, etc.) as approved by the USACE.	Vegetation, Wetlands
Perpetua would plant stream reclamation reaches and wetland reclamation areas with native plant species that are present in PAB, PEM, PSS, and palustrine forested wetlands and riparian areas along streams throughout the Mitigation Area.	Vegetation, Wetlands
To address stream temperature, riparian planting widths along restored and enhanced stream reaches would be 18 feet wide on each stream bank where possible. Taller and denser vegetation such as spruce trees would be planted. Further, the creation of the lined Stibnite Lake, a feature similar in size to the present Yellow Pine pit lake, would replace the function of the existing Yellow Pine pit lake in buffering stream temperature extremes and reduce maximum stream temperatures in East Fork SFSR in and downstream of the SGP.	Vegetation, Wetlands, Surface Water, Reclamation

REC 7322
PRI-00001002

3.0 AFFECTED ENVIRONMENT

3.1 Introduction

Chapter 3 describes the existing natural and human environment that would potentially be affected by the SGP. The natural and human environment is further divided into resources or resource uses - physical environment, biological resources, and social resources/environment. Each resource section is organized as follows: a brief introduction and scope of analysis including a definition of the analysis area specific to the resource; relevant laws, regulations and policies; and existing conditions of the resource in the analysis area.

This EIS is purposely designed to efficiently detail what is necessary in order to understand the affected environment and environmental effects related to the alternatives that are evaluated. Many of the subsections of this EIS summarize more detailed information that is discussed in specialist reports which are cited in the subsections. These reports include any information that has become available since the DEIS was released in August 2020. Readers who are interested in reviewing the more detailed information may download the specialist reports of interest from the same website hosting this EIS. The specialist reports that are available include:

- Air Quality Specialist Report (Forest Service 2023a)
- Climate Change Specialist Report (Forest Service 2023b)
- Soils and Reclamation Cover Materials Specialist Report (Forest Service 2023c)
- Noise Specialist Report (Forest Service 2023d)
- Surface Water and Groundwater Quantity Specialist Report (Forest Service 2023e)
- Surface Water and Groundwater Quality Specialist Report (Forest Service 2023f)
- Vegetation: General Vegetation Communities, Botanical Resources, and Non-Native Plants Specialist Report (Forest Service 2023g)
- Wetland and Riparian Resources Specialist Report (Forest Service 2023h)
- Fisheries and Aquatic Habitat Including Threatened, Endangered, Proposed, and Sensitive Species Specialist Report (Forest Service 2023i)
- Wildlife and Wildlife Habitat Including Threatened, Endangered, Candidate, and Sensitive Species Specialist Report (Forest Service 2023j)
- Access and Transportation Specialist Report (Forest Service 2023k)
- Heritage Resources Specialist Report (Forest Service 2023l)
- Recreation Specialist Report (Forest Service 2023m)
- Scenic Resources Specialist Report (Forest Service 2023n)
- Social and Economic Conditions Specialist Report (Forest Service 2023o)
- Special Designations Specialist Report (Forest Service 2023p)
- Tribal Rights and Interests Specialist Report (Forest Service 2023q)

Certain of the environmental resources evaluated in this EIS are essentially unchanged from 2020 so specialist reports were not prepared for these resources, which include: geology, hazardous materials, environmental justice, timber, land use, and public health and safety.

REC 7323
PRI-00001003

A key concept in air quality analysis is the definition of "ambient air" as a defined area in which air pollutant effects to air are to be compared to the national and state ambient air quality standards because that area is accessible to the general public (EPA 2019a). For purposes of the SGP, the area outside the area of Operations Boundary is defined as ambient air for modeling analyses is the Operations Area Boundary. This area is illustrated in **Figure 3.3-1** and is understood to be the limit of the operations area that would be closed to unrestricted public access. In this area, public access would be prohibited, or restricted through such measures that are accepted as means to control public access (EPA 2019a) such as security checkpoints, physical barriers at points of potential access road and trail entry, and security surveillance patrols.

A May 12, 2021, memorandum developed for the Forest Service by Stantec Consulting Services Inc. (Stantec) outlines the rationale to exclude a portion of the proposed seasonal through-site controlled public access road through the mine operations from the public as approved by both the IDEQ and the accepted by the EPA from ambient air for dispersion modeling purposes (Stantec 2021). This stretch of road is from Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375). The EPA Region X has indicated that the access road could possibly be excluded from ambient air if sufficient enforceable measures are taken to comply with the 2019 revised policy (EPA 2019a). Exclusion of the public access road from ambient air protections is a unique case that relies on measures assumed to meet the standards inferred in the 2019 revised ambient air policy. However, a formal EPA policy review of the ambient air boundary for the SGP has not been conducted nor requested. A formal review is not necessarily required. The EPA did provide formal comment on IDEQ's air quality Permit to Construct (PTC) recommending a review be requested by the state and that initial measures in the PTC were too ambiguous to determine compliance with the revised ambient air policy. To comply with this measure, Perpetua has developed an access and transportation management plan that is included as Appendix D in the Air Quality Specialist Report (Forest Service 2023a). The Stantec memorandum provides details that IDEQ, who is responsible for issuing air permits in the state, have excluded the road because of access restriction measures put in place consistent with their rules and requirements in the permit. IDEQ has accessed the access road restriction and stated that only registered guests would have access to or through the mine as stated in the final PTC issued on June 17, 2022. IDEQ is confident of its interpretation of ambient air and asserts that methods applied to exclude areas is appropriate. The PTC also requires an Access Management Plan to be developed outlining specific requirements relating to access control. Further information regarding IDEQ's ambient air interpretation is available in the PTC, condition 2.7, and the Response to Comments document, Comment 16.

3.3.3 Relevant Laws, Regulations, Policies, and Plans

The Clean Air Act (CAA) of 1970 (42 USC 7401 et seq.), as amended in 1977 and 1990, regulates air emissions and protects air quality and air quality related values across the U.S. Provisions of the CAA that are relevant to the analysis of SGP air quality effects are listed below:

- National Ambient Air Quality Standards (NAAQS)
- Attainment and Non-Attainment Area Designations
- New Source Review Permitting
- New Source Performance Standards (NSPS)

REC 7324
PRI-00001004

4.0 ENVIRONMENTAL CONSEQUENCES

4.1 Introduction

Chapter 4 describes the potential environmental consequences of implementing each of the alternatives presented in Chapter 2. Pursuant to 40 CFR 1500.1(b) and 1500.4, this section summarizes the completed analysis and forms the scientific and analytical basis for the comparison of alternatives. The alternatives described in Chapter 2 may cause, either directly or indirectly, changes in the human and natural environment. This EIS analyzes these potential changes and discloses the effects to the decision-makers and the public. Disclosure is a fundamental goal of NEPA. In addition, applicable mitigation measures and irreversible and irretrievable effects also are discussed. Effects of each action can be neutral, beneficial, and/or adverse. Effects are quantified whenever possible, and/or are qualitatively discussed.

The individual resource discussions are generally presented by issue(s) and organized with the presentation of the effects analysis issues and indicators for the resource; a brief methodology for the analysis of impacts; an evaluation of the alternatives' impacts to the resource; irreversible and irretrievable commitments, and short-term uses versus long-term productivity. A table summarizing and comparing these quantitative and qualitative impacts to each resource by alternative is located in **Section 2.8**.

4.1.1 Effects Analysis Indicators and Methodology of Analysis

An issue is defined as a point of concern, disagreement, debate, or dispute with a proposed activity based on some anticipated effect. Issues are described in terms of cause and effect; that is, if an action occurs, an impact could result. Issues are addressed by describing comparative factors that provide a way to define, compare, and contrast the effects of the alternatives, including the No Action.

An indicator is an element or parameter used to determine change (and the intensity of change) in a resource (e.g., acres of wetlands disturbed). These issues and indicators are used to predict or detect change in a resource related to causal effects of the alternatives in Chapter 4 (i.e., environmental consequences).

In addition, the analysis procedures and assumptions used to develop the current conditions and environmental consequences are summarized in this section. Unless specifically stated otherwise, additional supporting information, including detailed analysis procedures and assumptions for each resource area, can be found in the SGP record.

The modeling, analysis, and unit amounts for indicators such as acreage and road miles are all best estimates based on the latest available information. The modeling and analysis conducted for this SDEIS are intended to indicate relative differences among the alternatives, rather than to predict absolute amounts of activities, outputs, or effects.

REC 7325
PRI-00001005

emissions. These process exhaust control technologies are accounted for in the maximum emissions estimates in **Table 4.3-5**:

- Activated carbon regeneration kiln – wet scrubber and activated carbon filter;
- Retort – activated carbon canisters and filter pack; and
- Induction furnaces – baghouse filter and activated carbon filter pack.

Near-Field Analysis NAAQS

Assessment of conformance to the NAAQS is based on the highest receptor concentration in the modeling domain for the pollutants and averaging times corresponding to the standards. The modeled maximum concentration at each receptor is added to the selected background concentrations that represent current existing conditions. If the results from this computation are below the NAAQS, then impacts at other locations in the domain would be below the NAAQS as well.

For NAAQS modeling inputs, the highest emissions of each pollutant during any LOM year were determined and provided in **Table 4.3-6**. For the 2021 MMP, the highest criteria pollutant emissions occur during two different years, LOM 6 (CO, NO_X, and SO_2) and LOM 10 ($PM_{2.5}$ and PM_{10}). Therefore, to capture the highest modeled concentration for each pollutant, separate modeling was performed for LOM 6 and 10 (i.e., two models). Note that VOC emission maximums from LOM 3 were not modeled because there is no specific NAAQS for these emissions, however VOCs are addressed as part of the secondary $PM_{2.5}$ analysis.

Table 4.3-6 LOM Years for Pollutant-Specific Maximum Annual Emissions

Pollutant	LOM Year	SGP Total Annual Emissions (tpy)
CO	6	535.5
NO_2	6	335.2
PM_{10}	10	320.1
$PM_{2.5}$	10	69.2
SO_2	6	7.3
VOC	3	27.4
HAPs	10	8.5
Hg	10	13.3 (lb/yr)

The 2021 MMP would include a 12-foot-wide gravel road to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375) through the SGP. Perpetua received a final PTC from IDEQ on June 17, 2022. This application proposed to exclude the public road on the basis of restricted access and maintaining full control, and that people traveling on the road would be considered "guests of the mine." IDEQ accepted the private road concept proposed by Perpetua (see PTC Condition 2.7, Response to Comments #16 and Statement of Basis on the IDEQ website) and in response to comments on February 18, 2021, also states that the roadway between Stibnite Road at Sugar Creek and Thunder Mountain Road at Meadow Creek was appropriately excluded from ambient air. Additionally, the EPA

REC 7320
PRI-00001006

Region X has indicated that the access road could possibly be excluded from ambient air if sufficient enforceable measures are taken to comply with the 2019 revised policy (EPA 2019a). Exclusion of the public access road from ambient air protections is a unique case that relies on measures assumed to meet the standards inferred in the 2019 revised ambient air policy. However, a formal EPA policy review of the ambient air boundary for the SGP has not been conducted nor requested. A formal review is not necessarily required. The EPA did provide formal comment on IDEQ's air quality PTC recommending a review be requested by the State and that initial measures in the PTC were too ambiguous to determine compliance with the revised ambient air policy. To comply with this measure, Perpetua has developed a transportation management plan that is included as Appendix D of the Air Quality Specialist Report (Forest Service 2023a).

The AERMOD dispersion modeling results for the 2021 MMP analysis emissions and comparison with the applicable NAAQS are provided in **Table 4.3-7**. The geographic location of the maximum impacts amongst the criteria pollutants and averaging periods between LOM 6 and 10 are provided in Figure 4 of the Air Quality Analysis Addendum ModPro2 (Air Sciences 2021a). The results demonstrate compliance with all NAAQS and would be considered to have a moderate impact locally and minor impact regionally. Additionally, **Table 4.3-8** provides geographic locations of the NAAQS maximums.

Table 4.3-7 Near-Field NAAQS Compliance Demonstration

Pollutant	Averaging Time	Maximum Modeled Conc. (µg/m^3)	Background Conc.[3] (µg/m^3)	Total Impact Conc. (µg/m^3)	NAAQS (µg/m^3)	NAAQS Compliance
CO	8 hours	404.6	1,110	1,515	10,000	Yes
CO	1 hour	495.5	1,740	2,236	40,000	Yes
Lead	3-month rolling	Not Required[1]	Not Required[1]	Not Required[1]	Not Required[1]	Not Required[1]
NO_2	Annual	19.8	0.9	20.7	100	Yes
NO_2	1 hour	129.8	4.3	134.1	188	Yes
O_3	8 hours	3.0	117.7	120.7	137	Yes
PM_{10}	24 hours	15	37.0	51.9	150	Yes
$PM_{2.5}$ [2]	Annual	1.1	3.5	4.6	12	Yes
$PM_{2.5}$ [2]	24 hours	2.7	15.0	17.7	35	Yes
SO_2	1 hour	3.0	12.3	15.3	196	Yes
SO_2	3 hours	1.8	16.8	18.6	1,300	Yes

[1] Lead modeling is not required per IDEQ as the facility-wide emissions are less than 10 percent of the lead significant emission rate of 0.6 tpy and considered "Below Regulatory Concern".
[2] Includes the secondary impacts.
[3] All background concentrations are derived from the NW Airquest data (WSU 2018).

REC 7327
PRI-00001007

During construction, public access through the Operations Area Boundary on Stibnite Road would be restricted for 1 year or more while a new 4-mile-long, 12-foot-wide gravel road is constructed to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375).

The through-SGP public access road would provide seasonal access, similar to current conditions. During operations, restricted public access through the Operations Area Boundary would be provided during the snow-free season to all vehicle types. Vehicles passing through the Operations Area would be required to check-in with mine personnel at the North or South entry points to receive a safety briefing and would also be required to check-out with mine site personnel upon exiting. For safety purposes, no stopping or deviating from the public access road would be allowed. Operations Area Boundary access would be restricted during road construction and maintenance, blasting, highwall scaling, mining in the immediate area of the road, and similar operations.

Public access would be separated from other mine roads by berms, security fencing, and an underpass to allow the public road to pass beneath the mine haul road. The public access road would not be plowed in the winter (current county maintenance standards) and static and electronic signage and automated timed stoplights would be present at points of public access to inform the public of seasonal and temporary closures.

The newly constructed Burntlog Route connecting to Thunder Mountain Road would be a temporary road necessary for mining purposes and would meet 36 CFR 228A requirements for environmental protection to assume that mine operations are conducted to minimize adverse environmental impacts to the extent feasible for roads. Accordingly, the road would not be designated for public motor vehicle use under 36 CFR 212.50 on the Motor Vehicle Use Map. Therefore, for public motor vehicle use to be allowed on the road when other public access roads are blocked by mine operations, one of the other exceptions from the prohibitions on motor vehicle use on NFS land at 36 CFR 261.13 must be met. The approved plan of operations would meet the exception for written Forest Service authorization under 36 CFR 261.13(h) by including a provision in the mine plan for public use of the road when other public road access is blocked by mine operations.

Impacts to public access during construction would be localized, short-term, and minor to major. Major impacts would generally be associated with road construction and non-standard maintenance activities plus the mobilization of equipment resulting in over-sized loads.

Operations

Traffic Volumes

Upon completion of Burntlog Route, mine vehicles would travel approximately 71 miles from the intersection of Warm Lake Road and SH 55 to the Operation Area Boundary. Approximately 15 miles of new roads managed by Perpetua would be created during the life of the mine. No new NFS roads would be created during the life of the mine. **Table 4.16-4** shows the existing and 2021 MMP AADT for the main roadway segments in the access and transportation analysis area during operations.

REC 7328
PRI-00001008

Table 4.16-8 Access Impacts During Construction and Operations

Road	Mine Year -3	Mine Year -2	Mine Year -1	Mine Operations
Warm Lake Road (Cascade to Landmark)	Limited effects	Limited effects	Limited effects	Limited effects
Johnson Creek Road (Landmark to Yellow Pine)	Limited effects	Temporary closures	Seasonal access	Seasonal access
Stibnite Road (Yellow Pine to Stibnite)	Limited effects	Temporary closures	Closed in Operations Area	Seasonal access
Thunder Mountain Road (Stibnite to Thunder Mountain)	Limited effects	No access when Stibnite Road is temporarily closed	Access through new Burntlog Route only	Seasonal access via new public access road through site
Meadow Creek Lookout Road	Temporary closures for nearby Burntlog Route construction	Limited effects	1.8-mile shared segment with new Burntlog Route	1.8-mile shared segment with new Burntlog Route
New Burntlog Route (Landmark to Stibnite)	Under construction	Under construction	Site access plus public access	Site access with public access restriction

The Burntlog Route would be a mine access road operated by the SGP for the duration of the Project. As such, Project-related use of the route would be regulated per the Forest Service's decision on the Project and incorporate compliance with the Project's Transportation Management Plan. Public use of the Burntlog Route would be restricted. Seasonal use of the newly constructed portions of the Burntlog Route would be allowed only during the snow-free portion of Year -1 when there would be no other access to the Thunder Mountain Road.

Public use of existing segments of the Burntlog Route would not be modified by the SGP decision but would be subject to temporary closures for new Burntlog Route construction. During operations, public use of existing segments of the Burntlog Route (i.e., Burnt Log Road [FS447], Meadow Creek Lookout Road [FR51290], and Thunder Mountain Road [FR50375]) would be unrestricted. The main road segment where public access would continue would be a 1.8-mile section of the Meadow Creek Lookout Road, coincident with the Burntlog Route. Signage would be placed at all intersections with Forest Service roads and trails to identify road segments with public access restrictions.

The Forest Service would require Perpetua or any other Project owner, to develop and implement a Burntlog Route Access Plan to restrict public access per this mitigation measure and to provide notifications to the public when the newly constructed segments of the Burntlog Route would be open. The road would not be designated for public motor vehicle use under 36 CFR 212.50 on the Motor Vehicle Use Map. Therefore, for public motor vehicle use to be allowed on the road when other public access roads are blocked by mine operations, one of the other exceptions from the prohibitions on motor vehicle use on NFS land at 36 CFR 261.13 must be met. The 2021 MMP would meet the exception for

REC 7329
PRI-00001009

written Forest Service authorization under 36 CFR 261.13(h) by including a provision in the mine plan for public use of the road when access via other public road is blocked by mining operations.

Effectiveness: While public access restrictions would not completely eliminate potential impacts of mine traffic associated with traffic incidents, wildlife interactions, wilderness solitude, and tribal interests, the enforcement of the Transportation Management Plan, Burntlog Route Access Plan, and Project design features would be effective as a means to minimize these impacts via traffic controls and reduced road usage, resulting in reductions in traffic incidents and wildlife interactions as well as reducing dust emissions and sedimentation from the roadway. These restrictions would also mitigate potential impacts to public safety and emergency services by removing the public from the route for the majority of time it is in use. Public access restrictions would also reduce the potential for unauthorized route creation leading to possible wilderness intrusions and would reduce the potential for impacts to tribal traditional use areas.

Traffic Delay Notifications

Issue: Road improvement, repair, and maintenance activities plus the transportation of large loads to the Operations Area Boundary would result in road closures and traffic delays on site access roads (i.e., Warm Lake Road (e.g., Big Creek Summit), Johnson Creek Road, Stibnite Road, and Thunder Mountain Road). These delays would affect public use of the access roads for their non-Project-related usage.

Mitigation Measure – Traffic Delay Notifications: Perpetua would coordinate with the Forest Service, Valley County Road and Bridge Department, Valley County Sheriff Department, Valley County Recreation Department, Cascade Rural Fire Protection District, Warm Lake Campground, and Yellow Pine Town Council to provide information regarding planned roadwork, road usage, and traffic delays. This coordination would include publication and weekly updating of the planned schedule for SGP roadwork and large-load road usage that would be available on a project webpage on the internet, on a system accessible by phone dial-in, and at the coordinating entities' physical locations. Also, in coordination with the Forest Service and Valley County Road and Bridge Department, roadside signage indicating the current and planned traffic delays for the next week would be displayed near the intersection of SH 55 and Warm Lake Road, at the intersection of Warm Lake Road and Johnson Creek Road, and at the Yellow Pine rest area.

Effectiveness: Traffic delay notifications would allow public road users to make informed decisions about their routes and travel to minimize the effects of travel delays on their public road usage. However, travel delays would not be completely eliminated.

See also the Cabin Creek Road OSV mitigation measure (**Section 4.19.3**).

REC 7330
PRI-00001010

EXHIBIT 6 Excerpts from Errata

USDA Forest Service
U.S. DEPARTMENT OF AGRICULTURE

50516
Region 4

January 2025
Payette and Boise National Forests

Stibnite Gold Project

Final Environmental Impact Statement

Errata



Cover photo: Yellow Pine pit. Midas Gold, Stibnite Gold Project Plan of Restoration and Operations September 2016.

PRI-00001011

Stibnite Gold Project Final Environmental Impact Statement Errata Document

1. Introduction

The Stibnite Gold Project Draft Record of Decision and the Final Environmental Impact Statement (FEIS) were released on September 6, 2024. This errata sheet documents corrections to the text of the September 2024 published FEIS and should be reviewed along with the FEIS. These corrections reflect instructions provided by Kelly Orr, the Intermountain Region Deputy Regional Forester, in the response to objections dated October 21, 2024, and additional clarifications. These corrections are consistent with the direction given in Forest Service Handbook 1909.15, Chapter 10, Section 18. There are no changes to the project or significant new circumstances identified in this errata sheet that affect the analysis and conclusions in the Stibnite Gold Project FEIS, therefore, a supplement to or revision of the FEIS is not needed. These changes also apply to the Stibnite Gold Project specialist reports, as applicable.

Article II. Chapter 2

1. FEIS, Chapter 2, Section 2.4.4.4 Public Access (page 2-20)

The description regarding seasonal public access through the operating mine site to Thunder Mountain Road is modified per the italicized text:

During operations, the public access road through the Operations Area Boundary would provide seasonal use, open to all vehicles; access would not be provided in winter when impassable (current county maintenance standards) and signs would inform the public of seasonal and temporary closures. Public vehicles passing through would be required to check-in with mine personnel at the North or South SGP entry points and would receive a safety briefing and would also be required to check-out with SGP personnel upon exiting the SGP. For safety purposes, public access would be separated from other SGP roads by berms, security fencing, and the underpass to allow the public road to pass beneath the mine haul road. No stopping or deviating from the public access road would be allowed. Perpetua could restrict access to any vehicles due to concerns related to public or employee health and safety, such as during road construction and maintenance, blasting, highwall scaling, mining in the immediate area of the road, and similar operations. *Because public use of the road would be subject to Perpetua's control measures on general use, the public access road is not considered a public road.*

Significance: The addition clarifies the status of the access road through the site with regard to whether it will be operated as a public road.

2. FEIS, Chapter 2, Section 2.4.9 Environmental Design Features (Table 2.4-12 on page 2-106)

An environmental design feature used in the wildlife specialist report effects analysis unintentionally omitted from Table 2.4-12. The following row is added into Table 2.4-12 on page 2-106.

EXHIBIT 7
Excerpts from ROD

United States Department of Agriculture

U.S. Forest Service

Payette and Boise National Forests

Final Record of Decision

Stibnite Gold Project

Valley County, Idaho

January 2025

REC 7335

PRI-00001013

preparation and early construction until the worker housing facility is constructed. Administrative offices, a transportation hub, warehouses, and assay laboratory facilities, all supporting mine-related activities, will be located offsite and outside of the operations area boundary.

Prior to site preparation and construction of surface facilities, vegetation will be removed from operating areas. Any merchantable timber on National Forest System lands will be purchased from the Forest Service through a timber sale. Access to the mine site during the construction period will be from Cascade, Idaho via the County Road 10-579 (Warm Lake Road), to County Road 10-413 (Johnson Creek Road), and then to County Road 50-412 (Stibnite Road). As part of the Stibnite Gold Project construction, a new access route, the Burntlog Route, will be constructed to connect the Warm Lake Road to the mine site. The new Burntlog Route will be used during the operating and closure periods and will be reclaimed as part of closure. The Burntlog Route will be used by Perpetua and its contractors for mine access, but public use of the route will be restricted as described in the Burnt Log Route Public Access Restriction mitigation measure in Part 2.3.10. The Johnson Creek Road and Stibnite Road will only be used for alternative site access in case of emergency or unplanned closure of the Burntlog Route.

Mining

The Selected Alternative includes a total of approximately 3,266 acres of new and re-disturbance of surface resources through the creation or expansion of three open-pits, an ore processing area, a tailings storage facility and buttress, an access roads, a transmission line, dewatering and industrial water supply wells, a worker housing facility, a road maintenance facility, an underground exploration decline, and other ancillary facilities (**Fi ure 1**). The acreages of disturbance for each mine feature are presented in Table 2.4-1 of the FEIS.

The proposed facilities and methods of mining are described in greater detail in Section 2.4 of the FEIS. The estimated operating mine life is approximately 15 years preceded by a three-year construction period, a five-year closure period, and an estimated 15-year post-closure period for water treatment of residual process solution. Perpetua will employ approximately 640 personnel during the construction period, 580 personnel during the operating period, 160 personnel during the closure period, and 40 personnel during the post-closure period.

General mine operations will include drilling, blasting, loading, and hauling using excavators, dozers, and a fleet of trucks. Ore will be hauled to the on-site mill facility, and overburden will be placed as a buttress to the tailings storage facility embankment or backfilled into the mined-out pits (**Fi ure 2**). Reclamation will take place concurrently with mining operations, as feasible, and will be completed during the closure and post-closure periods.

The Stibnite Gold Project will consist of mining three primary mineral deposits and the re-mining of historical tailings using conventional open pit mining methods. Ore from three open pits (Yellow Pine, Hangar Flats, and West End pits) will be sent to either the crusher, located near the processing plant, or one of several ore stockpiles in various locations within the operations area boundary (**Fi ure 2**). Ore will be stockpiled and processed at a future time during extended periods when the ore tonnage or ore type from the pits exceed the availability of the ore processing plant. Pre-stripping or removing the overlying soil and development rock (also known as waste rock) to access the mineral deposit, will commence during the construction phase in Mine Year 2. Ore removal and processing will begin in Mine Year 1 (operations phase) and continue year-round for approximately 15 years. Mine operations will occur in the area of two historical open pit mined areas (Yellow Pine and West End) and one new open pit (Hangar Flats) that includes the sites of former underground mining and mineral processing facilities. Development rock will be hauled to the tailings storage facility embankment or placed in one of four destinations: the tailings storage facility buttress or the Yellow Pine, Hangar Flats, or West End open pits once they are mined out.

iti ation easures ite ar Pine Impact Rectif in an Restorin

- VEG-11. If damage or removal of any live whitebark pine trees cannot be avoided, the Project Operator will make every reasonable effort to collect the cones, scion, pollen, or other genetic material from live mature trees (particularly "plus" trees) within the same seed zone for future restoration efforts before the live whitebark pine is damaged or killed. The Project Operator will coordinate with the Forest Service and U.S. Fish and Wildlife Service to identify potential restoration efforts for the species within or near the Stibnite Gold Project.
- VEG-12. If collection cannot occur, the Project Operator will contact the Forest Service and U.S. Fish and Wildlife Service to explore additional options, which may include replanting in accordance with current whitebark pine replanting guidelines or best practices, or suitable alternatives with whitebark pine seedlings or seed stock of known superior parentage ("plus" whitebark pine). Whitebark pine used for replanting will be of the same seed zone as the mature trees that were removed.

Clark's Nutcracker Habitat

Issue Impacts to whitebark pine seed dispersers, primarily the Clark's nutcracker and its habitat.

iti ation easure Clar s utcrac er

VEG-13. Where possible, the Project Operator will avoid or limit cutting of mature whitebark pine trees in stands that are of sufficient size to support Clark's nutcracker use of the area (30,888 to 61,776 acres of cone bearing whitebark pine habitat within a 20.3-mile radius).

2.3.9 Wildlife

Wolverine

Issue Impacts to wolverine habitat.

iti ation easure ol erine Impact inimi ation

- The Forest Service wildlife biologist will be notified of any occupied wolverine dens encountered during construction and operation.
- If a wolverine is observed within or near the Project, the Forest Service wildlife biologist and U.S. Fish and Wildlife Service will be notified immediately and coordination with Perpetua will occur regarding modifications to construction and operation activities to avoid potential disruption of wolverine denning activities.
- Off road use and the construction of new or temporary roads in wolverine habitat will be limited.
- New or temporary roads will be marked off limits to non-authorized motorized access to reduce traffic and increased access in wolverine habitat.
- For exploratory drilling activities, from December 1 to April 1, a 1-mile no-disturbance buffer will be implemented around denning habitat as modeled using the persistent snow cover layer.

2.3.10 Transportation

Burntlog Route Public Access Restriction

Issue Unrestricted public use of the Burntlog Route (consisting of the existing Forest Road [FR] 447 [Burnt Log Road] and new road segments connecting to FR 50375 [Thunder Mountain Road] and FR 51290 [Meadow Creek Lookout Road]) would have potential impacts associated with traffic incidents, public safety, emergency services, wildlife interactions, wilderness solitude, and tribal interests.

iti ation easure Burntlo Route pu lic access restriction Construction of the Stibnite Gold Project is expected to take three years (Mine Years -3 through -1). The Burntlog Route is anticipated to take two years to construct (i.e., Mine Year -3 and -2). The access to Meadow Creek Lookout Road will experience short-term closures during Year -3 when crossings of the new Burntlog Route are constructed.

The through-site public access to Thunder Mountain Road will be largely unaffected during Year -3 with more temporary closures in Year -2, then completely closed during Year -1 before re-opening on a new seasonal access route in Year 1 (Table 3).

Table 3 Access Impacts During Construction and Operations

Road	Mine Year -3	Mine Year -2	Mine Year -1	Mine Operations
Warm Lake Road (Cascade to Landmark)	Limited effects	Limited effects	Limited effects	Limited effects
Johnson Creek Road (Landmark to Yellow Pine)	Limited effects	Temporary closures	Seasonal access	Seasonal access
Stibnite Road (Yellow Pine to Stibnite)	Limited effects	Temporary closures	Closed in Operations Area	Seasonal access
Thunder Mountain Road (Stibnite to Thunder Mountain)	Limited effects	No access when Stibnite Road is temporarily closed	Access through new Burntlog Route only	Seasonal access via new public access road through site
Meadow Creek Lookout Road	Temporary closures for nearby Burntlog Route construction	Limited effects	1.8-mile shared segment with new Burntlog Route	1.8-mile shared segment with new Burntlog Route
New Burntlog Route (Landmark to Stibnite)	Under construction	Under construction	Site access plus public access	Site access with public access restriction

The Burntlog Route will be a mine access road operated by the Stibnite Gold Project for the duration of the project. As such, project-related use of the route will be regulated per the Forest Service's decision on the Stibnite Gold Project and incorporate compliance with the project's Transportation Management Plan. Public use of the Burntlog Route will be restricted. Seasonal use of the newly constructed portions of the Burntlog Route will be allowed only during the snow-free portion of Year -1 when there would be no other access to the Thunder Mountain Road.

Public use of existing segments of the Burntlog Route will not be modified by the Stibnite Gold Project decision but would be subject to temporary closures for new Burntlog Route construction. During operations, public use of existing segments of the Burntlog Route (i.e., Burnt Log Road [FS447], Meadow Creek Lookout Road [FR51290], and Thunder Mountain Road [FR50375]) will be unrestricted. The main road segment where public access would continue will be a 1.8-mile section of the Meadow Creek Lookout Road, coincident with the Burntlog Route. Signage would be placed at all intersections with Forest Service roads and trails to identify road segments with public access restrictions.

The Forest Service will require the Project Operator, to develop and implement a Burntlog Route Access Plan to restrict public access per this mitigation measure and to provide notifications to the public when the newly constructed segments of the Burntlog Route would be open.

Description	Type	Reference	Resources Affected
• Temporary wooden structure could be erected around portions of the drill, pumps, and heaters, with acoustic absorbent panels. These temporary structures will not be put in place if they created safety issues related to exhaust vapor build-up. • When feasible, activities such as helicopter use and blasting, could be scheduled at the same time.			
In revegetation and seeding projects in occupied sensitive plant habitat, a Forest botanist shall be consulted to ensure appropriate species are used.	FP Component	BNF and PNF: BTST05	Vegetation
Design and implement projects within occupied habitats of Sensitive species to help prevent them from becoming listed. Use Forest Service-approved portions of Conservation Strategies and Agreements, as appropriate, in the management of Sensitive species habitat to keep management actions from contributing to a trend toward listing for these species.	FP Component	BNF and PNF: WIST02	Wildlife, Vegetation

Table 6 Proponent Proposed Environmental Design Features

Description	Resources Affected
Following crushing, the crushed ore will report via conveyor to a dome-shaped, covered stockpile.	Air Quality
Dust emission controls, such as water sprays and/or bag house dust collectors, will reduce dust from crushing, conveying, and stockpiling.	Air Quality
Dust will be controlled in a similar manner to the ore crushing and conveying process using water sprays and/or bag house dust collectors.	Air Quality
Air emissions from the leaching facility will be captured in a series of air pollution controls, and the material collected will be disposed of as a solid waste or a hazardous waste depending on characterization of the waste.	Air Quality
Air emissions from the induction furnace will be captured in a series of emission controls. Mercury from the induction furnace will be converted to a liquid metallic state, and then securely stored prior to shipment to a certified hazardous waste disposal facility.	Air Quality
Silos will be equipped with air emission controls except for Prill Silo.	Air Quality
All off-highway diesel engines will be Environmental Protection Agency Tier IV or better.	Air Quality, Climate Change
The Project Operator will encourage employees to use company provided shuttle buses as transport to the Stibnite Gold Logistics Facility from towns along SH 55.	Air Quality, Health and Safety, Transportation and Access
Busing and/or vanpooling will be provided for the Project Operator and contractor employees. The associated parking area will accommodate approximately 300 vehicles. To the degree practicable, the Project Operator will mandate the use of busing and vans for employee and contractor transportation to the Stibnite Gold Project and the worker housing facility.	Air Quality, Health and Safety, Transportation and Access
Proper dust control will be employed along transportation corridors and active mining areas using aquatic safe dust suppression chemicals and methods.	Air Quality, Water Resources, Fish, Wildlife

Description	Resources Affected
Other legacy materials may be encountered during construction and operations. If encountered, these materials will be characterized to determine potential for reprocessing, reuse, or disposal.	Hazardous Materials
Small scale composting associated with organic materials generated at the worker housing facility may be incorporated within the centralized growth media stockpile in the Fiddle valley.	Hazardous Materials
An Explosives and Blasting Management Plan will be prepared for the Stibnite Gold Project. Explosives storage, transport, handling, and use will comply with applicable Department of Homeland Security, Bureau of Alcohol, Tobacco, Firearms and Explosives, and Mine Safety and Health Administration regulations.	Health and Safety
For safety and security reasons, no alcohol, firearms, or illegal drugs will be permitted on site.	Health and Safety
For safety and security reasons, public access into the mine area will be prevented by using fencing, gate locking, security personnel, and/or notice postings that prohibit unauthorized entry; no unauthorized vehicles or personnel will be permitted on the Stibnite Gold Project.	Health and Safety
Personnel transporting, handling, or using any hazardous chemicals (including sodium cyanide) will be trained to ensure the safe use of such materials. The Project Operator will design, construct, and manage facilities to conform to International Cyanide Management Code.	Health and Safety, Fish, Wildlife, Hazardous Materials
Fuel and other petroleum products at the site will be stored in above ground containment structures, with appropriate secondary containment measures.	Health and Safety, Fish, Wildlife, Hazardous Materials
Air emissions, groundwater, surface water, and aquatic parameters will be monitored during mine construction, operation, closure, and post-closure as specified in the final authorizations from the regulating agencies.	Monitoring
Monitoring will be conducted following the completion of closure and reclamation of all facilities and disturbance areas to demonstrate compliance with permit requirements and to measure the success of reclamation and mitigation.	Monitoring
The draft EMMP includes the following plans for monitoring aquatic resources: Stream and Wetlands Monitoring and Management Plan and Fisheries and Aquatic Habitat Monitoring and Management Plan.	Monitoring
The ore processing facility building will be enclosed.	Noise, Wildlife, Health and Safety
Appropriate sound dampening and muffling equipment will be utilized to minimize noise excursion from equipment and facilities. When possible, schedule high noise activities at the same time. Monitor and maintain equipment to reduce noise related impacts.	Noise, Wildlife, Health and Safety
When practicable, pumps, generators, and engines will be turned off when not in use to avoid unnecessary noise generation and reduce energy consumption.	Noise, Wildlife, Health and Safety
Electric line power will be utilized during operations to eliminate diesel generator noise, except in emergency situations when grid power is down or temporary use in remote areas where it is not practical to run power lines.	Noise, Wildlife, Health and Safety
An 8-mile temporary 16-foot-wide groomed over-snow vehicle trail will be created adjacent to Johnson Creek Road between Landmark and Trout Creek Campground during construction of the Burntlog Route.	Recreation

Description	Resources Affected
Soil stability will be estimated for all reclaimed areas using qualitative descriptors.	Soils, Reclamation
Slope stability will be monitored during the erosion inspections.	Soils, Reclamation
If the performance of reclaimed areas is not satisfactory, appropriate maintenance activities will be implemented. Maintenance activities may include one or more of the following: • Sediment removal from sediment basins, stormwater drainage channels, and diversions as necessary to maintain their design capacity; • Diverting surface water away from reclaimed areas where erosion jeopardizes attainment of reclamation standards; • Stabilizing rills, gullies, and other erosion features or slope failures that have exposed development rock; • Noxious weed and invasive plant species control; and, • Re-seeding or re-applying reclamation treatments in areas where it is determined through monitoring and agency consultation that reclamation will not meet standards.	Soils, Reclamation
The Project Operator will submit an annual report to the Forest Service and the other federal and state agencies that are responsible for issuing authorizations applicable to reclamation for the preceding calendar year. The annual report will contain descriptions of the reclamation activities completed during the previous year, a summary of areas reclaimed, a discussion of the results of the reclamation monitoring conducted, and corrective actions implemented.	Soils, Reclamation
A new 12-foot-wide gravel road will be constructed to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375) through the Stibnite Gold Project. During operations, the public access road will be used to travel through the Stibnite Gold Project and will provide seasonal use, open to all vehicles. Vehicles passing through the Stibnite Gold Project will be required to check-in with mine personnel at the North or South Stibnite Gold Project entry points.	Transportation and Access, Health and Safety
Post reclamation, a road will be established over the backfilled Yellow Pine pit to allow public access through the reclaimed site and connect Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375). This will replace the operational phase public access route.	Transportation and Access
Prior to site preparation and construction of surface facilities, vegetation will be removed from operating areas. Trees and deadwood, shrubs, and slash not needed to construct windrows at the edge of Burntlog Route disturbance (to function as sediment barriers), will be chipped, and suitable soil will be separately salvaged and stockpiled (except for a small portion that will be 'live handled') for use as part of site reclamation and restoration. Portions of the salvaged soil will be blended with the chipped wood to create growth media. All growth media placed in stockpiles will be stabilized, seeded, and mulched to protect the stockpiles from wind and water erosion.	Vegetation
The Project Operator will inspect and remove vegetation material (including noxious weeds) from mechanical equipment and properly dispose to minimize the spread of unwanted vegetation.	Vegetation
Wood wastes and wood mulch are the two primary sources of compost. Food waste produced from on-site meal preparation and wastes may provide another source. Combined and properly managed during composting, these materials will provide a source of organic matter to be blended into substrate materials suitable for mitigation.	Vegetation
The Project Operator will be responsible for noxious weed control within areas disturbed by Stibnite Gold Project activities.	Vegetation, Wildlife
Develop and employ planting plans for wildlife benefits (cover, forage, etc.) using approved seed mixes.	Vegetation, Wildlife

10.3.10 Road Use and Maintenance

Description	Reference
Minor surface improvements (e.g., ditch and culvert repair, adding gravel, winter snow removal, and summer dust suppression) will occur on the Yellow Pine Route to reduce sediment runoff and dust generation.	2021 Modified Mine Plan
Once all final mine closure and reclamation work has been completed, the Project Operator will reduce the 21-foot-wide travel way of 19.8 miles of Burntlog Road (FR 447), 1.3 mile of Meadow Creek Lookout Road (FR 51290), and 2.0 miles along Thunder Mountain Road (FR 375) of Burntlog Route to their approximate pre-mining width.	2021 Modified Mine Plan
The approximately 15 miles of Burntlog Route connecting to Meadow Creek Lookout Road (FR 51290) and Thunder Mountain Road (FR 50375) will be decommissioned.	2021 Modified Mine Plan
Following mining and ore processing operations, unless they are taken over by a third-party for ongoing use and maintenance, the Burntlog Maintenance Facility buildings will be removed. The sewer system and septic tanks for the facility will be decommissioned. Soil and rock beneath fuel storage areas and chemical storage buildings will be tested for contamination. All reagents, petroleum products, solvents, and other hazardous or toxic materials will be removed from the site and disposed of according to applicable state and federal regulations. After demolition of the buildings and facilities, the site will be graded, and drainage restored.	2021 Modified Mine Plan
A new 12-foot-wide gravel road will be constructed to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375) through the Stibnite Gold Project. During operations, the public access road will be used to travel through the Stibnite Gold Project and will provide seasonal use, open to all vehicles. Vehicles passing through the Stibnite Gold Project will be required to check-in with mine personnel at the North or South Stibnite Gold Project entry points.	2021 Modified Mine Plan
Post reclamation, a road will be established over the backfilled Yellow Pine pit to allow public access through the reclaimed site and connect Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375). This will replace the operational phase public access route.	2021 Modified Mine Plan
New roads constructed for the Project on National Forest System lands will be closed and reclaimed, as required by Forest Service, once they are no longer needed to support Project construction, operations,	2021 Modified Mine Plan
Project-related traffic will be restricted to existing roadways and Project areas. Off-road travel in previously undisturbed areas will be forbidden.	2021 Modified Mine Plan

10.3.11 Reclamation and Restoration

Description	Reference
Facilities will be located on previously impacted lands when that location fits into mine operations.	2021 Modified Mine Plan
Productive lands that support wildlife and fisheries habitat and dispersed recreation will be established on Project-related surface disturbance.	2021 Modified Mine Plan
Approximately 37 percent of the reclamation will be done concurrent to mining and ore processing; the remaining 63 percent will be accomplished during closure. Annual reclamation activities are described in a schedule provided in Table 3-1 of the Reclamation Closure Plan. Concurrent reclamation areas will focus on construction period restoration efforts (e.g., East Fork Meadow Creek, aka Blowout Creek) and laydown yards, Yellow Pine Pit area facilities, and Hangar Flats Pit area facilities. Closure period activities are focused on the West End Pit area, tailings storage facility area, Fiddle growth media stockpile, and process plant area. This information is also presented graphically in Appendix C to the Compensatory Mitigation Plan.	2021 Modified Mine Plan
The Yellow Pine pit will be backfilled with West End pit development rock during operations.	2021 Modified Mine Plan
A sinuous channel will be constructed through the backfilled area for the reconstructed East Fork South Fork Salmon River with an average valley gradient approximating the historical, pre-disturbance river gradient.	2021 Modified Mine Plan
The backfill will be placed to achieve a mounded final reclamation surface to promote drainage away from the West End pit and prevent formation of a pit lake within Midnight pit.	2021 Modified Mine Plan
The floor of the sidehill pit southwest of the main West End pit will be graded to drain, covered with growth media, and revegetated.	2021 Modified Mine Plan

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY

STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	Case Docket No. 0101-22-01 OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOURTH FORK SALMON, Petitioner, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondents, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	ORDER ON SAVE THE SOUTH FORK SALMON'S MOTION FOR RECONSIDERATION BASED ON NEW EVIDENCE

I. INTRODUCTION

On January 24, 2025, Save the South Fork Salmon ("SSFS") filed *Petitioner Save the South Fork Salmon's Motion for Reconsideration Based on New Evidence* ("Motion for Reconsideration"). The Motion for Reconsideration seeks reconsideration of the Idaho Department of Environmental Quality Board's ("DEQ Board") *Final Order* issued in this matter on May 9, 2024. The Motion for Reconsideration asserts that the United States Forest Service's

January 2, 2025 Final Record of Decision ("USFS ROD") for the Stibnite Gold Project ("STP") provides relevant new information that addresses the issue of whether Perpetua Resources Idaho, Inc. ("Perpetua") has legal control to preclude public access to the Stibnite Road Access Route such that it was appropriate for the Department of Environmental Quality ("DEQ") to exclude the road from ambient air quality protections when it issued the Air Quality Permit to Construct ("PTC") at issue in this case.

BACKGROUND

The DEQ Board issued a *Final Order* in this matter on May 9, 2024. The Final Order found that 1) DEQ acted reasonably and in accordance with law when it determined that Perpetua will have legal control of the Stibnite Road Access Route such that it could properly be excluded from consideration as ambient air, 2) DEQ acted reasonably and in accordance with law when it determined that Perpetua will have physical and practical control of the Stibnite Road Access Route such that it could properly be excluded from consideration as ambient air, 3) DEQ acted reasonably and in accordance with law when it allowed Perpetua to submit some plans after the PTC was issued, 4) the PTC includes enforceable conditions that will achieve 93.3% dust control, and 5) DEQ did not act reasonably and in accordance with law when it analyzed the ambient arsenic air concentrations for the Stibnite Gold Project. The *Final Order* remanded the ambient arsenic air concentration issue back to the Hearing Officer for additional fact-finding.

On May 23, 2024, Petitioners the Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon filed a *Petitioners' Motion for Clarification and/or Reconsideration* of the *Final Order.* On May 23, 2024, Respondent/Intervenors DEQ and Perpetua filed a *Joint Motion for Reconsideration and/or Clarification of Final Order* and *Memorandum in Support of*

Joint Motion for Reconsideration and/or Clarification of Final Order. On June 3, 2024, Petitioners filed *Petitioners Response Opposing DEQ/Perpetua's Motion for Reconsideration*. On June 4, 2024, DEQ and Perpetua filed a *Joint Motion to Strike Petitioners Response.* The motions raised several issues including that the DEQ Board: 1) vacate the PTC while the matter was on remand or order an amended Application for Permit to Construction be filed, 2) reconsider the *Final Order* including clarification of its effective date, 3) reconsider its decision on the ambient arsenic concentrations, 4) hold additional hearings on the arsenic issues before issuing the *Final Order*, 5) reconsider or clarify the instructions on remand to the Hearing Officer.

On June 12, 2024, the DEQ Board issued an *Order on Petitions for Reconsideration and/or Clarification of Final Order* ("Order on Reconsideration"). The DEQ Board denied all the requests for reconsideration/clarification except the request for clarification of the effective date of the *Final Order*. The DEQ Board found:

> While the Board's decision is final as to the first four issues, it is not final as to the arsenic issue. Therefore, the Board will stay issuance of a final order on all five issues until the remand before the Hearing Officer is complete and all statutory deadlines for review of the Hearing Officer's Orders have run. The order will still be a "Final Order," but it will not be considered "effective" for purposes of I.C. §§ 67-5246(5), 67-5270, and 67-5273 until the Hearing Officer has issued an order on the arsenic issue and all statutorily allowed administrative review of that issue has been completed. At that point, all five issues will be considered "final" and appealable under I.C. §§ 67-5270 and 67-5273. This will allow a full factual record to be developed for the arsenic issue and will prevent the parties from having to simultaneously file for judicial review and engage in additional fact finding before the Hearing Officer.

Order on Reconsideration at 6. The case was remanded to the Hearing Officer and a hearing was held October 17–18, 2024. The Hearing Officer issued a *Findings of*

Fact, Conclusions of Law, and Preliminary Order on January 7, 2025. On January 21, 2025, Petitioners filed their *Petitioners' Petition for Review of January 7, 2025 Preliminary Order, Memorandum in Support, and Request for Hearing.* On January 24, 2025, Save the South Fork Salmon filed its Motion for Reconsideration of the *Final Order*.

ANALYSIS

The Motion for Reconsideration seeks to have the DEQ Board reconsider its *Final Order* based on new evidence in the form of the USFS Final ROD. The DEQ Board's Order on Reconsideration made clear, however, that the *Final Order* would be stayed "until the remand before the Hearing Officer is complete and all statutory deadlines for review of the Hearing Officer's Orders have run." Order on Reconsideration at 6. It also made clear that the *Final Order* "will not be considered "effective" for purposes of I.C. §§ 67-5246(5), 67-5270, and 67-5273 until the Hearing Officer has issued an order on the arsenic issue and all statutorily-allowed administrative review of that issue has been completed." *Id.* The DEQ Board is actively in the process of hearing a petition for administrative review of the Hearing Officer's order. Thus, the statutorily-allowed deadlines for administrative review have not yet run and the *Final Order* is not yet final for purposes of I.C. §§ 67-5246(5), 67-5270, and 67-5273. Because of this, the Motion for Reconsideration of the *Final Order* is premature. A Motion for Reconsideration of the *Final Order* will not be appropriate until after all the administrative deadlines have passed and the *Final Order* becomes effective.

CONCLUSION

Based on the foregoing it is hereby ordered the Motion for Reconsideration is denied, without prejudice.

Dated this 24th day of February, 2025

Dr. John R. MacMillan
Chairman, Idaho Board of Environmental Quality

CERTIFICATE OF SERVICE

I HEREBY CERTIFY that on this 24th day of February, 2025, the foregoing was filed, served, and copied as shown below.

Hannah M.C. Young
Michael A. Short
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
hannah.young@deq.idaho.gov
michael.short@deq.idaho.gove

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole C. Hancock
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
Nicole.hancock@stoel.com

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Dylan B. Lawrence
Varin Thomas LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
Counsel for the Idaho
Board of Environmental Quality
ann.yribar@ag.idaho.gov

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com

/s/ Diane Cutler
Diane Cutler
Department of Environmental Quality
Hearing Coordinator

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	Agency Case No. 0101-22-01 OAH Case No. 23-245-01 **NOTICE OF ORAL ARGUMENT**

On January 7, 2025, the Hearing Officer issued the *Findings of Fact, Conclusions of Law, and Preliminary Order*, and on January 21, 2025, Petitioners filed *Petitioners' Petition for Review of January 7, 2025 Preliminary Order, Memorandum in Support, and Request for Hearing*.

Pursuant to Idaho Code § 67-5245(b)(5) and IDAPA 62.01.01.626.02.i, NOTICE IS HEREBY GIVEN that oral argument will take place on April 2 & 3, at 9:00 a.m. Mountain Time, or as soon thereafter as the matter may be heard, in conference rooms A and B at the Department of Environmental Quality State Office, 1410 N. Hilton, Boise, Idaho. The parties will each be allowed 30 minutes for argument. Petitioners will be allowed 10 minutes for rebuttal.

The oral argument in this matter will be heard by the Idaho Board of Environmental Quality at the Special Board Meeting scheduled to commence at 9:00 a.m. Mountain Time on

April 2, 2025. If additional time is needed, the Board will reconvene at 9 a.m. on April 3, 2025 to continue the meeting. The public may attend the meeting in person or via Microsoft Teams. The Teams link will be available in the Meeting Notice posted at https://www.deq.idaho.gov/board-of-environmental-quality/ at least 24 hours prior to the meeting date.

Dated this 26th day of February, 2025.

/s/ Diane Cutler

Diane Cutler, Hearing Coordinator
Rules and Planning Analyst
Department of Environmental Quality
1410 N. Hilton, Boise, ID 83706
(208)373-0165
diane.cutler@deq.idaho.gov

CERTIFICATE OF SERVICE

I HEREBY CERTIFY that on this 26th day of February, 2025, the foregoing was filed, served, and copied as shown below.

Dylan B. Lawrence
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov

Hannah M.C. Young
Michael A. Short
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
hannah.young@deq.idaho.gov
michael.short@deq.idaho.gov

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole C. Hancock
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
nicole.hancock@stoel.com

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
Counsel for the Idaho
Board of Environmental Quality
ann.yribar@ag.idaho.gov

ARV, A Veritext Company
Court Reporting Service
calendar-arv@veritex.com

/s/ Diane Cutler
Diane Cutler

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	Agency Case No. 0101-22-01 OAH Case No. 23-245-01 **NOTICE OF SPECIAL MEETING OF THE BOARD OF ENVIRONMENTAL QUALITY | April 28, 2025**

NOTICE IS HEREBY GIVEN that the Board of Environmental Quality (DEQ Board) has scheduled a special meeting for the purpose of holding an executive session pursuant to Idaho Code § 74-206(1)(f) to communicate with legal counsel to discuss the ramifications of and legal options regarding this pending contested case. Because the Board will not take any action at this meeting, the parties are invited but not required to attend.

The special meeting will be held on April 28, 2025, at 9:00 a.m. Mountain Time in conference rooms C and D at the Department of Environmental Quality State Office, 1410 N. Hilton, Boise, Idaho. The public may attend the meeting in person or via Microsoft Teams. The Teams link will be available in the Meeting Notice posted at https://www.deq.idaho.gov/board-of-environmental-quality/ at least 24 hours prior to the meeting date.

Dated this 11th day of April, 2025.

/s/ Diane Cutler

Diane Cutler, Hearing Coordinator
Rules and Planning Analyst
Department of Environmental Quality
1410 N. Hilton, Boise, ID 83706
(208)373-0165
diane.cutler@deq.idaho.gov

CERTIFICATE OF SERVICE

I HEREBY CERTIFY that on this 11th day of April, 2025, the foregoing was filed, served, and copied as shown below.

Dylan B. Lawrence
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov

Hannah M.C. Young
Michael A. Short
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
hannah.young@deq.idaho.gov
michael.short@deq.idaho.gov

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole C. Hancock
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
nicole.hancock@stoel.com

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
Counsel for the Idaho
Board of Environmental Quality
ann.yribar@ag.idaho.gov

/s/ Diane Cutler
Diane Cutler

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	Agency Case No. 0101-22-01 OAH Case No. 23-245-01 **NOTICE OF SPECIAL MEETING OF THE BOARD OF ENVIRONMENTAL QUALITY | May 15, 2025**

NOTICE IS HEREBY GIVEN that the Board of Environmental Quality (DEQ Board) has scheduled a Special Meeting to take action in the above-captioned matter. The DEQ Board will discuss and adopt a final order prior to service of the written order within 56 days of the April 2, 2025 oral argument. Attendance by the parties is encouraged.

The Special Board Meeting will be held on May 15, 2025, at 9:00 a.m. Mountain Time in conference rooms A and B at the Department of Environmental Quality State Office, 1410 N. Hilton, Boise, Idaho. The public may attend the meeting in person or via Microsoft Teams. The Teams link will be available in the Meeting Notice posted at https://www.deq.idaho.gov/board-of-environmental-quality/ at least 24 hours prior to the meeting date.

Dated this 1st day of May, 2025.

/s/ Diane Cutler

Diane Cutler, Hearing Coordinator
Rules and Planning Analyst
Department of Environmental Quality
1410 N. Hilton, Boise, ID 83706
(208)373-0165
diane.cutler@deq.idaho.gov

CERTIFICATE OF SERVICE

I HEREBY CERTIFY that on this 1st day of May, 2025, the foregoing was filed, served, and copied as shown below.

Dylan B. Lawrence
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov

Hannah M.C. Young
Michael A. Short
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
hannah.young@deq.idaho.gov
michael.short@deq.idaho.gov

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole C. Hancock
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
nicole.hancock@stoel.com

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
Counsel for the Idaho
Board of Environmental Quality
ann.yribar@ag.idaho.gov

/s/ Diane Cutler
Diane Cutler

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY

STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	Case Docket No. 010-22-01 OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondents, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	FINAL ORDER

I. INTRODUCTION

On July 22, 2022, the Nez Perce Tribe, the Idaho Conservation League, and Save the South Fork Salmon (collectively "Petitioners"), filed a *Petition to Initiate Contested Case: Air Quality Permit to Construct P-2019.0047 (Jun. 17, 2022)*, seeking review of the Idaho Department of Environmental Quality's ("DEQ") issuance on June 17, 2022, of Air Quality Permit to Construct P-2019.0047 ("PTC"), to mining company Perpetua Resources Idaho, Inc.

("Perpetua") for its proposed Stibnite Gold Project ("SGP"). REC 0001–0028. Perpetua filed a Petition to Intervene in the matter on August 12, 2022. REC 0040–0043. A Hearing Officer was appointed and the parties participated in discovery and ultimately filed cross-motions for summary judgement. REC 319–322, REC 1204–1206, REC 1276–1278. On October 31, 2023, the Hearing Officer issued a *Preliminary Order*. REC 3280–3328. On November 14, 2023, the Petitioners filed a *Petition for Review* of the *Preliminary Order.* REC 3342–3356. On December 5, 2023, the Hearing Officer issued an *Amended Preliminary Order*. REC 3372–3425. In response, the Petitioners filed an *Amended Petition for Review* that requested review by the Board of Environmental Quality of both the October 31, 2023 *Preliminary Order* and the December 5, 2023, *Amended Preliminary Order*. REC 3426–3441.

The *Amended Petition for Review*, claimed the following errors with the PTC:

1. That DEQ erred in finding Perpetua has legal control of the Stibnite Road Access Route such that the Route need not comply with ambient air quality standards.

2. That DEQ erred in finding Perpetua will be able to practically and physically preclude the general public from accessing locations within the ambient air boundary.

3. That DEQ violated the Air Rules[1] by allowing Perpetua to submit plans with project details after the PTC was issued and without allowing for public comment on the plans.

4. That the PTC does not include enforceable conditions that will achieve 93.3% dust control.

5. That DEQ violated the Air Rules when calculating the ambient arsenic concentrations attributable to the SGP by diluting them by 16/70.

REC 3427–3428. The DEQ Board received briefing and heard oral argument on the Petition. REC 3448–C, REC 3694.

[1] The "Air Rules" are found at IDAPA 58.01.01.

On May 9, 2024, the Board issued a *Final Order* in this matter. REC 3695–3720. The Final Order found that sufficient evidence existed to support DEQ's findings in four of the five issues brought for review and that DEQ acted reasonably in making those decisions. The Board found, however, with regard to the ambient arsenic air concentration analysis, that there was not sufficient evidence to support DEQ's analysis and that further factual development was needed on that issue. Consequently, the Board remanded that issue to the Hearing Officer.

On May 23, 2024, Petitioners filed their *Petitioners' Motion for Clarification and/or Reconsideration.* REC 3721–3727. On May 23, 2024, DEQ and Perpetua filed a *Joint Motion for Reconsideration and/or Clarification of Final Order* and *Memorandum in Support of Joint Motion for Reconsideration and/or Clarification of Final Order.* REC 3728–3751. On June 3, 2024, Petitioners filed *Petitioners Response Opposing DEQ/Perpetua's Motion for Reconsideration.* On June 4, 2024, DEQ and Perpetua filed a *Joint Motion to Strike Petitioners Response.* On June 12, 2024, the DEQ Board issued its *Order on Petitions for Reconsideration and/or Clarification of Final Order*. REC 3835–3843. The Order denied the Petitions for Reconsideration, but granted the motion for clarification holding that the *Final Order* was final as to the first four issues brought by the Petition for Review, but not final as to the final arsenic issue. REC 3840. The DEQ Board stayed issuance of the *Final Order* on all five issues until the remand before the Hearing Officer was complete and all statutory deadlines for review of the Hearing Officer's order have run. REC 3840.

The matter was remanded to the Hearing Officer for development of a factual record on the arsenic issue. A hearing was held October 17–18, 2024. TR 0183–0851. The Hearing Officer issued a *Findings of Fact, Conclusions of Law, and Preliminary Order* on January 7, 2025 ("*Preliminary Order"*). REC 7091–7118. The Hearing Officer found that "(a) DEQ acted

reasonably in using a 5-year rolling average for T-RACT that was not supported by further permit conditions; (b) there was sufficient evidence to support DEQ's T-RACT analysis regarding non-West End Pit production; and (c) DEQ acted reasonably and in accordance with law when it applied the 16/70 adjustment to the AACC for arsenic." REC 7111. On January 21, 2025, Petitioners filed *Petitioners' Petition for Review of January 7, 2025 Preliminary Order, Memorandum in Support, and Request for Hearing*. REC 7119–7145. Petitioners asserted the Hearing Officer erred based on the following:

1. The 16/70 adjustment for arsenic is unlawful, sets a dangerous new precedent, and is not supported by the evidence; and
2. Using a five-year rolling average is not reasonable to assess compliance with arsenic limits, and the Permit's conditions are not sufficient to limit production from West End Pit and/or non-West End Pit sources to meet arsenic limited.

REC 7122.

The Board of Environmental Quality has the authority to review Preliminary Orders pursuant to I.C. § 67-5245(2) and IDAPA 58.01.23.730. The Parties presented briefs on the issues in this matter and participated in oral argument on April 2, 2025.

II. STANDARD OF REVIEW

In making its decision on the *Amended Petition for Review* the Board of Environmental Quality "shall exercise all the decision-making power that [it] would have had if the agency head had presided over the hearing." I.C. § 67-5245(7). This means that the Board of Environmental Quality can take a "de novo" or completely new look at the facts and issues. The Board of Environmental Quality must determine whether DEQ "has acted reasonably and in accordance

with law" when issuing the Permit. *See* I.C. §§ 67-5248(a) and 67-5279; *In the Matter of Sunnyside Park Utilities' Application for Sewage Disposal Permit*, Final Order on Petition for Review of Preliminary Order, at p. 10 (BEQ Dkt. 0103-07-02, April 7, 2009).

III. ANALYSIS

1. There was Sufficient Evidence to Demonstrate that DEQ Acted Reasonably and in Accordance with Law in Using a Five-Year Rolling Average for T-RACT.

Petitioners assert that there was insufficient evidence presented to the Hearing Officer to support DEQ's use of the five-year rolling average for hauling ore. Condition 3.5 of the PTC states: "The permittee shall haul not more than 180,000 tons per day (T/day) of ore and DR" and "not more than 135,000 T/day of ore and DR, based on a 5-year rolling average." REC 385. The five-year rolling average was a T-RACT used by DEQ per Section 210 to ensure compliance with the cancer risk levels allowed by the Idaho Air Rules. IDAPA 58.01.01.210.02.d.ii. Evidence presented at the hearing demonstrated that the 5-year rolling average allowed under Condition 3.5, along with the complement of other T-RACT conditions, would not allow arsenic concentrations to exceed the amount that is equivalent to ten (10) times the applicable acceptable ambient concentration listed in Section 586. IDAPA 58.01.01.210.12.b, Transcript 10/18/2024, 283:10–276:7, REC 3925–3926, REC 3885, REC 4138–4139, REC 4287–4288. The DEQ Board has reviewed the evidence in the record and agrees with the analysis set forth in the *Preliminary Order*. REC 7105–7108. Section 210 of the Idaho Air Rules gives DEQ the authority to use T-RACT to demonstrate compliance with the cancer risk levels in the rules. The DEQ Board finds that there was sufficient evidence presented to the Hearing Officer to justify the use of the 5-year rolling average and that DEQ's use of the 5-year rolling average was reasonable and in accordance with law.

2. **There was Sufficient Evidence to Demonstrate that DEQ Acted Reasonably and in Accordance with Law in Not Including Additional Permit Conditions Limiting the Non-West End Pit Production Limit.**

Petitioners assert that the Hearing Officer erred in his conclusion that the permit conditions included in the PTC were sufficient to limit the non-West End Pit production. Permit Condition No. 3.6 states: "The permittee shall haul no more than 788.4 million tons (MT) of ore and DR from the West End deposit over the life of the mine." REC 385. The West End pit limit was a T-RACT used by DEQ per Section 210 to ensure compliance with the cancer risk levels allowed by the Idaho Air Rules. IDAPA 58.01.01.210. The DEQ Board has reviewed the evidence in the record and agrees with the analysis set forth in the *Preliminary Order*. REC 7108–7111, Transcript 10/18/2024, 270:12–23, Transcript 10/18/2024, 280:2–281:24, Transcript 10/17/2024, 45:2–48:22, Transcript 10/17/2024, 116:15–23, REC 4139–4141, REC 3919, REC 3926–3928. Section 210 of the Idaho Air Rules gives DEQ the authority to use T-RACT to demonstrate compliance with the cancer risk levels in the rules. The DEQ Board finds that there was sufficient evidence presented to the Hearing Officer to demonstrate that DEQ was reasonable and acted in accordance with law when it decided not to include a specific condition in the PTC limiting the non-West End Pit production to 50% of the total mine haulage for the SGP.

3. **There was Sufficient Evidence to Demonstrate that DEQ Acted Reasonably and in Accordance with Law When it Applied the 16/70 Calculation to the Ambient Air Concentration Analysis.**

Petitioners assert that DEQ acted unreasonably when it applied the 16/70 factor in its calculations. The parties presented voluminous evidence at the hearing on this topic and also provided additional information during oral arguments before the DEQ Board. In its previous Final Order, the DEQ Board expressed concern whether there was sufficient evidence to justify

the 16/70 adjustment, whether the adjustment was lawful under the Idaho Air Rules, and whether public health and environment would be protected. IDAPA 58.01.01. However, review of the evidence presented to the Hearing Officer and the briefing and oral arguments presented in the matter have convinced the DEQ Board that the 16/70 adjustment was reasonable and was not in violation of the Air Rules.

a. Overview of the Air Rules Requirement for Determining Ambient Arsenic Concentrations.

The Air Rule requirements for toxic pollutants begin with IDAPA 58.01.01.161. Section 161 is the over-arching policy or qualitative standard that should be applied to the emission of toxic contaminants such as arsenic. It provides: "Any contaminant that is by its nature toxic to human or animal life or vegetation ***must not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human life or vegetation.***" (emphasis added). To obtain a permit to construct an applicant must demonstrate, to the satisfaction of the Department:

> ***Using the methods provided in Section 210***, the emissions of toxic air pollutants from the stationary source or modification would not injure or unreasonably affect human or animal life or vegetation ***as required by Section 161***. Compliance with all applicable toxic air pollutant carcinogenic increments and toxic air pollutant non-carcinogenic increments demonstrates preconstruction compliance with Section 161 ***with regard to the pollutants listed in Section 585 and 586.***

IDAPA 58.01.01.203.03 (emphasis added). Thus, if a toxic air pollutant is listed in IDAPA 58.01.01.585 or 586 ("Section 586") it must be evaluated under the methods provided in Section 210.

Arsenic is listed in Section 586 of the Air Rules which consists of a table that lists each carcinogenic[2] toxic air pollutant that is covered by the rules. Section 586 includes "the screening emissions levels (EL) and acceptable ambient concentrations (AACC)" for each toxic carcinogenic pollutant listed. The EL listed for arsenic is "1.5E-06 lb/hr" and the AACC for arsenic is "2.3E-04 µg/m^3." The AACC is the carcinogen concentration in air in which daily exposure would limit the risk of cancer to 1:1,000,000 over a lifetime, which is identified as 70 years. The AACCs listed in the table in Section 586 are based on "annual averages." IDAPA 58.01.01.586.

Section 210.01 provides that the applicant must first identify what toxic air pollutants will be emitted by the project. IDAPA 58.01.01.210.01. Then the applicant must use "standard scientific and engineering principles and practices to estimate the emission rate" of the pollutant. IDAPA 58.01.01.210.02.a.[3] If the EL exceeds the levels listed in Section 586, then the applicant must continue with further analysis under Section 210.

The Applicant must then use "the modeling methods provided in Subsection 202.02 to estimate the ambient concentrations at specific receptor sites for any toxic air pollutant emitted from the point(s) of emission." IDAPA 58.01.01.210.03.a.[4] The "point of compliance is the

---

[2] A carcinogen is an agent capable of inducing cancer. Cancer is a disease of heritable, somatic mutations affecting cell growth and differentiation, characterized by an abnormal, uncontrolled growth of cells.

[3] The "uncontrolled emissions rate" is "calculated using the maximum capacity of the source . . . without the effect of any physical or operational limitations." IDAPA 58.01.01.210.02.b.

The "controlled emissions rate" is "calculated using the maximum capacity of the source . . . with the effect of any physical or operational limitations that has been specifically described" by the applicant and submitted to DEQ. IDAPA 58.01.01.210.02.c.

The "T-RACT emissions rate" is "calculated using the maximum capacity of the source . . . with the effect of any physical or operational limitation other than control equipment that has been specifically described" by the applicant and "an emission standard that is T-RACT." IDAPA 58.01.01.210.02.d.

[4] Section 202.02 provides that modeling "must be based on the applicable air quality models, data bases, and other requirements specified in 40 CFR Part 51, Appendix W (Guideline on Air Quality Models). Where an air quality model specified in the 'Guideline on Air Quality Models' is inappropriate, the model may be modified or another

receptor site that is estimated to have the highest ambient concentration of the toxic air pollutant of all the receptor sites . . .." IDAPA 58.01.01.210.03.b. Preconstruction compliance for toxic pollutants can be demonstrated using any of the methods "described in Subsection 210.05 through 210.08 and may use any applicable specialized method described in Subsection 210.09 through 210.12." IDAPA 58.01.01.210.04.[5]

Most applicable here are the compliance methods described in Section 210.12, which provides for the use of T-RACT to demonstrate preconstruction compliance for toxic pollutants listed in Section 586. T-RACT stands for "Toxic Air Pollutant Reasonably Available Control Technology" and "is an emission standard based on the lowest emission of toxic air pollutants that a particular source is capable of meeting by the application of control technology that is reasonably available, *as determined by the Department*, considering technological and economic feasibility." IDAPA 58.01.01.210 (emphasis added). The applicant must comply with IDAPA 58.01.01.210.13 and 210.14 to first get the T-RACT approved by DEQ before it can be used in the modeling. If T-RACT is used it allows for a comparison of:

> [T]he source's . . . approved T-RACT ambient concentration at the point of compliance for the toxic air pollutant to the amount of the toxic air pollutant that would contribute an ambient air cancer risk probability of less than one to one hundred thousand (1:100,000) (which amount is equivalent to ten (10) times the applicable acceptable ambient concentration listed in Section 586).

IDAPA 58.01.01.210.12.b. Thus, if the source's approved T-RACT ambient concentration meets the AACC listed in Section 586 times 10, then "no further procedures for demonstrating

---

model substituted, subject to written approval of the EPA Administrator and public comment pursuant to Subsection 209.01.c; provided that modifications and substitutions or models used for toxic air pollutants will be reviewed by the Department."

[5] Section 210.05 Uncontrolled Emissions; Section 210.06 Uncontrolled Ambient Concentration; Section 210.07 Controlled Emissions, Section 210.08 Controlled Ambient Emissions; Section 210.09 Net Emissions; Section 210.10 Net Ambient Concentration; Section 210.11 Toxic Air Pollutant Offset Ambient Concentration; Section 210.12 T-RACT Ambient Concentration for Carcinogens.

preconstruction compliance will be required for that toxic air pollutant as part of the application process." IDAPA 58.01.01.210.12.c. DEQ must then include appropriate conditions in the permit to ensure that the T-RACT is implemented so that the 10-times ambient concentrations can be met. IDAPA 58.01.01.210.12.d. Thus, the Air Rules establish two acceptable cancer risk levels—1 in 1,000,000 (the AACC level) and 1 in 100,000 (the T-RACT level). As long as the estimated cancer risk of a project meets either acceptable cancer risk level, the health protection requirements of Section 161 are satisfied.

Section 210 provides one further analysis that has bearing in this case. Section 210.15 provides that "short term" projects "may utilize a short-term adjustment factor of ten (10). For a carcinogen, multiply either the applicable acceptable ambient concentration (AACC) or the screening emission rate, but not both, by ten (10), to demonstrate preconstruction compliance." IDAPA 58.01.01.210.15. "Short Term Source" is defined as any new stationary source "with an operational life no greater than five (5) years from the inception of any operations to the cessation of actual operations." IDAPA 58.01.01.007.08. Thus, short term sources are also allowed 10 times the AACC, which would represent a 1 in 100,000 cancer risk, as long as the operational source life is no greater than five (5) years.

b. There was Sufficient Evidence to Demonstrate that DEQ Acted Reasonably When it Applied the 16/70 Adjustment.

DEQ performed its analysis of ambient arsenic levels by first determining that the levels of arsenic that would be generated by the project exceeded the EL levels found in Section 586. REC 1760. DEQ then "undertook the task of evaluating whether a more refined approach could be used to demonstrate compliance with TAP rules of Section 210." REC 1242. The first step in the refinement was to apply the T-RACT analysis under Rule 210.12. It is permissible under Rule 210.12 to apply T-RACT limits in multiple iterations to demonstrate compliance with

IDAPA 58.01.01.203.03. REC 1242. DEQ developed a complement of T-RACT limits for the permit:

1. Permit Conditions 2.1–2.6: Requiring measures to prevent fugitive dust. REC 374–375.

2. Permit Condition 3.5: Limiting the mine production to 180,000 tons per day of ore and DR and no more than 135,000 tons per day, on a five-year rolling average. REC 385.

3. Permit Condition 3.6: Limiting the total lifetime, facility-wide production of the mine to 788.4 million tons. REC 385.

4. Permit Condition 3.6: Limiting the West-End Pit production to no more than 50% (394.2 million tons) of the total mine production over the life of the mine. REC 385.

5. Permit Condition 3.11: Requiring dust collection systems with a minimum control efficiency of 90% on all drilling rigs. REC 385.

6. Permit Condition 3.13: Requiring haul road capping. REC 385.

This complement of T-RACT conditions create enforceable limits on the operation of the mine that will ensure emissions fall within limits that are protective of human health and the environment. One of the numeric T-RACT limits placed on the mine was a 788.4 million tons lifetime facility-wide total mining limit. Permit Condition No. 3.6 states: "The permittee shall haul no more than 788.4 million tons (MT) of ore and DR [development rock] from all deposits over the life of the mine . . .." REC 385, Transcript 10/18/2024, 280:23–281:6, 282:19–21. Thus, under the PTC, no more than 788.4 million tons of ore may ever be extracted from the SGP. Taken in conjunction with the five-year rolling average stated in Condition 3.5,[6] the fastest the mine could reach the 788.4 million tons of ore extraction would be 16 years. As explained at the hearing:

[6] Condition 3.5 states: "The permittee shall haul not more than 180,000 tons per day (T/day) of ore and DR" and "not more than 135,000 T/day of ore and DR, based on a 5-year rolling average." REC 385.

> So in this case, the parameter is production, so there's —that production is split up between 135,000 tons per day and 788.4 million tons. The 16 years is calculated from those limits. So if we take —if you take, you know, 788.4 million tons and you divide into that 135,000 tons a day, you arrive at 16. So 16 years is calculated. 16 years would not make a good metric for putting in the permit. Years don't equal emissions. Production equals emissions. That's why it's permitted that way. This is how every agency does it.

Transcript 10/18/2024, 315:7–315:19; *see also* Transcript 10/17/2024, 197:23–198:5, 199:20–199:24. Thus, the T-RACT Condition limiting total life-of-mine production to 788.4 million tons limits the lifetime of the mine to, at a minimum, 16 years.[7] This 16-year timeframe meant that the project was neither a short-term source of 5-years or less as defined by IDAPA 58.01.01.007.08, nor was it a source that would operate for a full 70-year lifetime.

Given this shortened operational timeframe, and as explained in the *Expert Declaration of Norka E. Paden, Ph.D*, DEQ decided to use "EPA's methodology for adjusting exposure duration given the known exposure duration (lifetime of the mine.)." REC 3878, Transcript 10/17/2024, 166:24–167:4, 143:21–144:1; 144:17–145:2; 190:1–5; 191:1–193:5. The EPA methodology is consistent with the scientifically established relationship between dose and duration of dose. The Air Rules establish two acceptable cancer risk levels—1 in 1,000,000 (the AACC level) and 1 in 100,000 (the T-RACT level).[8] IDAPA 58.01.01.210.12.b, 586. The DEQ Board finds there was sufficient evidence presented at the hearing that adjusting for exposure duration by applying the 16/70 calculation demonstrated an acceptable exposure risk and was

[7] There was considerable testimony demonstrating that a PTC condition explicitly limiting the life of the mine to 16 years was not necessary because "the years don't make emissions. The production makes emissions." Transcript 10/18/024, 316:7–316:9. If the mine was to operate at a lower production limit for a longer period of time, such as 50% production for 32-years "that would have a concurrent drop in the concentration, the exposure concentration [for arsenic]. And then that would happen for 32 years, at which point you would still end up with a cumulative dose that is the same [as for 16 years]. . . .Because if you're 50 percent production for the emissions, it's going to take you twice as long. But the end result is that you still have the same cumulative dose for your lifetime." Transcript 10/17/2024, 206:5–206:18.

[8] The Air Rules also provide a further acceptable level for short-term sources operating for less than five-years. IDAPA 58.01.01.007.08. As noted above, this also allows up to a 1:100,000 cancer risk.

reasonable. Transcript 10/17/2024, 167:5–168:11; Transcript 10/17/2024, 138:15–139:13, Transcript 10/17/2024, 195:22–203:17, REC 3876–3881, REC 701–707. Using the 16/70 calculation resulted in a 1:240,000 (4:1,000,000) cancer risk, which is less than the 1:100,000 allowed for by the Air Rules. REC 3878 The DEQ Board finds that this calculation was reasonable and complied with the directive in Rule 161 that arsenic "not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation." IDAPA 58.01.01.161.

c. **DEQ Acted in Accordance with Law When it Applied the 16/70 Calculation.**

The DEQ Board further finds that the 16/70 calculation was not in violation of the Idaho Air Rules. The Air Rules clearly provide an AACC standard in Section 586. They then clearly provide an adjustment to that AACC standard when T-RACT can be used to control emissions. IDAPA 58.01.01.210.12.b. When using T-RACT, the AACC may be adjusted to allow an ambient concentration at the point of compliance for the toxic air pollutant that would contribute an ambient air cancer risk probability of less than one to one hundred thousand (1:100,000). IDAPA 58.01.01.210.12.b–c. As noted above, the daily limit of 135,000 tons (Condition 3.5) and the 788.4 million ton total limit for the life of the mine (Condition 3.6) were T-RACT conditions applied by DEQ under Rule 210. REC 385. As outlined above, the 16/70 adjustment was based on a recognized EPA-methodology for determining cancer risk for projects lasting less than a lifetime (70-years). There was extensive evidence presented demonstrating that the 16/70 calculation was derived by taking the 788.4 million total production limit and the 135,000 daily average to determine the life of the mine would be, at a minimum, 16-years.[9] Applying the 16-year duration using the EPA-methodology resulted in a project cancer risk exposure of

[9] Given Conditions 3.5 and 3.6, a longer life-of-mine duration would result in lower annual emissions and the project cancer risk would remain less than the maximum allowed cancer risk of 1:100,000. REC 3875. 3878–79.

1:240,000, which is less than the maximum cancer risk allowed by the Air Rules of 1:100,000. REC 3876-3881. It was within DEQ's discretion to use the EPA methodology to effectuate the T-RACT limits found in Condition 3.5 and 3.6. Thus, the DEQ Board finds that the 16/70 calculation was acceptable under the Idaho Air Rules and complied with the Rule 161's directive that toxic pollutants not be emitted in quantities that will "injure or unreasonably affect human or animal life or vegetation."

IV. CONCLUSION

Based on the foregoing, it is hereby ordered:

1. There was Sufficient Evidence to Demonstrate that DEQ Acted Reasonably and in Accordance with Law in Using a Five-Year Rolling Average for T-RACT.

2. There was Sufficient Evidence to Demonstrate that DEQ Acted Reasonably and in Accordance with Law in Not Including Additional Permit Conditions Limiting the Non-West End Pit Production Limit.

3. There was Sufficient Evidence to Demonstrate that DEQ Acted Reasonably and in Accordance with Law When it Applied the 16/70 Adjustment.

This Order is final as to all issues presented, as well as to all issues previously decided in the *Final Order* issued in this matter on May 9, 2024. REC 3695–3720.

Dated this 27th day of May, 2025

Dr. John R. MacMillan
Chairman, Idaho Board of Environmental Quality

CERTIFICATE OF SERVICE

I HEREBY CERTIFY that on this 27th day of May 2025, I caused to be served a true and correct copy of the foregoing FINAL ORDER by transmitting a copy thereof in the manner listed below:

Hannah Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
hannah.young@deq.idaho.gov

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
Counsel for the Idaho
Board of Environmental Quality
ann.yribar@ag.idaho.gov

Dylan Lawrence
Varin Thomas LLC
P.O. Box 1676
Boise, ID 83701
Hearing Officer
dylan@varinthomas.com

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-004
filings@oah.idaho.gov

_____

/s/ Diane Cutler
Diane Cutler
Idaho Department of Environmental Quality
diane.cutler@deq.idaho.gov

EXPLANATORY INFORMATION TO ACCOMPANY A FINAL ORDER

The accompanying order is a "**Final Order**" issued by the Board of Environmental Quality pursuant to section 67-5246, Idaho Code.

PETITION FOR RECONSIDERAQTION

Any party may file a petition for reconsideration of a final order within fourteen (14) days of the service date of this order as shown on the certificate of service. **Note: The petition must be received by the Board of Environmental Quality within this fourteen (14) day period.** The Board of Environmental Quality will act on a petition for reconsideration within twenty-one (21) days of its receipt, or the petition will be considered denied by operation of law. See Section 67-5246(4), Idaho Code.

APPEAL OF FINAL ORDER TO DISTRICT COURT

Pursuant to Section 67-5270 and 67-5272, Idaho Code, any party aggrieved by a final order or orders previously issued in a matter before the Board of Environmental Quality may appeal the final order and all previously issued orders in the matter to district court by filing a petition in the district court of the county in which:

i. A hearing was held,
ii. The final agency action was taken,
iii. The party seeking review of the orders resides, or
iv. The real property or personal property that was the subject of the agency action is located.

The appeal must be filed within twenty-eight (28) days of: a) the service date of the final order, b) the service date of an order denying a petition for reconsideration, or c) the failure within twenty-one (21) days to grant or deny a petition for reconsideration, whichever is later. See Section 67-5273, Idaho Code. The filing of an appeal to district court does not in itself stay the effectiveness or enforcement of the order under appeal.

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	Agency Case No. 0101-22-01
	)	OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON	)	**PETITIONER SAVE THE SOUTH FORK SALMON'S MOTION FOR RECONSIDERATION BASED ON NEW EVIDENCE AND MEMORANDUM IN SUPPORT**
Petitioners,	)	
v.	)	
IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	
Respondent,	)	
and	)	
PERPETUA RESOURCES IDAHO, INC.	)	
Intervenor-Respondent.	)	

Petitioner Save the South Fork Salmon ("SSFS") hereby moves the Idaho Board of Environmental Quality (the "Board") for reconsideration of the Board's May 9, 2024 Final Order regarding the issue of whether the Stibnite Road Access Route (the "Access Route") was appropriately excluded from ambient air protections in the permit to construct the Department of Environmental Quality ("DEQ") issued to Perpetua Resources Idaho ("Perpetua"). Specifically, the U.S. Forest Service's January 3, 2025 Final Record of Decision for the Stibnite Gold Project, and supporting documents, provide relevant new information that address the issue of whether Perpetua has legal control to preclude public access from the Access Route.

On June 12, 2024, the Board issued an Order on petitions for Reconsideration and/or Clarification of Final Order, which stayed the statutory deadlines under Idaho Code ("I.C.") § 67-5246 for the May 9, 2024 Final Order until other issues (ambient arsenic concentration) remanded back to the Hearing Officer were resolved. REC 3840 (stating the Board "will stay issuance of a final order on all five issues until the remand before the Hearing Officer is complete and all statutory deadlines for review of the Hearing Officer's Orders have run."). On May 27, 2025, the Board issued its Order on the remaining arsenic issues. This Motion for Reconsideration is timely brought under Idaho Code §§ 67-5246, 67-5276 and IDAPA 04.11.01.740.

BACKGROUND

In this contested case, Petitioners Nez Perce Tribe, Idaho Conservation League, and SSFS challenge the DEQ's approval of a permit to construct issued to Perpetua for the proposed Stibnite Gold Project (the "Project"): a massive open-pit mine in Valley County, Idaho.

On June 17, 2022, DEQ issued permit to construct P-2019.0047 (the "Permit"), which is the Permit at issue in this contested case. On July 22, 2022, Petitioners timely filed the original

Petition to Initiate Contested Case. One of the claims Petitioners raised was that DEQ acted unreasonably and not in accordance with the law when it determined, without specific evidence, that Perpetua would have legal control of the Stibnite Road Access Route such that it could exclude the Access Route from ambient air.

After briefing and a hearing on cross-motions for summary judgment in front of the Board, on May 9, 2024, the Board issued a Final Order, holding that "DEQ Acted Reasonably and in Accordance with law When it Determined that Perpetua Will have Legal Control of the Stibnite Road Access Route Such that it could Properly be Excluded from Consideration as Ambient Air." REC 3717. Specifically, the Board stated:

> Perpetua will have to obtain permission from the [Forest Service], to operate the mine. Part of obtaining permission from the [Forest Service] will involve an evaluation of the project under the National Environmental Policy Act ("NEPA"). During the NEPA process, the [Forest Service] will evaluate continuing access to the [Stibnite Gold Project] by the general public. The record demonstrates that "[o]ne of the alternatives currently being evaluated in the Draft environmental impact statement (EIS), Alternative 2, would provide continuing access through the [Stibnite Gold Project] site on a realigned Stibnite Road during mine operations." REC 893. However, it is noted that the "implementation of this Plan [Alternative 2 with continuing public access through the site] is contingent upon the selection of the applicable alternative by the [Forest Service] as the preferred alternative for the [Stibnite Gold Project] and inclusion of the proposed Stibnite Road access route as a component of the approved [Stibnite Gold Project]." REC 893, see also REC 895–896 (describing alternatives for alignment of the access route.).
>
> The NEPA process is not yet complete, and no final EIS has been issued by the [Forest Service]. Transcript p. 38, ln. 12. Thus, the record does not contain any evidence that the USFS will require continuing public access through the [Stibnite Gold Project]. DEQ recognized at oral argument that, should the [Forest Service] ultimately require public access through the [Stibnite Gold Project], the ambient air boundary analysis will have to be reevaluated. Transcript p. 88 ln. 19–p.89 ln. 17. The Board of

> Environmental Quality will not speculate as to the outcome of the [Forest Service] NEPA process and finds there is not sufficient evidence to support a conclusion that Perpetua will not have legal authority to control access to the federal lands within the project boundaries.

REC 3699-3700. The Board held that, without further "evidence suggesting that Perpetua will not have legal authority to prevent the general public from" using the Access Route, "[i]t was reasonable for DEQ to rely on Perpetua's representations in its application" that Perpetua would have legal control. REC 3701.

Since the May 9, 2024 Final Order was issued, the Final Environmental Impact Statement ("FEIS") and Record of Decision ("ROD") have been issued. *See* Thrower Decl., Ex. 1 (FEIS); Thrower Decl., Ex. 2 (ROD). As discussed in detail below, statements from the FEIS and ROD unequivocally demonstrate that "the [Forest Service] will require continuing public access through the [Stibnite Gold Project]." Accordingly, consistent with the U.S. Environmental Protection Agency ("EPA") policy, DEQ guidance, and the Clean Air Act, the Access Route cannot be excluded from ambient air protections and the Board should remand the Permit back to DEQ to reevaluate the ambient air boundary analysis.

MEMORANDUM IN SUPPORT

I. New information demonstrates Perpetua does not have legal control to preclude public access over the Stibnite Road Access Route.

On January 3, 2025, the Forest Service completed the environmental review process and issued the FEIS and ROD for the Stibnite Gold Project. The Forest Service's final decision documents unequivocally establish that the Stibnite Road Access Route is for public use and that Perpetua does not have legal authority to preclude such use. Specifically, the FEIS describes the Access Route in the alternative that was ultimately chosen as a route specifically for public use to access recreational sites on public land:

Under both action alternatives, there would also be a controlled public access route through the SGP during the operations, and closure and reclamation phases; however, public access would be intermittently interrupted during the construction phase. Thrower Decl., Ex. 1 (FEIS at ES-25).

All Phases: Access Routes: Construction/Operations: Access route around the Yellow Pine pit for public access. Thrower Decl., Ex. 1 (FEIS at 2-4 (Table 2.2-1).

Seasonal public access through the Operations Area Boundary provided by constructing new road through Yellow Pine pit and below mine haul road to link Stibnite Road to Thunder Mountain Road. Thrower Decl., Ex. 1 (FEIS at 2-5).

The Stibnite Road portion of the route is also a county-maintained native surface road, open to all vehicles with seasonal restrictions due to snow. This road is plowed in the winter by Perpetua through an agreement with Valley County. Stibnite Road connects to Thunder Mountain Road on the southeastern portion of the Stibnite site and currently provides seasonal (non-winter) public access through the site. Thrower Decl., Ex. 1 (FEIS at 2-15).

A new 4-mile long, 12-foot-wide gravel road would be constructed to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road through the SGP (Figure 2.4-2). The road would be constructed on a widened bench on the west side within the Yellow Pine pit, then head south of the Yellow Pine pit, where this road would utilize an underpass to cross under a SGP haul road and continue southward, parallel to and on the east side of the mine haul road on a partially revegetated portion of a former haul road (Figure 2.4-2). Southwest of the ore processing area, the public access road would connect with Thunder Mountain Road and continue toward the worker housing facility, exiting the SGP to the southeast. Thrower Decl., Ex. 1 (FEIS at 2-20).

During operations, the public access road through the Operations Area Boundary would provide seasonal use, open to all vehicles . . . . * * * Perpetua could restrict access to any vehicles due to concerns related to public or employee health and safety, such as during road construction and maintenance, blasting, highwall scaling, mining in the immediate area of the road, and similar operations. Thrower Decl., Ex. 1 (FEIS at 2-20).

A new 12-foot-wide gravel road would be constructed to provide public access from Stibnite Road (FR 50412) to Thunder Mountain

Road (FR 50375) through the SGP. During operations, the public access road would be used to travel through the SGP and would provide seasonal use, open to all vehicles. Thrower Decl., Ex. 1 (FEIS at 2-115).

The SGP may affect access to public lands during mine construction, operations, and closure and reclamation: Mine site public access during operations (not plowed). Thrower Decl., Ex. 1 (FEIS at 2-159 (Table 2.8.1)).

There would be public access through the Operations Area Boundary, which may result in less displacement of use to areas/facilities accessed from Thunder Mountain Road (FR 50375). Thrower Decl., Ex. 1 (FEIS at 2-164).

Stibnite Road connects to Thunder Mountain Road on the southeastern portion of the Stibnite mine site and currently provides public access through the mine area. Thrower Decl., Ex. 1 (FEIS at 3-423).

During operations, restricted public access through the site would be provided by constructing a new road around the Yellow Pine pit and below the mine haul road to link Stibnite Road to Thunder Mountain Road. Thrower Decl., Ex. 1 (FEIS at 4-36).

The 2021 MMP would include a 12-foot-wide gravel road to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375) through the SGP. Perpetua received a final PTC from IDEQ on June 17, 2022. This application proposed to exclude the public road on the basis of restricted access and maintaining full control, and that people traveling on the road would be considered "guests of the mine." IDEQ accepted the private road concept proposed by Perpetua . . . Thrower Decl., Ex. 1 (FEIS at 4-43).

Providing public access through the SGP reduces the miles of new motorized trails open to all vehicles in the Meadow Creek IRA, and this is expected to reduce net air quality effects due to vehicles traversing the SGP area. Thrower Decl., Ex. 1 (FEIS at 4-61).

Access to and through the Operations Area Boundary would be maintained during construction, operation, and closure and reclamation. There would be public access through the Operations Area Boundary during construction and operations via a new gravel road constructed to connect Stibnite Road to Thunder Mountain Road. Thrower Decl., Ex. 1 (FEIS at 4-78 – 4-79).

The reroute of Stibnite Road and the designation of a temporary OSV route to replace an existing OSV route are actions that fall under the Travel Management Rule (36 CFR 212), Subparts B and C, respectively (FSM7715.03(5)). These actions require consideration under the Travel Management Rule Minimization Criteria (36 CFR 212.55(b)). Thrower Decl., Ex. 1 (FEIS at 4-593).

The impacts to public access through the Operations Area Boundary would be the same as under the 2021 MMP. The public access road would provide access to recreation sites/areas via Thunder Mountain Road; therefore, the access road would allow continuous access to the Thunder Mountain Road sites/areas. Thrower Decl., Ex. 1 (FEIS at 4-597).

The reroute of Stibnite Road and the designation of a temporary OSV route to replace an existing OSV route are actions that fall under the Travel Management Rule (36 CFR 212), Subparts B and C respectively (FSM7715.03(5)). These actions require consideration under the Travel Management Rule Minimization Criteria (36 CFR 212.55(b)). The Travel Management Rule analysis was added to Section 4.19 of the Final EIS. Thrower Decl., Ex. 1 (FEIS, Appx. B at B-29).

Further the comment expresses concern about public access restrictions, which would be anticipated more so during mine construction. Public access would not be allowed on the newly constructed Burntlog Route segments; therefore, the public would need to utilize the public access route through the mine site to connect to Thunder Mountain Road once constructed. Thrower Decl., Ex. 1 (FEIS, Appx. B at B-496).

Section 4.16 of the SDEIS states that a permanent service road through the backfilled Yellow Pine pit would be established for public access, which would result in a total of approximately 2.2 additional miles of new road that would be accessible for public use following reclamation. Thrower Decl., Ex. 1 (FEIS, Appx. B at B-500).

Under the 2021 MMP, there would be a public access route through the SGP during the operations, and closure and reclamation phases, however, public access would be intermittently interrupted during the construction phase. Public access through the SGP would provide motorized access to Thunder Mountain Road. Thrower Decl., Ex. 1 (FEIS, Appx. B at B-502).

> Overall, public access and motorized vehicle use in the analysis area would still be permitted. Thrower Decl., Ex. 1 (FEIS, Appx. B at B-503).

The ROD–which is a legally binding document that provides the specific conditions that the Forest Service mandated in its approval of the Project and must be met by Perpetua[1]–unequivocally states that the Access Route is a new road built through the Stibnite Gold Project, and specifically for public access and open to all vehicles:

> A new 12-foot-wide gravel road will be constructed to provide public access from Stibnite Road (FR50412) to Thunder Mountain Road (FR 50375) through the Stibnite Gold Project. During operations, the public access road will be used to travel through the Stibnite Gold Project and will provide seasonal use, open to all vehicles. Thrower Decl., Ex. 2 (ROD at 74 (Table 6), 102).

These statements establish that: (1) the Stibnite Road Access Route will be constructed to provide public access through the mine site; (2) the Access Route will be open to "all vehicles" seasonally in a similar manner to current county maintenance standards; (3) the Access Route for public access will be separated from other mine roads and features where the public will not be allowed to access; and (4) although Perpetua has control to impose safety restrictions on the Access Route, the Access Route is open for public use. In short, the FEIS and ROD provide significant evidence that Perpetua does not have legal control to preclude public access over the Access Route.

Notably, allowing public access over the Access Route was analyzed in the FEIS (and ultimately approved in the ROD) pursuant to the Forest Service's Travel Management Rule, which governs the designation of roads and trails for motor vehicle use on National Forests, requires public involvement, and requires consideration of minimization criteria. Thrower Decl.,

[1] "Regulatory and Forest Service requirements and requirements associated with environmental design features are listed in Tables 5 and 6, and made conditions of this decision. These tables are also contained in the FEIS as Tables 2.4-12 and 2.4-13." Thrower Decl., Ex. 2 (ROD at 54).

Ex. 1 (FEIS at 4-593); *see* 36 C.F.R. §§ 212.51, 212.52, 212.55. Even more, revision of those designations–e.g., closure of the Access Route to public use–would require further public involvement and further analysis of the minimization criteria. 36 C.F.R. § 212.54.

In other words, because the Access Route is a designated road open to public use under the Travel Management Rule, Perpetua does not have the legal control to preclude public use; only the Forest Service has that authority after meeting "the requirements for public involvement in § 212.52, the requirements for coordination with governmental entities in § 212.53, and the criteria in § 212.55 . . . ." *Id.* § 212.54. Consequently, although Perpetua has been given legal control to restrict public access for safety purposes, *see* Thrower Decl., Ex. 1 (FEIS 2-20), it does not have control to preclude public access through the entirety of operations.

The final EIS and ROD provide the specific evidence that the Board determined was lacking to make a determination that "the USFS will require continuing public access through the [Stibnite Gold Project]." REC 3699. At a minimum, based on this information, the Board should hold DEQ to its word that "should the USFS ultimately require public access through the [Stibnite Gold Project], the ambient air boundary analysis will have to be reevaluated." REC 3699 (citing Transcript p. 88 ln. 19-p.89 ln. 17).

II. Without legal control to preclude public access, EPA policy, DEQ guidance, and the Clean Air Act mandate that DEQ cannot exclude the Stibnite Road Access Route from ambient air.

The Clean Air Act and Idaho's Air Rules, IDAPA 58.01.01 *et seq.*, require Perpetua to meet various air quality standards, including the National Ambient Air Quality Standards ("NAAQS") and acceptable ambient concentrations of carcinogens ("AACCs") for toxic air pollutants ("TAPs"), in ambient air. *See*, *e.g.*, Air Rules Sections 006.11 (NAAQS), 006.125 (TAPs). By contrast, in areas excluded from ambient air, a facility does not have to demonstrate

compliance with the NAAQS or TAPs. Both EPA and DEQ define "ambient air" as "that portion of the atmosphere . . to which the general public has access." 40 C.F.R. § 50.19(c); Air Rules Section 006.10. "The essence of EPA's regulatory definition of ambient air links ambient air to public access." *Resisting Envtl. Destruction on Indigenous Lands (REDOIL) v. U.S. EPA*, 716 F.3d 1155, 1164 (9th Cir. 2013). EPA's long-standing policy, therefore, has been to exempt from ambient air only "the atmosphere over land owned or controlled by the source and to which public access is precluded." REC 1138.

The Stibnite Road Access Route is a public access road traversing the Project site (*see* Fig. 1 below), and the Forest Service has chosen the mine alternative that will provide–not preclude–public access to the Access Route traversing the Project site. *See* Thrower Decl., Ex. 2 (ROD at 74 (Table 6)).

//

//

//

//

//

//

//

//

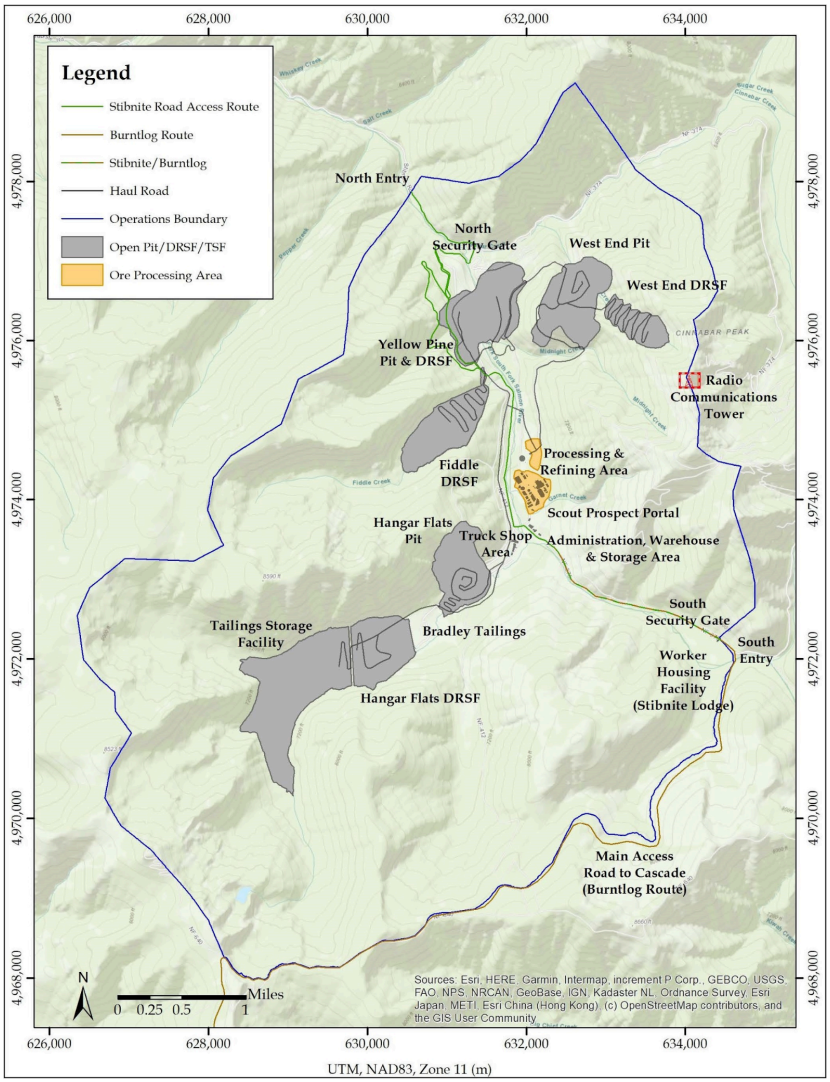
//

//

//

//

Fig. 1. Map reproduced from SOB (REC 0415) showing Project operations boundary, which is also the DEQ-approved ambient air boundary. The Stibnite Road Access Route is shown in green.



The importance of maintaining public access was highlighted in public comments received through the National Environmental Policy Act ("NEPA") process for the Project, "particularly for those in the Johnson Creek and Yellow Pine area who use Stibnite Road to access Thunder Mountain Road and points beyond." REC 0895. Maintaining access to these important recreational areas "is consistent with the [Forest Service] travel management plan." REC 0896. The Access Route will be *the only* way that the public will be able to access these

recreational sites on public lands as the Forest Service determined that the "Main Access road to Cascade (Burntlog Route)," *see* Figure 1, above, will not be open for public use during mine operations. Thrower Decl., Ex. 2 (ROD at 28) ("Public use of the Burntlog Route will be restricted. Seasonal use of the newly constructed portions of the Burntlog Route will be allowed *only* during the snow-free portion of Year -1 when there would be no other access to the Thunder Mountain Road".) (emphasis added); *see also* Thrower Decl., Ex. 1 (FEIS, Appx. B at B-496).

Because the public will be able to use the Access Route, it is ambient air where health-based air quality standards must be met. DEQ, however, excluded Perpetua's entire operations boundary showing in Fig. 1 below–including the Access Route–from ambient air. DEQ's decision to exclude the Access Route from ambient air cannot be squared with the CAA, the Air Rules, and EPA's national ambient air policy.

According to the Supreme Court in *Train v. Natural Resources Defense Council, Inc.*, 421 U.S. 60, 65 (1975), ambient air "is the statute's term for outdoor air used by the general public." EPA's policy for excluding certain portions from ambient air explains:

> [T]he EPA's policy allowing exclusion of some areas external to buildings is not based on language in the regulatory definition mandating exclusion or providing particular criteria for such an exclusion, but rather, is inferred as the inverse of what is affirmatively covered by that definition (*i.e.*, if "ambient air" is defined as that to which the general public has access, then that to which the general public does not have access is not ambient air. . . . The EPA continues to view the "general public" to include any person(s) other than those who are permitted access to the property as employees or business invitees of a specific stationary source (including trespassers).

REC 1145. Above all, EPA has long recognized that certain areas external to buildings may be excluded from the regulatory definition of ambient air because *the general public does not have access to them*." REC 1140 (emphasis added):

> [T]he general public does not have access to land occupied by a stationary source . . . when the land meets [two conditions:] (1) it is owned or controlled by the owner or operator . . .; and (2) the land is surrounded by a fence or other physical barriers that preclude general public access.

REC 1141; *see also* REC 1109 (DEQ guidance stating the same). "Controlled" means the owner or operator has "'the power to control public access' and 'the power to *exclude* the general public.'" REC 1141 (emphasis added). It is clear from EPA's policy that the exemption from ambient air is available only for areas where the general public *will be precluded from entering*–both because there is no legal right to access, as well as no "physical or practical access." REC 1145.

DEQ's guidance is similar to EPA's policy in that it "assume[s] that the air within the facility boundaries is ambient air unless the facility can demonstrate that public access is *precluded*." REC 1109. "The facility-proposed ambient air boundary must include justification that demonstrates the facility has reasonable control of the area *and effectively precludes public access on a routine basis*." *Id.*

Here, the Permit does not preclude access by the general public because it can't. Rather, the Permit allows, and the FEIS and ROD require, public access over the Access Route, and therefore, the Permit inappropriately exempts the Access Route from ambient air.[2]

//

//

[2] The fact that the FEIS Errata states that "[b]ecause public use of the road would be subject to Perpetua's control measures on general use, the public access road is not considered a public road" does not change the analysis. *See* Thrower Decl., Ex. 3 (FEIS Errata at 1). Under EPA's ambient air policy, ownership of the road or property is inconsequential as long as the public has the right to traverse it: "Although a source may restrict public access onto his or her private property, the owner and the individuals that are permitted access to his or her downwind property are, generally speaking, members of the general public relative to the upwind stationary source." REC 1145.

III. DEQ's determination that the public were "guests of the mine" is inconsistent with DEQ guidance, EPA policy, and the Clean Air Act.

When issuing the Permit, to circumvent the problem that it could not preclude public use on the Access Route but the air above the Access Route is not ambient air, DEQ maintained that the "roadway is not public" because Perpetua "has sole control of access through the site" and "is not obligated to allow access." REC 0956; REC 0958. The FEIS and ROD, as discussed above, demonstrate that is not the case. Control of the Access Route is a public use road pursuant to its designation as one under the Travel Management Plan. Perpetua does not have sole control to preclude public access.

Furthermore, DEQ erroneously rationalized because Perpetua will have the ability to "state the conditions of allowed access," the general public passing through the mine site to access public land are now "guests of [Perpetua] in the same manner as those touring the facility as part of a classroom fieldtrip [sic]." REC 0956. Disavowing itself of any responsibility for mine "guests," including schoolchildren, DEQ explained: "Since those requesting access to the site are guests of [Perpetua] and no longer members of the public, health and safety of such guests . . . is the responsibility of [Perpetua] and outside of the scope of the [Permit]." REC 0936. DEQ's rationalization is disingenuous, and as EPA warns in its policy "would expand the exclusion beyond reason and deny the protection of the NAAQS to large numbers of people." REC 1145.

Moreover, those guidelines state that an applicant's proposal to exclude an area from ambient air "must include justification that demonstrates the facility has reasonable control of the area and *effectively precludes public access on a routine basis*." REC 1109 (emphasis added). Notably, DEQ guidelines identify the precise situation here—when "general public [is] allowed on site as a part of a right-of-way easement or common service road"—as being ambient air.

REC 1110. DEQ guidelines also provide that the "'general public' is considered anyone not directly associated with the facility." REC 1109. The fact that the Access Route was authorized to be built specifically to provide public access, and is a designated motorized route under the Travel Management Plan, and users of the Access Road have no ability to access any of the mining facilities, contradicts DEQ's assertion that people traveling to access public lands are "guests" of the mine. *See* Thrower Decl., Ex. 1 (FEIS at 2-5) ("Seasonal public access through the Operations Area Boundary provided by constructing new road through Yellow Pine pit and below mine haul road to link Stibnite Road to Thunder Mountain Road."); REC 0895.

DEQ's guidance is consistent with EPA's policy:

> The EPA continues to view the "general public" to include any person(s) other than those who are permitted access to the property as employees or business invitees of a specific stationary source (including trespassers). Although a source may restrict public access onto his or her private property, the owner and the individuals that are permitted access to his or her downwind property are, generally speaking, members of the general public relative to the upwind stationary source.

REC 1145.

Notably, throughout the entirety of this case before the Office of Administrative Hearings and this Board, DEQ has never identified a single case where it has allowed the general public to travel through a facility where the route is exempt from ambient air protections.

Nothing in the Idaho Air Rules, DEQ's guidance, EPA policy, or DEQ's past practice suggests that, because "access for all guests will be carefully managed," the public is not afforded the protections of ambient air under the CAA.

The record thus does not, and cannot, demonstrate that Perpetua may legally or practically preclude public access to the Access Route, and DEQ's determination to the contrary was unreasonable, as was its decision to label the public as "guests of the mine." DEQ's

determination was not well-reasoned, and is inconsistent with the Idaho Air Rules, the CAA, and EPA policy. The Hearing Officer should vacate the permit and remand it back to DEQ for further review.

IV. The Permit must be set aside and remanded to re-evaluate the conditions in light of the new information.

Under the Idaho APA, when an agency action is not affirmed by a court, it "shall" be set aside, in whole or in part, and remanded for further proceedings as necessary. I.C. § 67-5279. *See also In re Variance ZV2011-2*, 156 Idaho 491, 496 (Idaho 2014) (vacating and remanding arbitrary agency action for further proceedings consistent with the Court's opinion).

Here, DEQ admitted in oral argument before the Board that if new information or changed circumstances would require DEQ "change the analysis" and "go back to the drawing board on the permit:

> BOARD CHAIR BOWEN: And just one follow-up. Let's say the permit goes through the NEPA process with U.S. Forest Service, and they determine or their stipulation is that you must provide public access through the site. What happens to the permit if they make a general ruling like that? What's the status of the permit?
>
> MS. YOUNG: Yes, that would be a change in circumstances; right? And not to throw Perpetua under the bus here, but that's a little bit of the risk that they took by applying for the process while the NEPA process was still ongoing. You know, but the bottom line -- and I don't want to -- Mr. Pooser will talk about this much more eloquently than I -- but the importance of the mine plan and why a lot, not just this piece, is riding on the mine plan. If the mine plan's not approved, then there's no project anyway so then they don't need an air permit anyways, right? But if it were to be approved with that caveat that they would have to be -- general public on that road, for example, that would change the analysis, and we'd probably have to go back to the drawing board on the permit.

Tr. 88:19-25, 89:1-17.[3] Because the Forest Service has unequivocally approved the mine plan that requires the Access Route to be open to public use; has designated the Access Route for public use under the Travel Management Rule, and because Perpetua has no legal authority to preclude public use, the Board should set aside the Permit and remand to DEQ for consideration of the new information and re-evaluation of whether the Access Route should be considered as ambient air.

CONCLUSION

The Forest Service has made its final determination regarding public use of the Stibnite Road Access Route; the Access Route is a designated motorized route open to the public, and Perpetua cannot change that designation. Neither DEQ nor the Board need to "speculate" any more about the status of public use of the Access Route. REC 3700. This new information presents sufficient evidence that Perpetua does not have legal authority to control the Access Route to preclude public use. As such, consistent with DEQ guidance, EPA policy, the Idaho Air Rules, and the Clean Air Act, the Access Road cannot be excluded from ambient air. The new information also demonstrates that DEQ's attempt to put a square peg in a round hole by calling the public "guests of the mine" will not suffice to comply with the law.

The Board should remand the Permit back to DEQ for reconsideration of the ambient air boundary analysis.

Dated June 6, 2025

Respectfully submitted,

/s/ Julia Thrower
Julia Thrower
Attorney for Save the South Fork Salmon

[3] From the transcript of the Mar. 14, 2024 Contested Case Hearing before the Board of Environmental Quality.

CERTIFICATE OF SERVICE

I hereby certify that I have this 6th day of June 2025, served a true and correct copy of the foregoing PETITIONER SAVE THE SOUTH FORK SALMON MOTION FOR RECONSIDERATION BASED ON NEW EVIDENCE AND MEMORANDUM IN SUPPORT upon all parties of record in this proceeding by delivering a copy by e-mail to the following:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov

Dylan V. Lawrence
Hearing Officer
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com

Diane Cutler, Hearing Coordinator
Rules and Planning Analyst
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
(208)373-0165
diane.cutler@deq.idaho.gov

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Hannah M.C. Young
Michael Short
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
hannah.young@deq.idaho.gov
michael.short@deq.idaho.gov

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole Hancock
Stoel Rives LLP
101 S. Capitol Blvd., Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
nicole.hancock@stoel.com

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
ann.yribar@ag.idaho.gov

s/*Julia Thrower*
Julia S. Thrower

Julia Thrower (ISB # 10251)
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
208.271.6503
jthrower@mtntoplaw.com

Attorney for Save the South Fork Salmon

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	)	Agency Case No. 0101-22-01 OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC. Intervenor-Respondent.	)	**DECLARATION OF JULIA THROWER**

I, JULIA THROWER, hereby declare as follows:

1. The following facts are personally known to me, and if called as a witness, I could and would competently testify thereto. I am over eighteen years of age.

2. I am counsel of record representing Petitioner Save the South Fork Salmon in this matter.

3. The attached Exhibits 1, 2, and 3 are true and correct copies of the following documents or excerpts of those documents, which were obtained online from the Payette National Forest Stibnit Gold Project EIS website: https://www.fs.usda.gov/project/?project=50516.

4. Exhibit 1 contains excerpts from the U.S. Forest Service, Stibnite Gold Project Final Environmental Impact Statement (January 2025).

5. Exhibit 2 contains excerpts of the U.S. Forest Service, Payette and Boise National Forests, Final Record of Decision, Stibnite Gold Project, Valley County, Idaho (January 2025).

6. Exhibit 3 contains excerpts of the U.S. Forest Service, Payette and Boise National Forests, Stibnite Gold Project, Final Environmental Impact Statement Errata (January 2025).

I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge, information and belief, and based on my personal experiences.

Signed this 6th day of June 2025, in McCall, Idaho.

/s/ Julia Thrower
Julia S. Thrower

CERTIFICATE OF SERVICE

I hereby certify that I have this 6th day of June 2025, served a true and correct copy of the foregoing DECLARATION OF JULIA THROWER upon all parties of record in this proceeding by delivering a copy by e-mail to the following:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov

Dylan V. Lawrence
Hearing Officer
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com

Diane Cutler, Hearing Coordinator
Rules and Planning Analyst
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
(208)373-0165
diane.cutler@deq.idaho.gov

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Hannah M.C. Young
Michael Short
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
hannah.young@deq.idaho.gov
michael.short@deq.idaho.gov

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole Hancock
Stoel Rives LLP
101 S. Capitol Blvd., Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
nicole.hancock@stoel.com

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
ann.yribar@ag.idaho.gov

Exhibit 1

Stibnite Gold Project
Final Environmental Impact Statement
(excerpts)

United States Department of Agriculture
Forest Service

Stibnite Gold Project

Final

Environmental Impact Statement

Forest Service, Region 4, Payette and Boise National Forests, Valley County, Idaho



REC 7396

Lead Agency:	USDA Forest Service
Cooperating Agencies:	U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, Idaho Governor's Office of Energy and Mineral Resources, Idaho Department of Lands, Idaho Department of Water Resources, Idaho Department of Environmental Quality, Valley County
Responsible Official:	Matthew Davis, Forest Supervisor, Payette National Forest 500 N. Mission Street, Building 2, McCall, Idaho 83638 Phone: (208) 634-6945
For Information Contact:	Brian Harris, Public Affairs Officer, Payette National Forest 500 N. Mission Street, Building 2, McCall, Idaho 83638 Phone: (208) 634-0784 Email: brian.d.harris@usda.gov
Abstract:	This Final Environmental Impact Statement (EIS) is a public document that discloses the direct, indirect, and cumulative effects of the proposed action and alternative actions for the Stibnite Gold Project. This document follows the format established in the Council on Environmental Quality (CEQ) regulations (40 Code of Federal Regulations [CFR] Parts 1500–1508). It includes a discussion of the purpose and need for the proposal; alternatives to the proposal; the physical, biological, social, and economic impacts of the proposed action and alternatives; and a listing of agencies and persons consulted. The document tiers to and incorporates by reference material in the Final EIS and record of decision (ROD) for the 2003 Land and Resource Management Plan (Forest Plan), as amended for the Payette National Forest, and the Final EIS and ROD for the 2010 Boise Forest Plan.

Written Correspondence on this Final EIS can be directed to:

Matthew Davis, Payette Forest Supervisor
Stibnite Gold Project
500 N. Mission Street, Building 2, McCall, Idaho 83638

Electronic Correspondence on this Final EIS can be directed to: Link available on Project website

Please state "Stibnite Gold Project" in the subject line when providing any electronic correspondence, or on the envelope when providing correspondence by mail. Electronic correspondence must be submitted in a common digital format such as plain text (.txt), rich text format (.rtf), Word (.doc, .docx) or PDF (.pdf).

Project Website: https://www.fs.usda.gov/project/?project=50516

Cover Photo Credits: Yellow Pine pit. Midas Gold, Stibnite Gold Project Plan of Restoration and Operations September 2016.

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident. Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English. To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at http://www.ascr.usda.gov/complaint_filing_cust.html and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by: (1) mail: U.S. Department of Agriculture Office of the Assistant Secretary for Civil Rights 1400 Independence Avenue, SW Washington, D.C. 20250-9410; (2) fax: (202) 690-7442; or (3) email: program.intake@usda.gov. USDA is an equal opportunity provider, employer, and lender.

Executive Summary

Introduction

The Stibnite Gold Project (SGP) proposes mine operations on federal, state, and private lands located in Valley County, Idaho. This Final Environmental Impact Statement (Final EIS) was prepared in response to a revised Plan of Restoration and Operations (Plan) for the SGP. The Forest Service received the original SGP Plan in 2016, (Midas Gold Idaho, Inc. [Midas Gold] 2016a) for review and approval in accordance with regulations at 36 Code of Federal Regulations (CFR) 228 Subpart A. A revised Plan was submitted to the Forest Service in 2019 (Brown and Caldwell 2019a). A draft EIS (DEIS) evaluating five alternatives based on the revised Plan was released by the Forest Service in August 2020. A further modified Plan was initially submitted by Midas Gold in December 2020 with a revised submittal in October of 2021 (Perpetua 2021a). Midas Gold changed their name to Perpetua Resources Ltd (Perpetua) in February 2021. In consideration of the modified Plan, the Forest Service determined that a supplemental draft EIS (SDEIS) was warranted and released in October 2022. In the SDEIS, two of the previous action alternatives (August 2020 DEIS Alternatives 1 and 3) were eliminated from further consideration. Therefore, the SDEIS evaluated the Proposed Action, the Johnson Creek Route Alternative, and the No Action Alternative. After review and consideration of the public comments on the SDEIS, revisions were made to the Final EIS including addition of mitigation measures to offset Project effects. Environmental effects of the alternatives are described in this executive summary and a compilation and comparison of these effects is found in **Table 2.8-1** of this Final EIS.

The Forest Service is the lead agency in the preparation of this Final EIS (40 CFR 1501.5). The Project occurs on both the Boise and Payette National Forests; the Payette National Forest (PNF) is the agency lead. Cooperating agencies include the U.S. Army Corps of Engineers (USACE), U.S. Environmental Protection Agency (EPA), Idaho Governor's Office of Energy and Mineral Resources (OEMR), Idaho Department of Lands (IDL), Idaho Department of Environmental Quality (IDEQ), Idaho Department of Water Resources (IDWR), and Valley County, Idaho.

Purpose and Need

The Forest Service purpose is to consider approval of Perpetua's proposed use of the surface of NFS lands in connection with operations authorized by the U.S. mining laws as first described in the Plan submitted September 2016, then refined in 2019 (Brown and Caldwell 2019a), and further modified in 2021 as the 2021 Modified Mine Plan (2021 MMP; Perpetua 2021a). The Forest Service's need for action is to ensure that the proposed occupancy and use of NFS lands is consistent with statutory and regulatory requirements. For purposes of this environmental analysis, the agency is assuming the proposed uses would be able to be authorized under existing regulatory authorities.

The need for action is to:

- Consider approval of Perpetua's 2021 MMP for development of the SGP to mine and mill gold, silver, and antimony deposits that, where feasible, would minimize adverse environmental impacts on NFS surface resources; and ensure that measures are included that provide for mitigation of environmental impacts and reclamation of the NFS surface disturbance.

REC 7398

in slower travel times for non-mine-related traffic and may deter other travelers from using these roadways. Travelers may use alternative roadways including McCall-Stibnite Road to South Fork Salmon River Road.

During operations, mine-related traffic would include transport of employees to and from the SGP, delivery of supplies, and activities associated with road maintenance such as snowplowing and sanding. Under the 2021 MMP and the Johnson Creek Route Alternative, operational AADT would be 50 vehicles (33 heavy vehicles and 17 light vehicles), resulting in approximately four mine-related vehicles per hour traveling outside the SGP.

The upgraded Burnt Log Road and the newly constructed Burntlog Route would experience an increase in traffic of over 71 percent under the 2021 MMP, with 27.5 percent of the traffic comprised of heavy vehicles. Under the Johnson Creek Route Alternative, traffic on Johnson Creek Road and Stibnite Road would increase approximately 71 percent as well, also with 27.5 percent of the traffic comprised of heavy vehicles. Although heavy vehicles currently use Johnson Creek Route to access the SGP, the Johnson Creek Route Alternative traffic would result in a noticeable change in baseline driver experience and slower drive times due to the substantial increase in mine-related heavy vehicles along the Johnson Creek Route during the life of the SGP. Even though upgrades to Johnson Creek Road and Stibnite Road would be made, these roads would still have many curves and slopes.

During closure and reclamation, activities including slope recontouring, facility removal, seeding and planting, and post-closure environmental monitoring would require approximately 7 years. Closure and reclamation would generate a total estimated AADT of 27 vehicles (15 heavy vehicles and 12 light vehicles). Post-closure monitoring activities would generate a total estimated AADT of six light vehicles.

Local roads experience a seasonal effect which results in noticeable differences in traffic. Valley County has many summer recreational areas that attract visitors from May through October with peak AADT levels in June, July, and August. Mine access via the Johnson Creek Route would be more impactful on summer recreational traffic because it would utilize established roads rather than new road development. Winter driving conditions influence the amount of traffic and result in lower AADT levels during the winter months. Therefore, the effect of SGP traffic on these roads would show a noticeably greater increase in mine-related winter traffic during winter. Post-closure winter traffic would not be as noticeable as heavy vehicle deliveries would not occur and approximately six mine-related light vehicles per day would utilize the accessible roadways in the analysis area for monitoring and maintenance purposes.

Public Access

Under the 2021 MMP, public access to the SGP area would be enhanced by the development of a new access road (Burntlog Route) compliant with current road standards. Under both action alternatives, there would also be a controlled public access route through the SGP during the operations, and closure and reclamation phases; however, public access would be intermittently interrupted during the construction phase. Under the Johnson Creek Route Alternative, the Burntlog Route would not be constructed, and the Johnson Creek Route would be used for both public and SGP-related access. To continue providing OSV access to Landmark, a groomed OSV route between Warm Lake and Trout Creek Campground on Cabin Creek Road would be established as part of the 2021 MMP to connect to Landmark from Trout Creek

REC 7399

Campground via an OSV route on the west side of Johnson Creek Road, along with a parking area, resulting in a new winter access facility that would be maintained by Valley County.

Safety and Emergency Access

For the duration of the SGP, the increase in total volume of mine-related vehicles, specifically heavy vehicles or trucks, on the Johnson Creek and Burntlog routes would result in an increased risk for accidents occurring between public and SGP-related traffic due to the one-lane constraints during construction that restrict the passing of slower moving vehicles and due to increasing traffic on the road with more frequent heavy vehicle travel. Proposed controls for deliveries of hazardous materials would address the risk of accidents for those convoys. The steep terrain would be a greater risk to safety along the Johnson Creek Route under the Johnson Creek Route Alternative as it would be the only route used for the life of the SGP and would require safety considerations for geotechnical hazards, landslides, and avalanche zones, including intermittent and extended road closures during the four years of construction. Additionally, access into the SGP mine site under the Johnson Creek Route Alternative would be through a single point of ingress and egress and would require additional safety considerations for mine deliveries and public access. The steep climb to provide access around the Yellow Pine pit would require a wider road with more switchbacks to accommodate the heavy trucks transporting mine supplies and may increase hazardous driving conditions for crew rotation, emergency responses, and wildfire evacuation.

Other Modes of Transportation

Under both action alternatives, a helipad would be located at the SGP for exploration during daylight hours, Medevac purposes, and avalanche control activities. Approximately one round trip (two truck trips) of antimony concentrate would be hauled off-site daily. The daily shipment of antimony and the potential transport of supplies and materials to and from the SGP would generate minimal to negligible changes in regional water transportation. Although there is no commercial rail transportation system in the analysis area, there is potential for the trucks to transport mine products to rail lines located in Boise or for supplies and materials to be indirectly transported to and from the SGP by trucks originating from rail shipments. Nevertheless, these impacts would generate negligible changes to rail transport during operation of the SGP and would not substantially alter the regional level of service.

Heritage Resources

Of the 250 heritage resources in the area of potential effects (APE), 100 have been determined not eligible for listing on the National Register of Historic Places (NRHP) and would require no further management. The remaining 150 sites, however, would require additional consideration and/or management if impacted by the SGP and its components and include 64 resources documented as eligible for listing on the NRHP, three NRHP-listed resources, and 83 resources identified as unevaluated for listing on the NRHP. Unevaluated heritage resources are addressed the same way as NRHP-eligible heritage resources for the assessment of impacts, until their eligibility is determined.

Under the 2021 MMP, 53 historic properties would be within the physical and visual/auditory/vibratory (VAV) APE and an additional 97 historic properties within the VAV APE only.

Under the Johnson Creek Route Alternative, a total of 51 historic properties are located within the physical and VAV APEs and an additional 84 historic properties are located only within the VAV APE.

2.0 ALTERNATIVES INCLUDING THE PROPOSED ACTION

2.1 Introduction

Chapter 2 describes the action proposed by Perpetua in its 2021 MMP submitted in October 2021 (Perpetua 2021a), an additional alternative utilizing another access route, and the No Action Alternative. Each alternative (including the No Action Alternative) would result in different environmental effects, which are analyzed in detail in Chapter 4. In addition, **Section 2.6** includes a discussion of other alternatives considered but eliminated from further analysis. **Section 2.7** summarizes the Agency Preferred Alternative. **Section 2.8** concludes with a comparative summary of the environmental effects.

2.2 Development of Alternatives

2.2.1 Regulatory Setting for Alternatives Development

Alternatives to the Proposed Action were developed by the Forest Service, with input from other cooperating agencies, guided by the NEPA, CWA, and U.S. Department of Agriculture Forest Service regulations (40 CFR 1502.14, 40 CFR 230, and 36 CFR 220.5, respectively), Forest Service Region 4 guidance, and the FSH. The Organic Administration Act, and Forest Service regulations at 36 CFR 228 Subpart A, governing mineral development on NFS lands also provided guidance regarding alternatives development.

2.2.2 Alternatives Screening Criteria

As used in this EIS, an action "alternative" is a complete package of operations, activities, and facilities that comprise a functioning mine project. A complete mining plan has several "component" parts, each necessary to allow production. In many instances, operational components may be further comprised of "subcomponents." To develop a range of reasonable alternatives, Perpetua's plan of operations, as supplemented by additional information and clarifications, was separated into components and subcomponents.

Public comments received during scoping provided early input into potential alternatives to the proposed SGP. An iterative review by the Forest Service and cooperating agencies, evaluated these comments to determine whether they were reasonable alternatives to the proposed SGP using four basic screening criteria described below. In addition to alternatives suggested during scoping, the Forest Service, cooperating agencies, and Perpetua also completed an alternatives development and review process. This process incorporated a review of the Plan and included consideration of alternatives Perpetua had already evaluated prior to the submission of their Plan (Midas Gold 2016a, Appendix G). Potential alternatives and component options were screened based upon four criteria:

1. Does the alternative, including a combination of component options, meet the purpose and need of the SGP?

2. Would the alternative or component option potentially reduce environmental effects to at least one resource?
3. Is the alternative or component option technically feasible?
4. Is the alternative or component option economically feasible?

Alternatives or component options not meeting the purpose and need (described in **Section 1.6**) were documented and eliminated first. Each remaining alternative was then evaluated for technical and economic feasibility and potential environmental impacts using the significant impact issues identified through the scoping process (**Section 1.10**). Infeasible alternatives or alternatives lacking any environmental benefit over the Proposed Action were then eliminated. In addition, options similar in design to an alternative that was carried forward into detailed analysis were screened out to avoid duplication. **Section 2.6** provides additional discussion of specific component alternatives and options that were considered but eliminated.

Further review of alternatives after consideration of comments on the DEIS and submittal of a 2021 MMP by Perpetua eliminated certain action alternatives considered in the DEIS (**Section 2.6**).

Project refinements included in the 2021 MMP: (1) are supported by updated data and analysis that identify opportunities to reduce potential environmental impacts; (2) further ameliorate potential environmental impacts; (3) are informed by public and agency comments on the DEIS, and; (4) align with the NEPA, and all applicable federal, State, and local regulations and permit requirements.

2.2.3 Alternatives Overview

As described below, there are two action alternatives and the No Action Alternative. In general terms, these alternatives are:

No Action Alternative – The No Action Alternative provides an environmental baseline for comparison of the action alternatives. Under the No Action Alternative, the mining, ore processing, and related activities under the action alternatives, including removal of legacy materials, would not take place. However, existing, and approved activities (i.e., approved exploration activities and associated reclamation obligations) would continue and Perpetua would not be precluded from subsequently submitting another plan of operations for consideration and evaluation pursuant to the General Mining Law of 1872.

2021 MMP – The 2021 MMP is based upon Perpetua's Modified Plan of Operations submitted in October 2021 for the SGP. The SGP operations footprint would be within the identified Operations Area Boundary (**Figure 2.4-1**). The Operations Area Boundary is defined as the ambient air boundary (Air Sciences 2018a) and encompasses 14,221 acres, of which 13,441 acres are NFS lands and 780 acres of private lands. Within the Operations Area Boundary, the SGP operations footprint is where mining activities would occur, such as explosives handling, blasting, drilling, and heavy equipment operation which require strict safety protocols and controlled access. For access, the 2021 MMP would utilize Warm Lake Road, Johnson Creek Road, and Stibnite Road (comprising the Johnson Creek Route) during construction of the Burntlog Route, then utilize the Burntlog Route for the last year of construction of the mine site through operations and reclamation. The 2021 MMP primarily refines the open pit mining, pit

backfill, water management, and closure aspects of the project compared to earlier Plan of Operations submittals.

In the 2021 MMP, public access on the newly constructed portions of the Burntlog Route was not restricted. Therefore, this EIS analyzed the effects of unrestricted public access along the existing and new portions of the Burntlog Route, describing the full Burntlog Route as available for access along with the potential effects of that access. Based on the analysis of these effects, restrictions on public access to the new portions of the Burntlog Route were developed by the Forest Service (see **Section 4.16.3**) and have been included in the draft Record of Decision.

Johnson Creek Route Alternative – The Johnson Creek Route Alternative was developed by the Forest Service and the cooperating agencies to evaluate potential reductions from access related effects. The mining portion of this alternative would be the same as the 2021 MMP. Therefore, the primary focus of the Johnson Creek Route Alternative is consideration of using an existing route, which would require improvements, for mine access during operations and reclamation instead of a route that under the 2021 MMP requires new road construction in and through IRAs.

2.2.4 Components Common to and Primary Differences Between the Action Alternatives

The following mine components would be common to the two action alternatives:

- Mine pit locations, areal extents, and mining and backfilling methods
- Transportation management on existing and proposed roads
- Pit dewatering, surface water management, and water treatment
- Ore processing
- Lime generation
- Tailings Storage Facility (TSF) construction and operation
- TSF Buttress construction methods
- Water supply needs and uses
- Management of mine impacted water and stormwater runoff
- Electrical transmission lines
- Stibnite Gold Logistics Facility (SGLF)
- A road maintenance facility (location different depending on alternative, see **Table 2.2-1**)
- Surface and underground exploration
- Stibnite Gold Project worker housing facility

These mine components are described under the 2021 MMP and would remain the same under the Johnson Creek Route Alternative. **Table 2.2-1** provides a summary of the differences between the action

alternatives. Because **Table 2.2-1** describes primary differences, not all the components listed above are included in the table.

Table 2.2-1 Action Alternatives Summary

SGP Phase	Component/ Subcomponent	2021 MMP	Johnson Creek Route Alternative
All Phases	SGP timeline	• Construction: Approximately 3 years. • Operations: Approximately 15 years. • Exploration: Approximately 17 years (during construction and operations). • Reclamation: Approximately 5 years (except for the TSF which would require an additional 9 years for tailings dewatering and consolidation). • Closure/Post-Closure Water Treatment: Approximately through Mine Year 40. • Environmental Monitoring: As long as needed.	Same as 2021 MMP except: • Construction: Approximately 5 years (upgrading the existing Johnson Creek and Stibnite Roads to provide permanent mine access).
All Phases	Access Roads	Construction/Operations: • Warm lake road from State Highway (SH) 55 to Johnson Creek Route intersection (34 miles). • Johnson Creek Route for SGP access during early construction with minor improvements within the road prism. • Burntlog Route (38 miles) for SGP access during last year of construction, mining and ore processing operations, and closure and reclamation. Includes improvements of existing segments (23 miles) and road construction for new segments (15 miles). • Up to eight borrow areas developed along Burntlog Route for materials needed for road improvements and maintenance. • Access route around the Yellow Pine pit for public access. Closure and Reclamation: • New sections of Burntlog Route to be reclaimed after the closure and reclamation period.	• Warm lake road from SH 55 to Johnson Creek Route intersection (34 miles). • Johnson Creek Route (39 miles: Johnson Creek Road 25 miles, Stibnite Road 14 miles) upgraded and used for access throughout life of mine (LOM) instead of the Burntlog Route. • Access route around the Yellow Pine pit for public access, employee access, and deliveries of supplies and equipment to the processing, warehouse, worker housing facility, and administration areas. • No improvements or construction of new segments for Burntlog Route. • Up to seven borrow sources developed along the Johnson Creek Route for materials needed for road improvements and maintenance. Closure and Reclamation: • Improved Johnson Creek and Stibnite roads would not be reclaimed to pre-existing conditions.

SGP Phase	Component/ Subcomponent	2021 MMP	Johnson Creek Route Alternative
All Phases	Public Access	Construction: • Temporary groomed over-snow vehicle (OSV) route on the west side of Johnson Creek from Trout Creek to Landmark while Burntlog Route is constructed (8 miles). • OSV route on Johnson Creek Road from Wapiti Meadows to Trout Creek Campground closed during construction (9 miles). • OSV route from Warm Lake to Landmark closed during construction through reclamation and closure (8.5 miles). • Cabin Creek Road groomed OSV route (11 miles). • Public roads remain open through the Operations Area Boundary with temporary closures as needed to accommodate construction. Operations: • Groomed OSV route moves from west side of Johnson Creek Road to Johnson Creek Road from Landmark to Wapiti Meadows (16.7 miles). • Stibnite Road (County Road [CR] 50-412) / Thunder Mountain Road (FR 50375) closed through the Operations Area Boundary. • Seasonal public access through the Operations Area Boundary provided by constructing new road through Yellow Pine pit and below mine haul road to link Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375). • Public access allowed on Burntlog Route to Thunder Mountain Road (FR 50375). Closure and Reclamation: • New road constructed over the Yellow Pine Backfill (backfilled Yellow Pine pit) connecting Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375).	Construction and Operations: Same as 2021 MMP except: • OSV route on the west side of Johnson Creek from Wapiti Meadows to Trout Creek Campground would be closed from construction through mine closure (9 miles). • Groomed OSV route on the west side of Johnson Creek from Trout Creek to Landmark lasting from construction through mine closure. Closure and Reclamation: Same as 2021 MMP.

OSV route would minimize the interactions between SGP traffic and recreational traffic in the winter. The proposed OSV route is illustrated in **Figure 2.4-4**.

- Expanded wintertime public vehicle access on Warm Lake Road east of Warm Lake Lodge would commingle SGP and public travel.

Changes to the SH 55 and Warm Lake Road intersection would improve access for large trucks carrying equipment and supplies to the SGP and would facilitate turns from SH 55 onto Warm Lake Road and from Warm Lake Road back onto SH 55. Any changes proposed to the intersection would need to be approved and implemented by the Idaho Transportation Department (ITD). Recommended changes to the intersection include: the addition of left and right turning lanes (Parametrix 2018a); an intersection modification to accommodate larger trucks; potential relocation of two power poles (HDR Engineering, Inc. [HDR] 2017a); and a modification to the westbound approach at Warm Lake Road to improve the view of traffic coming from the north.

Johnson Creek Route

During the initial construction period of the Burntlog Route (approximately 2 to 3 years), mine-related traffic would access the SGP from SH 55, north of the city of Cascade, via Warm Lake Road for approximately 34 miles, then north on Johnson Creek Road (CR 10-413) for approximately 25 miles to the village of Yellow Pine, and from Yellow Pine east approximately 14 miles to the SGP via the Stibnite Road (CR 50-412). The portion of the route that includes Johnson Creek Road and Stibnite Road is known as the Johnson Creek Route. This route is primarily situated topographically adjacent to the valley bottom, paralleling Johnson Creek and then the East Fork SFSR.

Johnson Creek Road is a county-maintained, native-surface road that is open to vehicles with seasonal restrictions due to snow. During the winter, Valley County plows approximately 10 miles of Johnson Creek Road from Yellow Pine south to Wapiti Meadow Ranch and grooms the remaining 17 miles of Johnson Creek Road from Wapiti Meadow Ranch to Warm Lake Road at Landmark for OSV use. Valley County does not plow Warm Lake Road from Warm Lake to Landmark; this section is a designated groomed OSV route.

The Stibnite Road portion of the route is also a county-maintained native surface road, open to all vehicles with seasonal restrictions due to snow. This road is plowed in the winter by Perpetua through an agreement with Valley County. Stibnite Road connects to Thunder Mountain Road on the southeastern portion of the Stibnite site and currently provides seasonal (non-winter) public access through the site.

Minor surface improvements (such as ditch and culvert repair, adding gravel, winter snow removal, resurfacing if required, and summer dust suppression) would occur on the Johnson Creek Route under the 2021 MMP to reduce sediment runoff and dust generation. However, there would be no road alignment modification or widening of these existing roads along the Johnson Creek Route. The road varies in elevation from approximately 4,750 to 6,700 feet amsl with an average grade of 1.5 to 2 percent with occasional local segments with grade up to approximately 8 percent.

2.4.4.4 Public Access

During construction of the SGP and completion of the Burntlog Route, to the degree practicable, the public would continue to have access on forest roads currently available to the public (**Figure 2.4-1**). However, public access through the Operations Area Boundary on Stibnite Road would be restricted for a period of approximately one year while a new through-site public access road is constructed. A new 4-mile long, 12-foot-wide gravel road would be constructed to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road through the SGP (**Figure 2.4-2**). The road would be constructed on a widened bench on the west side within the Yellow Pine pit, then head south of the Yellow Pine pit, where this road would utilize an underpass to cross under a SGP haul road and continue southward, parallel to and on the east side of the mine haul road on a partially revegetated portion of a former haul road (**Figure 2.4-2**). Southwest of the ore processing area, the public access road would connect with Thunder Mountain Road and continue toward the worker housing facility, exiting the SGP to the southeast.

During operations, the public access road through the Operations Area Boundary would provide seasonal use, open to all vehicles; access would not be provided in winter when impassable (current county maintenance standards) and signs would inform the public of seasonal and temporary closures. Public vehicles passing through would be required to check-in with mine personnel at the North or South SGP entry points and would receive a safety briefing and would also be required to check-out with SGP personnel upon exiting the SGP. For safety purposes, public access would be separated from other SGP roads by berms, security fencing, and the underpass to allow the public road to pass beneath the mine haul road. No stopping or deviating from the public access road would be allowed. Perpetua could restrict access to any vehicles due to concerns related to public or employee health and safety, such as during road construction and maintenance, blasting, highwall scaling, mining in the immediate area of the road, and similar operations.

Public access along Johnson Creek Road during the life of the SGP would be unchanged; however, closures spanning from a half-day to multiple days could occur due to construction activities. Total closures of half-day to multiple days could occur during construction work on Stibnite Road between the village of Yellow Pine and the SGP, part of Thunder Mountain Road, and Burnt Log Road.

Public access on existing segments of the Burnt Log Road would be restricted for limited periods of time to upgrade road segments during construction of the Burntlog Route. Other routes available for public use are shown on **Figure 2.4-1**.

Public access by foot via existing trails or on roads would be restricted within the Operations Area Boundary shown on **Figure 2.4-2**. Security personnel, fencing (including wildlife exclusion fencing), and signs would restrict public access to vehicular traffic on the designated public access roadway inside the Operations Area Boundary.

Warm Lake to Landmark Groomed OSV Route Closure

Due to year-round mine access to the SGP Operations Area along the Warm Lake Road, an existing, approximately 8.5-mile-long groomed OSV route from Warm Lake to Landmark would be closed for the life of the SGP. To replace this recreational use, a dedicated alternative OSV route would be established from the Warm Lake area to Landmark via the Cabin Creek Road and Johnson Creek Road (**Figure 2.4-4**).

Cabin Creek Road Groomed OSV Route

Near Warm Lake, an approximately 2-acre parking area would be established west of South Fork Road on FR 474B. A new 3.2-mile groomer access trail would be established from the parking area to the Forest Service Warm Lake Project Camp south of Paradise Valley Road (FR 488) where the groomer would be stored. An approximate 0.1-mile segment would be groomed from the intersection of Paradise Valley Road and FR 488A to Warm Lake Road. The Cabin Creek Road (FR 467) groomed OSV route would extend approximately 11 miles to the Trout Creek Campground on Johnson Creek Road. Portions of Cabin Creek Road would require stream crossing improvements, road widening, and surface grading to support the OSV route grooming equipment.

Johnson Creek Groomed OSV Route

An approximately 8-mile temporary groomed OSV route would be created and maintained on NFS lands adjacent to the west side of Johnson Creek Road (CR 10-413) from Trout Creek Campground to Landmark. Portions of the temporary groomed OSV route would be established using a snowplow wing attachment requiring some vegetation and tree removal to allow for safe snowplowing. In areas where topography and vegetation prevent using the wing attachment to establish the groomed OSV route, sections would merge with Johnson Creek Road. During construction, operations, and closure, the OSV route would include an additional 0.34-mile segment south of and paralleling the Warm Lake Road heading east connecting Johnson Creek Road to Deadwood-Stanley Road (FR 579) (**Figure 2.4-4**).

Warm Lake Area OSV Connection

A 0.3-mile, 16-foot-wide groomed OSV route would be created and maintained north of Warm Lake Road to connect the southern end of the Cabin Creek Road OSV route to the Warm Lake Road (FR 579). It would also provide access to North Shoreline Drive (FR 489) from the Cabin Creek Road OSV route. This 0.3-mile route would be used throughout construction, operations, and closure, and would require the removal of some vegetation and trees.

Temporary OSV Closure Trout Creek Campground to Wapiti Meadows

OSV access would be temporarily halted between Trout Creek Campground and Wapiti Meadows (about 9 miles north of Trout Creek Campground on Johnson Creek Road; **Figure 2.4-4**) for approximately 2 to 3 years during construction of the Burntlog Route. Once construction of the Burntlog Route has been completed, the Johnson Creek Route would no longer be used by mine-related traffic and the OSV route would be returned to the unplowed Johnson Creek Road and extended northward to provide approximately 17 miles of groomed OSV access between Landmark and Wapiti Meadows. Resumption of OSV access between Trout Creek Campground and Wapiti Meadows would occur following construction of the Burntlog Route.

Travel Management Rule

The reroute of Stibnite Road and the designation of a temporary OSV route to replace an existing OSV route are actions that fall under the Travel Management Rule (36 CFR 212), Subparts B and C, respectively (FSM7715.03(5)). These actions require consideration under the Travel Management Rule Minimization Criteria (36 CFR 212.55(b)). This is presented in **Section 4.19**, Recreation Resources.

2.4.4.5 Traffic

Traffic associated with SGP construction would occur year-round, depending upon road and weather conditions. Construction-related traffic and material hauling would be most concentrated from May through November, and personnel would be transported primarily using buses and vans. The total estimated annual average daily traffic (AADT) for construction and operations activities driving from SH 55 to the SGLF and between the SGLF and the SGP are listed in **Table 2.4-2**. Supplies and deliveries for the SGP during construction would access the SGLF using SH 55 to Warm Lake Road and would use SH 55 through Cascade and other communities along SH 55 south of Cascade including Banks and Horseshoe Bend.

Table 2.4-2 Project Construction and Operations SGP Traffic

Phase	Route	Transport Type	AADT
Construction	SH 55 to SGLF	HV	30
Construction	SH 55 to SGLF	LV	169
Total			**199**
Construction	SGLF to SGP	HV	45
Construction	SGLF to SGP	LV	20
Total			**65**
Operations	SH 55 to SGLF	HV	25
Operations	SH 55 to SGLF	LV	131
Total			**156**
Operations	SGLF to SGP	HV	33
Operations	SGLF to SGP	LV	17
Total			**50**
Reclamation and Closure	SH 55 to SGP	HV	15
Reclamation and Closure	SH 55 to SGP	LV	12
Total			**27**

SH 55 to SGLF – State Highway 55 to Stibnite Gold Logistics Facility
SGLF to SGP - Stibnite Gold Logistics Facility to Stibnite Gold Project
HV – heavy vehicle
LV – light vehicle
AADT – annual average daily traffic

Supplies and deliveries for the SGP during operations would access the SGLF using SH 55 to Warm Lake Road. Approximately two-thirds of all mine-related traffic would originate south of Warm Lake Road and would use SH 55 through Cascade and other communities along SH 55 south of Cascade including Banks

Description	Resources Affected
Perpetua would submit an annual report to the USFS and the other federal and state agencies that are responsible for issuing authorizations applicable to reclamation for the preceding calendar year. The annual report would contain descriptions of the reclamation activities completed during the previous year, a summary of areas reclaimed, a discussion of the results of the reclamation monitoring conducted, and corrective actions implemented.	Soils, Reclamation
A new 12-foot-wide gravel road would be constructed to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375) through the SGP. During operations, the public access road would be used to travel through the SGP and would provide seasonal use, open to all vehicles. Vehicles passing through the SGP would be required to check-in with mine personnel at the North or South SGP entry points.	Transportation and Access, Health and Safety
Post reclamation, a road would be established over the backfilled Yellow Pine pit to allow public access through the reclaimed site and connect Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375). This would replace the operational phase public access route.	Transportation and Access
Prior to site preparation and construction of surface facilities, vegetation would be removed from operating areas. Trees and deadwood, shrubs, and slash not needed to construct windrows at the edge of Burntlog Route disturbance (to function as sediment barriers), would be chipped, and suitable soil would be separately salvaged and stockpiled (except for a small portion that would be 'live handled') for use as part of site reclamation and restoration. Portions of the salvaged soil would be blended with the chipped wood to create growth media. All growth media placed in stockpiles would be stabilized, seeded, and mulched to protect the stockpiles from wind and water erosion.	Vegetation
Perpetua would inspect and remove vegetation material (including noxious weeds) from mechanical equipment and properly dispose to minimize the spread of unwanted vegetation.	Vegetation
Wood wastes and wood mulch are the two primary sources of compost. Food waste produced from on-site meal preparation and wastes may provide another source. Combined and properly managed during composting, these materials would provide a source of organic matter to be blended into substrate materials suitable for mitigation.	Vegetation
Perpetua would be responsible for noxious weed control within areas disturbed by SGP activities.	Vegetation, Wildlife
Develop and employ planting plans for wildlife benefits (cover, forage, etc.) using approved seed mixes.	Vegetation, Wildlife
Perpetua would use aquatic safe herbicides during vegetation management activities and noxious weed control. Adhere to chemical label restrictions, Federal and State rules on usage. Use proper equipment for chemical application by trained personnel.	Vegetation, Fish
Perpetua or its designated contractor(s) would perform long-term maintenance as necessary, including maintaining and monitoring the Mitigation Area (including stream and wetlands) in perpetuity once the final performance standards are met or until such responsibility is relinquished to an appropriate third party (Forest Service, etc.) as approved by the USACE.	Vegetation, Wetlands
Perpetua would plant stream reclamation reaches and wetland reclamation areas with native plant species that are present in PAB, PEM, PSS, and palustrine forested wetlands and riparian areas along streams throughout the Mitigation Area.	Vegetation, Wetlands
To address stream temperature, riparian planting widths along restored and enhanced stream reaches would be 18 feet wide on each stream bank where possible. Taller and denser vegetation such as spruce trees would be planted. Further, the creation of the lined Stibnite Lake, a feature similar in size to the present Yellow Pine pit lake, would replace the function of the existing Yellow Pine pit lake in buffering stream temperature extremes and reduce maximum stream temperatures in East Fork SFSR in and downstream of the SGP.	Vegetation, Wetlands, Surface Water, Reclamation

Issue	Indicator	Baseline Conditions	No Action Alternative	2021 MMP	Johnson Creek Route Alternative
Land Use and Land Management					
The SGP would cause changes in land use or land management.	Acres of land used for SGP components by land management agency.	(Analysis area) Private: 925 acres State: 77 acres BNF: 1,027 acres PNF: 2,373 acres BOR: 25 acres	Same as Baseline Condition.	Private: 819 acres State: 62 acres BNF: 933 acres PNF: 1,439 acres BOR: 12.5 acres	Private: 828 acres State: 62 acres BNF: 820 acres PNF: 1,372 acres BOR: 12.5 acres
	Acres of total and new land disturbance within SGP area.	Existing disturbance acreage within analysis area: 1,554 acres (includes historic mine disturbance, existing roads and utilities)	Same as Baseline Condition.	Disturbance acreage impacts: 3,266 total acres 51% (1,674 acres) of total is new disturbance	Disturbance acreage impacts: 3,095 total acres 50% (1,544 acres) of total is new disturbance
The SGP could cause changes in or create new ROWs or easements.	Miles or acres of new or changed ROWs or easements, regardless of jurisdiction.	Total existing ROW (transmission lines and roads): 666 acres	Same as Baseline Condition.	Total new ROW (transmission lines and roads): 763 acres	Total new ROW (transmission lines and roads): 639 acres
Access and Transportation					
The SGP may affect access to public lands during mine construction, operations, and closure and reclamation.	Number, location, and description of changes in access due to new and improved roadways.	See **Table 3.16-1** and **Figure 3.16-1**.	Same as Baseline Condition.	Burntlog Route (plowed). Mine site public access during operations (not plowed). Loss of winter groomed OSV route on Warm Lake Road to Landmark. Loss of winter groomed OSV route on Johnson Creek Road from Wapiti Meadows to Trout Creek Campground during construction of Burntlog Route.	No Burntlog Route, only Johnson Creek Route (plowed). Mine site public access during operations (not plowed). Loss of winter groomed OSV route on Warm Lake Road to Landmark. Loss of winter groomed OSV route on Johnson Creek Road from Wapiti Meadows to Trout Creek Campground for life of SGP.
The SGP may change the miles of roads and trails, the amount of use, and types of vehicles on each road or trail.	Miles of new road for public use.	Forest Service = 1,557 miles Valley County = 278 miles State = 131 miles	Same as Baseline Condition.	Forest Service = no change Valley County = 2.2 miles State = no change Private = 15 miles (with an additional 4 miles through the SGP)	Forest Service = no change Valley County = 2.2 miles State = no change Private = 4 miles through the SGP
	Change in amount of use.	See **Table 3.16-2** for existing roads.	Same as Baseline Condition.	Johnson Creek Route = 5 mine-related vehicles/hr. during construction Burntlog Route = 4 mine- related vehicles/hr. during operations; 2 mine-related vehicles/hr. closure and operations	Johnson Creek Route = 5 mine-related vehicles/hr. during construction; 4 mine- related vehicles/hr. during operations; 2 mine-related vehicles/hr. closure and reclamation
	Changes in frequency of rail, air, and water transportation.	Rail – no active lines Air – 7 public use airports Water – Port of Lewiston	Same as Baseline Condition.	Rail - No impact. Air – Helicopter usage for when roads are inaccessible. Water – potentially 1 roundtrip (2 truck trips) daily of antimony concentrate that could be shipped out via the Port of Lewiston.	Rail - No impact. Air – Helicopter usage for when roads are inaccessible. Helicopter usage during construction to install repeaters. Water – potentially 1 roundtrip (2 truck trips) daily of antimony concentrate that could be shipped out via the Port of Lewiston.

REC 7411

Issue	Indicator	Baseline Conditions	No Action Alternative	2021 MMP	Johnson Creek Route Alternative
The SGP may affect public safety on the roads used by mine vehicles during construction, operations, and closure and reclamation activities.	Approximate miles of roads used by mine vehicles.	Johnson Creek Route = 70 miles Burntlog Route = 0 mile (does not exist)	Same as Baseline Condition.	Johnson Creek Route = 70 miles Burntlog Route = 71 miles	Johnson Creek Route = 70 miles Burntlog Route = 0 mile
	Change in traffic volume. (AADT)	Refer to **Table 3.16-2**.	Same as Baseline Condition.	Construction = 65 (45 HV) Operations = 50 (33 HV) Closure and Reclamation = 25 (13 HV) Post Closure = 6 (0 HV)	Construction = 65 (45 HV) Operations = 50 (33 HV) Closure and Reclamation = 25 (13 HV) Post Closure = 6 (0 HV)
	Number of accidents, both current and projected.	Warm Lake Road = 8/year Johnson Creek Road = 2/year Stibnite Road = 1/year	Same as Baseline Condition.	Perpetua would implement safety measures to reduce accidents including radio communications, pilot cars, and hour restrictions.	Perpetua would implement safety measures to reduce accidents including radio communications, pilot cars, and hour restrictions. Johnson Creek Route has a steeper topography and terrain that would require wider roads, more cut/fill sections, and more switchbacks.
	Change in emergency access.	N/A	N/A	Additional access routes through the SGP.	Additional access routes via public access during the winter.
	Change in OSV access.	Groomed OSV route along Warm Lake Road from Warm Lake Parking Area to Landmark Groomed OSV route along Johnson Creek Road from Landmark north to Wapiti Meadows	Same as Baseline Condition.	Groomed OSV from Warm Lake to Landmark closed for use for life of SGP. An alternative OSV route would be established from Trout Creek Campground to Landmark. Warm Lake area OSV would be created north of Warm Lake Road to southern end of Cabin Creek Road OSV Route to Warm Lake Road. Paradise Valley, North Shore Lodge, and Johnson Creek Road to FR 579 OSV connectors. OSV from Trout Creek Campground to Wapiti Meadows closed through construction of Burntlog Route. Groomed OSV route would be re-established on Johnson Creek Road between Landmark and Wapiti Meadows following construction.	Same as under the 2021 MMP; except the OSV from Trout Creek Campground to Wapiti Meadows closed for life of SGP.
Heritage Resources					
The SGP may affect historic properties through ground disturbance.	Locations of ground disturbance.	N/A	N/A	3,266 acres Ground disturbing activities could affect historic properties at these locations: Access Roads (including OSV routes) Construction of Burntlog Route and associated facilities (access roads, borrow areas) VHF repeater sites and telecommunications tower location and associated access roads Transmission line corridor upgrades and access roads	3,095 acres Same as 2021 MMP except: Reduces ground disturbance. Limits disturbance for new road construction as Burntlog Route would not be constructed. Extensive upgrades to Johnson Creek and Stibnite Roads would be required including cut and fill areas.

REC 7412

Issue	Indicator	Baseline Conditions	No Action Alternative	2021 MMP	Johnson Creek Route Alternative
The SGP may affect infrastructure and services as related to emergency services, medical services, law enforcement, social services, sanitation, and wastewater treatment.	Capacity of existing infrastructure and services to meet anticipated increased use.	Due to the remote nature, most of the SGP area is located more than 30 miles from the nearest local emergency services.	Same as Baseline Condition.	Moderate and positive. Emergency medical technicians and emergency equipment and supplies would be on-site, including an ambulance, first aid, and medical supplies.	Same as the 2021 MMP.
The SGP may cause public health effects related to changing environmental conditions.	Disruption of recreational areas during construction, operation, and closure and reclamation.	Recreation is a major use throughout much of the SGP area; activities commonly include hunting, fishing, sightseeing, hiking, camping, all-terrain vehicle use, snowmobiling, and horseback riding.	Same as Baseline Condition.	Negligible. Displacement of project-area recreational activities would be offset by improved access to alternative recreational areas.	Same as the 2021 MMP.
	Psychological effects due to noise.	Sound levels at the 12 baseline noise measurement locations in the SGP area ranged from 34 dBA to 64 dBA.	Same as Baseline Condition.	Negligible. Predicted noise levels would be under, at, or slightly over the outdoor threshold level of 55 dBA.	Same as the 2021 MMP.
Recreation					
The SGP may cause changes to recreation setting, access, facilities, and/or opportunities.	Changes in motorized access (including restrictions and/or changes in maintenance) to recreation opportunities.	State and County roads provide access to connecting unpaved Forest Service roads, which provide access to NFS lands and facilities.	Current access to the area via Johnson Creek Road and Stibnite Road would remain unimpeded. In general, areas that are inaccessible to motorized vehicles would continue to be inaccessible to vehicles or certain vehicle types in summer.	Access to the areas/facilities accessed from Thunder Mountain Road (FR 50375) east of the Operations Area Boundary would be modified due to closure of Stibnite Road (CR 50-412) and construction of the Burntlog Route, which would provide motorized access (year-round) to areas that currently do not have motorized access. Winter access would be increased along Cabin Creek Road due to new OSV route. There would be direct access to Thunder Mountain Road through the Operations Area Boundary during operations, in addition to access via the Burntlog Route. The re-routed segment of the Burntlog Route would provide increased motorized access to areas without such access currently. Access to several OSV routes would be affected by plowing of Johnson Creek Road, Warm Lake Road, and the Burntlog Route. Construction activities for transmission lines and the maintenance facility may result in delays or detoured access. After mine reclamation, the Stibnite Road public access through the mine to Thunder Mountain Road would be restored.	Similar to the 2021 MMP, except there would be no Burntlog Route and resulting new motorized access to areas from these facilities. Access to several OSV routes would be affected by plowing of Johnson Creek Road and Warm Lake Road.

REC 7413

Issue	Indicator	Baseline Conditions	No Action Alternative	2021 MMP	Johnson Creek Route Alternative
	Changes in recreation physical setting characteristics and related ROS class (by season) measured in acres.	Designated ROS classes in the analysis area vary by season, and include Rural, Roaded Natural, Roaded Modified, Semi-Primitive Motorized, Semi-Primitive Non-Motorized, and Primitive. Estimated existing ROS physical settings are similar.	Generally, existing designated ROS classes and physical recreation setting characteristics would remain as is. Modifications to the recreation setting in the SGP area continued low level of unauthorized motorized use, and increased winter motorized access and use could lead to changes in the designated ROS class and/or ROS physical setting of some areas due to additional motorized use both in the summer and winter. Acreage of Estimated ROS Physical Setting Classes – Summer/Winter: • Primitive: 17,278/21,370 acres • Semi Primitive Non-Motorized: 218,512/245,210 acres • Semi-Primitive Motorized: 83,497/240,387 acres • Semi-Primitive Motorized Groomed (winter only): 50,436 acres (this acreage overlaps other features) • Roaded Natural: 140,594/7,511 acres • Rural: 81,450/26,853 acres	Several components would result in inconsistencies with existing designated ROS classes including: Burntlog Route, plowing of the Burntlog Route, temporary plowing of the Johnson Creek Road and Stibnite Road, plowing of Warm Lake Road (CR 10-579), new transmission line. Acreage of Disturbance to ROS Physical Setting Classes During Operations – Summer/Winter: Primitive: 0/0 acres Semi Primitive Non-Motorized: 0/0 acres Semi-Primitive Motorized: 42/364 acres Semi-Primitive Motorized Groomed (winter only): 163 acres Roaded Natural: 685/387 acres Rural: 345/322 acres	Similar to the 2021 MMP, except there would be no inconsistencies with existing designated ROS classes related to the Burntlog Route or plowing of the Burntlog Route. Inconsistency with the existing designated ROS class for Johnson Creek and Stibnite Roads in the winter would not be temporary during construction (as in the 2021 MMP) but would continue through operations and reclamation because the roads would be plowed as part of the Johnson Creek Route. Acreage of Estimated ROS Physical Setting Classes During Operations – Summer/Winter: Primitive: 0/0 acres Semi Primitive Non-Motorized: 0/0 acres Semi-Primitive Motorized: 43/212 acres Semi-Primitive Motorized Groomed (winter only): 113 acres Roaded Natural: 387/34acres Rural: 353/536 acres
	Changes in recreation facilities (trails, campgrounds, trailheads), including the level of development and setting.	The Warm Lake area contains most of the developed recreation facilities (apart from trailheads). Scattered campgrounds and other facilities also are located in the Big Creek and Landmark areas and along Johnson Creek Road around and south of Yellow Pine. Developed recreation facilities primarily include campgrounds, cabins/lookouts, trailheads, and trails.	Same as Baseline Condition	The Stibnite Mining District Interpretive Site would be closed until after mine reclamation. Mine components would alter the setting of recreation facilities adjacent to them to a more developed setting due to increased man-made development, noise, traffic, etc. These components include the mine and facilities within the Operations Area Boundary, Burntlog Route, upgraded transmission lines, new transmission line to the Operations Area, Johnson Creek substation, a small VHF repeater on Meadow Creek Lookout, use of Warm Lake Road, and temporary use of the Johnson Creek Route.	Similar to the 2021 MMP, except the Burntlog Route would not be built and therefore would not affect the setting of existing recreation facilities. In addition, changes to the setting of recreation facilities along the Johnson Creek Route would be affected through reclamation and not just temporarily during construction.
	Changes in recreation use, potentially due to changes in recreation facilities, opportunities, access, and setting.	Developed recreation use is limited to the developed recreation sites (i.e., overnight facilities) located primarily in the Warm Lake, Landmark and Johnson Creek Road areas. Most recreation in the analysis area is dispersed use, which occurs outside of developed recreation sites.	Existing recreation use would continue. Some unauthorized motorized use may continue to occur off of existing roads and motorized trails. Motorized winter use has expanded in recent years, and may continue to expand in the future, resulting in additional OSV routes and additional areas receiving winter motorized use.	There would be public access through the Operations Area Boundary, which may result in less displacement of use to areas/facilities accessed from Thunder Mountain Road (FR 50375). In addition, there could be increased dispersed recreation use along the Burntlog Route . Some recreation use may return to the Operations Area Boundary after reclamation; however, due to the changes in the recreation setting, some use may be displaced to areas where the recreation setting is more natural.	Similar to the 2021 MMP. The Burntlog Route would not be built; therefore, there would be no resulting displacement or increase in recreation use from this route.

REC 7414

3.0 AFFECTED ENVIRONMENT

3.1 Introduction

Chapter 3 describes the existing natural and human environment that would potentially be affected by the SGP. The natural and human environment is further divided into resources or resource uses - physical environment, biological resources, and social resources/environment. Each resource section is organized as follows: a brief introduction and scope of analysis including a definition of the analysis area specific to the resource; relevant laws, regulations and policies; and existing conditions of the resource in the analysis area.

This EIS is purposely designed to efficiently detail what is necessary in order to understand the affected environment and environmental effects related to the alternatives that are evaluated. Many of the subsections of this EIS summarize more detailed information that is discussed in specialist reports which are cited in the subsections. These reports include any information that has become available since the DEIS was released in August 2020. Readers who are interested in reviewing the more detailed information may download the specialist reports of interest from the same website hosting this EIS. The specialist reports that are available include:

- Air Quality Specialist Report (Forest Service 2023a)
- Climate Change Specialist Report (Forest Service 2023b)
- Soils and Reclamation Cover Materials Specialist Report (Forest Service 2023c)
- Noise Specialist Report (Forest Service 2023d)
- Surface Water and Groundwater Quantity Specialist Report (Forest Service 2023e)
- Surface Water and Groundwater Quality Specialist Report (Forest Service 2023f)
- Vegetation: General Vegetation Communities, Botanical Resources, and Non-Native Plants Specialist Report (Forest Service 2023g)
- Wetland and Riparian Resources Specialist Report (Forest Service 2023h)
- Fisheries and Aquatic Habitat Including Threatened, Endangered, Proposed, and Sensitive Species Specialist Report (Forest Service 2023i)
- Wildlife and Wildlife Habitat Including Threatened, Endangered, Candidate, and Sensitive Species Specialist Report (Forest Service 2023j)
- Access and Transportation Specialist Report (Forest Service 2023k)
- Heritage Resources Specialist Report (Forest Service 2023l)
- Recreation Specialist Report (Forest Service 2023m)
- Scenic Resources Specialist Report (Forest Service 2023n)
- Social and Economic Conditions Specialist Report (Forest Service 2023o)
- Special Designations Specialist Report (Forest Service 2023p)
- Tribal Rights and Interests Specialist Report (Forest Service 2023q)

Certain of the environmental resources evaluated in this EIS are essentially unchanged from 2020 so specialist reports were not prepared for these resources, which include: geology, hazardous materials, environmental justice, timber, land use, and public health and safety.

Johnson Creek Road

During non-winter conditions (roads clear of snow), the Operations Area Boundary can be accessed from the City of Cascade by traveling northeast on Warm Lake Road for about 34 miles to Landmark, then north on Johnson Creek Road for approximately 25 miles to the village of Yellow Pine, and approximately 14 miles east on the Stibnite Road portion of McCall-Stibnite Road (Stibnite Road). Johnson Creek Road and the Stibnite Road portion of McCall-Stibnite Road is currently used to access the Operations Area Boundary during the summer.

The Johnson Creek Road is a county maintained, native surface road that is open to vehicles with seasonal restrictions due to snow. During the winter, Valley County plows approximately 10 miles of Johnson Creek Road from Yellow Pine to Wapiti Meadow Ranch and Perpetua (under agreement with Valley County) plows along Stibnite Road. Valley County grooms the remaining 17 miles of Johnson Creek Road from Wapiti Meadow Ranch to Warm Lake Road at Landmark for OSV use. Valley County does not plow Warm Lake Road from Warm Lake to Landmark. This section is a designated groomed OSV route.

McCall-Stibnite Road

The Stibnite Road from the intersection with Johnson Creek Road then east to the mine is also a county-maintained native surface road, open to all vehicles with seasonal restrictions due to snow. This road is plowed in the winter by Perpetua through an agreement with Valley County. Stibnite Road connects to Thunder Mountain Road on the southeastern portion of the Stibnite mine site and currently provides public access through the mine area.

The analysis area can be accessed from McCall during non-winter conditions by traveling east on the Lick Creek Road portion of McCall-Stibnite Road for approximately 37 miles to the East Fork Road portion of McCall-Stibnite Road, then approximately 16 miles to the village of Yellow Pine, and approximately 14 miles east on Stibnite Road. Lick Creek Road is not maintained during the winter; however, East Fork Road and Stibnite Road are plowed from the intersection with SFSR Road to Yellow Pine by Valley County and from Yellow Pine to the Operations Area Boundary by Perpetua to access their private land inholdings in the area. Although the Lick Creek and East Fork roads are not proposed to be used by the SGP, they provide access for other users of the analysis area.

South Fork Salmon River Road

The SFSR Road can be accessed year-round from Cascade by traveling approximately 24 miles northeast on Warm Lake Road to the intersection with SFSR Road. It then travels north for approximately 30 miles to intersect with the East Fork Road portion of the McCall-Stibnite Road. Some segments along SFSR Road have sharp curves which can be challenging for heavy vehicle travel. Although this route currently provides the only access to the Operations Area Boundary during winter months, it is not proposed to be used by the SGP.

3.16.4.3 Existing Stream Crossings

Existing stream crossings along the existing Johnson Creek, Stibnite, and Burnt Log roads are shown on **Figure 3.13-7**. There are 213 existing stream crossings along existing main access roads in the analysis

4.0 ENVIRONMENTAL CONSEQUENCES

4.1 Introduction

Chapter 4 describes the potential environmental consequences of implementing each of the alternatives presented in Chapter 2. Pursuant to 40 CFR 1500.1(b) and 1500.4, this section summarizes the completed analysis and forms the scientific and analytical basis for the comparison of alternatives. The alternatives described in Chapter 2 may cause, either directly or indirectly, changes in the human and natural environment. This EIS analyzes these potential changes and discloses the effects to the decision-makers and the public. Disclosure is a fundamental goal of NEPA. In addition, applicable mitigation measures and irreversible and irretrievable effects also are discussed. Effects of each action can be neutral, beneficial, and/or adverse. Effects are quantified whenever possible, and/or are qualitatively discussed.

The individual resource discussions are generally presented by issue(s) and organized with the presentation of the effects analysis issues and indicators for the resource; a brief methodology for the analysis of impacts; an evaluation of the alternatives' impacts to the resource; irreversible and irretrievable commitments, and short-term uses versus long-term productivity. A table summarizing and comparing these quantitative and qualitative impacts to each resource by alternative is located in **Section 2.8**.

4.1.1 Effects Analysis Indicators and Methodology of Analysis

An issue is defined as a point of concern, disagreement, debate, or dispute with a proposed activity based on some anticipated effect. Issues are described in terms of cause and effect; that is, if an action occurs, an impact could result. Issues are addressed by describing comparative factors that provide a way to define, compare, and contrast the effects of the alternatives, including the No Action.

An indicator is an element or parameter used to determine change (and the intensity of change) in a resource (e.g., acres of wetlands disturbed). These issues and indicators are used to predict or detect change in a resource related to causal effects of the alternatives in Chapter 4 (i.e., environmental consequences).

In addition, the analysis procedures and assumptions used to develop the current conditions and environmental consequences are summarized in this section. Unless specifically stated otherwise, additional supporting information, including detailed analysis procedures and assumptions for each resource area, can be found in the SGP record.

The modeling, analysis, and unit amounts for indicators such as acreage and road miles are all best estimates based on the latest available information. The modeling and analysis conducted for this SDEIS are intended to indicate relative differences among the alternatives, rather than to predict absolute amounts of activities, outputs, or effects.

If none of the action alternatives proceed, the current uses by Perpetua and other users on patented mine/mill site claims and on NFS lands would continue to follow all existing applicable air quality regulations. Uses of NFS lands that may result in air pollutant emissions include mineral exploration, dispersed OHV use, snowmobiling, and other forms of recreation.

4.3.4.2 2021 MMP

Construction and Operations Description

The construction of the 2021 MMP includes building power transmission, access roads, and mining/processing facilities. These operations are to be performed during LOM 1 through LOM 3. Operations would begin in LOM 4 through LOM 18. Access road construction would consist of development of the Burntlog Route for mine access and minor improvements for the Johnson Creek route. Also, while the Burntlog Route is being developed, a temporary groomed OSV trail would be constructed on the west side of Johnson Creek from Trout Creek to Landmark for public access. Other public access construction would be a Cabin Creek Road groomed OSV trail. Eight borrow sources along the Burntlog Route would also be constructed.

During operations, restricted public access through the site would be provided by constructing a new road around the Yellow Pine pit and below the mine haul road to link Stibnite Road to Thunder Mountain Road.

Lastly, operations would include communication towers and an offsite logistics and road maintenance facilities. A cell tower would be located north of the Hangar Flats pit with very high frequency repeater sites. There would also be a communication site at the SGLF with upgrades to the existing site. The Burntlog road maintenance facility would be located approximately 4.4 miles east of the junction of Johnson Creek Road and Warm Lake Road along the proposed Burntlog Route.

Construction and Operations Air Emissions Inventory

Air pollutant emissions were initially estimated for activities and process sources included in the 2021 MMP for each LOM year. The LOM years presented in this discussion are based on years starting with LOM 1 as the first year of construction. LOM 6 is expected to produce the highest overall annual total of criteria pollutant emissions.

Air pollutant emission point sources for the construction phase would include engine-driven generators, portable conical crusher and screens, diesel-fired heaters, and engine-driven air compressors. The fugitive sources related to mine construction and operations would be haul, access, and construction road dust from vehicle travel during the pre-production years, as well as earth-moving equipment, material transfers, storage in several construction stockpiles and development rock piles, tailpipe emissions and exploratory activities. The use of ANFO explosives also would be considered a mine construction phase source, as well as an ongoing operations phase source.

emissions. These process exhaust control technologies are accounted for in the maximum emissions estimates in **Table 4.3-5**:

- Activated carbon regeneration kiln – wet scrubber and activated carbon filter;
- Retort – activated carbon canisters and filter pack; and
- Induction furnaces – baghouse filter and activated carbon filter pack.

Near-Field Analysis NAAQS

Assessment of conformance to the NAAQS is based on the highest receptor concentration in the modeling domain for the pollutants and averaging times corresponding to the standards. The modeled maximum concentration at each receptor is added to the selected background concentrations that represent current existing conditions. If the results from this computation are below the NAAQS, then impacts at other locations in the domain would be below the NAAQS as well.

For NAAQS modeling inputs, the highest emissions of each pollutant during any LOM year were determined and provided in **Table 4.3-6**. For the 2021 MMP, the highest criteria pollutant emissions occur during two different years, LOM 6 (CO, NO_X, and SO_2) and LOM 10 ($PM_{2.5}$ and PM_{10}). Therefore, to capture the highest modeled concentration for each pollutant, separate modeling was performed for LOM 6 and 10 (i.e., two models). Note that VOC emission maximums from LOM 3 were not modeled because there is no specific NAAQS for these emissions, however VOCs are addressed as part of the secondary $PM_{2.5}$ analysis.

Table 4.3-6 LOM Years for Pollutant-Specific Maximum Annual Emissions

Pollutant	LOM Year	SGP Total Annual Emissions (tpy)
CO	6	535.5
NO_2	6	335.2
PM_{10}	10	320.1
$PM_{2.5}$	10	69.2
SO_2	6	7.3
VOC	3	27.4
HAPs	10	8.5
Hg	10	13.3 (lb/yr)

The 2021 MMP would include a 12-foot-wide gravel road to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375) through the SGP. Perpetua received a final PTC from IDEQ on June 17, 2022. This application proposed to exclude the public road on the basis of restricted access and maintaining full control, and that people traveling on the road would be considered "guests of the mine." IDEQ accepted the private road concept proposed by Perpetua (see PTC Condition 2.7, Response to Comments #16 and Statement of Basis on the IDEQ website) and in response to comments on February 18, 2021, also states that the roadway between Stibnite Road at Sugar Creek and Thunder Mountain Road at Meadow Creek was appropriately excluded from ambient air. Additionally, the EPA

Region X has indicated that the access road could possibly be excluded from ambient air if sufficient enforceable measures are taken to comply with the 2019 revised policy (EPA 2019a). Exclusion of the public access road from ambient air protections is a unique case that relies on measures assumed to meet the standards inferred in the 2019 revised ambient air policy. However, a formal EPA policy review of the ambient air boundary for the SGP has not been conducted nor requested. A formal review is not necessarily required. The EPA did provide formal comment on IDEQ's air quality PTC recommending a review be requested by the State and that initial measures in the PTC were too ambiguous to determine compliance with the revised ambient air policy. To comply with this measure, Perpetua has developed a transportation management plan that is included as Appendix D of the Air Quality Specialist Report (Forest Service 2023a).

The AERMOD dispersion modeling results for the 2021 MMP analysis emissions and comparison with the applicable NAAQS are provided in **Table 4.3-7**. The geographic location of the maximum impacts amongst the criteria pollutants and averaging periods between LOM 6 and 10 are provided in Figure 4 of the Air Quality Analysis Addendum ModPro2 (Air Sciences 2021a). The results demonstrate compliance with all NAAQS and would be considered to have a moderate impact locally and minor impact regionally. Additionally, **Table 4.3-8** provides geographic locations of the NAAQS maximums.

Table 4.3-7 Near-Field NAAQS Compliance Demonstration

Pollutant	Averaging Time	Maximum Modeled Conc. (µg/m^3)	Background Conc.[3] (µg/m^3)	Total Impact Conc. (µg/m^3)	NAAQS (µg/m^3)	NAAQS Compliance
CO	8 hours	404.6	1,110	1,515	10,000	Yes
CO	1 hour	495.5	1,740	2,236	40,000	Yes
Lead	3-month rolling	Not Required[1]	Not Required[1]	Not Required[1]	Not Required[1]	Not Required[1]
NO_2	Annual	19.8	0.9	20.7	100	Yes
NO_2	1 hour	129.8	4.3	134.1	188	Yes
O_3	8 hours	3.0	117.7	120.7	137	Yes
PM_{10}	24 hours	15	37.0	51.9	150	Yes
$PM_{2.5}$ [2]	Annual	1.1	3.5	4.6	12	Yes
$PM_{2.5}$ [2]	24 hours	2.7	15.0	17.7	35	Yes
SO_2	1 hour	3.0	12.3	15.3	196	Yes
SO_2	3 hours	1.8	16.8	18.6	1,300	Yes

[1] Lead modeling is not required per IDEQ as the facility-wide emissions are less than 10 percent of the lead significant emission rate of 0.6 tpy and considered "Below Regulatory Concern".
[2] Includes the secondary impacts.
[3] All background concentrations are derived from the NW Airquest data (WSU 2018).

SGP would be slightly less for this alternative. The location of ambient air pollutant concentrations due to vehicle traffic would differ, with such effects being located along the Johnson Creek Route.

Providing public access through the SGP reduces the miles of new motorized trails open to all vehicles in the Meadow Creek IRA, and this is expected to reduce net air quality effects due to vehicles traversing the SGP area.

Several air pollution design features proposed by Perpetua are common to both action alternatives and are described in **Section 2.4.9**. Emission control devices and designs would be put in place to abate emissions of particulate matter, Hg, and criteria pollutant emissions from internal-combustion engines the same as the 2021 MMP. Operational and reclamation air emission impacts for this alternative would therefore be the same as the 2021 MMP.

The stationary facilities would be designed, constructed, and operated with the same air pollution controls as the 2021 MMP to comply with applicable regulations and any air quality permits issued by IDEQ. The PTC includes stipulations for control of airborne dust from vehicle traffic along the Johnson Creek Route that are based on applicable state and federal regulations.

4.3.5 Mitigation Measures

Mitigation measures required by the Forest Service would represent reasonable and effective means to reduce the impacts identified in the previous narrative or to reduce uncertainty regarding the forecasting of impacts into the future. These mitigation measures would be in addition to the Forest Service requirements and EDFs (**Section 2.4.9**) accounted for in the preceding impact analysis.

A number of emission controls and monitoring actions have been proposed by Perpetua in compliance with government requirements. These are described below:

Perpetua would develop a fugitive dust control plan (FDCP) that would address the following at a minimum:

- Procedures followed by Perpetua employees to control and minimize fugitive dust emissions.
- Trigger levels to be set that require corrective action.
- Actions to bring fugitive dust emissions within acceptable ranges.
- Steps to demonstrate that appropriate corrective procedures are followed.
- Procedures to verify that Perpetua is controlling avoidable fugitive dust emissions.

Additionally, the IDEQ permit would include the following control measures proposed by Perpetua for HAP and mercury emissions. The implementation of these requirements was included in the Forest Service's assessment of air quality effects and the Forest Service decision includes implementation of these control measures:

- Mining – chemical dust suppressant and water application on haul roads, reasonable controls, FDCP
- Rock dumps and storage piles - reasonable controls, FDCP

temperatures and reduced stream flows. The SGP area could experience climate change impacts to fish resources and fish habitat by lowering streamflows, increased water temperatures, and decreased water quality which would adversely impact aquatic species and habitat. Process and design modifications, such as rerouting Hennessy Creek, lining the Meadow Creek diversion channel, piping low flows, and the complete backfill of Hangar Flats pit that would improve streamflow and temperature in Meadow Creek, would help to reduce these impacts.

Wildlife and Wildlife Habitat

Climate change impacts to wildlife and wildlife habitat in the SGP area would include habitat loss and fragmentation, physiological sensitivities, and alterations in the timing of seasonal life cycles. Habitat loss and fragmentation may occur in the region and analysis area due to the increased potential for wildfire that is anticipated from changing climatic conditions (Halofsky et al. 2018). Construction and operation of the SGP, access roads, utilities, and off-site facilities would additionally impact wildlife from habitat loss and fragmentation. Reclamation activities are intended to achieve post-mining land use for wildlife habitat as reasonably possible, which would help to reclaim habitat connectivity. However, some displacement and habitat fragmentation would be a long-term effect.

Timber Resources

Timber resources in the SGP area are vulnerable to climate change impacts from changing temperatures and precipitation patterns, increased wildfire frequency and intensity, and insects and disease. Direct effects of climate change on timber (e.g., temperature and precipitation) are likely to be minor, but indirect effects from various disturbances (e.g., increased temperatures and warmer winters causing insect and disease outbreaks) may be significant for the timber industry (Halofsky et al. 2018).

The 2021 MMP would result in ground disturbance in locations currently covered by forested vegetation. Post-closure, disturbed areas would be revegetated. To address losses of vegetation from disturbance, the Reclamation and Closure Plan (Tetra Tech 2021a) proposes to replant with conifer and other tree species, which would be located completely within the Operations Area Boundary. The success of the reclamation could be impacted due to the increased risk to timber from wildfire, insects, and disease due to climate change (American Forests 2017; Halofsky et al. 2018).

Land Use and Land Management

The 2021 MMP would alter land use in areas of new or expanded right-of-way and easements to accommodate access roads, utilities, and off-site facilities. Climate change could also impact how lands in the SGP area are used in the long term, altering the surrounding environment (e.g., decreasing ground cover, larger wildfire burn areas, decreased stream flows impacting how the area is used for recreational or tribal purposes) and impacting accessibility. Land management effects caused by the SGP are not expected to be noticeably impacted by climate change.

Access and Transportation

Access to and through the Operations Area Boundary would be maintained during construction, operation, and closure and reclamation. There would be public access through the Operations Area Boundary during construction and operations via a new gravel road constructed to connect Stibnite Road

to Thunder Mountain Road. Climatic changes causing an increase in severe events, such as floods, landslides, and avalanches, can add stress to roadways and other infrastructure, which may result in more frequent maintenance and repairs.

Heritage Resources and Tribal Rights and Interests

The 2021 MMP could impact historic properties, due to ground and visual disturbance in the SGP area. Changing climatic conditions are expected to exacerbate the damage and loss of heritage resources and natural areas utilized by tribes for activities such as hunting, fishing, and gathering in the SGP area through increased soil erosion, more frequent and intense wildfires, flooding, degraded water quality, and wildlife and fish habitat impacts.

Public Health and Safety

Climate change impacts to public health and safety would be experienced through impacts to air, soil, and water quality. The 2021 MMP has the potential to impact public health and safety through the transportation and use of fuels and chemicals, natural environmental hazards, economic impacts, changes to public services and infrastructure, and impacts to the local population.

Climate change could exacerbate some impacts to public health and safety by affecting the way potential hazardous material spills enter the environment. It also could increase the frequency and amplify the impacts of natural hazards such as avalanches and landslides, flash floods, and wildfires (Halofsky et al. 2018). More extreme heat days and higher temperatures over time could increase air quality and health risks over both the short and long term, impacting the public and the employees' abilities to work (Runkle et al. 2017).

Recreation

Much of the SGP area is used for recreation year-round, which would be both directly and indirectly impacted by climate change. The 2021 MMP has the potential to impact recreational access, recreation facilities, dispersed recreation areas, special use permits, recreational motorized travel, and recreation use. Direct impacts from climate change would include variable precipitation and rising temperatures, which could affect individual decisions to recreate in a certain area. Indirect impacts from climate change would be experienced through the changing conditions that may alter the recreation facilities, opportunities, and setting.

Changing climatic conditions could alter the ecological conditions that affect the quality of the recreation experience, including warmer water temperatures, decreased streamflow, and habitat loss and fragmentation. In the Rocky Mountain region, it is expected that snow-based activities (skiing, snowmobiling) would be impacted negatively by climate change due to warmer winters (Halofsky et al. 2018). Primitive area use, horseback riding on trails, motorized water activities, birding, hunting, and fishing in the region also are expected to be negatively influenced by climate change; however, longer periods of warmer temperatures are expected to increase participation in warm-weather activities such as water recreation and hiking (Askew and Bowker 2018).

the area, as some species sensitive to human presence may not return to the area for years after the mine is closed, resulting in a minor, permanent, and localized impact.

The 2021 MMP components that would affect the Idaho Wilderness Company operating area during closure and reclamation would be similar to those described for construction and operations. The loss of cellular coverage on portions of the analysis area may impact customer safety in the SGP but would aid in returning primitive recreation experiences to the FCRNRW areas in the Idaho Wilderness Company operating area. Providing public access through the SGP after closure and reclamation would restore the ability for the Idaho Wilderness Company to reach portions of their operating area without a detour. Displacement of permitted use may continue past reclamation due to permanent changes in the recreation setting within the Operations Area Boundary and potential changes to wildlife present in the area, as some species sensitive to human presence may not return to the area for years after the mine is closed, which would result in a minor, permanent, and localized impact.

Closure and reclamation of all 2021 MMP components would affect the Juniper Mountain Outfitters operating area either directly or indirectly due to recreation displacement from other areas. The ability of Juniper Mountain Outfitters to access their operating area, provide IOGLB licensed activities, and the quality of recreation experiences for customers participating in guided activities near these components may be impacted during closure and reclamation due to noise and reclamation activity. Displacement of permitted use may continue past reclamation due to the changes in the recreation setting in the Operations Area Boundary, and potential changes to wildlife present in the area, as some species sensitive to human presence may not return to the area for years after the mine is closed, which would result in a negligible, permanent, and localized impact.

There are no 2021 MMP components that would impact the North Shore or Warm Lake Lodges, Warm Lake Camp, YWAM, or Warm Lake recreation residence tract during closure and reclamation; therefore, no impacts are anticipated.

Winter use of the Cabin Creek Road OSV route during closure and reclamation would continue to impact the Paradise Valley recreation residence tract as described for construction and operations.

Travel Management Rule

The reroute of Stibnite Road and the designation of a temporary OSV route to replace an existing OSV route are actions that fall under the Travel Management Rule (36 CFR 212), Subparts B and C, respectively (FSM7715.03(5)). These actions require consideration under the Travel Management Rule Minimization Criteria (36 CFR 212.55(b)). The responsible official shall consider the effects on the following, with the objective of minimizing:

- Damage to soil, watershed, vegetation, and other forest resources;
- Harassment of wildlife and significant disruption of wildlife habitats;
- Conflicts between motor vehicle use and existing or proposed recreations uses of NFS lands or neighboring federal lands;
- Conflicts among different classes of motor vehicle uses of NFS lands or neighboring federal lands; and,

- Compatibility of motor vehicle use with existing conditions in populated areas, taking into account sound, emissions, and other factors.

Table 4.19-3 describes where the Travel Management Rule criteria were addressed in the EIS.

Table 4.19-3 Criteria for Designation of Roads, Trails, and Areas Review

Criteria	Section of EIS Addressing Criteria	Applicable Screening Criteria
General Criteria 36 CFR 212.55(a)		
NFS natural and cultural resources, public safety, provision of recreation opportunities, access needs, conflicts among uses of NFS lands, the need for maintenance and administration of roads, trails, and areas that would arise if the uses under consideration are designated, and availability of resources for maintenance and administration.	Sections 4.17, 4.18, 4.19, 4.16, and 4.15	Heritage resources, public health and safety, recreation, access and transportation, land use and land management.
Consider combinations of uses (such as motorized and non-motorized, different vehicle classes, and highway-legal and non-highway-legal vehicles).	Section 4.16	Access and transportation.
Minimization Criteria 36 CFR 212.55(b)		
Damage to soil, watershed, vegetation, and other forest resources.	Sections 4.5, 4.8, 4.9, 4.10, and 4.14	Watersheds and water resources, soils, vegetation, and other forest resources
Harassment of wildlife and significant disruption of wildlife habitats.	Section 4.13	Wildlife and TES Wildlife
Conflicts between motor vehicle use and existing or proposed recreation uses of NFS lands or neighboring federal lands.	Sections 4.16 and 4.19	Recreation conflict. Motor vehicle conflict and compatibility
Conflicts among different classes of motor vehicle uses of NFS lands or neighboring federal lands.	Section 4.16, the Transportation Management Plan, EDFs (Table 2.4-13), and Forest Service Requirements (Table 2.4-12)	Motor vehicle conflict and compatibility Road engineering geometry and criteria.
Compatibility of motor vehicle use with existing conditions in populated areas, taking into account sound, emissions, and other factors.	Section 4.23, the Transportation Management Plan, EDFs (Table 2.4-13), and Forest Service Requirements (Table 2.4-12)	Designated areas, special designations, or potential special designations. Rights of access.

The 2021 MMP considered the minimization criteria for the reroute of Stibnite Road through the mine site and the temporary relocation of the Warm Lake OSV route to Cabin Creek Road and west of Johnson

Creek Road. Damage to soil, watershed, vegetation, and other forest resources was analyzed by determining if the routes intersect with impaired watersheds, wetlands, riparian areas, high-risk flood hazard areas, soils having erosion potential, and riparian vegetation communities.

4.19.2.3 Johnson Creek Route Alternative

The Johnson Creek Route Alternative is similar to the 2021 MMP, with the main differences that affect recreation consisting of use of the Johnson Creek Route for access to the mine for all phases (no construction or use of the Burntlog Route); a change in the location of the Landmark Maintenance Facility; and use of helicopters for construction and maintenance of cell towers and repeater sites in IRAs managed for backcountry/restoration. These changes would result in different impacts than the 2021 MMP, particularly the use of the Johnson Creek Route.

Recreation Opportunities, Facilities, Access, and Use

Construction and Operations

Impacts of the Johnson Creek Route Alternative during construction and operations would be the same as those described under the 2021 MMP, except for those described below. The Burntlog Route and Burntlog Maintenance Facility would not be constructed under the Johnson Creek Route Alternative; therefore, there would be no construction impacts related to those facilities.

Johnson Creek Route

Year-Round

Use of Johnson Creek and Stibnite roads as the route to the Operations Area Boundary during construction, operations, and reclamation and closure would result in impacts to the recreation setting of the existing recreation sites/areas along these roads due to increased noise, traffic, and safety-related issues from mine-related traffic (Forest Service 2023d, 2023k), leading to a change in recreation experiences for some visitors. Traffic on Johnson Creek and Stibnite roads would substantially increase (almost two times the current traffic conditions, respectively), thereby increasing the noise and activity near campgrounds and trailheads adjacent to these roads. Impacts are anticipated to be moderate, short-term, and localized.

Recreation facilities affected by the increase in traffic and traffic noise would include Burntlog and Quartz Creek Trailheads; Buck Mountain, Trout Creek, Ice Hole, Golden Gate, and Yellow Pine Campgrounds; Twin Bridges dispersed camping area; and Johnson Creek Cabin. The recreation setting of these facilities would be altered to a more developed setting due to an increase in the sights and sounds of humans, which would displace recreationists to avoid noise associated with activities and traffic along Johnson Creek and Stibnite roads, particularly recreationists participating in non-motorized activities. Motorized users who use Johnson Creek and Stibnite roads for recreation also may be displaced due to the increased traffic along the roadways. Wildlife-related recreation opportunities also would decrease along these roadways due to wildlife displacement from traffic and noise. This impact is anticipated to be minor, short term, and localized.

During construction, there would be periodic temporary road closures on Johnson Creek Road that would result in reduced access to recreation sites/areas, reduced recreation opportunities, reduced use due to a lack of access, and impacts to recreation experiences due to visitor expectations regarding site/area availability. Impacts from road closures would affect recreation sites/areas along Johnson Creek Road, as well as sites, trails, and areas accessed from this main route. Impacts would persist throughout construction and are anticipated to be moderate, short term, and localized. There also would be daily closure of Stibnite Road for most of the middle of the day during mine construction that would result in reduced access to recreation sites/areas off Stibnite Road and Thunder Mountain Road, reduced recreation opportunities and use due to temporary reductions in access and impacts to recreation experiences due to delays in reaching destinations. Impacts from road closures would affect recreation sites/areas along Stibnite Road, as well as sites, trails, and areas accessed from this main route, particularly sites off Thunder Mountain Road. Depending on where the closure started on Stibnite Road, access to the Big Creek area north of the mine also may be affected. Impacts would persist throughout the mine construction period and are anticipated to be moderate, short term, and localized.

Although Stibnite Road would be open for public access as part of the Johnson Creek Route, the Stibnite Mining District Interpretive Site would not be available for public use, because it would be within the Operations Area Boundary where no public use would be allowed. This impact is anticipated to be moderate, long term, and localized.

The Yellow Pine Escapades are Special Use Permit ATV and UTV events that frequently use Johnson Creek and Stibnite roads in addition to varying Forest Service trails based on the event type. The Yellow Pine Escapades are hosted by the Yellow Pine Community Hall Committee as fundraising events for the community hall maintenance (Yellow Pine Escapades 2022) and may include stops at interpretive sites for educational purposes. Increased traffic on Johnson Creek and Stibnite roads, decreased trail access due to road closures, and the closure of the Stibnite Mining District Interpretive Site are anticipated to have a moderate, long-term, and localized impact on these recreational events.

Impacts during construction and operations would be the same as under the 2021 MMP because Johnson Creek and Stibnite roads would continue to be used as the main access roads into the Operations Area Boundary and would require periodic road maintenance activities. AADT for these roads would be lower during operations than described under construction, but within 15 vehicles, thus resulting in similar impacts described under construction; however, impacts due to temporary closure of Johnson Creek and Stibnite Roads would not occur during operations. Fish adjacent to the Johnson Creek Route may be affected by increased sediment and could be affected if a spill were to occur. While there may be injury or mortality to individual fish, population-level effects are not expected (**Section 4.12**). There may be decreased fishing success immediately along the Johnson Creek Road, but there would continue to be opportunities for fishing within the creeks in the adjacent areas. Operational impacts from the Johnson Creek Route to fishing recreation would be minor, long term, and localized.

Winter

Impacts during construction and operations from the plowing of Johnson Creek Road would be similar to those described for construction under the 2021 MMP; however, the groomed OSV route parallel and along the western side of Johnson Creek Road would run from Trout Creek Campground to Landmark (approximately 8 miles) under the Johnson Creek Route Alternative. The Ditch Creek Road infrequently

groomed OSV route would be inaccessible as it is north of the Trout Creek Campground on the closed OSV route between the campground and Wapiti Meadows. The new groomed OSV route along Johnson Creek Road would remain through operations and closure/reclamation under the Johnson Creek Route Alternative as the Johnson Creek Route would be used throughout the life of the SGP. Therefore, impacts from the plowing of Johnson Creek Road under the Johnson Creek Route Alternative are anticipated to be minor, long term, and localized.

Public Access

Road closure impacts on the Johnson Creek route would be the same as those described under the 2021 MMP, except impacts to recreation access, use, and opportunities along Thunder Mountain Road would begin during construction and continue until the public access road through the Operations Area Boundary was complete and open to public use to provide access to the Thunder Mountain area. Construction under the Johnson Creek Route Alternative is expected to take 2 years longer than the 2021 MMP.

The impacts to public access through the Operations Area Boundary would be the same as under the 2021 MMP. The public access road would provide access to recreation sites/areas via Thunder Mountain Road; therefore, the access road would allow continuous access to the Thunder Mountain Road sites/areas. However, as described under the 2021 MMP, there would be temporary closures of this route during some mining activities that would result in minor, short term, and localized impacts to recreation.

Landmark Maintenance Facility

The Landmark Maintenance Facility would be located approximately 0.1 mile south of Landmark and the historic cabins located there. Access to the maintenance facility would be off Warm Lake Road. There would be no delays or additional traffic along Warm Lake Road in this area since the Burntlog Route would not be constructed, but rather from all construction-related traffic using Warm Lake Road to Johnson Creek Road. It is assumed that construction equipment would travel east on Warm Lake Road; therefore, delays would likely affect access to Horn Creek Road, Rec Spur 579U2, 450 South, and Burnt Log Road, which are east of the maintenance facility site. This impact is anticipated to be moderate, short term, and localized.

Noise associated with construction activities could reduce opportunities for noise-sensitive recreation activities at and around the maintenance facility location (up to 1.1 miles away) (AECOM 2019c), including wildlife-related recreation activities, because wildlife may be displaced. Construction activities would not affect use of the historic cabins; however, construction noise at the site may affect the recreation setting of the cabins, because it may be audible from the cabin sites. Some recreationists may choose to visit other areas or sites to avoid delays or noise from construction activities. Any reduction in recreation opportunities, displacement of dispersed recreational use, or changes in access would be temporary until maintenance facility construction was completed. These impacts would be minor, short term, and localized.

Development of the Landmark Maintenance Facility would reduce recreation opportunities due to physical removal of acreage for the facility (3.5 acres). Traffic due to maintenance activities and vehicles would not be expected to result in frequent traffic delays on Warm Lake Road but may result in

Appendix B

Response to Public Comments on the SDEIS and Response to Public Concerns on the 2020 DEIS

Author	Comment Letter	Comment Number	Comment	Comment Category	Comment Response
			for our organizations, given the location of these proposed routes, is the impact that each route will have on wildlife populations and on roadless characteristics. The SDEIS does not even mention that there are requirements the Forest Service must abide by when designating ORV routes, including groomed snowmobile trails, much less apply these requirements to the proposed new routes. The Forest Service must explain how taking actions that could dramatically increase OSV use on the Cabin Creek Road and along Johnson Creek will satisfy the requirement to minimize harassment of wildlife or significant disruption of their habitat. If these routes cannot be located in a manner that complies with the minimization criteria, they cannot be designated. The Forest Service's assertion that these trails can be authorized under 36 CFR 228A as part of a plan of operations246 is incorrect. Access and infrastructure for recreation is not necessary to conducting mine operations. Designating routes for recreational use and access falls squarely under the Travel Management Rule. While the Forest Service can certainly designate routes for this purpose as part of the Stibnite Gold Mine NEPA analysis, it must apply the requirements of the Travel Management Rule when doing so.		
Bonnie Gestring (Northwest Program Director, Earthworks) and seven others	17634	221	The SDEIS fails to discuss in any way what impact the proposed OSV route along Johnson Creek will have. Because the Payette National Forest has not conducted winter travel management planning in accordance with Subpart C of the Travel Management Rule, it cannot assume that its existing system of OSV routes and areas comply with this Rule. The forest must apply the OSV Rule when designating new OSV routes in association with this project, even if the new routes are temporary or are adjacent to an existing route. Therefore, even though the Johnson Creek route will parallel an existing OSV route (the Johnson Creek road), the Forest Service cannot assume that a) the impacts of this route are the same as the existing route or b) that the existing route complies with the Travel Management Rule.	REG	The reroute of Stibnite Road and the designation of a temporary OSV route to replace an existing OSV route are actions that fall under the Travel Management Rule (36 CFR 212), Subparts B and C respectively (FSM7715.03(5)). These actions require consideration under the Travel Management Rule Minimization Criteria (36 CFR 212.55(b)). The Travel Management Rule analysis was added to Section 4.19 of the Final EIS.
Bonnie Gestring (Northwest Program Director, Earthworks) and seven others	17634	225	As recounted elsewhere, this violates the Idaho Roadless Rule and the Forest Plan. The added recreational pressures on this area are in no way related to mining activities and would make the mining impacts on ecological integrity even worse instead of mitigating them. As such, the Forest Service should make as few changes in existing recreational access as possible and not expand motorized use unless necessary. The Forest Service and Perpetua should continue to allow public access through the Stibnite Operational Area on to Thunder Mountain, with a new route sited through the project area to avoid mining operations. As noted elsewhere, we believe that this is a public road and that Perpetua and the Forest Service need to utilize the normal ambient air quality standards for members of the public on this route. To manage public expectations and avoid delays, we recommend that Perpetua and the Forest Service have a web page describing the estimated schedule and potential closure times for each day and week.	REG	The proposed public access road through the operations area would avoid interaction with mining activities. The EPA and IDEQ agree that the public access road through the proposed mining operations area would be under the control of Perpetua while mining is in progress. They have concluded that ambient air quality standards would not apply to the road during this time. The recommendation for up-to-date scheduling of when public access might be interrupted on certain roads has been included in the EIS as a mitigation measure.
Bonnie Gestring (Northwest Program Director, Earthworks) and seven others	17634	379	CC. Additional Review of State Regulations Needed In the SDEIS, the Forest Service consistently defers to the state of Idaho on issues involving the management of federal lands and the effects on public resources. In many instances, the Forest Service assumes to some degree that various state processes have sufficiently addressed key resource issues associated with the SGP. However, these state rulemaking and permitting processes may actually have fewer safeguards in place to protect taxpayers, public health, water quality, fisheries and wildlife compared to NEPA and other federal laws. Perpetua Resources has been closely involved in several recent state rulemaking and permitting processes that will impact the SGP. These include the Idaho Department of Lands rulemaking regarding financial assurances and cyanidation regulations, and Idaho Department of Environmental Quality's air quality permit. In each of these instances, the mining company successfully reduced the permitting requirements or safeguards for key elements over the objections of conservation organizations and others. Groups like the Idaho Conservation League had pointed out that the new proposed rules and permits are less protective than regulations in other states. The federal government was not directly involved in the rulemaking processes or air quality permitting, but the EPA did comment on the final draft of the state air permit expressing significant concerns.	REG	This comment suggests that the Forest Service is deferring to state regulatory programs for the environmental analysis. This is not correct. The SDEIS clearly identifies the state regulatory programs that would apply to the Proposed Action and where the state has created certain environmental standards that would apply to the project these have been included in the EIS. The Forest Service has not deferred the necessary hard look at the environmental impacts required under NEPA and has required Perpetua to provide separate environmental documentation to support the NEPA analysis separately from what they may prepare for the state agencies. An example of this is discussed in Section 4.3 of the SDEIS where separate air emission inventory and air quality impact modeling was required by the Forest Service to support its evaluation of the reasonably foreseeable impacts as required under NEPA. The Forest Service NEPA air impact evaluation included impacts from fugitive dust emission as well as off-site vehicle emissions.

REC 7430

Author	Comment Letter	Comment Number	Comment	Comment Category	Comment Response
Small, Nathan (Chairman, Fort Hall Business Council, Shoshone-Bannock Tribes)	18903	26	Please consider using FR 440 as a route off of the Johnson Creek road and into the mine area, completely avoiding the Stibnite Road and the town of Yellow Pine.	ACC	The two alternatives analyzed in the SDEIS include the 2021 MMP, which would involve construction and use of Burntlog Route from Warm Lake Road to access the Operations Area Boundary, and the Johnson Creek Route Alternative, which would involve access to the Operations Area Boundary via Johnson Creek Road connecting to Stibnite Road from the Town of Yellow Pine. These two alternatives were deemed as the most environmentally, economically, and technically feasible to carry forward for analysis in the SDEIS. Other potential identified transportation and access road alternatives that were considered but eliminated from detailed analysis are discussed in Section 2.6.4.
Michael Gibson (Trout Unlimited), Aaron Lieberman (Idaho Outfitters & Guides Association), Garret Visser (Idaho Wildlife Federation)	18871	13	We are concerned about the dramatic changes to public access proposed in the SDEIS. Increases in motorized use seem inevitable and the risk for illegal use could have major impacts to both the roadless character of the area and wilderness characteristics found in the Burntlog, Black Lake, Meadow Creek and Horse Heaven Inventoried Roadless Areas, all of which are classified as Backcountry Restoration under the Idaho Roadless Rule. Additionally the close proximity of the Burnt Log route could affect wilderness characteristics in the Frank Church - River of No Return Wilderness area. The SDEIS proposes closing 14,221 acres of public access in the project area. These acres provide important public access for outdoor pursuits, such as hunting and fishing, and we question why the closure area proposed is so large.	ACC	The comment expresses concern first about the increase in access and that it may lead to increased motorized use. In Section 4.16 of the SDEIS, it is discussed that there would be an overall increase in road traffic that varies slightly between the 2021 MMP and the Johnson Creek Route Alternative. The concern in the comment is that motorized access that doesn't exist now, specifically the Burntlog Route, would have a detrimental impact on the area. The impacts associated with the Burntlog Route are discussed in relation to the Alternatives in the SDEIS (Section 4.16.2). Upon completion of construction, the Burntlog Route would provide main access to the SGP. Upon closure, the Burntlog Route would be returned to current existing conditions, including reclamation of newly constructed segments where it does not currently exist. Further the comment expresses concern about public access restrictions, which would be anticipated more so during mine construction. Public access would not be allowed on the newly constructed Burntlog Route segments; therefore, the public would need to utilize the public access route through the mine site to connect to Thunder Mountain Road once constructed. Public access would be reduced by road closures from half-day to multiple days during construction on the Stibnite Road, east of Yellow Pine.
Michael Gibson (Trout Unlimited), Aaron Lieberman (Idaho Outfitters & Guides Association), Garret Visser (Idaho Wildlife Federation)	18871	14	While the Idaho Roadless Rule does not prohibit road building in roadless as needed for access to claims related to the Mining Law of 1872 (36 CFR 294.25 (b)), the question of whether the proposed Burntlog route can be accessed by the public or be closed to administrative use only falls to general mining laws and should be considered by the USFS before approving this alternative. Additionally, any new claims for mineral development (i.e. gravel pits) within the four roadless areas affected by this alternative would seem to run contrary to restrictions to new mineral development set forth in the Idaho Roadless Rule for areas designated as Backcountry Restoration. Further, we have serious concerns about impacts to roadless characteristics that a road of this length and size will have if used for mining and/or public travel for the life span of the project. Additionally, the opportunity exists for the illegal pioneering of routes in such a remote area without a serious enforcement presence.	ACC	A mitigation measure has been added to the EIS regarding public use restrictions for newly constructed segments of the Burntlog Route. After construction is completed, public use would be allowed on Burntlog Route only when other public access roads are blocked by mine operations per 36 CFR 261.13 for public use exceptions. Impacts to special designation areas, including Idaho Roadless Areas, are fully analyzed for all alternatives under Section 4.23 of the SDEIS.
Michael Gibson (Trout Unlimited), Aaron Lieberman (Idaho Outfitters & Guides Association), Garret Visser (Idaho Wildlife Federation)	18871	15	The Johnson Creek route parallels Johnson Creek, a known bull trout stronghold. While disturbances to roadless character associated with the Burntlog route are not preferable, the Johnson Creek route could prove deleterious to resident bull trout. The SDEIS seems to downplay the risks of spills and sediment load associated with needed road improvements, would impact bull trout that are using this stream.	ACC	The 2021 MMP utilizing the Burntlog Route is the agency preferred alternative. As stated in the SDEIS Section 4.7.2, the use of the Johnson Creek Route rather than construction of the Burntlog Route would increase the risk of spills and sedimentation in Johnson Creek and the East Fork SFSR, as analyzed for fish resources and fish habitat in Section 4.12 and 5.12.
Jolie Drake	18929	5	Along with on-site use, the transportation of hazardous material is dangerous. The supply and export of mining materials will use the only rural road that accesses the mine: a narrow, treacherous 50-mile stretch of road that sits directly adjacent to the EFSFSR. The project estimates half a million round trips on this road, with many trucks requiring a HAZMAT vehicle escort, where even one spill into the river just feet away could sterilize all life for the foreseeable future.	ACC	The Project includes development of a new mine access route, the Burntlog Route, to limit the amount of traffic and material transportation adjacent to the East Fork SFSR.

REC 7431

Author	Comment Letter	Comment Number	Comment	Comment Category	Comment Response
Alan Haslam (Vice President, Permitting, Perpetua Resources Idaho, Inc.)	19325	104	Proposed (new) to be plowed: "***2021 MMP:*** *Burnt Log Road – 21 miles (currently groomed). Burnt Log Road Extension – 15 miles (proposed new).* " "***Johnson Creek Route Alternative:*** *Johnson Creek Road – 17 miles (conversion of existing OSV portion of Johnson Creek Road).* " Should include 8 miles of Warm Lake Rd between Warm Lake and Landmark. Please review and revise.	ACC	Revision complete.
Alan Haslam (Vice President, Permitting, Perpetua Resources Idaho, Inc.)	19325	105	"***Burnt Log Road*** *(plowed).* *Mine site public access during operations (not plowed).* ***Loss of winter groomed OSV trail on Warm Lake Road to Landmark. Loss of winter groomed OSV trail on Johnson Creek Road from Wapiti Meadows to Trout Creek campground during construction of Burntlog Route.*** " "**Burnt Log Road**" should read "**Burntlog Route**". These two statements about OSV losses (for both MMP and JCR alt) fail to describe how these losses will be mitigated, i.e. new OSV routes along CC and the west side of JC Rd to maintain access to Landmark. Should also include that as part of the MMP that following construction JC Rd will be groomed again between Landmark and Wapiti. Please review and revise.	ACC	Table 2.8-1 of the SDEIS provides only a summary of the comparison of impacts under the three alternatives analyzed. Environmental protection measures and mitigation for these losses is described in full and analyzed in Section 4.16 of the SDEIS. Revision to "Burntlog Route" complete.
Alan Haslam (Vice President, Permitting, Perpetua Resources Idaho, Inc.)	19325	106	"***2021 MMP:*** *Forest Service = no change; Valley County = 2.2 miles; State = no change; Private = 13.5 miles (with an additional 4 miles through the SGP)* " "***Johnson Creek Alternative Route:*** *Forest Service = no change; Valley County = 2.2 miles; State = no change; Private = 4 miles through the SGP* " Please provide the source for this information as it differs from what is presented in Chapter 4.	ACC	Section 4.16 of the SDEIS states that a permanent service road through the backfilled Yellow Pine pit would be established for public access, which would result in a total of approximately 2.2 additional miles of new road that would be accessible for public use following reclamation. This section also states that approximately 13.5 miles of new private access roads would be created during the life of the mine.
Alan Haslam (Vice President, Permitting, Perpetua Resources Idaho, Inc.)	19325	677	"***Access and Transportation*** " Access and transportation direct and indirect effects include air, water and rail. Please included in this subsection.	ACC	Text explaining cumulative effects on other modes of transportation has been added to the cumulative analysis.
Alan Haslam (Vice President, Permitting, Perpetua Resources Idaho, Inc.)	19325	678	"*The contribution to traffic volumes of the action alternatives which include traffic generated from the reconstruction of the transmission line combined with these projects would likely have a greater cumulative effect on the* ***roadways closer to the SGP*** . " Please clarify if there is an assumption that other projects will use Burntlog Route for access.	ACC	The text has been clarified to note that this assumption does include the Burntlog Route, given that the Burntlog Route would allow for public access when other routes are not available, despite that it would be constructed as a temporary road that is necessary for mining purposes.
Alan Haslam (Vice President, Permitting, Perpetua Resources Idaho, Inc.)	19325	679	"*The ASAOC (EPA 2021) (Table 5.1-3) would be additive to anticipated SGP traffic.* " ASAOC precedes SGP , which means it would not be temporally additive. ASAOC is also part of the No Action, in which it is additive to Golden meadows exploration and other geotech programs, NOT the SGP. Please revise.	ACC	Because the ASAOC is considered a Reasonably Foreseeable Future Action as an authorized project that is anticipated to be constructed between 2022 through 2025 (Table 5.1-2 and 5.1-3), impacts of such would be additive to the SGP and is therefore considered a cumulative effect under all alternatives.
Alan Haslam (Vice President, Permitting, Perpetua Resources Idaho, Inc.)	19325	680	"*Projects that are currently undergoing reclamation or will in the future* ***would likely*** *cause further damage to any historic properties in the area. These projects would likely be closed, which involves the removal of some of the infrastructure and reclamation of the land to restore native wildlife and plant habitats that are important to Native American tribes.* ***However, mature forest types wouldn't be available for decades.*** *Several CERCLA Removal Actions were conducted by the Forest Service, EPA, and Exxon-Mobil Corporation. These actions also can impact historic properties by removing*	ACC	Revision complete.

REC 7432

Author	Comment Letter	Comment Number	Comment	Comment Category	Comment Response
			submitted to Idaho Transportation Department and Valley County as recently as September 2020 as needing safety improvements to accommodate the turning geometry of their large vehicles. These concerns are not addresses in the DSEIS.		accessible via the SH 55 and Warm Lake Road intersection, were carried forward for the analysis in the SDEIS (2021 MMP Burntlog Route and the Johnson Creek Route Alternative). Perpetua would commit to meeting the ITD requirements for SH 55.
Ruth Lewinski	19378	9	A significant increase in traffic is also anticipated. For all road sections, it was unclear if/how Perpetua would be contributing for the burden of increased heavy truck traffic along any of the roadways they will be using.	ACC	Under the 2021 MMP, delivery of materials to the SGP would be planned in advance with established dates and times; therefore, vehicle traffic outside the Operations Area Boundary would likely occur between 5:00 am and 7:00 pm (daylight hours) everyday resulting in approximately five mine-related vehicles traveling on the Johnson Creek Route per hour during the two years the Burntlog Route is constructed. Overall, there would be less mine-related traffic on the road during operations than during construction; however, the driver experience would still be noticeably different than existing conditions with an increase in mine-related heavy vehicles and slower travel times. Similarly, during closure and reclamation, hauling materials would be planned in advance with established dates and times; therefore, vehicle traffic outside the Operations Area Boundary would likely occur between 5:00 am and 7:00 pm (daylight hours) resulting in approximately two mine-related vehicles traveling on the Burntlog Route per hour during closure and reclamation. The more traveled roadways would have a less noticeable change in daily traffic.
Jesse Lutz	19386	11	Average daily traffic counts are not available in the DEIS (or SDEIS). There should be data available on this subject within the document. Road counter data would show current user trends on country and forest service roads within the analysis area. It could also be used in reference to the use proposed on new or improved routes in the analysis area.	ACC	AADT is provided for the SGP access roads within the access and transportation analysis area, provided in Section 3.16 of the SDEIS. AADT increases under the 2021 MMP and the Johnson Creek Route Alternative are provided in Section 4.16 of the SDEIS.
Bonnie Gestring (Northwest Program Director, Earthworks) and seven others	17634	158	The Stibnite Gold Project also represents an activity that is not covered by the South Fork Salmon River Road EIS or Biological Opinion and needs to be analyzed for Forest Plan compliance and cumulative effects. The Burntlog Route will likely be impassable for periods of time in winter. Such closures are reasonably foreseeable and should not constitute an emergency and allow for a time-critical, emergency, or weather-related excuses to haul hazardous chemicals down the South Fork Salmon River Road. Instead, the Forest Service should ensure that the Johnson Creek Route is available as an alternative. In addition, the SGP should be designed from the beginning to factor in extensive and multiple delays in transporting materials as a normal part of its winter operations. The Forest Service needs to verify that transportation of hazardous materials, including diesel fuel, will not be allowed at any time on the South Fork Salmon River Road.	ACC	The Burntlog Route and the Johnson Creek Route Alternative are the only two action alternatives analyzed in the SDEIS. All previously analyzed and/or considered alternatives have not been carried forward for analysis (SDEIS Section 2.6). The 2021 MMP (Burntlog Route) is the preferred alternative as it would be the safest alternative for both the human and wildlife environment. Under the 2021 MMP, the Johnson Creek Route would be utilized during the 2 to 3 years of construction for the Burntlog Route, and those improvements would remain during the life of the mine. Further, the 83-mile South Fork Salmon River Route would not be used as access to the SGP (SDEIS Section 4.16.2).
Bonnie Gestring (Northwest Program Director, Earthworks) and seven others	17634	166	To begin, the SDEIS is unclear about whether the Stibnite Road between Yellow Pine and the mine site will be maintained year-round as an alternative ingress/egress even if the Burntlog Route is chosen for primary mine site access. As discussed below, due to location and elevation, the Burntlog Route may be impassable for days to a week or more during winter/early spring. Indeed, the Burntlog Route would be the second highest road in the state of Idaho that is maintained year-round. And unlike Galena Summit on State Highway 75, the Burntlog Route travels for 30 miles over 7000 feet and 10 miles over 8000 feet in an area that receives twice the annual snow water equivalent as Galena. Alternate access, such as the Johnson Creek Road from Warm Lake to Yellow Pine and the Stibnite Road between Yellow Pine and the mine site, to allow for emergency services or uninterrupted mining operations, may be necessary.	ACC	Comment noted. Refer to Section 4.16.2 of the SDEIS regarding the Stibnite Road maintenance agreement, wherein it is stated that the existing maintenance agreement with Valley County would continue.
Bonnie Gestring (Northwest Program Director, Earthworks) and seven others	17634	186	Encouraging public motorized use along these routes may also reduce the opportunities for non-motorized recreation in the area. As such, we recommend that these routes remain closed to public motorized vehicle access, and that Perpetua and the Forest Service provide a more thorough description of measures to prevent unauthorized use, with Perpetua committing to compensate Idaho Power for additional gates and outreach, education and enforcement costs related to restricting access to these routes. The upgraded and newly constructed transmission lines may dramatically increase the amount of unauthorized motorized vehicle use and associated negative impacts, including human-caused wildfire ignitions. Additional outreach and education regarding travel management plans will help keep OHVs on designated routes and slow weed expansion. As part of this effort, we recommend partnering with user groups to help educate users on open routes. Signs and informational kiosks with maps should be placed	ACC	A mitigation measure has been added to the revised EIS describing public use restrictions for the newly constructed segments of the Burntlog Route. Under the 2021 MMP, there would be a public access route through the SGP during the operations, and closure and reclamation phases, however, public access would be intermittently interrupted during the construction phase. Public access through the SGP would provide motorized access to Thunder Mountain Road. Under the Johnson Creek Route Alternative, public access on Johnson Creek Road would be completely restricted for one full year during the first year of construction due to improvements to Johnson Creek Road. Periodic lane restrictions and appropriate signage would be posted to notify motorized vehicle users of construction activities and electronic signage and automated timed stoplights would be present at points of public access to inform the public of seasonal and temporary closures.

REC 7433

Author	Comment Letter	Comment Number	Comment	Comment Category	Comment Response
			at all trailheads and staging areas that communicate the Forest Service's policies and regulations regarding the use of motor vehicles on public lands. Printed materials in maps and at kiosks should include the following points: taking a map and knowing the trail system, keeping vehicles clean, using spark arrestors to avoid wildfires, staying on designated trails, and staying off muddy trails. Photos in outreach materials should display recreationists using proper trail etiquette. These resources should also be available online, and perhaps be accessible using a QR code incorporated into all signs and information kiosks. The agency should indicate it reserves the right to close an area to motorized travel if recreationists do not follow the policies and regulations, or if recreationists participate in destructive riding practices on public lands. Outreach materials should include phone numbers for the relevant Forest Service or utility offices so that members of the public can report violations in a timely manner, thus increasing the capacity of user groups to encourage responsible use of the land.		Overall, public access and motorized vehicle use in the analysis area would still be permitted. The development of recreational print and signage materials is not related to the Forest Service decision to be made on the SGP and is therefore outside the scope of this EIS.
Bonnie Gestring (Northwest Program Director, Earthworks) and seven others	17634	187	We also recommend that all signs and trail markers should include an emblem of an American flag and the logo of local OHV groups that support the designated trail system in order to discourage theft and vandalism to help ensure that information remains readable and available. The Forest Service and Perpetua need to commit to additional trail rangers in the area for outreach, education, and enforcement actions.	ACC	The development of Forest Service recreational signage is outside the scope of this EIS. Neither the 2021 MMP nor the Johnson Creek Route Alternative propose agency employment within the proposed employee descriptions for construction, operations, and closure and reclamation.
Bonnie Gestring (Northwest Program Director, Earthworks) and seven others	17634	194	7. The SDEIS fails to clarify public access along the Burntlog Route Adding to this confusion, the SDEIS is inconsistent regarding whether the new 15-mile section of the Burntlog Route will be open to the public or not. The SDEIS states that, "Approximately 13.5 miles of new private access roads would be created during the life of the mine," (SDEIS, p. 4-490, emphasis added). This statement appears to align with the provisions of the Idaho Roadless Rule being cited for authorizing the extension of the Burntlog Route with new construction that will lead to the SGP mine site. Several Specialist Reports also say that the Burntlog Route will be closed to public access, whereas other documents inconsistently state that the route could be open, will be open when other access is closed or simply will be open. The analysis fails to describe how the Forest Service/Perpetua will ensure that the proposed new section of the Burntlog Route will remain "private" and only available for direct mine-related traffic. Because new road construction for public access is prohibited under the Idaho Roadless Rule, and the Forest Service has failed to identify potential methods enforcing this restriction, authorizing the construction of the route will represent a violation of the Roadless Rule and the Forest Plan. As it stands, increased traffic volumes associated with mine construction, operations, and closure activities will result in decreased wildlife security and impacts to roadless and wilderness values (see below and our specific comments regarding Special Designations). Allowing public access on roads proposed for authorization specifically for mine access will increase impacts to the roadless areas through unauthorized trail creation, increased sediment delivery, and will significantly increase Perpetua's liability should a traffic accident occur between mine-associated trucks/equipment and a private citizen traveling within the mine site or along the Burntlog Route. Further, traditional closure methods such as Kelly humps or large boulders are obviously inappropriate for this application. Therefore, we recommend the Forest Service require Perpetua to construct and staff an "access control booth" at the point where the existing Burnt Log Road ends and where the proposed new construction of the Burntlog Route would begin during summer operations when the Burnt Log road is open to wheeled vehicles. If mine operations are to extend to 24 hour shifts with traffic potentially moving through this corridor potentially at all times of the day and night, then the booth should be staffed 24 hours/day, seven days/week unless the mine and all associated operations and transportation is closed. During those periods, the road should be heavily gated with all potential "drive around" opportunities closed and/or removed. The recommendation for a staffed access control point will adequately restrict summer traffic on the newly constructed portion of the Burnt Log Road; however, it does not address the increased traffic that will occur on the existing portion of the Burntlog Route during the winter when it is plowed and maintained for mine access. This portion is currently unavailable to the majority of summer motorized	ACC	As stated in the Transportation Management Plan (July 2021), the Burntlog Route would be a two-lane, all-weather, gravel-surfaced road. It would be required to meet all applicable Forest Service design criteria as well as criteria for semi-trailers (WB-50) and oversize deliveries of large equipment (WB-67) and (Parametrix 2018c). Following closure and the reclamation of the Burntlog Route, Stibnite Road from Yellow Pine to the SGP would be restored to the current alignment.

REC 7434

Exhibit 2

Stibnite Gold Project
Record of Decision
(excerpt)

United States Department of Agriculture

U.S. Forest Service

Payette and Boise National Forests

Final Record of Decision

Stibnite Gold Project

Valley County, Idaho

January 2025

The United States Department of Agriculture (USDA) is committed to making its digital content accessible. USDA customers, employees, job applicants, and members of the public with disabilities must have access to information and communication technology (ICT) comparable to the access available to those without disabilities. The U.S. Access Board ("Access Board") is responsible for developing accessibility standards. In 2017, the Access Board published a Final Rule that updated the accessibility requirements in Section 508 of the Rehabilitation Act of 1973 (Section 508), 29 U.S.C. 794d, and refreshed the guidelines in the law. The Final Rule went into effect on January 18, 2018. The standards are available at Information and Communication Technology: Revised 508 Standards and 255 Guidelines.

For more information, see the USDA Accessibility Statement.

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at How to File a Program Discrimination Complaint and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by: (1) mail: U.S. Department of Agriculture, Office of the Assistant Secretary for Civil Rights, 1400 Independence Avenue, SW, Washington, D.C. 20250-9410; (2) fax: (202) 690-7442; or (3): mail to: program.intake@usda.gov.

USDA is an equal opportunity provider, employer, and lender.

Final Record of Decision
Stibnite Gold Project

LEAD AGENCY:

U.S. Department of Agriculture
Payette National Forest
500 North Mission Street
McCall, Idaho 83638
(208) 634-0700

Boise National Forest
1249 Vinnell Way Ste 200
Boise, Idaho 83709
(208) 373-4100

DATE DECISION SIGNED: January 3, 2025

COOPERATING AGENCIES:

Idaho Department of Environmental Quality
Idaho Department of Lands
Idaho Department of Water Resources
Idaho Office of Energy and Mineral Resources
U.S. Army Corps of Engineers
U.S. Environmental Protection Agency
Valley County

Preface

In 2016, the Payette National Forest accepted a proposed Plan of Operations submitted by Perpetua Resources Idaho Inc. (Perpetua). Based on my review of the environmental analysis disclosed in the Stibnite Gold Project Final Environmental Impact Statement (FEIS), specialist reports, other supporting analyses, associated land management plans, the project record, and in consideration of public comments received on the Stibnite Gold Project Draft Environmental Impact Statement (DEIS), and Supplemental DEIS, this Final record of decision (ROD) describes my decision and the rationale for my decision. The draft and final environmental impact statement documents along with other supporting documents can be accessed on the project website (https://www.fs.usda.gov/project/?project=50516).

Perpetua is proposing to develop an open pit mining operation on National Forest System lands located approximately 98 miles by air and 146 miles by road northeast of Boise, Idaho; approximately 44 miles by air and 68 miles by road northeast of Cascade, Idaho; and approximately 10 miles by air and 14 miles by road east of the community of Yellow Pine, Idaho. The deposit associated with the Stibnite Gold Project, which has been explored to date, is located primarily on National Forest System land that is open to mineral entry under the General Mining Law of 1872. The Stibnite Gold Project is located within the Payette and Boise National Forests. The Forest Supervisor for the Payette National Forest was delegated as the responsible official for the Stibnite Gold Project because the proposed mining activities are proposed to occur on the Payette National Forest. Secondary proposed project activities to mining operations such as the access road are proposed to occur within the Boise National Forest.

In the United States, the General Mining Law of 1872 (30 U.S.C. 21-54) is the principal law governing the exploration and development of locatable minerals on federal lands. Surface use of National Forest System lands in connection with operations authorized by the United States mining laws is governed by regulations found at 36 Code of Federal Regulations (CFR) Part 228 Subpart A. Pursuant to 36 CFR 228.8, all such operations shall be conducted so as, where feasible, to minimize adverse environmental impacts on National Forest surface resources.

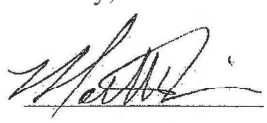
Prior to authorizing the use of National Forest System lands and approving a plan of operations, the Forest Service must analyze the potential effects of the activities that the agency will authorize in accordance with the National Environmental Policy Act (NEPA). In this case, the Stibnite Gold Project, and its associated activities, proposed by Perpetua, was analyzed in a FEIS (Forest Service 2024a).

Because the Stibnite Gold Project includes the discharge of dredge and fill material into waters of the U.S., including wetlands, the U.S. Army Corps of Engineers, pursuant to Section 404 of the Clean Water Act, will review the Stibnite Gold Project and render a decision to either issue, issue with special condition, or deny a permit for the Stibnite Gold Project. Because of separate agency authorities, the Forest Service and U.S. Army Corps of Engineers each prepared a separate ROD for their respective decisions. The decisions of each agency are developed in coordination with the other. This decision presumes the U.S. Army Corps of Engineers will select the Agency Preferred Alternative identified in the FEIS.

The Draft ROD was published in conjunction with the FEIS and was made available to people and entities on the Stibnite Gold Project mailing list and the general public. This Final ROD was developed following the conclusion of the pre-decisional objection process, as required under 36 CFR 218 Subparts A and B.

Questions can be directed to Kara Kirkpatrick-Kreitinger, Forest Environmental Coordinator at (208) 631-8427 or kara.kirkpatrick-kreitinger@usda.gov.

Sincerely,



Matthew Davis
Forest Supervisor, Payette National Forest

Table of Contents

Part 1 Introduction 1
1.1 About This Document 1
1.2 Setting 1
1.2.1 Background 1
1.2.2 Location 2
1.3 Purpose and Need for Action 2
1.4 Pre-decisional Administrative Review 3
Part 2 Decision and Rationale 3
2.1 Introduction and Decision Authority 3
2.2 The Forest Service Decision 4
2.2.1 Boise National Forest Supervisor Decision 4
2.2.2 Payette National Forest Supervisor Decision 4
2.2.3 Selected Alternative 4
2.3 Mitigation 14
2.3.1 Geology, Minerals, and Paleontology 15
2.3.2 Soils 15
2.3.3 Air Quality 17
2.3.4 Climate Change 19
2.3.5 Noise 19
2.3.6 Water Resources 19
2.3.7 Wetlands and Riparian Areas 23
2.3.8 Vegetation 24
2.3.9 Wildlife 27
2.3.10 Transportation 27
2.3.11 Recreation 29
2.3.12 Heritage Resources 29
2.3.13 Tribal Treaty Rights and Interests 32
2.3.14 General Measure 34
2.4 Principle Reasons for the Decision 34
2.4.1 Principle Reason – Selected Alternative (2021 Modified Mine Plan) 35
2.4.2 Principle Reason – Special Use Authorizations 36

Part 3 Alternatives Considered 36
3.1 Other Alternatives Considered in Detail 36
3.1.1 No Action Alternative 36
3.1.2 Reasons for Not Selecting the No Action Alternative 37
3.1.3 Johnson Creek Alternative 37
3.1.4 Reasons for Not Selecting the Johnson Creek Route Alternative 37
3.2 Environmentally Preferred Alternative 37
3.3 Alternatives Eliminated from Detailed Analysis 38
Part 4 Public Involvement 38
4.1 Public Involvement Process 38
4.1.1 Scoping 38
4.1.2 Comment Periods 39
Part 5 Consultation with Other Agencies 39
Part 6 Tribal Consultation and Government-to-Government Consultation 40
Part 7 Legally Required Findings 42
7.1 National Environmental Policy Act 42
7.2 National Forest Management Act 42
7.3 Federal Land Policy and Management Act (FLPMA) 43
7.4 Multiple-Use Sustained Yield Act 43
7.5 General Mining Act of 1872 44
7.6 Endangered Species Act and the Magnuson-Stevens Fishery Conservation and Management Act 44
7.7 National Historic Preservation Act 45
7.8 Tribal Consultation and Coordination 46
7.9 Migratory Bird Treaty Act 47
7.10 Executive Order 13112 - Invasive Species 47
7.11 Executive Order 11988 – Floodplain Management 48
7.12 Executive Order 11990 – Protection of Wetlands, Clean Water Act, and Idaho Groundwater Rule 48
7.13 Idaho Stream Channel Protection Act 49
7.14 Safe Drinking Water Act 49
7.15 Clean Air Act 49
7.16 Executive Orders 12898, 13985, 13990, 14008 49
7.17 Resource Conservation and Recovery Act 49

7.18 Idaho Roadless Rule 50
7.19 Travel Management Rule 50
7.20 Special Uses 50
7.21 Treaties 51
Part 8 Implementation 51
Part 9 Further Information and Contact Person 51
9.1 Responsible Official and Signature 51
Part 10 Environmental Design Features, Protection Measures, and Monitoring 52
10.1 Plans, Permits, and Authorizations 52
10.2 Regulatory and Forest Service Requirements 54
10.3 Environmental Design Features 81
10.3.1 Fish - General 81
10.3.2 Fish - Sediment 93
10.3.3 Wildlife – General 95
10.3.4 Wildlife – Canada Lynx 97
10.3.5 Wildlife – Northern Idaho Ground Squirrel 98
10.3.6 Wildlife – Wolverine 98
10.3.7 Vegetation – General 98
10.3.8 Vegetation – Noxious Weeds 100
10.3.9 Vegetation – Whitebark Pine 101
10.3.10 Road Use and Maintenance 102
10.3.11 Reclamation and Restoration 102
10.3.12 Water Resources 115
10.3.13 Wastes and Hazardous Materials 122
10.3.14 Other Design Features 123
10.4 Biological Opinions Terms and Conditions and Adopted Conservation Recommendations 125
10.5 Biological Opinion Monitoring Requirements 135
Part 11 References 136

List of Tables

Table 1 Proposed Land and Resource Management Plan Amendments 7
Table 2 Rationale for Deviation from Land and Resource Management Plan Guidelines 10
Table 3 Access Impacts During Construction and Operations 28
Table 4 Programmatic Agreement Consulting Parties 46
Table 5 Prominent Regulatory and Land and Resource Management Plan Requirements 55
Table 6 Proponent Proposed Environmental Design Features 67

List of Figures

Figure 1 General Project Area

Figure 2 General Facilities

Acronyms and Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
ADT	average daily traffic
AECOM	AECOM Technical Services, Inc.
ASAOC	Administrative Settlement Agreement and Order of Consent
BMP	Best Management Practice
BNF	Boise National Forest
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CGP	Construction General Permit
DEIS	Draft Environmental Impact Statement
EA	Environmental Assessment
EIS	Environmental Impact Statement
EMMP	Environmental Monitoring and Management Plan
FDCP	Fugitive Dust Control Plan
FEIS	Final Environmental Impact Statement
FLPMA	Federal Land Policy and Management Act
Forest Service	U.S. Department of Agriculture Forest Service
FR	Forest Road

ft	feet
Hecla	Hecla Mining Company
IDAPA	Idaho Administrative Procedures Act
MA	Management Area
Midas Gold	Midas Gold Idaho, Inc.
ModPRO	revised Plan of Restoration and Operations
ModPRO2	modified Plan of Restoration and Operations
N/A or NA	not available/applicable
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOA	Notice of Availability
PAB	palustrine aquatic bed
PEM	palustrine emergent marsh
Perpetua	Perpetua Resources Ltd.
PFO	palustrine forested
Plan	modified Plan of Restoration and Operations
PNF	Payette National Forest
PSS	palustrine scrub-shrub
Rio ASE	Rio Applied Science and Engineering
ROD	Record of Decision
SDEIS	Supplemental Draft Environmental Impact Statement
SHPO	State Historic Preservation Office
SPCC	Spill Prevention, Control and Countermeasure
SWPPP	Stormwater Pollution Prevention Plan
TEPC	Threatened, Endangered, Proposed or Candidate
U.S.	United States
USC	United States Code
USDA	U.S. Department of Agriculture

This page left blank intentionally.

Mitigation Measure – Burntlog Route public access restriction: Construction of the Stibnite Gold Project is expected to take three years (Mine Years -3 through -1). The Burntlog Route is anticipated to take two years to construct (i.e., Mine Year -3 and -2). The access to Meadow Creek Lookout Road will experience short-term closures during Year -3 when crossings of the new Burntlog Route are constructed.

The through-site public access to Thunder Mountain Road will be largely unaffected during Year -3 with more temporary closures in Year -2, then completely closed during Year -1 before re-opening on a new seasonal access route in Year 1 (Table 3).

Table 3 Access Impacts During Construction and Operations

Road	Mine Year -3	Mine Year -2	Mine Year -1	Mine Operations
Warm Lake Road (Cascade to Landmark)	Limited effects	Limited effects	Limited effects	Limited effects
Johnson Creek Road (Landmark to Yellow Pine)	Limited effects	Temporary closures	Seasonal access	Seasonal access
Stibnite Road (Yellow Pine to Stibnite)	Limited effects	Temporary closures	Closed in Operations Area	Seasonal access
Thunder Mountain Road (Stibnite to Thunder Mountain)	Limited effects	No access when Stibnite Road is temporarily closed	Access through new Burntlog Route only	Seasonal access via new public access road through site
Meadow Creek Lookout Road	Temporary closures for nearby Burntlog Route construction	Limited effects	1.8-mile shared segment with new Burntlog Route	1.8-mile shared segment with new Burntlog Route
New Burntlog Route (Landmark to Stibnite)	Under construction	Under construction	Site access plus public access	Site access with public access restriction

The Burntlog Route will be a mine access road operated by the Stibnite Gold Project for the duration of the project. As such, project-related use of the route will be regulated per the Forest Service's decision on the Stibnite Gold Project and incorporate compliance with the project's Transportation Management Plan. Public use of the Burntlog Route will be restricted. Seasonal use of the newly constructed portions of the Burntlog Route will be allowed only during the snow-free portion of Year -1 when there would be no other access to the Thunder Mountain Road.

Public use of existing segments of the Burntlog Route will not be modified by the Stibnite Gold Project decision but would be subject to temporary closures for new Burntlog Route construction. During operations, public use of existing segments of the Burntlog Route (i.e., Burnt Log Road [FS447], Meadow Creek Lookout Road [FR51290], and Thunder Mountain Road [FR50375]) will be unrestricted. The main road segment where public access would continue will be a 1.8-mile section of the Meadow Creek Lookout Road, coincident with the Burntlog Route. Signage would be placed at all intersections with Forest Service roads and trails to identify road segments with public access restrictions.

The Forest Service will require the Project Operator, to develop and implement a Burntlog Route Access Plan to restrict public access per this mitigation measure and to provide notifications to the public when the newly constructed segments of the Burntlog Route would be open.

Any Forest Service decision to allow operations to be conducted would be based on the impacts analyzed for under NEPA, and compliance would be based on adherence to the actions for which that analysis was based, independent of the mine's compliance status with decisions and permits from other agencies. For example, if groundwater and/or surface water diversion within Idaho Department of Water Resources' water authorizations resulted in an impact to streamflow significantly different from what the Forest Service analyzed and based its decision on, that impact would not be authorized without further analysis and approval.

The Stibnite Gold Project incorporates a number of environmental design features, operational activities, best practices, mitigation measures, and monitoring plans intended to reduce impacts to the environment. The Forest Service will form an Interested Agency Review Board to provide oversight for the Stibnite Gold Project's environmental-related activities including adaptive management. The Interested Agency Review Board will consist of all permitting agencies including Idaho Department of Environmental Quality, Idaho Department of Lands, Idaho Department of Water Resources, National Marine Fisheries Service, U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, Valley County, and the Forest Service.

Member agencies on the Interested Agency Review Board will have access to Stibnite Gold Project design reports, Stibnite Gold Project as-built drawings, environmental monitoring reports, model updates required by environmental mitigation measures, and any environmental action plans. These agencies will also have the opportunity to provide input where appropriate on Stibnite Gold Project documentation. Specific construction stage documentation subject to Interested Agency Review Board review upon their completion include:

- Construction-level design of the water treatment plants,
- Construction-level design of the tailings storage facility,
- Construction-level design of the processing plant facility components,
- Construction-level design of the Burntlog Route,
- Construction-level design of the fish tunnel,
- Construction-level design of the East Fork South Fork Salmon River water intake,
- The final Stormwater Pollution Prevention Plan,
- The final Compensatory Mitigation Plan,
- Monitoring and mitigation plans under the Environmental Monitoring and Management Plan (EMMP) (including adaptive management), and
- Engineering as-builts for completed facilities.

The Interested Agency Review Board will meet at least annually to review road maintenance activities, environmental monitoring data, project development, and any adaptive management measures.

10.2 Regulatory and Forest Service Requirements

Regulatory and Forest Service requirements and requirements associated with environmental design features are listed in Tables 5 and 6, and made conditions of this decision. These tables are also contained in the FEIS as Tables 2.4-12 and 2.4-13.

Description	Resources Affected
Soil stability will be estimated for all reclaimed areas using qualitative descriptors.	Soils, Reclamation
Slope stability will be monitored during the erosion inspections.	Soils, Reclamation
If the performance of reclaimed areas is not satisfactory, appropriate maintenance activities will be implemented. Maintenance activities may include one or more of the following: • Sediment removal from sediment basins, stormwater drainage channels, and diversions as necessary to maintain their design capacity; • Diverting surface water away from reclaimed areas where erosion jeopardizes attainment of reclamation standards; • Stabilizing rills, gullies, and other erosion features or slope failures that have exposed development rock; • Noxious weed and invasive plant species control; and, • Re-seeding or re-applying reclamation treatments in areas where it is determined through monitoring and agency consultation that reclamation will not meet standards.	Soils, Reclamation
The Project Operator will submit an annual report to the Forest Service and the other federal and state agencies that are responsible for issuing authorizations applicable to reclamation for the preceding calendar year. The annual report will contain descriptions of the reclamation activities completed during the previous year, a summary of areas reclaimed, a discussion of the results of the reclamation monitoring conducted, and corrective actions implemented.	Soils, Reclamation
A new 12-foot-wide gravel road will be constructed to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375) through the Stibnite Gold Project. During operations, the public access road will be used to travel through the Stibnite Gold Project and will provide seasonal use, open to all vehicles. Vehicles passing through the Stibnite Gold Project will be required to check-in with mine personnel at the North or South Stibnite Gold Project entry points.	Transportation and Access, Health and Safety
Post reclamation, a road will be established over the backfilled Yellow Pine pit to allow public access through the reclaimed site and connect Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375). This will replace the operational phase public access route.	Transportation and Access
Prior to site preparation and construction of surface facilities, vegetation will be removed from operating areas. Trees and deadwood, shrubs, and slash not needed to construct windrows at the edge of Burntlog Route disturbance (to function as sediment barriers), will be chipped, and suitable soil will be separately salvaged and stockpiled (except for a small portion that will be 'live handled') for use as part of site reclamation and restoration. Portions of the salvaged soil will be blended with the chipped wood to create growth media. All growth media placed in stockpiles will be stabilized, seeded, and mulched to protect the stockpiles from wind and water erosion.	Vegetation
The Project Operator will inspect and remove vegetation material (including noxious weeds) from mechanical equipment and properly dispose to minimize the spread of unwanted vegetation.	Vegetation
Wood wastes and wood mulch are the two primary sources of compost. Food waste produced from on-site meal preparation and wastes may provide another source. Combined and properly managed during composting, these materials will provide a source of organic matter to be blended into substrate materials suitable for mitigation.	Vegetation
The Project Operator will be responsible for noxious weed control within areas disturbed by Stibnite Gold Project activities.	Vegetation, Wildlife
Develop and employ planting plans for wildlife benefits (cover, forage, etc.) using approved seed mixes.	Vegetation, Wildlife

10.3.10 Road Use and Maintenance

Description	Reference
Minor surface improvements (e.g., ditch and culvert repair, adding gravel, winter snow removal, and summer dust suppression) will occur on the Yellow Pine Route to reduce sediment runoff and dust generation.	2021 Modified Mine Plan
Once all final mine closure and reclamation work has been completed, the Project Operator will reduce the 21-foot-wide travel way of 19.8 miles of Burntlog Road (FR 447), 1.3 mile of Meadow Creek Lookout Road (FR 51290), and 2.0 miles along Thunder Mountain Road (FR 375) of Burntlog Route to their approximate pre-mining width.	2021 Modified Mine Plan
The approximately 15 miles of Burntlog Route connecting to Meadow Creek Lookout Road (FR 51290) and Thunder Mountain Road (FR 50375) will be decommissioned.	2021 Modified Mine Plan
Following mining and ore processing operations, unless they are taken over by a third-party for ongoing use and maintenance, the Burntlog Maintenance Facility buildings will be removed. The sewer system and septic tanks for the facility will be decommissioned. Soil and rock beneath fuel storage areas and chemical storage buildings will be tested for contamination. All reagents, petroleum products, solvents, and other hazardous or toxic materials will be removed from the site and disposed of according to applicable state and federal regulations. After demolition of the buildings and facilities, the site will be graded, and drainage restored.	2021 Modified Mine Plan
A new 12-foot-wide gravel road will be constructed to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375) through the Stibnite Gold Project. During operations, the public access road will be used to travel through the Stibnite Gold Project and will provide seasonal use, open to all vehicles. Vehicles passing through the Stibnite Gold Project will be required to check-in with mine personnel at the North or South Stibnite Gold Project entry points.	2021 Modified Mine Plan
Post reclamation, a road will be established over the backfilled Yellow Pine pit to allow public access through the reclaimed site and connect Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375). This will replace the operational phase public access route.	2021 Modified Mine Plan
New roads constructed for the Project on National Forest System lands will be closed and reclaimed, as required by Forest Service, once they are no longer needed to support Project construction, operations,	2021 Modified Mine Plan
Project-related traffic will be restricted to existing roadways and Project areas. Off-road travel in previously undisturbed areas will be forbidden.	2021 Modified Mine Plan

REC 7449

10.3.11 Reclamation and Restoration

Description	Reference
Facilities will be located on previously impacted lands when that location fits into mine operations.	2021 Modified Mine Plan
Productive lands that support wildlife and fisheries habitat and dispersed recreation will be established on Project-related surface disturbance.	2021 Modified Mine Plan
Approximately 37 percent of the reclamation will be done concurrent to mining and ore processing; the remaining 63 percent will be accomplished during closure. Annual reclamation activities are described in a schedule provided in Table 3-1 of the Reclamation Closure Plan. Concurrent reclamation areas will focus on construction period restoration efforts (e.g., East Fork Meadow Creek, aka Blowout Creek) and laydown yards, Yellow Pine Pit area facilities, and Hangar Flats Pit area facilities. Closure period activities are focused on the West End Pit area, tailings storage facility area, Fiddle growth media stockpile, and process plant area. This information is also presented graphically in Appendix C to the Compensatory Mitigation Plan.	2021 Modified Mine Plan
The Yellow Pine pit will be backfilled with West End pit development rock during operations.	2021 Modified Mine Plan
A sinuous channel will be constructed through the backfilled area for the reconstructed East Fork South Fork Salmon River with an average valley gradient approximating the historical, pre-disturbance river gradient.	2021 Modified Mine Plan
The backfill will be placed to achieve a mounded final reclamation surface to promote drainage away from the West End pit and prevent formation of a pit lake within Midnight pit.	2021 Modified Mine Plan
The floor of the sidehill pit southwest of the main West End pit will be graded to drain, covered with growth media, and revegetated.	2021 Modified Mine Plan

Exhibit 3

Stibnite Gold Project
Final Environmental Impact Statement Errata

Forest Service
U.S. DEPARTMENT OF AGRICULTURE

50516
Region 4

January 2025
Payette and Boise National Forests

Stibnite Gold Project

Final Environmental Impact Statement

Errata



Cover photo: Yellow Pine pit. Midas Gold, Stibnite Gold Project Plan of Restoration and Operations September 2016.

The United States Department of Agriculture (USDA) is committed to making its digital content accessible. USDA customers, employees, job applicants, and members of the public with disabilities must have access to information and communication technology (ICT) comparable to the access available to those without disabilities. The U.S. Access Board ("Access Board") is responsible for developing accessibility standards. In 2017, the Access Board published a Final Rule that updated the accessibility requirements in Section 508 of the Rehabilitation Act of 1973 (Section 508), 29 U.S.C. 794d, and refreshed the guidelines in the law. The Final Rule went into effect on January 18, 2018. The standards are available at Information and Communication Technology: Revised 508 Standards and 255 Guidelines.

For more information, see the USDA Accessibility Statement.

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at How to File a Program Discrimination Complaint and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by: (1) mail: U.S. Department of Agriculture, Office of the Assistant Secretary for Civil Rights, 1400 Independence Avenue, SW, Washington, D.C. 20250-9410; (2) fax: (202) 690-7442; or (3): mail to: program.intake@usda.gov.

USDA is an equal opportunity provider, employer, and lender.

Article I. Contents i

Stibnite Gold Project Final Environmental Impact Statement Errata Document 1

1. Introduction 1

Article II. Chapter 2 1

1. FEIS, Chapter 2, Section 2.4.4.4 Public Access (page 2-20) 1

2. FEIS, Chapter 2, Section 2.4.9 Environmental Design Features (Table 2.4-12 on page 2-106) 1

3. FEIS, Chapter 2, Section 2.4.9 Environmental Design Features (Table 2.4-13 on page 2-110). 2

4. FEIS, Chapter 2, Section 2.4.9 Environmental Design Features (Table 2.4-13 on page 2-110). 3

Article III. Chapter 3 3

1. FEIS, Chapter 3, Section 3.3.3 Air Quality Relevant Laws, Regulations, Policies, and Plans (Table 3.3-1 on page 3-35). 3

Article IV. Chapter 4 4

1. FEIS, Chapter 4, Section 4.2.3 Geologic Resources and Geotechnical Hazards Mitigation Measures (page 4-22 to 4-23) 4

2. FEIS, Chapter 4, Section 4.9.3 Water Quality Mitigation Measures (page 4-302). 4

3. FEIS, Chapter 4, Section 4.9.3 Water Quality Mitigation Measures (page 4-303). 5

   (i) Tailings Supernatant Pond Water Quality 5

4. FEIS, Chapter 4, Section 4.10.2.2 Sensitive and Forest Watch Species (page 4-313 to 4-315) and Vegetation Specialist Report Section 7.2.3.5 (page 67 to 70). 5

   (i) Bent-flowered Milkvetch (Astragalus vexilliflexus var. vexilliflexus) 5

   (ii) Least Moonwort (Botrychium simplex) 6

   (iii) Blandow's Helodium (Helodium blandowii) 6

   (iv) Sweetgrass (Hierochloe odorata) 7

   (v) Sacajawea's Bitterroot (Lewisia sacajaweana) 7

   (vi) Rannoch-rush (Scheuchzeria palustris) 8

5. FEIS, Chapter 4, Section 4.10.3 Vegetation Mitigation Measures (page 4-329) 9

   (i) Forest Watch Species 9

6. FEIS, Chapter 4, Section 4.11.3 Wetlands and Riparian Resources Mitigation Measures (page 4-350). 9

7. FEIS, Chapter 4, Section 4.24.3 Tribal Rights and Interests Mitigation Measures (page 4-728 to 4-729). 10

Article V. FEIS, Chapter 7, References 10

Article VI. FEIS, Appendix B, Response to Public Comments on the SDEIS and Response to Public Concerns on the 2020 DEIS 10

1. FEIS, Appendix B, Laws and Regulations (page B-6). 10
2. FEIS, Appendix B, Special Designations (page B-618) 11

Article VII. Stibnite Gold Project Wetlands and Riparian Resources Specialist Report 11

1. Wetland and Riparian Resources Specialist Report, Section 7.2.1.1 (page 73) 11

Stibnite Gold Project Final Environmental Impact Statement Errata Document

1. Introduction

The Stibnite Gold Project Draft Record of Decision and the Final Environmental Impact Statement (FEIS) were released on September 6, 2024. This errata sheet documents corrections to the text of the September 2024 published FEIS and should be reviewed along with the FEIS. These corrections reflect instructions provided by Kelly Orr, the Intermountain Region Deputy Regional Forester, in the response to objections dated October 21, 2024, and additional clarifications. These corrections are consistent with the direction given in Forest Service Handbook 1909.15, Chapter 10, Section 18. There are no changes to the project or significant new circumstances identified in this errata sheet that affect the analysis and conclusions in the Stibnite Gold Project FEIS, therefore, a supplement to or revision of the FEIS is not needed. These changes also apply to the Stibnite Gold Project specialist reports, as applicable.

Article II. Chapter 2

1. FEIS, Chapter 2, Section 2.4.4.4 Public Access (page 2-20)

The description regarding seasonal public access through the operating mine site to Thunder Mountain Road is modified per the italicized text:

During operations, the public access road through the Operations Area Boundary would provide seasonal use, open to all vehicles; access would not be provided in winter when impassable (current county maintenance standards) and signs would inform the public of seasonal and temporary closures. Public vehicles passing through would be required to check-in with mine personnel at the North or South SGP entry points and would receive a safety briefing and would also be required to check-out with SGP personnel upon exiting the SGP. For safety purposes, public access would be separated from other SGP roads by berms, security fencing, and the underpass to allow the public road to pass beneath the mine haul road. No stopping or deviating from the public access road would be allowed. Perpetua could restrict access to any vehicles due to concerns related to public or employee health and safety, such as during road construction and maintenance, blasting, highwall scaling, mining in the immediate area of the road, and similar operations. *Because public use of the road would be subject to Perpetua's control measures on general use, the public access road is not considered a public road.*

Significance: The addition clarifies the status of the access road through the site with regard to whether it will be operated as a public road.

2. FEIS, Chapter 2, Section 2.4.9 Environmental Design Features (Table 2.4-12 on page 2-106)

An environmental design feature used in the wildlife specialist report effects analysis unintentionally omitted from Table 2.4-12. The following row is added into Table 2.4-12 on page 2-106.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	Agency Case No. 0101-22-01 OAH Case No. 23-245-01 **NOTICE OF SPECIAL MEETING OF THE BOARD OF ENVIRONMENTAL QUALITY | June 24, 2025**

NOTICE IS HEREBY GIVEN that the Board of Environmental Quality (DEQ Board) has scheduled a Special Meeting to take action in the above-captioned matter. The DEQ Board will hold an executive session pursuant to Idaho Code § 74-206(1)(f) to communicate with legal counsel to discuss the ramifications of and legal options regarding this pending contested case. The Board will also consider the *Petitioner Save the South Fork Salmon's Motion for Reconsideration Based on New Evidence* filed June 6, 2025.

The Special Board Meeting will be held on June 24, 2025, at 12:00 p.m. Mountain Time in conference rooms A and B at the Department of Environmental Quality State Office, 1410 N. Hilton, Boise, Idaho. The public may attend the meeting in person or via Microsoft Teams. The

Teams link will be available in the Meeting Notice posted at https://www.deq.idaho.gov/board-of-environmental-quality/ at least 24 hours prior to the meeting date.

Dated this 13th day of June, 2025.

/s/ Diane Cutler
Diane Cutler, Hearing Coordinator
Rules and Planning Analyst
Department of Environmental Quality
1410 N. Hilton, Boise, ID 83706
(208)373-0165
diane.cutler@deq.idaho.gov

CERTIFICATE OF SERVICE

I HEREBY CERTIFY that on this 13th day of June, 2025, the foregoing was filed, served, and copied as shown below.

Dylan B. Lawrence
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov

Hannah M.C. Young
Michael A. Short
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
hannah.young@deq.idaho.gov
michael.short@deq.idaho.gov

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole C. Hancock
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
nicole.hancock@stoel.com

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
Counsel for the Idaho
Board of Environmental Quality
ann.yribar@ag.idaho.gov

/s/ Diane Cutler
Diane Cutler

RAÚL R. LABRADOR
Attorney General

SCOTT L. CAMPBELL
Deputy Attorney General
Chief, Energy and Natural Resources Division

HANNAH M.C. YOUNG, ISB #9781
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton, 2nd Floor
Boise, Idaho 83706
Telephone: (208) 373-0422
Facsimile: (208) 373-0481
Email: hannah.young@deq.idaho.gov

Attorneys for Respondent

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047

NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON,

Petitioners,

v.

IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY,

Respondent,

and

PERPETUA RESOURCES IDAHO, INC.,

Intervenor.

Case Docket No. 0101-22-01
OAH Case No. 23-245-01

RESPONDENT IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY'S RESPONSE TO PETITIONER SAVE THE SOUTH FORK SALMON'S MOTION FOR RECONSIDERATION BASED ON NEW EVIDENCE

Respondent, the Idaho Department of Environmental Quality ("DEQ"), by and through the Office of the Attorney General, hereby submits this Response to Petitioner Save the South Fork Salmon's ("SSFS") *Motion for Reconsideration Based on New Evidence* ("Motion for Reconsideration").

INTRODUCTION

On June 17, 2022, DEQ issued an air quality permit, a Permit to Construct ("PTC"), to Perpetua Resources Idaho, Inc. ("Perpetua") for the Stibnite Gold Project ("SGP"). REC 1274. In the PTC, DEQ determined that the Stibnite Access Route ("the Route"), an access road that runs through the SGP, was not accessible by the general public and was, therefore, not "ambient air," as that term is defined in the applicable rules. REC 3475. The Hearing Officer and then the Board of Environmental Quality ("the Board") ultimately agreed with DEQ's determination that the Route was not ambient air. *See* REC 3297, REC 3701. On January 24, 2025, SSFS filed its first motion for reconsideration, appealing the Board's decision due to "new evidence." REC 7147. On February 24, 2025, the Board issued its Order on SSFS's motion, finding it was premature given the Board's May 9, 2024 *Final Order* ("2024 Final Order") was not final for purposes of I.C. §§ 67-5246(5), 67-5270, and 67-5273. REC 7343-7348. After the Board issued its final decision on all issues on May 27, 2025 ("2025 Final Order"), SSFS filed its instant Motion for Reconsideration. REC 7374-7391. DEQ continues to assert there is no new evidence that should change the Board's decision, and the Board should find that DEQ acted both reasonably and lawfully in excluding the Route from ambient air.

PROCEDURAL HISTORY

On July 22, 2022, SSFS, the Nez Perce Tribe, and the Idaho Conservation League (collectively, "Petitioners") initiated a contested case, challenging DEQ's issuance of the PTC to

Perpetua for the SGP. REC 0001-0028. Thereafter, the Board appointed a Hearing Officer to oversee and decide the contested case. REC 0031-0032. On August 12, 2022, DEQ responded to the Petition, denying it committed any error in issuing the PTC. REC 0033-0039. Perpetua then moved to intervene in the contested case, which the Hearing Officer granted. REC 0040-0045.

On September 6, 2022, Perpetua filed a *Motion to Dismiss the Petition*, which DEQ joined. REC 0052-0124. In ruling on the Motion, the Hearing Officer dismissed three of Petitioners' claims and partially dismissed a fourth. REC 0160-0186. Petitioners were given leave to amend their Petition, and an Amended Petition was filed in January 2023. REC 0263-0292.

Petitioners filed a *Motion for Summary Judgment* on April 14, 2023, and DEQ and Perpetua filed their own Motions for Summary Judgment on May 12, 2023. REC 0319-0363; REC 1204-1232; REC 1276-1336. After hearing oral argument, the Hearing Officer issued his *Memorandum Decision on Motions for Summary Judgment and Preliminary Order* on October 31, 2023, appearing to dismiss all of Petitioners' claims. REC 3280-3328. Seeking clarity on his decision, DEQ and Perpetua filed a *Joint Motion for Reconsideration and/or Clarification* on November 10, 2023. REC 3332-3341. On December 5, 2023, the Hearing Officer issued his *Amended Memorandum Decision on Motions for Summary Judgment and Preliminary Order*. REC 3372-3425. The Hearing Officer made it clear he dismissed all of Petitioners' claims. *Id*.

On December 15, 2023, Petitioners filed their *Amended Petition for Review of Preliminary Orders*, initiating its first appeal to the Board. REC 3426-3441. After briefing and oral argument, the Board issued its 2024 Final Order, finding that DEQ acted reasonably and in accordance with the law on four of the five issues before the Board. Relevant to this Motion for Reconsideration, the Board found that DEQ acted reasonably and in accordance with law when it found Perpetua has both legal and practical control of the Stibnite Access Route and properly excluded it from

consideration as ambient air. REC 3701. After a remand on the fifth issue, related to DEQ's analysis of arsenic emissions, the Board then found that DEQ was reasonable and lawful on all issues before the Board in its 2025 Final Order. REC 7371.

On January 24, 2025, SSFS first filed its first motion to reconsider. REC 7146-7185. As discussed above, the Board determined SSFS's motion was premature. REC 7343-7348. Now that this matter has been fully decided, SSFS once again brings its Motion to Reconsider. REC 7374-7391. In its Motion to Reconsider, SSFS again claims that "the U.S. Forest Service's January 3, 2025 Final Record of Decision for the Stibnite Gold Project, and supporting documents, provide relevant new information that address the issue of whether Perpetua has legal control to preclude public access from the Stibnite Road Access Route." REC 7375. Thus, SSFS asks the Board to "remand the Permit back to DEQ to reevaluate the ambient air boundary analysis". REC 7377

LEGAL STANDARD

In a contested case proceeding, "the Board must determine whether DEQ has acted reasonably and in accordance with law." *In the Matter of Sunnyside Park Utilities' Application for Sewage Disposal Permit*, Final Order on Petition for Review of Preliminary Order, at 10 (BEQ Dkt. 0103-07-02, Apr. 7, 2009).[1] A court will affirm the Board's decision, should it be appealed, unless the court finds that DEQ and the Board's decision is in violation of constitutional or statutory provisions, is in excess of statutory authority, is made on unlawful procedure, or is arbitrary, capricious, or an abuse of discretion. *See* I.C. § 67-5279(3).[2] But, it is the Petitioners who have "the burden of proving by a preponderance of the evidence, the allegations in the

[1] Publicly available at https://www2.deq.idaho.gov/admin/LEIA/api/document/download/5566.

[2] The Hearing Officer recognized the helpfulness of using the judicial standard of review in I.C. § 67-5279, "[b]ecause those are the standards that ultimately govern the disposition of this matter…" REC 3377. Further, and importantly, Petitioners use the judicial standard of review set out in I.C. § 67-5279 in asking for relief. REC 3474.

petition." IDAPA 58.01.23.062. Thus, the Board must uphold DEQ's decision to issue the PTC unless it determines that Petitioners have in fact proven, by a preponderance of the evidence, that DEQ's decision was (1) unreasonable, (2) not in accordance with law, (3) issued upon unlawful procedure, and (4) was arbitrary, capricious, or an abuse of discretion.

ARGUMENT

In its 2024 Final Order, the Board found "that there is sufficient evidence in the record to support DEQ's conclusion that Perpetua has practical and legal control over the Stibnite Road Access Route such that it may be excluded from consideration as ambient air." REC 3703. The evidence has not changed. The Board's analysis should also remain unchanged. For the reasons discussed below, DEQ's decision to exclude the Route from ambient air remains reasonable and lawful.

I. The PTC Requires Perpetua to Have the Ability to Restrict the General Public from the Route.

SSFS does not assert that any condition of the PTC has changed or that Perpetua will be unable to comply with the terms of the PTC. The PTC requires that the "general public" be precluded from accessing the Route and requires that access for all guests be carefully managed. REC 0376. For example, Permit Condition 2.7 requires a combination of security escort vehicles, manned guardhouses, locked gates, barriers, warning signs, and registration of all guests to the mine site. *Id*. Condition 2.7 also requires Perpetua to submit an Access Management Plan, which must include the specific measures Perpetua will use to discourage public access, including those included in Condition 2.7. *Id.* These conditions will be more than sufficient to notify a reasonable person that his or her presence is not permitted unless specifically granted by

Perpetua and therefore punishable under I.C. § 18-7008 for criminal trespass and actionable under I.C. § 6-202 for civil trespass.

In its initial review, the Board agreed, finding "there are substantial conditions in the PTC that require Perpetua to implement practical and physical restrictions on access to the SGP by the general public." REC 3701. None of the language cited by SSFS from the Forest Service's Final Environmental Impact Statement ("FEIS") prevents Perpetua from complying with the conditions of the PTC. For example, SSFS points to the following language:

> A new 12-foot-wide gravel road will be constructed to provide public access from Stibnite Road (FR50412) to Thunder Mountain Road (FR 50375) through the Stibnite Gold Project. During operations, the public access road will be used to travel through the Stibnite Gold Project and will provide seasonal use, open to all vehicles.

REC 7981. The Forest Service has always referred to this as a public access road – Perpetua agreed to include the road to benefit the public and to provide members of the public with access. *See* REC 3295. Accordingly, in the FEIS sections quoted by SSFS, the Forst Service consistently refers to the Route as a "public access route." REC 7388-7381. But SSFS is asking the Board to interpret these simple references to "public access" as some mandate that Perpetua must allow unfettered access on the road or as an admission that Perpetua does not have the ability to preclude access. *See* REC 7381-7382. However, in the more than three pages of cherry-picked language from the Forest Service's FEIS, never does the Forest Service say that Perpetua *must* grant the public unfettered access. The Forest Service never states that Perpetua *shall* allow the public to access the Route without the ability to also preclude access. The fact has not changed that Perpetua must be able to preclude the public from using the road at any time, for any reason, or discontinue access at its discretion. REC 1238.

In addition, nothing in the FEIS or Record of Decision changes the fact that the members of the public become "invitees" of Perpetua once they enter the mine boundary, for purposes of an ambient air analysis. *See* REC 1145 (EPA's Revised Policy on Exclusions from "Ambient Air"). Nothing in the FEIS or other related documents prevents Perpetua having or asserting this level of control. And SSFS does not allege that the Forest Service's interpretation or assessment of the road has changed throughout its review. Thus, there is no new evidence demonstrating that Perpetua will now be unable to meet the PTC requirements.

II. DEQ Reasonably Relies on Perpetua's Assertions Regarding Control of the Stibnite Access Route.

DEQ excluded the Route from ambient air because, in part, Perpetua represented during the permitting process that it would have legal authority to prohibit access by the "general public" and the practical ability to do so. REC 1260; REC 1236-1240. Under the Rules for the Control of Air Pollution in Idaho, IDAPA 58.01.01 ("Air Rules"), a permit applicant is required to certify that the information and statements provided in a permit application are "true, accurate, and complete." IDAPA 58.01.01.123. In its permit application, Perpetua (then Midas Gold) stated that it "will legally control the SGP, an active industrial site where mining activities will occur, such as heavy equipment operation," and that it "has established an operations boundary to identify the area where public access will be excluded." REC 1807. DEQ's reliance on these assertions was completely reasonable and supported by the Air Rules. The Board agreed, finding: "It was reasonable for DEQ to rely on Perpetua's representations in its application form that it would have legal control over access to the Stibnite Road Access Route." REC 3700.

The Board went on to state that "DEQ recognized at oral argument that, should the [Forest Service] ultimately require public access through the SGP, the ambient air boundary analysis will have to be reevaluated." REC 3700, TR 0080. According to the information provided by SSFS,

the Forest Service is not *requiring* public access through the SGP. The information presented by SSFS does not conflict with the information provided to DEQ, and SSFS does not allege that Perpetua has in any way changed the assertions made to DEQ. In fact, in its Response to SSFS's initial motion for reconsideration, Perpetua continued to assert that "[t]he FEIS and ROD authorize Perpetua to restrict and control when and under what conditions vehicles use the Stibnite Access Route as DEQ authorized in the PTC," and, therefore, "Perpetua will have legal control over access through the Stibnite Access Route." REC 7273-7274. Therefore, there is no evidence in the record that would make DEQ's reliance on Perpetua's statements related to the Route unreasonable or unlawful.

III. DEQ and EPA Guidance Continue to Support DEQ's Determination.

Finally, DEQ's determination that the Route is not ambient air is still supported by both DEQ and EPA guidance. The Hearing Officer summarized the Environmental Protection Agency ("EPA") guidance well when he stated:

> According to EPA's 2019 ambient air policy: (1) it is appropriate to exclude areas from ambient air where measures are employed that are "effective in precluding access to the land by the general public;" (2) such measures can include physical barriers, but physical barriers are not required; (3) determinations by the agency are discretionary on a case-by-case basis; (4) the permit applicant must have the legal ability to preclude access by the general public and must employ measures that actually preclude the general public as a practical matter; (5) in evaluating the adequacy of the preclusion measures, the agency applies a "rule of reason" as to whether the general public will have access "under reasonably anticipated circumstances.

REC 3392. Similarly, DEQ's guidance focuses on the ways in which the permittee will discourage public access. REC 3392. The nature or remote location of the facility may discourage public access, or the permittee may take steps to prevent access. *Id.* If the general public is sufficiently precluded, it is reasonable to consider that the facility or specific area would not qualify as ambient air. *Id.* This is different from a "right-of-way easement" or "common service road." As one

example, PTC condition 2.7 requires registration of all guests of a mine—surely no easement or common service road requires such registration.[3]

The Board has already reviewed both EPA and DEQ guidance and determined that the Route was properly excluded from ambient air. REC 3698. Again, the guidance continues to support DEQ's decision. The general public will be sufficiently excluded due to the measures Perpetua must take to comply with the PTC. And while the general public *may* be given access on Perpetua's terms, that is not the same as Perpetua relinquishing legal or practical control. Accordingly, nothing in the FEIS or related documents changes the analysis.

CONCLUSION

The PTC requires Perpetua to have legal and practical control of the Stibnite Access Route. Perpetua continues to assert, and the evidence continues to demonstrate, that Perpetua has the necessary control over the Stibnite Access Route. Thus, DEQ's decision to exclude the Route from ambient air is reasonable and lawful. The Board should confirm its 2024 Final Order and 2025 Order and deny SSFS's Motion to Reconsider.

DATED: June 18, 2025

STATE OF IDAHO
OFFICE OF THE ATTORNEY GENERAL

/s/ Hannah M.C. Young
HANNAH M.C. YOUNG
Deputy Attorney General
Attorneys for the Idaho Department of Environmental Quality

[3] The FEIS discusses the need for users of the Route to check-in with Perpetua. The language from the FEIS, and quoted by SSFS, states: "Public vehicles passing through would be required to check-in with mine personnel at the North or South SGP entry points and would receive a safety briefing and would also be required to check-out with the SGP personnel upon exhibiting the SGP." REC 7149.

CERTIFICATION OF SERVICE

I HEREBY CERTIFY that on this 18th day of June, 2025 a true and correct copy of the foregoing *RESPONDENT IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY'S RESPONSE TO PETITIONER SAVE THE SOUTH FORK SALMON'S MOTION FOR RECONSIDERATION BASED ON NEW EVIDENCE* was served on the following via electronic mail to the indicated address:

Bryan Hurlbutt
Laurence ("Laird") J. Lucas
Advocates for the West
P.O. Box 1612
Boise, ID 83701

Attorneys for Petitioner Nez Perce Tribe and Idaho Conservation League

bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638

Attorney for Petitioner
Save the South Fork Salmon

jthrower@mtntoplaw.com
via electronic service

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole C. Hancock
Stoel Rives LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702

Attorneys for Intervenor
Perpetua Resources of Idaho, Inc.

krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com
nicole.hancock@stoel.com
via electronic service

Dylan B. Lawrence
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701

Hearing Officer

dylan@varinthomas.com
via electronic service

Office of Administrative Hearings

filings@oah.idaho.gov
via electronic service

Diane Cutler
Hearing Coordinator
Rules and Planning Analyst
Department of Environmental Quality
1410 N Hilton
Boise ID 83706

diane.cutler@deq.idaho.gov
via electronic service

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010

ann.yribar@ag.idaho.gov
via electronic service

/s/ DeAnne M. Chaffin
DeAnne M. Chaffin
Legal Assistant

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
Nicole C. Hancock, ISB No. 6899
nicole.hancock@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	Case Docket No. 0101-22-01 OAH Case No. 23-245-01 PERPETUA'S BRIEF IN OPPOSITION TO PETITIONER'S MOTION FOR RECONSIDERATION BASED ON NEW EVIDENCE

Intervenor-Respondent Perpetua Resources Idaho, Inc. ("Perpetua") submits this opposition to the Motion for Reconsideration Based on New Evidence ("Pet. Mot.") submitted by Petitioner Save the South Fork Salmon ("Petitioner"). Petitioner claims that the Final Environmental Impact Statement ("FEIS") and Record of Decision ("ROD") issued by the United States Forest Service ("Forest Service") for the Stibnite Gold Project (the "Project") constitute new evidence that Perpetua does not have legal control over the Stibnite Access Route. Petitioner's claim fails on its face. The Forest Service's Errata to the FEIS expressly confirms that the Stibnite Access Route is not a public road. Moreover, Perpetua maintains the same control over access to the Stibnite Access Route as has been described by the Forest Service throughout the National Environmental Policy Act ("NEPA") process and the Idaho Department of Environmental Quality ("DEQ") in development of the Permit to Construct ("PTC"). The Board should reject Petitioner's claims and dismiss the Motion.

INTRODUCTION

I. Procedural History

The Project is a mining and mineral processing operation that will be constructed and operated on state, private, and federal land in Valley County, Idaho. In addition to gold and silver, Perpetua will produce antimony essential to military applications critical for national security. The Forest Service and various other federal and state agencies have issued their approvals for the Project, with a few state permit applications still under review.[1]

[1] Perpetua has received all of the federal permits it is required to obtain for the Project, including, in addition to the ROD, a Section 404 permit from the United States Army Corps of Engineers required under the federal Clean Water Act and biological opinions from the United States Fish and Wildlife Service and the National Marines Fisheries Service required under the federal Endangered Species Act. Idaho state agencies that have issued various regulatory approvals include the DEQ, Department of Lands, and Department of Water Resources ("DWR"). The Idaho Pollution Discharge Elimination System ("IPDES") and stream alteration permits required to commence construction of the Project are in the advanced stages of review by DEQ and DWR, respectively.

Before commencing construction on the Project, Perpetua must obtain various regulatory approvals, including a PTC from DEQ , as well as a separate federal regulatory processes that includes review under NEPA and that provides Perpetua with the authorization to conduct operations on Forest Service lands. This comprehensive NEPA review required the Forest Service to develop an Environmental Impact Statement ("EIS") prior to issuing a ROD to authorize Perpetua's Mine Plan.[2] 42 U.S.C. § 4332(2)(C). The Forest Service issued a Draft EIS ("DEIS") on August 14, 2020, and a Supplemental DEIS on October 28, 2022. The Forest Service issued the FEIS in September 2024 and the Final ROD in January 2025.

In 2017, during the initial scoping phase of the NEPA process, Perpetua modified its original Mine Plan to include the Stibnite Access Route after receiving feedback from various communities, including comments from local residents that the Project would lengthen travel time for those who use the existing Stibnite Road to access Thunder Mountain Road. *See* REC 676, 893–895, 1758. Under the modified Mine Plan, Perpetua will control the Stibnite Access Route and will allow registered visitors restricted and limited use for the sole purpose of accessing other National Forest areas on the north side of the Project. This has not changed throughout the PTC and NEPA processes. *See* Declaration Of W. Christopher Pooser In Support Of Perpetua's Opposition To Reconsideration ("Pooser Decl."), Exh. 1 at REC 376, Exh. 2 at REC 415, 676–677, 893–897, Exh. 3, Exh. 4, Exh. 5, Exh. 6, Exh. 7. The PTC, issued by DEQ on June 17, 2022, includes the same ambient air boundary as set forth in the DEIS (and subsequently the SDEIS and FEIS). *See id.*, Exh. 1 at REC 376, Exh. 2 at REC 676–677.

[2] An EIS includes a comprehensive environmental analysis of the proposed activity and its potential impacts, as well as possible alternatives. The ROD completes the NEPA process by documenting the responsible federal agency's decision on the proposed activity—or an alternative—subject to mitigation measures. *See* 42 U.S.C. § 4321.

On May 9, 2024, the Idaho Board of Environmental Quality (the "Board") issued a Final Order finding that "DEQ acted reasonably and in accordance with law when it found Perpetua has legal and practical control of the Stibnite Access Route such that it could be excluded from the ambient air boundary." REC 3698–3703. The Board found that (1) there was sufficient evidence to demonstrate that Perpetua will have legal control over access to the ambient air boundary and (2) the PTC contains enforceable conditions that will preclude practical access by the general public. *Id.* Both of these findings remain accurate and supported by the evidence.

At the time of the issuance of the PTC and the Board's Final Order, the Forest Service had not issued the FEIS and ROD. The Board stated that it would not speculate as to the outcome of the NEPA process but found that there was sufficient evidence in the record to support DEQ's conclusion that Perpetua will have legal authority to control access. *Id.* The Board acknowledged DEQ's statement during oral argument that "should the [Forest Service] ultimately require public access through the [Project], the ambient air boundary analysis will have to be reevaluated." REC 3700.

On September 6, 2024, the Forest Service issued the FEIS. On January 3, 2025, the Forest Service issued the ROD. The ROD gives Perpetua legal authority to control the Project's boundary, including control of access to the Stibnite Access Route. Along with the ROD, the Forest Service also issued an Errata to the FEIS to provide clarifications in response to objections. The Errata states that because of the control Perpetua will exercise over the Stibnite Access Route (which was the same basis for the Board's relevant findings), the Route is not a public road. Pooser Decl., Exh. 6 at PRI 1070. The FEIS, Errata, and ROD issued after the Board's initial findings approving the air boundary for the PTC are all consistent with the DEIS and Supplemental DEIS, on which Board relied for its decision on the air boundary. Each of

these documents, issued by the Forest Service after the Board's relevant decision, reflect Perpetua's legal control over the Stibnite Access Route, and the conditions for practical control over the Route mirror the conditions originally set forth in the DEIS and the Supplemental DEIS. *Compare id.*, Exh. 5, 6, 7 *with* Exh. 3, 4. Perpetua's legal ability to control access to the Stibnite Access Route did not change in any substantive fashion between the DEIS in 2020, the Supplemental DEIS in 2022, the FEIS in 2024, and the Errata and ROD in 2025.

Despite this reality, Petitioner now seeks reconsideration of the Board's Final Order based on its assertion of "new evidence" in the FEIS and the ROD—where there is none—and requests remand of the PTC to DEQ for reconsideration of the ambient air boundary analysis. Pet. Mot. at 5.

II. EPA Guidance on Ambient Air and the Board's Conclusion that the Stibnite Access Route is Not Ambient Air

Idaho regulations define "ambient air" consistent with EPA regulations as "that portion of the atmosphere, external to buildings, to which the general public has access." IDAPA 58.01.01.006.05. *See also* 40 C.F.R. § 50.1(e) (same definition). EPA and DEQ have long recognized that an applicant need not demonstrate the impact of a source's emissions on air within areas where general public access is restricted. *See* REC 1138, 1341, 1805.

EPA has consistently exempted from "ambient air" "the atmosphere over land [1] owned *or controlled* by the source and [2] to which the public access is precluded by a fence or other physical barriers." REC 1138 (emphasis added). In 2019, EPA issued detailed guidance on exclusions to "ambient air." REC 1138–1151. EPA affirmed previous guidance that legal control means that the "owner or operator of the source has the legal right to use the land, and that its land-use right includes" the power to control and to exclude public access. REC 1142. EPA also

broadened the "fence or other physical barriers" (i.e., practical control) element to recognize that physical boundaries are not the only way in which to preclude public access. REC 1146. Specifically, EPA recognized that other measures (such as video surveillance, monitoring, clear signage, and routine security patrols) may be effective in deterring or precluding general public access to the land. *Id*. EPA emphasized that individual, case-by-case analyses of effective control measures should not incorporate a bright-line test. REC 1147–1148. As EPA explains in the 2019 guidance, agencies should apply a "rule of reason in evaluating the effectiveness of any measure proposed by a source …" *Id*.

In the context of permitting for mining projects, state agencies regularly rely on this EPA guidance, including the "rule of reason" principle, when determining that applicants will have legal control over ambient air boundaries and will impose sufficient measures to practically control access. Indeed, practical control measures beyond fencing and physical barriers, such as those relied on for this Project by the Forest Service in the ROD and by DEQ in the PTC, are typical and necessary for mining projects, given the large-scale nature of such operations.

Although Petitioner conflates the two elements of public access in its analysis, Petitioner expressly states that it is only challenging the first element—legal control—or whether Perpetua has land-use rights that include the authority to control and exclude access from the Stibnite Access Route. Petitioner did not request reconsideration of the Board's determination in the Final Order that Perpetua will preclude practical access by the general public.

ARGUMENT

The Forest Service's FEIS and ROD do not warrant remand of the PTC to DEQ for reconsideration of its ambient air boundary analysis because (I) the Errata expressly confirms that the Stibnite Access Route is not a public road; (II) the FEIS and ROD support the Board's

original conclusion that Perpetua has legal (as well as practical) control over the Stibnite Access Route; and (III) the FEIS and ROD provide no new evidence to trigger reconsideration.

I. The Forest Service's Errata Expressly Confirms that the Stibnite Access Route is Not a Public Road

Petitioner largely ignores the Forest Service's Errata to the FEIS, which flatly contradicts Petitioner's argument and further confirms that Perpetua has legal control over the Stibnite Access Route. *See* Pooser Decl., Exhibit 6 at PRI 1070. The Errata added the following statement to the end of a paragraph in the FEIS reviewing the many measures that Perpetua will take to restrict access to the Project site:

> Because public use of the road would be subject to Perpetua's control measures on general use, *the public access road is not considered a public road*.

Id. (emphasis added). The Forest Service explained that "[t]he addition clarifies the status of the access road through the site with regard to whether it will be operated as a public road." *Id.*

This characterization of the Stibnite Access Route is consistent with Forest Service guidance, which limits a "public road" to one that is "(1) [a]vailable, except during scheduled periods, extreme weather, or emergency conditions; (2) [p]assable by four-wheel standard passenger cars; and open to the general public for use without restrictive gates, prohibitive signs or regulation other than restrictions based on size, weight, or class of registration." *See Pub. Lands for the People, Inc. v. United States Dep't of Agric.*, 2010 U.S. Dist. LEXIS 132748, at *34–35 (E.D. Cal. Dec. 14, 2010). Indeed, Perpetua has the legal authorization from the Forest Service to control access to the Stibnite Access Route with restrictive gates, prohibitive signs, and other control measures set out in the PTC, FEIS, and ROD. Pooser Decl., Exh. 1 at REC 376, Exh. 5 at PRI 1054, Exh. 7 at PRI 1077−1078.

Petitioner attempts to waive away the statements of the Forest Service in the Errata by claiming that it does not change the ambient air analysis for air permitting. Pet. Mot. at 12, n. 2. Petitioner relies on an excerpt from EPA guidance to argue that ownership of the road or property is inconsequential. *Id.* However, the excerpt Petitioner references concerns a narrow circumstance that is not at play here—whether individuals allowed access to a downwind property are considered members of the public for purposes of the ambient air analysis for a separate, upwind property. REC 1145. More broadly, Petitioner misses the main point of the statement in the Errata: the Stibnite Access Route is not a public road where the public will have uncontrolled access.

The Forest Service's Errata explicitly contradicts Petitioner's claim that the FEIS and ROD "unequivocally establish" that the Stibnite Access Route is for public use. An analysis of "fact-dependent, context-specific, and policy-laden choices" by the Forest Service in an EIS is due "substantial deference."[3] The Forest Service's unequivocal confirmation in the Errata that the Stibnite Access Route is not a public road reconfirms the conclusion in the DEIS, Supplemental EIS, FEIS, and ROD (and the PTC and Statement of Basis) that Perpetua will maintain legal control over access through the Stibnite Access Route. This determination should end the inquiry.

II. The FEIS and ROD Provide No New Evidence

Petitioner's argument hinges on the claim that the FEIS and ROD provide new evidence that "unequivocally establish that the Stibnite Road Access Route is for public use and that Perpetua does not have legal authority to preclude such use." Pet. Mot. at 3 (emphasis added).

[3] Seven Cty. Infrastructure Coal. v. Eagle Cty., 221 L.Ed.2d 820, 837 (U.S. 2025).

Petitioner's claim of alleged "new" evidence is simply wrong as a factual matter. Petitioner's Motion should be denied for this reason alone.

The FEIS and ROD provide clear descriptions of Perpetua's control of access and nothing in the FEIS or ROD changes either the Forest Service's analysis of the control question in the DEIS and the Supplemental DEIS, or the DEQ's analysis of the question when it first issued the PTC in June 2022. To be crystal clear, the characterization of Perpetua's legal control over the Stibnite Access Route has not changed throughout DEQ's development of the PTC, the Board's review of Petitioner's challenge, or the Forest Service's NEPA review.

DEQ's June 2022 Statement of Basis for the PTC recognized that Perpetua "will legally control the [Project site]" and provide limited public access through the Stibnite Access Route, subject to restrictions in Perpetua's Access Management Plan:

> [Perpetua] has the legal authority to control access to the Stibnite Road access route and would provide seasonal (non-winter conditions) access only. At the discretion of [Perpetua], additional access controls may occur during various phases of construction, during mine operations that present potential safely hazards such as blasting, due to inclement weather, or under any other circumstances that may present a threat to the protection of public or employee health and safety. [Perpetua] has the legal and practical ability to enforce its control over roadway access and to monitor traffic passing through the [Project] site.

Pooser Decl., Exh. 2 at REC 676–677.

The PTC then provides the following minimum control measures that Perpetua will implement in its Access Management Plan relative to the Stibnite Access Route:

- Preclude unauthorized access at primary access points through the use of security escort vehicles, manned guardhouses, locked gates, barriers, or equivalent measures;
- Post warning signs and place boulders at secondary access points;
- Use trained security personnel to patrol the Project site and escort trespassers off the site;

- Provide access only to "registered guests" for the sole purpose of passing through the Project site to another destination; and
- Require guests to complete a registration sheet that explains Perpetua's requirements for accessing the site and identifies potential hazards.

See id., Exh. 1 at REC 376.

The relevant analysis and conditions have not changed since DEQ made its initial decisions in May 2024 approving the air boundary included within the PTC. Nonetheless, Petitioner erroneously claims that certain excerpts from the FEIS and ROD now establish that Perpetua will not legally control the Stibnite Access Route. Pet. Mot. at 3–7. Petitioner cites a series of excerpts which describe the location and physical characteristics of the Route, its limited seasonal use for access through the Project site, and the control that the Forest Service authorizes Perpetua to exert over the Route. *Id.* But the content of these excerpts are also found in the DEIS and Supplemental DEIS. Indeed, for many of the excerpts, the Forest Service used *nearly the exact same language* as it used in the Supplemental DEIS—which was available at the time of DEQ's decision—with only a few grammatical differences. *Compare* Pet. Mot. at 4 (citing FEIS at ES-25) *with* Pooser Decl., Exh. 4, Excerpts from Supplemental DEIS at PRI 1035; *compare* Pet. Mot. at 7 (citing ROD at 74, 102) *with* Pooser Decl., Exh. 4, Excerpts from Supplemental DEIS at PRI 1040 *and* Pooser Decl., Exh. 3, Excerpts from DEIS at PRI 1027–1028.

In one example, Petitioner conveniently left out the full quotation from the FEIS, which describes those restrictions Perpetua will use to control access (denoted below in italics) and are directly relevant to Perpetua's legal control over access to the Stibnite Access Route:

> During operations, the public access road through the Operations Area Boundary would provide seasonal use, open to all vehicles; access would not be provided in winter when impassable (current county maintenance standards) and signs would inform the public of

> seasonal and temporary closures. *Public vehicles passing through would be required to check-in with mine personnel at the North or South SGP entry points and would receive a safety briefing and would also be required to check-out with SGP personnel upon exiting the SGP. For safety purposes, public access would be separated from other SGP roads by berms, security fencing, and the underpass to allow the public road to pass beneath the mine haul road. No stopping or deviating from the public access road would be allowed. Perpetua could restrict access to any vehicles due to concerns related to public or employee health and safety, such as during road construction and maintenance, blasting, highwall scaling, mining in the immediate area of the road, and similar operations.*

Pooser Decl., Exh. 4, Excerpts from Supplemental DEIS at PRI 1039 (emphasis added). *See also id.*, Exh. 3, Excerpts from DEIS at PRI 1027–1028.

The attached Exhibits—which include Forest Service determinations that Perpetua requests be administratively noticed by the Board[4]—include portions of the DEQ permitting record and additional NEPA documents that further demonstrate this consistency. *See id.*, Exh. 1, Excerpts from Permit to Construct, Exh. 2, Excerpts from Statement of Basis, Exh. 3, Excerpts from DEIS, Exh. 4, Excerpts from Supplemental DEIS, Exh. 5, Excerpts from FEIS, Exh. 6, Excerpts from Errata, Exh. 7, Excerpts from ROD.

Nor do the FEIS and ROD *require* public access—in fact the agency explicitly stated the opposite in the Errata. Nonethless, Petitioner claims that Perpetua does not have legal control over the Stibnite Access Route because the FEIS analyzed and the ROD approved of "allowing public access" over the Stibnite Access Route "pursuant to the Forest Service's Travel Management Rule." Pet. Mot. at 7–8. Petitioner argues that the Stibnite Access Route is "open to

[4] Pursuant to IDAPA § 62.01.01.479, Idaho Code § 67-5251(4)(a), Idaho Code § 9-101(3), and I.R.E. Rule 201(b)(2), Perpetua requests that the Board take judicial notice that the Forest Service made the determinations in the highlighted portions of the NEPA documents. These highlighted portions provide adjudicative facts that are "not subject to reasonable dispute because" they are part of "official acts" of the Forest Service. *See* Hastings v. Idaho Dep't of Water Res., 173 Idaho 630, 547 P.3d 1190, 1200-01 (2024) (affirming the district court's decision to take judicial notice of a conditional permit issued by the Idaho Department of Water Resources under Idaho Code § 9-101(3) and I.R.E. Rule 201(b)(2)).

public use" under the Travel Management Rule such that an additional regulatory process would be required for Perpetua to restrict access to the Route. *Id.*

As an initial matter, whether the Forest Service should undertake a separate, additional regulatory process is beyond the scope of this proceeding and does not implicate the Board's authority in its review of the PTC. In addition, Petitioner's characterization of this analysis under the Travel Management Rule and applicability to the ambient air boundary analysis is incorrect and misleading. The designation of Forest Service roads under the Travel Management Rule only broadly establishes roads "that are designated for motor vehicle use" and prohibits travel outside of such roads. 36 C.F.R. § 212.50(a). Under the text of the Rule, road designations do not restrict the ability of the Forest Service to authorize lessees or project operators to control public access to such roads, as the Forest Service authorizes Perpetua to do in the ROD. *See* 36 C.F.R. Part 212, Subpart B.

Moreover, the Forest Service's analysis under the Travel Management Rule presents no new information since the Board made its decision in May 2024 —rather, the Plan simply reiterates the control measures that Perpetua has authority to implement over the "[t]he reroute of Stibnite Road" through the Project site. Pooser Decl., Exh. 5 at PRI 1065, Exh. 7 at PRI 1075. The Forest Service analyzed the "reroute" under the Travel Management Rule's Minimization Criteria, which only concern impacts on forest resources, wildlife, and populated areas; conflicts between motor vehicle use and recreation on National Forest lands; and conflicts among different classes of motor vehicle use, and populated areas. *See id.*; 36 C.F.R. § 212.55(b). Contrary to Petitioner's claim, this limited analysis neither addresses nor impacts Perpetua's legal authority under the ROD to control access through the Project Site. And, as the Forest

Service acknowledges in the FEIS, Perpetua analyzed these same criteria for the reroute of Stibnite Road in the 2021 Mine Plan. *See* Pooser Decl., Exh. 5 at PRI 1065–1067.

At bottom, Petitioner appears to suggest that the Forest Service somehow lacked the authority to limit public access on the Stibnite Access Route without further proceedings. This suggestion is legally incorrect with respect to federal law. But, more importantly in the current circumstances, a motion before the Board relating to a state permit is not the proper forum to raise such a federal challenge.[5]

The Stibnite Access Route is an element of the approved Mine Plan for the Project that is in the ultimate control of Perpetua—as illustrated by the measures Perpetua will implement to limit access and manage use as well as by the Forest Services' findings in the Errata and other relevant documentation. The DEIS, Supplemental EIS, and FEIS analyzed the environmental impacts of Perpetua's Mine Plan, including the restricted public access (controlled and limited by Perpetua) through the Stibnite Access Route. *See* Pooser Decl., Exh. 3, Exh. 4, Exh. 5. Then, in the ROD, the Forest Service approved Perpetua's Mine Plan and authorized Perpetua to control use of the Route and preclude public access pursuant to the Access Management Plan. Therefore, nothing has changed from the information in the DEIS or Supplemental DEIS on which the Board relied for its decision in May 2024, and there is nothing "new" for the Board to reevaluate now.

[5] Even assuming for the sake of argument that Petitioner could establish that some further process is required under federal regulations for the Forest Service to impose limitations on the public's use of the Stibnite Access Route, that would not change the outcome or the decision by the Forest Service to authorize the project and, therefore, is not a basis to disturb the authorization or delay construction of the project. *See* Seven Cty. Infrastructure Coal., 221 L.Ed.2d at 837.

III. The FEIS and ROD Support the Board's Original Conclusion that Perpetua Will Have Legal Control Over the Stibnite Access Route

In its May 2024 Final Order, the Board concluded that there was sufficient evidence to demonstrate that Perpetua will have legal control over the Stibnite Access Route. REC 3698–3703. Additionally, the Board explained that Perpetua's measures to control practical access "make[] clear that access. . . will only be available under a very limited basis and not to the 'general public.'" REC 3702. Because the characterization of Perpetua's legal control over the Stibnite Access Route in the FEIS and ROD are consistent with the PTC, Statement of Basis, DEIS, and Supplemental DEIS, nothing in these final NEPA documents alters the Board's conclusions. The FEIS and ROD authorize Perpetua to restrict and control when and under what conditions vehicles use the Stibnite Access Route as DEQ authorized in the PTC. *See* Pooser Decl., Exh. 5, Exh. 7. Accordingly, the FEIS and ROD support the Board's Final Order.

While Petitioner spends much of its Motion for Reconsideration arguing that Perpetua does not have legal control over the Stibnite Access Route and that DEQ cannot exclude the Route from the ambient air analysis, these arguments merely repeat the claims that Petitioner has been making for nearly three years in briefing this contested case before the Board. *See* REC 0339–0343; REC 2336–2340; REC 3476–3483; REC 3629–3655.

As the United States Supreme Court emphasized in its decision in *Seven County Coalition v. Eagle County, Colorado*, 221 L.Ed.2d 820, 837 (U.S. 2025) last month, "[d]elay upon delay" creates a process that "seems to borde[r] on the Kafkaesque" and unduly slows projects and increases costs.[6] The Supreme Court emphasized the importance of deferring to the expertise of regulatory agencies in their factual and scientific determinations as well as avoiding

[6] Seven Cty. Infrastructure Coal. at 837 (internal quotation marks excluded).

"micromanaging" agency determinations that fall within " a broad zone of reasonableness," particularly in the context of large and complex infrastructure projects which have suffered from excessive regulatory delays, litigation, and judicial overreach. 221 L.Ed.2d at 837–38. While the Supreme Court's decision regarded analysis under NEPA, rather than the Clean Air Act, the Court's core concerns are directly on point—a "course correction" is necessary to provide greater predictability for infrastructure planning and financing and to prevent excessive administrative and judicial review that unfairly hinders project development. *See id.*

Here, DEQ and the Board properly and carefully analyzed the relevant legal and factual matters regarding the ambient air boundary established in the PTC. Petitioner's Motion merely repackages its prior legal arguments to repeat already-rejected claims and overheated rhetoric. There is no need for additional process. The Board already addressed these arguments in the May 2024 Final Order, and Petitioner fails to establish the existence of new evidence that would undermine the Board's initial conclusion. There is nothing left to reconsider.

CONCLUSION

As the FEIS and the ROD provide no new information that would change DEQ's conclusion, remand to DEQ is neither appropriate nor necessary. Remand would be a waste of agency resources and time, particularly in light of the years of review that DEQ has already spent scrutinizing the PTC.

DATED: June 18, 2025.

STOEL RIVES LLP

/s/ *W Christopher Pooser*
Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Nicole C. Hancock

Attorneys for Perpetua Resources Idaho, Inc.

CERTIFICATE OF SERVICE

I hereby certify that on this 18th day of June 2025, a true and correct copy of the foregoing PERPETUA'S BRIEF IN OPPOSITION TO PETITIONER'S MOTION FOR RECONSIDERATION BASED ON NEW EVIDENCE was served on the following:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Dylan B. Lawrence
Hearing Officer
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Bryan Hurlbutt
Laurence ("Laird") J. Lucas
Advocates for the West P.O.
Box 1612 Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Michael A. Short
Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
michael.short@deq.idaho.gov
hannah.young@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
Counsel for the Idaho
Board of Environmental Quality
ann.yribar@ag.idaho.gov
via electronic service

Diane Cutler, Hearing Coordinator
Rules and Planning Analyst
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
(208) 373-0165
diane.cutler@deq.idaho.gov
via electronic service

/s/ *W. Christopher Pooser*
W. Christopher Pooser
Attorneys for Perpetua Resources Idaho, Inc.

Krista K. McIntyre, ISB No. 4675
krista.mcintyre@stoel.com
W. Christopher Pooser, ISB No. 5525
christopher.pooser@stoel.com
Wade C. Foster, ISB No. 11105
wade.foster@stoel.com
Nicole C. Hancock, ISB No. 6899
nicole.hancock@stoel.com
STOEL RIVES LLP
101 S Capitol Boulevard, Suite 1900
Boise, ID 83702
Telephone: 208.389.9000

Attorneys for Perpetua Resources Idaho, Inc.

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY
STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047 NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondent, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	Case Docket No. 0101-22-01 OAH Case No. 23-245-01 DECLARATION OF W. CHRISTOPHER POOSER IN SUPPORT OF PERPETUA'S OPPOSITION TO RECONSIDERATION

I, W. CHRISTOPHER POOSER, declare as follows:

1. I am a partner at Stoel Rives LLP and an attorney of record for Intervenor-Respondent Perpetua Resources Idaho, Inc. ("Perpetua") in the above-entitled matter. As such, I

have personal knowledge of the facts and statements contained in this Declaration. I submit this Declaration in support of Perpetua's Opposition to Petitioner's Motion for Reconsideration Based on New Evidence.

2. Exhibits 1 through 2 are true and correct excerpts from Idaho Department of Environmental Quality permitting documents regarding the Stibnite Gold Project that are currently in the record and labeled with REC numbers. Portions of the documents relevant to Perpetua's Opposition have been highlighted for ease of reading.

3. Exhibits 3 through 7 are true and correct excerpts from the United States Forest Service's review of the Stibnite Gold Project under the National Environmental Policy Act, obtained online from the Payette National Forest Stibnite Gold Project EIS website: https://www.fs.usda.gov/project/?project=50516. For purposes of the record, these documents have been Bates-stamped with "PRI" numbers consistent with previous declarations. Portions of the documents relevant to Perpetua's Opposition have been highlighted for ease of reading.

Ex. No.	REC or Bates No.	Document Description
1	REC 367, 376	Excerpts from Permit to Construct (June 17, 2022)
2	REC 410, 415, 676–677, 893–897	Excerpts from Statement of Basis (June 17, 2022)
3	PRI 1021–1033	Excerpts from Draft Environmental Impact Statement (August 2020)
4	PRI 1034–1048	Excerpts from Supplemental Draft Environmental Impact Statement (October 28, 2022)
5	PRI 1049–1068	Excerpts from Final Environmental Impact Statement (September 6, 2024)
6	PRI 1069–1070	Excerpts from Errata to Final Environmental Impact Statement (January 3, 2025)
7	PRI 1071–1079	Excerpts from Record of Decision (January 3, 2025)

I declare under penalty of perjury under the laws of the state of Idaho that the foregoing is true and correct.

DATED: June 18, 2025.

STOEL RIVES LLP

/s/ *W Christopher Pooser*
W. Christopher Pooser

CERTIFICATE OF SERVICE

I hereby certify that on this 18th day of June 2025, a true and correct copy of the foregoing was served on the following:

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-0104
filings@oah.idaho.gov
via electronic service

Dylan B. Lawrence
Hearing Officer
Varin Thomas, LLC
P.O. Box 1676
Boise, ID 83701
dylan@varinthomas.com
via electronic service

Bryan Hurlbutt
Laurence ("Laird") J. Lucas
Advocates for the West P.O.
Box 1612 Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org
via electronic service

Michael A. Short
Hannah M.C. Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
michael.short@deq.idaho.gov
hannah.young@deq.idaho.gov
via electronic service

Julia Thrower
Mountain Top Law
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com
via electronic service

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
Counsel for the Idaho
Board of Environmental Quality
ann.yribar@ag.idaho.gov
via electronic service

Diane Cutler, Hearing Coordinator
Rules and Planning Analyst
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
(208) 373-0165
diane.cutler@deq.idaho.gov
via electronic service

/s/ *W. Christopher Pooser*
W. Christopher Pooser
Attorneys for Perpetua Resources Idaho, Inc.

EXHIBIT 1
Excerpts from Permit to Construct

Air Quality

PERMIT TO CONSTRUCT

Permittee	Perpetua Resources Idaho, Inc.
Permit Number	P-2019.0047
Project ID	62288
Facility ID	085-00011
Facility Location	Forest Service Roads NF-374 and NF-412 Stibnite, Idaho 83611

Permit Authority

This permit (a) is issued according to the "Rules for the Control of Air Pollution in Idaho" (Rules), IDAPA 58.01.01.200–228; (b) pertains only to emissions of air contaminants regulated by the State of Idaho and to the sources specifically allowed to be constructed or modified by this permit; (c) has been granted on the basis of design information presented with the application; (d) does not affect the title of the premises upon which the equipment is to be located; (e) does not release the permittee from any liability for any loss due to damage to person or property caused by, resulting from, or arising out of the design, installation, maintenance, or operation of the proposed equipment; (f) does not release the permittee from compliance with other applicable federal, state, tribal, or local laws, regulations, or ordinances; and (g) in no manner implies or suggests that the Idaho Department of Environmental Quality (DEQ) or its officers, agents, or employees assume any liability, directly or indirectly, for any loss due to damage to person or property caused by, resulting from, or arising out of design, installation, maintenance, or operation of the proposed equipment. Changes in design, equipment, or operations may be considered a modification subject to DEQ review in accordance with IDAPA 58.01.01.200–228.

Date Issued June 17, 2022

Kelli Wetzel

Kelli Wetzel, Permit Writer

Mike Simon

Mike Simon, Stationary Source Bureau Chief

the Stockpile Transfer to Reclaim Conveyors (OC9), Reclaim Conveyors to SAG Mill Feed Conveyor (OC10), and SAG Mill Feed Transfer to SAG Mill conveyor (OC11).

- Develop specific criteria to determine what frequency and type (water and/or chemical) of dust suppressant must be applied, and appropriate suppressant application rates. Chemical dust suppressants shall be applied consistent with manufacturer's instructions and recommendations.
- Develop and implement precautionary measures to address high-wind events, such as when average (sustained) wind speed is forecast to exceed 25 miles per hour.
- Provide training/orientation to all relevant employees regarding FDCP requirements, including the necessity of restricting public access as specified in the Access Management Plan (AMP). Visible emissions evaluations shall be conducted by the permittee's employees who are certified visible emission observers.
- At least once each year, evaluate FDCP requirements to identify additional requirements and evaluate effectiveness of practices, including dust suppressant application rates, as appropriate.

2.7 The permittee shall develop and maintain an AMP that identifies the facility boundary and all primary and secondary access points, and clearly specifies measures used to discourage public access to the facility. The permittee shall comply with the measures identified in the AMP at all times. The measures specified in the AMP shall be incorporated by reference to this permit and shall be enforceable permit conditions. At a minimum, the AMP shall include requirements to:

- Observe all primary access points to preclude unauthorized public access. Onsite personnel shall be available for this purpose during active mining and mineral processing operations. Public access to the facility may be monitored by the use of security escort vehicles or manned guardhouses, or sufficiently precluded by the use of locked gates, barriers, or equivalent measures. Primary access points include the North and South Security Gates.
- Post warning signs and periodically patrol secondary access points to the facility to preclude public access. Onsite personnel shall be available for this purpose. Plans shall be described in the AMP, including identifying the access points monitored, the frequency of patrol, and measures employed to discourage access (e.g., locked gates, barriers, natural features, etc.). Secondary access points include secondary roadways and trails traversing the facility.
- Only registered guests of the facility will be allowed access to or through the facility. Those seeking to be a guest for the sole purpose of passing through the facility to another destination shall be provided a registration sheet that explains Perpetua's requirements for accessing the site and identifies potential hazards of the site.

2.8 Copies of the FDCP and AMP shall be submitted to DEQ for approval 30 days prior to startup at the address provided (Permit Condition 2.26), and shall remain onsite at all times. Any changes to the FDCP or the AMP shall be submitted to DEQ for review, comment, and approval 30 days prior to the change.

EXHIBIT 2
Excerpts from Statement of Basis

Statement of Basis

Permit to Construct No. P-2019.0047
Project ID 62288

Perpetua Resources Idaho, Inc.
Stibnite, Idaho

Facility ID 085-00011

Final

June 17, 2022

Kelli Wetzel KW
Permit Writer

The purpose of this Statement of Basis is to satisfy the requirements of IDAPA 58.01.01.et seq, Rules for the Control of Air Pollution in Idaho, for issuing air permits.

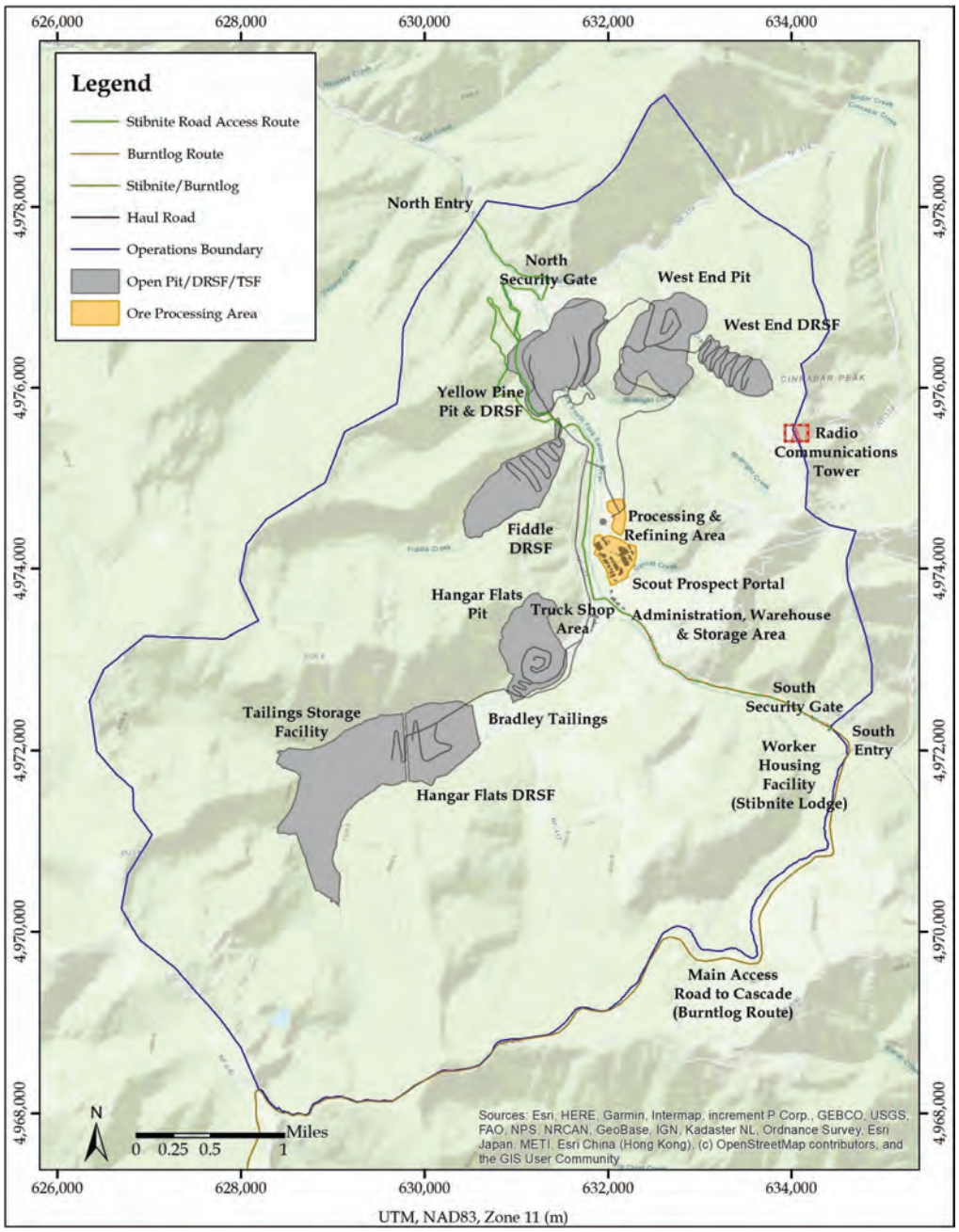
FACILITY INFORMATION

Description

Perpetua Resources Idaho, Inc. (PRI) proposes to construct and operate the Stibnite Gold Project (SGP), consisting of conventional open-pit mining, ore preparation, and gold extraction operations.

SGP is to be located in Valley County at the intersection Forest Service roads NF-374 and NF-412 (Stibnite Road), approximately 10 miles east of Yellow Pine. The proposed Burntlog Route access road will provide year-round access to the site. The project comprises a combination of public national forest and private lands. The mining operations boundary within which public access will be excluded is defined in Figure 1. This operations boundary also defines the ambient air boundary used in all ambient air quality impact analyses.

Figure 1 PROJECT AREA OF OPERATIONS



3.3.10 Ambient Air Boundary

Ambient air is defined in Section 006 of the Idaho Air Rules as "that portion of the atmosphere, external to buildings, to which the general public has access."

PRI will legally control the SGP, an active industrial site where mining activities will occur, such as heavy equipment operation. Most areas of the mine will require strict safety protocols and controlled access. PRI has established an operations boundary to identify the area where public access will be excluded. Public access inside the operations boundary will be restricted for the life of the mine by physical barriers at points of potential access, including the current Stibnite Road point of entry and proposed site access via the Burntlog Route, as well as natural features of the landscape that prevent access. Consistent with the guidance provided in the EPA's draft revised policy on ambient air (EPA 2018b), public access control will include the following measures:

- Primary Access Points: The Stibnite Road (north) and Burntlog Route (south) access points will include locked gates. Guard shacks will be located at each gate to monitor all vehicle ingress/egress. Each gate also will include appropriate adjacent barriers (i.e., fencing, bollards, boulders, or other barriers) to prevent any vehicle from circumventing the gate and gaining site access. These primary access points are also controlled by adjacent natural features, such as streams and creeks, steep topography, and areas of thick vegetation and undergrowth that serve as natural barriers or impediments to access.

- Secondary Access Points: Other potential access points, such as secondary roadways and trails, will include posted signs warning the public against entry into the site. At these locations, boulders will be placed across the trail and at an appropriate width adjacent to the trail to prevent any vehicle from circumventing the barrier. These secondary access points also incorporate adjacent natural features, such as streams and creeks, steep topography, and areas of thick vegetation and undergrowth that serve as natural barriers or impediments to access. Some mine features, such as the TSF and process plant areas, will include perimeter fencing.

- Surveillance: PRI security personnel will routinely patrol mine facilities and roadways for unauthorized individuals. In addition, all onsite personnel will be trained on the necessity of restricting public access to areas within the operations boundary. Any suspected trespassing by unauthorized individuals will be reported immediately to security, and trespassers will be escorted off the site.

In response to comments from local community citizens, PRI will manage an access route to provide the general public with limited access through the SGP site between Stibnite Road at Sugar Creek and Thunder Mountain Road at Meadow Creek (shown in Figure 2). This route will be managed in accordance with the Stibnite Road Access Management Plan which is summarized as follows:

The proposed Stibnite Road access route through the SGP site is meant to provide controlled through-site access that is safe, provides travel-time comparable to current conditions and is consistent with the United States Forest Service travel management plan. The Stibnite Road access route extends from the north entry point southward to the Administration, Warehouse and Storage Area. Continuing southward, the Stibnite Road access route incorporates the Burntlog access road segment that occurs within the operations area and extends to the south entry point as shown on Figure 2. PRI has the legal authority to control access to the Stibnite Road access route and would provide seasonal (non-winter conditions) access only. At the discretion of PRI, additional access controls may occur during various phases of construction, during mine operations that present potential safely hazards such as blasting, due to

REC 7497
REC 0676
PET 310

inclement weather, or under any other circumstances that may present a threat to the protection of public or employee health and safety. PRI has the legal and practical ability to enforce its control over roadway access and to monitor traffic passing through the SGP site. Signage will be placed at the North Security Gate (near the bridge over Sugar Creek) and the South Security Gate (near the Stibnite Lodge) to provide information to travelers, and guard shacks will be located at each gate to monitor all vehicle ingress/egress. Persons wishing to traverse the SGP site on the Stibnite Road access route will be required to check in at the security gate to receive a safety briefing and to alert mine staff of their presence. Travelers will be required to check out upon exiting the site to ensure passage through the site in a safe and timely manner. Travelers will not be allowed to stop or loiter while traveling though the operations area. Along its full length, the Stibnite Road access route would have appropriate signage to direct travelers and would be separated from mine haul roads and areas of mine operations by fencing, berms, or gates to prevent travelers from straying from the route. When possible and to the degree practicable, anticipated public access restrictions will be communicated to the public in a timely manner so that they may plan appropriately. Receptors on the Stibnite Road access route were not included in the SGP air quality analyses as this road is not considered ambient air.

The worker housing facility will be located within the project operations boundary, near the south access security gate. This housing facility will be used strictly for accommodating employees, contractors, and official visitors, and it will not be accessible to the general public. Therefore, the atmosphere over the land occupied by the worker housing facility is not considered ambient air, and receptors were not placed at this location for the air quality analyses.

The operations boundary, shown in Figure 2 above and Figure 9 below, was used to define the ambient air boundary for air dispersion modeling purposes.

3.3.11 Nearby Co-Contributing Sources

If impacts of neighboring emission sources on receptors showing a significant impact from the sources subject to the permitting action are not adequately accounted for by the background concentration used, then emissions from those sources must be modeled. The nearest significant permitted facility to SGP is Tamarack Mill, located more than 75 kilometers (km) west. This facility is located too far away to cause a significant concentration gradient along the periphery of the SGP and was therefore not included in the cumulative impact analyses for SGP.

3.3.12 Receptor Network

DEQ determined that the receptor grid used in the submitted modeling analyses was adequate to resolve maximum modeled impacts.

The SGP air quality analyses were performed using the following receptor spacing and extents (Table 18):

- 25-m-spaced receptors placed along the ambient air boundary;
- 50-m-spaced receptors extending 250 m beyond the ambient air boundary;
- 100-m-spaced receptors extending 1 km beyond the 50-m-spaced receptors;
- 500-m-spaced receptors extending 5 km beyond the ambient air boundary; and
- 1-km-spaced receptors extending 10 km beyond the ambient air boundary.

In addition, each highest modeled impact was evaluated further by performing a hot-spot analysis using a finer 25-m-spacing receptor grid. The modeling receptor grid is shown below in Figure 9. The full grid,

405 S. 8th Street #201
Boise, ID USA 83702
info@midasgoldidaho.com

MAX.TSX
MDRPF.OTCQX

www.midasgoldidaho.com

Midas Gold Idaho, Inc. - Stibnite Gold Project
Stibnite Road Access Management Plan – Version 1

April 15, 2020

1 Purpose and Objectives

This Stibnite Road Access Management Plan (Plan) describes the methods whereby Midas Gold Idaho, Inc. (Midas Gold), an Idaho corporation, would manage access on designated roads that traverse the proposed Stibnite Gold Project (SGP) mine site. The SGP is described in Midas Gold's Plan of Restoration and Operations (PRO).

The SGP is a proposed open pit mine that will be located at Stibnite, in central Idaho (see inset, Figure 1). The United States Forest Service (USFS) Forest System Road (FR) that passes through Stibnite (Stibnite Road; FR 50412) extends from the village of Yellow Pine eastward along the East Fork of the South Fork of the Salmon River for approximately 14 miles. Stibnite Road then continues south through the historic Stibnite mine site and connects with Thunder Mountain Road (FR 50375) on the southeastern portion of the proposed SGP. This route also allows for access to Meadow Creek Lookout Road (FR 51290; see Figure 1). As initially proposed, construction and operations at the SGP would prohibit access through the mine site for the life of the mine (approximately 20 to 25 years). During this period, alternative access to Thunder Mountain Road and Meadow Creek Lookout Road would be provided via the newly constructed Burntlog Route; a proposed mine access route that would connect the existing Burnt Log Road to Thunder Mountain Road with a new section of roadway and an upgraded section of Meadow Creek Lookout Road. Additionally, as proposed in the PRO, an off-highway vehicle (OHV) Trail would be upgraded to connect Horse Heaven/Powerline Road to Meadow Creek Lookout Road. Public access routes proposed in the PRO are illustrated in Figure 1. As part of reclamation of the SGP and closure of the mine site, Stibnite Road would be re-established in an alignment similar to its current location and would become the primary access route to Thunder Mountain Road. The Burntlog Route would be reclaimed to its previous condition and would no longer be connected to Thunder Mountain Road.

Following the presentation of the proposed public access routes described above in Midas Gold's PRO, an alternative public access route has been proposed by Midas Gold and would pass through the SGP mine site (Stibnite Road access route). This alternative route is under evaluation as part of the USFS's obligation to review the SGP in accordance with the National Environmental Policy Act (NEPA). One of the alternatives currently being evaluated in the Draft environmental impact statement (EIS), Alternative 2, would provide continued access through the SGP site on a realigned Stibnite Road during mine operations. The implementation of this Plan is contingent upon the selection of the applicable alternative by the USFS as the preferred alternative for the SGP and inclusion of the proposed Stibnite Road access route as a component of the approved SGP.

The health and safety of the public and the employees of the SGP is Midas Gold's priority. The procedures included in this Plan would be implemented by Midas Gold over the course of the life of the mine to ensure that the use of the Stibnite Road access route is conducted safely and responsibly.

2 Project Information

2.1 Introduction

Midas Gold has proposed to redevelop portions of the Stibnite Mining District (District) as described in the SGP PRO, submitted to the United States Forest Service (USFS) in September 2016. The SGP will be located at Stibnite in Valley County, approximately 92 miles by air and 144 miles by road northeast of Boise, Idaho; 44 air miles northeast of Cascade, Idaho; and 10 air miles east of Yellow Pine, Idaho. Current access to the site is from State Highway 55 to the SGP area via Warm Lake, Johnson Creek, and Stibnite Roads as shown in Figure 1. The proposed layout of the SGP mine features is illustrated in Figure 2.

Mining operations in the District first began in the 1920s and continued episodically through 1996. Proposed SGP mine operations described in Section 9 of the PRO would include open-pit mining in the three previously mined areas:

- The Yellow Pine open pit will encompass the area of the former Yellow Pine pit, Homestake pit, and portions of the Bradley Mining Company rock dumps.
- The West End open pit will encompass the former Stibnite Mines, Inc., open pits.
- The Hangar Flats open pit will encompass the former underground Meadow Creek Mine area, Hecla heap, and adjacent former mill and smelter area.

Other features and facilities that would be part of SGP mine operations include development rock storage facilities (DRSF), a tailings storage facility (TSF) and tailings pipeline, surface water management features (diversions, collection ditches, stormwater collection ponds), an ore processing facility, a water treatment facility, equipment maintenance and storage buildings, a worker housing facility, and all associated haul roads and access roads. The north and south points of entry to the SGP would have security gates and guard shacks that would be occupied on a continual basis. Features related to SGP mine but located off-site are illustrated in Figure 1 and include the Landmark Road Maintenance Facility, Stibnite Gold Logistics Facility, and features associated with powerline upgrades and extension.

The general timeline for constructing, operating, restoring, and mitigating the SGP is approximately 20 to 25 years, including 3 years of site preparation, construction, and early restoration activities; 12 to 15 years of operations; and 5 to 7 years of final closure and reclamation work. The SGP will produce gold, silver, and antimony over the 12- to 15-year mining period.

2.2 The SGP and NEPA

The proposed SGP occurs on patented mining claims (private land) and land administered by the United States Forest Service (USFS) within both the Boise National Forest (BNF) and Payette National Forest (PNF). The Big Creek/Stibnite Management Area 13, which includes the District, is administered by the Krassel Ranger District of the PNF. Proposed actions that occur on Federally managed lands require environmental review and analysis in compliance with NEPA. The NEPA analysis for the SGP was initiated

in mid-2017 with the USFS as the lead agency. The USFS is preparing an EIS to evaluate the environmental effects of the proposed SGP as well as a range of alternatives to the proposed action.

Public comments received for the SGP indicated that the change in access through the SGP for 20 to 25 years was of significant concern, particularly for those in the Johnson Creek and Yellow Pine area who use Stibnite Road to access Thunder Mountain Road and points beyond. At the direction of the USFS, Midas Gold evaluated numerous additional access options for the SGP that provided access similar to existing conditions and travel times. Midas Gold identified a suitable access route through the SGP site that would provide through-site access during operations. The road was designed to be separated from mine operations and to provide access similar to that provided by the existing Stibnite Road. The alternative access route through the SGP was included for consideration in the Draft EIS document as a component of Alternative 2.

2.3 Proposed Stibnite Road Access Route Through the SGP

The proposed SGP Stibnite Road access route that is currently under evaluation in the SGP Draft EIS is illustrated in Figure 2 and would include one of the two optional routes described below. During mine site construction, a new 12-foot-wide gravel road would be constructed to provide public access from Stibnite Road on the northern end of the SGP to Thunder Mountain Road on the southeastern end of the site. Along its full length, the Stibnite Road access route would have appropriate signage to direct travelers and would be separated from mine haul roads and areas of mine operations by fencing, berms, or gates to prevent travelers from straying from the route.

Two optional routes were identified and include variations in alignment in the vicinity of the Yellow Pine pit:

- **Stibnite Road Access Route: Option 1** – The access road would begin at the North Security Gate and would be constructed along a widened bench of the western portion of Yellow Pine pit during an early operational phase of the mine. South of the Yellow Pine pit this road would pass beneath the mine haul leading to the Fiddle Creek DRSF and would then parallel a mine haul road along a partially revegetated portion of the former Bradley mine haul road. In the central portion of the SGP site near the Mine Administration Building, the road would connect with the Burntlog Route and continue southeast toward the Worker Housing Facility and the South (Main) Security Gate. From the north end (North Security Gate) of the SGP to the south end (South Security Gate), this road would be approximately 3 miles in length.

- **Stibnite Road Access Route: Option 2** – The access road would begin at the North Security Gate and would be constructed west of the Yellow Pine pit. South of the Yellow Pine pit this road would pass beneath the mine haul leading to the Fiddle Creek DRSF and would then parallel a mine haul road along a partially revegetated portion of the former Bradley mine haul road. In the central portion of the SGP site near the Mine Administration Building, the road would connect with the Burntlog Route and continue southeast toward the Worker Housing Facility and the South (Main) Security Gate. From the north end (North Security Gate) of the SGP to the south end (South Security Gate), this road would be approximately 4 miles in length.

Based on assessment of impacts and public and agency feedback, one of these two options would be selected if Alternative 2 is identified as the Preferred Alternative for the Midas Gold SGP.

2.4 Access Controls

The proposed Stibnite Road access route through the SGP site is meant to provide controlled, through-site access that is safe, and provides travel-time comparable to current conditions. Additionally, the Stibnite Road access route would provide access that is consistent with the USFS travel management plan. Whereas Stibnite Road between Yellow Pine and Stibnite is not plowed in winter, Midas Gold would operate the Stibnite Road access route on a seasonal basis, i.e. access would not be provided in winter. Public access to the road would begin when Stibnite Road becomes passable in the Spring.

For either of the two route options described above, the northern extent of the Stibnite Road access route would begin at the North Security Gate, would continue southward traversing the SGP mine site, would connect with the Burntlog Route and would continue southeastward out of the mine operations area. The access route would exit South Security Gate near the employee housing facility.

Midas Gold has the legal authority to control access to the Stibnite Road access route and would provide seasonal (non-winter conditions) access only. At the discretion of Midas Gold, additional access controls may occur during various phases of construction, during mine operations that present potential safety hazards such as blasting or pit expansion, due to inclement weather, or under any other circumstances that may present a threat to the protection of public health and safety. Midas Gold has the legal and practical ability to enforce its control over roadway access and to monitor traffic passing through the SGP site. Signage would be placed at the North Security Gate (near the bridge over Sugar Creek) and the Main (South) Security Gate (near the Stibnite Lodge) entry points to provide information to travelers, and guard shacks would be located at each SGP Site entry gate to monitor all vehicle ingress/egress. To ensure passage through the site in a safe and timely manner, persons wishing to traverse the SGP site on the Stibnite Road access route would be required to check in at the security gate upon entry to receive a safety briefing and to alert mine staff as to their presence. After passing through the SGP site, travelers would also be required to stop at the guard shack upon exiting to check out. Travelers would not be allowed to stop or loiter while traveling though the operations area. Along its full length, the Stibnite Road access route would have appropriate signage to direct travelers and would be separated from mine haul roads and areas of mine operations by fencing, berms, or gates to prevent travelers from straying from the route.

Midas Gold would have the ability to temporarily restrict travel along the Stibnite Road access route for the protection of public health and safety. When possible and to the degree practicable, anticipated public access restrictions would be communicated to the public in a timely manner so that they may plan appropriately.

3 Conclusion

Midas Gold's SGP is under evaluation by the USFS and is proceeding through environmental analysis under NEPA. Midas Gold's proposed action and several alternatives to the proposed action will be included in the forthcoming Draft EIS. Alternative 2 in the Draft EIS includes an access alternative that would route a roadway, the Stibnite Road access route, through the mine site.

Maintaining and protecting SGP mine employee and public health and safety is Midas Gold's priority. This Stibnite Road Access Management Plan has been prepared to demonstrate that appropriate best practices, roadway construction features, and Midas Gold SGP site security measures would be in place over the life of the SGP mine and would effectively control access to the Stibnite Road access route.

This Plan will be updated and revised as appropriate.

List of Figures

Figure 1 – Site Vicinity Map
Figure 2 – Mine Site Layout

EXHIBIT 3
Excerpts from Draft EIS

United States Department of Agriculture
Forest Service

Stibnite Gold Project

Draft Environmental Impact Statement

Forest Service, Region 4, Payette and Boise National Forests, Valley County, Idaho

August 2020



REC 7505

PRI-00001021

Table 2.2-1 Primary Differences Between the Action Alternatives

SGP Phase	Component/Subcomponent	Alternative 1	Alternative 2	Alternative 3	Alternative 4
All Phases	SGP timeline	• Construction: Approximately 3 years • Operations: Approximately 12 years • Exploration: Approximately 15 years (during construction and operations) • Reclamation: Approximately 5 years • Environmental Monitoring: As long as needed	Same as Alternative 1	Same as Alternative 1 : .	Same as Alternative 1 except: Construction: Approximately 5 years
All Phases	Access Roads	Construction/Operations: • Yellow Pine Route for mine site access during early construction with minor improvements • Burntlog Route for mine site access during construction, mining and ore processing operations, and closure and reclamation. • Associated eight borrow areas developed along Burntlog Route for materials needed for road improvements and maintenance Closure and Reclamation • New sections of Burntlog Route to be reclaimed after the closure and reclamation period	Same as Alternative 1, except: • Reroute of a 5.3-mile segment of the Burntlog Route (Riordan Creek Segment)	Same as Alternative 1, except: • The Burntlog Route in the vicinity of the East Fork South Fork Salmon River (EFSFSR) TSF rerouted on a new road segment, to come into the mine site adjacent to Blowout Creek during operations • Rerouting of the Burntlog Route would eliminate access to two of the eight borrow areas	• Yellow Pine Route upgraded and used for mine site access throughout life of mine instead of the Burntlog Route • Access route around the Yellow Pine pit for employee access and deliveries of supplies and equipment to the processing, warehouse, worker housing facility, and administration areas • No improvements or construction of new segments for Burntlog Route • Associated borrow sources developed along the Yellow Pine Route for materials needed for road improvements and maintenance
All Phases	Public Access	Construction: • Temporary groomed over-snow vehicle (OSV) trail on the west side of Johnson Creek from Trout Creek to Landmark while Burntlog Route is constructed • Cabin Creek Road Groomed OSV trail • Public roads remain open through the mine site with temporary closures as needed to accommodate construction • Off-highway vehicle (OHV) Trail from Horse Heaven/Powerline to Meadow Creek Lookout Road (National Forest System Road [FR] 51290) Operations: • Stibnite Road (County Road [CR] 50-412) / Thunder Mountain Road (FR 50375) closed through the mine site • Public access allowed on Burntlog Route to Thunder Mountain Road (FR 50375) through the mine site • OHV Trail from Horse Heaven/Powerline to Meadow Creek Lookout Road (FR 51290) • Cabin Creek Road Groomed OSV trail Closure and Reclamation: • New road constructed over the Yellow Pine DRSF (backfilled Yellow Pine pit) connecting Stibnite Road (CR 50-412) to Thunder Mountain Road (FR 50375)	Construction: Same as Alternative 1 Operations: Same as Alternative 1 except: • Public access through the mine site provided by constructing new road to link Stibnite Road (CR 50-412) to Thunder Mountain Road (FR 50375) with two options: ○ Option 1 - through Yellow Pine pit and below mine haul road ○ Option 2 - west of Yellow Pine pit and below mine haul road Closure and Reclamation: Same as Alternative 1	Construction: Same as Alternative 1 except: • Meadow Creek Lookout Road would be upgraded from Burntlog Route to Monumental Summit for public access • No OHV Trail from Horse Heaven/Powerline to Meadow Creek Lookout Road (FR 51290) Operations: Same as Alternative 1 except: • No public access through the mine site • Public access on Burntlog Route connecting to upgraded Meadow Creek Lookout Road (FR 51290) • No OHV Trail from Horse Heaven/Powerline to Meadow Creek Lookout Road (FR 51290) Closure and Reclamation: • Road established over Yellow Pine DRSF (same as Alt 1) to middle of mine site where public access provided around the TSF using one of two options: ○ Conversion of the temporary operational TSF access road along the TSF pipeline route to a permanent public access road connecting to the existing road at both ends ○ Retention of mine access road through Blowout Creek drainage for public access	Construction: Same as Alternative 1 except: • No OHV Trail from Horse Heaven/Powerline to Meadow Creek Lookout Road (FR 51290) • Groomed OSV trail on the west side of Johnson Creek from Wapiti Meadows to Landmark from construction through mine closure Operations: Same as Alternative 1 except: • No OHV Trail from Horse Heaven/Powerline to Meadow Creek Lookout Road (FR 51290) • Public access through the mine site provided on same route as mine access around the Yellow Pine pit. • Groomed OSV trail on the west side of Johnson Creek from Trout Creek to Landmark from construction through mine closure Closure and Reclamation: Same as Alternative 1

REC 7506

PRI-00001022

2.4.3 Timeline

Timelines for construction, operations, and closure and reclamation for Alternative 2 would be the same as for Alternative 1.

2.4.4 Construction Phase

Construction activities and timing under Alternative 2 would be essentially the same as under Alternative 1. However, the modifications described in **Table 2.4-1** above would eliminate, relocate or modify interrelated construction activities.

2.4.4.1 Access Roads

BURNTLOG ROUTE – RIORDAN CREEK SEGMENT

Under Alternative 2, a section of new road construction along Burntlog Route (**Figure 2.4-3**) would be located on the south side of the Riordan Creek drainage and cross Riordan Creek north of Black Lake. The approximately 5.3-mile road segment would have 12 stream crossings, 3 of which cross perennial streams. The elevation of this road segment is approximately 8,000 to 8,600 feet and the average grade of this road segment would be 5 to 6 percent. The new construction portion of Burntlog Route under Alternative 2 would be approximately 13.5 miles and under Alternative 1 would be approximately 15 miles.

2.4.4.2 Public Access

STIBNITE ROAD TO THUNDER MOUNTAIN ROAD LINK

During mine site construction, a new 12-foot-wide gravel road would be constructed to provide public access from Stibnite Road (CR 50-412) to Thunder Mountain Road (FR 50375). The public access road would be constructed prior to the removal of development rock from Yellow Pine pit.

There are two options for a public access road through the mine site:

- Option 1 (**Figure 2.4-4**) – Constructed along a widened bench of the western portion of Yellow Pine pit (**Figure 2.4-5**). South of Yellow Pine pit this road would parallel a mine haul road and use a partially revegetated portion of the former Bradley mine haul road (**Figure 2.4-6**). The public access road portion through Yellow Pine pit would include a rockfall catchment area. This road would be approximately 3 miles in length.
- Option 2 (**Figure 2.4-7**) – Constructed west of the Yellow Pine pit. South of Yellow Pine pit, this road would parallel a mine haul road and use a partially revegetated portion of the former Bradley mine haul road (**Figure 2.4-8**). This road would be approximately 4 miles in length.

Based on assessment of impacts and public and agency feedback, one of these two options would be selected.

REC 7507

PRI-00001023

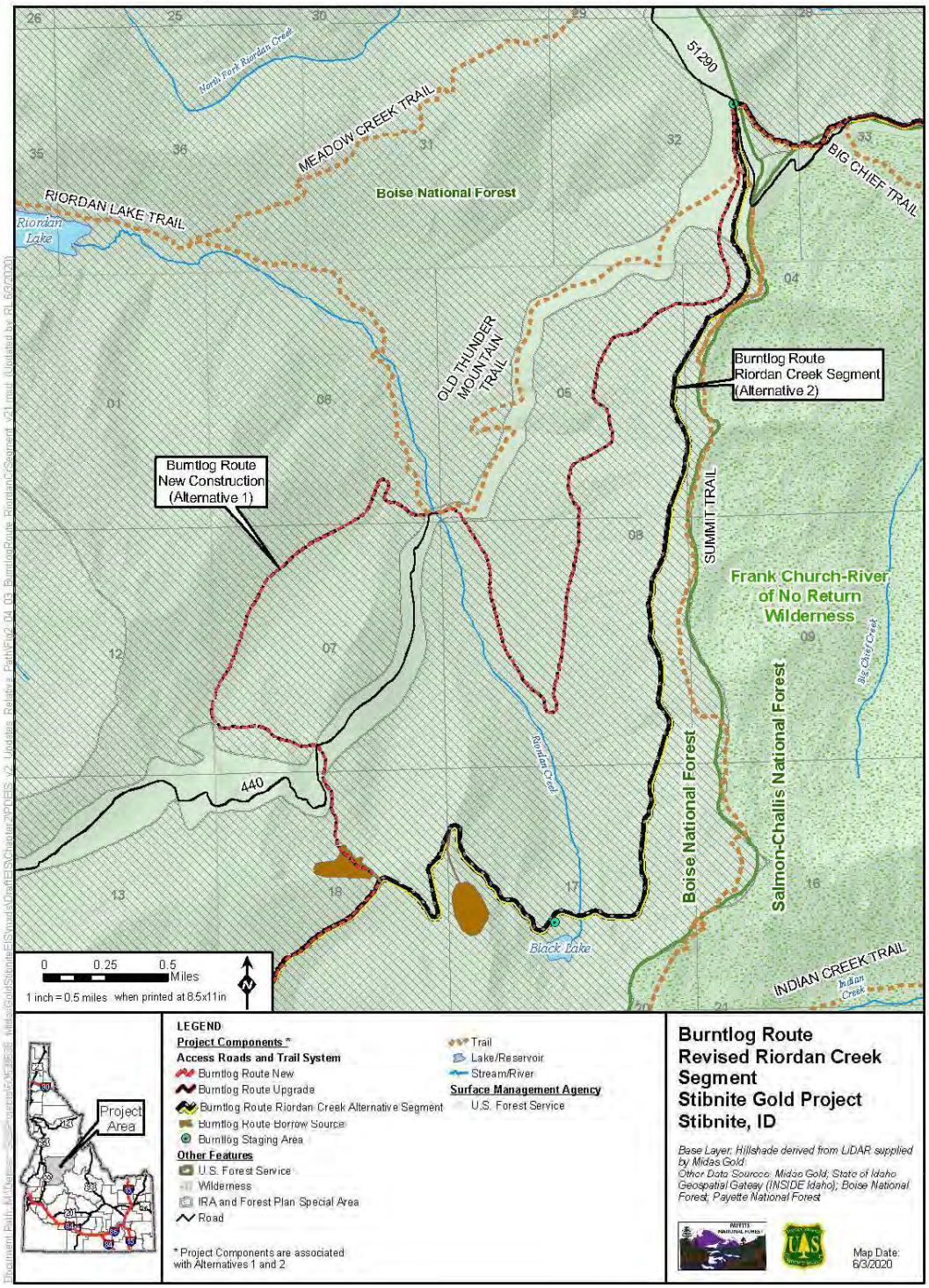


Figure Source: AECOM 2020a

Figure 2.4-3 Burntlog Route Revised Riordan Creek Segment

REC 7508

PRI-00001024

This page intentinally left blank

REC 7509

PRI-00001025

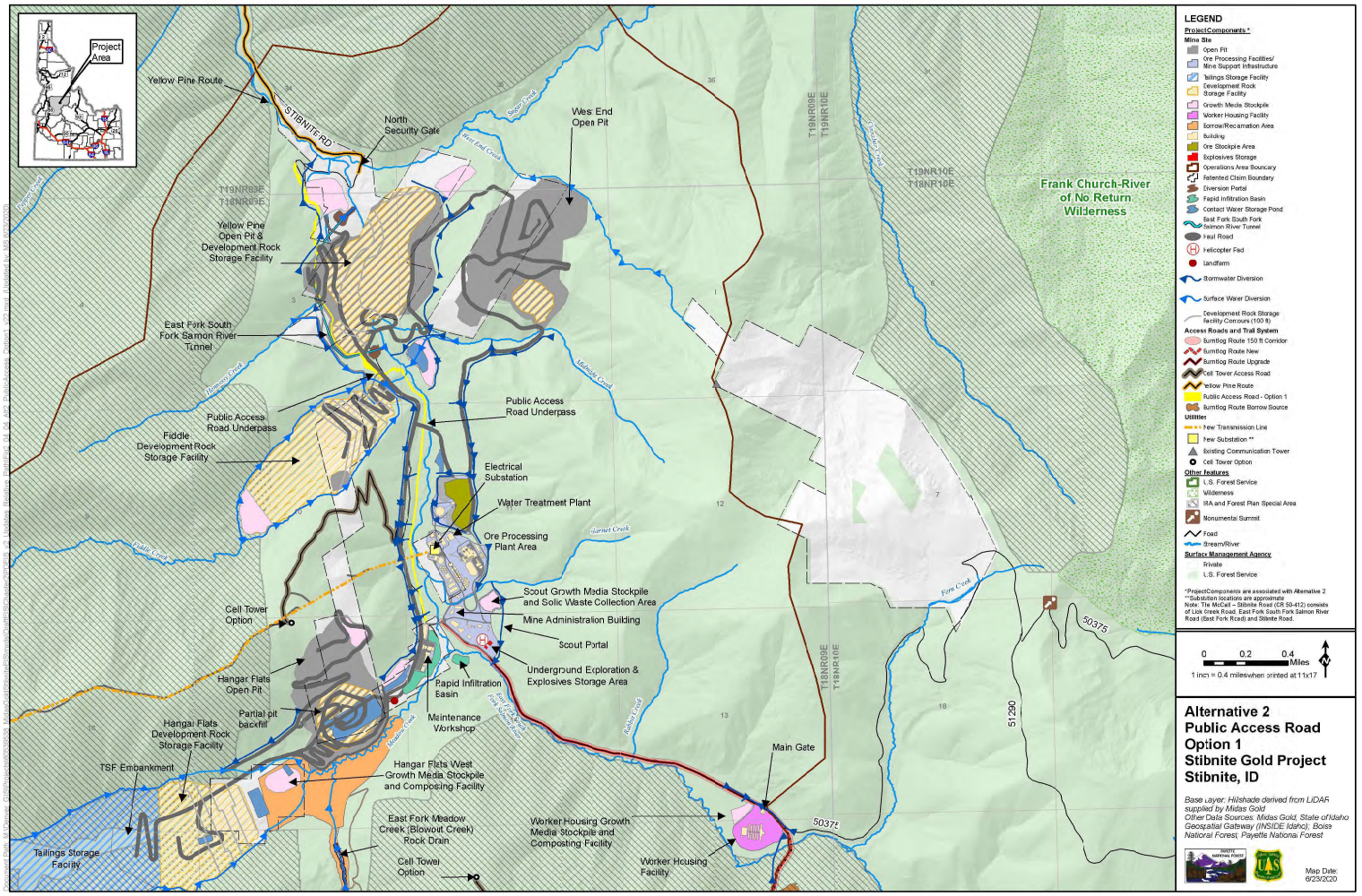


Figure Source: AECOM 2020a

Figure 2.4-4 Alternative 2 Public Access Road Option 1

REC 7510

PRI-00001026

When the volume of water needing treatment in the Centralized WTP exceeds 4,000 gpm, such as during spring runoff, contact water ponds would be used to equalize the flows through the Centralized WTP. For high water years, mine pits also could be temporarily used to hold water for treatment.

During mine operation, the Centralized WTP is expected to require the following chemicals and reagents on an annual basis.

Sodium Hypochlorite – 15,000 gallons

Ferric Sulfate – 125,000 gallons/year

Hydrated Lime – 250 tons

Organic Flocculant (polymer) – 1,900 gallons

Sulfuric Acid – 2,400 gallons

Sodium Bisulfite – 2,000 gallons

Organic sulfide precipitant, if needed

Transport of these chemicals and reagents would add approximately 40 round trips for delivery to the operational AADT presented in **Table 2.4-3**. An estimated 2 to 4 employees would be required to operate the Centralized WTP.

The resulting solids from the Centralized WTP are not expected to be classified as a hazardous waste, and would be disposed in the TSF. Treated water would be discharged through the RIBs and/or direct discharge to the EFSFSR through an IPDES permitted outfall.

2.4.5.7 Access Roads

Access during operations would be the same as described in Alternative 1, except that a portion of the Burntlog Route would be relocated as described in Section 2.4.3.1, Access Roads.

2.4.5.8 Public Access

STIBNITE ROAD TO THUNDER MOUNTAIN ROAD LINK

Public Access during operations would be the same as described in Alternative 1, except that a new 12-foot-wide gravel road would be constructed to provide public access from Stibnite Road (CR 50-412) to Thunder Mountain Road (FR 50375) as described in Section 2.4.4.2, Public Access. The public access road would be used to travel through the mine site and would provide seasonal use, open to all vehicles. Vehicles passing through the mine site would be required to check-in with mine personnel at the Main or North Gates guard shacks upon entering the mine site and would receive a safety briefing. Vehicles on the public access road would be required to pass through the mine site without stopping or deviating from the public access road and would be required to check-out with mine site personnel upon exiting the mine site, to ensure they are clear of the site for safety purposes. Midas Gold would have the option to restrict mine site access to any vehicles due to concerns related to public or employee health

and safety, such as during blasting, mining in the immediate area of the road and other similar operations.

Berms, security fencing, and two underpasses, to allow the public road to pass beneath the mine haul road, would separate the public access road from other mine site roads. One underpass would be located north of the Fiddle DRSF and a second underpass would be located near the ore processing facility area. The public access road would be temporarily closed during construction and maintenance, and during other mining activities that would be considered public safety hazards (e.g., highwall scaling, blasting). Signs would be placed to inform the public of temporary closures and the public access road would not be plowed in the winter.

2.4.5.9 Off-site Facilities

Under Alternative 2, a maintenance facility (Burntlog Maintenance Facility) would be constructed within a borrow source site 4.4 miles east of the junction of Johnson Creek Road and Warm Lake Road (**Figure 2.4-1**). The relocated maintenance facility would include the same components as described in Alternative 1.

2.4.5.10 Traffic

The production of lime on-site would reduce lime deliveries to the site by 2,032 trips per year and would require an average of 133 additional propane deliveries per year (Midas Gold 2018b).

Table 2.4-3 shows the expected operational supply and haulage traffic under Alternative 2. The AADT for Alternative 2 is 50 vehicles.

2.4.6 Closure and Reclamation

Closure and Reclamation activities under Alternative 2 would be the same as under Alternative 1, except as described below.

2.4.6.1 Hangar Flats DRSF

Upon completion of final grading of the Hangar Flats DRSF, a low permeability geosynthetic cover would be placed on the top of the DRSF, which would be designed to limit infiltration through the DRSF. The geosynthetic liner would be overlain by placement of an inert soil/rock layer and growth media and revegetated.

2.4.6.2 Fiddle DRSF

Upon completion of final grading of the Fiddle DRSF, a low permeability geosynthetic cover would be placed on the top and outslopes of the DRSF that is designed to limit infiltration through the DRSF. The geosynthetic liner would be overlain by placement of an inert soil/rock layer and growth media and revegetated.

4 ENVIRONMENTAL CONSEQUENCES

4.1 INTRODUCTION

Chapter 4 describes the potential environmental consequences of implementing each of the alternatives presented in Chapter 2. Pursuant to 40 Code of Federal Regulations (CFR) 1500.1(b) and 1500.4, this section summarizes the completed analysis and forms the scientific and analytical basis for the comparison of alternatives. The alternatives described in Chapter 2 may cause, either directly or indirectly, changes in the human and natural environment. This Environmental Impact Statement (EIS) analyzes these potential changes and discloses the effects to the decision-makers and the public. Disclosure is a fundamental goal of the National Environmental Policy Act (NEPA). In addition, cumulative effects along with applicable mitigation measures and irreversible and irretrievable effects also are discussed. Effects of each action can be neutral, beneficial, and/or adverse. Effects are quantified whenever possible, and/or are qualitatively discussed.

The individual resource discussions are generally presented by issue(s) and organized with the presentation of the effects analysis issues and indicators for the resource; a brief methodology for the analysis of impacts; an evaluation of the alternatives' impacts to the resource; a discussion of cumulative effects, irreversible and irretrievable commitments, and short-term uses versus long-term productivity; followed by a summary of impacts by issues and indicators. The final subsection provides a table summarizing and comparing quantitative and qualitative impacts to each resource by alternative.

Section 4.1, Introduction, provides a brief explanation of what each resource section will address, including a summary of incomplete and unavailable information relevant to evaluating significant adverse impacts; the presentation of past, present, and reasonably foreseeable future actions (RFFAs) used for the direct, indirect, and cumulative impact analyses; and a discussion of Forest Plan Consistency and Potential Forest Plan Amendments.

4.1.1 Effects Analysis Indicators and Methodology of Analysis

An issue is defined as a point of disagreement, debate, or dispute with a proposed activity based on some anticipated effect. Issues are described in terms of cause and effect; that is, if an action occurs, an impact could result. Issues are addressed by describing comparative factors that provide a way to define, compare, and contrast the effects of the alternatives, including No Action.

REC 7513

PRI-00001029

Table 4.3-21 Maximum Annual HAP and Air Toxics Emissions Summary – Alternative 2 NSR Inventory [1]

Source Category	HCN (tpy)	H_2SO_4 (tpy)	HAP (tpy)	Hg (lbs/yr)
Ore Processing and Refining	0.97	8.9	1.8	24.9
Mining Fugitive	0.0	0.0	.0004	7.1
Total	**0.97**	**8.9**	**5.3**	**32.0**

Table Source: Air Sciences 2020

Table Notes:

1 - The HAP and Air Toxics emissions conform to the accepted PTC application to IDEQ.

H_2SO_4 = sulfuric acid, mist form. HCN = hydrogen cyanide.

HAP = Hazardous Air Pollutants. Hg = mercury (all forms).

tpy. = Tons per year. VOCs = Volatile Organic Compounds.

4.3.2.2.3 OPERATIONS PHASE – CONTROLLED ACCESS ROADWAY

The controlled access road for Alternative 2 is shown in **Figure 4.3-2** as it was included in a supplemental dispersion modeling analysis for this alternative. Although the route would be hypothetically open to all vehicles year-round, the level of usage is expected to vary seasonally because the destination areas are generally inaccessible except to over-snow vehicles between December and March. Roadway dust emissions would be reduced or eliminated during the wet months and periods of snow cover. In consideration of this, the modeling of the roadway impacts was only performed for the period of April through November. In addition, the IDEQ determination that the road is not within the regulated ambient air means that NAAQS do not apply for protection of individuals using the road.

To assess possible risk due to use of the controlled access roadway, supplemental dispersion modeling for this alternative treated the path of the public access road as "ambient air." This requires that model receptors be positioned along the route as illustrated in **Figure 4.3-2** to predict pollutant concentrations. Treatment of the access road as ambient air could be considered a conservative approach, because several measures would be in place, consistent with EPA policy regarding sufficient measures to restrict or control public access (EPA 2019a). All public traffic on the proposed road would be required to check in and out of the mine site, and therefore they could be considered guests of the mine. Public vehicles would need to be checked in at security checkpoints at either end of the route through the Operations Area Boundary. Because the roadway would be fenced off, and on a separate ROW, no public access to the mine site or other operational areas would be allowed. Taken together, these practices allowed IDEQ to determine that the controlled access roadway can be excluded from ambient air analyses.

4.16.2.2.2 Public Access

Under Alternative 2, public access would be the same as Alternative 1 (e.g., the newly constructed Burntlog Route connecting to Meadow Creek Lookout Road [FR 51290]), except public access also would be provided through the mine site from Stibnite Road to Thunder Mountain Road (FR 50375) during mining operations. The newly constructed Burntlog Route connecting to Meadow Creek Lookout Road and then Thunder Mountain Road would allow public access when other routes are not available (i.e., the public access route through the mine site). The newly constructed roadway portion of the Burntlog Route would be a temporary road that is necessary for mining purposes and would meet 36 CFR 228A requirements for environmental protection. Public motor vehicle use would be allowed on the newly constructed, private mining road when other public access roads are blocked by mine operations. Approximately 13.5 miles of new roads managed by Midas Gold, but open to public access when needed, would be created.

After mine construction is complete, a 12-foot-wide, approximately 3- to 4-mile gravel road connecting Stibnite Road to Thunder Mountain Road would be open to all vehicles year-round. Midas Gold would maintain the public access road under Valley County's FRTA easement; however, it would not be plowed. There are two options for public access through the mine site (refer to Section 2.4.4.2, Public Access). Under Option 1, an approximately 3-mile public access road through a widened portion of the western side of Yellow Pine pit and paralleling a mine haul road would be constructed. Under Option 2, an approximately 4-mile public access road west of the Yellow Pine pit and paralleling the same mine haul road as Option 1 would be constructed. The selected public access road option would be separated from the mine site roads by berms, security fencing, and underpasses. For added safety, the public access road would be temporarily closed during construction and maintenance activities of the public access road, and during other mining activities that would be considered public safety hazards (e.g., high wall scaling and blasting). Signs would be placed to inform the public of the closure. During closures on the road through the mine site, public use of the Burntlog Route would be allowed.

4.16.2.2.3 Closure and Reclamation

Impacts to traffic volume and public access under Alternative 2 would be similar to those described under Alternative 1 for closure and reclamation; however, Alternative 2 would require an additional 40 truck trips per year to deliver chemicals for water treatment in perpetuity. Like operations, 40 truck trips for water treatment would provide an increase of 0.1 AADT for closure and reclamation and post-closure traffic. Post-closure, traffic to the mine site (i.e., the additional 40 truck trips per year required to deliver chemicals for water treatment in perpetuity) would no longer utilize the Burntlog Route, but would use the Yellow Pine Route to access the mine site which would be plowed to provide year-round access for treatment plant workers. Water treatment-related deliveries would not occur during the winter; supplies and waste would be stockpiled on site. Public access to and through the mine site would remain post reclamation and would require revision to the existing FRTA easement with Valley County.

relates to noise is "low" and the possibility is rated as "low," with an overall public health rating of "negligible."

4.18.2.1.4.3 Nutrition

Activities in the SGP area related to nutrition include fishing, hunting, or gathering of berries (or other edible vegetation). Contaminants in surface water could potentially bioaccumulate in the edible tissues of fish in impacted surface water or in wildlife that drink impacted surface water. Likewise, contaminants in soil could potentially bioaccumulate in plants growing in impacted soils. As discussed above, implementation of controls and surface water management during mine operations and the closure and reclamation activities would likely decrease concentrations of contaminants in soil and surface water relative to existing conditions. In addition, recreational exposures are expected to be of limited frequency and short duration (the Payette National Forest camping stay limit for individual campground sites is 16 days). For these reasons, the magnitude of impact on public health as it relates to nutrition is "low" and the possibility is rated as "low," with an overall public health rating of "negligible." There are no differences in impact findings among the construction, operation, and closure and reclamation phases of Alternative 1.

4.18.2.2 Alternative 2

Alternative 2 is similar to Alternative 1 with the main differences consisting of re-routing of a segment of the Burntlog Route, allowing public access through the mine site during operations, change in the location of the maintenance facility, re-routing a portion of the transmission line to be upgraded around the Thunder Mountain Estates, generating lime at the mine site, and establishment of a Centralized Water Treatment Plant. These changes are intended to reduce potential effects on surface water quality, reduce potential traffic related issues by providing public access through the mine site and potentially decreasing incidental public use of Burntlog Route, reduce SGP-related annual average daily traffic to the mine site during operations (through on-site lime generation) and reduce overall disturbance in the SGP area. However, Alternative 2 also would include an on-site propane-fired lime kiln and has higher air emissions than Alternative 1.

As discussed in Section 4.3.2, Direct and Indirect Effects on Air Quality, the $PM_{2.5}$ "annual" average (computed as the mean values from April through November) and PM_{10} 24-hour average concentrations (12.8 µg/m^3 and 179.7 µg/m^3, respectively) are predicted to be slightly over the respective NAAQS criteria at receptors along the public access road through the mine site (12 µg/m^3 and 150 µg/m^3, respectively). NAAQS are set at a level expected to protect public health with an adequate margin of safety, taking into consideration effects on susceptible populations. Signage and security checkpoints would alert the public to requirements for driving through the mine site, including check in and out at the checkpoints, no stopping or loitering while traversing the operations area, and restrictions would be enforced by signage, fencing, berms and/or gates to restrict travel to the designated route. The amount of time spent within the mine site on the public access road would be of limited duration. In addition, it is anticipated that people would only occasionally use the route through the mine site, such that the frequency

of exposure would be limited. While air modeling results exceeded the NAAQS criteria during the operations phase along the public access road through the mine site, the limited duration and frequency of exposure to PM at modeled air concentrations would likely be minimal, which would significantly reduce the public health impact associated with air quality, even for sensitive subpopulations. The slight exceedances of the NAAQS criteria along the public access road are expected to have little to no effect on the health of the general population, however, sensitive susceptible populations are at greater risk of health effects associated with air quality conditions.

Overall, impacts to public health and safety under Alternative 2 would therefore be slightly improved compared to Alternative 1 for traffic-related issues and surface water quality impacts. However, on-site lime generation could lead to slightly greater air quality impacts along the public access route through the mine site, that could affect sensitive subpopulations.

4.18.2.3 Alternative 3

Alternative 3 is similar to Alternative 1 with the main differences being no construction of the Meadow Creek off-highway-vehicle Connector Trail, the tailings storage facility (TSF) constructed in the EFSFSR, and different access through the mine site after mine closure/reclamation. Impacts to public health and safety would be essentially the same as those described under Alternative 1.

4.18.2.4 Alternative 4

Alternative 4 is similar to Alternative 1 with the main differences being the use of the Yellow Pine Route for access to the mine for all phases, and public road access through the mine during operations (similar to Alternative 2). These changes would result in different impacts than Alternative 1, particularly the use of the Yellow Pine Route.

Under Alternative 4, the Yellow Pine Route would be used from construction through operations and closure and reclamation and the Burntlog Route would not be constructed. Use of Johnson Creek (CR 10-413) and Stibnite (CR 50-412) roads as the primary route to the mine site during construction, operations, and closure and reclamation would result in increased noise, traffic, and safety-related issues from mine-related traffic along the Yellow Pine Route. The Yellow Pine Route would route all mine-related traffic through the Village of Yellow Pine and public traffic and mine traffic would share the same road from Landmark to the mine site. Additionally, the Yellow Pine Route would result in one point of entry to the SGP, effectively combining public access with mining traffic for the life of the mine. This limited ingress/egress to the SGP site also will impact emergency vehicle access during periods of road blockage.

The steep terrain along the Yellow Pine Route would likely be a greater risk to public safety under Alternative 4, because it would be the only route used for the life of the SGP and would require safety considerations for geotechnical hazards, landslides, and avalanche zones (see Section 4.2, Geologic Resources and Geotechnical Hazards). Overall, Alternative 4 could lead to greater public health and safety impacts compared to Alternative 1 through use of the Yellow Pine Route (increase traffic-related issues and increased geotechnical, landslide, and

EXHIBIT 4
Excerpts from Supplemental EIS

United States Department of Agriculture
Forest Service

Stibnite Gold Project

Supplemental Draft Environmental Impact Statement

Forest Service, Region 4, Payette and Boise National Forests, Valley County, Idaho



REC 7519

PRI-00001034

During operations, mine-related traffic would include transport of employees to and from the SGP, delivery of supplies, and activities associated with road maintenance such as snowplowing and sanding. Under the 2021 MMP and the Johnson Creek Route Alternative, operational AADT would be 50 vehicles (33 heavy vehicles and 17 light vehicles), resulting in approximately four mine-related vehicles per hour traveling outside the SGP.

The upgraded Burnt Log Road and the newly constructed Burntlog Route would experience an increase in traffic of over 71 percent under the 2021 MMP, with 27.5 percent of the traffic comprised of heavy vehicles. Although heavy vehicles currently use Johnson Creek Route to access the SGP, the Johnson Creek Route Alternative traffic would result in a noticeable change in baseline driver experience and slower drive times due to the substantial increase in mine-related heavy vehicles along the Johnson Creek Route during the life of the SGP. Even though upgrades to Johnson Creek Road and Stibnite Road would be made, these roads would still have many curves and slopes.

During closure and reclamation, activities including slope recontouring, facility removal, seeding and planting, and post-closure environmental monitoring would require approximately 7 years. Closure and reclamation would generate a total estimated AADT of 27 vehicles (15 heavy vehicles and 12 light vehicles). Post-closure monitoring activities would generate a total estimated AADT of six light vehicles.

Local roads experience a seasonal effect which results in noticeable differences in traffic. Valley County has many summer recreational areas that attract visitors from May through October with peak AADT levels in June, July, and August. Mine access via the Johnson Creek Route would be more impactful on summer recreational traffic because it would utilize established roads rather than new road development. Winter driving conditions influence the amount of traffic and result in lower AADT levels during the winter months. Therefore, the effect of SGP traffic on these roads would show a noticeably greater increase in mine-related winter traffic during winter. Post-closure winter traffic would not be as noticeable as heavy vehicle deliveries would not occur and approximately six mine-related light vehicles per day would utilize the accessible roadways in the analysis area for monitoring and maintenance purposes.

Public Access

Under the 2021 MMP, public access to the SGP area would be enhanced by the development of a new access road (Burntlog Route) compliant with current road standards. Under both action alternatives, there would also be a controlled public access route through the SGP during the operations, and closure and reclamation phases; however, public access would be intermittently interrupted during the construction phase. Under the Johnson Creek Route Alternative, the Burntlog Route would not be constructed, and the Johnson Creek Route would be used for both public and SGP-related access. To continue providing OSV access to Landmark, a 10.4-mile groomed OSV route between Warm Lake and Trout Creek Campground on Cabin Creek Road would be created as part of the 2021 MMP along with a parking area, resulting in a new winter access facility that would be maintained by Valley County.

Safety and Emergency Access

For the duration of the SGP, the increase in total volume of mine-related vehicles, specifically heavy vehicles or trucks, on the Yellow Pine and Burntlog routes would result in an increased risk for accidents occurring between public and SGP-related traffic due to the one-lane constraints during construction, for

REC 7520

PRI-00001035

Table 2.2-1 Action Alternatives Summary

SGP Phase	Component/ Subcomponent	2021 MMP	Johnson Creek Route Alternative
All Phases	SGP timeline	• Construction: Approximately 3 years. • Operations: Approximately 15 years. • Exploration: Approximately 17 years (during construction and operations). • Reclamation: Approximately 5 years (except for the TSF which would require an additional 9 years for tailings dewatering and consolidation). • Closure/Post-Closure Water Treatment: Approximately through Mine Year 40. • Environmental Monitoring: As long as needed.	Same as 2021 MMP except: • Construction: Approximately 5 years (upgrading the existing Johnson Creek and Stibnite Roads to provide permanent mine access).
All Phases	Access Roads	Construction/Operations: • Warm lake road from State Highway (SH) 55 to Johnson Creek Route intersection (34 miles). • Johnson Creek Route for SGP access during early construction with minor improvements within the road prism. • Burntlog Route (38 miles) for SGP access during last year of construction, mining and ore processing operations, and closure and reclamation. Includes improvements of existing segments (23 miles) and road construction for new segments (15 miles). • Up to eight borrow areas developed along Burntlog Route for materials needed for road improvements and maintenance. • Access route around the Yellow Pine pit for public access. Closure and Reclamation: • New sections of Burntlog Route to be reclaimed after the closure and reclamation period.	• Warm lake road from SH 55 to Johnson Creek Route intersection (34 miles). • Johnson Creek Route (39 miles: Johnson Creek Road 25 miles, Stibnite Road 14 miles) upgraded and used for access throughout life of mine (LOM) instead of the Burntlog Route. • Access route around the Yellow Pine pit for public access, employee access, and deliveries of supplies and equipment to the processing, warehouse, worker housing facility, and administration areas. • No improvements or construction of new segments for Burntlog Route. • Up to seven borrow sources developed along the Johnson Creek Route for materials needed for road improvements and maintenance. Closure and Reclamation: • Improved Johnson Creek and Stibnite roads would not be reclaimed to pre-existing conditions.

REC 7521

PRI-00001036

SGP Phase	Component/ Subcomponent	2021 MMP	Johnson Creek Route Alternative
All Phases	Public Access	Construction: • Temporary groomed over-snow vehicle (OSV) trail on the west side of Johnson Creek from Trout Creek to Landmark while Burntlog Route is constructed (8 miles). • OSV trail on west side of Johnson Creek from Wapiti Meadows to Trout Creek campground closed during construction (9 miles). • OSV trail from Warm Lake to Landmark closed during construction through operations (8.5 miles). • Cabin Creek Road Groomed OSV trail (11 miles). • Public roads remain open through the SGP with temporary closures as needed to accommodate construction. Operations: • Groomed OSV trail moves from west side of Johnson Creek Road to Johnson Creek Road from Landmark to Wapiti Meadows (16.7 miles). • Stibnite Road (County Road [CR] 50-412) / Thunder Mountain Road (FR 50375) closed through the SGP. • Seasonal public access through the Operations Area Boundary provided by constructing new road through Yellow Pine pit and below mine haul road to link Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375). • Public access allowed on Burntlog Route to Thunder Mountain Road (FR 50375). Closure and Reclamation: • New road constructed over the Yellow Pine Backfill (backfilled Yellow Pine pit) connecting Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375).	Construction and Operations: Same as 2021 MMP except: • OSV trail on the west side of Johnson Creek from Wapiti Meadows to Trout Creek campground would be closed from construction through mine closure (9 miles). • Groomed OSV trail on the west side of Johnson Creek from Trout Creek to Landmark lasting from construction through mine closure. Closure and Reclamation: Same as 2021 MMP.

REC 7522

PRI-00001037

- Expanded wintertime public vehicle access on Warm Lake Road east of Warm Lake Lodge would commingle SGP and public travel.

Changes to the SH 55 and Warm Lake Road intersection would improve access for large trucks carrying equipment and supplies to the SGP and would facilitate turns from SH 55 onto Warm Lake Road and from Warm Lake Road back onto SH 55. Any changes proposed to the intersection would need to be approved and implemented by the Idaho Transportation Department (ITD). Recommended changes to the intersection include: the addition of left and right turning lanes (Parametrix 2018a); an intersection modification to accommodate larger trucks; potential relocation of two power poles (HDR Engineering, Inc. [HDR] 2017a); and a modification to the westbound approach at Warm Lake Road to improve the view of traffic coming from the north.

Johnson Creek Route

During the initial construction period of the Burntlog Route (approximately 2 to 3 years), mine-related traffic would access the SGP from SH 55, north of the city of Cascade, via Warm Lake Road for approximately 34 miles, then north on Johnson Creek Road (CR 10-413) for approximately 25 miles to the village of Yellow Pine, and from Yellow Pine east approximately 14 miles to the SGP via the Stibnite Road (CR 50-412). The portion of the route that includes Johnson Creek Road and Stibnite Road is known as the Johnson Creek Route. This route is primarily situated topographically adjacent to the valley bottom, paralleling Johnson Creek and then the East Fork SFSR.

Johnson Creek Road is a county-maintained, native-surface road that is open to vehicles with seasonal restrictions due to snow. During the winter, Valley County plows approximately 10 miles of Johnson Creek Road from Yellow Pine south to Wapiti Meadow Ranch and grooms the remaining 17 miles of Johnson Creek Road from Wapiti Meadow Ranch to Warm Lake Road at Landmark for OSV use. Valley County does not plow Warm Lake Road from Warm Lake to Landmark; this section is a designated groomed OSV route.

The Stibnite Road portion of the route is also a county-maintained native surface road, open to all vehicles with seasonal restrictions due to snow. This road is plowed in the winter by Perpetua through an agreement with Valley County. Stibnite Road connects to Thunder Mountain Road on the southeastern portion of the Stibnite site and currently provides seasonal (non-winter) public access through the site.

REC 7523

PRI-00001038

2.4.4.4 Public Access

During construction of the SGP and completion of the Burntlog Route, to the degree practicable, the public would continue to have access on forest roads currently available to the public (**Figure 2.4-1**). However, current public access through the SGP on Stibnite Road would be restricted for a period of approximately one year while a new through-site public access road is constructed. A new 4-mile long, 12-foot-wide gravel road would be constructed to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road through the SGP (**Figure 2.4-2**). The road would be constructed on a widened bench on the west side within the Yellow Pine pit, then head south of the Yellow Pine pit, where this road would utilize an underpass to cross under a SGP haul road and continue southward, parallel to and on the east side of the mine haul road on a partially revegetated portion of a former haul road (**Figure 2.4-2**). Southwest of the ore processing area, the public access road would connect with Thunder Mountain Road and continue toward the worker housing facility, exiting the SGP to the southeast.

During operations, the public access road through the SGP would provide seasonal use, open to all vehicles; access would not be provided in winter when impassable (current county maintenance standards) and signs would inform the public of seasonal and temporary closures. Vehicles passing through the SGP would be required to check-in with mine personnel at the North or South SGP entry points and would receive a safety briefing and would also be required to check-out with SGP personnel upon exiting the SGP. For safety purposes, public access would be separated from other SGP roads by berms, security fencing, and the underpass to allow the public road to pass beneath the mine haul road. No stopping or deviating from the public access road would be allowed. Perpetua would restrict SGP access to any vehicles due to concerns related to public or employee health and safety, such as during road construction and maintenance, blasting, highwall scaling, mining in the immediate area of the road, and similar operations.

Public access would continue along Johnson Creek Road and Burnt Log Road. Total closures of half-day to multiple days could occur during construction work on Stibnite Road between the village of Yellow Pine and the SGP, part of Thunder Mountain Road, and Burnt Log Road.

Public use of the Burntlog Route would provide motorized access to Meadow Creek Lookout Road (FR 51290) and Monumental Summit. Other routes available for public use are shown on **Figure 2.4-1**.

Public access by foot via existing trails or on roads would be restricted within the Operations Area Boundary shown on **Figure 2.4-2**. Security personnel, fencing (including wildlife exclusion fencing), and signs would restrict public access to vehicular traffic on the designated public access roadway inside the Operations Area Boundary.

Warm Lake to Landmark Groomed OSV Trail

Due to year-round access to the SGP along the Burntlog Route, an existing, approximately 8.5-mile-long groomed OSV trail from Warm Lake to Landmark would be closed for the life of the SGP. To replace this recreational use, a dedicated alternative OSV route would be established from Warm Lake area to Landmark via the Cabin Creek/Trout Creek drainages and Johnson Creek Road (**Figure 2.4-4**).

REC 7524

PRI-00001039

Description	Resources Affected
A new 12-foot-wide gravel road would be constructed to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375) through the SGP. During operations, the public access road would be used to travel through the SGP and would provide seasonal use, open to all vehicles. Vehicles passing through the SGP would be required to check-in with mine personnel at the North or South SGP entry points.	Transportation and Access, Health and Safety
Post reclamation, a road would be established over the backfilled Yellow Pine pit to allow public access through the reclaimed site and connect Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375). This would replace the operational phase public access route.	Transportation and Access
Prior to site preparation and construction of surface facilities, vegetation would be removed from operating areas. Merchantable timber on NFS surface lands could be purchased from the USFS. Non-merchantable trees, deadwood, shrubs, and slash would be removed, and any remaining vegetation would be grubbed using a bulldozer. The resulting material would be saved for future use in reclamation activities. Specifically, the organic matter would be chipped and stockpiled for use as mulch or blended to create a growth media additive. After vegetation removal, growth media would be salvaged and stockpiled. Stockpiles would be stabilized, seeded, and mulched to protect the stockpiles from wind and water erosion.	Vegetation
Perpetua would inspect and remove vegetation material (including noxious weeds) from mechanical equipment and properly dispose to minimize the spread of unwanted vegetation.	Vegetation
Wood wastes and wood mulch are the two primary sources of compost. Food waste produced from on-site meal preparation and wastes may provide another source. Combined and properly managed during composting, these materials would provide a source of organic matter to be blended into substrate materials suitable for mitigation.	Vegetation
Perpetua would be responsible for noxious weed control within areas disturbed by SGP activities.	Vegetation, Wildlife
Develop and employ planting plans for wildlife benefits (cover, forage, etc.) using approved seed mixes.	Vegetation, Wildlife
Perpetua would use aquatic safe herbicides during vegetation management activities and noxious weed control. Adhere to chemical label restrictions, federal/state rules on usage. Use proper equipment for chemical application by trained personnel.	Vegetation, Fish
Perpetua or its designated contractor(s) would perform long-term maintenance as necessary, including maintaining and monitoring the Mitigation Area (including stream and wetlands) in perpetuity once the final performance standards are met or until such responsibility is relinquished to an appropriate third party (Forest Service, etc.) as approved by the USACE.	Vegetation, Wetlands
Perpetua would plant stream reclamation reaches and wetland reclamation areas with native plant species that are present in PAB, PEM, PSS, and palustrine forested wetlands and riparian areas along streams throughout the Mitigation Area.	Vegetation, Wetlands
To address stream temperature, riparian planting widths along restored and enhanced stream reaches would be 18 feet wide on each stream bank where possible. Taller and denser vegetation such as spruce trees would be planted. Further, the creation of the lined Stibnite Lake, a feature similar in size to the present Yellow Pine pit lake, would replace the function of the existing Yellow Pine pit lake in buffering stream temperature extremes and reduce maximum stream temperatures in East Fork SFSR in and downstream of the SGP.	Vegetation, Wetlands, Surface Water, Reclamation
Pre-construction water management activities would include the installation of surface water management features and implementation of best management practices to reduce erosion and sediment delivery to streams. These water management features and best management practices could include sedimentation ponds; run-on water diversion ditches, trenches, and/or berms; runoff water collection ditches; silt fence; water bars; culverts; energy dissipation structures; terraces; and other features specified in construction permits.	Water Resources

REC 7525

PRI-00001040

Issue	Indicator	Baseline Conditions	No Action Alternative	2021 MMP	Johnson Creek Route Alternative
	Miles of new roads and new transmission lines.	Access Roads – existing roads – 135 miles Utilities – existing roads – 30 miles	Same as Baseline Condition.	Access Roads – new roads – 28 miles Utilities – new utility access roads – 25 miles	Access Roads – new roads – 0 miles Utilities – same as the 2021 MMP.
	Miles of existing roads that are not currently plowed that would be plowed.	Currently plowed: Warm Lake Road – 26 miles Stibnite Road – 14 miles	Same as Baseline Condition.	Proposed (new) to be plowed: Burnt Log Road – 21 miles (currently groomed). Burnt Log Road Extension – 15 miles (proposed new).	Proposed (new) to be plowed: Johnson Creek Road – 17 miles (conversion of existing OSV portion of Johnson Creek Road).
Timber Resources					
The SGP may change the availability of timber resources, including sawtimber and special forest products.	Volumes of timber resources removed.	Timber resources data are available for the analysis area on NFS lands in the PNF and BNF.	0 CF (total)	438,243 CF *(total)* 342,442 CF (Forest Service) 95,801 CF (Other Federal, State and Private Land)	547,984 CF *(total)* 447,058 CF (Forest Service) 100,926 CF (Other Federal, State and Private Land)
	Acres from which timber resources removed.	Timber resources data are available for the analysis area on NFS lands in the PNF and BNF.	0 acres *(total)*	595 acres (total) 468 acres (Forest Service) 127 acres (Other Federal, State and Private Timber)	733 acres (total) 601 acres (Forest Service) 132 acres (Other Federal, State and Private Timber)
	Acres suited for timber production permanently converted to other, non-productive land uses.	Maps of the Timberland Vegetation Communities in the analysis area are included in **Section 3.14**.	0 acres *(total)*	66 acres (*BNF*) 0 acres (*PNF*)	282 acres *(BNF)* 0 acres (*PNF*)
Land Use and Land Management					
The SGP would cause changes in land use or land management.	Acres of land used for SGP components by land management agency.	(Analysis area) Private: 925 acres State: 77 acres BNF: 1,027 acres PNF: 2,373 acres BOR: 25 acres	Same as Baseline Condition.	Private: 819 acres State: 62 acres BNF: 933 acres PNF: 1,439 acres BOR: 12.5 acres	Private: 829 acres State: 62 acres BNF: 820 acres PNF: 1,372 acres BOR: 12.5 acres
	Acres of total and new land disturbance within SGP area.	Existing disturbance acreage within analysis area: 1,554 acres (includes historic mine disturbance, existing roads and utilities)	Same as Baseline Condition.	Disturbance acreage impacts: 3,266 total acres 51% (1,674 acres) of total is new disturbance	Disturbance acreage impacts: 3,095 total acres 50% (1,544 acres) of total is new disturbance
The SGP could cause changes in or create new ROWs or easements.	Miles or acres of new or changed ROWs or easements, regardless of jurisdiction.	Total existing ROW (transmission lines and roads): 666 acres	Same as Baseline Condition.	Total new ROW (transmission lines and roads): 763 acres	Total new ROW (transmission lines and roads): 639 acres
Access and Transportation					
The SGP may affect access to public lands during mine construction, operations, and closure and reclamation.	Number, location, and description of changes in access due to new and improved roadways.	See **Table 3.16-1** and **Figure 3.16-1**.	Same as Baseline Condition.	Burnt Log Road (plowed). Mine site public access during operations (not plowed). Loss of winter groomed OSV trail on Warm Lake Road to Landmark. Loss of winter groomed OSV trail on Johnson Creek Road from Wapiti Meadows to Trout Creek campground during construction of Burntlog Route.	No Burntlog Route, only Johnson Creek Route (plowed). Mine site public access during operations (not plowed). Loss of winter groomed OSV trail on Warm Lake Road to Landmark. Loss of winter groomed OSV trail on Johnson Creek Road from Wapiti Meadows to Trout Creek campground for life of SGP.

REC 7526

PRI-00001041

Issue	Indicator	Baseline Conditions	No Action Alternative	2021 MMP	Johnson Creek Route Alternative
				After mine reclamation, direct public access through the mine to Thunder Mountain Road would be restored.	
	Changes in recreation physical setting characteristics and related ROS class (by season) measured in acres.	Designated ROS classes in the analysis area vary by season, and include Rural, Roaded Natural, Roaded Modified, Semi-Primitive Motorized, Semi-Primitive Non-Motorized, and Primitive. Estimated existing ROS physical settings are similar.	Generally, existing designated ROS classes and physical recreation setting characteristics would remain as is. Modifications to the recreation setting in the SGP area continued low level of unauthorized motorized use, and increased winter motorized access and use could lead to changes in the designated ROS class and/or ROS physical setting of some areas due to additional motorized use both in the summer and winter. Acreage of Estimated ROS Physical Setting Classes – Summer/Winter: • Primitive: 17,278/21,370 acres • Semi Primitive Non-Motorized: 218,512/245,210 acres • Semi-Primitive Motorized: 83,497/240,387 acres • Semi-Primitive Motorized Groomed (winter only): 50,436 acres (this acreage overlaps other features) • Roaded Natural: 140,594/7,511 acres • Rural: 81,450/26,853 acres	Several components would result in inconsistencies with existing designated ROS classes including: Burntlog Route, plowing of the Burntlog Route, temporary plowing of the Johnson Creek Road and Stibnite Road, plowing of Warm Lake Road (CR 10-579), new transmission line. Acreage of Disturbance to ROS Physical Setting Classes During Operations – Summer/Winter: Primitive: 0/0 acres Semi Primitive Non-Motorized: 0/0 acres Semi-Primitive Motorized: 42/364 acres Semi-Primitive Motorized Groomed (winter only): 163 acres Roaded Natural: 685/387 acres Rural: 345/322 acres	Similar to the 2021 MMP, except there would be no inconsistencies with existing designated ROS classes related to the Burntlog Route or plowing of the Burntlog Route. Inconsistency with the existing designated ROS class for Johnson Creek and Stibnite Roads in the winter would not be temporary during construction (as in the 2021 MMP) but would continue through operations and reclamation because the roads would be plowed as part of the Johnson Creek Route. Acreage of Estimated ROS Physical Setting Classes During Operations – Summer/Winter: Primitive: 0/0 acres Semi Primitive Non-Motorized: 0/0 acres Semi-Primitive Motorized: 43/212 acres Semi-Primitive Motorized Groomed (winter only): 113 acres Roaded Natural: 387/34acres Rural: 353/536 acres
	Changes in recreation facilities (trails, campgrounds, trailheads), including the level of development and setting.	The Warm Lake area contains most of the developed recreation facilities (apart from trailheads). Scattered campgrounds and other facilities also are located in the Big Creek and Landmark areas and along Johnson Creek Road around and south of Yellow Pine. Developed recreation facilities primarily include campgrounds, cabins/lookouts, trailheads, and trails.	Same as Baseline Condition	The Stibnite Mining District Interpretive Site would be closed until after mine reclamation. Mine components would alter the setting of recreation facilities adjacent to them to a more developed setting due to increased man-made development, noise, traffic, etc. These components include the mine and facilities at the SGP, Burntlog Route, upgraded transmission lines, new transmission line to the SGP, Johnson Creek substation, cell tower on Meadow Creek Lookout Road, use of Warm Lake Road, and temporary use of the Johnson Creek Route.	Similar to the 2021 MMP, except the Burntlog Route would not be built and therefore would not affect the setting of existing recreation facilities. In addition, changes to the setting of recreation facilities along the Johnson Creek Route would be affected through reclamation and not just temporarily during construction.
	Changes in recreation use, potentially due to changes in recreation facilities, opportunities, access, and setting.	Developed recreation use is limited to the developed recreation sites (i.e., overnight facilities) located primarily in the Warm Lake, Landmark and Johnson Creek Road areas. Most recreation in the analysis area is dispersed use, which occurs outside of developed recreation sites.	Existing recreation use would continue. Some unauthorized motorized use may continue to occur off of existing roads and motorized trails. Motorized winter use has expanded in recent years, and may continue to expand in the future, resulting in additional OSV routes and additional areas receiving winter motorized use.	There would be public access through the SGP, which may result in less displacement of use to areas/facilities accessed from Thunder Mountain Road (FR 50375). In addition, there would be less likelihood for increased dispersed recreation use along the Burntlog Route as this route would only be available for public use when the route through the SGP was closed. Some recreation use may return to the SGP area after reclamation; however, due to the changes in the recreation setting, some use may be displaced to areas where the recreation setting is more natural.	Similar to the 2021 MMP. The Burntlog Route would not be built; therefore, there would be no resulting displacement or increase in recreation use from this route.

REC 7527

PRI-00001042

The maintenance of certain NFS roads is coordinated between the Forest Service and Valley County through Schedule A agreements. Typically, NFS road maintenance activities (including dust control, removal of debris from roadway and rights-of-way, road repair, and snow removal) are coordinated with the Valley County Roads and Bridge Department. Most Valley County backcountry roads are closed through the winter and melt off in the spring (Valley County 2017). Similarly, NFS roads are closed by snow in the winter and re-open once the snow melts off in the spring. Therefore, roads do not open for through-traffic until at least mid-June and often close to public use as early as October 15.

3.16.4.2 Primary Routes

There are three existing primary routes within the analysis area to access the Operations Area Boundary from Cascade or McCall: Johnson Creek, Lick Creek, and SFSR routes as shown on **Figure 3.16-1**. All of the routes require the use of Idaho SH 55.

Johnson Creek Route

During non-winter conditions (roads clear of snow), the Operations Area Boundary can be accessed from the City of Cascade by traveling northeast on Warm Lake Road for about 34 miles to Landmark, then north on Johnson Creek Road for approximately 25 miles to the village of Yellow Pine, and approximately 14 miles east on the Stibnite Road portion of McCall-Stibnite Road (Stibnite Road). The Johnson Creek Route, which only includes Johnson Creek Road and the Stibnite Road portion of McCall-Stibnite Road, is currently used to access the Operations Area Boundary during the summer.

The Johnson Creek Road is a county maintained, native surface road that is open to vehicles with seasonal restrictions due to snow. During the winter, Valley County plows approximately 10 miles of Johnson Creek Road from Yellow Pine to Wapiti Meadow Ranch and Perpetua (under agreement with Valley County) plows along Stibnite Road. Valley County grooms the remaining 17 miles of Johnson Creek Road from Wapiti Meadow Ranch to Warm Lake Road at Landmark for OSV use. Valley County does not plow Warm Lake Road from Warm Lake to Landmark. This section is a designated groomed OSV route.

The Stibnite Road portion of the route is also a county-maintained native surface road, open to all vehicles with seasonal restrictions due to snow. This road is plowed in the winter by Perpetua through an agreement with Valley County. Stibnite Road connects to Thunder Mountain Road on the southeastern portion of the Stibnite site and currently provides public access through the site.

Lick Creek Route

The SGP also can be accessed from McCall during non-winter conditions by traveling east on the Lick Creek portion of McCall-Stibnite Road (Lick Creek Road) for approximately 37 miles to the East Fork South Fork portion of McCall-Stibnite Road (East Fork Road), then approximately 16 miles to the village of Yellow Pine, and approximately 14 miles east on Stibnite Road. Lick Creek Road is not maintained during the winter; however, East Fork Road and Stibnite Road are plowed from SFSR Road to Yellow Pine by Valley County and from Yellow Pine to the Operations Area Boundary by Perpetua to access their private land inholdings in the area.

REC 7528

PRI-00001043

wastes. There would be temporary air quality effects related to the earthmoving and tailpipe emissions from the construction equipment and vehicles used to access the site. This work is planned to occur between 2022 and 2024.

If none of the action alternatives proceed, the current uses by Perpetua and other users on patented mine/mill site claims and on the PNF and BNF would continue to follow all existing applicable air quality regulations. Uses of NFS lands that may result in air pollutant emissions include mineral exploration, dispersed OHV use, snowmobiling, and other forms of recreation.

4.3.4.2 2021 MMP

Construction and Operations Description

The construction of the 2021 MMP includes building power transmission, access roads, and mining/processing facilities. These operations are to be performed during LOM 1 through LOM 3. Operations would begin in LOM 4 through LOM 18. Access road construction would consist of development of the Burntlog Route for mine access and minor improvements for the Johnson Creek route. Also, while the Burntlog Route is being developed, a temporary groomed OSV trail would be constructed on the west side of Johnson Creek from Trout Creek to Landmark for public access. Other public access construction would be a Cabin Creek Road groomed OSV trail. Eight borrow sources along the Burntlog Route would also be constructed.

During operations, public access through the site would be provided by constructing a new road around the Yellow Pine pit and below the mine haul road to link Stibnite Road to Thunder Mountain Road. Public access would also be allowed on the Burntlog Route.

Lastly, operations would include communication towers and an offsite logistics and road maintenance facilities. A cell tower would be located north of the Hangar Flats pit with very high frequency repeater sites. There would also be a communication site at the SGLF with upgrades to the existing site. The Burntlog road maintenance facility would be located approximately 4.4 miles east of the junction of Johnson Creek Road and Warm Lake Road along the proposed Burntlog Route.

Construction and Operations Air Emissions Inventory

Air pollutant emissions were initially estimated for activities and process sources included in the 2021 MMP for each LOM year. The LOM years presented in this discussion are based on years starting with LOM 1 as the first year of construction. LOM 6 is expected to produce the highest overall annual total of criteria pollutant emissions.

Air pollutant emission point sources for the construction phase would include engine-driven generators, portable conical crusher and screens, diesel-fired heaters, and engine-driven air compressors. The fugitive sources related to mine construction and operations would be haul, access, and construction road dust from vehicle travel during the pre-production years, as well as earth-moving equipment, material transfers, storage in several construction stockpiles and waste rock piles, tailpipe emissions and exploratory activities. The use of ANFO explosives also would be considered a mine construction phase source, as well as an ongoing operations phase source.

REC 7529

PRI-00001044

existing conditions. If the results from this computation are below the NAAQS, then impacts at other locations in the domain would be below the NAAQS as well.

For NAAQS modeling inputs, the highest emissions of each pollutant during any LOM year were determined and provided in **Table 4.3-6**. For the 2021 MMP, the highest criteria pollutant emissions occur during two different years, LOM 6 (CO, NO_X, and SO_2) and LOM 10 ($PM_{2.5}$ and PM_{10}). Therefore, to capture the highest modeled concentration for each pollutant, separate modeling was performed for LOM 6 and 10 (i.e., two models). Note that VOC emission maximums from LOM 3 were not modeled because there is no specific NAAQS for these emissions, however VOCs are addressed as part of the secondary $PM_{2.5}$ analysis.

Table 4.3-6 LOM Years for Pollutant-Specific Maximum Annual Emissions

Pollutant	LOM Year	SGP Total Annual Emissions (tpy)
CO	6	535.5
NO_2	6	335.2
PM_{10}	10	320.1
$PM_{2.5}$	10	69.2
SO_2	6	7.3
VOC	3	27.4
HAPs	10	8.5
Hg	10	13.3 (lb/yr)

The 2021 MMP would include a 12-foot wide gravel road to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375) through the SGP. Perpetua received a final PTC from IDEQ on June 17, 2022. This application proposed to exclude the public road on the basis of restricted access and maintaining full control, and that people traveling on the road would be considered "guests of the mine." IDEQ accepted the private road concept proposed by Perpetua (see PTC Condition 2.7, Response to Comments #16 and Statement of Basis on the IDEQ website) and in response to comments on February 18, 2021, also states that the roadway between Stibnite Road at Sugar Creek and Thunder Mountain Road at Meadow Creek was appropriately excluded from ambient air. Additionally, the EPA Region X has indicated that the access road could possibly be excluded from ambient air if sufficient enforceable measures are taken to comply with the 2019 revised policy (EPA 2019a). To comply with this measure, Perpetua has developed a transportation management plan and is included as Appendix D of the Air Quality Specialist Report (Forest Service 2022a).

The AERMOD dispersion modeling results for the 2021 MMP analysis emissions and comparison with the applicable NAAQS are provided in **Table 4.3-7**. The geographic location of the maximum impacts amongst the criteria pollutants and averaging periods between LOM 6 and 10 are provided in Figure 4 of the Air Quality Analysis Addendum ModPro2 (Air Sciences 2021a). The results demonstrate compliance with all NAAQS and would be considered to have a moderate impact locally and minor impact regionally. Additionally, **Table 4.3-8** provides geographic locations of the NAAQS maximums.

REC 7530

PRI-00001045

Controlled public access through the SGP during mine operations would be provided by an access road connecting McCall-Stibnite Road (CR 50-412) to Thunder Mountain Road (FR 50375) through the mine area. Similar to this same feature described under the 2021 MMP, this public access road would be constructed during the first year of mine operation and public access to this road would be carefully controlled; fences would prohibit public visitors on this road from having access to the SGP mining or support activities.

Construction

The Burntlog Route would not be constructed. Using the Johnson Creek Route for mine access would avoid disturbance-related air quality impacts from construction of approximately 20 miles of new road for the Burntlog Route. This would have the effect of decreasing overall roadway construction phase vehicle tailpipe and airborne dust emissions. The topographic features of the route (e.g., a portion of the route is along a river through a canyon) do not affect the nature of the air emissions during construction. However, the location of air pollutant concentrations may differ because construction activities would take place along a different ROW compared to other action alternatives.

No road widening or straightening of curves would be required for the Johnson Creek Road (CR 10-413) portion of the alternative. The Stibnite Road (CR 50-412) portion would be improved by widening curves to accommodate 55-foot semi-truck trailers. Approximately one mile of road past the village of Yellow Pine would be paved. Based on relative roadway length affected, these changes in roadway construction to improve the Johnson Creek Route would represent a decrease of overall construction phase emissions. However, the magnitude of the emissions difference would be small compared to total construction emissions during the first three LOM years. Also, the construction phase emissions for these upgrades to the Johnson Creek Route would be less than the emissions for construction of approximately 20 miles of new road to develop the Burntlog Route under other action alternatives.

This alternative would require an extra 2 years (3 vs 5) for construction of the upgrades to the Johnson Creek Route and the SGP. As a result, operations would start in LOM 6 instead of LOM 4 and the highest impact years for emissions would be LOM 8 and 12 (as compared to LOM 6 and 10 for the 2021 MMP).

Operations

The Johnson Creek Route would be used to access the SGP. The length of this route is approximately 1.5 miles shorter than the Burntlog Route, so that the overall tailpipe emissions for vehicles accessing the SGP would be slightly less for this alternative. The location of ambient air pollutant concentrations due to vehicle traffic would differ, with such effects being located along the Johnson Creek Route.

Providing public access through the SGP reduces the miles of new motorized trails open to all vehicles in the Meadow Creek IRA, and this is expected to reduce net air quality effects due to vehicles traversing the SGP area.

Several air pollution design features proposed by Perpetua are common to both action alternatives and are described in **Section 2.4.9**. Emission control devices and designs would be put in place to abate emissions of particulate matter, Hg, and criteria pollutant emissions from internal-combustion engines the same as

REC 7531

PRI-00001046

Access and Transportation

Access to and through the Operations Area Boundary would be maintained during construction, operation, and closure and reclamation. There would be public access through the Operations Area Boundary during construction and operations via a new gravel road constructed to connect Stibnite Road to Thunder Mountain Road. Climatic changes causing an increase in severe events, such as floods, landslides, and avalanches, can add stress to roadways and other infrastructure, which may result in more frequent maintenance and repairs.

Heritage Resources and Tribal Rights and Interests

The 2021 MMP could impact historic properties, due to ground and visual disturbance in the SGP area. Changing climatic conditions are expected to exacerbate the damage and loss of heritage resources and natural areas utilized by tribes for activities such as hunting, fishing, and gathering in the SGP area through increased soil erosion, more frequent and intense wildfires, flooding, degraded water quality, and wildlife and fish habitat impacts.

Public Health and Safety

Climate change impacts to public health and safety would be experienced through impacts to air, soil, and water quality. The 2021 MMP has the potential to impact public health and safety through the transportation and use of fuels and chemicals, natural environmental hazards, economic impacts, changes to public services and infrastructure, and impacts to the local population.

Climate change could exacerbate some impacts to public health and safety by affecting the way potential hazardous material spills enter the environment. It also could increase the frequency and amplify the impacts of natural hazards such as avalanches and landslides, flash floods, and wildfires (Halofsky et al. 2018). More extreme heat days and higher temperatures over time could increase air quality and health risks over both the short and long term, impacting the public and the employees' abilities to work (Runkle et al. 2017).

Recreation

Much of the SGP area is used for recreation year-round, which would be both directly and indirectly impacted by climate change. The 2021 MMP has the potential to impact recreational access, recreation facilities, dispersed recreation areas, special use permits, recreational motorized travel, and recreation use. Direct impacts from climate change would include variable precipitation and rising temperatures, which could affect individual decisions to recreate in a certain area. Indirect impacts from climate change would be experienced through the changing conditions that may alter the recreation facilities, opportunities, and setting.

Changing climatic conditions could alter the ecological conditions that affect the quality of the recreation experience, including warmer water temperatures, decreased streamflow, and habitat loss and fragmentation. In the Rocky Mountain region, it is expected that snow-based activities (skiing, snowmobiling) would be impacted negatively by climate change due to warmer winters (Halofsky et al. 2018). Primitive area use, horseback riding on trails, motorized water activities, birding, hunting, and fishing in the region also are expected to be negatively influenced by climate change; however, longer

REC 7532

PRI-00001047

Public Access

Road closure impacts on the Johnson Creek route would be the same as those described under the 2021 MMP, except impacts to recreation access, use, and opportunities along Thunder Mountain Road would begin during construction and continue until the public access road through the Operations Area Boundary was complete and open to public use to provide access to the Thunder Mountain area. Construction under the Johnson Creek Route Alternative is expected to take 2 years longer than the 2021 MMP.

The impacts to public access through the Operations Area Boundary would be the same as under the 2021 MMP. The public access road would provide access to recreation sites/areas via Thunder Mountain Road; therefore, the access road would allow continuous access to the Thunder Mountain Road sites/areas. However, as described under the 2021 MMP, there would be temporary closures of this route during some mining activities that would result in minor, short term, and localized impacts to recreation.

Landmark Maintenance Facility

The Landmark Maintenance Facility would be located approximately 0.1 mile south of Landmark and the historic cabins located there. Access to the maintenance facility would be off Warm Lake Road. There would be no delays or additional traffic along Warm Lake Road in this area since the Burntlog Route would not be constructed, but rather from all construction-related traffic using Warm Lake Road to Johnson Creek Road. It is assumed that construction equipment would travel east on Warm Lake Road; therefore, delays would likely affect access to Horn Creek Road, Rec Spur 579U2, 450 South, and Burnt Log Road, which are east of the maintenance facility site. This impact is anticipated to be moderate, short term, and localized.

Noise associated with construction activities could reduce opportunities for noise-sensitive recreation activities at and around the maintenance facility location (up to 1.1 miles away) (AECOM 2019c), including wildlife-related recreation activities, because wildlife may be displaced. Construction activities would not affect use of the historic cabins; however, construction noise at the site may affect the recreation setting of the cabins, because it may be audible from the cabin sites. Some recreationists may choose to visit other areas or sites to avoid delays or noise from construction activities. Any reduction in recreation opportunities, displacement of dispersed recreational use, or changes in access would be temporary until maintenance facility construction was completed. These impacts would be minor, short term, and localized.

Development of the Landmark Maintenance Facility would reduce recreation opportunities due to physical removal of acreage for the facility (3.5 acres). Traffic due to maintenance activities and vehicles would not be expected to result in frequent traffic delays on Warm Lake Road but may result in occasional delays due to road plowing, grading, repairs, etc., and would occur as operational impacts because the facility site would be accessed via the Johnson Creek Route. Traffic and other operational noise from the maintenance facility would generally not be audible from the facility; however, road maintenance activities would result in noise levels above background ambient noise levels of 40 dBA for up to 0.8 to 1 mile from the road (AECOM 2019c). This would likely reduce opportunities for some recreational activities in this area, particularly wildlife-related recreation activities, because wildlife may be displaced from the general maintenance facility area. Operation activity noise from the maintenance

REC 7533

PRI-00001048

EXHIBIT 5
Excerpts from Final EIS

United States Department of Agriculture
Forest Service

Stibnite Gold Project

Final

Environmental Impact Statement

Forest Service, Region 4, Payette and Boise National Forests, Valley County, Idaho



REC 7535

PRI-00001049

in slower travel times for non-mine-related traffic and may deter other travelers from using these roadways. Travelers may use alternative roadways including McCall-Stibnite Road to South Fork Salmon River Road.

During operations, mine-related traffic would include transport of employees to and from the SGP, delivery of supplies, and activities associated with road maintenance such as snowplowing and sanding. Under the 2021 MMP and the Johnson Creek Route Alternative, operational AADT would be 50 vehicles (33 heavy vehicles and 17 light vehicles), resulting in approximately four mine-related vehicles per hour traveling outside the SGP.

The upgraded Burnt Log Road and the newly constructed Burntlog Route would experience an increase in traffic of over 71 percent under the 2021 MMP, with 27.5 percent of the traffic comprised of heavy vehicles. Under the Johnson Creek Route Alternative, traffic on Johnson Creek Road and Stibnite Road would increase approximately 71 percent as well, also with 27.5 percent of the traffic comprised of heavy vehicles. Although heavy vehicles currently use Johnson Creek Route to access the SGP, the Johnson Creek Route Alternative traffic would result in a noticeable change in baseline driver experience and slower drive times due to the substantial increase in mine-related heavy vehicles along the Johnson Creek Route during the life of the SGP. Even though upgrades to Johnson Creek Road and Stibnite Road would be made, these roads would still have many curves and slopes.

During closure and reclamation, activities including slope recontouring, facility removal, seeding and planting, and post-closure environmental monitoring would require approximately 7 years. Closure and reclamation would generate a total estimated AADT of 27 vehicles (15 heavy vehicles and 12 light vehicles). Post-closure monitoring activities would generate a total estimated AADT of six light vehicles.

Local roads experience a seasonal effect which results in noticeable differences in traffic. Valley County has many summer recreational areas that attract visitors from May through October with peak AADT levels in June, July, and August. Mine access via the Johnson Creek Route would be more impactful on summer recreational traffic because it would utilize established roads rather than new road development. Winter driving conditions influence the amount of traffic and result in lower AADT levels during the winter months. Therefore, the effect of SGP traffic on these roads would show a noticeably greater increase in mine-related winter traffic during winter. Post-closure winter traffic would not be as noticeable as heavy vehicle deliveries would not occur and approximately six mine-related light vehicles per day would utilize the accessible roadways in the analysis area for monitoring and maintenance purposes.

Public Access

Under the 2021 MMP, public access to the SGP area would be enhanced by the development of a new access road (Burntlog Route) compliant with current road standards. Under both action alternatives, there would also be a controlled public access route through the SGP during the operations, and closure and reclamation phases; however, public access would be intermittently interrupted during the construction phase. Under the Johnson Creek Route Alternative, the Burntlog Route would not be constructed, and the Johnson Creek Route would be used for both public and SGP-related access. To continue providing OSV access to Landmark, a groomed OSV route between Warm Lake and Trout Creek Campground on Cabin Creek Road would be established as part of the 2021 MMP to connect to Landmark from Trout Creek

REC 7536 PRI-00001050

alternatives. Because **Table 2.2-1** describes primary differences, not all the components listed above are included in the table.

Table 2.2-1 Action Alternatives Summary

SGP Phase	Component/ Subcomponent	2021 MMP	Johnson Creek Route Alternative
All Phases	SGP timeline	• Construction: Approximately 3 years. • Operations: Approximately 15 years. • Exploration: Approximately 17 years (during construction and operations). • Reclamation: Approximately 5 years (except for the TSF which would require an additional 9 years for tailings dewatering and consolidation). • Closure/Post-Closure Water Treatment: Approximately through Mine Year 40. • Environmental Monitoring: As long as needed.	Same as 2021 MMP except: • Construction: Approximately 5 years (upgrading the existing Johnson Creek and Stibnite Roads to provide permanent mine access).
All Phases	Access Roads	Construction/Operations: • Warm lake road from State Highway (SH) 55 to Johnson Creek Route intersection (34 miles). • Johnson Creek Route for SGP access during early construction with minor improvements within the road prism. • Burntlog Route (38 miles) for SGP access during last year of construction, mining and ore processing operations, and closure and reclamation. Includes improvements of existing segments (23 miles) and road construction for new segments (15 miles). • Up to eight borrow areas developed along Burntlog Route for materials needed for road improvements and maintenance. • Access route around the Yellow Pine pit for public access. Closure and Reclamation: • New sections of Burntlog Route to be reclaimed after the closure and reclamation period.	• Warm lake road from SH 55 to Johnson Creek Route intersection (34 miles). • Johnson Creek Route (39 miles: Johnson Creek Road 25 miles, Stibnite Road 14 miles) upgraded and used for access throughout life of mine (LOM) instead of the Burntlog Route. • Access route around the Yellow Pine pit for public access, employee access, and deliveries of supplies and equipment to the processing, warehouse, worker housing facility, and administration areas. • No improvements or construction of new segments for Burntlog Route. • Up to seven borrow sources developed along the Johnson Creek Route for materials needed for road improvements and maintenance. Closure and Reclamation: • Improved Johnson Creek and Stibnite roads would not be reclaimed to pre-existing conditions.

REC 7537

PRI-00001051

SGP Phase	Component/ Subcomponent	2021 MMP	Johnson Creek Route Alternative
All Phases	Public Access	Construction: • Temporary groomed over-snow vehicle (OSV) route on the west side of Johnson Creek from Trout Creek to Landmark while Burntlog Route is constructed (8 miles). • OSV route on Johnson Creek Road from Wapiti Meadows to Trout Creek Campground closed during construction (9 miles). • OSV route from Warm Lake to Landmark closed during construction through reclamation and closure (8.5 miles). • Cabin Creek Road groomed OSV route (11 miles). • Public roads remain open through the Operations Area Boundary with temporary closures as needed to accommodate construction. Operations: • Groomed OSV route moves from west side of Johnson Creek Road to Johnson Creek Road from Landmark to Wapiti Meadows (16.7 miles). • Stibnite Road (County Road [CR] 50-412) / Thunder Mountain Road (FR 50375) closed through the Operations Area Boundary. • Seasonal public access through the Operations Area Boundary provided by constructing new road through Yellow Pine pit and below mine haul road to link Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375). • Public access allowed on Burntlog Route to Thunder Mountain Road (FR 50375). Closure and Reclamation: • New road constructed over the Yellow Pine Backfill (backfilled Yellow Pine pit) connecting Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375).	Construction and Operations: Same as 2021 MMP except: • OSV route on the west side of Johnson Creek from Wapiti Meadows to Trout Creek Campground would be closed from construction through mine closure (9 miles). • Groomed OSV route on the west side of Johnson Creek from Trout Creek to Landmark lasting from construction through mine closure. Closure and Reclamation: Same as 2021 MMP.

REC 7538

PRI-00001052

OSV route would minimize the interactions between SGP traffic and recreational traffic in the winter. The proposed OSV route is illustrated in **Figure 2.4-4**.

- Expanded wintertime public vehicle access on Warm Lake Road east of Warm Lake Lodge would commingle SGP and public travel.

Changes to the SH 55 and Warm Lake Road intersection would improve access for large trucks carrying equipment and supplies to the SGP and would facilitate turns from SH 55 onto Warm Lake Road and from Warm Lake Road back onto SH 55. Any changes proposed to the intersection would need to be approved and implemented by the Idaho Transportation Department (ITD). Recommended changes to the intersection include: the addition of left and right turning lanes (Parametrix 2018a); an intersection modification to accommodate larger trucks; potential relocation of two power poles (HDR Engineering, Inc. [HDR] 2017a); and a modification to the westbound approach at Warm Lake Road to improve the view of traffic coming from the north.

Johnson Creek Route

During the initial construction period of the Burntlog Route (approximately 2 to 3 years), mine-related traffic would access the SGP from SH 55, north of the city of Cascade, via Warm Lake Road for approximately 34 miles, then north on Johnson Creek Road (CR 10-413) for approximately 25 miles to the village of Yellow Pine, and from Yellow Pine east approximately 14 miles to the SGP via the Stibnite Road (CR 50-412). The portion of the route that includes Johnson Creek Road and Stibnite Road is known as the Johnson Creek Route. This route is primarily situated topographically adjacent to the valley bottom, paralleling Johnson Creek and then the East Fork SFSR.

Johnson Creek Road is a county-maintained, native-surface road that is open to vehicles with seasonal restrictions due to snow. During the winter, Valley County plows approximately 10 miles of Johnson Creek Road from Yellow Pine south to Wapiti Meadow Ranch and grooms the remaining 17 miles of Johnson Creek Road from Wapiti Meadow Ranch to Warm Lake Road at Landmark for OSV use. Valley County does not plow Warm Lake Road from Warm Lake to Landmark; this section is a designated groomed OSV route.

The Stibnite Road portion of the route is also a county-maintained native surface road, open to all vehicles with seasonal restrictions due to snow. This road is plowed in the winter by Perpetua through an agreement with Valley County. Stibnite Road connects to Thunder Mountain Road on the southeastern portion of the Stibnite site and currently provides seasonal (non-winter) public access through the site.

Minor surface improvements (such as ditch and culvert repair, adding gravel, winter snow removal, resurfacing if required, and summer dust suppression) would occur on the Johnson Creek Route under the 2021 MMP to reduce sediment runoff and dust generation. However, there would be no road alignment modification or widening of these existing roads along the Johnson Creek Route. The road varies in elevation from approximately 4,750 to 6,700 feet amsl with an average grade of 1.5 to 2 percent with occasional local segments with grade up to approximately 8 percent.

REC 7539

PRI-00001053

2.4.4.4 Public Access

During construction of the SGP and completion of the Burntlog Route, to the degree practicable, the public would continue to have access on forest roads currently available to the public (**Figure 2.4-1**). However, public access through the Operations Area Boundary on Stibnite Road would be restricted for a period of approximately one year while a new through-site public access road is constructed. A new 4-mile long, 12-foot-wide gravel road would be constructed to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road through the SGP (**Figure 2.4-2**). The road would be constructed on a widened bench on the west side within the Yellow Pine pit, then head south of the Yellow Pine pit, where this road would utilize an underpass to cross under a SGP haul road and continue southward, parallel to and on the east side of the mine haul road on a partially revegetated portion of a former haul road (**Figure 2.4-2**). Southwest of the ore processing area, the public access road would connect with Thunder Mountain Road and continue toward the worker housing facility, exiting the SGP to the southeast.

During operations, the public access road through the Operations Area Boundary would provide seasonal use, open to all vehicles; access would not be provided in winter when impassable (current county maintenance standards) and signs would inform the public of seasonal and temporary closures. Public vehicles passing through would be required to check-in with mine personnel at the North or South SGP entry points and would receive a safety briefing and would also be required to check-out with SGP personnel upon exiting the SGP. For safety purposes, public access would be separated from other SGP roads by berms, security fencing, and the underpass to allow the public road to pass beneath the mine haul road. No stopping or deviating from the public access road would be allowed. Perpetua could restrict access to any vehicles due to concerns related to public or employee health and safety, such as during road construction and maintenance, blasting, highwall scaling, mining in the immediate area of the road, and similar operations.

Public access along Johnson Creek Road during the life of the SGP would be unchanged; however, closures spanning from a half-day to multiple days could occur due to construction activities. Total closures of half-day to multiple days could occur during construction work on Stibnite Road between the village of Yellow Pine and the SGP, part of Thunder Mountain Road, and Burnt Log Road.

Public access on existing segments of the Burnt Log Road would be restricted for limited periods of time to upgrade road segments during construction of the Burntlog Route. Other routes available for public use are shown on **Figure 2.4-1**.

Public access by foot via existing trails or on roads would be restricted within the Operations Area Boundary shown on **Figure 2.4-2**. Security personnel, fencing (including wildlife exclusion fencing), and signs would restrict public access to vehicular traffic on the designated public access roadway inside the Operations Area Boundary.

REC 7540

PRI-00001054

Description	Resources Affected
Perpetua would submit an annual report to the USFS and the other federal and state agencies that are responsible for issuing authorizations applicable to reclamation for the preceding calendar year. The annual report would contain descriptions of the reclamation activities completed during the previous year, a summary of areas reclaimed, a discussion of the results of the reclamation monitoring conducted, and corrective actions implemented.	Soils, Reclamation
A new 12-foot-wide gravel road would be constructed to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375) through the SGP. During operations, the public access road would be used to travel through the SGP and would provide seasonal use, open to all vehicles. Vehicles passing through the SGP would be required to check-in with mine personnel at the North or South SGP entry points.	Transportation and Access, Health and Safety
Post reclamation, a road would be established over the backfilled Yellow Pine pit to allow public access through the reclaimed site and connect Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375). This would replace the operational phase public access route.	Transportation and Access
Prior to site preparation and construction of surface facilities, vegetation would be removed from operating areas. Trees and deadwood, shrubs, and slash not needed to construct windrows at the edge of Burntlog Route disturbance (to function as sediment barriers), would be chipped, and suitable soil would be separately salvaged and stockpiled (except for a small portion that would be 'live handled') for use as part of site reclamation and restoration. Portions of the salvaged soil would be blended with the chipped wood to create growth media. All growth media placed in stockpiles would be stabilized, seeded, and mulched to protect the stockpiles from wind and water erosion.	Vegetation
Perpetua would inspect and remove vegetation material (including noxious weeds) from mechanical equipment and properly dispose to minimize the spread of unwanted vegetation.	Vegetation
Wood wastes and wood mulch are the two primary sources of compost. Food waste produced from on-site meal preparation and wastes may provide another source. Combined and properly managed during composting, these materials would provide a source of organic matter to be blended into substrate materials suitable for mitigation.	Vegetation
Perpetua would be responsible for noxious weed control within areas disturbed by SGP activities.	Vegetation, Wildlife
Develop and employ planting plans for wildlife benefits (cover, forage, etc.) using approved seed mixes.	Vegetation, Wildlife
Perpetua would use aquatic safe herbicides during vegetation management activities and noxious weed control. Adhere to chemical label restrictions, Federal and State rules on usage. Use proper equipment for chemical application by trained personnel.	Vegetation, Fish
Perpetua or its designated contractor(s) would perform long-term maintenance as necessary, including maintaining and monitoring the Mitigation Area (including stream and wetlands) in perpetuity once the final performance standards are met or until such responsibility is relinquished to an appropriate third party (Forest Service, etc.) as approved by the USACE.	Vegetation, Wetlands
Perpetua would plant stream reclamation reaches and wetland reclamation areas with native plant species that are present in PAB, PEM, PSS, and palustrine forested wetlands and riparian areas along streams throughout the Mitigation Area.	Vegetation, Wetlands
To address stream temperature, riparian planting widths along restored and enhanced stream reaches would be 18 feet wide on each stream bank where possible. Taller and denser vegetation such as spruce trees would be planted. Further, the creation of the lined Stibnite Lake, a feature similar in size to the present Yellow Pine pit lake, would replace the function of the existing Yellow Pine pit lake in buffering stream temperature extremes and reduce maximum stream temperatures in East Fork SFSR in and downstream of the SGP.	Vegetation, Wetlands, Surface Water, Reclamation

REC 7541

PRI-00001055

Issue	Indicator	Baseline Conditions	No Action Alternative	2021 MMP	Johnson Creek Route Alternative
Land Use and Land Management					
The SGP would cause changes in land use or land management.	Acres of land used for SGP components by land management agency.	(Analysis area) Private: 925 acres State: 77 acres BNF: 1,027 acres PNF: 2,373 acres BOR: 25 acres	Same as Baseline Condition.	Private: 819 acres State: 62 acres BNF: 933 acres PNF: 1,439 acres BOR: 12.5 acres	Private: 828 acres State: 62 acres BNF: 820 acres PNF: 1,372 acres BOR: 12.5 acres
	Acres of total and new land disturbance within SGP area.	Existing disturbance acreage within analysis area: 1,554 acres (includes historic mine disturbance, existing roads and utilities)	Same as Baseline Condition.	Disturbance acreage impacts: 3,266 total acres 51% (1,674 acres) of total is new disturbance	Disturbance acreage impacts: 3,095 total acres 50% (1,544 acres) of total is new disturbance
The SGP could cause changes in or create new ROWs or easements.	Miles or acres of new or changed ROWs or easements, regardless of jurisdiction.	Total existing ROW (transmission lines and roads): 666 acres	Same as Baseline Condition.	Total new ROW (transmission lines and roads): 763 acres	Total new ROW (transmission lines and roads): 639 acres
Access and Transportation					
The SGP may affect access to public lands during mine construction, operations, and closure and reclamation.	Number, location, and description of changes in access due to new and improved roadways.	See **Table 3.16-1** and **Figure 3.16-1**.	Same as Baseline Condition.	Burntlog Route (plowed). Mine site public access during operations (not plowed). Loss of winter groomed OSV route on Warm Lake Road to Landmark. Loss of winter groomed OSV route on Johnson Creek Road from Wapiti Meadows to Trout Creek Campground during construction of Burntlog Route.	No Burntlog Route, only Johnson Creek Route (plowed). Mine site public access during operations (not plowed). Loss of winter groomed OSV route on Warm Lake Road to Landmark. Loss of winter groomed OSV route on Johnson Creek Road from Wapiti Meadows to Trout Creek Campground for life of SGP.
The SGP may change the miles of roads and trails, the amount of use, and types of vehicles on each road or trail.	Miles of new road for public use.	Forest Service = 1,557 miles Valley County = 278 miles State = 131 miles	Same as Baseline Condition.	Forest Service = no change Valley County = 2.2 miles State = no change Private = 15 miles (with an additional 4 miles through the SGP)	Forest Service = no change Valley County = 2.2 miles State = no change Private = 4 miles through the SGP
	Change in amount of use.	See **Table 3.16-2** for existing roads.	Same as Baseline Condition.	Johnson Creek Route = 5 mine-related vehicles/hr. during construction Burntlog Route = 4 mine- related vehicles/hr. during operations; 2 mine-related vehicles/hr. closure and operations	Johnson Creek Route = 5 mine-related vehicles/hr. during construction; 4 mine- related vehicles/hr. during operations; 2 mine-related vehicles/hr. closure and reclamation
	Changes in frequency of rail, air, and water transportation.	Rail – no active lines Air – 7 public use airports Water – Port of Lewiston	Same as Baseline Condition.	Rail - No impact. Air – Helicopter usage for when roads are inaccessible. Water – potentially 1 roundtrip (2 truck trips) daily of antimony concentrate that could be shipped out via the Port of Lewiston.	Rail - No impact. Air – Helicopter usage for when roads are inaccessible. Helicopter usage during construction to install repeaters. Water – potentially 1 roundtrip (2 truck trips) daily of antimony concentrate that could be shipped out via the Port of Lewiston.

REC 7542

PRI-00001056

Issue	Indicator	Baseline Conditions	No Action Alternative	2021 MMP	Johnson Creek Route Alternative
	Changes in recreation physical setting characteristics and related ROS class (by season) measured in acres.	Designated ROS classes in the analysis area vary by season, and include Rural, Roaded Natural, Roaded Modified, Semi-Primitive Motorized, Semi-Primitive Non-Motorized, and Primitive. Estimated existing ROS physical settings are similar.	Generally, existing designated ROS classes and physical recreation setting characteristics would remain as is. Modifications to the recreation setting in the SGP area continued low level of unauthorized motorized use, and increased winter motorized access and use could lead to changes in the designated ROS class and/or ROS physical setting of some areas due to additional motorized use both in the summer and winter. Acreage of Estimated ROS Physical Setting Classes – Summer/Winter: • Primitive: 17,278/21,370 acres • Semi Primitive Non-Motorized: 218,512/245,210 acres • Semi-Primitive Motorized: 83,497/240,387 acres • Semi-Primitive Motorized Groomed (winter only): 50,436 acres (this acreage overlaps other features) • Roaded Natural: 140,594/7,511 acres • Rural: 81,450/26,853 acres	Several components would result in inconsistencies with existing designated ROS classes including: Burntlog Route, plowing of the Burntlog Route, temporary plowing of the Johnson Creek Road and Stibnite Road, plowing of Warm Lake Road (CR 10-579), new transmission line. Acreage of Disturbance to ROS Physical Setting Classes During Operations – Summer/Winter: Primitive: 0/0 acres Semi Primitive Non-Motorized: 0/0 acres Semi-Primitive Motorized: 42/364 acres Semi-Primitive Motorized Groomed (winter only): 163 acres Roaded Natural: 685/387 acres Rural: 345/322 acres	Similar to the 2021 MMP, except there would be no inconsistencies with existing designated ROS classes related to the Burntlog Route or plowing of the Burntlog Route. Inconsistency with the existing designated ROS class for Johnson Creek and Stibnite Roads in the winter would not be temporary during construction (as in the 2021 MMP) but would continue through operations and reclamation because the roads would be plowed as part of the Johnson Creek Route. Acreage of Estimated ROS Physical Setting Classes During Operations – Summer/Winter: Primitive: 0/0 acres Semi Primitive Non-Motorized: 0/0 acres Semi-Primitive Motorized: 43/212 acres Semi-Primitive Motorized Groomed (winter only): 113 acres Roaded Natural: 387/34acres Rural: 353/536 acres
	Changes in recreation facilities (trails, campgrounds, trailheads), including the level of development and setting.	The Warm Lake area contains most of the developed recreation facilities (apart from trailheads). Scattered campgrounds and other facilities also are located in the Big Creek and Landmark areas and along Johnson Creek Road around and south of Yellow Pine. Developed recreation facilities primarily include campgrounds, cabins/lookouts, trailheads, and trails.	Same as Baseline Condition	The Stibnite Mining District Interpretive Site would be closed until after mine reclamation. Mine components would alter the setting of recreation facilities adjacent to them to a more developed setting due to increased man-made development, noise, traffic, etc. These components include the mine and facilities within the Operations Area Boundary, Burntlog Route, upgraded transmission lines, new transmission line to the Operations Area, Johnson Creek substation, a small VHF repeater on Meadow Creek Lookout, use of Warm Lake Road, and temporary use of the Johnson Creek Route.	Similar to the 2021 MMP, except the Burntlog Route would not be built and therefore would not affect the setting of existing recreation facilities. In addition, changes to the setting of recreation facilities along the Johnson Creek Route would be affected through reclamation and not just temporarily during construction.
	Changes in recreation use, potentially due to changes in recreation facilities, opportunities, access, and setting.	Developed recreation use is limited to the developed recreation sites (i.e., overnight facilities) located primarily in the Warm Lake, Landmark and Johnson Creek Road areas. Most recreation in the analysis area is dispersed use, which occurs outside of developed recreation sites.	Existing recreation use would continue. Some unauthorized motorized use may continue to occur off of existing roads and motorized trails. Motorized winter use has expanded in recent years, and may continue to expand in the future, resulting in additional OSV routes and additional areas receiving winter motorized use.	There would be public access through the Operations Area Boundary, which may result in less displacement of use to areas/facilities accessed from Thunder Mountain Road (FR 50375). In addition, there could be increased dispersed recreation use along the Burntlog Route . Some recreation use may return to the Operations Area Boundary after reclamation; however, due to the changes in the recreation setting, some use may be displaced to areas where the recreation setting is more natural.	Similar to the 2021 MMP. The Burntlog Route would not be built; therefore, there would be no resulting displacement or increase in recreation use from this route.

REC 7543

PRI-00001057

Johnson Creek Road

During non-winter conditions (roads clear of snow), the Operations Area Boundary can be accessed from the City of Cascade by traveling northeast on Warm Lake Road for about 34 miles to Landmark, then north on Johnson Creek Road for approximately 25 miles to the village of Yellow Pine, and approximately 14 miles east on the Stibnite Road portion of McCall-Stibnite Road (Stibnite Road). Johnson Creek Road and the Stibnite Road portion of McCall-Stibnite Road is currently used to access the Operations Area Boundary during the summer.

The Johnson Creek Road is a county maintained, native surface road that is open to vehicles with seasonal restrictions due to snow. During the winter, Valley County plows approximately 10 miles of Johnson Creek Road from Yellow Pine to Wapiti Meadow Ranch and Perpetua (under agreement with Valley County) plows along Stibnite Road. Valley County grooms the remaining 17 miles of Johnson Creek Road from Wapiti Meadow Ranch to Warm Lake Road at Landmark for OSV use. Valley County does not plow Warm Lake Road from Warm Lake to Landmark. This section is a designated groomed OSV route.

McCall-Stibnite Road

The Stibnite Road from the intersection with Johnson Creek Road then east to the mine is also a county-maintained native surface road, open to all vehicles with seasonal restrictions due to snow. This road is plowed in the winter by Perpetua through an agreement with Valley County. Stibnite Road connects to Thunder Mountain Road on the southeastern portion of the Stibnite mine site and currently provides public access through the mine area.

The analysis area can be accessed from McCall during non-winter conditions by traveling east on the Lick Creek Road portion of McCall-Stibnite Road for approximately 37 miles to the East Fork Road portion of McCall-Stibnite Road, then approximately 16 miles to the village of Yellow Pine, and approximately 14 miles east on Stibnite Road. Lick Creek Road is not maintained during the winter; however, East Fork Road and Stibnite Road are plowed from the intersection with SFSR Road to Yellow Pine by Valley County and from Yellow Pine to the Operations Area Boundary by Perpetua to access their private land inholdings in the area. Although the Lick Creek and East Fork roads are not proposed to be used by the SGP, they provide access for other users of the analysis area.

South Fork Salmon River Road

The SFSR Road can be accessed year-round from Cascade by traveling approximately 24 miles northeast on Warm Lake Road to the intersection with SFSR Road. It then travels north for approximately 30 miles to intersect with the East Fork Road portion of the McCall-Stibnite Road. Some segments along SFSR Road have sharp curves which can be challenging for heavy vehicle travel. Although this route currently provides the only access to the Operations Area Boundary during winter months, it is not proposed to be used by the SGP.

3.16.4.3 Existing Stream Crossings

Existing stream crossings along the existing Johnson Creek, Stibnite, and Burnt Log roads are shown on **Figure 3.13-7**. There are 213 existing stream crossings along existing main access roads in the analysis

REC 7544 PRI-00001058

If none of the action alternatives proceed, the current uses by Perpetua and other users on patented mine/mill site claims and on NFS lands would continue to follow all existing applicable air quality regulations. Uses of NFS lands that may result in air pollutant emissions include mineral exploration, dispersed OHV use, snowmobiling, and other forms of recreation.

4.3.4.2 2021 MMP

Construction and Operations Description

The construction of the 2021 MMP includes building power transmission, access roads, and mining/processing facilities. These operations are to be performed during LOM 1 through LOM 3. Operations would begin in LOM 4 through LOM 18. Access road construction would consist of development of the Burntlog Route for mine access and minor improvements for the Johnson Creek route. Also, while the Burntlog Route is being developed, a temporary groomed OSV trail would be constructed on the west side of Johnson Creek from Trout Creek to Landmark for public access. Other public access construction would be a Cabin Creek Road groomed OSV trail. Eight borrow sources along the Burntlog Route would also be constructed.

During operations, restricted public access through the site would be provided by constructing a new road around the Yellow Pine pit and below the mine haul road to link Stibnite Road to Thunder Mountain Road.

Lastly, operations would include communication towers and an offsite logistics and road maintenance facilities. A cell tower would be located north of the Hangar Flats pit with very high frequency repeater sites. There would also be a communication site at the SGLF with upgrades to the existing site. The Burntlog road maintenance facility would be located approximately 4.4 miles east of the junction of Johnson Creek Road and Warm Lake Road along the proposed Burntlog Route.

Construction and Operations Air Emissions Inventory

Air pollutant emissions were initially estimated for activities and process sources included in the 2021 MMP for each LOM year. The LOM years presented in this discussion are based on years starting with LOM 1 as the first year of construction. LOM 6 is expected to produce the highest overall annual total of criteria pollutant emissions.

Air pollutant emission point sources for the construction phase would include engine-driven generators, portable conical crusher and screens, diesel-fired heaters, and engine-driven air compressors. The fugitive sources related to mine construction and operations would be haul, access, and construction road dust from vehicle travel during the pre-production years, as well as earth-moving equipment, material transfers, storage in several construction stockpiles and development rock piles, tailpipe emissions and exploratory activities. The use of ANFO explosives also would be considered a mine construction phase source, as well as an ongoing operations phase source.

REC 7545

PRI-00001059

emissions. These process exhaust control technologies are accounted for in the maximum emissions estimates in **Table 4.3-5**:

- Activated carbon regeneration kiln – wet scrubber and activated carbon filter;
- Retort – activated carbon canisters and filter pack; and
- Induction furnaces – baghouse filter and activated carbon filter pack.

Near-Field Analysis NAAQS

Assessment of conformance to the NAAQS is based on the highest receptor concentration in the modeling domain for the pollutants and averaging times corresponding to the standards. The modeled maximum concentration at each receptor is added to the selected background concentrations that represent current existing conditions. If the results from this computation are below the NAAQS, then impacts at other locations in the domain would be below the NAAQS as well.

For NAAQS modeling inputs, the highest emissions of each pollutant during any LOM year were determined and provided in **Table 4.3-6**. For the 2021 MMP, the highest criteria pollutant emissions occur during two different years, LOM 6 (CO, NO_X, and SO_2) and LOM 10 ($PM_{2.5}$ and PM_{10}). Therefore, to capture the highest modeled concentration for each pollutant, separate modeling was performed for LOM 6 and 10 (i.e., two models). Note that VOC emission maximums from LOM 3 were not modeled because there is no specific NAAQS for these emissions, however VOCs are addressed as part of the secondary $PM_{2.5}$ analysis.

Table 4.3-6 LOM Years for Pollutant-Specific Maximum Annual Emissions

Pollutant	LOM Year	SGP Total Annual Emissions (tpy)
CO	6	535.5
NO_2	6	335.2
PM_{10}	10	320.1
$PM_{2.5}$	10	69.2
SO_2	6	7.3
VOC	3	27.4
HAPs	10	8.5
Hg	10	13.3 (lb/yr)

The 2021 MMP would include a 12-foot-wide gravel road to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375) through the SGP. Perpetua received a final PTC from IDEQ on June 17, 2022. This application proposed to exclude the public road on the basis of restricted access and maintaining full control, and that people traveling on the road would be considered "guests of the mine." IDEQ accepted the private road concept proposed by Perpetua (see PTC Condition 2.7, Response to Comments #16 and Statement of Basis on the IDEQ website) and in response to comments on February 18, 2021, also states that the roadway between Stibnite Road at Sugar Creek and Thunder Mountain Road at Meadow Creek was appropriately excluded from ambient air. Additionally, the EPA

REC 7546 PRI-00001060

Region X has indicated that the access road could possibly be excluded from ambient air if sufficient enforceable measures are taken to comply with the 2019 revised policy (EPA 2019a). Exclusion of the public access road from ambient air protections is a unique case that relies on measures assumed to meet the standards inferred in the 2019 revised ambient air policy. However, a formal EPA policy review of the ambient air boundary for the SGP has not been conducted nor requested. A formal review is not necessarily required. The EPA did provide formal comment on IDEQ's air quality PTC recommending a review be requested by the State and that initial measures in the PTC were too ambiguous to determine compliance with the revised ambient air policy. To comply with this measure, Perpetua has developed a transportation management plan that is included as Appendix D of the Air Quality Specialist Report (Forest Service 2023a).

The AERMOD dispersion modeling results for the 2021 MMP analysis emissions and comparison with the applicable NAAQS are provided in **Table 4.3-7**. The geographic location of the maximum impacts amongst the criteria pollutants and averaging periods between LOM 6 and 10 are provided in Figure 4 of the Air Quality Analysis Addendum ModPro2 (Air Sciences 2021a). The results demonstrate compliance with all NAAQS and would be considered to have a moderate impact locally and minor impact regionally. Additionally, **Table 4.3-8** provides geographic locations of the NAAQS maximums.

Table 4.3-7 Near-Field NAAQS Compliance Demonstration

Pollutant	Averaging Time	Maximum Modeled Conc. (µg/m³)	Background Conc.[3] (µg/m³)	Total Impact Conc. (µg/m³)	NAAQS (µg/m³)	NAAQS Compliance
CO	8 hours	404.6	1,110	1,515	10,000	Yes
CO	1 hour	495.5	1,740	2,236	40,000	Yes
Lead	3-month rolling	Not Required[1]	Not Required[1]	Not Required[1]	Not Required[1]	Not Required[1]
NO_2	Annual	19.8	0.9	20.7	100	Yes
NO_2	1 hour	129.8	4.3	134.1	188	Yes
O_3	8 hours	3.0	117.7	120.7	137	Yes
PM_{10}	24 hours	15	37.0	51.9	150	Yes
$PM_{2.5}$ [2]	Annual	1.1	3.5	4.6	12	Yes
$PM_{2.5}$ [2]	24 hours	2.7	15.0	17.7	35	Yes
SO_2	1 hour	3.0	12.3	15.3	196	Yes
SO_2	3 hours	1.8	16.8	18.6	1,300	Yes

[1] Lead modeling is not required per IDEQ as the facility-wide emissions are less than 10 percent of the lead significant emission rate of 0.6 tpy and considered "Below Regulatory Concern".
[2] Includes the secondary impacts.
[3] All background concentrations are derived from the NW Airquest data (WSU 2018).

REC 7547
PRI-00001061

SGP would be slightly less for this alternative. The location of ambient air pollutant concentrations due to vehicle traffic would differ, with such effects being located along the Johnson Creek Route.

Providing public access through the SGP reduces the miles of new motorized trails open to all vehicles in the Meadow Creek IRA, and this is expected to reduce net air quality effects due to vehicles traversing the SGP area.

Several air pollution design features proposed by Perpetua are common to both action alternatives and are described in **Section 2.4.9**. Emission control devices and designs would be put in place to abate emissions of particulate matter, Hg, and criteria pollutant emissions from internal-combustion engines the same as the 2021 MMP. Operational and reclamation air emission impacts for this alternative would therefore be the same as the 2021 MMP.

The stationary facilities would be designed, constructed, and operated with the same air pollution controls as the 2021 MMP to comply with applicable regulations and any air quality permits issued by IDEQ. The PTC includes stipulations for control of airborne dust from vehicle traffic along the Johnson Creek Route that are based on applicable state and federal regulations.

4.3.5 Mitigation Measures

Mitigation measures required by the Forest Service would represent reasonable and effective means to reduce the impacts identified in the previous narrative or to reduce uncertainty regarding the forecasting of impacts into the future. These mitigation measures would be in addition to the Forest Service requirements and EDFs (**Section 2.4.9**) accounted for in the preceding impact analysis.

A number of emission controls and monitoring actions have been proposed by Perpetua in compliance with government requirements. These are described below:

Perpetua would develop a fugitive dust control plan (FDCP) that would address the following at a minimum:

- Procedures followed by Perpetua employees to control and minimize fugitive dust emissions.
- Trigger levels to be set that require corrective action.
- Actions to bring fugitive dust emissions within acceptable ranges.
- Steps to demonstrate that appropriate corrective procedures are followed.
- Procedures to verify that Perpetua is controlling avoidable fugitive dust emissions.

Additionally, the IDEQ permit would include the following control measures proposed by Perpetua for HAP and mercury emissions. The implementation of these requirements was included in the Forest Service's assessment of air quality effects and the Forest Service decision includes implementation of these control measures:

- Mining – chemical dust suppressant and water application on haul roads, reasonable controls, FDCP
- Rock dumps and storage piles - reasonable controls, FDCP

REC 7548

PRI-00001062

temperatures and reduced stream flows. The SGP area could experience climate change impacts to fish resources and fish habitat by lowering streamflows, increased water temperatures, and decreased water quality which would adversely impact aquatic species and habitat. Process and design modifications, such as rerouting Hennessy Creek, lining the Meadow Creek diversion channel, piping low flows, and the complete backfill of Hangar Flats pit that would improve streamflow and temperature in Meadow Creek, would help to reduce these impacts.

Wildlife and Wildlife Habitat

Climate change impacts to wildlife and wildlife habitat in the SGP area would include habitat loss and fragmentation, physiological sensitivities, and alterations in the timing of seasonal life cycles. Habitat loss and fragmentation may occur in the region and analysis area due to the increased potential for wildfire that is anticipated from changing climatic conditions (Halofsky et al. 2018). Construction and operation of the SGP, access roads, utilities, and off-site facilities would additionally impact wildlife from habitat loss and fragmentation. Reclamation activities are intended to achieve post-mining land use for wildlife habitat as reasonably possible, which would help to reclaim habitat connectivity. However, some displacement and habitat fragmentation would be a long-term effect.

Timber Resources

Timber resources in the SGP area are vulnerable to climate change impacts from changing temperatures and precipitation patterns, increased wildfire frequency and intensity, and insects and disease. Direct effects of climate change on timber (e.g., temperature and precipitation) are likely to be minor, but indirect effects from various disturbances (e.g., increased temperatures and warmer winters causing insect and disease outbreaks) may be significant for the timber industry (Halofsky et al. 2018).

The 2021 MMP would result in ground disturbance in locations currently covered by forested vegetation. Post-closure, disturbed areas would be revegetated. To address losses of vegetation from disturbance, the Reclamation and Closure Plan (Tetra Tech 2021a) proposes to replant with conifer and other tree species, which would be located completely within the Operations Area Boundary. The success of the reclamation could be impacted due to the increased risk to timber from wildfire, insects, and disease due to climate change (American Forests 2017; Halofsky et al. 2018).

Land Use and Land Management

The 2021 MMP would alter land use in areas of new or expanded right-of-way and easements to accommodate access roads, utilities, and off-site facilities. Climate change could also impact how lands in the SGP area are used in the long term, altering the surrounding environment (e.g., decreasing ground cover, larger wildfire burn areas, decreased stream flows impacting how the area is used for recreational or tribal purposes) and impacting accessibility. Land management effects caused by the SGP are not expected to be noticeably impacted by climate change.

Access and Transportation

Access to and through the Operations Area Boundary would be maintained during construction, operation, and closure and reclamation. There would be public access through the Operations Area Boundary during construction and operations via a new gravel road constructed to connect Stibnite Road

REC 7549

PRI-00001063

to Thunder Mountain Road. Climatic changes causing an increase in severe events, such as floods, landslides, and avalanches, can add stress to roadways and other infrastructure, which may result in more frequent maintenance and repairs.

Heritage Resources and Tribal Rights and Interests

The 2021 MMP could impact historic properties, due to ground and visual disturbance in the SGP area. Changing climatic conditions are expected to exacerbate the damage and loss of heritage resources and natural areas utilized by tribes for activities such as hunting, fishing, and gathering in the SGP area through increased soil erosion, more frequent and intense wildfires, flooding, degraded water quality, and wildlife and fish habitat impacts.

Public Health and Safety

Climate change impacts to public health and safety would be experienced through impacts to air, soil, and water quality. The 2021 MMP has the potential to impact public health and safety through the transportation and use of fuels and chemicals, natural environmental hazards, economic impacts, changes to public services and infrastructure, and impacts to the local population.

Climate change could exacerbate some impacts to public health and safety by affecting the way potential hazardous material spills enter the environment. It also could increase the frequency and amplify the impacts of natural hazards such as avalanches and landslides, flash floods, and wildfires (Halofsky et al. 2018). More extreme heat days and higher temperatures over time could increase air quality and health risks over both the short and long term, impacting the public and the employees' abilities to work (Runkle et al. 2017).

Recreation

Much of the SGP area is used for recreation year-round, which would be both directly and indirectly impacted by climate change. The 2021 MMP has the potential to impact recreational access, recreation facilities, dispersed recreation areas, special use permits, recreational motorized travel, and recreation use. Direct impacts from climate change would include variable precipitation and rising temperatures, which could affect individual decisions to recreate in a certain area. Indirect impacts from climate change would be experienced through the changing conditions that may alter the recreation facilities, opportunities, and setting.

Changing climatic conditions could alter the ecological conditions that affect the quality of the recreation experience, including warmer water temperatures, decreased streamflow, and habitat loss and fragmentation. In the Rocky Mountain region, it is expected that snow-based activities (skiing, snowmobiling) would be impacted negatively by climate change due to warmer winters (Halofsky et al. 2018). Primitive area use, horseback riding on trails, motorized water activities, birding, hunting, and fishing in the region also are expected to be negatively influenced by climate change; however, longer periods of warmer temperatures are expected to increase participation in warm-weather activities such as water recreation and hiking (Askew and Bowker 2018).

REC 7550

PRI-00001064

the area, as some species sensitive to human presence may not return to the area for years after the mine is closed, resulting in a minor, permanent, and localized impact.

The 2021 MMP components that would affect the Idaho Wilderness Company operating area during closure and reclamation would be similar to those described for construction and operations. The loss of cellular coverage on portions of the analysis area may impact customer safety in the SGP but would aid in returning primitive recreation experiences to the FCRNRW areas in the Idaho Wilderness Company operating area. Providing public access through the SGP after closure and reclamation would restore the ability for the Idaho Wilderness Company to reach portions of their operating area without a detour. Displacement of permitted use may continue past reclamation due to permanent changes in the recreation setting within the Operations Area Boundary and potential changes to wildlife present in the area, as some species sensitive to human presence may not return to the area for years after the mine is closed, which would result in a minor, permanent, and localized impact.

Closure and reclamation of all 2021 MMP components would affect the Juniper Mountain Outfitters operating area either directly or indirectly due to recreation displacement from other areas. The ability of Juniper Mountain Outfitters to access their operating area, provide IOGLB licensed activities, and the quality of recreation experiences for customers participating in guided activities near these components may be impacted during closure and reclamation due to noise and reclamation activity. Displacement of permitted use may continue past reclamation due to the changes in the recreation setting in the Operations Area Boundary, and potential changes to wildlife present in the area, as some species sensitive to human presence may not return to the area for years after the mine is closed, which would result in a negligible, permanent, and localized impact.

There are no 2021 MMP components that would impact the North Shore or Warm Lake Lodges, Warm Lake Camp, YWAM, or Warm Lake recreation residence tract during closure and reclamation; therefore, no impacts are anticipated.

Winter use of the Cabin Creek Road OSV route during closure and reclamation would continue to impact the Paradise Valley recreation residence tract as described for construction and operations.

Travel Management Rule

The reroute of Stibnite Road and the designation of a temporary OSV route to replace an existing OSV route are actions that fall under the Travel Management Rule (36 CFR 212), Subparts B and C, respectively (FSM7715.03(5)). These actions require consideration under the Travel Management Rule Minimization Criteria (36 CFR 212.55(b)). The responsible official shall consider the effects on the following, with the objective of minimizing:

- Damage to soil, watershed, vegetation, and other forest resources;
- Harassment of wildlife and significant disruption of wildlife habitats;
- Conflicts between motor vehicle use and existing or proposed recreations uses of NFS lands or neighboring federal lands;
- Conflicts among different classes of motor vehicle uses of NFS lands or neighboring federal lands; and,

REC 7551

PRI-00001065

- Compatibility of motor vehicle use with existing conditions in populated areas, taking into account sound, emissions, and other factors.

Table 4.19-3 describes where the Travel Management Rule criteria were addressed in the EIS.

Table 4.19-3 Criteria for Designation of Roads, Trails, and Areas Review

Criteria	Section of EIS Addressing Criteria	Applicable Screening Criteria
General Criteria 36 CFR 212.55(a)		
NFS natural and cultural resources, public safety, provision of recreation opportunities, access needs, conflicts among uses of NFS lands, the need for maintenance and administration of roads, trails, and areas that would arise if the uses under consideration are designated, and availability of resources for maintenance and administration.	Sections 4.17, 4.18, 4.19, 4.16, and 4.15	Heritage resources, public health and safety, recreation, access and transportation, land use and land management.
Consider combinations of uses (such as motorized and non-motorized, different vehicle classes, and highway-legal and non-highway-legal vehicles).	Section 4.16	Access and transportation.
Minimization Criteria 36 CFR 212.55(b)		
Damage to soil, watershed, vegetation, and other forest resources.	Sections 4.5, 4.8, 4.9, 4.10, and 4.14	Watersheds and water resources, soils, vegetation, and other forest resources
Harassment of wildlife and significant disruption of wildlife habitats.	Section 4.13	Wildlife and TES Wildlife
Conflicts between motor vehicle use and existing or proposed recreation uses of NFS lands or neighboring federal lands.	Sections 4.16 and 4.19	Recreation conflict. Motor vehicle conflict and compatibility
Conflicts among different classes of motor vehicle uses of NFS lands or neighboring federal lands.	Section 4.16, the Transportation Management Plan, EDFs (Table 2.4-13), and Forest Service Requirements (Table 2.4-12)	Motor vehicle conflict and compatibility Road engineering geometry and criteria.
Compatibility of motor vehicle use with existing conditions in populated areas, taking into account sound, emissions, and other factors.	Section 4.23, the Transportation Management Plan, EDFs (Table 2.4-13), and Forest Service Requirements (Table 2.4-12)	Designated areas, special designations, or potential special designations. Rights of access.

The 2021 MMP considered the minimization criteria for the reroute of Stibnite Road through the mine site and the temporary relocation of the Warm Lake OSV route to Cabin Creek Road and west of Johnson

REC 7552

PRI-00001066

Creek Road. Damage to soil, watershed, vegetation, and other forest resources was analyzed by determining if the routes intersect with impaired watersheds, wetlands, riparian areas, high-risk flood hazard areas, soils having erosion potential, and riparian vegetation communities.

4.19.2.3 Johnson Creek Route Alternative

The Johnson Creek Route Alternative is similar to the 2021 MMP, with the main differences that affect recreation consisting of use of the Johnson Creek Route for access to the mine for all phases (no construction or use of the Burntlog Route); a change in the location of the Landmark Maintenance Facility; and use of helicopters for construction and maintenance of cell towers and repeater sites in IRAs managed for backcountry/restoration. These changes would result in different impacts than the 2021 MMP, particularly the use of the Johnson Creek Route.

Recreation Opportunities, Facilities, Access, and Use

Construction and Operations

Impacts of the Johnson Creek Route Alternative during construction and operations would be the same as those described under the 2021 MMP, except for those described below. The Burntlog Route and Burntlog Maintenance Facility would not be constructed under the Johnson Creek Route Alternative; therefore, there would be no construction impacts related to those facilities.

Johnson Creek Route

Year-Round

Use of Johnson Creek and Stibnite roads as the route to the Operations Area Boundary during construction, operations, and reclamation and closure would result in impacts to the recreation setting of the existing recreation sites/areas along these roads due to increased noise, traffic, and safety-related issues from mine-related traffic (Forest Service 2023d, 2023k), leading to a change in recreation experiences for some visitors. Traffic on Johnson Creek and Stibnite roads would substantially increase (almost two times the current traffic conditions, respectively), thereby increasing the noise and activity near campgrounds and trailheads adjacent to these roads. Impacts are anticipated to be moderate, short-term, and localized.

Recreation facilities affected by the increase in traffic and traffic noise would include Burntlog and Quartz Creek Trailheads; Buck Mountain, Trout Creek, Ice Hole, Golden Gate, and Yellow Pine Campgrounds; Twin Bridges dispersed camping area; and Johnson Creek Cabin. The recreation setting of these facilities would be altered to a more developed setting due to an increase in the sights and sounds of humans, which would displace recreationists to avoid noise associated with activities and traffic along Johnson Creek and Stibnite roads, particularly recreationists participating in non-motorized activities. Motorized users who use Johnson Creek and Stibnite roads for recreation also may be displaced due to the increased traffic along the roadways. Wildlife-related recreation opportunities also would decrease along these roadways due to wildlife displacement from traffic and noise. This impact is anticipated to be minor, short term, and localized.

REC 7553

PRI-00001067

groomed OSV route would be inaccessible as it is north of the Trout Creek Campground on the closed OSV route between the campground and Wapiti Meadows. The new groomed OSV route along Johnson Creek Road would remain through operations and closure/reclamation under the Johnson Creek Route Alternative as the Johnson Creek Route would be used throughout the life of the SGP. Therefore, impacts from the plowing of Johnson Creek Road under the Johnson Creek Route Alternative are anticipated to be minor, long term, and localized.

Public Access

Road closure impacts on the Johnson Creek route would be the same as those described under the 2021 MMP, except impacts to recreation access, use, and opportunities along Thunder Mountain Road would begin during construction and continue until the public access road through the Operations Area Boundary was complete and open to public use to provide access to the Thunder Mountain area. Construction under the Johnson Creek Route Alternative is expected to take 2 years longer than the 2021 MMP.

The impacts to public access through the Operations Area Boundary would be the same as under the 2021 MMP. The public access road would provide access to recreation sites/areas via Thunder Mountain Road; therefore, the access road would allow continuous access to the Thunder Mountain Road sites/areas. However, as described under the 2021 MMP, there would be temporary closures of this route during some mining activities that would result in minor, short term, and localized impacts to recreation.

Landmark Maintenance Facility

The Landmark Maintenance Facility would be located approximately 0.1 mile south of Landmark and the historic cabins located there. Access to the maintenance facility would be off Warm Lake Road. There would be no delays or additional traffic along Warm Lake Road in this area since the Burntlog Route would not be constructed, but rather from all construction-related traffic using Warm Lake Road to Johnson Creek Road. It is assumed that construction equipment would travel east on Warm Lake Road; therefore, delays would likely affect access to Horn Creek Road, Rec Spur 579U2, 450 South, and Burnt Log Road, which are east of the maintenance facility site. This impact is anticipated to be moderate, short term, and localized.

Noise associated with construction activities could reduce opportunities for noise-sensitive recreation activities at and around the maintenance facility location (up to 1.1 miles away) (AECOM 2019c), including wildlife-related recreation activities, because wildlife may be displaced. Construction activities would not affect use of the historic cabins; however, construction noise at the site may affect the recreation setting of the cabins, because it may be audible from the cabin sites. Some recreationists may choose to visit other areas or sites to avoid delays or noise from construction activities. Any reduction in recreation opportunities, displacement of dispersed recreational use, or changes in access would be temporary until maintenance facility construction was completed. These impacts would be minor, short term, and localized.

Development of the Landmark Maintenance Facility would reduce recreation opportunities due to physical removal of acreage for the facility (3.5 acres). Traffic due to maintenance activities and vehicles would not be expected to result in frequent traffic delays on Warm Lake Road but may result in

REC 7554

PRI-00001068

EXHIBIT 6
Excerpts from Errata

USDA Forest Service
U.S. DEPARTMENT OF AGRICULTURE

50516
Region 4

January 2025
Payette and Boise National Forests

Stibnite Gold Project

Final Environmental Impact Statement

Errata



Cover photo: Yellow Pine pit. Midas Gold, Stibnite Gold Project Plan of Restoration and Operations September 2016.

Stibnite Gold Project Final Environmental Impact Statement Errata Document

1. Introduction

The Stibnite Gold Project Draft Record of Decision and the Final Environmental Impact Statement (FEIS) were released on September 6, 2024. This errata sheet documents corrections to the text of the September 2024 published FEIS and should be reviewed along with the FEIS. These corrections reflect instructions provided by Kelly Orr, the Intermountain Region Deputy Regional Forester, in the response to objections dated October 21, 2024, and additional clarifications. These corrections are consistent with the direction given in Forest Service Handbook 1909.15, Chapter 10, Section 18. There are no changes to the project or significant new circumstances identified in this errata sheet that affect the analysis and conclusions in the Stibnite Gold Project FEIS, therefore, a supplement to or revision of the FEIS is not needed. These changes also apply to the Stibnite Gold Project specialist reports, as applicable.

Article II. Chapter 2

1. FEIS, Chapter 2, Section 2.4.4.4 Public Access (page 2-20)

The description regarding seasonal public access through the operating mine site to Thunder Mountain Road is modified per the italicized text:

During operations, the public access road through the Operations Area Boundary would provide seasonal use, open to all vehicles; access would not be provided in winter when impassable (current county maintenance standards) and signs would inform the public of seasonal and temporary closures. Public vehicles passing through would be required to check-in with mine personnel at the North or South SGP entry points and would receive a safety briefing and would also be required to check-out with SGP personnel upon exiting the SGP. For safety purposes, public access would be separated from other SGP roads by berms, security fencing, and the underpass to allow the public road to pass beneath the mine haul road. No stopping or deviating from the public access road would be allowed. Perpetua could restrict access to any vehicles due to concerns related to public or employee health and safety, such as during road construction and maintenance, blasting, highwall scaling, mining in the immediate area of the road, and similar operations. *Because public use of the road would be subject to Perpetua's control measures on general use, the public access road is not considered a public road.*

Significance: The addition clarifies the status of the access road through the site with regard to whether it will be operated as a public road.

2. FEIS, Chapter 2, Section 2.4.9 Environmental Design Features (Table 2.4-12 on page 2-106)

An environmental design feature used in the wildlife specialist report effects analysis unintentionally omitted from Table 2.4-12. The following row is added into Table 2.4-12 on page 2-106.

REC 7557

PRI-00001070

EXHIBIT 7
Excerpts from ROD

United States Department of Agriculture

U.S. Forest Service

Payette and Boise National Forests

Final Record of Decision

Stibnite Gold Project

Valley County, Idaho

January 2025

REC 7559

PRI-00001071

preparation and early construction until the worker housing facility is constructed. Administrative offices, a transportation hub, warehouses, and assay laboratory facilities, all supporting mine-related activities, will be located offsite and outside of the operations area boundary.

Prior to site preparation and construction of surface facilities, vegetation will be removed from operating areas. Any merchantable timber on National Forest System lands will be purchased from the Forest Service through a timber sale. Access to the mine site during the construction period will be from Cascade, Idaho via the County Road 10-579 (Warm Lake Road), to County Road 10-413 (Johnson Creek Road), and then to County Road 50-412 (Stibnite Road). As part of the Stibnite Gold Project construction, a new access route, the Burntlog Route, will be constructed to connect the Warm Lake Road to the mine site. The new Burntlog Route will be used during the operating and closure periods and will be reclaimed as part of closure. The Burntlog Route will be used by Perpetua and its contractors for mine access, but public use of the route will be restricted as described in the Burnt Log Route Public Access Restriction mitigation measure in Part 2.3.10. The Johnson Creek Road and Stibnite Road will only be used for alternative site access in case of emergency or unplanned closure of the Burntlog Route.

Mining

The Selected Alternative includes a total of approximately 3,266 acres of new and re-disturbance of surface resources through the creation or expansion of three open-pits, an ore processing area, a tailings storage facility and buttress, an access roads, a transmission line, dewatering and industrial water supply wells, a worker housing facility, a road maintenance facility, an underground exploration decline, and other ancillary facilities (**Figure 1**). The acreages of disturbance for each mine feature are presented in Table 2.4-1 of the FEIS.

The proposed facilities and methods of mining are described in greater detail in Section 2.4 of the FEIS. The estimated operating mine life is approximately 15 years preceded by a three-year construction period, a five-year closure period, and an estimated 15-year post-closure period for water treatment of residual process solution. Perpetua will employ approximately 640 personnel during the construction period, 580 personnel during the operating period, 160 personnel during the closure period, and 40 personnel during the post-closure period.

General mine operations will include drilling, blasting, loading, and hauling using excavators, dozers, and a fleet of trucks. Ore will be hauled to the on-site mill facility, and overburden will be placed as a buttress to the tailings storage facility embankment or backfilled into the mined-out pits (**Figure 2**). Reclamation will take place concurrently with mining operations, as feasible, and will be completed during the closure and post-closure periods.

The Stibnite Gold Project will consist of mining three primary mineral deposits and the re-mining of historical tailings using conventional open pit mining methods. Ore from three open pits (Yellow Pine, Hangar Flats, and West End pits) will be sent to either the crusher, located near the processing plant, or one of several ore stockpiles in various locations within the operations area boundary (**Figure 2**). Ore will be stockpiled and processed at a future time during extended periods when the ore tonnage or ore type from the pits exceed the availability of the ore processing plant. Pre-stripping or removing the overlying soil and development rock (also known as waste rock) to access the mineral deposit, will commence during the construction phase in Mine Year 2. Ore removal and processing will begin in Mine Year 1 (operations phase) and continue year-round for approximately 15 years. Mine operations will occur in the area of two historical open pit mined areas (Yellow Pine and West End) and one new open pit (Hangar Flats) that includes the sites of former underground mining and mineral processing facilities. Development rock will be hauled to the tailings storage facility embankment or placed in one of four destinations: the tailings storage facility buttress or the Yellow Pine, Hangar Flats, or West End open pits once they are mined out.

REC 7560
PRI-00001072

Mitigation Measures – Whitebark Pine Impact Rectifying and Restoring:

- VEG-11. If damage or removal of any live whitebark pine trees cannot be avoided, the Project Operator will make every reasonable effort to collect the cones, scion, pollen, or other genetic material from live mature trees (particularly "plus" trees) within the same seed zone for future restoration efforts before the live whitebark pine is damaged or killed. The Project Operator will coordinate with the Forest Service and U.S. Fish and Wildlife Service to identify potential restoration efforts for the species within or near the Stibnite Gold Project.
- VEG-12. If collection cannot occur, the Project Operator will contact the Forest Service and U.S. Fish and Wildlife Service to explore additional options, which may include replanting in accordance with current whitebark pine replanting guidelines or best practices, or suitable alternatives with whitebark pine seedlings or seed stock of known superior parentage ("plus" whitebark pine). Whitebark pine used for replanting will be of the same seed zone as the mature trees that were removed.

Clark's Nutcracker Habitat

Issue: Impacts to whitebark pine seed dispersers, primarily the Clark's nutcracker and its habitat.

Mitigation Measure – Clark's Nutcracker:

VEG-13. Where possible, the Project Operator will avoid or limit cutting of mature whitebark pine trees in stands that are of sufficient size to support Clark's nutcracker use of the area (30,888 to 61,776 acres of cone bearing whitebark pine habitat within a 20.3-mile radius).

2.3.9 Wildlife

Wolverine

Issue: Impacts to wolverine habitat.

Mitigation Measure – Wolverine Impact Minimization:

- The Forest Service wildlife biologist will be notified of any occupied wolverine dens encountered during construction and operation.
- If a wolverine is observed within or near the Project, the Forest Service wildlife biologist and U.S. Fish and Wildlife Service will be notified immediately and coordination with Perpetua will occur regarding modifications to construction and operation activities to avoid potential disruption of wolverine denning activities.
- Off road use and the construction of new or temporary roads in wolverine habitat will be limited.
- New or temporary roads will be marked off limits to non-authorized motorized access to reduce traffic and increased access in wolverine habitat.
- For exploratory drilling activities, from December 1 to April 1, a 1-mile no-disturbance buffer will be implemented around denning habitat as modeled using the persistent snow cover layer.

2.3.10 Transportation

Burntlog Route Public Access Restriction

Issue: Unrestricted public use of the Burntlog Route (consisting of the existing Forest Road [FR] 447 [Burnt Log Road] and new road segments connecting to FR 50375 [Thunder Mountain Road] and FR 51290 [Meadow Creek Lookout Road]) would have potential impacts associated with traffic incidents, public safety, emergency services, wildlife interactions, wilderness solitude, and tribal interests.

Mitigation Measure – Burntlog Route public access restriction: Construction of the Stibnite Gold Project is expected to take three years (Mine Years -3 through -1). The Burntlog Route is anticipated to take two years to construct (i.e., Mine Year -3 and -2). The access to Meadow Creek Lookout Road will experience short-term closures during Year -3 when crossings of the new Burntlog Route are constructed.

The through-site public access to Thunder Mountain Road will be largely unaffected during Year -3 with more temporary closures in Year -2, then completely closed during Year -1 before re-opening on a new seasonal access route in Year 1 (Table 3).

Table 3 Access Impacts During Construction and Operations

Road	Mine Year -3	Mine Year -2	Mine Year -1	Mine Operations
Warm Lake Road (Cascade to Landmark)	Limited effects	Limited effects	Limited effects	Limited effects
Johnson Creek Road (Landmark to Yellow Pine)	Limited effects	Temporary closures	Seasonal access	Seasonal access
Stibnite Road (Yellow Pine to Stibnite)	Limited effects	Temporary closures	Closed in Operations Area	Seasonal access
Thunder Mountain Road (Stibnite to Thunder Mountain)	Limited effects	No access when Stibnite Road is temporarily closed	Access through new Burntlog Route only	Seasonal access via new public access road through site
Meadow Creek Lookout Road	Temporary closures for nearby Burntlog Route construction	Limited effects	1.8-mile shared segment with new Burntlog Route	1.8-mile shared segment with new Burntlog Route
New Burntlog Route (Landmark to Stibnite)	Under construction	Under construction	Site access plus public access	Site access with public access restriction

The Burntlog Route will be a mine access road operated by the Stibnite Gold Project for the duration of the project. As such, project-related use of the route will be regulated per the Forest Service's decision on the Stibnite Gold Project and incorporate compliance with the project's Transportation Management Plan. Public use of the Burntlog Route will be restricted. Seasonal use of the newly constructed portions of the Burntlog Route will be allowed only during the snow-free portion of Year -1 when there would be no other access to the Thunder Mountain Road.

Public use of existing segments of the Burntlog Route will not be modified by the Stibnite Gold Project decision but would be subject to temporary closures for new Burntlog Route construction. During operations, public use of existing segments of the Burntlog Route (i.e., Burnt Log Road [FS447], Meadow Creek Lookout Road [FR51290], and Thunder Mountain Road [FR50375]) will be unrestricted. The main road segment where public access would continue will be a 1.8-mile section of the Meadow Creek Lookout Road, coincident with the Burntlog Route. Signage would be placed at all intersections with Forest Service roads and trails to identify road segments with public access restrictions.

The Forest Service will require the Project Operator, to develop and implement a Burntlog Route Access Plan to restrict public access per this mitigation measure and to provide notifications to the public when the newly constructed segments of the Burntlog Route would be open.

characterized according to the Resource Conservation and Recovery Act requirements, managed in compliance with state and federal regulations and recycled or disposed of in existing, permitted facilities. Non-hazardous solid waste will be hauled from the mine site by licensed waste disposal services for disposal off-site.

7.18 Idaho Roadless Rule

Per 36 CFR 294.25(b), the Idaho Roadless Rule does not affect mining activities conducted pursuant to the General Mining Law of 1872. Idaho Roadless Area characteristics affected by the Stibnite Gold Project have been disclosed in the FEIS. The Idaho Roadless Commission has been briefed routinely throughout the analysis process.

7.19 Travel Management Rule

The reroute of Stibnite Road via the Burntlog Route and the designation of a temporary over-snow vehicle route to replace an existing over-snow vehicle route are actions that fall under the Travel Management Rule (36 CFR 212), Subparts B and C, respectively (FSM 7715.03(5)).

The over-snow vehicle route designation requires consideration under the Travel Management Rule Minimization Criteria (36 CFR 212.55(b)). The environmental design features (see Parts 10.2, 10.3.2, 10.3.3, 10.3.4, 10.3.6, 10.3.7, 10.3.12, and 10.3.14 below) and mitigation measures (see Parts 2.3.2, 2.3.5, 2.3.6, 2.3.8, and 2.3.11) were developed with the objective of minimizing:

- *Damage to soil, watershed, vegetation, and other forest resources* – The route uses the existing Cabin Creek Road (FR 50467) to minimize new ground disturbance. Best management practices and environmental design features protective of soils, water, and vegetation are described in Table 5, Table 6, and Parts 10.3.2, 10.3.7, and 10.3.12 of this ROD below. Cabin Creek, a 303(d) listed stream for water temperature, is adjacent to the over-snow vehicle route. There are no municipal or domestic water supplies in the vicinity of the trail;
- *Harassment of wildlife and significant disruption of wildlife habitats* – The route uses the existing Cabin Creek Road (FR 50467) to minimize effects on wildlife. Best management practices and environmental design features protective of wildlife are described in Table 5, Table 6, and Parts 10.3.3, 10.3.4, and 10.3.6 of this ROD below;
- *Conflicts between motor vehicle use and existing or proposed recreational uses of National Forest System lands or neighboring federal lands* – The route uses the existing Cabin Creek Road (FR 50467) to minimize effects on neighboring recreation;
- *Conflicts among different classes of motor vehicle uses of National Forest System lands or neighboring federal lands* – The over-snow vehicle route does not cross other vehicle routes; and,
- *Compatibility of motor vehicle use with existing conditions in populated areas, taking into account sound, emissions, and other factors* – There are no populated areas in the vicinity of the over-snow vehicle route.

I find that the Selected Alternative complies with the Travel Management Rule.

7.20 Special Uses

The Payette and Boise National Forest Land and Resource Management Plans allow special uses that serve the public, promote public health and safety, protect the environment, are legally mandated, and are compatible with other resources. This may include special uses for ancillary facilities related to exploration and mining-related operations that lie on National Forest System lands outside of mineral lease boundaries. The power transmission line meets the special uses screening criteria at 36 CFR 251.53(l)(4) and considerations put forth at 36 CFR 228 Subpart A for uses in connection with operations under the mining laws.

Description	Type	Reference	Resources Affected
• Temporary wooden structure could be erected around portions of the drill, pumps, and heaters, with acoustic absorbent panels. These temporary structures will not be put in place if they created safety issues related to exhaust vapor build-up. • When feasible, activities such as helicopter use and blasting, could be scheduled at the same time.			
In revegetation and seeding projects in occupied sensitive plant habitat, a Forest botanist shall be consulted to ensure appropriate species are used.	FP Component	BNF and PNF: BTST05	Vegetation
Design and implement projects within occupied habitats of Sensitive species to help prevent them from becoming listed. Use Forest Service-approved portions of Conservation Strategies and Agreements, as appropriate, in the management of Sensitive species habitat to keep management actions from contributing to a trend toward listing for these species.	FP Component	BNF and PNF: WIST02	Wildlife, Vegetation

Table 6 Proponent Proposed Environmental Design Features

Description	Resources Affected
Following crushing, the crushed ore will report via conveyor to a dome-shaped, covered stockpile.	Air Quality
Dust emission controls, such as water sprays and/or bag house dust collectors, will reduce dust from crushing, conveying, and stockpiling.	Air Quality
Dust will be controlled in a similar manner to the ore crushing and conveying process using water sprays and/or bag house dust collectors.	Air Quality
Air emissions from the leaching facility will be captured in a series of air pollution controls, and the material collected will be disposed of as a solid waste or a hazardous waste depending on characterization of the waste.	Air Quality
Air emissions from the induction furnace will be captured in a series of emission controls. Mercury from the induction furnace will be converted to a liquid metallic state, and then securely stored prior to shipment to a certified hazardous waste disposal facility.	Air Quality
Silos will be equipped with air emission controls except for Prill Silo.	Air Quality
All off-highway diesel engines will be Environmental Protection Agency Tier IV or better.	Air Quality, Climate Change
The Project Operator will encourage employees to use company provided shuttle buses as transport to the Stibnite Gold Logistics Facility from towns along SH 55.	Air Quality, Health and Safety, Transportation and Access
Busing and/or vanpooling will be provided for the Project Operator and contractor employees. The associated parking area will accommodate approximately 300 vehicles. To the degree practicable, the Project Operator will mandate the use of busing and vans for employee and contractor transportation to the Stibnite Gold Project and the worker housing facility.	Air Quality, Health and Safety, Transportation and Access
Proper dust control will be employed along transportation corridors and active mining areas using aquatic safe dust suppression chemicals and methods.	Air Quality, Water Resources, Fish, Wildlife

Description	Resources Affected
Other legacy materials may be encountered during construction and operations. If encountered, these materials will be characterized to determine potential for reprocessing, reuse, or disposal.	Hazardous Materials
Small scale composting associated with organic materials generated at the worker housing facility may be incorporated within the centralized growth media stockpile in the Fiddle valley.	Hazardous Materials
An Explosives and Blasting Management Plan will be prepared for the Stibnite Gold Project. Explosives storage, transport, handling, and use will comply with applicable Department of Homeland Security, Bureau of Alcohol, Tobacco, Firearms and Explosives, and Mine Safety and Health Administration regulations.	Health and Safety
For safety and security reasons, no alcohol, firearms, or illegal drugs will be permitted on site.	Health and Safety
For safety and security reasons, public access into the mine area will be prevented by using fencing, gate locking, security personnel, and/or notice postings that prohibit unauthorized entry; no unauthorized vehicles or personnel will be permitted on the Stibnite Gold Project.	Health and Safety
Personnel transporting, handling, or using any hazardous chemicals (including sodium cyanide) will be trained to ensure the safe use of such materials. The Project Operator will design, construct, and manage facilities to conform to International Cyanide Management Code.	Health and Safety, Fish, Wildlife, Hazardous Materials
Fuel and other petroleum products at the site will be stored in above ground containment structures, with appropriate secondary containment measures.	Health and Safety, Fish, Wildlife, Hazardous Materials
Air emissions, groundwater, surface water, and aquatic parameters will be monitored during mine construction, operation, closure, and post-closure as specified in the final authorizations from the regulating agencies.	Monitoring
Monitoring will be conducted following the completion of closure and reclamation of all facilities and disturbance areas to demonstrate compliance with permit requirements and to measure the success of reclamation and mitigation.	Monitoring
The draft EMMP includes the following plans for monitoring aquatic resources: Stream and Wetlands Monitoring and Management Plan and Fisheries and Aquatic Habitat Monitoring and Management Plan.	Monitoring
The ore processing facility building will be enclosed.	Noise, Wildlife, Health and Safety
Appropriate sound dampening and muffling equipment will be utilized to minimize noise excursion from equipment and facilities. When possible, schedule high noise activities at the same time. Monitor and maintain equipment to reduce noise related impacts.	Noise, Wildlife, Health and Safety
When practicable, pumps, generators, and engines will be turned off when not in use to avoid unnecessary noise generation and reduce energy consumption.	Noise, Wildlife, Health and Safety
Electric line power will be utilized during operations to eliminate diesel generator noise, except in emergency situations when grid power is down or temporary use in remote areas where it is not practical to run power lines.	Noise, Wildlife, Health and Safety
An 8-mile temporary 16-foot-wide groomed over-snow vehicle trail will be created adjacent to Johnson Creek Road between Landmark and Trout Creek Campground during construction of the Burntlog Route.	Recreation

Description	Resources Affected
Soil stability will be estimated for all reclaimed areas using qualitative descriptors.	Soils, Reclamation
Slope stability will be monitored during the erosion inspections.	Soils, Reclamation
If the performance of reclaimed areas is not satisfactory, appropriate maintenance activities will be implemented. Maintenance activities may include one or more of the following: • Sediment removal from sediment basins, stormwater drainage channels, and diversions as necessary to maintain their design capacity; • Diverting surface water away from reclaimed areas where erosion jeopardizes attainment of reclamation standards; • Stabilizing rills, gullies, and other erosion features or slope failures that have exposed development rock; • Noxious weed and invasive plant species control; and, • Re-seeding or re-applying reclamation treatments in areas where it is determined through monitoring and agency consultation that reclamation will not meet standards.	Soils, Reclamation
The Project Operator will submit an annual report to the Forest Service and the other federal and state agencies that are responsible for issuing authorizations applicable to reclamation for the preceding calendar year. The annual report will contain descriptions of the reclamation activities completed during the previous year, a summary of areas reclaimed, a discussion of the results of the reclamation monitoring conducted, and corrective actions implemented.	Soils, Reclamation
A new 12-foot-wide gravel road will be constructed to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375) through the Stibnite Gold Project. During operations, the public access road will be used to travel through the Stibnite Gold Project and will provide seasonal use, open to all vehicles. Vehicles passing through the Stibnite Gold Project will be required to check-in with mine personnel at the North or South Stibnite Gold Project entry points.	Transportation and Access, Health and Safety
Post reclamation, a road will be established over the backfilled Yellow Pine pit to allow public access through the reclaimed site and connect Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375). This will replace the operational phase public access route.	Transportation and Access
Prior to site preparation and construction of surface facilities, vegetation will be removed from operating areas. Trees and deadwood, shrubs, and slash not needed to construct windrows at the edge of Burntlog Route disturbance (to function as sediment barriers), will be chipped, and suitable soil will be separately salvaged and stockpiled (except for a small portion that will be 'live handled') for use as part of site reclamation and restoration. Portions of the salvaged soil will be blended with the chipped wood to create growth media. All growth media placed in stockpiles will be stabilized, seeded, and mulched to protect the stockpiles from wind and water erosion.	Vegetation
The Project Operator will inspect and remove vegetation material (including noxious weeds) from mechanical equipment and properly dispose to minimize the spread of unwanted vegetation.	Vegetation
Wood wastes and wood mulch are the two primary sources of compost. Food waste produced from on-site meal preparation and wastes may provide another source. Combined and properly managed during composting, these materials will provide a source of organic matter to be blended into substrate materials suitable for mitigation.	Vegetation
The Project Operator will be responsible for noxious weed control within areas disturbed by Stibnite Gold Project activities.	Vegetation, Wildlife
Develop and employ planting plans for wildlife benefits (cover, forage, etc.) using approved seed mixes.	Vegetation, Wildlife

10.3.10 Road Use and Maintenance

Description	Reference
Minor surface improvements (e.g., ditch and culvert repair, adding gravel, winter snow removal, and summer dust suppression) will occur on the Yellow Pine Route to reduce sediment runoff and dust generation.	2021 Modified Mine Plan
Once all final mine closure and reclamation work has been completed, the Project Operator will reduce the 21-foot-wide travel way of 19.8 miles of Burntlog Road (FR 447), 1.3 mile of Meadow Creek Lookout Road (FR 51290), and 2.0 miles along Thunder Mountain Road (FR 375) of Burntlog Route to their approximate pre-mining width.	2021 Modified Mine Plan
The approximately 15 miles of Burntlog Route connecting to Meadow Creek Lookout Road (FR 51290) and Thunder Mountain Road (FR 50375) will be decommissioned.	2021 Modified Mine Plan
Following mining and ore processing operations, unless they are taken over by a third-party for ongoing use and maintenance, the Burntlog Maintenance Facility buildings will be removed. The sewer system and septic tanks for the facility will be decommissioned. Soil and rock beneath fuel storage areas and chemical storage buildings will be tested for contamination. All reagents, petroleum products, solvents, and other hazardous or toxic materials will be removed from the site and disposed of according to applicable state and federal regulations. After demolition of the buildings and facilities, the site will be graded, and drainage restored.	2021 Modified Mine Plan
A new 12-foot-wide gravel road will be constructed to provide public access from Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375) through the Stibnite Gold Project. During operations, the public access road will be used to travel through the Stibnite Gold Project and will provide seasonal use, open to all vehicles. Vehicles passing through the Stibnite Gold Project will be required to check-in with mine personnel at the North or South Stibnite Gold Project entry points.	2021 Modified Mine Plan
Post reclamation, a road will be established over the backfilled Yellow Pine pit to allow public access through the reclaimed site and connect Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375). This will replace the operational phase public access route.	2021 Modified Mine Plan
New roads constructed for the Project on National Forest System lands will be closed and reclaimed, as required by Forest Service, once they are no longer needed to support Project construction, operations,	2021 Modified Mine Plan
Project-related traffic will be restricted to existing roadways and Project areas. Off-road travel in previously undisturbed areas will be forbidden.	2021 Modified Mine Plan

10.3.11 Reclamation and Restoration

Description	Reference
Facilities will be located on previously impacted lands when that location fits into mine operations.	2021 Modified Mine Plan
Productive lands that support wildlife and fisheries habitat and dispersed recreation will be established on Project-related surface disturbance.	2021 Modified Mine Plan
Approximately 37 percent of the reclamation will be done concurrent to mining and ore processing; the remaining 63 percent will be accomplished during closure. Annual reclamation activities are described in a schedule provided in Table 3-1 of the Reclamation Closure Plan. Concurrent reclamation areas will focus on construction period restoration efforts (e.g., East Fork Meadow Creek, aka Blowout Creek) and laydown yards, Yellow Pine Pit area facilities, and Hangar Flats Pit area facilities. Closure period activities are focused on the West End Pit area, tailings storage facility area, Fiddle growth media stockpile, and process plant area. This information is also presented graphically in Appendix C to the Compensatory Mitigation Plan.	2021 Modified Mine Plan
The Yellow Pine pit will be backfilled with West End pit development rock during operations.	2021 Modified Mine Plan
A sinuous channel will be constructed through the backfilled area for the reconstructed East Fork South Fork Salmon River with an average valley gradient approximating the historical, pre-disturbance river gradient.	2021 Modified Mine Plan
The backfill will be placed to achieve a mounded final reclamation surface to promote drainage away from the West End pit and prevent formation of a pit lake within Midnight pit.	2021 Modified Mine Plan
The floor of the sidehill pit southwest of the main West End pit will be graded to drain, covered with growth media, and revegetated.	2021 Modified Mine Plan

BEFORE THE BOARD OF ENVIRONMENTAL QUALITY

STATE OF IDAHO

IN THE MATTER OF AIR QUALITY PERMIT TO CONSTRUCT P-2019.0047	Case Docket No. 0101-22-01 OAH Case No. 23-245-01
NEZ PERCE TRIBE, IDAHO CONSERVATION LEAGUE, and SAVE THE SOUTH FORK SALMON, Petitioners, v. IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY, Respondents, and PERPETUA RESOURCES IDAHO, INC., Intervenor-Respondent.	ORDER ON SAVE THE SOUTH FORK SALMON'S MOTION FOR RECONSIDERATION BASED ON NEW EVIDENCE DATED JUNE 6, 2025

I. INTRODUCTION

On June 6, 2025, Save the South Fork Salmon ("SSFS") filed a *Petitioner Save the South Fork Salmon's Motion for Reconsideration Based on New Evidence and Memorandum in Support* ("Motion for Reconsideration"), along with a *Declaration of Julia Thrower* ("Declaration."). The Motion for Reconsideration seeks reconsideration of the Idaho Department of Environmental Quality Board's ("DEQ Board") *Final Order* issued in this matter on May 27,

2025. The Motion for Reconsideration asserts that the United States Forest Service's January 2025 Final Environmental Impact Statement("FEIS") and Final Record of Decision ("ROD") for the Stibnite Gold Project ("STP") provides relevant new information that addresses the issue of whether Perpetua Resources Idaho, Inc. ("Perpetua") has legal control to preclude public access to the Stibnite Road Access Route such that it was appropriate for the Department of Environmental Quality ("DEQ") to exclude the road from ambient air quality protections when it issued the Air Quality Permit to Construct ("PTC") at issue in this case.

BACKGROUND

The DEQ Board issued a *Final Order* in this matter on May 9, 2024. REC 3695–3720. The Final Order found that 1) DEQ acted reasonably and in accordance with law when it determined that Perpetua will have legal control of the Stibnite Road Access Route such that it could properly be excluded from consideration as ambient air, 2) DEQ acted reasonably and in accordance with law when it determined that Perpetua will have physical and practical control of the Stibnite Road Access Route such that it could properly be excluded from consideration as ambient air, 3) DEQ acted reasonably and in accordance with law when it allowed Perpetua to submit some plans after the PTC was issued, 4) the PTC includes enforceable conditions that will achieve 93.3% dust control, and 5) DEQ did not act reasonably and in accordance with law when it analyzed the ambient arsenic air concentrations for the Stibnite Gold Project. REC 3717. The *Final Order* remanded the ambient arsenic air concentration issue back to the Hearing Officer for additional fact-finding. REC 3717.

On May 23, 2024, Petitioners the Nez Perce Tribe, Idaho Conservation League, and Save the South Fork Salmon filed a *Petitioners' Motion for Clarification and/or Reconsideration* of the *Final Order.* REC 3721–3727. On May 23, 2024, Respondent/Intervenors DEQ and

Perpetua filed a *Joint Motion for Reconsideration and/or Clarification of Final Order* and *Memorandum in Support of Joint Motion for Reconsideration and/or Clarification of Final Order*. REC 3728–3730. On June 3, 2024, Petitioners filed *Petitioners Response Opposing DEQ/Perpetua's Motion for Reconsideration*. REC 3757–3761. On June 4, 2024, DEQ and Perpetua filed a *Joint Motion to Strike Petitioners Response*. REC 3823–3827. The motions raised several issues including that the DEQ Board: 1) vacate the PTC while the matter was on remand or order an amended Application for Permit to Construction be filed, 2) reconsideration of the *Final Order* including clarification of its effective date, 3) reconsider its decision on the ambient arsenic concentrations, 4) hold additional hearings on the arsenic issues before issuing the *Final Order*, 5) reconsider or clarify the instructions on remand to the Hearing Officer.

On June 12, 2024, the DEQ Board issued an *Order on Petitions for Reconsideration and/or Clarification of Final Order* ("Order on Reconsideration"). REC 3835–T3843 The DEQ Board denied all the requests for reconsideration/clarification except the request for clarification of the effective date of the *Final Order*. REC 3842. The DEQ Board stayed issuance of the *Final Order* until the remand before the Hearing Officer was complete and all statutory deadline for revies of the Hearing Officer's Order had run. REC 3840 . The case was remanded to the Hearing Officer and a hearing was held October 17–18, 2024. The Hearing Officer issued a *Findings of Fact, Conclusions of Law, and Preliminary Order* on January 7, 2025. REC 7091–7118. On January 21, 2025, Petitioners filed their *Petitioners' Petition for Review of January 7, 2025 Preliminary Order, Memorandum in Support, and Request for Hearing.* REC 7119–7145. The Petition requested a review of three issues: 1) That the 16/70 adjustment for arsenic was unlawful and not supported by the evidence, 2) the five-year rolling average was not reasonable, and 3) the PTC conditions were insufficient to limit production from West End Pit and/or non-

West End Pit sources to meet arsenic limits. REC 7122. On January 24, 2025, Save the South Fork Salmon filed its *Motion for Reconsideration of the Final Order*. REC 7146–7185. On February 24, 2025, the DEQ Board denied the *Motion for Reconsideration* without prejudice finding that, given it stay of the *Final Order*, the Motion was not timely filed. REC 7343–7348.

On May 27, 2025, the Board issued its *Final Order*. REC 7358–7373. The *Final Order* found: 1) there was Sufficient Evidence to Demonstrate that DEQ Acted Reasonably and in Accordance with Law in Using a Five-Year Rolling Average for T-RACT, 2) there was Sufficient Evidence to Demonstrate that DEQ Acted Reasonably and in Accordance with Law in Not Including Additional Permit Conditions Limiting the Non-West End Pit Production Limit, 3) there was Sufficient Evidence to Demonstrate that DEQ Acted Reasonably and in Accordance with Law When it Applied the 16/70 Adjustment. REC 7371. The Final Order was final as to all issues presented, as well as to all issues previously decided in the Final Order issued in this matter on May 9, 2024. REC 7371.

On June 6, 2025 Petitioners Save the South for Salmon filed *Petitioner's Save the South Fork Salmon Motion for Reconsideration Based on New Evidence and Memorandum in Support*. REC 7374–7391.

ANALYSIS

The Motion for Reconsideration seeks to have the DEQ Board reconsider its *Final Order* based on new evidence in the form of the Forest Service's FEIS and ROD. Petitioners argue that the FEIS and ROD provide new evidence demonstrating that Perpetua will not have legal control to preclude public access over the Stibnite Access Road. In support of this argument, Petitioners cite multiple portions of the FEIS that refer to the Stibnite Access Road as a "public road."

Petition at 4–7. However, the Petitioners failed to site[1] the following language found in the Stibnite Gold Project Final Environmental Impact Statement Errata ("FEIS Errata"):

> During operations, the public access road through the Operations Area Boundary would provide seasonal use, open to all vehicles; access would not be provided in winter when impassable (current county maintenance standards) and signs would inform the public of seasonal and temporary closures. Public vehicles passing through would be required to check-in with mine personnel at the North or South SGP entry points and would receive a safety briefing and would also be required to check-out with SGP personnel upon exiting the SGP. For safety purposes, public access would be separated from other SGP roads by berms, security fencing, and the underpass to allow the public road to pass beneath the mine haul road. No stopping or deviating from the public access road would be allowed. Perpetua could restrict access to any vehicles due to concerns related to public or employee health and safety, such as during road construction and maintenance, blasting, highwall scaling, mining in the immediate area of the road, and similar operations. *Because public use of the road would be subject to Perpetua's control measures on general use, the public access road is not considered a public road.*

Declaration of Julia Thrower at Exhibit 3 p. 1 (italics in original).

This language from the FEIS Errata supports rather than undermines the DEQ Board's analysis set forth in its May 9, 2024 *Final Order*. REC 3698–3703. In the May 9, 2024 *Final* Order, the DEQ Board analyzed the conditions set forth in the PTC that would require Perpetua maintain legal, physical, and practical controls over the Stibnite Access Road such that it was properly excluded from consideration as ambient air. *Id.* Nothing in the language from the FEIS Errata cited above undermines that analysis. Indeed, the italicized last sentence makes it clear that the USFS is expressly not designating the Stibnite Access Road as a "public road." Thus,

[1] While Petitioners do make reference to the FEIS Errata in Footnote 2 on page 12 of their Petition, they do not cite it in the body of their petition, nor deal with it substantively in their analysis.

Petitioners have not presented any new evidence that would cause the DEQ Board to have to reevaluate the analysis it provided on this issue in the May 9, 2024 *Final Order.*

CONCLUSION

Based on the foregoing it is hereby ordered the Motion for Reconsideration is denied.

Dated this 27th day of June, 2025

Dr. John R. MacMillan
Chairman, Idaho Board of Environmental Quality

CERTIFICATE OF SERVICE

I HEREBY CERTIFY that on this 27th day of June 2025, I caused to be served a true and correct copy of the foregoing ORDER ON SAVE THE SOUTH FORK SALMON'S MOTION FOR RECONSIDERATION BASED ON NEW EVIDENCE DATED JUNE 6, 2025 by transmitting a copy thereof in the manner listed below:

Hannah Young
Deputy Attorney General
Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
hannah.young@deq.idaho.gov

Julia Thrower
Mountain Top Law PLLC
614 Thompson Ave.
McCall, ID 83638
jthrower@mtntoplaw.com

Bryan Hurlbutt
Laird Lucas
Advocates for the West
P.O. Box 1621
Boise, ID 83701
bhurlbutt@advocateswest.org
llucas@advocateswest.org

Krista K. McIntyre
W. Christopher Pooser
Wade C. Foster
Stoel Rives LLP
101 S. Capitol Blvd, Suite 1900
Boise, ID 83702
krista.mcintyre@stoel.com
christopher.pooser@stoel.com
wade.foster@stoel.com

Ann Yribar
Deputy Attorney General
Energy and Natural Resources Division
Office of the Attorney General
P.O. Box 83720
Boise, ID 83720-0010
Counsel for the Idaho
Board of Environmental Quality
ann.yribar@ag.idaho.gov

Dylan Lawrence
Varin Thomas LLC
P.O. Box 1676
Boise, ID 83701
Hearing Officer
dylan@varinthomas.com

Office of Administrative Hearings
P.O. Box 83720
Boise, ID 83720-004
filings@oah.idaho.gov

_____

/s/ Diane Cutler

Diane Cutler, Hearing Coordinator
Department of Environmental Quality
1410 N. Hilton
Boise, Idaho 83706
diane.cutler@deq.idaho.gov